

# LTE - Can SDN paradigm be applied?

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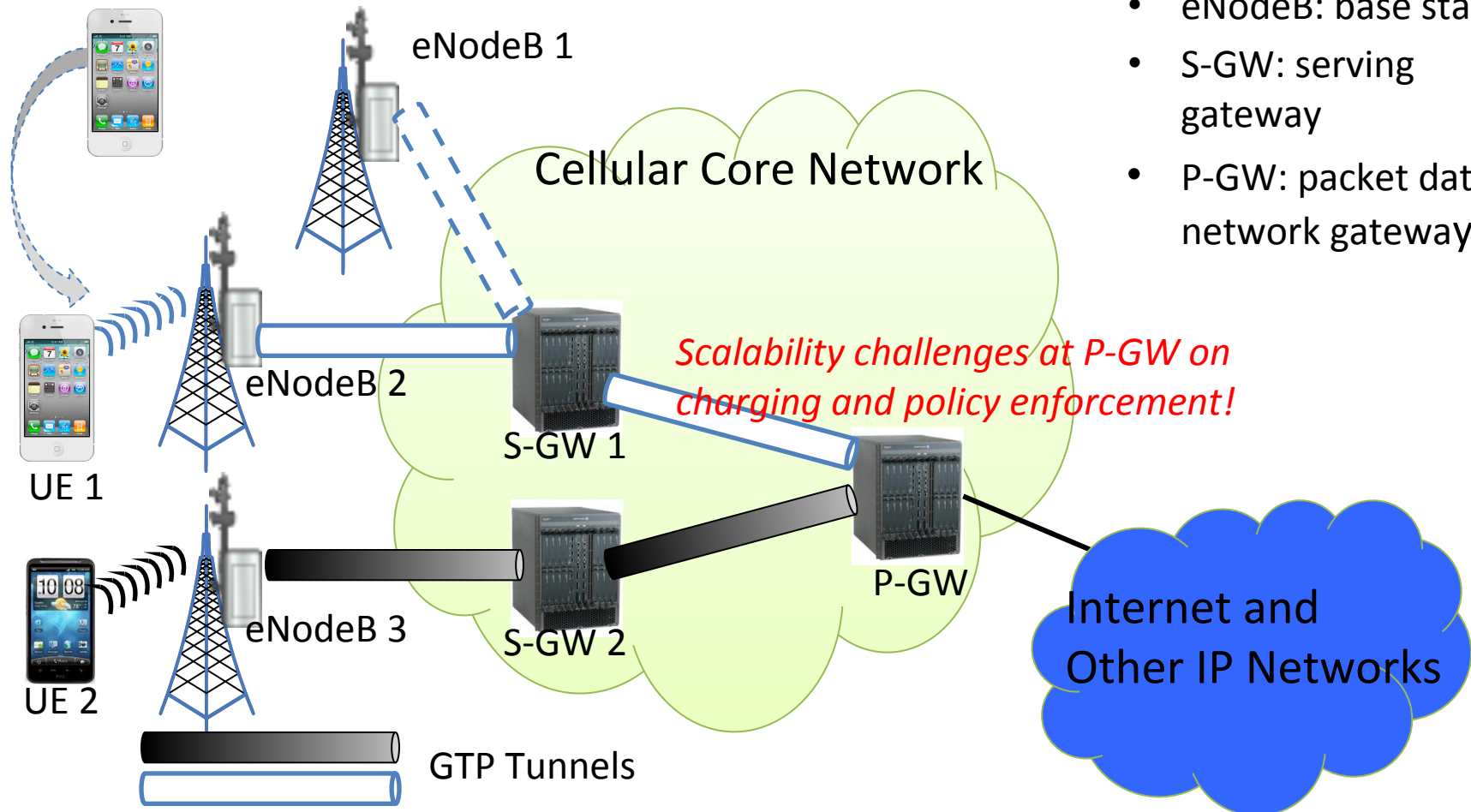
***Towards Software Defined Cellular Networks***

Li Erran Li (Bell Labs, Alcatel-Lucent) Morley Mao (University of Michigan) Jennifer Rexford (Princeton University)

