RECO, SLV and free5GC - a path toward softwarization and virtualization of 5G core networks

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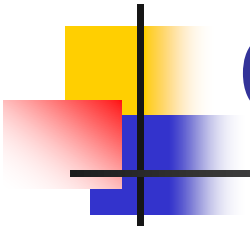
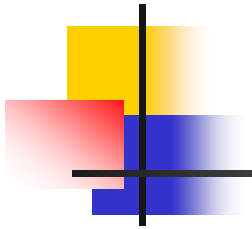


Outline

- Background
  - with focus on core networks
- What is 5G?
  - Softwarization and Virtualization
- Our open-source projects
  - Reconfigurable Core (RECO)
  - Service Level Virtualization (SLV)
  - free5GC

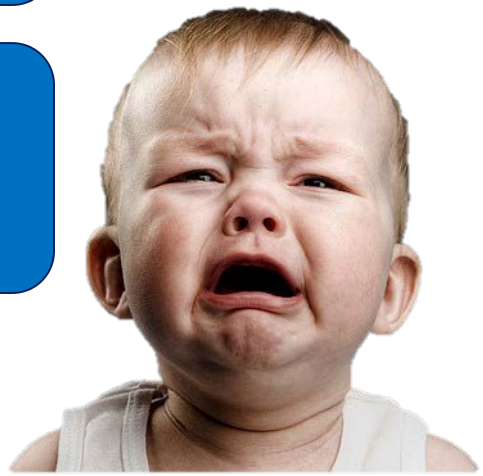


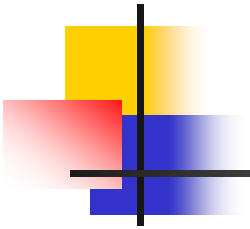
What's wrong with the current 4G core network?

All Propriety Hardware

Specialized Features

Specialized Hardware





High cost

limits innovation

Not flexible

How to solve?

Softwarization and Virtualization

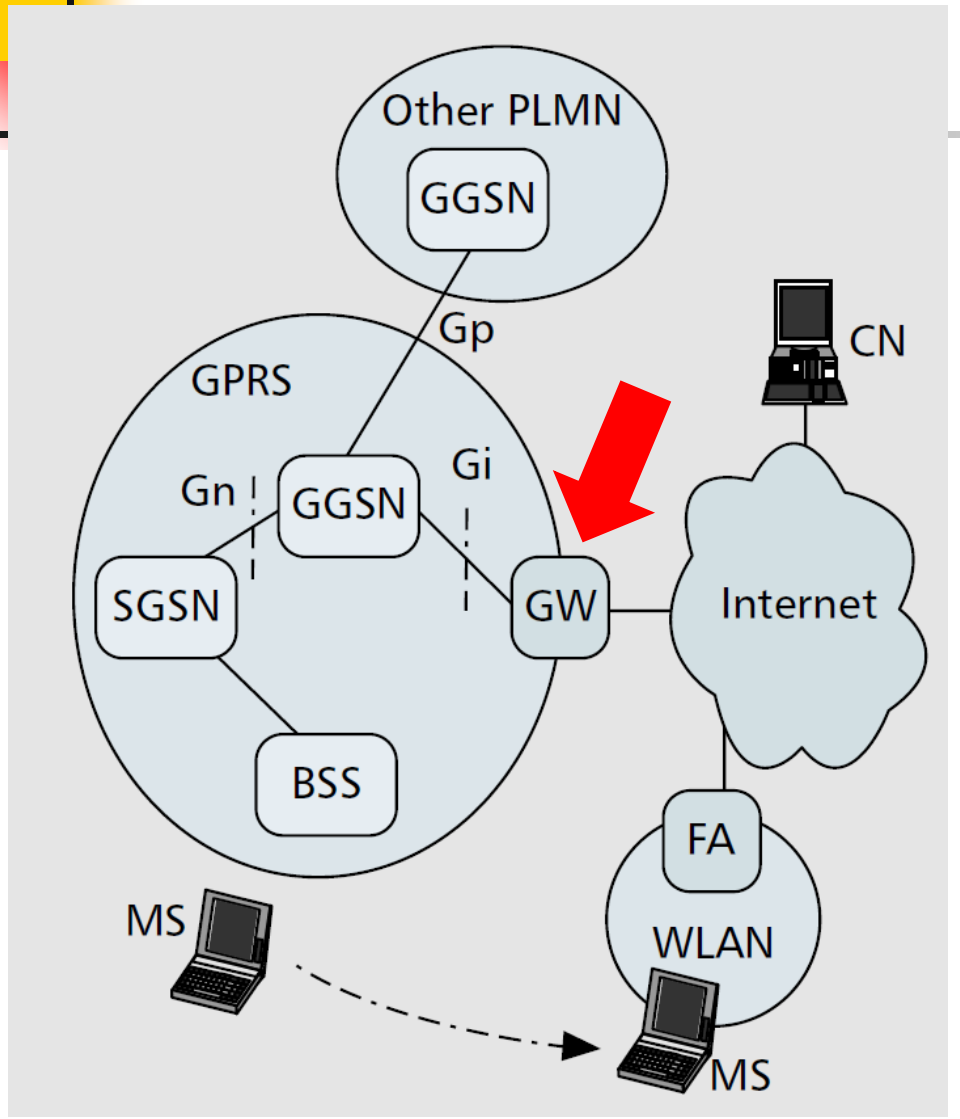
Research topics of softwarization and virtualization

