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# **VDL Mode 3 NEXCOM**

**May 2002**

**D. A. Nelson**



# Why is NEXCOM Necessary?

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- **VHF Communications Established as Primary Communications Link Since Before WW II**
  - 25 kHz Channel Spacing Adopted in 1974.
  - Additional 1 MHz Added to Band
  - ACARS Data Communications Established in 1978
- **Aeronautical Traffic has Increased by Orders of Magnitude and will Continue to Increase**
  - VHF Continues to be Spectrum of Choice. Additional Spectrum Allocation Difficult if not Impossible to Obtain
  - Studies Predict Spectrum Saturation by 2009 to 2011



# What Are The Options?

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- **Make More Efficient Use of Existing Spectrum**
  - **Europe has Adopted 8.33 kHz Channel Spacing for Portions of Their Airspace. (Three Voice Channels in Space of One)**
  - **ACARS Providers are Adopting VDL Mode 2 for Data Communications. (31.5 KBPS Vs. 2.4 KBPS)**
  - **Substitute Data for Voice Communications**
  - **Digital Voice Communications**
- **Allocate New Aeronautical Communications Frequency Band(s)**



# Why Mode 3 For NEXCOM?

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- **Mode 3 Provides Efficient Spectrum Utilization**
  - Four Voice or Data Channels Per 25 kHz Channel
  - Voice and Data on Same Frequency
  - Voice and Data are Digital Information
- **Mode 3 Allows Ground Station Control**
- **Mode 3 Provides Flexibility for Voice / Data Transition**
- **Mode 3 Builds on the Capabilities of Mode 2**
- **Mode 3 uses Independent Time Source**

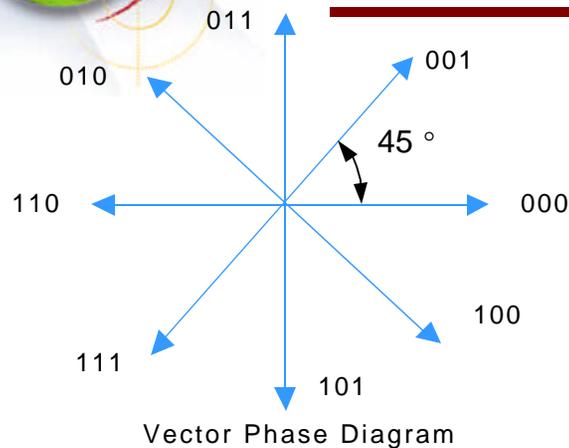


## What is Mode 3?

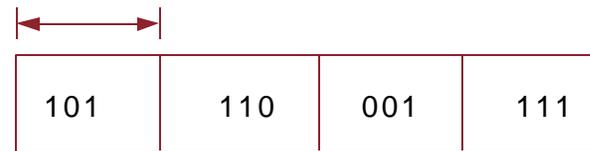
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- **Mode 3 is D8PSK Modulation**
- **Mode 3 is TDMA (Multiple Channels Differentiated in Time)**
- **Mode 3 is Digital Voice**
- **Mode 3 Provides Both Voice and Data**
- **Mode 3 Offers Flexibility**

# VDL Mode 3 Physical Layer

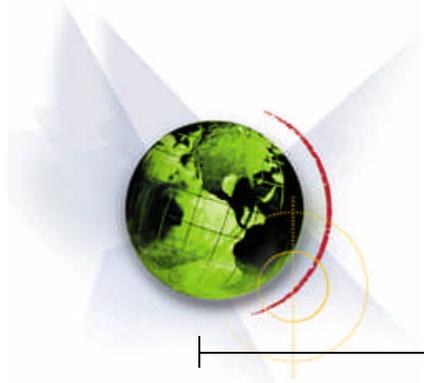


9.524 micro sec. (10.5 kHz)

