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Organised by:   CHAMBER OF GRADUATED SURVEYORS

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VRS powered by BeiDou and Galileo

Rana Charara
Trimble Infrastructure

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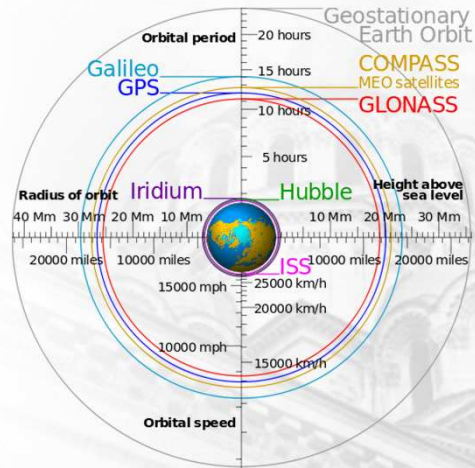


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GNSS System

- GPS
- GLONASS
- GALILEO
- BEIDOU
- QZSS
- IRNSS
- SBAS Systems



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Potential

	GPS	Glonass	QZSS	BeiDou	Galileo	All
First launch	1978	1982	2010	2007	2011	
Fully operational	1995	2011	??	2020	2018	
Number of satellites	32	31	7	35	30	135
Current status	32 operational	24 operational 1 in preparation 2 on maintenance 3 reserved 1 on test	1 operational 3 planned until 2017	14 operational	4 in space 22 budgeted	75



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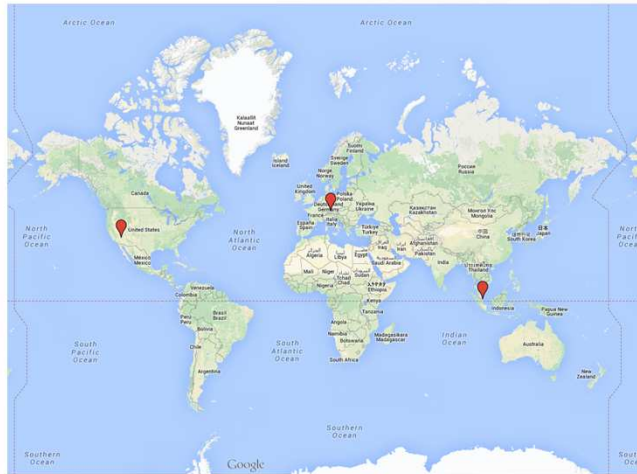




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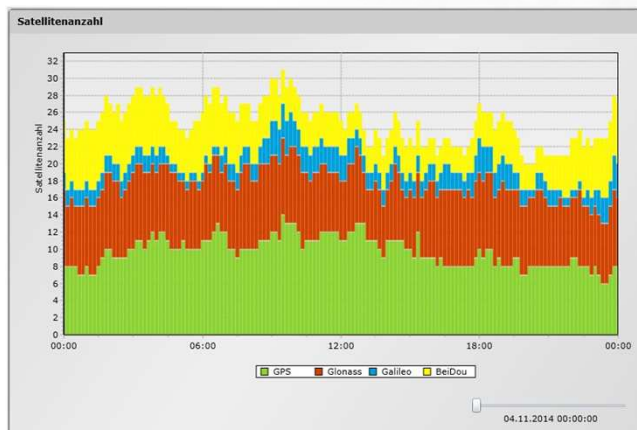


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Las Vegas



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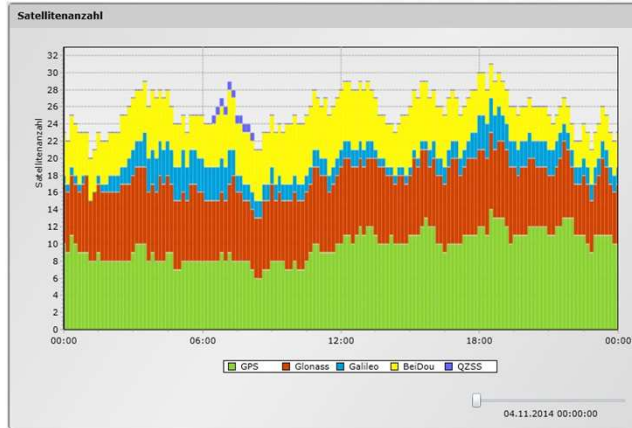




