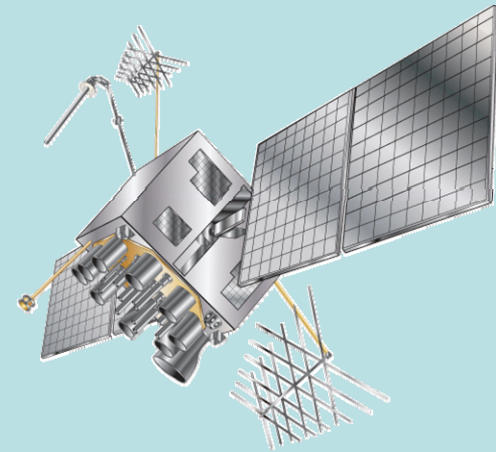
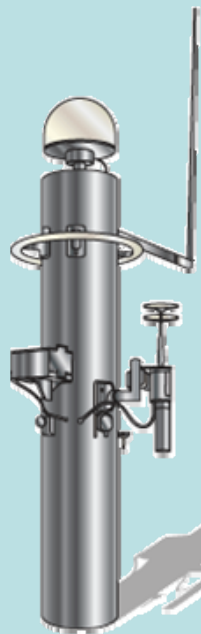


Reducing cost and improving efficiency of land and engineering survey with satellite positioning reference station data



4.2.2010

Simon Kwok
Lands Department



The Hong Kong Satellite Positioning Reference Station Data Services

Service Goal

- Improve positioning accuracy
- Reduce operation cost
- Enhance efficiency
- Increase productivity
- Improve management capability
- Deliver value added services to your customers
- Improve quality of life

The Hong Kong Satellite Positioning Reference Station Network

香港衛星定位參考站網



Users can use only one receiver and the data of the reference station to measure accurate position.



It helps the users to save time and cost.

12 Reference Stations

- 9 reference stations on hills

(Siu Lang Shui, Lam Tei, Kam Tin, Ngong Ping, Mui Wo, Sha Tin, Shap Sze Heung, Wong Shek, Obelisk Hill)

- 3 reference stations on the roof of buildings

(Fanling, Stonecutters, Peng Chau)

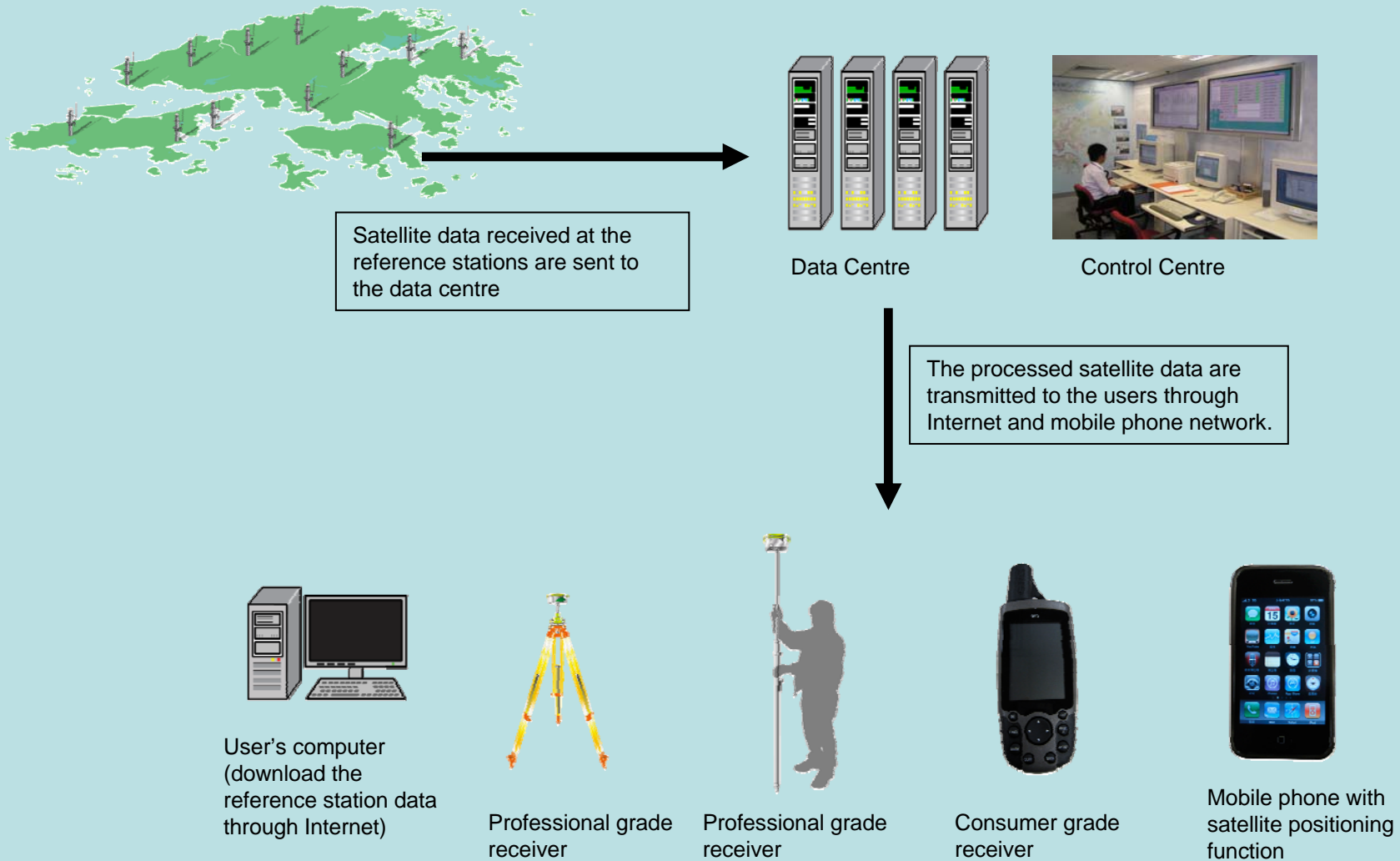


Ngong Ping station 昂坪站



Stonecutters Island station 昂船洲站

The Hong Kong Satellite Positioning Reference Station Data Services



The data services provided

1. RINEX Data Service

For highly accurate and reliable applications (Post-processing)

