Self Organizing Network

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Agenda

- What is SON
- Management reference model & SON architecture option
- Son functions – high level
- Real son
- Son functions –low level
- SON in standardization
- SON in 5G

What is SON?

https://www.youtube.com/watch?v=EDC_J6RoR4Q

- Cellular operators need to manage a large number of nodes from more than one vendor and for more than one technology !

- Self-Organizing is an automation technology: it reduces manual involvement of the network operator and turning it automatic hence reduces OPEX (operating expenditure)

- SON improves network's KPIs

  Key Performance Indicators

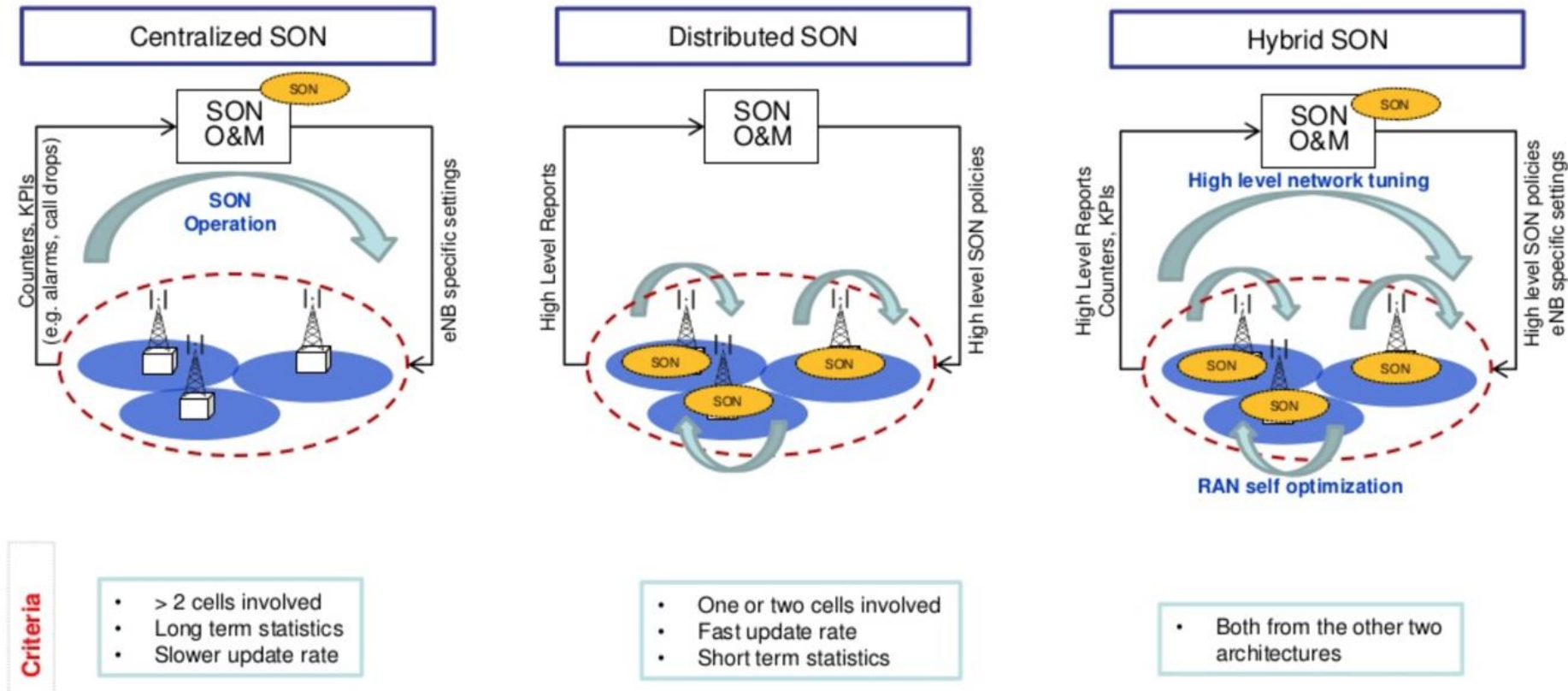Accessibility, Retainability, Integrity, Mobility, Availability
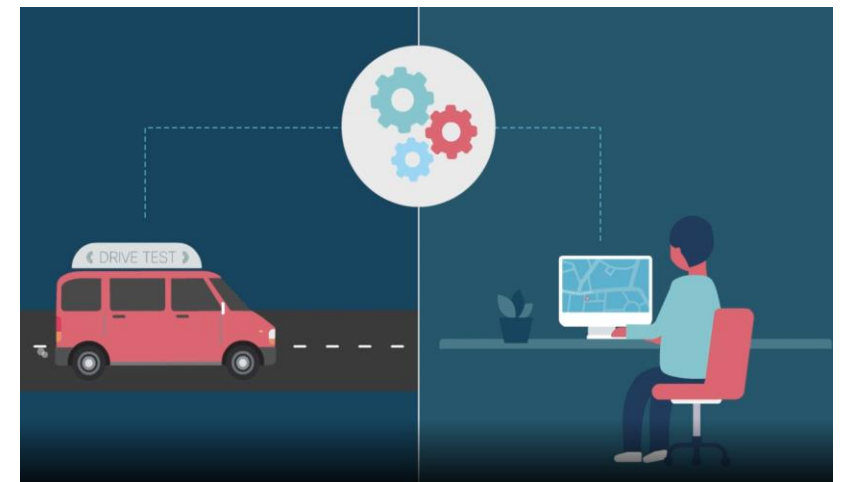
Management reference model
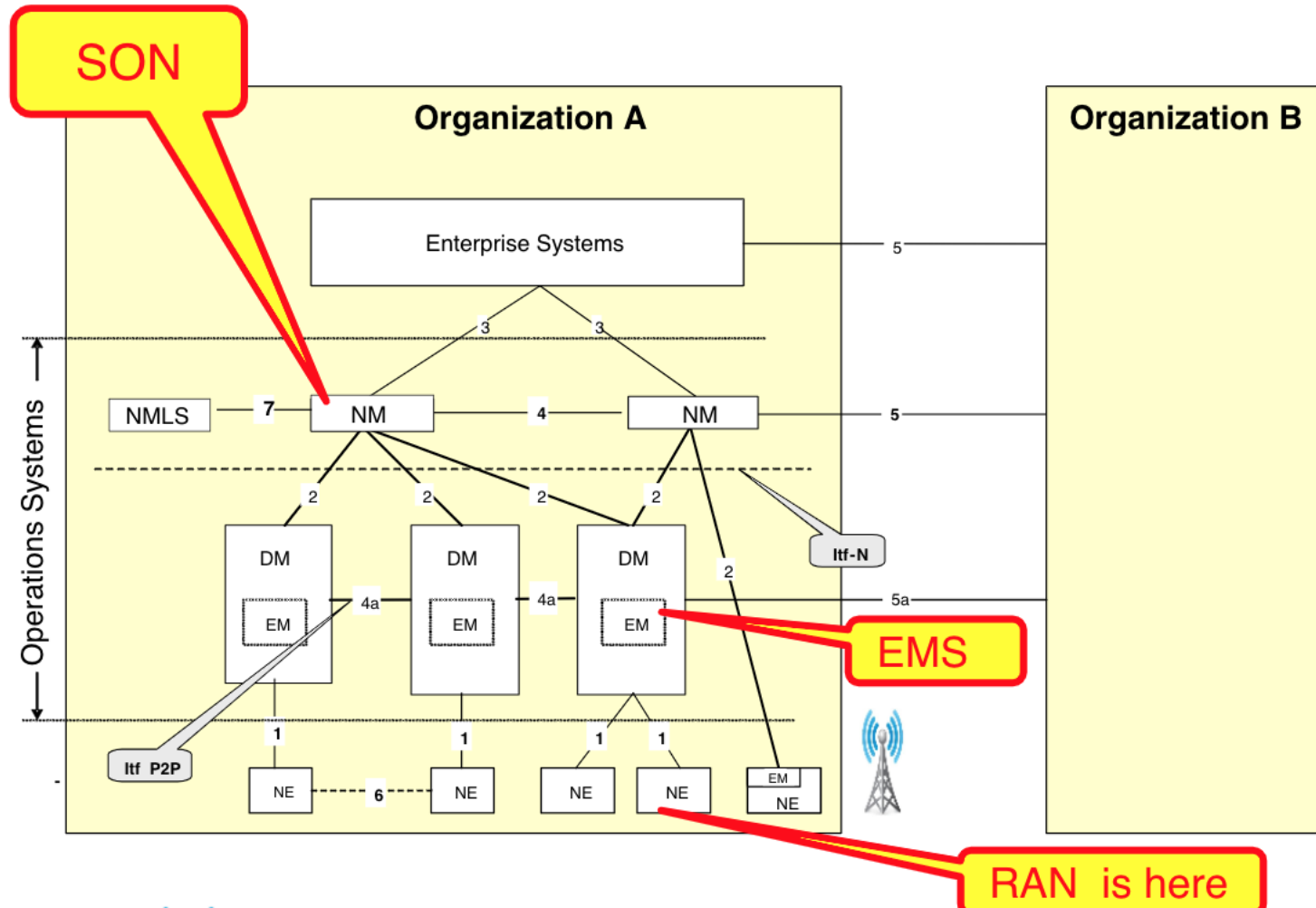
SON "jargon":
- PM:
  Performance management
- CM:
  Configuration management
- FM:
  Fault management

