



# The Saudi Positioning System & Measurement results

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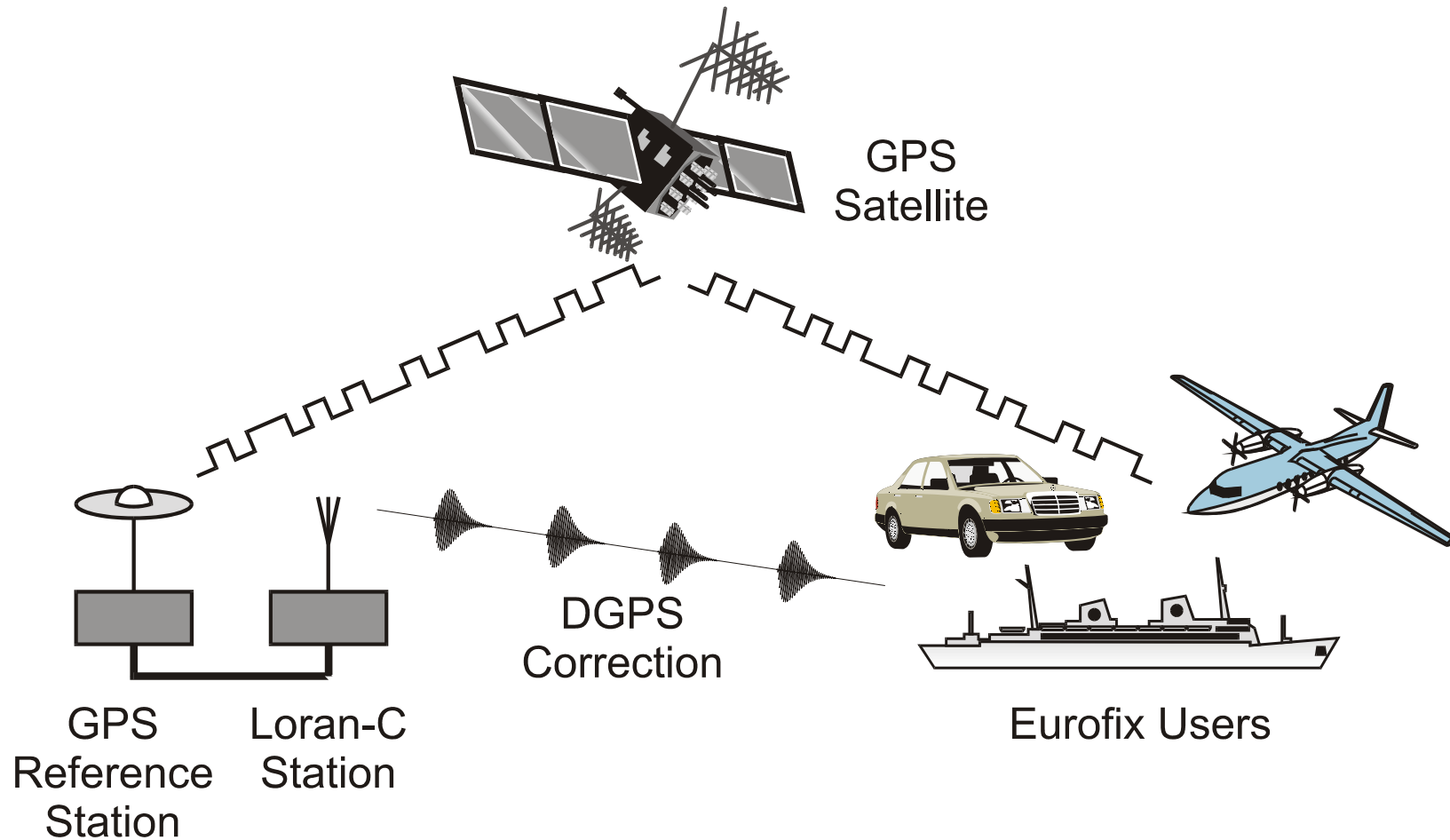


# Saudi Positioning System

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- March 2004, Saudi Ports Authority awarded a contract to Megapulse and Reelektronika to install Eurofix on three Loran-C stations in Saudi Arabia
  - Ash Shaykh Humayd, Afif, and Al Muwassam
    - DGPS Reference station
    - DGPS Integrity monitor
    - Signal modulation equipment at the Loran stations
- DGPS and Integrity service from the Eastern Med through Suez, the Red Sea, and into the Gulf of Aden
- The Saudi Positioning Service is on air since 8 March 2005

