



2018

Application of Beidou System(BDS)
in High-Speed Rail (HSR) Industry

Reporter : Wang Jin

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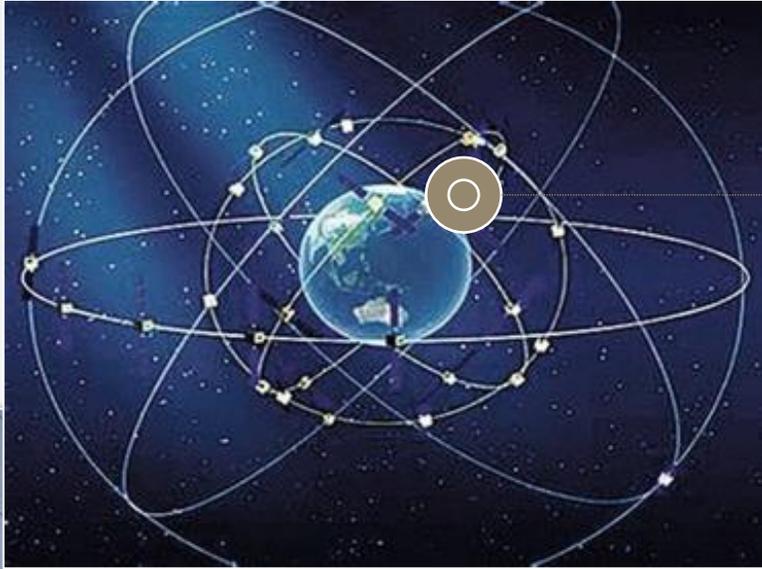
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The basic information of BDS and HSR in China and why it is necessary to apply BDS in HSR measurement.





Beidou System

- By 2018, BDS will cover "One Belt And One Road" countries, and complete 35 satellite launch networks around 2020 to provide services for global users.
- In recent years, with the construction and implementation of Beidou foundation enhancement system, BDS already possesses the ability to provide high-precision services in the whole country.



HSR in China

- longest, fastest and biggest in the world
- serves in open-air, high operating speed, short skylight time
- intensive periodical fatigue load
- In China, it also has the characteristics of fast construction, diversified infrastructures and long operation time.



High-Precision Positioning is Important in HSR.

With the continuous development of Internet, information and big data technology, high-precision location information is particularly important in all aspects of railway survey, design, construction, operation and maintenance.



Roadbed

Slope



Bridge

01

After investigation, the following three aspects are very urgent.

- 01 **Monitoring Deformation of HSR Infrastructure**
- 02 **Irregularity Detection of HSR Tracks**
- 03 **Control Network Construction of HSR Measurement**





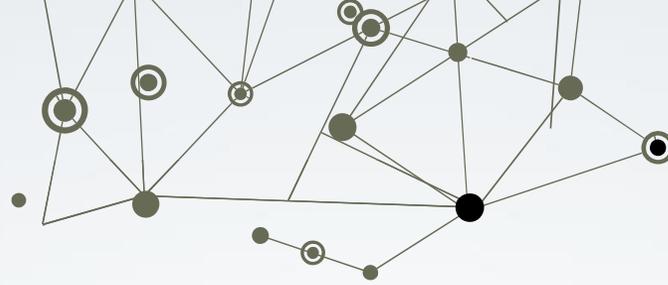
Monitoring Deformation of HSR Infrastructure

Why to do it? How to do it ?
What results have we gained?



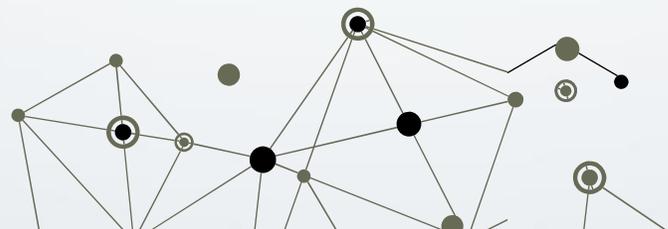
02

Why to do it ?



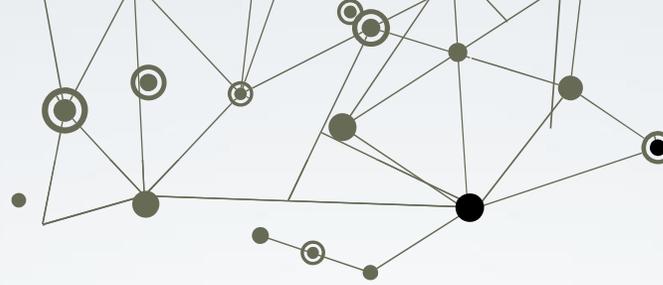
HRS serves in open-air. It has salient features of high operating speed, short skylight time , intensive periodical fatigue load and so on.

In order to ensure safety and reliability of HRS, it is necessary to use BDS to monitor the deformation status of its infrastructure with high precision, high automaticity and high stability.



02

Why to do it ?



Existing Monitoring Modes

- Total Station Corner Intersection
- Leveling

Drawbacks:

- Observation Cycle is Long.
- Accuracy is Greatly Impacted by Operators.

