# Proposal Drafted for Allocating Space-to-Space Frequencies in the GPS Spectrum Bands

Radionavigation Satellite Service (RNSS) systems such as the U.S. Global Positioning System (GPS) and the Russian Global Navigation Satellite System (GLONASS) are primarily being used today in the space-to-Earth direction (i.e., from GPS satellite to Earth user) for a broad range of applications such as geological surveying; aircraft, automobile, and maritime navigation; hiking and mountain climbing; and precision farming and mining. However, these navigation systems are being used increasingly in space.

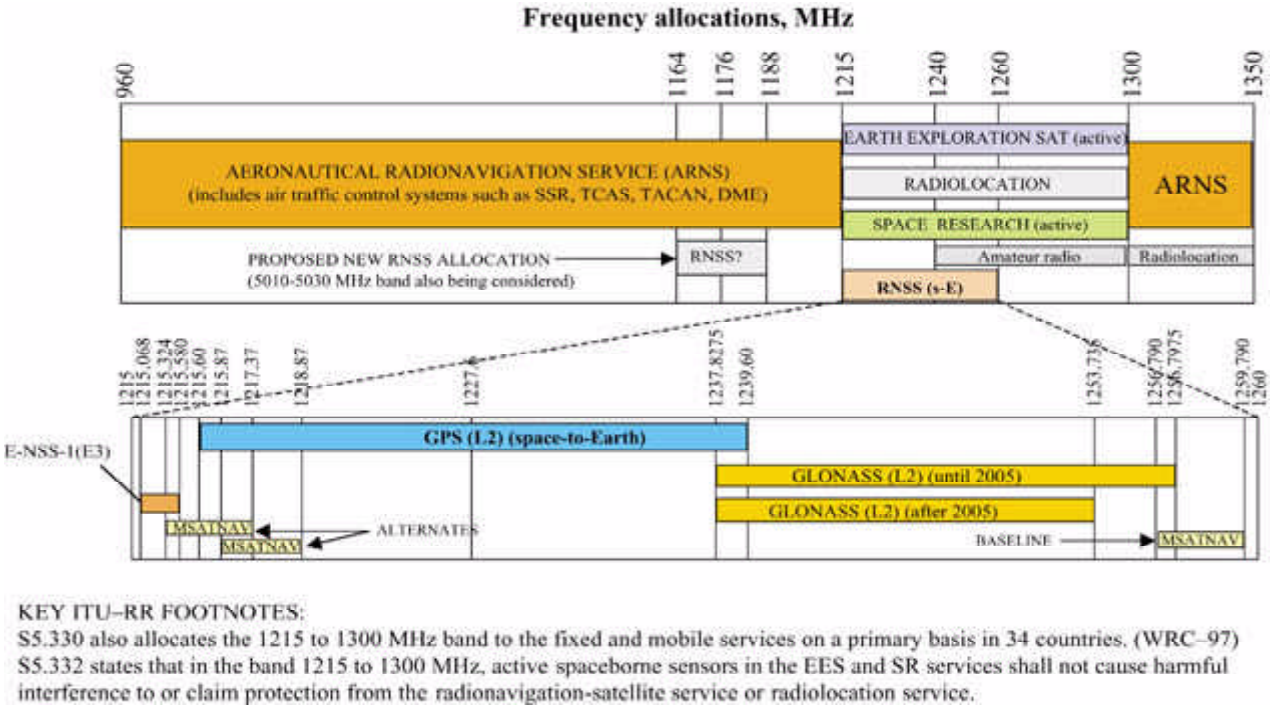
Beginning with the launch of the TOPEX/Poseidon remote-sensing mission in 1992, over 90 GPS receivers have flown onboard spacecraft for such applications as real-time spacecraft navigation, three-axis attitude control, precise time synchronization, precision orbit determination, and atmospheric profiling. In addition to use onboard many science spacecraft, GPS has been used or is planned to be used onboard the shuttles, the International Space Station, the International Space Station Emergency Crew Return Vehicle, and many commercial satellite systems such as Orbcomm, Globalstar, and Teledesic.

