The Edge Networking Evolution and the Softwarization of Internet of Things

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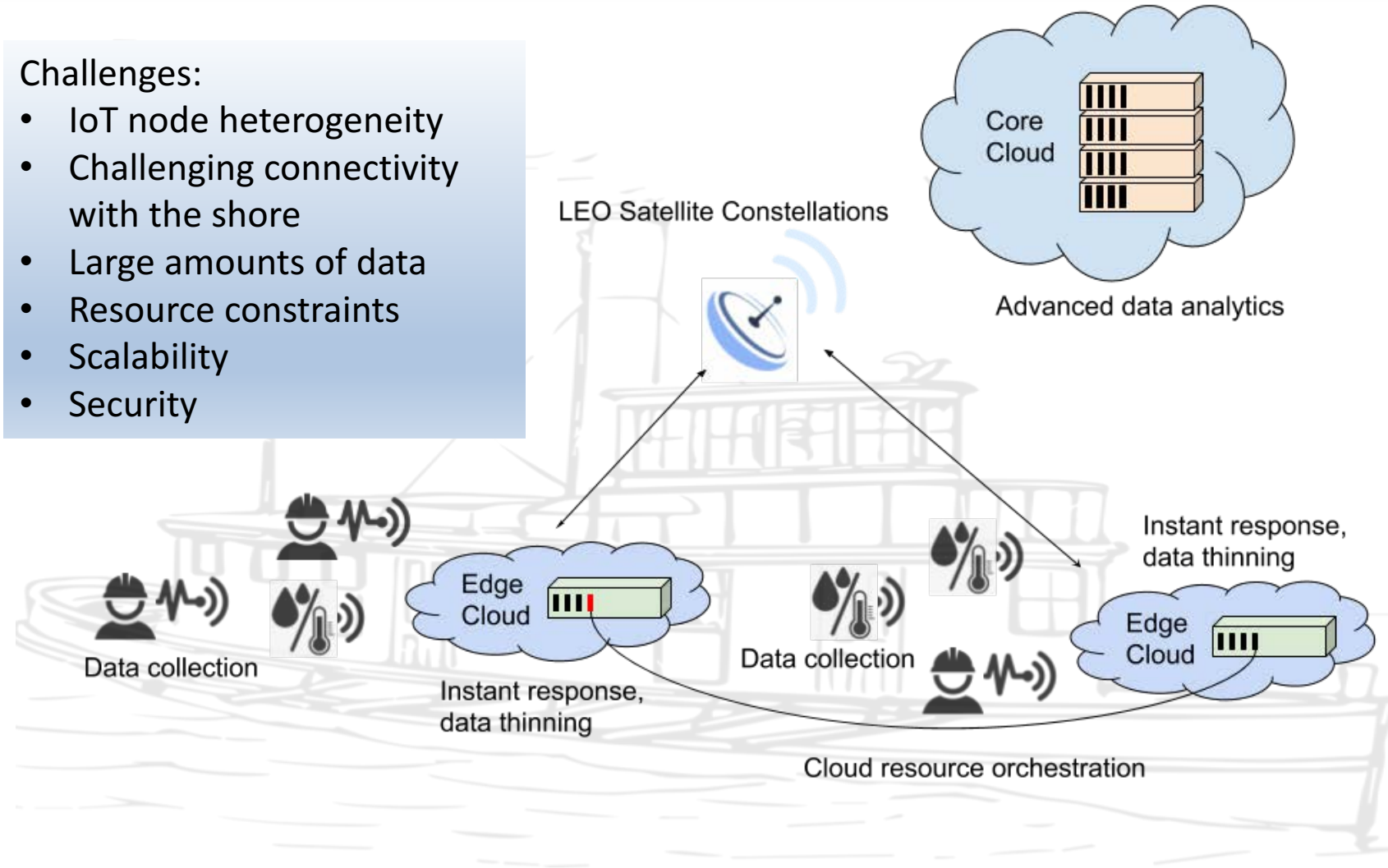
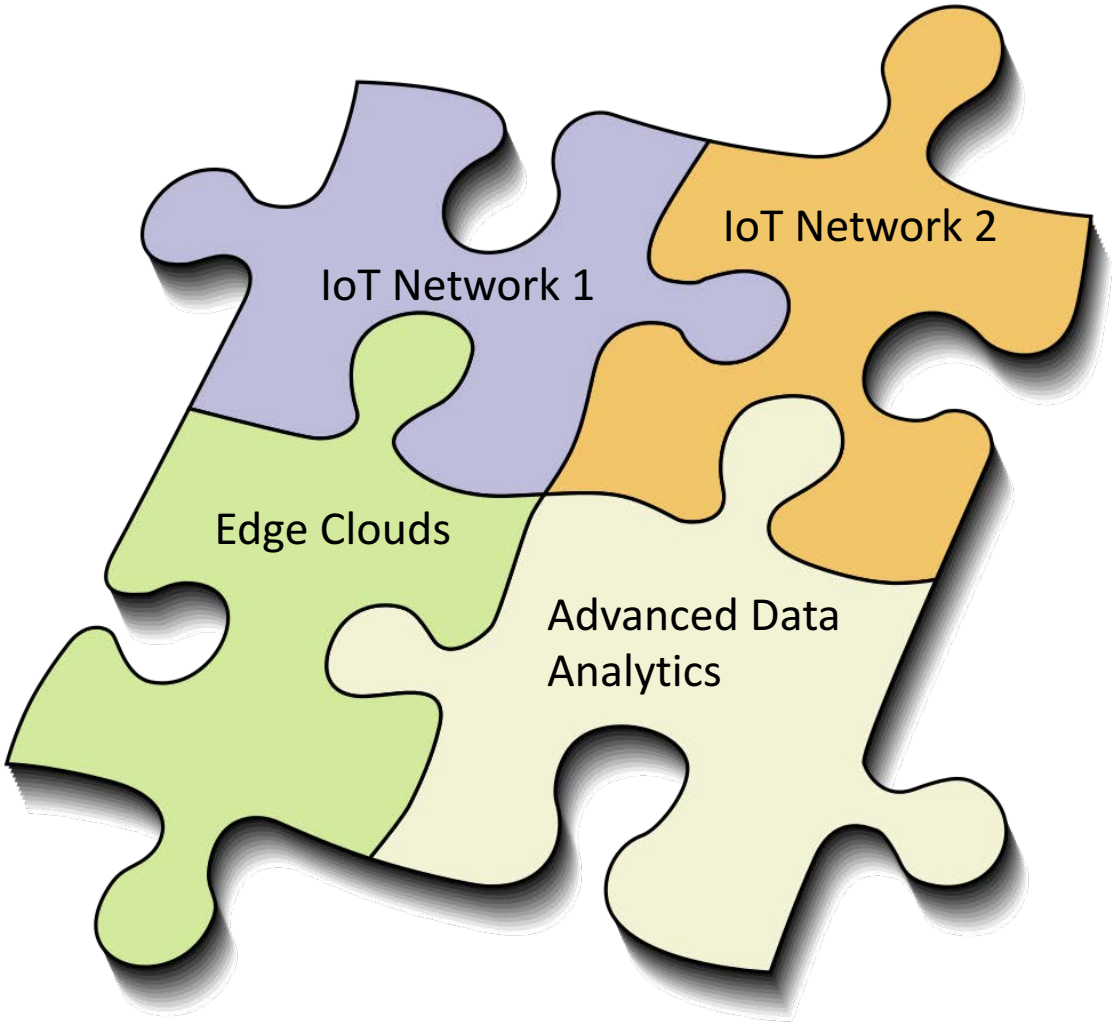
Motivating use-case: IoTs and the maritime industry