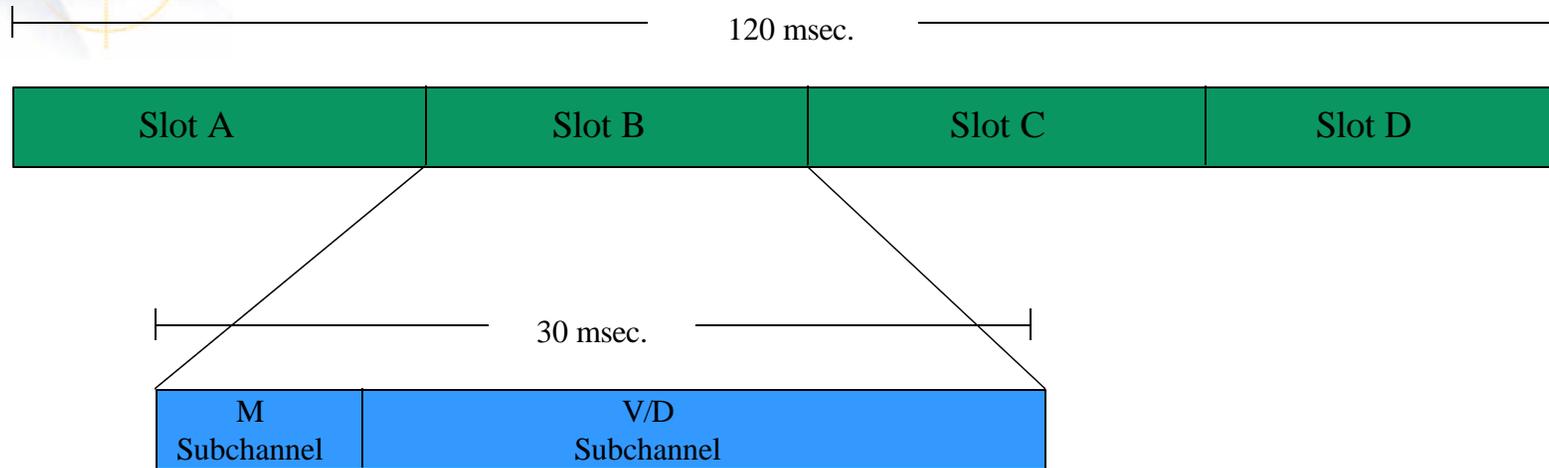


Information Data Stream

- **Mode 3 Utilizes a Digital Modulation Technique Known as D8PSK**
  - Data Content is Relative Phase Shift from One Symbol to Next, Each 45 Degrees Representing a Different Number
  - Symbol Rate is 10.5 kHz for Data Rate of 31.5 kBPS
- **Same Modulation as Used for VDL Mode 2**



