Robust UWB Wireless

Activity:

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Abstract:

ESA has been investigating the use of wireless network technologies for intra-spacecraft applications for several years. There is still a need for a technological solution to diverse types of applications which require a very high level of robustness and a variety of data-rates, while having a very low impact on other systems operating in its proximity. Studies have shown that electromagnetic compatibility (EMC) has to be carefully managed when integrating wireless interfaces within a closed metallic cavity among other electronic payloads, for both radiated susceptibility and radiated emission levels. Due to its extremely wide bandwidth (typically >500 MHz) and its low regulation-based radio frequency power emission per MHz, ultra-wideband (UWB) is a data communication technology that may contribute to reducing the potential EMC issues within spacecraft, launcher or testing environments while giving the users up to several hundreds of Mbps throughput. It is currently commercially using the 3.1-10.6 GHz frequency range, a range which has already been allocated to other parties, therefore justifying the requirements to limit the transmit power to a level where interferences with these parties will be avoided. The FCC power spectral density emission limit for UWB emitters operating in this band is -41.3 dBm/MHz (Part 15 limit).

UWB technologies may be applicable for an extensive range of space applications, principally because of their very low power emissions, their very flexible data transfer rates (e.g. with 100kbps – 1024 Mbps the use of the channel capacity is actually very close to the Shannon limit) and their inherent high resistance to harsh multi-path and interference conditions. Possible applications target sensing systems, command and control busses, EGSE connection to units under test and high-speed instrument data transfer (for instance, newly-designed missions using CCD-based instruments may use several dozens of Spacewire wired links to transfer the imaging data to the mass memory, generating a relatively complex integration task). The wide RF bandwidth of ultra-wideband commercial standards, generally between 500 MHz and 1.3 GHz wide, may very well overcome the issues related to multi-path fading in a set of reflective spacecraft cavities. It is recalled that intra-spacecraft environments are highly reflective ones, which may pose difficulties when integrating more traditional narrow-band wireless systems while keeping the transmit power low. Moreover, low-complexity modulation schemes such as impulse-based UWB may provide a large amount of processing gain so that even two simultaneous transmissions that do collide may both result in a successful data transfer. Regarding security, the extremely short lengths of UWB pulses (in the case of an impulse-based radio) can make them very difficult to intercept, while the high processing gain makes the technology really resistant to jamming (hard to jam all frequencies).
This activity has two major objectives:

1. To assess and evaluate the physical channel of pulse-based ultra-wideband IEEE802.15.4a standard for the following applications and propagation environments:
    a. Wireless sensors for ground testing (at least accelerometers and temperature)
    b. Intra-satellite applications for flight (evaluation in at least three satellites with different cavity architectures)
    c. Inter-stage communication link bridging two launcher avionics buses.
2. To prototype a versatile, highly reliable and deterministic network communication system and protocol stack on top of the IEEE802.15.4a pulse-based UWB wireless physical layer, potentially suitable for accelerometer, on-board data bus and real-time point-to-point data transfer applications. Results will be presented