



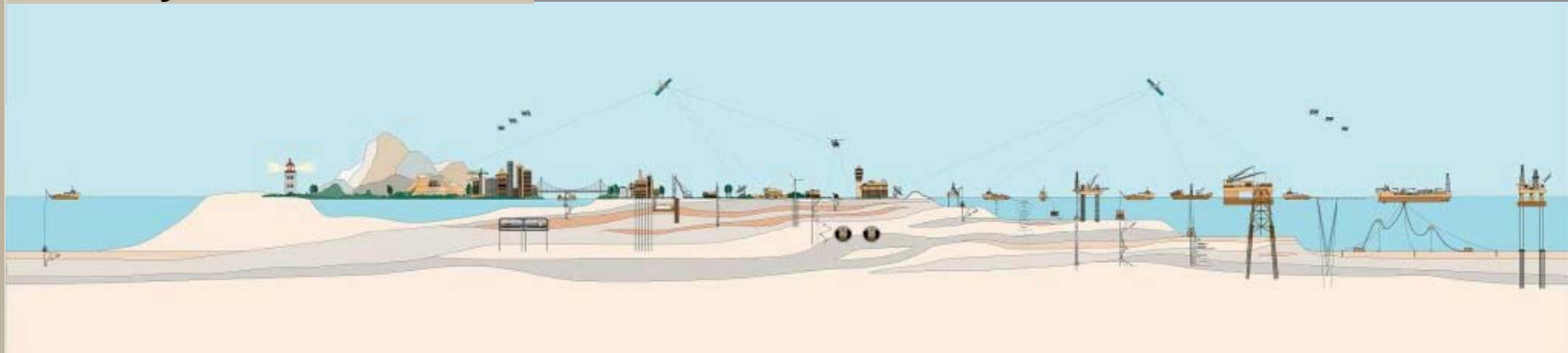
DYNAMIC POSITIONING CONFERENCE

Advances in DGPS Systems

28 September 2004

Ole Ørpen

Fugro Seastar, Oslo,
Norway

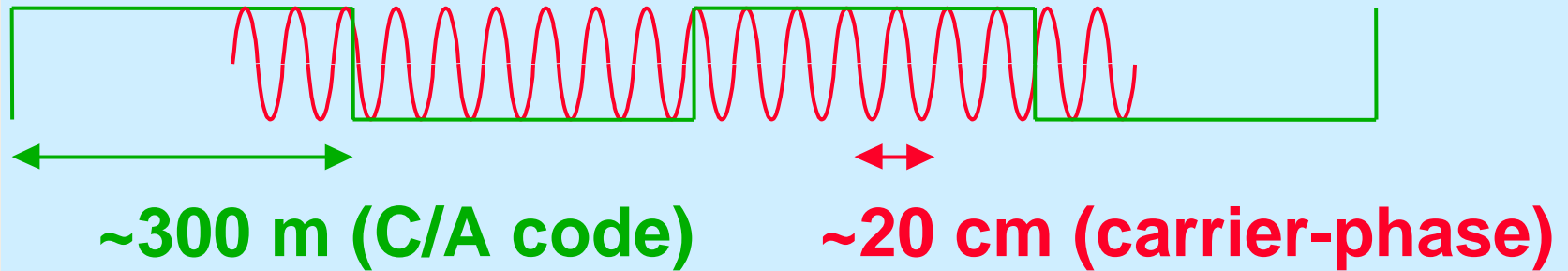




SCOPE OF PRESENTATION

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

PHASE BASED GPS DECIMETRE SERVICES

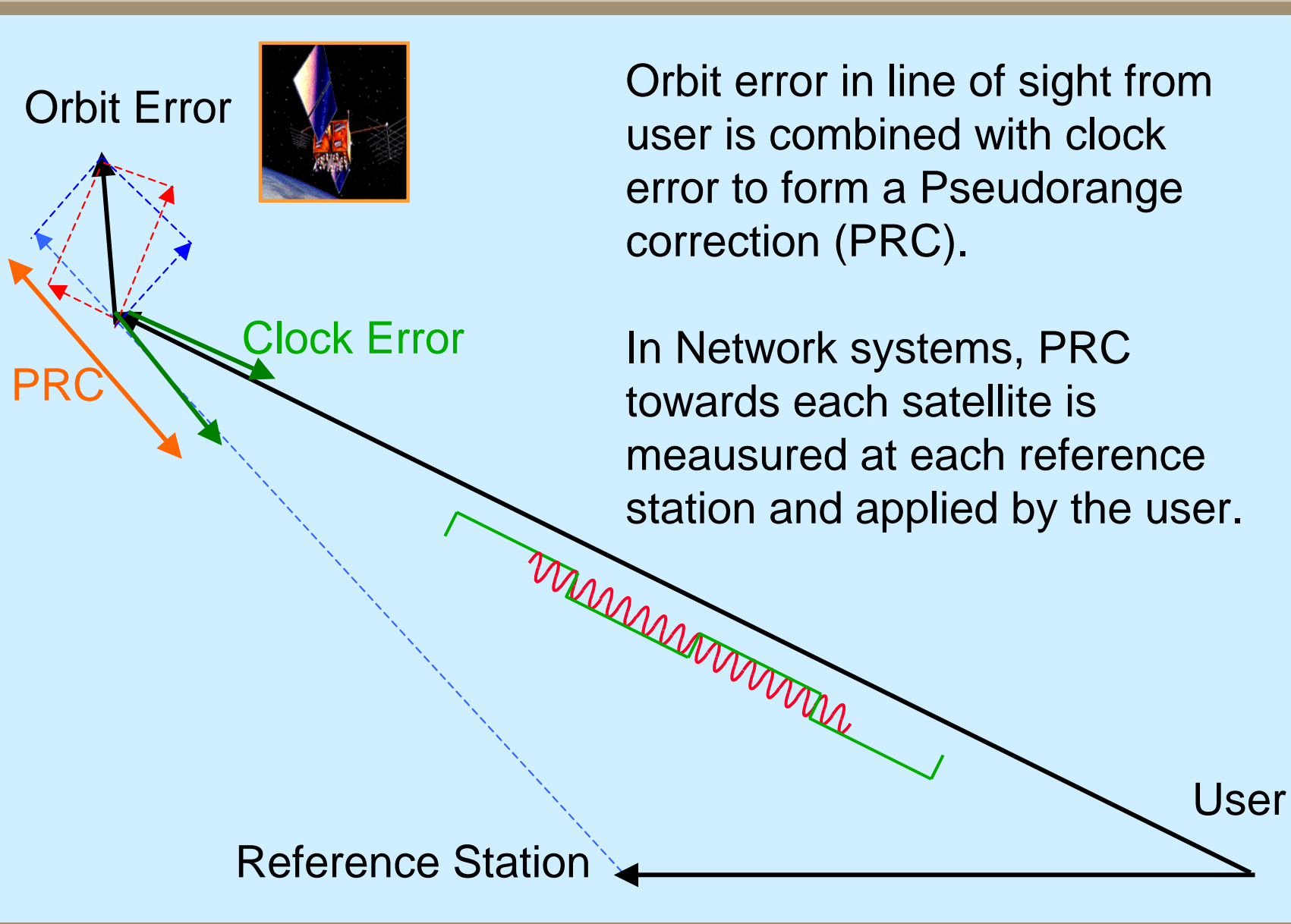


Measurement accuracy: Code < 0.5 m; Phase < 1 cm

