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mobile business

5G

5G Security

MOB1 Guest Lecture at Goethe University Frankfurt

29.01.2024

Sebastian Fritsch

secuvera GmbH, Gäufelden/Stuttgart

- Agenda
  - → **Introduction & Motivation**
  - – 5G Overview
  - – 5G Security: Regulation and Certification
  - – Security Testing in 5G
  - – Future Challenges

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- whoami
  - Sebastian Fritsch
  - Dipl.-Inform.
    - TU Darmstadt
  - Product Security Evaluator
  - Head of Evaluation Facility (CC Laboratory, ITSEF)
  - Working in ISO and IEC
    - ISO SC 27/WG 3 develops Common Criteria (ISO 15408/18045)
    - IEC TC 65/WG 10 develops IEC 62443

- We are…
  - 35 top security experts
- What we do…
  - IT Security, Cybersecurity, 100%
- We are located in?
  - near Stuttgart, Gäufelden
  - Remote

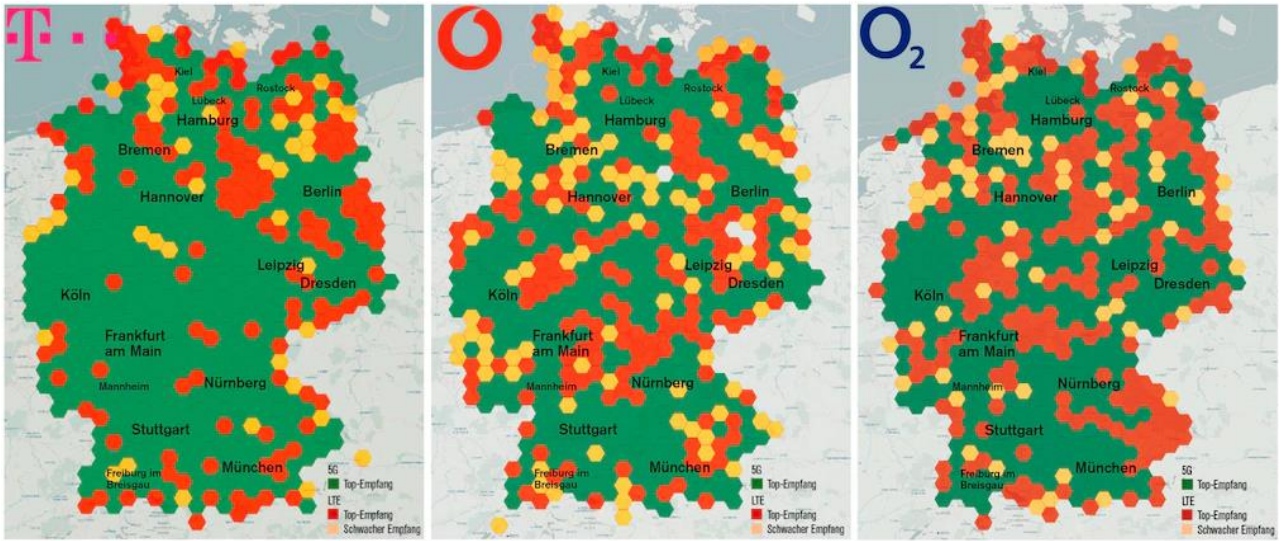
- BSI Security Testing Lab (aka ITSEF)
  - **5G Security Testing Lab**
- Penetration testing / web application security
- ISO/IEC 27001 / Security Management
- Training, Consulting,
  Research Projects, …

- Agenda
  - Introduction & Motivation
  - → **5G Overview**
  - 5G Security: Regulation and Certification
  - Security Testing in 5G
  - Future Challenges

- Who is already using 5G?

Source: www.teltarif.de

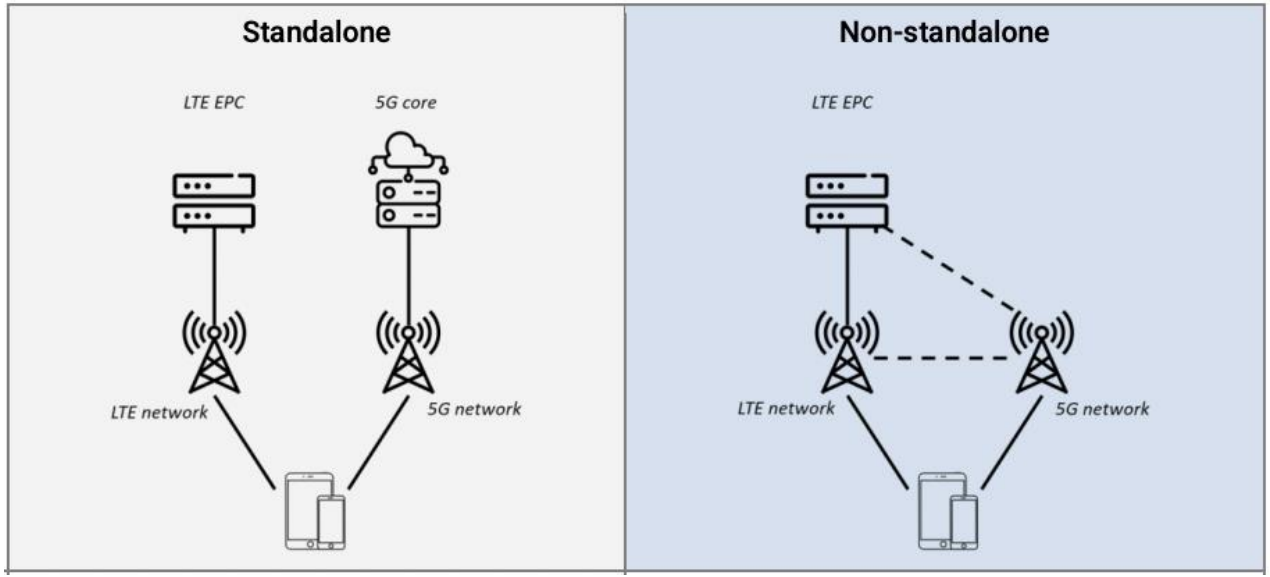
- 5G Availability
  - Germany, October 2022



Source: https://www.computerbild.de/artikel/cb-Tests-Handy-Mobilfunk-Netztest-2022-2023-34919053.html

