Software engineering perspectives in Virtual and Software Defined Networks

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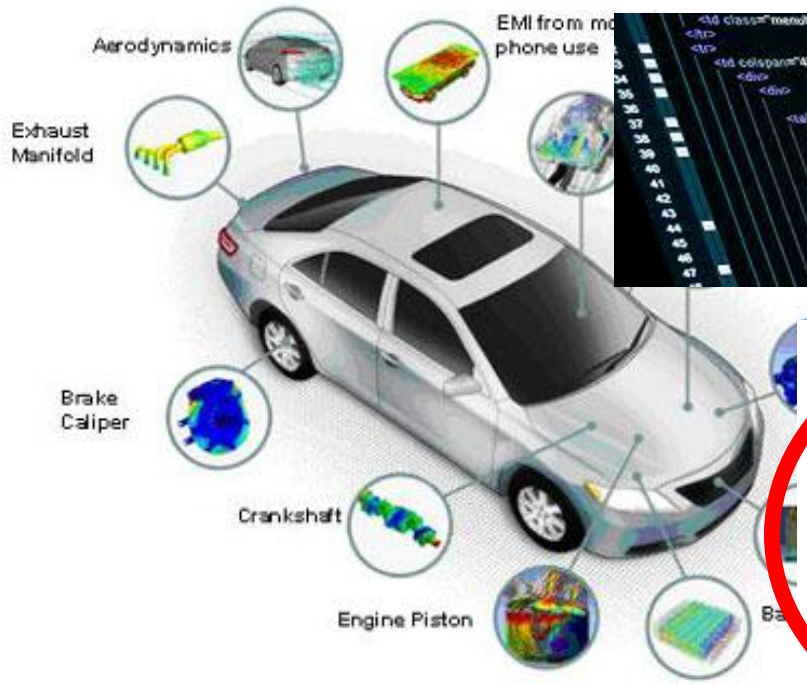
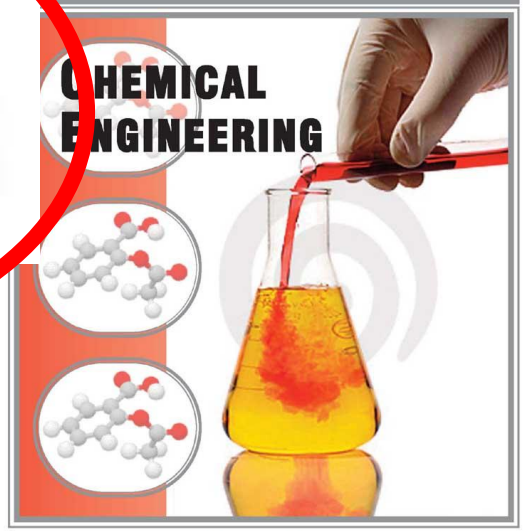
- Motivation
  - Emerging technologies and new network paradigms influence software lifecycle processes (Open network, ‘As a Service’, IoT, service compositions,)
  - Quality of Service --> Quality of Experience
  - Information and communication (ICT) become enabling technology in many application domains and here we need real software engineering work:
    - If service is realized by software what is changed in quality requirements on software
    - How network complexity reflected on software systems

Software engineering?

- "the systematic application of scientific and technological knowledge, methods, and experience to the design, implementation, testing, and documentation of software„ (*"Systems and software engineering - Vocabulary," ISO/IEC/IEEE std 24765:2010, 2010.)*
- "the application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software„ (*"IEEE Standard Glossary of Software Engineering Terminology," IEEE std 610.12-1990, 1990.*)
- "an engineering discipline that is concerned with all aspects of software production„ (*Sommerville, Ian (2007), Software Engineering (8th ed.). Harlow, England: Pearson Education. p. 7. ISBN 0-321-31379-8.*)
- and "the establishment and use of sound engineering principles in order to economically obtain software that is reliable and works efficiently on real machines", (*"Software Engineering". Information Processing (North-Holland Publishing Co.) **71**: 530–538. 1972.*)

How we can define software engineering profession?





