
# Universal Network Concepts for Lightwave Exploitation

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# OUTLINE

- System-Level Benefits
- Ways by which WDM can enhance the effectiveness of military platforms
- Technical Obstacles
- Multi-Mode –VS- Single-Mode Controversy
- Specific Platform Constraints
- Promising Technologies / Innovations
- Importance of Mil-Spec Requirements
- WDM – Will it levy requirements on electronic components?
- Dual-Use Opportunities

# Why WDM Is Needed For Avionics

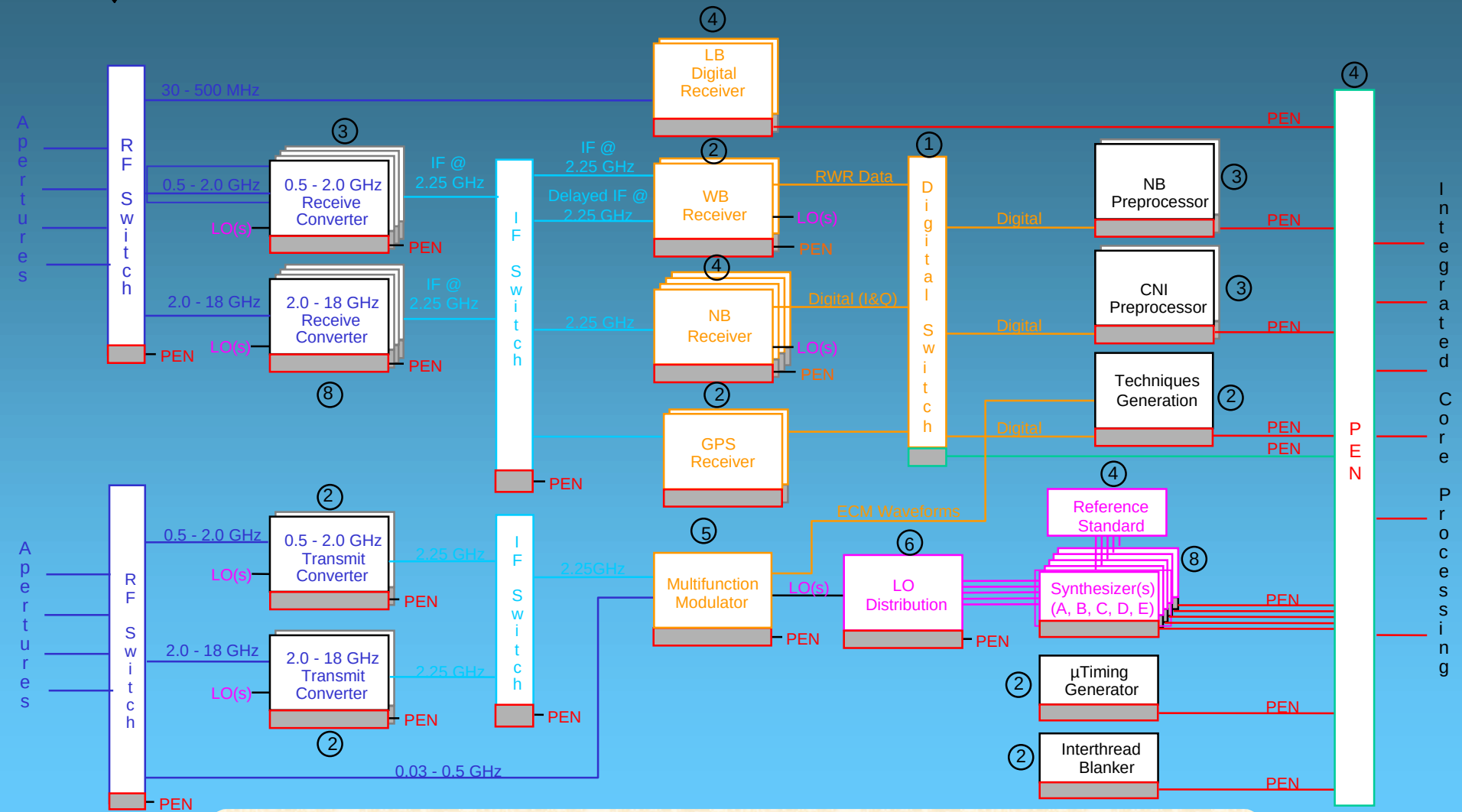
***Avionics Networks Characteristics***

- Many Different I/O Types
  - RF, Analog, Digital, Discretes, Timing Strobes
  - EMI Problems in Mixed Signal Environment
- Many Different Network Media / Connectors
  - Coaxial, TSP, Copper Cable, F/O, Backplane Traces/Vias
- Many High Bandwidth/High Frequency Channels
- Avionics Modules are Connector Bound
  - But Still Desire 2-Level Line-Replaceable Modules
- Sensors Located Throughout Airframe
  - But Coaxial Cable Has High Signal Losses/Distortion
- Many Pt-to-Pt Cables Reduce Manufacturing Repeatibility
  - Decrease Reliability/Effective Diagnostics

**What is Needed is a Common Network That Can Satisfy All Connectivity Requirements of An Avionics Suite, Single Channel, Single Connector.**

