International Committee on
Global Navigation Satellite Systems

March, 2010

ICG WORKING GROUP ON COMPATIBILITY & INTEROPERABILITY

Global and Regional Navigation Satellite Systems and Satellite-based Augmentations

INDUSTRY AND USER COMMUNITY QUESTIONNAIRE

Dear Respondent:

The ICG working group on compatibility and interoperability invites you to provide us with answers to each item in this questionnaire to the best of your ability. The intent is to obtain worldwide input from industry, academic institutions, and other representatives of the GNSS user community with technical expertise regarding GNSS signals and other system characteristics which, from your perspective, aid or hinder the combined use of these signals in applications for which you are responsible or for which you supply equipment or services.

First, please fill-in the following information:

NAME: _____

AFFILIATION: _____

APPLICATION SECTOR(S) YOU REPRESENT OR DESIGN/MANUFACTURE EQUIPMENT FOR:

_____

Before beginning the questionnaire, please refer to briefings which describe current and planned GNSS signals from GPS (U.S.), GLONASS (Russia), Galileo (Europe), Compass (China), QZSS (Japan), and IRNSS (India). These are available at the following web site:

http://www.unoosa.org/oosa/SAP/gnss/icg/icg04/presentations.html

Once you have completed the remainder of the questionnaire, please return a MS Word or Adobe PDF version by e-mail to the following individuals:

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The ICG Providers Forum, comprised of the six system providers mentioned above, has developed the following working definition of GNSS interoperability:

> ***Interoperability*** refers to the ability of global and regional navigation satellite systems and augmentations and the services they provide to be used together to provide better capabilities at the user level than would be achieved by relying solely on the open signals of one system
>
> - Interoperability allows navigation with signals from different systems with minimal additional receiver cost or complexity.
> - Multiple constellations broadcasting interoperable open signals will result in improved observed geometry, increasing end user accuracy everywhere and improving service availability in environments where satellite visibility is often obscured.
> - Geodetic reference frames realization and system time steerage standards should adhere to existing international standards to the maximum extent practical.
> - Any additional solutions to improve interoperability are encouraged.

Please consider this definition in your answers or if your definition of GNSS interoperability is different from this one, please provide this definition below:

QUESTIONS

Some of the questions below ask you to grade certain signal characteristics as to their importance in overall interoperability considerations for a particular type of application. We understand there may be different answers for different products or applications, and there will be the opportunity for different answers for each type of product or application. Please feel free to explain your answers in as much detail as you would like, by typing in additional text in the blank rows below each bullet.

1. On a scale of one to five, with five being most important and one being least important, please score each performance characteristic below in terms of its importance as a potential benefit of using signals from two or more global and/or regional navigation satellite systems for your area of GNSS application.

a. Improved accuracy	1 2 3 4 5
b. Improved availability	1 2 3 4 5
c. Quicker time to first fix	1 2 3 4 5
d. Better in-door signal tracking	1 2 3 4 5
e. Greater protection against intentional or unintentional radio frequency interference, and/or spoofing	1 2 3 4 5

2. Are there any other characteristics that should be considered a benefit of using two or more GNSS?

_____

3. On a scale of minus five to plus five, with negative five representing the greatest performance detriment and positive five representing the greatest performance benefit, , please quantify the detriment/benefit of each characteristic below on increasing the performance of multi-system receivers vs. single system receivers:

a. common carrier frequencies	-1 -2 -3 -4 -5 0 1 2 3 4 5
b. uncommon carrier frequency bands (frequency diversity)	-1 -2 -3 -4 -5 0 1 2 3 4 5
c. Spectral separation within the same frequency band* * Spectral separation refers to different modulations on the same center frequency such as a BPSK 1 and a BOC signal centered on 1575.42 MHz or two signals in the same band like 960-1215 MHz but on two different center frequencies, regardless of the services that the separated signals provide.	-1 -2 -3 -4 -5 0 1 2 3 4 5
d. Uncommon signal differentiation (CDMA vs. FDMA)	-1 -2 -3 -4 -5 0 1 2 3 4 5
e. Common signal power spectra	-1 -2 -3 -4 -5 0 1 2 3 4 5
f. Common signal modulation types	-1 -2 -3 -4 -5 0 1 2 3 4 5
g. Common data message rate	-1 -2 -3 -4 -5 0 1 2 3 4 5
h. Common message format	-1 -2 -3 -4 -5 0 1 2 3 4 5
i. Common system performance metrics (equivalency of single system accuracy (URE), availability, etc.)	-1 -2 -3 -4 -5 0 1 2 3 4 5
j. Coincident reference systems	-1 -2 -3 -4 -5 0 1 2 3 4 5
k. Coincident system times	-1 -2 -3 -4 -5 0 1 2 3 4 5

4. When considering the use of multiple GNSS, with five being most important and one being not very important, please rank the importance of the following service related considerations:

a. The provision of service assurances such as a commitment to maintain constellation performance	1 2 3 4 5
b. Publication of a service performance standard or specification	1 2 3 4 5
c. The issuance of notices when service may degrade due to maintenance or outage	1 2 3 4 5

