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National Security Space Office

National Positioning, Navigation, and Timing Architecture

American Institute of Aeronautics and Astronautics

Space 2008

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Overview

- PNT Architecture Background
- Architecture Development
- Guiding Principles
- Recommendations
- Next Steps



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
- Status: Released on June 18, 2008



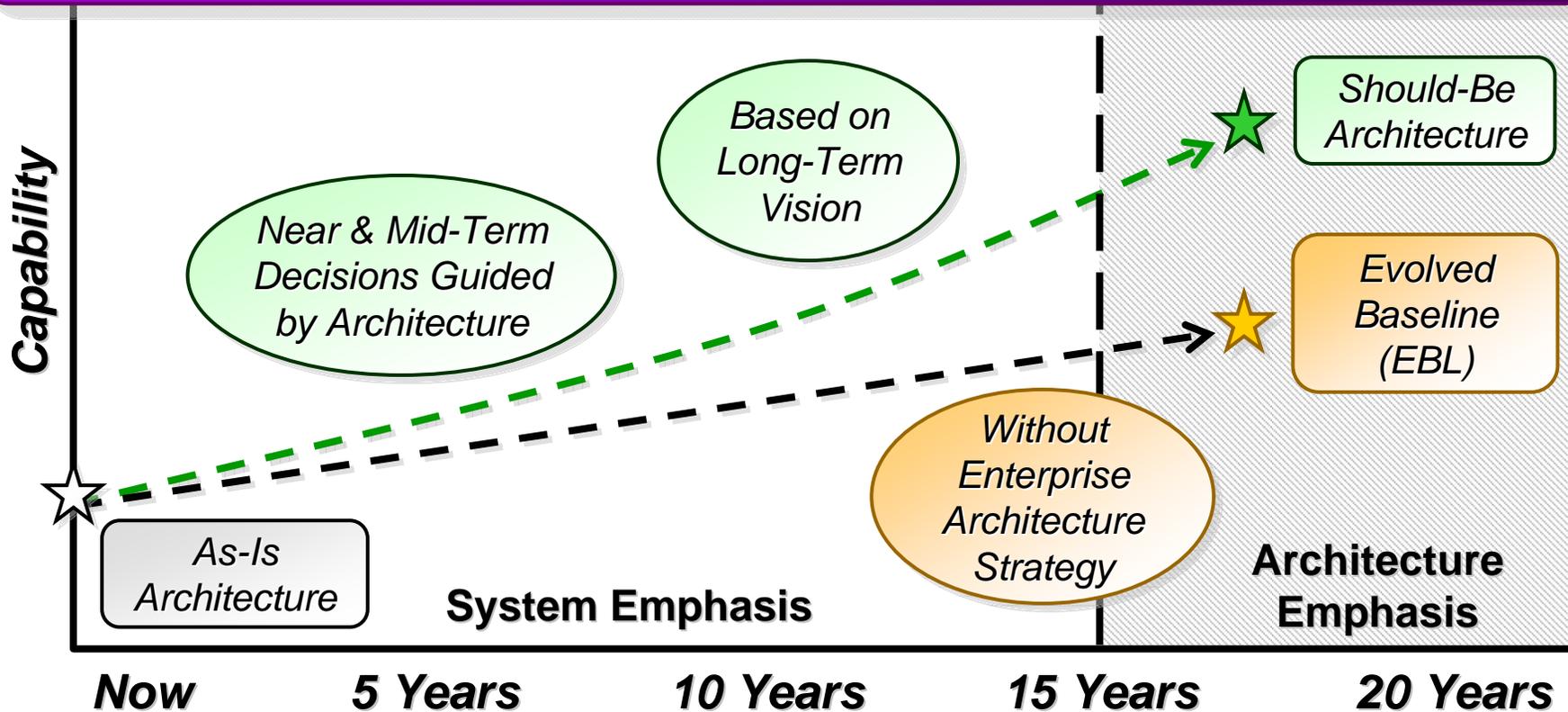
Primary PNT Gaps

- Gaps primarily drawn from military's PNT Joint Capabilities Document, with additions and modifications from parallel civil community documents and discussions
 - Operations in Physically Impeded Environments
 - Operations in 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



