

# Civil PNT Policy and Utility

**Civil GPS Service Interface Committee  
U.S. States and Local Government Subcommittee  
Groton, CT  
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# GPS is a Critical Component of the Global Information Infrastructure



Satellite  
Operations



Precision Agriculture



Surveying & Mapping



Aviation



Communications



Disease Control



Power  
Grids



Trucking &  
Shipping



Oil Exploration

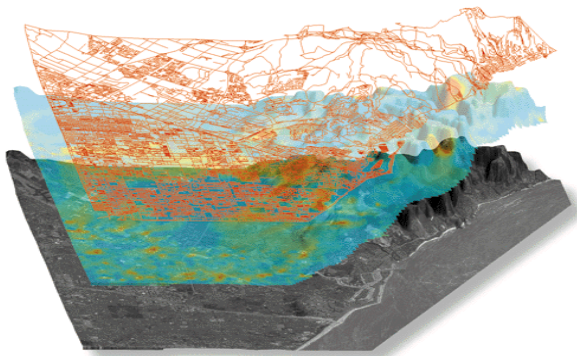


Fishing &  
Boating



Personal  
Navigation

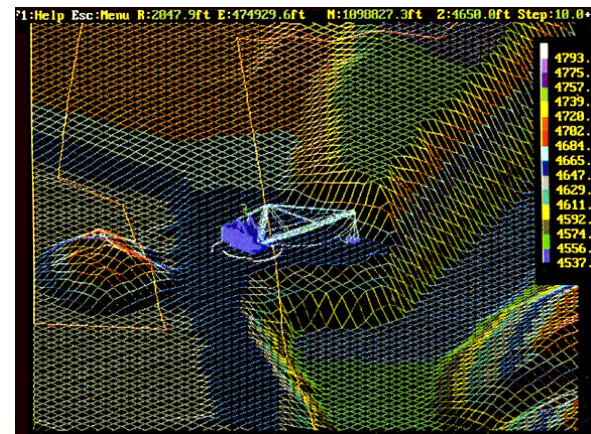
# Surveying, Mapping, GIS



- Surveying is essential to any new development
  - Electrification
  - Telecom tower placement
  - Pipeline installation
  - Dam construction
  - Port dredging
- GPS enables 2-5 cm real-time positioning accuracy
  - Mm-level accuracy possible with post-mission data processing
- 100%-300% savings in time, cost, labor
  - Stakeless, paperless surveys

# Construction, Mining

- Faster site preparation
- Enhanced management of assets, equipment
  - More efficient asset utilization
  - Less idling of workers, machinery
- Precise automated machine control
  - Up to 70% increased job site productivity
  - Saves time, fuel, and emissions
  - Reduces maintenance
  - Prevents accidents
- Automated, wireless job tasking
  - Smaller, more empowered workforce – no foreman
  - Real-time progress tracked remotely



# Agriculture

- Improved management of land, machinery, personnel, time
  - Optimized placement of crop rows, seeds
  - Enhanced monitoring of crop yields, soil quality, problems
  - Automated, 24-hour operations using lighter equipment, less fuel, less labor
- Plant-specific applications of water, fertilizer, pesticides, herbicides
  - Up to 80% increase in efficiency
- Greater crop yields, profit margins
- Environmental benefits
  - Reduced chemical use
  - Precise leveling of fields reduces runoff
  - Strip tillage/no tillage releases less CO<sub>2</sub>
  - Reduced CO<sub>2</sub> emissions from lighter, more efficient machinery



This grain combine can be outfitted with a GPS receiver, yield monitor, and electronic sensors to track crop production based on location. These data can be transferred to a geographic information system to create a yield map and subsequently used to analyze the field and make site-specific management decisions.

# Timing

- GPS offers an inexpensive alternative to high-maintenance timing equipment, networks
- Synchronization, management of communication networks
  - Phones, pagers, wireless systems
  - LANs, WANs, Internet, satellites
  - Cell phone tower handoffs
  - Digital TV
- Financial transactions
  - Stock exchanges
  - ATMs
  - E-commerce
- Power grid management
  - Load balancing
  - Fault detection, location



# Disaster Management

- Assists in disaster planning efforts such as flood plain mapping
- Structure monitoring
  - Lock and dams
  - Levees
  - Bridges
- Helps relief workers navigate disaster areas devoid of landmarks
- Facilitates containment and management of wildfires
- Enables disaster warning systems
  - GPS-equipped buoys for tsunami warnings
  - GPS ground networks monitor crustal motion, earthquakes
- Enables emergency response
  - E-911
  - NG-911 (text, video, Facebook, tweets)



