Modernizing the Naval Space Surveillance System

Part 1

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Presentation Outline

- Service Life Extension Program (SLEP)
- Original Naval space surveillance requirements
- Summarize current VHF Fence system and some problems
- A new DoD space surveillance requirement
- Broad considerations for new Fence
- Organizations and roles
- Acquisition schedule for this SLEP
- From life extension to modernization
- Plans for 2001
- Summary

Service Life Extension Program (SLEP)

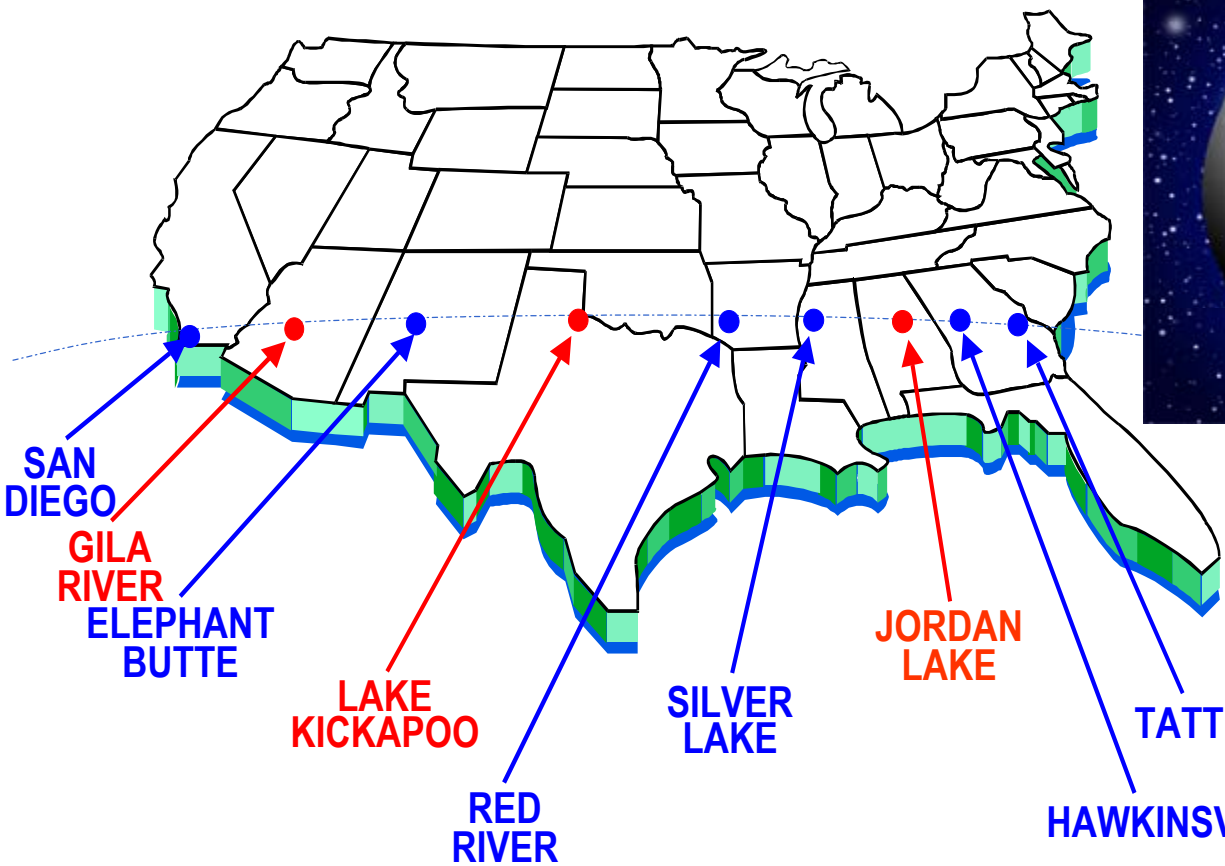
- Parts obsolescence demands technology refresh (sustain the system but do not overly enhance the system)
- Modify hardware design at transmitter, receiver, and central processing sites to accommodate newer technology
- Government procurement cycles cannot keep up with rapid commercial changes

