5G Standardization, 5G Security Enhancements, and Supporting Infrastructure Security Considerations.

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Foundational Standards Developing Organizations

Internet Engineering Task Force

Internet Protocols

- TCP/IP, TLS, IPSEC

3rd Generation Partnership Program

Cellular Systems

- 3G, LTE, VOLTE, 5G

European Telecommunications Standards Institute

Virtualization Standards

ICT Standards

Institute of Electrical and Electronics Engineers

802.11 – WiFi

5G Related work

3GPP Overview

- 3GPP is a global initiative responsible mobile communications specifications.
- 3GPP partners with regional SDO organizations (ETSI, ARIB, ATIS, CCSA, etc.) to set cellular telecommunications standards.

TLDR; 3GPP wrote (is writing) the technical specifications for 5G, defining interoperable interfaces, protocols, and security features.

3GPP Overview Cont.

- 3 overarching groups – Radio Access Network (RAN), Service and System Aspects (SA), and Core Network and Terminals (CT)
- Each group has a plenary group associated responsible for setting priorities, timelines, coordination

Radio Access Network (RAN)	Service & Systems Aspects (SA)	Core Network & Terminals (CT)
RAN 1 - Radio Layer 1 (Physical)	SA 1 - Services	CT 1 – User equipment & Core network radio protocols
RAN 2 - Radio Interface architecture and protocols	SA 2 - Architecture	CT 3 - Interworking between a 3GPP networks and external nodes or networks
RAN 3 - Radio architecture and Interface protocols	**SA 3 - Security**	CT 4 – Core network aspects
RAN 4 - Radio performance and protocol aspects	SA 4 - Codec	CT 6 – Smart card application aspects (SIMS)
RAN 5- Mobile terminal conformance testing	SA 5 - Telecom Management	
	SA 6 – Mission Critical	

3GPP Overview Cont.

- The RAN groups are responsible for the definition of the functions, requirements and interfaces of the Radio Network
- The SA groups are responsible for the overall architecture and service capabilities of systems based on 3GPP specifications.
- The CT groups are responsible for specifying terminal interfaces (logical and physical), terminal capabilities (such as execution environments) and the Core network part of 3GPP systems.
- 3GPP works using a three-stage methodology that is applied in 3GPP as follows;
  - Stage 1 is an overall service description from the user's standpoint.
  - Stage 2 is an overall description of the organization of the network functions to map service requirements into network capabilities.
  - Stage 3 is the definition of switching and signaling capabilities needed to support services defined in stage 1.

