5G Security - Evolution not Revolution

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#PSCR2020

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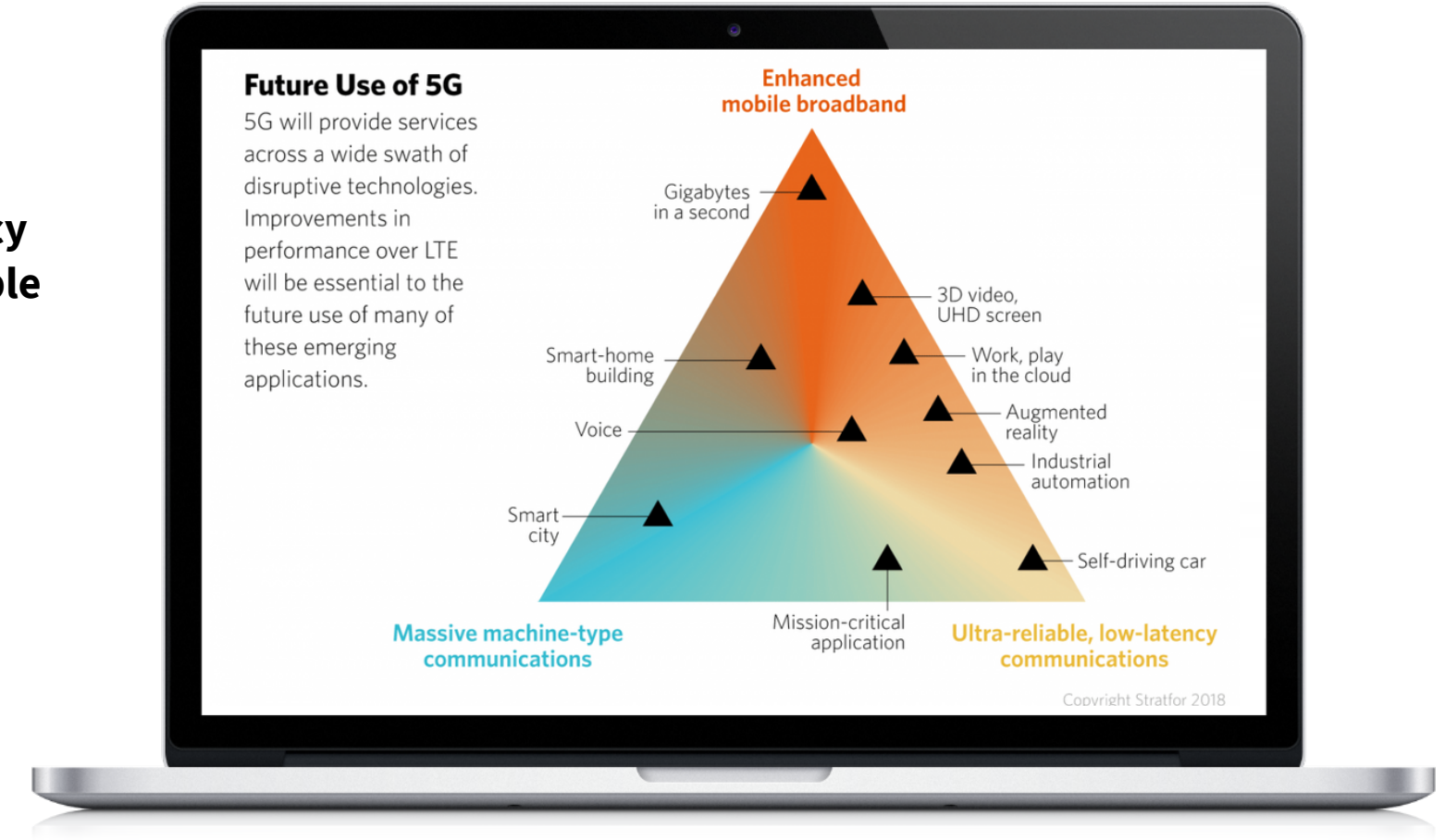
The 5G Capabilities

