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Author: Mr. Lacoste Frederic
Centre National d'Etudes Spatiales (CNES), France

Mr. Eric Peragin
Centre National d'Etudes Spatiales (CNES), France
Mr. Jean-Paul Aguttes
Centre National d'Etudes Spatiales (CNES), France
Mr. Vincent Fabbro
Office National d'Etudes et de Recherches Aérospatiales (ONERA), France
Mr. Joel Lemorton
Office National d'Etudes et de Recherches Aérospatiales (ONERA), France
Mr. Rolland Fleury
Telecom Bretagne, France
Mr. Patrick Lassudrie-Duchesne
Telecom Bretagne, France

REACTIVE COMMAND TO LEO SATELLITE USING HF TRANSIONOSPHERIC LINKS: THE HFPE TECHNOLOGICAL EXPERIMENT

Abstract

Huge ground networks or GEO relay satellites are generally studied as potential solutions when LEO satellite systems require reactive TTC. An original way to address reactive TC could be to use ionospheric propagation at HF frequency band. Indeed, communications HF links based on multiple ionospheric bounces have been and are still widely used for terrestrial long distance radiobroadcasting and telecommunications. For reactive TTC purpose, it may be possible to extend this Trans Horizon communications principle by adding a final propagation through the ionosphere after the multiple bounces path. Such a principle could enable to get a worldwide TTC coverage using a limited number of HF ground stations, typically less than 10. It would rely on a worldwide space and time knowledge of ionospheric characteristics. The assessment of the concept feasibility has first required the development of a model able to predict both the multiple bounces terrestrial propagation below the ionosphere and then the final transionospheric link. This software tool has been developed from an existing one used to plan terrestrial point-to-point HF communications: SATIS. A ray launching algorithm based on NeQuick 2 ionospheric profiles has been added to SATIS to address the final path through ionosphere. Then, this modified SATIS software has been intensively used to identify the most favourable ground locations and to assess the availability gain provided by multiple ionospheric bounces. It also gives access to predicted link parameters: frequency, elevation and propagation loss. Finally, preliminary link budget based on these simulations and on the open literature have been performed for TC throughputs in the [10 bps ; 3 kbps] range. A technological experiment, HFPE, is now being prepared to demonstrate and assess the concept performances with a real LEO satellite. The scientific instrument IME-HF from TARANIS satellite is planned to be used in 2015-2016 to collect experimental data for this validation purpose. This paper will give details on both the analyses based on software simulations and on the HFPE experiment.