

# APPLICATIONS for WDM TECHNOLOGY in MILITARY SYSTEMS

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**Joseph Wilgus**  
Information Directorate  
Wright-Patterson AFB OH  
Air Force Research Laboratory



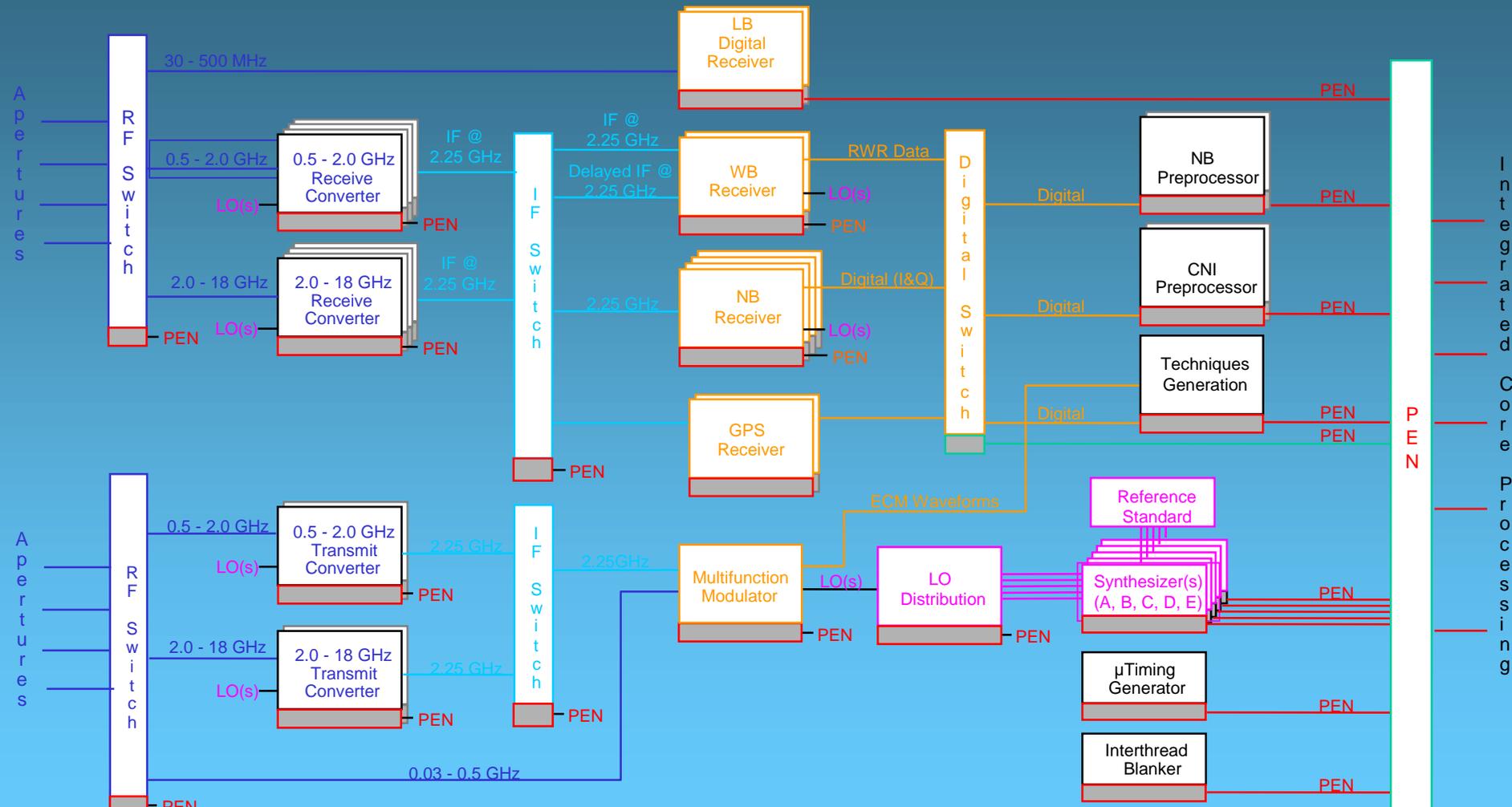
# OUTLINE



- **Ways by which WDM has enhanced the effectiveness of military platforms**
- **System-Level Benefits**
- **Technical Challenges / Specific Platform Constraints**
- **Needed Developments**



