



ICG Working Group A meeting

Views on Multilateral Compatibility Coordination

China Satellite Navigation Office

Oct. 18th, 2010



Outline

1. Background and Focus of ICG
2. Compatibility Scope on ICG Platform
3. Realization of Compatibility
4. Multilateral Compatibility Coordination
5. Conclusions



Background of ICG

◆ Purpose of ICG

- To promote cooperation related to civil satellite-based PNT and value-added services.
- To increase GNSS use to support sustainable development, particularly in the developing countries.



Background of ICG

◆ Property of ICG

- Established on a voluntary basis as an informal body
- respecting the roles and functions of GNSS service providers and intergovernmental bodies such as ITU
- All ICG or its working groups recommendations will be decided on the basis of consensus of its members , do not create legal obligations, and will be acted upon at the discretion of each member



Focus of ICG

- ◆ Focus on Open Civil signals: Open and free of direct user charge
- ◆ Realization of Open Civil signal Interoperability
 - ✓ Common carrier frequency and spectrum: beneficial
 - ✓ Frequency diversity
- ◆ Compatibility aiming to interoperability: limited to open civil signals



Compatibility Scope on ICG platform

- ◆ The ability of multiple civil satellite navigation systems to be used separately or together:
 - without causing harmful interference with use of each individual service or signal
 - Open civil signals to be spectral separated with all other services or signals
 - Compatibility among CS/PRS/AS/Military signals to be discussed through bilateral coordination in the framework of ITU or other suitable channels



Realization of Compatibility

- ◆ Compatibility aiming at interoperability of civil signals:
 - same or similar link budgets;
 - common maximum and minimum received power level: assuring common max/min carrier-noise ratio;
 - comparable noise contribution: the more signals put into one frequency band, the more noise floor increased, limit noise floor level is beneficial.



Multilateral Compatibility Coordination

- ◆ Requirement analysis
- ◆ Related rules
- ◆ Some concerns



Multilateral Compatibility Coordination

◆ Requirement analysis

- may be convenient when there's a need to achieve consensus for concerned systems on the same issue:
 - L1C/B1C/E1OS/...
 - L5/B2a/E5a/...
- contributing to GNSS rules and standardization
 - ICG output may be proposed as new questions and studies for ITU, ICAO and IMO considerations through appropriate mechanisms
 - GNSS international rules and standards would benefit the promotion of mass-market and specialized applications



Multilateral Compatibility Coordination

◆ Related rules

- Basic principles: rational, equitable, efficient and economical use of RF spectrum
- At present, relevant ITU regulations and recommendations such as ITU-R Res.610 and Rec. ITU-R M.1831 are effective and widely adopted ways for GNSS bilateral compatibility coordination which can cover the whole range of PNT signals and services as bilaterally wished
- others



Multilateral Compatibility Coordination

◆ Some concerns

- Bilateral compatibility coordination between GNSSs is in process or completed. Prior to successful bilateral coordination, multilateral compatibility coordination will probably increase the complexity of the issue.
- Adding limit such as satellite number or signal number in one band may influence the design, development and modernization of GNSSs.



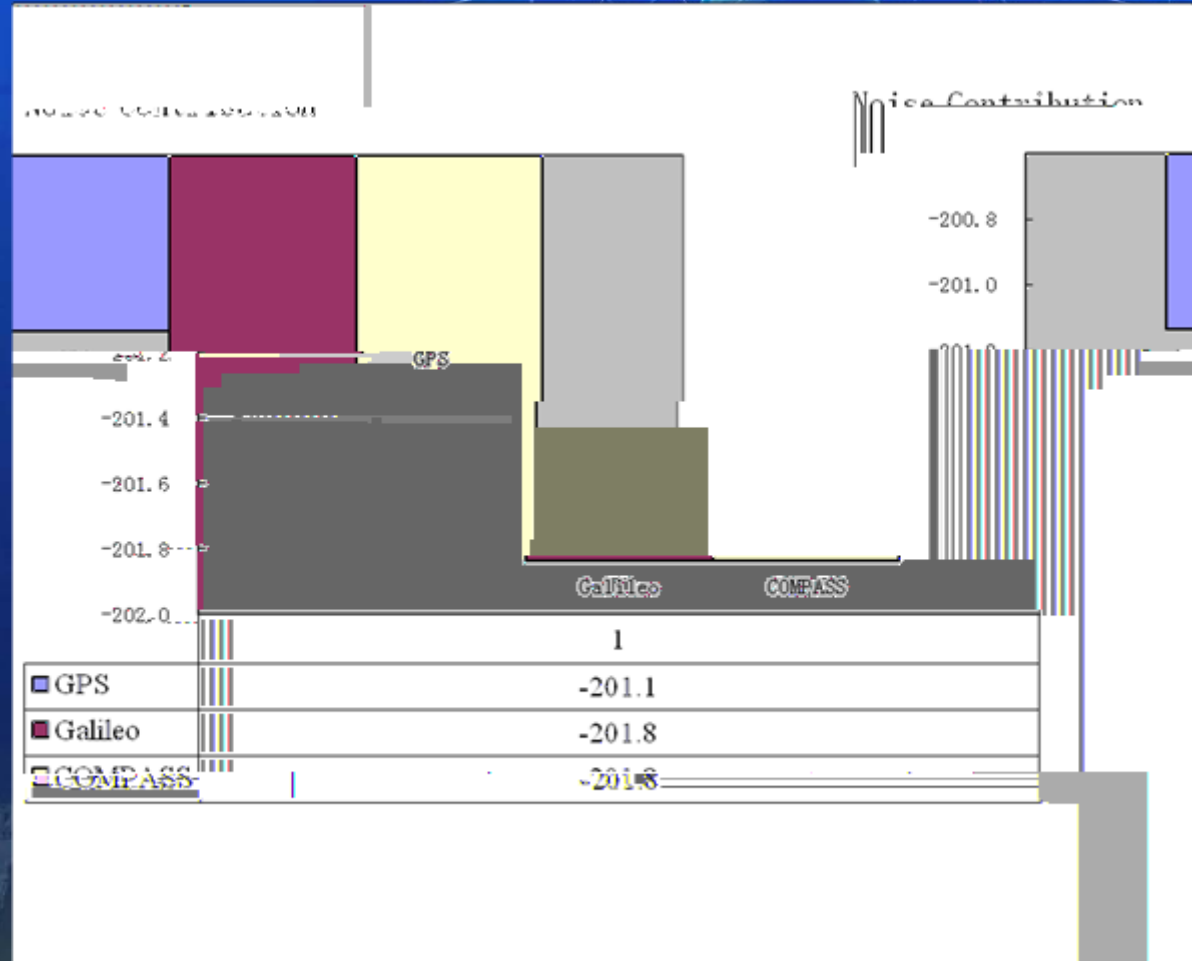
Example 1: Noise Contribution of L1C/B1C/E1OS

