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ComNets

Bundle streaming service: design, implementation and performance evaluation

• INTRODUCTION

The Bundle Streaming Service (BSS) and Bundle Streaming Service Protocol (BSSP) are proposed methods for ensuring the reliable transmission and retrieval of streaming video data over networks that may be delayed or disrupted[1]. BSS framework transmits streaming data using Delay- and Disruption-Tolerant Networks (DTNs) bundles, allowing for in-order stream processing with minimal latency [2]. It ensures consistent data delivery, facilitating ad hoc replay and evaluation of recently received information. The system comprises of a bundle forwarder and a software library that is designed to resolve the challenges associated with streaming live and archived information across DTNs, involving propagation delays, increased error rates, shifting bandwidth and interruptions. The emphasis lies on a simplified configuration, implementation, and processes which enhance the overall viewing experience for end users.

• DESIGN AND IMPLEMENTATION

1. Out-of-stream Bundles: Lost bundles are classified as out-of-stream, and through re-transmission these are preserved to the database for future playback.
2. Channel Selection: Bundles with higher creation time are sent over a 'best-efforts' channel; bundles with lower creation time are sent over a 'reliable' channel.
3. ipnfw : Interplanetary Overlay Network(ION) default forwarder, that sends bundles containing endpoint identifiers that follow the Interplanetary Network(IPN) naming scheme[2].
4. bssfw: BSS forwarder tracks the creation times of the bundles as it passes from node X to node Y at each hop [2].

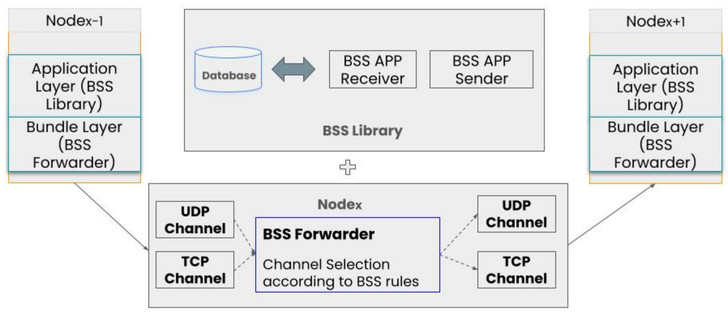
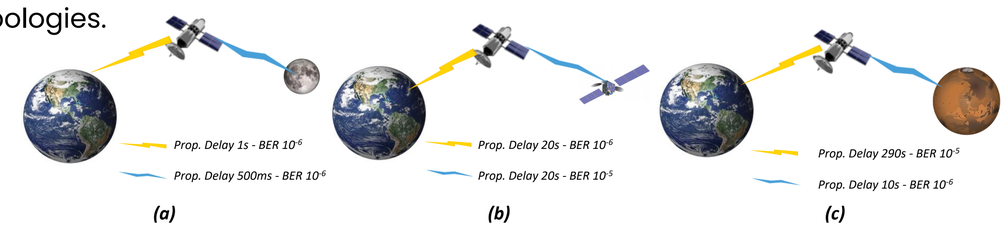


Fig. (1) BSS architecture and network layering [2].

• USE CASES AND RELATED SCENARIOS

In order to assess the BSS, paper uses a set of flexible scenarios based on realistic use cases that allows to evaluate BSS performance under various communication patterns. These scenarios were built upon a diverse sample of stressed networking environments, including both terrestrial and space network topologies.



(a) *(b)* *(c)*

Fig. (2) All three network topologies employed in space scenarios: (a) Moon, (b) spacecraft and (c) Mars [2].

