Workshop on Integrated Communications, Navigation and Surveillance Technologies for Advanced Future Air Transportation Systems

May 1-3, 2001

Cleveland, Ohio, USA

Integrated CNS Workshop Conclusions and Recommendations

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1.0 INTRODUCTION

The NASA Glenn research Center organized and hosted the Workshop on Integrated Communications, Navigation, and Surveillance Technologies for Advanced Future Air Transportation Systems (Integrated CNS Workshop), which took place May 1-3, 2001 at the Wyndham Hotel in Cleveland, Ohio.

The purpose of the workshop was:

> To understand current efforts in near and far term R&D and demonstration of digital communications technologies and applications for air transportation,
>
> To identify R&D requirements that must be filled in order to enable the future vision for a safe, high capacity advanced air transportation system, and develop recommendations for how those requirements can be filled, and
>
> To develop a "roadmap" and an advocacy function for developing and funding the necessary R&D programs to achieve the future vision for national and global air transportation.

The workshop attracted 135 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 final day of the workshop to consider the primary outcomes and recommendations of the workshop.

This report presents the findings of the Executive Committee.

2.0 ORGANIZATION OF THE INTEGRATED CNS WORKSHOP

The Integrated CNS Workshop consisted of three primary elements: Technical presentations covering a variety of topics relating to CNS requirements and research needs; five breakout sessions to generate issues, ideas and recommendations for future CNS research and development; and an Executive Committee working meeting to condense the Integrated CNS Workshop results into a concise set of issues and recommendations.

Welcoming remarks by the Director of the NASA Glenn Research center, Mr. Donald Campbell, and the keynote Address by NASA Associate Administrator for Aerospace Technology Mr. Sam Venneri, were followed by six technical presentation sessions during May 1 and 2:

> Session A: Visions of the Future of Air Transportation
> Session B: Current Near and Mid-Term R&D and Demonstration Programs
> Session C: Domestic and Internatinal Communications/Datalink R&D and

Demonstration Programs
Session D: Near and Mid Term Issues and Needs
Session E: Research and Technology Development for Far-Term Datalink Systems
Session F: Perspectives on Far-Term Research Needs

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

At the conclusion of the presentations, five breakout sessions were held during the afternoon of May 2, with participation of the workshop attendees according to their interests. The breakout sessions were:

- Near and Mid-Term CNS Technology R&D Needs
- Far-Term CNS Technology R&D Needs
- Assessment of Current CNS Technology R&D Programs
- 2020 Operational Concepts
- Organizing the R&D Community and Advocacy

Each breakout session presented a report of its findings to the Integrated CNS Workshop attendees. The breakout session presentations are given in Appendix B of this report.

The Executive Committee met during the morning of May 3 to consider the presentations from the technical sessions and the outputs of the five breakout sessions in considering the content of the Integrated CNS Workshop final Report. A briefout of the preliminary results of the Executive Committee was presented to the workshop attendees at 12:30 PM, May 3, after which the workshop was adjourned. The Executive Committee continued working remotely to complete this final report.

3.0 THE EXECUTIVE COMMITTEE'S FINAL REPORT OF THE INTEGRATED CNS WORKSHOP

The Workshop on Integrated CNS Technologies for Advanced Future Air Transportation Systems examined CNS technology research and development issues from several points of view. Near and mid-term issues considered the current state of CNS within the National Airspace System (NAS) and global aviation system and upgrades and improvements to that system that are well along in the development stage or in early stages of deployment. Far-term research issues looked at next-generation air transportation systems, the so-called "2020 Vision" and the implications for CNS research and development of implementing that vision. To enable the CNS research community to address the issues identified for the near- mid- and far-term systems, the Workshop also explored concepts for organizing the CNS research and development community and developing an advocacy position to elevate the visibility of CNS needs within the aviation system.

In producing the final report, the Executive Committee also chose to view the CNS research and development issues and needs along similar lines. Hence the report is organized into the following three main sections: Implications of Implementing the "2020 Vision" on CNS Research and Development; Technology Gap Issues and the Transition from the Present to the Future CNS System; and CNS Research and Development Steering, Review and Guidance Plan. These sections are followed by a Summary of Workshop Recommendations.

