SC25 Network Research Exhibition: Demonstration Publishable Abstract

Middle-East Transcontinental eScience Bridge

Alex Moura, King Abdullah University of Science and Technology - KAUST, alex.moura@kaust.edu.sa

Abstract

The King Abdullah University of Science and Technology - (KAUST) in Saudi Arabia is developing its new Data Transfer Service (DTS) platform, aimed at accelerating data-intensive science between the Middle East region and global collaborators — and present it in a demonstration.

The demonstration objective is to validate 400 Gbps disk-to disk transfers and be prepared for future international circuit capacity from KAUST main campus in Thuwal, Saudi Arabia, and its PoPs located in NetherLight, Amsterdam and SingaREN Open Exchange (SOX) in Singapore. KAUST Global Exchange is a high-capacity important asset for partners of and collaborators in Europe and in Asia, in particular, the members of the Asia-Pacific Europe Ring (AER) cooperation, like CSTNET, GEANT, NORDUnet, SINET/NII, and SURF. KAUST Global Exchange is a transcontinental eScience bridge that helps to address critical infrastructure resilience challenges, supporting the Global Research and Education Networks (GREN) for research collaborations.

Building on recent analysis of Red Sea submarine cable vulnerabilities that disrupted 90% of Europe-Asia communications in February 2024 [1], this demonstration reinforces strategic approach to infrastructure diversification through high-capacity, geographically diverse routing. The objective is to achieve disk-to-disk transfers approaching 400Gbps between KAUST campus via its Poins of Presence in NetherLight, Amsterdam and SingaREN SOX, Singapore, and transported by Asia-Pacific Europe Ring (AER) partners leveraging circuits on both AAE-1 and TGN-EA submarine cables.

In this demonstration, KAUST plans to use two Data Transfer Nodes (DTN) equipped with one 400 Gbps Nvidia Mellanox ConnectX-7 network interface each, and one DTN with 100 Gbps port located in its main campus to send scientific datasets via intercontinental paths to Caltech servers connected on their booth via SCInet, at SC25 in St. Louis. Monitoring will quantify throughput, loss, and jitter.

Preliminary lab tests indicate that the tuned DTS stack sustains ≥95 % line-rate over 400 Gbps, and KAUST wants to evaluate this efficiency and evaluate TCP/QUIC parameter sets that optimize the throughput over three-continent spans. The demonstration is expected to confirm the scalability of KAUST's DTS and Science DMZ architecture, furnish comparative performance data for 400 Gbps, and provide design guidance to share with the Global Research and Education Network community through the GNA-G. Ultimately, the work positions KAUST and Saudi Arabia as an emerging hub for multi-hundred gigabit research networking while offering a reproducible blueprint for benefit of the whole community.

Goals

Some high level goals that demonstrate success, beginning with the most achievable through the stretch goals.

1. Sustain Proven Performance (Baseline) – Achieve ≥95 % line-rate disk-to-disk transfers over KAUST's production 2 × 200 Gbps circuits, establishing a repeatable 400 Gbps benchmark and validating DTS stability in a multi-domain environment.

2. Double Capacity (Primary Goal) – Demonstrate continuous ≥300 Gbps throughput from KAUST to Caltech servers in SCInet, confirming that the architecture scales without architectural changes.

3. Reusable Tuning Blueprint – Publish the KAUST DTN configurations set that enables high-efficiency transfers over ≥12,000 km, offering a plug-and-play playbook for GREN peers.

4. Pathfinder: KAUST will test its capacity for 400 Gbps aiming to become one of the few research and education institutions, likely the first in the Middle East region, to leverage this capacity, highlighting the technological path that is pursuing to evolve its international connectivity in its mission to support eScience, testing the limits of its Global Exchange

resilience, to increase support to AER partners, and for benefit of the whole global society.

Critically, this work positions KAUST and Saudi Arabia as an emerging hub for multi-hundred-gigabit research networking while demonstrating practical solutions to the infrastructure vulnerabilities that threaten global research collaboration, offering a reproducible blueprint for other National Research and Education Networks seeking to enhance both capacity and resilience. This project aligns with the Saudi Vision 2030. The strategic timing of this demonstration, following the February 2024 Red Sea cable incidents that highlighted critical vulnerabilities in global communications infrastructure, underscores the importance of KAUST's approach to infrastructure diversification. By establishing high-capacity alternative routing paths, this work contributes to global research infrastructure resilience while positioning the Middle East as a critical bridge between European, Asian, and African research networks.

