Management Frameworks for Future Mobile Communication Networks: Main Challenges

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Key requirements for network infrastructure towards 2020

Support up to 1000 times more traffic

Manage up to 10 times more users

Enable Gbps peak speeds

Reduce latency to milliseconds

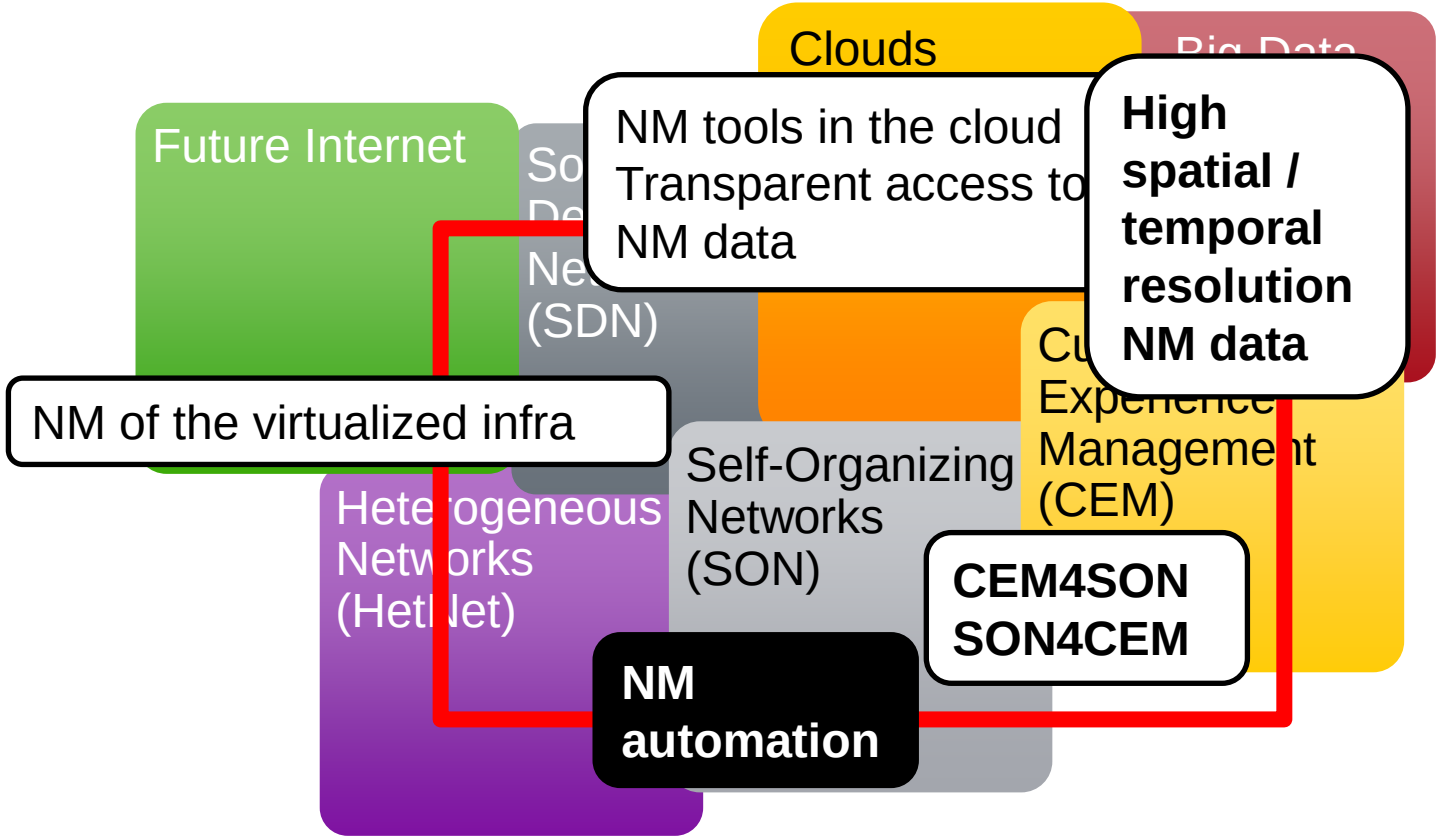
Improve energy efficiency

Make networks self-aware, self-adaptable, and intelligent

Deliver safe superior customer experience

We cannot predict all the use cases
so flexibility is a key requirement

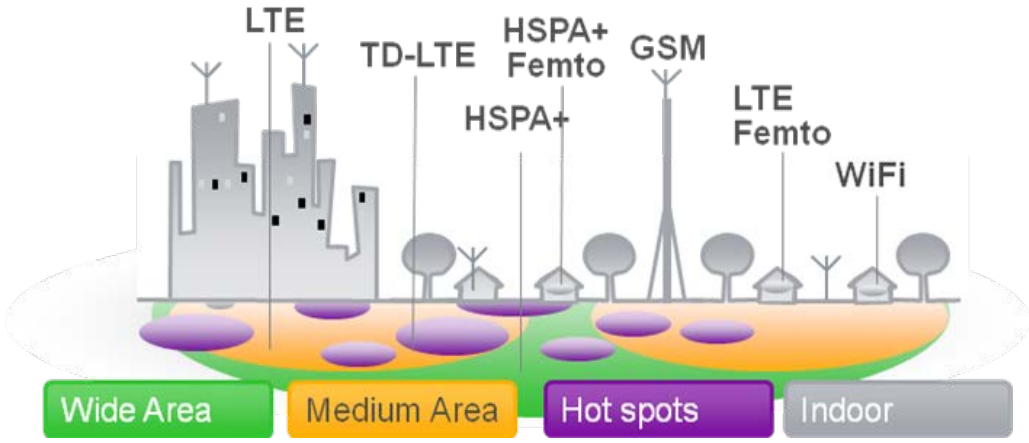
