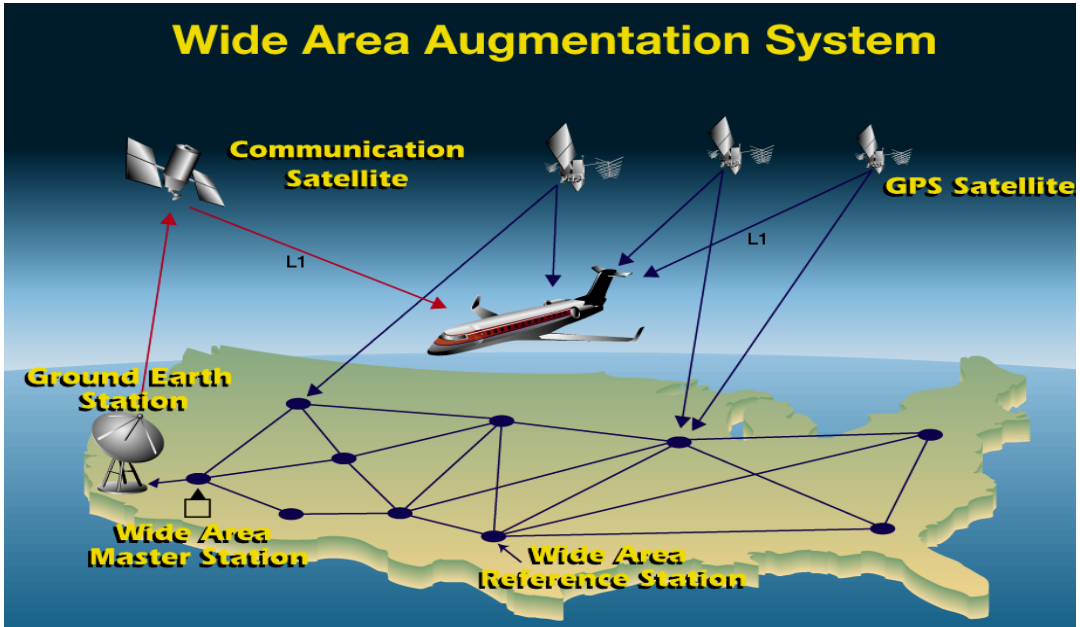
Analysis and Evaluation of WAAS for Maritime Users



Outline

- Background
- Project Objective
- Scope of Work
- Phase I Data Planned Collection Effort
- Phase II Analysis and Data Collection
- Simulation Modeling

Background

- FAA Developed the GPS Wide Area Augmentation System (WAAS) for Aviation Use
- WAAS Reached IOC in July 2003 and Achieves Accuracies of 1-2m Horizontal and 2-3m Vertical
- WAAS Receivers are Widely Available in the Public Marketplace and Are Being Used in Maritime Regions
- 2004 Radionavigation Task Force Report Identified Need to Assess Whether WAAS can Meet Maritime Requirements

Project Objective

Perform an Independent, Technical Evaluation to Determine if WAAS Can Satisfy Performance Requirements for Maritime Navigation and Positioning Applications

Scope of Work

- Use a WAAS Model to Assess Coverage, Availability, Integrity and Accuracy (Volpe Model Developed for FAA and Validated with FAA Tech Center Data)
- Determine Impact of Using WAAS Integrity for Maritime Applications (Can WAAS Meet Maritime Requirements; Is There An Availability Impact if WAAS Receiver Requirements for Aviation are Too Stringent for Maritime Use?)

Scope of Work (Cont.)

- Collect Site Data With GFP WAAS Maritime and Aviation Receivers and Antennas (2 Maritime RCVRs and 1 Certified Aviation RCVR)

  - Examine Differences Between Off-the-Shelf Maritime Receiver, Reference Station Receiver, and Certified Aviation Receiver

  - Ohio University and C2CEN to Provide Support With Data Collection Effort

- If WAAS Cannot Meet Maritime Requirements, Provide Recommendations for Improvements for WAAS Enhancements and/or Receiver Design

Maritime Requirements

Table 2-2. Current Maritime User Requirements for Purposes of System Planning and Development - Inland Waterway Phase