2. Network RTK Data Service

For centimetre-level accuracy application

3. DGPS Data Service

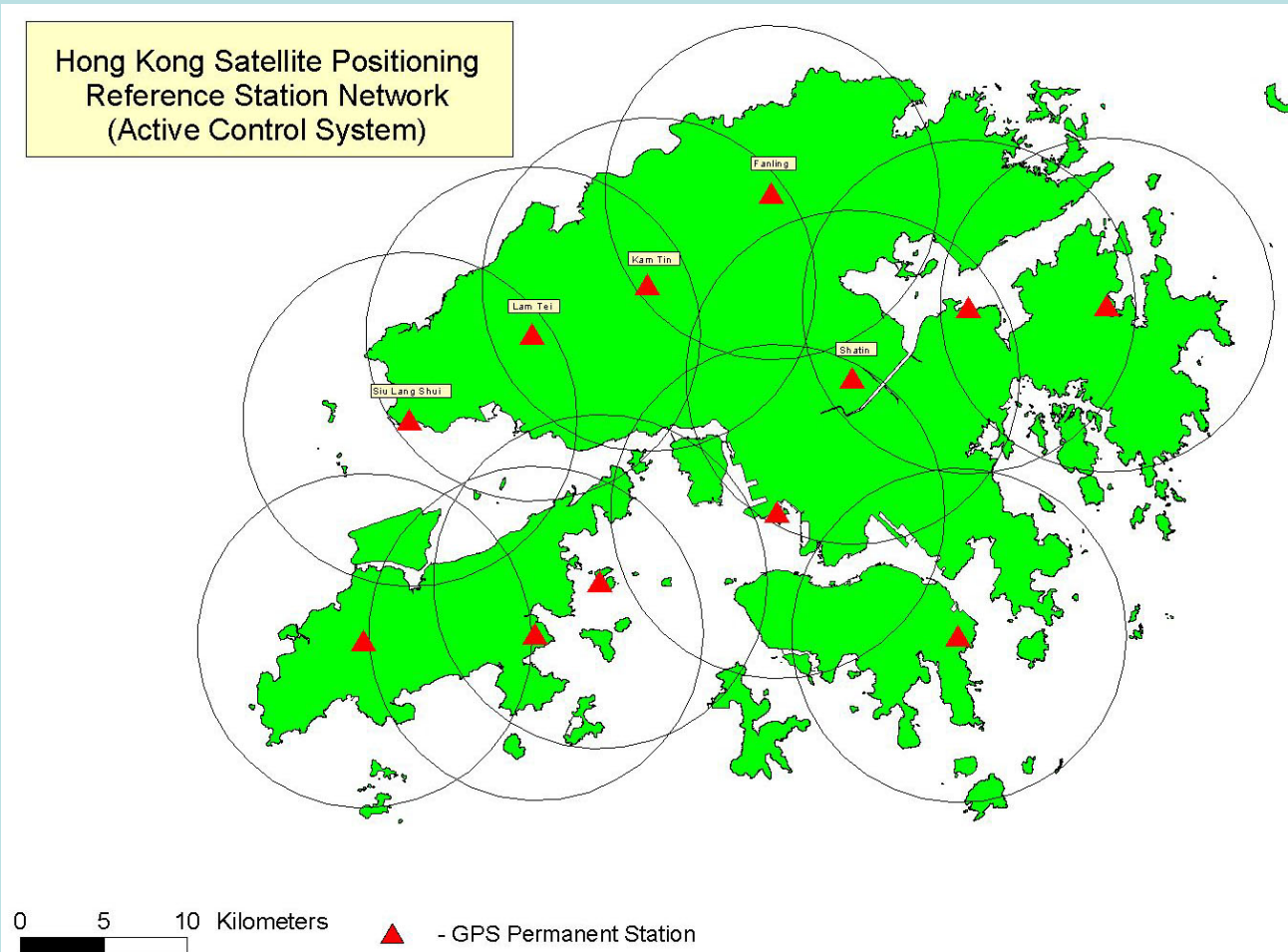
For metre-level accuracy application

Visit the following website to register as a users of the data service.

<http://www.geodetic.gov.hk/SatRef>

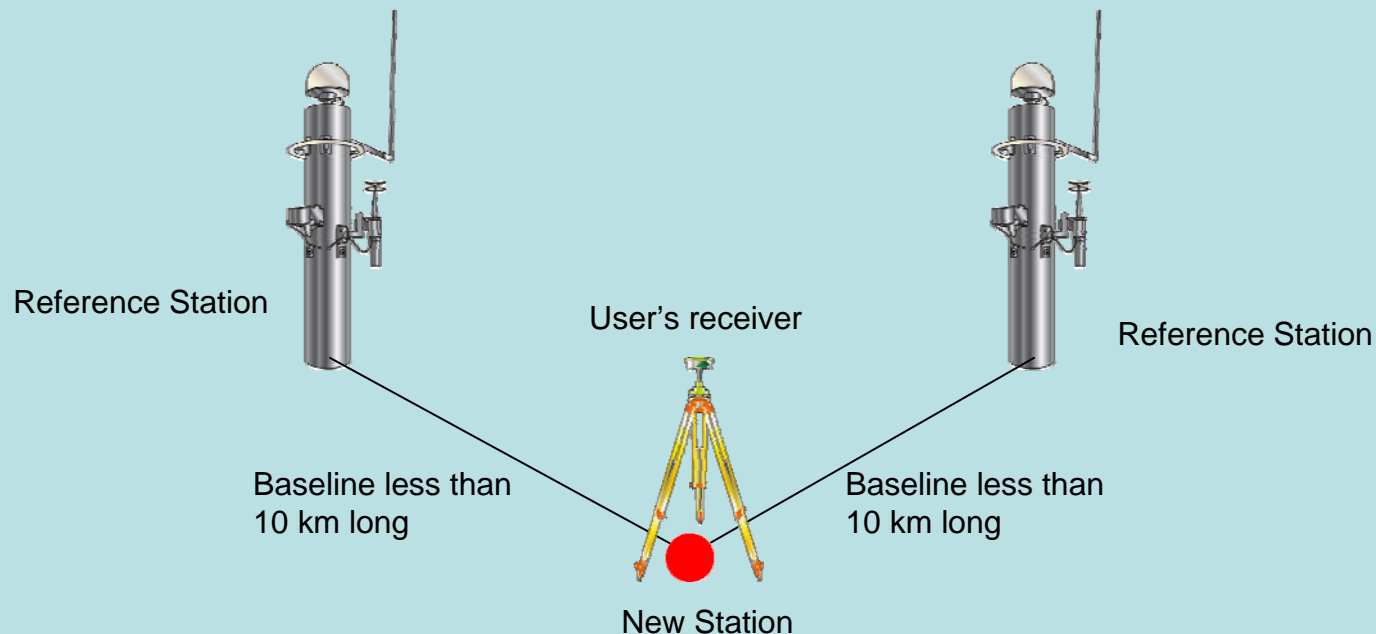
Design Principle

- Station Spacing : about 15 km
- Enable users to measure baselines from at **least 2** reference stations which are within **10 km** from the user.



Advantage

- Static Survey
(Post-processing of the satellite observations received at the reference stations and the new station)
 - short observation time (10 to 15 minutes)
(to achieve 2 - 3 cm accuracy)
 - Reduce labour cost and operation time



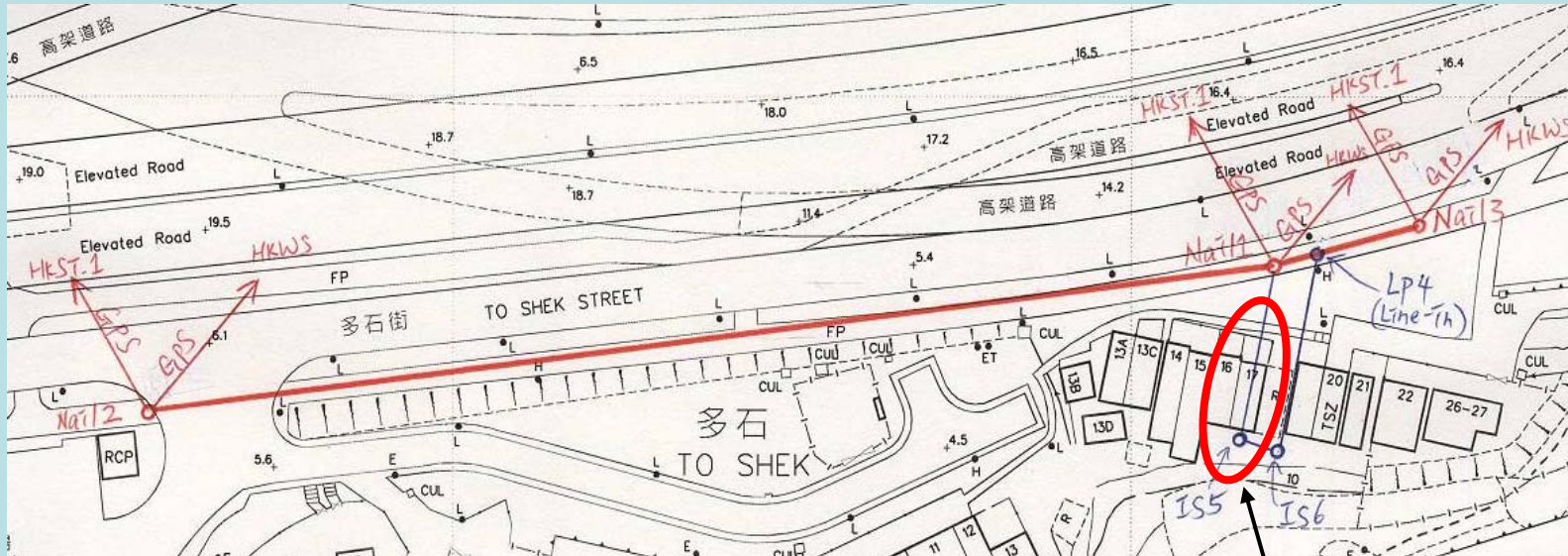
A Case Study :