3GPP Working Groups

Radio Access Network (RAN)	Service & Systems Aspects (SA)	Core Network & Terminals (CT)
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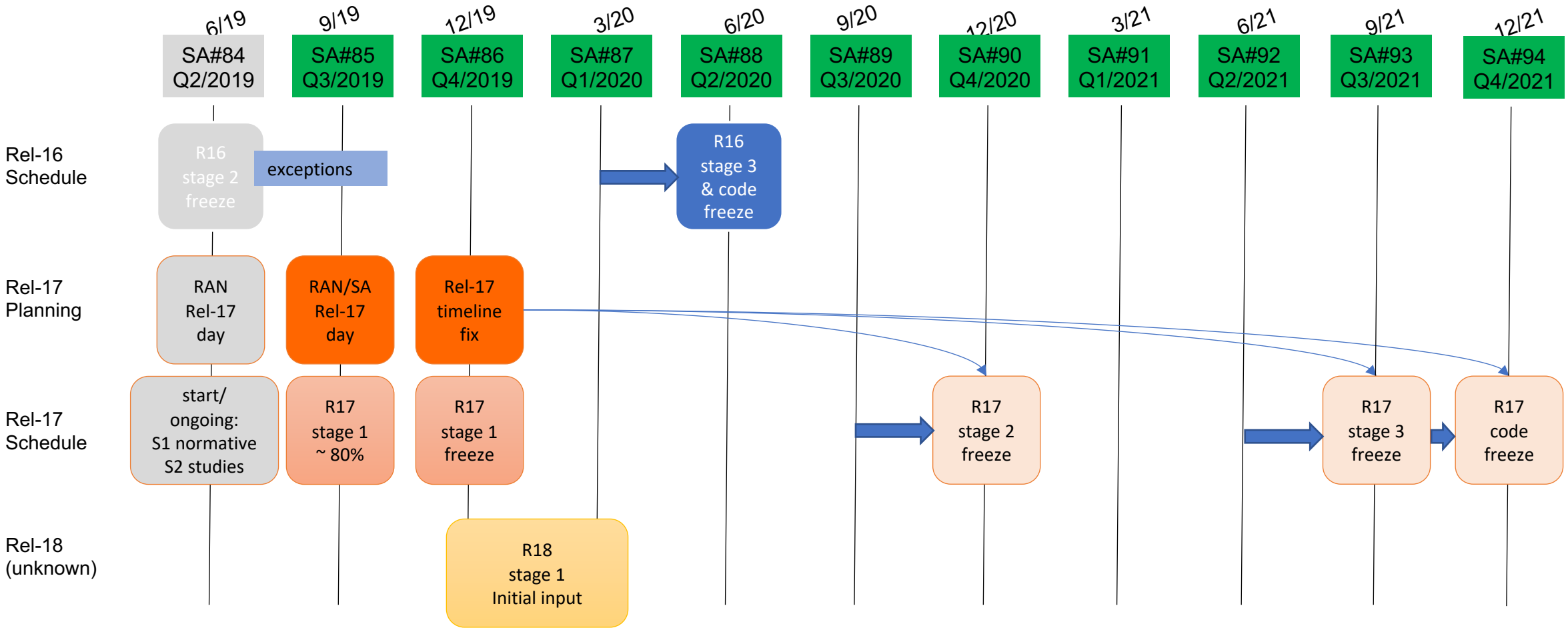
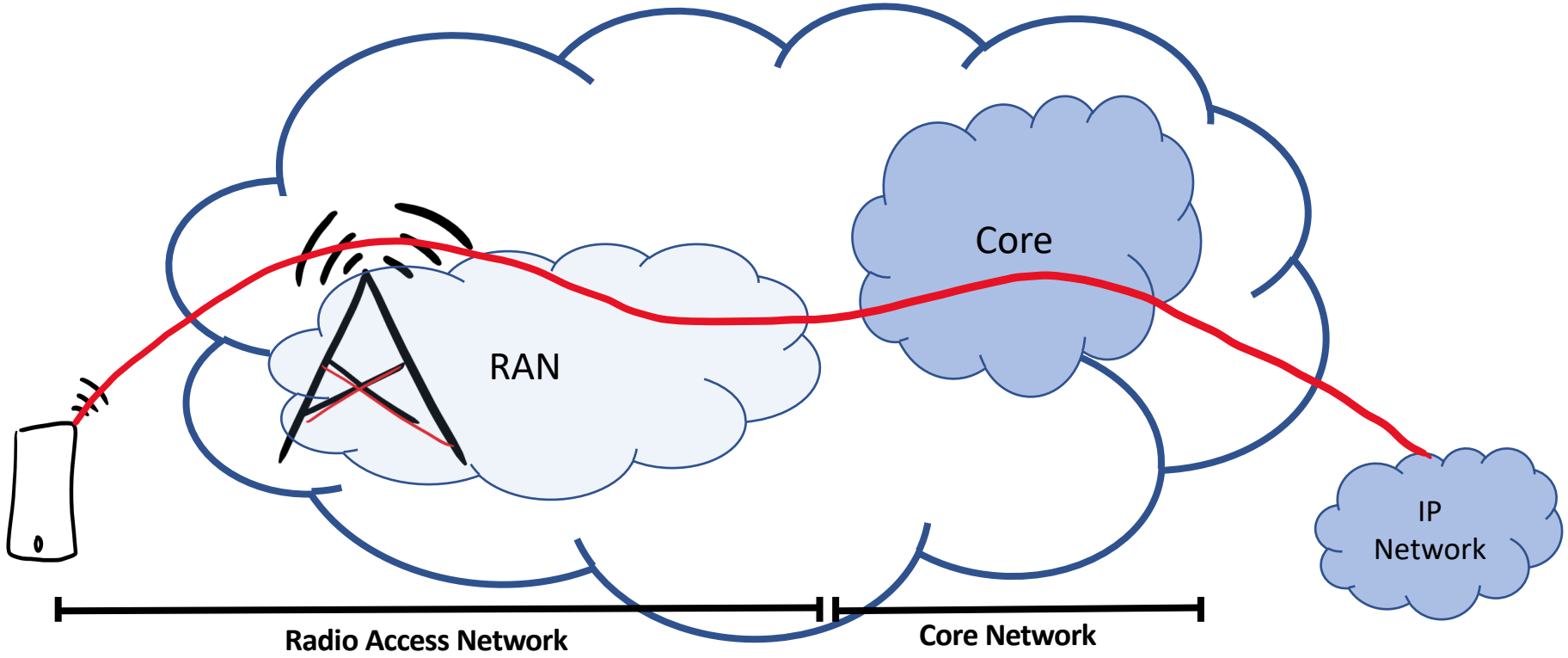
3GPP Process (SA3 Perspective)

