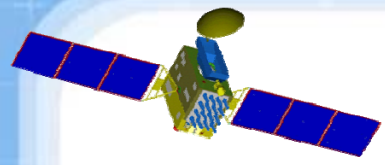
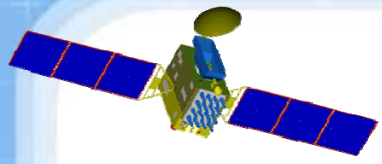


Primary Analysis of Multi-constellation Interoperability

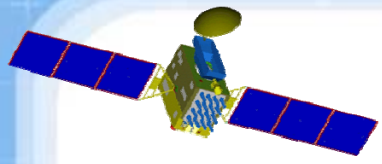
China National Administration of GNSS and Applications

March, 2010, Munich



Integrated Positioning with Multi-constellation

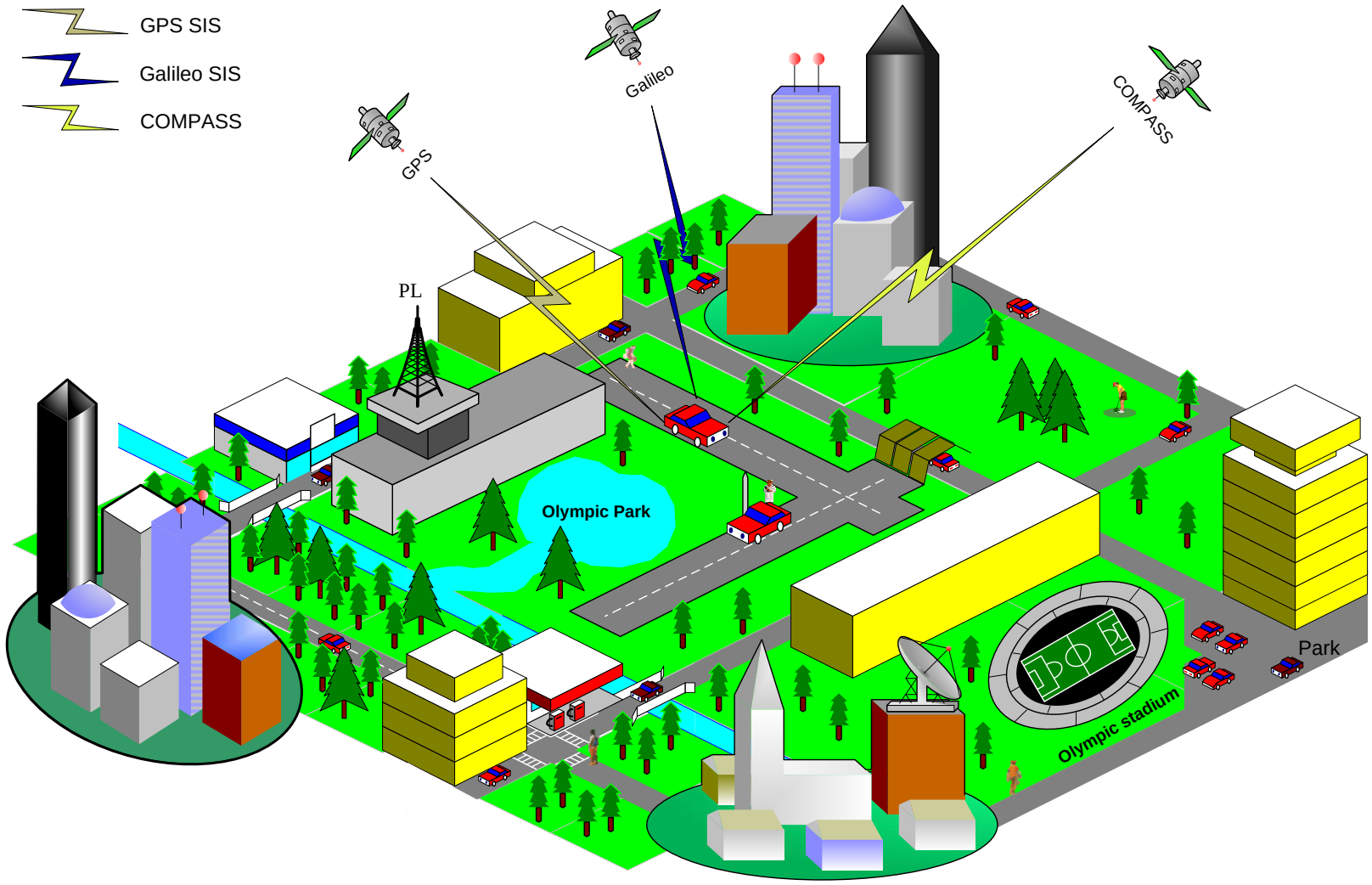
- Enhancing system redundancy and reliability.
- Getting higher accuracy than using a single constellation.
- Increasing the coverage of space and time to realize continuous navigation.
- providing wide-area and real time precise positioning service.

