Mission Accomplished - The Payoff in New GNSS Technologies

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Trimble.

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Introduction

- Trimble has led the development of high precision GNSS systems since the mid 1980s
- RTK was quickly established once radio comms; correction streams; on-the-fly initialization; and faster processors were available
- Initialization techniques have been effective but the concepts remain from the 1990's
- No corrections = no precise positions
- What is changing..?



Todays Mission..

- The following presentation aims to:
 - Highlight changes in GNSS Technology
 - Highlight changes in GNSS Constellations
 - Introduce new correction services
 - I hope it is 'Mission Possible'...





How did we get here? 4000SLD - First Dual-freq *Backpackable* (1988)



Trimble Navigation, the world leader in GPS, is pleased to introduce the 4000SLD. The new 4000SLD is the surveyor's answer to a lightweight, backpackable, dual-frequency GPS system that can be operated in any environmental extreme. The 4000SLD can be preprogrammed in the office for ease of operator use while in the field.

Weight:	Receiver/Datalogger Antenna/Preamp Cables	35 lbs 8.5 lbs 10 meters, 1 lb 30 meters, 10 lbs
Dimensions:	Receiver/Datalogger Antenna/Preamp	19.25" W x 7.25" H x 19.75" D 20" diameter x 4.88"
Power:	12 VDC to 35 VDC, 62 Watts nominal	



How did we get here? 4000SSE - First RTK with On-the-fly Initialization (1994)



Size:	9.8"W x 11.0"D x 4.0"H (24.8cm x 28.0cm x 10.2cm)
Weight:	6.8 lbs. (3.1kg) receiver 15.4 lbs. (7.0kg) system weight with receiver, batteries, cables and backpack
Power:	Nominal 10.5 to 35 VDC, 9 watts; triple DC power inputs

Total Weight: 15.4 lbs (with everything!)



How did we get here? 4800 - First RTK with *No Strings Attached!* (1997)



How did we get here? R8-GNSS, 2005, First GPS/GLONASS RTK





What is Planned..

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System	Origin	Current	Future
GPS	USA	31 Satellites;28 Satellites with L1, L22 Satellites with L1, L2, L5	Triple Frequency fully available ~ 2017; GPS III ~ 2020
GLONASS	Russia	24 Satellites; FDMA, L1 & L2	CDMA signals to be added in new K series satellites (maybe compatible with modernized GPS)
QZSS	Japan	1 Satellite; Modernized GPS L1, L2, L5 + LEX signal	2 more satellite launches planned
GALILEO	EU	6 Validation Satellites; E1, E5A, E5B, E6 (E1 compatible with GPS L1C)	Full Constellation (30 satellites) ~ 2020
BeiDou	China	15 Satellites; (5 GEO; 5 MEO; 5 Inclined GEO) B1, B2, B3 signals Navigation Message Released Dec 2012	Global coverage (35 satellites) ~ 2020

Putting New Signals to Work

	Urban Canyon #1	Urban Canyon #2		
GPS	331.9m	76.2m		
GPS+GLONASS	42.9 (13%)	7.6m (10%)		
GPS+Galileo	10.7 (3%)	5.4m (7%)		
GPS+GLONASS+Galileo	43.0 (13%)	24.7m (32%)		
Positive numbers indicate improvement over GPS.				

	Indoor #1	Indoor #2		
GPS	278.7m	70.3m		
GPS+GLONASS	68.4m (25%)	11.8m (17%)		
GPS+Galileo	24.6m (9%)	10.1m (14%)		
GPS+GLONASS+Galileo	64.0m (23%)	15.8m (23%)		
Positive numbers indicate improvement over GPS.				

The tables above show the summary results for various scenarios and constellation combinations. The GPS row shows the absolute 2D errors in meters. All other rows show the improvement (+) or degradation (-) in meters and percentages relative to GPS-only fixes. All measurements are within the 95th percentile.



GPS Constellation Update

- April 28 CNAV messages broadcast on all operational L2C and L5 signals
- May 16 Latest GPS Constellation launches include the sixth GPSIIF satellite with L5 signals
- First launch to be tracked by GPS
- 2 further launches by end 2014



Photo credit: United Launch Alliance



More Channels Available





Bringing Advances Down to Earth

- Additional satellites and signals will enhance performance of RTK:
 - Precise code measurements (AltBOC, etc)
 - Triple-frequency GNSS
 - Improved convergence times
 - Extended range of operation from a single reference station
 Improved ionospheric and tropospheric bias estimation
 - Ever improving accuracy
 Uncorrelated multipath from so many signals









Likely to see 90 GNSS satellites in orbit by 2015; 120+ satellites by 2020 The R10, Trimble 360 Receiver Technology supports signals from: GPS, GLONASS, QZSS, GALILEO, BeiDou constellations;

With 440 GNSS tracking channels







A New Vision on Precision

Positioning example on 11km baseline





HD-GNSS - Precision Based Surveying

- HD-GNSS delivers seamless convergence to the same traditional 'fixed' precisions levels – fast!
- An important aspect of the scheme is that it delivers corresponding converging precisions
- The polarized switch from 'float to fixed' is gone (and these terms!)
- An environment that caused a 'bad init' reports higher precisions







HD-GNSS - Precision Based Surveying



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The Wait is Over

"The benefits of having three or even four mature constellations will be quite significant,...."

"More observations, redundancy and compatibility are the most obvious benefits. We will also see different services being offered such as guaranteed integrity of signals, safety of life systems and the supporting infrastructure, faster solutions, improvements to receiver autonomous integrity monitoring (RAIM), improved modeling, and of course benefits to the consumer: **more receiver capabilities and options.**"

Neil Weston – Deputy Director US National Geodetic Survey



New Signals, New Corrections



Trimble RTX Network Concepts



Trimble has established a global GNSS receiver tracking network ~ 100 stations

GNSS data from the tracking station network are processed at a central RTX control center (server) to produce cm-level satellite orbits and clocks



Trimble RTX Extension Service



"Anything else new?"





"and also"









Mission Accomplished ?

Thank You for your attention Trimble.