Dynamic network resource management in the cloud

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Introduction

- What kind of cloud

- What is network resource in the cloud

- What is specific to telco

- Why dynamic

- How to make dynamic – automation
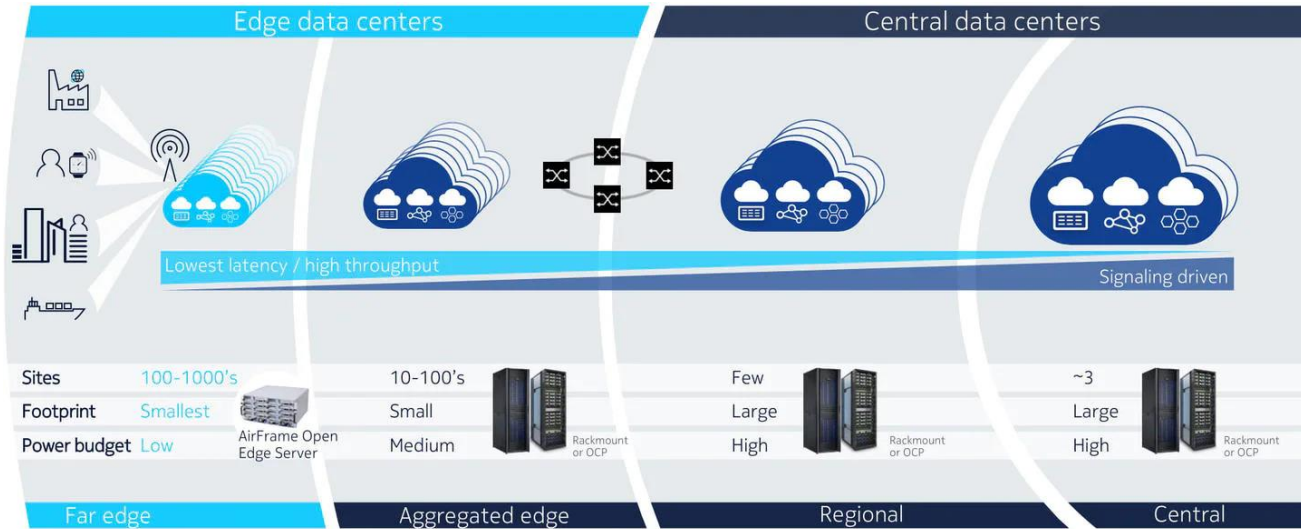
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Central to edge clouds

In telco environments

Central

- Typically: private cloud of telco provider
  - From cloud vendor
- In hyperscaler cloud
  - Geography, etc. can be typically selected
  - Not the same as public
- Other cloud provider

Edge

- Typically: private cloud of telco provider
- Hyperscaler edge offerings
  - Multiple offerings – managed, unmanaged, appliance, hardware included, standalone, etc.
  - Often bundled with workload (analytics, 5G core, etc.)
- Other cloud provider edge offerings

	Edge data centers		Central data centers	
Lowest latency / high throughput → Signaling driven				
Sites	100-1000's	10-100's	Few	~3
Footprint	Smallest	Small	Large	Large
Power budget	Low	Medium	High	High
	AirFrame Open Edge Server	Rackmount or OCP	Rackmount or OCP	Rackmount or OCP
	Far edge	Aggregated edge	Regional	Central

