Newsletter #5 July 2023

TeraFlow

Contents

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101015857

EDITOR'S NOTE

The TeraFlow project has reached its conclusion, and throughout its course, several important lessons have been learned. One significant challenge encountered was the difficulty of establishing a common way of working among different companies involved in the project. Despite this challenge, the project successfully utilized a reference project, such as OpenSource MANO (OSM), to guide its implementation and foster collaboration.

To ensure the sustainability of the TeraFlow ecosystem, efforts were made to establish a presence in Standards Development Organizations (SDOs) such as the Internet Engineering Task Force (IETF), Telecom Infra Project (TIP), and the European Telecommunications Standards Institute (ETSI). This involvement in SDOs allowed TeraFlow to contribute to the development of standards and specifications, ensuring interoperability and industry-wide adoption.

The project recognized that while Software-Defined Networking (SDN) may have lost some momentum, its foundational principles are crucial for the successful implementation of emerging applications such as Zero-Touch Service Management (ZSM) and Automation. Therefore, it is necessary to explore new business models that leverage SDN as a fundamental component.

The support from ETSI has been instrumental in the success of TeraFlow. The research and development work undertaken by the project has been remarkable, making a real impact in both SDOs and Open-Source Software (OSS) communities.

TeraFlow has also made efforts to enhance its visibility in research and industrial conferences. Numerous workshops, paper presentations, demonstrations, and booths have been organized to showcase the project's achievements and engage with the wider community. It is worth noting that the project was not significantly impacted by the COVID-19 pandemic, allowing it to continue its activities uninterrupted.

With the conclusion of the TeraFlow project, its legacy and ecosystem sustainability have been ensured. However, specific actions need to be taken in the future to build upon the project's achievements. One such action is the incorporation of TeraFlow solutions into other projects within the SNS (Service Network Systems) framework, with up to eight projects utilizing and further developing TeraFlow's work.

Additionally, there is a recognized need for a project focused on integration costs and further research work. This would enable the exploration of potential challenges and costs associated with integrating TeraFlow's solutions into existing network infrastructures, while also fostering continued research and innovation in the field.

Ricard Vilalta. Research Director at CTTC/CERCA, TeraFlow Project Coordinator and Chair of ETSI OSG TeraFlowSDN

Work package progress

WP5: Prototype integration, demonstration and validation

CHALMERS UNIVERSITY OF TECHNOLOGY

WP5 has been responsible for performing the TeraFlowSDN integration, followed by experimentation, validation, and evaluation using a range of benchmark indicators. In the last six months of the project, we concentrated on the collection, analysis, and reporting of KPIs. As a result, a new metrics collection framework is now fully integrated into the components, and a service mesh has been adopted to enable scalability and load balancing.

The project identified three scenarios representing some of the challenges posed by B5G networks, namely: Autonomous Network Beyond 5G, Inter-domain, and Cybersecurity. For each one of the scenarios, we identified: the main technical challenges, the features required (i.e., from the TeraFlowSDN point of view), the TeraFlowSDN component to be developed to provide these features, and the use cases of interest to be investigated to validate and benchmark the performance of the TeraFlowSDN prototype. During this period, the project produced D5.3, a document where we have completed scenario description, as well as detailed set-ups per each of the analysed workflows.

Each scenario description includes a reference on how TFS architecture has been instantiated. Sequence diagrams have been detailed per workflow, with details on interactions between TFS components and related network elements. During this period, scenarios have been demonstrated in several conferences such as OFC23.

The high-level architecture depicted in scenario 1 includes integrated network elements within different technological domains, enabling the autonomous provisioning, configuration, and management of transport network slices. These slices consist of various Virtual Private Network (VPN) services like Layer 2 (L2VPN) and Layer 3 (L3VPN) services with dedicated Service Level Agreements (SLAs). The interaction between the NFV Orchestrator (e.g., ETSI OpenSource MANO) and TeraFlowSDN North-Bound Interfaces (NBI) allows provisioning of L2/L3VPN connectivity.