# ISS Network Requirements





# Why WDM Is Needed For Avionics

## Avionics Networks Characteristics

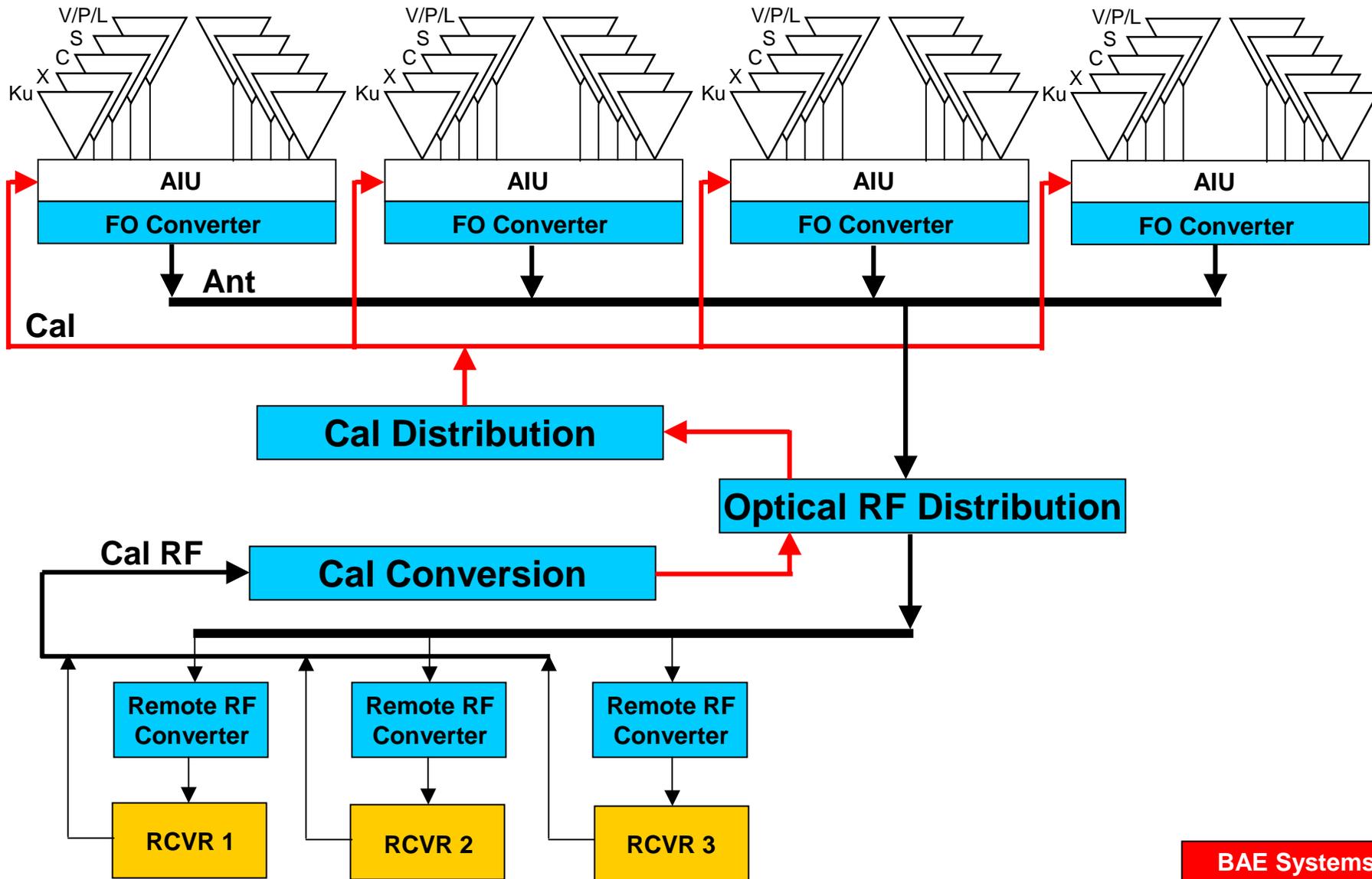
- Many Different I/O Types
  - RF, Analog, Digital, Discretes & Timing Strobes
  - EMI Problems in Mixed Signal Environment
- Many Different Network Media / Connectors
  - Coaxial, TSP, Copper Cable, F/O, Backplane Traces/Vias
- Many High Bandwidth/High Frequency Channels
- Avionics Modules are Connector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



