# GPS OCX Program Status

## Stanford 2012 PNT Challenges & Opportunities Symposium


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**14 Nov 2012**


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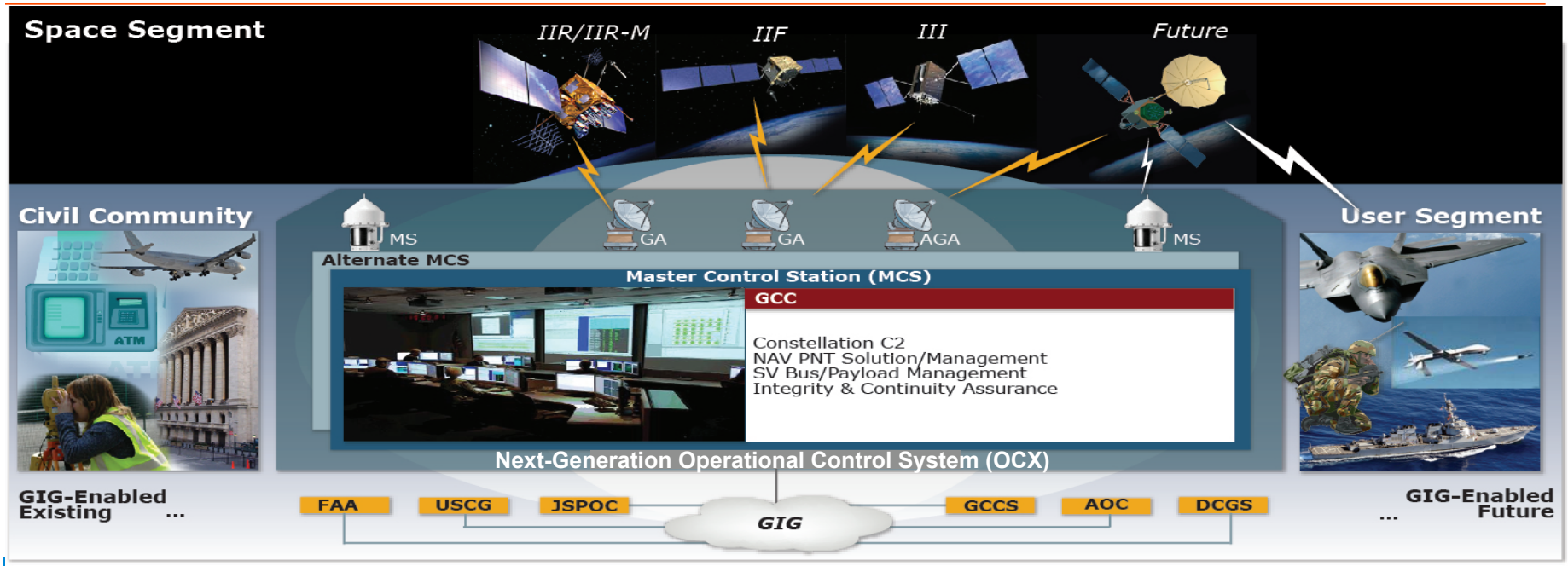
# GPS OCX
# Next Generation Operational Control System




## Service Oriented Architecture

### ....Provides Enhanced Capabilities

- Additional signals: L5, L1C, L2C, M-Code
- Command & Control and Mission Management for GPS IIR, IIR-M, IIF and III
- Robust IA to counter emerging cyber-threats
- Improved accuracy inherent in design
- Integrity & continuity using WAAS algorithms
- Operator automation

### ....Supports Future Capabilities

- Flexible architecture to accommodate new functional capabilities, evolving CONOPS, and additional automation
- Internal SOA to enable new GIG/Net-Centric interfaces
- Re-programmable M-Code monitor station receiver
- PSICA infrastructure in Block 1 lays foundation for future integrity requirements

