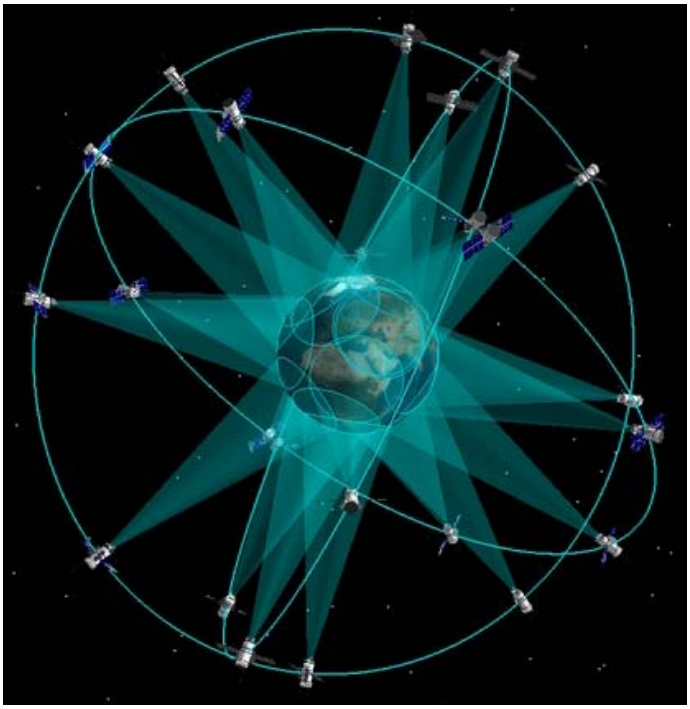
THE EVOLUTION OF GNSS BASED SFN NETWORK SYNCRONISATION SYSTEMS *(GPS, GLONASS, etc.)*

Over a year ago, we published a technical note entitled "THE STABLE SYNCHRONIZATION OF SINGLE FREQUENCY NETWORKS USING NEW CONCEPT GPS" in which were described the specific, not easily implementable features required for GPS receivers/synchronizers employed in digital, single frequency radio-TV broadcasting networks (SFN - Single Frequency Network) necessary to avoid de-synchronization issues and the ensuing serious disturbs/interferences that may result from them. This technical note illustrates the latest developments that make the use of time and frequency references (1PPS and 10MHz) based upon navigation satellite reception (GNSS - Global Navigation Satellite System: GPS, GLONASS, etc.) safer and more stable even under extreme conditions. Thanks to these further implementations, we feel that it can be said that, today, GNSS based synchronisation systems, besides being safe and easily installable, represent the technologically and economically most beneficial solution..

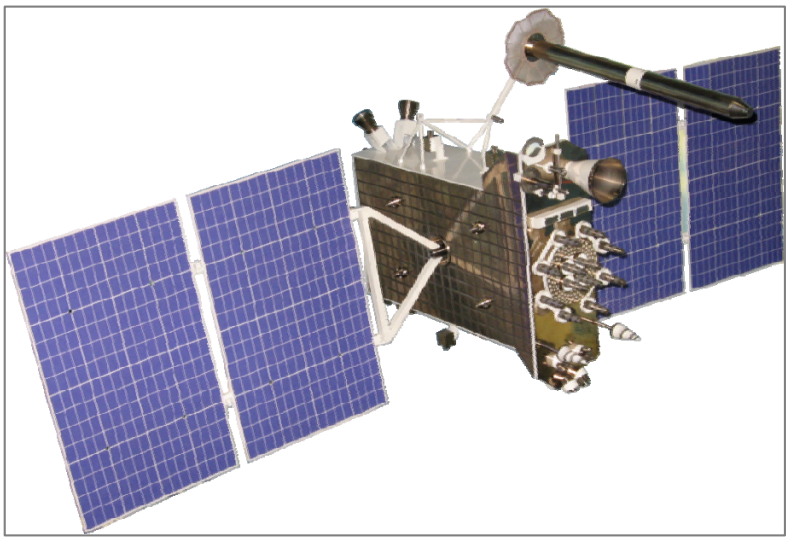
Digital, single frequency radio-TV broadcasting network *(SFN)* synchronisation systems, be they based upon DVB-T, DVB-T2, ISDB-T or other standards, are, for the most part, based upon the reception of signals transmitted by the American "GPS" navigation satellite network. Considering the numerous worldwide applications based upon its use, the GPS service, provided by 24 satellites *(plus reserves)*, is considered to be safe and its deactivation is deemed to be virtually impossible. Since 2012, another satellite navigation system, called GLONASS *(Global'naya Navigatsionnaya Sputnikovaya Sistema)*, also based upon a 24 satellite constellation, has become operational. The Russian GLONASS system had been abandoned in 1996, only to be completed and resumed in December 2011. Besides GPS, GLONASS is currently the only other fully operational global satellite navigation system. Other systems are under development and implementation: the European "GALILEO" and the Chinese "BEIDOU" *(that will be called "COMPASS")*, besides many others planned or operational only on a regional scale. Both systems *(GPS and GLONASS)* employ the UTC *(Coordinated Universal Time)* and are therefore compatible having the same "time base" *(subject to the necessary conversions / adaptations).*



