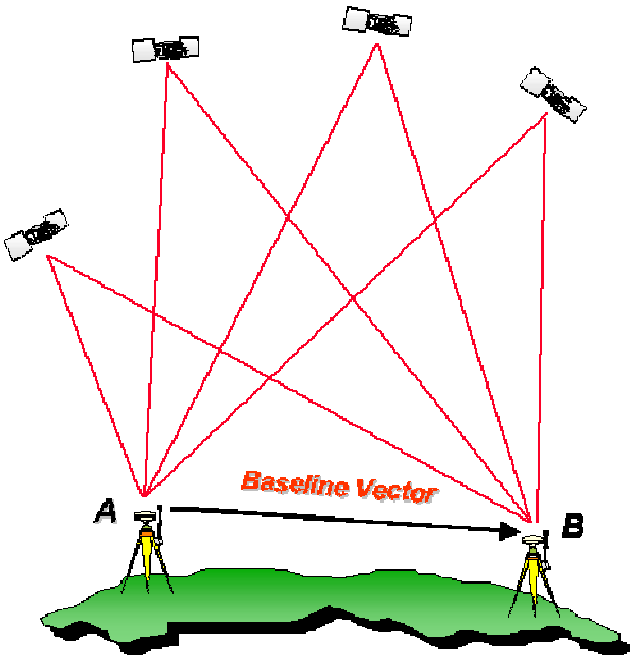
INTRODUCTION TO GNSS NETWORK RTK

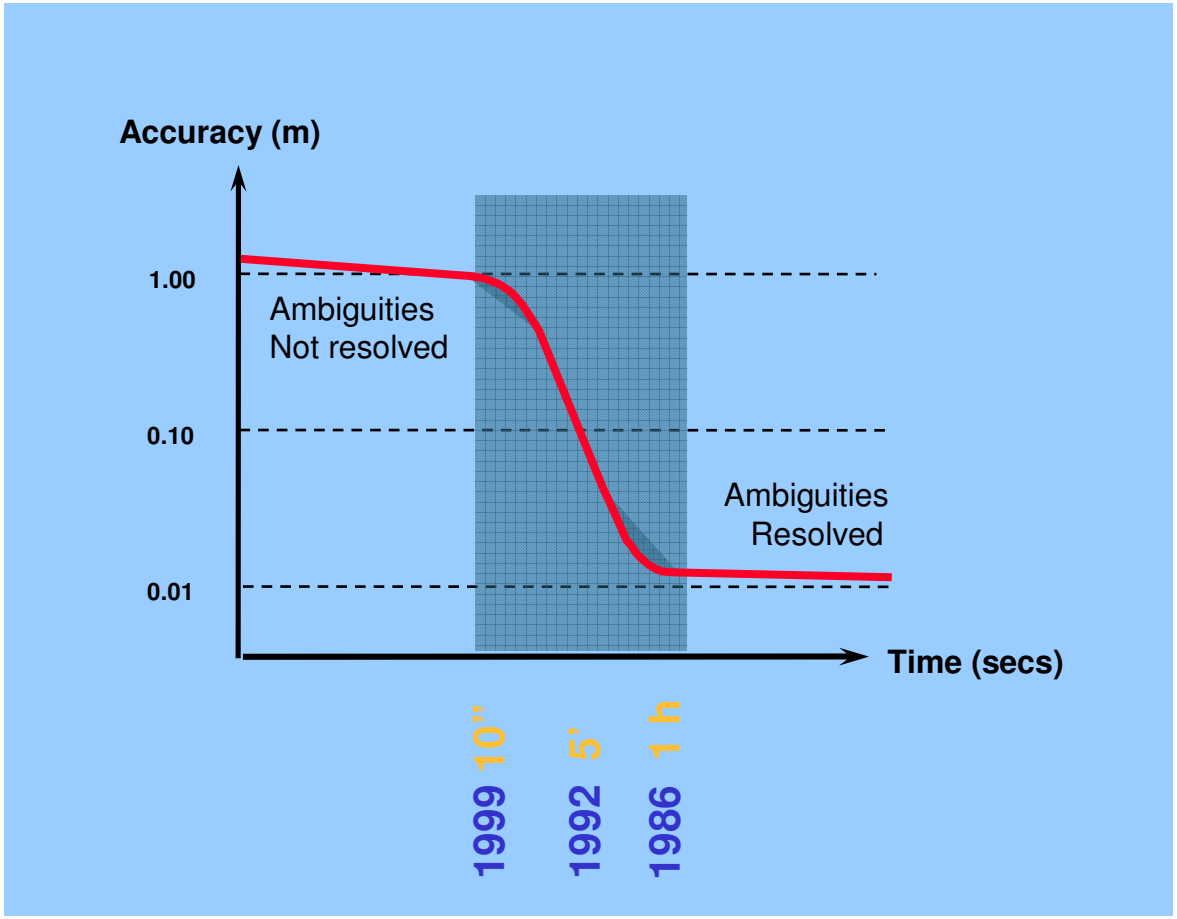
BAKU (AZERBAIDJAN) 12 Mai 2009

Ezzedine Djerbi
Leica Geo-Systems
Switzerland

- GPS & GLONASS constellations have never been designed to serve the civilian applications so far. They have been designed first for defense applications.
- However and thanks to the outstanding efforts and fair competition between research centers and universities, GPS has been turned to generate much more profit from and for civilian applications.
- The key was to process the GPS signals in such a way that the users can benefit of the same accuracy that they get from classical surveying instruments, first in post-processing and nowadays even in real time.

GPS & GLONASS is the key for precise positioning « Differential »





- when it has to be right

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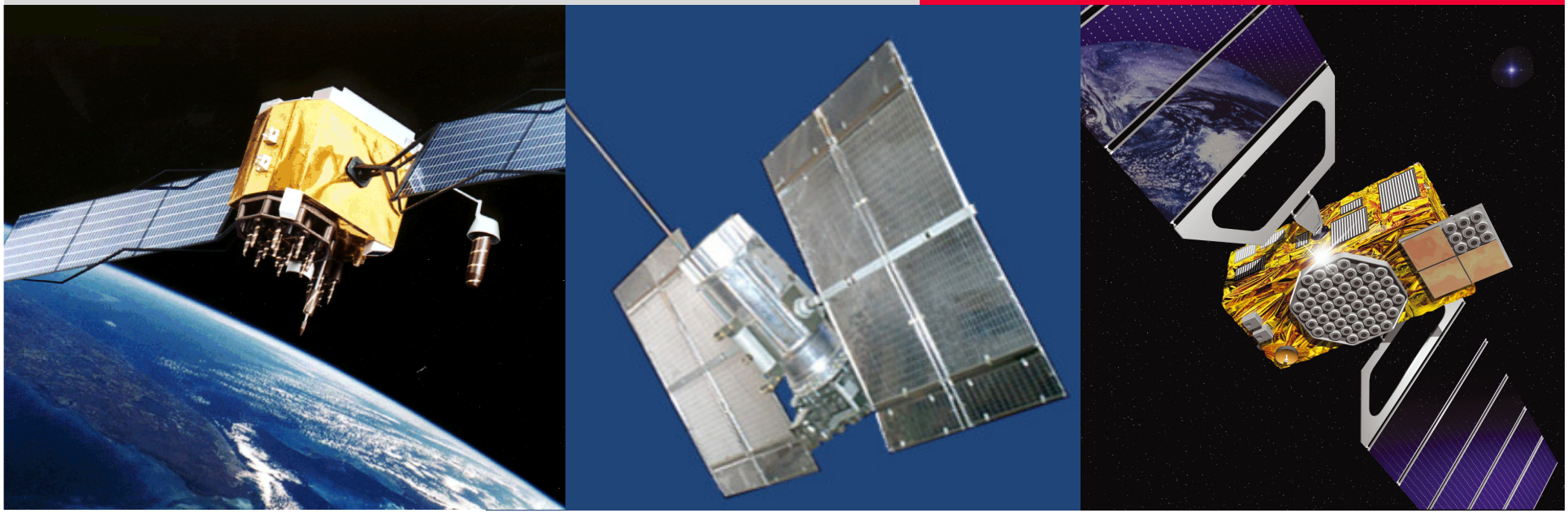

Existing and future GNSS Based Surveying

NAVSTAR **GPS**

USA, military system, developed in the 70s

GLONASS

Russian equivalent to GPS, developed in the 80s

GALILEO

Europe's GNSS, civil system, under development

Compass

China's global navigation satellite system, under development

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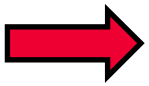
Future GNSS systems
GNSS-based surveying …