# GPS OCX Team
# Experience, Roles and Responsibilities

| Division | GPS Enterprise Experience | GPS OCX Role and Responsibility |
|---|---|---|
| Raytheon<br>Intelligence & Information Systems (IIS)<br>Aurora, CO | • **Delivered More than 110 Ground Stations During the Past 40 Years**<br>• **Extensive Legacy Controlling Satellites from All Major Vendors**<br>• Developer of NPOESS GS, DCGS, NCES, MCS | • Program Management<br>• System Integration<br>• Systems/Software/Test Engineering<br>• Risk and Opportunity Management<br>• Transition Lead |
| RTN Network Centric Systems (NCS)<br>Fullerton, CA | • **Delivered only FAA-Certified Space-Based Precision Navigation System**, the GPS Wide Area Augmentation System<br>• GPS Augmentation Systems for Japan & India | • System Safety and Integrity<br>• PSICA Solution<br>• Integrity Certification |
| RTN Integrated Defense Systems (IDS)<br>Huntsville, AL | • **Over 100 Labor-Years of C2 HSI Experience**<br>• Automation Experience (DDG-1000, Firescout UAV Tactical Control System, Surveillance Radar Missile Warning Center) | • Human Factors Lead<br>• Human System Integration, Design, Planning, and Products |
| ITT<br>Space Systems Division<br>Clifton, NJ | • **Provider of All GPS IIA, IIR, & IIR-M NAV Payloads and all AF MS Receivers**<br>• **Developer of GPS IIF (L1/L2) and III NAV Payloads and NGA L2C/SAASM MS Receivers**<br>• Over 30 Years Generating Signal-in-Space (SIS)<br>• Developed MNSA Cryptology Solutions | • PNT Solution Lead<br>• Receiver Development and Key Mgmt<br>• Mission Data Processing IPT Lead<br>• Navigation Lead Processing Elements<br>• Precision Monitor Station Receivers<br>• Cryptographic Security for Exclusive Military Ops |
| BOEING<br>I&SS Mission Operations<br>Colorado Springs, CO | • **Current Lead GPS O&S Contractor at Schriever AFB**<br>• **Led AEP & LADO Transition**<br>• Provides and Operates Boeing GPS Center<br>• Block IIF Satellites and Validated Models<br>• 63% of Current Sustainment Team | • Operations and Sustainment (O&S) and Logistics System Integration Lead<br>• ICD Lead for Communications/ Networks/Data Storage<br>• Sys. Engineering and Transition Supt.<br>• Life Cycle Support |
| BRAXTON<br>Colorado Springs, CO | • **Built and Delivered LADO for IIR-M and IIF Launch, and Anomaly and Disposal for All GPS Satellites**<br>• GPS Simulators with Validated Models | • Simulation IPT Member<br>• Spacecraft Models<br>• Powerful High-Fidelity Satellite and Network Simulation Algorithms |
| JPL<br>Pasadena, CA | • **High Performance Real Time GPS Orbit Determination & Positioning Sys. - GDGPS** | • PNT Subject Matter Expert (SME)<br>• Kalman Filter Algorithms |
| INFINITY SYSTEMS ENGINEERING<br>Colorado Springs, CO | • **Key GPS Operations Support Contractor**<br>• AEP & LADO C2 System Team Member Throughout Development and Ops<br>• 9% of Current Sustainment Team | • IPTs (SEIT, O&S)<br>• Training and Technical Order Lead<br>• CTS Courseware<br>• OPSCON Development Ops Support |

***Raytheon GPS Team:* One Team — Common Process — Working Together for Over Four Years**

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# OCX Core Requirements/Capabilities

## Technical Challenges

- M-Code →
- Anti-Tamper →
- Integrity Monitoring →
- External Interfaces →
- Info Assurance →
- PNT Performance →

| Area | Attributes | OCS Current | OCX PDR (Jun 2011) |
|---|---|---|---|
| Navigation Signals | L1 / L2: C/A, P(Y) | Yes | Yes |
| | M-Code | No | Yes |
| | L1C, L2C, L5 | No | Yes |
| Services | Modernized Signal Monitoring (OMSRE) | No | Yes |
| | Military & Civil Navigation Related Messaging | No | Yes |
| NAVWAR (Anti-jam) | Flexible power | Yes | Yes |
| | Integrated Situational Awareness | No | Yes |
| Architecture | Flexible, Scalable, Adaptable, Evolvable | No | Yes |
| | Integrity Infrastructure | No | Yes |
| | Net-Centric Migration/New Interfaces | No | Yes |
| | Modern Key Management | No | Yes |
| | Advanced Software and Architecture Standards | No | Yes |
| | Advanced Information Assurance | No | Yes |
| | Operate over 32 satellites | No | Yes |
| Performance | Navigation Solution Performance Improvement | No | Yes |
| SV Family Support | GPS IIR, IIR/M | Yes | Yes |
| | GPS IIF | Yes | Yes |
| | GPS III | No | Yes |

