3GPP TSG SA2 Meeting #157
Berlin, Germany, May 22 – 26, 2023

S2-2307044

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CICT Mobile

# Discussion and proposal for Rel 19 Satellite

CATT, Thales?, Novamint?

# Overview of integrating satellite into 5GS

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## Support of transparent mode satellite access

- ✓ ***Architecture***
  - gNB is on the ground
- ✓ ***Mobility management***
  - New RAT type for NR satellite access: "NR(LEO)", "NR(MEO)", "NR(GEO)" and "NR(OTHERSAT)".
  - Registration area management for hard TA case and soft TA case
  - Mobility restriction
  - Network selection based on UE location
  - UE location verification
- ✓ ***PCC/QoS control***
  - New 5QI for satellite access
  - Policy adjustment considering satellite access type
- ✓ ***Discontinuous satellite coverage***
  - Provision of satellite coverage availability information to the UE and AMF via OAM or AF.
  - Power saving management for UEs out of satellite coverage: indicating
  - Paging optimization using last known UE location

## Support of satellite backhaul

- ✓ ***PCC/QoS control***
  - Satellite backhaul category
  - QoS monitoring on dynamic backhaul delay
  - Policy adjustment considering backhaul delay
  - Exposure of satellite backhaul information

## Support of UPF on board

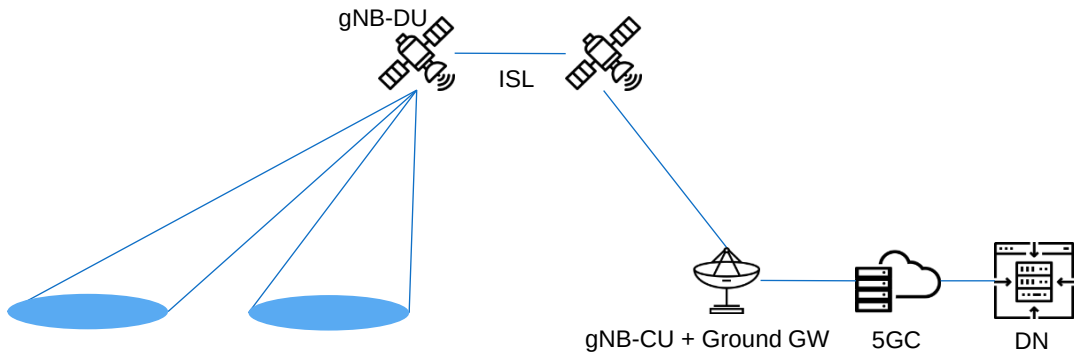
- ✓ ***Edge computing via UPF on board GEO satellite***
  - Selection of UPF onboard
  - Provision of URSP rule to UE for accessing service on GEO satellite
- ✓ ***Local switching via UPF on board GEO satellite***
  - UPF on board working as PSA or UL-CL + local PSA
  - Activation of local data switching based on target UP IP or AF request
  - User plane configuration to enable local data switching