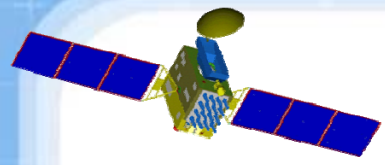


Integrated Positioning with Multi-constellation

- high accuracy differential navigation
- autonomous precise navigation
- precise navigation for airplane
- establishing maintenance of time and frequency
- marine management
- precise measurement, etc.

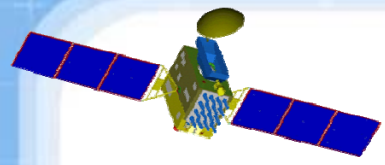
Benefits of Multi-constellation Case in Cities





Integrated Positioning with Multi-constellation

- **Key techniques:**
  - **Integrated receiving antenna technology of high precision**
  - **Base band signal processing technology for multi-system and multi-frequency.**
  - **Coordinate and time precise conversion technology among GPS/GLONASS/COMPASS/GALILEO and data fusion technology, including integrated positioning technology, autonomous integrity monitoring technology with multi-constellation.**



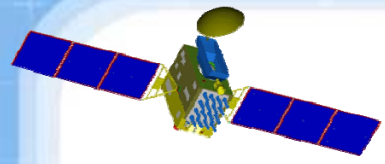
DOP Analysis for Multi-constellation

DOP Analysis for Multi- constellation

- 5 GEO： 58.75E、80E、110.5E、140E、160E
- 3 IGSO:

Satellite index *I*	RAAN $\Omega_{i,0}$ (degree)	Argument of latitude $u_{i,0}$ (degree)
1	248.824525	0
2	128.824636	120
3	8.824746	240

