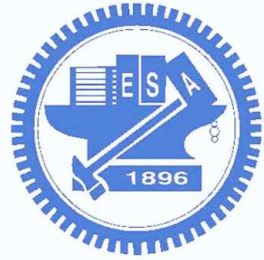

Taiwan Peering Forum 8/7/2017



Realizing IoT & 5G Innovation and Services with SDN/NFV

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Vice Chancellor, University System of Taiwan



Outline

1. Enablers for IoT & 5G Innovation and Services
2. Vision of Network Evolution by SDN/NFV
3. NCTU Roadmap in SDN/NFV Research
4. NCTU Future Plan
5. Conclusion



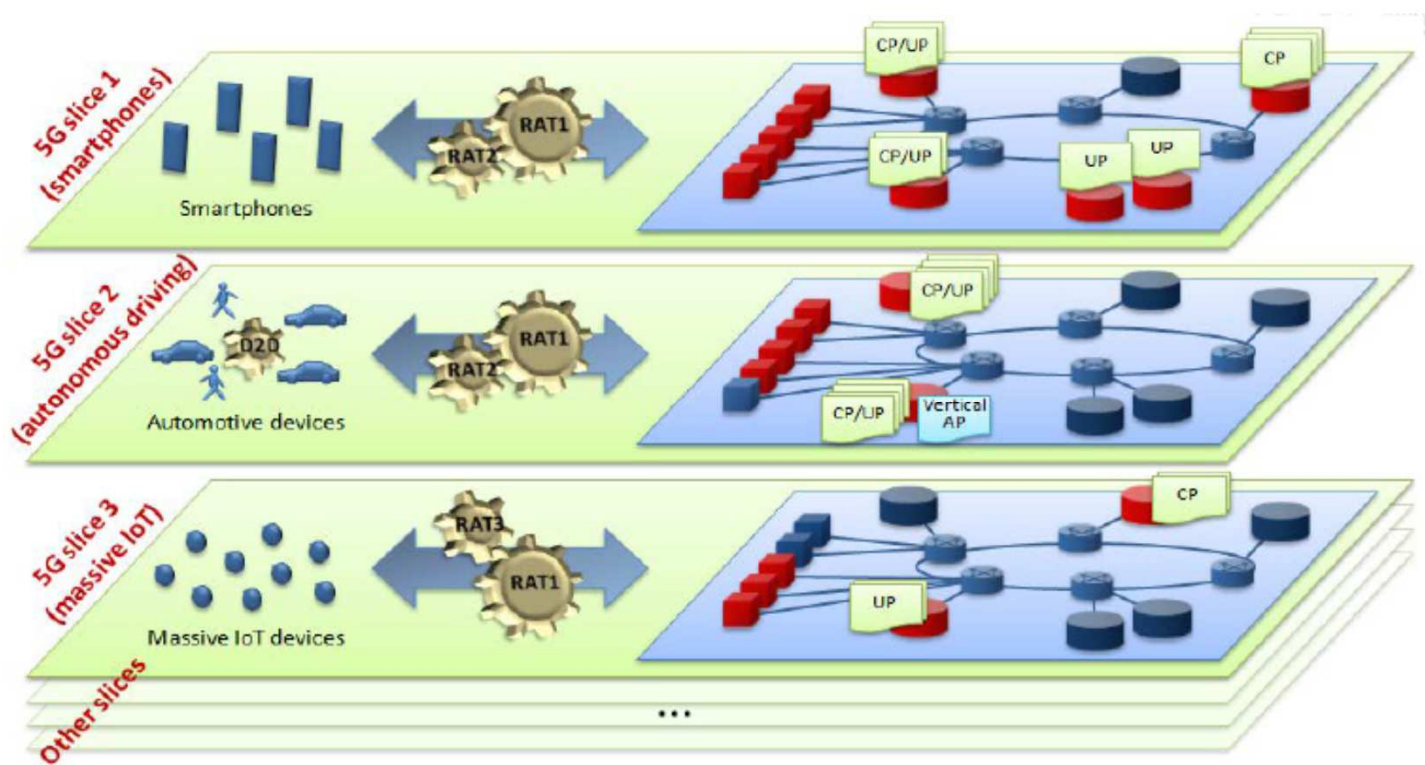
Enablers for IoT & 5G Innovation and Services

- Innovative IoT services such as Tactile Internet, Autonomous Driving and Massive M2M are considered major service offers in the future.
- These IoT services are characterized by very diverse QoS, security, latency and mobility requirements.
- Consequently, a more flexible, adaptable network than the existing 4G is required to accommodate and inspire IoT service innovation.
- For each service innovation, a specific network with the designated QoS, security, latency and mobility features must be provided.
- Network slicing envisaged by 5G networks will be the answer.
- SDN/NFV are the key technologies to realize network slicing in 5G.



What's Network Slicing?

