



Satellite Navigation Program



Joe Fee
International Technical Program Manager
Federal Aviation Administration

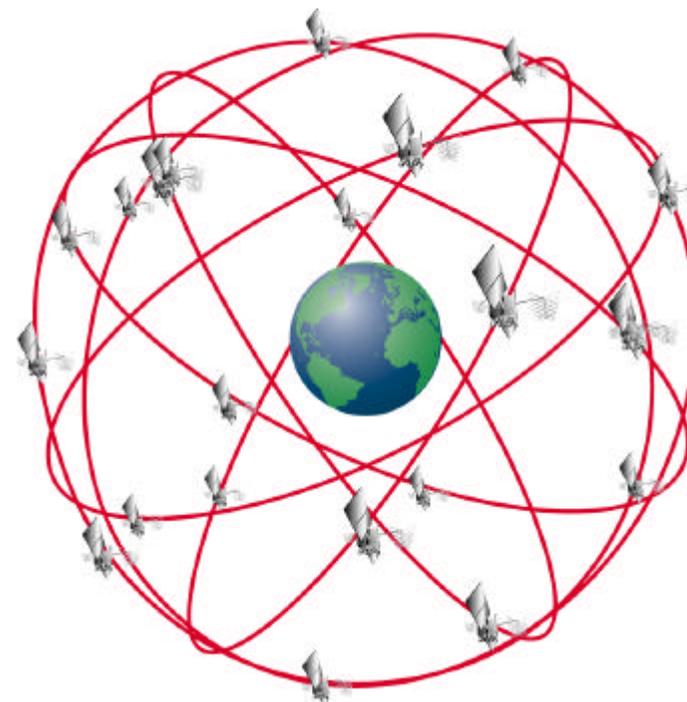


Basic GPS System



- **Space Segment**

- 24 Satellites
- 6 Orbital Planes
- 4 Satellites per Plane
- Orbit at Approximately 11,000 Nautical Miles Above the Earth
- Orbits Every 12 Hours