Impacts

The proposed permanent high-bandwidth eScience bridge will promote multifaceted benefits across institutional, national, regional, and global levels.

By demonstrating sustained multi-hundred-gigabit transfers over its Science DMZ architecture, KAUST reinforces itself as a high-capacity research institution. This showcase would not be possible without the support provided by SCInet, and will validate the reliability of the new DTN infrastructure, positioning KAUST as a valued partner for large-scale data-intensive projects, and provide a tested tuning blueprint that will be shared with other research groups.

1. This research is essential to improve KAUST cyberinfrastructure to support large-scale eScience in Shaheen III - the fastest supercomputer in the Middle-East region - and the research community at large.

2. Testing the limits of KAUST international links using its new DTS would not have been possible without SCInet support.

3. The infrastructure will serve as a foundation for future KAUST initiatives aimed at enhancing eScience capabilities and fostering cross-disciplinary collaborations.

4. The deployment of a new, 800 Gbps-capable DTS represents a significant leap forward that positions Saudi Arabia among the most capable R&E institutions. It delivers high-performance connectivity to KAUST researchers, supports data-rich scientific programs (e.g., genomics, climate modeling), and strengthens the country's position in the global knowledge economy. The project also brings opportunities for Saudi engineers and scientists to leverage cutting-edge networking technologies, contributing to workforce development and technological sovereignty.

5. The bridge enhances regional collaboration by providing a resilient, high-throughput conduit that links the Middle-East, to international partners enabling large-volume data sharing for advanced collaborative research projects, accelerating scientific discovery, and strengthening Middle-East's role as a hub for cross-continental research initiatives. The demonstration underscores the need for encouraging investments to deploy similar high-capacity links across the region, for a more resilient R&E infrastructure. In the wake of recent geopolitical tensions that have disrupted submarine cable systems, causing slower data transfers and occasional outages impacting scientific research, this demonstration highlights the importance of increasing the number of high-capacity network nodes and links across the region, which is urgently required to safeguard and improve scientific activities and outcomes amidst geopolitical instabilities.

Resources

Required resources from SCinet WAN are 100 to 200 Gbps transport services from NetherLight in Amsterdam and from SingAREN Open Exchange (SOX) facility in Singapore to the SCInet network at the SC25 venue.

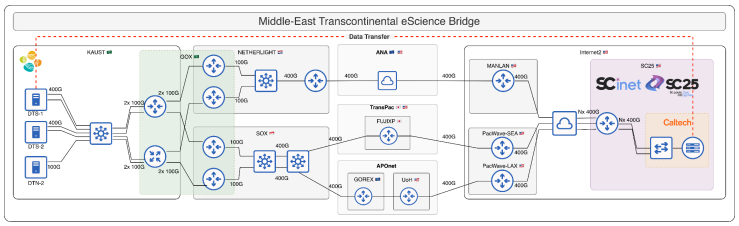

Image 1 - Transcontinental eScience Bridge network topology

References

[1] Center for Strategic and International Studies. (2024). Red Sea Cable Damage Reveals Soft Underbelly of Global Economy.

https://www.csis.org/analysis/red-sea-cable-damage reveals-soft-underbelly-global-economy

Involved Parties

List of other institutions, researchers, and entities involved in the planning and execution of this demonstration.

- Kara, Akbar, Ciena, akara@ciena.com
- Harvey Newman, Caltech, newman@hep.caltech.edu
- Francis Lee, SingAREN/SOX, ebslee@ntu.edu.sg
- Simon Green, SOX, simonpetergreen@singaren.net.sg
- Sadi Koçak, NetherLight, sadi.kocak@surf.nl
- Hirotaka Sato, KDDI, ir-satou@ote.kddi.com
- Marcos Schwarz, RNP, marcos.schwarz@rnp.br
- Alex Moura, KAUST, alex.moura@kaust.edu.sa