Frankfurt WAM

Examples of multilateration implementation

ICAO Seminar on the Implementation of Aeronautical Surveillance and Automation Systems in the SAM Region

San Carlos de Bariloche 6-8 Decembre 2010

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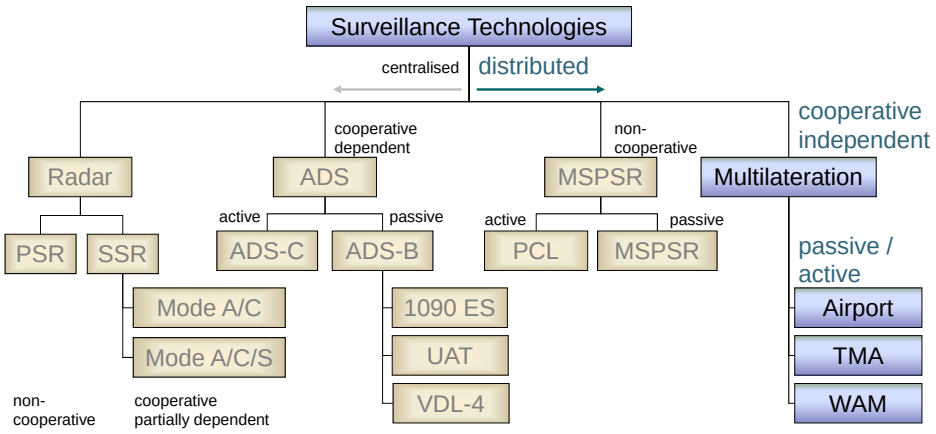
New Surveillance Technologies in ATM



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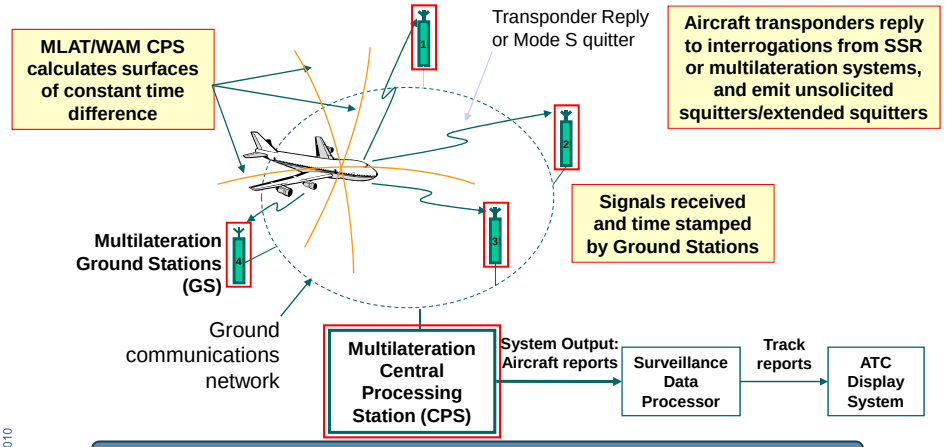
Fundamental Principle of Multilateration

Airport Multilateration (MLAT)
Wide Area Multilateration (WAM)



Multilateration measures Positions

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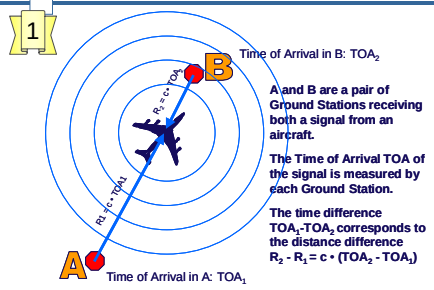
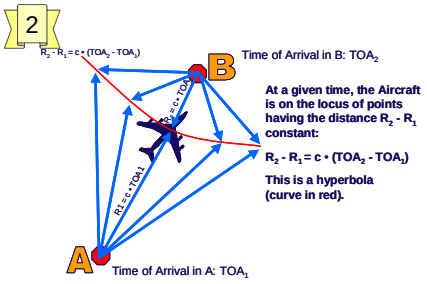
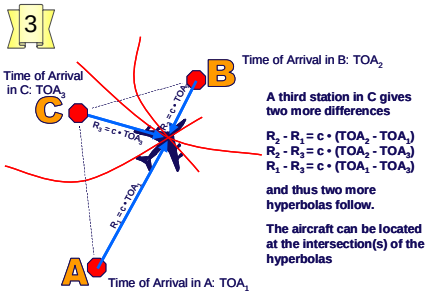
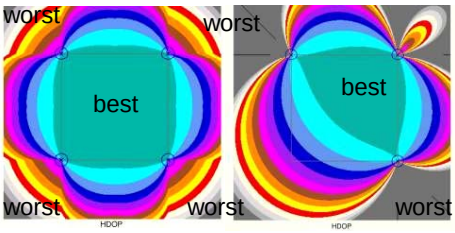
Multilateration Basics







