
New Concepts In Long Range Positioning

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Civil GPS Service Interface Committee
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Introduction

- **Background to developments**
- **Requirements & Objectives**
- **Technical challenges**
- **Description of techniques and methods**
- **Solutions and results**
- **Summary and conclusions**

Background

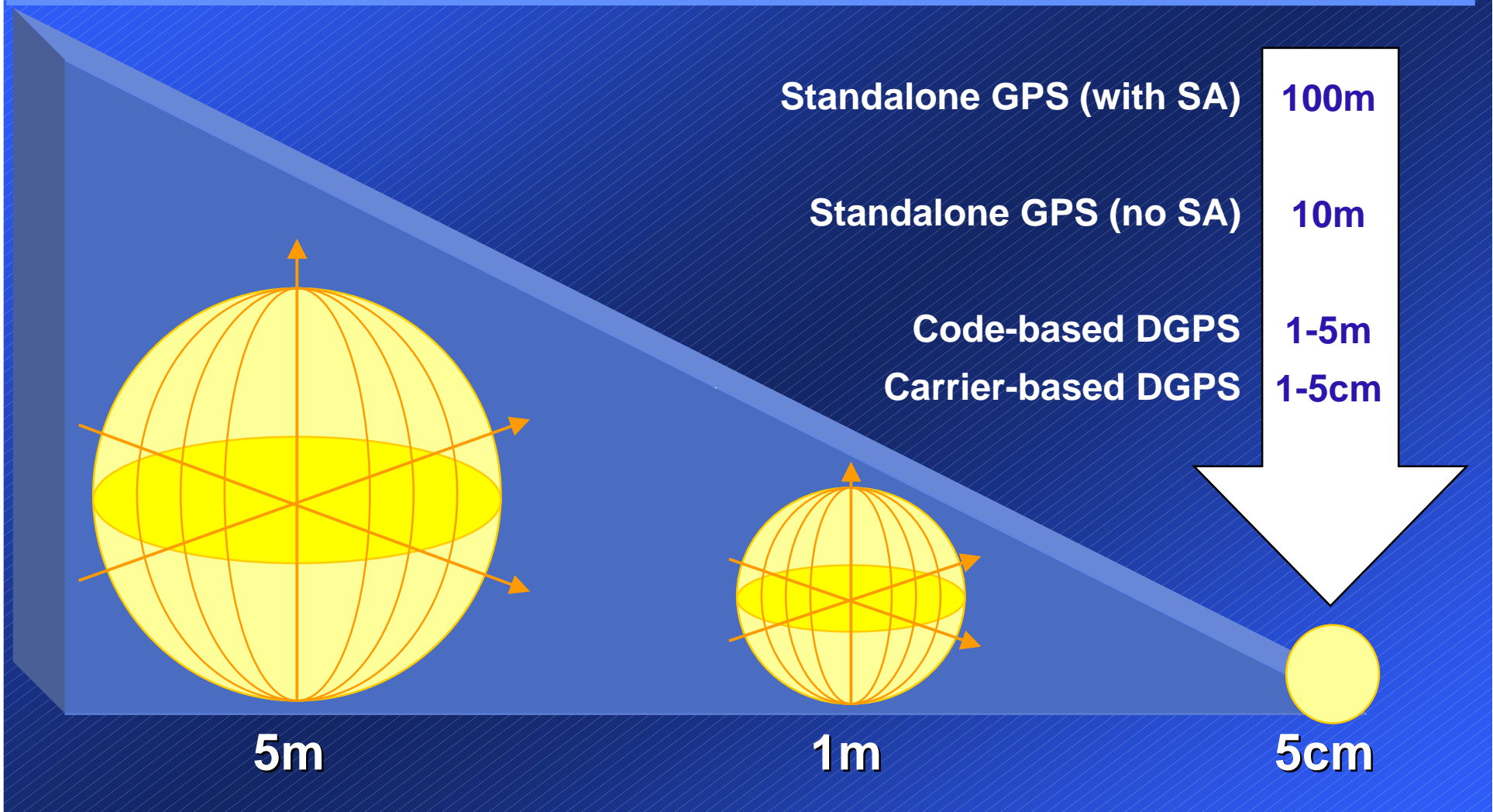
- **GPS hardware and software developments**
- **Increase in positioning accuracy requirements**
 - **MBES, construction and deep water projects**
- **Cost and availability of positioning services**
- **Dual frequency data**
- **WAAS, EGNOS and Competition.**

DGPS Hardware Developments



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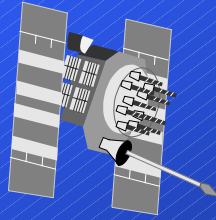
GPS Systems Performance



GPS Observables

- Two independent range observables
 - Code (pseudo-range)
 - Carrier phase
- GPS receiver only measures fractional part of observables
- Both measurements ambiguous by an integer number of wavelengths

GPS Measurement Wavelengths



Carrier frequencies

L1: 1575.42 MHz (wavelength \approx 19cm)

L2: 1227.60 MHz (wavelength \approx 24cm)

Code

L1: C/A code - civilian
(code wavelength \approx 293m)

P (Y) code - military

L2: P (Y) code - military

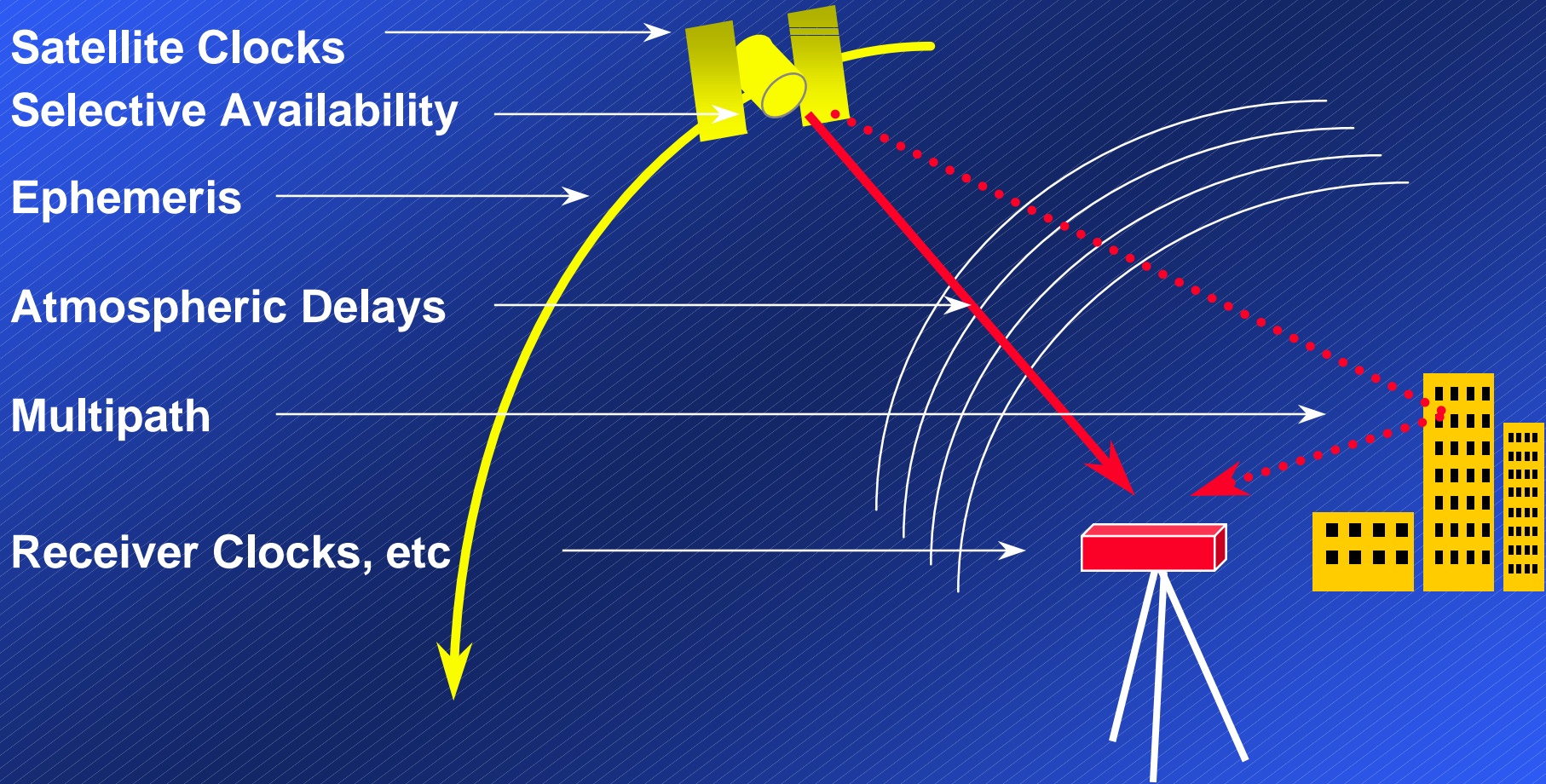
CYCLE SLIPS



New Integer Ambiguity (N)