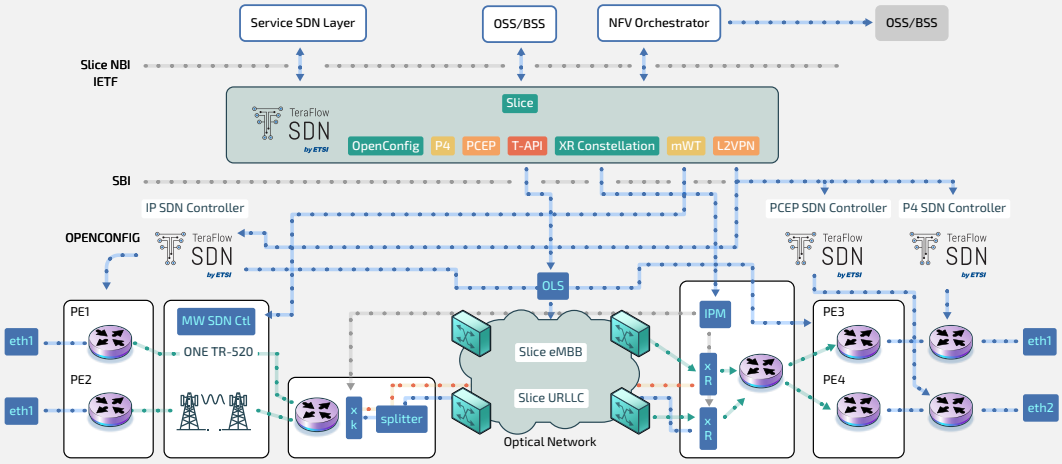


Figure 1: TeraFlow Scenario 1

The deployment of Cooperative, Connected, and Automated Mobility (CCAM) services over a distributed edge and cloud infrastructure presents various challenges that require addressing. These challenges include unified resource management, multi-domain networking, and inter-domain slicing while preserving data confidentiality. The TeraFlowSDN Controller plays a critical role in overcoming these obstacles. It facilitates unified resource management by provisioning integrated services, managing computing, storage, and networking resources, and optimizing both cloud and network resources. Additionally, the TeraFlowSDN Controller tackles multi-domain networking by deploying per-domain slice instances and orchestrating their integration to form end-to-end transport network slices across multiple domains. Furthermore, when dealing with different network operators, the controller incorporates a Distributed Ledger Technology component based on blockchain to ensure data privacy during inter-domain slicing while enabling collaboration between operators. These topics are considered in Scenario 2

