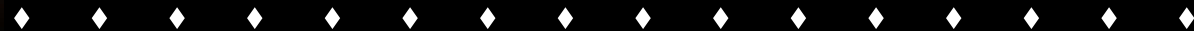


# GPS Civil Augmentations

## *Status and Future*

**UN / USA International  
Meeting on GNSS**

**December, 2004**



**Mr. Hank Skalski**

**U.S. Department of Transportation**





# Overview

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- **Background**
- **Civil GPS Augmentation Systems**



# Background

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- GPS has been **active program** for over 25 years
  - Developmental satellites began launch in 1978
  - Operational satellites began launch in 1989
  - Achieved full operational capability in 1995
- Designed as a **dual-use** system
  - Military applications for US and Allied use
  - Civilian applications for worldwide use
- GPS not **originally designed** to do many of the civil applications being done today.



# Current Civil GPS Capabilities

	Applications	Integrity	Availability	Accuracy
Maritime	Ocean transit	Green	Green	Green
	Coastal navigation	Green	Green	Green
	Inland waterway	Red	Red	Red
	Harbor entrance & approach	Red	Red	Red
Land	Highway navigation	Green	Green	Green
	Emergency Response	Green	Green	Green
	Transit vehicle management	Red	Red	Red
	Railroad train control	Red	Red	Red
Aviation	Oceanic en route	Green	Green	Green
	Domestic en route	Green	Red	Green
	Non-precision approaches	Green	Red	Green
	Precision approaches	Red	Red	Red

Requirements can be met by GPS Alone



Requirements are not met by GPS alone





# Improve Civil GPS Services

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- **Given current civil GPS shortfalls, improvements are needed:**
  - **Early 1990's** began developing GPS augmentation systems
  - **Mid-2000** began modifying GPS IIR/IIF satellites with new civil signals
  - **Currently** reviewing system architecture for 2010 and beyond - GPS III



# Overview

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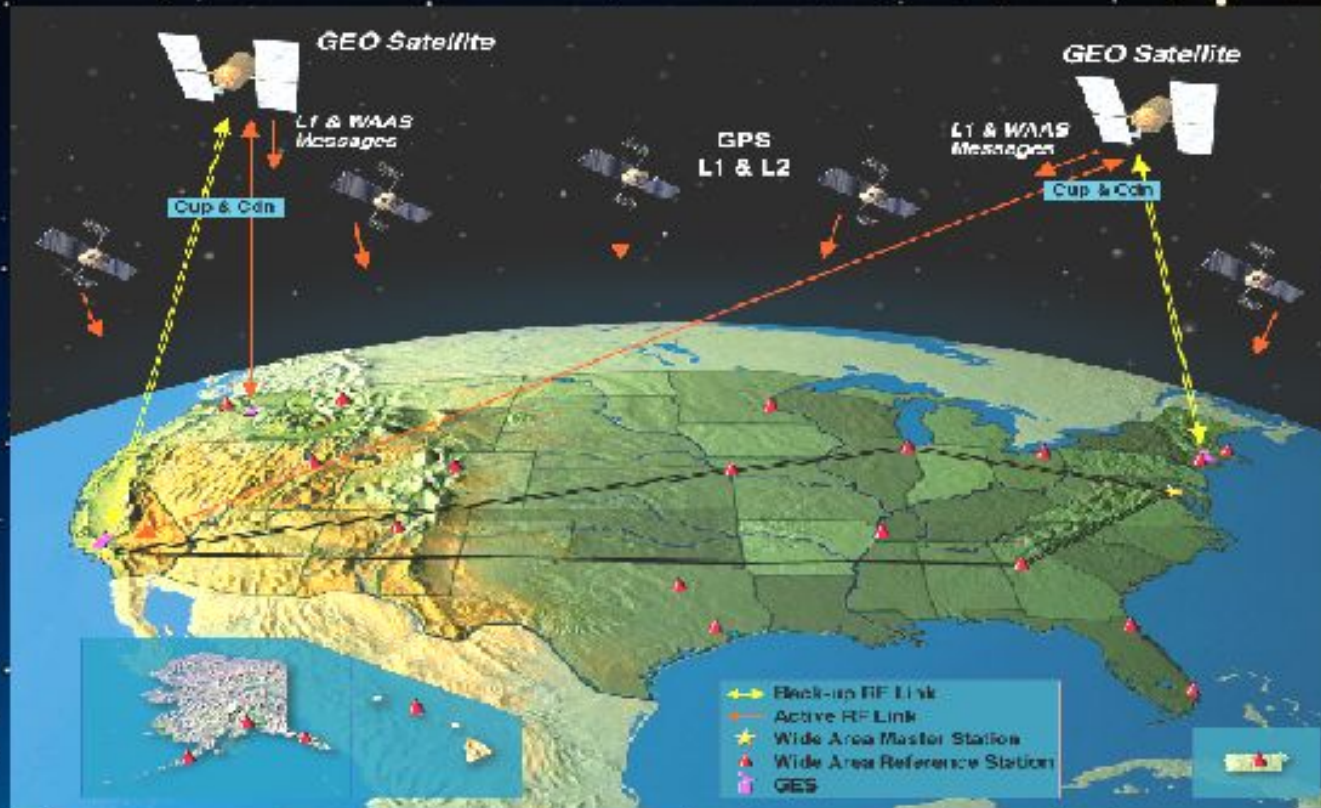
- **Background**
- **Civil Augmentation Systems**
  - **Wide Area Augmentation System (WAAS)**
  - **Local Area Augmentation System (LAAS)**
  - **Maritime Differential GPS (MDGPS)**
  - **Nationwide Differential GPS (NDGPS)**
  - **Continuously Operation Reference System (CORS)**