.. today and in 2017

2009

- **31 GPS and 18 GLONASS SV**
- **2 frequencies (L1, L2)**
- **26 observation per epoch on average in open sky**
- **12 observations per epoch on average with obstructions**
- **RTK up to 50km**
- **8“ typical initialization time**
- **RTK accuracy ±15mm**



2015

- **32 GPS, 24 GLONASS, 30 Galileo SV (+ Comp.)**
- **3 frequencies (L1, L2, L5)**
- **>80 observation per epoch on average in open sky**
- **32 observations per epoch on average with obstructions**
- **RTK up to 80km**
- **1“ typical initialization time**
- **RTK accuracy ±10mm**

REFERENCE STATION SOLUTIONS

- when it has to be right

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TEMPORARY TO PERMANENT REFERENCE STATION

versus

Temporary GNSS Base Station

Permanent GNSS Reference Station

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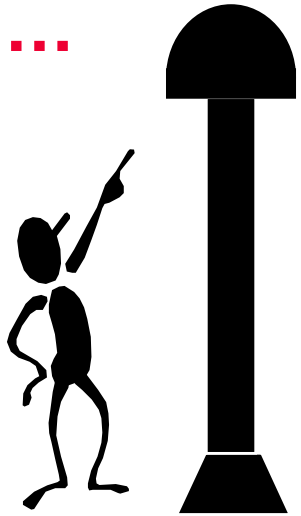
From Temporary … to Permanent Reference Station … Single Base



Permanent
Reference station.
Available any time
24/7 continuously
without any
operator…

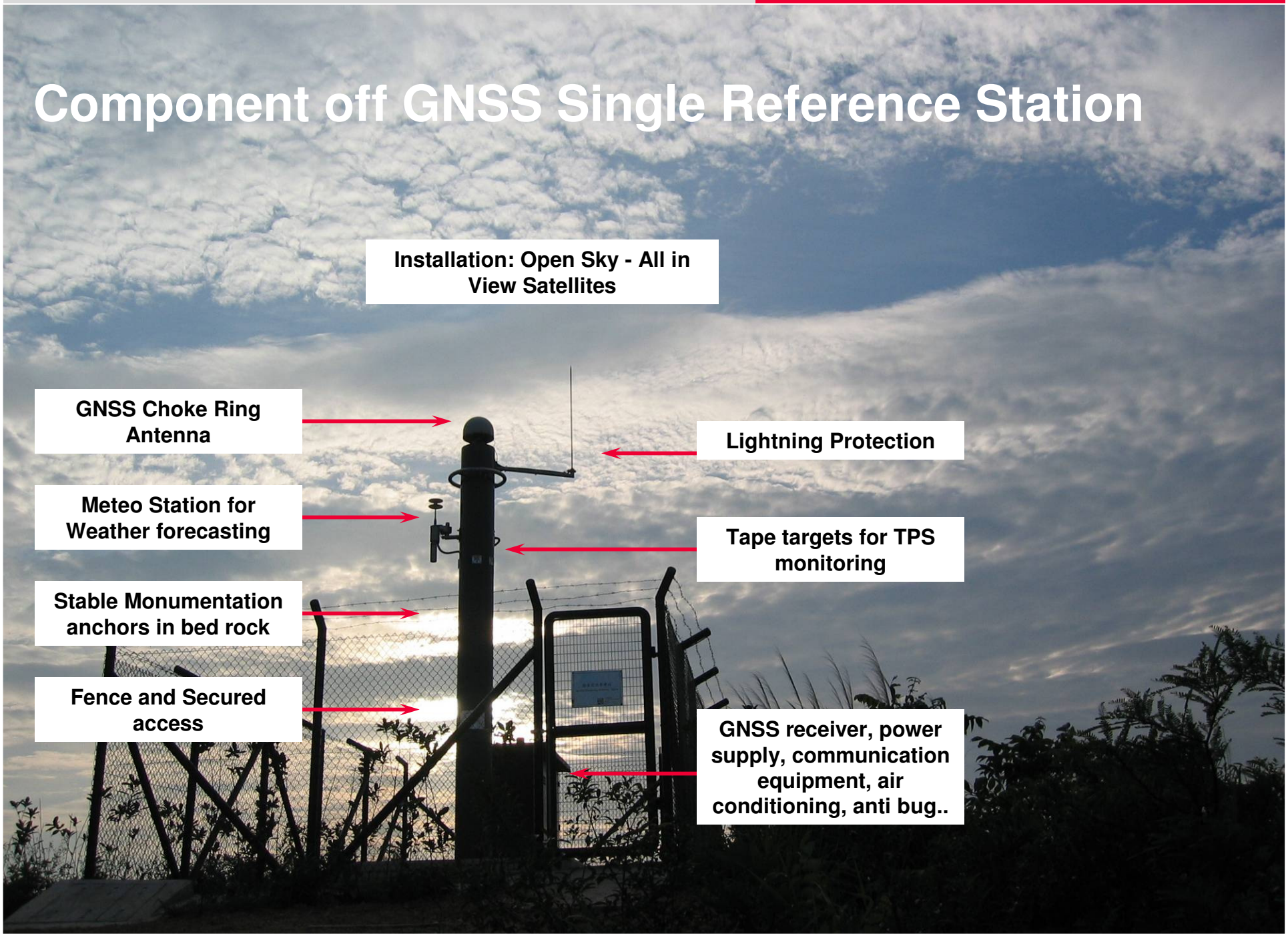
What is a C.O.R.S Continuously Operating Reference Station ?

A continuously operating GNSS reference station comprises a **GNSS receiver and antenna set up in a stable manner** at a safe location with a reliable power supply.

The receiver operates continuously, logging raw data, perhaps also streaming (continuously outputting) raw data, and often outputting RTCM and DGPS data for transmission to RTK, GIS and GNSS navigation devices.

The receiver is usually controlled by a computer that can be located remotely if necessary. **The PC will usually download data files at regular intervals** and pass them to a web site for access by the GNSS user community.