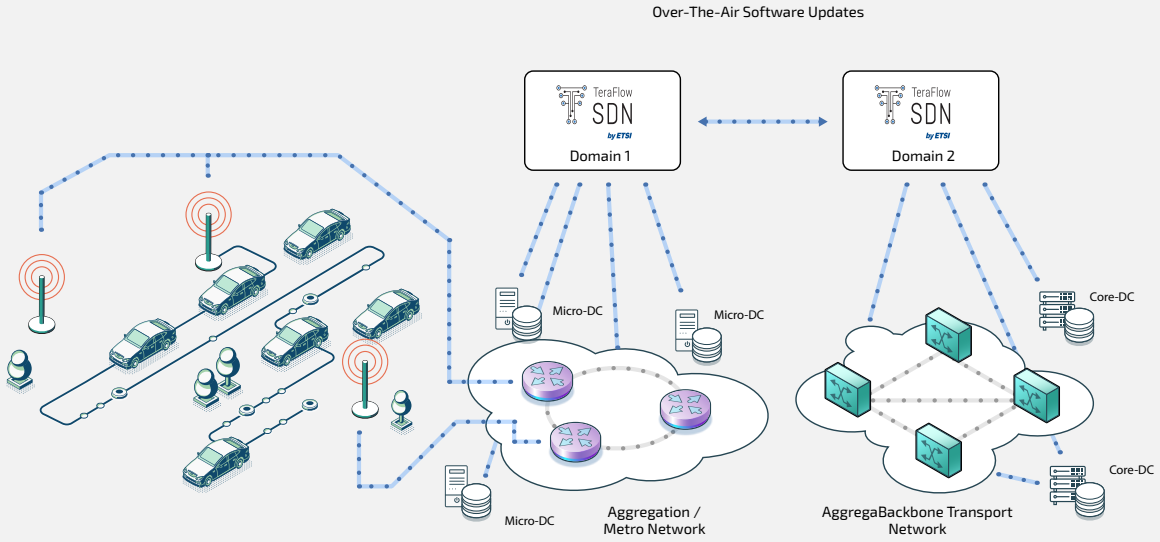


Figure 2: TeraFlow Scenario 2

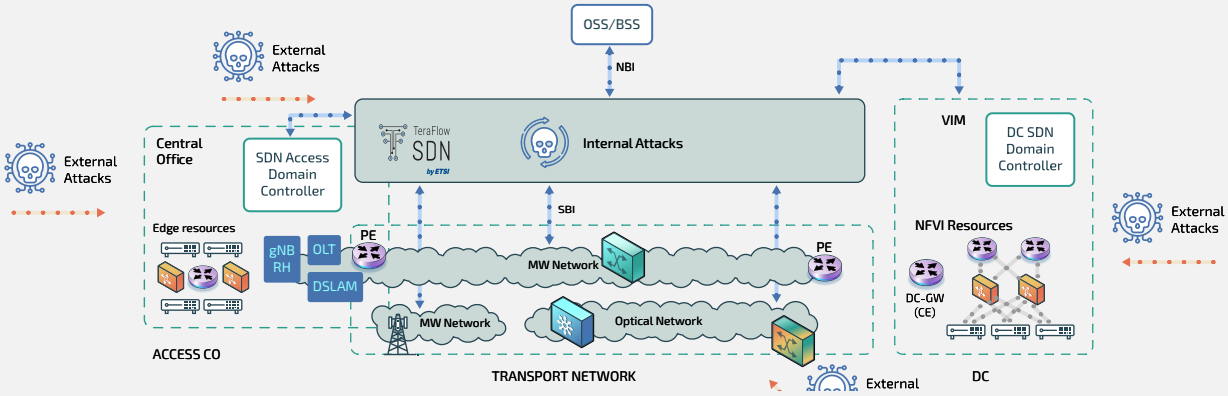


Figure 3:TeraFlow Scenario 3

Cybersecurity and threats in the context of an automated network are described in Scenario 3. Attacks may target the IP or the optical layers at the data plane. Attacks exploiting the IP layer traverse or target devices located in the access segment (e.g., edge DCs), the core network, or core DCs. In this case, per-packet inspection is necessary to detect and identify attacks, enabling their mitigation. However, inspecting packets is a demanding operation. Executing this process at a central packet inspector instance is impractical. Packets must be transported from the remote site, e.g., Central Office (CO) or DC, to a central location, incurring significant traffic and computing loads. Therefore, designing distributed packet inspection becomes necessary for efficient and effective attack detection at the IP layer. Moreover, it is necessary to coordinate the distributed packet inspectors, which means that a central entity is still necessary, but only for consolidating and coordinating the network's security status.

Functional tests were created for the scenarios into the CI/CD environment. This enabled the validation of modifications not only in terms of unitary tests (i.e., tests more focused on the individual functionalities of each component) but also in terms of end-to-end workflows.

D5.3 extended the metrics definitions previously delivered in D5.1. The new deliverable reports the elaborated metrics collection framework which has been developed by integrating state-of-the-art open-source software into the TeraFlowSDN architecture. A performance evaluation section has been provided per workflow, with dedicated attention to the aforementioned metrics.

Two leading open-source software platforms are used: Prometheus, a solution for exposing and collecting metrics about the software performance at run time, and Grafana, a solution for creating graphical dashboards combining multiple data sources.

Adopting Prometheus, Grafana and a service mesh software capable of performing load balancing for gRPC requests granted TeraFlowSDN a wide range of functionalities that can be used to evaluate the system's performance and identify potential bottlenecks or targets for optimization.

WP6 – Standardization, Dissemination and Exploitation

2023 has been crucial again for impact creation. Work Package 6 in TeraFlow project has been devoted to design strategies and execute plans for impact creation, with the goal of sharing advances and facilitating the adoption of results. D6.3 focused on the work done in T6.3 during 2022, providing an exploitation plan for all relevant results, individual exploitation plans from all partners and an action plan to promote further use of these results. And finally, D6.4 has provided a complete and detailed overview of all dissemination, communication, collaboration, and standardisation activities carried out by the consortium from January 2022 to June 2023, as well as an update of the exploitation activities described in D6.3. . Participation of TeraFlow and ETSI TFS in OFC, ONDM, ICC, P4 Global Workshop, HPSR, MWC, IETF, EuCNC, NGON and NetSoft helped to increase the project visibility. Additionally, to close the work carried out in WP6, D6.4 also provides an analysis of the overall impact achieved by the project, explaining how, thanks to the results achieved, together with an effective planning and consecution of WP6 activities, the future of TFS (main project result) looks very promising.

