Third Integrated Communications, Navigation and Surveillance (ICNS) Conference and Workshop 2003

Conclusions and Recommendations

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June 9, 2003

1.0 INTRODUCTION

The NASA Glenn Research Center organized and hosted the Third Integrated Communications, Navigation, and Surveillance (ICNS) Technologies Conference and Workshop, which took place May 19-22, 2003 at the Sheraton Barcelo Hotel in Annapolis, Maryland.

This conference followed the very successful (First) Workshop on Integrated Communications, Navigation, and Surveillance Technologies for Advanced Future Air Transportation Systems, held May 1-3, 2001 at the Wyndham Hotel in Cleveland, Ohio, and Second Integrated Communications, Navigation, and Surveillance (ICNS) Technologies Conference and Workshop, held April 29-May 2, 2002 at the Marriott Tysons Corner in Vienna, Virginia.

The purpose of the Third 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 234 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. 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 THIRD INTEGRATED CNS CONFERENCE AND WORKSHOP

The Third ICNS Conference and Workshop consisted of three primary elements: Technical presentations covering a variety of topics relating to CNS requirements and research needs; six 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 set of issues and recommendations.

Welcoming remarks by the Deputy Director of the Aeronautics Directorate of the NASA Glenn Research Center, Dr. Jaiwon Shin, and the Keynote Address by Carl McCullough of the White House Office of Science, Technology and Policy, were followed by a Plenary Session of aviation industry and R&D leaders: Robert Pearce of NASA Headquarters, Claire Robinson of the Federal Aviation Administration, Neal Planzer of the Department of Defense Policy Board on Federal Aviation, William Sears of the Air Transport Association, and George Donahue of George Mason University. Ten technical presentation sessions filled the program from May 20 through the morning of May 22, 2003:

Session A1: Emerging Network Technologies
Session A2: Integrated CNS Systems and Architectures
Session B1: Datalink Communications Systems
Session B2: Surveillance Systems
Session B3: Simulation and Modeling
Session C1: Navigation
Session C2: Airborne Internet
Session C3 Digital Flight Information Service
Session D1: Security Initiatives Impacting CNS
Session D2: Software Radio

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 technical presentations, six breakout sessions were held during the afternoon of May 22, with participation of the workshop attendees according to their interests. The breakout sessions were:

- Integrated CNS Architecture – Future Directions
- Modeling and Simulation of CNS Systems
- Software Defined Radio – Technology and Requirements
- Next Generation Terrestrial Air-Ground Datalink
- Future Surveillance Systems
- Information Security and CNS Hardening

Each breakout session presented a report of its findings to the Integrated CNS Workshop attendees at the end of the day on May 22. The breakout session presentations can be found in Appendix B of this report.

The Executive Committee met during the morning of May 23 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 Third 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 THIRD INTEGRATED CNS CONFERENCE AND WORKSHOP

The Third 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

Four major themes emerged during the Executive Committee discussions, resulting in five major recommendations. The themes are described in the following subsections, along with the related recommendations.

3.1.1 Software Radios/Multi Function Avionics

The emergence of software radio/multi function radio technologies (as evidenced by the presentation of several papers at the Conference) at a cost level that would make them attractive to commercial and general aviation users hold great promise for ATM designers and planners. The proliferation of separate C, N, and S, technologies and the global proliferation of different systems to perform the CNS functions bring with it significant cost and infrastructure burdens to the user community. In addition,

significantly delays in system installation and complication of the global standards for civil aviation result.

Past strategy for global C, N, and S, system standardization has had the goal of securing international standardization on a single system or signal format. However, as individual national needs grow and change, the difficulty of obtaining international standardization on a single design has increased tremendously. The time may well have passed in which achievement of a single CNS standard is possible because national needs and economics vary greatly throughout the world.

The emergence of software radio technologies offers the potential of proving a "sea state" change in international CNS planning. Instead of striving for a single signal standard that will accommodate all national needs, the emphasis can change to one of insuring interoperability of individual CNS systems without burdening the users and requiring that they carry many separate systems to perform identical functions in different parts of the world.

The economics of this technology may, indeed, offer the "all purpose interconnection" between separate C.N. and S technologies which would allow a single set of avionics to economically accommodate many different standards. This, in turn, would enable the acceleration of the pace of international standardization of new CNS systems and may indeed allow the development of less complex CNS systems that do not individually have the burdens of maintaining legacy compatibility.

Because of the attractiveness of this technology as a facilitator of new CNS systems, it is recommended that:

Development of a multi-mode, multi application automatically configurable avionics architecture should be a major research thrust for NASA.

3.1.2 Aviation Spectrum Planning Leadership is Needed

Aviation spectrum is a precious resource that is coming under increasing attack from commercial interests who want to use the spectrum for non-aviation applications. This pressure has been growing for many years, but of late, the pressure has accelerated due to the rapid expansion of the internet, cellular telephone, and related information technology services. This issue is compounded by the fact that many of he contemporary aviation CNS services and technologies date back to WWII and, by today's standards, are very inefficient users of the spectrum.

In 2007, the World Radio Conference will hold a meeting to study the re-allocation of the aviation spectrum. One can expect to be presented with many arguments that aviation uses spectrum very inefficiently and that other services can easily share (or encroach) on this spectrum without harming aviation operations. Furthermore, the development of

new CNS services will place increased demands on the integrity of the aviation spectrum.

Attendees at the ICNS Conference did not believe that the United States, or that aviation in general, was in a good position to defend the *continued exclusive use* of the currently allocated spectrum. They believe that much research has to be done to understand the spectrum implications of future aviation needs and aviation CNS systems.

The U.S. must be in a position to understand the implications of alternative proposals and, if appropriate, to defend the continued allocation of the current spectrum for aviation's needs. There was concern expressed that, unless specific action was taken to obtain this data, development of future ICNS systems could be severely hampered. The concern was that aviation interests in the U.S. do not seem to be taking the appropriate steps to be able to defend the future needs ICNS needs. Therefore, it was strongly recommended that:

NASA, in cooperation with the FAA, ensure that the requirements for future aviation spectrum are thoroughly and accurately defined and that spectrum is protected.

3.1.3 Integration of Safety and Security Projects

The growing emphasis on Homeland Security is already placing increased demands on the ICNS services to support these operations. Concerns exist regarding spoofing, data encryption, intentional jamming and interference, data distribution, etc. In addition, new services are being contemplated such as down-linking of cockpit/cabin video and current flight information to aid in the national Homeland Security efforts. As one contemplates the future architecture of a CNS system, it is clear that full provisions must be made to accommodate Homeland Security needs.

Concern was expressed at the ICNS conference regarding the possibility that NASA efforts in security and capacity may tend to diverge. Reasons for this concern included the fact that these programs were being separately managed and both seem to be seeking a total system concept of operations that are following different paths toward this end. While this is not inherently bad, it was nonetheless believed that:

NASA must take aggressive action to insure that its research efforts on security and aviation capacity are closely coordinated so that incompatibilities do not arise.

3.1.4 Conference Future Direction

It was agreed by virtually all attendees that this Third ICNS Conference was quite useful and meaningful and that efforts to proceed with future ICNS conferences should continue. It was believed that the Conference is sufficiently institutionalized and mature so that conscious consideration should be given to the direction, form, and content of the future efforts. Several options were identified that could potentially enhance the scope and content of future Conferences.

