

SPACEOPS 2004

EIGHTH INTERNATIONAL CONFERENCE
ON
SPACE OPERATIONS

Montreal, Canada,
17 – 21 May 2004

Summary Report
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1. INTRODUCTION

SpaceOps 2004, the Eighth International Conference on Space Operations was held in Montreal, Canada from 17 to 21 May. The following report summarizes the conference activities that transpired during five days of technical and plenary sessions, the exhibits and posters, and other ceremonies and social activities that took place. It includes a number of observations and comments accumulated during the meetings from both technical and organizational viewpoints. A brief preamble on what Space Operations is and a few history notes from past conferences and archives is provided for perspective.

1.1 SPACE OPERATIONS

SpaceOps defines itself as a spacecraft-operations-oriented, international association of representatives from a majority of the world's space-faring nations. It was founded in 1990 to foster continuous technical interchange on all aspects of space mission operations and ground data systems, and to promote and maintain an international community of space operations experts. The forum for discussing these state-of-the-art operations principles, methods, and tools is the bi-annual symposia held at varying locations around the world. This year's symposium was held in Montreal, Canada.

SpaceOps membership is still expanding. As many as ten nations have been represented on the SpaceOps Executive Committee, and the inclusion of additional member countries is a work-in-progress. SpaceOps is managed through two Committees, an Executive Committee and a Committee-at-large.

The Executive Committee membership consists of one member from each country or international consortium authorized to represent the entire country or international consortium delegation in matters addressed by the executive committee. The Committee-at-large membership is limited to 30 active members and consists of one member from each space agency installation - limited to 5 for each country or international consortium. The Committees are chaired by the most recent and the next host country's executive committee members.

Plans are currently underway to include industrial members in SpaceOps including membership on the Committee-at-large. Papers presented at all SpaceOps symposia are available at the interconnected SpaceOps web sites of the symposia host organizations.

1.2 A BRIEF HISTORY

SpaceOps was formed out of the realization that the number of people involved in space mission operations is large and that an organized community or technical forum was needed. Mission Operations have become an increasingly large segment of space agencies' budgets. As a result, there is great interest in improving the capabilities and cost efficiencies of mission operations. It was in the spirit of providing the broadest possible managerial and technical interchange between space agencies, academia, and industry that SpaceOps was founded.

Since its inception in 1990, SpaceOps has held eight highly successful symposia hosted by various countries around the world, with past themes of "Bringing Space Operations into the 21st Century" (Houston, Texas, 2002), "Global Operations for the Next Century" (Munich, Germany, 1996), and "Opportunities in Ground Data Systems for High Efficiency Operations of Space Missions" (Greenbelt, Maryland, 1994). The theme for Montreal's SpaceOps 2004 was "A Global Enterprise" to reflect its much greater participation and sponsorship from industry than in previous conferences.

The seven previous conferences were in Houston, Texas (2002); Toulouse, France (2000); Tokyo, Japan (1998); Munich, Germany (1996); Greenbelt, Maryland (1994); NASA/JPL, United States (1992); and the European Space Agency (ESA) (1990). Technical sessions have focused on the gamut of issues that face space operations personnel - Cross Support and Interoperability, Ground Segment Engineering and Architectures, Operations, Mission Planning and Control, Mission Product Processing, Simulation and

Modeling, Operations Management, Standardization, Enabling Technologies, Cost Efficient, Operations, Automation, and Experience from Current or Recent Missions.

Access to archival information, documentation and conference proceedings for past SpaceOps meetings can be found by visiting the space ops website at www.spaceoperations.org or sites.uol.com.br/atsme/spaceops.

1.3 SPACEOPS 2004

The eighth and latest symposium held in the spring of 2004 in Montreal, Canada, from 17th – 21st May - was also the first to be held in the country. State-of-the-art operations principles, methods, and tools were discussed, creating an excellent opportunity to foster exchanges of ideas on managerial and technical aspects of space mission operations in areas such as robotics, earth observation (EO) and communications satellites, space science and the manned and unmanned exploration of space.

Nine space agencies were represented at SpaceOps 2004 – CSA (Canada), CNES (France), DLR (Germany), ESA (European Union), ISRO (India), INPE (Spain), ASI (Italy), JAXA (Japan), and NASA (United States). It was hosted by the Canadian Space Agency with sponsorship from ALCATEL, ariannespace, BOEING, EADS Space, HARRIS, ILS and SkyTerra Communications. SpaceOps 2004 also had the support of ABB, AIAA, COM DEV, EMS, MDA, NEPTEC, RADARSAT and SED.

2. THE CONFERENCE – SPACEOPS 2004

2.1 REGISTRATION AND VENUE

Day 1 was reserved for registration, the opening ceremony, and a welcome reception in the evening that included the opening of the exhibits from forty-one organizations.

2.1.1 Comments and Observations

Delegates were cordially and professionally received at one of three registration desks located on level 3 of Montreal's Centre Mont Royal where badges, registration packages and a complete, well-organized Conference Program were collected. All entrances to the Centre Mont Royal were well signed for directions to SpaceOps 2004. As the former head office of the International Civil Aviation Organization (ICAO) the Centre Mont Royal was well suited to host this major international conference in its 730-seat Amphitheatre and in several other rooms for technical sessions. Almost four hundred delegates were registered at the time.

2.2 OPENING CEREMONY

After well-prepared welcome statements from the conference Chair Mary Ellen McGuire, from Executive Committee Co-chair Dr. Surendra Parashar, and from CSA President Dr. Marc Garneau, delegates listened to a brief message from Canada's Federal Minister of Industry the Honourable Lucienne Robillard.

Mme. Robillard spoke of Canada and Space Operations being a "perfect fit". Canada's entry into the membership of space communities with the launch of its first satellite Anik in 1969 was highlighted. Collaboration was touted as the new prerequisite for competitiveness. Although mischaracterized as space exploration, the CSA's current niche-market activities in ISS robotics and Earth Observation (EO) were pointed to as good examples of this collaboration.

CSA president, Dr. Marc Garneau also spoke briefly on a short history of the CSA, its focus on EO and the economic/commercial benefits, and closed with the statement that the current Prime Minister of

Canada, the Honourable Paul Martin wants space to be a universal good. After his speech, Dr. Garneau exited for a media scrum.

The opening ceremony continued with a half-hour of welcome messages delivered via videoconference (a first for SpaceOps conferences) from the Marshall Space Flight Centre, the UK, DLR in Germany, NASA's JPL, the Chandra X-Ray Observatory in Cambridge, Mass, the CSA, and the ESA (on DVD).

Before finally introducing the conference's two keynote speakers, several 'firsts' for SpaceOps 2004 were noted by Executive Committee Co-chair Dr. Parashar. These included:

- The first video-conference mentioned above
- The first interactive poster session (housed in the Exhibit Hall on level 4)
- The first formal inclusion of space industry interests in a major way
- The first CEO round table breakfast and discussion with leading figures in space business talking about the emerging broadband, multi-media market.

Unknown to delegates at the time, another first for the conference would be the live telecast two days later (Wednesday evening May 19, outside the Exhibits Hall) of the launch of an Atlas II vehicle carrying an AMC-11 satellite. It was launched by ILS (one of the conference sponsors) from Cape Canaveral at 6:22 pm EDT. The AMC-11 spacecraft is a twin to AMC-10, launched in February. Together they form a premier cable neighborhood and a platform for services.