Control survey for measuring a house site
using the reference stations



Site be surveyed

Control Diagram

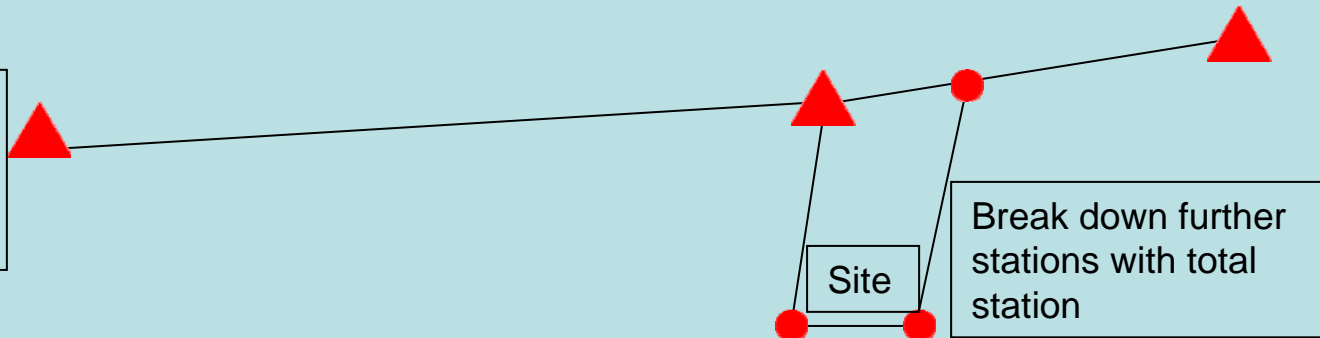


Select new control stations very close to the site.

Save the time and effort to run a long traverse from other control stations.

Site

First order stations fixed by using reference station data



Accuracy Standard

- Use Static GPS Survey to establish **3 *GPS control stations***.
 - Accuracy standard: $\pm \sqrt{10^2 + (3L)^2}$ mm or **30mm**, whichever the less, where L = length of baseline in km
- Break down **3 *traverse stations***
 - Linear misclosure = $(10 + 2S / 15)$ mm, where S = total length of traverse in metre
 - Angular misclosure = $30 \sqrt{n}$ seconds, where n = number of survey station in the traverse

