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TRUSTED, AUTONOMOUS AND INTENT-BASED TRANSPORT NETWORKS FOR F5G ADVANCED

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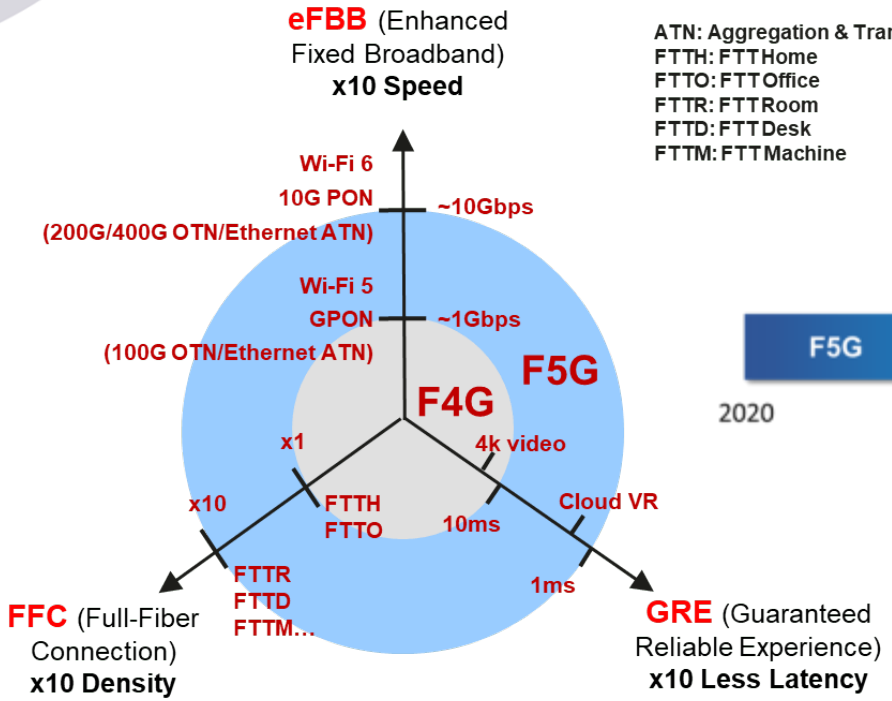
PACKET OPTICAL NETWORKS AND SERVICES

OUTLINE

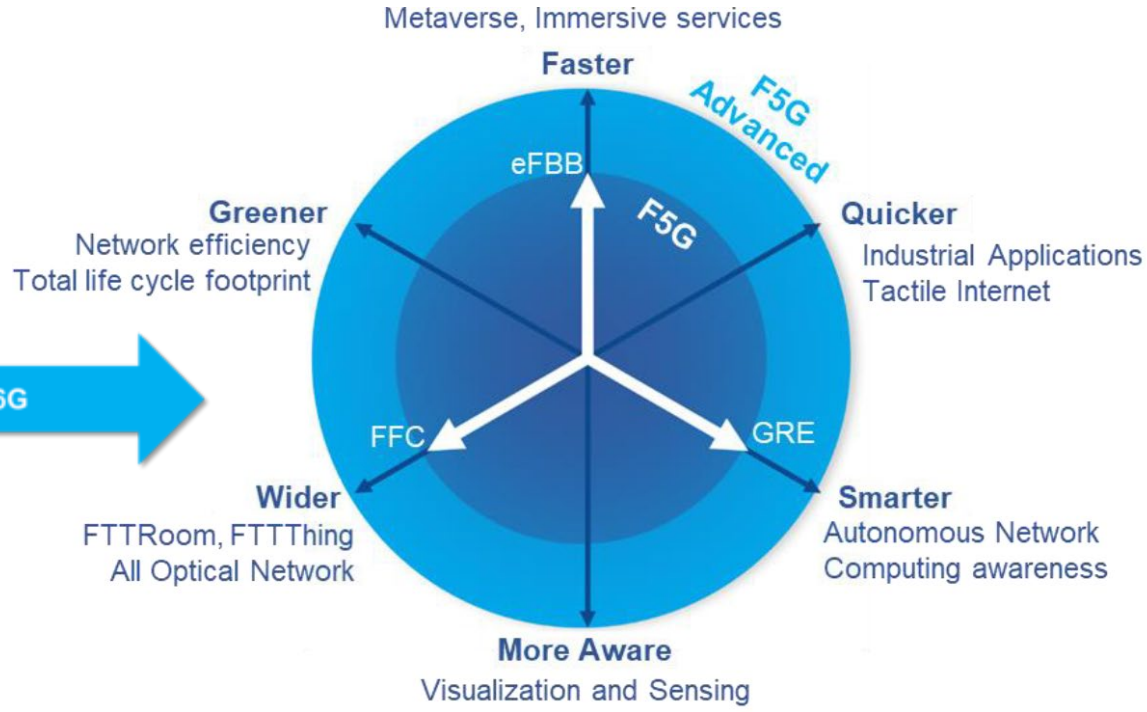
- F5G Advanced
- Trusted transport networks
- Intent-based autonomous transport networks
- Evolution of TeraFLOW SDN controller