GPS Error Sources



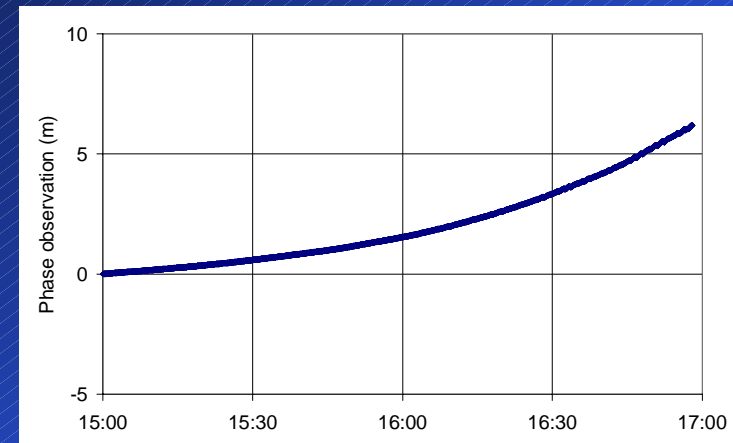
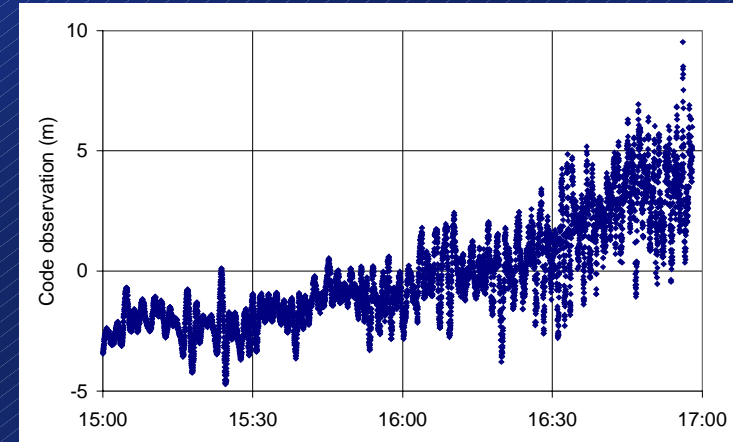
Carrier-Phase DGPS

Advantages

- Lower levels of multipath error
- Lower levels of measurement noise

Disadvantages

- Unknown number of wavelengths
- Positioning affected by similar biases to Pseudo-Ranges:
 - Ionosphere and troposphere
 - Satellite & receiver clocks



Genesis - The RACAL LRTK System

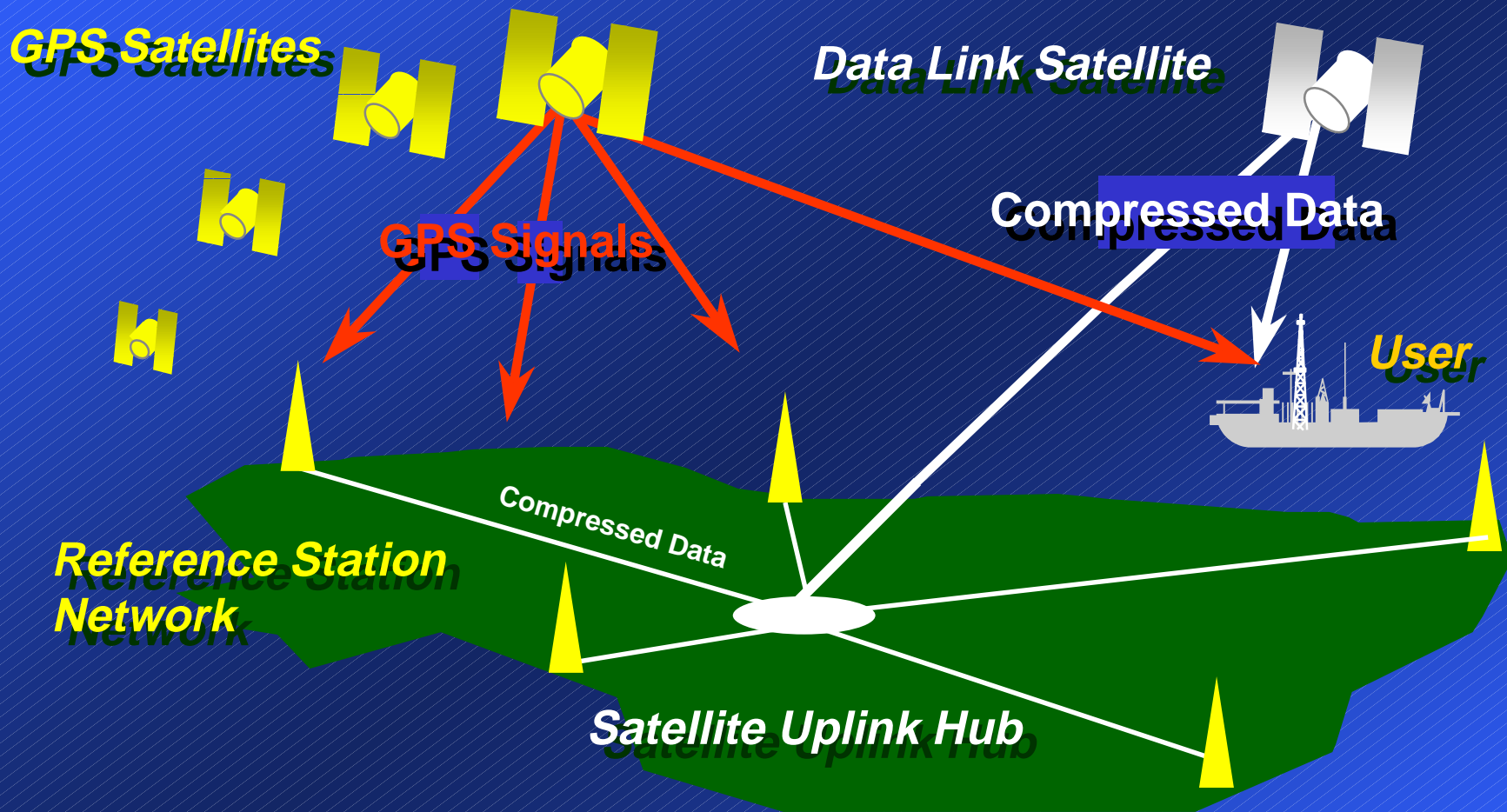
OVERVIEW

- Accurate to better than 20 cm
- Satellite-based LRTK system
- Operational over long baselines (>500km)
- Provides a robust LRTK System
(User Equipment, Quality Parameters,
smooth positioning mode, Network Solution)