Hampden ENGINEERING CORPORATION

What kind of software do engineers produce today?

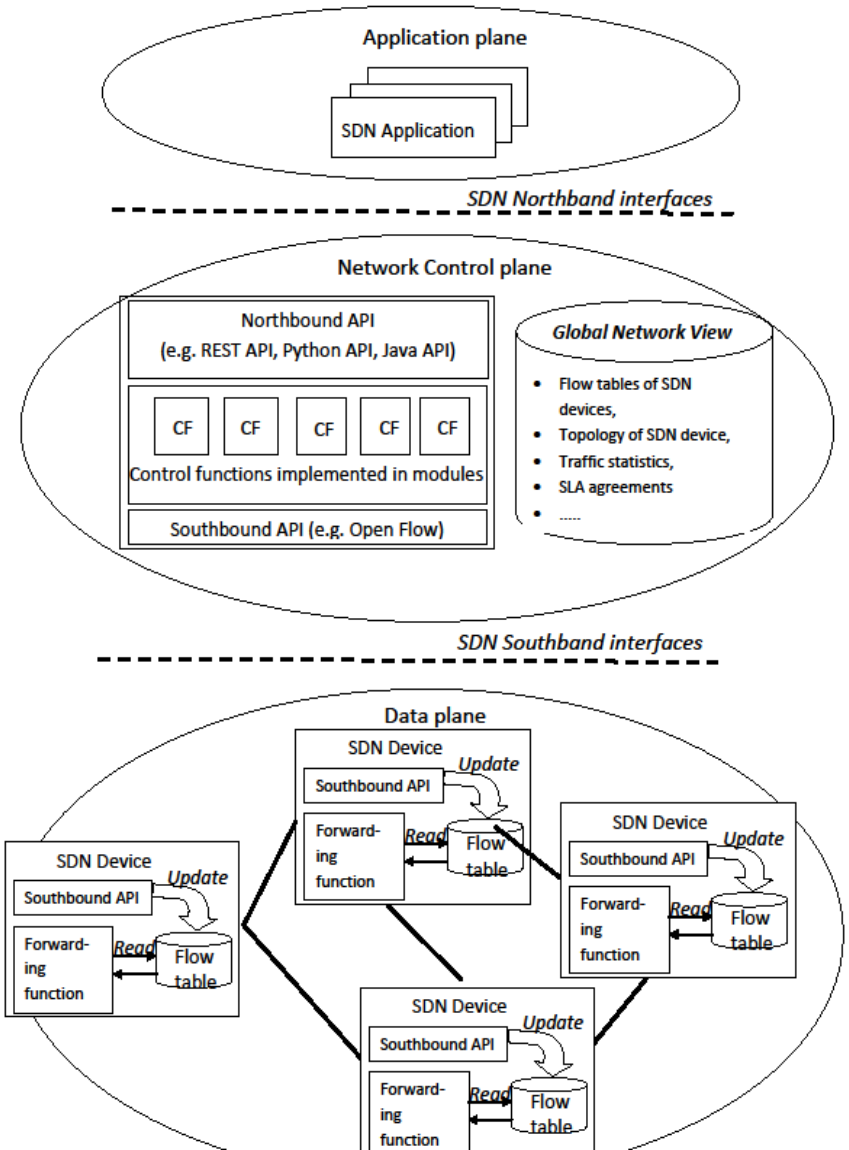
- Complex
- Reliable
- Distributed
- Real time demands
- ….