It was noted that there are very close ties between the emerging CNS technologies and the emerging "weather" technologies, but that this linkage was not well represented at this Conference. In fact, as one looks to the future, inclusion of weather needs (including wake vortex detection and avoidance technologies) will be a major requirement to be addressed in the design of future radar, data link, communications, and even GPS systems -- to name just a few.

It was believed by the Executive Committee that:

The scope of future ICNS Conference be expanded to include a major string on "weather" and that the scope be clearly broadened to include emerging weather technologies.

In addition to the above recommendation, there was considerable discussion at the Conference regarding both the organization and content of future Conferences. The intent was clearly to increase the impact of this Conference by including such strategies as:

- Focusing on additional invited papers
- Requiring written papers for all presentations
- Having peer review of papers
- Seeking additional international participation
- Formulating the sessions around a panel structure
- Organizing around issues
- Including aviation user panels in which representatives from various aviation user groups would describe their needs and concerns regarding future CNS and Weather systems

The Executive Committee discussed all of these options and concluded that all should be carefully considered as part of the planning for future ICNS Conferences. Because of the complexity of these issues, however, no final decision was made; rather, it is recommended that:

The ICNS Conference Executive Committee and/or others as deemed appropriate by NASA, be invited to convene within the next two months to consider and recommend to NASA these (or other) strategies for future ICNS Conferences.

3.2 Key Breakout Session Results

The key results from each of the six Workshop Breakout Sessions, as determined by the Executive Committee review of the Breakout Sessions' presentations prepared by the co-chairpersons of each session, are presented below. The full reports from each breakout session are presented in Appendix B.

3.2.1 Integrated CNS Architecture – Future Directions Session

The Integrated CSN Architectures session members identified a number of key attributes of the future ICNS architecture. The Executive Committee agreed upon the following as the most important of these key attributes:

- Security
- Flexibility (equipage, cost)
- Design Standards Independence
- Better leveraging of off the shelf products (IP, commercial, military)
- Cost Beneficial
- Performance
- Better Distribution of Weather, Terrain, Wake Vortex, etc. ~~Information~~
- Interoperability not Common Standards
- System Perspective (early CNS integration, not vertical C,N,S)
- No single point failure
- Information integration (weather information, surveillance, etc.)
- Moving from air traffic control to air traffic management

The most important of the key technical requirements identified by the session members are: the need to optimize air/ground and air/air channels to minimize the number of different CNS links needed; integrate CNS functionality through a network-centric architecture; terrain independence to achieve flexibility to operate in different areas; and integrate ground-based and satellite based surveillance systems.

The session identified 22 key technologies needed for developing long-term architectures. The most important of these are the following:

- Development of surveillance technologies for both security and air traffic management system backup, which needs to include non-cooperative surveillance.

- Research in standards and protocols, spectrum issues and optimum utilization of bandwidth.

- Increase the level of operability in all types of weather, i.e. make weather less of a factor in system efficiency, involving advanced technologies such as synthetic vision.

- The use of system engineering approaches and processes to build the system.

3.2.2 Modeling and Simulation of CNS Systems Session

The key results of the Modeling and Simulation Session are the following:

An increased emphasis on validation, verification, and building trust in model/simulation results is needed, as indicated by the specific recommendations below. An important area of CNS system modeling on which NASA in particular should focus is development of a modeling simulation capability to enable evaluation at the communication network level – network protocols and communication architectures to create the basis for national decisions

Specific Breakout Session Recommendations:

1. Collaboration among model builders must be fostered.
2. A list of existing models and simulations should be developed.
3. Models should be designed with compatible model interfaces – so other models can use their outputs or contribute to the inputs.
4. Standardization of scenarios and metrics is needed.

Continued exchange of information between CNS modeling and simulation experts must be encouraged, perhaps through the establishment of a CNS modeling and simulation forum, to implement the breakout session recommendations.

3.2.3 Software Defined Radio – Technology and Requirements Session

The potential offered by multi-functional avionics enabled by software defined technologies was recognized by the Executive Committee as a major theme of the conference and was addressed in section 3.1 of this report. Here, some of the key results of the Software Radio Breakout Session are summarized.

The multi-function avionics engendered by software radio technology is potentially a key enabler of modernization of the CNS infrastructure. However, it is important to understand the impact on the whole ICNS architecture.

Much discussion centered on the possible use of software radio technology developed for military use. A key that must be answered is: What is the subset of the military version that is applicable?

In order to move ahead with research and development to make multi-functional avionics based on software radio technology a reality for civil aviation, the breakout session recommended the approach outlined below.

Specific Breakout Session Recommended Approach:

- Conduct a detailed survey of the existing technology (JTRS, commercial wireless and existing avionics) to determine
  - Benefits and advantages
  - Lifetime of the existing technology
  - Integration with future technology
- Conduct a cost-benefit analysis of the application of multi-function avionics based on software radio technology
- Conduct a system safety assessment and analysis in order to make certification of the technology an important aspect of research and development from the beginning of the process.
- Develop a twenty year roadmap for radio technologies

The Executive Committee noted that the aviation community needs to be able to implement this affordably, soon enough to replace existing equipment as it needs to be retired, and therefore a twenty year planning horizon is not sufficiently aggressive to attain this goal. However, the Executive Committee did not recommend a specific alternate time frame.

3.2.4 Next Generation Terrestrial Air-Ground Datalink Session

The Next-Generation Terrestrial Air-Ground Datalink session members addressed the issue from the broader perspective of *"Next Generation Unconstrained Air-Ground Communication System"*.

The key research areas the session identified are: the need for the development of a concept of operations for communications; alternatives to frequency partitioning to achieve safety, such as required communications performance (RCP) and virtual private network technologies; evolution of the certification process to reduce certification cost impacts; improved understanding of electromagnetic interference (EMI) issues; information hardening to enable complete information security and integrity.

Recommendations made by the session and agreed with by the executive committee were: Maintain close control on economic perspective on research initiatives (e.g. take advantage of other on-board communications), and creation of a *steering committee (NASA, FAA, User Community, Broader Industry, etc.) to monitor/recommend research activities for implementation and economic realities.*

3.2.5 Future Surveillance Systems Session

The key research and development topics identified in the Future Surveillance Systems session considered most important by the Executive Committee are:

- Space based surveillance for non cooperative targets
- Next generation of collision avoidance systems (beyond TCAS)
- Model for 2020 traffic density, mix and separation requirements for all domains
- Use of airborne platform as meteorology probe
- Secure ADS-B
- Ability to fuse disparate sources with integrity monitoring
- National security needs (multi-function?)

Important additional attributes include supporting advanced ATM concepts (i.e. closely spaced runways) and surveillance architectures that seamlessly include all domains (i.e. surface, etc).

Other key issues include the security implications of emerging CNS technologies and application, policy and regulatory implications, equipage costs and benefits, and CNS firewalls.

3.2.6 Information Security and CNS Hardening Session

The Information Security and CNS Hardening Session identified the most important research and technology needs as: the need for a secure databases, for example for System Wide Information Management concepts (SWIM) and delivery of TFR/Protected Area for situation awareness in real-time; the need for the ability to perform analysis of system impact of security technologies and services on CNS infrastructure; and the capability to model quantifiable performance tradeoffs such as security risk, quality of service, and cost.

The key recommendation in the information security area is to establish strong leadership from the FAA to move security initiatives forward.

4.0 SUMMARY OF CONFERENCE AND WORKSHOP CONCLUSIONS AND RECOMMENDATIONS

The ICNS Conference Executive Committee identified common themes and issues from the conference and also reviewed the outputs of the six workshop breakout sessions to derive the most important issues and recommendations. These results are given in detail in the previous section and in Appendix B, and are summarized below.

