APPLICATIONS for WDM TECHNOLOGY in MILITARY SYSTEMS

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14. ABSTRACT

15. SUBJECT TERMS

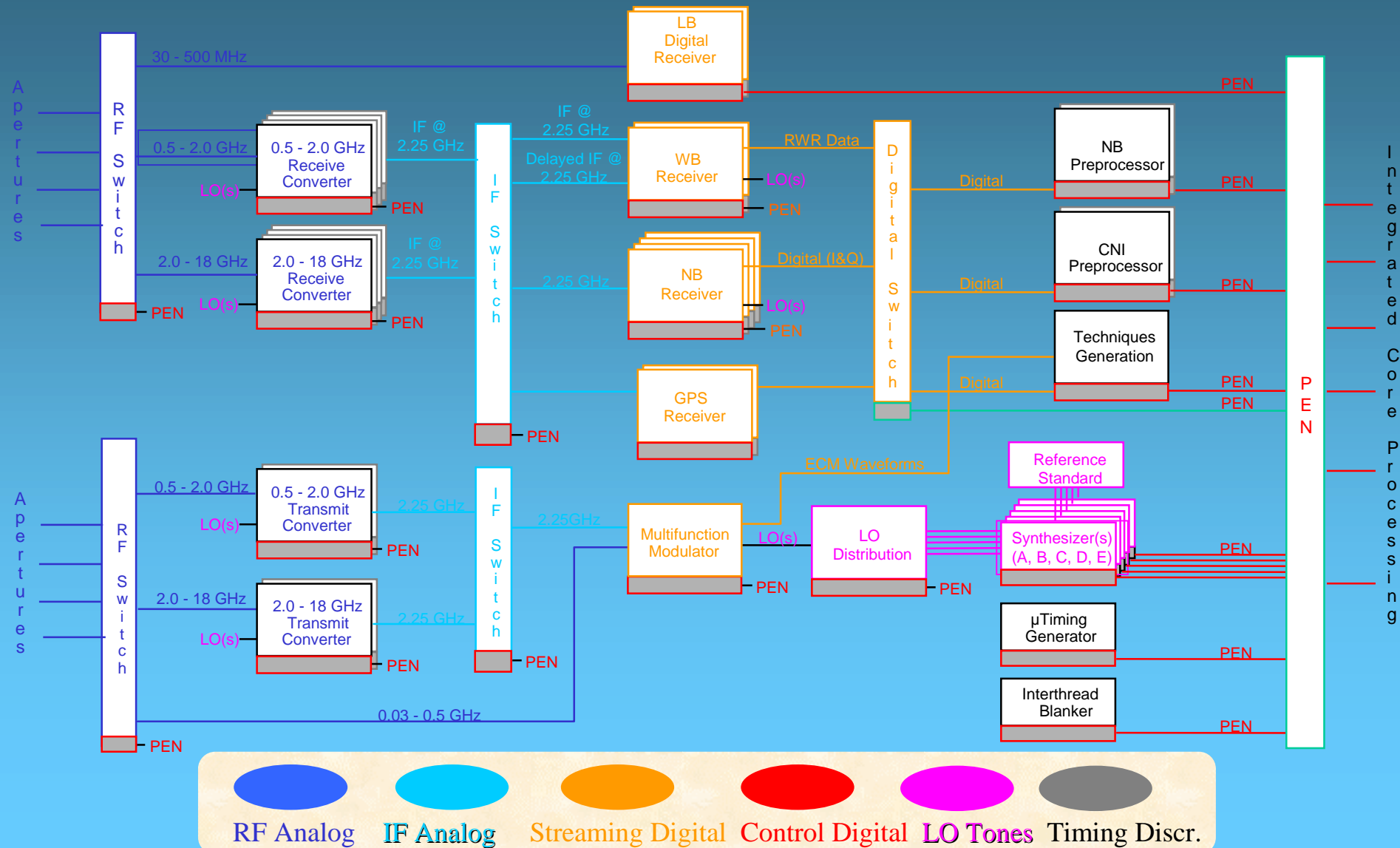| 16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
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OUTLINE

- **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 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!

