# Fifth Integrated Communications, Navigation and Surveillance (ICNS) Conference and Workshop 2005

# Conclusions and Recommendations

Prepared by:

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## 1.0 INTRODUCTION

The NASA Glenn Research Center organized and hosted the Fifth Integrated Communications, Navigation, and Surveillance (ICNS) Technologies Conference and Workshop, which took place May 2-5, 2005 at the Hyatt Fair Lakes Hotel in Fairfax, Virginia.

This fifth conference of the annual series followed the very successful previous conferences: the 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), and fourth ICNS Conference (April 26-30 in Fairfax, Virginia).

The purpose of the Fifth ICNS Conference was to assemble government, industry and academic communities performing research and development for advanced 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 capable of meeting long-term capacity and performance requirements.
- Provide a forum for fostering R&D 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 230 attendees from government, industry and academia to address these purposes through plenary panel sessions, technical presentations, breakout workshop sessions, and individual and group discussions during the workshop and after-hours events, and included 9 international attendees. An Executive Committee consisting of representatives of 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 FIFTH INTEGRATED CNS CONFERENCE AND WORKSHOP

The Fifth ICNS Conference and Workshop consisted of four primary elements: Plenary Sessions 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.

At the opening of the Conference on May 3, 2005, welcoming remarks by the Deputy Director of the NASA Glenn Research Center Mr. Richard Christianson were followed by a Plenary Session focused on the Joint Development and Planning Office (JPDO) activities, chaired by Mr. Fred Messina, Sensis Corporation and included the following panel members: Mr. Karl Grundmann, Communications Director, Joint Planning and Development Office, Federal Aviation Administration; Colonel David Rhodes, Lead JPDO IPT for User-Specific Situational Awareness; Mr. Doug Arbuckle, Lead JPDO IPT for Agile Air Traffic Management System; Mr. Bo Bollinger, President, Air Traffic Control Association and Mr. Jerry Thompson, Chairman, JTA.

A second Plenary Session on R&T Programs also took place on May 3, 2005 chaired by Ms. Denise Ponchak, NASA Glenn Research Center and included the following panel members: Mr Robert Beard, Computer Sciences Corporation, Mr. Konstantinos Martzaklis, NASA Glenn Research Center and Mr. Robert Jacobsen, NASA Ames Research Center.

A third Plenary Session on Global Communications Initiatives took place on the morning of May 4, 2005, chaired by Mr. Chris Wargo of Computer Networks & Software, Inc. The panel included the following members: Mr. Alex Wandels, Eurocontrol; Captain Joe Burns, United Airlines; Mr. Paul Mettus, Lockheed Martin Transportation and Security Solutions and Mr. Phillip Clinch, SITA.

Eleven technical presentation sessions filled the program from May 3-5, 2005:

| | |
|---|---|
| Session A1: | Integrated CNS Systems and Architectures<br>Chairs: Mr. Chris Daskalakis, DOT Volpe National Transportation Systems Center and Ms. Ann Tedford, Federal Aviation Administration |
| Session A2: | Datalink Communications Systems<br>Chair: Mr. Todd Donovan, Sensis Corporation |
| Session A3: | Navigation, System Demonstrations & Operations<br>Chair: Mr. David Buchanan, NASA Glenn Research Center |
| Session A4: | Safety and Security Initiatives Impacting CNS<br>Chair: Mr. Richard Reinhart, NASA Glenn Research Center |
| Session B1: | CNS Research and Technology Development<br>Chair: Mr. Art Feinberg, Intelligent Automation Inc. |
| Session B2: | Airborne Internet<br>Chair: Mr. James Meer, Microflight |
| Session B3: | Avionics for System-Level Enhancements<br>Chair: Mr. Ronald Stroup, Federal Aviation Administration |
| Session B4: | SWIM<br>Chair: Mr. Rafael Apaza, Federal Aviation Administration |
| Session C1: | Weather Products and Data Dissemination Technologies<br>Chairs: Mr. Michael Jarrell, NASA Glenn Research Center and Mr. Tom Tanger, Ohio Aerospace Institute |
| Session C2: | Airspace Communications Networks<br>Chair: Mr. Cal Ramos, NASA Glenn Research Center |
| Session C3: | Surveillance Systems<br>Chair: Mr. Len Carlson, Technology Services Corporation |

Gene Fujikawa of the NASA Glenn Research Center served as the technical program chair. The list of 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 workshop breakout sessions were held during the afternoons of May 4 and 5, three during each afternoon, with participation of the workshop attendees according to their interests. The workshop breakout sessions were:

May 4, 2005:

1. Next Generation Airport Surface Communications
   Co-Chairs: Rafael Apaza, FAA; David Matolak, Ohio University; Todd Donovan, Sensis Corporation
2. Airborne Internet Consortium Forum
   Chairs: James Meer, Microflight Inc., Ralph Yost, FAA
3. Aeronautical Data Link: Air Traffic Implementation in the Domestic US
   Chairs: Mike Murphy, ATNSI, Ann Tedford, FAA

May 5, 2005:

4. Role of Multi-Mode Multi-Function Digital Avionics in the Future NAS
   Chairs: Michael Harrison, AMA Inc., Chris Wargo, CNS Inc.
5. Role of Multi-Mode Multi-Function Digital Avionics in the Future NAS
   Chairs: Israel Greenfeld, NASA GRC, Mark Schell, CSSI Inc.
6. Aviation Spectrum Needs and Challenges
   Chairs: Lawrence Foore, NASA GRC, David Matolak, Ohio University

The breakout session results are summarized in the following section.

