Fourth Integrated Communications, Navigation and Surveillance (ICNS) Conference and Workshop 2004

Conclusions and Recommendations

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1.0 INTRODUCTION

The NASA Glenn Research Center organized and hosted the Fourth Integrated Communications, Navigation, and Surveillance (ICNS) Technologies Conference and Workshop, which took place April 26-30, 2004 at the Hyatt Fair Lakes Hotel in Fairfax, Virginia.

This fourth conference of the annual series followed the very successful first ICNS Conference (May 1-3, 2001 in Cleveland, Ohio), second ICNS conference (April 29-May 2, 2002 in Vienna, Virginia), and third ICNS conference (May 19-22, 2003 in Annapolis, Maryland).

The purpose of the Fourth ICNS Conference was to assemble government, industry and academic communities performing research and development for advanced digital communications, surveillance and navigation systems and associated applications supporting the national and global air transportation systems to:

- Understand current efforts and recent results in near- and far-term R&D and technology demonstration.

- Identify integrated digital communications, navigation and surveillance R&D requirements necessary for a safe, secure and reliable, high-capacity, advanced air transportation system.

- Provide a forum for fostering collaboration and coordination.

- Discuss critical issues and develop recommendations to achieve the future integrated CNS vision for national and global air transportation.

The workshop attracted 316 attendees from government, industry and academia to address these purposes through technical presentations, breakout sessions, and individual and group discussions during the workshop and after-hours events, and included 16 international attendees. An Executive Committee consisting of representatives of several key segments of the aviation community concerned with CNS issues met on the day following the workshop to consider the primary outcomes and recommendations of the workshop.

This report presents an overview of the conference, workshop breakout session results, and the findings of the Executive Committee.

2.0 ORGANIZATION OF THE FOURTH INTEGRATED CNS CONFERENCE AND WORKSHOP

The Fourth ICNS Conference and Workshop consisted of four primary elements: A Plenary session consisting of presentations on major topics and trends in aviation; Technical presentations covering a variety of topics relating to CNS requirements and research needs; six workshop breakout sessions to generate issues, ideas and recommendations for future CNS research and development; and an Executive Committee working meeting to condense the ICNS Conference and Workshop results into a concise summary including key issues and recommendations.

Welcoming remarks by the Deputy Director of the NASA Glenn Research Center Mr. Richard Christianson, and the Keynote Address by Dr. J. Victor Lebacqz, NASA Associate Administrator for Aeronautics, were followed by a Plenary Session of aviation industry and R&D leaders: Ms. Ann Tedford, Manager, Operations Planning Systems Engineering, Federal Aviation Administration; Mr. Karl Grundmann, Communications Director, Joint Planning and Development Office, Federal Aviation Administration; Mr. Paul Polski, Chief of Staff, Transportation Security Administration, Department of Homeland Security; Mr. John S. Walker, President, J S Walker Group/Aviation Solutions Inc.; Mr. Ira Pearl, Director, Flight Operations Technical Support, Delta Airlines; Dr. Bruce J. Holmes, Associate Director, Airspace systems Program Office, NASA Langley Research Center; and Mr. Sadegh Kavoussi, President, AvMet Applications International, LLC.

Fourteen technical presentation sessions filled the program from April 27 through April 29, 2004:

Session A1: CNS Systems and Architectures
Session A2: Communications Datalink
Session A3: Surface
Session B1: Weather Information Communications, WINCOMM and Aviation Weather
Session B2: Surveillance
Session B3: Simulation and Modeling
Session B4: Security
Session C1: Spectrum
Session C2: Airborne Internet
Session C3: IP Based Transition for Aviation
Session C4: SWIM
Session C5: Airborne Internet
Session C6: Demonstrations

The list of Session Chairpersons, presenters and titles of their presentations is given in Appendix A of this report. The presentations are posted on the Integrated CNS Workshop website at http://spacecom.grc.nasa.gov/icnsconf/.

At the conclusion of the presentations, six breakout sessions were held during the morning of April 30, 2004, with participation of the workshop attendees according to their interests. The breakout sessions were:

- Certification: How to get a better Certification Process
- Improving VHF Spectrum Utilization
- System Wide Information Management (SWIM)
- Software Defined Multi-function Multi-Mode Avionics
- Weather Information Communications
- A Global Solution for the Future ATC Communications System

The breakout session results are summarized in the following section.

The Executive Committee met during the afternoon of April 30, 2004, to review the presentations from the technical sessions and the outputs of the six breakout sessions in considering the Executive Committee Comments and Recommendations to be included in the Fourth Integrated CNS Conference and Workshop Final Report. The results of the Executive Committee meeting were collected and compiled into the Final Report by the Executive

Committee Chairman, Robert Kerczewski of NASA, and the Executive Committee Secretary, Marty Pozesky of MTP Associates. The following section presents the Executive Committee's comments and recommendations.

3.0 THE FINAL REPORT OF THE EXECUTIVE COMMITTEE OF THE FOURTH INTEGRATED CNS CONFERENCE AND WORKSHOP

The Fourth Integrated CNS Conference and Workshop Executive Committee examined the plenary and technical presentations, and in particular the results of the six Workshop Breakout Session to determine the issues and recommendations to be contained in the Conference Final Report. The Workshop Breakout Sessions were chosen to reflect some of the key issues in the aviation industry in regards to aeronautical CNS industry.

In producing this report, the Executive Committee reviewed the Breakout Session outputs individually, and also observed common themes and issues. Results collected from the Executive Committee deliberations are therefore grouped into two areas: Major Conference Summary and Recommendations, and Key Breakout Session Results.

3.1 Major Conference Summary and Recommendations

Themes that emerged during the Executive Committee discussions are organized into five categories, followed by recommendations, presented in the following sections.

3.1.1 US Leadership in Aviation

A recurrent theme at the ICNS Conference has been the observation that the lack of funding and commitment by both the US Government and the US commercial aviation industry has not kept up with the requirements for modern aviation. Plenary session speakers as well as some technical session speakers repeated the theme that the United States is losing its global leadership role in aviation. A strong plea was made for the US Government and the private sector to step out and exert international leadership.

3.1.2 Technology Insertion Cycle

A related theme in both the plenary and technical sessions, and also mentioned in workshop sessions, is the long timeline required to insert new technologies into the aviation system. Technologies can become significantly obsolete during the time from concept development to final implementation in what has become the "normal" aviation technology development and insertion cycle. The Aeronautical Telecommunications Network protocol is an example of a technology that was forward thinking at the time of its initial concept acceptance, but has become obsolete and essentially superceded as the world's data communication protocol by the ubiquitous Internet Protocol (IP) long before being introduced in any substantial way into the National and Global Airspace System operations.

A result of the long time to implementation is that stakeholders and advocates of new technologies lose interest, and those charged with developing and implementing lose the commitment of their organizations and the user community.

The two processes most associated with the long implementation time lines are certification and standardization. Both processes need to be shortened and made more efficient, without compromising safety.

It is also often noted that the user community, both commercial and private, is very reluctant to add new equipage and technologies to their individual small aircraft or airline fleets. The cost of buying, installing and maintaining new equipage is cited as the primary reason. For the private aircraft owners, the cost of new equipage can simply be prohibitive, with no significant cost recovery mechanism to create an equipage incentive. For the airlines, return-on-investment time frames for new equipage have been reduced to months in the current airline financial environment, making the cost benefit case extremely difficult to make.

