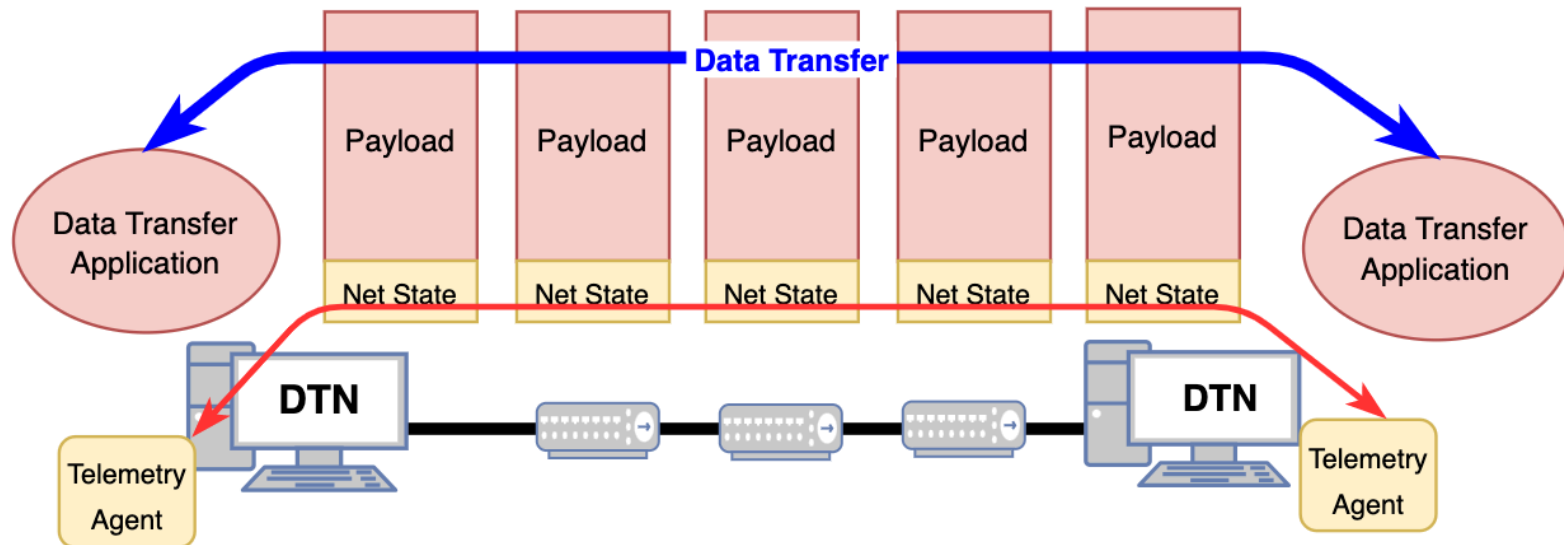


Q-Factor: A Framework to Enable Ultra High-Speed Data Transfer Optimization based on Real-Time Network State Information provided by Programmable Data Planes – Award 2018754

Campus Cyberinfrastructure (CC*)

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Motivation and Objective

- Create an end-to-end framework where endpoints would have network state information to dynamically tune data transfer parameters in real time
 - Bandwidth and resources optimization
- Summary of proposed activities:
 - Expanding the Management Plane to endpoints
 - Developing a Telemetry Agent to consume network state information and tune endpoints
 - Evaluating tuning at scale over multiple scenarios by leveraging AmLight and Esnet networks and testbeds
- Specific needs from FABRIC:
 - We need to understand FABRIC's use cases to make Q-Factor useful for the FABRIC community
- Critical gap to be addressed is:
 - Understanding how network telemetry provided by current programmable forwarding planes could be used to enable better data transfer performance and resource optimization
- Transformative:
 - Q-Factor will enable endpoints to adapt their data transfers to the network conditions in real time, avoiding packet drops, extra jitter/delays, and excessive memory consumption.
- Objective: Improve data transfers over long-haul high-bandwidth programmable networks

