A Software-Defined Approach for End-to-end IoT Networking

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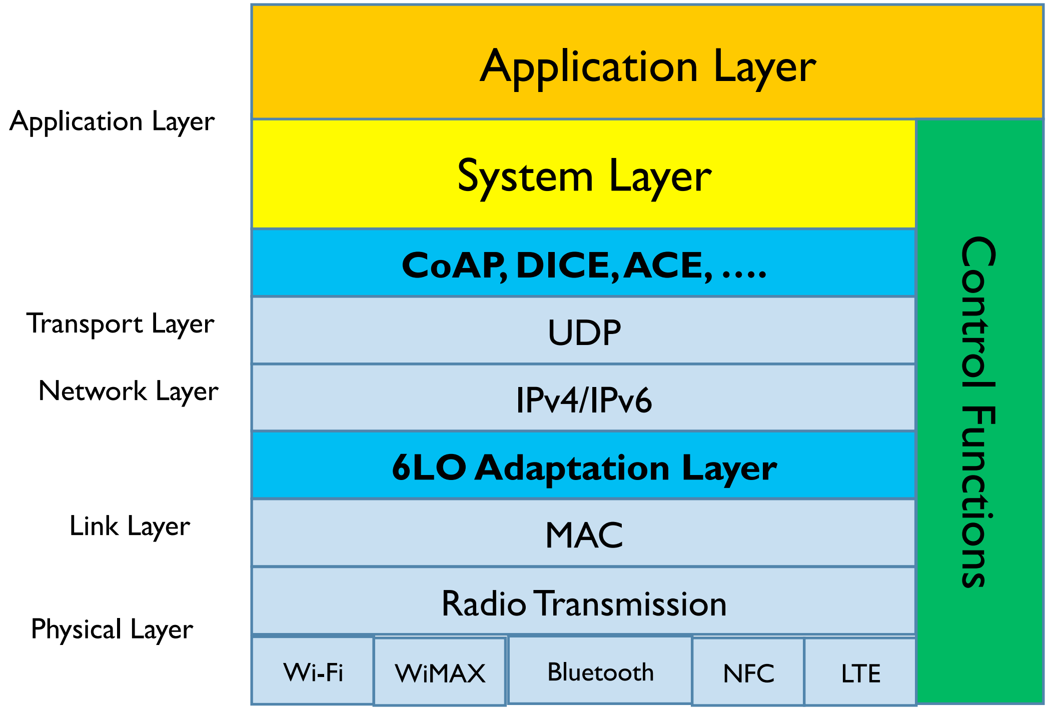
Problem and Challenges

- Problems with end-to-end IP networking to resource-constra ined IoT devices
  - Need adaptation and/or mapping functions for end-to-end global IP networkin g
  - Manage a large number of devices with variety of IoT protocols
- Capability mismatch between devices
  - MTU differences, simplified vs. full protocol stack (e.g., CoAP/UDP vs. HTTP/T CP), single stack vs. dual stack, processing and communications bandwidth, slee p schedule, security protocols, etc.
- Rapid interaction between services and infrastructure
  - E.g., More agile communication (e.g., scale-in/out)

Variety of IoT Protocols



- Various Physical Layers
  - ➢ WiFi, WiMAX, BLE, NFC, LTE, …
- Various 6LO Functions
  - ➢ IPv6-over-foo adaptation layer using 6LoWPAN technologies (RFC4944, RFC6282, RFC6775 ..)
- Constrained Application Protocol
  - ➢ RFC 7252 CoAP and related mapping protocols
- Constrained Security Protocols
  - ➢ DTLS In Constrained Environments (DICE, draft-ietf-dice-profile-05)
  - ➢ Authentication and Authorization for Constrained Environments (ACE, Work-in-Progress)