3.1 Implications of Implementing the "2020 Vision" on CNS Research and Development

The Integrated CNS Workshop and the Executive Committee considered the expected, or hoped for, characteristics of the NAS in the year 2020. Although there is much debate about what the operational concepts and other characteristics of the NAS can and should be in 2020, there was a general consensus reached on several key aspects which have significant implications for the CNS infrastructure.

Several significant changes in 2020 airspace operations and operational concepts, compared to today's system, that will have a major impact on CNS were identified. Point-to-point operations, with greatly increased use of smaller regional jets accessing small and medium size airports, will be a major driver increasing the demands on the CNS infrastructure. This is coupled with greatly increased use of non-prime airspace in order to achieve a higher overall system capacity. By 2020, the implementation of self separation concepts will be underway and represent a growing demand on the CNS infrastructure, requiring a significantly higher rate of collaboration and information exchange. Collaborative decision making across the entire NAS and involving all NAS users will have become a requirement to optimize system efficiency and reduce costs. The need for near-real-time collaboration will place significant new requirements on the CNS infrastructure, and in particular will require a faster, higher capacity communications network.

By the 2020 time frame, radio navigation techniques based upon accuracy-augmented satellite navigational systems will be a ubiquitous aspect of NAS operations. Improved surveillance, in terms of coverage and accuracy, will have resulted from widespread deployment of Automatic Dependent Surveillance (ADS). Greatly increased situational awareness available to users, including NAS status, weather, and other information will result. Movement of this type of information through the NAS will depend upon a distributed communications network providing a high level of integration of voice, datalink, text, iconic and graphical information. To enable this high capacity integrated network, the "Next NEXCOM" will need to have been developed and deployed by 2020.

These changes can only be enabled through the infusion of new, lower cost technologies into the NAS, requiring the development a new certification paradigms and processes which can allow the rapid infusion state-of-the-art technologies into the NAS.

3.2 Technology Gap Issues and the Transition from the Present to the Future CNS System

The planning of CNS research and development must take into account gaps in CNS capabilities in the near- and mid-term time frames as well as issues involved in the transition from the current NAS to the 2020 vision. The issues identified by the Workshop and refined by the Executive Committee in this area can be grouped into three categories: operational needs resulting in CNS infrastructure requirements; CNS technology research and development needs; and needed approaches to research and development.

Several key operational needs were identified that must be analyzed for their impact on CNS system requirements and resulting research and development needs. The growing collaboration and collaborative decision making environment requires an improved ground communications infrastructure and communications processes which can support this environment regardless of geographic location. Significant operational efficiencies that could be gained through user preferred trajectories (UPT) are unavailable due to a lack of supporting infrastructure, with the result that the FAA is unable to support UPT in high quantities. The integration of traffic information (Traffic Information Service (TIS), ADS, radar, etc.) must be enabled through appropriate CNS infrastructures. The traffic information must be further reinforced with the addition of weather and airspace status information. Improvements in weather forecasting and nowcasting are required, including increased use of aircraft as weather sensors. All of these operational needs, seen as becoming necessary in the near and mid-term time frames and essential to the transition to the 2020 vision, place significant requirements on the CNS infrastructure beyond current capabilities. The extent to which the currently planned CNS infrastructure upgrades and improvements will be adequate to meet these needs in the mid- and long-terms is also a subject which requires study.

CNS technology research and development needs were identified in the frequency/spectrum area and in datalink assessment and development. The growing frequency congestion problem must be addressed through research and development of methods for improving spectral efficiency and frequency use. New approaches to spectrum use must be studied, regarding bandwidth, rather than frequency channels as the key resource. In addition, significant study and planning is needed to enable the aviation community to retain important spectral bands for aviation use – near- mid- and long-term plans must be developed for use of these spectral bands, backed by credible research proving the long-term needs for retaining these bands for exclusive aviation use.

The need to quantify, through objective and unbiased research, analysis, and testing, the current communications choices (e.g. VHF digital link modes 2, 3, and 4) was cited as critical to near- and mid-term decisions in deployment of these proposed systems and the economic incentives for aircraft equipage. Also, as stated above, the ability of these systems to support growing and new operational demands needs to be assessed. In light of the long time frame required to develop and deploy new datalink technologies, the initial research and development of the next generation datalink, referred to during the

Integrated CNS Workshop as the "Next NEXCOM", needs to begin now in order to be in place to enable the 2020 vision.

