NEXCOM Industry Roundtable: Air/Ground Communications Modernization

September 18, 2000
Opening Remarks

Amr ElSawy
Senior Vice President and General Manager
MITRE/CAASD
Roundtable Participation

- **Airlines**
  - American, Continental, Delta, Federal Express, Northwest, Southwest, TWA, United, UPS, US Airways

- **International**
  - Eurocontrol, NAV Canada

- **Avionics Manufacturers**
  - Honeywell, Rockwell/Collins

- **Service Providers**
  - ARINC, SITA

- **Unions**
  - NATCA, PASS

- **Airframe Manufacturers**
  - Airbus, Boeing

- **Associations**
  - AOPA, ATA, NBAA

- **Government & Other**
  - DOD, FAA, RTCA, ATNSI, MITRE
Objectives

- Provide an understanding of the FAA’s NEXCOM Program Plan and the issues associated with A/G modernization
- Continue and expand the dialog with the leaders of the aviation industry concerning the current plans associated with A/G modernization
Agenda

• Opening Remarks (9:00 AM)
  Monte Belger & Steve Zaidman

• A/G Communication Problems
  – ATC Communications Operational Impact Ron Morgan (FAA)
  – Spectrum Problem George Sakai (FAA)
  – 8.33 Experience in Europe Geoff Bailey (Eurocontrol)
  – Spectrum Assessment Analysis Jim Chadwick (MITRE)
  – Next Generation Air/Ground Communications System Requirements Jim Washington (FAA)

• A/G Modernization
  – NEXCOM Program Plan Jim Eck (FAA)

• Discussion and Feedback (1:00-4:30 PM)
  – Summary and Next Steps
ATC - Communications
Operational Impact

Ron Morgan
Director of Air Traffic Service
AAT-1
ATC Needs

• Increased Voice Communications
  – Enhanced Capacity
  • Airspace
    – NAS Airspace Redesign/Dynamic Sector
    – Reduced Vertical Separation Minima - Domestically
  • New Runways/Taxiways/Gates/Ramps
  • More Efficient Use of Existing Surface Resources (e.g. Split Ground & Local Control)
• New Airports
• Terminal Area Consolidation & Redesign
ATC Needs

• ATS Programs Requiring Enhancements
  – Runway Safety Program
  – Precision Runway Monitor (PRM)
    • Anti-blocking/Override technology
• Support critical/crucial immediate incentives (e.g. choke-point)
ATC Needs

- Increased Data Capability
  - Support a Robust Data Capability
  - Assure Performance for Time Critical Control Instructions
  - High Reliability/High Integrity Data
  - ATN Compatibility
ATC Needs

• Added New Capabilities to Enhance Controller Efficiency
  – Controller Override
    • Stuck Microphone
  – Anti-blocking
  – Next Channel Uplink
• Support New Technologies
  – Decision Support Tools
    • CTAS, FAST, URET
ATC Needs

• Safe Transparent Transition Strategy through:
  – Human Factors
    • Pilot/Controller
  – Joint FAA/User Transition & Implementation
  – Risk Management
  – Training
Summary

• Communications are the heart of the CNS/ATM System

• The Planned Capabilities of NEXCOM Include:
  – Increased Capacity within the available Frequency Spectrum to efficiently meet voice and data requirements
  – An air/ground communications link that supports both Voice and Data communications, in a functionally simultaneous manner
  – A replacement of aging VHF equipment
  – New operational capabilities enabled by Digital Functions
Summary

- ATC Needs Additional Voice Communications
- International Agreements/Commitments to VDL-3 at the 1995 ICAO ComDiv/Ops Meeting
- U.S. Is on VDL-3 Track
- Recommendation: *Stay the course, VDL-3*
Spectrum Utilization in the NAS

George Sakai, Program Director
Office of Spectrum Policy and Management
ASR-1
History of VHF Usage

- 1960’s: 50 kHz spaced channels implemented
- 1977: 25 kHz spaced channels implemented above 18,000 feet
- 1979: Additional allocation of 136-137 MHz internationally
- 1986: 25 kHz spaced channels implemented below 18,000 feet
- 1990: 136-137 MHz band implemented
- 1990: VHF congestion addressed internationally (1990 ICAO Com/Met/Ops)
- 1991: RTCA SC-172 established
- 1994: TDMA recommended by RTCA-172
Limited VHF Resource to Meet Requirements

