The 5G Era – An Opportunity in the Making

A Framework for Success – Building Open, Federated Testbeds

Executive Summary

A new, international Open Testbed Community (OTC) emerged from an intensive workshop on federated testbeds that took place in San Francisco the week of May 3rd. This workshop was spearheaded by leaders from the IEEE SDN Initiative[1] and EIT Digital[2]. As we move from the era of protocols to the era of innovation in the global Information and Telecommunication ecosystem there is an opportunity to consolidate disjoint development efforts. This opportunity will leverage Software Defined Networks (SDN) and Network Function Virtualization (NFV) for agile, robust, interoperability between SDN islands. The workshop culminated in a significant intent to start an Open, Federated Testbed (OFTB) by interconnecting three existing centers of expertise based in the USA and Europe. The outcome of these efforts will be reported in the Berlin5GWeek event in November 2016. The workshop brought new collaboration and support for the IEEE SDN Initiative that is building an engineering catalog of testbeds, toolkits and software that can be rated by the technical community. They will also track testing requests to better coordinate effective use of OTC resources and prioritize testing. This nicely complement the effort of EIT Digital to expand the Federated Testbed (FTB) started in 2016 and under expansion that can be used to stimulate innovation in the area of 5G and future communications services.

Roberto Minerva of Telecom Italia, the Chairman of the workshop stated: "We estimate that the combination of these new Open Federated Testbeds and the IEEE Testbed Catalog will result in a 50% reduction the time to test network functions, applications, services and even new, disruptive business models." The testing will spur important work on performance, orchestration, and validation. This is an open initiative, and all stakeholders are encouraged to help shape this important work. A goal of this work will be to set clear, achievable deliverables in the spirit of agile software development.

---

[1] The Software Defined Network (SDN) initiative within the Institute of Electrical and Electronics Engineers, a US-based, non-profit professional organization with an international membership.
[2] European Institute of Innovation and Technology: EIT Digital is a pan-European digital innovation and entrepreneurial education organization that is driving Europe's digital transformation.

Summary of Workshop

Twenty thought leaders from the IEEE SDN Initiative, EIT Digital, service providers, industry and academia gathered for a two-day workshop to discuss the idea of a Federated Testbed (FTB) that would allow accelerated development of SDN and NFV as two important components of 5G era networks.

Roberto Saracco, who is the director of the EIT Digital Italian Node and the Chair of the IEEE Future Direction Committee, opened the workshop by explaining that 5G will not just be a faster version of 4G Networks, but will instead host and connect decentralized, heterogeneous networks; thereby opening possibilities for entirely new and disruptive business models. Saracco calls it "5G: a revolution in the making – The edge takes the upper hand. When terminals are no longer terminals but network nodes, and they can decide autonomously when and where to connect to the big networks (the ones provided by Operators,) then they are basically taking the upper hand. The tail is wagging the dog!" This new paradigm will open the doors wide for disruptive new services and business models – for example: will driverless cars have their own, decentralized communication network? Advanced, smarter terminal devices and the Internet of Things (IoT) offer boundless possibilities.

But how can innovative companies test their ideas? The national carriers and other large companies that depend heavily upon data communications (Amazon, Google or Apple, for example) have the resources to develop their own, proprietary testbeds which they may or may not want to share with others. Smaller companies and service providers cannot afford to invest in such a private testbed, so how are they supposed to test their ideas for technical feasibility and interoperability? And, more importantly, how will we test interoperability of applications across SDNs?

Eileen Healy, the Co-Chair of the SDN Initiative, explained the mission of the Initiative and why it was sponsoring the workshop. As a three-year Initiative to accelerate the understanding and deployment of SDN, the members focus on academic research and gaps in the service provider community that might slow the rollout of real world SDN. In particular, the initiative is funding a series of collaborative efforts on Open Mobile Edge Cloud (OMEC) to drive radical transformation of mobility networks. The first phase of this work is being done by ON.Lab. The Initiative is also developing the Testbed Catalog mentioned above and is the sponsor of NetSoft, a global Softwarization conference.

The workshop proceeded with a number of talks by the participants covering various aspects of how a testbed for SDN and NFV might look, plus tools and testbeds that are already existing or under development. Marko Turpeinen and Sebastiano Miano of the EIT Digital - Silicon Valley Hub presented a testbed based in San Francisco and offered it for Federation, including help with the development of connecting software. Luca Prete, an engineer at ON.Lab in Menlo Park, California described ONOS, an SDN operating system OS for service providers that has scalability, high availability and high performance. He described a number of successful deployments of ONOS around the globe, which provide on-demand layer 2 network connections through OpenFlow. Thomas Magedanz, an IEEE SDN initiative leader and Director of the Software defined Networking Competence Center at Fraunhofer FOKUS described a set of OpenXXX enabling   the rapid realization of 5G SDN testbeds, such as the 5G Berlin Testbed One important tool for SDN testbed components and network management and

orchestration is Open Baton, also used within the EU SoftFIRE Project.. He shared his goals that a toolkit catalogue and any OFTB would enable people around the world, especially those with financial means, to experience SDN and VFW technologies and understand the benefits of these technologies.

