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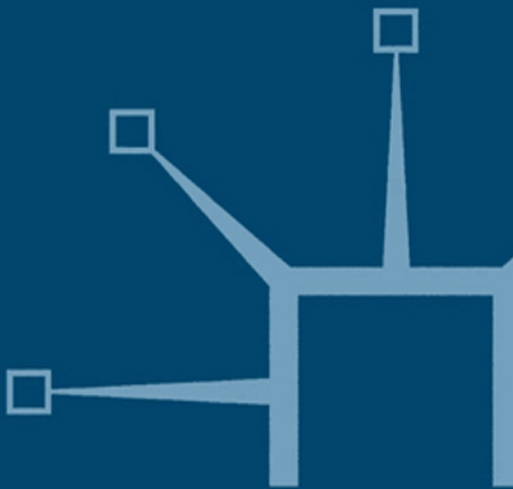
The Politics of Emerging Strategic Technologies

Implications for Geopolitics, Human Enhancement and Human Destiny

Nayef R.F. Al-Rodhan



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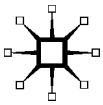

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General Introduction

Technology touches every element of our lives. Sometimes, this happens in obvious ways – one need only to observe the pervasiveness of cell phones, the Internet or even more mundane commodities such as medicine, electricity and television – but technology also inhabits our lives in less obvious ways. For example, artificial intelligence technology plays a role every time we transfer money to a bank account, and nanotechnology and related particles are present in products as basic as sunscreen and cosmetics. Just as important are the – now hypothetical but soon-to-be real – applications of emerging and revolutionary technologies. Developments in these fields promise to dramatically affect our lives and the world around us. Scientists are currently working across disciplines on concepts like nano-particles that eliminate carbon dioxide (CO_2) air pollution, customized and highly-targeted drug delivery systems, computers with smarter-than-human intelligence, as well as more fantastical things such as uploading one's brain function, memories and personality on to a computer.

Although many of these emerging strategic technologies (ESTs) are still in development, their capacities for altering our geopolitical landscape and our human existence are enormous. As a broad concept, ESTs can be defined as technologies the basic science and principles of which are understood and which have some existing applications but the full potential of which has yet to be tapped. Failure to fully take advantage of ESTs could be linked to a lack of resources or investment, a lack of market interest or the need for additional research and innovation before the technology is ready to go mainstream or to be applied to its fullest potential.[1]

Across the board, ESTs have the potential to dramatically influence our daily lives, from applications in business and health care to politics

and strategic planning to facilitating and improving our ordinary routines.[2] In some instances, emerging technologies may be at odds with prevailing processes or products. In such cases, ESTs may become disruptive and bring about a fundamental shift in the way we as humans approach an issue.[3]

Rarely have these emerging strategic technologies been examined together in a comprehensive fashion with an eye not just to their day-to-day applications but also to a consideration of how these technologies are altering and will continue to alter multiple facets of our geopolitical landscape and our human destiny – often dramatically. This book seeks to fill that gap by examining ESTs with scientific sophistication, in a context of international regulatory frameworks and with an eye to the potential challenges and opportunities that the technologies present in everything from health care to climate change to the enhancement of the human body and mind.

For the purposes of this book, the technologies that fall under the umbrella of ESTs are diverse and include the categories of information and communications technology (ICT), energy and climate change, health care, biotechnology, genomics, nanotechnology, materials science and artificial intelligence. Each type of technology or group of technologies was chosen because of its status as a new, cutting edge field and because of the likelihood that it will affect many facets of international security, human nature and the broader global community.

After introducing nine of the most significant emerging fields and sectors of strategic technology of the twenty-first century, this book will go deeper into uncharted territory, analysing the impact of emerging strategic technologies on human nature and the overall destiny of the human race. Such issues are weighty and important from philosophical and practical perspectives, but the way we use technology to alter our bodies and the essence of humanity will also reshape the global political structure. Policymakers must act now to construct legal and ethical frameworks that ensure we use technology to benefit the human race – not to inadvertently curtail its dignity or even eliminate it.

Certain ESTs – nanotechnology, biotechnology, information technology, artificial intelligence and cognitive science in particular – have the potential to be used to modify, alter or enhance the human body and mind. Given this potential, the next natural question is whether such changes also affect the essence of human nature and human dignity, and if so, how can the human race control and regulate these technologies so that they are used for good? The stakes of these new ESTs are high, and it is not an exaggeration to say that humanity's entire

destiny lies in the balance of how we decide to handle this technological revolution.

