DGPS satellite positioning through Internet for mobile GIS, tree survey and emergency services
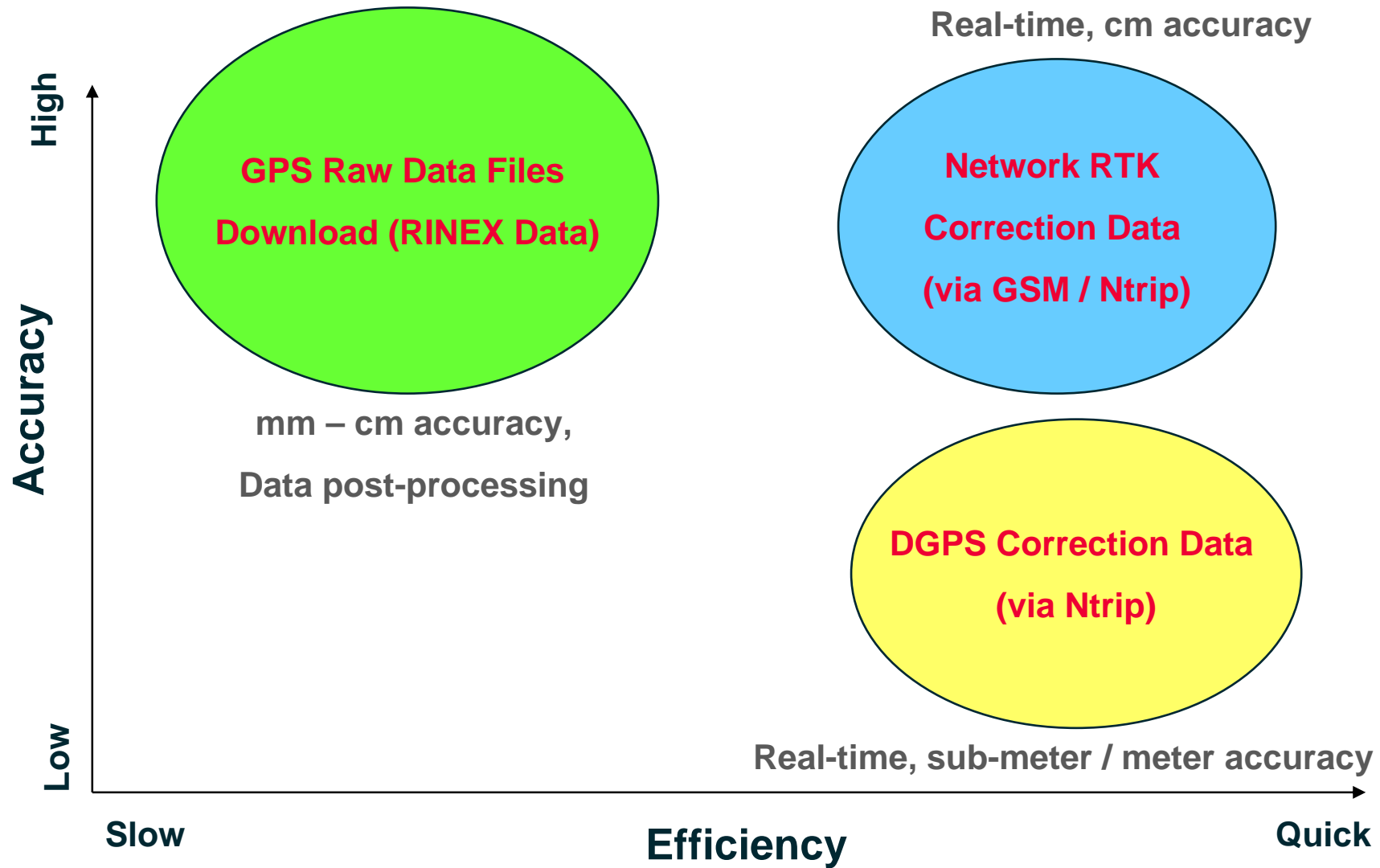
Vincent LUI

Leica Geosystems Limited

4th Feb 2010 - Workshop on the Hong Kong Satellites Positioning Reference Station Data Service Application
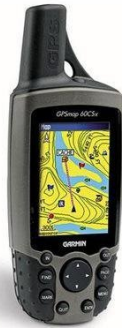
- when it has to be **right**

Leica **Geosystems**

SatRef GPS Data Services

Real-time, cm accuracy

GPS Raw Data Files Download (RINEX Data)

Network RTK Correction Data (via GSM / Ntrip)

mm – cm accuracy,
Data post-processing

DGPS Correction Data (via Ntrip)

Real-time, sub-meter / meter accuracy

High

Low

Accuracy

Slow

Quick

Efficiency

Various GPS / GNSS receiver available in market

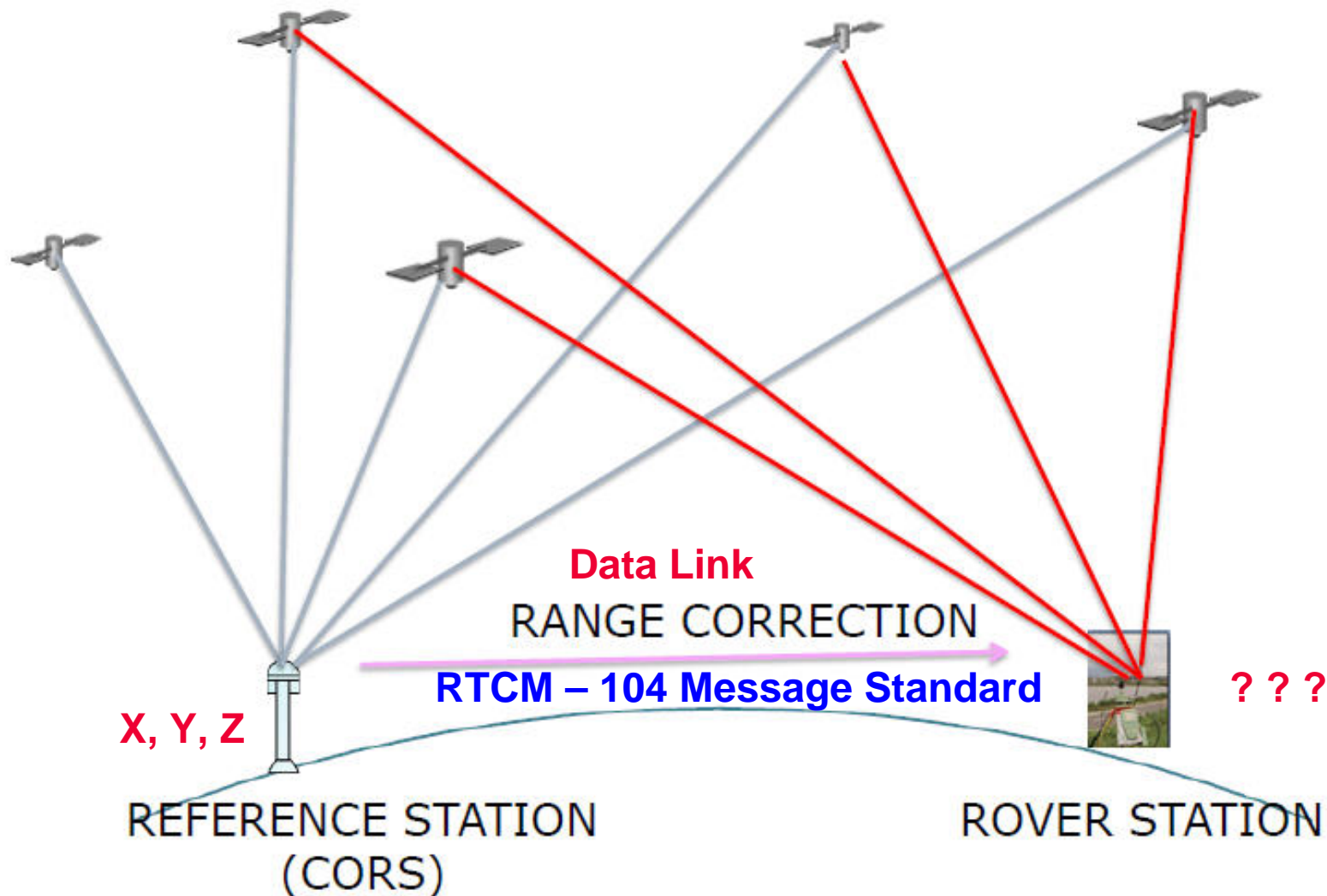**Meter Grade**
Accuracy GPS
receiver

Sub-meter grade
DGPS receiver

mm-cm geodetic grade
receiver, multi-satellites
system tracking

3

Differential GPS (DGPS) using range correction (Use Code Only, Not use carrier phase data)

Data Link

RANGE CORRECTION

RTCM – 104 Message Standard

X, Y, Z

? ? ?