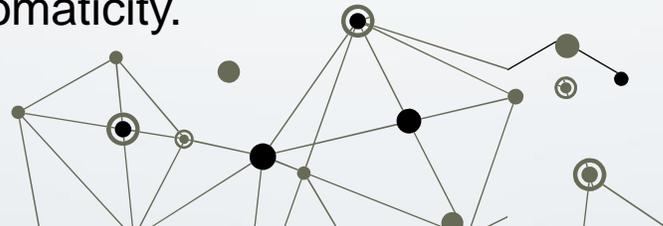
Therefore, the traditional methods become more and more difficult to meet the needs of HSR infrastructure measurement in the aspects of continuity, real-time and automaticity.



Total Station Corner Intersection

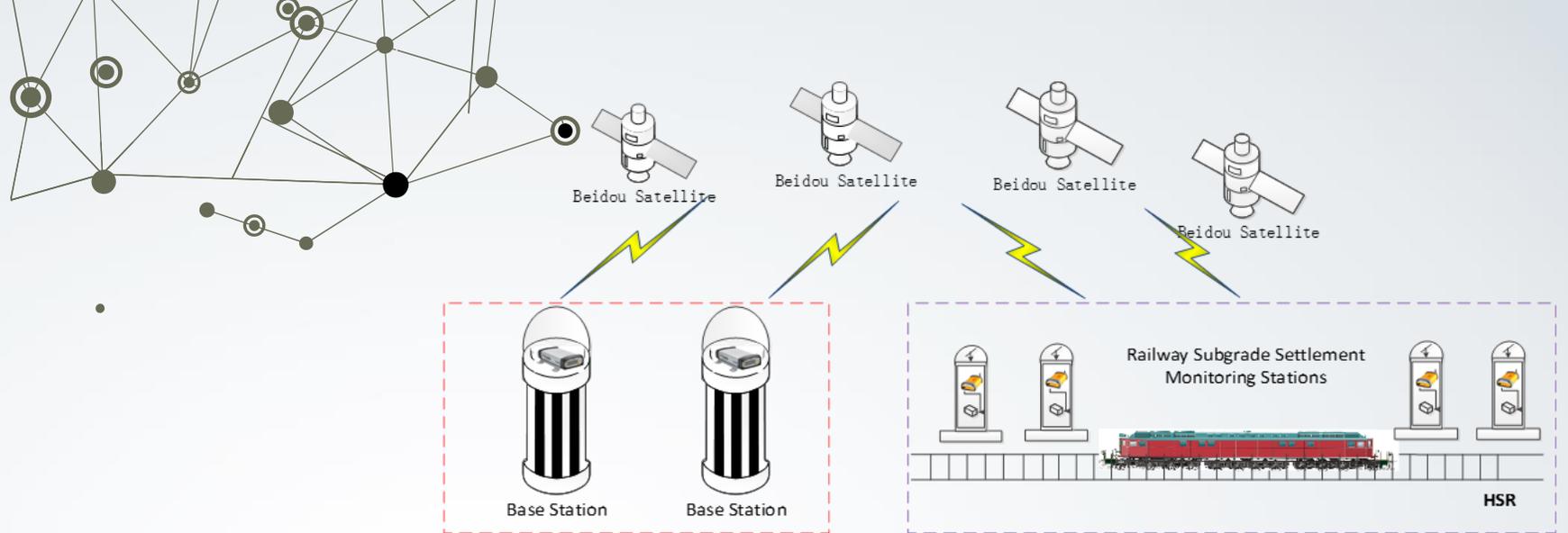


Leveling



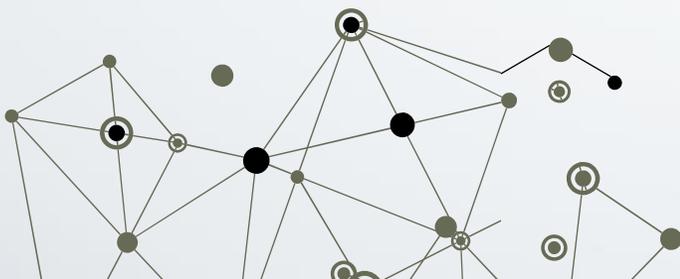
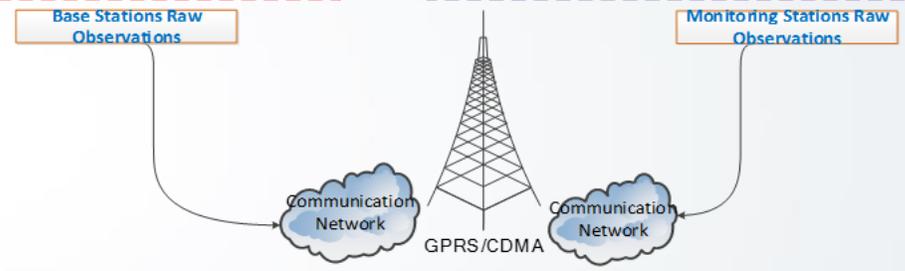
02

How to do it ?



