GPS III
System Architecture
Requirements Definition

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SUMMARY

◆ GPS III Program Overview
◆ System Architecture Requirements Definition
  ◆ Contractor Trade Study Teams
  ◆ SARD Government Team
  ◆ Trade Study Process and Products
  ◆ GPS III and Galileo
◆ GPS III Capability Goals
◆ Conclusion
GPS III Purpose

- Plan and grow system capabilities to meet future user needs for precise positioning and timing services
  - GPS ORD objective values as the target
- Procure most cost-effective system to meet future military and civilian requirements through 2030
  - Sustain GPS Service
  - Reduce Total Ownership Costs
  - Conscientious cost - benefit analyses for future requirements
- Make optimal use of system augmentations and complementary systems
- Re-look at entire GPS system architecture
  - Identify system-level trades for all system segments - space, control segment and user equipment

Ensure best GPS system for the nation for the next 30 years
GPS-III Program Approach

- System Architecture Investigation Studies leading to System Requirements Review - November 2000
  - Architectural trade space definition
  - Competitive contractor architecture definition
  - Comprehensive system requirements document

- Preliminary Design & Risk Reduction - Early 2002
  - Competitive Source Selection
  - Two qualified sources will compete for system design to reduce design/production risk

- Design/Production - Mid-year 2004
  - Down-select to single contractor at Preliminary Design Review

Three phase approach - flexible, allows future changes, reduces risk
GPS III Acquisition Strategy

<table>
<thead>
<tr>
<th>FY00</th>
<th>01</th>
<th>02</th>
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<tbody>
<tr>
<td>Authority to Proceed (August 00)</td>
<td>RFP/SS</td>
<td>Competitive Trade Studies (Two contractors)</td>
<td>Contract Award</td>
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<td>SARD</td>
<td>Alternative systems review</td>
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<td>PD/RR (Two contractors)</td>
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<td>JROC</td>
<td>Requirements Update</td>
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<td>04</td>
<td>05</td>
<td>06</td>
<td>07</td>
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<td>Design Reviews</td>
<td>Critical Design Review</td>
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<td>PD/RR (con’t)</td>
<td>EMD (Single contractor)</td>
<td>Box/System Qual Tests</td>
<td>Integ/Assy/Test</td>
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<tr>
<td>Down Select (MS II)</td>
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<td>Long Lead Production (MS IIIa)</td>
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Assess system wide architectural alternatives to:
- Meet ORD requirements
- Reduce total ownership costs
- Provide flexibility and robustness to meet evolving military and civil requirements for the next 30 years

Principal product of the SARD is a set of suggested requirements

Only the alternative(s) approved by the Government will lead to requirements
GPS III SARD Phase - Study Teams

- Competitive selection of two contractor teams
  - Proposals reviewed in September and October
  - Two 12 month Study Contract winners announced on November 9th

- Government SARD Team
  - JPO lead ensemble with military and civil agency participation
  - Review and blend contractors’ analysis and other government studies
  - Form the final baseline and alternatives to be presented to the Defense Acquisition Board (DAB)
Competitive Contractor Study Teams

**Boeing Government Info & Comm Systems**
- Boeing Satellite Systems (Hughes Space & Comm)
- Computer Sciences Corporation
- Lockheed Martin Management & Data Systems
- Raytheon Company

**Lockheed Martin Space Systems**
- ITT Industries
- Rockwell Collins
- Ball Aerospace
Government SARD Team

- Government Technical Oversight
  - U.S. Air Force GPS Joint Program Office
  - Additional Input from IGEB Agencies

- Principal Technical Support
  - The Aerospace Corporation
  - MITRE Corporation
    - Command, Control, Communications & Intelligence (C3I)
    - Center For Advanced Aviation Systems Design (CAASD)

- Additional Technical Support
  - National Security Agency
  - US Naval Observatory
  - Systems Engineering Technical Assistance (SETA) Contractors
The Questions to Answer

- What can be added to a system that delivers PNT services, that, for some marginal additional cost, will yield much greater benefit?
- How can the existing needs be met with greater reliability, margin and quality at lower cost and within schedule?
- How (and when) can the new capabilities/architectural elements be transitioned from the current configuration?
- What synergies with other systems can be utilized to achieve all of the above?
Alternative Futures