Knowledge and its influence on technological innovation and development

Why begin an analysis of emerging strategic technologies, geopolitics and human destiny with a section devoted to knowledge? Knowledge and technology are deeply intertwined, so it is a natural starting point for this book to take a deeper look at society's constructs of knowledge and how we can understand what knowledge really is and how it is acquired. Knowledge is a term used frequently and often bandied about, and its definition and meaning are seemingly taken for granted. Knowledge is understood by most societies to be good and useful, and yet we rarely take the time to probe its origins beyond a general idea that it comes from experience, active learning and advice from others. However, a deeper look at knowledge and its origins is in order here, because the political nature of knowledge, combined with how it is physically acquired, are fundamental, underlying elements in technological innovation and development and in determining why technology develops in the way it does. Knowledge also influences how we use technology and the types of problems and challenges we hope, either consciously or implicitly, that technology will solve.

In general, we ask questions and frame challenges based on what we think we know. Whether it is through neurologically-based physical knowledge, dogma, cultural norms, religious values, or any number of factors, what we know and what we think we know play a significant role in determining what we *will* know or the knowledge we will pursue next.

What is knowledge? From a governance perspective, 'knowledge is the ultimate public good'.[4] This is because of its non-exclusive and open nature. Knowledge can become a private good through the definition of property rights or other legal means but, more importantly, some knowledge is a *global* public good; every country in the world can potentially benefit from the scientific and technological knowledge produced by other countries.[5] Once created, knowledge can be shared in many forms and across time and space.[6] In addition, since knowledge can take on different personalities (e.g., theoretical or applied, public or commercial, codified or tacit), it is an inherently dynamic and complex good.[7]

As a basis for technological innovation - in areas as diverse as cognitive science, nanotechnology and biotechnology, information

technologies, energy and environmental sciences, genomics and proteomics – knowledge ultimately becomes a crucial part of furthering the social, economic and technological development of all nations. Moreover, according to the International Task Force on Global Public Goods, knowledge is the fundamental building block for other global public goods such as peace and security, the sustainable management of natural commons, financial stability and the control of communicable diseases.[8] Thus, the significance of knowledge in the context of both technology and society cannot be understated.

The acquisition of knowledge: the theory of *'neuro-rational physicalism (NRP)'*

It is tempting to speak of knowledge as something universal and, moreover, as something universally good, but this is not necessarily the case. Because of factors such as different life experiences, cultural backgrounds and societal norms, as well as the unique neurochemical processes that underlie the thought processes of each individual, knowledge and what we think we know are, in many ways, personal and not at all universal. If knowledge is not concrete and we only presume to know things for certain, it follows that we should examine where knowledge comes from and then to define what we can say we know for certain versus what we think we know that is not necessarily true or provable.

Where does knowledge come from? In my theory of *'neuro-rational physicalism (NRP)'*,[9] I explain that, contrary to many philosophies of the origins of knowledge, knowledge is neither purely based on empiricism nor entirely based on rationalism. Rather, knowledge comes from a combination of employing both sense experience and reason. Importantly, both these foundations of knowledge are *subject to interpretation*.[10] How we interpret our sense experience and how we frame the questions that generate our accepted knowledge depend on many things, including prior assumptions as well as cultural, spatial and temporal settings.[11] In other words, we use what we think we already know and our understanding of the world based on our own personal experiences as the foundation for our pursuits of new knowledge. Sense data can make great contributions to knowledge, but it is important to keep in mind that such data have a high probability of being incomplete, thus making them subject to error.[12] What we know, we only know with a reasonable amount of certainty, and this is why interpretation of knowledge or perceived knowledge is such a critical part of the knowledge equation.[13]

I also maintain that the acquisition, analysis and retention of knowledge has 'a physical neuro-biological foundation, including thoughts,

memories, perceptions and emotions' and that therefore 'mental states and thought processes are physical'.[14] They are rooted in chemical reactions and processes in the brain, all of which are physical. Metaphysics may tell us what a state of affairs may hold, but it does not necessarily tell us whether that state of affairs actually exists.

