An Analysis of Redundancy Schemes on Cloud Radio Access Network Reliability

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Introduction

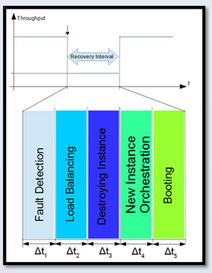
- Reliability is a key requirement for next generation of mobile networks.
- Virtualisation is a Key Enabler for 5G.
- Goal: Improve overall network reliability by utilising redundant virtual instances[1,2].
- The latency effect of RAN self healing sequences are the focus the investigation.
- Different redundancy schemes in telco cloud are analysed.

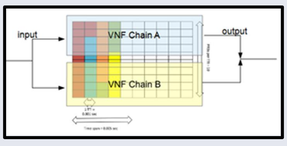
Assumptions

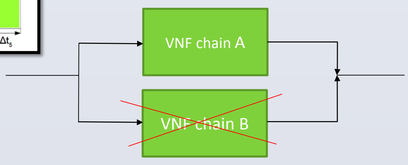
- All layers of RAN protocol stack are virtulised.
- VNF Chain is a group of VNFs able to process all layers (E.g. vPHY, vMAC, vPDCP).
- One eNodeB/gNodeB has one or more VNF chains. (Horizontal scaling approach)

VNF Healing Model

- Failure of any of the VNFs in the chain leads to interruption of the service.
- In case of the failure, the network with the healing capability has to perform a sequence of actions, to recover as follows.
- Fault Detection ($\Delta t1$): time to detect the occurrence of a fault in one of the instances.
- Load Balancing ($\Delta t2$): time to perform load balancing among the remaining active (i.e. non-faulty) instances.
- Destroy ($\Delta t3$): time to destroy the faulty instance and releasing the allocated resources.
- Orchestration ($\Delta t4$): time to orchestrate a new instance including allocating the required resources.
- Booting ($\Delta t5$) : time require for the container or virtual machine hosting the instance to boot and be ready.
- The time instance of failure occurrence is referred to as t_f.
- The total time taken by instance to recover from failure is referred as t_r.

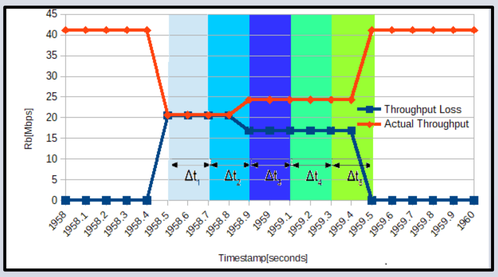






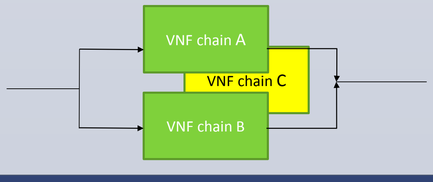
Active Only

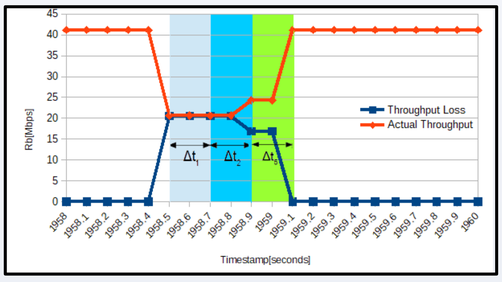
- A cell with peak computational load of estimated N unit, N parallel VNF chains are deployed, E.g. N=2.
- In case of failure, cell capacity reduce to half during critical time (t_f<t_c<t_f+Δt1+ Δt2).
- During moderate time tm (t_f+Δt1+ Δt2<t_m<t_h)Cell capacity between 0.5 to 1 based on load condition.
- **No Redundancy, Minimum Cost.**



Active Standby

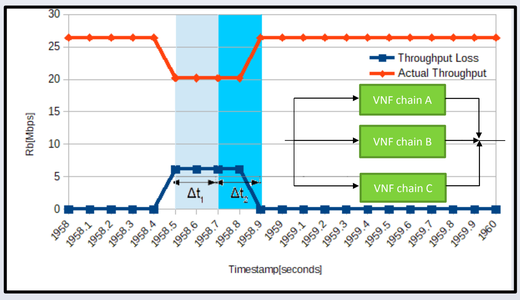
- A cell with peak computational load of estimated N unit, N parallel VNF chains are deployed.
- M instances are deployed in standby mode.
- In case of failure, cell capacity reduce to half during critical time t_f<t_c<t_f+Δt1+ Δt2.
- During moderate time, t_f+Δt1+ Δt2<t_m<t_h , Δt3= Δt4=0.
- Availability/Reliability improves compared to “Active Only”.
- **Lightest level of Redundancy, Edge Cloud.**





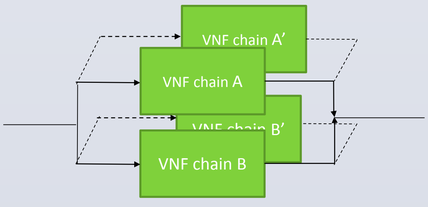
Load Sharing

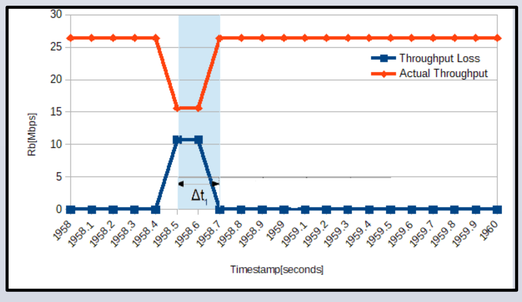
- A cell with peak computational load of estimated N unit, M redundant VNF chains, N+M VNF chains are deployed.
- Load is shared among N+M VNF chains.
- While t_c and t_m remains same as “Active Standby”, number of affected terminals are lesser than previous cases.
- During t_m probability of computational outage tends to zero due to over provisioning.
- Higher OPEX compared to “Active Standby” mode.
- Availability/Reliability is improved compared to “Active Standby”.
- **Higher Reliability improvement, central cloud deployment.**



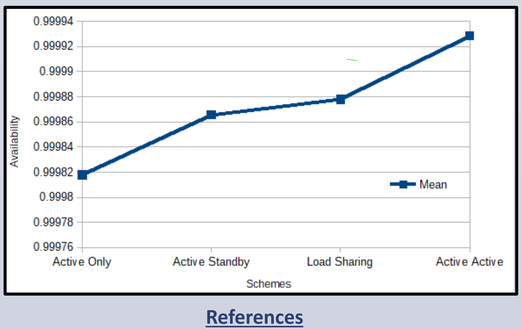
Active Active

- A cell with peak computational load of estimated N unit, N redundant VNF chains are deployed with one to one mapping.
- Identical information is being processed by 2 VNF chains at any given point of time.
- In case of failure, t_c = Δt_1 and t_m =0.
- Reliability is expected to be highest among all schemes.
- **Highest Reliability among four schemes, highest cost, can be recommended for URLLC use case.**





Results



References

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