# Saudi Positioning System overview



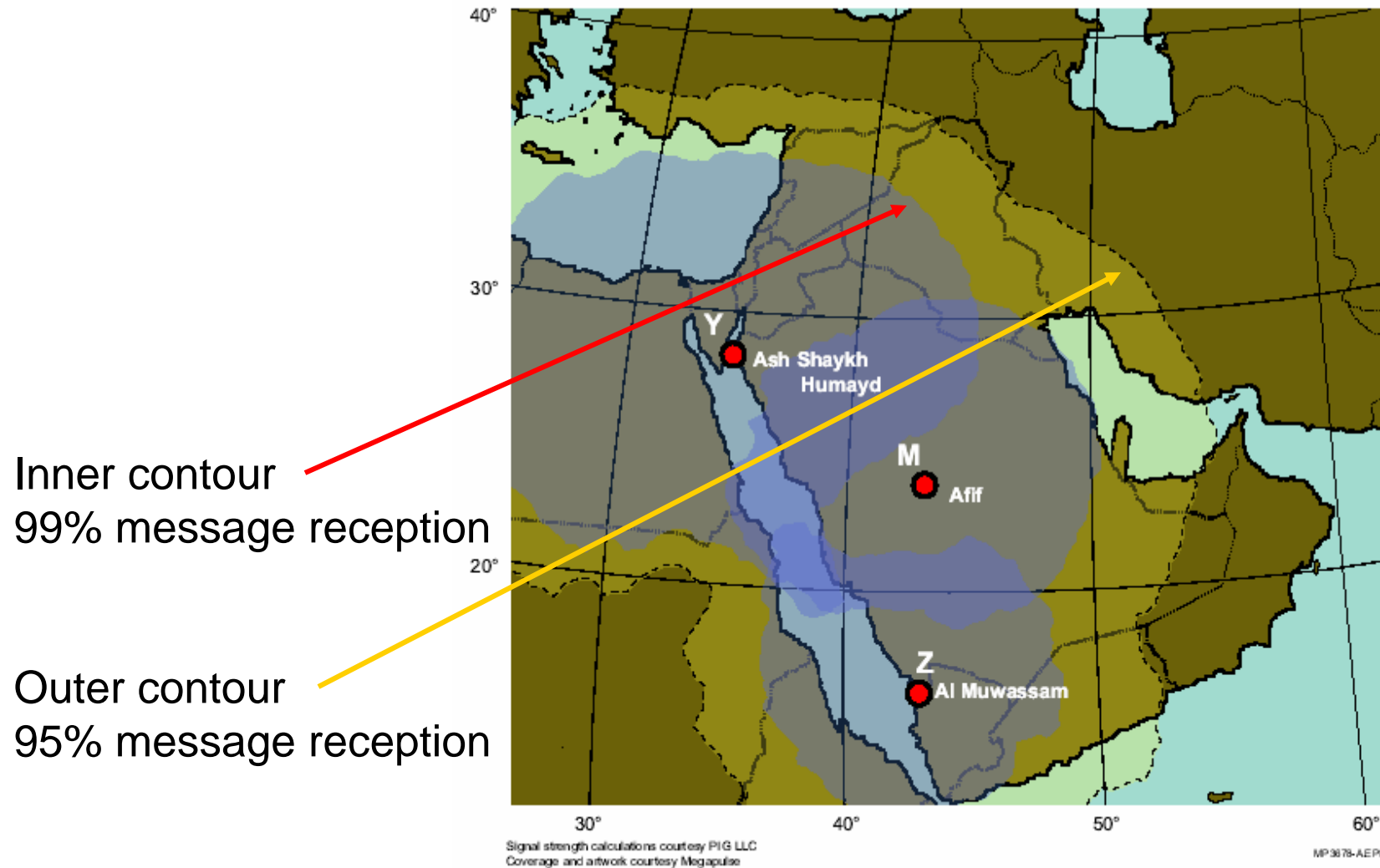


# Purpose of SAPS

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- Differential GPS and integrity over the whole kingdom with three Loran transmitters
- Radiobeacon installation would require some 50+ stations
- Loran provides additional system next to GPS:
  - Saudi Positioning System is Saudi owned and controlled
  - Threat of GPS being unavailable is more likely in that part of the world
- A fourth station is planned to be installed in 18 months time, extending DGPS range over Arabian Gulf and improving Loran coverage to the East

# Predicted SAPS datalink Coverage



# Site Surveys



**Afif**

**Al Muwassam**

- Site Surveys conducted September, 2004 to determine:
  - Equipment and antenna placement
    - GPS Survey
    - Loop Antenna Measurements
  - Equipment readiness
  - Material requirements



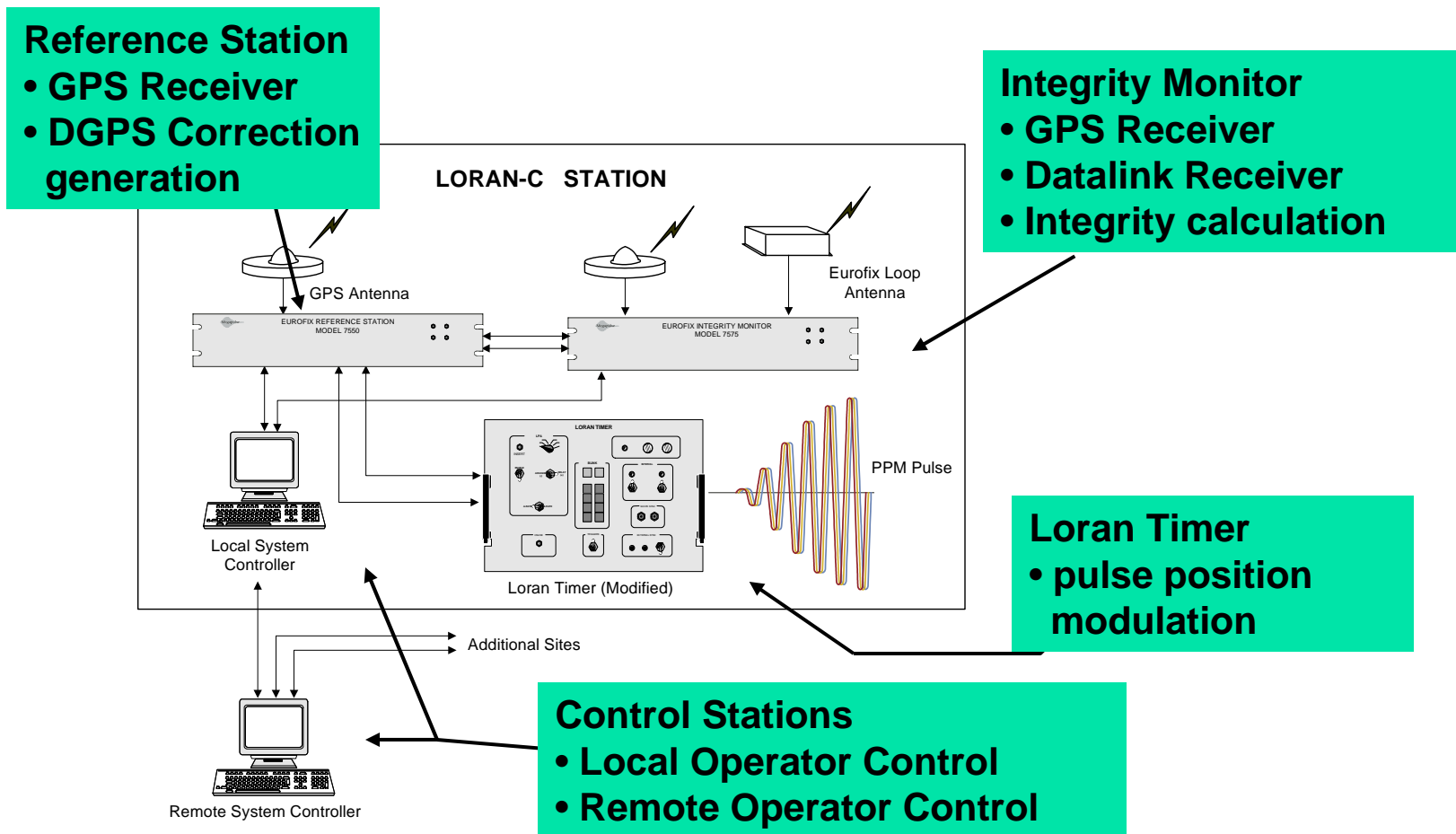
**Ash  
Shayk  
Humayd**



**Riyadh  
Control  
Center**



# SAPS Site Equipment





# RSIM Adaptation for dLoran

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- Reference Station and Integrity Monitor platforms are flexible
- Possible additional or alternate functionality:
  - Differential Loran correction generation
  - Differential Loran and integrity data broadcast
  - UTC synchronization of Loran with GPS
- Datalink Monitor receiver can be configured to monitor 9<sup>th</sup> pulse modulation
- Architecture supports use at both monitor and transmit sites for differential Loran network