Three Example Network Slices defined by NGMN



But many more will be required by IoT ... Source: NGMN 5G White Paper



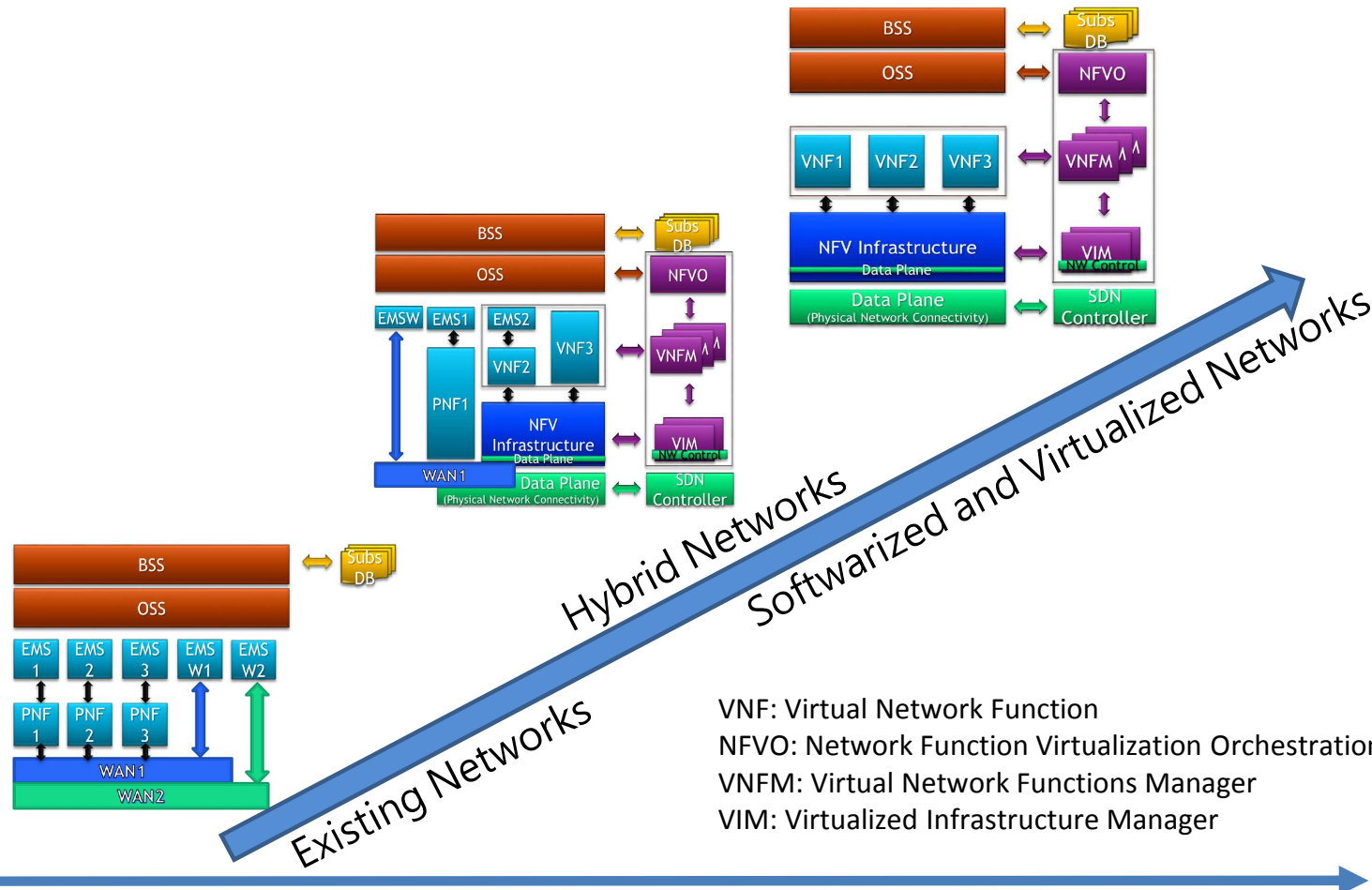
What are SDN and NFV?

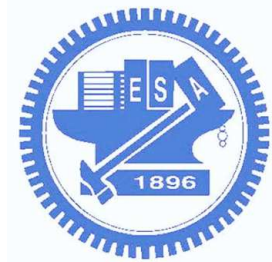
- SDN (Software-Defined Network) separates the control plan from the data plan via an SDN controller by defining a northbound and a southbound API.
- NFV (Network Function Virtualization) transforms traditional hardware-based network appliances to software-based service applications or APPs.
- SDN and NFV complement each other and jointly enable slicing-required network softwarization and virtualization.