# LTE Data plane is too centralized

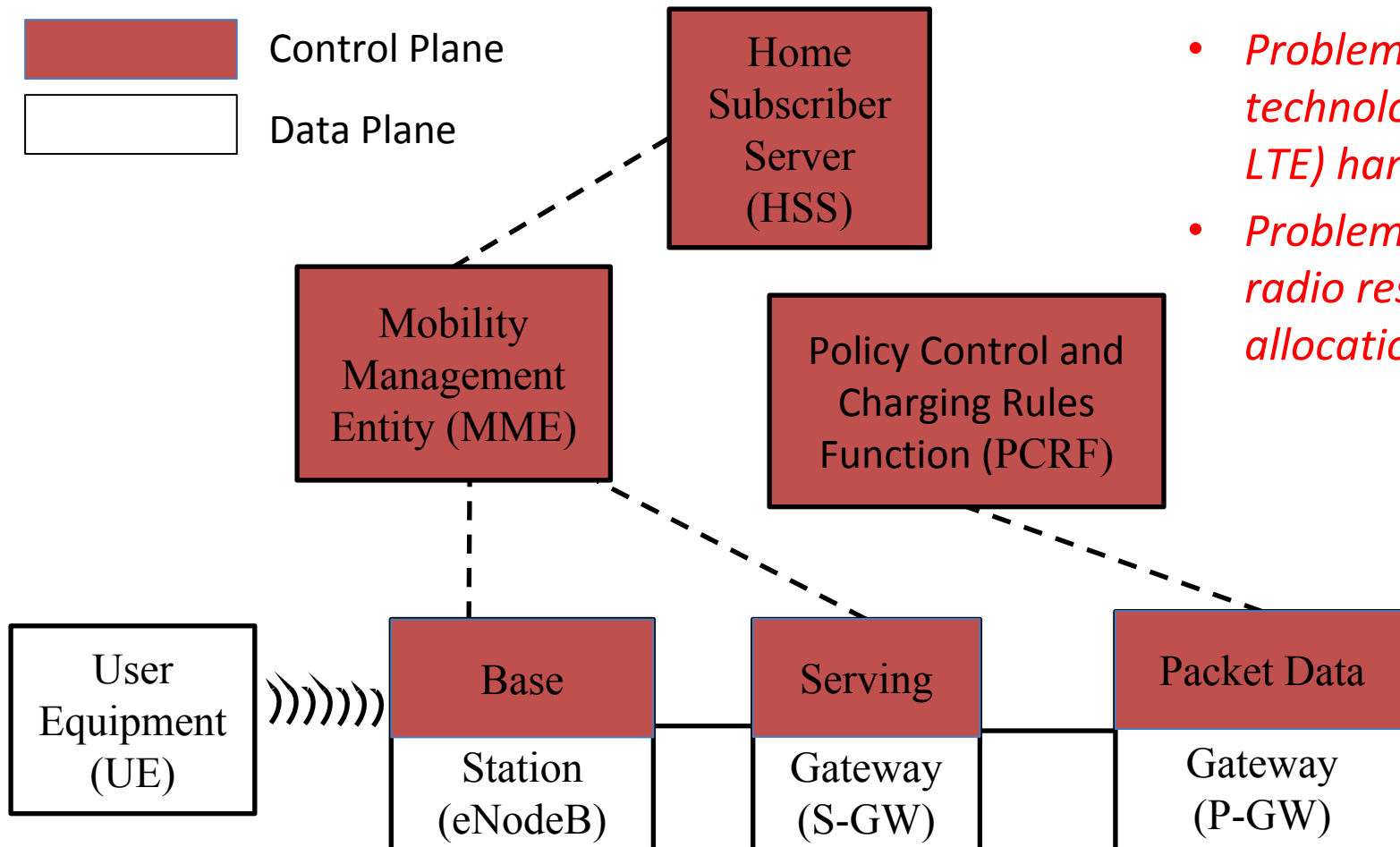
- Data plane is too centralized

- UE: user equipment
- eNodeB: base station
- S-GW: serving gateway
- P-GW: packet data network gateway