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





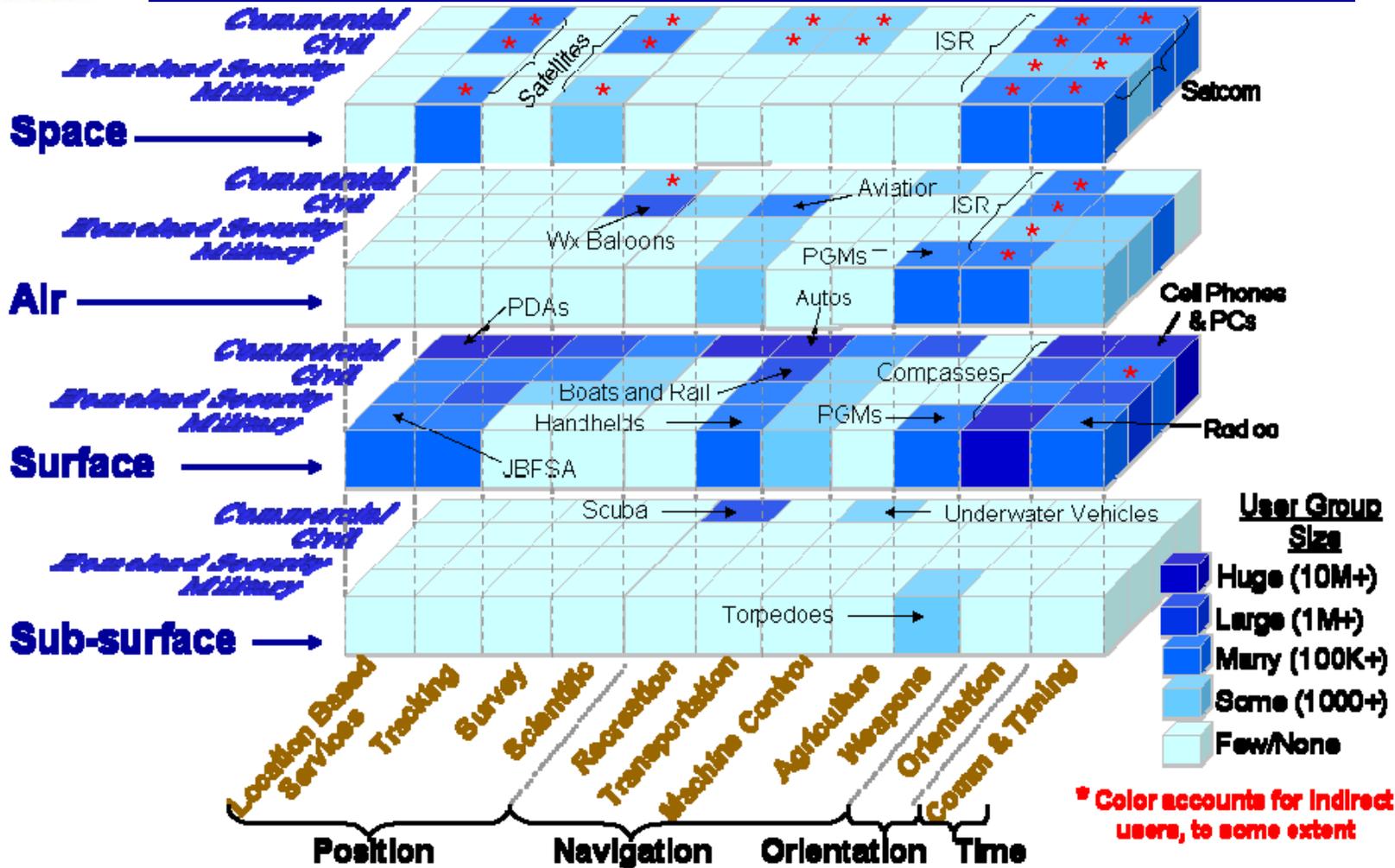
National PNT Architecture Scope

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

Broad Scope Requires Innovative Approaches and Focused Analysis Efforts



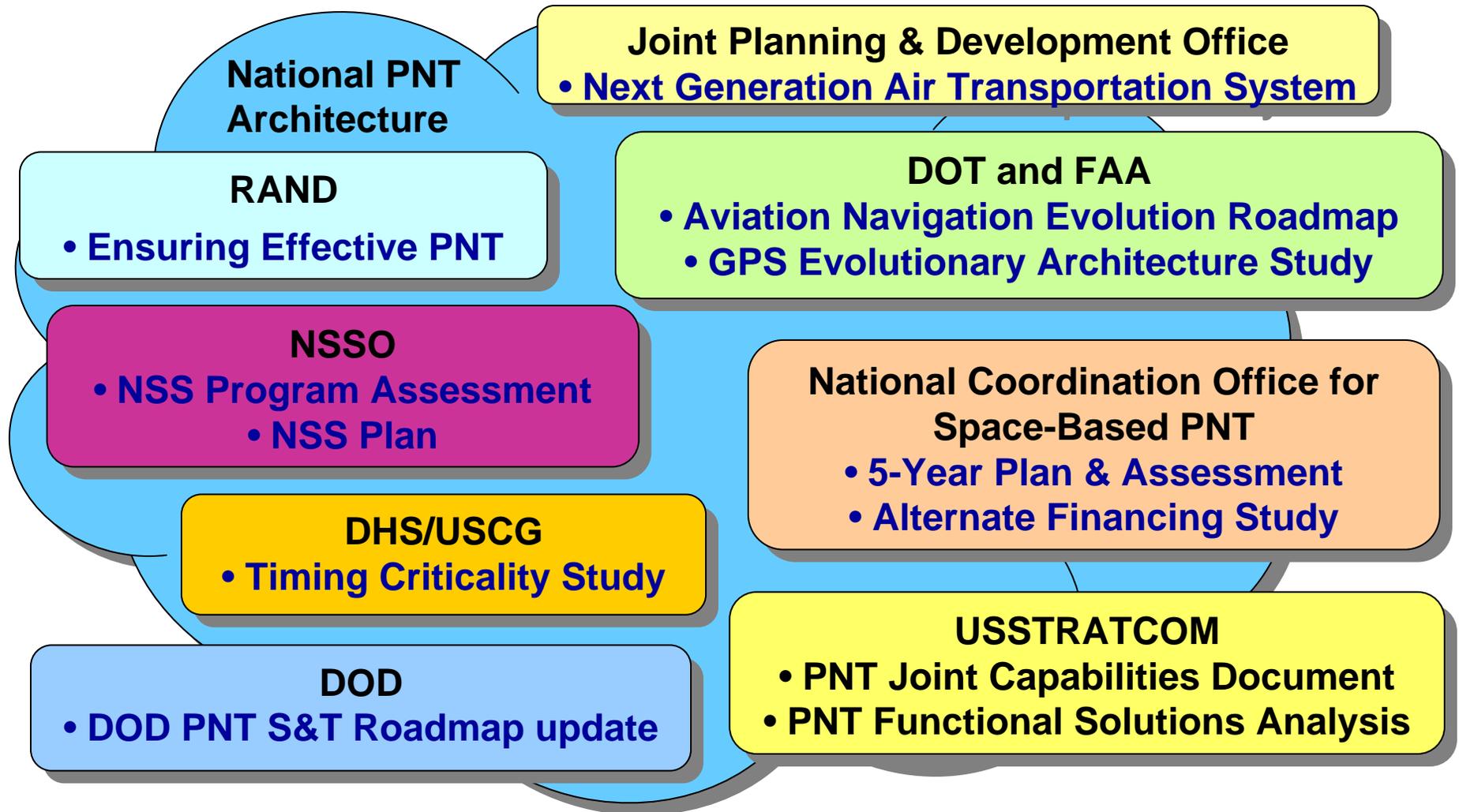
PNT User Perspectives (2025)



Framework to describe user needs & environments, and which users are affected by each capability gap



Related Efforts



MAINTAIN SHARED SITUATIONAL AWARENESS



National PNT Architecture Development History

Data Gathering

PNT User Perspectives (2025)

PNT Gap: Physically Impeded Environments

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Who: Cell phones, radios, PDAs for LBS, and asset tracking, surface transport

Where: Areas including indoors, urban canyons, underground, underwater, and under dense foliage; users moving at surface speeds; communications available

Issues: Cost a key constraint, multipath; user equipment size/weight

Reference: PNT_JCD pg 13

Needs & Gaps

Functional Reference Model

PNT Evolved Baseline (2025)

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Environment: Spectrum, Geopolitical, Weather, Fiscal

ENABLERS & INFRASTRUCTURE

Environment, Technology & Evolved Baseline

Concept Development

Concept Development PNT Architecture

- Source Location (of the service)
 - Terrestrial: concept provides in near- or beneath the surface of Earth
 - Space: concept provides service in space
- Service Volume (of the service)
 - Local: concept provides a meaningful service only at a fixed point
 - Interplanetary: concept provides a meaningful service throughout a system
 - Autonomy (of the user)
 - Dependent: concept requires to be provided information from external sources to provide a meaningful service
 - Local: concept provides a meaningful service only at a fixed point
 - Autonomous: concept, once established, requires no information from external sources to provide a meaningful service