Technology areas: Network Management (NM) perspective

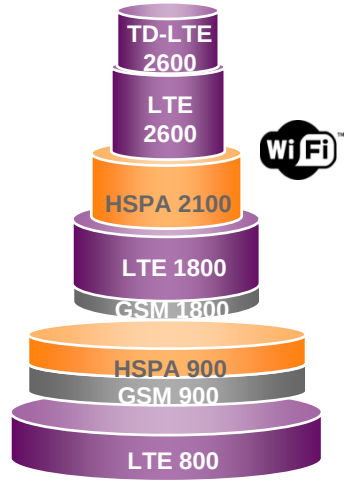


"Nobody knows what SDN is, nor does anyone know what the Cloud really is, so those topics have a strong affinity to each other": JS, September 2012.

Heterogeneous Networks („HetNet“) providing “unlimited” capacity and “ubiquitous” coverage

Multiple Radio Access Technologies („Multi-RAT“)



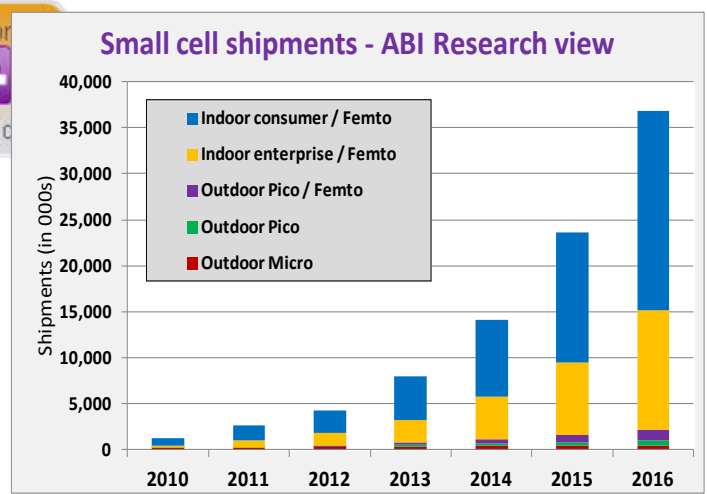


Spectrum & System options 2015

Multiple cell layers per RAT („Multi-layer“)

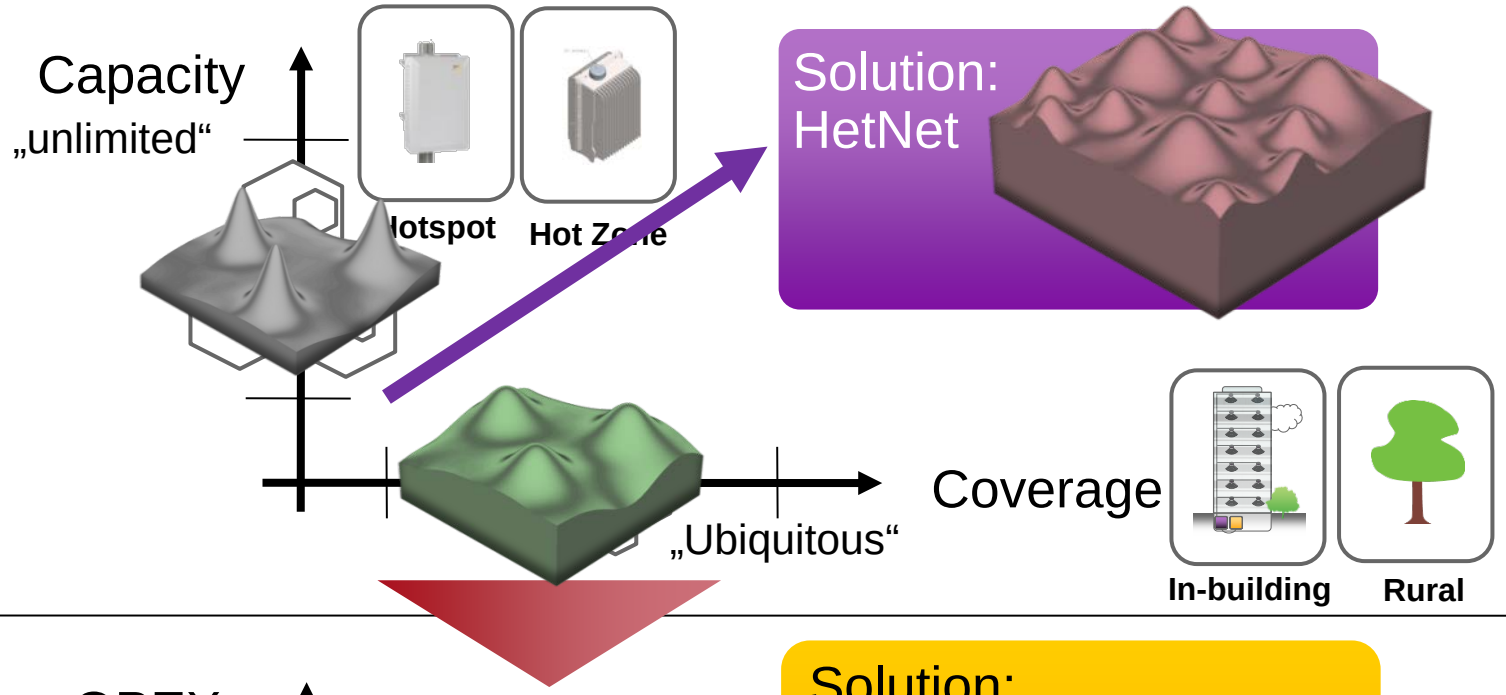
Scale (# of NE) → cost pressure (NE, backhaul, OAM)

