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NPTEL ONLINE CERTIFICATION COURSES

Advanced Technologies: Software-Defined Networking (SDN) in IIoT – Part 2

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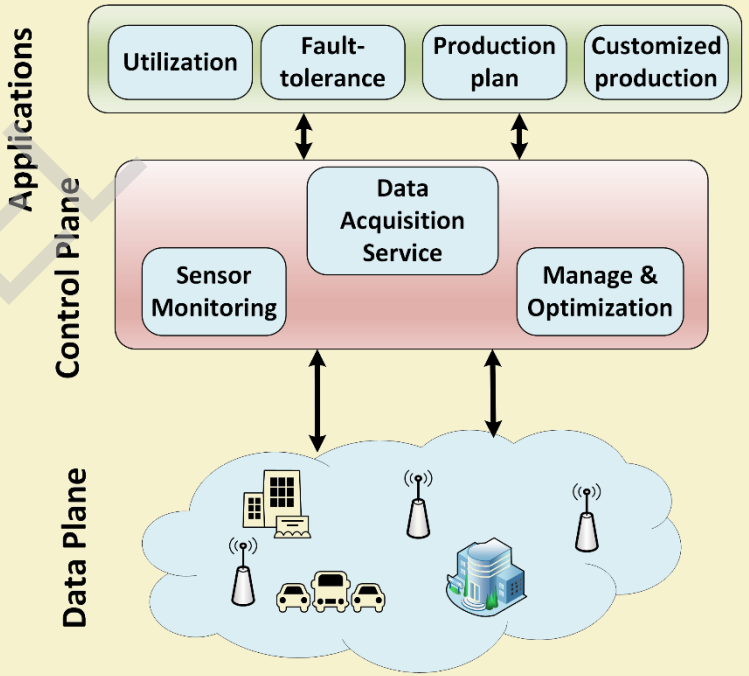
SDIIoT Architecture

- SDIIoT – WSN
- SDIIoT – Public Networks
- SDIIoT – Industrial Cloud
- SDIIoT – Industrial bus & network

