Reliable Operation of Heterogeneous Wireless Networks with SON (Self-Organizing Networks) - SON intro

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- Research

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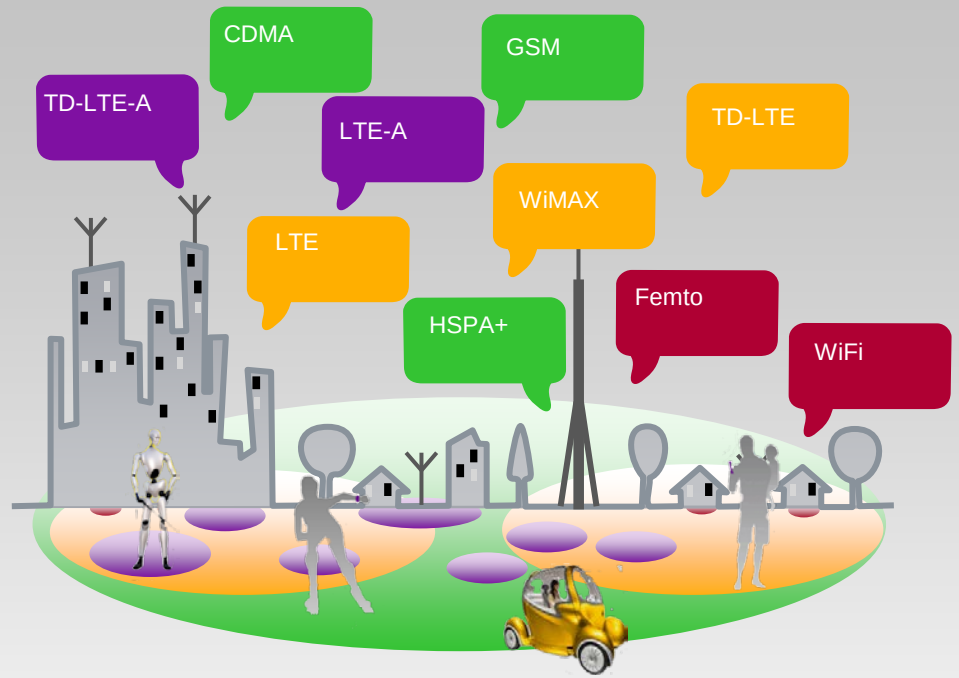
Why is SON needed?

Network systems are becoming more and more complex due to heterogeneity in the networks

Complexity challenges the management of networks → increased manual effort and cost

Moving from voice to data centric networks requires faster network operation & optimization cycles
→ more automation

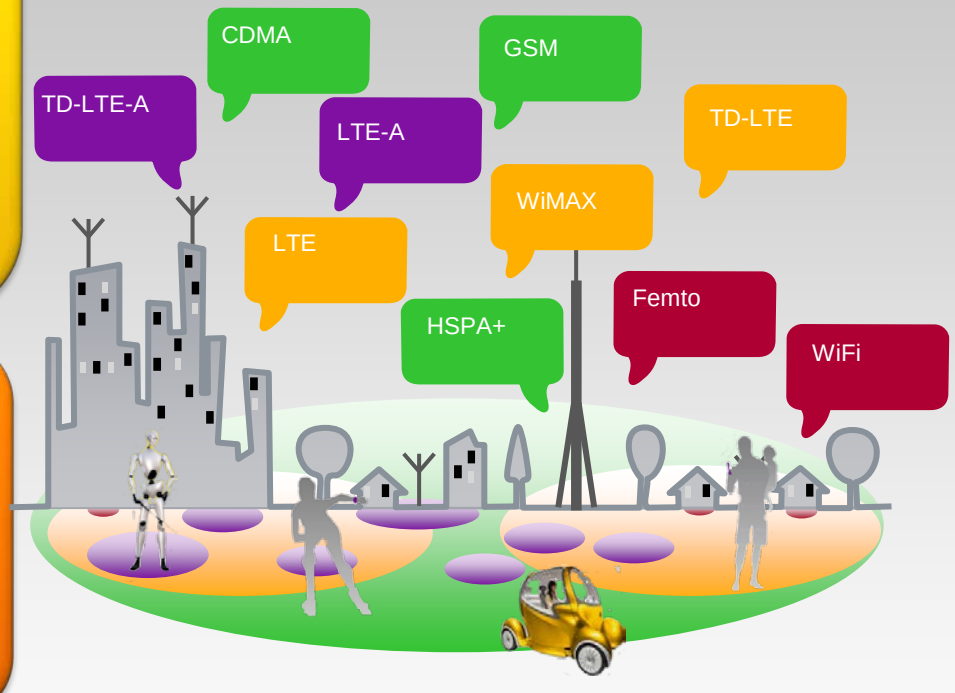


SON aims to address complexity through automation

Drivers for complexity

Consumers

- Consumers demand access to high performance wireless networks reliably everywhere
- Consumers expecting service and data rates comparable to fixed line today
- Growing number of mobile subscribers also in developing countries



Applications

- Not only voice, but different kinds of data services with high data rate requirement and tight latency
- Data services putting high pressure on performance of network. Networks need to be well tuned

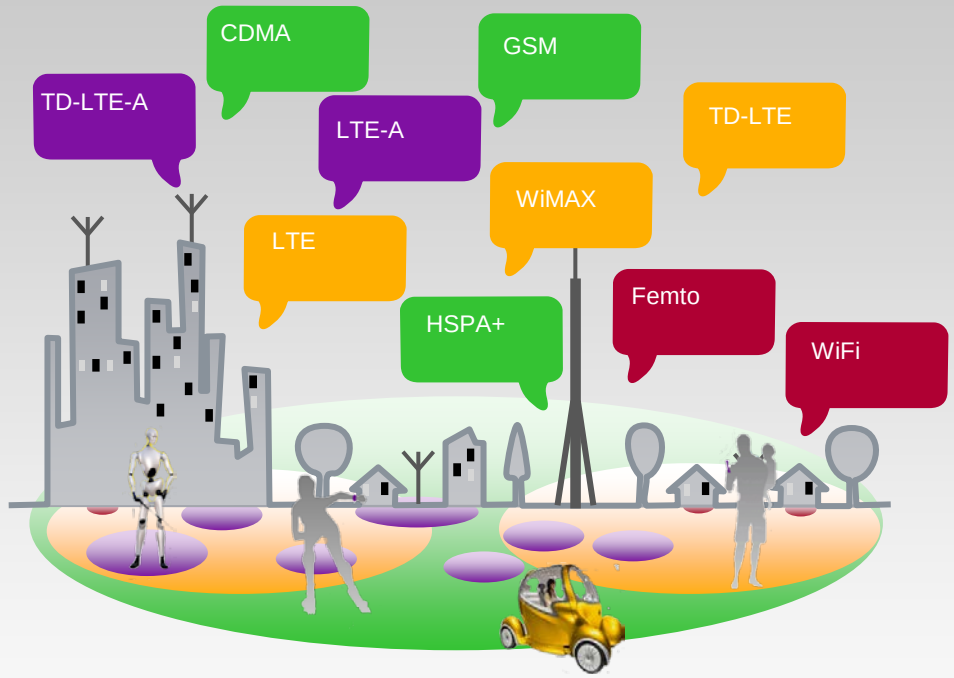
Terminals

- New terminals together with new network technologies (enabling new applications and services) → higher throughput and latency demands

