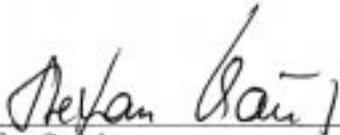


Commercialization of the ISS: An Industry Perspective



The Strategic Planning Working Group of the International Space Station Commercialization Workshop II (further described in *Appendix A: History of the International Space Station Commercialization Workshops*) provides the enclosed recommendations on "Commercialization of the ISS: An Industry Perspective."

Signed on April 20, 2001:



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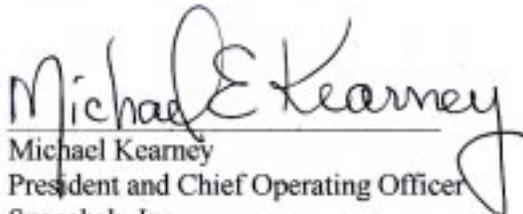
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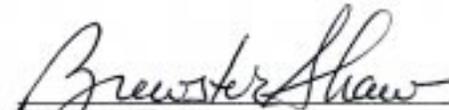
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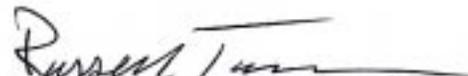
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Commercialization of the ISS: An Industry Perspective

Introduction

The International Space Station (ISS), which is being developed through the international cooperative efforts of various governments, is intended to contribute to the economic growth of each partner country through commercialization. Commercialization of ISS can open new markets to industry and can free valuable resources that may be used by partner governments for other national purposes. Participation by commercial industry in the ISS partner governments' efforts will be key to achieving "the economic development of Earth orbital space"¹. Companies now assessing the business cases necessary to ensure a return on corporate investment in such opportunities have come to a common conclusion that ISS commercial business must evolve from its present state to be viable. Industry representatives are prepared to discuss with the ISS partner governments ways to facilitate commercialization of the ISS.

The ISS Commercialization Workshop II² convened an ad hoc group, the Strategic Planning Working Group ("SPWG"), to provide the ISS partner governments with their common perspective on commercialization. This paper describes their common vision, details what they perceive as the major impediments to industry participation, and provides a roadmap for the transition to commercial activity. The SPWG developed this Industry Perspective, which was then submitted to interested parties, including the participants of the ISS Commercialization Workshops, general industry, and academia, to allow them to endorse the contents. This paper is being provided to the international space agencies as a public, non-exclusionary effort to support the space agencies in facilitating commercialization of the ISS.

The Vision

Space commerce in the future is envisioned as a web of commercial activity in and in support of Earth orbital space that is identical to terrestrial commerce in every respect except location. All of the commercial mechanisms that function on the ground will be at work in space commerce. ISS can move toward this vision by following a methodological path that develops maximum commercial utilization as soon as possible, leads to privatized operations, and ultimately concludes at full commercialization of human activity in low Earth orbit, as illustrated in Figure 1.

¹ Commercial Space Act of 1998, U.S. Public Law 105-303.

² See *Appendix A: History of the International Space Station Commercialization Workshops*, which describes the ISS Commercialization Workshops in more detail.

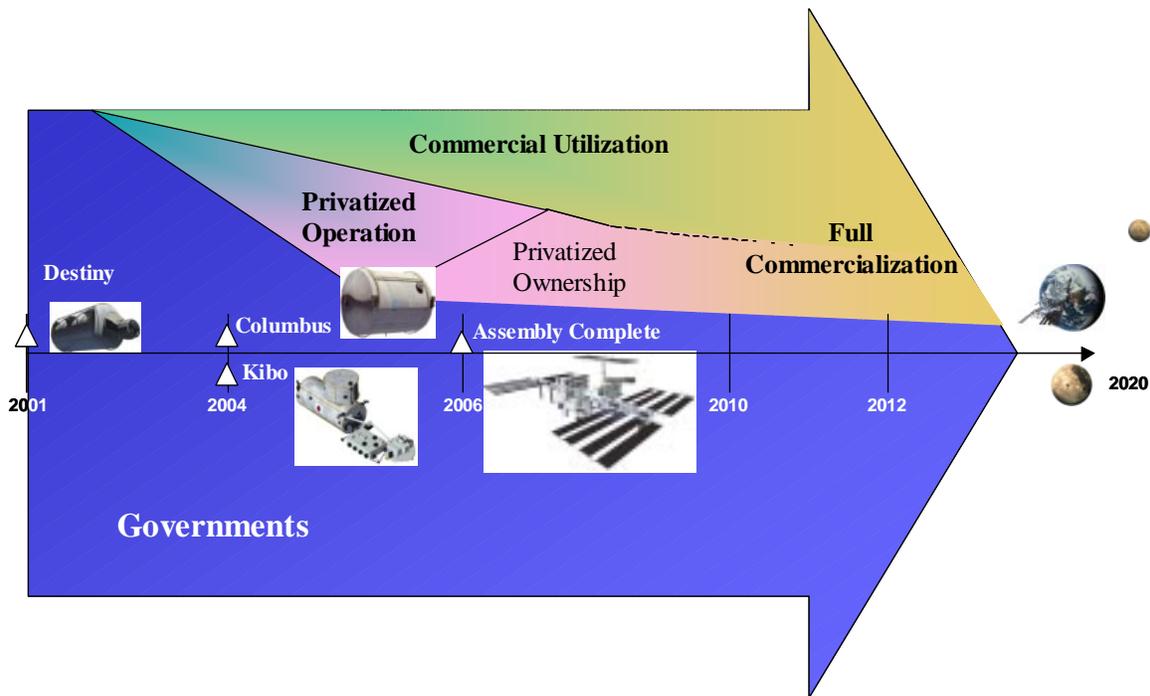


Figure 1: ISS Commercialization – ISS Ownership and Operational Responsibility

Three different components of commercialization can be envisioned: utilization of public assets by private companies (“commercial utilization”), partial ownership and/or operation of public assets by private companies (“privatization”), and private ownership of assets as a basis for services on or in support of ISS (“commercialization” or “full commercialization”). Table 1 identifies these differences. All three components can be pursued in parallel with different levels of emphasis as a market develops for space commerce on ISS.

	Today	Commercial Utilization	Privatization	Full Commercialization
Ownership	Public	Public	Public	Private
Operation	Public	Public	Private	Private
Use	Predominantly Public	Private	Public/Private	Public/Private

Table 1: Different Components of Commercialization

The Need

All international partner governments have agreed to open the public assets of ISS to commercial use to foster the development of space commerce. Commerce in space can stimulate direct economic growth on Earth. When commercial companies are able to conduct routine

commercial operations in low Earth orbit, their activity will relieve the International Partners from the responsibility for low Earth orbit operations, freeing up agency funds that can be used for other national purposes. This concept for ISS is portrayed in Figure 2. Space agencies may also achieve some revenue and/or cost savings from commercial activity on ISS.