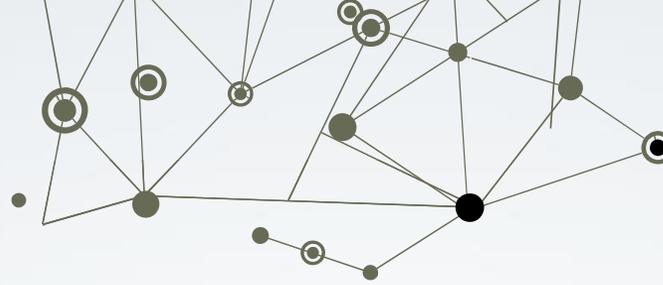
☆☆ System Composition

- Data Acquisition Subsystem
- Data Processing Center
- Analysis & Distribution Center



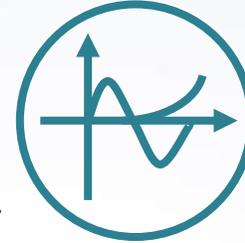
02

System Features



High Stability

Operate all weather and not subject to climatic conditions and disaster conditions.



Two Monitoring Methods

Acquire two high-precision monitoring ways, real-time processing and post-processing.



Running Unattended

System unattended, automatic operation and the operating reliability of more than 99%.



High Real-time

Real-time display monitoring point of the current state and deformation curves.



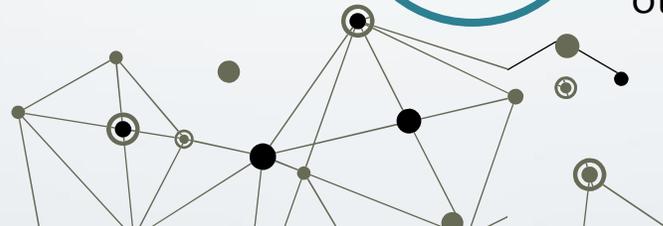
Automatic Alarm

Real-time display monitoring stations' current state and deformation curves.

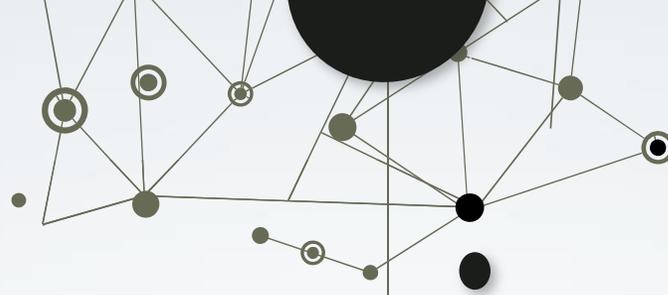


Personalized Management

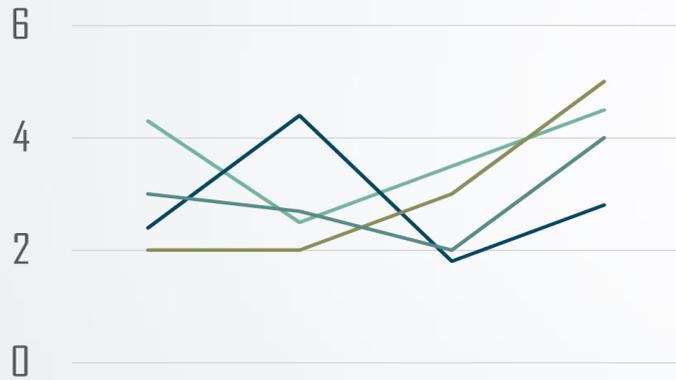
Support user rights management, site information management, automatic report generation and other functions.



02 / Accuracy



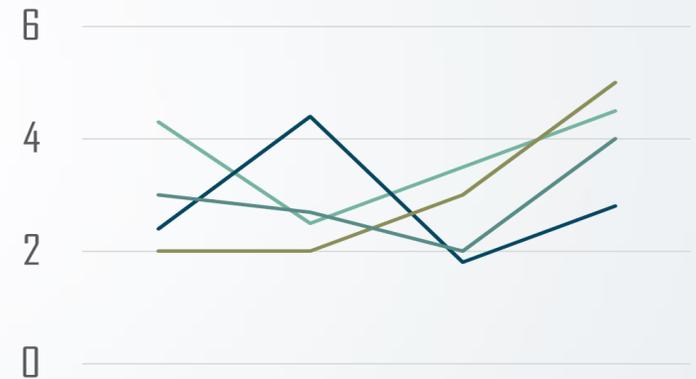
Real-time processing (Instantaneous deformation monitoring)



Horizontal direction : 2cm+1ppm

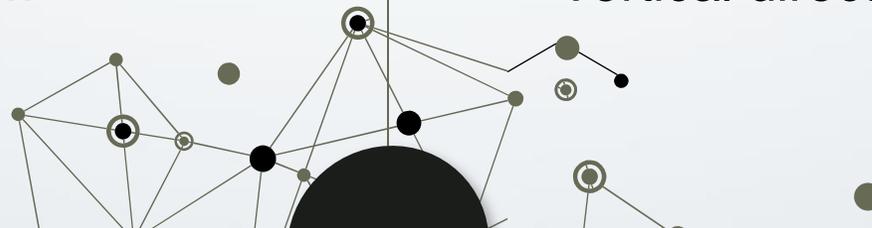
Vertical direction : 3cm+1ppm

Post-processing (Gradual deformation monitoring)