Executive Committee Recommendations

1. Development of a multi-mode, multi application automatically configurable avionics architecture should be a major research thrust for NASA.

2. NASA, in cooperation with the FAA, define (and execute) the work necessary to insure that the necessary requirements for the future aviation spectrum are understood and protected.

3. NASA must take aggressive action to insure that its research efforts on security and aviation capacity are closely coordinated so that incompatibilities do not arise.

4. The scope of future ICNS Conference be expanded to include a major string on "weather" and that the scope be clearly broadened to include emerging weather technologies.

5. The ICNS Conference Executive Committee and/or others as deemed appropriate by NASA, be invited to convene within the next two months to consider and recommend to NASA these (or other) strategies for future ICNS Conferences.

Workshop Breakout Session Key Issues and Recommendations

1. Integrated CNS Architecture – Future Directions

   Key technical requirements of the future ICNS Architecture:
   - Optimization of air/ground and air/air channels.
   - Integration of CNS functionality through a network-centric architecture.
   - Terrain independence to achieve flexibility to operate in different areas.
   - Integration of ground-based and satellite based surveillance systems.

   Key technologies needed for developing long-term architectures. The most important of these are the following:

   - Surveillance technologies for both security and air traffic management system backup, which needs to include non-cooperative surveillance.
   - Research in standards and protocols, spectrum issues and optimum utilization of bandwidth.

- Technologies to enable increased level of operability in all types of weather, i.e. make weather less of a factor in system efficiency, involving advanced technologies such as synthetic vision.
- The use of system engineering approaches and processes to build the system.

2. Modeling and Simulation of CNS Systems

Specific Breakout Session Recommendations:

- Collaboration among model builders must be fostered.
- A list of existing models and simulations should be developed.
- Models should be designed with compatible model interfaces – so other models can use their outputs or contribute to the inputs.
- Standardization of scenarios and metrics is needed.

The establishment of a CNS modeling and simulation forum is recommended to implement the breakout session recommendations.

3. Software Defined Radio – Technology and Requirements

Multi-functional avionics enabled by software defined technologies:

Specific Breakout Session Recommended Approach:

- Conduct a detailed survey of the existing technology (JTRS, commercial wireless and existing avionics.
- Conduct a cost-benefit analysis of the application of multi-function avionics based on software radio technology.
- Conduct a system safety assessment and analysis.
- Develop a roadmap for multi-function avionics that can be implemented this affordably and soon enough to replace existing equipment as it needs to be retired.

4. Next-Generation Terrestrial Air-Ground Datalink

Key recommendations:

- Maintain close control on economic perspective on research initiatives (e.g. take advantage of other on-board communications).
- Create a steering committee (NASA, FAA, User Community, Broader Industry, etc.) to monitor/recommend research activities for implementation and economic realities.

5. Future Surveillance Systems

Key research and development topics:

- Space based surveillance for non cooperative targets.
- Next generation of collision avoidance systems (beyond TCAS).
- Model for 2020 traffic density, mix and separation requirements for all domains.
- Use of airborne platform as meteorology probe.
- Secure ADS-B.
- Ability to fuse disparate sources with integrity monitoring.
- National security needs (multi-functional surveillance system).
- Ability to support advanced ATM concepts (e.g. closely spaced runways).
- Surveillance architectures must seamlessly include all domains (i.e. surface, etc).

6. Information Security and CNS Hardening

Key research and technology needs:

- Secure databases.
- The ability to perform analysis of system impact of security technologies and services on CNS infrastructure.
- The capability to model quantifiable performance tradeoffs such as security risk, quality of service, and cost.

The key recommendation in the information security area is to establish strong leadership from the FAA to move security initiatives forward.

APPENDIX A
The Technical Sessions of the 3rd Integrated Communications, Navigation and Surveillance Technologies Conference

Tuesday, May 20, 2003		
07:30 – 08:30 am	Registration/Continental Breakfast – Sponsored by Sensis Corporation	
Opening Plenary Session Session Chair – Pete Vrotsos, NASA Glenn Research Center		
08:30 – 08:40 am	Welcome	Donald Campbell, NASA Glenn Research Center
08:40 – 08:50 am	Overview Week	Denise Ponchak, NASA Glenn Research Center
08:50 – 09:00 am	Opening Remarks	Pete Vrotsos, NASA Glenn Research Center
09:00 – 09:30 am	Keynote Address	Carl McCullough, Agency Representative for Federal Aviation
09:30 – 09:45 am	BREAK	
09:45 – 10:00 am	Introduction to Panel	Pete Vrotsos/NASA Glenn Research Center
10:00 – 11:15 am	Transforming the NAS	Robert Pearce, NASA Headquarters Claire Robinson, Federal Aviation Administration Neil Planzer, DoD Policy Board on Federal Aviation William Sears, Air Transport Association George Donohue, George Mason University
11:15 – 11:40 am	Questions to the Panel	
11:40 – 01:00 pm	LUNCH – Sponsored by ARINC	
Session A1 – Emerging Network Technologies Session Chair – Chris Wargo, Computer Networks & Software, Inc.		
01:00 – 01:30 pm	Aeronautical Telecommunications Using IPv6	Bob Stephens, Tectura Corporation
01:30 – 02:00 pm	Mobile Networking – Including Application to Aeronautical Internets	Will Ivancic, NASA Glenn Research Center
02:00 – 02:30 pm	Internet Protocol for Aeronautical Exchange (iPAX-TF) – European Initiatives for IP Deployment	Eivan Cerasi, Eurocontrol
02:30 – 02:45 pm	BREAK	
02:45 – 03:15 pm	Applications Using the Airborne Internet for Cost Effective Airport Information	Edwin Tirona, Dynamic Systems Integration
03:15 – 03:45 pm	Unified Air-Ground IP Networks – Ground Infrastructure	Jocelyn Descaillot, SITA
03:45 – 04:15 pm	ATN over IP Models for Evaluation	Crispin Netto, Computer Networks & Software, Inc.
Session A2 – Integrated CNS Systems & Architectures Session Chairs – Ann Tedford, FAA and Michael Zernic, NASA Glenn Research Center		
01:00 – 01:30 pm	GCNSS Demonstration Segment A Flight Demonstration	Bob "Prof" Struth, Boeing Air Traffic Management
01:30 – 02:00 pm	A TDMA Broadcast Satellite/Ground Architecture for the Aeronautical Telecommunications Networks	Mohammed Shamma and Rajesh Raghavan, Analex Corporation
02:00 – 02:30 pm	MTSAT	Shigeki Masuda, Air Traffic Services Department, JCAB
02:30 – 02:45 pm	BREAK	
02:45 – 03:15 pm	Hybrid Terrestrial/Satellite High Bandwidth Aeronautical Communication Systems	Michael Farneth, Sensis Corp.
03:15 – 03:45 pm	Satellite Communications for ATM	Mohammed Shamma, Analex Corporation
03:45 – 04:15 pm	A Common Information Network for Aeronautical Communications	Mark Taylor, Boeing ATM

