An Overview of the Advance Multifunction RF Concept (AMRFC) Test-Bed

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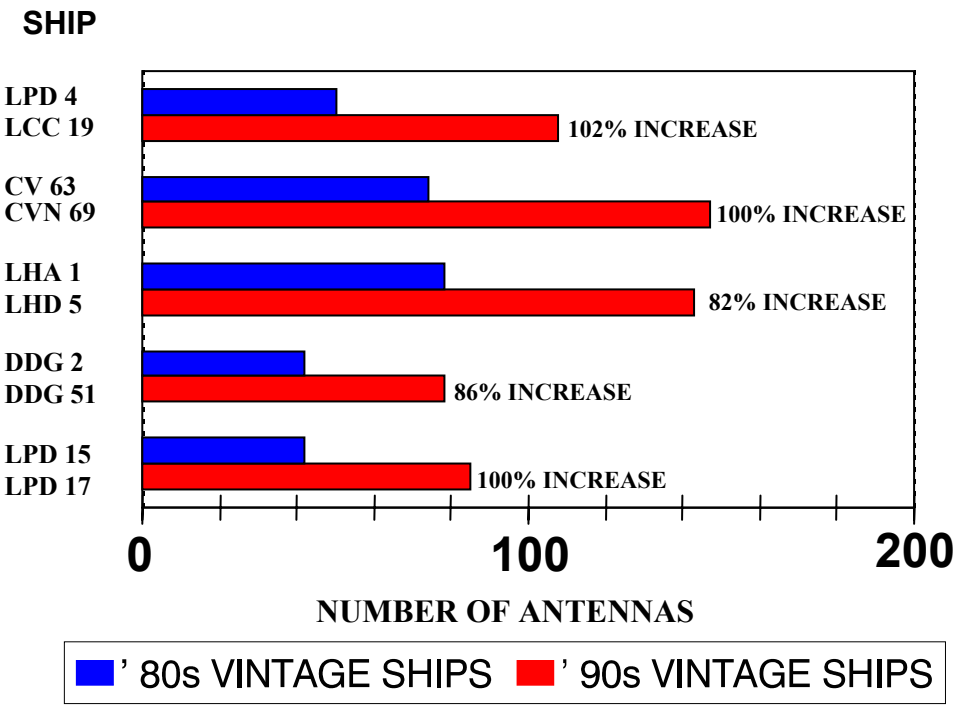
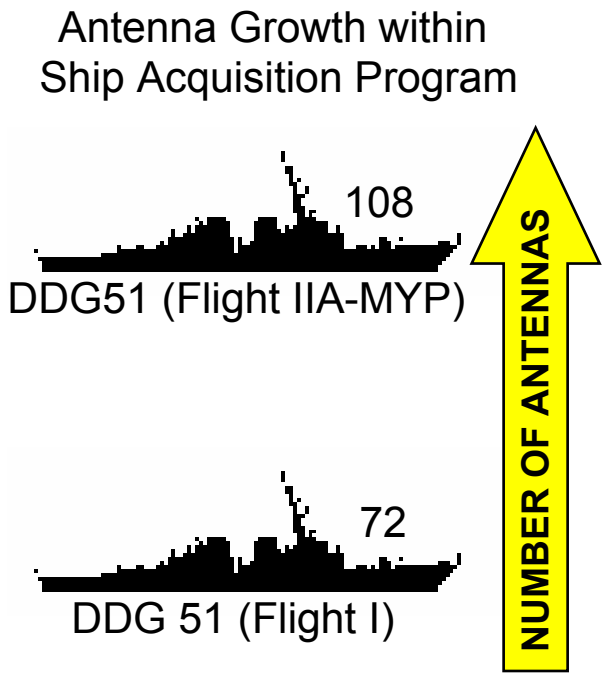
The Advanced Multifunction RF Concept

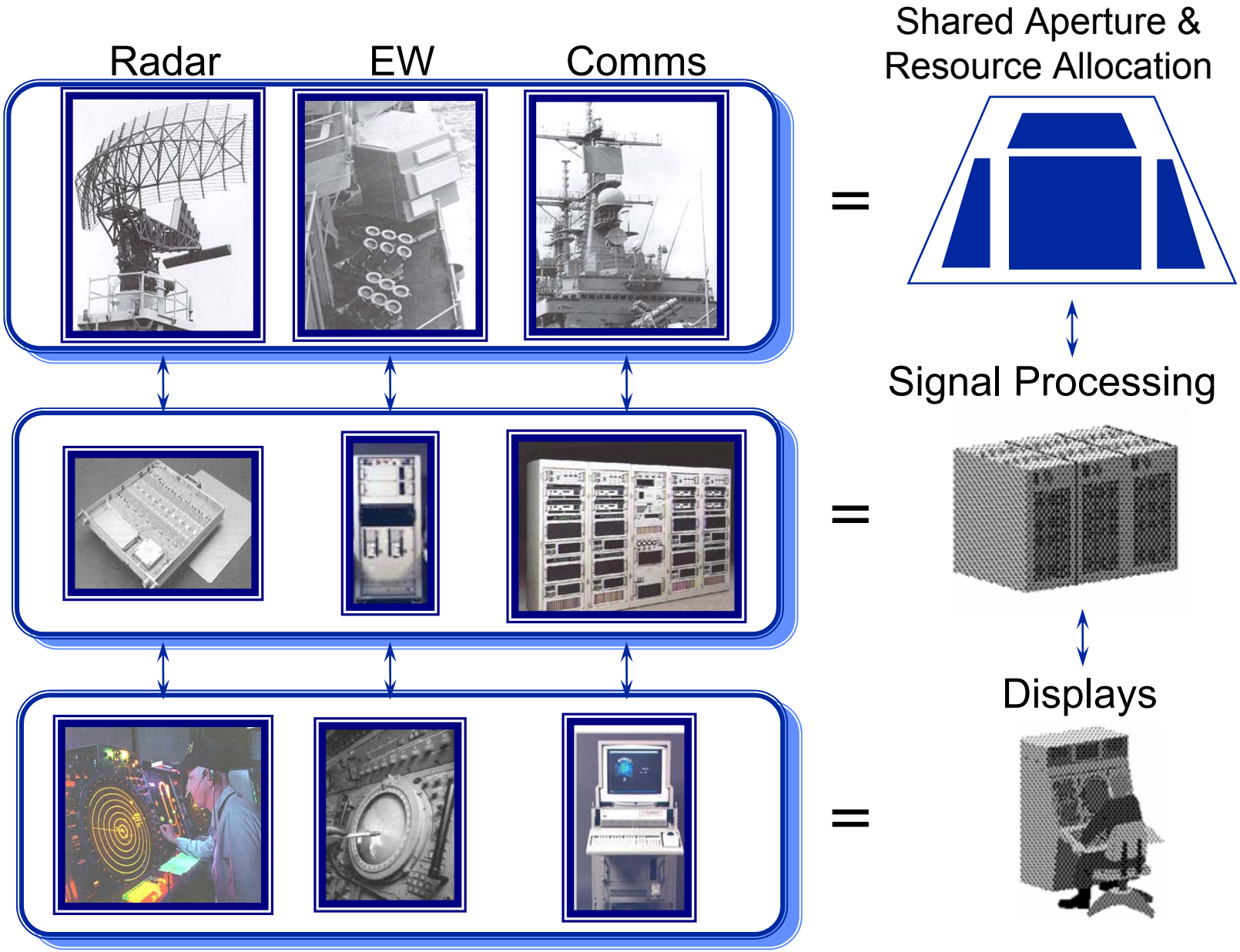
Develop the capability to integrate Radar, Electronic Warfare, and Communication functions into a common set of RF apertures capable of supporting multiple simultaneous beams such that the functionality is defined by software.

