# *GPS Modernization and Program Update*

## GPS Update to ION
## Southern California Chapter

***22 Feb 2011***

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**Director**
**Global Positioning Systems Directorate**

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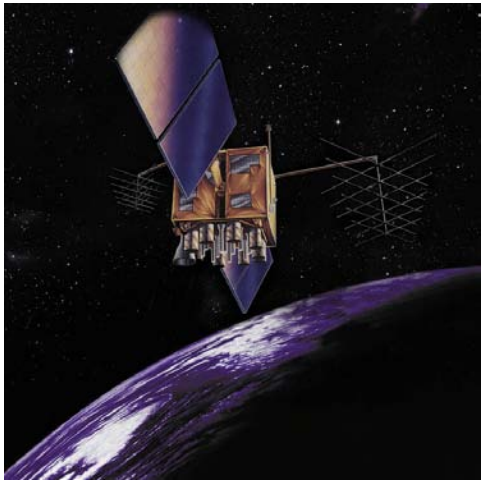
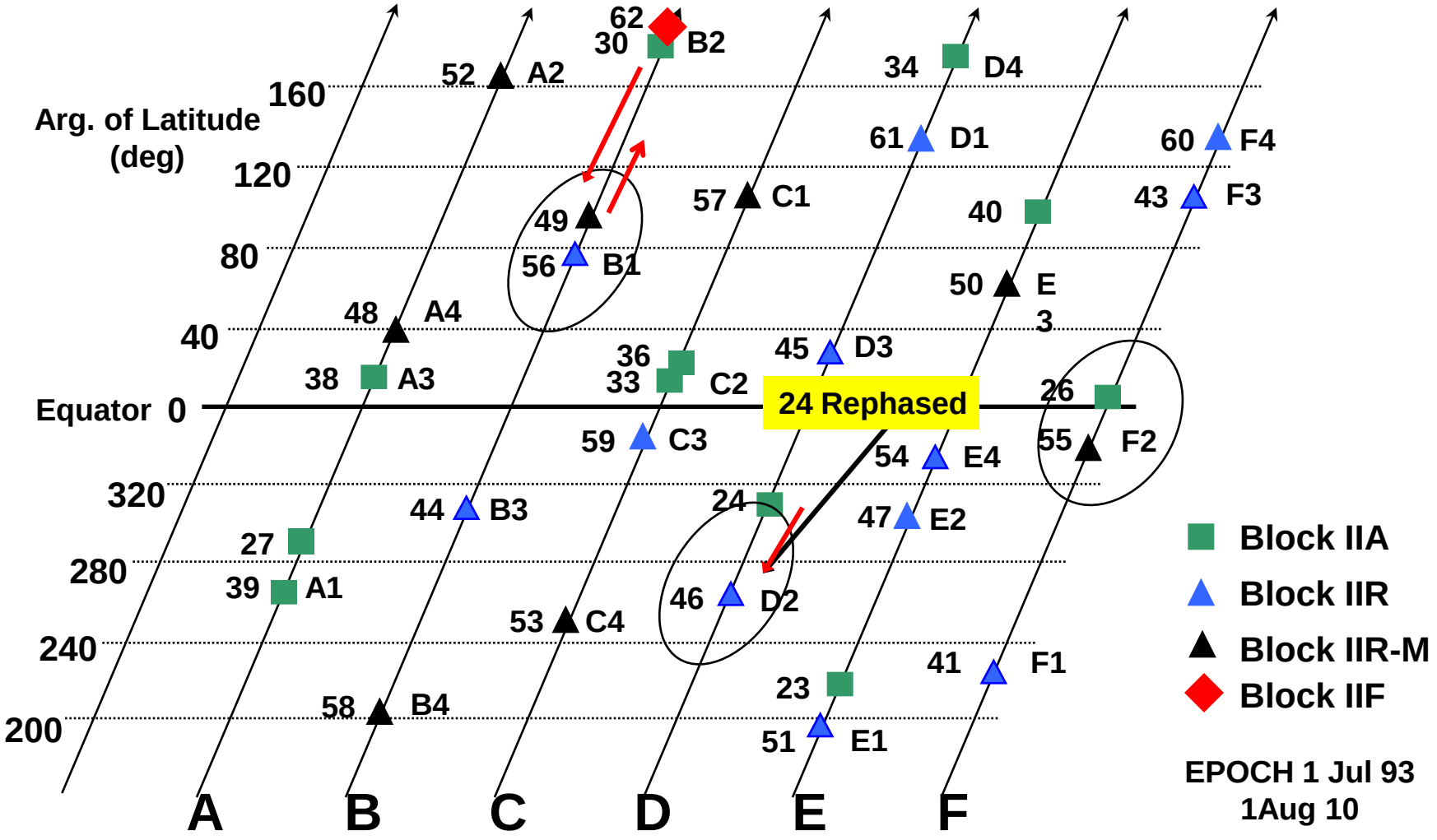
- **Current Constellation**
- **Modernization**
- **Other Improvements**