REQUIREMENTS	MEASURES OF MINIMUM PERFORMANCE CRITERIA TO MEET REQUIREMENTS								
	ACCURACY (meters, 2drms)		COVERAGE	AVAILABILITY	RELIABILITY	FIX INTERVAL (seconds)	FIX DIMENSIONS	SYSTEM CAPACITY	AMBIGUITY
	PREDICTABLE	REPEATABLE							
Safety of Navigation (All Ships & Tows)	2-5	2-5	US Inland Waterway Systems	99.9%	*	1-2	2	Unlimited	Resolvable with 99.9% confidence
Safety of Navigation (Recreational Boats & Smaller Vessels)	5-10	5-10	US Inland Waterway Systems	99.9%	*	5-10	2	Unlimited	Resolvable with 99.9% confidence
River Engineering & Construction Vessels	0.1**-5	0.1**-5	US Inland Waterway Systems	99%	*	1-2	2 or 3	Unlimited	Resolvable with 99.9% confidence

Table 2-3. Current Maritime User Requirements/Benefits for Purposes of System Planning and Development - Harbor Entrance and Approach Phase

(a)

REQUIREMENTS	MEASURES OF MINIMUM PERFORMANCE CRITERIA TO MEET REQUIREMENTS								
	ACCURACY (meters, 2drms)		COVERAGE	AVAILABILITY	RELIABILITY	FIX INTERVAL (seconds)	FIX DIMENSIONS	SYSTEM CAPACITY	AMBIGUITY
	PREDICTABLE	REPEATABLE							
Safety of Navigation (Large Ships & Tows)	8-20***	-	US harbor entrance and approach	99.7%	**	6-10	2	Unlimited	Resolvable with 99.9% confidence
Safety of Navigation (Smaller Ships)	8-20	8-20	US harbor entrance and approach	99.9%	**	***	2	Unlimited	Resolvable with 99.9% confidence
Resource Exploration	1-5*	1-5*	US harbor entrance and approach	99%	**	1	2	Unlimited	Resolvable with 99.9% confidence
Engineering & Construction Vessels Harbor Phase	0.1****-5	0.1****-5	Entrance channel & jetties, etc.	99%	**	1-2	2 and 3	Unlimited	Resolvable with 99.9% confidence

(b)

Benefits	MEASURES OF MINIMUM PERFORMANCE CRITERIA TO MEET REQUIREMENTS								
Fishing, Recreational & Other Small Vessels	8-20	4-10	US harbor Entrance and approach	99.7%	**	***	2	Unlimited	Resolvable with 99.9% confidence

* Based on stated user need.

** Dependent upon mission time.

*** Varies from one harbor to another. Specific requirements are being reviewed by the Coast Guard.

**** Vertical dimension.

Scope of Work (Cont.)

Project Conducted in Two Phases :

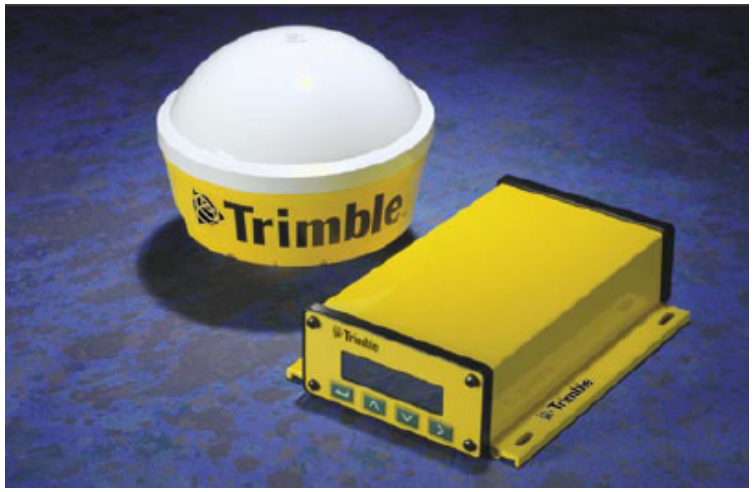
Phase I: WAAS Modeling to Assess Current Coverage, Availability, Integrity, and Accuracy Along With Limited Site Data Collection for Verification of the Model

Phase II: Additional Site Data Collection and Enhancements to the Model Based on Phase I Results. Enhancements to the WAAS Model to Assess WAAS Improved Capability at FOC (New Geos and Additional Reference Stations)