High Speed

Massive IoT

Low Latency
Ultra-Reliable

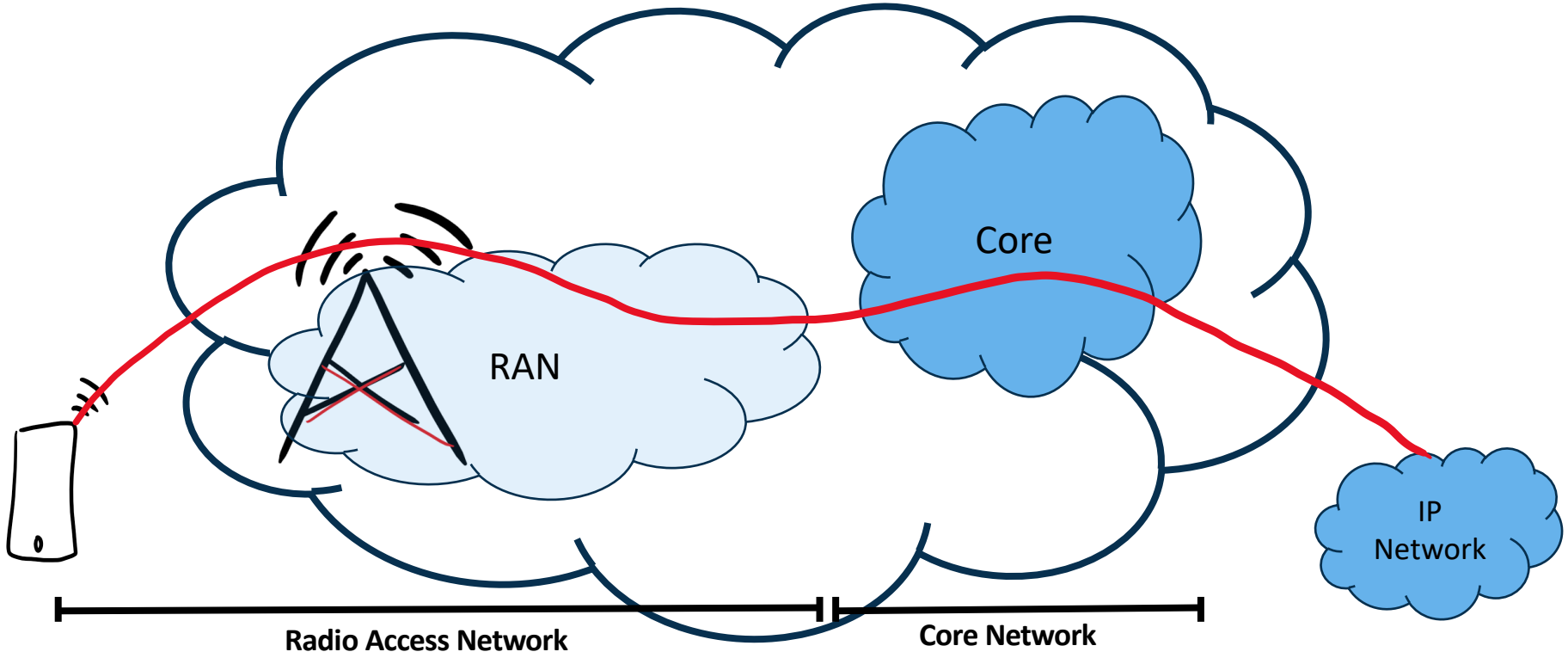
5G has been envisioned and designed to provide capabilities focused on three core use cases.



3GPP Overview

- 3GPP is a global initiative responsible for 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.

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.

Types of Security Provided by LTE & 5G Networks

Access Stratum Security

Security between the device and base station

- Encryption and integrity protection AS signaling
- Encryption and integrity* protection of User Plane traffic