- How to retain the required performance for network entities while it is virtualized?
- How to design and implement the automatic self-management MANO system?
- ……
- **How to implement customized VNFs efficiently for a flexible *OPEN* 5G core network?**

Doing research in core networks

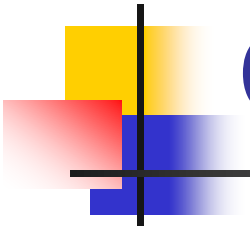
- The core networks are very expensive, and it’s not easy to access the source code.
- People usually could only conduct mathematical analysis and simulation to verify their ideas.
- With open-source core networks, researchers can implement and test their proposed algorithms in a real testbed.

Gateway (GW) Approach



J.-C. Chen and H.-W. Lin, "A gateway approach to mobility integration of GPRS and wireless LANs," *IEEE Wireless Communications*, vol. 12, no. 2, pp. 86-95, Apr. 2005.

Node	Model
BTS	Siemens BS20
BSC	Siemens BSC
HLR	Siemens SR8
SGSN	Nokia DX200
GGSN	Nokia GN2500



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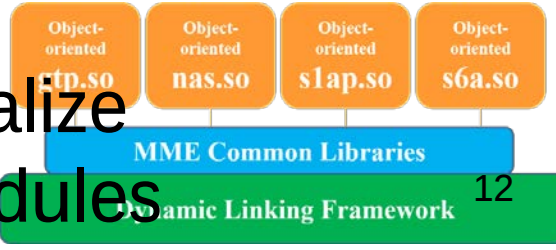
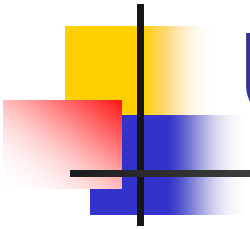
Reconfigurable Core (RECO)

- http://reconet.org/reco/
- C.-H. Wu, W.-J. Chen, and J.-C. Chen, "Poster - RECO: a reconfigurable core network for future 5G communication systems," in *Proc. of ACM International Conference on Mobile Computing and Networking (MobiCom '17),* (Snowbird, UT, USA), pp. 594 - 596, Oct. 2017.

Reconfigurable Core (RECO)

- Common modules
  - common MME libraries which different types of users share. E.g., UDP, SCTP, hash table
- Object-oriented customized modules
  - customized modules which differ between different types of users
- Dynamic Linking Framework
  - parse descriptor load and initialize corresponding customized modules



