

BEAM HOPPING A FLEXIBLE APPROACH FOR MORE EFFICIENCY

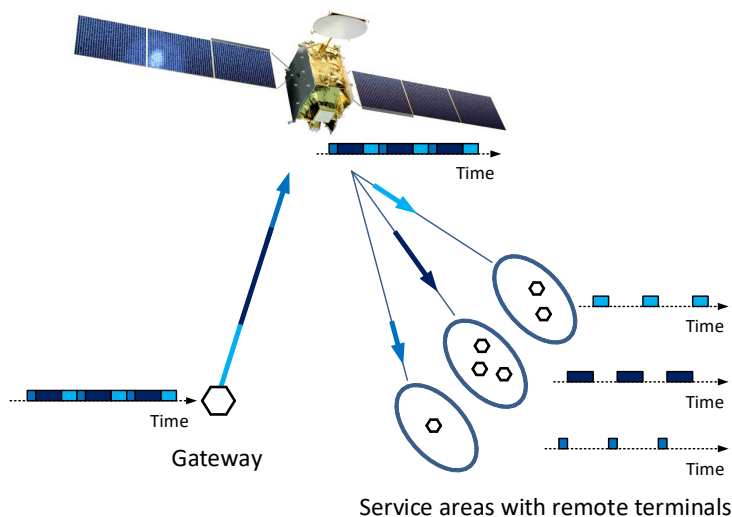


Figure 1
 Forward link beam hopping
 of the Eutelsat Quantum
 satellite to three service
 areas

Rising demand for worldwide mobile communications on land, in the air and at sea calls for satellite coverage tailored to individual needs. Current satellite communication systems use static beam configuration, which offers limited options for adjusting beam capacity to variations in data rate demand. In contrast, beam hopping makes it possible to shift capacity from one beam to another. To demonstrate the feasibility of beam hopping, concepts for network and terminal synchronization have been developed, implemented in hardware and successfully verified in the lab and in over-the-air tests with a conventional bent-pipe satellite.

Fraunhofer Institute for Integrated Circuits IIS
 Am Wolfsmantel 33
 91058 Erlangen, Germany

Contact
 Christian Rohde
 Phone +49 9131 776-6335
 christian.rohde@iis.fraunhofer.de

www.iis.fraunhofer.de

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Beam hopping: A flexible demand-based resource allocation concept

Beam hopping, based on the DVB-S2X transmission standard, enables time sharing of satellite capacity among different beams, making satellite systems more flexible and efficient. The satellite performs demultiplexing of the uplink signal and distribution via periodic switching of the satellite beam to different coverage areas. The switching time plan as well as the addressed coverage areas and coverage shapes can be reconfigured according to actual needs.

System architecture

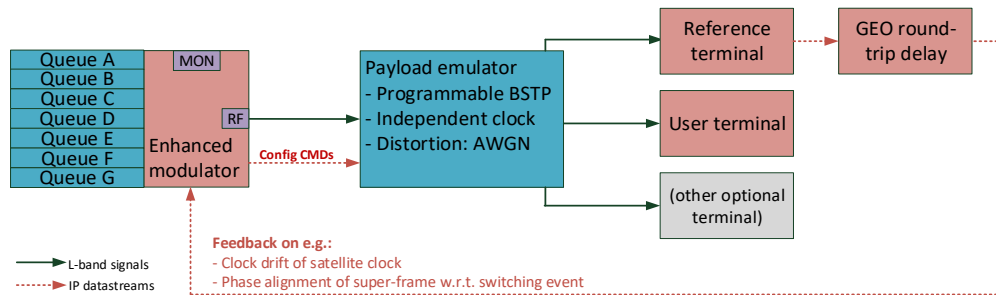


Figure 2
Beam hopping testbed with forward link transmission

In collaboration with ESA (under the contract 4000115704/16/UK/AD), a beam hopping testbed has been developed. The testbed consists of four major components using DVB-S2X Super-Frame Format 4:

- Wideband modulator that runs network synchronization algorithms
- Payload emulator that handles switching to different outputs according to a reconfigurable beam switching time plan (BSTP) relative to its internal clock
- Reference terminal that estimates various offsets from the bursty input signal and provides feedback to the modulator-side synchronization algorithms
- User terminal for demodulation and decoding of the bursty input signal

The testbed provides a proof of concept, implementing and testing a control loop to verify the gateway-satellite timing synchronization. It supports cold acquisition for system start-up, a tracking mode to follow variations over time, and a means of alignment that enables simultaneous BSTP updates at the payload emulator and modulator. The main features of the beam hopping testbed are:

- Wideband transmission over L-band using time-slicing technique
- Configurable symbol rates from 30 MHz to 200 MHz
- End-to-end data transmission in a reconfigurable beam hopping system
- DVB-S2X-compliant implementation of beam hopping
 - All roll-offs: 5%, 10%, 15%, 20%, 25%, 35%
 - All MODCODs: QPSK to 256 APSK

Benefits at a glance

- Conventional bent-pipe satellites can be used for over-the-air beam hopping tests by placing the payload emulator in the uplink transmission chain
- Terminal and ground station equipment manufacturers can test their devices under various beam hopping conditions and impairments in the lab and over-the-air
- Satellite payloads can be verified in end-to-end beam hopping system tests
- Ground segment equipment that is proven in the lab and in over-the-air tests