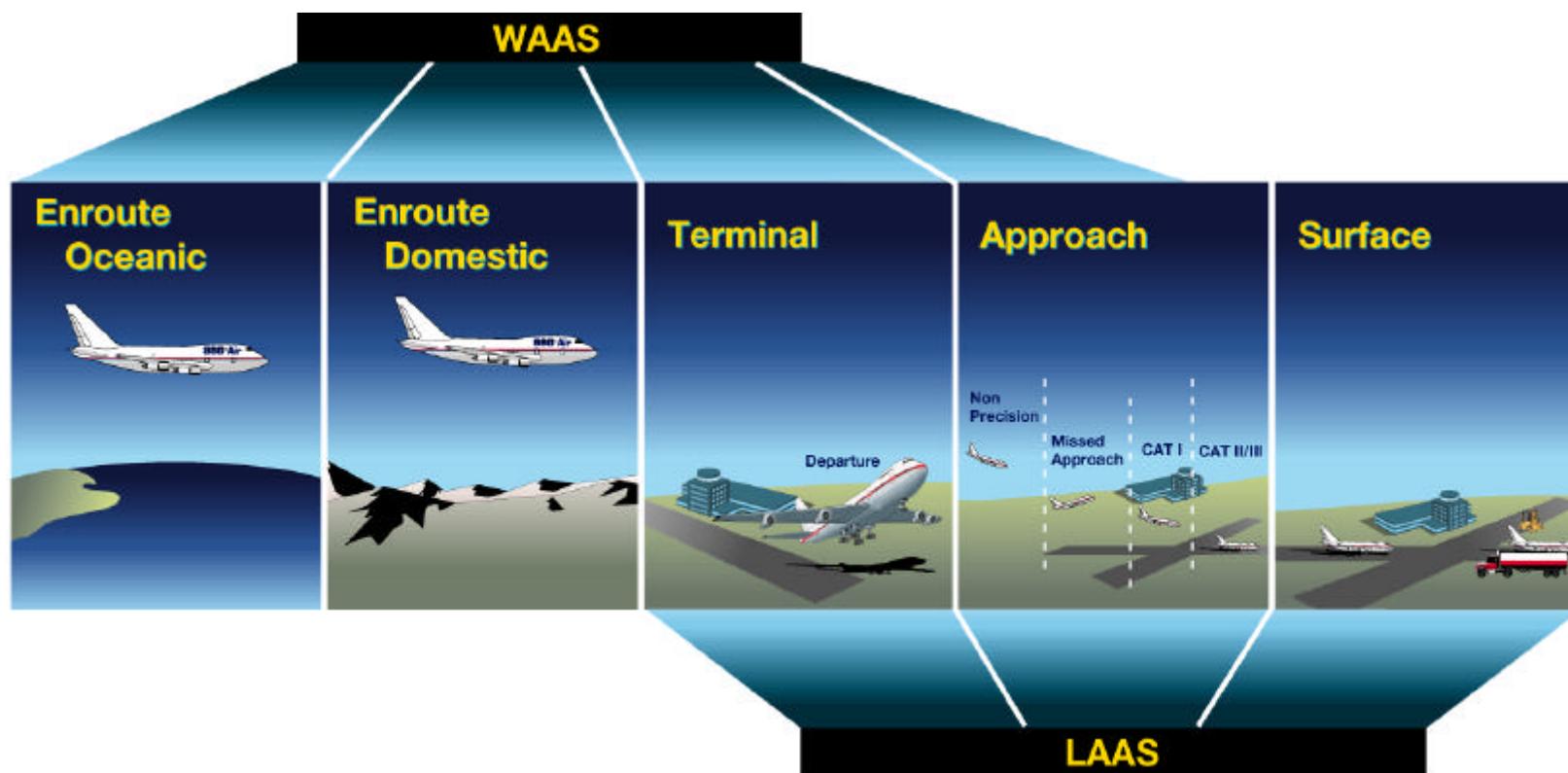


- **Ground Control Segment**

- Master Control Station, Colorado Springs
- 5 Monitor Stations at Worldwide Locations

