

APPENDIX D : PATHFINDERS

As discussed in the main report, during the course of the development of the market review for the International Space Station, KPMG found a range of significant impediments or barriers that must be overcome for commercial development of the ISS to flourish. In collaboration with the CSVAT, KPMG has identified a series of "Pathfinder" programs that could help to foster commercialization and commercial development by pushing the bounds which currently define the ISS operational environment. It is important to note that by the very nature of the CSVAT's composition, with representation from many of the leading aerospace companies in the U.S., that the Pathfinders presented have a correlation to their existing businesses. However, KPMG and the CSVAT want to stress that the Pathfinders we have identified are not in any way to be construed as the only opportunities available for fostering commercial activity. We highly encourage NASA to undertake a forceful proactive effort to promote the development and submission of a wide range of such opportunities by the commercial community. The Pathfinders we have included were based primarily upon their potential to accomplish one or more of the following:

- **Cost Reduction** – providing a significant cost savings in the area of operations or hardware procurement, by selecting privately-built hardware in lieu of the traditional NASA-driven procurement program or by allowing private industry to make use of excess capacity in the ISS/STS system;
- **Capability Enhancement** – improving the overall suite of services and functions available to both NASA and commercial users of the ISS by permitting additional facilities or capabilities to be added to the ISS and/or STS;
- **Value Extraction** – creating new streams of revenue by capitalizing on the inherent value of the ISS program, using such vehicles as licensing, sponsorship, advertising, or similar entertainment-related ventures.

The Pathfinders presented in this section represent a sample of the wide spectrum of programs and ideas that should be embraced by NASA and enabled, where necessary, by Congress in order to foster an environment that is more conducive to true commercial operation and utilization than currently exists.

PATHFINDER : INCREASE SPACE SHUTTLE FLIGHT RATE FOR COMMERCIAL MISSIONS

Description

The current flight rate for the space shuttle fleet underutilizes the capacity of the system and could be increased in order to allow additional flights to be conducted at marginal cost. These additional flights could be had without requiring an expansion of the major cost elements associated with shuttle operations (e.g., the contractor and civil service communities). The marginal cost, as well as additional costs associated with payload carrier leases, payload element support and mission integration could be borne by private sector customers.

Commercial Opportunity

By operating additional shuttle flights at marginal cost it would be possible for NASA to accelerate market demand development for space research and development by providing scheduled, accessible, repeatable flights for potential industry users. Such flights would be a critical enabler of market growth, by providing a greater set of R&D opportunities for industry to better understand the potential applications and opportunities that would be available on the International Space Station.

Advantages to NASA/ISS Commercialization

By tapping the unused flight capacity of the space shuttle, NASA would be able to foster demand and develop an understanding of price elasticity for industry use of STS/ISS resources and capabilities for space R&D. By doing so, NASA would be able to mitigate one of the most serious impediments to fostering industry demand for ISS facilities - the lack of a large database of commercially oriented in space R&D testing. The addition of multiple R&D related flights per year could add from two to three flights per year, thereby significantly increasing commercial access to space and stimulating industrial use of the ISS as a multipurpose R&D facility.

PATHFINDER : SPACE TECHNOLOGY TESTBED

Description

The International Space Station can be a powerful tool to satisfy industry needs for a commercial spacecraft technology testbed. A significant and growing commercial market already exists for new, more capable communications and remote sensing satellites. Competition in this market strongly motivates satellite manufacturers and spacecraft component developers to test and demonstrate new space hardware (e.g., antennas, solar panels, sensors, etc.) in a realistic environment. External attach points on the ISS allow it to function uniquely as a space technology testbed (STT) for proposed new spacecraft hardware. Commercial STT activities on the ISS encompass engineering research and technology demonstrations as well as generation of revenue by certain types of prototype hardware (e.g., advanced sensors).

In the past, the spacecraft technology demonstration function has been primarily performed by free flying satellites, typically paid for by government. However, in view of the expanding commercial satellite market, government is significantly reducing its STT activities and expecting industry to fill the gap. As a result, industry will be pushed to find an affordable alternative for conducting key space based experiments and validations. Commercial STT operations on ISS provide that alternative.

As a platform for SST operations, the ISS offers technology developers more than just the micro-gravity environment. The ISS delivers the combined environments of vacuum, micro-gravity, thermal cycling, sunlight, and earth vantage point necessary to test and verify satellite components and technologies. Additionally, ISS technology development experimenters will have a virtual presence throughout the course of a demonstration, with the possibility of retrieving their hardware for post test evaluation. Moreover, the cost of commercial STT operations on the ISS will be significantly less than that of the alternative, stand-alone technology demonstration satellites.