Drivers for complexity

Capacity needs
- Huge demand for increase capacity by new cannot be met by just adding more hardware
- New types of cells will emerge making network heterogeneous

Legacy networks
- Operators will keep their existing 2G and 3G investments for years
- LTE and LTE-A networks are operated in parallel with GSM and HSPA networks in the next decade



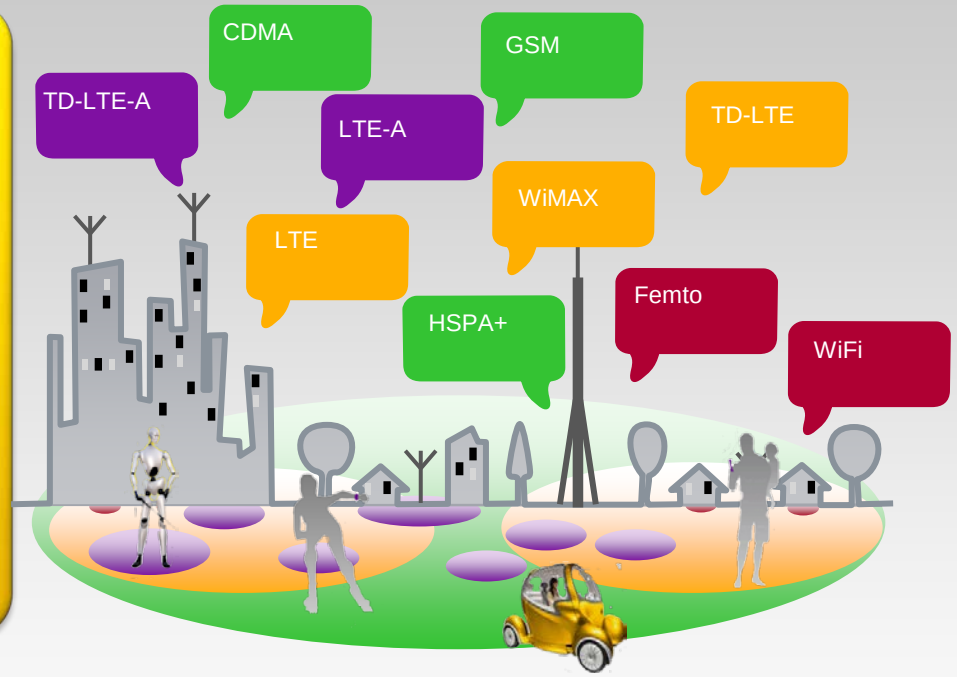
Frequency variants
- Several frequency bands are utilized jointly for providing required capacity and coverage

Network implications of complexity

- Huge number of small base stations to be managed
- Huge amount of parameters to be operated due to inter-system operability need

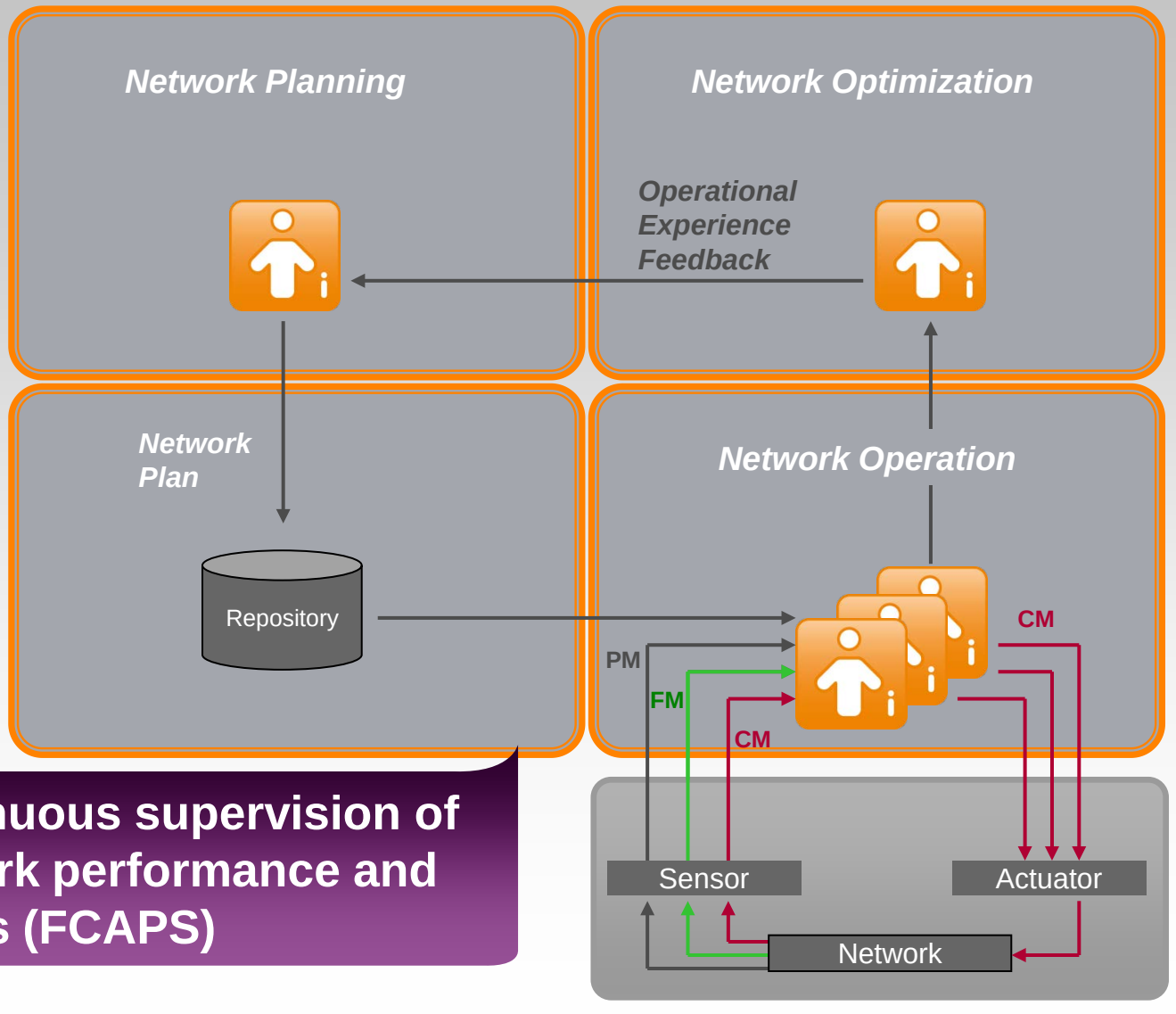
→ increased human workload and cost

- Difficult to maintain all parameters and base stations in optimum
- Incorrect parameters lead to low network performance and poor quality of experience



