

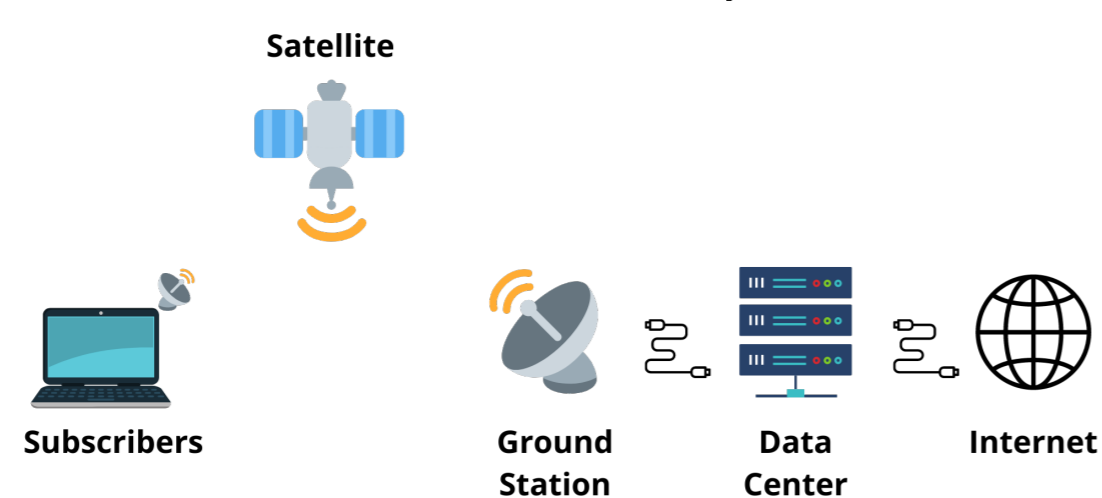
Research context and motivation

Satellite Communication (SatCom) offers **internet connectivity** where traditional infrastructures are **too expensive** to deploy.

When using satellites in a **geostationary** orbit, the distance from Earth forces a **RTT** higher than **550 ms**.

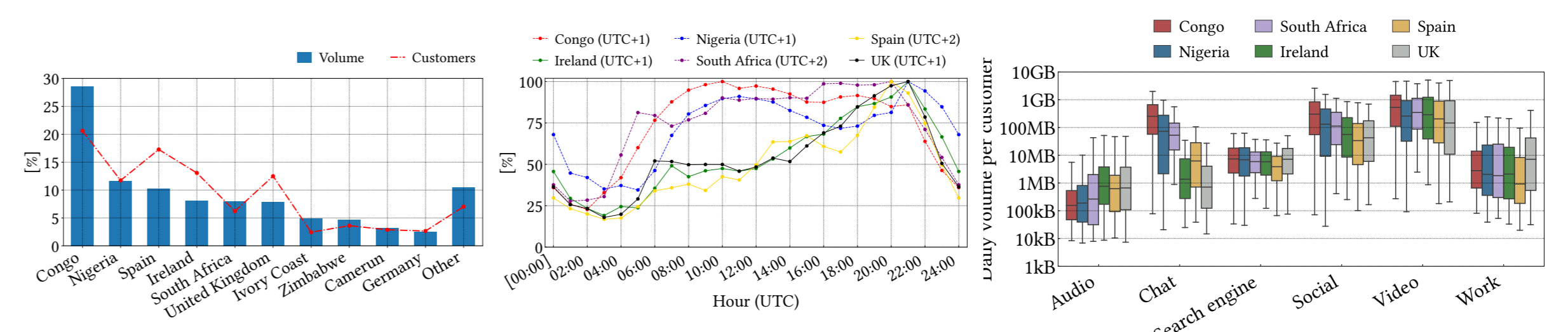
In this work, we have studied the **performance** of the SatCom technology, as well as the usage habits of subscribers in **different countries** in **Europe** and **Africa**.

We highlight the implications of such **technology** on Internet usage and functioning, while discussing possible **optimizations** that the **ISP** could implement to **improve** the service offered to SatCom subscribers.