Original Naval Space Surveillance Requirements

- Operations Requirement, 1959
  - 30 cm objects at 140 to 3,700 km
  - All inclinations
  - Single pass
  - Near real-time reporting
  - Maintain catalog for satellite reconnaissance prediction

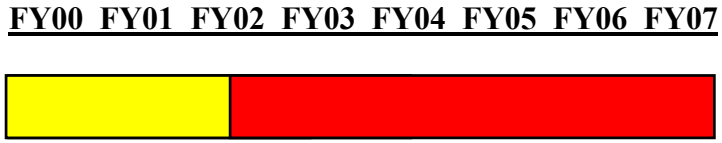
NAVSPACECOM Sensor Sites

CURRENT VHF FENCE (NINE SITES)



Routine Maintenance for Mission Processing

July
1999

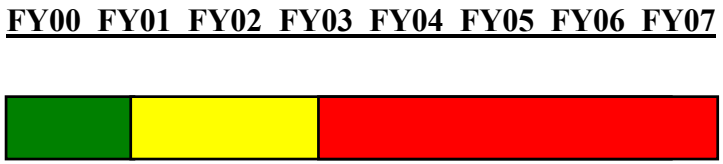


System Status Drivers

Data base at capacity
File servers at capacity

Secure voice switch
Local area network

Oct
2000

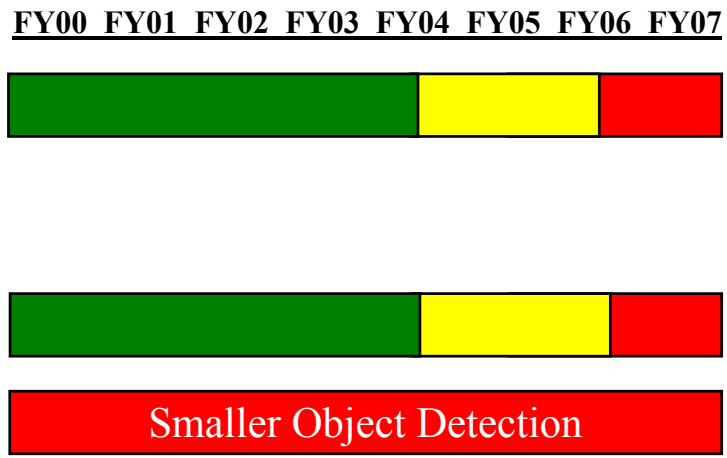


Purchase and install:
Disk drives and network hardware

Modernization Issues for the Sensor

Transmitter System: 1985-88, 15 year design life
- power amplifier transistors out of production
- custom power supplies occasionally fail

Receiver System: 1990, 15 year design life
- MAP boards 7 generations out of date
- FFT boards 4 generations out of date
- VAX computers obsolete
- antennas - restart closed manufacturing lines to replace corroded elements



System Status Drivers

July 1999
- Hardware obsolescence
- Dwindling spares, new parts no longer made
- Meets accuracy requirements
- Detects 30cm objects

March 2000
- Hardware obsolescence
- Dwindling spares, new parts no longer made
- Meets accuracy requirements
- Does not detect objects smaller than 30cm