Degree of feasible
- Planning
- Human interaction in deployment and operation

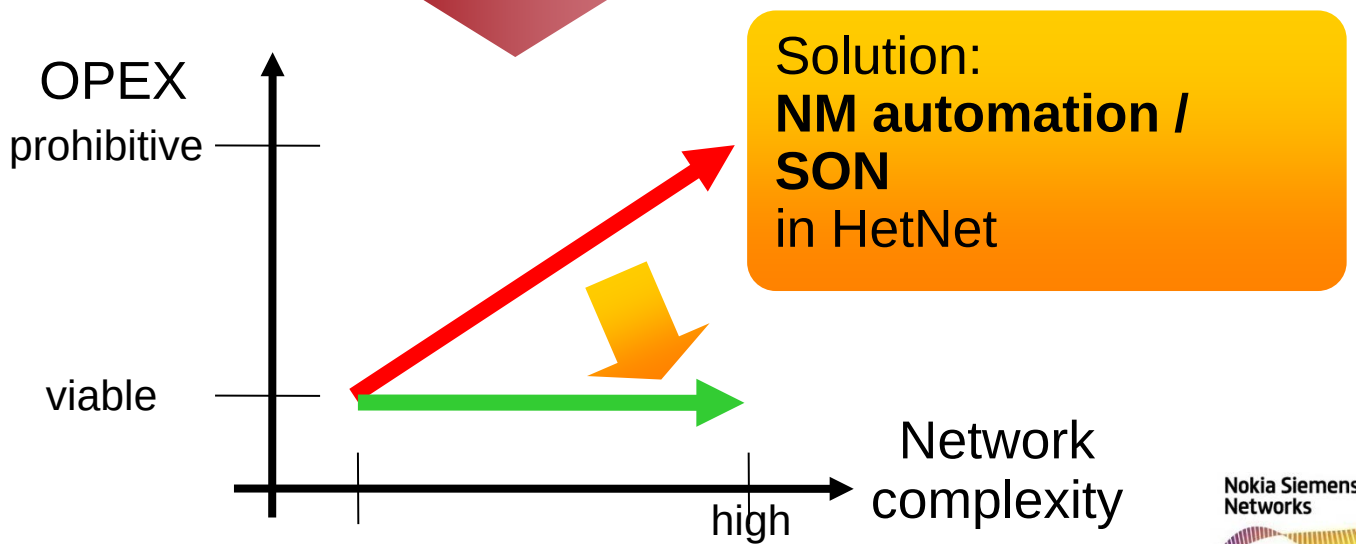


Densification and higher distribution brings complexity

Trend: exploding demand for ubiquitous mobile broadband



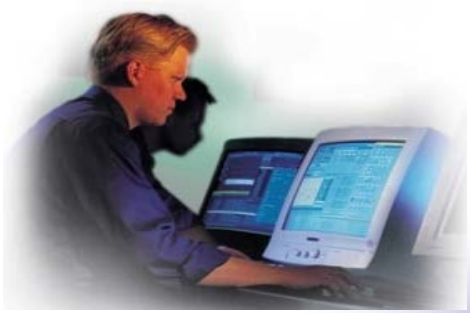
Problem: exploding OPEX to operate a complex (fragmented) network infrastructure



Self-Organization

applied to infrastructure networks ?