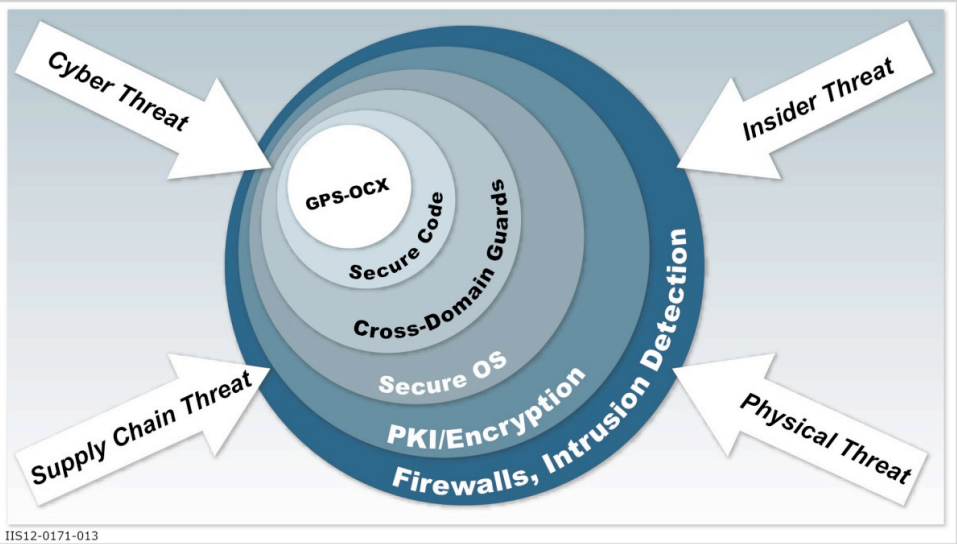


***Robust Systems Engineering Ensures Required Capabilities***

# OCX Information Assurance Features

## Defense In Depth:

- DOD 8500.2 compliance
- Insider threat protection
- Cross Domain Solutions
- Security enclaves supported by Multiple Independent Levels of Security (MILS)
- Firewalls enforce network policy and separate Mission Critical Systems
- Architecture isolates external interfaces




## Strong Information Assurance Processes:

- Secure coding standards for application development
- Robust supply-chain security controls
- Hardened COTS validated in secure closed environment

***OCX supports increased connectivity by addressing the growing IA threat***

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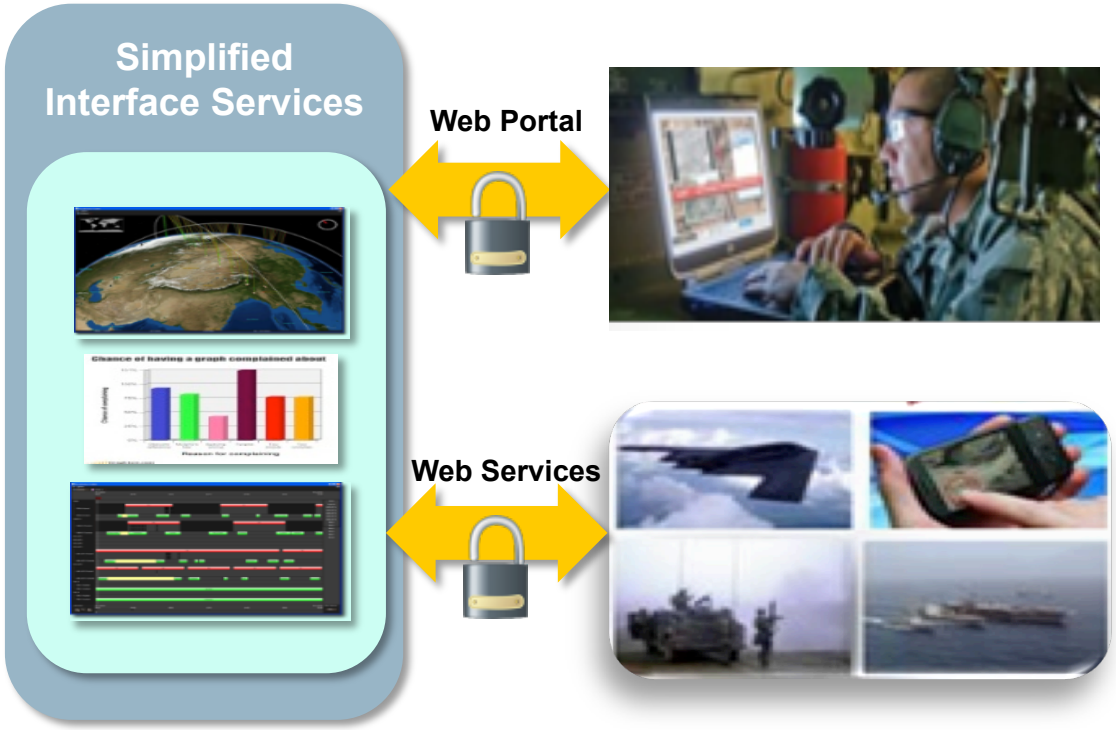
# OCX Simplified Net-Centric Interfaces

