Networking and IoT: future common challenges and assets

Next-generation IoT
Smart Networks and Services Partnership, Stakeholder Workshop

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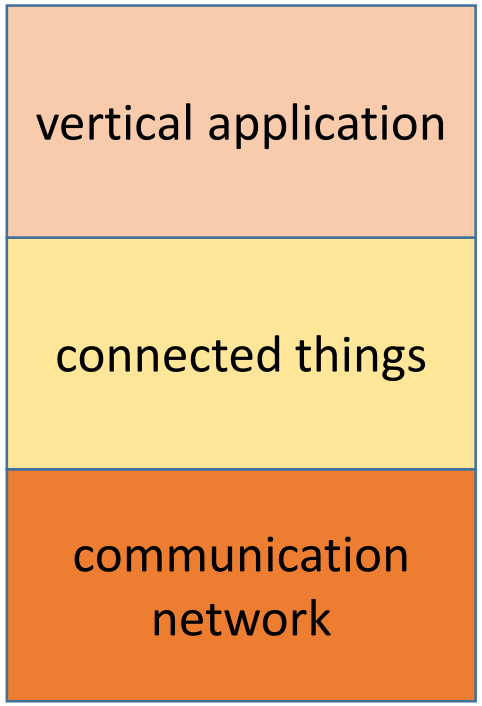
Intro questions