Non-physical knowledge does exist and is an integral part of our daily lives and experiences. However, because it cannot be physically verified, this type of knowledge is best described as *'possible truths subject to proof'*, a concept that I proposed previously.[15] In other words, this refers to the ideas that we believe to be logically true even if we do not currently have the scientific methodologies or physical resources to prove them.[16] It is in this area that reason becomes a central part of knowledge, as rationalism recognizes that all knowledge is at least partially based on concepts we take for granted as being true.[17] The key point to keep in mind is that 'physicalism' is the defining component of what we know for certain. In short, 'all the universe and its energies are physical' and thus real, verifiable knowledge has a fundamentally physical foundation.[18]

It is worth stressing that although reason cannot be entirely certain as a form of knowledge, and although it is subject to interpretation, reason is nonetheless a central component of human dignity and of living a dignified life. Indeed, 'a life governed by reason is likely to be more dignified than one shaped by dogma and unbridled emotions'.[19] A graphical presentation of *'NRP'* can be found in Figure 1.

'NRP' and technological development

To draw a full circle between *'NRP'* and technology, it is necessary to ask how the *'NRP'* understanding of knowledge applies specifically to technological development. First, it is worth noting that even in science, knowledge is not acquired through pure observation.[20] Scientists first ask questions and, importantly, these questions are based on things that are already established or accepted.[21] For example, gravity is a known force, so scientists will seek to understand *how* gravity affects something; not *whether* gravity affects it. This is where the importance of interpretation and society comes into play, as different experiences or observations may lead to different frameworks for scientific discovery.

Much of what we often consider knowledge is actually a point of view held without sufficient grounds: in a word, dogma.[22] Whether this dogma comes from family values or religious backgrounds, dogma can undermine our rationality and, by extension, our dignity. Often, our dogmatic beliefs are based on the societal norms and customs we

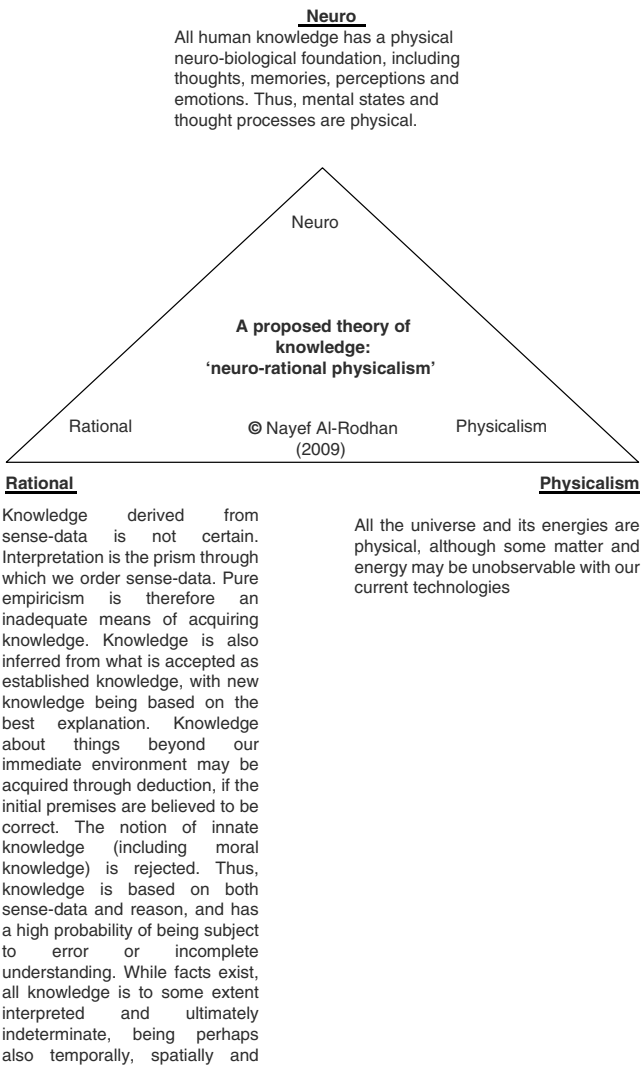

Figure 1 A proposed theory of knowledge: *'neuro-rational physicalism' '(NRP)'*

Source: N.R.F. Al-Rodhan (2009) *Sustainable History and the Dignity of Man: A Philosophy of History and Civilisational Triumph* (Berlin: LIT), p. 131. Reproduced with permission from LIT.

observe in day-to-day life. This is not to say that such norms are necessarily bad in and of themselves – although a life governed by reason is certainly preferable – it is just to highlight the possible fallacies of these norms and the role they play in our approaches to knowledge in general and to scientific discovery in particular.

We will ask questions and frame technological challenges based on what we think we know. This is true whether that knowledge is neurochemically based physical knowledge, *'possible truths subject to proof'*, or merely dogma rooted in cultural norms, belief systems, and so on.

