5G end-to-end solutions from operation perspective

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Agenda

1. Elisa & Finland – the land of mobile data
2. Elisa 5G path
3. 5G as part of whole technology stack
4. Automated 5G RAN operations
5. Value for customers and Elisa

Elisa operates in digitally advanced and attractive markets…

Finland has mobile data usage[1)]

- FIN 36.2 GB per capita per month
- EU 8.0 GB per capita per month

Mobile broadband widely preferred

- Exceptionally high share of mobile broadband-only households 36%[2)]

Regulator drives digitalisation and competitiveness

- Early allocation of frequencies
- Proactive dialogue between stakeholders
- Technology-neutral broadband policy

[1)] Rewheel 2019, *Mobile data competitiveness rankings.*
[2)] Eurostat, Rewheel analysis 2019.

Striking 5G experience by providing…

- High quality & user experience
- Wide selection of terminals and subscriptions
- Extensive coverage
- Cutting edge technologies
- High level of automation

2021 End-to-end 5G standalone, over 3M Finns under 5G coverage

2020 5G standalone connection demo, 8 Gbps pilot using mmWave, over 1M Finns under 5G coverage

2019 Starting device & subscription sales

2019 Commercial 5G network

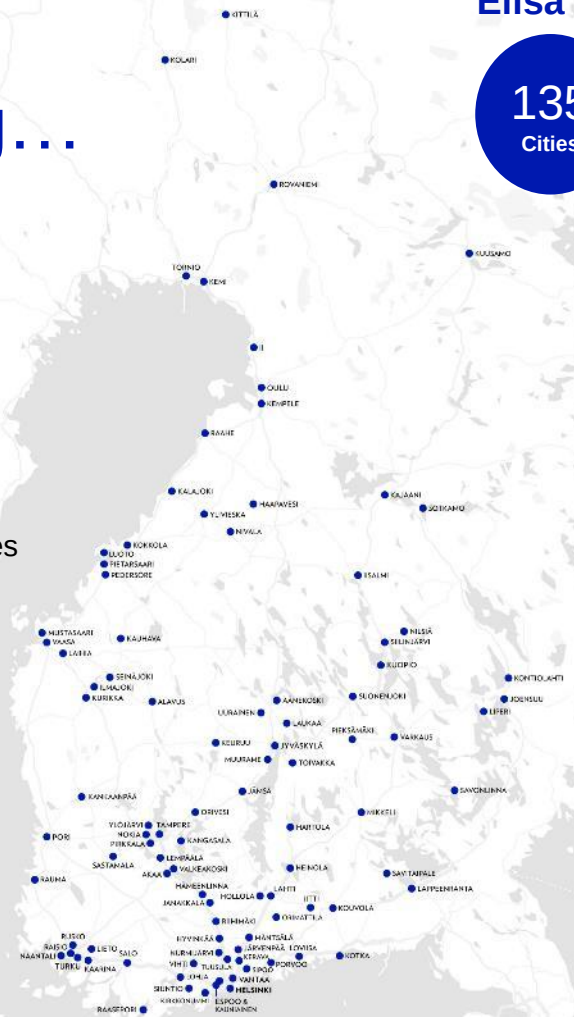
2018 Opening 5G network opened

2017 Starting 5G/3.5GHz tests

2016 Demonstrating 5G

Elisa 5G

135 Cities



5G as part of whole technology stack

Technological components in 5G networks

Terminals and subscriptions

5G non-standalone (NSA): different terminal types have been available, subscriptions with speed-tier based pricing.