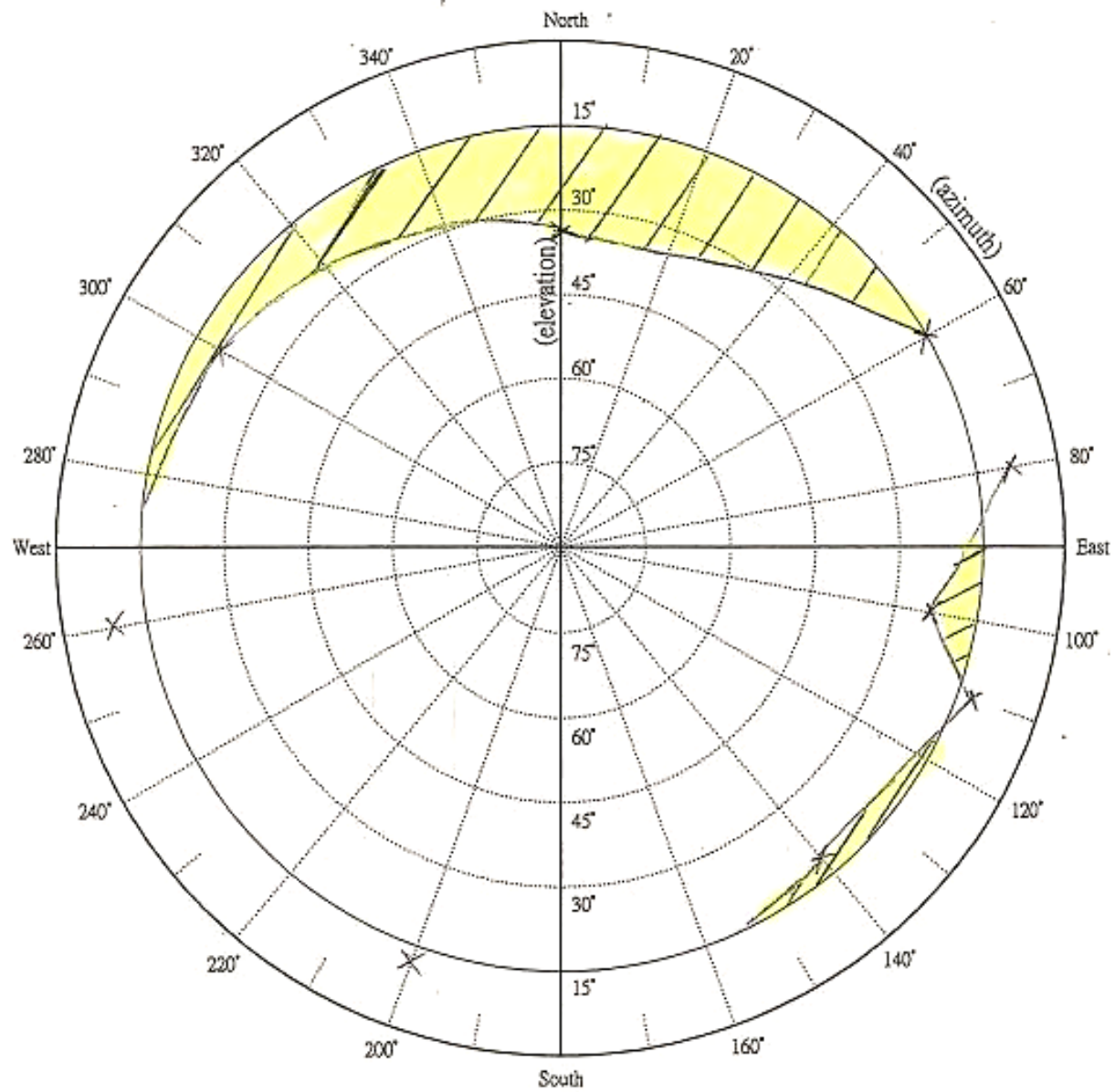
Environment of GPS Control Station

Nail 1



Nail 1

Obstruction Diagram of Nail 1



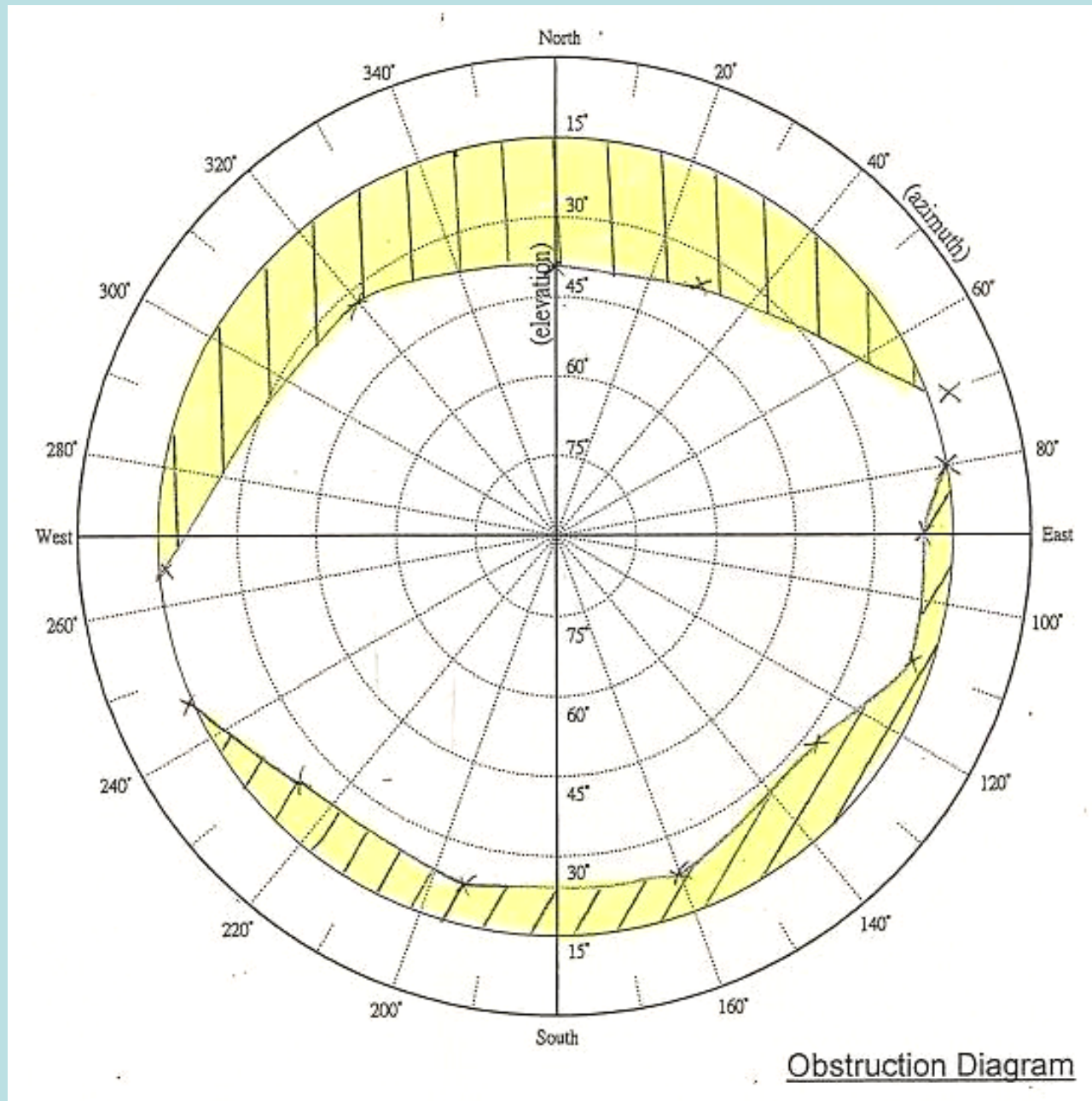
Obstruction Diagram

Environment of GPS Control Station

Nail 2



Obstruction Diagram of Nail 2



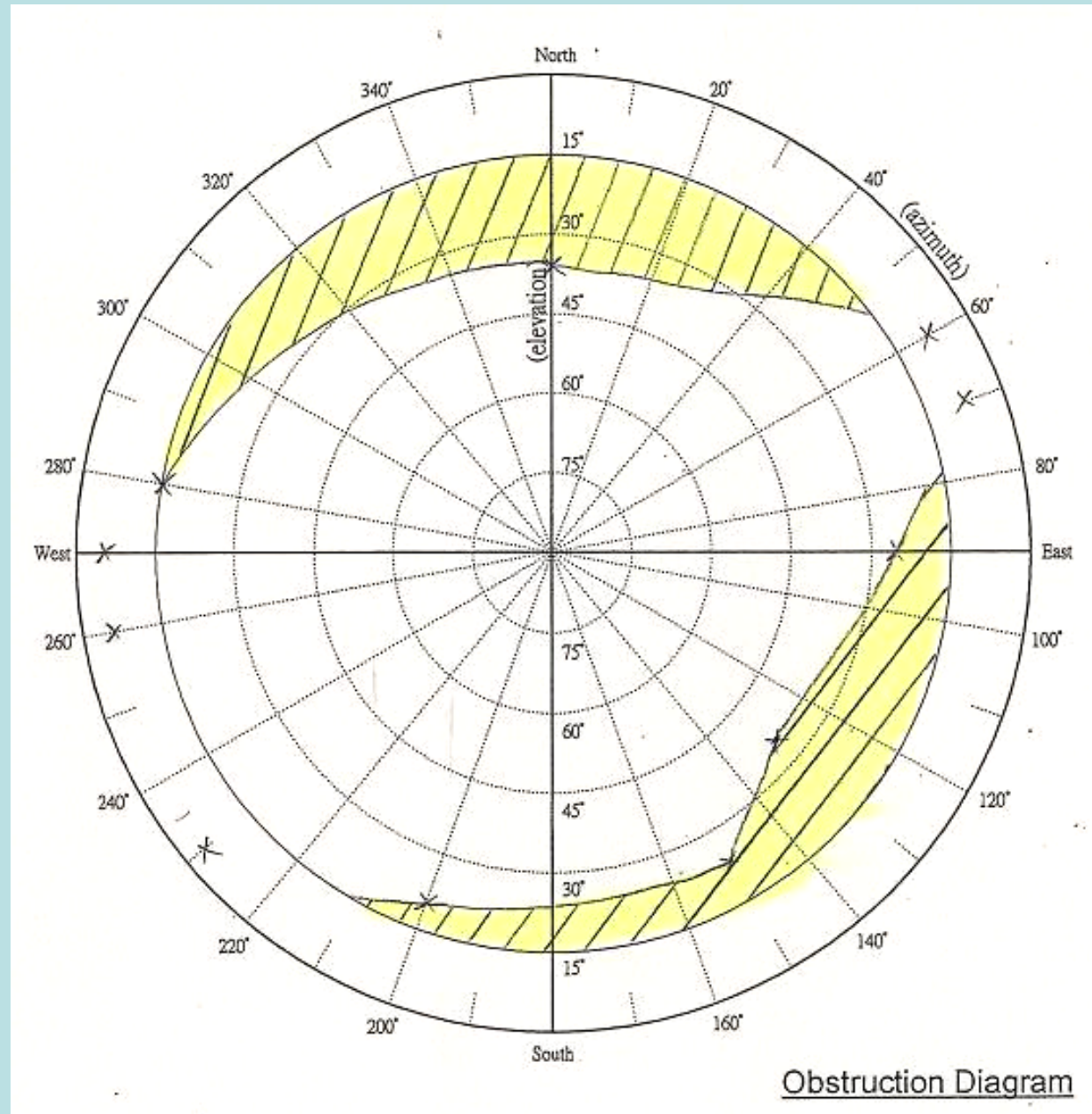
Environment of GPS Control Station

Nail 3



Nail 3

Obstruction Diagram of Nail 3



Equipment Used

Compared to traditional approach, only need 1 additional receiver to perform GPS survey.

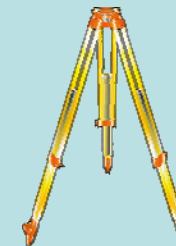
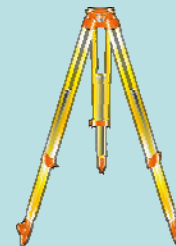
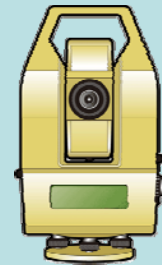
1. Static GPS measurement

- One GPS receiver



2. Traversing

- One total station
- Two prisms
- Three tripods



GPS Measurement Sequence

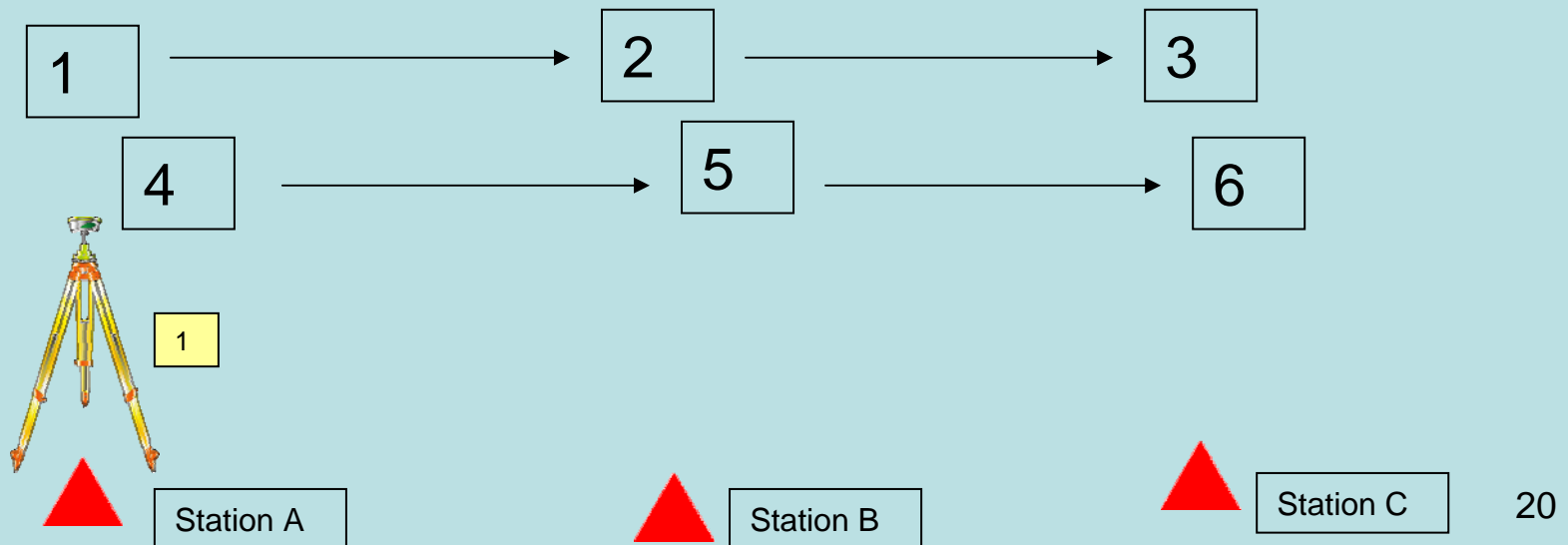
First Observation Session

- Step 1: Occupy **Station A** (15 minutes)
- Step 2: Occupy **Station B** (15 minutes)
- Step 3: Occupy **Station C** (15 minutes)