Towards 6G

- (Use of) new/other virtualization (e.g. serverless, unikernels, microVMs, WASM, etc.)
- Heterogeneous (nested virtualization, hybrid public/private, central/edge)
- Multi-cloud orchestration, multi-cloud management
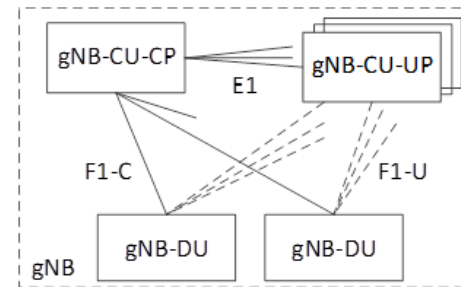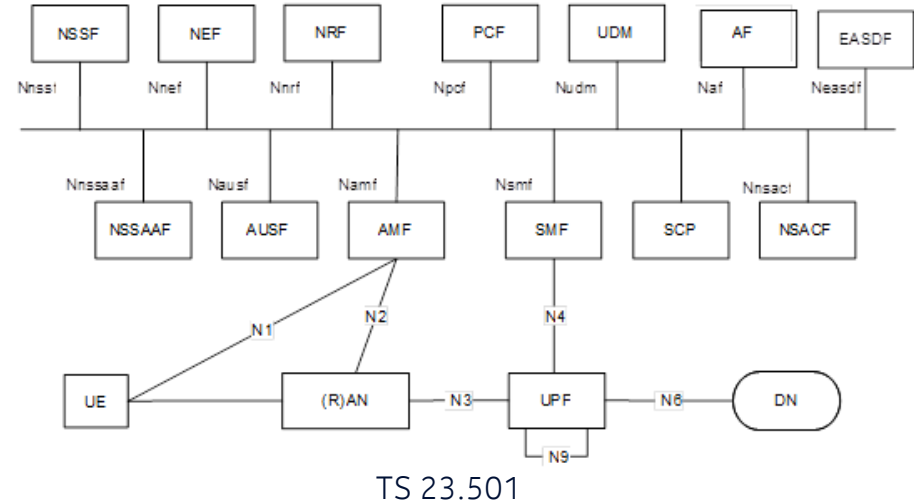
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Network resources in cloud
Workloads in 3GPP mobile

5G Core

- Control plane
  - Compute heavy, storage heavy, central
- User plane
  - Network heavy (+compute heavy)
  - Close(r) to endpoints (e.g edge UPF)

RAN (Radio Access Network)

- Centralized Unit – Control Plane, User Plane
- Distributed Unit – network+compute
- (Radio Unit) – not (yet) in cloud

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Network resources in cloud
Other workloads

Central

- Network management platforms, for all network domains:

  - domain controllers, slicing management, operational support (OSS), business support (BSS), network management (NMS), analytics, Open-RAN Service Management and Orchestration, automation platforms, etc.

- Customer relations, business relations, charging, (CRM, BRM), etc.

- "N6 LAN" functions, security functions

- Media content (CDN)

- Software delivery platforms (CI/CD),

- Etc.

Towards edge / edge

- Wireline, convergence

  - BNG (Broadband Network Gateway), gateway functions (e.g. Fix-mobile Convergence Access Gateway Function)

  - vPON nodes (vOLT, vONT)

- RAN

  - O-RAN Radio Intelligent Controller, controller apps

- Multi-access Edge Computing

- Etc.

Edge

- Enterprise networks
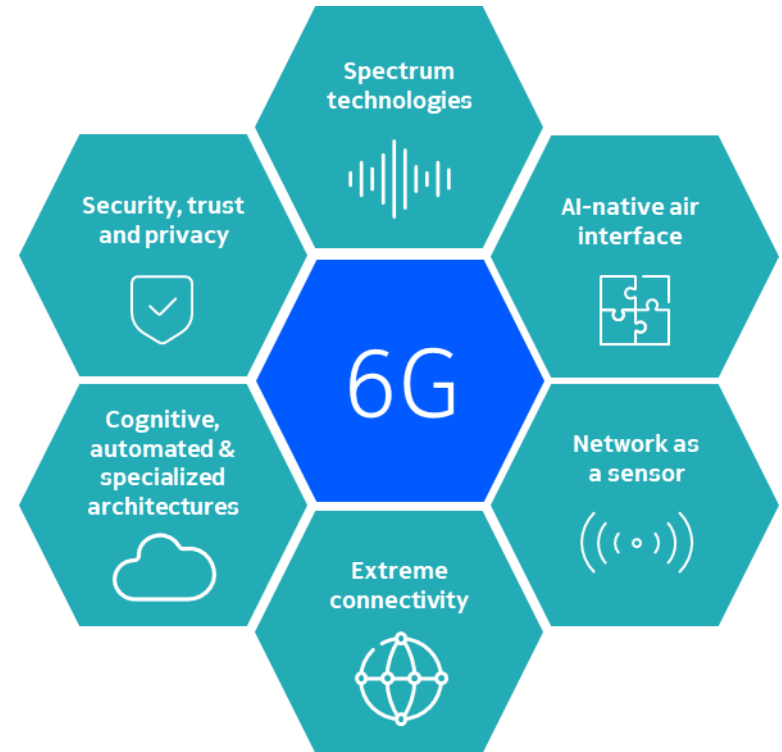
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Network resources in cloud
What 6G brings

Towards 6G – potential changes to come
- Increased importance of analytics workloads
- ML pipelines, training, AI model inference
  - Storage heavy, compute heavy
- Increased weight of NPN (Non Public Network), enterprise, subnetworks
- Network automation and management functions more distributed
- Different functional splits, more functions
- Merge of some functions (e.g. RAN/Core UPF)
- "Movement" towards edge from central
- Compute/capacity information for network decisions

New workloads
- Digital twins
- Sensing / processing / fusion
- Etc.