Motivation: Shipboard Antenna Growth





The AMRF Concept



New Capabilities & Benefits

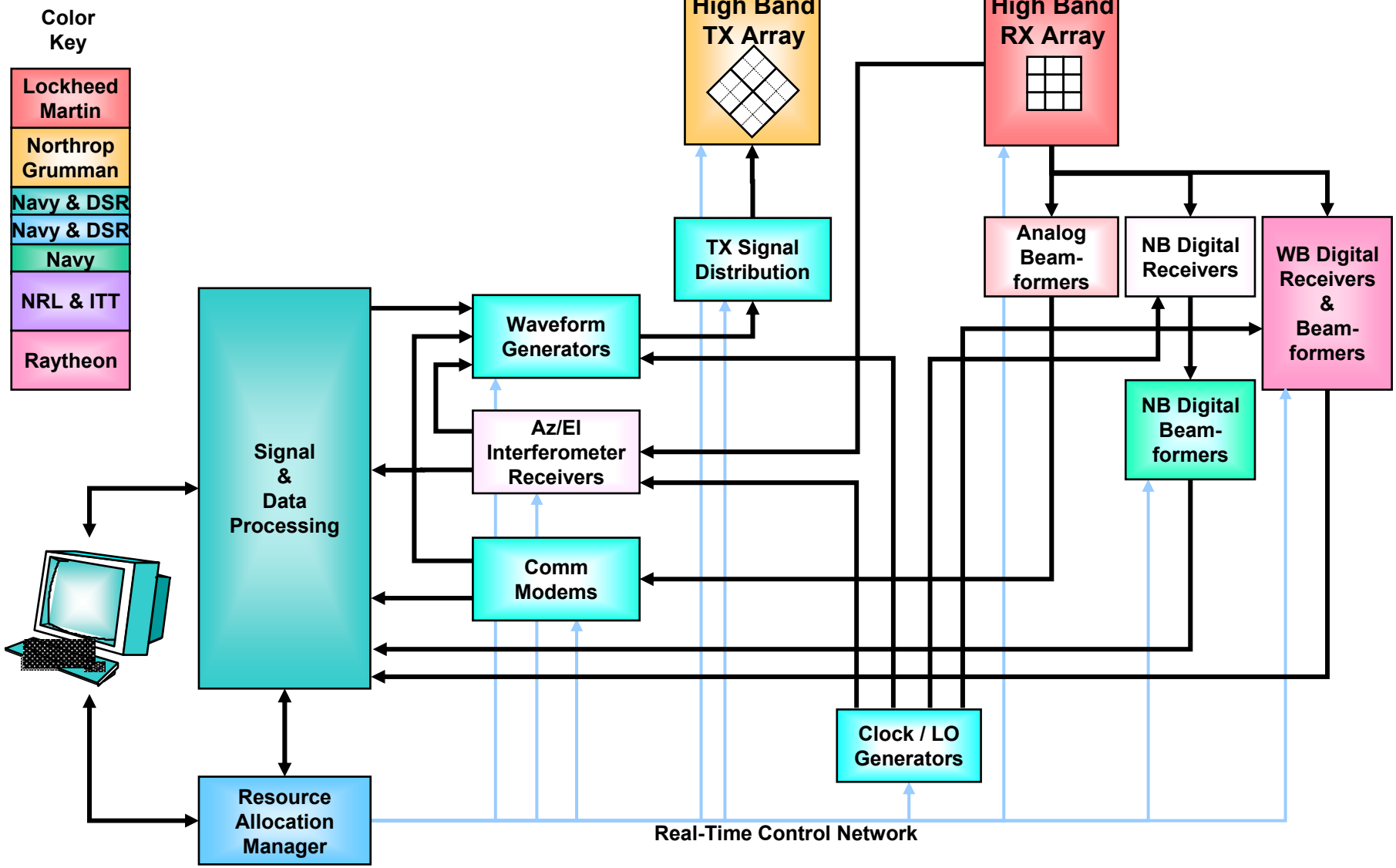
- Reduces Total Number of Required Topside Arrays
  - Lower Ship Radar Cross Section (RCS), IR Signature
- Increases Potential for Future Growth without Major Ship Alterations
  - New RF Functions Added without New Apertures
  - New Ship Designs May Be Less Amenable to Additional Antennas (Limited Deckhouse Size)
  - Isolation Treatments Being Developed to Work Over a Wide Band
- Tighter Control over EMI/EMC Issues
  - Enables More Intelligent & Agile Frequency Management
- Functionality Primarily Defined by Software
  - Upgrade Costs Significantly Lowered
  - New Functionality Added Quickly
  - Interoperability with Legacy Systems
  - New Requirements Swiftly Addressed
- Potential for Substantial Reduction in Life Cycle Costs
  - Reduced Number of Unique Spare Parts
  - Fewer shipboard RF systems result in lower manning for ship
    - › Greatly Reduces Required Number of Equipment Specialists
- Enables Reallocation of RF Functions in terms of
  - Frequency – Jammer Avoidance, ITU Compliance
  - Transmit Power, Aperture, & Bandwidth – Use only the amount needed
  - Polarization – Frequency Reuse

RF Functions (i.e. – The Platform) Can Be Customized to Tactical Environment, Enhancing War-fighting Capabilities