REFERENCE STATION
(CORS)

ROVER STATION

Traditional DGPS service in HK – Marine Beacon

Hydrographic Office, Marine Department
The Government of the Hong Kong Special Administrative Region

Asia's world city HONG KONG

GovHK香港政府一站通   繁體版 简体版   SITE MAP

DGPS - CORRECTION SERVICE

| HOME |
| ABOUT US |
| THE BASICS |
| SERVICES |

HYDROGRAPHIC SURVEYING
- Survey Vessels
- Equipment
WRECK SEARCH
NAUTICAL CHARTING

A permanent Global Positioning System (GPS) reference station, located on the top of the island, Kau Yi Chau, was established in 1996. The reference station continuously monitors the status of the GPS and broadcast differential correction signals. The broadcasting service is free; any user equipped with a standard DGPS receiver will be able to make use of the corrections to improve the accuracy of their GPS positions.

Kau Yi Chau
beacon station

The Reference Station at Kau Yi Chau

The GPS Reference Station Receiver Antenna

The Broadcasting Radio Antenna

Broadcasting Period:	24 hours
Station ID:	852 & 853
Frequency:	289.0 kHz
Bit Rate:	200 bps
Modulation Mode:	Minimum Shift Keying
Differential Data Format:	Radio Technical Commission for Maritime Services (RTCM) SC- 104 Version 2.0 format.
Range:	50 km
RTCM Message Type:	1,3,5,7 and 16
Signal Warning:	RTCM type 16 'screen pop-up' message

Traditional DGPS service in HK – Marine Beacon
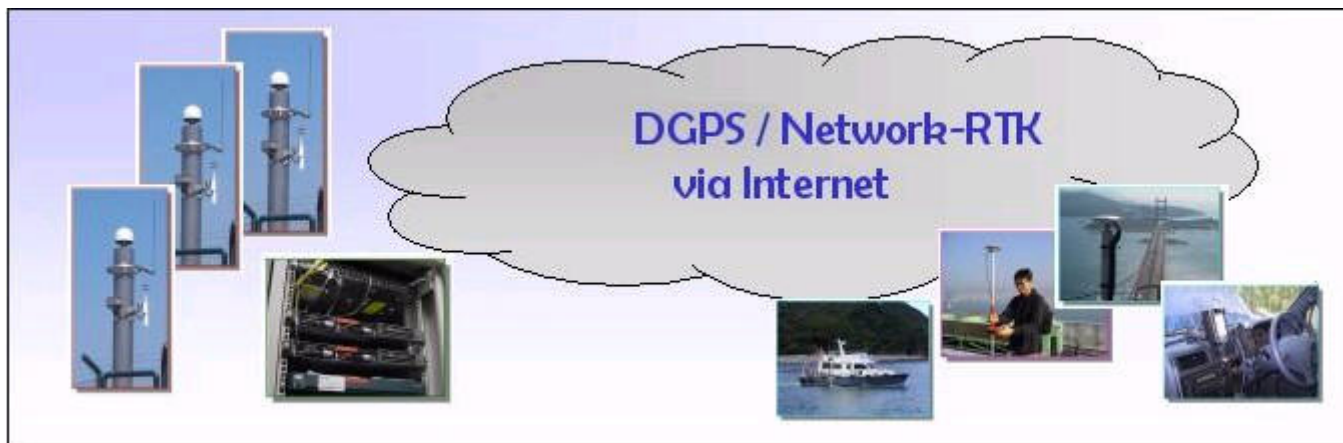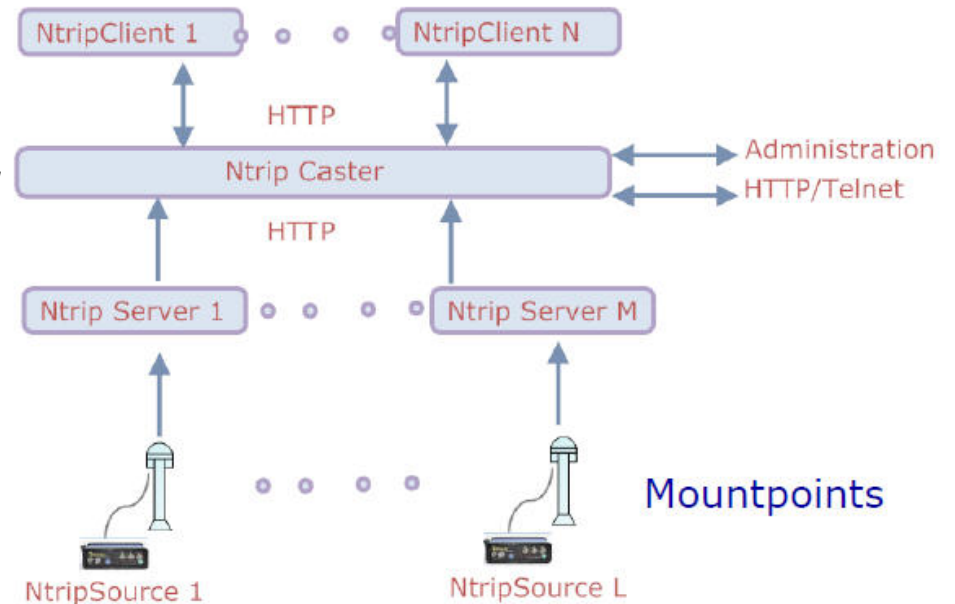
Kau Yi Chau Station (commissioned in 1996)

▪ GPS antenna is situated at the main triangulation monument (Trig.75) at the top of the island.

▪ It is operated by the Hydrographic Office of Marine Department

▪ DGPS correction is broadcasted using marine radio beacon frequency band (289 KHz). This frequency is suitable for signal transmission in the coastal area and at sea, but NOT of the optimum use for signal transmission on land.

▪ DGPS data from the beacon station could not be received in many urban or forest areas.

Solution – Sending real-time DGPS data via Internet SatRef Ntrip Services

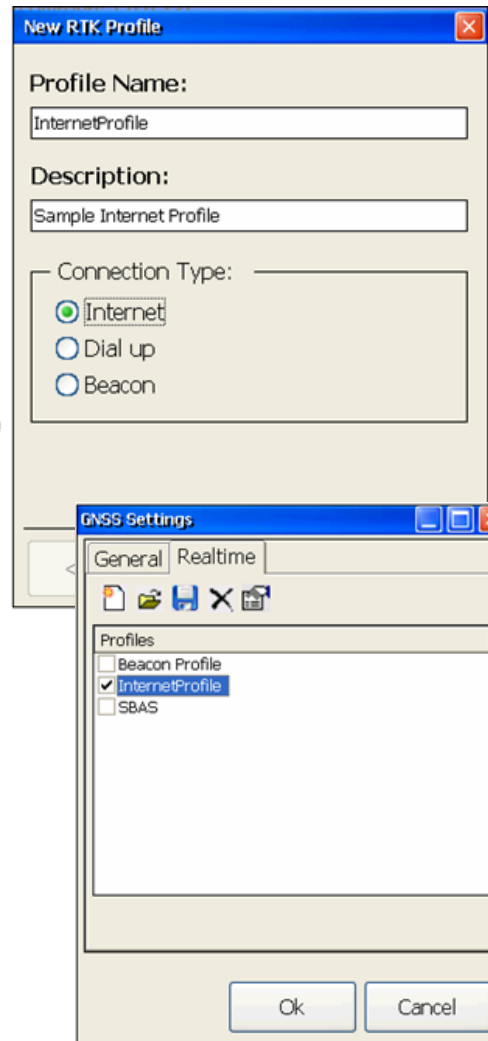**Ntrip –** Networked Transport of RTCM via Internet Protocol

➤To deliver GPS data (GPS raw data / **DGPS data** / Network RTK data) to multiple users via the Internet simultaneously.