Novel contributions

- A **first** profile characterization on **SatCom** environment.
- Estimation of **Satellite RTT**.
- Geographic **pattern** analysis.
- Daily/Monthly traffic **pattern** analysis.
- Impact of local **popular services** due to the Ground Station (**GS**) location.
- **DNS** tangling and its **impact** on performance.



Addressed research questions/problems

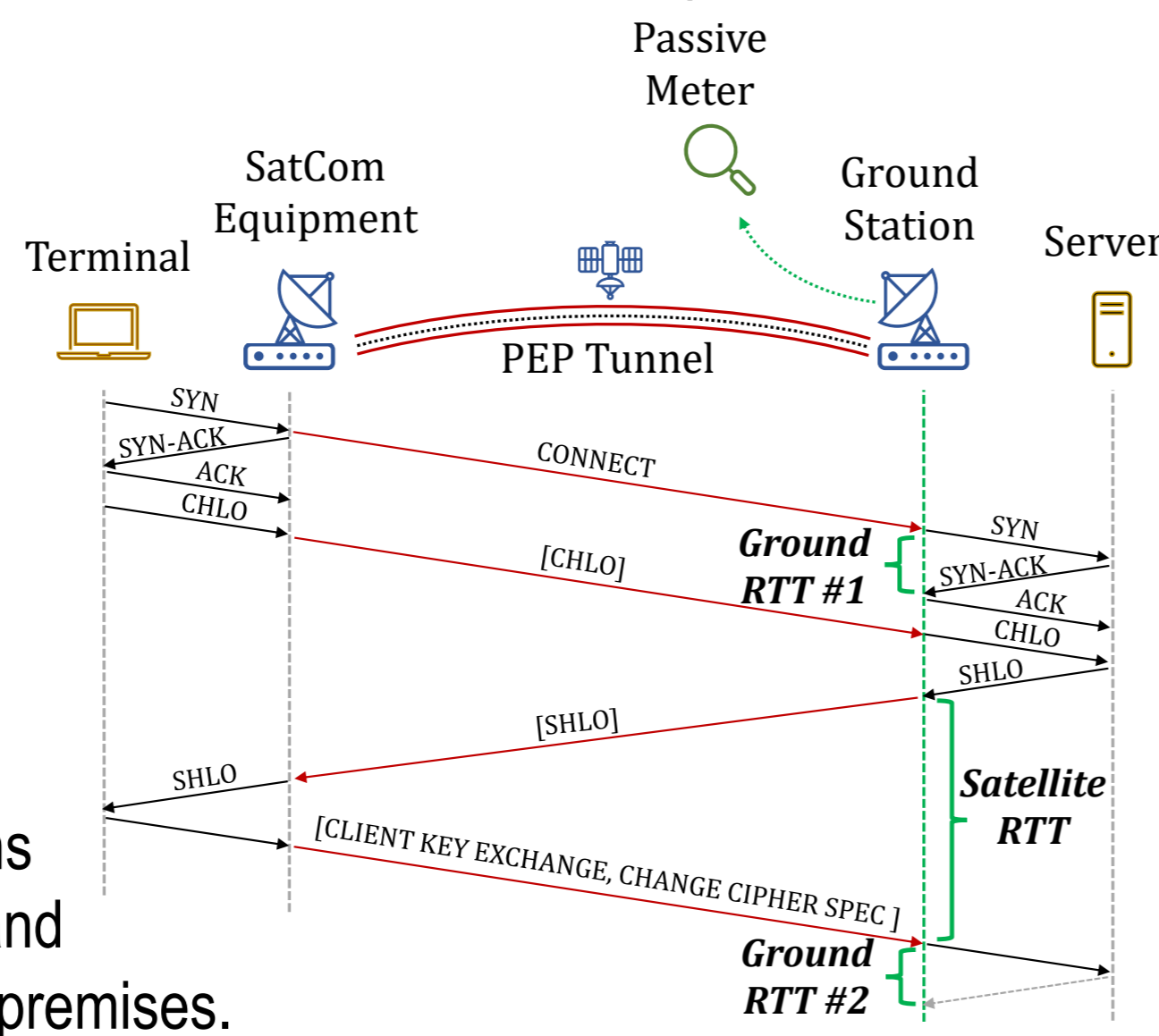
Question:

The satellite operator uses **Performance Enhancing Proxy (PEP)** to **improve** the **Quality of Experience (QoE)** of customers.