In each case, continued emphasis on reducing the cost of new technologies is an obvious need. However, one plenary session speaker went even further to suggest that the aviation system, including the regulatory bodies and air traffic service providers (ATSP, i.e., FAA, etc.) would benefit if they simply purchased new equipment for all users. Short of purchasing the equipment, the mandating of equipage should be considered as well. Such policies are encouraged because they would accelerate equipage, resulting in faster benefits to both the users and ATSPs, and potentially reduced costs to the ASTPs due to a shorter time frame in which the support of legacy systems is necessary.

3.1.3 Airborne Internet

The Airborne Internet has a growing visibility both at the ICNS Conference and within the aviation community. With the establishment of the Airborne Internet Consortium, serious industry efforts are now underway to develop and implement Airborne Internet concepts and applications. The Airborne Internet concept appears to be realizable and of great value to aviation, especially the general aviation community in the Small Aircraft Transportation System (SATS) concept which seeks to increase the use of small, non-towered airport. However it must be strongly coupled with other aviation networking efforts to enable a globally interoperable system for aviation.

3.1.4 Joint Program Development Office

Key US government agencies and departments, including the FAA, NASA, Department of Homeland Security Transportation Security Agency, and the Department of Defense are working together through the Joint Program Development Office (JPDO) to define the long term development requirements for aviation in the US and globally, and coordinate the research programs of the agencies involved to achieve the long-term vision. The development of the long term aviation vision, a detailed research plan to realize the vision, and the commitment of resources to complete the needed research are all desired outcomes of the JPDO.

The outputs from the ICNS Conferences provide important recommendations for future communications, navigation and surveillance requirements that the Executive Committee strongly encourages the JPDO to consider.

3.1.5 Other Issues

Several other issues of interest noted by the Executive Committee from the Conference are summarized below.

FAA programs involving improvements for the general aviation community (e.g. Capstone in Alaska) involve the provision of user equipment for the purpose of operational evaluations of new technologies and systems. Such research efforts involve a close working relationship between the user community and the FAA, and have resulted in successful demonstrations and positive operational evaluations. There are significant continuing benefits for leaving equipment in place after the conclusion of the demonstrations and operational evaluations and such a policy is strongly recommended.

The reorganization of the FAA into the Air Traffic Operations (ATO) which is now underway is a cause of some concern in the aviation CNS community. The new operational paradigm of the ATO is not well understood by the aviation community. The impression evolving is that the ATO will be driven purely by a viewpoint of the FAA's return-on-investment. The consequences of this type of major paradigm shift are unknown. A better definition of ATO policies and intentions is needed.

Unmanned aerial vehicles (UAVs) were featured by two of the plenary speakers as well as several technical presentations. UAV technology is a rapidly emerging aviation area, with a potentially very significant future market. The impact of UAVs on the NAS needs to be well understood and the insertion of UAV operations has significant safety implications which must be dealt with to the same extent as all other NAS operations.

The Executive Committee also discussed future ICNS conferences. The growth of the ICNS Conference from 2001 through 2004 has been steady and considerable. Attendance and the number of technical presentations have more than doubled. In 2004 this growth was handled by having three parallel technical sessions and extending the conference by a half day. However, additional conference growth cannot be handled in a similar manner, therefore some selection processes may be necessary in the future. The Executive Committee suggests establishing specific focus areas for future conferences and limiting conference presentations to those areas, while including presentations in non-focus areas as poster or display presentations or in brief summary presentations. The Executive Committee also suggests that workshop breakout sessions be integrated throughout the conference, rather than all at the end, to enable attendees to participate in more than one session, and to connect workshop sessions to related technical presentations sessions, all within the focus areas of the particular conference. A conference summary session, in which major themes of technical sessions are presented, is also suggested. The Executive Committee encourages increased international participation through improved publicity and the use of international mailing lists if possible. A final recommendation of the Executive Committee is to keep the conference in the Washington DC metropolitan area – this has been a successful policy to date and enables participation by location within the area of the largest geographical concentration of aviation industry and government organizations.

The Executive Committee will continue to meet periodically to assist in the development of future ICNS conferences.

3.2 Summary of Executive Committee Recommendations

The key Executive Committee recommendations resulting from the 2004 ICNS Conference and Workshop are the following:

1. The United States public and private aviation community – government, industry, and user community – needs to step up and exert international leadership in aviation.
2. The length of the technology development and insertion cycle is a serious impediment to achieving the goal of creating a transformed, 21st century aviation system, and must be reduced.
    a. Certification and standardization processes are the two main drivers to lengthening the time to technology insertion and both must be addressed.
    b. Reducing the cost, and improving the cost-benefit ratio will contribute to making technology adoption more rapid.
    c. The direct purchase of user equipment by the ATSP and/or government regulatory agency, and the mandating of equipage are policies that should be considered to shorten the technology transition time.
3. The development and implementation of airborne internet technologies and applications should be strongly supported, but must be strongly coupled with other aviation networking efforts to enable a globally interoperable system for aviation.
4. The Joint Program Development Office must develop the long term aviation vision, a detailed research plan to realize the vision, and the resource commitment to complete the needed research. The JPDO should also consider the outputs of the INCS Conferences as part of this process.
5. The FAA and other organizations involved should consider a policy of leaving equipment in place after the conclusion of the demonstrations and operational evaluations to obtain the significant continuing benefits available.
6. The FAA should better define its policies and intentions in reorganizing into the ATO to the community so that possible consequences can be considered and analyzed.
7. The impact of UAVs on the NAS needs to be well understood and the insertion of UAV operations has significant safety implications which must be dealt with to the same extent as all other NAS operations.

3.3 Key Breakout Session Results

The key results from each of the six Workshop Breakout Sessions, as prepared under the direction of the co-chairpersons of each session, are presented below.

3.3.1 Certification: How to Get a Better Certification Process

The Certification Workshop Session members established the goal of identifying candidate research topics to minimize certification as a “risk to the commercialization of CNS technologies” by reducing time and cost of certification while maintaining the appropriate level of quality.

In identifying certification research and development, the group first identified the Certification process as shown in Figure 3.3.1.1.

