# Benefits Of GNSS Receiver In The Era Of Multi-Systems

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# To understand the GNSS receiver, it becomes important to understand the multi-systems

The world of GNSS is changing fast:

- GPS is under modernization;
- GLONASS is on the way to be globally available;
- The development of COMPASS is going ahead;
- GALILEO is being built continually;
- The Japanese and the Indian regional systems are becoming a reality.

# OUTLINE

**Part Ⅰ： Some Techniques And Testing (Or Simulation ) Result Of GNSS Receiver**

**Part Ⅱ：Potential Application In The Future**

**Part Ⅲ： As GNSS Receiver Manufacturer, What We Concerned?**

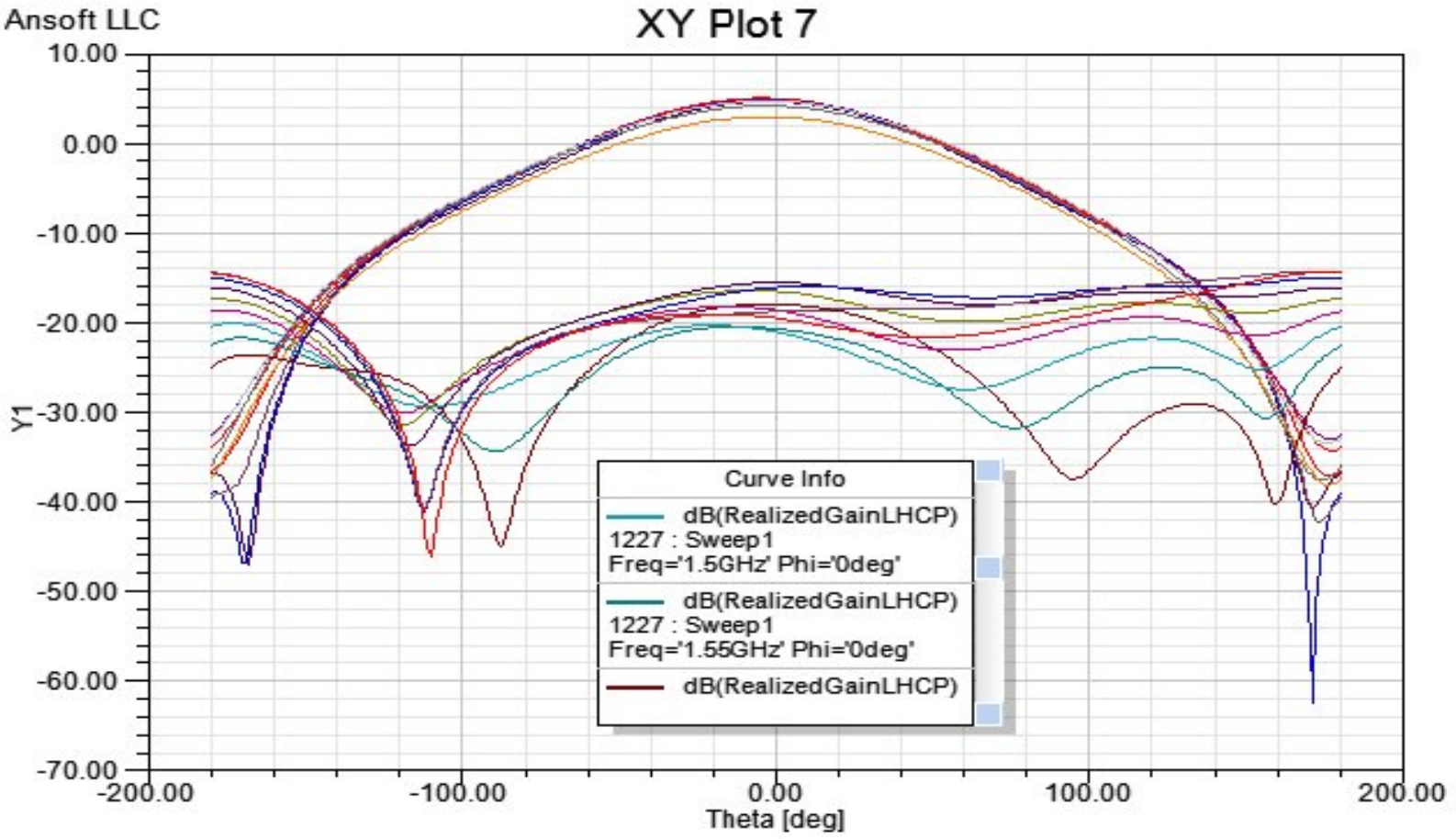
# Part Ⅰ

## Some Techniques And Testing (Or Simulation) Result Of GNSS Receiver

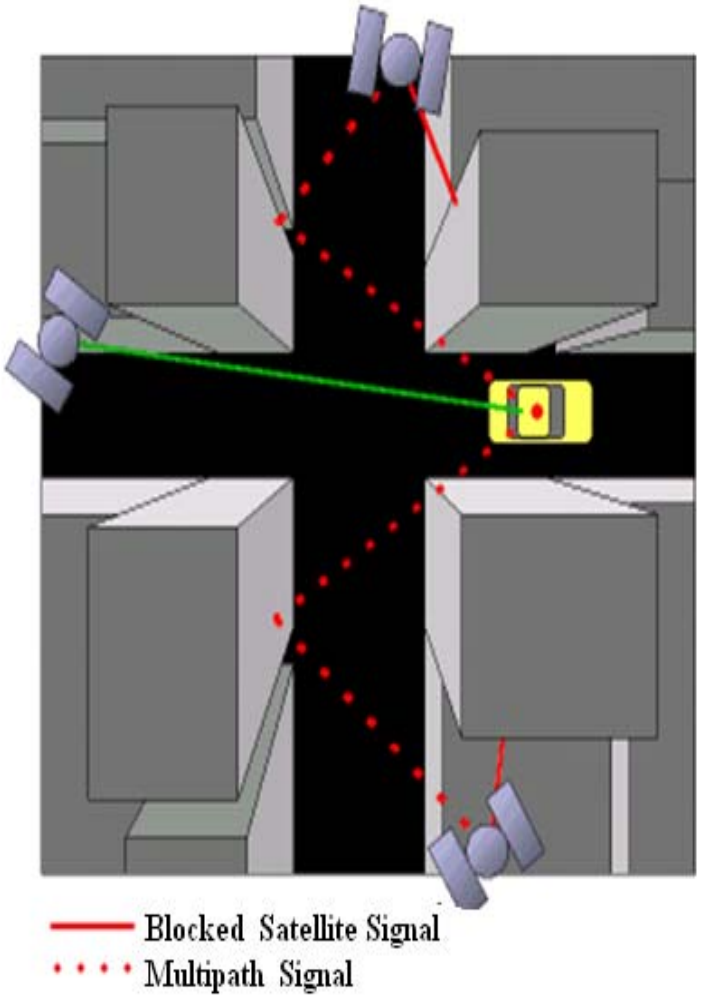
# 1.1 Antenna

- Frequency bandwidth cover 1.1G-1.6G, can support all GNSS system;
- Antenna phase center is steady-going;
- To be applicable under any weather.

