National Positioning Navigation and Timing Architecture Update
Civil GPS Service Interface Committee Meeting

Presented by James Doherty

Karen Van Dyke, DOT/RITA/Volpe Center

LCDR Jeff Vicario, National Security Space Office

Originally presented 24 September 2007

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	DOMAIN	MISSIONS	SOURCES	PROVIDERS
Military Homeland Security Civil Commercial	Space Air Surface Sub-Surface	Location Based Services Tracking Survey Scientific Recreation Transportation Machine Control Agriculture Weapons Orientation Communications and Timing	GNSS GNSS Augmentation Terrestrial NAVAIDS Onboard / User Equip Networks	Military Civil Commercial International

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
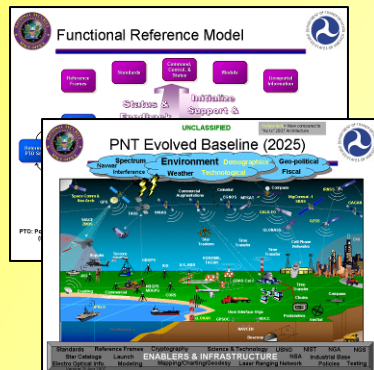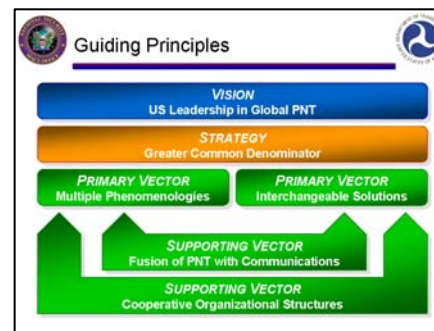- Policy Board on Federal Aviation

Cumulative Process

Data Gathering
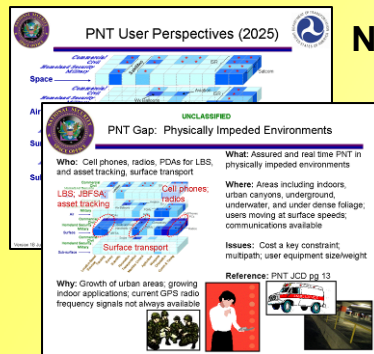
Needs & Gaps
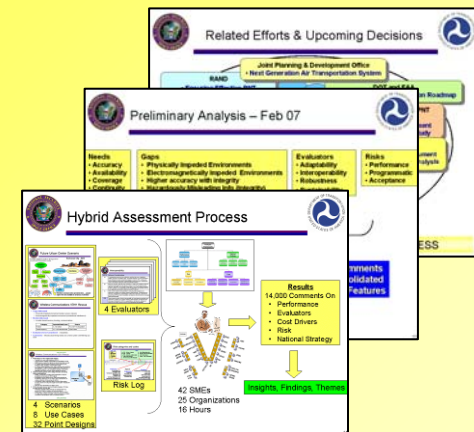
Environment, Technology & Evolved Baseline

Concept Development

Trade Space, Features & Architectures

Analysis & Assessment

Analytical Framework
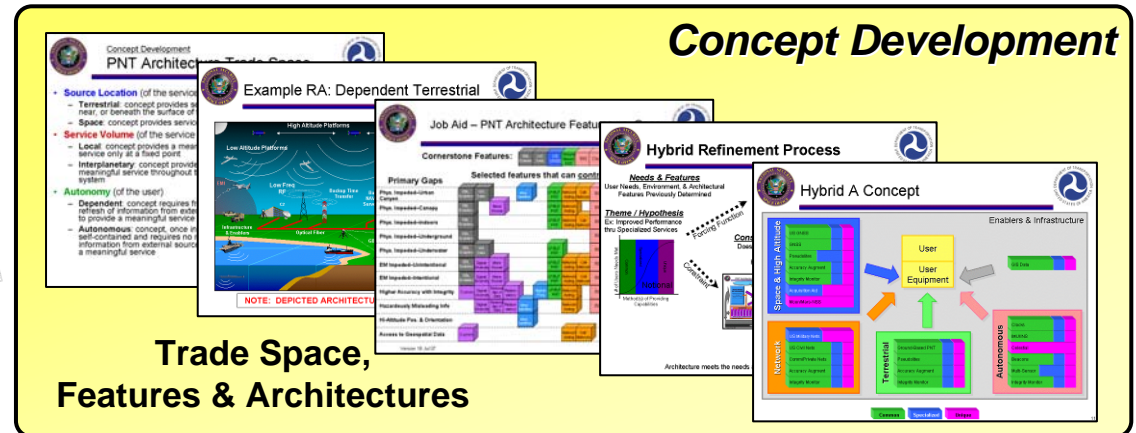
Community Involvement