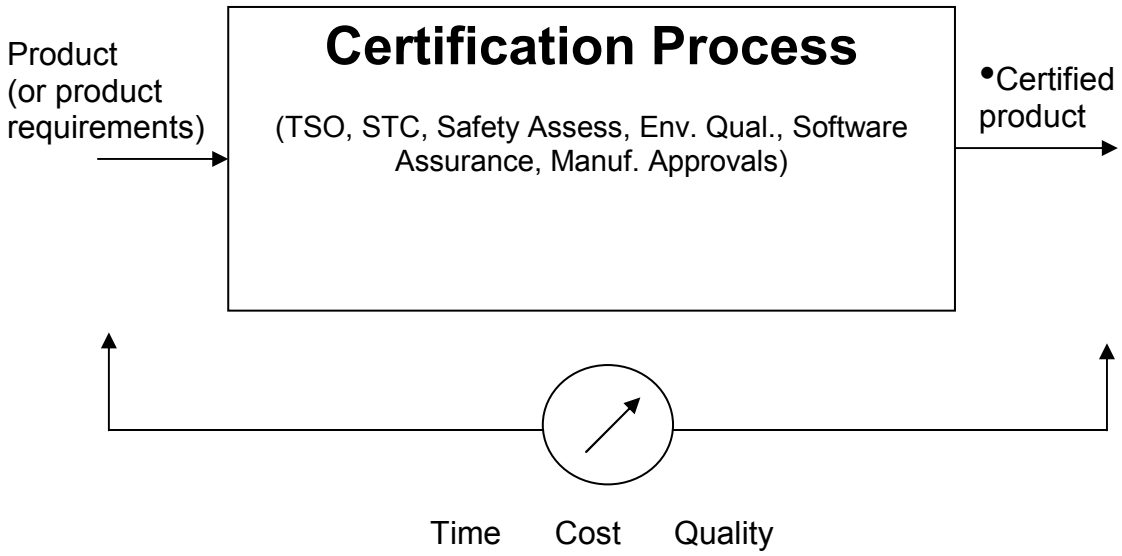

Figure 3.3.1.1 – Certification Process Definition

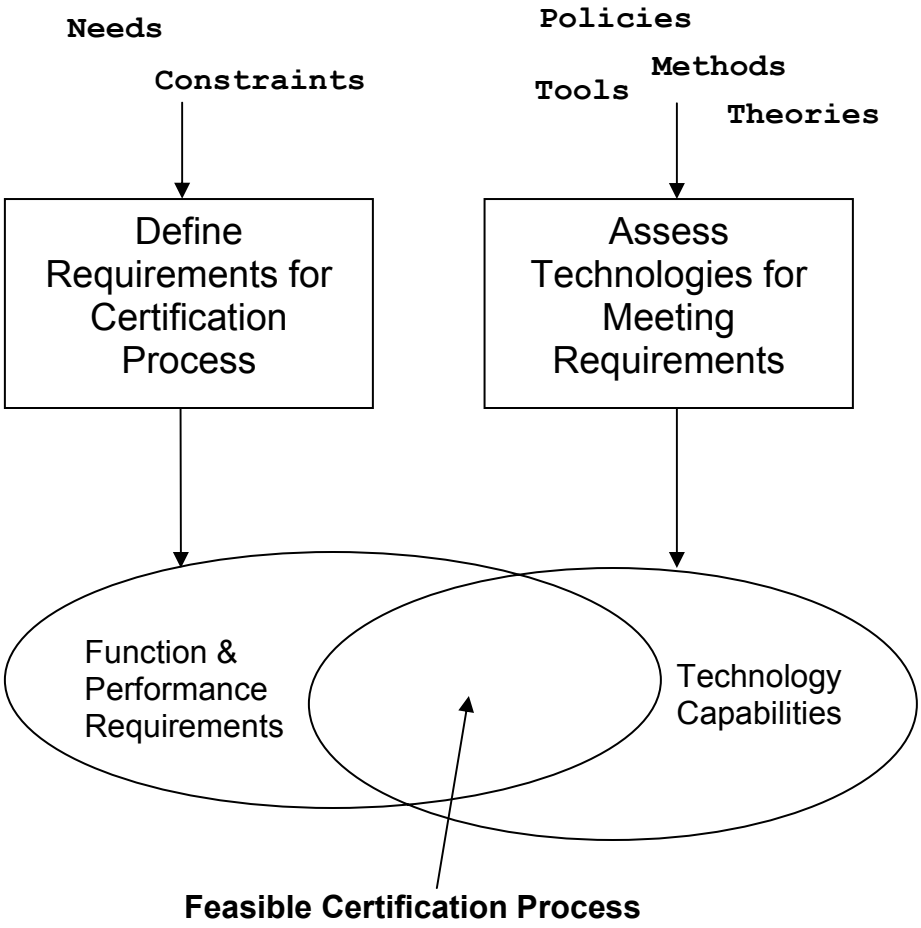

Figure 3.3.1.2 – Feasible Certification Process Description

The certification process includes the identification of functional and performance requirements to satisfy the needs and constraints, and assess the technologies for meeting the requirements. A feasible certification process is the overlap between requirements and technology capabilities as shown in Figure 3.3.1.2.

The members defined an R & D plan consisting of five major elements as indicated in Figure 3.3.1.3.

The definition of functional requirements includes the following two elements:

- Document a regulatory judgment that a device meets all applicable regulatory requirements and can be manufactured properly
- Provide credible prediction of future service experience for new devices

The definition of performance requirements includes the following two elements:

- Collect historic data
    - Cost of avionics (e.g. comm) over time
    - Comparison cost of certified vs. non-certified products
- Identify Metrics
    - Ratio Price/Development Costs

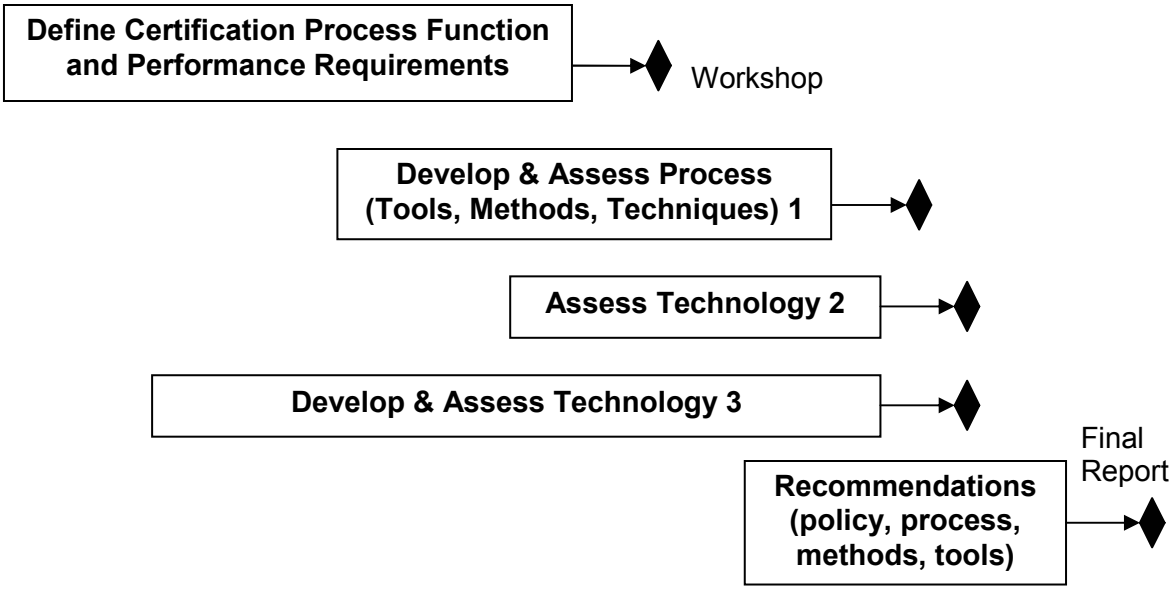

Figure 3.3.1.3 R & D Plan Elements

3.3.2 Improving VHF Spectrum Utilization

Objective: Identify technologies to improve the performance and spectrum efficiency of future VHF communication systems

Summary: VHF spectrum utilization is a major consideration in developing future air-ground communication systems. Several research initiatives were identified that hold promise to improving the spectrum utilization and efficiency of future communications systems. They include:

Near Term Possibilities:

- Improved VHF Antennas
- Frequency pooling techniques
- Reallocation of existing assignments – specifically the movement of AWOS/ASOS services to the 112-118 MHz band
- Dynamic geographic frequency allocation

Mid Term Possibilities

- Use of OFDM technology for communication
- Use of C-band for terminal area communications
- Use of full duplex techniques

Longer Term Possibilities

- Dynamic Frequency Allocation in VHF Band
- Use of Cellular Techniques
- Superconducting Filters
- Spread Spectrum Techniques

It was also noted that introduction of future security improvements needs serious consideration as we move forward to the next generation system.