Dr. Mehran Anvari: "Impact of Space Technology on Health Care"

The first keynote speaker, Dr. Mehran Anvari, Director of the Centre for Minimal Access Surgery, essentially opened his half-hour presentation with a statement that rural health care was in crisis. He offered as possible solutions to alleviate some of the problems (1) mentoring, (2) tele-help (tele-medicine) and (3) new technology.

He focused on a promising new medical procedure that is being developed. It is known as remote telerobotic surgery (TRS). Its technology is derived from work done in conjunction with CSA and MDR the developer of "Dextre", part of Canada's robotics contribution to the ISS. Although still too expensive for remote regions, TRS promises to be a unique, internationally marketable, high-tech piece of medical equipment capable of providing direct health and social benefits to both cities and remote communities alike.

Delegates marveled at the impressive videotaped demonstration of Dr. Anvari operating from a computer terminal using 'joysticks' in Montreal, Quebec to perform delicate abdominal surgery on a patient lying on an operating table several hundred miles away in Sudbury, Ontario. Many types of surgery including heart operations will be possible using the TRS technique.

The long term sees TRS also being used on and by astronauts on spacecraft like the International Space Station (ISS) or Mars mission vehicles for example, and eventually on deep space travel missions once methods are developed to handle latency. The medical community sees TRS as a 'payback' to the space community and society.

Col. Richard L. Reaser: on the evolution of GPS

The second keynote speaker, Col. Richard L. Reaser, Jr., is the Chief Engineer of the Navstar Joint Program Office. Col. Reaser talked in a relaxed and casual manner about the very successful GPS. He cited the more than twenty-eight satellites currently in orbit serving users after more than sixty launches and only two failures. Its mission is to link to 'search and rescue', and GPS is continually being upgraded as part of a long-term modernization program to GPS3.

While the European version of GPS known as Galileo comes on-line, GPS and Galileo will be coordinating with each other to use a common civil signal, one that will not overlay or interfere with military signals. GPS and Galileo working together was cited as a good example of international cooperation

The Chair of the Technical Program Committee, Dan Showalter, rounded out the opening ceremonies by promoting the interactive poster sessions then introduced the five teams of Track Chairs and Co-chairs that will preside over the Technical Sessions:

Track	Title	Chair	Co-Chair
1	Sharing the Resources <i>Building and Utilizing Partnerships</i>	G. Campan, CNES	E. Bergamini, INPE
2	Building the Operational System <i>Engineering & Technology in the Multi-Mission/Multi-Organization Era</i>	J. Statman, NASA	T. Hillman, MDA
3	Sharing the Mission Experience <i>Applying the Lessons Learned for Future Benefits</i>	J. Costrell, NASA	M. Forbes, SED
4	Managing the Mission <i>Challenges for Managers in the Global Environment</i>	H. Nye, ESA	T. Walsh, NOAA
5	Broadening the Scope Narrowing the Gap <i>Pushing the Mission, Operation and Operator Envelope</i>	D. Wendling, Telesat	T. Kuch, DLR

R. Moman and M. E. McGuire officially closed out the opening ceremonies at 17 h 00, extending general thanks and gratitude once again to all delegates, organizers, sponsors and supporters.

2.2.1 Comments and Observations

The “Opening Ceremony” card distributed to delegates entering the amphitheater was helpful. It clearly defined the schedule of events and timeframes, and delegates appreciated the speakers keeping to the schedule.

The highlight of the opening ceremony, and likely the one to be most easily remembered was Dr. Anvari’s videotape presentation of a remotely controlled medical operating procedure using a Canadian developed Telerobotic surgery technique. This technology is an excellent example of the social & health benefits that can accrue through the combined use of robotics and Earth orbiting communications satellites able to serve all regions of Canada.

It was unfortunate that the Minister of Industry had to leave the opening ceremony early and was unable to be present at Dr. Anvari’s videotaped demonstration.

2.3 NORTHERN LIGHTS WELCOME RECEPTION & EXHIBIT OPENING

A very congenial and relaxed atmosphere with “appetizing Canadian specialties” to consume and an open bar policy for beer and wine, had a strong positive influence on conversations and meetings, networking, and the free exchanges of ideas, business cards, and general information and developments in the space operations industry and related space activities.

The forty-one exhibits were well spaced in the level-4 exhibit hall with ample room to move between the rows. They were well attended during the Northern Lights reception and exhibit opening with many delegates staying until the 19 h 30 closing hour and past. Exhibits were always staffed by at least one or two helpful industry representatives to answer questions.

2.4 PLENARY SESSIONS

There were three plenary sessions, all held in the large amphitheatre: (1) Mars Mission Operations, (2) Space Operations Challenges of Today, and (3) ISS Operations.

2.4.1 Mars Missions Operations

This first of three plenary sessions (Day 2, Tuesday 18 May), discussing the operational challenges of Mars surface and orbiting vehicles, was the best attended. A. Downen from NASA/JPL introduced the invited panelists - Eugene L. Tattini, (NASA/JPL Deputy Director), Mark Sims (U. Leicester), Mike McKay (ESA), Ichiro Nakatani (JAXA), Pete Theisinger (NASA/JPL), Chad Edwards (NASA/JPL), and Steve Squyres (Cornell U.).

A relaxed but professional and informative Lt. Gen. Tattini spoke briefly about the Mars missions and its theme of “Follow the Water” and introduced the speakers in turn for their talks.

Mark Sims (Scisys) from Univ. of Leicester highlighted a number of interesting details about the ill-fated Beagle II Mars Lander, details that likely conspired to cause its demise. Beagle II was built at a cost of only \$US6M. Its ultra-low budget necessitated, for example, learning how to fly a probe during the cruise phase of the mission (Mars Express ~ 6 months), and not being afforded the time for testing with the real spacecraft. One lesson learned was that a full set of working avionics is essential.

Mike McKay (ESA – Mars Express) provided details about the other half of the low budget, Mars Express/Beagle II mission. The challenges it faced were (1) fifty percent less financial resources than normal, (2) operationally flying, orbiting and landing as a single operation instead of as three, and (3) cross-support with NASA/JPL.

‘Heritage’ was characterized as sometimes a “Friend or Foe?” inheritance tax. Team building was emphasized. The positive aspects of carbon dioxide and water ice detection by the orbiter were highlighted and European space agencies were looking forward to ESA’s Aurora program missions [ExoMars and Earth re-entry Vehicle Demonstrator (EVD)] and participating in the eventual manned exploration of Mars.

Japan’s Nozomi spacecraft was the subject of the next talk by Prof. Ichiro Nakatani of JAXA. His opening comment was that Americans often start their talks with a joke, while Japanese start with an apology. This reflected the unfortunate failure of the Nozomi spacecraft to enter Martian orbit last January after a convoluted five-year journey. Details were provided about the failed rescue attempt but lessons learned included those of basic operational technologies. No specifics were given about what basic science had been acquired. There was also no talk of the Canadian supplied Thermal Plasma Analyzer (TPA) experiment on board Nozomi that was also lost.

P. Theisinger (NASA/JPL, MER project) who was introduced by Lt. Gen. Tattini with high praise, cited the difference between design and reality with reference to operating on Mars time or Earth time for missions like Pathfinder and MER. The earlier comment about the Mars-Express/Beagle II project having to work to a low budget, and consequently to a short five-year schedule for a first mission was responded to with a statement that at NASA the successful MER had worked to only a three-year schedule.