Picture 1 The GLONASS satellites constellation

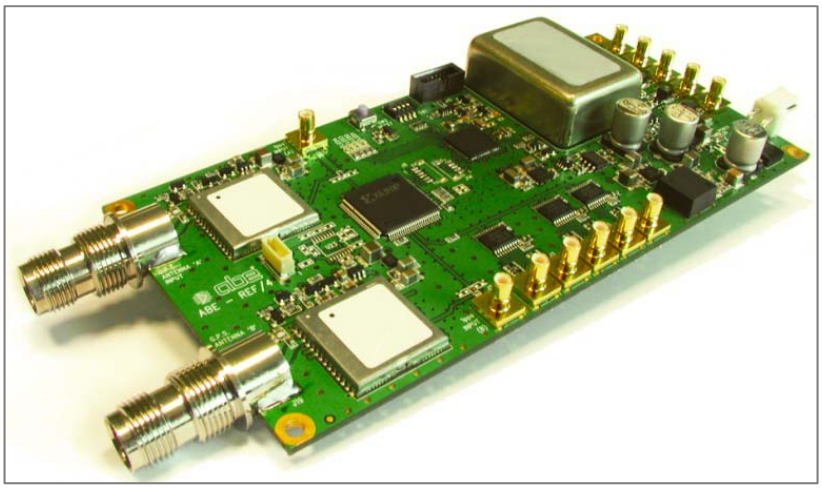
The frequency employed by GLONASS is of roughly 1602MHz: 27MHz higher than the one of GPS.
The availability of a satellite navigation system alternative to GPS and operating on a different frequency provides three benefits:

- The availability of an alternative service provider, allowing a significant increase in the confidence that at least one service will always be active *(although, as stated above, the likelihood of the GPS service being deactivated is reasonably only theoretical)*
- The reception of two services on two different frequencies so that, should one frequency be disturbed, the other might not be *(for example, when harmonics of transmitters in the vicinity of the GNSS receiver/synchroniser fall within the reception band of one of the two satellite systems)*
- The reception of multiple satellites, thus decreasing the likelihood of signal dropout and therefore the chances of holdover



Picture 2 A GLONASS satellite

A considerations and a clarification must however be given with regard to the receiving antennas. In the January 2012 technical paper *("THE STABLE SYNCHRONIZATION OF SINGLE FREQUENCY NETWORKS USING NEW CONCEPT GPS")* the subject of receiving antennas had already been tackled in detail: now, to receive both satellite systems at the same time *(with the same antenna and the same radio)*, the antennas need to be able to receive both the 1575MHz *(GPS)* and the 1602MHz *(GLONASS)* frequencies. There is, however, another option: to use twin radio receivers/synchronisers with one aerial filtered to receive GPS only and the other to receive GLONASS only. This way, the strong radiofrequency emissions that may be present in transmission sites in which GNSS receivers/synchronisers are installed and that could "block", by saturating the receiving antennas' pre-amplifiers, will be less likely to do so in both frequency bands. In its navigation satellite reception based receivers/synchronisers, ABE Elettronica has also implemented the GLONASS system; the receiver board can, in fact, be equipped with one or two radio receivers, both capable of receiving both GPS and GLONASS satellites.



Picture 3 A GNSS circuit board equipped with 2 bi-standard receivers (GPS + GLONASS) and a reference oven oscillator

Besides this, an anti-jamming function has also been implemented to reduce the chance that any "jammers" may obscure satellite reception.

In addition to all the above, we would also like to mention the special functions, created using proprietary algorithms, implemented on the GNSS synchronisers developed by ABE Elettronica:

- "ZERO CUMULATED ERROR": very long term cumulated error virtually equal to zero
- "SINGLE SATELLITE OPERATION": the capability to operate also in the case of reception of a single satellite
- "FAST COLD START-UP": allows quick cold start times of the equipment *(typically one minute)* without creating desynchronization problems
- "HOLDOVER ERROR RECOVERY": the capability of correcting the holdover error cumulated during any satellite signal dropout periods

For a detailed description of the above functions, we direct you the January 2012 Technical Note: "THE STABLE SYNCHRONIZATION OF SINGLE FREQUENCY NETWORKS USING NEW CONCEPT GPS".

Picture 4 The GNS1000 receiver/synchroniser with 2 preamplified antennas

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