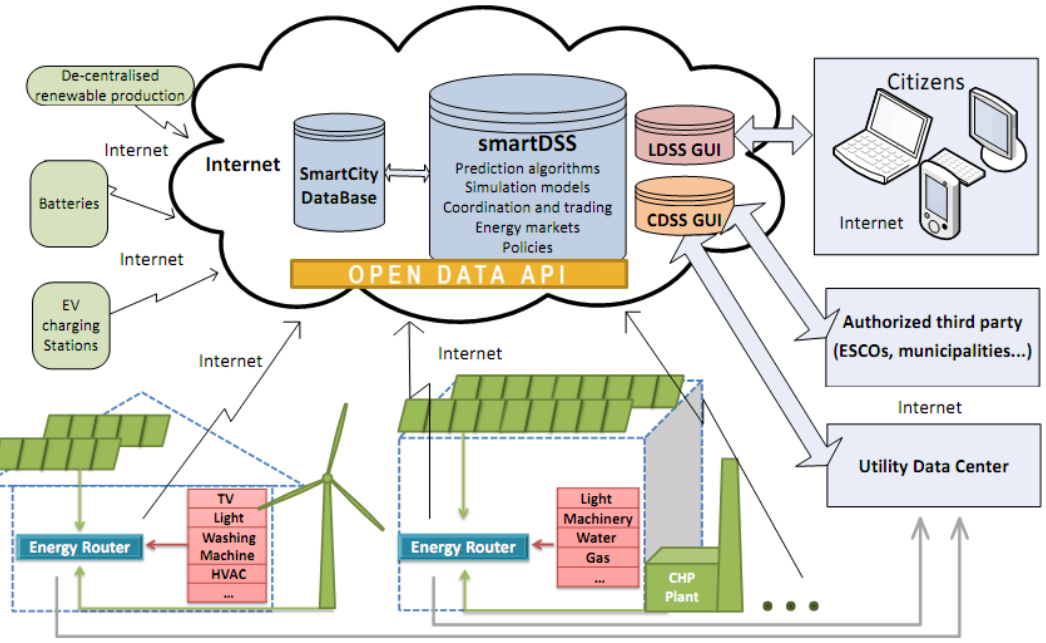
Emegring network technologies

- Convergence of IT and communication software
- End user devices with unbounded possibilities
- Virtual infrastructure providing just imagination of stabile phisical hardware
- Problems with vendor locking solutions
- Open platform movement
- Problem with interoperability
- Middleware platforms

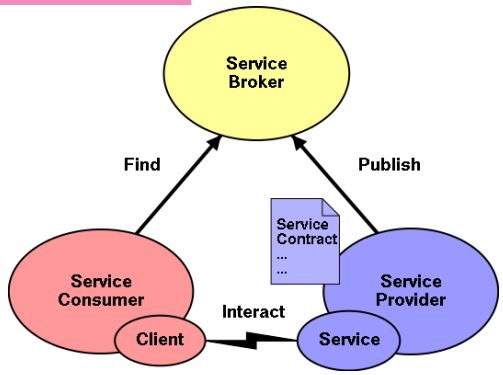
Main trends in telecommunication network

- More and more software systems tend to evolve towards complex software systems (e.g. IoS) and systems of systems (SoS)
- Interconnection of peripheral systems over distributed network into system of systems (IoT)



