Chair of Network Architectures and Services
School of Computation, Information, and Technology
Technical University of Munich

Development of a Framework for Retrieval of Parameters of the Starlink Dish

Final talk for the IDP by

Roberto Castellotti
advised by Leander Seidlitz, Johannes Zirngibl

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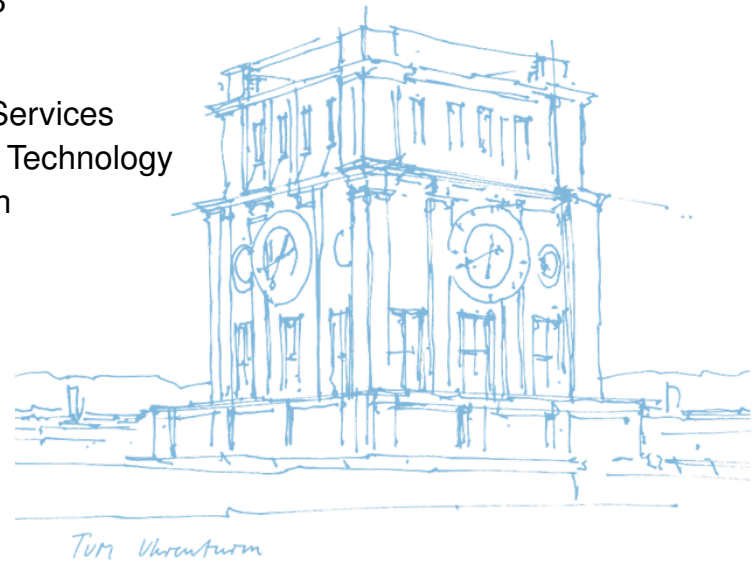

