Background

Global Strategic Trends is a comprehensive view of the future produced by a research team at the Development, Concepts and Doctrine Centre (DCDC). This edition of Global Strategic Trends is benchmarked at 12 January 2010.

Conditions of Release

The findings contained in Global Strategic Trends are DCDC’s and the document does not represent an official position of Her Majesty’s Government or the Ministry of Defence (MOD). The information is, however, Crown Copyright.

Departmental Direction

Global Strategic Trends is an examination of the strategic context that faces defence and the challenges and opportunities it provides for the MOD. MOD direction on the DCDC Strategic Trends Programme stresses the requirement for a comprehensive approach.

DCDC’s Strategic Trends Programme aims to provide a detailed analysis of the future strategic context for defence out to 2040. This will be an essential input into policy and concept development. Major outputs include:

- Trends based analysis of the future strategic context;
- Analysis of alternative futures, key risks and shocks, including an assessment of their probability, frequency and magnitude;
- Identification of how shocks might impact on the future strategic context;
- Identification of the broad defence and security implications of this analysis.

Building on previous editions of Global Strategic Trends, the analysis adopts a comprehensive approach to the key drivers and deduces the salient themes out to 2040. In compiling the analysis, the Strategic Trends Programme makes use of a broad and diverse evidence base.
Foreword by the Assistant Chief of the Defence Staff (Development, Concepts and Doctrine) – Major General Paul Newton CBE

The DCDC Strategic Trends Programme provides a comprehensive analysis of the future strategic context out to 2040. The work is based on research conducted at DCDC in conjunction with subject matter experts across a range of disciplines. These experts come from a multitude of backgrounds, including government and academia. It is a global view of future trends and DCDC has conducted workshops and consultations in Europe, the Middle East, Asia, Africa and North America to gain an international perspective.

The document is a contribution to a growing body of knowledge and is aimed at the defence community. It seeks to build on previous editions of Global Strategic Trends with a more accessible format. It has a greater focus on defence and security issues and expands on other subjects, including resources, and the resurgence of ideology. From a comprehensive review of trends, it draws out 3 key themes: how we will adapt to the reality of a shifting climate and breakneck technological innovation (see the Human Environment); the dominance of the West in international affairs will fade and global power will become more evenly distributed between the West and the rising powers in Asia (see the Dynamics of Global Power); and finally, as society and the distribution of global power changes, the challenges to defence and security will increase (see Evolving Defence and Security Challenges). It draws lessons from contemporary events to conclude that globalisation is a more volatile process than previously envisaged and that this volatility may leave globalised systems more vulnerable to strategic shock and systemic failure. It also draws out high level global defence and security implications.

Previous editions of Global Strategic Trends have been accused of taking a pessimistic view of the future. However, in this edition, we see the opportunities as well as challenges and believe that we provide a realistic assessment. The period out to 2040 will be a time of transition, which is likely to be characterised by instability, both in the relations between states, and in the relations between groups within states. This period of transition will not occur in a linear fashion; as climate change, global inequality, population growth, resource scarcity and the shift of power from west to east will transform the strategic context. These will be persistent, complex challenges.

However, it is the manner in which states, their leaders and their populations react to these challenges that will define the era. If they choose to implement collective responses then the challenges are likely to be overcome, and progress and development will follow. However, if they miscalculate under pressure, are constrained by misunderstanding, or fail to seize opportunities, the result is likely to be instability, tension and ultimately conflict.
Global Strategic Trends

Purpose

The need for defence to understand the future strategic context was articulated in the Strategic Defence Review (1998), which confirmed the long-term nature of defence planning and the need for a wide-ranging understanding of the future strategic environment. Global Strategic Trends provides a measure of context and coherence in an area characterised by transition, risk, ambiguity and change.

The DCDC approach goes beyond solely identifying potential future defence and security challenges to which our Armed Forces will have to respond, and looks at the developments in areas that will shape the wider strategic context within which defence will have to interact. For example, the document addresses subjects such as: the shifting global balance of power; emerging demographic and resource challenges; as well as climate change and societal changes.

One of the strengths of the Global Strategic Trends assessment is its relative independence from wider defence decision-making. Consequently, Global Strategic Trends is able to inform defence decisions, without being constrained by the latest good idea, fashionable trend or received wisdom. Some of the findings in Global Strategic Trends will, therefore, challenge views which derive from existing or transient circumstances, instead drawing on long-term trends and the enduring features of the strategic context.

This edition of Global Strategic Trends has contributed towards the Defence Green Paper.
Global Strategic Trends

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How to Read Global Strategic Trends

This is the fourth edition of Global Strategic Trends. It is a stand-alone document that seeks to explore the relevance of global trends to defence and security out to 2040, while building on previous editions. This document is split into 3 sections:

- **Executive Summary and Implications for Defence and Security.** This section highlights the major themes and their relevance to defence and security.

- **Part 1: Analysis.** This section brings together the important arguments, themes and analyses of the evidence. It is split into 3 sub-sections:
  
  o **Ring Road Issues.** The 4 key drivers for change that will affect the lives of everyone on the planet.

  o **Key Themes.** Three essays on *The Human Environment, Dynamics of Global Power* and *Evolving Defence and Security Challenges* that develop and analyse trends and drivers as well as identifying the most likely outcomes.

  o **Strategic Shocks.** These are high impact events that have the potential to rapidly alter the strategic context.

- **Part 2: Dimensions.** This section considers underlying trends and drivers for the key themes. It summarises some of the evidence upon which they are based. This is intended as a reference section, and will also be of interest to some specialist readers.

**Hot Topics** are distributed through the document and identify issues of particular interest that are covered in greater depth.
Definitions

The definitions of some of the terms used within the document are:

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Trend</td>
<td>A trend is a discernable pattern of change.</td>
</tr>
<tr>
<td>Driver</td>
<td>A driver is a factor that directly influences or causes change.</td>
</tr>
<tr>
<td>Ring Road Issue</td>
<td>A driver that is so pervasive in nature and influence that it will affect the life of everyone on the planet over the next 30 years.</td>
</tr>
<tr>
<td>Dimension</td>
<td>In depth research and analysis on trends and drivers, organised into 5 key areas: Social; Resource and Environment; Economic; Geopolitical; and Science and Technology.</td>
</tr>
<tr>
<td>Outcomes</td>
<td>A description of salient features of the future strategic context, with an associated level of confidence. Alternative outcomes are judged less likely than probable outcomes.</td>
</tr>
<tr>
<td>Risks and Benefits</td>
<td>The consequences of the outcomes and how they could manifest themselves and affect defence business.</td>
</tr>
<tr>
<td>Strategic Shock</td>
<td>A shock is a high impact event that results in a discontinuity or an abrupt alteration in the strategic context. The strategic shock can either be expected or unexpected; the important point is that it dislocates the strategic context from the trends that have preceded it.</td>
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Outline Methodology

Global Strategic Trends is based on driver and trend analysis. The process identifies trends and drivers in the social, science and technology, economic, resource and environment, and geopolitical dimensions. Within each of these dimensions, key trends have been determined through detailed analysis with subject matter experts. A cross-dimensional analysis then considers how these trends are likely to develop and interact, in order to establish the key themes: The Human Environment, The Dynamics of Global Power, and Evolving Defence and Security Challenges. The assessments are made to varying degrees of probability to reflect multiple alternative outcomes. The future outlined in Global Strategic Trends is realistic, based on the most probable outcomes, although alternative futures are also explored.
These outcomes are discussed in 3 key themes:

- The Human Environment.
- Dynamics of Global Power.
- Evolving Defence and Security Challenges.

These key themes identify outcomes from the trends and drivers. They are intended to help: understand interactions between the trends; distinguish between long-term significant changes and short-term turbulence; and identify major challenges and opportunities in the future strategic context.

As well as establishing trend-based outcomes, Global Strategic Trends seeks to identify and interpret the likely pattern of change over the next 30 years. In doing so, it assesses that during this period human activity will be dominated by 4 pervasive issues, which are described here as Ring Road Issues:

- Climate Change.
- Globalisation.
- Global Inequality.
- Innovation.
Expressing Probability

Each finding within Global Strategic Trends is presented with an assessment of likelihood assigned to it. This assessment represents the probability of the finding as viewed by the authors. Such probabilities are, of necessity, subjective. Their function within this document is to provide a measure that can be used as a guide for policy planners who need to make rapid, informed decisions regarding complex global issues using a readily comparable scale for judgements.¹

Using the expressions listed below, these assessments are presented throughout the document in italics. Because of the high number of variables, trends-based analysis can never offer precise predictive analysis and the terms below provide a coarse indication of uncertainty, based on the available evidence.

<table>
<thead>
<tr>
<th>Description</th>
<th>Associated Probability Range</th>
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<tbody>
<tr>
<td>Will</td>
<td>Greater than 90%</td>
</tr>
<tr>
<td>Likely/Probably</td>
<td>Between 60% and 90%</td>
</tr>
<tr>
<td>May/Possibly</td>
<td>Between 10% and 60%</td>
</tr>
<tr>
<td>Unlikely/Improbable</td>
<td>Less than 10%</td>
</tr>
</tbody>
</table>

¹ In order to acknowledge the uncertainty of an event the first task is to measure the intensity of your belief in the truth of that event; to attach to each event a number, which describes your attitude to the statement. Lindley D.V, Understanding Uncertainty, 2006.
Executive Summary and Implications for Defence and Security

This section highlights the major themes and their relevance to defence and security.
Executive Summary and Implications for Defence and Security

The era out to 2040 will be a time of transition; this is likely to be characterised by instability, both in the relations between states, and in the relations between groups within states. During this timeframe the world is likely to face the reality of a changing climate, rapid population growth, resource scarcity, resurgence in ideology, and shifts in global power from West to East. No state, group or individual can meet these challenges in isolation, only collective responses will be sufficient. Hence, the struggle to establish an effective system of global governance, capable of responding to these challenges, will be a central theme of the era. Globalisation, global inequality, climate change and technological innovation will affect the lives of everyone on the planet. There will be constant tension between greater interdependence between states, groups and individuals and intensifying competition between them. Dependence on complex global systems, such as global supply chains for resources, is likely to increase the risk of systemic failures.2

The distribution of global power will change. Out to 2040, the locus of global power will move away from the United States (US) and Europe towards Asia, as the global system shifts from a uni-polar towards a multi-polar distribution of power.3 This shift, coupled with the global challenges of climate change, resource scarcity and population growth, is likely to result in a period of instability in international relations, accompanied by the possibility of intense competition between major powers. The hegemonic dominance of the US will fade. She is likely to remain the pre-eminent military power, although, in political, economic and military terms, she is likely to be increasingly constrained as others grow in influence and confidence. However, the rise of individual states, such as China, should not be considered a certainty given the nature and magnitude of the challenges they face, nor should their eventual influence be over-estimated. Instead there will be several states and institutions competing for regional and global influence, cooperating and competing within the international community.

Globalisation is likely to continue, underpinned by the rapid development of global telecommunications, and resulting in a pervasive information environment in which much of the global population will be capable of being online all the time. Politically, globalisation is likely to raise the level of interdependence between states and individuals within the globalised economy. It is likely to be an engine for accelerating economic growth, but also a source of risk, as local markets become increasingly exposed to destabilising fluctuations in the wider global economy. Economically, globalisation is likely to generate winners and losers, especially in the labour market. As a result, everyday life is likely to be competitive, dynamic and fluid, leading to the possibility that political decisions may limit globalisation in order to protect reluctant populations from its negative effects. Looser forms of political, cultural and economic association will multiply as physical dispersion no longer acts as a barrier for those who share common interests.

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2 A systemic failure is the failure of a chain of markets or institutions. It is not limited to finance, and can occur in any complex system.
3 A uni-polar world has a single dominant power. A multi-polar world has 3 or more states or alliances that dominate world politics.
The physical manifestations of globalisation are likely to be most apparent in the globalised core, which comprises the most interdependent and economically successful regions of the world. Instability within the globalised core is likely to adversely affect the national interests of major powers. Resources, trade, capital and intellectual property are likely to flow through this core, and rely on complex networks of physical and virtual infrastructure that are likely to be vulnerable to physical disruption or cyber attack by multiple actors. This infrastructure includes air and sea lanes and their associated ports, rail and road infrastructure, communications links, gas, oil, electricity pipelines and cables, food distribution centres, banking and finance hubs, universities and science parks, manufacturing and energy production facilities. Consequently, increasing dependency on this infrastructure, and the global supply chains that underpin globalisation, will leave the global economy vulnerable to disruption. Ensuring the security of this globally distributed infrastructure is likely to be of multilateral interest.

Climate change will amplify existing social, political and resource stresses, shifting the tipping point at which conflict ignites, rather than directly causing it. Extant greenhouse gas emissions will result in global temperature increases out to 2040, which are likely to be unevenly distributed, irrespective of any agreement to limit future emissions. These temperature increases are likely to lead to significant environmental change that may, for example, include desertification in the Saharan margins and changes to rainfall distribution patterns within the monsoon belt of the Arabian Sea and South Asia. The frequency and intensity of extreme weather events may change, possibly with severe impact on low-lying coastal regions. Rapid glacial melt, particularly in the Himalayas, may exacerbate water management problems in China, India, Pakistan and Bangladesh. Disease carriers, such as malarial mosquitoes, are likely to spread into previously temperate zones.

Sufficient energy, food and freshwater resources are likely to be available to sustain the growing global population and the global economy. However, distribution and access to resources will be uneven, and local and regional shortages will occur, increasing the likelihood of societal instability and of disagreement between states, and providing the triggers that may ignite conflict. Poorer states will often be unable to access the necessary resources to allow their economies to develop and their populations to prosper. The frequency, scale and duration of humanitarian crises are likely to increase. Many states, including China and India, are likely to become more dependent on food imports to feed their large and increasingly affluent populations. A shift in agricultural patterns and the distribution of grain growing areas, coupled with the rise in animal and plant diseases, is likely to disrupt food production, resulting in increased migration. However, improvements and efficiencies in agricultural production are likely to meet much of the increased demand, given likely scientific advances that develop high-yield, disease resistant crop strains, combined with better land usage and improved irrigation. Some regions, such as Siberia and parts of Canada, may open up to wider cultivation. The oceans will be further exploited for protein, raising the demand for fishing rights in previously inaccessible areas, such as the Polar Regions.

The proportion of the global population living in absolute poverty is likely to decline. However, inequality of opportunity will be more apparent due to globalisation and increased access to more readily and cheaply available telecommunications.
inequality is *likely* to be a significant source of grievance, *possibly* resulting in an increased incidence of conflict. This is despite growing numbers of people who are *likely* to be materially more prosperous than their parents. Demographic trends *may* also fuel instability, especially in the Middle East, Central Asia and sub-Saharan Africa. Youth bulges are *likely* to provide a reservoir of disaffected young people. In particular, young males with limited economic prospects *may* be susceptible to radicalisation. However, states that experience lower birth rates and increased longevity are *likely* to benefit from a growing workforce and a falling dependency ratio. The result is a ‘demographic dividend’, which can produce a virtuous cycle of growth.

By 2040, around 65%, or 6 billion, of the world’s population *will* live in urban areas, attracted by access to jobs, resources and security. The greatest increases in urbanisation *will* occur in Africa and Asia. Up to 2 billion people *may* live in slums. Many large urban areas, especially in regions of the world suffering from poor governance, are *likely* to become centres of criminality and disaffection and *may* also be focal points for extremist ideologies. Rapid urbanisation is *likely* to lead to an increased probability of urban, rather than rural, insurgency. The worst affected cities *may* fail, with significant humanitarian and security implications. A greater understanding of the dynamics of urban societies *will* be required if instability within these regions is to be identified and managed.

New ideologies *will* emerge, driven by religion, ethnic differences, nationalism, inequality or a combination of these factors. Ideological conflicts are *likely* to occur and extremist groups *may* use violence to achieve political objectives. There *may* be a resurgence of anti-capitalist ideologies, such as Marxism. Diaspora communities are *likely* to increase in size and influence and many *will* bring economic benefits to their host states. However, those that fail to integrate are *likely* to remain reservoirs for resentment. Some of these groups are *likely* to become involved in ideologically driven conflicts, and *may* act as proxies for other states. Similarly, host states *may* be drawn into regions and conflicts that reflect the interests of their diaspora communities.

The proliferation of modern weapons’ technologies, and *probably* Weapons of Mass Destruction (WMD), *will* generate instability and shift the military balance of power in various regions. Counter-proliferation initiatives are *unlikely* to be wholly successful, and nuclear weapons are *likely* to proliferate. Terrorist groups are *likely* to acquire and use chemical, biological and radiological weapons *possibly* through organised crime groups. Many states are *likely* to develop ballistic and cruise missiles capable of delivering Chemical, Biological, Radiological or Nuclear (CBRN) weapons, as well as conventional payloads. Ballistic Missile Defence (BMD) and other air defence technologies *may* mitigate some of the risk, but they are *unlikely* to remove the threat completely.

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4 A youth bulge is a peak on a demographic graph of median age in which the bulk of a population occurs between the ages of 15-21.


6 North Atlantic Treaty Organization (NATO) doctrinal publications define Weapons of Mass Destruction (WMD) as weapons that are capable of a high order of destruction and of being used in such a manner as to destroy people, infrastructure or other resources on a large scale.

7 Chemical, Biological and Radiological (CBRN) weapons are a specific type (and therefore a sub-set) of WMD.
Terrorists are likely to acquire and use chemical, biological and radiological weapons

Innovation and technology will continue to facilitate change. Energy efficient technologies will become available, although a breakthrough in alternative forms of energy that reduces dependency on hydrocarbons is unlikely. The most significant innovations are likely to involve sensors, electro-optics and materials. Application of nano-technologies, whether through materials or devices, will become pervasive and diverse, particularly in synthetic reproduction, novel power sources, and health care. Improvements in health care, for those who can afford it, are likely to significantly enhance longevity and quality of life.

States and non-state actors will exist in a condition of persistent competition. The fundamental nature of conflict will endure. It will remain an inherently human endeavour, with all the uncertainty that this implies. However, the character of conflict will continue to evolve, remaining innately volatile. State and non-state actors will seek to combine conventional, irregular and high-end asymmetric methods concurrently, often in the same time and space and across the combined domains of the air, land, sea, space and cyberspace. Conflict is likely to involve a range of transnational, state, group and individual participants who will operate at global and local levels. In some conflicts, there is likely to be concurrent inter-communal violence, terrorism, insurgency, pervasive criminality and widespread disorder. Tactics, techniques and technologies will continue to converge as adversaries rapidly adapt to seek advantage and influence, including through economic, financial, legal and diplomatic means. These forms of conflict will transcend conventional understanding of what equates to irregular and regular military activity. Innovative communication techniques will create a network-enabled audience, providing

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8 ‘Now and in the future we have no less than 5 interdependent geographies for warfare: land, sea, air, space, and cyberspace. It has been rare in history for a new geography to be added to the elite short list of environments for warfare. Now there are 2 such new geographies, space and cyberspace, and we are becoming ever more dependent upon them both.’ Gray C.S, The 21st Century Security Environment and the Future of War, 2008.
both a challenge and an opportunity for military operations. Adaptive adversaries will seek to utilise the media and the opponent’s political system to their advantage. States will increasingly sponsor proxies, seeking to exploit gaps in the international system while minimising state-on-state risks.

The strategic balance of military power is likely to change as Asian states close the technological gap with the West in some areas, develop and maintain strong military forces, and produce and export advanced military equipment to allied states and proxies. The majority of the technological breakthroughs are likely to be driven by the commercial sector, although technological adaptation in defence will continue at a rapid pace. Non-lethal, Directed Energy Weapons (DEW), space and cyber technologies will be available to a wide variety of actors, both state and non-state.

Out to 2040, there are few convincing reasons to suggest that the world will become more peaceful. Pressure on resources, climate change, population increases and the changing distribution of power are likely to result in increased instability and likelihood of armed conflict. Total war,\(^9\) harnessing the full power of industrial states, war between major Western powers, and war between liberal democracies, are all unlikely.\(^10\) However, disagreements between major powers over borders, influence and resources are probable. Such disagreements may lead to confrontation, including limited wars, where adversaries deliberately exercise restraint in the methods of warfare, their level of commitment or the objectives sought. Intra-state conflict will remain the most common type of conflict. The use of proxies is likely and conflict involving the proxies and partners of major powers is possible. Western militaries may become involved in coalition action against adversaries possessing significant military capabilities, with Western forces possibly fighting from a position of near-parity or even relative disadvantage. Apparently unsophisticated adversaries will have ready access to cheap, yet highly effective, technologies.

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\(^9\) For example, World War II.
Global Defence and Security Implications

- The incidence of armed conflict is likely to increase underpinned by: an unstable transition to a multi-polar world that allows old and new state rivalries to emerge; widespread global inequality that heightens associated grievances; population increases, resource scarcity and the adverse effects of climate change that combine to increase instability; and the increased importance of ideology.

- Future conflict will remain unpredictable and violent. Its character will continue to evolve and present new challenges. While technology will remain important, people are likely to provide the asymmetric edge when responding to both expected and unexpected challenges, if invested in and empowered through decentralisation.

- The differences between state, state-sponsored and non-state adversaries will blur. The range of threats will diversify, as technology and innovation opens up novel avenues of attack and adaptive adversaries exploit opportunities.

- Soft power will increasingly be utilised to facilitate the achievement of political goals. Moreover, all elements of power are likely to be wielded by a broader spectrum of actors and agencies, including organised criminal, terrorist and insurgent groups. The degree to which a state or group combines hard and soft power into an amalgam of effective statecraft will determine their ability to achieve strategic objectives. Nonetheless, while traditional levers of power will continue to form the basis of statecraft, it is unlikely that the military instrument alone will be decisive.

- The CBRN threat from state and non-state actors is likely to increase, facilitated by lowering of some entry barriers, dual purpose industrial facilities and the proliferation of technical knowledge and expertise. Terrorist attacks using chemical, biological and radiological weapons are likely, as are mass-casualty attacks using novel methods. The likelihood of nuclear weapons usage will increase.

- The economic prosperity of many states will depend on functioning globalised markets and access to the global commons. Multilateral military activity to protect globalisation, including protection of global supply chains and space-based infrastructure from physical and virtual disruption, is likely. Such interdependence will give most conflicts, wherever they occur, a global dimension.

- The changing balance of power is likely to deter military intervention by major powers outside their spheres of influence, without widespread multilateral agreement, which is likely to reduce the latitude for discretion. When intervention becomes unavoidable, actors will seek to distance themselves by use of proxy forces, cyber attack, as well as covert and clandestine methods. Persistent,

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11 Statecraft is the skilful management of state affairs (Concise Oxford English Dictionary).
complex problems will require the integration of all levers of state power, both across government and among partners and allies.

- There will be an increasing range of political, legal, ethical and financial imperatives to build relationships with like-minded partners. New alliances and partnerships will form and established ones will be adapted to meet the breadth and depth of the challenges. For European powers, the North Atlantic Treaty Organization (NATO) is likely to remain the defence organisation of choice.

- Control and access to hydrocarbons will remain important and major powers are likely to use their defence forces to safeguard supplies. Conflicts over food and water resources are possible. For some protagonists, these may be viewed as wars of survival. Competition for resources will increase the geostrategic importance of certain regions such as; the Asian Meridian, the wider Middle East and the Polar Regions.

- Climate change will amplify existing social, political and resource stresses, shifting the tipping point at which conflict ignites, rather than directly causing it. Climate change is likely to increase the frequency, scale and duration of humanitarian crises. It is also likely to change patterns of migration, making border security an ongoing concern, especially in the developed world.

- Support to states suffering from instability will require interoperability between a wide range of joint and coalition military forces, other arms of state, and non-state actors, including international institutions, Non-governmental Organisations (NGOs) and contractors. Organisations will need to develop to ensure that they are able to effectively integrate their activities.

- Unlike some potential adversaries, Western defence forces will be subject to legislation that constrains their scope for action. This includes legislation concerning the conduct of operations, the emissions of greenhouse gases, and individual rights.

- Conflict will remain focused on influencing adversaries, neutrals and those at home, whose perceptions will be vital. Military operations are likely to continue to result in casualties and face the challenge of demonstrating legitimacy to sceptical public audiences. Influence activity, the battle of ideas, and perceptions of moral legitimacy will be important for success. Concepts of casualty acceptance and aversion are likely to remain linked to perceptions of the legitimacy of the conflict.

- Perceptions of inequality and associated grievances will result in increased instability and societal tension, possibly setting the conditions for conflict. Where instability affects national and multilateral interests, there is likely to be a requirement to provide support for legitimate governance structures and for stabilisation operations.
• Radicalisation, extremism and terrorism will continue to generate threats. Network technologies will provide new opportunities for group formation. Many threats will operate transnationally, requiring ongoing cooperation and multinational interoperability between security services to provide an effective response.

• The West is likely to lose its broad qualitative advantage in military equipment in some areas, challenging a Western paradigm of war; that technology can replace mass. The proliferation of advanced weaponry will continue. As technological parity between adversaries is approached, casualty rates are likely to escalate. Potential adversaries, both state and non-state, will leverage high-technology niche capabilities and employ innovative concepts of operation. Regional powers armed with precision-guided missiles and anti-access technologies, such as submarines and sophisticated surface-to-air missiles, will make traditional power projection strategies more costly.

• Advances in robotics, cognitive science coupled with powerful computing, sensors, energy efficiency and nano-technology will combine to produce rapid improvements in the capabilities of combat systems.

• Defence production is likely to become increasingly internationalised and most states will lack guaranteed access to industrial surge capacity during times of escalating tension. Weapons themselves are likely to become more portable, more widely available and easier to use.

• Increasing dependence on Information and Communications Technology (ICT), and reliance on space-based assets to receive or transmit information across the electromagnetic spectrum, will maintain the importance of cybersecurity. Cyberspace will be widely exploited by all types of actors, but the effects of their actions are likely to vary. Attribution, intent and legitimacy of cyber-attacks will all be disputed.

• Strategic shocks will occur, although their character and detail remain unpredictable. Complex interconnected and interdependent systems will be subject to systemic risk and the potential of cascading failures. Organisations that are built around agility and versatility are the most likely to be successful at adapting to events.

• Success in future conflict, especially against adaptive and agile adversaries, will require a shift away from kinetic to influence activity, underpinned by a greater understanding of the enemy. This understanding will require more emphasis on intelligence gathering, cultural awareness, individual and collective training, and focused comprehensive approaches.

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12 Information, Communications and Technology (ICT) is the entire infrastructure, organisation, personnel, and components that collect, process, store, transmit, display, disseminate and act on information.
Resource security *will* become an increasingly important issue for governments and defence forces. While the United Nations (UN) Charter framework *will* remain in place, the legal prohibition on the use of force is likely to come under increasing pressure when resource security adversely affects national survival. In such circumstances, a state *may* interpret the legal framework in a manner that seeks to legitimise their use of force.
Part 1
Analysis

This section brings together the important arguments, themes and analysis of the evidence. It is split into 3 sub-sections:

- **Ring Road Issues.** The Ring Road issues are the 4 key drivers of change that will affect the lives of everyone on the planet.

- **Key Themes.** Three essays on *The Human Environment, Dynamics of Global Power* and *Evolving Defence and Security Challenges* that develop and analyse trends and drivers and identify the most likely outcomes.

- **Strategic Shocks.** High impact events that have the potential to rapidly alter the strategic context.
Ring Road Issues

The Ring Road issues are key drivers of change that will affect the lives of everyone on the planet over the next 30 years.

Globalisation

During the next 30 years, the number of transactions, conducted irrespective of physical distance, is likely to increase. Such an expansion is likely to shape and, in general, improve everyday life for millions of people. A key feature of globalisation is likely to be the continuing internationalisation of markets for goods, capital, services and labour, which integrates geographically dispersed consumers and suppliers. This is likely to be an engine for accelerating economic growth, but also a source of risk, as local markets become increasingly exposed to destabilising fluctuations in the wider global economy. These developments are likely to be driven by advances in global telecommunications, resulting in a pervasive information environment in which much of the global population will be able to be ‘online all the time’. There are likely to be winners and losers in a global economy led by market forces, especially in the field of labour, which will be subject to the laws of supply and demand. As a result, everyday life for people is likely to lack stability and certainty, leading to the possibility that political decisions, made to protect reluctant populations from the negative effects, may limit the extent of globalisation. This interconnectivity will significantly reduce the time available to plan for and respond to global events, which may lead to political or economic miscalculation. Socially, looser forms of political, cultural and economic associations are likely to multiply. Virtual and disassociated groups are likely to form, linking members who are physically dispersed, but who share common interests and seek competitive advantage by association. Politically, globalisation is likely to raise levels of interdependence between states that are increasingly integrated within the globalised economy.

A feature of globalisation is likely to be the continuing internationalisation of markets
Climate Change

Overwhelming evidence indicates that the atmosphere will continue to warm at an unprecedented rate throughout the 21st century. A scientific consensus holds that a large part of this warming is attributable to human activities, primarily through increased concentrations of carbon dioxide and other greenhouse gases. However, there is uncertainty about the rate and magnitude of change over the next century. For example, feedback mechanisms, such as melting ice-caps that accelerate global warming as less light is reflected back to space, may play a significant role. Despite this uncertainty, by 2040, the global temperature is likely to have risen by around 2°C above pre-industrial levels. This rise is independent of future emissions agreements which will be vital only in limiting the magnitude of change beyond 2040. These agreements will be highly politicised, especially given their effect on relationships between the developed and developing economies.

Overwhelming evidence indicates that the atmosphere will continue to warm

Climate change will affect the land, the atmosphere and the oceans, and may be an unstable and unpredictable process, involving both progressive evolution and sudden instabilities. Major changes are likely to include melting ice-caps, progressive thermal expansion of the oceans, and increasing acidity of seawater as carbon dioxide transfers from the atmosphere. These changes will have consequences that vary over time and geographical extent. For example, some regions will experience desertification, others will experience permanent inundation, and tundra and permafrost are likely to melt, releasing methane, possibly in large amounts.13 Land available for habitation is likely to reduce, and patterns of agriculture are likely to change. Tropical diseases, such as malaria, are likely to move north and into previously temperate zones. Extreme weather events will change in frequency and intensity, threatening densely populated littoral, urban and farming regions with changing growing seasons, flooding and storm damage, and resulting in increased migration.

13 Methane is 8 times more powerful as a greenhouse gas than carbon dioxide.
Global Inequality

Economic, social and political inequality of opportunity, occurring between both individuals and groups will continue to fuel perceptions of injustice among those whose expectations are not met. This will increase tension and instability, both within and between societies and result in expressions of unrest such as disorder, violence, criminality, terrorism and insurgency. While material conditions for most people are likely to improve over the next 30 years, the gap between rich and poor is likely to increase. Absolute poverty will remain a global challenge. Significant per capita disparities will exist within most countries and across some regions. In some areas of sub-Saharan Africa, previous falls in poverty may be reversed. Differentials in material well-being will be more explicit, highlighted by increased access to more readily and cheaply available telecommunications. Associated grievances and resentments are likely to increase despite growing numbers of people being materially more prosperous than their parents and grandparents. Inequality may also lead to the resurgence of not only anti-capitalist ideologies, possibly linked to religious, anarchist or nihilist movements, but also to populism and even Marxism. Conversely, it may also lead to demand for greater access to the benefits of globalisation and greater connectivity for the least developed states.

Significant per capita disparities will exist within most countries
Innovation

Innovation will create new opportunities and generate value, by successfully exploiting new and improved technologies, techniques and services, overcoming cultural and process barriers. It will occur when invention reduces costs to a point where an explosive growth cycle is realised or where a new market is created. For example, over the past 20 years the reducing cost of mobile telecommunications has made them readily available. Scientific advancement or invention is likely to produce breakthroughs in several disciplines primarily in Information and Communications Technology (ICT), though developments will also be observed in biotechnology, and energy management. Examples of such advances include: growth in biotechnology pharmaceuticals, stimulated by an ageing population; and energy management advances driven by the need to reduce carbon usage and reliance on fossil fuels. The complexity and interdependence of physical, social, and virtual environments will increase, and successful innovation is likely to require a collaborative, networked approach to development. The overall pace and direction of this development is likely to be driven by commercial logic, although initial research activity is likely to remain primarily government funded. There is likely to be significant lags between invention and the development of ethical norms governing their application. Also, the fact that innovation is a creative process that is difficult to control or regulate may make it easier for immoral actors to evade controls, leading to perverse applications.
Key Theme – The Human Environment

People are, and will remain, the most important driver of change, underpinning societal, geopolitical and security developments. This section seeks to investigate trends in society by considering how challenges in the physical domain, combined with societal change and technological advances, will shape the human environment. Robust demographic growth, resource scarcity and the need to address climate change will require innovative technological and organisational solutions that have a profound effect on society. These demographic, physical and economic drivers will be interlinked and intense, shaping behaviour, development and the need for adaptation out to 2040.

The Human Environment Key Theme considers:

- The Physical Environment.
- Changes in Society.
- The Technological Challenge.

The hot topics are Radicalisation and Global Health.

The Physical Environment

The global population is likely to grow from 6.9 billion in 2010 to 8.8 billion by 2040 with many enjoying increasing prosperity accompanied by burgeoning material expectations.\(^{14,15}\) Rapid population growth is a continuation of a trend stretching back to the last century that is likely to continue, before possibly moderating late in the 21st century as economic development leads to a progressive decline in global fertility rates.\(^{16}\) Population driven resource demand is therefore likely to increase in intensity out to 2040 before gradually subsiding in the late 21st century as technological and organisational innovations take effect, and the rate of population growth declines. The most acute stresses are likely to arise from competition for energy, food and freshwater, as well as access to the ‘global commons’.\(^{17}\)

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\(^{14}\) For instance in India the middle class has tripled in size to 250 million people and may reach 50% of the population by 2040. *Time Asia*, November 2004.

\(^{15}\) In 1998, the United Nation (UN)’s best estimate for 2050 was that there would be 8.9 billion humans on the planet. Two years later, the figure was revised to 9.3 billion. The number subsequently fell and rose again. Modest changes in birth rates can have significant consequences over a couple of generations. For example, rises in US and European birth rates are among the developments factored into the UN’s latest ‘middle’ projection that world population in 2050 will be just over 9.1 billion. *UN Population Division of the Department of Economics and Social Affairs*.

\(^{16}\) Processes such as globalisation and urbanisation are likely to contribute to the trend towards smaller family size seen in developed countries over the past 50 years. This trend is likely to continue in developing countries. For example, a recent UN projection assumes a decline of the global fertility rate to 2.02 by 2050, and eventually to 1.85, with total world population starting to decrease by the end of this century. *Department of Economic and Social Affairs, Population Division, World Population in 2300, 2004*.

\(^{17}\) The ‘global commons’ are those regions used jointly by the members of a community. They include, but are not limited to, those parts of the earth’s surface beyond national jurisdictions such as the open ocean and the living resources found there, the atmosphere and orbital Space. The only landmass that may be regarded as part of the ‘global commons’ is Antarctica.
Global energy, food and water supplies are likely to be sufficient for the increased global population. However, geographic distribution, access, cost and transportation will be critical issues. The inability of some regions and segments of society to meet the costs involved in accessing resources makes local and regional scarcity likely, stunting economic and societal development and leading to poverty, instability and conflict. For example Mexico city has already experienced conflict over access to water supplies.\(^\text{18}\) Despite this, growing numbers of people are likely to enjoy increasing affluence as consumption and global Gross Domestic Product (GDP) per capita rise. Such economic growth is likely to lead to a continued reduction in absolute poverty; however, rapid population growth may contribute to increased levels in the least developed regions.\(^\text{19}\) Economic development is likely to be directly linked to greater resource consumption. However, an increased number of cars, the change to protein-rich diets, and increasing personal water usage will be partially offset by the emergence of renewable and unconventional energy sources, increasing crop yields and innovative solutions, such as conservation measures.\(^\text{20}\) Producer and consumer economies will seek political and economic partnerships to guarantee supply, some of which will require moral compromises to be made. Scrambles for energy, minerals and fertile land are likely to occur with increasing intensity. These scrambles may not always be motivated by immediate shortage, as many states compete for access to long-term supplies and

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\(^{18}\) Bankin D, Mexico City’s Water Crisis, NACAL Report on the Americas 2009 and Dry Taps in Mexico City: A Water Crisis Gets Worse at [http://www.time.com/time/world/article/0,8599,1890623,00.html](http://www.time.com/time/world/article/0,8599,1890623,00.html)

\(^{19}\) Absolute poverty is defined here as those living on the equivalent of $1 per day or less.