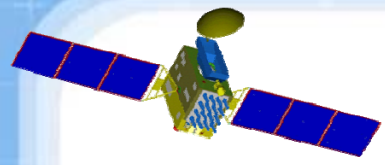
- 27 MEO



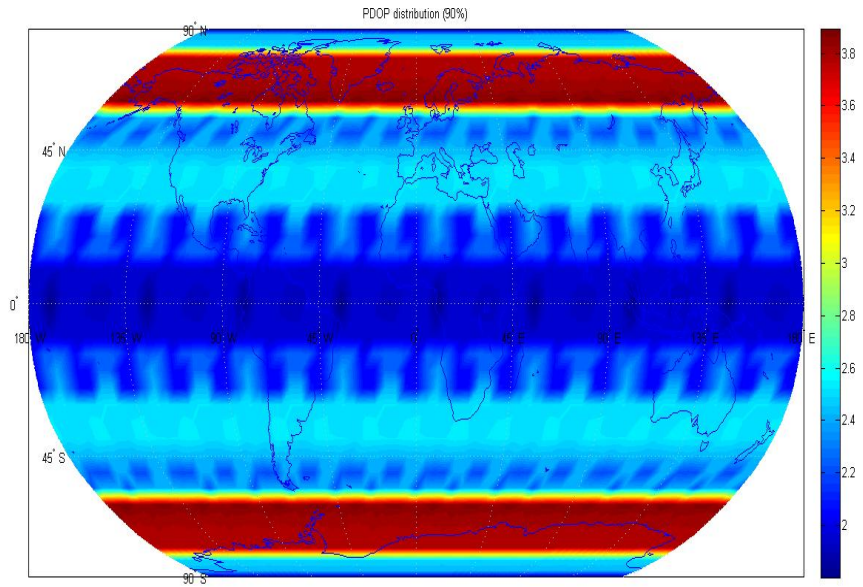
DOP Analysis for Multi-constellation

- 27 MEO

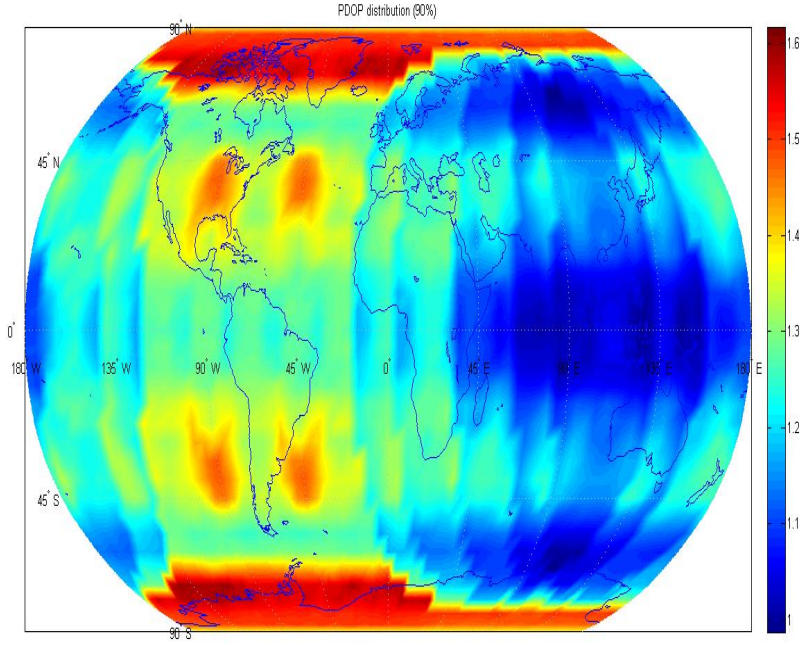
Satellite index I	RAAN Ωi,0 (degree)	Argument of latitude ui,0 (degree)
1	0	0
2	0	45
3	0	90
4	0	135
5	0	180
6	0	225
7	0	270
8	0	315
9	120	15
10	120	60
11	120	105
12	120	150
13	120	195
14	120	240
15	120	285
16	120	330
17	240	30
18	240	75
19	240	120
20	240	165
21	240	210
22	240	255
23	240	300
24	240	345
25	0	10
26	120	55