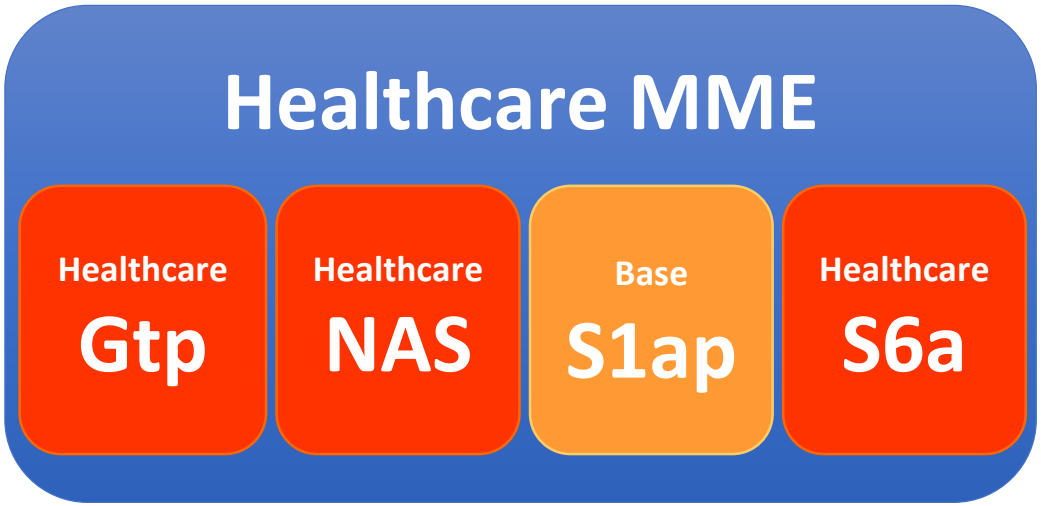


Use cases

- For remote-control surgery
- For high-speed users

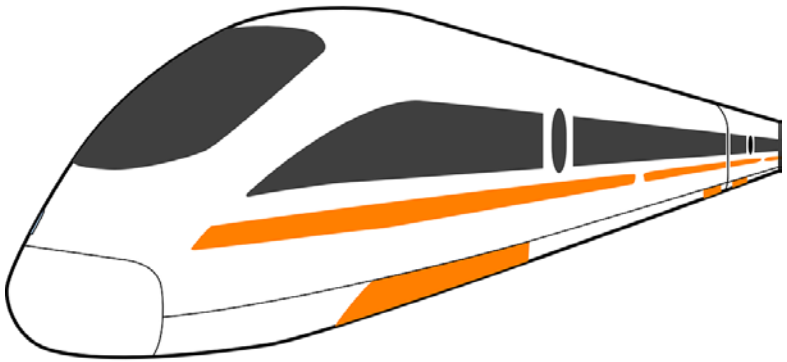
For remote-control surgery

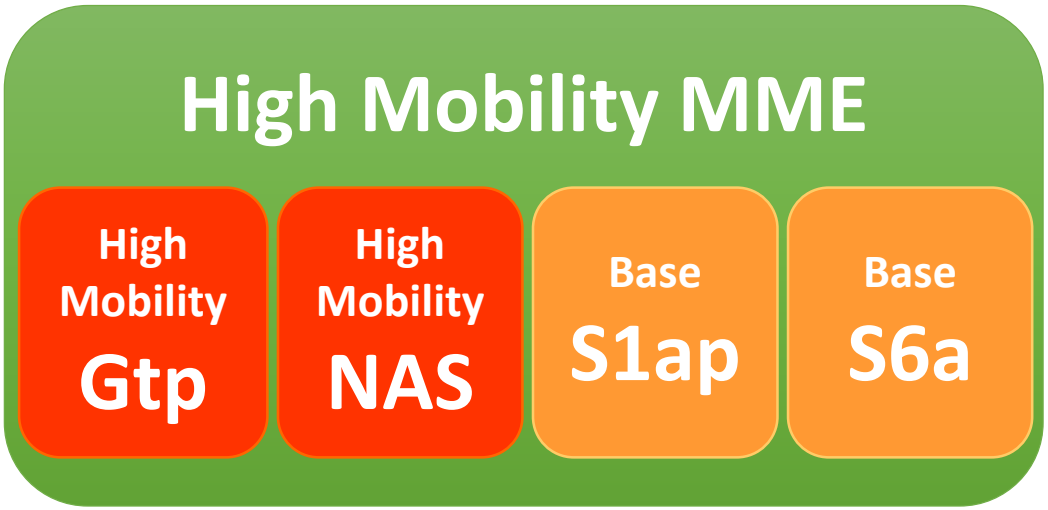
- Low latency ➡ GTP module
- High security ➡ NAS and S6a module