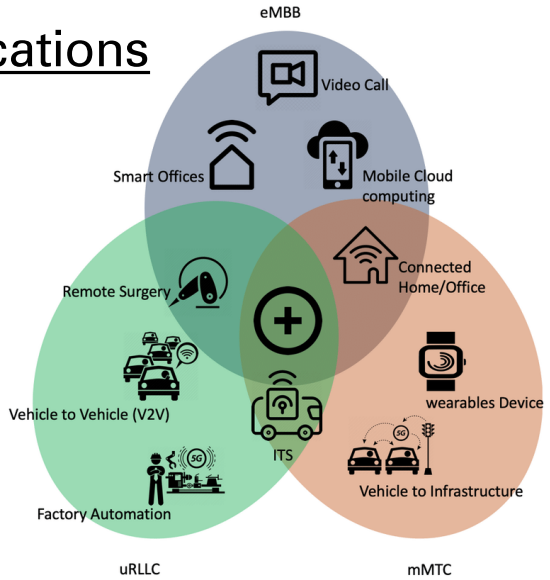
- Two types of 5G networks
  - Public networks
    - Germany: Telekom, Vodafone, Telefonica, 1&1
  - Private networks
    - „5G-Campusnetze“
    - Germany: needs licence from BNetzA (Federal Network Agency)

- 4G to 5G migration
  - Non-standalone networks: allow migration path



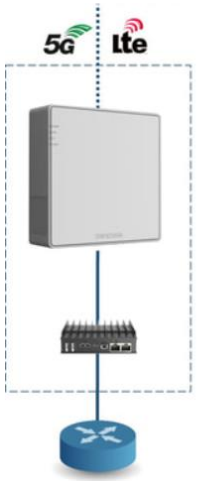
- 5G technology’s impact on B2B landscape
  1. B2B Applications of 5G
  2. B2B Service Model
  3. Network Configuration for B2B
  4. B2B Collaborations in 5G Development

- New use-cases
  - 5G brings new use-cases and new applications for mobile networks → *Verticals*
    - E-Health
    - Smart Energy Grid
    - Smart Factories
    - Media & Entertainment
    - Mobility
    - …
  - New 5G service categories/profiles
    - Enhanced Mobile Broadband (eMBB)
    - Massive Machine-type Communications (mMTC)
    - Ultra-reliable and Low Latency Communications (URLLC)



Source: https://www.researchgate.net/figure/5G-three-main-use-cases-with-examples-of-associated-applications-17_fig4_343115757

- Alternative for connectivity
  - 5G allows public deployments (mobile operators) or private deployment (private 5G networks)
  - WiFi and 5G will become more competitive standards

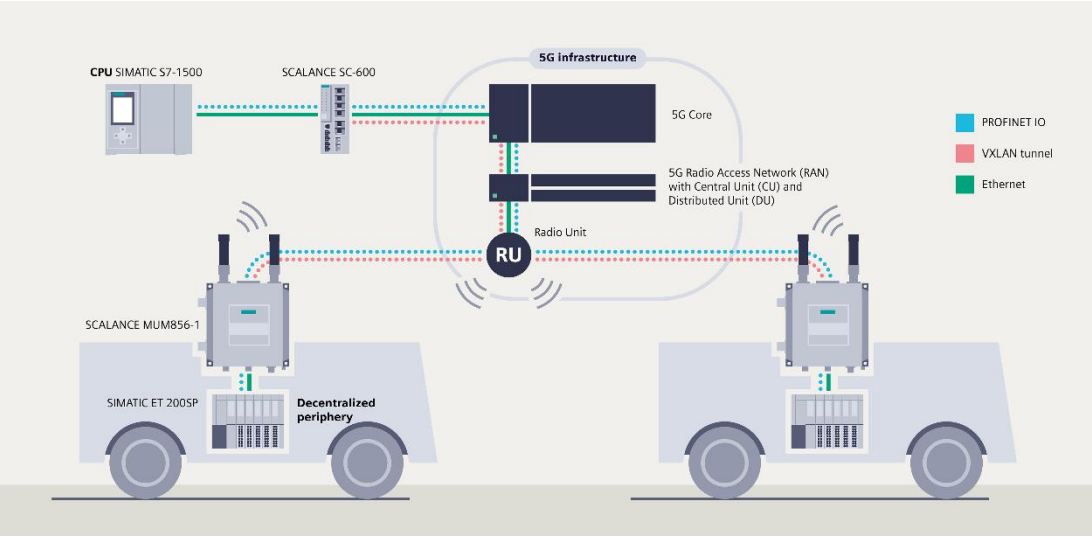


5G Indoor

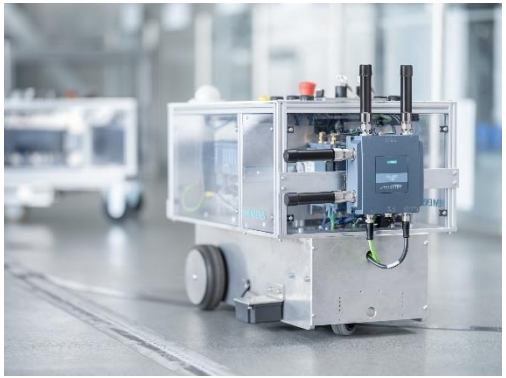
Source: https://www.mecsware.com/

form factor comparable to WiFi access points

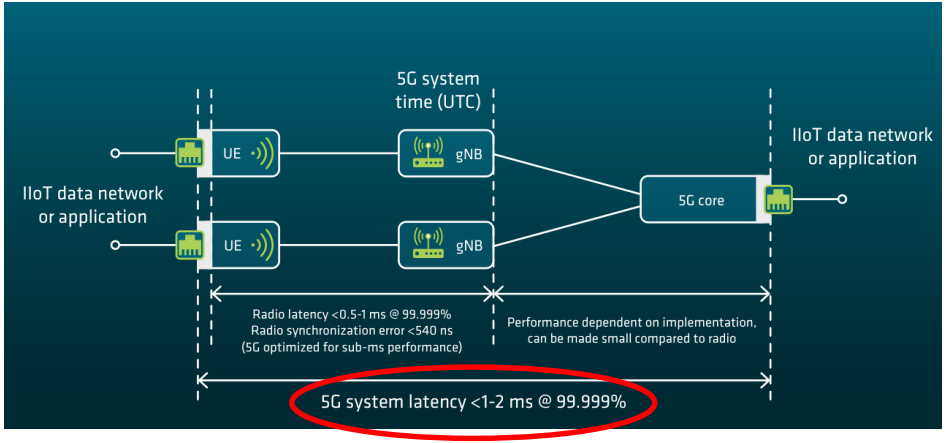
5G Use-Case example



Source: Siemens, https://new.siemens.com/de/de/produkte/automatisierung/industrielle-kommunikation/industrial-5g.html