Backhaul

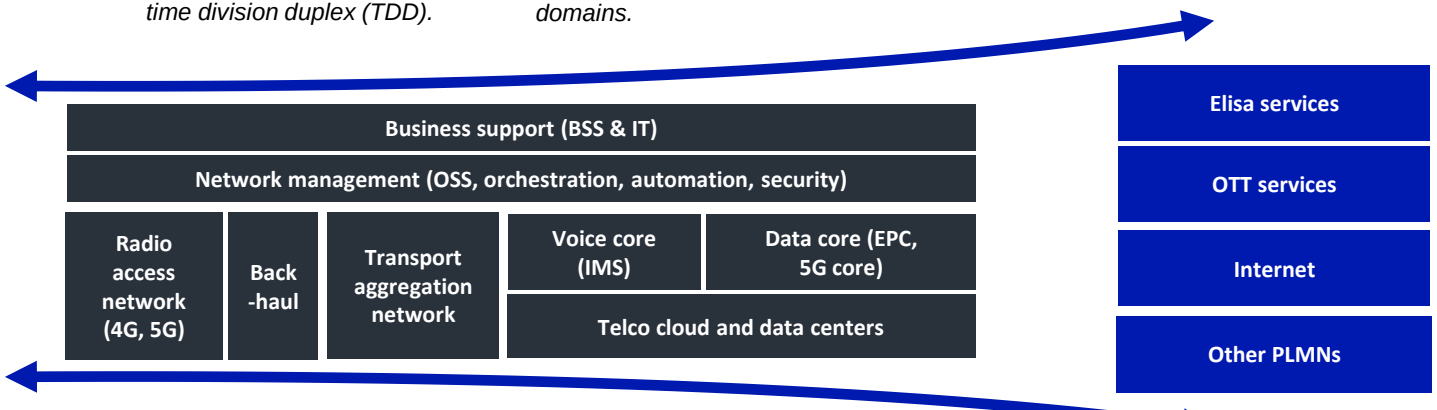
Connectivity from radio access sites towards core network based on 10G fibre and microwave solutions. Relays site-based accurate synchronization for 5G time division duplex (TDD).

Network management

Network management entity deploying different technical functionalities. Separated between different technology domains.

Business support

Main entities to provide interface between business management and technical functionalities for subscriptions.



Radio access network

5G rollouts ongoing (over 70% population coverage). Main frequencies 3500 MHz together with 4G frequencies. 5G standalone (SA) will be based on using also lower 5G frequencies.

Transport aggregation network

Optical backbone network to connect radio access and core network. Relays site-based synchronization for 5G time division duplex (TDD).

Core network

Central core network that deploys data and voice connectivity together with functionalities required for user session and mobility management. 5G NSA is based on 4G core, 5G SA brings a new core functionalities.

IMS = IP Multimedia Subsystem
OSS = Operations support system
BSS = Business support system
EPC= Evolved packet core (4G)
OTT = Over-the-top
PLMN = Public land mobile network

5G provides way towards service evolution

Technological improvements in SA over NSA seen in customer experience:

- No 4G dependency any more
- Shorter session setup times
- Shorter session interruption time during handovers
- Enables service evolution

Mobile broad-band network

5G services network

	Speeds in DL/UL	Latency	Core Network	Voice	Data	QoS/E	Terminals	Sub-scriptions	Customer benefit
5G NSA	400 Mbps (max 2 Gbps) 30 Mbps (max 200 Mbps)	10-30 ms	4G	VoLTE	5G + 4G with even 3CA*	QCI scheduling based on speed tier. Service differentiation with SPID	All 5G terminals support 5G NSA, and several 4G carrier aggregation combinations	Speed-based tiering (300, 600, 1000 Mbps)	Improved user bitrates and network capacity
5G SA	300 Mbps*** (max 1.5 Gbps) 25 Mbps (max 200 Mbps)	<10-30 ms	5G	VoLTE with EPS fallback (later VoNR)	5G and 700/2100 MHz (2CA**)	Same as in NSA, and native support for RAN-aware slicing	Limited availability of terminals with SA and 5G carrier aggregation capability	Basic 5G SA combined with requirements of new services (use cases)	Same as in NSA, and improved QoS/E depending on new service requirements

* Typically 4G includes 800, 1800 and 2100/2600 MHz.
** 5G SA with 700 MHz and/or 2100 MHz, other frequencies allocated to 5G based on 4G traffic.
*** End user experience could be improved by allocating higher priority for 5G SA users than 5G NSA users.

CA: carrier aggregation
VoLTE: voice over LTE
VoNR: voice over new radio
EPS: Evolved packet core
QoS/E: Quality of Service / Experience
S-NSSAI: Single-network slice selection assistance information
QCI: QoS class identifier
HSS: Home subscriber server
SDIP: Service profile identifier

5G as part of whole technology stack

5G slicing as end-to-end solution

Slicing: technical capability to create **multiple logical** end-to-end networks on a **mobile network** for different use cases which demand **diverse service level requirements**

Terminals and subscriptions

Basic support existing up to 8 slices and needs subscription-based slice provisioning.

