SYSTEM ENGINEERING AREA

Time Correlation/Synchronization BoF Report and Draft CharterFebruary 2011

Approved:

Ed Greenberg _____ _____

BoF Chair Date

Peter Shames_____ _____

Area Director Date

Executive Summary

This WG will define a set of standards for Time Correlation providing missions with precise approaches to correlate their spacecraft clocks with UTC and laying the foundation for future space networks where synchronized clocks will be an important infrastructural element.

The effort will involve the following:

1) Develop a Green Book on Time Correlation describing:
    - Return (TLM) channel time delay method
    - Proposed methodology using PN Ranging
    - End to End process for missions using Proximity Links
2) Develop a Blue Book to define the parameters and the protocol for the transfer of Time Correlation data, generated in space and on ground, using PN Ranging.
3) Develop a Magenta Book for Time Correlation documenting the recommended practice for using the approaches identified in the Green Book.
4) NOTE: Need for developing a Time Synchronization standard for space networks is not yet ripe. This should be reviewed again in the coming years.

Terminology

Clock correlation	a method by which we relate the reading on a remote clock with the “master timing source” (i.e. UTC)
Clock synchronization	a method of adjusting the remote clock/or the clocks frequency source to maintain its integrated time within an acceptable tolerance to the master clock source.

Objectives

1) Identify and document in a Green Book the current methods used for time correlation and clock synchronization:
    a. Describe approaches for different environments

- Near Earth using Global Positional Satellite (GPS)
- Near Earth Without GPS
  - Using one way data delay coupled with trajectory data
  - Using two way range signal (similar to Tracking and Data Relay Satellite System (TDRSS))
- Deep Space
  - Using one way data delay coupled with trajectory data
  - Using two way range signal method that includes time correlation
  - Local area time zones (i.e. rovers and orbiters around Mars)

b. Identify error sources effecting performance
   i. One way is limited to orbit knowledge
   ii. Two way has range time built in.
   iii. Poorly calibrated factors
c. Determine if there are limiting attributes within the current CCSDS Recommendations (i.e. time tags in SLE services)

2) Develop recommendations for use of identified approaches and their expected performance in a Magenta Book
3) Review current methods for performing Clock correlations and projections to determine if a recommended approach is feasible.
4) Investigate the means to improve performance accuracy, encouraging white papers on the subject. These can then be codified into the proposed Magenta Book or become the subject for new Blue Books
5) Develop advocacy material for utilizing CCSDS PN Ranging for time correlation.
6) Determine the requirements for time synchronization for emerging environments/enterprises.
7) Determine the necessary parameters that need to be exchanged to perform time correlation for each of the documented methodologies. Document parameters & protocols in a Blue Book.

Schedule

Date	Milestone
November 2010	WG charter submitted to SE Area
November 2010	WG Charter Adopted by CESG
January 2011	Green Book organization prepared and work delegated
March. 2011	List and characterize Error Sources within the end to end path
May 2011	Current Time Correlation approaches documented
May 2011	White paper for new methods to achieve improved time correlation using PN ranging and Transponder upgrades
October 2011	Submit draft of Green Book on Current Time Correlation approaches.
October 2011	White Book on recommended approaches for Time Correlation based for various operational environments. (Magenta book track)
January 2012	White book for exchange of parameters for Time Correlation
May 2012	Submit draft Red Book on recommended approaches for Time Correlation
May 2012	Review the Time Synchronization needs for planned Space Networks, including possible methods and coupling to the recommended Time Correlation practices
July 2010	Interoperability testing, write test report
October 2012	Final draft Magenta book for recommended Time Correlation methods
October 2012	Final draft Blue Book for exchange of parameters for Time Correlation, including interoperability test report

Risk Management

Schedule relies upon the support of multiple CCSDS Agencies and on the allocation of adequate Agency resources to the WG. This work involves coordination between SLS area and the SE area. Coordination will also be required between this WG and the MOIMS SM&C WG when they work on MO Time Services.

Note: JPL has been testing PN ranging and the next generation Transponder has accepted the requirement to time tag their Clock in association with a specified bit in the PN. Bepi-Columbo is currently building a transponder that performs regenerated ranging using the PN but they have no requirement to use the PN correlation to time tag the PN with the transponder clock.