THE SIX DIMENSIONS OF F5G ADVANCED

Technical characteristics of F5G



Technical characteristics of F5G Advanced



In addition, trustworthiness of the network is a foundational principle that must not be neglected.

(https://www.etsi.org/deliver/etsi_gr/F5G/001_099/001/01.01.01_60/gr_F5G001v010101p.pdf)

ETSI White paper No#50 Fixed 5th Generation Advanced and Beyond, September 2022, ISBN No. 979108262071

TRUSTED TRANSPORT NETWORKS

TRUST IN MULTI-STAKEHOLDERS SCENARIOS

- Up until now we worked on the resources but what about the owners (providers)?
  → How do we trust them? Especially in multi-stakeholder scenarios?
  → Need to define a way to compare providers easily.

- Trusting something, it means I feel secure about it.
- Using Trust: Subjectivity towards objectivity
  - Trust is based on feelings, reputation no. → **Trusted Risk (TR) = sum of Reputations (Rx)**
  - TR and R are percentage (%) values. → From 0% (not trustworthy) to 100% (trustworthy)

$$TR = w \sum R_x$$

→ $0 \leq TR \leq 1$
→ $0 \leq R_x \leq 1$
→ $w = 1$(weight)

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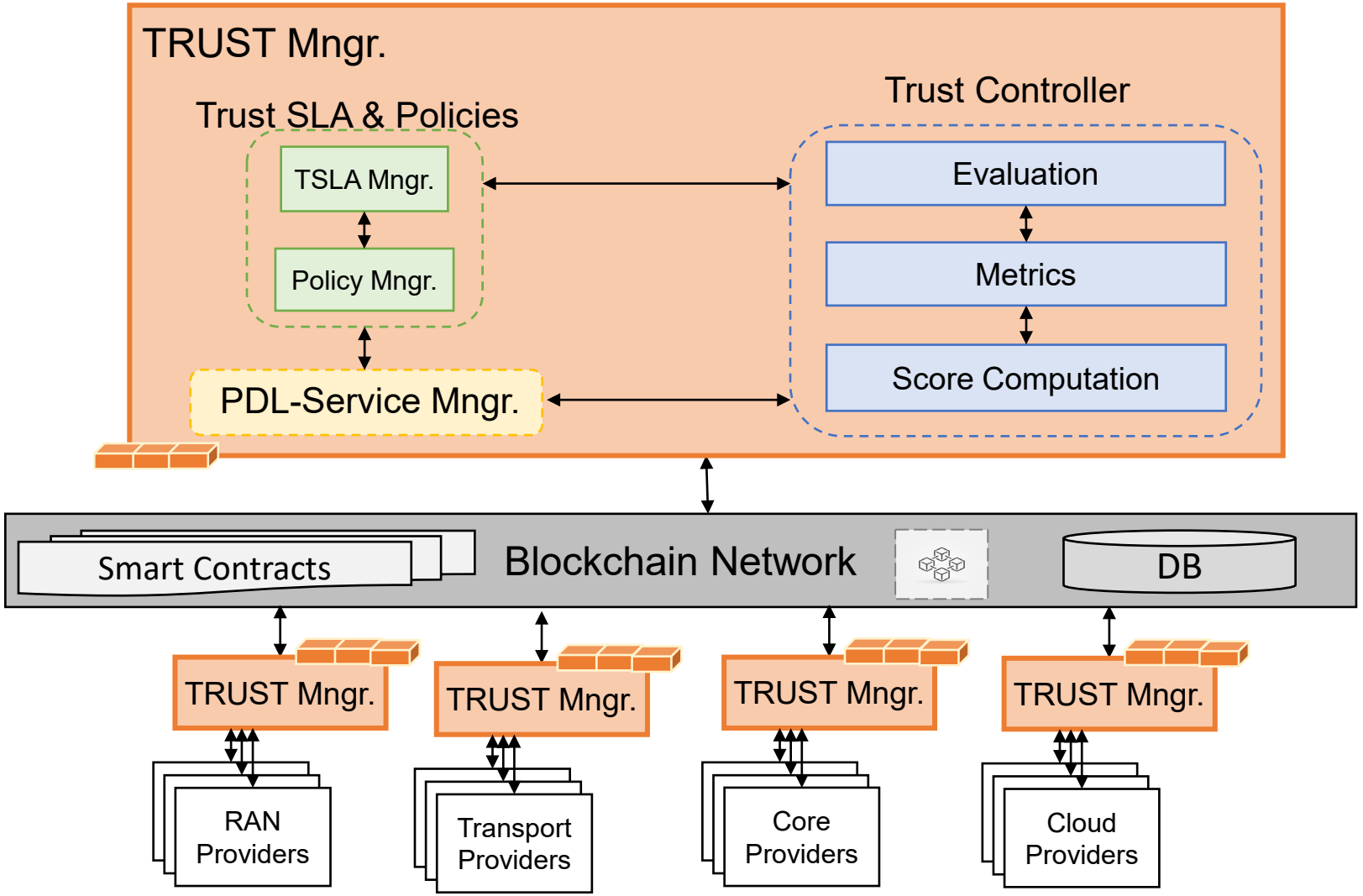
TRUST SERVICE LEVEL AGREEMENT (SLA)