**Integration of satellite components into 5GS has been studied in Rel 16, Rel 17 and 18**

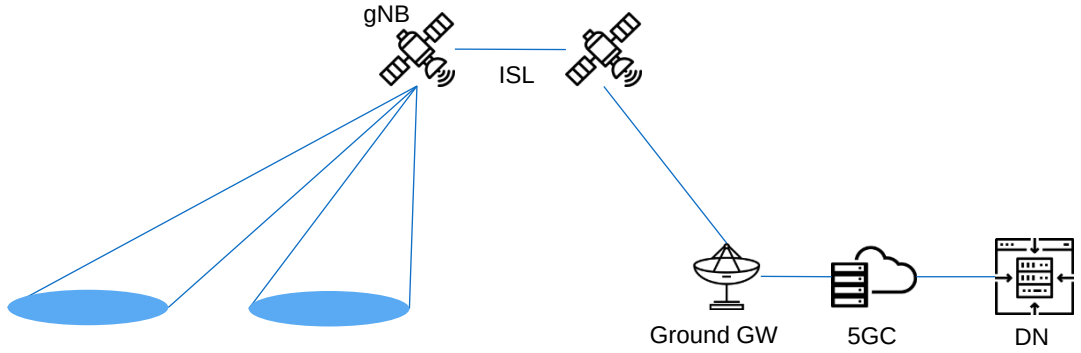
# New Architecture options

Architecture options for regenerative mode satellite access

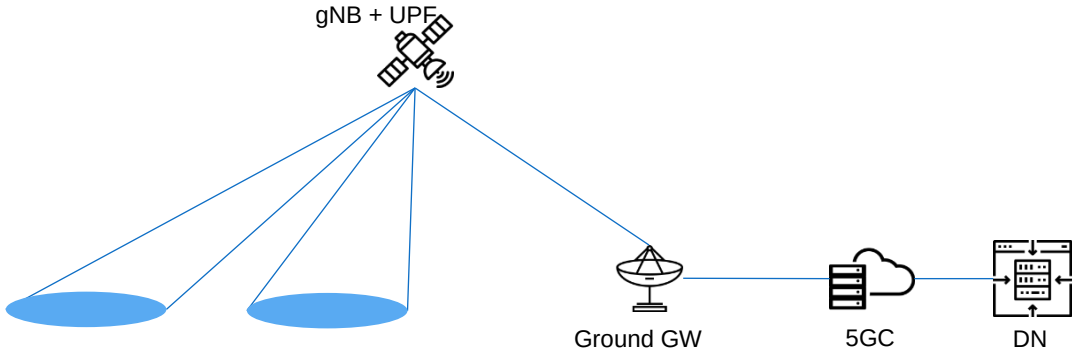
- ✓ ***Option 1:*** gNB-DU on the satellite
  - As gNB-CU is on the ground, the NG interface is not impacted
  - If ISL is involved on the F1 interface, the latency over N1 interface will be changed dynamically




- ✓ ***Option 2:*** whole gNB on the satellite
  - For NGSO satellite, the NG interface between the gNB on board and the 5GC changes dynamically
  - If ISL is involved on the NG interface, the latency over N1/NG interface will changed dynamically




- ✓ ***Option 3:*** gNB + UPF on the satellite
  - For NGSO satellite, the NG interface between the gNB on board and the 5GC changes dynamically
  - If ISL is involved on the NG interface, the latency over N1/NG interface will changed dynamically
  - UPF moves along with satellite



# New Requirements from Rel-19 Stage1

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## Store and Forward Satellite Operation

- ✓ ***General Aspects***
  - Store user data on the satellite when the feeder link is unavailable and forward when the feeder link is available
  - Forward the stored data between satellites via ISI
- ✓ ***Specific Aspects***
  - Provisioning of specific QoS and policies
  - Set data retention period, data storage quota, total amount of stored data per satellite for each UE
  - Limit the total amount of the stored data
  - Inform a UE of S&F operation, data retention time
  - Inform an application server of S&F operation with a UE
- ✓ ***Security Aspects***
  - UE registration for S&F operation when the satellite connectivity is unavailable
  - Authentication and service authorization
  - Preserve data security when forward the stored data via ISI
- ✓ ***Charging Aspects :*** per UE, per application

## Dual Access

- Steer/Switch/Split UP traffic across two 5G NTNs or TN & NTN
- Access control for different access networks of shared RANs

## Communication between UEs

- ✓ ***General Aspects***
  - Communication between UEs via UE-Satellite-UE connectivity*
  - Support UE-Satellite-UE connectivity of HPLMN and/or VPLMN
  - Efficient communication path for a UE using only satellite access
  - QoS control
  - Diverse communication type (e.g. unicast, multicast, broadcast)
  - Different network connection paths (e.g. direct, indirect )
- ✓ ***Service Continuity Aspects***
  - Minimum service interruption when a UE changes the coverage of a satellite due to UE's and/or satellite's movement
  - When UE communication path moves between serving satellites, between 5G TN and 5G NTN, from one to several satellites via ISI
- ✓ ***Security Aspects:*** Authorization and service authentication
- ✓ ***Charging & Orchestration Aspects:*** data exchange, network planning