SON basics

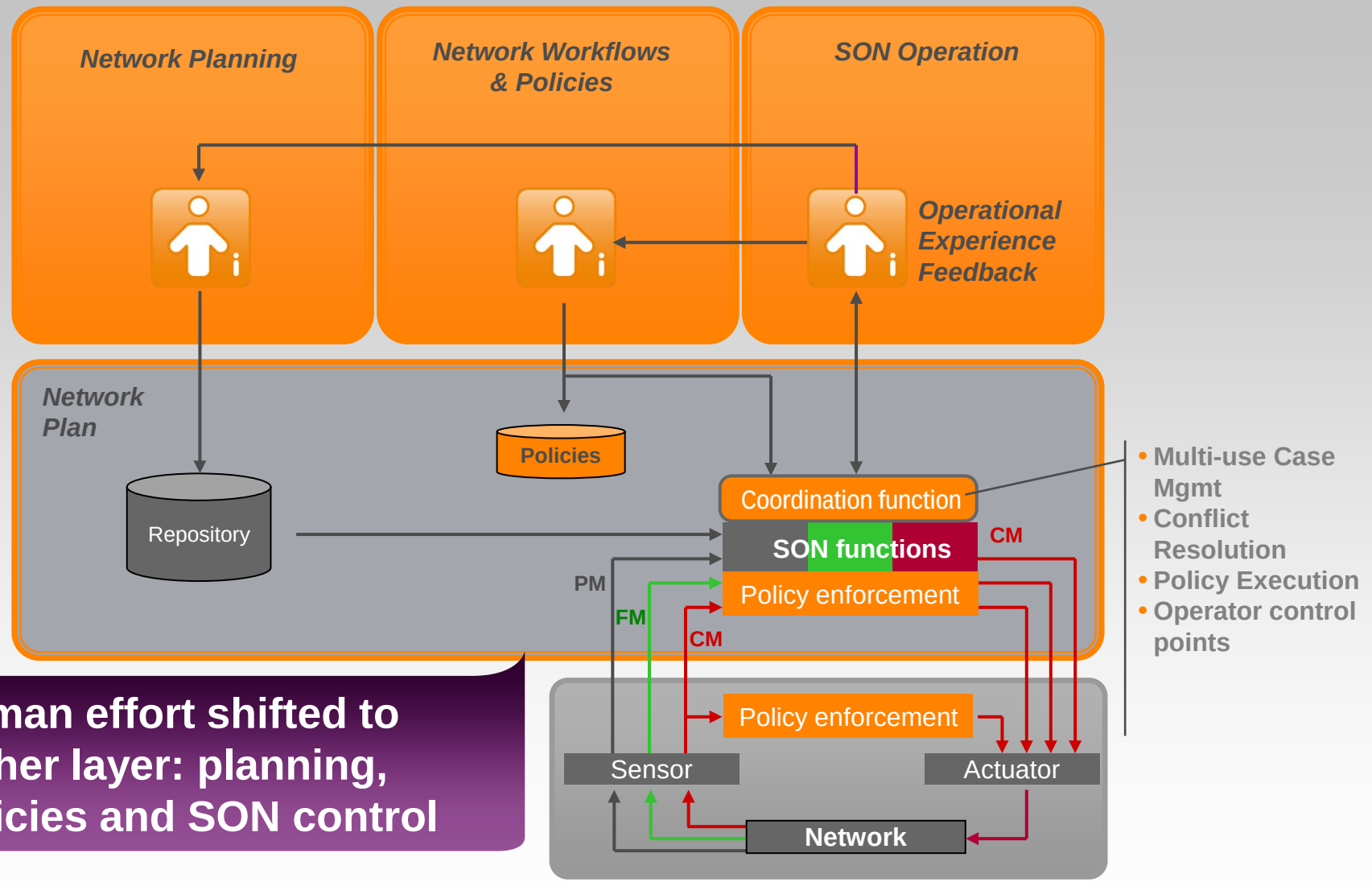
Network operations today



Continuous supervision of network performance and alarms (FCAPS)

SON basics

Network operations with SON

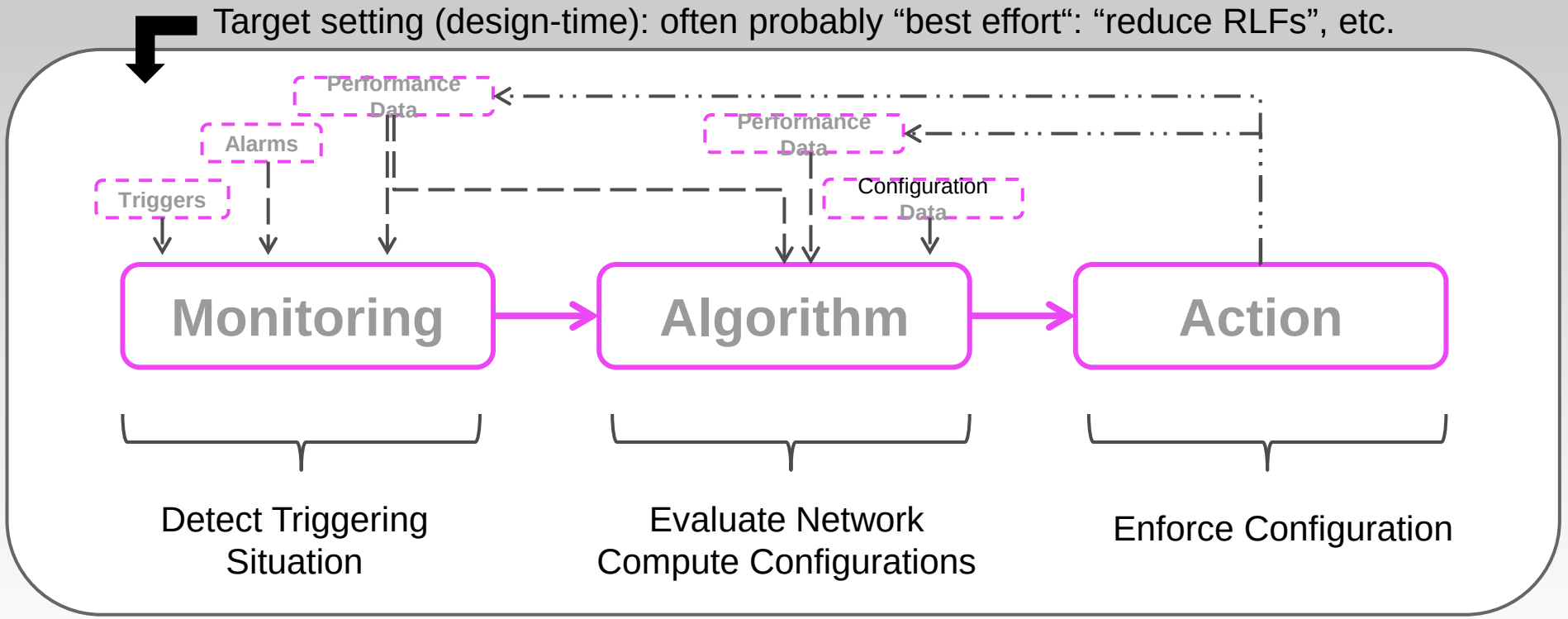


Human effort shifted to higher layer: planning, policies and SON control

→ **Automation** to improve **operability** / **serviceability** and **reliability**