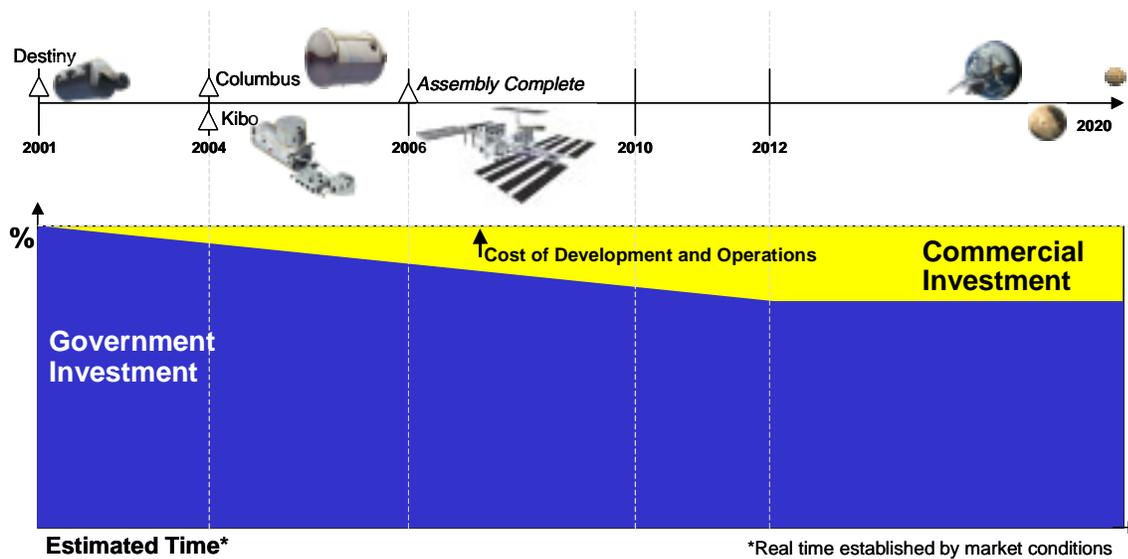


Figure 2: Projected Commercial Development Offsets Cost over Time

It is the policy of the partner governments to encourage commercialization of the ISS. In the U.S., this policy has been codified in the U.S. Commercial Space Act of 1998, which states:

The Congress declares that a priority goal of constructing the International Space Station is the economic development of Earth orbital space. The Congress further declares that free and competitive markets create the most efficient conditions for promoting economic development, and should therefore govern the economic development of Earth orbital space. The Congress further declares that the use of free market principles in operating, servicing, allocating the use of, and adding capabilities to the Space Station, and the resulting fullest possible engagement of commercial providers and participation of commercial users, will reduce Space Station operational costs for all partners and the Federal Government's share of the United States burden to fund operations.

Current Market

Three qualitatively different markets can be identified for commercialization activities.

Conventional commercial utilization market. The primary mission of the International Space Station revolves around research and development (R&D). Manufacturing and education are also considered to be part of the primary mission. The commercial market for services in ISS's

primary mission areas will be referred to as the conventional commercial utilization market. Currently, there is almost no demand from this market. All of the challenges identified below must be addressed before this market can become significant.

Non-conventional commercial utilization market. ISS presents opportunities for commercial activities outside of the primary mission areas, activities like advertising, promotion, and other entertainment and media activity. Some challenges remain in the way of a vigorous market for non-conventional commercial utilization, though, in general, this market is more ready than that for conventional commercial utilization.

Government market. Although it does not constitute commercial utilization as defined above, the space agencies could stimulate commercialization by purchasing services from commercial service providers. The government market can be easily identified; its needs are known. However, space agencies have traditionally preferred not to use industrially developed assets but to define, procure, and own their own assets. Several challenges must be overcome for commercial service providers to serve this market.

The following section discusses the challenges related to these markets.

Challenges

The members of the ISS Commercialization Workshops, with their knowledge of what is needed to attract business investment, have identified factors in the current conditions for commercial use of ISS that inhibit commercialization. Although utilization is limited during assembly operations, this interval can be employed for removing impediments and taking other steps necessary to encourage commercial activity.

Four broad categories of impediments were identified: policy, technical, financial, and legal. Fifteen specific impediments are summarized below. Appendices B, C, D, and E contain a more detailed discussion including suggested approaches to solutions.

Policy

- *Commercial Allocation.* Current policies allocating ISS access and resources for commercial uses are subject to varying interpretation and application. The space agencies should establish a policy whereby most commercial entities seeking to do business on ISS can obtain access to it and its resources in packages tailored to their needs under terms that permit them to do business.
- *Activity approval.* Current policy does not make clear what activities will or will not be permitted on ISS. The international partners should set guidelines that bound disapproved activities and determine the process for an efficient, open review of questionable activities.
- *Barriers to free enterprise.* Ordinary space agency practices contain many elements that prevent development of a free market for business on ISS. ISS should become a “common

market” for supply and purchase of services among member nations. Commercial sources should be given preferential consideration when competing with government sources.

Technical and Program

- *Time and cost.* Legacy approaches to ensuring safety, compatibility, and mission success impose requirements that result in a commercially prohibitive cost and time environment. Templates for integration must be reduced to 2 to 3 months for samples, routine experiments, and static payloads, and to 6 to 12 months for more complex hardware. Process costs should be significantly reduced while safety is maintained.
- *Accessibility.* Transportation assets and ISS resources available for commercial payloads are limited. The manifesting process precludes the certainty required for commercial applications. Commercial users must be able to receive service on their scheduled time or be given priority at the next available opportunity.
- *Standards.* Because technical standards and requirements among the ISS modules and logistics vehicles have evolved to meet different needs, issues have arisen with regard to their applicability. Space agencies, with industry participation, should reduce ISS standards to a minimal, top level set that permits commercial providers to maximize efficiency and to provide flexibility to users.

Financial

- *Commercial Market.* There is currently no commercial market for conventional commercial utilization. Non-conventional utilization is constrained by activities approval (see *Activities Approval* in the Policy Challenges section). Private companies must be able to sell products and services in, from, or related to human space to customers using assets that are privately operated, where transactions are governed by market conditions.
- *Pricing.* Published prices for transportation and ISS access are not compatible with market demand. Objective criteria for waiving these prices are not defined. Space commerce demands well-defined products and services that are priced based on their value to the customer. The pricing mechanism should set and adjust prices in accordance with free market principles of supply and demand.

Legal

- *Liability.* Uncertainty associated with legal third-party or product liability exposure related to commercial entities can inhibit commercial activity. Commercial users of ISS should be asked to bear a defined share of financial liability that is commensurate with a business case.
- *Tangible Property Rights.* Mechanisms or processes establishing the property rights for hardware, payloads, and systems that are provided by commercial entities and added to the ISS

baseline are inadequate. Governments should define property rights in space in a way that is compatible with terrestrial practice.

- *Trade Practices.* The time and uncertainty associated with the international transfer of data, goods, and people inhibit ISS commercial activity. Governments could establish ISS and its ground support as a free trade zone and could address policy accordingly in connection with trade, subsidies, tariffs, export, import, and immigration.
- *Intellectual Property Rights.* Currently there are inadequate processes to address infringement of international intellectual property rights. Enforceable international conventions relating to intellectual property rights should apply. Commercial type measures should be enforced for proprietary infringements short of patent actions.
- *Definition of Common Terms.* Differences in the interpretation of terms in space law and in multilateral agreements make it difficult to determine applicability of existing law or agreements. Terms should be defined to allow law to apply to activity in space in a manner identical to terrestrial practice.
- *Jurisdiction.* The unique international character of ISS sets up a potential conflict of laws for deciding jurisdiction in conflicts involving commercial entities. Jurisdiction should be established before conflicts arise.
- *Adjudication.* Currently, there are different international organizations that adjudicate disputes under international space law (the International Court of Justice) and under international trade law (the World Trade Organization). A single organization that can apply both sets of international law could be established or designated to adjudicate any disputes arising from space commerce.

