



Hyper Softwarization and High-Precision Infrastructure

Design Challenges

DEP @ NetSoft 2018



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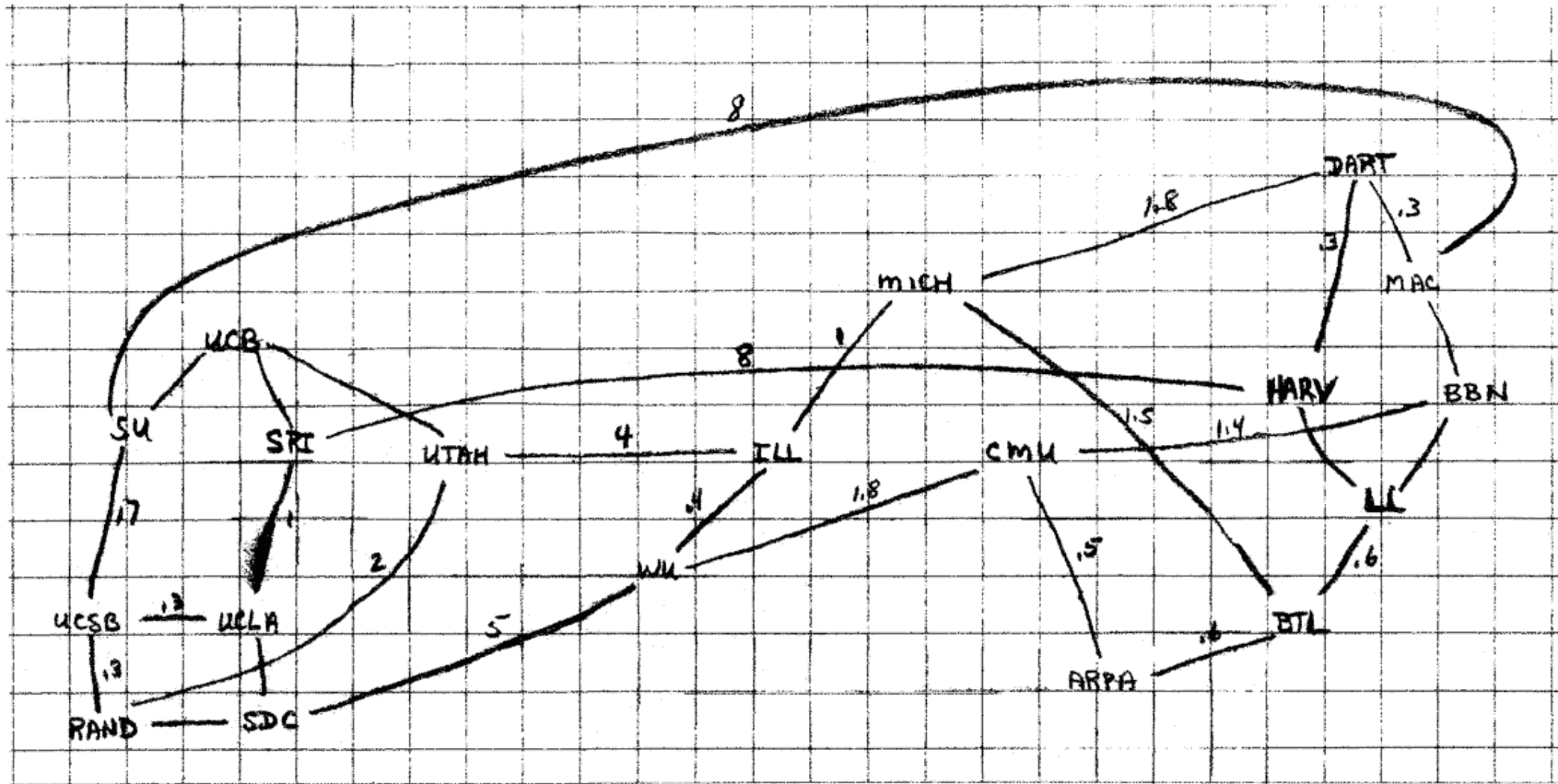
Change of abstractions