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



Orbit error in line of sight from user is combined with clock error to form a Pseudorange correction (PRC).

In Network systems, PRC towards each satellite is measured at each reference station and applied by the user.



FUGRO DECIMETRE SERVICES

SeaSTAR HP

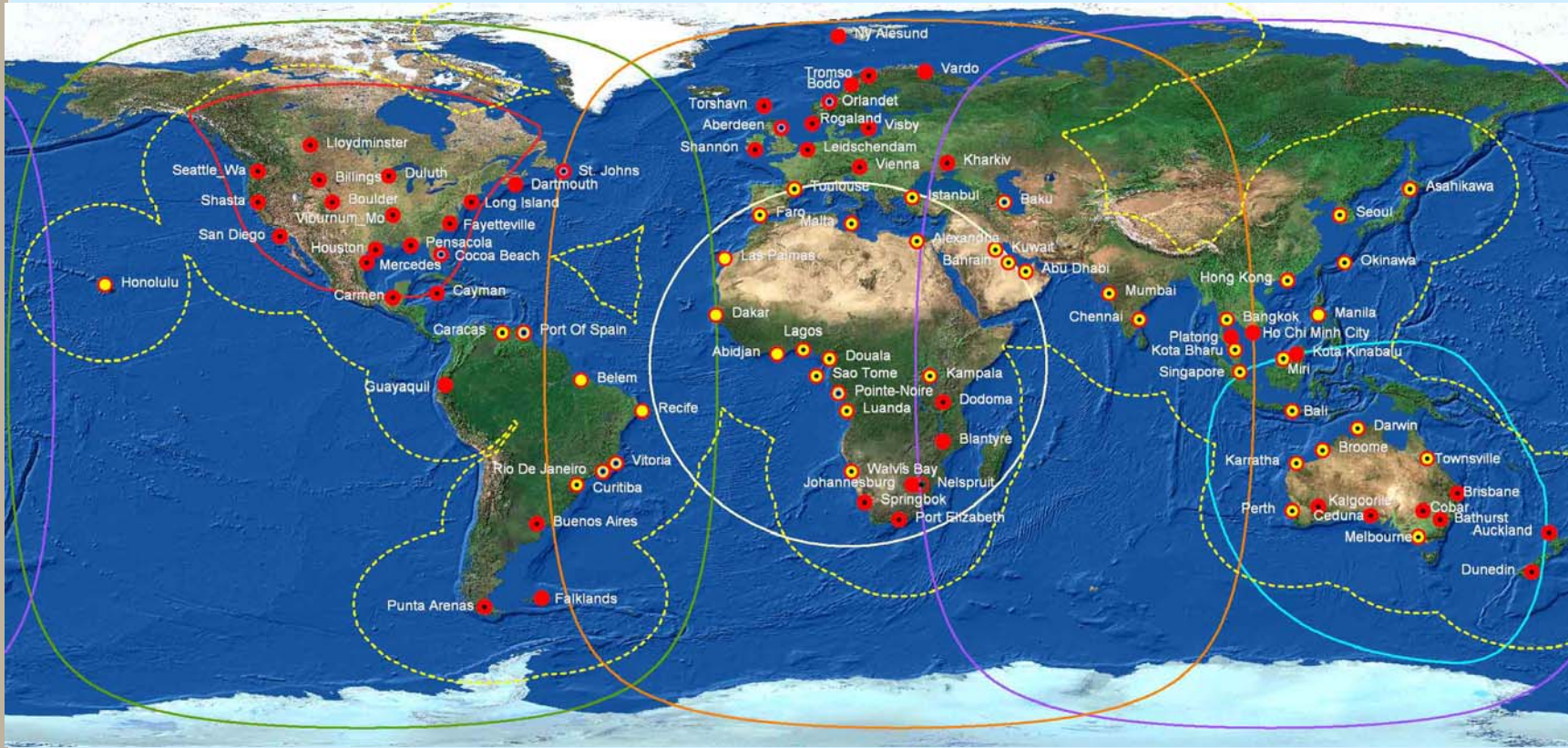
- Network solution based on an optimum configuration of approximately 90 reference stations around the world