WAAS Receivers Used for Maritime Testing

Furuno GPS/WAAS Navigator GP-37

Trimble DSM132 GPS/WAAS Receiver



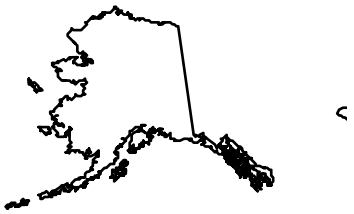
Garmin CNX80/ GPS480

Truth Data Ashtech ZXII

Ashtech Z12

- Post-processes kinematic solution planned.
- Access after test to downloaded data

Phase I Data Collection Sites

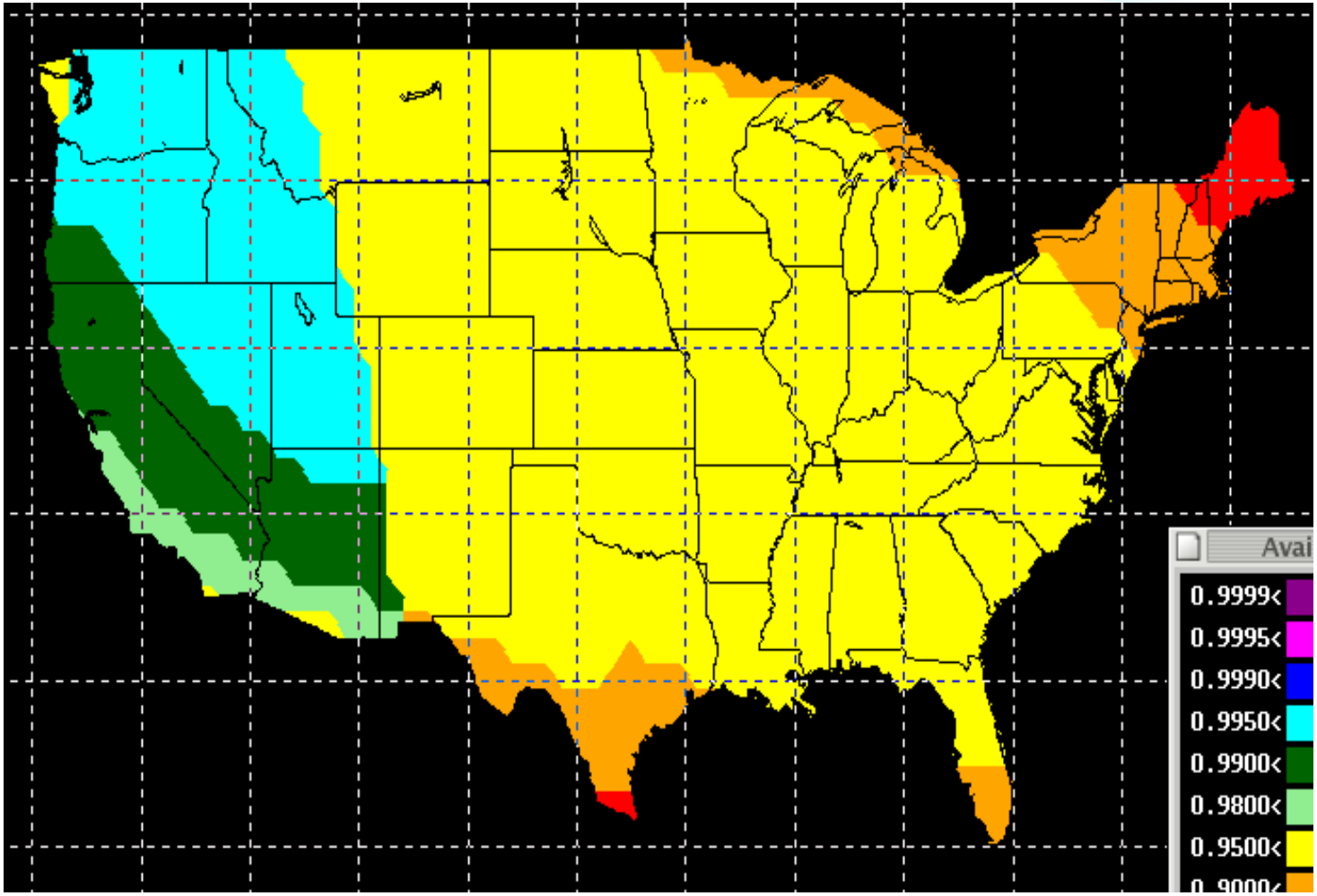


- Data Collected on Shore Over a 24-Hour Period
- Data Collected Along a Harbor or Waterway for 6-7 Hours