High-Precision Eco-systems of Applications

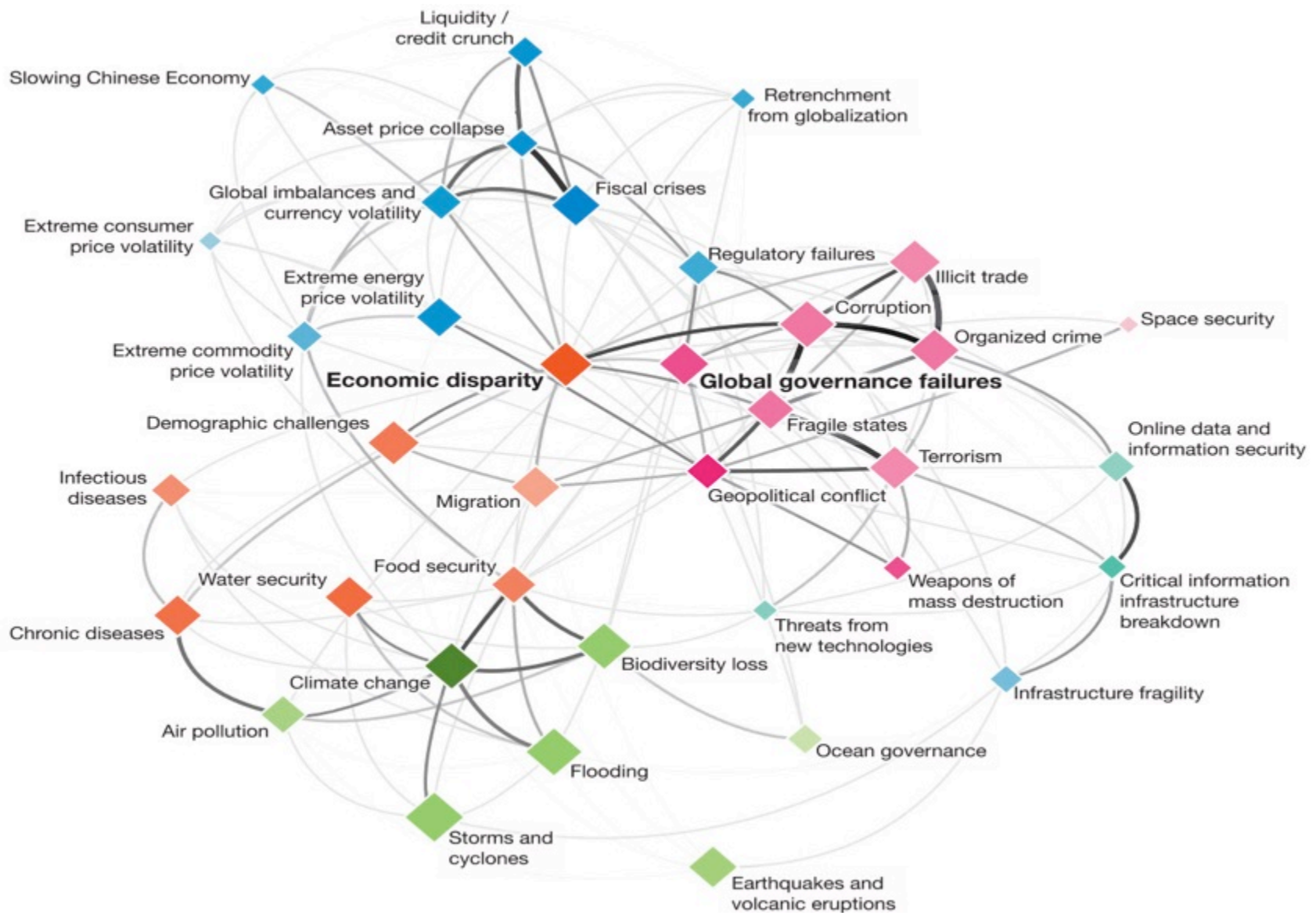
Increase Intelligence and Automation

ARPAnet Plan – late 1960s