**WDM Can Provide This Universal Avionics Network If Specific Component, Cost & Packaging Challenges Can Be Overcome!**

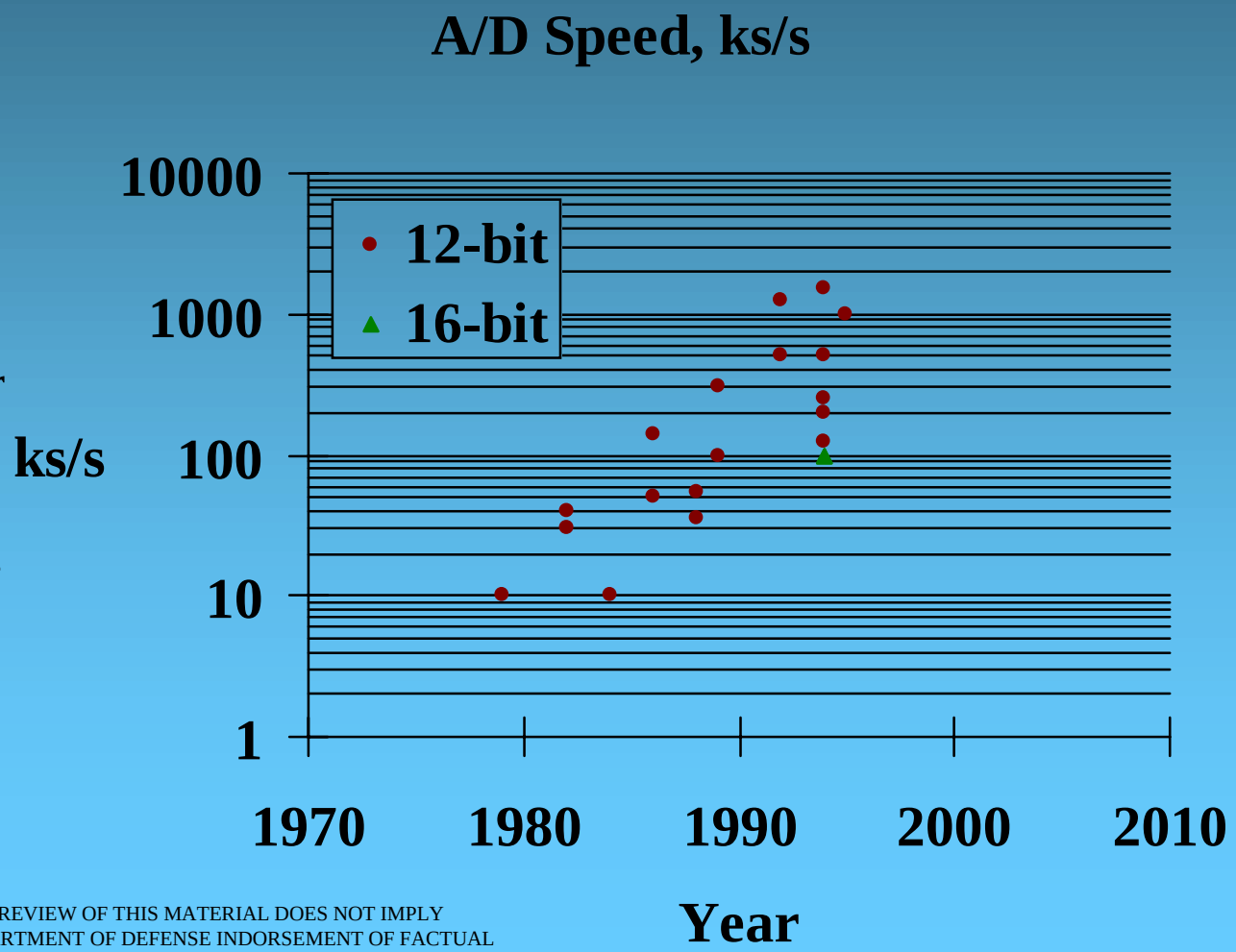
# ISS Network Requirements



# A/D Technology

Key to the digital receivers utility is the precision of the A/D's.

Precision of 12 bits is marginally adequate for for high performance digitized IF receivers, with 