Cellular macro network
- Tightly planned, automated operation
- Single operator
- Single vendor equipment per OAM domain



Cellular Heterogeneous Network
- Some parts only coarsely planned, highly automated operation
- Multi-operator (shared infra)
- Multi-vendor per domain

Ad-hoc / mesh network
- Uncoordinated deployment, autonomous operation
- Only node operator
- Open environment, standardized protocols between nodes

"Self-organization is a process where the organization (constraint, redundancy) of a system spontaneously increases, i.e., without this increase being controlled by the environment or an encompassing or otherwise external system." (F. Heylighen, Principia Cybernetica Web, 1997)

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Self-Organizing Networks (SON) in (E)UTRAN

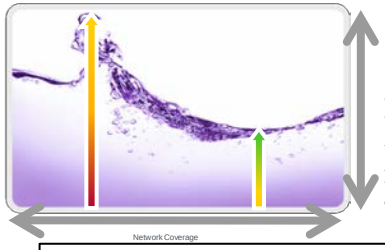
Autonomous, distributed

Autonomous, centralized

Automated, centralized

SON operation

SON management & coordination



Self-Healing

Cell Anomaly Detection, Diagnosis and Recovery

Radio planning

Auto-connectivity & -commissioning

ANR

Energy Saving

CCO*

MRO*

MLB*

Self-Optimization

Interference Management

Traffic Steering incl. WiFi offload

Customer

Experience

Design

Build

Operate / Maintain

*MRO: Mobility Robustness Optimization MLB: Mobility Load Balancing CCO: Coverage & Capacity Optimization