Pointing to solar flares as a possible explanation for problems on missions like Odyssey and Nozomi, it was stated that they did not hurt MER. An impressive set of mages from Mars’ Gusev Crater and Meridiani Planum were displayed during the talk.

Mars communications, to deal with the growing number of rovers/landers and orbiters visiting Mars, was the topic of concern of Chad Edwards (NASA/JPL). A network for communications will be needed for the projected Mbit/sec data rates arising from larger bandwidth issues and for EDL (entry, descent & landing – 6minutes of hell!) of different types of ‘flyers’. Phoenix Scout (2007) and MSL (2009) are coming. Another factor in Beagle-II’s failure may have been that it had no Earth connection.

In introducing Steve Squyres, Lt. Gen. Tattini commented on his energy and intensity and his “doing it for the science”. “Operational complexity” was stressed as a key characterization of the MER project (Spirit & Opportunity). Its flexibility was unprecedented in responding within a day instead of in days or weeks, working by the preferred iterative process of hypothesis formulation and testing.

Squyres’ used the expression, “fiendishly complicated” several times to characterize robotic field geology on Mars. Plenty of detail was well presented in a very short time to describe one Sol of daily operations and was outlined in flowcharts on ‘data-analysis/response/action’ by three groups of people (engineers / payload specialists / science theme guys).

To date Spirit has so far found only basaltic lava rocks. It is on its way to Columbia Hill (2.5 km away @ ~100m/sol) while dust is building up on its solar panels. In the meantime Opportunity has “landed in a treasure trove” and needs to move only a few meters a day. It has found Jarosite, which forms only in presence of water.

Q&A period: Initially it appeared that no one would ask questions after the panelists had finished talking. Ultimately there was only a single question posed: Given the success of Pathfinder and MER missions and the failure of MPL and Beagle II, will airbags become the lander of choice? The answer was that it would depend on the weight. The 2007 mission for exobiology is at the limit of airbags capability to support weight during landing. A follow on question about the possible use of LIDAR (Light Detection and Ranging) was replied to by saying that options are being reviewed.

2.4.1.1 Comments and Observations

NASA/JPL speakers were considerably more animated in their presentations on the Mars Exploration Rovers (MER) mission, and showed more enthusiasm and motivation than their UK and Japanese counterparts who summarized the Mars Express/Beagle II and Nozomi projects respectively. It was understandable that significantly more information was delivered about MER projects and programs. It is partly explained by the fact that (1) MER is still in progress while Mars Express/Beagle II and Nozomi are either not operating or not in the public eye, and (2) MER is proving to be a well-publicized success while both the UK and Japanese missions have had much less return for their efforts.

One rationale for the disparity in success is that the playing field for space programs is uneven when it comes to funding. NASA’s \$15 billion budget far outweighs any other agency’s budget, and can be a cause for envy and a source of tension. This was evident in comments made during and after the Mars plenary session by the Mars Express and MER teams.

During the session, the Mars Express team lamented a restricted budget that necessitated working to a tight five-year schedule for their first major Mars mission. This was countered by the MER team’s boast of doing a Mars mission in only three. Private discussions later during the reception in the Exhibits Hall revealed resentment over the MER statement. Here, if only briefly, the benefits of a friendly competitive environment, or the merits of collaboration and partnership were second to self-congratulation. While the MER comment was somewhat disingenuous given NASA’s established infrastructure, its healthy budget and its depth of experience, it illustrates in part how funding disparities conflict with the ideal of sharing resources.

An important point highlighted here, and in at least one of the technical sessions (Ref: Technical Session Track 1, Sharing the Resources; talk by B. McGuffie - “Mars Reconnaissance Orbiter (MER) - From Downlink to Archive”), was the issue of processing the terabits of information streaming down from MRO, from the myriad satellites and rovers of all kinds, and on how much can realistically be analyzed by

scientists and graduate students in a timely manner. An old maxim seemed applicable – that the space community is sometimes ‘a victim of its own success’ - and the question of whether the space agencies were experiencing cornucopia or information overload seemed a legitimate one to ask at times.

2.4.2 Space Operations Challenges of Today

This second plenary session (Day 3, Wednesday 19 May), focused primarily on the operational challenges of current and planned EO, ISS and communications satellites in business and industry. Dr. Shabeer Ahmed former director of Canada’s David Florida Lab and plenary Chair introduced the invited panelists - R. Schell (Lockheed-Martin), S. Burns (EUMETSAT), G. Campan (CNES), J. Rogers (NASA), and R. Tinley (Telesat). R. Spearing (NASA) and Mike Williams (EUMETSAT), originally scheduled for the talks were unable to be present and were replaced by John Rogers and S. Burns respectively.

Rich Schell’s presentation on Government-Industry partnerships had as its subtitle ‘Promise and the Pain’. Speaking clearly and with authority he expressed appreciation for how tough it was in the industry. He weighed the challenges of getting an economic return-on-investment, sharing assets and liability, sharing priorities, securing IT, and having better interfaces against the benefits of shared risk, reduced cost of ownership, workforce retention, and a broader base for recovery in downturns.

Ideas like ground tracking, WAN, ISS command to CSA have worked, while outsourcing of IT for mission criticals, selling services on government assets, and commercializing single user systems have not. He concluded by saying that significant changes are needed and goals need to be defined.

S. Burns of EUMETSAT (replacing M. Williams also from EUMETSAT) was mostly a historical account of METEOSAT started in 1977, news on an expected launch of MSG-2 in March 2005 and other information on the EUMETSAT and EPS programs. The chair commented that low dissemination cost and operability were important for weather satellites.

The talk by Genevieve Campan (CNES – Space ops) titled ‘Experiences and Challenges’ was noteworthy. After listing a multitude of existing partnerships on missions with French contribution, ESA responsibilities, projects with international cooperation on domestic-based LEO space activities for public benefit, a myriad of satellite operations in progress were identified. More than two-dozen satellites for communications and space science were in operation. Seven satellites, including micro-sats and mini-sats, were to be launched in 2004, to be followed by the ISS Autonomous Transfer Vehicle (ATV) in 2005, COROT in 2006 and eventually Pleiades, a dual-satellite EO project.

The challenge facing CNES Space Ops was constructing and maintaining a coherent program of operating in an environment of ‘small, fast, cheap’ micro-sats and mini-sats, and large EO satellites for domestic military, scientific (ISS), and international programs (Galileo).

The Chair commented that there is real challenge in just managing the day-to-day operations of the many satellites and vehicles currently on-orbit or in deep space.

J. Rogers (NASA) speaking for R. Spearing (NASA) had no overheads and spoke very briefly on NASA’s perspective on upcoming challenges. The next two decades would see spectrum sharing and interoperability for satellites as a major challenge, along with data transfer rates for planned Moon / Mars missions and the Consultative Committee for Space Data Systems (CCSDS).

The Chair stressed the importance of cooperation.

R. Tinley (V.P. Telesat), speaking about the challenge of Space Ops, spent some time talking about Telesat and its services before addressing industry issues. The issues were described as a slow recovery from the downturn, and an oversupply of transponders for a few more years while the industry waits for HDTV, movement on ITAR restrictions, and solving reliability problems. Liability issues within the insurance industry had become a major issue since the events of 9/11.

Two items on the space community’s wish list would be the removal of payloads from the munitions list, and ITAR free commercial communication satellites.

Fewer operators, fewer manufacturers, a shift from communications to military services were cited as trends or changes in the industry. The advent of direct-to-home, broadband (ANIK F2), HDTV, XM radio, and ANIK F3 were encouraging indicators that the industry was emerging from a downturn. This could be seen in the increased activity in consulting services. But it was recognized that better reliability was needed to recover from the space insurance industry.