Current Analog 18 GHz Link WDM System

BAE Systems

System-Level Benefits

- **Open to Technology Insertion**

- **Simplified Interconnect approach – can handle <u>Any</u> 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 <u>New</u> 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, …)**
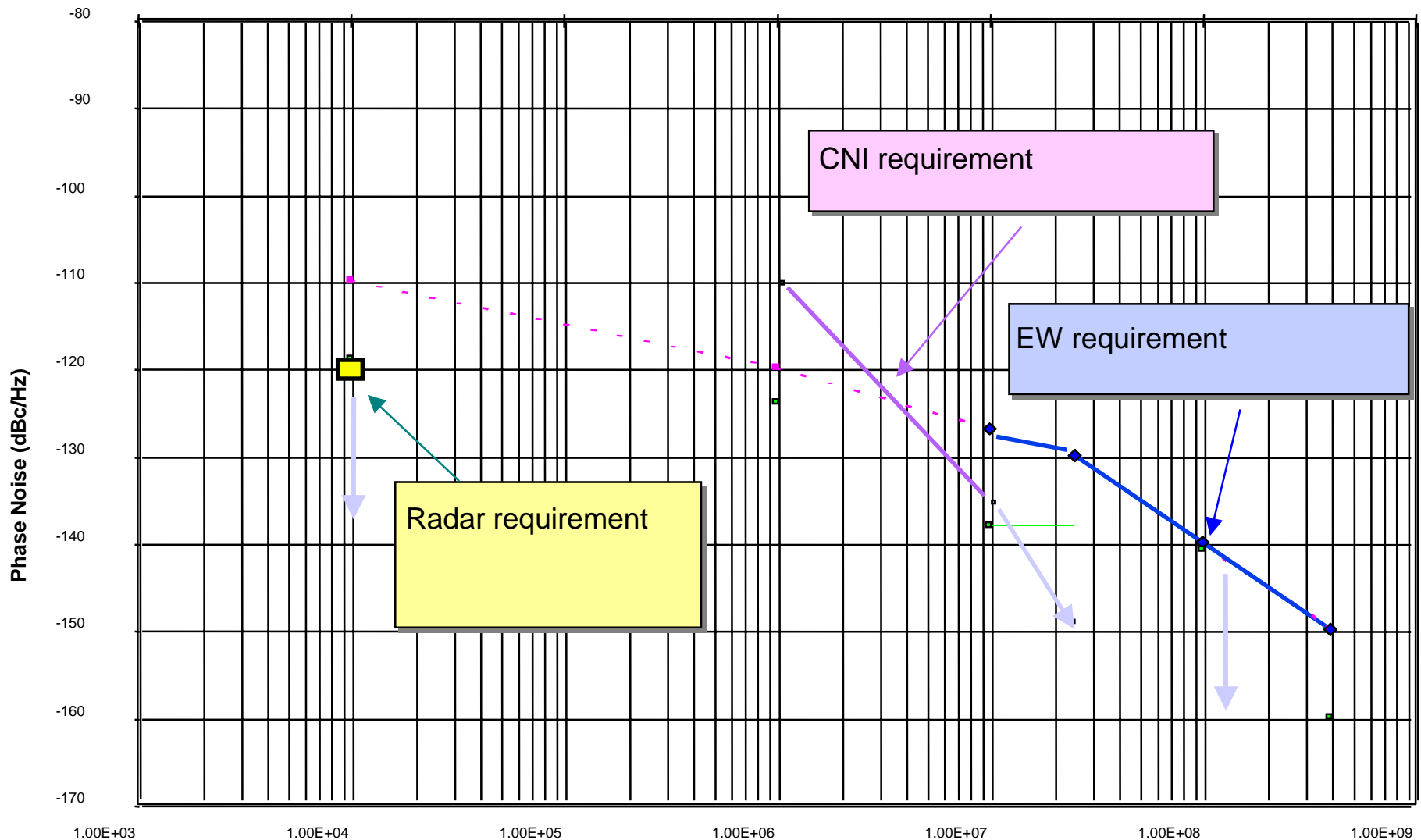
Performance Requirements for Current & Near-term Radar Systems