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Munich



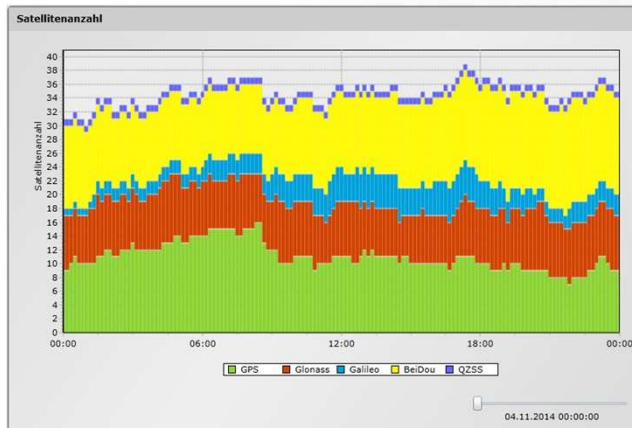
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Singapore



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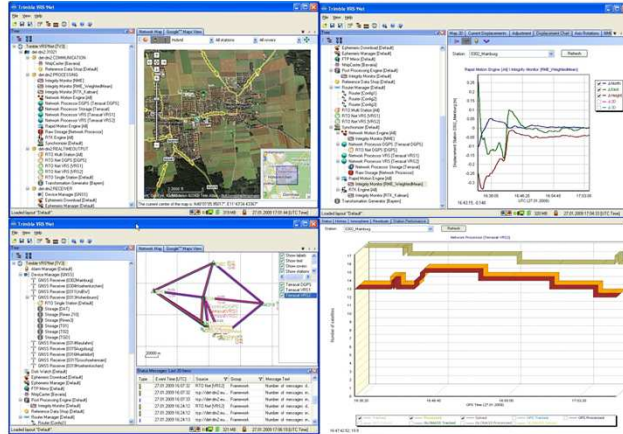




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Potential Galileo / BeiDou

- A lot more satellites
- Increasing number of frequencies
- Limitations in processing power and memory
- Dependency on neighbor stations



New Approach



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Trimble VRS



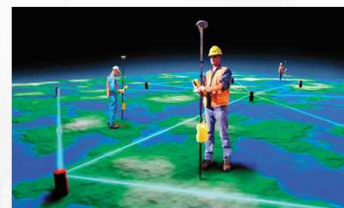
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Trimble VRS



- Atmosphere is split in a linear and a non-linear part
- Compute Ionosphere and Troposphere residuals per station (linear part)
- Interpolation of the best combination of the surrounding up to 6 stations
- VRS removes the linear part for the rover location



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CenterPoint RTX

Tracking network

- >100 stations in 53 countries
- Trimble NetR5/NetR9

Control centers

- Munich, Germany
- Ashburn, USA



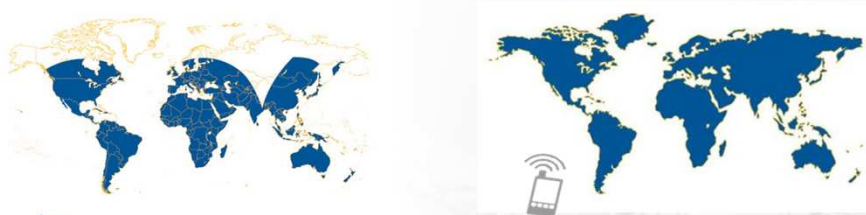
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CenterPoint RTX Services



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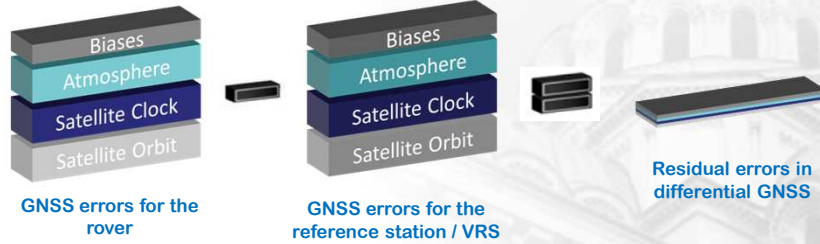




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RTK basics



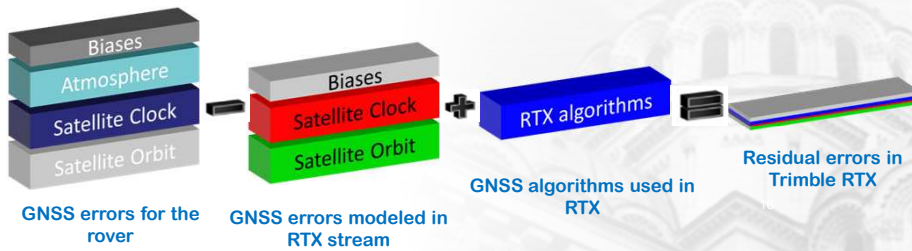
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RTX basics