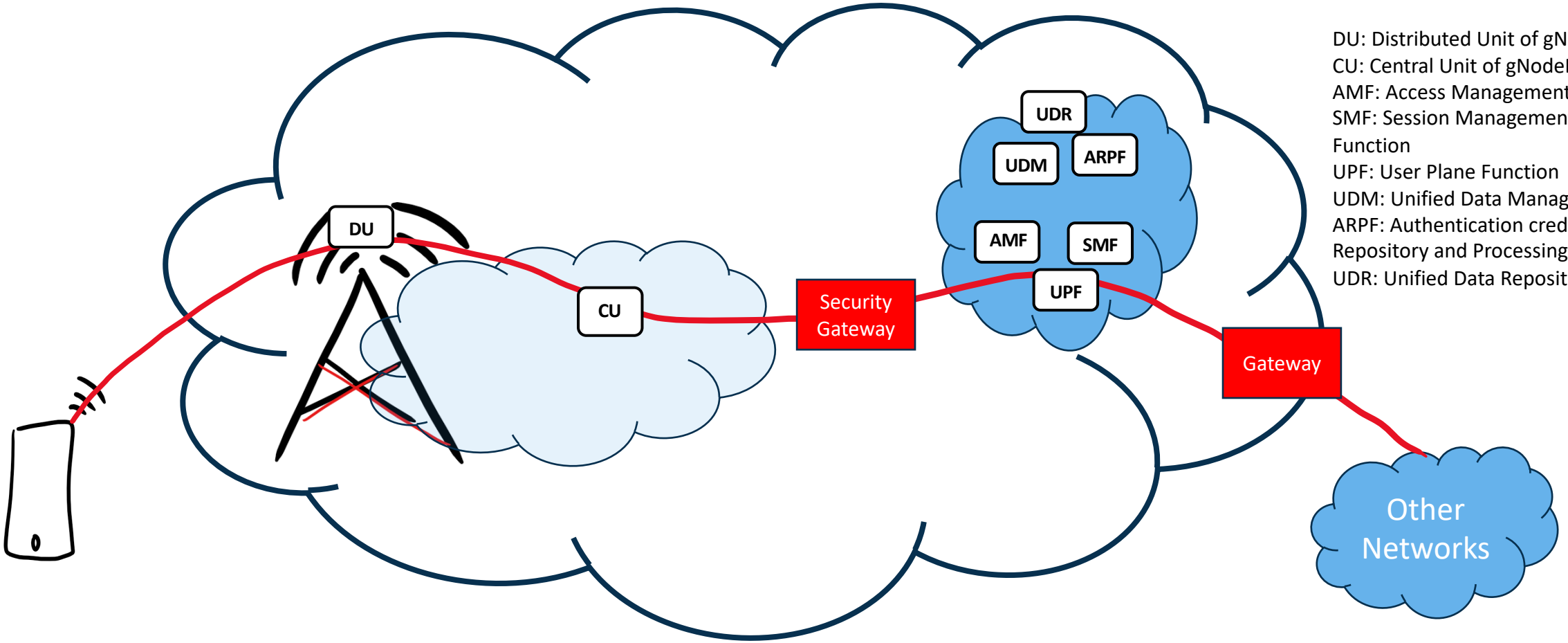
Non-Access Stratum Security

Security of signaling traffic between a device and the network function supporting mobility

