



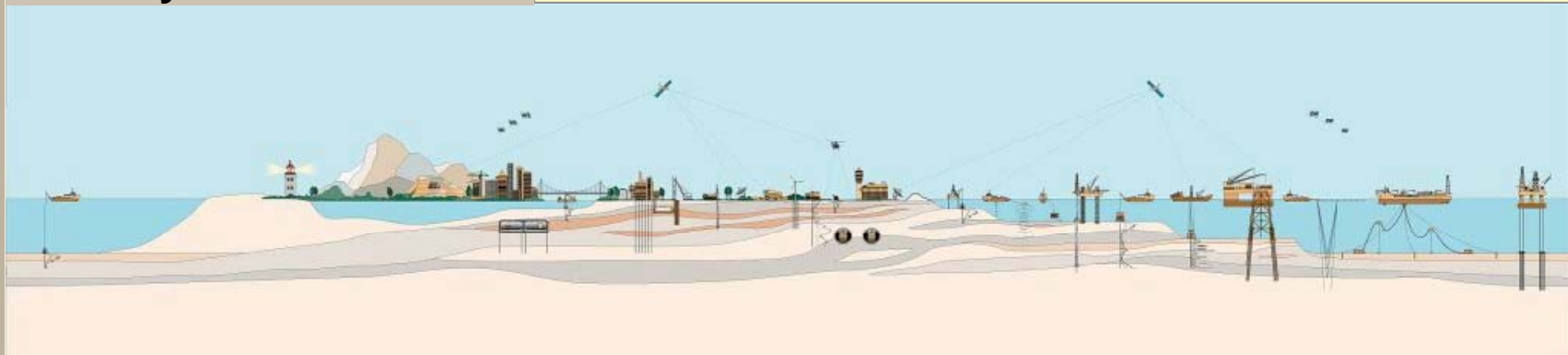
# DYNAMIC POSITIONING CONFERENCE

## Advances in DGPS Systems

28 September 2004

Ole Ørpen

Fugro Seastar, Oslo,  
Norway

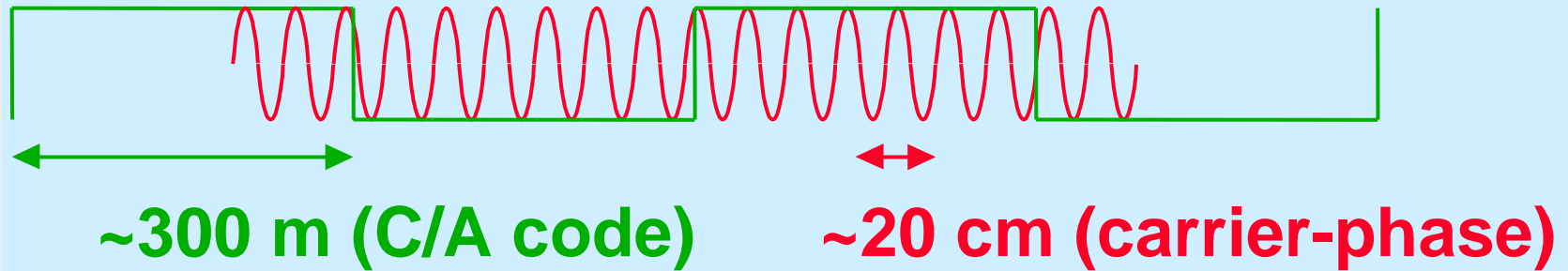




## SCOPE OF PRESENTATION

- Background.
- Carrier Phase Based Solutions.
- Orbit/Clock Solutions.
- Operational Experience.
- Independent Network and Orbit/Clock Services.