## GNSS Free & Positioning

- ✓ ***Service Aspects***
  - Service policy for UE w/ or w/o GNSS capability (HPLMN/VPLMN)
- ✓ ***Positioning Aspects***
  - Positioning service and provide delivered QoS info. to a UE
  - Determine location of a UE using only satellite access

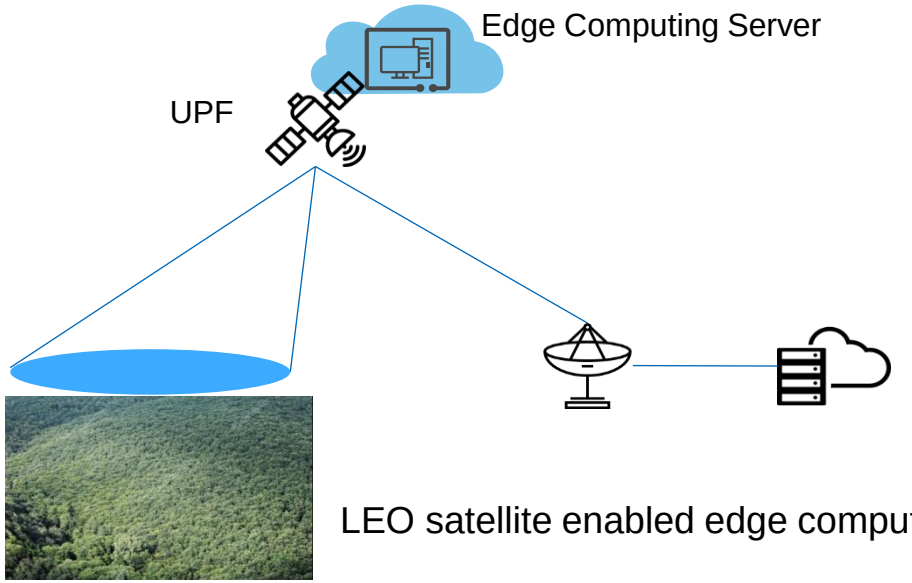
** [UE-Satellite-UE] stands for "Satellite access without going through the ground network"*

# Down-scoped use cases in Rel 18

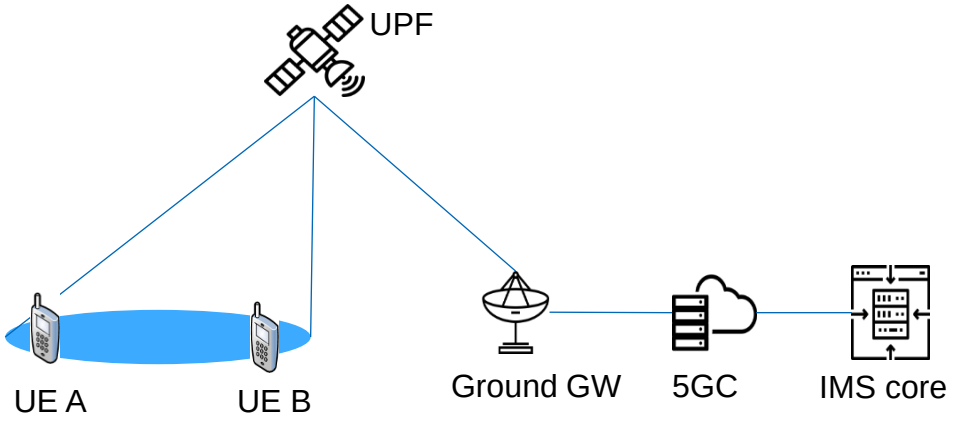
- ✓ ***Case 1: LEO satellite enabled edge computing***
  - LEO satellite is much closer to the UE comparing with GEO satellite
  - There are much more LEO satellite than GEO satellite
  - LEO satellite enabled edge computing can reduce E2E delay significantly and provide more computing resource to remote Ues