SON architecture options

- Centralized: SON entity observes the whole network: aware of different layers, RAT and vendor

- Distributed : SON is located in each eNB: it knows the cell and UE each performance all the time and can act fast Hybrid solution

SON functions

SON solutions can be divided into three categories:

1) Self-Configuration 2) Self-Optimization 3) Self-Healing

Self Configuration

Plug in

Network

eNB

Configuration downloading
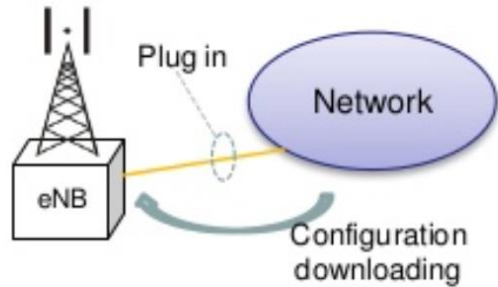
Self Configuration example features:
- Plug and play eNB (e.g. HeNB)
- Before eNB switches transmitters
- Downloading configuration:
  (IP address, Cell IDs, powers, etc)
- Secure connection establishment

Self Optimization

Optimize powers
HO params
PRACH params

eNB

eNB
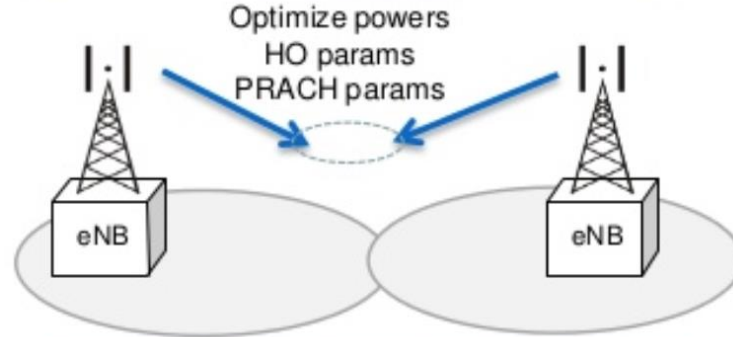
Self Optimization example features:
- Based on UE/eNB measurements:
  (e.g. throughputs, HO failures, etc)
- Based on NW performance meas.
  (e.g. RLFs, Drops, etc)
- Aim – maximize NW performance
  and provide cost savings
- Optimization of parameters for:
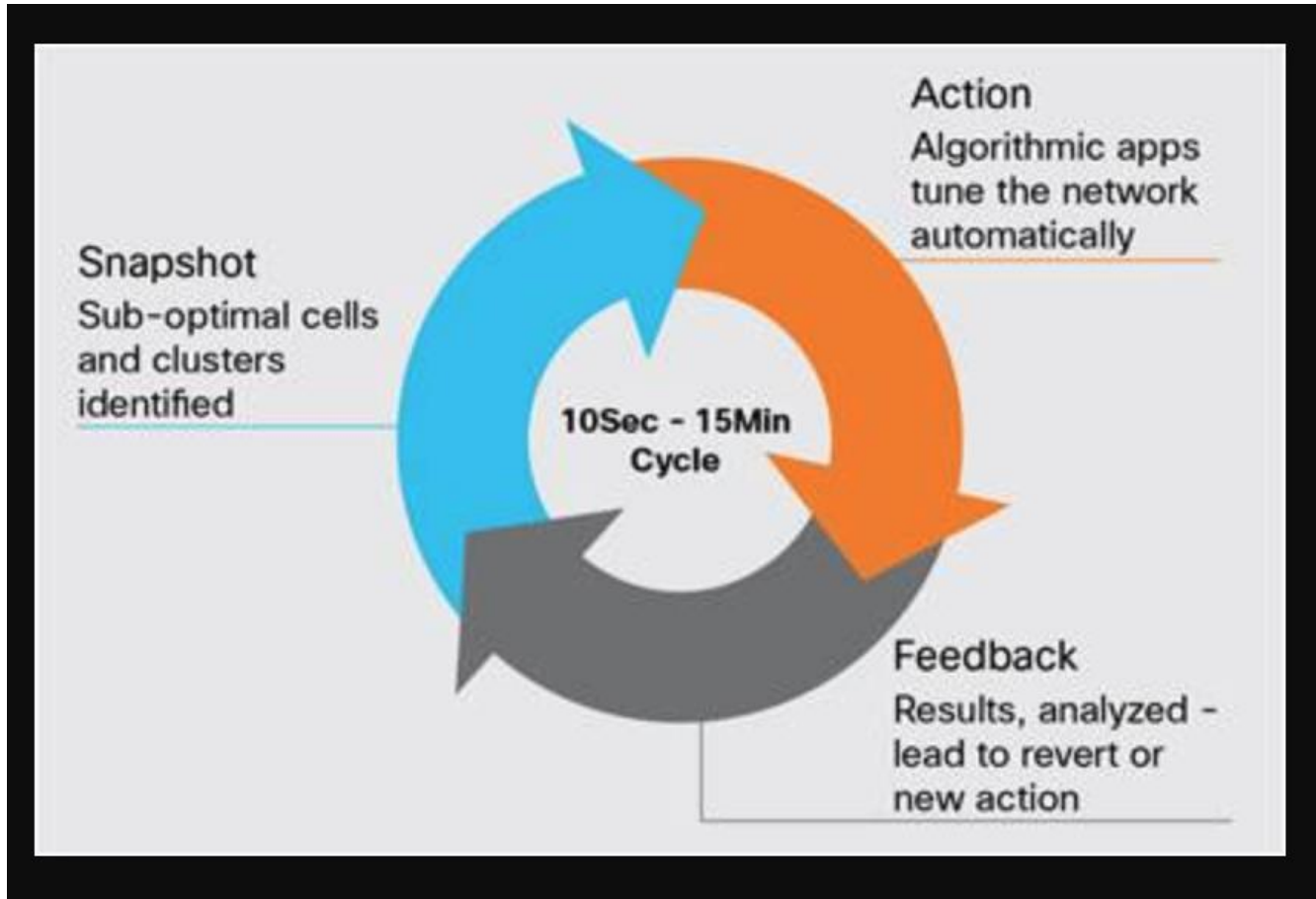 HO, RACH, ICIC, TxPower

Self Healing
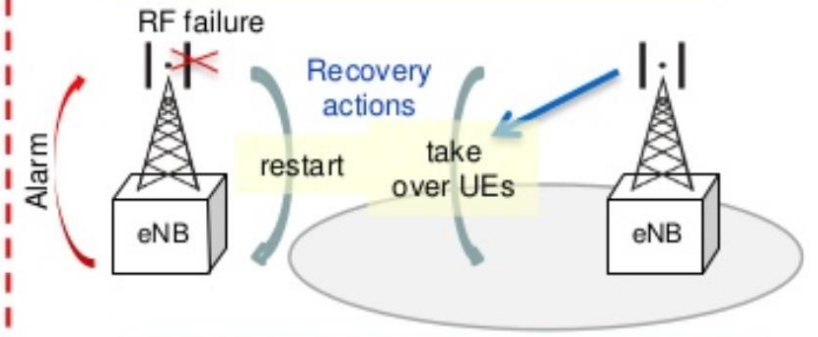
RF failure

Recovery actions

Alarm

restart   take over UEs

eNB

eNB

Self Healing example features:
- Automatic detection and locatization
  of NW failures and faults
- Performing recovery actions
  (e.g. reconfiguration, restart, reload,
  load fallback software)

What's real (great) SON looks like

Figure 1: Cell virtual footprint after running DLB-L, as perceived by a UE comparing the loaded cell to an offloader cell