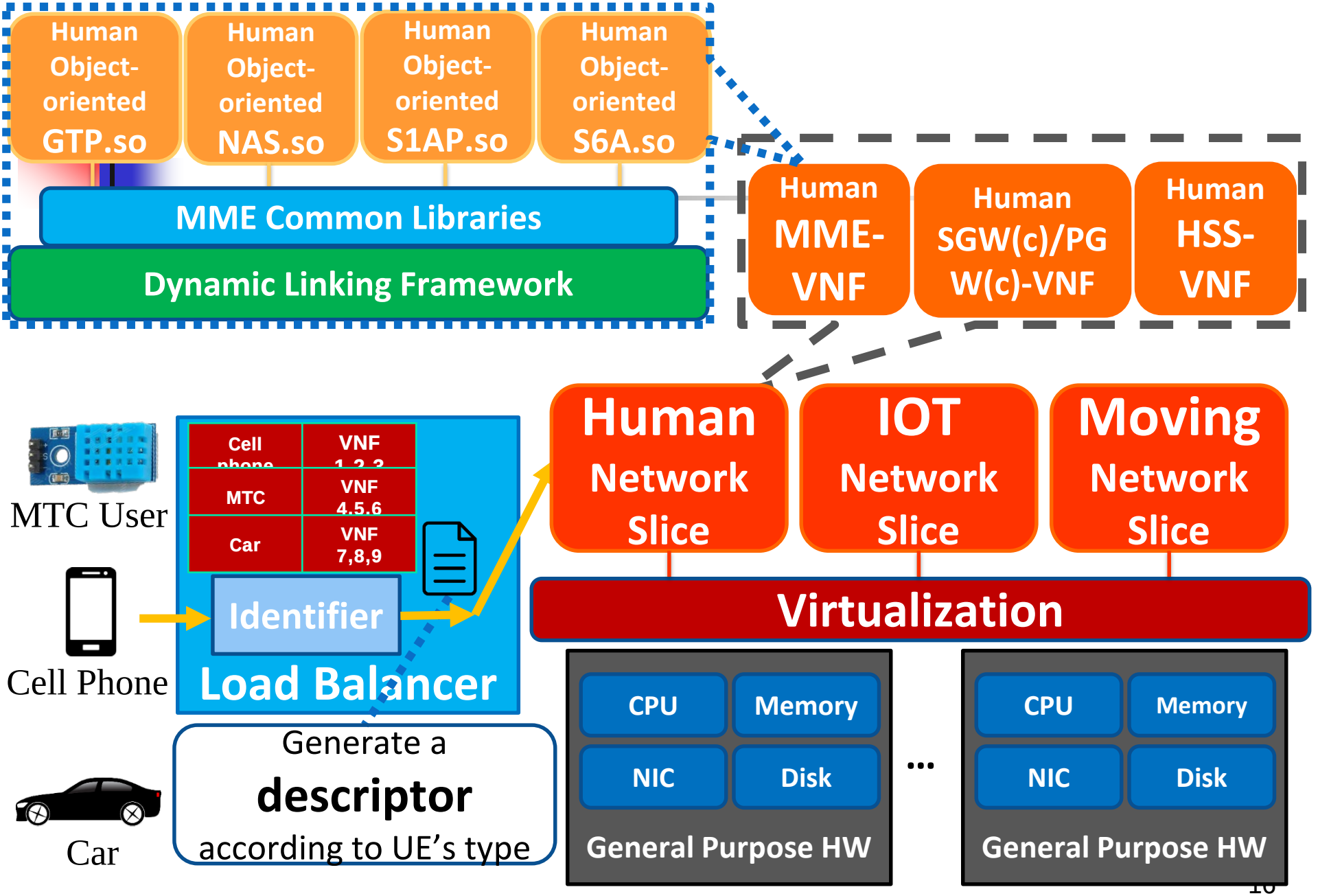


For high-speed users

- High mobility ➡ GTP module
- Frequent handover and location update ➡ NAS module






Human Object-oriented GTP.so
Human Object-oriented NAS.so
Human Object-oriented S1AP.so
Human Object-oriented S6A.so
MME Common Libraries
Dynamic Linking Framework
Human MME-VNF
Human SGW(c)/PGW(c)-VNF
Human HSS-VNF
Human Network Slice
IOT Network Slice
Moving Network Slice
Virtualization
MTC User
Cell Phone
Car
Cell phone
VNF 1,2,3
MTC
VNF 4,5,6
Car
VNF 7,8,9
Identifier
Load Balancer
Generate a descriptor according to UE's type
CPU
Memory
NIC
Disk
General Purpose HW
...
CPU
Memory
NIC
Disk
General Purpose HW

Service Level Virtualization (SLV)

