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GEOPOLITICAL DEVELOPMENTS AND THE FUTURE OF THE SPACE SECTOR

OECD Futures Project on The Commercialisation of Space and the Development of space Infrastructure: The Role of Public and Private Actors

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GEOPOLITICAL DEVELOPMENTS AND THE FUTURE OF THE SPACE SECTOR

by

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FOREWORD

This working paper has been produced in the framework of the International Futures Programme's two-year project *The Commercialisation of Space: Development of Space Infrastructure*. The main purpose of the Project is to take stock of the opportunities and challenges facing the space sector, particularly civilian applications, with a view to reaching a better understanding of the issues at stake and of the solutions that could be applied -- both at national and international levels -- in order to ensure that the sector contributes fully to the development of the economy and society at large. The Project is to be carried out in five main phases: (1) Assessment of the future evolution of the sector; (2) Selection and Clustering of Promising Applications; (3) Consideration of Business Models; (4) Improving the Framework Conditions; (5) Conclusion. The work of the two first phases is now available as an OECD publication: *Space 2030: Exploring the Future of Space Applications.* It is to a large extent based on four background papers that were drafted in summer 2003 by outside experts. They are:

- Bouchard, R. (2003), "Commercialisation of Space, Technology Trends".
- Hertzfeld, H. and M. Fouquin (2003), "Economic Conditions and the Space Sector".
- Kane, T. and M. Mowthorpe (2003), "The Space Sector and Geopolitical Developments".
- Macauley, M. and D. Chen (2003), "Space Resources and the Challenge of Energy and the Environment".

The working papers provide a picture of potentially promising space applications over the next 20-30 years on the basis of a "top-down" assessment of some of the key drivers likely to have a major bearing on the supply and demand conditions facing space actors in the future. For the purpose of this assessment, four main drivers of change have been identified: geopolitical developments, socio-economic developments, energy and the environment, and science and technology. Each of these four drivers is the main focus of a separate paper.

In addition, a fifth "bottom-up" paper, focused more specifically on space applications, was used in the analysis:

- Peeters, W. and C. Jolly (2003), "Evaluation of Future Space Markets".

OUTLINE

I. Introduction - The space sector and geopolitical developments

The relationship between space activities and international politics is one of symbiosis. Government investment makes space travel possible, and space capabilities, in turn, have become elemental to national power. Therefore, power relations among nations shape the market for space-related goods and services. Projections about the future of commercial space applications must take the global political environment into account. Although strategic competition can inspire governments to invest in space for military reasons, this report concludes that the commercial development of space will proceed most rapidly in an atmosphere of international co-operation and tranquillity.

A. The geopolitical dimension of space activities

Space programmes serve state policy in a wide variety of ways. Not only is space vital to the military, it offers governments ways to project their political ideas, boost their own economies, support friendly regimes and promote global development. Satellite communications, for instance, are clearly useful for controlling armed forces and conducting economic transactions in distant parts of the world. Moreover, satellites allow countries with poorly developed ground infrastructures to bring their domestic communications systems up to modern standards.

These improvements in communications are not only useful for their own sake, they produce a wide variety of improvements in living standards and national potential. Telemedicine, for instance, allows underdeveloped countries and armed forces alike to get maximum use out of their medical resources. The spread of cultural attitudes and political ideas has profound, if less tangible, significance. Global communications benefit those who can present their ideologies attractively, magnifying the effects of what political scientist Joseph Nye has described as 'soft power.'

Space-based surveillance likewise has direct and indirect political implications. The ability to collect photographs, radar images and other forms of data from orbit is valuable as a source of military intelligence. Such capabilities can serve the cause of peace as well as war. America and the Soviet Union found satellite inspection indispensable as a non-intrusive (if occasionally unreliable) way to verify compliance with arms control treaties. Moreover, satellite remote sensing can assist national economic development by prospecting for new deposits of natural resources and monitoring the use of known ones.

Satellite navigation systems have a wide variety of civilian uses. Such systems also allow armed forces to carry out many tasks more efficiently, from targeting artillery to manoeuvring units through unfamiliar terrain. The most accurate 'smart' munitions depend on satellite navigation. Actual space weapons are in their infancy, but anti-satellite systems exist, and the military importance of space will make them increasingly valuable. Missile defense systems will be able to protect larger regions more effectively if they are at least partially based in space.

If governments need space, the space industry is equally dependent on governments. As of 2003, states or international consortia operate many satellites, many ground stations and all space launch systems. States also regulate aircraft, radio transmissions and many of the other technologies that

support space operations. A wide variety of space applications depend on a finite number of communications frequencies and orbital positions, and regulation plays an important role in allocating such resources fairly and efficiently.

Public policy will also play a vital role in creating an environment in which commercial space applications can emerge. For the space industry to develop, it must attract capital. Much of this capital must come from private sources. Investors, however, are wary of the high risks, large outlays and lengthy start-up times associated with space. Furthermore, investors find it difficult to obtain detailed business information concerning the space industry.

Government policy contributes to the economic stability that encourages people to make risky, long-term investments, government mandates can help make more information available, and government subsidies may help private firms overcome the barriers to becoming involved in space. Governments which are motivated primarily by military concerns will wish to promote their national space industries, but the relationship between the armed forces and the commercial use of space is problematic. The military may support space commerce - ideally with friendly nations - as a way of generating revenue for research, development and industrial expansion. If a nation's space industry is suitably advanced, the military will also want to keep a number of aerospace firms healthy, so that they will compete to develop superior products at the minimum price.

Nevertheless, military interests are also likely to support strict controls on technology exports. This may prevent space firms from forming valuable international partnerships. Although some military space applications will have civilian spin-offs, others will not. The military may also make such heavy use of national space launch facilities, etc. that little capacity is left for commercial use. To summarise, although military investment has supported the space industry in the past, the commercial use of space is likely to expand fastest and in the widest range of areas as a civilian enterprise.

Civilian space industries and basic scientific research are likely to benefit most when governments succeed at developing co-operative international policies. Since earth orbit is inherently transnational, any attempts to regulate the satellite industry must be international. Moreover, the space industry is so small, its start-up costs are so high and the technical difficulties of breaking in are so daunting that it has more to gain from the economies of scale made possible by co-operation than from the discipline encouraged by competition. Certainly, when the public sector subsidises space activities, coalitions of nations have the potential to raise more money and access more scientific research than individual countries.

B. Inter-relation between the space sector and the geopolitical environment.

History illustrates the close relationship between space and international politics. The research and development programmes that produced the first space vehicles were also the programmes that developed the first intercontinental ballistic missiles, and American president John Kennedy explicitly portrayed the 'space race' as an extension of the Cold War. In the 1970s, US-USSR rivalry subsided modestly, national economies faltered, and governments reigned in funding for more spectacular space missions. Cold War competition had, however, created the infrastructure for further commercial and military usage of space.

Space applications have tended to reinforce the distribution of power internationally, allowing developed countries to raise their military capabilities to new levels. The 1991 Gulf War highlighted the advantages space powers enjoy over their opponents. This conflict led many to speculate that information technology - much of which depends on satellites - had paved the way for a revolution in military affairs (RMA). Chinese leaders took the RMA hypothesis seriously, and this has helped fuel their interest in space.

European countries, meanwhile, have found it advantageous to pool their resources on space ventures, and to develop alternatives to American space capabilities. Although European initiatives such as the Galileo global navigation system are valuable simply as commercial enterprises, they also help the European Union establish its independence from the US. Japan and India have also used national space programmes to proclaim and promote their national significance. In the twenty-first century, one can expect to see political developments on earth reflected in orbit.

The means of exercising power are evolving, and space technology plays a role in this process. Attitudes toward nuclear weapons, for instance, have changed considerably since the 1980s. During the Cold War, Western countries relied on nuclear forces to counter the numerical superiority of the Warsaw Pact's ground forces. The fall of the Communist regimes reversed this situation, putting western countries in a position of conventional military superiority and forcing their opponents to search for asymmetric tactics.

The developed world's space technology has helped it achieve its current advantages. Satellite communications and surveillance give its leaders an unprecedented level of ability to monitor situations and initiate action throughout the world. Anyone who wishes to challenge the developed countries will be interested in ways of destroying or disrupting the west's space systems. Those who wish to challenge the developed world's current superiority may also do as the West did in its struggle with the USSR, and turn to nuclear weapons.

Although there are many ways to deliver nuclear weapons, ballistic missiles have numerous advantages, particularly in state-to-state warfare. Some developed-world strategists, notably in America, hope to protect their people and secure their current superiority by deploying missile defence systems. Others, both within the developed world and outside it, argue that attempts to deploy missile defences would touch off new arms races. Although some plans for missile defences and anti-satellite weapons are entirely ground-based, more advanced versions of both require space-based systems. Space technology may play a critical role in helping the currently powerful countries maintain their advantages, and it may play an equally critical role in helping others to challenge them.

II. Main strategic trends and factors likely to shape the geopolitical environment over the next 20-30 years

As of 2003, state governments and organisations of state governments dominate international life. Among economically developed and militarily competent states, the defining characteristic of the current geopolitical environment is its high level of consensus. The powerful states accept each other's existence and aspire to broadly compatible political and economic ideals. Global

commerce flourishes. In military terms, these countries - particularly the United States - reign supreme.

No power with the credible capability to overturn this system has demonstrated any interest in doing so. Individuals, clandestine cells and even major cultural groups may object to the status quo, but they lack the financial, organisational or military power to destroy it. This is not to deny that such actors play an important role in politics. Trans-national non-governmental organisations (NGOs) have become increasingly effective at influencing state policy, organisations such as the European Union play an increasing role in government and violent groups such as al-Qaeda have driven states to launch a costly war on terrorism. The current system, however, appears likely to endure.