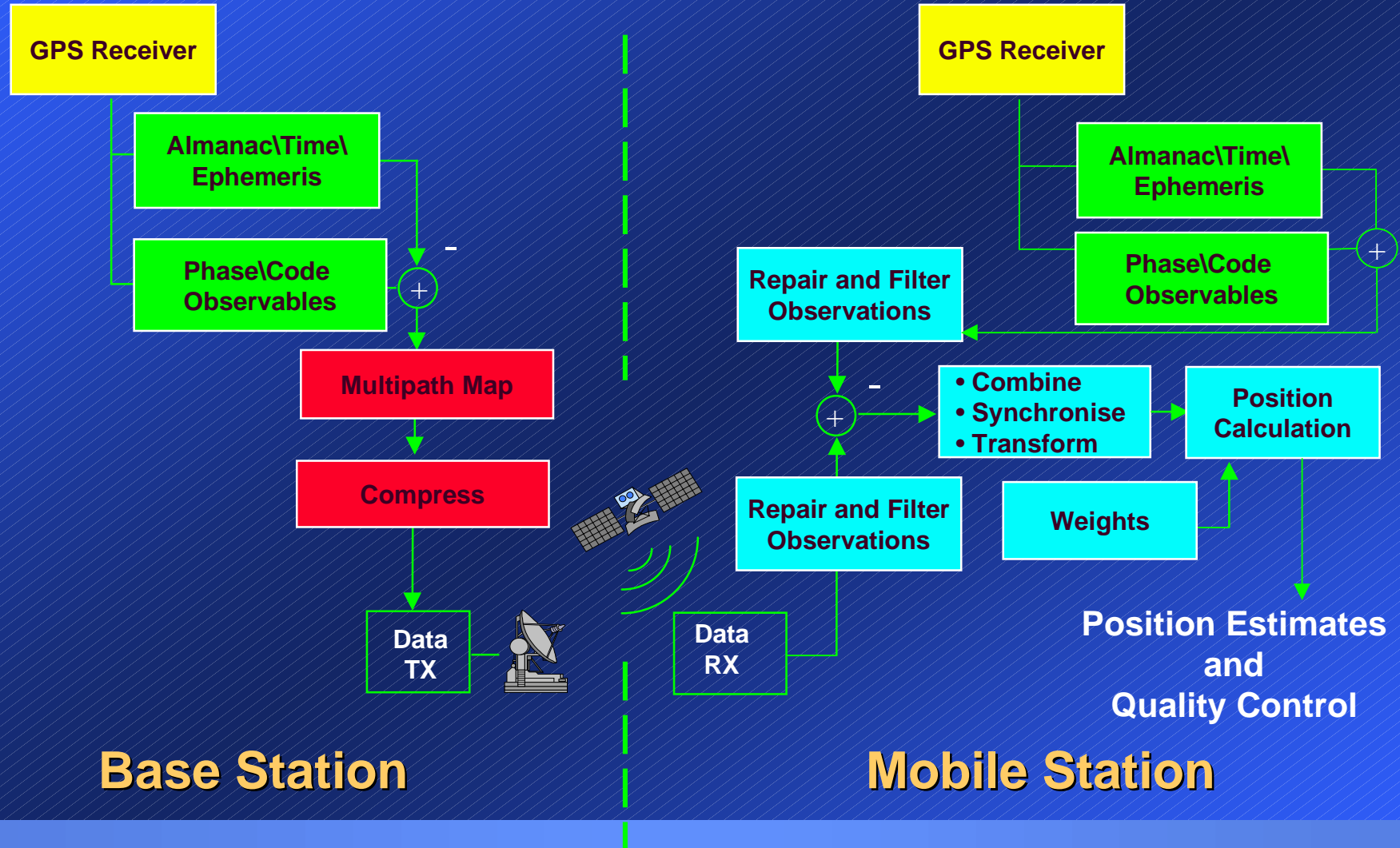
RACAL LRTK Challenges

- **Technique**
 - Error Modeling (Atmosphere, Multipath)
 - QC Statistics (reliable QC statistics)
 - Robust Transition between solution types
- **Data Transmission**
 - Data Compression
 - Transmission mode vs Baseline lengths
(i.e. performance at long ranges required to support Satellite-based Transmission mode)

RACAL Genesis General Architecture



RACAL Genesis System Components



RACAL Genesis Results - 50km

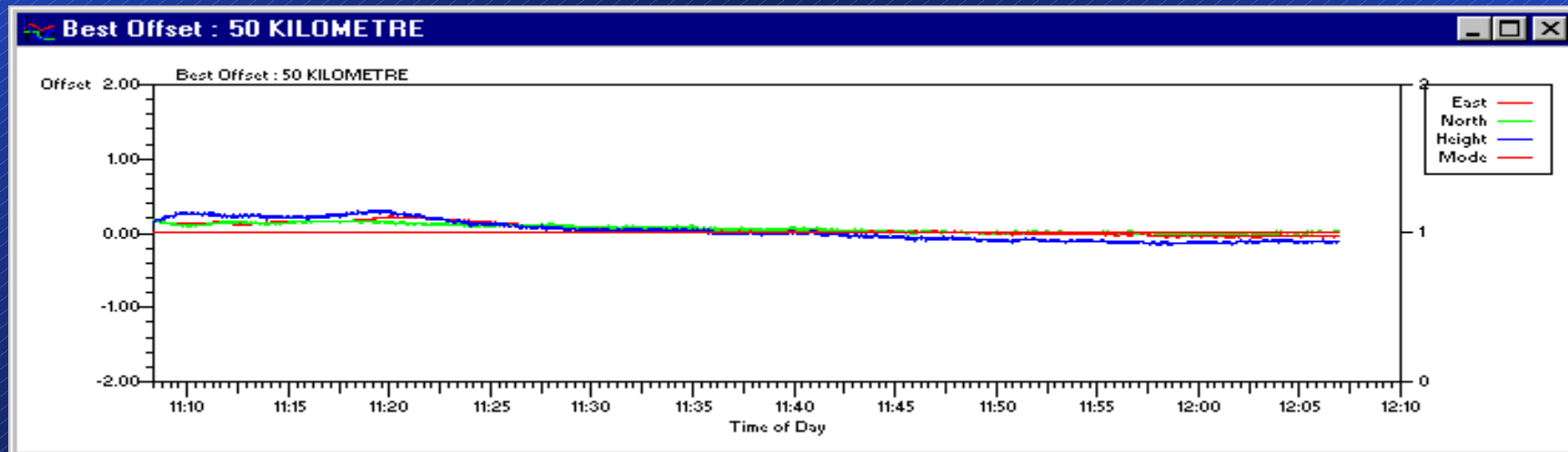
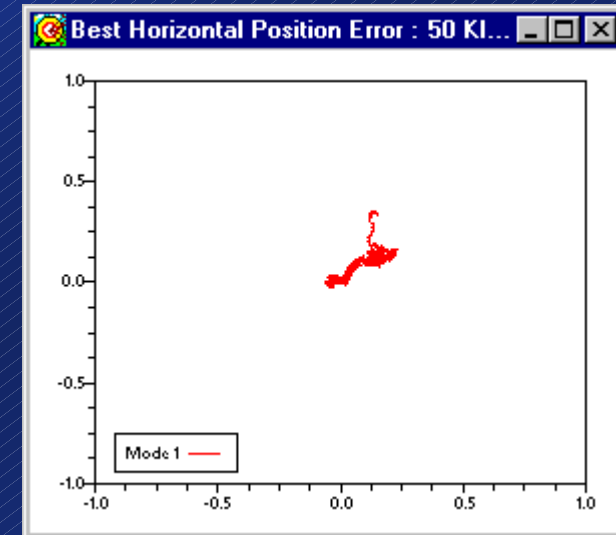


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RACAL Genesis Results - 50km Baseline

Typical Static real time performance over 2 hours including initialization:

	Mean	SD(2σ)
Delta East	-0.002m	0.17m
Delta North	0.070m	0.11m
Delta Height	-0.026m	0.21m



RACAL Genesis Results - 200km



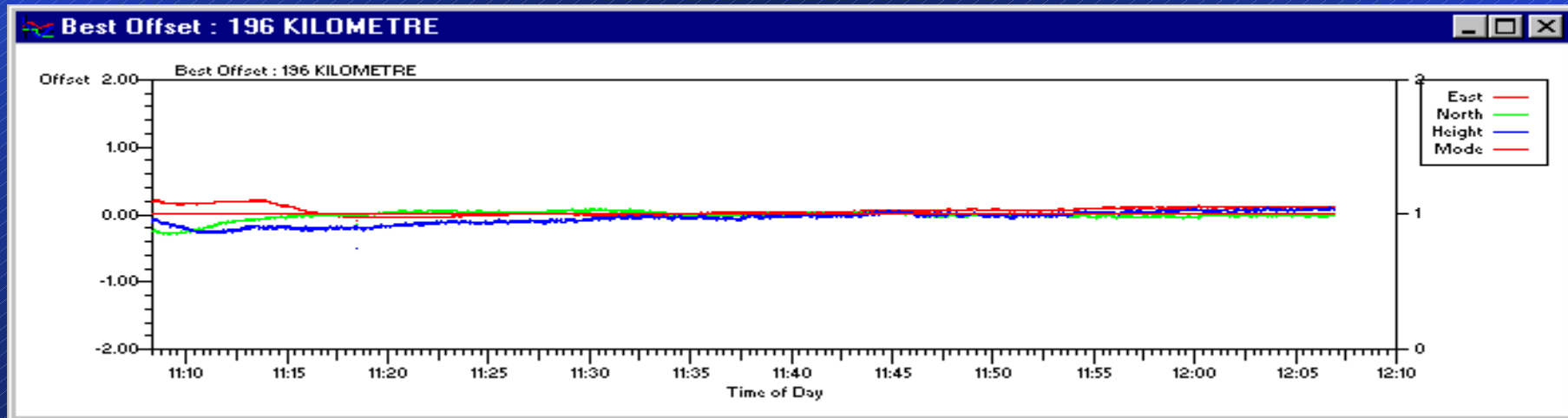
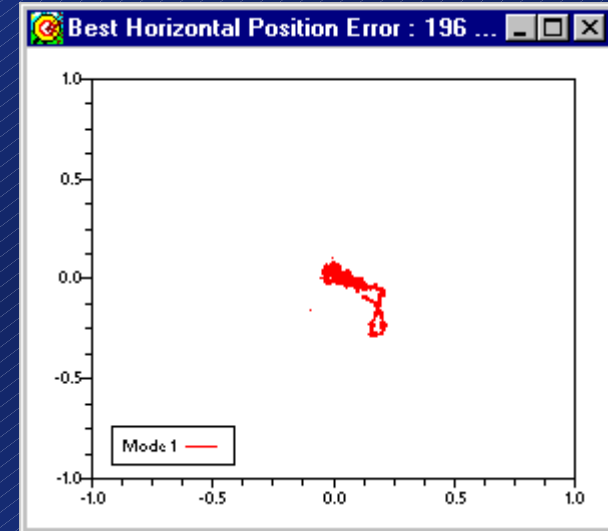
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RACAL Genesis Results - 200km