# Gains of Antenna

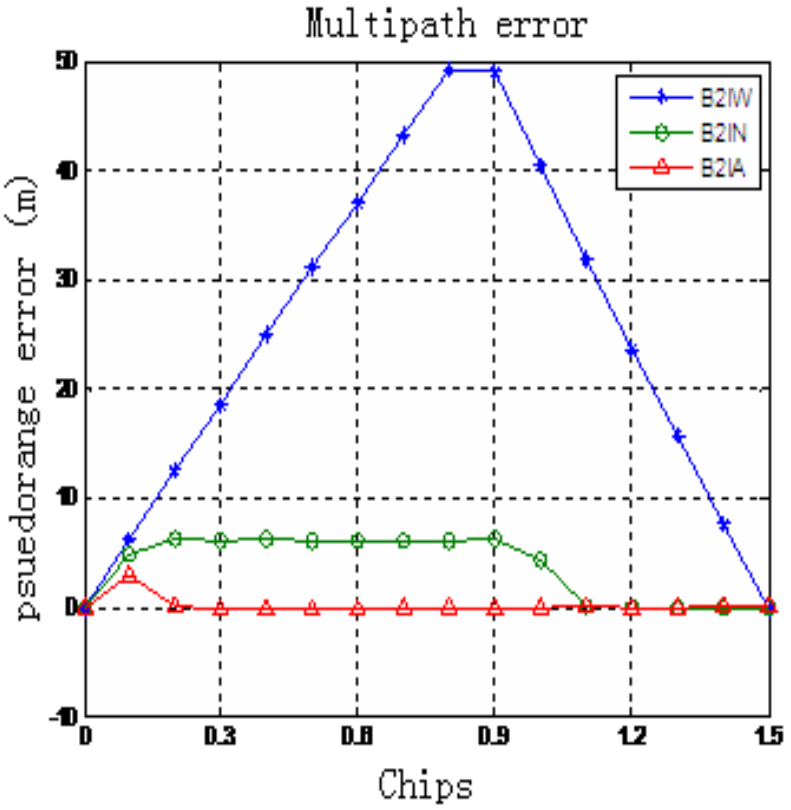


# 1.2 Multipath Mitigation




- Multipath is commonly happened in the city
- Satellite signal bounces before hitting antennae
- Causes include buildings, vehicles, etc…
- Provides inaccurate positional reading