Core net-centric infrastructure delivered in Block 1




## Advantages

- Expanded user access
- Standards based interoperability
- Built in security
- Cyber threat resilience
- Easy to change
- Flexible products & applications
- Affordable

***Reduces cost, increases performance, improves user support***

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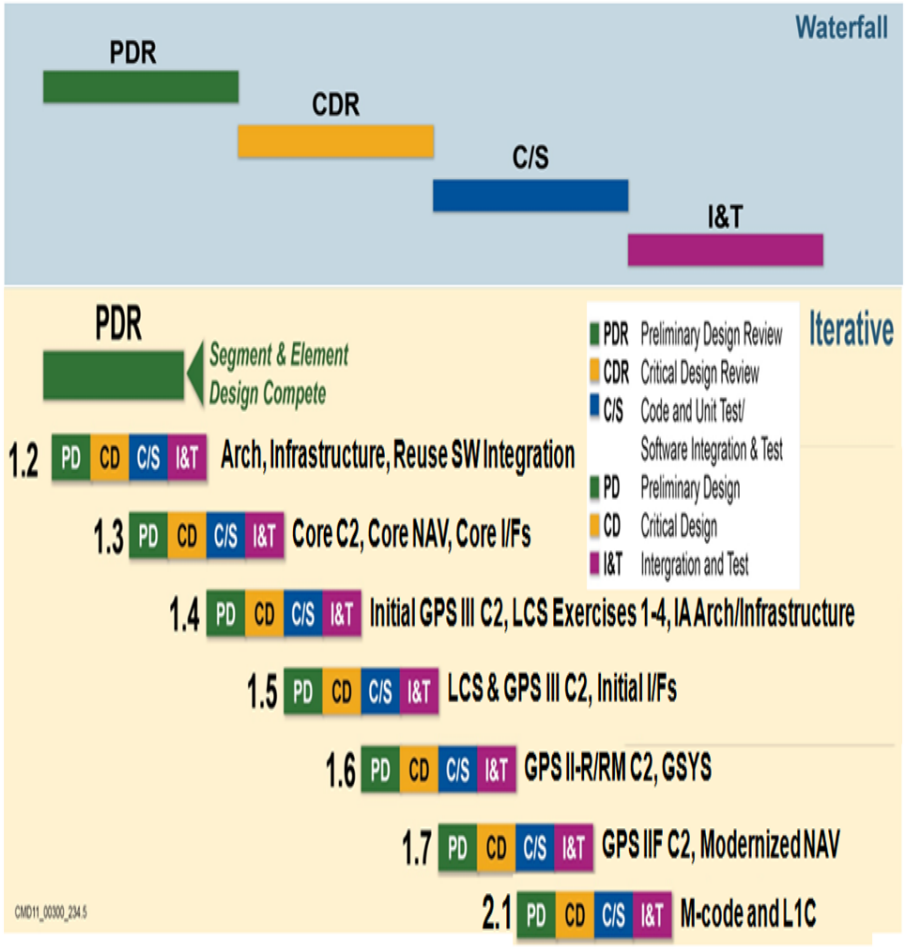
# OCX Iterative Software Development

GPS OCX employs a commercial best-practice iterative software development process that reduces risk

- Addresses infrastructure and high risk development in early iterations
- Each iteration is evaluated in depth
- Requirements satisfaction and product maturity is understood throughout development
- Lessons learned are applied to future iterations
- Enables on ramps and off ramps to address evolving mission needs

