Thoughts on Future Network Research Topics and Facilities

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The GEANT Testbeds Service (GTS) provides dynamically allocated cyber-infrastructure facilities across Europe to the European R&E community and their international collaborators.   This is a new service, deployed initially in 2014-H2, and based upon work from many prior research and experimental networks including GENI, FIRE, and numerous other programs from the last 10 years.   GTS is able to quickly and easily reserve and place into service user defined and user controlled networks composed of high capacity transport circuits, high performance computational resources, and user controlled [SDN] switching elements – all of which support software defined networking principles.   The service was initially only intended to address the immediate needs of the network research community, but its early success in terms of research projects and user uptake has lead to a broader view of how such virtual network environments can be employed more generally to eliminate the risk of early TRL concepts in a production infrastructure and to assist in shepherding those applications and services through their evolution into mature production capabilities.

There are a number of observations that we see already with the Testbeds Service that we think will be relevant to future network research and globally distributed large scale applications and services:

The notion of the Software Defined Exchange (SDX) – an exchange point that offers a broad set of cyber-infrastructure resources or services and does so using SDN control principles – will, in our opinion, prove to be an important defining concept and service model.   However, the SDX is just the tip of an iceberg; it is a trivial example of much more far reaching notion we call Software Defined "Fabrics" (SDX Fabrics).   The concept development of SDXs and SDX Fabrics – formalizing the abstractions and fundamental properties of this class of abstract network constructs – will be a valuable goal for the future networks and network research.

Next, we see *virtualization* as a powerful concept that solves a number of practical issues associated with inter-domain SDN scaling, security, and extensibility. NFV is an area where virtualization means different thing to different people. Work in these areas – and integrating the proposed models into a workable generalized virtualization model that covers more than just one form of NFV is needed.   The GEANT project, in conjunction with a number of its users and researchers has developed an open, extensible, Generalized Virtualization Model that describes how a very broad range of cyber infrastructure resources can be virtualized and managed through their lifecycle.   Integrating and formalizing these virtualization

models, and building a global consensus for a common inter-domain control plane will bring a sea-change to modern networks.

Finally, given these novel emerging service architectures, the ability to deliver, enforce, monitor, and verify service performance is crucial. There are many issues to be addressed to create a formal protocol model that works in the context of virtualized heterogeneous resources and services. And the ability to determine how or where these services may be failing so that remedial action can be initiated is a prerequisite for these service models to evolve into production capabilities.   These must all be automated using secure scalable inter-domain protocols.

GEANT held a GTS Tech+Futures Workshop in October 2015 in Copenhagen to explore the current applications using GTS services, and to discuss with other users, service providers, developers, and vendors the features and capabilities that should be part of future development planning. The GTS management would like to offer the GTS service to the international research community as both a tool for research and as an example of how research topics can be explored and then integrated into leading edge advanced network services.   We would also like to learn what types of research is envisioned so that those requirements and support can also be folded in the GTS development roadmap.

These are only a few strategic topics to be considered for future network research. Development of GTS will continue in GN4 Phase 2 through 2019. As the facility most able to deliver core network services supporting research across the European foot print, we would like to maintain a close and collaborative relationship with the US network research community and programs.