\(^{20}\) These sources include photovoltaic cells within solar panels that are used to convert solar energy into electricity and exploitation of tar sands. These are oil-rich rocks that contain a form of hydrocarbon that currently requires considerable effort to extract and process.
develop extensive strategic reserves. The combined effects of climate change and increased demand for food production are likely to alter the productivity and distribution of the world’s ‘bread-basket’ regions and accelerate soil degradation in previously fertile areas. The inequality between areas that either possess an abundance of natural resources, or can afford access to them, and those that cannot is likely to be a source of grievance, providing an ethical challenge to the global market-based economic system.

By 2040 climate change, and associated measures designed to limit greenhouse gas emissions, will have a significant effect on the development of societal norms, the cost and usage of energy, land use, and economic development strategies. A new, higher temperature global climate will be a reality and many measures to limit further long-term temperature increases are likely to have been implemented. The measures are likely to be agreed multilaterally after a period of discord regarding the associated economic and financial burden of how individual states and regions bear the costs. These disagreements, based on differing narratives for apportioning responsibility for climate change, are likely to be particularly intense between developed and developing economies.21 This is likely to place greater emphasis on sustaining rather than maximising economic growth, particularly in the West. Options for enhancing sustainability include technological solutions, such as carbon capture and storage that are likely to allow widespread usage of fossil fuels to continue. Material expectations will be tempered by greater environmental awareness. These developments will mitigate, and may counteract, a number of the long-term de-stabilising impacts of climate change, but considerable uncertainty surrounds the rapidity with which such solutions can emerge, and adaptation is unlikely to be smooth or wholly successful.

Climate change, and the progressive impact of gradual temperature increases, will exacerbate resource scarcity by altering regional precipitation patterns, affecting agricultural production capacity, and worsening existing problems of resource distribution and access. Climate change will also cause some previously infertile land regions to become fertile. However, such regions are likely to lack the necessary farming infrastructures and it will take considerable time and effort to establish them. These changes in the pattern of agriculture are likely to impact on food security. Environmental changes are also likely to lead to significant increases in environmentally-induced migration. Such migrants are likely to move locally, and then regionally, with a relatively small proportion of them moving internationally. However, much of the migration will be uncontrolled and generate significant social and economic impacts wherever it occurs. States and cities that are unable to cope are likely to seek international humanitarian assistance of unprecedented scale and duration.

21 Such difficulties were exemplified during the Copenhagen summit in December 2009.
22 The first prototype carbon capture unit in the UK, run by Scottish Power, is working at a coal-fired power station in Longannet. During tests it has captured around 90% of the carbon content emitted from exhaust gas. Carbon Capture Journal, 30 November 2009.
Changes in Society

Out to 2040, the demographic profiles of societies will change. The developing world will account for the majority of population growth and represent 7.6 billion people, or around 85% of the global total. Many of these people will enjoy improved economic status and heightened material expectations. This economic development, along with widespread availability of birth-control measures, increasing life expectancy and continued urbanisation, is likely to temper birth rates in some regions. However, limited economic development and cultural norms will persist, sustaining high fertility rates in other regions such as sub-Saharan Africa, parts of the Middle East and Asia, and specifically in countries such as Afghanistan, Syria, Yemen and Pakistan. In contrast, Europe, Japan and eventually China and Latin America are likely to face the problems of an ageing and declining population. Russia, in particular, is likely to experience a population collapse from over 140 million in 2009 down to 122 million by 2040, posing significant social, security and economic problems, particularly as the decline is most acute amongst ethnic Russians rather than minority groups. However, the long-term decline in fertility rates experienced by the most developed states is eventually likely to be halted, or even reversed, as societal norms change.

Climate change will amplify existing social, political and resource stresses. It is likely to be an indirect factor that sets the conditions for conflict, rather than directly causing it. The effects of climate change are likely to dominate the global political agenda, especially in the developed world where it will represent an increasingly important single issue. The developed world is likely to experience a degree of transformation as it moves from a consumerist society based on freedom of choice to a more constrained, sustainable societal model that provides financial and social rewards to encourage greener practices and discourage waste. This will represent a shift in international norms as the developed world looks to achieve sustainability, while the developing world continues to concentrate on building the infrastructure required to maximise economic growth. Despite this, the developing world is likely to represent an important engine of innovation where new, cheap, environmentally sustainable technologies are trialled without opposition from industrial interests that defend inefficient, legacy systems. The developing world is unlikely to be constrained by the stringent legal controls applied to the developed world. In certain research areas, such as cloning and clinical trials, this may lead to technological advances that may be deemed unethical in the West.

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23 UN Population Division definition 2008. All regions of the world except Europe, Northern America, Australia/New Zealand and Japan.
24 By 2040, Afghanistan is likely to see its population increase from 29.1 million in 2010 to 62.3 million in 2040; Syria from 22.5 million to 34.1 million; Yemen from 24.3 million to 46.9 million; and Pakistan from 184.8 million to 302.8 million. UN World Population Prospects, 2008 Revision, Medium Variant.
25 The population of the Russian Federation is projected to be 140 million in 2010 declining to 122 million by 2040. A decline of 18 million over 30 years (10950 days) equates to a loss of 1700 people a day. UN Population Division, 2008 Revision, Medium Variant.
26 Fertility has tended to decrease with increases in prosperity and living standards (as measured by the Human Development Index (HDI)). However, this may only be true for earlier stages of development. At higher levels of development (above a HDI of 0.86 a level only found in the most developed economies) fertility in many countries increases with HDI. Thus, falls occur as HDI approaches 0.86, but above that level HDI begins to increase again in many countries. It is likely that countries with an HDI above 0.86, such as Italy, Spain, Netherlands, Germany, and Sweden, have implemented policies that persuade women to have children. However, other countries, such as Canada, South Korea and Japan, have not yet followed this path. Shripad Turjapurkar, 2009, Babies make a comeback, Nature, Volume 460, page 693. Myrskyla et al (2009), Advances in development reverse fertility declines, 2009.
Figure 3 – Global Population Growth and Age Demographic by Region 2010 - 2040
Broader and deeper social interaction, facilitated by globalisation, sustained international migration, and ubiquitous global ICT connections may drive the development of a global culture, although the characteristics this culture takes are difficult to anticipate. Social trends are likely to reinforce this, with some religious movements, such as Pentecostalism, becoming increasingly globalised in outlook and character. Furthermore, individuals and small businesses are likely to become increasingly connected to worldwide markets. The complex international relationships that result are likely to lead to an increased familiarity with other cultures. Knowledge of overseas events is likely to become constant and real-time, providing the opportunity for violent responses to be orchestrated through communications networks that may be untraceable and poorly understood by the traditional security apparatus. The social tensions caused by intrusive global culture are likely to be most acute amongst those who seek to maintain their indigenous and traditional customs and beliefs, and feel threatened by changes. This is likely to lead to an increasing number of individuals and groups, many of whom form around single issues that differentiate them from wider society, becoming marginalised and possibly radicalised.

Protest on global issues may be conducted on rapidly expanding scales

The presence of transnational diaspora, with close ties to their home countries, will often cause events in the migrants’ state of origin to become political issues in the host state. Protest action in response to global or transnational issues may be conducted on an expanding scale with, for example, local events in Bangladesh leading to protests by ethnic Bangladeshis in London. These protests may include demands for intervention to address problems in the state of origin or, alternatively, lead to transnational inter-communal violence conducted between different ethnic communities in the host country. Often, the host state government may be perceived as a source of grievance due to
ideological or cultural differences. When such conditions exist, particularly when exacerbated by high levels of marginalisation and social exclusion, sections of the populace will develop grievances that may lead to extremism. Examples include the 7/7 attacks in 2005 on the London transport network where terrorism was justified through reference to historical injustices, repression, and violence against Islam. Technology will facilitate the organisation of protests and high impact terrorist attacks that occur rapidly, and without fore-warning, and seek to achieve symbolic effects that create the greatest media impact. The 2004 Madrid train bombings in the run-up to the Spanish national elections demonstrate the ability of trans-national terrorism to achieve political effect.

Regions of alternatively governed space will continue to exist in both rural and urban environments where instruments of legitimate national governance do not operate effectively and power resides locally with tribal groups, warlords or criminal gangs. Diaspora communities in developed states may form similar enclaves.28 Instability, crime and terrorism are likely to radiate from such centres making their containment or stabilisation an ongoing international problem. Regions that suffer the highest levels of inequality and poverty are also likely to experience increased risk of humanitarian catastrophes caused by an amalgam of climate change, resource pressures, the effect of disease, and population growth. Clear moral cases that invite humanitarian intervention will persist.

Within the global system an innate cultural divide is likely to remain between societies that are principally individualistic in outlook and those that foster strong collective identities. Both types of society will be challenged and undergo change. For example, collectivist societies are likely to face calls for more democracy, freer markets, freedom of speech and belief, and individual legal rights. However, individualistic societies are likely to experience tensions as their constituents increasingly question the role and authority of the state and wrestle with the balance between the needs of the many and the rights of the individual. For example, China is likely to continue to foster a strong collective identity based on nationalism. However, the manner in which the Chinese state resolves the inevitable tensions associated with the rise of individualism, along with divided allegiances as open religious affiliation becomes more widespread, may come to define its future path.

Religious affiliation will remain a collective identity that transcends national boundaries. Many religions will have transnational presence and institutions such as the Roman Catholic Church will remain influential and Islam as a faith will continue through the ‘umma’ to unify individuals across borders. In a number of religious contexts, including Judaism, Sikhism and Islam, religious identity is likely to remain more significant than national identity. Because of increasing global connectivity diaspora communities are more likely to react to events impacting on their religious or cultural identity. Single issues, such as women’s rights, or the desire to practise different languages or cultures, will form barriers to integration, generating further tensions and possibly conflict. However, although these differences may result in tension between different societies,

28 For example, Albanian, Jamaican or Somali criminal gangs operating in cities such as London.
29 ‘Umma’ is the Arabic term for the whole community of Muslims bound together by the ties of religion.
they are unlikely to result in a ‘Clash of Civilisations’. Moreover, external influences and extended exposure to liberal cultures is likely to soften support for violent extremism and gradually decrease the impact of ideologically-driven terrorism.

As the globalised economy becomes increasingly dependent on knowledge-based industries, creativity and innovation, the importance of advanced education will increase. However, global access to education will remain variable, although ICT based initiatives are likely to improve basic skills in numeracy and literacy. Those who do become better educated may suffer frustration if they continue to experience inequality of opportunity based on their physical location, culture or language. The increasing role that ICT will play in future society is likely to lead to the vast majority of individuals developing the skills required to use and operate such technology. However the proportion of the population with the harder skills required to understand the fundamental principles of how such technology works is likely to decline.

The state will remain the pre-eminent actor in international relations and many individual states will be dominated by elite groups that emerge from distinct socio-economic, educational, tribal and ethnic groups. However, the emergence of a global elite, a powerful network of individuals and institutions that sits above the level of individual states and influences the global agenda, is also possible. Elites provide an indication as to how different regions may see the world and to what strategies they afford the greatest priority. The Western world is likely to remain dominated by personality politics with charismatic leaders engaging their publics on emotional and personal issues based on morality and values. In East Asia, a more technologically focused leadership will seek stability, economic growth and the collective good, affording less significance to social issues and individual rights. In the developing world, traditional forms of organisation are likely to remain significant even if states transform their governance structures according to democratic principles. Transformation, especially if it is driven by globalisation, is likely to generate tensions within traditional systems and may spill over into conflict between groups, as was illustrated by violence following the 2007 Kenyan elections. Countries that sustain both caste and class systems may also experience internal tensions or instability as hierarchical systems become subject to stress.

31 Hard skills describe technical disciplines such as maths, engineering and physics.
Hot Topic – Radicalisation

Radicalisation is defined as the process of advocating political, ideological or societal reform that can, in some instances, lead to the generation of extremist beliefs and terrorist activity. Extremists, either violent or non-violent, are those radicalised groups and individuals who are willing to cross ethical and legal boundaries. Terrorists are the most fanatical examples of extremists, willing to use ‘armed propaganda’ to achieve their goals and are likely to develop compelling messages to gain support. Through considered narratives, which explain their aims and actions to a target audience, such groups are likely to encourage local responses in support of their objectives.

Out to 2040, radicalisation will continue, driven by a range of complex factors, such as the gradual shift in political beliefs, individual and group grievances, and economic and social inequalities. Although the precise links between poverty and radicalisation remain unclear, poverty is likely to encourage radicalisation due to the grievances it generates and the long-term stresses it causes. Traits exhibited by fragile states, including high levels of inequality, poor human rights, and minimal social support, healthcare and welfare systems, are likely to allow radicalisation to develop. States in the liberal, developed world are also likely to experience radicalisation, partly as a consequence of globalisation, migration and sustained societal inequality. State actions are likely to have a significant impact on the process of radicalisation. For example, during stabilisation operations, the over-vigorous application of military power to crush radical groups may result in increased public support for them, or drive them to ally with other extremists. Moreover, it may force radical groups to become more extreme, possibly condensing into terrorist cells.

Many of the conflicts and disputes exploited by international terrorist organisations show no signs of early resolution and, out to 2040, international terrorism will persist. Terrorist organisations, such as al-Qaeda, are likely to evolve, while maintaining their overall strategic aims. Al-Qaeda’s pursuit of global objectives will rely upon radicalisation to provide support and to generate the conditions in which they can operate.

However, there may be a number of factors that reduce the spread of international terrorism. For example, ideologies based upon a selective interpretation of Islam, contemporary politics and history, are likely to be rejected by many Muslims across the Islamic world. The use of terrorist violence is unlikely to succeed in the long-term and indiscriminate killing is likely to further erode terrorist support and credibility.

34 Armed propaganda is classically viewed as the mechanism through which a terrorist group tries to advance its goals by violent action, based on how a given attack will influence external audiences and constituencies.
35 The desire to respond to grievances (either long established or recently generated) can be due to the impact of a single event, such as the killing of a family member or a perceived ethnic, tribal or religious affront by another group.
36 Relative deprivation itself is the discrepancy between what an individual or group has, and what they believe they are entitled to. Gurr suggests that relative deprivation leads to discontent, which tends to lead to politicisation of discontent, which can lead to political violence. Ted Robert Gurr, Why Men Rebel, 1970.
38 Assuming continued international pressure, the al-Qaeda ‘core’ organisation is likely to fragment and may not survive in its current form. The core group will not be able to achieve its strategic goal (popular unrest and uprising leading to the overthrow of governments and the establishment of a caliphate), but it will still have the capability to conduct significant terrorist attacks. The United Kingdom’s Strategy for Countering International Terrorism, March 2009.
39 Ibid.
New forms of extremism and terrorist violence are likely to emerge, both locally and internationally. For example, in China the polarisation of societal structures and inequality between the elite, the urbanised workers and rural peasants are likely to become a source of grievance. Consequently, China may experience the radicalisation of a new generation of urban workers, who already number around 120 million, and have been drawn from the countryside by the prospect of better paid employment but do not receive the same rights as those originating from the city.40

The Technological Challenge

Technology will provide partial solutions for both adapting to, and mitigating the effects of, climate change. However, it is unlikely that, by 2040, technology will have produced low emission energy sources capable of providing the majority of the energy demanded. Nevertheless, advances in carbon capture technology are likely to be significant, allowing fossil fuel usage to continue in a limited emission regime, with particular expansion in the use of coal. Despite this, resource competition, carbon pricing, increased energy demand and the limitations imposed by climate change are likely to increase the cost of fossil fuels, stimulating the development of cleaner, renewable energy solutions and nuclear power.41 Supply and demand for energy are likely to be closely matched. However, an inability to alter supply rapidly, in response to sharp changes in demand (and vice versa), is likely to result in market volatility and price spikes. Supply problems are likely to be exacerbated by under-investment, instability and the deliberate actions of states seeking wider political objectives, making energy security an ongoing concern. These spikes are likely to be of greater magnitude than in previous energy crises, severely affecting global economic growth and making the development of novel energy sources, previously deemed economically unviable, both economically and politically necessary.42 These economic imperatives will transform energy production and usage, but breakthrough events, such as commercially viable nuclear fusion, are unlikely to come to fruition by 2040, and regions rich in natural resources will therefore retain strategic importance. Emerging research into fledgling disciplines such as geo-engineering may provide methods to ameliorate climate

41 Carbon pricing provides economic incentives to reduce carbon emissions.
42 As mineral processing and extraction technologies become increasingly efficient, previously exhausted reserves may become economically viable again. This could also include the mining of refuse and waste sites.
change. However, attempts to conduct geo-engineering projects in the Earth’s complex biosphere are likely to be a source of tension and considerable anxiety regarding unintended outcomes.

The future global environment will be defined by physical, social and virtual networks. The physical system will consist of complex interconnections, including extensive resource pipelines, communication cables, satellites and travel routes. The virtual networks will consist of communications servers linking individuals and objects, many of which will be networked through individual Internet Protocol (IP) addresses. The majority of individuals are likely to have access to network connections leading to large-scale changes in identity through the use of multiple online profiles. Remote working is likely to become the norm with controlled network spaces representing the new work environments. Virtual reality technologies are likely to blur the distinction between real and virtual life, facilitating the formation of ubiquitous groups that will form and disband with considerable rapidity. New ideas, beliefs and fads will be transmitted near-instantaneously around the globe. Avenues for protest, and opportunities for new and old forms of crime, will emerge and may allow hostile groups to form and rapidly create effect. At the same time, however, greater access to information resources will expand the opportunities for research and knowledge development through virtual interfaces, diminishing the effect of geographic separation between those who seek to collaborate. The increasing ease of use and importance of computers and networks in many aspects of life is likely to lead to dependence on them and create critical vulnerabilities for potential adversaries to attack. These vulnerabilities will be reduced by reversionary options and in the longer term resilience may be increased by the development of intelligent, self-repairing networks. However, institutions based upon hierarchical, ordered structures, will find themselves challenged by competitors and potential adversaries who are able to capitalise on the rapidity of communication and group formation enabled by social networking technology. There may be need for bureaucracies to decentralise to address these challenges.

Developments in social networking technology will continue to facilitate the rise of ‘citizen journalism’ and make it increasingly difficult for even the most autocratic states to control access to information, especially as globalised connectivity allows local news stories to be broadcast instantaneously across the globe. In such circumstances tension and instability are likely to occur as autocratic states attempt to address rapid changes in popular opinion through force. The public response to the 2009 Iranian elections, with information spread and protests coordinated through transnational social networks, provides an example of the potential impact. Similarly, in response to the 2008 earthquake in the Sichuan Province, the Chinese government relaxed its policies on the control of social network services leading to an increased coordination of aid, but simultaneously creating a virtual environment in which the official response to the disaster could be openly criticised by the general public, leading to wide-scale protest and unrest.
Hot Topic – Global Health

By 2040, health will be recognised as a fundamental global issue. Acknowledgement that healthcare provision contributes to stability at local, national and global levels may lead to increased international investment in global health in order to reduce inequality and also provide positive opportunities for education and training. Such developments are unlikely to be rapid, but will be accelerated by high impact events, such as pandemics and episodes of mass migration.

Average global life expectancy is likely to increase, driven by continued advances in the quality and coverage of healthcare. However, access to healthcare is likely to remain unequal between the developed and developing worlds and, at the national level, between different socio-economic groups. Hence, although health inequality will be affected by genetic, cultural and behavioural drivers, the most significant inequality drivers are likely to be material deprivation and an individual’s local socio-economic environment. The costs associated with healthcare in the ageing societies of the developed world will be considerable, especially in Europe, but also in Japan, Korea and China. Individuals in the developed world and in the expanding middle-classes of India, China and Latin America are likely to demand increasing levels of healthcare. Geriatric and palliative medicine will become increasingly important with a significant proportion of the global healthcare industry existing to prolong life. This will create an increased burden on states in addressing long-term health requirements and also increasing pension commitments and welfare support. These costs, and continual pressure to improve healthcare standards, will be an important ongoing political issue that exerts pressure on government budgets.

The geographic extent of certain diseases, such as Dengue Fever, will spread

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43 Palliative medicine treats the symptoms not the cause of disease.
Dependence on international trade, relatively unconstrained movement of people, and high levels of legal and clandestine migration will minimise the opportunities to isolate outbreaks and provide channels that can propagate a viral pandemic. Other diseases such as cholera, malaria, water-borne infectious diseases, tuberculosis and hepatitis will remain significant. The geographic extent of certain diseases will be modified by variations in climate, with regions not previously susceptible to diseases, such as Dengue fever and Lyme disease, becoming progressively affected. In the developing world, global inequality in healthcare provision will result in medical care being poorly coordinated and often reactive. Many states will lack access to a legal pharmaceutical industry, depending instead on unregulated and often counterfeit sources of drug and vaccine production. The level of HIV/AIDS will remain significant in the developing world and within Russia, although increased awareness, better availability of anti-retroviral medications, and the likely development of a successful vaccine, are likely to make the disease less of an international concern. Variability in healthcare provision and treatment regimes make it likely that previously manageable diseases, such as tuberculosis, MRSA and other bacterial or viral infections, will continue to be prevalent.

Global recognition of the importance of a healthy lifestyle is likely to increase. Diagnosis and treatment of genetic diseases will improve, and lifestyle choice is likely to become the main driver of poor health in the developed world. The treatment of chronic lifestyle diseases will grow in importance, placing increased emphasis on primary care. Individuals within the developing world are increasingly likely to be exposed to Western, mass-consumer dietary options and lifestyle vices and will, consequently, fall prey to similar lifestyle diseases.

Significant healthcare developments are likely in the global pharmaceutical industry with novel and targeted drug design solutions arising from the application of advanced genetics and nano-technology. Stem-cell technology is likely to lead to the growth of tissue specific cells and organs. Research will remain ethically controversial, but its application is likely to prove its utility, especially as mature cell re-programming develops. Screening and real-time health monitoring will be available and systems able to regulate health down to the cellular or even nuclear level are likely to be developed. Genetic testing and modification of foetuses will be achievable, although strict regulation in many societies may result in offshore or illicit treatment centres emerging. Human augmentation, especially with mobile communications and computing devices, will become practicable and may have significant military application, despite ethical and legal concerns.
Key Theme – The Dynamics of Global Power

This key theme examines shifts in geopolitical power out to 2040. The locus of global power *will* move away from the Atlantic towards Asia and the Pacific, as the global system shifts from a uni-polar to a multi-polar distribution of power and the hegemonic dominance of the US diminishes. This is *likely* to place increasing stress on the international rules-based system and generate opportunities for both cooperation and confrontation between major powers.

*The Dynamics of Global Power* analyses trends in:

- The Changing Distribution of Global Power.
- Globalisation and Instability.
- Interdependence and Competition.
- Geopolitical Influence.
- The International System – subdivided into the following groups:
  - Contemporary Powers;
  - Rising Powers;
  - Emerging Powers;
  - Pivotal Regions.

The Hot Topics within this section are *Frontier Disputes* and *The Asian Meridian*.

The locus of global power will move away from the Atlantic towards Asia and the Pacific.
The Changing Distribution of Global Power

The distribution of the elements of global power is complex. For long periods of the late 20th century power was concentrated either in the 2 superpowers, or, with the fall of the Soviet Union, in the United States as the global hegemon. While military power is currently concentrated in a few, great or major powers, economic power is more widely spread across a range of state actors and global institutions, and in this realm, power is already multi-polar. The shift in power from the US and Europe to Asia, coupled with the global challenges of climate change, global resource scarcity and population growth, is likely to result in a period of instability in international relations, accompanied by the possibility of intense competition between major powers.

The US is likely to remain the pre-eminent military power. However, in political, economic and military terms she is likely to become increasingly constrained and consequently her global leadership is likely to diminish. Moreover, the US and her allies may find it increasingly difficult to capitalise on softer elements of their power, as rising and emerging powers grow in influence and confidence. However, Western economic models, coupled with their relatively open societies, are likely to remain attractive influences to many individuals, especially entrepreneurs, and to some states. However, the rise of individual states, such as China, should not be considered a certainty given the nature and magnitude of the challenges they face, nor should their eventual influence be over-estimated. For example, the US, the European Union (EU) and Japan represent around 60% of world GDP and share many common values, such as a commitment to market economies and democracy. Out to 2040, this dominant position will fade, but together with like-minded allies they are likely to represent up to 50% of world output, have powerful military forces available, and exert significant influence over the international system, irrespective of the increased influence of China, India, Brazil and other actors. Moreover, the changing distribution of power is unlikely to be simple, linear or apply to all levers of power simultaneously. Most actors are likely to find adaptation challenging. The realignment process is likely to encompass a period of non-polarity, as states strive to realign their power to the changing strategic environment, and struggle to achieve objectives through traditional mechanisms.

The processes of global governance capable of bringing interested parties together to tackle global issues are likely to continue to evolve, in particular to deal with collective challenges, such as climate change. The strength of the collective responses agreed will depend on perceptions of national interest, and be linked to the scope, breadth, cost of enforcement, and marginal costs involved. Perceptions of equity are also likely to be important. The global governance process is likely to help moderate the effects of instability by facilitating political cooperation rather than confrontation. However, the

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44 DCDC research identifies several complimentary definitions of power, including those of Nye, Waltz, Mearsheimer, Buzan and Waever. In summary, power status can be defined by the amalgam of military strength, access to resources, size of economies, educational opportunity, demographics, geo-political position and political stability amongst others.
45 The US is currently the only great power; the major powers are China, Russia, France and the United Kingdom. Japan and Germany are major economic powers. Their status is unlikely to change out to 2040. However, powers, such as India and Brazil are likely to have achieved major power status by 2040 and China may reach great power status by 2040.
46 Hass R N, The Age of Non-polarity, Foreign Affairs, Washington, May/June 2008 in this he stated 'the US uni-polar moment is over. International relations in the 21st century will be defined by non-polarity. Power will be diffuse rather than concentrated, and the influence of nation-states will decline as that of non-state actors increases'.

development of a truly effective global governance process capable of agreeing strong collective deals is likely to involve considerable discord and require the stimuli of significant international crises to drive change. Such crisis-induced change is likely to be the norm, rather than proactive and pre-emptive change and is likely to give the impression of an enduring crisis of global governance. Moreover, even when global agreements are reached on issues ranging from climate change to nuclear non-proliferation, many are likely to be ineffectually implemented and resistance to intrusive policing and regulatory frameworks will persist.

Global institutions such as the UN, the World Trade Organisation (WTO), G8 and G20, World Bank and the International Monetary Fund (IMF) will remain influential, especially in addressing the problems of a highly globalised and interdependent world. A global government is improbable. The contemporary powers will remain reluctant to share power and the rising and emerging powers will seek appropriate levels of recognition, especially in the UN Security Council (UNSC). Despite concessions, without significant reform the least developed states may continue to see global institutions as being unrepresentative of their interests and place most value on the services they provide.
Globalisation and Instability

Globalisation is likely to continue. It is both an idea and a process linked to transactions of capital, goods, services, people, intellectual property, information and resources that are conducted via physical and virtual networks. Its influence is likely to be pervasive, with the economic success of states dependent on access to, and exploitation of, opportunities within the globalised economy. However, many individuals and some political elites will regard globalisation as threatening to their interests and to social stability, resulting in periodic local arrangements that protect sensitive industries and sectors of societies. While globalisation is inevitable over very long time periods, it can be temporarily slowed, halted or even reversed as demonstrated by the events of the Great Depression (see the Economic Dimension). Out to 2040, widespread economic protectionist measures are possible in response to geopolitical insecurity or macro-economic instability. If implemented they would lead to a decrease in interdependence, an increase in inter-state and inter-bloc rivalries, and the fostering of confrontational rather than cooperative approaches, with significant defence and security implications.

Despite strong transnational trends, the state will remain the building block of the international system, providing security and economic opportunity for citizens. However, globalisation is likely to have a Darwinian ‘survival of the fittest’ effect on poor governance by dissuading international investment and providing incentives for governments to improve practice in order to meet accepted norms. Contemporary, rising, and emerging powers are likely to use their influence to promote and protect the globalised system on which their prosperity depends. In extremis, this may include using military force.

Security of global supply chains, and access to the ‘global commons’ and global markets will be a priority for virtually all states. Effective governance, regulation, operation and control of the networks that underpin economic activity will be an ever-present concern. These networks, in the maritime, land, air, cyberspace or space domains, traverse vulnerable chokepoints and are dependent on functioning nodes to link major centres of trade, finance, intellectual endeavour, energy production, and industrial production and consumption. The infrastructure underpinning these networks is likely to evolve as the global economy develops and new technologies are introduced. Inherent network resilience and redundancy is likely to be difficult to assess. However, they are likely to be vulnerable to infrequent external shocks that cause systemic disruption, although the form and severity this disruption takes is difficult to anticipate. Examples could include the following vulnerabilities: the impact of geopolitical instability on maritime choke-points; the disruption of energy production; distribution and refining capabilities due to regional conflicts and natural hazards; and the intensifying dependence of developed economies on cyberspace.

Regions that exhibit the most intense economic and financial global linkages, underpinned by the necessary network infrastructure, represent a globalised core, the geographical boundaries of which are illustrated in Figure 4. This graphic also illustrates important suppliers of energy and strategic minerals, and states at risk of instability. Given that

Prosperity in the developed world is associated with globalisation, instability within the globalised core is *likely* to directly affect the interests of the developed world. Moreover, the Middle East and the Asian Meridian (see Hot Topic - The Asian Meridian) are regions where the globalised core, resource exporters and states at risk of instability are juxtaposed. Greater instability, with severe consequences to the international system is *likely*, making these regions particularly relevant out to 2040. In addition, the borders of the globalised core do not follow state borders. For example, the centres of industrial production and commerce in China’s littoral regions are intimately linked into globalised networks, but the relationship of China’s rural hinterland is different. Here, the predominant connection is the flow of remittances from migrant workers attracted to the rapidly-expanding conurbations by economic opportunity. Splits, such as these within a state, have always been present, but are *likely* to remain a source of domestic social tension made more acute by the inequality generated between the economic ‘haves’ and ‘have-nots’. The effects of such inequalities are context specific, but they *will* often be a cause of instability, threatening the cohesion of some states.

The number of internationally recognised states, as defined by membership of the UN, has grown rapidly. In 1950, the UN had 60 members but this had risen to 192 by 2009, an addition of around 2 states per year. Many new states were recognised following the independence of former European colonies and the collapse of the Soviet Union. However, others were created by violent, enduring separatist movements that fragmented previously viable states, for example in Yugoslavia. Out to 2040, state fragmentation is *likely* to continue, although the rate at which new states are recognised *will* slow. Some cities *may* also seek to secede from states and look for greater recognition as independent entities. Most new states are *likely* to be small both geographically and demographically and *will* seek alliances and protection to safeguard their independence and territorial integrity. For example, Slovenia gained independence in 1991, UN membership in 1992 and EU and NATO membership in 2004. *De facto* states that lack full international recognition, such as Kosovo, highlight some of the problems facing would-be states. *48* Not only does she have a history of conflict, but she is land-locked, has a large ethnic minority with close ties to Serbia, problems with governance and competing interests between the EU, the US and Russia who are all engaged in the region.

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48 Other *de facto* states include Transnistria and North Cyprus.
Figure 4 – Global Infrastructure and Resources Map

Interdependence and Competition

A defining feature of the next 30 years will be the constant tension between greater interdependence and intensifying competition between individuals, communities and states. This feature will stimulate competing strategies based around the extent to which these groupings will wish to exploit, or resist, change. Difficulty in meeting global resource demand is likely to become an enduring feature, resulting in states gradually drifting towards seeking individual rather than multilateral solutions. For example, despite the benefits of globalisation, bilateral agreements between resource suppliers and major consumers are likely to become increasingly common, threatening to fragment global markets. Similarly, despite economic interdependence and global challenges, such as climate change, that require cooperative solutions; the use of power is increasingly likely to focus on self-interest rather than the common good.

Global consumer demand, especially in China and India, heightened by increasing material expectations, will continue to feed through to economic activity and the demand for resources. States, rather than Multinational Corporations (MNCs) and markets, are likely to become a stronger force in shaping responses to resource scarcity and the energy market is likely to be increasingly dominated by state-controlled corporations. This increase in state influence may cause uncertainty as to intent and result in volatility, especially in energy markets. Offshore production of food and other agricultural produce, highlighted by state-sponsored land purchases in fertile agricultural regions, is likely to continue. This utilisation of developing states by wealthier states for resource extraction is likely to have a degree of mutual benefit. However, in regions that are prone to instability, it is likely to become a source of grievance and possibly conflict, especially where it is perceived to be detrimental to the indigenous population.\footnote{For example, the investment by Daewoo of South Korea in 1.3 million hectares of agricultural land in Madagascar was linked to the ousting of the Malagasy President Marc Ravalomanana. RAND (Europe).}
Geopolitical Influence

The maintenance and expansion of geopolitical influence will be an important consideration for all powers, especially those with global or regional leadership aspirations. Informal spheres of influence are likely to coalesce around the leadership of China, India, the US, Russia and others. Similarly, middle and lower-rank powers are likely to band together into regional blocs, often based on trade and economic links, in an effort to maximise their collective prosperity and influence. These trends towards regionalisation are likely to be compatible with globalisation in the same way that the EU is both a regional bloc and a cog in the globalised economy. The spheres and blocs are likely to be based around geographical proximity, common security challenges, cultural linkages, language, economic ties, political or religious ideology and possibly coercion. However, given the pervasive character of globalisation and mass communication, influence within the spheres is unlikely to be static or exclusively limited to a single major power. Moreover, the boundary of the spheres is likely to be ill-defined and fluid, reflecting the ongoing competition for influence. Intervention by a great or major power into the sphere of interest of another major power is unlikely given the risk of conflict, especially as these powers are likely to be able to deploy WMD or significant amounts of conventional military force. Hence, the greatest likelihood of confrontation between major powers lies in contested regions, especially those in geo-strategic locations, those with significant resource potential or in areas where the spheres overlap or touch. Such areas include parts of Africa, the Indian Ocean Region, the Asian Meridian, and the Arctic.

Changes in the distribution of power, the need for influence in a globalised world and balance of power considerations are likely to drive the formation of formal alliances and informal partnerships. Traditional alliances, such as NATO, are likely to continue, but states will also seek partnerships of common interest with non-traditional partners. However, the effectiveness of partnerships, especially in times of crisis, is likely to be less certain than that of an enduring alliance. Within Europe, the EU is likely to increase its influence and expand its economic, foreign policy and security role. However, a more extensive defence relationship that would extend EU power into and beyond Europe’s near abroad is unlikely. For European powers, NATO is likely to remain the defence organisation of choice. In the international security environment, consensus on collective military action is unlikely, and the proliferation of anti-access technologies is likely to inhibit individual state actors and groups from regularly exercising military power on a global scale. The strengthening influence of rising powers may result in a reinterpretation of international legal norms resulting in a less western-influenced international legal system. For example, human rights legislation may come to place more emphasis on collective rather individual rights.

New ideologies and macro-economic frameworks that re-shape the geopolitical landscape are likely to develop in response to the changing political, economic and social context.

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50 For example, Russia already claims such a sphere of influence in her near-abroad – however many of its neighbours refute these claims.
51 For example, sub-surface warfare capabilities, integrated air defence systems and short-range ballistic missiles.
52 For example, in March 2009, a UN forum passed a resolution condemning ‘defamation of religion’ as a human rights violation, despite wide concerns that it could be used to justify curbs on free speech. Reported by Reuters, 26 Mar 2009. Available online at http://www.reuters.com/article/worldNews/idUSTRE52P60220090326 (accessed 11 May 09).
Their nature is difficult to anticipate but grievance, in the face of continued inequality and highlighted by pervasive global communications, *may* result in a revival of Communism, especially if it evolves and dissociates itself from the failures of the Soviet Union. Similarly, nationalism *will* remain a powerful force, especially as the international environment becomes increasingly competitive, and far-right ideologies *may* see a revival. Influential religiously and philosophically inspired ideologies, linked to Islam and Confucianism, *may* also emerge. The US-led liberal model, known as the ‘Washington Consensus’, constructed around the institutions and policies of the western powers, has been the dominant global model, especially since the end of the Cold War. However, this model is *likely* to be unattractive to governments struggling with the adverse impact of poverty, climate change, and global inequality, especially where ruling elites fear loss of political power. These states, especially in developing economies, are *likely* to adopt alternative models. For example, the ‘Beijing Model’ of a less *laissez-faire*, more planned, regulated and controlled political and economic market system.53

The International System

This section examines the international system dividing it into key powers and regions; for ease of explanation these are grouped under Contemporary, Rising and Emerging powers and Pivotal regions. These states and regions have been examined because they *will* impact on global defence and security. The groupings are designed for ease of reference and in the limited space available are not fully inclusive of all state and non-state actors.

