Internet in Space“ Testing Activites

“In space, no one can hear you scream. But you will be able to send e-mail, thanks to a new protocol being developed for use there. It's hard to maintain a stable connection in orbit, so the interplanetary Internet will have to be especially tolerant of delays and disruptions.” *(Time Magazine)*

Following up the article form Vinton G. Cerf in one of the previous issues of the “Communicator” (see URL-1) the Editor for SpaceOps News had the opportunity to attend a Seminar at the German Space Operations Center (GSOC) at DLR. Martin Pilgram, chief security and standardization engineer for spaceflight operations of GSOC summarized the current status of “Delay/Disruption Tolerant Networking” (DTN).

The method (“store and forward”) and protocols investigated might be obtained as published in various papers (eg., URL-2) – this article tries to summarize the current implementation status and further planning as derived from Martin Pilgram’s presentation.

Two examples for gound-based implementations are the “Zebranet” and the “N4C” project conducted by the European Union within the the current (2008 -2011) EC Program 7 initiative.

The **Zebranet** is a project conducted in Kenia by the University of Princeton to track wild Zebras in an area via wireless transmissions without stationary antennas. The animals are equipped with light weight collars containing GPS receivers and small solar powered transmitters. The data content is transmitted every two hours to the animal(s) in reach, stored and relayed on with the new animal’s own information until the information is finally collected by mobile units and transported via a gateway (ranger station) to the Internet.

Three different protocols are used for error correction, data collision detection and packetizing (Fluten-, History based- and “Direct”-protocols).

N4C will be looking at ways to extend Internet access to remote regions that do not have reliable and affordable network access today.

Combined with the large distances involved, this means that the 'always on' paradigm of constant connectivity and essentially synchronous access enjoyed in many urban areas today will not be available to these regions. The N4C project is developing applications using the DTN technology. Of interest are the various applications to be supported by the program: The *Web Caching Appli*cation will transmit websites on a cyclic basis in both directions in addition to ad hoc requests and search requests. *Email/Not So Instant Messenger Applications* shall work asynchronously like the nomal e-mail application. *Hiker's Applications* shall work on PDA’s and supply essential information like hospitals etc., meteorological data and tracking of animals

Shall be included as well.

DTN Zebranet

DTN Zebranet Protocols

Space applications of DTN could be traced to have been started with the assignment of an IP address to the DERA STRV-1b project in 1996 by JPL.

With the **DINET-1 experiment** in October 2008 the automatic operations of the deep space mission Deep Impact using DTN was successfully demonstrated the first time by JPL. Delay times of 49 up to 81 seconds as well as end-to-end transmission delays of days were tolerated. In total 292 images (14.5 MB) were transferred. Station handovers and transient failures in DSN uplink service were handled automatically and invisibly. No data loss and no data corruption occurred anywhere in the network, despite several transient unanticipated lapses in service at Deep Space Network (DSN) stations during tracking passes. The only outage happened at a ground

station due to a power loss and subsequent reboot activities. The protocol overhead was 1%, thus very reasonable.

DTN standardization by various international panels and working groups is underway since 2007, among others the IOAG (Interagency Operations Advisary Group) and CCSDS (Consultative Committee for Space Data Systems) work on the definition of reliable hop-by-hop transfer services. The final release of those is planned for 2011.

Until then NASA plans further demonstrations for space applications using ISS (ISS-1 & ISS-2) and another deep space demonstration (DINET-2), a LEO demo using TDRSS and possible even a Lunar try-out.

ISS-1, planned for summer 2009 will use the CGBA (Commercial Generic Bioprocessing Apparatus) of the University of Colorado, installed in the US Destiny module. The experiment will be modified to be usable as a DTN node to be handled by the control team in Marshall Space Flight Center (MSFC) for DTN data distribution on the ground to centers like APL, GSFC, JPL and the University of Colorado via an experimental network DEN (DTN Experimental Network)..

ISS-2, planned for 2010 expands this idea to establish more DTN nodes on board the ISS including the Columbus module of ESA and the Japanese module Kibo as well as establishing appropriate DTN nodes at the responsible control centers (Col-CC at Germany and JAXA at Japan, etc.).

Summary: From an operations point of view the question is whether the use of packets for up- and downlink has to be replaced by (available?) filebased applications in order to reduce the cost for the ground segment.

DTN using “store and forward” technology certainly has its place in terrestrial networks and will definitely find its place also in space.

URL-1: “An Interplanetary Internet” (Vinton G. Cerf, JPL)
http://www.opsjournal.org/assets/SecureDocumentLibrary/DocumentLibraryManager/documents/2008Q4_SOC_Cerf.pdf

URL-2: In-Space Crew-Collaborative Task Scheduling (John Jaap, MSFC)
http://pdf.aiaa.org/getfile.cfm?urlX=5%3A7I%276D%26XZ%22C%23R0%5FUWT%5B%5EPK%3B%3A4%3AD%23%0A

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