- Trust SLA: a first approach
  - Client defines trust parameters alongside service performance (SLA).
  - Trust requirements: Simple but clear
- Permissioned Blockchain to manage the trust
  - To distribute transparent trust information.
  - Common way to compute & update TR and R.
- Blockchain:
  - A geographically distributed database (DB) with all participants (peers) keeping a copy of all the information and working together to validate and accept any information.
  - Distributed / Secure/ Public/ Traceability/ Immutable.

```
{
  "service-id": <uuid4>,
  "sla": {
    "accepted-requests": 500,
    "throughput": "100 Mbps"
  },
  "tsla": {
    "min-trust-score": 80,
    "min-rep-depl": 75,
    "min-rep-term": 85,
    "min-rep-sla": 80
  }
}
```

TRUST MANAGER

- Trust SLA & Policies
  - TSLAs & policies life-cycle (e.g., deployment, configuration, termination)
- Trust Controller
  - Evaluation + Metrics + Score Computation
- PDL-Service manager
  - Local services control & Blockchain gateway.



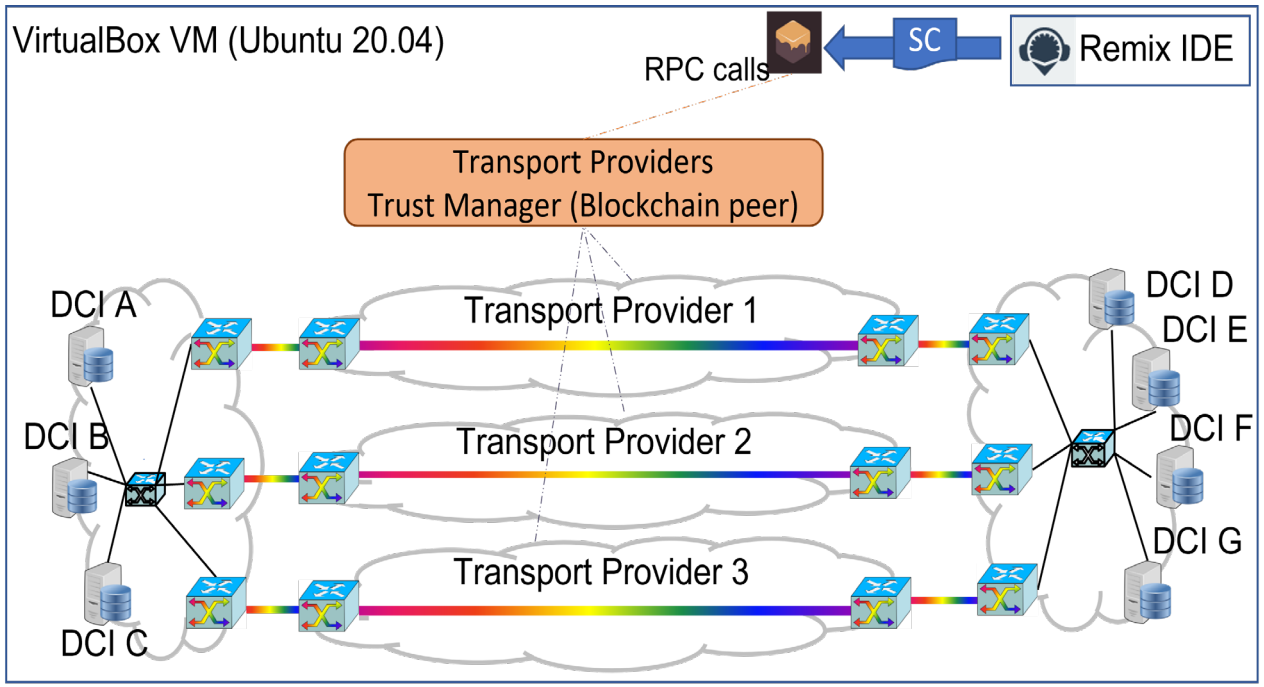
EXPERIMENTAL VALIDATION: TRANSPORT SERVICE FOR DATACENTER INTERCONNECTION USE CASE