Atos

Highlights of the period

Launch of Release 2.0 and 2.1

On February 2023, the ETSI Open Source Group TeraFlowSDN and the TeraFlow project, funded by the European Commission under Horizon 2020 Programme, launched the second release of the TeraFlowSDN controller (2.0).

This second TeraFlowSDN release has been focusing on scalability and resilience of the controller, with a complete re-design of the Context Component to include a scalable database (i.e., CrocoachDB) to support the most stringent non-functional requirements.

This second release also put a stake on network automation, with the implementation of lots of new workflows, including L3VPN establishment with SLA, multi-layer topology discovery, service Access Control List (ACL), service restoration, service location-awareness, traffic engineering, slice SLA enforcement, slice grouping, forecasting, inter-domain slice SLA enforcement, inter-domain connectivity provisioning and SLA enforcement using DLT, and Energy-aware network service placement.

TeraFlowSDN Release 2 provided extended and validated support for end-to-end transport network slicing over multiple network domains. This release completed SDN orchestration for L2/L3VPN provisioning, microwave networks, Point-to-Multipoint integration of XR optical transceivers, and interaction with optical SDN controllers through the Open Networking Foundation (ONF) Transport API (TAPI). SDN control was provided for OpenConfig-based routers and P4 white boxes, including the ability to load a P4 pipeline on a given P4 switch, getting runtime information (i.e., flow tables) from the P4 switch, and pushing runtime entries into the P4 switch pipeline, enabling full usage of P4 switches.

Service Level Agreement (SLA) validation was re-engineered through all the workflows, from Device Monitoring to Service and Slice Life Cycle Management. The Slice, Service, Policy, Device and Monitoring Components were upgraded to support the necessary network automation workflows. Slicing mechanisms were introduced, along with the Path Computation Component which will allow new use cases, such as energy-aware service placement.

TeraFlowSDN Release 2 brought updates to Cybersecurity mechanisms, including novel components for distributed or centralized attack detection, inference, and mitigation, as well as new supported use cases. Distributed Ledger Technology (DLT) was extended to interact with the Inter-domain Component and use the deployed Hyperledger Fabric.

> "Our second release of TeraFlowSDN provides unique features to the community", said Ricard Vilalta, Research Director at CTTC and Chair of ETSI TeraFlowSDN. "Cloud-native SDN in the next evolution for telco transport networks, and TeraFlowSDN is paving the way."

The source code of TeraFlowSDN is publicly available under the Apache Software License 2.0 for download and installation at https://labs.etsi.org/rep/tfs/controller. TeraFlowSDN release 2.1 which included more integrated contributions, bug fixes and security patches was launched on July 2023.

Three scenarios will be demonstrated to validate the performance of the components developed and their potential value for end-users and early adopters of TeraFlowSDN were demonstrated and validated in three scenarios: Autonomous Network Beyond 5G, Inter-domain and Cybersecurity.

ETSI Presentation webinar of TeraFlowSDN

TeraFlowSDN Release 2 launched

TeraFlow Introduces TeraFlowSDN 2.1: A Major Leap in Software-Defined Networking

ETSI TeraFlowSDN to serve as reference implementation for TIP

The implementation of Telecom Infra Project (TIP) Open Optical & Packet Transport (OOPT) Mandatory Use Case Requirements for SDN for Transport (MUST) in ETSI TeraFlowSDN cloud native SDN Controller could make it possible to accelerate network innovation in packet-optical networks.

On February 2023, the ETSI TeraFlowSDN community announced its commitment to the implementation of TIP's Mandatory Use Case Requirements for SDN for Transport (MUST) Requirements in their innovative cloud native SDN Controller. This would position TeraFlowSDN as a reference implementation in the Telecom Infra Project Open Optical & Packet Transport group (TIP OOPT). This alignment would also accelerate the adoption of SDN standards for IP/MPLS, Optical and Microwave transport technologies, which is one of the main objectives of MUST, and would foster the development and adoption of open, standards-based infrastructure solutions that can be easily integrated and deployed in real-world networks, enabling the delivery of new services and applications.