The Chair commented that considerations should be given to revisit government regulation around the world.

Q&A period: Although the plenary session finished early with time for questions, only a single question was raised and was directed to S. Burns about EUMETSAT.

2.4.2.1 Comments and Observations

During his talk, speaker S. Burns (EUMETSAT) skipped hurriedly over many pages of his presentation. It rarely addressed the issue of ‘challenges’ (the theme of the plenary), and the subject matter was more suited to a technical rather than plenary session. This may have likely been due to the fact that S. Burns was a last-minute replacement for Williams.

The theme of this plenary session, ‘Space Operations Challenges of Today’ may have been best illustrated in the talk by G. Campan, the track chair for the ‘Sharing the Resources’ Technical Session. The key is being able to effectively and efficiently manage the day-to-day operations of many simultaneous and ongoing projects and missions, while maintaining qualified staffing levels and delivering products, information and services for public benefit to the myriad stakeholders who generally expect the best. These responsibilities extend even to the often forgotten tasks of monitoring space debris and/or safely decommissioning or de-orbiting dead or useless satellites (Reference: Technical Session Track 3, Sharing the Mission Experience; talk by L. Moliner – “SPOT-1 Earth Observation Satellite Deorbiting”).

The perception is that while these objectives are being met, there is little remaining time for long term planning or for addressing real challenges of direction, strategy, policy and global cooperation. Planning is generally and consequently of the short-term type, concentrating on cooperative handling of day-to-day space operations at the domestic and international level, while the solution of pressing issues like standardization, security & resource sharing, and technology transfer is postponed.

In the 1996 SpaceOps conference in Munich Germany, standardization was an important theme. Almost a decade later it still is. Also, it is ironic that in a period of apparent information overload, NASA’s Deep Space Network (DSN) has actually increased its capacity such that it now has a slight excess. (Reference: Technical Session Track 1, Sharing the resources; talk by Silverman - “An Asset Contention Period: DSN’s ’03 / ’04 Challenge”). DSN is in a position to handle even more data. It received a \$53 million upgrade to accommodate a projected capacity shortfall in early 2004 due to several missions arriving simultaneously at Mars (Mars Express/Beagle II, Nozomi, and MER).

The real challenge may be to overcome a culture of a continuation of doing things in a certain way because it has sufficed in the past. It may have been best expressed by Howard Nye, track chair for ‘managing the mission’, when he concluded during the closing ceremonies by saying it was time for “the tail to wag the dog.”

2.4.3 ISS Operations

This third plenary session (Day 4, Thursday 20 May), discussing ISS operations, appeared to have the lowest attendance (100-150) likely due to the cessation of many ISS activities since the Columbia shuttle accident of last February 2003.

Panelists identified by Chair Benoit Marcotte (CSA) were: B. Gerstenmaier (NASA), S. Creasy (NASA), C. Lorenz (CSA), L. Baize (CNES), Kehr (DLR), C. Harada (JAXA) and M. Kearney (NASA/MSFC).

B. Marcotte (CSA) spoke briefly about ISS in-orbit assembly that started in 1998 and the delivery of the Russian module in 2000. He noted the general feeling of appreciation by the space community for Russia's support of ISS with Soyuz and Progress since the Columbia accident.

B. Gerstenmaier (NASA) provided the most complete update on the current status and future of the ISS. Its operations are ongoing but with a crew of only two for the time being. NASA's ISS group is working through the challenges. Issues requiring critical attention include oxygen generation (last spare installed), control moment gyros that cannot be replaced until the shuttle is up, reduced in-orbit spares, and exercise equipment that is degraded but functional. Despite these problems, the environment is good.

Talking quickly through a series of informative graphic animations, the many flights remaining to complete the ISS were highlighted (Columbus, the ATV, JEM, Dextre, solar arrays, truss et cetera).

That NASA wishes to complete the ISS was perceived as good and the ISS group is working hard to include it in NASA's space vision - as a test bed for new hardware, a demo for critical capabilities and a research platform in bioastronautics. The group is looking forward to the shuttle's return to flight and is keeping the ISS in an assembly ready configuration.

Susan Creasy (NASA) identified the technical and logistical challenges facing ISS given the growing operations infrastructure. Issues to be dealt with include scheduling, rotations and flights, the implications of recommendations from the Columbia Accident Investigation Board (CAIB), the President's vision, and the most important cargo to fly. Modifications will create up-mass/down-mass problems. Many items are waiting to be returned making stowage a problem. Inventory on the ISS has become very important.

CSA Challenges as described by C. Lorenz (CSA) echoed those of NASA. Plans and schedules are under constant revision with ISS crew now reduced to two, and consumables and reserve operations capability becoming issues. The robotics schedule is in flux due to a number of scope changes especially in software. Maintenance of MSS is hard because of the change in duty cycles and assembly sequence. The short term will remain dynamic but the partnership of CSA robotics staff and NASA holding during difficult times is credit to the relationship.

L. Baize (CNES) outlined details about the first ATV (Autonomous transfer vehicle) being built by CNES that will hopefully be launched in 2005 once the shuttle returns to flight. It will dock for six months, providing propulsion support to boost the space station, and will be capable of delivering twenty tons. It will be allowed to burn up in the atmosphere once its mission is complete.

J. Kehr (DLR) talked about the challenges facing the team working on the Columbus module. It comprises eight institutions throughout Germany and has its control centre in Oberpfaffenhofen. The Columbus module will be under DLR system control, coordinate European payloads and operate under a 1998 communications agreement.

C. Harada (JAXA) explained that JAXA, a combination of three space agencies, has only been in existence since October 2003. Its contribution to the ISS, the Japanese Exp. Module (JEM), is in operations preparation mode. It resembles a mini-ISS - pressurized, with communications capability, experiments and robotic manipulator. It is already at CSA waiting for launch and will require three shuttle flights to install. It is to be attached to Node 2 by the Canadian SSRMS.

M. Kearney (NASA/MSFC) described the ground system technical operations, listing the challenges met or not met and those to be addressed in the future. The challenges that were met included (1) distributed arch for MCSS (computers, LANs and PCs), (2) Distributed MCC around globe, and (3) better payload / science handling. Those not met included telepresence, short latency, telescience

operations, challenges for the Moon / Mars vision, security, and export control without interference. The big challenges that remained were the retention of security without interference for which progress will be slow, and standardized MCC interfaces.

Q&A period: Only two questions were put to the panel. The first inquired about whether the projected 2010 completion date for ISS was realistic if the shuttle returned to flight by early 2005. The reply was non-committal but NASA was confident of working to complete by that time. A second question inquired about the use of the ISS. In the reply, an example of liver cell growth as a commercial activity was cited. NASA is trying to get industry involved.

2.4.3.1 Comments and Observations

The message from the ISS plenary session was more subdued than the previous two and the Columbia shuttle accident continues to negatively affect ISS completion. Speakers could only talk confidently about past achievements while remaining uncertain about the space shuttle's return to flight and its impact on future ISS assembly and maintenance operations. It was curious and at the same time disappointing that several speakers expressed gratitude for the availability of Russian Soyuz and Progress vehicles to keep the ISS on-orbit and supplied, yet Russia was not a conference participant.