The Executive Committee met during the morning of May 6, 2005, to review the presentations from the technical and panel sessions and the outputs of the six breakout sessions in considering the Executive Committee Comments and Recommendations to be included in the Fifth Integrated CNS Conference and Workshop Final Report. Mr. Kerczewski, Ms. Ponchak, Mr. Phillips, Mr. Kenagy, Mr. Lewis, and Dr. Rankin were present during the meeting. The results of the Executive Committee meeting were collected and compiled into the Final Report by the Executive Committee Chairman, Robert Kerczewski of NASA. Other members of the committee reviewed the final report prior to its completion and their comments are included herein. The following section presents the Executive Committee's comments and recommendations.

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

The 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 two major areas – results of the plenary sessions and general conference and aviation industry trends.

### 3.1.1 – General Conference Trends

The Executive Committee discussed industry trends that emerged at the Conference. The following comments summarize the trends as observed during the Conference.

Unmanned Aerial Vehicles (UAVs) continue to garner increasing interest. As a number of companies, as well as the military plan to introduce or increase the use of UAVs, the impact on airspace operations will become significant. The military has operated UAVs for many years in combat and surveillance situations, and together with the Department of Homeland Security is expected to increase use of UAVs in domestic airspace. These two agencies represent the first implementers and will provide early results on ways to operate UAVs in domestic airspace and the possible impact on NAS operations.

The advent of mass-produced microjets, being used for both private operations and especially for air taxi services, has been projected to create a major impact on airspace operations as well. In particular, the number of possible microjets projected to be in operation represents a significant percentage of all airspace operations in the future. The use of small airports for these air taxi operations, the need for smaller, higher capability avionics to enable operations in high altitude airspace, and the impact on airspace system capacity requirements are issues of growing interest.

The impact of globalization of air transportation continues to drive the need for global interoperability of airspace technologies and concepts.

System wide information management (SWIM) will potentially be the integrating piece for air traffic management advances enabling airspace system capacity gains, and will provide the integrating backbone for “Integrated CNS”.

Aviation spectrum issues also continue to increase in importance. The upcoming World Radiocommunication Conference 2007 will have a significant aviation spectrum agenda. The need for adequate spectrum for future aviation growth, and the potential of losing aviation spectrum to other uses, is of growing concern. Development of better spectrum management and utilization methods is essential. The movement of CNS systems to the digital realm significantly reduces the need to separate communications, navigation and surveillance into separate frequency bands, but as long as analog systems persist there will likely still be a requirement for some separation.

The development and implementation of CNS infrastructure to support needed improvements in air traffic management requires more involvement from the user community. The traditional near term focus of the aviation user community has become more acute in recent years due to

financial difficulties of the major legacy airlines in particular. However the impact on the users of CNS infrastructure changes and the impact of users on the ability to implement new technologies are both significant. More involvement on the part of the user community is essential and a way must be found to increase their involvement.
Renewed interest in applications of satellite communications to air traffic management has recently occurred. The cost-effectiveness of satellite communications for aviation is still a difficult issue for most domains, other than oceanic.

The potential for significant improvements in avionics cost, functionality, and adaptability through software-defined multi-mode techniques is still considered very high. However, certification remains a major challenge, and more feedback and involvement from certification experts is needed.

The Executive Committee offers the following recommendations for future ICNS Conferences, based on observations of the 2005 Conference.

- Coverage of SWIM needs to increase at future ICNS Conferences.
- The ICNS Conference has a level of openness that allows people to bring in their points of view for public scrutiny. But perhaps there may be a need to enable greater opportunities to correct or rebut comments.
- A session focusing on policy for development/implementation of next-generation CNS is recommended.
- The FAA's plans for adopting IP-based information networks should be presented.
- Participation by UAV community should be increased.

### 3.1.2 ICNS Conference 2005 Plenary Sessions

Three plenary sessions were presented at the conference. The first presented the objectives, current status and plans of the Joint Planning and Development Office (JPDO), a multi-agency effort by the US government to development a coordinated approach to the definition, development and implementation of the future National Airspace System (NAS) The second presented R&T Program perspectives from NASA and industry. And the third presented a number of views from the aviation community on international global communications trends, from both user and air traffic service provider perspective.

All three plenary sessions were well attended and included active dialog between the panels and the audience. Each one presented valuable discussions and insights in critical areas relevant to future CNS needs and approaches to realizing those needs. The Executive Committee recommends that all three sessions be repeated at the next conference. The sections below provide additional elaboration of the plenary session's results.

#### 3.1.2.1. JPDO Plenary Session

The JPDO Plenary Session demonstrated that a quantum increase in progress of the JPDO has occurred in the year since JPDO goals and objectives were presented at the 2004 ICNS

Conference. In particular, the updates on the Agile Air Traffic Integrated Product Team (IPT) and the Shard Situational Awareness IPT demonstrated that the JPDO has progressed significantly in achieving the definition of a Next Generation Air Traffic System (NGATS) concept sufficient to enable research, development and implementation to be accomplished. The overall framework for the JPDO concept and approach to enabling its realization is becoming more coherent. However, the conceptual development remains at a high level, with a clear implementation plan yet to be developed. The formation of the JPDO-based NGATS Research Institute has progressed as well. Overall, the JPDO is expected to continue to pick up momentum and influence.

Efforts to derive cost estimates for the total implementation of the NGATS are as yet immature. A significant question of how the JPDO defined transformation to NGATS will be funded remains – will there be sufficient backing by Congress and the Administration?