Backhaul

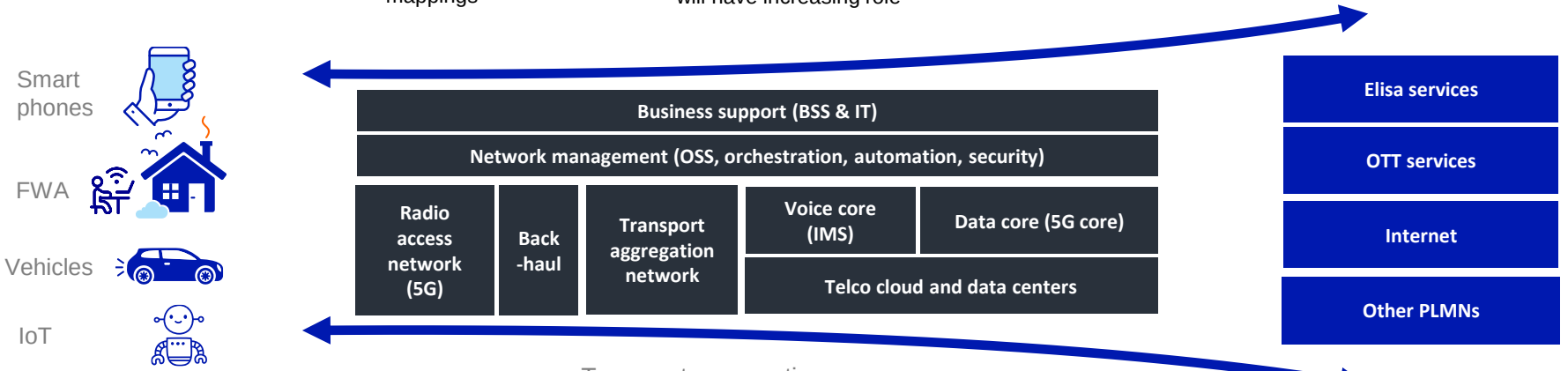
Per transport path IP addressing, routing, and security with IP QoS mechanisms as VLAN mappings

Network management

Network and slice provisioning and management ability. For end-to-end management, orchestration and automation will have increasing role

Business support

Slice provisioning based on subscriptions. Possibilities to obtain better service level agreements (SLA).



Radio access network

RAN is slice-aware (S-NSSAI) which enables slice-based QoS (5QI, GBR) scheduling. Slice list (NSSAI) based cell selection and mobility together for slice-based optimization.

Transport aggregation network

Per transport path IP addressing, routing, and security with IP QoS mechanisms as VLAN mappings

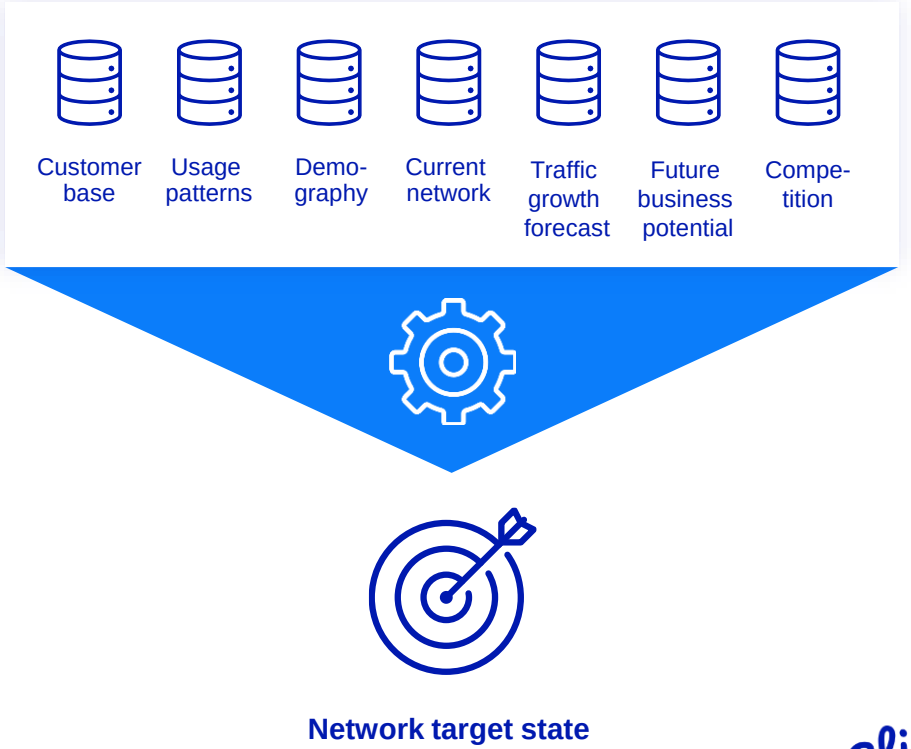
Core network

Key slicing functions supported on the 5G core with static and dynamic mechanisms for slice provisioning and management.