Rough sketch by Larry Roberts

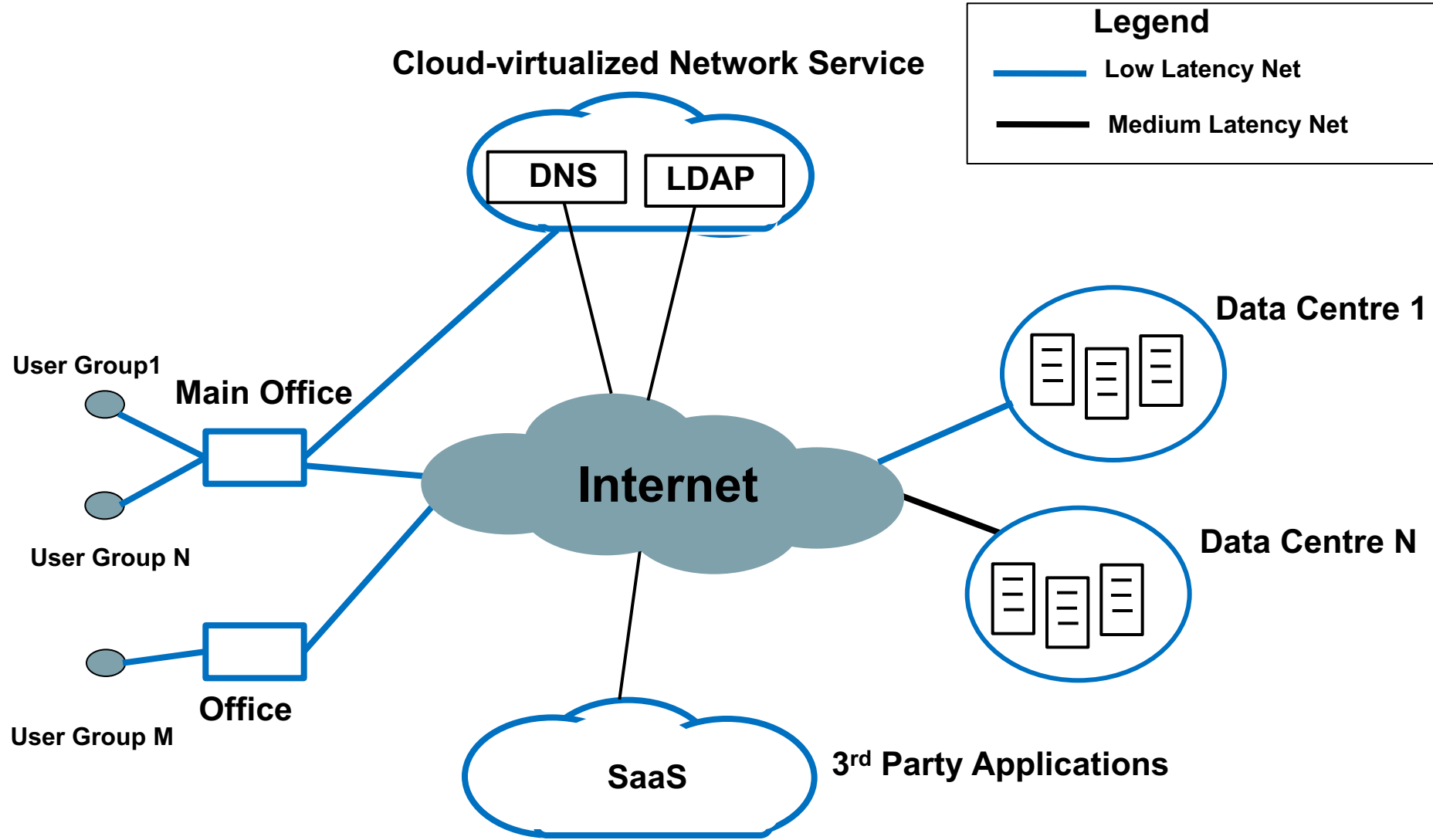


A highly joint with interdependencies World and moving towards hyper softwarization