Typical Accuracy Distribution from Theory



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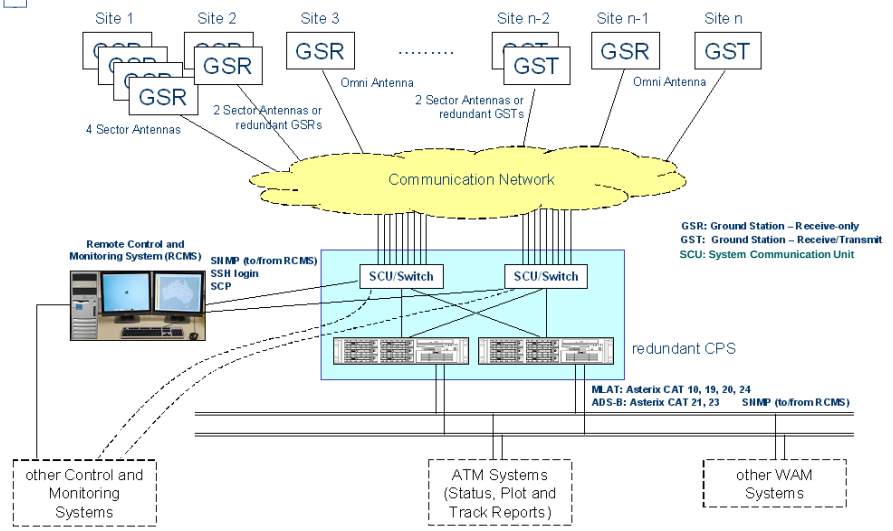
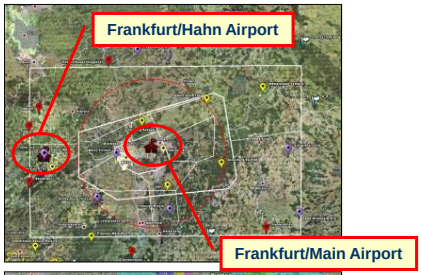
MLAT/WAM System Block diagram

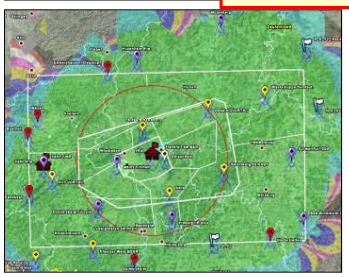


Flexible and scalable network centred Architecture

MAGS WAM: DFS PAM Frankfurt

Coverage Requirements

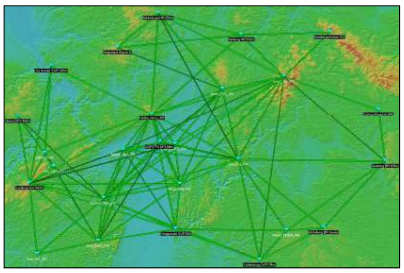




Coverage Simulations

Wide Area Multilateration (WAM) System, Terminal Area Multilateration System, Airport Surface Multilateration System

- Frankfurt Terminal Area (120 NM x 80 NM)
- Among the heaviest 1090 MHz radio load in the world (according to FAA)

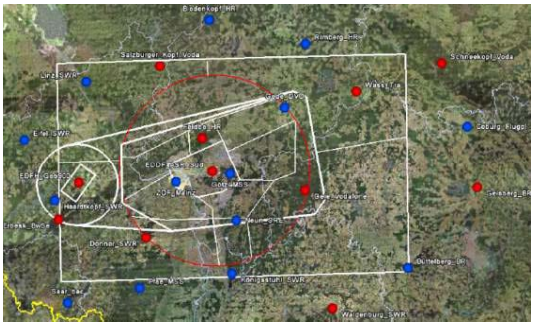


Link Budget Models

Sites selection

Stepwise process based upon:

- Detailed visual and graphical topography analysis
- Computer simulations of the multilateration performance.
- A series of site surveys and succeeding discussions with DFS



blue **=** GSR sites (receive function only).
red **=** GST sites (receive/transmit function).