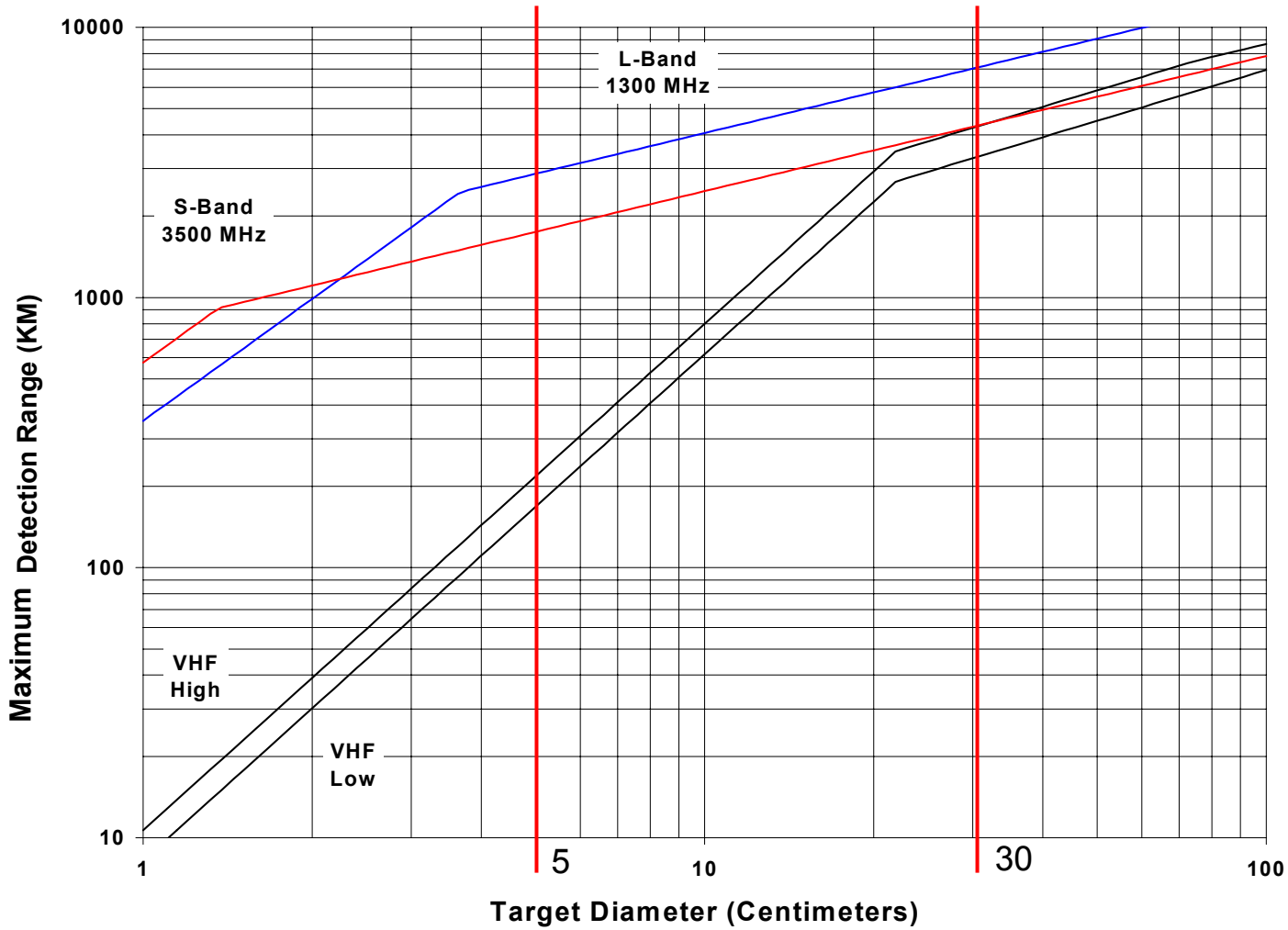
New Surveillance Requirements

- Capstone Requirements Document (CRD) for Space Control, 2000
  - Requirement: detect objects to 5 cm
  - Goal: detect objects to 1 cm
  - In low Earth orbits
- *Naval Fence's derived requirements*
  - *100,000 previously undetected objects*
  - *More accurate orbit ephemeris*

