EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR COMMUNICATIONS NETWORKS, CONTENT AND TECHNOLOGY

Artificial Intelligence and Digital Industry
Robotics and Artificial Intelligence

Reference Testing and Experimentation facilities in Digital Europe Programme

WORKSHOP REPORT

ON THE WORKSHOP ON REFERENCE TESTING AND EXPERIMENTATION FACILITIES FOR EDGE AI

17 JANUARY 2020

1.1. BACKGROUND: THE DRAFT ORIENTATIONS FOR THE PREPARATION OF THE WORK PROGRAMME(S) 2021-2022 OF THE DIGITAL EUROPE PROGRAMME:

[…] The first two years of the programme will focus on developing an infrastructure which offers businesses and the public sector access to AI tools and components and data resources, as well as reference testing and experimentation facilities in some prioritised application sectors.
Actions will focus on […]:

- **developing world-class large-scale reference Testing and Experimentation Facilities (TEF) for AI hardware, software, components, systems and solutions, and underlying resources (data, computing, cloud) in a number of sectors;[…]**

Developing Large Testing and Experimentation Facilities to provide a common, highly specialised resource to be shared at European level and foster the deployment of trustworthy AI in the following areas:

1) a common European platform to design and manufacture edge intelligence components and systems based on neuromorphic and quantum technologies
2) reference sites for applications in essential sectors such as health, agri-food, manufacturing, smart cities and smart mobility (including environment and climate perspective).

This orientations document also stressed the strong links that will be established with the initiative to **establish EU-wide common data spaces**.

1.2. EXECUTIVE SUMMARY

Introduction:

- Edge AI TEFs are recognized as an opportunity in the area of neuromorphic chips, embedded AI, tiny machine learning, low-power hardware (HW) components as well as for EU designed and built chips for data processing at local level. TEF could be the means to develop chips that are secure, trusted and energy efficient and to rapidly achieve critical mass/economy of scale.
- The project concerns the set-up of a distributed European integration and fabrication platform to support the design, testing, experimentation and validation of advanced semiconductor components for a wide variety of AI applications.
- Data is the fuel of AI. A model trained on data from a third country might introduce a bias distorting its application in Europe. Therefore Europe needs to generate and process its own data.
- Thanks to AI at the Edge, data can be processed where it is captured with advantages in terms of security, privacy and latency, no data bias and best trade-off between performance and energy.

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Technical, energy constraints and specific use cases requiring instantaneous life-critical decisions make it unviable to stream all the data to the cloud where AI runs.

- Strengths in EU for Edge AI: Embedded systems, low-power consumption and new/alternative computing models.
- Weaknesses in EU for Edge AI: Computing hardware, lack of advanced fabrication capacity.

Over 80 participants attended the workshop held on 17 January:

- 24 delegates from 17 Member States plus Norway,
- Representatives from a wide array of organizations, including large system houses, IDMs, RTOs, SMEs, Start-ups.

Stakeholders' presentations:

- Technology today is not energetically sustainable. There is a need to improve hardware and software (latency, efficiency).
- Data is needed, not only best-case scenarios, but also and mainly worst-case scenarios.
- There is a need for standardisation, certification, and explainability of AI. The latter is defined as the ability of the machine to explain its decisions and actions to users. Testing and validation of hardware and software need to be reinforced. Virtualisation and digital twins could be also promoted. Validation of process technology is key.
- There are already EU competitors for cloud services andGaia-X could be considered as one way to reach trusted cloud services.

Stakeholder meeting takeaways:

- What is "Edge AI" needs to be clearly defined and agreed upon among all key actors. The definition of Edge today may vary according to type of industry, operators, to whom, where and when it is asked. For example if edge is defined as "anything that is not a data centre cloud", it could be Deep Edge, Far Edge, Consumer/Enterprise Edge etc.
- The full-picture of the initiative, involving roles of different players (including the EU), landscape of TEFs, their links with DIHs and how they will interact and operate with each other will need to be clarified.
- Interest/involvement of SMEs in the platform should be taken into account. For that a survey for participation of industries would be needed.
- TEF management structure should be elaborated and built on already existing success stories. A bottom-up approach tailored for TEF is suggested: it could be a launching board for start-ups which would make them attractive to Venture Capital. However, it has to be considered that competition between companies could hinder sharing of innovation within the TEF.
- Some promising areas are proposed:
    - Agriculture,
    - Smart Home,
    - Health,
    - Manufacturing,
    - Cross cutting applications – predictive maintenance, image processing for measurement technology and metrology,
    - Mobility/autonomous driving beyond ADAS.
- There is a need to define both the technology-readiness level and the process certification-standardization parameters and thresholds which would make a product ready for the market.