14 to 16 bits being the desired precision in order to achieve he dynamic range of high performance surveillance receivers.



# DDS Trends

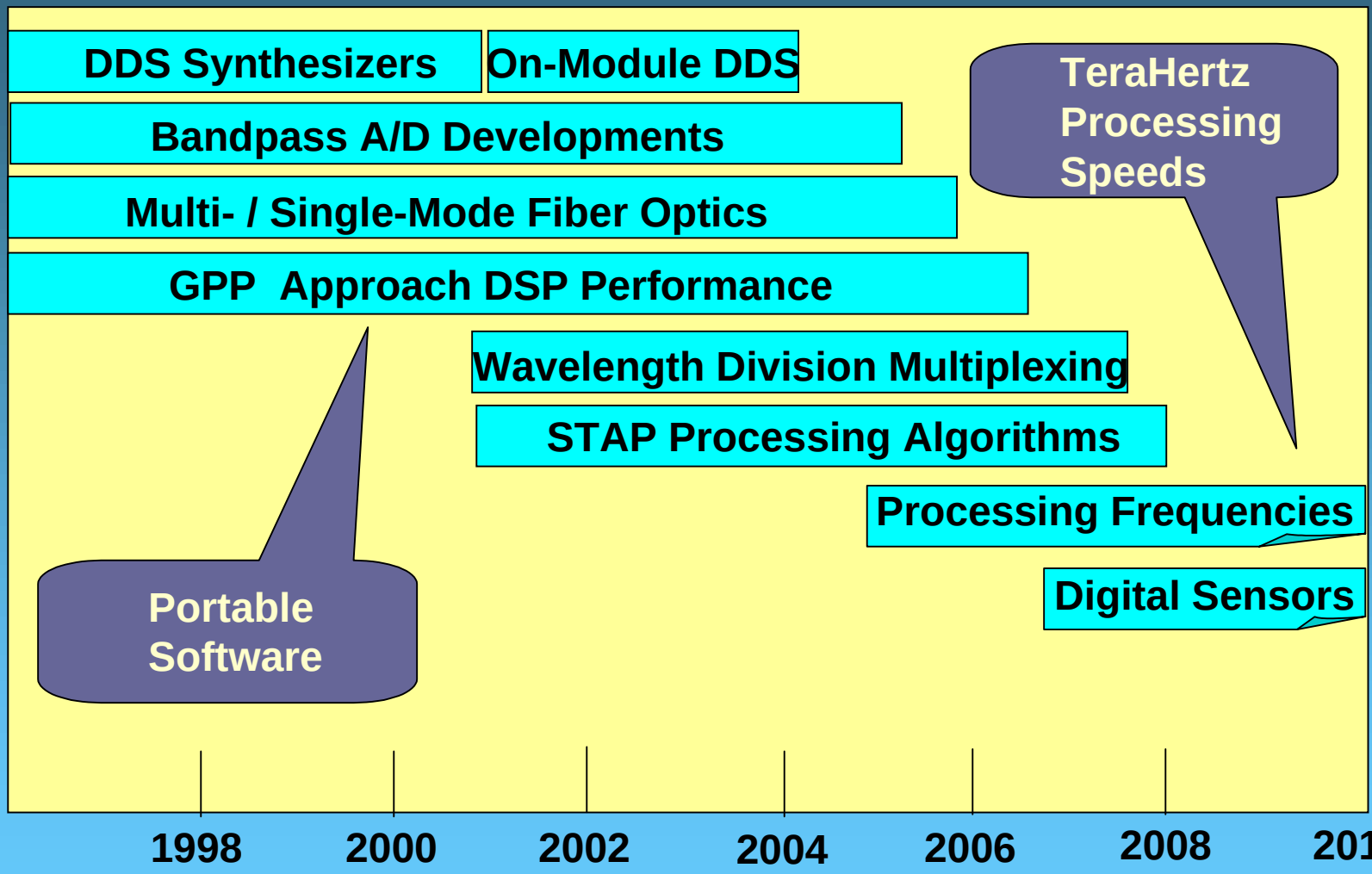
- Historically doubled clock speed about every three years
- With funding, could decrease spurious signals to -80 dBc level within five years with 14-bit DAC development effort
- Projections