"The implementation of TIP MUST requirements in ETSI TeraFlowSDN, and its positioning as TIP MUST Reference Implementation, benefits the community and helps to align efforts towards open packet-optical transport networks," says Juan Pedro Fernández-Palacios, Head of Unit Transport Networks at Telefonica, MUST lead member and Vice-Chair of ETSI TeraFlowSDN. "Telecom Operators will benefit from this strategy, which will make it possible to accelerate the validation of upcoming network equipment and the development and deployment of new innovative services".

ETSI TeraFlowSDN to serve as reference implementation for TIP

TeraFlow in the International Women in Engineering Day 2023

On 2023 TeraFlow joint the Women's Engineering Society (WES) celebration of the 10th Anniversary of the International Women in Engineering Day.

The International Women in Engineering Day began in the UK in 2014 as a national campaign from the Women's Engineering Society. Since then, INWED has grown enormously, receiving UNESCO patronage in 2016 and becoming international in 2017 for the first time due to the interest and enthusiasm developed by the international audience and participants in the previous years. International Women in Engineering Day (INWED) was born to enable the celebration of women in engineering to become global.

International Women in Engineering Day 2023

This year, TeraFlow prepared a special campaign in social networks, with posts that were lunched along the day and explained the CV and the contribution to TeraFlow of some of the women in engineering in our project team.

TeraFlow World Tour: Seven events in less than one month!

In the last month of the project, TeraFlow team went crazy over and bet everything that they had!

From 25th May to 21st June 2023, our team presented the project in 7 different events, attended two booths and organized two workshops and one hackfest. Read more information in the section News and Events!

News & Events

Workshop on 6G organized by the Hexa-X project and ICT-52 cluster

18- 19 January 2023, online

On this event, Ricard Vilalta (CTTC) presented "TeraFlow: Do we need yet another SDN controller? Use cases for a novel cloud-native SDN controller for beyond 5G networks" in this event.

Teraflow in HEXA x workshop, VIRTUAL ICT-52 Workshop on 6G 2023

ETSI Research Conference

6-8 February 2023, Sofia Antipolis (France)

This face-to-face event provided an exceptional opportunity for the research community to come together with industry representatives and standardization experts to discuss future technology research and links to standardization developments. "Overview of TeraFlow H2020 Project - the journey from an EU Research Project to Standards Activity" was presented by TeraFlow coordinator, Ricard Vilalta. TeraFlow and its sibling project Open Source MANO were also presented by one of TeraFlow partners, Diego R. López from Telefónica. The title of his presentation was "The ETSI ISG NFV Research Agenda".

ETSI Research Conference

ETSI TeraFlowSDN webinar

13 February 2023, online event

This webinar offered an overview of the announced ETSI TeraFlowSDN release 2.0, and a demonstration of some of its features.

ETSI TeraFlowSDN webinar

NetBCN

21 February 2023, Barcelona (Spain)

NetBCN is the open community around Internet and network technologies in Barcelona area. Our TeraFlow project coordinator, Ricard Vilalta was there presenting TeraFlowSDN.

Mobile World Congress (MWC2023)

MWC2023, 27 February -2 March 2023, Barcelona (Spain)

TeraFlow was exhibited in the booth of the Centre Tecnològic de Telecomunicacions de Catalunya (CTTC). Our coordinator took this opportunity to spread the word about the TeraFlowSDN group and the second release of its cloudified software controller for virtualized transport networks and participated in international standardization fora. He also could establish new alliances and got interesting contributions. TeraFlow in the Mobile World Congress

OFC 2023

5-9 March 2023, San Diego, California (USA)

OFC is the largest global conference and exhibition for optical communications and networking professionals. The program goes from research to marketplace, from components to systems and networks and from technical sessions to the exhibition. OFC draws attendees from all corners of the globe. TeraFlow participated very actively in this event with five accepted papers, two invited speakers, and two live demonstrations.

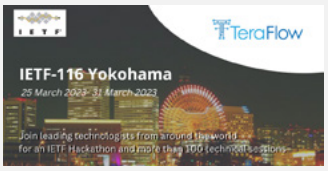
Five TeraFlow papers accepted in OFC 2023, OFC conference.