Commercial Opportunity

The economic sector that will initially drive this commercial use of the ISS is the multibillion dollar commercial satellite manufacturing industry. Space infrastructure revenues have quadrupled in the last ten years, and double digit percent growth is expected to continue in the future. Today the market for commercial satellite manufacturing can be segmented into GEO, Broadband LEO (internet in the sky), Big LEO (global telephony), Remote Sensing and Little LEO (messaging). The projections for commercial revenues for satellite manufacturing for the year 2000 total \$7-10 billion dollars for all of these

segments. Eventually, an even larger market for satellite hardware and technology associated with space based entertainment, tourism, and manufacturing will emerge. For the current commercial satellite industry, a space technology testbed operating on the ISS can tap a potential market of \$30-120 million per year. This estimate of the addressable market is based on projections from current practices and trends; it does not consider the additional potential of the ISS to expand the market or accelerate the rate of technological advancement.

Advantages to NASA/ISS Commercialization

NASA and DOD can also take advantage of this ISS based technology advancement infrastructure. They can employ the commercial STT on the ISS to engineer and test space hardware for their unique applications. Once a commercial STT on ISS demonstrates utility and ease of use to bona fide industry customers, the business concept will evolve to pay financial dividends to NASA. In the pathfinder stage, customers will pay for experiment hardware development and integration services. In the fully developed stage, customers could reimburse NASA for transportation charges and eventually pay rents for accommodations on ISS.

PATHFINDER : COMMERCIAL FREE FLYER

Description

One concept for commercialization would be to provide a long flight duration free-flyer service on a commercial basis for use with the Space Shuttle and International Space Station. A current example of this technology has been proposed. Three uses are known today – test flights for the US Air Force and commercial satellite instruments, space science missions for space agencies, and use with the ISS. Options under consideration for the free-flyer's development include the evolution of existing design or a clean sheet design. Integration services will be packaged with the flight hardware to provide an end-to-end service on a fixed-price basis.

Commercial Opportunity

Four general customer groups are known today for a commercial free-flyer service. Very preliminary discussions between industry and the US Air Force have revealed the possible need for an end-to-end, commercially provided free-flyer service for long duration flight opportunities. Space agency space science missions are flown on an irregular basis on existing and planned free-flying government carriers. A market is developing for the flight test of satellite components to shorten time-to-market for new capabilities and potentially reduce overall development cost. The ISS Program has had preliminary discussions toward the pre-planned product development of a free-flyer for Station use. Similar services on the Space Shuttle for pressurized and unpressurized research payloads and space station resupply cargo have already been proven. The addition of a robust free-flyer flight platform will address the space science and test flight objectives of space agencies, the Air Force, and the commercial satellite industry.

An existing organization has agreed to invest private capital to acquire the new spacecraft if NASA accepts the proposed Pathfinder. Three obvious development options include the evolution of the Wake Shield Facility which a private company is in the process of licensing from the University of Houston, the evolution of another existing design, or if justified by market conditions, the development of a new carrier using existing components provided on an international basis. Evolution of an existing design can minimize the development risk. Incorporation of a pallet as the free-flyer's bus will reduce system cost and expand manifesting opportunities with unrelated cargo and research missions. Joint development with the Goddard Space Flight Center of a commercial Spartan 400 could present the best scenario.

Advantages to NASA/ISS Commercialization

This commercial approach would facilitate the continued evolution of the successful Spartan spacecraft series at a fraction of the cost customers would expect to pay for a government development. NASA's mission costs would be reduced by commercial sale on each flight. Commercial practices should speed the development of the facility, making it available sooner to support the domestic satellite industry. NASA would also save funds by commercializing "routine" spaceflight operations so that it can focus on its exploration and technology development missions.

PATHFINDER : MPLM CARGO RACK PROCESSING SERVICES

Description

The proposed effort will provide NASA with Level 4 logistics services for pressurized supplies and equipment to be transported to the International Space Station (ISS) by a Multi-purpose Pressurized Logistics Module (MPLM) in Collapsible Transport Bags (CTBs). The service will deliver to NASA bagged cargo integrated into commercial logistics racks, enabling NASA and other ISS users to take advantage of commercial cargo processing services and gain use of commercially developed logistics racks. Since the commercial logistics racks are optimized for carrying logistics in Collapsible Transport Bags (CTBs), the tare weight for carrying bagged cargo is minimized. A weight savings on the order of a thousand pounds on a typical MPLM flight can be converted to additional payload. The core structure of the commercial logistics racks and the cargo processing infrastructure to support it are being developed to serve a proposed commercial logistics double module. Using the existing commercially owned hardware and processes will enable efficient commercial processing of cargo for MPLM resupply flights.