Starlink 101

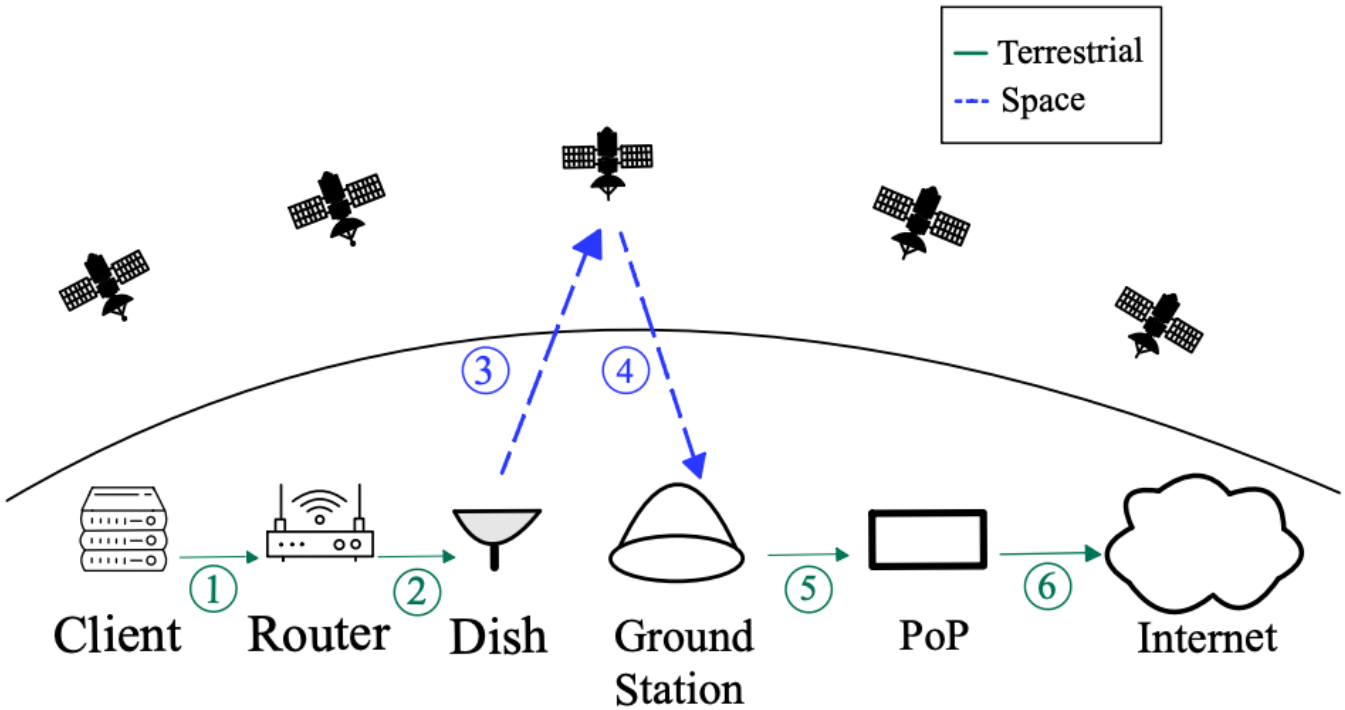

Figure 1: starlink in a nutshell (ignoring ISL), from [1]

Understanding routing decisions

- retrieved ip address blocks from major cloud providers (aws,azure,oracle), as we know their position [1]
- chose 5 geographically sparse targets around the globe (for aws: ap-northeast-2, us-east-1, ap-south-1, sa-east-1, me-south-1)
- tracerouted the targets over several days

[1] the fact we know the position doesn't really mean a traceroute to a certain address is really a traceroute to that geographic area