# Testing Result of Multipath Mitigation (1)




Wide correlation

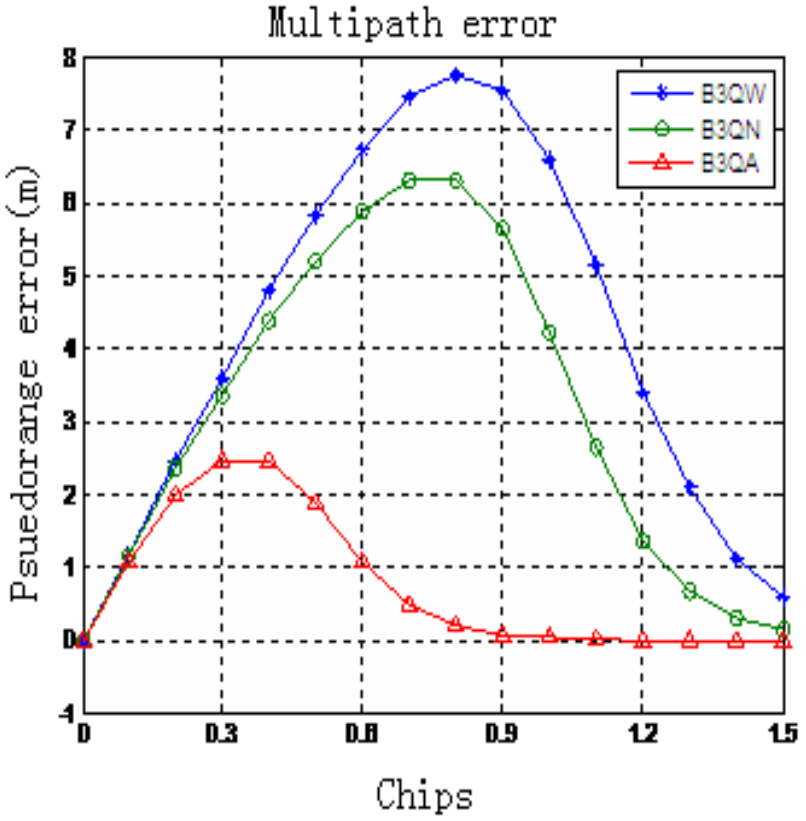
Narrow correlation

Anti-multipath correlation

Multipath error has been eliminated about 98%

Chip rate: 2.046MHz

# Testing Result of Multipath Mitigation (2)




Chip rate： 10.23MHz

Wide correlation

Narrow correlation

Anti-multipath correlation

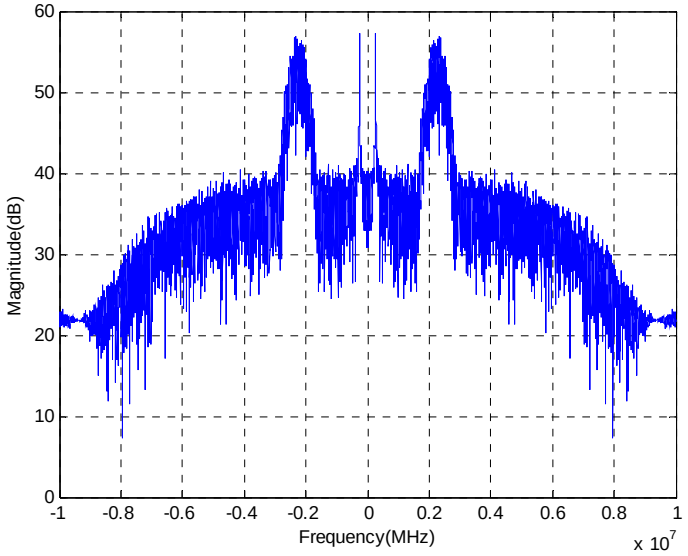
Multipath error has been eliminated about 80%.

# 1.3 Anti-Interference

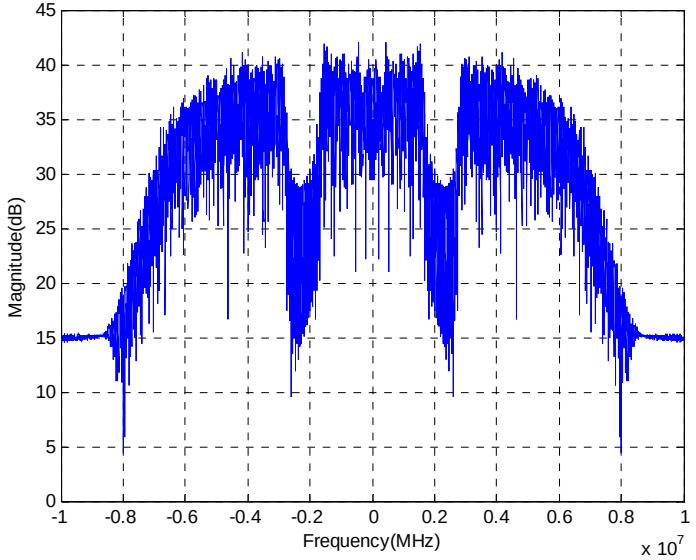