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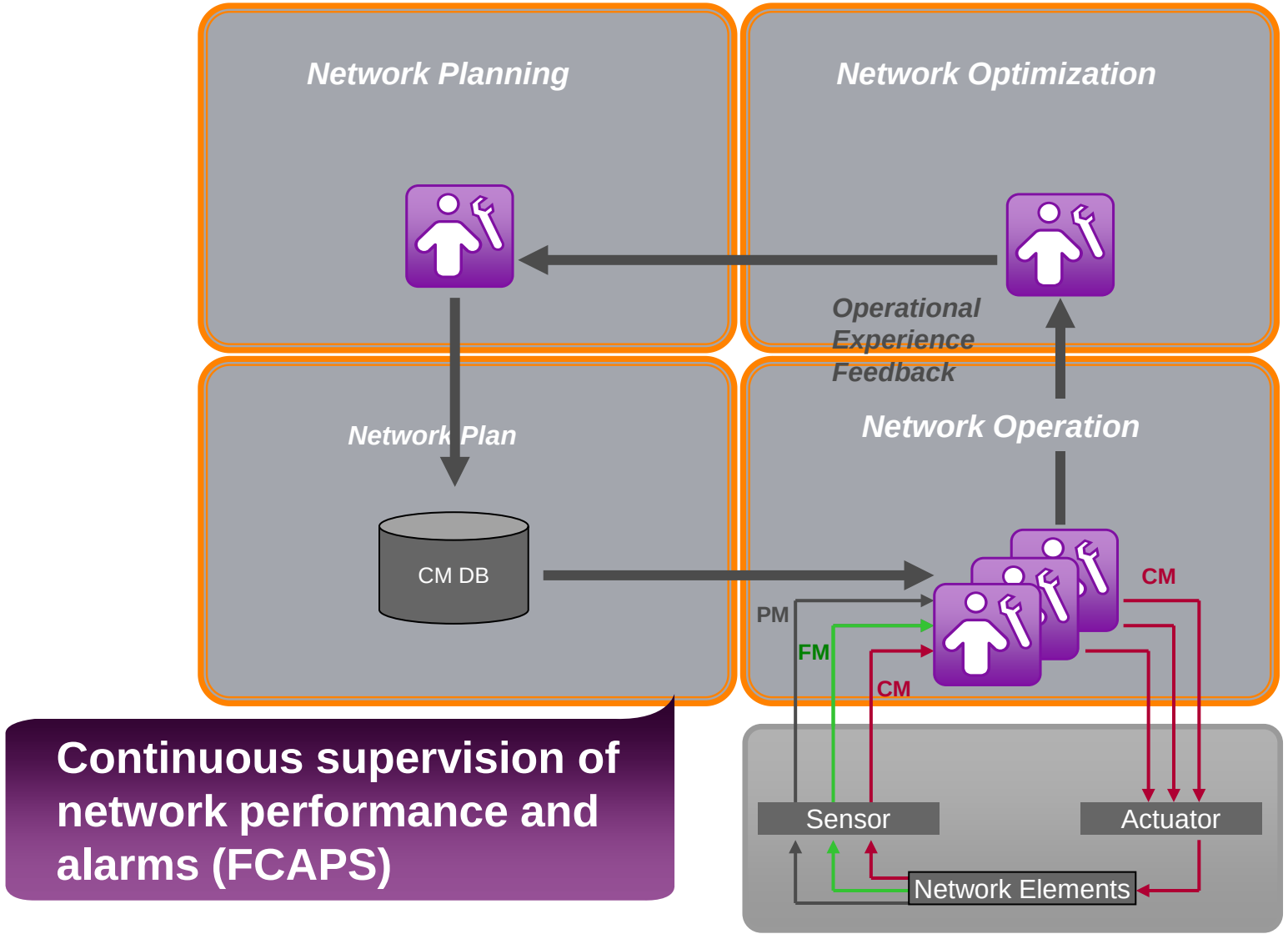
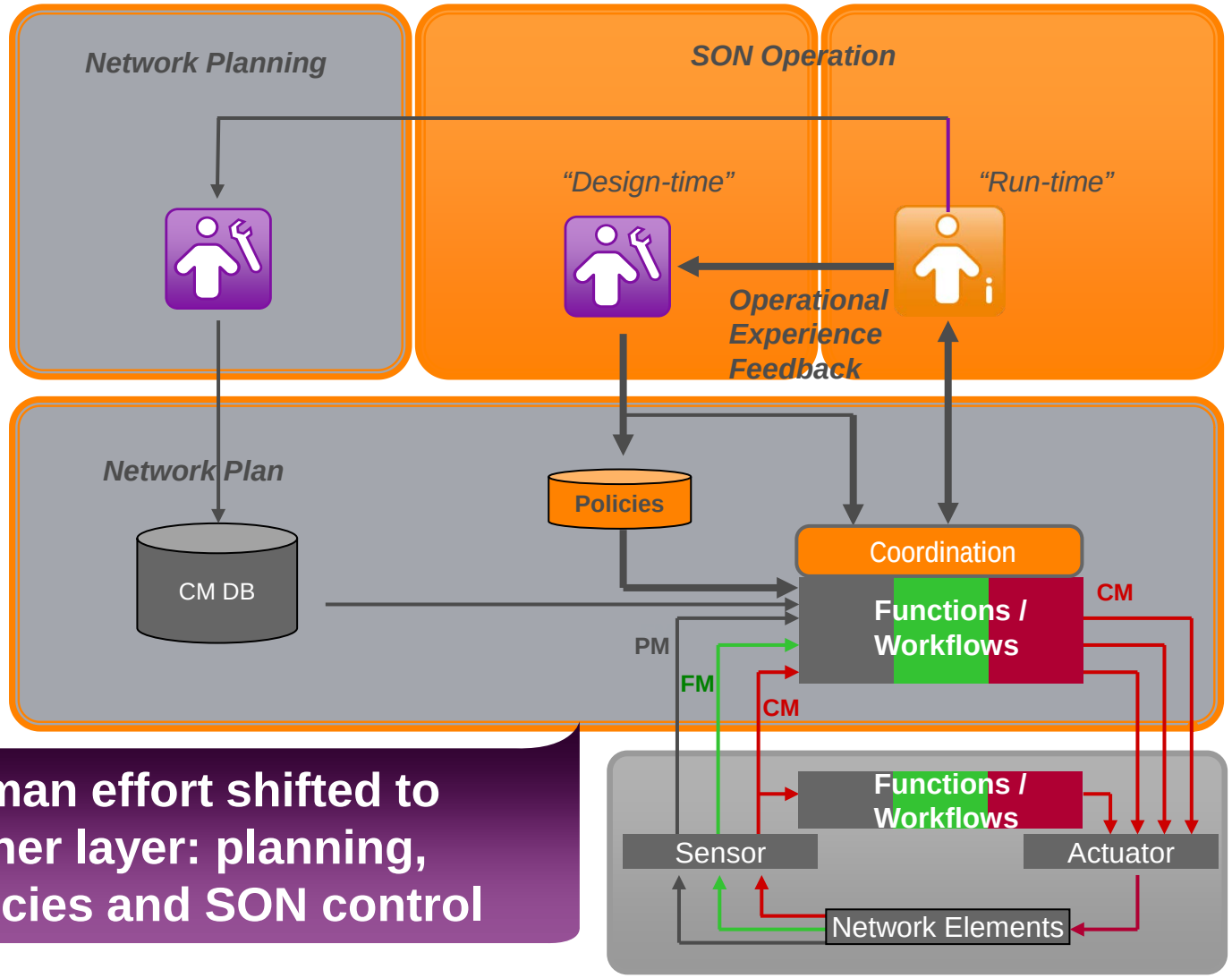
Network planning, operation, optimization



