Hva er cloud og virtualisering? Og hvorfor trenger vi det?

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The 5G promised land

- ✓ Umbrella covering all legacy 2G-4G +
  - ✓ Mission critical communication
  - ✓ Things and people
- ✓ Challenges
  - ✓ Higher capacity
  - ✓ Lower end-to-end latency
  - ✓ Massive device connectivity (IoT)
  - ✓ Consistent QoE
  - ✓ Reduced OPEX and CAPEX costs

European Commission

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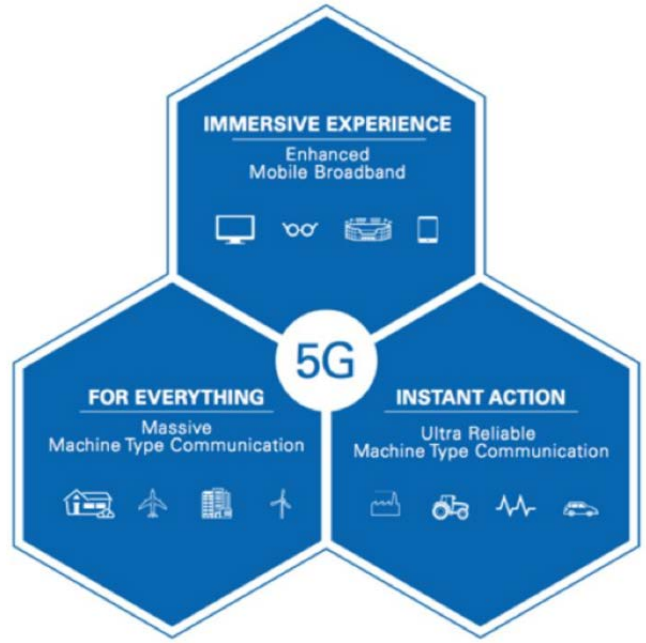
3 service categories of 5G

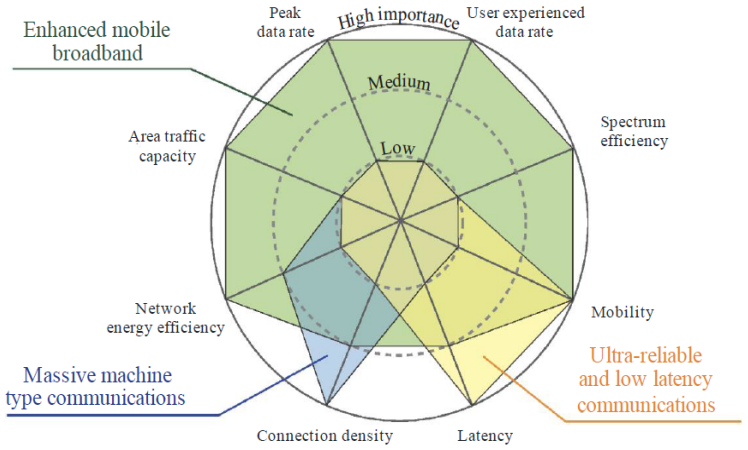
- ✓ eMBB
  - ✓ capacity enhancement
- ✓ Massive machine type communication (mMTC)
  - ✓ 106 devices /km^2, 99.9 % availability, 125 b/s *
- ✓ Critical machine type communication (uMTC)
  - ✓ High reliability (10^{-5}) success, latency < 0.5 ms *

5G will support applications with very different requirements
→ Need for flexible, "elastic" solutions

* *TR22.891*



Source: National Instruments



ITU-R, "Recommendation ITU-R M.2083-0, IMT Vision – Framework and overall objectives of the future development of IMT for 2020 and beyond," Sep 2015.