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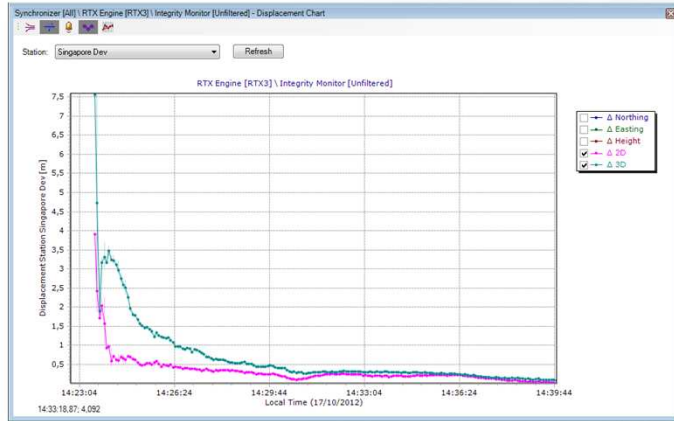




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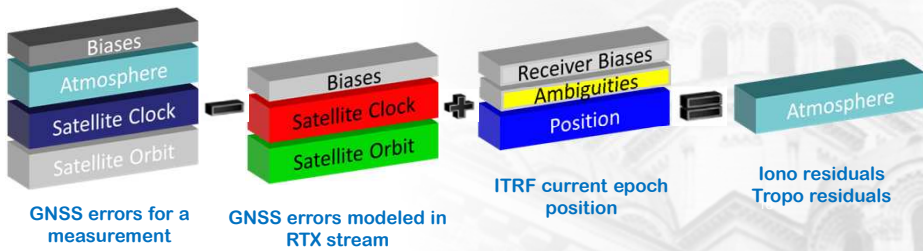
RTX basics



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RTKNet principle



- PPP approach
- Computation on an absolute level
- Independent per station





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RTXNet – PPP approach

- Satellite clocks
 - Satellite orbits
 - Satellite bias
 - Receiver bias
 - Earth tides
 - Pole tides
 - Carrier phase wind up
 - Yaw angle correction
 - Satellite antenna phase correction
 - Ambiguities
 - Position
- RTX stream
 - RTX stream
 - RTX stream / DCB Files
 - Receiver type calibration files
 - Computed from files
 - Computed from correction file
 - Computed
 - Computed
 - From calibration files
 - Computed
 - Provided



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Network Performance

- Ionosphere
 - Linear part + non-linear part
- Linear part is removed from the VRS stream
- Non-linear part affects the Rover in solving ambiguities and position accuracy
 - > as smaller as better



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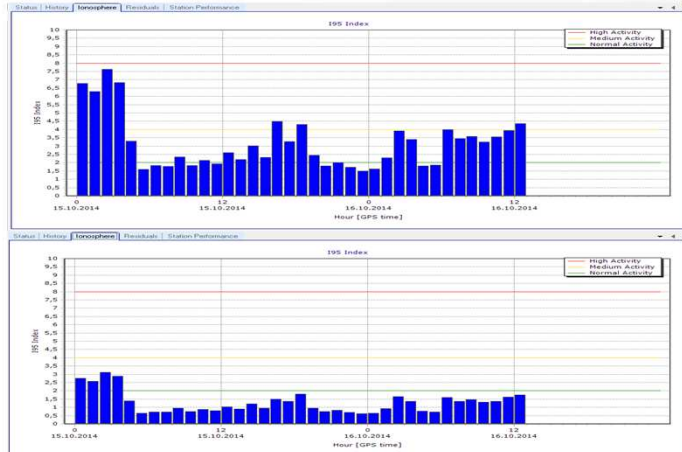