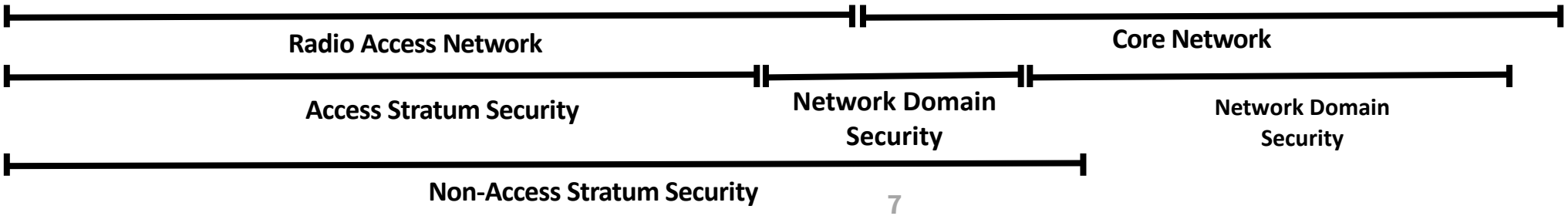
Network Domain Security

Provides security by utilizing IPSEC tunnels

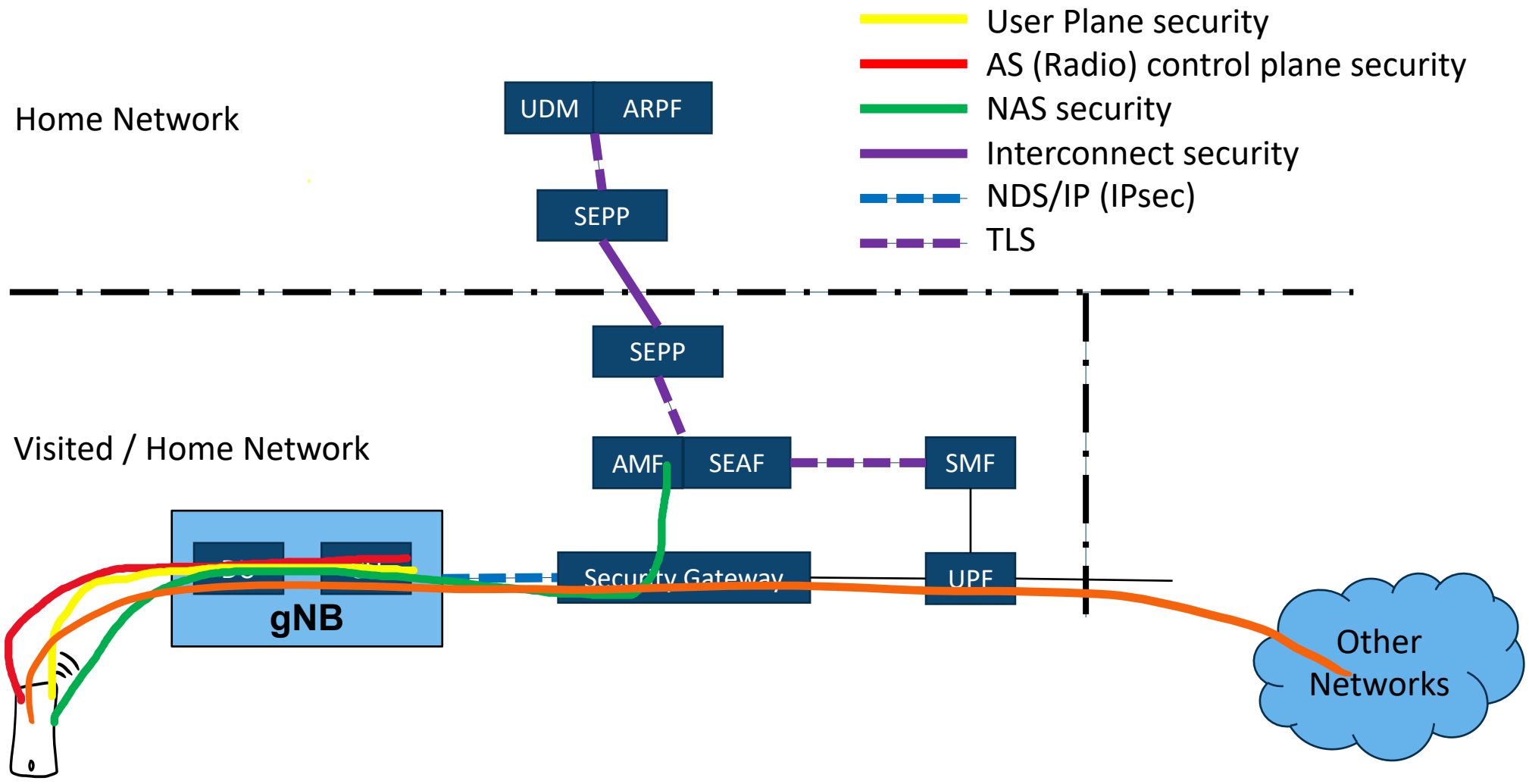
Mobile Network Security in a Nutshell



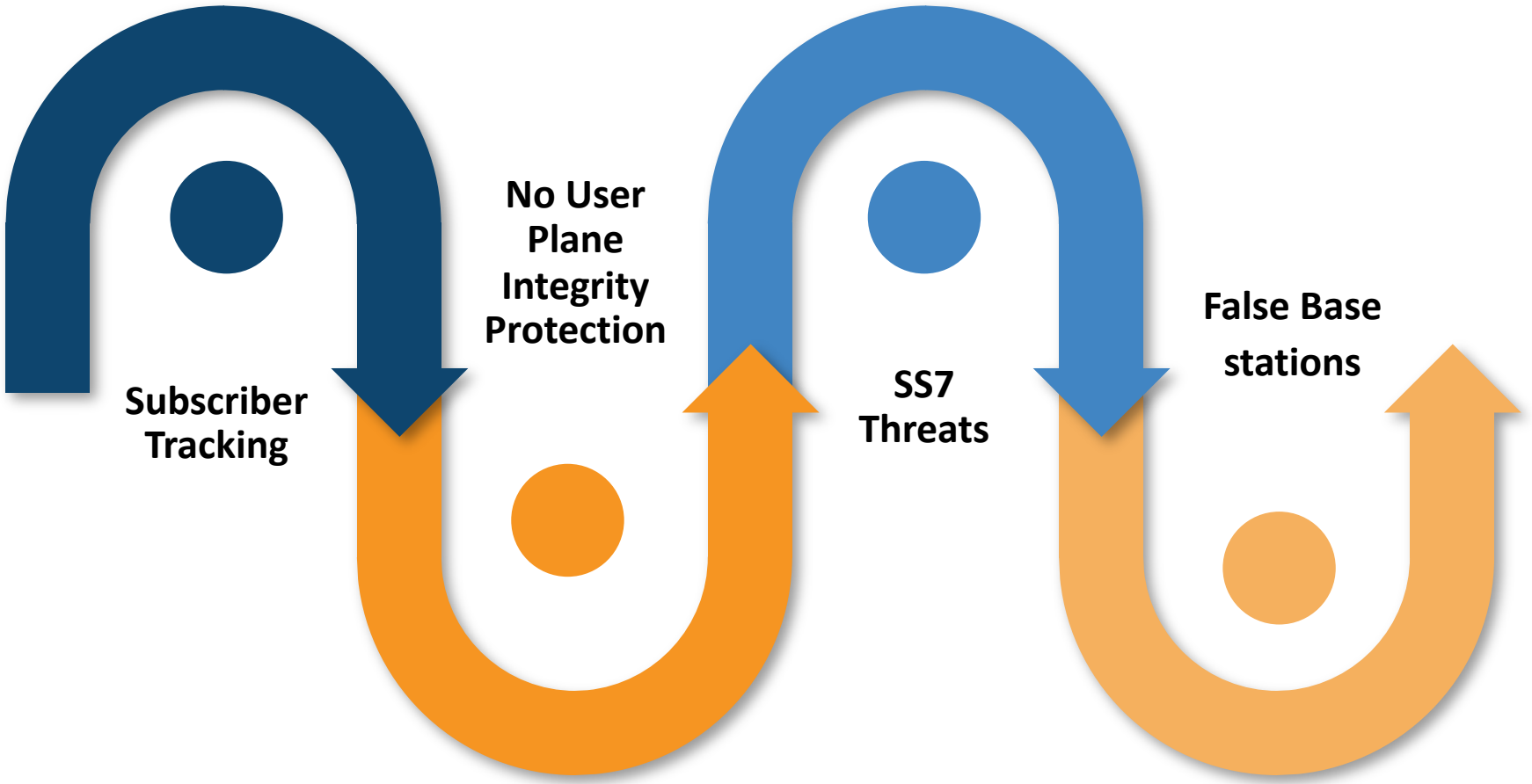
DU: Distributed Unit of gNodeB
CU: Central Unit of gNodeB
AMF: Access Management Function
SMF: Session Management Function
UPF: User Plane Function
UDM: Unified Data Management
ARPF: Authentication credential Repository and Processing Function
UDR: Unified Data Repository



5G System Security Architecture



Known Security Issues With LTE



New 3GPP 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)

- Centralized Unit performs security functions such as confidentiality and integrity protection
- Access Stratum security terminates at the CU
- Centralized unit can an be physically located closer to the core in more trusted environment

Visibility

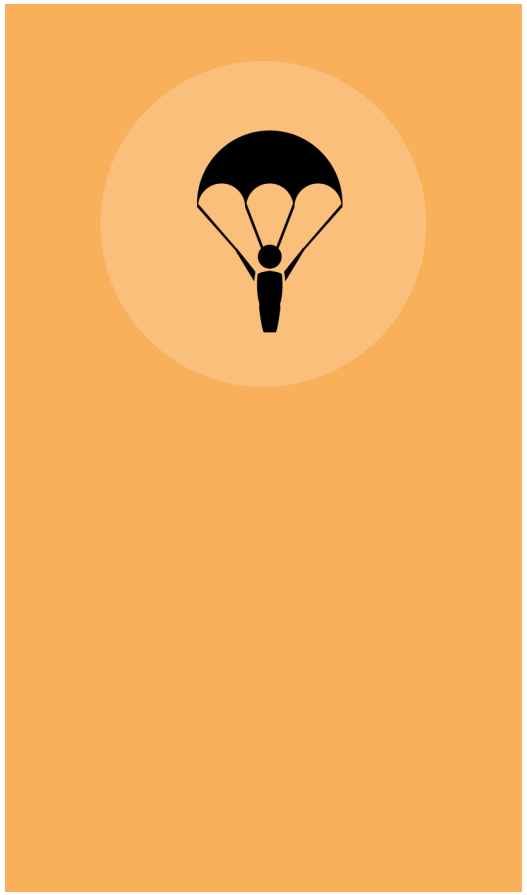
- 3GPP requirement in 5G security specification to enable applications to assess the security being applied to the connection

Authentication in 2G, 3G and 4G

AKA is the only supported authentication method

- AKA is slightly different in all generations
- Pre-Shared key is stored in the device and in the home network
- AKA is generally made up of two parts
  - Generation of the authentication vector (AV)
  - Authentication of Device using AV to generate shared session keys between network and device

Authentication Enhancements in 5G



Credential storage on secure hardware (UICC)

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

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

WiFi / fixed broadband networks

Native EAP support over 3GPP access networks

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

5G Subscriber Privacy

Prevention of subscriber identity from being sent over the air unprotected

- Fixes issues associated with IMSI catching in LTE
- Routing information like mobile country code (MCC) and mobile network code (MNC) still sent unprotected

Cycle temporary identifiers regularly

Terminology!