- Noise Figures from 3 – 10 dB
- SFDR better than 80 – 120 dB/Hz$^{2/3}$
- 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 ±1 MHz
- Switching times of 1μsec to 100μsecs (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
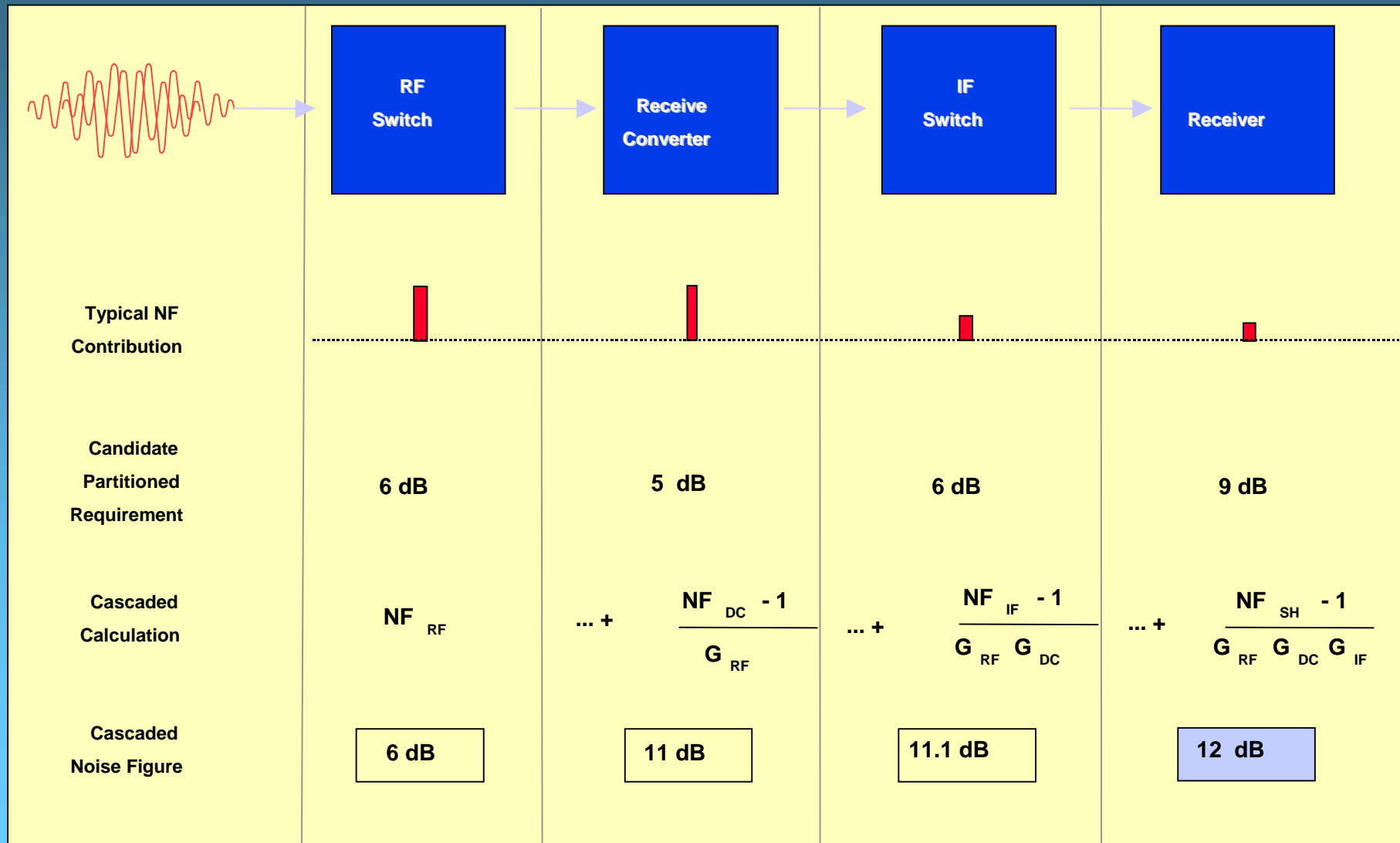- Out of band filter rejection from 30 to 50 dB (optical) at 0.5% of bandwidth