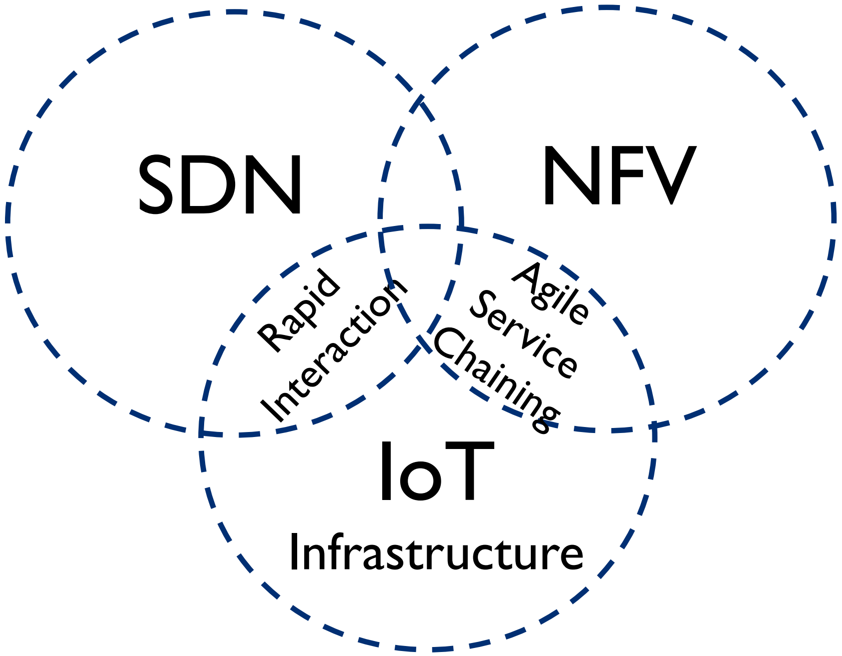
Note that we will mainly focus on end-to-end networking to resource-constrained nodes using 6LO, CoAP, DICE, RIOT protocols, etc.

6Lo Functions

- IPv6 over Networks of Resource-constrained Nodes (6Lo WG)
- IPv6-over-foo adaptation layer specifications using 6LoWPAN technologies (RFC4944, RFC6282, RFC6775 ….)
  - →Transmission of IPv6 Packets over BLUETOOTH(R) Low Energy
  - →Transmission of IPv6 Packets over DECT Ultra Low Energy
  - →Transmission of IPv6 over MS/TP Networks
  - →Transmission of IPv6 packets over ITU-T G.9959 Networks
  - →Transmission of IPv6 Packets over IEEE 1901.2 Narrowband Powerline Commu nication Networks
  - →<u>Transmission of IPv6 Packets over Near Field Communication (NFC)</u>