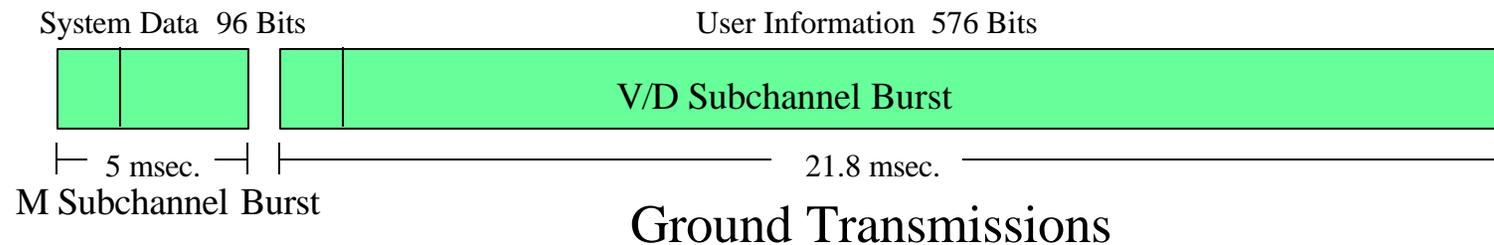
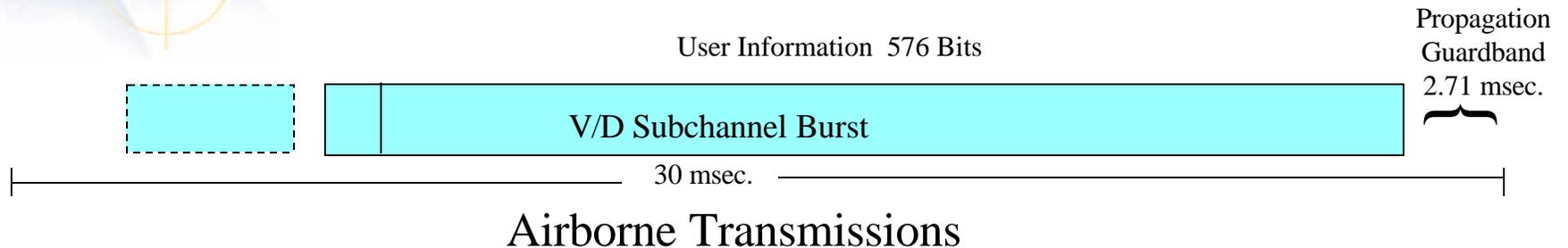
# VDL Mode 3 TDMA Structure



- **Each Slot is One Independent Voice/Data Channel**
- **Management (M) Channel Controls the Channel**
- **Voice/Data (V/D) Channel Contains Digitized Voice or Digital Data (4.8 kbps Rate)**



