Overview

• PNT Architecture Background
• Architecture Development
• Guiding Principles
• Draft “Should Be” Architecture
PNT Architecture Background

• Study requested by
  – Assistant Secretary of Defense for Networks and Information Integration
  – Under Secretary of Transportation for Policy
  – National Space-based PNT Executive Committee

• Justification - PNT Strategic Landscape is Changing
  – Gaps in current capabilities
  – Insufficient unity of effort towards future PNT capabilities

• Products
  – 20 year strategic outlook to guide near and mid-term decisions on PNT capabilities
# National PNT Architecture Scope

## USERS
- Military
- Homeland Security
- Civil
- Commercial

## DOMAIN
- Space
- Air
- Surface
- Sub-Surface

## MISSIONS
- Location Based Services
- Tracking
- Survey
- Scientific
- Recreation
- Transportation
- Machine Control
- Agriculture
- Weapons
- Orientation
- Communications and Timing

## SOURCES
- GNSS
- GNSS Augmentation
- Terrestrial NAVAIDS
- Onboard / User Equip Networks

## PROVIDERS
- Military
- Civil
- Commercial
- International

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Broad Scope Requires Innovative Approaches and Focused Analysis Efforts
PNT Architecture Stakeholders

- Dept of Defense / Networks and Information Integration
- Dept of Transportation / RITA
- Dept of Commerce
- Dept of Homeland Security
- Dept of State
- NASA
- National Coordination Office for Space-Based PNT
- Dept of Transportation / FAA
- Dept of Transportation / FHWA
- Dept of Transportation / FRA
- Department of Interior / USGS
- National Security Agency
- National Geospatial-Intelligence Agency
- US Army
- US Navy
- US Air Force
- US Marine Corps
- US Coast Guard
- US Strategic Command
- Joint Staff
- Air Force Space Command
- Space & Missile Systems Center
- Dept of Defense / S&T
- US Naval Observatory
- National Institute of Standards and Technology
- Joint Planning Development Office
- Policy Board on Federal Aviation
Cumulative Process

**Data Gathering**
- Needs & Gaps

**Environment, Technology & Evolved Baseline**

**Concept Development**
- Trade Space, Features & Architectures
- Community Involvement
  - Architecture Development Team, Subject Matter Experts, Small Working Groups & Industry

**Analysis & Assessment**
- Analytical Framework
Primary PNT Gaps

• Gaps primarily drawn from military’s PNT Joint Capabilities Document, with additions and modifications from parallel civil community documents and discussions
  – Physically Impeded Environments
  – Electromagnetically Impeded Environments
  – Higher accuracy with integrity
  – Notification of Hazardously Misleading Info (Integrity)
  – High Altitude/Space Position and Orientation
  – Geospatial information - access to improved GIS data (regarding intended path of travel)
  – Insufficient modeling capability
PNT User Perspectives (2025)

Framework to describe user needs & environments, and which users are affected by each capability gap
Primary Objective of the Architecture

“…provide more effective and efficient PNT capabilities focused on the 2025 timeframe and an evolutionary path for government provided systems and services.” – Terms of Reference

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Capability

System Emphasis

Architecture Emphasis

As-Is Architecture

Near & Mid Term Decisions Guided by Architecture

Based on Long Term Vision

Without Enterprise Architecture Strategy

Evolved Baseline (EBL)

Should-Be Architecture

Now 5 Years 10 Years 15 Years 20 Years

…provide more effective and efficient PNT capabilities focused on the 2025 timeframe and an evolutionary path for government provided systems and services.” – Terms of Reference
Status of PNT Architecture Effort

• Proposed National PNT Architecture recommendations presented to National PNT Architecture Decision Coordination Group on 14 Aug 2007
• Study sponsors support recommendations in principle
• National Coordination Office for Space-Based PNT requested to coordinate an Executive Steering Group review of architecture recommendations
• Review and comment resolution in progress
Guiding Principles