# Current Analog 18 GHz Link WDM System





# System-Level Benefits

- **Open to Technology Insertion**
- **Simplified Interconnect approach – can handle Any signal or combination of signals**
  - **Non-blocking sensor distribution (Each subsystem has access to any sensor at any time)**
- **Simplified RF Phase Matching**
  - **Accurate AOA**
- **Provides New design paradigm for embedded system architectures**
  - **Distance-Independent and Reconfigurable Designs**
- **Volume / Weight Savings**
- **Promotes use of COTs digital / RF Hardware**
- **Small, compact RF / Digital designs applicable to multiple platforms (UAVs, Fighters, Bombers, Helicopters, Cruisers, Ground Support, ...)**



# Performance Requirements for Current & Near-term Radar Systems

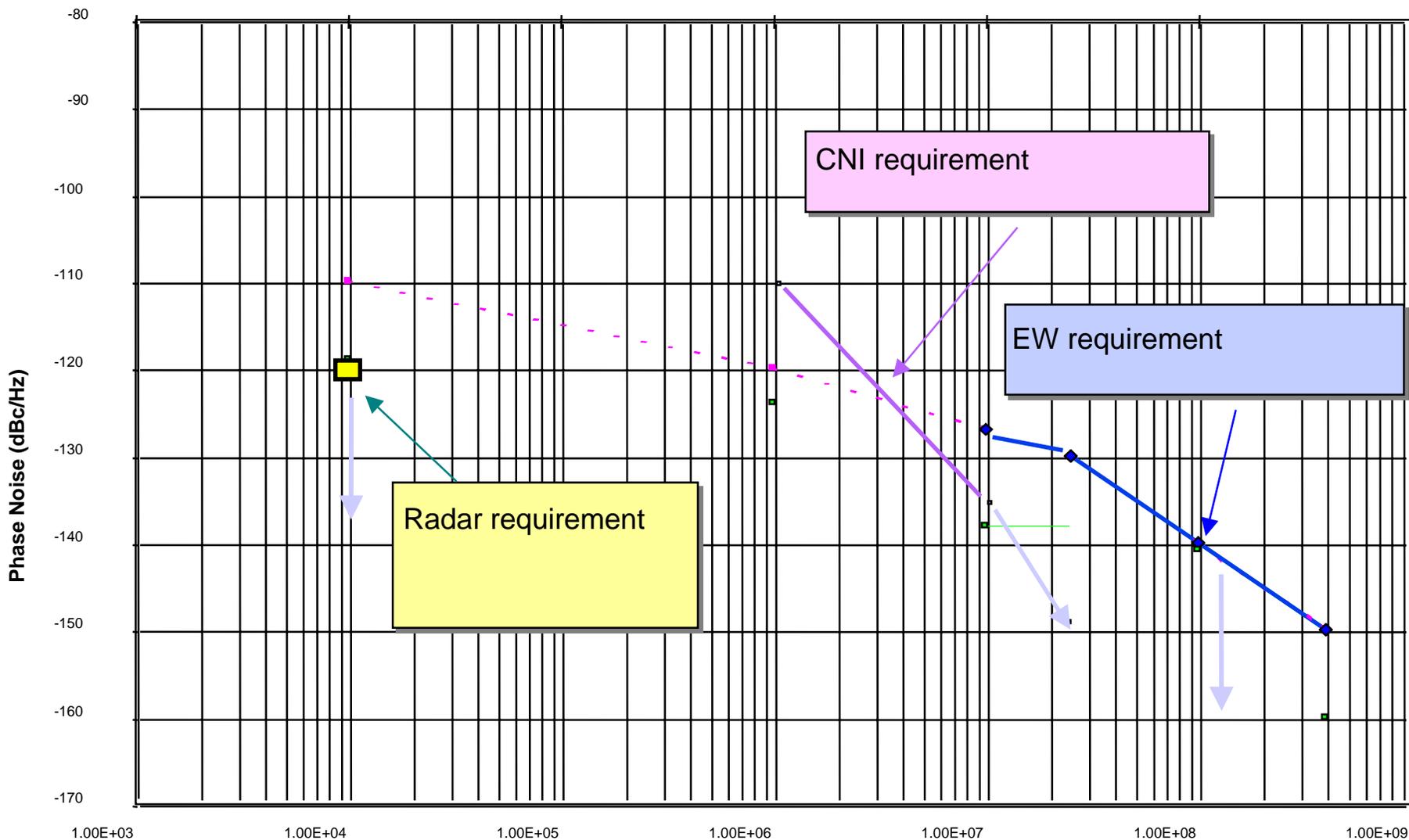


- Noise Figures from 3 – 10 dB
- SFDR better than 80 – 120 dB/Hz<sup>2/3</sup>
- Relative Noise at 10 KHz from RF carrier < 80 – 130 dBc/Hz
- Frequency Range to cover sub-GHz – 100 GHz with up to 50% BW
- Amplitude stability better than  $\pm 0.3$  to  $\pm 1.5$  dB
- Frequency accuracy better than  $\pm 1$  MHz
- Switching times of  $1\mu\text{sec}$  to  $100\mu\text{secs}$  (beam steering)
- Filter bandwidths from 1 MHz to several GHz
- Delays from tens of nanoseconds (beam steering) to tens of mSec (signal processing)
- Delay precision from 1-10 picoseconds
- Out of band filter rejection from 30 to 50 dB (optical) at 0.5% of bandwidth