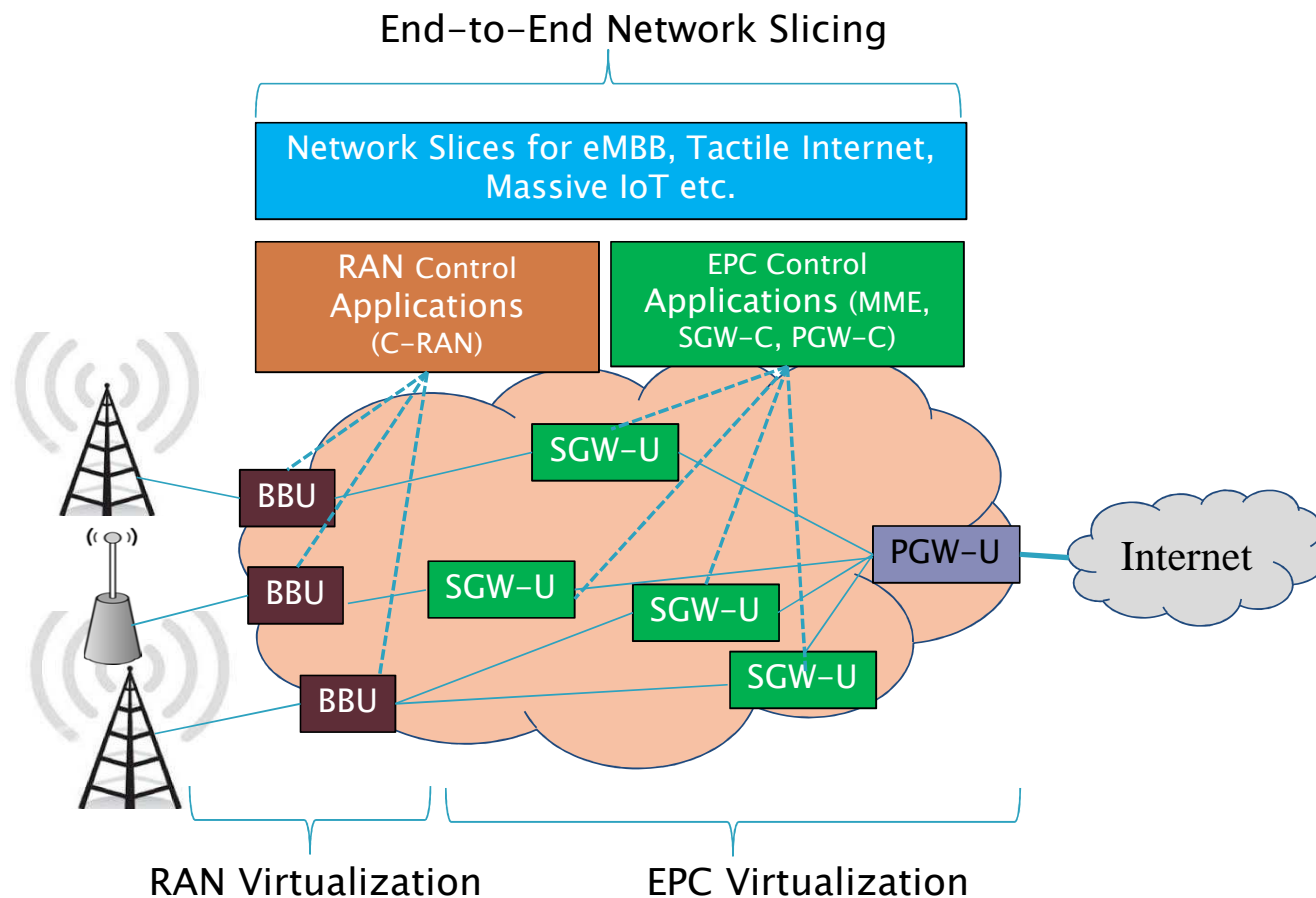
Vision of Network Evolution by SDN/NFV

Degree of Softwarization and Virtualization



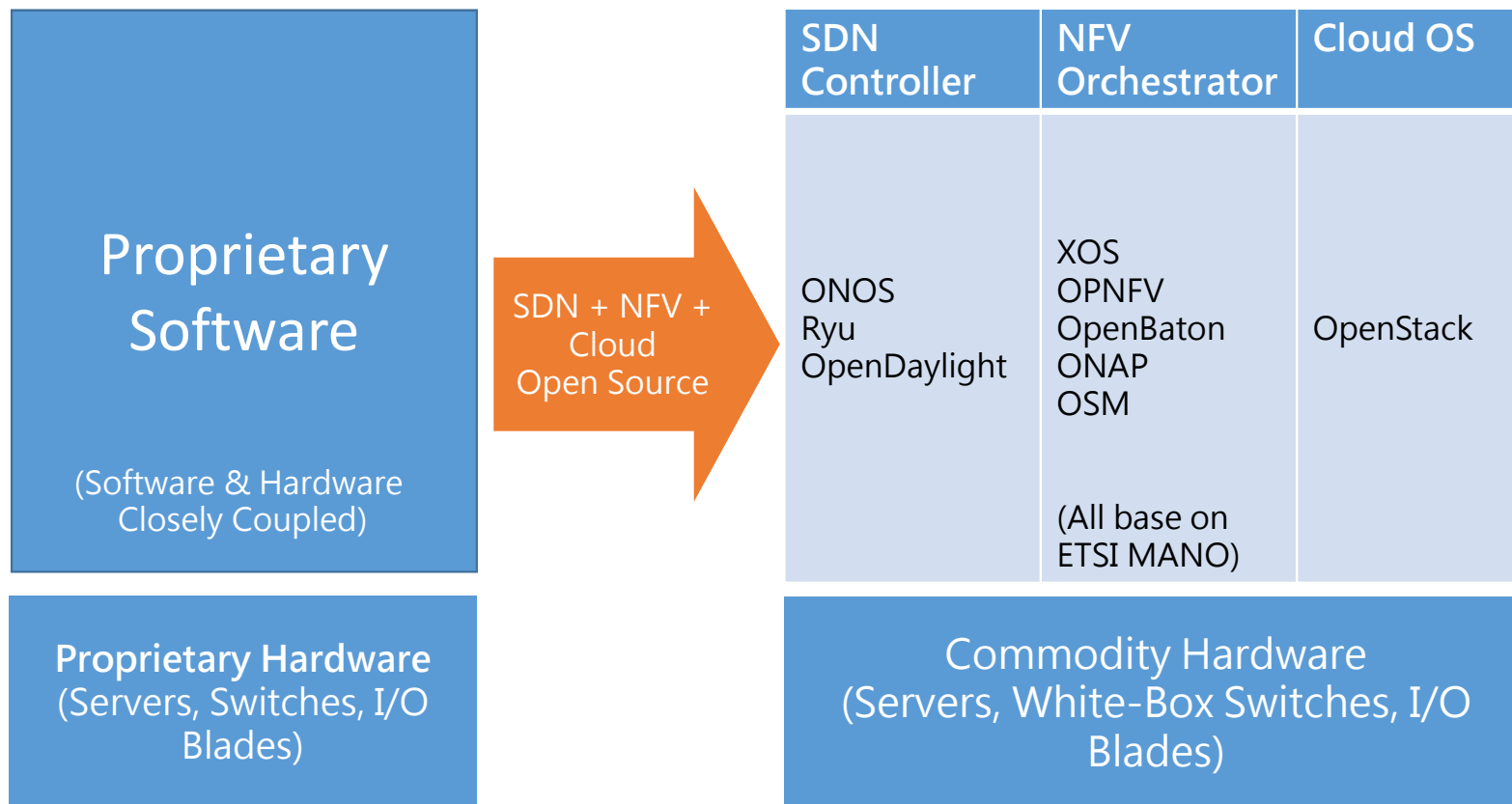


Envisaged Architecture of 5G Networks



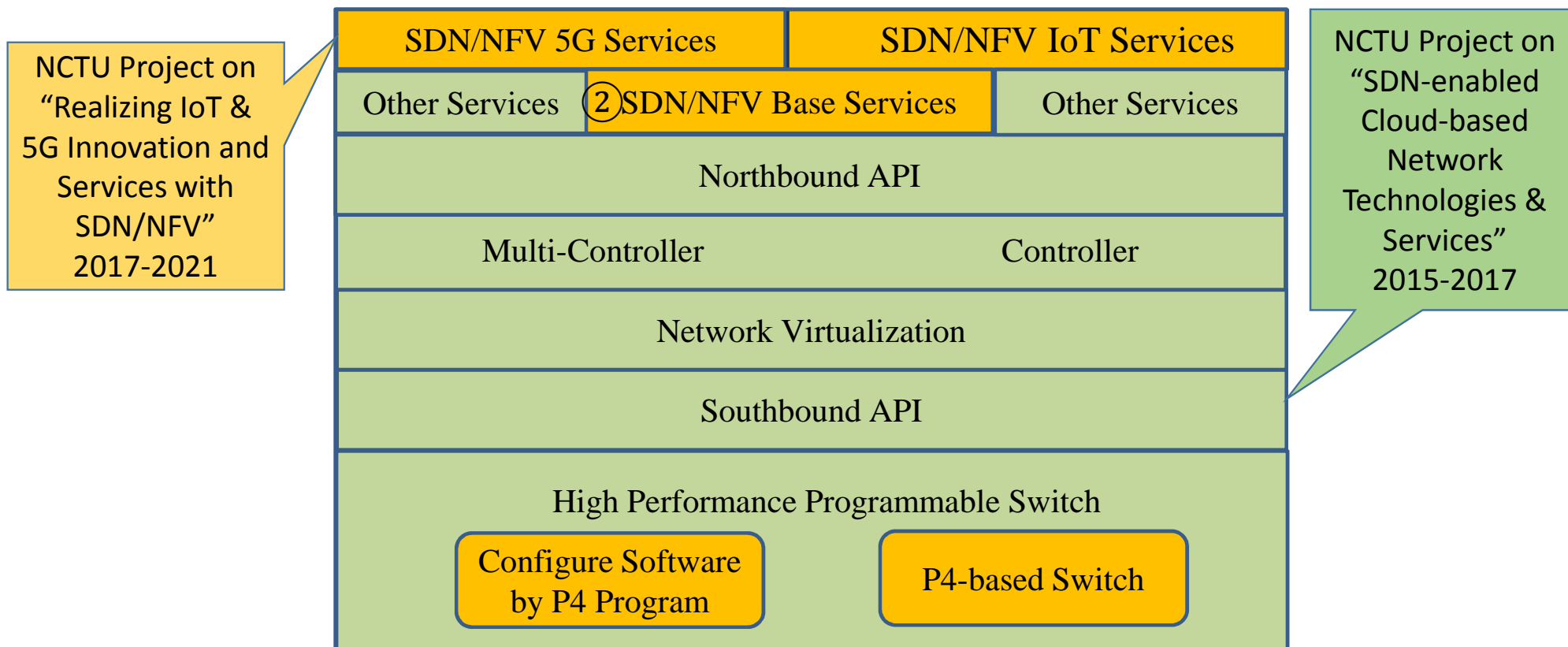


Major Transformation by SDN/NFV/Cloud

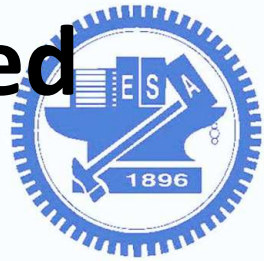




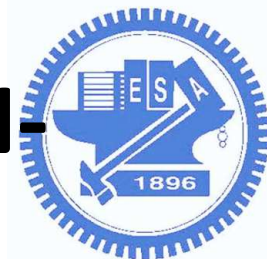
NCTU Roadmap in SDN/NFV Research



NCTU Project on “SDN-enabled Cloud-based Network Technologies & Services” 2015-2017



- Technical Focuses
 - Controller
 - SDN Multi-Controller
 - Service Chaining
 - Network Virtualization
 - Service Orchestration
 - Southbound APIs
 - Northbound APIs
 - SDN Switch/Access Point



