

IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)  
Advances in Space-based Communication Technologies, Part 1 (4)

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CHALLENGES OF OPTICAL AND MMWAVE/RF COMMUNICATION LINKS FOR  
NANOSATELLITE MISSIONS

**Abstract**

With the growing complexity and application potential of nanosatellite missions, there is an exponential growth in the downlink data-rates needed. Both Optical and mmWave/RF communications play a significant role in filling technology gaps to achieve high downlink data-rates. These advanced communication technologies have turned out to be potential solutions to data-congestion problems faced by nanosatellites. In recent times, nanosatellites have crossed the Gbps downlink barrier, but the main challenge has been in achieving power efficient systems (improving bits/Joule).

To make a comprehensive performance assessment, a full end-to-end communication link, starting from the satellite side transmission modules (transmitter block, amplifier block, antenna/laser diodes etc), through the lossy channel and up to the ground station side reception modules (receiver antenna/telescope, receiver frontend, etc), is simulated and analysed.

As a first step in this paper, these individual blocks of both optical and mmWave/RF communication systems are explained. Link budget tools that incorporate channel loss models from ITU are used to illustrate the implementation challenges in the two technologies. For this study, the same power budget is assumed for both the transmission technologies (on the satellite side) and the design specifications are derived for rest of the blocks in the communication link to achieve a downlink data-rate of 1 Gbps (usable data). Using this analysis, the requirements posed by these advanced communication systems on the satellite and overall mission operations are derived. To conclude, this paper presents state-of-the-art technologies in optical communications and mmWave/RF communications that are suitable for nanosatellite missions.