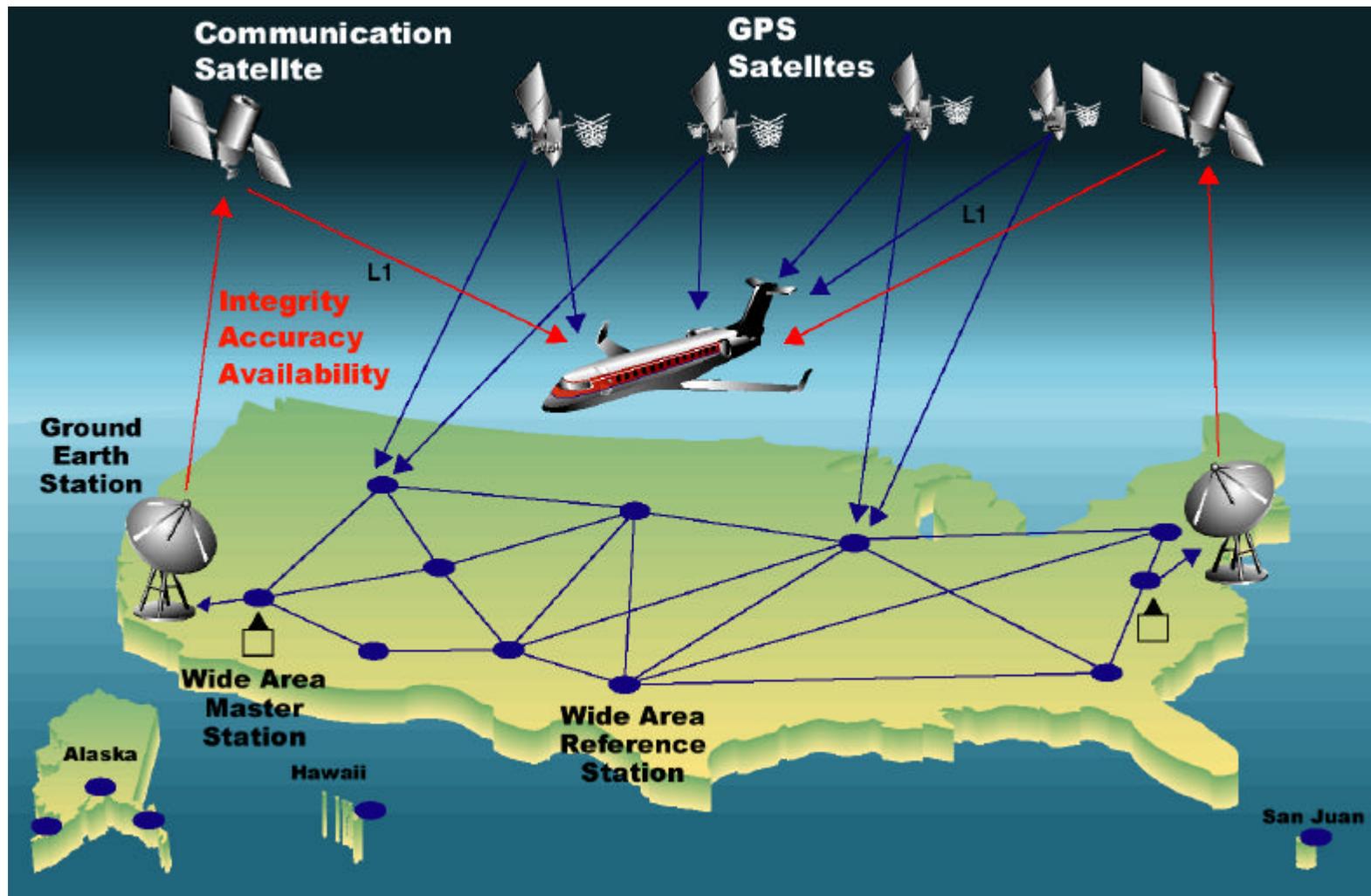


Satellite Navigation's Mission WAAS/LAAS Implementation





Wide Area Augmentation System (WAAS) Architecture





WAAS System Status



Communications

- **Satellites**
 - 2 of 2 on Orbit
- **Terrestrial Communications Links Installation Complete**

Hardware

- **WAAS Reference Stations**
 - 25 of 25 WRSs Installed/Tested (as of 6/3/98)
- **WAAS Master Station**
 - 2 of 2 WMSs Installed/Tested (as of 6/3/98)

Key Issues

- **Stability**
- **Integrity**



WAAS Key Issues



- **Stability**
 - **21-Day Stability Test Completed - June 30, 2000**
 - **Public Announcement of SIS Availability for Non-Safety Applications - Aug 24, 2000**

- **Integrity**
 - **Meeting FAA Integrity Requirement (Safety) is Now Most Significant Schedule Driver**
 - **Integrity Requirements (Precision Approach)**
 - **10⁻⁷/Approach**
 - **Time to Alarm: 6.2 Seconds for LNAV/VNAV**
 - **5.2 Seconds for GLS**



FAA Response to Integrity Issue



- **Formed WAAS Integrity Performance Panel (WIPP)**
 - FAA Established Team of Experts in January 2000 To Work Closely With Raytheon to Identify Most Cost-Effective and Expedient Solution
 - Team Includes FAA, MITRE, Stanford University, Ohio University, JPL
 - WIPP Actions:
 - Identify a Path to Achieve LNAV/VNAV Integrity
 - Identify Migration Path to GLS
- **Chartered Independent Review Board (IRB)**
 - Reports Directly to FAA Administrator on WIPP Products and Other Program Activities