All of these techniques should be investigated with particular emphasis on contacting DARPA to identify emerging opportunities.

3.3.3 System Wide Information management - SWIM

The SWIM Workshop Session identified issues and strategies in three areas: policy, technologies, and transition. These are summarized below.

SWIM Policy Issues and Strategies:

- Objectives, scope and boundaries of SWIM need to be clearly defined and articulated.
- How will international harmonization be achieved? (information standards, architecture, policy)
  - EUROCAE WG 59 Interoperability
  - EUROCAE WG 61 Architecture
- What is the security policy and its objectives? (access, ownership, levels, strategy)
  - Needs to be identified early and coordinated
- How might SWIM take advantage of the work done in support DoD's GIG?
- How can we simplify the safety certification process?
- What are the data and information approval requirements for specific applications?
- Does the SWIM team understand the implications of certification on development?
- How will standards be influenced, adapted and enforced?
- What is the strategy for performance management and metrics?

SWIM Technology Issues and Strategies:

- How will architecture address the four domains: oceanic, en route, terminal, airport?
  - Physical, data, and application
- How should the data be modeled and validated?
- Security architecture should be developed in concert with technology architecture.
- Business case needs to be identified and articulated.
- Scalability, flexibility, evolvability are key considerations for the architecture.
- How will SWIM architecture accommodate COTS end systems for NAS subsystems with proprietary interfaces?
- What are the technology gaps?

SWIM Transition Issues and Strategies:

- Is there a sufficient understanding of the current architectures?
- What are the current activities and how will they be leveraged to benefit SWIM?
  - How will the East Coast broadcast services migrate to SWIM?
  - Investigate UAL's EFB for applicability to SWIM.
- What are the defined future ATC capabilities?
- How will existing operational capabilities be maintained?
- How can we gain early buy-in from aviation industry and other stakeholders?
  - Develop business case to improve ROI.
  - Identify early benefits.
  - Conduct outreach to stakeholders.

- What are the windows of opportunity for SWIM?
  - What is the ROI?
  - How will operating costs be reduced and/or services be improved?
- What are the plans for vulnerability and security analysis and risk management?
- What are the plans for program management and evaluation criteria to be incorporated in the transition plan?

3.3.4 Software Defined Multi-mode, Multi-function Avionics

The Software Defined Multi-mode, Multi-function Avionics Workshop Session identified the primary software defined avionics issues for five areas: Market drivers, equipage, implementation, cost, and certification. These are summarized below.

Software Defined Avionics Market Driver Issues:

- What are the most desirable/marketable combinations of legacy and/or emerging CNS functions and/or modes?
  - For those combinations, what are the application(s), flight domains and aircraft categories?
    - Multi-mode avionics more marketable than multi-function avionics (easier certification; esp for integration of communication modes and integration of navigation modes; market: international air traffic, international business jet operators)
      - Desirability of software reconfiguration as opposed to multiple hardware implementations
      - Easier international standardization
    - How do we capture the best of open architectures vs. proprietary innovations?
      - The market size just isn't that large; hard to obtain enough market share when market isn't large to begin with.
    - Other
      - Potential for reduction of legacy ground infrastructure once a certain percentage of the (military) fleet is equipped (UHF, TACAN)
      - Potential for implementation of SDA in ground infrastructure for future-proofing (next generation air-ground com) and cost reduction
- What are the most desirable/marketable combinations of legacy and/or emerging CNS functions and/or modes?
  - For those combinations, what are the application(s), flight domains and aircraft categories?
    - Synergistic integration and fusion of existing and emerging functions may enable higher total system performance reliability and therefore operation in more desirable airspace and airports, preferential routing, etc.
      - May require policy & procedure changes
      - Self-separation at high altitudes
      - Reduced spacing for oceanic routes
      - Human machine interface (managing/reducing workload, novel or more intuitive ways of presenting information)
    - Other benefits:
      - Reduced training needs

        - Reduced costs of equipage, maintenance, spare parts
        - Added capabilities for greater reach into other markets (increase revenues)
        - Reduced downtime for re-equipage via software download (raises significant certification issues)
- What are the most desirable/marketable combinations of legacy and/or emerging CNS functions and/or modes?
    - For those combinations, what are the application(s), flight domains and aircraft categories?
        - Drawbacks
            - Complexity issues
            - Human machine interface (too complex??)

Software Defined Avionics Equipage Issues:

- What equipage/sparing strategies are enabled by software defined avionics to reduce cost?
    - For broad suite of integrated functions (e.g. VHF/UHF/L-Band)
    - For narrow suite of functions (e.g. VHF/UHF and L-band)
        - Box level reconfiguration of functionality as opposed to board level replacements
            - Issues of open (built to a standard performance and interface specification) vs. proprietary architecture
            - The level of functional integration may be offset by single point of failure
        - Graceful degradation to minimal functionality
        - Certification of the suite of components at the functional level is responsibility of avionics integrator
        - Reduced box count, reduced physical size of box, reduced spare parts (helps with cost, reliability, maintainability)
        - Need to address safety and robustness aspects of reduced equipage (A failsafe capability? A safe restart mode? Graceful degradation to minimum capabilities for safe flight?)

Software Defined Avionics Implementation Issues:

- What implementation considerations are most critical for success?
    - E.g. open SDA architecture; integration level of hardware and software; performance degradation from integration; security concerns
        - Consider a tailored subset of the SCA as a viable alternative for civil aviation (as opposed to JTRS subset of SCA)
        - Partitioning DO178b software certification specifications
            - Aspects of certifying multiple modes in the same function may be different from certifying multiple functions in an SDA
        - Antennae issues (location, interference) caused by multi-function avionics
        - Need to consider the human-machine interface
            - Should be intuitive
            - Opportunity to take advantage of background/experience of rising generation of users
            - Should leverage the fusion of …
        - Minimize downtime for MRO (maintenance, repair, operations)/Upgrades

        - Sparing philosophy and equipage issues may force novel implementation backups
- What implementation considerations are most critical for success?
    - E.g. open SDA architecture; integration level of hardware and software; performance degradation from integration; security concerns
        - Security & Safety: multiple channels for varying security levels (e.g. red/black portions of JTRS architecture)
        - Must still maintain safety and security standards of today
        - Authentication, verification and validation aspects of SDA

Software Defined Avionics Cost Issues:

- How will initial cost, annual operating costs and life cycle cost of SDA have to compare with that of conventional avionics to be attractive in the next 5 years?
    - What are the best ways to improve those cost perceptions?
        - Pricing strategies of initial investment
        - Who should pay for initial equipage costs?
            - Benefit to FAA and NAS?
            - Benefit to user of NAS?
        - Leveraged development of ground and airborne components that perform the same function (hardware and software components)
        - International operability to increase market size
        - International harmonization of standards to increase market size
            - RTCA & EUROCAE

Software Defined Avionics Certification Issues:

- What are specific concerns facing certification of SDA?
    - What recommendations will reduce cost and time of certification and life-cycle recertification of SDA?
        - The nature of the software architecture for the SDA greatly affects its certifiability
        - Certify at the performance level as opposed to the internal implementation level
        - Aircraft location at time of upgrade (reconfigurations on ground or in flight would have different security, safety and certification issues to consider)
        - Is the FAA certification methodology equipped to address certification of SDA? Does it impress another policy decision by the FAA concerning how certification is accomplished?
        - Can software development tools aid the certification process with certifiable process steps/tools?
        - Lessons learned from prior experience from SDA:
            - Avidyne avionics radio for NEXCOM
            - Honeywell EPIC radio
            - Scalability, flexibility, adaptability

3.3.5 Weather Communications

There is a broad spectrum of weather information which can serve aviation but it is clear that the requirements for information will vary dramatically by the type of user and class of service. In

addition, issues regarding where the information is to be processed (tailored) for the individual user – on the ground or in the aircraft – will significantly impact the capacity of the data link and communications channel needed to provide weather information.