Component off GNSS Single Reference Station



has to be right

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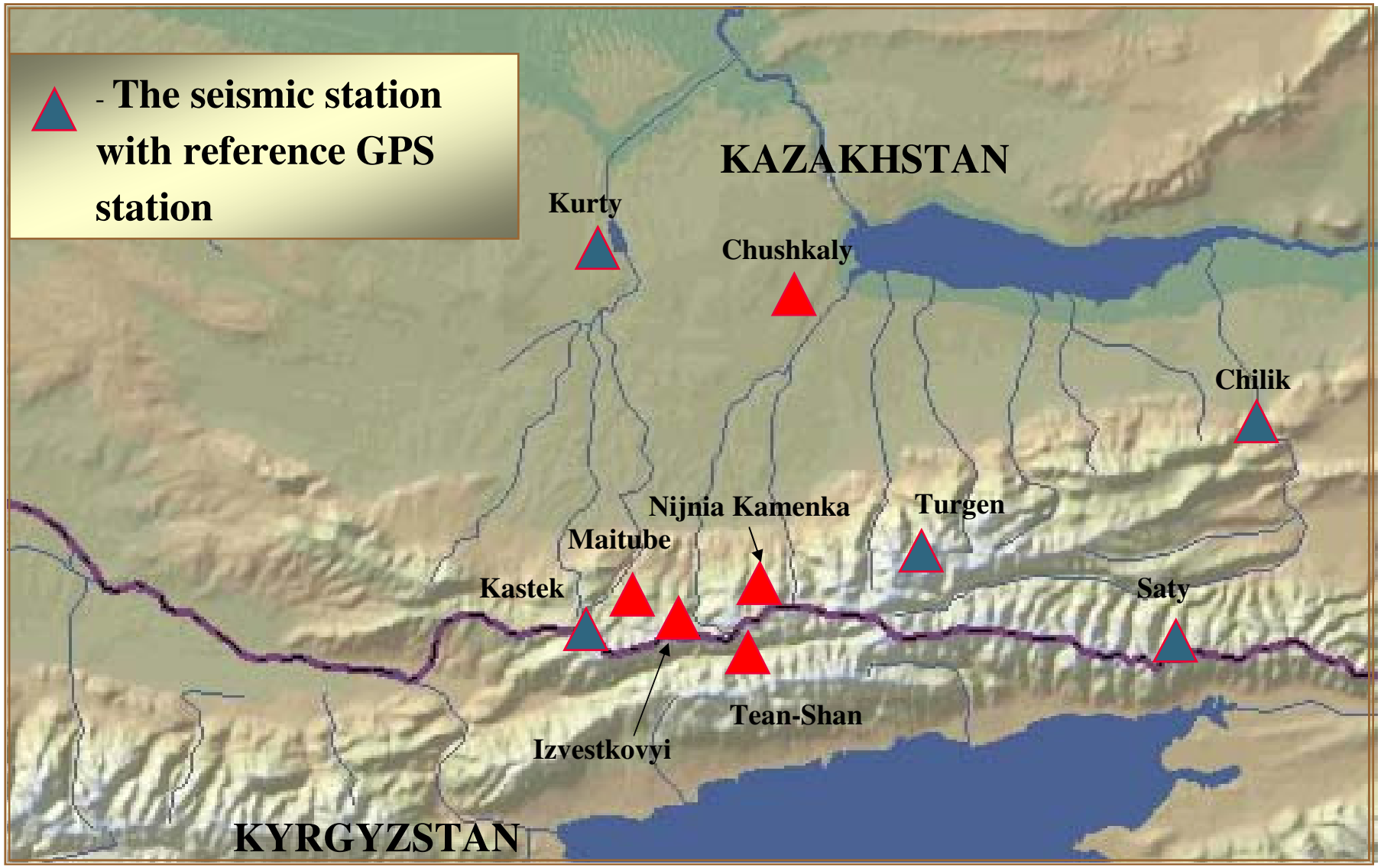
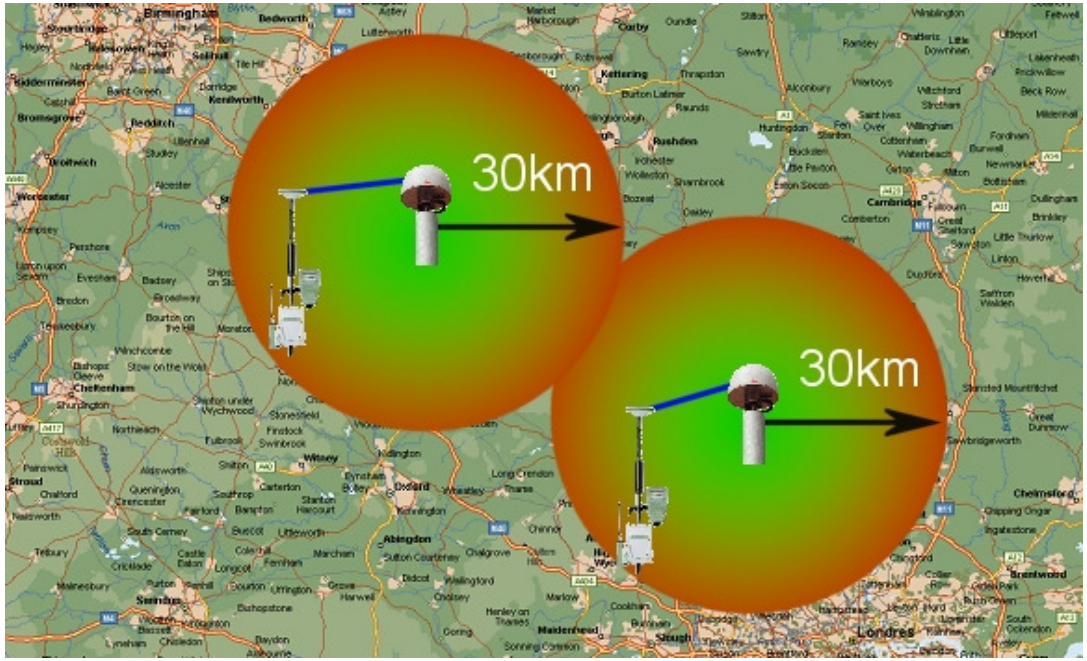
FIRST C.O.R.S
IN ULAANBATAR MONGOLIA



Conventional Single

G.N.S.S REFERENCE STATION

RTK



RTK Single Base Station

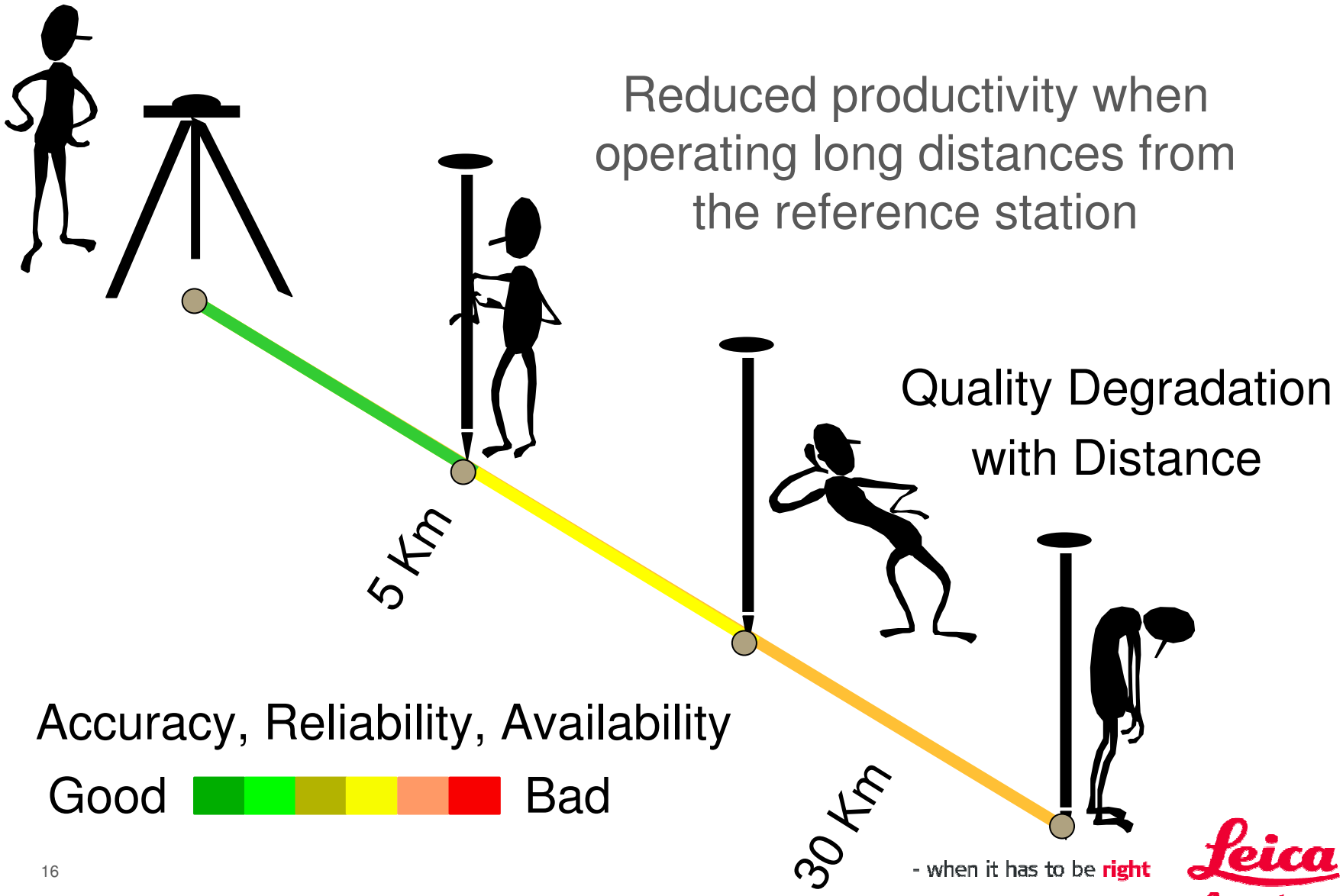
It‘s a

- Temporary installation on a tripod or Permanent station
- Reference, for GPS operations in a small area (up to 30km) over a limited time

Accuracy, Reliability, Availability

Good — Poor

GNSS Single RTK



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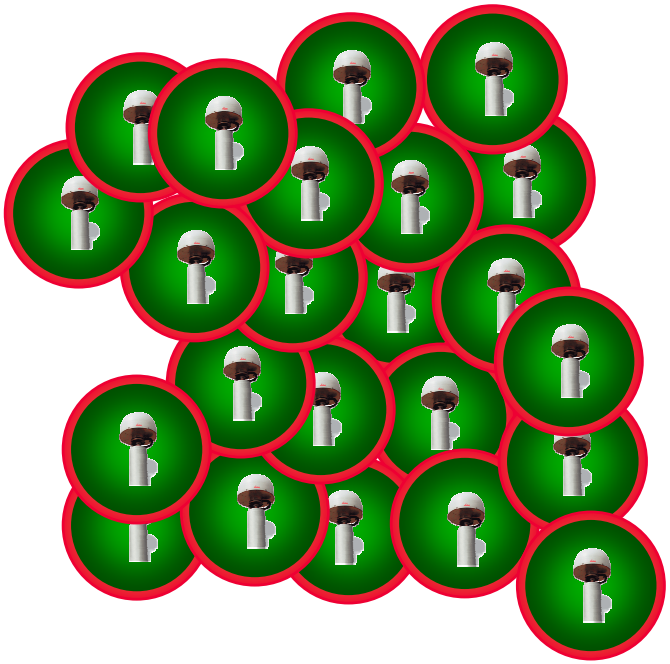
Real time coverage