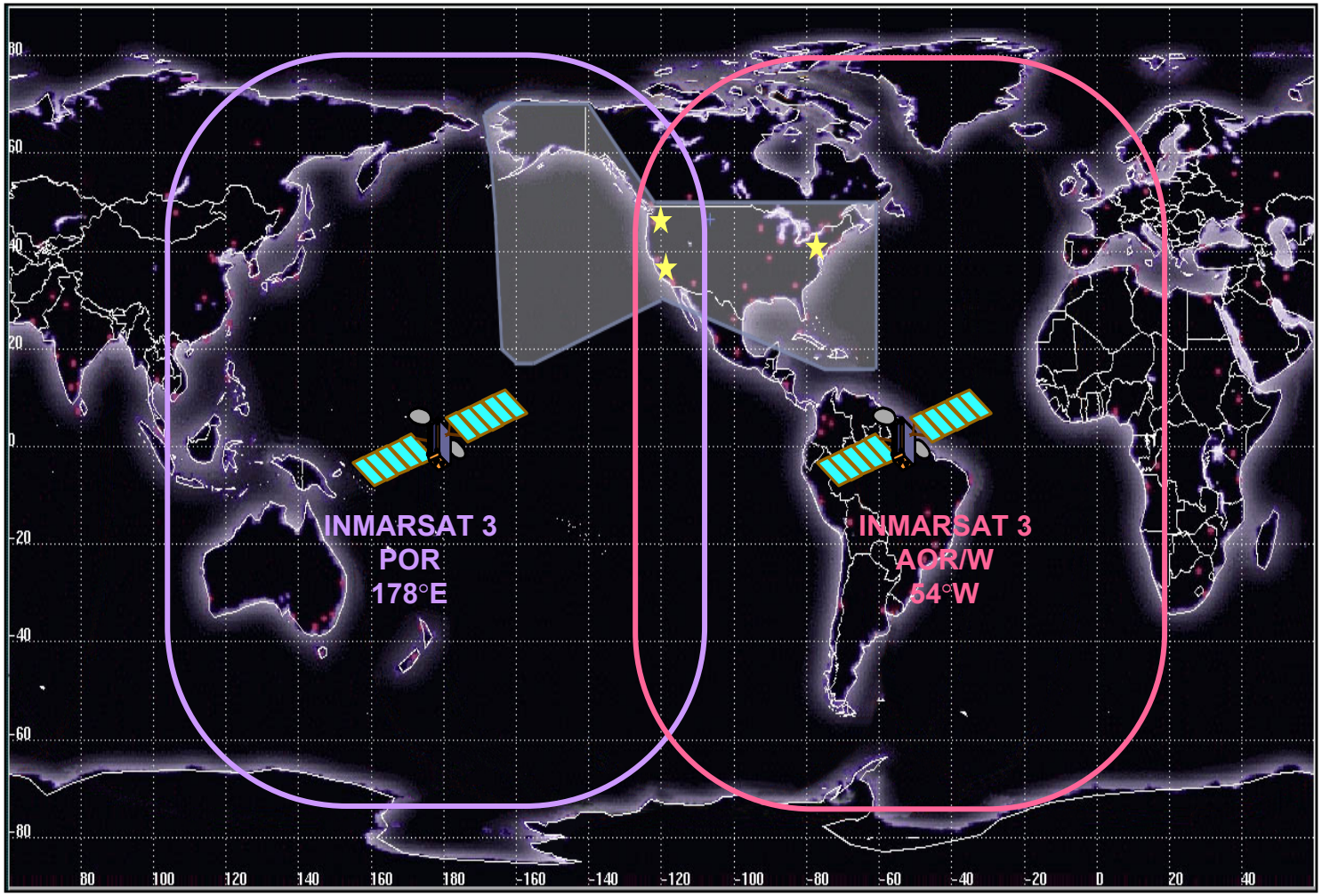
Phase II Data Collection Sites (Minimum of 6 Sites)

- Key West, FL
- San Francisco, CA
- Charleston, SC
- Norfolk, VA
- New York, NY
- Boston, MA
- Sault St. Marie, MI
- St. Louis, MO

