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A DTN-ready application for the real-time dissemination of Earth Observation data received by Direct Readout stations

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The majority of Earth observation satellites operate in low Earth sun-synchronous orbit and transmit data captured by a variety of sensors. The effective dissemination of satellite data in real-time is a crucial parameter for disaster monitoring in particular. Generally, a spacecraft collects data and then stores it on-board until it passes over dedicated ground stations to transmit the data. Additionally, some satellites (e.g. Terra, Aqua, Suomi-NPP, NOAA series satellites) have the so-called Direct Broadcast (DB) capability, which is based on a real-time data transmission sub-system. Compatible Direct Readout (DR) stations in direct line of sight are able to receive these transmissions.

To date data exchange between DR stations have not been fully exploited for real-time data dissemination. Stations around the world store data locally, which is then disseminated on demand via Internet gateways based on the standard TCP-IP protocols. On the other hand, Delay Tolerant Networks (DTNs), which deliver data by enabling store-and-forward transmission in order to cope with link failures, service disruptions and network congestion, could prove as an alternative/complementary transmission mechanism for the efficient dissemination of data. The DTN architecture allows for efficient utilization of the network, using in-network storage and taking advantage of the network availability among the interconnected nodes. Although DTNs were originally developed for high-propagation delay, challenged connectivity environments such as deep space, the broader research community has investigated possible architectural enhancements for various emerging applications (e.g., terrestrial infrastructure, ground-to-air communications, content retrieval and dissemination).

In this paper, a scheme for the effective dissemination of DB data is conceptualized, designed and implemented based on store-and-forward transmission capabilities provided by DTNs. For demonstration purposes, a set-up has been designed and implemented which emulates the interconnection and data transmission of various HRPT/AVHRR DR stations based on pre-scheduled contacts via the DTN architecture. According to the scheme adopted, as soon as the satellite scans the earth and after image reception, a contact is established with a DTN node and data transmission is initiated. These DR stations form a DTN overlay, taking advantage of the routing, transport and security mechanisms developed. Most importantly, data received at a station can automatically be forwarded to any other station belonging to the same “interest” group through a flexible DTN multicasting mechanism. Thus, a composite image of an extended area (or potentially an image of the entire globe, depending on the interest groups formed is constructed in each node in an imperceptible way. Upon processing of the received data streams, stations are able to further disseminate new products to other interested third party entities exploiting the DTN overlay and the filtering capabilities provided by a web-based tool.

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