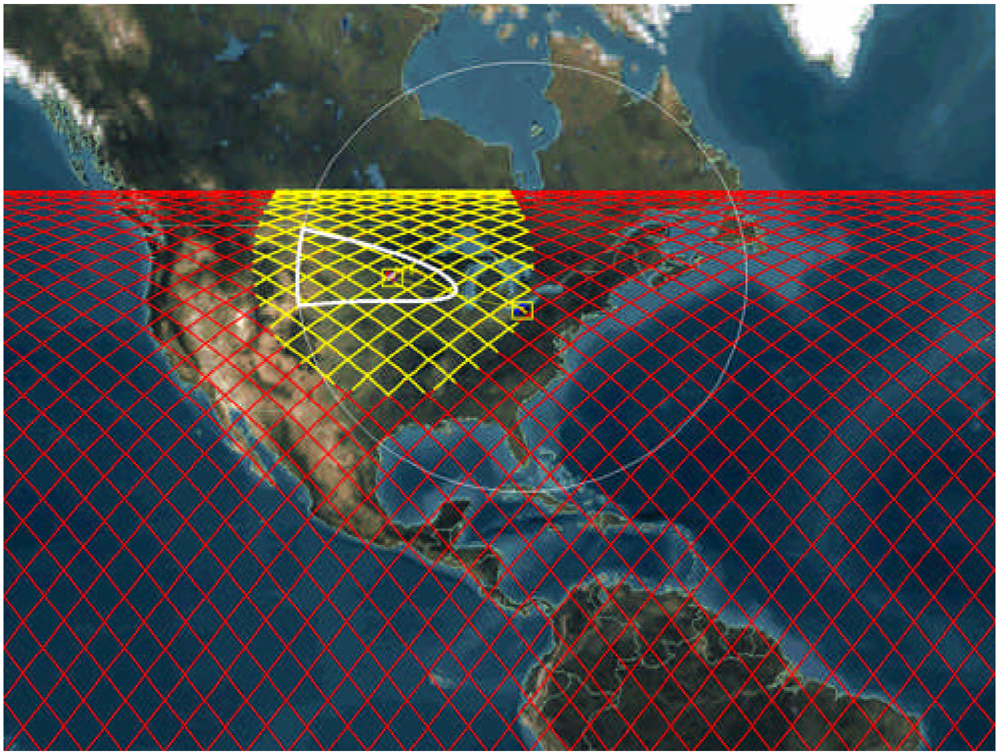
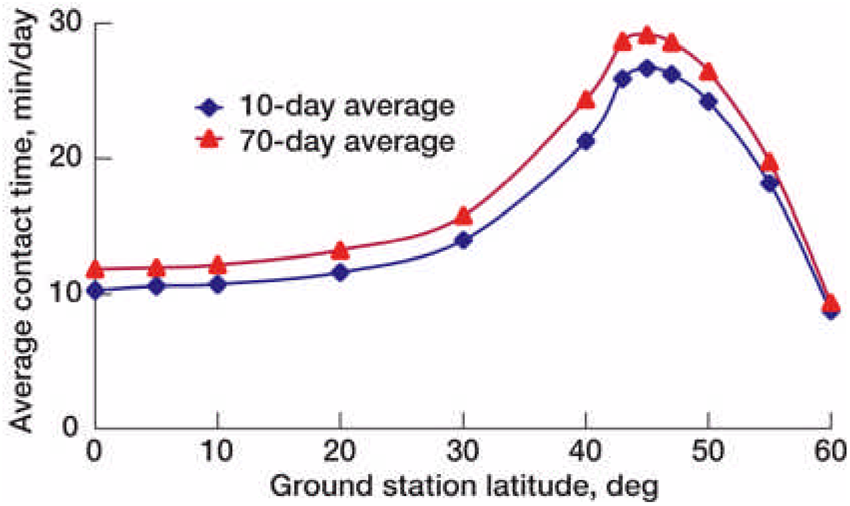
Advanced Communications Architecture Demonstration Made Significant Progress



Access simulation for a sample ground station.
Simulation for a ground station located at 44.5° latitude. The red lines show the ground tracks of the International Space Station; the yellow lines show when communication contact is established with the ground station; the heavy white line shows the projection of a transmission beam onto the Earth's surface; and the fine white circle shows the maximum coverage area of the transmitter on the International Space Station.

