RTK Networks for competitive advantage in Machine Control and Site Positioning

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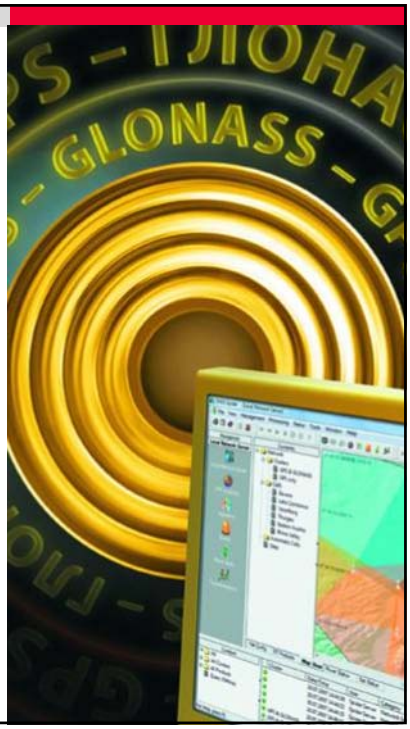

Overview

Demands of Machine Control and Site Positioning

Motivation for RTK Networks

Benefits of RTK Networks

- Functional (relating to spatial processes and dimensional control)
- Fiscal (relating to OPEX, project costs and ROI)

Telematics Fusion

Concluding Remarks

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Demands of Machine Control & Site Positioning

Positioning demands in engineering projects range from

metres -> centimetres -> millimetres

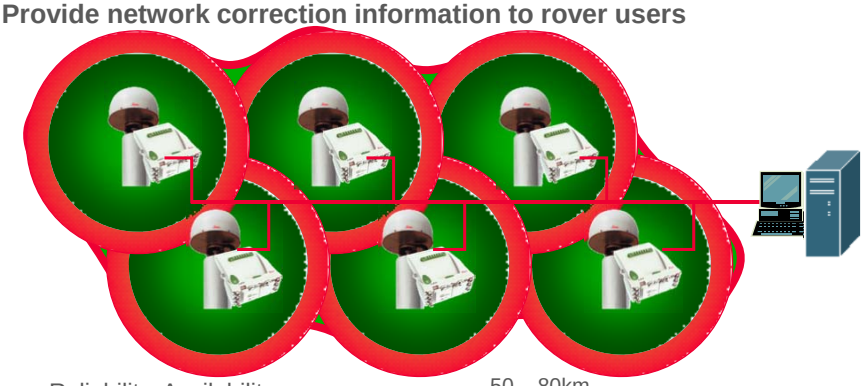
For Machine Control (MC) applications, there are two specific challenges:

1. **Data Fidelity – *Spatial Accuracy & Correctness of the DTM***
2. **Data Access – *Temporal Accuracy of the design model***

=> Get 'Connected' with RTK Networks and Telemetry systems

Motivations for RTK Networks (RTN)

1. **Model and estimate distance-dependent errors across a region**
   - **Main error sources: ionosphere, troposphere and satellite orbits**
2. **Provide network correction information to rover users**



Accuracy, Reliability, Availability

Good — Poor

50 – 80km

30 – 50mi

Typical Station Spacing

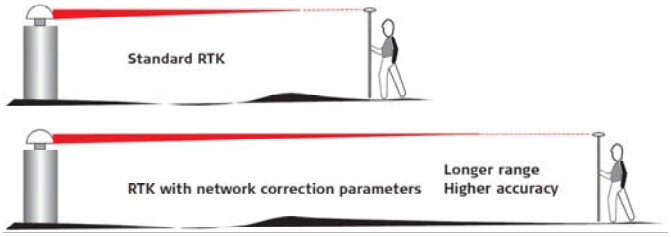
RTK Networks – Functional Benefits
Accuracy

"degree of closeness of calculated positions to the truth position"