	GPS L1C	GPS L1CA	GPS L1P	WAAS L1CA	Galileo E1OS	EGNOS E1CA	COMPASS MEO B1C	COMPASS GEO B1C
Maximum Received Power (dBW)	-152	-153	-150	-152.5	-152	-155	-152	-153
Minimum Received Power (dBW)	-157	-158.5	-161.5	-158.5	-157	-161	-157	-157.7
SSC(dB/Hz)	-65.4	-68.1	-68.1	-68.1	-65.4	-68.1	-65.4	-65.4
Gagg (dB)	13.1	13.1	13.1	6.7	11.5	6.4	11.5	11.2
Noise Contribution (dBW/Hz)	-204.3	-208	-205	-213.9	-205.9	-216.7	-205.9	-207.2
Thermal noise (dBW/Hz)	-204							
GPS noise contribution (dBW/Hz)	-201.1	-200.6		-203.6	NA			
Galileo noise contribution (dBW/Hz)	NA				-201.8	-203.8	NA	
COMPASS noise contribution (dBW/Hz)	NA						-201.8	-202.3
Total noise excluding regional system (dBW/Hz)	-197.5							



Example 1: Noise Contribution of L1C/B1C/E10S

- GPS, Galileo and BeiDou have comparable noise contribution level;
- The maximum difference is only 0.7dB.





Example 1: Noise Contribution of L1C/B1C/E1OS

C/N0 (dB/Hz)	GPS L1C	Galileo E1OS	COMPASS MEO B1C
Maximum	45.5	45.5	45.5
Minimum	40.5	40.5	40.5

- If all the signals adopt same minimum/maximum received power, the minimum/maximum C/N0 for all signals are common.
- This will be beneficial and equal for all the GNSSs as well as users.



Example 2: DOPs Improvement percentage with Compass

Global Area	GDOP	HDOP	VDOP
GPS	48.1%	45.8%	47.9%
GPS+GLONASS	33.9%	31.8%	33.9%
GPS + GLONASS + Galileo	23.6%	24.6%	24.6%

Europe Area	GDOP	HDOP	VDOP
GPS	49.7%	48.9%	48.7%
GPS+GLONASS	34.0%	33.3%	33.8%
GPS + GLONASS + Galileo	23.8%	24.2%	23.4%



Example 3: Calculation for Visible Satellites

➤ BeiDou notably improves the visibility of satellites in high elevation angles.

scheme	30° (90%>)		40° (90%>)	
	min	mean	min	mean
GPS	3	3.6	1	2.1
GPS+BeiDou	7	9.4	3	5.9
GPS+GLONASS	4	6.4	2	3.8
GPS+GLONASS+BeiDou	8	12.2	5	7.9
GPS+ GLONASS+GALILEO	8	10.8	5	6.8
GPS+ GLONASS+GALILEO+BeiDou	12	16.6	7	10.1



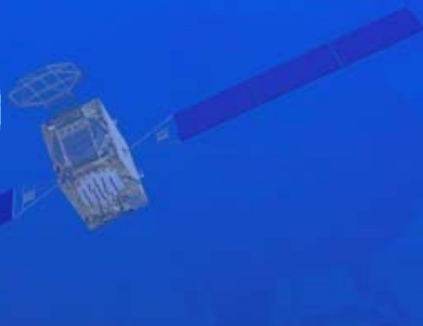
Conclusions

- ◆ Multi-GNSSs is good for users.
- ◆ GNSS compatibility is a critical and technical issue for all system providers with a common goal for better user applications;
- ◆ ICG is seeking its role, ways forward and relationship with other coordination platforms to promote civil PNT services;
- ◆ Multiple compatibility coordination is beneficial to find solutions of issues of common interest.



Future works

- ◆ Some technical issues to discuss in order to achieve multiple compatibility:
 - Establishing receiver models which can be accepted by all GNSSs and determining the relevant parameters.
 - Determining the minimum receiver C/N_0 and reasonable protective threshold.
 - determining the reference assumptions for computations, etc.



Thanks for your attention!

beidouint@beidou.gov.cn

Serve the world Benefit the mankind
quality, safety, application and benefit