5G Use-Case example



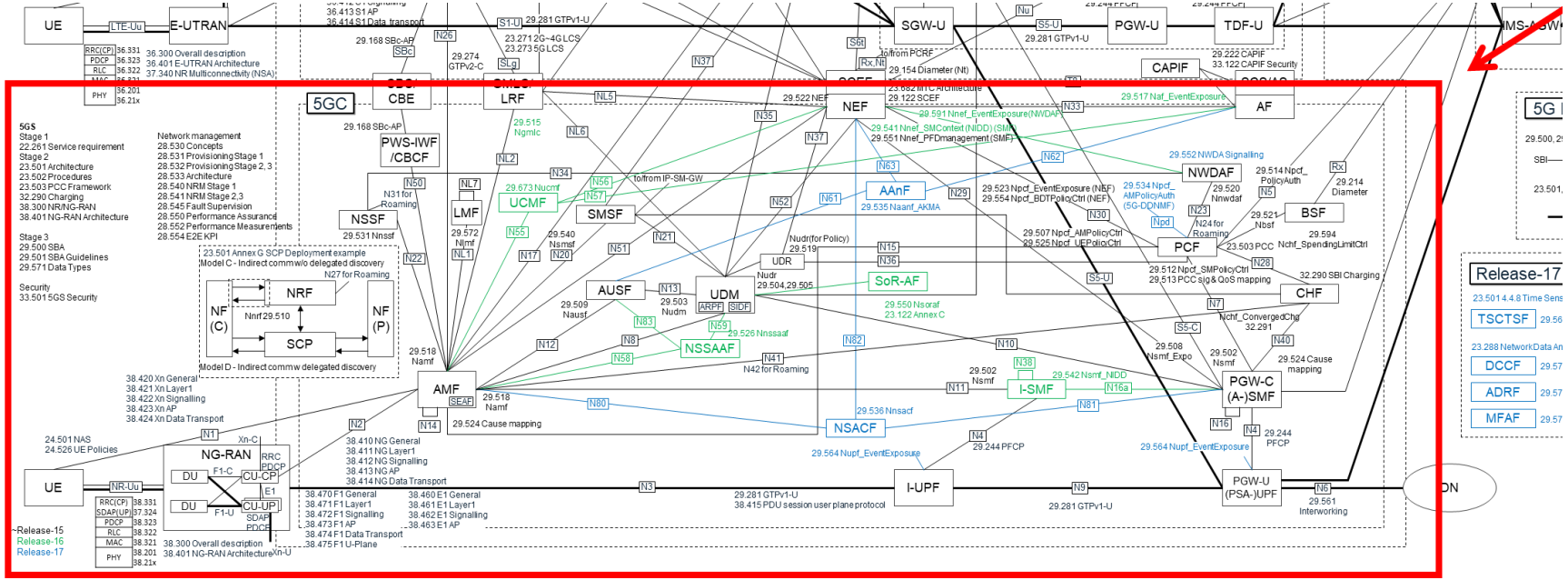
Source: 5G-ACIA White Paper, 5G for Industrial Internet of Things (IIoT): Capabilities, Features, and Potential

Classical fieldbuses for automation systems (wired connections)

ORGANIZATION	RESPONSE TIME (for 100 axles)	JITTER	DATA RATE
Ethernet/IP CIPSync ODVA	1ms	<1ms	100Mbit/s
Ethernet Powerlink EPSG	<1ms	<1ms	100Mbit/s
PROFINET-IRT PNO	<1ms	<1ms	100Mbit/s
SERCOS-III IGS	<0.5ms	<0.1ms	100Mbit/s
EtherCAT ETG	0.1ms	<0.1ms	100Mbit/s

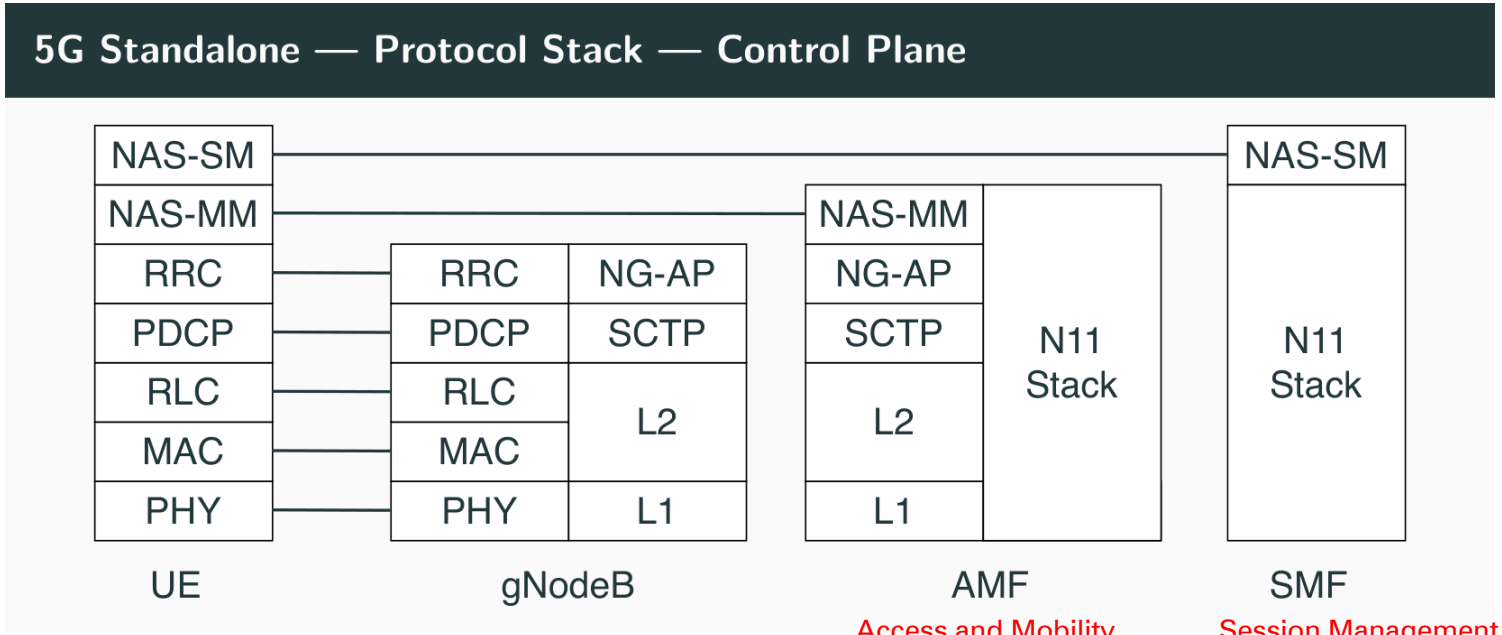
Real-time comparison of the various real-time methods
(Source: IEBmedia)

- 5G Protocols → 3GPP → 5G



Source: https://github.com/nickel0/3GPP-Overall-Architecture

- # 5G Internals: Protocol Stack



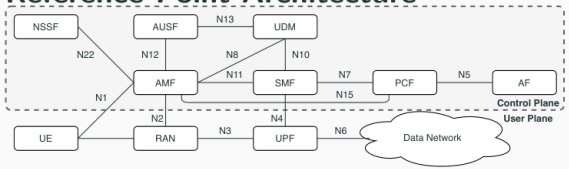
Source: David Rupprecht, Radix Security, 5G Security: Attacks & Architecture