Commercial Opportunity

Use of the logistics processing service will relieve NASA of the need to develop, qualify, purchase and sustain a system optimized to carry CTBs, estimated at about a \$3M effort. NASA will also gain the efficiencies of having the same logistics processing services for both of its major carriers. Commercial practices will be used in processing the logistics for the commercial logistics racks. These processes were proven in the ISS Phase I Program and are being used on ISS missions 2A.1 and 2A.2. Use of these existing processes for MPLM cargo effectively commercializes all of the ISS bagged cargo processing activities which should ultimately result in lower costs to NASA.

Commercial logistics racks will carry five more bags and 140 more pounds of cargo than NASA's Resupply Stowage Rack while weighing 263 pounds less. It will hold 465 pounds more cargo per rack in the same volume as NASA's Resupply Stowage Platform, and/or save 100 pounds of weight per rack over the (yet to be developed) Resupply Stowage Platform-2. On a typical MPLM flight with 6 to 8 bag-carrying racks, this savings results in significantly more payload carrying capacity. These margins should prove important, and may prove critical, to meeting the logistics needs of the ISS.

When a commercial customer base develops, the company should be in a position to buy from NASA an allocation of the MPLM capacity at a price which the market will support then resell it to commercial customers in conjunction with its logistics processing services.

Advantages to NASA/ISS Commercialization

This Pathfinder supports the effort by private enterprise to build a business supplying logistics service to the commercial users of the ISS. In addition, the ISS international cooperative agreements do not include transportation to ISS as part of their barter. Thus, both would likely be better enabled through the implementation of this Pathfinder. And, as ISS commercialization proceeds, there will likely be a need to transport increasing amounts of commercial utilization hardware in support of private research. Early commercialization of the logistics processing will provide a mature, market priced service for commercial customers.

	NASA'S RESUPPLY STOWAGE RACK	NASA'S RESUPPLY STOWAGE PALLET	COMMERCIAL LOGISTICS RACK
VOLUME (BAGS)	20	10	25
WEIGHT (LB)			
TARE	550	300	287
PAYLOAD	700	350	840
TOTAL	1,250	650	1,115
EFFICIENCY	56%	54%	75%

PATHFINDER: SPACECAM

Description

An existing company has expressed a desire to license the existing NASA AERCam technology to develop a commercial multi-use free flying camera system to meet ISS requirements. Use of this technology by the private entity would not incur any additional NASA engineering, construction or operations cost above what has already been spent on the technology to date.

Commercial Opportunity

Public interest in the space program is on the rise, with recent successes in both manned and unmanned projects building a heightened level of awareness and support for space-related endeavors. The SpaceCam would potentially enable the generation of significant revenue from the ISS assembly program as well as through the licensing of imagery/logos on the cameras and potentially on the ISS. Specific market opportunities for the SpaceCams include:

- Commercially produced and distributed TV programming on ISS construction & operations.
- System lease / rental for productions (TV shows, commercials, etc.)
- Sponsorship & promotional fees.
- Specialty stereo video feeds to attractions and theme parks for VR astronaut EVA experiences.
- ISS and Earth imagery sales (specialized cable networks, etc.)

Advantages to NASA/ISS Commercialization

The SpaceCam provides NASA with a proven safe, high-performance system that can be cost-effectively developed and operated. Used in close cooperation with safety and operational elements of NASA, the SpaceCam can achieve a useful, safe and minimally invasive operational system. The SpaceCam provides NASA with a significant reduction in the amount of EVA required to maintain the International Space Station. An added benefit is that it would potentially increase the efficiency of remaining EVA. The SpaceCam can increase the safety of docking / berthing operations by providing orthogonal views to assist the RMS operator. The SpaceCam provides a relatively small-scale Pathfinder for NASA to begin with. It also enhances other potential commercial opportunities by making high quality imagery of ISS exterior available, thus helping to tell the story of the ISS to the public in an appealing way and maintaining the link between the public and the ISS program as it moves forward.