All GST sites are acting as ***time calibrators*** and ***interrogators***.

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Special Considerations for Multilateration Systems

Geometry of Ground Station Sites and Target : DOP
- ➔ Common GS coverage required : min 3 GS for 2D, min 4 GS for 3D
- ➔ Good GS constellation required

Synchronisation accuracy
- ➔ Stable and precise common GS time base required

Line of sight restrictions
- ➔ Sufficiently strong signals required (Time of Arrival (TOA) accuracy corresponds to S/N (strong signals = good TOA, weak signals = bad TOA)

Potential obstacles for signal propagation (e.g. terrain, buildings...)
- ➔ Multipath processing required (Wrong TOA, e.g. due to multipath, particularly when no direct signal due to masking)

Availability of the site/building, accessibility

Availability of power supply and data network

Operational constraints, e.g. obstacle clearance limits

Implementing Multilateration requires both:
a good system and good planning!

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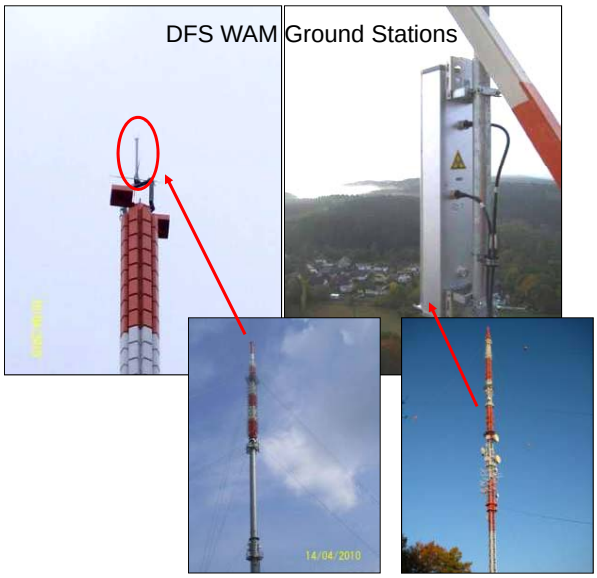
Installed WAM Sites

DFS WAM Central Processing Station



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Good sites do exist, but...

...many others came before – and they have similar needs

- No space on mast
- Top position occupied
- Strong transmitters
- Harmonics close to the 1090 MHz frequency
- Icefall may impact antenna‘s life
- Daily lightning strikes

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WAM Ground Station Enclosure Types

10 HU indoor

24 HU indoor

24 HU outdoor

24 HU indoor

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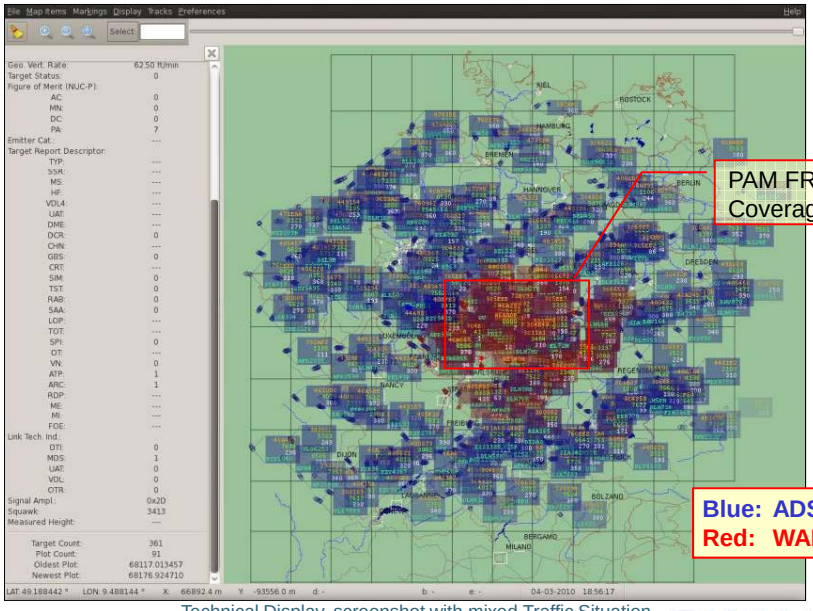
WAM : DFS PAM FRA initial test results