Automated network planning, operation, optimization

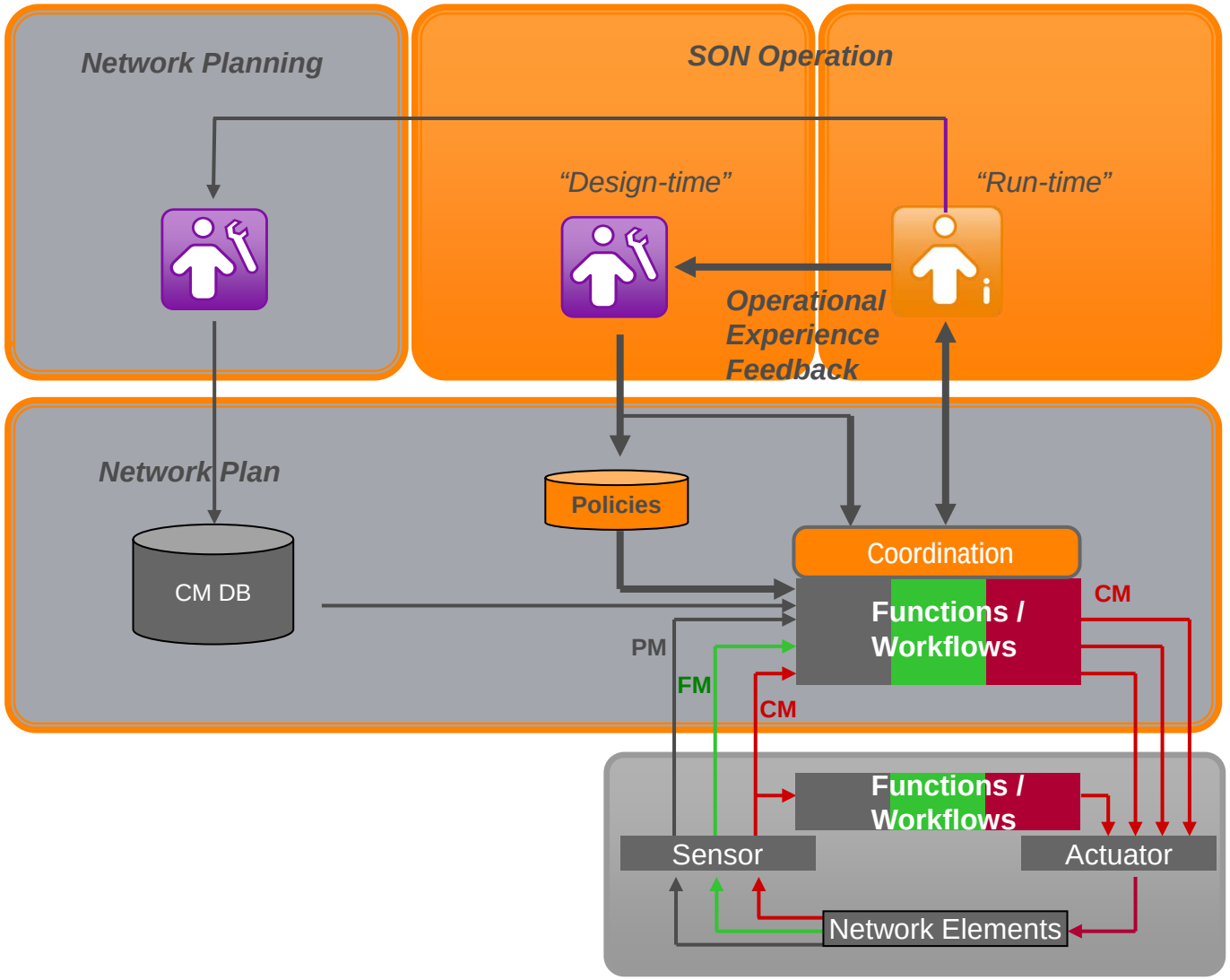


Human effort shifted to higher layer: planning, policies and SON control

Management framework:

- Existing / future organization, processes and use cases
- (SW) Architecture
- SW lifecycle
- Human-Machine Interface
- (Multi-vendor) Interfaces, Information Models (and their framework)
- Protocols
- Automated Functions / Algorithms
- *Technologies:*
  - *Rule-/policy-based systems*
  - *Statistical / probabilistic techniques*
  - *Machine learning*
  - *…*

Management frameworks: challenges



Operator use cases:

- Change management (organization)
- Target setting / refinement for automated / autonomic functions (management / coordination)
- Integration of human-level workflows with automated functions / transition

Semantics:

- Operator / vendor cooperation (function lifecycle, safety / trust)
- Modelling of machine-level functions and workflows
- Context-aware function deployment
- Multi-vendor system integration → run-time coordination

Dynamics:

- Network dynamics, variable user demand → amount / frequency of network data → uncertainty

Challenge: time cycles

- Potential conflicts depend on the respective timing, e.g., a „slow“ CCO has impact on a „fast“ MRO with lower probability
- SON is not only about reducing OPEX as it is today, but doing network operations
  - **Faster**
  - More **adaptively**, cf. variable user demand over the course of a day (NSN‘s LiquidNet)

→ more frequent executions

- Centralized SON: lower bound on data availability
  (granularity period GP: 15mins – 1h)
  → lower bound on the execution interval