SeaSTAR XP

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



FUGRO NETWORK SITES

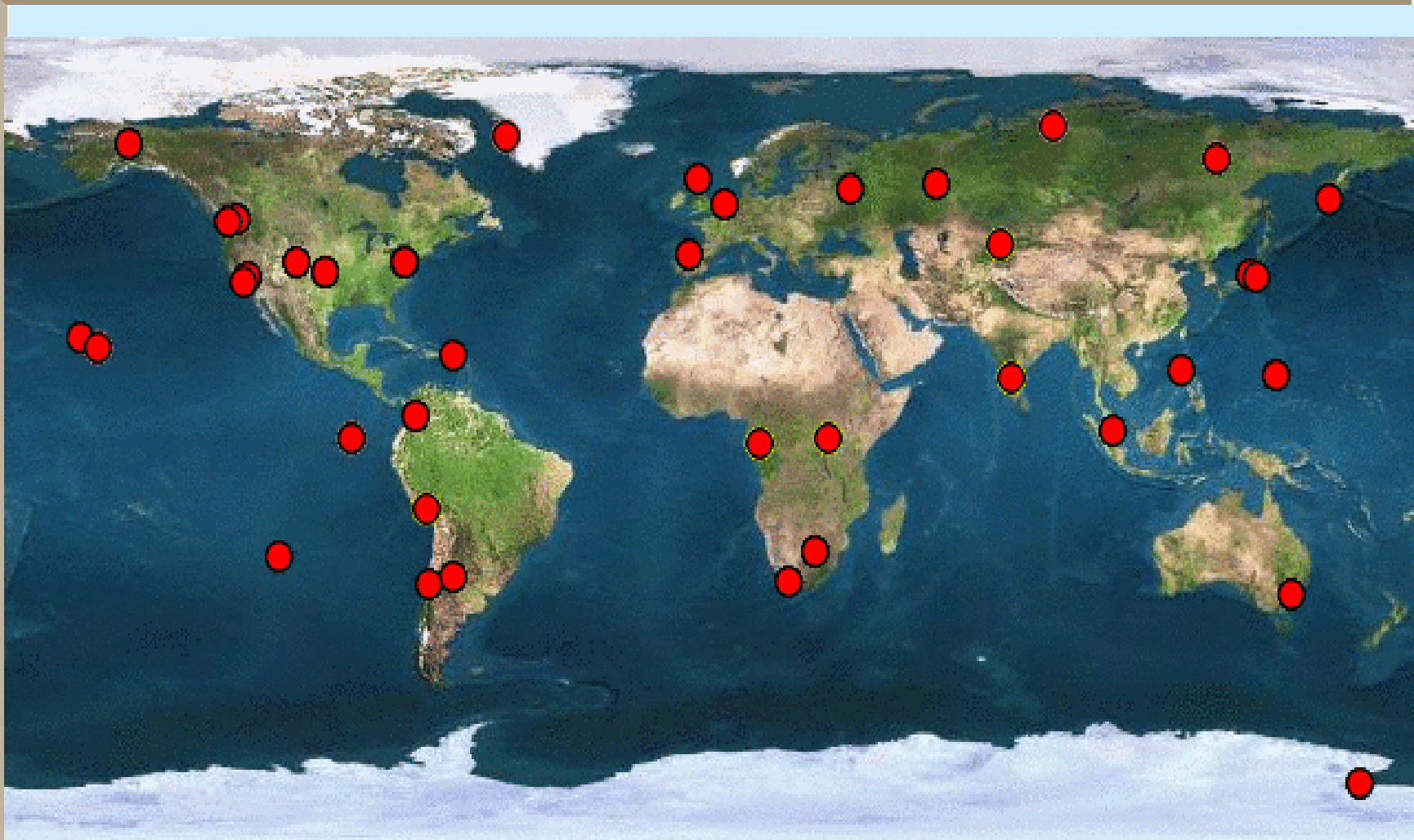


Appr. 90 Stations World Wide used in HP

Fugro Seastar AS



NASA/JPL SITES FOR ORBIT/CLOCK



Appr. 40 Real Time Stations World Wide used in XP

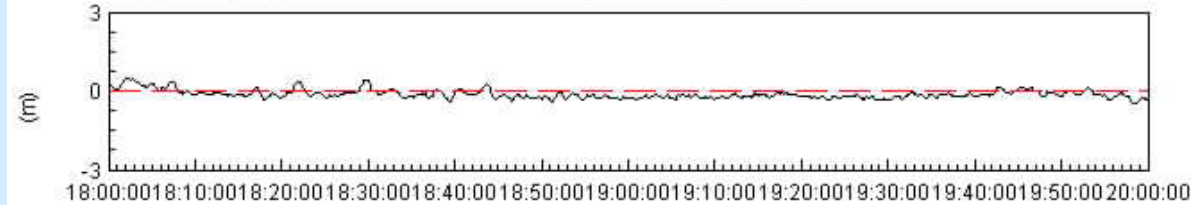


PHASE BASED SERVICE (TOP) VS CODE BASED SERVICE (BOTTOM) WITH SHADOWING

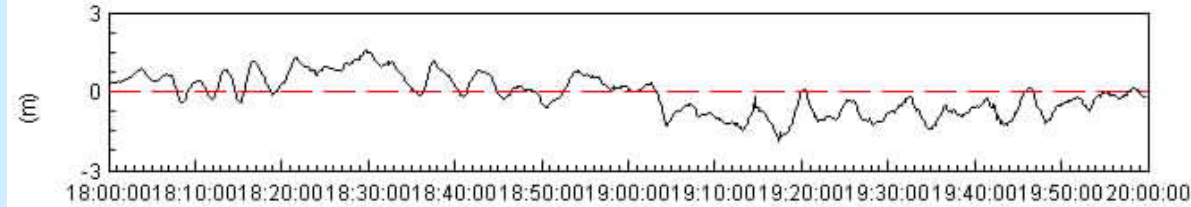


Drillship at harbour.
Phase based service
not influenced by
Shadowing/Multipath.
Variations in northing
are ship movements