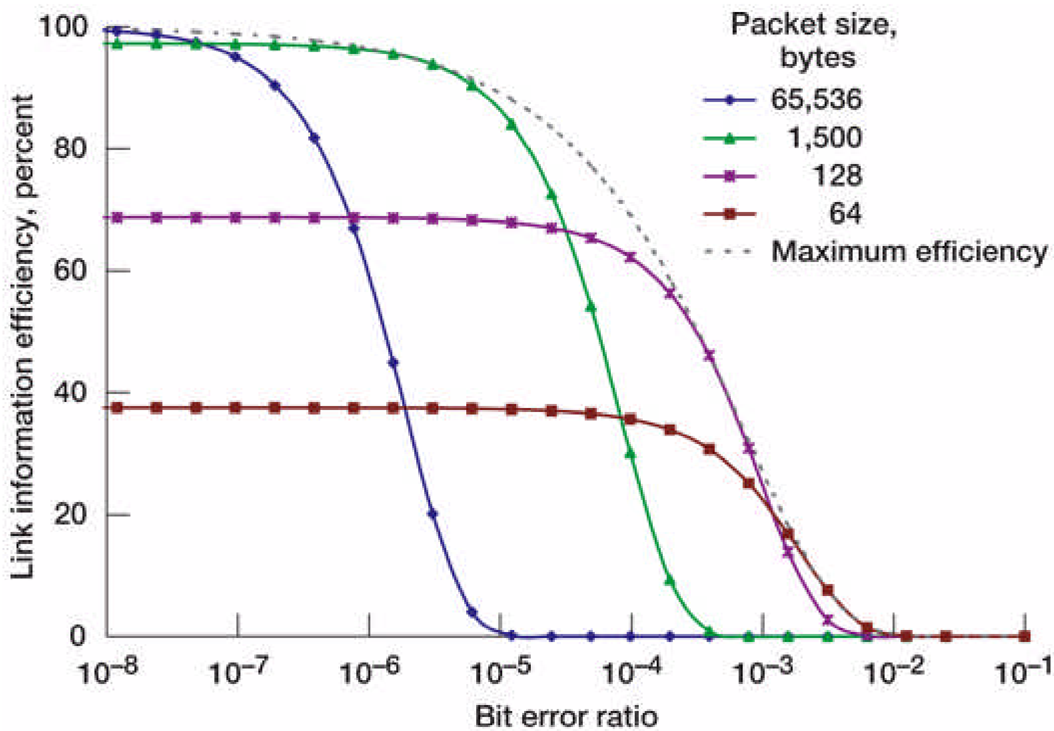
The Advanced Communications Architecture Demonstration (ACAD) is a concept architecture to provide high-rate Ka-band (27-GHz) direct-to-ground delivery of payload data from the International Space Station. This new concept in delivering data from the space station targets scientific experiments that buffer data onboard. The concept design provides a method to augment the current downlink capability through the Tracking Data Relay Satellite System (TDRSS) Ku-band (15-GHz) communications system. The ACAD concept pushes the limits of technology in high-rate data communications for space-qualified systems. Research activities are ongoing in examining the various aspects of high-rate communications systems including (1) link budget parametric analyses, (2) antenna configuration trade studies, (3) orbital simulations (see the preceding figure), (4) optimization of ground station contact time (see the following graph), (5) processor and storage architecture definition, and (6) protocol evaluations and dependencies.



Ground station latitude versus average contact time.
Parametric study of the average communications contact time (in minutes per day) for various ground station latitudes (in degrees). The yellow line shows the results averaged over a 70-day period. The blue line shows the results averaged over a 10-day period.

Current satellite communications research efforts are focusing on delivering data at high transmission rates to accommodate increased data volume needs. However, the technology available for NASA missions still appears to be limited when data transmission rates are above 150 million bits per second (Mbps). ACAD provides a system capable of delivering high-rate data at an information rate of at least 622 Mbps, and coding and protocol overhead can easily drive the required modulation to gigabit rates. ACAD focuses on assessing the state of the art in high-rate, space-qualified communication systems and is pushing to close existing technology gaps.

Although packet-based protocols such as Transmission Control Protocol/Internet Protocol (TCP/IP) have become pervasive in terrestrial communications systems, inefficiencies may exist when they are used over satellite networks. Several findings were made regarding the implications of these protocols when used over highly bandwidth asymmetric radio networks with high error conditions. As part of this effort, formulations have been derived to optimize the efficiency of packet-based protocols by tuning packet sizes on the basis of link conditions (see the following graph). These findings have wide application to both low-Earth-orbit satellite communications architectures and aeronautics communications architectures.



Link bit error ratio versus information efficiency.
Impact of bit error ratio on link information efficiency (in percent) for several different packet sizes (64, 128, 1500, and 65,536). The grey dashed line represents the maximum attainable efficiency for the optimum sized packet.

Satellite communications systems are typically designed to provide a link margin for the worst-case scenario. However, the findings uncovered with this research may allow future systems to be designed with less margin, thereby conserving spacecraft power as well as reducing signal interference. In addition, these findings can be applied to standards-based protocols to allow communications to be maintained under much worse error conditions than have been permissible in the past.

The ACAD project is managed under the Space Communications Applied Systems & Technologies Program of the Space Communications Officeand is being developed as a collaborative team effort among members of the Space Communications Officeand researchers in the NASA Glenn Research Center's Communications Technology Division, including itsSatellite Networks and Architectures Branch.

Find out more about this research: http://ctd.grc.nasa.gov/5610/5610.html

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