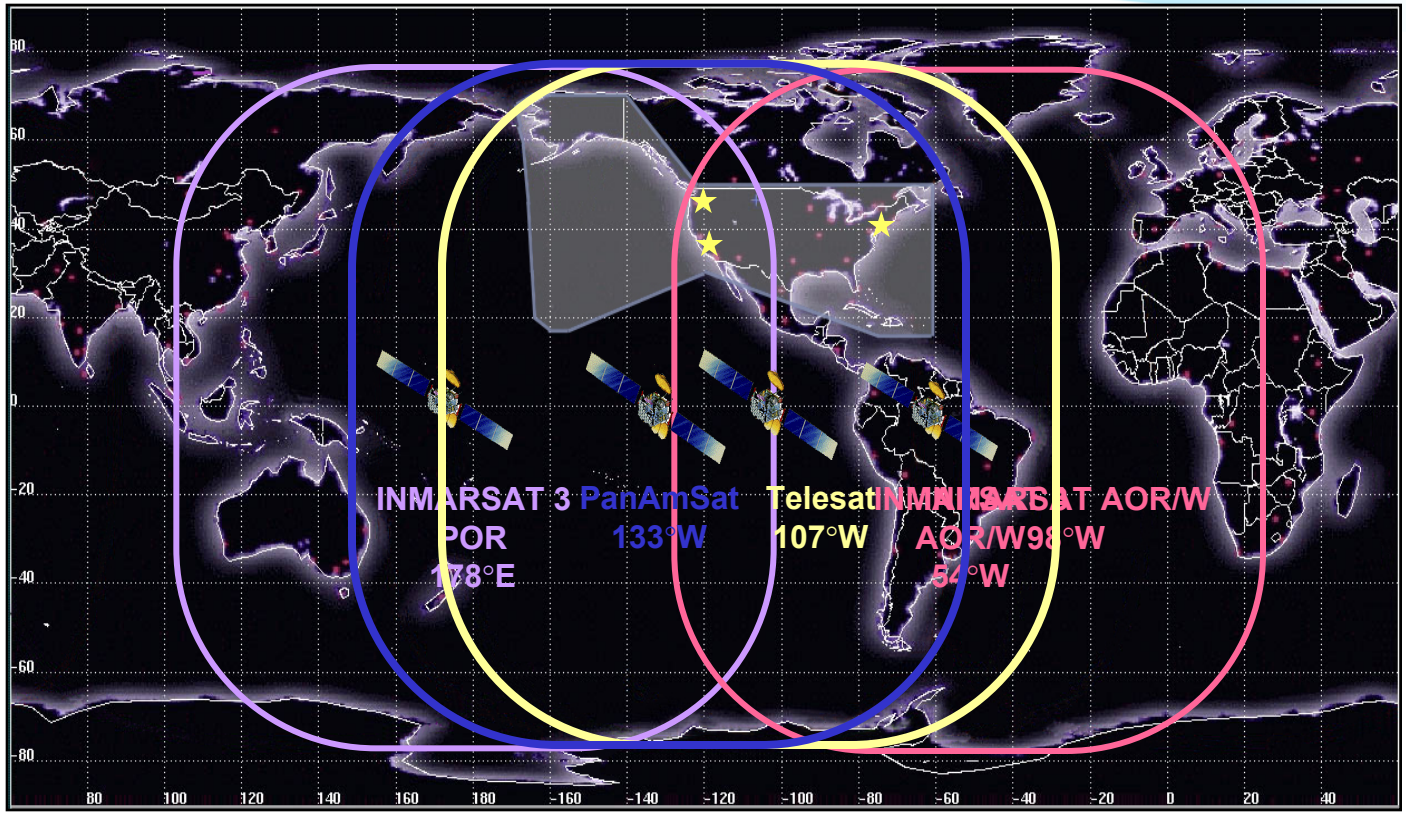
Current WAAS LPV Availability



Current GEO Service
Inmarsat III



GEO Transition



- Provides Dual Coverage Over CONUS and Alaska with AOR/W as hot spare
- AOR/W Moves from 54 West to 98 West

Regional Cooperation for Additional WAAS Reference Stations

Summary

- Phase I Expected to be Completed in November 2005
- Phase II Expected to be Completed in April 2006
- Determine Impact of Using WAAS Integrity for Maritime Applications

  - Can WAAS Meet Maritime Requirements

  - Is There An Availability Impact if WAAS Receiver Requirements for Aviation are Too Stringent for Maritime Use?

Acknowledgements

DOT OST P-50

USCG C2CEN

USCG NAVCEN

USCG HQ and Local Districts

FAA WAAS Program Office

Ohio University

Questions?

Contact for Additional Information

Karen Van Dyke

DOT/Volpe Center

Vandyke@volpe.dot.gov

617-494-2432