Routing on Satellites

RIPE80

Marvin Gaube, Tesat-Spacecom

About Me

- Corporate Student at Tesat-Spacecom
- Community Networking
  with Freifunk Frankfurt (AS64475) during free time

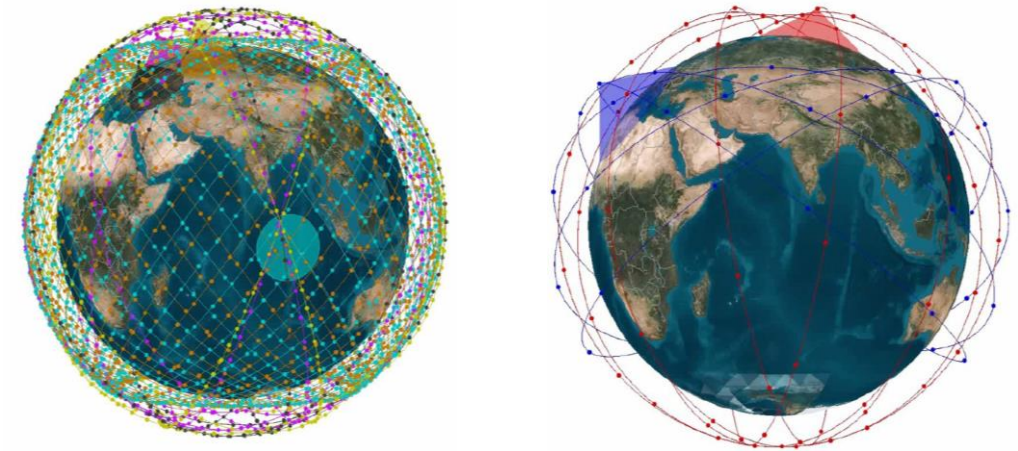
- TESAT: Communication Products for Satellites
  - Optical links (Intersatellite Links & Direct to Earth)
  - Part of the Airbus group
  - Huge experience with optical satellite communication

- Practical Thesis:
  - How to achieve packet forwarding on a Satellite Constellation with a mesh topology?
  - Traditionally: Layer 1 – relay (“bent pipe”)
  - Intersatellite Links requiring switching and routing

LEO Satellite Constellations

- Many satellites in Low Earth Orbit (a few hundred kilometers)
- Main purpose: Global connectivity (internet access)
- (Optical) Intersatellite-Links (ISL) forming a mesh-network
  - Not “just” L1-Relay, as traditional Bent-Pipe-Satellites used to be

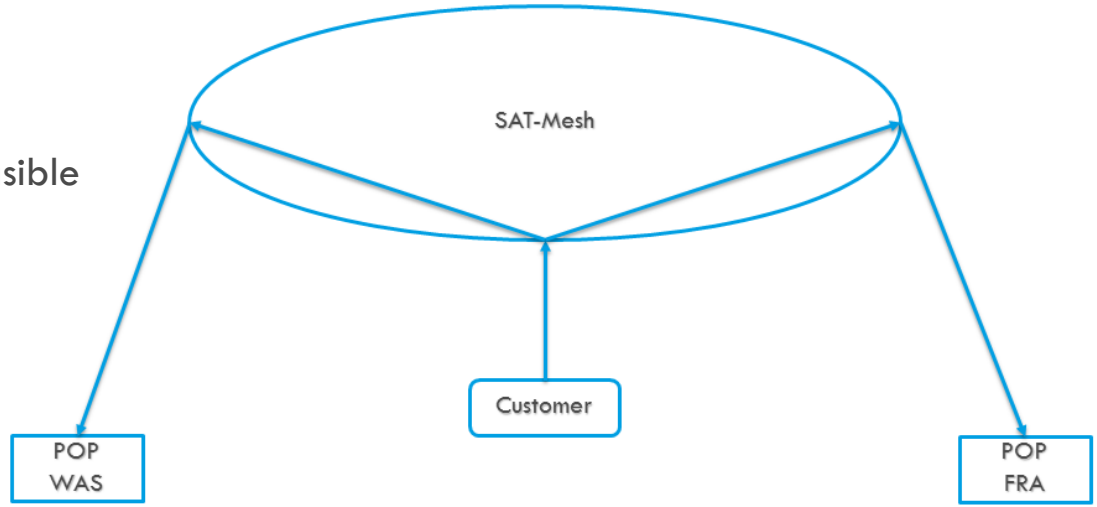
- Telesat LEO
  - 117 Satellites with optical ISL
- SpaceX Starlink
  - 4425 Satellites with optical ISL
- Amazon Kuiper
  - 3236 Satellites, only +- 56° Latitude



SpaceX (left) and Telesat (right)
Inigo del Portillo, Bruce G. Cameron, Edward F. Crawley.
“A Technical Comparison of Three Low Earth Orbit Satellite Constellation Systems to Provide Global Broadband.” - International Astronautical Conference, 2018 IAF
http://www.mit.edu/~portillo/publications.html