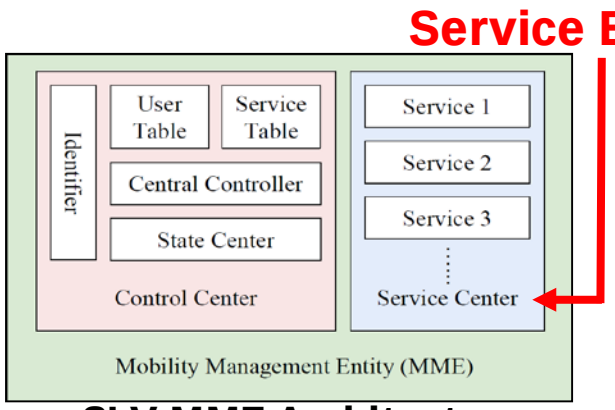
- http://reconet.org/slv/
- B.-J. Qiu, Y.-S. Hsueh, J.-C. Chen, J.-R. Li, Y.-M. Lin, P.-F. Ho, and T.-J. Tan, "Poster: Service Level Virtualization (SLV) - a preliminary implementation of 3GPP Service Based Architecture (SBA)," in *Proc. of ACM International Conference on Mobile Computing and Networking (MobiCom '18)*, (New Delhi, India), pp. 669 - 671, Oct. 2018.

Service Level Virtualization (SLV) for 5GC

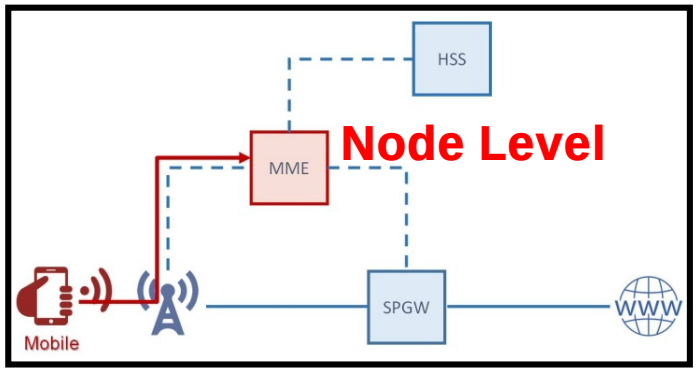
- **SLV: a preliminary implementation of 3GPP R15 Service Based Architecture (SBA)**
  (1) An entity is decomposed into different service blocks to provide different services.
  (2) Tested with commercial handsets and base stations.

Demo at IEEE 5G World Forum, Santa Clara, CA, USA, July 9-11, 2018

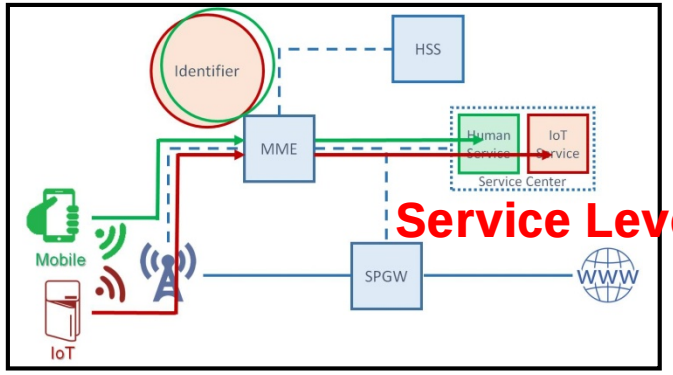
- Virtualize the core network at service level
- Create a new component called **Service Center** to manage customized services