Wednesday, May 21, 2003 – Track 1		
07:30 – 08:30 am	Registration/Continental Breakfast	
Session B1 – Datalink Communications Systems Session Chair – Mitch Huffman, Delta Airlines		
08:30 – 09:00 am	Data in Voice (DiV) – An Aeronautical In-Band Messaging Service	Vince Campanella, FREQUENTIS
09:00 – 09:30 am	VDL Mode 3 Integrated Voice and Data Link	Thomas Kabaservice, Harris Corporation (presented by Carol Gabica)
09:30 – 10:00 am	Frequency Reuse, Cell Separation, and Capacity Analysis of VHF Digital Link Mode 3 TDMA	Mohammed Shamma and Thanh Nguyen, Analex Corporation, Rafael Apaza, Federal Aviation Administration
10:00 – 10:15 am	BREAK	
10:15 – 10:45 am	Controller Pilot Data Link Communications (CPDLC) Over VHF Digital Link (VDL) Mode 2	John Burks, ARINC
10:45 – 11:15 am	High Frequency Data Link Background and Future Plans	Pat deBarros, ARINC
11:15 – 11:45 am	ARINC ACARS Messenger	Rolf Stefani, ARINC
11:45 – 01:00 pm	LUNCH – Sponsored by Boeing Air Traffic Management	
01:00 – 01:30 pm	Developing the Air Traffic Controller-Computer Interface for Controller-Pilot Data Link Communication	Robert Potter and Benjamin Linn, CTA, Inc.
01:30 – 02:00 pm	Advanced Airport Data Link - Concept and Demonstrator Implementation for a Modern Airport Data Link	Erik Haas and Michael Schnell, German Aerospace Center
02:00 – 02:30 pm	SITA ATS Aircom Data Link Services and What's Next?	Kathleen Kearns, SITA
02:30 – 03:00 pm	The Aeronautical Data Link: Decision Framework for Architectural Analysis	A. Terry Morris and Plesent Goode, NASA Langley Research Center
03:00 – 03:15 pm	BREAK	
Session C1 – Navigation Session Chair – Rafael Apaza, Federal Aviation Administration		
03:15 – 03:45 pm	The Past, Present, & Future of LAAS	Gary Skillicorn, Federal Aviation Administration
03:45 – 04:15 pm	A Real-Time Bi-Directional Differential Global Positioning System	Chris Bartone and Ranjeet Shetty, Ohio University
04:15 – 04:45 pm	CNS/ATM for Tactical Military Aircraft	Steven Frain, Naval Air Systems Command and Garth Van Sickle, DCS Corporation
04:45 – 05:15 pm	Vertically-Guided Instrument Approaches Using the Wide Area Augmentation System (WAAS)	Emily Calle, H. Leslie Crane, S.Vince Massimini and Frederick Niles, The MITRE Corporation

12:00 – 06:00 pm	SATS Airborne Internet Demonstration	Board Room

Wednesday, May 21, 2003 – Track 2		
07:30 – 08:30 am	Registration/Continental Breakfast	
Session B2 – Surveillance Systems Session Chairs – Len Carlson, Technology Services Corp. and Marc Viggiano, Sensis Corp.		
08:30 – 09:00 am	Using Automatic Dependent Surveillance Broadcast (ADS-B) and Other Technologies to Enhance Safety and Efficiency in the NAS	Ken Leonard, Federal Aviation Administration
09:00 – 09:30 am	NASA AATT HITS Program (Helicopter In-Flight Tracking System) FAA Safe Flight 21 En Route and Oceanic Applications	Anastasios Daskalakis and Patrick J. Martone, U.S. DOT Volpe Center
09:30 – 10:00 am	Evolution Path of a Surveillance Data Network	Scott Remillard and Chris Smith, Sensis Corporation
10:00 – 10:15 am	BREAK	
10:15 – 10:45 am	Intent or How Do We Get to Trajectory-Based Air Traffic Control and Management?	Mike Harrison, Aviation Management Corporation
10:45 – 11:15 am	Development of a Vehicle Independent Surveillance Data Collection System	Seamus McGovern and Kam Chin, DOT Volpe Center
11:15 – 11:45 am	Implementing a Smart Landing Facility for Mixed Traffic	Tim Pratt, Eric Shea and Charles Florin, Virginia Tech
11:45 – 01:00 pm	LUNCH – Sponsored by Boeing Air Traffic Management	
01:00 – 01:30 pm	High Performance Situation Display Capability for the CNS/ATM Domain	Waseem Naqvi and Jean-Marie Dautelle, Raytheon
01:30 – 02:00 pm	Evolving Advanced Traffic Surveillance Prototype Avionics Towards Products	Sethu Rathinam, Rockwell Collins
02:00 – 02:30 pm	Improved Emergency Locator and Tracking Beacons for Aircraft	Tim Pratt, Eric Shea and Charles Florin, Virginia Tech
02:30 – 02:45 pm	BREAK	
Session C2 – Airborne Internet Session Chairs – Pete McHugh, Federal Aviation Administration and James Meer, Microflight		
02:45 – 03:45 pm	A Small Aircraft Transportation System…Can be Networked…	Ralph Yost, Federal Aviation Administration Tech Center (presented by Pete McHugh, Federal Aviation Administration)
03:45 – 04:15 pm	Real-Time Small Aircraft Transportation System (SATS) Engineering Test Bed for the Definition, Development and Validation of Operations Using an Airborne Internet (AI) Architecture	Steve Friedman and Wendell Turner, ADSI, Inc.
04:15 – 04:45 pm	Aviation Web Services the JEMPRS Story	Randy Schmidt, Ken Garove and Eric Kramer, Microsoft Corporation

12:00 – 06:00 pm	SATS Airborne Internet Demonstration	Board Room

Wednesday, May 21, 2003 – Track 3		
07:30 – 08:30 am	Registration/Continental Breakfast	
Session B3 – Simulation and Modeling Session Chairs – Fred Seelig, MITRE and Thanh Nguyen, Analex Corporation		
08:30 – 09:00 am	Boeing ATM Tools, Models and Simulations	Joni Robbins, Boeing
09:00 – 09:30 am	Modeling CNS for the Virtual Air Space Technologies Toolbox	Steve Mainger, NASA Glenn Research Center and Tom Mulkerin, Mulkerin Associates Inc.
09:30 – 10:00 am	Testing Complex Communication Systems in a Virtual Environment	Manuel Garcia, ViaSat, Inc.
10:00 – 10:15 am	BREAK	
10:15 – 10:45 am	IPv6 Modeling in OPNET	Taylor Salman, OPNET Technologies, Inc.
10:45 – 11:15 am	General Aviation Aircraft Data Communications Analysis Using a Web-Based Tool	Tom Mulkerin, Mulkerin Associates and Michael Zernic, NASA Glenn Research Center
11:15 – 11:45 am	A Performance Study of the ATN COTP over the VDL Mode 3 Subnetwork	Brian Hung, MITRE
11:45 – 01:00 pm	LUNCH – Sponsored by Boeing Air Traffic Management	
01:00 – 01:30 pm	Evaluating VDL Mode 2 Performance Through Simulation	Steven Bretmersky and Vijay Konangi, Cleveland State University and Robert Kerczewski, NASA Glenn Research Center
01:30 – 02:00 pm	A Comparison of Mode S ADS-B Performance in Three LA Basin 2020 Scenarios	Rajesh Raghaven, Analex Corporation
02:00 – 02:30 pm	RF Design and Spectrum Analysis Methods	Minh Nguyen, MITRE
02:30 – 02:45 pm	BREAK	
Session C3 – Digital Flight Information Service Session Chair – Mike Jarrell, NASA Glenn Research Center and Tom Tanger, Lockheed Martin M and DS		
02:45 – 03:15 pm	Turbulence Auto-Pirep System (TAPS)	Paul Robinson, AeroTech Research
03:15 – 03:45 pm	Evaluating Safety Results from Capstone Phase 1 and Interim Assessment of 2000-2001	Worth Kirkman, MITRE
03:45 – 04:15 pm	Updating Electronic Charts Using ADS-B Broadcast Services	Gary Livack, Federal Aviation Administration and Ken Staub
04:15 – 04:45 pm	CoopATS: The Cooperative Air Traffic Services Concept	Jose Roca, Eurocontrol
04:45 – 05:15 pm	Integrated Cockpit Systems as Aviation Moves Forward	Gary Stuteville, Honeywell