The Contemporary Powers

The contemporary powers are those that have wielded global power and influence post-World War II, and continue to do so today. These powers include the US, Japan, Russia, the European powers, and institutions of global governance, such as the UN. Out to 2040, they *will* face challenges to their power, such as changes in demography and economic prosperity, although the impact of these challenges *will* differ in scale for each actor.

The United States

By 2040, the US is *likely* to lose her hegemonic status as rising powers enjoy more rapid economic growth and close the technology gap in military capability. The US share of global GDP has already decreased from around 50% in 1950 to 22% in 2007, and although it remains 3 times the size of her nearest national competitor,54 this shrinkage *will* continue, resulting in a diminution of US economic power. Despite this relative decline, the US economy and military *will* remain amongst the world’s strongest and, with her well-established educational system, *may* be particularly adept in exploiting emergent technologies that could drive an economic resurgence. The US is *likely* to remain a

53 The Beijing Consensus is a planned approach to economic growth that uses the power of the state to gradually de-regulate and open up the economy to growth, while minimising instability. In practical terms, this means that individual freedoms are curtailed for what the state views as its collective good. It is based on the model adopted by the Chinese Communist Party. Cooper J.R, The Beijing Consensus, 5 November 2004. Cited at http://fpc.org.uk/fsblob/244.pdf
54 In terms of its share of Global GDP Japan is the world’s second largest economy. In terms of purchasing power parity China is the second largest economy. International Monetary Fund World Economic Outlook Database 2008.
centre of innovation, economic opportunity and populist culture, which will remain attractive to both states and individuals seeking her support and partnership.

When compared to other contemporary powers, robust population growth and less significant demographic ageing will help underpin US economic performance, in contrast to the demographic stagnation that is likely to occur in continental Europe, Russia and Japan. This contrast will maintain US influence and leadership in the context of the contemporary powers. For example, the US population as a percentage of the developed world population was around 25% in 2008, and is likely to approach 33% by 2040. Latin America is likely to be a particular area of interest for the US given the growth of her hispanic minority from only 6% in 1980, to around 22% by 2040.

The US will remain a politically stable major power; however, her response to the decline of her hegemony will be a critical factor for global stability. She is likely to respond positively to impending challenges by renewing alliances and partnerships as well as forming collaborative relationships with emerging and rising powers, carefully calibrating her military responses, and concentrating on soft power to achieve her objectives. However, on occasion she is also likely to seek opportunities to bolster her power and prestige as her position comes under threat. There will also remain, at least out to 2020, a global expectation that she will provide international leadership in times of crisis. However, the US is, on occasion, likely to operate in its self-interest rather than that of the global system, and this is likely to result in tension between her and the emerging and rising powers. Some states and non-state actors are likely to resist any US attempt to protect her global standing, especially where she is perceived as being overextended and vulnerable. Increased competition and confrontation may range from opposing US diplomatic and trade initiatives, to undermining US attempts to secure favourable access to resources and the global commons, coupled with attempts to drive wedges between the US and her allies. While it is unlikely that any state would directly challenge the US militarily, asymmetric attacks, from ideologically opposed state and non-state actors are likely.

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55 Calculations of population are based on sum of US, Europe, Japan, Australia, New Zealand and Canada population using UN Population Division 2008 figures, medium variant.
The European Powers

Individual European states are *likely* to continue to exercise economic power under the auspices of the EU, which is *likely* to retain significant global economic influence. It is the world’s largest economic bloc; in 2008 it had a combined output of $16 trillion, 20% greater than the US, and comprised 31% of the global economy in terms of its share of global GDP. However, the EU economy is *likely* to grow less rapidly than the US, China and India, such that by 2040, they will all share similar magnitudes of economic output. This relative under-performance *will* be the result of demographic challenges that are *likely* to decrease Europe’s share of the global population from 22% in 1950 to about 6% by 2040. Moreover, ageing *will* cause disproportionate decreases in the traditional workforce that *will* challenge norms for retirement and is *likely* to increase demand for migrant workers. The demographic profile, along with the diversity of national interests between member states, *will* diminish the ability of the EU to exert economic power. Difficult economic conditions *may* cause political tensions, particularly over monetary policy that threaten Euro Zone cohesion and cause significant economic dislocation. However, the Euro is *likely* to survive as a viable currency with an increased membership.

The EU is *likely* to remain the focus for most national economic and some foreign policy matters, but political integration is *likely* to be slow at best. Internally, and on its peripheries, poor economic performance and inequality *may* contribute to creating pockets of extremism; this has the potential to lead to instability and violence. Nationalist, ethnic and ideological movements *may* gain in prominenence. Violent extremism, concentrated in areas of social deprivation within large disaffected migrant communities, or in areas with underlying ethnic tensions, such as in the Balkans or the Basque Region, *may* increase in intensity. Externally, Europe *will* find itself faced in the east and in the Arctic by an assertive Russia upon whom it is dependent for gas supplies. To the south, it *will* face the combined impacts of a rising population in North Africa and illegal migration.

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57 In 2008 the EU’s share of global GDP was 31%, in terms of Purchasing Power Parity (PPP) it was 23%. *International Monetary Fund (IMF) World Economic Outlook Database 2008.*
European states are likely to focus on integrating border security arrangements, especially on the southern flank of Europe, considering instability in North Africa and the Levant to be a direct threat to European security, and engaging with North African states to promote stability, access energy resources and pre-empt possible large-scale migration. Further coordination of military forces is likely. In particular, financial restraints are likely to result in a requirement to pool and share capabilities, for example, capabilities such as strategic airlift. NATO is likely to remain the guarantor of European security, despite the fact that the US will be less focused on Europe. The EU is likely to remain reluctant to project military power beyond the Petersberg tasks\textsuperscript{58} even in cases of clear multilateral interest such as in the Balkans, or where the humanitarian imperative is clear. By being drawn closer into a Mediterranean dialogue with Europe, the Maghreb region is likely to follow a different political model of development from the wider Middle East. Political Islamic influences will remain important, but diaspora communities in southern Europe may drive increasing political, economic and energy cooperation. Of those states in North Africa drawing economically and politically closer to the EU, Egypt, is perhaps of the greatest geostrategic significance and may remain a moderating influence, despite challenges from violent extremism, demographic expansion and climate change.

By 2040, the UK population is likely to expand to around 70 million, rivalling Germany as the most populous EU state. The UK economy is likely to benefit from relatively high birth rates and inward migration that sustains workforce levels when compared to other EU states.\textsuperscript{59} The median age of the population is also likely to be significantly below the EU average. The UK economy is likely to remain within the top 10 global economies, measured by GDP. Socially, the UK will be a diverse society with significant increases in minority populations.

The UK and France are likely to continue to be medium-rank global powers in their own right. Their economies will remain integrated into the globalised system and dependent on international links and they will continue to engage diplomatically and militarily in pursuit of national strategic objectives. They will maintain close links with the US, but also develop new partnerships with rising and emerging powers. Both the UK and France are likely to continue as nuclear weapon states with independent seats on the UNSC.

Russia

Russia’s ambition to recapture her standing as a global and regional power in the face of domestic political, social, and demographic challenges will continue, making her a security challenge for Europe and, by implication, for the US. Her external relations are likely to be driven by a sense of insecurity, a belief in her right to be a global power and economic factors. She is likely to form strong links with some EU states, when it is in her national interest to do so, periodically seeking to disrupt EU and NATO coherence. The near-

\textsuperscript{58} The Petersberg tasks are an integral part of the European Security and Defence Policy (ESDP). They were explicitly included in the Treaty on European Union (Article 17) and cover: humanitarian and rescue tasks; peace-keeping tasks; tasks of combat forces in crisis management, including peacemaking. These tasks were set out in the Petersberg Declaration adopted at the Ministerial Council of the Western European Union (WEU) in June 1992.

\textsuperscript{59} The UK population is likely to grow to around 70 million and the median age is likely to be around 42 years. Germany’s population is likely to have contracted from 82 million to around 74 million. The median age is likely to rise from 44 to around 51 years. \textit{UN Population Division}, 2008 Revision, Medium Variant.
abroad of former Soviet satellites will continue to be heavily influenced by Russian hard and soft power and is likely to remain part of a de facto, although largely unwelcome, Russian sphere of influence. Interference in the internal affairs in the Ukraine, and the states of the Caucasus and Central Asia, is probable and Russia will strongly oppose NATO expansion. Russia will seek to dominate the Arctic, considering the region as central to her future prosperity and security. She will continue to view China and Japan suspiciously and, despite her membership of the Shanghai Cooperation Organisation, will seek to deter foreign infiltration and influence, most notably from China in eastern Siberia.

Russia will continue to face pressing social challenges. High mortality rates, particularly among males, combined with low fertility rates, are likely to result in falls concentrated within the ethnic Russian section of the population (see The Human Environment Key Theme). In contrast, the proportion of Russia’s large non-ethnic groupings, especially Islamic groups in the southern regions, is rising and is likely to exacerbate separatist tensions. Failure to reverse this demographic trend, particularly in economically vital regions of Siberia and Russian Central Asia, may result in national decline and an inability to control her energy rich hinterland. These adverse trends may be a precursor to a period of instability within Russia, which may result in success for separatist movements and the possibility of a resurgence of radical ideology.

Europe will remain Russia’s primary economic focus with access to the EU's markets for hydrocarbon exports being an economic imperative. Russia suffered a decade of economic and political turbulence following the collapse of the Soviet Union, but since the turn of the century her economy has performed strongly based on her resource wealth and rising commodity prices. Oil, gas, strategic minerals and agricultural produce account for more than 80% of Russian exports. Russia will remain one of the largest arms exporters and will continue to sell its latest and most technologically advanced equipment; some of which may equal, or surpass, the capabilities of Western-sourced systems. The Russian economy is likely to remain dependent on the commodities sector and subject to fluctuating global market forces and price volatility. Some forecasts suggest that, by 2040, Russia could be the largest economy in Europe with living standards approaching Western levels as a result of a 10-fold increase in output per head.60 However, these forecasts are likely to prove over-optimistic given the numerous challenges. Limited investment in the hydrocarbon sector’s infrastructure, especially in the gas industry, is likely to create a short-term supply problem affecting the domestic energy market and threatening exports. Large increases in domestic energy tariffs to reduce demand may lead to internal unrest, and Russian administrations are likely to be torn between maintaining revenue streams from exports and minimising internal dissent. Russia’s highly centralised political framework is unlikely to overcome these challenges and provide the sustained growth required to turn optimistic forecasts into reality. Moreover, the centralised political control, typified by the Putin era, is likely to endure and may become increasingly authoritarian. The majority of the electorate is likely to accept this, especially the growing middle classes that welcome stability. Russia will periodically leverage her hydrocarbon resources in pursuit of foreign policy goals.

60 Goldmann Sachs, BRICS and Beyond, 2007. (BRICS is the acronym for Brazil, Russia, India and China)
The Russian economy is likely to remain dependent on commodities

Japan

Japan will remain one of the world’s largest economies, despite severe demographic challenges. Economically and militarily, she will view China as both an opportunity and as a threat and this paradoxical view will drive Sino-Japanese relations. She is likely to seek to retain her regional economic influence, possibly by forging and exploiting a closer relationship with the Association of Southeast Asian Nations (ASEAN) group, both to counter Chinese influence and to prevent other emerging powers, such as Korea, taking a leading position.

Japan is a major resource importer and will face resource security issues. She is likely to gradually normalise constitutional restrictions on deploying military forces overseas and invest in her self-defence forces to dissuade and deter aggressors. Wedged between Russia, China, and Korea such changes are likely to be viewed with suspicion by her regional neighbours, given historical events. Her alliance with the US is likely to remain central to her national security, although concerns over long-term US intentions may lead her to seek other partnerships, possibly with India as a hedge against the rise of China.

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61 Japan has virtually no domestic oil or natural gas reserves and is the second-largest net importer of crude oil and largest net importer of liquefied natural gas in the world. Including nuclear power, Japan is still only 16% energy self-sufficient. US Energy Information Administration.
Japan’s alliance with the US is likely to remain central to her national security

The Rising Powers — China and India

The rising powers already seek to join or surpass the contemporary powers in global influence. Their rising status will be underpinned by large populations and continued economic development. Their political, diplomatic and military power will grow throughout the period to 2040. This group includes China and India.

China

China is likely to maintain a pragmatic and supportive approach to the conduct of international relations, sharing the benefits of an effective rules-based system and relying on trade in raw materials, energy and manufactured goods, to support economic development. However, her current policies of non-intervention and non-interference are likely to be superseded by a more interventionist approach, as her power and influence increases. She will develop political, economic and military strategies to secure trade and communications lanes in the event of tension and may try to isolate the region. These strategies are likely to result in an expansion of activity and influence in resource rich regions, such as Africa and Latin America, with investment decisions being increasingly challenged by local concerns and Western ethical objections. The Indian Ocean region, and particularly the Asian Meridian (see Hot Topic - The Asian Meridian)

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62 This reflects President Jiang Zemin’s ‘16 character’ guiding principle on US-China relations: ‘enhance trust, reduce trouble, develop cooperation, and avoid confrontation’.
are likely to become areas of geostrategic competition involving China, the US and India.63

China's economic growth since 1978 has been the greatest of any large country in history, averaging 10% per year and significantly expanding her share of the global economy. She is the world's largest producer and consumer of steel, the second largest consumer of energy and already, by some measures, the world's second-largest economy. Her future economic development and stability will be significant for the global economy, influencing global economic demand and shaping her future political direction. Estimates of China's economic growth vary considerably. According to some she has the potential to become the world's largest economy by 2025, and double the size of the US economy by 2040.64 However, she faces significant environmental, social, political, financial and demographic challenges that are likely to temper economic growth rates, resulting in an economy roughly comparable in size to the US and EU economies by 2040. A symbiotic economic relationship between the US and China exists whereby China holds significant quantities of US government debt in the form of Treasury Bonds, and the US imports competitively priced Chinese consumer goods. This relationship is likely to continue, although it may change in character as China's internal economic demand increases.65

China's continuing economic development is likely to establish her as the leading regional power in East Asia and the western Pacific, although she is unlikely to directly challenge the US militarily outside of this region.66,67 War between East Asian states is unlikely, but the pace of change and latent tensions are such that the likelihood is higher than in other regions, such as Europe. China's desire for primacy in her near-abroad, allied to nationalistic impulses and historic antipathies, may result in periodic military posturing and confrontation with traditional regional rivals such as India, Japan, Korea and the US. Regional arms races, both nuclear and conventional, are possible, although efforts to prevent proliferation will continue. Potential flashpoints include Taiwan and her relationship with China, and multi-party disputes over potentially resource rich territorial claims in the South China Sea. China is likely to represent the most capable potential adversary for the US and she will modernise her Armed Forces to counter perceived US, Indian and Asian threats. By 2040, she will have developed her power projection and maritime security capability and, if required, be prepared to use military force to achieve her objectives.68

63 China practices what they style as a pragmatic ‘calculative security strategy’, one that emphasises the primacy of economic growth, amicable international relations combined with increasing efforts to create a more modern military, and a continued search for asymmetric strategic advantages. Tellis A.J and Swaine M.D, 2000 RAND, Interpreting China’s Grand Strategy: Past, Present and Future.

64 Goldmann Sachs, BRICs and Beyond, 2007.


66 Any challenge would be indirect, for example, through proxies.

67 China’s ‘string of pearls’ strategy of ‘building presence’ is seen by some as an expansionist move. However, Chinese presence through the South China littorals, the Strait of Malacca across the Indian Ocean and on to the Arabian Gulf and East Africa is most likely to be concerned with securing multilateral trade and supply lines rather than a direct precursor to future expeditionary bases in countries such as Myanmar, Bangladesh, Cambodia, and along the Horn of Africa.

68 China is an advocate of utilising state-led hybrid or asymmetric warfare to further its aims. This is referred in Chinese literature as ‘High-Tech Local Wars’. This is extensively detailed in Zhenxing W and Suping Y, On PSYWAR in Recent High-Tech Local Wars, Junshi Kexue (China Military Science), 20 December 2000, pages 127-33.
More so than other major powers, China’s future path has a wide range of possibilities, ranging from the emergence of a fully democratic China through to the fragmentation, or even collapse, of the state. All are unlikely, but none can be completely dismissed. China’s future will ultimately be defined by whether, and how, she manages to create a system of politics that can sustain social cohesion alongside rising prosperity.\(^{69}\) China’s rise is not guaranteed and internal contradictions are likely to disrupt development, lead to challenges to the authority of the state and affect her external policies and interaction. Internal inequalities between a relatively prosperous, urbanised littoral region and an under-developed rural hinterland, and the lack of transparent and accountable governance, are likely to periodically create internal tensions that may spill over into organised disorder and political violence. Alternatively, rapidly expanding urban areas may produce a diversity of political movements campaigning for greater political and social freedoms. Similarly, environmental degradation, social unrest, demographic ageing, gender imbalances, water supply difficulties caused by fluctuations in Himalayan glacial melt, and agricultural degradation may all disrupt China’s rise, although civil war, complete state breakdown or reversion to the inward-looking policies of the Maoist era are all unlikely. Separatist movements, especially in remote ethnically or culturally distinct regions, will proliferate, often conducting irregular and terrorist campaigns as they grow in confidence and capability.\(^{70}\)

India

By 2040, India is likely to have overtaken China to be the world’s most populous state. She is likely to prosper economically and take her place as a major power in a multi-polar world. In 1980, India’s share of the global economy was slightly greater than China’s, but since then her growth rate has lagged and her economy is, at present, less than half the size of China’s.\(^{71}\) By 2040, she is likely to reduce this gap and her economic output is likely to be of a broadly similar magnitude to China, the US and the EU. Despite poor infrastructure, problems with the educational system, caste restrictions and the challenges of excessive bureaucracy and corruption, her economy has clear advantages over other developing economies. These include a large English speaking population, robust demographic growth, and relatively stable governance. Given her large and rapidly expanding population, India’s output per person will remain significantly below that of the contemporary powers, although the middle class is likely to grow and the incidence of absolute poverty may fall.

India is likely to follow an ‘India First’ policy as it acquires political power and influence, vigorously pursuing her interests in the Indian Ocean region and along the Asian Meridian. India’s influence in global affairs will increase and she is likely to become a permanent member of the UN Security Council. Her diaspora communities, especially those involved in science, business and technology are likely to become increasingly influential, especially in the contemporary and emerging powers, but also as a lever for Indian government.

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\(^{70}\) China will have ongoing conflict, especially in the regions of Tibet and Xinjiang.

\(^{71}\) In 1980, China’s share of the global economy at purchasing power parity rates was 2% against an Indian share of 2.1%. By 2007, China’s share was 10.7% against 4.6% for India. IMF World Economic Outlook Database 2008.
influence in the wider Middle East. India is unlikely to challenge the global influence of the US and the wider interests of China in Africa and Latin America.

India will feel constrained and threatened by historical enmity and potential security challenges from her near neighbours, especially Pakistan and China. She is likely to continue her traditional aversion to alliances and maintain a desire for strategic autonomy, while continuing support for legitimate international security missions under the banner of the UN. However, although India will continue to invest heavily in the development of her Armed Forces, she is unlikely to be drawn into unilateral or multilateral interventions outside of the Indian Ocean region. Internally, India will continue to face complex, protracted and bloody challenges from insurgents and terrorists.

India may be affected by widespread political and social turmoil in neighbouring states: many face considerable challenges, such as inequality, religious and ethnic differences and population growth. For example, religious and ethnic turmoil is likely to continue in Central Asia and the region is likely to remain beset by instability in governance. Similarly, an increased frequency of extreme weather events may overwhelm governance capacity and affect regional stability, especially in Bangladesh and densely populated low-lying areas of Sri Lanka and Myanmar.

India will feel threatened by external security challenges and internal insurgency

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72 India is currently dealing with: insurgencies in Assam, Jammu and Kashmir, the Punjab, Nagaland-Khaplang; attacks from Islamic terrorist groups like Harkat-ul-Jihad-al-Islami and Lashkar-e-Toiba; Maoist Naxalist attacks in Eastern India; and, extremist Hindu violence.
The Emerging Powers

The emerging powers are those actors that lack the scale of the rising powers, but retain potential and ambition to be regional powers with a voice at the global level. Some will be vulnerable to regional and internal instability. This group includes Brazil, Turkey, Iran, Israel, South Africa, Nigeria and some non-state actors.

Brazil

Brazil’s emergence as a major economic power based on strong democratic institutions, a diverse economy, and commodity exports will alter the balance of power in the Americas. She is the largest state by area and population and shares a border with all but 2 of the other South American states. Her relationship with the US will see a progressive reduction in dependence and greater equality. Brazil’s economic development may be a catalyst for similar progress by other South American states. However, such economic development throughout the region may be complicated by corruption and a resurgent populism that will have substantial appeal to the 25% of the population of Latin America which continues to live on less than $2 a day.73

The growing influence of Brazil, and any decline in US influence in Latin America, may provide the catalyst for the Union of South American Nations (UNASUR) to progressively integrate Latin American economies. However, substantive development into a cohesive political entity, given historic antipathy between some states, is unlikely. If, however, integration is successful it is likely to result in significant external investment, especially from China, and increasing opportunities for stability and prosperity. Large diasporas from UNASUR states may comprise 40% of the total youth population of the US, providing UNASUR with a mechanism to exert wider influence.74

Brazil is likely to remain the most significant of the emerging powers. She is blessed with significant economic and geostrategic potential and may grow her influence to rival that of China and India. In particular, she may also be the catalyst for further strengthening of south-south relationships. These relationships by-pass the contemporary powers and establish links directly between rising and emerging powers. The India-Brazil-South Africa (IBSA) group is one example. Whereas in the Cold War states could be broadly categorised with respect to their relations with the 2 superpowers, in a multi-polar world such categorisation will be impossible. More numerous and pervasive south-south political, economic and social links are likely due to the complexity of the multi-polar geopolitical framework.75

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74 US Census Bureau, August 2008.
75 The links are likely to resemble a noodle-bowl model rather than the Cold War hub-and-spoke system.
Turkey

Turkey’s geostrategic location, between Russian, EU, Central Asian and Middle Eastern influences, is fundamental to her importance. She also has a youthful population, a strong military and is likely to enjoy strong economic growth boosted by a ‘demographic dividend’. Moreover, Turkey sits astride energy transit routes that flow from east to west, with energy exports from Central Asia and the Caucasus to Europe passing through Turkey either by ship, via the Bosphorus, or in pipelines such as the BTC.76 Turkey is likely to be vital to EU energy security, providing a supply route that bypasses Russian transit lanes.

Turkey links the secular, democratic ideals of Europe to the Islamic perspectives of the Middle East and the wider Central Asian region. While Turkish society may take on more explicit Muslim characteristics, overall, despite challenges, she is likely to remain wedded to mainstream Western ideals and to retain her secular democracy. Turkey is likely to remain closely aligned to the EU, and her accession as a full member is possible, providing not only an economic stimulus for both parties, but also an effective link for Europe into the Middle East, the Caucasus and into Central Asia. Equally, it is possible that Turkey takes on an increasingly independent role in the region, seeking to define her own position and role separate from European interests; however, Turkey will remain an influential NATO state.

Iran

Iran is likely to become the most powerful state in the Middle East, although her rise to prominence will be contested. She will remain the most populous Gulf state despite experiencing a significant demographic shift: 30 years ago, each woman had an average of 6.5 children; by 2008 this had fallen to 1.7.77 She will continue her cultural leadership of the Shia. In addition, she has vast energy reserves and her geostrategic location at the crossroads of Asia and Europe dominates vital supply lines through the Gulf. In comparison with the wider region, Iran is likely to continue with its more advanced educational system, for both genders, and she is likely to continue to show a greater respect for women’s rights than is shown by some of her neighbours. Taken together, her strong cultural, economic and military advantages are likely to make her a significant regional power in South West Asia and the Middle East. As such, Iran will represent a complex challenge to the contemporary and rising powers, and as her influence grows, she is likely to shed her image as a pariah state and be treated with degree of realpolitik by the international community.

Iran is likely to be a key to stability within the Gulf Region. In the short-term she faces considerable instability that may result in changes to both the nature and style of her governance making a more inclusive and moderate Islamic government likely. Such changes are unlikely to alter her desire for regional leadership and international respect.

76 The Baku-Tbilisi-Ceyhan (BTC) project is a $3 billion investment transporting energy from the Caspian Sea via an oil pipeline from Azerbaijan, through Georgia, to Turkey for onward delivery to world markets. The Nabucco gas pipeline, is scheduled to come on-stream in 2014.
Iran is likely to continue with her more advanced educational system, for both genders, and is likely to continue to show respect for women’s rights.

Iran’s oil and gas exports constitute around 75% of government income and 80% of exports. She has the third largest proven global oil reserves and the second largest gas reserves. Despite this, Iran has been forced into periods of petrol rationing, due to a lack of domestic infrastructure investment. In the near-term, ageing fields, domestic subsidies, lack of investment and a restrictive sanctions regime may lead to greater dependence on refined energy imports. Economically, Iran has adopted national plans that resemble those of eastern Europe in the 1970’s. The large public sector is controlled by groups backed by clerical elements and the Iranian Revolutionary Guard that dominate inefficient, bureaucratic and corrupt ‘nationalised’ industries, stifling innovation and growth. Iran’s long term economic growth is likely to be strong if she can fully exploit her energy reserves and diversify her economy. Liberalisation in the banking and financial services’ sector is occurring and with an educated population and entrepreneurial class, linked to an economically successful diaspora, this is likely to support a more dynamic Iranian economy, which may begin to break reliance on the hydrocarbon sector.

Militarily, Iran views herself as a powerful regional military force with the largest Armed Forces in the Gulf Region comprising 545,000 active and 350,000 reserve members. She has sought to manufacture her own defence equipment and imports discrete capabilities from Russia, China and North Korea. She has rebuilt versatile naval forces including attack submarines and has capable air and ground forces. Moreover, the Islamic Revolutionary Guard Corps have military, maritime and air assets that can operate independently of the main Iranian Armed Forces. It is likely that modernisation of her Armed Forces will remain a national priority although the experience of Iranian proxies in

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78 US Energy Information Administration, Iran Energy Data, 2009.
Iraq and in Lebanon, and overwhelming US and Israeli conventional superiority, are likely to encourage the Iranians to further develop asymmetric tactics.

Iran may seek to become a nuclear weapons state by 2040, possibly viewing such status as a source of national prestige and security. Iran already has enrichment technology that could be used to produce fissile material for a nuclear weapon and there are widespread concerns, endorsed by the UNSC and IAEA, about possible military dimensions to its nuclear programme. Iran's pursuit of proliferation-sensitive technology has already brought her into confrontation with the international community. Unless international confidence in Iran's nuclear intentions is restored, this will remain a global security concern and may steer other states to consider a similar course.

**Other Emerging Powers**

The emergence of powers within sub-Saharan Africa, capable of leading surrounding states towards stability and economic development, is unlikely. South Africa and Nigeria have potential, but face many challenges and are unlikely to become capable of spreading stability beyond their own borders into the wider region. For example, Nigeria faces social, political and economic challenges from violent groups in the Niger Delta and an increasingly violent divide between Christian and Islamic groups. Nigeria may experience decreasing corruption and ethnic violence, as well as the development of stable political structures that allows her to achieve a degree of human security and develop her natural resources for the common good. South Africa is more likely to exert a positive regional influence, but despite lobbying for a seat on an expanded UNSC, she too faces numerous challenges and may find that the strains of regional instability are too much to overcome. For example, the whole of sub-Saharan Africa will be buffeted by global trends such as climate change that exacerbate problems with poor governance, lack of human security and economic and social development.

Powerful mercantile cities, such as Shanghai or Mumbai, may become increasingly influential within their host states, and in some cases may challenge the states control. Similarly, international governance arrangements may lead to some levers of power, traditionally residing with states, migrating upwards into multilateral or supranational institutions. Urbanisation will continue and some cities may become important power centres in their own right, although others, especially those located in weak states are likely to suffer failures in governance and instability. Cities will also become more interlinked by their communication and transport infrastructure, attracting the global economic, political and financial elites that benefit from ready access to a global network.

It is unlikely that MNCs can become true centres of power by providing alternate governance on a global or even regional scale. However, they will remain influential, for example, in 1983, the top 500 MNCs had revenues equal to 15% of global GDP but by 2007 this had increased to over 40%. State-owned MNCs, are likely to become increasingly influential, especially in the energy and agriculture sectors and, periodically,

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are likely to act as state proxies. Similarly, media and communication corporations may become ubiquitous global brands under the control of state agencies.

Terrorist groups and networks are unlikely to achieve more than fleeting impact on global power. Terrorism will remain a persistent threat, but while individual groups, such as al-Qaeda, may endure and aspire to operate from and establish their interpretation of Islamic rule in failed states, they are unlikely to be capable of destabilising well-established states. Other groups will rise to prominence and mass-casualty attacks, of similar impact and scale to 9/11, Bali and Mumbai will occur. Analysis suggests that terrorism does have a greater chance of coercing target states into making territorial rather than ideological concessions. However, historically, terrorist success rates are extremely low and this is unlikely to change. Groups, such as al-Qaeda, that have maximalist objectives and those that primarily attack civilian targets are unlikely to achieve their political objectives. 

Pivotal Regions

Pivotal regions are those whose future paths are likely to have an effect on global stability disproportionate to their geopolitical status. They represent significant strategic choke points, where trends have the potential to converge to give them importance out of proportion to their economic, political or demographic standing. These regions include the wider Middle East, the Asian Meridian, sub-Saharan Africa, the Polar regions and the Korean peninsula.

Wider Middle East

Large segments of Muslim majority countries in the wider Middle East are likely to resist social change and strive to retain their traditions and culture. This struggle, stoked by historical grievances, is likely to cause social and political tensions out to 2040. Concurrently, modernising factions will try to change Islamic society from within, seeking a model that allows traditionalism and modernity to co-exist. This competition between modernity and traditionalism is likely to cause widespread instability in the region. Radical movements (see Hot Topic Radicalisation) will continue to emerge, and national and transnational extremist groups are likely to continue using terrorism as a tactic to achieve their objectives. However, a global caliphate is unlikely, although some extremist groups are likely to harbour aspirations to establish their interpretation of Islamic rule in failed states. Change, including greater empowerment of women and a transformation in the system of education, is possible. These changes may ultimately lead to rapid development of Islamic societies, including improved governance arrangements and a more liberalised political and social model.

The Arabian Peninsula and the wider Gulf Region will remain at risk of instability and state weakness. Saudi Arabia is likely to retain her strategic importance as the world’s largest

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82 In Iraq in 2007, captured material suggested that al-Qaeda favoured the instalment of a caliphate - or Islamic government. This desire to create an emirate, from which to build a safe haven for expanding its jihad, has been a feature of its message since 2003. Council for Foreign Affairs at: http://www.cfr.org/publication/13007/

oil producer, increasing her share of world production;\textsuperscript{84} and by 2040 she \textit{will} experience a population explosion of over 50%.\textsuperscript{85} Over the same period, Yemen is \textit{likely} to see over 90% population growth.\textsuperscript{86} Consequently, a ‘youth bulge’ \textit{will} be created in Yemeni society, and this is \textit{likely} to be mirrored throughout the Middle East. While these economies and societies are adjusting to their youth bulges, there are \textit{likely} to be high numbers of unemployed youths who seek social and economic advancement through extra-legal means. Such action \textit{may} be a cause of instability within these countries, which leads to conflict.\textsuperscript{87} For example, between 1970 and 1999, 80% of civil conflicts occurred in countries where 60% or more of the population were under the age of 30 and Yemen is \textit{likely} to remain in this category.\textsuperscript{88} The collapse of such states is \textit{possible}, especially if economic and political reform does not match the expectations of the population. Such instability \textit{may} provide opportunities for ideological extremists, destabilising not only the Arabian Peninsula, but also the Horn of Africa and the global supply routes through the Red Sea and the Strait of Hormuz. Iraq’s fortunes \textit{may} rebound restoring her position as a regional force, although her neighbours are \textit{likely} to seek to moderate any rise. The smaller Gulf States \textit{may} achieve successful niche positions in finance and trade and solidify their place in the globalised core. However, they \textit{will} remain extremely vulnerable to regional instability with wider implications for the interests of other states. For example, many of the Gulf States have large diaspora populations, especially from South Asia, who provide remittance income back to their states of origin. In addition, if instability in the Gulf states forced a requirement to evacuate foreign nationals, such an operation would be on an unprecedented scale, with Dubai alone hosting one million foreign workers of whom around 500,000 are of Indian descent, and around 30,000 originate from the West.\textsuperscript{89} The Gulf States are \textit{likely} to retain their relationships with the US and the West, although they \textit{will} seek to maximise their interests with other powers, especially as the influence of China, India and Iran grows.

Israel \textit{will} be pivotal to the geopolitics in the Middle Eastern region, providing a unifying force that brings her opponents and detractors together. She is \textit{likely} to retain an economic profile similar to that of the mainstream European states and continue to be a leader in technological innovation and economic development. However, although her long-term survival seems assured, Israel \textit{will} continue to face significant security challenges, both internally and externally, especially if a long-lasting settlement with the Palestinians cannot be achieved. For Israel, the prospect of a nuclear-armed Iran, or Arab state, \textit{will} remain an existential concern. A Palestinian state is \textit{possible} in the near-term although, in the longer-term, further development of the governance and security sectors \textit{will} be required. A mutually beneficial economic relationship between Israel and an independent Palestinian state is \textit{possible}. However, continued distrust and ambivalence is \textit{likely} to make Palestine a continuing focus for discontent and violence.

\textsuperscript{84} Saudi oil production is expected to increase from around 12% of global production to around 15% by 2030. \textit{International Energy Agency, World Energy Outlook}, 2008.
\textsuperscript{85} Saudi population is forecast to increase from 26.2 million in 2010 to 40.4 million in 2040, an increase of 53%. \textit{UN Population Division}, 2008 Revision Medium Variant.
\textsuperscript{86} Yemen’s population is forecast to increase from 24.2 million in 2010 to 46.8 million in 2040, an increase of 93%. \textit{UN Population Division}, 2008 Revision Medium Variant.
\textsuperscript{88} Yemen currently has around 75% of its population aged under 30. By 2040, this is likely to fall to around 60%. \textit{UN Population Division}, 2008 Revision Medium Variant.
\textsuperscript{89} Central Intelligence Agency (CIA) World Factbook.
Pakistan will continue to face drivers of instability. However, the institutions of state, in particular the Armed Forces and its civil society, are likely to prove resilient. In the longer-term, a dynamic intelligentsia and diaspora that mitigate ongoing instability may transform Pakistani society and the fragmentation of the state is unlikely. Pakistan's nuclear weapons are unlikely to fall into the hands of extremists or be deliberately proliferated to other Islamic states. However, the security of Pakistan’s nuclear arsenal and its nuclear technological knowledge is likely to remain a significant concern for India and the wider international community.

Central Asia is likely to remain prone to state weakness and instability and the resource rich area that stretches from Suez through Central and South Asia to Xinjiang has been described, by some prominent commentators, as the ‘Global Balkans’ of Eurasia. It is an area that engages the interests of many great powers and the Central Asian Republics will become increasingly important centres of energy production, in particular gas. However, they are likely to be at risk of instability. Afghanistan is likely to struggle to retain stability although it may sustain sufficient economic growth to improve its longer term prospects.

Sub-Saharan Africa

From 2006-07, the economies of more than 30 African states grew at a rate of 4% or more and many states enjoyed rising levels of prosperity, stability, and the normalisation of governance. Moreover, new technologies, including wind and solar power stations, may also improve prospects for many rural Africans. Agricultural production may also increase given that only 4% of the continent's farmland is irrigated, and yields would benefit from better access to fertilisers, disease resistant crop strains and improved storage.