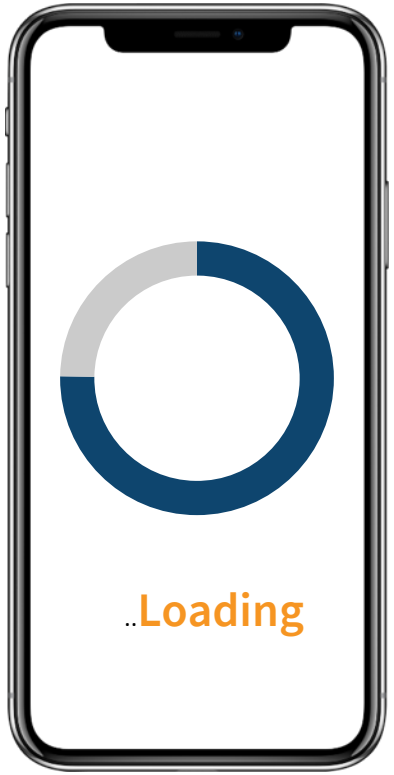
Unprotected 5G Subscriber Identity -> **SUPI** Subscriber Unique Permanente Identifier

Protected 5G Subscriber Identity -> **SUCI** Subscriber Concealed Permanente Identifier

Current 5G Deployments

5G Non-Standalone (NSA) Deployment Option

- 5G NSA Utilizes a 4G Core
- Device has Dual Connectivity to LTE and 5G base stations
- 5G radio is used to increase capacity
- LTE radio is master node; 5G Radio is secondary
- Security is same as 4G