Coordination of JPDO activities with the aviation industry are in the early stages and must continue to increase. International coordination is also important, but as yet consists of minimal participation by Europe and seems to be ignoring Asia and other parts of the world.

The time frames with which the JPDO is dealing present some confusion. The JPDO timelines appear to be somewhat optimistic. Do the NGATS developments, apparently not starting until 2015, line up well with planned FAA modernizations prior to 2015 (for example, the FAA's Operational Evolution Plan)?

The Executive Committee recommends that the JPDO be a featured component of the next ICNS Conference. The JPDO itself should target the ICNS Conference as a valuable forum for dissemination of its results and progress and for aviation community feedback.

### 3.1.2.2 R&T Programs

The R&T Programs plenary session reviewed three areas. The National Institute for Aerospace's (NIA) Aviation Plan for American Leadership was presented, followed by a review of NASA's Airspace Systems Program and NASA Glenn Research Center's CNS research projects.

The NIA's Aviation Plan was produced at the direction of the US Congress. Unfortunately specific details could not yet be presented because Congress had not officially authorized release of the report. The outline of the plan was presented.

NASA's Airspace System Program has fortunately not been impacted in a major way by NASA Aeronautics budget cuts. Continued support for CNS research within the program is expected to continue. The Airspace Systems Program's CNS research, executed in the Space Based Technologies Project and Virtual Airspace Modeling and Simulation – CNS model development project at NASA Glenn Research Center remains the major NASA CNS R&D program, with smaller efforts in the Aviation Safety and Security Program.

### 3.1.2.3 Global Communications Initiatives

The international plenary session presented several key viewpoints. Other regions, particularly Europe, are moving ahead in a number of areas relative to the US, due to more urgent requirements. In addition, there are several well-funded European efforts aimed at future at air

traffic management modernization that are significant, such as SESAME and NexSAT. Although the US and Europe have been the predominant drivers of air traffic management modernization, there needs to be more cognizance of other regional efforts such as in Asia and Australia.
The airlines viewpoint also needs greater consideration. Understanding of what the airlines are willing and able to do would improve the viability of modernization plans. A good example that was presented at the session was United Airlines implementation of a number of commercial communications links for internal airline applications.

The Executive Committee recommends that this international session be continued in the future. The need for international perspective in aviation and air traffic management is very high – presentation of international perspective – including the SESAME project, IATA, Asian representation, and others would greatly enhance the value of a future international session. Also of interest would be a perspective from European-based airlines, as well as a major cargo carrier discussing requirements placed on aircraft to operate in different regions of the world. The Executive Committee recommends having a European point-of-contact to help add international participation at the next conference.

## 3.2 Key Breakout Session Results

The key results from each of the six Workshop Breakout Sessions were prepared under the direction of the co-chairpersons of each session. The Executive Committee agreed with the comments and recommendations of the session, with a few additions, as presented in summary form below.

### 3.2.1 Next Generation Airport Surface Communications

Major issues:

- Ownership of an airport surface communications system – owned by the FAA or leased?
- Definition of the Future Concept of Use – Need to define (or at least bound) the overall architecture and the potential of using the 5GHz protected extended MLS band.
- What are the objectives from which we derive future requirements – Which applications could be removed from the requirements study effort to facilitate finding answers?
- How does the ongoing FAA work influence this effort – for example how would the NGATS Plan to reduce lights and signage affect the future network?
- What is the business case – What would facilitate users to participate?

Recommendations

- Continue development of the Concept of Use, but don't iterate indefinitely. Set deadlines and use multiple reviews
- Continue development of the Business Case

- Continue engineering studies of the extended MLS band

- Need to define the inherently government functions that a new airport network needs to perform (e.g. safety, security, runway operations)
- The defined architecture will need to be scalable and flexible and secure.

- The defined architecture should work to build on commercial architectures that are in development. It should also focus on defining how the inherently government functions could be accommodated by these commercial systems, or by suitably modified versions of these systems, to meet unique requirements, e.g., security.

- Explore how the system may fund itself for example:

  - The collection of landing fees
  - Improvements of aircraft fueling operations
  - Reductions in maintenance of lighting and signs (ground facilities)
  - The ability of the system to provide (sell) services

- Define who may be the first group(s) to benefit, then use needs of these groups to help determine objectives and concept of use.

- Aircraft operators desire participation should be voluntary

### 3.2.2 Airborne Internet Consortium Forum

Questions and Issues raised:

- Does AI have Applicability to the aviation community?
  - Consensus that AI will occur (although complete architecture not fully defined) …
  - When will AI occur - a function of why; a function of applications and cost model
- Do you (workshop participants) support the development of open-standards for AI?
  - How do you see the best approach to obtaining (developing) AI open standards?
    - Work with standards bodies (IETF, AEEC, RTCA); try to use existing standards; protocol implementation compliance statements
- What ATM functionality/services can AI bring to the flight deck?
  - At a high level, JPDO defined high level functionality – access to secure net-centric info
  - important to define/establish comm performance requirements; understand AI in context with standards, develop step by step strategy for implementation to meet requirements
- What functionality/services can AI bring to the cabin and passengers?