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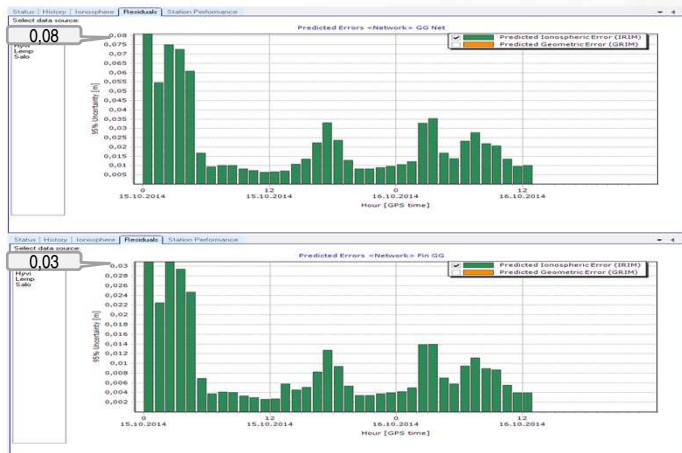
I95 – liner part of Ionosphere



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IRIM – non-linear part of ionosphere





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RTXNet – Ionosphere

- I95 and IRIM are both lower in RTXNet
- Both together represents the whole ionosphere or similar error sources [delay]



- RTXNet is slower in fixing new satellites
- Low satellites have highest impact from Ionosphere and similar error source
-> Rover gets improved corrections



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RTXNet – Station spacing



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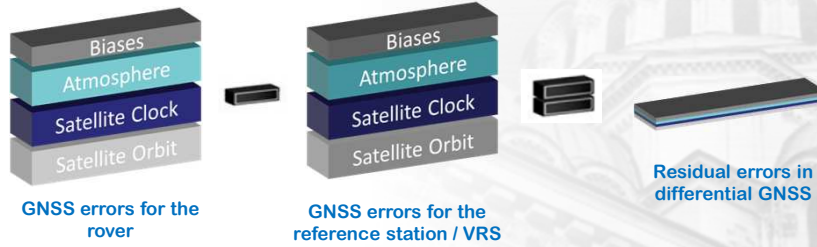


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RTXNet – Station spacing

- No distance limit for the Network processor
- But if we look at the rover ...



- Increased station distance will increase the non-linear part
-> Reduce fixing and positioning performance of the rover



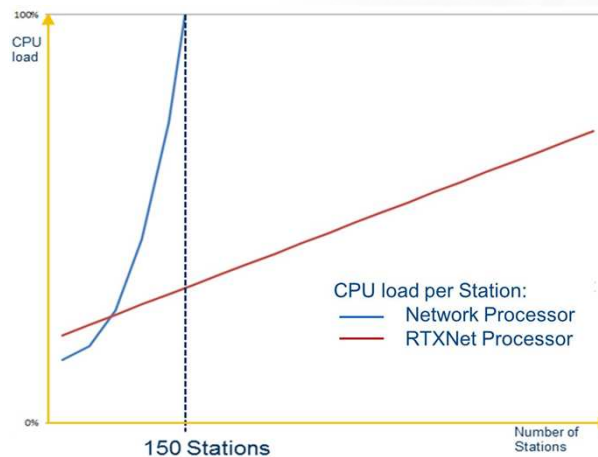
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CPU utilization



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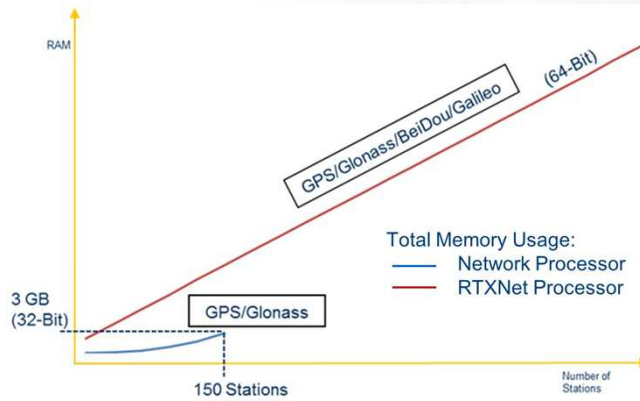




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Memory utilization



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Summary

- PPP driven approach
- No baselines, no network – each station will be processed independently
- Errors will not be distributed in the network, but remain at each station
- High requirements on position accuracy
- RTCM 3.x MSM, CMRx
- 64 bit



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Summary

	Network processor	RTXNet
Max number of stations	150 stations	300 stations
Support satellite systems	GPS, Glonass, QZSS	GPS, Glonass, QZSS, BeiDou, Galileo
Position sensitivity	< 5 cm	< 1 cm
Expected performance	> 98%	> 90%
	Distribute error in the network	Keep any error at the station
	50 – 70 km station spacing	No inter station relation
Rover performance	50 – 70 km station spacing	50 – 70 km station spacing



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Thank you!

Contact

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