# PHASE BASED GPS DECIMETRE SERVICES

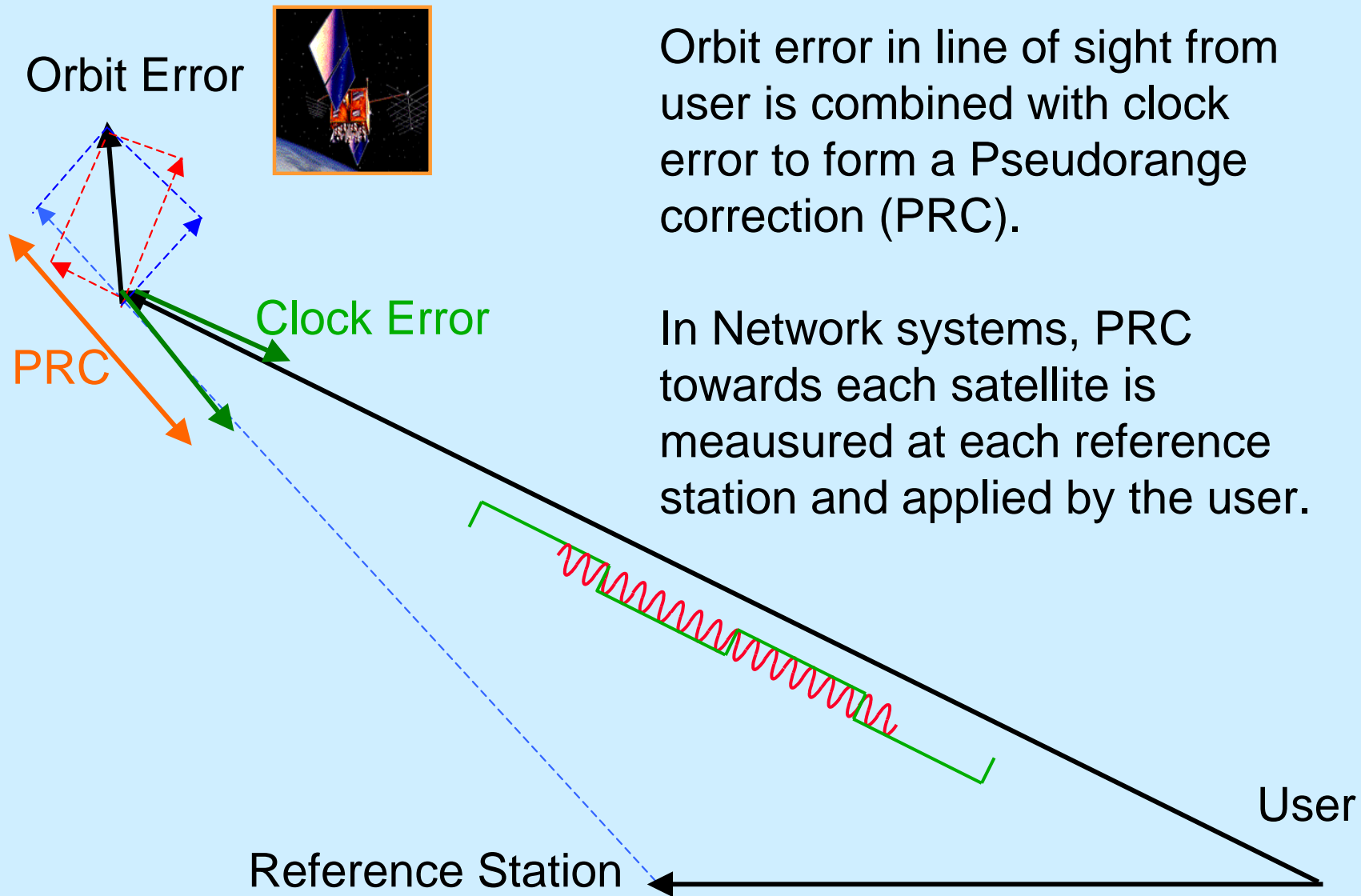


Measurement accuracy: Code < 0.5 m; Phase < 1 cm

Position accuracy: 10 cm Horizontal, 15 cm height (95%)

Characteristics:

- Carrier-phase measurements
- Dual-frequency ionospheric delay correction
- Tropospheric delay estimation
- Network solution or Orbit/Clock Solution
- Less susceptible to multipath and other code tracking errors





# FUGRO DECIMETRE SERVICES

## SeaSTAR HP

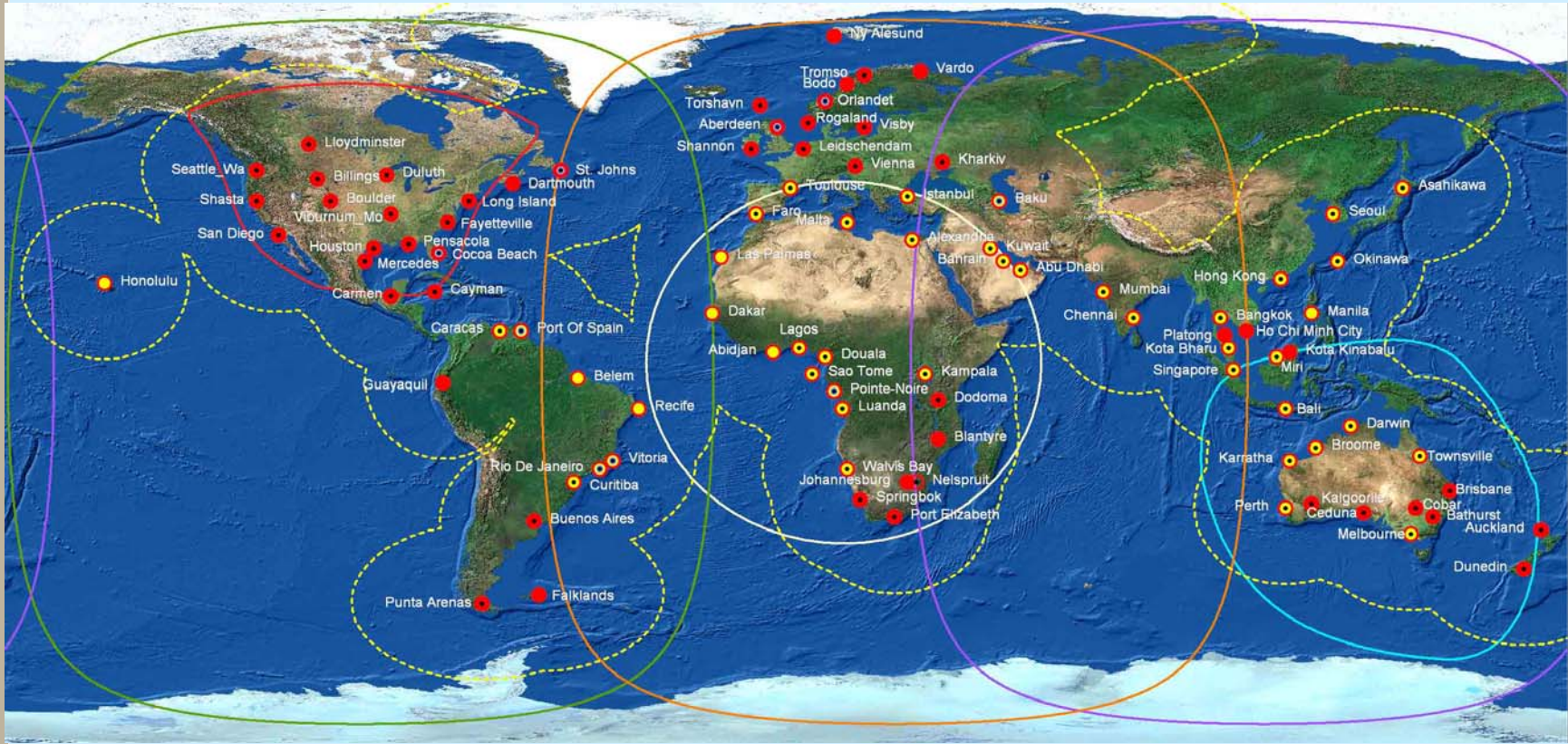
- Network solution based on an optimum configuration of approximately 90 reference stations around the world

## SeaSTAR XP

- Orbit/Clock solution (also called State Space solution) in co-operation with NASA's JPL (Jet Propulsion Laboratory)