The virtual cell coverage, as perceived by the UE is different than it is and UE executes HO/reselection, leaving the loaded cell
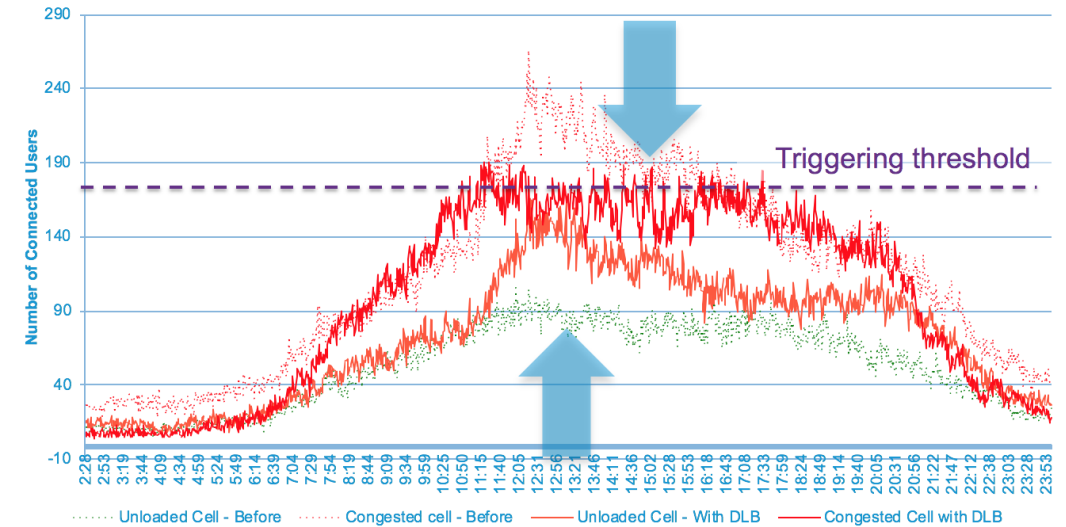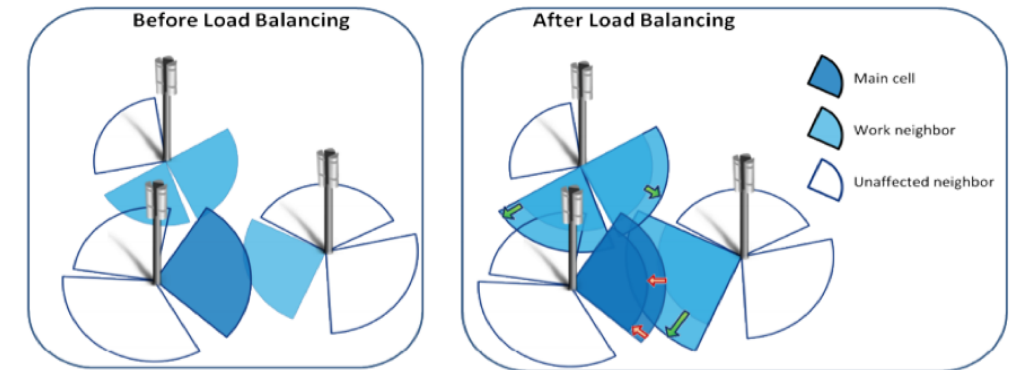
- CellIndividualOffset.
- Qoffset

Self configuration (function1)

Dynamic plug-and-play configuration of newly deployed eNBs:

- Automatic Inventory & Automatic Software Download

- Automatic Physical Cell ID (PCI) assignment (and PCI confusion correction)

- Automatic neighbor relations: ANR

The eNB will by itself configure the Physical Cell Identity, transmission frequency and power, leading to faster cell planning and rollout.

- 3GPP Rel 8 main focus was on these items to support the commercial deployment of LTE networks
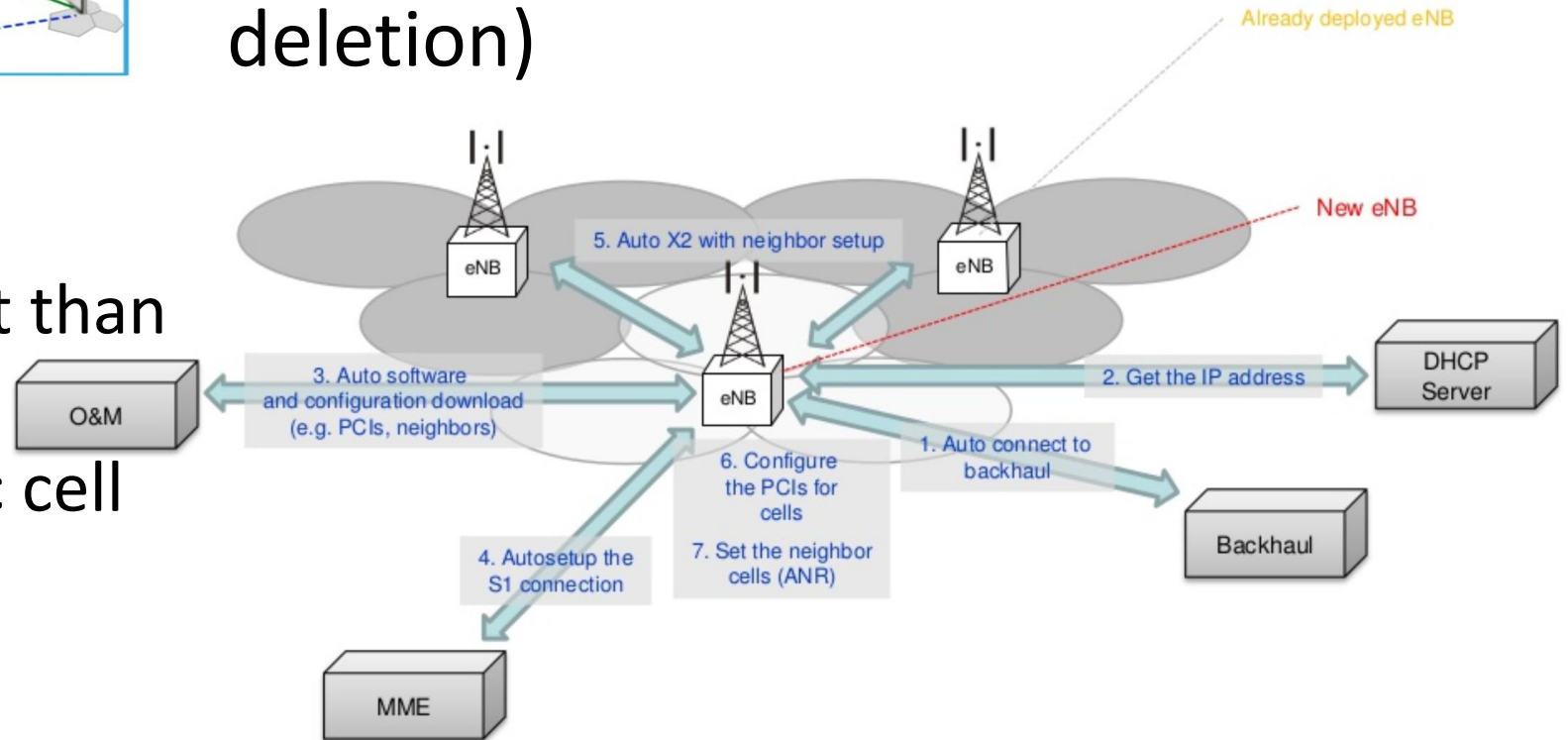
Self configuration - Example
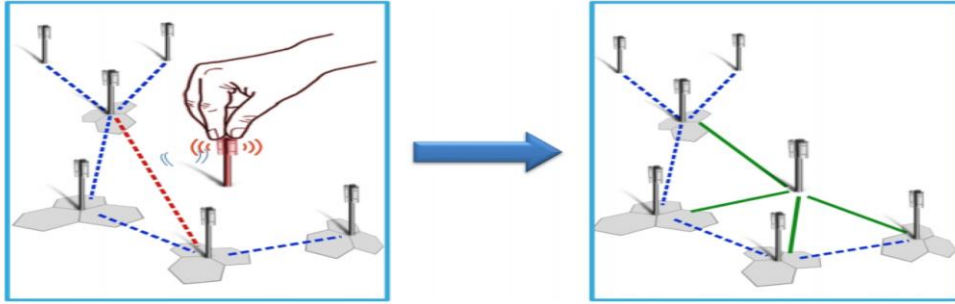
The ANR app builds and maintains an optimal neighbor lists (addition & deletion)