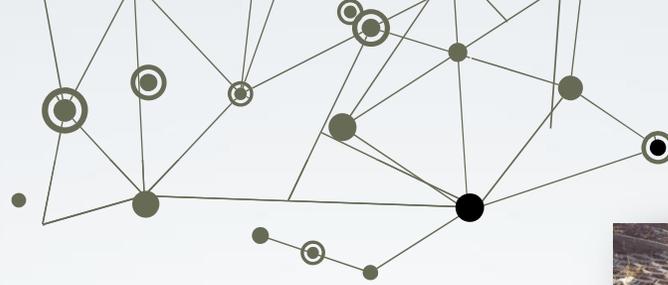
Horizontal direction : 2mm+1ppm

Vertical direction : 3mm+1ppm



02

Practical Applications



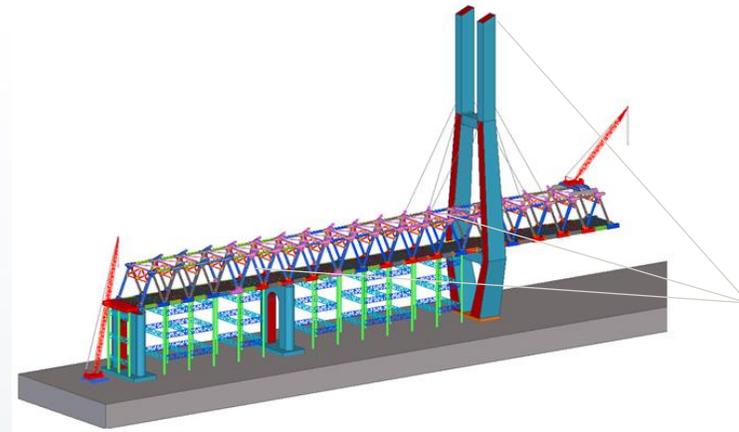
- ◆ Subgrade Settlement Monitoring from Lianyungang to Yancheng



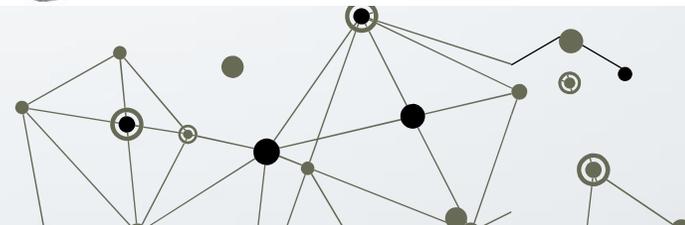
- ◆ Railway Bridge Deformation Monitoring from Xuzhou to Yancheng



- ◆ Slope Monitoring of Passenger Dedicated Line from Beijing to Shenyang



GNSS Deformation Monitoring Points





Irregularity Detection of HSR Tracks

Why to do it? How to do it ?
What results have we gained?



03

Why to do it ?



As China's HRS operating speed up to 350km / h, the track foundations need to be very smooth to maintain such high-speed operation. However, in practice, the tracks exist orbital deformation such as deviation from the design value, linear orbit irregularities, curved orbital irregularities.

Rail deformation will seriously threaten the operating safety of high-speed trains. Therefore, the detection of rail deformation is of great significance. It's the basic guarantee for the safe operation of trains.

03

Why to do it ?



