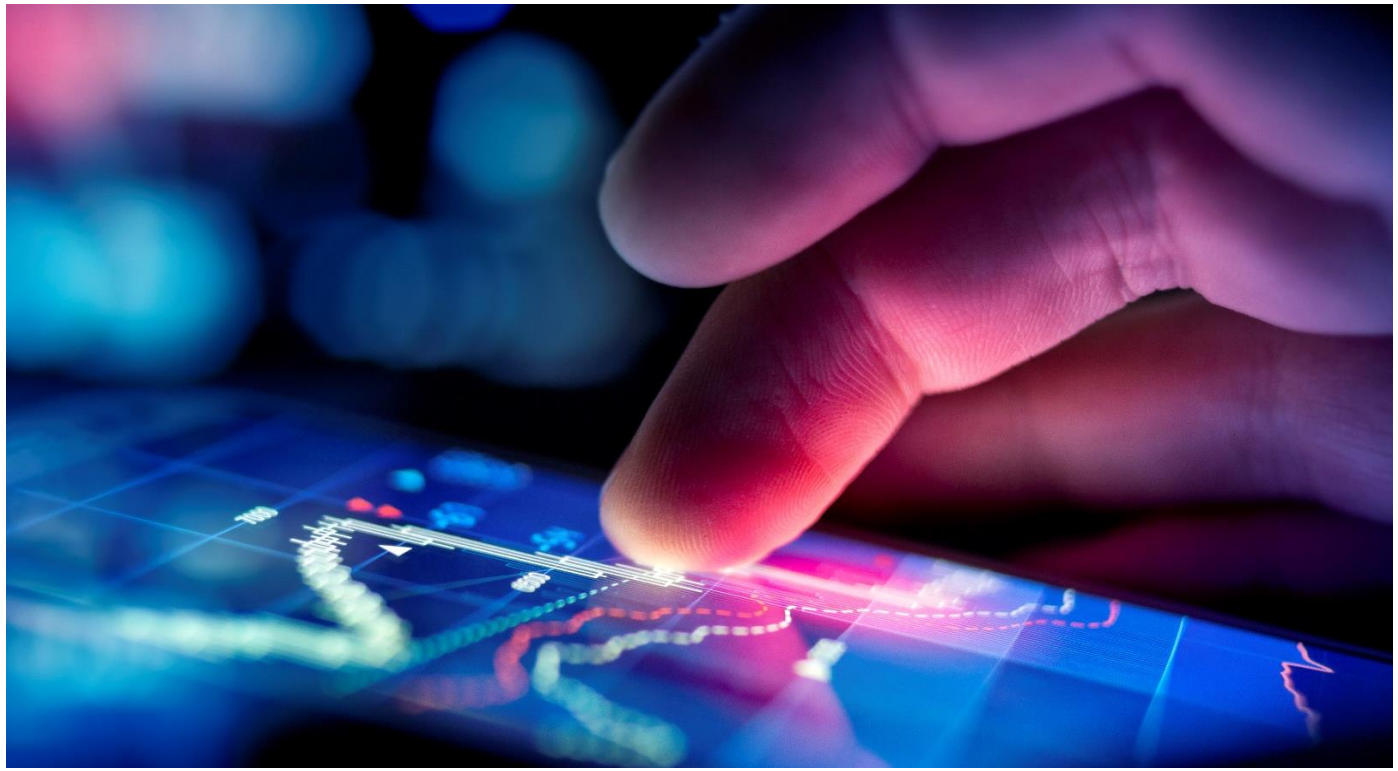
European
Global Navigation
Satellite Systems
Agency

DUAL FREQUENCY Q&As



Prague, 4 June 2018

1. What exactly is dual-frequency navigation for smartphones? Is it possible to have dual-frequency navigation without Galileo, for example?

Global Navigation Satellite System (GNSS) signals are (mainly) provided through three frequencies in the L band:

- Upper (L1, E1, B1)
- Lower (L5, E5, B2)
- Medium (L2, E6, B3)

* L stands for the GPS or Glonass frequencies, E for the Galileo ones and B for Beidou, however they refer to the same frequency (i.e. L1 is pretty much the same as E1).