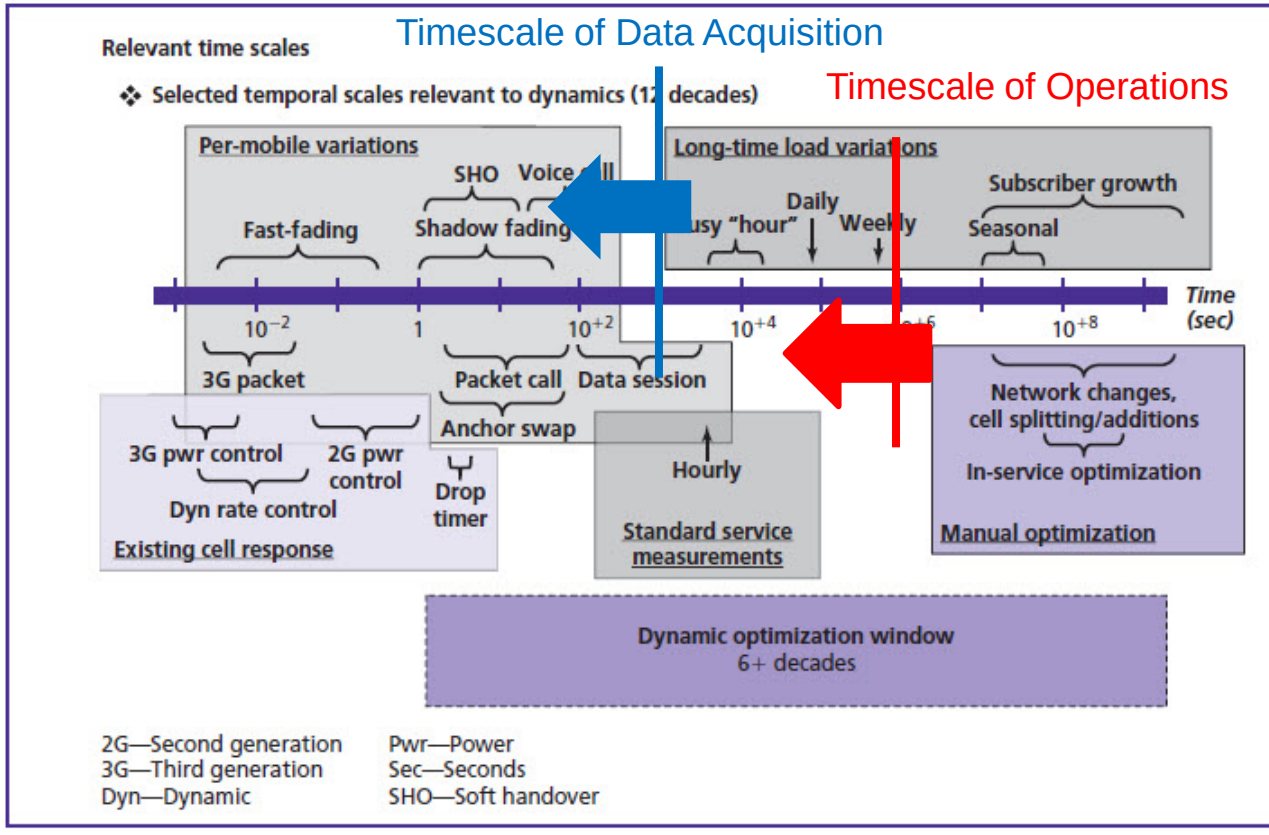


Figure 2.
A Bell Laboratories slide from 2003 showing relevant time scales for dynamic optimization.

10 Bell Labs Technical Journal DOI: 10.1002/bltj

→ C-SON function instances will have *sync‘ed execution intervals, overlapping impact times*
→ **Concurrency issues → Coordination**

→ **move further towards (near) real-time data acquisition / analysis**

Challenge: „knowns“ and „unknowns“

“There are **known knowns**; there are things we know that we know.
There are **known unknowns**; that is to say, there are things that we now know we don't know.
But there are also **unknown unknowns** – there are things we do not know we don’t know.”

Statement awarded „Foot in Mouth“ Award 2003
Linguist Geoffrey Pullum: “completely straightforward; impeccable (syntactically, semantically, logically, and rhetorically).“
Source: http://en.wikipedia.org/wiki/There_are_known_knowns