# FUGRO NETWORK SITES

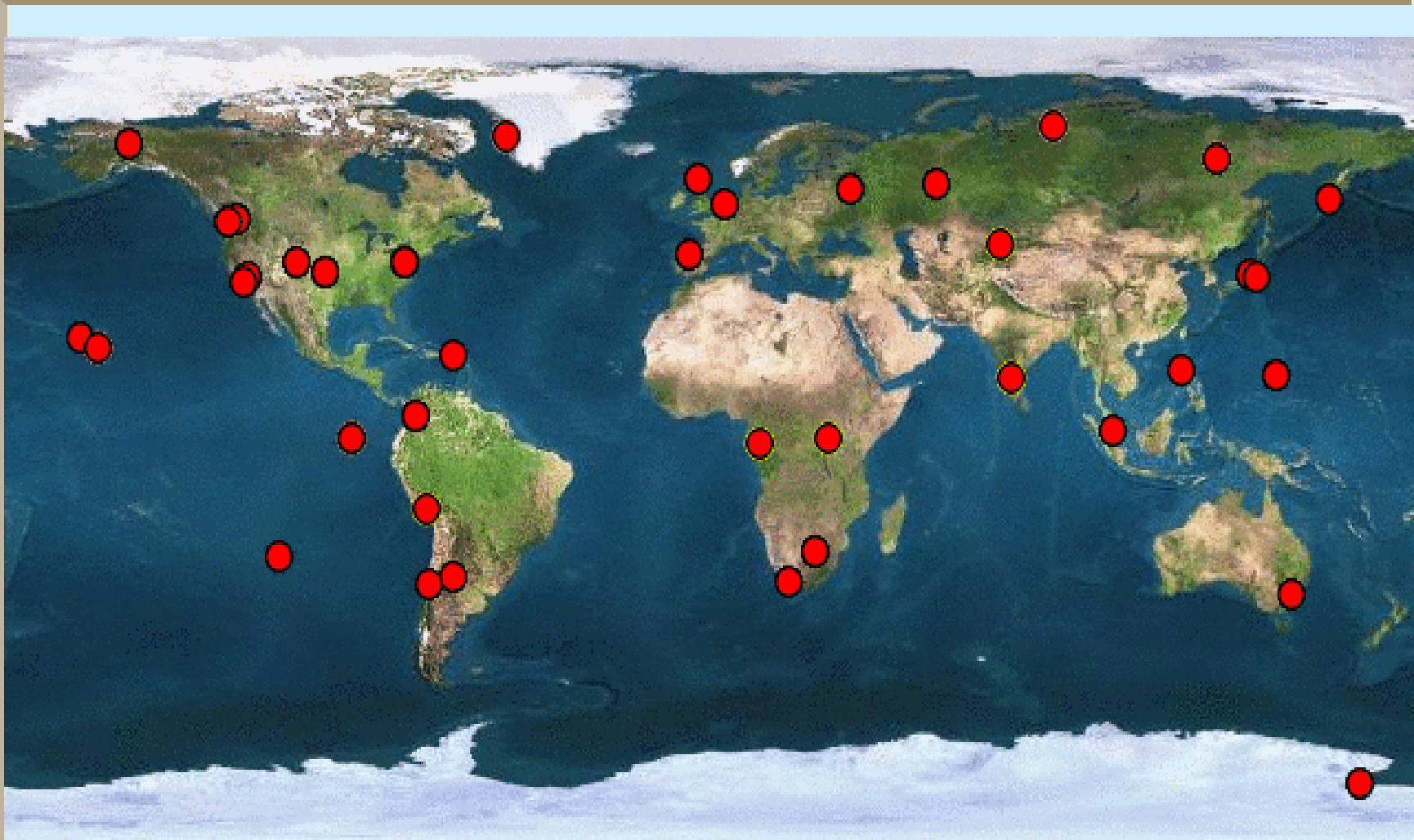


**Appr. 90 Stations World Wide used in HP**

**Fugro Seastar AS**



## NASA/JPL SITES FOR ORBIT/CLOCK



**Appr. 40 Real Time Stations World Wide used in XP**

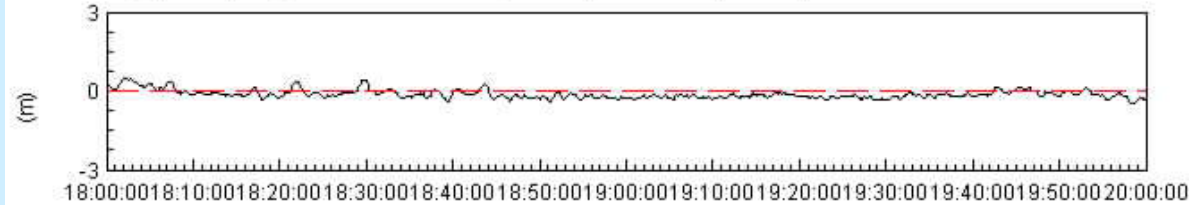


# PHASE BASED SERVICE (TOP) VS CODE BASED SERVICE (BOTTOM) WITH SHADOWING

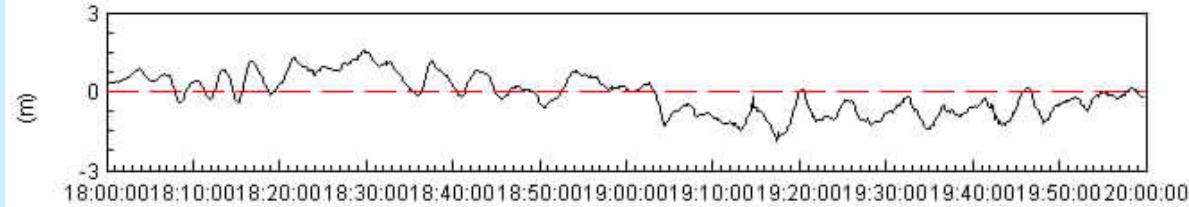


Drillship at harbour.  
Phase based service  
not influenced by  
Shadowing/Multipath.  
Variations in northing  
are ship movements