DOP analysis for Multi constellations



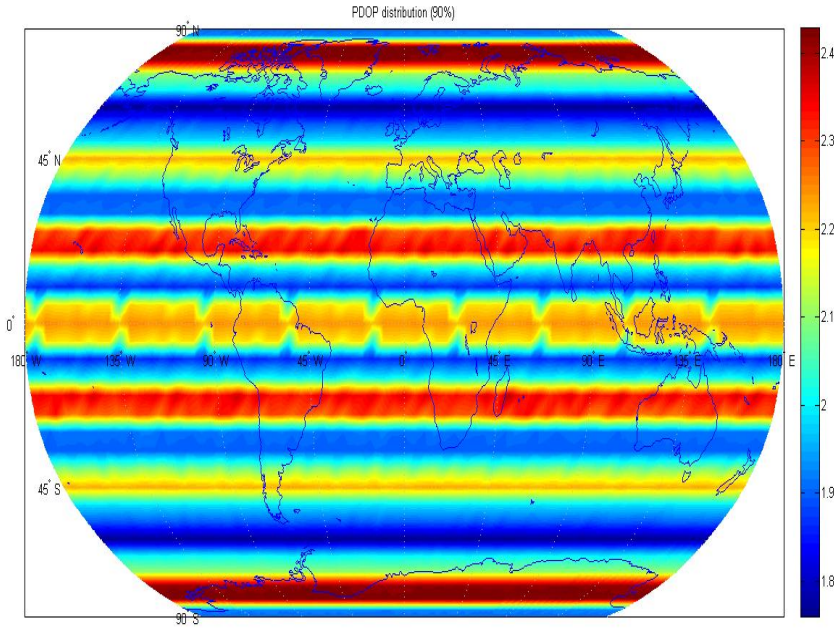
GPS



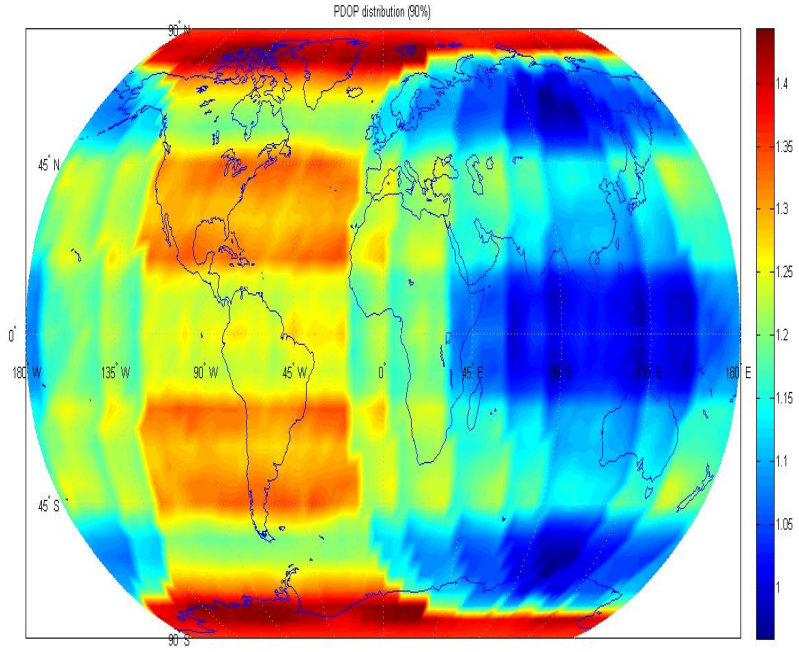
GPS+COMPASS constellation

(cut angle：5°)

GALILEO+COMPASS



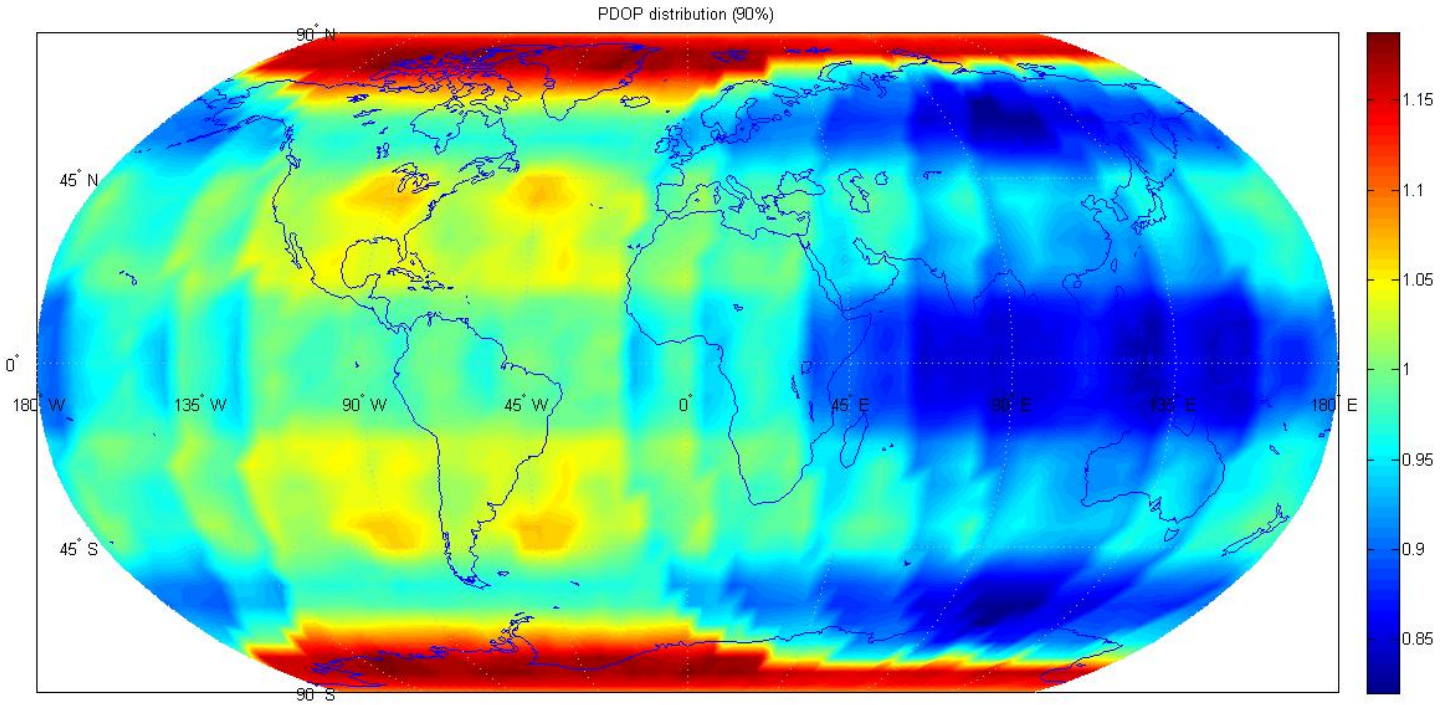
GALILEO constellation



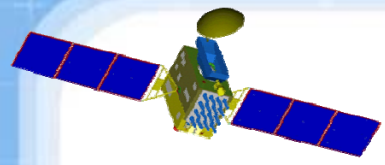
GALILEO+COMPASS constellation

(cut angle：5°)