| Year | Clock | Spurious Signal Level |
|---|---|---|
| 1997 | 1 GHz | -70 dBc |
| 1999 | 2 GHz | -70 dBc |
| 2002 | 4 GHz | -70 dBc |
| 2002 | 0.5GHz | -80 dBc |
| 2005 | 8 GHz | -70 dBc |
| 2005 | 1 GHz | -80 dBc |

# Preprocessor Technology Trends

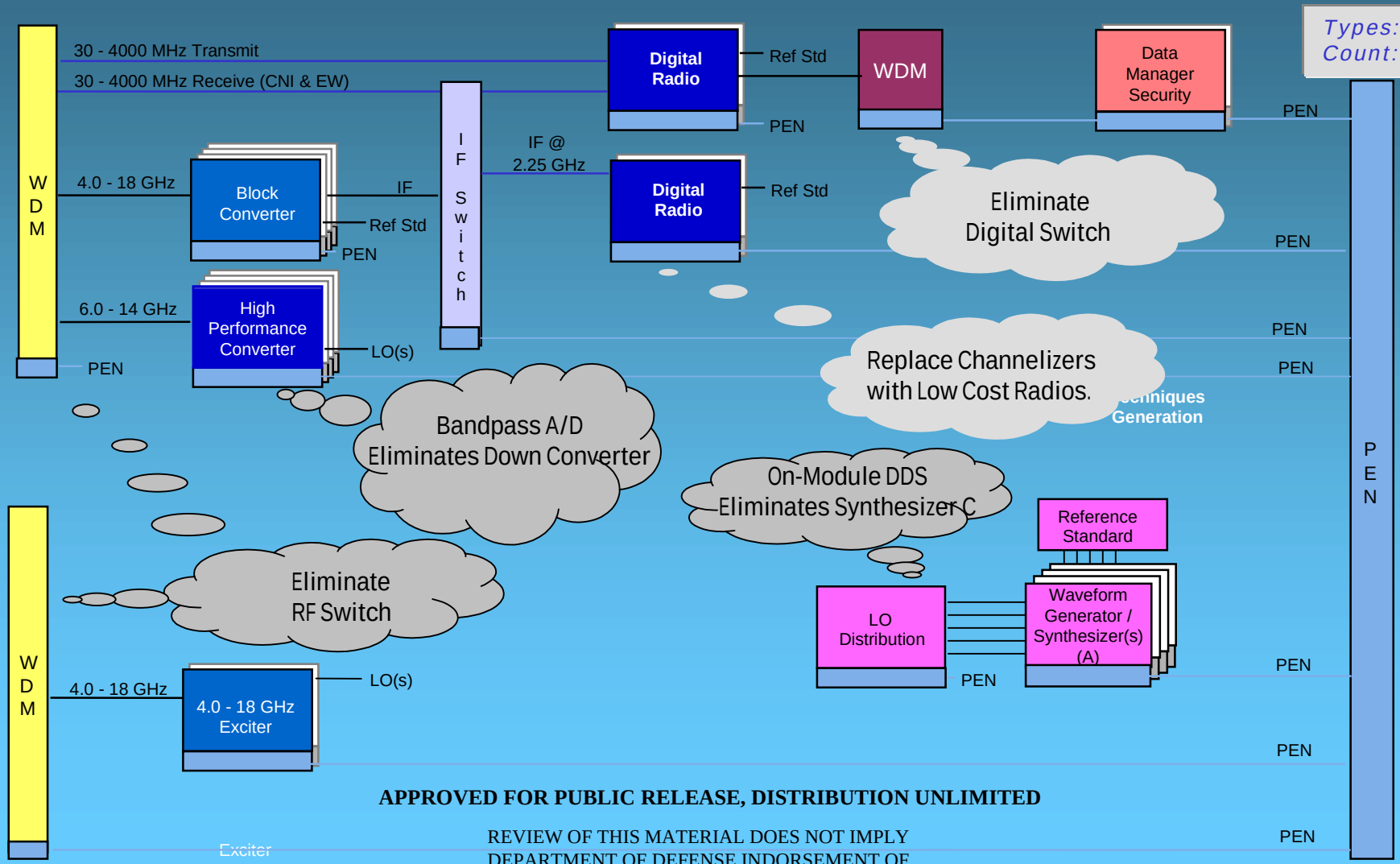
- GaAs Logic
  - VLSI Applications-Double Speed Every Five Years
    - 1990 450 MHz
    - 1995 1 GHz
    - 2000 2 GHz
    - 2005 4 GHz
    - 2010 8 GHz
  - Very simple functions at 10 GHz in 1995
  - Power Halved Every Five Years
    - 1995 .5 mW/Gate @ 1 GHz
    - 2000 .5 mW/Gate @ 2 Ghz
    - 2005 .5 mW/Gate @ 4 GHz
    - 2010 .25 mW/Gate @4 GHz
  - Device Complexity
    - 1990 >10,000 Transistors