NASA representatives Gerstenmeier and Creasy breezed quickly through pages of information on planned activities once the shuttle is flying again, and on the host of day-to-day maintenance & logistical tasks needing attention until that happens. Participating space agencies CSA (Canada with Dextre), DLR (Germany with Columbus), CNES (France with the ATV) and JAXA (Japan with GEM) are marching in position, maintaining equipment in an assembly ready configuration until CAIB recommendations are addressed and the remaining three shuttles are flight ready. The hope is that the news will be much better in two years time at SpaceOps 2006 in Italy.

2.5 TECHNICAL SESSIONS

Presentations attended were primarily in the "Sharing the resources" sessions of Track 1 in room International-1 on level 3. These are listed in the Appendix. For purposes of this report, the number of sessions attended for each track was as follows: Track 1: Sharing the Resources – 21; Track-2: Building the Operational System – 5; Track 3: Sharing the Mission Experience – 6; Track 4: Managing the Mission – 1; Track 5: Broadening the Scope, Narrowing the gap – 2. A total of 35 sessions were attended. Ratings were roughly on a 1-to-5 scale from 'very weak' to 'very good' where a middle grade of 3 (average) represents a good quality, professional presentation using state-of-the-art software and hardware.

2.5.1 Comments and Observations

Seating capacities for the technical sessions were more than adequate. In Cartier-1, Cartier-2, International-1, and International-2, they ranged from about 112 to about 150 but with the observed attendance never exceeding about eighty or ninety delegates in each, and in many cases with as few as ten in attendance. Seating capacities for Amphitheatre-1 and Amphitheatre-2 was over 300 each but as with other sessions, observed attendance never exceeded about eighty of ninety delegates and in some cases was as low as 10 or 20. The total seating capacity for technical sessions was about 1150, more than double the number of delegates.

Movement between level 3 (where the Cartier and International rooms were located) and levels 1 and 4 (where the Amphitheatre and Exhibit Hall were located respectively) was at times inconvenient. The optimum situation is usually to have all rooms if possible on one level or two at the most. Although stairs and elevators were immediately available outside the rooms, accessing three levels of rooms spread over four floors was occasionally confusing for some delegates.

The listing of the Technical Session talks in the Conference Program was well organized but minor inconsistencies could be found. As an example, the final three talks of the Tuesday session of

‘Sharing the Resources’ in room International -1 were on “Standardization” but the session title was “Cross-Support and Interoperability”. “Standardization” was the session title on Wednesday.

Of the thirty-five technical sessions attended over a four-day period, three were selected as a sample for specific comments:

Technical Session Track 3, Sharing the Mission Experience; talk by A. McGarry - “Increasing Science with Diminishing Resources – Extending Ulysses to 2008”

The Ulysses mission is a low-cost, NASA/ESA mission launched fourteen years ago in 1990. It recently received a third extension to 2008. It continues to generate useful scientific knowledge about the heliosphere at a very low cost and illustrates how success breeds funding. But one of its biggest challenges is getting Deep Space Network (DSN) time. The speaker noted that commercial ventures often “bump up” in priority while science often “bumps down”.

Technical Session Track 1, Sharing the resources; talk by R. St. Jean (CSA) – “Emergency Response to a Major Crisis through the International Charter on Space and Major Disasters”

The charter exists essentially as an independent, self-sustaining organization of space agencies (including the CSA with Radarsat) that find, monitor, and quickly disseminate information about major disasters on Earth such as earthquakes and floods. While agencies collaborate on this commercially available service, the new and continuing member countries communicate and exchange information without standardized forms which defeats the purpose of disseminating disaster information as quickly as possible. ‘Standardization’ and ‘sharing the resources’ should go hand-in-hand.

Technical Session Track 1, Sharing the resources; talk by J.H. Matsuura – “Legal Aspects of International Technology Transfer in Support of International Space Missions”

This was the only talk of its kind on a subject that will become increasingly important as space becomes more and more commercialized. The different types of restrictions, trade secrets, and embargos that exist, and controls by governments and other organizations were mentioned. The types of penalties imposed for illegal technology or intellectual property transfers were also mentioned but no concrete examples were ever provided on how legal matters can specifically impact operations. The lack of examples was a common omission in many talks.

Canada’s Radarsat program was given good visibility with seven talks. Four were on the upcoming Radarsat-2 (a planning system, order handling/mission planning functions, automated ground control system operations, and PLUTO Operations Procedure Language Standard). Three were on Radarsat-1 (MMO Operation, extended background data acquisition planning, and the hurricane watch program).

2.6 POSTER SESSIONS & RECEPTION

During the Tuesday evening and Wednesday evening ‘Poster Session and Reception’ events, delegates had access to more than forty posters each night covering the five themes of the technical sessions. They were arranged around the perimeter of the exhibit hall on level 4, and were decidedly engineering oriented with more than 50% of the posters falling into the Track 2 category: “Building the Operational System: Engineering and Technology in the Multi-Mission/Multi-Organization Era”. About 30% fell into Track 3 category: “Sharing the Mission Experience: Applying Lessons Learned for Future Benefits”.

Three posters focused on “Sharing the Resources”, one on “Managing the Mission” and eight on “Broadening the Scope, Narrowing the Gap”. Two complimentary drinks were served to delegates for each of the two Poster and Exhibit sessions.

2.6.1 Comments and Observations

The imbalance in the selected themes for the poster sessions reflected the claim by some that greater attention is being paid to the design & engineering of innovative mission concepts by space agencies and institutions, while the challenging, lower-profile tasks of managing or operating projects that have made it past the funding, manufacturing and launch phases are less well attended to.

It is consistent with presentations made during the previous day's plenary session titled 'Space Operations Challenges of Today'. A real challenge and responsibility of the space community is the management of daily operations of the many satellites and vehicles already on-orbit or in deep space, and of retrieving, storing, analyzing and archiving the reams of information that continue to be communicated back to Earth. A standing complaint appears to be that scientists, engineers and Principal Investigators (PIs) building the next great mission, or Project Managers directing a project through to the end, spend insufficient time worrying about the impact of their ideas and decisions on the downstream end of the project (after launch) and the operational difficulties associated with it.

2.7 LUNCHESES AND BREAKS

Lunches were taken from any of several 'food stations' located on level 4. Other 'lounges', 'coffee lounges' and tables were well distributed on levels 4, 3 and 1 including the Exhibit Hall for break periods. They were well used and lineups were never long. Catering services were very good.

Having lunches served indoors near the lecture halls, instead of encouraging delegates to eat out at Montreal restaurants helped to keep the conference running on time.

2.8 GALA DINNER

The Gala Dinner took place in the historic Windsor Station a fifteen-minute walk from the Centre Mont Royal. The rain that fell that evening was a minor inconvenience. Catering and food were again excellent and wine and beer for an hour before dinner while guests mixed was taken full advantage of.

That there were no speeches before, during, or after the dinner seemed appreciated, as were the copies of a book titled "Ariane", a photographic record of the launch facility and its projects, that was distributed to all guests.