Example RA: Dependent Terrestrial

Job Aid - PNT Architecture Features

Hybrid Refinement Process

Hybrid A Concept

Needs & Features: User Needs, Environment, & Architectural Features Previously Determined

Theme / Hypothesis: To Improve Performance Through Specialized Services

Architecture needs the needs

Enablers & Infrastructure

Network, Terrestrial, Autonomous

User, User Equipment

Green, Specified, New

Trade Space, Features & Architectures

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Guiding Principles

VISION
US Leadership in Global PNT

STRATEGY
Greater Common Denominator

VECTOR
Multiple Phenomenologies

VECTOR
Interchangeable Solutions

VECTOR
Synergy of PNT & Communications

VECTOR
Cooperative Organizational Structures

Community Involvement

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

Analysis & Assessment

Related Efforts & Upcoming Decisions

Preliminary Analysis - Feb 07

Hybrid Assessment Process

4 Evaluators

Results:

- 14,000 Comments On:
 - Performance
 - Evaluators
 - Cost Drivers
 - Risk
 - National Strategy
- 42 SMEs
- 25 Organizations
- 16 Hours

Insights, Findings, Themes

4 Scenarios, 8 Use Cases, 32 Detail Designs

42,000 Comments On: Performance, Evaluators, Cost Drivers, Risk, National Strategy

42 SMEs, 25 Organizations, 16 Hours

Insights, Findings, Themes

4 Scenarios, 8 Use Cases, 32 Detail Designs

Analytical Framework



Guiding Principles

VISION

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STRATEGY

Greater Common Denominator

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Multiple Phenomenologies

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Interchangeable Solutions

VECTOR

Synergy of PNT & Communications

VECTOR

Cooperative Organizational Structures



National PNT Architecture Vision

US Leadership in Global PNT

- Based on a foundation of national policy
- Efficiently develop and field the best technologies and systems (e.g. cost, schedule, acceptable risks, user impact)
- Promulgate stable policies (commitment to funding, commitment to performance, advanced notice of change, etc)
- Foster innovation through competition within the commercial sector
- 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
- Promulgate a predominantly “dependent” architecture where users rely upon external sources
- Leverage ongoing US GNSS modernization to assure global service and support national interests
- Promote adoption of low-burden “autonomous” features for robustness
- Specialized needs still require specialized solutions
- Balance provided or enabled capabilities with the need for a national security advantage



Strategy: Greater Common Denominator

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

- Recommendations
 - Maintain GPS as a cornerstone of the National PNT Architecture
 - Monitor PNT signals to verify service levels, observe environmental effects, detect anomalies, and identify signal interference for near real-time dissemination
 - Transition or divest US GNSS augmentation assets that are unnecessarily redundant after capability is available from GPS modernization or other methods
 - Continue to investigate methods to provide high-accuracy-with-integrity solutions for safety-of-life applications
 - Develop a national approach to protect military PNT advantage



Vector: Multiple Phenomenologies

1

Use Multiple Phenomenologies to the Maximum Extent Practical to Ensure Robust Availability

- Recommendations

- Encourage appropriate development and employment of equipment that integrates information from diverse sources and information paths
- Assess the potential for the use of foreign PNT systems for safety-of-life applications and critical infrastructure users and, as appropriate, develop clear standards and criteria for their use
- Continue military PNT exclusive use policy while studying development of capabilities to enable military use of other signals
- Promote standards for PNT pseudolites and beacons to facilitate interchangeability and avoid interference
- Study evolution of space-based and terrestrial PNT capabilities to support diversity in PNT sources and information paths
- Ensure critical infrastructure precise time and time interval users have access to and take advantage of multiple available sources



Vector: Interchangeable Solutions

2

Strive for Interchangeable Solutions to Enhance Efficiency and Exploit Source Diversity

- Recommendations

- Use participation in international PNT-related activities to promote the interchangeability of PNT sources while assuring compatibility
- Evolve standards, calibration techniques, and reference frames to support future accuracy and integrity needs
- Identify and develop common standards that meet users' needs for PNT information exchange, assurance and protection
- Establish common standards that meet users' needs for the depiction of position information for local and regional operations



Vector: Synergy of PNT & Communications

3

Pursue, where Appropriate, Fusion of PNT with New and Evolving Communications Capabilities

- Recommendation
 - Identify and evaluate methods, standards and potential capabilities for fusion of PNT with communications