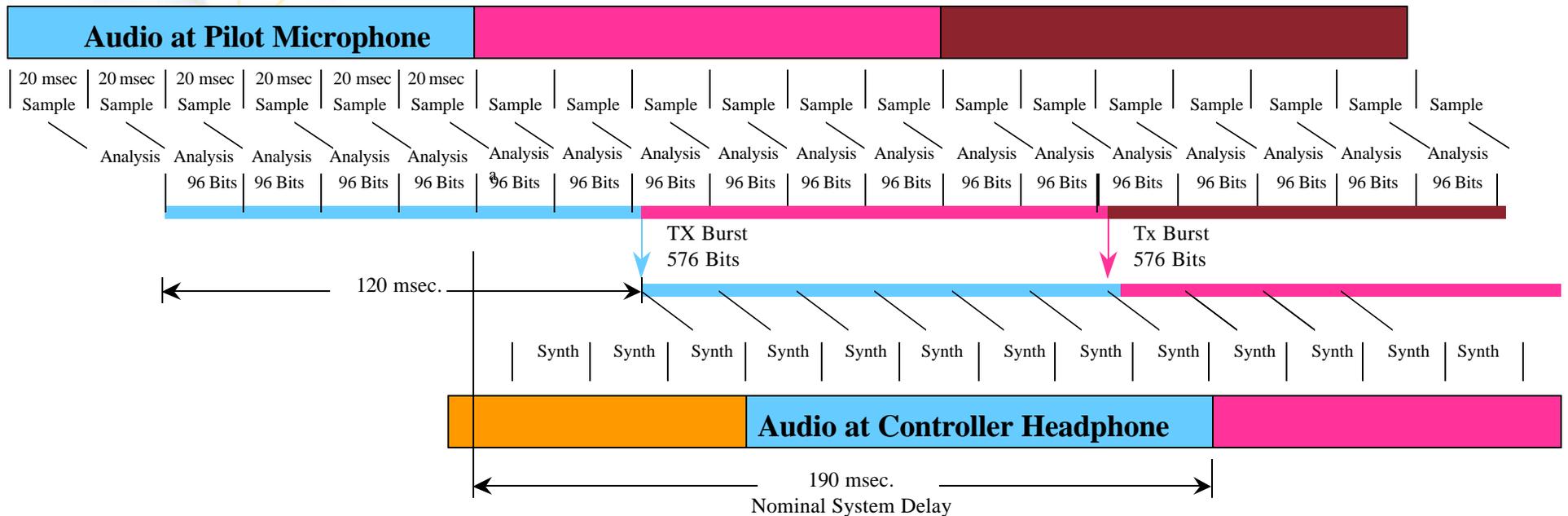
# VDL Mode 3 Slot Structure



- **Management Subchannel Transmitted Only by Ground for Voice Circuits**
  - Controls Subchannel System Configuration
  - Controls Direction of Transmission
  - Provides Voice Signal Status
- **Propagation Guardband Determines Range (2.71 msec. = 215 NM)**



# VDL Mode 3 Vocoder Operation



- **Vocoder Samples Voice Data in 20 Millisecond Increments and Converts to 96 Bit Data Packet**
- **Six Packets are Transmitted in V/D Subchannel Each 120 Msec.**
- **Receiver Reconstitutes 96 Bit Packets and Converts to Analog**



## **NEXCOM VDL Mode 3 System Configurations**

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- **4V - Four Independent Voice Stations**
- **2V2S - Two Independent Voice Stations with Site Diversity**
- **2V2D - Two Independent Stations Each with One Voice and One Data Slot**
- **3V1D - Three Independent Voice Station with Shared Data Channel**
- **3T - Trunked Channel - Dynamic Assignment**



## **VDL Mode 3 Operational Benefits**

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- **Airborne Lockout During Ground Transmission**
- **Ground Arbitration for “Near Simultaneous” Airborne Transmissions**
- **Ground “Start Over” of Simultaneous Transmissions.**
- **Protection Against Stuck Microphone**
- **Improved Squelch Operation**
- **Improved Co-Channel Performance**
- **Not Susceptible to Noise Amplitude Modulation**
- **Security from “Phantom Controller”**



## **VDL Mode 3 Infrastructure Benefits**

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- **Significant Increase in Voice and Data Channels Available**
- **Station Can Have Dedicated Voice and Data Channel**
- **A Single Transceiver Can Have Both a Voice and Data Circuit to a Station**
- **Multi-site Diversity for Improved Communication Link**
- **Simplification of Voice to Data Transition**
- **Automatic Communication Channel Selection**
- **Time Source Independent from Navigation**



# VHF Communications Mode 3 Advantages/Disadvantages

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- **Advantages**

- **Single Transceiver and Frequency for Both Voice/Data**
- **Ground Controlled - Allows Prioritization (Voice & Data)**
- **Better Spectrum Utilization**
- **Use Existing 25 kHz Channel Spacing**
- **Complimentary with VDL Mode 2**

- **Disadvantages**

- **Requires New Digital Transceiver for Both Voice & Data**
- **Wider Spectrum may Affect Frequency Assignments**



# VHF Communications Mode 3 Implementation

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- **FAA Plans to Implement Mode 3 in Three Phases**
  - **Segment One - Digital Voice in High and Super High En Route Sectors (2007 to 2011)**
  - **Segment Two - CPDLC Over Mode 3 in Segment One Sectors**
  - **Segment Three - Voice and Data for Remainder of En Route and High Density Terminals (2011 to 2015)**