Understanding routing decisions

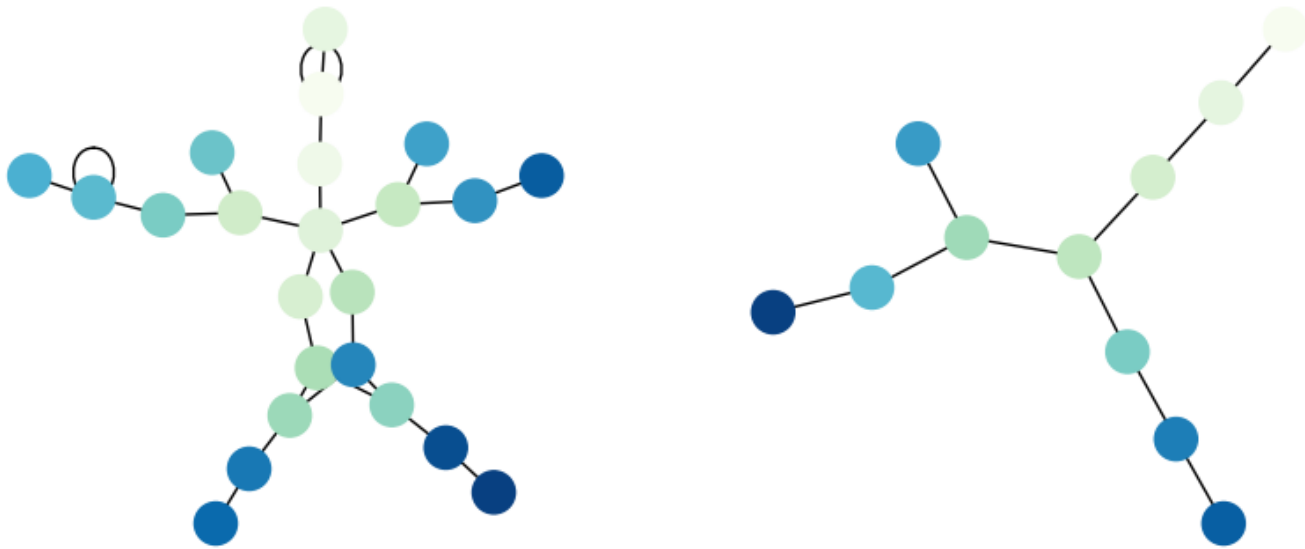

Figure 2: First 7 hops of traceroutes to 5 AWS datacenters using ICMP

Understanding routing decisions

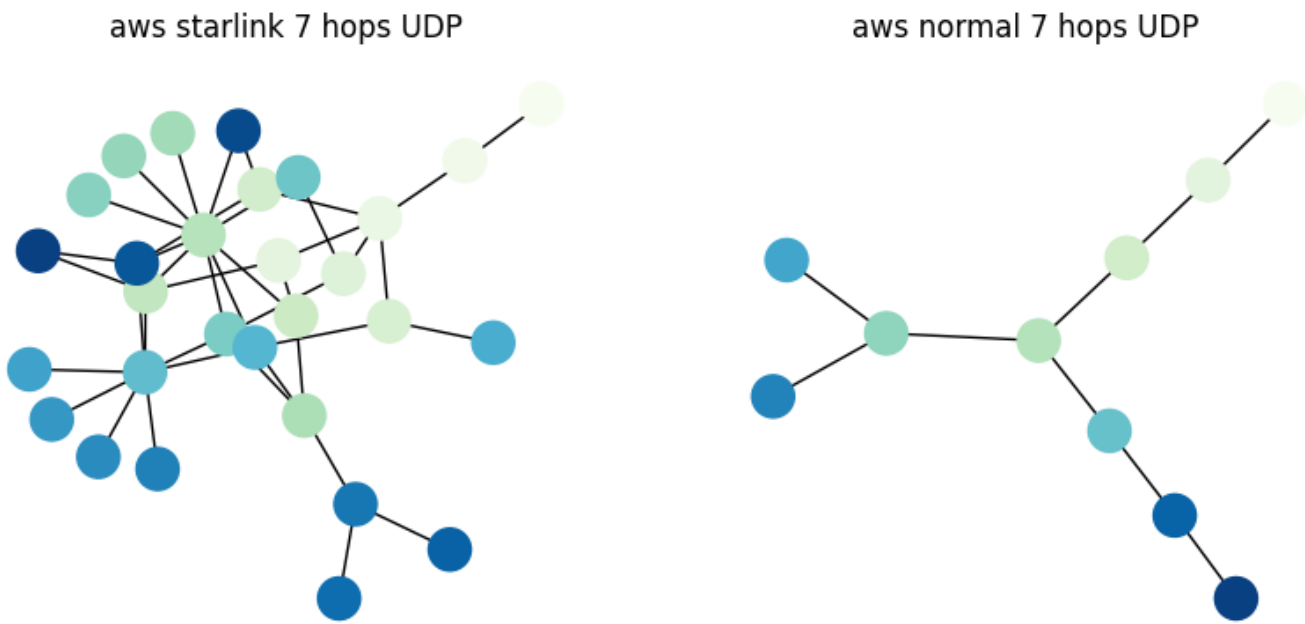

Figure 3: First 7 hops of traceroutes to 5 AWS datacenters using UDP

Understanding routing decisions

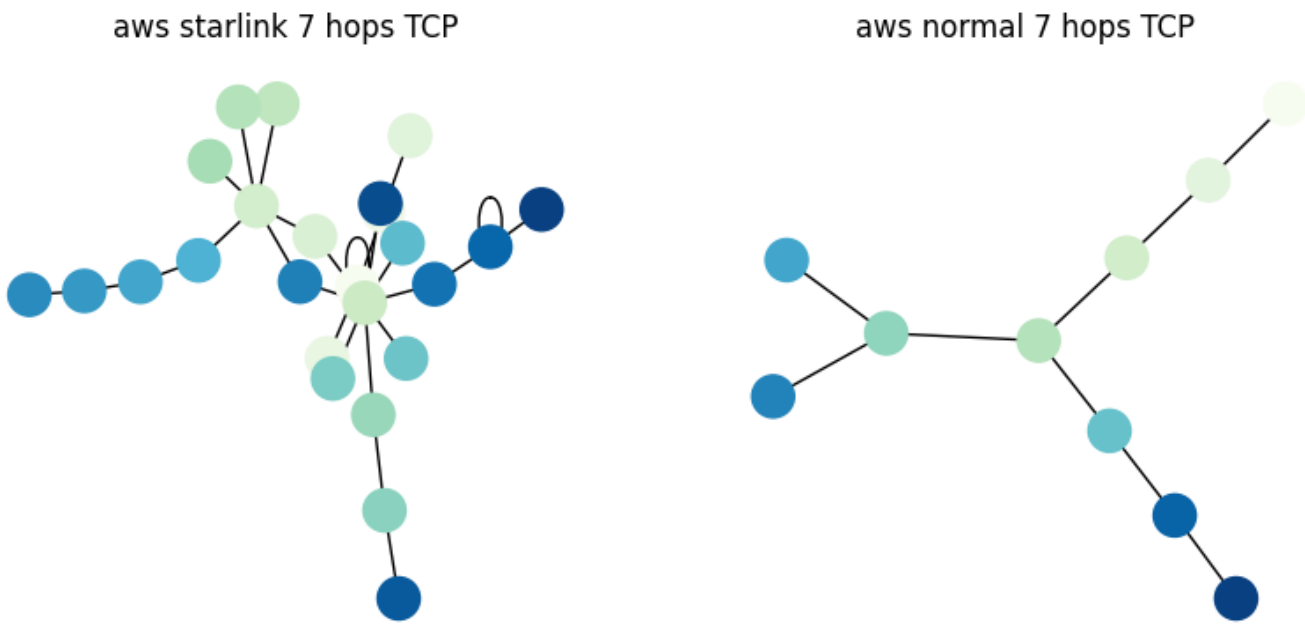

Figure 4: First 7 hops of traceroutes to 5 AWS datacenters using TCP

Measuring RTT changes when applying stress iperf

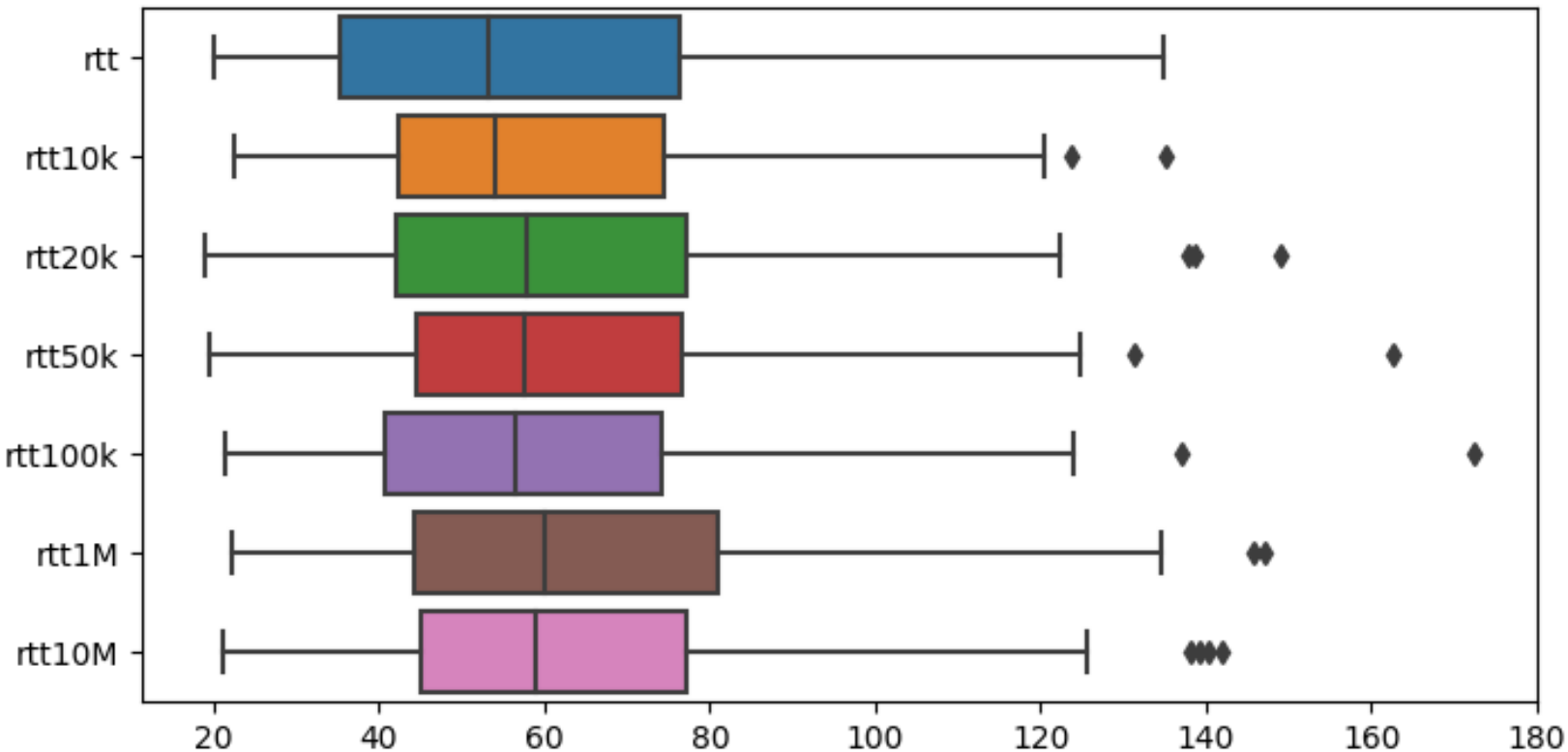

Figure 5: measuring RTT changes when applying stress iperf

Visualize Visible Satellites

- from celestrak.org we can download a list of Starlink's satellites TLEs
- A two-line element set (TLE) is a data format encoding a list of orbital elements of an Earth-orbiting object for a given point in time, the epoch. Using a suitable prediction formula, the state (position and velocity) at any point in the past or future can be estimated to some accuracy. (from wikipedia.org)

common.calculate_visible_satellites

```python
def calculate_visible_satellites(...):
# ...
satellites = load.tle_file(stations_url)
observer = Topos(observer_latitude, observer_longitude, observer_elevation)
t = load.timescale().now()

# Calculate satellite positions
positions = [(sat, (sat - observer).at(t)) for sat in satellites]

# Filter visible satellites
visible_satellites = []
for sat, position in positions:
    alt, az, distance = position.altaz()
    # Satellite is above the horizon
    if alt.degrees > 0 and distance.km < distance_km:
        visible_satellites.append((sat, alt, az))

return visible_satellites
```