Systemic interdependencies of the socio-economic variables of the highly connected world (i.e.: reference: World Economic Forum)

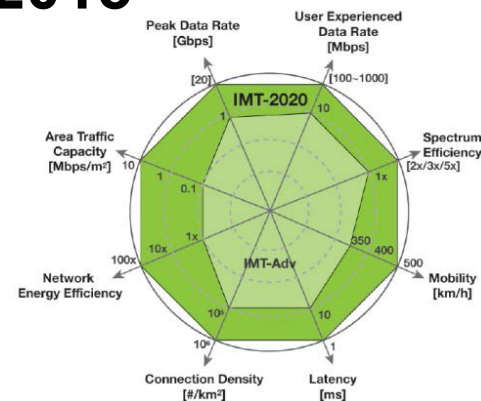
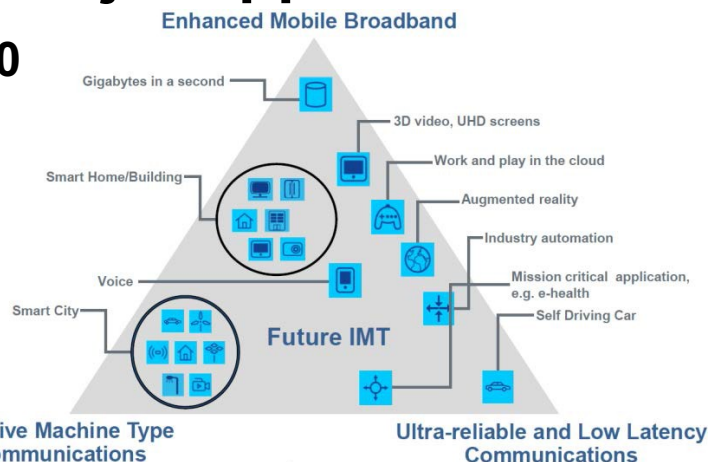
Application-Centric Infrastructure



Application Areas in terms of KPIs (IMT2020 and Beyond)

Three major application scenarios - 2015

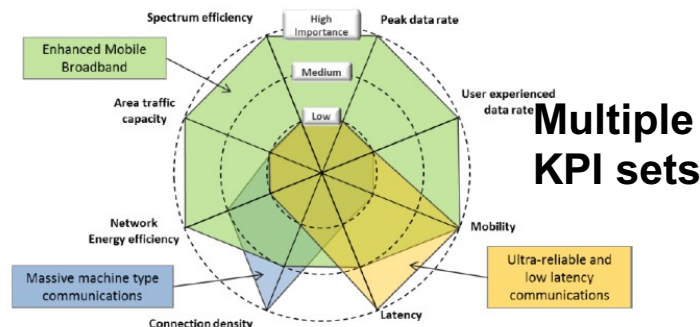
IMT-2020



Traffic density	Connection density	Latency	Mobility	Energy efficiency
10Tbps/Km2	1M/Km2	1ms AI	500Km/h	100 times

User experienced rate data rate	Spectrum efficiency	Peak data
0.1~1Gbps	3, 5 in some cases	10~20Gbps

KPIs



New requirements pushed by the Industry 4.0 - 2018

(Siemens, Bosch, ABB,...)