Challenges:

- IoT node heterogeneity
- Challenging connectivity with the shore
- Large amounts of data
- Resource constraints
- Scalability
- Security



Internet of Things: An IPv6 address is not enough



Currently:

- IoTs with wide-range of network conditions and requirements
- Separated context-sensitive solutions

Four enablers:

1) IoT network softwarization
2) Cloud orchestration for IoTs
3) E2E network slicing up-to the IoT device
4) Softwarized IoT testbeds

Enabler I: IoT network softwarization

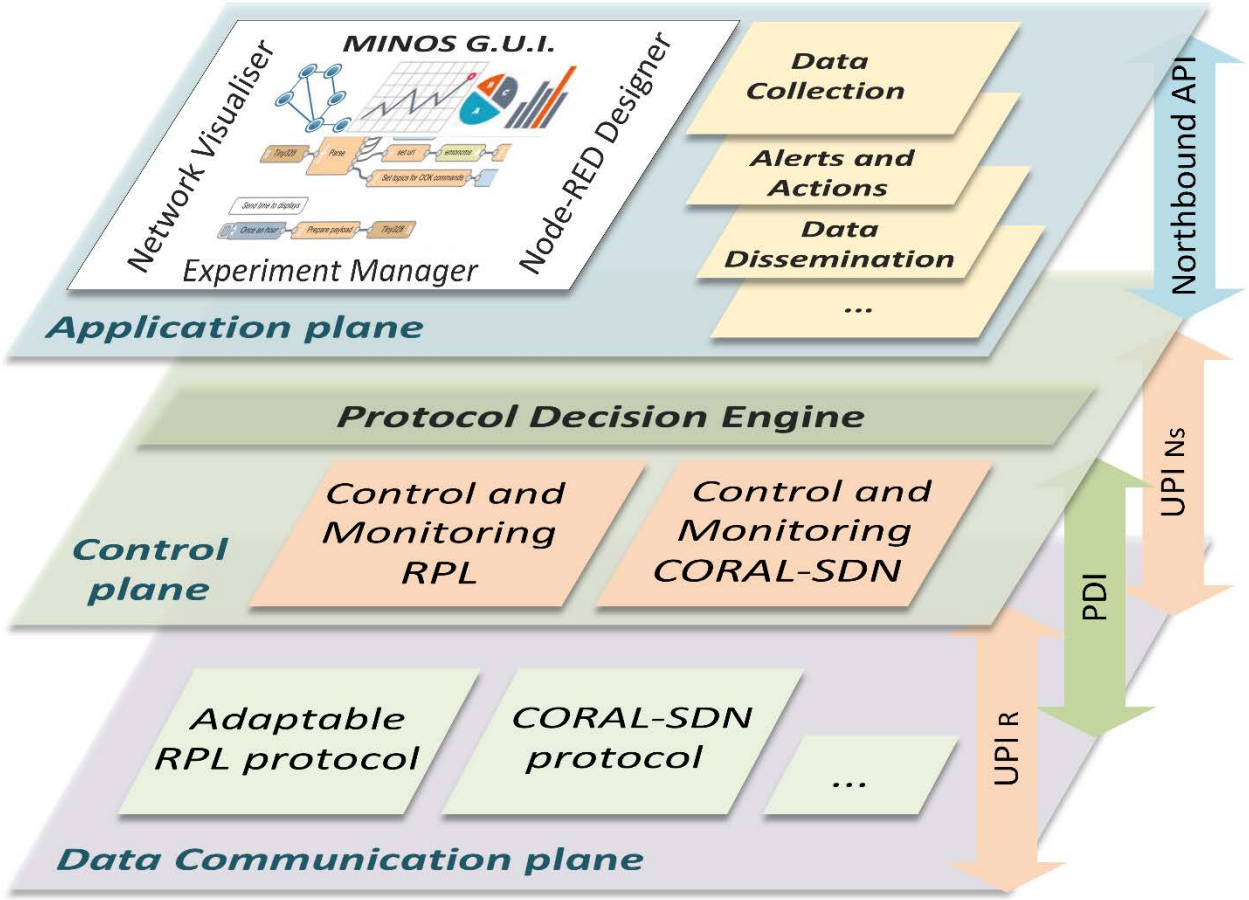
Softwarized IoT Protocols

Evolutionary
WSN -> SDNs

Revolutionary
SDNs -> WSNs

Issues:

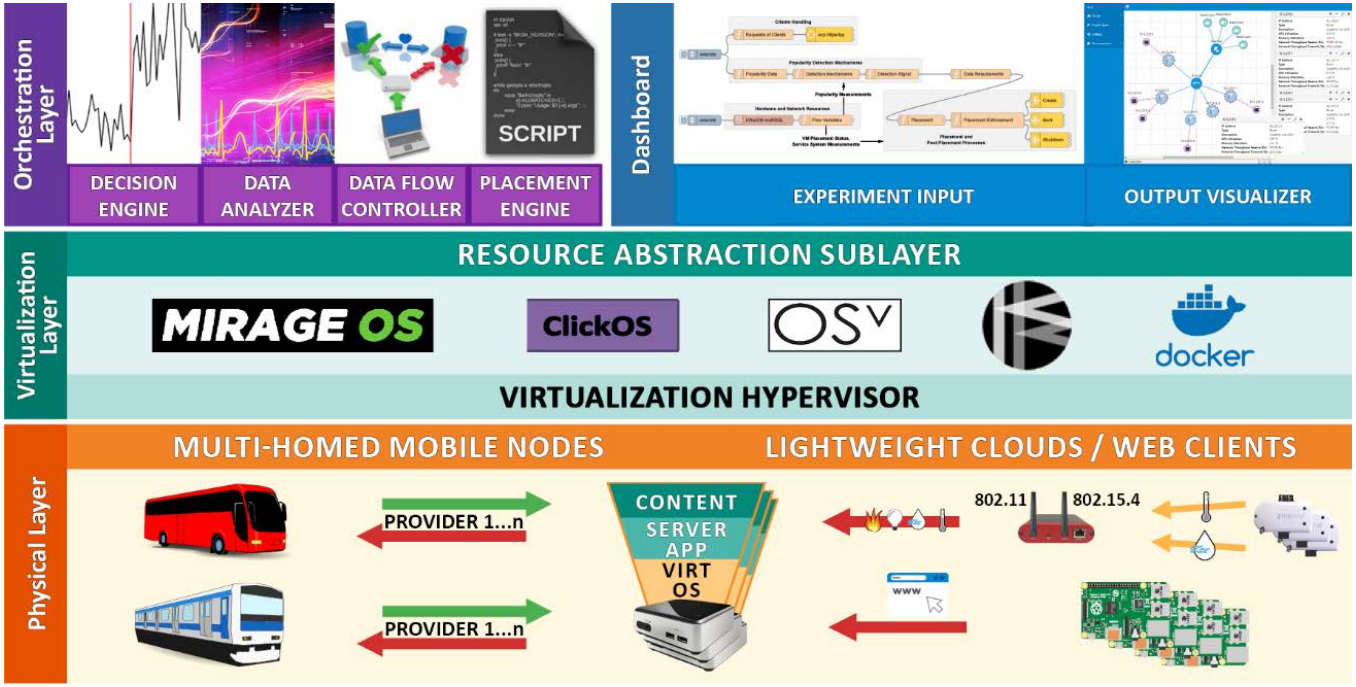
- Control channel overhead
- Intermittent connectivity with the controller
- Scalability of control messages
- Mobility
- No single protocol that works everywhere



Supported by the open call schemes of the WiSHFUL (grant agr. no 645274) and MONROE (grant agr. no 644399) projects.

Enabler II: Cloud orchestration for IoTs

- **Cloud-to-edge compute continuum**:
  - micro-services
- **Utilize alternative edge cloud resources:**
  - resource abstractions
- **Programmable orchestration features**
  - efficient resource allocation
- **Network flow control**
  - dynamic load balancing