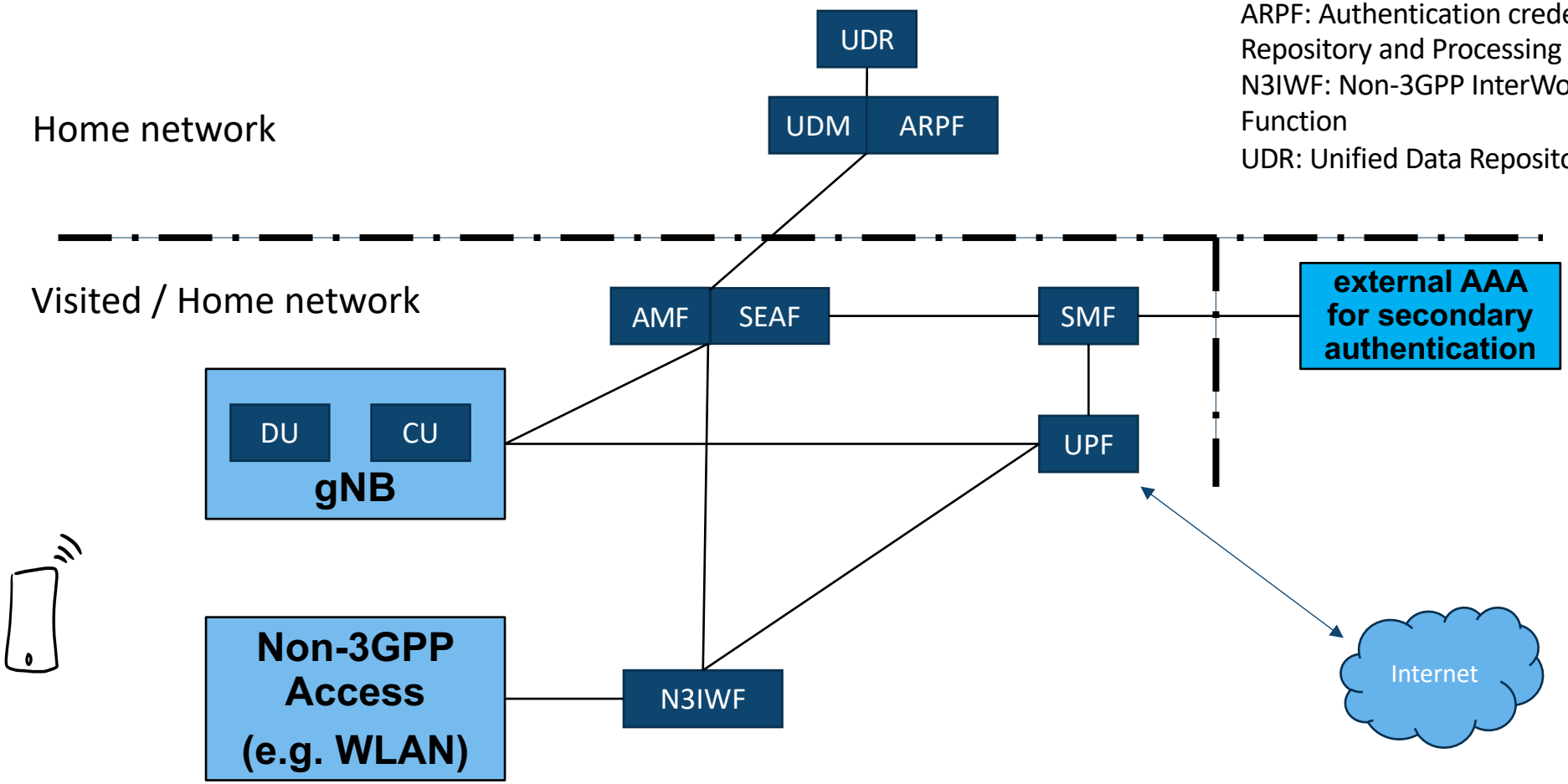


5G…Let’s go to the Cloud

- The 5G system introduces the concept of a service-based architecture (SBA) for the first time in cellular networks.
- Moving past the traditional network functions as boxes and network functions as VM.
- SBA is pushing the 5G core to look more like a cloud native application and less like a legacy telecommunication stack.

Mobile Network – A 5G World

gNB: 5G base station
AMF: Access Management Function
SEAF: Security Anchor Function
SMF: Session Management Function
UPF: User Plane Function
UDM: Unified Data Management
ARPF: Authentication credential Repository and Processing Function
N3IWF: Non-3GPP InterWorking Function
UDR: Unified Data Repository



Beyond the 3GPP System

- 5G networks are comprised of many components utilizing different modern information technologies

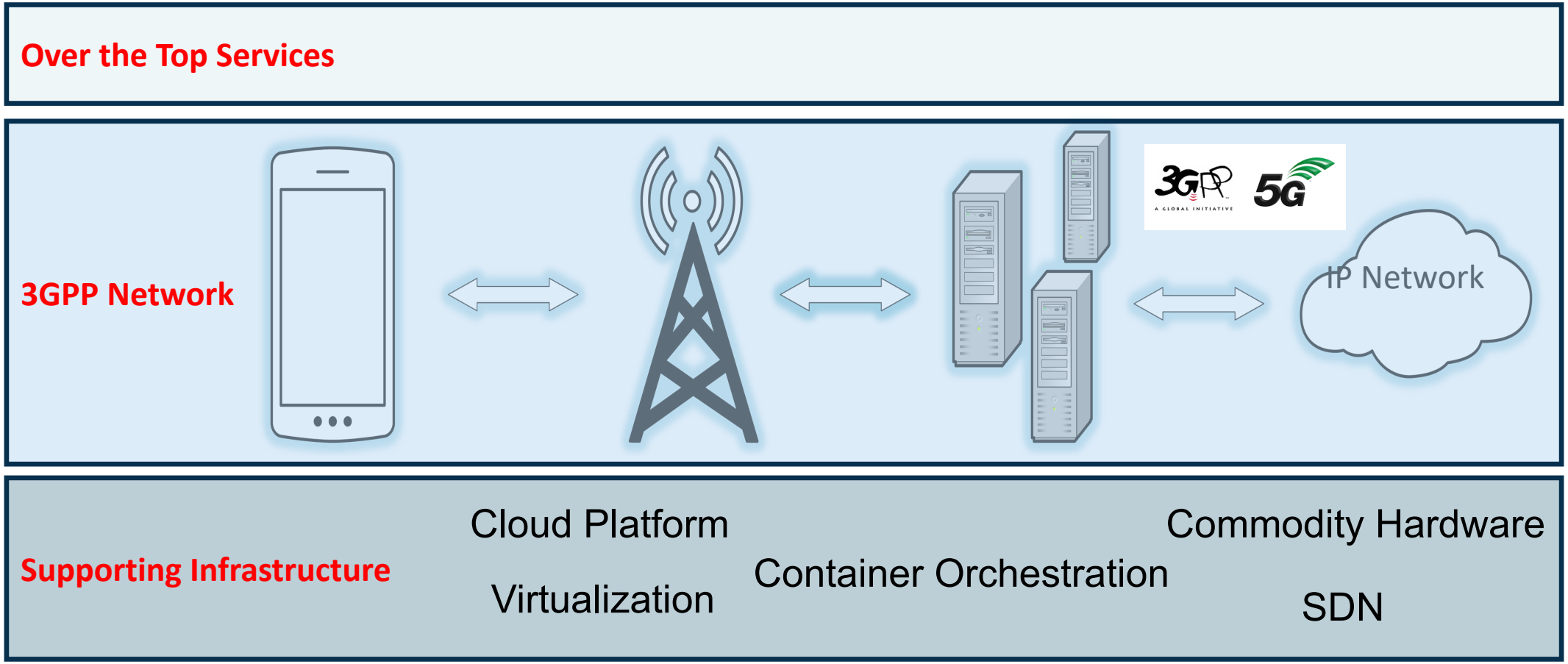
- 3GPP Network Functions are ONLY one piece of the evolution to 5G deployments