Recommendations

Appendices B, C, D, and E contain suggested paths through which desired end-states may be realized. However, several recommendations are common to all commercialization efforts:

- *Regulatory organizations.* No additional international regulatory organizations should be developed under the premise of facilitating commerce in space.
- *Capitalism.* Free market principles, mechanisms, and activities should guide commercialization. Any activity that discourages or interferes with free markets should be eliminated.
- *Terrestrial practice.* Policy, laws, treaties, customs, and business practices established and operating on Earth should be the basis for activity in space.

- *Consultation.* Representatives of industry should be consulted whenever international partner governments consider policies or practices that could affect commercial space activity.
- *Support.* Purchasers of products and services in support of human space should select commercial sources whenever they are available.

Roadmap

The Strategic Planning Working Group (“SPWG”) of the ISS Commercialization Workshop II offers a roadmap to guide the space agencies and other governmental organizations in setting priorities for action on the identified needs of space commerce. The challenges listed above have different levels of urgency, discussed in Appendices B, C, D, and E. Based on those urgencies and their dependency on each other, the list of challenges has been prioritized below. The urgency of specific challenges will vary somewhat depending on the market served, but the following list provides a reasonable generalization of the relative urgency of all challenges. The analysis assumes that all markets are equally important, and that each should be served as soon as possible.

The dates offered in this roadmap, attached as Figure 3, presume that commercial activity will begin during ISS’s early utilization period to take advantage of current commercial interest. This will require aggressive efforts to remove those impediments that inhibit commercial activity, especially those affecting the early steps in business planning. This roadmap assumes that committed efforts on the part of the space agencies begin in July 2001. “Quarters” and “halves” below refer to calendar, not fiscal years.

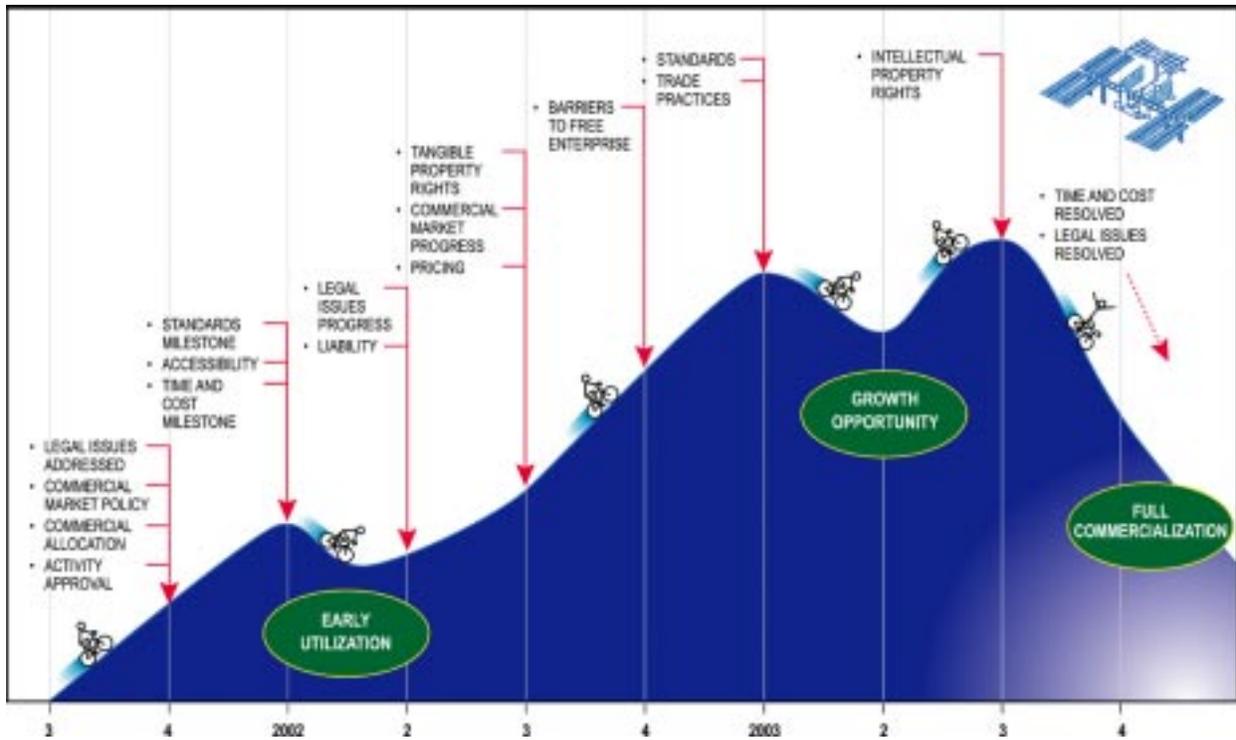


Figure 3: Roadmap to Commercialization of the ISS

The Appendices contain more detail needed to understand the assigned priority. Page number references provided below refer to the specific appendix in which the issues related to each challenge are detailed.

Immediate attention

Four challenges must be addressed before any commercial activity can get underway.

Activity approval (page B-2). Without guidance as to what activities will be permitted or prohibited, most companies will not consider doing business. This approval is on the critical path for the non-conventional commercial utilization market, and it will probably take several months to resolve the issues needed to support this market. A policy providing blanket approval for primary mission activities also should support activity in the conventional commercial and government markets. An explicit policy for all commercial activities should be implemented as soon as possible since early adoption will indicate the range of feasible commercial activity for all markets. Target time frame for resolution of this challenge: last quarter, 2001.

Commercial Allocation (page B-1). A lack of clear terms for the commercial allocation of ISS, including transportation and on-orbit resources, impedes the critical path for all three markets; commercial entities cannot consider doing business until this challenge has been resolved. However, resolution of this challenge is most urgent for the government market, since it is less

constrained by other challenges. Target time frame for resolution of this challenge: last quarter, 2001.

Time and cost (page C-1). This challenge is on the critical path of all the markets, however it will affect the three markets differently. Conventional commercial utilization will be extremely sensitive to requirements that result in long payload preparation lead times and that add costs to their project life cycle; significant improvements must be realized before this market will respond. The government and non-conventional commercial utilization markets will be less sensitive, though improvement is necessary even in these markets to make sales. Continual improvement in the cargo and payload processing time and cost will open progressively larger markets and allow progressively more commercial service providers to close business cases. Target time frame for resolution of this challenge: demonstrated progress against this challenge by the beginning of 2002 would encourage potential service providers; a detailed resolution plan that is responsive to market demand should be implemented by the end of 2002.

Accessibility (page C-2). Policies to insure commercial entities timely access to transportation and on-orbit resources must be in place before they will consider doing business. When commercial entities must invest capital, they will need assurance of the timing for the return on their investment, based on a timely flight opportunity, in order to close the business case. Target time frame for resolution of this challenge: end of 2001.

Other Priorities

The following challenges all must be resolved to permit full commercialization. They are arranged in rough order of urgency depending upon the timing of their impact on market development.