Moreover, few of the threats to the current international system affect the space industry. Although the 11 September attacks on the United States have provoked an spectacular global reaction, they have not altered states' regulatory power or budgetary priorities sufficiently to revolutionise any country's space programme. Terrorists will strike again, and if they manage to acquire nuclear weapons, they may inflict considerably more casualties. Given their failure to stage any attack on the scale of 11 September from 2002-2003, however, it seems unlikely that they will obtain the means to disrupt global society or national space programmes significantly more than they already have. Accordingly, those who wish to understand how geopolitical developments are likely to affect the commercial development of space are well-advised to focus on geopolitical relations among states.

Can the current consensus among states continue? Will international relations evolve in ways that encourage the commercial space industry, or will political events retard this industry's development? The answers to such questions are largely up to the states themselves. Governments face both internal and external pressures to pursue policies of narrow self-interest, even at the risk of provoking conflict with other states.

States may, for instance, find themselves forced to compete more aggressively for natural resources. Popular movements may push governments to adopt more belligerent positions - especially if members of politically active socio-economic classes or ethnic/cultural groups become further alienated from the global status quo. States may also find that their traditional security interests put them at odds. When conflicts develop, stronger states will be reluctant to compromise with those who can neither support nor sanction them. States that perceive themselves as disadvantaged may feel inclined to join forces out of mutual interest.

Moreover, there is no guarantee that the prosperous and technologically advanced nations of 2003 will retain their lead. If progress in those countries was to slow while progress in others was to accelerate, the rising powers would probably seek to revise the international system. A change in the balance of power would probably lead numerous countries to realign their commercial and diplomatic relationships. Such developments would almost certainly lead to conflict.

Conflict, whatever its origin, will affect the development of the space industry both directly and indirectly. Governments will shape their policies to reflect what they perceive as their national interests. As states deploy anti-satellite weapons, space platforms will become increasingly vulnerable to military action, and their operators may have to take expensive countermeasures.

The level of conflict in the international environment will also help determine the degree to which states co-operate on trade and environmental issues. As the reports by Macauley, Chen, Hertzfeld and Fouquin have shown, international co-operation in both areas will play an important role in determining the future of the space industry.

III. The Scenarios

A. Approach adopted for the construction of scenarios

1. Core main assumptions made

These scenarios assume that there will be broad continuity between the social, economic, energy, environmental and technological conditions over the next three decades and the trends that prevail today. Nation-states will remain the principle units of government, although trans-national organisations and non-governmental organisations will take on important roles. European Union states will share sovereignty on critical issues but retain their separate identities. Europe, America and East Asia will remain prosperous compared to Africa, Central Asia and Latin America. Broad trends toward individualism and humanitarianism will continue, although there will be backlashes, especially among those who feel that the developed world's prosperity has left them behind.

Energy will grow increasingly scarce. Environmental concerns will grow more pressing, although technological advances will provide at least localised relief. Technology will continue to provide new economic opportunities, but progress will be sporadic and there will be no panaceas.

2. Main uncertainties considered in scenario building

As of 2003, the prospects for a third world war within the next three decades appear slight. Nevertheless, practically all the potential sources of conflict identified in Part II are present at minor levels. As the IEA has noted, the developed states are unlikely to run out of resources in the first half of the 21st century, but emerging economic powers such as the People's Republic of China (PRC) may have more difficulty meeting their needs. Radical anti-Westernism is rampant in the developing world, exacerbated by religious differences, cultural conflicts and economic inequality. Popular movements in the developed world champion the cause of the global have-nots as well.

Opponents of the current world order may well resort to violence. As noted earlier, however, there are few reasons to believe that clandestine cells of militants will achieve more in the first three decades of the 21st century than they achieved in the last three decades of the 20th. Mao's writings on guerrilla warfare may illuminate the strategic significance of early 21st century terrorists. According to Mao, isolated attacks such as those associated with al-Qaeda are merely a first step in a guerrilla campaign. To achieve meaningful results, Mao argues, guerrillas must go on to establish base areas within which to organise armed forces capable of sustaining operations which gradually take on the characteristics of so-called conventional warfare.

To achieve these feats, Mao contends, the guerrillas must have more attractive political ideas and more efficient administrative methods than their opponents. The Communist insurgencies of the

20th century tended to confirm Mao's theories. Historians of that period might also note that guerrillas tended to be most successful when they had access to relatively safe havens in nearby states. Twentieth-century guerrillas also relied heavily on support from global superpowers.

The anti-Western militants who have captivated world attention since 11 September have yet to move beyond the first stage of Mao's model. To do so, they must capture or ally themselves with organised territorial entities - or, to put it more simply, states. For these reasons, although the authors of this study acknowledge that such militants will influence world politics in the early 21st century, they have chosen to focus on state politics in their scenarios. Radical opponents of the current world order will influence state actions, but they seem unlikely to destroy the state system.

States, however, may not maintain their current level of for amity much longer. Differences over economic and security policy have led to international disputes even among the United States and its Western European allies. The arguments over the 2003 Iraq war are merely the most recent of many such disagreements, which have concerned issues ranging from the appropriate way to handle crises in the Balkans to the best way to manage global carbon emissions to the wisdom of America's plans to renounce the 1972 Anti-Ballistic Missile Treaty. When international organisations have proved unable to resolve such disputes, powerful countries have fallen back on their own judgement. America, as the most powerful nation in the world, is notorious for exercising this option, but Western European countries followed similar logic when they supported the decision to intervene in the Kosovo crisis without waiting for approval from the United Nations.

Meanwhile, to paraphrase China expert Gerald Segal, on no single strategic issue are China and the West on the same side. ('Does China Matter?', Foreign Affairs, Vol. 78, No. 5, p. 31.) Not only is the PRC engaged in a dispute with the remnants of the Republic of China on Taiwan, it claims territory from numerous East Asian nations while carrying on open rivalries with Japan, India and the US.The PRC has arranged arms purchases and joint military exercises with the government of Russia, which also complains of being marginalised under the current international system. Major Western economies are suffering from a slowdown, while the PRC makes impressive claims about its potential for economic growth. The PRC has historically used its economic gains to modernise its armed forces, and appears determined to continue.

Will these threats to the prevailing international consensus mushroom, or will nations bring them under control? The scenario designers believe that this is the main source of geopolitical uncertainty affecting the commercial development of space. Accordingly, the designers have based their scenarios on two driving factors. The first is the degree to which the leading states eschew co-operation in favour of the unilateral pursuit of national interests, while the second is the degree to which emerging nations manage to displace the currently dominant actors.

Numerous countries have the potential to play important roles in world politics, and numerous countries may participate in future space programmes. Only a few, however, have the economic means to alter the overall geopolitical environment sufficiently to change markets for commercial space applications. Russia, for instance, is a nuclear power, a space power and a force to be reckoned with on two continents, but it probably lacks the wealth to improve its current position in any dramatic way within the time frame of this study. During the 1970s and 1980s, assorted

researchers suggested that Japan might achieve superpower status, but Japan's long economic slump and lack of indigenous resources makes this unlikely in the early 21st century.

European countries, on the other hand, have the collective wealth to change the pattern of international relations considerably. The European Union could reduce America's turn-of-the-century hegemony simply by resolving to pursue more independent policies. The People's Republic of China also has the potential to revise the 2003-era international system considerably, not because it could equal Europe and America in economic or military terms, but because it could become considerably more powerful than it currently is in a relatively short period of time. India might do the same, but this seems unlikely. For these reasons, the designers have chosen to focus on America, Europe and the PRC in their scenarios. Many of their predictions would continue to apply by analogy if other countries unexpectedly develop the means and the will to overturn the existing system.

3. Overview of and rationale for the scenarios

The first scenario, Beggar Thy Neighbour, presumes that American leaders and the American public grow increasingly impatient with the difficulty of addressing US security problems through multilateral means. Accordingly, the US pursues its own security without regard for the international community. Other peoples, states and organisations of states feel compelled to respond by adopting self-interested policies of their own, leading to a healthy market for military space applications, but a dearth of resources for all others. The international political situation faced with increased tensions and a self-interested approach to international relations leads to a fragmentation of the space industry. A consequence of this is that it has an adverse effect on space markets with the economies of scale achieved through international cooperative projects not being able to be achieved on a large scale.

Military research produces spinoffs and military investment expands launch facilities and other space infrastructure, but the high potential for space conflict forces satellite producers to adopt expensive security measures. Restrictions on technology transfer, nationalistic policies of awarding government contracts and generally increasing difficulties of achieving international cooperation fragment the market for space applications. Given the importance of economies of scale in the space industry, this seriously injures commercial development in the sector. The authors have based most of their predictions for American military space systems and European responses on the respective nations' current plans.

The second scenario, Ad Astra, reverses the assumptions of scenario one, and explores the possibilities of extensive co-operation. Although military spending declines, international joint ventures provide considerable resources for space applications. International organisations allocate orbital slots and address the problem of space debris rationally, and higher levels of political stability allow long-term plans to bear fruit. Again, this scenario reflects influential theories about the contemporary world, and again, the authors have based their vision of Russian, European and Chinese co-operation on those countries' actual proposals.

The third scenario, Eastern Star Rising, considers what might happen if the American economy stagnates and the Chinese economy meets the Chinese government's most optimistic predictions. These developments allow the PRC to challenge the global status quo. Scenario-specific

assumptions explain why, in this hypothetical future, China adopts a hostile stance toward the current world order. America pursues many of the policies it pursued under Scenario One, but with fewer resources and less political will. Initially, the PRC promotes co-operation, but it uses joint ventures to improve its own position at the expense of others.