# LTE Control plane is too distributed

- No clear separation of control plane and data plane



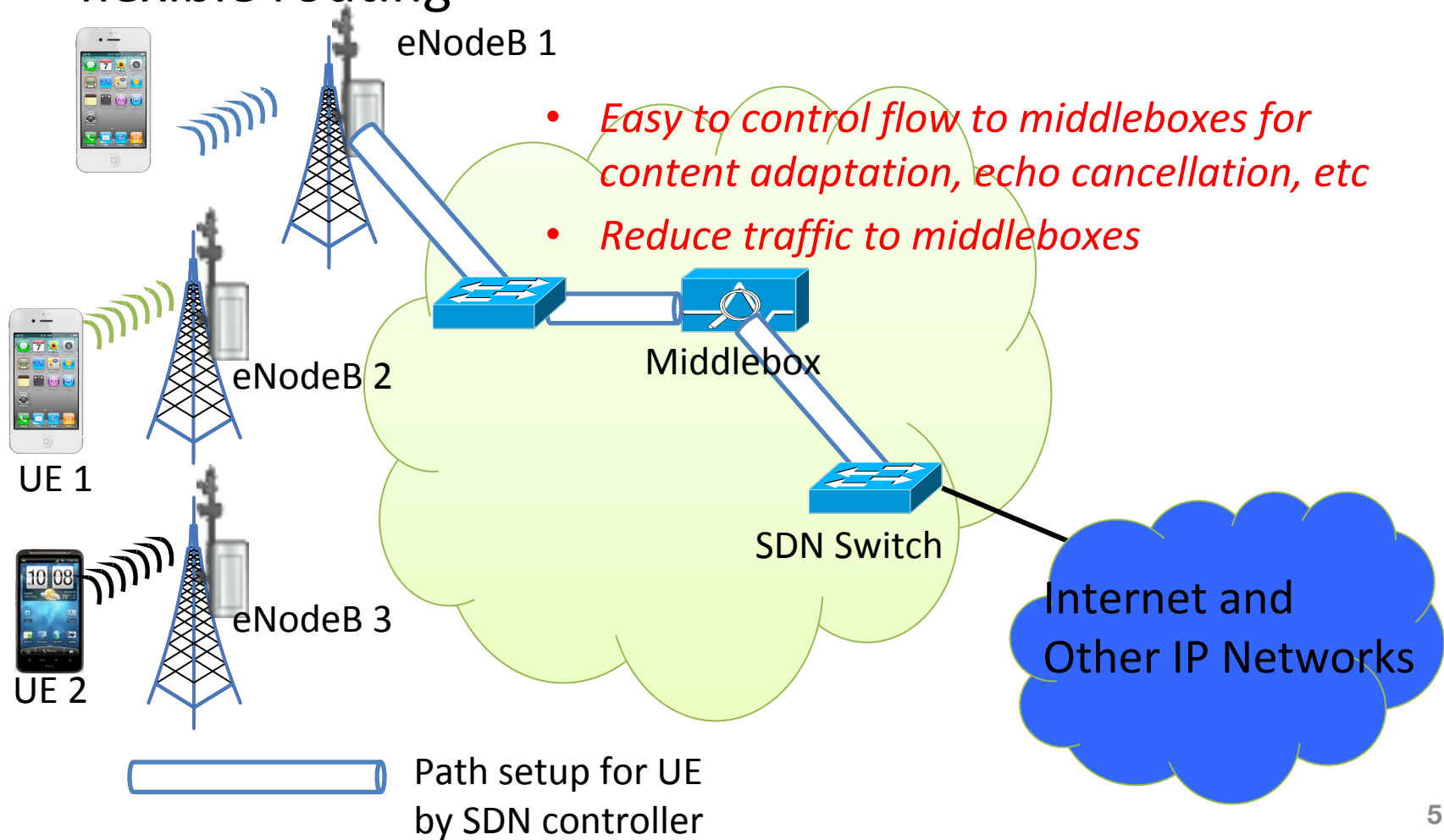
- *Problem with Inter-technology (e.g. 3G to LTE) handoff*
- *Problem of inefficient radio resource allocation*

# Advantages of SDN for Cellular Networks

- Advantage of logically centralized control plane
  - Flexible support of middleboxes
  - Better inter-cell interference management
  - Scalable distributed enforcement of QoS and firewall policies in data plane
  - Flexible support of virtual operators by partitioning flow space
- Advantage of common control protocol
  - Seamless subscriber mobility across technologies
- Advantage of SDN switch
  - Traffic counters enable easy monitoring for network control and billing