- 5G Internals
  - AMF: Access and Mobility Management Function
    - Mobility & Registration & Connection Management
    - User Authentication & Core Network Security Anchor
  - SMF: Session Management Function
    - Session (User Plane Data) management
    - Session Establishment / Modification/ Release
    - Controlling QoS Parameter (Quality of Service)
    - Configuration of the UPF (User Plane Function)
  - …much more other Network Functions

5G Internals: Protocol Stack

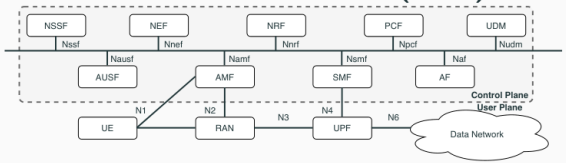
5G Core Architecture - Two Perspectives

Reference Point Architecture



- Elements Network Functions
- Interaction between NFs represented by point-to-point reference point
- Software based simplified Network Functions

Service Based Architecture (SBA)



- Service based interfaces
- Web based RESTful APIs
- Set of definitions acting as interface between different software applications enabling communication

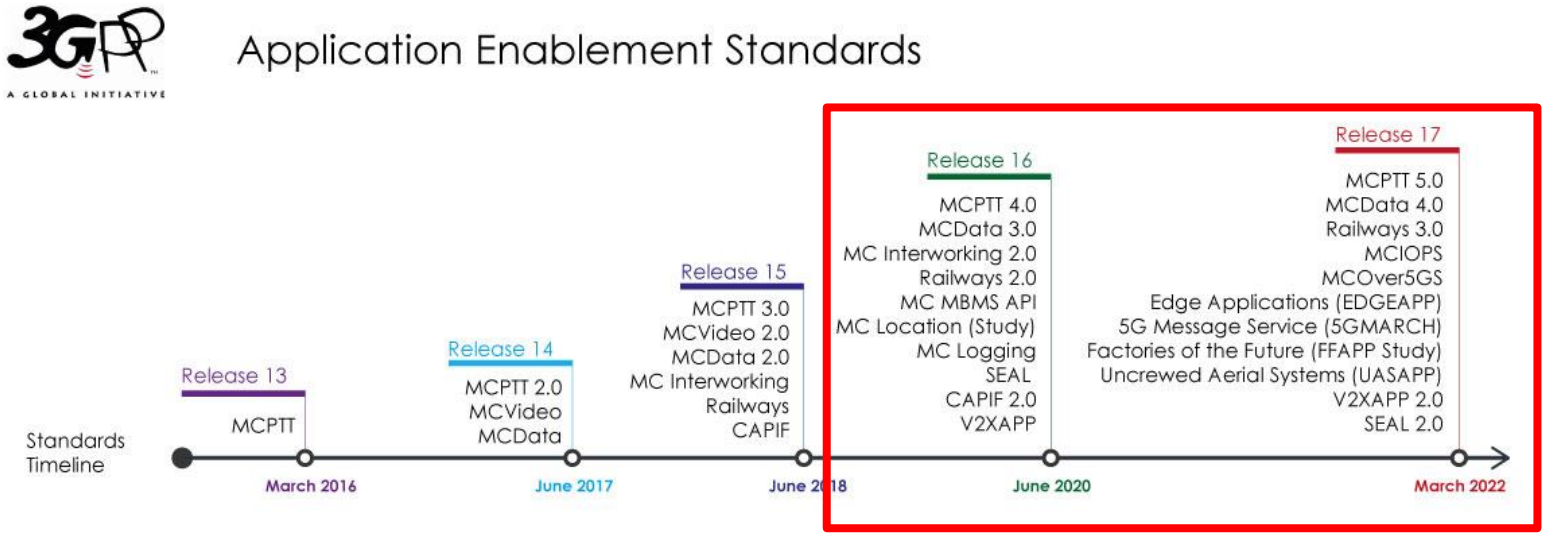
Source: David Rupprecht, Radix Security, 5G Security: Architecture & Security Features

- Do you remember?

  5G evolution works like this:
  - 5G Non-Standalone (NSA)
    - uses existing 4G RAN and 4G Core Network
  - 5G Standalone (SA)
    - greenfield network

  security impact: legacy support and more interfaces

- # 5G Releases

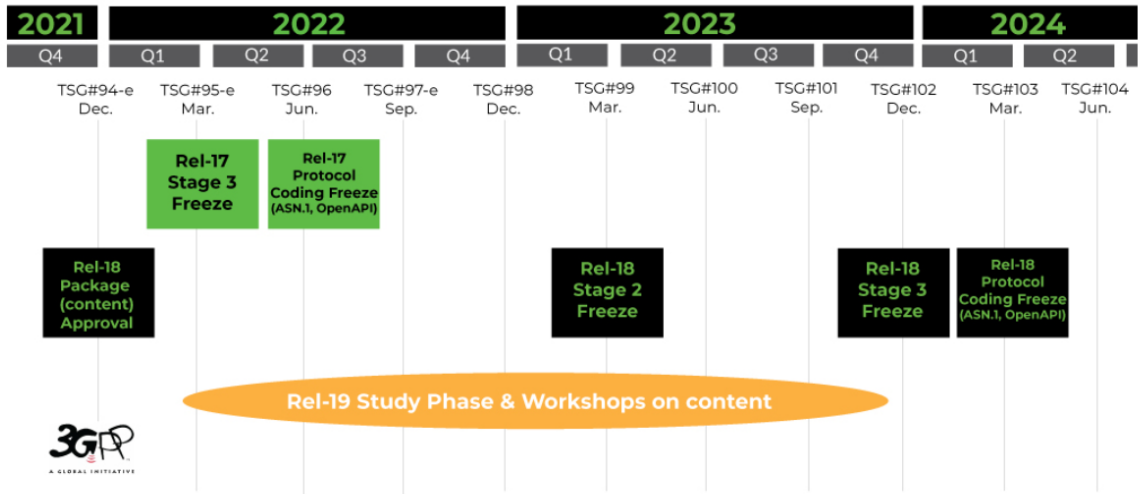


Source: https://www.3gpp.org/news-events/3gpp-news/sa6-app-enable

5G Release Roadmap

High frequency of new releases
→ challenge for security evaluation

Release timelines:



Source: https://www.3gpp.org/specifications-technologies/releases

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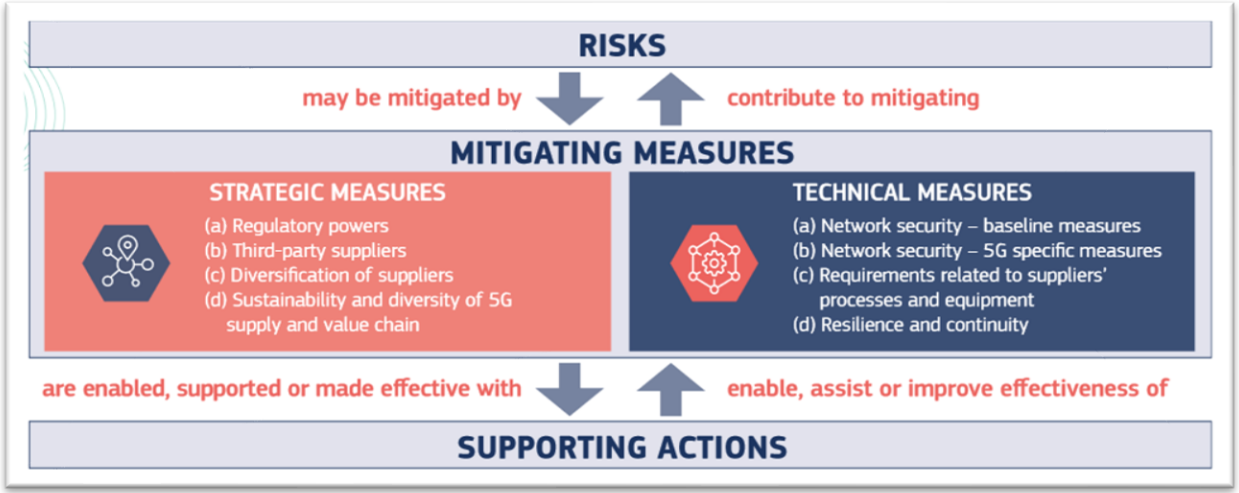
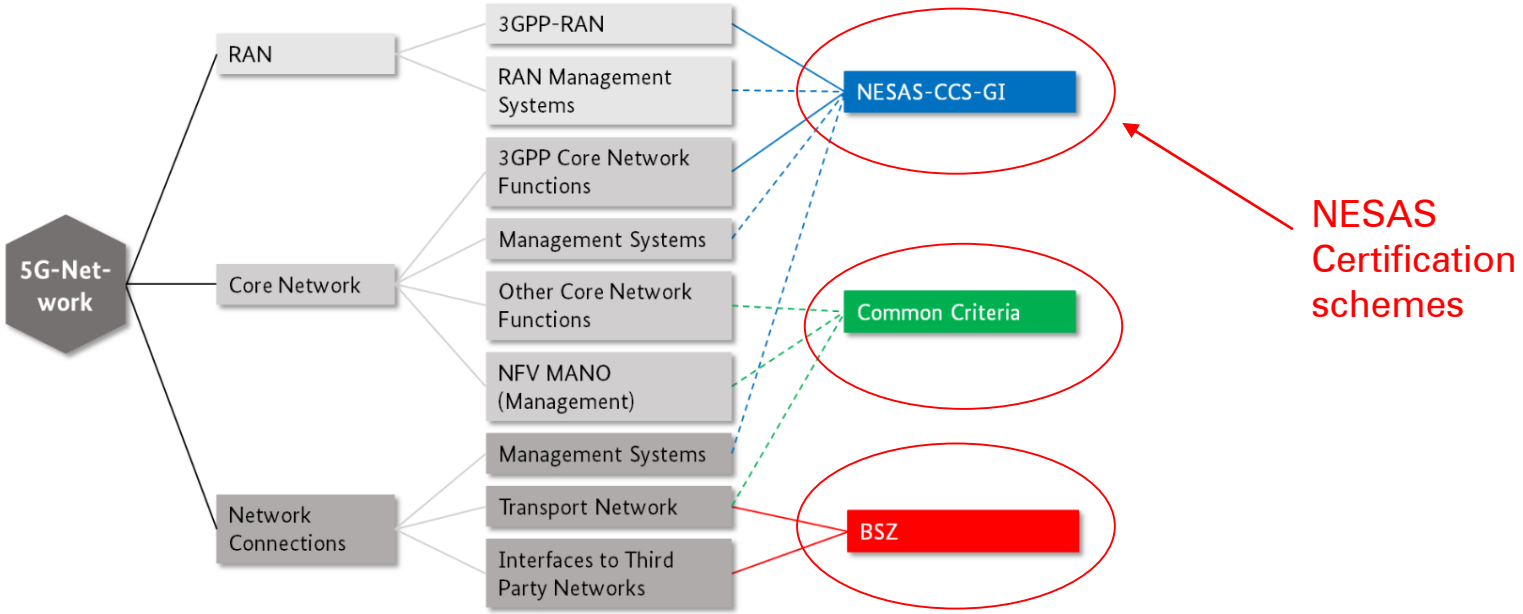
5G Regulation in Europe



Source: EU Commission

- German 5G Certification Strategy
  - Article 165(4) of the Telecommunications Act (TKG)
    - operators of public telecommunications networks with increased risk potential may use critical components [..] only if they have been checked and certified by an approved certification body prior to their first use.
  - SiKa (Sicherheitskatalog)
    - Catalogue of security requirements for the operation of telecommunications and data processing systems and for the processing of personal data pursuant to § 109 of the Telecommunications Act (TKG), Version 2.0
  - BSI TR-03161: Security in Telecommunications Infrastructure

German 5G Certification Strategy (TR-03163)

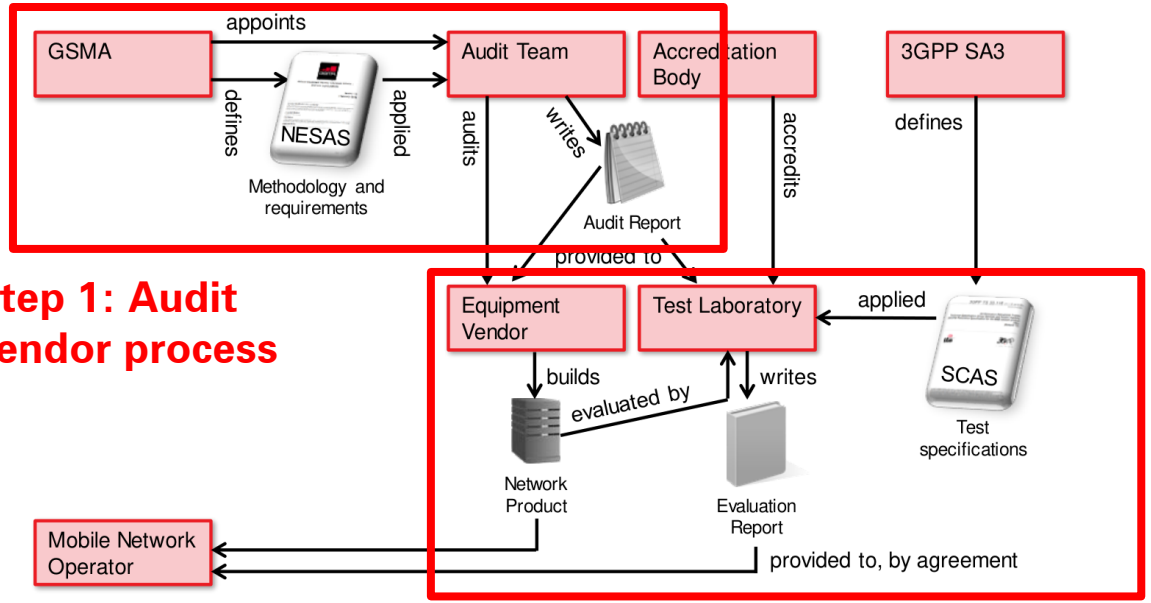


Source: BSI, TR-03163: Security in Telecommunications Infrastructure, Annex A, Version 1.2