For example, whether a society decides to pursue anti-aging or life extension technologies will depend in part on how that society perceives old age and death. In China and in many Latin American cultures, the elderly are valued for their wisdom and experience, and the impetus to look younger or to reduce wrinkles is minimal (although this is changing rapidly). The opposite is true in many parts of Europe and North America. Youth is valued almost above all else, and the industries and technologies created to reduce signs of aging, such as wrinkles, age spots and loss of skin elasticity, are worth billions of dollars. In this roughly constructed framework, it could be argued that scientists in Europe and North America will be more likely than their Chinese or Latin American counterparts to seek the knowledge and to pursue technological innovation that might minimize or reverse the signs of aging. The reasons for this discrepancy can be attributed to different cultural frameworks, yet it has real implications for technological innovation and development.

In short, we can only seek to use technology to control, manage or improve the issues, challenges, and opportunities we know about or what we believe we know from society and culture. This theme is explored in greater depth below.

The theoretical foundation: approaching the study of science and technology through the lens of *'neuro-rational physicalism (NRP)'*

Science and Technology Studies (STS) is a relatively new, interdisciplinary field that looks at how social, political and cultural forces affect scientific and technological research and development.[23] It is possible to trace its roots to the early 1970s.[24] STS strives to understand science and technology not only from a technical and practical standpoint, but also from a social point of view. According to this theoretical approach, one should 'use the tools of the social sciences and humanities to study,

understand and analyse science, technology and the work of engineers and scientists past and present'[25]. The STS school argues that knowledge is socially distributed. STS emphasises that both technology and science 'are social institutions that depend on social factors'[26]. This realization raises questions such as: Who or what is controlling science? Who is responsible for driving technological change? Why do we trust some experts and not others? What are the values and ethical dilemmas related to science and technology? How are science and technology related to questions of social justice?[27] How does our basis of knowledge fit into this framework?

In my opinion, knowledge is rooted in *'neuro-rational physicalism (NRP)'*, and, as a part of that, all knowledge is subject to interpretation. Given this fact, our societal, temporal, spatial and cultural contexts will define the questions we ask in pursuit of new sciences and technologies as well as how we respond to and apply scientific innovations. This analysis is compatible with the STS school of thought because how we respond to and understand metaphysical truths and *'possible truths subject to proof'* will be largely influenced by the realities of our daily lives and societies. Society will play a great role in defining which technologies we pursue and what problems we seek to solve through technology from a practical perspective, and *'NRP'* will define how we approach the development of these new, socially motivated sciences and technologies in a technical sense. In other words, we can only develop new technologies using the knowledge we already have, so *'NRP'* will guide how society's demands for technology actually develop and manifest themselves. Thus, the direction of strategic technological developments and innovation in the twenty-first century will, on the one hand, be driven by society and society's changing needs in response to changing geostrategic threats while, on the other hand, the basis for technological developments will also be limited to what we know for certain through *'NRP'*.

The theoretical framework of STS in conjunction with *'NRP'* is suitable for this analysis because this book looks deeply at the ways in which science and technology are shaping society and how we plan for our global future. It also looks carefully at how society's needs and desires are pushing certain technological developments at the cost of others. For example, one of the ongoing themes throughout this book is the technological gaps between rich countries and poor ones. An extension of this trend is the fact that scientists often focus their energy on the more lucrative demands of people in developed countries.

Market forces of supply and demand are just one of the ways in which society shapes technology and vice versa. We see similar patterns with regard to protecting global public goods such as the environment. As climate change and environmental protection receive more and more attention from policymakers and activists, we see science and technology follow a similar course. The more society begins to care about CO_2 emissions and environmental degradation, the more research we are seeing into things like hydrogen fuel cells, environmental monitoring biosensors and other similarly focused technological innovations.

Our human nature is also a driving force in the developmental path of new technological innovations and developments, as is our means of acquiring knowledge. *'NRP'* stresses that the way we develop knowledge affects technological developments in much the same way that our societal and cultural frameworks do. I believe that scientific knowledge is premised on the best available explanation of a given phenomenon, and that knowledge is therefore somewhat approximate, and it is difficult, if not impossible, to be dogmatic about what we know for certain.[28] This puts a certain ethical obligation on knowledge and how we apply it to technological development. By not looking at knowledge through an ethical lens, we run the risk of undermining human dignity.[29] As I elaborate in Part II of this book, humans are inherently driven by emotional self-interest, and we are inevitably drawn to technologies that will correct perceived flaws or improve our natural capacities. This facet of our nature, combined with the way we acquire knowledge, is unquestionably pushing science and technology in certain directions. Cosmetic surgery, prosthetic limbs and fertility treatments are just some of the more common examples of technologies designed specifically to improve or enhance our human selves. By the same token, the availability of a broad range of new enhancement technologies is influencing society, our relationships with each other and how we plan our futures, both from an individual perspective and from a political and societal one. New technologies offer some unprecedented opportunities for the betterment of the human condition, but they could also have a strongly negative impact on the future of humanity. This fact must be kept in mind as progress is made with further technological and scientific advances, and is explored in this study.