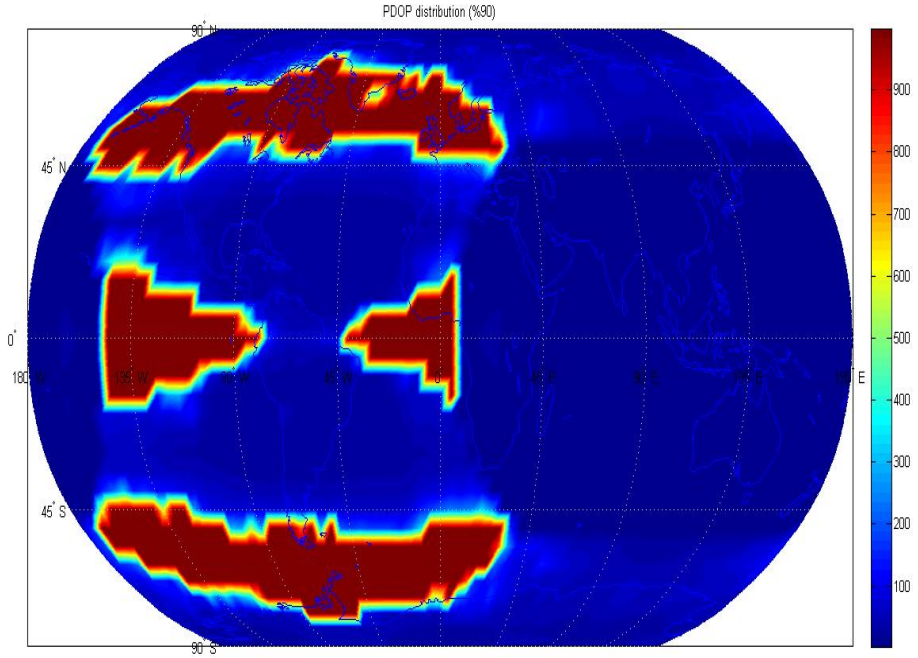
COMPASS+GPS+GALILEO

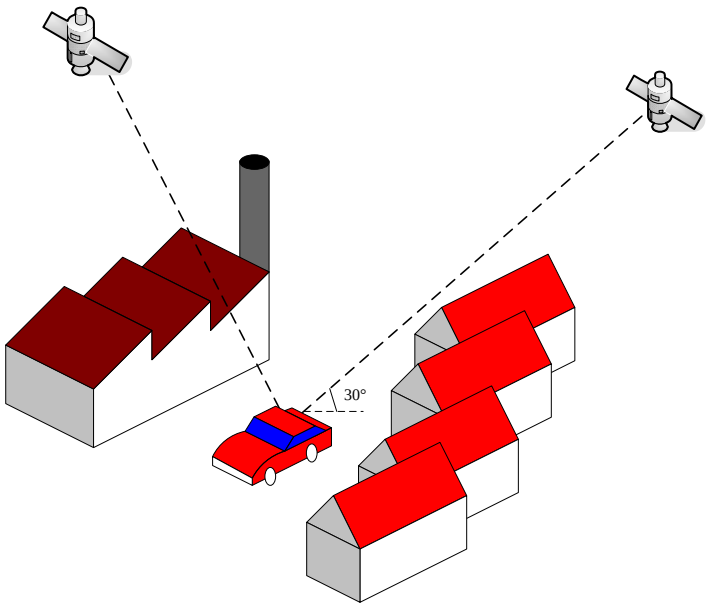


(cut angle：5 °)