**VISION**
US Leadership in Global PNT

**STRATEGY**
Greater Common Denominator

**PRIMARY VECTOR**
- Multiple Phenomenologies
- Interchangeable Solutions

**SUPPORTING VECTOR**
- Fusion of PNT with Communications
- Cooperative Organizational Structures
National PNT Architecture Vision

US Leadership in Global PNT

- Embrace & expand upon the US Space-Based PNT Policy
- Efficiently (cost, schedule, acceptable risks, user impact) develop and field the best technologies and systems
- Promulgate stable policies (commitment to funding, commitment to performance, advanced notice of change, etc)
- Foster innovation through commercial competition
- Ensure robust and enduring inter-agency coordination and cooperation
- Maximize the practical use of military, civil, commercial and foreign systems and technologies
- Judiciously develop and apply standards and best practices
National PNT Architecture Strategy

The US can Best Achieve Efficiency and Effectiveness through a Greater Common Denominator Approach

- Satisfy common needs with common solutions
- Predominantly a “dependent” architecture where users rely upon external sources
- Leverage ongoing US GNSS modernization to assure global service and support national interests
- Promote wide adoption of low-burden “autonomous” features for robustness
- Specialized needs still require specialized solutions
- Balance provided or enabled capabilities with the need for a military PNT advantage
High Level Vectors

- Use Multiple Phenomenologies to the Maximum Extent Practical to Ensure Robust Availability
- Strive for Interchangeable Solutions to Enhance Efficiency and Exploit Source Diversity
- Pursue Fusion of PNT with New and Evolving Communications Capabilities
- Promote Interagency Coordination & Cooperation to Ensure the Necessary levels of Information Sharing
“Should-Be” PNT Architecture (2025)

ENABLERS & INFRASTRUCTURE

- Standards
- Reference Frames
- Crypto
- Science & Technology
- USNO
- NIST
- NGA
- NGS

- Star Catalogs
- Launch
- Modeling
- Mapping/Charting/Geodesy
- Laser Ranging Network
- NSA
- Industrial Base
- Policies

- Electro Optical Info.
- Clocks
- Sensors & Sensor Aiding
- Inertial
- Weather
- Geo-political

- Spectra
- Interference
- Environment
- Demographics
- Geopolitical
- Fiscal

- Space Comm & Nav Arch
- GPS
- SATCOM
- Aiding Data & Ranging Signals
- Foreign GNSS

- Wireless Networks
- Tracking
- Commercial Augmentations
- Evolved GNSS Augmentation
- Cell Phone Networks

- Geospatial Data
- Pseudolites & Beacons

- PNT signal monitoring
- User Interface Orgs
- PNT User Equipment

- Autonomous

Cooperative Organizational Structures

Fusion of PNT with Communications

Multiple Phenomenologies
Next Steps

• Complete National Space-based PNT Executive Steering Group (ESG) review of PNT Architecture recommendations

• Sponsors (Asst Sec Def for Networks and Info Integration and Under Sec of Transportation for Policy) review and approve National PNT Architecture recommendations in an Architecture Decision Memorandum

• Workshop to Obtain Public Feedback on Recommendations

• NSSO, RITA & NII oversee development of detailed transition and implementation planning

• Architecture Implementation Memorandum
  – Approved event-based implementation timeline
  – Coordinate through Decision Coordination Group members and co-sponsors as appropriate

• Influence update to PNT planning documents
  – Federal Radionavigation Plan
  – Five-Year National Space-Based PNT Plan
Points of Contact

• Karen Van Dyke
  – DOT/RITA/Volpe Center
  – vandyke@volpe.dot.gov
  – 617-494-2432

• Lieutenant Commander Jeff Vicario
  – NSSO
  – jeff.vicario@osd.mil
  – nsso.pnt@osd.mil
  – 571-432-1535

Acknowledgement of additional co-authors:
CAPT Milton Abner, NSSO
CAPT James Dalberg, NSSO
Lt Col Shawn Brennan, NSSO
Lt Col John Maguire, NSSO
CDR Ed Kneller, NSSO
CDR Eric Watkiss, NSSO
Jules McNeff, OSD/NII
Kent Hyatt, OSD/NII