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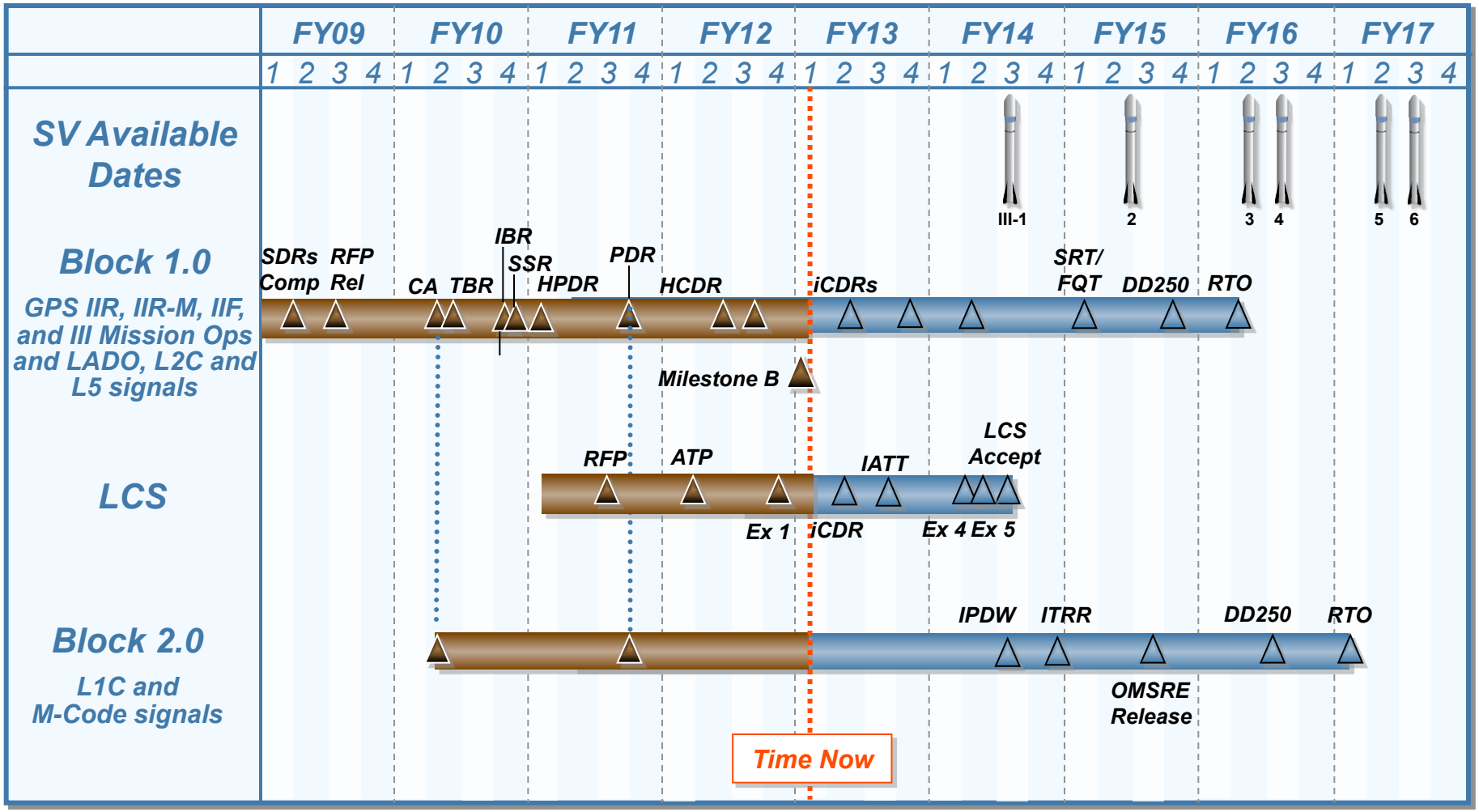
# OCX Block Development Plan

On Contract

| OCX Block | Signals Supported | RTO |
|---|---|---|
| **Block 0** – Provide GPS SV III Launch and early orbit check out capability (Launch and Checkout System (LCS)) and IA 8500.2 | | May 2014 |
| **Block 1** – Provides GPS Block IIR, IIR-M, IIF and III on-orbit capability including L2C and L5, IA 8500.2 & JAFAN full compliance, and support of existing User Equipment (backward compatibility) | L1 P(Y), L1C/A<br>L2 P(Y), L2C<br>L5 | Feb 2016 |
| **Block 2** – Provides M-code and L1C | L1 P(Y), L1C/A, L1M, L1C<br>L2 P(Y), L2C, L2M<br>L5 | Oct 2016 |

***OCX Architecture Supports Blocks 0 Through 2 Requirements***

# GPS OCX Summary Schedule

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# OCX Program Is Showing Solid Progress


- Preliminary Design Review confirmed a solid technical baseline; all KPPs and TPMs are green (Aug 2011)
- Successful exchange of command & telemetry data between OCX and GPS III satellite simulator (Feb 2012)
- Software Iteration 1.3 complete (Apr 2012)
- Software Iteration 1.4 complete (Jun 2012)
- Monitoring station receiver EMI testing complete (Jul 2012)
- Launch and Checkout System (LCS) Exercise 1 in support of first GPS III launch complete (Aug 2012)
- Iteration 1.5 for GPS III LCS tracking to schedule
- Milestone B approved (Oct 2012)

# Summary

- Raytheon is committed to delivering a robust OCX to support GPS III and future warfighter needs and is applying the full resources of the company to this critical program

- We have made program management and process changes that are reflected in improved program performance

- We continue to make significant progress and are on track to support GPS III launch readiness