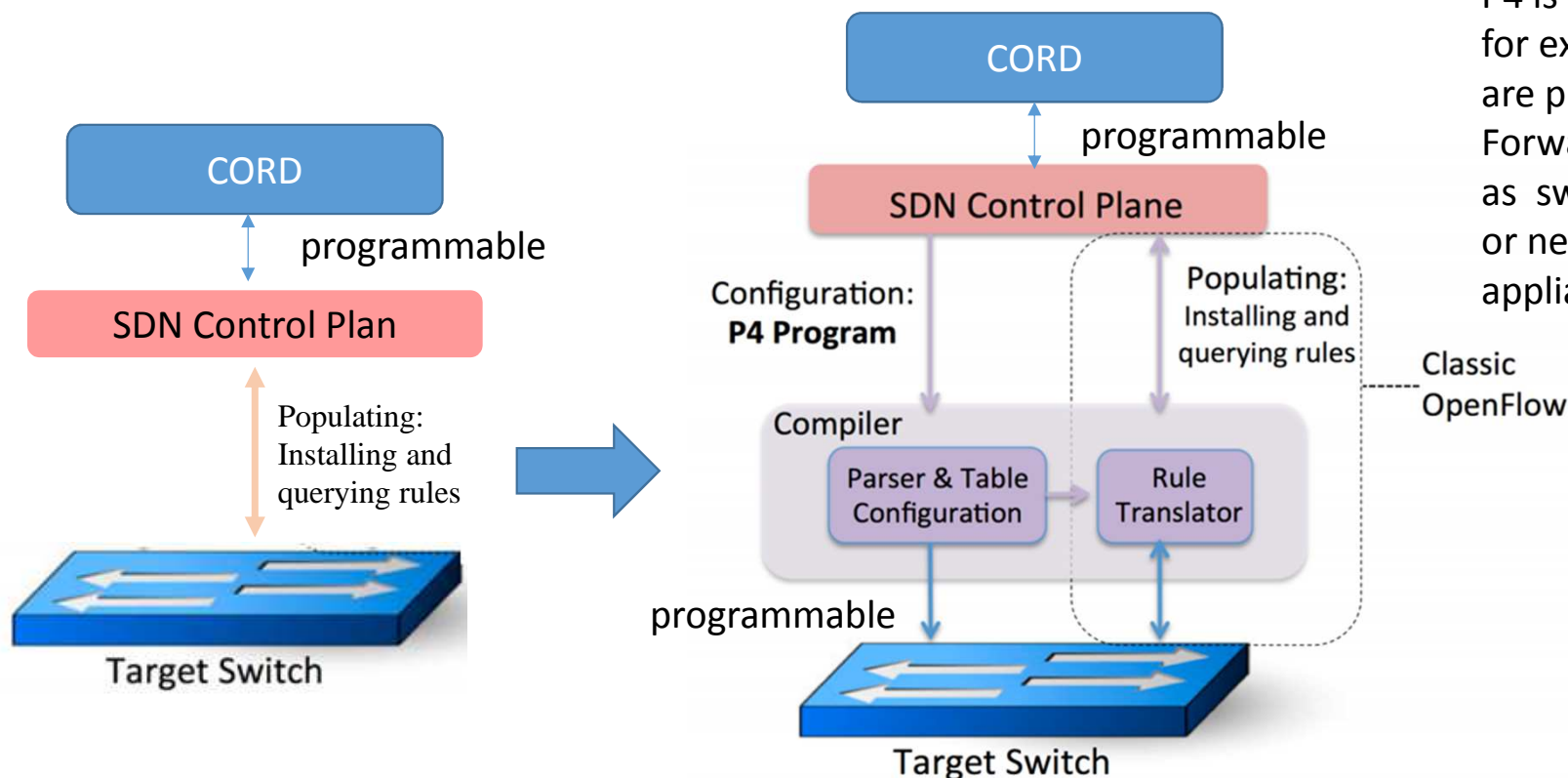
NCTU Research Accomplishments on “SDN-enabled Cloud-based Networks”

- Established the NCTU SDN testbed that incorporates Ryu、OpenDaylight and ONOS controllers with a variety of SDN switches from different vendors.
- Successfully participated in global SDN-IP Peering of ONF and connected the NCTU SDN testbed to eight cities around the globe in five continents to increase the visibility of Taiwan.
- Successfully assisted Chunghwa Telecom to incorporate SDN in their broadband networks based on Ryu as the controller.
- Proactively promoted an SDN ecosystem in Taiwan.
- Trained over 250 PhD/MS students in the MOST project with expertise in SDN/NFV
- Produced more than 35 patents
- NCTU Network Benchmarking Lab (NBL) was approved by ONF as one of seven ONF Authorized Test Labs for OpenFlow conformance testing.

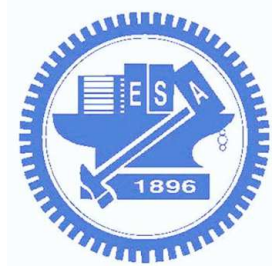


NCTU Future Plan (1)