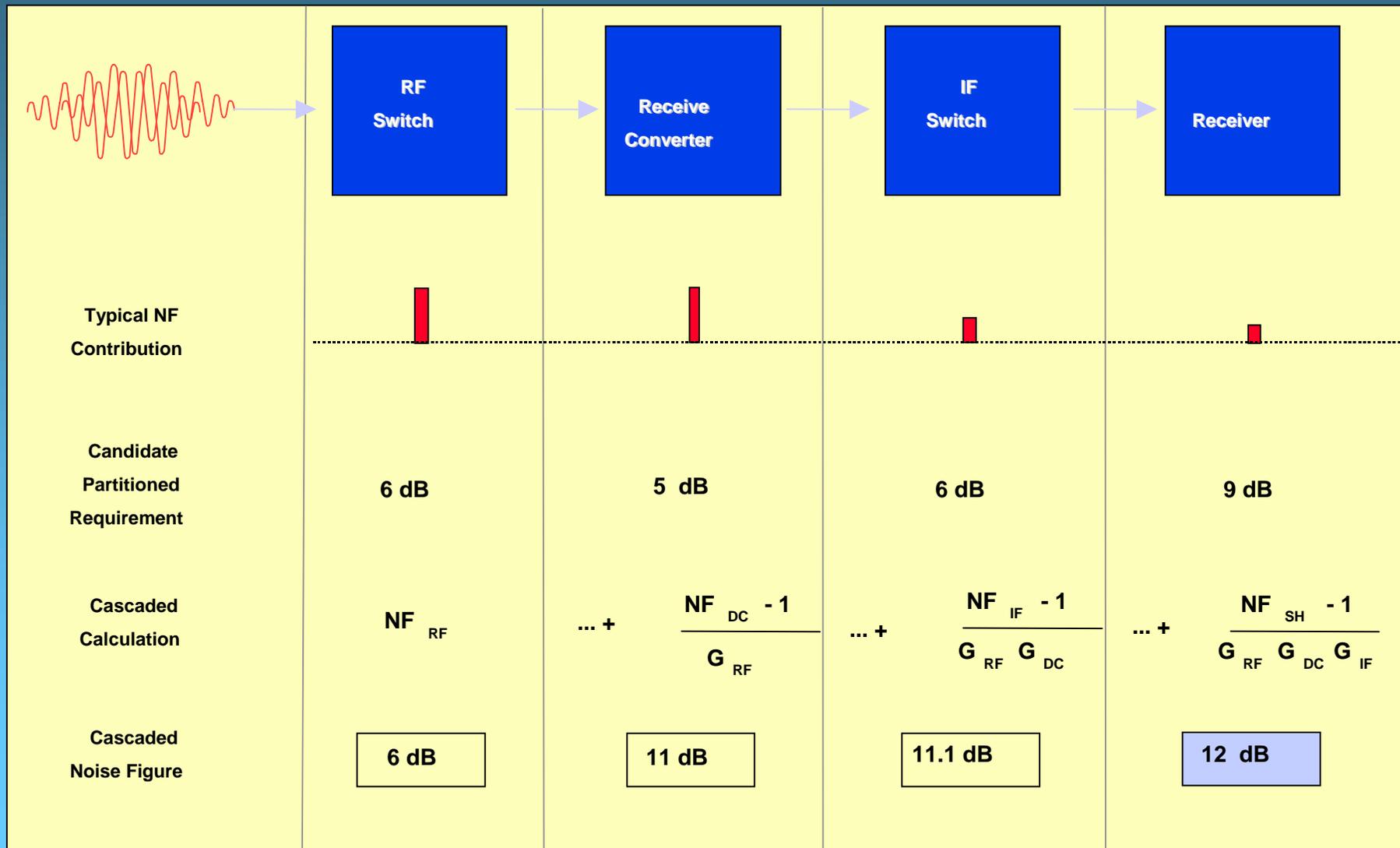
# PHASE NOISE REQUIREMENTS

## LO Phase Noise Requirements for ISS



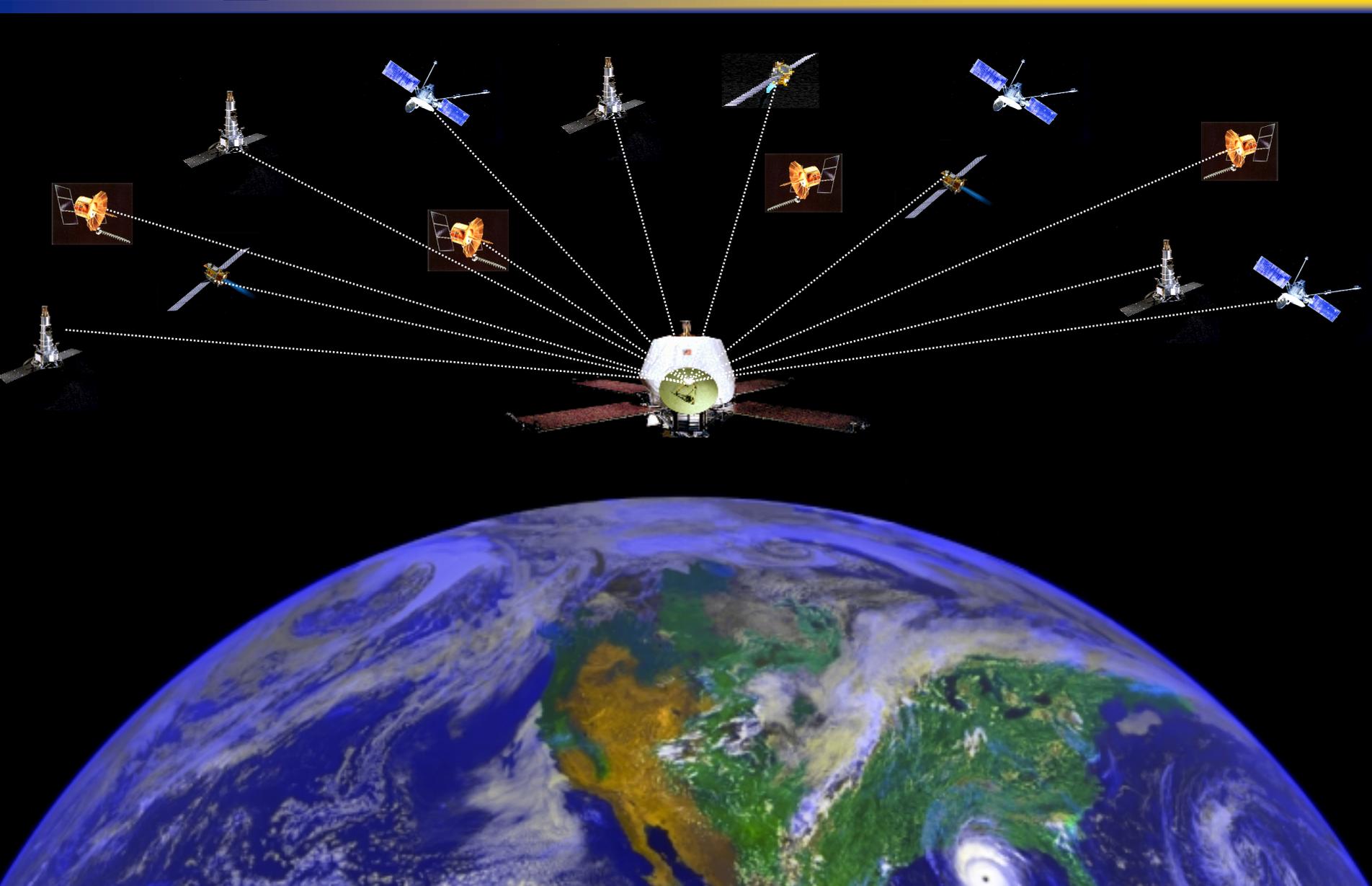


# MODULES WITHIN RADAR THREAD