Spectrum technologies

Security, trust and privacy

AI-native air interface

6G

Cognitive, automated & specialized architectures

Network as a sensor

Extreme connectivity

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What's so special about telco

Telco workload requirements

- "Traditional" placement question / network function chaining:
  - Given set of cloud points of presence, with certain capacities along various dimensions (CPU, memory, vDisk, network) → where to place network functions with given individual resource requirements along those dimensions
- Dynamically in time
- **Special telco requirements**
  - Network performance:
    - DPDK (DataPlane Development Kit), SRIOV (Single Root Input-Output Virtualization), datacenter network fabric
    - CPU pinning, hyperthreading
    - Storage, storage performance

- **Special telco requirements**
  - **Accelerators.**
    - Their virtualization
    - Smart NICs
    - GPU, ASICs, etc.
  - ARM vs x86
  - HA – not thousands of equivalent servers
    - Number of nines
- **Regulatory**
  - E.g. subscribe data should stay within the country
  - Legal interception
  - Persistence of data
  - Interworking, roaming
  - Service quality

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Why dynamic
And why not

General advantages

- Statistical multiplexing gains

- Utilize what cloud is about

- Flexible network resources – according to traffic variations (geo and time)

aaS models

- E.g. 5G core as a Service

- Direct cost impact

Sustainability

- Turn off what is not needed

- Tune processor speed to what is needed

Risks

- Increased complexity

- Efficiency gain vs complexity cost

- Stability

- Performance

- Timescales

- Infra/platform resources should be also dynamically adjusted

- Cloud vendor lock-in

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Why dynamic
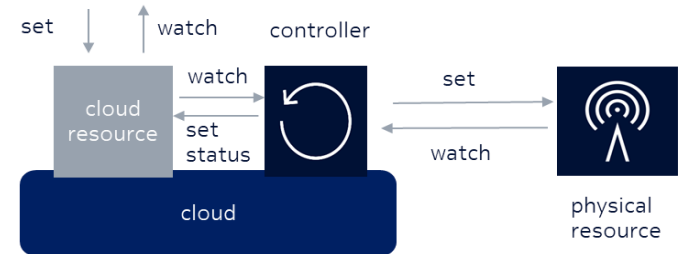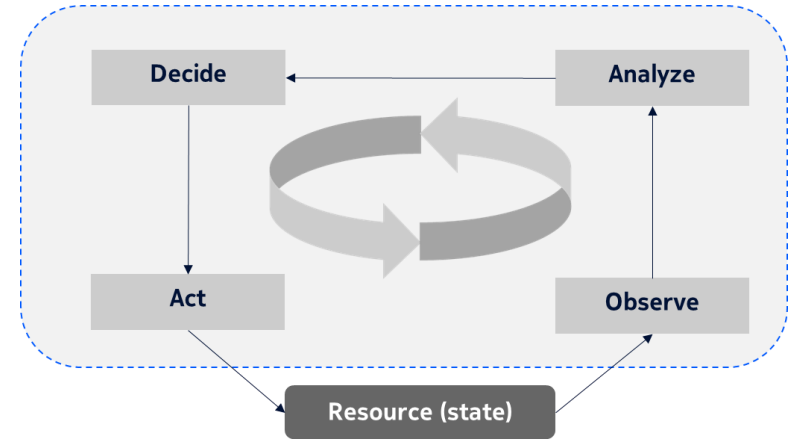## And how

Automation is a must

- "Traditional" telco: network automation, service automation
- From automation to autonomy / *autonomous* operations
- Closed loop control with AI assisted decisions
- Intent based / declarative management at all layers
  - Declare desired state and constantly keep

Adopt cloud automation and tooling

- Network is software running in cloud, network resources ~ cloud resources
- Lifecycle management, automation
- *Operator pattern* – extend the notion of resource
- Telemetry, logging, reporting, etc.
- Open source, community, products

Adopt cloud / sw / IT tooling

- GitOps
- Infrastructure, configuration as data / as code
- CI/CD

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