- 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.

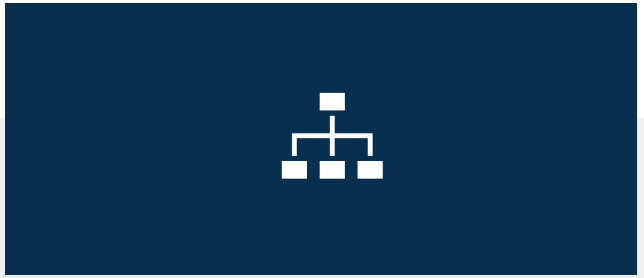
The Full Stack Architecture



5G Cybersecurity at The NCCoE

Enhanced Security Capabilities

Demonstrate increased cybersecurity protections in 5G networks from the addition of standards-based features



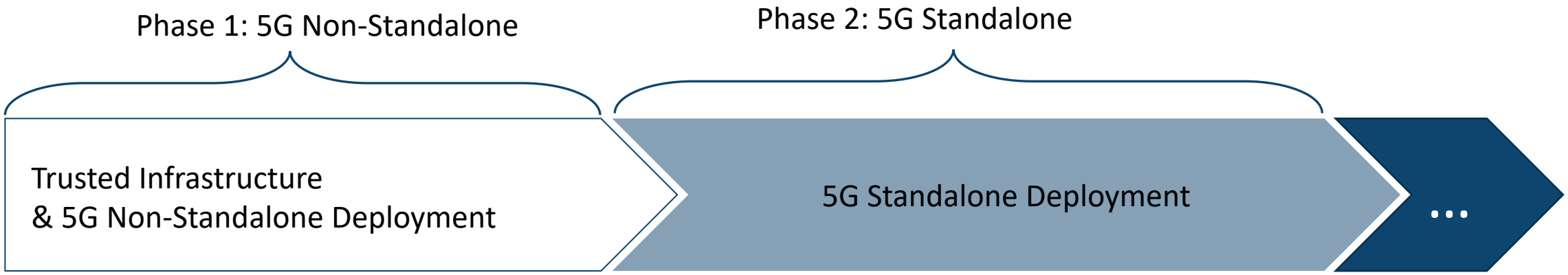
Modern supporting Technologies

Increased use of modern information technologies Supporting the 5G System to allow for the addition of modern cybersecurity best practices

Practical Approach

As 5G technologies are still being specified and developed, it's important to effectively scope and prioritize this effort

Project Phases and Associated Security Characteristics



Infrastructure Security Capabilities

- Trusted Hardware
- Isolation & policy enforcement
- Visibility into trust status & operations
- Compliance

5G NSA Deployment Security Capabilities

- Enable EPC based security features
- False base station detection
- Serving network disable legacy RATs
  - Network / UE based

Infrastructure Security Capabilities

- Continuation from previous
- Service based architecture security
  - TLS certificate management
  - VM & Container Orchestration

5G SA Deployment Security Capabilities

- Subscriber privacy
- User plane integrity protection
- CU/DU Split
- Authentication enhancements
- Roaming security
- Network exposure function

Current Status

The **National Cybersecurity Center of Excellence** is soliciting industry collaborators for this project…

Join our Community of Interest—By joining the 5G Community of Interest (CoI), you will receive periodic updates and the opportunity to share your expertise to help guide this project. Join the CoI by emailing us at 5G-Security@nist.gov.

Contact Us

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