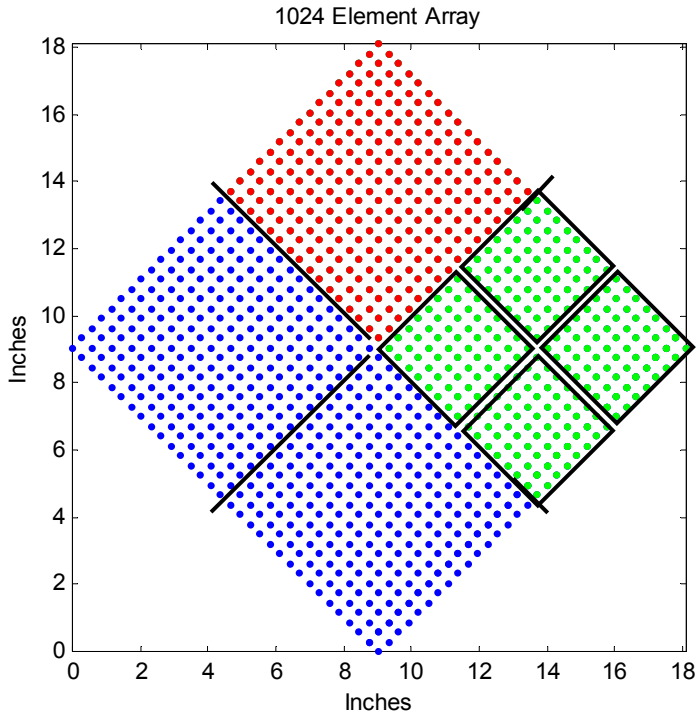
High Band Test-Bed Functions

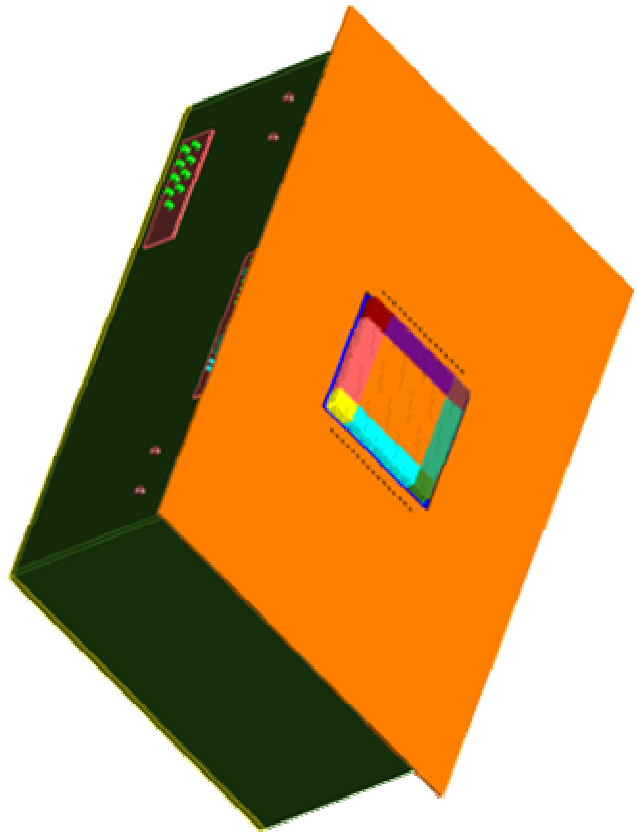
- Communications
  - Satellite Communications
    - › Commercial Ku-Band & Military DSCS (X-Band)
  - Line-of-Sight Communications
    - › Common Data Link (CDL, TCDL) (X-Band & Ku-Band)
- Electronic Attack (EA)
  - Noise Jamming
  - Deceptive Jamming
- Electronic Surveillance (ES)
  - High Probability of Intercept – Precision Direction Finding (HPOI-PDF)
  - High Gain High Sensitivity (HGHS)
- Radar
  - Surface Navigation Radar
- Array & Subsystem Calibration, Characterization, and Diagnostics

AMRFC Test-Bed High Level Block Diagram



High Band Transmit Antenna



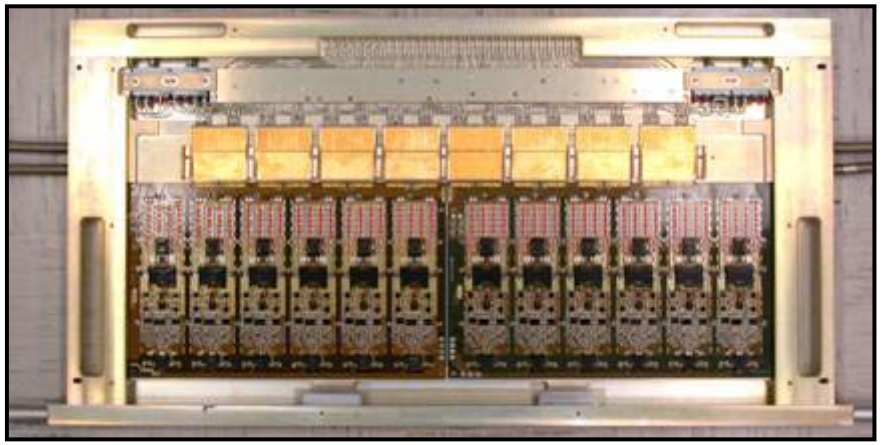


- Full Array
  - 1024 Dual-Polarization Elements
  - 16 Subarrays
- Possible Apertures
  - 4 Quads = 256 each
  - 2 Halves = 512 each
  - 1 Full = 1024 each

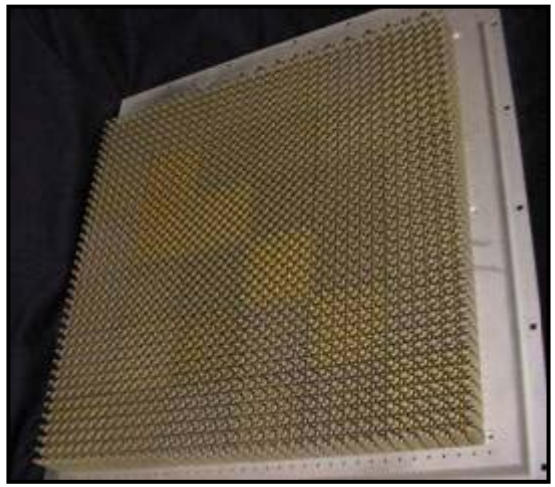
- Equivalent of 5W / HPA
- 0.413” square grid
- Operating Frequency: 6 - 18 GHz

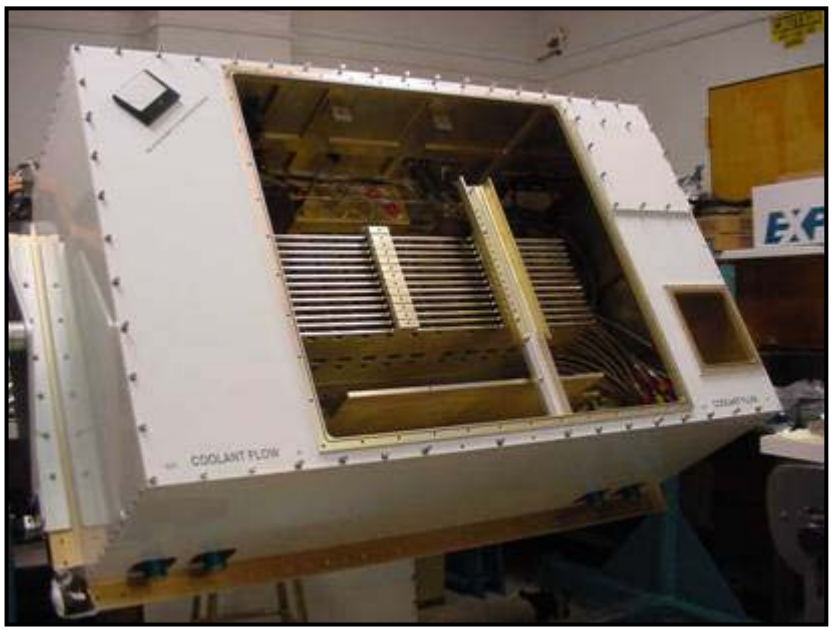
Transmit Array Slat Assembly, Antenna, & Enclosure