✈ FAA
✈ Other Federal
✈ DoD
✈ Non-Federal

Total Channels Available = 760    ATC Channels = 524
Current VHF Spectrum Utilization

AOC 30%

ATS 70%

EnRoute 15%
Terminal 7%
Tower 18%
FSS/Unicom 16%
ATIS/AWOS 9%
Emergency 4%
Misc Com 1%
U. S. Growth of ATC Frequency Assignments

Increase in number of channel assignments per year = 307 average
Voice Channel Assignments Relationship to Air Carrier Operations

![Graph showing the relationship between Flight Operations and Spectrum Assignments over the years.](image)

**Legend:**
- Pink: Flight Operations
- Blue: Spectrum
- Gray: Linear (Flight Operations)
- Gray: Linear (Spectrum)
Current Status of VHF Congestion

- Difficult to satisfy ATC requirements in some parts of the country

- New spectrum requirements continue to grow -- additional sectors, FIS, AWOS/ASOS, etc.
Measures Taken to Minimize VHF Congestion

- Relaxed protection of co-channel use (from 20 dB to 14 dB)
- Reduced radio power to 10 watts to use spectrum more efficiently
- Use of voice outlets on VOR/NDB for ATIS/AWOS/ASOS
- Use of several remote communications facilities at large airports
- Use of one VHF in each sector
- Use of selective keying in large sectors
- Limit operational coverage area
- Developed special radio equipment to mitigate co-site problem
- Refined engineering techniques
- Assign ground control frequencies outside of the ground control band 121.6-121.9 MHz
- Install new BUEC sites near the primary site
Remaining Spectrum Resources

Total Number of Voice Channels

What is Left Today

Channels Available With NEXCOM
Conclusions

- Total depletion of VHF channels expected to occur prior to end of decade
- We need to proceed with the plan.
8.33 kHz Implementation in Europe

G.N. Bailey, Head of Communications Unit
C. Hamel, 8.33 Programme Manager
EUROCONTROL
Spectrum Assessment Analysis

Jim Chadwick
Director Communications, Navigation & Surveillance
MITRE/CAASD
Nationwide VHF A/G Radio Spectrum

One-Megahertz Bin Starting at Indicated Frequency

- Altitude >= 30,000 ft.
- Altitude < 30,000 ft.
ATC Circuits Density
En Route Sectors with traffic density projected to operate at 130% of capacity by 2015.

16 additional requests pending for Great Lakes Region by 2002

Circuit Denial: Cleveland Center Sector 36

Spectrum En Route Limitations
-- 2% Growth in Demand --
Airport Spectrum Case Studies

• Four airports with planned new runways were surveyed

• Results show that
  – Three airports are experiencing interference problems and frequency shortages today that limit traffic growth
  – Three airports will require additional frequency assignments (19 in total)
  – Facility managers stated that without new frequencies full utilization of planned runways will not be obtained
    • 50%-100% reduction of projected increase in operations
  – Stuck microphone was identified as a significant operational issue
Drivers for Spectrum

- Air Traffic Volume
- Number of Controllers
- Controller Workload
- Split Sectors
- New Runways
- Airspace Redesign
- New Procedures (e.g., RNAV, RVSM)
- Data Link
- PRM
- ASOS
- AWOS

Spectrum is a Constrained Resource

Number of Frequencies
Frequency Assignments Prediction Model

![Graph showing the relationship between ATC voice channels and air carrier operations with a trend line and historical data points. The R^2 value is 85%.](image)
Anticipated Number of Frequency Assignments

- Predicted frequency assignments in 2015 is approximately 35% more than today

![Graph showing the number of frequency assignments from 1999 to 2015.]

- 1999: 10,985
- 2015: 14,853
Frequency Congestion Has Cost and Efficiency Implications

Historically, circuit growth has been 4% per year. Increasing cost/difficulty of placing new circuits reduces growth rate. Reduced growth rate implies a less efficient NAS.