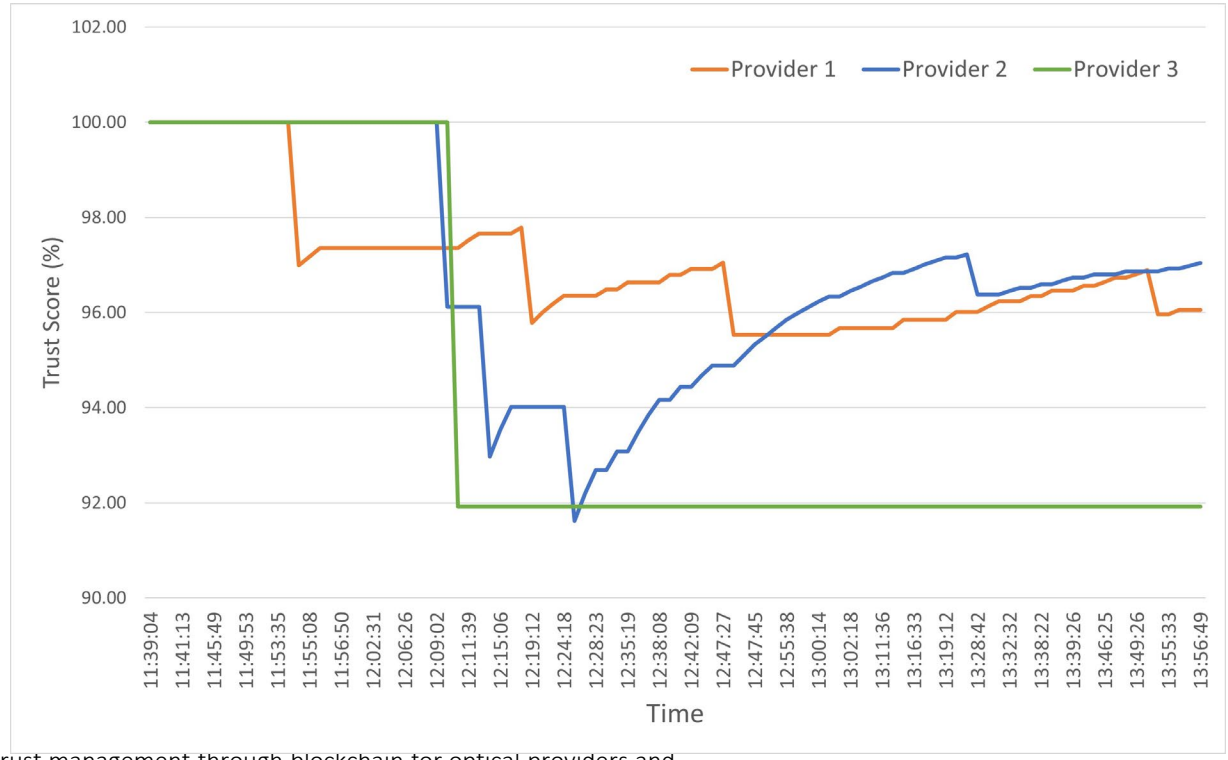
$$Trust\ (T) = \left(\alpha R_{prov\_rate} + \beta R_{term\_rate} + \gamma R_{sla\_correction}\right) \cdot 100 =$$