# Wide Area Augmentation System (WAAS)



## WAAS Architecture

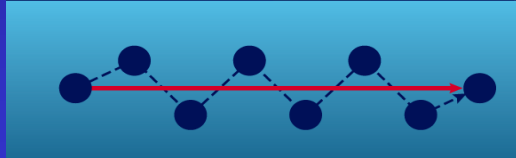




# WAAS Benefits



Primary Means of Navigation - **Take-Off, En Route, Approach and Landing**



More Direct Routes - **Not Restricted By Location of Ground-Based Navigation Equipment**



Approach with Vertical Guidance Capability - **At Any Qualified U.S. Airport**



Decommission of Older, Expensive Ground-Based Navigation equipment (**Reduced maintenance costs**)



Simplify and Reduce Equipment On Board Aircraft

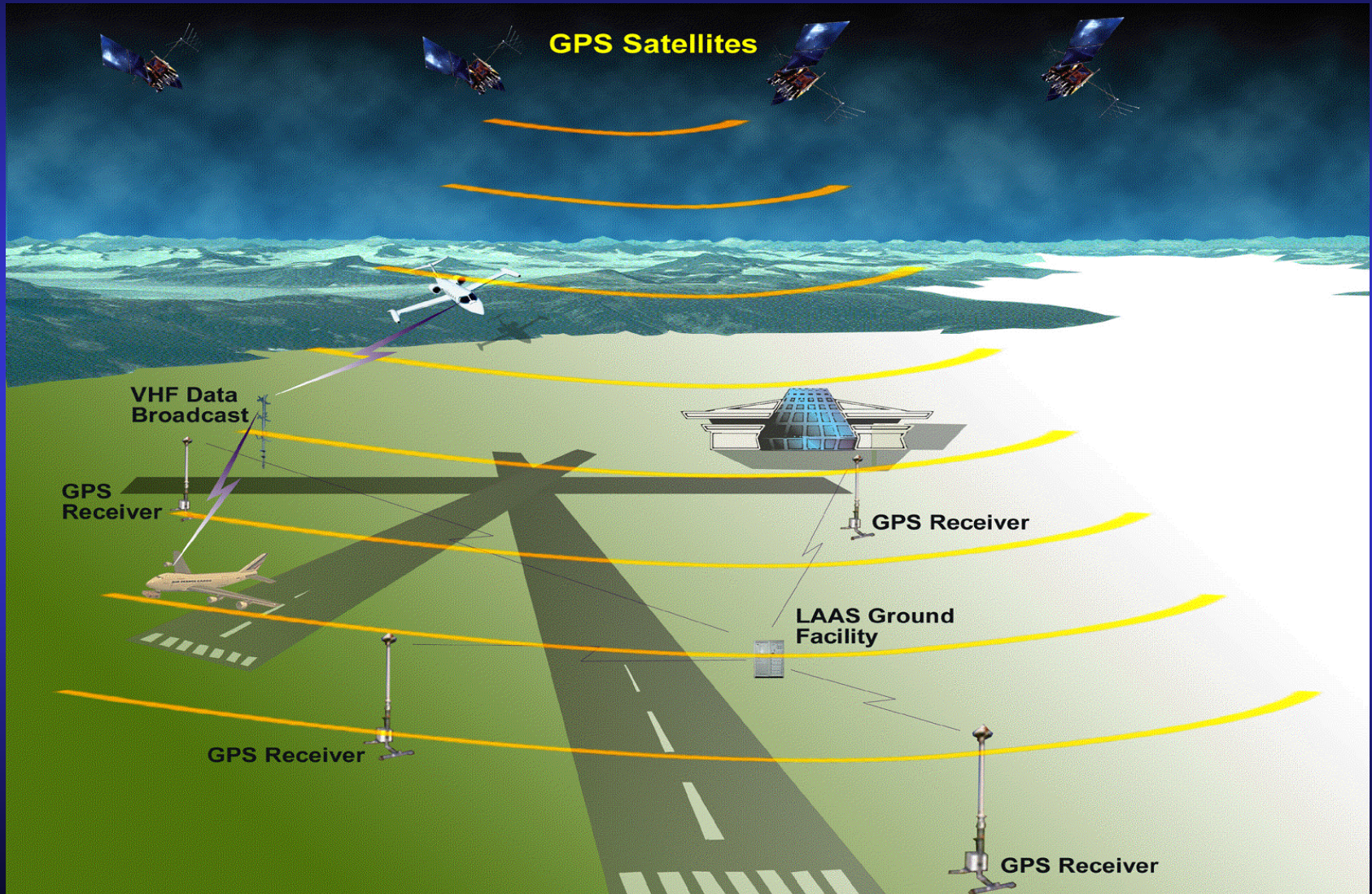