PCI APP enforces:
1. Each cell's PCI is different than its neighbors
2. Each neighbor of specific cell has different PCI

Already deployed eNB

New eNB

5. Auto X2 with neighbor setup

eNB

eNB

eNB

O&M

3. Auto software and configuration download (e.g. PCIs, neighbors)

2. Get the IP address

DHCP Server

1. Auto connect to backhaul

Backhaul

4. Autosetup the S1 connection

6. Configure the PCIs for cells

7. Set the neighbor cells (ANR)

MME

Self optimization (function 2)

- Optimization of:
  - coverage
  - capacity
  - interference
  - Handover

Main apps:

- Load balancing optimization
- Mobility robustness optimization
- RACH optimization
- Coverage and capacity optimization (CCO)
- Inter-Cell Interference Coordination
- Power Saving
- Minimize of drive testing (MDT)

*Both Release 9 & 10 SON functionality focused on the operational aspects of already commercial networks

Load balancing

- Cells suffering congestion can transfer load to other cells, which have spare resources. Relevant for Intra freq, inter-freq, inter-RAT

RACH (Random Access Channel) optimization

- RACH is an uplink unsynchronized channel, used for initial access, hand-over or uplink synchronization

- When poorly configured access setup time and accesses failures increase, impacting both call setup and handover performance

- App maximizes procedure success rate and minimize attempts

- Done by: root sequence's planning, rach tx power control, backoff time, etc.

MRO

- Mobility robustness optimization is a solution for automatic detection and correction of errors in the mobility configuration.

- main focus is on errors causing Radio link failure (RLF) due to too late or early handover, or handover to an incorrect cell.
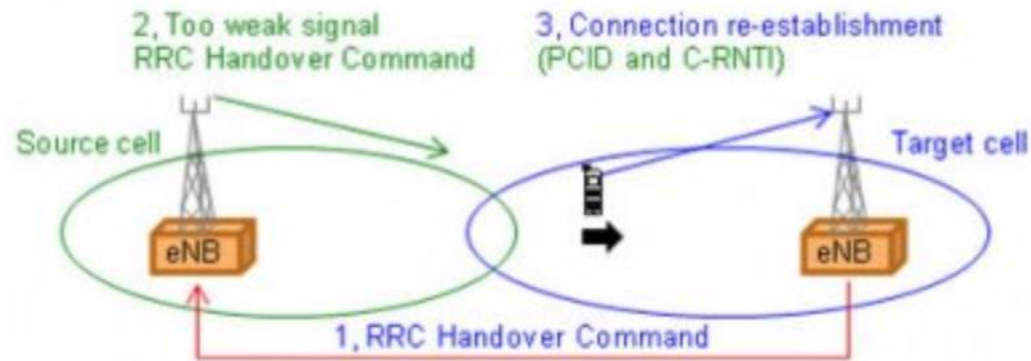

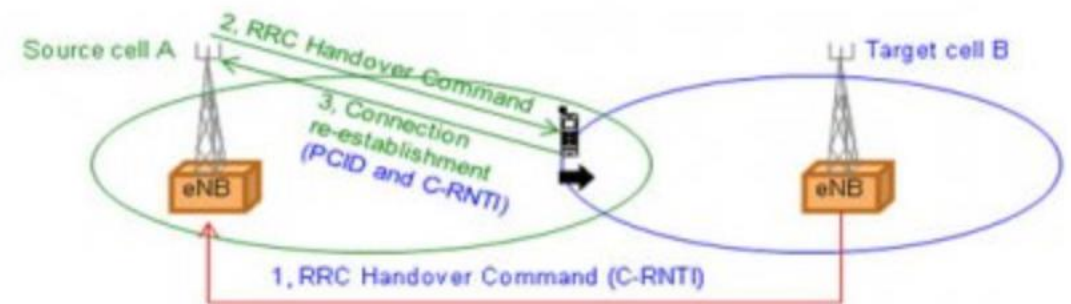Figure 3, Late Handover, the UE does not receive the RRC

Figure 4, Handover too early, the signal strength in the target cell

Coverage and Capacity Optimization

- Coverage & capacity were traditionally planned based on network measurements and usage of theoretical propagation models in planning tools and extensive drive tests.
- This method is still largely based on measurement estimations and inaccurate.
- CCO enables automatic correction of capacity/coverage problems depending on slowly changing environment and relaying on real network measurement rather than on theoretical models