High-Speed
Integrated Test Train

✘ Accuracy

Efficiency



Static Rail
Inspection Car

Accuracy

✘ Efficiency



Judging by Eyes
and Rulers

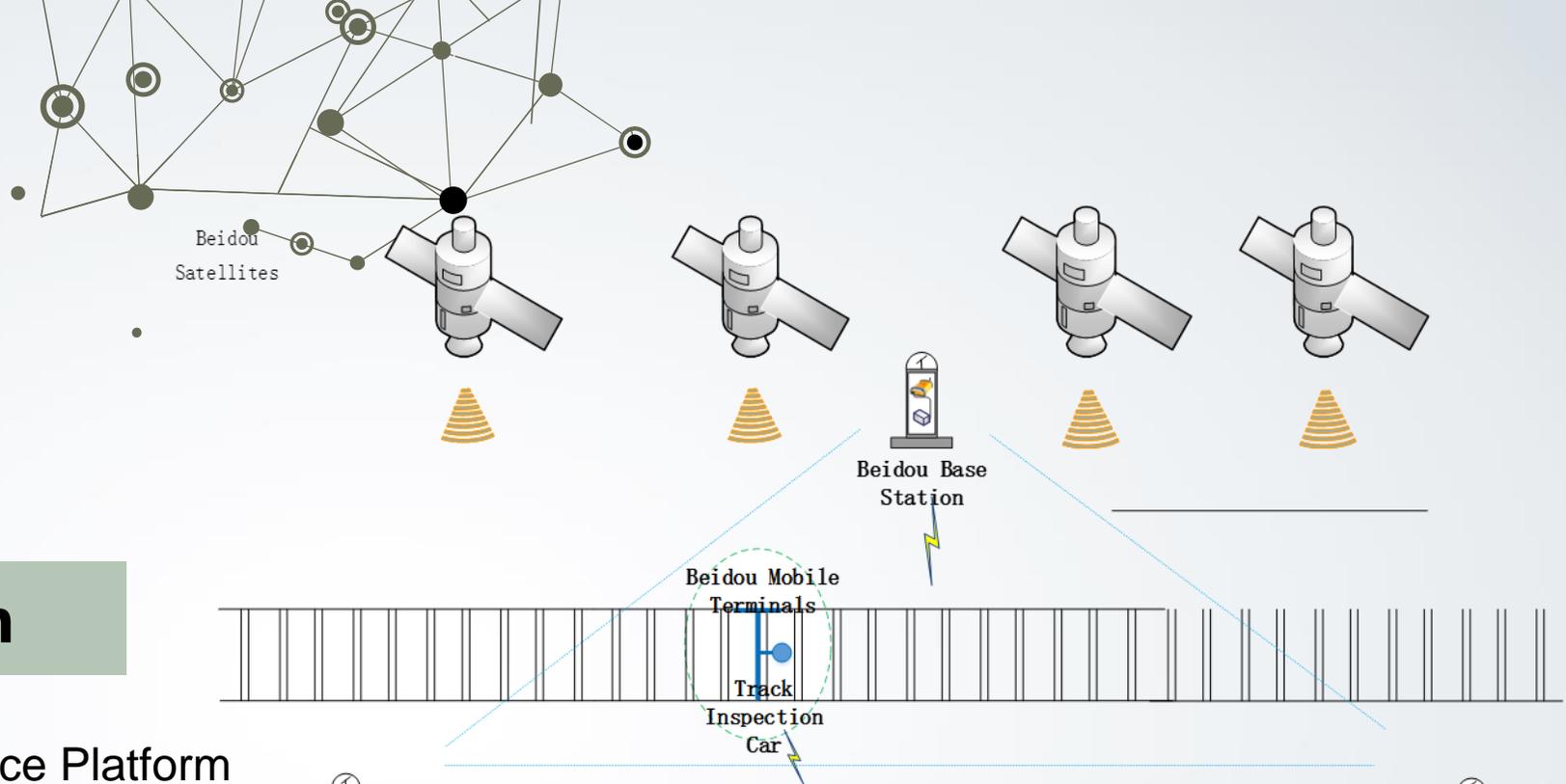
✘ Accuracy

✘ Efficiency

Existing measurement solutions can not meet the requirements of HSR deformation measurement at the same time in **accuracy** and **efficiency**.

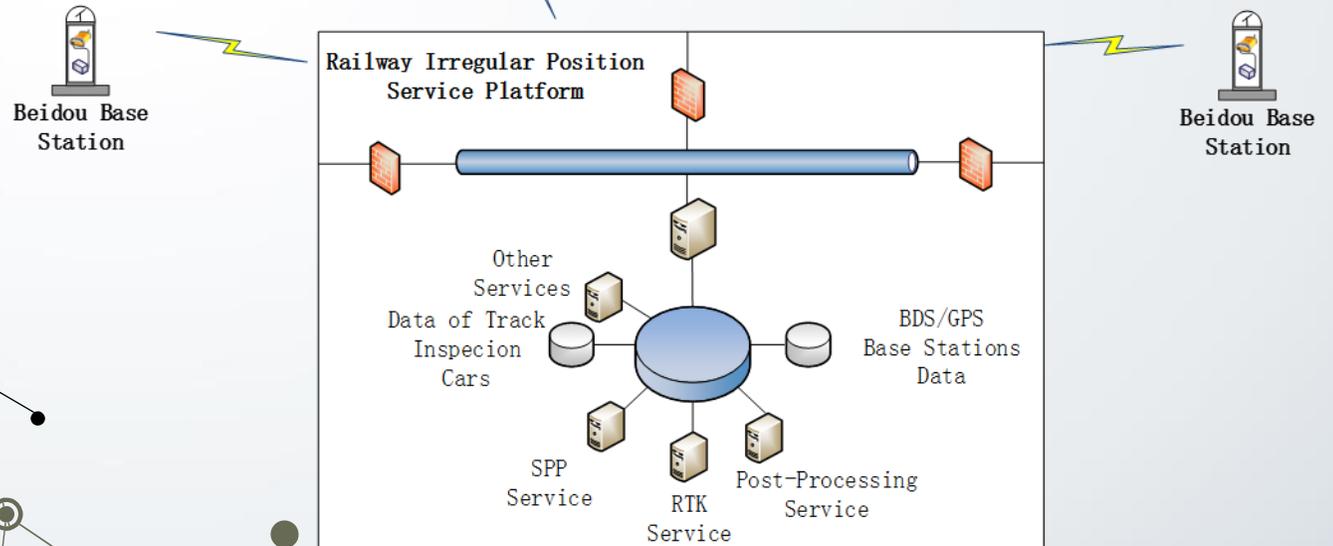
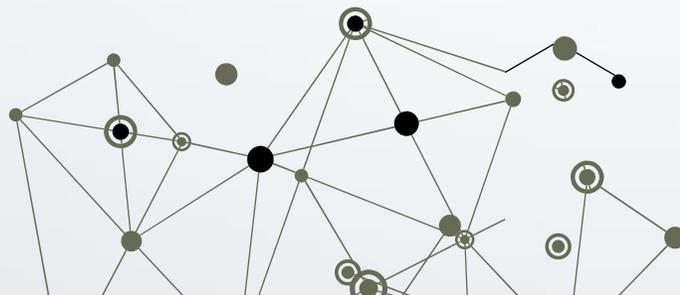
03

How to do it ?