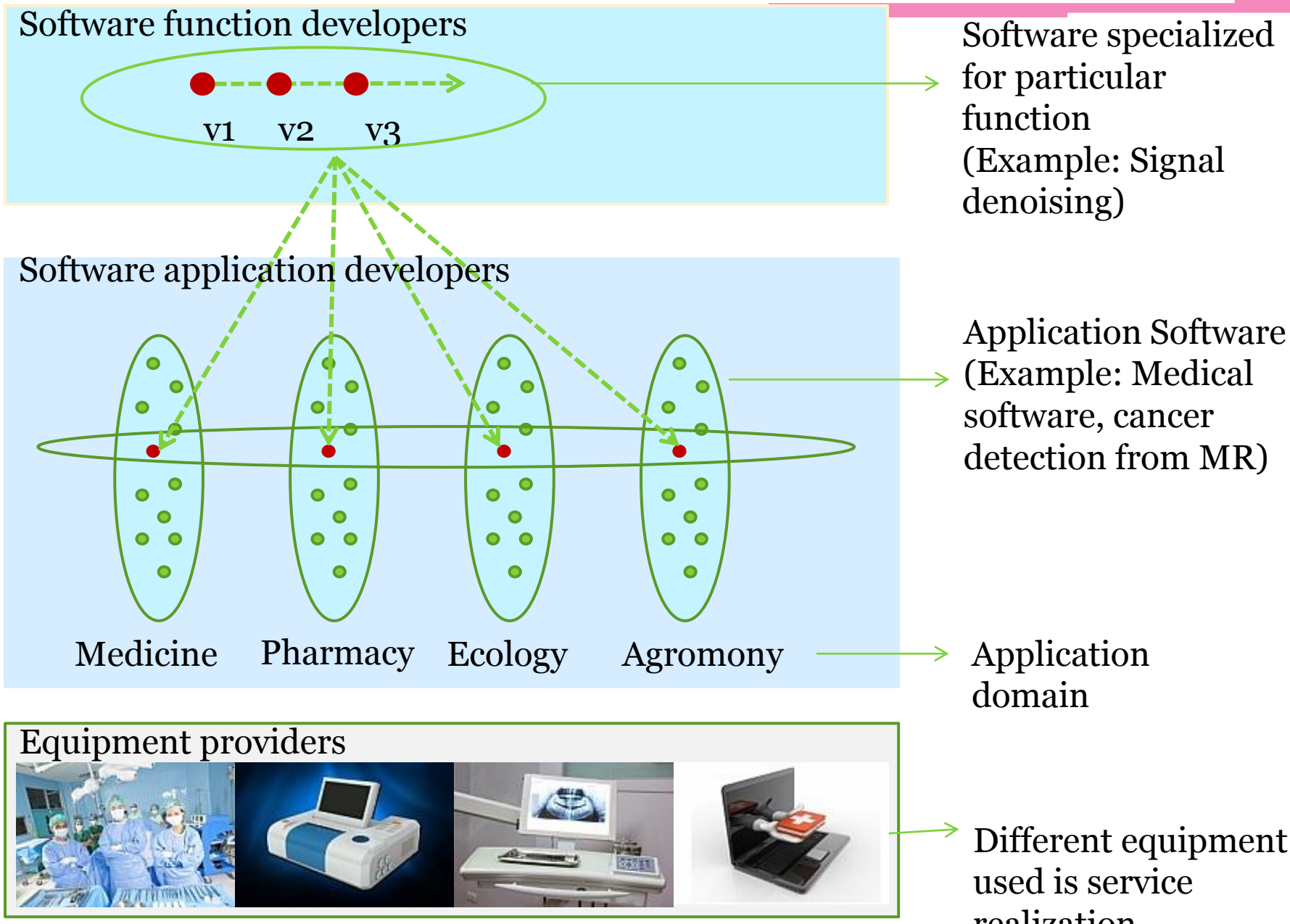


Software in ‘Internet of Service’