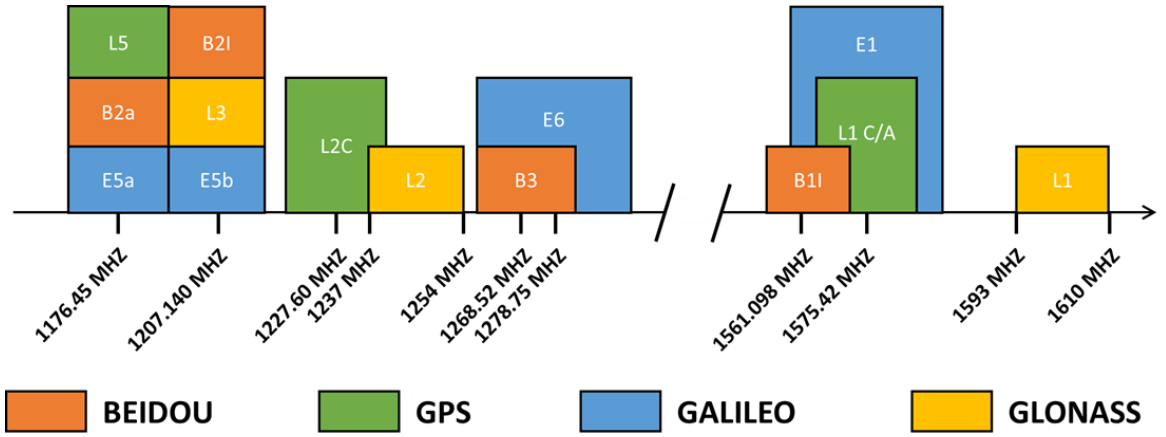


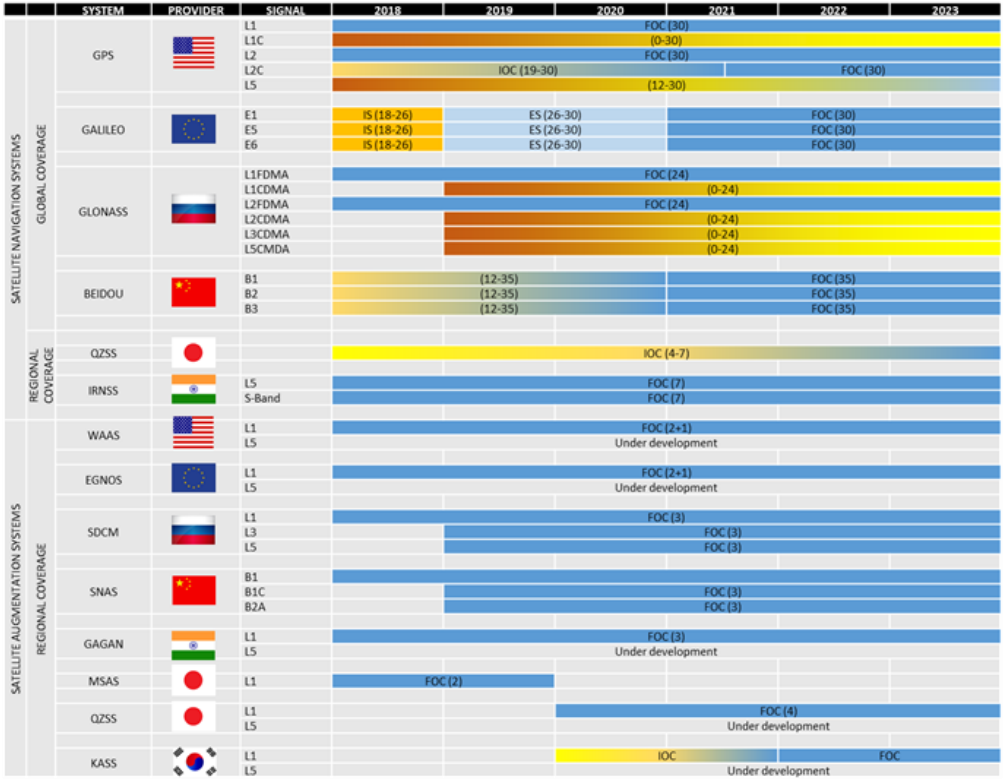
Figure 1GNSS signals in the L Band

In simple terms, each frequency carries an amount of information from the satellites to the receiver, so that the receiver can calculate a position. Up to now, only sophisticated equipment used in professional areas, such as surveying or agriculture, were able to benefit from multiple GNSS frequencies (2 or even 3), while mass market devices such as smartphones had to rely on single (L1-E1) frequency receivers, due to cost considerations, battery capacity, etc.

Thanks to the first dual-frequency receivers for smartphones (the first being the BCM4775 launched by Broadcom, with other companies following suit), now the mass market can also benefit from multi frequency. This will result in better positioning, especially in urban environments.

Technically, it is not only the addition of Galileo that has enabled dual GNSS (from the graph above you can see that GPS, Glonass and Beidou also have signals allocated in the L5 bandwidth, making it possible to have an L1/L5 dual-frequency combination). Nevertheless, the Galileo constellation has the most satellites with E1/L1 and E5/L5 frequency capabilities. This is because the Galileo satellites are all capable of broadcasting in E5/ L5, while not all GPS and Glonass satellites have this feature, even though the constellations are 'more complete'. Indeed, legacy GPS satellites do not broadcast in L5, as this a feature that only the newer recently launched satellites have (in the case of GPS – those launched after 2010, in the GPS Block IIF series, while Glonass satellites will embed this feature only with launches after 2018). In conclusion, Galileo is currently a key enabler of E1/E5 dual frequency.