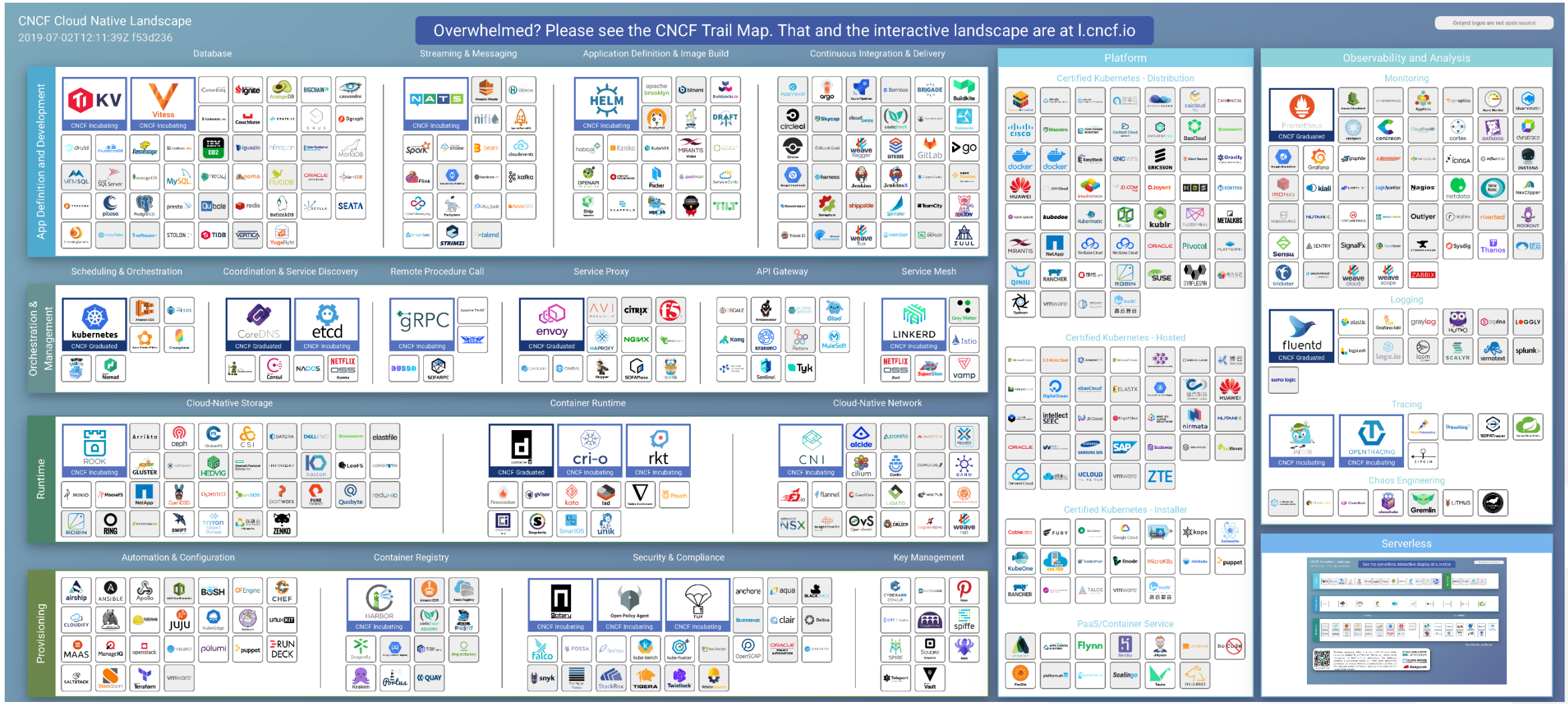


- Where is the boundary (H/V) between a communication network and the connected devices?
- Where is the boundary between the “things”, their platforms, and the applications on top?
- Btw, can we really talk about data plane KPIs?

A forward look at networking and IoT symbiosis

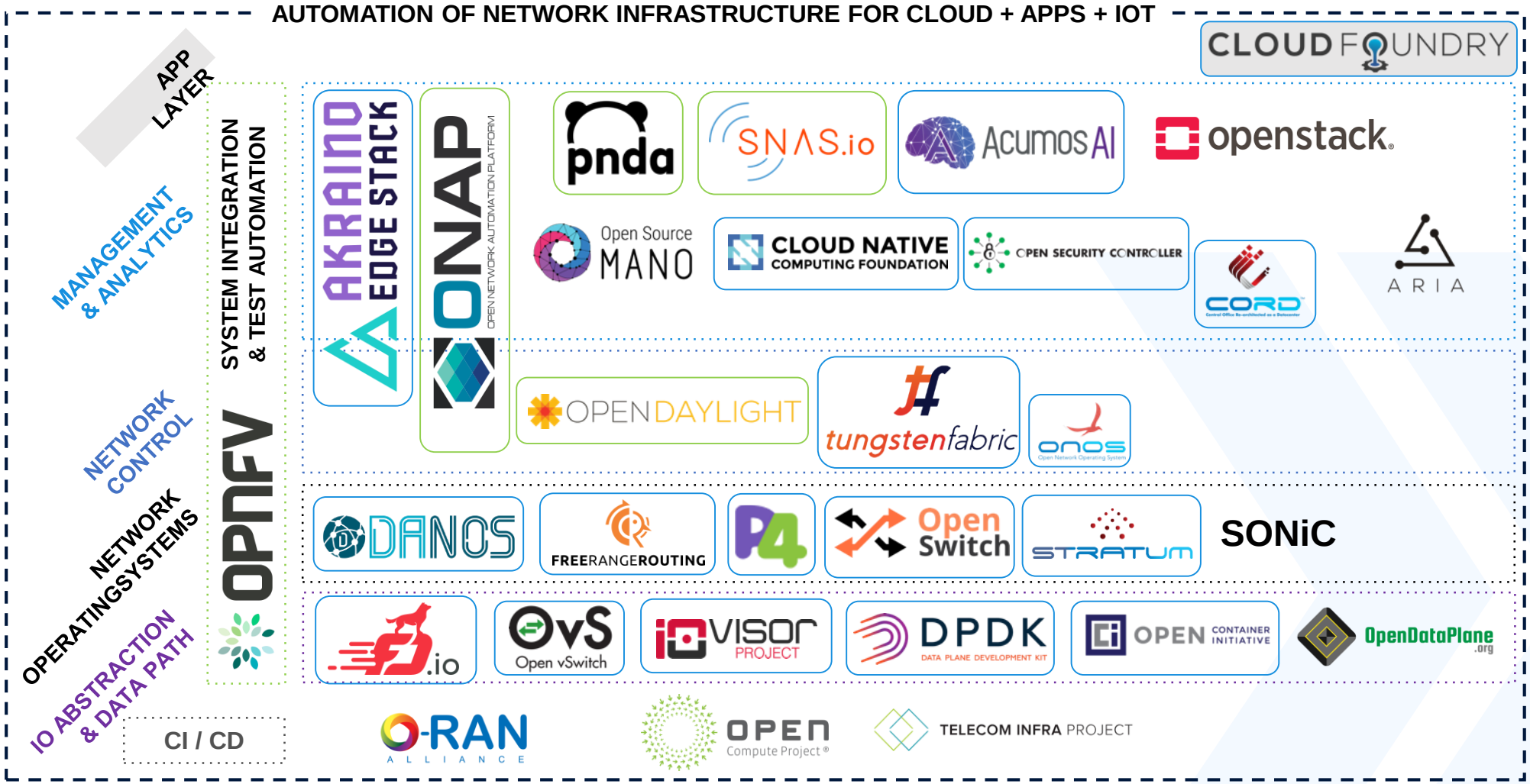
- Communication networks and IoT to be **more deeply integrated** than today
  - Truly massive and hyper dense deployment of sensors/actuators (75B by 2025)
  - Truly seamless symbiosis of interworking platforms, models, functions (anywhere/any-device computing, programmable and function-based approach to data correlation, alerting, event processing, etc.)
  - Beyond the concept of "Network is the Internet"
    - Future networks will bring more than IP and HTML: quantum networks/security, centralized and swarm AI functions, nano-nets & protocols, etc.
    - Need for more efficient use of service-based architecture approaches to split and interface to the various cross-layer functions: p2p interfaces vs pub/sub across a shared infrastructure message fabric / service bus
- **Simplify the babel of protocols**, platforms and ad-hoc solutions both in IoT and in networking
  - Various emerging standards in M2M (e.g. OMA DM, LWM2M, MQTT, Google Thread, AllJoin/AllSeen, etc.), no final single voice expected
  - Interoperability among IoT platforms remains a crafted solution for specific cases, or opens up to OTT (e.g. Google Home, Amazon's Alexa, Microsoft's Cortana)