All things considered, it is hard to deny the intimate and almost symbiotic relationship between society, science and technology, and for this reason STS, approached through the lens of *'NRP'*, is an appropriate and useful framework for this book and its message.

An overview of this book

Part I examines nine specific emerging technologies and how they are likely to influence international relations, global governance and geopolitics in the near and distant future. Each chapter is divided along roughly the same lines. The technology and its potential are introduced, and the broader industry is reviewed. I then evaluate the specific and relevant technological innovations in each field with an eye to scientific depth, accuracy and technological relevance. Once the nature of the emerging strategic technology has been outlined, each chapter spends some time looking at the relevant international regulatory structures governing each technology – or, in several cases, the lack thereof. Finally, and most importantly, each chapter analyses how the respective EST is shaping geostrategy and global politics.

Part II looks precisely at these issues of technological achievement and their application to human enhancement. It is an area often neglected by policymakers, as many of the implications of technology on human nature are seemingly abstract and exist only in the more distant future. Thus, regulating these technologies and their applications seems to be a low priority. Add in, the fact that many of the issues surrounding these technologies can quickly become political, ethical and religious minefields, and policymakers will feel even less inclined to take the political risk by addressing them in-depth. However, Part II of this book strenuously argues that it is precisely because of the uncertain nature of human enhancement, as well as technology's incredible power to fundamentally change our essence as human beings, that it is imperative for us to establish a legal and ethical regulatory framework for dealing with these issues *now*. Any delay and we run an increasingly large risk that these technologies may get out of our control. In such a situation, it is not an overstatement to say that this could eventually threaten the future of the human race.

Part II starts with some of the key definitions used in the discourse on human enhancement, including the characteristics of trans- and post-humans, the difference between enhancement and eugenics, and my theories of human nature, human dignity, and '*sustainable history*'. Once these terms have been defined and explained, I spend some time setting out the arguments for and against enhancement, drawing on the writings of some of the world's leading bioethicists and philosophers. I then set out my assessment of human enhancement. In short, I believe that wide scale human enhancement is not a question of if but of when, and I outline in detail my proposal of '*inevitable transhumanism*'.

I then move on to describe some specific enhancement technologies used on individuals, and to take a more macro look at human enhancement. Using my previously proposed *'multi-sum security principle'*,[30] I analyse the ways in which human enhancement could threaten or at least alter the context of global security. Looking at topics such as human, environmental, national, transcultural and transnational security, the recommendations and practical examples in this section are again highly relevant to interested policymakers. Finally, this book analyses the current regulatory frameworks for dealing with human enhancement and makes some policy recommendations for improving international regulatory structures. The urgency with which such regulations must be adopted is a key theme in this final section.

Although often described as though they exist in separate policy silos, science and society are deeply interconnected and intertwined. This fact will only become more evident in the future, as emerging strategic technologies increasingly dominate and define major geopolitical challenges. For policymakers, technology offers endless opportunities but also many possible pitfalls. This book will help provide a framework and a structure for contextualizing these technologies and for helping policymakers navigate these rapidly advancing developments. From regulatory issues to the five dimensions of global security, it is only when we adopt a comprehensive, interdisciplinary perspective on the role that technologies play in our lives that we will be able to maximize the potential of technologies to better our societies and our global future.

Part I

Emerging Strategic Technologies: Geopolitical Implications

1
Introduction

Technology has contributed to human health, development, community growth and economic stability since the dawn of history. For our primitive ancestors, the ability to create fire was a version of technological innovation that dramatically improved the quality of life, providing a heat source, increased protection from animal attacks and new ways to prepare food. To say that the power to make fire revolutionized life for our ancient predecessors would be a dramatic understatement.

