IEEE Emerging Technology Reliability Roundtable 2017

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http://cqr.committees.comsoc.org/etr-rt-2017/

ETR Roundtable Participants' Input to the Roundtable Summary of Findings

Introduction

The scope of the RoundTable is to identify new challenges and solutions for **RAS** *(Reliability, Availability and Serviceability*), along with advances in technologies and networking.

Considering the huge impact of virtualization, programmability and automation, the ERT decided to focus its 2017 event to emerging technology areas like the Cloud Computing, NFV (Network Functions Virtualization), SDN (Software-Defined Networking), and similar large-scale distributed and virtualization systems. Accordingly, ERT 2017 was co-located with the 3rd IEEE Conference on **Network Softwarization** (Netsoft 2017) located in Bologna, Italy.

This RoundTable, organized upon invitation only, was held on July 3, 2017. It was well balanced with talks by Telcos (AT&T, Orange and Telecom Italia), Vendors (Huawei, Nokia and Ericsson), Academia (Ghent University, Politecnico Milano and UCL) and other Players (Airbus, Thalès).

The Speakers addressed various issues and challenges of upcoming softwarized infrastructures, providing further insight and impact on reliability. The talks provided some food for thoughts in the common discussion held after each presentation and summarized in the closing discussion for highlighting major issues to address. Most of the topics have been considered by several speakers, which showed some common understanding on reliability challenges, among which:

- End-to-end handling of Reliability aspects
- Dealing with uncertainty
- Diagnosis
- Automation
- Complexity and optimization
- Reliability Assurance in 5G and network slicing
- New tools such as Machine Learning, and in general, Artificial Intelligence.
- Open networking platforms.

After the Workshop, participants were offered the opportunity to provide some further analysis which is reported hereafter. Though half of the speakers only sent some further inputs, these additional comments indeed well reflect the consensus that was discussed during the Roundtable and they provide interesting food for thoughts for future work, in particular within the IEEE Emerging Technology Reliability Roundtable. The comments are listed in alphabetical order of contributors, and show some similar concerns.

Prosper Chemouil (Orange Labs, France):

Network Reliability has been often concerned with designing a robust network that could handle traffic uncertainties and failures so as to adequately delivering service. As such, a lot of effort had been made on optimization techniques, mostly in a static way.

Today, not only the need to implement services or to reconfigure networks has become more urgent, but the evolution on networking, based on virtualized network functions running over a virtualized infrastructure and connected through software-defined paradigms make the Reliability issue even more crucial. Though the optimization challenge in a cloud environment still remains important, in particular regarding placement of functions or equipment such as SDN controllers, the problem has moved towards more real-time challenges incurred by the flexibility and programmability offered by the new models.

In this more software-oriented model which is based on common hardware, the performance of single elements is proved to be less important than previously, so what is really important is the end-to-end reliability of service. So, it is crucial to consider the reliability issue as a global (multi-domain) challenge rather than by-section or by network. What is essential is that service is adequately provided, even if parts of the network are below performance.

Special care must be taken on software failures that can have significant impact overall, in particular in a new DevOps mode where micros-services may be provided by different teams. This raises the need for well-defined APIs. The introduction of continuous integration / continuous deployment (CI/CD) is certainly a way to overcome such impact, but may hide the need for an appropriate design of overall networks.

In the new environment that we are deploying, it is important to recognize that monitoring is becoming a key issue, generating lots of data that can be processed to identify anomalies or changes. This is ever more true as we can used other data that the one we collect from network elements, and data generated by social networks for example should be used to correlate various sources of information. As such big data techniques may become more important to address reliability challenges.

In this new virtualized environment, vertical services may be offered through virtually sliced networks, with different QoS objectives and it becomes important to see how reliability issues should be mitigated so as to deliver the right reliability index to the right vertical service. Techniques like multi-objective optimization should certainly help solve the problem.

Furthermore, as automation is now a must, appropriate techniques should be implemented to identify any issue in service delivery. AI techniques are not new but progress witnessed in machine learning shows that such approaches may be necessary in the near-future as it will become

impossible to detect root causes in such a network entanglement. Still, we are far from an accepted framework for such AI solutions, and more work is to be done on this domain. This trend is certainly timely since operational models such as AT&T's driven ONAP (Open Network Automation Platform), resulting from the merge of ECOMP and Open-O are calling for more automation. In parallel, new concepts such as Intent-Based Networking, proposed for simplifying the service delivery procedures through declarative prescriptions triggering policy-based rules, are expected to be combined with Artificial Intelligence techniques to execute efficient, rapid, trustworthy management operations.

Alex Galis (University College London, UK):

Hereafter are some few focus & integration frontiers as proposals for the work and next IEEE Emerging Technology Reliability Roundtable (ETR-RT).

- A shift in networking and a transition from "network of entities", as in current systems, to "network of (virtual) functions / capabilities". As such "network (virtual) functions" in a network slice are units of reliability, availability and serviceability.
- E2E Multi-Domain Network Operating System Facilities - Smart Network Fabric: Network Abstraction, Allocate (virtual) network resources, Maintain network state, Ensure network Reliability in a multi domain environment, Service customized Network Slices (enabled by NFV principles).
- E2N Multi-Domain Orchestration: E2E coordination, conflict resolution, multi-domain information exchange, multi-domain reliability.
- Abstracting, isolating and separating logical network behaviors from the underlying physical network resources; Monitoring status and behavior of Network Slicing in a single and/or multi-domain NFV environment; transparency and auditing of all interactions between S/W components and network (virtual) functions.