- Work in complex electromagnetic environment without accident.

- Some techniques will provide greater protection against intentional or unintentional radio frequency interference.

# Simulation Result of Anti-Interference




Signal Spectrum with Interference




Signal Spectrum by Anti-interference Processing

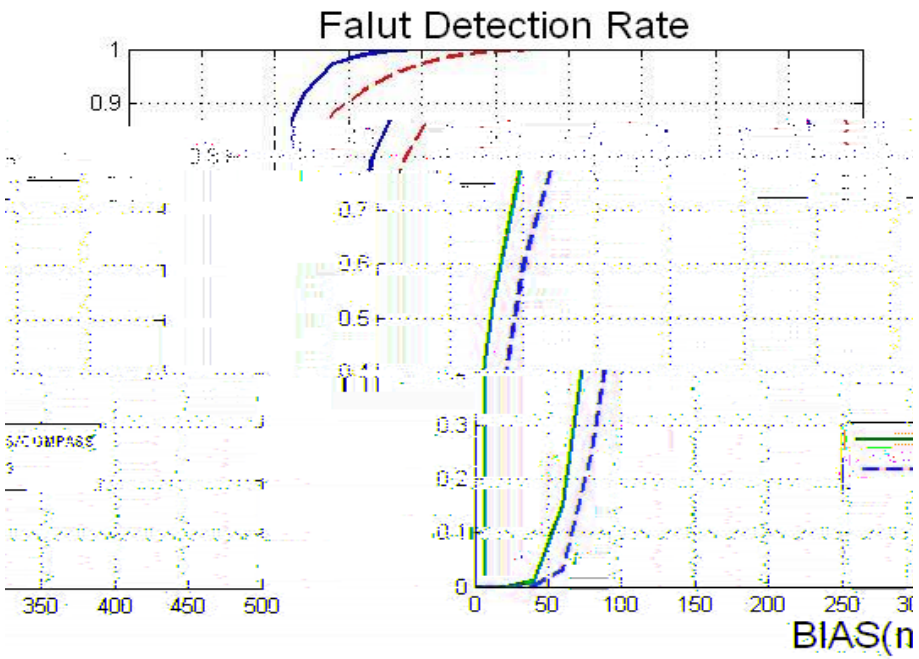
This result has proved that the single frequency interferences and narrow-band interferences have been cancelled effectively.