Our Approach

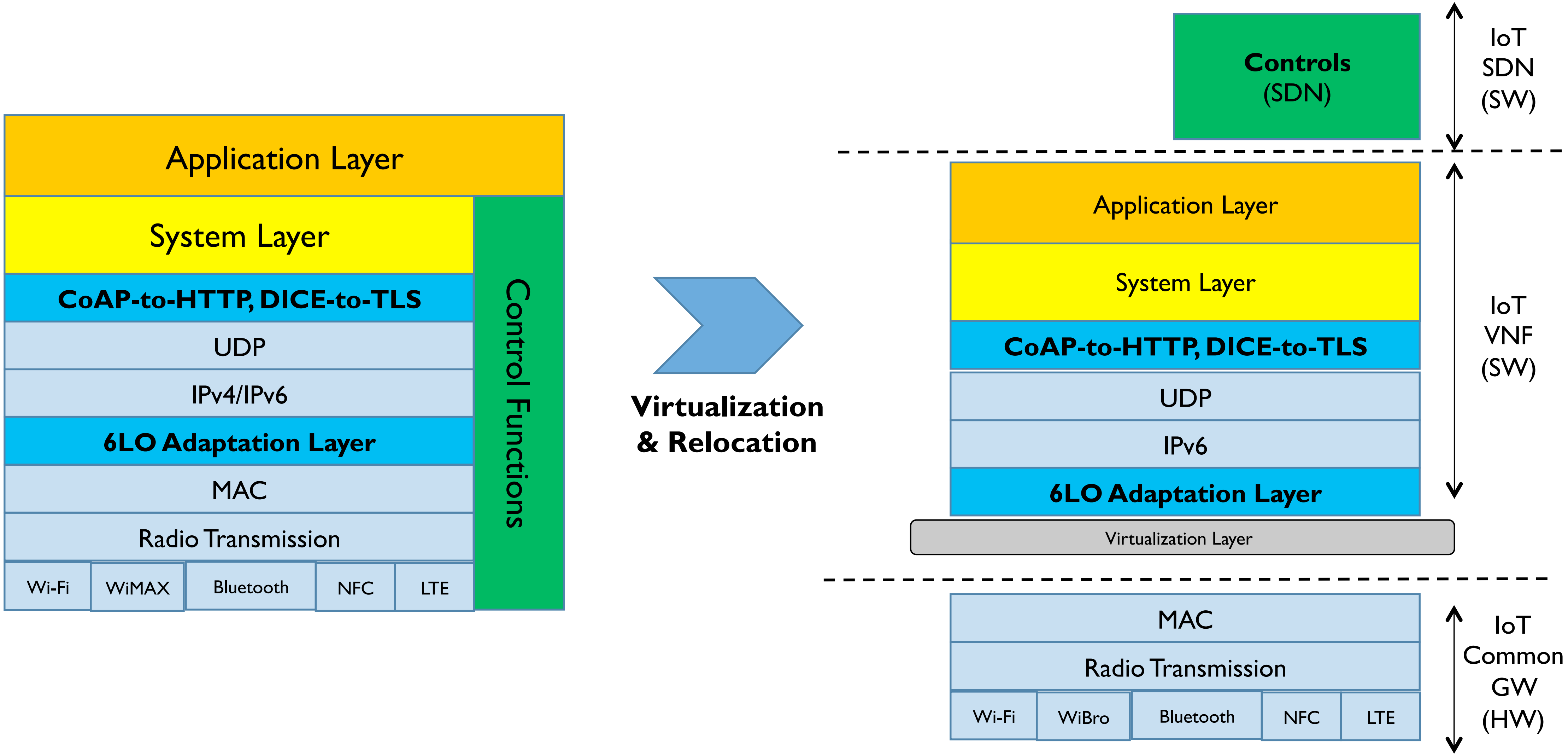
- SDN and NFV can solve those problems and challenges.
  - ➢SDIoT : A Software-defined end-to-end IoT infrastructure (including aka, IoT service chaining support)
- IoT Infrastructure could be built by means of NFV with integration of SDN which makes it more agile.
- SDN and NFV will be enablers for new IoT Infrastructure.