# GPS Constellation

- **Very robust constellation**
  - 31 space vehicles currently in operation
    - 11 GPS IIA
    - 12 GPS IIR
    - 7 GPS IIR-M
    - 1 GPS IIF
  - 3 additional satellites in residual status
  - 1 satellite in “test” mode – SVN 49
- **Global GPS civil service performance commitment met continuously since Dec 1993**



# Current Satellite Positions




***Expanded Constellation will be fully achieved by Jun 2011***

# Coming Up: SPS PS Update

- **Planning a draft update of the SPS PS by 1QFY11**
  - Name change to "Open Service Performance Standard" (OS PS)
  - Addition of L2C signal to current L1 C/A signal
  - Same performance values
  - Draft update will be circulated for review & comment within U.S. Government
  - SPS PS update approval before Initial Operational Capability (IOC) declaration for L2C

- **Planning subsequent draft updates for L5 signal & for L1C signal**
  - Prior to each subsequent IOC declaration

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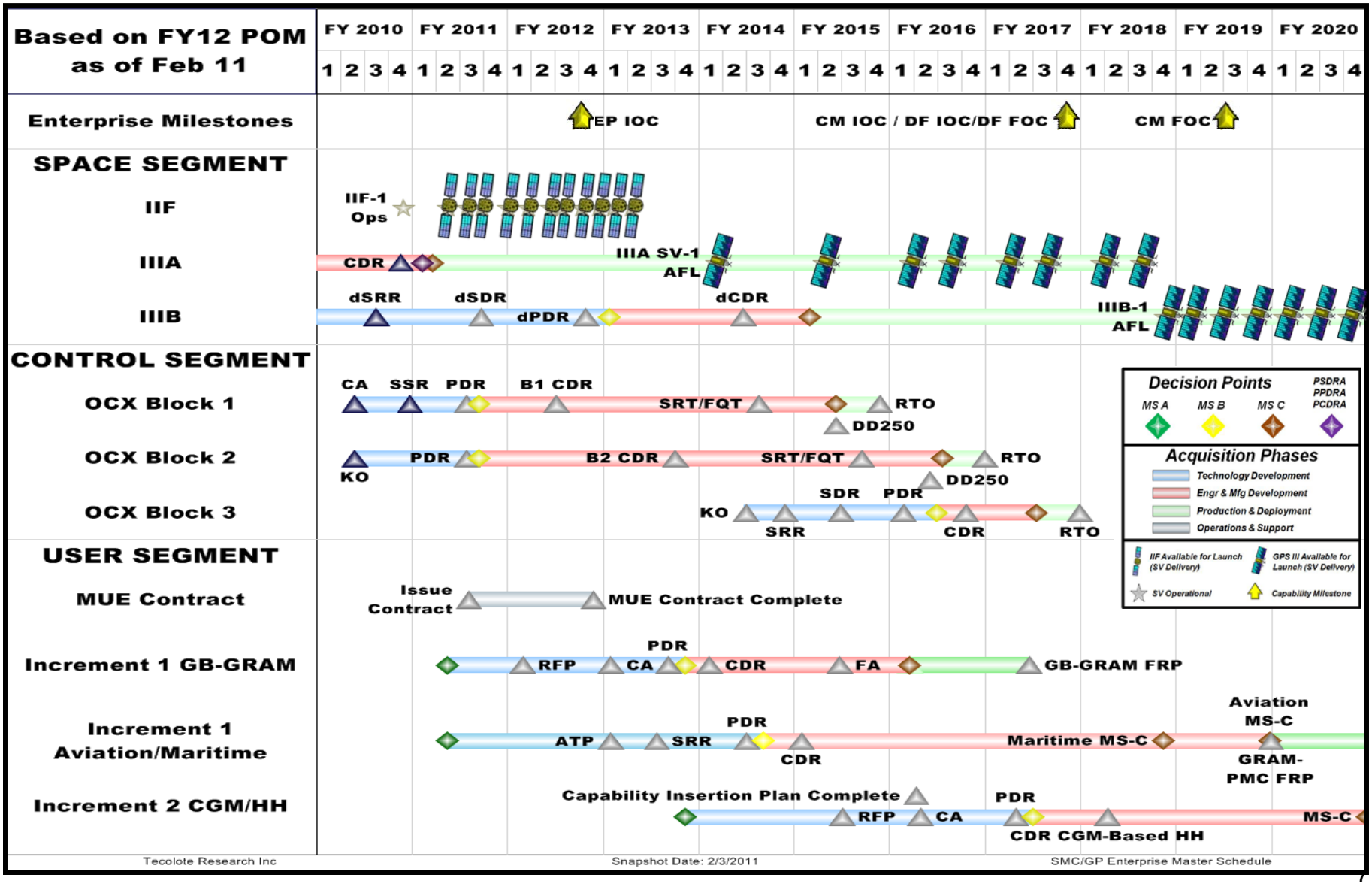
# GPS Enterprise Schedule