Limitations of single GNSS Reference station RTK



Accuracy, Reliability, Availability

Good — Poor

- No continuity in quality of service (accuracy, reliability, availability)
- High density of stations required for good coverage
- Higher cost
- Multiple reference stations delivering RTK directly to users is not really a network

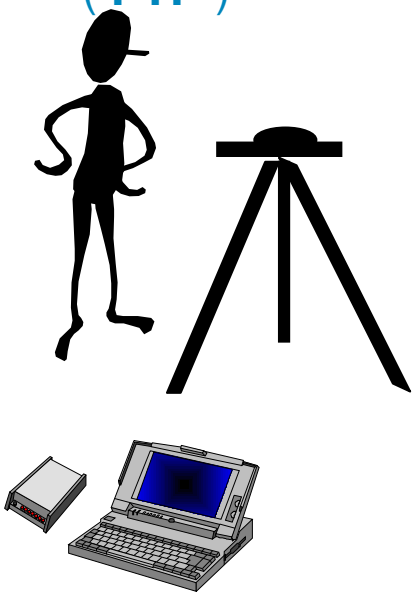
Single
G.N.S.S REFERENCE STATION
RTK
Products

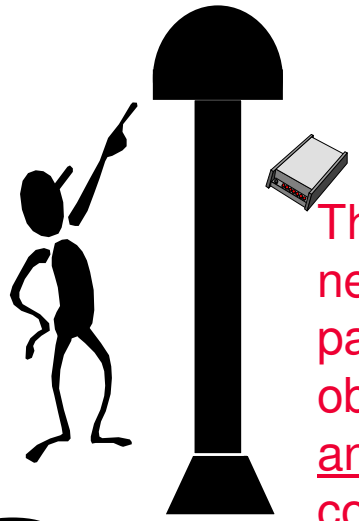
A GNSS Reference Station is a “**server**” of observations.

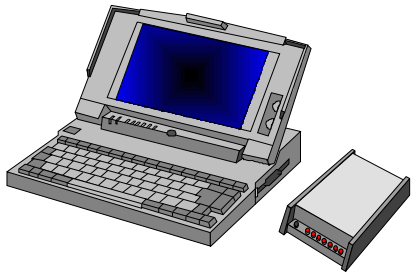
(GPS + Tilts + Meteo)

A Post-processing rover user wants to **download** RINEX files from a Web server

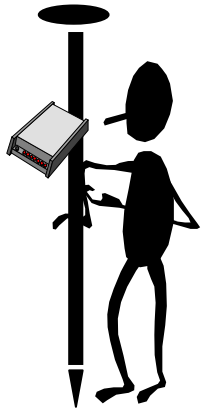
(**FTP**)





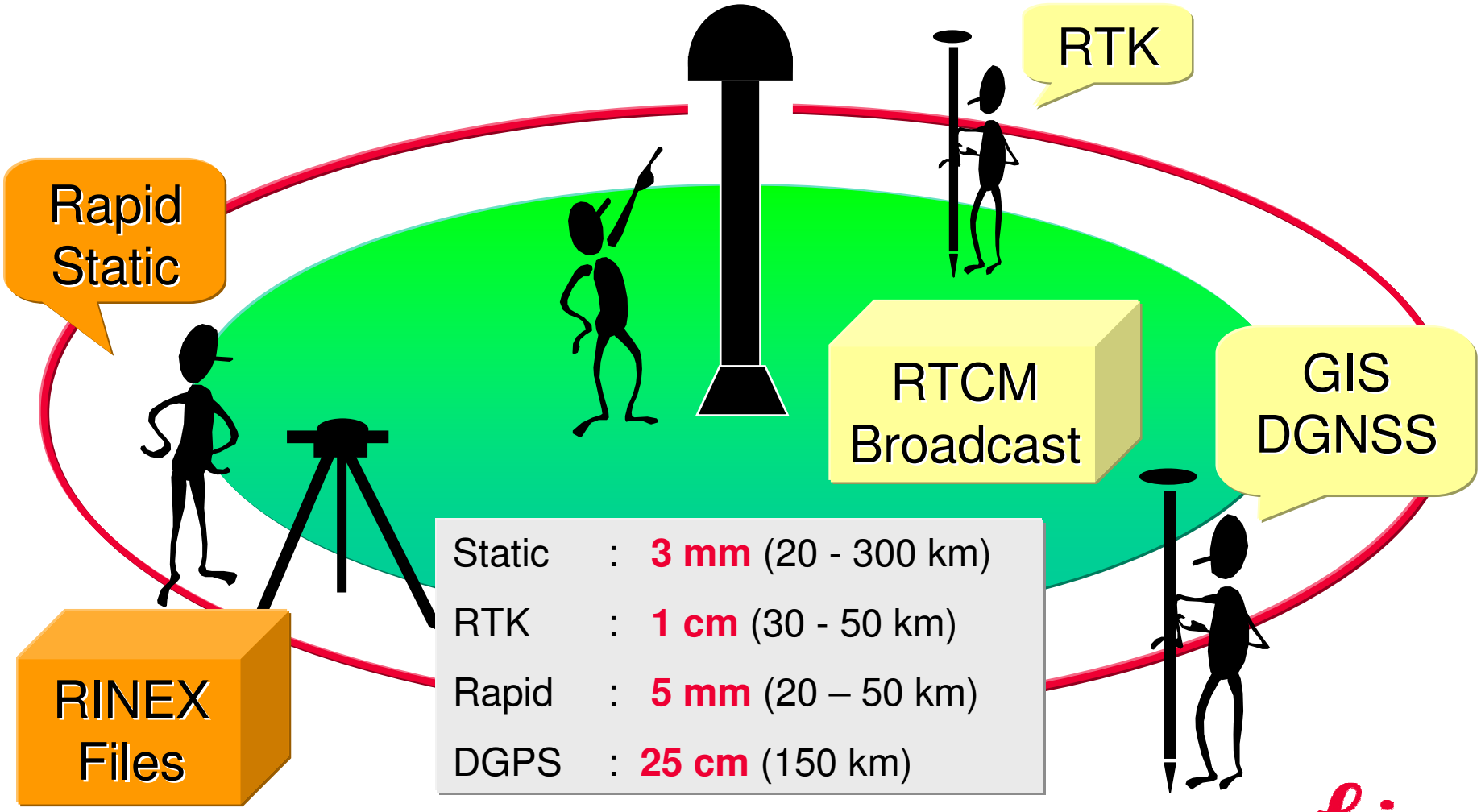


The **Central Processing Facility** need to **control** the “server” parameters and to **collect** observations from the RS “server” and to re-distribute observations and corrections.



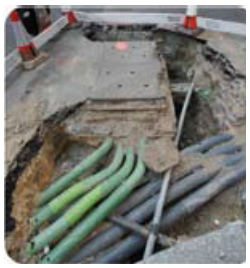
A RTK rover user wants to get in **real time** observations and corrections **from the air (wireless Internet)**.

Single
G.N.S.S REFERENCE STATION PRODUCTS



Applications

Building Construction



Utilities Sector

GPS Monitoring

Precise Vehicle Tracking

Emergency Services

Port Operations

Land Surveying

Machine Control

Agriculture

- when it has to be **right**

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BENEFITS:

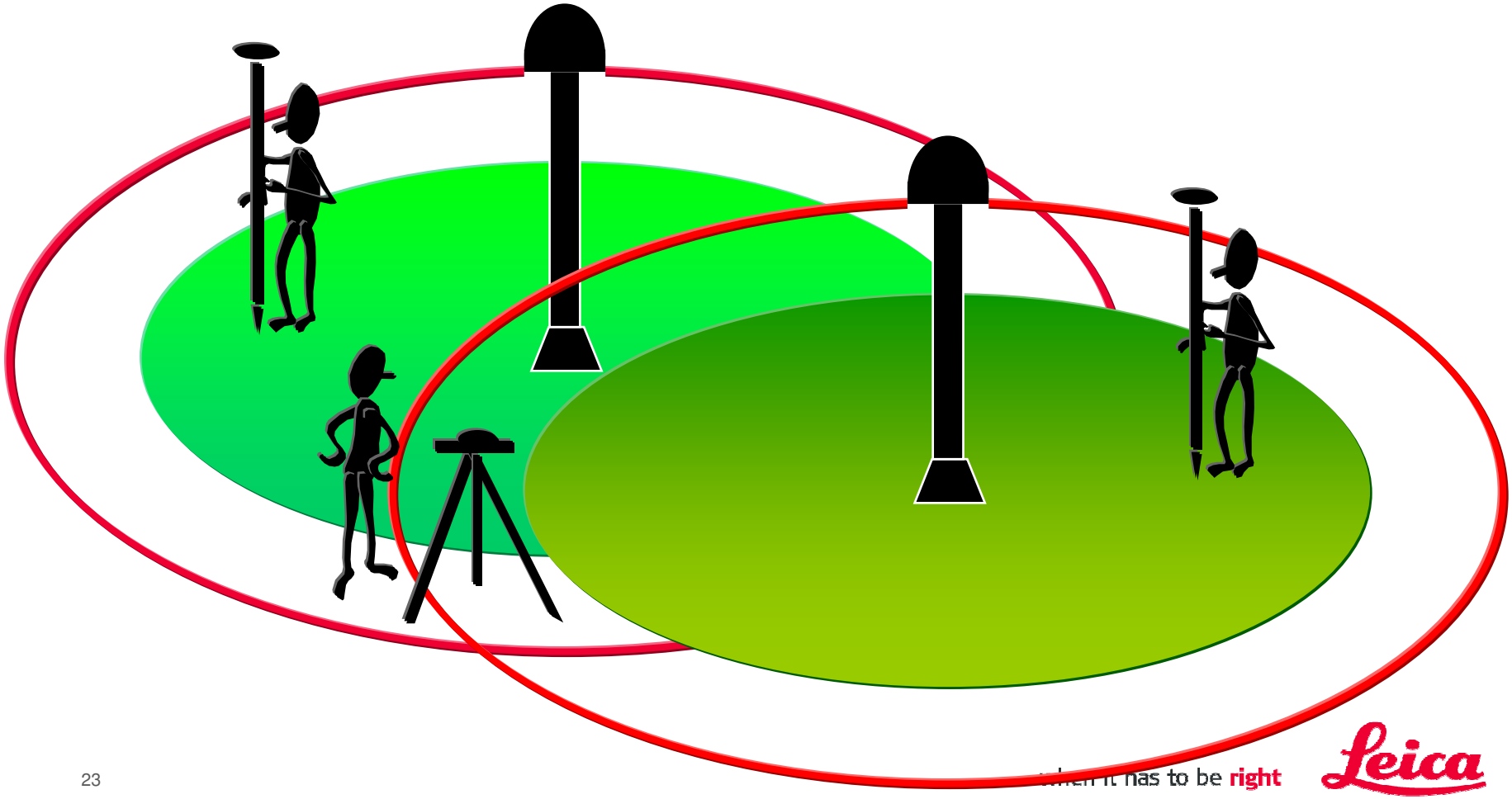
Single GNSS Permanent Reference Stations

- No local base station required
- Reduced user equipment costs
- Higher productivity
- Working on a common datum
- Power and communications
- Security
- Site selection – clear sky view
- Common good infrastructure

GNSS Networks
powered by Leica Geosystems

If we need to cover a larger area ?

We have to « network » the single RS's



Motivation for Network RTK

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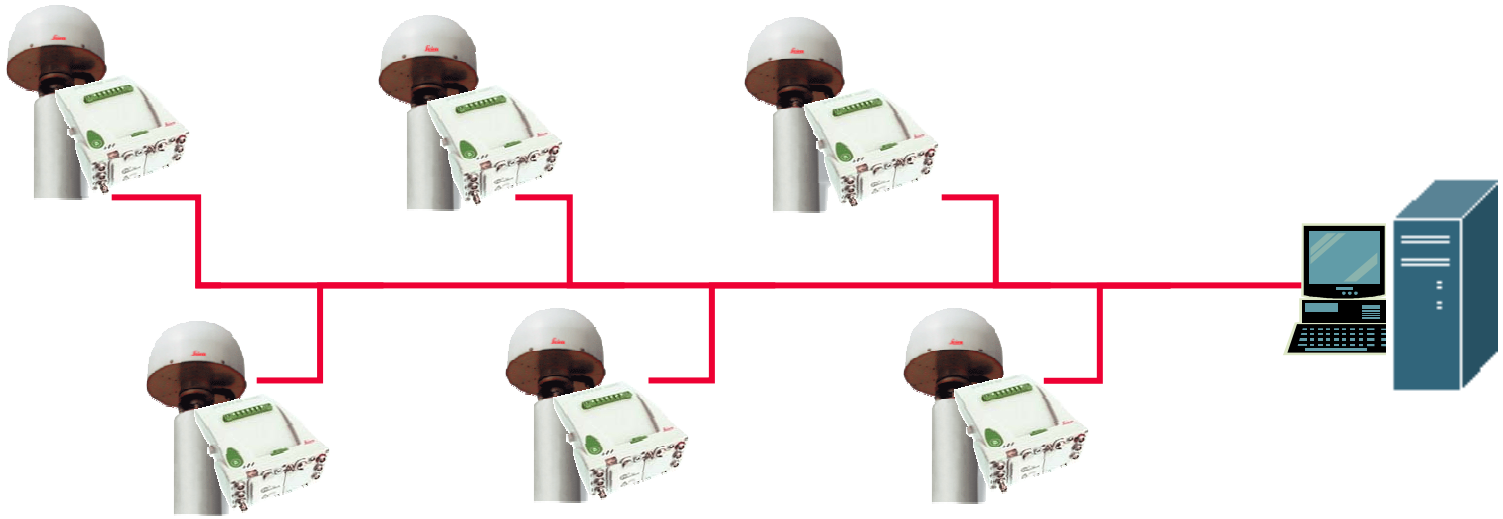
- Improve accuracy, reliability and availability
- Make rover performance more uniform across the network
- Reduce the number of stations required to cover the area



Accuracy, Reliability, Availability

Good — Poor

- when it has to be right

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Benefits of GPS RTK Network

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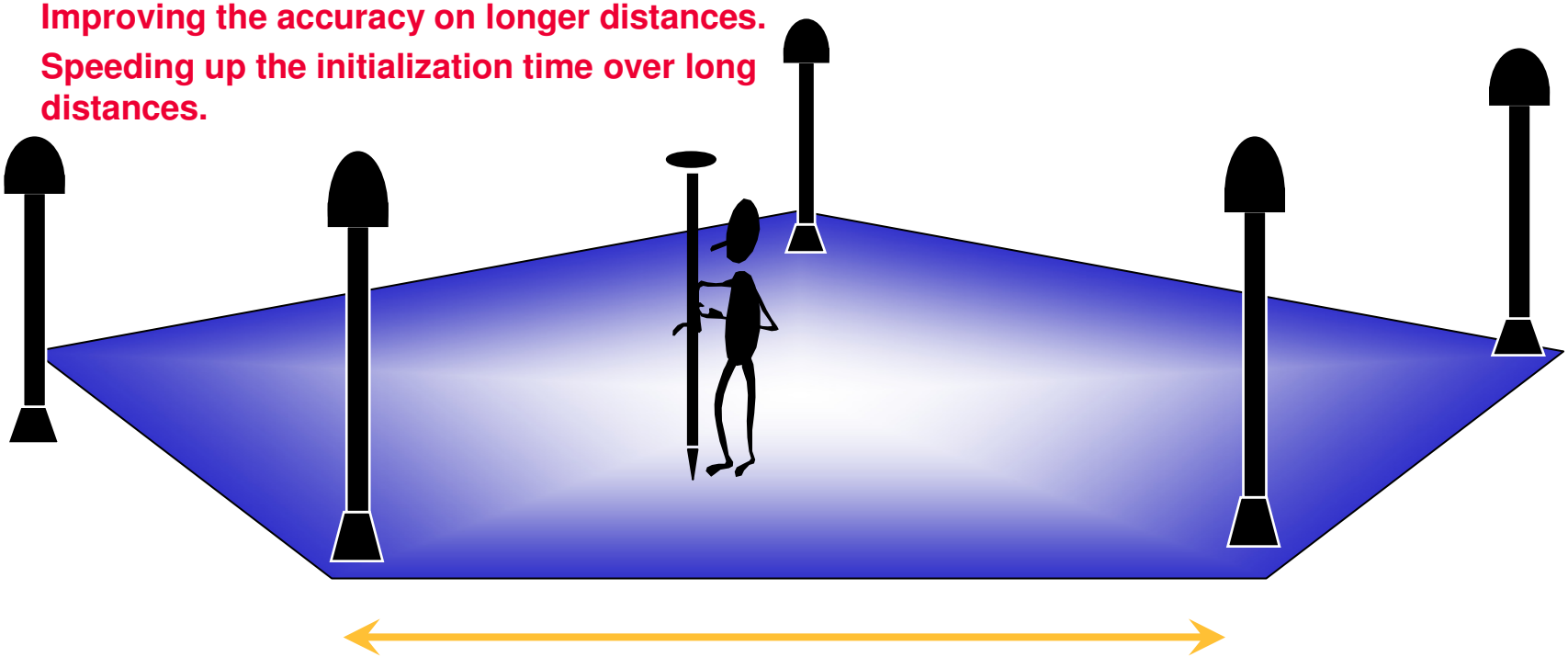
Extending the distance from a single reference station.