- ✓ ***Case 2: LEO satellite enabled Local data switching***
  - For LEO satellite constellation, dynamic satellite backhaul exists and has limited bandwidth
  - Local data switching can save backhaul resources

- ✓ ***Case 3: LEO satellite enabled Local call switching***
  - Similar reasons to support local call switching
  - Coordination between IMS core and 5GC may be needed




LEO satellite enabled edge computing




LEO satellite enabled local data/call switching

# Prioritized work in SA2



** [UE-Satellite-UE] stands for "Satellite access without going through the ground network"*

# Possible Task#1: Support of regenerative payload satellite

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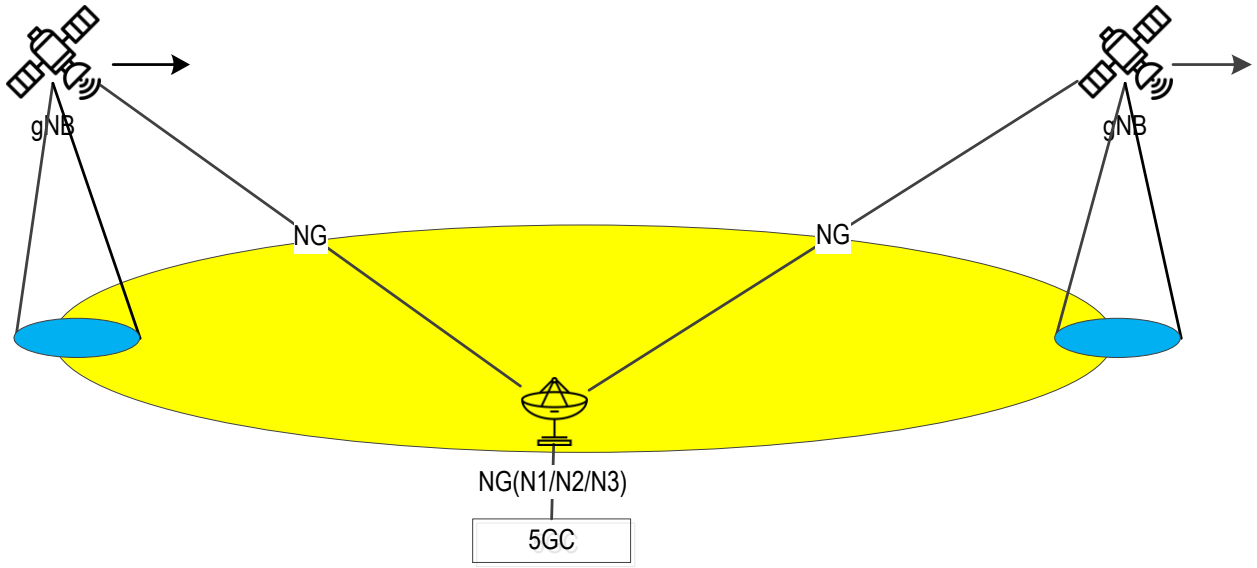
**Support of regenerative payload satellite access**

- T1.1: Interface management
  - Efficiently handling of frequent NG connection change
  - Efficient configuration update for RAN and AMF
- T1.2: Mobility management
  - Paging handling considering dynamic gNB coverage
- T1.3: Protocol impact
  - Whether the impact of increased delay caused by ISL to NAS/NG-AP/F1 protocol exists



# Possible Task#2: Store and Forward

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**Scenarios of using store and forward:**

- ✓ ***Scenario 1: temporary /intermittent loss of feeder link***
  - The NGSO may lose the feeder link towards the ground gateway temporarily.
- ✓ ***Scenario 2: no feeder link in certain area***
  - At a remote area, the NGSO satellite has no feeder link towards the ground gateway.
- ✓ ***Scenario 3: temporary store packets from UEs***
  - In a certain area, the satellite may have inefficient path toward 5GC on the ground (e.g. in case of cross-seam ISL involved in the backhaul connection ), so the satellite may store UL data temporarily and forward them when the path become efficient
  - In the above case, the satellite may store packets from multiple UEs and send them as A bundle payload as defined in the rfc9171.