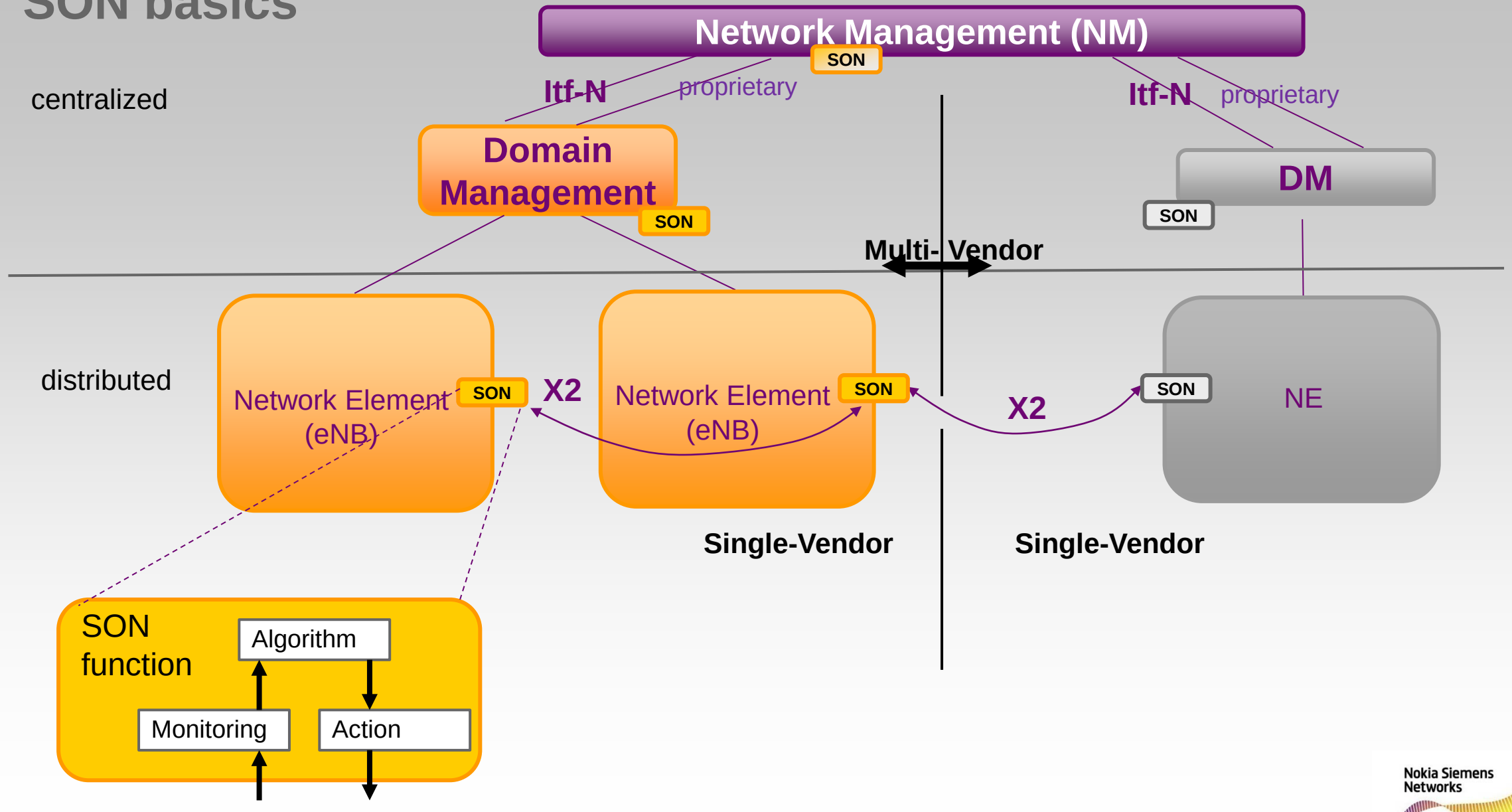
SON basics

- **(SON) use case:** a description of “who“ can do “what“ (with SON functionality)
- **SON function:** a specific realization of the functionality to fulfill a SON use case