Growth in A/G Circuit Demand

Unsatisfied Demand Reduces NAS Efficiency

Increasing Cost and Difficulty of Provisioning New Circuits

# Deployed A/G Circuits

Circuits (1000s)

25
20
15
10
5


Year
## Options Comparison

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Spectrum Capacity Results

At a 2-3% spectrum growth rate, both VDL-3 and 8.33 will last approximately 30 years.
Operational Transition is Technology Independent

- Ultrahigh Sector
  - FL600
- High Altitude Sector
  - Class A Airspace
  - FL180
- Low Altitude Sector
  - 240
- Terminal Airspace
  - 100
  - 180

Operational Transition is Technology Independent
### NEXCOM Timeline Factors

<table>
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<tr>
<th>Year</th>
<th>Events</th>
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</thead>
</table>
| 00   | • Risk mitigation  
  - R & D  
  • Standards Adoption |
| 02   | • Acquisition Activities  
  • Initial user equipage lead time  
  • Operational evaluation |
| 10   | • Time necessary for user equipage and transition |

- Spectrum transition requires a long lead time
- Transition needs to start now while a few frequencies are still available in congested geographical areas
  - Any delay will increase the economic penalties for the FAA and users
Next Generation Air/Ground Communications System Requirements

Jim Washington
Director of Air Traffic System Requirements Service
ARS-1
Next Generation Air/Ground Communications System Objectives

- Identify and implement a system that will
  - Alleviate the spectrum congestion problem
  - Reduce maintenance costs of radio systems
  - Increase security/channel control
  - Establish a communications path for data link for all users
  - Provide flexibility for future growth of services
Accommodate Growing Number of Sectors and Services

- Predicted frequency assignments in 2015 is approximately 35% more than today
Reduce Logistics Cost

A/G Voice Communications Infrastructure


- Planned Life Cycle: VFSS
- Planned Life Cycle: GRIM Vodata
- Planned Life Cycle: Intelect
- Planned Life Cycle: CSTI
- Planned Life Cycle: ITT
- Planned Life Cycle: CFE Analog Radios
- Planned Life Cycle: Motorola
- Planned Life Cycle: BUEC (ITT)
- Planned Life Cycle: S-BUEC

Reduce Logistics Cost
NAS Air/Ground Communications Infrastructure

- 21 ARTCCs, 3 CERAPs, 720 BUECs & 793 RCAGs
- 175 TRACONs, 346 ATCTs, and 1422 RTRs
- 61 AFSSs, 14 FSSs and 1854 RCOs

Air Route Traffic Control Center (ARTCC)
Remote Communications Air/Ground (RCAG)

Terminal Facilities
- TRACON
- Airport Traffic Control Tower (ATCT)

Remote Transmitter/Receiver (RTR)
Remote Communications Outlet (RCO)

- VHF and UHF ATC bands
- Approximately 10,000 VHF assignments
- About 50,000 VHF & UHF TX, RX & TCVRs
- Dedicated networks for each operational environment
- Limited restoral capabilities
- Limited remote maintenance capability

Automated Flight Service Station (AFSS)
Air Traffic Services System Needs

• Enhanced Capacity
• Increased Data Capacity
• New Capabilities to Enhance Controller Efficiency
• Support New Air Traffic Technologies
• Provides security to eliminate phantom controllers
• Provide for a Safe Transition to the Next Generation Communications System
Investment Analysis

- Six competing architectures were rigorously evaluated against the needs of the Next Generation Air/Ground Communications System

- VDL-3 identified as the architecture that best meets the needs of the Next Generation Air/Ground Communications System

- Final requirements document completed for the Next Generation Air/Ground Communications System
Requirements

- Four specific functionalities:
  - Provide Air Traffic (AT) controllers the capability to accommodate the growing number of sectors and services using the available, limited radio frequency (RF) spectrum.
  - Reduce logistics costs (supplies, maintenance, training, etc.) i.e., replace expensive to maintain VHF and UHF radios that are 1960’s technology and have exceeded their life expectancy by 10 years.
  - Provide new data link communications capability to all classes of users.
  - Reduce A/G RF interference and provide security mechanisms to identify unauthorized users (e.g., “phantom controllers”)

## Options Comparison

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FAA’s NEXCOM Program Plan

Jim Eck, Product Lead
Air/Ground Communications
AND-360
NEXCOM History

- RTCA initiated SC-172 to develop solution; VDL MASP started
- RTCA & ICAO recommended future A/G communication system be TDMA VDL-3
- FAA/MITRE VDL-3 radio prototype tested
- ICAO/JCAB/EuroControl/UK/FRG/FAA complete VDL-3 SARPs validation