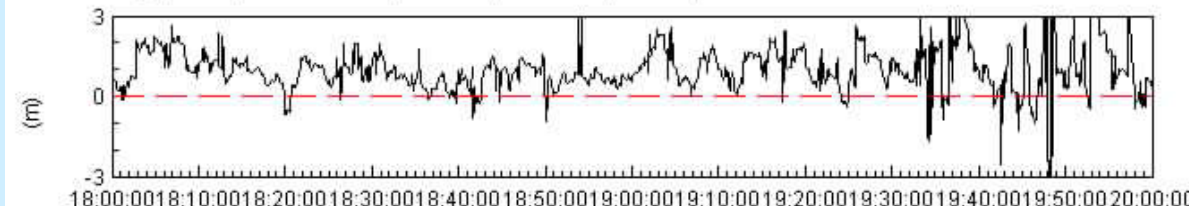
Delta Easting (Ref Pos) Fugro HP: dE: Min:-0.51, Max:0.48, Mean:-0.13, SD:0.16, Count:7200



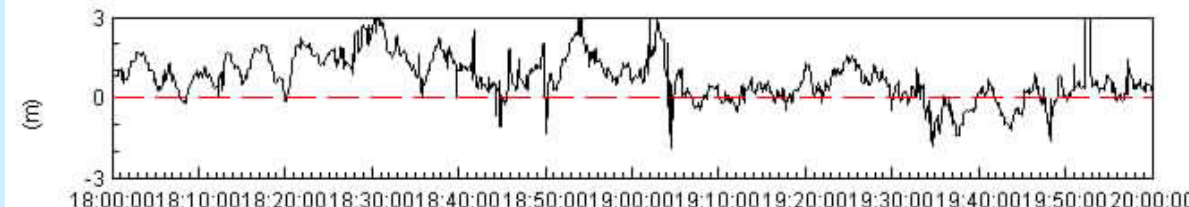
Delta Northing (Ref Pos) Fugro HP: dN: Min:-1.93, Max:1.56, Mean:-0.11, SD:0.73, Count:7200



Delta Easting (Ref Pos): dE: Min:-4.29, Max:5.80, Mean:0.98, SD:0.80, Count:7195



Delta Northing (Ref Pos): dN: Min:-1.97, Max:7.50, Mean:0.76, SD:0.96, Count:7195



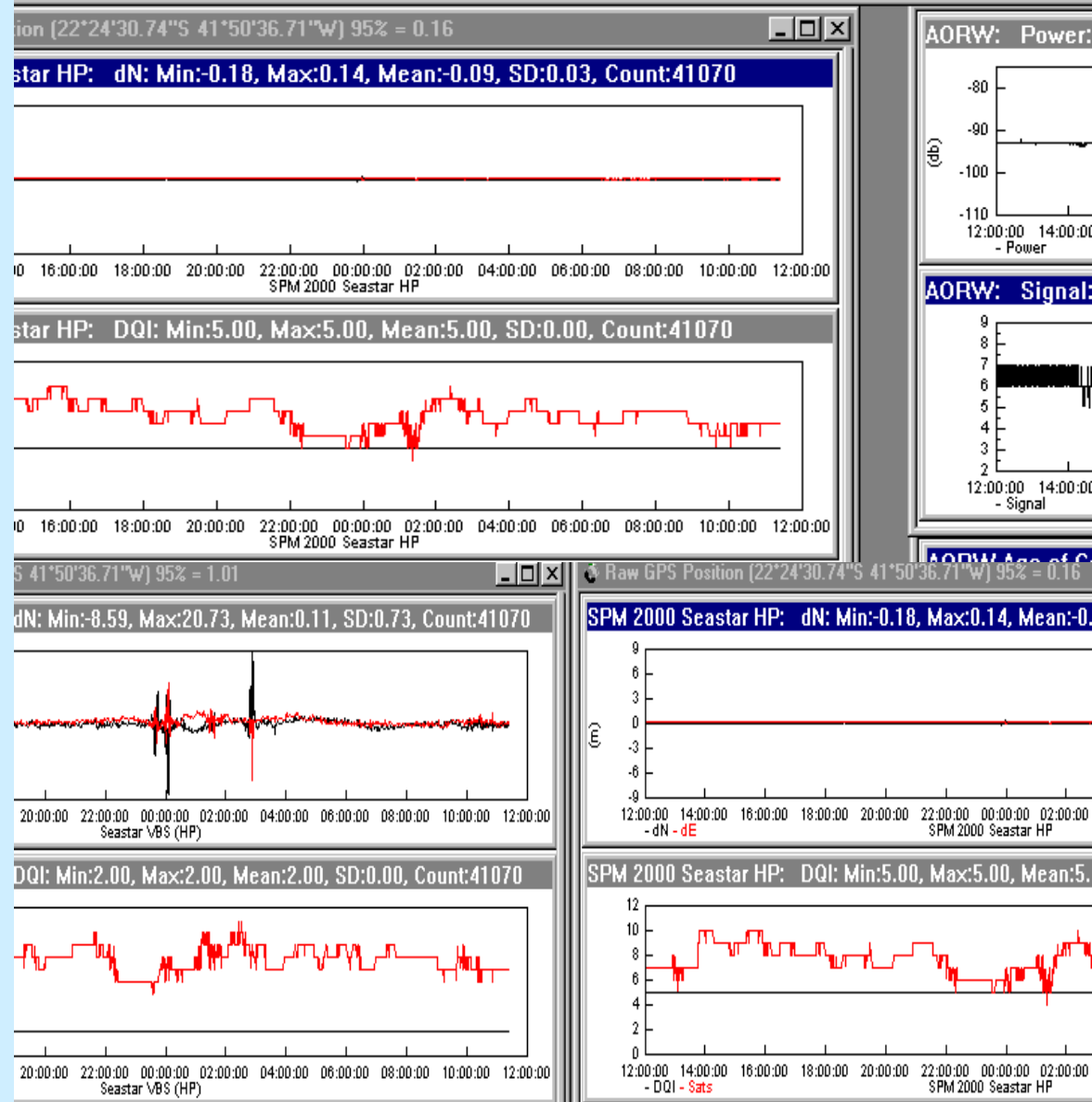
Data from the same GPS antenna and GPS receiver