Increased Capacity - **Reduced Separation Due to Improved Accuracy**



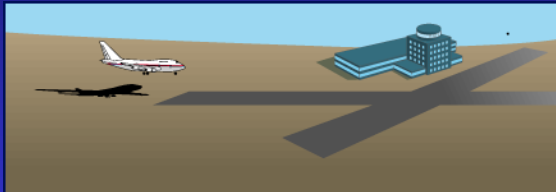


# LOCAL AREA AUGMENTATION SYSTEM (LAAS)





# LAAS Benefits



**Precision Approach Landing System**



**Remote Coverage** - Augments Wide Area System in Locations Not Cost Effective (Terrain Traffic Volume)



**Tailored Approaches** - To Avoid Obstacles, Noise Sensitive Areas, or Congested Airspace (Helicopter Urban Access)



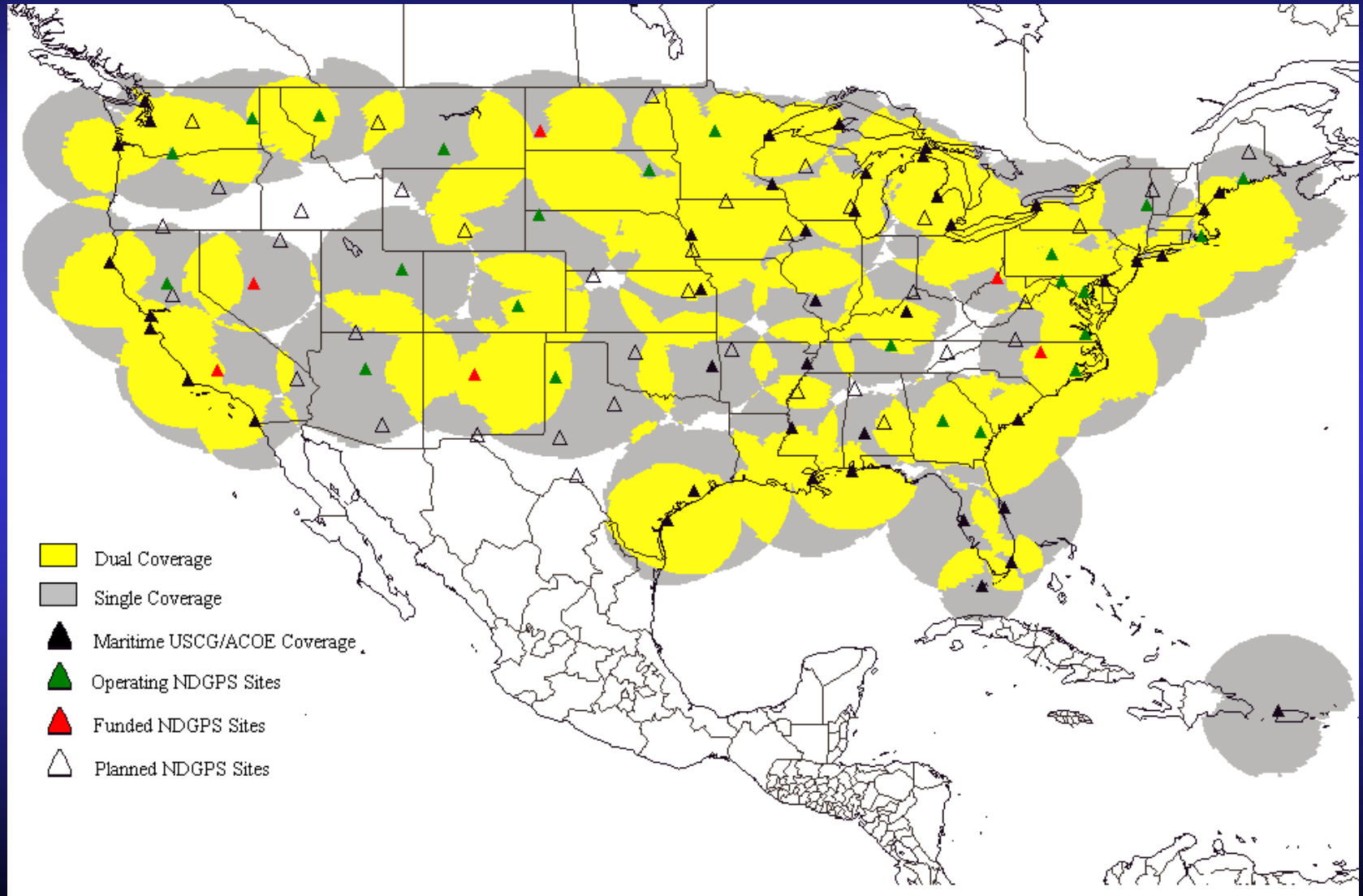
**Multiple Runway Coverage** - One LAAS Will Serve the Entire Airport (Reduced Equipment and Maintenance Costs)