# GPS Modernization – New Civil Signals

- **Second civil signal "L2C"**
  - Designed to meet commercial needs
  - Available since 2005 without data message
  - Phased roll-out of CNAV message
  - Full capability:  24 satellites and full CNAV ~2016 *


- **Third civil signal "L5"**
  - Designed to meet transportation safety-of-life requirements
  - Uses Aeronautical Radio Navigation Service band
  - Available since 2010; 24 satellites and full CNAV ~2020*

- **Fourth civil signal "L1C"**
  - Designed for GNSS interoperability
  - Specification developed in cooperation with industry
  - Launches with GPS III in 2014
  - Available on 24 SVs by ~ 2026*

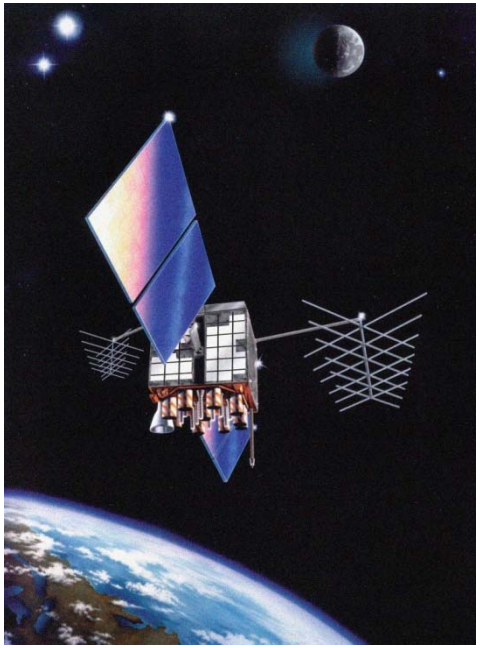
***Urban Canyons***

**Improved performance in challenged environments**

* FOC dates are based on our best guess for launch schedule

# IIR/IIR-M Satellites

- **All GPS IIR and IIR-M satellites have now been launched**
  - Current backbone of the GPS constellation
- **Excellent on-orbit performance**
  - SIS URE of .50 meters - 1 Year Performance Jul 2010
- **Excellent life expectancy**
  - Solar array capacity far exceeds specified Mean Mission Duration
  - No clock failures to date
- **Completed deployment of IIR-M**
  - L2C CNAV message type 0 capability deployed this year on IIR-M to support testing of civil UE
  - Full CNAV message with OCX



# IIF Satellites

- **Launched GPS IIF SV-1 in May 2010**
  - SVN62, PRN 25
  - Was set healthy 26 Aug 10
  - First operational L5
- **11 more IIFs in the pipeline**
  - SVs 2-5 are in production
- **IIF SV-2 launch by Summer 2011**