Second Observation Session

- Step 4: Occupy **Station A** (15 minutes)
- Step 5: Occupy **Station B** (15 minutes)
- Step 6: Occupy **Station C** (15 minutes)

Total time taken for GPS measurement : **1.5 hours**



GPS Measurement Sequence

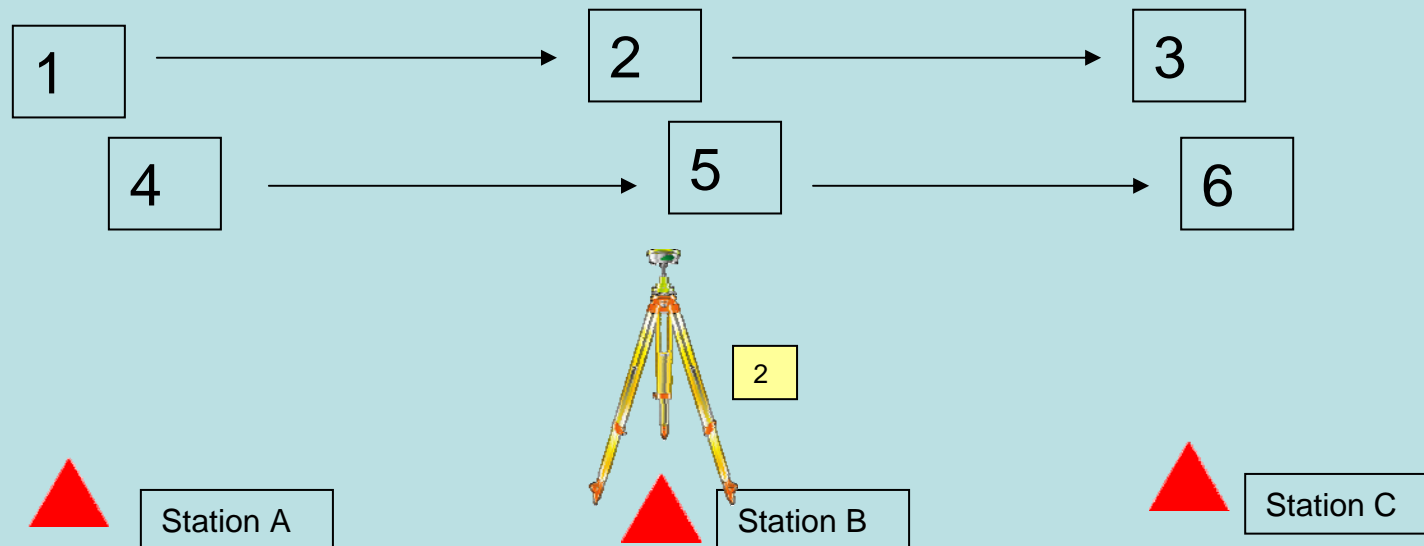
First Observation Session

- Step 1: Occupy **Station A** (15 minutes)
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- Step 3: Occupy **Station C** (15 minutes)

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GPS Measurement Sequence

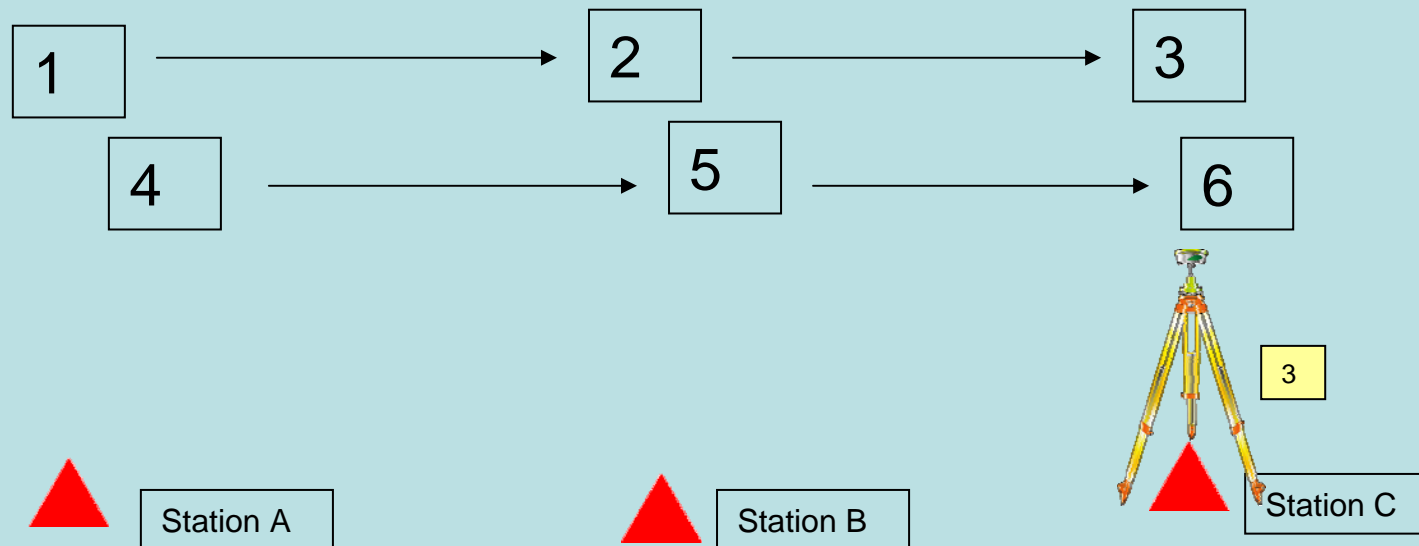
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- Step 3: Occupy **Station C** (15 minutes)

Second Observation Session

- Step 4: Occupy **Station A** (15 minutes)
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- Step 6: Occupy **Station C** (15 minutes)

Total time taken for GPS measurement : **1.5 hours**



GPS Measurement Sequence

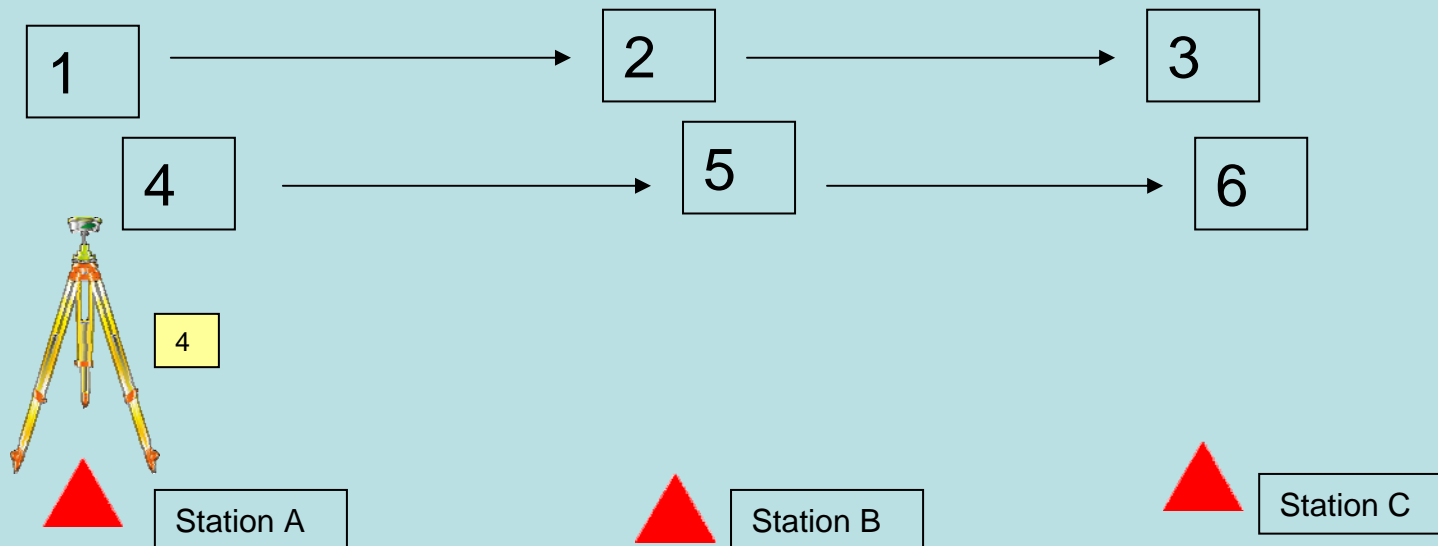
First Observation Session

- Step 1: Occupy **Station A** (15 minutes)
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Second Observation Session