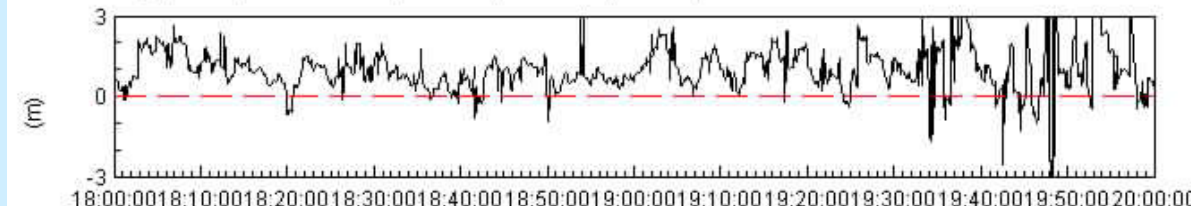
Delta Easting (Ref Pos) Fugro HP: dE: Min:-0.51, Max:0.48, Mean:-0.13, SD:0.16, Count:7200



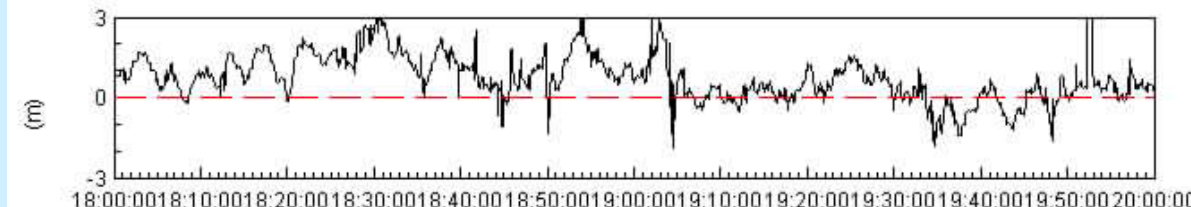
Delta Northing (Ref Pos) Fugro HP: dN: Min:-1.93, Max:1.56, Mean:-0.11, SD:0.73, Count:7200



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



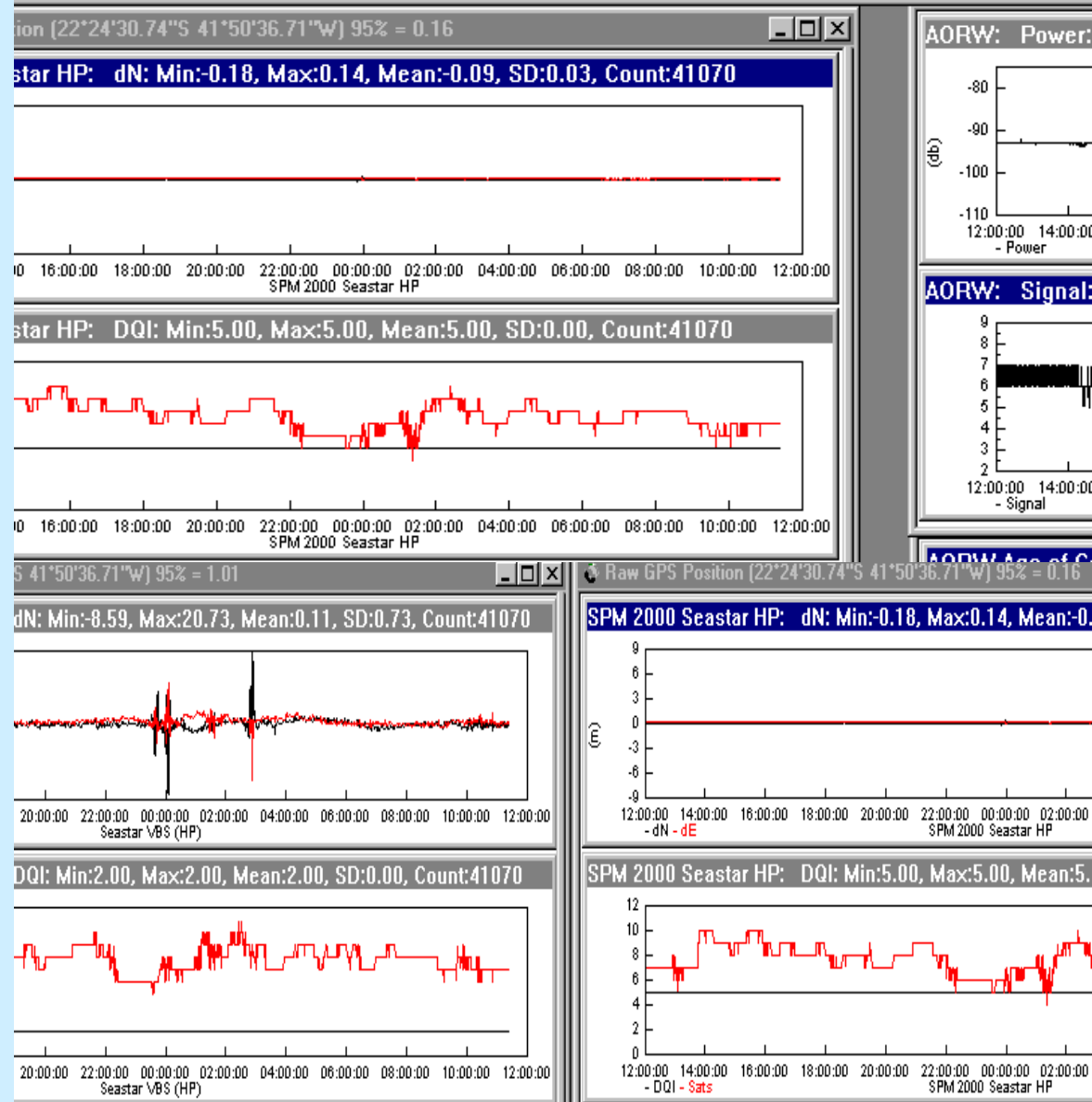
Data from the same GPS antenna and GPS receiver