# GPS III

- **Newest block of GPS satellites**
  - First satellite to broadcast common L1C signal
  - Multiple civil and military signals; L1 C/A, L1 P(Y), L1M, L1C, L2C, L2 P(Y), L2M, L5
  - +10 dB earth coverage power increase on M-Code
  - Three Rubidium clocks
- **Completed Critical Design Review for Block IIIA**
  - Two months in advance
- **Completed Delta System Requirements Review for Block IIIB**
- **Conducting Analysis of Alternatives for Blocks IIIB and IIIC**
  - Revalidate requirements and associated cost/benefits

# Ground Segment

Monitor Station


Ground Antenna

- **Deployed several AEP upgrades including SAASM upgrade**
- **Conducted flex power demo with live IIR-M SVs**
- **Awarded OCX Phase B to Raytheon Feb 2010**
  - Completed Technical Baseline Review Mar 2010
  - Completed Independent Baseline Review Aug 2010
  - Completed Software Specification Review Sep 2010
  - Preliminary Design Review planned for Apr 2011
  - OCX Block I deployment planned for 2015

# User Segment

- **Delivers new set of GPS receivers to support service nominated lead platforms**
  - Support operations in a Navigation Warfare (NAVWAR) environment and countering current and emerging PNT threats
  - Upgrade GPS receivers to exploit new technologies: M-Code, Blue Force Electronic Attack (BFEA), Anti-Jam, Anti-Spoof & Anti-Tamper
  - Prevent PNT service disruptions due to non-compliance
- **Common GPS Module (CGM) proposed to meet long-term needs of DoD GPS users & authorized foreign allies**
- **Modernized User Equipment (MUE)**
  - Prototype GB-GRAM-M receiver deliveries completed 1QFY11
  - Undergoing independent Govt testing. Est. Completion ~4QFY11
- **Military GPS User Equipment (MGUE)**
  - Entering Technology Development Phase leveraging the success and achievements of MUE
  - Technical Requirement Document (TRD) anticipated CCB ~ 2QFY11
  - Targeting MGUE RFP release 1QFY12

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# *Flex Power*

- **Modernized GPS SVs have Flex Power capabilities**
  - Can shift power between M-Code, P(Y) code and C/A code
- **Previous on-orbit testing conducted in 2005 and 2007**
- **Conducted extensive on-orbit Flex Power test Sep 7-11, 2010**
  - Turned on Flex Power for 8 IIR-M satellites
- **Identified two issues**
  - Canadian Differential GPS Service - planned for decommissioning NLT Mar 2011
  - FAA integrity monitors gave false positives – mitigations being developed
- **Developing Flex Power Concept of Operations (CONOPS)**

# Capability Deployment

- **GPS receiver anomalies were reported several times this year coinciding with testing activities**
  - Almanac problem in Nov 2009, SAASM problem in Jan 2010, etc.
- **Problems were traced to non-compliant UE**
  - Unauthorized use of reserved bits, incorrect assumption on almanac time, incorrect implementation/interpretation of a security function
- **Problems mitigated by working extensively with UE vendors to fix non-compliance issues**
- **Undertaking improvements in deployment method and certification paradigm**

***Smooth Deployment of New Capabilities Key to Modernization***

# New Transition and Certification Paradigms

- **Instituting methodical capability transition process**
  - Carefully planned transition event testing
  - Extensive participation by representative users and applications
  - Identification of potential issues prior to capability deployment

- **Improvements in compliance verification are being put in place**
  - Exploring Underwriters Laboratories construct for independent certification of ICD compliance and associated testing

- **Seeking feedback from user community on transition approaches and compliance verification**