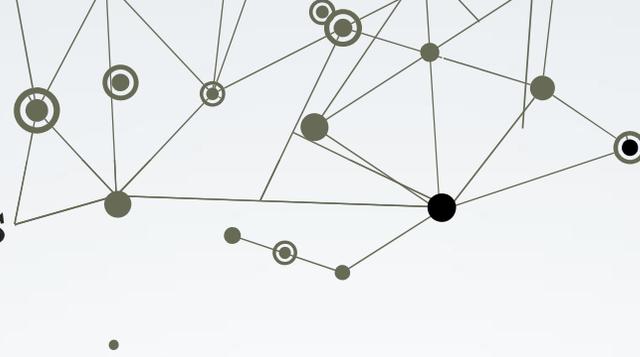
System Composition

- Tracks Irregularity Location Service Platform
- Beidou Mobile Terminals
- Track Inspection Car

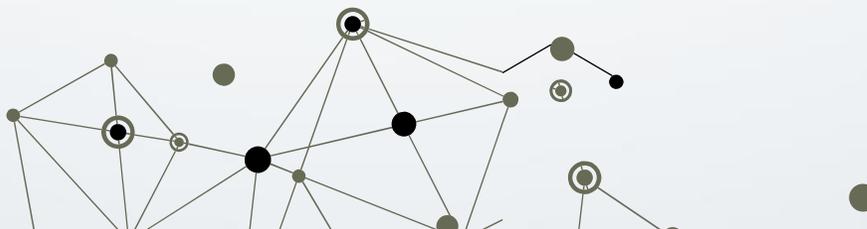


03

Performance Indicators

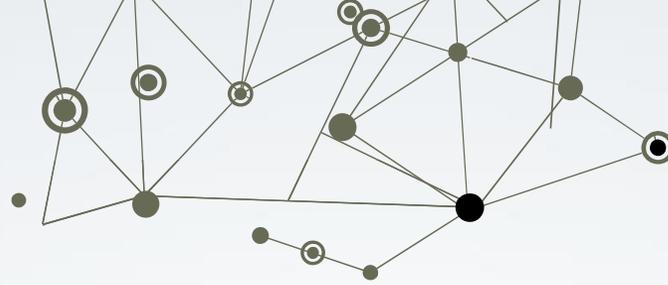


Performance Indicators		
Accuracy		Operating Speed
Phase Position (Horizontal、 Vertical)	$\pm 0.5\text{mm}$	1000m/h
Line Lateral Deviation	$\pm 2.5\text{mm}$	
Line Longitudinal Deviation	$\pm 3.0\text{mm}$	