➤ Condition: The user's location must able to access wireless Internet (e.g. GPRS / Wi-Fi communication network)

To receive DGPS data via Ntrip
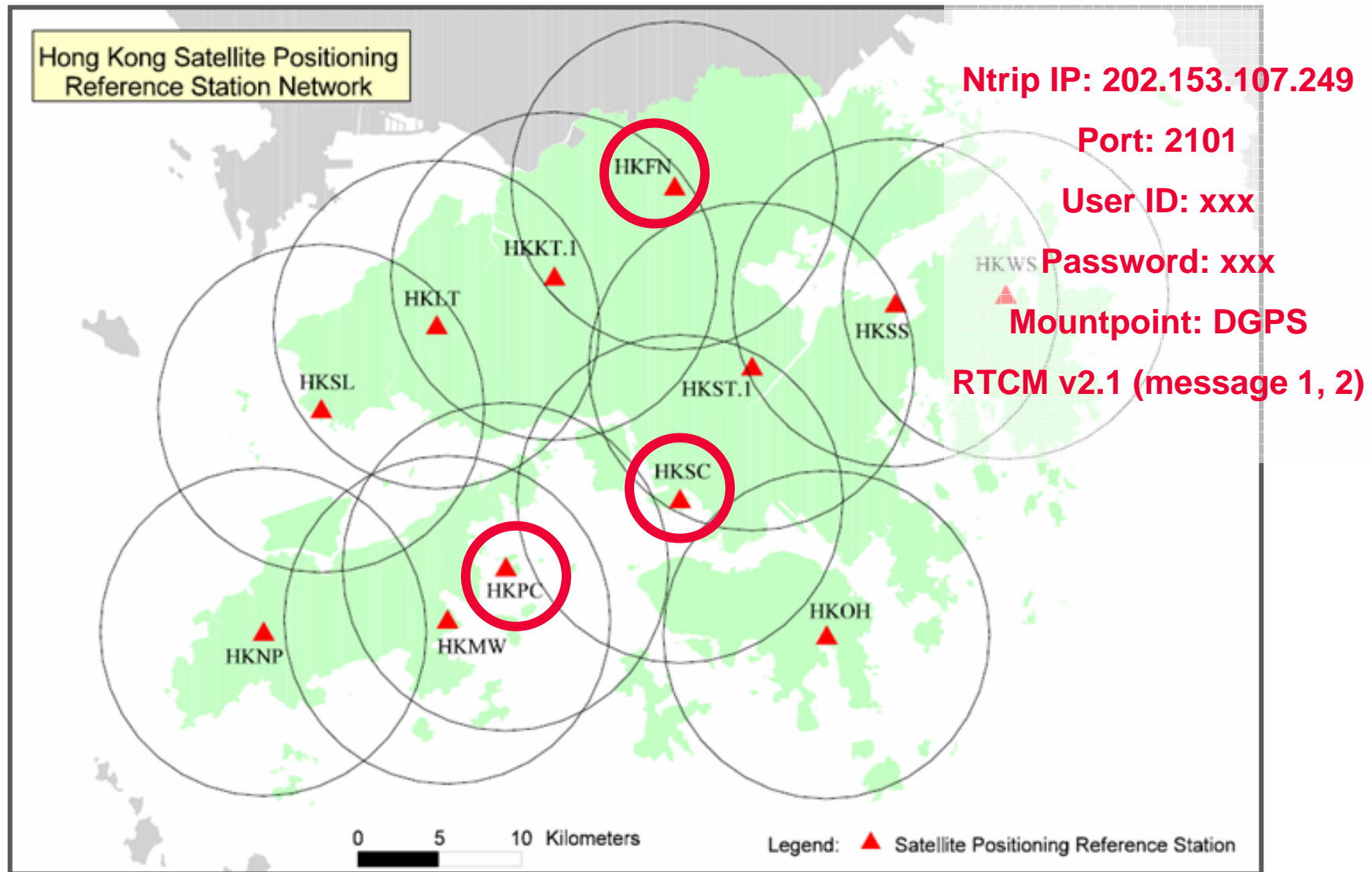
GPS receiver integrated with Ntrip Client program

New RTK Profile

Profile Name:
InternetProfile

Description:
Sample Internet Profile

Connection Type:
- ● Internet
- ○ Dial up
- ○ Beacon

GNSS Settings

General | Realtime

Profiles
- ☐ Beacon Profile
- ☑ InternetProfile
- ☐ SBAS

Ok   Cancel

GPS receiver

Bluetooth

GNSS Internet Radio 1.4.11

Broadcaster   Settings

START   STOP   Stream Details

Bytes: 0

Select Network:
All

Select Stream or Update:
Update source table

Adjust Settings or press START.

Mobile Device (e.g. PDA)

Ntrip Client program

(e.g. GNSS Internet Radio)

Access DGPS data service in SatRef

Hong Kong Satellite Positioning Reference Station Network

HKFN
HKKT.1
HKLT
HKSL
HKST.1
HKSS
HKWS
HKSC
HKPC
HKNP
HKMW
HKOH

Ntrip IP: 202.153.107.249

Port: 2101

User ID: xxx

Password: xxx

Mountpoint: DGPS

RTCM v2.1 (message 1, 2)

0   5   10 Kilometers

Legend: ▲ Satellite Positioning Reference Station

Benefits of DGPS positioning via Ntrip

❖ **IP base**, Support serving DGPS data to **large number of users simultaneously**

    (More **easy** for future system **expansion** for larger user group)

❖ **Lower communication cost** on the user side

❖ **No distance limitation** for sending DGPS data to all users

❖ **Fast position fixing performance** by GPS **L1 code** solution

❖ The system structure is ready for rendering data services on web through **3G, HSDPA, EDGE, Wi-Fi and other wireless mobile IP** technologies

❖ Data **Security policy** on accessing data services

Application - Tree Survey

❑ For **environmental protection** & **public safety reasons**, trees in HK are preserved and inspected regularly

❑ To build a tree survey plan, we need to <u>identify</u>, <u>get position</u> and <u>numbering</u> all the trees on site

❑ According to government standard, each tree should be **"pictured"** from root collar to overall crown with **proper label**

❑ **Additional information** required from survey:

Species	
Sizes	Girth, Height, Spread
Tree form	Good / Fair / Poor
Tree Health	Good / Fair / Poor
Amenity Value	High / Medium / Low
Survival rate after transplant	High / Medium / Low
Other remarks	e.g. any defects on tree

Tree Survey – conventional methods

❖ **By relatively measurement from other objects on map**

❖ **By using Theodolite / Total Station**

Issues:

- Need **control points**

- **traversing need to be done in advance** for getting necessary control point coordinates **(i.e. More time required !)**

- **More manpower is required**

- **Survey result cannot be delivered / presented on site** – usually need **data computation / post-processing** and **output to CAD or map format files back in office**

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A new way – Using SatRef DGPS data with a DGPS handheld receiver

Very Simple Operation – collecting tree / other features in the field

1. **Turn ON** receiver, start **tracking satellites and receive DGPS data** of SatRef via Ntrip

2. Select a **point**, **line** or **polygon** feature

3. Go to the feature, Click capture point.

4. Enter **Attributes** in "**digital form**"

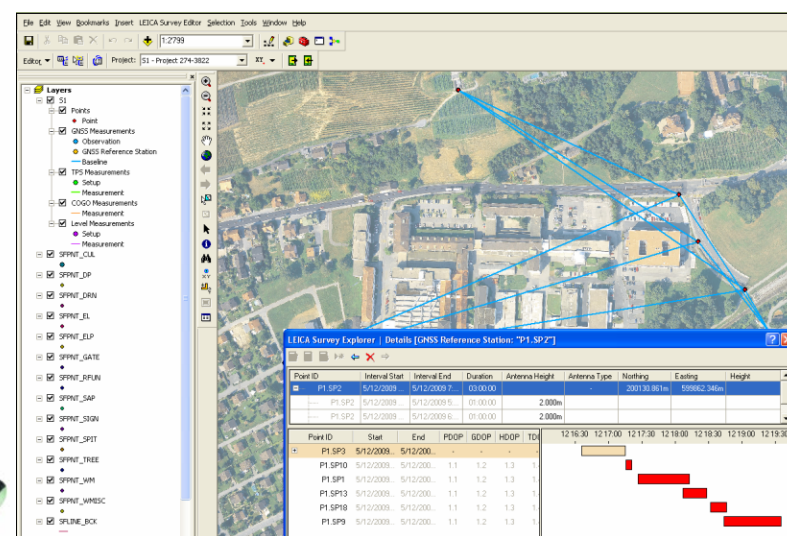5. Take a **photo** for record.