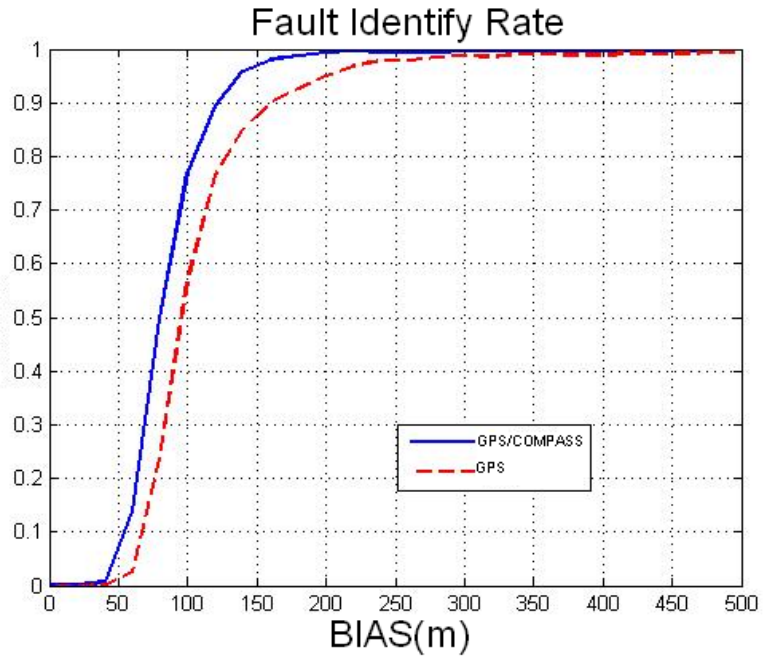
The capability of anti-interference is beyond 50dBc for the narrow interference within 10% band-width of signal.

# 1.4 Signal Quality Monitoring

- Integrity monitoring is an important technique in the development of GNSS receiver.
- Gives notice to end-users when the receiver can not provide correct navigational information.
- Multi-system can provide more information to do this by GNSS receiver.

# Simulation Result of Fault Detection and Identify




When the pseudorange bias is same, fault can be detected and identified more efficiently by GPS/COMPASS than by GPS only, improve about 10%.

