SC18 Network Research Exhibition: Demonstration Final Publishable Submission

Programmable Privacy-Preserving Network Measurement for Network Usage Analysis and Troubleshooting

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Abstract

Network measurement and monitoring are instrumental to network operations, planning and troubleshooting. However, increasing line rates (100+Gbps), changing measurement targets and metrics, privacy concerns, and policy differences across multiple R&E network domains have introduced tremendous challenges in operating such high-speed heterogeneous networks, understanding the traffic patterns, providing for resource optimization, and locating and resolving network issues. There is strong demand for a flexible, high-performance measurement instrument that can empower network operators to achieve the versatile objectives of effective network management and resource provisioning. In this demonstration, we present AMIS: Advanced Measurement Instrument and Services to achieve programmable, flow-granularity and event-driven network measurement, sustain scalable line rates, to meet evolving measurement objectives and to derive knowledge for network advancement.

1. Objectives

The project aims to help planning and management of ultra-high speed international research networks connecting critical science instrument (e.g. LHC and LSST) and HPC centers. First, this project will take full advantage of capabilities of state-of-art multi-core processors and emerging packet processing techniques (e.g. DPDK, RSS) to deliver a highly programmable network measurement appliance scalable to line rate of 100+Gbps. Second, the event-driven query language, software APIs, libraries and tools will be developed to support programmable and software-defined measurement that empowers the network operators to design complex and responsive measurement tasks. Third, the project will deliver operational prototypes at the already-identified and future international R&E network exchange points to conduct measurement operations and gather network flow information for analysis and sharing, while preserving data privacy. The project will strengthen ongoing academia-industry collaborations and lead to new cooperation among national and international partners.

2. Innovation

AMIS enables network operators to 1) launch measurement queries in a declarative language, 2) build network events (e.g. packet loss rate exceeds a threshold) into a measurement query to trigger subsequent measurement tasks, 3) design event-driven measurement queries to diagnose network issues along paths, 4) acquire fine-grained network flow statistics while preserving user privacy and 5) trace packets and flows to answer multipurpose queries. This network measurement instrument supports a set of APIs and measurement operations instantiated on an open multicore-based

programmable platform to capture flow-granular metrics, and speeds up packet processing on 100Gbps links using Data Plane Development Kit (DPDK) and Receive Side Scaling (RSS). Distributed measurement is supported by designing dynamic task dispatching and result aggregating algorithms. The instrument also leverages state-of-the-art privacy preserving algorithms to deliver network usage analytics without unnecessarily exposing user information. The configuration and data management is scalable due to the use of a cloud-based data processing architecture.

3. Overview of IRNC AMIS Framework

There are four major parts in AMIS project listed as follows, shown in Fig 1. For more details, please check our wiki page: https://acanets.uml.edu/amis/w/index.php/Overview