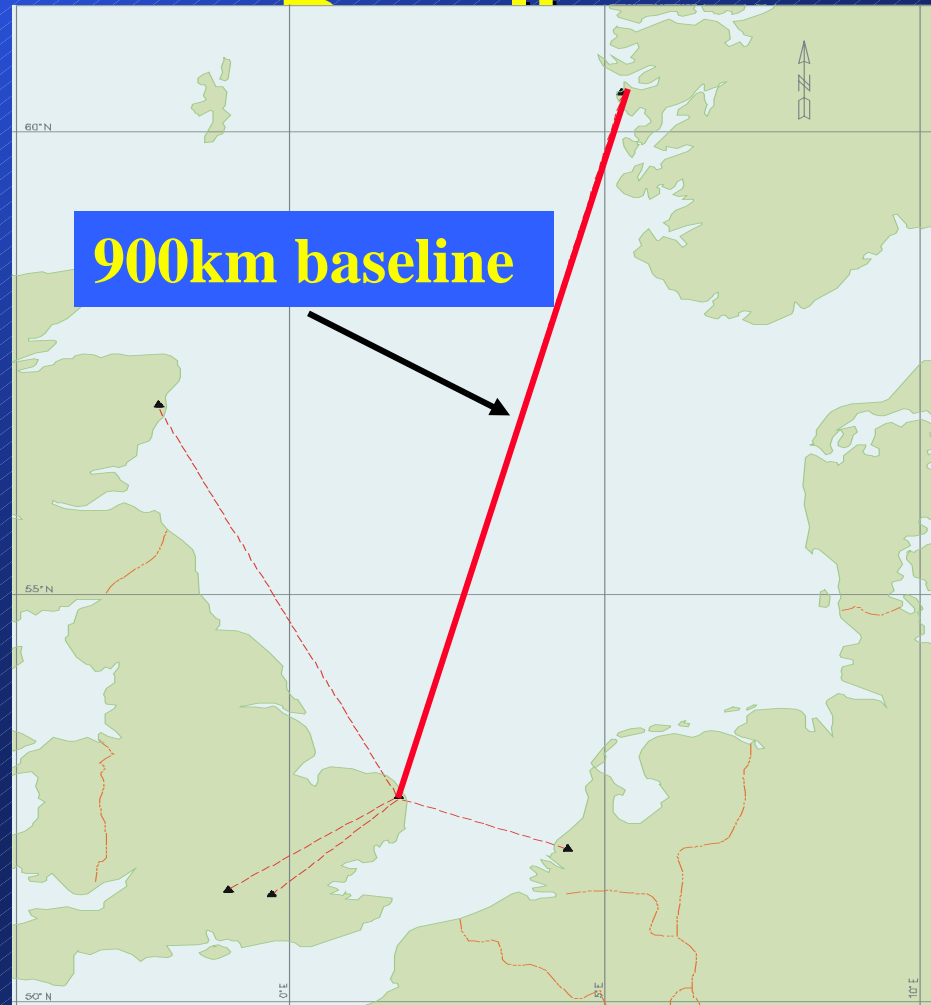
Baseline

Typical Static real time performance over 2 hours including initialization:

	Mean	SD(2σ)
Delta East	0.110m	0.14m
Delta North	-0.004m	0.12m
Delta Height	-0.013m	0.20m



RACAL Genesis Results - 900km



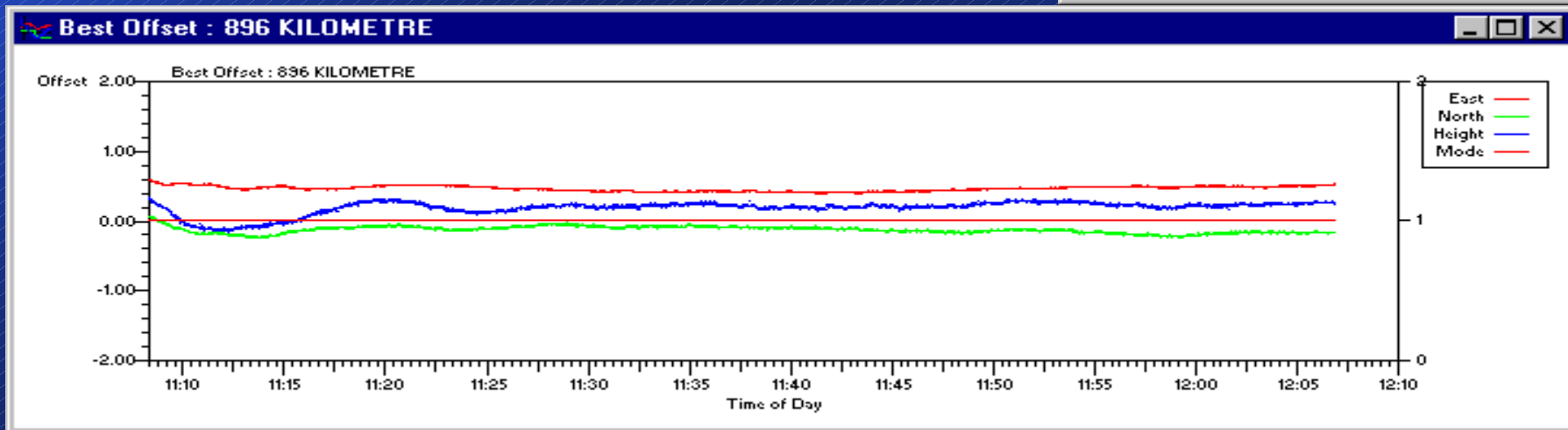
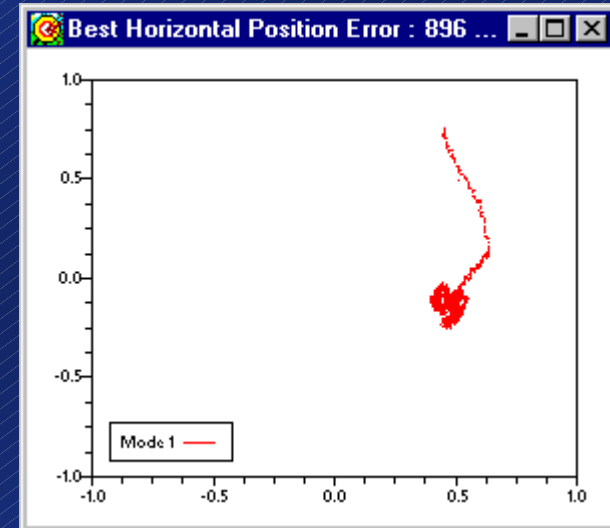
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RACAL Genesis Results - 900km

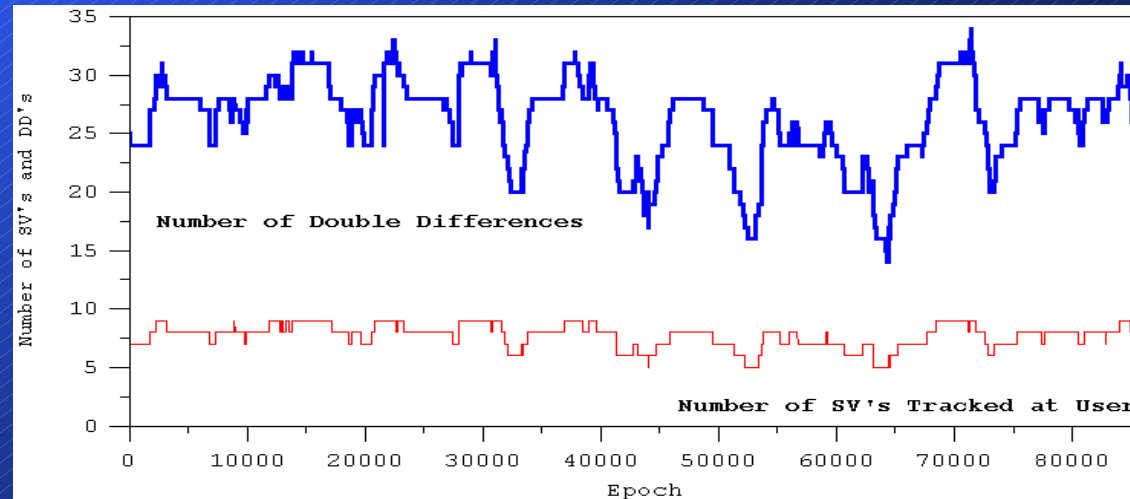
Typical Static real time performance over 2 hours including initialization:

	Mean	SD(2σ)
Delta East	0.490m	0.09m
Delta North	-0.185m	0.35m
Delta Height	0.316m	0.38m

Baseline

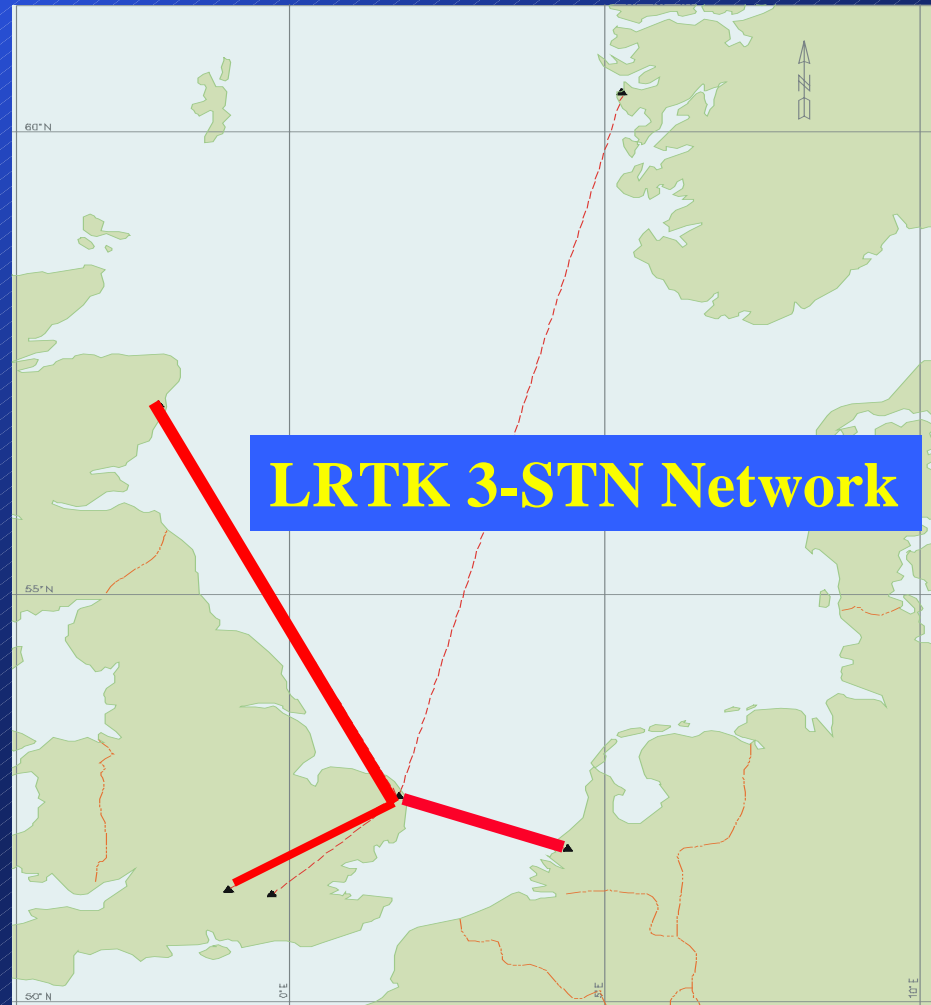


RACAL Genesis Network



- 4 Station Network LRTK Solution v Single User SV Tracking (24 Hours)
- 2 periods in particular would not have enough DD's for Single Baseline

RACAL Genesis Results - Network

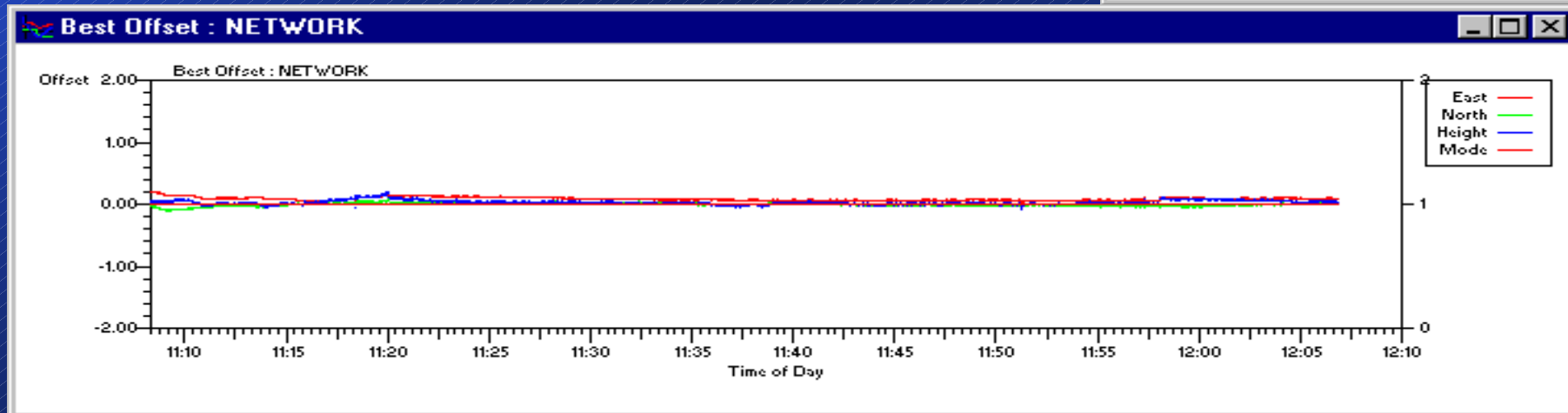
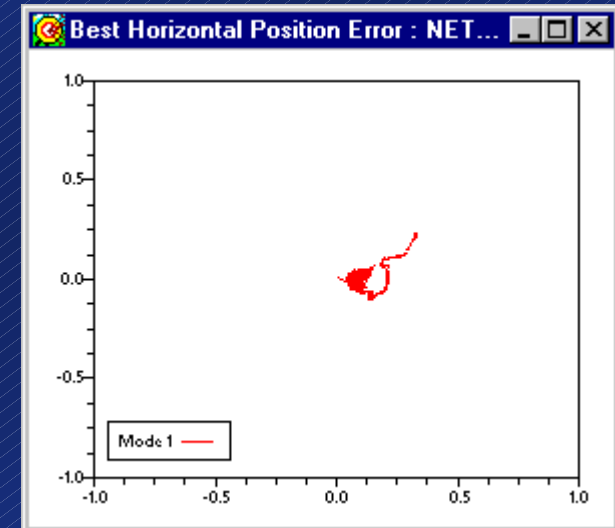