- Step 4: Occupy **Station A** (15 minutes)
- Step 5: Occupy **Station B** (15 minutes)
- Step 6: Occupy **Station C** (15 minutes)

Total time taken for GPS measurement : **1.5 hours**



GPS Measurement Sequence

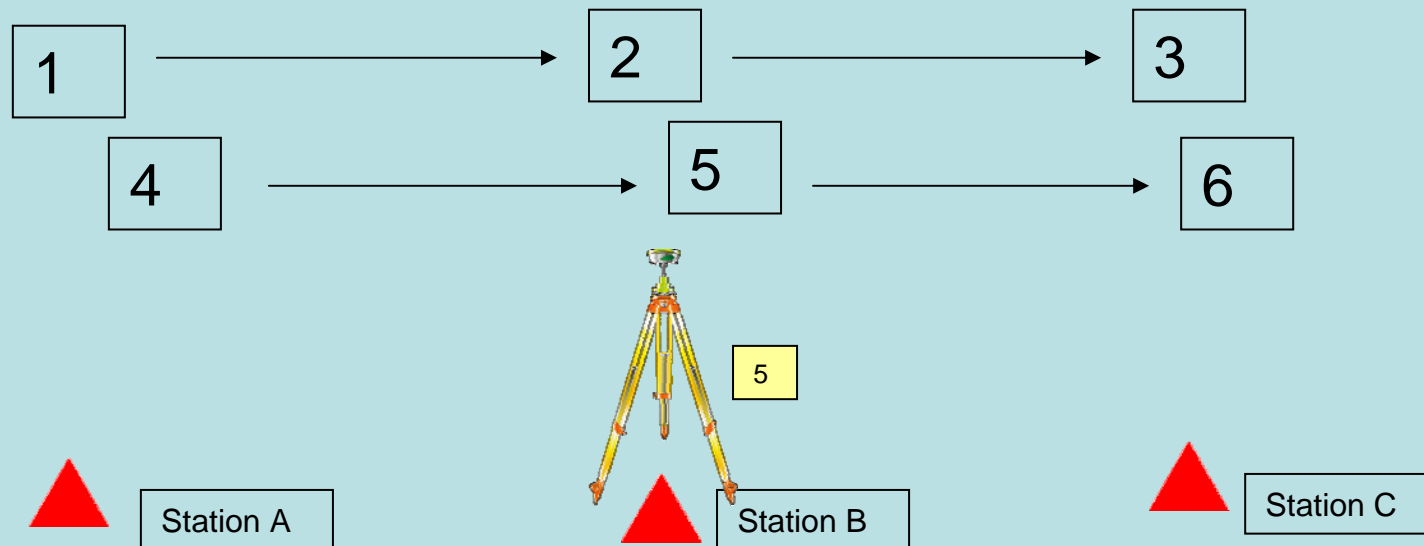
First Observation Session

- Step 1: Occupy **Station A** (15 minutes)
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- Step 3: Occupy **Station C** (15 minutes)

Second Observation Session

- Step 4: Occupy **Station A** (15 minutes)
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- Step 6: Occupy **Station C** (15 minutes)

Total time taken for GPS measurement : **1.5 hours**



GPS Measurement Sequence

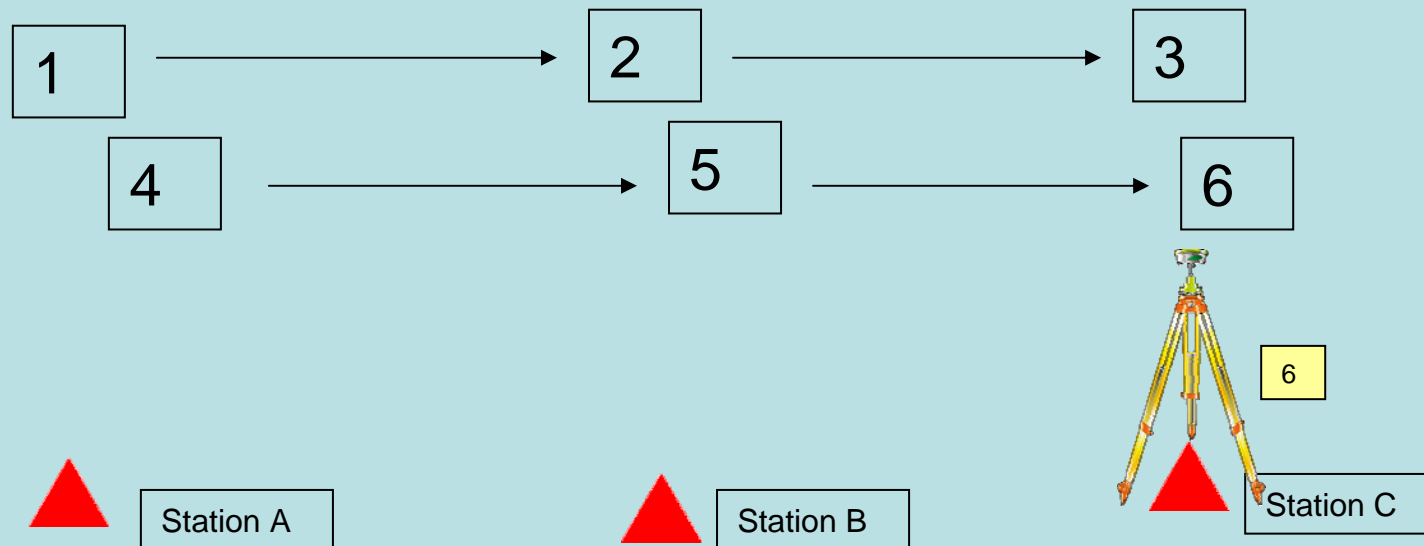
First Observation Session

- Step 1: Occupy **Station A** (15 minutes)
- Step 2: Occupy **Station B** (15 minutes)
- Step 3: Occupy **Station C** (15 minutes)