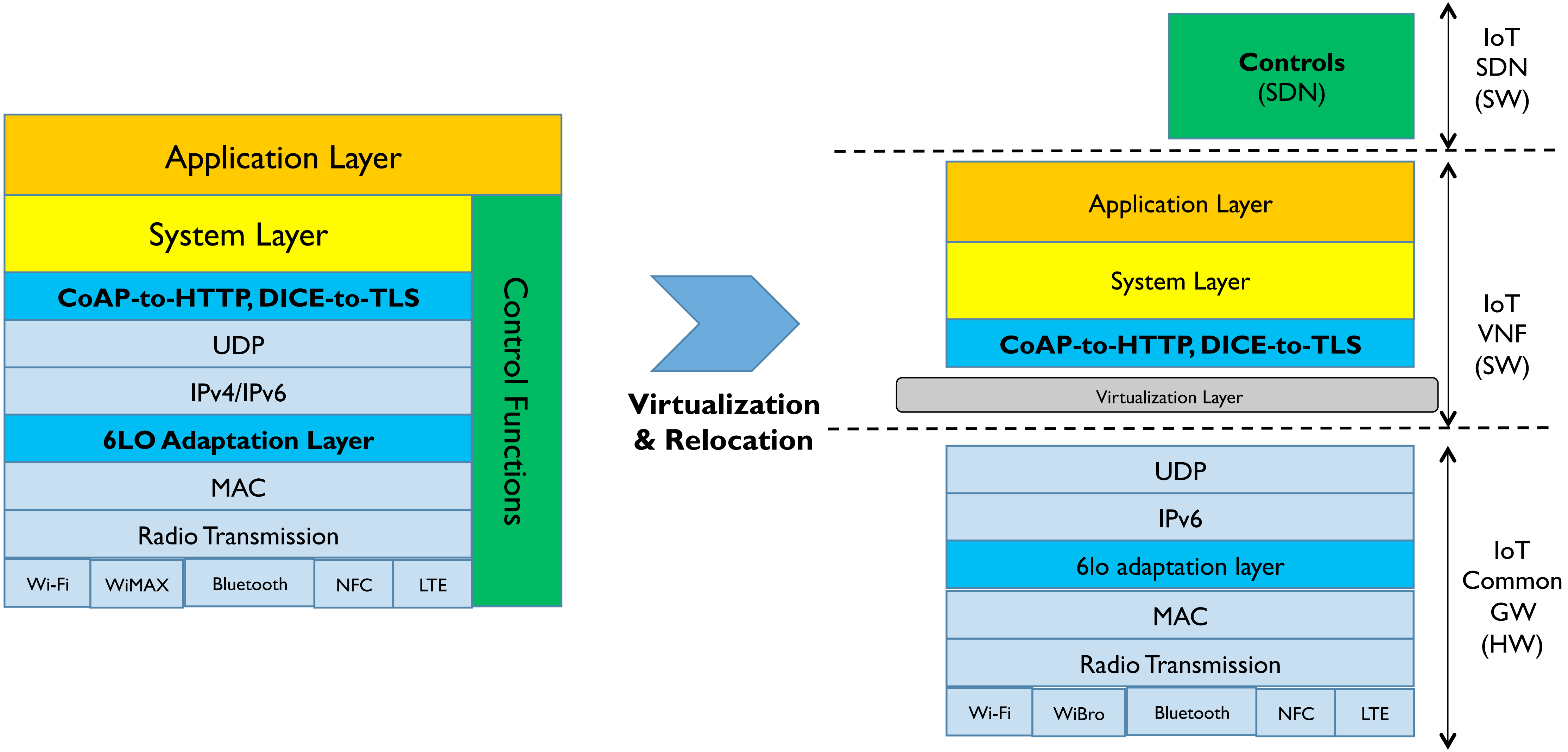
Two Basic Questions

1) How to relocate various IoT functions from HW appli ances to VMs and make them connected or chained to gether ?
2) How to abstract IoT's behaviors by SDN concept ?

1) How to relocate IoT GW functions ?