In moving forward in these research and development areas, the approach must consider several key elements from the start. Economic issues are of critical importance. Research and technology development must have in mind affordability and upward compatibility – the capability of low-cost upgrading of equipment and systems, where even the first generation technology is designed for future retrofit. Systems must also be developed such that economic incentives to adopt new systems and install new equipage are built in from the initial design. The research and design process must also become more fully aware of, and integrated with the certification processes that will be required. The time needed for certification must be reduced, including working to develop better, more coordinated certification paradigms which allow the certification process to be accomplished in parallel with system/software/equipment development. This process really needs to begin in the research stage. Equally important, the research and development process must be grounded in an environment that is fully cognizant of the operational concepts that the research is ultimately intended to address. This is needed to avoid the divergence of technology development from the requirements of the operational concept being implemented and avoid the "solution looking for a problem" syndrome.

3.3 CNS Research and Development Organization, Coordination and Guidance

The Integrated CNS Workshop participants and the Executive Committee recognized a need for a greater level of leadership and organization in the CNS research community. CNS research today is fragmented, often uncoordinated and of low visibility, existing as parts of other programs and often considered as "someone else's problem". The traditional approach of separate systems, separate equipment, separate communications links, separate frequencies, etc. to address individual applications and operational needs must be replaced by an over-arching approach of CNS as an integrated network of systems. The CNS research and development community must have its own identity as the most important infrastructure through which the 2020 operational vision is enabled.

In order to raise the level of visibility of the CNS research and development, to provide focus and guidance to the research, to coordinate and harmonize different research efforts to achieve a common goal, and to garner the necessary resources, a CNS research and development coordination committee or committees must be formed. The committee must have both a national and international focus and be associated with and include membership of the key organizations responsible for aviation system research and development including the FAA, NASA and Eurocontrol. The committee must be able to operate at sufficiently high levels within these organizations to draw attention to critical issues and gain the necessary support and resources to properly address such issues. The input of the aviation user community is of critical importance to this effort. The committee must be able to foster creative, credible, high quality and high value research and interact with the entire aviation community.

As its success criteria, the committee must be able to focus research and development funding to enable the 2020 aviation system vision, as well as helping to solve the near/mid-term problems. The committee must be able to place real, credible data in front of the aviation community's decision makers. The committee must provide guidance to achieve the optimal coordination of national and international CNS research and development efforts and influence national and international coordinating and regulatory bodies.

Such a coordinating committee is believed to be of fundamental importance in addressing the various critical CNS research issues that have been identified by the Integrated CNS Workshop participants and are outlined in this report.

4.0 SUMMARY OF WORKSHOP CONCLUSIONS AND RECOMMENDATIONS

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 A
The Technical Sessions of the Workshop on Integrated Communications, Navigation and Surveillance Technologies for Advanced Future Air Transportation Systems

Keynote Address
"Aerospace Technology Enterprise Goals & Objectives" – Samuel Venneri, NASA Headquarters

Session A - Visions of the Future of Air Transportation
Chairperson: Denise Ponchak, NASA Glenn Research Center

"COMModitizing the Airspace" – Dave Witchey, United Airlines

"Vision of Future Air Transportation" – Michael Harrison, Federal Aviation Administration

"Air Transportation System - Beyond Tomorrow" – Frank Aguilera, NASA Ames Research Center

"NASA Aviation Safety Program" – Douglas Rohn, NASA Glenn Research Center

"NASA Aerospace Technology Enterprise Small Aircraft Transportation System – Program Overview" – Dave Hahne, NASA Langley Research Center (Presented by Michael Zernic, NASA Glenn Research Center)

Session B - Current, Near, and Mid-Term R&D and Demonstration Programs
Chairpersons: Roy Oishi, ARINC and David Olsen, Federal Aviation Administration

"Smart Landing Facility – Operational Concept" – Steven Bussolari, MIT Lincoln Laboratory

"Safe Flight 21 and Surface Technology Roadmap" – Ken Leonard, Federal Aviation Administration, AND-500

"UAT Technical Aspects and MOPS Status" – Jim Dieudonne, MITRE/CAASD

"Status of Loran-C Evaluations" – Jim Nagle, Booz-Allen & Hamilton

"CPDLC for NASA Runway Incursion Prevention System" – James Rankin, Ohio University, Avionics Engineering Center

Session C - Domestic Industry and International Communications/Datalink R&D and Demonstration Programs

Chairpersons: Mike Murphy, ATNSI and Robert Kerczewski, NASA Glenn Research Center