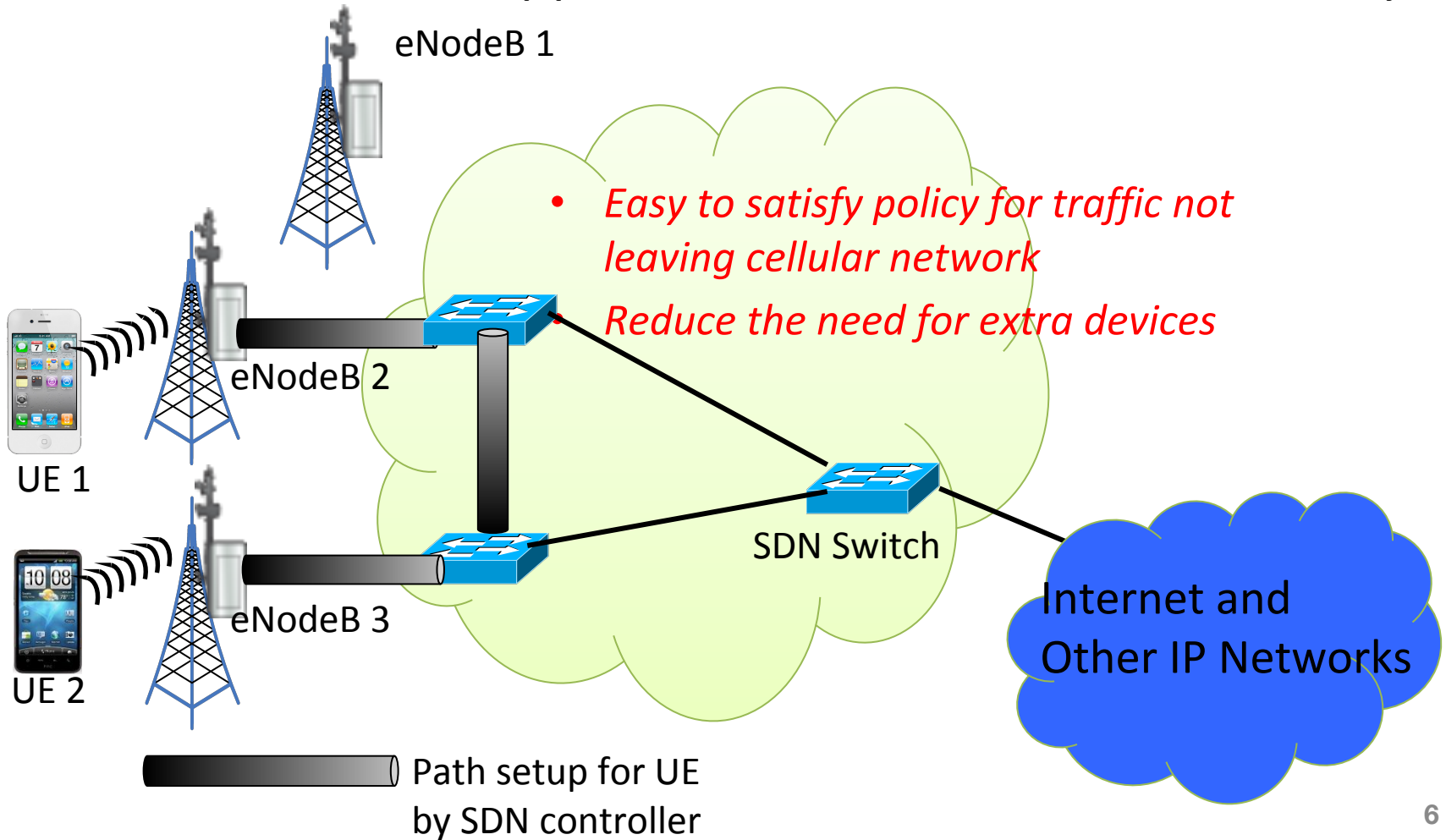
# Flexible Middlebox Support

- SDN provides fine grained packet classification and flexible routing



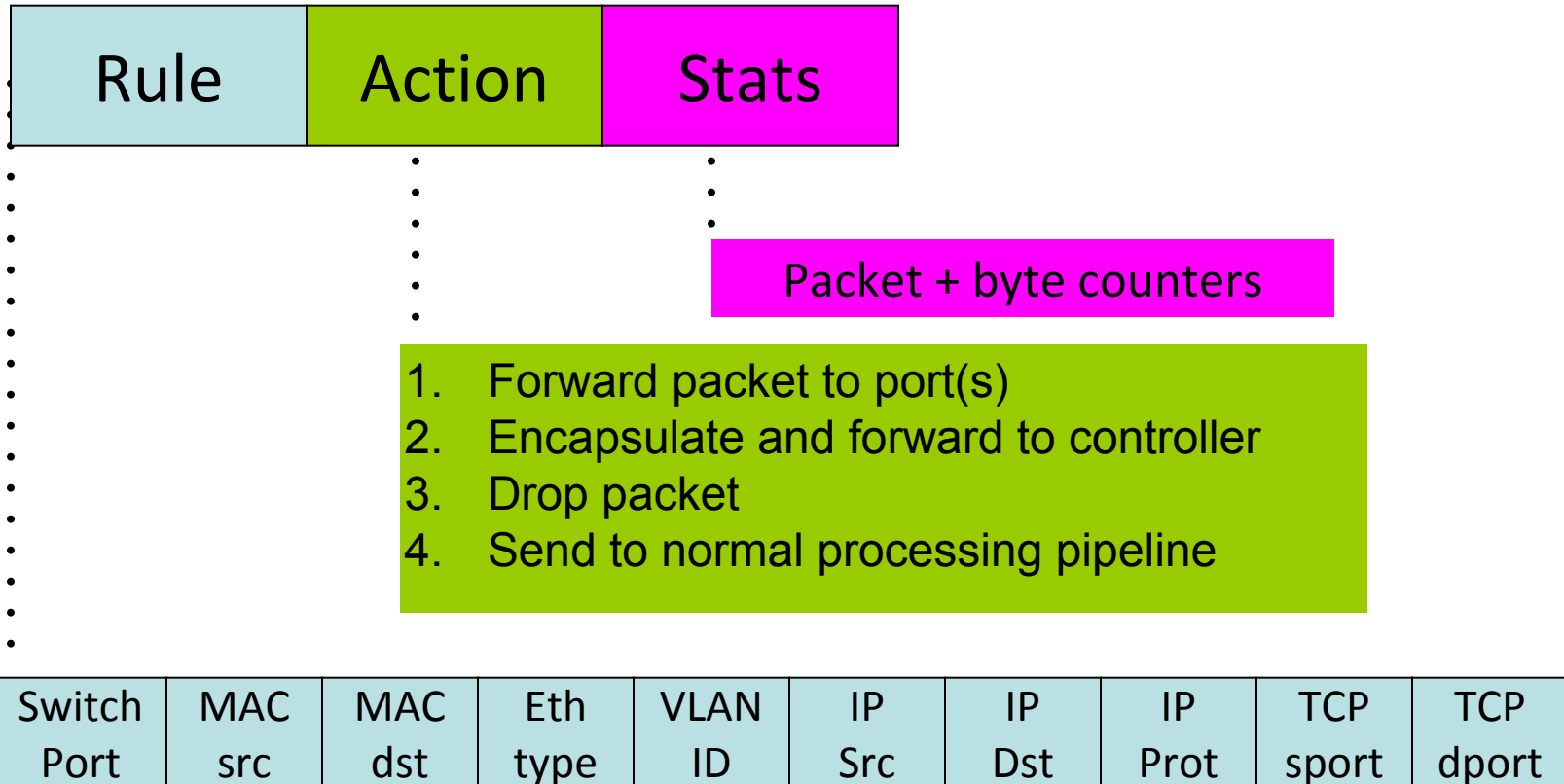
# Flexible Middlebox Support (Cont'd)