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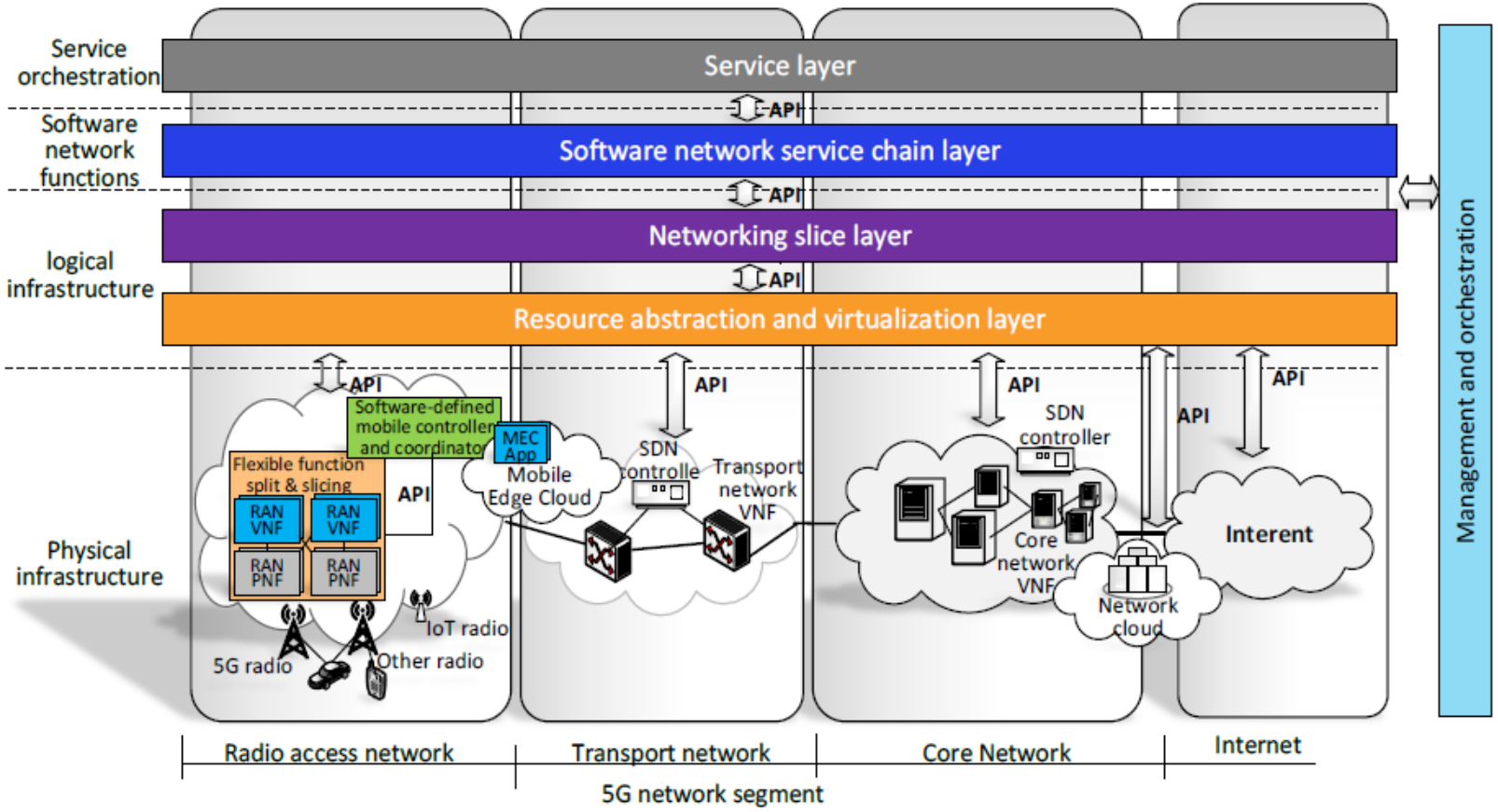
Software network technologies in 5G - virtualization

- ✓ The overall network should be SW-(re)configurable in order to address conflicting requirements
- ✓ Decoupling of SW and HW = virtualizing
- ✓ Reuse of infrastructure resources (SW and HW platforms) ☺
- ✓ Network Slicing
  - ✓ Deployment of multiple logical networks as independent business operations
- ✓ Future-proofing design as updates can be easily and swiftly implemented by SW ☺