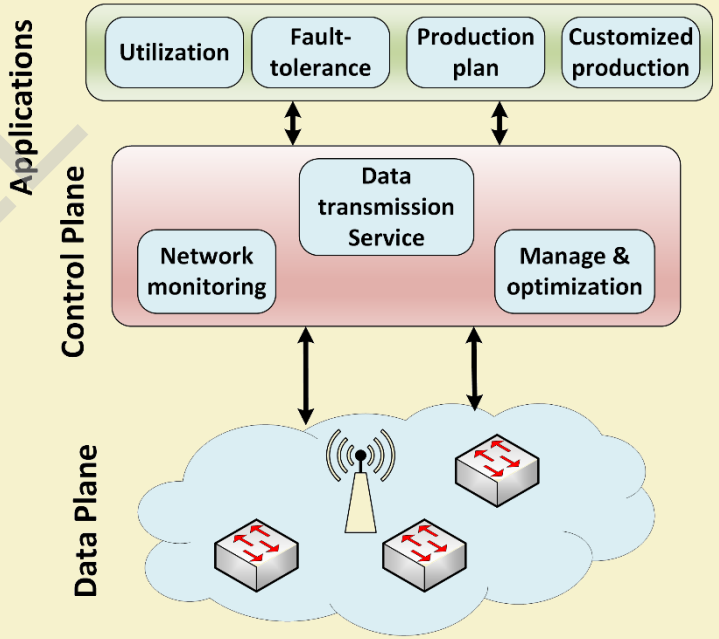
SDIIoT Architecture - WSN

- Software-defined WSN platform in the context of industry 4.0



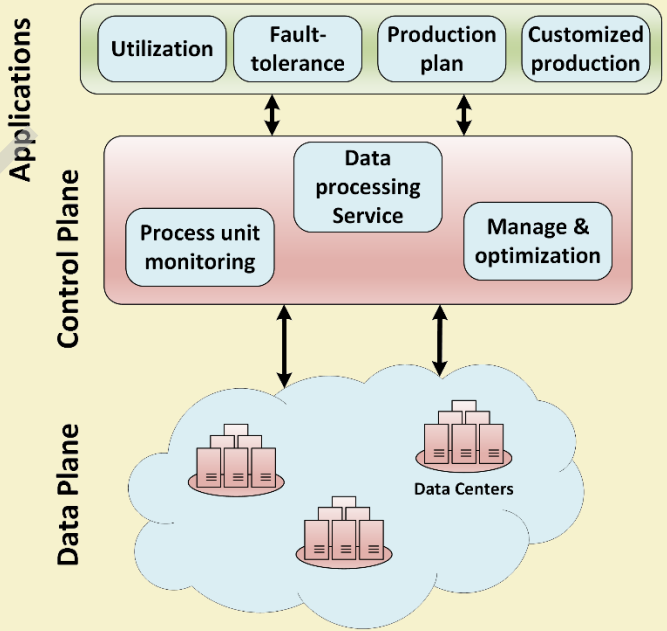
SDIIoT Architecture – Public Networks

- Public network consists of switches, routers, and access network.
- Network monitoring, management and optimization are done at the control plane.



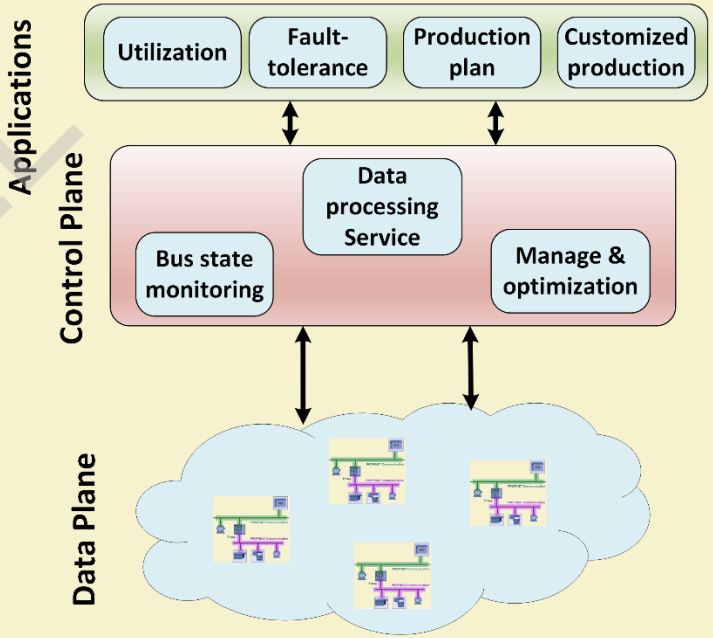
SDIIoT Architecture – Industrial Cloud

- Focuses on data center network.
- Data processing is done at this stage.



SDIIoT Architecture – Industrial Bus & Network

- It includes bus network.
- Monitoring of bus network is done.



Software-Defined 6TiSCH IIoT

- Time scheduled channel hoping (TSCH)
  - Deterministic communication
  - Efficient resource allocation in constrained networks (e.g., IoT and IIoT)
- IETF 6TiSCH is introduced to achieve the objectives

Challenges: SDN in 6TiSCH

- Unreliable link – low power and lossy network
- Control overhead due to message exchange between SDN controller and devices
- Increased jitter