John Anton, NSSO
Jennifer Buchanan, NSSO
Michael David, NSSO
John Emilian, NSSO
Paul Popejoy, NSSO
David Schoonenberg, NSSO
James Wentworth, NSSO
Mary Zappi, NSSO

A copy of this brief will be posted at http://www.acq.osd.mil/nsso/pnt/pnt.htm as well as on CGSIC meeting website
BACKUP SLIDES
AVAILABLE FOR PRESENTATION
USE ONLY IF NEEDED
Related Efforts & Upcoming Decisions

- **Recent & Upcoming Decisions**
  - Future of eLORAN
  - Future of NDGPS and High Accuracy NDGPS
  - Backup SATNAV Tasking
  - Backup PNT Needs (ADS-B, NGATS, Timing Infrastructure)
  - GPS III and OCX Acquisition Strategies

**National PNT Architecture**

- **DOT and FAA**
  - Aviation Navigation Evolution Roadmap

- **National Coordination Office for Space-Based PNT**
  - 5-Year Plan & Assessment
  - Alternate Financing Study

- **USSTRATCOM**
  - PNT Joint Capabilities Document
  - PNT Functional Solutions Analysis

- **DOD**
  - DOD PNT S&T Roadmap update

- **Rand**
  - Ensuring Effective PNT

- **NSSO**
  - NSS Program Assessment
  - NSS Plan

- **Joint Planning & Development Office**
  - Next Generation Air Transportation System
"As-Is" PNT Architecture (2007)

Standards
Reference Frames
Star Catalogs
Electro Optical Info.

ENABLERs & INFRASTRUCTURE

Investigation
Synthesis
Testing

Security
Weather
Geo-political
Fiscal

Navwar
Spectrum
Interference

Environment

Comprehensive
Weather

Geo-political

USNO
NIST
NGA
NGS

User Interface Orgs
Clocks

Navnet
Launch

Testing

Inertial

Requirements
Mapping/Charting/Geodesy

Policy

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Intelligence Agency (NGA), 2007.

Beacons

User Interface Orgs

Navnet
Launch

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Policy

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Industry Day Participants (Sep-Oct 06)

- On-Grid
- Analytical Graphics Incorporated
- Oak Ridge National Labs
- Boeing Commercial Aircraft
- Lockheed Martin IS&S
- Jet Propulsion Lab
- Boeing Phantom Works

- Advanced Navigation & Positioning Corporation
- NavComTech
- OmniStar
- SiRF
- AeroAstro
- NAVSYS Corp
- Viasat
- Advanced Research Corporation
- USGIC

- Boeing Navigation & Communication Systems
- Honeywell
- Booz Allen Hamilton
- International Loran Association
- Rockwell Collins
- AFRL – AFIT ANT
- Penn State ARL
- Raytheon
- A-B-Sea Research
PNT Architecture Workshop at Volpe
26 April 07, DOT Volpe Center

- Institute of Navigation
- GPS World Magazine
- Boeing
- Booz Allen Hamilton
- Giftet Inc.
- OnGrid
- GPS Industry Council
- NavComTech
- Rockwell Collins
- LMCO
- Alion Science & Technology
- Advanced Research Corp
- Omnistar
- Megapulse

- Ohio University
- Chungnam National University
- NIST
- STRATCOM
- USCG C2CEN
- Navy JPALS Team
- DOT/FHWA
- Oak Ridge National Lab
- MITRE
- DoD (Retired)
- FAA

- GPS World review
  http://sidt.gpsworld.com/gpssidt/article/articleDetail.jsp?id=422965
Three Themes (Hybrid Architectures)

Hybrid A
- Common solutions for many users
- Horizontal integration
- Greatest common denominator
- Emphasis on global and long range broadcasts direct to users

Hybrid B
- Common solutions for many users
- Horizontal integration
- Greatest common denominator
- Emphasis on networks

Hybrid C
- Specialized solutions for each user group
- Vertical integration
- Least common denominator
- Emphasis on autonomous solutions