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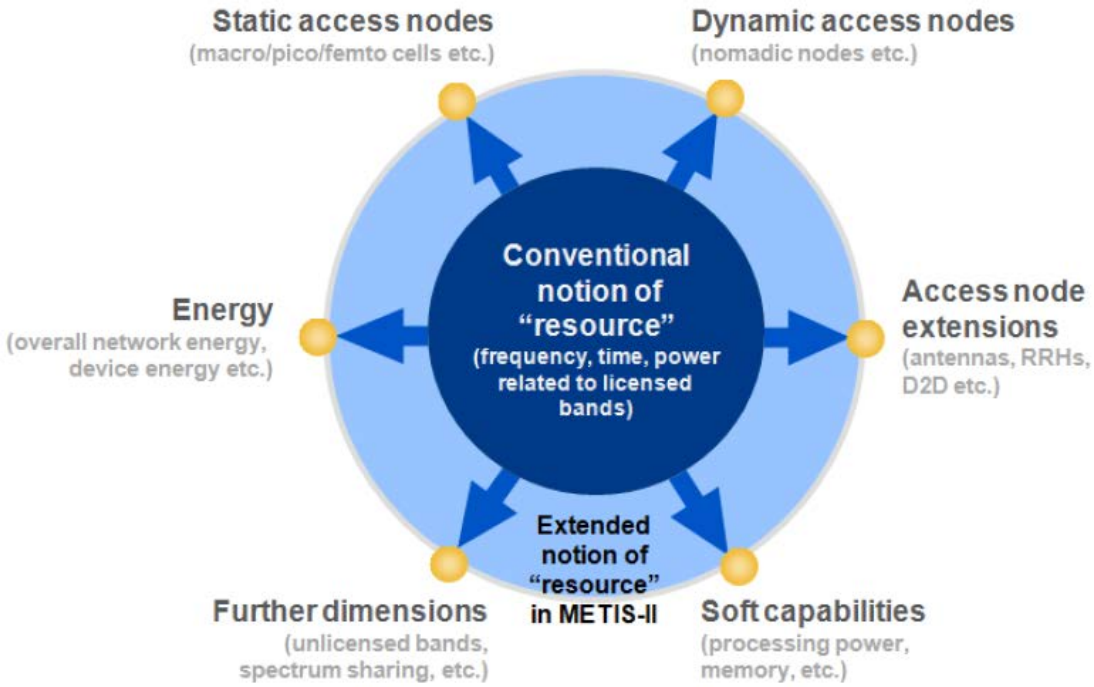
Virtual Network Functions in 5G

- ✓ Extension of the notion "resource"
  - ✓ The VNFs will play an important role especially in the design of Core Network functions
  - ✓ Connectivity; filtering, forwarding, packet inspection
  - ✓ Computation; virtual machines, SW running on top of high-volume platforms, switches…
  - ✓ Storage; database functionality - inside or edge of network
- ✓ VNF are defined regardless of physical infrastructure
  - ✓ Mapping to physical architecture in a service-specific way
  - ✓ Flexible instantiation ☺
  - ✓ Avoids vendor lock-in ☺