- GSMA's security initiatives/schemes
  - GSMA Security Accreditation Scheme (SAS) for assessment of the security of UICC and eUICC suppliers, and their subscription management service providers
  - **GSMA Network Equipment Security Assurance Scheme (NESAS)**

    https://www.gsma.com/security/network-equipment-security-assurance-scheme/
    - allows mobile operators to audit and test network equipment vendors, and their products, against a security baseline
    - in general: specification-based approach

- Two assurance pillars in NESAS



Source: GSMA, Document FS.13 – NESAS Overview v.2.2

- Step 1: Audit Security Development Lifecycle (SDL)

  NESAS Development process requirements
  - [REQ-DES-01] Security by Design
  - [REQ-IMP-01] Source Code Review
  - [REQ-BUI-01] Automated Build Process
  - [REQ-TES-01] Security Testing
  - [REQ-REL-01] Software Integrity Protection
  - [REQ-OPE-01] Security Point of Contact
  - [REQ-GEN-01] Version Control System

NESAS, FS.16 – NESAS Development and Lifecycle Security Requirements v.2.0

- Step 2: Product evaluation (Network component)
  - Need for testing requirements
  - SCAS documents from 3GPP

    TS 33.117 Catalogue of general security assurance requirements
    TS 33.116 Security Assurance Specification (SCAS) for the MME network product class
    TS 33.216 Security Assurance Specification (SCAS) for the evolved Node B (eNB) network product class
    TS 33.250 Security assurance specification for the PGW network product class
    TS 33.511 Security Assurance Specification (SCAS) for the next generation Node B (gNodeB) network product
    TS 33.512 5G Security Assurance Specification (SCAS); Access and Mobility management Function (AMF)
    …
  - Set of SCAS documents refers to 3GPP-Release
    - Available for 3GPP release 16, 17 and 18

- SCAS Test cases
  - SCAS document example
    - Example from *TS 33.117 Catalogue of general security assurance requirements*
    - Security functional requirements and related test cases
    - Basic vulnerability testing requirements
  - Tests are specified in 3GPP working groups

4.2.3.5.2 Protecting sessions – Inactivity timeout

Requirement Name: Protecting sessions – inactivity timeout

Requirement Description: An OAM user interactive session shall be terminated automatically after a specified period of inactivity. It shall be possible to configure an inactivity time-out period.

NOTE: The kind of activity required to reset the timeout timer depends on the type of user session.

Test Name: TC_PROTECTING_SESSION_ INAC TIMEOUT

Purpose:

To ensure an OAM user interactive session shall be terminated at inactivity timeout.

Procedure and execution steps:

Pre-Conditions:

- The tester has privileges to create an OAM user interactive session.
- The tester has privileges to configure the inactivity time-out period for user interactive session.
- Session log should be enabled.

Execution Steps

1. The tester creates OAM user A interaction session.
2. The tester configures the inactivity time-out period for user A to x minute, for example 1 minute.
3. The tester does not make any actions on the network production in x minutes. After that, the tester checks whether OAM user A interaction session has been terminated automatically.

Expected Results:

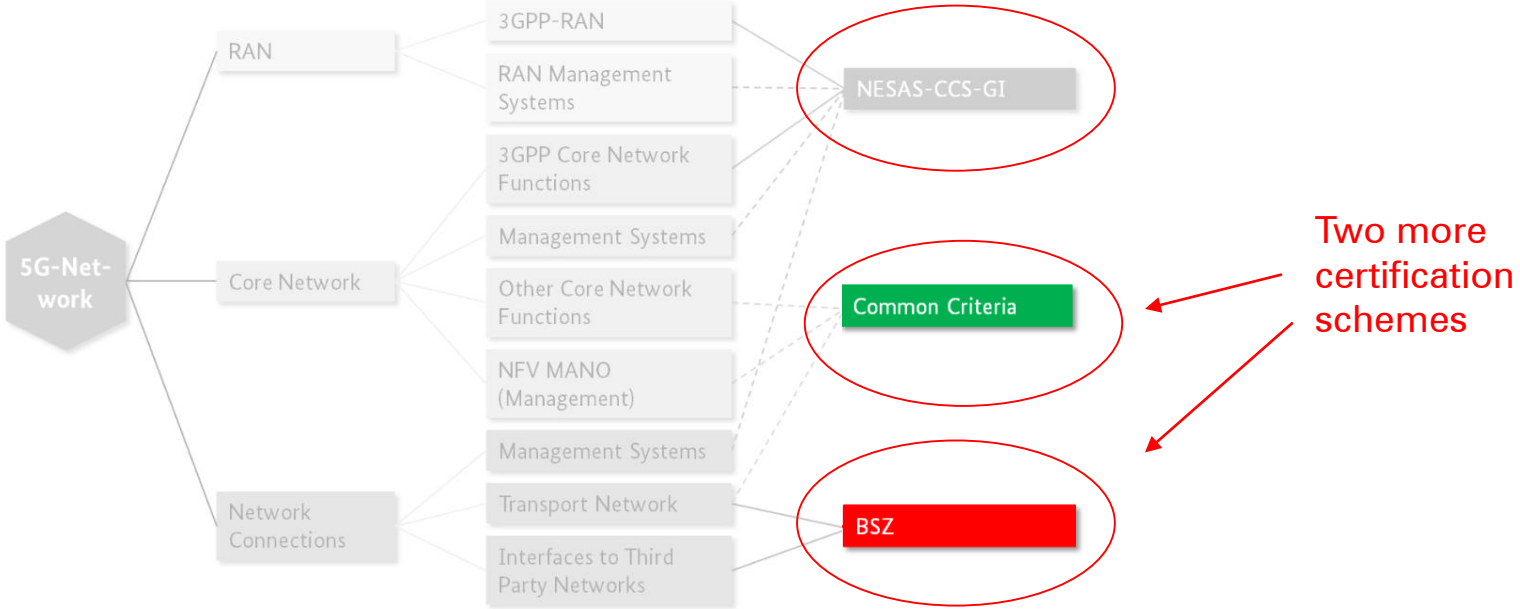
- In step 3, OAM user A interaction session has been terminated automatically after x minute.