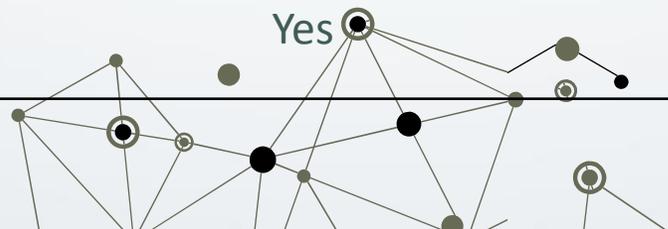


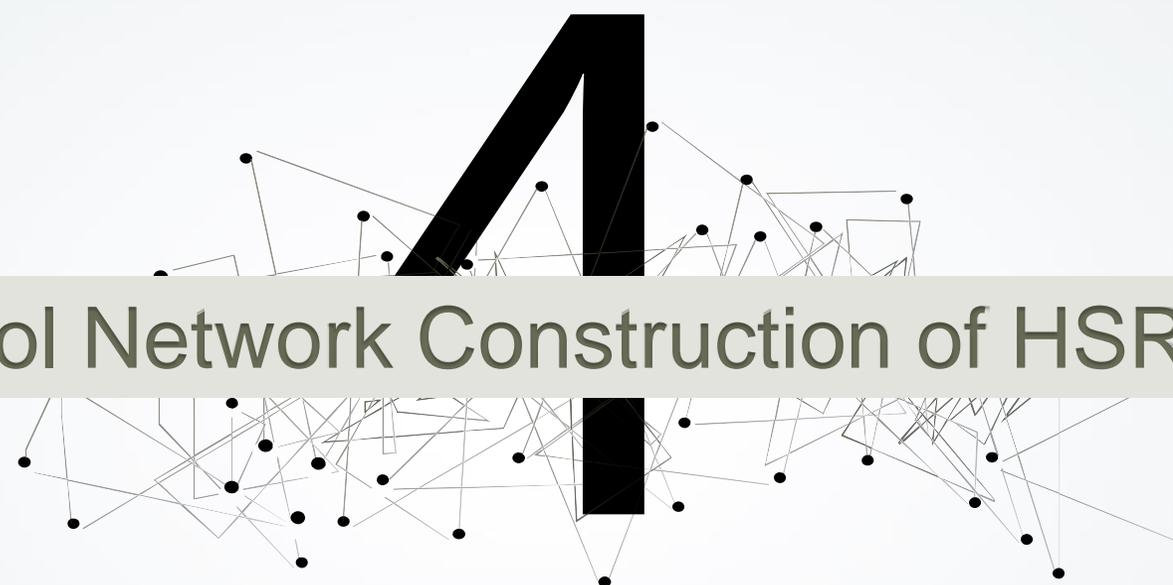
03

Comparative Analysis



	Track Inspection Car with Total Station	Track Inspection Car with BDS
Measurement Mode	Static Measurement	Static and Dynamic Measurement
Measurement Efficiency	200m/h	1000m/h
Control Points of Rail	Every 50-70m need a pair of CP III control points.	Only need a small amount of reference stations and the coordinates can be automatically calibrated.
Influence by Environment	Seriously	Almost unaffected
Margin Error	Existing	Nonexistent
Professional Degree of operators	High	Low
Fieldwork workload	large	small
Indoor workload	Very Simple	Simple
Whether to complete the tunnel measurement	Yes	Needed to Combine Other Sensors





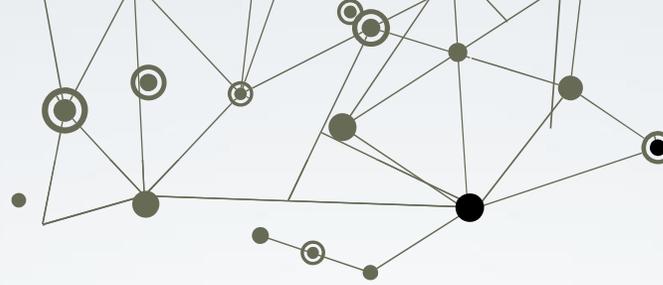
Control Network Construction of HSR Measurement

Why to do it? How to do it?
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04

Why to do it ?



Survey Stage



Construction Stage



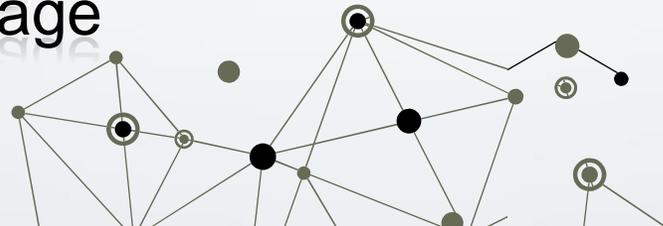
Operation & Maintenance Stage

Three Stages of Control Network Construction of HSR :

- Survey
- Construction
- Operation & Maintenance

Survey control network, construction control network and operation & maintenance control network should use **the same basic plane control network and basic elevation control network.**

BDS high-precision positioning services can **support the three networks integration and provide an accurate and stable measurement standards** for HSR measurement.