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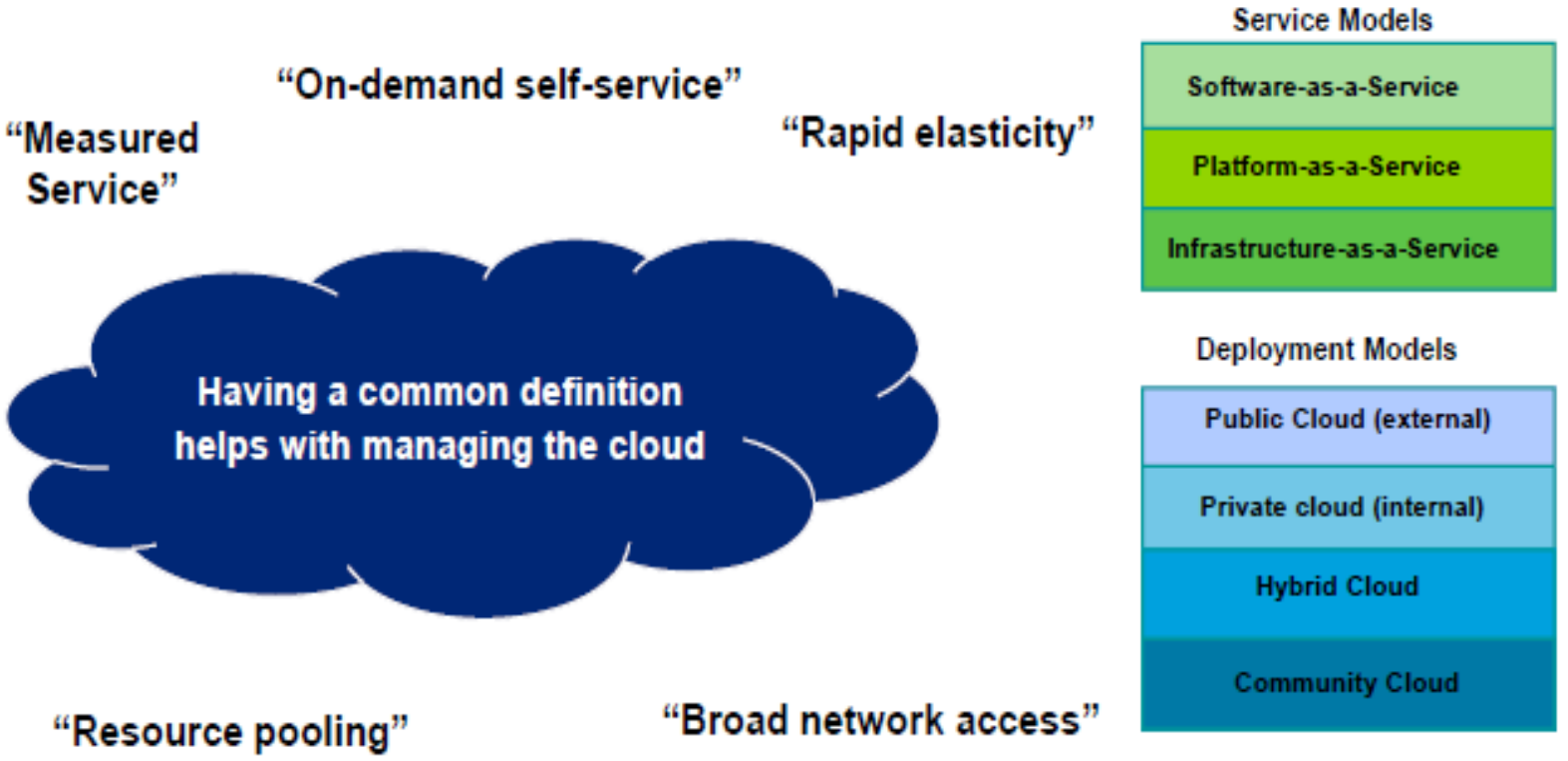
What is cloud computing?

- ✓ NIST 800-145 definition: Ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources



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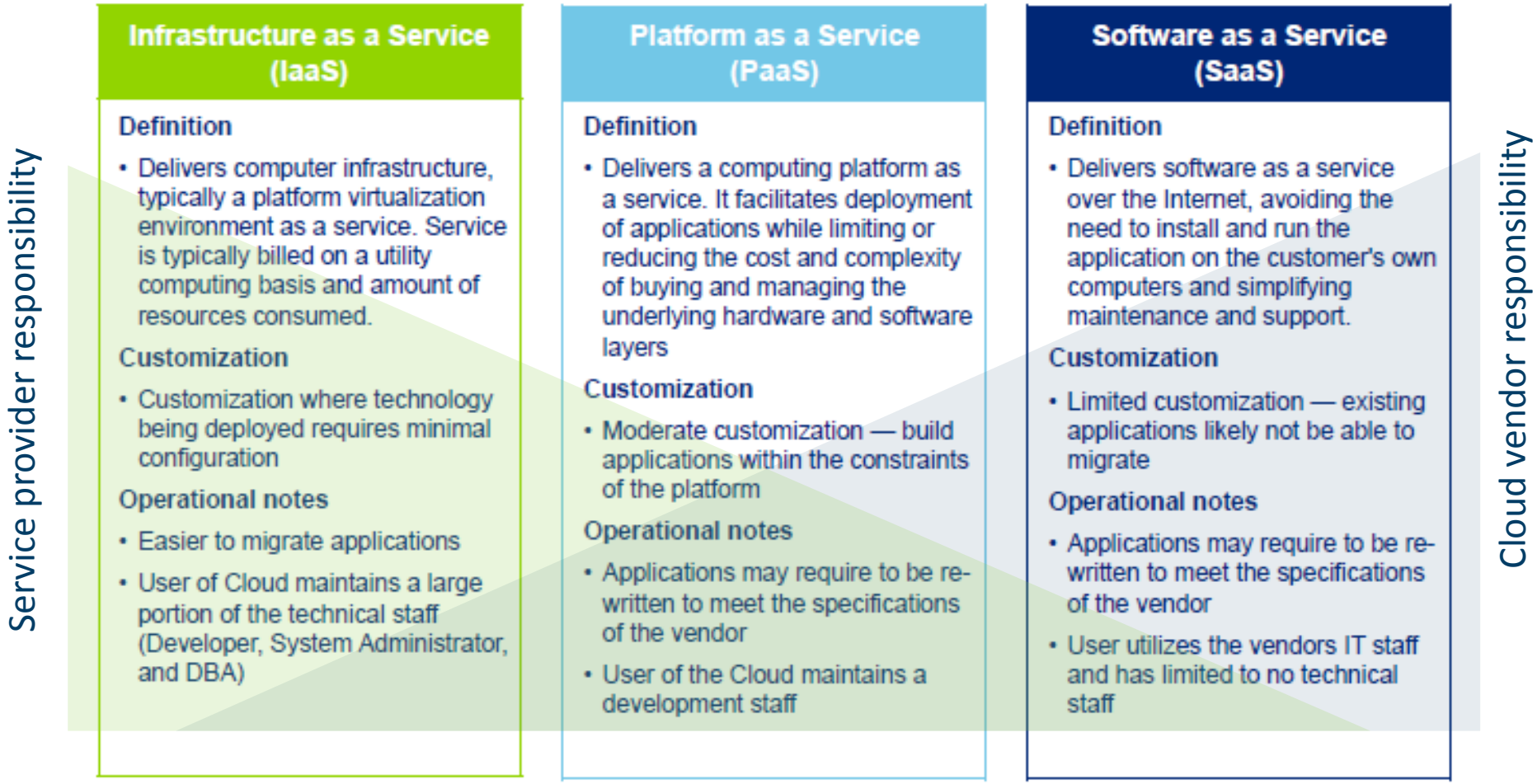
Cloud computing: service delivery