Interference Mitigation

- Low interference →higher SINR→ higher spectral efficiency and more capacity
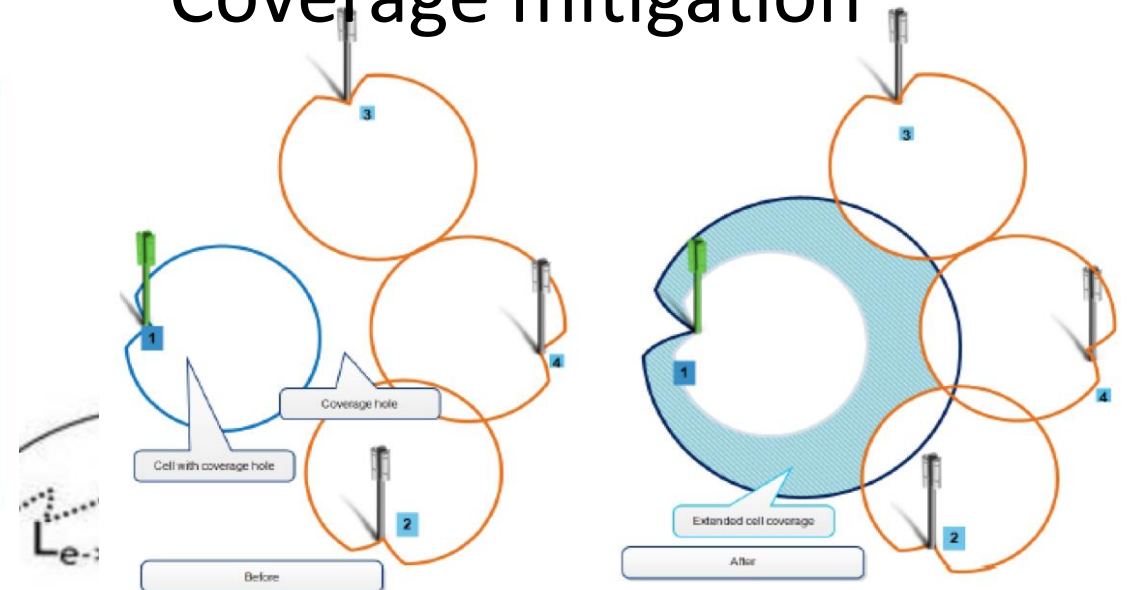
Coverage capacity and interference mitigation

Interference mitigation
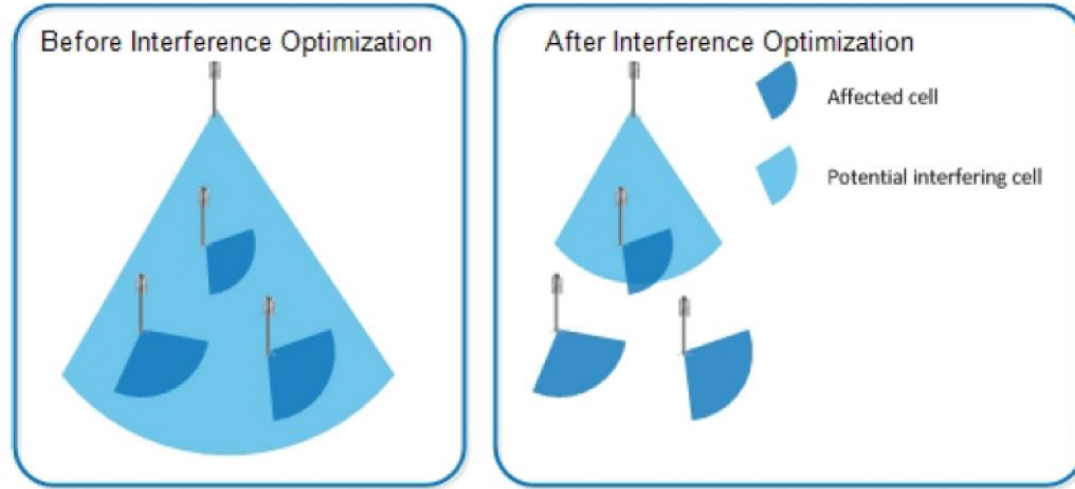
> Downtilting Antenna using RET (Remote Electrical Tilt)

Coverage mitigation

> Uptilting Antenna using RET (Remote Electrical Tilt)

Figure 8. Uplink Interference Scenario and Path-loss / Cross-Loss notation.

- Usage of electric tilt change
- Coverage & capacity trade off

Power saving

- In order to save energy some cells can be switched off when capacity is not needed.

- The power consumption in a base station is not only related to load and power is required even if there are no users to serve.