BCN LatAm Summit

13-14 March 2023, online event

BCN LATAM SUMMIT, organized by TeleSemana, is the only virtual event for telecommunications professionals in Latin America which offers a synthesized view of what happened at MWC Barcelona. Thousands of executives and more than 60 regulatory and government agencies in Latin America receive TeleSemana's business-critical information every week. Our coordinator talked about transport network evolution with ETSI TeraFlowSDN for 5G and 6G use cases. BCN LatAm Summit.

IETF



25-31 March 2023, Yokohama (Japan)

The IETF is the principal body engaged in the development of new Internet standard specifications which celebrates meetings three times a year. The IETF Hackathon is a collaborative event that takes place in the previous weekend to each event that encourages developers and subject matter experts to discuss, collaborate and develop utilities, ideas, sample code and solutions that show practical implementations of IETF standards. Our colleagues in Old Dog Consulting and also in CTTC and Telefónica coordinated the involvement for ETSI TeraFlowSDN in the IETF Hackathon. The TeraFlowSDN team was working with other IETF engineers to implement improvements to the TFS NBI for IETF slicing and service models using YANG data models.

TeraFlow in IETF-116 Hackaton, TeraFlow at IETF-116

MPLS SD & AI Net World 2023

18-20 April 2023, Paris (France)

In this event, TeraFlow was presented by Silvia Almagia - Technical Expert, Centre for Testing and Interoperability, ETSI - as one of the most relevant Open Source Initiatives within the ETSI perspective session on Recent Advances in the Network Transformation Plan, chaired by Diego R. López from Telefónica I+D. MPLS SD & AI Net World 2023,

ONMD 2023

8-11 May 2023, Coimbra (Portugal)

ONMD 2023 addressed cutting-edge research in established areas of optical networking and their adoption in support of a wide variety of new services and applications. In the framework of this event, TeraFlow was presented with other EU funded projects on the workshop entitled "Challenges of optical communications in the 6G era: a view from EU projects". ONMD 2023, ONMD conference website.

AI-NET annual event 2023

25 May 2023, Massy (France) – 1st TFS World Tour Event

Carlos Natalino from Chalmers University presented TeraFlowSDN during the annual event of the AI-NET project in Massy, France. AI-NET is the CELTIC-NEXT EUREKA CLUSTER flagship project, and one of its subprojects, AI-NET-PROTECT, has plans to use TeraFlow for their demonstrator. This event was attended for more than 50 people - public authorities or relevant actors in research and industry. AI-NET annual event 2023

IEEE ICC'23 conference, AI/ML-driven Autonomous 6G networks workshop

29 May 2023, Rome (Italy) – 2nd TFS World Tour Event

Our coordinator presented "TeraFlowSDN controller for AI-based cybersecurity and network automation" as a part of the Workshop on "AI/ML-driven Autonomous 6G networks" organised by the 6G Smart Networks and Services Industry Association (6G-IA) in the framework of the IEEE ICC'23 conference. TeraFlow had also a dedicated booth, participated in Podium Industrial Pitches and presented a paper. IEEE ICC'23 conference, AI/ML-driven Autonomous 6G networks workshop

NGON & 5G Transport 2023

30 May- 1 June 2023, Cote d'Azur (France) – 3rd TFS World Tour Event

This event focused on optical networking and transport technologies for 5G networks. It is a platform for industry professionals, researchers, and experts to gather, share knowledge, discuss advancements, and explore the latest trends in optical networking and 5G transport. Raúl Muñoz brought TeraFlow H2020 into the discussion of F5G during the workshop "ETSI: Evolving Towards F5G-Advanced for Green 10Gbps Everywhere". Old Dog chaired the roundtable "Is it the End Nigh for Layered IP Over DWDM: Smart Pluggable Coherent Optics" and the workshop "Role of Standards in Automating Intelligent Optical Networks".