The need for weather information will play a strong role is future systems design and planning – free flight capability may become critically dependent upon the availability and quality of weather information.

There also needs to be research into how aircraft derived weather information can be disseminated to other aircraft and how much context sensitive weather information is required in the future NAS.

3.3.6 A Global Solution to Future ATC

This workshop concentrated on identifying several aspects of a future ATC Communication System; in particular, the workshop focused on identifying key performance characteristics of a future global solution; political, organizational, and technical strategies for developing a solution; and some possible candidate technologies to be considered; and important issues to be addressed in the future. Several key concerns were identified – any one of which has the potential of delaying or invalidating a unified approach to a future system. Key elements that were identified in each area were as follows:

System Characteristics

- Support for 2015 – 2025 time frame.
- Global Interoperability – not necessarily a single standard signal-in-space but interoperability provided through software or multi-mode radios.
- Need to efficient serve different classes of users -- air carrier, military, general aviation, etc.
- Improved safety and security
- Spectrum planning as an adherent element of architecture – may not be totally within Aviation VHF Band
- Support for data and voice communications
- Air-to-air as well as air-to-ground operational support for “Free Flight”
- Ease of Transition
- Flexible future evolution

Possible Technologies for Consideration

- TCP/IP and its derivatives (including voice over IP as a possible back-up)
- Airborne Internet
- Ad Hoc Networking
- Domain dependent technology (oceanic vs terminal)
- Packetized Voice
- Improved compression and encryption
- Narrowband, wideband, and broadband technologies

Planning and Development Strategies

- Early involvement of the users in the development of systems
- Use of multi-mode radios or software radios as a key element on the ground and in the aircraft

- Early planning on a world-wide basis recognizing Europes unique problem with 8.33
- Extensive use of simulation in evaluating alternative systems
- NASA and FAA leadership in defining and simulating technologies

Key Problems and Pitfalls to Avoid

- Avoid long transitions because they are expensive and limit capability
- Identify method to speed up certification of multi-mode and software radios
- Achieve full user involvement and support
- Identify and negotiate realistic spectrum requirements
- Achieve policy commitments as early as possible and stick to them

4.0 CONCLUSION

The Fourth ICNS Conference and Workshop continued a series of successful conferences and workshop dating to the first conference, held in May, 2001. Each conference has exceeded the previous one in terms of attendance, number of presentations, and overall value to the aviation community and to NASA as conference host. The over 300 participants and over 100 presentations at the 4th ICNS Conference are a testament to the growing recognition of the importance of developing an advanced, high performance and high capacity integrated communications, navigation and surveillance infrastructure to carry the national and global airspace systems into a next generation of safe and efficient growth. The aviation community has been an enthusiastic participant in the definition and development of the future ICNS infrastructure through the ICNS Conferences, and has contributed substantially to the development of NASA CNS R&D programs through this process.

A summary of conclusions and recommendations resulting from the 4th ICNS Conference has been compiled based on the ICNS Conference Executive Committee deliberations on the afternoon of April 30, 2004, and is presented in this report. The Committee based its work on the review of the Conference plenary session and technical session contributions of the conference participants, as well as the breakout workshop session results. The workshop breakout sessions developed summaries of their deliberations, which are contained in full in section 3.3 of this report. As a result of time limitations of the Committee meeting, the conclusions and recommendations represent the highlights and key issues gleaned from the conference and workshop results. These conclusions and recommendations are presented in sections 3.1 and 3.2.

APPENDIX A
The Technical Sessions of the 4th Integrated Communications, Navigation and Surveillance Technologies Conference

Tuesday, April 27, 2004		
07:15 – 08:15 am	Registration/Continental Breakfast	
Opening Plenary Session Session Chair: Pete Vrotsos, NASA Glenn Research Center		
08:15 – 08:25 am	Overview Week	Denise Ponchak, Conference Chair, NASA Glenn Research Center
08:25 – 08:35 am	Welcome	Rich Christiansen, Deputy Director, NASA Glenn Research Center
08:35 – 09:05 am	Keynote Address	Victor Lebacqz, Associate Administrator for Aeronautics, NASA Headquarters
09:05 – 09:15 am	Opening Remarks	Pete Vrotsos, Plenary Chair, NASA Glenn Research Center
09:15 – 09:35 am	The ATO and the NAS Architecture	Ann Tedford, Manager, Operations Planning Systems Engineering, Federal Aviation Administration
09:35 – 09:55 am	JPDO Overview & Status	Karl Grundmann, Communications Director, Joint Planning & Development Office, Federal Aviation Administration
09:55 – 10:20 am	**BREAK**	
10:20 – 10:40 am	Department of Homeland Security Programs	Paul Polski, Chief of Staff, Transportation Security Administration, Department of Homeland Security
10:40 – 11:00 am	Enabling America's Next Generation of Aviation Vehicles - UAV's	John S. Walker, President, JSWalker Group/Aviation Solutions, Inc.
11:00 – 11:20 am	CNS Implementation - An Airline Perspective	Ira Pearl, Director, Flight Operations Technical Support, Delta Air Lines
11:20 – 11:40 am	Transportation Network Topologies	Bruce Holmes, Associate Director, Airspace Systems Programs Office, NASA Langley Research Center and John Scott, Icosystems, Inc.
11:40 – 12:00 pm	Aviation Weather Roadmaps	Sadegh Kavoussi, President, AvMet Applications International, LLC
12:00 – 01:15 pm	**LUNCH**	
Session A1 – CNS Systems & Architectures Session Chair: Ann Tedford, Federal Aviation Administration		
01:15 – 01:45 pm	Pilot's Perspective: The Road to Future I-CNS Applications	Rip Torn and Robert Wayne, Air Line Pilot Association, International
01:45 – 02:15 pm	The Next NAS – 2025 Demand Projections	Michael Harrison, Aviation Management Associates, Inc.
02:15 – 02:45 pm	Unmanned Aerial Vehicle (UAV) Cargo System Senior Design Capstone Project	Kevin Han, Angela Garcia, Indah Leo, Miguel Martin del Campo, Chnur Muhammad, Libni Ortiz and George Donohue, George Mason University
02:45 – 03:15 pm	Air and Ground ATM Systems Integration Need or Fashion….	Jean-Claude Richard, Air Traffic Alliance
03:15 – 03:30 pm	**BREAK**	
03:30 – 04:00 pm	Global Communications, Navigation, and Surveillance Systems Program Progress and Plans	Chip Meserole, The Boeing Company and James Dieudonne, The MITRE Corporation
04:00 – 04:30 pm	Emergent Issues of Network Centric Architectures and Shared Infrastructures	Marie Stella, Federal Aviation Administration
04:30 – 05:00 pm	Air Transportation Infrastructure Concept for the 21st Century	Herman Rediess, Federal Aviation Administration