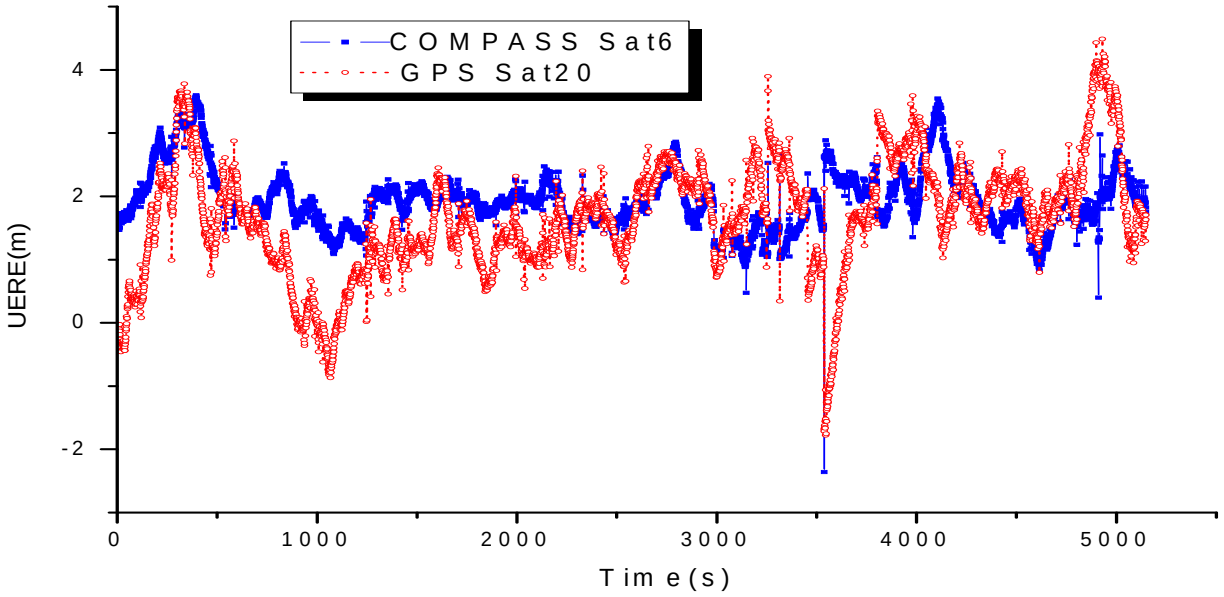
# 1.5 Accuracy Analysis

Accuracy evaluation method:

Position error = PDOP X UERE

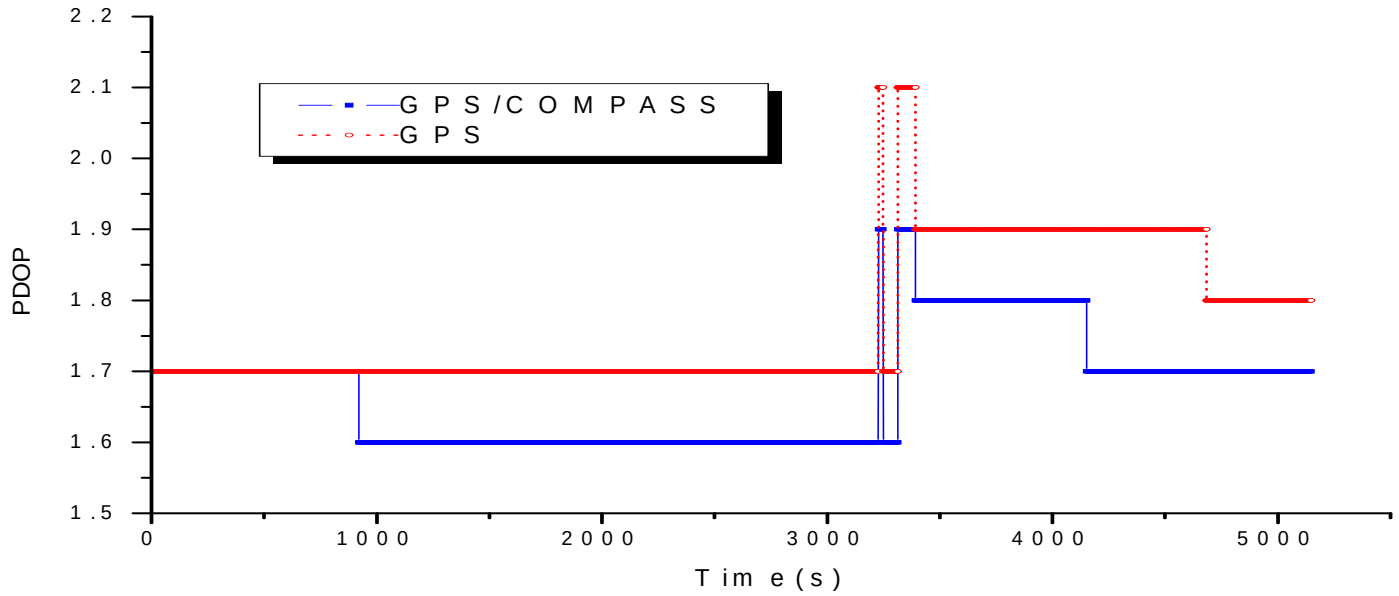
There are some figures and statistics of comparative results between the GPS/COMPASS and GPS :