Figure 2 Planning based upon publicly available information as of May 2018, © European GNSS Agency 2018



Development plans

The figure on the left shows the current development plans for each satellite navigation system over the next five years. The signal sets, status and number of satellites are reported as follows:

Signal status	Number of satellites (X)
No service	
Initial services	
Full services	

2. There is talk of decimetre level positioning with the new technology. So how does the existing tech in smartphones compare?

Nowadays, the accuracy in smartphones provided by GNSS is in the order of 5 meters or more, especially when part of the sky is obstructed by buildings or trees, while the new dual-frequency chipsets promise accuracy of a few decimetres.

3. In addition to increased accuracy, what other kinds of consumer benefits for augmented reality will this new technology bring?

Dual-frequency navigation is a game changer for augmented reality applications. Technically, application developers will be able to take advantage of decimetre level accuracy and the greater availability of accurate positioning when developing their applications. We believe that this will result in a significantly better user experience: it will be easier to navigate in the augmented reality and to tag things in the augmented space.

What's more, some professional applications, such as mapping or productivity apps, which have been run on dedicated devices up to now, might also become available in smartphones.

4. What kind of consumer benefits will dual-frequency navigation bring for pedestrian and vehicle navigation? Again, is it just increased accuracy, or can we expect more?

We expect the experiences of users of pedestrian and vehicle navigation applications to be positively enhanced, especially in urban environments characterized by high buildings, and the performance gain compared to the previous generation of handsets will be very evident, e.g.:

- The time-to-first-fix (i.e. the time a receiver takes to calculate the first position once the device is turned on) will decrease. This will allow users to quickly understand the direction to take when exiting a metro station, for example.
- Not only will users be able to locate themselves in parallel streets without error, but even lane-level car navigation can be implemented. Similarly, our phones will be able to tell us which side of the sidewalk we are walking on, which can enable a number of innovative applications (e.g. parking slots).
- Turn-by-turn navigation will be significantly smoother, resulting in enhanced safety and less time spent in the car.
- Signals transmitted in L5/E5 are by design more robust against interference than those in L1/E1, so the user will experience much better continuity of service (the signal will not be lost so easily).

For the same reason as above, the L5/E5 signals are much more resistant to the "multipath" effect (where signals reflected by buildings are mistakenly taken as the true signal), which means that users will have greater accuracy than when using the L1/E1 signals only.

5. Are there any other mobile manufacturers that you're working with on the technology?

A key component of the GSA's mission is to engage the market and to ensure uptake of Galileo. As you can see from the GSA Market Report, the mass market segment (smartphones and road devices) is the most relevant one (i.e. accounting for more than 50% of users). The GSA is very keen to work with the entire mobile ecosystem (from chipset manufacturers to application developers) to ensure adoption of Galileo. This also includes mobile manufacturers, e.g. through testing of chipsets and devices. The GSA is collaborating with many smartphones vendors and the main chipset manufactures towards the smooth integration of Galileo. While we cannot mention any names, you can refer to usegalileo.eu[1] to find out which devices have embedded Galileo.

We are thrilled about the entry into the market of the first dual-GNSS smartphone and we are pretty sure that the Xiaomi Mi 8 will be the first in a long list.

The introduction of dual-frequency multi-constellation (GPS+Galileo) capacity in the new Xiaomi Mi 8 makes this phone unique, as it is the only one on the market up to now to support these features

[1] The next release of usegalileo.eu is planned by mid-July, with a broader segment portfolio and new applications and devices.

Dual frequency multi constellation will make our lives easier by helping all location-based applications to calculate our position more accurately than ever. On top of that, the speed of calculating our position when we turn on the phone will be increased. Another immediate improvement that users will notice is that their position will be more accurately calculated, especially when they are surrounded by buildings in the centre of big cities.

Pedestrian navigation in cities will improve so much that our phones will be able to tell us which side of the sidewalk we are on, enabling them to show us the way to our destination with unprecedented precision.

The next generation of augmented reality applications will definitely be impacted by this accuracy improvement, making their "virtual" world more precise by locating the user with decimetre accuracy. This leads us to expect a bright future for GNSS in smartphones, and especially for European GNSS (Galileo and EGNOS), which will play an even greater role when more dual-frequency devices appear on the market, as they surely will!

References:

- GSA/ GNSS Technology Market Report
- Broadcom
- GPS World
- IEEE Spectrum