"As A Service" trend =



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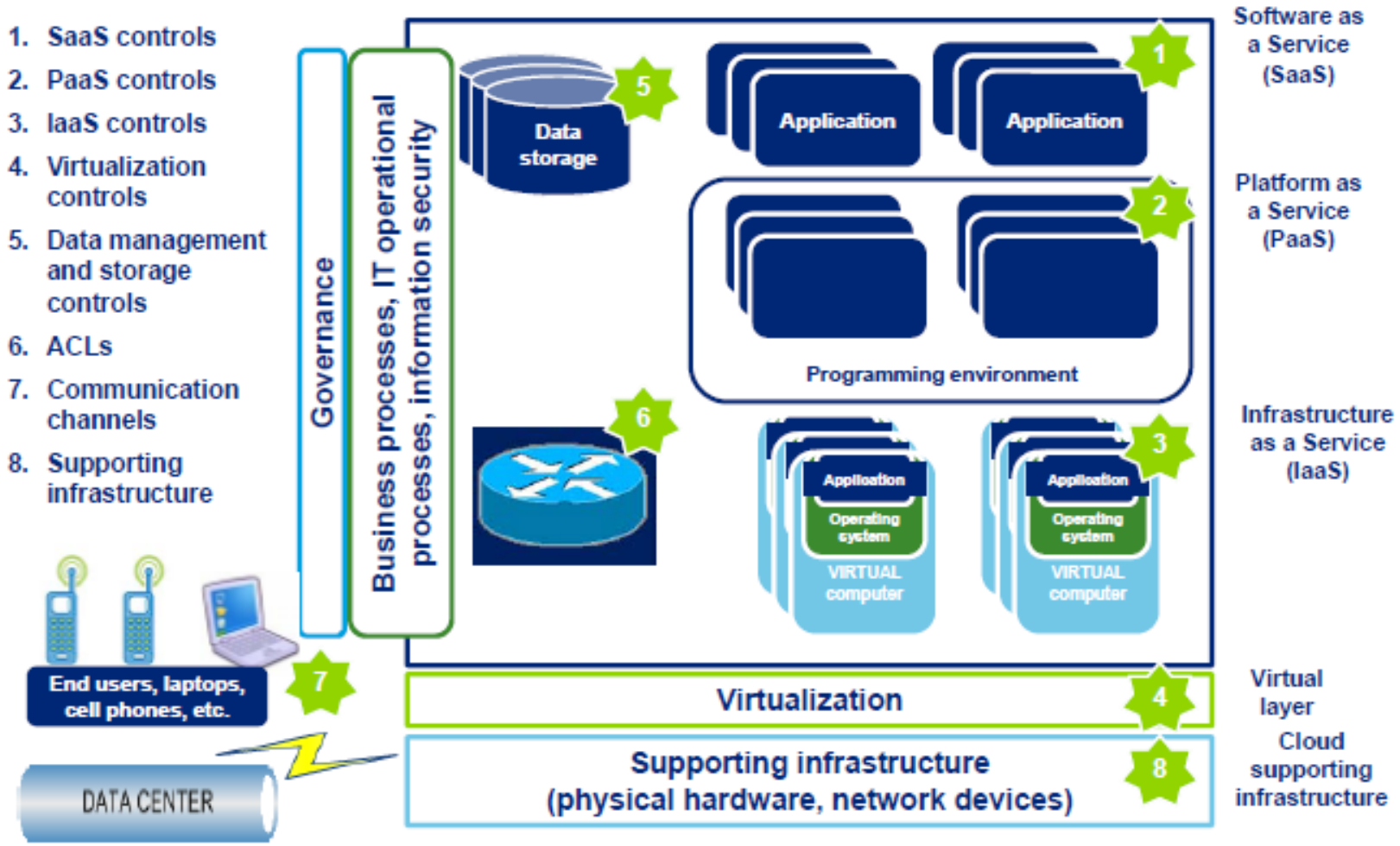
Combining virtualization and cloud

- ✓ Network and virtualization layer links cloud services and providers of data centers
- ✓ Control points are spread



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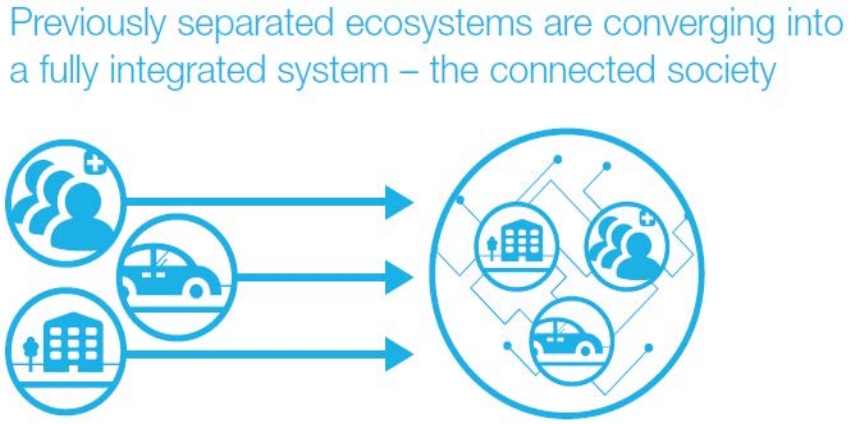
Virtualization and cloud environments

- ✓ Ecosystems; 3rd parties and vendor chain. From integration of services and platforms to more open market place
  - ✓ 5G-centered umbrella
  - ✓ De-centralized approach
- ✓ Multi-cloud environments for different slices / KPIs
- ✓ Combination of cloud services
- ✓ Best of breed ☺
- ✓ Redundancy and always available services ☺
- ✓ Develop and roll-out new services in a very short time ☺



Telia report "Connected things. New digital ecosystems – unlocking the growth potential of IoT", 2017 edition.