(Use receiver's built-in camera)

Done!
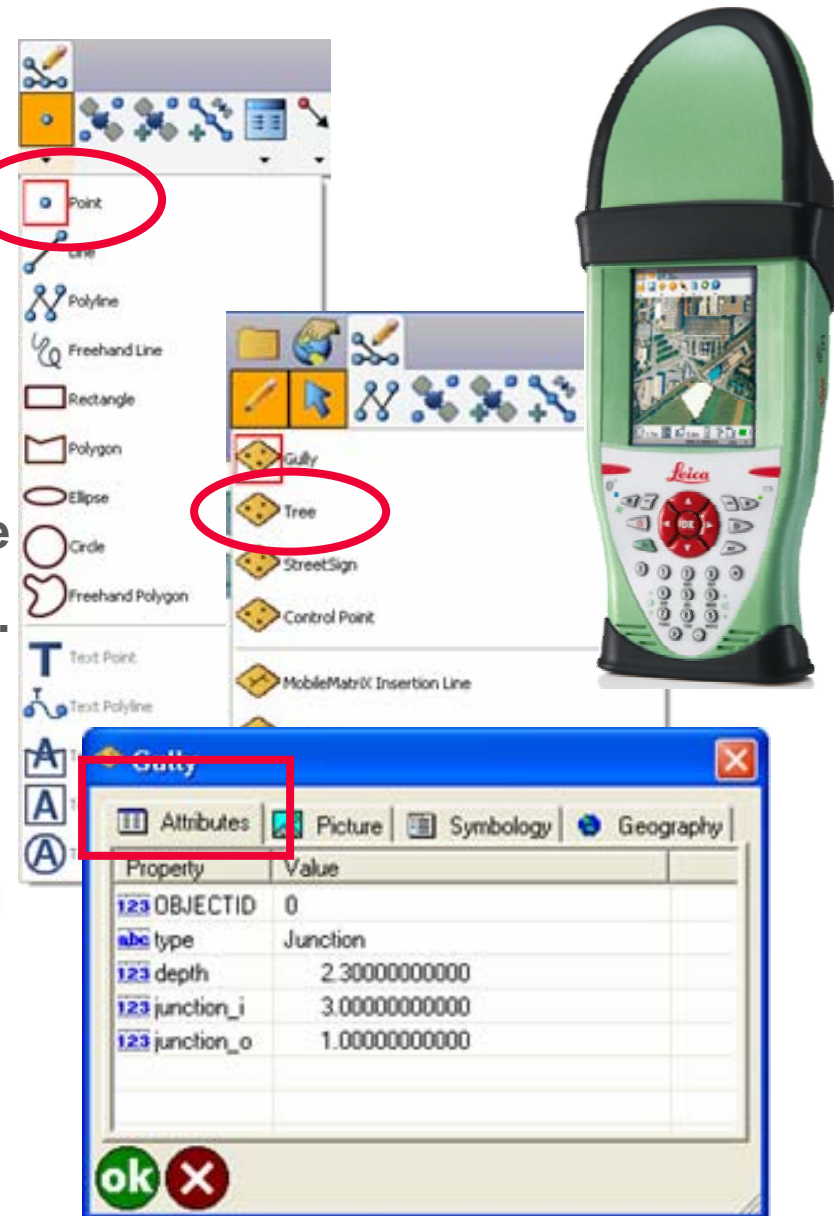
Accuracy

Receiver Antenna	Real-Time (DGPS)	Post-Processing	
		'Rapid Static' (3 sec – 5 min)	'Static' (approx. 5-7 min)
Internal Antenna	0.40 m	0.40 m	-
External Antenna	0.30 m	0.30 m	10 mm + 2 ppm
SBAS	1 - 1.20 m	-	-

Internal Antenna

External Antenna

Software for Data Post-Processing

Graphical Operation Interface & GIS / CAD support

Check In
features result / GPS raw data

Office SW

EasyIn

Check Out
features / maps to receiver

EasyOut

Field SW
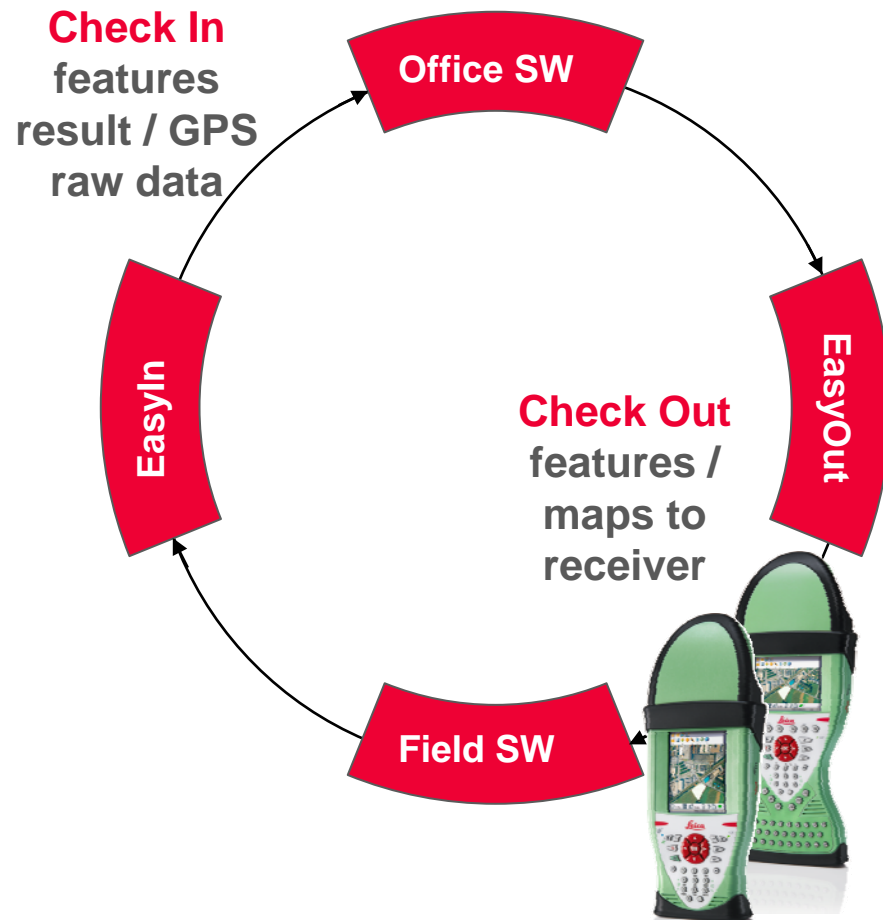
Support Vector / Raster Data

DXF, DGN, DWG, Shape files, TIF, etc
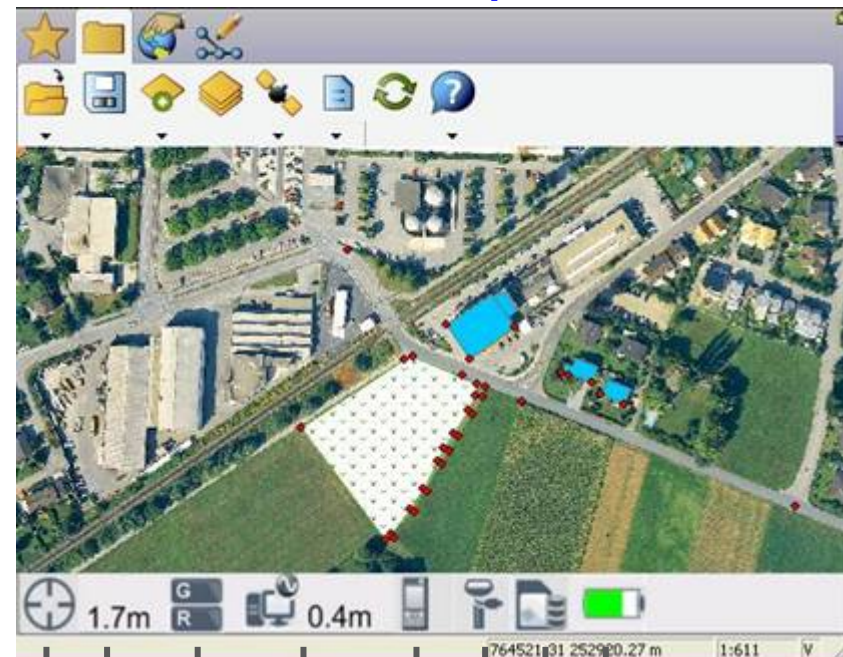
Solution type