Over the millennia, technology has become considerably more advanced, and its far-reaching impact on human lives has advanced just as considerably. History-changing innovations have ranged from the stunningly simple to the phenomenally complex. For example, at the time of its creation, the wheel was a revolutionary concept that greatly facilitated people's capacity to transport goods over long distances with less energy. Today, the wheel is such an integral part of our daily lives that we quite literally cannot conceive of our lives without it. In fact, virtually every mechanized system in existence today is dependent on the wheel in some form or another.[1] Its role in modern society is so deeply embedded that it is hard to fathom how different our lives would be without this simple technology, and yet, despite its seeming simplicity, at the time of its creation, the wheel was at least as momentous a change to daily life as the Internet has been in contemporary history.

The next generation of technology inevitably builds on previous generations, and each new discovery potentially paves the way for something even bigger and better. We have obviously come a long way since the discovery of fire and the invention of the wheel. Our contemporaries are able to manipulate matter at the subatomic level to create explosions that are so powerful and enormous in their effect that they can literally disable satellites in orbit around the world.[2] With Internet access at the

click of a mouse, we have practically unlimited access to information at our fingertips, and someone in Paris, France, can communicate with someone in Paris, Texas, in real time and at virtually no cost. These examples are just the tip of the iceberg of already tested or established technological innovations that are influencing our daily lives.

Richard Lipsey, Kenneth Carlaw and Clifford Bekar define technological change in terms of categories of 'general purpose technologies' or GPTs. According to them, a GPT is 'a single generic technology, recognizable as such over its whole lifetime, that initially has much scope for improvement and eventually comes to be widely used, to have many uses, and to have many spillover effects'.[3] Previously developed GPTs include the domestication of plants and animals, printing, the steam engine and the computer.[4] Certain ESTs also have the potential to become GPTs, in particular nanotechnology and biotechnology.[5] In general, GPTs are rare in human history, occurring roughly two to three times per millennium over the past 10,000 years, but the pace of change is accelerating.[6]

Looking at how technology has influenced and shaped human life so dramatically and so consistently over the course of human history, it is natural to wonder what is next for our world and technology. What might the next big innovation system be and how will it affect us as human beings and as citizens of the broader world community? Part I of this book seeks to answer these questions. Over the past 50 years, we have seen our ways of interacting with the world change completely as a result of the information technology revolution. Now, we are on the cusp of a period of convergence in which technologies that were previously considered and studied separately (e.g., biotechnology, information technology and cognitive science) are being approached in an increasingly interdisciplinary fashion. The potential for these different technologies to come together and lead to new discoveries in the fields of health, energy and the environment are enormous. United, these technologies have tremendous potential.

Part I examines some of the most promising emerging strategic technologies of the twenty-first century and analyses ongoing developments in these fields. Importantly, it assesses how each technology could affect our geopolitical landscape both as a stand-alone entity and in conjunction with other emerging strategic technologies.

The technologies covered in this section were chosen in part because they are already having a major impact on our daily lives, but also because of their future potential to alter our individual existences as well as the fabric of the global society in which we live – from broad

categories of technologies that influence the way we communicate, how we use energy, our environmental preservation efforts and the management of human health and quality of life to more specific technological fields such as biotechnology, genomics, nanotechnology, materials science and cognitive science. Part I provides policymakers and other interested parties with an understanding of how technology already influences geopolitics and how it may fundamentally shape issues of geopolitics and geostrategy in the near and distant future. It explores the implications of existing and potential technologies in order to provide a more sophisticated understanding of the interplay between technology and some of our biggest global threats. It assesses the less obvious ways in which high-profile technologies will influence our globe for better or worse.

Rooted in science, technology is often evaluated using a systematic, causal methodology. A new drug cures a disease, and therefore the impact of that new drug is assessed strictly in relation to its ability to perform its assigned task. Part I acknowledges the significance of such direct impacts of technology, but it also demonstrates the indirect impacts of technology. Not only can a new drug potentially eradicate a deadly disease, for example, but it may also enable a mother to survive an illness, thereby avoiding the tragedy of orphaned children. Growing up in a more stable home, these children are more likely to develop normally, learn family values, and so on. The new drug technology would admittedly have the primary effect of saving a mother's life, but its secondary and tertiary effects could mean healthier, happier children and a greater capability of both the mother and the children to contribute to their society's cultural and economic development. When the effects of such a technology are multiplied beyond one single mother to mothers around the world, it is clear that even technology designed to improve a single individual's health can have dramatic geopolitical implications.

Each chapter in Part I describes a different technology; the context of the technology's industry, with information relating to sales and major players in the field; the most relevant technological developments in the field, both existing and potential; the regulatory structures that exist for each technology as well as the regulatory shortcomings; and, finally and perhaps most importantly, the geopolitical and geostrategic implications of each of the selected technological fields.