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Risks in the context of clouds

- ✓ Risks are spread
  - ✓ Virtualization layer
  - ✓ Service: IaAS, PaAS, SaAS
  - ✓ Deployment: private vs. public clouds
  - ✓ Business models
  - ✓ Net neutrality vs. slicing

- ✓ Some examples of good conduct:
  - ✓ Manage authentication and access
  - ✓ Select cloud service providers that respect regulatory frames
  - ✓ Oversight and updating of all cloud service providers
  - ✓ Define privacy processes, monitor and revise privacy statements if necessary
  - ✓ Develop security management procedures across delivery chain

A particular risk: privacy

- ✓ Personally Identifiable Information (PIIs)
  - ✓ Strict legal definition or information leading to person identity
  - ✓ Individual identity (name, social security number, date and place of birth, biometric record…)
  - ✓ Medical, educational, financial, employment information that can help deducing identity
  - ✓ MAC and IP addresses not strictly PII but need protection
- ✓ Ecosystem of PII-dependent digital services is growing
- ✓ PII are collected, stored, exchanged, and applied by different kinds of services….(*)
- ✓ New European law (**) enforcing right to be informed of PII status and possibly to deletion of own PIIs
  - ✓ -> Traceability in the cloud-based network architecture
  - ✓ Important in case of intrusion

- A. Omerovic, M. Natvig, I. Tardy, "Privacy Scorecard – Refined Design and Results of a Trial on a Mobility as a Service Example", accepted for publication in the proceedings of the 27th European Safety and Reliability Association Conference (ESREL) 2017.

** European Parliament, Council of the European Union. Regulation (EU) 2016/679 - *Protection of natural persons with regard to the processing of personal data and on the free movement of such data*, 2016.

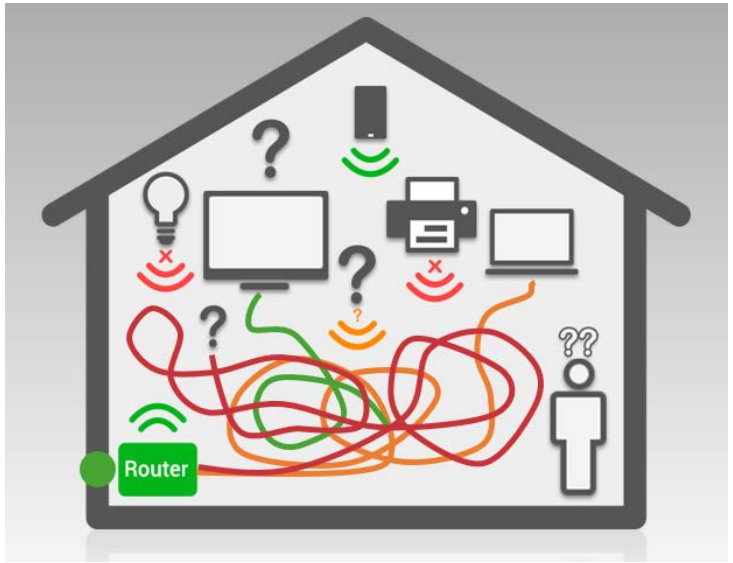
Measures enforcing privacy in a cloud context (*)

- ✓ Non-disclosure
  - ✓ Clear policy to specify how the cloud provider may access customers' data
  - ✓ The cloud provider may not disclose any of the customers' data to 3rd party, unless previously agreed
  - ✓ The cloud provider will only disclose customers' data to 3rd party on a need-to-know basis
- ✓ Anonymity
  - ✓ The cloud provider will not provide common logs to any other customer or 3rd party
- ✓ Data minimization
  - ✓ The cloud provider will only require the minimal set of data necessary to perform the service
- ✓ Data processing agreement (DPA) statements
  - ✓ The data processor will only act upon instructions from the controller
  - ✓ The data processor will comply with the same security obligations as the controller itself
  - ✓ No change during the lifetime of the contract unless there is consent from the customer