**Aircraft Surface Navigation** - Aircraft Use as a Guide When Taxiing in Inclement Weather



# Nationwide/Marine DGPS





# NDGPS/MDGPS Benefits

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## Primary

- Marine navigation
- Positive Train Control
- Intelligent Transportation Systems

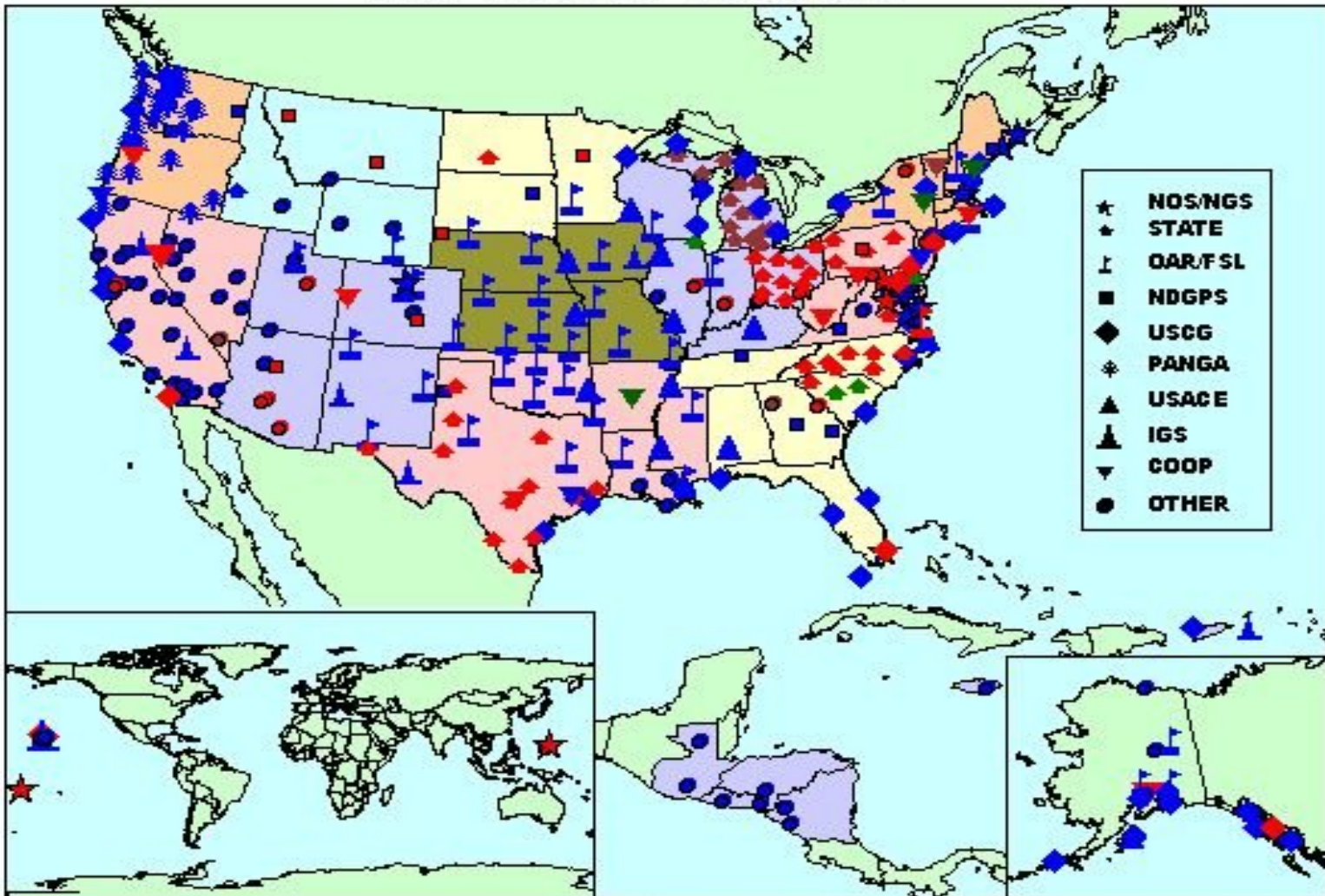
## Other

- Precision Agriculture
- Geographic databases
- Railroad & Highway inventory
- Emergency response
- Automatic vehicle location
- Snowplow guidance
- HAZMAT Tracking



# National Continuously Operating Reference System (CORS)

CORS Coverage - March 2002



Symbol color denotes sampling rates: (1 second) (5 seconds) (15 seconds) (30 seconds)



# CORS Status/Benefits

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- Operated by Commerce's **National Oceanic and Atmospheric Administration (NOAA)** CORS data provides the **framework for**
  - National civil mapping, surveying, and many engineering applications
  - Collecting meteorological data at some sites
- **Benefits**
  - Precise survey and mapping
  - Remote sensing and Weather forecasting



# GPS Civil Capabilities

	Application	Integrity	Availability	Accuracy
Maritime	Ocean transit	GPS	GPS	GPS
	Coastal navigation	GPS	GPS	GPS
	Inland waterway	NDGPS	NDGPS	NDGPS
	Harbor entrance & approach	NDGPS	NDGPS	NDGPS
Land	Highway navigation	GPS	GPS	GPS
	Emergency Response	GPS	GPS	GPS
	Transit vehicle management	NDGPS	NDGPS	NDGPS
	Railroad train control	NDGPS	NDGPS	NDGPS
Aviation	Oceanic en route	GPS	GPS	GPS
	Domestic en route	GPS	WAAS	GPS
	Non-precision approaches	GPS	WAAS	GPS
	Precision approaches	WAAS/LAAS	WAAS/LAAS	WAAS/LAAS

