DESIMETERSYSTEM FOR HØYNØYAKTIG POSISJONERING OG NAVIGASJON

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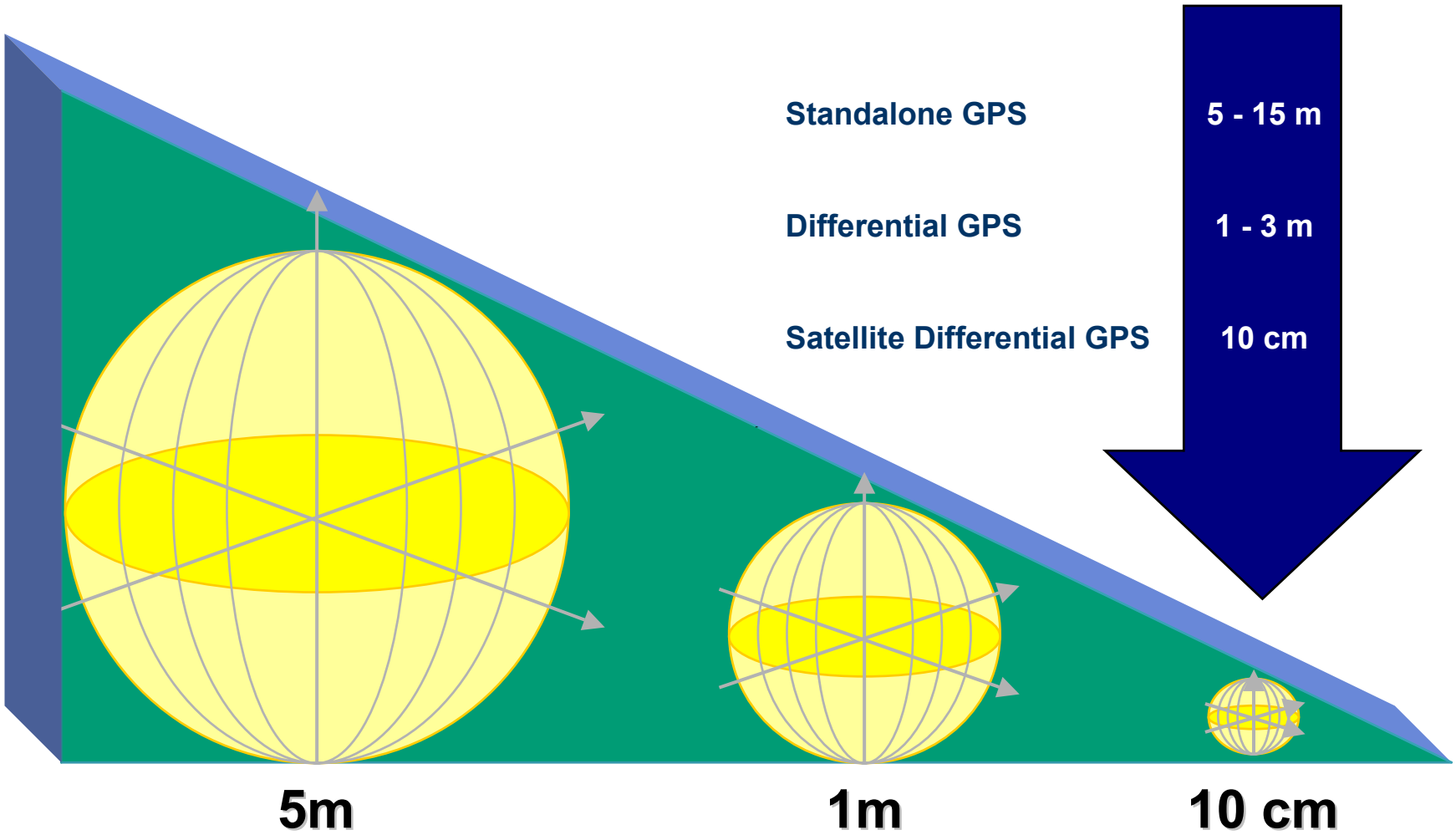
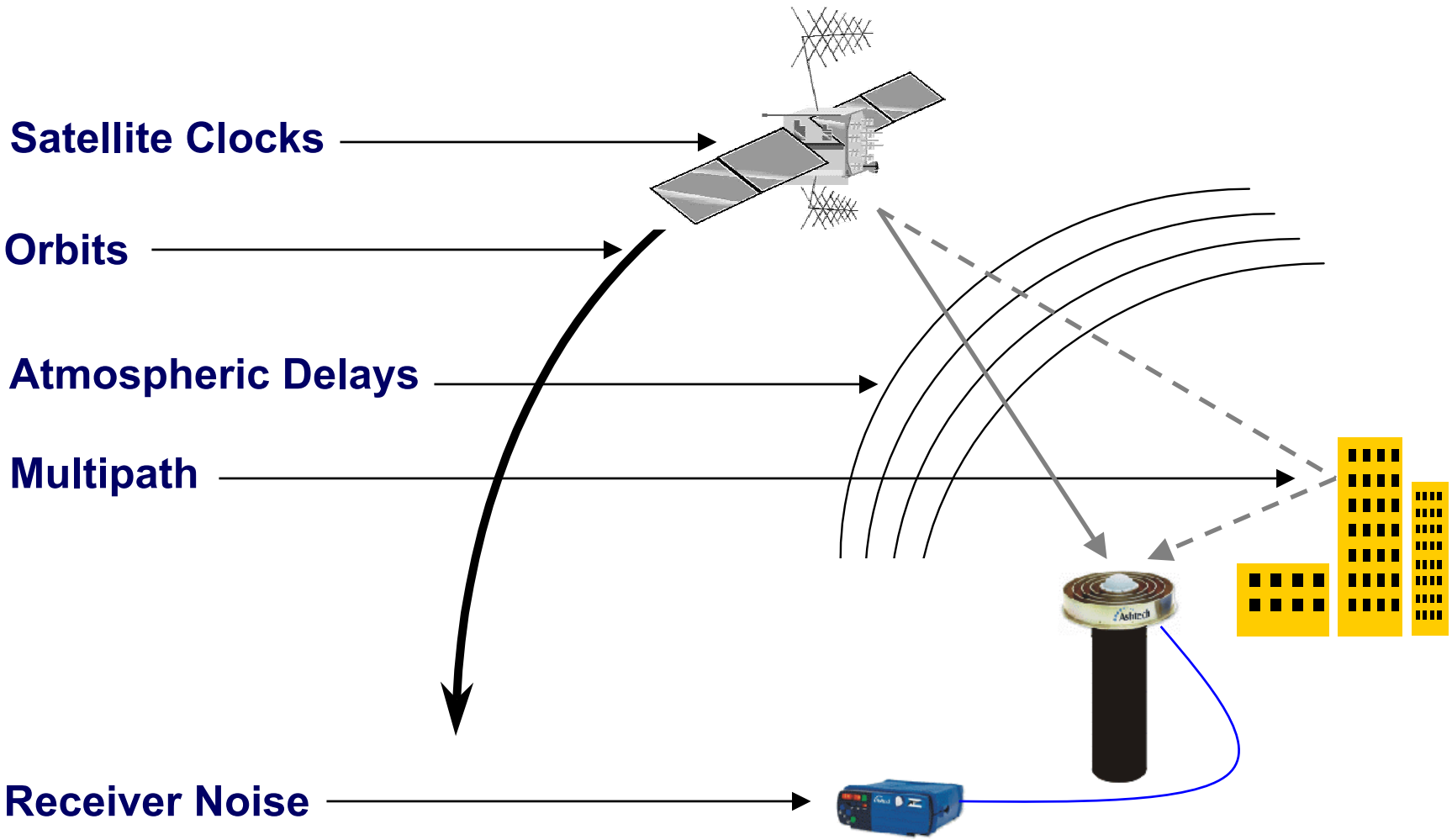
Scope of Presentation