B. Scenario 1: Beggar Thy Neighbour

1. Trends and Causal Factors Shaping The Future Geopolitical Environment

The most significant factor affecting the geopolitical environment related to space under this scenario is the United States acting increasingly unilaterally. The increasingly interdependent nature of international relations means that the actions of large powers gone unchecked can affect the interests of smaller powers. A consequence of this is that smaller powers welcome international rules and treaties to ensure that their interests can be protected. On the other hand the large powers do not want to have their freedom of action constrained and this subsequently means that achieving these international rules and treaties is difficult, if not impossible. This means that large powers often pursue their own interests, ignoring international rules when they differ from their own perspectives.

The strategy of pre-emptive strikes developed under the United States' National Military Strategy to neutralise the possible threat faced from Iraq's weapons of mass destruction was the catalyst. The United States' resentment towards those countries that had not supported this action in the United Nations meant that the US no longer sought United Nations authority when undertaking military action. The perception of the United Nations was that the Security Council no longer reflected the dominant powers in the world and required reform. The UN's legitimacy was therefore questioned which made large powers more likely to seek to act outside of the framework of the United Nations. The United States therefore feeling increasingly isolated in the international arena sought to further expand its missile defence system to include space-based weapon systems in attempt to make itself secure from possible missile threats.

The process of developing the Common Foreign and Security Policy (CFSP) of the European Union was enhanced with the Treaty of Nice. The Treaty that became effective on the 1st Feb 2003 contained new provisions for the CFSP of the European Union. It increases the areas that fall under the qualified majority voting and widens the role of the Political and Security Committee for crisis management operations. The Treaty also pertains to the European Security Defence Policy (ESDP) and the gradual formulation of a defence policy. The formulation of a European defence policy was speeded up as the EU member states responded to the divergence of interests with the United States.

Europe, sensing the unilateralist nature of the United States, sought to increase its own military independence in the realm of military space. In order to meet this aspiration, Europe reassessed its space assets requirements and decided to bring forward the timescale for the acquisition of the following assets. One was for an independent navigation positioning system in the form of the Galileo project, and the other was for reconnaissance assets under the Global Monitoring for Environment and Security (GMES) system. These two systems were deemed to be sufficient to enable Europe to be self-sufficient in the realm of space. However, the United States began to raise concerns over Europe's Galileo system.

Both Russia and China feel threatened by America's unilateral actions. The loss of prestige Russia has on the international stage makes it increasingly cautious of the actions of the United States. The United States promotion of its interests outside of the United Nation's framework exacerbates this feeling and adds to nationalist sentiment in Russia. China similarly concerned about the United States' power and its statements in support of Taiwan, leads to further nationalist feelings. In order to alleviate this sense of insecurity, Russia and China seek ways to counter the United States space-based missile defence assets by developing anti-satellite weapons.

Treaty Restrictions on the Weaponisation of Space

The treaty that still has ramifications for the weaponisation of space is the Outer Space Treaty of 1967. This specifically prohibited military installations on the moon and other celestial bodies and banned weapons of mass destruction from space. The abandonment of the Anti-Ballistic Missile Treaty that came into effect in June 2002 effectively removed any restrictions on placing weapons in space. Since there is no ASAT Treaty, there are not limits on these systems either. There have been attempts in the United Nations Conference on Disarmament to place restrictions on the nature of weapons being placed into space. These were known as PAROS, the prevention of an arms race in outer space. The proponents for these talks are Russia and China, however they have met resistance from the United States, Israel and Micronesia that did not want to place such limits.

Although the Japanese space industry continues to struggle, Japan develops its own indigenous space programme.

2. Scenario Specific Assumptions

- The United States continues to act unilaterally.

- The European Union acts as a single identity, and no specific country adopts a different approaches in international affairs.

- Russia and China adopt adversarial approaches to international politics, especially with the United States.

3. Timeline of Events Leading to Future Vision

- 2003-2010

In 2004 the United States carried out its intended ground-based phase of its missile defence plans. The first phase was ten ground-based interceptors using exoatmospheric kill vehicles (EKV) capable of intercepting intercontinental ballistic missiles in space. These were split between six based at Fort Greely, Alaska and four based at Vandenburg Air Force Base, California. This was expanded in 2005 with a combination of twenty interceptors spread between the two sites. The contract to build the EKV which was estimated to be worth around $1billion. This phase also included twenty sea-based interceptors on Aegis-class cruisers and destroyers with their sensors netted together to provide them with a capability of intercepting short and medium range missiles

and eventually intermediate range. The sea-based interceptor programme is worth $2.2 billion. The interceptors were spread between three Aegis ships with fifteen other ships available for surveillance that improved the performance of the ground-based interceptors. The United Kingdom and Denmark's early warning radars were upgraded in order for these forward-deployed radars were able to enhance the performance of the US' interceptors.

The successful experimental in-orbit testing in 2006 of the space-based kinetic hit to kill missile defence programme formerly known as "Brilliant Pebbles" led to a decision by the United States to develop the system and have the system operational by 2010. The space-based kinetic hit to kill system essentially is launched in close succession with the detection of a threat ballistic missile. The interceptor uses kinetic energy with an acceleration of around 10km/s covering a range of around 400km to intercept a target that requires 90 seconds to accelerate and rams the missile in its boost phase and renders it disabled. The development of the Brilliant Pebbles has a total through life cost of $4 billion.

The deployment of the United States national missile defence system spurred Russia to develop anti-satellite systems. Russia began this programme of development by testing a high altitude weapon firing an electromagnetic pulse (EMP) similar to that caused by nuclear blasts. This has the capacity to disrupt the functioning of satellites. Also related to the development of anti-satellite capabilities is the development of an air-launched system. Russia modified its Mikoyan MiG-31 high altitude long range interceptor aircraft in order for it to be able to carry an anti-satellite weapon on its centre under fuselage stores position. The anti-satellite weapon the MiG carries is a two-stage missile that uses infrared to acquire the target and then fire small rocket thrusters to ram a potential target satellite. These two developments enabled Russia to have a means of disrupting the United States' missile defence architecture.

The United States' Airborne Laser (ABL) successfully intercepted a ballistic missile in its boost phase by firing directed energy from a turret in the aircraft's nose in 2005. The ABL is a modified Boeing 747 aircraft that has the ability to fire directed energy at potential targets. The successful test enabled the Airborne Laser to enter production, with an initial operational capability with three aircraft achieved by 2006 and full operational capability with seven aircraft in 2008. A latent capability exists in using the Airborne Laser as an anti-satellite weapon. The primary problem in using the ABL as an ASAT weapon arises from the use of infrared technology to track targets and cue the laser. This requires a bright infrared reflection from the target. To use the ABL in an ASAT mission role an active system such as radar has to be used to detect the satellites. The ABL is capable of intercepting satellites within 200 miles of the Earth's surface. It can be assumed that the ABL could destroy most low-Earth orbit satellites given its ability to deploy to a precise location that the satellites must fly over. The ABL programme cost is around $6 billion.

Galileo was developed as a civilian and commercially oriented radio navigation system under private sector control of operations. The deadline for occupying the Galileo frequency bands under the International Telecommunications Union rules was the first half of 2006. If this deadline had not been met there was a risk of the frequency bands being forfeited. Therefore the EU launched a piggyback testbed payload of four satellites in 2004. The remainder of the 30 medium-Earth-orbit fleet were launched during 2005-2008. Also, Europe wanted to begin operation of Galileo before the US next generation GPS III that was scheduled to begin launching in 2009.

There were three levels of service Galileo provides: an open access service (OAS); a commercial access service (CAS); and a public service (consisting of safety-oriented and regulated services). The open access is freely available and has an access of within 6 metres and a service availability of 99%. The commercial service includes a charging mechanism to generate revenue, one area of contention is the international civil aviation opposes any encryption of the safety-critical services. The public regulated service is aimed towards emergency services, humanitarian operations and implementation of EU transport policies such as road tolling. A central and somewhat controversial issue was whether Galileo should provide a Governmental Access Service (GAS) - this has the most serious consequences for military security.
Europe seeks interoperability with the United States over Galileo in order to offer a more reliable navigation service. In addition to this Europe wants to gain access to the radio navigation market, that was previously the exclusive domain of the United States. The issue of interoperability can occur on two levels. On one level concern is given to interoperability in that the signals from the GPS and Galileo navigation systems do not jam one another. On the other level users of Galileo will be using it under legal constraints and the issue of interoperability arises when legal constraints change depending on which satellite navigation system was being used. The engineering problem of using a receiver system capable of decoding both GPS and Galileo simultaneously can be over come by using the correct sort of antenna and at a low cost according to Walter F. Blanchard, "Achieving GPS-Galileo Interoperability: The Challenges Ahead" Space Policy, September 2002. The problem of interoperability is to ensure the agreement of a common set of operating rules and legal liability.

The US authorises the use of GPS in its own airspace, which is presently the case and does not want to authorise Galileo. Similarly, Europe would not want to authorise GPS in European airspace. This causes a problem for intercontinental flights between Europe and the United States, as well as those with connecting flights between the two continents since Europe and some other countries would want to legislate for Galileo, resulting in international air traffic carrying dual GPS/Galileo equipment. The two systems would not reinforce one another, which is not a problem in terms of cockpit operations since a dual use receiver could be used. A problem that could arise as Blanchard points out is if an incident occurs in the United States when using a dual receiver the US authorities may not want to deal with it on the grounds a non-US approved system was in use. Similarly the reverse could occur in Europe.