- What equipage incentive (i.e. business case) do you see that would enable AI onto the aircraft?
  - Consider all classes/types of aviation – Commercial GA, Biz Jet, Helicopter

  - What Cost savings do you see AI providing?
  - What applications would benefit from AI?
  - How do you see AI research and development being funded?
  - What is the strategy to link with industry (what areas to engage; when/how) to leverage their technology for Aviation

### 3.2.3 Aeronautical Data Link: Air Traffic Implementation in the Domestic US

What data link implementation can be accomplished in the near term with what we have? The key issues are:

- There is no FAA funded program for domestic data link; Should the FAA wait for ERAM rollout or can something be done earlier? Would the FAA consider operating its own Mode-2 network?
- Need customer support to build the case; What is the value proposition for near term data link in the NAS? Who would pay for messages? Different business models may have significant impact on expected costs of communication services. Other resources than funding may be the limiting factor; such as time.
- What's the cost of letting Europe and others set the standards for data link implementation?
- How does a data link strategy fit into an overall communications strategy? How to enable data link in other domains such as terminal airspace? Do you need a new link to do terminal data link or are there early implementation opportunities? How to balance across communications, navigation, and ATM functionality.

What applications and benefits can be obtained with existing equipage and infrastructure?

- Reduce voice congestion at major terminals to increase capacity; There is a significant safety benefit to off loading non-time critical communications; Could use the voice switching HMI to provide data link capabilities.
- What is the benefit of datalink delivery of taxi clearance (DDTC) as implemented with NWA at Detroit?
  - Saves 1.7 minutes on pushback at per flight IAD.
  - Will save 2 minutes at DTW with ASDE-X.
  - Major airline at airport needs to push the capability; Airlines pay for it since they see the value.
- What applications are welcomed by controllers (and what won't be welcomed)

What are the future data link needs?

- Where do we want data link to end up? Will the future be determined by government or private concerns?
- What are air-to-air communications requirements to support functions like wake vortex information? Or, exchange between a leader and follower for roll rate to manage blunder risk.
- How do we gather and integrate the requirements from a range of sources, e.g., weather, video, security. Does the link include surveillance information?
- A common weather source is needed.
- Need to focus on performance requirements rather than equipment-based requirements.

How do we transition from today to the future?

- Need to manage what needs to be managed by humans and what can be handled by machines. Minimize complexity.
- How will legacy equipment be integrated - A-380 will be flying in 2050, how will it be supported?
- How do we manage information flow so as to minimize information overload for humans?
- Need money to get there from here. What is the tipping point that gets the process started?
- How can ATC communications share cost base with APC such as a broadband link?
- How to get tangible experience with data link in the domestic environment?
- How to factor in the IP transition that is occurring in telecommunications?
- How is RCP defined and applied? What is the capacity and frequency requirement?

### 3.2.4 Role of Multi-Mode Multi-Function Digital Avionics in the Future NAS

- Problem:
  - Current avionics are generally: not interoperable across CNS modes and national standards; expensive to upgrade and certify; not easily reconfigurable for new functions and/or modes; and not able to provide user-selected integration of C, N, S and management functions.
  - The number of waveforms (both new and legacy) is beginning to overwhelm ability to fit aircraft with new capabilities.
  - A new, cost-effective methodology to certify avionics is needed (both initial and subsequent for added waveforms).

- Objective:
  - Develop an architecture and prototype for multi-function multi-mode digital avionics (MMDA) that demonstrate: interoperability with international standards and operational modes; low life-cycle cost to equip/modify; compliance with existing and next generation air-ground and air-air CNS requirements & functions; and compliance with redundancy, certification, security and safety standards.

- Which class of aircraft will most likely have the most immediate benefit from application of a flexible, open standard based, integrated modular avionics approach?
  - High end GA (Cargo airlines

- Barriers/Key Issues:
  - Cost
  - Requirement for more functionality vs. integrating CNS technologies in a single box
  - Graceful degradation, self healing, system recovery from crash, faults
  - Pushback from existing vendors due to existing avionics (proprietary content)
  - Human factors
  - Hardware variations
  - System configuration management
  - Use of standards outside aviation's purview
  - Overcoming today's certification culture; Safety analysis to support RMA
  - Defining form, fit, function standards

Stakeholders

- Manufacturer, User, Big OEMs (air-framers), Installers & maintainers, Airports, Air traffic service providers
  - Accepting the future vision of an aircraft being a “Node-in-the-sky”, what new functions or capabilities will be required for an integrated modular avionics system to meet this vision?
    - Weather info (Uplinks & downlinks)
    - Dynamic routing
    - QoS, Policy, Decision making
    - Discovery info middleware
    - Safety assessment function
    - Ability to receive dynamic changes in airspace
- Info providers, ATSP, FAA, JPDO, Airlines, ISPs, JEPPESON, Airborne Internet Consortium, OS OEMs, Industry committees
  - What are the key barriers in the development of a (Technical Standard Order) TSO'd open architecture and will this approach enable the successful acceptance of a software based, integrated modular avionics system?
    - Standards development duration
    - Proprietary OS
    - Encourage NASA to foster a team that includes DO 178B experience
  - Open standards and commercial technology such ARINC 653, DO-178, Real-Time OS’s, etc… exist now, what are the work in progress or gap areas that need further standardization for developing an open architecture for integrated modular avionics?
    - ARINC 653 is an API specification
    - Go find an OS standard
    - Absence of ICAO standard
    - List of standards to adopt/adapt

### 3.2.5 Potential Roles for Satellite Communications in Air Traffic Management

Conclusions from this session:

- If requirements are established, and a satcom link can meet those requirements, there’s no reason you would not use satcom
  - But the economic case would have to close
  - Requirements would vary between applications
  - Analyze benefits of combining applications
  - Performance tradeoffs vs. costs
- It would be better to measure reliability of service (RCP?) by considering a set of links rather than requiring each individual link to meet that performance
  - It would be better if RCP definitions allowed this approach
- Unfair economic benefits/penalties may accrue due to mandating of equipage
  - ANSPs need to be more active in providing economic incentives to address this problem, or other means of relief
  - Accelerate the end-to-end implementation
- Satellite communications is the ultimate solution for oceanic
  - Consider how they can then provide other services
  - The percentage of fleets equipping for oceanic may become high in the future

## 3.2.6 Aviation Spectrum Needs and Challenges

- Workshop Goals:
  - Discuss current issues with aviation bands of interest.
    - Record input/comments.
  - Draft an agenda or record topics of interest to be discussed at a breakout session of the August ACAST 2005 Workshop.
- Bands of Interest
  - ILS/VOR Band (108–117.975 MHz)
  - ILS Glide Slope Band (328.6–335.4 MHz)
  - DME Band (960–1215 MHz)
  - MLS Band (5000–5250 MHz)

VOR/ILS Band (108–117.975 MHz)

- Discussion Points
  - Would require the reallocation of this band for AM(R)S
  - Eurocontrol has submitted a draft position to the ITU WP8B to decommission some VORs and continue 8.33 KHz voice expansion down into this band.
- Comments/Discussion
  - If WAAS equipage permits, up to ½ existing VORs could be decommissioned, opening up additional VHF spectrum (much longer than people think)
  - Could get secondary "allocation" in which both ARN and AM(R)S can be deployed (FCC is currently against)
  - If VOR band does get re-allocated, what additional capacity will this provide, and will it be sufficient for needs up to 2025?

ILS Glide Slope Band (328.6–335.4 MHz)

- Discussion Points
  - Requires a reallocation to AM(R)S.
  - This band provides propagation characteristics similar to the VHF voice bands;
  - More efficient use of this band could provide spectrum relief.
  - Often overlooked due to the limited bandwidth. 8.33 KHz voice in this channel?
- Comments/Discussion
  - Difficult to convince users of system that additional signals/services could be deployed without interference
  - Would likely require equipage with new ILS-GS receivers
  - Only possible long-term ?

DME Band (960–1215 MHz)

- Discussion Points
  - Would require the reallocation of this band for AM(R)S services.
  - Some discussion recently as a solution in a separate voice/data scheme.
  - Coexist with JTIDS (frequency hopped).
- Comments/Discussion
  - UAT at 978 MHz (in US only, so far)
  - DMEs will NOT go away; is there a continued need for TACANS?
  - Channel/propagation characteristics for wideband signaling?

- Difficult to convince military to “give up/share” parts of band, unless they obtain some benefit (e.g., UAV spectrum)

MLS Band (5000–5250 MHz)

- Discussion Points
  - Would require the reallocation of this band for AM(R)S services
  - Dr. David Matolak is performing an MLS band channel characterization and modeling study under grant with NASA GRC.
  - Propagation limitations in the C-band could limit solutions to the airport surface.
  - There is a need to develop a business case for C-band deployment.
  - Still MLSs in use, and new ones being deployed
- Comments/Discussion
  - 5150-5250 is UNII/ISM band; 5000-5091 is MLS band
  - How to create motivation for equipage?
  - What exactly is needed to have band classified for AM(R)S use

Other Spectrum Considerations

- UAV spectrum requirements (Unmanned Aircraft systems – UAS)
  - Safety-of-Life (SoL) Command & Control - Between UAV controller and ATC
  - Payload Data
  - Both LOS and Beyond LOS (BLOS) need to be considered.
  - Could involve a combination of the following
    - AM(R)S (SoL LOS); AM(R)S (SoL BLOS); Generic AMSS (non-SoL LOS) ; Generic AMSS (non-SoL BLOS)
- Voice in VHF band, Data in DME band.
- Possible WRC-2010 Agenda Items.
- What are the implications of having “general” (generic?) aviation allocations.
- What are the implications of dynamic allocation?
- Comments/Discussion
  - Reliability & BW requirements of UAVs ill-defined
  - For WRC-2010 agenda: is there a need to keep C, N, and S bands/services separate?

ACAST Workshop 2005
Potential Spectrum Workshop Agenda Items

- Update on Dr. Matolak’s 5 GHz sounding campaign.
- Update on draft positions for WRC-07
  - ICAO WG-F, WG-C; Eurocontrol; FAA
- C-band antennas for communications usage.
- Update on Future Communications Study
- Prototype 5 GHz wireless network (Sensis, Protium)
- UAVs

## 3.3 Summary of Recommendations

The Executive Committee offers the following recommendations for future ICNS Conferences, based on observations of the 2005 Conference.

- Coverage of SWIM should be increased at future ICNS Conferences.
- The ICNS Conference has a level of openness that allows people to bring In their points of view for public scrutiny. But a way to enable greater opportunities to correct or rebut comments should be considered.

- A session focusing on policy for development/implementation of next-generation CNS is recommended.

- The FAA's plans for adopting IP-based information networks should be presented.

- Participation by UAV community should be increased.

- All three plenary sessions be repeated at the next conference.
  - The Executive Committee recommends that the JPDO be a featured component of the next ICNS Conference.
  - Review of NASA Programs and Projects that contain CNS R&D is very useful.
  - The international session should also be continued in the future. Presentation of international perspective – including the SESAME project, IATA, Asian representation, and others would greatly enhance the value of a future international session. Also of interest would be a perspective from European-based airlines, as well as a major cargo carrier discussing requirements placed on aircraft to operate in different regions of the world

- The Executive Committee recommends having a European point-of-contact to help add international participation at the next conference.