# PHASE BASED SERVICE (TOP) VS CODE BASED SERVICE (BOTTOM) DURING SCINTILLATIONS

*Phase based service (top) and code based service (bottom) in Macae Brazil.*

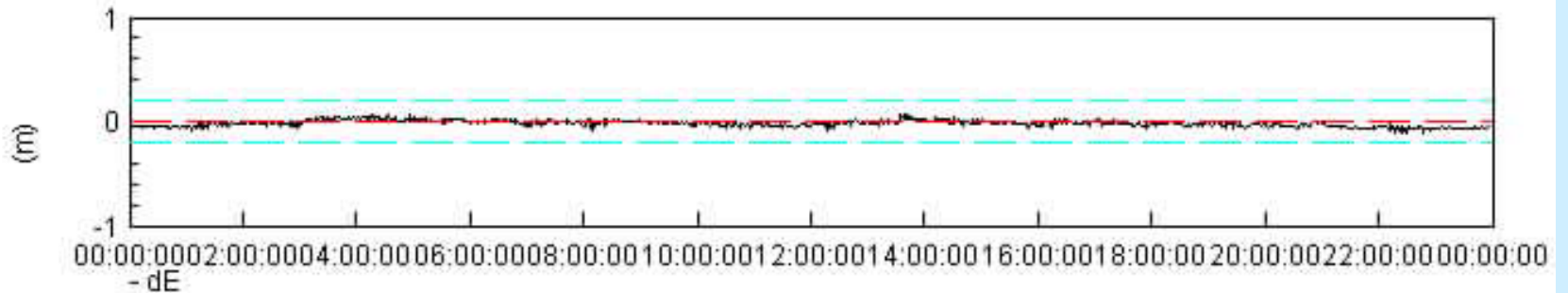
*Between 23:00 and 03:00 ionospheric scintillations result in the GPS receiver losing lock on some satellites, creating large errors in the code solution when reacquiring.*



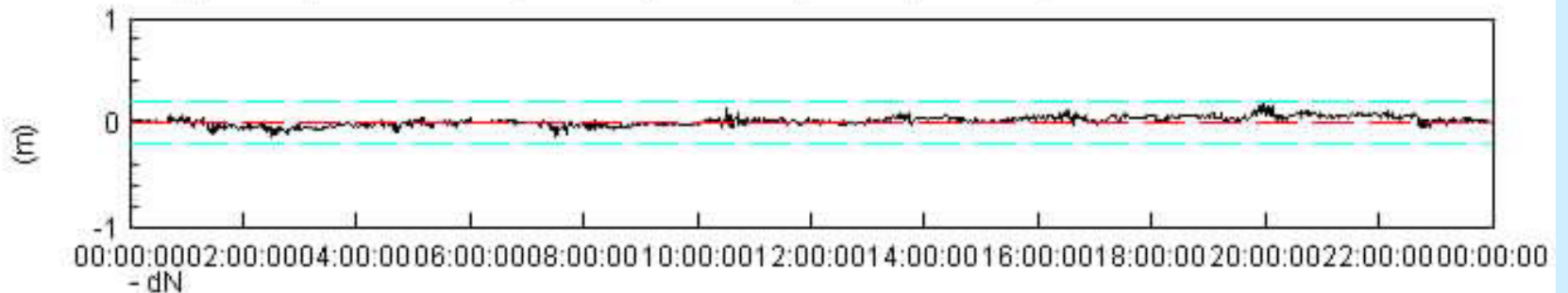


# NETWORK SOLUTION, OSLO 12 APRIL 2004

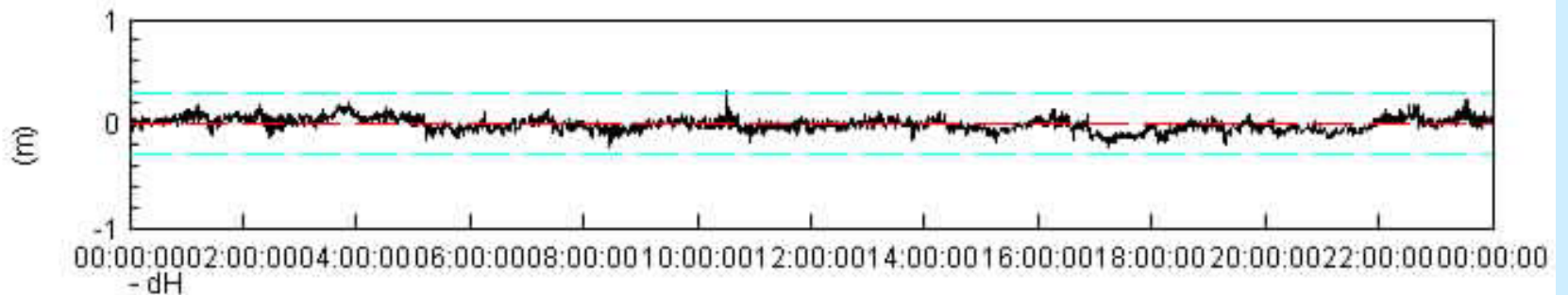
Delta Easting (Ref Pos) HP SPM4.01- Oslo EASAT: dE: Min:-0.12, Max:0.10, Mean:-0.02, SD:0.03, 2SD:0.06, Count:78699



Delta Northing (Ref Pos) : dN: Min:-0.15, Max:0.21, Mean:0.01, SD:0.04, 2SD:0.08, Count:78699