- Characterisation of edge AI should address CPU power and power consumption at device level. Edge AI TEFs are expected to define performance benchmarks, for instance power efficiency, cost, memory usage, accuracy validation, false positive resilience. Benchmarking on tests, simulation tools, environments and real test beds is suggested. Optimisation of algorithm should also be taken into account.
- Competitions and hackathons could be organised in the context of TEFs.
- Successful experiment cases should be available to the community. Open data is suggested.
- The TEF should be provided with the following essential components:
    - Sensors to be tested, as those are considered to have an impact on AI development. Sensors are expected to be both commercial off-the-shelf and cutting-edge, however they will have to be adapted and developed specifically for AI.
    - Hardware for edge computing.
- Clarification of the specification of Edge AI TEFs is of utmost priority, including "access to data" and specific hardware related software features. In relation to the latter, new hardware should be built with the legacy software system necessary to simulate and emulate the hardware solutions.
- In parallel to the edge AI initiative, there is the urgent need to establish standards for data collection, labelling and exchange.

1.2.1. Existing Landscape:

In the workshop, the European Commission asked experts and Member States' representatives to provide examples of existing testing sites for edge AI applications. The examples provided and listed below do not influence the outcome of future calls, they just serve to illustrate existing types of facilities, their setup, function, etc. Any Member State willing to provide to the European Commission additional examples of testing sites is welcome to do so.

Experts presented existing projects where testing and experimentation were being undertaken in edge AI. Fraunhofer offered to share its experience as their Forschungsfabrik initiative could be considered a role model for EU collaboration. Furthermore, CEA-Leti, Fraunhofer/FMD and Imec are already joining forces (MoUs and partial NDAs are in place).

More generally, some argued that roles of different players, including the EU, need to be better defined, as well as the full-picture, the landscape of TEFs and links with DIHs. The TEF concept should be better explained.

Participants to the workshop asked to respond to a questionnaire on EDGE AI TEFs indicated as potential candidate sites "5G Berlin", "Arena 2036 Stuttgart", IMEC, Fraunhofer, CEA-Leti. EU Academia and other RTOs expressed their interest for collaboration.

1.2.2. Needs and Impact

Experts discussed the needs and impact of new reference TEFs for edge AI.

Overall, experts believed that a TEF for edge AI should create critical mass for the industry, speed up prototyping, provide initial scale production and strengthen European value chains in key digital technologies.

According to the experts, a TEF for edge AI would need the following:

- Multiple collaborations/contributions;

- Develop algorithm, design and technology at the same time to make breakthrough more likely;

- Advance in Edge AI testing methodology development and critical system testing;

- Access to secure data spaces to allow for sharing and trading of standardized data and AI models. Data sets should also include examples of successful technologies/experiments that can be replicated/amended. Some participants considered data as most important, others recognized the key role hardware will have in the future of AI. However, Edge AI TEFs are suggested to provide reference datasets not only to test, but also to train different algorithms on different HW architectures.

- Access to sector-specific environments and infrastructure, e.g. real machines or shop floors for manufacturing, autonomous farms, validation & demonstration farms and simulation environments year round for agriculture;

- Systematic interaction with DIHs for technology transfer to European industry/SMEs;

- High degree of robustness, resilience and fault tolerance (especially for manufacturing);

- Access to high performance computing;

- Benchmarking common to industry in Europe on KPIs relevant for Edge AI, e.g. power, efficiency, cost, memory usage, accuracy validation and false positive resilience;

- Interoperability of technologies;

- Training on data and cybersecurity; educational resources and test environments in new edge AI technologies;

- Standardisation, certification, and explainability of AI.

The impact of a TEF in edge AI would be to combine expertise and strengthen the European IP base, avoid redundancies and duplication as well as broaden the competences and research services to industrial stakeholders. It would also support Europe's competitiveness and technological sovereignty. Most of all, Edge AI TEFs initiative is supposed to give easier access to leading world-class Edge AI technology in Europe to companies (e.g. design houses, etc.) of any size located in Europe.