# (1) UERE Comparison



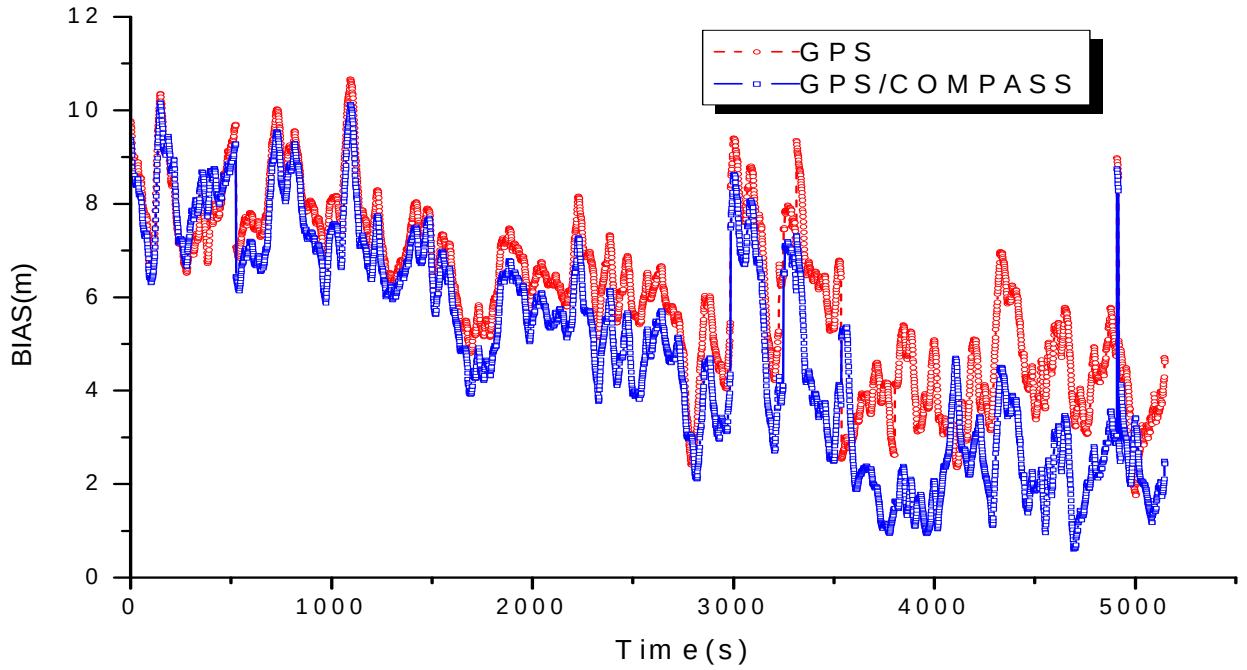

| UERE(m) | Min | Max | Mean | Std |
|---|---|---|---|---|
| GPS | -1.78 | 4.483 | 1.753 | 0.904 |
| GPS/COMPASS | -2.361 | 3.596 | 1.839 | 0.469 |

# (2) PDOP Comparison




| PDOP | Min | Max | Mean | Std |
|---|---|---|---|---|
| GPS | 1.742 | 2.195 | 1.767 | 0.097 |
| GPS/COMPASS | 1.633 | 1.982 | 1.672 | 0.078 |

# (3) Position Error Comparison




| BIAS(m) | Min | Max | Mean | Std |
|---|---|---|---|---|
| GPS | 1.753 | 10.663 | 6.073 | 2.350 |
| GPS/COMPASS | 0.602 | 10.160 | 5.497 | 1.842 |

So,

GNSS receiver has many benefits to the almost all end-users.

It deserves more attention in the era of multi-systems.