Vector: Cooperative Organizational Structures

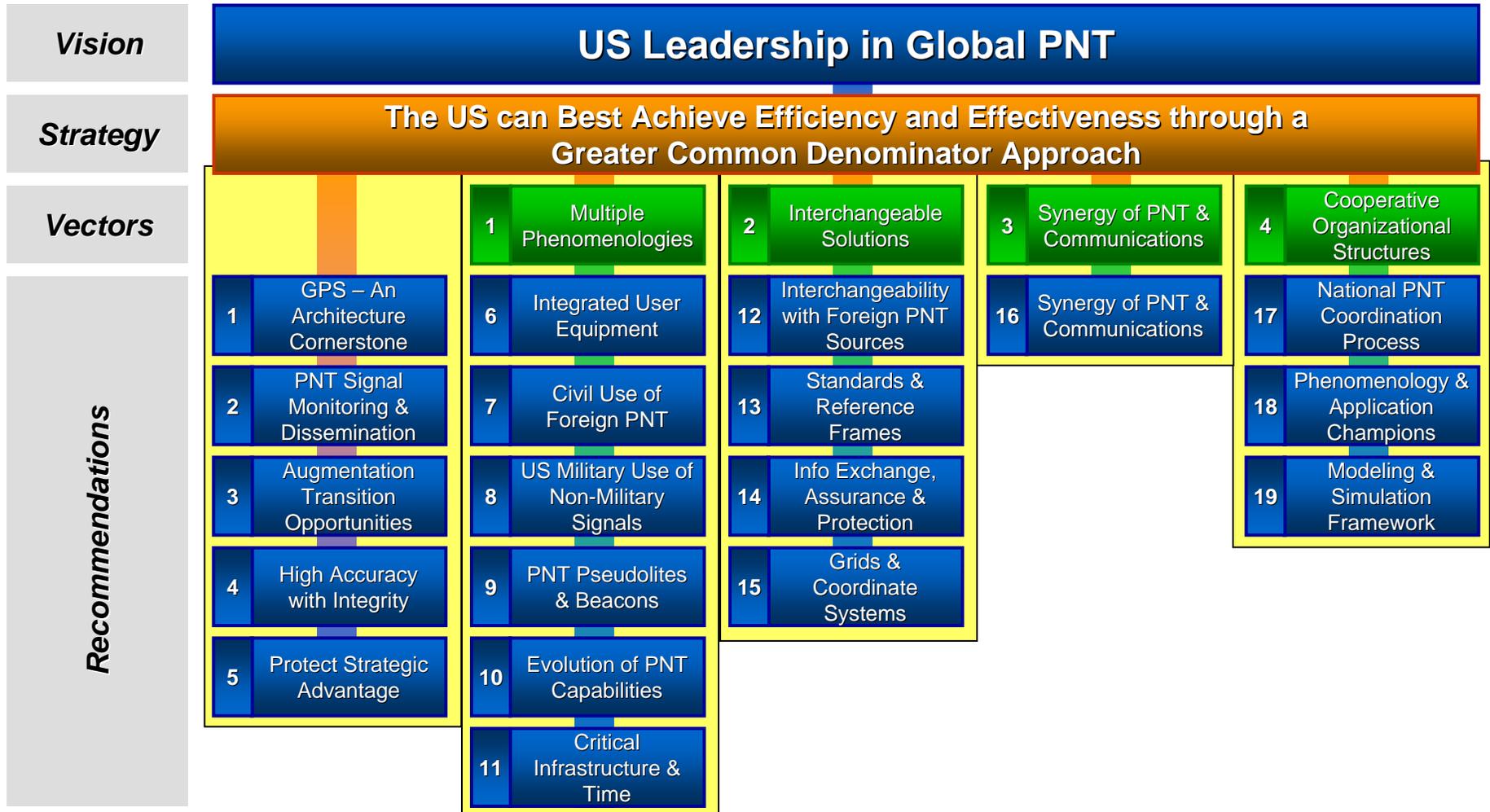
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Promote Interagency Coordination & Cooperation to Ensure the Necessary levels of Information Sharing

- Recommendations
 - Develop a national PNT coordination process
 - Identify and leverage centers of excellence for PNT phenomenology and applications
 - Define, develop, sustain, and manage a PNT modeling and simulation core analytical framework



Recommendation Tree





Next Steps

- Workshops to Obtain Public Feedback on Recommendations
 - First “Industry Day” session in conjunction with the 2008 Institute of Navigation (ION) Global Navigation Satellite System (GNSS) conference on September 16 in Savannah, GA
- NSSO, DOT/RITA & ASD(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