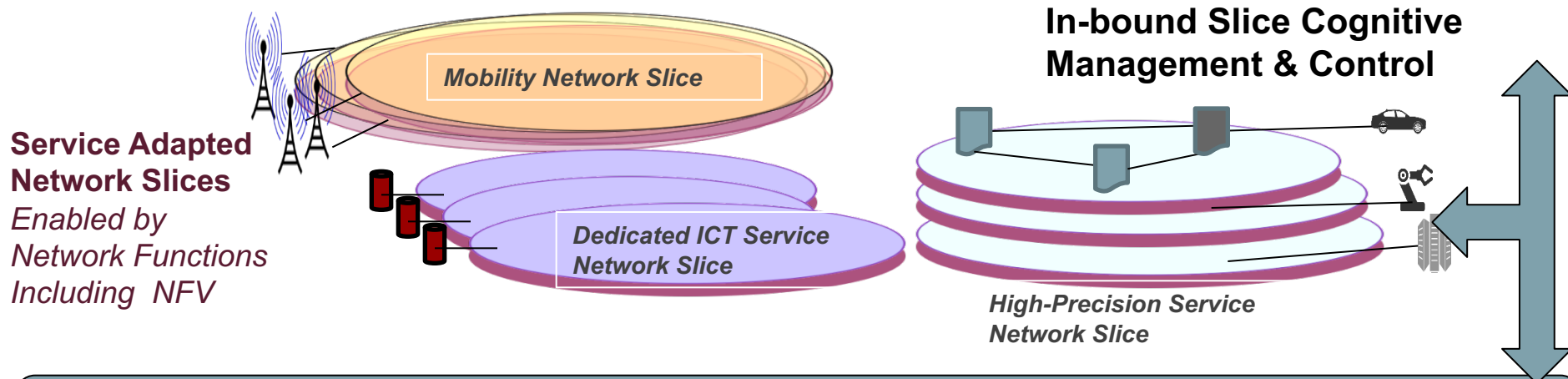
Availability: 99.999999%, Jitter < 1us, Latency < 0.5 ms

High Precision Services with Guaranteed Bandwidth & Latency

Changing the abstractions

- Transition from network devices to (virtual) light-weight network functions with inbound management
- Dynamically adapting the network services with guaranteed bandwidth & latency & QoS demands
- Creating the dynamic, configurable, programmable, resilient, safe network
- Programmable network operating facilities with simple interface to the smart network fabric
- Increased Intelligence Enabled Application & Network infrastructure

E2N Multi-Domain Orchestration
E2E coordination, conflict resolution, multi-domain information exchange