WAAS Operational Status



- **Initial Operational Capability with LNAV/VNAV in 2002**
 - Vertical Guidance Down to 350 Feet Above Threshold
- **Precision Approach Capability Equivalent to Category I ILS**
 - Continuing Development



International Status



Canada

- **Transitioning to Operational Canadian WAAS (CWAAS)**
- **Future Agreement Underway to Integrate WAAS and CWAAS**

Mexico

- **Working Cooperatively With the FAA to Install 3 WAAS Testbed Stations (NSTB Single-strand Reference Stations) in Mazatlan, Merida, and Mexico City**
- **Preparing to Conduct Joint Faa/mexico Tests to Define Mexico Operational WAAS Participation, Expected Benefits and Overall System Performance**



International Status (Con't)



South America

- **The Caribbean and South American (CAR/SAM) Region Is Committed to a GNSS Solution As a Foundation for a Larger CNS/ATM Transition Within Latin America**
- **The CAR/SAM Test Bed (CSTB) Will Be Based on WAAS Testbed Stations (NSTB Single-strand Reference Stations)**
 - **Will Provide Test Capability for All of South America, Central America, and the Caribbean**
- **In the Future, LAAS Prototype Equipment Will Be Used to Conduct Tests for Providing a Precision Approach Capability to the Region**



International Status (Con't)