- General approach: Study document (TR), followed by technical specifications (TS)
  - TR analyzes security issues and potential solutions
  - TS presents definitive solutions
  - Leverages protocols from other SDOs (e.g. IETF, IEEE)
- Iterative pipeline
  - SA3 (security) defines solutions based on SA1's requirements and SA2's architecture (for Mission Critical, SA6's architecture)
  - Tight timelines require groups to work in parallel and re-work or add to solutions as needed
- SA3's security solutions are concretized by CT1
  - Optimal/feasible solutions require back-and-forth between SA3 and CT1
- Consensus process
  - Resorting to a vote is rare, viewed as a process failure

Current 3GPP Timeline

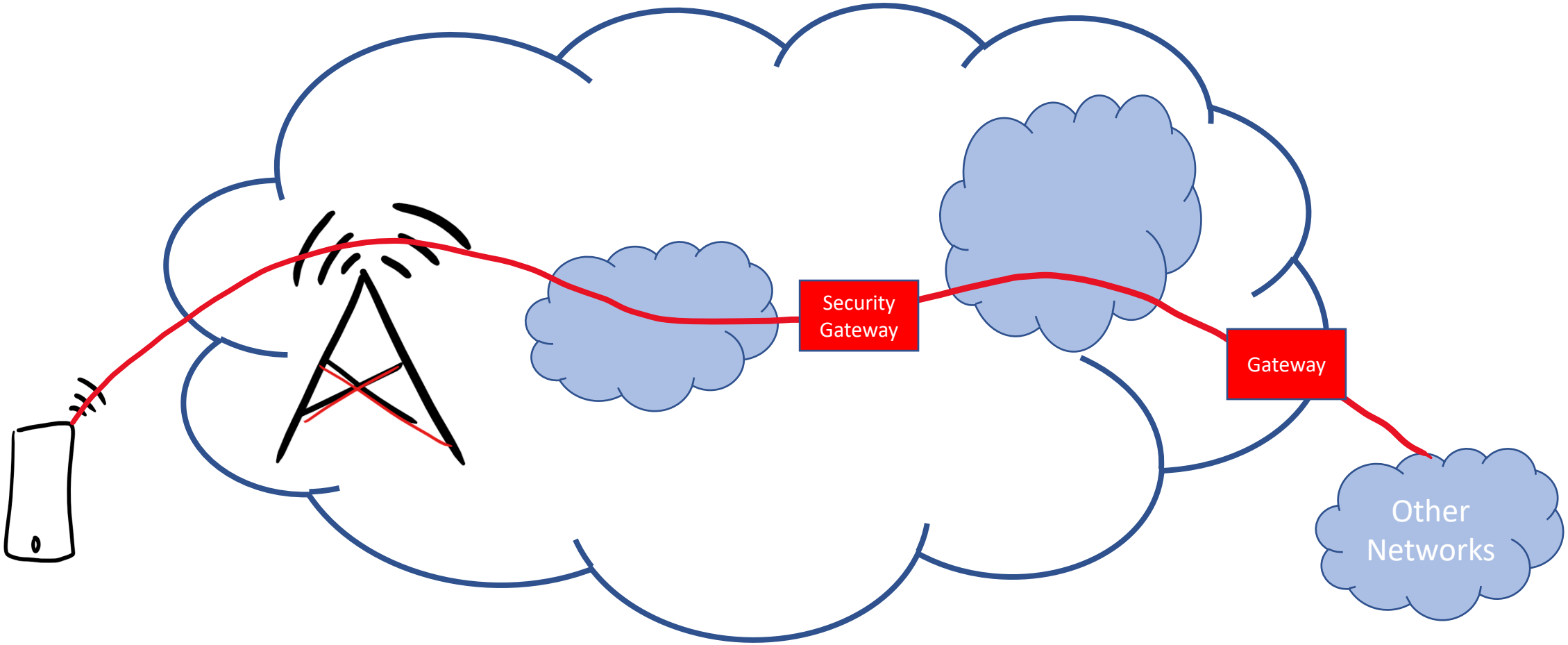


Mobile Network – The Basics

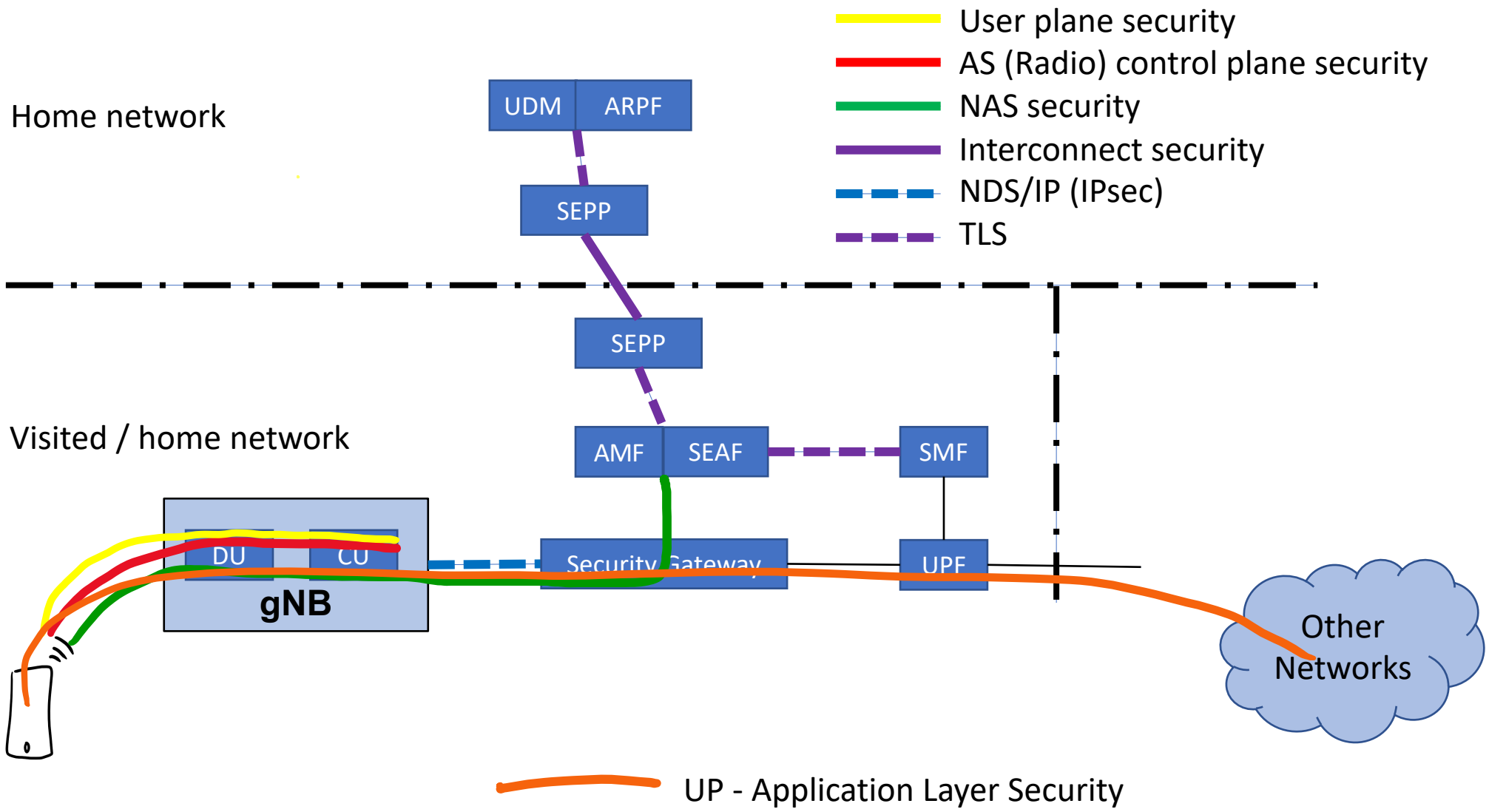


- A device connects to a network of base stations or Radio Access Network (RAN)
- The RAN connects to a 3GPP Packet Core (Core)
- The Packet Core provides connectivity to the internet or other IP network.

Mobile Network Security



5G System Security Architecture



Known Security Issues With LTE

- Subscriber tracking
- No user plane integrity protection
- Roaming issues (SS7 & diameter threats)
- False Base stations

New Security Features

- User Plane Traffic Integrity
- Subscriber Privacy
- Security Edge Protection Proxy
- Increased Home Control
- Unified Authentication Framework
- CU / DU Separation

Radio Network Security

Integrity protection for user plane

- Finally!
- Control plane integrity protection was available since UMTS

Split of gNB into Central and Distributed Unit (CU/DU)

- CU performs security functions (confidentiality/integrity)
  - AS (air interface) security terminates at the CU.
- Can be located closer to the core

Visibility

- Requirement to enable applications to check security being applied to the connection