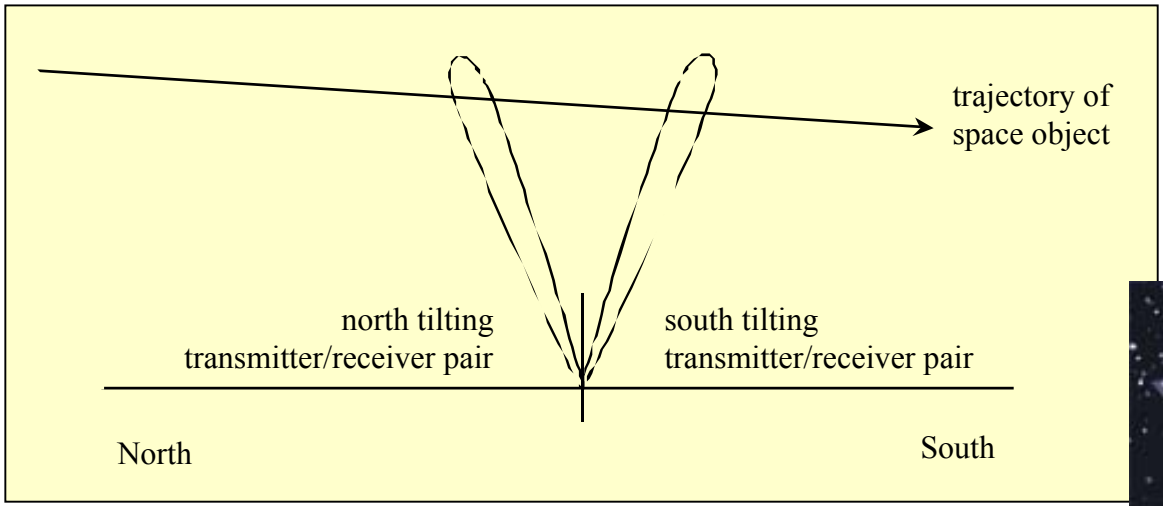
Broad Considerations for the New Fence

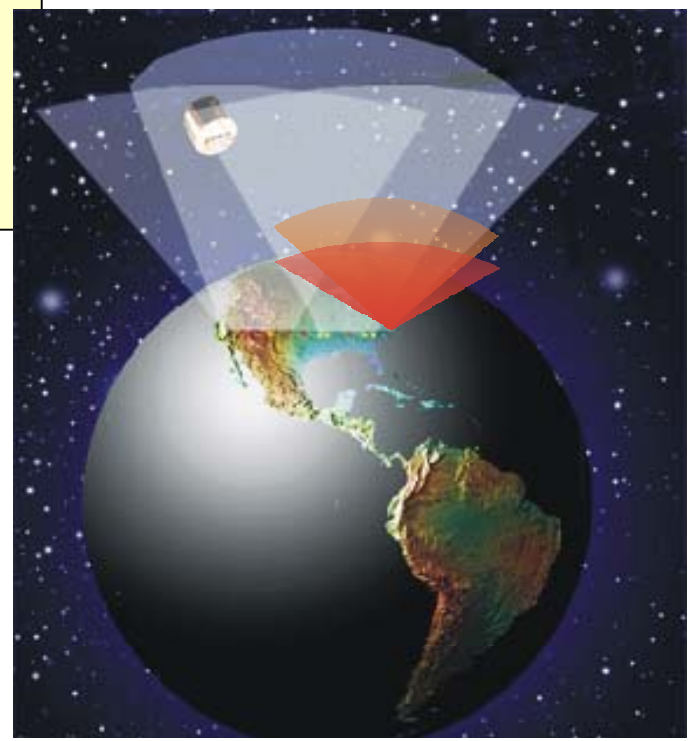
- Detection of smaller objects drives radar to smaller wavelengths
- Perhaps 100,000 previously undetected objects will be seen - how to process
- Cost trade between accuracy of radar system vs accuracy of orbit determination algorithms and processes
- Imply new schemes for initial orbit determination such that UCTs are managed
- Constraints
  - Keep life-cycle costs down by automating UCT processing such that no additional analysts needed
  - Use current real estate
  - Maintain costs within budgets