Europe's Global Monitoring for Environment and Security (GMES) system - a satellite based intelligence gathering and processing capability - was implemented in 2008. It was intended to provide civil and military means for intelligence sharing and crisis management. It provided Europe with its own strategic, independent capability for monitoring security issues on a global basis. It enabled Europe to maintain a capability to monitor global trends and events and to take a leadership role. The European reconnaissance system is composed of two elements. The first element of the five-satellite system the SAR-Lupe radar satellite was launched in 2004 with the full fleet in service in 2006. The SAR-Lupe system cost $240 million. Other reconnaissance satellites included in the system are France's Helios 1 and the Helios 2 day/night system deployed in 2004, and the Franco-Italian Cosmo-Skymed/Pleiades high-resolution radar/optical network.

In 2008 the International Space Station is stalled. The increased tension in the international arena eventually leads to the abandonment of the International Space Station (ISS). The concern in the

United States over technology transfer with Russia causes Congress to cut funding for the ISS programme. NASA facing these reductions in funding can no longer support the ISS and the space station activities are eventually wound down.

The European Union by 2010 adopts a common defence policy. The European Council proposes a common defence policy. The public concern within the Member States towards the United States' actions, especially since Iraq and with the development of a national missile defence system in the United States, creates the feeling that it is necessary for Europe to develop a common defence policy. After much discussion between the Member Sates this is eventually agreed and ratified.

- 2010-2020

In response to United States' missile defence deployment, China developed and ground tested an advanced anti-satellite weapon, called a parasitic satellite. A "parasitic satellite" is a micro-satellite that is designed to attach itself to a target satellite and can be activated when required, to either jam or destroy the intended satellite. It was claimed that the parasite satellite is able to attack satellites in low, medium or high-orbit, and is so small as to not affect the target satellites normal functions and hence go undetected. The cost of this "parasitic satellite" is reported to be one-hundredth or one-thousandth of that of an ordinary satellite. The parasitic satellite was developed by the Small Satellite Research Institute of the Chinese Academy of Space Technology and cost around $2 billion. China also showed signs of interested in developing a ground-based laser in cooperation with Russia capable of interfering with the sensors of satellites in low-earth orbit, however the effectiveness against hardened satellites is hard to determine.

- 2020-2030

The successful in orbit test by the United States of a half-scale Space-Based Laser (SBL) provided the impetus to develop and deploy a constellation of Space-Based Lasers in 2020. The space-based laser demonstration programme cost around$4 billion, In 2020 the United States had a constellation of twelve SBLs, this provided an ability to intercept 94 percent of all missile threats in most theatre threat scenarios. The initial system consisted of twelve SBLs, and cost $10 billion. A twenty constellation of SBLs at a 40o inclination that was deployed by 2024 provided a robust theatre-missile defence capability, and cost a further $6 billion. A constellation of 24 Space-Based Lasers operating at an inclination of 60o that was deployed by 2026 provided national missile defence threat negation along with full theatre missile defence negation. The upgrade to 24 SBLs cost a further $4 billion. The SBL also had an inherent anti-satellite capability. The costs associated in the development of the space-based laser belie the significant resources the United States' had invested during the Strategic Defence Initiative in 1983. Any aspiring countries desiring to develop a space-based laser would have a significant development investment to make. It is unlikely that China and Europe would have the necessary resources to develop a space-based laser.

The desire of the United States and Europe to move towards energy independence, combined with the adversarial relationship that exists with Russia and China, means that the cooperation required to develop Satellite Solar Power is unattainable.

- 2030 Vision of the World

The United States is the major dominant power. It operates outside of the framework of the United Nations when it feels that its interests are at odds with the Security Council members. The European Union has developed its common defence approach to enable it to respond to crisis management situations. Russia and China adopt adversarial approaches to international politics, as a response to the United States operating outside of framework of the United Nations. Russia due to its economic plight, especially in the 2003-2010 is unlikely to be a significant actor.

C. Scenario 2: Ad Astra

1. Trends and Causal Factors Shaping The Future Geopolitical Environment

The United States after conducting the operation against Iraq and acting as what was seen by many as unilaterally, and not seeking a second United Nations resolution, adopts a more multilateralist approach to international relations. The United States sensing the concerns of Europe, Russia and China towards the United States' missile defence plans, adopts a conciliatory note, and deploys a less robust missile defence system. Indeed the United States offers to cooperate with the creation a joint missile defence plan with Europe and Russia. As a consequence of European, Russian and Chinese concern the United States abandons its plans to weaponise space since the previous missile defence architecture included space-based kinetic interceptors and space-based lasers.

The United States' multilateral approach to international relations and its readiness to resolve disputes through international forums such as the United Nations means that other emerging powers such as India and China no longer feel threatened by the power of the United States. The United States addresses the concerns of Russia and China and negotiates a treaty that limits placing weapons in space. It is in essence a revised ABM Treaty that acknowledges the need for national missile defence systems, but limits these to ground based interceptors with space-based sensors to detect and track incoming ballistic missiles. Indeed the tensions that emerged between the United States and parts of Europe over the United States action in Iraq are eased. The relationship between the United States and Europe develops into one of strategic partnership. The European Union does not feel an urgent requirement to develop its Common Foreign and Security Policy towards a common defence policy.

North Korea however still remains a problem. The embattled communist regime remains isolated and continues to threaten regional stability in Asia with its nuclear weapons programme.

2. Scenario Specific Assumptions

- The United States and Europe maintain a politically cordial relationship.

- Russia and China similarly have good relations with the United States.

- North Korea continues to be a rogue state and seeks to create international tension.

- Japan and the United States continue to have a strong security relationship.

- Russia continues to struggle economically.

3. Timeline of Events Leading to Future Vision
   - 2003-2010

The United States deploys a thin ground-based missile defence system which is limited to twenty interceptors. The United States offers to develop a global missile defence shield with Europe and Russia. Japan already in negotiation with the United States regarding missile defences develops a sea-based missile defence system. China seeks to develop a missile defence system based on its own capabilities. The main concern of ballistic missile attack stems from the embattled communist regime in North Korea, which continues to develop longer range ballistic missiles combined with its nuclear weapons programme. These concerns are shared by the United States and Europe. Europe and Russia accept the United States offer of developing a global missile defence system and a ground-based missile defence programme is deployed in 2010. This system is similar to the United States' missile defence system, except European and Russian companies are involved with the development of the system.

Japan feeling threatened by North Korea's ballistic missile development continued the enlargement of its satellite reconnaissance programme. Japan had launched its first two reconnaissance satellites on March 28, 2003 on a H-2A booster. Japan's National Space Development Agency spent $2.2 billion on the reconnaissance programme. The cost of each of the reconnaissance satellites was around $440 million. Japan launched two further satellites in 2004 to complete the four satellite reconnaissance programme. The United States has been involved (around $130 million) in the project offering technical advice on satellite and ground control systems for the mission.

The launch cost of a 190lb satellite by the H-IIA was $80 million, although this was later reduced to $65 million. The Japanese government after funding the research and development of the H-IIA launcher privatised the launcher in 2005.

The United States and Russian companies continue to cooperate, an example of this is the Russian powered Lockheed Martin/International Launch Services Atlas III booster. The International Launch Service arrangement Lockheed Martin has with the Russian Khrunichev Proton has been in place since the mid-1990s. This launcher provides back up schedule assurance in connection with the Lockheed Martin Atlas V.

Japan in 2005 reconfigured the H-IIA launcher in order to make it capable of putting 16,500lb payloads into geostationary orbit. The International Launch Services' Atlas V during this timeframe was capable of carrying payloads up to 16, 845 lb to geostationary orbit. The competition includes the European Ariane 5 variant with a cryogenic upper stage providing it with a payload capacity of 26, 400 lb in 2006. Boeing's Delta IV EELV in this timeframe is able to carry payloads of up to 28, 950 lb.

The United States also cooperated with Japan's space programme. An example of which was the cooperation with Ishikawajima-Harima Heavy Industries (IHI) through Lockheed Martin Space

Systems. This involved the export of the Lockheed Martin Atlas III as the first stage for the Japanese GX, a commercial launcher which was in service in 2006. IHI provided the second stage and was the programme integrator. The Japanese investment in the International Space Station hardware exceeds $3.1 billion and involves nine major Japanese aerospace companies.

NASA which was prohibited under the Iran Non-proliferation Act from spending US money in Russia on hardware for the ISS, had these restrictions lifted. This enabled Russia's space industry to receive a required boost. Russia's dwindling military space assets which had provided the space industry with over thirty missions in 2001 and twenty-one missions in 2002, continued to fall. The ISS was somewhat of a lifeline for the Russian space industry.

A reassessment was made of US/Chinese space cooperation. This was centred on China's involvement in the International Space Station. As a result of this cooperation, a reassessment was made of US aerospace export restrictions that previously prevented commercial Chinese launch of US-built communications satellites and European satellites containing US parts. These restrictions had had a detrimental effect on both the Chinese and US communications satellites sales.

Ariane 5 was the pillar of Europe's space programme. An EC-B variant of the Ariane 5 enters service in 2006 and provides the in-orbit reignition that the Galileo system requires.

In 2008 the Galileo navigational positioning system becomes fully operational. The interoperability problems between the United States's GPS system and Galileo are able to be resolved politically. This eradicates the problems associated with dual use receivers and the approval required when using the airspace above the United States and Europe should an incident occur. Both Russia and China showed strong interest in using and sharing in system services (except secure signals). Russia was especially interested since its navigational system GLONASS had by this time become dysfunctional.