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

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

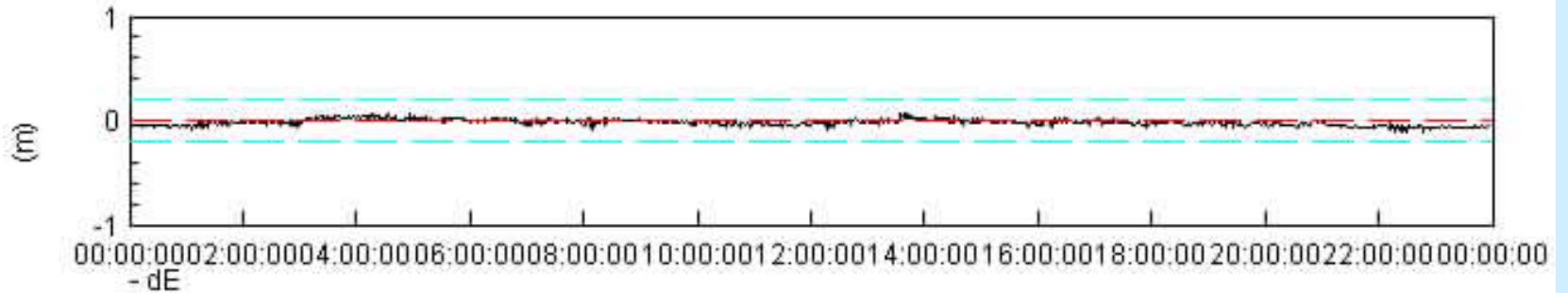
Between 23:00 and 03:00 ionospheric scintillations result in the GPS receiver loosing lock on some satellites, creating large errors in the code solution when reaquiring.



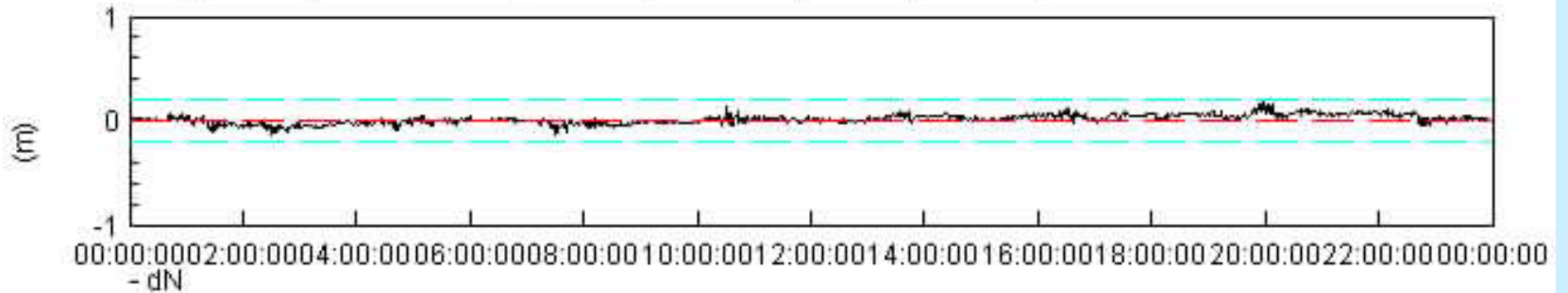


NETWORK SOLUTION, OSLO 12 APRIL 2004

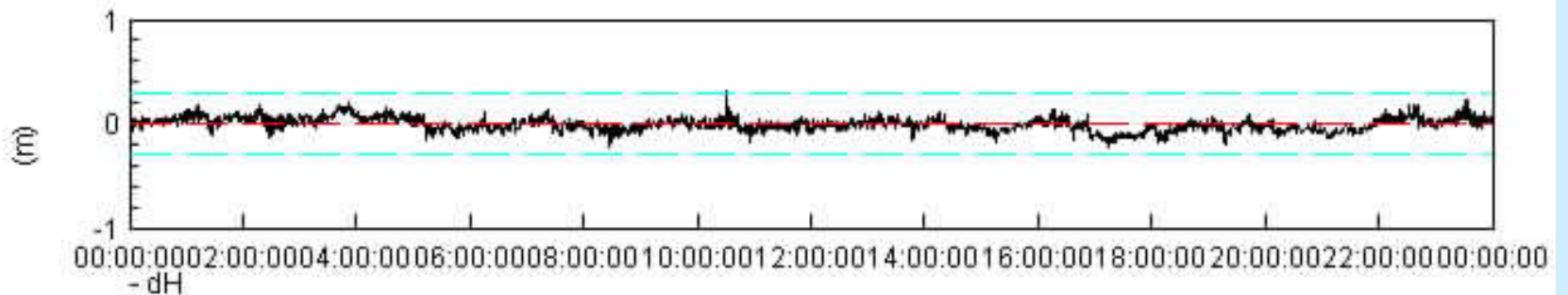
Delta Easting (Ref Pos) HP SPM4.01- Oslo EASAT: dE: Min:-0.12, Max:0.10, Mean:-0.02, SD:0.03, 2SD:0.06, Count:78699