Improving the accuracy on longer distances.

Speeding up the initialization time over long distances.



75 to 100 Km

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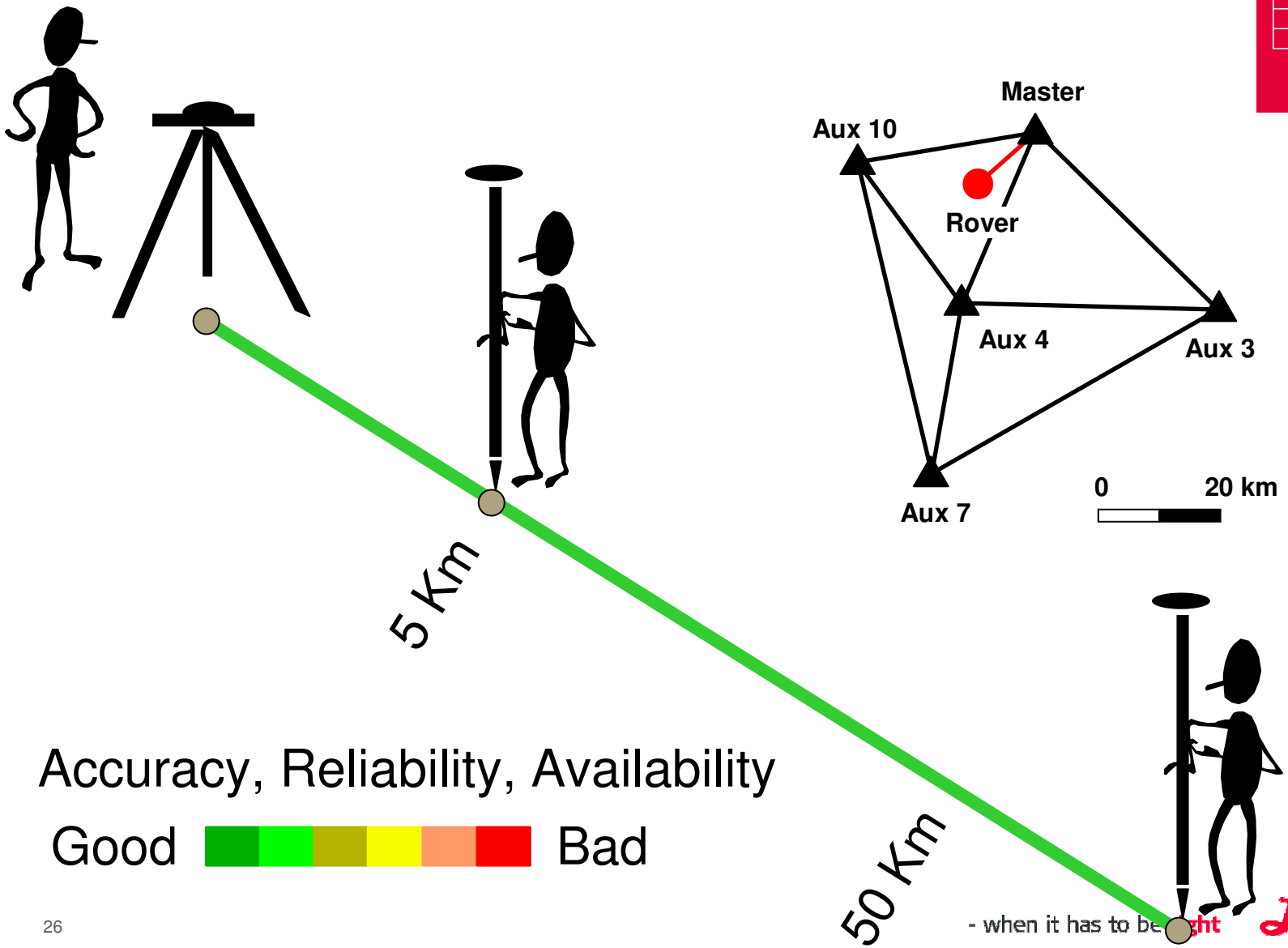
GNSS Network RTK

SmartRTK



Accuracy, Reliability, Availability

Good Bad

- when it has to be right

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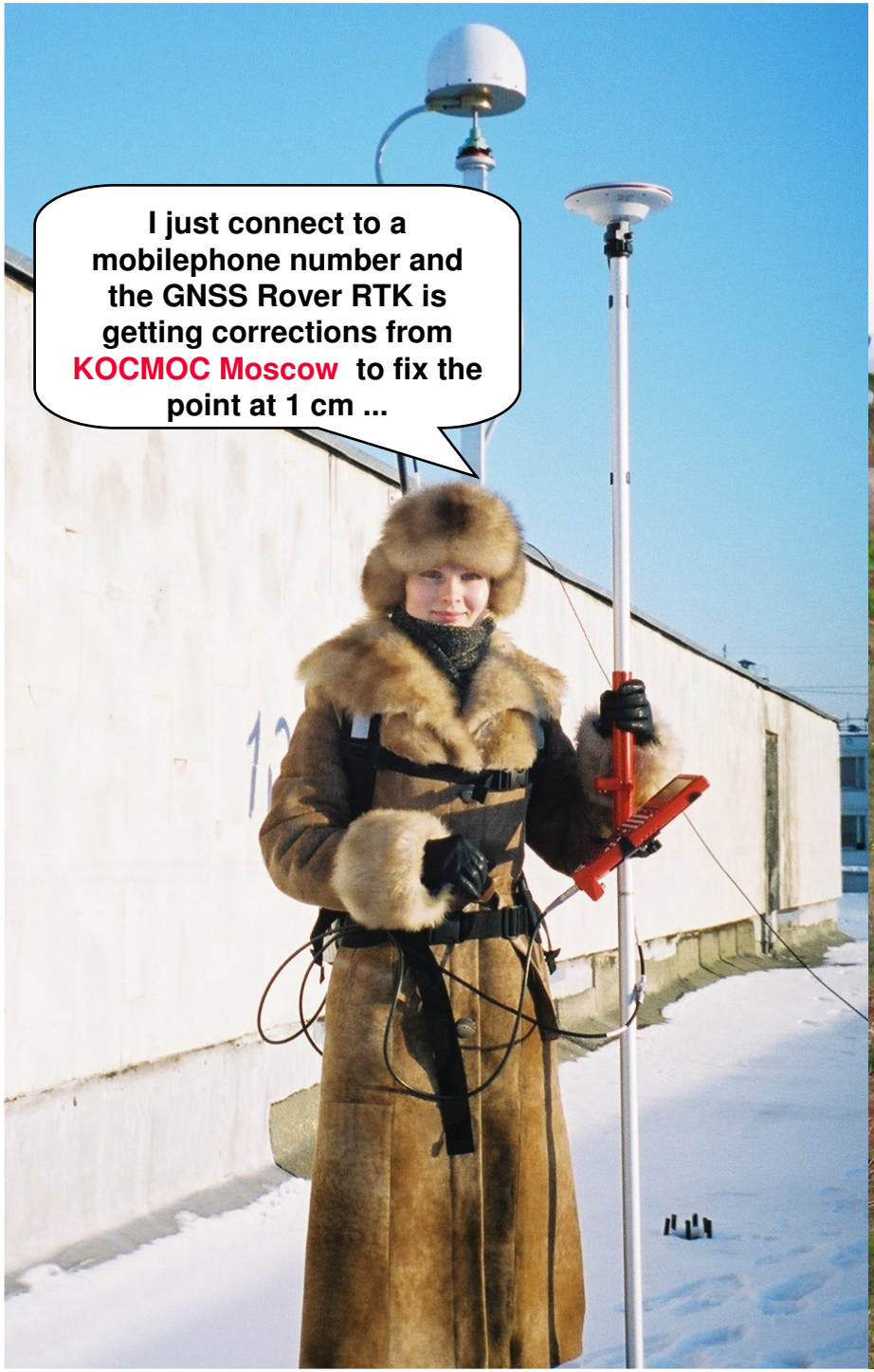
GNSS Survey assisted by GNSS Network RTK…


I just connect to a mobilephone number and the GNSS Rover RTK is getting corrections from KOCMOC Moscow to fix the point at 1 cm ...