Expected format of evidence:

A testing report provided by the testing agency which will consist of the following information:

- Session log
- Settings, protocols and configurations used
- Test result (Passed or not)

German 5G Certification Strategy (TR-03163)



Source: BSI, TR-03163: Security in Telecommunications Infrastructure, Annex A, Version 1.2

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  - 5G Security: Regulation and Certification
  - → **Security Testing in 5G**
  - Future Challenges

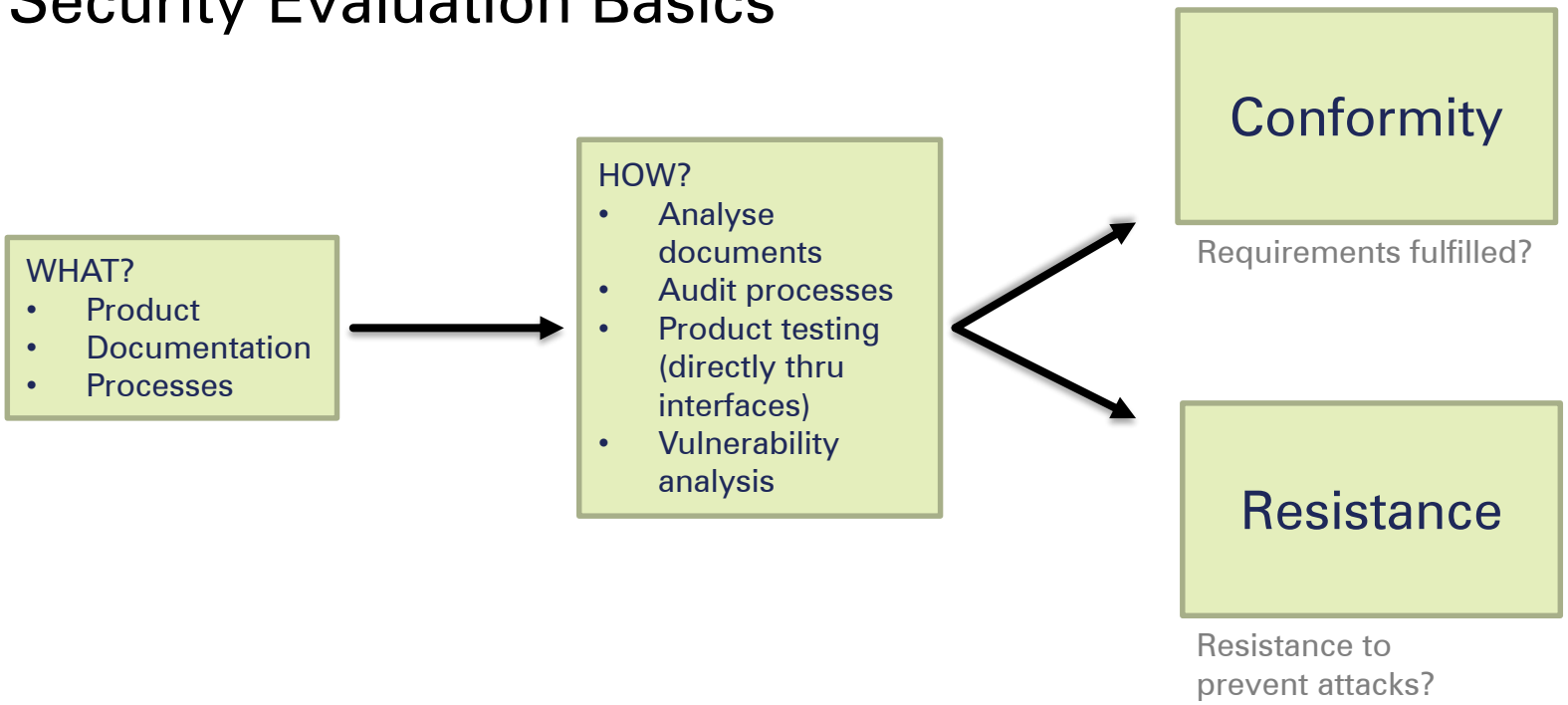
- Security …in general
  - Security is about CIA
    - Confidentiality, Integrity, Availability
    - and Privacy
    - and Safety, Quality… (sometimes called essential functions)
  - What is the security scope?
    - Security functionality
    - Security of products
    - Security of systems

- Security Certification
  - Security Evaluation
    - Evaluate/Analyse Products (includes Design) and Processes
  - Security Testing
    - Test product directly
    - Vulnerability analysis
  - Complexity of Security Testing
    - specification, implementation, configuration, interfaces, (continuous) state of the art, …
    - *we never know the complete behaviour, new knowledge arises*

- Security Evaluation: two approaches (two cultures)
  1. Specification-based approach
     - (exactly) define required security functionality
     - develop and maintain test cases
     - pro/con:
       + predictable evaluation execution time
       – does not find problems outside the scope

- Security Evaluation: two approaches (two cultures)
  2. Attack-based approach
     - allows evaluation team to be investigative and attack focused
     - need for test engineering (in case of new products, new technologies) as part of the evaluation project
     - pro/con:
       + allows state-of-the-art evaluation results (high quality)
       – uncertainties for vendors regarding test cases and competition

- Security Evaluation Basics



- Security Evaluation Example
  - Example 1:
    Test authentication functionality → testing → develop test cases (derived from security functional requirements) → allows pass/fail tests
  - Example 2:
    Search for vulnerabilities in used 3rd party software libraries (reading SBOM, or use root shell, or …) → vulnerability analysis → might lead to exploitable vulnerability in product interface

- Basic Requirements for Testers
  - Basic technical skills
    - Computer science, Communications engineering, …, MINT
  - Knowledge of the technology

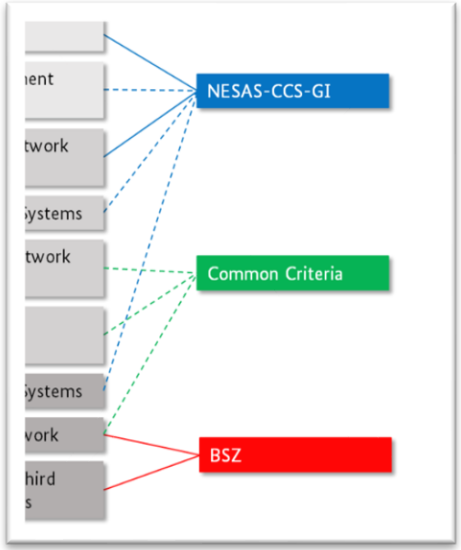
    for example
    - Network products → TCP/IP, WAN technologies, WiFi, …
  - Loves to learn new things (in a short timeframe)
    - deep-dive into specific technologies
  - Team player
    - sharing knowledge and experience is key to run commercial evaluation projects