Pricing (page D-2). Having a pricing policy for the commercial allocation that is based on supply and demand will be necessary to close business cases. Business cases that involve significant investment require longer lead times and drive the urgency for resolution of this challenge. Target time frame for resolution of this challenge: first half of 2002.

Commercial Market (page D-1). A sound business case for commercialization is hindered by the lack of a market. Building a market is key to self-sustaining space commerce. Since the conventional commercial utilization market will likely grow from service providers in the government market, early implementation of policies that enable commercial access to the government market is critical to growing robust, conventional commercial applications as soon as possible. Service providers who seek to serve the government market must also have guidance on how to offer those services, as well as expectations about the size and value of the market. Target time frame for resolution of this challenge: to support the government market, a statement of policy supporting commercial service providers by the governments in the third quarter of 2001 would be appropriate, with the implementation details worked out in the first half of 2002.

There is evidence that a non-conventional commercial utilization market exists and can evolve with resolution of policies relating to activity approval (see *Activity Approval* in Appendix B). Target time frame for resolution of this challenge: to support the non-conventional utilization market, major decisions on marketing and branding would be appropriate in the first quarter of 2002.

Tangible Property Rights (page E-2). Policies establishing the ownership of tangible property placed aboard ISS are necessary to close business cases for commercial projects. For example, investors must be certain that their share in or rights to the asset will not be assumed by another party once placed aboard ISS. Target time frame for resolution of this challenge: first half of 2002.

Liability (page E-1). Policies establishing liability limits are required to enable commercial entities to assess and price options for covering their liability. Because these costs are included in the business case, they must be known before most business cases can be closed. Target time frame for resolution of this challenge: first quarter of 2002.

Standards (page C-3). A clear understanding of a minimal set of uniform technical standards will be necessary for equipment development. In general, this understanding will be required earlier for the non-conventional commercial utilization market both because it has fewer other impediments in the way of its business opportunities, and because those providing equipment for primary mission areas can assume the existing standards for purposes of the business case. The earlier these standards are resolved, the sooner mechanisms can be established to allow them to be verified on a commercial basis, which should have a significant impact on the *Time and Cost* challenge. Target time frame for resolution of this challenge: end of 2001 for promotional materials and other passive cargo; last half of 2002 for more general standards.

Barriers to Free Enterprise (page B-3). Allowing ISS to become a common market will likely be necessary to close business cases for the conventional commercial utilization market. However because other, more formidable impediments stand in the way of business activity in this market, its urgency is less. Removal of this impediment will also be necessary for business growth in the government market. Target time frame for resolution of this challenge: third quarter of 2002.

Trade Practices (page E-2). The removal of barriers to the exchange of data, goods, and people will be important to delivering services, especially in the conventional commercial utilization and government markets. Trade practices may affect marketing activities and even the estimates of market size for the purpose of the business case, though businesses may be able to work around these impediments as long as resolution of those barriers is in progress. Target time frame for resolution of this challenge: end of 2002.

Intellectual Property Rights (page E-3). Clear protection for intellectual property will be important to all markets and is essential to the conventional commercial utilization market. Service providers will have difficulty marketing their services and commercial users will be reluctant to enter into contracts for access to ISS until these issues are resolved. This challenge is

less urgent because other formidable impediments are likely to delay the development of the conventional commercial services market. However, settling these issues soon will enable early, high value utilization that may not have to wait on full resolution of the more formidable challenges. Target time frame for resolution of this challenge: first half of 2003.

Definition of Terms/Jurisdiction/Adjudication (pages E-5 and E-6). Resolution of these legal issues, which are connected with settling disputes that may arise on orbit, will not be needed before commercial activities are in operation. It is not possible to estimate how soon after commercial activities begin the first conflict requiring legal recourse may arise. Target time frame for resolution of these challenges: because these issues involve complicated international negotiations and will likely require political approval, both of which may take several years, coordinated efforts to resolve these issues should begin in the third quarter of 2001.

Conclusion

The members of the SPWG look forward to the time when commercialization of the ISS will be a reality, thereby opening new opportunities and markets to industry in the member nations and freeing up the resources of the ISS partner agencies for other national purposes. They offer to the space agencies this initial document summarizing industry's perspectives on ISS commercialization challenges and stand ready to initiate a dialog with the ISS partner agencies regarding the suggested roadmap for resolving these challenges. Though the SPWG operates as an informal body, they offer their continued support to the ISS partner agencies to facilitate commercialization of the ISS.

Appendix A

History of the International Space Station Commercialization Workshops

NASA initiated ISS Commercialization with its response³ to the Commercial Space Act of 1998⁴. Several studies have been performed in the U.S. (e.g. KPMG⁵) and Europe (e.g. Batelle, ACCESS, Cranfield University⁶) to prepare the path for commercialization. None of these studies were able to identify a short-term commercial market, but all of them identified several points that hamper commercialization.

To facilitate resolution to these obstacles and to clear the way for commercialization, space industry took the initiative. Industry held a workshop in Bremen in March 2000. Approximately 40 executives, senior experts, and managers from space agencies, other government agencies, space industry, finance, insurance and potential customers came together to discuss the framework for commercialization. The group concluded that there was work to be done before ISS commercialization becomes a reality. The challenges described in the appendices that follow reflect many of the recommendations from this workshop.

A second workshop was held in August 2000 to identify the challenges to the current state of ISS commercialization, to define the end state and to propose a way to resolve the open issues. In the second workshop, the 70 participants decided that a working group from the workshop, called the Strategic Planning Working Group (“SPWG”), would (a) author a strategic roadmap to facilitate commercialization, and (b) submit the strategic roadmap to the workshop participants for endorsement. Detailed information about the second workshop can be found on the Internet under: www.unitedspacealliance.com/isscw.

³ NASA Commercial Development Plan for the ISS (November 16, 1998)

⁴ Commercial Space Act of 1998. U.S. Public Law 105-303

⁵ “Commerce and the International Space Station”, results of an independent study required under the Commercial Space Act of 1998, commissioned by NASA and performed by KPMG, LLC, November, 1999

⁶ “Commercialization of the European Utilization of ISS,” Summary Presentation, Batelle-ITM, The Cranfield Marketing Planning Centre, ACCESS-Matrix; ESA/ESTEC, May 24, 2000

Appendix B

Policy Challenges

Space agency activities have evolved largely without attention to the special needs of commercial activity. Commercial activity has been considered only as commercial utilization, and commercial users seen as differing from agency-sponsored users only in their source of funding. This has resulted in a body of policy, either implicit or explicit, that does not meet the needs of the full range of potential commercial activity. A policy framework that includes commercial needs explicitly is, therefore, a necessary foundation for ISS commercialization. Three impediments in the area of policy require attention.

Commercial Allocation

Description of the challenge: At present, no clear policy exists stating whether and how the space agencies will provide commercial companies assured access to ISS and its transportation systems. Some space agencies have identified a certain percentage of their capacity for commercial applications, however this is targeted at specially cultivated commercial activity such as NASA's commercial space centers or ESA's microgravity applications program. In general, this access is packaged in a way that presumes the commercial participant will be pursuing research and doing so under a model that resembles the way science has been performed on the Shuttle, namely in locker-sized packages with finite duration experiments. The few precedents already established for commercial access to ISS do not appear to be broadly applicable, nor are their terms and conditions publicly known.