Current Accuracy

Tracked Satellites

Estimated Post-Processed Accuracy
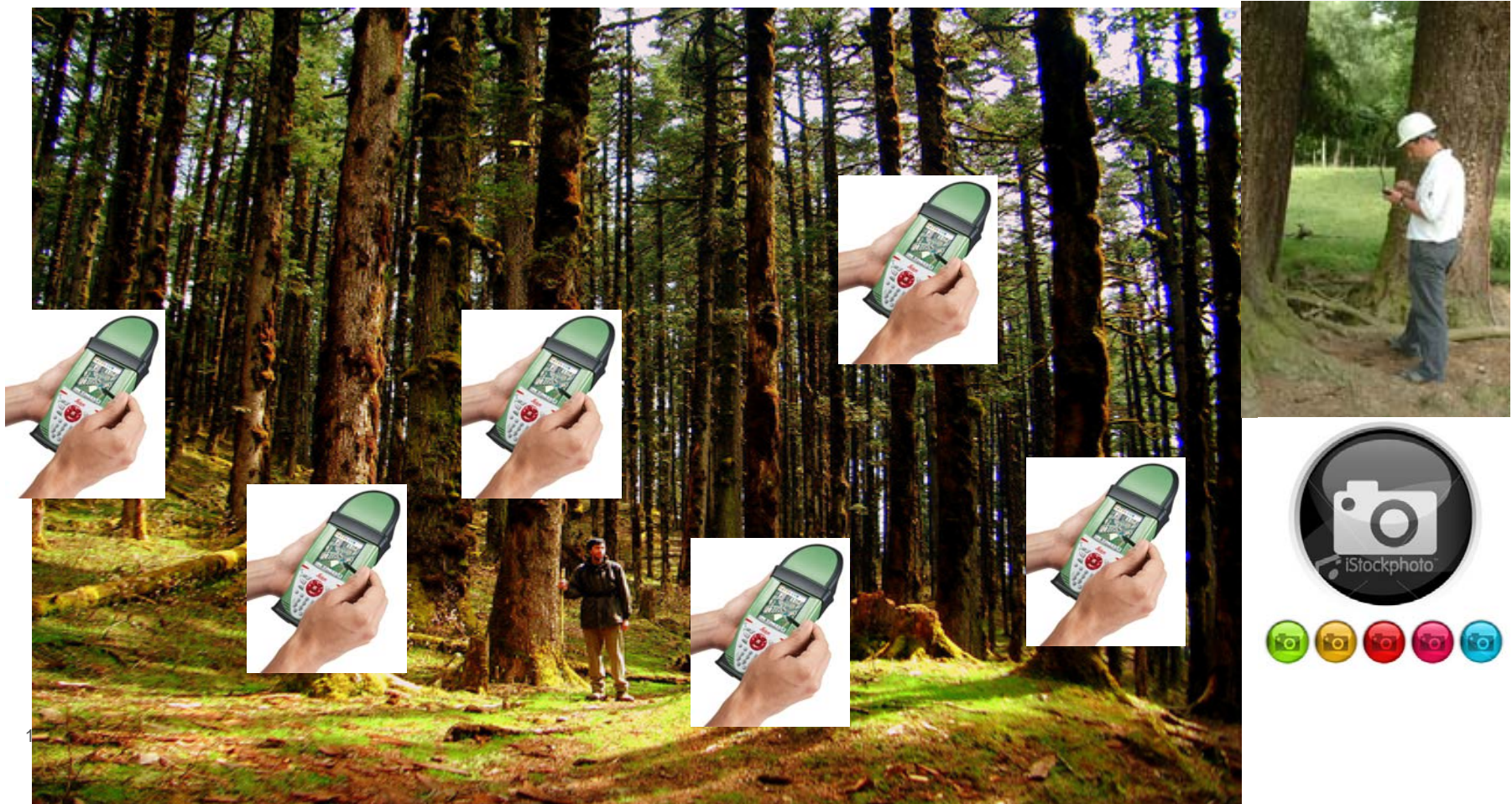
RT devices

External Antenna

Memory

Battery

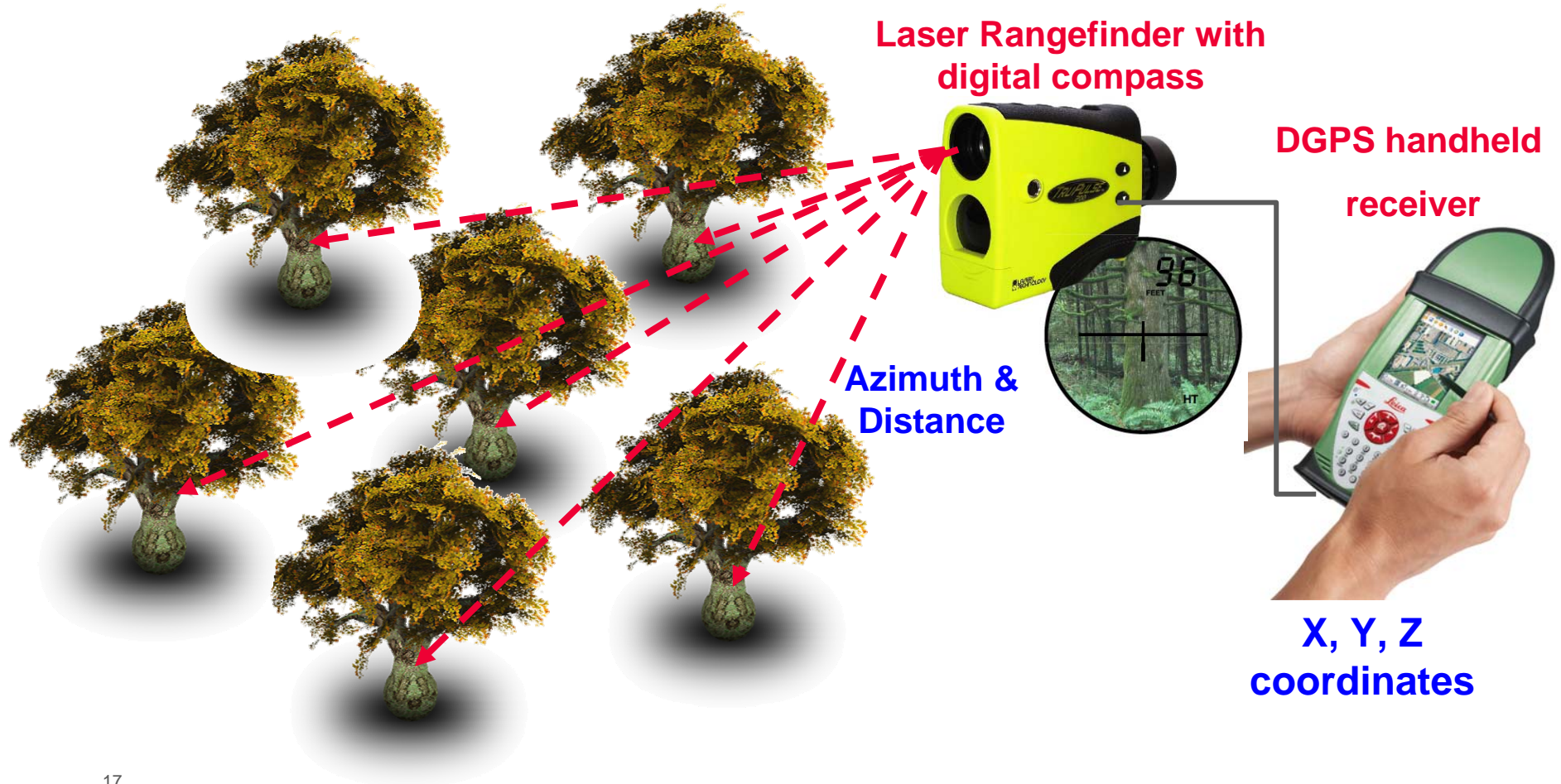# Tree Survey – by DGPS positioning using SatRef real-time data correction