"Flight Information Services Data Link Through FAA-Industry Agreements" – Ernie Dash, Raytheon

"The Aeronautical Telecommunication Network: a Cooperative Agreement" – Mike Murphy, ATNSI

"Avionics R&D for CNS/ATM Environment in China" – Shimin Gu, Chinese Aero Radio Electronics Research Institute

Session D - Near and Mid-Term Issues and Needs
Chairpersons: Michael Zernic, NASA Glenn Research Center and James Branstetter, Federal Aviation Administration

"CNS/ATM Strategy" – Abe Jaafar, Delta Airlines

"Spectrum Management in the R&D Process" – Brandy Ingargiola, Federal Aviation Administration

"Expanding Hopkins to Meet Air Traffic Needs" – Mark VanLoh, Cleveland Hopkins International Airport

"CNS Data Link - Avionics Manufacturer Perspective" – Steve Koczo, Rockwell Collins

"CNS - Don't Forget the Ground!" – Noel Schmidt, Architecture Technology Corporation

Session E - Research and Technology Development for Far-Term Datalink Systems
Chairpersons: Gus Martzaklis, NASA Glenn Research Center and Paul Mallasch, Scitor Enterprises, Inc.

"NAS Architecture and Research and Development Efforts" – Michael Harrison, Federal Aviation Administration, ASD-100

"Communications System Architecture Development for Air Traffic Management and Aviation Weather Information Dissemination" – Doug Blythe, Aeronautical Radio, Inc.

"NASA Datalink Communications Research and Technology Development for Aeronautics" – Gus Martzaklis, NASA Glenn Research Center

"Next Generation Satellite Systems for Aeronautical Communications: Research Issues" – Toni Trani, Virginia Tech

"Commercial Aviation Mobile Datalink Communication Decision Choices – Meeting Commercial Air Traveler Stakeholders' Expected Value" – Paul Mallasch, Scitor Enterprises, Inc.

“Advanced Wideband System: Analysis of Alternatives for Wideband Military Satellite Communications in the 2008+ Timeframe” – Roy Axford, Space & Naval Warfare Systems Center

Session F - Perspectives on Far-Term Research Needs
Chairpersons: Chris Wargo, CNS, Inc. and Michael Ball, University of Maryland

“Key Issues for the 2020+ Integrated CNS Architecture” – Chris Wargo, Computer Networks & Software, Inc.

“Next Generation Collaborative Traffic Flow Management Systems” – Michael Ball, University of Maryland

“Evolution of Future Aircraft Data Communication” – Jean-Paul Moreaux, EADS Airbus

“Future of the National Airspace System” – Neil Planzer, United States Air Force, DoD

“Regional Aircraft: A New CNS Challenge – The View from the Front Seat” – Richard Weiss, Atlantic Southeast Airlines

“Beyond 2010, A NAS Evolution” – Michael Harrison, Federal Aviation Administration

APPENDIX B

Presentations of the Breakout Session of the Workshop on Integrated Communications, Navigation and Surveillance Technologies for Advanced Future Air Transportation Systems

Session 1 - Near and Mid-Term CNS Technology R&D Needs

- Spectrum Issues
  - Lack of frequencies/ different concepts
  - Data link requirements for terminal area link? Too much data linking for the tactical phase of flight may be concern
    -C-band? 400Mhz
  - How far can you get with a terminal data link in a 2007 time frame?
  - Any analysis as to how many data link you need . .
  - A creative data link allocation strategy
  - What up-date rates would improve decision support services
  - Equipage transmission issue for VHF
  - How to expand spectrum?
  - The FAA has a study in place that says we will run out of spectrum by year 2009
  - Should look at other frequencies outside of spectrum
  - More study and analysis needs to be done on the future of Nexcom system
  - Frequency recapture/reuse

- CPDLC ISSUES
  - Goal of 5 seconds for one way communications from the controller to the pilot for terminal area, but building system around 10 second enroute goal.

- VDL Issues
  - We need to use mode 2, they don't have AOA customers signed up
  - Possibility with mode 2 for a lot of interference (antenna issue)
  - Is there a role for NASA in this VDL-3 for NEXCOM
  - What if we go the VDL-3 route?