Second Observation Session

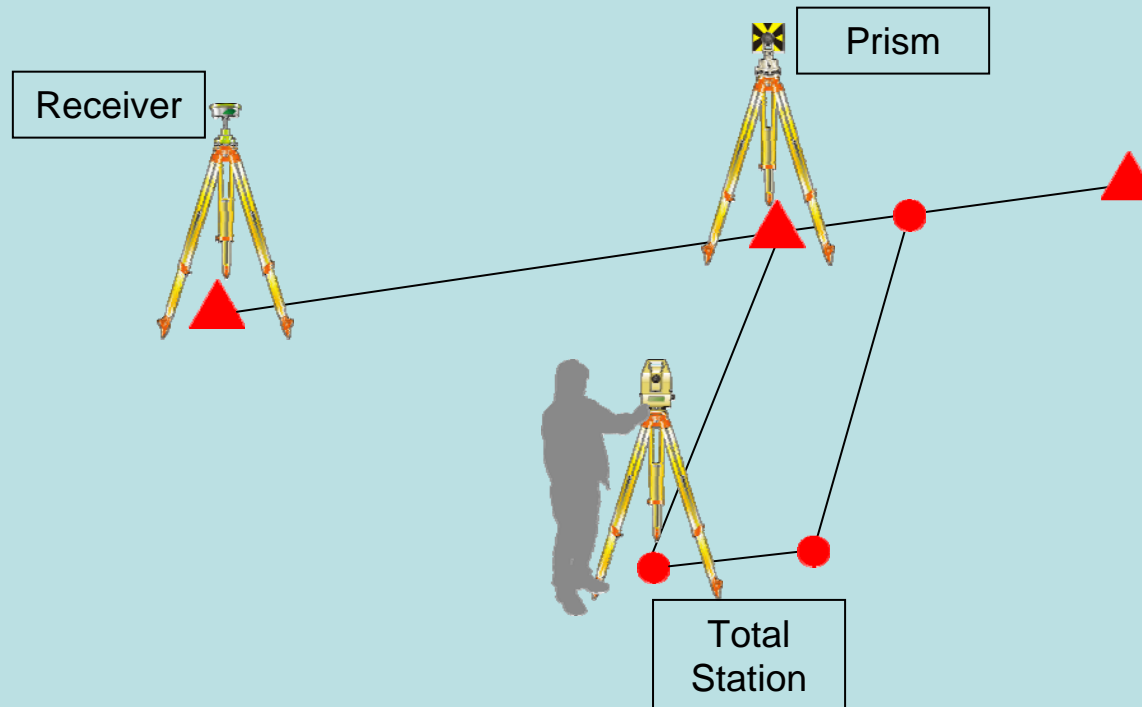
- Step 4: Occupy **Station A** (15 minutes)
- Step 5: Occupy **Station B** (15 minutes)
- Step 6: Occupy **Station C** (15 minutes)

Total time taken for GPS measurement : **1.5 hours**



During the time of GPS measurement, the surveyor can carry out traversing and details survey at the same time.

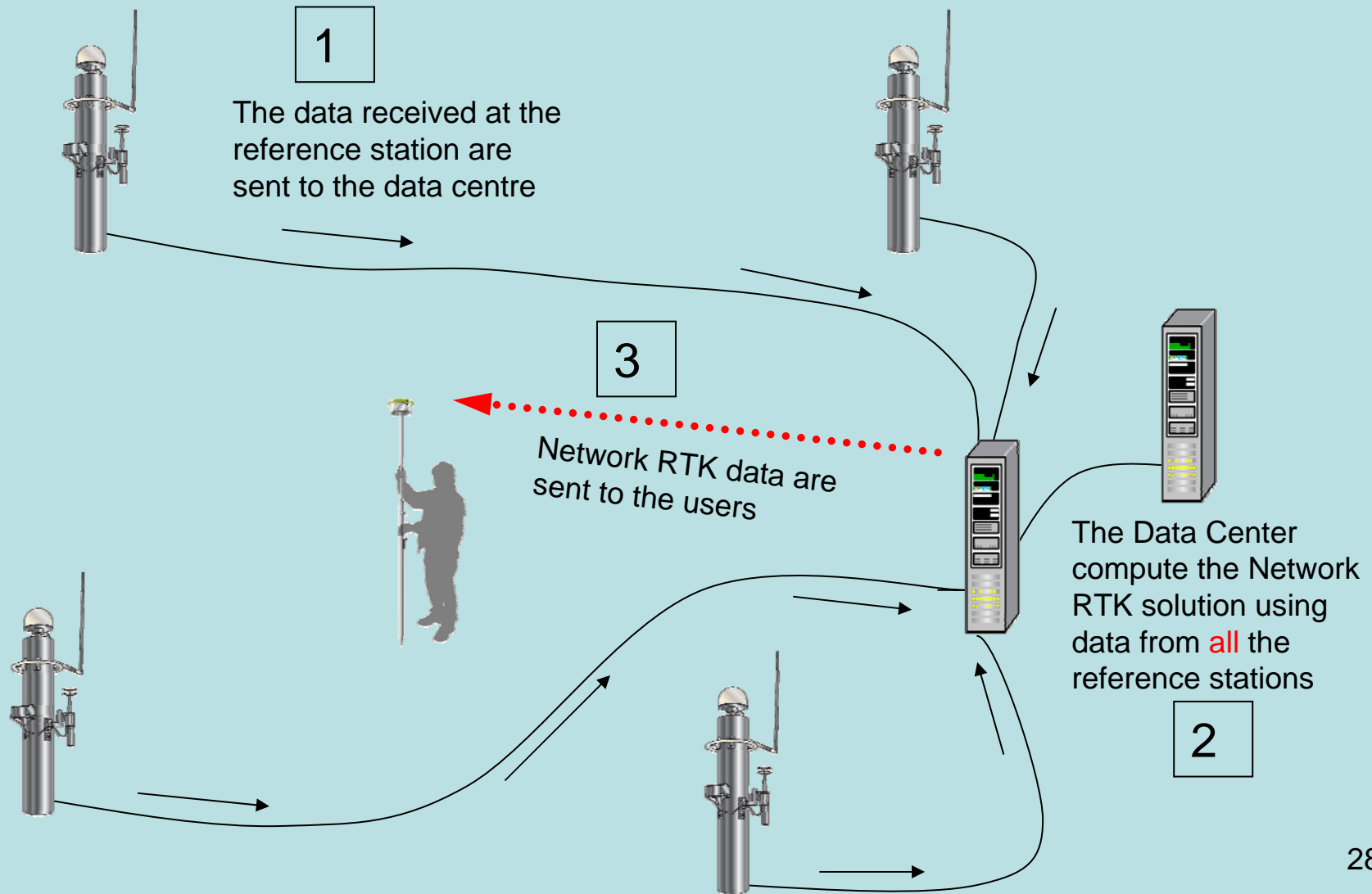
- For this case - There is no additional time needed for establishing the 3 GPS control stations
- It saves time and cost.



Network RTK Data Service

Network RTK Data Service

The Hong Kong Reference Station Network provides network RTK data service.



Advantage of using Network RTK

The Network RTK accuracy is 5 - 10 cm.

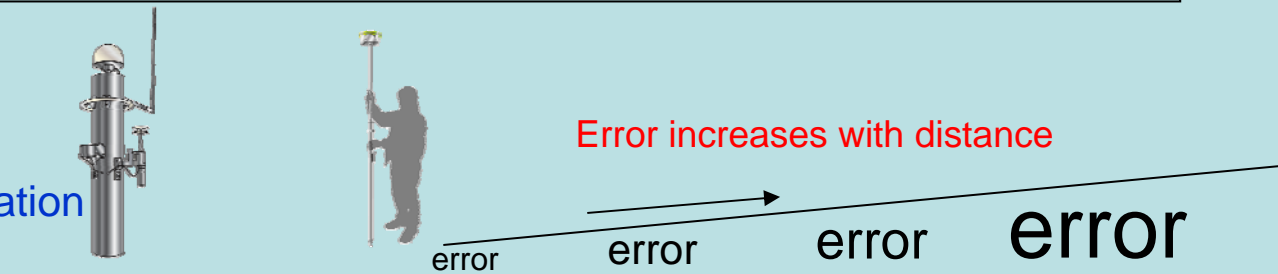
The accuracy of the position fixed by network RTK is the **same** within the coverage of the reference station network.

Disadvantage of using single-base-station RTK

The **error increases** in proportion to the rover-to-base station distance.