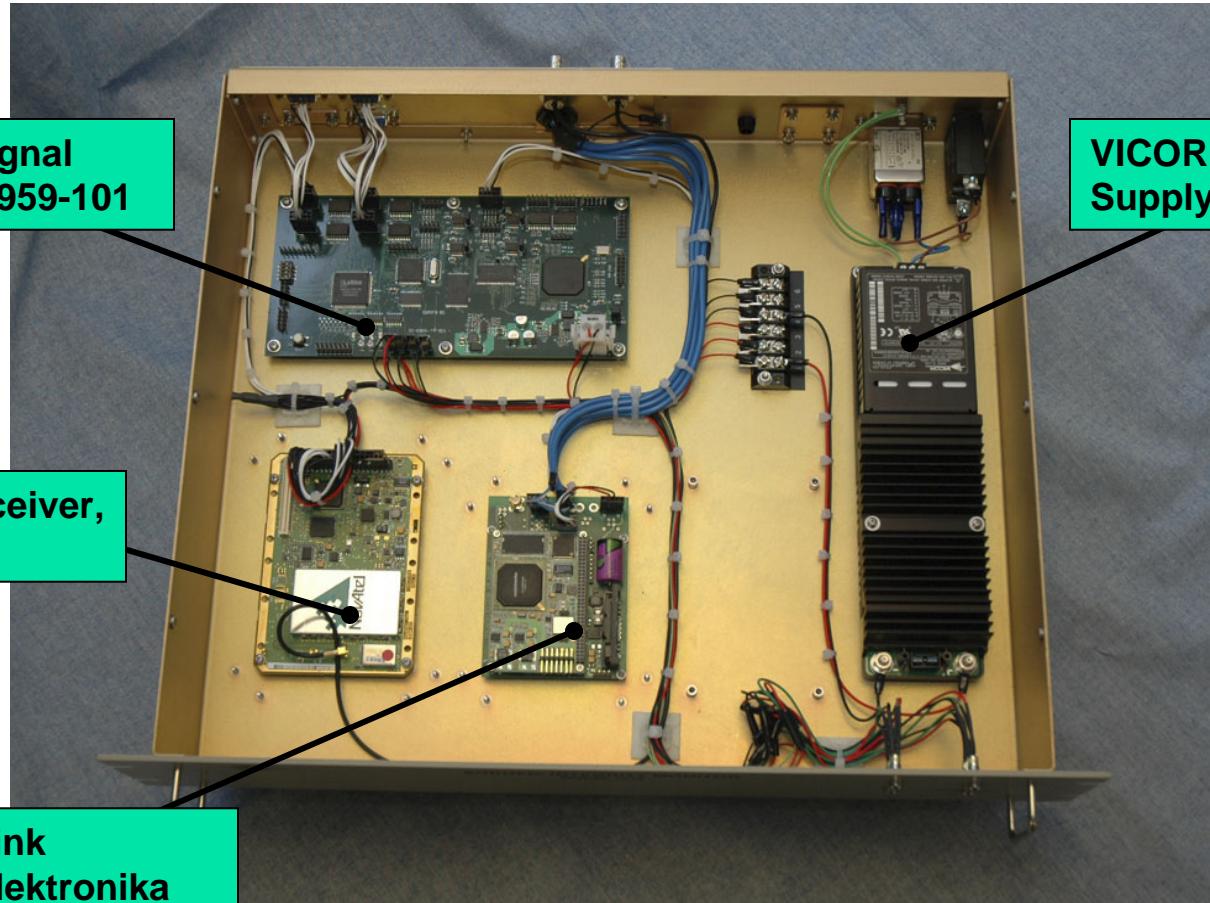
# Eurofix Integrity Monitor

**Eurofix Digital Signal Processor, 32-10959-101**

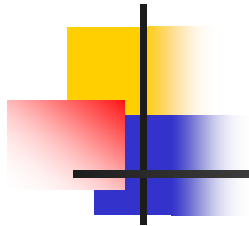
**VICOR 5 Volt Power Supply, VI-LUO-CY**

