TITLE: Know Thyself: Monitoring Wide-Area Network for Science Applications

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EXPERTISE: Data management, Network traffic/performance modeling, Network monitoring

KEY DOE NETWORK/MONITORING CHALLENGES

In the next decade, we anticipate the development of networking technologies to evolve its focus from increasing the network speed to expanding the networking services. The emergence of Internet of things is a sign of new services to come. In this push to make networking more intelligent and more expansive, there is a great need to monitor the state of networking resources in order to have the necessary information to make the smart decisions. In DOE research community, there will be similar monitoring challenges due to anticipated increases in the volume and variety of science data. For the basic form of network monitoring, where the traffic volume is the only variable recorded, the key challenge is to keep up with the increasing rate data exchanges. As networking technology migrate from custom hardware to specialized software, such as the network operating system, software defined networking, and named data networking, there will be significant variety of networking resources that need to be monitored their states so that they could dynamically react to user demands and changing environment. The current state of the art in real time network monitoring focuses on tracking the volume of incoming/outgoing traffic in the network. Such information only provides a partial characteristic of the network state, wound not be comprehensive enough to make the optimal decisions in the new networked world. Other approaches such as probabilistic distributions of essential variables related to the traffic statistics would have challenges in an exponential increase of computational and storage complexity with additional variables to monitor in real time. The volume of network activity logs would be another challenge in the network monitoring. For example, traditional packet sampling in a static linear form, such as 1 in 1000 network flows, may need to adjust the sampling rate significantly due to the high activities.

In the past decade, the network activities have grown exponentially with the network bandwidth increase, and in the next decade, we anticipate much higher network activities with more data activities over the network and even larger network bandwidth. Consequently, better network monitoring techniques and network activities logging technologies are needed in the future.

DOE RESEARCH DIRECTION

As networking technology switches from custom hardware to customizable software services, we foresee a great need to better monitor all aspects of the networking system. In particular, the increasing network activities and the volume of activity logs will change how the network is being monitoring from the traditional monitoring techniques. For example, network sampling method would reflect the increasing network activities better than the simple static linear random sampling. Network traffic monitoring would show better characterization of the network state in real time with increasing network activities than the simple incoming/outgoing traffic volume record in the network. Existing networking research has been largely concentrated on optimizing the network usage and increasing the network bandwidth; we believe the next challenge is in the network monitoring issue. Ultimately better network monitoring will prevent the network misuse, and provide effective network management and security capability.