- Introduction – Summary of GPS Errors.
- Review of Principles of Differential GPS.
- Principles of SkyFix XP Satellite Differential GPS (Decimetre Accuracy).
- Overview of MultiFix4 SDGPS QC Software.
- System Performance and Accuracy.
- Offshore Applications for Systems with Decimetre Accuracy.
- Geodesy Associated with for Global Decimetric Systems.

GPS System Performance



GPS Error Sources



Principles of Differential GPS

- Based on monitoring and correcting systematic errors in the GPS System.
- Establish a GPS receiver on an accurately co-ordinated point (Reference Station).
- Observe the GPS System's systematic errors at this point (pseudorange corrections) – estimated errors.
- Transfer these corrections to a mobile user via a data link.
- Apply these corrections to the GPS measurements observed at the mobile user and compute a position.
- System accuracy dependant on range from mobile to reference station.

Principles of Satellite Differential GPS

- Satellite Differential GPS – SDGPS – approaches the differential technique from a different perspective.
- No reference station range restrictions.
- Global coverage from a single set of corrections transmitted over communications satellite links.
- Extremely High Accuracy Positioning
  - 10cm – Horizontal
  - 15cm – Vertical

Main Features of SDGPS

- Corrections are applied to the main GPS error sources:
  - Satellite Orbits
  - Satellite Clocks

  SDGPS Corrections

  - Ionosphere
  - Troposphere

  SDGPS Software

  - Multipath
  - Receiver Noise

  Carrier Phase & Receiver Technology

- Results in an ‘error free’ GPS position

SDGPS Satellite Corrections

- Satellite Orbit Corrections:
  - Each individual error source on each satellite is identified and uniquely corrected for.
  - Thales GeoSolutions' network of reference stations are used to continuously track all satellites simultaneously.
  - By tracking each satellite throughout its orbit a precise orbit correction can be generated.
- Satellite Clock Corrections:
  - The global network of reference stations are also used to generate highly accurate clock corrections.
- These corrections are transmitted over the SDGPS Link.

SDGPS Software Functionality

- Ionosphere Delays:
  - Dual frequency GPS observations used by SDGPS software to compute the ionospheric delays.
- Tropospheric Delays:
  - Tropospheric delays are no longer modelled. These are computed by the SDGPS software.
- Multipath & Receiver Noise:
  - Use of carrier phase data in addition to code minimises these effects.
  - Use of new GPS receiver technology, e.g. ‘Strobe Edge’ correlator technology in the Thales ZX-Sensor receiver.