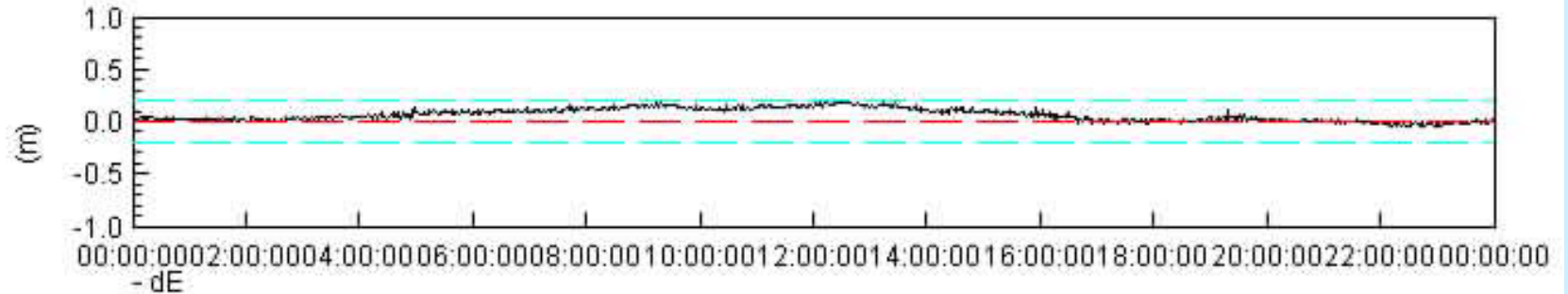
Delta Height (Ref Pos) : dH: Min:-0.25, Max:0.34, Mean:-0.00, SD:0.06, 2SD:0.12, Count:78699



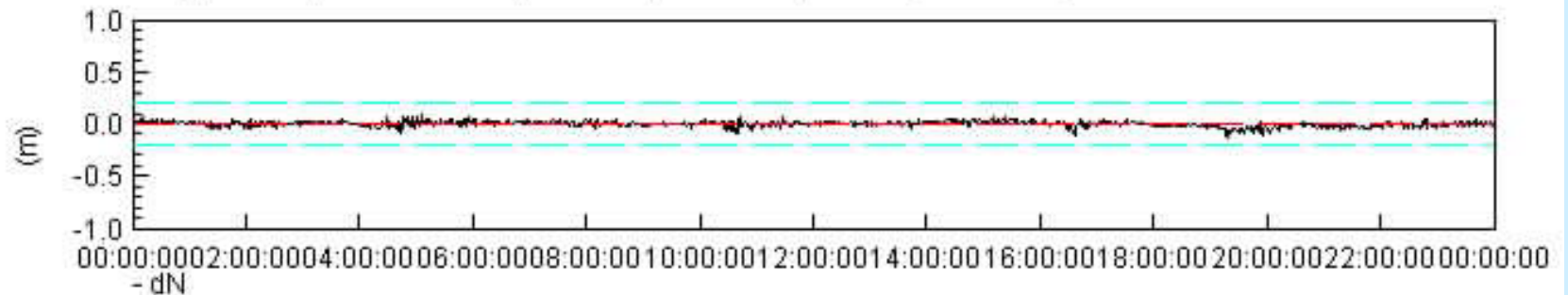


# ORBIT/CLOCK SOLUTION, OSLO 12 APRIL 2004

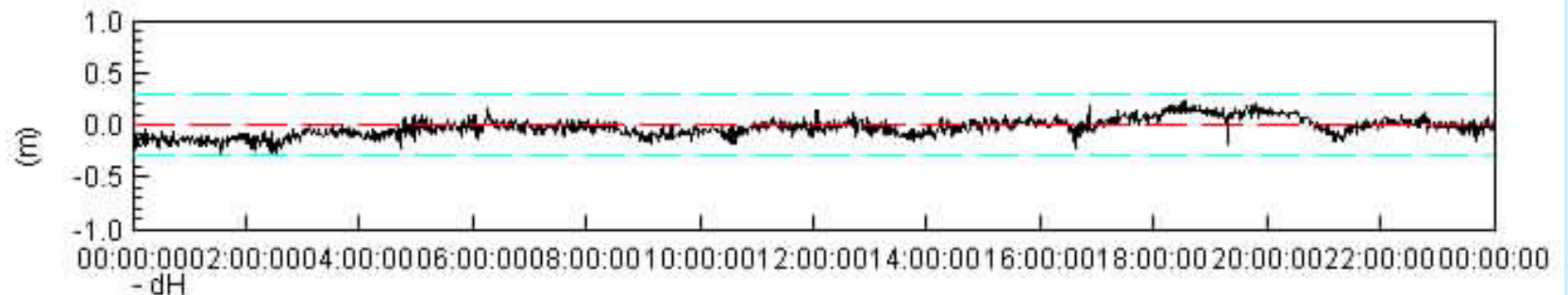
Delta Easting (Ref Pos) GSS SPM4.01 Oslo AFSAT: dE: Min:-0.07, Max:0.21, Mean:0.07, SD:0.06, 2SD:0.12, Count:78665



Delta Northing (Ref Pos): dN: Min:-0.14, Max:0.09, Mean:-0.00, SD:0.02, 2SD:0.05, Count:78665



