

Future GPS & Free Services

PNT Policy Lessons

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October 16, 2008

Early U.S. GPS Commitments

1991-2: The U.S. Government commits to:

- **SPS available for a minimum of 10 years**
 - **100m 2drms (95%) horizontal accuracy**
 - **Provided free of charge**
- **48-hour advance notice before disruption of SPS**
- **Warning time of 6 years before change in policy**

1984 - Federal Geodetic Control Committee standards

- **GPS data allowed for geodesy and mapping**
- **Fostered first commercial survey receivers**

No Obvious Model for GPS Funding

- **GPS services are like a “super lighthouse”**
 - That the U.S. built alone and provided as charity
 - Users can’t be seen or hailed at port
- **GPS receivers are like AM/FM radios**
 - Without advertising
- **GPS is not a public utility or like cable TV**
 - Hard to meter, no hard connection required
 - Marginal direct cost of a user is zero
- **Even a “private” organization would need government powers or assistance**
 - To collect fees
 - Liability shield for safety of life uses

GPS Funding Options

- **Status Quo - DoD pays for space and ground segments, users pay for their own equipment**
 - Justified on national security alone
- **Cost sharing with other government agencies**
 - Civil Function in DoD? (e.g., Corp of Engineers)
 - Risks with multiple Congressional committees
- **GPS is privatized or internationally managed**
 - Risks to U.S. national and regional security
- **GPS displaced by foreign/private space systems**
 - Need lower costs and exclude ineligible users

GPS Funding Options (cont.)

- **GPS is augmented by civil/private/foreign elements**
 - Already happening in DGPS services
 - Direct or indirect user fees can be imposed
 - Trust Fund mechanisms
 - Competition to private DGPS providers
- **Excise taxes on GPS/DGPS-related equipment**
 - Limited by very price-sensitive market
 - Enforceable only in the United States
- **No effective fee collection technology for GPS**
 - Optimal Price = Marginal Cost = Zero

Liability for Providing GPS

- **U.S. Government and U.S. firms can be sued for negligent maintenance of navigation aids**
- **No absolute sovereign immunity in G-7 Countries**
 - Liability is a factor in international acceptance of GPS, e.g., use of the Chicago Convention
 - Some European governments believe new laws are required to use the GPS signal in public safety/navigation applications
- **Warning notices are an important liability factor**
 - Notice to mariners, notice to airmen (e.g., USCGIC)
 - Integrity monitoring

International Confidence in GPS

- **Formal U.S. commitments are important to foreign government acceptance of GPS in “safety of life” uses**
 - Useful, but not vital, for commercial acceptance
- **International integrity monitoring is important to liability questions**
 - Acceptable for national security, vital to public safety
- **Ensuring clean spectrum for the continuous availability of GPS signals**
 - As well as alternative systems

Market vs. Governmental Views of GPS

Foreign governments have more concerns with GPS than foreign individuals or firms

- **GPS affects national roles and responsibilities, such as military security, public safety, and international trade**
- **GPS is a dual-use technology that requires civil-military-commercial dialog**
 - Common in the United States, rare elsewhere
- **GPS serves public interests, but spectrum is under pressure from private interests**

Responses to Common Objections

- **Free Rider Problem - economic**
 - “we paid for it - why are they getting it free?”
- **Free Rider Problem - military**
 - “we paid for it - why are they using it?”
- **Top Economic Objective**
 - acceptance as a global standard and protecting its utility are more important to U.S. commercial advantage than fees
- **Top National Security Objective**
 - ensuring freedom from interference is more important than just preventing misuse
 - international agreements can enhance U.S. ability to prevent misuse and enhance regional security

Backup Slides

Key Decisions Regarding GPS

- **U.S. Policy**

- Commitments in the Federal Radionavigation Plan
- GPS funding, modernization, augmentations
- Selective Availability (done)

- **Foreign Governments**

- Acceptance of GPS as a navigational aid
- Avoidance of trade barriers and special taxes

- **International**

- Protection of spectrum allocations
- Cooperative or competitive augmentations
- Accidental and hostile misuse of GPS technologies

Alternative Visions for the Future of GPS

- **GPS continues as a DoD system**
 - or jointly with other USG agencies
- **GPS becomes a U.S. regulated public utility**
- **GPS is privatized or internationally managed**
- **GPS gradually displaced by private space systems**
 - or other technologies
- **GPS is augmented by civil/private/foreign elements**

GPS Signals are a Public Good which Require Competence and Stability to Protect U.S. Interests

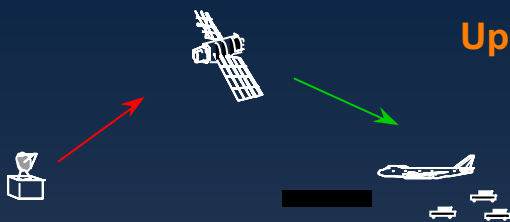
Preferred Forms of GPS Governance

- For national security reasons, GPS should remain subject to U.S. control.
- For public safety and commercial reasons, international integrity monitoring and enhanced availability should be encouraged.
- User equipment will be under local/private control unless forbidden by extreme efforts.

Regime / System/Function	International	Regional	National/ Bilateral	Local Private
GPS - space control ground (user equip.)			X X	X
Wide-Area Augmentation Systems - integrity availability accuracy	X X	X X ?	X X X	
Local-area Augmentation Systems - DGPS		?	X	X

Some Encryption Modes for DGPS Signals

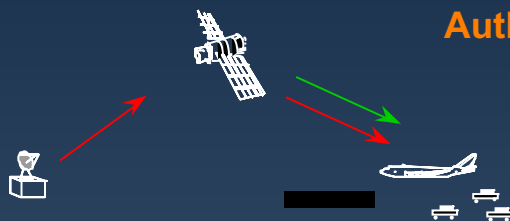
Link Encryption



Up-link Protection

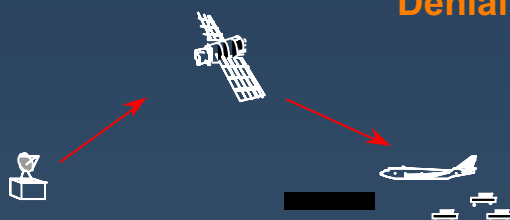
Data Stream At End User

■ Clear ■ Encrypted



Authentication Only

Signature



Denial and Authentication



Rationale for Encryption

Denial

- Prevent use by hostile forces
- Prevent use by free riders

Requires data to be encrypted and key management

Authentication

- Confirm sender's identity
- Prevent spoofing of signal

Requires signature to be encrypted

International GPS Standards

Standards are key to global economics

- Especially in GPS augmentations for public safety and commercial uses
- Goal of “plug and play” for hardware, software
 - Synergistic technologies such as communications
- Potential national, regional, international barriers
 - GPS equipment in the WTO Information Technology Agreement
 - Mutual Recognition Agreements (MRAs)