# NEXCOM

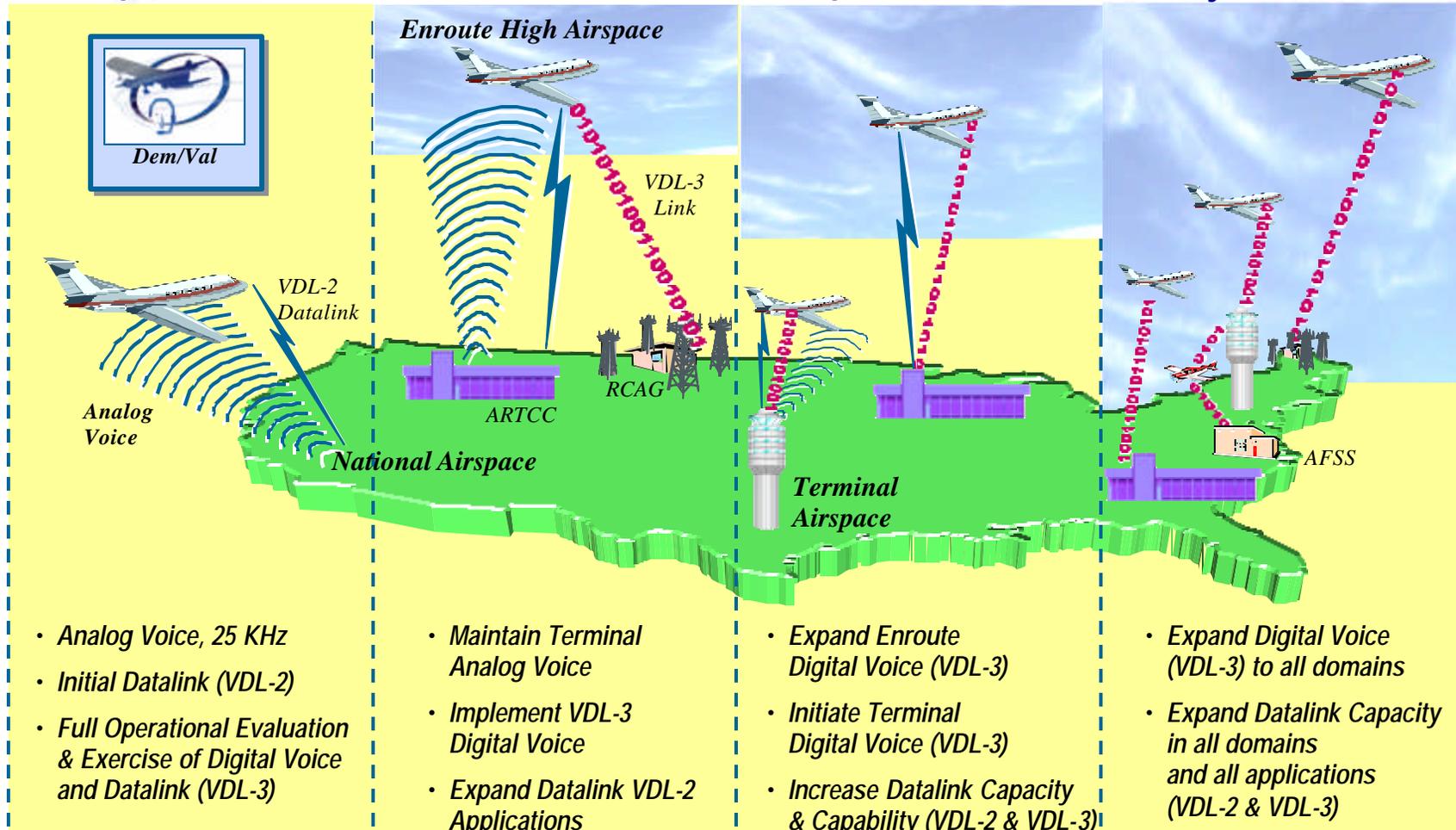
## “Transition to Digital Communications”