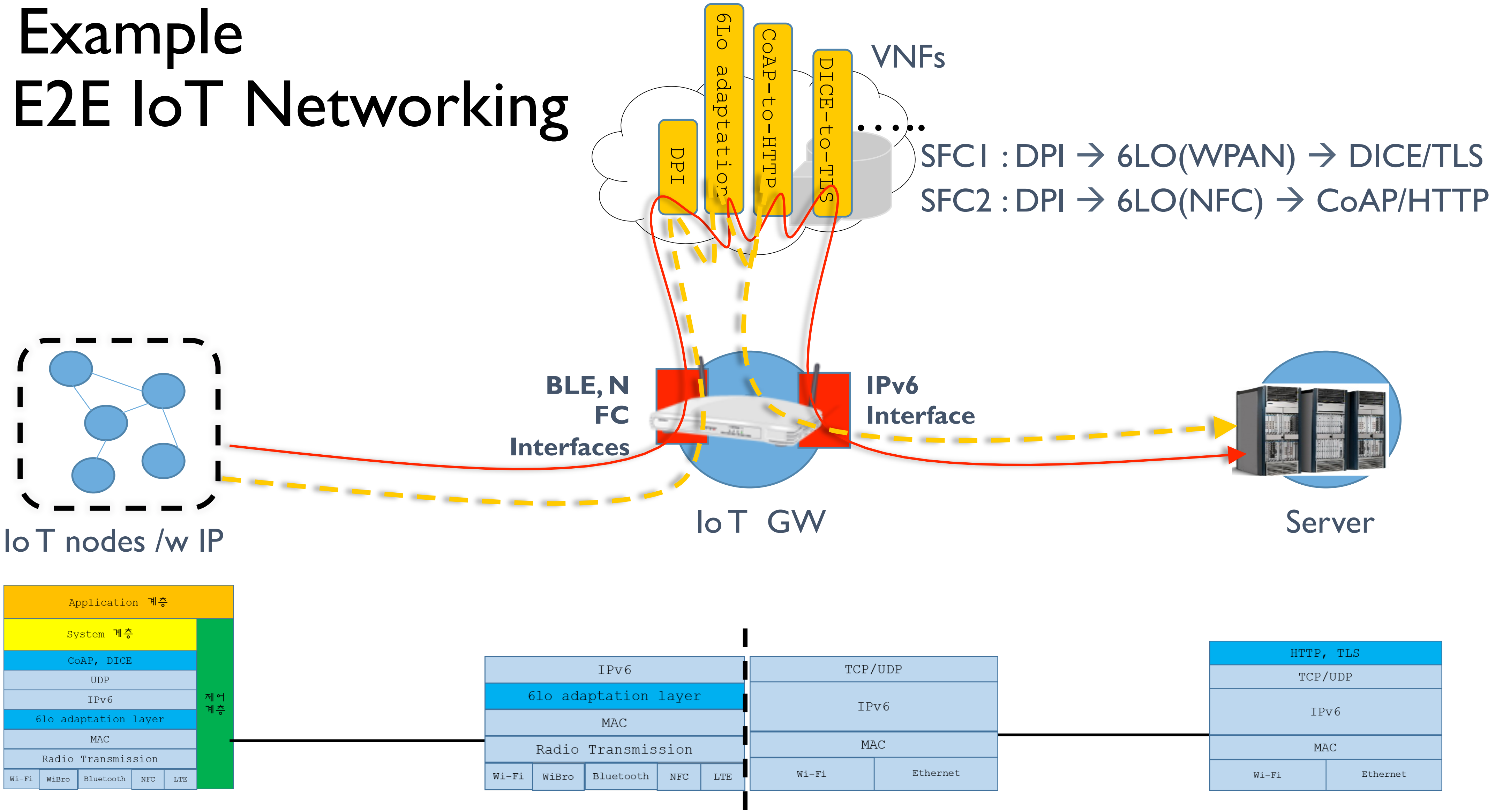
1) How to relocate IoT GW functions ?