The Role of Standards in Automating Intelligent Optical Networks, TeraFlow in NGON & 5G Transport 2023

IEEE HPSR 2023

5-7 June 2023, Albuquerque, NM (USA) – 4th TFS World Tour Event

Panagiotis Famelis presented the TeraFlowSDN poster and paper "P5: Event-driven Policy Framework for P4-based Traffic Engineering". IEEE HPSR 2023

EuCNC & 6G Summit 2023

6-9 June 2023, Gothenburg (Sweden) - 5th TFS World Tour Event

The event focused on all aspects of telecommunications ranging from 5G deployment and mobile IoT to 6G exploration and future communications systems and networks, including experimentation and testbeds, and applications and services. In the last years more than 1300 delegates and more than 70 exhibitors have attended the conference. TeraFlow was an exhibitor in this event with a dedicated booth and was presented by Pablo Armingol from Telefónica in the Special Session 7, "Novel technologies in disaggregated packet-optical networks to support 6G" chaired by Ricard Vilalta and Ramón Casellas from CTTC. EuCNC & 6G Summit 2023

Open Source MANO Ecosystem Day (OSM#15)

14 June 2023, Castelldefels, Barcelona (Spain) - 6th TFS World Tour Event

The OSM Ecosystem Day allowed the OSM Ecosystem organizations to share their Open Source MANO experiences. On behalf of TeraFlow, Lluis Gifre and Ricard Vilalta presented the talk "ETSI OSM-TFS Integration: New WIM-related features and future OSM+TFS integration plans – CTTC". Open Source MANO Ecosystem Day (OSM#15)

NetSoft23

19-21 June 2023, Madrid (Spain)- 7th TFS World Tour Event

TeraFlow was NetSoft 2023 Hackfest patron and organized there the 2nd ETSI TFS Hackfest The event took the form of a competition: participants were grouped in teams and collaborated to complete a list of challenges. Besides of the Hackfest, TeraFlow organized the workshop "DataSlice 2023: From Data Plane Programmability to Slicing Automation for Softwarized Infrastructures towards 6G". NetSoft23.

Upcoming Events

ETSI TFS#3 Hackfest

16-17 October 2023, Castelldefels, Barcelona (Spain)

ETSI's Centre for Testing and Interoperability and the TeraFlowSDN Community are organizing the TFS#3 Hackfest on 16-17 October 2023. The event will be hosted by CTTC in their premises in Castelldefels, Barcelona, Spain, and co-located with the TFS#3 Ecosystem Day, TFS#3 Plenary and ACROSS Project Meeting.

This Hackfest will be dedicated to the use of P4 in TeraFlowSDN, starting with an overview, followed by a gradual walkthrough of an end-to-end P4 based demo, then a more interactive session. Sessions will be led by key members of the TeraFlowSDN community. Participants will be able to build their own hands on experience of P4 forwarding with TeraFlowSDN: deployment, configuration, operation, monitoring, update, etc. ETSI TFS#3 Hackfest

Meet our partners

IN THIS SECTION WE PRESENT THE PARTNERS OF THE CONSORTIUM, THEIR PROFILE, MAIN EXPERTISE AND CONTRIBUTION TO THE PROJECT. IN OUR FIVE AND LAST NEWSLETTER YOU CAN KNOW MORE ABOUT INFINERA, SIAE AND UPM.

ADVA

ADVA SE (ADVA) is a global provider of telecommunications equipment. With innovative Optical, Ethernet and Control transport solutions, ADVA SE builds the foundation for high-speed, next generation networks. The company's FSP product family adds scalability and intelligence to customers' networks while removing complexity and cost.
ADVA SE is a global market leader in Metro WDM systems and Ethernet Access Devices. ADVA Ensemble is an award-winning network virtualization solution that empowers their customers with choice: choice of hardware platforms, choice of software vendors and choice of deployment locations. With the industry's most comprehensive NFV portfolio, it currently offers carrier-class service orchestration on a highly scalable, highperformance virtualization platform for hosting multi-vendor VNFs. Advanced zero touch provisioning and SDNenabled programmable traffic steering allows to provision new network services quickly and automatically, without manual intervention. ADVA Optical Networking worldwide counts more than 1900 employees, of which more than 600 are engineers working in research and development functions. ADVA has 25 years of experience in building optical and Ethernet transport equipment for access, metro and regional/core networks. It is and has been involved in various national and international research projects.