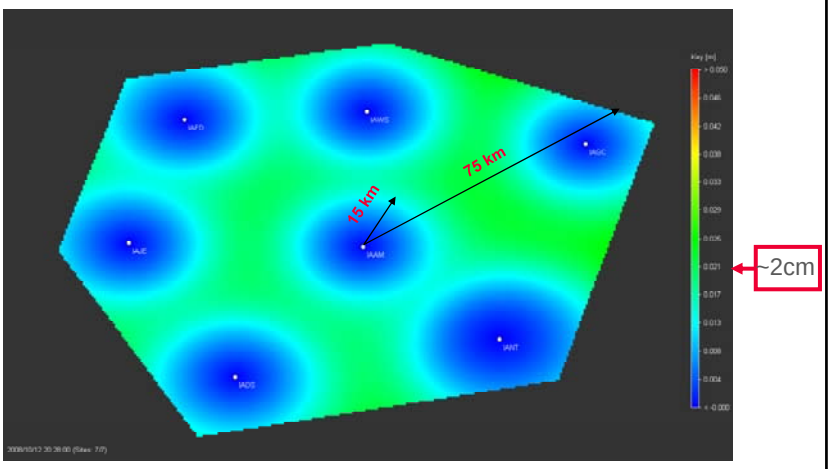
Spatial Accuracy –– improves as the distance-dependent component (ppm) is reduced significantly through network GNSS processing,

As the RTK range increases, reference stations can be further apart.

- Thus fewer stations are needed to provide RTK coverage for a given area.

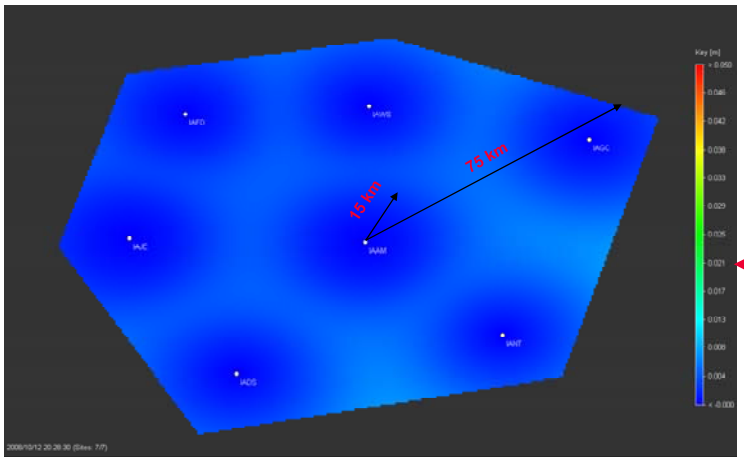


Real-time Residual Ionosphere Errors [NOVA]
Standard (Single-baseline) RTK Solution



[NOVA] 'Network Online Visualization of Accuracy' from Leica GNSS QC

Real-time Residual Ionosphere Errors [NOVA]
Networked RTK Solution



More homogenous positioning accuracy across the network

RTK Networks – Functional Benefits
Reliability

"ability to repeatedly yield correct phase ambiguity solutions"

RTN improves positioning reliability and TTFA, especially:

- **when operating at long ranges and under difficult ionospheric conditions.**
- **when using the RTCM V3 MAC standard messages**
  - providing full traceable network error information
- **as more robust solutions are demanded**
  - a network model of atmospheric disturbances, not a 1D estimation as with standard single baseline RTK

RTK Networks – Functional Benefits
Availability

"proportion of time a system is in a functioning condition"

Permanent stations, fixed communication lines, and **redundant server architecture** ensure near 100% availability 24/7.

- **Saves cost & daily setup** – eliminates the need for a temporary base station, or the expense of installing a private base station
- **Less down time** – Redundancy allows the network to operate even when some of the bases are deemed faulty
- **Local bases have no redundancy** when they are struck by outages.