# Part Ⅱ

## Potential Application In The Future

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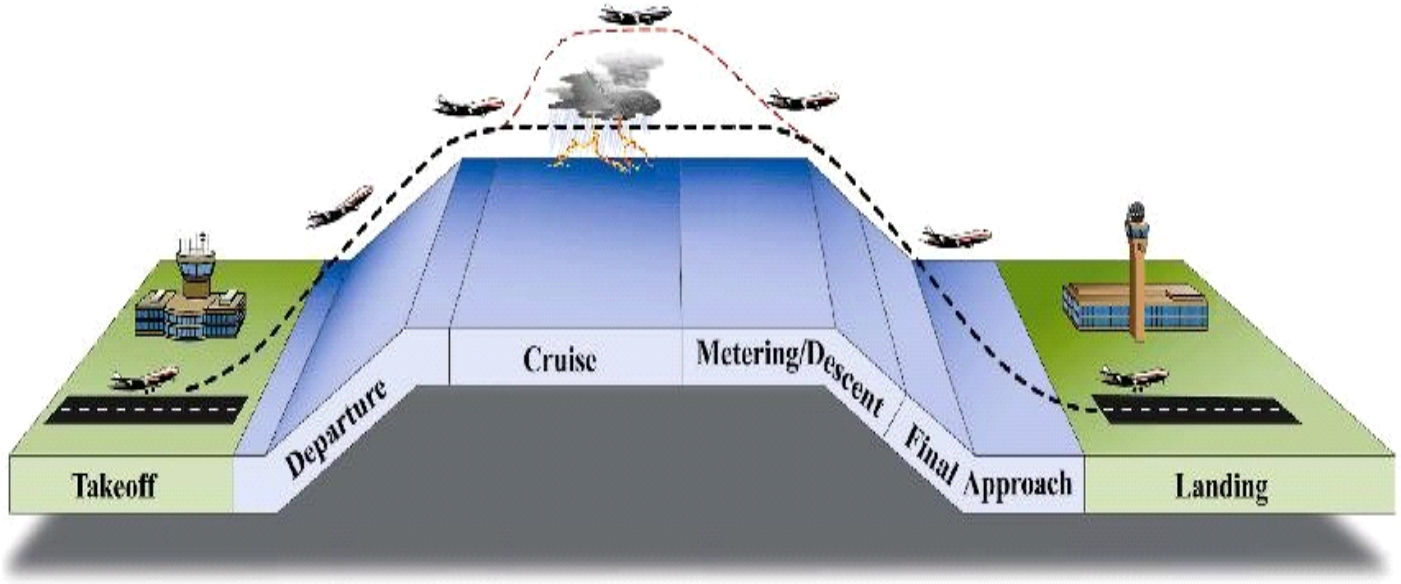
GNSS receiver will be an important equipment for the next generation of air transportation system, train control and maritime applications, to provide seamless worldwide service .

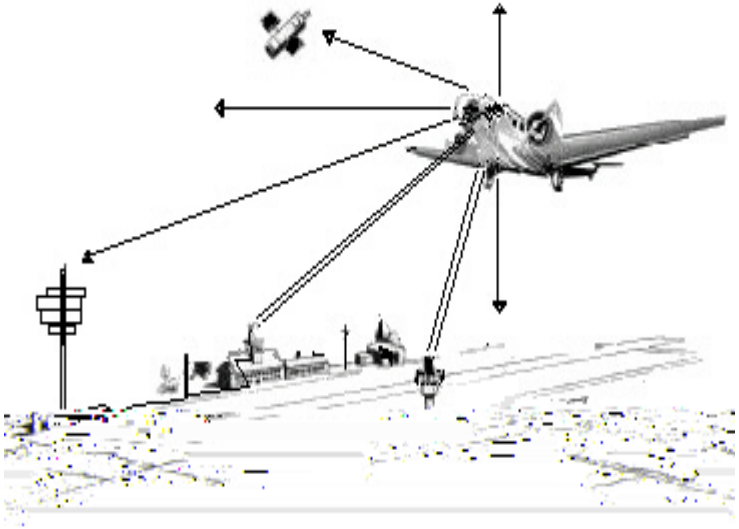
# GNSS Aviation Applications




The application of GNSS in aircraft is becoming increasingly common.

COMPASS will provide difference information and integrity message to end-users, just like WAAS.

It is possible to use GNSS receiver as a primary navigation manner for aviation in China area.



Stand-alone GNSS non-precision and Cat. I approach will also become possible in China area.

# Part Ⅲ

## As a GNSS Receiver Manufacturer What Do We Concerned?

As receiver manufacturers, we hope:

(1) The signals of multi-constellation have common carrier frequencies, moderate bandwidth and in-complicated modulation.

- To reduce cost and complexity of GNSS receiver

As receiver manufacturers, we hope:

(2) Data-less signal component

- Pilot carrier improves tracking threshold
- Better for high precise phase measurements

As receiver manufacturers, we hope:

(3) Satellites orbit from different navigation system should be planned reasonably to get the best geometric arrangement in multi-systems.

- To obtain the most optimized performance characteristic (such as DOP, accuracy, integrity etc…).

# Thanks

# for your attention!