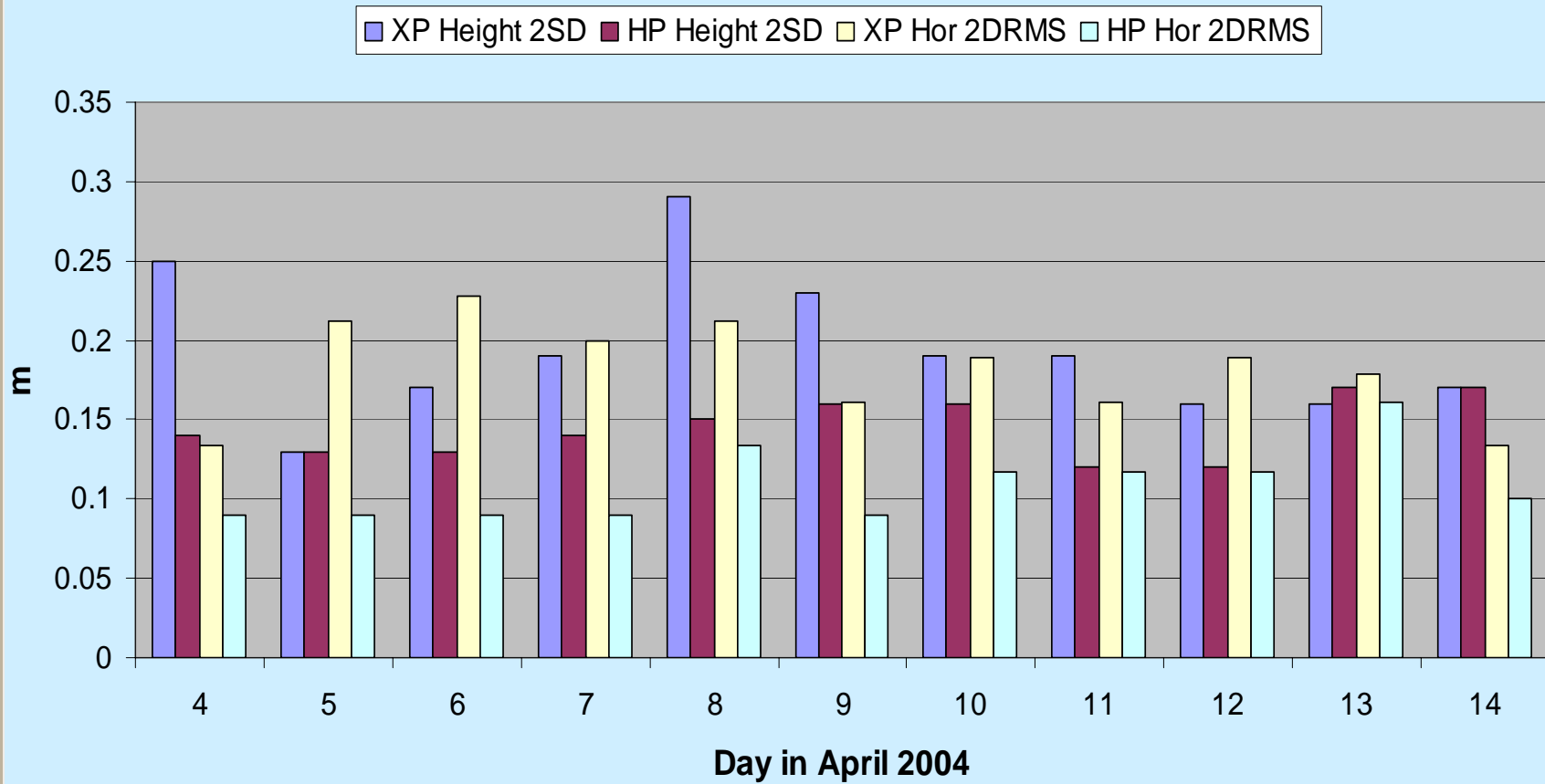
Delta Height (Ref Pos): dH: Min:-0.33, Max:0.25, Mean:-0.03, SD:0.08, 2SD:0.16, Count:78665