Microwave Detection Sensitivity vs. VHF Fence



Notional Dual Beam Achieves Single Pass Orbit Determination

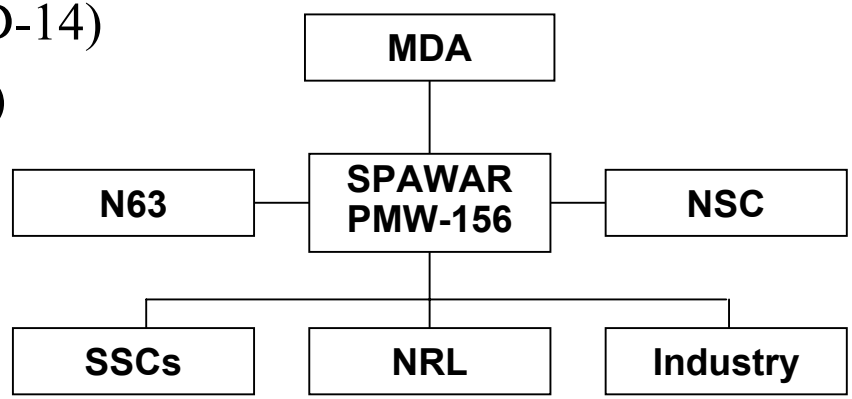




Ensured correlation of same object establishes single pass orbit determination

Organizations and Roles

- SPAWAR:
  - Milestone Decision Authority (PD-14)
  - Acquisition (currently PMW-156)
- N63: Resource Sponsor
- NSC:
  - Customer
  - Program and Technical support



- SSC-San Diego: Program, Technical, and Acquisition support (Systems Engineering)
- SSC-Charleston: Technical support (Sensor and Field)
- NRL: Technical support (Sensor and Software)
- Industry: End-to-end design, specification support (Sensor, Field, Systems Engineering)

Actual and Anticipated Funding for Studies, Design, and Implementation

FY 00	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07
$0.6	$5.1	$4 development	$10 demonstration	$25 produce 1st segment	$33 install 1st segment	$33 produce 2nd segment	$33 install 2nd segment
Phase I	Phase II	Phase III (total $138) for East and West sites					

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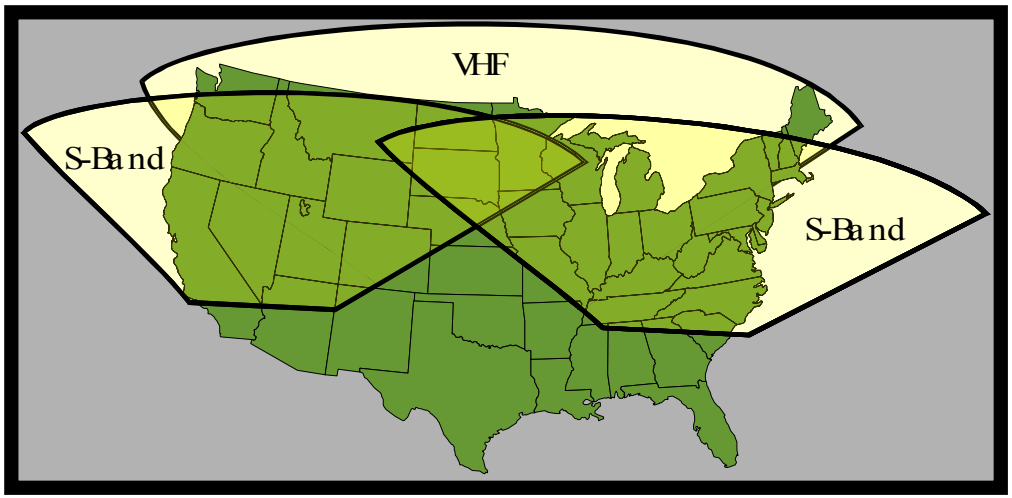
in Millions of dollars
FY 08 and FY 09 unspecified
additional $70 M for Central site