2
Information and Communications Technology (ICT)

General overview

In the first ever issue of *PC Magazine* published in January 1982, Bill Gates predicted that computers and related technologies would change the way people worked. Twenty-five years later in the same publication, Gates reflected that this technology had indeed changed the way we worked but, more importantly, it was changing how we lived.[1]

Information and communications technology (ICT), more specifically digital ICT, is a central part of this change. ICT includes some of the most important technological innovations of the twentieth century.[2] A broad term, ICT and related services span the entire range of the production, consumption and distribution of information in all media, ranging from the Internet and satellites to radio and television.[3] They also include all technologies that collect, distribute, produce, consume and store information.[4] In recent decades no technology has had a global impact on the same level as ICT. Improvements in ICT have transformed the nature of production, communication, and dissemination of information and have expanded their reach. The increasing availability of information and the growth of communications networks have contributed greatly to the process of globalization.[5] Overall, rapidly evolving ICT makes it possible for us to live in a more globalized and interconnected world, and it is directly influencing everything from business to health to global discussions on politics, culture and religion.

The global ICT industry

ICT is an increasingly prevalent facet of modern life, with a strong and growing presence in the daily routines of businesses, governments and

private households around the world. In June 2008, nearly 1.5 billion people worldwide were accessing the Internet, an increase of over 300 per cent since 2000.[6] Overall, the global ICT marketplace was estimated to be worth approximately USD 3.7 trillion in 2008, and by 2011 it is expected to have exceeded four trillion USD, even in spite of the global economic slowdown.[7] The United States, Japan and China are the world's largest spending countries on ICT.[8] In total, countries outside the Organization for Economic Cooperation and Development (OECD) make up over 20 per cent of world investment in ICT, and they are responsible for about 50 per cent of all the ICT products manufactured.[9]

While the United States is currently the world's largest user of the Internet and related services, it is likely that this will change over the next decade. Internet usage in China, India and parts of Africa is expected to grow especially quickly, as are these countries' international Internet revenue streams.[10] Some of the major technologies and innovations driving ICT are outlined below.

Relevant technologies

The Internet

First it was the telegraph, then the telephone, the radio and the computer. All these communications technologies laid the groundwork for what is now regarded as one of the most significant technological revolutions of modern times: the Internet.[11] Essentially a widespread information infrastructure, the Internet first made its public debut at the 1972 International Computer Communication Conference. Designed to allow networked computers to communicate transparently across numerous linked packet networks,[12] the Internet is a 'network of networks', capable of delivering information and data to any part of the global network, often in just a matter of seconds.[13] The development of the World Wide Web in 1992 made accessing information over the Internet dramatically easier.[14] Defined by its creator Tim Berners-Lee, as 'an abstract (imaginary) space of information',[15] the World Wide Web was one of the major catalysts that made the Internet more user-friendly and a central part of daily life.

The other major component that helped transform the Internet to mainstream usage was the development of user-friendly web browsers such as Netscape Navigator, Internet Explorer and Firefox. Without the simplicity of design of these browsers, the Internet would never have taken off. Indeed, as J.R. Okin notes, the most remarkable thing about the Internet is how its engineering makes it simple, usable and able to be

customized to a variety of needs.[16] Browsers in particular keep the technical components of the Internet 'hidden from view', making it accessible and user-friendly for those without a highly technical background.[17] Without the advent of these browsers, it is unlikely that the Internet would have become the widespread commercial force it is today.

The Internet constitutes a major shift in the communications realm, largely because of its interactivity and accessibility.[18] Combining computers and telephony, the Information Revolution – as it has been called – makes it possible to create, store, exchange and use information at any time and from anywhere.[19] Moreover, the Internet and related technologies represent 'the sum of all the private and public investment, activities, decisions, inventions and creativity of a billion users, over 23,000 autonomous systems, and countless creators and innovators'.[20] In short, the Internet is the fastest growing communication tool in human history. Since its inception, it has had a profound impact on the global political, economic and social structure. It has changed the way we communicate, the way we educate and the way we access and exchange information.[21]

Broadband

Broadband refers to telecommunications that benefit from a wide band of frequencies with which to transmit information. High-speed Internet is one of the most prevalent forms of broadband, and it allows for faster transmission of data, higher quality services such as streaming video and interactive services, and constant Internet access that is not dependent on a phone line.[22] As broadband becomes more widely available, it is leading to greater economic opportunities, better distribution of Internet services to populations regardless of income or geographical location, and more reliable Internet access.[23] Broadband is largely responsible for the deeper integration of the Internet and related services into our daily lives, as well as for the growing convergence between technology and lifestyle. Broadband is also interesting as an example of technology that was initially designed for a restricted group of users – the military and scientists – that was later extended to the general public. This is a theme that is often seen in cases of emerging strategic technologies.