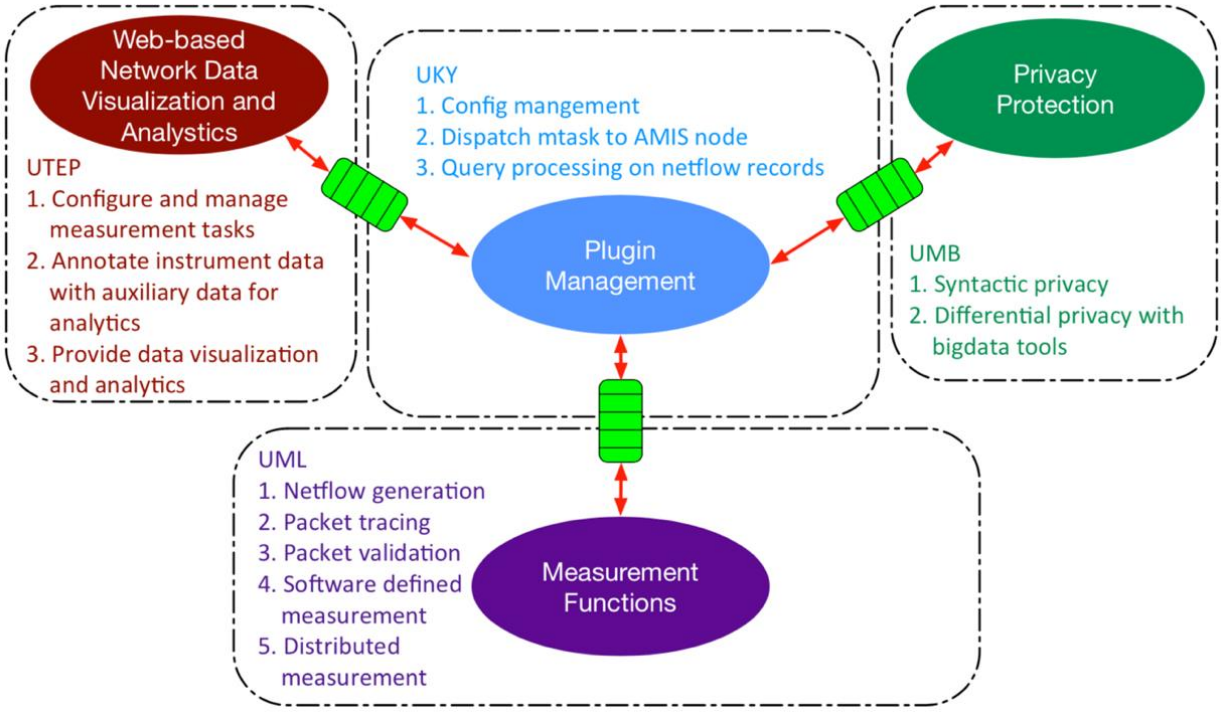

Fig 1. AMIS Framework

4. AMIS Network Resources

For SC18 demonstration,

- 5 AMIS instruments deployed at University of Massachusetts Lowell, University of Kentucky, StarLight, AMPATH and LSST (Chile), shown in Fig 2.
- 100G network traffic across continents (LSST/Chile - Ampath/FIU - SC18 show floor - StarLight – NCSA) monitored by our AMIS instruments on the path.

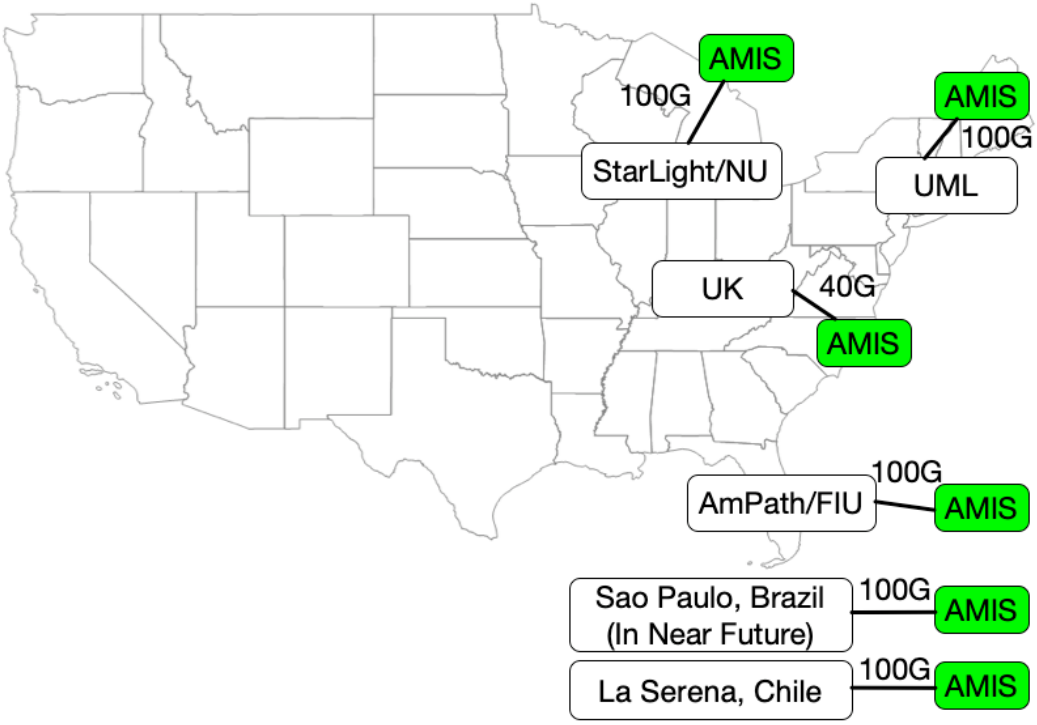

Fig 2. AMIS Instruments Topology

5. SC18 Demonstrations (Booth #2851)

- Distributed AMIS measurement framework
- Netflow information for 100Gbps flows
- Event-driven measurement queries to diagnose network issues along paths
- Acquire fine-grained network flow statistics while preserving user privacy
- Visualize traffic analysis results

6. Involved Parties

- IRNC AMIS Team
  - Yan Luo, PI, University of Massachusetts Lowell
  - Gabriel Ghinita, Co-PI, University of Massachusetts Boston
  - Cody Bumgardner, Co-PI, University of Kentucky
  - Michael McGarry, Co-PI, University of Texas El Paso
- Other Collaborators
  - Joe Mambretti, Jim Chen and Fei Yeh, StarLight/iCAIR/Northwestern University
  - Jeronimo Bezerra, AMPATH/Florida International University
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