- Networking Issues
  - ATN vs IP networking issue
  - IP-6 viable alternative for ATN

- Antenna Issues
  - Near term issue to put more and more antennas up
  - Such a diverse problem to integrate antennas
  - VHF antenna usage study might make some sense
  - A stakeholder is GA

- Safety standpoint

- Moving from a data-link airspace to a non-data-link airspace
  - Hybrid systems issues
  - Getting together with SATS program to do a demo
  - What are the trade offs between latency/ hand-off issues, etc.?

- Collaboration and Decision Making
  - NASA needs to come out as an advocate for a specific solution
  - There needs to be a process to fast-track things (Y2K paradigm)
  - Industry and government need to get together and make a decision
  - Issues need to be put in front of the people who need to know (congress)
  - Consensus for CNS requirements
  - Lack of consistent definitions, no strong consensus on requirements
  - A tool to manage discrepancies needs to be present
  - Utilize the DO264 as a baseline for definitions, terms, and requirements

- SATS Related
  - Where do we start putting RCP in (technical roadmap for RCP and SATS)
  - Want high-level requirements on RCP and RNP integrating legacy systems with the SATS etc.
  - What does class SATS airspace mean for aviation?
  - Firming-up of information content; categorize

- Modeling and Simulation
  - Near term resolution modeling is not the type that we need
  - Should NASA's role be to look at simulation/CNS issues?
  - Goal in developing lab capability

- Identify stakeholders ID research
  - Avionics/Airframe manufacturers
  - Service providers
    - Communication SP
    - ATC SP
    - Weather service
    - Internet services
    - Other FIS
    - Satellite owners
  - Airline owners
  - GA/airline pilots and owners
  - DOD
  - Certification folks
  - Airports
  - Public
  - Regulatory agencies/FCC

Session 2 – Far-Term CNS Technology R&D Needs

- Brainstorm Issue Needs
- Review and Assessment
- Ranking
- NASA Program Allocation

1. Impact on Aviation Profitability {n-l}
    A. Wireless in the US vs. others with Wireless (overcome legacy infrastructure)
    B. the rest of the world won't wait
    C. U.S. GNP adversely affected with loss of leadership
2. Continue drive for Global Aviation Communication Standards & Coverage (over oceans etc.) {b-h}
3. Commoditized Aerospace Mechanisms (reference M. Ball & D. Witchy presentations) {c-h}
4. Better High Speed Data Communication Links {s-h}
5. Multi-functional Data link (APC, AAC, AOC, ATS, & ATC) {c-m}
6. Dynamic Frequency Allocation (unbounded by regulatory allocations) {c-m}
    A. Time-based
    B. Spatial-based
7. Security/Vulnerability {s-h}
    * CDMA- e.g: to enhance anti-jam
8. Enhanced CNS Traffic Model (to allow for faster comparison of proposals) {c-m}
9. Sub-network Assessment Tools {c-h}
    * Data open access
10. Harmonization on Internet Protocol {c-h}
11. Enhance Safety Improvements Based on digital communications
12. Tools to allow dropping-fixed route structure {c-m}System Design based upon Object Changes {c-m}
14. Automatic/Collaborative {c-m}
    * Intermodal Dynamic Sizing self-organized schedule
15. Capacity equal VFR for all conditions {b-h}
16. Network Ground Infrastructure {s-l}
    * Improvement- Hybrid
17. Losing ground situational awareness {s-h}
    A. High situational awareness on ground through synthetic vision
    B. Cameras around plane
    C. IR Engines
18. Human Factors- Cross all voice to data to Multi-media transition {s-h}
19. Mobile within mobile "wireless
20. Ultra wideband- {c-m}
21. Airborne Internet {s-m}
22. Aircraft Sensor {b-m}
    * Generation, fusion and distribution of aircraft sensing information, e.g., weather
23. Appoint a NAS program manager {b-h}

Legend: c = Capacity; s = Safety; b = Both; l = Low, m = Medium; h =High

Session 3 – Assessment of Current CNS Technology R&D Programs

R&D Gaps

- I/F between CMU and FMC
  - Move uploaded data and auto-load into FMC/FMS
- Human factors in the cockpit
  - More workload is not necessarily a bad thing
- CONOPS on Datalink for ATC
  - Risk of visual overload in the cockpit
- Low-cost MFDs
  - Enabling technology for situational awareness
- Short-term controller aids
  - e.g. Ten mile offset
- Shared separation responsibility
  - Don't abandon progress toward self-separation
- Communications shortfalls at small airports
  - as identified by Rick Weiss
- Approach lighting systems at small airports