Web 2.0

Web 2.0 is a term that was coined in the early 2000s for what was perceived to be a new era of the Internet. It was introduced by the Vice-President of O'Reilly Media Inc. Dale Dougherty, as he and other

Internet executives sought to assess the future potential of the Internet in the wake of the 2000 bursting of the 'dot-com bubble'.[24] Web 2.0 is associated with collaboration among users, and a high degree of participation, networking and creativity. Tim O'Reilly defines Web 2.0 as:

> The network as platform, spanning all connected devices; Web 2.0 applications are those that make the most of the intrinsic advantages of that platform: delivering software as a continually updated service that gets better the more people use it, consuming and remixing data from multiple sources, including individual users, while providing their own data and services in a form that allows remixing by others, creating network effects through an 'architecture of participation,' and going beyond the page metaphor of Web 1.0 to deliver rich user experiences.[25]

Sometimes called the 'living' or 'active' Web,[26] Web 2.0 is focused on collaborating, sharing, socializing and connecting. In many ways, Web 2.0 makes the Internet more personal as it offers a space where people have a chance to express themselves and to share their experiences with people around the world. The highly diverse applications and services include social networking, photograph- and video-sharing sites, weblogs (blogs), wikis, podcasts, tagging and social book marking. The use of Facebook, Twitter, YouTube, eBay and so on, is expanding exponentially. In 2009, Facebook directed 13 per cent of traffic to portals such as Yahoo or MSN, while Google and eBay accounted for about 7 per cent.[27]

While the term 'Web 2.0' has been dismissed in some circles as meaningless, it is still one of the best, most concise ways to summarize the changing role the Internet is playing in people's social lives. Web 2.0 is not an all-encompassing summary of the Internet's significance to modern lives, but in terms of social networking and helping people connect with each other at the individual and community levels, the term is quite useful. A more participatory, social Internet has the potential to promote better mutual understanding and positive empowerment, as well as to develop respect and forgiveness among and within cultures. At its best, Web 2.0 could promote the adoption of a set of shared values and, as a result, the creation of a more secure world.

Blogs

Blogs are a key component of Web 2.0, and they are so important that they merit going into with some additional detail. In a previous work,

I designated blogs as the 'fifth estate' after the other modern estates that influence policy: the executive, legislative, and judicial branches of the government and the media as a whole.[28] Blogs are regularly updated online resources reporting about topics and events of interest to the writer. Other key components of a blog include the use of the Really Simple Syndication (RSS)-feed file format, which permits readers to see new content automatically; reverse chronological organization; links to other interesting blogs; and the option for readers to comment on individual blog postings, thus making blogs a very interactive form of media.[29] Blogs have a number of features that make them important for issues of international security. For example, their content often lacks any editorial oversight, which contributes to openness and freedom of speech but also undermines quality control and makes it easier to spread false information.[30] Blogs tend to be difficult to censor and are often reflective of the opinion of the 'masses' as opposed to the elites of a society.[31] As is outlined below, blogs have demonstrated that they are capable of effecting social change and contributing to peaceful dissidence. However, blogs, the Internet, the growing ease of communication and the ability of rogue groups to connect with one another are also increasing risks of terrorism, and contributing to organized crime and manipulation by extremist political groups or cults.

Mobile Internet

Mobile computing refers to the 'ability to use technology that is not physically connected to a static network'.[32] Wi-Fi, a wireless technology using radio waves to offer Internet access, is one of the most popular and important technologies driving this mobile computing revolution.[33]

Mobile Internet technology has become more widespread and accessible through innovations like the Blackberry and the iPhone, and mobile Internet is expected to grow into 'a thriving, low-cost network of billions of devices by 2020'.[34] According to the Research Consultancy Mobile World, about 140 million new mobile subscribers were registered in the first quarter of 2009.[35] Trends in this area point to more 'location-aware' mobile devices that may offer personalized shopping suggestions as you walk down the street, or chances for parents to monitor their child's location.[36] As the technology is refined, mobile Internet will look increasingly like fixed line Internet, offering similar but not completely equal services, speed and accessibility. Overall, mobile Internet will mean increased Internet accessibility and faster, more varied communications. At the same time, more location-aware