2.9 CEO ROUND TABLE BREAKFAST & CEO ROUND TABLE

At the well-attended CEO Breakfast and Round Table, CEOs from Telesat, CSA, Boeing Satellite Systems, EADS- Astrium, Alcatel, ariannespace, and MacDonald Dettwiler Space group spoke in general terms about the present and future of the telecom industry citing in particular opportunities in the emerging broadband market as well as satellite communications, broadcasting and the Internet. The CEOs were:

L. Boisvert,	CEO & Pres.	Telesat
M. Garneau,	Pres.	CSA
D. Ryan,	Pres.	Boeing Satellite Systems Inc.
Antoine Bouvier,	Chairman & CEO,	EADS - Astrium
H. de Pesquidoux,	CEO	Alcatel
Jean-Yves le Gall,	CEO	arianespace
Dave Caddey,	Pres.	MacDonald Dettwiler Space group

After the CEO statements a series of questions, still focusing on the broadband issue and future developments, was put to the panel by moderator Dr. M. Garneau. Replies were general, non-committal and conservative about newer, heavier, more sophisticated, satellites and equipment coming online as the communications industry comes out of its slump, but as was to be expected, without firm commitments on delivery dates or expected investment costs. Emerging Asian markets and demand for broadband would provide new opportunities for competitors who would be challenged to improve and streamline operational efficiencies and address interface and standardization issues.

The conference's three plenary themes on Mars, the Challenges, and the ISS were never part of the discussions and only a single mention was made about one other important issue - 'low cost access to space' - by Dave Caddey, President of MacDonald Dettwiler Space Group.

Time constraints limited the question and answer period by the general audience of delegates to only three questions that stuck to the theme of satellite communications operations and broadband Internet.

2.10 CLOSING CEREMONY

After a few administrative announcements by Rogers having to do with AIAA publishing and serving as Space Ops secretariat, the chairs of the Organizing Committee (M.E. McGuire) and the Technical Program Committee (D. Showalter) provided statistics on SpaceOps 2004 and thanked the many sponsors. One hundred and twenty three organizations from twenty countries had given two hundred and ninety three presentations. Space Ops as a global enterprise had been demonstrated and a space ops community was definitely in place.

The track chairs spoke in turn summarizing their sessions:

Track 1 – 'Sharing the resources': G. Campan (CNES) reported no missing speakers during the four days of talks and attendances of between 15-80 delegates per session. Standardization was a main focus of the talks and while most papers were from space agencies, thirty two percent came from industry. Two concluding remarks made were that (1) Standardization is essential and (2) Security is important.

Track 2 – 'Building the Operational System': J. Statman (NASA) reported one hundred and fifty papers submitted, fifty-nine oral presentations plus posters and very good attendance. Only one speaker was missing but a replacement was found. The Consultative Committee on Space Data Systems (CCSDS) recognizes many suppliers making Space Ops truly global. It is also a maturing business, as evidence of the many 'lessons learned' comments from presenters suggested. A third of the papers addressed future systems.

Track 3 – 'Sharing the Mission Experience': J. Costrell (NASA) reported ninety papers, forty-nine accepted, with many themes listed. That half were from agencies was considered low. Subjects covered included deep space, Mars, landers, orbiters, EDL, asteroids, planets, Cassini, EO, comets, and science. There were also more partnership papers than normal this time. An important point made was that people and organizational aspects appeared for the first time. The speaker commented: "A Lander is not an instrument."

Track 4 – 'Managing the Mission': H. Nye (ESA) reported international participation, large audiences, and talks that often ran overtime. Space Ops is looking beyond classical management, especially in knowledge, risk, safety, and cost elements. It is being globally challenged and it is important to get the environment right. Space Ops is not just the end of a mission, and it is time to "get the tail to wag the dog."

Track 5 – 'Broadening the Scope, Narrowing the gap': D. Wendling, (Telesat) offered no statistics but cited a common thread in the sessions – continuing to push the envelope to meet demand. The solution themes were standardization, teamwork, and innovation, and it was encouraging to have commercial representation at Space Ops.

The final expressions of thanks and recognition from the Executive Committee Co-chairs, Dr. Parashar and Dr. Mamen singled out three individuals - the Conference Manager Michelle Robitaille, Organizing Committee Chair M.E. McGuire, and Amy McGuire. SpaceOps 2004 had delivered a comprehensive, high quality program of excellent technical content with industry involvement.

It was left for Dr. Mamen to finally declare the conference closed and for Claudio Canu to briefly present himself as Executive committee Chair for the next conference, Space Ops 2006 in Rome, Italy.

3.0 OVERALL OBSERVATIONS AND COMMENTARY

3.1 ORGANIZATIONAL

Comments from delegates were that SpaceOps 2004 was as professionally organized and conducted as any international conference can be. Advance notice was available in print form in an excellent Registration Bulletin or via the Space ops website with complete details on the organizing committee, conference program, exhibits, speakers, accommodations, social events, and the venue and registration. The conference was run in a workman like fashion.

Entrances at the Centre Mont Royal in Montreal were well signed for directions to the SpaceOps 2004 registration desk, and reception and registration appeared to operate smoothly and efficiently without any glitches. The "Opening Ceremony" card distributed to delegates as they entered the main amphitheater was very helpful. It clearly defined the schedule of events and timeframes for the day, and gave notice of the workmanlike fashion in which the conference would be conducted. Delegates appreciated the speakers keeping to the schedule.

The opening ceremony was an opportunity to showcase a unique Canadian technology, telerobotic surgery by Dr. Anvari, however its most important audience member, the Minister of Industry was unable to stay long enough to witness the impressive videotaped demonstration that was provided.

The Northern Lights Welcome Reception was very successful and very well received. It set the stage for the equally enjoyable and well-attended exhibits and poster sessions. Exhibits were found to be as good a quality as in previous Space Ops conferences. They were staffed with at least one person at all times to answer questions.

Sponsors' booths were located in the level-4 corridor and not the Exhibit Hall and after the first day were less popular than those in the Exhibit Hall. It was unclear after the fact why sponsors' booths were in general separated from exhibitors' booths and why Radarsat International for example (RSI – a MacDonald-Dettwiler subsidiary) did not have its own booth.

There was only positive feedback from the introduction of poster sessions (a first for the Space Ops conference). They proved to be as popular as the exhibits and are worth considering for inclusion into future conferences.

The Cyber café was in a quiet corner on level 4 away from the conference rooms and appeared well used. On occasion during coffee breaks and lunches attendees were seen waiting in line for a place to open up their laptops and connect. Comfortable chairs and tables spread around were well used.

Plenary sessions were well attended, with the largest being at the 'Mars Mission Operations' plenary and the least at 'ISS Operations'. Besides the obvious reason for a lower attendance at the ISS plenary, there was the fact that the Mars Missions Operations panel included an impressive line up of distinguished guests from NASA/JPL, the MER project, ESA and JAXA.

The quality of the technical session (as listed in the appendix) talks was generally good. Most had at least one or two questions at the end suggesting that the audience was usually engaged. However, the front rows of seats of most rooms were often empty unless a room was full, and some talks lacked useful examples to more clearly convey ideas and concepts being presented.

For technical sessions most delegates often moved from room to room between talks with few choosing to follow a single track throughout the conference. The fact that the chairs and co-chairs were very effective in keeping the session speakers to their time limits allowed the delegates to do this easily. On the rare occasion when a speaker did not show or was late, a replacement was found or the schedule speakers were interchanged. Very few negative comments were heard and most were favourable. A minor

albeit infrequent irritant was cell-phone ringing during a talk. Chairs could have reminded delegates at the beginning of each presentation to turn them off. With regard to the question and answer periods during technical sessions, delegates and sometimes session chairs or co-chairs forgot about or ignored the use of the microphones. Changing floors to change sessions was also a minor inconvenience.