**NovAtel GPS Receiver, OEM4-G2-3151R**

**Eurofix Datalink Receiver, reelektronika**



**Reference Station in similar box**



# Loran-C/Eurofix TX Control

Cs clocks, timers, Eurofix modulators & monitor receivers



Eurofix Local System Controller



**Eurofix Reference Station**

**Eurofix Integrity Monitor**

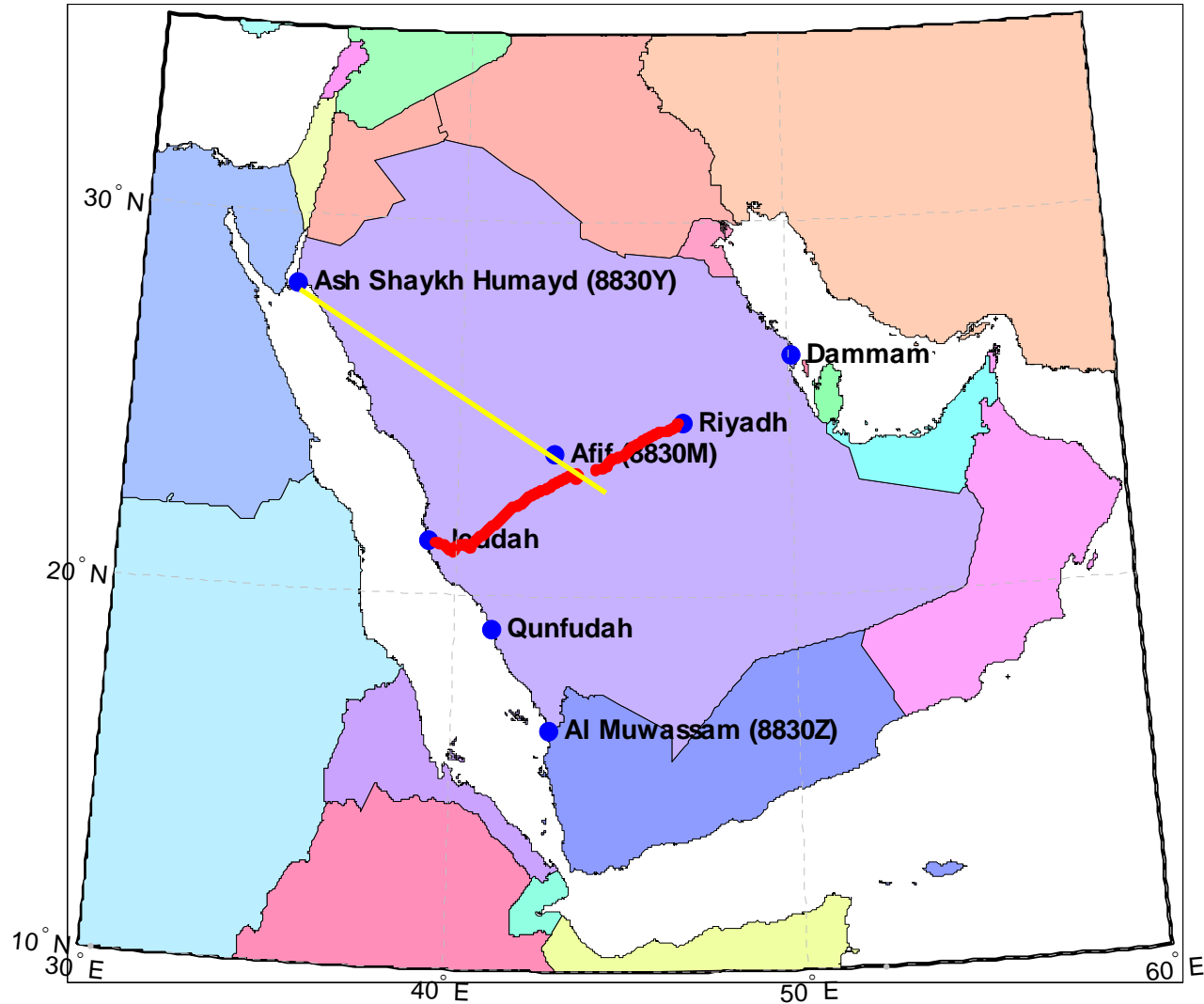


# Driving Riyadh - Jeddah





# Autonomous Loran-C position

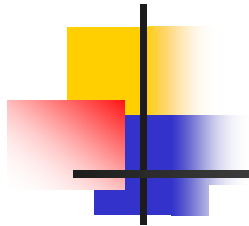




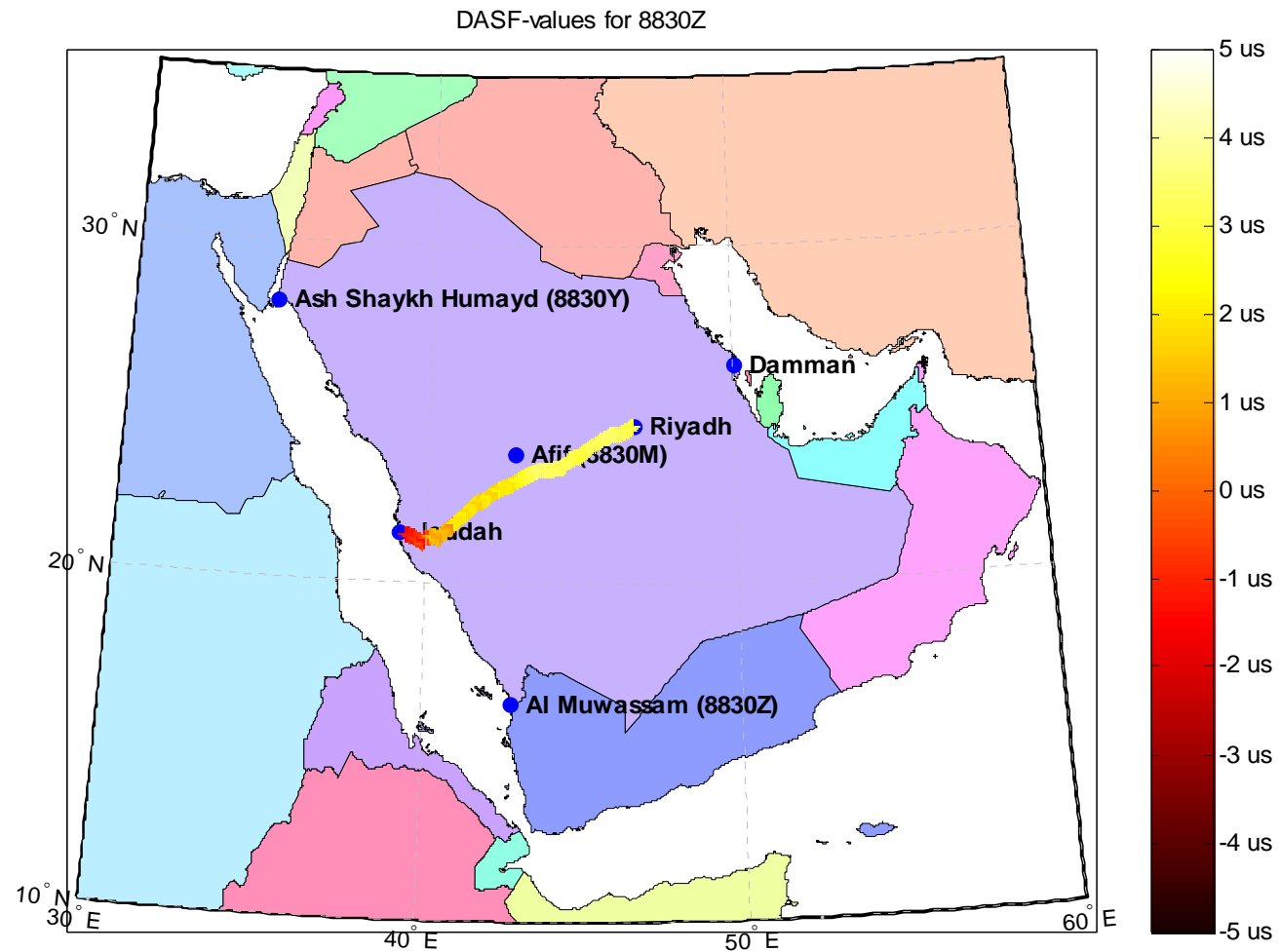
# DASFs: The Next Best Thing

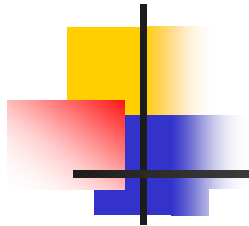
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- To measure True ASFs, you need:
  - Truth reference for position (GPS)
  - Truth reference for time (Cesium-like)
- DASFs:
  - Measure the *difference* in ASF between a station and a chosen *reference* station
  - Are comparable to TD-corrections, however, DASFs also work cross-chain
  - Are much easier to measure than True ASFs
  - Are as valid as ASFs, however hide the underlying fundamentals of propagation and their use imposes some restrictions