Lessons Learned

- Being made aware of projects currently in the works
- Have people from the front line influence R&D efforts so the results can be applied in practical applications
  - e.g. controllers, aircraft certification, flight standards and AOC people
- International implications (NAS vs. Global CNS/ATM)

Session 4 – 2020 Operational Concepts

Methodology

- Met and Shared
- Brainstormed Assumptions
- Agreed on (a few) ConOps Issues

NAS Assumptions

- NAS will be more self-aware than now
- Ground to space based nav system transformation occurring
- Better weather forecasts - 2 hour lead time to 90% accuracy
- Dynamic resectorization exists
- Weather, traffic and Airspace awareness in cockpit will become essential
- AOC plays increasing role in ATM environment

ATM Assumptions

- Move from Tactical to Strategic ATC (ATM)
- Moving toward ADS-B, but radar is still present and will be into…
- Some kind of EFR exists
- Self-separation exists at some level, but not pervasive
- No European "One Sky" yet

HUB Assumptions

- RLV operations
- Fortress Hubs
- Regional Hubs
- Municipal Hubs
- Rural
- Others

Other Assumptions

- Still hungry for bandwidth, and it is still limiting
- Point to point is the driver
- Environmental concerns are increasing constraints
- AC mix is increased to rotorcraft, etc., but SATS operations are more prevalent
- UAVs
- In ten years, we'll HAVE TO KNOW what we want for 20 years from now...

Concept

- DATA --> INFO --> KNOWLEDGE management
- Optimization
    - System?
    - Individual?

- Balancing
    - Who goes first?
    - Dynamic management
- Dipping into existing capacity...
- Interline Alliances...
- AOC
    - Enhanced role
    - Intermodal issues
- Dynamic resectorization no longer geographically constrained
- HUB RTAs combined with FMS arrivals, CDTI, and distributed awareness
- Needs INCENTIVIZATION for equipage - from commercial to GA

Conclusions

- It will take 20 years to get there...
- ***Dynamic*** collaboration is going to play a huge role
- Requires low cost, combined avionics within 10 years to hit a 20 year horizon
- Requires more than just aviation to ensure throughput
- This deserves more thought to get NASA directed
- Target rich environment

Session 5 – Organizing the R&D Community and Advocacy

- Known Relevant Orgs
  - NASA/FAA Integrated Program Team
  - Eurocontrol, Other Respective Countries
  - Country (some are leaders, some followers)
    - Gov't
      - FAA, NASA, DoD (e.g., US)
    - Industry
      - Avionics, Airlines, etc
    - Academic
      - Universities, Coalitions
    - Country's interface into the international scene
- Why Organize
  - National Goals
  - Common Objectives
    - Segregate near-term implementations from distracting R&D efforts
  - Leverage $$
  - Implementation Timelines
  - Swell the advocacy
- Process
  - Joint Leadership (FAA/NASA)
  - Strategic Goals
  - Solicit input from key orgs (advisory committees, REDAC)
  - Evaluation cycle (2 tiers: domestic + int'l)
    - leverage activities, id gaps, selective duplication for confidence, agreements, decisions, iterate/update
  - Products meet Goals (matrix, map, investment plan)
  - International Harmonization
- Forums/Venues
  - Existing, new? (conference, technical workshop, open but invited, how often)
    - Smaller mtg of spectrum utilization, reserved, re-allocation, re-use, guard-bands, survey of bandwidth requirements)
  - Context (CNS, Communication, ?)
  - Topics (process, analyses - data, not just paper, products, harmonized recommendations)
  - Formal blessing & sponsor (NASA/FAA advisory/exec committee?)
- Advocacy
  - What orgs are most effective to advocate ***to?***
  - State/Fed Gov't??
    - What is this advocacy role?
  - Airlines (United at WRC as well as American, NW, Delta)
    - Influence Aircraft & avionics purchases
    - Users views as more objective
  - Industry/Manufactures
    - Caution as to motive

- Products of this Breakout Session
  - White paper from this CNS workshop Exec Committee submitted to Venerri/Zaidman advisory committee
    - Recommendations on organization & advocacy
      - Provide more balance to CNS, rather than the currently more favored ATM aspects
    - Standing committee, legal body
      6 Consider implications of comm tech discussions w/foreign nationals