$$0 \geq T \geq 1\ and\ 0 \geq R \geq 1$$

$$\alpha + \beta + \gamma = 1$$

$$0 \geq \alpha \geq 1\ and\ 0 \geq \beta \geq 1\ and\ 0 \geq \gamma \geq 1$$





P. Alemany, R. Muñoz, J. Martrat, A. Pastor, R. Díaz, D. Lopez, R. Martínez, R. Casellas, and R. Vilalta, "Trust management through blockchain for optical providers and services," submitted in the JOCN, January 2023.

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INTENT-BASED AUTONOMOUS TRANSPORT NETWORKS

BENEFITS OF AUTOMATION

- Increase dynamicity:
  - Traffic prediction for self-configuration and self-optimization networks
  - E.g., New connections, Increase/decrease capacity, avoid congested areas, …
- Increased Reliability:
  - Failure prediction (health monitoring) for self-healing and self-protecting networks
  - E.g., Preventive maintenance, root cause analysis, suggested recovery,…

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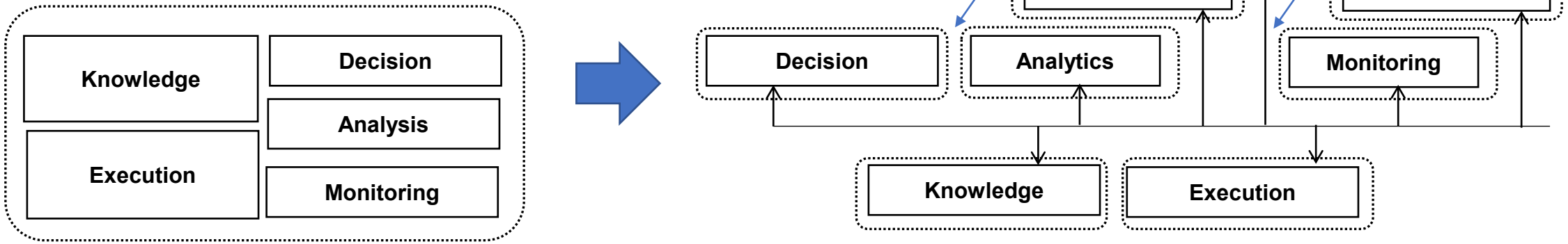
CLOUD-NATIVE CONTROL AND MANAGEMENT (C&M) ARCHITECTURES

- Build and run scalable apps leveraging container-based deployment and microservices providing the basis for zero-touch operations support:
  - Auto Scaling
  - Load Balancing
  - Self-healing
  - Automated Rollbacks/Rollouts