Tuesday, April 27, 2004		
Session A2 – Communications Datalink Session Chair: Art Feinberg, Intelligent Automation Inc.		
01:15 – 01:45 pm	Seamless Integration of VDL into the NAS with the Multimode Digital Radio	Frank Jaworski , Jim McChesney and Chang Zhang, ITT Aerospace
01:45 – 02:15 pm	Operational Benefits of Transitioning the Traditional Voice-based Controller/Pilot COM Radio System to Digital Technology	Tom Davis and Steve Dougherty, Raytheon Company
02:15 – 02:45 pm	MMDA Qualification Issues	Michael Kocin, ViaSat, Inc.
02:45 – 03:15 pm	SITA ATS AIRCOM Data Link Services and What's Next	Kathleen Kearns, SITA
03:15 – 03:30 pm	**BREAK**	
03:30 – 04:00 pm	Next Generation FANS over Inmarsat BGAN	Dave Morse and Karl Griep, Avaliant, and Rich Deininger, Tectura
04:00 – 04:30 pm	Protocol Support for a New Satellite-Based Airspace Communication Network	Yadong Shang, Michael Hadjitheodosiou and John Baras, University of Maryland
04:30 – 05:00 pm	B-VHF – A Multi-Carrier Broadband Communications Concept for Air Traffic Management in the VHF Band	Bernhard Haindl, Miodrag Sajatovic, Christoph Rihacek, Johannes Prinz, Frequentis GmbH and Michael Schnell, DLR
Session A3 – Surface Session Chair: Chris Daskalakis, DOT Volpe National Transportation Systems Center		
01:15 – 01:45 pm	Architecture and Interfaces for Runway Safety Systems	Eric Chartier, Architecture Technology Corporation and Dan Hicok, Federal Aviation Administration
01:45 – 02:15 pm	A Demonstration of the Final Approach Runway Occupancy Signal System	Jaime Figueroa, Federal Aviation Administration and Kirk Swanson, Architecture Technology Corporation
02:15 – 02:45 pm	Airport Surface Surveillance Service – An Alternate Approach	Kirk Swanson, Architecture Technology Corporation and Dan Hicok, Federal Aviation Administration
02:45 – 03:15 pm	Very Closely Spaced Parallel Approaches	Siroos Sekhavat Tafti, George Mason University
03:15 – 03:30 pm	**BREAK**	
03:30 – 04:00 pm	Fleet Mixture and Arrival Rate Estimation at Memphis International Airport	Ben Levy, J. Legge, M. Romano, R. Collins, Sensis Corporation and Chris Daskalakis, DOT, Volpe National Transportation Systems Center
04:00 – 04:30 pm	Adaptive Channel Equalization for a Potential Airport Wireless Area Network	Minh Nguyen and Izabela Gheorghisor, The MITRE Corporation
04:30 – 05:00 pm	Determination of Controller Issued Taxi Clearances	Brent Midwood, US DOT, Volpe Center

Wednesday, April 28, 2004 – Track 1		
07:15 – 08:15 am	Registration/Continental Breakfast	
Session B1 – Weather Information Communication, WINCOMM and Aviation Weather Session Chairs: Mike Jarrell, NASA Glenn Research Center and Thomas Tanger, Ohio Aerospace Institute		
08:15 – 08:45 am	Weather Information Communications (WINCOMM) Project: Dissemination of Weather Information for the Reduction of Aviation Weather-Related Accident Casual Factors	Michael Jarrell, NASA Glenn Research Center and Thomas Tanger, Ohio Aerospace Institute
08:45 – 09:15 am	Weather Products for Airspace Management	Thomas Fraim, NOAA and Anthony Ramirez, Science and Technology Corporation
09:15 – 09:45 am	Pilot Weather Needs: Understanding, Quantification, Value	James Tauss and Gary Church, Aviation Management Associates, Inc.
09:45 – 10:00 am	**BREAK**	
10:00 – 10:30 am	A New Aviation Weather Technology that Forecasts NEXRAD Reflectivity Fields	Mike Cetinich, Jeppesen and Mike Eilts, Weather Decision Technologies
10:30 – 11:00 am	Oceanic Weather Product Development	Tenny Lindholm, The National Center for Atmospheric Research (presented by Gary Blackburn)
11:00 – 11:30 am	Flight Information Services Communication Architectures	Robert Nichols, Sunita Munjal, and Robert Pattay, The Johns Hopkins University Applied Physics Laboratory
11:30 – 12:00 pm	Communications Requirements and Architectures for Terminal Area Weather Distribution	Sunita Munjal, Robert S. Pattay, and Robert A. Nichols, The Johns Hopkins University Applied Physics Laboratory
12:00 – 01:00 pm	**LUNCH**	
01:00 – 01:30 pm	Analysis of Candidate Communication Architectures for TAMDAR Implementation in 2007-2015	Michael Castle, The John Hopkins University Applied Physics Laboratory
01:30 – 02:00 pm	Flight Test of Weather Data Exchange Using the Universal Access Transceiver (UAT) Automatic Dependent Surveillance – Broadcast (ADS-B) Data Link	Lawrence Bachman, The John Hopkins University Applied Physics Laboratory
02:00 – 02:30 pm	Flight Test of Weather Data Exchange Using the 1090 Extended Squitter (1090ES) and VDL Mode 3 Data Links	James Griner, NASA Glenn Research Center
02:30 – 03:00 pm	Automated Handoff for VDL Mode 3	Ionut Cardei and Sabera Kazi, Honeywell
03:00 – 03:15 pm	**BREAK**	
03:15 – 03:45 pm	A Low Cost Single Chip VDL Compatible Transceiver ASIC	Robert Becker, Honeywell
03:45 – 04:15 pm	Enhancing In-Flight Transoceanic Communications Using Swift-64 Packet Mode Service	Richard Slywczak, NASA Glenn Research Center
04:15 – 04:45 pm	ESCAN	Lisa Lust, Honeywell