Programmable Network Equipment based on P4

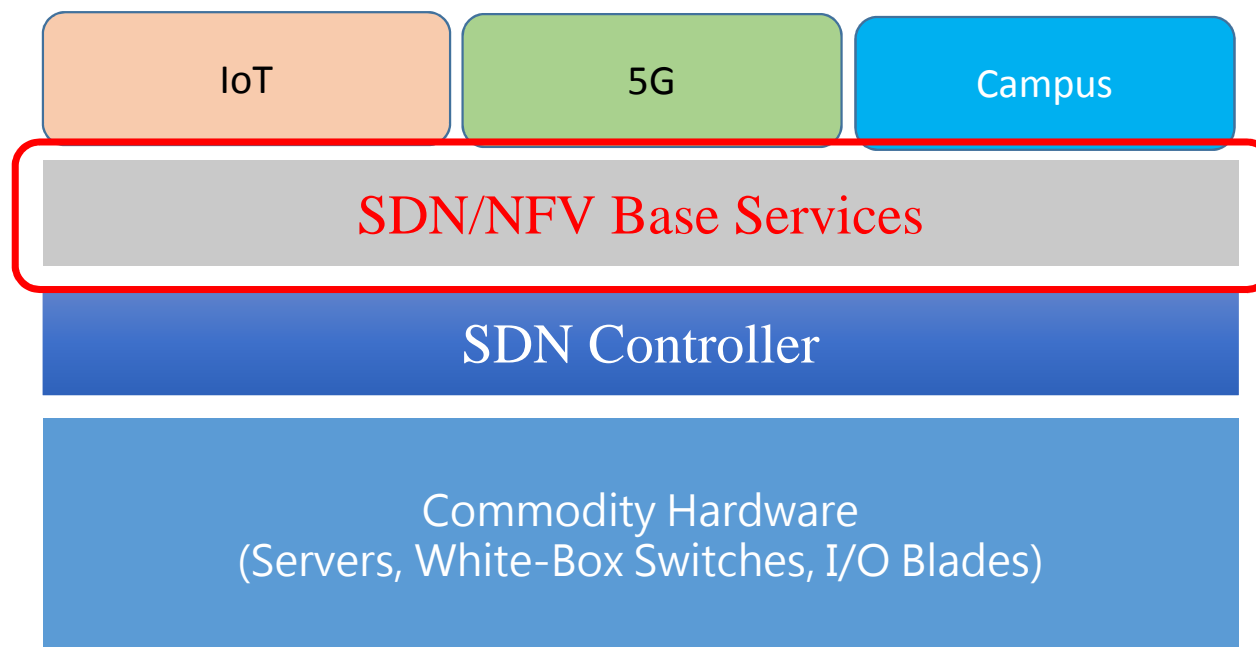


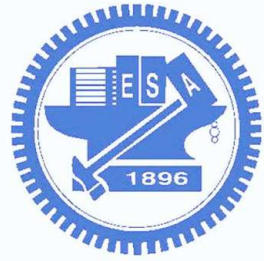
P4 is a declarative language for expressing how packets are processed in network Forwarding elements such as switches, NICs, routers, or network function appliances



NCTU Future Plan (2)

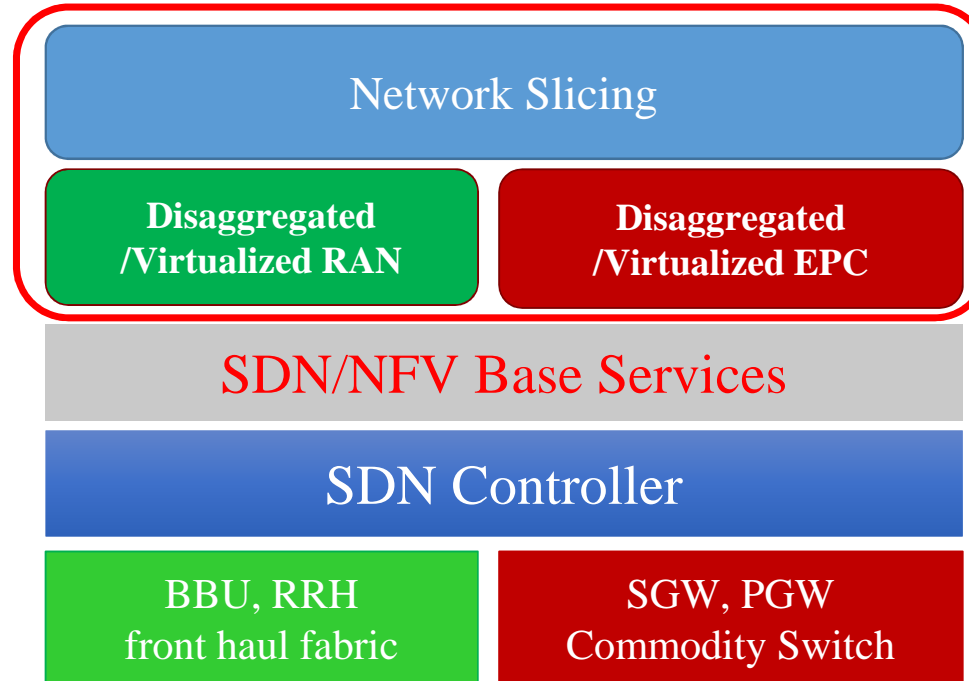
SDN/NFV Base Services





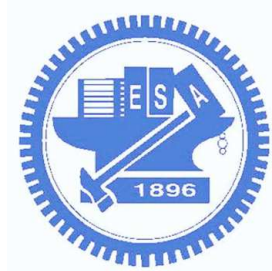
NCTU Future Plan (3)

SDN/NFV 5G Services



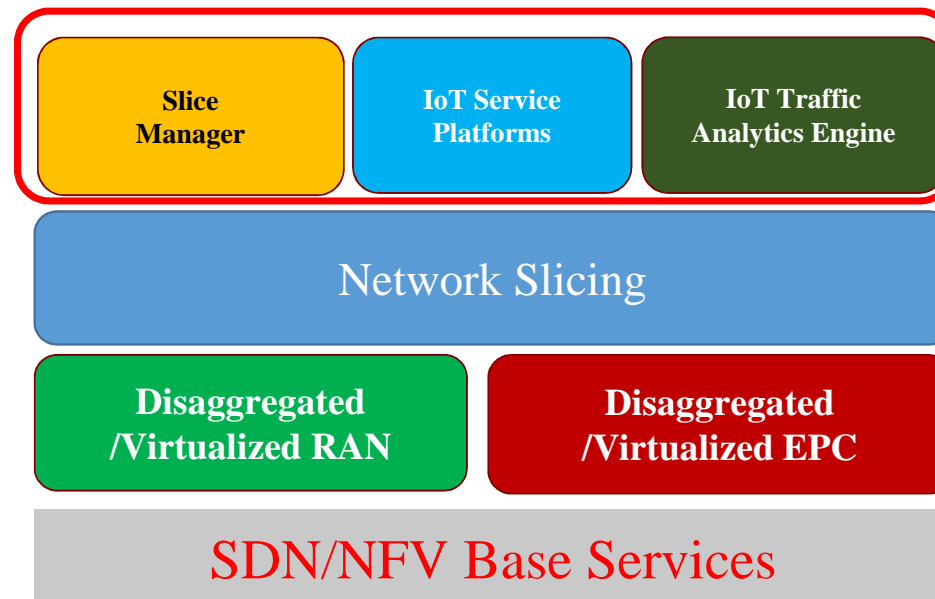
5G Access
-BBU: Base Band Unit
-RRH: Remote Radio Head