A very complex landscape of cloud native technologies and solutions



Source https://landscape.cncf.io/

Open Source Networking / SDO Landscape



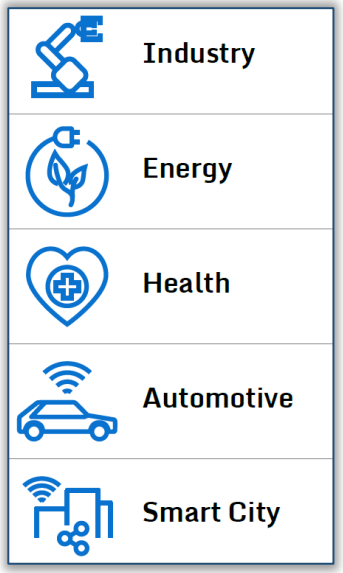
STANDARDS

MEF, ITU, tmforum, IETF, NIST, ONF Open Networking Foundation, ETSI World Class Standards, OIF Optical Internetworking Forum, IEEE 802, 3GPP, CableLabs

Source **THE LINUX FOUNDATION NETWORKING**
https://www.linuxfoundation.org/projects/networking/

A forward look at networking and IoT symbiosis

- **Common R&D ground** of technology domains



- **Common verticals** with use cases that imply the strong interleaving of networking and IoT

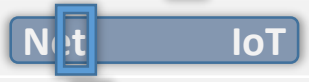
Common verticals and use cases [1]