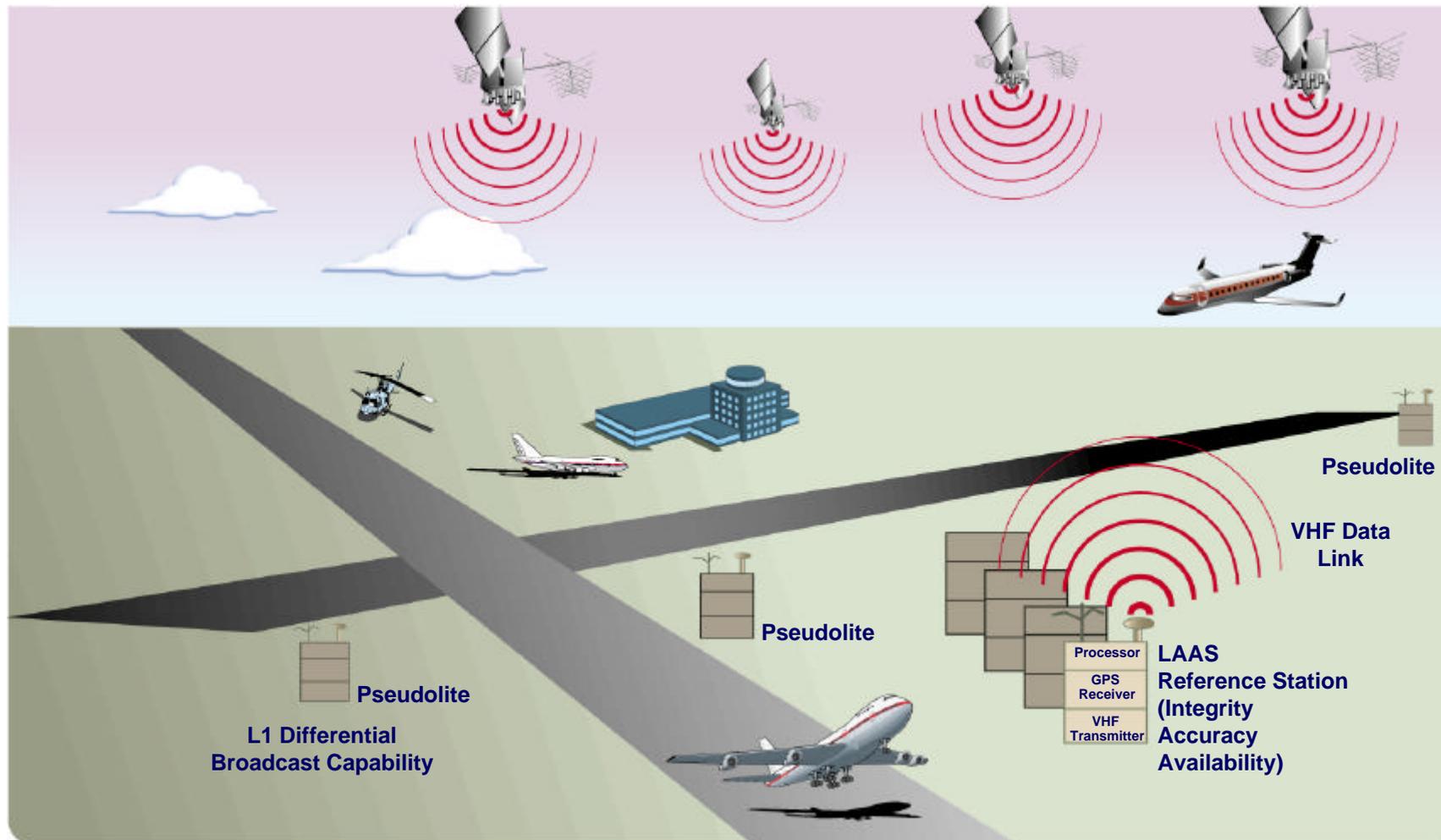


Japan/Europe

- **Interoperability Working Group (IWG) Established to Discuss Critical Interoperability Issues Important to Satellite Based Augmentation Systems (SBAS) Providers**
- **IWG/1 Was the First Such Meeting Between All SBAS Providers, Hosted by U.S. - Aug 97**
- **Seven Additional Meetings Have Been Held in Europe, Canada and Most Recently in Japan (May 2000)**



Local Area Augmentation System (LAAS) Architecture





LAAS Background



- **Government Industry Partnerships Signed (4/99)**
 - Raytheon and Honeywell Teams
- **LAAS Flight Tests in Atlantic City, NJ (8/99)**
 - ATA, FAA, and UPS Participated
- **LAAS Flight Trials in Memphis, TN (11/99)**
 - ATA, FAA, and FedEx Participated



LAAS Implementation Plans



- **Install 20 CAT I LAAS Beginning in 2002**
- **Install First CAT III LAAS in 2005**
- **Plan Calls For a Total of 160 LAAS**
 - 46 CAT I
 - 114 CAT III



Practical Aspects of Satellite Navigation



- **Routes**
 - Direct
 - Independent of Ground Infrastructure

- **Approaches**
 - Greater Uniformity
 - More Precise / Easier to Fly
 - Vertical Guidance Available for Most Airports



Status of GPS Approach Procedures



- **2,353 GPS Non-precision Procedures Have Been Published**
- **1,057 of the GPS NPA's Provide New Capability to Runways that Previously Did Not Have a Straight-In IFR Approach**
- **146 LNAV/VNAV Approaches Have Been Developed**



GPS Today and Tomorrow



- **27 Satellites With L1 C/A Signal Today**
- **WAAS Initial Operational Capability LNAV/VNAV in 2002**
- **LAAS CAT I Commissioning 2002**
- **LAAS CAT III Commissioning 2005**