Other general recommendations resulting from the Fifth ICNS Conference include the following:

The JPDO itself should target the ICNS Conference as a valuable forum for dissemination of its results and progress and for aviation community feedback.

The need for international perspective in aviation and air traffic management is very high.

Finally, conclusions and recommendations reached by the six workshop sessions are endorsed by the Executive Committee as presented in Section 3.2.

## 4.0 CONCLUSION

The Fifth ICNS Conference and Workshop continued a series of successful conferences and workshop dating to the first conference, held in May, 2001. Each conference has succeeded in terms of high attendance, number of presentations, and overall value to the aviation community and to NASA as conference host. The 230 participants and over 95 presentations at the 5th 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 5th ICNS Conference has been compiled based on the ICNS Conference Executive Committee deliberations on the morning of May 6, 2005, 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 3.2 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 3.3.

## APPENDIX A
## The Technical Sessions of the 5th Integrated Communications, Navigation and Surveillance Technologies Conference

| Tuesday, May 3, 2005 | |
|---|---|
| **Session A1 – Integrated CNS Systems and Architectures<br>Session Chairs: Chris Daskalakis, DOT Volpe National Transportation Systems Center and<br>Ann Tedford, Federal Aviation Administration** | |
| Developing a Model for Joint Infrastructure Investment | Stephen Giles and Michele Steinbach, The MITRE Corporation |
| Continuing the Commitment to Capacity | Gisele Mohler, Federal Aviation Administration |
| Overview FAA's NAS Strategy Simulator | Lance Sherry, Bengi Mezhepoglu, George Mason University, Dan Goldner, Ventana Systems, Anne Yablonski and Dave Knorr, Federal Aviation Administration |
| Analysis of Air Traffic Control Systems Interference Impact on Galileo Aeronautical Receivers | Massimiliano DeAngelis, AMS-Alenia Marconi Systems, Romano Fantacci, Simone Menci, University of Florence and Claudio Rinaldi, ENAV S.p.A. |
| Communications Operating Concept and Requirements for the Future Radio System | Gregg Anderson, Federal Aviation Administration, Patricia Chavez, John Gonda and William Saumsiegle, The MITRE Corporation |
| Global Communications, Navigation, and Surveillance Systems Program – Progress and Plans | Chip Meserole, The Boeing Company |
| An Integrated Global CNS System | Robert Crow, AirNav, Inc. |
| The Single Integrated Airspace Approach to Global Airspace: One World - One Airspace - One Perception | William Laska, John Edwards, Dirk Caudill and Andrew Chrisman, SRS Technologies, Inc. |
| **Session A2 – Datalink Communications Systems<br>Session Chair: Todd Donovan, Sensis Corporation** | |
| Measurement of the Safety Impact of Installing ADS-B on General Aviation Aircraft at Embry-Riddle Aeronautical University | Steven Hampton and Richard Theokas, Embry-Riddle Aeronautical University |
| Aircraft Automatic Dependent Surveillance – Broadcast (ADS-B) Verification and Validation | Jimmy Krozel, Metron Aviation Inc. and Dominick Andrisani, Purdue University |
| A Predictive Model of User Equipage Costs for Future Air Traffic Services and Capabilities: An Automatic Dependent Surveillance - Broadcast Example | Kent Hollinger, James Nickum, Doyle Peed and Todd Stock, The MITRE Corporation |
| Strategic Applications of Controller-Assigned Airborne Separation (CAAS) | Elliott Simons, David Maroney, Pamela Hawkins and Christopher DeSenti,The MITRE Corporation |
| VHF Channel Occupancy Measurements over Core Europe | Johannes Prinz, Christoph Rihacek, Miodrag Sajatovic, Frequentis GmbH, Santiago Zazo, Universidad Politécnica de Madrid, Javier Lopez-Perez and Ivan Perez-Alvarez, Universidad de Las Palmas de Gran Canaria |
| A Study on Mobility in VDL Modes 2 and 3 | Robert Murawski, Steven Bretmersky, and Vijay Konangi, Cleveland State University |
| SITA AIRCOM Datalink Implementation Status | Kathleen Kearns, SITA |
| Aeronautical Data Link Road Map, An Air Carrier Perspective | Mike Murphy, ATN Systems, Inc. |

