Problems and Requirements of Satellite Constellation for Internet

draft-lhan-problems-requirements-satellite-net-03
Agenda

- Satellite Networks: 3GPP work

- 3GPP Wireless Access via Satellite Network (TR 38.821)
  - Satellite-based NG-RAN Architectures
  - Layer-3 in Satellite-network Architectures

- I.D on Satellite Network: Problems & Requirements
  - List of a series of I.D on Satellite Networks
  - draft-lhan-problems-requirements-satellite-net-03
    - Changes: ver-02 => ver-03

- Conclusion & next steps
3GPP work related to Satellite neworks

- TR.38.811  Study on NR to support NTN (Rel-15)
- **TR 38.821**  Solutions for NR to support NTN (Rel-16)
- TR 22.822  Study on using satellite access in 5G (Rel-16)
- TR 23.737
  - (Phase-1) Study on architecture aspects for using satellite access in 5G
  - (Phase-2) Integration of satellite components in the 5G architecture
- TR 28.808  Study on management and orchestration aspects with integrated satellite components in a 5G network (Rel-17)
- TR 22.926  Guidelines for extra territorial 5G systems (Rel-18)
- TR 24.821  CT aspects of 5GC architecture for satellite networks (Rel-17)
- (SA2) SID: 5GSATB  5G system with satellite backhaul – In progress
- (SA2) SID: 5GSAT_Ph2  5G Satellite Access Phase 2 – In progress
Satellite Network for 3GPP Wireless Access*

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End user terminal or local network access Internet through Mobile Access Network and Satellite Network

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*Both pictures are newly added to our revised I.D draft (ver#03)*
Satellite-based NG-RAN Architectures*

Satellite w/ transparent payload (normally for small area, traditional way)

Satellite w/ regenerative payload (gNB-DU on board, gNB-CU on ground; normally for big-area)

Satellite w/ regenerative payload (gNB on board, with and without ISL; normally for big-area)

- Satellite network being the infrastructure for wireless access and Internet, it provides the gNB, front haul and back haul transport functionalities.
- A satellite network could be shared by different SPs to provide services, which means standardized protocols are necessary for many functionalities.
- IP connectivity is key underlay technology for 5G.
  - NG interface: between gNB and AMF/UPF
  - Xn interface: between gNBs
  - F1/F2 interface: between gNB DU and gNB CU

*3GPP TR 38.821 Solutions for NR to support NTN
**Visionary Layer-3 work in LEO Satellite-network Architectures**

One Satellite relay - transparent payload
- Simplest; downlink to Internet;
- 2 GS-distance < Coverage-diameter
- Light L3 work (exchanging the IP address for GS)

Multiple Satellite relay - transparent or regenerative payload
- Networking, path-selection, protocols, packet forwarding
- Qs: Which satellites, which satellite-paths, which GS-paths?

Satellite network with Inter-Satellite Link (ISL) –
- To replace relay; shorter path than relay
- Best solution, Most likely the future model
- Microwave ISL -> Laser ISL

Extreme dynamics:
- peering, link-quality/cost, path, etc.;
- Routing convergence; heavy computational load;
- IGP/BGP mutual- advertise/withdraw
List of a series of I.D on Satellite Networks

Satellite network - Problems and Solutions From L3 Perspective
•draft-lhan-problems-requirements-satellite-net-03
•draft-lhan-satellite-semantic-addressing-01
•draft-lhan-satellite-instructive-routing-00
•draft-retana-lsr-ospf-monitor-node-00

Changes: draft-lhan-problems-requirements-satellite-net-02 => 03
•3GPP wireless access (in a previous slide)
•3GPP latest development with satellite backhaul
•Use case: 5G Satellite backhaul
•Add a new author
3GPP Latest Development w/ Satellite Backhaul

- 3GPP SA1/2 WG SIDs: 5GSATB (rel-18), 5G_SAT_Ph2/3 (rel-18/-19)
- Satellite backhaul:
  - UPFs on board-SAT w/ gNB on the ground
  - Backhaul: GEO BH, LEO BH, and LEO BH w/ ISL (Inter-satellite-link)
  - Edge computing can be deployed on Sat.
- LEO-BH w/ multi-ISL
  - Extremely dynamics for LEO network
  - Satellite peering relationship changes roughly every 5-min thanks to orbital movements: impair perf, stability, and even cause connectivity-loss.
  - No proper technologies to provide steady IP transport for SAT backhaul, impact service.
Use Case: LEO w/ Multi-ISL as a 5G Backhaul

Sat#: Satellite  GS: Ground Station
UPF: User Plane Function (5G)  gNB: Next Generation NodeB

Sat#1

Sat#2

Two multi-hop ISL paths:
• UEs rely on a multi-hop ISL path to connect to 5GC on the ground
• Two UEs communicate via the local data switching on satellite(s) (N19 ISL)

Some multi-ISL related challenges (dynamic topology, transmission capabilities, etc.):
• UE-to-UE session time over 5-min – topology/peering changes, link-cost varies, etc.
• UEs belonging to the same 5G-VN group, i.e., 5G LAN-type service w/ PSA UPF

− So, need standardized & efficient satellite-based routing protocols for more efficient satellite communication
− Of course, the ‘dynamics’ talked about here is ‘not random’ – the movement of a satellite is normally periodic and could be well predicated based on the operation information of satellite constellation; meaning more predictably easier & better services.
Conclusion & Next Steps

- Satellite communication is critical for some 5G-adv services (Rel-18)
  - Keep following up with 3GPP SA WGs on 5G SAT use cases

- Working on & Refining our I.D drafts: Satellite network - Problems and Solutions From L3 Perspective
  - draft-lhan-problems-requirements-satellite-net-03
  - draft-lhan-satellite-semantic-addressing-01
  - draft-lhan-satellite-instructive-routing-00
  - draft-retana-lsr-ospf-monitor-node-00

- Will have **side-meeting in IETF-115**, lets work together.

Comments?