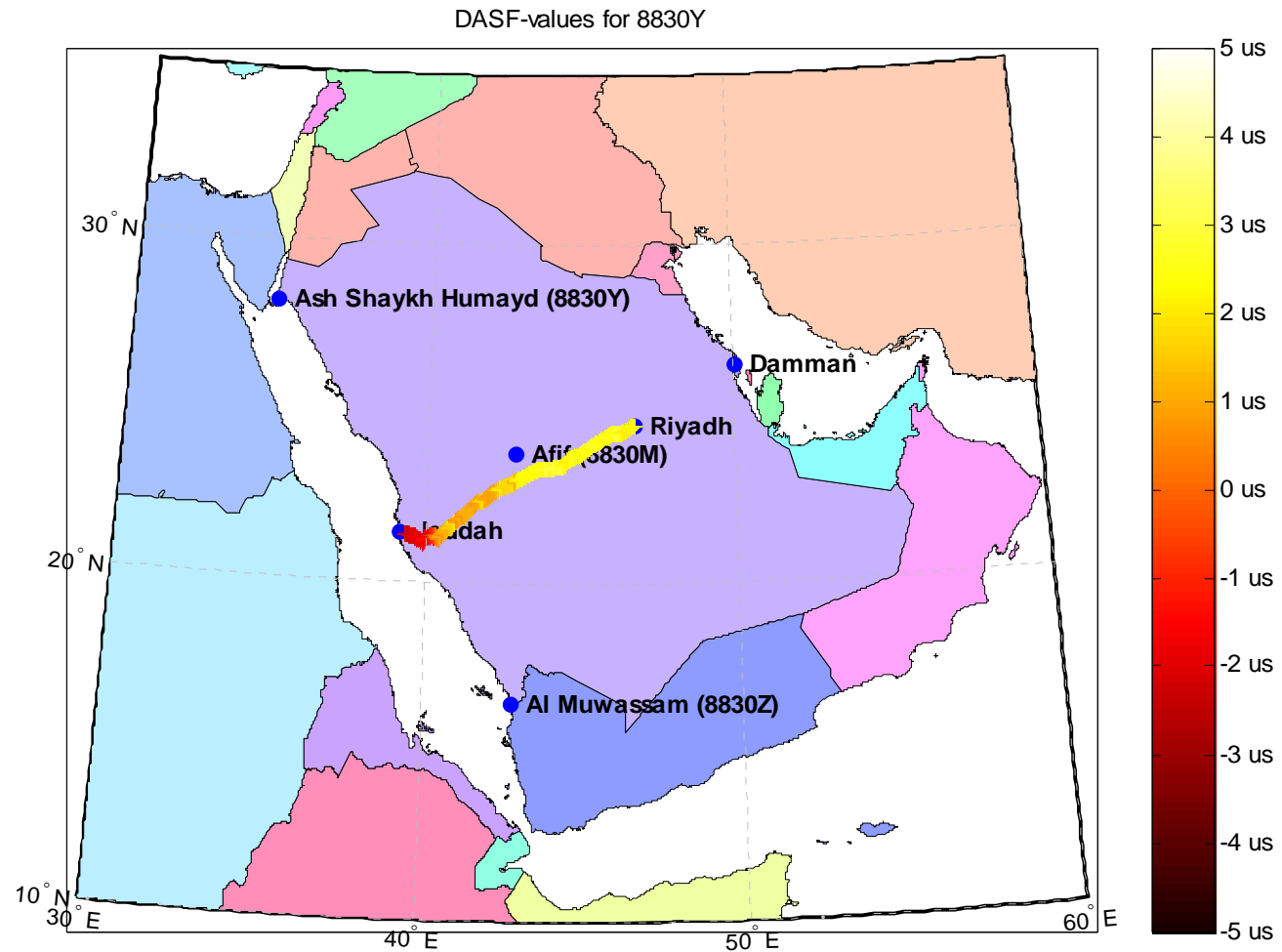


# Differential ASF (8830Z)





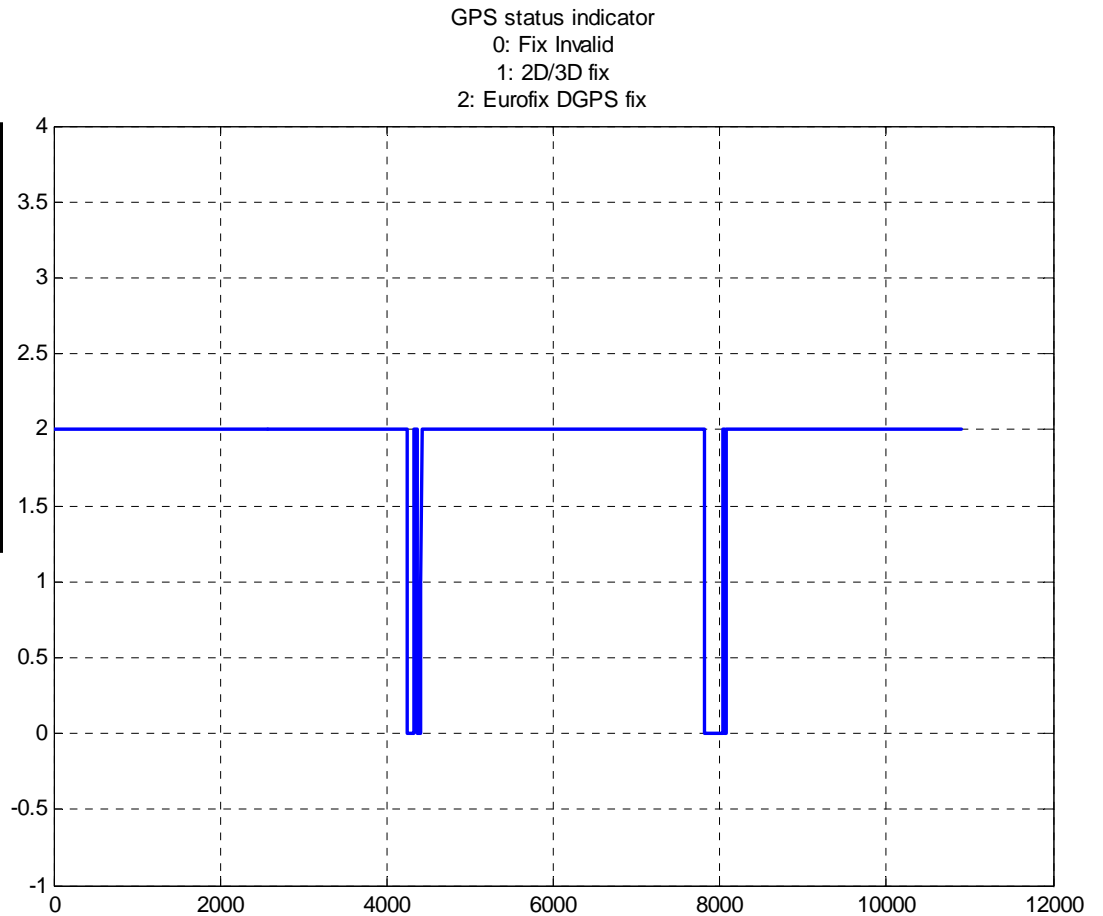
# Differential ASF (8830Y)





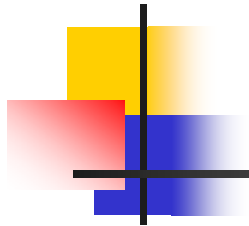
# Eurofix DGPS reception

Station	# Msgs successfully received	Pct (%) (/10506)
8830M	10415	99.1%
8830Y	4367	41.6%
8830Z	5777	55.0%