My Total Station is getting precise coordinates by using GNSS receiver integrated …and connected to the Kunming GNSS Network RTK
Leica
TCRP1202

Network RTK BENEFITS

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- Increased coverage
- Improved availability
- Improved reliability
- Faster rover initialisations
- Consistent high accuracy
- Higher productivity
- No local base station required
- Fewer reference stations needed
- Working on a common datum

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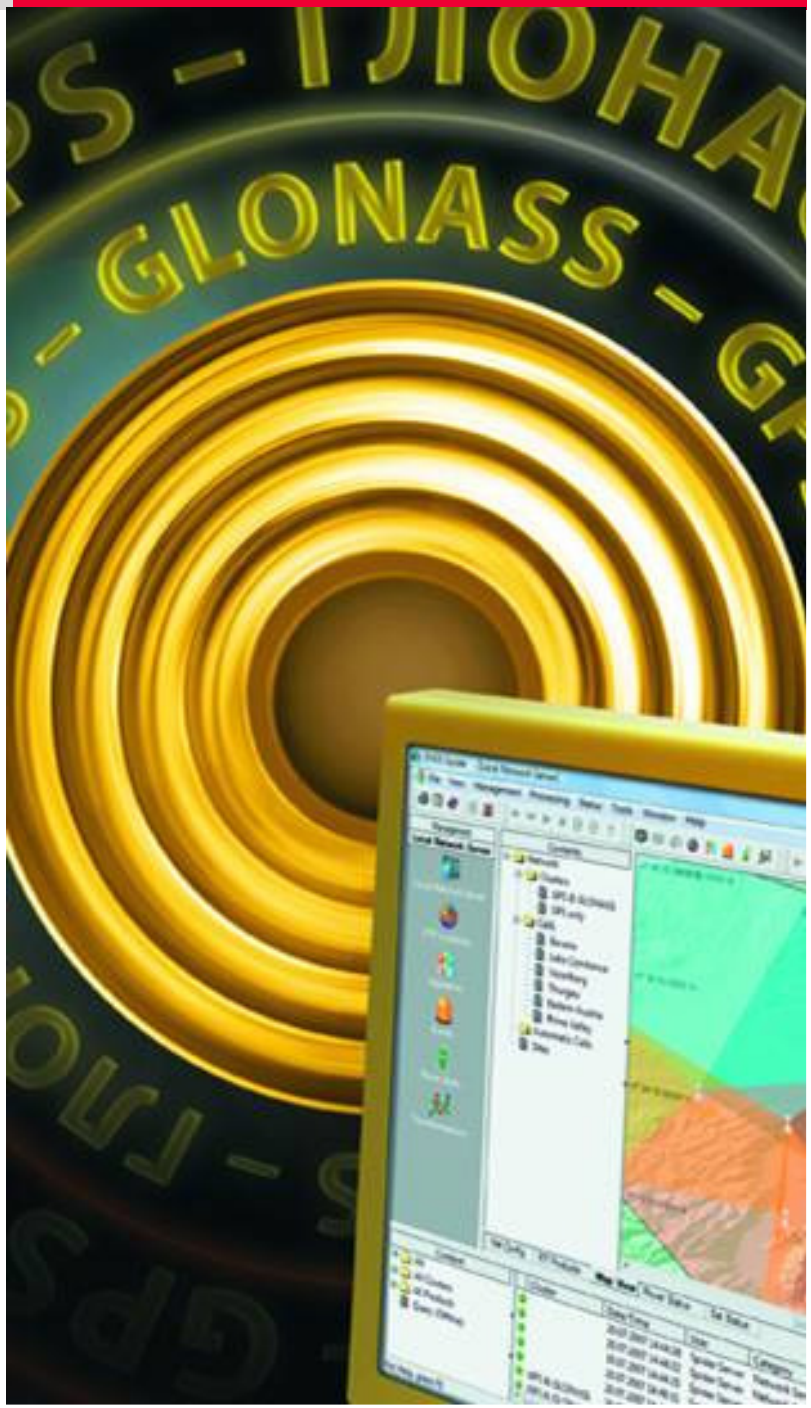
Software

Solutions & Management

For Networks G.N.S.S



GPS Spider
System Overview

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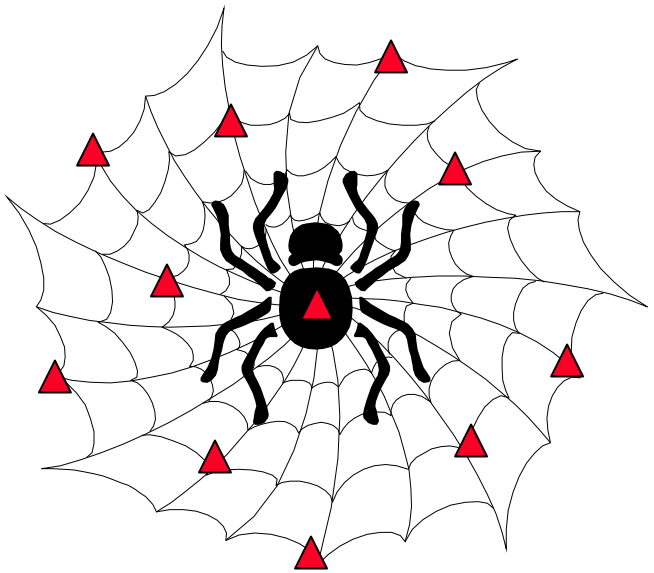
- GPS Spider is the Leica GPS reference station and network software
- GPS Spider is built in different modules following an unique architecture offering both un-equalled flexibility and scalability
- SpiderNet is the networking solution of GPS Spider
- Conveniently configure and start GPS receivers
- Automatically monitor GPS receivers and data streams
- Manage GPS Raw and RINEX data
- Compute station coordinates in real-time or post-processing for monitoring applications
- Process GPS Network corrections in real-time or post-processing
- Generate and distribute Single Base and Network RTK corrections in various formats
- Manage and monitor RTK rover users, generate logs for accounting & billing



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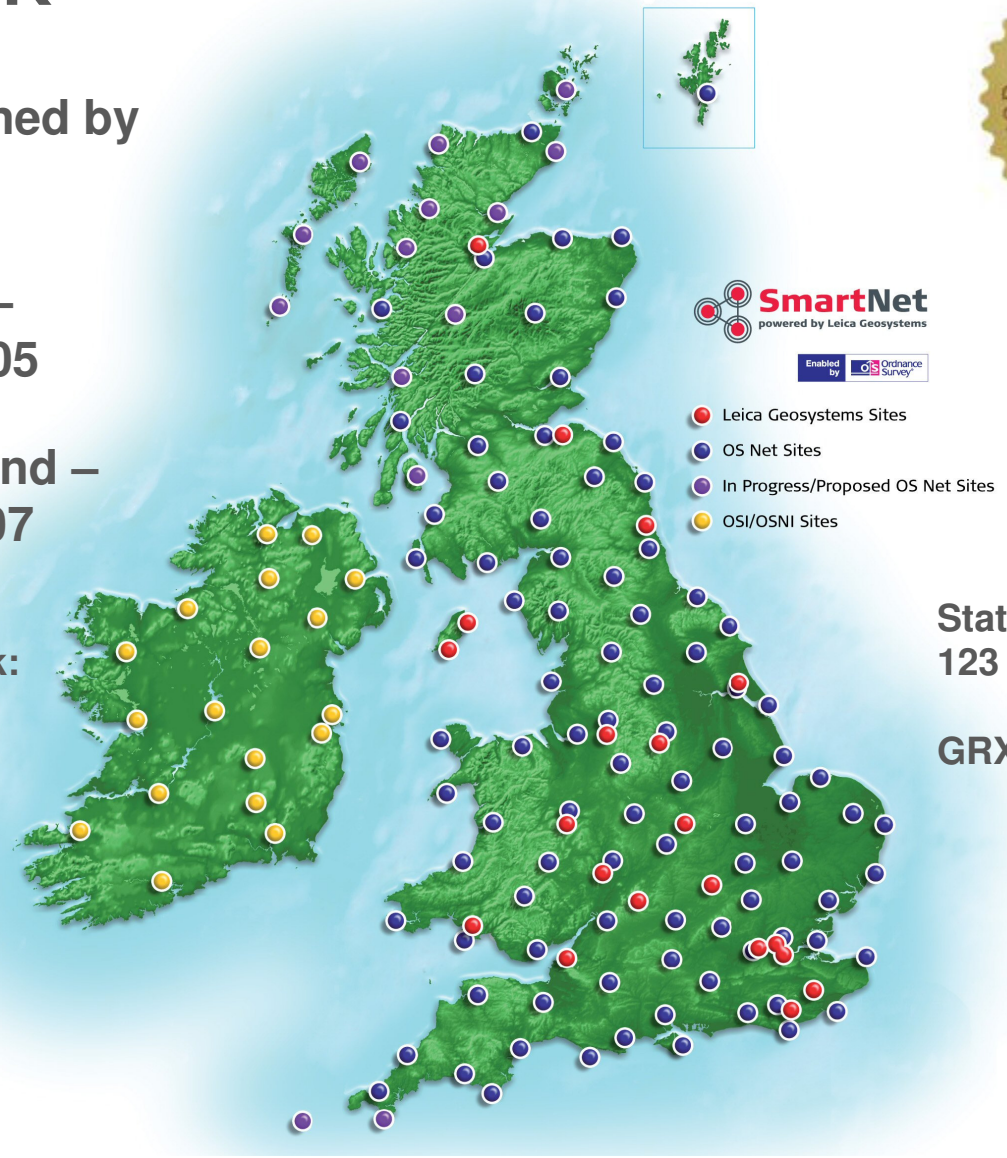
GNSS Networks
SmartNet UK