Despite these positive signs, many of the states of sub-Saharan Africa are likely to remain weak and at risk of instability. With a few exceptions, notably Afghanistan and the Palestinian territories, most of the world’s fastest growing populations are located in sub-Saharan Africa, where the population of 800 million people is likely to be over 1.5 billion by 2040 and possibly as high as 3 billion by the end of the century. Economically, despite opportunities to profit from the exploitation of resources, the states of sub-Saharan Africa will remain amongst the least developed, with widespread poverty and inequality exacerbating political, social and cultural tensions. Some bright spots of good governance and rapid economic development, such as Botswana, are likely to emerge, but poor governance, instability, corruption, rapidly growing populations and poor public health are likely to be the dominant trends. Moreover, considering Africa’s limited resilience, the worst case effects of climate change on agricultural production and competition for resources amongst major powers, many states within it may fail. Such a failure may be accompanied by widespread conflict and humanitarian and migration crises on an unprecedented scale. The Sahel region, the Congo Basin and southern Africa are likely to be at particular risk. State fragmentation along ethnic, cultural and religious lines is possible with the competing interests of major powers, often focused on resource exploitation rather than development, exacerbating this trend through the sponsorship of proxy groups for their own ends. Disengagement from Africa by the major powers is

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unlikely, especially for European states and China, given the links that already exist. In particular, the African diaspora may grow in importance. However, continuing security challenges and other priorities may lead to increased containment rather than development.

The Korean Peninsula

North Korea will continue to suffer severe problems, such as energy and food distribution difficulties. As the ruling dynasty dies out, power struggles are likely. North Korea is therefore likely to become increasingly brittle over time and suffer political collapse, most likely resulting in a reunified Korea. The transition will be fraught with tension. There will be significant scope for rapid mass population movements into neighbouring states. Furthermore, the threat of conflict with a nuclear-armed regime, increasingly aware of its possible demise, is likely to be of the greatest concern to the international community. Despite the substantial burden of transition, a reunified Korea, which may retain a nuclear weapons capability, as well as substantial economic and military power, is likely to become a significant power in East Asia, changing the regional balance of power, and causing concern to both China and Japan.
The Polar Regions

In the Arctic, technological advances and the acute effect of climate change will facilitate economic exploitation. The geographic extent of Arctic Sea ice has declined markedly over the past 50 years with the trend accelerating to reach a low in 2007, of only half its previous extent. Shipping routes, such as the North West Passage and Northern Sea Route, are likely to be open for longer periods and there may, in the summer months, be viable routes across the deep water of the Arctic Ocean, despite extreme weather conditions. The Arctic is likely to become a significant global source of fossil fuels and strategic minerals, with most deposits likely to be found in Russian territory. The division of the Arctic Ocean by the surrounding states, particularly Russia and Canada will give these states significant advantages both as centres of energy resource, and as shorter links to markets in the Far East.

The Antarctic Treaty System, which applies south of 60 degree latitude, is likely to remain extant, providing environmental protection and preventing militarisation. However, global resource pressures, coupled with improvements in energy extraction technology pioneered in the Arctic, may increase the demand for access to the region and wider economic exploitation is possible. Any significant indications of energy resources in the adjacent seas, especially in areas where disputes about sovereignty exist, are likely to exacerbate tensions amongst competing regional powers. A ‘scramble for Antarctica’ is unlikely. However within the defined treaty limitations there may be significant competition for energy and fishing resources in the Southern Oceans, with the rising and emerging powers challenging the existing patterns of exploitation.

Figure 5 – Map of the Arctic showing boundaries of claimed & disputed territories

91 International Boundary Research Unit, Durham University.
Hot Topic – The Asian Meridian

The Asian Meridian is *likely* to be an economically successful region that sits at the intersection of the Chinese and Indian spheres of influence and is *likely* to be a region of geostrategic competition. It is the region from Hong Kong in the North, through South East Asia into Australia. It has a diverse population with large Indian and Chinese diasporas and historic links to the US and Europe, in addition to treaty arrangements such as the Five Powers Defence Agreement.92 The region sits astride the global trade routes of the Malacca and Lombok Straits through which 20% of global oil production is transported, including 80% of China’s oil imports. Over 60% of global shipping travelling through these choke-points is destined for Chinese ports.93 Similarly, Japan imports over 80% of her energy needs along these routes. The importance of these choke-points is *likely* to grow out to 2040 placing the region at the intersection of probable Indian, US and Chinese spheres of influence. Moreover, Australia and Indonesia together account for almost half the world’s coal exports and Australia in particular is a large mineral exporter.94

Figure 6 – Map showing the Asian Meridian which stretches from Hong Kong to Darwin

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92 The Five Powers Defence Agreement links the UK, Australia, Singapore, Malaysia and New Zealand. These states agree to consult each other should a direct threat against Malaysia or Singapore occur.


94 In 2007, global coal exports totalled 908 million tons of which Australia exported 247 million tons and Indonesia 187 million tons. Coal Portal.
The region encompasses several states and other city states, such as Hong Kong and Singapore that are major centres of economic and financial activity. In particular, Vietnam has a large population and is likely to continue her economic development as an important manufacturing base, becoming increasingly influential within the ASEAN region.95

Australia, a partner and ally to the US, is also an Asian power in her own right and a centre of innovation, resource production and stability. She is likely to act as a bridge between the contemporary and rising powers and become increasingly influential.

China sources 80% of her oil imports through the Malacca and Lombok Straits

Islamic influences will be strong in the Asian Meridian, especially in Indonesia, Malaysia and Brunei, and amongst segments of the population in Thailand and the Philippines. Indonesia, the world’s most populous Muslim majority country,96 may experience robust economic development. However, internal problems between differing religious and ethnic groups and the disproportionate effects of climate change in the region are likely to inhibit economic and political development. Irregular activity and terrorism in support of separatism are likely and state fragmentation is possible, affecting energy exports and leading to insecurity and subsequent growth in maritime piracy, disrupting global trade.97 Any disruption is likely to elicit a multinational response with China playing a significant role.

Competition for regional influence is likely to be significant, exacerbating instability and possible disputes over resources and sovereignty (see Hot Topic - Frontier Disputes). ASEAN is likely to develop its economic interconnectivity between member states but it is unlikely to emulate the EU as a supranational power in its own right. The growth in defence spending along the Meridian will continue with investment in maritime and air capabilities being substantially increased. While these forces are primarily for defensive purposes, including countering piracy in the Indonesian and Philippine archipelagos, many states in the region will be looking to use them to reinforce claims of sovereignty, both along their borders, in the international straits and to further their claims in the contested Exclusive Economic Zone (EEZ) areas, such as around the Spratly Islands in the South China Sea.

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95 Goldman Sachs, BRICs and Beyond: N-11; More Than An Acronym, 2007.
96 Indonesia’s population is 232.5 million. UN Population Division, 2008 medium variant. Muslim 86.1%, Protestant 5.7%, Roman Catholic 3%, Hindu 1.8%, other or unspecified 3.4% (2000 census) CIA World Factbook.
Out to 2040, the position of international boundaries and frontiers is likely to be a source of tension. These tensions will either be between two opposing states, or, by an existing ethnic or nationalist group whose historic territories are divided by an international border. Most frontier disputes are settled amicably through legal arrangements. For example, in 2008 Russia and China settled a century old dispute regarding their Amur River border. However, other frontier disputes are less liable to be settled amicably, especially where ethnic differences are aggravated by inequality and also historical antagonism, and where access and ownership of scarce resources are involved. For example, in 1990, part of the Iraqi justification for the invasion of Kuwait centred on ownership of cross-border oil reserves. Maintenance of territorial integrity and the importance of clearly defined boundaries to both established states and an expanding patchwork of smaller states will continue to be an important security concern. Lack of clarity may generate tension and instability, and provide a possible trigger for conflict. Factors that exacerbate tension and the probability of conflict are likely to include: resource ownership; ethnic, religious and ideological differences; the presence and scale of any recent conflict; the involvement of other interested parties; the likelihood of successful negotiations; the presence of a fence or wall that denies movement; and the degree to which a border is clearly defined.
There will be continued tension over boundaries that artificially divide perceived ethnic, national or religious communities. This is likely to result in continuing tension in the Caucasus, along the boundaries of regions inhabited by Kurdish majorities and in sub-Saharan Africa, especially in the Sudan, amongst others.

The UN Convention on the Law of the Sea (UNCLOS) will be a factor in maritime boundary disputes. It defines maritime boundaries and the limits of maritime claims. Disputes between states can arise where claims to an EEZ or an outer Continental Shelf overlap. Where the overlaps are generated by features or islands whose positions or sovereignty are disputed, third party intervention is often needed to resolve the issues. The Convention provides its own dispute resolution framework, and the International Court of Justice also decides disputed cases. At present, about 50% of maritime boundaries are determined; the remainder represent the more difficult boundaries in areas with disputes, and progress to resolve them is slow. Drivers for resolution of maritime jurisdiction are provided by the need to exploit oil and the need to manage fisheries and by 2040, one can expect to see fewer unresolved boundaries representing the more intractable disputes. Global hot spots for maritime disputes will continue, as currently seen in the South China Sea, the Far East and South America. Military confrontation cannot be ruled out, but it is likely to be the exception rather than the norm.

**Figure 7 – Analysis of Frontier Disputes Shows Areas With Most Potential for Conflict by 2040**
Key Theme – Evolving Defence and Security Challenges

Scope

This key theme builds on preceding chapters in order to consider how they will shape conflict out to 2040. Since the Cold War, the likelihood of major inter-state warfare has been perceived as being more remote while instability, societal conflicts and terrorism have frequently led to confrontation and crisis. The sources of potential conflict worldwide have increased and their forms have diversified. The global system has become increasingly interdependent and interconnected and has given conflict, wherever it occurs, a global dimension. Some states and non-state actors, such as terrorist groups, have gained increased global reach. All of these trends are likely to continue. However, out to 2040, they are likely to converge with others, and further significant change in the character of conflict can be expected. Powerful states, such as China, are likely to continue their rise. Along with others, they are likely to develop military equipment that rivals that developed by the Western powers, and export it to partners and proxies. While stringent efforts will be made to prevent it, WMD are likely to proliferate and the likelihood of their usage will increase. Instability within states will continue. The incidence of armed conflict is likely to increase. In an era of persistent challenge, adaptation and evolution, complex problems are unlikely to be solved by military power alone, and integrated, multinational approaches will be the norm.

Evolving Defence and Security Challenges analyses trends in:

- The Contemporary Military Context.
- Trends in Armed Conflict.
- Technology and Conflict.
- Balance of Military Power.
- The Proliferation of Weapons of Mass Destruction.
- Evolving Legal Norms and Legitimacy.
- Future Conflict.
- Responding to the Challenges of Future Conflict.

The Hot Topics in this theme are Defence and Security, The Future of Deterrence, The Importance of Influence and Characteristics of the Future Operating Environment.

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98 This section incorporates work published by DCDC in 2009 and 2010 on the Evolving and Future Characters of Conflict.
Figure 8 – Current and Future Regions of Multiple Stress

The top map plots current estimates of demographic growth, water and food shortage, and crop decline. The shaded area represents regions where 2 or more stresses overlap. A representation of current conflict is then overlaid and, although direct cause and effect is not implied, there is a degree of correlation. The map below takes forecasts of the same variables out to 2040 and shows that the multiple stress zones are likely to extend into Central and East Asia. This will result in challenges for states in these regions and may increase the likelihood of conflict. The area shaded in yellow represents the further expansion of multiple stress zones to include densely populated regions at risk from climate-induced coastal inundation.

The Contemporary Military Context

It is impossible to assess trends in future warfare without first seeking to understand the contemporary military context, both globally and in the UK. Military power is an agent of policy and will remain so. However, once started, conflict has its own dynamic that can drive policy. Military power cannot be separated from the diplomatic and economic levers of power. Additionally military power cannot be considered in isolation in the chaotic and complex strategic environment. These levers of power, amplified by the growing power of information, form the armoury of statecraft; the use of wisdom and judgment that blends hard and soft power in an integrated pursuit of national interests; however, these levers can be destabilising if used with miscalculation and adventurism.

Strategy is one element in the practical application of statecraft. It seeks to align objectives, concepts and resources to increase the probability of policy success. It applies rationality and linearity to circumstances that may not be either and, despite appearances and expectations, is therefore primarily an art rather than a science. It is most effective when it anticipates and leads change. Strategy is time sensitive; timing and rate of change matter. Strategic stability, such as that enjoyed by the West at the end of the Cold War, provided little impetus for change, and strategic advantage reduced this impetus further. Western strategy has therefore too often focused on the short-term, and made it difficult to advocate strategies that pre-empt major upheavals in the strategic environment. Such proactive strategies for change can be deferred as a result of the preference for near-term stability and the avoidance of political risk. The attacks of 9/11 significantly disrupted the strategic equilibrium. Out to 2040, more numerous, rapid and complex changes are likely to require far-sighted and agile strategies.

The evolution of conflict is not linear, nor is it driven by single factors such as technology, economics, religion or geography. Rather the character of conflict evolves in close relation to changes in the broader strategic context. Technology sets the parameters of the possible, but it is human endeavour and ingenuity, expressed through innovative strategy, tactics and doctrine, that generate radical changes in the character or conduct of war. These radical changes are often termed Revolutions in Military Affairs (RMAs). They are frequently acclaimed in marketing strategies and academic papers, but in reality they are rare. Two understandings of what constitutes an RMA have emerged and are often conflated. The first refers to a relatively rapid change at the operational level of war, usually brought about by harnessing new technologies to new concepts of operations. The second is a concept of revolution in a larger sense, epochal upheavals in which society itself is transformed. The ‘*Levée en Masse*’ during the French Revolution is an example, as are the changes in warfare brought about by industrialisation in the 19th Century.

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102 During the French revolution, in response to the dangers of foreign war, the Committee of Public Safety established a mass conscription (*Levée en Masse*) and succeeded in training an army of about 800,000 soldiers in less than a year. This was much larger than any army available to other European states, and laid the basis for Napoleon’s domination of Europe. In addition to bringing out the creativity of the Committee of Public Safety, the *Levée en Masse* represents a turning point in the history of warfare and the starting point of ‘total’ war involving all elements of the population, and all the reserves of the state.
At the operational level, information-age technology has spawned concepts such as Rapid Dominance\textsuperscript{103} that suggest Western technological superiority allows it to define war on its own terms, as exemplified, by the defeat of Iraq’s conventional Armed Forces in 2003. Much current capability and thinking about conflict dates from such operational-level concepts and has produced some clear benefits, such as Network Enabled Capability (NEC). However, the operational-level RMA concepts cannot be a complete solution to the problems of conflict. Adversaries have adapted to counteract the West’s preferred way of warfare, seeking a variety of ‘high-end’ and ‘low-end’ asymmetric techniques, ranging from suicide attacks and improvised explosive devices through to the innovative use of technologically advanced weaponry and the development of agile, resilient, decentralised organisational structures.

At the strategic level, and over a longer time-scale, the ongoing transformation of society at the global level is likely to be reflected upon as resulting in a RMA. The multi-faceted process of globalisation is likely to continue this transformation of both global and local societies over the next 30 years, causing comprehensive changes in the character of conflict. Public perceptions will matter, both in the West and elsewhere. The nature of the changes cannot be predicted in detail, but they are likely to be wide-ranging and focused on national interest, the importance of influence rather than just kinetic activity, on networks of states, groups and individuals rather than hierarchical structures and organisations, and on agility and asymmetry rather than the simple balance of military power.

This societal-level RMA poses several dilemmas for Western defence strategists, especially given the associated requirement to prevail in current conflicts. First, strategy is best when based on pragmatism not ideology. Additionally, it should be derived from, and rooted in, core national interests.\textsuperscript{104} The second dilemma is to understand the specific problem, given that future conflict will take many forms. This inherent unpredictability has traditionally been mitigated by spreading risk, for example, by maintaining a range of balanced forces as a hedge against uncertainty. For the majority, if not all, states this approach is likely to become prohibitively expensive due to the pressure on financial resources combined with the increasing scope of conflict. States are therefore likely to seek alternative strategies to manage risk including increased interdependence and burden-sharing with traditional allies, the formation of new partnerships with states and groups that share common interests or values. States are also likely to recognise that the military cannot be used to achieve rapid effect at relatively low cost and with limited risk. The third task of strategists is to achieve an asymmetric edge, such that when required, the state maintains a capacity to apply power in order to deter, coerce, shape and seize the initiative, or alternatively to respond to the unexpected. In the past, the Western way of warfare put a high premium on technology and organisation to deliver this edge. While both factors remain vital, achieving sufficient

\textsuperscript{103}Rapid dominance, also known as ‘shock and awe’, was a military concept based on the use of overwhelming power, dominant battlefield awareness and manoeuvres, and spectacular displays of force to paralyse an adversary’s perception of the battlefield and destroy its will to fight. Ullman H.K and Wade J.P, \textit{Shock and Awe: Achieving Rapid Dominance}, US National Defense University.

\textsuperscript{104}Flournoy M, brief to the US Army Leadership Forum, 2009.
mass is already problematic and this will become increasingly more so especially as technological advantage is likely to wane.

Trends in Armed Conflict

Since the end of the Cold War, the incidence of armed conflict declined, reaching a low in the early 21st century. Quantitative studies reveal that there were fewer inter-state and intra-state conflicts, and despite global population increases, fewer battle-related deaths. However, conflict has become more pervasive both in terms of participation and public perception. The number of states engaged in armed conflict has increased to its highest level since 1945, mainly due to participation in multilateral wars. Moreover, the number of active peacekeeping operations has doubled when compared to Cold War levels, with around half of these being conducted under the auspices of the UN. The number of new armed conflicts erupting each year has been consistent and the decrease in active conflicts since 1990 is due to the resolution or freezing of older conflicts. The public perception of conflict has been shaped by media coverage. Enabled by rapid advances in communications technologies, this coverage has made conflict more conspicuous by distributing near real-time images and information to every corner of the globe.

Since 1945, the average lethality of war has reduced for combatants and annual totals for battle-deaths have declined steadily. However, the decline in battle-deaths alone does not paint the full picture. On average, inter-state wars have typically lasted around 3 years, civil wars just over 5 years, and ethnic wars nearly 10 years. Moreover, since 1945, one-third of large-scale insurgencies have been linked to mass killing of civilians, as in the Democratic Republic of Congo (DRC), Rwanda and Darfur. For example, in the DRC, war resulted in an estimated 145,000 battle-deaths, but around 300,000 violent deaths of civilians, and up to 3 million deaths from all war-related causes, the most significant being disease and deprivation. High numbers of civilian casualties, despite declining numbers of combatant deaths, will raise ethical questions regarding the legitimacy of operations, proportionality and the importance of human security. Any lack of legitimacy will undermine soft power activities. However, disproportionate civilian casualties are likely to continue as long as irregular and societal war ‘amongst the people’ remains dominant and the incidence of inter-state war, typically associated with high numbers of combatant deaths, remains depressed.

In the aftermath of the 9/11 terrorist attacks, the incidence of armed conflict has increased following a period of decline since the end of the Cold War (see Figure 9). Out to 2040, the incidence of armed conflict is unlikely to resume its downward trend and is likely to increase, driven by a number of factors. First, the uni-polar US-dominated world order has already started to develop a more multi-polar distribution of power, and this evolution...
will continue. Such a change can have positive effects, by forcing states to find multilateral solutions to common problems. However, it also leads to instability in the international system and is likely to offer the opportunity for suppressed state rivalries to re-emerge, increasing the potential for competition and confrontation between regional powers. Similarly, some of the conflicts frozen since the end of the Cold War may thaw quickly. Second, global inequality is likely to remain widespread and will be made more explicit as access to globalised media increases. This access will heighten inequality associated grievances, by making them more apparent to those who lack, or are denied, opportunity. Third, population increases, resource scarcity and the adverse effects of climate change, are likely to combine, increasing the likelihood of instability and of disagreement between states, and providing the triggers that can ignite conflict. Finally, since 1990, the absence of a clear ideological divide, such as existed between the West and the Soviet bloc, has contributed to the decline in conflict. Out to 2040, political and religious ideologies that espouse populist or belligerent narratives are likely to grow in importance (see Hot Topic – The Resurgence of Ideology). All of these factors will be exacerbated by periods of global economic recession. Other factors are likely to mitigate some of the risks. For example, inclusive and effective global governance institutions and economic interdependence are likely to have a stabilising effect. However, on balance, these factors are unlikely to further reduce the incidence of conflict.

Regionally, conflict is not evenly distributed, with the majority of recent conflicts erupting in Africa and Asia (see Figure 8). Moreover, in the post-Cold War era, 77% of all international crises involved one weak state, a significant increase on the Cold War era, and suggestive of a link between economic and social development, and conflict. Regions that have a recent history of conflict are particularly at risk, as are states that possess significant natural resources or are of geostrategic importance. Most weak states are located in Africa and Asia (see Figure 4) and the greatest likelihood of future conflict will continue to be in these regions.

110 For example, the Russo-Georgia conflict in 2008.
Out to 2040, the UK is *unlikely* to become disassociated from global trends. Political choice *will* continue to be the most important factor in determining when, how and if the UK Armed Forces experience combat. In particular, considerations regarding the UK’s role in the international system, its alliance commitments and the degree of engagement to protect global interests *will* be important. Casualty rates *will* continue to have an important effect on these political choices and on public support. Nevertheless, concepts of casualty acceptance and aversion are *likely* to remain linked to perceptions of the importance and legitimacy of the conflict, and the likelihood of success, rather than a simple compassionate response.

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Figure 9 – Global Trends in Armed Conflict

![Figure 9 – Global Trends in Armed Conflict](image)

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111 Source: Centre for International Development and Conflict Management (CIDCM).
Out to 2040, the incidence of armed conflict is likely to increase
Defence and security are linked, but different, concepts. Defence primarily refers to states and alliances resisting physical attack by a third party.\textsuperscript{112} Defence is about the survival of the state and is not a discretionary activity. Security is a contested concept that can never be absolute. It is therefore, to some extent, discretionary. It implies freedom from threats to core values both for individuals and groups.\textsuperscript{113} The decline in the incidence of interstate war and the emergence of transnational threats, especially in the developed world, has resulted in greater political emphasis being placed on security rather than defence. Moreover, security has gradually evolved from the concepts of national and international security to the idea of human security.

Out to 2040, defence and security will remain vital, both in the virtual and physical domains, including space and cyberspace. However, defence is likely to increase in importance as population growth, climate change, resource scarcity and instability, threaten the ability of states to provide for their populations. These factors are likely to result in an emphasis on defending access to the physical necessities of survival. Many of these necessities will be international and linked to globalisation, implying the need for major powers to operate globally and for alliances and partnerships that defend common interests. These common interests make it likely that the needs of the many often outweigh individual rights. Hence, to some extent, the trend towards human security rather than international and national security, is likely to be reversed. It should be noted that defence activity is unlikely to be conducted solely by military forces, and should not be conflated with military activity, nor will security activity be purely the domain of security forces.

Hot Topic – The Future of Deterrence

Out to 2040, discouraging conflict will be increasingly important, especially as the strategic balance of military power shifts away from the US to a more multi-polar distribution. Deterrence will remain a vital conflict prevention tool. The object of deterrence is to maintain the status quo by preventing real or potential enemies from initiating hostile acts. It is related to, but different from coercion, where the goal is changing the behaviour of an adversary, so changing the situation. To be effective, deterrence must be credible, capable, and clearly signalled such that the target audience fully understands the consequences of their behaviour. The main expression of deterrence has often been nuclear weapons, but most military forces have a deterrence role. As the scope of conflict broadens so will the scope of deterrence and many actors can be expected to develop, for example, cyber deterrence capabilities, as well as mechanisms to deter adversaries in the economic, financial and other domains.

Nuclear deterrence will be complicated by the emergence of more actors capable of delivering WMD at range. Instability is likely, until states develop the necessary understanding of diverse political and strategic cultures required in a multi-polar world, and cope with the reality of horizontal proliferation and a rising number of de facto nuclear weapon states. Existing arms control mechanisms are likely to endure in some form and relationships between the established nuclear powers are likely to remain stable. Relationships between the established nuclear powers and those who are currently developing their own nuclear capability may arise, although the challenge of maintaining effective communication will be high. Broader participation in arms control may be achieved, although this is unlikely to reduce the probability of conflict. Effective ballistic missile defence systems will have the long-term potential to undermine the viability of some states’ nuclear deterrence.

Much activity will focus on deterring irregular actors, including terrorists. This includes deterring them from acquiring and employing CBRN materials, but also from committing more conventional violent attacks. Some individuals and groups are unlikely to respond to deterrence, but most groups with political objectives, including many of those that espouse religious narratives, are likely to act rationally and respond, provided deterrence is intelligently focussed and signalled. This will require detailed study of individual groups in order to develop a deep understanding, rather than blanket application of a universal deterrent solution. Even groups that seemingly have nothing to lose, such as groups that espouse suicide attacks, will continue to value and protect their ideology, cause and narrative. Moreover, many irregular actors have links to states that will recognise and respond to both deterrence and coercion. Some groups that remain resistant to deterrence will respond to coercion, including non-kinetic methods such as investment in development, while others will necessarily be subject to disruption and attack.

Technology and Conflict

Technology has already broadened the scope of conflict from the land, maritime and air environments to encompass cyberspace and space. It offers new possibilities for conflict and is exploited through innovations in organisation, strategy and tactics. Out to 2040, rapid technological innovation will have a significant impact on the evolving character of conflict. It will continue to be a double-edged sword, offering advantages to major powers able to afford the most advanced technologies, but also to entrepreneurs and innovators who collaborate to find new uses for existing technologies. These entrepreneurs, including smaller states and non-state actors, will rapidly be able to adapt strategies, whereas major powers are likely to suffer from institutional inertia and the financial drag associated with large weapons programmes.

For the first half of the period out to 2040, the vanguard for technological development is likely to continue to shift from the state to the commercial sector. The proliferation of these commercial systems and technologies will allow allies and adversaries to be similarly equipped, if they can afford to buy on the open market. Developing states and non-state actors will rapidly be able to exploit low-cost, evolving and emerging technologies to gain an asymmetric advantage. However, for the latter part of the period, the trend towards the commercial sector may slow or even reverse as states focus on self-interest and invest in research to combat climate change, resource scarcity and other challenges.

Since the end of the Cold War, the largest suppliers of conventional weapons to the international arms market have been the US, Russia, Germany, France and the UK. The major purchasers have been China and India, with Asia accounting for 37% of trade, Europe 23%, and the Middle East 22%. The overall level of transfers has increased from a low in 2002 and is valued at around $45 billion per annum. Forward orders suggest that the volume of international arms transfers is likely to increase during the first half of the period and that Saudi Arabia, Libya and Taiwan are likely to feature as major importers.

The future strategic challenges faced by major powers are unlikely to be resolved by technological ‘magic bullets’ alone. However, wealthier states, especially those with shrinking populations, may be seduced into favouring complex technological solutions over more traditional, human approaches, despite struggling to meet the associated costs. The dominance of technological quality over quantity, exemplified by the conventional combat phases of the Gulf Wars, where mass was superseded by sophisticated weaponry and improvements in organisation and training, will be challenged. The value of the human will remain critical in people-centric operations where influence is vital, and some military tasks will remain both manpower and equipment intensive. The trend towards highly specialised weapon systems that prevailed throughout the Cold War has resulted in their adaptation for use in new contexts. However, high associated costs, novel weapon technologies and the multitude of potential tasks faced by militaries will make simple, versatile, kinetic weapons invaluable. This is true for developed states, but also for

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irregular actors who will seek to use simple, flexible and inexpensive weapons, such as improvised explosive devices (IEDs) to achieve effect at all levels of conflict. Technology inevitably spreads, and no military has ever enjoyed a perpetual monopoly on any capability. The technological advantage enjoyed by the West since 1945 is likely to be eroded as technological diffusion and strengthened Research and Development (R&D) activity, particularly in Asia, feeds through to weapons production. For example, in some areas, China’s military equipment available for export to potential adversaries is likely to be comparable to European equipment by 2020 and approach US standards by 2040.117 Technological parity is likely to challenge a Western paradigm of war; that technology can replace mass and lead to rapid, decisive effect.118 Moreover, combat between equally matched adversaries is likely to result in escalating numbers of casualties. This changing paradigm will also require the ability to plan for modes of conflict with adversaries that leverage niche high-tech capabilities and employ innovative concepts of operation.119 For example, regional powers armed with precision-guided missiles and anti-access technologies, such as submarines, cruise missiles and sophisticated surface-to-air missiles, may make traditional power projection strategies infeasible.

The development of networked systems will continue. Access to information will spur knowledge and understanding, and act as a critical enabler in future conflict. Irregular actors will continue to use widely available technology such as the Internet to both conceal and promote their activities. Similarly, developed states will seek to integrate and synchronise platforms, sensors and shooters in a quest to lessen the ‘Fog of War’. Although technical improvements will be considerable, tactical advantage is likely to be short-lived as adversaries rapidly adapt.

The dominance of technological quality over quantity will be challenged

The Balance of Military Power

The balance of military power will become multi-polar, although the US is likely to remain pre- eminent. Confronted with few direct territorial threats and ageing populations, most affluent societies are likely to minimise their defence expenditure by investing in conflict prevention, burden-sharing through participation in alliances, and contracting out security. The US is likely to be the exception, making by far the greatest commitment to defence, although its economic power and technological advantage is likely to become increasingly challenged. These developments are likely to make intervention operations increasingly fraught with military risk, unless they command widespread multilateral support. Adversaries will seek to prolong conflict if they consider it advantageous, targeting the cohesion of alliances, coalitions and public support. Prevention strategies offer the attraction of avoiding conflict, with associated human and financial savings. However, they will require sustained investment, and patient and intelligent implementation, and are unlikely to be entirely successful as partnership rests upon a shared assessment of risk and reward. Moreover, success will be difficult to measure and require early political engagement and commitment of resources.

Defence spending of the rising powers is likely to increase in proportion to their economic growth and their expanding range of global interests. Sino-US rivalry is likely and active hostility and belligerency, especially through proxies, is possible. However, direct war between the world’s foremost powers remains unlikely. China is likely to seek a range of important asymmetric capabilities in the form of an ‘assassin’s mace’ of deterrent, compellent and attack capabilities for immediate regional requirements that offset US offshore maritime capability. This is likely to constitute 2-tier armed forces, consisting of nuclear weapons and large relatively unsophisticated forces for territorial defence, together with smaller higher-capability forces for power projection, predominantly within their sphere of interest rather than globally. Low-income states will continue to operate forces that, in principle, are organised along conventional lines, but will probably bear a closer resemblance to the irregular armed groupings operating locally within them. However, the diffusion of technology is likely to provide even low-income states with some access to advanced weaponry that adds risk and complexity to the battlespace.

Alliances and partnerships, linked to spheres of influence, are likely to be fundamental to the future balance of military power. Their nature and objectives are likely to reflect geopolitical reality and be linked to the fears and interests of their constituents, which may be both state and non-state. NATO is likely to endure and remain the basis for collaboration between western states, performing the vital roles of facilitating political dialogue and military interoperability between members, partners and prospective partners to underpin multinational operations. The defensive alliance at its heart will remain extant. A full and constructive partnership between NATO and Russia is unlikely. The US, however, will increasingly view Asia and Latin America, rather than Europe and the Middle East as the focus of threats to its security. Additionally political difficulties are likely to persist, complicating NATO’s utility as a collective security implement. NATO expansion, particularly into the Caucuses, is possible, but most probably through

120 An ‘assassin’s mace’ is used to designate a wide array of technologies that may afford an inferior military an advantage in a conflict with a superior military power.
partnership arrangements rather than formal alliance. Other alliances and partnerships, with political, defence and security objectives will emerge, focused primarily on the major powers and their spheres of influence, although they are unlikely to be ideologically opposed blocs, as seen during the Cold War. Rather, the alliances and partnerships are likely to share some common security interests, such as the protection of the global supply chain, and are likely to cooperate with each other, within the framework of a globalised world, rather than simply confronting each other along fixed frontiers.

The defence spending of rising powers is likely to increase

Hot Topic – The Importance of Influence

Military operations will focus on influencing people. Despite the unifying effect of globalisation, people from dissimilar cultures will continue to act and think differently, depending on their personal and group context. Hence, knowledge and understanding will be required of how people from different cultures think; what symbols, themes, messages, etiquette and practices are important; how systems of reciprocity or kinship function, and how these establish deep allegiances and social obligations. Relevant groups will include domestic audiences, key regional leaders and populations, coalition partners, diaspora communities and broader international opinion.

In conflict and confrontation, most actors will place considerable emphasis and dependence on the psychological rather than just the physical. All military activity, including force, will continue to be designed to influence, and is likely to be planned and executed in support of a campaign narrative. Technology will enable the development of extensive social networks that in turn will multiply opportunities for those seeking to achieve influence through the distribution of recorded images. This imagery, combined with simple, fluid narratives, can shape both local and global perceptions. Individuals, groups and states will be subject to influence from sensational acts of terrorism, such as
mass casualty events or executions, conducted to influence populations. Terror attacks are likely to demoralise and encourage, intimidate and motivate with messages highly tuned to specific target audiences in order to alter opinions.

Knowledge will empower and enable, even when the physical contest cannot be won. Information and intelligence gathering systems will be required to provide knowledge about people’s perceptions, beliefs and opinions, and how they can be influenced. Influence will be attained when the behaviour of the target audience changes through the coordination of all levers of power including military action, words and images. Influence will not just be about messages or media, but how the combination of word and deed are portrayed, interpreted and understood through the lens of culture, history, religion and tradition. Speed of response is likely to be vital and first impressions will count. Notions such as winning and victory are likely to be of little relevance if an adversary can remain credible in the battle space of ideas.

The Proliferation of Weapons of Mass Destruction

Nuclear proliferation will be a significant factor affecting global security, especially as the transition to a multi-polar distribution of power brings change and uncertainty. The number of nuclear weapon states has gradually increased, although this increase has not been linear. The long-term credibility of treaties designed to limit nuclear proliferation and the reaction of the international community to proliferation by Israel, Pakistan, India, Iran and North Korea will affect the decision-making in states tempted to acquire nuclear weapons. The policing regimes associated with nuclear non-proliferation are likely to be increasingly intrusive. Some states, such as Iran, will view development of nuclear weapons as both a security guarantee and a source of national prestige. Other states, such as Japan, Saudi Arabia and South Korea, faced with nuclear armed neighbours and concerns over US commitment to their security, may react by creating deterrent forces. While this raises the spectre of regional arms races it may, paradoxically, bring a degree of high-risk stability to regional relations provided a mutual understanding of motives and red-lines can be reached rapidly. However, some states may view tactical nuclear devices as weapons rather than deterrents. States, and extremist groups, lacking the technical ability to develop nuclear weapons and appropriate delivery systems may seek to purchase the knowledge, materials and technology via illicit channels. However, terrorist groups are unlikely to acquire deliverable nuclear weapons without state sponsorship, but are likely to acquire some aspect of a biological, radiological or chemical weapons capability, ranging from simple devices with localised effects through to mass casualty attacks. Although less than 10 states have offensive chemical and biological weapons programmes, the number with the potential capabilities to produce such weapons is likely to increase in the future. Some of those who seek to achieve strategic effect at the expense of legitimacy, especially terrorist groups, are likely to use them. The choice of agent in the future is likely to be determined by the need to defeat defensive measures; circumvention of arms controls; credible denialability of use; and ease of production within existing industrial facilities. In particular, the production of chemical and

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121 Such treaties include the Non-Proliferation Treaty and the Comprehensive Test Ban Treaty along with numerous others.
122 For example, in 2007 Iraqi insurgents used chlorine truck bombs as improvised chemical weapons.
biological agents will be difficult to detect and counter when legitimate industrial and pharmaceutical facilities are used. Attacks, akin to those carried out by the Aum Shin cult in Tokyo are probable.

Evolving Legal Norms and Legitimacy

Future conflict will continue to be characterised by disputed interpretations of legitimacy. Western norms for conflict based around notions of *jus ad bellum* and *jus in bello*,\textsuperscript{123} and the widely accepted Hague and Geneva Conventions, are likely to be challenged by alternative paradigms for the conduct of conflict. Furthermore, the application of domestic law and international human rights obligations may result in unanticipated restrictions. In general, affluent and well-integrated states are likely to promote international legal norms, while poor and weakly-integrated states and non-state actors are likely to be guided by different norms that develop from their individual circumstances. While the majority of states will continue to legitimise their actions under existing international law, constraining international legal arrangements may become such an impediment to the achievement of strategic objectives that they are bypassed or ignored; competition for resources, for example, may exacerbate unconventional interpretations of international law.