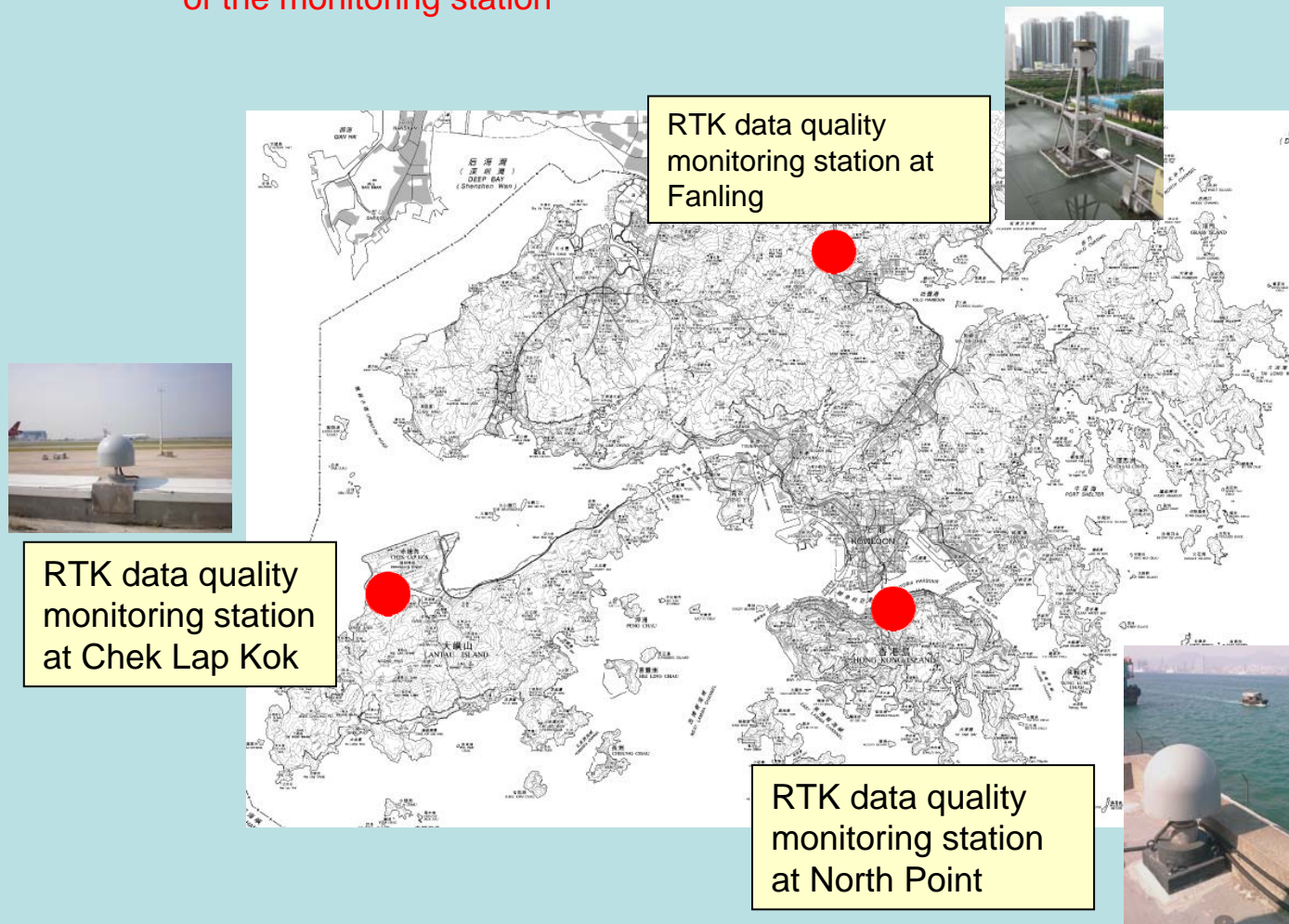
In the Hong Kong environment, quite often there is **no fixed solution** for baseline over 10 km when the ionospheric effect is high.

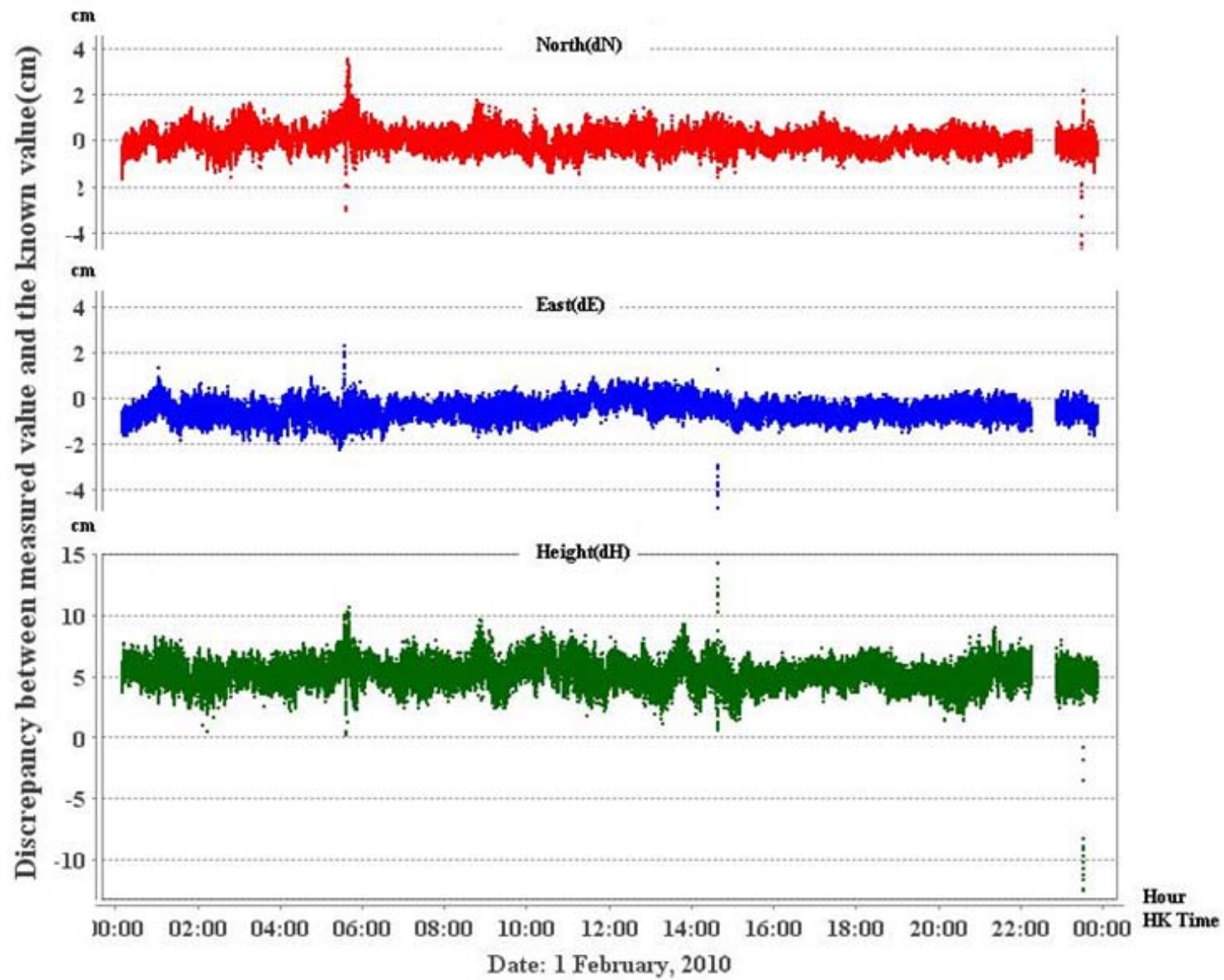
single-base-station
RTK



The quality of the Network RTK data generated from the Hong Kong Satellite Positioning Reference Station Network are checked at 3 monitoring stations continuously.

- Every epoch (1 second) of RTK measurement is checked against the known position of the monitoring station





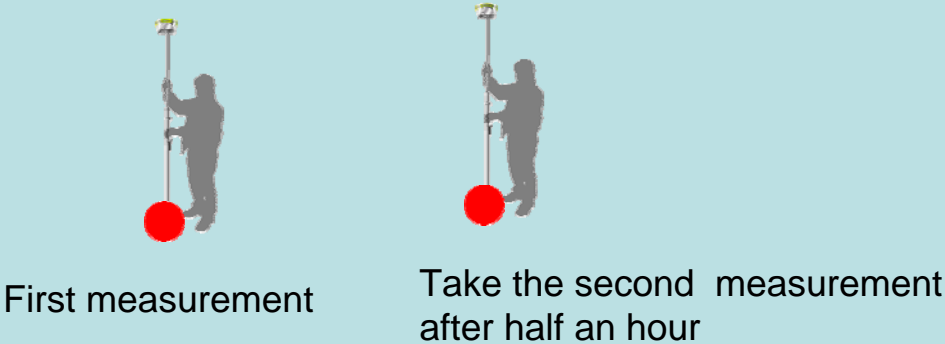
The quality of the Network RTK data generated by the Hong Kong Satellite Positioning Reference Station

Network RTK is very convenient.
But it is important to apply check to your measurements.

Check against a point with known position.



Repeat measurements.



Check by independent measurement between two points.