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



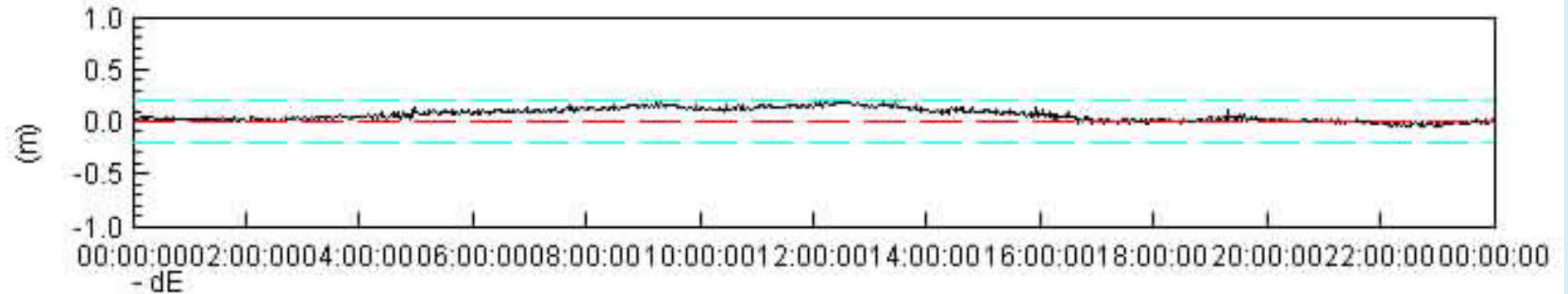
Delta Height (Ref Pos) : dH: Min:-0.25, Max:0.34, Mean:-0.00, SD:0.06, 2SD:0.12, Count:78699



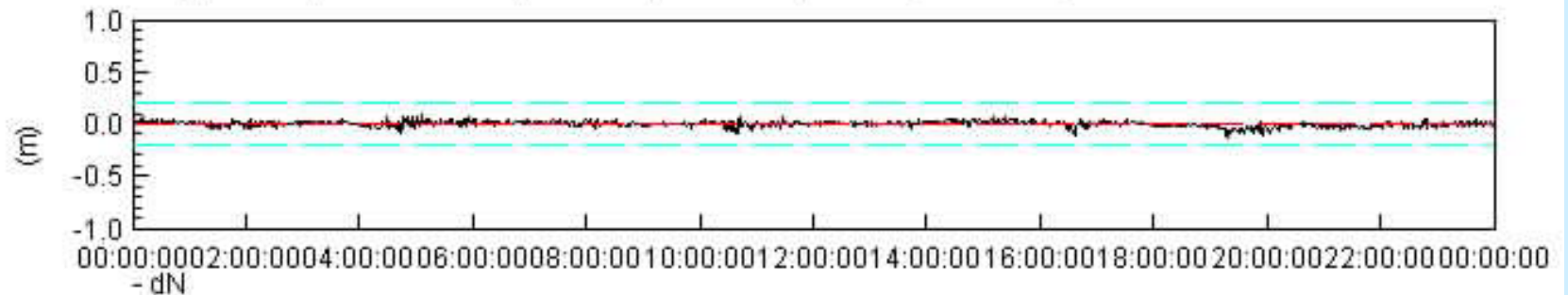


ORBIT/CLOCK SOLUTION, OSLO 12 APRIL 2004

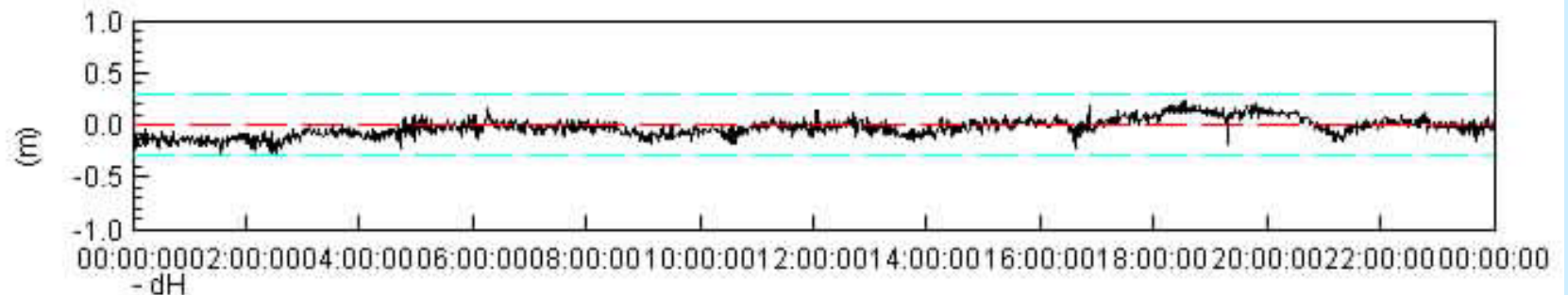
Delta Easting (Ref Pos) GSS SPM4.01 Oslo AFSAT: dE: Min:-0.07, Max:0.21, Mean:0.07, SD:0.06, 2SD:0.12, Count:78665