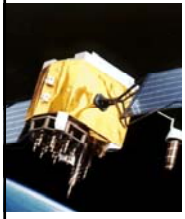
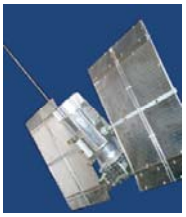
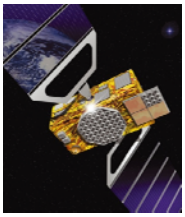
RTK Networks – Functional Benefits
Scalability

"ability for the technology to accept increased workload without impacting performance"

- Larger network coverage (**new sites, demands, users**)
- New communications technology

Supporting current & future signals

- GPS & GLONASS
- GALILEO & COMPASS

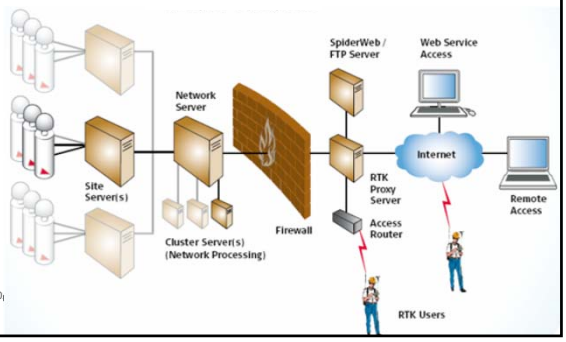





GNSS future proof

RTK Networks – Functional Benefits
Flexibility

Centralised RTN software capable of:

- networked services – Network RTK and WADGPS
- **supporting multiple users and applications simultaneously**
- conventional RTK and DGPS services
- **Post-processing Services (RINEX)**
- satisfies corporate IT security policies



RTK Networks – Functional Benefits
Compatibility

Incorporates data from major & legacy base stations.

Providing standardised RTCM correction information at various rates in various formats:

- **RTCM MAC**, Leica, CMR/CMR+ etc

Supports various Network Computation Approaches

- MAX, iMAX, Virtual RS, FKP

Supports various communication protocols:

- GSM / GPRS / HSDPA / CDMA
- TCP/IP (RTCM NTRIP)
- radio (UHF & VHF)

Coordinate Transformations

- **RTCM V3.1 TRAFO message**

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RTK Networks – Fiscal Benefits
Productivity

"Increased work rate with lower costs"

In Machine Control terms:

- **achieving grade specifications with fewer passes**
  - Fewer passes means less driving and ultimately lower machine costs, and faster completion times.

3D Machine Control systems, such as Leica's PowerGrade 3D using RedLine GNSS technology, can operate in:

- **'Indicate' mode – providing visual signs to cut or fill according to the design requiring operator interaction**
- **'Automatic' mode – fully automated 3D MC**

RTK Networks – Fiscal Benefits
Productivity in Agronomy

Positioning Goal - improved repeatability of the measurement

- **Possible to realize "Pass-to-Pass" navigation for applications requiring a high level of precision such as tractor auto-steering.**
- **Reductions in the number of passes means lower vehicle and fuel costs, leading to increased profitability.**

RTK Networks – Fiscal Benefits
Materials

Increases in Raw material prices over the last years have focussed contractors on achieving **tighter grade specifications**.

- Tightening the specification of sub-grade by 1cm on a 10m wide carriageway
- => Material saving of 100m^3 / km

Factoring in the relevant savings of different materials adds up to considerable savings of the overall project costs.

RTK Networks – Fiscal Benefits
Reduced Labour

Labour costs are considerable for projects – whether it is machine operator, vehicle driver or site surveyor.

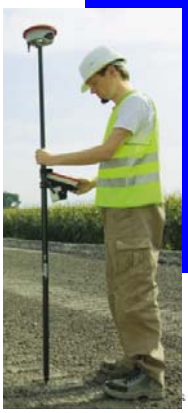
- **Once the machine has been calibrated successfully, the need for grade-checkers can even be eliminated.**
- **Machine Idle times are reduced** as no longer must machines idle unproductively while a surveyor travels to site.

