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GPS Use in U.S. Critical Infrastructure

and Emergency Communications

Presented to the
DOT, DoD, and DHS

United States Technical Training Institute (USTTI)

Presenter

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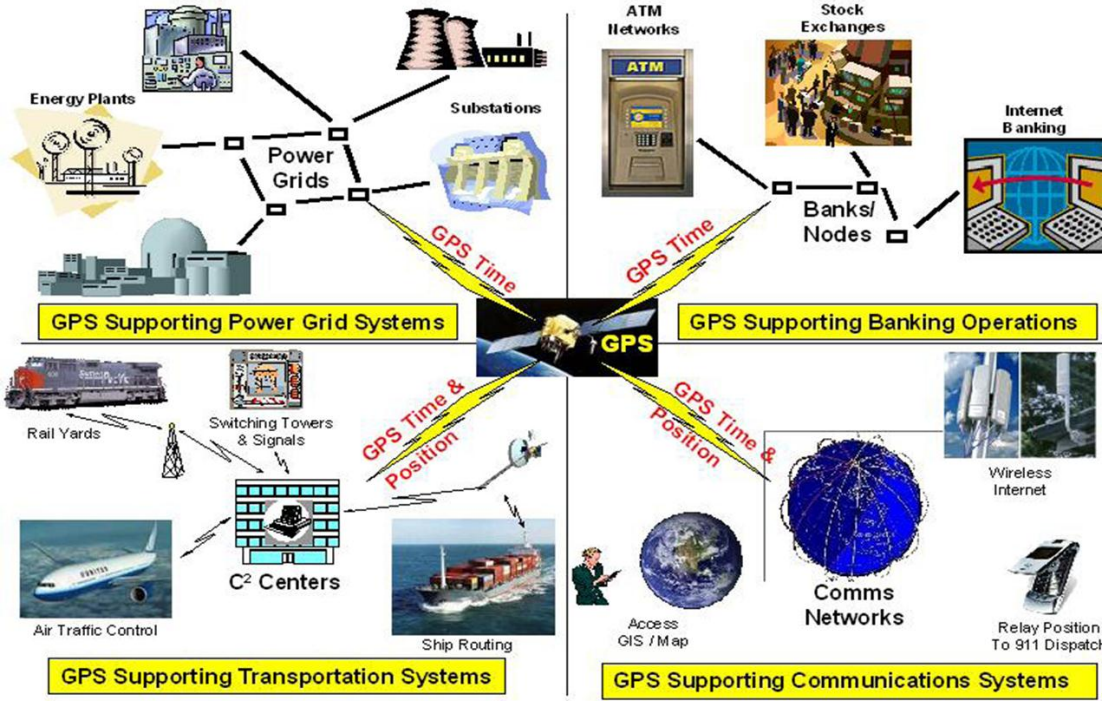
GPS Use Expanding within U.S. Infrastructure

- GPS is increasingly integrated into sectors' operations because it is accurate, available, reliable, and provided at no cost to users
- Interdependencies exist between critical infrastructure sectors that use GPS.



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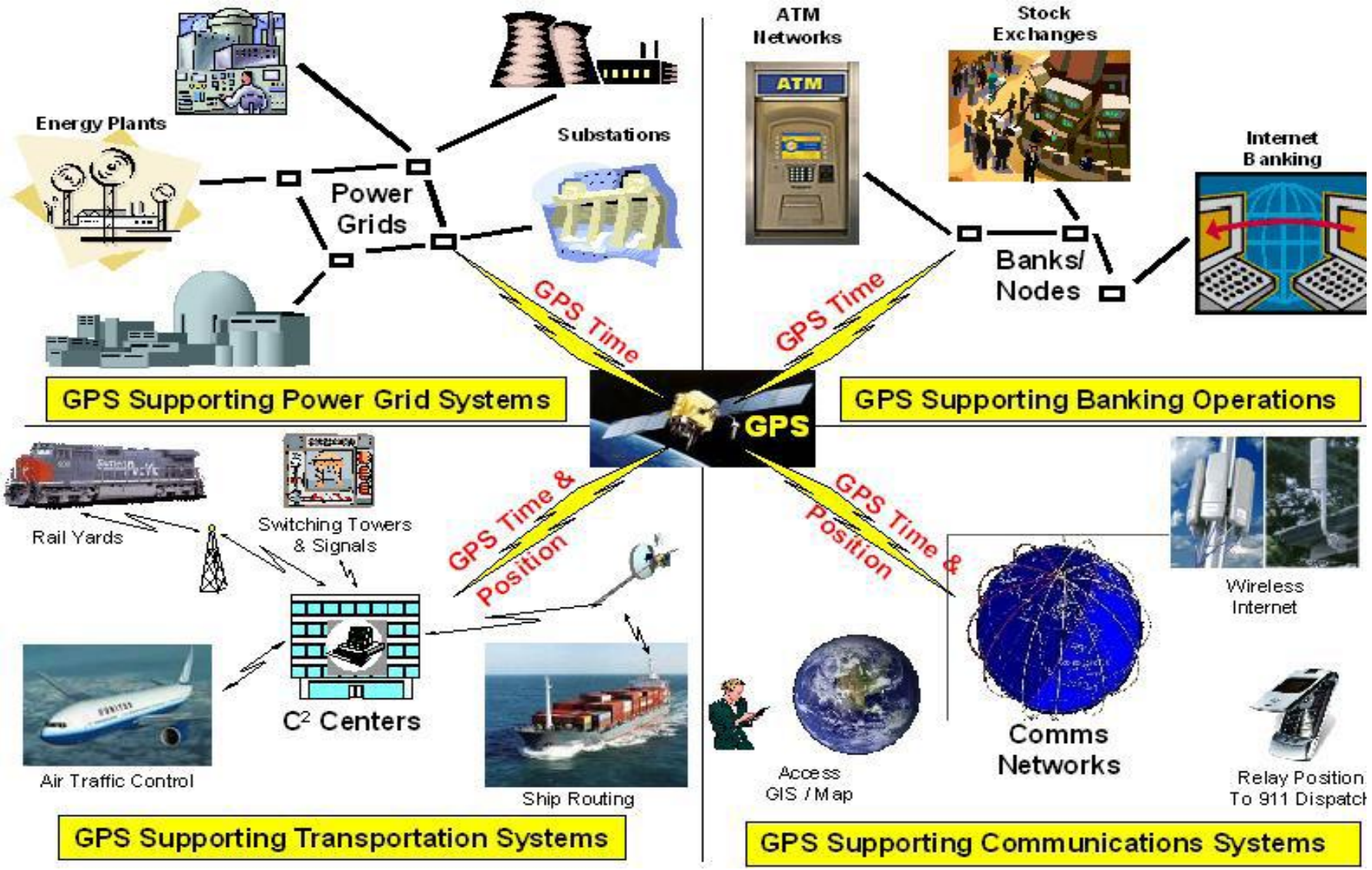
Civilian GPS Applications