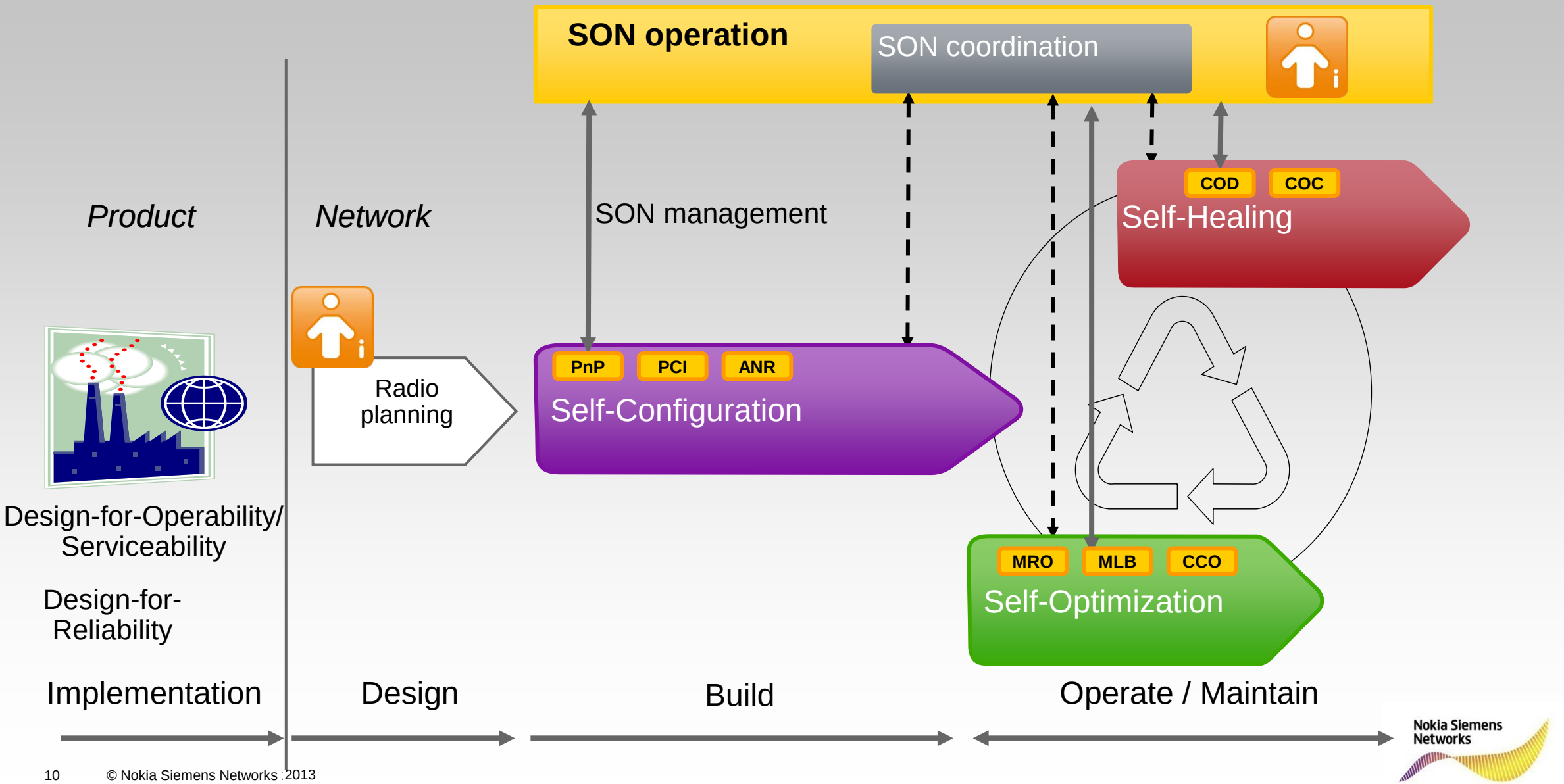


- **SON function instance:** instantiation of a SON function (specific time, specific network region)
  - Algorithm execution is triggered autonomously by the monitoring part detecting a relevant condition