- 2010-2020

The United States military space requirement continues to enable US launch contractors to benefit from a regular demand for space launches. The contract for the National Reconnaissance Office's Future Imagery Architecture (FIA) was worth $6 billion up to 2010 for the initial satellites alone. The National Image and Mapping Agency spent a further $2.7 billion for equipment upgrades to handle the FIA date flow.

The US Evolved Expendable Launch Vehicle (EELV) Delta IV began launching National Reconnaissance Organisation satellites in early 2004. The Delta IV met its target to obtain 50% of the global market for commercial satellite launches. There were five Delta IV versions with prices ranging from $75-$160 million per launch, smaller versions of the Delta IV were available for under $75 million. The Delta IV began to make a profit in 2010 since its business plan was based on 18-20 missions per year compared with the annual 5-6 flights that occurred during the period 2003-2007.

The Atlas V cost $75 million for its launch services. The two EELV launchers together provided the United States with assured access to space. This was to ensure that one launcher would be available if the other launcher developed problems.

The US Air Force believed that through 2020 the two new EELVs would reduce the cost per pound to orbit to $7,000, compared with the $20,000 for the old booster fleet. The Air Force estimated that it would pay $75 million for EELV medium class satellite launches, $110 million for intermediate weight satellites and $150 million for heavy payloads. The two EELV launcher families have a total of 17 variants that can be tailored to payload-size saving costs.

The European Union adopts a common defence policy by 2020. The momentum developed from the integration process of the European Union leads towards the creation of a EU common defence policy. Europe does not feel concerned about the United States, but does want to develop its own structure to enable it to act on the international stage. The public opinion in the Member States also feels that Europe should develop a defence policy capable of dealing with humanitarian and rescue tasks, peacekeeping tasks and combat-force tasks in crisis management, including peacemaking. The EU has the desire to act autonomously in international crisis management where NATO is not engaged and in compliance with the United Nations.

- 2020-2030

The United States though NASA's Space Launch Initiative began investing $4.8 billion to develop technology for the next generation of reusable launch vehicle to replace the space shuttle fleet. A decision was taken in 2005 to start work on a flight vehicle. The previously cancelled X-33 reusable, suborbital space plane was resurrected. The X-33 enabled the cost of launching payloads into low earth orbit to be reduced from $10,000 per pound to $1,000. The X-33 programme was developed through a government/industry partnership.

The European launcher development schedule committed Europe to a decision in 2010 to start the development of a RLV programme. There were fears that making a decision later that the United States would make Europe vulnerable to a US technological breakthrough in the area. Europe began cooperating with Russia and Japan to develop a RLV. The tri nation RLV began service in 2022 shortly after the United States had developed its RLV. This put the three nations slightly behind the United States.

The potential of space tourism, once the preserve of wealthy individuals is finally achieved. The development of a reusable launch vehicle by the private sector, differing from the X-33 programme since it does not require the heavy thrust to deliver heavy payloads into orbit. This reusable launch vehicle, the X-40, enables the cost of space tourism to be reduced significantly enabling a wider group of people to travel to space. The X-40 through private investment driving down launch costs enables the growth of a space tourism industry.

- 2030 Vision of the World

The United States adopts a multilateral approach to international relations. The abandonment of its plans to weaponise space combined with its readiness to resolve disputes through international forums such as the United Nations alleviates the concerns Russia, China and other emerging

powers have. The European Union develops a common defence approach but sees itself a strategic partner with the United States. The international environment enables the space industry to restructure to enable it to benefit from significant economies of scale, especially through international cooperation. This environment also enables space-based services to become competitive with the terrestrial alternatives.

The spirit of cooperation between the United States and Europe along with that achieved with the development of the International Space Station with Russia, China and Japan enables the SSP to come to fruition. The complexities of the production of solar energy in space and its subsequent distribution to the countries on Earth are able to be resolved under this scenario, whereas under the "Beggar Thy Neighbour" scenario the political tensions are insurmountable.

Scenario 3: Eastern Star Rising

1. Scenario-specific trends and causal factors

- China's Diplomatic Position

China has deep differences with other prominent nations. Having suffered two centuries of national humiliation, the Chinese are exceptionally concerned about maintaining their sovereignty. China has territorial disputes with many of its neighbours. The PRC must count India, Japan and the United States as likely rivals. China's Communist system of government further divides it from many other nations.

Russia has opposed China in the past. As of 2003, however, Moscow is co-operating actively with Beijing, probably in an attempt to offset American power. Given the unlikelihood of war, Moscow has little to lose from this policy. The factors that support the Sino-Russian alliance at the turn of the century persist throughout most of this scenario. At the end of the scenario, Russia finds itself associated with China in a world crisis. The Russian leaders of the early 21st century had not intended to put their country in such a position, but the Russian leaders of the mid-21st century find themselves at least temporarily caught in this situation.

- China's Looming Food and Energy Crisis

China is approaching the limits of its ability to produce food and energy. If it achieves its development goals, its demand for both will increase. China will need new sources of food and energy. The PRC will also need increasing amounts of hard currency to buy these things abroad. As the PRC becomes more dependent on imports, it will need the means to protect its access to foreign suppliers.

- China's Modernisation Priorities

China has given economic development priority over military expansion. PRC leaders adopted this policy, not out of liberal ideals, but out of the belief that over the long term this would maximise their country's national power. The civil, as China's "sixteen-character slogan" stresses, must support the military.

- China's Space Requirements

Space plays a vital role in China's plans, for both material and psychological reasons. As a large country with underdeveloped infrastructure, the PRC finds satellite transmission particularly valuable for both civilian and military telecommunications. The same factors give China a special interest in using space imagery to find and manage natural resources. By launching satellites for foreign clients, China earns revenue and gains technological experience. PRC armed forces are keenly interested in the idea that information technology - much of which depends on space assets - has opened the way for a Revolution in Military Affairs (RMA). The Chinese government is also eager to achieve the prestige of having a robust space programme.

- China's Technological Development

China's scientific and industrial establishment has achieved global standards of sophistication at producing certain forms of advanced technology. One of the PRC's so-called "pockets of excellence" is rocketry. Nevertheless, China lags behind the developed world in electronics, software, power systems, materials technology and sensor technology, all of which are vital to its space programme. The PRC also lacks the research and production facilities it will need to overcome these handicaps. Therefore, its space programme would benefit considerably from outside assistance.

- China's Interest in Miniaturised Satellites

Whereas established space powers such as the United States have focused on building large satellites capable of performing a wide variety of missions, the PRC has demonstrated an interest in smaller platforms. China's contracts with the UK firm Surrey Ltd. have given Beijing experience with miniaturised satellites. Although such so-called microsatellites tend to have shorter lifespans and more specialised capabilities than larger equivalents, their light weight makes them cheaper to launch. This will help China and its international partners expand their satellite fleets more rapidly.

Improvements in data processing and space propulsion technology may make it possible to deploy microsatellites in networked clusters. Clustered imaging satellites could survey large areas of the earth's surface at exceptionally high levels of resolution. Some researchers hope to overcome the short lifespan of microsatellites by using orbital solar power stations to send them energy in the form of microwave beams. If China focuses research efforts on enhancing microsatellites in such ways, it may be able to "leapfrog" past the West in this particular area of technology.

2. Scenario-specific assumptions

- China Enjoys Exceptional Economic Growth

China's economy grew dramatically in the 1990s, and the PRC has demonstrated the ability to prosper even when other Asian countries are performing more modestly. This scenario assumes that China's economy continues to expand at a similar rate in the early 21st century.

- America's Economic Slowdown Continues

The United States remains the world's largest economy. Nevertheless, it suffers from a growing trade deficit combined with high levels of personal and government debt. This will make it increasingly difficult for it to maintain its historic levels of consumption, which, in turn, will make it increasingly difficult for its manufacturers to generate revenue. Although the American economy grew out of a similar situation in the 1990s, this scenario assumes that the US is less fortunate in the early 21st century, and that American growth remains sluggish.

- Continued International Tensions

Except where otherwise noted, this scenario adopts the assumptions of Scenario 1. The PRC has historically traded actively with Japan, America and others even while pursuing political rivalries with them, and this scenario assumes that it will continue to do so. China's need for resources compels it to maintain the best possible relations with its trading partners. Nevertheless, China's ideological differences with other nations, aspirations for political independence, territorial disputes and determination to achieve direct control over vital resources eventually force Beijing and its international partners into a crisis.

- Fundamental Western Unity

This scenario assumes that, despite the trans-Atlantic tensions prevalent in 2003, Americans and Europeans remain conscious of their shared economic system, political ideals and cultural heritage. Therefore, this scenario assumes that America and the European Union will present a united front against overt challenges to their current global position. This scenario does not, however, assume that Europe and America will perceive such challenges in the same way at any given time, nor does it assume that Russia and Ukraine will behave identically to EU members.

3. Timeline of events leading to the future vision

- 2004-2010

With the success of the Shenzhou V programme, the People's Republic of China becomes the third nation to launch human beings into space. This dramatises the fact that China's space launch programme is achieving world standards of safety. Beijing continues to offer space launch services as inexpensively as its agreements with the United States will allow. The PRC also launches the remaining remote-sensing satellites in the China-Brazil Earth Resources Satellite (CBERS) programme by 2006, as planned, expands its constellation of Feng Huo (FH) military communications satellites and deploys a reliable radar earth imaging satellite. China expands its own system of earth stations. Chinese firms solicit contracts to build earth stations in developing countries.