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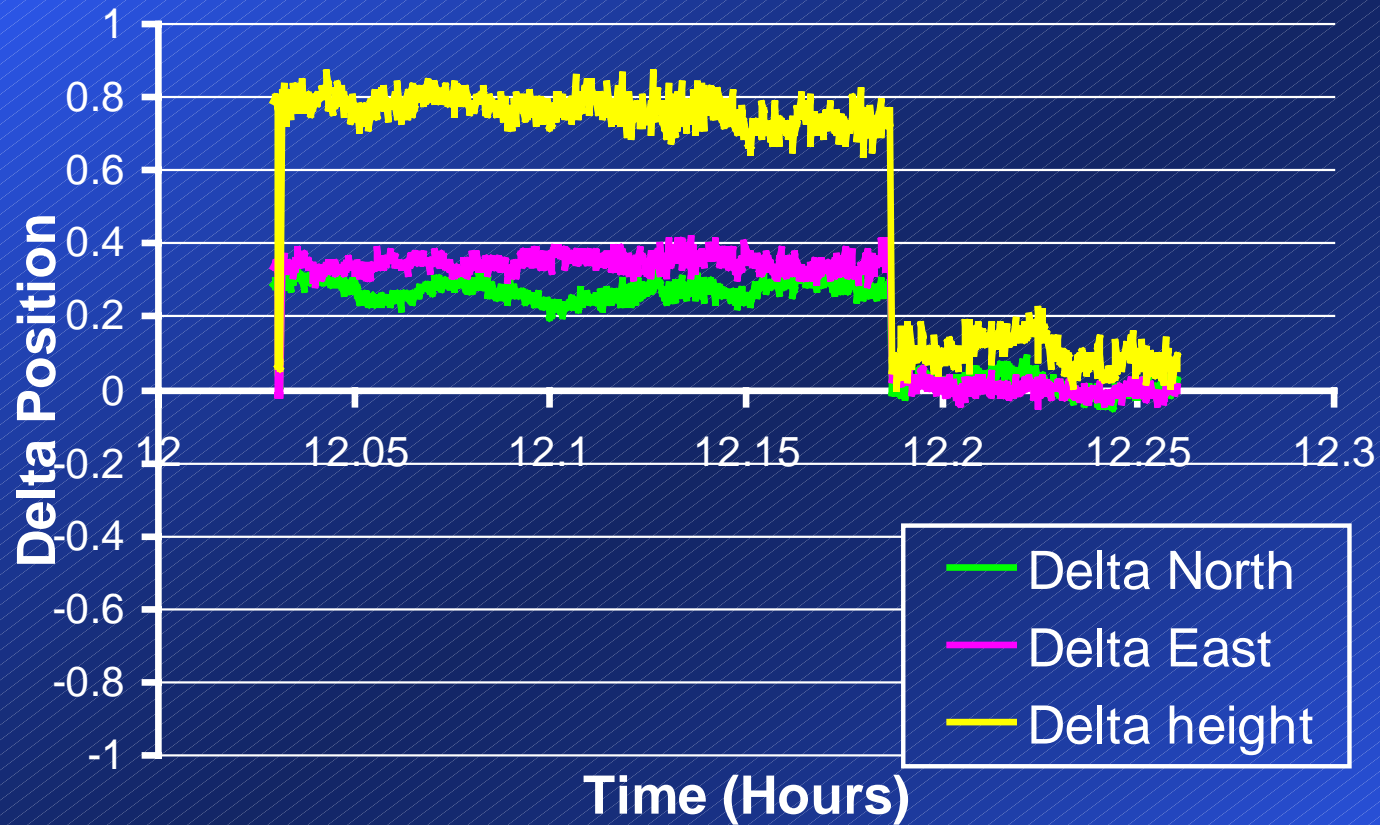
RACAL Genesis Results - Network

Typical Static real time performance over 2 hours including initialization:

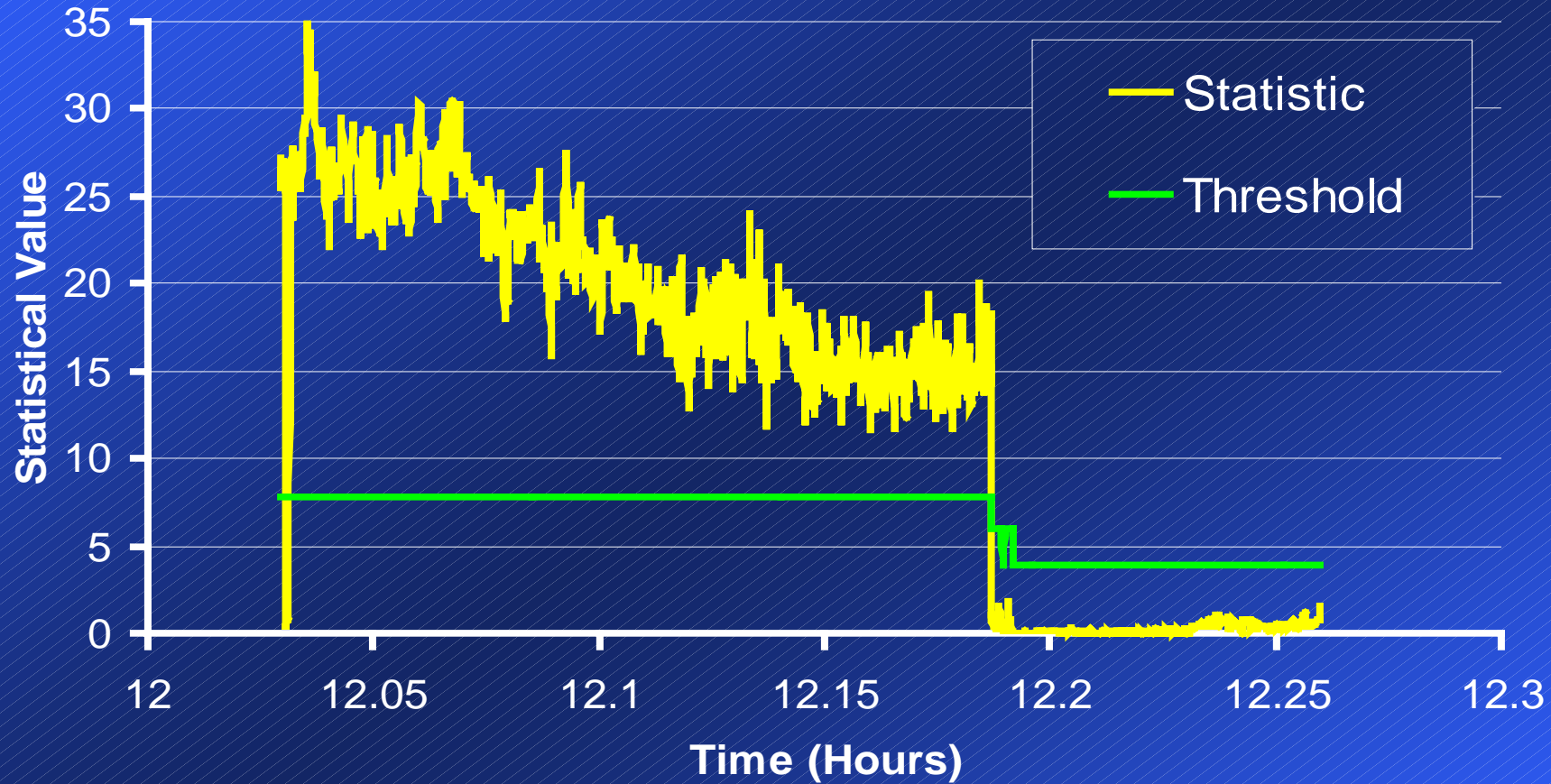
	Mean	SD(2σ)
Delta East	0.100m	0.08m
Delta North	0.002m	0.09m
Delta Height	0.062m	0.10m



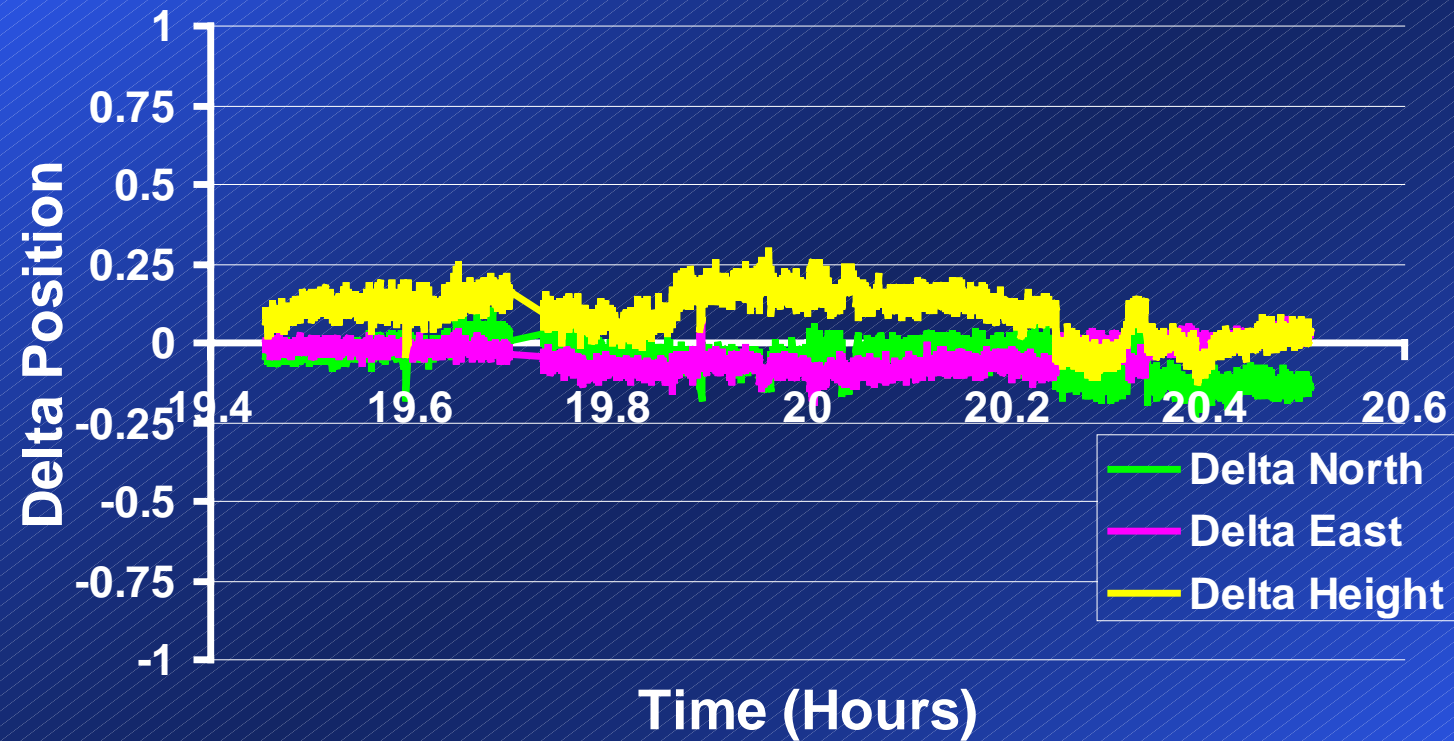
Delta Position – Wrong Integer Determination