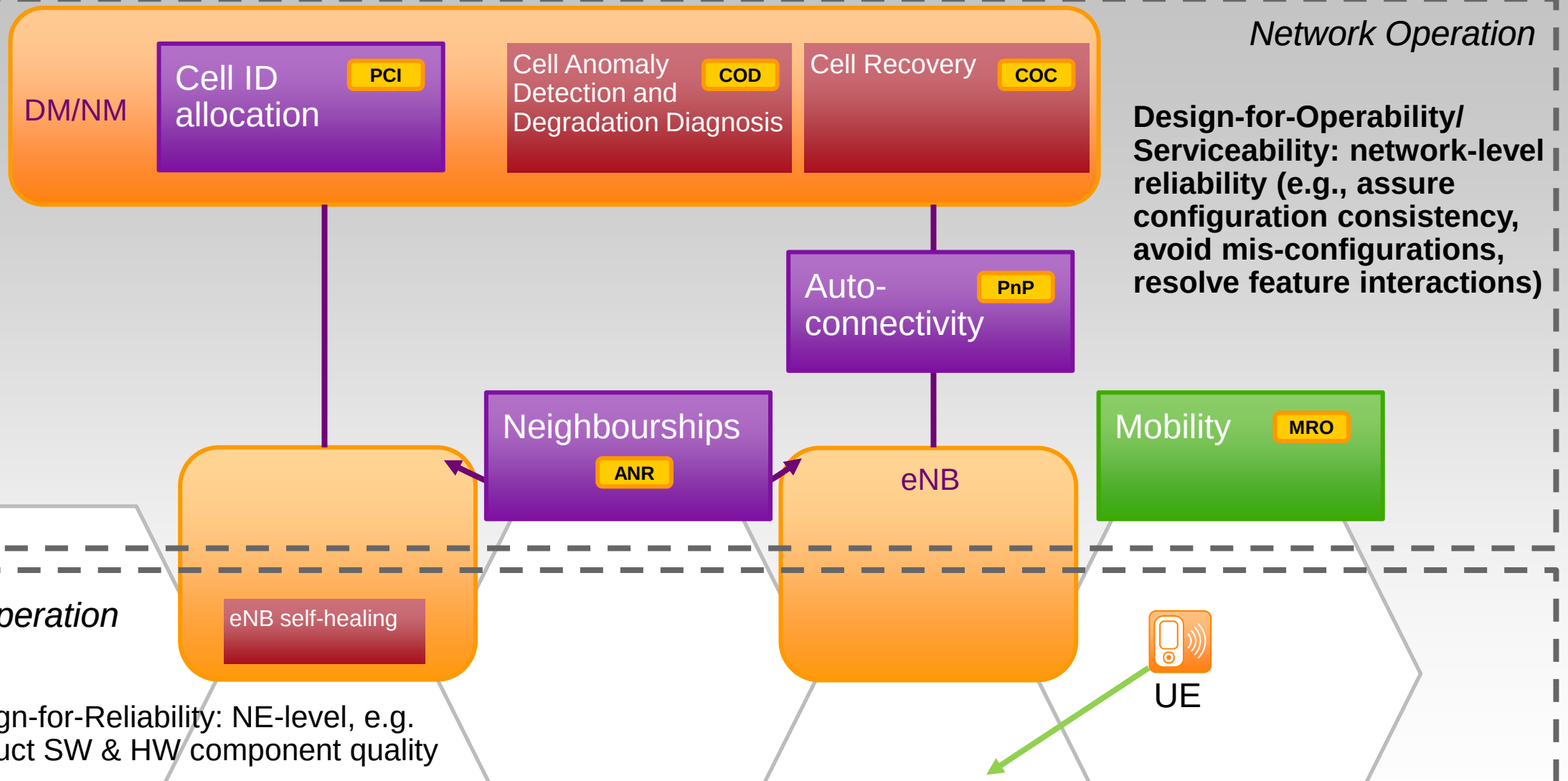
SON basics



SON basics: operational lifecycle



SON: operability / serviceability, reliability

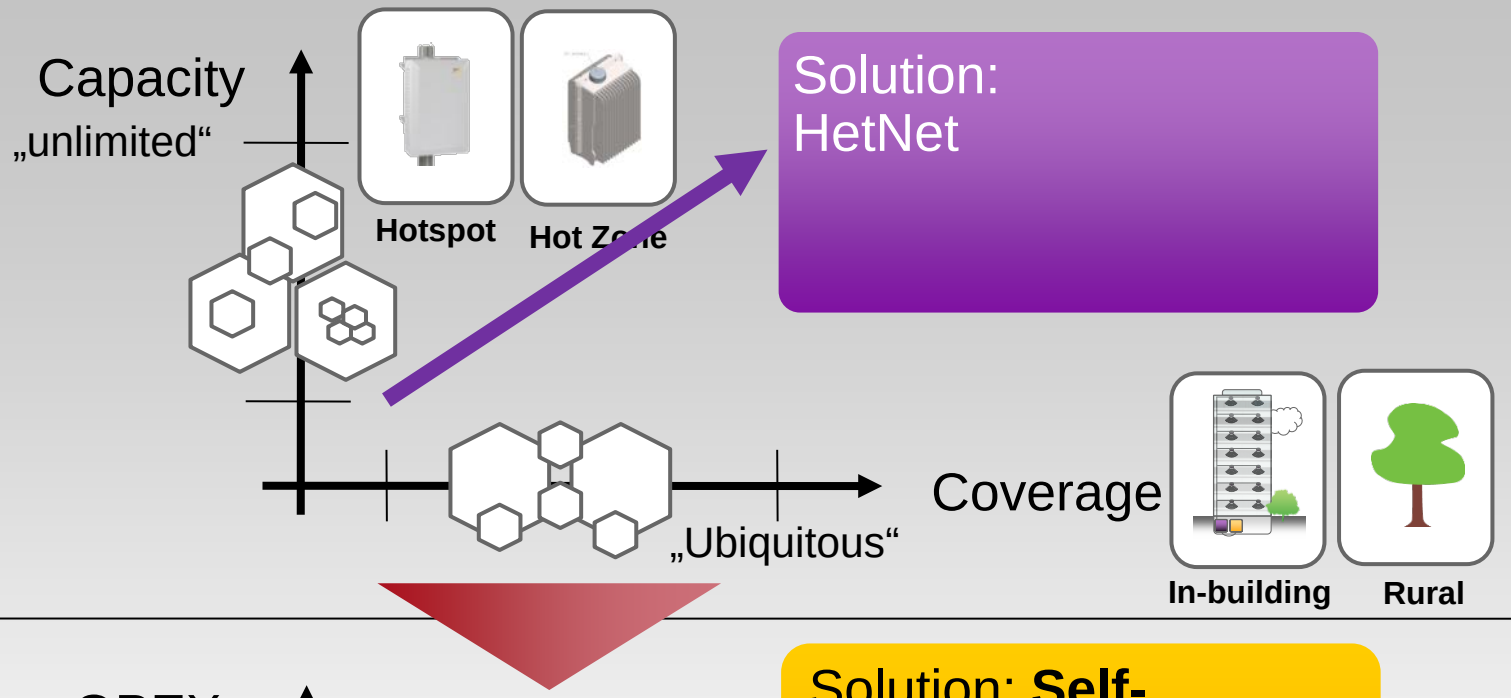


Design-for-Operability/ Serviceability: network-level reliability (e.g., assure configuration consistency, avoid mis-configurations, resolve feature interactions)

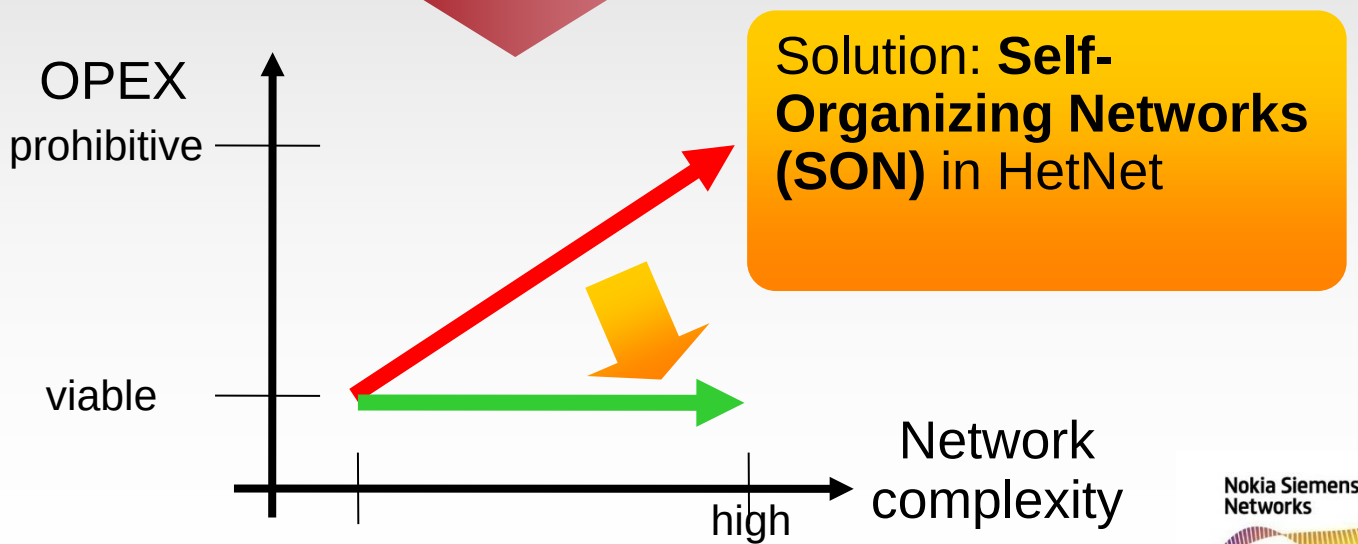
Design-for-Reliability: NE-level, e.g. product SW & HW component quality

Densification and higher distribution brings complexity

Trend: exploding demand for ubiquitous mobile broadband



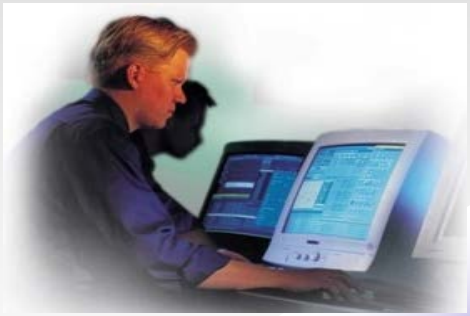
Problem: exploding OPEX to operate a complex (fragmented) network infrastructure