12:00 – 06:00 pm	SATS Airborne Internet Demonstration	Board Room

Thursday, May 22, 2003		
07:30 – 08:30 am	Registration/Continental Breakfast	
08:00 – 08:30 am	Prep Meeting for Workshop Breakout Session Chairs – Board Room	
Session D1 – Security Initiatives Impacting CNS Session Chairs – Marie Stella, FAA and Gus Martzaklis, NASA Glenn Research Center		
08:30 – 08:40 am	Introduction and Session Objective	Gus Martzaklis, NASA Glenn Research Center
08:40 – 09:00 am	MOMS (Management, Operational and Maintenance Security) in the NAS – the Challenge of the New Millennium	Marie Stella, Federal Aviation Administration
09:00 – 09:30 am	Data Link Security for Airline Operational Communications and Air Traffic Service - *An Opportunity for Synergistic Efforts*	Donald Kauffman, Honeywell
09:30 – 10:00 am	Providing the Foundation for Security Certification within U.S. Government Civil Agencies Integrated Communications, Navigation, and Surveillance (ICNS)	Beryl Hosack and Joe Guirreri, Computer Sciences Corp.
10:00 – 10:15 am	BREAK	
10:15 – 10:45 am	An Architectural Concept for Intrusion Tolerance in Air Traffic Networks	Jeff Maddalon and Paul Miner, NASA Langley Research Center
10:45 – 11:05 am	Security Considerations for the Future e-Enabled Aircraft	Chris Wargo and Chris Dhas, Computer Networks & Software, Inc.
11:05 – 11:25 am	North American Aerospace Surveillance Council (NAASC) & Inter-agency Homeland Air Security (IHAS) Foundations for the Future	Tim Wallace, Federal Aviation Administration (presented by Dave Vechik)
11:25 – 11:45 am	Securing the Vehicle and the NAS: Information Security and CNS Hardening Research Issues	Gus Martzaklis, NASA Glenn Research Center
11:45 – 01:00 pm	LUNCH	
Session D2 – Software Radio Session Chairs – Jim Budinger and Richard Reinhart, NASA Glenn Research Center		
08:30 – 09:00 am	Software Radio (R)Evolution and its Application to Aeronautical Mobile Communications	Minh Nguyen, The MITRE Corporation
09:00 – 09:30 am	Software Definable Radio Aviation Key to Global Interoperability	Michel Gelinas, Mike Durkin and Chris Long, General Dynamics Decision Systems
09:30 – 10:00 am	The Software Defined Radio	Edward Calhoun, Rockwell Collins
10:00 – 10:15 am	BREAK	
10:15 – 10:45 am	Wideband Software Defined Radio (SDR) Design Using Field Programmable Gate Arrays (FPGAs)	John Porcello, Booz-Allen & Hamilton and Ramon Llanos, Electronic Combat Division, Intelligence and Information Warfare Directorate (I2WD), US Army CECOM
10:45 – 11:15 am	Software Reuse in Safety-Critical Systems	Leanna Rierson and Barbara Lingberg, Federal Aviation Administration
11:15 – 11:45 am	Joint Tactical Radio System (JTRS) Program Status and JTRS ORD Waveforms R/Evolution	Gene Harrison, MITRE
11:45 – 01:00 pm	LUNCH	
Workshop Breakout Sessions Break 3:00 – 3:15 pm		
01:00 – 01:15 pm	I-CNS Workshop Overview	Robert Kerczewski, NASA GRC
01:15 – 05:00 pm	Integrated CNS Architecture - Future Directions	Art Feinberg, Aviation Management Associates, Inc. and Chris Wargo, CNS, Inc.
01:15 – 05:00 pm	Modeling and Simulation of CNS Systems	Thanh C. Nguyen, Analex and Fred Selig, MITRE/CAASD
01:15 – 05:00 pm	Software Defined Radio - Technology and Requirements	Jim Budinger and Rich Reinhart, NASA GRC
01:15 – 05:00 pm	Next Generation Terrestrial Air-Ground Datalink	Rafael Apaza, FAA, Rob Fuschino, United Airlines
01:15 – 05:00 pm	Future Surveillance Systems	Jim Branstetter, FAA
01:15 – 05:00 pm	Information Security and CNS Hardening	Gus Martzaklis, NASA GRC and Marie Stella, FAA
05:00 – 05:30 pm	Breakout Session Brief Out	All

APPENDIX B

Presentations of the Breakout Session of the 3rd Integrated Communications, Navigation and Surveillance Technologies Conference

The breakout sessions convened after lunch (approximately 1:15 p.m.) on Thursday, May 22, 2003. The six breakout sessions met in separate rooms under the leadership of breakout session chairs as indicated below. The six sessions were attended by ICNS Conference attendees based primarily on the attendee's interests and expertise areas. The ICNS technical organizers and breakout session chairs also solicited attendees who were thought to be vital for particular breakout sessions, in some cases.

Breakout Session 1 – Integrated CNS Architecture
Chairs:
Art Feinberg, Aviation Management Associates
Chris Wargo, Computer Networks & Software, Inc.

Group Report

- Reviewed last year's session results for "revolutionizing CNS"
- Introduction of group members
- Overview of session
- Technologies capabilities do not require global standards
- Timeframe
  - Far enough out to influence long term systems
  - Involves two parts: target date and operational deployment
  - 2020 and beyond
  - Attributes includes standards independence
  - Aggressive thinking
  - 2010 system is deterministic (contracts in place)
  - Visualize architecture that takes advantage of technology
  - Think beyond current technology
- Architecture
  - Procedures, hardware, software are all part of architecture

Question 1

- 1 – What are the desired attributes of the long term ICNS architecture?
  - Security
  - Flexibility (equipage, cost)
    - Universal avionics (like software based radio)
    - UAVs, GA, wide body
    - Differing service levels
  - Design Standards Independence
    - Use public standards
    - Use better standards makers
    - Software independent radio
    - Protocol independence
  - Better leveraging of off the shelf products
    - Utilizing recent IP technologies
    - Other systems (commercial, public infrastructure)
    - Leverage Military CNS
  - Dynamic Scheduling
  - Cost Beneficial
    - Higher ROI and higher rate of change
    - Efficient use of equipment

Question 1 (continued)

- Business Side
  - Evolution
  - Concurrent evolution rather than serial
  - Prevent integration problems
- Performance
- Better Distribution of Weather Information
- Interoperability not Common Standards
- System Perspective (early CNS integration, not vertical C,N,S)
- Wireless Infrastructure, not necessarily SAT, VHF
- Integrated but not related to Wireless, not tying together equipment
- Information integration (weather information, surveillance, etc.)
- Moving from air traffic control to management
- Self determined Air Traffic Management (Collaborative)
- Not necessarily totally autonomous (restricted air space, other users)
- Some flexible components get autonomy
- Could user use system autonomously without worrying about other users
  - Could use and get more performance
  - More freedom
- Achieve autonomy when practical

