Software Defined Exchange (SDX) and Software Defined ScienceDMZ (SD-SDMZ) Ecosystem

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The Research and Education (R&E) cyberinfrastructure is in the early stages of a major transformation being driven by the emergence of Software Defined Infrastructure (SDI) technologies. In the context of this discussion, SDI is assumed to cover a broad range of technologies including host and storage system virtualization, Software Defined Networking (SDN), Network Functions Virtualization (NFV), Network Service Chaining (NSC), and other derivative technologies and functions. The R&E cyberinfrastructure space includes wide area networks, regional networks, campus infrastructures, and special purpose computational, storage, and cloud systems.

The University of Maryland/Mid-Atlantic Crossroads (UMD/MAX) operates a high performance regional network serving the R&E community in the Washington, D.C. metropolitan area. MAX also co-manages with Internet2, the Washington International Exchange (WIX) located in McLean, Virginia. In addition, UMD/MAX is building a next-generation ScienceDMZ at their Rivertech Cyberinfrastructure Center. The UMD/MAX focus is on applying SDI technologies to these three key components of the R&E cyberinfrastructure - Exchange Points, Regional Networks, and ScienceDMZs. The high level objective for this work is to enable "Software Defined Services" which can be made available to domain science applications, which span the entire end-to-end infrastructure. Toward this goal, we have developed a GRAM based MAX Aggregate Manager that has been deployed at the WIX. This has converted the WIX production Exchange point into a prototype Software Defined Exchange (SDX). This deployment includes prototype GENI policy features that allow us to enforce finer grained access control for exchange point attached resources. The driving use case for this is an Amazon Web Services (AWS) Direct Connect Service that MAX makes available via the WIX. The longer-term vision for SDX functions includes the integration of host and storage virtualization services. In a similar manner, we are developing a next-generation Software Defined ScienceDMZ (SD-SDMZ) concept which extends the current Data Transfer Node based service to one which includes a richer set of SDI based programmatically controlled network, compute, and storage resources.

All of this work is driven by a higher-level vision for future R&E cyberinfrastructure that consists of an ecosystem of ad hoc and dynamically federated SDXs and ScienceDMZs services. This will also require the interconnecting wide area and regional network infrastructures to participate in these federations and offer software defined services. This work is also motivated by the observation that science application workflows are generally distributed and multi-domain. Past experience indicates that commercial development efforts will not focus on these issues due to the business considerations associated with the multi-provider and multi-vendor topologies. The R&E community is uniquely positioned to address these issues.

There are many issues that require further research and development to realize this new SDI based R&E cyberinfrastructure. From the resource owners perspective, technologies and standards are needed to enable abstracted resource description and service provisioning in the context of voluntary and ad hoc federation participation. Services need to be defined in the context of end-to-end multi-domain services that add value to science users. Service level federation systems need to be developed that provide the proper security, authentication/authorization granularity, and dynamism. Multi-domain orchestration technologies are needed to work thru the issues of service provisioning in a multi-resource, multi-domain, and autonomous operator environments. All of this should strive to allow a user driven value added service and innovation ecosystem to emerge.