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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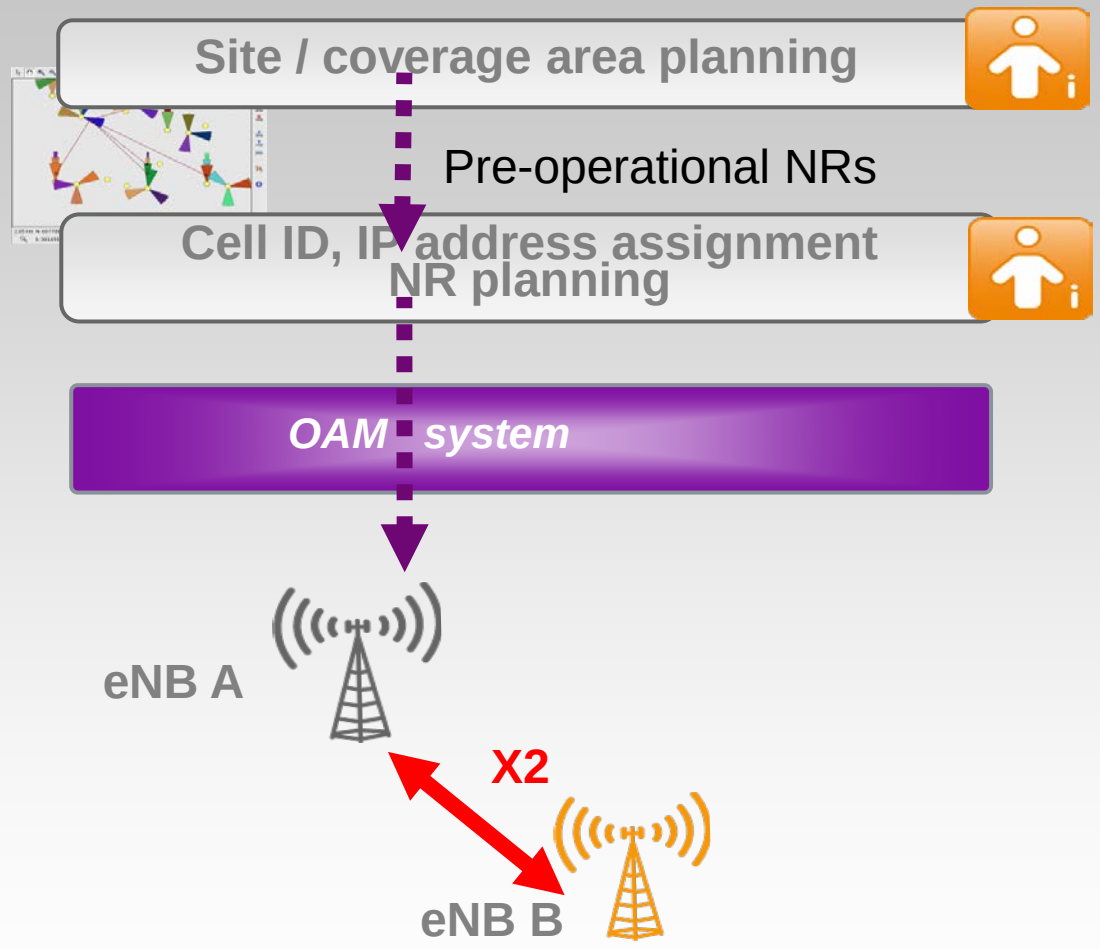
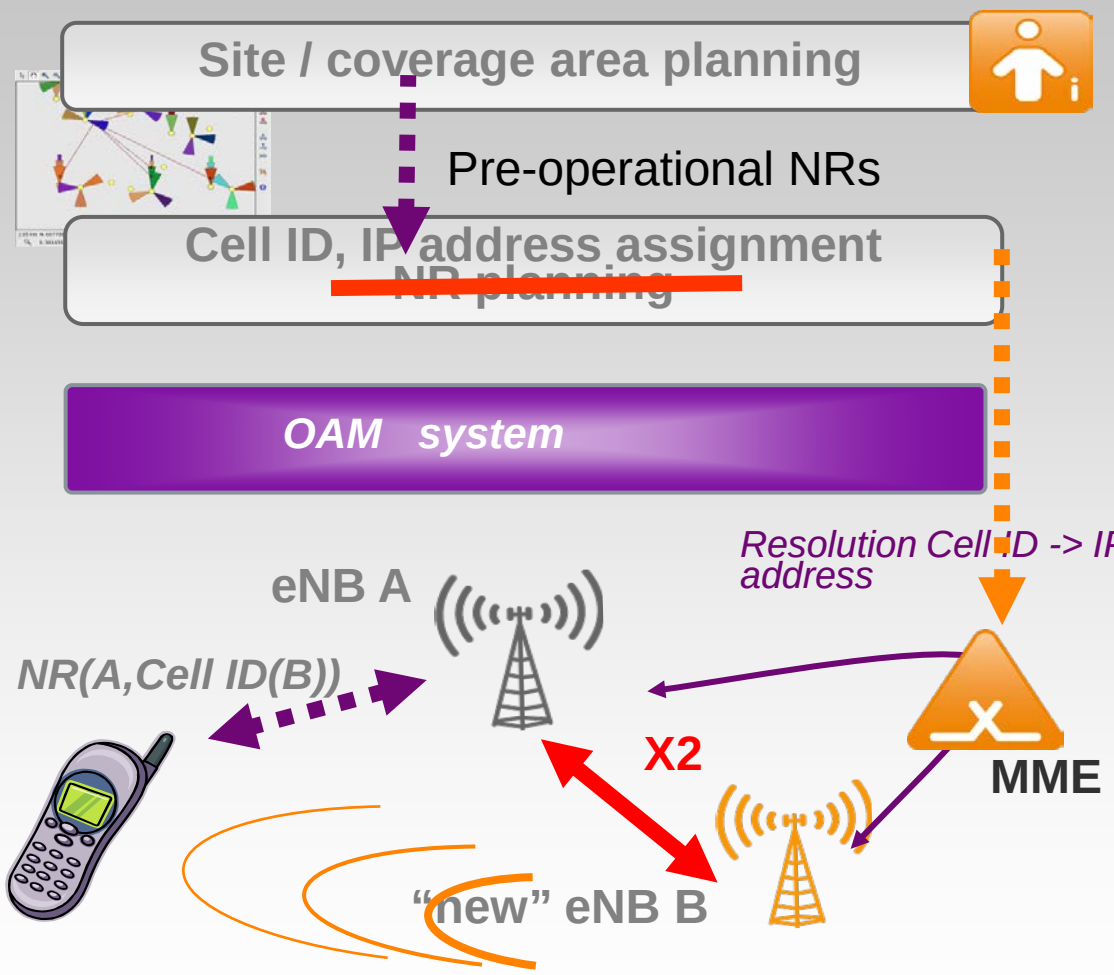
Example: Automatic Neighbour Relations (ANR)

Conventional



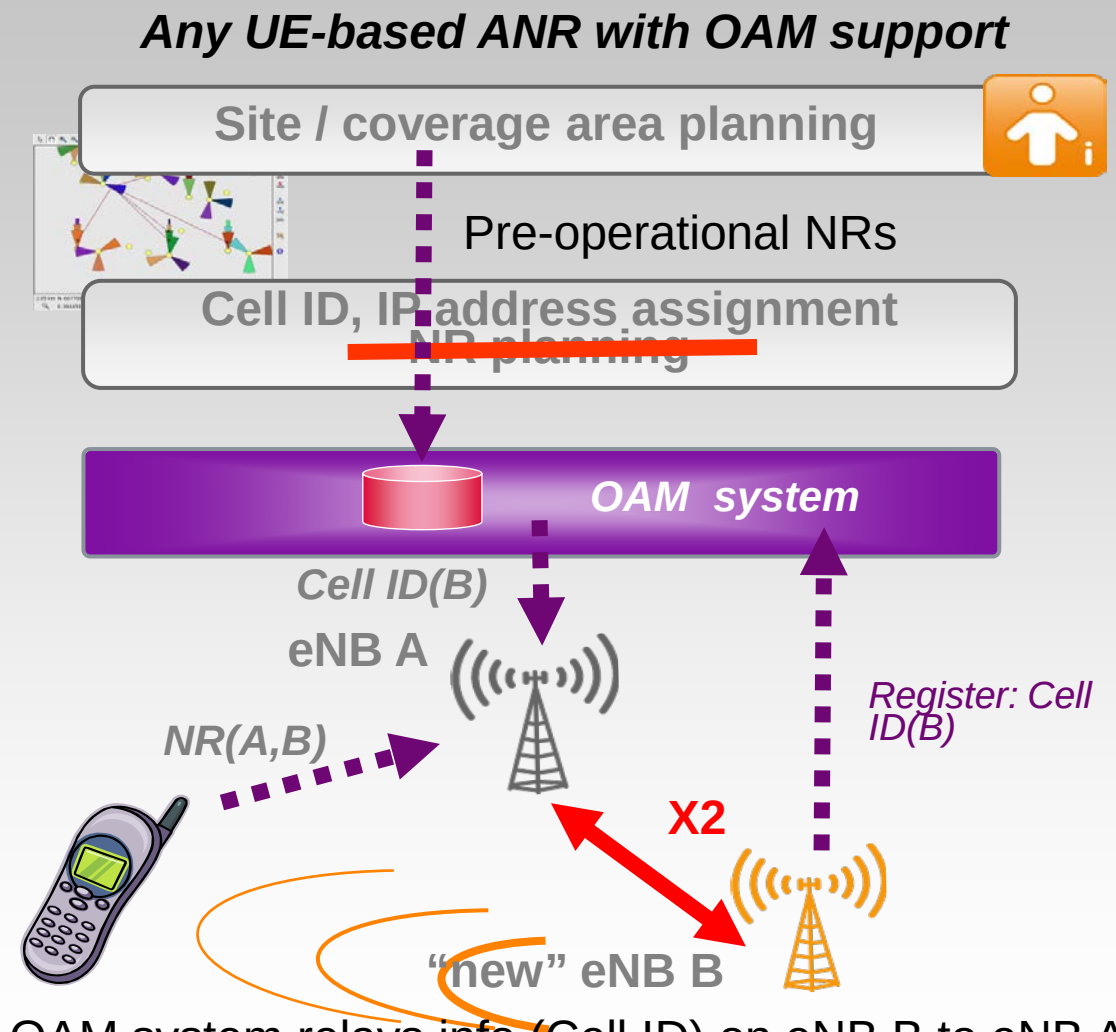
eNB A is pre-configured to know eNB B (Cell ID, IP address)