Conflict classification, and the legal envelope for operations, will contribute to the complexity of future conflict, creating major challenges for those engaged in the planning and conduct of operations. The challenges to legal norms and legitimacy include: the blurring of roles between civilian and military, regular and irregular; the chameleon-like behaviour of groups that switch identity, being concurrently organised criminals, terrorists, insurgents and agents of a state; the varying national and cultural interpretations of what constitutes legitimate behaviour; novel means and methods of conflict, for instance in cyberspace; the implications and effects of armed conflict on regional social, economic and financial security; and, the employment and role of Private Military Security Companies (PMSCs). Kinetic operations amongst the people, rather than around them, will require the most careful prosecution to remain within the taut legal framework of

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\textsuperscript{123} The laws of war are divided into 2 categories: *Jus in bello*, law concerning acceptable conduct in war; and *Jus ad bellum*, law concerning acceptable justifications to use armed force.
combatant/civilian distinction. Advanced weapons capable of great precision and discrimination will be available to both state and non-state actors; however, widespread technological diffusion of communications technology, for instance, will also make indiscriminate improvised weapons more accessible. States will be more constrained in the conduct of operations than many non-state actors.

Future Conflict

Conflict will continue to evolve, reflecting developments in society, politics and technology, and involving a range of transnational, state, group and individual actors. These actors will operate wherever they can gain advantage, broadening the scope of conflict beyond the pure military domain. The strategic, operational and tactical levels of war, as well as the physical and virtual environments, will become increasingly compressed, porous and difficult to differentiate. Activity at one level, or in one environment, will have effect in others. This compression will shape the character of military activity, demanding increased discrimination and judgement about how to deal with situations holistically; both from military forces and from the political leaders who employ them. Economic, financial, legal and diplomatic conflict are all likely, challenging legal norms, and requiring coordinated and integrated responses in order to protect from and respond to attacks. Orbital space and cyberspace will be part of the battlespace in the same manner as the air, land and maritime environments, but activity will also expand underground, into the deep ocean and other extreme environments. Complex cross-environment links will continue to make it difficult to constrain conflict to geographic localities. The technologies employed and the tactics and techniques practised are likely to converge as adversaries rapidly learn and adapt from each other.

Potential adversaries range from potent state military forces through to disorganised and poorly equipped groups, and even individuals. A single adversary may constitute an amalgam of regulars, insurgents, terrorists, irregulars, and criminals. Political violence will often be indistinguishable from criminal violence. Criminal elements will become more sophisticated; they may have access to military hardware and will be comfortable operating in cyberspace. Many of these groups will share information, lessons, tactics and procedures where they see mutual benefit and be unencumbered by bureaucratic process. Many will adapt rapidly to changes in the environment or context. These adversaries may be structured as distributed social networks with no identifiable structure or coherence, and no recognisable centre of gravity.

The distinction between inter-state and intra-state war, and between regular and irregular warfare, will remain blurred and categorising conflicts will often be difficult. State actors are likely to develop an increased capability to conduct irregular activity and non-state actors are likely to employ a broad range of capabilities, some of which have traditionally been associated with states. For example, some non-state actors will deploy advanced technological capabilities while continuing to use irregular tactics and formations, sponsor terrorist acts, and provoke criminal disorder.124 This blurring was demonstrated in the 2006 Lebanon War when irregular Hezbollah units defended territory against Israeli forces, utilised high-tech weaponry such as unmanned air vehicles and stand-off missiles.

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and sought to provide humanitarian relief to those affected by the conflict. Even in the developed world, some non-state actors are likely to deploy capabilities beyond the ability of law enforcement agencies to counter in isolation, requiring the use of military, paramilitary or other security forces, such as cyber security groups. However, not all actors will embrace this form of multi-modal conflict, with some restrained by ethical, cultural or legal constraints from operating across the full spectrum. In particular, some states will lack the confidence in their own cohesion to develop the force structures necessary to conduct irregular conflict.

Out to 2020, instability, the threats that radiate from weak states and transnational terrorism are likely to remain the dominant Western military paradigm. Conflicts generated by horizontal inequalities, in particular, the intersection of economic, social and political inequalities with ethno-nationalism, are likely to remain particularly intractable. Internationalised intra-state conflict and associated irregular conflict will frequently be characterised by inter-communal violence, terrorism, insurgency, pervasive criminality and widespread disorder as experienced in Afghanistan and Iraq. Military operations in support of stability are likely to be multi-faceted and blur elements of high intensity combat, with the requirement to establish security and to provide for the needs of the population. These operations will be multinational, and dependent on wide interoperability between a multitude of partners, both civilian and military. Intervention, on the back of US military dominance, to stabilise weak states will be a feasible policy response, although the gradual rise of multi-polarity will make such strategies less attractive, especially when other major powers oppose such activity. Direct inter-state conflict between major powers is unlikely given the legacy of US military hegemony and interdependence that raises the cost of conflict. However, inter-state rivalries are likely to be expressed through proxies that have linked or complementary objectives. Many of these proxy forces are likely to employ irregular tactics including terrorism, while concealing and refuting links to state sponsors in order to preserve their freedom of action and maintaining a degree of deniability for the state. Proxies are unlikely to follow predictable paths and are likely to prove difficult to control over time.125

From 2020, Western military power is likely to evolve, particularly in response to the changing balance of military power and the likely proliferation of WMD. Major powers are likely to find many areas of shared interest to facilitate cooperation, but they will also find issues on which cooperation is impossible. States, such as China and India, are likely to close the technological gap with Western powers in certain areas and will maintain strong military forces and defence industries that will export advanced military equipment to partner states and proxies. This proliferation is likely to alter the strategic balance of military forces. Threats will still radiate from weak states, but the potential threats posed by some, more powerful, states and their proxies will become more relevant.

Total war,126 harnessing the full power of industrial states, war between major Western powers, and war between liberal democracies, are unlikely.127 However, disagreements

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125 For example the Taleban have proven difficult to control for the Pakistani state intelligence services.
126 For example, World War II.
between major powers over borders, influence and resources are probable and may lead to confrontation, including limited wars, where adversaries deliberately exercise restraint in the methods of conflict, their level of commitment or the objectives sought. In such confrontations and conflicts, which are likely to be conducted using proxies and be coalition-based, much emphasis will be on diplomatic and economic levers of national power.

**Responding to the Challenges of Future Conflict**

Future strategic challenges are unlikely to be successfully addressed through utilisation of single levers of power, or unilateral responses. Military power will be necessary, but not sufficient. Similarly, hard power will be important, but combining it with soft power in a smart strategy is likely to be vital. The national security of major powers will dictate that they engage globally, and to a greater or lesser extent, multilaterally, in order to maintain the international system and ensure a degree of shared access to the global commons. For example, international terrorism, transnational organised crime, climate change, the proliferation and probable use of WMD, particularly chemical and biological devices, uncontrolled migration and cyber attacks are impervious to single-state or one-dimensional policy responses. In particular, the need for shared access is likely to mean the multilateral coordination to secure supply lines, robust alliances and partnerships, and a varying degree of commitment to international legal norms.

States will seek to integrate their national levers of power. Military force is unlikely to be effective as a discrete form of response. This need to integrate and synchronise responses is likely to result in increased international cooperation and the formation of new alliances and partnerships. Interoperability between joint and coalition military forces will be vital. Training of partners, including state militaries, other arms of government and non-state partners, such as PMSCs and others, will grow in importance. The parallel challenges of state-sponsored proxies and instability in weak states is likely to make investment in capacity building and partnership a significant task. Military education will be a vital component in preparing for the diversity of future challenges. Command and control of integrated multinational operations will evolve slowly, with organisations capable of directing integrated responses being developed incrementally. Victory in conflict will be difficult to
define and winning may be reliant upon public perception or stability. It will still be possible to defeat an enemy militarily, just as Sri Lankan forces defeated the Tamil Tigers in 2009. However, military victory alone will not necessarily lead to strategic success unless an enduring political settlement is achieved.

As integrated approaches are adopted, the roles and activities of civilian and military personnel will make the distinction between combatants and non-combatants difficult to discern at an individual level. Extensive use of PMSCs will add further complexity to the operating environment. Regular military forces will deploy in environments where armed irregular forces, for example gangs, bandits, semi-official militias, PMSCs, terrorists, child soldiers, criminal elements, cyber warriors and tribal groups and insurgents, are operating, often as adversaries, but sometimes as neutrals or even as partners. Armed Forces are likely to be organised, trained and equipped to fight both irregular wars amongst the people and high-end threats at the same time. Military personnel will find themselves employed in essentially non-military roles, owing to their readiness profile, training and capacity for organised action, often as the first response to natural disasters and other serious civil contingencies.

The future threat environment, fusing all the environmental domains, will be complex, as well as contested, congested, cluttered, connected and constrained. This is likely to require a shift in mindset by conventional defence and security forces. Conventional military powers have traditionally been built around fixed processes and hierarchal structures that, for both institutional and historic reasons, focus on providing military effect from environmental stovepipes. Such structures may need to adapt to maintain their utility when faced by a decentralised, asymmetric and agile adversary. Greater emphasis on open architectures, flattened organisational structures, mission command and decentralised control may be required to achieve desired effects. Adapting to the external environment, rather than seeking to control it is likely to be fundamental.

128 Land, Air, Maritime, Space and Cyberspace.
Hot Topic – Characteristics of the Future Operational Environment

The individual environments will be interlinked and porous, especially with regard to influence and information. The Future Operational Environment (FOE) will be complex, but certain features listed below are likely to be apparent.

Congested. The FOE will be congested. In particular, densely populated urban and littoral regions, especially those lacking effective governance, will provide havens in which criminal elements, terrorists and insurgents shelter, organise, and operate. Moreover, instability and the adaptive tactics of combatants will force some operations to be conducted within, rather than around, such regions. Operations in these congested regions will carry an increased risk of collateral damage and unpredictable second-order effects. On land, operations in Baghdad, Basra and Fallujah provide examples, as do Israeli incursions into Lebanon in 2006 and Gaza in 2009. In the littoral, congestion will be in the form of large numbers of vessels, multiple fixed structures above and below the waterline, local air activity, shipping lanes, port access and adjacent dense urban areas with local communication links leading inland. The increased use of joint, manned and unmanned, air assets will intensify the congestion of airspace, particularly when control of the air is contested. Similarly, the proliferation of space-based assets, as more actors develop independent launch capabilities, and greater commercial and military of use satellites, will serve to make orbital space increasingly congested.

Operations will be conducted in congested urban areas
**Cluttered.** Clutter, particularly in congested environments, will provide opportunities for concealment. Adversaries will seek to blend into the background. Indigenous actors with detailed local knowledge will hold an advantage, as will those that can gather and share relevant information rapidly. Physical targets will often be difficult to acquire and track, and dense urban and littoral terrain will provide safe-havens and multiple avenues for attack and escape. On land, adversaries will continue to utilise traditional concealment methods, such as the camouflage and concealment techniques used by Serb forces in Kosovo. Low signature targets and fleeting windows of opportunity, in which to engage adversaries, will make surveillance and attack difficult. Use will also be made of underground facilities. Few spaces are likely to remain neutral, with hospitals, schools and places of worship forming part of the operating landscape, again challenging existing internationally recognised norms of combat. In the Air and Maritime Environments, stealth technologies will confer an advantage, but in a cluttered environment, it may not always be a decisive one. Given the need for precision, time-critical decision-making, and for discrimination, it is likely that platforms that effectively combine find and attack functions, and which compress the sensor-to-shooter decision cycle, will be required. In cyberspace, the ability to remain concealed, while attacking at range with plausible deniability, is likely to provide the opportunity for small hostile groups to achieve strategic effect.

**Contested.** Adversaries are likely to contest any and all environments, often using novel or asymmetric methods. Technological diffusion, including the export of modern military equipment and its subsequent leakage, and innovative use of existing technologies, will underpin these challenges. In particular, the diminution of Western technological advantage and the proliferation of anti-access weapons, such as Surface-to-Air Missile Systems, submarines, offensive cyber capabilities and precision guided surface-to-surface missiles, will make force projection and sustainment difficult, challenging traditional concepts of expeditionary operations. On land, mobility is likely to be constrained by the use of mines, IEDs, or air and space effect, while additional low-cost strategic effect is achieved by car bombs and suicide attacks. In the maritime environment the proliferation of mines and submarine capability will threaten sea communications. For example, in East Asia the number of states with submarine capability has risen significantly over the last 10 years. Control of the air will be an essential requirement for any operation, enabling freedom of air, surface and sub-surface manoeuvre. Airspace and orbital space will be contested, as they will provide intelligence, situational awareness and an almost unhindered view of the electromagnetic spectrum, which is likely to provide an asymmetric advantage in combating lower-technology adversaries. However, such technology will need to be effectively integrated with other sources of information to ensure that the strategic nuances, the tactical complexities, and the social terrain are properly mapped and understood. Space-denial capabilities, including disruption of satellites, are likely to proliferate and increase in effectiveness. In addition to the main theatre of operations, the home base, including the families of Service personnel, will be threatened. Many aspects of the contested nature of the FOE will challenge existing legal

129 Future Air and Space Operational Concept (FA&SOC) 2009, page1-8, paragraph 122.
norms pertaining to warfare, resulting in legal and ethical dilemmas.

**Connected.** The concurrent blurring and broadening of conflict will be a global phenomenon, but is likely to be most apparent at physical and virtual nodes in cities, littorals and in cyberspace. Examples of nodes include strategic locations, such as centres of governance, in urban areas and maritime choke-points. Activity in all environments will tend to gravitate towards these nodes and they will require protection. Some are likely to suffer episodes of high-intensity warfare intertwined with stabilisation and humanitarian operations, conducted simultaneously across all environments. Networks, such as logistical re-supply routes, sea and air lines of communication, and the electromagnetic spectrum will connect the nodes. Air and space power, in particular, are likely to be increasingly reliant on, and vulnerable to, Computer Network Operations (CNO). All networks, both military and civilian, will be subject to both intentional and inadvertent disruption, and will need to be sufficiently robust to adapt.

**Constrained.** In the complex battlespace of the future, Western legal and societal norms will place continued constraints on the conduct of operations. The increasing difficulty of discrimination between combatants and non-combatants is likely to require more extensive targeting preparation, and the legal and moral requirement to take all feasible precautions in avoiding, or at least minimising, collateral damage will lead to the greater use of precision weapons. However, the use of such weapons will still carry risk. Furthermore, concerns about the proportionality of the use of non-precision weapons are likely to lead to attempts to further minimise their use. The use of non-precision weapons, or the failure of precision weapons to avoid all collateral damage, while legally permissible, may generate adverse perceptions that undermine the legitimacy of operations. In particular, the view that the use of air power is a ‘cruel overmatch or a blunt instrument’ is likely to be encouraged by adversaries who recognise the reach, precision and utility that such technology represents. Furthermore, legal challenges may be raised against the use of novel weapons and systems, such as Unmanned Aerial Systems, DEW, non-lethal weapons and CNO. Ethical concerns are likely to result in policy constraints on the use of such technologies, and may lead to new international treaties and constraints. The application of domestic law and international human rights obligations to an armed conflict situation will continue to be debated and reviewed, and may result in unanticipated restrictions. Any legal, moral or ethical constraints, which uphold the legitimacy and legality of Western military operations, are unlikely to restrict the actions of, or be reciprocated by, potential adversaries.

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133 Examples of maritime choke-points include the Bab-al-Mendab, Malacca, Suez and Hormuz.
134 FA&SOC 2009, page 1-10, paragraph 126.
136 As illustrated by the Ottawa Convention (1997) [On the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-personnel mines, and their Destruction], and attempts to limit the use of Cluster Bomb Munitions.
137 FA&SOC 2009, page v, paragraph 1.
Strategic Shocks

The strategic context in 2040 is not shaped just by trends and drivers. On occasion, single events can provide discontinuities that cut across existing trends and re-shape the strategic environment. Such an event is a **strategic shock**. Historic examples of these high-impact low probability events include:

- The 2007-8 financial crisis.
- The 9/11 terrorist attacks.
- The collapse of the Berlin Wall.

Strategic shocks have a cascade effect, leading to multiple, apparently unconnected and unforeseen changes. They transform the strategic context, changing behaviour and activity across the board. For example, the 2007 financial crisis began with US sub-prime debt. Failures in this relatively obscure area were magnified by a number of factors including high-levels of interconnectedness, a lack of confidence, and the complexity of the global financial system. The cascade effect brought the entire global financial system close to collapse. This in turn led to a transformed strategic context that had economic, geopolitical and social effects as the shock waves travelled outwards. The medium to long term effects of this crisis are uncertain, however, the implications of this strategic shock may yet be significant, or even catastrophic.

Other complex, interconnected global systems may also be at risk of systemic failure. This includes globalisation itself, which can be thought of as an amalgam of multiple complex sub-systems spanning the social, economic, financial and geopolitical domains. These systems are typically difficult to understand, and are subject to no overall control and variable standards of regulation. Moreover, their resilience is difficult to assess and measure, and confidence in the integrity of the system is often fundamental to its effective functioning. Examples include: the global system for trade and the supply lines and infrastructure that underpin it; energy and food supplies; and the global communications system, with its dependence on space-based utilities. Out to 2040, global interdependence and reliance on complex systems is *likely* to continue to increase. This provides many benefits, but may make future strategic shocks and the systemic failures more frequent and pervasive than in the past.

This section considers what some of these high impact, low-probability events could be, while recognising that others may be beyond our experience to anticipate, conceive or understand. It is not a comprehensive list. Acknowledgement that shocks *will* happen is important. It is recognition that the future cannot be predicted in detail or with certainty. However, they will inevitably influence defence and security in some way, providing a strong argument for versatile and adaptable defence institutions, equipment and personnel to deal with the unexpected challenges they will present.

The following is a selection of credible strategic shocks:
• **Collapse of a Pivotal State.** The sudden collapse of a pivotal state would threaten regional and global stability. For example, the descent into instability of a major hydrocarbon exporting state, such as Nigeria, Iran, Saudi Arabia or Russia, would have local and regional consequences, disrupting global energy supplies. This would affect global energy markets causing widespread economic, social and political dislocation. Similarly, if internal tensions caused instability within China the global economy could be disrupted by the simultaneous drop in demand for raw materials and reduced supply.

• **Cure for Ageing.** The development of a treatment that could prevent or cure the effects of ageing would have a significant impact on global society. Initial access to such an advance could be highly unequal and only be available to wealthier members of society, mostly in the developed world. The whole fabric of society would be challenged and new norms and expectations would rapidly develop in response to the change.

• **New Energy Source.** A novel, efficient form of energy generation could be developed that rapidly lowers demand for hydrocarbons. For example, the development of commercially available cold fusion reactors could result in the rapid economic marginalisation of oil-rich states. This loss of status and income in undiversified economies could lead to state-failure and provide opportunities for extremist groups to rise in influence.

• **Collapse of Global Communications.** A failure of the global communications system could occur for a variety of reasons; for example the destruction of satellites following an orbital electromagnetic pulse detonation or solar flare, or the complete overload of the global ICT infrastructure. Such an event is not without precedent. For example, in 1859, solar flare activity was linked to the collapse of the telegraph system when spark discharges shocked telegraph operators and set telegraph paper on fire. A similar collapse in the modern world would cause trade, commerce and the Internet to grind to a halt. Military operations dependent on the availability of communications networks would also be put at risk. Remaining bandwidth would see intense competition for access.

• **External Influences.** A number of strategic shocks could occur that are broadly outside the control of society, but would have considerable impact. These include a highly lethal pandemic, a geological or meteorological event of unprecedented scale, such as the eruption of a super-volcano, or the discovery of non-terrestrial intelligent life. In the military domain, the development of a new, as yet unforeseen capability that allows one state to exercise technological dominance over others would have a significant impact on the strategic context. Potential examples could include; quantum decryption, whole-scale application of nano-technology, biotechnology weapons or advanced robotics. This could ultimately result in the defeat of a Western military force on the battlefield in a ‘maxim gun’ moment, against an adversary who has the technological advantage over the West.

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139 The maxim gun moment refers to the Battle of Omdurman when the British defeated the Mahdist forces with losses of only 47 on the British side against around 10 000 on the Mahdist. Elements of the 1991 Gulf War, such as the destruction of Iraqi forces on the Basra Road, provide a similar example of military superiority.
Part 2

Dimensions

The section details the underlying trends and drivers and summarises the evidence upon which they are based. This is intended as a reference section. It will also be of interest to some specialist readers.
Social Dimension

Scope

Developments in the Social Dimension will be dominated by 3 processes: rapid demographic change; sustained urbanisation; and the impact of globalisation on culture, identity and belief. This section considers the changing nature of social relationships and the place of the individual within society.

The Hot Topics are Urbanisation and International Organised Crime.

Trends and Drivers

Changing Demographics. The global population is likely to grow from 6.9 billion in 2010 to 8.8 billion by 2040. The developing world will account for most of the growth, remaining relatively youthful, in contrast to the developed world and China, which will experience little population growth and undergo significant increases in median age (see Figure 3). As well as differences in median age, some regions are likely to experience skewed sex ratios. For example, in China, as a consequence of the one-child policy and a cultural preference for boys, many regions have shown greater proportions of male births. The nationwide sex ratio rose from 108 male births to 100 female, to 124 in the 2000-2004 period, and in China’s under-20 age group there are almost 33 million more males than females. A similar trend is occurring in India, but is less marked. In the West, ageing is likely to lead to policies to employ the ‘younger old’ who previously enjoyed longer retirement periods. This cultural shift may yield a second demographic dividend leading to a lower demand for migrant workers and decreasing the social welfare burden.

Language Development. English is likely to consolidate its position as the internationally dominant language for data and global services. Other supplementary transnational languages, such as Mandarin, Spanish and Arabic, may also proliferate as engagement in globalised communication increases. Sophisticated translation devices are likely to become widely available before 2040.

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140 World Population Prospects 2008 Revision, medium variant.
142 India has a male to female ratio of 1.08. UN World Population Prospects 2008, medium variant.
Risks and Benefits

Inability to Cope with Population Growth. Population growth will exacerbate existing economic, environmental and governance challenges. The most rapid population growth is likely to occur in regions that already face the greatest economic, social and political risks. For example, the population of sub-Saharan Africa is likely to almost double by 2040.143 If the proportion suffering malnutrition stays constant, then almost 500 million people are likely to require periodic humanitarian assistance.

Demographic Dividend. States, such as Turkey, that experience lower birth rates and increased longevity are likely to benefit from a growing workforce and a falling dependency ratio.144 The result is a ‘demographic dividend’, which occurs when a generation has fewer dependents than its parents. Such a change is likely to increase economic activity providing the initial impetus for greater industrial production; the increased supply of new workers can, if handled properly, enable a country to become more productive. There is evidence that demography accounted for about a third of East Asia’s rapid growth over the past 30 years.145 Nevertheless, as they reach retirement age, these demographic bulges can become economic burdens. Many African states have high birth rates and may experience such a dividend should the economic and industrial mechanisms required for its support be in place.

Generational Tension. Youthful, economically-exposed populations in the developing world are likely to be highly volatile, resulting in periodic social upheaval, widespread criminality and shifting allegiances. Such groups will remain amongst those most vulnerable to job losses during periods of economic downturn and may make significant contributions to political and social change during times of insufficiency. Inequality of opportunity may result in a resurgence of political engagement by younger generations, leading to an increase in activism and radical protest. However, in developed regions where aged populations hold political power (the so-called ‘grey vote’), the younger generation may feel disenfranchised and turn away from traditional politics.

Migration. The number of international migrants has increased from a total of 75 million a year in 1965, to 191 million a year in 2005 of whom around 10 million are refugees, and up to 40 million are illegal migrants.146 That number may grow to 230 million by 2050.147 Populations in many affluent societies are likely to decline, encouraging economic migration from less wealthy regions. The net flow to more developed regions already shows significant increases (see Figure 10). For example, in 1960, 57% of migrants lived in less developed regions, but by 2005 just 37% did so. Europe had the largest number of immigrants in 2005, followed by Asia and North America.148 Environmental pressures, economic incentives and political instability will continue to drive population movement from afflicted regions. Conflict and crises will also continue to result in the displacement

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143 The population of sub-Saharan Africa is likely to increase from around 863 million in 2010 to 1.53 billion in 2040.
144 The UN definition of dependency ratio is the ratio of the sum of the population aged 0-14 and that aged 65+ to the population aged 15-64.
146 UN Department of International Migration and Development - International Migration 2006 data.
147 UN Department of Economic and Social Affairs/Population Division, International Migration Report, 2002.
of large numbers of people, mainly into proximate regions, which may find themselves at risk of instability or exogenous shock. Such movement is likely to occur in regions of sub-Saharan Africa and Asia. This is supported by data on asylum seekers that show almost 45% of asylum applications made to industrialised nations originated from Asia. Africa was the second largest source continent with 30% of applications.¹⁴⁹

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Risks and Benefits

Mass Population Displacement. Conflicts, such as the war in Iraq, have demonstrated the potential for sudden movements of large numbers of people over extensive distances, with the potential for related shocks and second order effects. The United Nations' High Commission for Refugees (UNHCR) has measured a gradual increase in the number of internally displaced persons\(^{150}\) from 1998 to 2007; this has corresponded with a fall and then rise in the number of refugees over the same period (see Figure 11). This instability is *likely* to fuel radicalisation that *may* result in resurgent nationalism, and act as a catalyst for the spread of instability. For example, in 2005, Kenya produced an official government policy that outlined Somali and Sudanese refugee groups as specific risks to security, accusing them of bringing small arms into Kenya.\(^{151}\)

![Figure 11 – Mass Population Displacement\(^{152}\)](image)

Dynamic Diaspora. Societies, including the UK, *will* become increasingly transnational.\(^{153}\) Growing proportions of their populations are *likely* to consist of ethnic groups that are a mixture of newly arrived immigrants and established second and third diaspora generations. Developed economies *are likely* to sustain an economic gradient for immigration which *may* have a transformational effect on their society and culture. Information and Communications Technology (ICT) developments and advanced mass-transit systems *will* facilitate and increase connectivity between ethnic and national diaspora and their communities of origin. These advances *may* reduce incentives for

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\(^{150}\) Internally displaced persons (IDP) are those who are forced to flee their homes but who, unlike refugees, remain within the border of their home country. UNHCR – The UN Refugee Agency: [www.unhcr.org](http://www.unhcr.org)

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integration and assimilation and allow self-contained ‘virtual’ communities to exist across continents. Less benignly, diaspora will remain a medium for the international transmission of social risk, including: inter-communal violence, extremism and transnational organised crime, especially trafficking, smuggling and illicit trade. Such communities are likely to show local responses to transnational issues.

**Risks and Benefits**

**Super-Diversity.** Countries which encourage immigration as a means to address labour and skill shortages, involving a mixture of temporary workers and long-term settlers, will increasingly experience ‘super-diversity’, which may present challenges to social cohesion and economic stability in host countries. Competition for talented individuals is likely to occur as countries begin to offer incentives for diaspora to return to their countries of origin. The risk of a continuing ‘brain drain’ is likely to remain a challenge for some developing countries, although evidence suggests that talented individuals are likely to return to politically stable and economically successful countries of origin. Failure to manage migration is likely to impose significant resource constraints in destination and transit countries and also contribute to societal tensions.

**The Role of the Family.** The movement of people in pursuit of economic opportunity and a secure environment will create more cosmopolitan population centres and change the character and utility of the family. In conjunction with increased cultural awareness and sustained global migration, societal barriers may decline as their significance is increasingly understood, encouraging cross-cultural partnerships. However, certain groups may seek to retain their traditional identities and heritage by the establishment of rules and practices that prevent such cultural transformation. Decreasing fertility, informal partnerships and increasing numbers of urban dwellers are likely to result in smaller families; however, pressure on housing may lead to more extended family arrangements within one household, possibly with inter-generational dependencies. Societies with deeply established cultural structures and norms are likely to experience the greatest tension in the face of competing cultural transformation as certain sectors and generations seek to retain their traditions, whilst others wish to adopt newer conventions and practices that they have been exposed to through increased access to communications. For example, the exposure of societies in the developing world to forms of entertainment popular in the developed world such as television soap operas may have contributed to changes in family structures as groups become increasingly exposed to the concept of the nuclear family and have increasingly aspirational lifestyles.

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152 This graph illustrates that by 2007 the total number of IDP and refugees grew to 26 million, equivalent to the population of Romania.
153 For example, in 2007 the biggest ethnic groups in England were Indian (2.6%), Pakistani (1.8%), Black African (1.42%), Black Caribbean (1.2%), Chinese (0.8%) and Bangladeshi (0.69%).
Hot Topic – Urbanisation

The global urban population began to exceed the rural population in 2006. By 2040, 65% of people are likely to live in urban areas, with the majority of growth in the developing world, especially in Africa and Asia. A considerable proportion of urban growth is likely to occur in shanty towns, with the number of slum dwellers doubling to around 2 billion by 2040. Rapid urbanisation is likely to lead to urban rather than rural insurgency. Mega-cities are likely to remain significant, containing around 10% of the global urban population. However, approximately 50% of urban dwellers are likely to live within urban areas of less than 500,000 people. These regions are likely to absorb nearly half the projected increase of the urban population and face the greatest shortfalls in infrastructure and service provision increasing the risk of environmental disasters.

Africa’s rate of urbanisation may be the fastest the world has ever seen. In 1950, only Alexandria and Cairo exceeded 1 million people, but this may grow to 80 cities by 2040, plus a cluster of mega-cities headed by Kinshasa, Lagos and Cairo. Such growth will increase the resource burden and environmental impact of urban areas, especially as their growth is likely to remain unplanned, and is possibly unsustainable. However, although rapid urbanisation may result in a spate of failed cities requiring humanitarian assistance, it is also an expected part of the economic development cycle, and has numerous positive effects. These include, for example, better access to healthcare and improved educational and employment prospects.

Urbanisation will be driven by a combination of forced migration and instability, the pursuit of economic opportunity, and by the environmental consequences of climate change. However, the most significant growth in urban populations is likely to occur due to natural population growth, rather than from rural-urban migration. However, some states, such as India and China, are likely to continue to experience significant levels of rural-urban migration. Such movement is likely to produce tension in the recipient urban areas. This tension is likely to be exacerbated by competition for land, accommodation, access to resources and for employment opportunities. Cities are also likely to grow as the regions that surround them increasingly taking on peri-urban characteristics. Regions undergoing transformation through peri-urbanisation are likely to experience rapid societal change and mass adjustment to new employment and lifestyles.

Rapid and uncontrolled urbanisation without the required industrialisation to develop an effective infrastructure and associated support structures, will challenge urban governance and generate regions of instability, poverty and inequality. Most of the urban poor will be employed in the informal sector and will be highly vulnerable to externally-derived economic shocks and illicit exploitation.

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156 Evans M, War and the City in the New Urban Century, 2009.
157 A mega-city has in excess of 10 million people.
158 UN World Urbanisation Prospects Database, 2007 Revision.
159 Peri-urban regions lie in-between consolidated urban regions and rural ones. Typically they have lower population density, limited infrastructure and mixed land use.
As urbanisation continues, the growth of interdependencies and complex connections between cities will increase. This has been exhibited in Asia, where a common economic strategy has been the development of a heavy concentration of investment and urban development in and around coastal regions. The result of this growth is a mega-urban corridor stretching from Tokyo to Sydney through Seoul, Taipei, Shanghai, Hong Kong, Kuala Lumpur, Singapore and Jakarta. As systems become intertwined with other urban regions the increased complexity of networks are likely to increase the risk, and the impact of catastrophic systems failure. Due to greater reliance on the Internet and complex logistical supply and travel chains, coupled with global energy requirements and the movement of power through global grids, it is likely that such complex, interlinked networks could become increasingly fragile and susceptible to disruption.

Increased urbanisation and continued globalisation may, conversely, lead to a resurgence of interest in local issues. Higher population densities will foster the requirement to manage shared issues such as pollution, traffic access and neighbourhood crime. An increasingly connected global community may, conversely, lead to the local environment becoming increasingly significant both socially and politically as individual cities and regions become their own distinct nodes on the global network, possibly reducing the overall importance and relevance of the state.

Access to Information. The pervasiveness of ICT will enable more people to access and exploit sophisticated networks of information systems. For example, in 2007 there were 280 million mobile phone subscribers in Africa, a penetration rate of 30.4%. This number is expected to rise to 50% by 2012 and may result in total coverage in as little as 10 years. The Internet and associated technologies, together with digitised portable communications, will increasingly become the means by which a rapidly expanding array of audio, visual and written information products are distributed. For many people, group membership will extend beyond physically proximate communities, reflecting the ability to sustain relationships and identities over distance through globalised communications and travel. The increasing size of available networks will also increase economic and finance opportunities for individuals and smaller communities through initiatives, such as micro-finance. This may transform how business is conducted with a shift away from traditional hierarchical structures to smaller, networked structures that favour more even distribution of profit. Pervasive ICT will also provide diverse opportunities for organised criminal and terrorist groups, such as the Russian Mafia, the Asian Triads and al-Qaeda. Such groups, often based within ungoverned spaces, will exploit adaptable and flexible networks that challenge conventional law-enforcement approaches. The ubiquity of communications devices is likely to create internal tensions in authoritarian states, such as North Korea and Myanmar, as censorship is increasingly difficult to achieve and access to the ‘democratised’ Internet very difficult to prevent.

160 In Japan, infrastructure investment was concentrated in the Tokyo-Nagoya-Osaka Corridor, with more than 60 per cent of its urban population being concentrated in this region by 1970. In South Korea, similar concentrations of urban infrastructure and transportation investment has occurred in the Seoul/Pusan regions, containing 70 per cent of the South Korean urban population by the mid 1970’s. A similar strategy has been adopted in the development of Taipei/Kaohsinc, in the formation of Singapore and Hong Kong as city states, in Jabotabek (the Jakarta region) in Indonesia, Bangkok in Thailand, Kuala Lumpur and environs in Malaysia, and in the coastal regions in China.

161 Webber M, The Urban Place and the Non-Place Urban Realm: Explorations into the Urban Structure, 1964.

Increasing Media Impact. The media will retain an overarching influence shaping an individual’s values and beliefs both consciously and unconsciously. However, this impact is likely to vary across states, dependent on the censorship and control systems they have in place. The ‘democratised’ Internet makes it likely that almost every member of global society is able to access free information from a variety of sources. Even those without direct access are likely to have social contact with someone that can. The growth of a global communications system and the ubiquity and sophistication of mobile communication devices will mean that patterns of receiving and accessing information will change. Traditional media sources such as newspapers and scheduled broadcasts will remain, but are likely to be increasingly reliant on opinion pieces and gossip, focusing on specific scoops in order to sell hard copies. The traditional media will continue to attempt to shape the opinion of the general populace and will sell themselves on their trust, integrity and reliability. The trend for traditional media to focus on opinion pieces and campaigns is likely to be fuelled by the growth of new media forms that include the Internet and entertainment on demand. This will affect the profile of people who access media changing them from passive consumers to more cynical multiple source users who will take their opinion from many areas and form an opinion based on those they trust, and their own experience. The rise of Internet-enabled, citizen-journalists and formal, real-time and informal news distribution through the Internet will weaken the immediacy and influence of mainstream news providers. Breaking events will increasingly be transmitted to individuals directly, often without filters, legal sanctions or safeguards. Consequently, competition in a real-time news environment is likely to reduce the integrity of the editorial function, with pressure to release stories, narratives and opinions at the expense of facts.

Breaking events will increasingly be transmitted to individuals directly
Altered Identities. Identity is an umbrella term used to describe how people perceive themselves and others. An individual belongs to multiple identity groups, through birth, assimilation, or achievement and each particular group influences their values and beliefs. Historically key influences for identity have been often along ethnic, racial, national and religious lines, however out to 2040 new influences are likely to emerge. For example, online social interaction is likely to increase in sophistication and scale. Social networking sites fused with ‘virtual reality’ networking sites, such as Second Life, may lead to new ways of interacting, new variations of language and the formation of complex relationships between individuals on a global scale. Similarly, the importance of nationality as an influence on identity may decline as individuals become more globally aware. Internet-based working will continue to have an increasing importance increasing the extent of home based employment options. The virtual environment may also lead to individuals having increased difficulty interacting with the values and laws of the real world, having been able to permanently live out their fantasies and fictional lifestyles.