Monolithic Architecutre

Cloud-native Architecture

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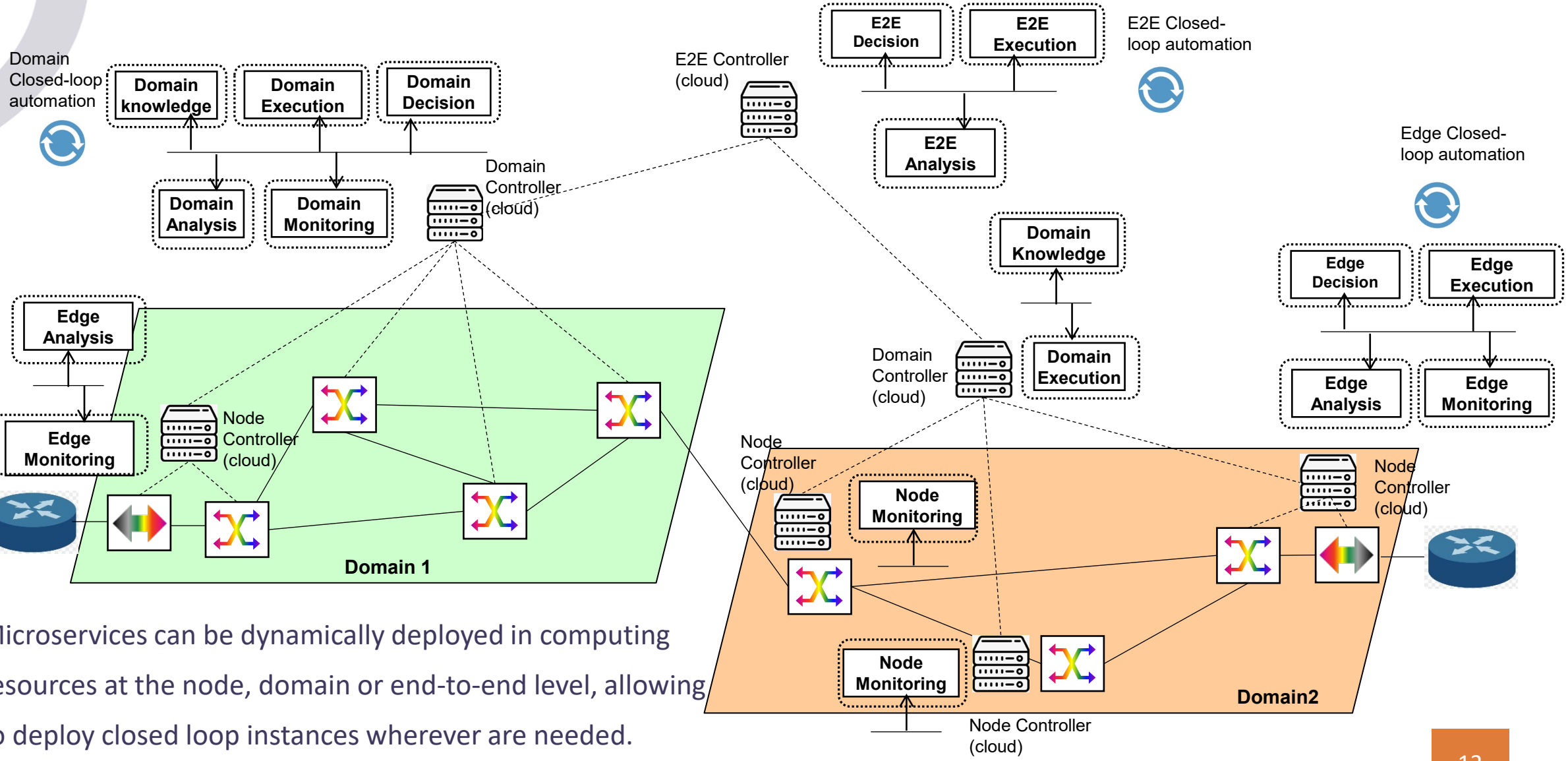
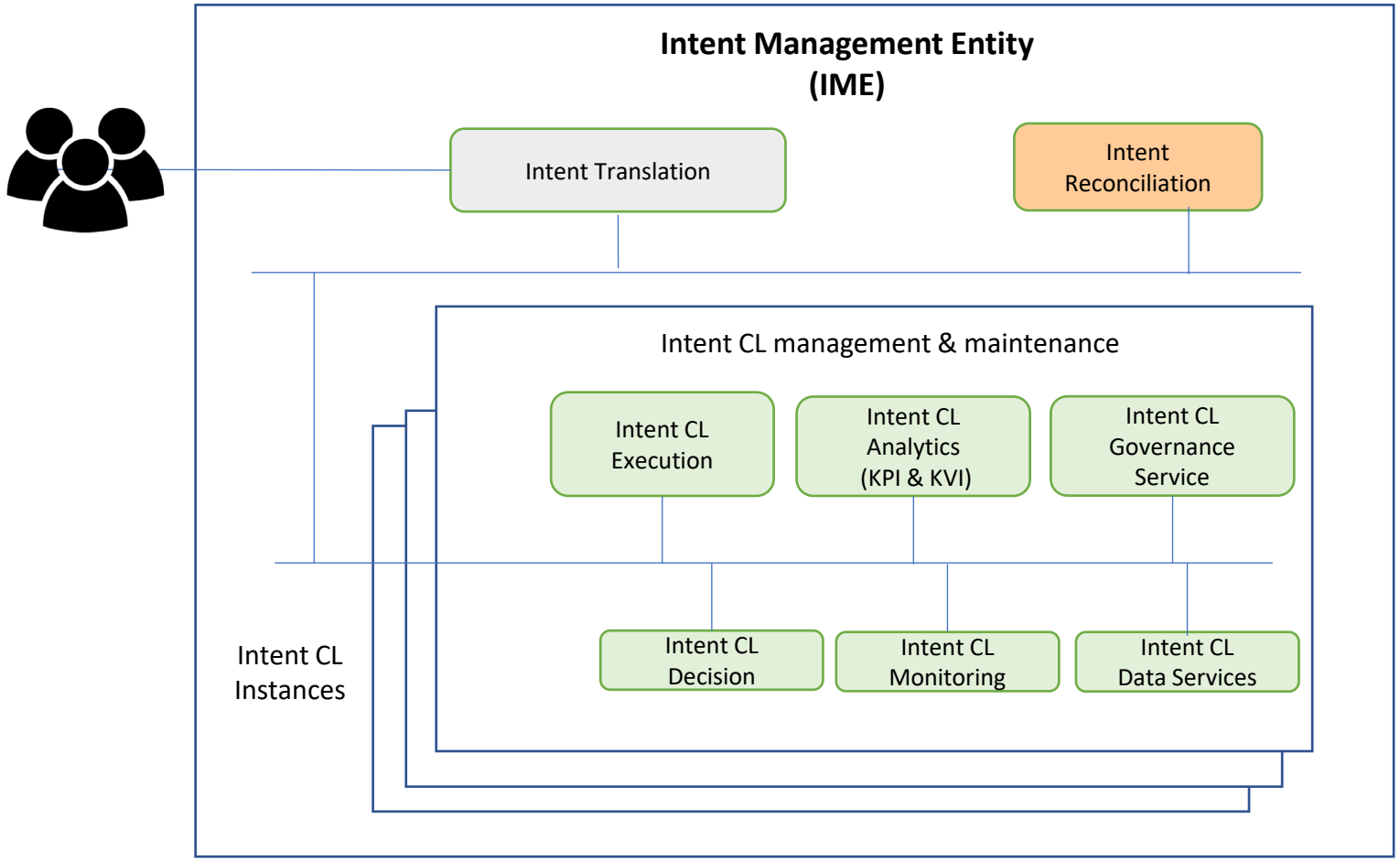
MULTI-DOMAIN CLOUD-NATIVE C&M ARCHITECTURES