RTK Networks – Fiscal Benefits
Safety

'Safety of life' is becoming a commonplace term in engineering construction projects

For necessary grade-checking tasks, RTNs afford higher RTK availability (corrections and services)

- **Faster RTK initialisation times mean grades can be checked quicker**
- **Surveyors spend less time 'at risk'**
- **Full "Auto" MC systems can even eliminate the need for grade-checkers**



RTK Networks – Fiscal Benefits
Fuel & Servicing Costs

Fuel, motor oil and servicing are all major expenses in project costs.

- **Projected price of crude oil could increase by over 30% in the next 20 years**

Transportation can count for up to 50% of mega-project costs.

"Fleet Management Systems"

- **Overview of machines' locations, fuel consumption and engine performance, brings many advantages to optimise their utilisation and productivity.**

Telematics Fusion
Position + Sensors + Connectivity + Applications

One major benefit of centralised RTK services for Site positioning, is that of *telemetry* – the connectivity from a remote location to a field computer inherently afforded by the RTK communications device. This connectivity can be classified in three forms:

- **Office to Machine (O2M)**
- **Machine to Office (M2O)**
- **Machine to Machine (M2M)**

Telematics as a real-time fusion technology, has greatly impacted the engineering industries to increase site productivity and machine uptime, whilst lowering the associated operational costs.

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Telematics Fusion
Remote Connectivity (O2M & M2O)

Leica mojoRTK

- **Tractor Auto-steering using nRTK and INS**
- **also provides 'Online' Remote Service Diagnostics via the nRTK Cell modem**
- **Product updates, eCommerce**

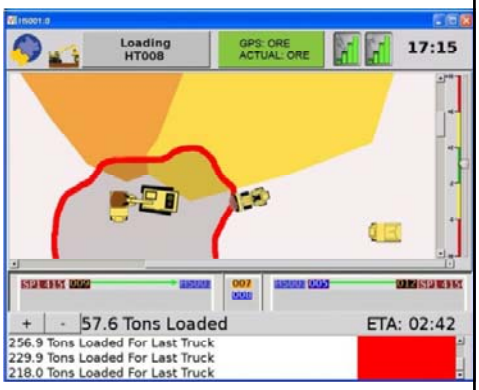
Virtual Wrench

JIGSAW360

Telematics Fusion
Real-time Safety (M2M)

Machines fitted with Jigsaw360 telemetry systems receive real-time updates of movement of other machines (M2M)

- **Vehicle positioned at cm RTK level using RTN data**
- **Proximity Alarms** configured for machines working within the operating area of another machine
- Monitoring of Loading Cycles, and traffic volume



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SmartNet
powered by Leica Geosystems

Leica Geosystems SmartNet
World Networks

- **Leica Geosystems SmartNets are a combination of**
  - Leica owned reference stations
  - Privately owned reference stations
  - Streamed data from other sources i.e. NMAs, DoTs, private companies.
- **Managed, maintained, monitored by Leica Geosystems via central data center**
- **Open network to all makes and models of GNSS equipment**
  - **Standard industry data transmissions – RTCM**
  - **Some proprietary data transmissions – Leica, CMR**
- **SmartNets in Australia, North America and UK**
  - Streams from over 2,000 stations!

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Olympics London 2012
SmartNet UK is the Exclusive Corrections Provider

SmartNet powered by Leica Geosystems

LONDON 2012

Picture courtesy of London2012.com

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Concluding Remarks
RTK Networks for Competitive Advantage

RTK Networks satisfy most spatial accuracy demands of Machine Control & Site Positioning (& others – Structural Monitoring)

- **affording higher accuracy and higher quality spatial control**

Connecting RTN services with telematic systems:

- **increases operational awareness** and facilitate informed decision making
- **optimizes productivity** and maximum site output
- **reduces OPEX & material wastage**, thus lowering project costs
- **ensures new levels of safety**

RTK Networks are the 'Foundations for future Infrastructure'

- **PIN - Positioning Infrastructure Networks?**

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RTK Networks for competitive advantage in
Machine Control and Site Positioning

Thank you for your attention!