Wednesday, April 28, 2004 – Track 2		
07:15 – 08:15 am	Registration/Continental Breakfast	
Session B2 – Surveillance Session Chairs: Marc Viggiano, Sensis Corporation and Len Carlson, Technology Services Corporation		
08:15 – 08:45 am	Aircraft Surveillance Applications (Extracts from ASA MASPS, DO-289)	Steve Koczo, Rockwell Collins and Jonathan Hammer, The MITRE Corporation
08:45 – 09:15 am	Determination of Requirements for Automatic Dependent Surveillance –Broadcast (ADS-B) to ADS-B Three Nautical Miles (nm) Separation Standard	Stan Jones, The MITRE Corporation (presented by Chris Moody)
09:15 – 09:45 am	General Aviation Use of ADSB – Effect on Near Mid-Air Collision Rates	Steve Hampton and Richard Theokas, Embry-Riddle Aeronautical University
09:45 – 10:00 am	**BREAK**	
10:00 – 10:30 am	Terminal Area Surveillance at Innsbruck Airport	Werner Langhans, Austro Control
10:30 – 11:00 am	Safe Flight 21 and Two Advanced Automatic Dependent Surveillance-Broadcast (ADS-B) Applications	Randall Bone and James Reagan, The MITRE Corporation
11:00 – 11:30 am	Alternative Surveillance Technology for the Gulf of Mexico	Chris Daskalakis and Patrick Martone, DOT Volpe Center
11:30 – 12:00 pm	East Coast Broadcast Services Implementation	Robert Strain, The MITRE Corporation
12:00 – 01:00 pm	**LUNCH**	
01:00 – 01:30 pm	Collaborative Decision Making (CDM) – An Integral Component of Air Traffic Management	Carol Huegel, Sensis Corporation
01:30 – 02:00 pm	ADS-B Performance in the TRACON for DAG-TM Concept Element 11	Rajesh Raghaven, Analex Corporation
02:00 – 02:30 pm	The Road to Free-Flight: Delivery of Trajectory Intent Information to the Flight Deck	Rajesh Raghaven, Analex Corporation
02:30 – 03:00 pm	Assigning Time Slot Resources for Uplink Broadcast Services	Chris Moody, Warrant Wilson and Izabela Gheorghisor, The MITRE Corporation
03:00 – 03:15 pm	**BREAK**	
03:15 – 03:45 pm	Implementation of the Surveillance Data Network Through the FAA Telecommunications Infrastructure	Scott Remillard, Sensis Corporation and Robert Coulson, Harris Corporation
03:45 – 04:15 pm	Provision of Distributed Integrated Air Traffic Management Displays for the Global Satellite Communication, Navigation and Surveillance System (GCNSS)	Ian Wilson and John Pesce, Embry-Riddle Aeronautical University
04:15 – 04:45 pm	Implementation of New Technologies in Radar Systems	Michael Coluzzi, Larry Carlin, Makoto Igawa and Bernard Ross, ITT Gilfillan
04:45 – 05:15 pm	Antistealth ISAR Technology for Target Detection and Identification by Linear Frequency Modulated Signal	Andon Dimitrov Lazarov, Bourgas Free University and Chavdar Nikolaev Minchev, National Military Academy (Cancelled)

Wednesday, April 28, 2004 – Track 3		
07:15 – 08:15 am	Registration/Continental Breakfast	
Session B3 – Simulation & Modeling Session Chairs: Thanh Nguyen, Analex Corporation and Brian Hung, The MITRE Corporation		
08:15 – 08:45 am	The Processing of Airspace Concept Evaluation Using FASTE-CNS as a Pre- or Post-Simulation CNS Analysis Tool	Steven Mainger, NASA Glenn Research Center
08:45 – 09:15 am	Proposed Development of NASA Glenn Research Center's Aeronautical Networks Research Simulator	Thanh Nguyen, Analex Corporation, Robert Kerczewski, NASA Glenn Research Center, Chris Wargo, CNS, Inc., Michael Kocin, and Manuel Garcia, ViaSat Inc.
09:15 – 09:45 am	Simulation of Controller Pilot Data Link Communications over VHF Digital Link Mode 3	Steven Bretmersky, Robert Murawski, Cleveland State University, Thanh Nguyen and Rajesh Raghavan, Analex Corporation
09:45 – 10:00 am	BREAK	
10:00 – 10:30 am	Data Communications Performance of AOCDL and AUTOMET over a VDL Mode 2 Link	Steven Bretmersky, Robert Murawski, Vijay Konangi, Cleveland State University and Robert Kerczewski, NASA Glenn Research Center
10:30 – 11:00 am	A Performance Study of the VDL Mode 3 Subnetwork Aircraft MAC Sublayer Random Access Algorithm	Brian Hung, The MITRE Corporation
11:00 – 11:30 pm	ERLANG B/C Link Availability/Blockage for Data and Voice Over VDL Mode 3	Mohammed Shamma, Analex Corporation
11:30 – 12:00 pm	Investigation of Party Line Voice over Inmarsat's Mobile Packet Data Service	Richard Deininger, Tectura Corporation (presented by Bob Stephens)
12:00 – 01:00 pm	**LUNCH**	
01:00 – 01:30 pm	Aviation Communications Emulation Testbed	Charles Sheehe, NASA Glenn Research Center and Thomas Mulkerin, Mulkerin Associates Inc.
01:30 – 02:00 pm	Agent Infrastructures for Modeling and Simulation of CNS in the NAS	Goutam Satapathy and Vikram Manikonda, Intelligent Automation, Inc.
02:00 – 02:30 pm	Oceanic Situational Awareness for the North Atlantic Corridor	Bryan Welch and Israel Greenfeld, NASA Glenn Research Center
02:30 – 03:00 pm	Transmission Protocols and Information Reachability for Ad Hoc Airborne Networks	Yiyuan Zhao, University of Minnesota and Maggie Cheng, University of Missouri
03:00 – 03:15 pm	**BREAK**	
Session B4 – Security Session Chair: Marie Stella, Federal Aviation Administration		
03:15 – 03:35 pm	Can Current Security Policies Meet NAS Security and Safety Needs?	Marie Stella, Federal Aviation Administration
03:35 – 03:55 pm	Link Security for Aeronautical Wireless Networks	Kelly Mesveskas, Vic Patel, Federal Aviation Administration and Simon Blake-Wilson, BCI
03:55 – 04:15 pm	Security Architecture for Aeronautical Networks	Robert Stephens, Boeing Air Traffic Management, Tectura Corporation
04:15 – 05:15 pm	Audience Discussion – NAS Security Requirements 2020	

Thursday, April 29, 2004 – Track 1		
07:15 – 08:15 am	Registration/Continental Breakfast	
Session C1 – Navigation Session Chairs: Rafael Apaza, Federal Aviation Administration and James Budinger, NASA Glenn Research Center		
08:15 – 08:45 am	Alternative Obstacle Clearance Criteria for RNP RNAV Instrument Approaches	S. Vince Massimini and Frederick Niles, The MITRE Corporation
08:45 – 09:15 am	Extending Wide Area Augmentation System Service into Central and South America	Deihim Hashemi and Daniel O'Laughlin, The MITRE Corporation
09:15 – 09:45 am	Traffic Information Service - Broadcast (TIS-B): Calculation of Navigation Accuracy Category for Position and Velocity Parameters	Roxaneh Chamlou, The MITRE Corporation
09:45 – 10:00 am	**BREAK**	
10:00 – 10:30 am	Integrated GPS/Loran Prototypes for Aviation Applications	G. Linn Roth, Locus, Inc. and Mitchell Narins, Federal Aviation Administration
10:30 – 11:00 am	Development of Global Positioning System Prediction Tools to Support Flight Planning	Karen Van Dyke, Jon Parmet and Jayne Rossetti, DOT Volpe Center
11:00 – 11:30 am	INS/GPS/Odometer Integrated Navigation System and Adaptive Federated Filter	Bing-Fang Chen and Bin Wu, Beijing Institute of Tracking & Telecommunications Technology
11:30 – 12:00 pm	New Inertial Sensor for Aviation Navigation Application	John Jackson, Alton Highsmith, R. K. Pandey and L. T. Wurtz, The University of Alabama
12:00 – 01:00 pm	**LUNCH**	
01:00 – 01:30 pm	Effectiveness of the Automatic Dependent Surveillance – Broadcast (ADS-B) Ground Based Transceiver (GBT) Parrot System in Alaska	Young Lee, Chris Moody and James Reagan, The MITRE Corporation
01:30 – 02:00 pm	Short Baseline Interferometry for Precision Landing	Leonard Schuchman and Richard Orr, Satel
02:00 – 02:45 pm	**BREAK**	
Session C2 – Spectrum Session Chair: Frank Box, The MITRE Corporation		
02:45 – 03:15 pm	A Survey of Possible Methods for Mitigating the Impact of Radio Frequency Interference on Satellite Navigation Systems Used for Precision Approach	James Carroll, U.S. Department of Transportation/Volpe Center
03:15 – 03:45 pm	Test Plan: Measurements of the Effects of UWB Devices on Aircraft Avionics	James Hollansworth, NASA Glenn Research Center and Jay Ely, NASA Langley Research Center
03:45 – 04:15 pm	Frequency Spectrum for New Aviation Data Links: Initial Study Results	David Matolak, Ohio University and James Branstetter, Federal Aviation Administration
04:15 – 04:45 pm	Minimizing Interference in Dense Packaging Environments	Michael Violette and Steve Ferguson, Washington Laboratories, Ltd
04:45 – 05:15 pm	Nationwide Capacity of a Digital Air/Ground Radio System for Air Traffic Services	Frank Box, Philip Long and Richard Snow, The MITRE Corporation