- According to the legal operator license coverage must be maintained at all times!
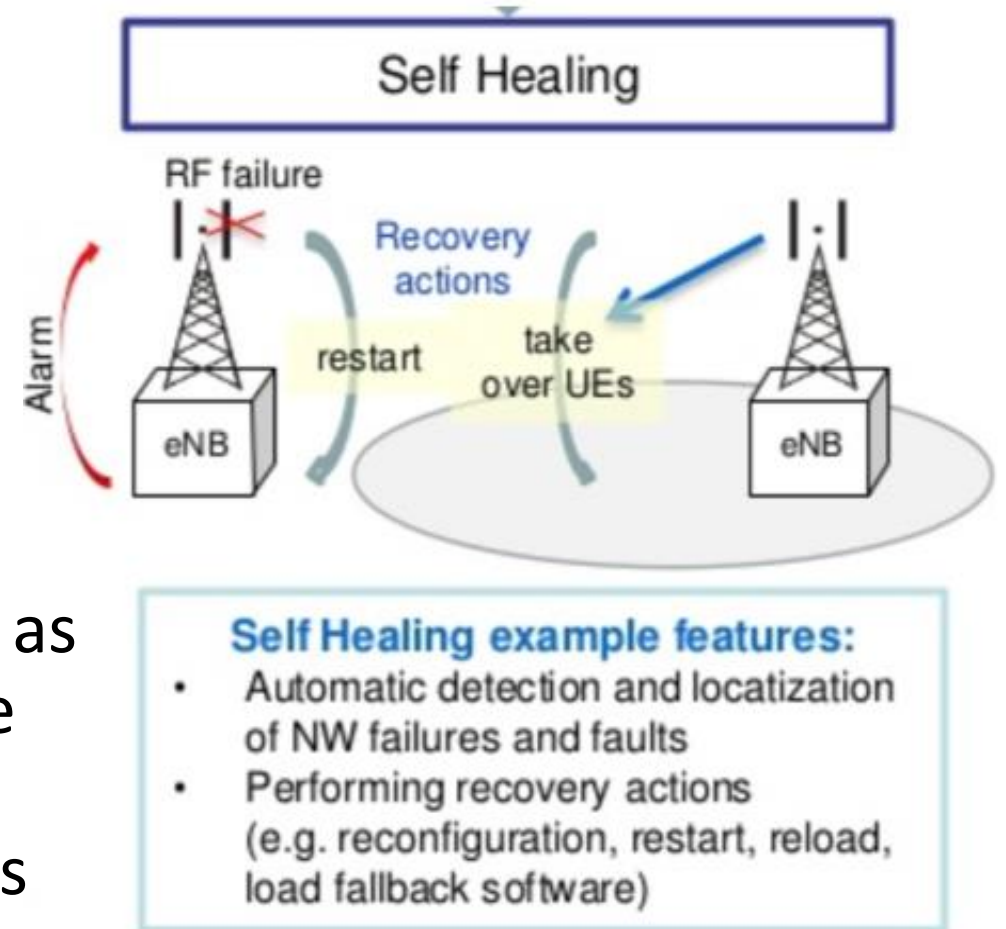
  → → → → Wake up call solution to the sleeping cell

- A cell is suspend after last user leaves.

  All incoming handovers are rejected.

- The cells that remain on, providing coverage

  can wake up a suspended cell when traffic load increase

Self healing (function3)

- Self-healing is a function that mitigates the faults automatically by triggering appropriate recovery actions.

- Classic use case is that once a cell is detected as unable to function, another cell is responsible for network recovery by changing its RF foot print "antenna uptilt"is order to serve the Ues used to be served by the unfunctional cell

Self Healing

RF failure

Recovery actions

Alarm

restart   take over UEs

eNB   eNB

Self Healing example features:
- Automatic detection and locatization of NW failures and faults
- Performing recovery actions (e.g. reconfiguration, restart, reload, load fallback software)

SON in standardization

- SON functionality and behavior has been defined and specified in generally accepted mobile industry recommendations produced by organizations such as 3GPP and the MGMN (Next Generation Mobile Networks)

- SON has been codified within 3GPP Release 8 and subsequent specifications in a series of standards including 36.902 as well as public white papers outlining use cases from the NGMN

- The first technology formally making use of SON features is LTE, but the technology has also been retro-fitted to older radio access technologies

SON for 5G [TR 28.861 – on work]

"A 5G network is more complex than previous generations of mobile networks, which means that the need for automation is higher for 5G"

- Based on the location of the SON algorithm, SON is categorized into centralized SON, distributed SON and hybrid SON.

- The centralized SON (C-SON) means the SON algorithm is located in the 3GPP management system

- 3GPP management system is monitoring and executes SON actions in and across multiple network domains such as RAN and Core
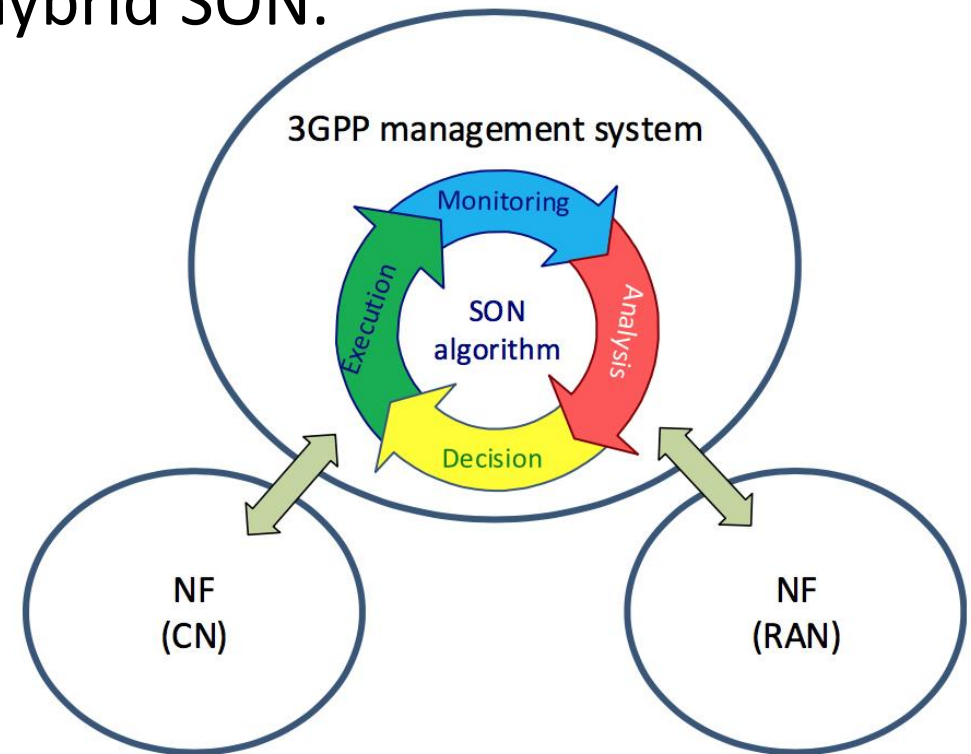

Figure 4.1.2-1 C-SON view

Distributed SON where the algorithm is located in the NFs

Figure 4.1.3-1 D-SON view

Hybrid SON

Figure 4.1.4-1 H-SON view

The 3GPP management system is responsible for management and control of the D-SON functions.