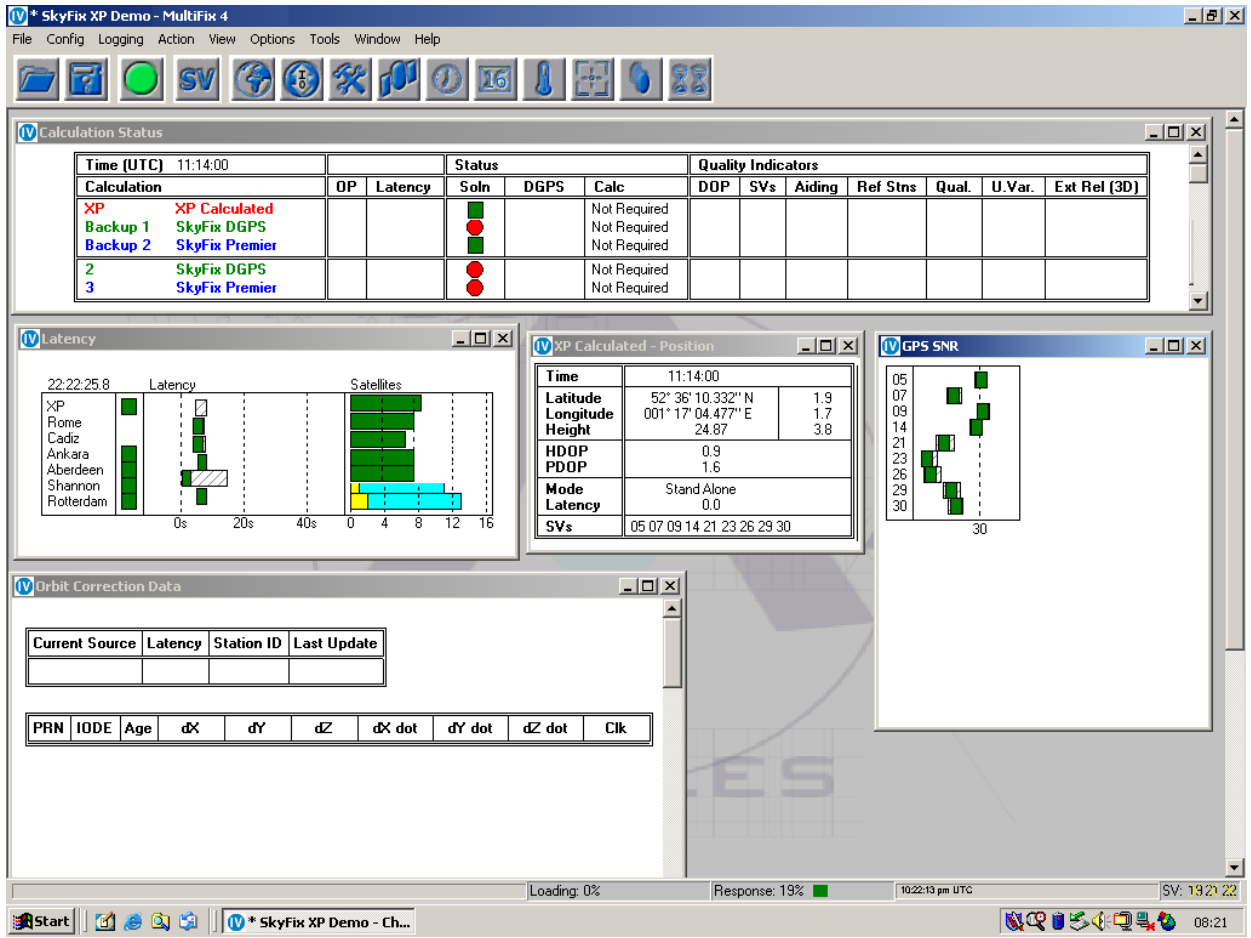
SDGPS QC SOFTWARE

Thales GeoSolutions Norge AS

THALES

MultiFix4 Software

- New Generation of GPS QC Software from Thales GeoSolutions.
- The result of several year's of precision GPS software development.
- Runs on Microsoft Windows 2000 / XP
- Incorporates the proven MultiFix3 technology.



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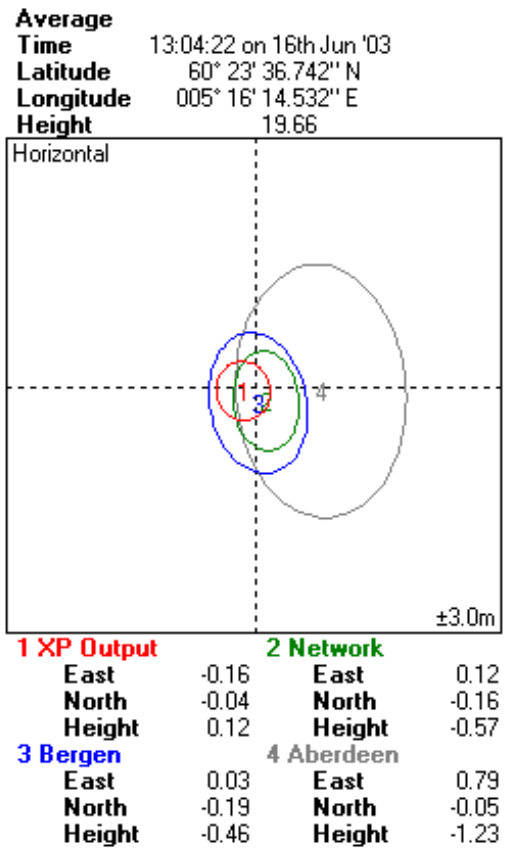
Calculation Status Display

Time (UTC) 12:58:20 on 16th Jun '03				Status			Quality Indicators						
Calculation		OP	Latency	Soln	DGPS	Calc	DOP	SVs	Aiding	Ref Stns	Qual.	U.Var.	Ext Rel (3D)
XP	XP Calculated	◀	7.0 sec	●	L1/L2 Diff	OK - Converged	2.6	7	3D	N/A	0.39	0.058	0.142
Backup 1	Network		4.2 sec	●	L1 Diff	OK	2.0	8	3D	4 of 4	0.84	0.808	1.532
Backup 2	Bergen		5.4 sec	●	L1 Diff	OK	2.1	7	3D	1 of 1	1.26	0.315	3.027
2	Network		4.2 sec	●	L1 Diff	OK	2.0	8	3D	4 of 4	0.84	0.808	1.532
3	Bergen		5.4 sec	●	L1 Diff	OK	2.1	7	3D	1 of 1	1.26	0.315	3.027
4	Aberdeen		5.4 sec	●	L1 Diff	OK	2.1	7	3D	1 of 1	2.20	2.097	5.115
5	Sumburgh		5.4 sec	●	L1 Diff	OK	2.1	7	3D	1 of 1	1.96	1.379	4.482
6	Kristiansund		4.2 sec	●	L1 Diff	OK	2.0	8	3D	1 of 1	1.84	0.500	4.031
7	Stand Alone		0.0 sec	●	Standalone	OK	2.0	8	3D	0 of 0	3.98	1.638	14.242

