

SLICES Workshop

Round-Up – Day 2

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Round-Up Day 2



Theme 1: Scientific Challenges

Theme 2: Industrial Perspectives

**Theme 3: Potential catalysts for SLICES
– the EC perspective**

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Scientific Challenges (1)

Vision for 2030

Our society will be data-driven; unlimited wireless connectivity
Wireless connectivity is driving major societal changes

Finland runs the World's first 6G Research Program

Critical Drivers towards 6G

Society, Business, Security, Radio technologies, AI, Standards



- 1. Wireless Connectivity**
Ultra-reliable low-latency communications vs. 1 Tbps
Enabling **Unmanned Processes**
- 2. Devices & Circuits**
THz communications materials & circuits
Enabling **Unlimited Connectivity**
- 3. Distributed Computing**
Mobile edge intelligence
Enabling **Time Critical & Trusted Apps**
- 4. Services & Applications**
Multidisciplinary research across verticals
Enabling **Disruptive Value Networks**

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Scientific Challenges (2)

- User-centric Internet; Responsible Internet to increase Trust
 - It's all about **Data Transparency Accountability Controllability**

Data about people



Photo source: Genetic Literacy Project

Personalized medicine (EPI)

Research data



Photo source: SKA organisation

Radio astronomy (SKA)

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Scientific Challenges (3)

Scaling the testbeds

- Automation
- Numbers and topology: interconnecting sites
- Diversity I: device and platform heterogeneity
- Diversity II: Users/machines and mobility
- Network architectures and protocols

Sharing the testbeds

- Automation and documentation
- Target audience
- Access to infrastructure
- Interconnecting
- Slicing in time & space
- Users' Data



Sample testbeds

Dense Wi-Fi networks

- v1: 45 Intel Edisons
- v2: 120 APUs w/ switched Ethernet backbone for control



Microcontroller environment

- 20–50 nodes
- Lightweight virtualization for in-network compute



Mobile node emulation

- Up to 1-10K nodes
- Running as VMs
- Connectivity controlled via simulator / traces



In-vehicle network testbed

- Software-defined topology
- Ansible-based config & test exec.



Some challenges

- Practical
- Space, scale
 - Radio interference
 - Ops & maintenance (people, funding)
- Scientific
- Inputs: measurements, living labs, models (realism)
 - Experimental explosion (complexity, time)
 - Usability ("error-free" even at 2am)
 - Ease of sharing (repos, formats, tool chains)
 - Reference models (benchmarks, metrics)
 - Reproducibility
 - Representativeness
 - Interpretation, generalization
 - Feedback loops
- Legal Regulatory
- Energy

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Industrial Perspectives (1)



Network 4 AI viewpoint

- ❑ **Model training**
 - E.g., realism in federated learning from heterogeneous deployments (practical system-level AI challenge)
- ❑ **Model-driven telemetry (MDT)**
 - Heterogeneity in the input data: multi-vendor (good to have “dirty data” AI problem)
- ❑ **Real-time**
 - Where (Cloud vs Fog vs Edge) to allocate AI resources: architectural tradeoffs of privacy vs cost vs ...
- ❑ **Control**
 - Delay+noise of MDT data streams: controllable/reproducible AI experiment in more challenging environment
 - Train on simulation (e.g., DRL takes lifetimes, cannot learn from real network) refine & validate on SLICES

Perspective of network vendors

- **Autonomous networking** as key topic
- **Network AI** in the spotlight!

AI 4 Network viewpoint

- ❑ **Model-driven O&M**
 - Unsupervised algorithms still need ground truth for benchmark
 - Large SLICES crowd: can the community crowdsource anomaly detection database beyond KDD99 (s/ImageNet/AnomalyNet/)?
- ❑ **Heterogeneity (again)**
 - Model ages and data drifts: study ageing of models imperative for deployment in a full AI lifecycle
- ❑ **Incremental training**
 - Incremental training: system-level problems bring algorithmic challenges
- ❑ **Real-time inference**
 - Inference: real-time low cost accurate inference

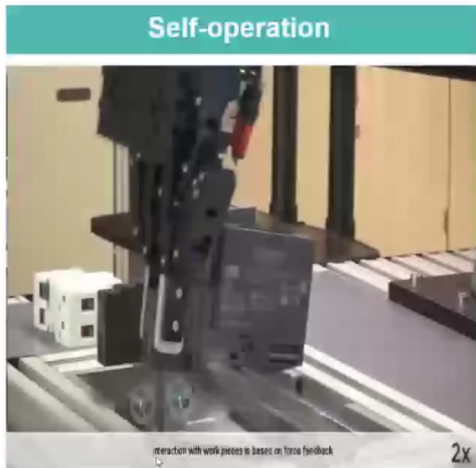
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Industrial Perspectives (2)

Perspective of manufacturing industries

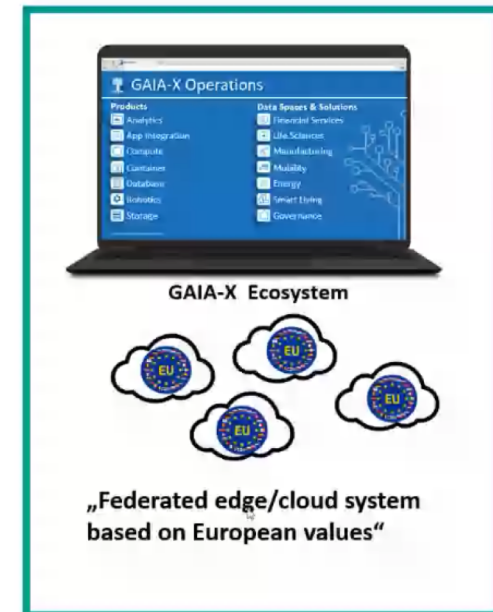
Future business opportunities with Data and AI
What are the needs from perspective of manufacturing industries?