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



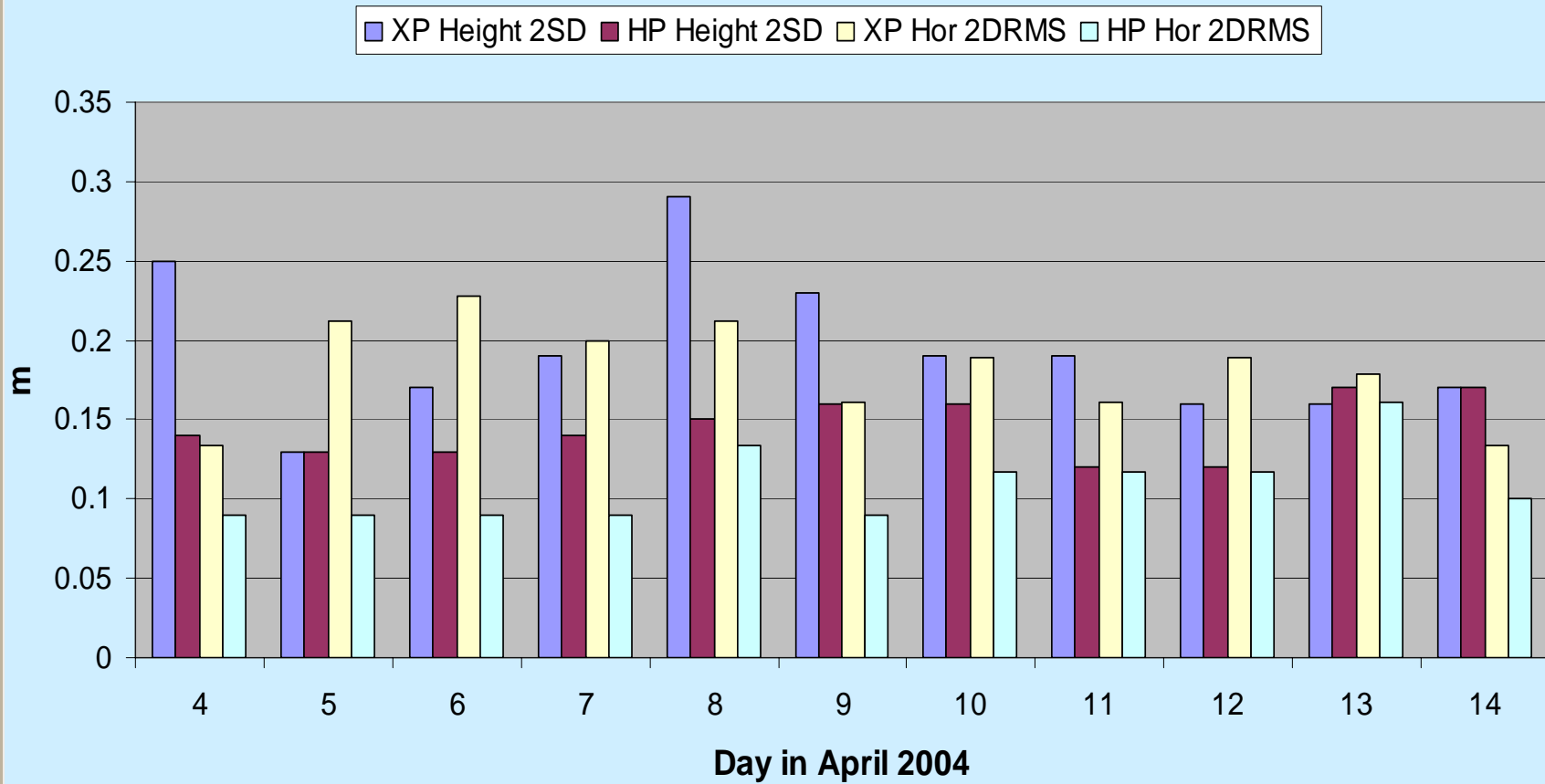
Delta Height (Ref Pos): dH: Min:-0.33, Max:0.25, Mean:-0.03, SD:0.08, 2SD:0.16, Count:78665