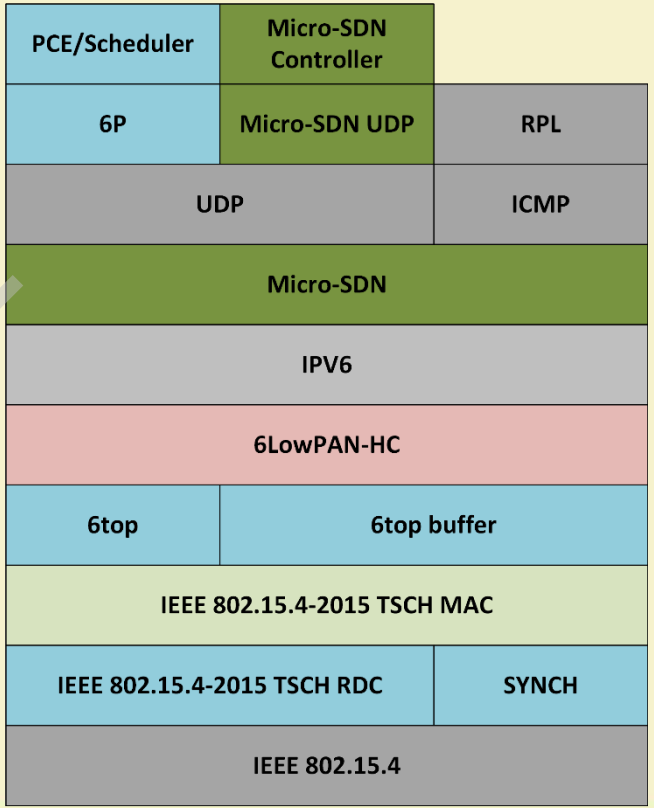
Software-Defined 6TiSCH*

- Slicing mechanism is proposed in Layer-2
- Dedicated forwarding paths across 6TiSCH network
- Slicing mechanism isolates the control overhead
- Allows deterministic and low-latency SDN controller communication
- Advantages of SDN is utilized, while minimizing the associated control overhead

*Baddeley et al., ’17

SD-6TiSCH Protocol Stack

- μSDN incorporates features for minimizing controller overhead
- Integrated with the Contiki IEEE 802.15.4-2015 stack



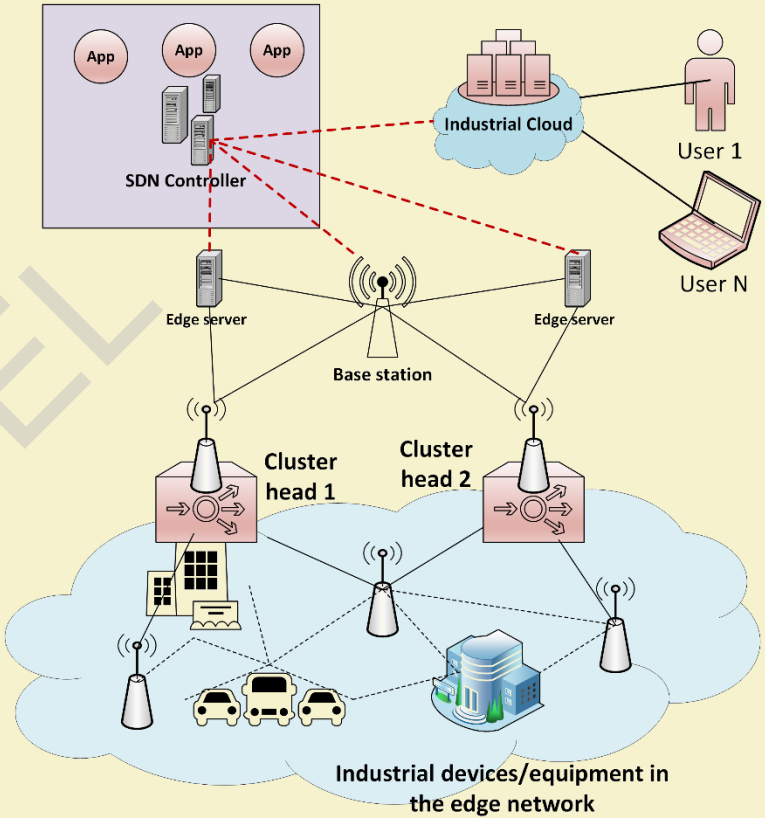
SD Edge Computing for IIoT*

- Adaptive transmission architecture with SDN and EC is proposed for IIoT
- Data stream is divided into two categories:
  - Ordinary data stream
  - Emergent data stream
- Emergent stream is served by finding paths which meet requirements based on a coarse-grained transmission path algorithm