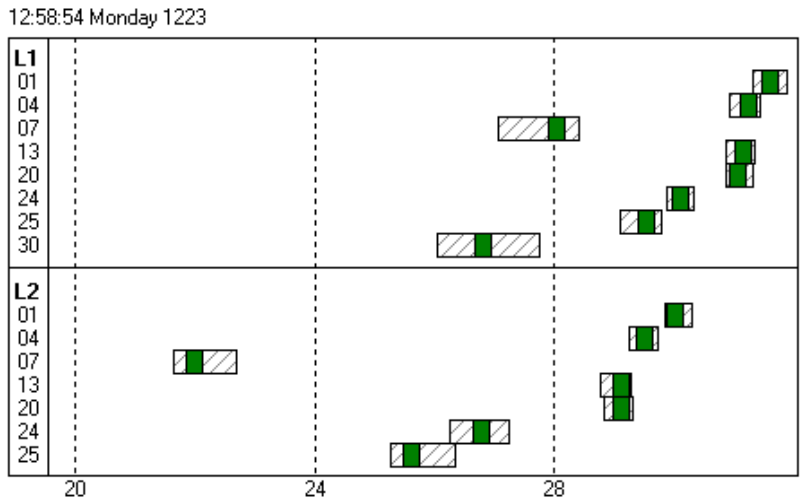
- Complete Summary of MultiFix4's Performance.
- Easily Understood "Traffic Light" Display.
- Automatic Computation Switching.
- Solution Status Summary.
- UKOOA Statistics / Quality Indicators Summary.

Extensive Quality Displays

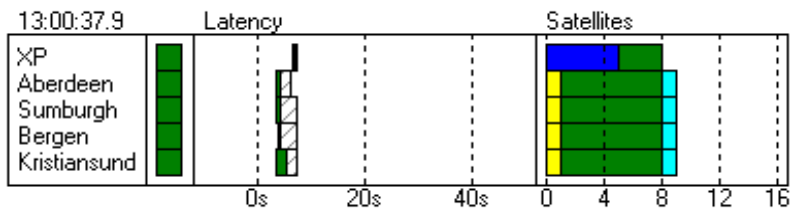
Position Quality



Satellite Tracking Monitoring

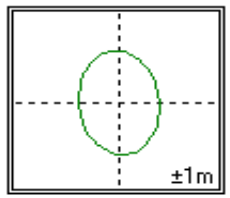


DGPS / SDGPS Status Monitoring



Full Display of all UKOOA Recommended DGPS Quality Figures

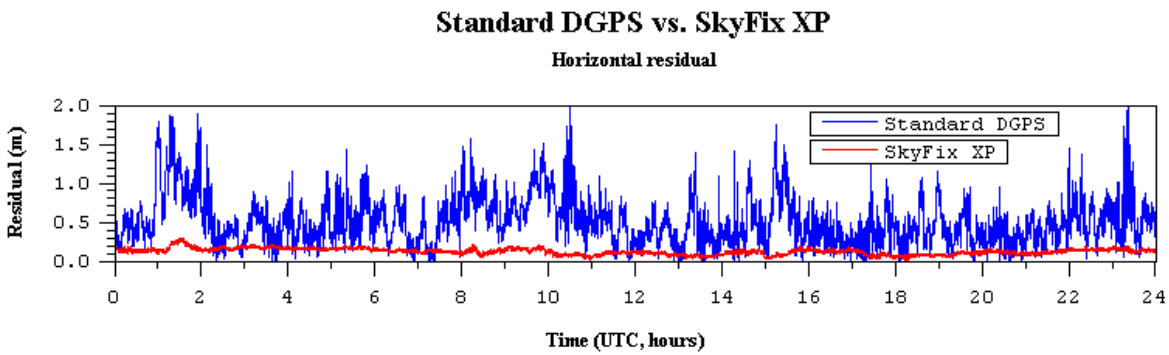
Latitude **Longitude** **Height**	60° 23' 36.737'' N 005° 16' 14.541'' E 19.53
F-Test	Pass
Unit Var.	0.749
Ext Rel (2D)	0.445