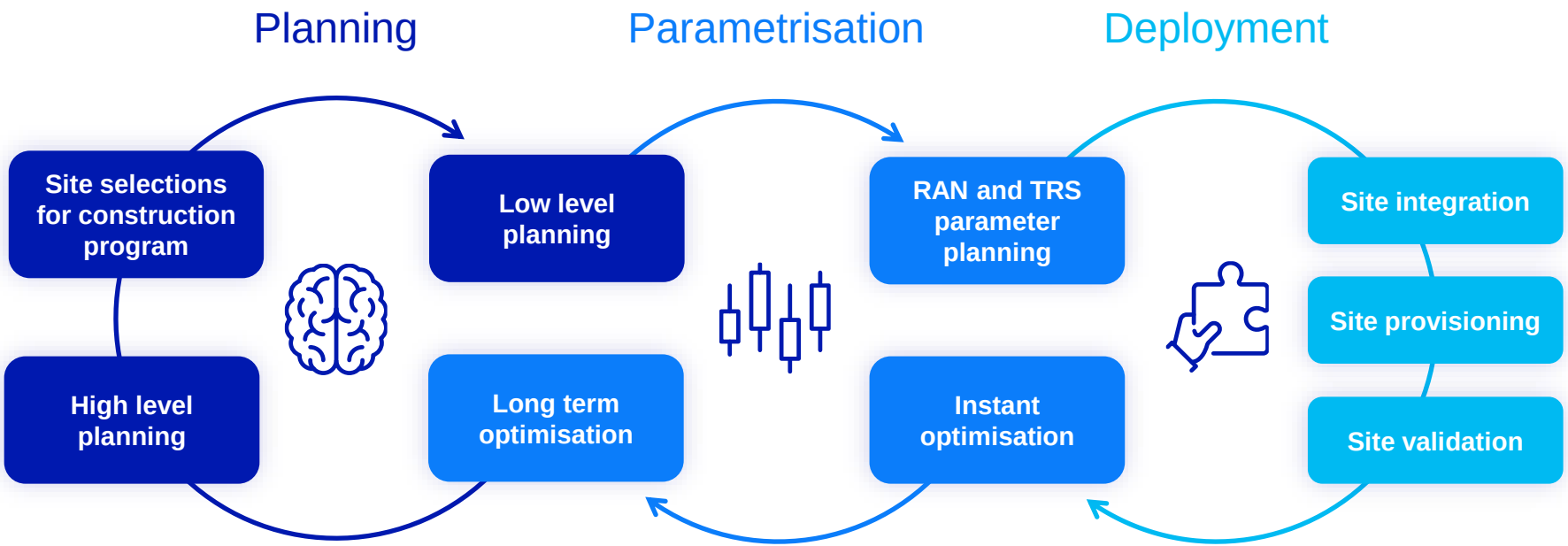
S-NSSAI: Single-network slice selection assistance information
5QI: 5G QoS identifier
GBR: Guarantee bit rate
DSCP: Differentiated Services Field Codepoints
VLAN: Virtual local area network

Network high level planning based on customer perceived value and data analysis

Network target state based on automatic analysis of massive amount of data that defines high capacity access technology for the whole country



Planning and deployment



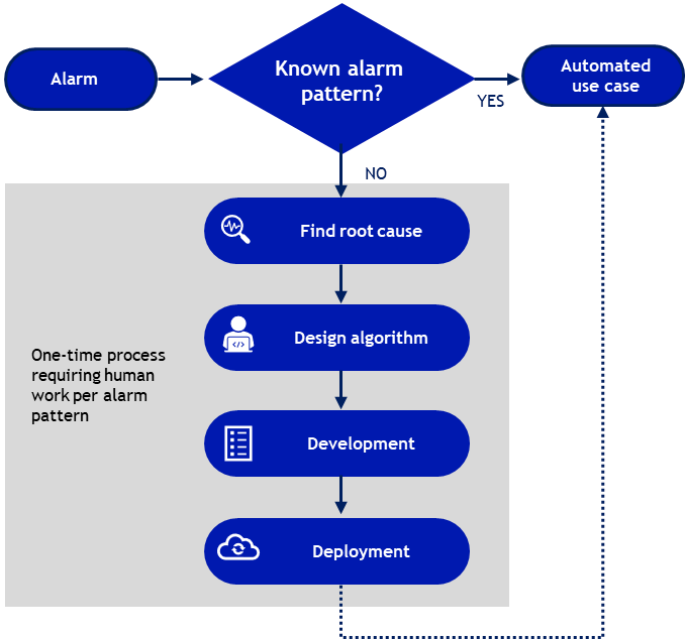
Automated processes as input for each other