*Li et al., ’18

SD-Edge IIoT Architecture

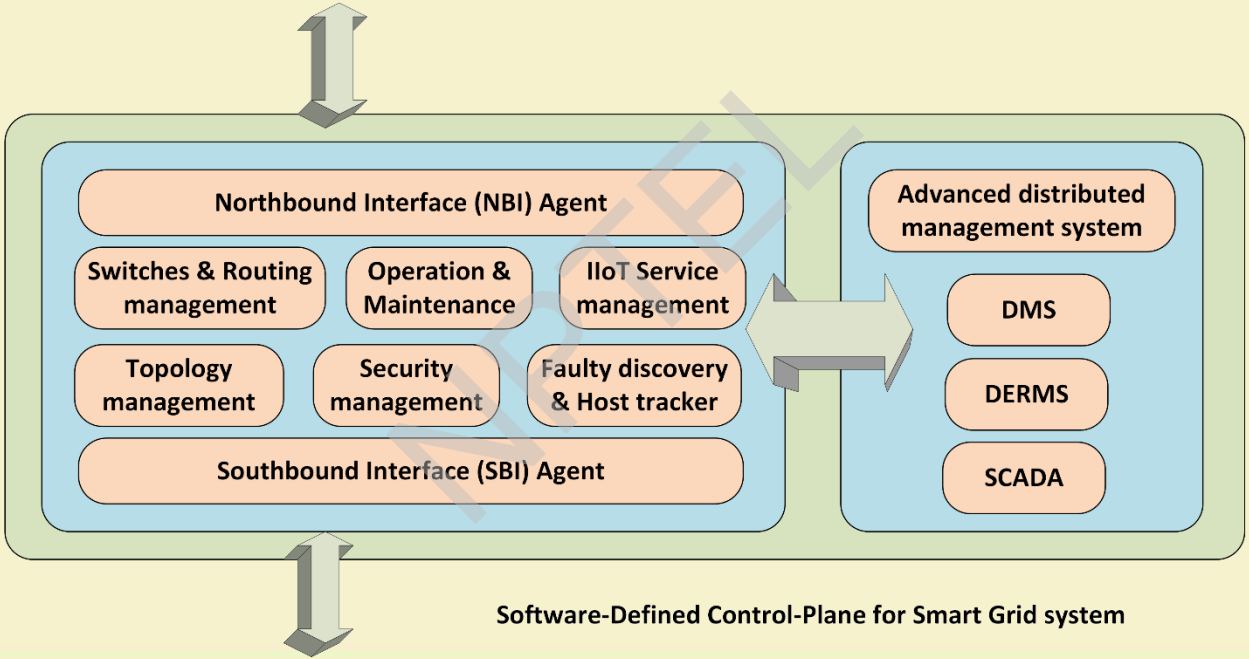
- Cluster head
- Industrial cloud
- Edge network
- SDN controller
- Devices/equipment
- Applications



Software-Defined Control Plane for Smart Grid*

- Smart grid monitoring system using a centralized controller
- Distribution management system (DMS)
- Distributed energy resource management system (DERMS)
- Supervisory control and data acquisition (SCADA)
- Presence of APIs at both ends – distribution side and generation side

*Al-Rubaye et al., ’17



Software-Defined Control-Plane for Smart Grid system

Challenges and Opportunities

- Absence of SDN protocol (like OpenFlow) for low power & lossy network
  - New protocol for enabling interaction between SDN controller and resource constrained devices may be proposed
  - Restructure of controller architecture and placement?
  - Do we need IoT middleware in software-defined IIoT system?

Challenges and Opportunities (contd.)

- Fog node/access devices play important role to provide emergent services (delay-constrained)
  - Can we utilize fog nodes as SDN controller?
  - What about the fault-tolerance of fog nodes?
  - Distributed/semi-distributed/fully centralized architecture?

References

- J. Wan, S. Tang, Z. Shu, D. Li, S. Wang, M. Imran, A. V. Vasilakos, "Software-defined industrial Internet of Things in the context of industry 4.0", *IEEE Sensors J.*, vol. 16, no. 20, pp. 7373-7380, Oct. 2016.
- M. Baddeley, R. Nejabati, G. Oikonomou, S. Gormus, M. Sooriyabandara, and D. Simeonidou, “Isolating SDN Control Traffic with Layer-2 Slicing in 6TiSCH Industrial IoT Networks”, in Proc. of the *IEEE Conference on NFV-SDN*, 2017.
- X. Li, D. Li, J. Wan, C. Liu, and M. Imran, “Adaptive transmission optimization in sdn-based industrial internet of things with edge computing,” *IEEE Internet of Things Journal*, 2018.
- S. Al-Rubaye, E. Kadhum, Q. Ni, A. Anpalagan, "Industrial Internet of Things Driven by SDN Platform for Smart Grid Resiliency", *IEEE Internet of Things Journal*, 2017.

Thank You!!