On the issue of language, SpaceOps 2004 was no different than previous space operations conferences. English is the working language even though for many delegates it is a second language. Some delegates clearly struggled. Some speakers talked too fast in English or spoke too softly and were hard to understand by those whose first language was not English. The occasional suggestion made about offering language translation seems logistically impractical and too expensive to implement. It is unclear if the executive organizing committees have ever investigated this possibility.

The late gala dinner the night before at Windsor Station (many guests were still present by about 23 h 00) impacted on the very early morning CEO Breakfast at 7 h 30. It elicited a comment from Boeing CEO Dave Ryan that he was still a bit under the influence of a little too much wine. This was likely the state-of-mind of many delegates. Despite the gala's late finish, the breakfast was well attended, but how alert the delegates were is unknown.

Round table discussions with CEOs on the panel consisted of brief statements by the CEOs followed by a series of prepared questions from the moderator, CSA president Marc Garneau. There was time for only three short questions from delegates before they returned to the rooms to finish the morning's technical sessions and close out the conference. The moderator's comment that these were "thought provoking discussions" was felt by some to be overstated.

The lengthy but well-deserved commendations from the Executive Committee Co-chair to all the organizers at the end of a rather long closing ceremony caused a fair number of delegates to leave early. Another comment from the delegates was that applause should be withheld until all individuals being cited for service are named. Applauding each person individually becomes too time consuming and tiresome.

Although there never appeared to be any administrative or organizational "emergencies", the use of cell phones by a couple of key individuals within the organizing committee to help coordinate the conference and handle potential 'emergencies' in the same way that security personnel use cell phones to communicate with each other during a security operation for events like political conventions, and other major public events and concerts, could be an inexpensive way of protecting against potentially troublesome snafus.

3.2 TECHNICAL

The first and third plenary sessions (on Mars and the ISS) focused on just two of the numerous challenges facing the space ops community today. Mars projects at one end of the spectrum are a 'hot topic' and are responsible for successfully generating and downloading enormous amounts of data and information to Earth ground stations. The ISS on the other hand, with its on-orbit assembly halted, currently produces little scientific feedback and is dealing with logistically difficult problems. For Mars the challenge is data reduction and analysis under an information overload condition, while for the ISS, it is a challenge of assembly completion. Between these two extremes are the daily challenges of operating and communicating with a myriad of other satellites and rovers currently on-orbit, in transit, or on a planetary surface in deep space.

The perception is that there is little time left for long term planning by the space agencies or for addressing critical space operations challenges in areas like strategy, internal direction, policy formulation and global cooperation. Planning is generally of the short-term type, concentrating on cooperative handling of day-to-day space operations at the domestic and international level, while solutions on pressing issues like standardization, security & resource sharing, or technology transfer are postponed.

In the 1996 SpaceOps conference in Munich Germany for example, standardization was an important theme. Almost a decade later it still is. The real challenge for space operations may be to

overcome a culture of continuing to do things in the way they have been done until now (i.e. merely discussing the long term issues as daily operations continue) and to take the initiative to actually start resolving them.

Funds management and financial support for space related activities are global problems however, and they limit space agencies' options. With their limited funding and with project costs often underestimated, it is tempting during cases of budget shortfalls to reallocate funds from the less-critical, downstream operations phase of a project to the upstream engineering, manufacturing and launch phases. The result is a reduced efficiency in data acquisition, dissemination and analysis, fewer staff for operations and as a result potentially less beneficial returns on investment. This is a looming fear for the ISS.

Calls during the technical sessions for sharing resources and mission experiences, and building and managing fully integrated missions, would carry greater weight if the funding levels of participating nations matched those of countries like the US and China, and a greater share of the risk was assumed. If space operations are to be a truly global enterprise, ways need to be found to have space nations like China and Russia participate in a meaningful way and at least attend the SpaceOps conferences.

Since US President Bush's Moon/Mars Vision announcement was only made last January 2004, it was too late to formally include in the Montreal conference. However, if there are significantly positive developments in the proposal in the next two years, it should become a topic of interest in the 2006 SpaceOps conference in Italy. If that indeed is the case, then issues of resource sharing, technology transfer, and "lessons learned" as they apply to the ISS would need to be carefully reexamined from many angles in the light of the newer Moon/Mars missions.

4. SUMMARY

The tone of the 2004 Space ops conference was professional and workmanlike, clearly defining the current state of space operations of space agencies and industries around the globe albeit with notable exceptions of those from Russia and China. Plenary sessions on Mars and the ISS provided overview reports on the operations of the two high profile programs: one the highly successful space exploration project MER, still in operation, and the other a space science project still in the logistically challenging assembly stage.

The third plenary session covered the gamut of challenges facing the global space community not only in space science and exploration, but also in the commercially important areas of satellite communications, Earth observation and the infrastructures supporting them. A number of speakers highlighted the importance of addressing key issues of standardization, security & resource sharing, and technology transfer if commercializing space for social benefit is to succeed. But better government-industry relations and country-to-country cooperation need to be nurtured for this to happen.

If the operational challenges are as real as they are claimed to be, future conferences may want to consider adding policy issues to their discussions. If the tail is to wag the dog as Howard Nye suggested in the closing ceremony, Space Ops may want to formally consider proposals or suggestions on how to get project funding locked in for downstream operations right from the beginning of a project when integrating operational aspects into the design phase. This idea was likely suggested in Wednesday's (May 19) track 4 technical session talks (session title: Management of Cost). The theme was managing the mission and life cycle costs, but making suggestions or recommendations is considerably easier than getting them implemented.

SpaceOps 2004 focused primarily on the daily operational aspects of past and present space science and space exploration missions and on satellite communications. The CEO round table exclusively addressed the commercial future of the broadband multi-media market. Although some talks addressed issues of sharing or allocating resources for missions, the challenge of optimizing resource allocation in either single or multi-nation missions and projects was not. It is a subject known loosely as Operations Research. Only two talks appeared to address it (Ref. 1: Technical Session Track 5, Broadening the Scope,

Narrowing the Gap – “Optimal Resource Development Through Life-Cycle Design of the Overall Operational System” by D. Showalter; and Ref. 2: Technical Session Track 2, Building the Operational System – “Multi-mission Operations Schedule Management Integrating Resource Optimization and Operations Automation” by P. Grandjean). Looking at Operations Research for space resources as a future topic of discussion should be of increasing value particularly if the Bush vision becomes an important part of the global space exploration landscape.

Calls for resource sharing and technology transfer are easier to make when partners contribute funds and resources equally. But the relatively large budgets of organizations like NASA compared to those of other agencies makes this difficult to implement. Also, the absence from the SpaceOps conference of Russia and China, the only two other countries in the world that have launched astronauts and/or tourists into space, suggests that cooperation in commercializing space and making space science and space exploration a global enterprise still has some important challenges to overcome.