- Microservices can be dynamically deployed in computing resources at the node, domain or end-to-end level, allowing to deploy closed loop instances wherever are needed.

INTENT MANAGEMENT ENTITY (IME)

- An intent is an abstracted description with a goal and a set of high-level requirements without defining the resources/techniques required to have the desired service properly working

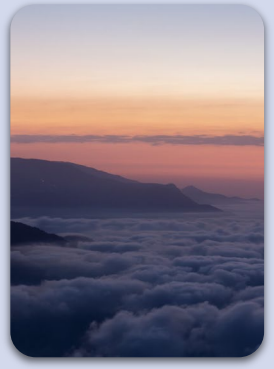


- Intent Translation:
  - translate the received intent to low-level services to meet the requirements and enforce intent closed loop instance deployment.
- Intent Reconciliation:
  - monitoring of the deployed intents, analysis of the data to detect intent conflicts, and decision to reconfigure an intent.

EVOLUTION OF TERAFLOW SDN CONTROLLER

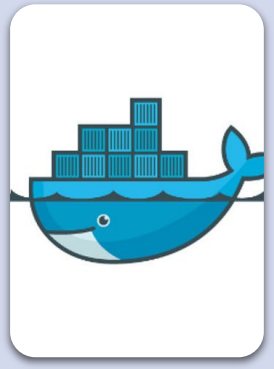
Do we need YET another Transport SDN controller?

TeraFlow SDN



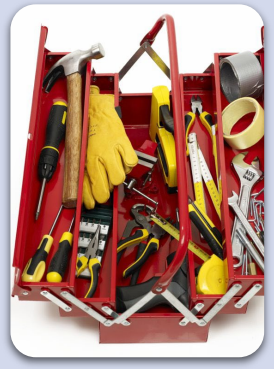
Cloud-native SDN controller for supporting future networks beyond 5G.

Hosted by ETSI and based on results of the European Union-funded TeraFlow 5G PPP research project.



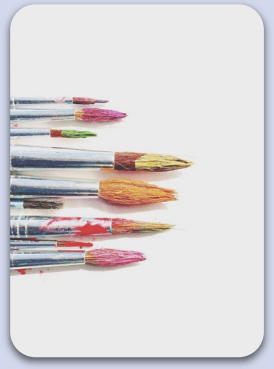
Micro-services architecture provides key benefits:

Scalability, Self-healing, Integrity



'Toolbox' for ETSI groups working on network transformation.