1990

- ICAO identified VHF congestion problem

1991

- RTCA/AEEC selected 31.5 kbps, D8PSK for VDL2/3

1993

- DOT/FAA approved the Mission Needs Statement for NEXCOM

1994

- FAA/MITRE VDL-3 radio prototype tested

1995

- COM/OPS/DIV ICAO Meeting approved VDL-3 for future communications

1997

- Investment Analysis completed, VDL-3 selected as FAA solution

1998

- ICAO AMCP recommends approval of VDL-3

1999

- FAA JRC approves new NEXCOM Program Baseline

2000
NEXCOM Objectives

• Provide for spectrum growth for at least 30 years (at a 2-3% growth rate)
• Modernize the A/G communications system
• Provide air-ground voice and data capability that meets user and AT needs
• Is affordable and provides for an adequate transition period
• Is operational within the next 10 years
Alternative Solutions

• Only VDL-3/VDL-2 or 8.33/VDL-2 can meet most of these objectives, and have been evaluated on the following 5 factors
  – Ability to provide additional spectrum capacity
  – Requirements
  – Costs to FAA and users
  – Benefits
  – Risks

• Other alternatives that fail to meet objectives
  – \(25kHz/VDL-2\) fails to meet spectrum capacity and AT requirements
  – \(CDMA, Satellite, and newer technologies\) fail to meet implementation time requirement because the standards and implementation process exceeds 10 years
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Costing Methodology and Assumptions

- Identified aircraft categories to consider (air transport aircraft)
- Identified aircraft configurations for each category
  - Analog (defined as a/c with 25kHz DSB-AM radio capability only)
  - Digital (defined as a/c with basic VDRs with 25kHz capability)
- Established equipage and cost assumptions
  - Costs based on vendor information and industry discussions
  - Equipage costs discounted 20% from “catalog prices”
  - Installation kits and labor included in estimates for upgrades
  - Installation certification costs not considered
  - VDL-2 transitions include single CMU
  - VDL-3 upgrades include capabilities of VDL-2
- Presented model/results to industry
  - Boeing, Delta, ARINC, AEEC, Airbus Industries
  - Awaiting feedback
## Aircraft Configuration Categories

<table>
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<tr>
<th>Classic</th>
<th>FMS/EFIS</th>
<th>Integrated</th>
</tr>
</thead>
<tbody>
<tr>
<td>All “analog”</td>
<td>“Analog” and “digital”</td>
<td>All “digital”</td>
</tr>
<tr>
<td>B727</td>
<td>B757-200</td>
<td>B777</td>
</tr>
<tr>
<td>B737-100/200/300</td>
<td>B767-200/300/300ER</td>
<td></td>
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<tr>
<td>B747-100/200/300</td>
<td>B747-400</td>
<td></td>
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<tr>
<td>DC-9</td>
<td>B737-400/500/600/700/800</td>
<td></td>
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<tr>
<td>MD-80/83/88</td>
<td>B737-900 (BBJ)</td>
<td></td>
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<tr>
<td>L-1011</td>
<td>B717</td>
<td></td>
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<tr>
<td>DC-8</td>
<td>MD-90</td>
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</tr>
<tr>
<td>DC-10</td>
<td>MD-11</td>
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<tr>
<td>A300/A310</td>
<td>A319/320/321/330/340</td>
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## Estimated Avionics Cost Summary

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<th>Type of Aircraft</th>
<th>Initial investment cost (per aircraft)</th>
<th>Cost Differential (per aircraft)</th>
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<td></td>
<td>VDL-3/VDL-2 (A)</td>
<td>8.33/VDL-2 (B)</td>
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<tr>
<td>FMS Airframe (analog radios)</td>
<td>$260K</td>
<td>$150 - 230K*</td>
</tr>
<tr>
<td></td>
<td>$265K</td>
<td>$155 - 240K*</td>
</tr>
<tr>
<td>FMS Airframe (digital radios)</td>
<td>$140K</td>
<td>$85 - 110K*</td>
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* Range is dependent upon whether the analog radio is upgradeable or must be replaced and number of VDRs selected in the initial VDL-2 transition.
8.33kHz ground system costs are higher than VDL-3 due to:
- Land acquisition
- More buildings and facilities
- More radios
- Antennas
- Radio control equipment
- Increased Telco

Data link service costs are assumed equal in both 8.33 and VDL-3 options
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### Beneficial Features