Next 5 years

5-10 years

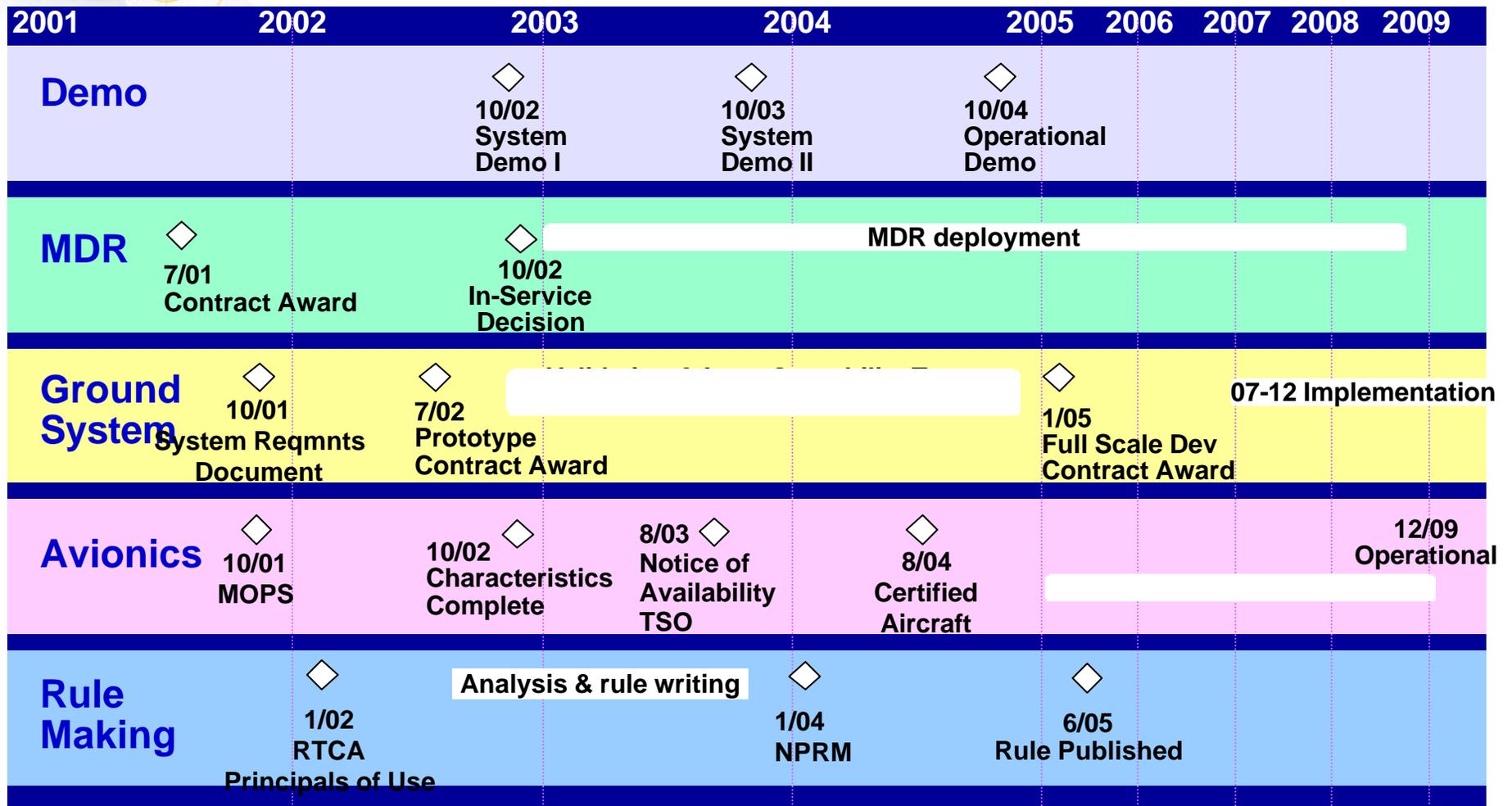
10-15 years

15-20 years





# NEXCOM Schedule Overview





## In Conclusion

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- **We Face a Communications Capacity Crisis**
- **Data Communications will have Increasing Importance and We Need to Plan for Them**
- **Short Term Solutions are Short Term**
- **VDL Mode 3 Provides an Attractive Solution**
  - **Effective Spectrum Utilization**
  - **Solution for Both Voice and Data**
  - **Operational Benefits**