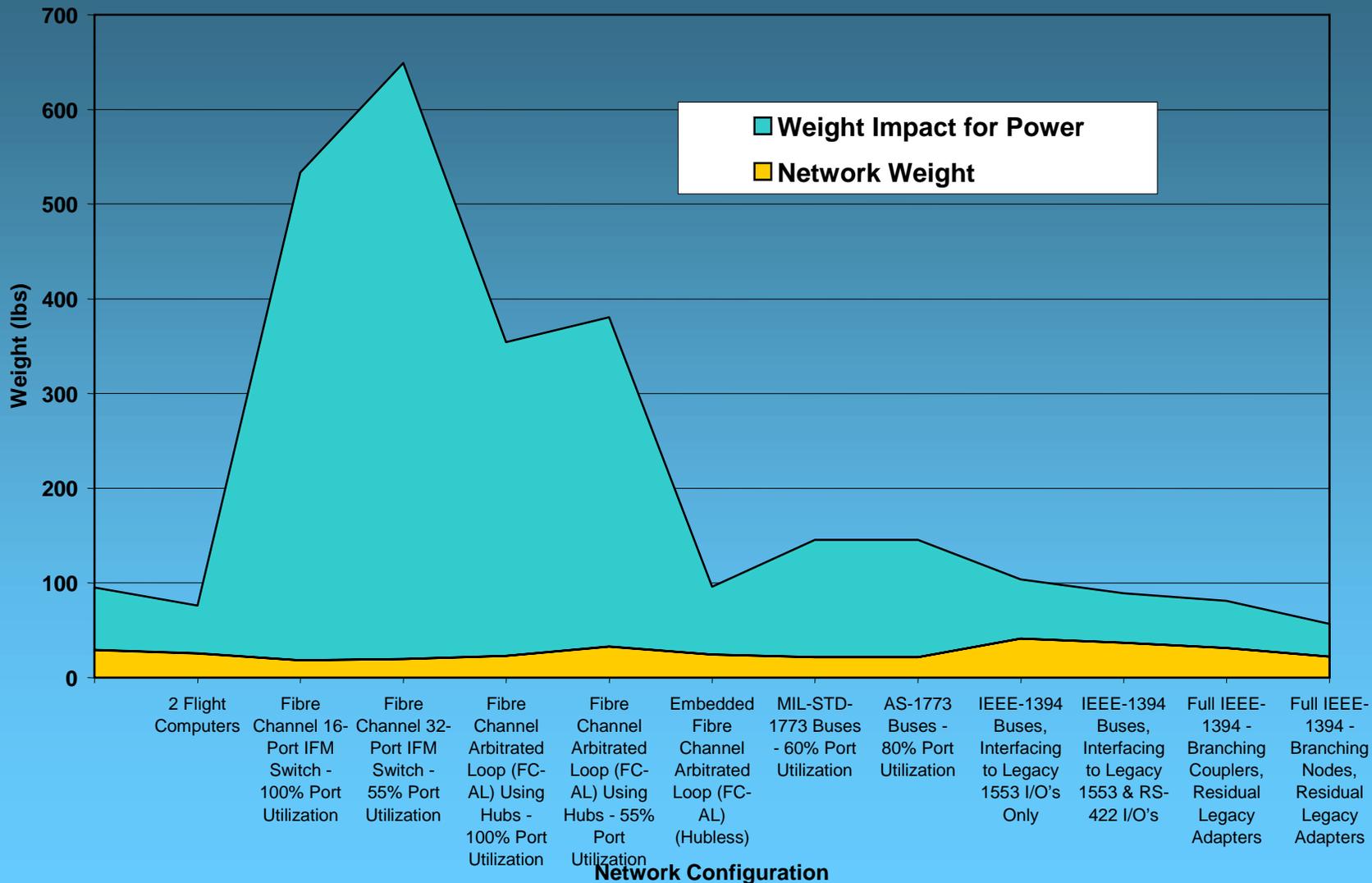


# Future Space Systems



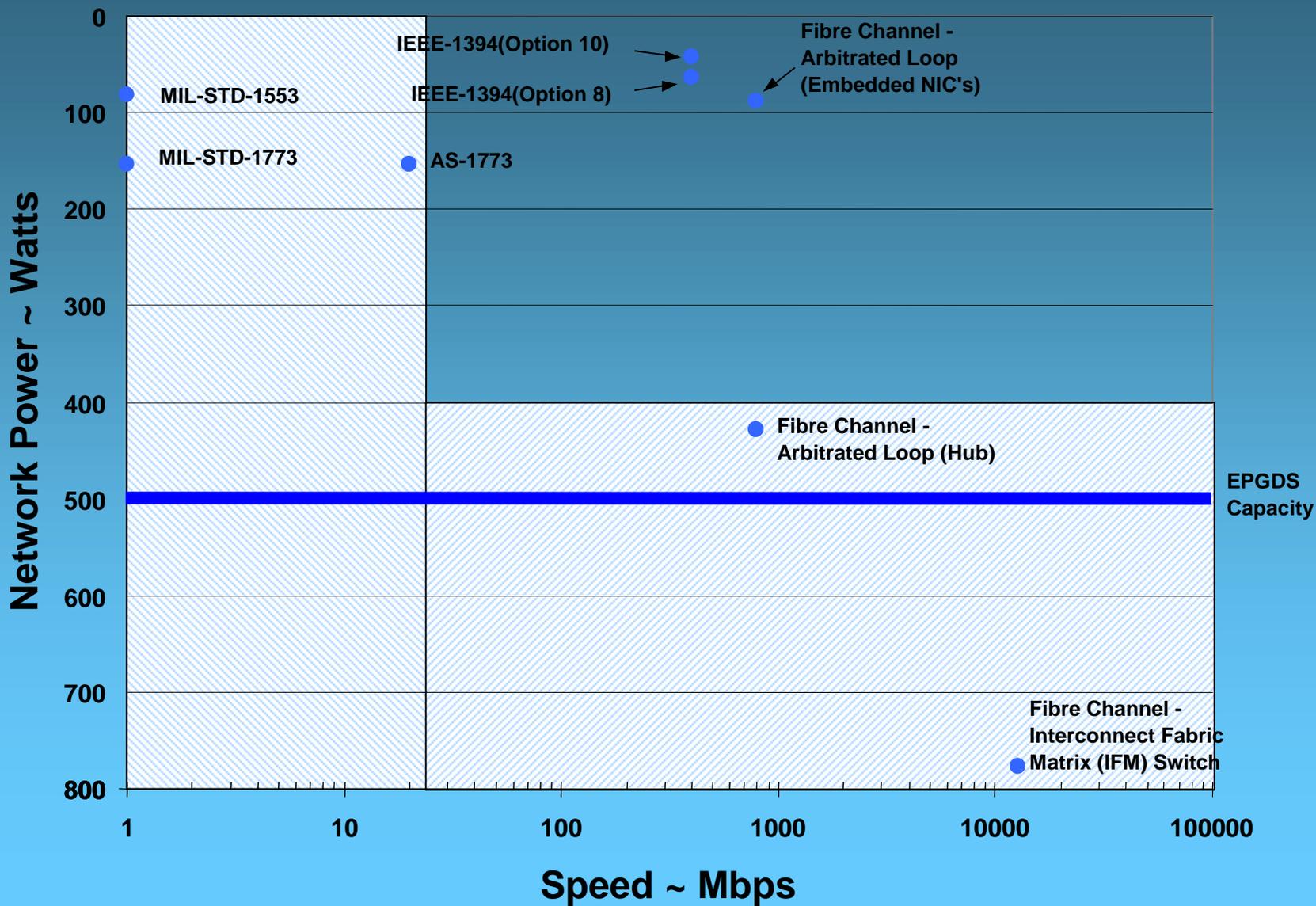


# Network Options -vs- Weight Impact for Space Platforms





# Bus Speed/Power Comparisons





## Needed Developments

- **Tunable Laser Arrays**
  - Low-cost, High-Power, Narrow-Linewidth
  - Interface Issues (Insertion Loss)
  - Temperature stability issues
  - Bandwidth, Dynamic Range, Isolation between channels
- **Mix-Mode Capability**
- **Photo-Receiver Arrays**
  - High-Power Capability
- **Optical tunable filters**
- **Low-noise Amplifiers**
- **Packaging Issues**