- SDN switch can support some middlebox functionality



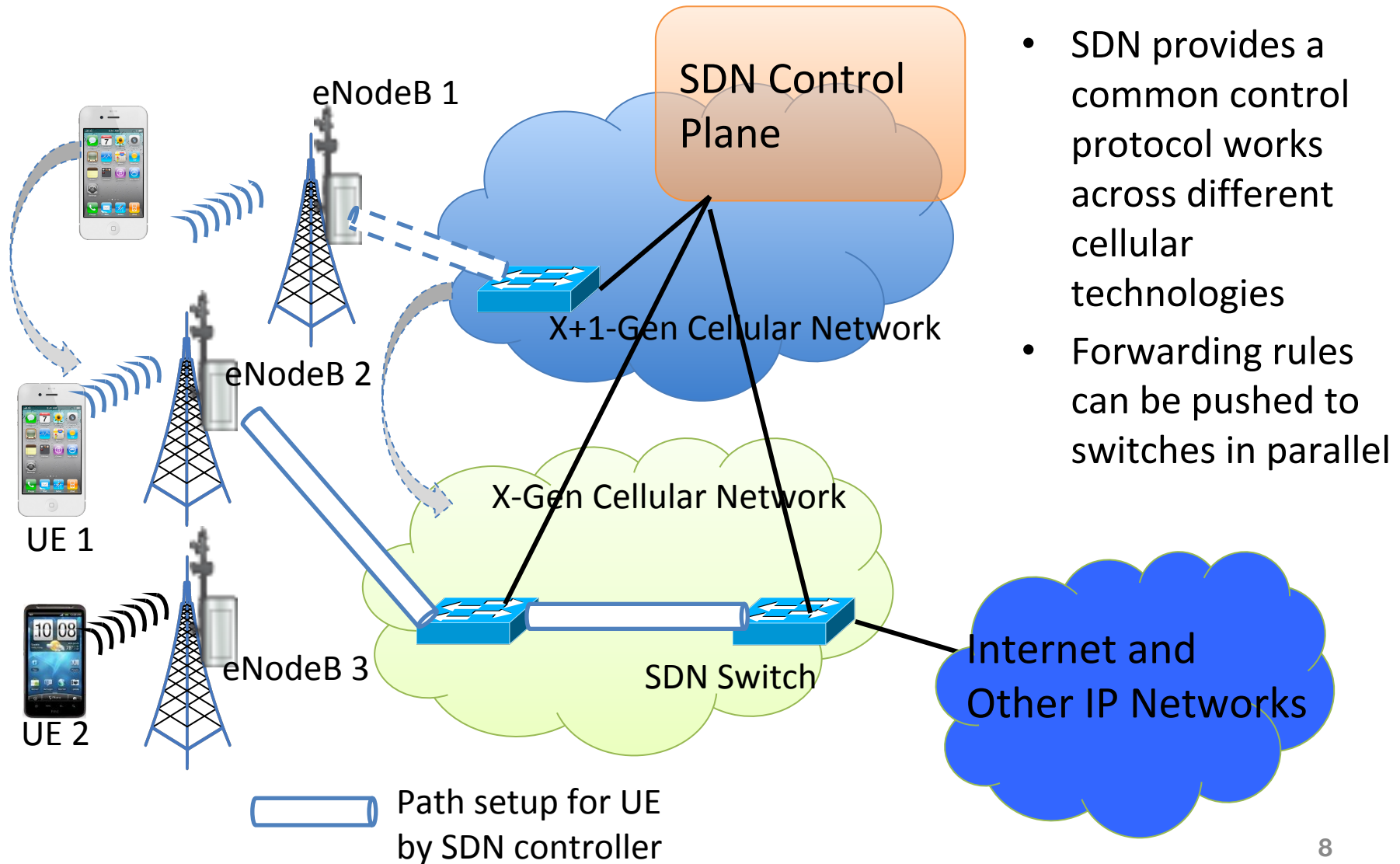
# Monitoring for Network Control & Billing

- Packet handling rules in SDN switches can efficiently monitor traffic at different level of granularity
  - Enable real time control and billing