Fully UE-based ANR



UE relays info (Cell ID) on eNB B to eNB A

Example: Automatic Neighbour Relations (ANR)



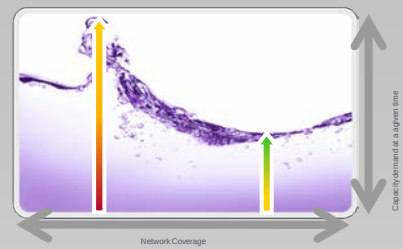
OAM system relays info (Cell ID) on eNB B to eNB A

Infrastructure network: key parameters already available in the system
→ no need to self-organize, but parameters need to be configured on the NEs

1. „Fully UE-based ANR" avoids that configuration (but requires **UE**/eNB/MME & protocols to be extended / standardized to do automatic, dynamic, distributed configuration)

2. „Any UE-based ANR with OAM support" does automatic, dynamic, centralized configuration in the OAM system (but is only partially standardized, needs proprietary integration)

Self-Organizing Networks (SON)



- SON in Radio
  - Support of Heterogeneous Networks management automation
    - **Self-Configuration: Plug-and-Play, PCI, ANR**
    - **Self-Optimization: MRO, MLB, ICIC, CCO** (antenna parameter optimization)
    - **Self Healing: automated detection /diagnosis & recovery** (e.g., **COC**) to identify relevant incidents and their causes
  - **Traffic steering** enabling service as a “one-network” for 3GPP RATs and WiFi off-loading.
  - Distribute the capacity and automate the network deployment according to actual traffic mix, traffic location and user demands by steering the beams of the **AAS**


Active antennas

- Using SON
  - Use of CLA*/**MDT*** for Coverage and Capacity Optimization. MDT is very useful,e.g. to locate and track traffic hot-spots
  - **CEM4SON:** SON using CE/QoE/QoS measurement as inputs, and CEM measuring CE/QoE/QoS impact of SON actions
  - **SON operation** (coordination and management)
- …towards learning and a “Cognitive Network”
  - Learn from environment and from former actions and adapt the decisions accordingly

* CLA: Call Location Analysis; MDT: Minimization of Drive Tests

Standardised SON Use Cases

RAN			SA 5
	SON Coordination		Rel.10
	Self-healing	• Cell Outage Compensation	Rel.10
Rel.10/11	Self-optimization extensions	• Mobility Robustness Optimization • Mobility Load Balancing • Energy Saving • Coverage and Capacity Optimization	Rel.10/11
Rel.9	Self-optimization	• Mobility Robustness Optimization • Mobility Load Balancing • RACH Optimization	Rel.9 Rel.10
Rel.8	Self-configuration	• SON Plug and Play • Automated Neighbor Relations Management (also Self-Opt) • Automatic SW Mgmt and Automatic Radio Configuration (R9)	Rel.8
Rel.10/11	Minimization of Drive Tests		Rel.10/11

SON in HetNets

SON operation

SON coordination

Additional requirements to SON functions wrt. HetNet:

- Functional: increased level of autonomy / knowledge on HetNet structure
- Non-functional: increased level of scalability, reliability and multi-vendor capability

Radio planning

Auto-connectivity & -commissioning

ANR

Self-Healing

Cell Degradation Detection, Diagnosis and Recovery

Energy Saving

MRO*

Self-Optimization

Interference Management

Traffic Steering incl. WiFi offload

Customer

Experience

Design

Build

Operate / Maintain

*MRO: Mobility Robustness Optimization

References

S. Hämäläinen, H. Sanneck, C. Sartori (eds.)
LTE Self-Organizing Networks (SON) - Network Management Automation for Operational Efficiency, Wiley, ISBN 978-1-119-97067-5, December 2011. Chapter 3
3GPP TS32.500 (2011) Technical Specification Group System Architecture, Telecommunication Management; Self-Organising Networks (SON); Concepts and Requirements, ver.11.0.0., Release 11, 18 June 2011. Available from http://www.3gpp.org/ftp/Specs/archive/32_series/32.500/32500-b00.zip [accessed 30 June 2011].
3GPP TS32.50x (2011) series, Specification Group System Architecture, Telecommunication management, Self-Configuration of Network Elements, 3rd Generation Partnership Project (3GPP).
3GPP TS32.52x (2011) series, Specification Group System Architecture, Telecommunication Management, Self-Organizing Networks (SON) Policy Network Resource Model (NRM) Integration Reference Point (IRP), 3rd Generation Partnership Project (3GPP).
3GPP TS32.53x (2011) series, Specification Group System Architecture, Telecommunication management, Software Management (SWM), 3rd Generation Partnership Project (3GPP).
3GPP TR36.902 (2011) Technical Specification, Technical Specification Group Radio Access Network, Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Self-Configuring and Self-Optimizing Network (SON) Use Cases and Solutions, ver.9.3.1., Release 9, 7 April 2011. Available from http://www.3gpp.org/ftp/Specs/archive/36_series/36.902/36902-931.zip [accessed 30 June 2011].

References

Kasinger, H., Bauer, B., Sanneck, H. and Schmelz, C. (2006) A management automation framework for mobile networks. In Proceedings of the 17th World Wireless Research Forum, Heidelberg, Germany.
Kephart, J.O. and Chess, D.M. (2003) The Vision of Autonomic Computing, IEEE Computer Magazine, pp. 41–50.
IBM (n.d.) Autonomic Computing, http://www.research.ibm.com/autonomic/ [accessed 1 August 2011].
NGMN (2007) NGMN Informative List of SON Use Cases, NGMN Technical Working Group, Self Organising Networks, (ed. F. Lehser), April.
NGMN(2008) Use Cases related to Self Organising Network, Overall Description,NGMNTechnicalWorking Group, Self Organising Networks, (ed. F. Lehser), December.
NGMN (2010) Top OPE Recommendations, NGMN P-OPE PROJECT, (ed. F. Lehser), September.