** SINTEF report n.A27131*

A concrete case; the smart home (1/2)

- ✓ A highly private sphere
- ✓ Several services
  - ✓ 3-play or individual Internet, broadcast, tel-services
  - ✓ Alarm
  - ✓ Distance heating, appliances control
  - ✓ Smart meters
- ✓ Services connected to individual clouds
- ✓ Alternatively, local aggregated control through cloud-enabled routers with dynamic deployments and instantiations



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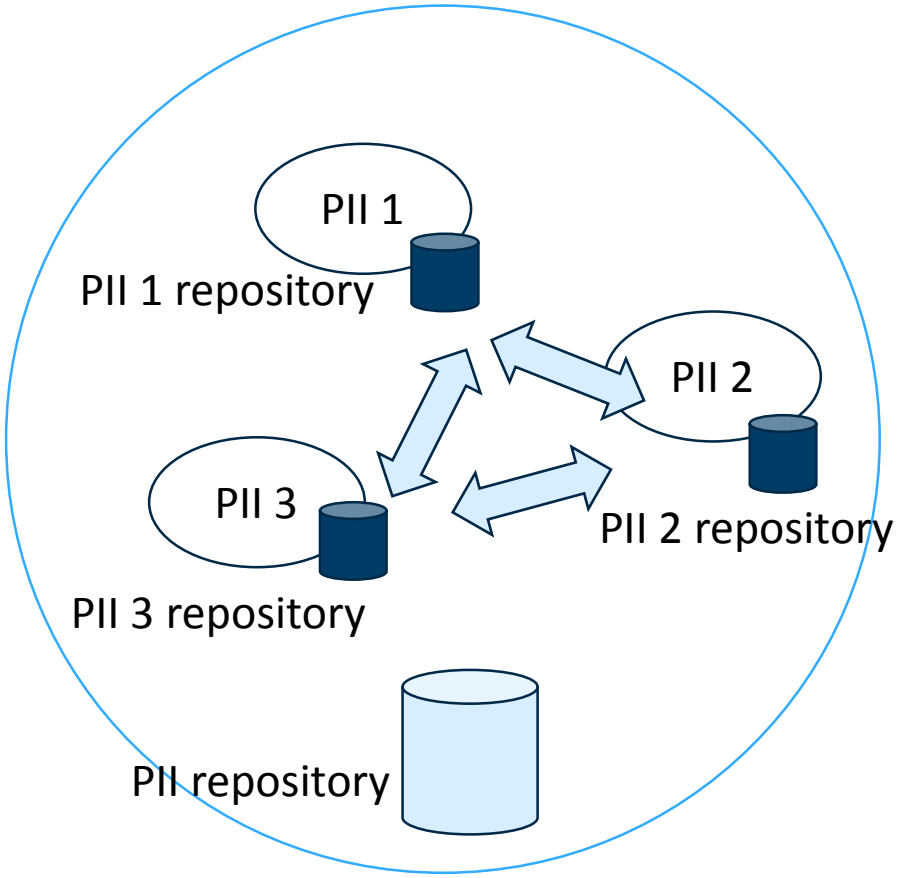
A concrete case; the smart home (2/2)

- ✓ Examples of PII to each service 1, 2, 3
  - ✓ Full name
  - ✓ Physical address
  - ✓ Tel-number, email @, MAC @
  - ✓ Favourite TV channels, web sites
  - ✓ Payment details
  - ✓ Energy consumption log
- ✓ When no connection nor coordination between services,
  - ✓ Only PII to that service need to be known
  - ✓ No exchange of PIIs across services
- ✓ Coordination
  - ✓ Risk of exchanging PII not necessary to all services but common denominator as a single stakeholder treats PII



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Conclusion

- ✓ Service enhancement is case-dependent and relies on clouds
- ✓ Elastic resources
- ✓ Swift time-to-market and updates
- ✓ Redundancy and resiliency
- ✓ Many stakeholders, responsibility must be ensured to retain confidence

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