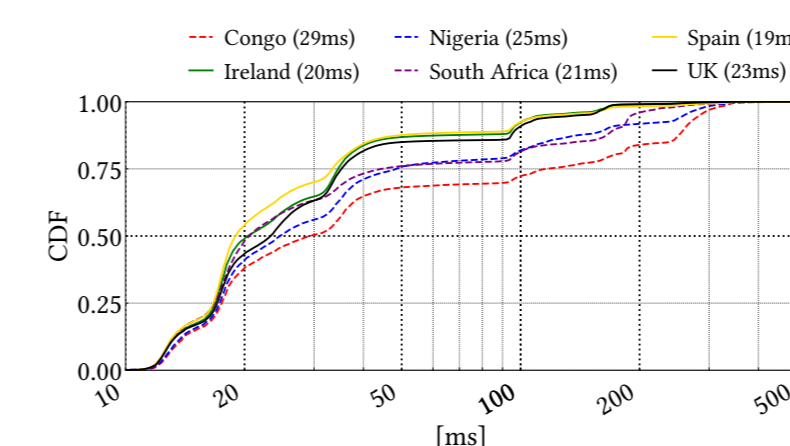
What **performance indicators** are useful to **monitor** customer and **PEP** performance?

Problems:

- Difficult to estimate **Satellite RTT**.
- User traffic using **UDP** (e.g., DNS, QUIC) **does not** benefit from **PEP acceleration** and therefore are forwarded as is.
- The ground station acts as a **NAT box**. This means that **all connections must be initiated** by an end-user client and **no server** can be run on the customer's premises.



Adopted methodologies

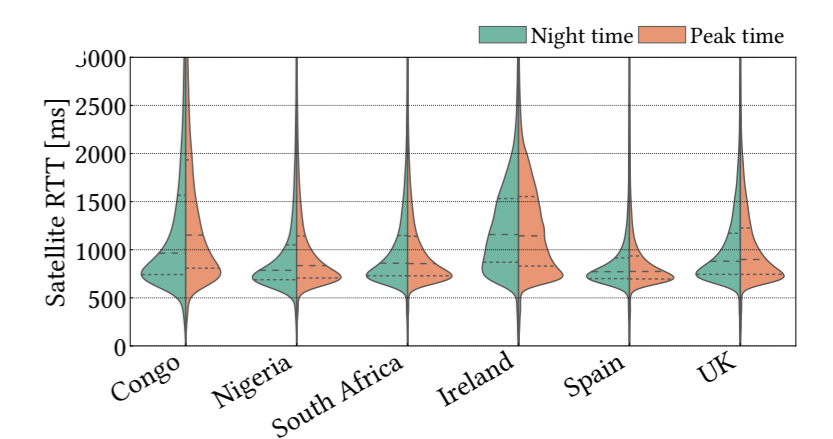


Ground RTT is more **deterministic** than the satellite RTT. **Bumps** reflect the **proximity** of the **servers** on the Internet to the SatCom GS