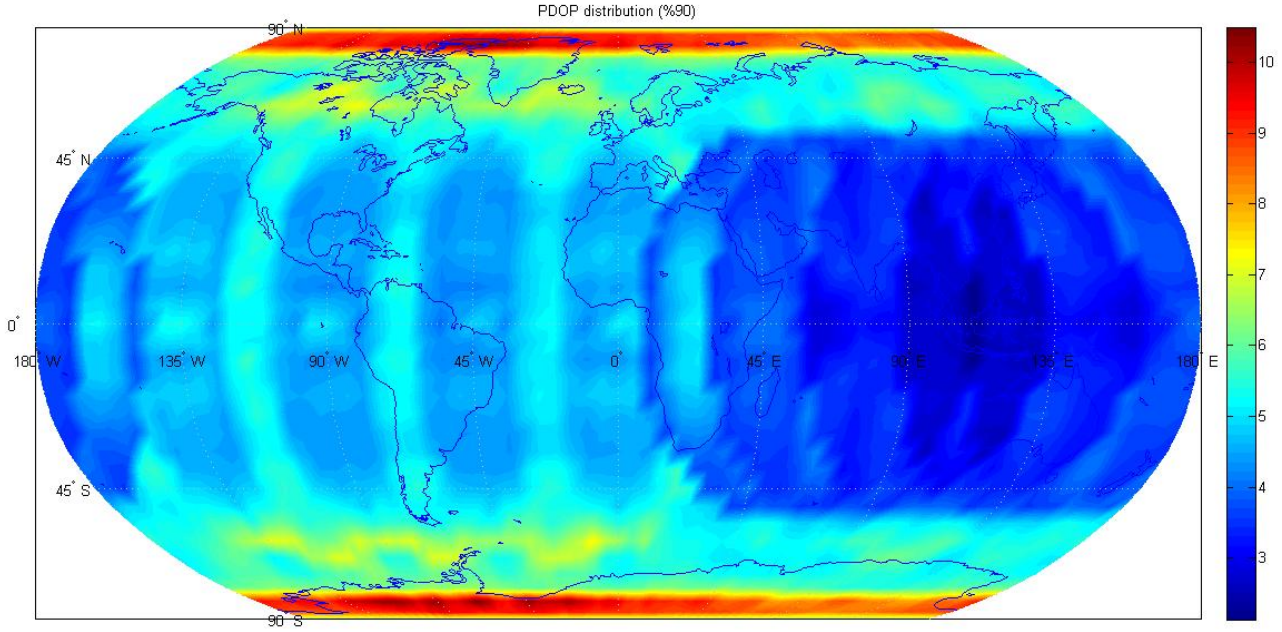


COMPASS (cut angle 30 °)