- 5G-specific Requirements for Testers
  - Knowledge of 3GPP terminology and concepts
    - major barrier to entry!
  - Basic protocols like HTTP, REST, TLS, OAUTH, …
  - Communication flows within 5G (physical/radio layer, different logical layers)
  - Deployment strategies: OpenRAN, Network Core Virtualization, Private 5G Scenarios/Devices
  - …

- 5G Security Evaluation
  - performed by ITSEF (IT Security Evaluation Facility)
    - or lab, works according to ISO/IEC 17025 (laboratory standard)
  - evaluation team
  - evaluation test setup

- Challenges in 5G Security Testing
  - 3GPP standards focus on functionality and interoperability
  - but no (additional) test interfaces yet
  - consideration of deployment aspects
  - use of vendor facilities, tools or resources
    - rapid turnaround times → major challenge for actual security certification models
  - fast 3GPP release cycle

- Do you remember? TR-03163 certification
  - NESAS
    - Allows for automated testing
    - *Specification-based*
  - Common Criteria (CC)
    - Classical security certification model
    - Compliance to protection profiles
    - *Attack-based* *(in Europe)*
  - BSZ
    - Fixed-time product penetration test
    - *Attack-based*



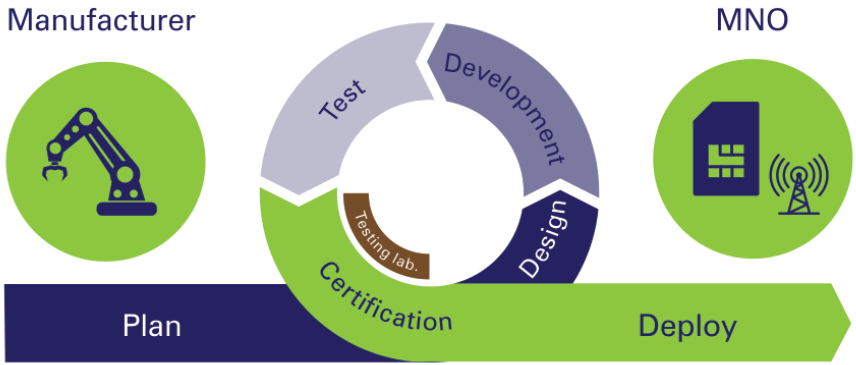
- Agenda
  - Introduction & Motivation
  - 5G Use-Cases & Internals
  - Threats & Risks in 5G Networks
  - Security Evaluation of 5G Components
  - → **Future Challenges**

- Complexity of 5G and legacy aspects
  - 5G must be configured and operated
  - Private 5G network
    - Do operators have security experts?
  - New opportunity to operate components from different vendors
    - more open connections
  - Backward compatibility
    - especially in non-standalone networks
    - behaviour of network components could be different

- Certification of 5G networks
  - Goal: operators (public or private) have the obligation to run secure networks
  - Configuration is typically a challenge in lab test setups
    - How to setup the full complexity?
    - Misconfiguration is often the root cause of undetected, exploitable vulnerabilities
  - Network scenarios are getting more diverse/complex, e.g. multi vendor strategy
  - **Open question:**
    Can we attest the security status of the whole 5G network?

- Agile evaluation/certification process
  - Industry complains: security evaluation limits innovation in products
  - Evaluation requires support/resources from vendors
  - **Open question:**
    Can we certify more agile?
    Certification as part of the development pipeline?

- Agile evaluation/certification process
  - Shift left optimization



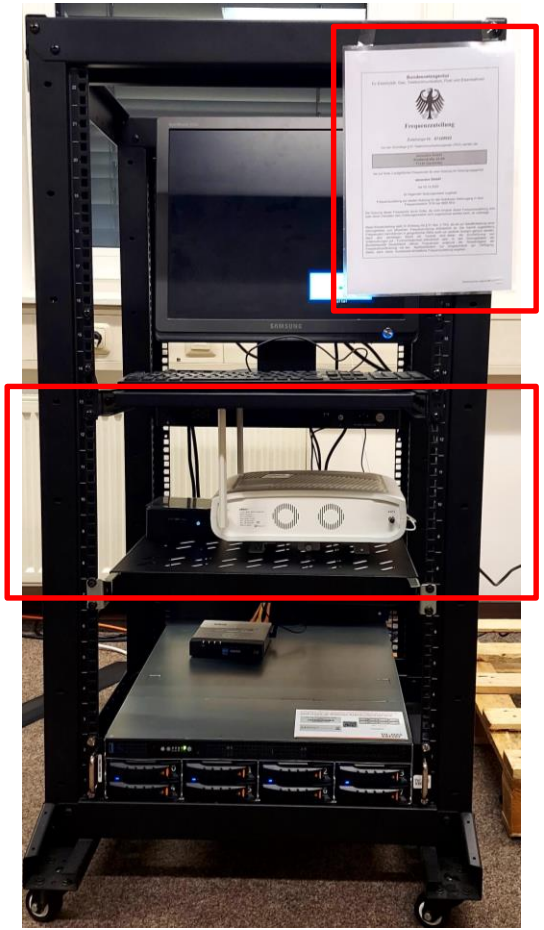
Source: OPNESAS Project

- Global security regulation
  - 5G Regulation in Germany
  - Cyber Resilience Act (CRA) in Europe
  - Regulation in North America, Asia, …
  - **Open question for manufactures:**
    How to avoid repetition of tests for different schemes and markets?
  - **And how to show compliance efficiently?**

Source: OPNESAS Project

- Are you interested in an 5G security internship?
  - secuvera is leading a 5G certification research project!
  - **OPNESAS**
    - project partners: secuvera, Radix Security & Ruhr Uni Bochum
    - 24 month, between 01/2023 and 12/2024
  - direct contact: sfritsch@secuvera.de
  - visit: https://www.secuvera.de/unternehmen/karriere/

- secuvera
  5G laboratory



Licence
(BNetzA)

Technology
(Core and Radio)

- What are our motivations?
  - …security hygiene for complex products
  - …identify weaknesses and errors before product is globally available
  - …have more secure products for own usage
  - …support the evolution of testing/evaluation criteria for future projects (not only for our team, standardization)

- We are looking for?
  - (Junior) Product Testers
  - (Junior) Consultants for Security Certification
  - (Junior) Industrial Security Consultants

- Details…
  - https://www.secuvera.de/unternehmen/karriere/

- Last but not least,
  since 5 years we are a…

- Why? Please have a look…
  - https://www.secuvera.de/unternehmen/karriere/secuvera-als-arbeitgeber/

secuvera

Cybersicherheit. Nachhaltig.

mobile business

5G

Vielen Dank!
Thank you!

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