Popularity of DNS resolvers in different countries

| Operator | EU | 9.10 | 1.87 | 43.75 | 28.95 | 38.10 | 3.98 |
|-----------------|-------|-------|-------|-------|-------|-------|--------|
| Google | 85.68 | 50.69 | 63.47 | 38.49 | 61.27 | 34.67 | 21.98 |
| CloudFlare | 3.02 | 2.54 | 10.36 | 2.03 | 2.05 | 6.04 | 19.97 |
| Nigerian Levels | 0.00 | 11.84 | 6.32 | 0.00 | 0.00 | 0.00 | 119.98 |
| Baidu | 1.22 | 4.00 | 0.65 | 0.49 | 0.72 | 6.97 | 17.99 |
| 114DNS | 0.45 | 7.63 | 0.09 | 0.00 | 0.00 | 0.49 | 23.99 |
| Other | 2.97 | 3.43 | 1.64 | 0.05 | 0.03 | 0.01 | 109.98 |
| | 5.11 | 10.46 | 15.38 | 15.07 | 6.87 | 13.67 | 29.97 |

Some **resolvers** suffer from a **very high RTT**. And why? **Routing problem**



The **minimum** satellite RTT is above **550 ms**. However, the distributions show **very large variability**

Future work

- Build a **ML** model capable of estimating **Quality of Experience (QoE)** for the end user using the **passive** data collected and the **active** experiments running in parallel.
- Create the **real-time** monitoring system that **tracks, collects, and visualizes** the QoS/E.

Submitted and published works

- A. Di Domenico, G. Perna, M. Trevisan, L. Vassio, D. Giordano, **A network analysis on cloud gaming: Stadia, GeForce Now and PSNow**, MDPI Network, vol. 1, no. 3, pp. 247-260
- G. Perna, D. Markudova, M. Trevisan, P. Garza, M. Meo, M. M. Munafò, G. Carofiglio, **Online classification of RTC traffic**, IEEE 2021 IEEE 18th Annual Consumer Communications & Networking Conference (CCNC), pp. 1-6
- G. Perna, M. Trevisan, D. Giordano, I. Drago, **A first look at HTTP/3 adoption and performance**, Elsevier Computer Communications, vol. 187, pp. 115-124
- G. Perna, D. Markudova, M. Trevisan, P. Garza, M. Meo, M. M. Munafò, **Retina: An open-source tool for flexible analysis of RTC traffic**, Elsevier Computer Networks, vol. 202, pp. 108637
- G. Perna, D. Markudova, M. Trevisan, P. Garza, M. Meo, M. M. Munafò, G. Carofiglio, **Real-Time Classification of Real-Time Communications**, IEEE Transactions on Network and Service Management
- G. Perna, M. Trevisan, D. Giordano, **Realistic testing of RTC applications under mobile networks**, Proceedings of the 16th International Conference on emerging Networking EXperiments and Technologies, pp. 532-533
- D. Perdices, G. Perna, M. Trevisan, D. Giordano, M. Mellia, **When Satellite is All You Have: Watching the Internet from 550 ms**, Proceedings of the 2022 Internet Measurement Conference (IMC)

List of attended classes

- 01UMNRV - Advanced deep Learning (didattica di eccellenza) (15/06/21, 6)
- 01UJBRV - Adversarial training of neural networks (03/06/21, 3)
- 01TRARV - Big data processing and programming (08/03/21, 4)
- 02LWHRV - Communication (06/07/22, 1)
- 01QTEIU - Data mining concepts and algorithms (01/02/21, 4)
- 01DMJRV - Design Thinking Processes and Methods (12/07/22, 4)
- 01SHMRV - Entrepreneurial Finance (12/07/22, 1)
- 01UNYRV - Personal branding (06/07/22, 1)
- 08IXTRV - Project management (06/07/22, 1)
- 01RISRV - Public speaking (06/07/22, 1)
- 01SYBRV - Research integrity (12/07/22, 1)
- 02QUBRS - Statistical data processing (04/02/21, 4)
- 02RHORV - The new Internet Society... (06/07/22, 1)
- 01UNXRV - Thinking out of the box (06/07/22, 1)
- 01SWPRV - Time management (05/09/22, 1)

| | Soft Skills | Hard Skills |
|--------|-------------|-------------|
| Points | 49.33 | 190.33 |
| Hours | 38 | 127 |

External training activities

- PhD school TMA – University of Twente, 16 hours, **16 (hard skills)** points
- (Planned) PhD school IRDTA – University of Lulea, 5 days school