Question 1 (continued)

- Responsibility consistent with user's performance
- Not trapped in system that in the future components won't apply anymore
- Freedom, not complete freedom
- Technology is letting the pilot be "his own controller"
- Fully digital

Question 2

- 2 – What are the key technical requirements of the long-term ICNS architecture?
  - Optimize channels for air to ground, air to air, etc. (minimize CNS links)
  - Integrate CNS functionality (network centric)
  - Situational awareness for all users
  - Networked with integrated displays
  - Sectors and classes refinement
  - CNS system that responds to dynamic sectors
  - Tools that allow communication loads, traffic loads (information loads) to be calculated for tests
  - User Intent
    - Part of situational awareness
  - Long term architecture that does not allow for single point failure
  - Redundancy
  - Diversity
  - Oceanic operation
  - Would not differentiate between ground or sea (global system)
  - Terrain independence (flexibility)
    - Transparent enough to work over different areas

Question 2 (continued)

- Real Time Information Sharing between all air space users
- Coverage for greater number of users and then migrate to everyone
- Delay has to appear to be zero or instantaneous to the user
- "Changing environment" vision
  - Expectation of better levels of safety
  - Better Efficiency
  - Increasing capacity
- Responsive to future environment (Concept of operation)
- Maintains large number of ground base radars
- Surveillance for safety and security
- Integrate ground based and satellite based surveillance systems
- Fulfills security requirements
- Normalizing or reducing long term operational cost
- Right type of business case

Question 3

- 3 – What are the key technologies to focus on in developing long-term architecture candidates
  - Secure Network technologies to support integration of CNS
  - Autonomic Systems (self monitoring, self maintaining)
  - Processor to interpret standards
  - Self configuring computers
  - Hybrid system engineering approach to integrate ground based and satellite based systems
  - Wireless broadband CNS implementation
  - Surveillance for backup and security
    - Non-cooperative surveillance system
    - May be ground based
    - Surveillance fusion
  - Integrated, universal display
  - Adequate situational awareness (virtual displays)
  - Protocols, Spectrum and Bandwidth research
  - Voice Synthesis and Response (voice recognition)

Question 3 (continued)

  - Ability to increase operability in all types of weather (make weather less of a factor of efficiency)
    - Synthetic vision systems
  - Closed width capture with total situation awareness
  - Non-conforming flight objects decision support tool
  - ILS (integrated logistics support), failure prediction system
  - System engineering tools and processes to build system
  - Aircraft tools integration
  - Service availability in case of failures
  - Better procedures
  - Technology migration (software engineering)
    - Open system architecture
  - Sensor improvements
    - New sensors
    - Order of magnitude improvements
  - Minimizing Interference (RF)
    - Insuring GPS signal integrity

Breakout Session 2 – Modeling and Simulation
Chairs:
Thanh Nguyen, Analex Corporation
Fred Seling, The MITRE Corporation

Modeling and Simulation of CNS Systems

1 – What is the current state-of-the-art of modeling and simulation of aeronautical CNS systems?

Current Tools

1. OPNET
2. TAAM (Total Airport and Airspace Model)
3. ACES (Airspace Concepts Evaluation System)
4. Eurocontrol's RAMS (Reorganized ATC Mathematical Simulation)
5. FASTE-CNS
6. NS-2 (Network Simulator)
7. MATLAB Simulink
8. QualNet
9. STK (Satellite Tool Kit)
10. Boeing CNS Modeling Tool

Above tools were identified by the workshop participants. Other tools do exist.

Modeling and Simulation of CNS Systems

Current Models

- MITRE CAASD (OPNET)
  - ATN, VDL-2, VDL-3 (various flavors), Mode-S
  - Measure throughput and delay, protocol overhead
- CSU (OPNET)
  - VDL-2, VDL-3 (3T), VDL-4, AMSS (Inmarsat)
  - Measure throughput and delay
- Analex GRC
  - VDL-3, ADS-B/Mode-S, UAT, Satellite TDMA
- University of MD (OPNET/STK)
  - Satellite link (GEO and MEO)
- CSSI (Custom Tools,a combination of COTS tools)
  - Operational concepts (airborne self separation)
- Seagull (3rd party traffic generators based on custom tools)
  - Fast time, real time, VDL-3, Mode-S, ATCRB-S
- CNS Inc. / GRC (C#, MS .net)
  - Physical layer applications
- Tools also developed at MIT Lincoln Labs, APL at JHU

Modeling and Simulation of CNS Systems

2 – What is the end goal of CNS modeling and simulations? What are the requirements?

1. Answer fundamental R&D Questions
   - Tradeoff between different technologies
     - Ground-based vs. satellite-based communications links
     - CDMA vs. TDMA Systems
   - Guide R&D directions and standards development
2. Show the impact of CNS system performance on pilot, aircraft and controller behavior
3. Impact of CNS performance on operational concepts and vice versa
4. Impact of environment (weather, terrain etc.) on CNS performance requirements
5. Guide acquisition decisions

Modeling and Simulation of CNS Systems

3 – What are the modeling and simulation gaps?

1. Lack of collaboration within modeling/simulation research community
2. Adaptive behavior of people in the system.
3. Integrating CNS models with behavior based operational models.
4. Impact of CNS performance on separation standards.
5. Security Modeling
6. Safety Modeling
7. Common unified library of interacting models (e.g a national testbed filled with libraries like VDL-2, VDL-3, EPS, WAAS radars)
8. Lack of standardized traffic models and scenarios, and their inconsistent use.
9. Inadequate definitions for fidelity

Modeling and Simulation of CNS Systems

3 – What are the modeling and simulation gaps? (..contd.)

10. ATN vs. IPv6
    - Mobile IPv6
    - Interoperability of ATN applications in IPv6
11. Modeling of acquisition/policy making process
12. Modeling of future CNS landscape
13. Model transitions between technologies
14. Consistent validation of models

4 – What is the recommended approach to eliminating these gaps and reaching the end goals?

1. Collaboration among model builders
2. Create a list of existing models and simulations.
3. Models should be designed with compatible model interfaces – so other models can use their outputs or contribute to the inputs.
4. Standardization of scenarios and metrics.

Breakout Session 3 – Software Defined Radio – Technology and Requirements

Chairs:

James Budinger, NASA Glenn Research Center
Richard Reinhart, NASA Glenn Research Center

Software Radio - Technology and Requirements

1 – What are the top level requirements and goals/desires for a software radio? (i.e what applications and needs should software radios address in communications, navigation and/or surveillance?)

- Maximize and leverage the accomplishments of the SDR forum, the software communications architecture, the Joint Tactical Radio System program, the NEXCOM program, and commercial wireless industry
- Develop a concepts of operations for different applications
  - Identify the long term problems and potential benefits for all users of the NAS that SDR can address
  - Define the evolutionary path for the next generation after NEXCOM
  - Define a long term evolutionary path for integrated C, N, and/or S functions for all users in NAS in long term
- Strive for open architectures and global standardization
  - Interoperability with international standards and interface standards
  - Pursue a layered approach, with scalability and extensibility

Question 1 (Concluded)

- Identify cost/benefit for airlines and users of the NAS
  - Classification of cost benefits based on classes of aircrafts, mission and ownership
  - Near term benefits to users (e.g. maintainability, Reduced Logistics
  - Long term benefits (e.g. Enabler of transition toward NAS enhancement and ICNS)
- Identify system reliability and availability of the equipment
- Enable expandable scope of capabilities via SDR to potentially include communication, navigation, and surveillance functions
- Proactively plan for implementation with systems safety assurance and certification
  - Compliance with current standardization framework and cognitive of other emerging standards

Software Radio - Technology and Requirements

2 - What are the prioritized challenges to development and infusion of software radios?