# Environmental Stewardship

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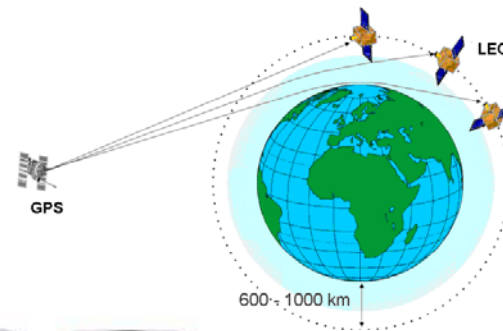
- Climate monitoring
  - Sea level rise measurements
  - Ice sheet change observations
  - Atmospheric moisture profiles
- Reduced greenhouse gas emissions
  - Efficient routing of aircraft, trucks, and other vehicles
  - Reduction of vehicle fleet idle times
- Oil and chemical spill cleanup
  - Positioning, modeling of spills to guide remediation efforts
- Commercial fishing
  - Enforcement of fishery boundaries
- Forestry
  - Safe and efficient lumbering
  - Monitoring of illegal deforestation
- Harbor and inland waterway dredging
  - Maintain/improve transportation channels
  - Dredge and dispose





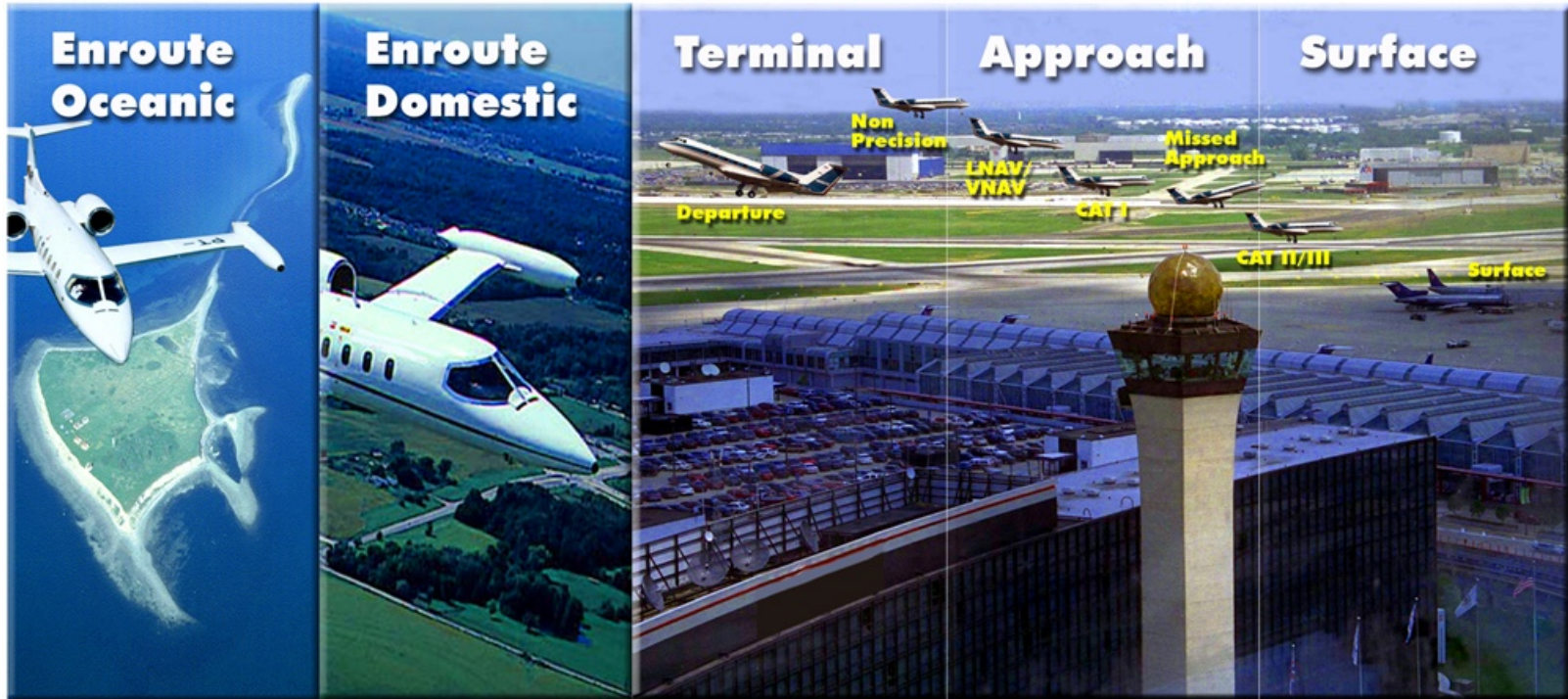
# New Applications Appear Every Day

- Mobile applications
  - Location based services
- Localized GIS datasets
- Personal, pet safety
- GPS radio occultation
- Road use taxation