Slat with Modules

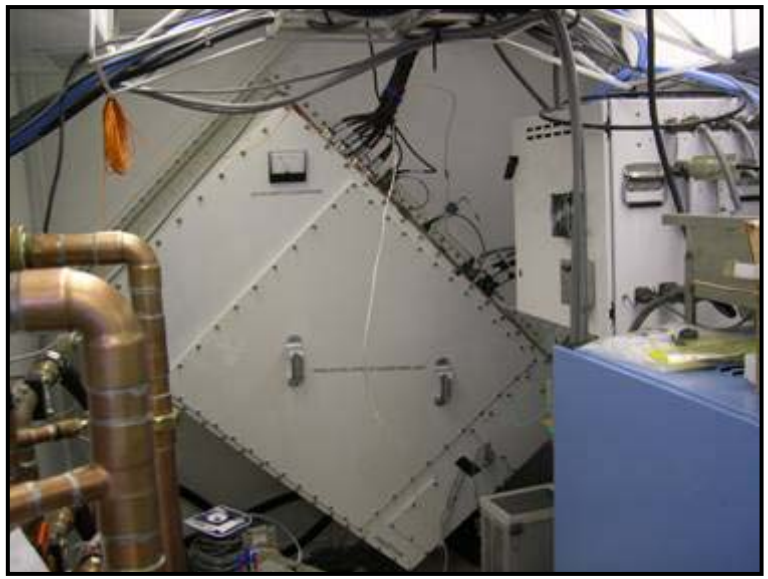


Array Face



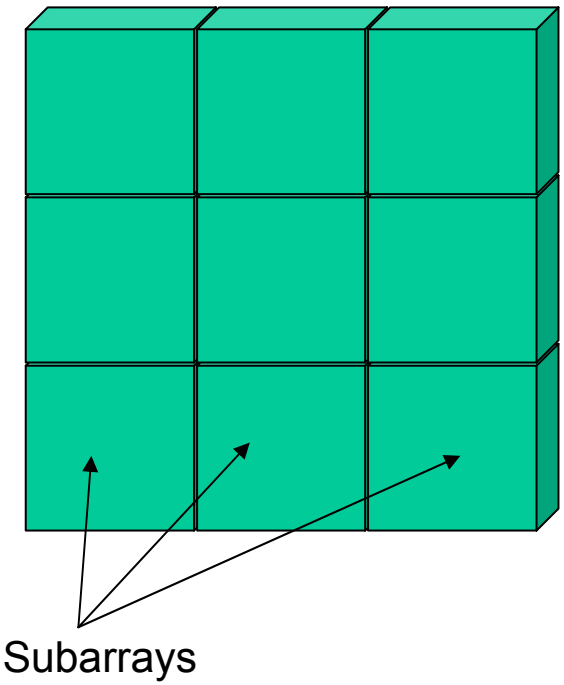


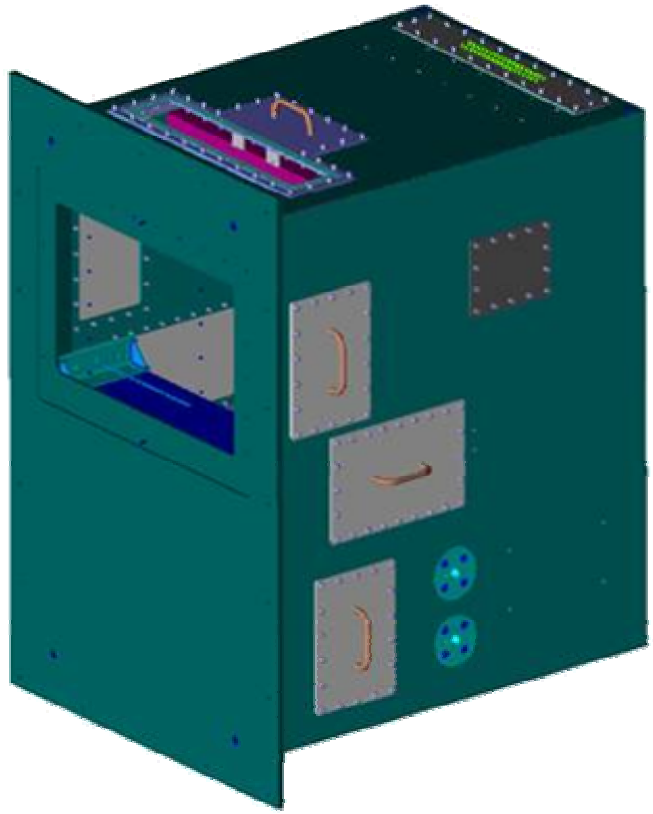
Array Chassis (Rear View)



Installed at CBD

High Band Receive Array

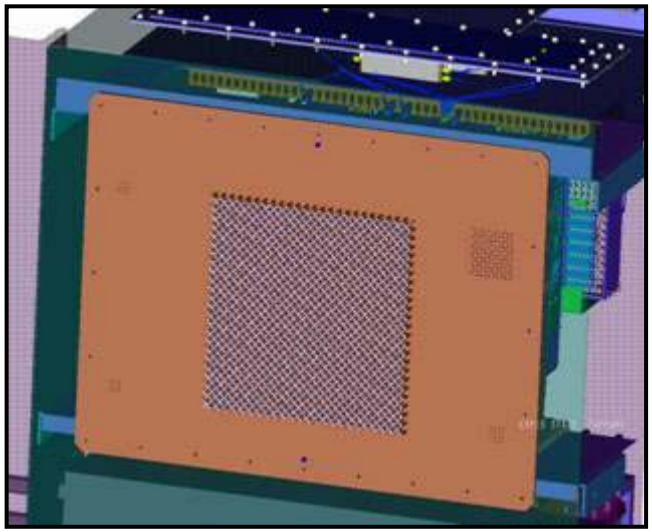




- 1152 Dual Polarization Elements
  - 3x3 Subarrays
  - 128 Elements per Subarray
- Array Size = 12.9”x12.9”

- Operating Frequency: 4.5 - 18 GHz
- 4 RF Ports/Module (& 4 RF Ports/Subarray)
  - 3 Slant Linear, 1 Any Polarization
  - 4 Simultaneous Beams per Module