Technical Display, screenshot with mixed Traffic Situation

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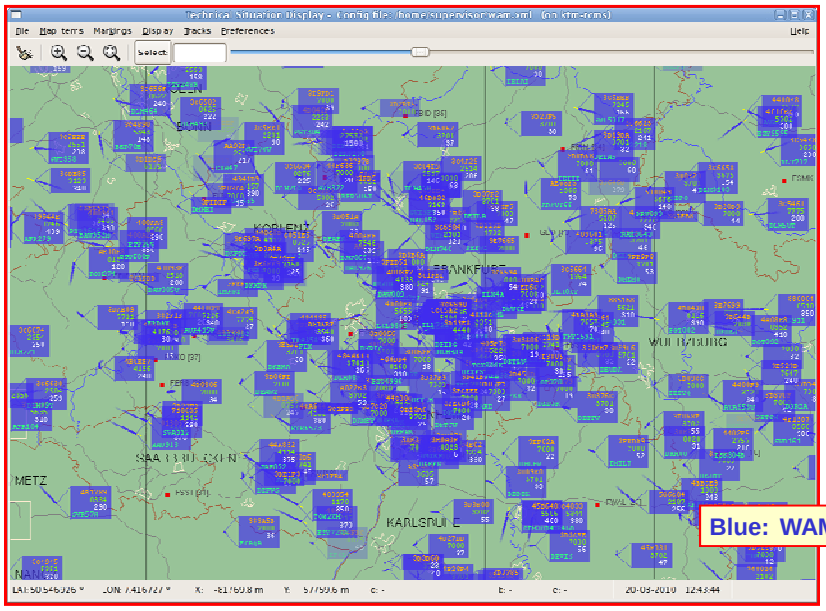
PAM-FRA: WAM Results within Coverage Area



Technical Display, screenshot with WAM-only Traffic Situation – zoomed-in on coverage area

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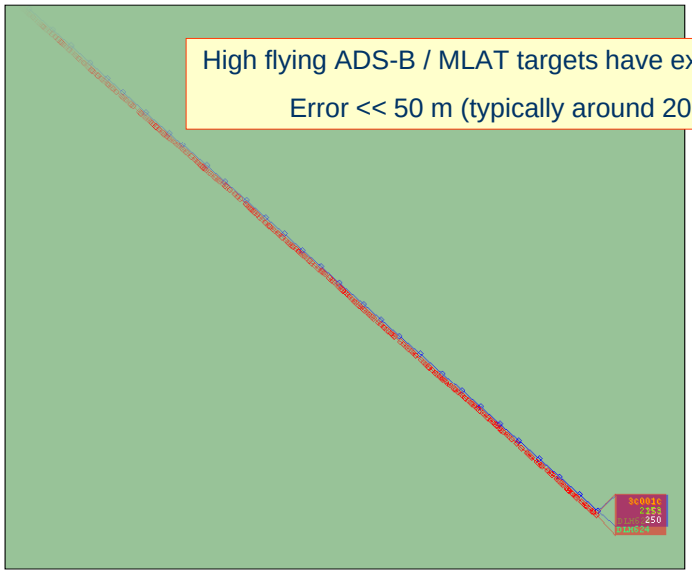
WAM: DFS PAM FRA - a closer look



High flying ADS-B / MLAT targets have excellent match.

Error << 50 m (typically around 20-30 m),

Blue: ADS-B
Red: WAM

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WAM/MLAT References

Thales WAM References

DFS PAM Frankfurt

•Upper and lower airspace, TMA, CTR, GND at two airports

NATS London TMA

•Upper and lower airspace, TMA, CTR ?

Afghanistan country-wide WAM

•Upper airspace coverage

Test bed: WAM STR (Stuttgart-Nuremberg Airspace)

•Upper and partially lower airspace, GND

Thales Airport MLAT References

- **Lyon St. Exupéry Airport**
- **Abu Dhabi Airport**
- **Taipeh Tayouan Airport**
- **Helsinki Vantaa Airport**
- **Milano Linate Airport**

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