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<th>Feature</th>
<th>Description</th>
<th>Alternative Solutions for 8.33kHz</th>
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<tr>
<td><strong>Anti-Blocking</strong></td>
<td>Prevents the inadvertent simultaneous and unintentional transmission of VHF transmissions</td>
<td>Per RTCA DO-209, technology exists for analog radios that approximate this VDL-3 feature. Not integrated or included in 8.33 cost estimate.</td>
</tr>
<tr>
<td><strong>Stuck Mic Resolution</strong></td>
<td>Reset aircraft radio after stuck microphone (pilot unaware)—channel automatically cleared after 35 seconds</td>
<td>Timer could be implemented for analog radios. CPDLC Baseline 1 has a free text message to check for stuck mic. Not integrated or included in 8.33 cost estimate.</td>
</tr>
<tr>
<td><strong>Controller Override</strong></td>
<td>Controller capability to obtain access to communication channel, preempting other users</td>
<td>Not feasible for 8.33/VDL-2. Next Channel Uplink with VDL-2 and CPDLC. Requires connecting the CPDLC application to the Radio Control head.</td>
</tr>
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<td><strong>Next Channel Uplink</strong></td>
<td>Capability to automatically send next channel to aircraft radio without pilot intervention for transfer to next ATC control sector (Auto Tune)</td>
<td>Not feasible for 8.33. Optional equipage with VDL-2 and CPDLC. Requires connecting the CPDLC application to the Radio Control head.</td>
</tr>
<tr>
<td><strong>Urgent Downlink Request</strong></td>
<td>Pilot capability to request urgent access to occupied communication channel</td>
<td>Not feasible for 8.33. Free Text Pilot Downlinks are not part of CPDLC Baseline 1.</td>
</tr>
<tr>
<td><strong>Integrated Voice and Data</strong></td>
<td>Single provisioned comm channel can provide both voice and data services to an aircraft</td>
<td>Build out of VDL-2 network to provide data coverage for all areas with voice coverage.</td>
</tr>
<tr>
<td><strong>ATC Priority Queuing</strong></td>
<td>Permits priority handling, predictable performance, and robust communications for ATC data link</td>
<td>Not feasible for 8.33. VDL-2 performance limited by CSMA protocol.</td>
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**Integrated features of VDL-3, combined with an enhanced infrastructure including redundancy and diversity, result in a robust air/ground communications system.**
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FAA/MITRE Testing

- Full Voice and Data implementation
- Integration and Flight Testing full featured system
- Vocoder validation
- Extensive flight testing in various flight scenarios
Flight Testing

- B727 & both Convair CV-580 Test Aircraft
FAA WJHTC Facilities

- Building 300 (NEXCOM Lab & Mock Tower)
- Remote Buildings 70 & 176
FAA/MITRE VDL Mode 3 Flight Test System

Control Site (NEXCOM Lab - Building 300)

- PC Display
- GNI Front End & ATN Router
- RCEs
- Ground Network Interface

Remote Radio Site (Bldgs 70&176)

- VDLRStat
- Radio
- Public Switch Tel. Network
- M
- M
- M
FAA/MITRE VDL Mode 3 Flight Test System

Control Site (NEXCOM Lab - Building 300)

- PC Display
- C-RCEs
- RDVS

Remote Radio Site (Mock Tower)

- VDLRStat
- GNI/RIU
- Radio

A/C Network Interface
- Aircraft Display
- Radio Control Panel
- Audio Unit
- VDLRStat Logging Program

Radio Control Site (NEXCOM Lab - Building 300)

- R-RCEs

NEXCOM Roundtable 9/18/00
## NEXCOM Program Strategy: Overview

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<th><strong>Objective</strong></th>
<th><strong>Strategy</strong></th>
<th><strong>Rationale</strong></th>
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<td>Infrastructure Sustainment</td>
<td>Part 1: Multi-mode Digital Radio Contract in FY01</td>
<td>Aging Radios No Current Radio Contract Maintains Options Flexibility</td>
</tr>
<tr>
<td>User Commitment/Aircraft Equipage/Transition/ Implementation</td>
<td>Part 2: User Involvement Via RTCA, ARAC, etc.</td>
<td>Aviation/Air Traffic user input needed to define the tech, ops, and regulatory aspects</td>
</tr>
<tr>
<td>Reduced Technical Risk/ Develop VDL 3 System/ Perform Demonstration Validation</td>
<td>Part 3: Demonstration Validation followed by VDL 3 Development Contractor Award</td>
<td>System solution that reflects tech, ops, and regulatory solutions from Part 2 with a Demonstration Validation</td>
</tr>
<tr>
<td>Continue to Try to Mitigate Spectrum Depletion Impacts</td>
<td>Part 4: Intensify Spectrum Work Around Efforts to Support ATC Services</td>
<td>NAS will continue to grow to meet user demand, must manage existing spectrum asset Deployment and cutover strategy</td>
</tr>
<tr>
<td>Deployed NEXCOM System</td>
<td>Part 5: Production &amp; Deployment for Digital Voice &amp; Data</td>
<td></td>
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NEXCOM Program Strategy: Key Milestones