5G Core
-MME: Mobility Management Entity
-SGW: Signaling Gateway
-PGW: Packet Gateway



NCTU Future Plan (4)

SDN/NFV IoT Services



15



Smart Campus Application

Alpha Test-Site: Single-Campus SDN/NFV

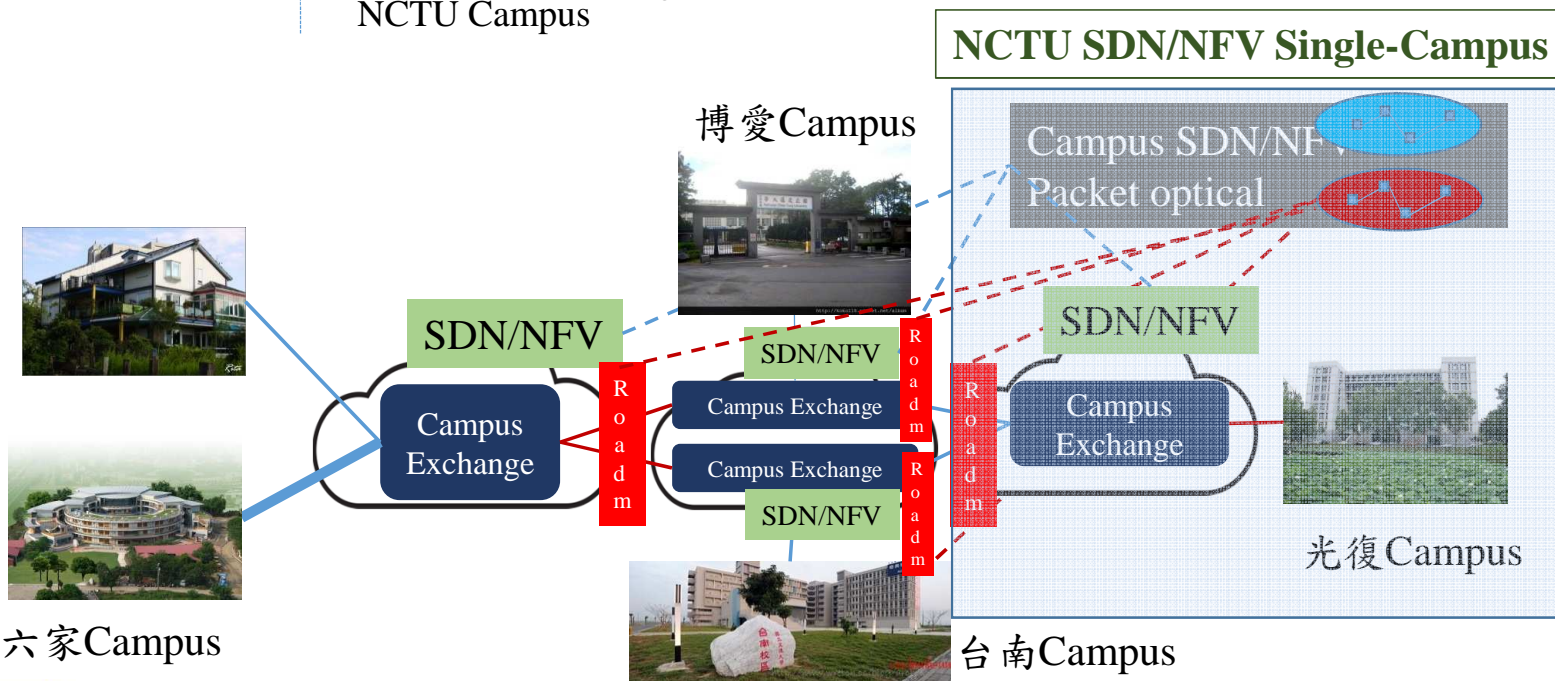
Study SDN/NFV Architectural Alternatives