Urgency: Requires immediate attention. Without confidence that a commercial allocation will be available, companies can undertake only tentative market exploration activities. Business cases cannot be opened, nor business models developed, without some expectation of the terms and conditions of access, and they cannot be closed without a firm understanding of the cost boundaries and impacts. Investors cannot be secured without the well-grounded expectation that ISS access will be available under stable conditions across the period in which the investment must earn its return.

Desired end state: Most commercial users are able to obtain access to ISS and its resources in packages tailored to their needs under terms that permit them to do business.

Possible path: In addition to the recommendations listed in the overview of this paper, especially those under *Capitalism*, *Terrestrial practice*, and *Consultation*, the following could establish the needed business confidence to permit wide-ranging commercial activity:

- Space agencies could reserve a certain percentage of their capacity and resources explicitly for commercial companies. Resources would explicitly include transportation. (See *Financial Challenges*, Appendix D for discussion on pricing.)
- Long-term commitments to access could be enabled.

- An open and transparent process could offer for sale any resources that become available on a short-term basis. For example, electrical energy that, because of changes in planned activity on ISS, will not be needed as planned, might be offered to other users on a “spot market” in a way similar to terrestrial practice. (Note: Developing this process, while necessary in the long run, has a low urgency today.)

Activity Approval

Description of the challenge: The space agencies have based their commercialization expectations around the presumption that commercial activity would be preponderantly research and/or manufacturing and suggested that certain other activities would not be permitted. The policies that govern approval of innovative uses of ISS seem to be subject to undefined scrutiny and influences. In this environment, even conventional research applications cannot be completely sure that their activity will be permitted on ISS. There is no clear understanding of how approval will be obtained or how long the approval process will take. These risks inhibit planning for conventional activity and prohibit it for innovative uses.

Urgency: Requires immediate attention. Without guidance as to what activities will be permitted or prohibited, most companies will not consider doing business. Activity approval is on the critical path for the non-conventional commercial utilization market because no current policy delineates what kinds of non-conventional activity will be prohibited. Nor is the process for obtaining such approvals clear.

Because the government and conventional commercial markets involve activities that are part of ISS’s primary mission, there may be a presumption of approval of business cases within these areas; but the business risk to commercial entities is increased by being forced to make this assumption. The lack of explicit statements giving approval to activities inside the primary mission area will discourage some entities for developing business cases and some investors from providing funds for commercial activities. A policy explicitly providing blanket approval of activities in the primary mission areas will remove one impediment that affects early activity in the government and conventional commercial utilization markets.

Desired end state: The international partners have established broad guidelines that bound disapproved activities, both Station-wide and within their individual modules. Standards preclude only activity that is unsafe, interferes with station operations, is in bad taste, or is out of accord with the Outer Space Treaty. An efficient, open process reviews novel activity with approval of anything not explicitly disapproved. Precedent guides approvals.

Possible path: Early guidelines could provide blanket approval for uncontroversial activity (e.g. research). IGAs could set Station-wide policy. Each space agency could define any additional limits on the use of its own assets. International partners and individual space agencies could establish processes for reviewing novel activities.

Barriers to Free Enterprise

Description of the challenge: Space agencies are accustomed to meeting their own national needs through non-commercial means. In the process, they have developed modes of operating that could undermine free and open markets, for example, subsidizing certain activities, and giving preference to their national companies. However, in a commercial environment, such activity increases business investment risk by limiting markets and distorting market valuation.

Urgency: Barriers to free enterprise affect the risks and growth potential of all three markets. Although some entrepreneurs can close business cases and attract investors without these barriers being removed, they do so at higher risk. Risk-averse businesses will not come forward in such an environment. However because other, more formidable impediments stand in the way of business activity, the urgency of resolving this challenge is less.

Desired end state: ISS has become a “common market” for supplying access to and purchasing services from companies of all member nations without discrimination. Commercial sources are given preferential consideration in government make – buy decisions.

Possible path: Recommendations listed in the Overview of this paper could guide policy decisions aimed at reducing the barriers to free enterprise.

Appendix C

Technical and Program Challenges

Space agency approaches for using the International Space Station (ISS) have evolved largely without attention to the special needs of commercial activity. The resultant technical approaches need improvement in order to support the full range of potential commercial activity.

Technical issues, involving engineering and/or operations considerations, are among the most challenging and urgent constraints on commercial activity. Specifically, three broad, technical problem areas – time and cost, accessibility, and technical standards and processes – require special attention.

Time and Cost of Cargo/Payload Preparation

Description of the challenge: Legacy approaches to ensuring safety, compatibility, and mission success impose requirements that result in a commercially prohibitive cost and time environment.

According to a National Research Council Study⁷, a NASA scientific investigation—including selection and manifesting on the flight schedule; technical definition, design, development, and verification; and, finally, flight operations and data collection and analysis—takes 4 to 8 years to complete. Even when the requirements of sponsored science (solicitation, science and engineering reviews, etc.) are factored out, as they would be for commercially developed payloads, the burden required to certify and integrate payloads into mission operations are time consuming and costly. The lead time and payload preparation activity are cost drivers that make it difficult or impossible for a commercial company to justify business plans that include Space Station utilization over a business plan that favors the use of terrestrial resources.

Urgency: Requires immediate attention. Shortening the integration template and making it more accommodating and less expensive is key to attracting commercial users. This challenge is on the critical path of all the markets, however it will affect the three markets differently. Conventional commercial utilization will be extremely sensitive to requirements that result in long payload preparation lead times and that add costs to their project life cycle; significant improvements must be realized before this market will respond. The government and non-conventional commercial utilization markets will be less sensitive, though improvement is necessary even in these markets to make sales.

Desired end-state: Payload preparation takes 2 to 3 months for samples, routine experiments, and static payloads, and 6 to 12 months for more complex hardware. Commercial users only certify that they maintain all safety parameters. Costs for payload preparation have been reduced an order of magnitude.

⁷ Institutional Arrangements for Space Station Research, National Research Council

Possible path: The integration template and requirements to fly commercial customers could be renovated to better accommodate commercial users. Paths forward could include the following:

- Evaluation of payload mission integration templates to offer recommendations for reduced cycle times; addressing disconnects between the ISS payload integration template, payload hardware development schedules, and potential vehicle-payload impacts; evaluating payload preparation requirements and developing recommendations for standardization, simplification, and consolidation.
- Contract work could contain special incentives that reward innovation in process improvement, or contract work could be commercialized (or privatized) to implement process efficiencies and improvements while maintaining safety.
- Commercial hardware could be pre-qualified so that all uses are subject to a streamlined approval process that considers only whether the specific samples are appropriate to its level of containment.

Accessibility

Description of the challenge:

Transportation assets and on-orbit resources available for commercial payloads are limited. The current manifesting process often shifts payloads from one flight or increment to another in order to optimize resource allocation. However, this flexibility precludes the certainty required for commercial applications.

Commercial activities on the station must be integrated in a manner that ensures timely access to those government assets needed to do business.

Urgency: Requires immediate attention. Policies to insure commercial entities timely access to transportation and on-orbit resources must be in place before they will consider doing business. When commercial entities must invest capital, they will need assurance of the timing for the return on their investment, based on a timely flight opportunity, in order to close the business case. Accessibility must improve before commercial markets can develop.