Meanwhile, Beijing sustains growth rates at or above its 2003 claim of over eight percent Gross Domestic Product (GDP) throughout the decade. This allows it to increase its investment in ongoing international space projects, and to propose new ones on favourable terms. The PRC builds on the success of its CBERS programme to promote co-operative space projects among

developing countries. This not only increases Beijing's number of potential partners, it decreases China's its dependence on both Russia and the West. China places special emphasis on projects using small satellites and relatively available technology to perform specific, economically useful missions.

The Chinese use their space programme to build up national technical capabilities. Since the PRC suffered from severe technological deficiencies at the end of the twentieth century, filling those gaps becomes one of its priorities in the first decade of the twenty-first. Not only does Beijing commission domestic research in these areas, it promotes joint ventures which will allow it to acquire this technology, whether openly or not, from abroad. One can expect the Chinese to be particularly interested in developing the following technologies: human (crew) systems, vehicle control systems, radio and data-based navigation systems, lasers, electro-optical sensors, gravity meters, magnetometers, radar, materials science, computer hardware, optical electronics, electronic components, electronics manufacturing, power and thermal management, software, space systems propulsion, modelling and simulation, industrial testing, robotics, electronic networks and switching and signal processing. This list is based on information from the DoD's Militarily Critical Technologies List, presented in Bernard D. Cole and Paul H.B. Godwin, "Advanced Military Technology and the PLA: Priorities and Capabilities for the 21st Century" in Larry M. Wortzel (ed), The Chinese Armed Forces in the 21st Century (Carlisle PA, 1999).

During the period 2004-2010, the PRC's communications, meteorological, navigation and earth resources satellites remain insufficient to meet China's needs. During this period, China is an important customer for space services. China will, for instance, buy images derived from SPOT, IKONOS and LANDSAT, rent the use of Galileo, GPS-2 and GLONASS, and buy time on foreign communications satellites. China also imports substantial numbers of completed satellites, mainly for communications purposes.
China's dynamism contrasts with sluggishness elsewhere. America invests in missile defences, as detailed in Scenario 1, but the US Congress is sceptical of more civilian-oriented programmes and outside investors grow increasingly worried about the consequences of America's trade and budget deficits. The Evolved Expendable Launch Vehicle proves adequate for America's military purposes, and Congress fails to invest in the more ambitious side of its Space Launch Initiative. US foreign policy remains controversial as American troops intervene to support the government of oil-rich Equatorial Guinea against a popular uprising. US firms play a role in international space ventures, but as tensions in Africa and elsewhere mount, American laws on technology transfer become increasingly restrictive.

European consortia proceed with Galileo and Global Monitoring for Environment and Security, but Europeans who wish to develop new projects find outside capital and launch facilities increasingly attractive. Russia proves willing to exchange technical expertise in return for external capital, and its use of France's Kourou launch site helps weave international space efforts together. Pakistan, Brazil, Indonesia, Iran and Egypt find the opportunity to join in relatively low-budget international space projects difficult to resist. Japan and Australia participate more cautiously.

The Indian government views China as a rival. China has also traditionally aligned itself with Pakistan. Accordingly, India wishes to keep up with the PRC in terms of both capabilities and prestige. India expands its space programme in partnership with Russia. China and India begin a

prominent race to outdo each other in landing probes, and, eventually, human beings, on the moon. America and Europe respond by revitalising their own lunar exploration programmes.

- 2010-2020

In 2010, China, Brazil and their partners begin exporting services such as space imagery and access to communications satellites. By 2015, China and Brazil meet virtually all of their own needs for these services, and have become major global providers. Less developed countries, however, have become increasingly avid consumers of remote sensing and telecommunications. Demand, accordingly, remains high.

The Chinese-led international joint ventures have proved profitable for many concerned. Indeed, by reducing the price of satellite communications and providing a greater wealth of data on the world's resources, these ventures have benefited the entire world. Nevertheless, in the second decade of the 21st century, China's differences with other nations become acute. In Asia, China annexes the disputed islands in the Spratly chain while demanding a timetable for reunification with Taiwan. In Africa and the Middle East, China supports factions at odds with Western interests, and vice versa.

Using launch facilities, industrial plant and technical expertise developed for civilian purposes, China augments its military communications and reconnaissance satellite fleet. The PRC upgrades its Beidou (Twin Star) Navigation system to the standards of the first-generation Global Positioning System, deploys an ASAT system based on parasitic microsatellites and continues research into ASAT lasers. Russia has also used its civilian space programme to improve its military position. Bouts of stagflation in the Western economies has curbed military spending even in America, allowing Russia and China to gain in military power, even when compared to the US.

In 2016, the Taiwanese government begins formal negotiations to reunite with the mainland. This provokes public protests, and a clique of Taiwanese military officers responds to the popular outcry by staging a coup and declaring independence. The PRC threatens war, and the United States declares its solidarity with Taiwan's new leaders. In the months of crisis which follow, European internal investigations reveal that China and Russia have been using joint space ventures as a cover for widespread espionage. Both have operated extensively through shell corporations in third countries, bringing all international ventures under suspicion. EU leaders, who have been growing increasingly concerned with Chinese moves in petroleum-rich countries, re-affirm the trans-Atlantic alliance, impose drastic new restrictions on technology transfer, and declare their support for Taiwan.

China and the West persuade the Taiwanese officers to restore civilian government and abandon their claim to formal independence, averting war. Nevertheless, the era of easy co-operation in space has ended. New security measures and new international hostilities dissolve broader international agreements. Purely scientific projects wither due to lack of funding, as do commercially risky ventures.

Space remains critical to political power. In the freshly competitive international environment, governments adopt policies reminiscent of mercantalism. National and trans-national

organisations fund space programmes with obvious benefit to their military and economic interests but impose punitive security and financial regulations to discourage programmes that appear more beneficial to their rivals. An entente prevails between America and the European Union, while a similar arrangement continues between Russia and China.

- 2020-2030

The PRC deploys its first clustered imaging satellites in 2015. In 2022, China deploys an orbiting solar power station to beam energy to microsatellites in the form of microwaves.

India, Japan, Taiwan and Australia attempt to match China's military space capabilities, further increasing demand for imaging and communications satellites. Taiwan continues to rely on successors to GPS for its navigational needs, while Australia uses a combination of GPS and Galileo. Japan launches a simple navigational satellite system in 2020. India remains dependent on foreign systems.

Meanwhile, competition among rival political-economic blocs encourages countries to ensure their access to markets and resources through increasingly blatant forms of imperialism. Food and energy shortages reinforce this trend. Meanwhile, competition for valuable orbital slots becomes intense, and the problem of space debris becomes critical. The lavish use of small, disposable satellites earlier in the century compounds these problems.

China's demand for resources is particularly pressing, both on earth and in space. Although its means to provide for itself peacefully are on the wane, its armed forces are no longer weak. America remains the pre-eminent naval power in the Pacific, but the US Navy discovers that China has grown into a more credible opponent. A regional war between nuclear-armed powers becomes possible, and the countries that have allied themselves with both sides may find themselves involved whether they wish to be or not.

- Vision for 2030

Prospects for international relations in general and the commercial development of space in particular appeared promising early in the century. America's stagnation and isolationism deprived other countries of a valuable partner, but did not prevent them from co-operating with one another. By 2030, however, both are in a state of crisis. Countries are dividing themselves into rival alliances. In the process, many nations that took advantage of opportunities for international joint ventures earlier in the century are now finding themselves forced to pull out of such projects.

These developments affect other areas of international life in much the same way they affect space. A plurality of social systems seemed possible, and there appeared to be opportunities for liberal regional or even global trading regimes. Countries lacked the resources for heroic energy/environmental projects such as space-generated solar power stations, but they had the opportunity to address ecological issues collectively if they chose. At the end of the century, diplomatic polarisation and a corresponding resurgence of nationalism limits opportunities for co-operation in economic, cultural and environmental fields.

IV. Implications of the scenarios for the space sector

A. Implications of scenario 1 for the evolution of the space sector

The weaponisation of space of space occurs initially with ballistic missile defence and its associated space systems occurring in the first decade. The importance of these systems would then lead to other nations seeking to counter these systems by deploying other space-borne weapon systems, such as anti-satellite weapons. The proliferation of these systems by other countries would have wide ranging implications for the evolution of the space industry. Fundamentally it could be beneficial in terms of providing a requirement for space assets and providing a surge in space launch requirements, as countries strive to place weapons into space. However the nature of space assets would change. There would be an increased market for military space applications and space weapons but commercial space applications would have to be hardened. The process of hardening these space assets would increase their weight and increase the cost of launching them. This may lead to a retardation of the space industry's development in fields not directly related to military space.

The promotion of the European navigation and positioning system, along with its associated infrastructure was seen as attempt by Europe to become a strategic partner. The United States through its provision of the Global Positioning System (GPS) was able to promote its national interest by maintaining the system as an international public good. The benefits of providing such a system accrues international prestige, technological leadership, economic competitiveness and security. In order to maintain this position of political and technological leadership the United States reverted to defensive posturing when Europe began to challenge this through the Galileo system. The European efforts to develop the Galileo system were perceived by the United States as being based on the need to establish key civilian and dual-use technologies in the context of tight European defence budgets. The Galileo programme represented an attempt by Europe to promote critical infrastructure in an arena where Europe had no natural comparative advantage, but where international competition was advanced through governmental intervention.