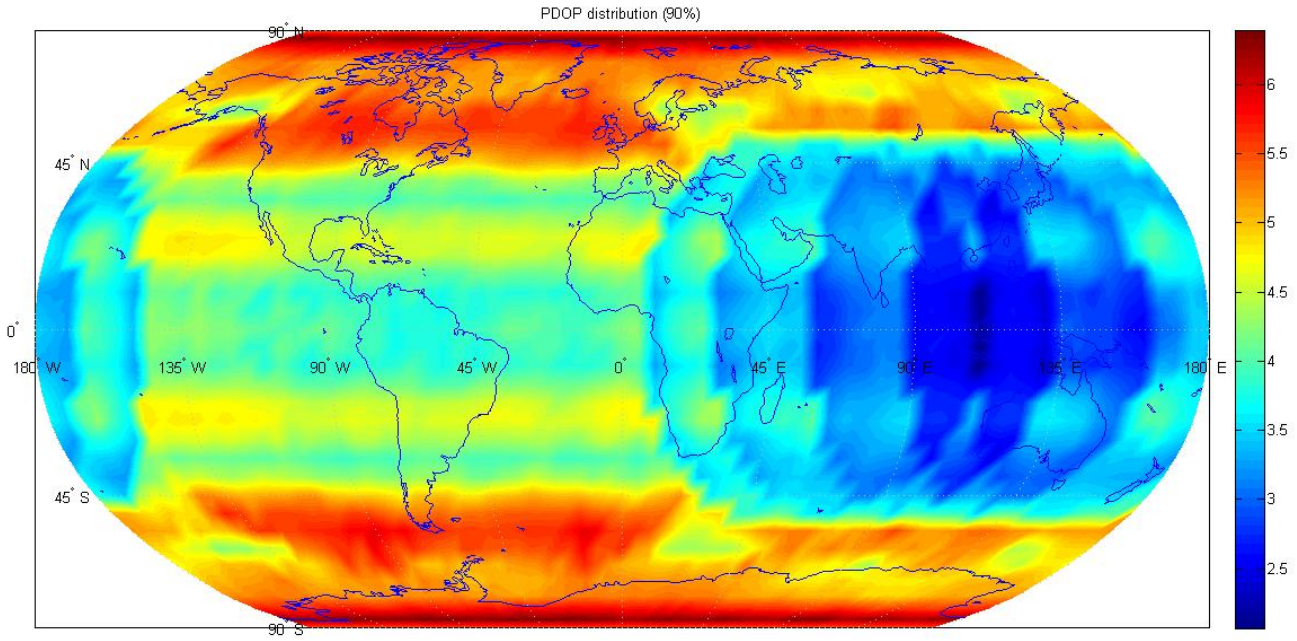


GPS+COMPASS



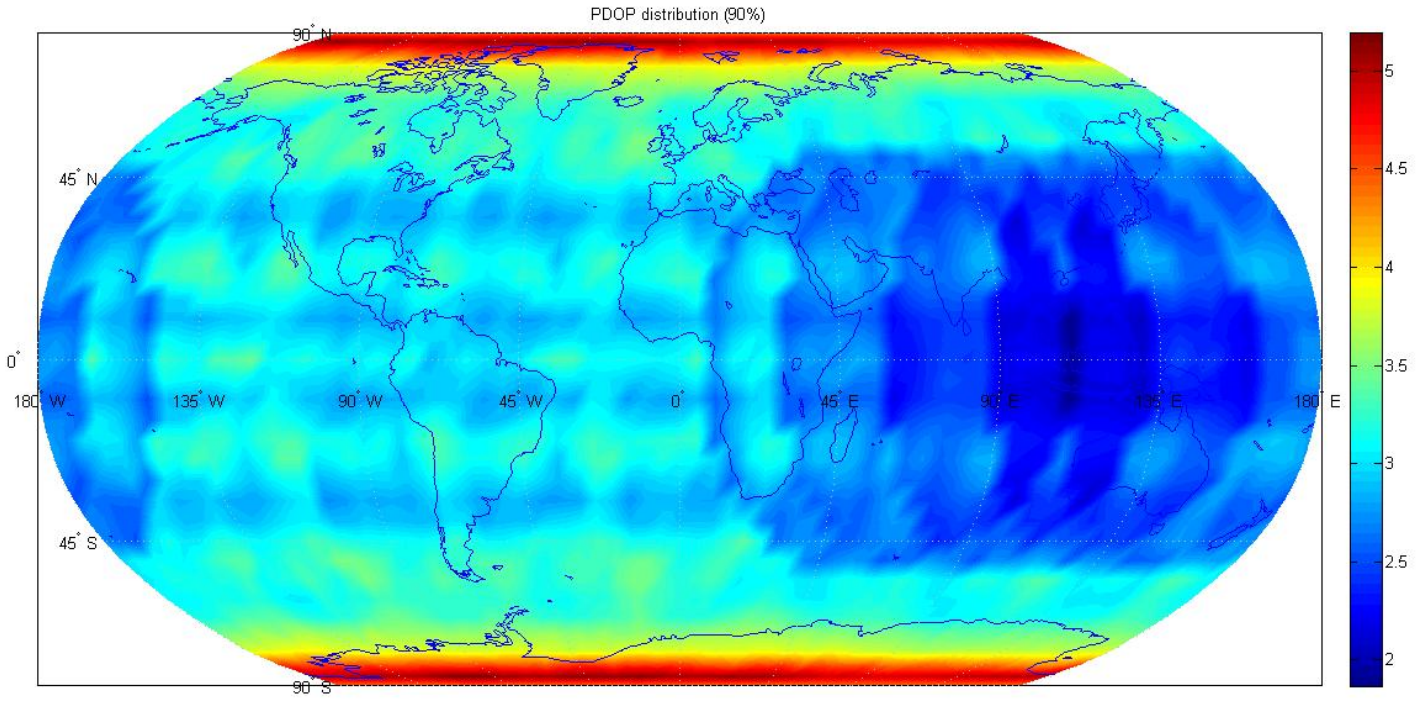
(cut angle：30 °)