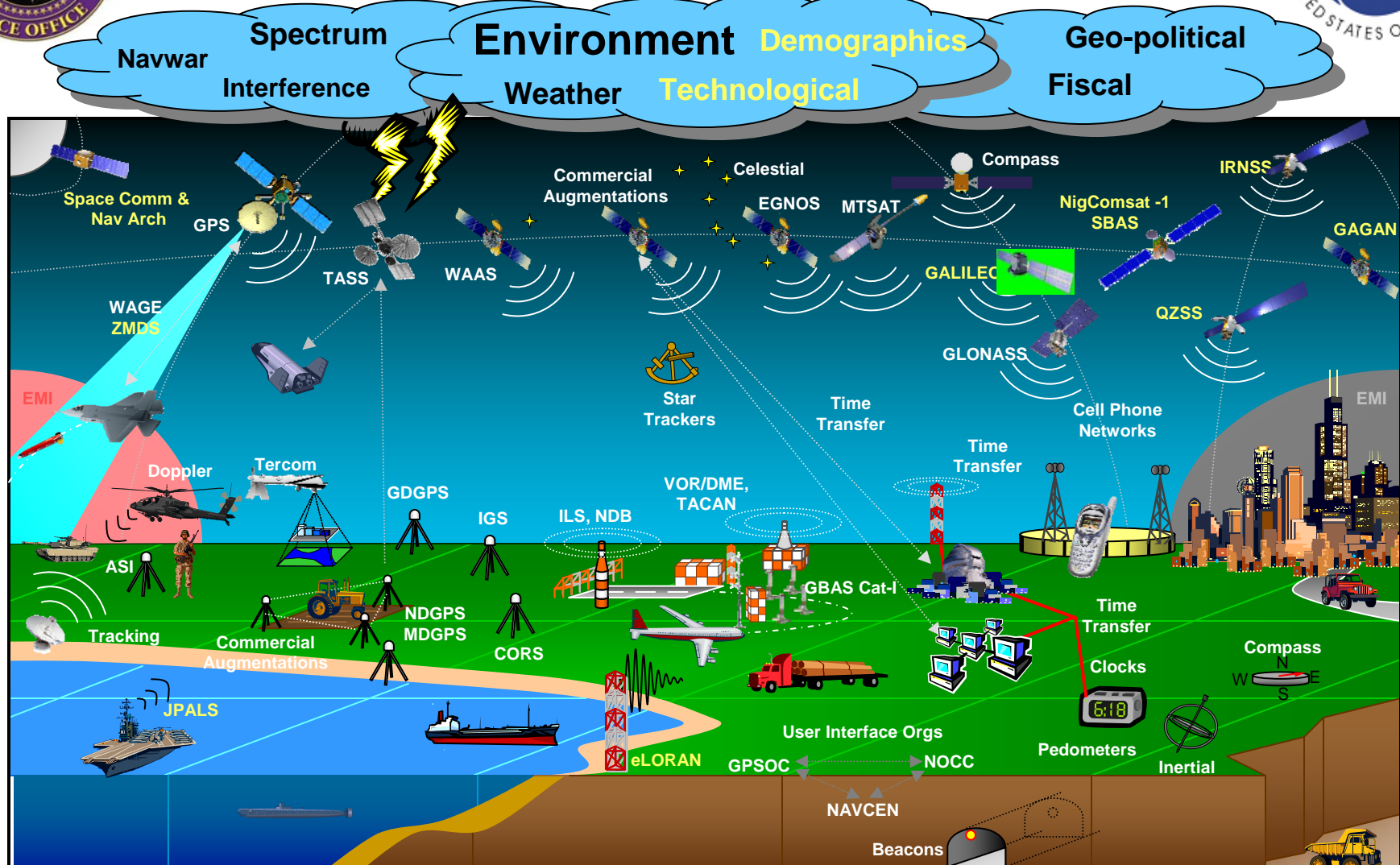Architecture Development Team, Subject Matter Experts, Small Working Groups & Industry

