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BCO Network WEBseries: Quality of Service (QoS), measuring for satellite

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Quality of service methodology for satellites in Europe

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This presentation discusses the QoS methodology for satellites in Europe as presented in the BCO Network publication

Outline

- Contents of the study
- Methodology and information required
- Summary/applicability for LEO
- Numerical example for LEO
- Summary/applicability for GEO
- Numerical example for GEO
- Annex 1: Detailed technical report on available satellite technologies and operators

Contents of the study

CONTENTS

Three main aspects considered:

- Limitations of the study in section II.
- Methodology and numerical example for LEO and GEO in section III.
- Examples of advertised SLAs in commercial offerings in section IV.

Annexes include:

- detailed technical description of satellite offerings (Annex 1),
- policies and commercial offers (Annex 2).

Methodology

1. Define the study area to the satellite provider technology
2. Indicate orbits and satellite coverage
3. Indicate min/average/max number of satellites serving the area
4. Indicate capacity per satellite/beam
5. Compute min/average/max capacity provided in the region
6. Compare with the required capacity at peak hour

This methodology is similar to the one proposed for Starlink RDOF Assessment by NCTA – The Rural Broadband Association (and executed by Cartesian)

Information required

1. **Data that must be provided by the funding authority:**

Parameter	Units
Area of the region	Km^2
Location	Latitude and Longitude coordinates
Target population	Thousands, % to be provided with the service
Minimum rate provided	Mbps

The peak time is computed as the % of the target population (i.e., 15% of the total population) at the Minimum rate provided.

2. **Data that must be provided by the LEO Satellite Operator:**

Parameters	Units
Minimum, Average and Maximum number of satellites covering the region	number
Minimum number of beams for min/avrg/max number of satellites covering the region	number
Bw per beam	Mbps
Over-subscription rate	ratio

Summary for LEO - Average

Based on average number of satellites observed in an area:

- Compute the total area of coverage for the service (based on operating latitudes of the satellite shells):

$$A_{tot} = 2\pi R^2(1 - sin\ \theta_{max})$$

- Compute the satellite density:

$$\rho = \text{Total Number Satellites}/A_{tot}$$

- Compute average number of satellite covering a region:

$$N_{sat} = \rho \times Area_{Region}$$

Summary for LEO

- Compute overall capacity in the region based on:

$$C = N_{\text{sat}} \times N_{\text{beams}} \times BW_{\text{beam}}$$

- Compute target population (e.g., based on households to be covered):

$$P_{target} = Percentage_{target} \times Total_{population}$$

- Consider the oversubscription rate to compute capacity per user:

$$C_{user} = \frac{C}{P_{target}} \times Oversubscription_{rate}$$

Numerical example for LEO

- Based on public data from Starlink and a rural area in Spain (100 Mbps per user)

# of beams per regi on	Min # of satellites (2)	Avrg. # of satellites (3)	Max # of satellites (8)
1	842.5 Mbps	1263 Mbps	3791 Mbps
8	6740 Mbps	10110 Mbps	30330 Mbps
48	40440 Mbps	60660 Mbps	181980 Mbps

# of beams per regi on	Min # of satellites (2)	Avrg. # of satellites (3)	Max # of satellites (8)
1	8 users	12 users	37 users
8	67 users	101 users	303 users
48	404 users	606 users	1819 users

Summary for GEO (assumption: 1 satellite)

- Given the area covered by beam (A_{beam}) and the capacity per beam (C_{beam}), compute the total capacity covering the target area of study (A_{target}):

$$C_{area} = \left\lceil \frac{A_{target}}{A_{beam}} \right\rceil \times C_{beam}$$

- Compute the ration between the population in the target area (P_{target}) and the population illuminated by all beams in the geographical area:

$$P_{illuminated} = \rho_{population} \times \sum_{1}^{\left\lceil \frac{A_{target}}{A_{beam}} \right\rceil} A_{beam}$$

Summary for GEO

- Compute the ratio between the illuminated population and the target population:

$$R_{population} = \frac{P_{illuminated}}{P_{target}}$$

- Compute the available capacity per user, accounting for the over-subscription rate:

$$C = R_{population} \times C_{area} \times Oversubscription_{rate}.$$

Numerical example for GEO

- From publicly available data (from Viasat 3):
  - Total capacity of the satellite: 1 TBps .
  - Total number of beams: 2000.
  - Capacity per beam: 1 TBps/2000 = 4 Gbps.
  - Area covered per beam = 20,000 Km2 (this data is not trivial to compute and variable).
- Illuminated population 250K, Population covered (12,5persons/Km2, 4/household, 15% rate) 9375, Target population 3329 (15% of 88796)
- Rate between target and covered population = 0.35
- The total capacity in a beam is 4 Gbps, therefore, the capacity in the target area is:

4 Gbps*0,35 = 1,4 Gbps. Per user, 1,4/3329= 0,42 Mbps approx.

Annex 1: Detailed technical report on available satellite technologies and operators

For:

- SpaceX / Starlink
- Oneweb
- Telesat / Lightspeed
- Amazon / Kuiper
- SES
- Eutelsat Konnect
- Viasat
- skyDSL
- Avanti

Report on the following:

- Radio technology used
- Number of beams per satellite
- Sat-to-Earth and Inter-Satellite bands
- Type of constellation and altitude
- Planned deployment phases, dates, and current status
- Throughput per satellite and aggregate
- Coverage areas and geographic zones covered
- Compatibility with mobile terminals
- Commercial availability by Country/Region

Service provider	Constellation type	Altitude (km)	Download speed (Mbps)	Upload Speed
SpaceX/ Starlink	LEO	540-570	100-200 (up to 300)	10-40
OneWeb	LEO	1200	50-100	5-20
Telesat/ LightSpeed	LEO	1015-1325	50-150	10-30
Amazon/ Kuiper	LEO	590,610,630	~100	10-25
Eutelsat Konnect	GEO	35786	50-100	6-20
Viasat	GEO	35786	12-100	3-30
SkyDSL	GEO	35786	20-50	2-6
Avanti	GEO	35786	30-60	6-15
SES	MEO/GEO	8000 (MEO) / 35786 (GEO)	50-500	10-50

Thanks!

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