Declining Civic Values. The spread of transnational networks are likely to impact on an individual’s identity. Many people in affluent societies are increasingly likely to regard their relationship with the state in consumerist rather than civic terms, while governance standards in many developing societies are unlikely to keep pace with economic and social change. Civic support systems may decline producing an increased reliance on local communities, extended family networks and personal patronage.

Gender Equality. The significance of the divide between societies that are progressing towards gender equality and those that are not, will continue to grow. Progress towards equality will be uneven and conditioned by cultural assumptions, demographic trends and economic circumstances. This issue is likely to remain a defining theme during the 21st century, influencing international political, economic and cultural relationships. In the developed world, increased demand for labour mobility is likely to be paralleled by trends towards an expansion in the number of women in the workplace, where they are increasingly likely to occupy leadership positions in business and politics. In the developing world, urbanisation is likely to provide increased opportunities for women in both employment and education, and challenge some cultural norms.
Hot Topic – International Organised Crime

Although measurement is difficult, international illicit trade is estimated to account for around $1 trillion of global Gross Domestic Product (GDP) per annum. In addition, it is estimated that a further $1 trillion is extorted by organised crime and that between $0.6-2.8 trillion is laundered annually. This can be compared to a global GDP of around $61 trillion and could make the value of global illicit trade around twice that of global military budgets.¹⁶³,¹⁶⁴ These large financial movements, which have been funded by illegal trading, fraud, arms trafficking, people smuggling, extortion, smuggling and the drugs trade will continue to distort the normal political and economic process. The reach of international criminal gangs stretches from the ungoverned spaces in the developing world through to the highly regulated and policed developed world. Corruption is endemic in many parts of the world, including developing and emerging economies and deters inward investment, business confidence and international trust.¹⁶⁵

Globalisation will provide diverse opportunities for organised criminal groups, which are likely to increasingly exploit adaptable and flexible networks that allow them to be based in ungoverned spaces. These ‘black holes’ are likely to challenge conventional law-enforcement approaches. Organised criminals and illicit groups are likely to increasingly take advantage of legitimate company structures to conduct or hide their criminal activity, leading to higher levels of global corruption and illicit trade, often involving the use of cyberspace. They are also likely to collaborate with, and may be indistinguishable from, paramilitary, terrorist and insurgent groups as well as weak and corrupt governments. They are likely to exploit growing consumer markets in rapidly growing economies. Organised criminals are likely to be more aggressive in defence of their assets and markets and in promoting their interests.

International organised crime will grow in volume, reach and profitability, and present a major challenge to governance, legal arrangements and international financial regulation. It is likely to exploit new ventures and markets in areas of accelerating economic growth and opportunity. Many states and other actors will continue to rely on narcotics and other forms of illicit trading to maintain liquidity in their economies. However, the illicit trade in narcotics may decline in response to a combination of legalisation and increasing intolerance of the social impact and cost in the developed world. Criminal networks will exploit new technologies to circumvent law enforcement activities and to gain further financial advantage. The lines between crime and political ideology will continue to be blurred with extremist groups utilising criminal networks, and vice versa, to further their aims. Some states are likely to use criminal transnational networks as proxies for their activities giving the states a deniable and asymmetric capability against other powers. In regions with little or no governance, or poorly developed market economies, international criminal groups may provide the only avenue of trade and economic growth in the absence of other, legal, activity.¹⁶⁶ A more nuanced approach by the major powers to international crime originating in the developing world, especially in failed or failing states may have to be undertaken if the conditions of failure are not to be further exacerbated.

¹⁶³ World Bank, Kaufmann D, Myths and Realities of Governance and Corruption and IMF, 2008.
¹⁶⁴ Global Spending on Defence is around $1.46 trillion, SIPRI, 2008.
¹⁶⁶ For example, the development of industries that manufacture counterfeit drugs is welcomed in some parts of Africa.
Resource and Environment Dimension

Scope

For most of its history, humankind has striven to secure resources in order to improve living standards and prosperity. During the last century, unprecedented numbers of people lived in conditions of increasing affluence and most of those who did not, aspired to do so. However, the trend in resource consumption is unsustainable; socially, environmentally and economically. The Resource and Environment Dimension considers how the aspiration to achieve ever higher standards of living, or to sustain existing levels, will be constrained by the nexus between resource availability and environmental limitations. In doing so, it considers the physical and environmental challenges that will condition political and social choices, the interplay of demand with supply, the environmental effects, and the consequences that may arise. These challenges include climate change and the production, distribution and consumption of resources including energy, food, water, strategic minerals and information.

The Hot Topics are Climate Change and Weak States, Food and Water and Minerals.

Trends and Drivers

Climate Change. Climate change is a Ring Road Issue. Overwhelming evidence indicates that the atmosphere will continue to warm at an unprecedented rate throughout the 21st century. This warming will affect production, availability, storage and use of energy, food and freshwater. Concerted attempts to reduce emissions of greenhouse gases, including carbon dioxide, methane, nitrous oxide and others, in addition to potential limits on availability of readily accessible hydrocarbon resources, will stimulate intensive investment in research to develop low-carbon energy production, as well as a focus on conservation.

Risks and Benefits

Extreme Weather Events. It is possible that the effects of climate change will be felt more rapidly and widely than anticipated leading, for example, to an unexpectedly large increase in the frequency and intensity of some extreme weather events, such as storm surges, challenging the collective and individual capacity to respond. Europe may experience extreme high summer temperatures and sustained heat waves with a frequency not seen in modern times. While northern Europe may experience a small increase in annual mean precipitation, mainly in the winter, the Mediterranean may become more arid.

Solar Output Variation. The sun is the earth’s primary energy source and short-term fluctuations in solar activity may confuse, mask or amplify the long-term effects of greenhouse gas accumulation in the atmosphere, resulting in inappropriate rates of mitigation and adaptation. The subsequent severe climatic or economic consequences may serve to amplify the degree of cooperation between states as they struggle to overcome the economic, humanitarian and societal difficulties generated.
Figure 12 – Predicted Temperature Increase 1960-2100\textsuperscript{167}

\textsuperscript{167} UK Met Office, Hadley Centre.
Hot Topic – Climate Change and Weak States

Weak states have limited capacity for governance, and many are unlikely to adapt to the environmental challenges of climate change. Weak states are likely to have youthful populations, large families and be dependant on rural production for their income. Extreme weather events and increasing temperature will exacerbate instability due to immediate shortages of food and water. Longer-term effects may include a degradation of agricultural land that increases internal and regional migration. Weak states will be insufficiently prosperous to procure alternative supplies through external markets. In addition, they often have poor human rights records and suffer endemic corruption which weakens governance and service provision, increasing the likelihood of recurring instability. As the severity and incidence of internal instability increases, exacerbated by climate change, long-term societal changes can occur, such as the creation of large numbers of orphaned children or the displacement of large ethnic or tribal groups.

Conflict in Darfur provides an example of how climate change may affect weak states. Prior to conflict, tensions were driven by drought. Although conflict began as a regional rebellion, the underlying cause was probably desertification, with a drop in rainfall of between 16% and 30% shifting the desert boundary 60 miles over 40 years. This desertification probably limited the ability of local eco-systems to support agriculture, resulting in tension and ultimately conflict between rival groups. The Sudanese government lacked the necessary infrastructure and resources to respond to the crisis. The initial regional uprising was suppressed through the recruitment of Arab militias, the Janjaweed, which waged a campaign of ethnic cleansing against Africans, resulting in around 500,000 deaths and 2 million environmental refugees.

By 2040, global temperature rises are likely to increase desertification in regions bordering the Sahara, possibly leading to similar examples of climate-induced instability and conflict. Countries such as Chad, Niger, Mali and Eritrea are susceptible to the same impacts that may result in conflict between tribal or ethnic groups. Elsewhere, changing patterns of rainfall distribution within the Monsoon belt in the Arabian Sea and South Asia may result in similar instability. Even stable governments will face increasing challenges as demonstrated by the flooding of New Orleans and the Mississippi Delta in 2005.

Energy Demand. Global Energy use has approximately doubled over the last 30 years and, by 2040, demand is likely to grow by more than half again. Despite concerns over climate change, demand is likely to remain positively correlated to economic growth with fossil fuels, meeting more than 80% of this increase. Urban areas will be responsible for over 75% of total demand. Industrialising states are likely to continue their energy-intensive economic growth: infrastructure and increasing transportation are likely

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168 A weak state lacks the will and capacity to use its domestic and international resources to deliver security, social welfare, economic growth and legitimate political institutions.


170 International Energy Agency, World Economic Outlook, 2008. Usage in 1980 was approximately 7 million tonnes or equivalent (MToe), rising to 11.7 MToe in 2007.


to account for over 85% of increases in global demand, with China and India accounting for 45% of this increase.\textsuperscript{173} Most states \textit{will} have to import energy, raising fears of dependence on unstable producer states, and stimulating conservation measures, diversification and the development of alternative supplies. A switch away from fossil fuels to using electricity as the predominant transmission medium is \textit{possible}. However, the infrastructure costs and technological challenges, especially in aviation, would limit any transition to wealthier regions of the world and certain sectors, such as domestic usage and some forms of transportation. Fossil fuels \textit{will} continue to be used in developing regions that cannot afford to change.

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\textbf{Risks and Benefits}

\textbf{Disruption of Supplies.} The periodic disruption of energy supplies from major exporting states \textit{will} cause global price spikes, which, in the most severe cases, \textit{may} trigger wider political instability, especially in economically vulnerable regions. Such disruption, \textit{possibly} caused by instability within producer states, resource nationalism, organised crime, terrorist attack, disruption of transportation, or infrastructure bottlenecks is \textit{likely} to result in multilateral action to restore supply chains. Prolonged constraints on the free market in energy \textit{may} arrest or limit the globalisation process. Similarly, rapid fluctuations in the supply of strategic resources, such as food or minerals, are \textit{likely} to cause significant and unpredictable economic, social and political dislocations, \textit{possibly} on a global scale.

\textbf{Energy Security.} The issue of energy security is one in which governments, and defence organisations, \textit{will} increasingly have to be engaged if states are to maintain their standards of living, and to ensure adequate supplies of natural resources, at reasonable prices. States who perceive that energy security is impacting on national survival are \textit{likely} to challenge conventional interpretations on the legality of the use of force. However, the cornerstone of the UN Charter, which prohibits the threat, or use, of force in international relations, \textit{will} remain firmly in place.

\textbf{Changing Energy Mix.} The energy mix \textit{will} evolve responding to cost, availability and technological developments. There \textit{will} be continued utilisation of all current energy sources, and fossil fuels are \textit{likely} to continue to account for over 75\% of total energy usage.\textsuperscript{174} Oil \textit{will} remain the dominant fuel, given its importance in the transportation sector and the availability of infrastructure that supports its distribution. However, by 2020, production growth of easily accessible oil and gas is \textit{unlikely} to match demand growth and therefore coal usage is \textit{likely} to show the greatest proportional increase, by over a third in absolute terms.\textsuperscript{175} Use of other liquid fuels, principally first generation biofuels derived from foodstuffs such as maize, is \textit{unlikely} to increase in significance due to their adverse impact on food production. However, new generations of biofuels, such as those derived from waste biomass using cellulosic processes, are \textit{likely} to become a viable alternative. Nuclear power provides only around 5\% of global energy production.

\textsuperscript{172} Shell, \textit{Shell Energy Scenarios to 2050}, 2008.
\textsuperscript{174} Fossil fuel usage drops from just over 80\% to just below 80\%. Continuing this trend out to 2040 suggests they will account for around 75\%. \textit{International Energy Agency, World Economic Outlook}, 2008, page 4.
This is *unlikely* to increase in the short term because nuclear reactors take several years to design and build. However, the desire to minimise carbon emissions is *likely* to lead to increased investment in nuclear energy and a rapid rise in nuclear fission production by 2040. Modern renewable technologies, including wind, geothermal, tidal, wave and solar energies, *will* grow rapidly from a low base. Along with hydro, they *will* take on an increasing share of the electricity generating capability.

### Risks and Benefits

**Proliferation of Civil Nuclear Power.** There are over 430 nuclear fission reactors operating around the world in 31 countries, with some 30 under construction, and a further 200 or more planned.\(^{176}\) Much of this expansion *will* be in the developing world.\(^{177}\) Accidents, such as at Chernobyl, and attacks on nuclear facilities have been rare, but the trend towards mass casualty and economic targeting by terrorists and irregular groups makes attacks on these institutions *more likely* in future. Moreover, the spread of nuclear materials and know-how *will* require an intrusive set of safeguards to prevent their use in weapons’ programmes. Finite uranium reserves are *likely* to require the development of breeder reactors and reprocessing facilities, further complicating control of nuclear materials.\(^{178}\)

**Volatile Energy Markets.** Energy supply *will* struggle to meet growing demand leading to upward pressure on prices. When supply and demand for energy are closely matched, rapid increases in demand to which supply can not react quickly can lead to large variations in price; therefore markets are *likely* to be volatile. For example, from 2007 to 2008 the price of oil spiked from below $60 per barrel to almost $150 before falling back to $40,\(^{179}\) affecting economic performance and investment decisions. Such destabilising movements of energy markets are *likely* to be detrimental to those countries unable to compete on price, resulting in more states following the example of China in establishing bilateral arrangements that seek to circumvent global markets. This bilateralism, fuelling tension amongst those who are excluded, *may* lead to political and even military interventions in order to protect access and safeguard supply.

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\(^{177}\) US Department of State, 2008, *Report on Proliferation Implications of the Global Expansion of Civil Nuclear Power*. To that end, 10 developing states are already assessed to be giving serious consideration to developing civil nuclear power and a further 20 have long-term plans underway.


Changing Patterns of Behaviour. Growing material prosperity is *likely* to result in behavioural changes with associated effects, such as changes in consumption, diet and health. The proportion of the world population considered to be middle-income has increased rapidly over the last 30 years and, out to 2040, *may* increase by a further 80 million per annum if rapid economic development continues in countries such as India, China and Brazil.180 Consumption of food, water, energy and minerals *will* remain positively correlated with increasing prosperity despite efforts towards conservation, recycling and environmentalism.

Hot Topic – Food and Water

By 2040, the global population is likely to increase to 8.8 billion requiring concomitant increases in the supply of food and water. Given that agriculture accounts for over 70% of global freshwater usage, the availability of food and water will be intimately related.\(^{181}\) Over 900 million people were undernourished in 2007. This represents a declining proportion of the global population, but in absolute terms is 80 million more than in 1990–92, with the largest increases in Asia and in sub-Saharan Africa.\(^{182}\) Similarly, it is estimated that around 2.5 billion people live in regions suffering from water scarcity, predominantly in Africa, the Middle East, as well as Central and East Asia. Of these almost 900 million lack access to safe drinking water causing more than 5 million deaths per year. Fertiliser production is an energy intensive process, and the challenge, with a heavy reliance on science and technology, will be to produce more food on less land with less water, fertiliser and pesticides, while using less energy.

<table>
<thead>
<tr>
<th>Region</th>
<th>Arable Land (as a % of global total)</th>
<th>% of Global Population</th>
</tr>
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<tbody>
<tr>
<td>SE Asia &amp; Pacific</td>
<td>29</td>
<td>53</td>
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<tr>
<td>OECD, Europe, Central Asia</td>
<td>46</td>
<td>22</td>
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<tr>
<td>Africa</td>
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<td>11</td>
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<td>Middle East, North Africa</td>
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<td>5</td>
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<tr>
<td>Latin America, Caribbean</td>
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<td>9</td>
</tr>
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Table 1 – Regional Distribution of Available Arable Land

A disparity already exists between population size and availability of land for food production in different regions. Global population growth will be unevenly distributed with much of the growth likely to occur in regions, such as sub-Saharan Africa and the Middle East, that already suffer from stresses to food and water supplies. Much of the growth will be highly concentrated in sprawling urban centres that are likely to outgrow the ability of their hinterland to provide for them. Asian countries with large populations and limited agricultural land are likely to continue to invest in agricultural production abroad. Moreover, climate change will affect food production, cultivation and animal husbandry patterns, with some regions unable to grow current food staples, such as rice and vegetables. Some previously fertile, densely populated regions will suffer declines in agricultural production. Similarly, changing precipitation patterns will increase pressure on water supplies and their associated industries and are likely to cause the number of water

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\(^{181}\) UN Food and Agriculture Agency, *Aqua Stat*.

stressed regions to rise. When shortages are threatened, the adoption of export restrictions for food, and disputes over water flows, are likely to increase, affecting global supply, aggravating shortages and eroding trust. For example, extreme weather events in 2005–07, including drought and floods, affected major cereal-producing countries, and world cereal production fell by 3.6% in 2005 and 6.9% in 2006 before recovering. In 2008, the ratio of world cereal stocks to utilisation was under 20%, the lowest in 3 decades, with major cereal producers including China, the European Union, India and the US holding significantly low levels of cereal stocks compared with earlier years. Two successive years of lower crop yields in a context of already low stock levels resulted in high global food prices, export restrictions and subsequent political, economic and social difficulties, such as food riots in West Africa, Haiti and Egypt.

Competition for land usage will increase. For example, bio-fuel production utilised around 100 million tonnes of cereals (4.7% of global cereal production) in 2008. Concerns over energy security are likely to lead to continued production of subsidised maize-based bio-fuels out to 2020. This is likely to place stress on food production and to be a significant source of demand for some agricultural commodities, such as sugar, maize, cassava, oilseeds and palm oil. Food prices will remain highly correlated with volatile petroleum prices which impact on fertiliser and transport costs. Sustained economic growth in developing countries, especially China and India, has already increased their purchasing power and the overall demand for food. This will continue with shifts in diet associated with increasing prosperity, such as increased meat consumption, having knock-on effects to the production of other food-stuffs and to associated demand for water. For example, it is estimated to take 10kg of grain to produce 1kg of beef. Genetic and scientific modification of crops to improve yields is likely to be necessary, to provide both for human and animal consumption, especially the introduction of pest-resistant, drought resistant and saline-tolerant crops capable of producing high-yields in challenging conditions. However, biotechnology research is likely to remain dogged by commercial, political and ethical issues that may slow the introduction of such crops, particularly in Europe.

World marine fishery resources have remained relatively stable since 1990, despite the deterioration of some fish stocks in specific regions. However, the contribution of aquaculture to global supplies of fish, crustaceans, molluscs and other aquatic animals increased from around 4% of total production in 1970 to over 32% in 2004, growing more rapidly (8.8 percent per year since 1970) than all other animal food-producing sectors. Production from aquaculture has outpaced population growth, with per

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183 Lower stock levels contribute to higher price volatility in world markets because of uncertainties about the adequacy of supplies in times of production shortfalls. UN Food and Agriculture Organisation, The State of Food Insecurity in the World, 2008.


185 The US government provides $7 billion a year (2007) in federal subsidies to its own farmers to cultivate bio-fuels. It is estimated that 8-12 kilograms of plant protein are required to produce one kilogram of meat, hence the price of feed grains rises and farmers plant such varieties in preference to food grains. Oxford Research Group, Food, Poverty and Security, May 2008.

186 Aquaculture refers to the farming of fresh and saltwater organisms including molluscs, crustaceans and aquatic plants. Unlike fishing, aquaculture, also known as aqua-farming, implies the cultivation of aquatic populations under controlled conditions.

187 Food and Agriculture Organisation (FAO), The State of World Fisheries International Aquaculture 2006, page 16. Compared with 1.2% for capture fisheries and 2.8% for terrestrial farmed meat production systems over the same period.
capita supply increasing from 0.7 kg in 1970 to 7.1 kg in 2004, representing an average annual growth rate of 7.1%. East and south eastern Asia are likely to remain the regions most dependent on marine produce in diets. Out to 2040, the marine environment will continue to see significant increase in demand. Fishery resources are likely to stagnate,188 with stocks remaining under constant heavy pressure and requiring careful husbanding to prevent major species becoming further depleted or extinct. Technological advances in aquaculture, combined with sheer necessity, will lead to further increases in farming activities, especially in the littoral regions, but possibly in oceanic regions. Aquaculture output is likely to increase by more than 50% placing stress on fragile ecosystems and adversely affecting biodiversity.

Figure 13 – Projected precipitation changes 2090s (% relative to 1980-99)189

By 2040, one-third of the world’s population will live in areas of water stress. Any increase in global temperatures will raise the moisture carrying capacity of the atmosphere and may lead to an overall increase in precipitation, especially in the Tropics and at high latitudes. However, mid-latitudes and semi-arid low latitudes may see less precipitation and increasing evaporation leading to decreased water availability. Asia, especially India, is particularly dependent on meltwater from Himalayan glaciers and may see an initial surge followed by a long-term decline as glaciers retreat. Per capita water consumption will continue to rise depleting existing water supplies, especially aquifer-borne fossilised water that is extensively exploited in desert and urban areas. Access to freshwater is an essential component of economic development, stability and health. Over 260 river basins are shared by 2 or more countries and 13 are shared by 5 or more countries. Many of those shared water resources are situated in regions, namely the Middle East and Africa, also facing the challenges of high population growth, stagnant economic growth, and political instability. Any increase in pollution, particularly from agricultural fertilisers and the poorly managed by-products of industrialisation and rapid urbanisation, will further threaten water availability and lead to a decrease in

188 Food and Agriculture Organisation, The State of World Fisheries International Aquaculture 2006. page 151. Figures are by weight.
biodiversity. In China only 50% of cities treat waste water and 5 of the 7 major river systems are classed as severely polluted. Furthermore, water extraction from the Colorado River, the Rio Grande and the Yellow River already results in them failing to reach the sea for at least part of each year. Water scarcity will be offset in the developed world through conservation and probable increases in the use of desalination. However, the desalination process is energy intensive and is likely to require increased investment in nuclear fission plants to generate the large amounts of energy required. In the developing world, increases in efficient use of water through improved irrigation, such as drip-fed systems, are likely to be employed.

Water extraction from the Colorado River, the Rio Grande and the Yellow River already results in them failing to reach the sea for at least part of each year

Risks and Benefits

Food Price Spikes. Increasing demand, and climate change, may affect the supply of key staples by, for example, drastically depleting fish stocks, or significantly reducing capacity to grow rice in South East Asia or wheat on the US plains. A succession of poor harvests may cause a major price spike, resulting in considerable economic and political turbulence, as well as humanitarian crises of significant proportions and frequency. Genetic and scientific modification of food is likely to be necessary, both for human and animal consumption and for biofuel production.

Conflict over Water. Inter-state conflicts caused by disputes over water distribution are possible, but historical experience indicates that countries generally seek equitable

189 UK Met Office Hadley Centre.  
190 UNEP. Freshwater Biodiversity: a Preliminary Global Assessment.  
192 Centre for Strategic and International Studies. Global Water Futures.
solutions to water disputes, and this is *likely* to remain the case. International agreements concerning access to water, such as those between India and Pakistan and between East African states, are *likely* to provide a basis for compromise. International trade, and the off-shoring of agricultural production to fertile regions *will* serve to mitigate the most acute water stress. However, increasing water stress *will* contribute significantly to tensions in already volatile regions, *possibly* triggering conflict. More importantly, localised water scarcity is *likely* to inhibit economic development and generate internal conflict within states as groups compete for access.193 Water management problems, such as pollution or localised flooding due to increased precipitation, run-off from urban sprawl and rapid glacial melt, are *likely* to challenge the ability of already weak states to provide for their populations. The most adverse consequences of water management problems are *unlikely* to be confined to remote rural regions. They are *likely* to be centred on rapidly expanding urban areas. Those regions most at risk include north Africa, sub-Saharan Africa, the Middle East and southern and Central Asia, including China.194

**Mass Population Displacement.** Combinations of food and water insecurity, climate change and the pursuit of economic advantage *may* stimulate rapid and large population movements destabilising neighbouring regions. In particular, sub-Saharan populations *will* be drawn towards the Mediterranean, Europe and the Middle East. In Southern Asia, coastal inundation, environmental pressure on land and acute economic competition *may* affect large populations in Bangladesh and on the east coast of India. Similar effects *may* be felt in the East Asian archipelagos, while low-lying islands *may* become uninhabitable. The developed world *will* face significant illegal migration pressure, and ethical dilemmas in determining how to deal with humanitarian effects.

**Environmental Impact.** Water and air pollution, and soil degradation through acidification, contamination, desertification, erosion, or salination *will* remain problems, especially in densely populated, rapidly industrialising states. Environmental degradation, the intensification of agriculture, and pace of urbanisation *may* reduce the fertility of, and access to, arable land. Technological and organisational solutions *will* emerge, such as improvements in the use of fertilisers, as *will* behavioural solutions, as waste becomes increasingly socially unacceptable and processes and accepted norms adapt. Environmentalism *will* remain a powerful movement, enjoying a broader base of support that encompasses elements of the developing world.

**Biodiversity.** Biodiversity is *likely* to become prized as research into the extent and variability of different forms of life yield significant technological and health advances. On land, diversity *will* be reduced as a side-effect of mass agricultural production techniques, industrialisation, urbanisation and through continued erosion of natural habitats, especially tropical rainforests. In the maritime environment, pollution and climate induced changes *will* degrade biodiversity, especially in Australasia where coral habitats are *likely* to be particularly affected. Bio-diverse regions are *likely* to be valued more highly by the global community than local communities, often resulting in tension between conservation and economic use.

193 For example, many commentators assess the water scarcity to be a major contributory factor to conflict in Darfur.

194 Xinhua News Agency. In 2007, the Yangtze River fell to its lowest level since 1877. The Yellow, Colorado and Murray-Darling Rivers fail to make it to the sea for at least part of the year.
Geophysical Risks. Between 1980 and 2000, 75% of the world’s population lived in areas affected by a natural disaster and, since 1998, around 500,000 people have been killed by earthquake activity alone, with the 2004 Indian Ocean tsunami accounting for over 40% of this total. Population growth, urbanisation in geophysically unstable regions, variable construction standards, and limitations of predictive and warning mechanisms suggest that casualty figures of this magnitude will be typical out to 2040. Demands on land usage will lead to increasing habitation in areas of significant risk, such as those susceptible to volcanic and seismic activity or low-lying coastal areas subject to inundation by tsunami. The net result is likely to be an increase in the scale of humanitarian crises and associated migration pressures.

Resource Nationalism. Resource nationalism is state control or dominance of particular resources, especially energy, and the use of this power to achieve national political objectives. In 1978, international companies controlled production from 70% of oil and gas reserves; at present they control only 20% with national or state-dominated oil companies controlling access to 75% of proven conventional reserves. National Oil Companies (NOCs) already account for 14 of the top 20 oil and gas production companies. This control is unlikely to change significantly although most NOCs will continue to recognise the interdependence that exists between producers and consumers. However, resource-rich states, especially those with ideological, geopolitical and populist agendas, such as Iran, Russia and Venezuela, or groupings such as Organisation of the Petroleum Exporting Countries (OPEC), will use, or threaten, all available levers of power to advance economic and foreign policy goals.

Risks and Benefits

Resource Wars. Supply disruptions caused by scarcity, hoarding or withholding of vital resources may cause conflict both between states and within states as groups vie for access. States that are unable to access the necessary materials to allow their population to survive and prosper, either through international markets or bilateral arrangements, may resort to the use of force. The range of outcomes associated with climate change heightens this risk.

Exploitation of Extreme Environments. The search for alternative sources of energy, minerals, food and water, enabled by the assured transfer and access to information, will become more urgent. Consequently the exploration of extreme environments such as: space; the Polar regions; the deep ocean; and deep underground regions is likely to increase. The US Geological Survey estimates that around 14% of the undiscovered

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197 Petroleum Intelligence Weekly (PIW), 2008. Ranked on reserves, of the top 20 oil and gas producers worldwide, 14 are national oil companies or newly privatised national oil companies. PIW’s ranking shows that Saudi Aramco, Gazprom, NIOC, Pemex, Sonatrach, INOC (Iraq), PetroChina, KPC, Petrobras, Petronas, Yukos, Lukoil, PDV (Venezuela) and NNPC are among the most important oil and gas companies in the world. PIW’s ranking on all measures ranks Saudi Aramco, PDV, NIOC, Pemex and PetroChina in the top 10 oil companies in the world.
global oil and gas reserves are likely to be located in the Arctic.198 Although environmental restrictions and technological difficulties inhibit exploration and production in this region, Arctic warming is likely to be at least double the global average, significantly improving future exploration prospects. Petrochemical companies, aggressively developing new extraction technologies, are likely to pursue production, undeterred by environmental limitations, constraints and concerns. The reduction in Arctic ice coverage is likely to continue, creating a strategically significant year-round northern sea route, offering shorter and more direct trade links between North America, Europe and Asia. Similarly, technology will generate commercially viable space applications. As the Apollo programme demonstrated, the exploration of remote and hostile environments is likely to stimulate and deliver technological innovation.

Technological Innovation. Diminishing availability of low cost, easily accessible hydrocarbon resources, and the need to reduce carbon emissions, will stimulate intensive research to find alternative forms of energy, although a rapid decline in hydrocarbon use is unlikely. Unconventional sources, such as oil sands and tars, are likely to become competitive as new technologies and processes mitigate higher extraction costs, high levels of associated emissions and environmental constraints. Methyl hydrate, especially in oceanic margins, is likely to become economically viable as a fuel source, although extraction from deep-water poses significant challenges. A technological breakthrough in the development of nuclear fusion may occur. Many incremental steps towards harnessing the energy of nuclear fusion have already been made, but a commercially available fusion reactor is unlikely in the next 30 years. Improvements in transmission mechanisms may stimulate developing states to specialise in low emission electricity generation for export to the developed world. For example, large-scale solar power generation in previously unproductive regions of North Africa may spur changing political relationships with Europe.

There is likely to be an increase in the exploration of extreme environments, such as the deep ocean beneath the Polar Ice Caps

Hot Topic – Minerals

During the Cold War a number of strategic non-energy minerals, essential for national economies and security, were regarded as vulnerable to supply disruption. These minerals, including chrome, nickel, cobalt, manganese and platinum (chiefly produced by South Africa and the then Union of Soviet Socialist Republics) were not available domestically and could not be guaranteed in time of crisis.

Out to 2040, a range of new factors influencing availability and supplies of certain critical minerals will remain vulnerable to disruption. Demand for minerals is likely to continue to increase in response to population growth, continuing industrialisation and higher material prosperity. New discoveries allied to technological advances will provide sufficient reserves, such that accessibility, rather than availability, is the primary concern.

Increasing demand for natural resources from developing economies, especially China, is likely to continue. Differing standards of financial and environmental regulation and transparency are likely to lead to growing influence in producing regions, such as Africa. Production of certain minerals, such as the Rare Earth Elements (REE), antimony and arsenic, is currently dominated by China. However, if supplies were disrupted alternative deposits are likely to be available for exploitation. In contrast, the location of fewer tungsten deposits are known and the impact on global markets of disruption to Chinese supplies is likely to be significant.
<table>
<thead>
<tr>
<th>Commodity</th>
<th>Chief Usage</th>
<th>Annual Production (Mn Tonnes)</th>
<th>Major Suppliers (% world production)</th>
<th>Threats/Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chrome</td>
<td>Steel Alloys</td>
<td>19.2</td>
<td>South Africa, India, Kazakhstan</td>
<td>Large deposits rare, South Africa has largest resources and production.</td>
</tr>
<tr>
<td>Cobalt</td>
<td>Steel and Special Alloys</td>
<td>0.059</td>
<td>DRC (37%), Canada, Australia</td>
<td>DRC has largest resources and production. China dominates metal production. Alternative sources are by-product of high-cost nickel operations.</td>
</tr>
<tr>
<td>Platinum</td>
<td>Exhauts, Industrial Processes</td>
<td>0.0002</td>
<td>South Africa (75%), Russia</td>
<td>Large deposits rare, South Africa has largest resources and production.</td>
</tr>
<tr>
<td>Antimony</td>
<td>Flame retardant, alloys</td>
<td>0.174</td>
<td>China (86%), South Africa, Tajikistan, Bolivia</td>
<td>China dominant, small-scale mines.</td>
</tr>
<tr>
<td>Rare Earth Elements</td>
<td>Electronics</td>
<td>0.12</td>
<td>China</td>
<td>China dominates supply, but deposits known elsewhere. Short-term disruption if new applications increase demand.</td>
</tr>
<tr>
<td>Titanium</td>
<td>Paint (as titanium dioxide (TiO2)). Aerospace Alloys.</td>
<td>6.1 TiO2 content</td>
<td>Australia, Canada, South Africa, China</td>
<td>New process for production of titanium metal may increase demand and lead to rapid depletion of existing reserves.</td>
</tr>
<tr>
<td>Tungsten</td>
<td>Cutting tools</td>
<td>0.074</td>
<td>China (83%)</td>
<td>China has largest resources and production. Deposits rare.</td>
</tr>
<tr>
<td>Uranium</td>
<td>Fuel for nuclear power generation</td>
<td>0.046 U3O8 equivalent</td>
<td>Canada, Australia, Kazakhstan, Niger</td>
<td>Rapid increase in nuclear power generation, but deposits widespread.</td>
</tr>
<tr>
<td>Manganese</td>
<td>Steel alloys</td>
<td>31.2</td>
<td>China, Gabon South Africa, Brazil, Australia</td>
<td>South Africa has largest resources, but production fairly widespread.</td>
</tr>
<tr>
<td>Tin</td>
<td>Solder and special alloys</td>
<td>0.25</td>
<td>China (98%), Indonesia</td>
<td>China dominant, but large resources</td>
</tr>
</tbody>
</table>

Table 2 – Global Mineral and Metal Resources

Certain minerals, such as iron ore, nickel, aluminium and coal, are not particularly vulnerable to disruption as supplies are widely distributed throughout the world. Other minerals, such as silver and gold, are also low risk as they are not critical to industrial processes and can be substituted. Various minor metals produced in very small quantities, such as gallium and germanium, are generally by-products of other more widely used metals, such as aluminium, copper, lead or zinc, and are recovered only from a few deposits. Their production is therefore inextricably linked to that of the major metal and cannot be easily raised to meet increasing demand.
Economic Dimension

Scope

Global economic growth has been driven by economic globalisation over the last 30 or more years, generating pervasive networks of connections and interdependencies between the major economic powers. The economic landscape has evolved rapidly: centrally planned economies such as the Soviet Union have collapsed; many Asian economies have enjoyed spectacular growth, particularly China which has embraced a market aware philosophy; and the EU has matured into a cohesive economic bloc. These changes have created a multi-polar economic landscape. The Economic Dimension considers drivers and trends related to economic growth, material expectations and economic power, in order to determine how they will affect the global economy.

The Hot Topic is the *Global Economic Recession*.

Trends and Drivers

**Economic Growth.** Over the last 30 years, the global economy has grown at a rate of 3-4% and output has increased 4-fold.¹⁹⁹ There has been regional variation: the newly-industrialised Asian economies have raised output 12-fold, while the G7 group of industrialised states have had a 5-fold increase. However, sub-Saharan Africa has experienced only a 3-fold increase, despite more than doubling its population and potential workforce during that time.²⁰⁰ Growth in the global economy will continue, accompanied by general improvements in material well-being. However, economic growth, combined with the continuing rise in the global population, will intensify the demand for natural resources, minerals, and energy. When allied to demographic ageing and environmental and political challenges, the likely result is a reduction in global economic growth rates. This growth will continue to be uneven, fluctuating over time and between regions, with sub-Saharan Africa likely to lag behind other regions primarily because of governance challenges, linked to endemic corruption. The most rapid growth is likely to be in developing economies that experience a 'demographic dividend' that boosts the workforce as a percentage of the population. Other states which have large workforces and maturing macro-economic frameworks such as China, India, and possibly Brazil, Mexico, Turkey and Vietnam are also likely to grow rapidly.²⁰¹

¹⁹⁹ Trend economic growth refers to average growth of an economy over a cycle of expansion and contraction. It is a moving average. IMF, *World Economic Outlook 2008*, page 3.
Economic Globalisation. Economic globalisation is one aspect of the wider process of globalisation (see the Globalisation Ring Road Issue). Since 1980, the global economy has integrated rapidly, driven by technological innovation that has dramatically reduced the costs of transportation and communications. For example, in real terms the unit cost of air transport fell by 80% between 1930 and 1990, and the cost of a 3 minute trans-Atlantic phone call fell from $250 in 1930 to virtually zero. Globalisation, based on persistent technological innovation, is likely to remain the most significant driver of long-term economic change. Nevertheless, liberal trade and investment policies that have accelerated globalisation since the end of World War II will be subject to periodic challenge, and may be temporarily reversed. In particular, the exposure of local markets to externally-derived risk may lead to unilateral protectionist action or preferential bilateral arrangements, especially in situations where social or regime stability is threatened. Hence, while globalisation is likely to continue, there are significant risks, and it cannot be ruled out that economic de-globalisation may be the defining trend out to 2040.