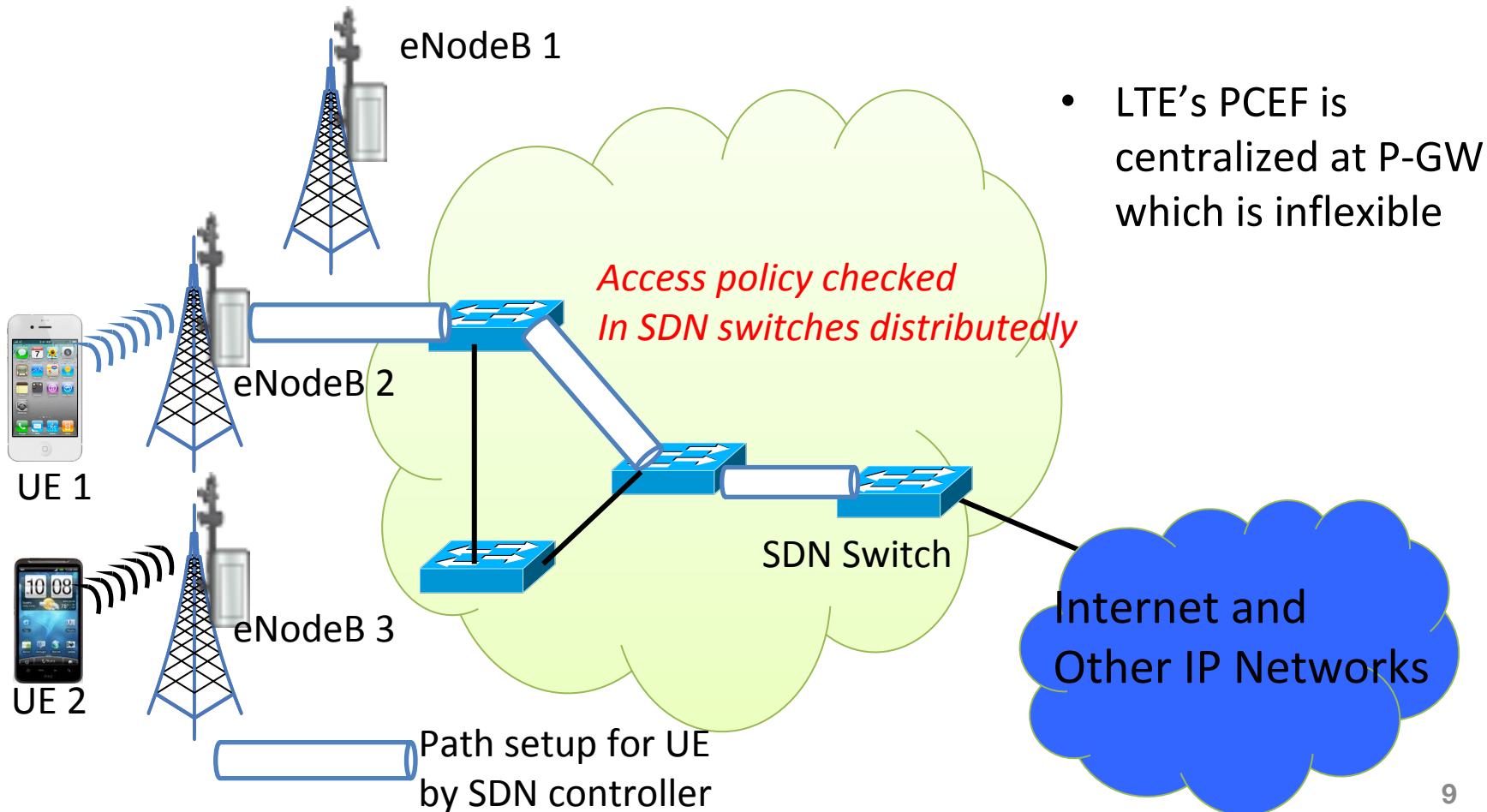
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# Seamless Subscriber Mobility