| Tuesday, May 3, 2005 | |
|---|---|
| **Session A3 – Navigation, System Demonstrations & Operations<br>Session Chair: David Buchanan, NASA Glenn Research Center** | |
| Tailored Arrivals Trials - Air Traffic Alliance, Boeing, Airservices Australia, QANTAS | Craig Roberts, Airservices, Brad Cornell, Rob Mead, Boeing and Michael Watson, Alliance |
| RNP-Based Parallel Instrument Approaches: Concepts and Benefits | Michael Mills and Suzanne Porter, The MITRE Corporation |
| Integrated GPS/eLoran Systems | G. Linn Roth, Locus, Inc. and Mitchell Narins, Federal Aviation Administration |
| Wide Area Augmentation System (WAAS) Industry Engagement | Don Hanlon, Federal Aviation Administration and David Beering, Infinite Global Infrastructure |
| Operational Results and Standardization Issues of Wide Area Multilateration Systems for Civil Air Traffic Control Purposes | Heinz Bartacek, Werner Langhans, Christian Scheiflinger, Johann Zemsky, Austro Control GmbH and Helmut Schreiber, Graz University of Technology |
| Safe Flight 21 Implementing Broadcast Services | Robert Strain, The MITRE Corporation |
| How the System Wide Evaluation and Planning Tool (SWEPT) Can Support Air Traffic Management Decision-Making in the Eastern U.S. | Paul Rigterink and Ed Ellenberger, Computer Sciences Corporation |
| **Session A4 – Safety and Security Initiatives Impacting CNS<br>Session Chair: Richard Reinhart, NASA Glenn Research Center** | |
| Evaluations of Sana and Cisco Host Intrusion Prevention Systems (HIPS) | Edwin Coover and Duncan Thomson, The MITRE Corporation |
| Digital Signatures for the Analogue Radio | Konrad Hofbauer, Graz University of Technology and Horst Hering, Eurocontrol |
| An Elliptic Curve Based Authentication Protocol for Controller-Pilot Data Link Communications | Dawit Getachew, Chicago State University and James Griner, NASA Glenn Research Center |
| Information Security for the Aviation Community: A Personal Perspective | Ted Signore, The MITRE Corporation |
| Communications-Supported Concepts for Highjacked Aircraft | Thomas Mulkerin, Mulkerin Associates, Inc. |
| Secure Key Management for NASA Space Communication | Aruna Balasubramanian, Sumita Mishra, CompSys Technologies, Inc. and Ramalingam Sridhar, State University of New York, Buffalo |
| Communications Technology for Improved Aviation Security | Sam Farroha, Cheryl Resch, Gary Stoneburner, Gerry Preziotti and Robert Nichols, The Johns Hopkins University Applied Physics Laboratory |
| SIP Based Communications in Netcentric Operations | Johannes Prinz, Wolfgang Kampichler, Christoph Kurth, Frequentis GmbH and Johannes Osrael, Information Systems Institute, Vienna University of Technology |

| Wednesday, May 4, 2005 | |
|---|---|
| **Session B1 – CNS Research and Technology Development**<br>**Session Chair: Art Feinberg, Intelligent Automation Inc.** | |
| FASTE-CNS: A Tool for Performance Evaluation of CNS Technologies | Chris Dhas, Chris Wargo, Sachin Lal, Computer Networks & Software, Inc. and Mannu Khanna, Comptel Inc. |
| Aeronautical Network Research Simulator (ANRS) | Manuel Garcia, Michael Kocin and Gregory Musser, ViaSat, Inc. |
| Channel Characterization in the 5 GHz Microwave Landing System Extension Band for Future Airport Surface Communications | Dave Matolak, Ohio University, Lawrence Foore, NASA Glenn Research Center and Rafael Apaza, Federal Aviation Administration |
| Detroit Deicing Decision Support Tool | Jonathan Lee, Suzanne Chen and Anastasios Daskalakis, U.S. Department of Transportation |
| ESCAN | Julian Bristow, David Meyers, Kelly Muldoon, Robert Becker and Lisa Lust, Honeywell |
| Beaming Bandwidth via Laser Communications | Mohsen Kavehrad and Belal Hamzeh,<br>The Pennsylvania State University |
| **Session B2 – Airborne Internet**<br>**Session Chair: James Meer, Microflight** | |
| Airborne Internet: Applications Abound | Ralph Yost, William J. Hughes FAA Technical Center |
| Multi-Protocol Data Radio | Prasad Nair, Project Management Enterprises, Inc. |
| Transformational Cost Reduction for Airborne Internet | Bill McNary, AeroSAT |
| Distributed Adaptive Operations: Command & Control of Networked-enabled Forces, Geographically Dispersed | Gregory Glaros, USN |
| Implementing the Electronic Flight Bag | Joe Burns, United Airlines |
| CompreX: XML Compression and the Airborne Internet | Kirk Swanson and Jason Judt, Architecture Technology Corporation |
| Airborne Internet Consortium Background | James Meer, Microflight |
| Session B3 – Avionics for System-Level Enhancements<br>**Session Chair: Ronald Stroup, Federal Aviation Administration** | |
| A Logical Architecture for Future Avionics | Paul Ravenhill, Helios Technology LTD |
| Interference Cancellation Receiver | Minh Nguyen, The MITRE Corporation and Amir Zaghloul, Virginia Polytechnic Institute and State University |
| MMDA Use of JTRS Architecture | Michael Kocin, ViaSat, Inc. |
| Increasing Needs for Modular Avionics in the CNS/ATM-Based Air Space | Gu Shimin, Chinese Aeronautic Radio and Electronics Research Institute |

| Wednesday, May 4, 2005 | |
|---|---|
| **Session B4 – SWIM<br>Session Chair: Rafael Apaza, Federal Aviation Administration** | |
| The Federal Aviation Administration (FAA) System Wide Information Management (SWIM) Program | John Loynes, Federal Aviation Administration |
| System Wide Information Management Prototyping Activities - An Architecture for Common Messaging | Paul Comitz, The Boeing Company and Josh Hung, Federal Aviation Administration |
| Aspects of Sharing Flight Data via SWIM | Jon Dehn, Lockheed Martin Transportation & Security Solutions and Sid Rudolph, IT Consulting Group |
| Mobile Communication Network Architecture (MCNA) Overview | David Morse, Avaliant LLC and James Budinger, NASA Glenn Research Center |
| Service Oriented Architecture (SOA) Enables an Agile National Airspace System - SWIM Provides the Pipeline Services | Josh Hung, Federal Aviation Administration |
| Technologies for Network-Enabled Operations | Brian Glass and Jack Levine, NASA Ames Research Center |
| The Business Case for SWIM | Steve Glickman, The Boeing Company |