Desired end state:

Access to transportation assets, on-orbit resources, and payload preparation goods and services is available from one or more established commercial sources.

Commercial users fly on their scheduled time and/or receive priority of the next available flight.

Possible path:

- Entry points and business interfaces could provide user-friendly access to transportation and on-orbit resources. Smart user interfaces could be developed with service catalogs for “standard” packaging of resources and corresponding flight opportunities.
- Space agencies could guarantee volume, upmass and on-orbit resources consistent with policy of allocated assets for commercial use. Contractual guarantees could include penalties and incentives.
- Flight options and allocation of transportation and on-orbit resources that permit dependable, recurring flight schedules and mission operation opportunities could be tracked.

Standards

Description of the challenge: Because technical standards and requirements among the ISS modules and logistics vehicles have evolved to meet different needs, issues have arisen with regard to their applicability. The complexity of interfaces and the accommodations aboard ISS is greater than on previous human space flight systems.

Because the ISS will use many aspects of the user data collected for multiple increments, uniform standards would ensure usability of the data products from one flight and crew to the next.

Urgency: Applicable standards must be delineated before commercial users and providers can develop sound business plans. A clear understanding of a minimal set of uniform technical standards will be necessary for equipment development. In general, this understanding will be required earlier for the non-conventional commercial utilization market both because it has fewer other impediments in the way of its business opportunities, and because those providing equipment for primary mission areas can assume the existing standards for purposes of the business case. The earlier these standards are resolved, the sooner mechanisms can be established to allow them to be verified on a commercial basis

Desired end state:

ISS standards consist of a minimal, top-level set that permits commercial providers to maximize efficiency and provides flexibility to users.

Enveloped requirements for sub-rack payloads across various ISS carriers (e.g. MPLM, mid-deck) cover development and verification requirements.

Businesses with experience in flight planning and integration provide commercial, value-added products and services that address the issues that affect costs. These services could also be provided to space agency users on a commercial business model.

After the processes on ISS have reached operational stability, an ISO-like, or Underwriters Laboratory (UL)-like commercial process provides information about and/or certifies compliance with minimal standards for interface compatibility and design and for operational safety.

Possible path:

Space agencies and industry could establish an international forum to identify and promote multilateral agreements on the minimum set of standards that must be met by commercial providers to ensure safe and effective missions. Open standards will be applied to the extent practical.

Appendix D

Financial Challenges

The end state for ISS commercial activity should be commerce in space that resembles commerce on Earth in every respect except its location. The same financial mechanisms that propel terrestrial commerce will be active in space commerce. This early phase of human space commerce should emphasize: 1) eliminating barriers to the use of established financial mechanisms and 2) putting in place mechanisms that ease the transition between the current government dominated activity and full private sector, commercial activity.

Two challenges have been identified that specifically hamper the establishment of financial mechanisms for ISS commercialization.

Commercial Market

Description of the challenge: Commercial utilization consists of two markets: the conventional commercial utilization market, and the non-conventional commercial utilization. The first market does not exist yet; it has to be nurtured by improving business conditions such as price, quality of service, timeliness, and predictability before a commercial market will develop.

The non-conventional commercial utilization market has shown interest through some recent projects, but approval for such activities on ISS for these customers is unclear, as discussed in *Appendix B: Policy Challenges*.

A third market can be identified, the government market. The government market exists, and its needs can easily be identified, although space agencies have traditionally preferred not to use commercially developed assets. The space agencies have made investments in technologies and applications that support commercial use; however, these investments need the activity of entrepreneurs – efficiency and service improvements, promotion and market development – if they are to grow into significant commercial activity.

Urgency: A sound business case for commercialization is hindered by the lack of a market. Building a market is key to self-sustaining space commerce. Since the conventional commercial utilization market will likely grow from service providers in the government market, early implementation of policies that enable commercial access to the government market is critical to growing robust, conventional commercial applications as soon as possible. Service providers who seek to serve the government market must also have guidance on how to offer those services, as well as expectations about the size and value of the market. There is evidence that a non-conventional commercial utilization market exists and can evolve with resolution of policies relating to activity approval (see *Activity Approval* in Appendix B).

Desired end state: Nobody can predict the markets that will become important in the long term. Regardless of the markets, in the future state, businesses do business with other businesses in

multiple tiers, both on orbit and on the ground. Private companies not only supply space-based services directly to customers, they provide space-based resources (e.g. power, communication), space based assets (e.g. refrigerated stowage), transportation services (e.g. launch and return, uploading and downloading of cargo), and ground based services (e.g. certification, integration and operations planning, insurance) to companies who serve those end customers. Other supporting businesses develop without targeted assistance from the space agencies. The space agencies are customers of this healthy, growing low Earth orbit (LEO) economy, purchasing services in LEO in exactly the same way that they purchase services on Earth. Private companies sell products and services in, from, or related to human space to commercial customers using assets that are privately owned, where transactions are governed by market conditions.

Possible path: Entrepreneurs can be encouraged to establish and grow space businesses if the space agencies use their purchasing power in commercial research and operations services to serve as the initial market. Space agencies could be open to buy commercial products and services from space industry to support the development of a commercial culture, and thus pave the way for commercial services to commercial customers.

Several studies (KPMG⁸, ACCESS, Batelle⁹, etc.) have found that to develop and create demand for non-conventional commercial utilization, marketing activities, promotion, and branding are recommended. To develop the conventional commercial utilization market, space agencies and industries could perform marketing and promotion activities like advertisement, entertainment, multimedia, and sponsorship. Non-conventional commercial utilization customers could serve as an efficient way of increasing public knowledge about ISS, and thus marketing ISS.

Pricing

Description of the challenge: A principal financial roadblock is establishing market driven prices for both the purchase of services from space agencies and for the sale of commercial services to the space agencies and to other private sector entities. Prices are an essential input to the business cases that determine investment, and to purchasing decisions that will establish a market. Space agencies are beginning to recognize that the cost-based price of access may be too high for many commercial applications and have stated a willingness to waive that price under certain circumstances. However, the nature of those circumstances is not clear, the process requires private business data, and waivers do not appear to be based on objective criteria. The challenge is to move away from the current environment where price is based on marginal cost to an environment where price is based on market driven supply and demand.

⁸ “Commerce and the International Space Station”, results of an independent study required under the Commercial Space Act of 1998, commissioned by NASA and performed by KPMG, LLC, November, 1999.

⁹ “Commercialization of the European Utilization of ISS,” Summary Presentation, Batelle-ITM, The Cranfield Marketing Planning Centre, ACCESS-Matrix; ESA/ESTEC, May 24, 2000

Urgency: Having a pricing policy for the commercial allocation that is based on supply and demand will be necessary to close business cases. Business cases that involve significant investment require longer lead times and drive the urgency for resolution of this challenge.

Desired end state: Products and services in support of ISS are well defined, and value based pricing mechanisms are in place. Prices are determined by free market principles of supply and demand and change in response to predictable parameters. An exchange has been established to accommodate buying and selling between multiple suppliers and multiple purchasers.

Possible Path: Competitive supply is one key to establishing prices for ISS, its resources, and transportation. The operators of the various ISS elements and launch systems could establish prices and service packages independently of each other in order to provide a basis for market competition that will adjust price to achieve value. Competitive demand, the other key, will grow from a robust market, addressed in the previous section *Commercial Market*.