**Challenges to support the scenarios:**

- ✓ ***For scenario 1:***
  - Which NF(s) is responsible for detecting the loss of feeder link
  - How to activate store and forward when detecting the loss of feeder link
- ✓ ***For scenario 2:***
  - The UE in a remote area can not be authenticated by 5GC as the UE signaling can never be sent to the 5GC on the ground.
- ✓ ***For scenario 3:***
  - How does the satellite decide to store the UL packets
  - How to know whether a packet is delay tolerant.

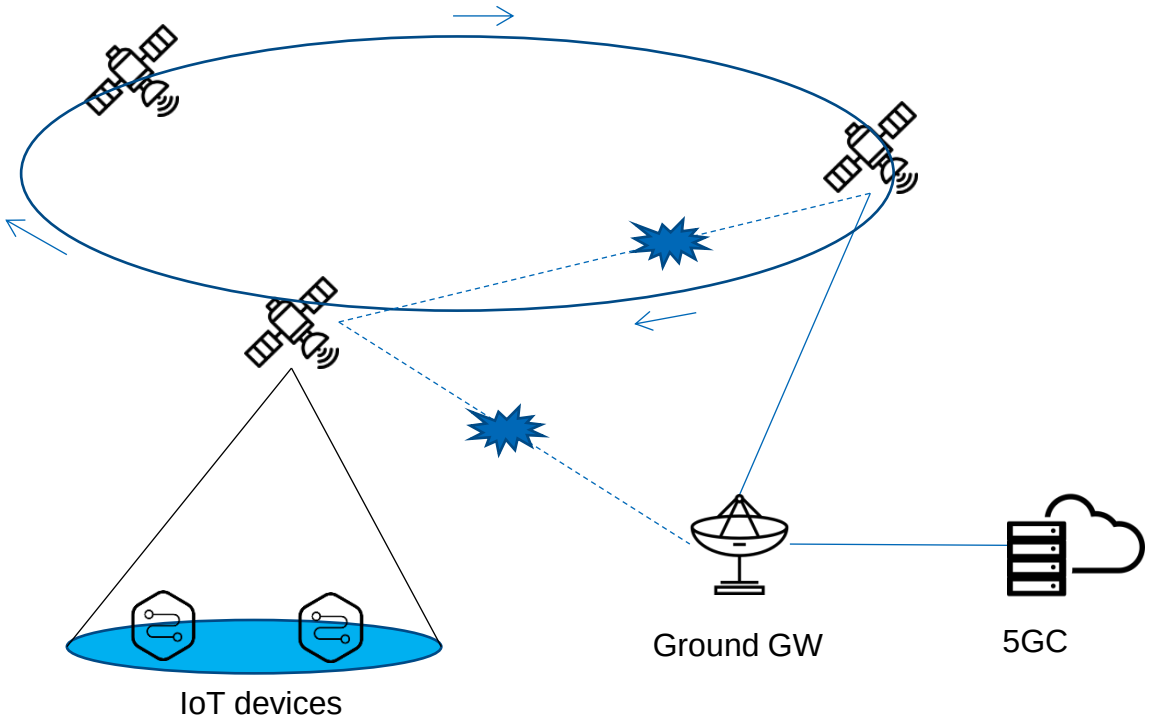
# Possible Task#2: Store and Forward

**Architectural assumption:**

- ✓ Only satellite working in regenerative mode can support store and forward
- ✓ UE must be authenticated when the UE data is to be stored and forwarded