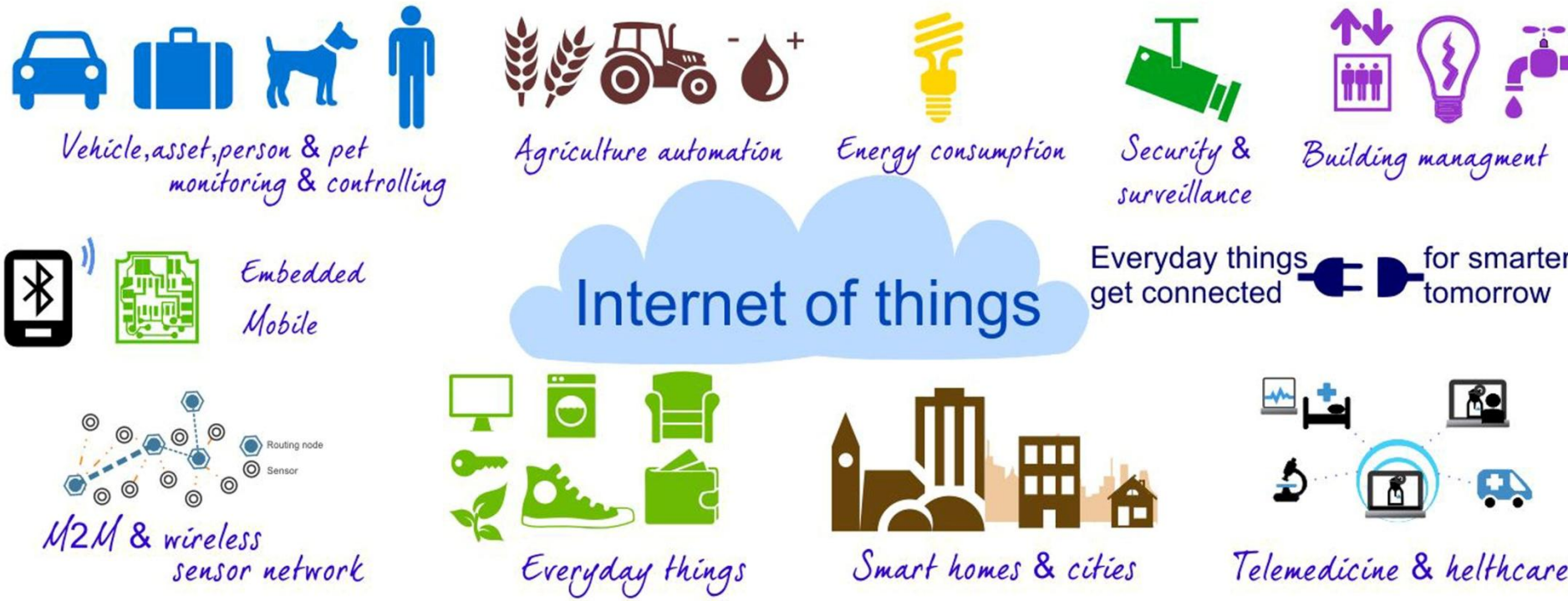
- In service oriented architecture (SOA) software is provided ‘**as a service**’
- In that concept ‘of service’ is referring to a technical understanding of software functions provided as Web service
- IoS combine that services and integrate functionalities that led to **complex service chains**
- Usually these service chains are developed by number of providers and offered to number of users
- Service chain composition is happening at layers above network layer
- Problem is how to secure quality of these service chains
- We need algorithms for autonomous control for a reliable IoS

Service Oriented Architecture



*Figures reused from http://www.freedigitalphotos.net/

Modern computing?