High Band Receive Array & Enclosure

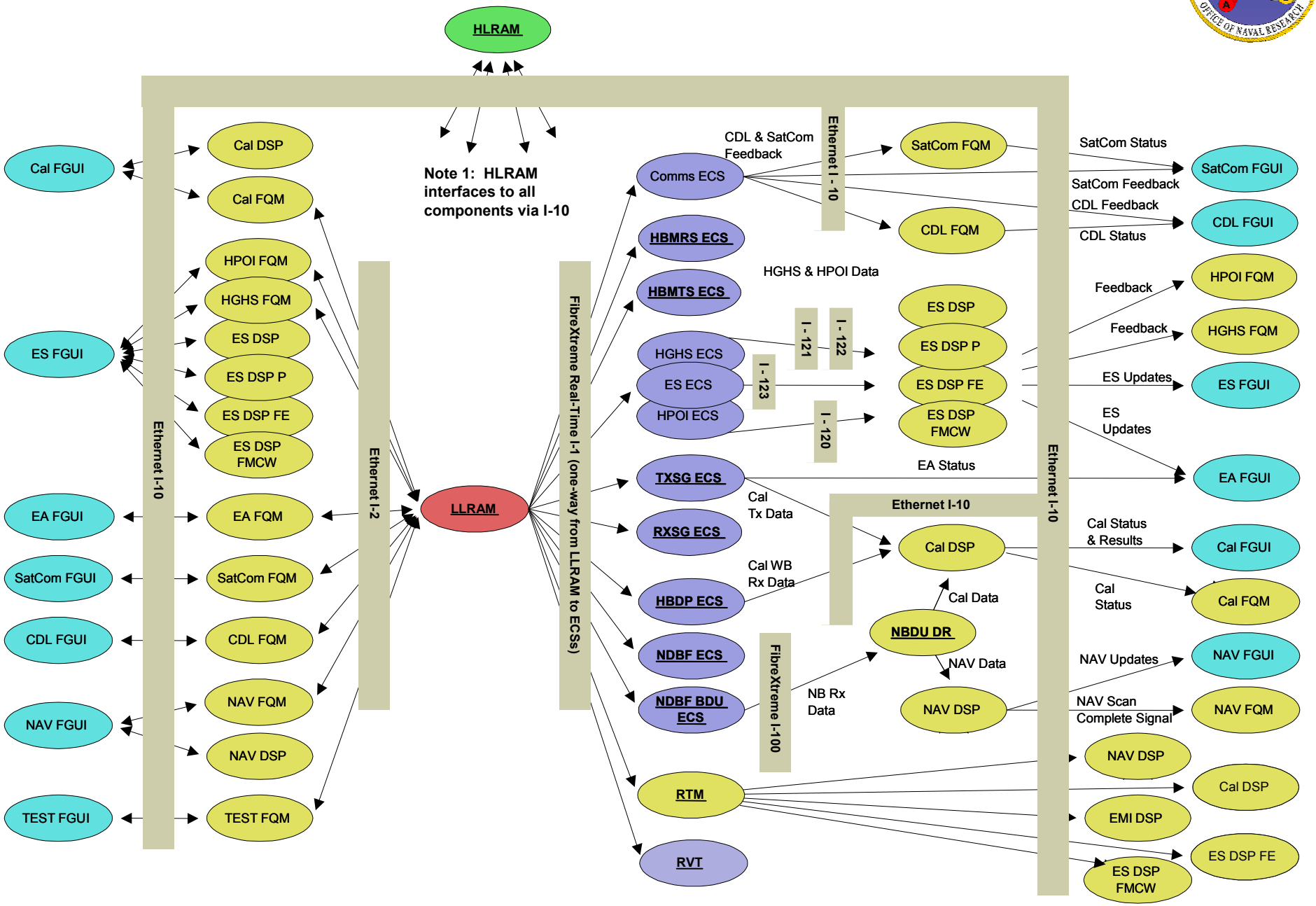


Array Face

Array Chassis

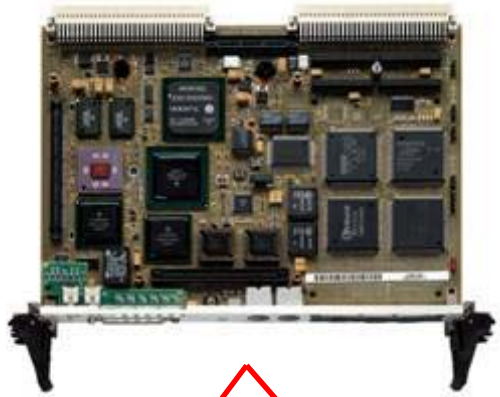
Installed at CBD

Test-Bed Software Resources



Distributed Processing and Control

Workstation(s)
(High Level-RAM
& FGUIs)



MVME2700

Ethernet

HP V2600
Exemplar

16 Parallel
Processing
Nodes

(FQM & DSP
Components)

DSP
Inputs

Embedded
Controller
#1

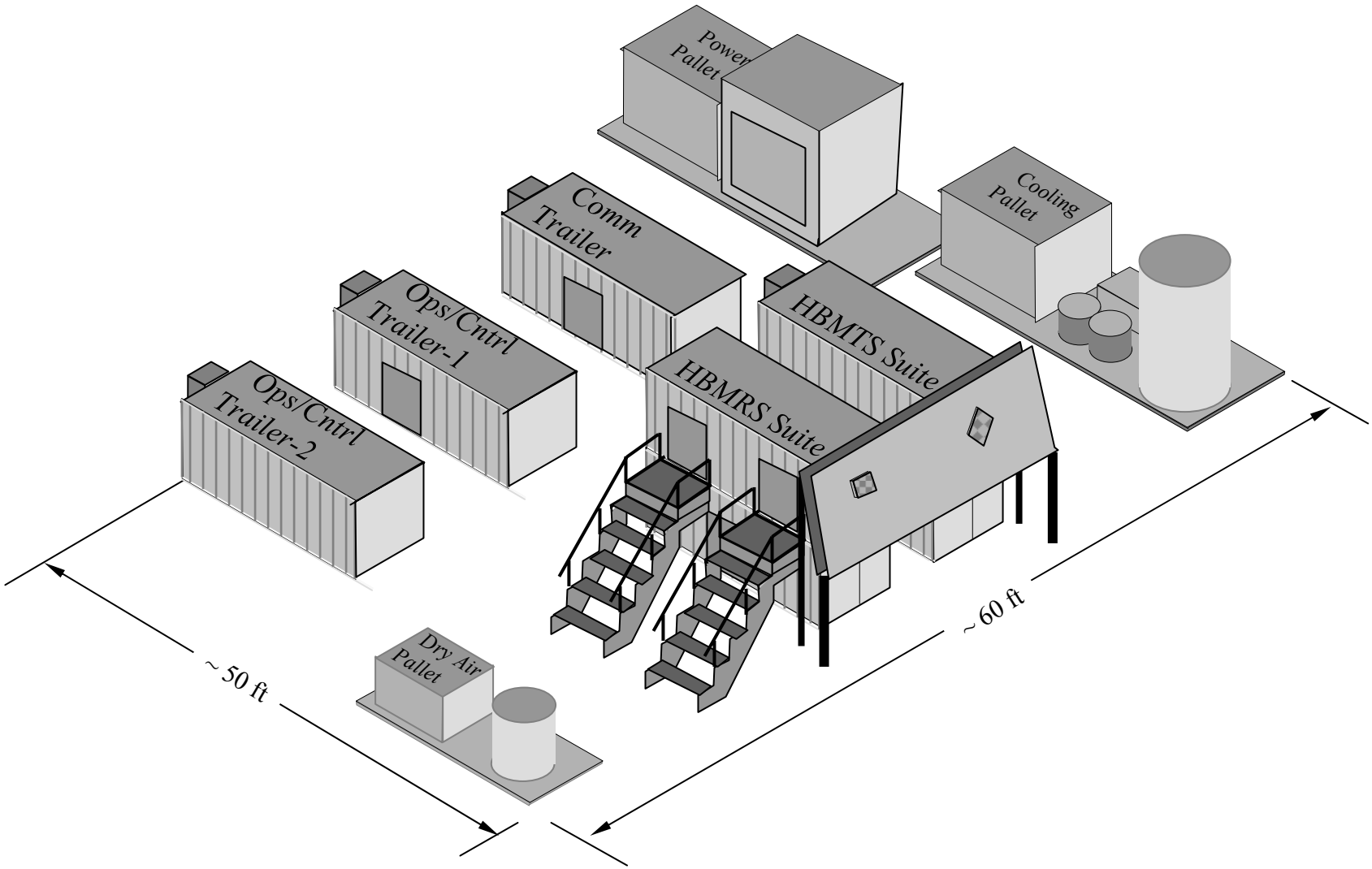
Embedded
Controller
#2

Low-Level
RAM

Real-Time Control Network

Tick
Generator

AMRFC Test Bed at CBD



AMRFC Site in Late October

AMRFC Site Today

Accomplishments / Summary

- All Major Subsystems now installed at CBD
  - Majority (>75%) of subsystems already converted from “stand-alone” to fully integrated (controlled through FGUI-FQM-LLRAM-ECS chain)
    - › Receive Array fully integrated
    - › Transmit Array fully integrated