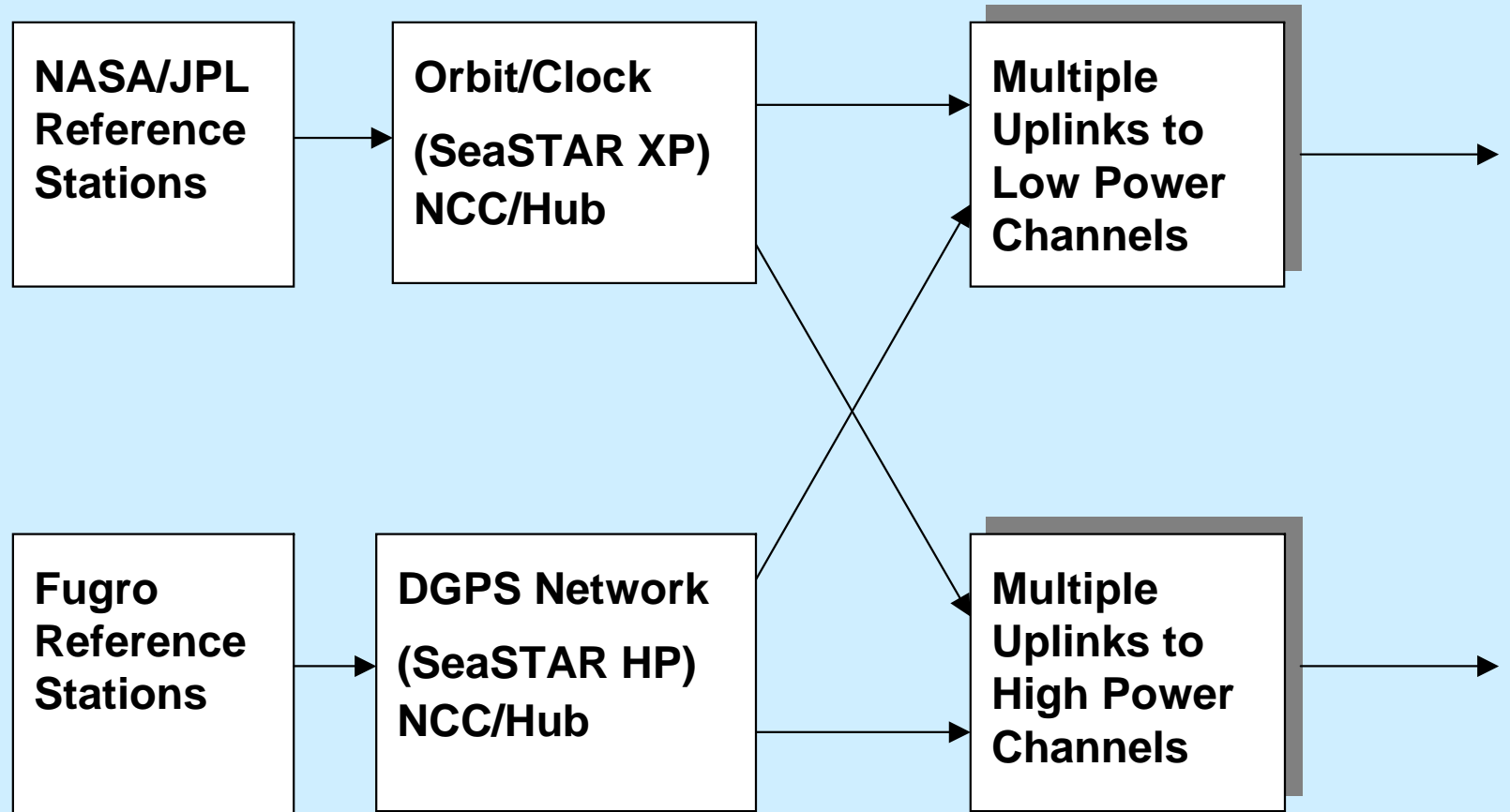
# NETWORK VS ORBIT/CLOCK ACCUARCY IN OSLO 4-14 APRIL 2004

Network (HP) and Orbit/Clock (XP) comparison in Oslo, 95%



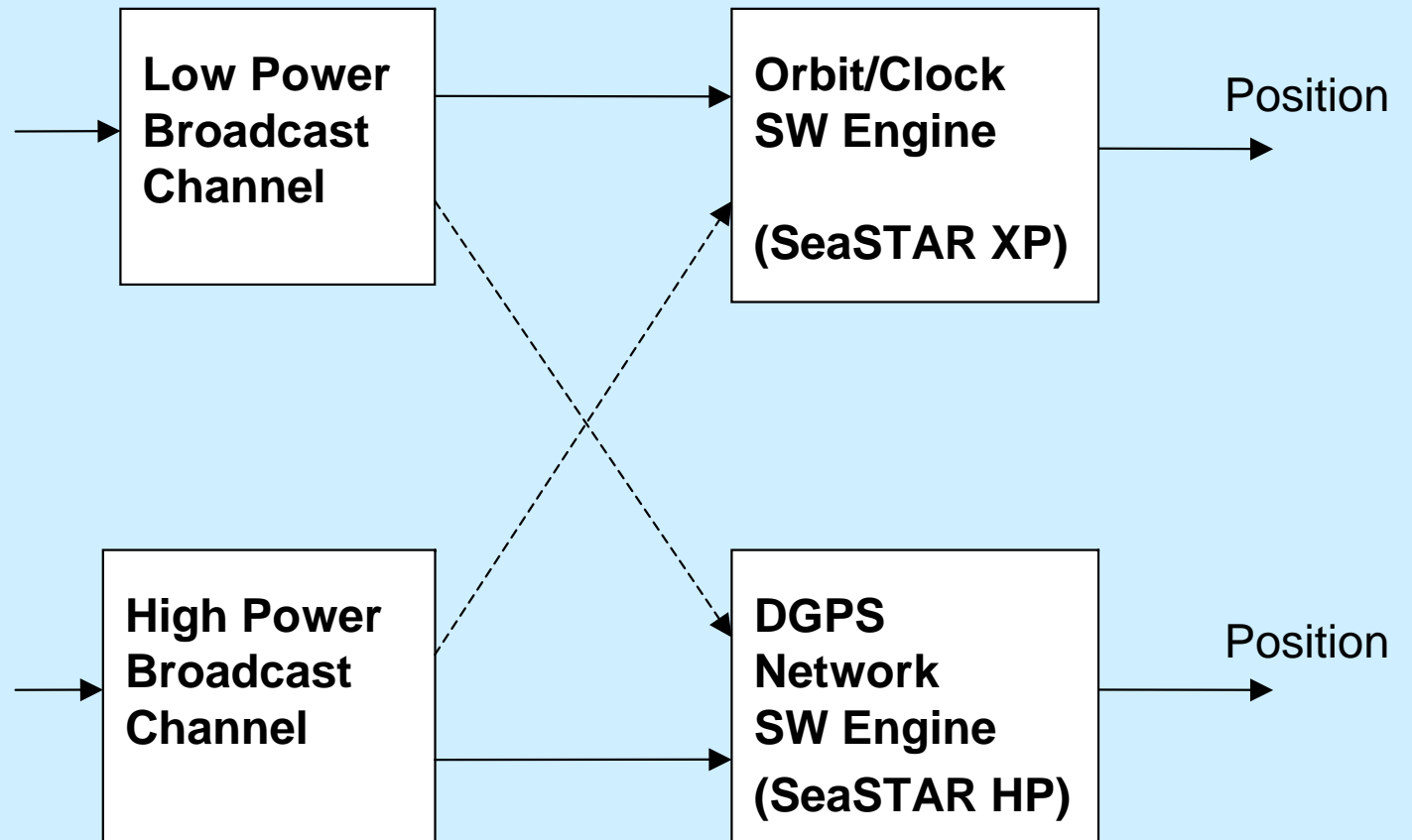


# NETWORK SETUP





# MOBILE SETUP





## CONCLUSIONS

- Two major advances in DGPS Services:
  - Carrier phase based decimetre accuracy
    - Less susceptible to multipath/code errors
  - Orbit/Clock corrections
    - Truly world wide decimetre accuracy
- Fugro will maintain independent Wide Area Network Carrier Phase and Orbit/Clock services
  - Independent reference stations, broadcasts, NCC/Hubs
  - Seastar HP, Seastar XP main services
  - Independent mobile equipment
  - Orbit/Clock and Network complementary solutions



# FUGRO SERVICES FOR DP APPLICATIONS

## Current Fugro DP Services

- SeaSTAR HP
- SeaSTAR Plus
- SeaSTAR (L1 service)
- Glonass

## Integrated DGPS Services

### Decimetre services

- SeaSTAR HP
- SeaSTAR XP

## Current TGS DP Services

- Skyfix XP
- Skyfix Premier
- Skyfix (L1 service)
- Glonass

### Metre services

- SeaSTAR Plus
- SeaSTAR (L1/VBS service)
- Glonass

**All services will be globally available in high and low power broadcasts**