Method A: Measure each tree's position by handheld DGPS receiver

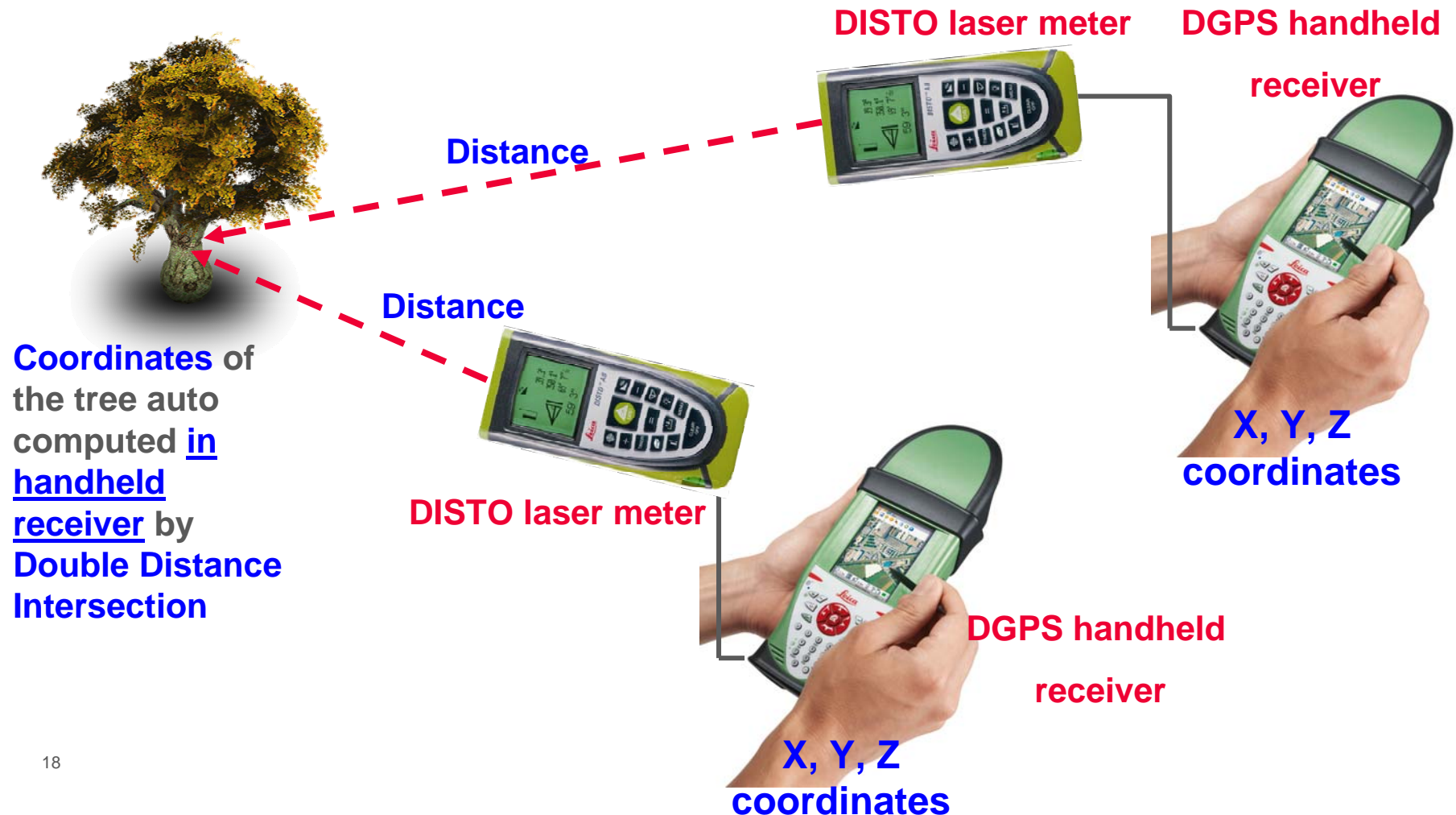**(0.4m – 1m accuracy) – by receiving SatRef's DGPS data via Ntrip**

Tree Survey – by DGPS positioning using SatRef real-time data correction

Method B: Measure each tree's position by **handheld DGPS receiver + Laser Rangefinder device**

Laser Rangefinder with digital compass

DGPS handheld receiver

Azimuth & Distance

X, Y, Z coordinates

Tree Survey – by DGPS positioning using SatRef real-time data correction

Method C: Measure each tree's position by **handheld DGPS receiver + DISTO Laser meter**

DISTO laser meter

DGPS handheld receiver

Distance

Coordinates of the tree auto computed <u>in handheld receiver</u> by **Double Distance Intersection**

Distance

X, Y, Z coordinates

DISTO laser meter

DGPS handheld receiver

X, Y, Z coordinates

Application – Mobile GIS

Deliver GIS intelligence to the field

- **Field – To – Finish** Solution on site

- **Reduce workload back in office**

- **Improve data records quality**

- **Eliminate reworks (errors can be inspected on site)**

- **Reduces costs and time**

- **Eliminate process and data redundancies**

- **Improve maintenance tasks and workflows**

Typical use in HK - Illegal Land / Pond Filling Sites

In *"Agriculture" zone*, any filling of land/pond also *requires permission* from the TPB, though such restriction does not apply to filling of land for the purposes of laying of soil **not exceeding 1.2 meters in thickness for cultivation**…"

Typical use in HK- Land / Pond Filling Sites – overlay Boundary record

Legend

OZP Zone
Lot Boundary

Land Filling Site
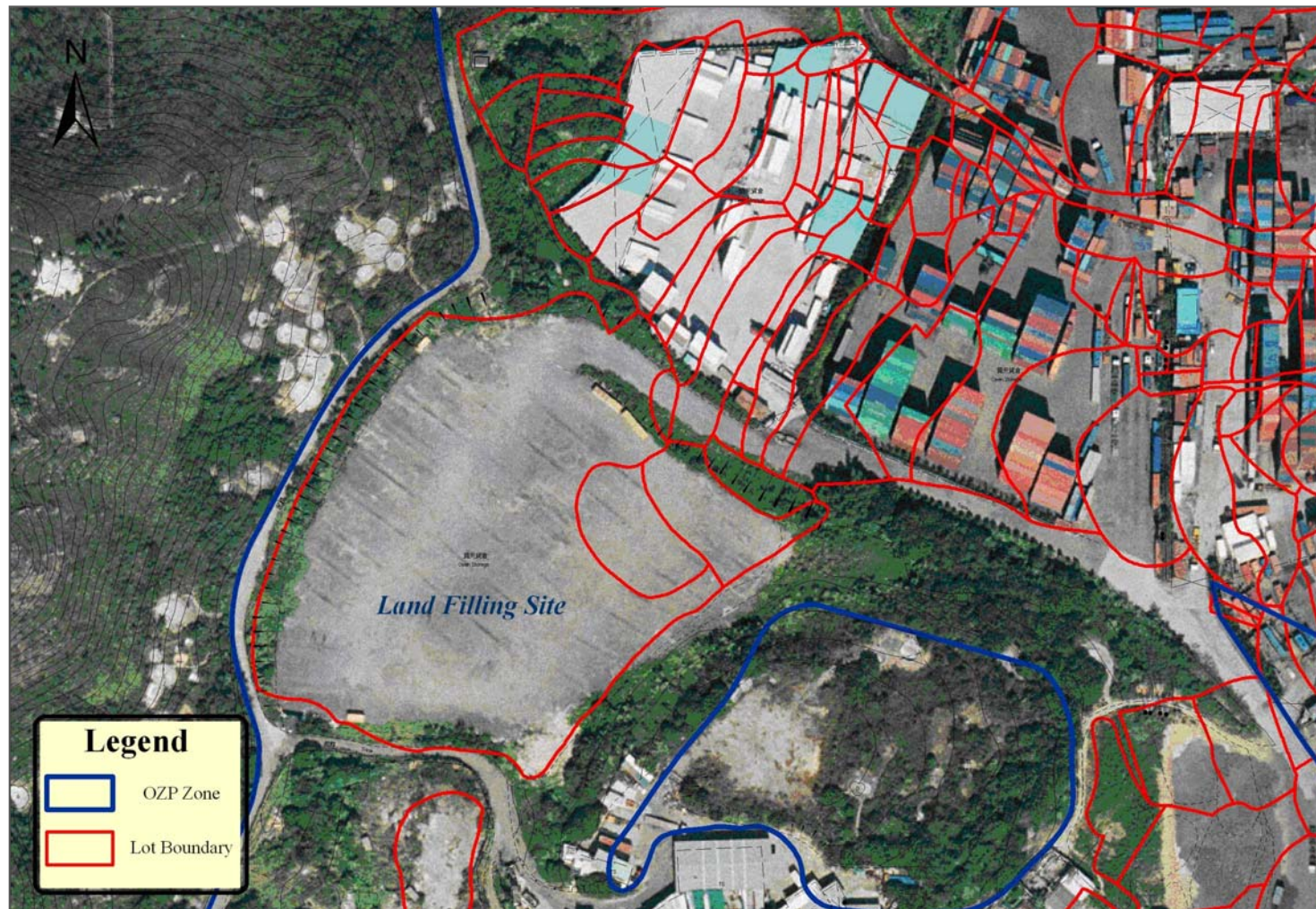
Application – Mobile GIS

- **Integration of**

  - **Data collection** of Geometry and Attribute

  - **Navigation** and **Stakeout**
    - Real time location information

- **Mobile GIS integrates 4 main components:**

  - **Positioning sensors** (such as GPS receiver),

  - (Rugged) **TabletPC / Pocket PC**

  - **DGPS Correction Data Service** and

  - **GIS software**

- The combination of these technologies makes the **enterprise database directly accessible to field crews** - whenever it is required.