Dr. Achim Autenrieth

José Juan Pedreño Manresa

In TeraFlow, ADVA:

- contributed to the deployment of Network Operating System (NOS) over whiteboxes.
- provided support defining the architecture of TeraFlowSDN and their NBI and SBI.
- provided Ensemble Activator to be run on top of whiteboxes and to be controlled through OpenConfig interface.
- explored multiple NBI for Transport Network Slicing component.
- contribute to the testbeds with Ensemble Activator (NOS) managed via TeraFlowSDN through its SBI using NETCONF/YANG.
- demonstrated Ensemble Activator through NETCONF/YANG and network slicing.
- was involved in demonstration, event participation, journals and publications participation.
- explored possible contributions in multiple SDO.
- focused on market trends and exploitation strategies in conjunction with network management .

NTNU

NTNU is a full range, Norway's largest university with more than 40 000 students and is the primary Norwegian university in engineering and technology. More than 400 PhD- degrees are awarded yearly. The annual budget of NTNU is around € 930 million, 21% of which is externally funded. Total R&D expenditures amounts to approx. € 200 million. NTNU is an active participant in the EU Framework Programme for Research and Innovation, has a long and successful tradition of hosting and training MSCA candidates, has a mature support system including EU advisors, project economists, HR section and legal department, all with extensive experience in running EU and MSCA projects. NTNU has received the "HR Excellence in Research Award" from the European Commission.

Assoc. Prof. Thomas Zinner

Prof. Harald Øverby

Research has been mainly conducted in the Faculty of Information Technology and Electrical Engineering, at the Department of Information Security and Communication Technology (IIK). IIK hosts several national and NTNU research laboratories/centers. They include the national Center for Cyber and Information Security (CCIS), the Norwegian Information Security Laboratory, NTNU Internet of Things Lab, and the NTNU QUAM (Quantitative Modelling of Dependability and Performance) Lab. At these labs, several physical testbeds and platforms are available, including a cloud laboratory testbed.

The role of NTNU within the TeraFlow consortium is on multi-operator interconnect for multi-operator slicing and (2) techno-economic analysis of proposed solutions.

Marija Gajic

Peer Stritzinger GmbH

DIPL. PHYS.
PEER STRITZINGER GMBH

Peer Stritzinger GmbH was founded in its current form in 2001. It specializes in embedded systems software development and device design. It distinguishes itself by reapplying technological knowledge in other domains of computer science like distributed systems, functional programming, real-time systems, concurrency, programming language design and implementation as well as applied cryptography.

Peer Stritzinger

Adam Lindberg

Dr. Mirjam Friesen

As of April 2016 the company receives ongoing investor funding. This allows it to grow - hiring is ongoing. The investment also makes sure there is additional backing and reduces the risk of not being able to complete the project.

Stritzinger GmbH is the manufacturer of Hydraprog, a mass flash system for automotive ECUs used in manufacturing and for updating stocks of ECUs in the logistics chain. Since 2007 the focus is on using Erlang in embedded systems development, taking advantage of its highly increased development efficiency over other embedded programming languages and systems. This allows the company as a SME to take over much larger projects with a lean team and gives it a competitive advantage over the usually conservative embedded systems domain.

Stritzinger GmbH is providing product development and software development to Bosch Rexroth and other parts of Bosch. It also participated in the German national research project SmartF-IT.

The company supports community building for Erlang on embedded system through its GRiSP project and conference sponsorships. In order to make it easy to get started with Erlang running directly on hardware Stritzinger GmbH built an embedded CPU board that boots directly into the Erlang VM. It has many sensor and actuator options which can be directly accessed from Erlang. The board has on board Wi-Fi for network connectivity.

Stritzinger GmbH built a compiler and runtime for the distributed PLC standard IEC61499 in Erlang compiling to beam files. Extending the distributed computing model of IEC61499 to make it more resilient to network and node outages might also be a LightKone use case. As it is unclear if the computing model of IEC61499 can be moved towards shared computation with the help of CRDTs, this is not presented as a separate use case. Stritzinger GmbH is contributing to IEC61499 distributed automation standard through IEC SC65B/WG15.

In TeraFlow, Stritzinger GmbH is providing the skills and experience in Erlang and Elixir, which allows the design and development of highly scalable and fault tolerant applications

TeraFlow

teraflow-h2020
TeraFlow_h2020
teraflow-h2020.eu
teraflowsdn
TeraFlowSDN

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101015857