- Technical/programmatic alternatives motivated by economic and policy-related considerations
- Civil possibilities include:
  - Current -- core GPS plus external augmentations
  - GPS program managing augmentations
  - Enhanced core incorporating augmentations
  - GPS incorporating or partnering with future civil satellite navigation elements
- Military possibilities include
  - GPS/NDS only
  - Multi-mission platform
  - Shared functions with other platforms
GPS Space-Only Solution with User Based Augmentations

- Nav. related Comm. Needs
- Aviation Needs
- High AJ Needs
- Terrestrial Precision Needs

GPS System Requirements
Space Only
POS/NAV/TIME
GPS/Civil Independent Space-Only Solution with User Based Augmentation

- Nav. related Comm. Needs
- High AJ Needs
- Aviation Needs
- Terrestrial Precision Needs
- POS/NAV/TIME

Civil Space Platform
GPS/Civil Interoperable Space-Only Solution with User Based Augmentations

GPS System Requirements
Space Only
POS/NAV/TIME

Nav. related Augmt.‘Comm. Needs
High AJ Needs
Aviation Needs
Terrestrial Precision Needs

Civil Space Platform

* Possible cooperative monitoring, crosslinks, satellite control, etc...
GPS Total Solution
Augmentations and Additional Missions

GPS System Requirements

Other DoD Space Platform Req.s

Aviation Needs

High AJ Needs

Terrestrial Precision Needs

NAV/POS/TIME

Augmt.

* Examples: crosslinks, SAR, Nav. related Comm., etc.
Outline of the SARD Process

1. ALTERNATIVE 1
   DERIVE INITIAL SET OF TOP-LEVEL REQUIREMENTS

2. CURRENT SYSTEM/TRANSITION
   SYNTHESIZE ARCHITECTURAL AND PROGRAMMATIC ELEMENTS / CONOPS TO MEET/EXCEED REQUIREMENTS

3. SYSTEM LEVEL

4. POST FOC
   POST IOC

5. SEGMENT LEVEL

6. SUB-SYSTEM LEVEL

7. VALIDATE ARCHITECTURE AND PROGRAM AND CONDUCT BEST-VALUE TRADE STUDIES
The SARD Phase Product

- Comprehensive System Requirements that are performance-based
  - System Requirements Document
  - Technical Requirements Document
- Used to Develop a Request for Proposal
  - Competitive Source Selection to award two contracts to enter the Preliminary Design & Risk Reduction Phase - October 2001
GPS III and Galileo

- USG is postured to cooperate with Europe in pursuing a fully interoperable GNSS based on:
  - Agreement to principles outlined in a draft agreement provided to the European Commission
  - A decision by Europe to go ahead with Galileo

- However:
  - GPS III architectural solutions should stand on their own
  - Premature to incorporate Galileo concepts into the GPS III architecture as EU has not yet made a decision
  - Advantageous to US Government to understand benefits of potential future systems like Galileo

- GPS III contractors may seek insight into the Galileo concepts by contacting potential Galileo contractors
# GPS III Capability Goals

<table>
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<th>System Characteristic</th>
<th>2000 GPS ORD</th>
<th>Civil PNT (Appendix F - 2000 ORD)</th>
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<tr>
<td></td>
<td>Threshold</td>
<td>Objective</td>
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<tr>
<td>Accuracy:</td>
<td></td>
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<tr>
<td>Horizontal</td>
<td>6.3m (95%)</td>
<td>1.0m (95%) – civilian</td>
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<tr>
<td></td>
<td>30.0m (99.9%)</td>
<td>2.1m (95%) – military</td>
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<td>Vertical</td>
<td>13.6m (95%)</td>
<td>4.0m (95%)</td>
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<td>40.0m (99.9%)</td>
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<tr>
<td>Availability</td>
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GPS III SARD

CONCLUSION

◆ GPS III will follow Block IIR and IIF modernization
  – Three phase approach -- System Architecture Requirements
    Definition Studies; Preliminary Design & Risk Reduction;
    Design/Production

◆ SARD Studies will assess system wide architectural
  alternatives resulting in system/technical
  requirements to achieve Objective Operational
  Requirements
  – Two Contractors and a Government Team are in place
  – SARD phase will consider potential future satellite navigation
    systems but it is premature to incorporate specific system
    characteristics into architectural alternatives

The Goal -- Procure a cost-effective system to sustain
GPS services and meet future military and civil
PNT requirements through 2030