Yellow font = New compared to "As Is" 2007 Architecture

PNT Evolved Baseline (2025)

Spectrum **Environment** **Demographics** **Geo-political**

Navwar **Interference** **Weather** **Technological** **Fiscal**

Compass

Celestial

Commercial Augmentations

IRNSS

Space Comm & Nav Arch

GPS

EGNOS MTSAT

NigComsat -1 SBAS

GAGAN

GALILEO

TASS

WAAS

WAGE ZMDS

QZSS

GLONASS

EMI

Star Trackers

Time Transfer

Cell Phone Networks

EMI

Doppler

Tercom

GDGPS

Time Transfer

VOR/DME, TACAN

ILS, NDB

IGS

ASI

GBAS Cat-I

Tracking

Commercial Augmentations

NDGPS MDGPS

CORS

Compass

Time Transfer

Clocks

JPALS

User Interface Orgs

eLORAN GPSOC NOCC

Pedometers

Inertial

NAVCEN

Beacons

Standards **Reference Frames** **Cryptography** **Science & Technology** **USNO** **NIST** **NGA** **NGS**

Star Catalogs **Launch** **ENABLERS & INFRASTRUCTURE** **NSA** **Industrial Base**

Electro Optical Info. **Modeling** **Mapping/Charting/Geodesy** **Laser Ranging Network** **Policies** **Testing**

