IEEE Emerging Technology Reliability Roundtable 2018

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Austin, Texas

http://cqr.committees.comsoc.org/etr-rt-2018/

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 ETR decided to focus its 2018 event to emerging technology areas like the Cloud Computing, Wireless/Mobility (with focus on 5G technologies), NFV (Network Functions Virtualization), SDN (Software-Defined Networking), and similar large-scale distributed and virtualization systems. Accordingly, ETR 2018 was co-located with the IEEE ComSoc International Communications Quality and Reliability Workshop (CQR 2018) that took place in Austin, Texas from May 15-17, 2018 (http://cqr2018.ieee-cqr.org /).

This RoundTable, organized upon invitation only, was held on May 14. 2018. It was well balanced with talks by Telecom Service Providers (AT&T, Verizon Wireless, China Mobile, and Iridium Communications), Vendors (Huawei, Nokia, National Instruments, Uplogix, and BaseN), and other Players (GM Research Labs).

The Speakers addressed various issues and challenges of the upcoming 5G deployment, softwarized infrastructures, and autonomous cars 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, the ETR Roundtable Moderator (Ray Bonelli) and few other 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 below and show some similar concerns.

Ray Bonelli (Roundtable Discussion Moderator)

The Emerging Technologies Reliability Round Table (ETR-RT) discussion focused on the challenges surrounding the introduction and implementation of 5G. Consensus among all participating in the discussion highlighted end-to-end integration as a major, if not the major challenge. Contributing to the integration challenge is the introduction of virtualization, thereby necessitating the 5G network platform and all related components to achieve a level of automation and serviceability beyond existing network capabilities. Another major challenge relates to the ability to continue measuring traditional carrier-grade Network reliability, currently based on system uptime, at a level in the range of 5-min downtime in a year (i.e., 5-9s or 99.999% availability.) (**Note:** Telcordia's fixed network End-to-End Network Availability Objective is 99.94%; that is approximately 315 minutes per year or one minute per day of unavailability[1]).

While other challenges were discussed, the ETR-RT identified several key actions/factors necessary to bring about a successful implementation of 5G. Service based architecture, being new, requires the ability to predict failures and, thus, correlate measurements (reliability) based on serviceability. New standards are required to make this happen. Implementation of 5G, while trials are underway, needs to be controlled to ensure reliability. The group estimated 65% percent of the network could be virtualized by year end, 2018 and suggested that 5G could be deployable for large-scale applications by 2020.

Finally, while 5-9s continues to serve as the 5Gnetwork reliability objective, several references to the new reliability standards were offered ranging from 5-9s to 6-9s (99.9999% availability, which allows 32 seconds or less downtime per year) for ultra-high reliability (both overall network reliability objectives) to setting the bar at 5-9s for the Network platform. It should be noted that Network providers have made the switch to Software Defined Networks (SDNs) and virtualized network functions with network "out of the box" components in the 3-9s range.

The group again agreed that until new standards were established, measuring Network reliability in 5G remains a challenge.

[1] *Telcordia Notes on the Networks* SR 2275, Section 4.6, Issue 4, October 2000.

The Carrier Challenge –Achieving 5-9s Availability on 3-9s Cloud Infrastructures

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Carriers are transforming their networks using SDN and cloud technologies to virtualize their networks. This brings with it new challenges for creating highly reliable services on commercial hardware and software. In implementing an application with traditional physical equipment, vendors control downtime using purpose-build hardware, and a tight coupling of the software with the hardware. This leads to higher availability at the cost of a less flexible, more expensive solution. Network providers have made the switch to virtualized network functions to achieve advantages with respect to cost, stability and flexibility. However, "out of the box" availability tends to be in the 3 9s range, rather than in the carrier-grade 5 9s range. Some of the contributing factors to lower availability are:

- Typical Clouds Have long planned outages (days vs. hours).
- Commodity hardware and software fail more often than purpose-built applications.
- Virtualized applications rely on many layers (hardware, operating system, hypervisor, application) that are provided by different vendors. Furthermore, the virtualized environment may be configured for shared tenancy, creating the possibility for applications to interfere with each other.
- Industry trends, amplified in virtual implementations, are for ever-faster software releases, which challenges current approaches to software quality testing and deployment. While the industry trend is to perform limited deployments, not all carrier grade applications are tolerant of failures.

High availability for virtualized applications can be achieved through a combination of architectural choices and capabilities that are made possible by SDN, real-time policy-driven orchestration and automation (www.onap.org) artificial intelligence (www.acumos.org). Some of the key capabilities are:

- Effects of planned and unplanned outages can be mitigated using replication within and across georedundant sites. Virtual function migration capabilities enabled by SDN help to minimize downtime.
- Enhanced data collection coupled with machine learning and artificial intelligence can be used to pinpoint failures and root cause.
- Closed loop recovery actions can automate the recovery process.
- Agile software stability testing and estimation.

As the technology continues to mature, several areas deserve attention:

- Standardization of measurements and methods for correlating data from different layers in the cloud.

- Application design guidelines to ensure that applications support “cloud native” capabilities such as virtual function migration and closed loop automation.
- New techniques for software stability testing in an agile development environment.

A Programmatic Approach for an Artificial Code of Conduct

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The unprecedented flexibility of advanced software defined systems and artificial intelligence defines game-changing technologies leading to zero-touch automation and, therefore, fostering self-service opportunities at both operational and service consumption levels.

“Zero touch” implies extreme automation to its fullest while self-service reveals that this new order elevates the criticality of HMS (Human Machine Systems.) More touch points surface compared to what legacy technologies allowed given their constraint and restricted nature. That prompts a new take on HCI (Human Computer Interaction) and QbD (Quality by Design) to best deliver service quality throughout: concept exploration and service definition, fulfilment and adaptation, assurance and security across multi-domain, highly decomposed, re-configurable and exceptionally dynamic end-to-end systems involving integration and service delivery in continuous motion.

These are thought out to (a) dramatically optimize support personnel ratios and (b) shift staff’s attention and efforts to value based activities and innovation. These are small agile teams and new talent tasked with jobs involving (c) far greater scale with (d) a wider interdisciplinary scope, and all to be performed at (e) digital speed. In this next-level productivity and more demanding and challenging context, success relies on new tools embracing Design Thinking’s HCD (Human-Centered-Design.)

That is applied to capability models and subsequent modes of operation for (f) HITL (Human “IN” The Loop) Computing largely devoted to deep domain expertise supported by Science Visualization, as well as (g) HOTL (Human “ON” the Loop) for system-wide supervisory responsibilities and ease of service creation and onboarding. HOTL draws from highly abstracted Visualization techniques and Low Code Development revealing the behavior of end-to-end systems and subsystems and adequate flow control. These are coupled with effective Cybernetics gearing up for context aware 360-closed-loop-control, zooming in and out between distributed and central levels. Last but not least, effective and efficient tools that are characterized by ease of use and consumability do attract many more new users from many more different domains to interact with these systems in a self-service fashion and create new business opportunities as a result.