5. On a scale of minus five to plus five, with negative five representing the greatest detrimental impact and positive five representing the greatest beneficial impact, please quantify the impact of each characteristic below on the cost, power consumption, and size/weight of multi-system receivers vs. single system receivers:

a. common carrier frequencies i. Cost ii. Power consumption iii. Size/Weight	 -1 -2 -3 -4 -5 0 1 2 3 4 5 -1 -2 -3 -4 -5 0 1 2 3 4 5 -1 -2 -3 -4 -5 b 1 2 3 4 5
b. uncommon carrier frequency bands (frequency diversity) i. Cost ii. Power consumption iii. Size/Weight	 -1 -2 -3 -4 -5 0 1 2 3 4 5 -1 -2 -3 -4 -5 0 1 2 3 4 5 -1 -2 -3 -4 -5 0 1 2 3 4 5

c. Spectral separation within the same frequency band* i. Cost ii. Power consumption iii. Size/Weight * Spectral separation refers to different modulations on the same center frequency such as a BPSK 1 and a BOC signal centered on 1575.42 MHz or two signals in the same band like 960-1215 MHz but on two different center frequencies, regardless of the services that the separated signals provide.	-1 -2 -3 -4 -5 0 1 2 3 4 5 -1 -2 -3 -4 -5 0 1 2 3 4 5 -1 -2 -3 -4 -5 0 1 2 3 4 5 -1 -2 -3 -4 -5 0 1 2 3 4 5
d. Uncommon signal differentiation (CDMA vs. FDMA) i. Cost ii. Power consumption iii. Size/Weight	-1 -2 -3 -4 -5 0 1 2 3 4 5 -1 -2 -3 -4 -5 0 1 2 3 4 5 -1 -2 -3 -4 -5 0 1 2 3 4 5
e. Common signal power spectra (Power Spectral Density) i. Cost ii. Power consumption iii. Size/Weight	-1 -2 -3 -4 -5 0 1 2 3 4 5 -1 -2 -3 -4 -5 0 1 2 3 4 5 -1 -2 -3 -4 -5 0 1 2 3 4 5
f. Common signal modulation types i. Cost ii. Power consumption	-1 -2 -3 -4 -5 0 1 2 3 4 5 -1 -2 -3 -4 -5 0 1 2 3 4 5 -1 -2 -3 -4 -5

iii. Size/Weight	0 1 2 3 4 5
g. Common data message rate	-1 -2 -3 -4 -5
i. Cost	0 1 2 3 4 5
ii. Power consumption	-1 -2 -3 -4 -5 0 1 2 3 4 5
iii. Size/Weight	-1 -2 -3 -4 -5 0 1 2 3 4 5
h. Common message format	-1 -2 -3 -4 -5
i. Cost	0 1 2 3 4 5
ii. Power consumption	-1 -2 -3 -4 -5 0 1 2 3 4 5
iii. Size/Weight	-1 -2 -3 -4 -5 0 1 2 3 4 5
i. Common system performance metrics (equivalency of single system accuracy, availability, etc.)	-1 -2 -3 -4 -5 0 1 2 3 4 5
i. Cost	-1 -2 -3 -4 -5 0 1 2 3 4 5
ii. Power consumption	-1 -2 -3 -4 -5 0 1 2 3 4 5
iii. Size/Weight	
j. Coincident reference systems	-1 -2 -3 -4 -5
i. Cost	0 1 2 3 4 5
ii. Power consumption	-1 -2 -3 -4 -5 0 1 2 3 4 5
iii. Size/Weight	-1 -2 -3 -4 -5 0 1 2 3 4 5

k. Coincident system times i. Cost ii. Power consumption iii. Size/Weight	-1 -2 -3 -4 -5 0 1 2 3 4 5 -1 -2 -3 -4 -5 0 1 2 3 4 5 -1 -2 -3 -4 -5 0 1 2 3 4 5

6. Would each of these characteristics also impact the cost of associated differential systems, and or the cost of data processing?

7. Are there any other criteria that should be considered a potential cost of using signals from more than one GNSS?

8. Are there any other signal parameters that should be considered?

9. On a scale of minus five to plus five, with negative five representing the greatest detrimental impact and positive five representing the greatest beneficial impact, evaluate the impact that small carrier frequency shifts (up to 200 - 250 KHz for signals in common frequency bands) for signals from an additional GNSS would have on the complexity of a multi-system receiver, and quality of signal processing and performance.

-1 -2 -3 -4 -5
0 1 2 3 4 5

10. Is there a limit to how many satellites-in-view from multiple GNSS constellations your application can use, beyond which there is no benefit or even a detriment to your areas of GNSS application?

11. On a scale of one to five, with five being most important and one being least important, please evaluate whether collaboration between system providers and integration of one or more GNSS at the space segment or ground control segment-level would be beneficial to user-level interoperability

1 2 3 4 5