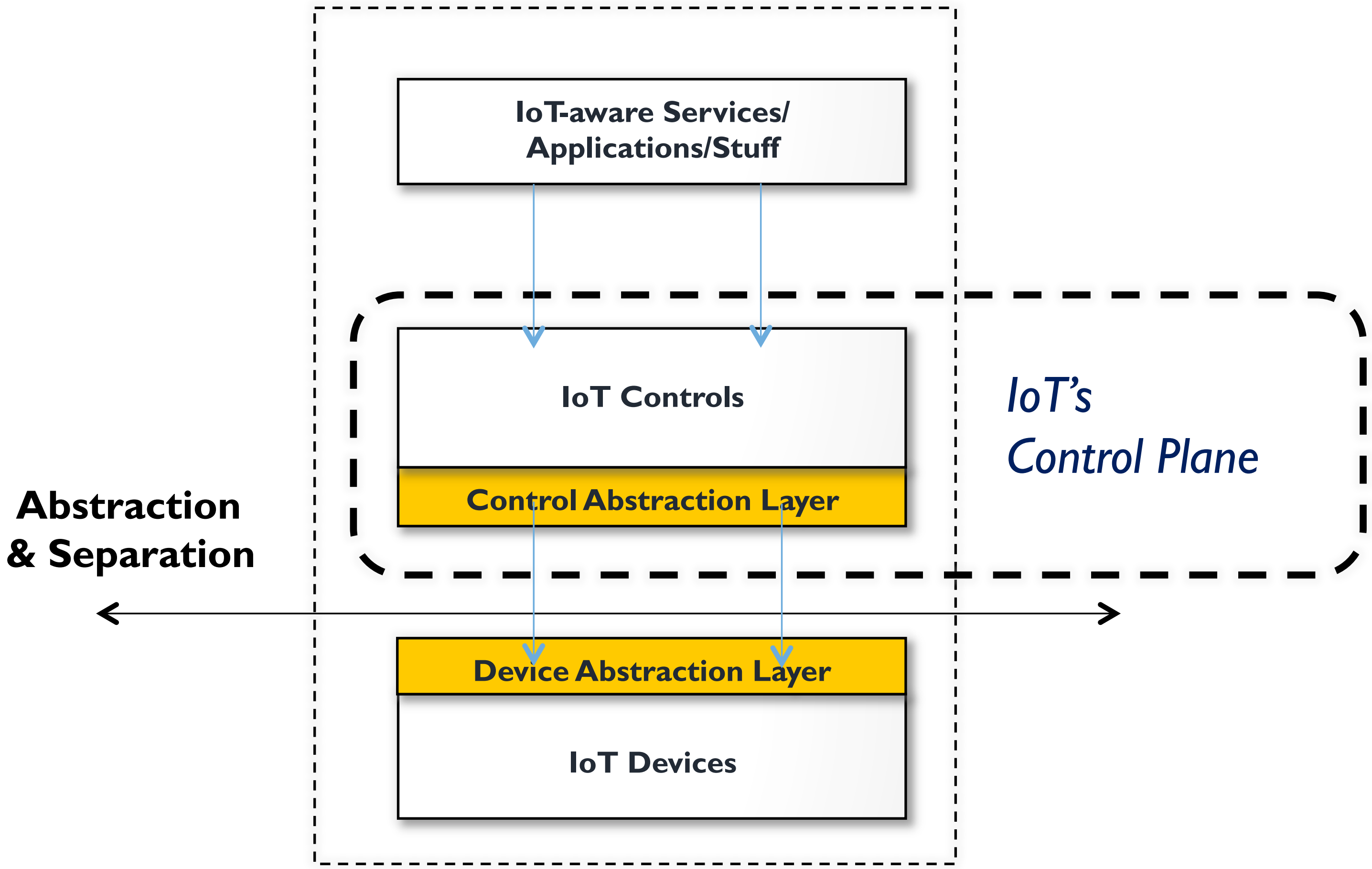
NFV IoT GW Functions Candidates

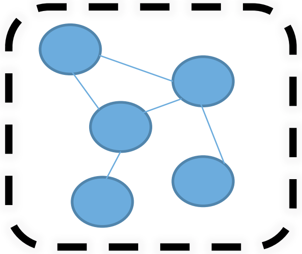
- IoT DPI functions
- L2~L3
  - IP mapping function for non-IP nodes
  - 6LO functions (IPv6 Packets over WPAN, BT, Low Power Wi-Fi, NFC, etc.)
    - RFC4944, RFC6282, RFC6775, and
    - Many other WG I-Ds (work-in-progresses)
- L4~L7
  - CoAP-HTTP protocols mapping <draft-ietf-core-http-mapping>
  - DICE-TLS protocols mapping …

Service Chaining Operation Example for E2E IoT Networking



2) How to abstract IoT's behaviors by SD N Concept ?