A Plausible Hybrid Concept



- Replacement East and West
  - 2 transmitters, 4 receivers
- VHF retained in Center
  - 1 transmitter, 2 receivers
- $70 M cost avoidance
  - Cannibalize old parts, avoids 3rd central site acquisition

– Detects small objects, with greater accuracy

From a Life Extension to Modernization

- Scope is a limited subset of the NSC operations
  - New sensor for smaller size detection and greater accuracy
  - New mission processing elements complements improved sensor
    - Handle increased data flow
    - Special perturbations methods for improved accuracy
    - Maintain increased catalog size

Plans for 2001 *(covered in next year's Part 2)*

- Systems Engineering Process
  - System Performance Specification
  - Trade studies
- Implementation of SimFence
  - Simulation using contractor provided: radar models, association and correlation algorithms
  - Design, refinement, and comparison
- Issue the RFP to begin Phase 3
- Direction to frequency allocation
- Routine operations and maintenance on current system

Presentation Summary

- Introduced the 10-year SLEP for the Fence
- Hardware at sites is at risk of failure due to lack of available parts
- New DoD requirements allow the Navy to investigate enhancing the Fence, not just extending service life
- Achieve 5 cm detections as objective, 1 cm detections as goal from current 30 cm
- To handle 100,000 newly detected objects, single pass orbit determination appears to be a must
- SPAWAR using government and industry teams
- Costs as a design driver: yield limitations on performance, drawn-out schedule, and funding - **no longer acceptable is performance at any cost**

(Words for speech, slide 5)

- Multistatic
- NRL design, VHF 217 MHz
- 3 TX, 6 RX, Dahlgren
- 33 deg
- fan-shaped
- fence penetration
- multipath RX to Dahlgren
- Detects > 10,000 Man-Made Objects

(Words for speech, slide 10)

- standard textbook assumptions
- SNR, Probability of Detection, VHF is high and low altitude RX
- represents upper limit of targets that can be detected
- VHF breaks 23 cm, L to 4 cm, S to 1.5 cm (radar resonance transition)
- large object sensitivity of S similar to VHF
- L more sensitive than S,yielding 60% greater range
- 5 cm S detects to 1,850 km, L to ~3,000 km, VHF to 200 km
- Two Higher Frequencies explored
  - L-band (1300 MHz)
    - best performance vs. cost
    - frequency allocation may be difficult
  - S-band (3500 MHz)
    - better sensitivity for very small objects (~1 cm)
    - frequency allocation more likely than L-band
- for a fixed cost - performance degrades for higher frequency: more power generation, higher component costs, more complex signal processing, target properties (physics of radar detection) become more complex

(Words for speech, slide 12)

- SPAWAR
  - acquisition and program management of SLEP covering the Sensor, Mission Processing, Network, and a portion of Command Center
  - 4 types of teams
    - 2 SPAWAR Systems Centers, and NRL, Industry
    - Subject Matter Experts from NSC participate as advisors
  - manages system integration with System Engineering Integrated Product Teams
  - to manage and maintain the configuration of systems and system components under development
- NSC to maintain and manage the configuration of the existing system.

(Words for speech, slide 13)

- Phase 1 ($600K, FY00, 4 months) Goals:
  - Solicited industry for system concepts under full and open competition
  - Issued three $200K contracts
  - Contractors identified performance, costs, and risks of designs options
  - Contractors identified risk mitigation efforts needed
- Phase 2 ($1.7M, FY01, 9 months) Goals:
  - Definitive trades investigated broader issues
  - Mitigate identified risks
  - Produce a performance design specification leading to $150M-$200M system RFP (FY02)