Supports use cases such as autonomous networks, inter-domain, and cybersecurity.



Enables the alignment of multi-SDO goals and helping to accelerate standardization cycles.

ETSI TeraFlowSDN to serve as reference implementation for Telecom Infra Project

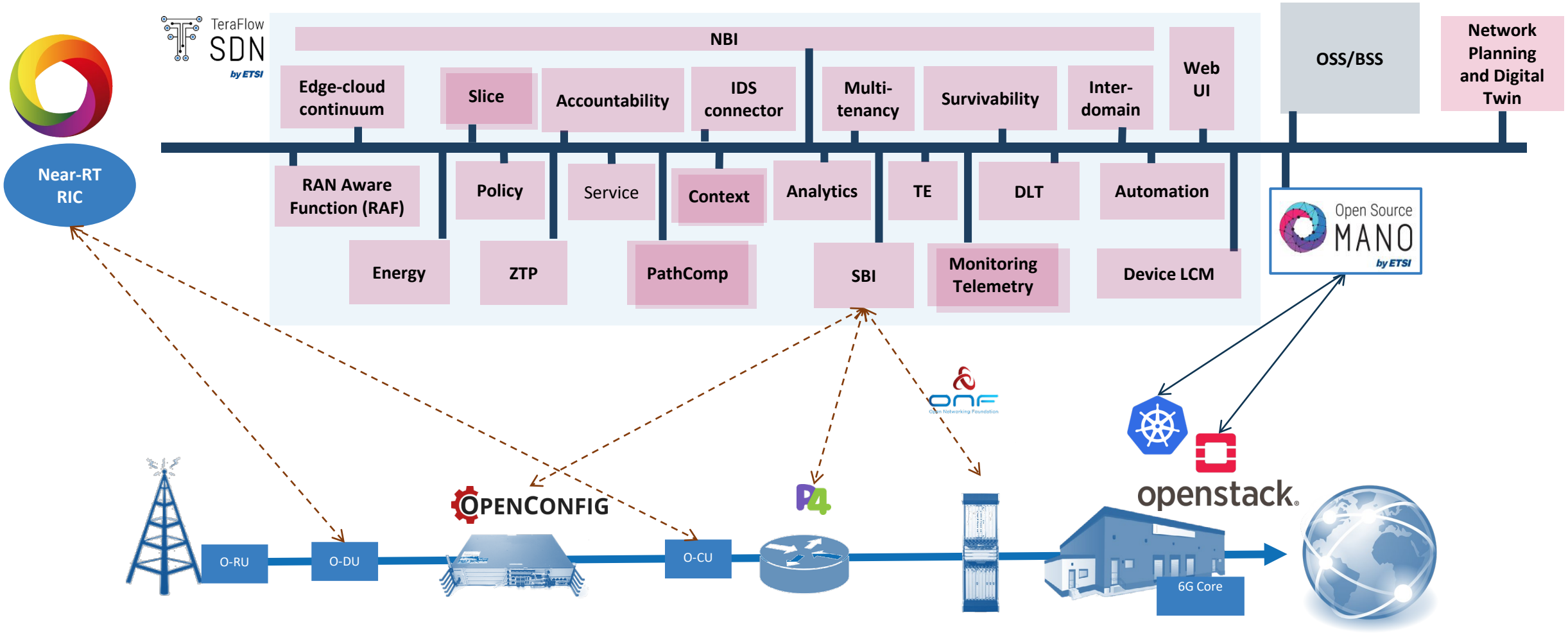
The source code of TeraFlowSDN is publicly available under the Apache Software Licence.

Need for TeraFlowSDN evolution

TeraFlow SDN

Edge – cloud continuum using Intent Based Networking	• Intelligent connectivity across a huge number of heterogeneous domains, resources with unlimited number of application requirements and conflict resolution mechanisms for incompatible requirements. • IT tools and practices extending to network (NetOps)
Accountable and Sustainable Networks	• Need to measure impact and deploy networks and services that minimize carbon footprint.
Open & Programmable API	• Need for operational simplicity. • Need for accelerated innovation.
Zero Trust Networks	• System integrity and self-preservation • Digital Twin Networks for Protected modes
Avoid industry fragmentation	• Competing standards addressing same areas and use cases.

TeraFlowSDN architecture evolution



Thank you! Questions?

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