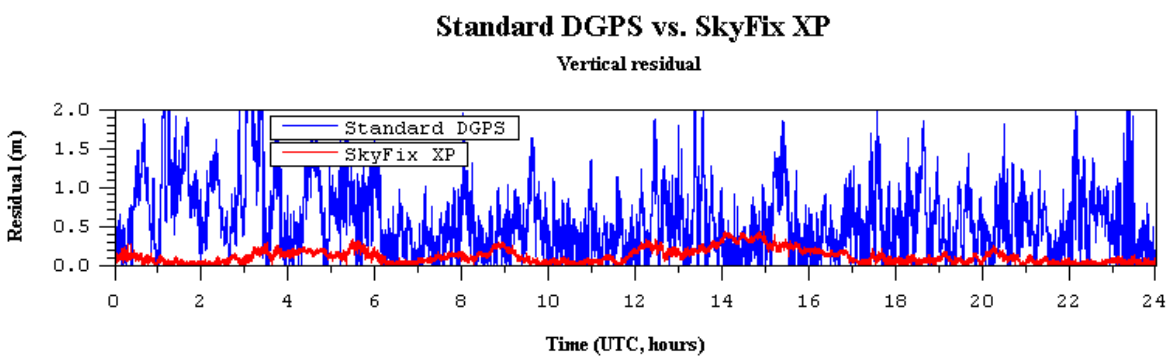


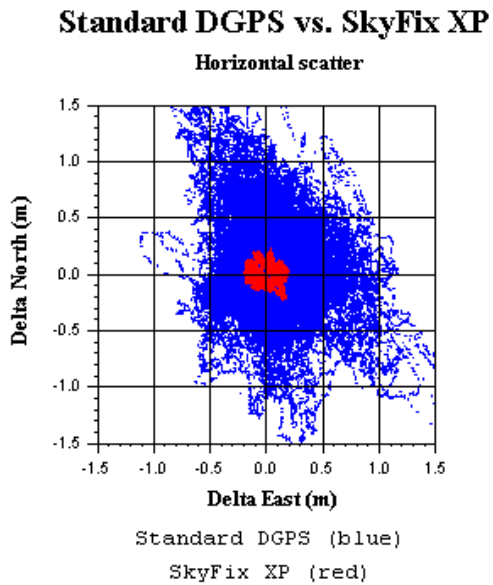
Station	RTCM	PRN	Elev.	Resid	SD	Norm. Resid.	MDE	Azi.	3D MDE	2D Pos	W Pass
Aberdeen	700	1	72°	-0.05	0.40	0.14	1.83	246°	0.33	0.06	Pass
		4	58°	0.12	0.38	0.32	1.82	137°	0.38	0.17	Pass
		7	12°	0.22	1.11	0.20	4.30	010°	0.49	0.20	Pass
		13	49°	-0.09	0.48	0.19	2.08	007°	0.29	0.22	Pass
		20	47°	-0.13	0.51	0.26	2.16	296°	0.17	0.15	Pass
		24	27°	-0.95	0.51	1.88	2.20	140°	0.20	0.16	Pass
		25	22°	1.47	0.62	2.37	2.59	226°	0.25	0.15	Pass
Sumburgh	710	1	72°	-0.24	0.35	0.68	1.63	245°	0.37	0.06	Pass
		4	58°	0.17	0.33	0.51	1.62	136°	0.44	0.20	Pass
		7	12°	0.73	1.00	0.73	3.92	010°	0.55	0.22	Pass
		13	49°	-0.04	0.42	0.09	1.86	008°	0.33	0.25	Pass
		20	47°	0.04	0.43	0.08	1.89	296°	0.20	0.18	Pass
		24	27°	-0.59	0.45	1.31	1.99	139°	0.22	0.19	Pass
		25	22°	0.71	0.53	1.34	2.30	225°	0.29	0.18	Pass
Bergen	780	1	72°	-0.09	0.23	0.37	1.16	214°	0.62	0.12	Pass
		4	58°	0.14	0.22	0.65	1.22	140°	0.75	0.36	Pass
		7	12°	0.28	0.48	0.59	2.53	012°	1.11	0.45	Pass
		13	49°	-0.06	0.23	0.25	1.21	012°	0.54	0.40	Pass
		20	47°	-0.14	0.23	0.64	1.21	288°	0.33	0.30	Pass
		24	27°	0.03	0.35	0.09	1.63	142°	0.30	0.28	Pass
		25	22°	0.14	0.34	0.40	1.73	218°	0.44	0.29	Pass
Kristiansund	790	1	72°	0.10	0.34	0.29	1.58	271°	0.36	0.06	Pass
		4	58°	0.44	0.33	1.35	1.58	129°	0.43	0.19	Pass
		13	49°	0.00	0.41	0.01	1.83	008°	0.37	0.28	Pass
		20	47°	-0.09	0.41	0.22	1.80	303°	0.23	0.20	Pass
		24	27°	-0.05	0.43	0.12	1.92	134°	0.23	0.18	Pass
		25	22°	-0.64	0.51	1.24	2.22	229°	0.30	0.17	Pass
		30	08°	-0.84	0.87	0.96	3.33	175°	0.27	0.07	Pass