Application – Mobile GIS
Map content

- **Extract** and **bring** your needed **enterprise Geo-database** into the field.

- **Digital maps** or **aerial images** as background (vector and raster)

- Benefits

  - **Substitutes** paper maps

  - Directly **editing** geo-database in the field

  - **Compare reality** with enterprise database

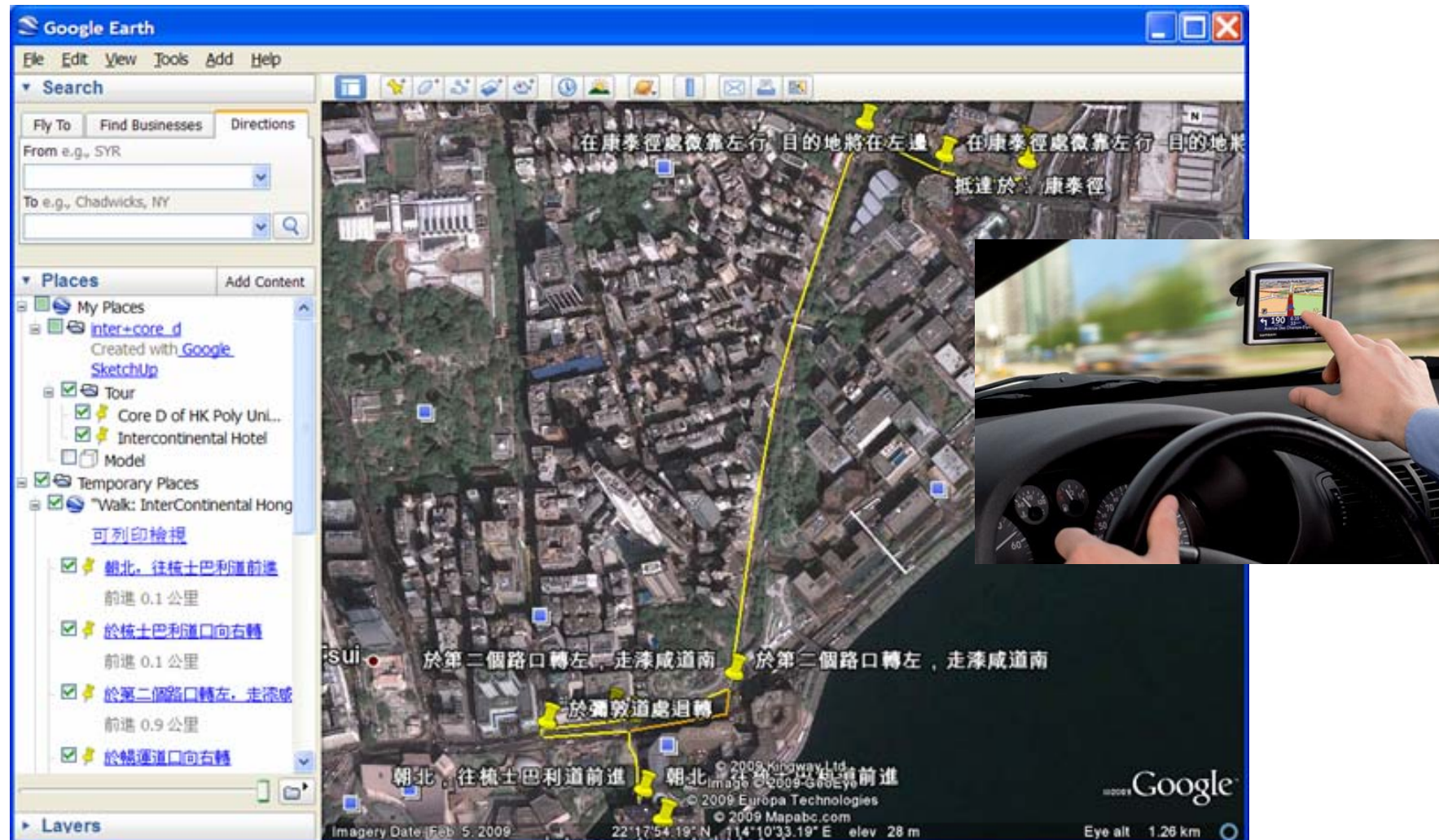 - **Geographic-enabled** stakeout, navigation and data collection

The Key is "Good Quality Position", need SatRef DGPS / RTK correction data

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Operation on the Geo-database in the field
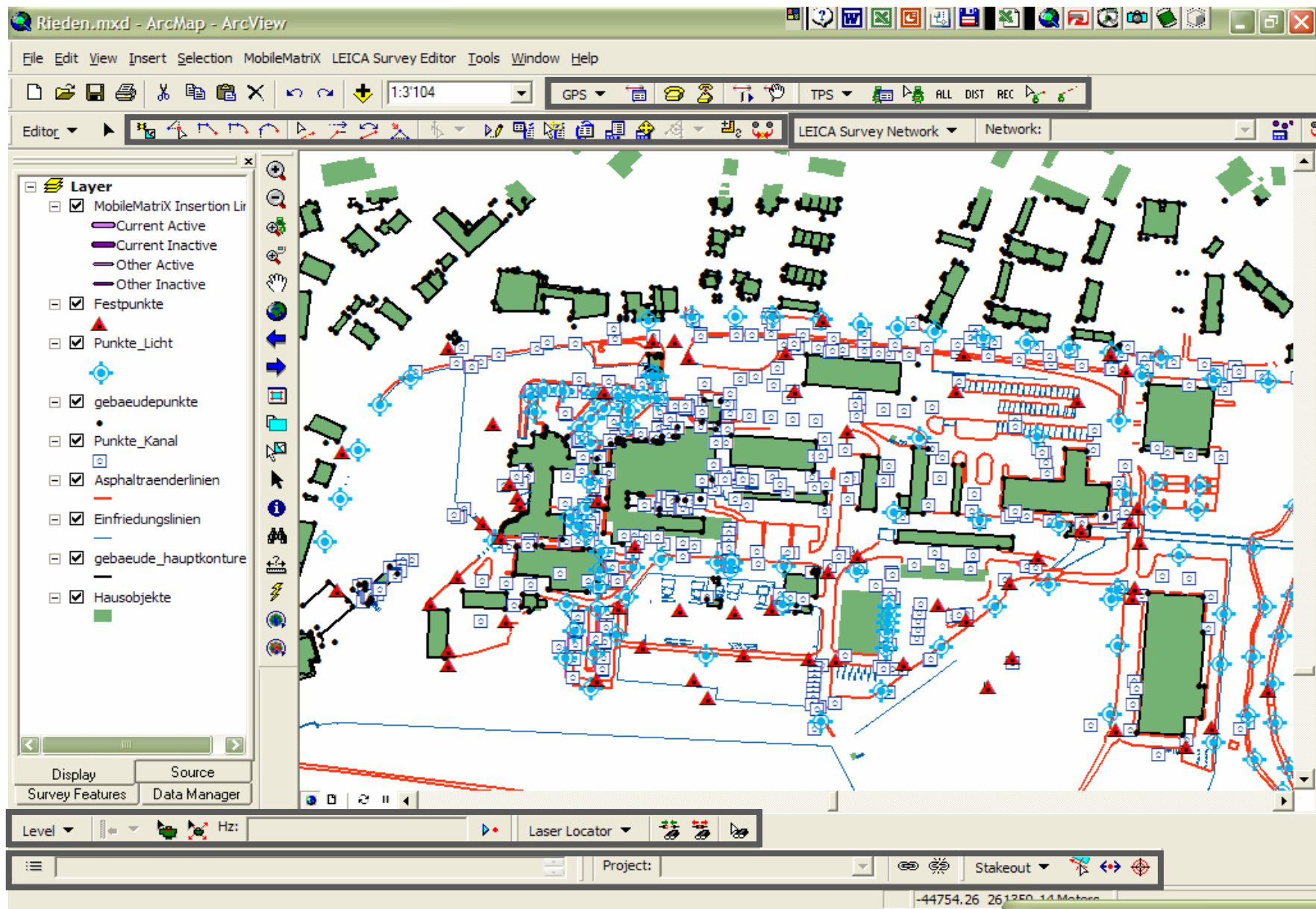
## Application – Emergency services – Shortest path & Navigation (mixing DGPS & GIS)