Vertical	Example Use Cases	Technical challenges
Smart Manufacturing	• Safe unfenced human-robot interaction in assembly lines	• Heavy-duty industrial robots with high load capacities in an HRI-capable assembly process • Industry-grade motion capturing systems • Certifiable sensor systems in combination with real-time supervision (e.g. for accurate and reliable localization) • Optimize response time of the whole safety system (⇒ edge computing)
Smart farming and food security	• Cooperative autonomous agriculture robots • Massive monitoring of individual plants and animals • Digital farm twin	• Cooperation between robots and with humans • Autonomous decisions (⇒ embedded AI at the edge) • Autonomous operation during years (⇒ ultra-low-power IoT) • Massive M2M (low-rate) communication
Smart Mobility	• Autonomous and hyper-connected On-demand Urban Public Transportation	• High volume of changes required by the mobility on-demand services ⇒ Integration of Data Analytics and AI mechanisms in OSS/BSS, and for the management of large sensor sets • Advanced wireless connectivity and radio technologies such as positioning and tracking, multi-RAT mobility and connectivity • Cloud and edge high-performance computing • Massive scale of autonomous IoT networks

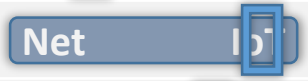
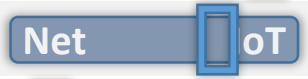
Common verticals and use cases [2]

Vertical	Example Use Cases	Technical challenges
Smart Water management	• Real-time water quality assessment and consumption optimization • Advance in personalized water services • Efficient operational management of the water infrastructure	• Huge amount of sensors in remote / hard-to-reach areas (rivers, lakes, pipes, irrigation systems, sewage, etc.) ⇒ complex MTC • Autonomous operation during years ⇒ ultra-low-power IoT • Huge amounts of information collected ⇒ edge computing to reduce the data transmitted • AI at platform level; e.g. to detect/predict water leaks, potential contamination, misuses, etc. • Potentially very large monitored area (e.g. rivers or lakes) ⇒ autonomous mobile platforms to capture information (UAVs or USVs)
Smart Energy management	• Management and maintenance of IoT tools with difficult accessibility	
Smart Buildings	• Connected building • Software Defined Building • Cognitive building • Human-centered building	• Building facility functions interconnected and truly interoperable at the syntactic and semantic level ⇒ objects are understood and exchanged among subsystems through standard protocols and APIs • Building facility completely monitored and controlled by IoT devices and Cyber-Physical Systems ⇒ its operations can be programmed by explicit software rules

R&D challenges for network & IoT [1]

Challenge area	Example challenges	Net-IoT balance
Network and communication systems	Integration of IoT and Network services	
	AI/ML-enabled Network and Services for IoT	
	Configuration, Orchestration and Open Device Management	
[Edge] Cloud and Fog	Convergence of protocols and SDN/NFV	
	Evolution of Fog and Edge Computing and Processing	
	Support for Swarm Computing	
Privacy, network & service security	Network & IoT security in highly virtualized networks	
	Network & IoT security+reliability for mission critical infra/serv	
	AI/ML support in support of network & IoT security	
	IoT and Distributed Ledger Technologies (DLTs)	

R&D challenges for network & IoT [2]

Challenge area	Example challenges	Net-IoT balance
Platform, Federation, Automation and Delivery	Extreme automation + real-time zero-touch service orchestration	
	Service injection loop	
	IoT distributed & federated archs, integrated with the net & AI	
	Support for network-unaware vertical services	
IoT Applications, User experience	Digital Twins for IoT	
	Tactile and Industrial-Tactile IoT	
Further technologies	Quantum Networking of Things	
	Nano-Things Networking (IoNT)	
	Bio-Nano-Things Networking (IoBNT)	
	Core human (e.g. mind-to-mind) communication	

So what should we aim for?

- No need for a one-fits-all solution
  - Dedicated platforms are ok; heterogeneity is ok
- But walking together (network & IoT) through the various domains (data plane, management, etc.) could help a lot
  - Avoid duplication of R&D efforts
  - A portfolio of common approaches
  - No need to craft solutions at each new purpose or platform

Questions?

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