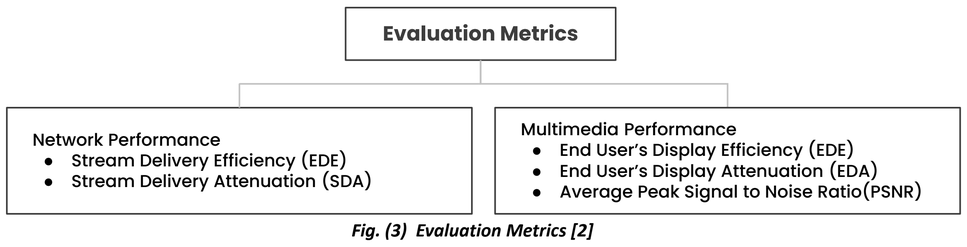
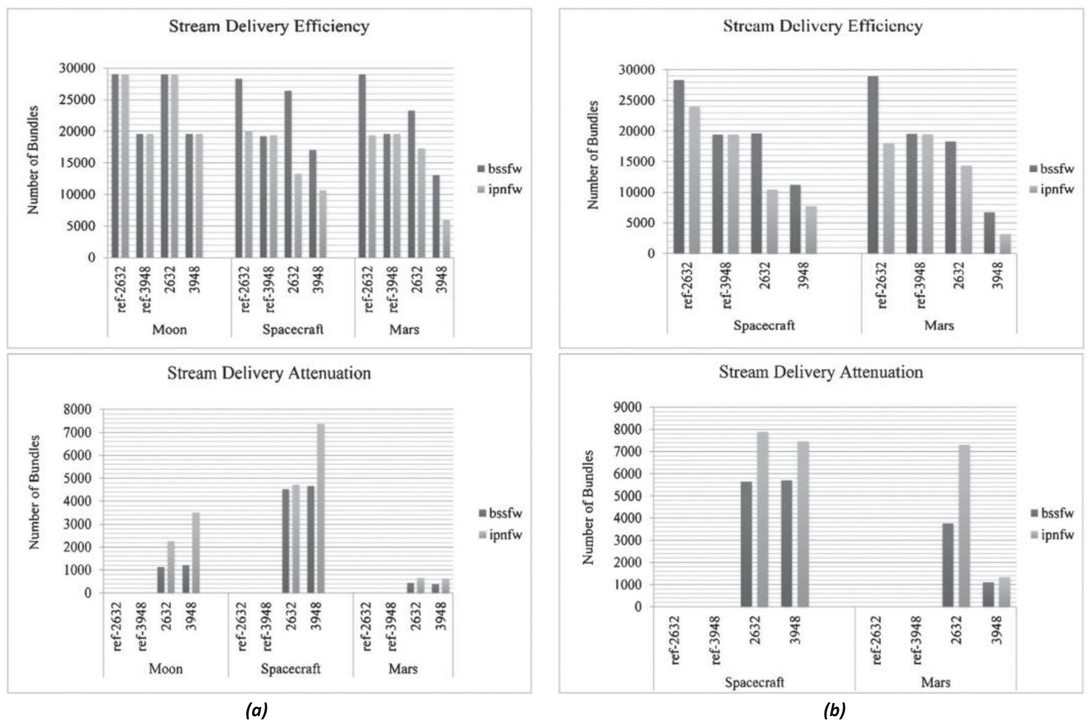


Fig. (3) Evaluation Metrics [2]

• RESULTS AND DISCUSSION

1. Fig.(4) analyzes all three scenarios for 3-node network topology (a), and a 5-node network topology (b). The results are consistent between both, showing that there is a significant improvement in the performance values of SDE ranging from 20% to 100%. Hence, bssfw outperforms ipnfw in terms of number of delivered bundles.
2. Moreover, it is also shown that bssfw will increase the received quality stream by significantly decreasing the SDA value.
3. Fig. 5(a) illustrates that BSS achieves substantial gain in EDE value, almost 18% more video frames successfully displayed.
4. The EDA metric (Fig.5(b)) depicts that BSS decreases the number of wrongly decoded frames.
5. BSS also has positive impact on PSNR, increasing its value from 12 dB to 14 dB displayed Fig. 5(c).



(a) *(b)*

Fig. (4) Comparison between BSS and ipnfw based on (a) 3-node and (b) 5-node network topology of all three space scenarios [2].

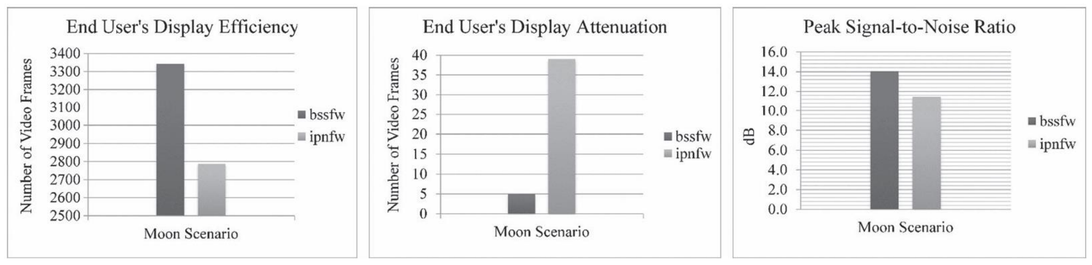


Fig. (5) Comparison between BSS and ipnfw based on (a) EDE, b) EDA and c) PSNR metrics for the 3-node network topology of the Moon Space scenario [2].

• CONCLUSIONS

1. Long-distance communications, particularly those between Earth and deep space, can benefit from the BSS protocol.
2. The creation of data streaming applications in DTNs is made easier by the application programming interface of the BSS framework.
3. Dual capability (reliable and unreliable transmission) enables a smoother real-time streaming viewing experience.

• REFERENCES

1. CCSDS, "Concepts and Rationale for Streaming Services Over Bundle Protocol", 2018. [online]. Available: https://public.ccsds.org/Pubs/730x2g1.pdf.
2. Sotirios-Angelos Lenas, Scott C. Burleigh and Vassilis Tsaoussidis, "Bundle Streaming Service: Design Implementation and Performance Evaluation", Transactions on Emerging Telecommunications Technologies, vol. 26, no. 5, pp. 905-17, 2015, [online] Available: https://doi.org/10.1002/ett.2762.