US concern is expressed regarding the Galileo programme and radio spectrum issues related to military applications. The Galileo system complicates the ability of the US to ensure availability of critical military GPS services in a time of crisis, and at the same time deny adversary forces similar capabilities. The political pressure by the US on Europe and the Galileo programme is part of an economic-industrial effort to maintain leadership with national military and security interests intertwined. The United States wanted Europe not to mandate the use of Galileo-either through regulations or standards-in any manner that could harm US GPS receiver manufacturers, service providers and users.

Europe unlike the United States' GPS System, guaranteed part of the signal that enables it to be used for air traffic control, financial transactions and other applications involving legal liability.

The cumulative economic and social benefit of Galileo for Europe up to the period 2020 is conservatively estimated at 24 billion Euros, with a total investment cost of 6 billion Euros. France, Germany, Italy, and the UK each have a 17.3% share in the programme, with Spain's share 10.13% and Belgium's 4.79%. EU estimates show that Galileo created 100,000 jobs.

Estimated Revenues for Galileo

	Millions of Euros		
	2010	**2015**	**2020**
Service Revenues	6	72	202
Purchase Revenues	62	300	314
Total	68	372	314

Source: Pricewaterhouse Coopers

One of the uncertainties of the Pricewaterhouse Coopers study is that it could be difficult to raise finances against the prospect of a return for such a long term. It therefore contains an area of uncertainty whether companies would be willing to make such advanced investments, with the prospect of return so far in the future in 2015. This could have an impact on the Galileo programme if investment was not able to found.

The military focus of the United States towards the space sector means that the Evolved Expendable Launch Vehicle is sufficient for the US' launch requirements. The Reusable Launch Vehicle whilst receiving attention from the military in terms of its desire for flexibility and rapid deployment of space assets does not come to fruition. This is because the funding required for the missile defence systems such as Airborne Laser and Space Based Laser means that Congress is unable to fund the development of the RLV fully. In this scenario the Space Launch Initiative is subsequently not developed. This has implications for the future of the space industry since the prospect of cheaper launch costs does not materialise.

B. Implications of scenario 2 for the evolution of the space sector

The ground-based missile defence system carried out in cooperation with the United States, Europe and Russia provide some revenue for the space industries. The missile defence shield is ground based, but it did incorporate space-based early warning satellites and satellites to track and cue the ground-based interceptors. These space assets enable the United States, European and Russia space industries to cooperate in this area. The total expenditure of such a system was in the region of $45 billion, of which more than half was in the space industrial sector. Russian industry benefits from the development of the ground-based component of the missile defence shield. The missile defence shield was able to be a cooperative venture between the United States, Europe and Russia due to the United States multilateral approach to international relations and its abandonment of its plans to weaponise space. The latter especially altered Russia's views towards missile defence and indeed alleviated many concerns in Europe. Japan benefits with the United States cooperation in the development of its sea-based missile defence programme.

The space launch industry in the mid 2000s was especially crowded. The United States two EELV launchers the Delta IV family and the Atlas, the European Ariane 5 variants and the Japanese H-II launcher series provided a global over capacity of launchers. This over capacity let to an extremely competitive launch market environment, and had the effect of driving launch

costs down. The United States launch companies were able to benefit from the US governmental contracts such as the Future Imagery Architecture. The European Ariane 5 similarly was able to prosper from the launch of the Galileo system, although the low cost of the Delta IV forced the launch cost of Ariane 5 down. The Japanese H-II launcher struggled to gain a foothold in the market, although it had undertaken a number of successful launches, its reliability was questioned and this had a detrimental impact on its ability to gain launch contracts. The reliability and low cost of the Delta IV launchers enabled the United States to be the dominant force in the space launch market.
The Russian and Chinese space launch industry benefit from the increased space launch market. They are able to increase their market share of the launch industry since they offer generally cheaper launches. The freer international market conditions realised under this scenario enable them to increase their revenues from providing space launches.

The decision to sort out the interoperability problems between GPS and Galileo had a corresponding effect on the revenues generated from Galileo. Overall it had the net effect of increasing the revenues by 10 percent. This had the an impact on the employment created by Galileo and EU estimates showed that 110, 000 jobs were created.

The International Space Station was able to become truly international with the reassessment of US/Chinese space co-operation. The relaxation of US aerospace export restrictions had a knock on effect of enabling China to become a participant in the ISS. The restrictions imposed under the US Iran Non-proliferation Act that had prevented the United States spending money on Russian hardware for the ISS were lifted and provided a boost for the Russian space industry. This was especially timely for the Russian space industry since Russian military space activities continued to wane.

The decision by Europe to make a judgement in 2010 on the development of a Reusable Launch Vehicle meant that the United States which had decided in 2005, was able to begin using its RLV in 2020, two years ahead of the tri-nation (European, Russian and Japanese) developed RLV. This enabled the United States to be ahead in the space launch market with its RLV and accrue the benefits the first into a sector can accrue, especially with the low payload costs to low earth orbit.

C. Implications of scenario 3 for the evolution of the space sector

In the short term, this scenario offers many advantages to the space industry. International rivalries spur governments to invest in space. Emerging spacefaring nations co-ordinate international ventures, allowing companies throughout the world to participate in this market. Although the total amount of money flowing into the space sector will be large, many of the individual buyers will be emerging space powers with limited budgets and limited access to technology. Such buyers will be interested in innovations that allow them to achieve maximum results with the technology they can afford - creating opportunities for smaller entrepreneurs.

With China's space launch industry becoming more reliable, the United States taking on a moderately ambitious military space program, Russia developing new rockets and the European space agency offering the Russians new launch facilities, the price of lifting cargo into orbit falls. This allows developing states to expand their use of satellite communications and imaging. Nevertheless, with America unwilling to develop a reusable space transport system, large-scale

space manufacturing and SSP remains unprofitable. The development of Galileo, other European space projects and the International Space Station follows the patterns described in Scenario I.

This scenario posits that China's economic growth allows it to increase its investment in the space sector. China's rivals, notably India, attempt to match its spending. Elsewhere in the world, both major and minor space powers join the PRC in joint ventures. Accordingly, the space sector grows from its position in 2003, both in absolute terms, and as a proportion of global economic activity. The space sector does not, however, receive the level of funding it enjoys in either of the other scenarios.

America remains the world's largest economy and the world's largest space power. Its economic woes and nationalistic policies deprive the international space market of an important source of capital. Public and private space agencies find it difficult to meet the research, development and start-up costs of more ambitious projects. Those with an interest in developing space applications will find money readily available, but in limited quantities. The same principle will apply to the availability of launch facilities -- a large number of countries will operate rockets like those used in the early 21st century, but none find the funds to produce a fully reusable space vehicle. This scenario will lead to considerable innovation in all forms of cheaper space applications, but it will retard major breakthroughs.

The relative hierarchy among the space powers remains the same, with America at the top, the European Space Agency and Russia on the second tier, Japan and China slightly behind, and India slightly behind that. China, however, closes the gap between itself and the more advanced powers considerably. One should also note that different space powers will excel in different areas. The developed countries continue to produce more sophisticated technology than China, but Europe and Japan focus their efforts on profitable enterprise and scientific research. Under certain environmental scenarios, these powers may also devote resources to using space for ecological management.

China will use the limited resources at its disposal to conduct spectacular missions for the sake of prestige, and to maximise its military power. India may do the same. Russia will collaborate with all parties, while working to keep its own military capabilities as up to date as possible. America remains in a position to fund military, prestige, commercial and purely scientific expeditions.

Although the period up until 2020 is a time of abundance for the space industry under this scenario, the decade 2020-2030 is a time of disaster. Governments directly ban certain commercial space operations and the growing amount of orbital debris makes others increasingly hazardous. The collapse of numerous international ventures causes insurers to raise their rates and private investors to withdraw their capital. Aerospace firms continue to receive military contracts, and a limited number of joint ventures within the various political and economic blocs continue, but the space industry becomes increasingly vulnerable to the faltering world economy.

D. Summary of the implications by broad application category

	Beggar Thy Neighbour	Ad Astra	Eastern Star Rising
Relative Importance of Sector…			
Military	HIGH United States deploys Space-Based Laser and robust missile defence system	LOW	MODERATE Attempts to respond to security crises hampered by economic conditions
Public/Civilian	LOW Governments fund primarily military space applications	HIGH	MODERATE China has joint ventures with developing countries
Commercial	LOW Focus mainly on military space applications	HIGH Reusable Launch Vehicle reduces launch costs and enables increased commercial activity	LOW-MODERATE Less capital affects commercial activities
Progress in Technology	MODERATE Military technology advances with some spin-offs	HIGH Rapid increase in space launch technology and spurs development in other areas	MODERATE Progress in cheaper technologies e.g. microsats, clustering
Launch Supply	MODERATE Military dominates launch market – EELV is sufficient	HIGH Reusable Launch Vehicle enables cheaper launches	MODERATE Many nations develop capabilities but no RLV
Space-Based Telecom	MODERATE	HIGH	MODERATE
Remote Sensing	MODERATE	HIGH	MODERATE
Navigation Positioning Systems	MODERATE Rivalry between United States and Europe concerning Galileo/GPS	HIGH Cooperation enables maximum potential from Galileo and GPS	MODERATE China develops Beidou
Missile Defence	HIGH Space and Ground Based Systems Deployed by United States	LOW Cooperation on Ground Based Systems. Absence of space-based missile defence systems	MODERATE US strained resources develops missile defence systems
Antisatellite Systems (ASAT)	HIGH	Nations View as unnecessary	HIGH Developed by US & Russia as scenario I, China develops space and directed energy ASATs
Satellite Solar Power	NOT DEVELOPED Lack of cooperation prevents development	DEVELOPED Cooperative environment enables its development	NOT DEVELOPED Lack of capital prevents development China develops solar energy to beam power to microsats
International Space Stations	NOT DEVELOPED	OPERATES	NOT DEVELOPED

V. Conclusions

A. Critical factors for the future development of space applications

Practically every significant application of space technology has required public funding in the initial phases of its development. This principle appears likely to hold true over the next three decades. Therefore, prospects for the commercial development of space are linked to politics. These scenarios indicate trends and events likely to influence government investment in space.