Civilian GPS penetration growing / dependencies not well understood



GPS Support to Aviation

- Enables three-dimensional position determination for all phases of flight from departure, en route, and arrival, to airport surface navigation

- NextGen would replace radar tracking with GPS; allow more direct routing that would save time and fuel, and provide more precise data about the distance of one plane from another (*Washington Post, 12 Sep 2012*)

- Allows more aircraft to fly more favorable and efficient routes, saving time, fuel, and increasing cargo revenue

- Enhanced Ground Proximity Warning System (EGPWS) that has proven successful in reducing the risk of Controlled Flight into Terrain

GPS Support to Railway

- Reduces accidents, delays, and operating costs, while increasing track capacity, customer satisfaction, and cost effectiveness
- More accurate information on train arrivals
- Automates track inspection systems that work faster and detect more defects than human crews
- Researchers exploring ways to integrate GPS into vehicle-to-vehicle communication systems that could warn trains and cars of potential collisions at railroad crossings.

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GPS Support to Maritime Operations

- Search and rescue
- Underwater surveying, buoy placement, and navigational hazard location and mapping.
- Navigate to optimum fishing locations, track fish migrations, and ensure compliance with regulations
- Management of maritime port facilities.
- GPS technology, coupled with geographic information system (GIS) software, is key to the efficient management and operation of automated container

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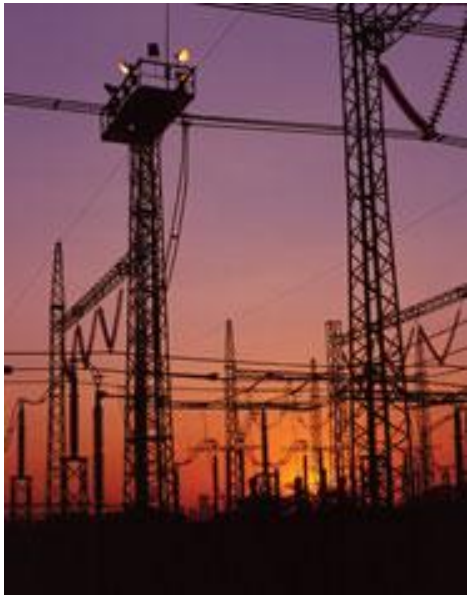
GPS Use in Public Safety/Disaster Relief

- Critical component of modern emergency response systems
  - Saves time during search and rescue operations
  - Coupled with geographic information system (GIS), and remote sensing technology, provides ability to create maps of the disaster areas for rescue and aid operations, as well as to assess damage
    - 2004 , Indian Ocean tsunami
    - 2005, Hurricanes Katrina and Rita, and Pakistan-India earthquake
  - During wildfires, aircraft combine GPS working with infrared scanners to identify fire boundaries and "hot spots
  - Precise location of police, fire, and rescue vehicles; reduces response times
  - Ground and maritime vehicles equipped with autonomous crash sensors and integrated with automatic comms, can rapidly call for help and locate crash site