| Thursday, May 5, 2005 | |
|---|---|
| **Session C1 – Weather Products and Data Dissemination Technologies<br>Session Chairs: Michael Jarrell, NASA Glenn Research Center and Thomas Tanger, Ohio Aerospace Institute** | |
| An Integrated Turbulence Avoidance Decision-Aid for Pilots, Dispatchers & Controllers | Paul Robinson, AeroTech Research, Inc. |
| In-Service Evaluation of a Prototype Turbulence Auto-PIREP System (TAPS) | Jason Prince, Paul Robinson, AeroTech Research, Inc. and Christian Amaral, Delta Air Lines |
| Characterizing Satellite-Based Communications to Provide Seamless and Effective Transoceanic Data Dissemination | Rich Slywczak and Okechukwu Mezu, NASA Glenn Research Center |
| Flight Testing of Weather Data Exchange Using the 1090 Extended Squitter (1090ES) and VDL Mode 3 Data Links | James Griner, NASA Glenn Research Center |
| WINCOMM UAT Laboratory Test Activities | Wayne Buhrman, The John Hopkins University |
| WINCOMM UAT Laboratory Test Results and Flight Test Plans | Randall Sleight and Wayne Buhrman, The John Hopkins University |
| Comprehensive Real-Time Analysis of Broadcasting Systems (CRABS) Software Use for Weather Information Communication (WINCOMM) Project | Stephen Giguere, The John Hopkins University |
| Potential IP Solutions for Networking Selected FAA Weather Systems | Ezra Jalleta, Minqi Liu and Mark Simons, The MITRE Corporation |
| A 4D Flight Profile Server and Probability-Based 4D Weather Objects: Toward a Common-Core Toolset for the NAS | Alexander Klein, George Mason University |
| Air Traffic Management Decision Support Using Integrated Methods of Diagnosing and Forecasting Aviation Weather | Tenny Lindholm, The National Center for Atmospheric Research |

| Thursday, May 5, 2005 | |
|---|---|
| **Session C2 – Airspace Communications Networks<br>Session Chair: Cal Ramos, NASA Glenn Research Center** | |
| FAA/Eurocontrol Future Communications Study Overview and Status | James Eck, Brent Phillips, Gregg Anderson, Rhonda Thomas, Federal Aviation Administration, James Budinger, NASA Glenn Research Center, Ron Bruno and Glenn Dyer, ITT Industries |
| Systems Methodology to Defining Surface Network Architecture | Thanh Nguyen, Analex Corporation |
| Integration of Airport Surface Communication Systems | Yang Wang, Lockheed Martin Transportation & Security Solutions and Yiyuan Zhao, University of Minnesota |
| Architectural Assessment for Optical Networks Deployed on Commercial Avionic Communication Systems | Hung Nguyen, NASA Glenn Research Center |
| Adjustable Range Broadcast for Desired Airborne Network Connectivity | Yiyuan Zhao, University of Minnesota and Yang Wang, Lockheed Martin Transportation & Security Solutions |
| A Hierarchical IP Addressing Scheme for Mobile Ad-Hoc Networks | Hussein Ali, David Smith and Herman Helgert, George Washington University |
| Evaluation of IPv6 Services for Future Aviation Networks | Anil Kumar, Aniket Bhat, Computer Networks & Software Inc. and Manu Khanna, Comptel, Inc. |
| NASA's Request for Comments on Global Air Space System Requirements | Will Ivancic, NASA Glenn Research Center |
| Defining Command, Control, and Communications for Unmanned Aircraft Systems | Stephen Henriksen, ITT Advanced Engineering & Sciences and Mike Schultz, Modern Technology Solutions Incorporated |

| Thursday, May 5, 2005 | |
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| **Session C3 – Surveillance Systems<br>Session Chair: Len Carlson, Technology Services Corporation** | |
| Departure Exclusion Zone – a Future Concept to Enhance Runway Operations Using Aircraft Derived Data | Carmine Primeggia, Federal Aviation Administration and Philip Hodgkins, BAE Systems |
| Wake Vortex Tracking Using a 35 GHz Pulsed Doppler Radar | Robert Neece, NASA Langley Research Center, Charles Britt, Joseph White, Chi Nguyen, RTI International, Ashok Mudukutore and Bill Hooper, Phase IV Systems, Inc. |
| X-Band Radar: More Than a Source for Airborne Weather | Steven Harrah, NASA Langley Research Center |
| The Right Radar Backup for ADS-B | Leslie Crane, The MITRE Corporation |
| Applications of a Surveillance Database and Server | Scott Remillard, Greg Berkebile and Todd Pittman, Sensis Corporation |
| Flight State Estimation from Surface Surveillance | Laurel Stell, Ted Carnoil, Metron Aviation Inc., Sandy Lozito, NASA Ames Research Center and Ved Sud, Federal Aviation Administration |
| Range Enhancement to Wide Area Multilateration Processing | Jeffrey Beyer, Sensis Corporation |
| The Standalone Traffic Information Service (TIS) Server | Jeffrey Beyer and Andrew Hepp, Sensis Corporation |
| Short Range Surveillance Link for Close Proximity Navigation During Closely Spaced Parallel | Pavan Reddy and Mary Ellen Miller, Raytheon Company |