Version 21 Aug 2007

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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
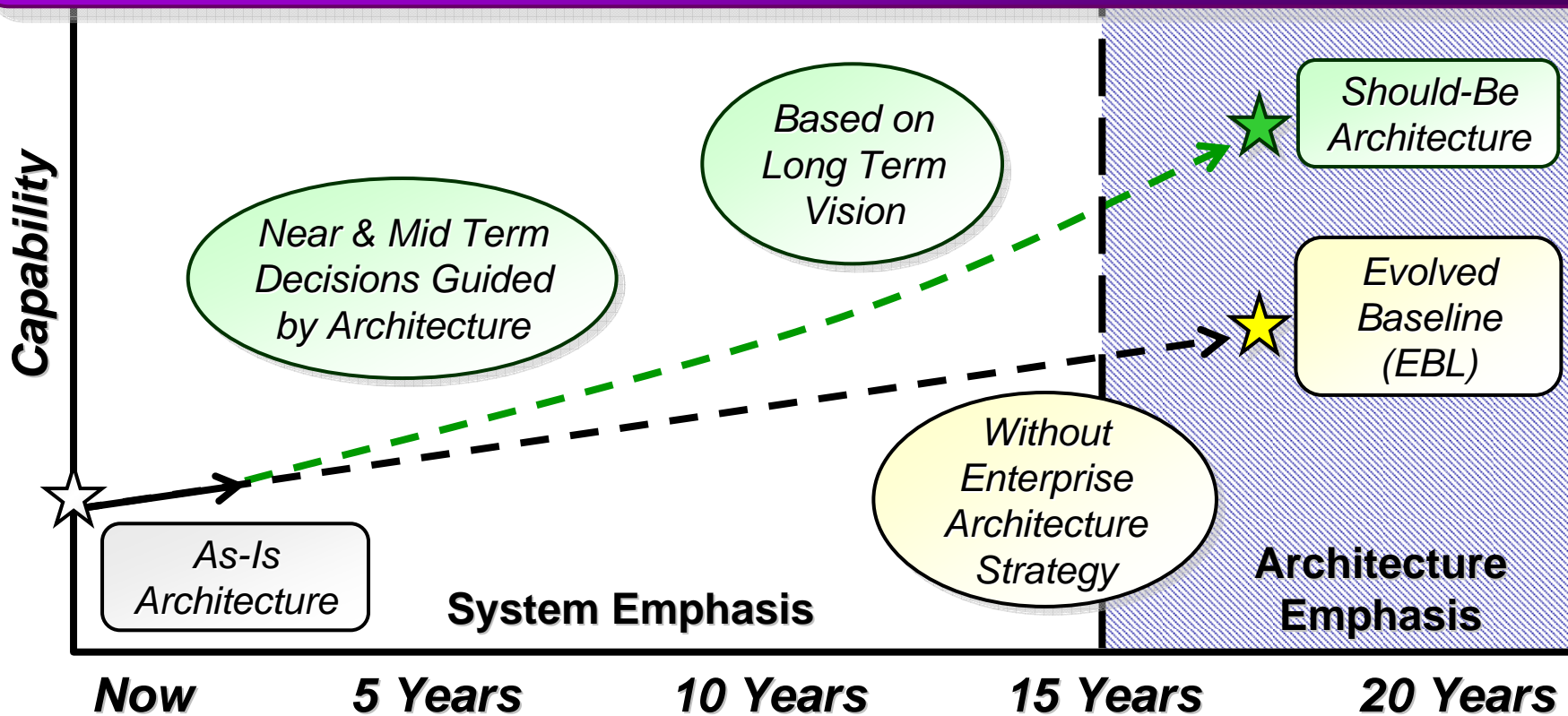
PNT User Perspectives (2025)
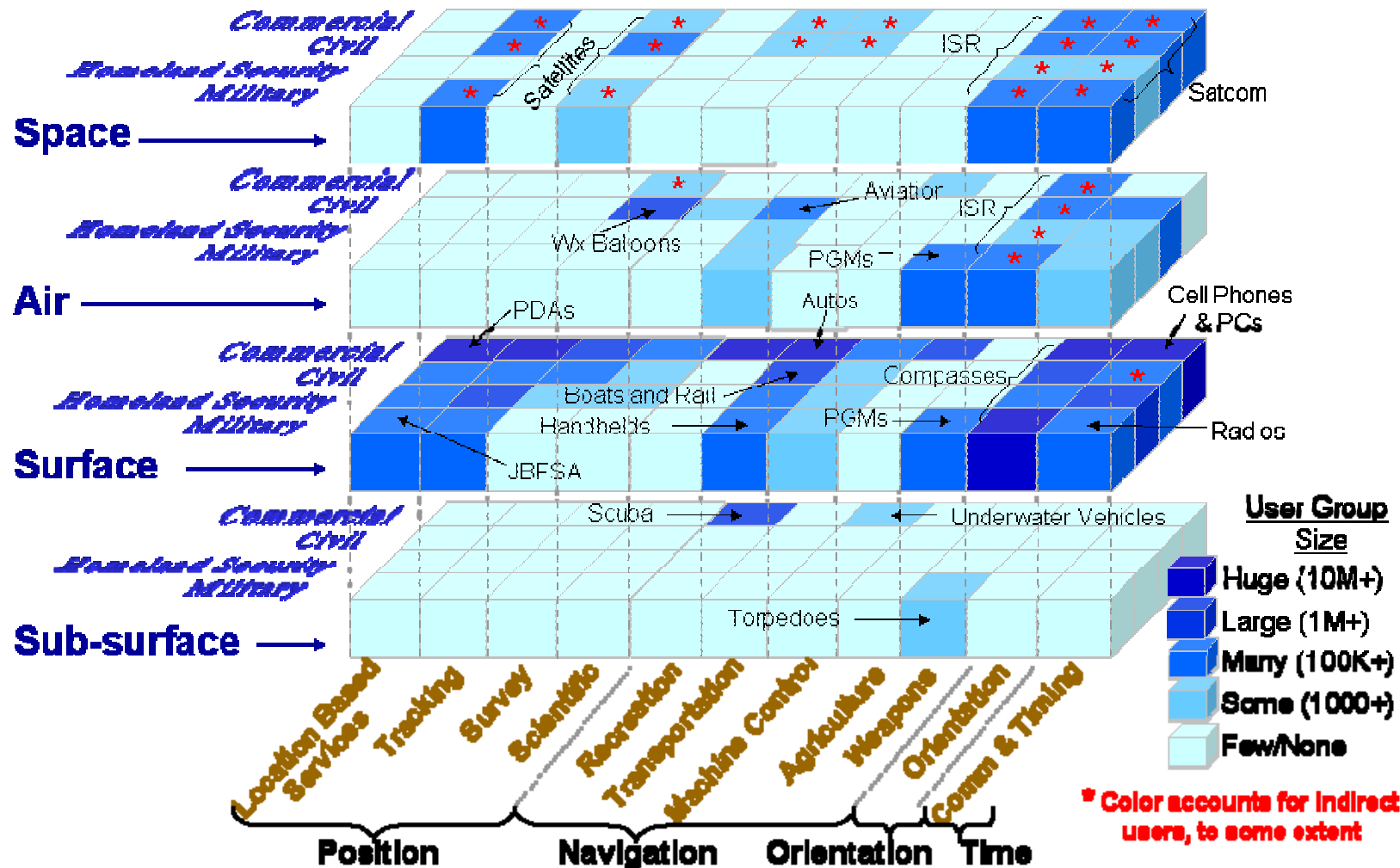
Framework to describe user needs & environments, and which users are affected by each capability gap