User Location Service
SpiderNET

Unique User Location Service

- **Relays user location** (NMEA) data provided by the DGPS rover to external 3rd party applications

- **Real time** or **file** based user position logging

- Allows **secure** independent trace of user activity

➔ Proivde rover data to 3rd parties

⬅ Receive rover data from the field
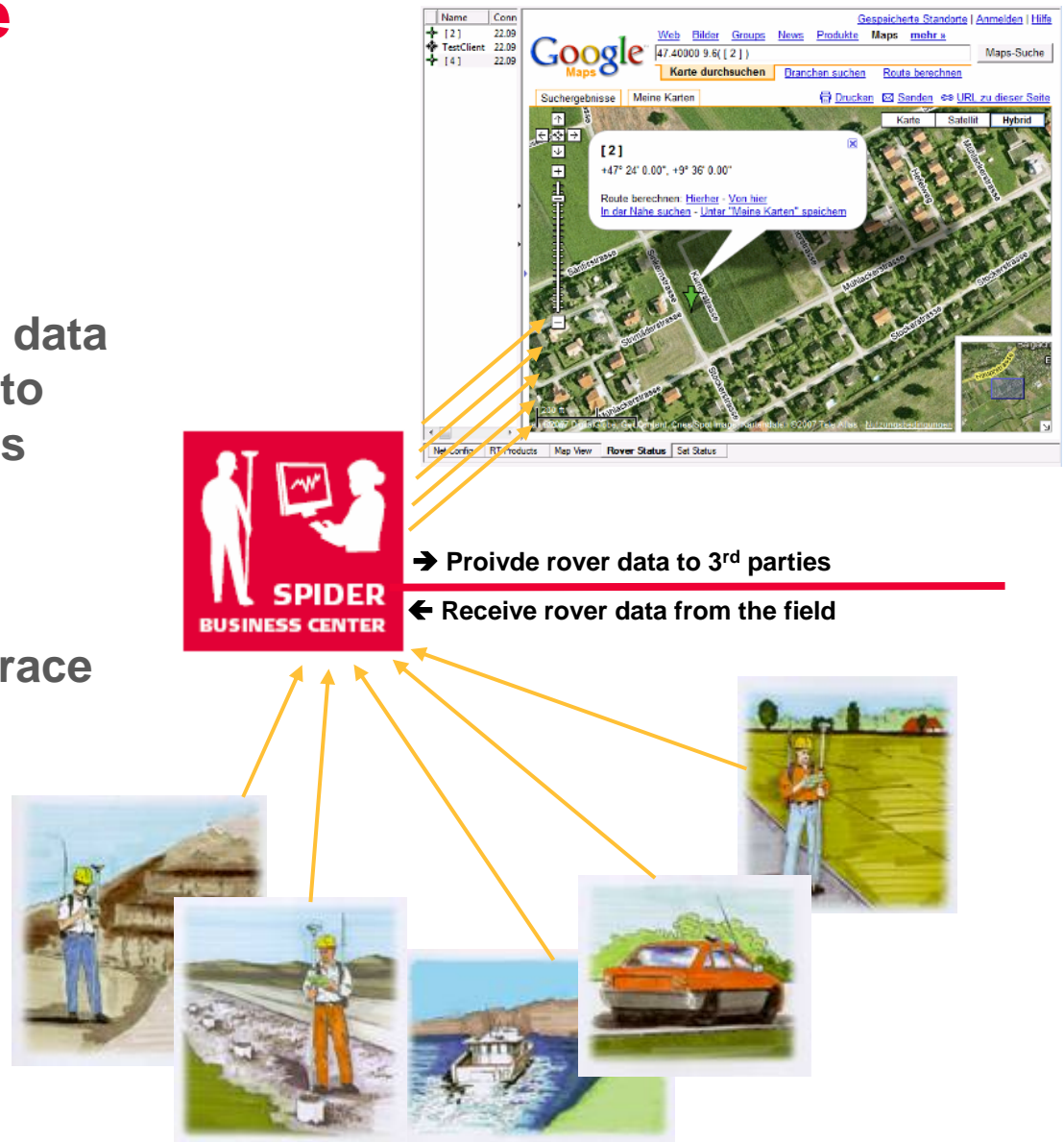
Application – Emergency services – Fleet Management
(enable by user location service function)
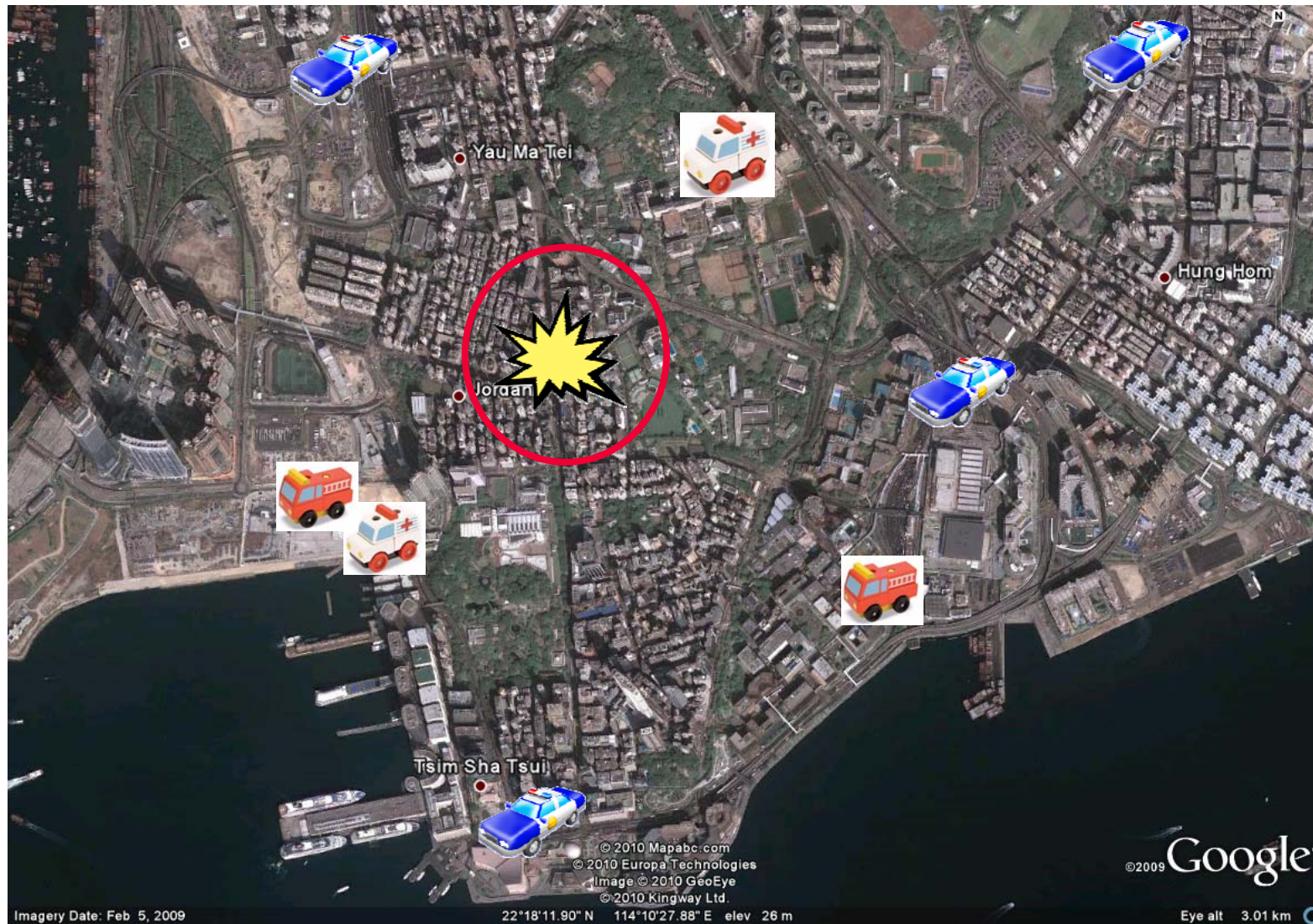
Thank You Very Much for Your Attention

Vincent Lui

Leica Geosystems Ltd

Tel: +852 2161 3882

Mobile: +852 9684 8571

Email: <u>vincent.lui@leica-geosystems.com.hk</u>