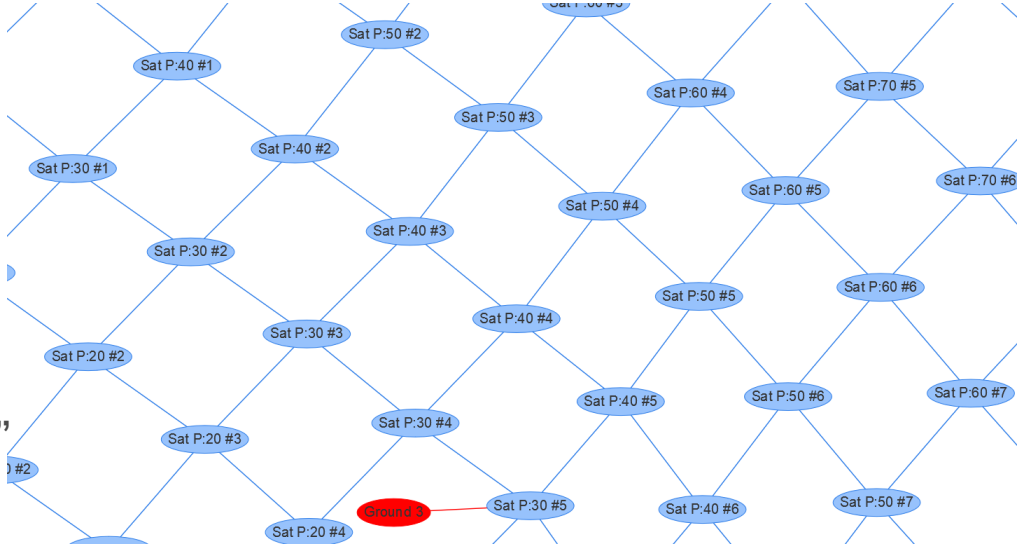
Use Case: Upstream/Transit

- Primary use case of a constellation:
  - Upstream/Transit
- USP: Low Latency, High Bandwidth where terrestrial networks are not feasible
- Potential Users:
  - Intercontinental Flights
  - Shipping Industry
  - Residents in remote Areas
- Both moving and fixed position clients
- Satellite network abstracted as mesh cloud, single ASN
- Data routed to the Gateway/POP best suited for destination



IGP: Temporospatial SDN

- Ground speed of satellites relatively high
- frequent link changes (ISL, User, Gateway)
  - Classic, reactive IGP not feasible
- We know and predict the satellite position
  - Route changes are foreseeable
  - → Temporospatial SDN[1]
- SDN controller can compute future flows
  - e.g. usage of OpenFlow “Scheduled Bundle” to preinstall flows



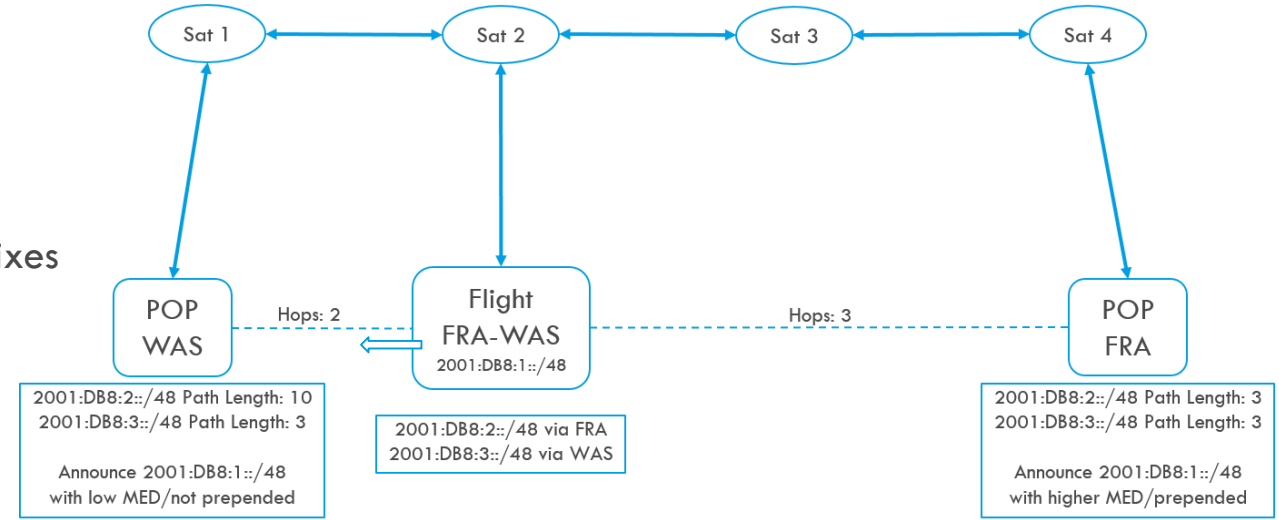
- Reactive IGP as fallback

[1] Barritt, B., Kichkaylo, T., Mandke, K et. al.(2017). Operating a UAV Mesh & Internet Backhaul Network using Temporospatial SDN.

External Routing
Integration into the DFZ

- Scenario: Transatlantic flight connected trough the constellation
- Outbound routing: SDN controller knows routes at all gateways, can compute best ground station
- Inbound routing: Bigger challenge for mobile users
  - When Flight FRA → WAS is near the US east coast, data for this flight shouldn't arrive at FRA POP
  - Change the route cost as user (airplane) moves (path prepending etc.)
  - But: Need /48 per individual mobile customer
  - 2018: ~25000 airplanes
    - assumption: 25 % usage

    → ~ 6000 additional prefixes (Today: ~86400 IP routes)



Summary

- LEO-Constellation with Intersatellite Links enables global connectivity
  - Remote Areas & Oceans
- Low latency, high bandwidth coverage (compared to existing solutions)
- Intelligent routing is necessary to reap the benefits
  - Not only a “relay” on layer 1
- Internal routing: Temporospatial SDN
- Outbound routing: Controller knows best gateway for destination
- Inbound routing: Challenge, BGP needs to adjust for target position
  - /48 per moving client?

Thank You!

Marvin Gaube
marvin.gaube@tesat.de

Tesat-Spacecom GmbH & Co. KG
Gerberstraße 49
71522 Backnang
www.tesat.de