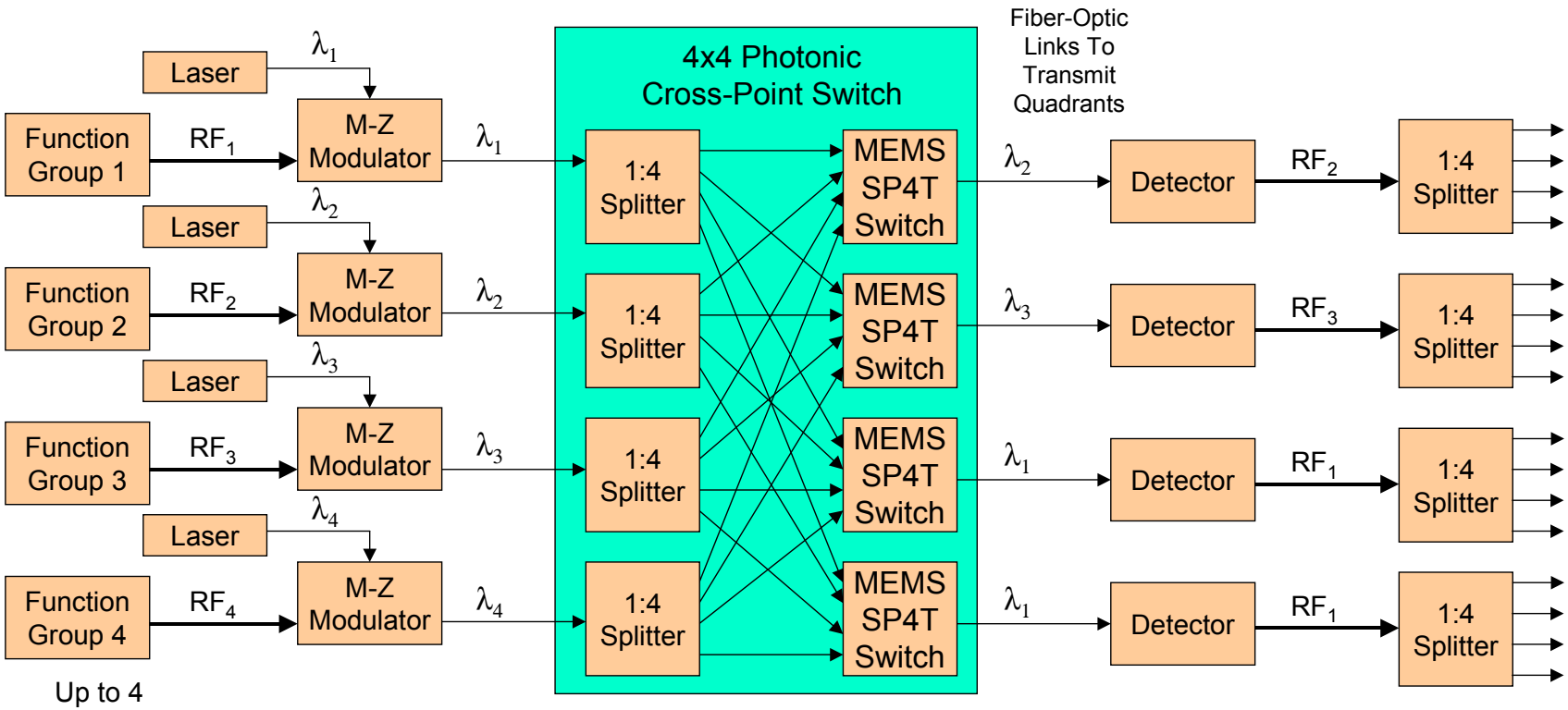
- Successfully transmitted and received to/from Tilghman Island
  - Pre-Functional Tests
- Successfully received Ku Satcom downlink (64 Kbps) from Telstar 11
- Successfully operated (64 Kbps) “bent-pipe” DSCS link with Tilghman Island psuedo-sat
- Radar function “loopback test” successfully completed

- Final Demonstrations scheduled for Summer 2004

- AMRFC Program to Continue Through FY07
  - MFEW/ES Program
  - Test-Bed Expected to be Operational Beyond FY07