- **AI and Robotics** are key enablers for innovation and a core driver of productivity



Vision: Self-x without detailed programming or engineering
... and without human supervision

GAIA-X: a federated data infrastructure for Europe



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Industrial Perspectives (3)

Perspective of technology supplier, service provider and system integrator

- **5G is a game changer** (while not the case for 4G)
- While delivering to different vertical markets (trains, drones, cars, airplanes, etc.) **vertical end-to-end slicing** is a key!



New research & testing methods:

(i) From build to run

(ii) Ilities



**CRITICALITY
CYBERSECURITY
RESILIENCE**

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Industrial Perspectives (4)

Perspective of the network operator



- Replication in Digital Era: **Twinning Networks**

- The native complexity of networks has made more difficult DT application
 - Metcalfe's law
 - Laser effect(s)
 - The invariants: topology/geometry, conservation, openness

- Deal with heterogeneity

- At all levels: sources, consumers, models, deployment styles, supporting infrastructures

- Beware the network differential facts
 - Topology (and geometry!) awareness
 - The conservation principle
 - Openness
 - Integrity and auditability
 - Isolation

An Essential Tool for Harnessing AI in Networks

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Industrial Perspectives (5)

Recommendation for SLICES

Recommendations and conclusions from the session speakers wrt RIs:

- Allow **repeatability** of experiments
- Ensure **data is collected** for further analysis
- Keep in mind **industry can provide use cases and new business models** for further validation in RIs
 - Blue-Sky Research vs Applied Science
- Research Infrastructures should not only offer technology components, but should be also capable of providing data from on-going and past experiments
 - Consider “**Experimental Data as a Service**”

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Potential catalysts for SLICES – the EC perspective

THE EUROPEAN RESEARCH INFRASTRUCTURE LANDSCAPE

- **Intergovernmental RIs:** Well established RIs supported by the member states.
- **New Pan-European RIs:** RIs listed in the ESFRI Roadmap
- **Networks of National RIs:** Networks of national and regional RIs open to all European researcher from both academia and industry. **These networks of RIs are promoted by the European Commission through projects supported by Horizon 2020 and Horizon Europe.**



What is the SRIA?

A strategic roadmap identifying key challenges and priorities for investment over the next funding period



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Potential catalysts for SLICES – the EC perspective



The 2018 ESFRI Roadmap

18 ESFRI Projects (6 new)

ENE	ENV	HF	PSE	SCI	DIGIT
EU SOLARIS WIND SCANNER MYRRHA		AnaEE ISBE MIRRI			
	ACTRIS DANUBIUS-RI	EMPHASIS	EST KM3NeT 2.0	E-RIH	
IFMIF-DONES	DiSSCo eLTER	EU-IBISBA METROFOOD-RI		EHR	

37 ESFRI Landmarks

ENE	ENV	HF	PSE	SCI	DIGIT
JHR	EMSO ERIC EUROARGO ERIC IAGOS ICOS ERIC LIFEWATCH ERIC	BBMRI ERIC EATRIS ERIC ECRIN ERIC ELIXIR INFRA FRONTIER INSTRUCT ERIC	E-ELT ELI Eur. Spallation Source ERIC EU-XFEL FAIR ILL SKA SPIRAL2	CESSDA ERIC CLARIN ERIC DARIAH ERIC ESS ERIC SHARE ERIC	PRACE
ECCSEL ERIC	EISCAT-3D EPOS ERIC	EMBRC ERIC EU-OPEN Screen ERIC ERINHA EuroBio Imaging	EMFL CTA		
			ESRF-EBS* HL-LHC		

Limited presence of DIGIT RIs.

But there are RI with main ICT components in other domains (ENV, SCI, etc.)

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Potential catalysts for SLICES – the EC perspective

Opportunities for SLICES within EOSC

Last H2020 projects to start - H2020-INFRAEOSC-2020-2

- INFRAEOSC-07: Increasing the service offer of the EOSC Portal (24 mio):
 - **EGI-ACE** (a1: Distributed and cloud computing resources)
 - **DICE** (a2: Data services)
 - **OpenAIRE Nexus** (a3: Services supporting scholarly communication at open access)
 - **C-SCALE & RELIANCE** (a6: Additional research enabling services)
- INFRAEOSC-03: Integration and consolidation of the existing pan-European access mechanism to public research infrastructures and commercial services through the EOSC Portal (40 mio)
 - **EOSC FUTURE**

Horizon Europe – Pillar 1 WP 2021-2022

- **Destination #1:** Developing, consolidating and optimising European Research Infrastructures to maintain global leadership
- **Destination #2:** Enabling an operational, open and FAIR EOSC ecosystem
- **Destination #3:** RI services to support health research, accelerate the green and digital transformation, and advance frontier knowledge
- **Destination #4:** Next generation of scientific instruments, tools and methods and advanced digital solutions
- **Destination #5:** Network connectivity – Enabling collaboration without boundaries

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Potential catalysts for SLICES – the EC perspective



Challenge?

"However, while an instrumented, interconnected and intelligent world has unprecedented potential to solve the key challenges of the time, this potential will only be realised if research infrastructures are evolving to allow scientists to make the best use of the available information"

SLICES Research Infrastructure



A scientific instrument designed to support large-scale, experimental ICT research

A programmable platform

The network infrastructure and services seen as networked software (not just a set of network protocols)

Thank you for joining!

**You may watch recordings from the
workshop on our website soon:**

www.slices-ri.eu