RAN: Radio access network
TRS: Transmission network

Automated operation and optimisation

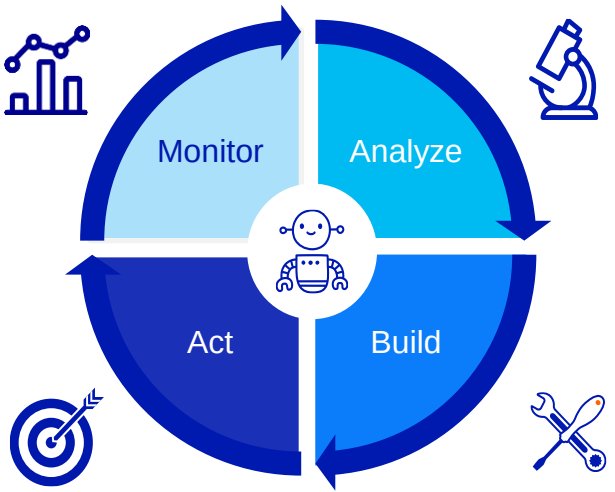
Automated network operations

- **100 % alarm monitoring** automated
- **100 % action ticketing** automated
- **90 % of ticket actions** automatically resolved



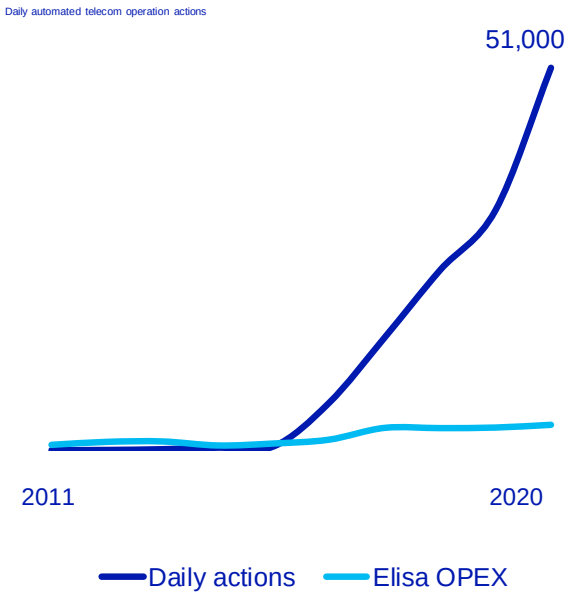
Automated network optimisation with closed-loop optimisation

- Enable consistent network quality (accessibility)
- Tackle increased network complexity (mobility, load balancing)
- Improve network efficiency (tilting, beamforming, energy saving)

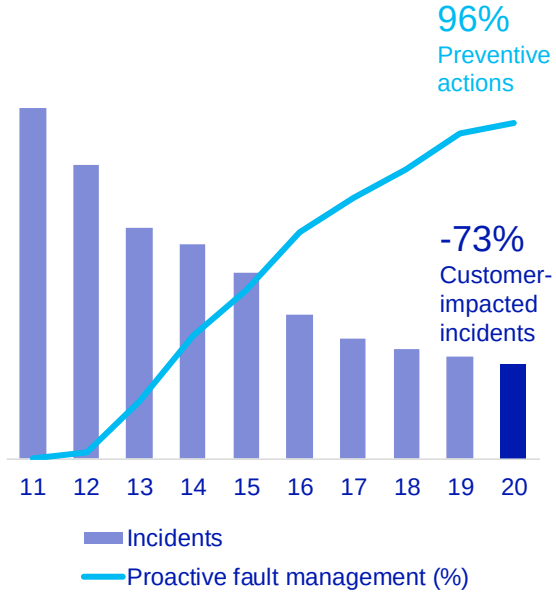


Sustainable improvements in network operations

Efficiency through increased automation



Customer-perceived quality improvement



Results

- **Over 40×** more data traffic in the mobile network with flat CAPEX% and OPEX[1)]
- **0 critical major faults** in Elisa's network since 2016
- **0-persons** in network operation centre. Focus in automation development and service operations.

We continue to deploy

- AI-driven automated network planning and capacity management
- Zero-touch access network deployment
- Fully software-based IP network and cloud operations

[1)] 2011-2020

AI: Artificial intelligence
IP: Internet protocol

Summary

5G implications seen all over the technology stack.

5G standalone will provide path towards 5G service evolution, but 5G non-standalone will play very crucial role in the future as well.

Slicing provides mechanism for operators to deploy virtual networks and obtain better preconditions for future 5G services and use cases.

Operational complexity can be tackled with automation.

Thank You!