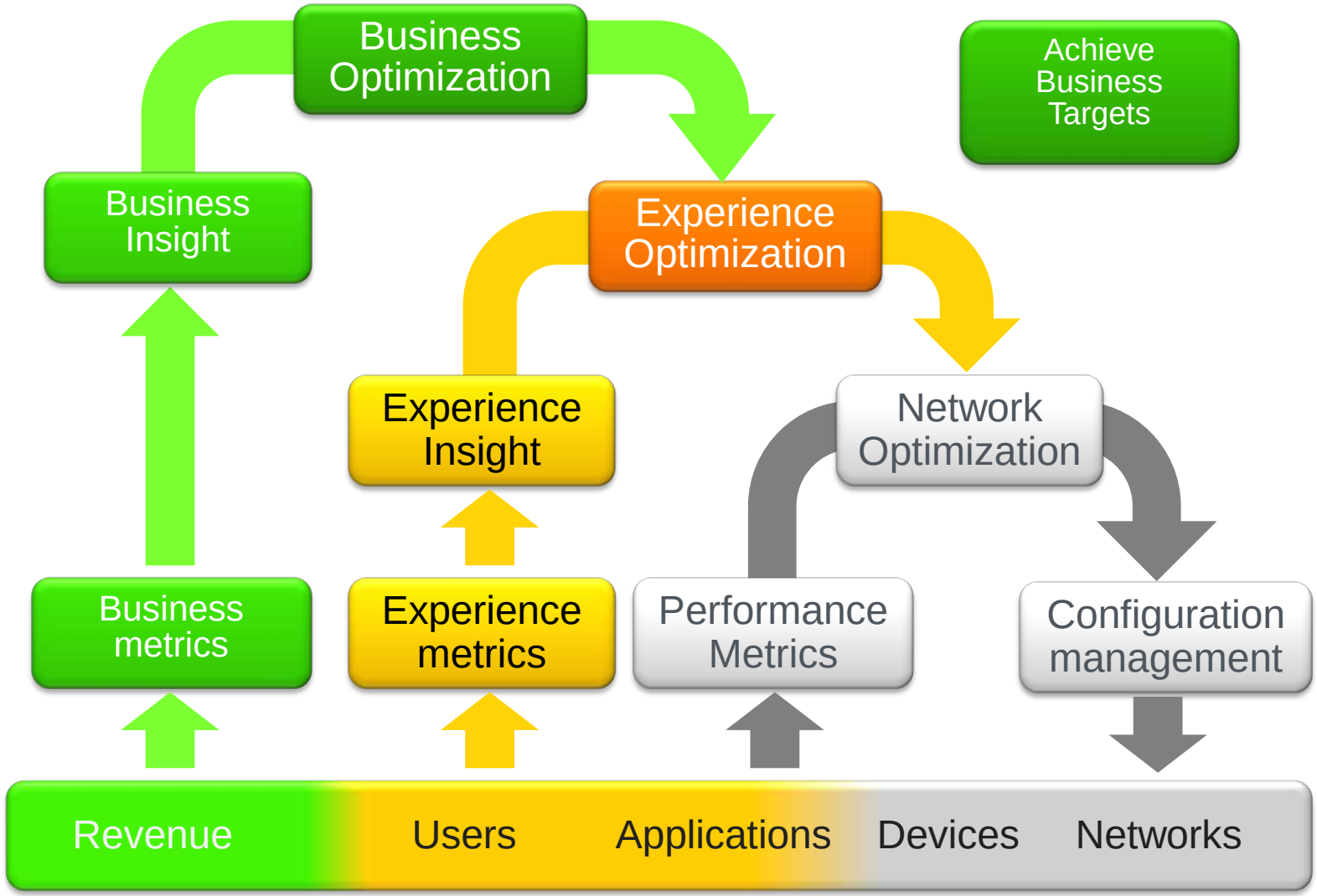
	Knowns	Unknowns
Known (we know that „something relevant“ is there → **automation)**	Labelled Diagnosis pattern (cause is known)	Detection / Unlabelled Diagnosis pattern (cause is not known)
Unknown (we don‘t know if „something relevant“ is there)	Problems (cause is known) without detection / diagnosis pattern	

Improve diagnosis: „Ground truth“ (expert knowledge, data mining)

Improve detection

(Improve visibility of problems: CRM)

Cognitive Networks – Capability to Optimize User Experience and the Network



Achieve Business Targets

Define business metrics and analyze business insight for business optimization

Drive experience optimization with business goals

Use your network as a tool for reaching business potentials

Implement Machine Intelligence

Source: Ossi Pöllanen, NSN

Conclusions

Mobile data traffic explosion → operators must „densify“ their network, increasing capacity and assuring coverage → **Heterogeneous Networks (HetNets)**

Decreasing revenue per user → operators must reduce costs to remain profitable; HetNets increase complexity and thus Operational Expenses (OPEX), however
→ **dilemma**

Manage complexity → apply **Automation / “Self-Organizing”** concepts to drive down costs for infrastructure networks
→ **Framework** needed to define and control the **semantics** and **dynamics** of the automated system supporting **operator use cases**

- Crucial to recognize (detect / diagnose) **relevant events** in the network
  → requirement to instrument the network (**data**) and run **automatic, online analysis**
- Faster network operation time cycles (“Liquid Network”) → requirement to **control concurrency** in the automated network operation

Expand from automated management driven by network data towards management driven by **customer experience** data and further towards management driven directly by **business objectives**

Thank you

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