Security concerns motivate governments to spend large sums on space applications. Paradoxically, however, space research has also seen outstanding examples of successful international co-operation. America and the USSR symbolically docked Apollo and Soyuz spacecraft even as they expanded their nuclear arsenals. The European Space Agency realistically hopes to deploy ambitious systems such as Galileo within five years while Europe's purely military joint ventures have often languished for decades. National governments may be unlikely to provide sufficient funds to generate real progress in space applications without the spur of military considerations, but coalitions of governments can share the expenses and rewards satisfactorily.

This means that space applications can achieve progress through either increased tension or the reduction of tension. The type of applications that thrive, however, differ in different international environments. Military research produces civilian spin-offs, but if one's goal is to commercial space applications, one would prefer to do so directly. Moreover, international tensions increase the risk of space operations while restricting the flow of goods and knowledge. The space industry will also tend to benefit from trends that increase prosperity, both nationally and globally. Over the long term, the commercial space sector has more to gain from peace than from war.

A peaceful international environment will also encourage private investment in space. Financiers, as well as state space agencies, will find it easier to pool their resources with their counterparts in other countries. Effective international management of problems such as space debris and allocating orbital slots will lower the potential complications of doing business in space, as will the reduced danger of war. Even when states initiate space programmes, the decline of nationalistic trading policies will allow firms from a wider range of countries to bid for contracts.

Not only will these developments increase the amount of money available for space applications, they will give the beneficial effects of free markets more scope to operate within the space sector. When a wide variety of space firms compete for capital from a wide variety of sources, they have an increased incentive to develop new products and efficient procedures. These scenarios also posit that states are most likely to fund research into reusable launch vehicles and other revolutionary components in the space infrastructure under conditions of international co-operation. Such developments would give entrepreneurs further opportunity to innovate.

International co-operation will benefit the commercial space sector both directly and indirectly. Government decisions to opt out of institutions and override other nations' concerns are danger signs for international order in general and for the space industry in particular. Inflammatory rhetoric that polarises public opinion along national lines is often both a cause and a symptom of

such decisions. Changes in the balance of power - often heralded by changes in economic productivity - produce a more complicated set of effects that will evolve over time. Such changes will have both pros and cons for the space sector, although they can easily lead to international crises, which are purely negative.

Table D summarises the ways in which these various factors come into play in this study's three scenarios. In Scenario I, increased international tensions induce governments to spend relatively large sums on space, but they channel this investment into military applications. America deploys ambitious weapons systems, notably national missile defences, but programmes of broader and more international interest, such as satellite solar power, the reusable launch vehicle and the international space station receive inadequate funding. Traditional space applications such as navigation, telecommunications and remote sensing fare better -- all have well-established commercial markets in 2003 and all have vital military applications -- but private firms make relatively sluggish progress at developing new commercial uses for such technology.

Scenario II reverses the outcomes of Scenario I, with less military development but more dramatic progress in civilian applications. Those applications also evolve in different ways. As noted above, proven space technology has a bright future under all three scenarios. In Ad Astra, however, public and private researchers develop the widest possible range of civilian uses for such applications. Under more militaristic scenarios, firms focus on serving the military market, security concerns restrict trade and nationalistic trading policies lead to destructive forms of competition, notably in satellite navigations systems.

The US government may not spend as lavishly in Ad Astra as it does in the scenarios where it perceives itself to be fortifying itself against a hostile world. Nevertheless, America funds its space programme generously in Scenario II. Numerous governments, including the US, pool their resources for ventures of international interest. The benign international environment also fosters increased levels of private investment in space, and as the space industry generates increased profits, it has more capital at its disposal. For these reasons the space sector grows larger in Ad Astra than in any of the other scenarios.

Scenario III presents a more complicated environment. When it begins, America follows the pattern set out in Scenario I, albeit with reduced resources. Other countries adopt many of the practices of Scenario II and reap many of the same benefits. The total volume of funds available to the space sector is smaller than it is in the other two scenarios, but researchers develop a wide range of new applications, as they do in Ad Astra.

This study focuses on the degree of co-operation in the international environment and changes in the balance of power as the most probable drivers of geopolitical change in the period 2003-2030. There are, however, other areas of uncertainty in world politics. Some, for instance, have suggested that trans-national corporations, terrorist organisations, political pressure groups etc. may displace the state as sources of funding and authority. If this took place, one would have to consider politics among these groups in much the same way that this study looks at politics among states. Given the importance of satellites to international communications, it seems reasonable that trans-national rivals to the nation-state would be interested in launching or buying satellites, and perhaps in threatening satellites belonging to their enemies.

A global cataclysm could change the geopolitical environment as well. Asteroid impacts, unexpectedly rapid global warming or the outbreak of a virulent new disease could dramatically change government priorities. Such events would draw funds away from elective space programs, although space systems might prove essential for monitoring and responding to the crisis. Governments would almost certainly unite against such a threat, although they might be less co-operative if they feared that others would blame their policies for contributing to the disaster. One can also imagine a doomsday scenario in which states abandon hope of managing a crisis and turn on each other in a struggle to seize whatever resources will help them survive in the post-catastrophe world.

B. Policy issues raised by the scenario analysis

The state of world politics has a profound effect on the funding available to the space industry, the sorts of applications which will attract that funding, the regulations space firms will operate under and the risks the commercial space industry must contend with. This study concludes that the commercial space industry will enjoy improved conditions in all of these areas if the international environment is harmonious. Many might question this argument -- conflict has stimulated development in the space sector in the past. The commercial space industry, however, seems to have become well-enough established to benefit from the long-term advantages of tranquillity, even if this deprives it of the short-term infusions of cash offered by strife.

To desire international harmony is simple; to achieve it is not. This is one of the points of Scenario III. The countries that institute co-operative foreign policies under that scenario reap the benefits of tranquillity in the short term. Nevertheless, they fail to address the political problems which appear when a discontented new power rises to challenge the status quo, and they ultimately experience the same crisis as the more aggressive powers. This affects the space sector as seriously as it affects all other aspects of international life.

The problems of improving the international commercial and security environment go beyond the scope of this study. Suffice it to say that those with an interest in the space sector must monitor both. One can, however, attempt to design one's space policies in order to minimise the ill effects of ongoing international developments while taking full advantage of likely opportunities. Space planners will, for instance, need to take geopolitical considerations into account when considering the following issues.

- Managing International Relationships

By being sensitive to global political issues, those responsible for international liaisons within the space sector can minimise the ill effects of larger geopolitical crises on their own multi-national ventures. Clearly, one must seek to maintain the most friendly relationships possible with the largest possible number of people. Managing international relationships, however, involves more than being nice. One must judge potential partners in terms of their ability to carry out their end of a bargain. One may also have to consider the ways in which a partnership might affect the strategic interests of one's polity.

Such issues play a large role in the petroleum industry, where corporations and governments have had to consider the implications of becoming involved with Iran, Iraq and the various states of

Central Asia. Political issues in the space sector have historically been less controversial. Given the close relationship between space and the military, this could change. Scenarios I and III indicate the ways in which the commercial space sector might suffer if it allows international tensions to disrupt cooperative space ventures, but the final crisis in Scenario III suggests that there are also dangers in tying one's fortunes to a relationship with one's country's political rivals. The most stable space relationships will be those that unite peoples with compatible political, ideological and economic interests.

- Assigning Responsibilities

Just as planners must pay attention to international politics when deciding how to form coalitions, they must also pay attention to political issues when deciding who is to do what on any given project. Frequently, they may find that only certain members of a partnership are capable of performing certain tasks. In other cases, some members may insist on controlling (or avoiding) certain aspects of the project as a condition of their participation. Nevertheless, when planners have at least partial control over the assignment of responsibilities, they will wish to take geopolitics into account as they consider how to give the most critical tasks to the most reliable partners.

- Targeting Research

This study notes that international conflict may deprive important space applications of capital for research, development and production. Although policymakers in the space industry cannot prevent conflict, they may be able to compensate for some of its effects by subsidising vital but vulnerable technologies.

- The Weaponisation of Space

In an age when satellites routinely guide missiles to their targets, one might argue that space has already been weaponised. Nevertheless, moves to place new types of weapons into orbit arouse international alarm. Scenarios I and II indicate the danger that one country's decision to field such assets might strike others as a hostile act. Not only might potential adversaries feel compelled to respond in kind, potential allies may resent being left out of such a decision.

As long as it remains possible to preserve the current international consensus, states are well-advised to consult each other as widely as possible before deploying any new class of armaments. If states feel that they need space-based weapons, they may be able to minimise controversy by making the decision to deploy them in concert with allies. Even the optimistic Scenario II envisions a coalition of countries developing ground-based missile defences, and the scenario could have proceeded along similar lines if these defences had included a space component. The effects of a weapon on international relations depend more on political context than on the operational details of the weapon itself.

C. Final Thoughts

Space assets may help promote economic growth. They may also help people manage natural resources and protect the earth's environment. Other authors have provided details on these topics. In addition to being desirable for their own sake, both growth and environmental health make it

easier for nations to live in harmony. Space policy alone is unlikely to determine the direction of world politics, but space policymakers may still play a role in creating a more stable and prosperous future.

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