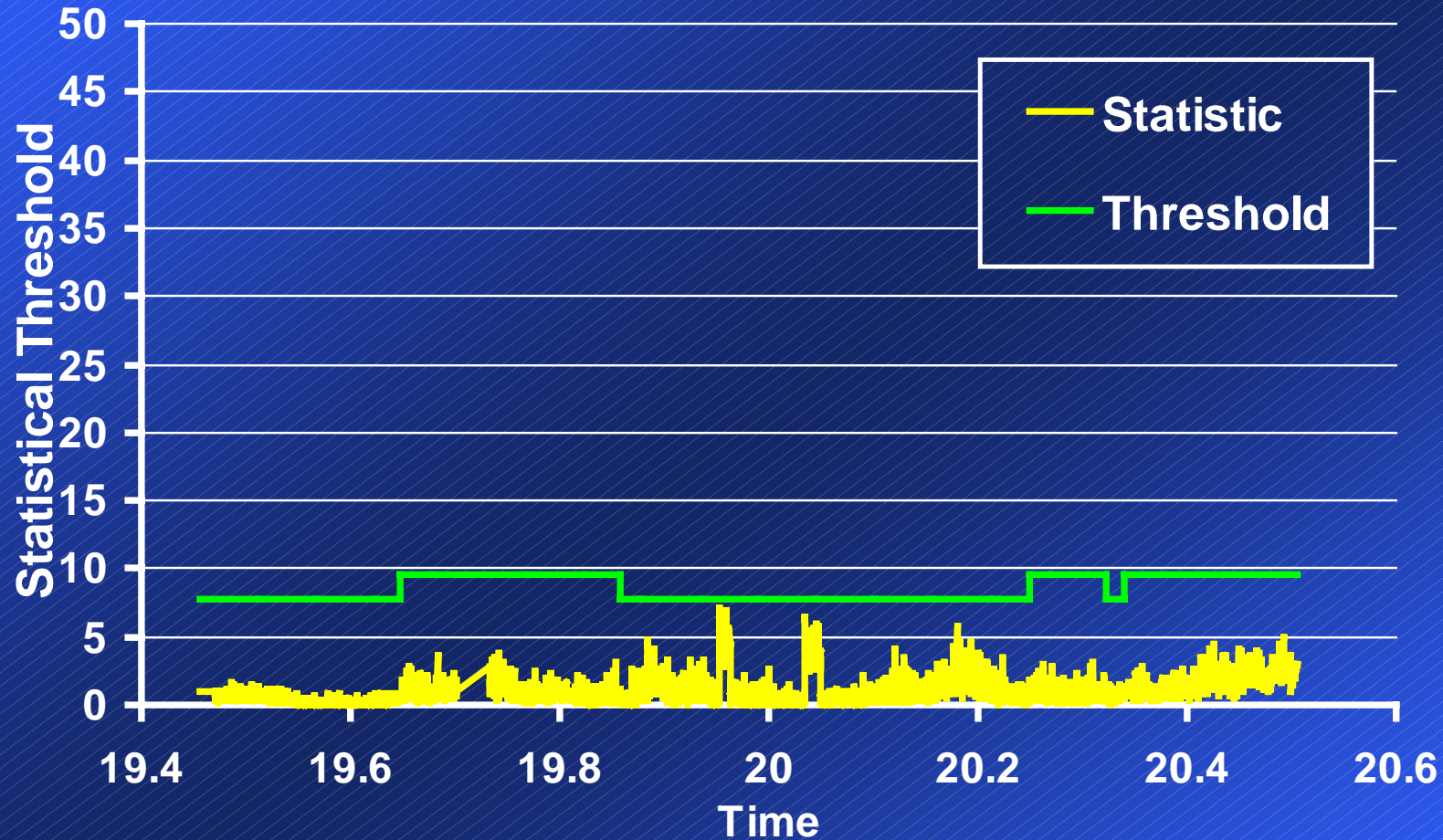
Statistical QC Control of LRTK Position Calculation



Delta Position – Right Integer Determination



Statistical QC Control of LRTK Position Calculation

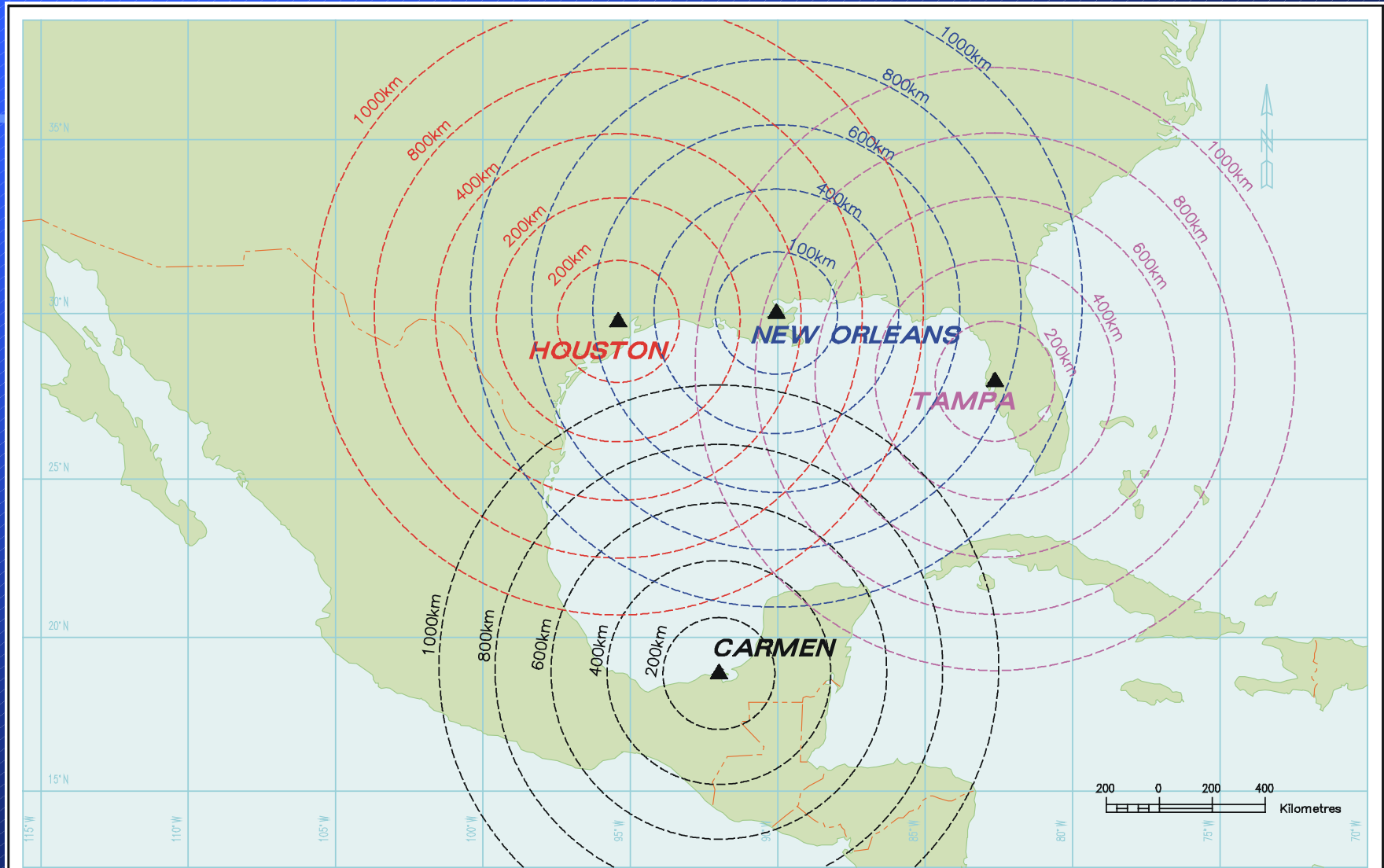


Summary & Conclusions

- **Sophisticated GPS Processing using a network of stations demonstrates LRTK potential.**
- **Genesis available in North and Norwegian Seas in 2001.**