Raytheon

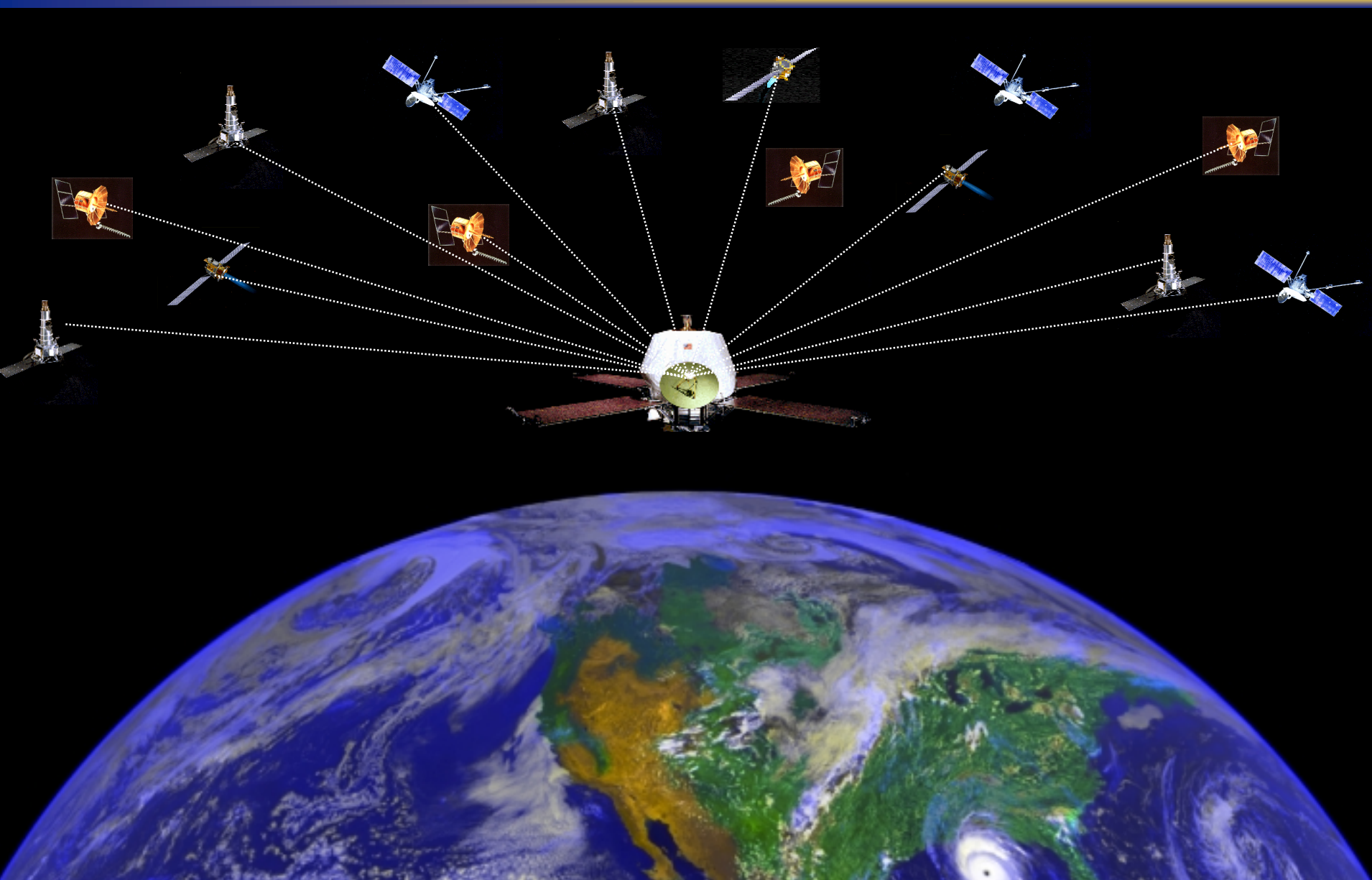# PHASE NOISE REQUIREMENTS

LO Phase Noise Requirements for ISS

MODULES WITHIN RADAR THREAD

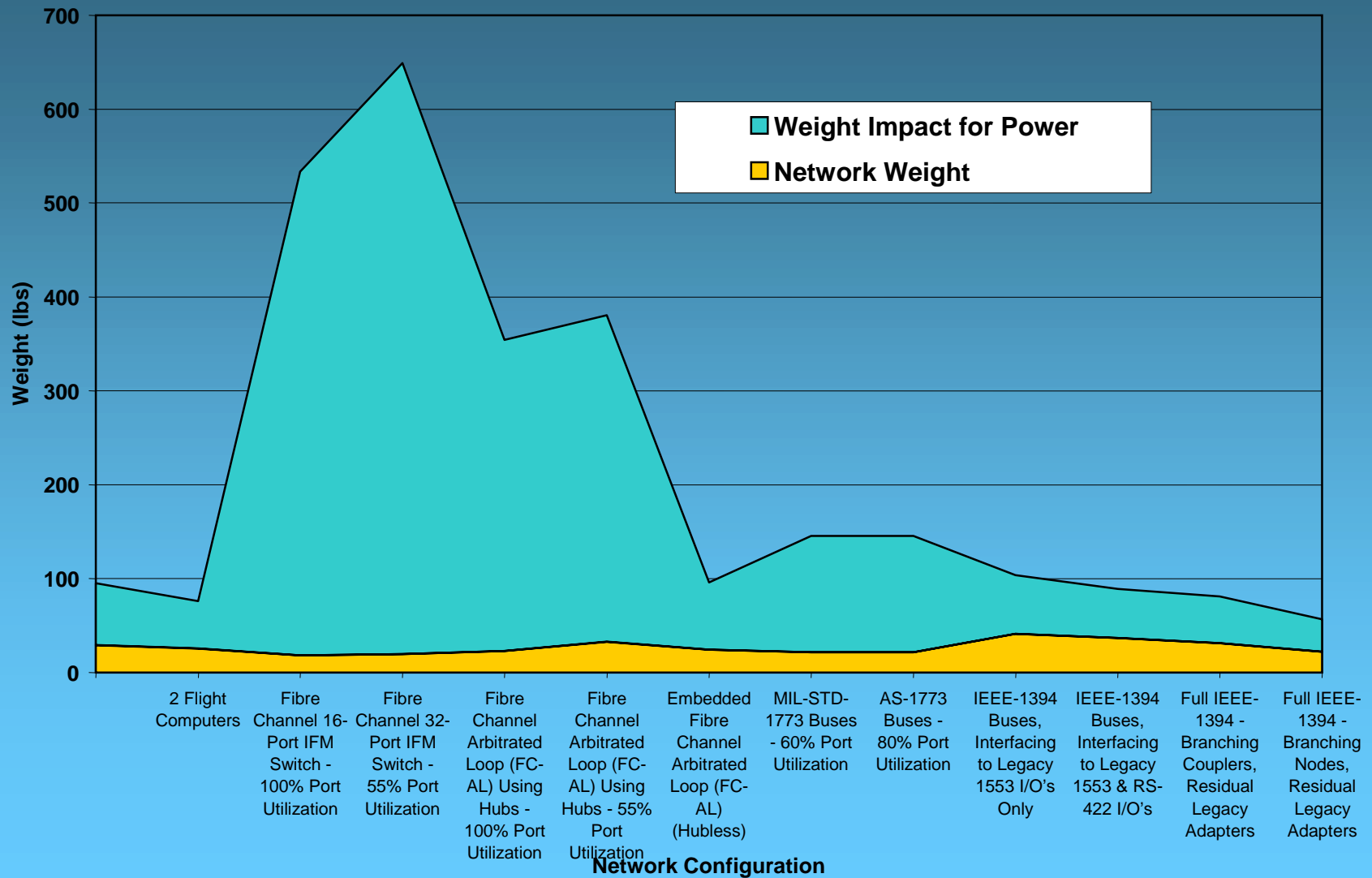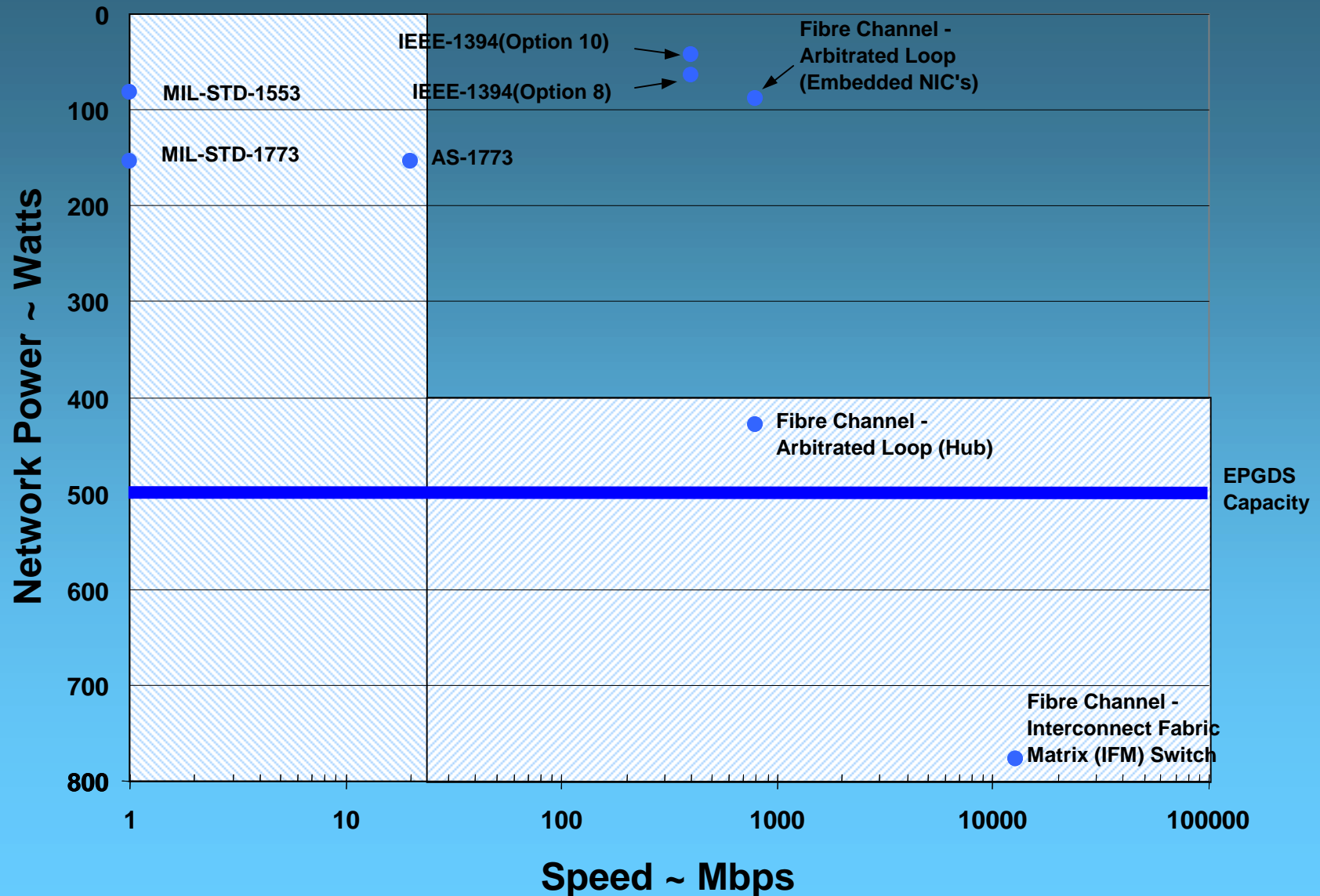|	RF Switch	Receive Converter	IF Switch	Receiver
Typical NF Contribution				
Candidate Partitioned Requirement	6 dB	5 dB	6 dB	9 dB
Cascaded Calculation	NF_{RF}	$... + \dfrac{NF_{DC} - 1}{G_{RF}}$	$... + \dfrac{NF_{IF} - 1}{G_{RF}\, G_{DC}}$	$... + \dfrac{NF_{SH} - 1}{G_{RF}\, G_{DC}\, G_{IF}}$
Cascaded Noise Figure	6 dB	11 dB	11.1 dB	12 dB

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**