Appendix E

Legal Challenges

The underlying legal framework for commercial activity on ISS does not adequately address several issues that could affect commercial users. Establishing such a framework requires a clear understanding of which components of the existing framework relate to commercialization of the ISS.

To establish a clear legal framework for commercial activities in space, it is imperative to understand the political and business paradigm that will be carrying out commercial activities. That paradigm will make it possible to apply existing law and to establish the legal framework to support the political and business paradigm.

The following seven broad issues have been identified.

Liability

Description of the challenge: The following issues related to liability may adversely affect growth of commercial activity because they can inhibit the market segments' ability to obtain financing:

- The applicability of the provision of international law, including, but not limited to Articles I and VII of the Liability Convention; Article 16 of the 1998 IGA, Cross-Waiver of Liability; and, The Hague Convention of 1972 is unclear.
- Different concepts of product liability among different national laws introduce conflict and commercial uncertainty.
- The applicability of Article 22 of the IGA, Criminal Jurisdiction, to non-Partner commercial users of ISS is unclear.
- Liability with respect to Intellectual Property has not yet been addressed. Article 16.3 (d) 4 of the IGA states that the cross-waiver of liability provision does not apply to intellectual property claims. In addition, if the World Trade Organization (WTO) Treaty is applicable to ISS commercialization activities, it is unclear whether Russia is bound to provide the protections for patent rights and other intellectual property rights that are required of WTO members by the WTO Agreement on Trade-Related Aspects of Intellectual Property Rights (the TRIPS Agreement), because Russia is not a member of the WTO.

Urgency: Policies establishing liability limits are required to enable commercial entities to assess and price options for covering their liability. Because these costs are included in the business case, they must be known before most business cases can be closed.

Desired end state: The costs of insuring risk and liability or any share thereof for a commercial venture are commensurate with the business case.

Possible paths:

- A global insurance consortium with an umbrella insurance paradigm could provide more appropriate protection against potential liabilities¹⁰.
- Aviation/maritime liability mitigation mechanisms could serve as a model for space activity.
- International partner governments could establish limits on risk that must be assumed by commercial partners. Government agencies could assume a share of the risk if needed to close most business cases.
- Government and industry could work jointly to educate the insurance industry on insurance needs.

Tangible Property Rights

Description of the challenge: Currently the mechanisms establishing property rights of commercial hardware and payloads are inadequate. The IGA assumes that all ISS hardware is the responsibility of the governments of member nations. The administrative mechanisms relative to security interests and debt financing are not clear.

Urgency: Policies establishing the ownership of tangible property placed aboard ISS are necessary to close business cases for commercial projects.

Desired end state: Property rights in space are equivalent to those on Earth.

Possible paths:

- The international government host could represent the property owner in accordance with the IGA.
- The international partner governments could sign a multilateral agreement adhering to a protocol for registering tangible property rights and ownership.

Trade Practices: Export/Import, Customs, Tariffs, Immigration

Description of the challenge: The international transfer of data, goods, and people for ISS commercial activity is slowed by the bureaucracies of the international partner governments. Such costly delays can inhibit commerce.

¹⁰ Astrium, Hermmann Ersfeld, "Workshop on the ISS", Berlin 08/09. June 2000.

The application of export and import laws, regulations and rules slows businesses transactions as officials seek specific guidance. In particular, questions concerning the applicability of the U.S. International Traffic in Arms Regulations to space activities have added delays of a year or more to routine data transfers. Such delays are not compatible with robust commercial activity.

The General Agreement on Tariffs and Trade of 1994 (GATT) and other parts of the WTO Treaty may apply to commercial activities on the ISS. The GATT/WTO principles of nondiscrimination, especially the principles of most-favored-nation treatment (“MFN treatment”) and national treatment for International Partners who are WTO members, raises issues because Russia is not a member of the WTO, and, therefore, not bound to comply with its commercial rules.

It is not clear whether the multilateral Agreement on Subsidies and Countervailing Measures will limit governmental incentives and support for private sector commercial activities on ISS.

Urgency: The removal of barriers to the exchange of data, goods, and people will be important to delivering services, especially in the conventional commercial utilization and government markets. Trade practices may affect marketing activities and even the estimates of market size for the purpose of the business case, though businesses may be able to work around these impediments as long as resolution of those barriers is in progress.

Desired end state: ISS and ground support for its commercial activity occur entirely within free trade zones.

Possible paths:

- Partner governments could establish a mechanism to facilitate international trade. They could enact legislation in accordance with Article 18 of the IGA, Customs and Immigration to expedite ISS commercial activities with, for example, entry and residence, speedy customs clearance, duty-free importation and exportation for items bound for space.

Intellectual Property Rights

Description of the challenge: Due to Article II and Article IV of the Outer Space Treaty and Article 21, Intellectual Property, of the IGA, there is not a uniform, standardized approach to protection of intellectual property rights (“IPRs”). Rather, the national laws of the International Partner states regarding intellectual property (“IP”) are relevant for ISS activities. Therefore, there is uncertainty regarding protection of commercial users’ IPRs. Without clear protection, commercial users and providers may not want to invest capital.

Although NASA has established standard agreements (pursuant to the Space Act Agreements Manual) and ESA is in the process of establishing standard agreements, it remains unclear how the various approaches will flow together with respect to, for instance, a commercial user whose use involves more than one module. Specifically:

- It is unclear as to how ownership of IP will be addressed. For example, will patents be granted on a first-to-file basis or on a first-to-invent basis? The application of invention secrecy laws, foreground information, background research/data is unclear if such applications will be different if the IP was developed on the ground or in space. Also, disclosure and publication issues have not been addressed.
- Infringement of IPRs has not been addressed.
- The mechanisms and protections for sharing of IPRs with both International Partner and non-Partner commercial users have not been determined. It is unclear how transfer and treatment of data, transfer of IPRs, and protection of data will be applied in practice.
- See *Jurisdiction* below and *Liability* above, as those sections relate to IPRs. Commercial users will need a clear understanding of who has what rights, where jurisdiction for disputes will rest, and how respective rights can be enforced.
- Confidentiality has not been addressed. For example, how will commercial users protect information to maintain their competitive advantage? How will the partner governments reconcile intellectual property developments with the public's right to know? Also, it is unclear how partner governments will reconcile the fulfillment of safety requirements in establishing guidelines for security of information.

Urgency: To establish credibility and confidence of potential customers to promote business growth, clear protection for intellectual property will be important to all markets and is essential to the conventional commercial utilization market. Service providers will have difficulty marketing their services and commercial users will be reluctant to enter into contracts for access to ISS until these issues are resolved. This challenge is less urgent because other formidable impediments are likely to delay the development of the conventional commercial services market. However, settling these issues soon will enable early, high value utilization that may not have to wait on full resolution of the more formidable challenges.

Desired end state: Commercial-type measures are used for proprietary infringements. International processes for establishing IPRs have been adopted in accordance with current international principles.

Possible path: The international partner governments could sign a multilateral agreement adopting an international regulatory organization as the determining agent to provide for remedies in intellectual property infringements and to enforce such remedies.

Lack of Standard Definition of Common Terms

Description of the Challenge: The lack of common definitions of basic terms inhibits the development of a legal framework for ISS commercial activity. For example, the terms “Space object”, “Space station”, “Payload”, “Commercialization/ commercial activity”, and “Non-Partner (commercial or not)” have different meanings in different contexts. Without clear definition and standardization of usage, it will be difficult to draft or enforce legislation.