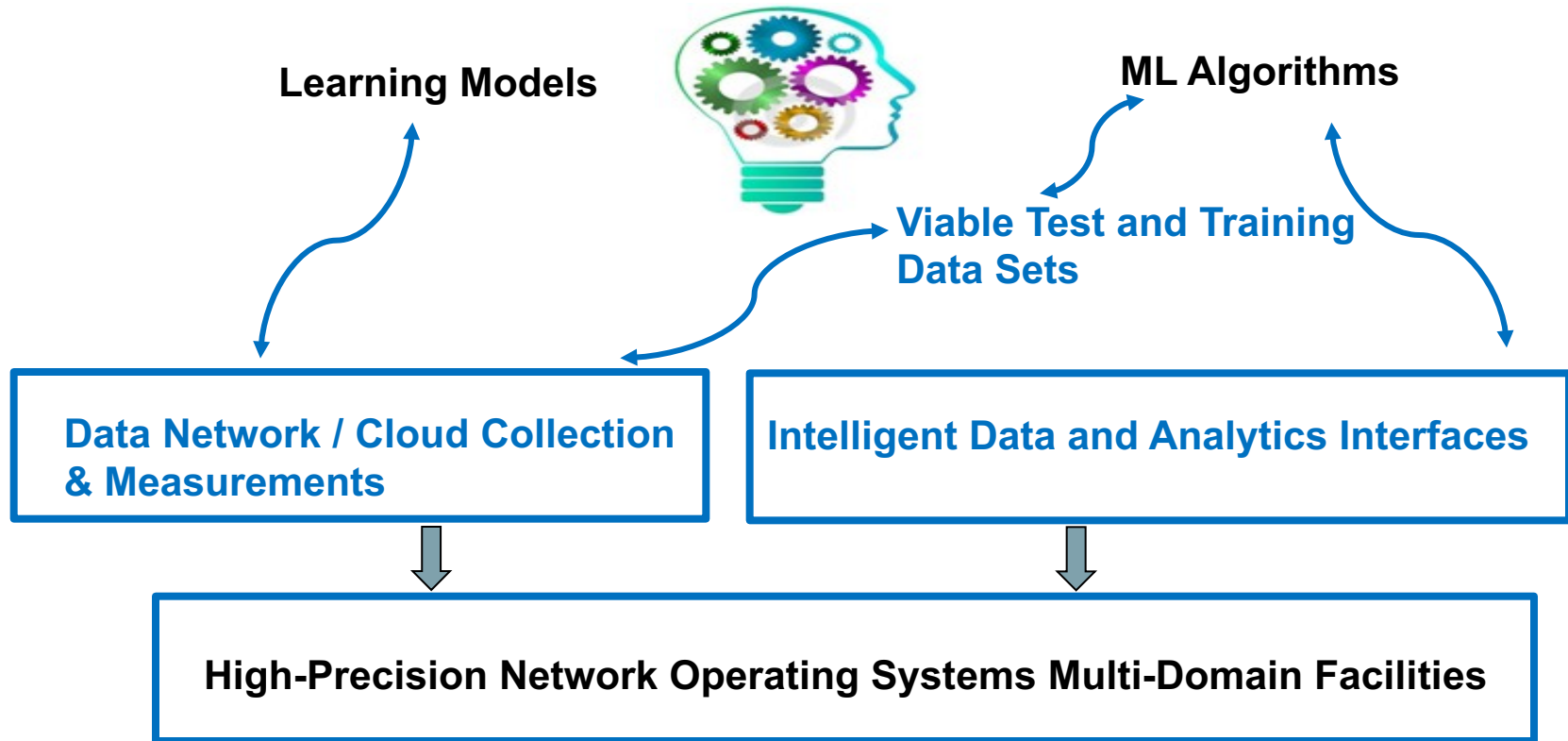


Light Weight Smart Network Fabric – E2E Operating System Facilities
Network Abstraction, Allocate (virtual) network resources/ slices, Maintain network state, Ensure network Reliability in a multi domain environment

Smart Cloud & Network Fabric
Enabled by Programmability Including SDN



Increased Intelligence Enabled Infrastructures



- The success of deep learning **has not been demonstrated in networking.**
- The essence and major motivation of deep learning lie right in unsupervised learning **aimed at automatic discovery of data representation.**
- What are the **appropriate objectives for learning effective representations?**
- How may the deep learning architectures and algorithms use distributed representations to **effectively disentangle the hidden factors of variation in the data?**
- All these important questions will need intensive research in order to further push the frontier of deep learning

Change of abstractions

- *High-Precision Network Services with Guaranteed Bandwidth & Latency / Restricted IP Network Programmability*
- *High-precision Non-IP Networks (e.g. ICN, NGP .. realised as slices)*
- *Multi-Domain Operating Coordination Facilities*
- *High Scalability in Network and Cloud Slicing*

High-Precision Eco-systems of Applications

- *High-precision network scenarios specification & design for robust and/or critical connectivity services, extreme QoS, autonomous driving, smart grids, unmanned vehicle management, tele-healthcare, automatic factory/industrial internet, entertainment, hologram, instantaneous teleporting, real-time gaming, tactile internet..*
- *Operation & Management Platforms redesign → Light-weight NFV (i.e. VIM, NFaaS, SaaS, ..), high-precision measurement and monitoring, Light-weight service function chaining*
- *High-Precision Networked Application-centric DevOps tools + application deployment emulators for testing KPIs*
- *Deep programmability light weight frameworks & tools*

Increase Intelligence and Automation

- *Development of Intelligence enabled Multi-domain Infrastructures*

Acknowledgement

- **5GEX – H2020 project “Multi-domain Network Service Orchestration” - <http://www.h2020-necos.eu>**
- **NECOS – H2020 project “Novel Enablers for Cloud Slicing” - <http://www.h2020-necos.eu>**
- **SONATA – H2020 project “Agile Service Development and Orchestration in 5G Virtualized Networks”- <http://sonata-nfv.eu>**