BACKUP

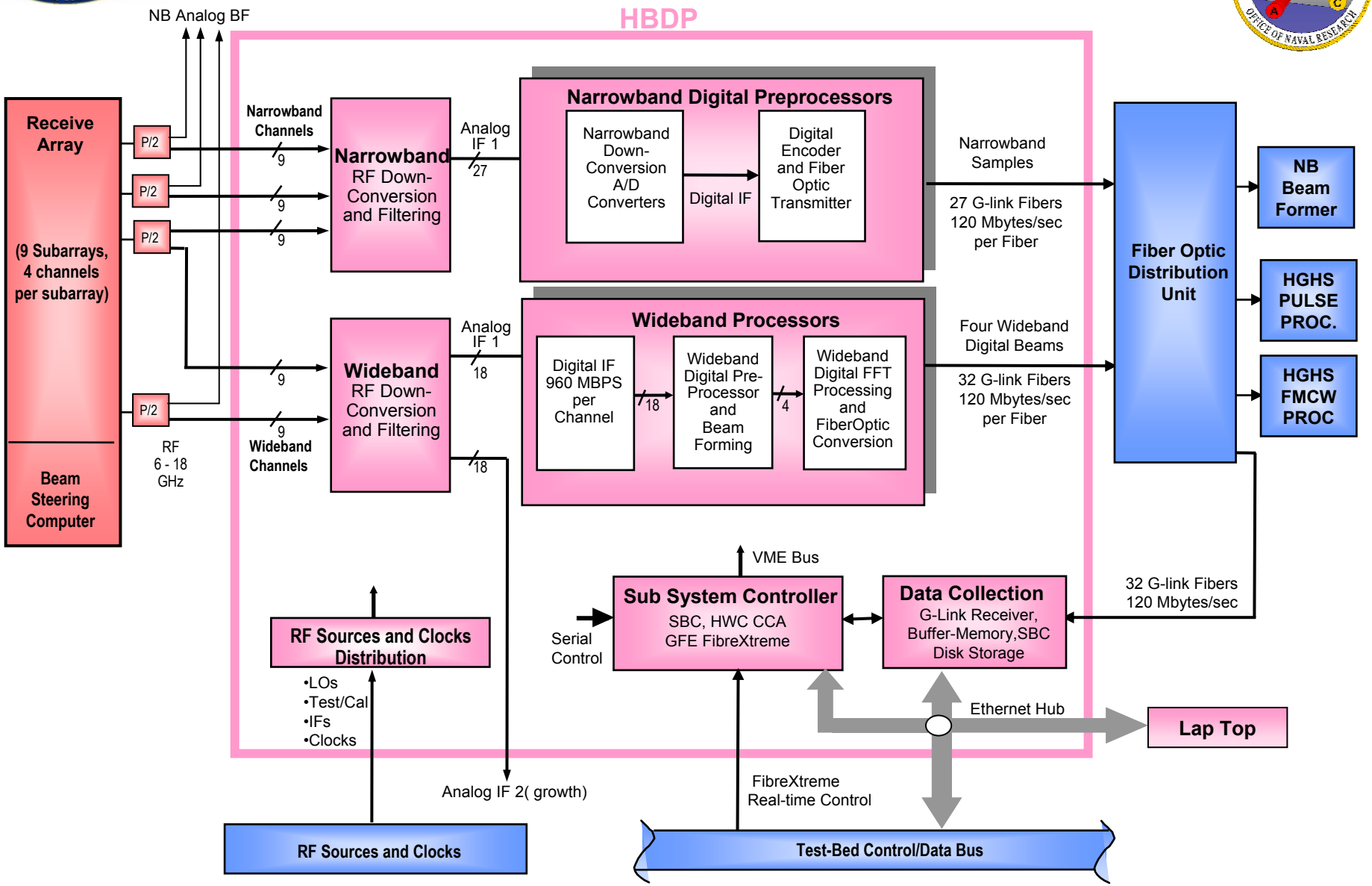
Transmit Waveform Distribution



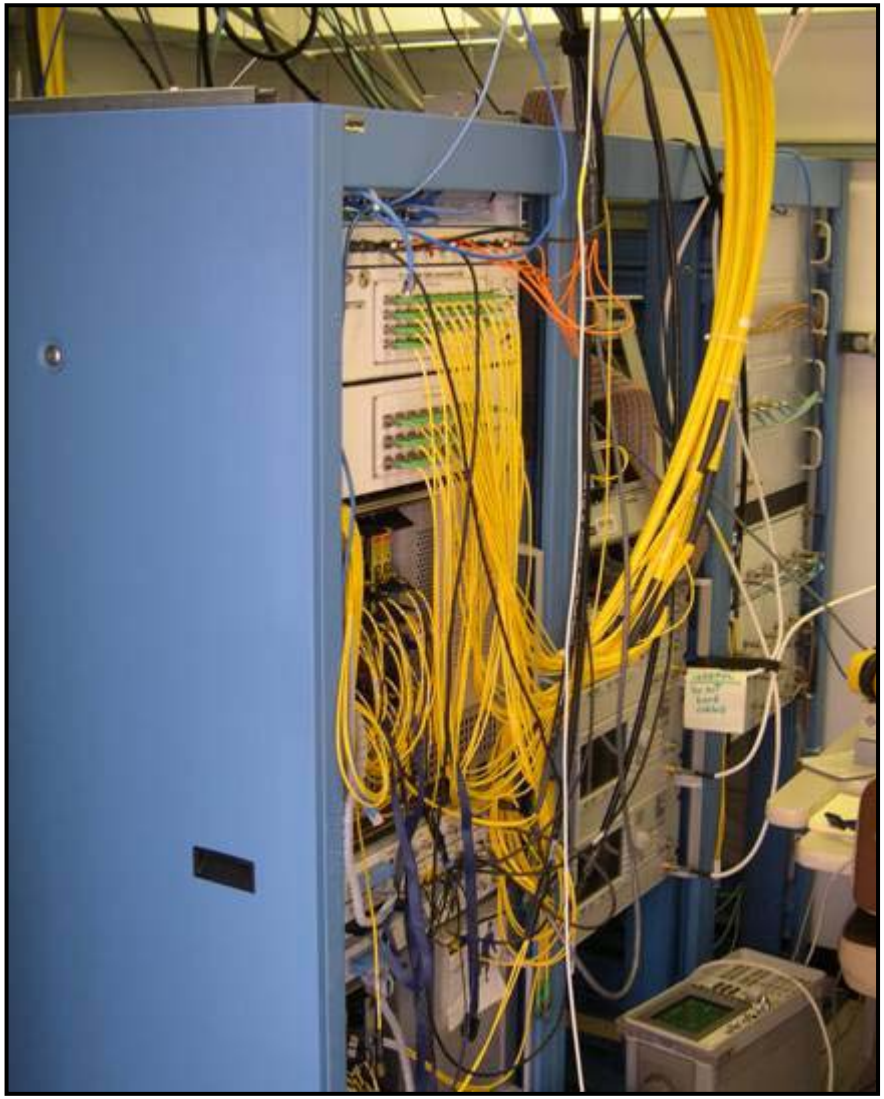
Note: This represents just one example of switch settings.
Carries Narrowband and Wideband Signals.

Waveform Generation & Distribution Equipment

High Band Digital Preprocessor Design



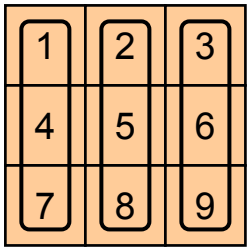
High Band Digital Preprocessor and Digital Beamforming Equipment