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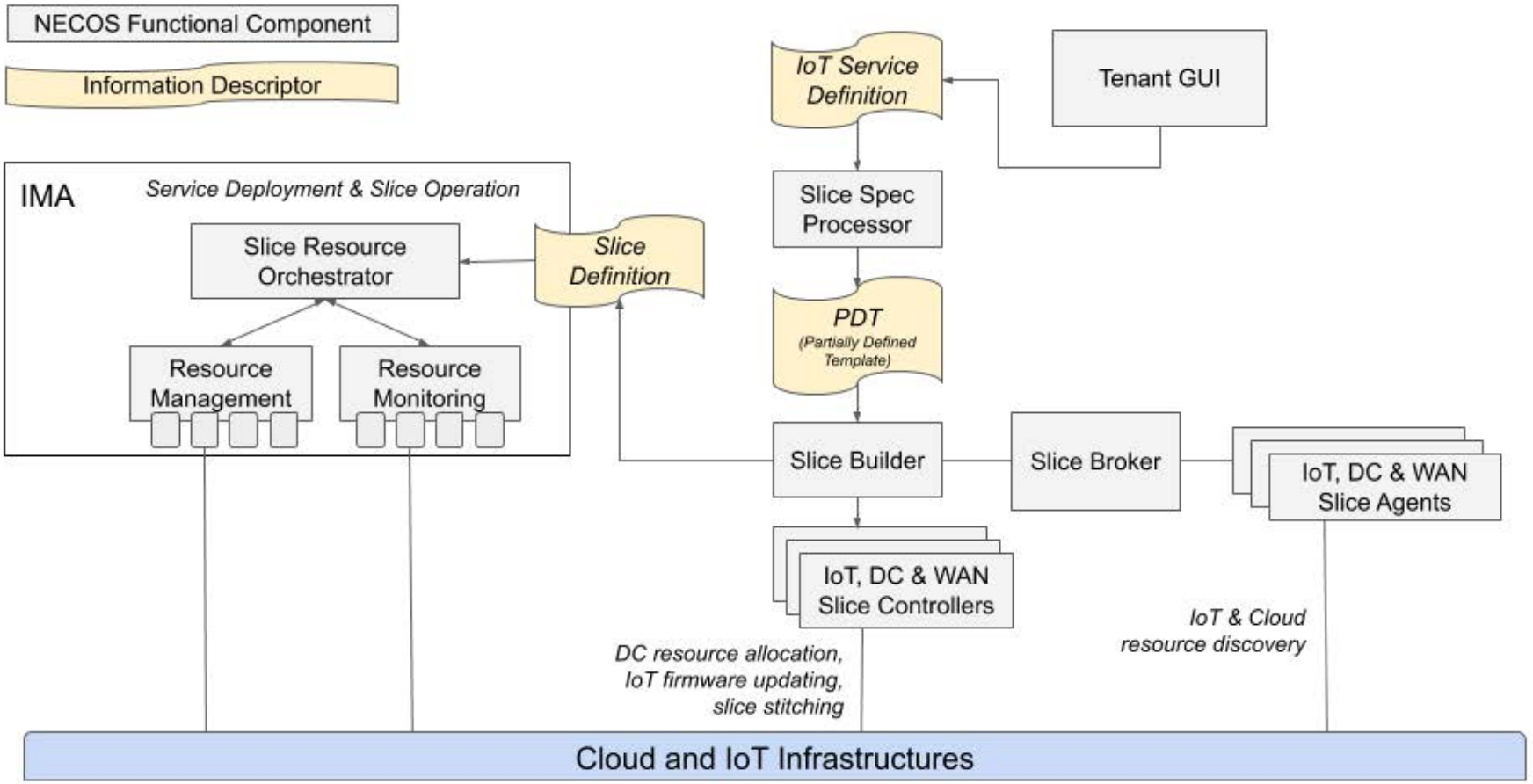
Enabler III: E2E network slicing up-to the IoT device



Supported by the EU-BRA Horizon 2020 NECOS Project (grant agr. no 777067) funded by the European Commission and the Brazilian Ministry of Science, Technology, Innovation, and Communication (MCTIC) through RNP and CTIC.

Enabler IV: Softwarized IoT test-bed facilities

- **Test-bed federations** (e.g., FED4FIRE+) allocating both cloud and IoT resources:
  - *edge clouds:* test-beds with low-end physical machines (e.g., wireless test-beds)
  - *IoT test-beds:* programmability of IoT devices, realistic radio communication conditions and data collection, e.g., IMEC w-iLab.t
  - *Smart-city IoT deployments:* replicating real application requirements, e.g., IMEC Citylab
- **New test-bed control abstractions** implementing E2E network slicing up-to the IoT protocol level
- **Radio and network control abstractions** over heterogeneous IoT nodes, e.g., WiSHFUL platform (http://github.com/wishful-project)
- **Softwarized IoT platforms**, e.g., MINOS or CORAL-SDN.
- **Realtime programmability** of IoT protocols:
  - Over the air programming
  - Dynamic ELF loading

- Relevant source code can be found at: http://github.com/swnrg

Conclusions

- There is **no single IoT protocol** solution:
  - protocol softwarization is the answer
- We need the **right abstractions**, interfaces and open standards:
  - spanning over both IoT and cloud resources
- **E2E network slicing** covering the IoT network protocol stack:
  - high-level IoT service descriptions triggering the slicing
- **Softwarized IoT test-bed experimentation** is important:
  - open-access test-bed federations can have a catalytic impact