Rapid Climate Change. Unexpectedly rapid climate change is likely to significantly shrink the global economy. Feedback mechanisms may cause the rate and magnitude of climate change to be greater than consensus forecasts, making mitigation and adaptation difficult and expensive. For example, the costs of stabilising atmospheric carbon dioxide levels may reach 2% of annual global output by 2050, although this estimate masks large variations across countries and regions. US could suffer only a 1% cost, but India and Africa may suffer costs of up to 5% of output. Failure to develop technologies in time to alleviate the worst effects of climate change is likely to result in severe economic dislocation, causing a reduction in consumption per head of up to 20%, with associated political, social and security implications, especially in states that are subject to the most extreme effects.

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202 Stern Review on the Economics of Climate Change. Executive Summary, page xiii. The initial estimate of 1% was increased by Lord Stern in later comments. The IMF (World Economic Outlook 2008, page139) estimates 2%.
204 Ibid, page139.
Economic De-globalisation. The period from around 1870 to 1914 is considered as a previous era of rapid globalisation. However, globalisation crumbled between 1914 and 1945, when global economic integration, as measured by international trade, capital flows and international migration, receded (see Figure 15). Out to 2040, barriers to trade, migration, as well as capital and intellectual flows introduced in response to geopolitical insecurity, protectionist interests, or macroeconomic instability, may reverse the globalisation process and result in a period of economic de-globalisation. Such a period may be characterised by: decreasing interdependence; increased competition and confrontation in international relations; regional or ideological blocs coalescing around common economic, political, social, cultural or security interests; and inter-state and inter-bloc rivalries.

206 Her Majesty’s Treasury, Responding to Global Economic Challenges: UK and China, October 2005.
Material Expectations. Material expectations, fuelled by access to increasingly globalised communications and media, will be heightened by continued global economic growth, and by visibility of high standards of living in affluent states. Visible marginalisation, economic inequality and a sense of grievance, where they occur, are likely to increase in significance and become major political issues, possibly based around transnational agendas that advocate violent activism. Capitalism, allied to market-driven economies, has proven the most prevailing (and accepted) political-economic ideology, and this will continue in some form. Individuals, especially in developing states, will aspire to attain increasing material wealth. However, the sheer scale of the gap means that a low-income state is unlikely to become a high income state, and vice versa, within the space of 30 years. The past 50 years has seen improved average living conditions for most of the world’s population, but inter-state and intra-state income inequality has remained extremely high. Global output growth per head is likely to continue, but at a reduced rate, especially in developing economies that have seen a 50% rise since 1980. The least developed economies may see the lowest rates of per capita growth as sub-Saharan Africa declined during the 1980s/90s.

Risks and Benefits

Inequality of Opportunity. Circumstance-based inequality is associated with criminality and may be a significant factor in initiating and prolonging conflict. However, reactions to inequality are context dependent and specific outcomes cannot be predicted with confidence, although states with high levels of inequality, between individuals, and particularly between groups, may be at greater risk. The coincidence of economic disparities with other inequalities, such as ethno-nationalist, political, or cultural fault lines, is crucial to understanding how inequality affects the probability of violent conflict. The juxtaposition of such inequalities is more likely to result in armed conflict being initiated and prolonged.

Global Trade. Since 1950 world trade has grown more than 27-fold in volume terms, 3 times faster than growth in world output, which expanded 8-fold during the same period. The driving forces behind this growth in trade are cheaper transportation and communications, more open trade policies, and changes in economic organisation, such as cross-border integration by Multinational Corporations (MNCs). When the global economy grows, and the majority of major economies participate in that growth, a significant backlash against trade liberalisation is unlikely and international trade will grow. However, trade growth may be temporarily reversed in response to periodic economic, resource or financial crises. Moreover, environmental crises and rising transportation costs, linked to climate change and high energy prices, may lower, or even reverse trade growth, especially in manufactured goods. The tension between faltering global agreements on trade liberalisation and the continued drive by MNCs to integrate

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212 Transportation costs vary with demand, however environmental costs (emissions) may also become a real cost in the long term.
production vertically\textsuperscript{213} is likely to result in the rise of regional trade agreements. This may provide a basis for a more regionalised structure of political and economic blocs. Around 400 regional and bilateral trade agreements already exist with many coming into force since negotiations on the Doha round began in 2001.\textsuperscript{214}

### Risks and Benefits

**Protectionism.** The desire to protect national industries from foreign competition remains a threat to globalisation, just as it was during the inter-war years when the infamous Smoot-Hawley Tariff Act was instituted by the US Congress.\textsuperscript{215} Irrespective of success in the global trade negotiations, it is unlikely that the World Trade Organisation (WTO) can maintain the momentum of tariff reductions established over the last 30 years, given the scale of earlier reductions and the drift towards states protecting certain sectors of their economies from competition and disruption. Further multilateral agreements may be completed. However, the increasing complexity of bilateral arrangements is likely to lead to a ‘noodle bowl’ set of links between states that favour rationalisation by regional, rather than global, trade agreements.\textsuperscript{216} Outright protectionism on a global scale is unlikely to take hold, but protracted trade disputes involving major powers are possible. Such disputes would result in increased competition and confrontation between states.

**Distribution of Economic Power.** Economic power has long been wielded by wealthy, high-income states such as the US and, to a certain extent, by the EU and its individual members, to achieve desired outcomes. This can be done through the negotiation of trade arrangements or through coercive sanctions. However, rapid economic growth in developing economies, increasing economic interdependence, and competition for strategic resources will erode the utility and effectiveness of economic power. The trend towards a multi-polar economic landscape is likely to continue. As resource scarcity starts to impact, China, India, and resource-rich states such as Russia, Iran, Saudi Arabia, and possibly Brazil are likely to use economic levers to achieve geopolitical ends more frequently. By 2040, China’s and India’s output is likely to be of a similar magnitude to US and EU output, although their per capita income will remain significantly lower. Hence, 2 of the 4 largest global economies are unlikely to be high income states. The manner in which this disparity is perceived, and the extent to which China and India focus on internal development rather than wider global challenges, is likely to be fundamental to the global economic and strategic outlook.

\textsuperscript{213} Vertical integration is the organisation of production whereby one business entity controls or owns all stages of the production and distribution of goods or services.

\textsuperscript{214} Lamy P, WTO President. 17 January 2007. ‘But as the WTO and it predecessor, the GATT, have evolved, a myriad of preferential trade agreements have been concluded by WTO members. By 2010, around 400 of such agreements could be active. These preferential agreements contradict the non discrimination principle which is one of the cornerstones of the WTO.’

\textsuperscript{215} The Smoot-Hawley Tariff Act was signed into law on June 17 1930, and raised US tariffs on over 20,000 imported goods to record levels, and, in the opinion of most economists, worsened the Great Depression. Many countries retaliated with their own increased tariffs on US goods, and American exports and imports plunged by more than half.

\textsuperscript{216} Baldwin R, Multilateralising Regionalism. By 2010, there are likely to be over 90 Free Trade Agreements affecting bilateral flows in East Asia.
System of Global Economic Governance. The contemporary global economy bears little resemblance to the fragmented post-World War II period when the current global economic governance regime was constructed. Although institutions created 60 years ago have adapted, the IMF and the World Bank are struggling to become representative and to remain relevant. Efforts to develop global institutions that are structured, funded, and empowered to act as a stabilising force for international financial markets will continue. Out to 2040, they are likely to find ways of enhancing the participation and voice of emerging economies. However, difficulties in gaining international consensus for change means that an effective system of global economic governance is likely to evolve slowly and face continued challenges.

Based on Maddison and IMF/World Bank projections.

Breugal, Global Governance, December 2006.
Sovereign Wealth Funds. A Sovereign Wealth Fund (SWF) is a pool of money derived from a country’s reserves, which is set aside for investment purposes that benefit the country’s economy and citizens. State-owned investment vehicles, particularly those of China, Norway, Russia and the petroleum exporting countries of the Middle East, have grown rapidly and hold almost $5 trillion in assets. States with large SWFs will be significant investors in developed and emerging economies over the next 30 years. They are a visible aspect of interdependence between states and are likely to be invested rationally for profit, as well as for political ends. However, individual investment decisions will be controversial and subject to scrutiny by suspicious host countries.

Poverty. Between 1990 and 2002, global average incomes increased by approximately 21% and the number of people living in absolute poverty declined by an estimated 130 million; global child mortality rates fell from 103 deaths per 1,000 live births a year to 88; life expectancy rose from 63 years to nearly 65 years; an additional 8% of people in the developing world gained access to clean water; and an additional 15% acquired access to improved sanitation services. Economic growth is likely to lead to a continued reduction, albeit unevenly distributed, in absolute poverty. Improved access to information is likely to stimulate growing concern over comparisons between living standards. However, given projected population growth in the least developed countries, the total numbers of people affected by poverty may increase, especially if the global economy grows less rapidly than expected. These increases are likely to be concentrated in particular regions that are afflicted by conflict, poor governance, and the worst effects of climate change, (such as sub-Saharan Africa).

Instability and Income Ratios. Strong economic growth, especially in Asia, has resulted in the growth of a global middle class. The global population of over 6 billion can be classified between high, middle and low-income in to the ratio 1:3:2. However, future population growth is likely to be concentrated within low-income states. Hence, as the global population rises towards 9 billion a ratio of 1:3:5 is possible, accentuating the challenge of economic inequality. Within the low-income strata there already exists a ‘bottom billion’ that are unlikely to rebel because they are too preoccupied simply with survival. It is those above this level where the majority of instability is likely to be concentrated as individuals and groups seek to improve their situation.

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219 The funding for a Sovereign Wealth Fund (SWF) comes from central bank reserves that accumulate as a result of budget and trade surpluses, especially from revenue generated from the exports of natural resources. The types of acceptable investments included in each SWF vary from country to country; countries with liquidity concerns limit investments to only very liquid public debt instruments.

220 McKinsey Global Institute in a recent report forecast a dramatic increase in the assets of sovereign-wealth funds over the next few years. It predicts that Asia’s sovereign assets, which at the end of 2007 stood at $4.6 trillion, will rise to at least $7.7 trillion by 2013 on conservative growth assumptions, and to as much as $12.2 trillion if economic growth continues at the fast pace of the past seven years. The Rise of State Capitalism, The Economist, 18 September 2008.

221 UN Millenium Project.

Patterns of Labour Mobility. Remittances from migrants in developed states, worth $240 billion per annum, or more than twice the level of international aid, are the largest source of external capital in many developing countries and directly benefit 10% of the global population.\textsuperscript{224} Over half of the 16 million highly skilled expatriate workers in the 4 main destinations (US, Europe, Canada and Australia) have originated from outside the OECD area.\textsuperscript{225} Out to 2040, highly capable and skilled individuals, particularly those in niche or scarce areas, will continue to attract substantial rewards for their services and are likely to be mobile within the global economy. This flow of skilled migrants will become more complex and will be affected by the growth of research and entrepreneurial opportunities in developing economies, fluctuating migration policies, and changes to traditional career models in business and academia. This may result in a ‘brain circulation’ rather than a ‘brain drain’, as developing economies continue to rise, and opportunities and safeguards become more predictable; a reverse flow of people to countries of origin may accelerate.

Risks and Benefits

Economic Migrants. Large differentials in per capita income are one driver for migration, inducing, for example, large-scale rural–urban migration in China, and international migration from Latin America into the US and from Africa into Europe. Cross-border income discrepancies can be extremely high. For example, Spain has an average income of $31,000, but Morocco’s is only $4,000. The tension between the desire of migrants to pursue economic and other opportunities in developed countries, and the willingness of host populations to accept continued migration will determine the future level of controlled migration. The developed world, particularly Europe, is likely to require immigration in order to maintain its workforce and skills base, and to compensate for its declining indigenous workforce. However, in phases of below trend economic growth, political pressure is likely to limit immigration in order to protect indigenous employment, leading to a surge in illegal migration, which will remain a security challenge.

Capital Flows. The volume of cross-border capital flows, both net and gross, is likely to increase, maintaining a high-level of financial interdependence between states. Gross capital flows have increased markedly over the last 30 years. For example, turnover on the foreign exchange markets generates flows of several hundred trillions of dollars per year. However, the majority of these trades represent short term speculative flows rather than longer-term investments, and net international flows, as a proportion of global output, are smaller than at the turn of the 20th century.\textsuperscript{226} The tension between the interdependency created by capital flows, and the instability that can be generated by capital flight, will continue. Financial instability may be one trigger by which protectionist-minded populations force de-globalising policies onto reluctant governments.

\textsuperscript{225} OECD Science, Technology and Industry Scoreboard 2005, Towards a Knowledge-based Economy.
\textsuperscript{226} At its peak, British net overseas investment, mainly in India, ran at 9% of GDP while British claims on the rest of the world were equal to 2 times GDP. This is significantly higher than any developed country today. Wolf M, Why Globalisation Works, 2004.
The volume of cross-border capital flows is likely to increase

The Role of Multinational Corporations. Over the last 30 years, industrial production has been de-centralised and geographically distributed in an unprecedented manner. Countries, regions, and firms have specialised in particular stages of a product’s manufacture in response to competition, internationalising the markets for goods, services and labour. Such specialisation requires large-scale transportation of components, and this has been facilitated by technological advances in transport and communications, and trade liberalisation. MNCs and out-sourcing have emerged as integrating factors in the globalised economy, producing networks of interdependence between states that are unprecedented in scale and pervasiveness. This integrating effort is likely to persist out to 2040. The rise of state-owned enterprises (5 of the 10 largest MNCs are currently state-owned by the Chinese, Brazilian and Russian governments) is likely to continue, as is the proportion of MNCs based in emerging rather than developed economies.

Risks and Benefits

Defence Industrial Base. Ownership and production within defence firms has become increasingly internationalised as MNCs seek competitive advantage. For example, in 1988 of the 15 leading European defence suppliers, 8 were state-controlled and 2 more had been in the recent past. By 2006, only one of the top 15 had a majority state holding. The geographical distribution of critical technologies, Research and Development (R&D) activity, and production has shifted from a national to an international base with the possibility of disruption to procurement chains especially in times of tension and conflict.

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Hot Topic – Global Economic Recession

The International Monetary Fund (IMF) considers there have been 5 global recessions in the last 30 years. Further global economic recessions will happen over the next 30 years, and governments are likely to respond to them with protectionist policies designed to shield their own economies and workforces. However, they are likely to temper the extent of such policies, to maintain the integrity of the international system for global trade and capital movements. In extremis, protectionist measures that cause the reversal of economic globalisation are possible.

The global recession of 2008-9 is illustrative of the probable response to, and effects of, future recessions. Its overall effect is probably to accelerate the shift of power from Europe/US towards Asia, and to diminish Western soft power by making its economic and financial systems less attractive. First, wide-ranging interdependencies within a complex global financial system made counter-party risk difficult to identify and allowed a localised crisis in US sub-prime mortgages to trigger a global financial crisis. Other complex globalised systems, such as supply chains, may be vulnerable to similar systemic shocks, suggesting a requirement to monitor, analyse and evaluate their resilience.

Second, it will be in the interest of major powers to find methods and mechanisms to deal cooperatively with the effects of recession, or of systemic failures. Economic and financial interdependency raises the cost of failure to act and provides stimuli to use innovative methods, such as coordinated central bank action, and revitalises cooperation through representative groupings, such as the G20. However, they may not always be successful in doing so. Third, global recessions will cause an increase in the incidence of poverty, at least temporarily, and are likely to promote grievance and dissatisfaction among those who suffer economic hardship. This in turn is likely to breed political violence, criminality, societal conflict and destabilisation of those states or regions unable to cope. Finally, economic crises will affect governments’ finances. There may be downward pressure on defence spending making measures, such as aid or intervention, unaffordable.
Geopolitical Dimension

Scope

The Geopolitical Dimension considers the drivers that will influence the future global political system. Two issues are likely to dominate out to 2040: the changing distribution of global power, from a uni-polar to a more diverse and complex structure; and the potential resurgence of political ideologies, driven by liberal democratic values, autocracy, religious, nationalist or other influences.

The Hot Topic in this section is the Resurgence of Ideology.

Trends and Drivers

Global Interconnectivity. The interdependence of the global system, underpinned by physical links, international governance and norms, and a belief in the positive benefits of international markets and trade, is likely to act as a double-edged sword. It will act as a stabilising influence between major powers by raising the costs of confrontation and conflict, but is also likely to destabilise states and regions that are unable to cope with the increased competition and social change that interconnectivity brings. Interconnectivity and interdependence is epitomised by the symbiotic relationship between China and the US. On one hand both states are likely to see each other as a security challenge, but they will continue to exploit the economic opportunities that exist between them. However, the interconnectivity of the global system also represents a significant systemic risk to highly-integrated economies given that failure of one part is likely to have broad impact.

The Constituents of Power. Power is the ability to influence others. The constituents of power will continue to comprise a mix of ‘hard’ and ‘soft’ elements. Hard power is military, economic and some elements of diplomatic activity that can be used to coerce or pay others to change their behaviour. Soft power is the power of attraction based on culture (when it is pleasing to others), values (when they are attractive and consistently practiced), and policies (when they are seen as inclusive and legitimate). Soft power is at its most effective when underpinned by hard power. The degree to which a state or group can combine hard and soft power into an amalgam of effective statecraft will determine their ability to achieve strategic objectives. Some states, especially in Europe, are already reluctant to use the military element of hard power. This trend towards a post-military society is likely to remain strong, but not irreversible. The ability of the Western liberal democracies to utilise power is likely to be challenged by the rise of alternative power bases in Asia, in particular in China and India. Moreover, all elements of power are likely to be wielded by a broader spectrum of actors and agencies, even by organised criminal, terrorist and insurgent groups.

The Role of the State. The state will remain the basic unit in international relations, although it will face challenges and the authority vested in it will vary. Most states will retain authority over the full spectrum of activities, whereas others, such as those in the

EU, will voluntarily divest some to regional or supranational authorities. Others, such as some states in Africa, will have little practical authority. Transnational movements and groups will remain influential and are likely to further erode some aspects of state power. The varying levels of authority will complicate the ability of states to achieve and sustain multilateral partnerships and agreements.

Global Governance. The UN will continue to offer a framework for international discourse. It will continue to be the global service provider, offering international coordination and direction in specific areas through bodies such as the World Health Organisation (WHO), UNHCR and United Nations Educational Social and Cultural Organisation (UNESCO). The permanent membership of the UN Security Council is likely to expand, but it will struggle to deal with conflict and tension. Other global institutions will face considerable challenges.

Differing Political Systems. Any assumption that Western liberal values and processes would become the global norm has already been severely challenged. Out to 2040, there will be an era of competing political systems, ranging from liberal democracy through to autocracy and theocracy. Tension between regions, states and nationalist identities, and corruption among ruling elites, are likely to constrain the spread of democracy. Liberal democracies will still dominate in the West. However, the arguments of some democratic movements may not be perceived as strong enough to solve the problems in some developing states that maintain, or turn to, more autocratic or authoritarian political systems. The populations of some states may favour stability, the promise of economic growth and limited de-regulation at the expense of fully representative government. Political systems based on tradition, be it ethnic, tribal or religious, are likely to remain features of the global political system, as are dictatorships.

Transnational Extremism. Transnational armed criminal, terrorist or insurgent groups, experienced in conflicts around the world will be part of the strategic landscape. Many extreme political groups will have a transnational following, and may increasingly employ sophisticated methods of coercion, including cyber attack and Weapons of Mass Destruction (WMD). They will remain highly unpredictable and a continued cause of tension and instability especially in regions that have underlying governance and economic problems, such as in sub-Saharan Africa and possibly Latin America. Most will demonstrate features associated with organised criminality, terrorism, disorder and insurgency, fuelled by perceived or actual grievances. There is likely to be an increased sponsorship of irregular activity by states, seeking to utilise and exploit, through proxies, gaps in the international system, either to assert themselves or to secure advantage without exposing themselves to state-on-state risks. Acts of extreme violence, including mass casualty attacks, will continue to be used by groups with sophisticated networks and the ability to exploit the media in order to maximise the impact of the ‘theatre of violence’.

United States Transition. The status, culture and actions of the US will have a decisive effect on the evolution of the international system, as it adjusts to an uneven, possibly unbalanced transition from a uni-polar to a multi-polar world.
Risks and Benefits

**US Decouples From Europe.** A shift in US strategic focus towards Asia, internal demographic change, and a changing balance of power in the Americas, based on Brazil’s economic growth, *may* result in a significant reduction in US engagement with Europe, challenging the viability of North Atlantic Treaty Organization (NATO) as the dominant provider of European security and defence architecture. However, the US *will* seek to safeguard its continuing economic investment in Europe and its interests in the Middle East and the Arctic. These are *likely* to ensure continuing defence and security cooperation with European partners, *probably* at reduced levels, but with a correspondingly greater investment in expeditionary and continental-US based capabilities.

**The Rising Powers.** China’s economic development *will* be one of the most significant factors in the future of the globalised economy. Other growing, or resurgent powers are *likely* to be of influence, with Brazil and *possibly* South Africa strengthening their status as regional powers.

**Weak States.** Many states and some regions *will* fail to attain the necessary level of economic and political development to compete in a sustained and successful manner in the global economy. These states are *likely* to be beset by a mixture of environmental, demographic, economic and political pressures with consequent impact on their stability and security. They can be regarded as weak states. Some weak states *may* fail completely, with sub-Saharan Africa and Central Asia, regions of global concern. The degree to which weak states impact on others is *likely* to depend on the security of supply of strategic resources to the globalised economy and whether internal instability spreads to neighbours, either through migration or conflict. Responses to weak states are *likely* to include humanitarian assistance, containment and stabilisation.

*Some states may fail completely, with sub-Saharan Africa of global concern*
Ungoverned Space. Some geographical regions, including weak states and rapidly growing cities, will not be subject to legal, legitimate or conventional administration. Where this occurs, power is likely to be wielded by groups ranging from warlords and armed criminal gangs through to traditional tribal or religious structures. Each region will be unique and engagement by outside powers will require an understanding of the individual context of the region. Some of these regions are likely to subsist through illicit trade and institutionalised criminal activity, while others will be ineffective in curbing instability. Many are likely to suffer conflict and be a source of instability in neighbouring regions. The risks associated with these spaces, including endemic criminal activity, the basing of terrorists, irregular activity and conflict, are likely to increase and add to the burdens of maintaining the integrity of the international system. Similarly, states that are unwilling or unable to invest sufficiently in maritime security, are unlikely to be able to patrol and enforce their jurisdiction and internationally binding maritime obligations in their territorial seas and economic zones. This may lead to activity stretching from maritime pollution, dumping of hazardous materials, illegal fishing, smuggling (of drugs, people and other forms of contraband) up to piracy attacks. This will be particularly important when an area of sea adjacent to a weak state encompasses key communication nodes, such as the Straits of Malacca or the Bab-el-Mandeb.

The Proliferation of Weapons of Mass Destruction. Access to technology that enables the production and distribution of WMD is likely to increase. Many states will feel that they require the prestige and deterrent value of WMD systems to reinforce their regional power.

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**Security of Chemical Biological Radiological and Nuclear materials.** Wider possession of WMD and Chemical Biological and Radiological and Nuclear (CBRN) technology and materials, by states with inadequate capacity for ensuring security and safety, will increase the risk of proliferation and incompetent handling. Catastrophic environmental damage is possible. Nuclear armed states that are vulnerable to instability will be of particular concern.

Non-State Actors. MNCs, large non-governmental organisations, as well as organised criminal groups, all work across the global stage. However, the authority of the state is likely to remain dominant. Non-State Actors are only likely to gain a similar degree of influence in areas where governance has broken down or is particularly fragile. Large MNCs, such as Gazprom, are increasingly state-owned and controlled, and other large corporations will have to work within the state based legislative framework if they are to gain access to resources and markets. While media and communication corporations may become ubiquitous global brands, the control by the state of the physical environment and operating space mean that it is unlikely that these corporations will have the means, methods or opportunities to usurp the power of the state. Non-governmental organisations, especially those associated with particular interests, will play niche roles and have influence within liberal democracies, but it is unlikely that their approaches of utilising the media, direct action and lobbying will have much impact on more authoritarian states.
Hot Topic – The Resurgence of Ideology

Religious belief will retain a significant influence on the vast majority of the global populace especially in the Americas, Africa and increasingly throughout Asia. Tension is likely between religious and secular groups. Strategic drivers such as economic recession, resource scarcity, social change and conflict are likely to contribute to the increasing significance of belief-based groups. Single issues may also emerge that divide opinion and forge identities, such as attitudes toward abortion, gender, the environment, religious law and the teaching of evolution.

The Christian Faith has around 2.2 billion adherents and an annual growth rate of around 1.4%. It is likely to remain the largest religious grouping. Islam has an estimated 1.3 billion adherents and an annual growth rate of 2.0%, with most growth coming from the developing world; it is likely to remain the world’s fastest growing major religion. New groups will continually form, grow and disband. Evangelical and individually-focused religious groups are likely to be increasingly socially engaged, working to provide welfare support and focusing on an individual's needs, moving away from a traditional organisation-centred model of belief. The spread of evangelical Christianity in Africa, Asia and South America may transform traditionally Western-based Christian institutions, giving them an increasingly non-European emphasis.

Religious ideology will continue to be a generally positive influence on behaviour, although at times it may also be a source of tension and conflict. Inter-faith and intra-faith conflicts will occur, for example between Christian and Muslim groups in parts of Africa. However, religion will often be the tool to motivate popular support in response to other grievances. Religion will often be the pretext rather than the source of conflict. The growth of new religious groups may result in tension, especially in areas that have long-established religions and traditions that experience considerable increases in minority faiths.

Islam will remain politically influential, although any form of pan-Islamic movement is unlikely. The largest Islamic group, with the widest geographical spread are the Sunnis that predominate parts of the Middle East, Southern India, the Malacca Straits, and through South Asia up into Russia. Tension between some Sunni and Shia’s will continue to be a source of instability. Sectarian conflict within Islam is likely to continue. Any rapprochement between Islam and Judaism is unlikely. The situation will be defined by continuing confrontation between a prosperous Israel and surrounding states that are likely to struggle economically and suffer from governance issues exacerbated by nationalist or violent political movements. Orthodox Islamic groups are likely to question the legitimacy of ruling regimes and seek to replace them with theocratic governments. Any such change would create tension, not only with the West and others who depend on access to Middle eastern resources, but also with Iran.

Europe is likely to remain broadly secular although a number of new belief structures may arise based more on reason than on faith. Consequently a new form of sacred secularism may arise which reacts strongly against any attempts to incorporate faith-based beliefs into the political and legal system and may itself form its own movement competing with both traditional and resurgent forms of religious belief. Tension is likely to occur from the

increased competition for ideas and membership between those who define themselves as secular and those particular brands of faith undergoing significant a ‘spiritual void’ in the developed world.

Nationalism is *likely* to remain significant. When coupled with destabilising grievances, it is *likely* to be a rallying point for dissent, often directed against migrant communities and within states with marked ethno-religious divisions. Potential areas of concern *will* be in the Balkans, the Caucasus, the Middle East and Africa. Nationalist sentiment in East Asia *will* remain strong, and *may* be a significant factor in relations between states. State fragmentation along nationalist fault-lines is *possible*, especially if economic performance deteriorates, and separatist movements, such as those in Tibet and Xinjiang, *will* continue. Russian nationalism is *likely* to be a destabilising influence for her near neighbours, especially in states with large concentrations of ethnic Russians. Equally, Russia *will* suffer from internal security problems with its own disaffected minorities. Cities and states with large diaspora communities affected by instability in their homelands *may* become proxy conflict zones themselves.

Many former Communist states, including Russia and China, have adopted hybrid methods of governance that attempt to accommodate capitalism and stability. Robust economic growth and moves towards individual freedoms has often suppressed potential discontent amongst their populations. However, should economic growth be halted or reversed, a return to more severe forms of authoritarianism, and even Marxism, is *possible*.

Environmentalist groups have grown in strength in the developed world. However, climate change is *likely* to put environmental issues into the global political consciousness. These groups are *likely* to exert considerable influence and *may* develop into niche political global movements. Some ‘green’ and ‘new age’ groups *may* resort to more direct action, rather than just political agitation, and in some extreme examples this *may* include violence.
Science and Technology Dimension

Scope

The interrelated effects of globalisation, including market-manipulation, the unpredictability of consumer demand and the multiplicity of complex routes to market, will lead to rapid technological change. Issues relating to the perceived benefits and drawbacks of technological development and their global supervision are likely to remain highly charged. The Science and Technology Dimension therefore considers broad trends, focusing on how innovation may unfold over the next 30 years. These broad trends include: the rapidly expanding global appetite for profits derived from technological advances; the influence of certain emerging economies; and the resulting potential for technology breakthroughs and their societal impact.

The Hot Topics are Cyberspace, Space, Ballistic Missile Defence and Novel Weapons.

Trends and Drivers

Pace of Development. Trend analysis indicates that the most substantial technological developments are likely to be in the areas of: ICT; sensor/network technology; behavioural and cognitive science; biotechnology; materials; and the production, storage and distribution of energy. Advances in nanotechnologies will underpin many breakthroughs. Developments in individual areas are likely to be evolutionary, but where disciplines interact, such as in the combination of cognitive science and ICT to produce advanced decision-support tools, developments may be revolutionary, resulting in the greatest opportunities for a novel or breakthrough application.

Commercial Imperative. Global economic growth, resource pressure in its widest sense and increasing socio-economic dependency ratios\(^{232}\) will fuel demand; creating opportunities for innovation and investment. Development is increasingly likely to be directed towards commercial imperatives. For example, business enterprises accounted for 68% of OECD Research and Development (R&D) expenditure.\(^{233}\) This aspect will drive innovators to identify maximum applications and markets for their discoveries, with interdisciplinary R&D likely to lead to the most revolutionary outcomes.

Research and Development. Increasing volumes of R&D will take place outside established centres of research, with rapid proliferation and expansion of information and research facilities in developing economies. The academic sector will become increasingly transnational as information technologies allow virtual collaborations. This is likely to lead to a decline and possibly even a reversal in the technological dominance of the West, with China and India poised to become technology leaders in some fields. Intellectual property and commercial exclusivity are likely to be under constant pressure from inadvertent disclosure, penetration and espionage. Under these conditions,

\(^{232}\) The UN definition of dependency ratio is the ratio of the sum of the population aged 0-14 and that aged 65+ to the population aged 15-64.

knowledge and innovation will become more diffuse and internationalised, accelerating the development process.

### Risks and Benefits

**Defence and Security – Research and Development.** R&D funding can be divided into 3 broad categories: private sector; government non-military; and military. The first of these is much larger than the others and is likely to grow. However, it is increasingly likely that defence and government budgets will be unable to service the totality of the defence and security R&D need; novel approaches to address the shortfall will be sought. The development of specific military technologies will out of necessity remain largely a government activity. For the remainder, the industrial base will be stimulated through ‘seed corn’ initiatives that promote development of novel technologies. Other avenues that are likely to be pursued include forming international, value-adding partnerships in military R&D. These are likely to sustain and acquire key enabling technological knowledge and capability, pull through technologies from multiple sources, particularly civil R&D, and harness the capabilities of academia and other civil research institutions. However, even where the civil sector is the dominant driving factor, transforming non-defence technologies into military advantage may require significant expenditure in defence R&D.

**Unintended Consequences.** The accelerating pace of innovation and possible rewards will increase the likelihood and frequency of breakthroughs. Any of these may result in unintended consequences; some are likely to be positive. However, some may have catastrophic effects or present potential threats, perhaps through perverse applications, such as the use of genetic engineering to produce designer bio-weapons. The rapid asymmetric insertion and exploitation of extant commercial technologies by adversaries, and the extent to which they can render existing defence capabilities obsolete or ineffective, will be of significant concern. The rate of innovation and adoption by society of certain technologies will pose significant challenges when compared to the traditional, long-term requirement and acquisition cycles. Conversely, there may be political pressure to adopt a precautionary approach, deliberately restraining such development.

**Information and Communications Technology.** By 2040 it is likely that the majority of the global population will find it difficult to ‘turn the outside world off’. ICT is likely to be so pervasive that people could be permanently connected to local or global networks, with inherent challenges to civil liberties. Even amongst those who make an explicit life-style choice to remain detached, choosing to be disconnected may be considered suspicious behaviour. There are a number of socio-economic trends that will lead to pervasive ICT including: a widening global economy, greater cultural assimilation and awareness of technology, and a steady reduction in the unit cost of ICT associated goods. The pervasiveness of ICT will be enhanced by the advent of more common functionality, supported by global service provision and developments in infrastructure, such as cloud computing. Cloud computing will transfer information and the processing means to ‘the cloud’, a dispersed system of internet-based databases, rather than a physical infrastructure ‘owned’ by the entity performing the processing.
find a competitive advantage over their rivals by merging more functions into a limited range of smaller devices. ICT investment will also be driven by new business models that help sustain the insertion of new technologies. Significant changes are likely to be observed in applications, mobile devices, and tailored information and interaction modes rather than in infrastructure. Constrained investment in infrastructure will be perceived as a factor that stifles innovation in the developed world, but arguably less so in the developing world, which has the potential to ‘leap-frog’ a generation of fixed infrastructure technologies.

ICT is likely to be so pervasive that people, across the globe, can be permanently connected

In addition, there will be far-reaching improvements in processing power and data storage resulting from innovations such as spintronics in silicon. Improved architectures enabled by advances in grid computing, photonics and possibly quantum computing (which may increase processing capabilities by 100 billion times), are also likely to lead to more intensive, diverse and perverse applications. Wearable and implanted wireless ICT is likely to become available to all that can afford it.

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236 Such as Magneto-resistive Random Access Memory.
237 Spintronics involves manipulating a property of electrons called spin and its research has enabled ultra dense memory in hard drives. Manipulating electron spin using magnetic fields can switch light being guided through metals used for information processing, including routing infrared light in optical communications or, modified for lower-frequency electromagnetic waves, and processing radio signals in cell phones.
Network Growth. Technological advances, and a greater understanding of social, physical and virtual network behaviour, will converge to drive new types of network architecture and applications. These will be increasingly accessed by remote and distributed means. Technology applications such as those supporting social networking will continue to reconfigure and enable new social models and means of interacting. This will raise fundamental issues about privacy, security, legal frameworks and the mechanisms for influence. The rate of growth of hardware development is unlikely to reduce before 2020, and software technology may fail to keep pace with these advances, contributing to an increasing proportion of major project failures. The growth of many networks is unlikely to be governed by top-down planning; such growth is likely to occur in a decentralised manner, often analogous to nature. In order to improve effectiveness and reduce vulnerability increased understanding of network topology and nodal behaviour, including people, will be required.

Figure 17 – The MetaWeb

There will be changes in network technology driven by: the need to improve end-to-end security; the requirement to support large numbers of Internet-enabled devices; and the ability to directly convert from optical to wireless connectivity. The evolution of ICT devices will be driven by their increasingly wide range of applications and rising demand by society. Increased Internet penetration across the globe, particularly in heavily populated areas, will influence Internet content and ownership.

Advances in Simulation. Advances in social science, behavioural science and mathematical modelling will combine, leading to more informed decision making. Advanced processing techniques and computational power will permit a more comprehensive level of modelling, potentially enabling more effective pattern recognition. This is likely to improve the identification, representation and explanation of systems and processes. As a result, simulation will become an increasingly powerful tool to aid policy and decision makers. Simulation will also blur the line between virtual and real environments.

Virtual Databases. Networks will undergo continual evolution of form not just scale. For example, incremental development of the ‘semantic web’ will occur, enabling machines to recognise, identify, capture, manipulate and interpret data with minimal or no human intervention. The semantic web, and associated technologies, will effectively create an integrated data store, with an unprecedented level of access that can be exploited by reasoning techniques to provide more sophisticated forms of analysis. The exploitation of these techniques may expose hitherto unseen patterns, interactions and associations, with potentially wide-ranging, unforeseen and unpredictable consequences. Sophisticated data-mining tools will include automatic data reduction/filtering along with automated algorithmic analysis to enable faster access to relevant information. Virtual Knowledge Bases will store knowledge extracted from traditional documents or messages within large meta-data (database) structures, and in logical formats that intelligent software can interpret. Virtual Knowledge Bases will provide: improved searching and alerts to stored

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239 The ‘semantic web’ is the abstract representation of data on the World Wide Web, which makes more of the content able to be processed by computers as opposed to humans. This facilitates more automated assistance and more effective discovery, integration, dissemination and reuse.
information; the ability to answer questions across the whole knowledge store in near natural language form; and automated situation reports on demand and in response to events to enhance situational awareness.