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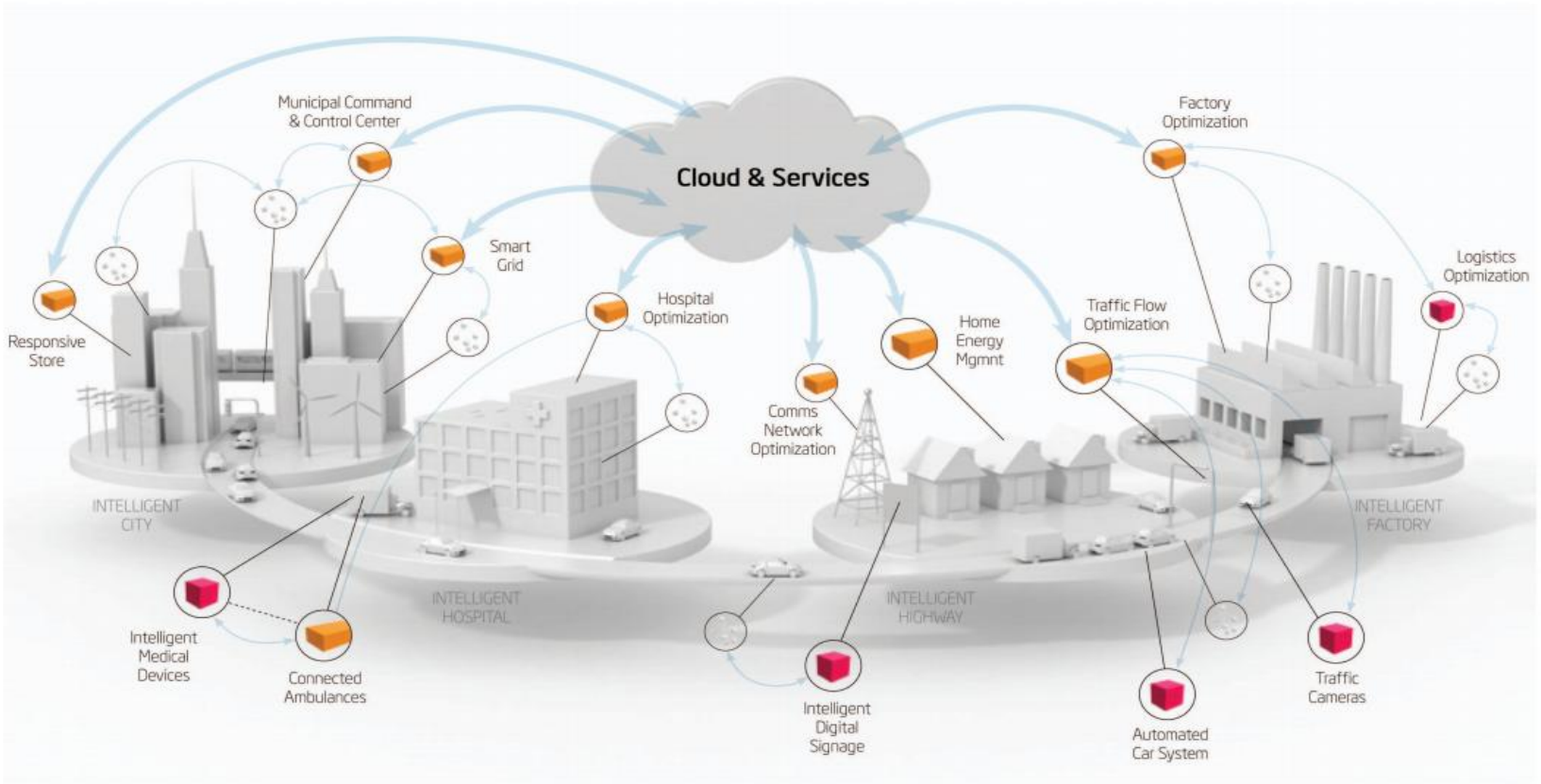