SDN/NFV Architecture (SW/HW) for NCTU Campus

NCTU Campus SDN/NFV design

NCTU SDN/NFV Campus implementation

Testing of NCTU SDN/NFV Campus





Smart Campus Application

Beta Test-Site (1): Multi-Campus SDN/NFV

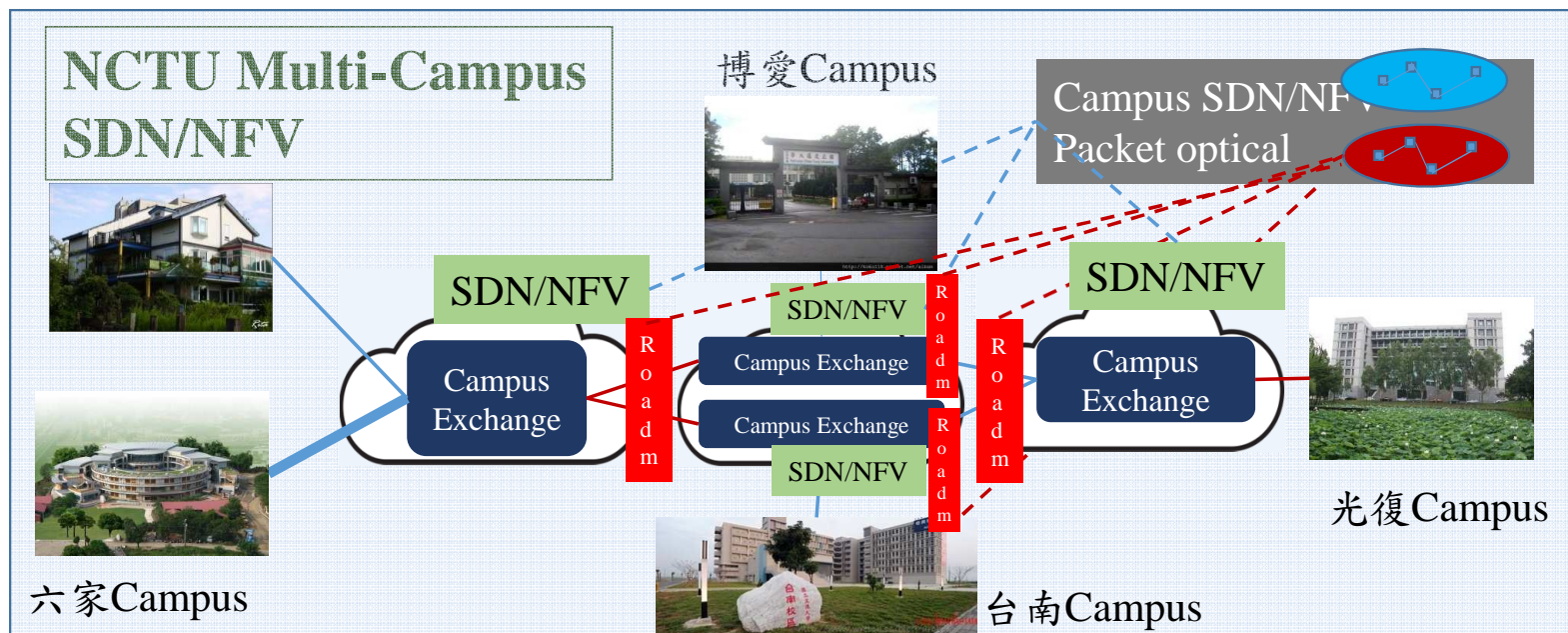
Study SDN/NFV Architectural Alternatives

SDN/NFV Architecture (SW/HW) for NCTU Campus

NCTU Campus SDN/NFV design

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Testing of NCTU SDN/NFV Campus





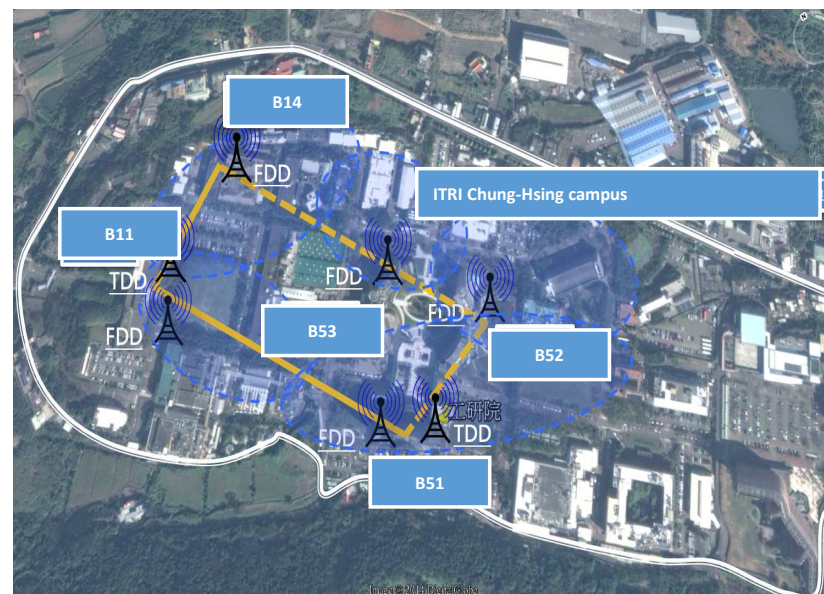
Smart Campus Application

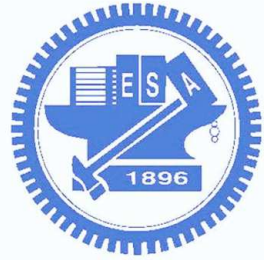
Beta Test-Site (2): Other & ITRI Campuses

Other University Campus in Hsinchu



ITRI Campus





4-Year Project under Planning

	First Year	Second Year	Third Year	Fourth Year
	Project Begins	1 st Milestones	2 nd Milestones	3 rd Milestones
Project Mgmt	→			
P4 switch	→			
P4 PNE	→			
SDN/NFV 5G	→			
SDN/NFV IoT	→			
SDN/NFV Mgmt	→			
IoT Smart City	→			
Other 5G Services	→			
Testing & Field Trial	→			



Conclusion

- Network slicing envisaged by 5G networks can realize IoT & 5G innovation and services.
- SDN/NFV are the key technologies to realize network slicing in 5G.
- NCTU has embarked in SDN/NFV research since 2015.
- We successfully participated in global SDN-IP Peering of ONF and connected our SDN testbed to eight cities around the globe.
- We were also approval by ONF as one of seven ONF Authorized Test Labs for OpenFlow conformance testing.
- We plan to launch new effort in SDN/NFV research to proactively promote IoT & 5G innovation and services.



Thank you!