Genesis North West Europe Coverage





GENESIS - Gulf Of Mexico

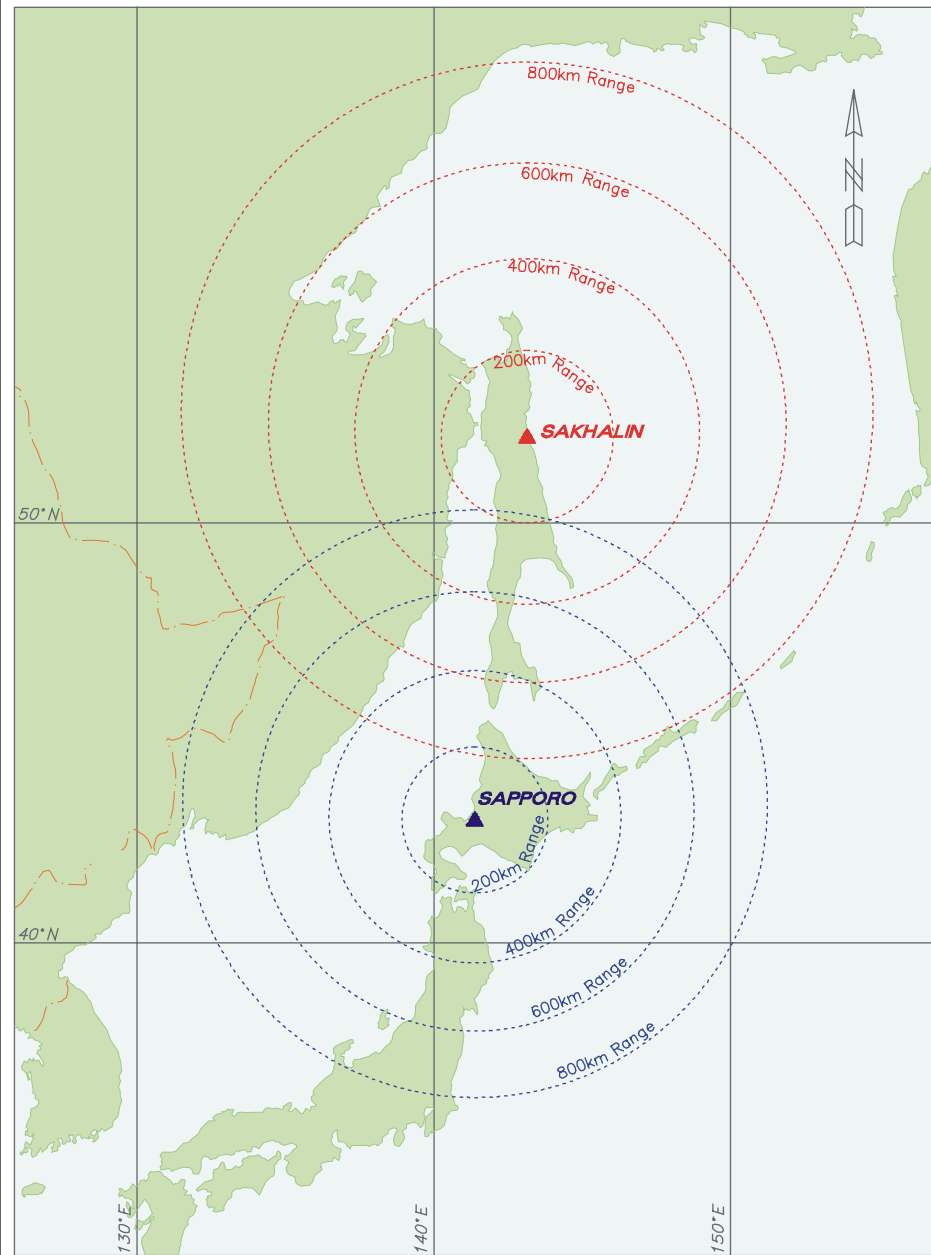
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GENESIS - North Pacific

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NOR/AC/10.2000-054g

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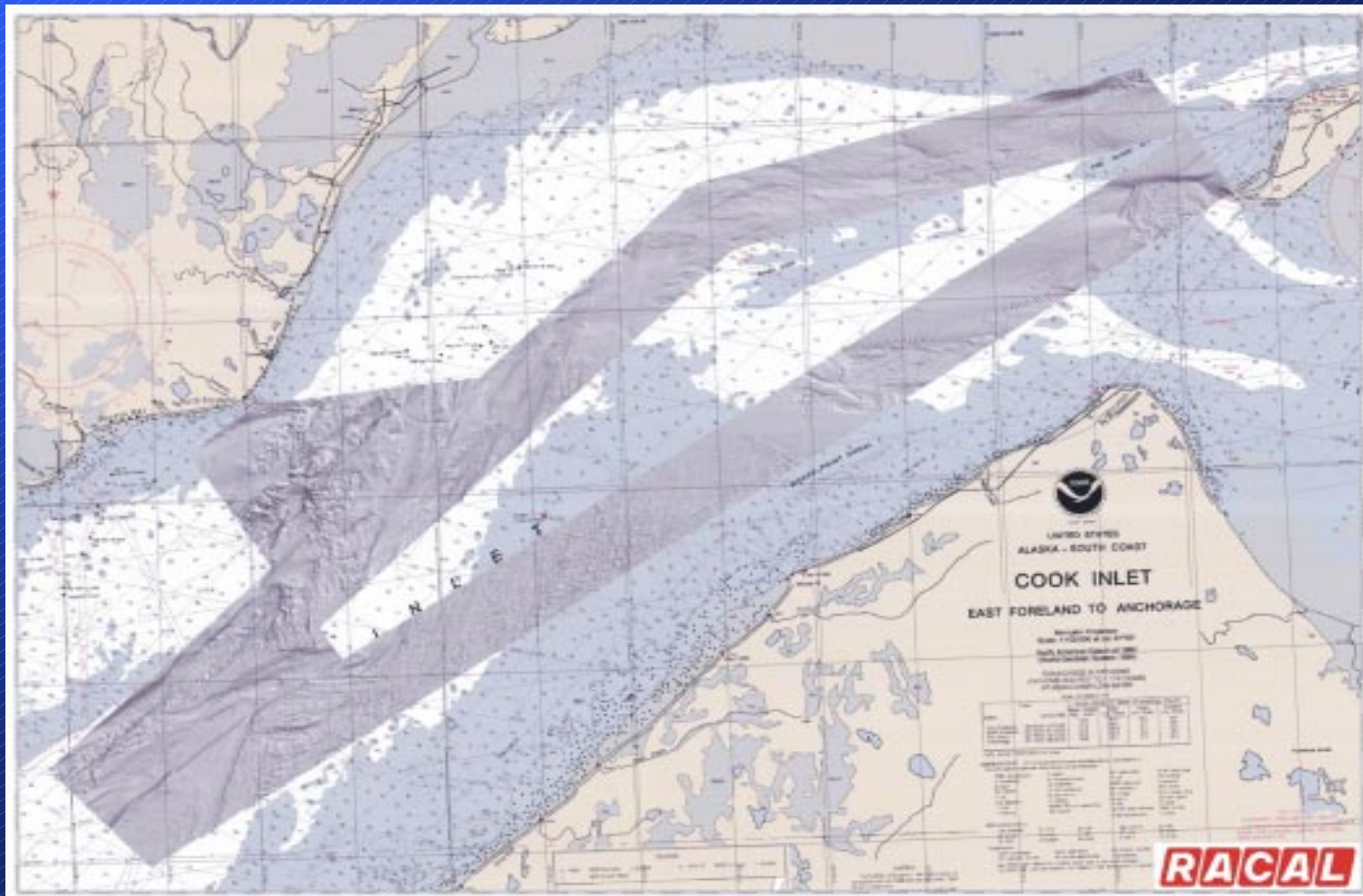
Applications for High Accuracy Positioning

Positioning & Vertical Control



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High Accuracy Navigation



High Accuracy 3D Control



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