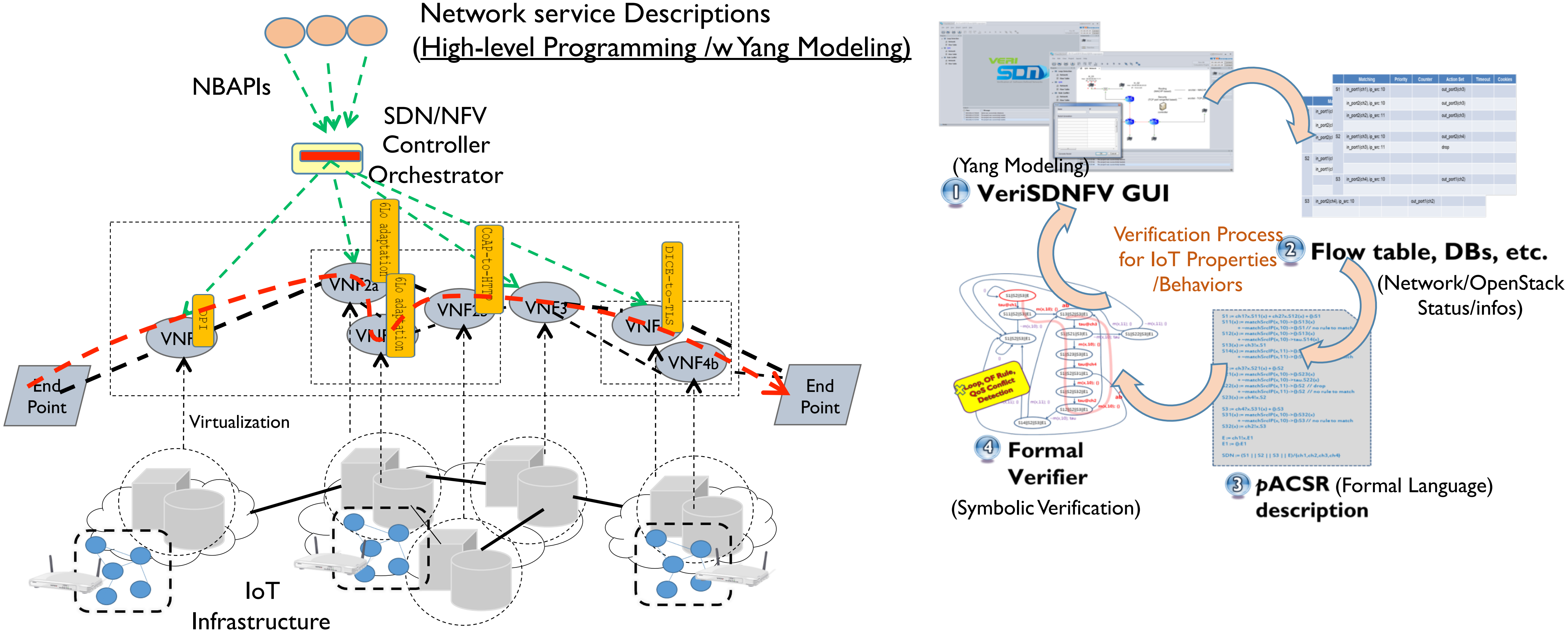


Yang Data Modeling

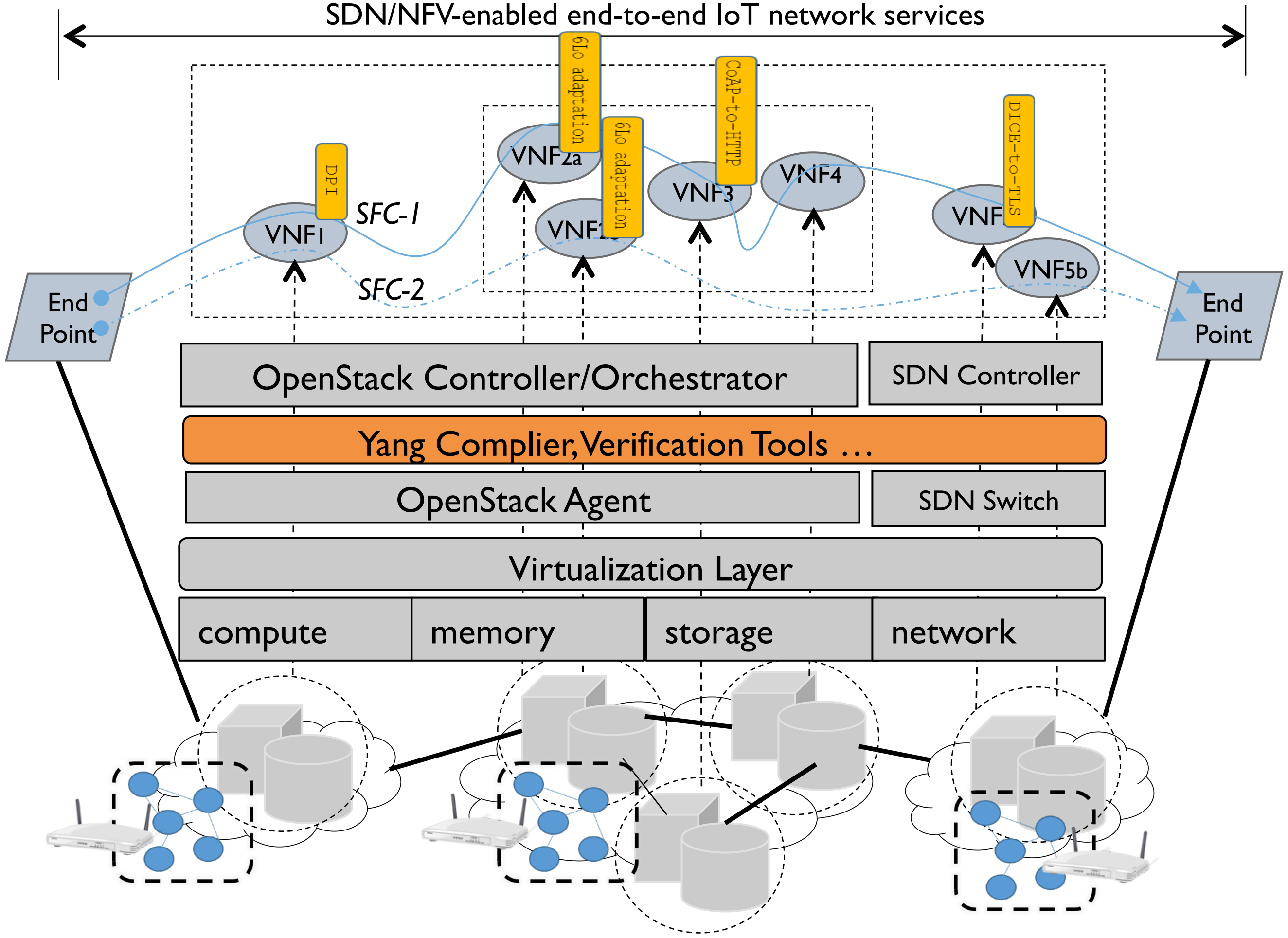
Properties and behaviors

- Connectivity (Mesh, radio/wireless …)
- QoS
- Real-time
- Delay/Jiter
- Reliability (Verification)
- Sensing/actuaction
- Robustness
- Security …
- ..

Adding SDN Automation and Verification in NFV and IoT Infrastructure

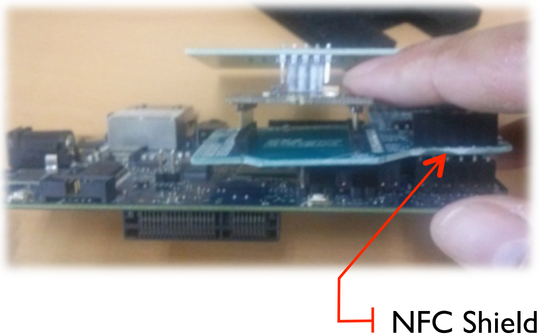


Our Development and Prototype



IPv6 over NFC functions
<draft-hong-6lo-ipv6-over-nfc>

Intel Galileo board with Debian Linux OS



NFC Shield

Wrap-up

- SDN and NFV offer a new way to design, deploy and manage IoT end-to-end network services.
  - SDN provides rapid interaction between services and infrastructure.
  - NFV makes IoT service functions chaining more agile.
- Our challenge is that how to relocate various IoT functions to VMs o n top of generic servers and abstract their behaviors by SDN.
- We are now developing a prototype, which is mainly focused on vario us 6LO functions chaining.
- We are also planning to propose a new (bar) BoF for I2NCN (Interface to Network of Constrained Nodes) at next IETF92 meeting.