Workplan

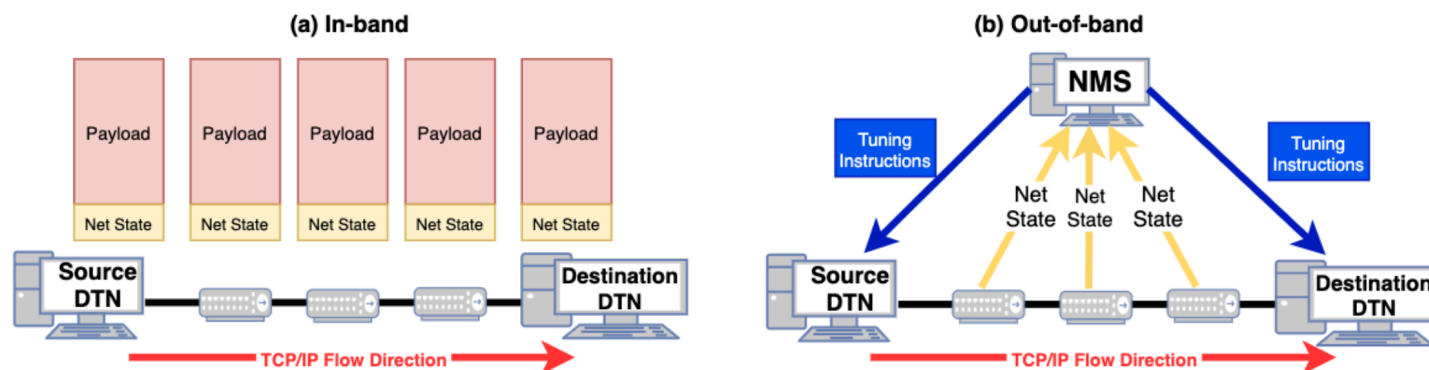
- Short term plans:
 - Recruiting a software developer and a postdoc
 - Assembling the Q-Factor AmLight/ESnet multidomain testbed
 - Designing and prototyping the [Vera Rubin|perfSonar|ScienceDMZ] use cases
- Long-term plans:
 - Developing the Q-Factor Telemetry Agent and evaluating it over multiple scenarios (different delays, bandwidth utilization, etc.) leveraging the Q-Factor testbed
 - Deploying Q-Factor at AmLight-ExP to support data transfers between Latin America and the U.S.
- What are the experimental data and artifact sharing methodology you plan to follow ?
 - Telemetry Agent source code and any other artifacts will be available via GITHUB/q-factor-project under Apache licenses
 - DTN and network telemetry data sets will be shared via Q-Factor website

- Risks and plans to mitigate them:
 - Under current circumstances, recruitment will be a lengthy and challenging process.
 - Software development has started with CS students to avoid delays.

Activities	LEADER	Area	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Purchasing NoviFlow switches, NICs, DTNs, and Optics	FIU	Purchasing								
Filling the PostDoc position	ESnet	Recruitment								
Installing Q-Factor DTNs, optics, and switches	ALL	Purchasing								
Designing DTN-to-DTN multi-domain testbed	ALL	Operationalization								
Designing & Developing NIC's Q-Factor application	ALL	Software Development								
Creating the DTN-to-DTN multi-domain testbed	ALL	Operationalization								
Designing & Developing Linux Loadable Kernel Module	ALL	Software Development								
Designing & Developing Telemetry Agent's Collector module	ALL	Software Development								
Designing & Developing Telemetry Agent's Tuning module	ALL	Software Development								
Running DTN-to-DTN experiments	ALL	Research								
Designing & Developing Out-of-Band API	ALL	Software Development								
Evaluating Q-Factor on ESnet and AmLight-ExP testbeds	ALL	Research								
Deploying Q-Factor in production at AmLight-ExP	FIU	Operationalization								
Expanding Q-Factor to AmLight-ExP's science drivers	FIU	Operationalization								
Submitting papers to academic conferences	ALL	Outreach								
Submitting presentations to academic conferences	ALL	Outreach								
Delivering final report	FIU	Outreach								

Q-Factor Tangible Metrics to Measure Success:

- **Software Development:** Developing the Telemetry Agent with good test coverage
- **Network Testbed:** Creating a multidomain testbed leveraging AmLight-ExP and ESnet testbeds to create different testing scenarios [regional and international].
- **Operationalization of Q-Factor:** Once the Telemetry Agent is ready and evaluated over production networks, our efforts will be deploying Q-Factor in production using AmLight-ExP's DTNs and adding Q-Factor as a new component of the perfSonar framework.
- **The External Research Advisory Committee** will meet to assess progress and discuss new direction and approaches.



Requirements

- Please comment on the specific hardware and software needs from FABRIC:
 - No infrastructure will be needed from FABRIC to carry out Q-Factor experimentation.
 - Q-Factor aims to collaborate with FABRIC to share knowledge and to expose Q-Factor to a broader community of users.
- What are the domain specific software stacks/features that you need to carry out your experiments?
 - Q-Factor leverages a programmable forwarding plane with support for in-band network telemetry.
- What level of support will you require from FABRIC developers?
 - Knowing FABRIC main uses cases will benefit Q-Factor during its evaluation phase.
- Do you have any suggestions to FABRIC developers?
 - Consider creating science workflows that support consuming network telemetry.
 - Consider creating a **programmable** data plane instead of a fixed-function data plane.
 - Consider using Linux Kernel 5+ due to its flexibility for fast networking processes.
 - Consider creating DTNs that allow scientists to modify the ANY software component, including the operating system.