5G Privacy Protections

Objectives;

- Protect permanent identifiers
- Cycle temporary identifiers regularly
- Avoid re-authentication

Outcomes;

- Encryption of SUPI with public key of home operator (SUCI)
- Routing information (home network ID) in clear
- SUPI revealed to VPLMN only after authentication
- Binding of SUPI into key
- Respond to identifier request with SUCI
- No SUPI based paging
- Reallocation of temporary Ids after security set up, on every periodic mobility registration update and after use in paging

5G Authentication Framework Enhancements

Credential storage on secure hardware (UICC)

- Allows the use of integrated secure element (e.g. integrated UICC)

Same Primary authentication method can be used over both 3GPP & non-3GPP access

- WiFi / fixed broadband networks
- N3IWF – Non-3GPP Interworking Function

One security context for both access technologies

Native EAP support over 3GPP access networks

- Enables operator to plug-in different credentials and authentication methods without impacting other intermediate network functions

Optional EAP based secondary authentication for access to specific data networks/services

- Allows applications to use their own credentials & authentication before allowing access to their dedicated application/service specific data networks (e.g., Amazon, Facebook, Enterprises)

Beyond the 3GPP System

- 5G networks are comprised of many components utilizing different modern information technologies
- 3GPP Network Functions are ONLY one piece of the evolution to 5G deployments
- Cybersecurity best practices used for the various components of the technology stack

Supporting Infrastructure and Security Protocols

- Cloud computing platforms
  - Virtualization
  - Containerization
  - Orchestration
- Internet security protocols
  - IPSec
  - TLS
  - JOSE, etc.

Questions / Comments?