SLV MME Architecture



LTE Architecture

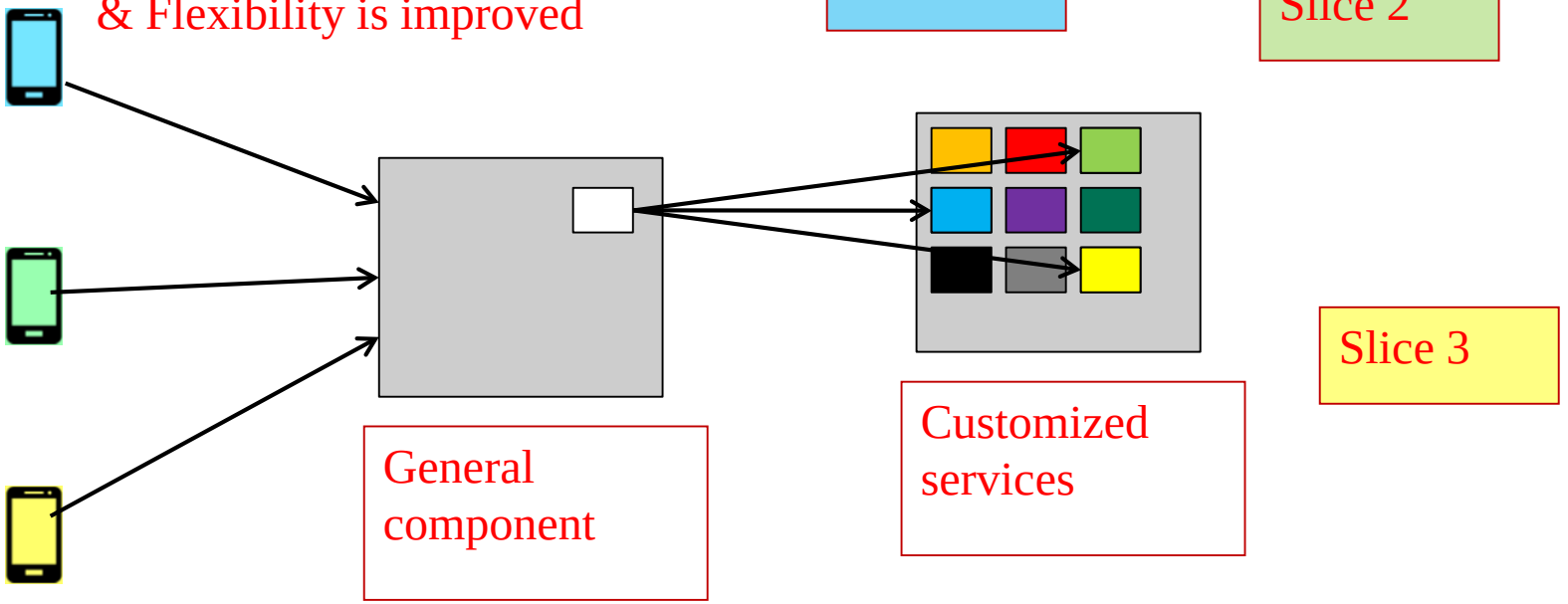


SLV Architecture

SLV – Service Level Virtualization

- Each function runs as a process on different hardware
- Resources are saved

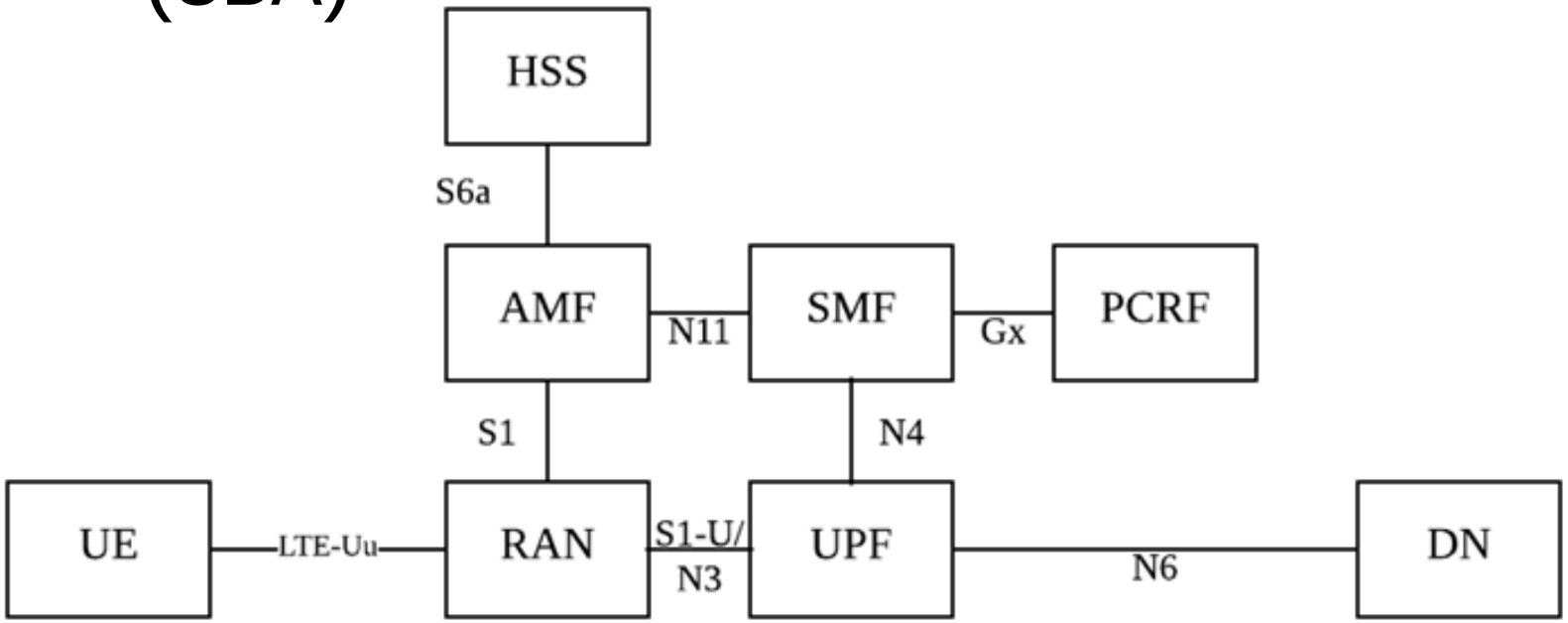
  & Flexibility is improved




free5GC

Stage 1 (current release)

- migrating 4G Evolved Packet Core (EPC) into 5GC Service-Based Architecture (SBA)