Thursday, April 29, 2004 – Track 2		
07:15 – 08:15 am	Registration/Continental Breakfast	
Session C3 – IP Based Transition for Aviation Session Chair: Chris Wargo, CNS, Inc.		
08:15 – 08:45 am	Status of IPv6 in Industry	Waseem Naqvi, Raytheon
08:45 – 09:15 am	IPv6 Test Bed for Testing Aeronautical Applications	Ryan Wilkins, Infinite Global Infrastructures, Chris Dhas, Computer Networks & Software, Inc. and Michael Zernic, NASA Glenn Research Center
09:15 – 09:45 am	Aviation and IPv6	Sachin Lal, Anil Kumar, Computer Networks & Software, Inc. and Manu Khanna, Comptel, Inc.
09:45 – 10:00 am	**BREAK**	
10:00 – 10:30 am	IPv6, Mobile IP, and Ad Hoc Technologies in Aeronautical Telecommunications Network: Putting the Pieces Together	Hussein Ali and Robert Rushing, Planning Systems, Inc.
10:30 – 11:00 am	Architectural Issues with the Use of IPSec	Ruben Bigio, Federal Aviation Administration, Jamie Chappell, Luoping Liu, BCI, Vic Patel, William J. Hughes FAA Technical Center, Jim Simpkins and Simon Blake-Wilson, BCI
11:00 – 11:30 am	IP Based Air-Ground Datalinks	Jocelyn Descaillot, SITA
11:30 – 12:00 pm	IMT-2000 Satellite Standards with Applications to Mobile Air Traffic Communications Networks	Mohammed Shamma, Analex Corporation
12:00 – 01:00 pm	**LUNCH**	
01:00 – 01:30 pm	Keeping Air Traffic Services Safe in a COTS Communications Environment	Diptesh Patel, National Air Traffic Services Ltd.
01:30 – 02:00 pm	Communication and the Future of Air Traffic Management	Mary Ellen Miller and Steven Dougherty, Raytheon
02:00 – 02:30 pm	Next Generation Datalink Applications	Peter Grogan, ARINC
02:30 – 02:45 pm	**BREAK**	
Session C4 – SWIM Session Chair: Cal Ramos, NASA Glenn Research Center		
02:45 – 03:15 pm	Net-Centric Strategy	Tim Wallace, Federal Aviation Administration
03:15 – 03:45 pm	System Wide Information Management (SWIM) Architecture Development	Zhenyi Jin, Tricia Gilbert, Stephen Henriksen, ITT Industries and Joshua Hung, Federal Aviation Administration
03:45 – 04:15 pm	System Wide Information Management Prototyping Activities	Duane Harkness, Avaliant LLC and Paul Comitz, Boeing Air Traffic Management
04:15 – 04:45 pm	System-Wide Information Management for Aeronautical Communications	Mark Taylor, The Boeing Company
04:45 – 05:15 pm	System Wide Information Management (SWIM) for Global Air Traffic Management (ATM)	Leon Sayadian and Eric Weill, Federal Aviation Administration

Thursday, April 29, 2004 – Track 3		
07:15 – 08:15 am	Registration/Continental Breakfast	
Session C5 – Airborne Internet Session Chair: James Meer, Microflight		
08:15 – 08:45 am	Airborne Internet/Collaborative Information Environment: Societal Trends Make *NOW* the Right Time to Create the "Network In The Sky"	Ralph Yost, William J. Hughes Technical Center
08:45 – 09:15 am	A Data Communications Concept for a SATS Scenario	James Hurlburt and Thomas Mulkerin, Mulkerin Associates Inc.
09:15 – 09:45 am	Transformational Cost Reduction for Airborne Broadband	William McNary, Aerosat
09:45 – 10:00 am	**BREAK**	
10:00 – 10:30 am	Next Generation Datalink for General Aviation	James Branstetter, Federal Aviation Administration
10:30 – 11:00 am	Electronic Flight Bags	Joe Burns, United Airlines
11:00 – 11:30 am	Mobi-Web: Bandwidth Management for a Mobile Collaborative Information Environment	Noel Schmidt, ATC Corporation
11:30 – 12:00 pm	Airborne Internet Consortium Developments	Jim Meer, Microflight and Paul Masson, STARNet, LLC
12:00 – 01:00 pm	**LUNCH**	
Session C6 – Demonstrations Session Chair: Michael Zernic, NASA Glenn Research Center		
01:00 – 01:30 pm	Global Communications, Navigation and Surveillance System (GCNSS) Flight Demonstrations	Robert Oxborrow, Boeing Company (presented by Robert Struth)
01:30 – 02:00 pm	Mobile Router Testing with Diverse RF Communications Links	David Brooks, Infinite Global Infrastructures, Doug Hoder, NASA Glenn Research Center and Ryan Wilkins, Infinite Global Infrastructures
02:00 – 02:30 pm	Passive Wake Acoustics Measurements at Denver International Airport	Frank Wang, Hadi Wassaf, John A. Volpe National Transportation Systems Center, Robert Dougherty, OptiNav, Inc., Kevin Clark, Andrew Gulsrud, John A. Volpe National Transportation Systems Center, Neil Fenichel, Microstar Laboratories, and Wayne Bryant, NASA Langley Research Center
02:30 – 02:45 pm	BREAK	
02:45 – 03:15 pm	Alaska's Capstone Program - Systems Engineering for Communication, Navigation and Surveillance	Daniel Stapleton and James Cieplak, The MITRE Corporation
03:15 – 03:30 pm	Aircraft in the Future ATM System	Pierre Depape, Airbus
03:30 – 04:00 pm	Overview of NASA Glenn Aero/Mobile Communication Demonstrations	David Brooks, Infinite Global Infrastructures, Doug Hoder, NASA Glenn Research Center and Ryan Wilkins, Infinite Global Infrastructures
04:00 – 04:30 pm	Mobile IP Demonstration	William Ivancic, NASA Glenn Research Center