From a frequency spectrum standpoint, however, one important difference between the space and terrestrial uses of GPS is that it is being used in space with no interference protection. This is because there is no frequency allocation for the space-to-space use of GPS (i.e., from GPS satellite to user spacecraft) in the International Telecommunications Union (ITU) regulatory table of frequency allocations. If another space-based or ground-based radio system interferes with a spaceborne GPS user, the spaceborne user presently has no recourse other than to accept the interference. Consequently, for the past year and a half, the NASA Glenn Research Center at Lewis Field and other Government agencies have been working within ITU toward obtaining a GPS space-to-space allocation at the next World Radio Conference in the year 2000 (WRC–2000).

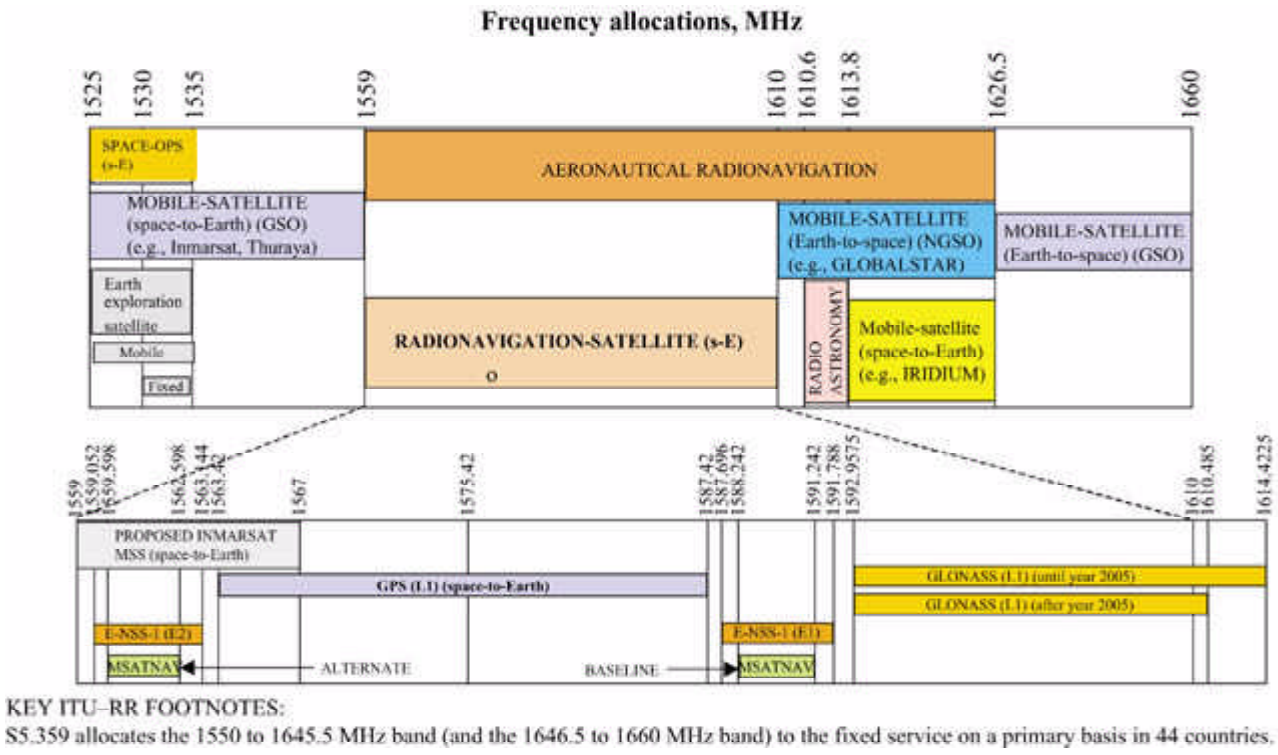
Numerous interference studies have been conducted in support of a primary space-to-space allocation in the 1215- to 1260-MHz and 1559- to 1610-MHz RNSS bands. Most of these studies and analyses were performed by Glenn and submitted as U.S. input documents to the international Working Party 8D meetings in Geneva, Switzerland. In the structure of the ITU, Working Party 8D is responsible for frequency spectrum issues in the RNSS and the mobile satellite service (MSS). The full texts of the studies are available from the ITU web site under Working Party 8D contributions.