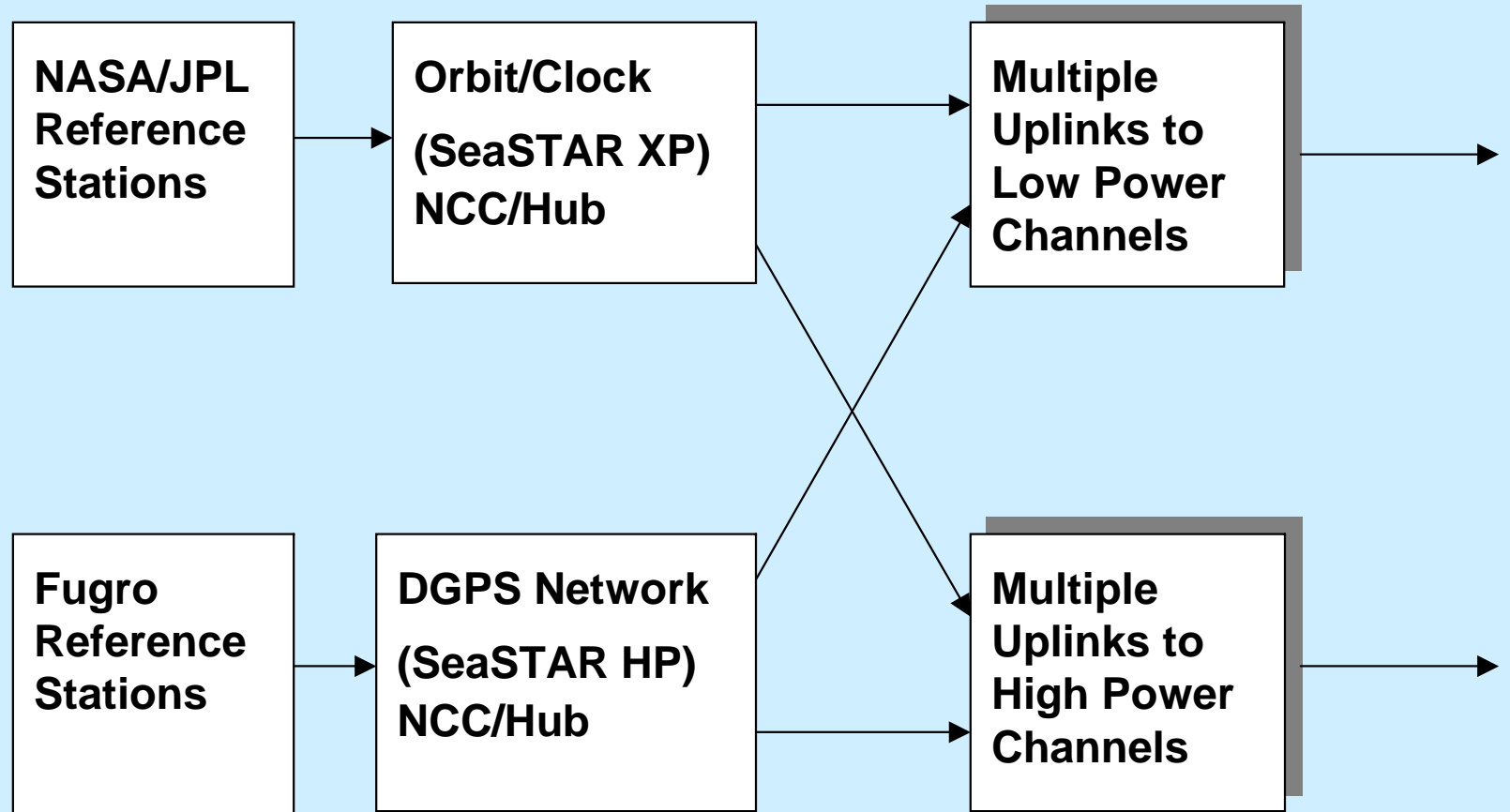
NETWORK VS ORBIT/CLOCK ACCUARCY IN OSLO 4-14 APRIL 2004

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



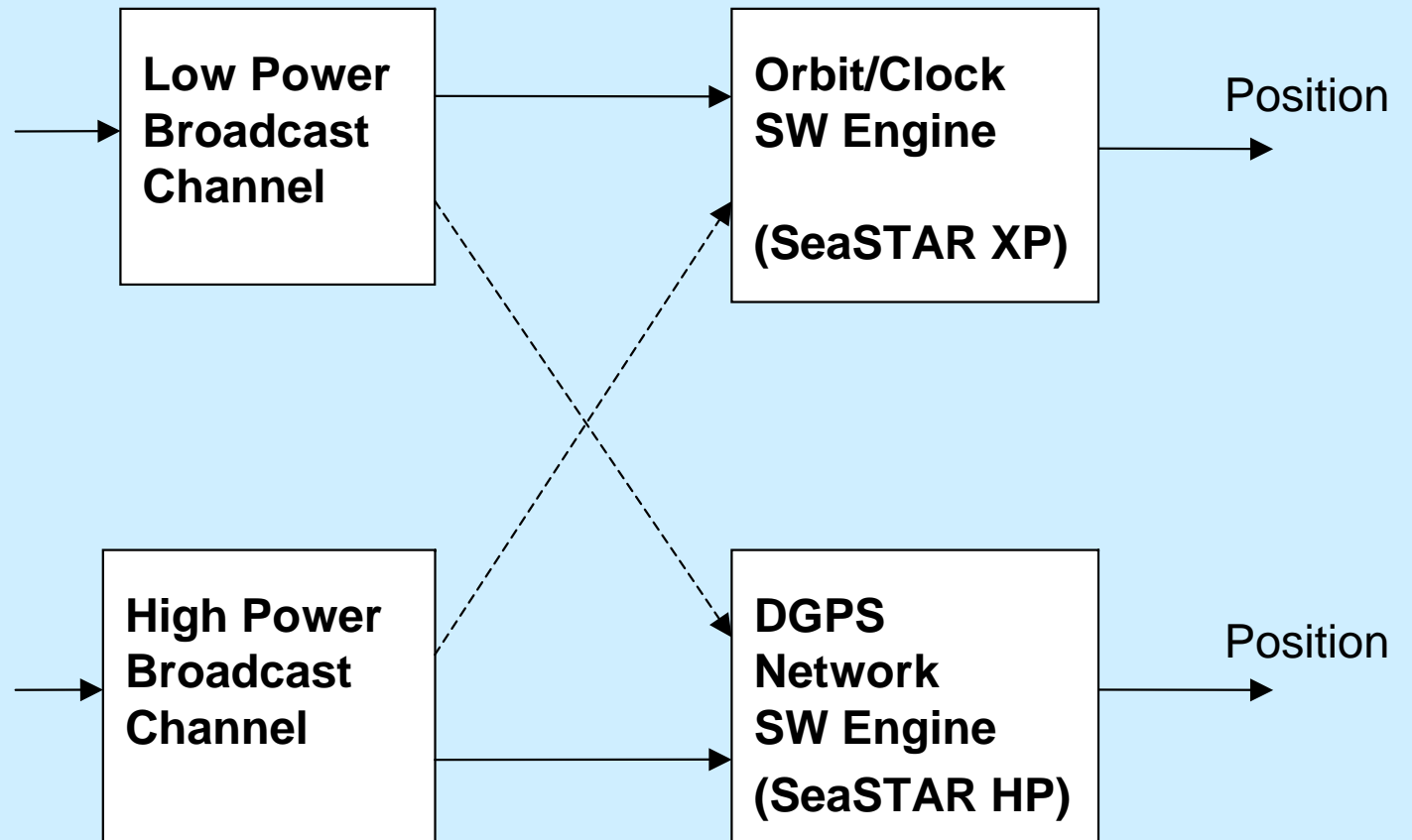


NETWORK SETUP





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