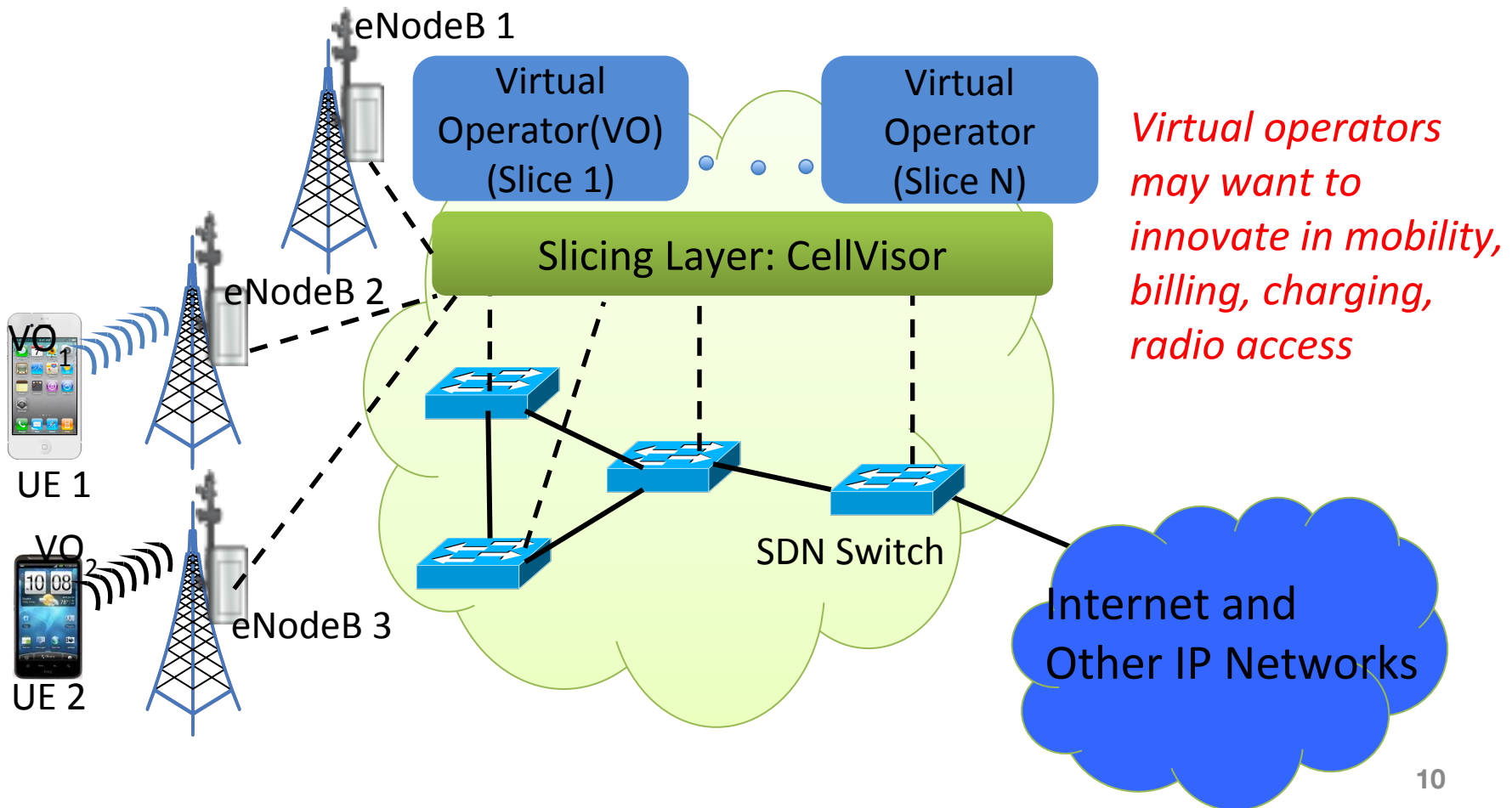


# Distributed QoS and ACL Enforcement



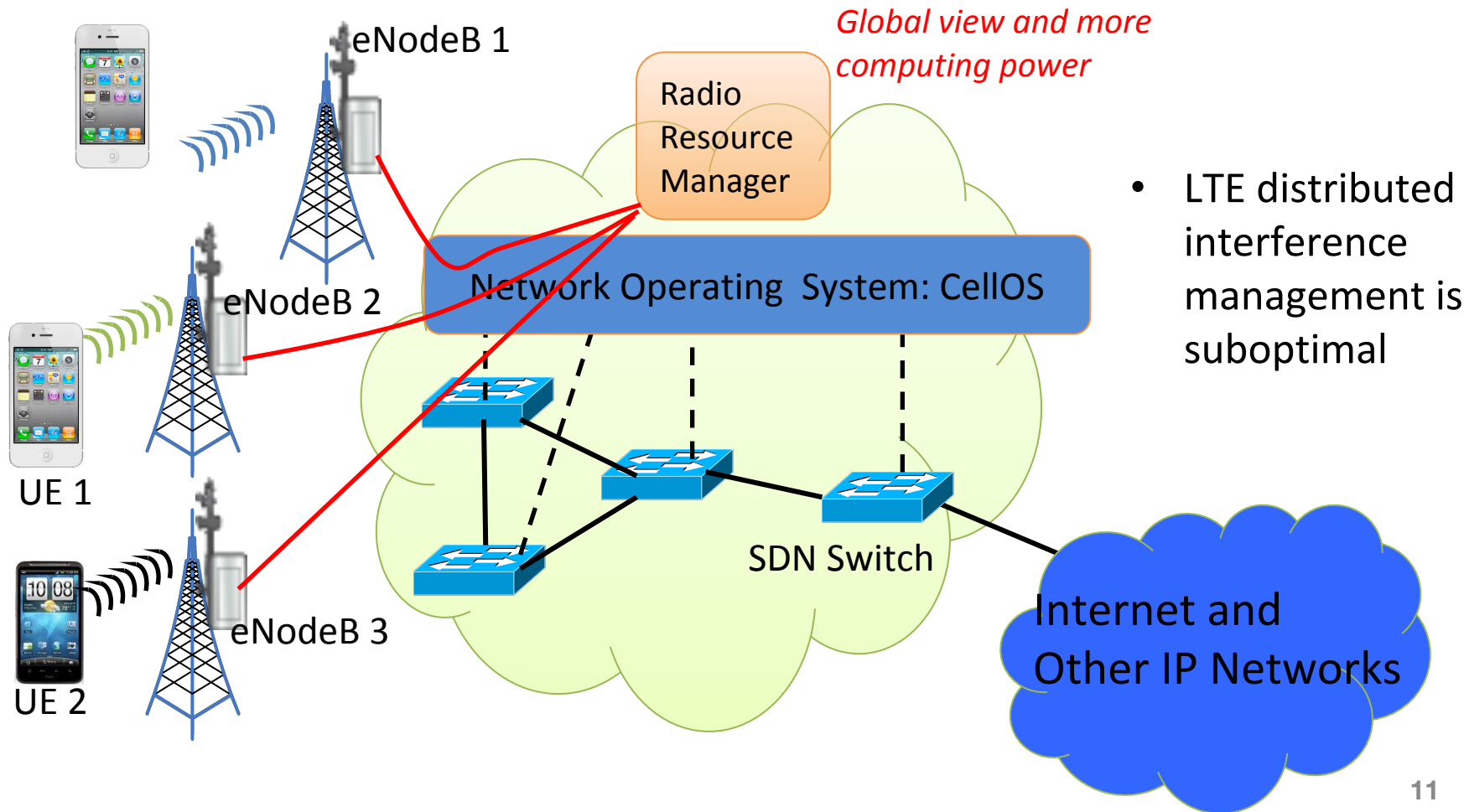
# Virtual Operators

- Flexible network virtualization by slicing flow space

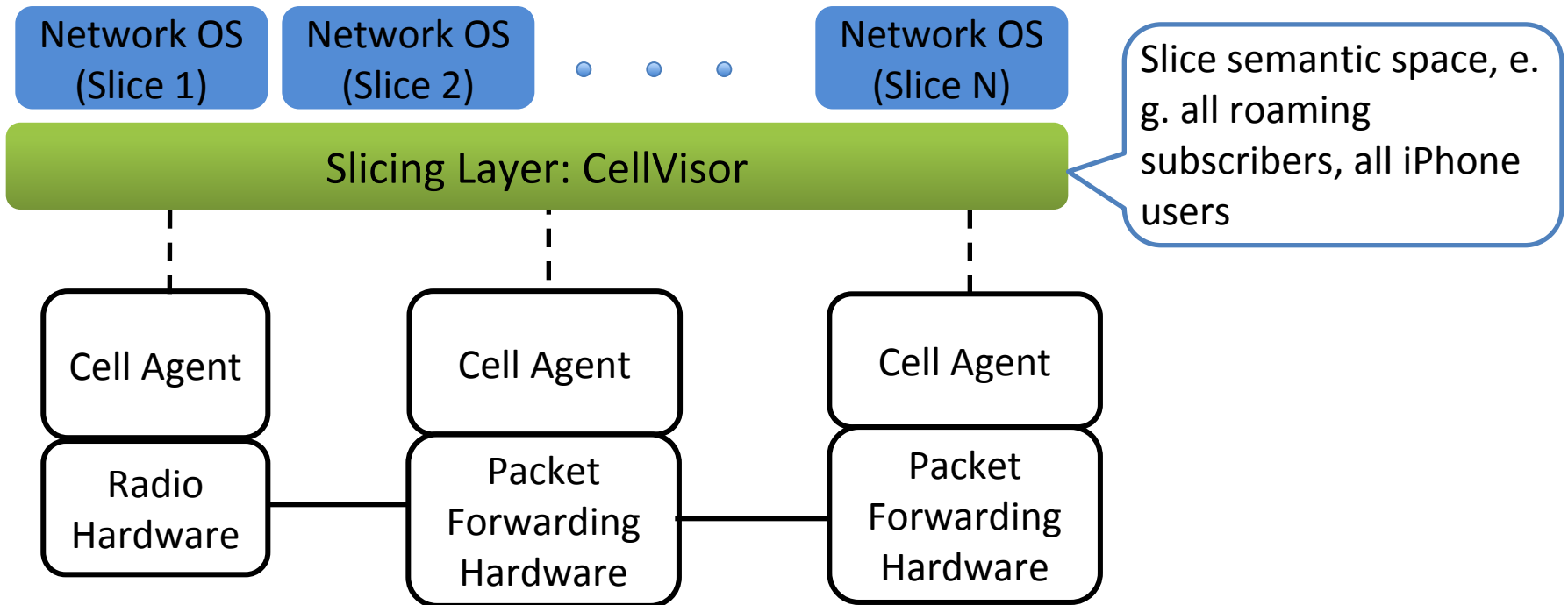


# Inter-Cell Interference Management

- Central base station control: better interference management



# Virtualization



# State of Art

- Stanford OpenRoad
  - Introduced openflow, FlowVisor, SNMPVisor to wireless networks
- Stanford OpenRadio
  - Programmable cellular data plane
- NEC base station virtualization
  - Slicing radio resources at the MAC layer
- Ericsson CloudEPC
  - Modify LTE control plane to control openflow switches
- Bell labs - Alcatel CellSDN
  - Provides scalable, fine-grain real time control and extensions: