



Stateless Paradigm for Resiliency in Beyond 5G Networks





By

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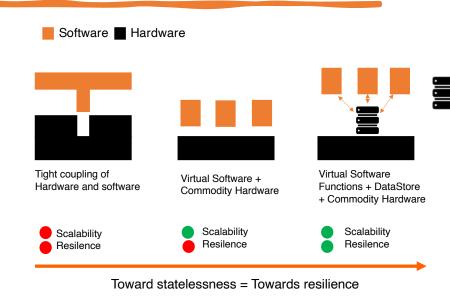


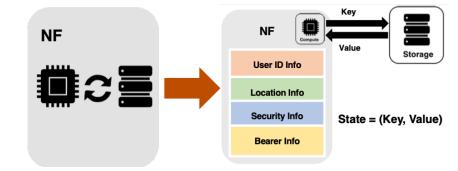
Outline

- Introduction
- State-of-Art
- Network entity resiliency
- Prerequisites for Stateless Implementation 3Ws
 - What to Store ?
 - When to Store ?
 - Where to Store ?
- Network traffic analysis
- Stateless user-plane
- Conclusion

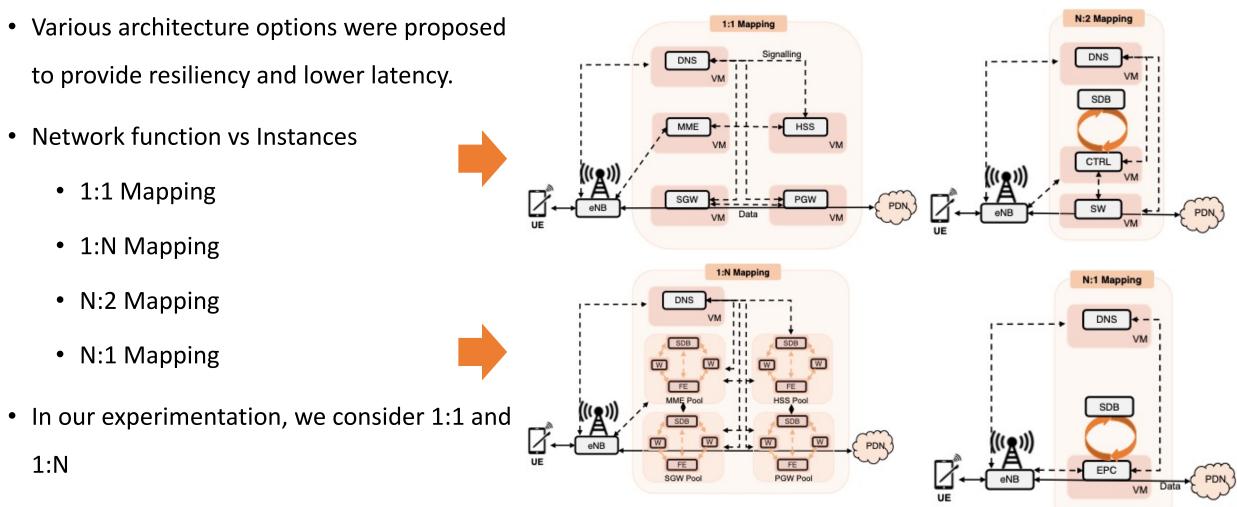
Introduction

- We moved from hardware centric to software centric and now data centric architectures.
- 5G use-cases and its varied traffic distribution have stringent latency, data rate, bandwidth than 4G LTE.
- Availability, Reliability and Scalability properties are expected of 5GS to ensure the above requirements of KPIs.
- Virtualization has helped to achieve scalability
- Stateless Network Functions helps in achieving resiliency and hence reliability.





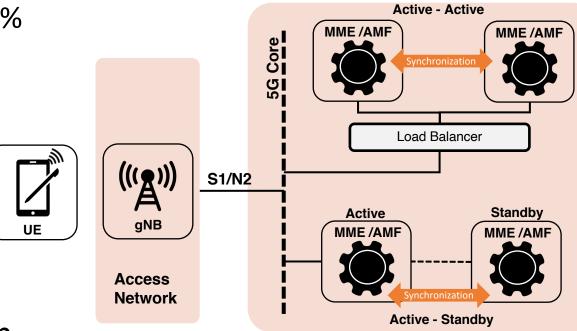
State of Art : Architectures



T. Taleb et al., "EASE: EPC as a service to ease mobile core network deployment over cloud," in IEEE Network, vol. 29, no. 2, pp. 78-88, March-April 2015.

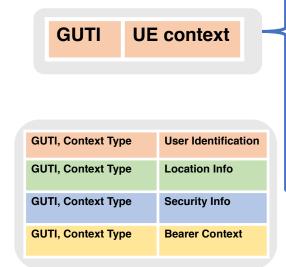
Today's Resilency Solutions

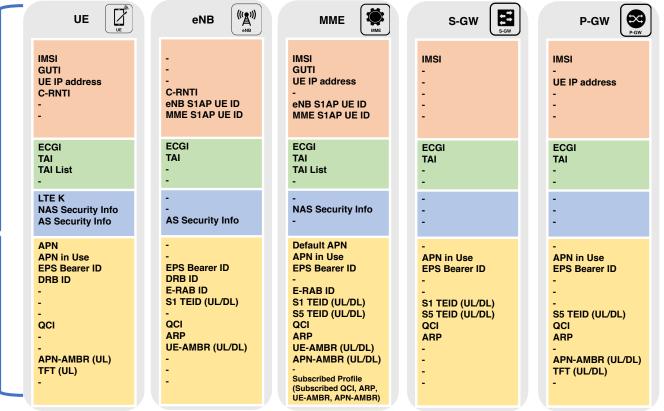
- Active Active :
 - Both systems are active
 - Need high degree of synchronization (30% CPU resources)
 - Expensive
- Active Standby:
 - One stand-by system
 - Expensive
- Both options take few seconds to minutes to resume services apart from being expensive



Stateless Concept – 3Ws

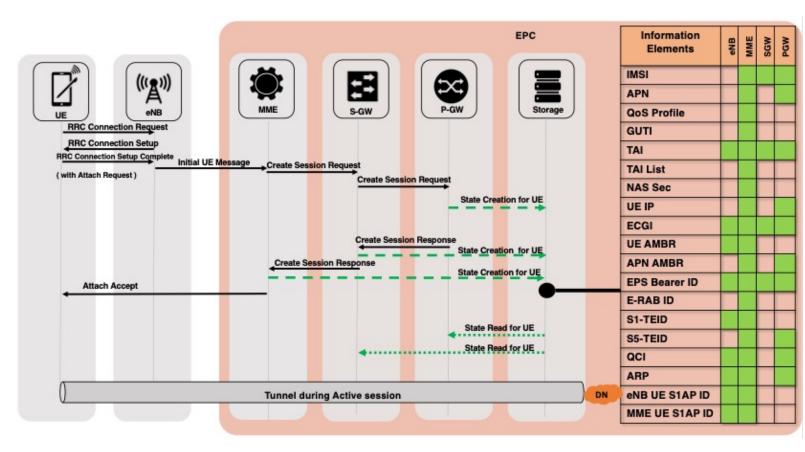
- What to Store ?
 - UE information exchanged between network entities like IMSI, TA etc.
- State storage template design can be,
 - One State
 - Multiple States





Stateless Concept – 3Ws

- When to Store ?
 - Message-level
 - Transaction-level
 - Procedure-level
- Challenges
 - Number of DB trasactions
 - Bottle neck issues
 - Consistency issues



Stateless Concept – 3Ws

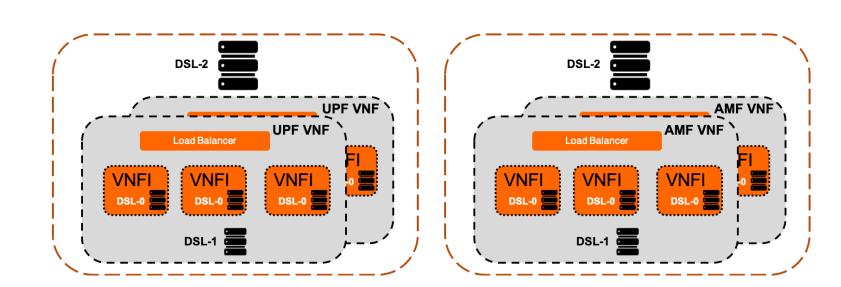
- Where to Store ?
 - Hierachical storage is benificial
 - We define Data Storage Levels (DSLs)
 - Central storage

Strong consistency

Network latency

Bottle neck issues

• Challenges ?

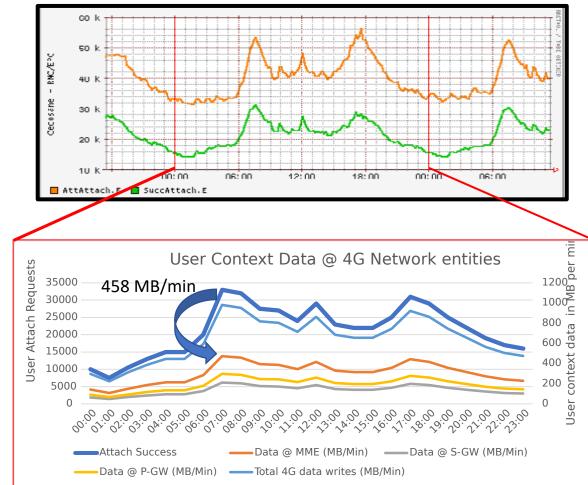


DSL-3

Network Traffic Analysis

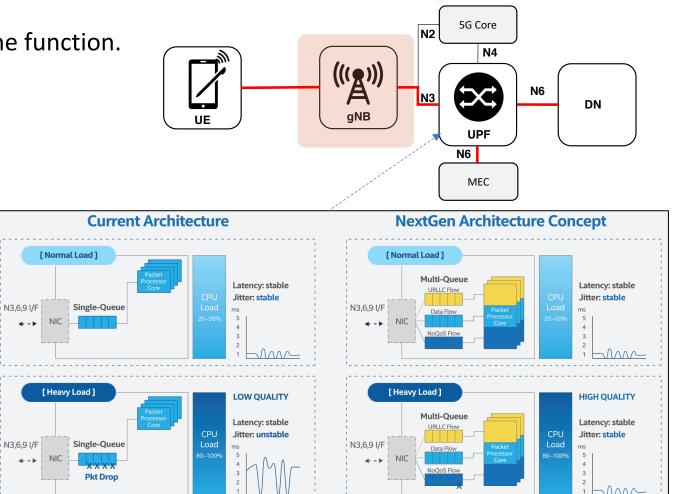
- LTE initial-attach traffic : objective is to understand the traffic at network entities.
 - Volume
 - Number of requests made by UE
 - Number of requests/queries made by NF to datastore
 - Size
 - Bytes of signalling messages
 - Bytes of state to/from datastore
 - Frequency
 - Influenced by both volume and size per unit time
- Only 60% of requests are accepted, 40% requests consume some network entity resources.





User/Data-Plane Stateless ?

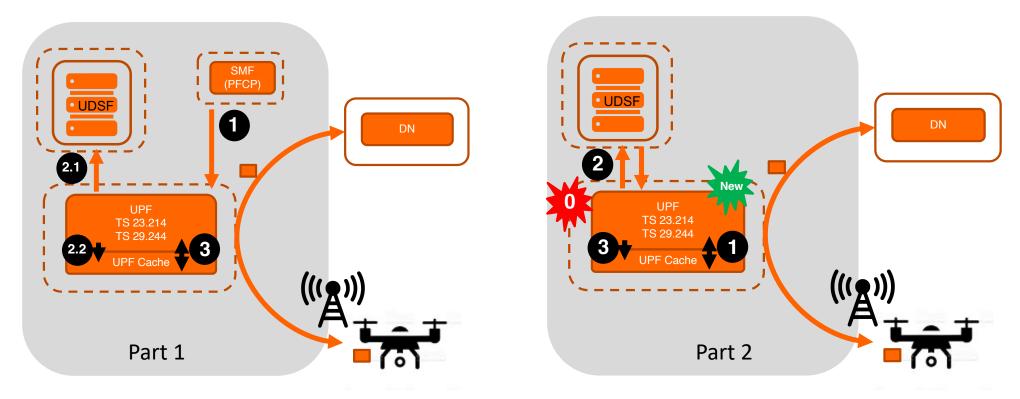
- High throughput is expected of an User-Plane function.
- Next-Generation User-Plane Fuction
 - Data Plane Development Kit (DPDK)
 - Vector Packet Processing (VPP)
- Intel Experiment
 - 50K users
 - 295 packets/sec (per UE)
 - 32 40 microseconds PPL



White Paper, Intel and SK Telecom, Low Latency 5G UPF Using Priority Based 5G Packet Classification

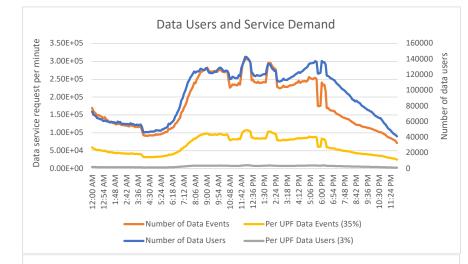
Quasi-Local Stateless Model

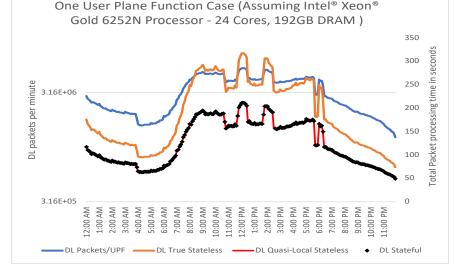
- Part 1 UPF caches the UE context to external datastore like 3GPP UDSF (TS 29.598).
- Part 2 Upon failure, a new instance fetches the UE context to process packets and caches it for future purpose.



One User-Plane Function case

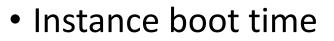
- Traffic following data service request
 - Over a period of 24h
 - Data service request (non voice)
- Assumptions (based on Intel experiment)
 - Number of UPFs = peak users/50K = 3 UPFs
 - Data service requests @ one UPF = ~ 34% of total requests
 - One data request = 295 packets
- Applying Stateless Schemes
 - True Stateless every packet needs context fetch
 - Quasi-Local Stateless first packet of UE needs context fetch
 - **Stateful** no fetch, context always in local cache.
- E2E latency is maintained with Stateless UPF



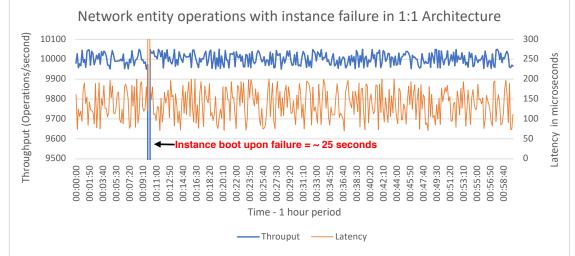


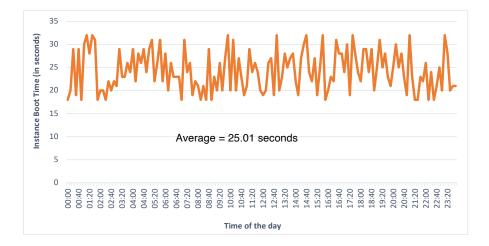
Failure Scenario

- Failure recovery
 - Non-telecom service with Quasi-Local Scheme
 - Service downtime approximates system unavailability.



- Simulation on Google Cloud Platform
- Average time of 25 seconds





Future Work

- Use Quasi-Local Stateless in real telecom system.
 - Open 5GS 5G SA core
 - UERANSIM UE, eNB
- Challenges
 - Resource with 32+ GB of RAM



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Conclusion

- Quasi-Local Model is well suited for User-Plane traffic
 - Packet processing latency is close to current stateful systems.
 - Indeed less expensive than that of dedicated redundant back-up systems.