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

Capability

Should-Be Architecture

Based on Long Term Vision

Near & Mid Term Decisions Guided by Architecture

Evolved Baseline (EBL)

Without Enterprise Architecture Strategy

As-Is Architecture

System Emphasis

Architecture Emphasis

Now   5 Years   10 Years   15 Years   20 Years

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

PRIMARY VECTOR
Interchangeable Solutions

SUPPORTING VECTOR
Fusion of PNT with Communications

SUPPORTING VECTOR
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

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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
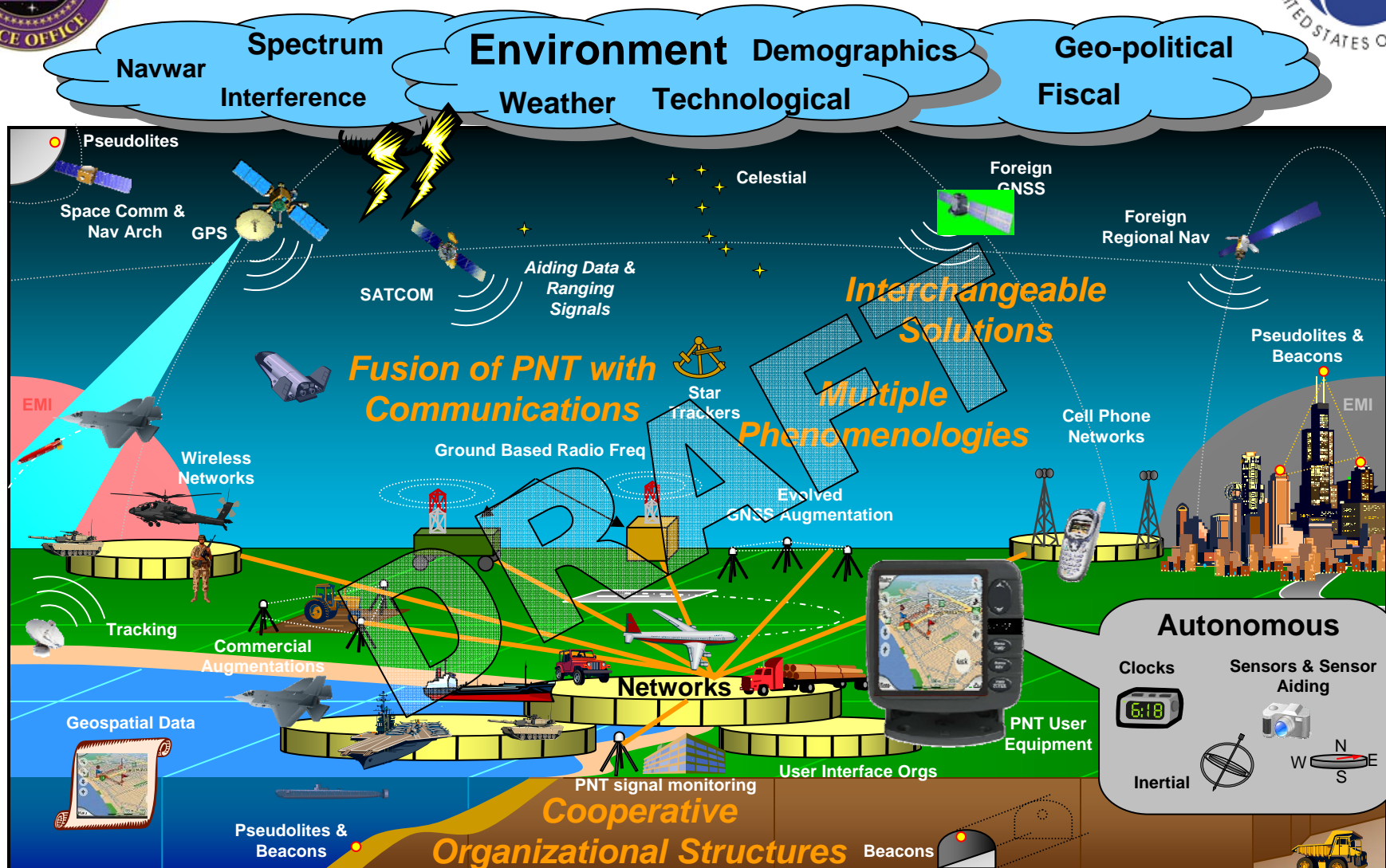Maximum Extent Practical to Ensure Robust Availability**