One existing example of a FTB being deployed in Europe, called SoftFire, was described by the organizing Chairman Roberto Minerva of Telecom Italia. SoftFire is a 2-year, pan-European experiment to integrate and federate experimental SDN facilities and testbed. The main objectives include testing for interoperability, programmability and data security. It will connect four separate testbeds, including FOKUS in Berlin, JOLnet in Italy, POD1 Ericsson in Sweden and USURREY, a TB at the University of Surrey in the UK. They will be looking for what are the major use cases for such a FTB, and what business models are possible; for example, could they offer a Testbed as a Service (TBaaS)? This experiment is expected to start in the fall of this year.

Christos Kollas, a Senior Researcher at Orange Silicon Valley, presented another testbed that has been developed by Orange in collaboration with other carriers and partners such as Amcor Telecom. One of his use cases under investigation is to provide NFV as a service. The San Francisco installation of this testbed is connected to Orange in France, and Kollas is working with start-up companies in California to test IoT concepts. In a related effort, Upkar Dhaliwal of Phluido and another leader in the IEEE SDN Initiative presented his concepts and products in the area of V-RAN – Virtual Radio Access Networks. His system provides a Radio Access As a Service (RaaS) fronthaul over IP services, allowing a network that is not constrained by physical distance with the benefits of lower cost and better performance and requiring no orchestration.

The idea of providing NFV Infrastructure, MANO (Management and Orchestration) and Validation as a Service (VaaS) under an automated test environment driven by Test Templates was presented by Wen-Pai Liu of the Silicon Valley-China Wireless Technology Association. Liu demonstrated that NFV components could be integrated, tested and validated well in a template-driven system. The final presentation of the first day was by Jose Verger, a Senior Researcher at Verizon. Verger explained that Verizon has many internal organizations working on SDN and NFV and that they have developed a number of platforms and testbeds in conjunction with their partners and suppliers. He indicated a willingness to collaborate with groups like this one to solve common problems.

The first day ended with an enumeration of the major questions to be answered the next day. The biggest questions that emerged were:

1. Does the world really need an Open Federated Testbed (OFTB) for SDN and NFV?
2. Who would be the customers and how could they be attracted?
3. What are the main use cases and business cases?
4. How can EIT-Digital, IEEE and other professional organizations (NSF, NIST, GEAND, etc.) best collaborate to make it happen?
5. What should be the timeframe for such a collaboration?

A facilitated group discussion on the second day brought out many interesting points and ideas for collaboration. There was a clear consensus that some kind of universally available OFTB was needed to

pave the way for innovation and accelerate progress toward 5G era networks based on SDN. The most important customers for such an OFTB would be revenue generating, smaller-cap companies who wanted to test and develop innovative and possibly disruptive new products and services made possible by 5G. The reason for Federation is that all testbeds are not the same. They differ in what kinds of networks they will handle and in many other aspects. Also, the group viewed the OFTB as a kind of nucleation point for these smaller companies to trade information and ideas and help develop rapid prototypes.

Patrick Consorti of EIT Digital floated the idea of "If we build it, they will come!" Not that we should build a complex hammer and then go look for a nail, but more in the spirit of Agile Software Development and the Open Source world: Build something small but useful in a very fast timeframe (Sprints) and then send it out to users to think about and try out. Get the feedback and collect further needs, and then add to the product. With a number of such iterations, we should have a very useful vehicle to serve the innovator companies. We speculated that the users would naturally segment into "Guilds" of different networking service needs such as autonomous vehicles, RANs, specialized IoTs, etc.

The members also felt that an OFTB would help to create and expand an ecosystem of use cases and stimulate standards development within these ecosystems. In fact, as the OFTBs developed along with the standards for SDN and 5G, they might evolve into certification systems with levels of certification for systems and possibly for people skills. There was some discussion of how such OFTBs could be funded or supported, and even what a business model might look like for such a system – offering models such as pay-per-use or Certification as a Service (CaaS).

The final discussion was around what real steps this workshop group could take toward an OFTB, and the results were very concrete! Representatives from SoftFire and EIT Digital proposed to connect their existing FTBs into a sort of "federation" (pending approval from their management, of course). Kollas from Orange also offered to include his system in such a test, as did Dhaliwal of Phluido. ON.Lab offered to help connect these testbeds through ONOS, its open network operating system. This federation could connect a number of testbeds in Europe and the U.S. A second outcome was the agreement of all workshop members to work with the IEEE SDN initiative to further compile a Catalog (in the form of a Wiki) of available testbeds and tools around the world (both open and commercial) for testing SDN, NFV and 5G service and product concepts. This Wiki would be a taxonomy of testbeds, listing what types of hosting and testing could be done and how to access them. The outcome of both of these efforts will be reported in the 5G week in Berlin in November 2016.

It was also agreed the participants would consider contributing chapters to an upcoming IEEE/Wiley Press book on SDN. All will be invited to a conference call in late June 2016 to discuss the outline. Author commitments/acceptance in early July. Chapter drafts will be due in September and the book will be published by mid 2017.

If you or your organization have an interest and would like to join in this open collaboration, we welcome you! Please contact Tim Kostyk at t.kostyk@ieee.org and for EIT Digital Marko Turpeinen at marko.turpeinen@eitdigital.eu