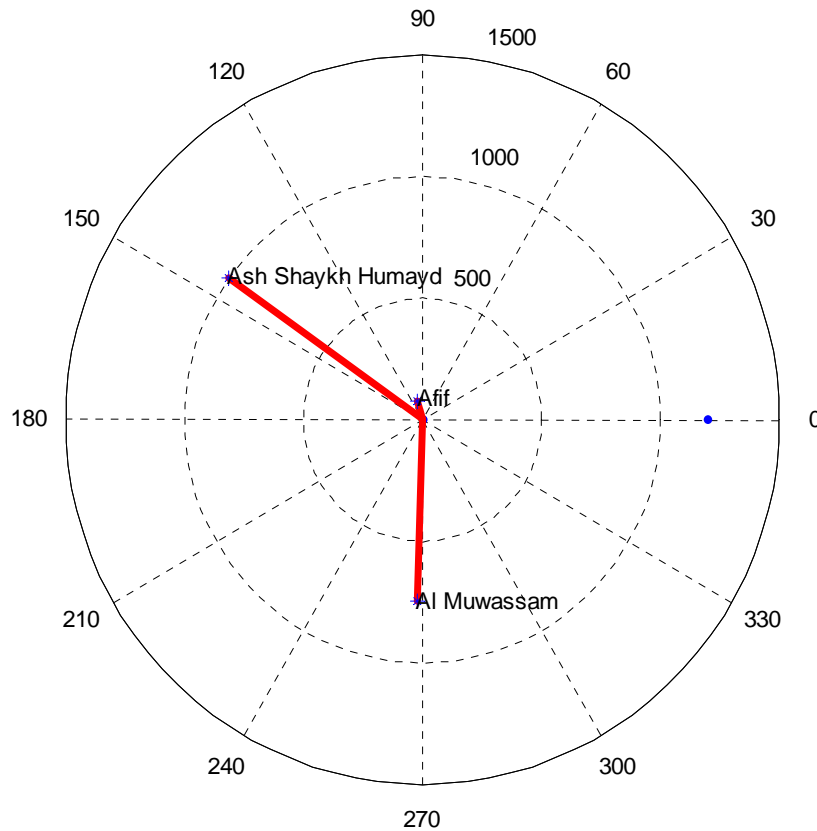


# Measurements under road

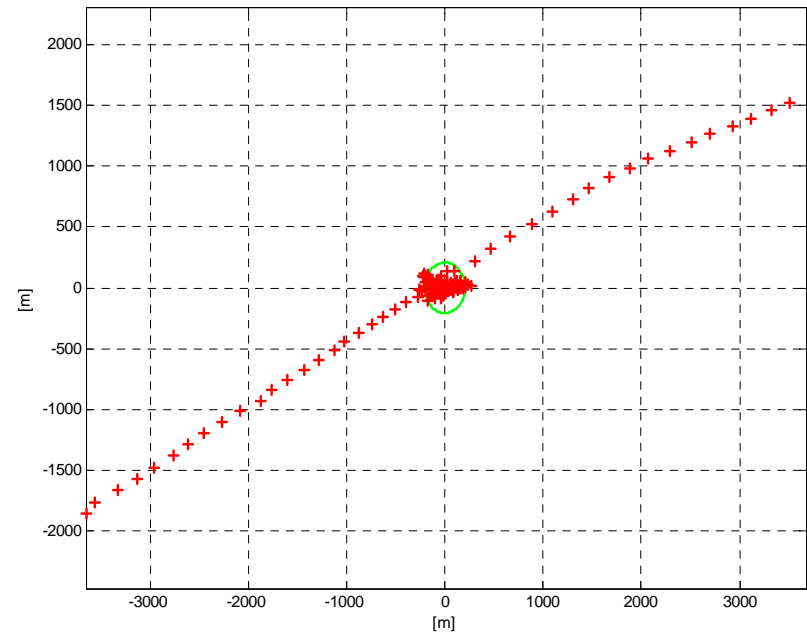


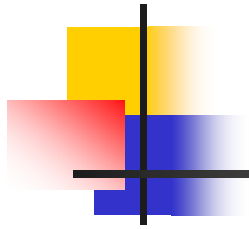


# Measurement under road

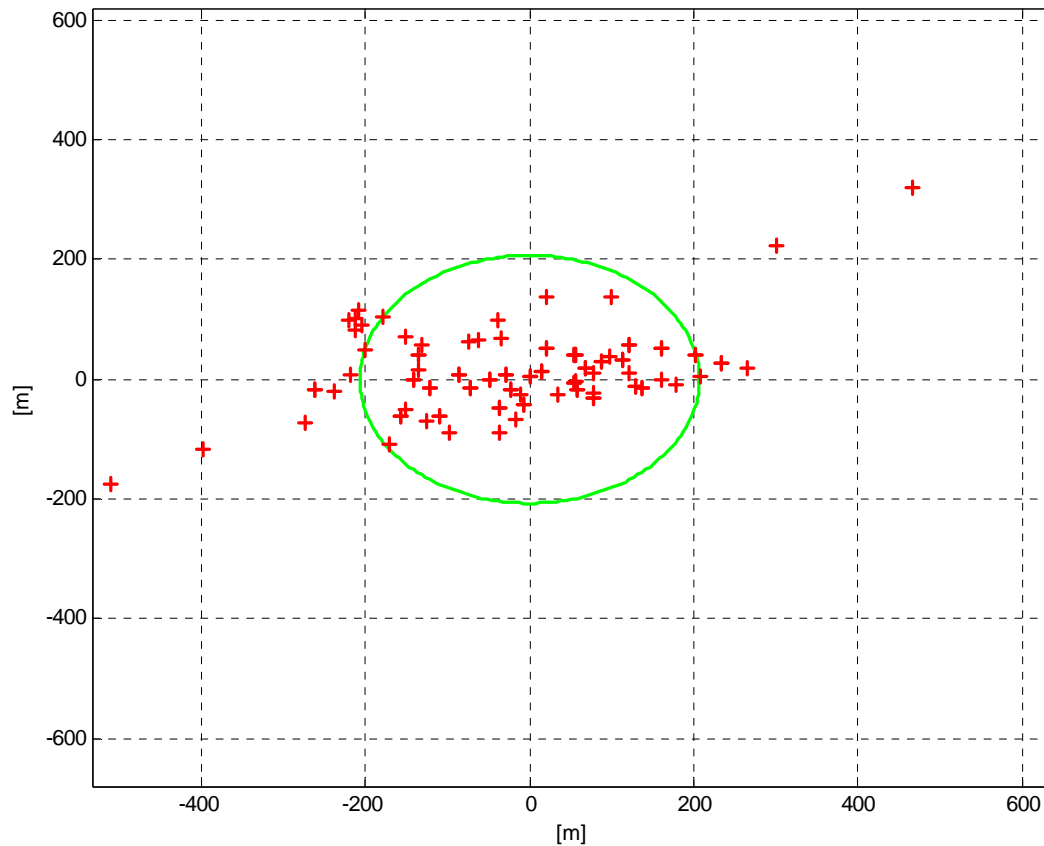


**Afif:** 77.2 km  
**Al Muwassam:** 742.3 km  
**Ash Shaykh Humayd:** 999.7 km





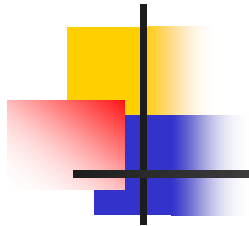
# Measurement under road



**95% accuracy: 206.8 meters**

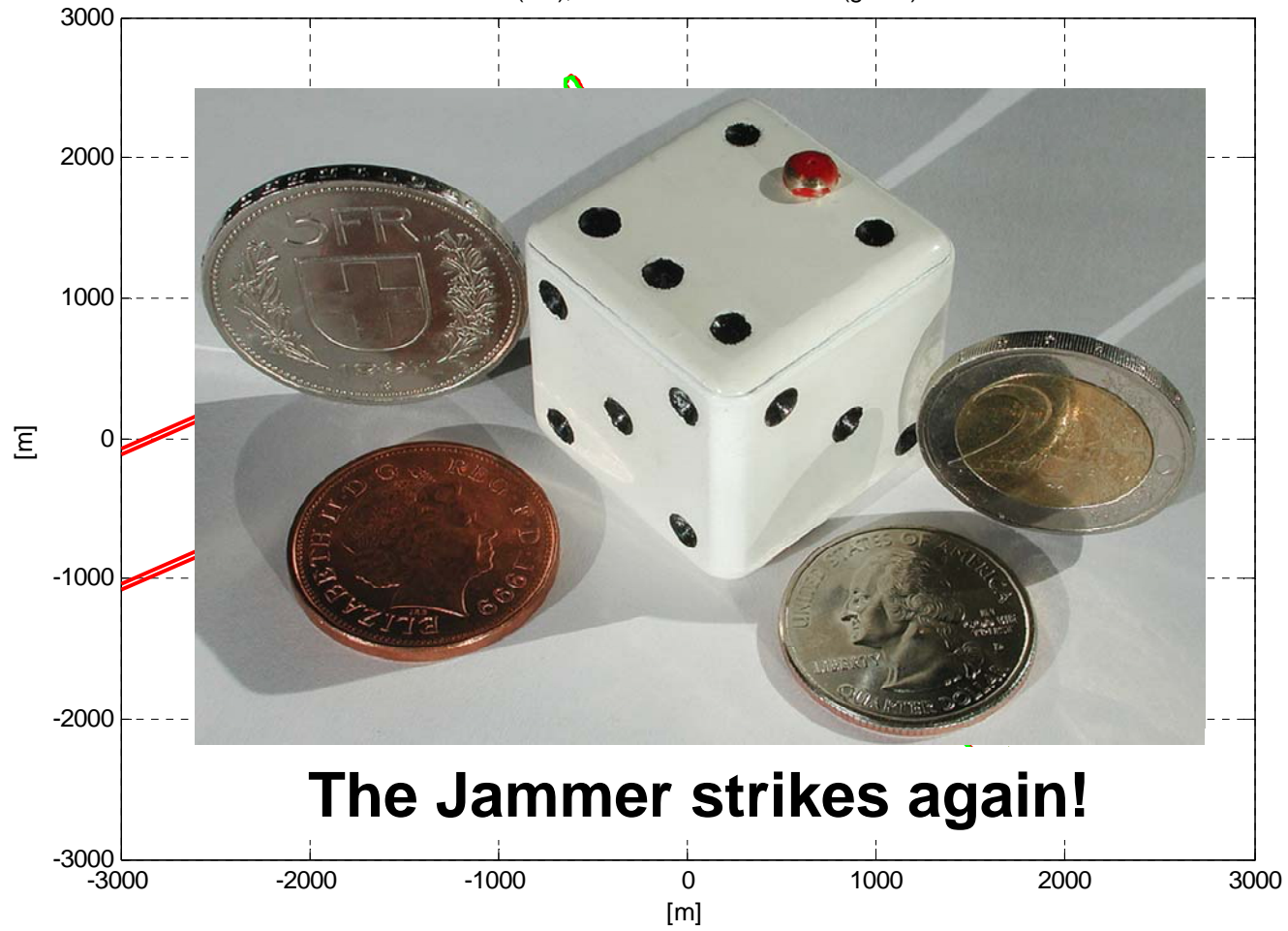
# Marine measurements in Jeddah

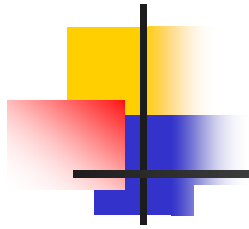