**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)

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

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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
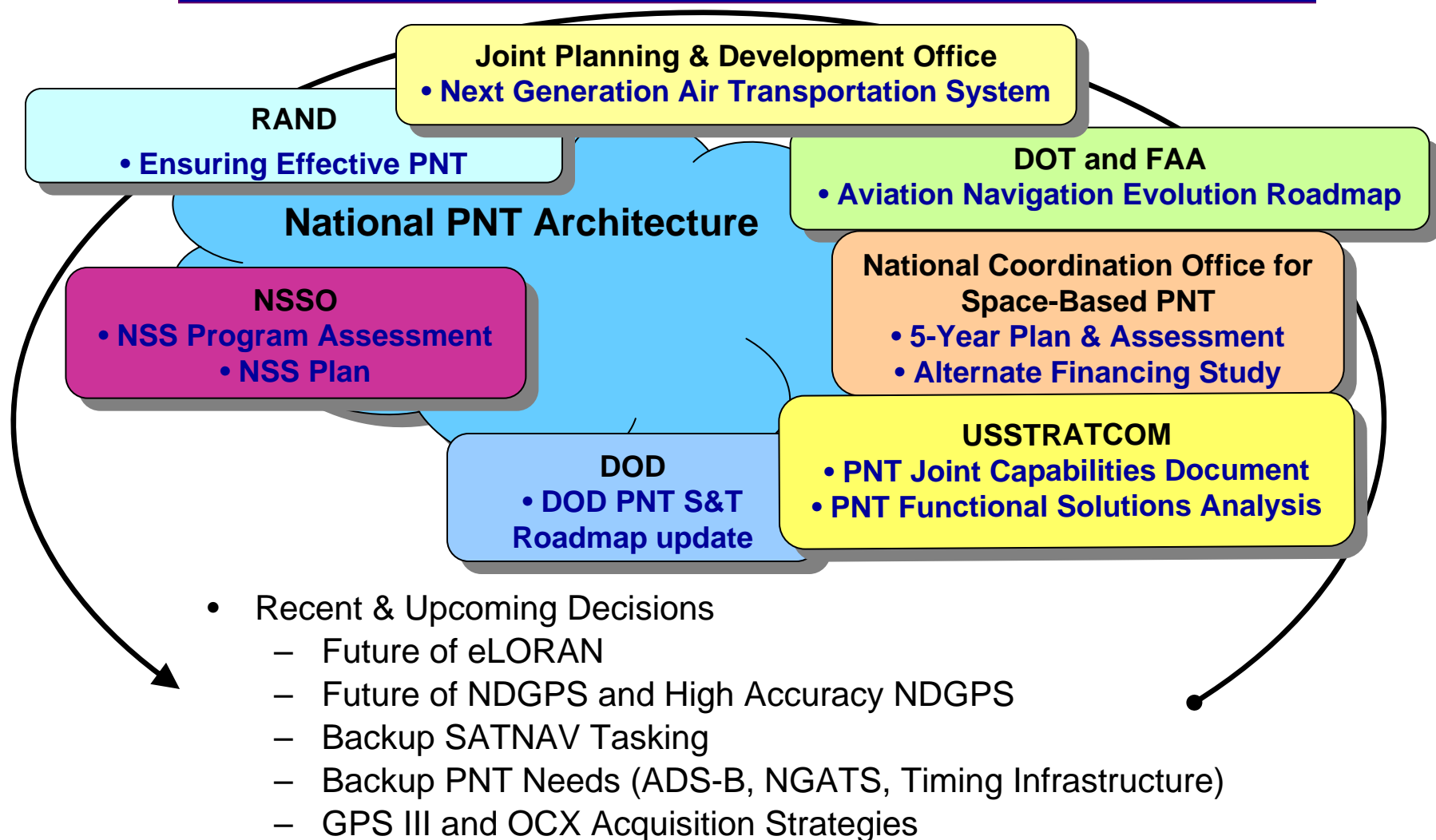
BACKUP SLIDES