- End user demand and acceptance
  - Economics
- Impact on system safety
  - Methodology of software and hardware certification
  - Effect on other safety critical avionics (C, N, and S functions)
  - How to certify the SDR and it's impact on other safety
- Policy and/or cultural issues
- Technical challenges
  - Cost sensitivity based on market demand
  - Size sensitivity based on application (e.g. Miniaturization)
  - Reliability, Flexibility, Upgradeable and Extensibility
  - Avionics for different classes of aircraft
- Roadmap for development and infusion of SDR into NAS and TSD

Software Radio - Technology and Requirements

3 - What are the technical and cost requirements? (i.e. what frequency range should be covered, what functions, what waveforms, what cost targets, etc.)

Software Radio - Technology and Requirements

4 - What is the recommended approach to reaching the goals? (i.e. what is the transition roadmap and timeframe for major milestones?)

- Detail survey of the existing technology (JTRS, Commercial wireless and existing avionics)
  - Benefits and advantages
  - Lifetime of the existing technology
  - Integration with future technology
- Cost benefit analysis
  - Elation to FAA for target system description
- System safety assessment and analysis
- Twenty year roadmap for radio technologies

Other Issues Parking Lot

- Should we develop a unified certification approach for software platforms?
  - Whom do we approach for that? OSTP,NSC,FCC, FAA?
- Should FAA ask RTCA to develop SDR standard?
- Should AEEC (and therefore the avionics suppliers and airlines) develop a common hardware standards?
- Is backward compatibility with legacy waveforms always a requirement?

Breakout Session 4 – Next Generation Terrestrial Air-Ground Datalink
Chairs:
Rafael Apaza, Federal Aviation Administration
Rob Fuschino, United Airlines

Next Generation Terrestrial Air-Ground Datalink

How 'Bout: "Next Generation Unconstrained Air-Ground Communication System?"

Assumption: 2025 and Beyond

Mission Need Statement: Connectivity that enables seamless communications for..

- Mission Accomplishment
- Operational Business
- Corporate Business
- Personal Needs/Desires

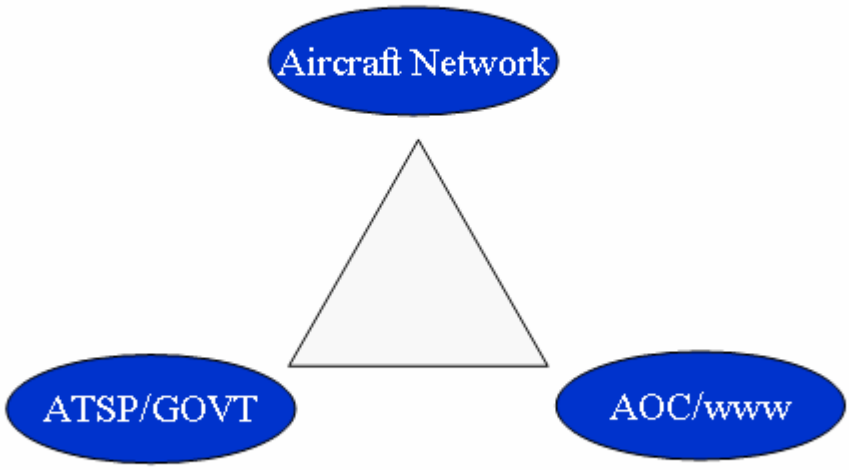
Next Generation Unconstrained Air-Ground Communications

Recommendation:

Maintain close control on economic perspective on research initiatives.

Maybe… *Steering committee (NASA, FAA, User Community, Broader Industry etc) to monitor/recommend research activities for implementation and economic realities.*

Next Generation Unconstrained Air-Ground Communications



Witchey Communications Triangle

Next Generation Unconstrained Air-Ground Communication

Key Research Areas

- CONOPS (Stay Focused)
- Alternates to Frequency Partitioning for Safety
  - -- RCP
  - -- Virtual Private Network
- Evolve the Certification Process ($$$)
- Really Understanding EMI
- Info Hardening

Breakout Session 5 – Future Surveillance Systems
Chairs:
James Branstetter, Federal Aviation Administration
Marc Viggiano, Sensis Corporation

Future Surveillance Systems--Requirements

- Requirements
  - Support 4D trajectory based separation
  - Support airborne self separation
  - Support national security requirements (conformance monitoring: non-cooperative targets; CONUS coverage)
  - Support of 3X NAS capacity
  - Gate to gate seamless coverage across all flight domains
  - Improved Weather surveillance
  - Support a mix of sensors and sources to provide a fused common air picture
  - Feed data to multiple users through publish/subscribe SDN
- Unmet Needs
  - Lower life cycle cost and improved RMA
  - Improved low altitude coverage
  - Less than 5 sec surveillance update rate in terminal area
  - Better use of overlap sensors
  - Wake vortex detection
  - Surveillance sufficient 4-6 Hr weather prediction

Sensis CORPORATION -1- *Detect the Difference*

Future Surveillance Systems—R & D Topics

- Space based surveillance for non cooperative targets
- Next generation of collision avoidance systems
- Model for 2020 traffic density, mix and separation requirements for all domains
- Define the role of the NAS in future air security
- Use of airborne platform as meteorology probe
- Wake Vortex detection and prediction
- Secure ADS-B
- Ability to fuse disparate sources with integrity monitoring

Future Surveillance Systems -- Other Issues

- Security implications of emerging CNS technologies and applications
  - Privacy, military freedom of movement
    - Anonymous/secure ADS-B
  - Securing surveillance network
- Policy and regulatory implications
  - Evaluate TIFR's, etc)
  - Who pays for equipage, etc?
  - What is a common ...? Revisit redundancy of CNS avionics/technology
- Equipage costs and benefits
  - Define benefits?
  - Limited mandates
  - What do I buy to be compliant? Need a path for "Well Dressed Cockpit"
  - Least expense equals more implementation
    - Leverage technology for low cost
- CNS firewalls

Breakout Session 6 – Information Security and CNS Hardening
Chairs:
Gus Martzaklis, NASA Glenn Research Center
Marie Stella, Federal Aviation Administration

Information Security & CNS Issues

Problem Statement

- Need to articulate the absence of a NAS-wide security policy
- No integrated strategy
- Lack of an Information Security vision
- Need for a policy that includes government, public and private assets
- Lack of funding and commitment
- Security is a concern
  - Globally
  - Commercially
  - General Aviation
  - DoD

Information Security and CNS Hardening

- Recommendations:
  - Consensus on the need for leadership from the FAA
  - Prepare a brief to the Joint Program Office to be presented to the FAA Administrator (Frank, Gus, Marie, Don to provide draft)
    1. To create an entity to establish US policy and compliance on CNS Information Security
    2. Distribute the policy internally among related US organizations
    3. Distribute policy to various industry groups (AEEC, ICAO etc..)
    4. Communicate policy to the international community
    5. Joint Program Office (JPO) could advocate the recommendations to the FAA Administrator.