smartnet.leica-geosystems.co.uk

Infrastructure – Owned by Ordnance Survey

Leica SmartNet GB – Operational Dec. 2005

Leica SmartNet Ireland – Operational July 2007



Stations Ireland Network:
22 sites in total

19 GRX1200 GG Pro

Stations GB Network:
123 sites in total

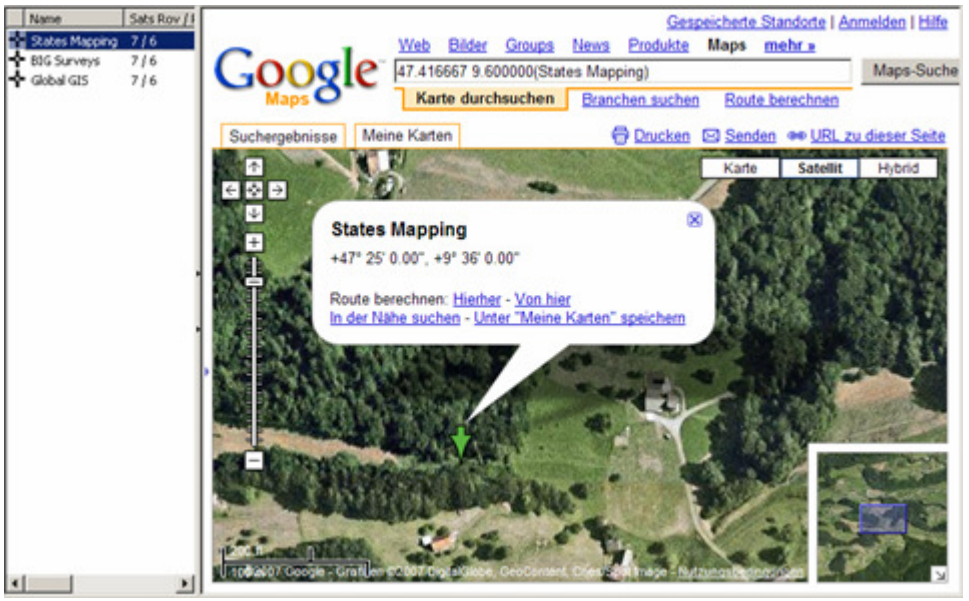
GRX1200+ and AR25

Leica GNSS Spider – Versatile Functionality

Spider Business Center

Unique User Management

- Manage RTK rover user access
- Authentication and authorisation for real-time product services
- Auditing and accounting allow to charge for services
- Advanced access control by …
  - data formats or access channel
  - Regional geographic area
  - Temporal restriction
  - Multiple connections



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GNSS
future proof

Monitoring Software

- GNSS QC data analysis software
- GeoMoS multi-sensor monitoring softwar
- GPS Spider processing software

Recent Projects

- Jiangyin Bridge, China
- IFC building, Hong Kong
- Ancona landslide monitoring, Italy

- when it has to be right

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GNSS Reference Stations and Networks
Expandable & Multi-Applications

- Bridge monitoring
- Tall Building monitoring
- Water Dam/Reservoir monitoring
- Seismic monitoring
- Landslide monitoring, subsidence
- Weather Forecasting
- Volcano monitoring
- Tide Gauge monitoring
- Agriculture
- Pipe Line, Oil and Gas Industry
- Offshore Platform
- Open Pit Mines
- Railway, Airport, Harbour
- Surveying & GIS

A GNSS Reference Station

… is Forever !

THANK YOU FOR YOUR ATTENTION AND COOPERATION

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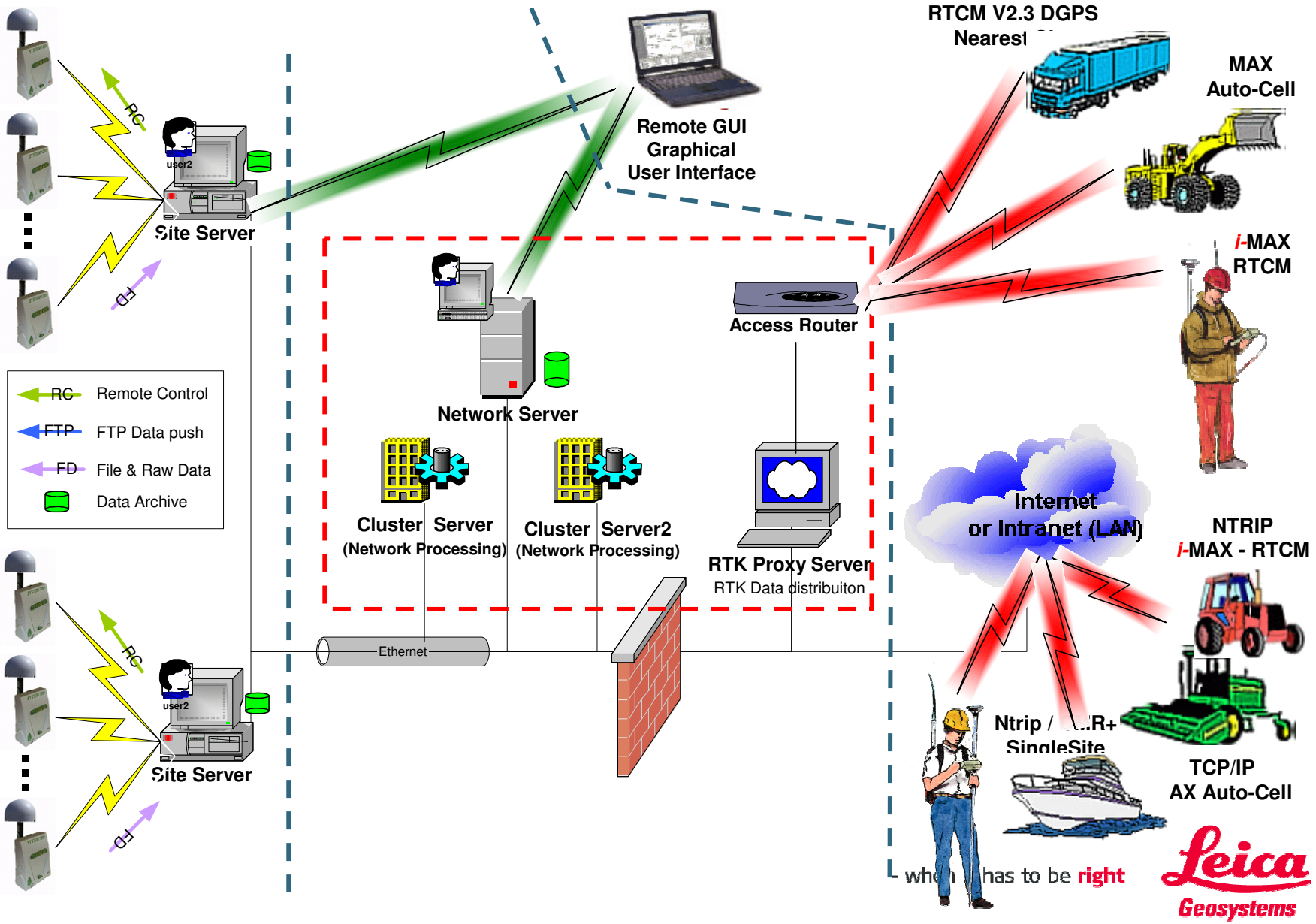
GPS SpiderNET – Architecture Overview



Why do monitoring ?

- Everything is moving - How much ?
- Measurements assists understanding – long term monitoring and storage of results
- Measurements assist prediction - when will it fail ?
- Operational efficiency – steeper slopes in mines, reduced materials cost in contruction
- Safety of people, equipment and machinery (injuries or death, legal action, lost production)
- Slope/Structural management – maintenance on demand
- Government regulations often require monitoring
- Reduce risk and insurance premiums - $$$$.