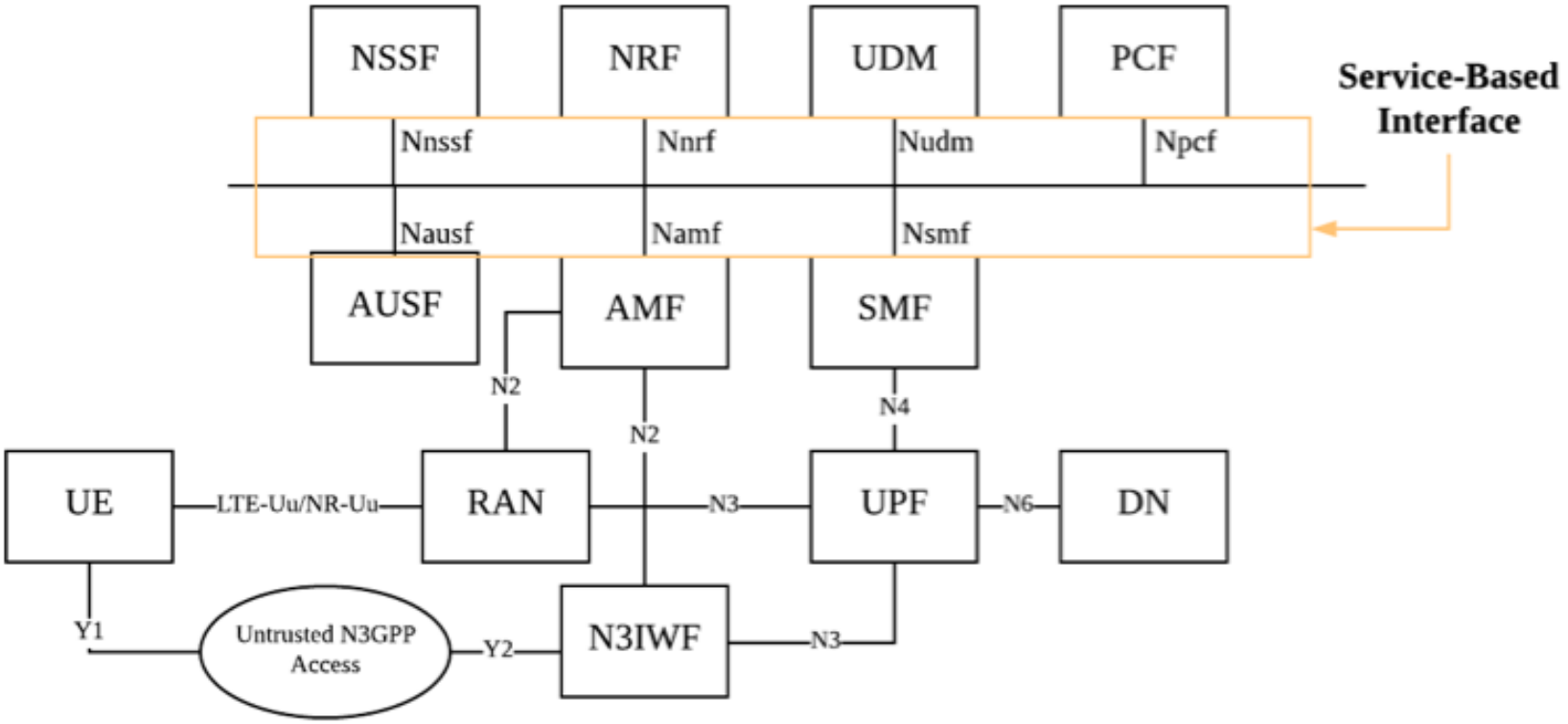


Contributors

- Released in January 2019
- National Chiao Tung University (12)
  - Chi Chang, Fu-Cheng Chen, Jyh-Cheng Chen, Te-Chih Chiu, Chia-Tso Chu, Wei-Ting Hu, Kuan-Ying Lee, Yi-Bing Jason Lin, Hsun-Chieh Pan, Sebastian Tan, Fu-Lian Weng, Yi-Hua Wu

Released in January 2019

Stage 2: implementing the 5GC features



Contributors

- Taiwan
  - National Chiao Tung University (26)
  - National Taichung University of Education (8)
  - Tunghai University (5)
  - National Taichung University of Science and Technology (4)
  - National Chung Cheng University (3)
- Norway
  - University of Agder (3)

Expect to released in September 2019

Stage 3: a full operational 5GC

- At least one of the application services, such as VoLTE, IPTV, will be supported in this stage.
- Add features: Operation, Administration and Management (OAM) of 5GC, 5G Orchestrator, and Network Slicing.

Expect to released in March 2020


Microsoft