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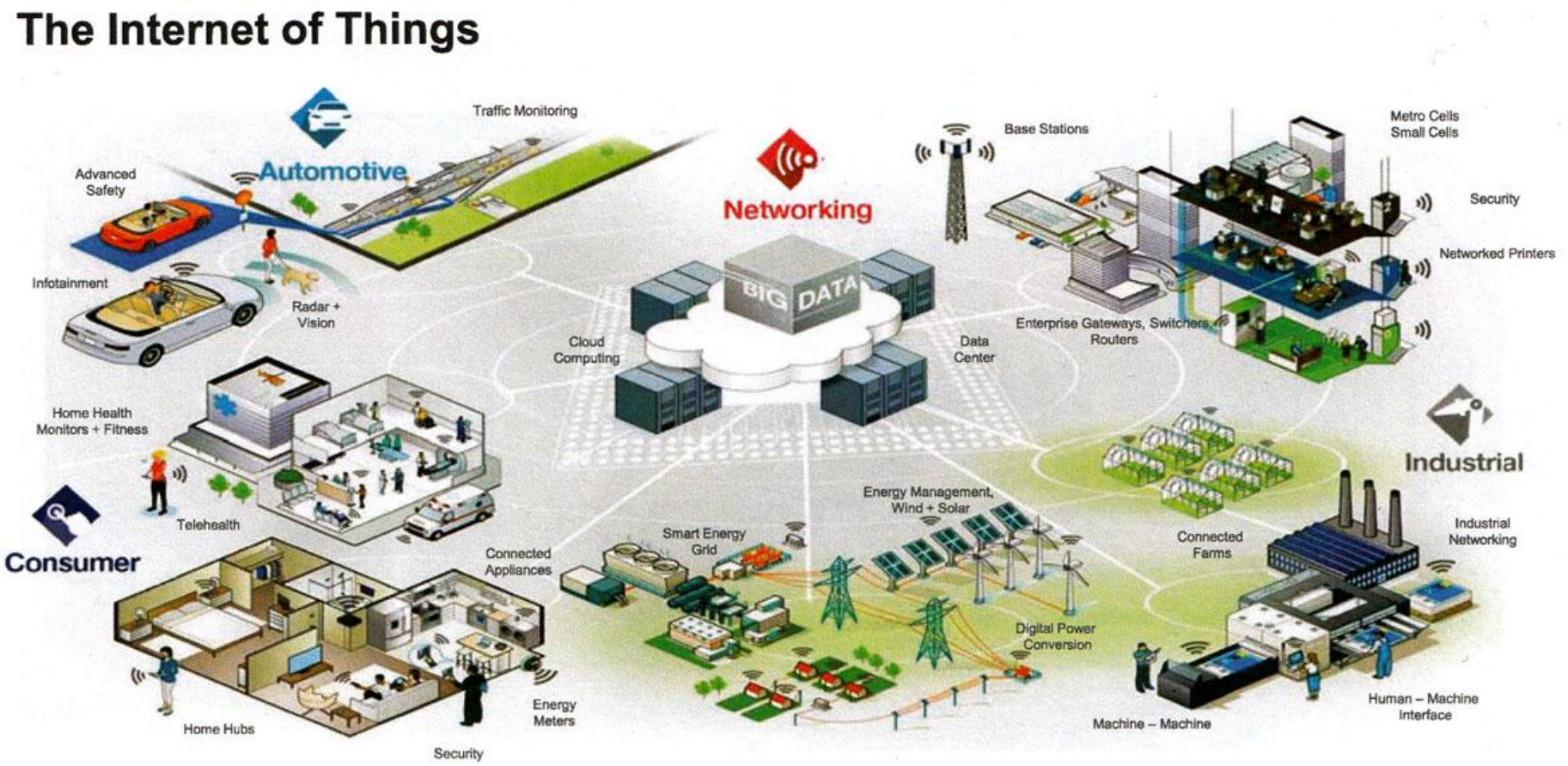