# Predicting Technology Trends



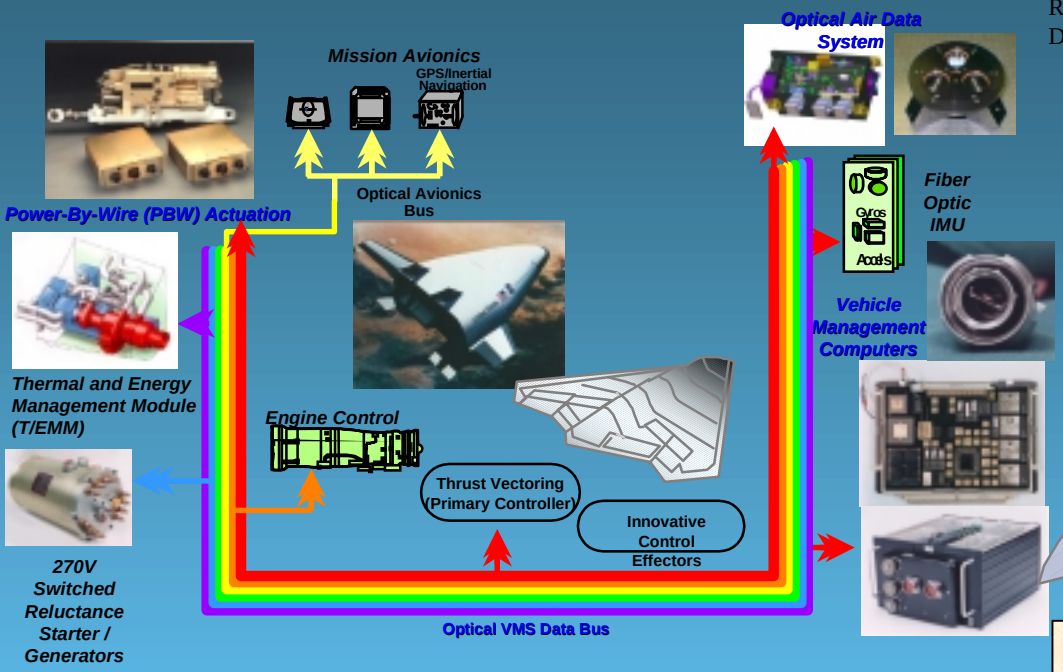

**Technology trends are based on improved materials and refined manufacturing techniques**

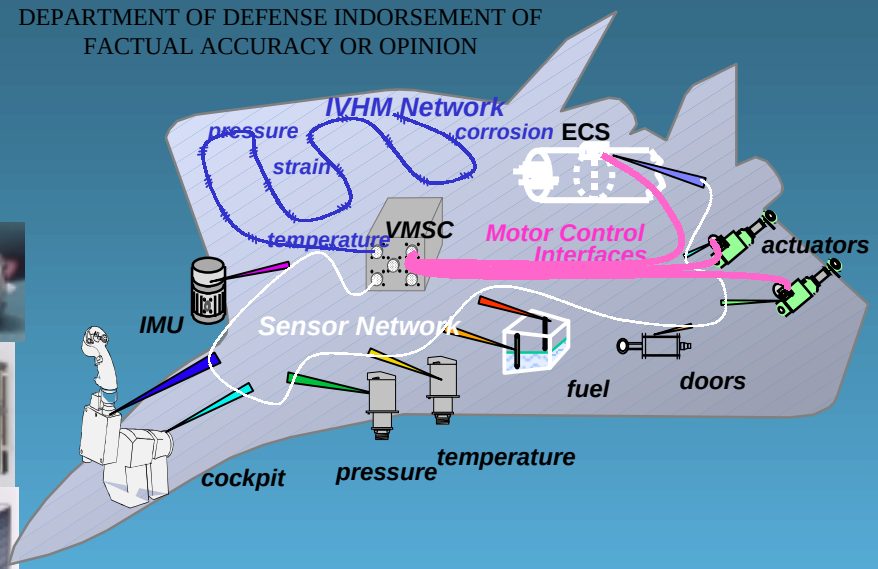
# Potential Application of WDM Technology in future Avionics Architectures [2010]



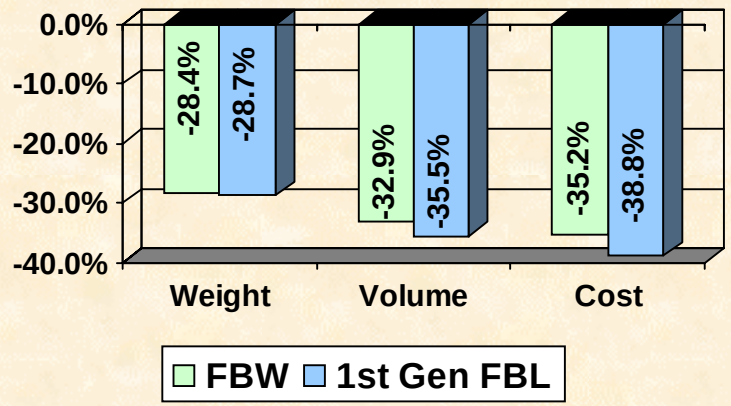
# Potential Applications of WDM Technology: Photonic Vehicle Management Systems