Unique research/technologies needed for aviation security

1. Traffic surveillance with respect to position, jamming/spoofing
2. Development of secure multicast for aviation environment
3. Need to look at scalability of IPv4, IPv6
4. Mitigation strategies for Info/CNS infrastructure "crashes"
   - Re-routing
   - Dynamic re-allocation of resources
5. Need for a secure database(s) (for e.g., SWIM) and delivery of TFR/Protected Area for situation awareness in real-time
6. Ability to perform analysis of system impact of security technologies/services on CNS infrastructure
7. Model to quantify performance tradeoffs (risk, QoS, Cost)
8. Need for a capability for confidentiality link while maintaining integrity and availability between FD-FD, FD-ATC, Law Enforcement/DoD
9. Need for IP and ATN Firewalls and scanners without degrading operations
10. General approach to leverage COTS technologies & best practices

Unique research/technologies needed for aviation security (cont.)

11. Accept the fact that Information Security breaches will happen. Need tools for Intrusion Detection and Mitigation
    - Detect, isolate & restore
    - Evaluate, correct & test
12. Anti-viral & "fortress" processor for key systems
13. Use of portable & wireless networks on aircraft (Industry beginning to look at it)

APPENDIX C

SUMMARY OF WORKSHOP CONCLUSIONS AND RECOMMENDATIONS FROM THE (FIRST) WORKSHOP ON INTEGRATED CNS TECHNOLOGIES, MAY 1-3, 2001.

The major conclusions and recommendations of the Executive Committee, based on the Integrated CNS Workshop results, are summarized as follows.

- Elements of the 2020 vision for airspace operations which represent major changes affecting requirements of the CNS infrastructure include: Greatly increased point-to-point operations; greater use of non-prime airspace, growing implementation of self separation concepts; and near-real-time collaboration.
- Other technologies which will need to be in place in 2020 are: radio navigation techniques on a ubiquitous basis; improved surveillance; greatly increased situational awareness; a highly integrated, distributed communications network; the "Next NEXCOM".
- The infusion of new, lower cost technologies into the NAS must be fostered, additionally requiring the development of new certification paradigms.
- In the near/mid-term time frames, CNS technologies must be developed and introduced into the system to enable: increased collaborative decision making; increased availability of user preferred trajectories; integration of traffic information; and integration of weather and airspace status information.
- There is an immediate need for research and development in frequency use and spectrum issues.
- There is an immediate need to quantify the performance of current communications datalink choices, in particular VDL Modes 2,3, and 4.
- Research and development of the "Next NEXCOM" needs to begin now.
- Research and development must be performed in such a way as to fully take into account the following key issues: affordability and upward compatibility of technologies and systems; design for future retrofit; economic incentives for adoption of new technologies; early integration with the certification process; and awareness of/grounding in the target operational concepts.

The key recommendation, required to enable the proper addressing of the issues listed above, is for the establishment of an oversight committee for CNS research and development. The committee must be of high visibility within the aviation research decision-making community, must be of an international composition and associated with the key research organizations, and must have a high degree of accessibility to the inputs of the entire aviation community. The committee should be chartered with the responsibility of coordinating and harmonizing CNS research efforts nationally and internationally, influencing the decision makers to properly address the critical CNS research and development issues, and focusing the available resources to attain the future vision.

The Executive Committee recommends that the establishment of such a committee is the key recommendation of this report and should be the first action taken by those responsible for and interested in the implementation of this report.

APPENDIX D

SUMMARY OF WORKSHOP CONCLUSIONS AND RECOMMENDATIONS FROM THE SECOND INTEGRATED CNS TECHNOLOGIES CONFERENCE AND WORKSHOP, APRIL 29 – MAY 3, 2002

A summary of conclusions and recommendations resulting from the 2nd ICNS Conference has been compiled based on the ICNS Conference Executive Committee deliberations on the morning of May 3, 2002. The Committee based its work on the review of the Conference breakout workshop sessions, as well as the plenary session and technical session contributions of the conference participants. The workshop breakout sessions provided considerable input to the Executive Committee. As a result of time limitations of the Committee meeting, the conclusions and recommendations below represent the highlights and key issues gleaned from the conference and workshop results. The reader is encouraged to review the outputs of the six workshop breakout sessions in Appendix B of this report for further details of important CNS issues and recommendations of the workshop breakout sessions.

The following paragraphs summarize the conclusions and recommendations of the 2nd Integrated CNS Conference and Workshop.

The Executive Committee strongly recommends a significant increase in government funding of research and development efforts that will result in the deployment of a modern CNS infrastructure supporting the continued growth of aviation in the U.S. and enabling a strongly competitive U.S. aviation industry.

The Executive Committee recommends increased efforts on the part of the FAA, NASA and relevant industry groups to foster the international coordination of CNS research and development that will lead to increased global interoperability of aviation systems. The focus of such efforts should include pursuing the development of international standards and protocols for CNS systems and discouraging the proliferation of different regional solutions.

The coordination of research and development efforts among international organizations must be increased.

The development of CNS technologies which mitigate global non-interoperability problems must be pursued.

The development and acceptance of international standards for future advance network protocols, based primarily on IP, must be vigorously pursued. In particular, joint research and development between the U.S. (NASA and FAA) and Eurocontrol must be increased.

Long term research and development of advanced future network architectures, resulting in integrated CNS information infrastructure is a necessity. The expected

continued expansion of total aviation information needs requires that the future architecture be able to accommodate continuously updated technologies while remaining backward compatible with existing technologies as much as practical. Technologies to increase wideband data to and from aircraft, sufficient spectrum allocations and fully optimized use of spectrum must be vigorously pursued.

The application of commercial network protocols, in particular IPv6, must be fully explored for aviation needs. The FAA and NASA should lead the creation of an Aviation Taskforce on Emerging Network Technologies, similar to Eurocontrol's iPAX Task Force. NASA should significantly increase research in network technology and IP implementation for aviation applications.

NASA should pursue research and development of reliable, sufficiently accurate, and cost-effective backup systems for satellite navigation.

Strategic planning of next generation surveillance systems must be undertaken, involving the civil aviation, military and homeland security communities to craft an optimum total architecture for the future.

The emergence of UAVs requires that the development of surveillance and communications standards for UAV operations in the NAS be undertaken by the appropriate standards development bodies.

Research and development in several key surveillance areas should be initiated or expanded. These areas include surveillance data fusion, airborne spectrum measurement, and oceanic surveillance.

The FAA and NASA should participate in thorough, well-designed system engineering efforts to identify threats and vulnerabilities of current CNS systems as well as next-generation architectures. This is a key first step to developing effective mitigation strategies and technologies to enable a secure and robust CNS infrastructure for both the near and far terms.

Organizations involved in CNS technologies for civil aviation must become fully engaged with DoD research and development efforts in order to enable leveraging of programs, potentially resulting in significant benefits for civil aviation. This can occur both for application of DoD sponsored technology to civil uses and to use of DoD CNS systems for benefit of civil aviation, with the GPS model as an example.

The development of a long-term CNS ConOps is a high priority. NASA should develop a strong system engineering function to help address this need. NASA should also increase the CNS simulation and modeling content of its VAMS Project to support this effort. Industry and the FAA must be fully engaged in the ConOps development in order to foster implementation.

Testbeds for evaluation and validation of next-generation CNS systems needs to be developed. The implementation of an Applications Research Facility, with emphasis on integration with NAS systems, is an important parallel step needed for eventually implementation.

Research into VDL Mode 3 needs to continue, in terms of its integration into NAS operations and its ultimate data carrying capacity vs. long-term aviation communications requirements.

Research and development of technologies for software defined radios should be given a high priority due to the potentially revolutionary impact such technologies can have on equipage, performance, and cost issues for civil aviation. Certification issues will require considerable attention.