Requirements can be met by GPS Alone



Requirements are met by GPS plus augmentations





# GPS IIR & IIF Civil Capabilities

	Application	Integrity	Availability	Accuracy
Maritime	Ocean transit	Green	Green	Green
	Coastal navigation	Green	Green	Green
	Inland waterway	Red	Yellow	Yellow
	Harbor entrance & approach	Red	Red	Yellow
Land	Highway navigation	Green	Green	Green
	Emergency Response	Green	Green	Green
	Transit vehicle management	Red	Yellow	Yellow
	Railroad train control	Red	Red	Yellow
Aviation	Oceanic en route	Green	Green	Green
	Domestic en route	Green	Yellow	Green
	Non-precision approaches	Green	Yellow	Green
	Precision approaches	Red	Red	Yellow

Requirements met by  
Current GPS Alone



Additional Requirements  
met by GPS IIR & IIF



Requirements not  
met by GPS alone







# GPS III Civil Capabilities

	Application	Integrity	Availability	Accuracy
Maritime	Ocean transit			
	Coastal navigation			
	Inland waterway	?	?	?
	Harbor entrance & approach	?	?	?
Land	Highway navigation			
	Emergency Response			
	Transit vehicle management	?	?	?
	Railroad train control	?	?	?
Aviation	Oceanic en route			
	Domestic en route		?	
	Non-precision approaches		?	
	Precision approaches	?	?	?

Requirements met by  
Current GPS Alone



Requirements to be  
met by GPS III





# Summary

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- GPS civil service currently has **shortfalls**
  - Fielding Augmentation systems for the near-term
- GPS **modernization underway**
  - GPS IIR-M/IIF satellites begin launch in 2005/2006
  - Defining civil GPS III capabilities for **2012 and beyond**
- As modernization proceeds, **will reassess** role of augmentation systems