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The On-Board Critical Message Transmission Design for Navigation Satellite Delay/Disruption Tolerant Network

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Abstract : The navigation satellite network, especially the Beidou MEO Constellation, can relay data effectively with wide coverage and is applied in navigation, detection, and position widely. But the constellation has not been completed, and the amount of satellites on-board is not enough to cover the earth, which makes the data-relay disrupted or delayed in the transition process. The data-relay function needs to tolerant the delay or disruption in some extension, which make the Beidou MEO Constellation a delay/disruption-tolerant network (DTN). The traditional DTN designs mainly employ the relay table as the basic of data path schedule computing. But in practical application, especially in critical condition, such as the war-time or the infliction heavy losses on the constellation, parts of the nodes may become invalid, then the traditional DTN design could be useless. Furthermore, when transmitting the critical message in the navigation system, the maximum priority strategy is used, but the nodes still inquiry the relay table to design the path, which makes the delay more than minutes. Under this circumstances, it needs a function which could compute the optimum data path on-board in real-time according to the constellation states. The on-board critical message transmission design for navigation satellite delay/disruption-tolerant network (DTN) is proposed, according to the characteristics of navigation satellite network. With the real-time computation of parameters in the network link, the least-delay transition path is deduced to retransmit the critical message in urgent conditions. First, the DTN model for constellation is established based on the time-varying matrix (TVM) instead of the time-varying graph (TVG); then, the least transition delay data path is deduced with the parameters of the current node; at last, the critical message transits to the next best node. For the on-board real-time computing, the time delay and misjudges of constellation states in ground stations are eliminated, and the residual information channel for each node can be used flexibly. Compare with the minute's delay of traditional DTN; the proposed transmits the critical message in seconds, which improves the re-transition efficiency. The hardware is implemented in FPGA based on the proposed model, and the tests prove the validity.

Keywords : critical message, DTN, navigation satellite, on-board, real-time
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