OF@TEIN+

Open/Federated Playgrounds for Future Networks

Building and Operating an Open and Federated Future Internet (SDN/NFV/Cloud-integrated) Testbed

Building on the success of the previous OF@TEIN project, OF@TEIN+ expands the network to include new partners in multiple developing countries. The collaboration further enhances and extends efforts to build and operate an open and federated future Internet (SDN/NFV/Cloud-integrated) testbed, further promoting Software Defined Network (SDN)-Cloud R&D collaboration amongst TEIN partners.

Through funding via the fourth phase of the Asi@Connect project, OF@TEIN+ contributes to work package 4 of Asi@Connect. This focuses on the deployment of specialised network products, services and associated capacity development - i.e. projects that make use of the Asi@Connect network as a platform to research, test and deploy future internet technologies and applications. Specifically, OF@TEIN+ interconnects multiple research education networks across the member countries through TEIN4's high speed connectivity, thus allowing the sharing of knowledge and multiparty research.

The main objective of OF@TEIN+ is to deploy a shared OpenFlow-based SDN testbed infrastructure between Korea and collaborators in South-East and South Asia over the TEIN4 network architecture. Initial project participants are:

- From South-East Asia: HUST (Hanoi, Vietnam), ASTI (Manila, Philippines), Chulalongkorn University (Bangkok, Thailand), ITB (Bandung, Indonesia), University of Malaya (Kuala Lumpur, Malaysia), MYREN NOC (Cyberjaya, Malaysia)
- From South Asia PERN (Islamabad, Pakistan)
  This has since expanded to also include sites in Taiwan, Hong Kong, Philippines, Bhutan, Cambodia, Yangon (Myanmar), Pakistan, Laos and India.

The OF@TEIN+ collaboration project is divided into the following five goals, and will be conducted over a period of 22 months. All of these goals rely on the Asi@Connect network and its interconnectivity with research networks in the participating countries

1. Gather and learn together
2. Build and upgrade together
3. Operate and automate together
4. Play and visualise together
5. Investigate and enrich together

Motivation and Goals

Members of the OF@TEIN+ collaboration can be divided into three different types of economy:

- Developed countries: Korea and Taiwan
- Developing countries: India, Indonesia, Malaysia, Philippines, Thailand, Vietnam, and Pakistan
- Least developed countries: Bhutan, Laos and Myanmar
  This is an important attempt to share resources and increase research collaboration across these three different types of economy. It is hoped that this collaboration can not only encourage the development of technology in each country but also contribute to research into multi-party SDN architecture and management. As such, the motivation behind this project is as follows:

- **Cloud enabled economical and flexible shared cyber-infrastructure**
  Cloud computing technology represents the future paradigm of on-demand access to converged/virtualised resources, in terms of compute/networking/storage, shared data and information, and a usage-based billing model. Thus, based on cloud infrastructure/platform/software as a service, diverse services could be easily and economically created and delivered in most academic, government and industry sectors.
- **The DevOps (Development & Operation) paradigm enables automated remote operation**
  The emergence of SDN/NFV/Cloud integration significantly reduces the total cost of ownership as it is distributed across the participating members. This technology shift is the key driver to manage an appropriately-sized resource pool for cloud-leveraged infrastructure, which can meet the current and future computing/storage demands of the TEIN community.
- **Asi@Connect NRENs enjoy network-based sharing of high-cost computing/storage resources**
  Easy resource sharing among partners for both HPC (High Performance Computing) servers and large-capacity data lake (file/object storage) will enhance ROI, while research outcomes and outputs will increase in both quantity and quality.
- **The OF@TEIN+ collaboration builds upon the excellent foundation of the previous OF@TEIN project**
  The collaboration experience and human networking in the OF@TEIN collaboration project (2012-2015) provides an excellent foundation for this community-driven open collaboration effort. With a stable starting platform, the progress of OF@TEIN+ is predictable and verifiable.
- **APAN Cloud Working Group (WG) can provide both technical support and operational expertise**
  Close ties with the APAN Cloud WG and its associated Cloud Task Force provides technical expertise to build and operate a shared OF@TEIN+ SDN-Cloud and data lake facility. All research efforts within the OF@TEIN+ project are also reported in the APAN workshop and this in turn also contributes indirectly to delivering the aims above.
  Thanks to the combination of the strong collaboration between the previous OF@TEIN partners and the participation of new members, the following goals have been set for OF@TEIN+, while addressing several targeted technical challenges:

Gather and Learn Together

The first goal of OF@TEIN+ is to encourage the sharing of knowledge about the Open and Federated SDN/NFV/Cloud-integrated Playground. This includes the tasks of evaluating and recruiting new members from participating countries, and organising collaboration events between them. With this goal in mind, the OF@TEIN+ project has now expanded to include 39 active members from 12 countries and has regular meetings to share research knowledge and experience. The future of network architecture is a software defined one and the members of the project are the ones that will be spearheading relevant research in their respective countries.

Exchange visits are an important element of the OF@TEIN+ project. Multiple workshops and training sessions are held at participating member countries to educate and share SDN knowledge. Each event also provides the opportunity to promote the project and expand research collaborations. For these reasons, project funding is allocated to ensure that there are as many opportunities for members of the project to participate as possible.

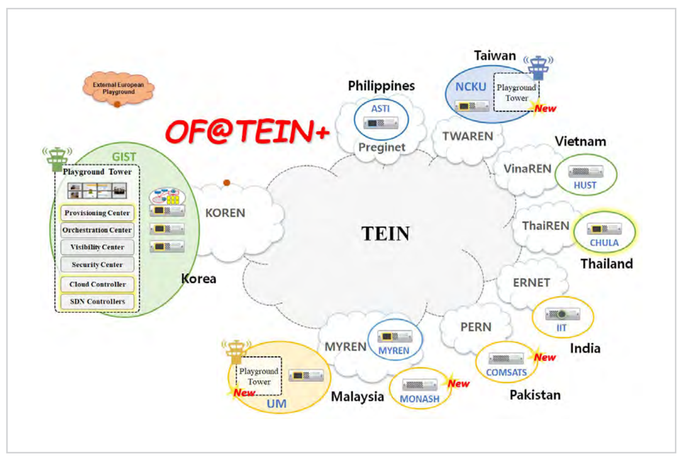
Build and Upgrade Together

The second goal is the deployment and upgrade of the Open/Federated Playground with Distributed SmartX Box Playground Resources and centralised data lake/analytics hardware. The existing SDN architecture of OF@TEIN provides the foundations for OF@TEIN+, and is expanded across member countries via their respective research networks.

To assist with this expansion, specialised equipment in the form of SmartX boxes have been developed and distributed to member research institutes. A significant portion of the funding obtained from Asi@Connect will be devoted to their purchase, distribution, development and deployment as well as providing training on these devices. The boxes interconnect via the TEIN4 backbone and support various functions from network monitoring to resource management. All work done to develop the SmartX box is available via GitHub repositories as open source code to encourage experimentation from both project members and the public.

Operate and Automate Together

The third goal encourages collaboration among leading members to enable automated DevOps-style operation of Playground Resources and Platforms. The goal also builds upon the hardware architecture of OF@TEIN+ to make available a high-availability data lake – this provides a centralised space for site-to-site interconnection troubleshooting. The upgrading of the existing OF@TEIN architecture now has a Datalike server with 48TB of storage operated with two Playground Tower servers each running 16 CPU cores.



Play and Visualise Together

Participating members actively participate in research activities and experiments using the OF@TEIN+ architecture and share their progress via online conference sessions and annual face-to-face events. Members are encouraged to establish partnerships with other research institutions to not only expand research opportunities but also learn about the varying nature of network infrastructure development in different countries. The results of OF@TEIN+ projects have been presented at multiple international conferences and workshops, as well as appearing in top tier journals.

Investigate and Enrich Together

The final goal looks to the future of the project. It aims to enhance the deployment of SDX-based solutions/designs/plans based on the co-developed research of the project members. This would contribute to any future projects involving the OF@TEIN+ network and also benefit current users. The initial plan to develop SOC deployment sites for security issues is also in the planning in this final phase.

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This activity has received funding from Asi@Connect project which is the European Union co-funding project under Grant contract ACA 2016-376-562.