- Switching on/off a D-SON function
- Making policies for a D-SON function
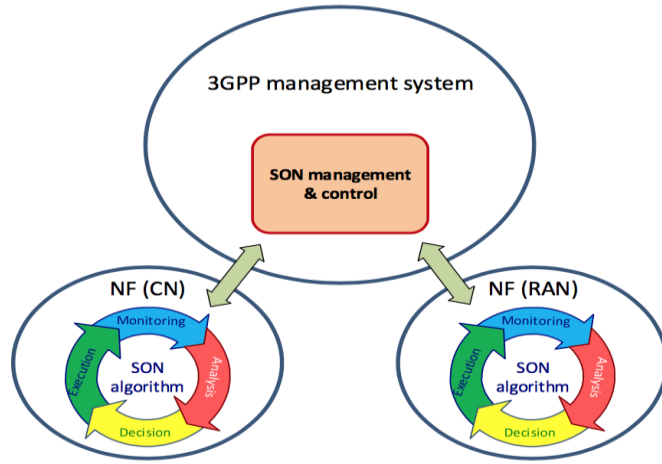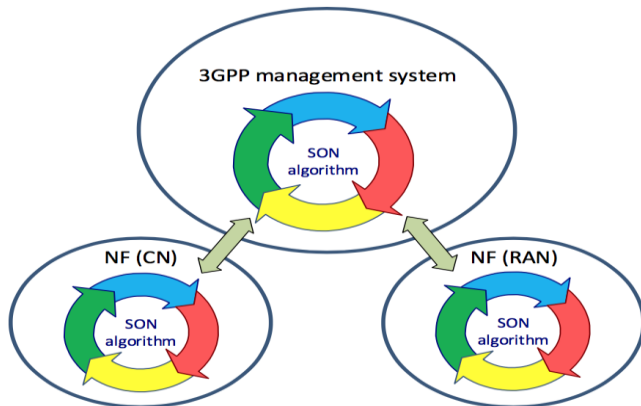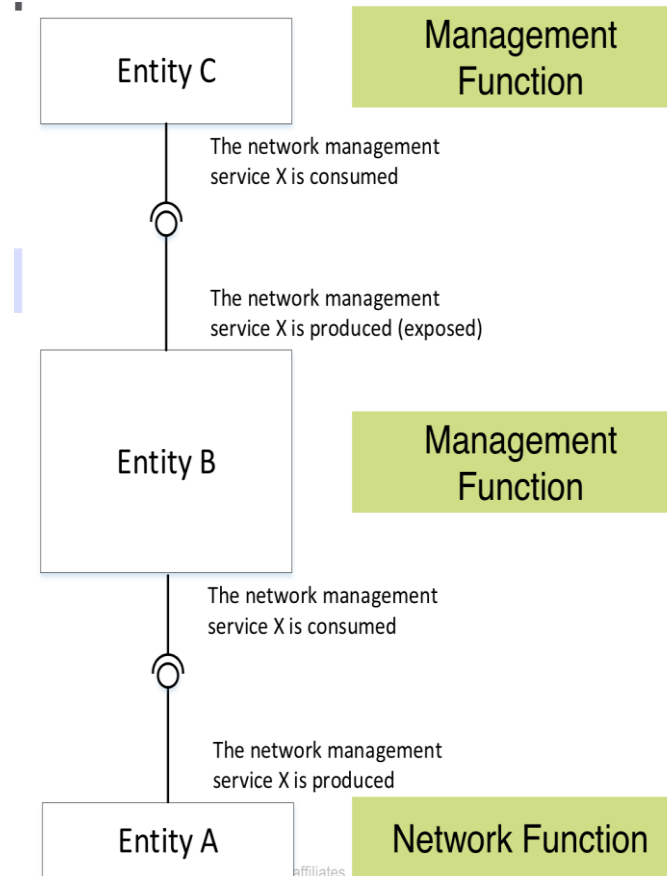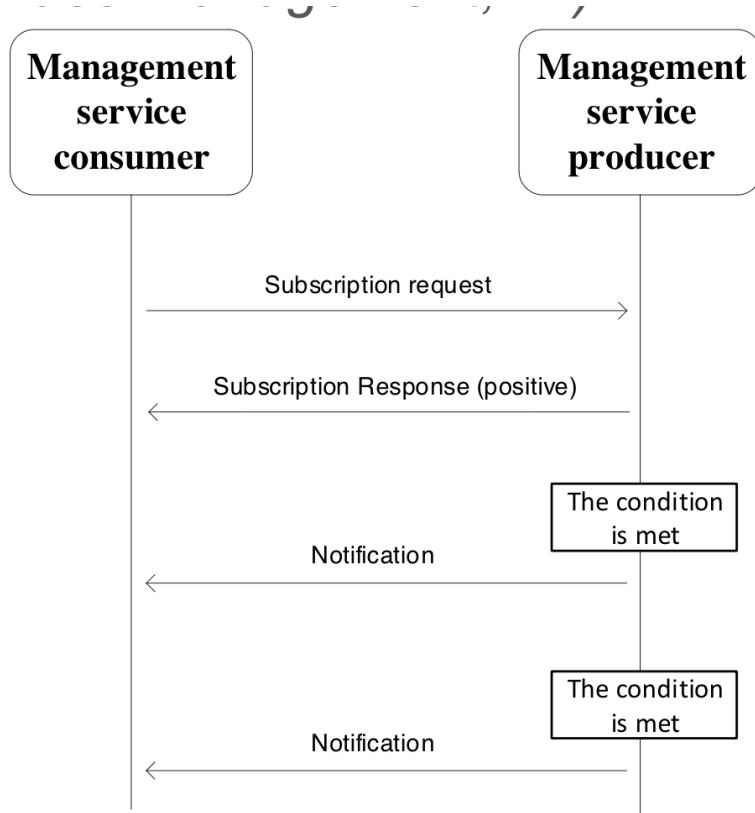- Providing supplementary information (e.g., the value range of an attribute) to a D-SON function

5G Service based Architecture

- Any entity can be a producer of the management service

- There can be a "proxy" consuming certain
- service and exposing or (re