**Risks and Benefits**

**Cryptography.** The requirement to maintain high grade cryptographic security will be imperative for commercial, defence and security requirements. Potential developments such as ‘quantum key distribution’ will aim to guarantee secure communication between users, preventing and also detecting any information interception attempts. However, the advent of quantum information processing, before the widespread application of quantum encryption, may exponentially increase the speed and effectiveness of attacks on data, meta-data structures, networks and underlying infrastructures. Development of algorithms, such as Shor’s, will break crypto keys with a one-way function, and make public key systems vulnerable to attack, increasing the susceptibility of coded information to be deciphered. Further challenges will arise if quantum computing can be realised before 2040; potentially stagnating other developments in either encryption or processing.

**Authenticity of Information.** The information environment will become increasingly crowded, with a proliferation of traditional web-page based sites, instant messaging and voice over Internet Protocol applications, and new forms of social media. Information will increasingly be transient in nature, generated and tailored to meet need, provide the context to queries, and interact with cyberspace by these and more advanced mediums. As a consequence it will become progressively more difficult to identify sources and validate the information that has been provided. Access to personal data, and its subsequent exploitation, will have to be safeguarded with commitments to protect user privacy and control. The majority of new content will be ‘opinion-based’, rather than formed through objective analysis and peer review, and may start to alter collective perceptions of truth. The continuing rise of the Internet will also give rise to different models for social interaction. Of increasing significance will be the ability to create, and support, online grouping by interests rather than by geography. This will be enhanced by unlimited contribution, and may be unconstrained by societal pressures, such as self-regulation or peer consensus. Combined with the increased timeliness and volume of information, this will challenge effective and precise decision-making at all levels. Society will increasingly use new media, relying on the Internet, rather than traditional sources such as newspapers. The impact of mobile phone videos posted on the Internet has transformed public confidence, scrutiny and interaction with institutions, forcing official organisations to respond to micro-events perceived to be of disproportionate significance to the public. Empowerment through the use of the Internet is likely to increase public demand for transparency and accountability.

240 Meta-data is structured data and describes the characteristics of a data resource.
242 For example, the number of Internet hosts worldwide grew by a factor of 15 between 1998 and 2008.
243 Current examples include, Skype, ICQ, and Windows Live Messenger.
244 Current examples include blogs, wikis, podcasts, photo and music sharing, social networking.
Avatars and e-Identity. The increasing pervasiveness of ICT will result in individuals or groups creating multiple personalities and identities for work, financial and social means, for legitimate and illegitimate reasons. The ability to identify people unambiguously in different environments will become more complex, having significant implications for tracking extremist groups, organised criminals and terrorists, and making the application of justice, often across national borders, problematic. Trusting the e-identity of other parties in e-transactions needed for secure, successful global commerce will be fraught with difficulty.

Behavioural and Cognitive Science. It will be more difficult to quantify the direct application of advances in cognitive science than it is in nanotechnology or biotechnology. However, indications are that certain interdisciplinary advances, such as neuro-imaging technologies, may make the mapping of brain activity with behaviour more reliable. Modelling techniques are likely to become more powerful and increasingly capable of more accurately understanding the complexity of human behaviour and performance at various scales, and over different time constants.

Advances in neuro-imaging may make the replication of brain activity more reliable

Understanding and describing such phenomena may lead to an ability to ‘map the human terrain’, linking intelligent socio-technical systems, with experiential learning and other information parameters such as culture and language. Extending cognition via new technologies, potentially through direct, seamless brain-machine interfaces, is likely to be facilitated through ‘cognitive prostheses’ that either augment or enhance vision, language, auditory, learning and memory capabilities. These devices will seem like modular ‘plug-ins’, and at other times, an entire cognitive system. Examples may include a ‘bionic eye’ using an electronic contact lens as a display or a medical sensor, or brain implants with electronic chips to aid memory and restore other cognitive functions. In addition, notwithstanding the potential ethical and legal issues, future drugs may be used to enhance the cognitive faculties of people, provide the ability to detect and identify potential intent, and manipulate the cognition senses to install the effects of fatigue or fear.

245 Research is underway to try and resolve this issue using a concept called zero knowledge proofs, Lysyanskaya A, Brown University, Providence, Security and Privacy, Institute of Electrical and Electronics, May-June 2007, Volume: 5, Issue: 3, pages 69-71.
Risks and Benefits

**Human Behaviour.** New imaging technologies that can assess brain structure, function and metabolism will revolutionise human behaviour sciences. Understanding the genetic information associated with the development of brain and peripheral nervous systems and known genetic markers may assist in describing the human susceptibilities to brain injury, and identifying which pharmacological agents may be used to sustain performance. These approaches may be used to optimise human performance, and lead to real-time remote monitoring of personnel through mood detectors and sensors. This could minimise psychological and physical imbalances caused by extreme conditions of duress, fatigue, information overload, and the exceeding of an individual's ability, that lead to errors. Although neural signalling agents are likely to assist in understanding the brain activity associated with evoking cooperation and trust, they may also indicate neurological changes that characterise confrontation.

The Role of Artificial Intelligence. To deliver intelligent machines, further maturation of Artificial Intelligence techniques and technologies will be required. However, specific approaches for improving machine intelligence are progressing in the areas of the expression of emotion, language interaction, and face recognition. These will be used as interim substitutes before direct machine intelligence is realised. Research will seek to map or ‘reverse engineer’ the human brain, in order to understand the ‘software of the human mind’. This work is likely to lead to the development of ‘neural models’ which, combined with other systems, such as sensors, may provide more human-like qualities for machine intelligence. The simulation of cognitive processes using Artificial Intelligence is likely to be focused, in the short term, on probability and pattern recognition and, in the longer term, to aid knowledge management and support decision-making, with potential diverse applications across government and commerce. Reliance on Artificial Intelligence will create new vulnerabilities that are likely to be exploited by criminals, terrorists or other adversaries.

**Personalised Education.** Advances in the understanding of human cognition and efforts to measure cognitive potential are likely to reshape the educational environment. Screening (genotyping and brain imaging) for cognitive abilities and handicaps will enable and shape personalised education, leading to a decline in traditional models, with new emphasis on online, on-demand and automated interactive training and tutoring, where providers of education and training may also become the managers of learning.

**Visual Analytics.** Research on perception and integration of visual motor information will lead to virtual reality improvements. Visual Analytics will become a full blown ‘interaction science’ that optimises virtual reality and other environments to fit the constraints of human cognition to optimise the processing of large data sets.

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246 The science of analytical reasoning facilitated by interactive visual interfaces.
Biotechnology. Biotechnology encompasses a wide range of issues entailing the biological modification of organisms and non-living materials to develop new properties, which have application in medicine, food science and agriculture, and industrial manufacturing. Developments in biotechnology are likely to be swift as indicated by the significant increase in global biotech revenues ($23 billion in 2000 to $50 billion in 2005) and the purchase by large pharmaceutical companies of ‘biotech’ firms in order to secure the most effective avenues for future drug development. The biotech industry has the potential to resolve resource issues and significantly improve healthcare. However, it is also likely to lead to new WMD threats, such as the delivery of lethal pathogens that could be targeted against specific groups. Biomedical developments are likely to see a disproportionate number of breakthrough events, similar to those achieved by physics in the 20th century. These developments will be driven by evolving challenges in public health, including an ageing population, health care disparities, emerging or re-emerging infectious diseases, and diseases that reflect the pressures of modern societies such as obesity and mental illness. The high initial cost of biotechnology R&D and the large variation in the quality of processing, delivery and distribution networks are likely to make the application and benefits of biotechnology uneven. Advances in the understanding and the subsequent manipulation of DNA will lead to significant progress in many areas, such as genetic engineering and microbiology. Stem cell and tissue engineering may offer novel forms of treatment for missing, damaged or diseased tissue.

Biomedical advances, such as the genetic modification of mosquito larvae, will be driven by evolving challenges in public health
Specific areas of interest will be where biology intersects with other sciences (for example biomimetics)\(^{247}\), possibly realising a wide range of diverse applications. These include: the design and manufacture of synthetic biological functions and systems; screening and filtering pathogenic genomes for desirable gene attributes; and the personalised delivery of medicine using pharmacogenomics.\(^{248}\) Other developments will offer the ability to engineer specific cells and bacteria. Human genome mapping has led to research in gene manipulation which may eliminate hereditary diseases and birth defects. Prediction and screening for conditions may be accurately performed before symptoms become apparent. The costs and time-cycle for DNA system design, sequencing and synthesis will continue to reduce, with significant reduction in design-to-synthesis timescales. Biotechnology also has the potential to increase food production by improving yield, resilience, quality and nutritional value. Genetic modification will be used to produce healthier foodstuffs. For example, ‘golden rice’ containing fortified Vitamin A is already available in Africa and South East Asia.

### Risks and Benefits

**Life Extension.** An increase in human life span is likely to occur through the better control or eradication of degenerative diseases and cancer, precisely customised drugs, gene therapy and the mitigation of ageing (and possibly even reversal of ageing characteristics). While increasing life span is likely to be a global phenomenon, disparities will remain according to socio-economic status, race and geography. The Western world will maintain an advantage through better medical and health care, sanitation, diet and quality of life. Projected quality of life will also improve through the use of regenerative medicine, tissue engineering, ‘bio-gerontechnology’,\(^{249}\) bionic implants, memory enhancing drugs, increased use of animal transplants or human organ cloning, and the development of artificial sensors capable of interfacing with the human mind. The sequencing and reading of the human genome is likely to lead to medical advancements and preventative treatments. Delaying the onset of biological ageing may lead to improved knowledge retention, particularly with those seeking to delay retirement from employment. However, the consequences of increased longevity will put huge demands on resources, including the provision of social care and pensions, medical care, food and employment. The development of medical prostheses, and biological autonomic tools, such as artificial immune systems, may augment and enhance human physical capabilities, while reducing stress and fatigue. Biomechanical and electronic systems, such as exoskeletons, will be closely integrated to individual user interface devices to gain effective use. Such augmentation capabilities will house wearable sensors, coupled with actuators to monitor and respond to limb movements. This provides the wearer with increased strength, endurance and dexterity. Use, and distribution, of these developments will raise significant ethical issues in some parts of the world.

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\(^{247}\) Biomimetics is the concept of taking ideas from nature and implementing them in another technology, such as engineering, design or computing.  

\(^{248}\) The branch of pharmacology which deals with the influence of genetic variation on drug response in patients.  

\(^{249}\) Related technologies that offer the means to accomplish control and improvement in the human condition, and improvements in lifespan.
Proliferation. The ready availability of biotechnology-related equipment and precursor materials, with associated decreasing costs, will create new dual-use purposes that lower entry barriers for everyone, including those intending deliberate misuse. Potential exploitation and effective weaponisation by individuals, groups, or states may allow the design and insertion of new and highly virulent biological-weapons and synthetic agents, using novel delivery systems, to target humans, materials or crops. Focus may be directed towards: the misuse of naturally occurring pathogens; exploiting mature bioprocessing technologies; rendering vaccines ineffective; and enabling the evasion of diagnostic and detection modalities. The wide availability and increased pace of DNA sequencing technology, coupled with the greater knowledge of pathogenic genomes, will enable the development of lethal pathogens that are resistant to a wide spectrum of antibiotic and antiviral therapies. As the technologies become widely used and accessible, the manipulation of genomes will require less specialist scientific knowledge. The incidence of ethical, cultural, religious or legal controls and constraints is likely to be uneven, offering those with less regulatory constraints a potentially asymmetric advantage.

Advances in Material Science. The design and manufacture of materials at the molecular level will result in ‘designer’ materials, with in-built capabilities to sense and modify their behaviour or functionality, introducing a new manufacturing paradigm. Most advances are likely to occur where material science combines with, or adopts, principles employed with other innovative disciplines including electronics, nanotechnology and biology. Smart materials, such as shape-changing memory alloys, that sense and respond both to their control systems and operating environment, will have wide applications, for example in jet-engine noise reduction. These materials will also possess the ability to indicate the need for, and potentially undertake, self-repair or maintenance. The developments in nanotechnology are likely to lead to: improved resistance to extreme pressure and temperature; greater elasticity, without loss of toughness; and step changes in tensile strength, already evident in the development of carbon nano-tubes. There will be increased opportunities for biologically developed smart materials. Smart nano-materials will facilitate the development of textiles that detect biotoxins, such as microbial cross-infections, in the environment, and protect the wearer against infection. ‘Meta-materials’ will have significant impact on stealth and countermeasures, providing opportunities to manipulate visible light, and utility in sensors. More efficient batteries, as well as energy-saving materials and devices, will be manufactured using smart materials. They will transform the construction, maintenance and performance of infrastructure, machinery and transport, making equipment lighter and more enduring. The production of new materials will be possible by processing under the extremes of temperature and pressure, under which conditions inert atoms or molecules may combine to change their structure and properties. New materials will also enable exploration into increasingly hostile and inaccessible environments including: the exploration of space; deep underground; deep underwater; and heavily contaminated environments. Their use may help to deliver breakthrough events.

Materials in which certain properties (structural, thermal, optical etc) can be significantly altered in a controlled manner by external stimuli or environment.
New Energy Technology. New sources of power generation will become commercially available and viable before 2040. Out to 2020, while advances may be evolutionary rather than revolutionary, the efficient use and management of power will increasingly be a key driver, particularly for the design of new devices. Hybridisation, along with fuel additives and smart design, will improve the energy efficiency of engines. Smart, conformal designs for low-power systems for efficient charge recovery, and the use of power scavenging techniques, will be examples of potential innovation. For short periods of operation, batteries are likely to remain the preferred power source; however, as energy demands increase, improved fuel cells adapted to suit the operating environment may become the preferred option for longer operations. Nonetheless, demand for traditional lithium-ion type batteries, will increase due to an increased uptake of hybrid and electric vehicles.

Other developments in battery technology will see advances in lithium-ion batteries or super-capacitors and emerging batteries based on new chemistries such as carbon, aluminium, zinc with air, and lithium-sulphur. Developments will also include the use of alternative cathode and anode materials such as lithium-iron phosphate and lithium-titanate, promoting safer use by avoiding the failure mechanisms of traditional lithium-ion batteries, while providing cost effective alternatives. The requirement for the power network to connect billions of devices, and operate reliably, may see the use of ‘smart power grids’ for effective electricity distribution. The grid will be flexible, accommodating distributed power generation from renewable sources and energy-efficient techniques. However, there may be a slow adoption of these technologies by utility firms until the technologies become mature and reliable. Bio-fuels will increase in importance, although initially they may be constrained by the perceived impact on the energy balance, environmental footprint, food supply, and changing lifestyles and diets. Other issues to be resolved will include the longevity of bio-fuels and legacy issues of compatibility with existing equipment, though this is likely to be addressed by future generations of bio-fuels.

Synthetic fuels from alternative hydrocarbon sources will become increasingly important and may contribute to the energy security of some nations. Solar power will become more efficient, less expensive, and more widely used. Harnessing solar energy from space will gain increasing attention, although this source faces several major challenges including: transferring power efficiently to the surface; infrastructure costs; and the potential to initiate confrontation in space. There is likely to be a strong market for smaller, more efficient autonomous power supplies, which is likely to lead to accelerated research in ethanol, methanol, hydrogen and radical fuel cell options. The future of hydrogen and fuel cell vehicles will largely depend on developments in the availability and capability of hydrogen infrastructure and storage systems. Although there will be renewed interest in power beaming, including the resonant magnetic field approach to reduce losses, the challenges of range, efficiency and safety will need to be overcome.
Solar power *will* become more efficient, less expensive and more widely used, including via new technology such as this solar updraft tower.

**Nanotechnology.** Nanotechnology focuses on manipulating matter at the atomic and molecular scale, generally at less than 100 nanometres in size. At this size, and using other scientific disciplines, the characteristics of matter can be changed. This *will* create new and unique properties with profound and diverse applications. Advances in nanotechnology, at the interdisciplinary frontier where physics, chemistry and biology meet, *will* be a key enabler of technological advance, involving: new additives and coatings; materials and sensor development; and medical treatments and health diagnosis. Products *will* be smaller and more energy efficient. They *will* be designed and manufactured with atomic precision and less production waste. Out to 2020, defence applications, in convergence with other disciplines, are *likely* to be predominantly in sensors, electro-optics and materials, including biologically active agents and surface-engineered materials. Additionally, integrated nano-devices *will* lead to the emergence of small, swarmed and autonomous systems. The application of nanotechnologies, whether through materials or devices, *will* become pervasive and diverse, particularly in manufacturing (strong lightweight materials for transportation applications), synthetic reproduction, novel power (battery) sources and health care (targeted drug delivery and augmented medical treatments).
Risks and Benefits

Nanotechnology Side-Effects. Nanotechnology applications will raise concerns over potential health effects and environmental impact. Subsequent action may lead to tracking and regulating the diversity of applications and products as well as the impact on the dynamics of development, especially in the domain of life sciences. Developments in nano-scale delivery systems, capable of specific targeting and crossing biological barriers, may lead to an enhanced risk of misuse. Nanotechnology may also provide the physical and chemical means to produce or have ready access to miniaturised undetectable materials to conceal or protect the degradation of dangerous biological-chemical agents; this raises serious issues over proliferation and detection of these materials.

Autonomous Systems and Robotics. As the information revolution continues, there will be a pervasive and dramatic growth in the role of unmanned, autonomous and intelligent systems. These systems will range in size from meshes of small sensors and personalised robots, which replicate human behaviour and appearance, to a cooperative plethora of intelligent networks or swarms of environmental-based platforms, with the power to act without human authorisation and direction. Systems will exhibit a range of autonomy levels from fully autonomous to significantly automated and self-coordinating, while still under high-level human command. Systems may have human-like mobility and user interfaces to act as assistants, while other designs may consist of collaborative networks of smart sensors, weapon systems or transportation platforms, treated as smart tools. Developments will be enabled by advancements in: miniaturisation; low cost and high performance computation; novel and efficient power sources; sensors; sense-making and communications. As systems and platforms become smarter, the interaction between automated and human components within the wider system will pose significant challenges, bound only by legal and operating barriers. For example, humans will be increasingly challenged by the complexity of controlling multiple autonomous systems and interpretation of the associated information. As the pace of technological change increases and the difficulties of fusing several technologies are overcome, humans unable to cope may become redundant and be replaced by intelligent machines, or upgraded through technology augmentation.

Public Perception. Continuing public aversion in the developed world to military casualties, will spur the further development of autonomous systems for a variety of dull, dirty and dangerous tasks. However, the perception that autonomous systems could cause harm to civilians and civilian property, as a result of system malfunction for instance, is possible.

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Societal Impact. Autonomous systems, in particular robots, may enable and support independent living for the ageing population, using machines to mitigate human weaknesses, particularly in rehabilitation, but also exploiting human strengths. Robots will provide increasing competitiveness in manufacturing, and are likely to play a key role in our homes and lives. Though quality of life may improve, reduced dependency on both large professional and low skilled human labour workforces may result in other societal pressures. Human-like sentient and servile companions may be more acceptable than conventional mechanical types that provide specific functions. Design will be further driven by the extension of human instincts, interests and skills. Humanoid robots may also carry out child-minding activities; studies have shown children to be highly responsive to robots, creating interest and curiosity, with close bonding and attachment, treating them as friends rather than as toys. These robots will have enhanced human-machine interactions, controlled by remote care-givers. Reservation towards robots may be more easily overcome by the younger generation growing-up in a highly technological world and accustomed to such technologies.

Education and Training. Intelligent tutoring systems and avatars may be developed to interactively aid teaching students, particularly those with learning difficulties. They may have the ability to understand when pupils are confused, then focus and tailor material for personalised individual learning.

Ethical and Regulatory Practices. In the Laws of Armed Conflict (LOAC), the lawfulness of an attack on a military objective must be kept under review during the planning stage and execution phase; attacks are cancelled or suspended where it is realised that a target is not a military objective, or that disproportionate collateral damage will result. While the desire to minimise military casualties will spur the further development of autonomous systems for a variety of tasks, involving risk to human life, the extent to which autonomous systems can meet the requirements of the LOAC will determine how widespread their use would become. While technology matures quickly and brings innovation, LOAC principles and specific weapons' laws will evolve more slowly. However, certain established legal principles, such as the prohibition of weapons that cause superfluous injury or unnecessary suffering, will remain extant and are likely to influence their development.

At the tactical level, rules of engagement will adapt to take account of autonomous capabilities and, in some circumstances, are likely to limit their utilisation. However, the delivery of lethal effect by armed autonomous systems will raise ethical, as well as legal, difficulties, and a code of ethics is likely to develop. While technology does not reduce accountability, proliferation will make autonomous systems available to various state and non-state actors who will resist, or ignore, legal or ethical restrictions, creating a multi-tier application of moral and regulatory practices.

Hot Topic – Cyberspace

From a national defence perspective, a number of underlying themes emerge. Offensive cyberspace capabilities will be used to penetrate and attack electronic-rich systems, networks and infrastructure. Recognition of malign intent and attribution will often be difficult. As civilian and military environments become increasingly dependent on integrated networks, and with space-based assets exclusively relying on the electromagnetic spectrum to receive or transmit data, the impact of cyber-attacks is likely to range from incremental to catastrophic.

Although people will remain the focus of the information domain, whether perception or reality, the degree of control will fluctuate. Central to the effective manipulation and management of the cyber domain will be control of the technological development and the mental capacity to understand how best to use the derived data. The complex interactions between cyberspace and ICT will be tightly coupled and vulnerable to attack. This may lead to cascading failure and emergent behaviours requiring mitigation through resilient design or the graceful degradation of systems when under stress or attack.

There will be novel threats. Some actors will identify the cyber vulnerability of potential adversaries and recognise that exploiting such vulnerabilities in times of conflict is less expensive than conventional warfare, and more difficult to detect, attribute and prove. Conversely, the technological leap made by developing states, for example moving to wireless networks, also renders them more vulnerable to cyber-attack than legacy fixed infrastructure. Examples of the use of cyber-technologies to influence strategic and tactical outcomes have been seen in Estonia and Georgia. Extensive ‘denial of service’ attacks contributed to both the military and economic pressures on the target government. While no state acknowledged itself as the perpetrator, such attacks as part of a unitary approach to conflict will become routine.

The incidents of cyber-espionage, cyber-terrorism and cyber-criminality will increase, especially across distributed virtual communities, raising ethical dilemmas. Protection of cyber assets will extend into active defence of civilian logistics and other supporting contractor organisations. Civilian and military information infrastructures, national and coalition, will co-exist and superimpose with ever-changing boundaries. This will require constant refreshing, posing major and novel problems for security. Defending and ensuring continuity of such interdependent systems will require trusted government and industrial partnerships, and the adoption of new approaches to ethical and technological cyber-management. Information infrastructure personnel will require a significantly different approach from physical infrastructure protection teams.

At the international level, the few existing laws concerning control of cyberspace will be reviewed, but national interests concerning the military use of cyberspace will delay progress towards agreement. The security and intelligence consequences will continue to be debated within the legal frameworks. However, their interpretations will often lag.
behind technology uptake and emerging forms of social and criminal behaviour. Conversely, it is likely that the role of organisations such as the International Telecommunication Union and the UN Internet Governance Forum will increase in relation to policing standards, dealing with intellectual property rights issues, and imposing regulations.

In the military context, the vast quantities of sensor data (which such systems will be able to process at up to one billion MIPS)\textsuperscript{256} have the potential to provide a more comprehensive view of the battlespace. Such processing power may also be deployed to provide a rapid and more extensively modelled set of alternative courses of action. These will be available on demand, in near-real-time, across a grid services architecture.\textsuperscript{257} Core technologies that enable such architectures are likely to be widely available. Open source information and intelligence collection, coupled with increased capacity of commercial-off-the-shelf\textsuperscript{258} technology and data-mining, will provide opportunities for global technological parity. Such parity may shift the balance of commercial advantage, raise the spectre of privacy concerns, and potentially aid targeting by terrorist groups and adversaries.

By 2040 the evolution of ‘non-human like’ intelligence\textsuperscript{259} in cyber-technologies will introduce radically different computational processes. Coupled with convergence of potential breakthrough fields such as quantum-, nano-, bio- and human sciences, application of non-human-like Intelligence to the cyber battlespace will potentially result in disruptive technologies.

\textsuperscript{256} MIPS: million instructions per second is a general measure of computing performance and, by implication, the amount of work a larger computer can do.
\textsuperscript{257} The Open Grid Services Architecture describes an architecture for a service-oriented grid computing environment for business and scientific use, developed within the Global Grid Forum.
\textsuperscript{258} Commercial off-the-shelf (COTS) is a term for software or hardware, generally technology or computer products, that are ready-made and available for sale, lease, or license to the general public.
\textsuperscript{259} Non-human-like intelligence may be able to model complex systems such as climate in far greater detail than at present.
Hot Topic – Space

Space divides into 3 communities of users: civil space, commercial space and security space. Much of the hardware is shared and the space launch industry supports all sectors, often simultaneously. Civil space encompasses pure science, such as astronomy, scientific applications, such as climate monitoring, and most manned space flight. The majority of commercial users provide services to terrestrial consumers through Satellite Communications (SATCOM), including broadcasting and satellite-based information systems, predominantly Position, Navigation and Timing (PNT) information. Security space incorporates military uses of PNT and SATCOM, state surveillance capabilities and uniquely military applications, such as nuclear detonation detection and missile launch warning. Space Situational Awareness (SSA), once principally the concern of security space users, is gaining importance in commercial space, as orbits become crowded and debris threat levels increase.

Civil space activity is often a source of national prestige and is characterised by international cooperation. Both aspects will continue, though as ambitions increase in areas such as inter-planetary exploration, cooperation will probably intensify. Developing nations will continue to enter the civil space arena, with assistance from established players providing a conduit for major power influence. Manned exploration of the Moon is likely to resume and may extend to Mars. The space tourism sector is developing and will continue to do so. Any discovery of life beyond Earth would be a strategic shock with significant cultural repercussions.

The commercial space sector will continue to grow. Some players levy small charges on mass-market end-users, such as SATCOM customers and broadcast recipients, while others provide bespoke services, such as specialist imagery, to a much smaller number of users. There will be a growing awareness of the extent of dependency on space capability for daily existence, though the continuing incorporation of space-dependent components, and systems within consumer products will make dependency and resilience hard to characterise. Growing analysis by states to ascertain their dependence on space is likely to mitigate the more obvious vulnerabilities by, for example, insisting on back-up systems for critical utilities. Commercial pressures, from insurers and others directly exposed to risk, are likely to lead to increased commercial investment in SSA, possibly in conjunction with national and international authorities and agencies.

Emerging and rising powers may make their first foray into space in the commercial or civil sectors, but the attractions of exploiting security space will endure. Non-state and irregular actors will seek to emulate this by unconventional means, such as adapting commercial capability and seeking to mitigate the advantages conferred by security space on states. The emphasis on expeditionary capability will perpetuate dependence on space capability, particularly for surveillance and communication. Justifiable aversion to collateral effects will also underpin enduring emphasis on precision and discrimination, which is dependent on space-based PNT. By 2040 this area may be more amenable to non-space-based solutions.
More prolific use of orbital space will increase the density of uncontrolled material. Space debris will present an increased risk to the integrity of existing systems and services through collision or other forms of interference. Active management will be required to avoid collisions, as happened between US and Russian satellites in 2009. While a catastrophic ‘domino effect’, of successive collisions is unlikely, certain orbits may become unusable without significant levels of investment and international political and commercial collaboration.

Widespread weaponisation of space by 2040 is possible. Primitive systems such as high-altitude nuclear detonation to counter systems in low-earth orbit are already technically feasible, and more sophisticated systems are under development. The introduction of space-based weapons, capable of striking targets both in orbit and on the ground, will be technically feasible, although political and treaty constraints are likely to limit their deployment. The surveillance, intelligence and communication capabilities of space-based utilities are likely to represent a critical vulnerability for technologically advanced states and their militaries. Advances in novel weapons technology and the spread of conventional technologies will result in widespread capability to deny, disrupt and destroy satellites in low-earth orbit. However, for the majority of actors, relative fragility of other aspects of an integrated space capability, such as the ground segment and radio frequency communications with satellites, are likely to offer more attractive avenues to negate hostile space capability.

Exploitation of space for security purposes will endure
Hot Topic – Ballistic Missile Defence

Ballistic missiles have been a feature of combat since the closing days of World War II. Their rapidly improved range and accuracy were driven by the Cold War imperative to deliver strategic nuclear payloads, while robust, portable, shorter-range systems served to give commanders a range of tactical options. Early attempts to counter strategic missiles by developing credible ballistic missile defence (BMD) systems were seen as inherently destabilising, since an asymmetric, comprehensive system would have amounted to a second-strike capability. Consequently BMD systems were constrained by treaty arrangements.

Over 5,000 missiles with ranges from tens of kilometres to several thousand kilometres are now distributed across more than 20 countries. Concerns regarding missile proliferation have prompted a re-evaluation of treaty constraints. Ballistic missile proliferation is likely to continue through indigenous development of missile technology by technically adept emerging powers, and the import and local adaptation of systems procured through international markets. Although inter-continental systems will remain the preserve of states, short-range tactical systems are likely to be acquired by some irregular combatants. There is likely to be a correlation between inter-continental systems and possession of nuclear payloads, given the expense and complexity of such systems. Established nuclear powers may exploit the increasing accuracy of missile technology to adapt long-range nuclear systems to carry conventional payloads. In the tactical domain, however, similar systems may be employed to deliver conventional and a variety of CBRN payloads. The existence of indistinguishable nuclear and conventional variants is likely to cause misunderstandings.

Counters to tactical and theatre systems are based on development of legacy surface-to-air missiles (SAMs) designed to attack air breathing systems, for example, the use of the Patriot SAMs to counter SCUD missiles during the first Gulf War in 1991. These systems will be supplanted by dedicated missile defence variants fielded by major powers. The proliferation of modern SAMs, enhanced by indigenous modification, may yield a credible BMD capability for emerging powers. This may extend even to irregular combatants, though the level of protection offered is unlikely to be comprehensive.

Active BMD, the interception of missiles in flight, is one way in which the threat from ballistic missiles can be countered; however, others include: arms control treaties, embargos to prevent proliferation, deterrence, counterforce, passive defence and collective protection. Nonetheless, the development of strategic BMD systems is likely to continue along multiple technical tracks by the major powers. The various technical lines of development, such as airborne lasers, space-based DEW or developed SAM systems all have potential to succeed. International cooperation may allow deployment to contain emerging missile-capable states, possibly under some ‘dual-key’ or shared basis. Depending on the scale of the threat to be countered, it is possible that a combination of systems is required to achieve the required level of protection. An over-arching battle management, command, control, computing and intelligence infrastructure is essential to maximise the effectiveness of the BMD engagement; additionally, this will link early warning sensors and weapons systems together.
Hot Topic – Novel Weapons

Out to 2040, the development and deployment of novel weapons is likely to become widespread. There is likely to be continuing demand for weapon systems to be tailored and adaptable, offering variable yields, detonation characteristics, degrees of precision coverage and reduced logistic burden. They will need the ability to defeat national strategic assets, infrastructure and forces in well-prepared defensive positions. This will often be in difficult terrain, such as the urban environment.

Directed Energy Weapons (DEW) will be capable of discrete target discrimination, producing a strike beam or field of electromagnetic energy, acoustic energy or atomic scale particles to cause disruptive or damaging effects, at near instantaneous speeds, to equipment, infrastructure or personnel. They will have widespread employment including: hand emplaced ‘suitcase’ devices; and ground, sea and air-based systems, with applications that include engine disablement and infrastructure attack. Although most applications will be anti-materiel, and particularly effective against systems dependent on optics or electronics, there will be developments in anti-personnel concepts, using radiation to direct thermal energy to the skin of an adversary, or employ optical or acoustic effects to cause behavioural change. Anti-materiel DEW will have to be carefully evaluated at the early stages of procurement to ensure their effects are discriminate; they will need to be capable of being directed towards the chosen military objective without causing disproportionate collateral damage to civilians or civilian objects.

Radio Frequency DEW (RF-DEW) systems will be in general service across the battlespace. As this becomes increasingly ‘digitised’, the need to protect vulnerable electronic systems and networks will be important. Devices and platforms will need to be hardened against these DEW threats, as part of a suite of electromagnetic environment protection measures. RF-DEW systems will be designed to incapacitate and repel personnel, with a low probability of fatality and permanent injury. Alternatively, they could disable equipment, with minimal collateral damage. Systems will exploit the susceptibilities of electronic-rich targets to non-ionising radiation. This capability is likely to be delivered from stand-off platforms, with the effect ranging from temporary to persistent disruption, or even permanent damage. Expected advances by the civil sector will see a significant reduction in the size and weight of these systems. Furthermore, developments in solid-state switching technologies are likely to enable cooperative engagement by a swarm of small RF-DEW systems.

Laser DEW will also deliver a range of effects on sensors, including: electro-optical countermeasures, for example temporary dazzle or disruption; or permanent sensor damage, lethal effect or physical destruction. Initially the size, weight and cost of systems will increase with the power of the laser source. However, as the efficiency of high power lasers increase, reductions will be observed, allowing a wide range of delivery platforms exploiting such systems.

Novel energetic materials technology utilises high-energy density materials, such as molecular composites, nano-structured systems and meta-stable compounds such as poly-nitrogen, to deliver performances many times that of current high explosives. Enhanced blast weapons differ from traditional fragmenting munitions, in that they seek to
incapacitate through maximising blast performance with reduced fragment damage. Warheads will be able to deliver a range of attack modes. They will be capable of delivering improved performance in the warhead and propulsion system, at a smaller size, thereby reducing the overall logistics burden. Some nations already have the ability to field an array of enhanced blast weapons, ranging from hand-held systems through bespoke indirect fire platforms, to large air delivered munitions. As enhanced blast weapons become more prolific on the battlefield they will have significant implications for future tactical doctrine; their employment will need to remain within the confines of LOAC, and will lead to advances in the design and use of counter-protection.

Environmental warfare will be capable of exploiting the delivery and spread of plant and human pathogens through the release of remote controlled insect-machine hybrids or insects, in order to cause physical, and subsequently, financial damage. Such methods may be used as incapacitants or as lethal pathogens to attack humans. It will provide the means for states or their proxies and terrorist groups to exert power.

Weather modification will continue to be explored. The aims are to obtain more water, reduce hail damage, eliminate fog, or other similar practical result in response to a recognised need. Manipulation of the weather may affect changes in operating conditions, limit aviation flight envelopes, generate poor visibility while providing concealment and disrupt lines of communications. Weather modification may also affect morale. Analysis by the World Meteorological Organisation (WMO) has shown that, if successful, rainfall enhancement and hail suppression operations could have significant economic benefit. The WMO Atmospheric Research and Environment Programme notes that there are several operational programmes in fog dispersion, rain and snow enhancement, as well as hail suppression.
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<td>Ballistic Missile Defence</td>
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<td>BTC</td>
<td>Baku-Tbilisi-Ceyhan</td>
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<td>BRICs</td>
<td>Brazil, Russia, India and China</td>
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<td>CBRN</td>
<td>Chemical, Biological, Radiological, and Nuclear</td>
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<td>CIA</td>
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<td>CIDCM</td>
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<td>EU</td>
<td>European Union</td>
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<td>G7, G20, G8</td>
<td>Group of 7, (20), 8 Industrialised Nations</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>ICT</td>
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<td>IDP</td>
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<td>MIPS</td>
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<td>PMSC</td>
<td>Private Military Security Company</td>
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<td>Position, Navigation and Timing</td>
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<td>R&amp;D</td>
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Sources & Acknowledgements

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Feedback for Global Strategic Trends – Out to 2040

This is the Fourth Edition of Global Strategic Trends and looks out to 2040. The trends and outcomes highlighted throughout the document are evidence based and are the result of discussion, analysis, assumptions and judgements. The team at DCDC would welcome your feedback on any of the judgements or evidence contained within the document. If you would like to comment please fill out the attached questionnaire and return it to the postal address provided on the Contact Details page. Alternatively you can fill in the form online at: www.mod.uk/defenceInternet/microsite/dcdc.

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