AVAILABLE FOR PRESENTATION

USE ONLY IF NEEDED

Related Efforts & Upcoming Decisions

Joint Planning & Development Office
- Next Generation Air Transportation System

RAND
- Ensuring Effective PNT

National PNT Architecture

DOT and FAA
- Aviation Navigation Evolution Roadmap

NSSO
- NSS Program Assessment
- NSS Plan

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

DOD
- DOD PNT S&T Roadmap update

USSTRATCOM
- PNT Joint Capabilities Document
- PNT Functional Solutions Analysis

- 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

MAINTAIN SHARED SITUATIONAL AWARENESS

"As-Is" PNT Architecture (2007)

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
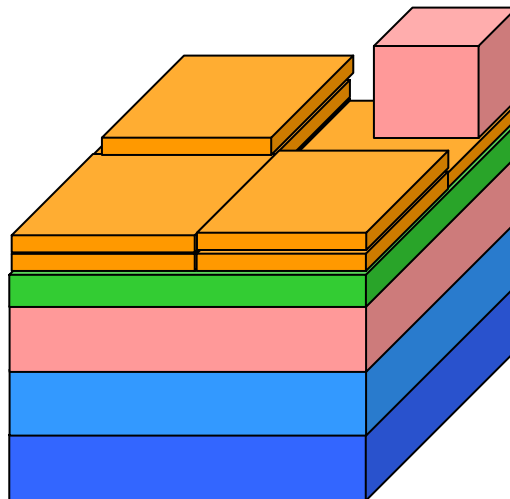
Three Themes (Hybrid Architectures)

Hybrid A

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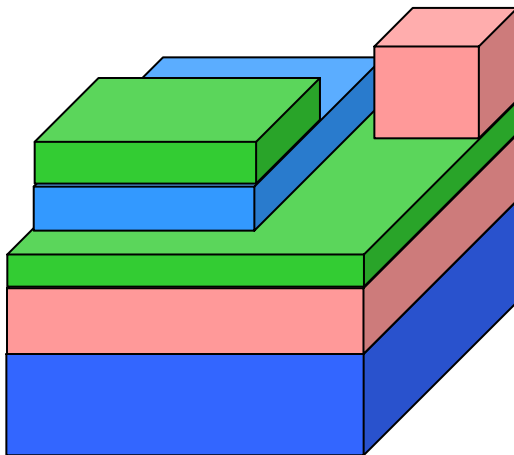
Hybrid B

- 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