Note that because spaceborne RNSS receivers operate in a receive-only mode with navigation signals already being broadcast toward the Earth, the addition of a space-to-space allocation will not result in interference with other systems. A space-based RNSS receiver, however, could experience interference from systems of other services, including

intraservice interference from other RNSS systems. The interference scenarios examined in the studies can be inferred from the following frequency allocation charts. In these charts, services labeled in all capital letters (e.g., "ARNS") have primary status, whereas those labeled with sentence-style capitalization (e.g., "Amateur radio") have secondary status (i.e., a service with secondary status cannot claim interference protection from or cause harmful interference to a service with primary status).




*Frequency allocations in the radio spectrum including the 1215- to 1260-MHz frequency band.*




*Frequency allocations in the radio spectrum including the 1559- to 1610-MHz frequency band.*

The top chart shows the ITU frequency allocations in the 960- to 1350-MHz range. Within this range, RNSS has a primary allocation in the space-to-Earth direction in the 1215- to 1260-MHz band. Active sensors (e.g., synthetic aperture radars) in the Earth exploration satellite (EES) service and space research (SR) service along with the radiolocation service also have primary status in the band. In addition, by footnote S5.330, fixed and mobile services also have primary status in some 34 countries. Interservice interference analyses to assess the sensitivity of space-based RNSS receivers to transmitters in these services were therefore conducted for all these cases.

The bottom portion of the top chart is an expanded view of the 1215- to 1260-MHz RNSS band showing the frequency plans for the current GPS and GLONASS systems as well as plans for some proposed European navigation satellite systems. These include the 48-satellite E–NSS–1 system from the European Space Agency, the 36-satellite MSATNAV system from the French space agency, and the 64-satellite LSATNAV system also from France. (Although not shown in the chart, LSATNAV is planned to have the same frequency plan as MSATNAV.) Europe has also proposed the Galileo system, which is still being defined. Note that navigation signals transmitted from the satellites of one RNSS system (e.g., MSATNAV) can potentially interfere with spaceborne receivers of a different RNSS system (e.g., GPS). Therefore, intraservice interference studies also were performed to evaluate this scenario.

The bottom chart shows the frequency allocations in the 1525- to 1660-MHz range.

Within this range, RNSS has a primary allocation in the space-to-Earth direction in the 1559- to 1610-MHz band. Note also that the Aeronautical Radionavigation Service (ARNS) also has primary status in the band. In addition, by footnote S5.359, fixed service has primary status in some 44 countries. Thus, interservice interference analyses were performed to evaluate the sensitivity of space-based RNSS receivers to transmitters in these two services.

The bottom portion of the bottom chart is an expanded view of the 1559- to 1610-MHz RNSS band showing the frequency plans for GPS and GLONASS and the proposed E–NSS–1 and MSATNAV systems. As in the 1215- to 1260-MHz band, intraservice interference analyses were performed to evaluate potential interference between various RNSS systems.

The bottom chart also shows an allocation for mobile satellite service downlinks from geostationary orbit (GSO) satellites immediately below 1559 MHz, an allocation for mobile satellite service uplinks to nongeostationary orbit (NGSO) satellites immediately above 1610 MHz, and another (secondary) allocation for MSS downlinks from NGSO satellites in the 1613.8- to 1626.5-MHz band. An allocation for mobile satellite service uplinks to GSO satellites also exists in the 1626.5- to 1660-MHz band. There is concern among some administrations that mobile satellite service systems using these bands could be restricted if their out-of-band emissions cause excessive interference to RNSS space receivers. A number of out-of-band interference analyses were therefore conducted, although not all were completed in time to be submitted to the Working Party 8D meeting last April.

Collectively, the studies show that RNSS spaceborne receivers can operate satisfactorily in the current interference environment. From the results of these studies, a draft Conference Preparatory Meeting text for the World Radio Conference in the year 2000 has been written and approved for the space-to-space issue. NASA is optimistic that this will provide the basis for a GPS space allocation at the World Radio Conference and, hence, protect future space-to-space GPS users from interference.

**Find out more about this research http://www.itu.int/home/index.html.**

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