Back Up Slides

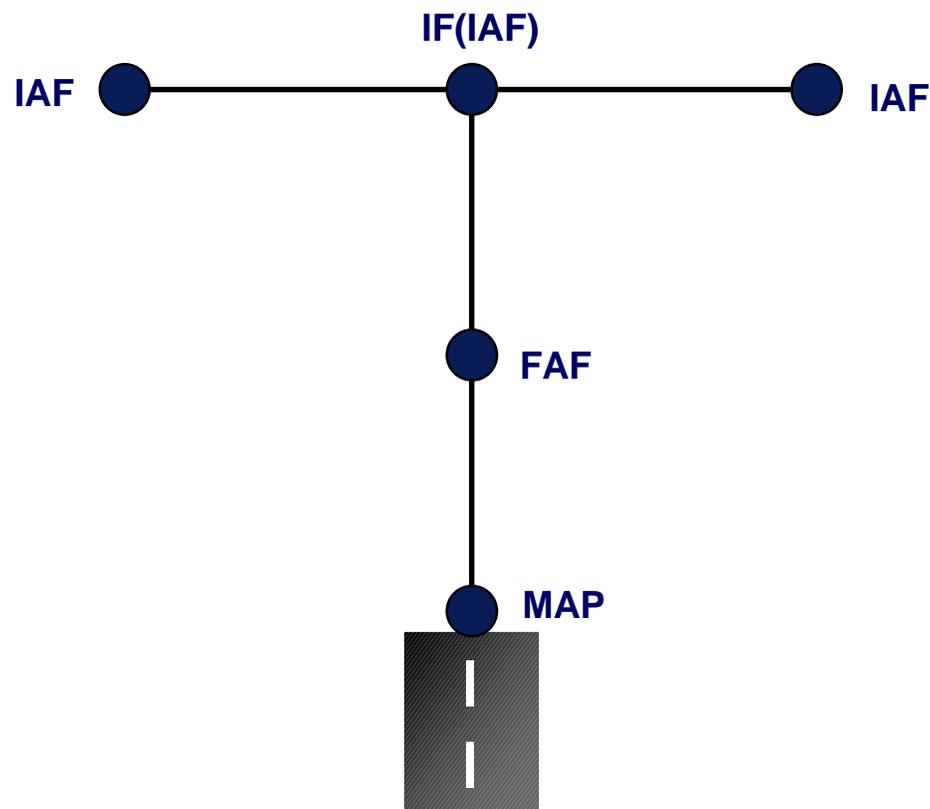




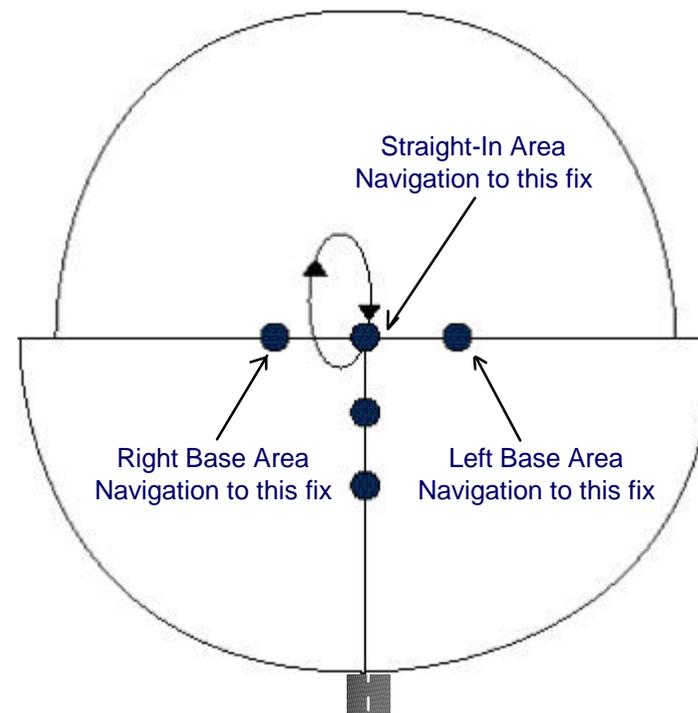
Basic "T" Approach



Basic "T"



Standard TAA





WAAS Procedures Development PLAN



	99	00	01	02	03	04	05	06	07	08	Total
WAAS	0	50*	490	490	490	485	485	485	485	150	3610
LNAV/VNAV	0	50*	490	490	490	485	485	485	485	150	3610
LNAV**	490	490	490	490	490	485	485	485	485	0	4340
Helicopter	10	10	10	10	10	15	15	15	15	0	100

* *Minimum.*

** *LNAV (TSO-129) Procedures will be reaccomplished when overlying WAAS and LNAV/VNAV are developed.*