Urgency: Resolution of this issue, which is connected with settling disputes that may arise on orbit, will not be needed before commercial activities are in operation. It is not possible to estimate how soon after commercial activities begin the first conflict requiring legal recourse will arise.

Desired end state: Applicability of law in space is consistent with applicability of law on Earth.

Possible path: Partner nations could sign a multilateral agreement on standard definitions with endorsement by affected international organizations (e.g. UN, WTO, etc.).

Jurisdiction

Description of the challenge: Current international law and the 1998 IGA do not provide direction about which body of law governs cases and controversies arising from commercial activities on the ISS. Standard business contracts generally state which laws are applicable. Certain laws appear to be in direct conflict, for example, law of state of registry, law of the forum where plaintiff begins case, law of plaintiff’s nationality, law of defendant’s nationality. Nor is it clear how acceptance of the ‘conflict of laws’ resolution by the appropriate parties (e.g., private or quasi-private contracts; arbitration; treaties or other international agreements to adjudicate disputes) would be secured.

No clear mechanism determines enforceability, for example, which courts have jurisdiction, what remedies are available, and how sanctions are to be enforced.

National law is not always compatible with obligations contained in international agreements such as:

- IGA and MOUs
- Provisions affecting outer space in each nation’s domestic laws
- International law in outer space (per Article I of Outer Space Treaty of 1967)

Commercial companies need a clear understanding of what jurisdiction prevails if conflict arises between international and national law, for example, an intellectual property dispute on the US managed portion of the Japanese or European modules.

Article VI of the Outer Space Treaty makes the contracting states internationally responsible for national activities in outer space. Per the discussion of *Standardization of Definitions* above, it is not clear what constitutes “national activities”, and, consequently, requires “authorisation and continuing supervision”.

Several of the applicable treaties, such as the Astronauts Rescue Convention of 1968, the Liability Convention of 1972, and the Registration Convention of 1975, all of which, like the Outer Space Treaty of 1967, fall under the auspices of the United Nations, and are likely to be interpreted according to the terms of the Vienna Convention on the Law of Treaties. This Convention has been ruled by the WTO Appellate Body, and accepted by other international tribunals, to be customary international law where the interpretation of international agreements are concerned.

Urgency: Resolution of this issue, which is connected with settling disputes that may arise on orbit, will not be needed before commercial activities are in operation. It is not possible to estimate how soon after commercial activities begin the first conflict requiring legal recourse will arise.

Desired end state: Clear jurisdiction has been established for international space commerce.

Possible path: The government agencies, national legislatures, and international organizations could facilitate the establishment of jurisdiction and could agree on a hierarchy of law.

Adjudication

Description of the challenge: There is no consolidated body of jurisprudence that applies to space commerce. The following list identifies some of the international agreements and other legal documents relevant to space-related activities including commerce.

Multilateral and Bilateral Agreements

- The Agreement Among the Government of Canada, the Governments of Member States of the European Space Agency, the Government of Japan, the Government of the Russian Federation, and the Government of the United States of America Concerning Cooperation on the Civil International Space Stations, dated January 29, 1998, also known as the Inter-Governmental Agreement (“IGA”).
- Memoranda of Understanding between the National Aeronautics and Space Administration and each of the individual international partners, including the various barter agreements between international partners that affect asset allocation.

International Treaties and Conventions

The following treaties fall under the auspices of the United Nations (UN). These treaties are enforced only insofar as the signatory nation is willing to enforce or abide by a judgment of the International Court of Justice in the event of a dispute.

- Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies of 1967
- Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Space, opened for signature at Washington, London and Moscow on April 22, 1968 (the “Astronauts Rescue Convention of 1968”)
- Convention on the International Liability for Damage Caused by Space Objects, opened for signature at London, Moscow, and Washington on March 29, 1972 (the “Liability Convention of 1972”)
- Convention on Registration of Objects Launched into Outer Space, adopted by the General Assembly of the United Nations, at New York, on November 12, 1974 (the “Registration Convention of 1974”)
- Agreement Governing the Activities of States on the Moon and other Celestial Bodies, opened for signature at New York on December 18, 1979 (the “Moon Treaty of 1979”) (This agreement has potential implications for property rights in outer space; however, this treaty has only been ratified by a handful of countries, and is not binding on non-signatories.)

Although the applicability of commerce and trade law has not yet been raised, several of the international agreements may be applicable to the commercial activities. Treaties of the World Trade Organization (“WTO”) may apply to space commerce, including:

- The General Agreement on Tariffs and Trade 1994 (the "GATT 1994")
- The Agreement on Technical Barriers to Trade (the "TBT Agreement")
- The Agreement on Subsidies and Countervailing Measures (the "SCM Agreement")
- The General Agreement on Trade in Services (the "GATS"), and especially the Protocol to the GATS relating to Basic Telecommunications Services
- The Agreement on Trade-Related Aspects of Intellectual Property Rights (the "TRIPS Agreement")
- The Agreement on Subsidies and Countervailing Measures (the “SCM Agreement”)

Other agreements under the WTO Treaty, including, for example, those agreements relating to import licensing, customs valuation, and rules of origin, may possibly have some application to commercialization of the ISS. However, those agreements listed above are likely to be most significant.

National Law and Regulation

The governments of the International Partners have enacted legislation relevant to commercial activities, space activities, and more specifically commercial activities in space. An appropriate adjudication framework must respect national laws of all the International Partner states as well as non-Partner countries that may be involved in commercialization activities.

Furthermore, there are many different government agencies and departments affected by space commerce. All such agencies and departments do not currently coordinate space commerce activities.

Civil (commercial) law contracts may be needed to address challenges related to jurisdiction.

Relevant Precedent

The 1984 Chicago Convention on International Civil Aviation may be applicable to the transfer of rights, responsibilities, functions and duties among the International Partners.¹¹

The UNIDROIT Committee of governmental experts draft Convention on International Interests in Mobile Equipment and a draft Protocol thereto on Matters specific to Aircraft Equipment, and the Sub-Committee of the ICAO Legal Committee on the study of international interests in mobile equipment, which defines space property to include such things as space stations and other visiting vehicles, may also apply to commercial arrangements on the ISS.

General References

The UN Committee on the Peaceful Uses of Outer Space (“COPUOS”)¹² includes a listing of Multilateral Legal Instruments, Establishment and Pronouncements of International Bodies and Organizations, Bilateral Legal Instruments, National Law and Legislation that may apply to commerce in space. In particular, pages 40-41 of the COPUOS report list the documents relevant to “International Space Station”.

Urgency: Resolution of this issue, which is connected with settling disputes that may arise on orbit, will not be needed before commercial activities are in operation. It is not possible to estimate how soon after commercial activities begin the first conflict requiring legal recourse will arise.

Desired end state: The same international legal framework for terrestrial commerce applies to space commerce.

¹² International Agreements and Other Available Legal Documents Relevant to Space-Related Activities, United Nations, Vienna, 1999. <http://www.oosa.unvienna.org/Reports/intlagree.pdf>

Possible path: International partner governments could sign a multilateral agreement adopting an international regulatory organization as the adjudicating organization when there is a dispute in space.