Part 1  Multi-mode radio contract award  July 2001

Part 2  Concept of Use  September 2001
        Transition & Implementation Plan  March 2003
        Demonstration Validation Plan  March 2003
        Publish Final Regulatory Guidance  June 2004

Part 3  Revise ATNSI Cooperative Agreement  Apr 2001
        System Development Study CA(s)  Jul 2002
        Demonstration Validation  2004
        Downselect to Final System Developer  Mar 2005

Part 4  Spectrum Efficiency Activities  Continuing

Part 5  VDL 3 Voice IOC  FY 2009
        VDL 3 Voice FOC  Depends on transition plan
        VDL 3 Data Deployment  Depends on transition plan
NEXCOM Proposed Program Strategy

2000
- JRC Decision 5/00
- Ground Radio MDR CA (7/01)
- VDL-3 Evaluation Prototype Development
- RTCA SC Con-Ops / Transition / Implementation & Evaluation Plans
- RTCA SC 172 VDL-3 SARPs MASP MOPs
- AEEC Avionics Characteristics
- Rules Development

2002
- VDL-3 Operational Evaluation
- Avionics Development (with FAA funding) e.g., ATNSI

2004
- MDR Deployment
- JRC Decision 9/04
- VDL-3 IOC
- User Equipage

2006
- VDL-3 System Development

2009
- OUTCOME
  - Radios for Infrastructure Sustainment
  - VDL-3 Integrated Voice & Data Systems Developed and Digital Voice Evaluated
  - User Commitment and Aircraft Equipage
  - VDL-3 Data Relief Available
  - VDL-3 Data Deployment


NEXCOM Roundtable 9/18/00
Activities Required for Risk Mitigation

• Airborne Equipage/Airspace User Coordination
  ➔ Fund avionics development
  ➔ Develop the transition plan through RTCA
  – FAA/Industry Outreach program to include GA Community

• Technical Acceptance/Development
  ➔ Fund Avionics Development
  ➔ Fund the development of an interoperability testbed at WJHTC
  – Work with avionics vendors to develop test equipment

• Infrastructure/Implementation
  ➔ Fund and develop required changes to VSCS and automation systems to support new features
  – A/G Communications Master Plan aligned with FAA field organization databases
Activities Required for Risk Mitigation

• Operational Acceptance
  ➔ Fund and Accelerate Human Factors Studies/Analysis with pilot and controller participation
  ➔ Fund early Validation Demonstration with commercial avionics

• Certification/Rulemaking
  – Form internal FAA group to determine preferred rulemaking process
  – RTCA - MASP's and MOPS
  – Coordination with AFS/AIR/AGC/APO as part of OSA

• Outcomes/Benefits
  ➔ Reconvene the C/AFT to further cost benefit analysis
  – Industry outreach and RTCA
Activities Required for Risk Mitigation

• Programmatic/Institutional
  – Develop A/G Communications System Master Plan
  – Work with RTCA

• Requirements Management
  – Integrated Review Board established

• State Coordination
  – Continue ICAO, RTCA, AEEC coordination

• Vendor/Contract
  – Multimode Digital Radio Procurement July 2001
    Contract Award
Summary

• Aviation community needs robust Air/Ground communications
• ATC VHF Spectrum depletion is real
• FAA communications infrastructure must be modernized
• VDL-3 program is designed to meet these needs
  – Incorporates early system demonstration validation to reduce development risk
  – Requires full user involvement for successful implementation
Next Steps

- Convene FAA internal group to determine the appropriate regulatory path as soon as possible
- Approve RTCA special committee requested by FAA as soon as possible
- Establish AEEC work program for VDL-3 avionics standards at the November general session
- Convene C/AFT to conduct NEXCOM cost/benefit analysis as soon as possible
- Amend ATNSI Cooperative Agreement to support VDL-3 avionics development
- Confirm user participation (with their aircraft) in the demonstration validation