COMPASS+GALILEO



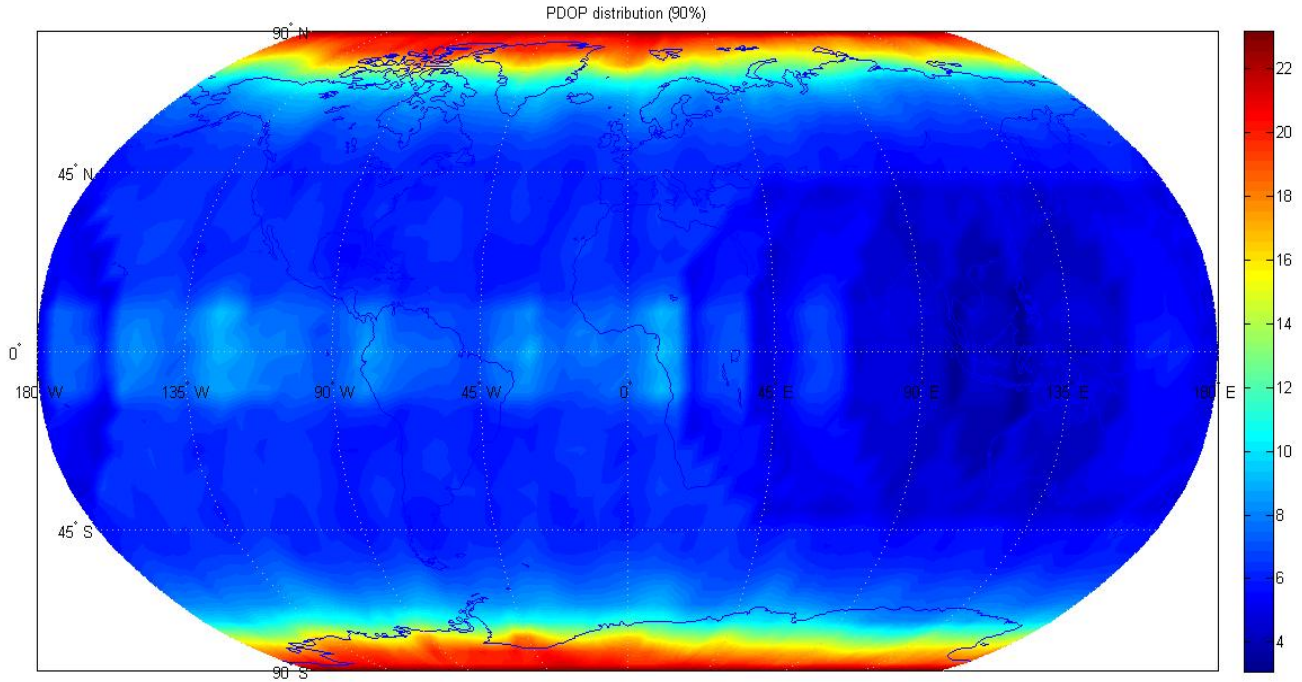
(cut angle：30 °)

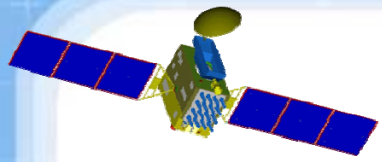
COMPASS+GPS+GALILEO



(cut angle：30 °)

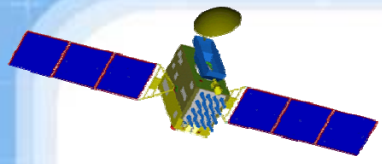
COMPASS+GPS+GALILEO
(cut angle：40°)





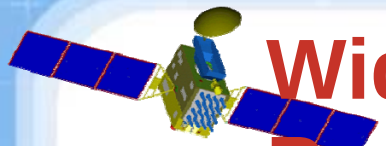
To sum up, two main advantages when the multi-constellation is used in navigation:

- 1:User accuracy can generally be improved dramatically.
- 2:In some special environments, such as city canyons, the navigation and positioning still work.



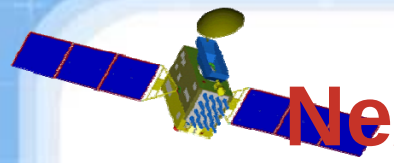
COMPASS's contribution in multi-constellation interoperablility

- In addition, COMPASS can offer services of regional communication and position reporting.
- It can be widely applied in aeronautical and maritime search and rescue.



Wide-area and Real Time Precise Positioning

- The wide-area and real time precise positioning service will be augmented by integrating the techniques such as real time data positioning, internet and satellite communication which result in positioning accuracy of 1 meter in China.

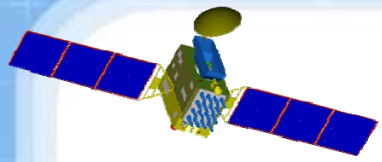


Next step

(1) Realizing service sharing of real time data in China by combining the existing real time reference stations .

(2) Increasing reference stations to satisfy the higher precision requirement of ionosphere grid.

(3) Developing key techniques and receivers with multiple modes and multiple frequencies with high precision.



Conclusion

- Integrated navigation with multi-constellation will improve the coverage remarkably in cases of high cut angle, such as in cities.
- The geometric strength of combined constellation will be greatly improved in China.
- Support and participate in the international activities of compatibility and interoperability for multi-constellation actively.


Thanks for your attention!