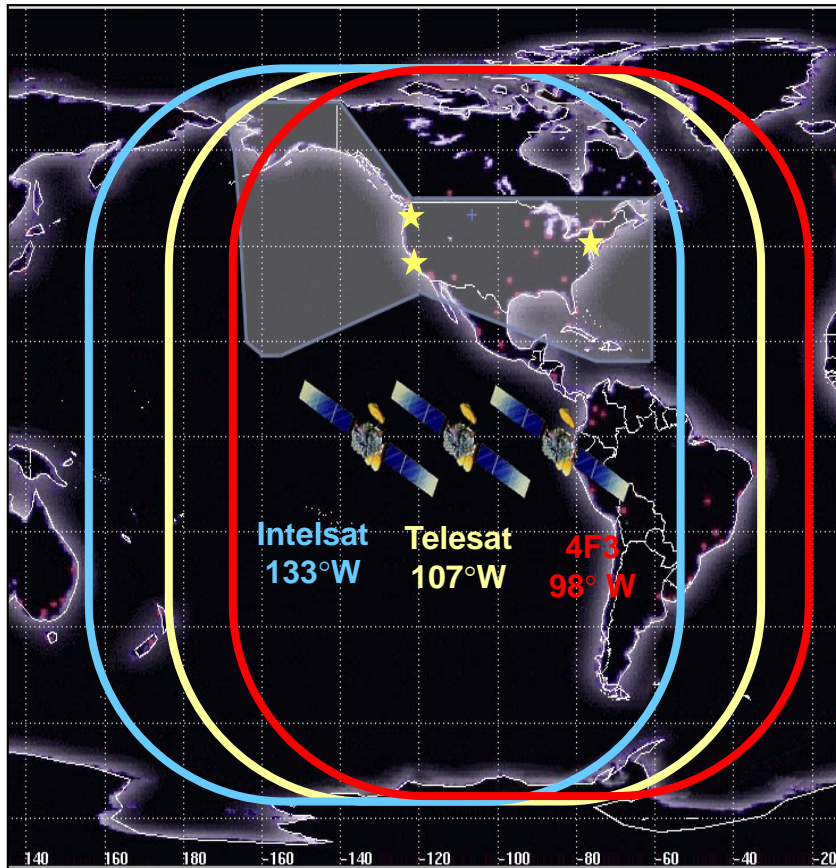
# FAA GPS Augmentation Programs

## WAAS



## LAAS

# WAAS Architecture



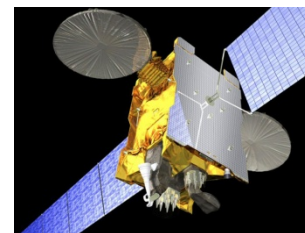
38 Reference Stations



3 Master Stations



4 Ground Earth Stations

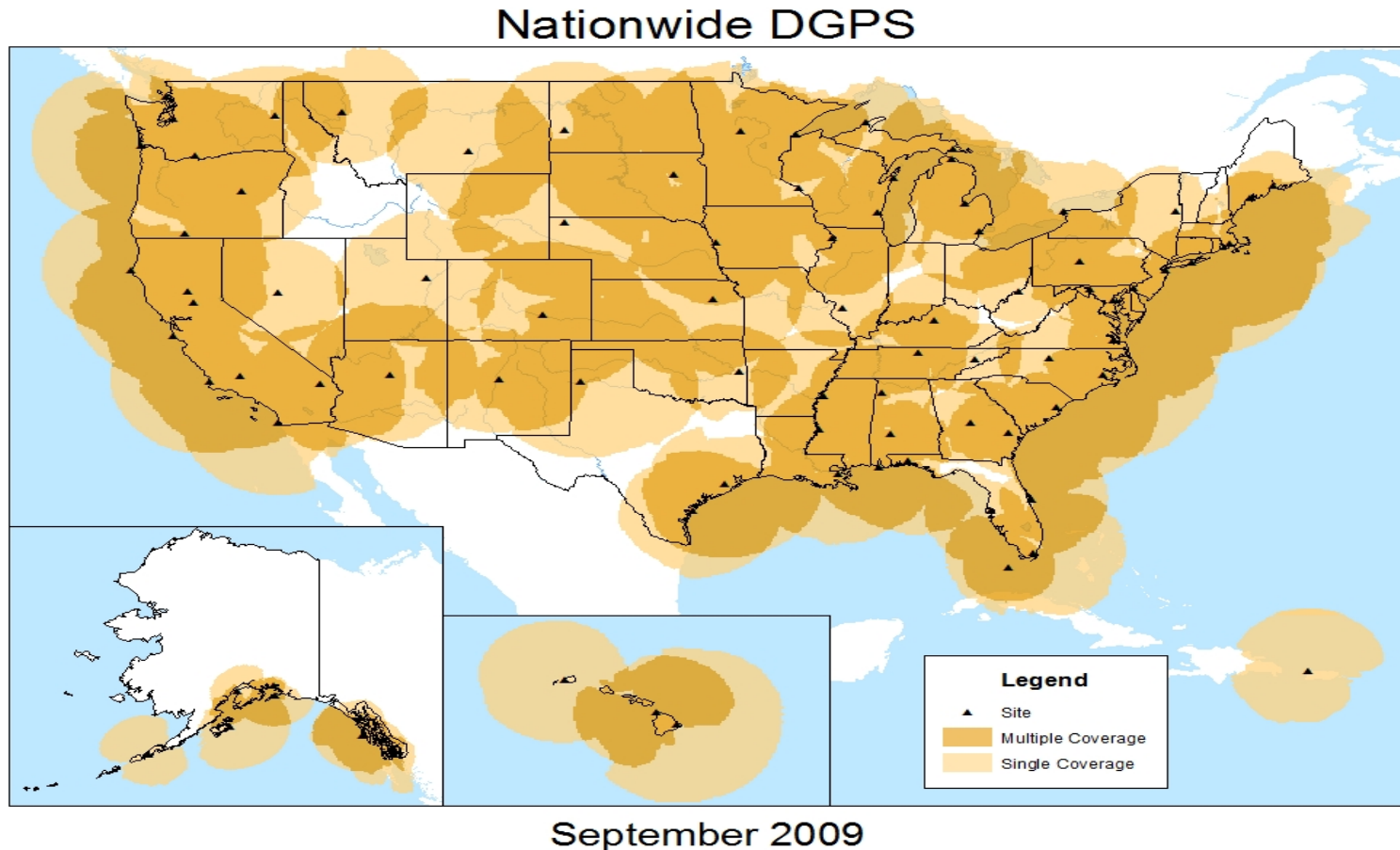


(2+1) Geostationary Satellite Links



2 Operational Control Centers

# Nationwide Differential GPS

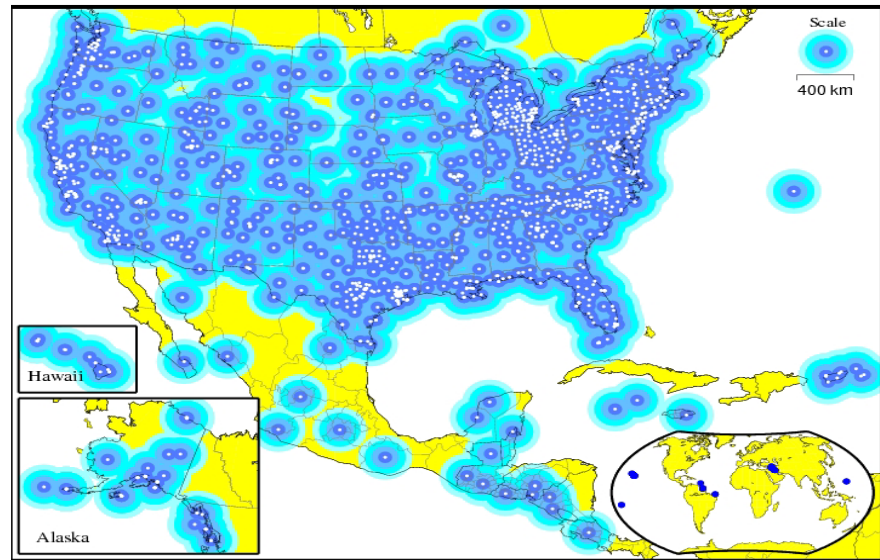


- Expansion of maritime differential GPS (DGPS) network to cover terrestrial United States
- Built to international standard adopted in 50+ countries



# National Continuously Operating Reference Stations (CORS)

- Enables highly accurate, 3-D positioning
  - Centimeter-level precision
  - Tied to National Spatial Reference System
- **1,500+** sites operated by 200+ public, private, academic organizations



- NOAA's Online Positioning User Service (OPUS) automatically processes coordinates submitted via the web from around the world
- OPUS-RS (Rapid Static) declared operational in 2007
- NOAA considering support for real-time networks