***ICD Compliance is Critical for GNSS Success***

# PRN Expansion

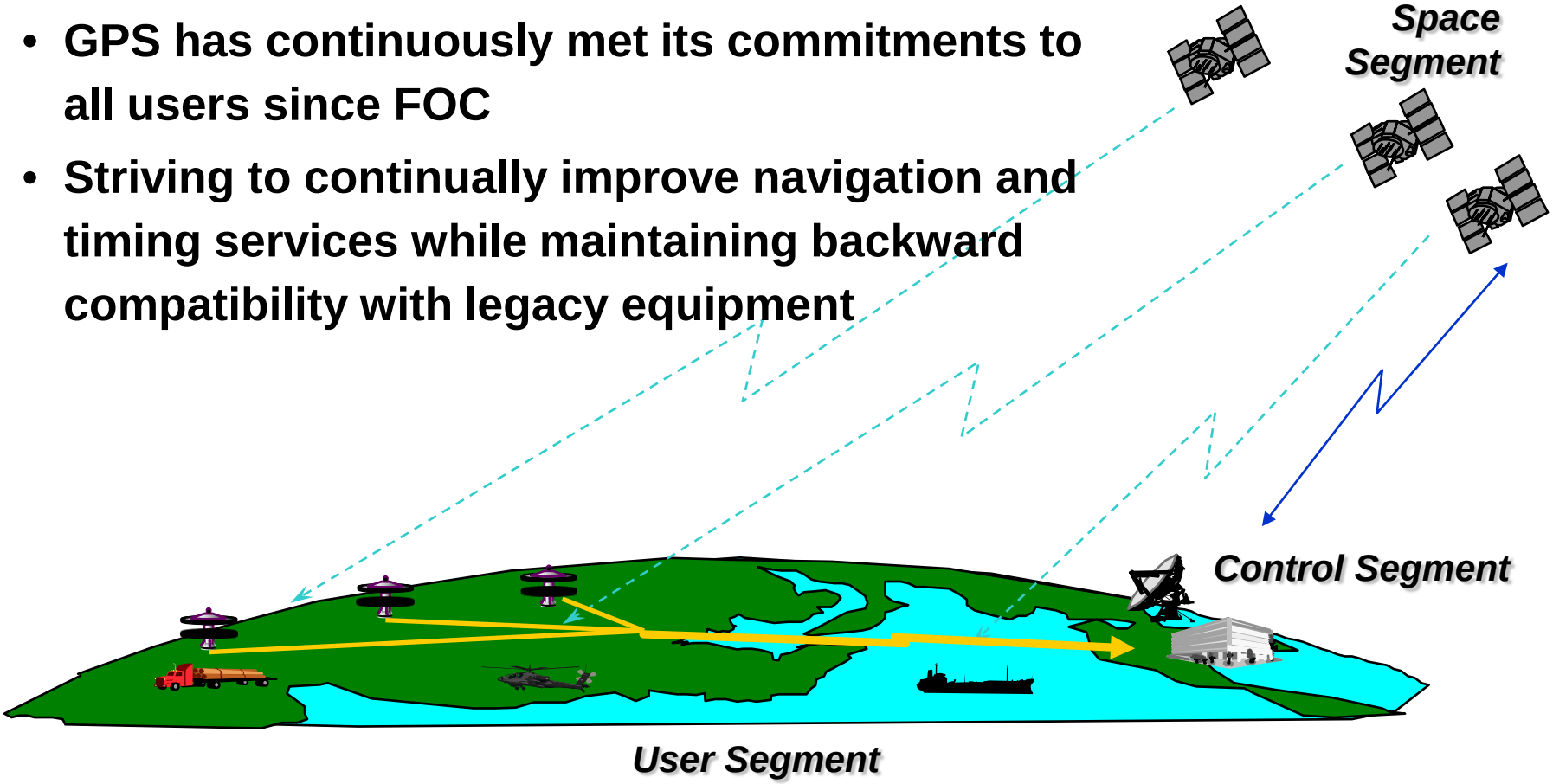
- **Control segment is currently limited to 32 PRNs, limitation removed with OCX**
- **Legacy UE are limited to 32 satellites**
- **Current constellation has 31 operational satellites and 3 residual non-operational satellites**
- **63 sets of L1 C/A, L2C, L5, and L1C codes have been defined**
- **Developing CONOPS and ICD changes to exploit additional PRN capability while remaining backward compatible with legacy UE**
  - Proposing to assign higher PRNs to the worse performing satellites
  - Soliciting feedback from user community

# Metrics

- **Developing an updated set of performance metrics**
  - Include different user applications and terrain environments
- **Need to shift away from just counting satellites in the sky**
  - 95% probability of 24 satellites anywhere in the constellation
- **Goal is to identify a short list of most meaningful metrics and report on them regularly**
  - Cover the big five, i.e. Availability, Accuracy, Bounded inaccuracy, Integrity, Interference (inadvertent or malicious)
  - Cover key user applications
- **Challenge is representing the metrics in terms of effect on users/application**

# Summary

- **Modernization of all GPS Segments is on track**
- **GPS has continuously met its commitments to all users since FOC**
- **Striving to continually improve navigation and timing services while maintaining backward compatibility with legacy equipment**




***Maintaining And Improving GPS Services For All Users Is Job #1***