# Marine measurements

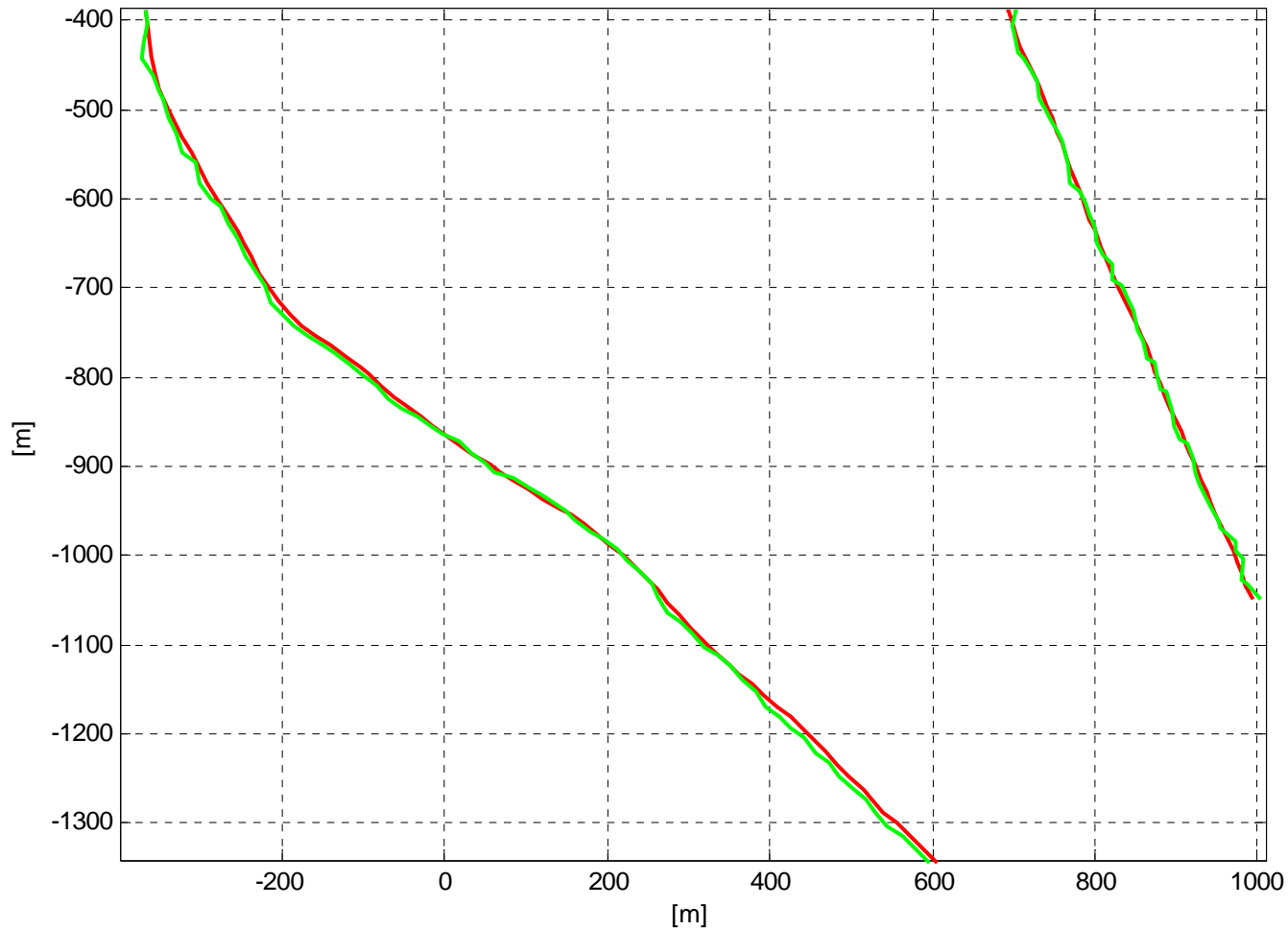
ASF-corrected Loran-C  
Port of Jeddah, 21 september 2005  
Center location: 21.465679 N, 39.116518 E  
GPS (red), ASF-corrected Loran-C (green)





# Marine measurements

ASF-corrected Loran-C  
Port of Jeddah, 21 september 2005  
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# Conclusions and The Future

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- SAPS service verified
  - Eurofix DGPS reception as expected
  - Loran-C service as expected
  - Due to specific geographic circumstances in Saudi Arabia, a few strategically chosen ASF-calibration points can improve accuracy significantly
- Saudi Arabia is now planning to:
  - Extend coverage by opening additional station in the East
  - Upgrade SAPS service level:
    - Redundant equipment installation
    - Install new, dedicated communication to sites
    - Install new system monitors
  - Promote use of system for various applications