# GPS-Based Applications are Critical to Major DOT Initiatives



## Aviation – NextGen

Reliable and accurate positioning worldwide  
Reduced delays  
More fuel-efficient routes  
Increased system capacity with enhanced safety



## Rail – Positive Train Control

Reduced probability of collisions  
Increased efficiency and capacity  
Rapid rail structure and conditioning mapping



## ITS/Connected Vehicle

Enable crash prevention among vehicles and between vehicles and infrastructure

Increased mobility and reduced environmental impact

# Easy to Purchase GPS Jamming Devices

- Growing market for low-cost GPS jammers
  - Concern over being tracked using GPS, particularly among those driving a company or fleet vehicle
- Many devices are battery-operated or can be plugged into a cigarette lighter
- Sold as “privacy protectors”



\$99



\$99



\$320



\$129



\$145



\$30



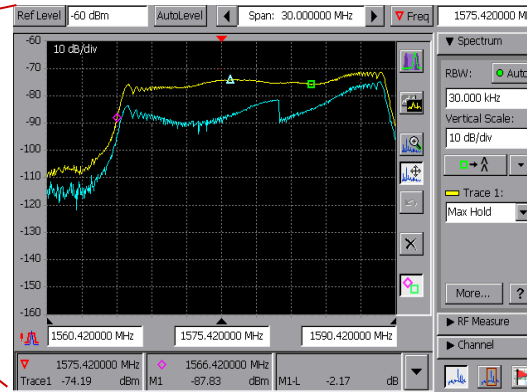
\$430



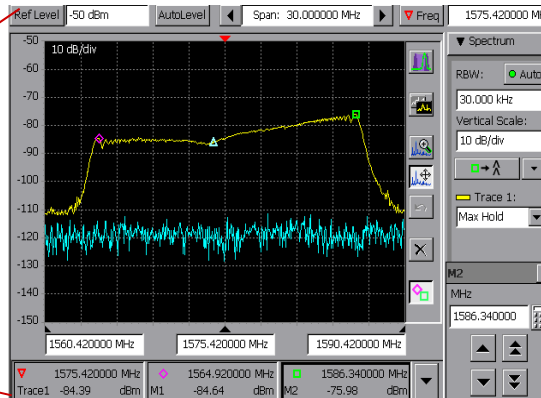
\$79



# Affect of GPS Jamming Devices



**RFI source  
“Locked-on” and  
pursued.**



**On Site ON-OFF  
tests confirms  
GPS RFI source.**



# LightSquared and GPS

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- Plans to provide a nationwide wireless broadband network integrated with satellite coverage
  - Combine existing mobile satellite communications services with a ground-based wireless communications network that uses the same L-band radio spectrum as the satellite
  - Network will transmit signals in a radio band immediately adjacent to the GPS frequencies (1525-1559 MHz/1626.5-1660.5 MHz band)
  - Concern that ground-based transmissions may interfere with GPS
  - 40,000 W transmitters; goal is nationwide 4G/LTE by end of 2015
- 18 November 2010 -Request submitted to FCC for modification of its (ancillary terrestrial component) ATC authority
- 26 January 2011 -FCC Order & Authorization
  - Conditional approval to build out its ground-based wireless network
  - Requires addressing GPS concerns

# GPS User Community Concerns

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- The base stations of the LightSquared network will transmit signals in a radio band immediately adjacent to the GPS frequencies.
  - The GPS community is concerned that LightSquared's ground-based transmissions may overpower the relatively weak GPS signal from space.
  - Although LightSquared will operate in its own radio band, that band is so close to the GPS signals that many GPS devices could pick up the stronger LightSquared signal and become overloaded or jammed.
- Some are also concerned that the FCC may approve a technical solution to the problem that requires millions of existing GPS users to upgrade or replace their devices.

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# FCC and Executive Branch Actions

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- FCC required that LightSquared create a working group with the GPS community to address interference concerns
  - Final report to be submitted by 15 June 2011
  - Process must be completed to the Commission's satisfaction before commencement of commercial service
  - Two limited interim reports thus far
  - Open sky testing at Holloman AFB completed
  - LightSquared request for field testing pending
- U.S. Government's National Space-Based PNT Systems Engineering Forum (NPEF) is conducting its own testing of the potential interference to GPS from the terrestrial network
- Deputy Secretaries of DoD and DOT have objected strenuously to the process, demanding comprehensive testing
- [www.pnt.gov/interference/lightsquared/](http://www.pnt.gov/interference/lightsquared/)