Appendix
 Comments on Sampling of Sessions Attended

Session Track	Session Description	Session Title	Presentation	Presenter	Venue	Comments
<u>DAY 2: Tuesday, 18 May '04</u>						
1	Sharing the Resources	Cross Support & Interoperability	Implementation of TT&C Network in Support LEOP of Scisat-1	Carpentier	Inter'1-1, 10 h 30	Average talk Attendance: N/A
1	Sharing the Resources	Cross Support & Interoperability	Inmarsat's TOPS – Evolution and Recent Achievements	Guariglia	Inter'1-1, 11 h 00	Dull Attendance: N/A
3	Sharing the Mission	Deep Space Mission Operations	Increasing Science with Diminishing Resources: Extending Ulysses to 2008	McGarry	Inter'1-2, 11 h 30	Very Good Attendance: ~ 20
1	Sharing the Resources	Cross Support & Interoperability	Managing Security & Flexibility in a Global Multi-mission TT&C Network	Ohlson	Inter'1-1, 12 h 00	Dull Attendance: ~ 20
1	Sharing the Resources	Cross Support & Interoperability	WRC-03 Decisions & Impacts on Implementing/Operating Networks of Space Agencies	Shoamanesh	Inter'1-1, 13 h 30	Average Attendance: ~ 30
1	Sharing the Resources	Cross Support & Interoperability	Facilities Shared thru Tracking Station Gateway & Control Center Gateway	Togni	Inter'1-1, 14 h 00	Dull Crowded O/heads Attendance: ~ 20
1	Sharing the Resources	Cross Support & Interoperability	E.R. to a Major Crisis thru International Charter on Space & Major Disasters	Saint-Jean	Inter'1-1, 14 h 30	Good Attendance: ~ 50
2	Building the Ops System	Mission Operations System	Design & Arch. Of Planning/Sequencing System for MER Operations	Maldaque (for Ko)	Amph-2, 15 h 30	Dull, too long Attendance: ~ 20
1	Sharing the Resources	Cross Support & Interoperability	Ground Systems – The Need for Standardization	Chaudhri	Inter'1-1, 16 h 00	Good Attendance ~75

Appendix (Continued)
 Comments on Sampling of Sessions Attended

Session Track	Session Description	Session Title	Presentation	Presenter	Venue	Comments
1	Sharing the Resources	Cross Support & Interoperability	The ECSS Standard on Space Segment Operability	Schmidt	Inter'1-1, 16 h 30	Average talk Attendance: N/A
2	Building the Ops System	Mission Operations System	Ops Considerations in dev. of Radarsat-2 Order Handling/Mission Planning	Morena	Amph-2, 17 h 00	Good talk Attendance: ~ 10
<u>DAY 3: Wednesday, 19 May '04</u>						
1	Sharing the Resources	Standardization	Proposed Evolution of CCSDS Protocols - Strategy and Technology	Carper	Inter'1-1, 10 h 30	Average talk Attendance: ~ 25 Not familiar with Equipment
2	Building the Ops System	Mission Operations System	Galileo: Mission Planning	Toribio	Amph-2, 11 h 00	Average talk Attendance: ~ 85
1	Sharing the Resources	Standardization	CCSDS Spacecraft Monitoring & Control	Merri	Inter'1-1, 11 h 30	Average talk Attendance: ~ 85
2	Building the Ops System	Mission Operations System	Ground Control Concept for on-orbit Robotic Maintenance Operations on ISS	Dhanji	Amph-2, 12 h 00	Good talk Attendance: ~ 25
3	Sharing the Mission Exp.	Deep Space Mission Operations	Developing Right: Lessons Learned from Cassini Saturn Mission Ops System	Gunn	Amph-1, 13 h 30	Good talk Attendance: ~ 80
1	Sharing the Resources	Standardization	A Standard for Flight Dynamics Interfaces	Dreger	Inter'1-1, 14 h 00	Average talk Attendance: ~ 40

Appendix (Continued)
 Comments on Sampling of Sessions Attended

Session Track	Session Description	Session Title	Presentation	Presenter	Venue	Comments
3	Sharing the Mission Exp.	Deep Space Mission Operations	Critical Monitoring of Cassini Saturn Orbit Insertion Maneuver	Asmar	Amph-1, 14 h 30	Good talk Attendance ~ 30
3	Sharing the Mission Exp.	Deep Space Mission Operations	Rosetta – Evaluation of Sun Interface During LEOP	Gesmundo	Amph-1, 16 h 30	Weak, leave early Attendance ~ 10
1	Sharing the Resources	Standardization	Space Link Extension: A Report From the Front Lines	Stoloff	Inter'1-1, 16 h 30	Arr. Late, Good Attendance: ~ 35
1	Sharing the Resources	Standardization	Network Security and SLE / IP Internet working for Inter-Agency Cooperation	Bertelsmeier	Inter'1-1, 17 h 00	Average Attendance: ~ 25
<u>DAY 4: Thursday, 20 May '04</u>						
1	Sharing the Resources	Missions: Apps, Case Studies, Reports	An Asset Contention Period: DSN's '03/'04 Challenge	Silverman	Inter'1-1, 10 h 30	Good Attendance: ~10
1	Sharing the Resources	Missions: Apps, Case Studies, Reports	Legal Aspects of International Technology Transfer in International Space Missions	Matsuura	Inter'1-1, 11 h 00	Good Attendance: ~ 25
1	Sharing the Resources	Missions: Apps, Case Studies, Reports	Promoting Ops Compatibility between Participating Organizations in ATV pgm	Monham	Inter'1-1, 11 h 30	Good Attendance: ~ 25
3	Sharing the Mission Exp.	ISS Operations	Telescience & Space Mission Ops at the Belgium User Support & Op Center	Vanhaverbeke	Inter'1-2, 12 h 00	Weak, dull Attendance: ~ 15
4	Managing the Mission	Management of ISS	ATV on its Way to ISS	Baize	Cartier-1, 13 h 30	Good Attendance: ~ 35

Appendix (Continued)
 Comments on Sampling of Sessions Attended

Session Track	Session Description	Session Title	Presentation	Presenter	Venue	Comments
5	Broader Scope, Narrowing Gap	Communications & Navigation	An Efficient Operations Users Interface for Scientific Missions	Montagnon	Cartier-2, 14 h 00	Weak, too fast Attendance: N/A
1	Sharing the Resources	Missions: Apps, Case Studies, Reports	Mars Reconnaissance Orbiter (MRO) - From Downlink to Archive	McGuffie (for DeJong)	Inter'1-1, 14 h 30	No Vid., average Attendance: ~ 35
5	Broader Scope, Narrowing Gap	Science Missions	The Role of Science & Operations in James Webb Telescope Mission Dev.	Hunter	Cartier-2, 15 h 30	Good Attendance: ~ 35
1	Sharing the Resources	Missions: Apps, Case Studies, Reports	Columbus Payload Integration & Ops; A Multi-lateral Process Implementation	Schmidt	Inter'1-1, 16 h 00	Weak, go early Attendance: ~ 20
3	Sharing the Mission Exp.	Mission Planning	Servicing the Hubble Space Telescope	Soderblum	Inter'1-1, 16 h 30	Very good Attendance: ~ 40
1	Sharing the Resources	Missions: Apps, Case Studies, Reports	A Strategic Mission Planning Concept for TerraSar-X (conflict avoidance...)	Wickler	Inter'1-1, 17 h 00	Good Attendance: N/A
<u>DAY 6: Friday, 21 May '04</u>						
1	Sharing the Resources	Studies and Proposals	The World Space Observatory: A Distributed Operations Concept	Ponz	Inter'1-1, 10 h 30	average Attendance: N/A All text without Graphics/images
2	Building the Ops System	Science Operations	Science Operations for Planetary Missions in the ESA	Koschny	Amph-2, 11 h 00	Average Attendance: ~ 40

Appendix (Continued)
Comments on Sampling of Sessions Attended

Session Track	Session Description	Session Title	Presentation	Presenter	Venue	Comments
1	Sharing the Resources	Studies and Proposals	Impact of SpaceWire Networks on Payload Implementation & Operation	Donadoni	Inter'1-1, 11 h 30	Good Attendance: ~ 15