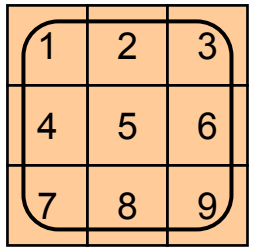
Transmit and Receive Array Assets

Receive Array Apertures

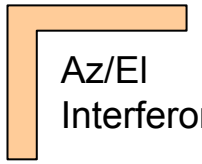
Port 1 NB Digital

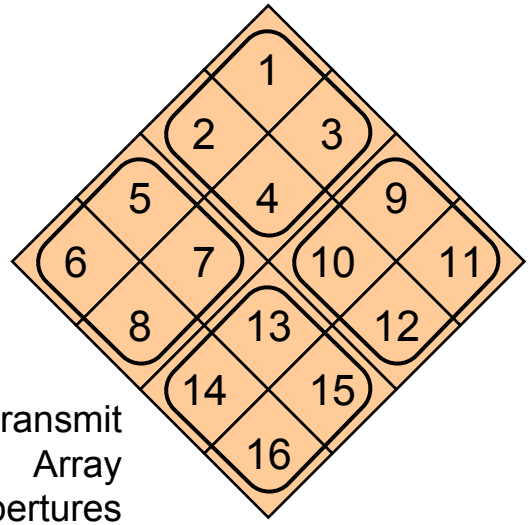


Port 1 Analog



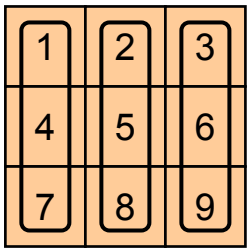
Az/El Interferometer



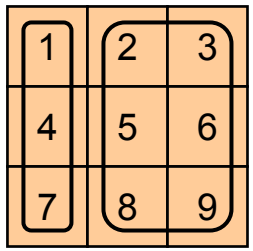


Transmit Array Apertures

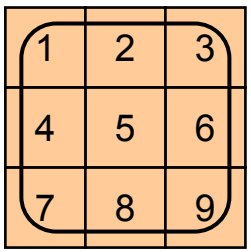
Port 2 NB Digital



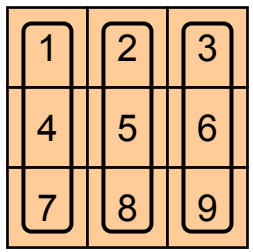
Port 2 Analog



Port 3 WB Digital

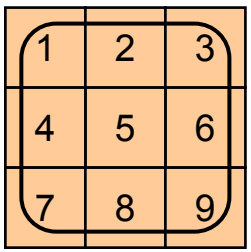


Port 3 Analog

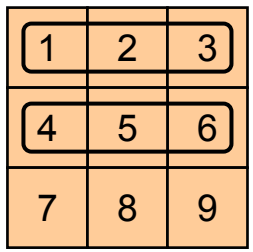


Auxiliary Receive Elements

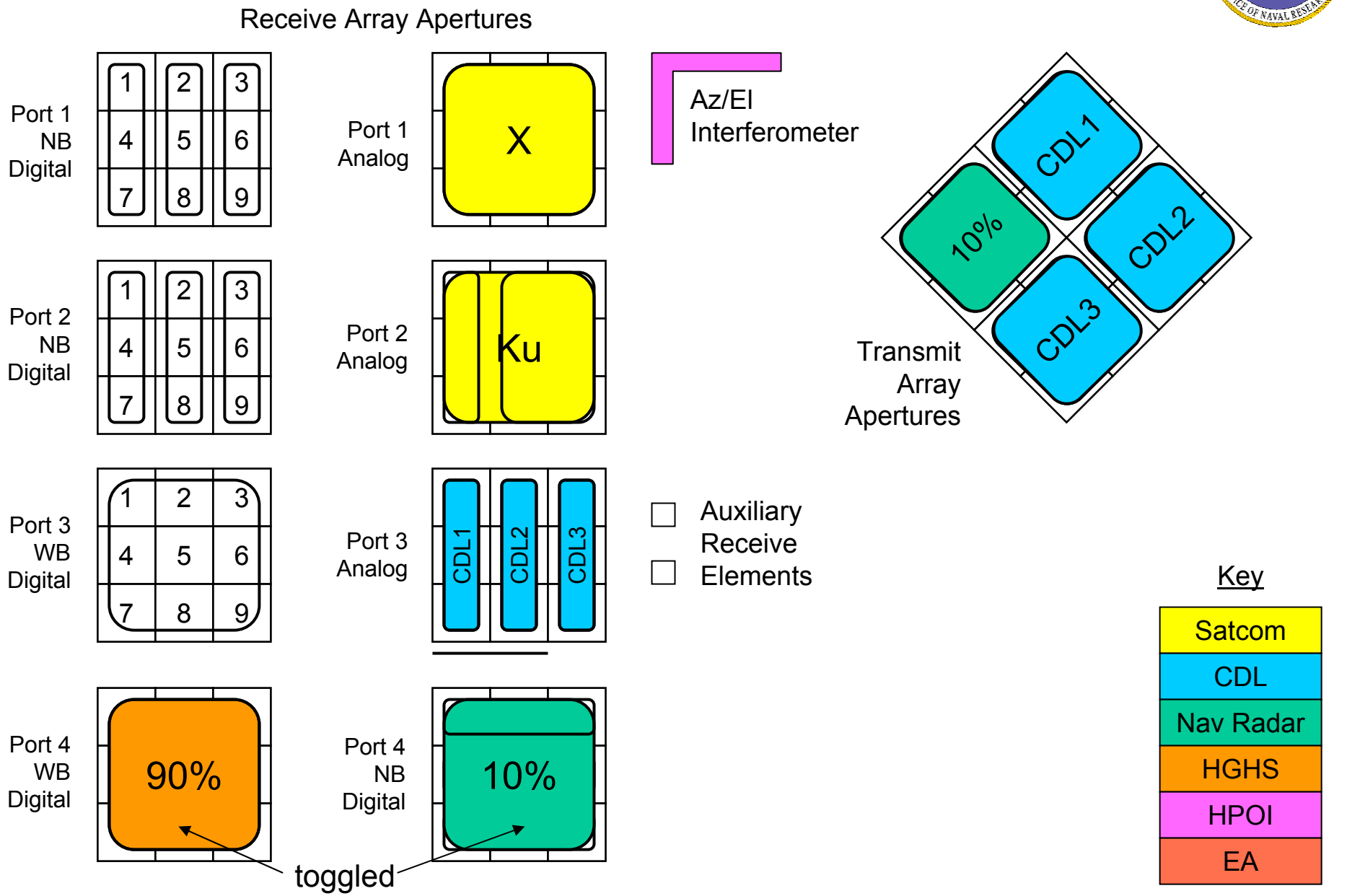
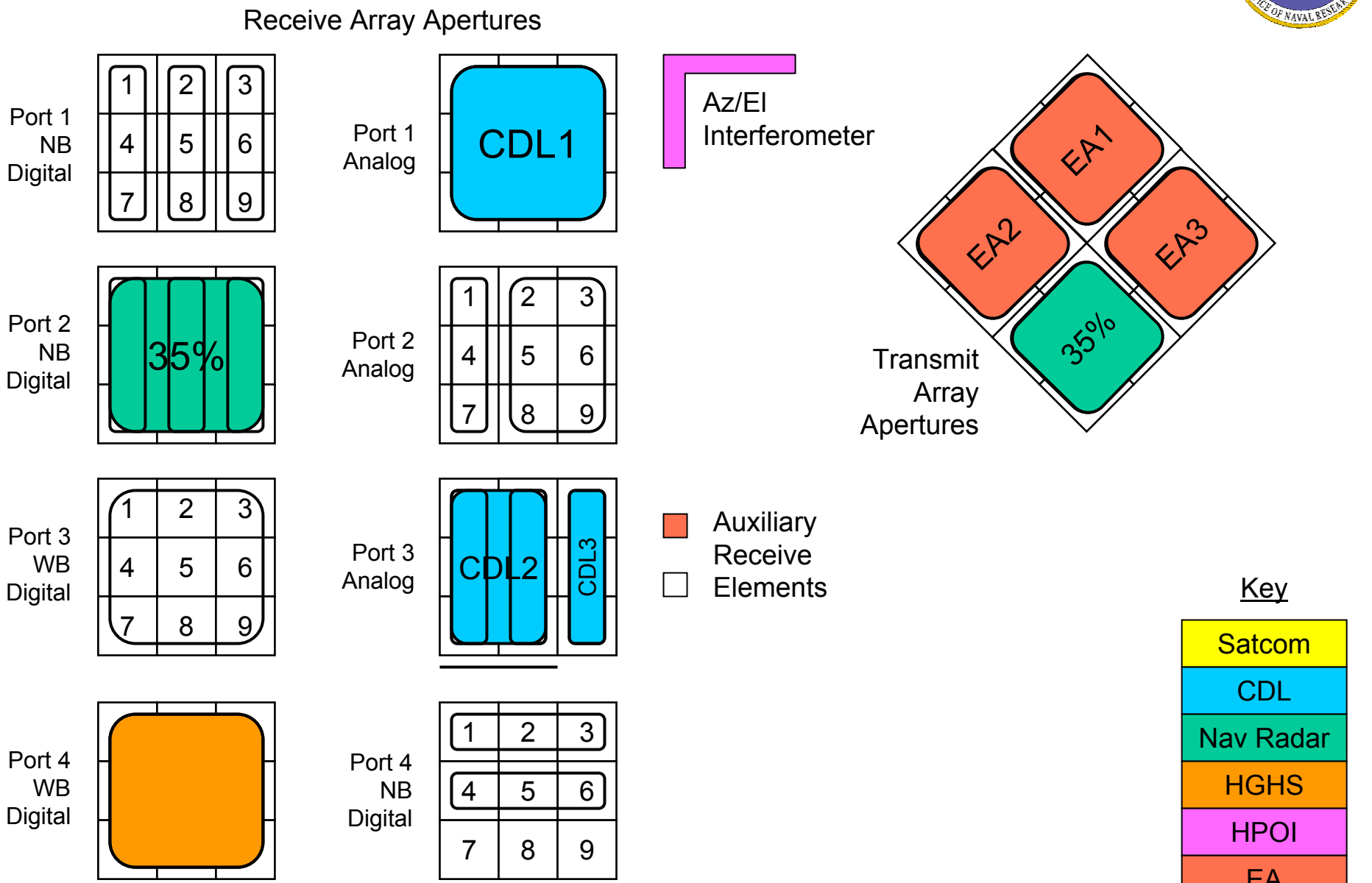
Port 4 WB Digital



Port 4 NB Digital



Normal Scenario 1 (Epoch 1)



Combat Scenario 3 (Epoch 3)