REVIEW OF THIS MATERIAL DOES NOT IMPLY DEPARTMENT OF DEFENSE INDORSEMENT OF FACTUAL ACCURACY OR OPINION




**VISION: FAULT TOLERANT AFFORDABLE VMS FOR UAVS AND SPACE**
**CHALLENGE: SENSE/SIGNAL OPTICALLY, COMPUTE ELECTRONICALLY**



# System-Level Benefits

- Open to Technology Insertion
  - Rolls with electrical / optical punches

- Simplified Interconnect approach – can handle Any signal or combination of signals

- Plug & Play Capability
  - Huge Bandwidth

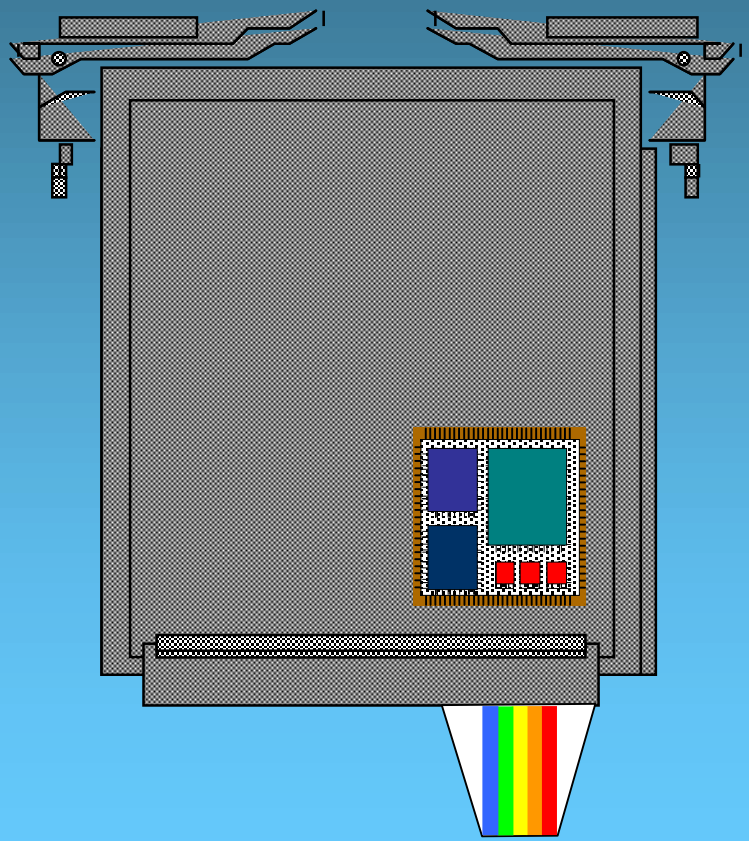
- Backplane / PWB signaling speeds across entire span of system distance

- Provides New design paradigm for embedded system architectures
  - Distance-Independent Designs
  - Roll your own architecture !

- Promotes use of COTs digital / RF Hardware

- Small, compact RF / Digital designs applicable to multiple platforms (UAVs, Fighters, Bombers, Helicopters, Cruisers, Ground Support, …)

# Summary



## Needed Developments

- **WDM Source / Photoreceiver Array**
  - **Low-cost, High-Power, Narrow-Linewidth Linear Arrays**
  - **Interface Issues (Insertion Loss)**
  - **Temperature stability issues**
  - **Bandwidth, Dynamic Range, Isolation between channels**
- **Multiplexers / Demultiplexers**
  - **Low cost**
- **Optical tunable filters**
- **Packaging Issues**