GPS Support to Other Infrastructure

- Timing - crucial to a variety of economic activities
- Communication systems, electrical power grids, and financial networks all rely on precision timing for synchronization and operational efficiency
- Wireless telephone/data networks use GPS time to keep all base stations in perfect synchronization
- Power companies and utilities have fundamental requirements for time and frequency to enable efficient power transmission and distribution



- Major investment banks use GPS to synchronize their network computers located around the world
- Companies worldwide use GPS to time-stamp business transactions to accurately maintain records synchronized
- Distributed networks of instruments that must work together to precisely measure common events i.e. seismic monitoring

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GPS Critical Infrastructure Timing Study

- GPS use & dependence for timing is growing
- Of the 18 CIKR sectors, 16 use GPS timing synchronization in operating and supporting systems
- Major uses of GPS timing include:
  - Network and phase synchronization in wireline and wireless networks (Communications/IT Sectors) used by multiple critical infrastructures
  - Precise frequency generation and stabilization for single frequency wireless networks (LMR simulcast)
  - Phase synchronization in Electric Power, Nuclear Power, and Dams/Hydroelectric power sectors/subsectors
  - Process scheduling, control, and synchronization in Oil and Natural Gas/Chemical/Critical Manufacturing/DIB sectors
  - Precise time stamping of data, transactions/high-frequency trading in Banking & Finance/Postal and Shipping sectors
- In general, GPS timing is used in *distributed* interconnected systems that require *synchronization* for monitoring, control, production, transaction tracking, and other similar functions

GPS Timing Usage by CIKR Sectors

CIKR Sector	Uses GPS Timing?	
	Yes	No
Communications Sector	X	
Emergency Services Sector	X	
Information Technology Sector	X	
Banking & Finance Sector	X	
Healthcare & Public Health Sector	X	
Energy/Electric Power and Oil & Natural Gas SubSector	X	
Nuclear Sector	X	
Dams Sector	X	
Chemical Sector	X	
Critical Manufacturing	X	
Defense Industrial Base Sectors	X	
Postal & Shipping Sector	X	
Transportation Sector	X	
Government Facilities Sector	X	
Commercial Facilities Sector	X	
National Monuments and Icons Sector		X
Agriculture and Food Sector		X
Water and Wastewater Sector		X

Summary
15 of the18 CIKR Sectors have some degree of GPS timing usage

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Risks/Threats to the GPS Signal

- *Unintentional*
  - **Interference**: Includes out-of-band emissions from other radio sources or in-band emissions from other systems, such as, for example, other satellite navigation systems
- *Intentional*
  - **Jamming**: The deliberate drowning out of legitimate Positioning, Navigation, and Timing, and Frequency (PNTF) signals using higher power signals to cause loss of satellite lock and to prevent reacquisition
  - **Spoofing**: The deliberate emitting of legitimate-appearing false signals to shift the computed position or time of a victim's receiver
- *Naturally Occurring*
  - **Space Weather:** Variable conditions on the Sun and the space environment that can influence the performance and reliability of space and ground based systems.

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Communications Act of 1934

- Federal law prohibits the marketing, sale, or use of a transmitter designed to block, jam, or interfere with cellular and Personal Communication Services, police radar, Global Positioning Systems, and wireless networking services.
  - Section 301 - requires persons operating or using radio transmitters to be licensed or authorized under the Commission's rules (47 U.S.C. § 301)
  - Section 302(b) - prohibits the manufacture, importation, marketing, sale or operation of these devices within the United States (47 U.S.C. § 302a(b))
  - Section 333 - prohibits willful or malicious interference with the radio communications of any station licensed or authorized under the Act or operated by the U.S. Government (47 U.S.C. § 333)

For more information: http://www.fcc.gov/encyclopedia/jammer-enforcement

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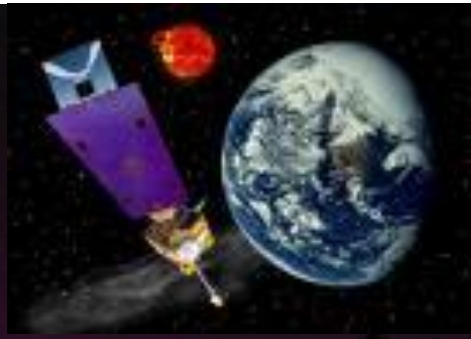
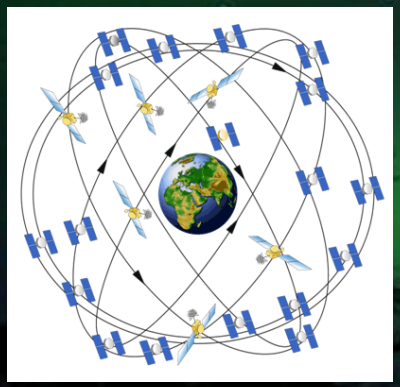
Geomagnetic Storm Impacts are Wide Ranging

Impacts from geomagnetic storms are wide-ranging with potentially significant consequences.



Satellite Operations

Manned Spaceflight



GPS

Power Grid Operations

Aircraft Operations

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Questions?