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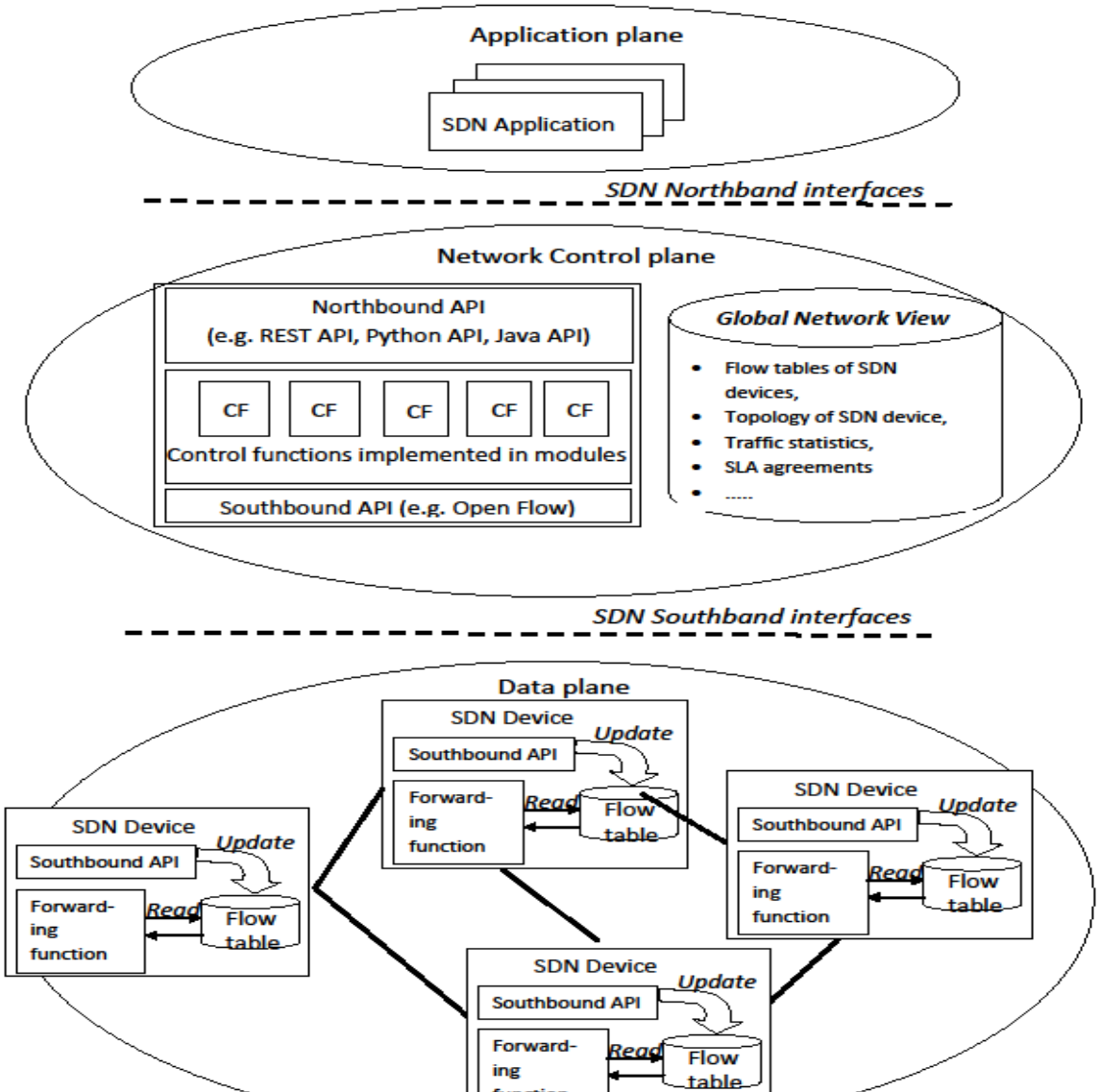
Software Defined Network



Modern networks and software

- Software become central part of the modern network
- Requrements:
  - It should run on any hardware,
  - serve to many users,
  - satisfy their complex communication needs,
  - deliver proper ICT service, effectively and efficiently and
  - has to be flexible on network context, information context, communication context, ….
- Modern network should provide **reliable and robust** ICT services (resistant against system failures, cyber-attacks, high-load and overload situations, flash crowds, etc.)

Revolution or evolution of software systems

- Future: Communicating software systems distributed over the network, autonomously managed
  - Networks of networks, Systems of systems,
  - Interconnected by Internet network
- Software services realized as service chains ad-hoc established per each user or group of users

Automation of software engineering knowledge

- Software lifecycle phases:
  - Software requirements
  - Software design
  - Implementation
  - Test
  - Maintanence

Key problems with software engineering evolution

- More and more software systems tend to evolve towards complex software systems (e.g. IoS)
- Interconnection of peripheral systems over distributed network into system of systems (IoT)
- Key problems become:
  - Can we develop foundations on software behavior?
  - How can we measure software behaviour in network?
  - Can we predict and simulate software behaviour in network?
  - How to manage complex software system?
  - Are we able just by observing properties of system parts to predict and model its overall behaviour?

Conclusion

- Do we have enough software engineering knowledge to provide software for new network technologies?
- Can we skip software engineer from software development process?