Listing 1: visualizing a single obstruction map

count of visible satellites across time

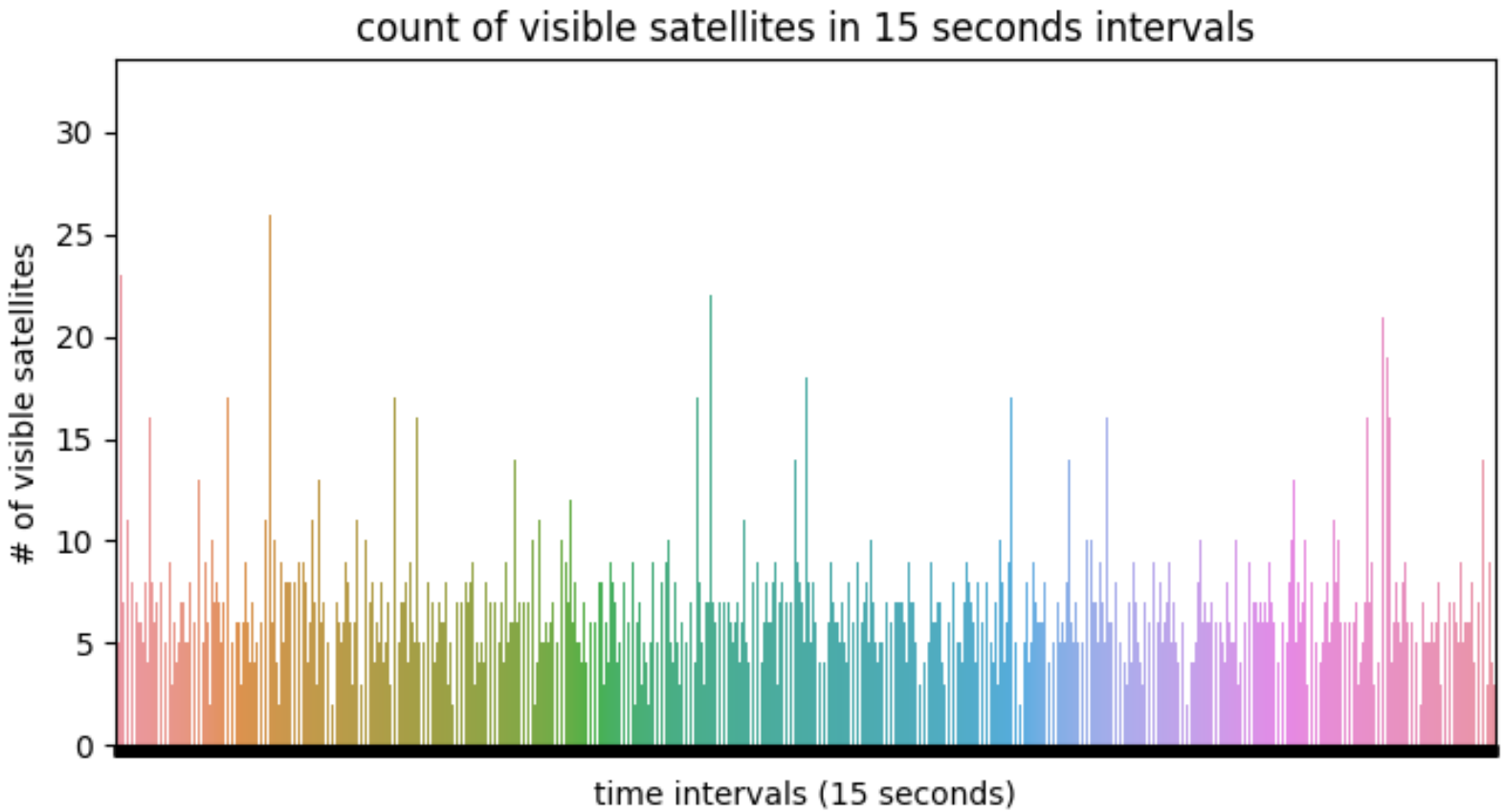

Figure 6: count of visible satellites across time

Visualizing Patterns in Visible Satellites

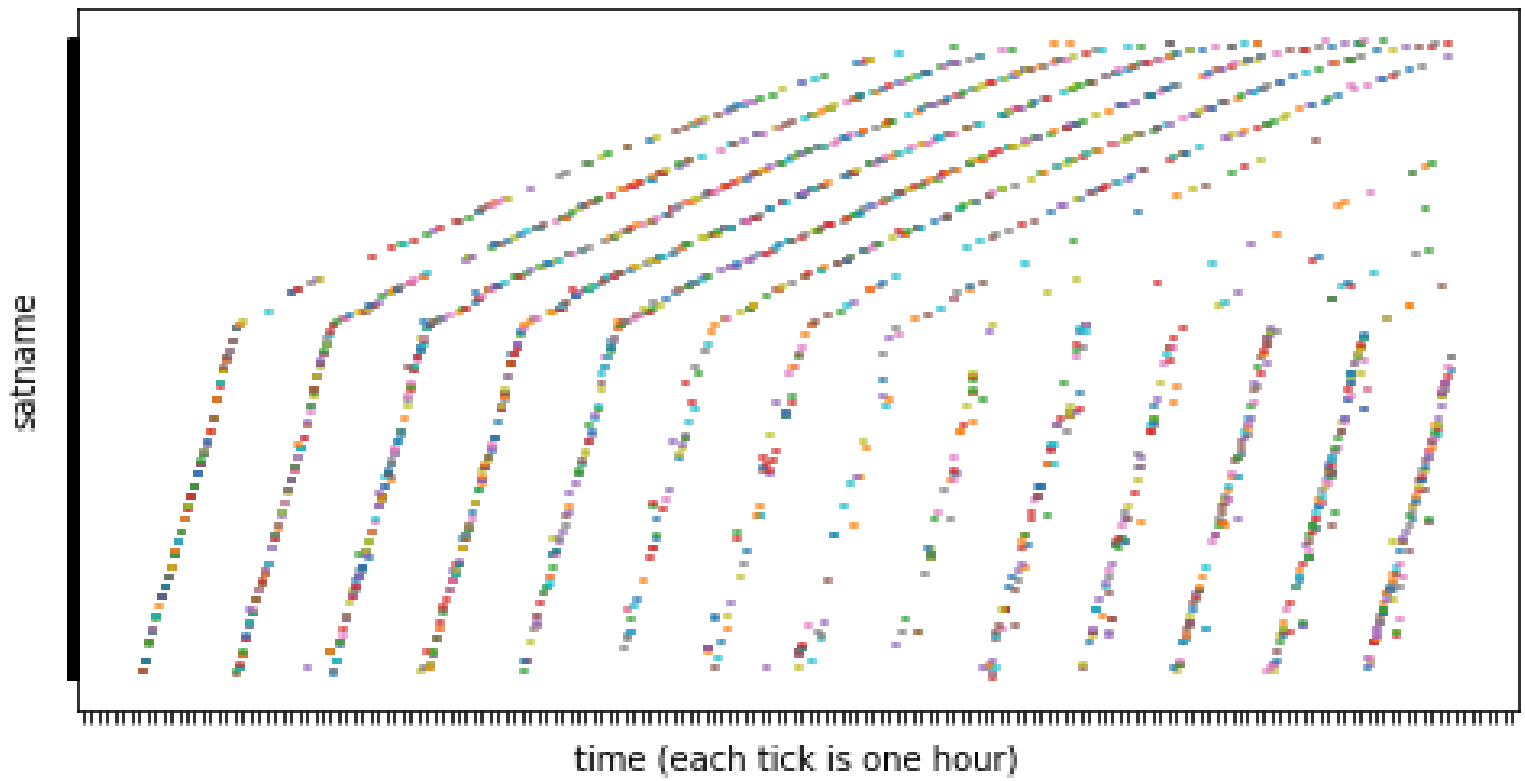

Figure 7: Visualizing patterns in visible satellites

the gRPC api

- the dish exposes a gRPC api with server reflection, "runtime construction of requests without having stub information precompiled into the client." [2]
- 55 "methods" are available, most of them don't work, we have 2 categories of errors: `Uninmplemented`, `PermissionDenied` and a couple of some other specific errors
- working methods: `reboot`, `get_status`, `start_dish_self_test`, `get_history`, `get_device_info`, `dish_power_save`, `dish_get_config`, `get_obstruction_map`
- to see all methods: https://gist.github.com/rcastellotti/e20630366dfeaeada6cc2680f562f6ac

[2] https://github.com/grpc/grpc/blob/master/doc/server-reflection.md

Next Actions

- investigate satellite handovers following the method described in [1] (we have a working script)
- try to correlate satellite handovers with sudden drops in bandwidth
- sneak peak: https://youtu.be/PjfMPr20suw

Bibliography

[1] L. Izhikevich, M. Tran, K. Izhikevich, G. Akiwate, and Z. Durumeric.
Democratizing leo satellite network measurement, 2023.