SYSTEM PERFORMANCE AND ACCURACY

SDGPS versus DGPS

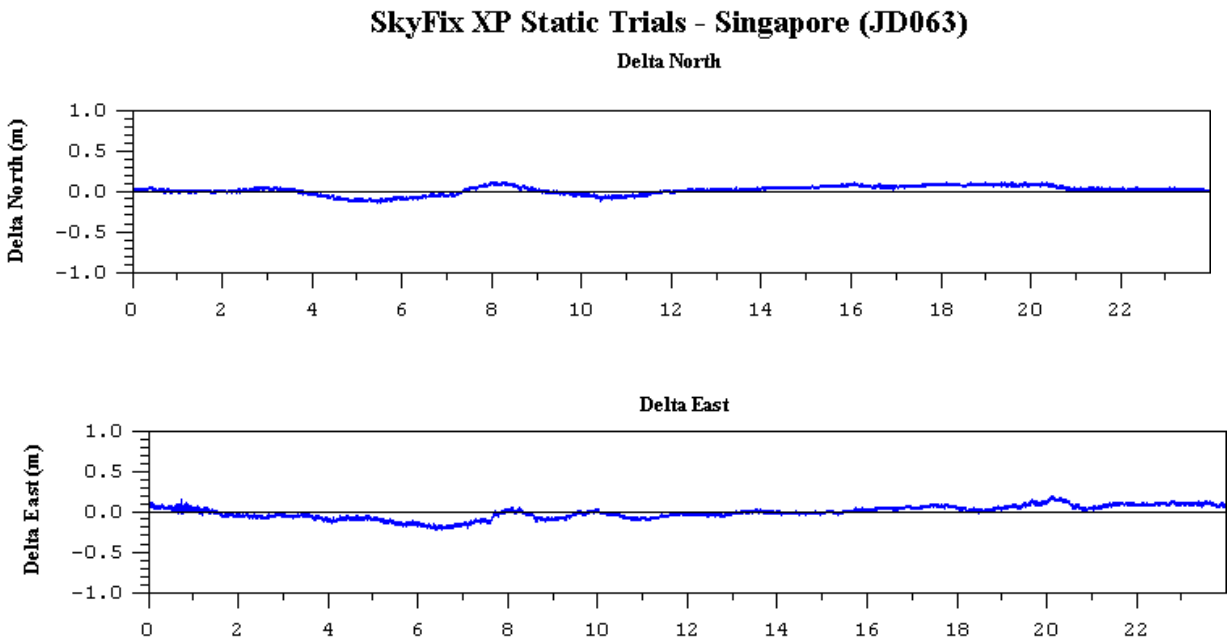






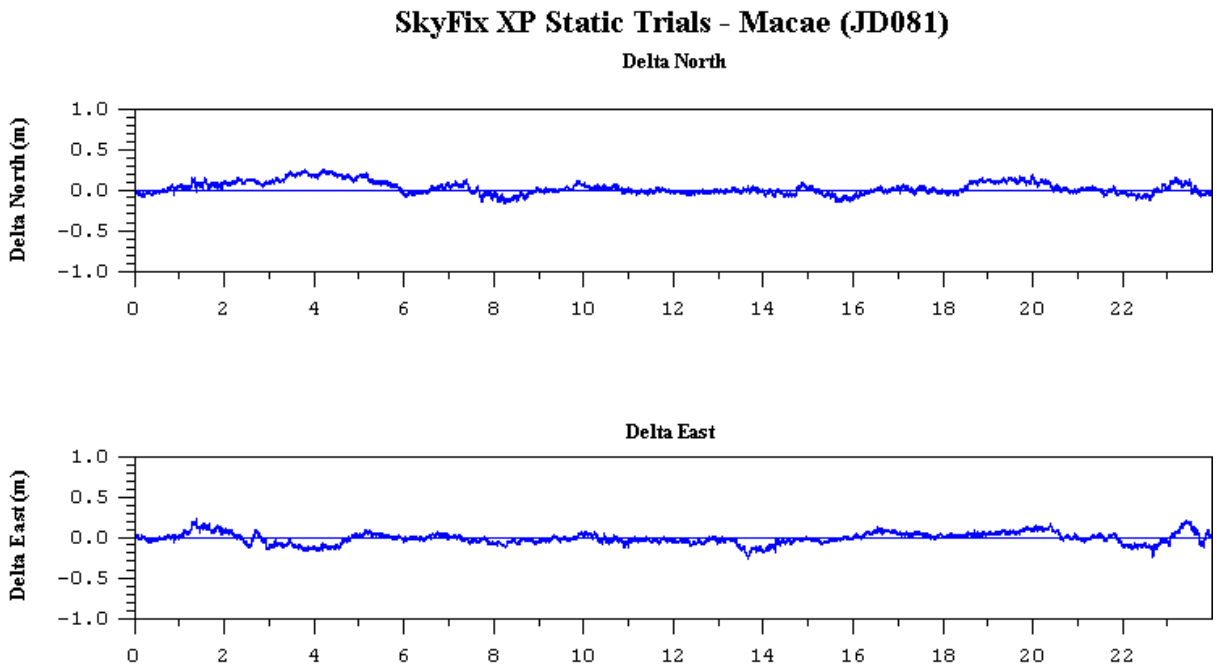
- 24 Hour Plots for Norwich, England

Singapore



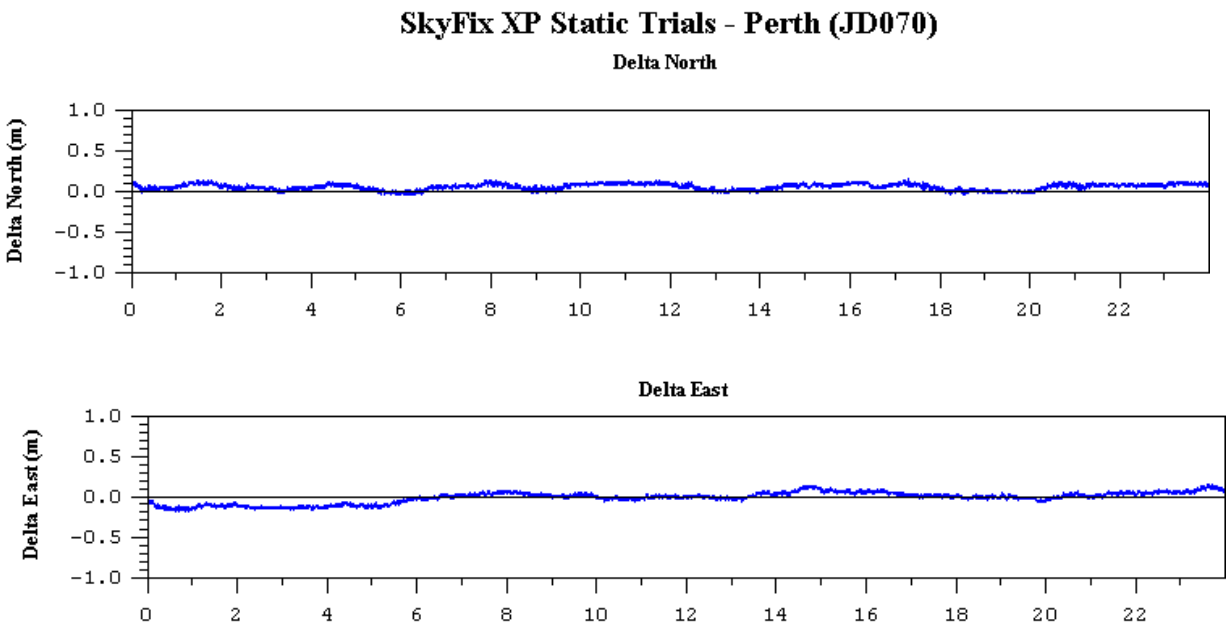
- 24 Hour Plot

Macae, Brazil



- 24 Hour Plot

Perth, Australia



- 24 Hour Plot

OFFSHORE APPLICATIONS

Offshore Applications

- Replacement for Tide Data for Subsea Engineering Projects:
  - Depth data traditionally corrected to vertical datum using tide data.
  - We now have the vertical accuracy to replace this data type.
  - Determine the height of vessel reference point / sensors with the aid of a motion sensor.
  - Can utilise a geoid model to produce geoid heights or use ellipsoidal heights as reference.
  - Thales Tide / Offset add-on to MultiFix4 available December 2003.

- High Precision Engineering:
  - Offshore platform installation.
  - Drilling rig positioning in critical areas.

Offshore Applications

- Replacement for Subsea LBL Acoustic Arrays:
  - LBL arrays are time consuming and expensive to deploy and calibrate.
  - A more elegant solution is SkyFix XP / MultiFix / HiPAP USBL.
  - Accuracy 20 cm to 50 cm subsea depending on water depth.

- Vessel Dynamic Positioning Systems
  - High accuracy = Less fuel used (savings in fuel costs).
  - Less fuel used = environmentally friendly.
  - Less thruster noise = quieter environment for survey sensors.

- Other Applications Requiring Decimetre Accuracy

SkyFix XP SDGPS Service & MultiFix4 were Launched as a Commercial Product in May 2003

QUESTIONS ?