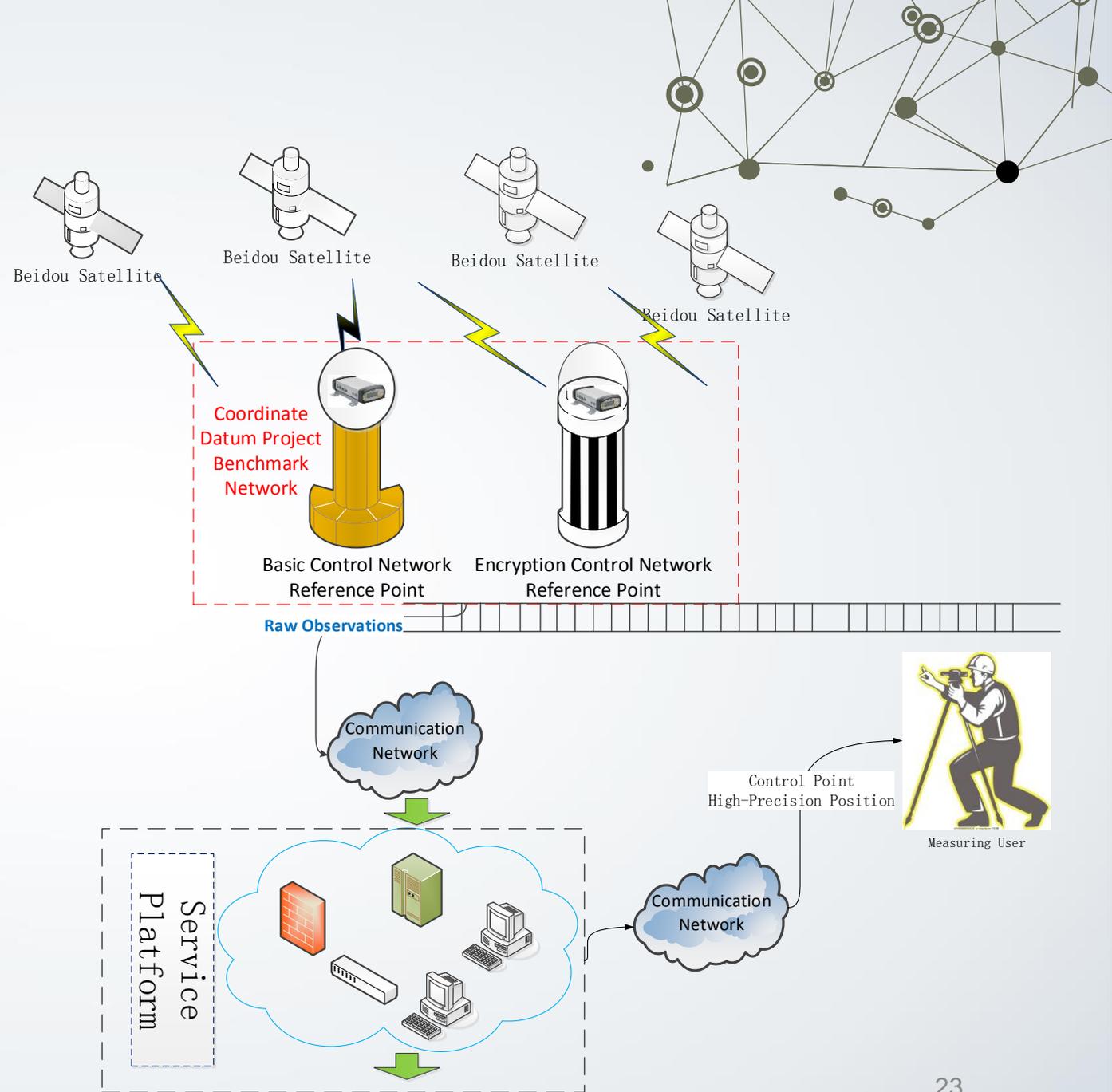
04

How to do it ?



System Composition

- The control network reference points
- The control network reference points
- The service platform



04

System Features

1

Unmanned automatic maintenance of the measurement control network's control points is realized.

2

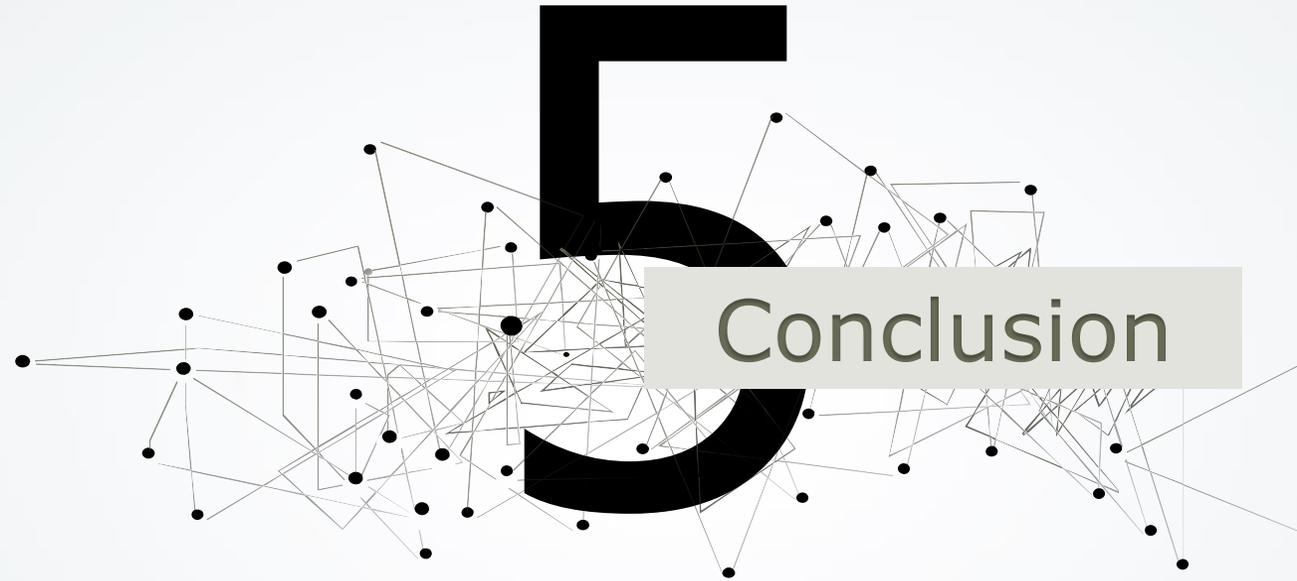
Significantly improve the work efficiency of all stages of measurement.

3

Control network's control points provide a benchmark for HSR automated deformation monitoring based on Beidou in operating duration.

4

It can provide the analysis and judgment basis for the whole settlement of HSR.





Beidou based high-speed railway industry in the application of unprecedented changes in high-speed rail survey and design, construction and operation and maintenance and other aspects of space-time information perception methods and data acquisition model. BDS will play an important role in the rapid development of automation and intelligence in China's HSR.

Thank You !