**Work for Rel 19**

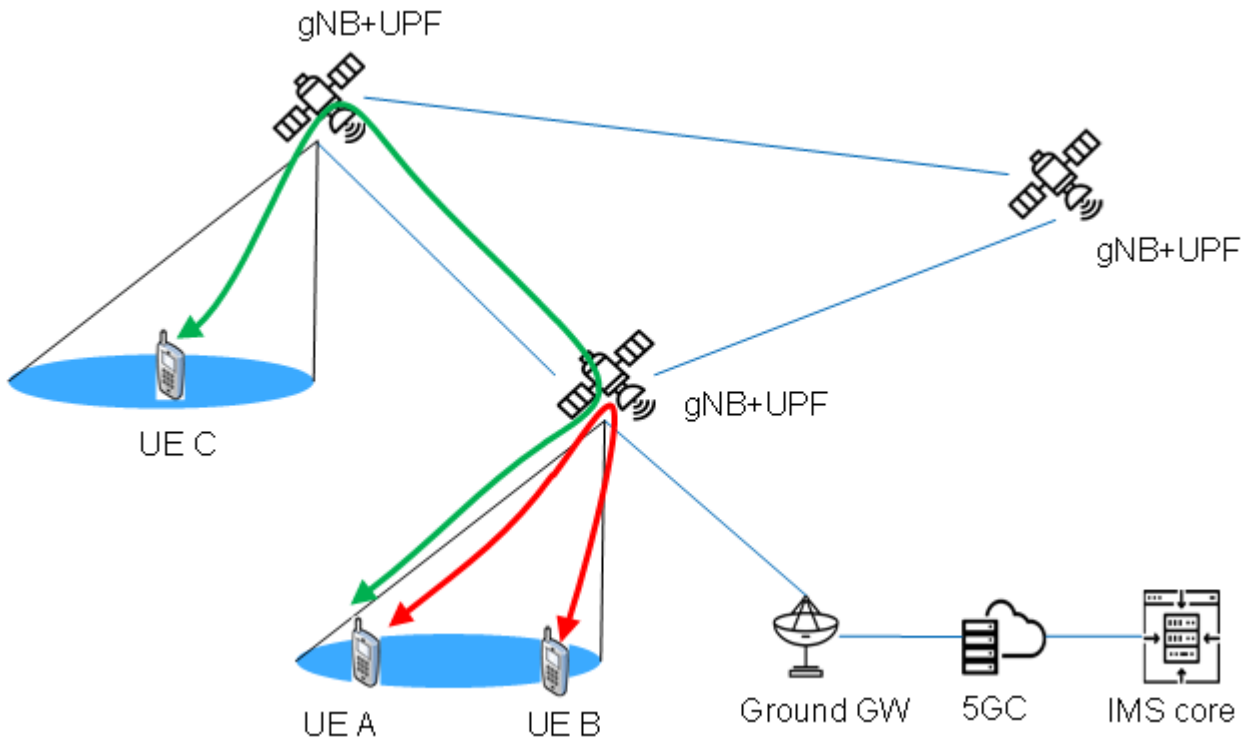
- T#2.1: Authentication of using store and forward
  - Authentication of UE to use store and forward.
  - UE configuration (e.g., time, area).
  - satellite configuration (e.g., buffer size, time).
- T#2.2: Store UL/DL data
  - When and where (which NF) to store the UL/DL data
  - How to store UL/DL data on the satellite
- T#2.3: Forward UL/DL data
  - How to forward the stored UL/DL data



# Possible Task#3: UE-satellite-UE communication

**Support of UE-satellite-UE communication**

- T3.1: Activation of UE-sat-UE communication
  - How to determine a UE-sat-UE communication
  - How to activate a UE-sat-UE communication
- T3.2: Session management aspects for UE-sat-UE communication
  - service continuity when the satellite serving the UE changes
  - QoS control and charging.




**NOTE:** When UPF on-board LEO satellite is used to support UE-sat-UE communication, LEO satellite enabled edge computing can also be supported.

# Other aspects

- TN-NTN Coordination (maybe not in the scope of this SID)
  - When and how to trigger a UE select an appropriate access network
  - Service continuity when changing access network

- Multicast and Broadcast Service via satellite.
  - Align to RAN study

- GNSS independent operation
  - Impact to UE location verification

**Based on the analysis, it is proposed to has a study for satellite in Rel-19, and the SID proposal can be found in the S2-2306896.**