Areas of interest for edge AI include deep learning, reduced precision, symbolic AI, digital coding, advanced non-volatile memories, 3D technologies, interconnect technologies, advanced packaging, sensors and actuators.

Many participants agreed that edge AI held inherent advantage on energy efficiency over clouds. One expert suggested that there should be a TEF on edge AI with a focus on efficient energy consumption.

1.2.3. Structure of the "facility"

According to the experts, the structure of TEFs for edge AI would be a distributed European integration platform to support design, test, experimentation, validation and deployment of advanced semiconductor components and solutions for a wide variety of next generation AI applications. The platform would enable access to cutting-edge technologies in Europe in the field of edge AI, for instance next generation AI chips and technology (e.g. advanced sensors with an intelligence on board) to European companies of any size.

Experts agreed TEF management structure should be elaborated and built on already existing success stories and European centres of excellence.

Stakeholders expect the structure to have the following characteristics:

- Multiple collaborations/contributions,
- Access to secure data spaces to allow for sharing and trading of standardized data and AI models,
- Access to sector-specific environments and infrastructure, e.g. real machines or shop floors for manufacturing, autonomous farms, validation & demonstration farms and simulation environments year-round for agriculture,
- Systematic interaction with DIHs for technology transfers to European industry/SMEs,
- Access to high performance computing,
- Standardisation, certification, and explainability.

1.2.4. Timing

Experts argued that the sector is ready for TEFs, but there was a discussion on what maturity level of technology the TEFs would be most appropriate for in order to be as close as possible to a given application.

The Edge AI TEFs initiative is inherently capital intensive and is expected in the short-term to focus on the acquisition of equipment and on related activities necessary to build-up the infrastructure with the aim to scale-up approaches currently under development.

1.2.5. Funding:

Clarification on funding mechanisms is needed.

Clarification on the establishment of the TEF form and structure, with clarity on the process lifecycle and timing would be essential, for MS. It is imperative to realize how TEFs would act as the direct answer to the given problem, while it should be defined with a business mind rather an academic one.

1.2.6. EU Added value:

To gain critical mass and compete with global players, cross-border cooperation is necessary. The collaboration between Fraunhofer, CEA-Leti and Imec is a good blueprint as they have the experience and capacity to work on this scale.

Recognized EU added value by participants to the workshop is:

- through dedicated and focused investments on instrumentation and experimental capacities, creating a European world-class cluster of excellence experimentation facilities, while avoiding duplication or redundancies within the network/platform,
- creating large synergies between partner organizations all over Europe (some know-how or specific required expertise may not be available in a single country),
- contributing to European Technology sovereignty,
- improving European data privacy and security,

- tackling Energy efficiency/Power consumption,

- boosting European economy and employment.

1.2.7. Ecosystems – access to value-chains:

Based on the existing work and collaboration between Fraunhofer, CEA and Imec and the rich, heterogeneous landscapes of European academia, centres of excellence, companies of any size including SMEs and Start-Ups, experts believed that the supply chain is available and ready to use the TEFs.

Furthermore, the TEFs for edge AI could provide the following to ensure its integration into the European ecosystem:

- Multiple collaborations/contributions with other players in the ecosystem

- Access to secure data spaces to allow for sharing and trading of standardized data and AI models,

- Access to sector-specific environments and infrastructure, e.g. real machines or shop floors for manufacturing, autonomous farms, validation & demonstration farms and simulation environments year-round for agriculture,

- Systematic interaction with DIHs for technology transfers to European industry/SMEs,

- Standardisation and certification.

One expert emphasised that edge AI requires highly specific skills that universities are not able to quickly produce, which makes training and retaining staff important - TEFs could help.

1.3. CONCLUSIONS:

The TEF should ideally be done by a European cross-border consortium. The sector seems ready to absorb the funding at this point in time. Collaboration with other projects, notably DIHs, is important, but requires further clarification.

Next steps will be:

- clarification of the edge AI TEF form and structure, timing and process lifecycle, mode of operation, including interaction with any size company e.g. large, SMEs, start-ups, academia…
- description of funding mechanisms.