Kelly Krick (Ericsson, Sweden):

SDN and NFV are fundamentally changing the way to deliver telecom services. However, OpenStack services, while improving, have not yet transformed to deliver the level of reliability and quality expected and needed. A large investment by service providers and vendors is underway and is necessary to realize the promise for open source software coupled with white box hardware. The path ahead requires further efforts in software development, integration, testing, and training. Key efforts that we must facilitate include:

- OPNFV projects which provide extensions to OpenStack deliver reliable software to manage the VIM and host VNFs.
- OPNFV CVP projects to test and qualify/certify NFVI as well as VNF readiness for interoperation and integration.
- Vendor cooperation (such as the OPNFV Plugfests) and to provide environments to test NFVI and VNFs to improve interoperability and reduce integration issues thus improving time to implement.

- ONAP to facilitate the automation and management of NFVI and VNF implementation.
- Transformation of staff to work with virtualized environments to deliver the services.

As Alex had noted in the meeting, we need to look at the horizontal as well as vertical integration points to see that the overall ecosystem is functioning properly. If not, we must establish the engineering requirements to fulfill the missions for SDN and NFV.

As a thought for our next round table, we could possibly get primes from OPNFV and ONAP communities to readout state of these efforts.

David Lu (AT&T):

The following points could be considered as additional areas that CQR could focus on (mainly on the SDN/VNF areas):

- ETE Service Path Modeling and Real Time Topology for SDN will be a very complex yet critical task to maintain service availability and timely trouble isolation and resolution.
- SDN provides new software control and opportunities for close loop automation yet presents enormous challenges to integrate VNF instantiation, performance monitoring, trouble isolation, change management, resource homing services, and service validation into a seamless flow. This could be great areas for CQR to tackle.
- In the new SDN/VNF paradigm, reliability concern must include hybrid network, not a pure VNF configuration to ensure ETE reliability.
- We must also consider leveraging software resiliency as part of design to compensate white box hardware technology 3 nines reliability to achieve desirable network and ETE service reliability of 4 to 6 nines.
- As software become increasingly important part and controlling elements of this new network, software version control and change management will be an independent yet essential element of reliability concern.
- Network troubleshooting and problem isolation must be considered as part of the software design.
- Network security and fraud protection must be an integral part of the new SDN reliability discipline with increasing weight.

Spilios Makris (Palindrome Technologies, USA)

As regards the IEEE P1917.1 Working Group (WG), the participants in the ETR provided the following feedback:

- P1917.1 WG made the right decision by not pursuing a review of SDN/NFV reference definitions that other Service Delivery Organizations (SDOs) have created (e.g., decide what are the right definitions that it could adopt or modify). The participants confirmed that service providers and suppliers already comply with the SDN/NFV definitions of other SDOs.
- The participants were skeptical regarding P1917.1 WG's proposed work to develop:

- Generic methods to align Service Level Agreements (SLAs) with the service reliability/availability metrics, and
- SLA templates focusing on service reliability/availability for an SDN/NFV Service Delivery Infrastructure (SDI).

The reason was that SLA-related requirements are usually addressed at the Telecom Management Forum (TM Forum).

- P1971.1 WG's list of current efforts (vg #12) and other proposed efforts under consideration (vg #13) cover a wide area. The participants were concerned that the WG may not have the necessary number of subject matter experts (SMEs) needed to address all these issues. Since the progress at the WG is based on the submitted contributions, there should be an effort to concentrate on those topics that the WG's regularly attending SMEs are willing to champion.
- P1971.1 WG's next steps and actions (vg #14) are reasonable and a good way forward.

Dimitri Papadimitriou (Nokia Bell Labs, Belgium):

If I would summarize the elements I would bring in the report as follows:

- Uncertainty, in demands, topology dynamics, etc. has become the central notion to capture for the optimal solving of reliable network design, location, allocation, scheduling and routing problems as well as their combinations. Optimization methods and techniques (such as distributional robust optimization) are now available that allow for their robust solving while addressing the tradeoff between resource consumption (static protection), recovery time (dynamic rerouting) and tractability.
- Due to the increase in complexity, dimensionality and size, automating the chain from obtaining and processing data to the formulation as well as the solving of these robust optimization problems becomes essential to capture in order to ensure the continuity of the (elastic) network services these environments aim to timely offer.
- It would be of interest for the network optimization/operational research community that experts in the field provide a list of key optimization problems they are/will be confronted to in the near future (from design to operational phases).

Massimo Tornatore (Politechnico di Milano, Italy):

Hereafter are a couple of items regarding open challenges on the Emerging Technology Reliability Topic:

1. Machine learning/AI/analytics for fault prevention and detection.

- Even if the field is currently starting to being investigated, several questions are still open.
- Which monitors/data do we really need? How often shall we get such monitoring data?
- Where shall we store this data ("reliability of monitored stored data")?
- What happens is rapidly changing scenarios, where models would need frequent re-training?

2. Service continuity in case of disconnected components using replicas provided by edge computing.

- Edge computing and content/service replicas enable new scenario where services can be provided (temporarily/at least for a transient phase, and especially for more static services as video delivery) even in case of disconnection of the main server, by redirecting users to secondary servers.
- In general, edge computing represents an enabler for ultra-high-reliability services in 5G.

This second point was mainly commented in my presentation, but it has been confirmed by David Lu (AT&T) during the final discussion.