Windows


hp 250 G6


DELL


Linux

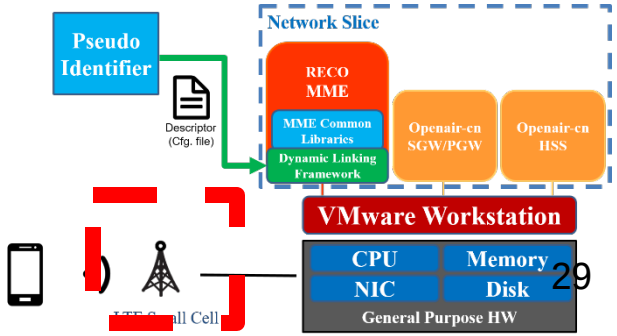

ASUS

Android

Free the cellular core network

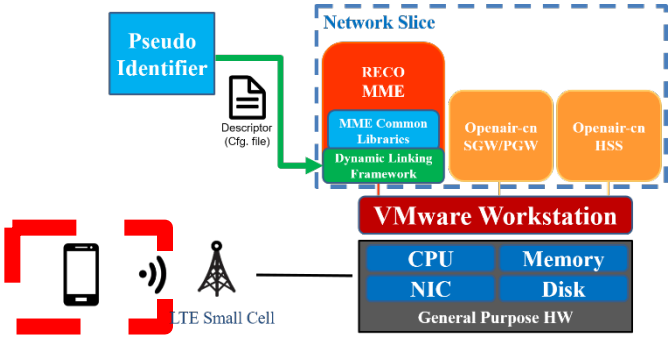
Equipment (1/2)

- LTE Small Cell: Wistron NeWeb OSQ4G-01E2



Equipment (2/2)

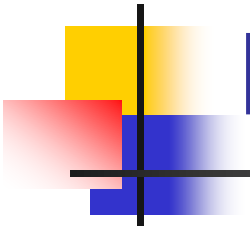
- UE1: Sony Xperia T3 D5103
- UE2: ASUS UX410 & D-Link LTE Dongle
- Programmable SIM card programmed by PySIM



Demo Video

https://www.free5gc.org/

- This is just a first step.
- Please use it, give us feedbacks, and even join us to develop the first comprehensive, free, and open-source 5G core network.



For more information

- Website: https://www.free5gc.org/
- Source code: https://bitbucket.org/nctu_5g/free5gc

Acknowledgments

- Chi Chang, Fu-Cheng Chen, Te-Chih Chiu, Chia-Tso Chu, Wei-Ting Hu, Kuan-Ying Lee, Yi-Bing Jason Lin, Hsun-Chieh Pan, Sebastian Tan, Fu-Lian Weng, Yi-Hua Wu, Chia-Lin Lai, Chen-Ying Hsieh, Bo-Jun Qiu, Pin-Fan Ho, and many others.


Thank You