3GPP LTE
Security Aspects

Dionisio Zumerle
Technical Officer, 3GPP
ETSI

Contents

- LTE security architecture
- Security algorithms
- Lawful Interception
- Backhaul Security
- Relay Node Security

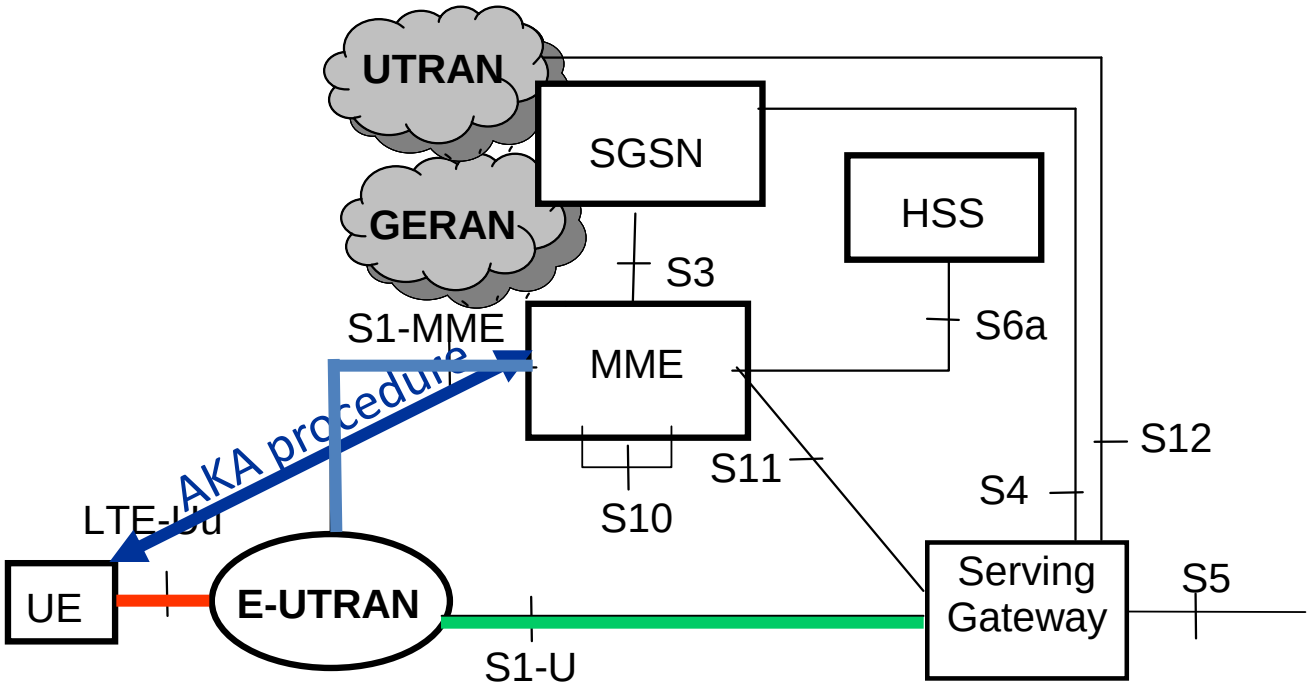
LTE Security Architecture

LTE Security:
UMTS Security and LTE Architectural impact

- UMTS security enhancements:
  - **Mutual authentication**
  - **Integrity keys**
  - **Public algorithms**
  - **"Deeper" encryption**
  - **Longer key length**
- LTE Architecture:
  - **Flat architecture**
  - **Separation of control plane and user plane**
  - **eNodeB instead of NodeB/RNC**
  - **All-IP network**
  - **Interworking with legacy and non-3GPP networks**

- Characteristics of LTE Security
  - **Re-use of UMTS Authentication and Key Agreement (AKA)**
  - **Use of USIM required (GSM SIM excluded)**
  - **Extended key hierarchy**
  - **Possibility for longer keys**
  - **Greater protection for backhaul**
  - **Integrated interworking security for legacy and non-3GPP networks**

AKA and signalling protection

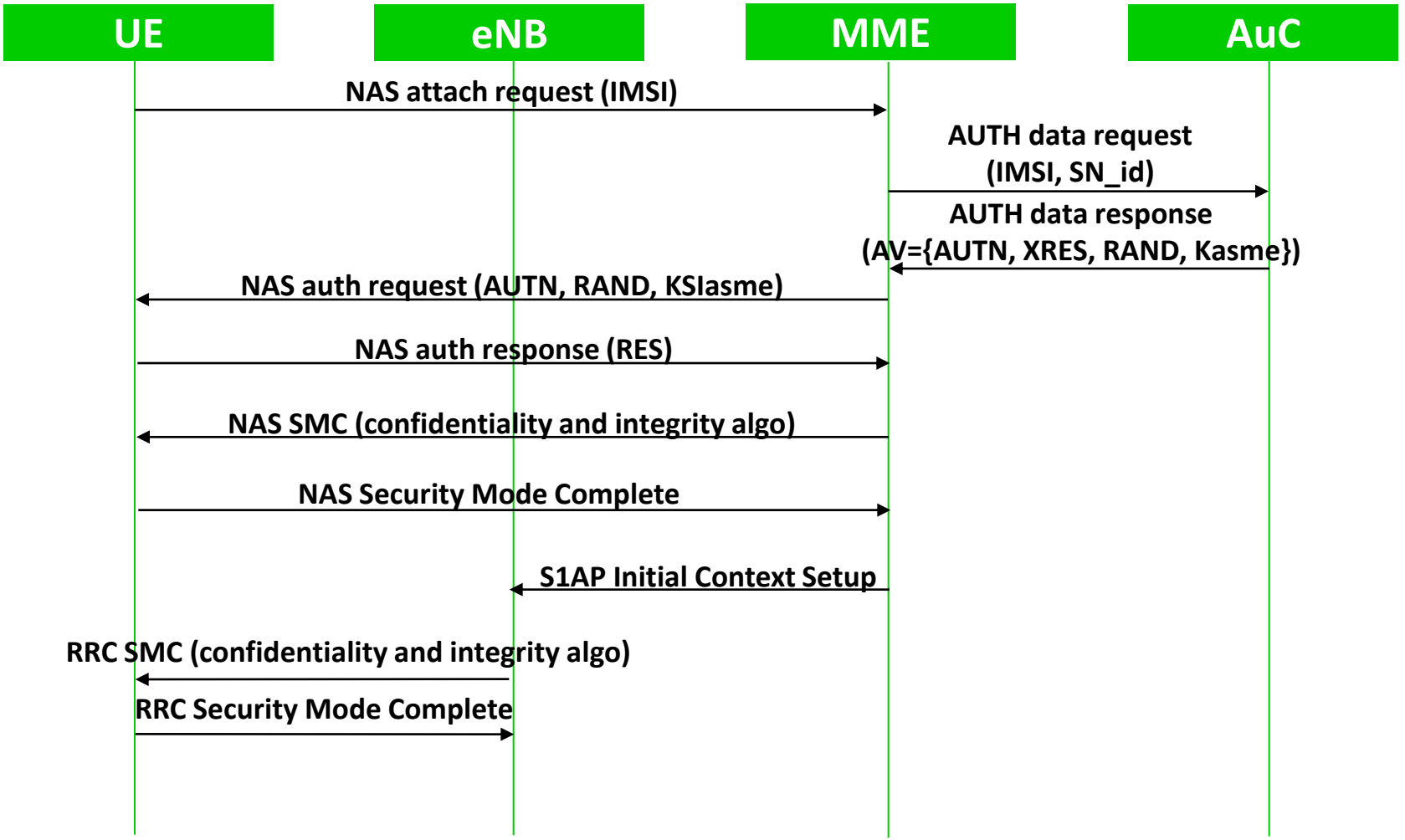


Confidentiality and integrity for signalling and confidentiality for user plane (RRC & NAS)

Confidentiality and integrity for signalling only (NAS)

Optional user plane protection (IPsec)

Authentication and Key Agreement

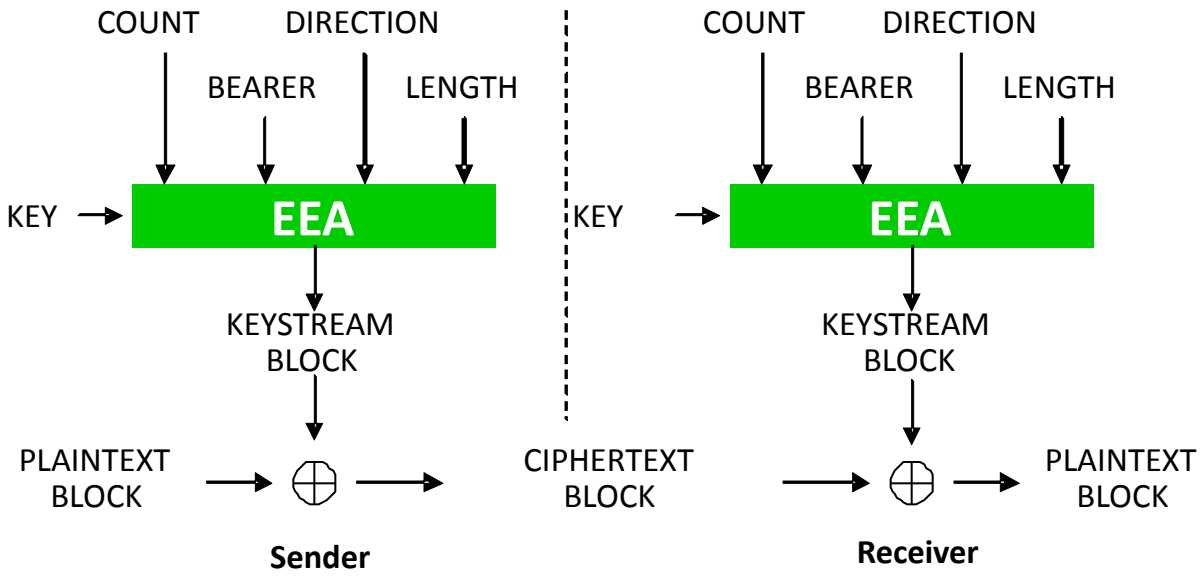


Security Algorithms

LTE Security Algorithms

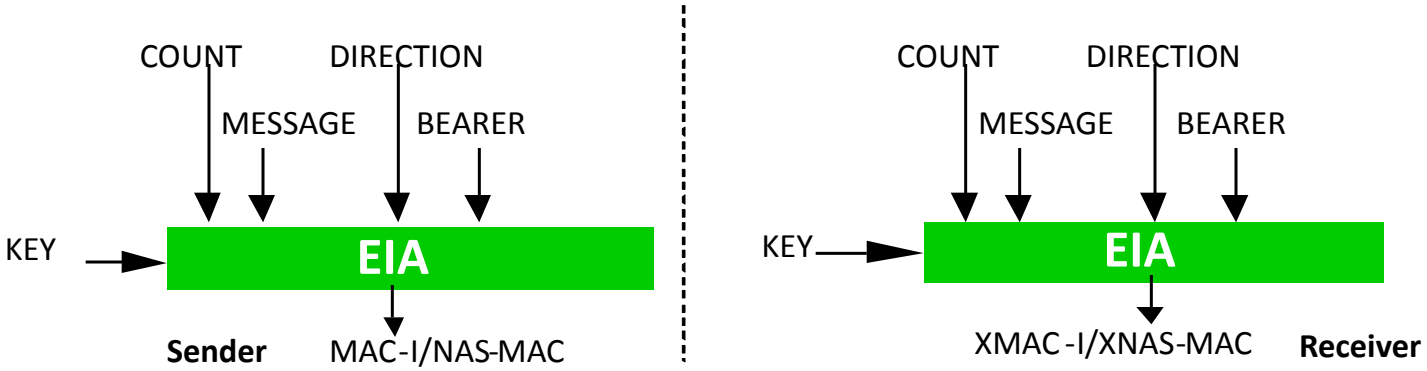
- Currently two separate algorithms specified
  - In addition to one NULL algorithm
- Current keylength 128 bits
  - Possibility to extend to 256 in the future
- Confidentiality protection of NAS/AS signalling recommended
- Integrity protection of NAS/AS signalling mandatory
- User data confidentiality protection recommended
- Ciphering/Deciphering applied on PDCP and NAS

LTE Ciphering and Integrity mechanisms



ciphering

integrity



128-EEA1/EIA1

- Based on SNOW 3G
  - stream cipher
  - keystream produced by Linear Feedback Shift Register (LFSR) and a Finite State Machine (FSM)
- Different from KASUMI as possible
  - selected during UMTS security design
- Allows for:
  - low power consumption
  - low gate count implementation in hardware

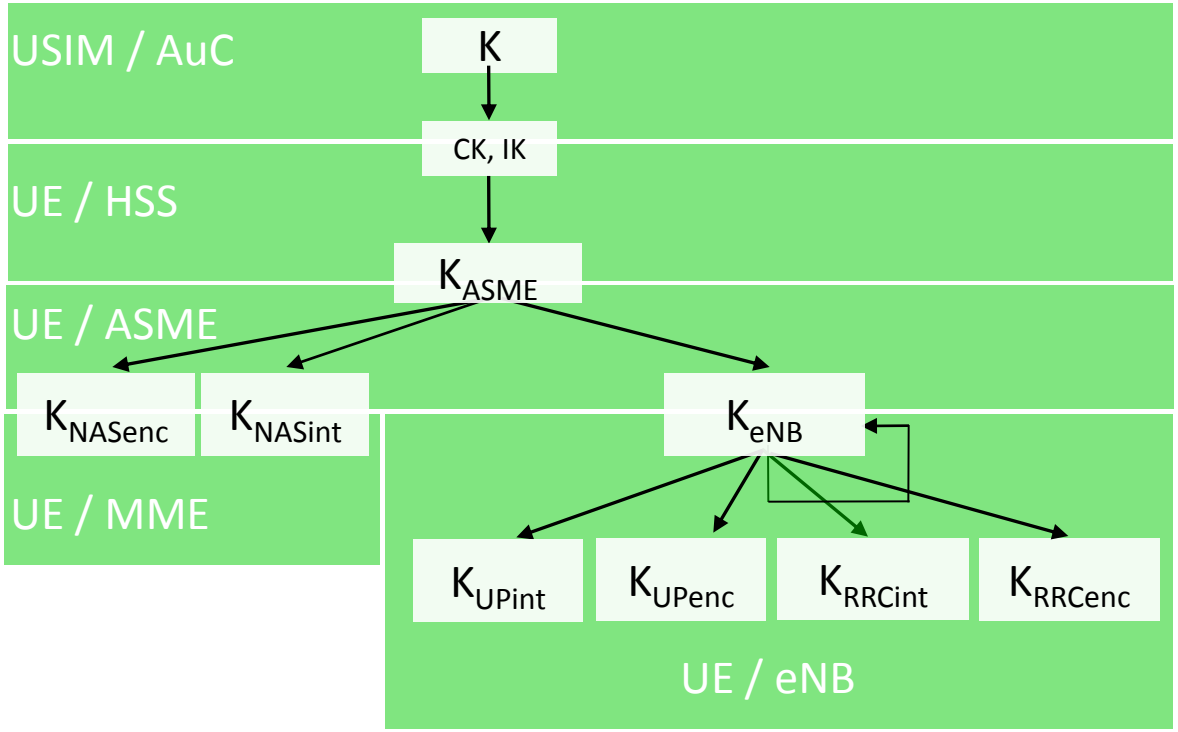
128-EEA2/EIA2

- AES block cipher
  - Counter (CTM) Mode for ciphering
  - CMAC Mode for MAC-I creation (integrity)
- Different from SNOW 3G as possible
  - Cracking one would not affect the other
- Reasons why KASUMI was not re-used:
  - eNB already supports AES
    - needs to support AES for NDS/IP
  - Similarity with other non-3GPP accesses (e.g. 802.11i)
  - Other

128-EEA3/EIA3

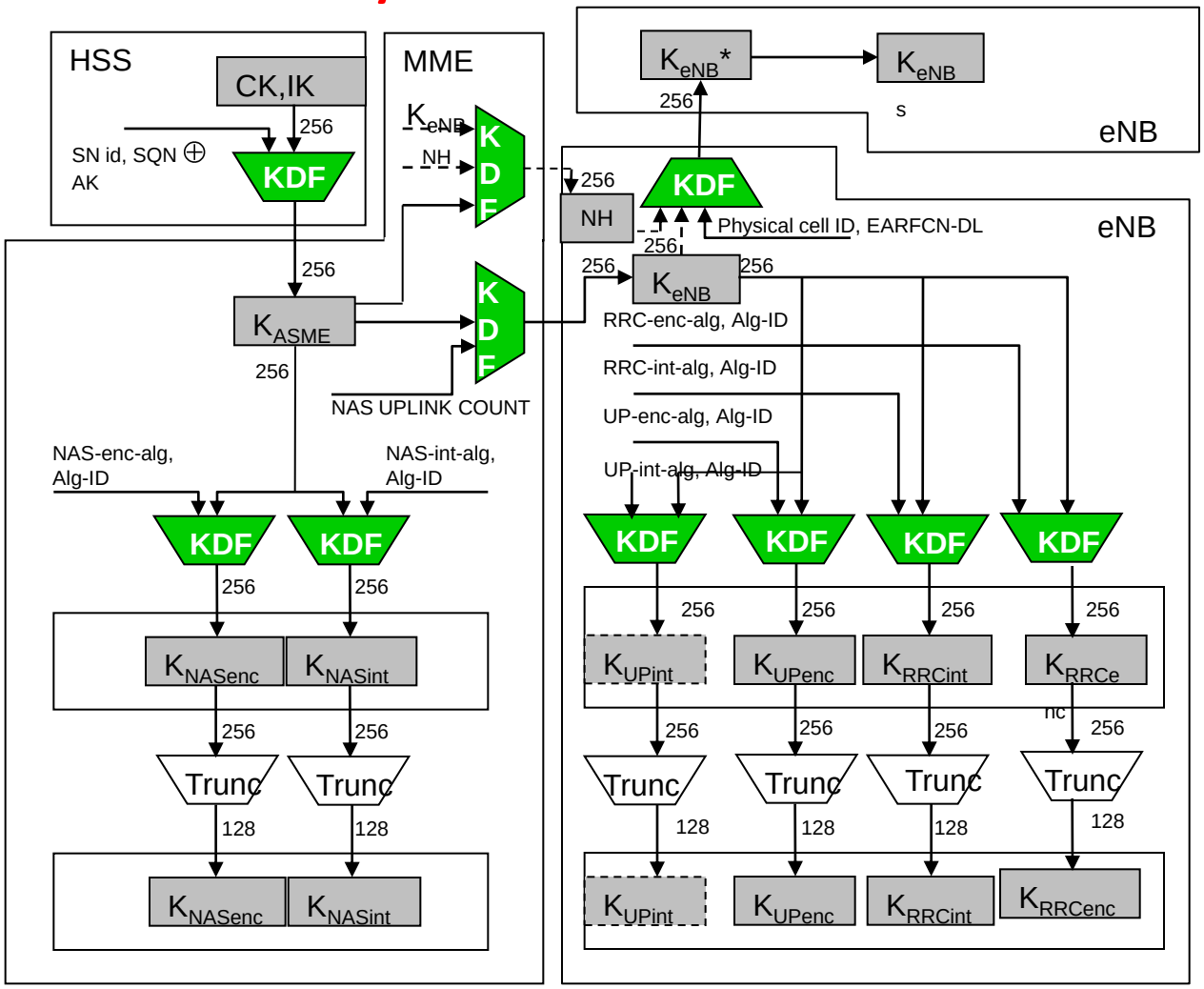
- Based on Chinese ZUC
  - stream cipher
- Three-phase evaluation ongoing
  - Public evaluation ongoing! http://zucalg.forumotion.net/
  - 2nd International Workshop on ZUC: June 5-6 in Beijing http://www.3gpp.org/Call-for-Papers-Beijing-ZUC
- Network-mandatory/network-optional to be decided

Deeper Key hierarchy in LTE



- Faster handovers and key changes, independent of AKA
- Added complexity in handling of security contexts
- Security breaches local

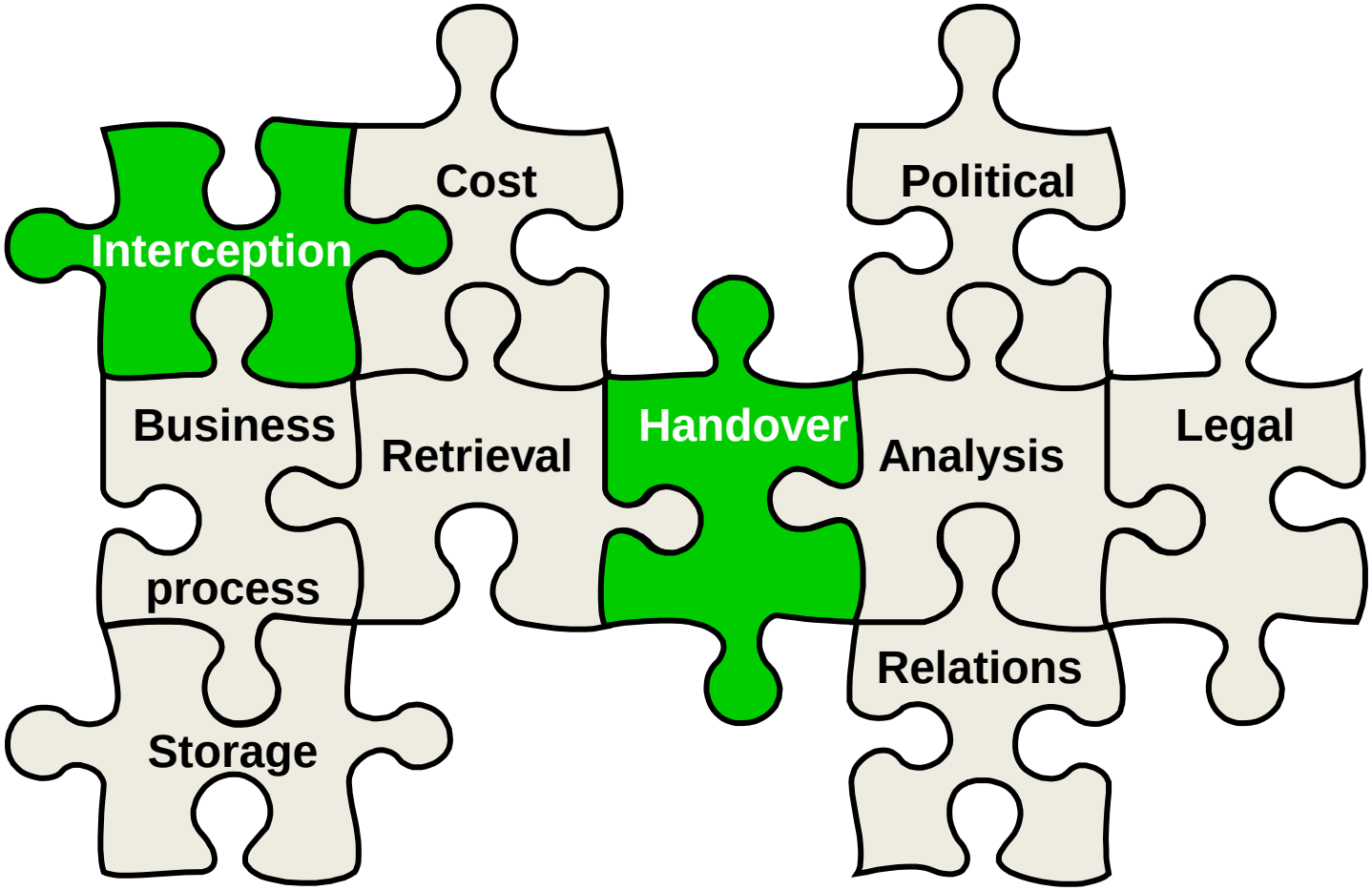
Key Derivation



Key distribution and key derivation scheme for EPS (network side), found in 33.401
Key Derivation Function (KDF) specification can be found in 33.220

Lawful Interception

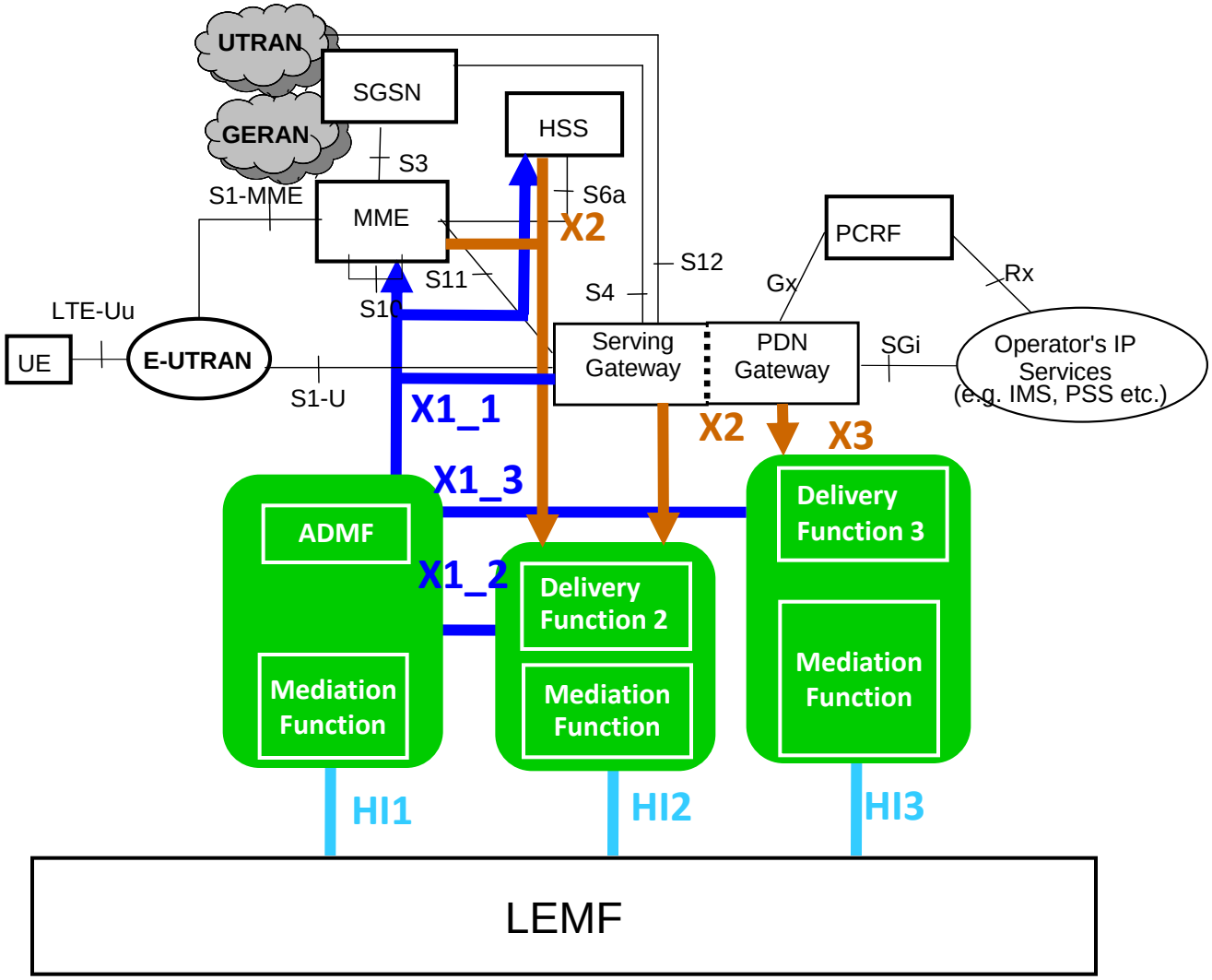
Lawful Interception in 3GPP



Lawful Interception in EPS

- Context and mechanisms similar to case of UMTS PS
  - Different core entities (ICE, Intercepting Control Elements)
  - ADMF handles requests from Law Enforcement Authorities
    - target identity: IMSI, MSISDN and IMEI
  - X1 interface provisions ICEs and Delivery Functions
  - X2 delivers IRI (Intercept Related Information)
  - X3 delivers CC (Content of Communication)
  - HI1,2,3: Handover Interfaces with law enforcement
    - Convey requests for interception of targets (HI1)
    - Deliver IRI (HI2) and CC (HI3) to LEAs

EPS LI Architecture



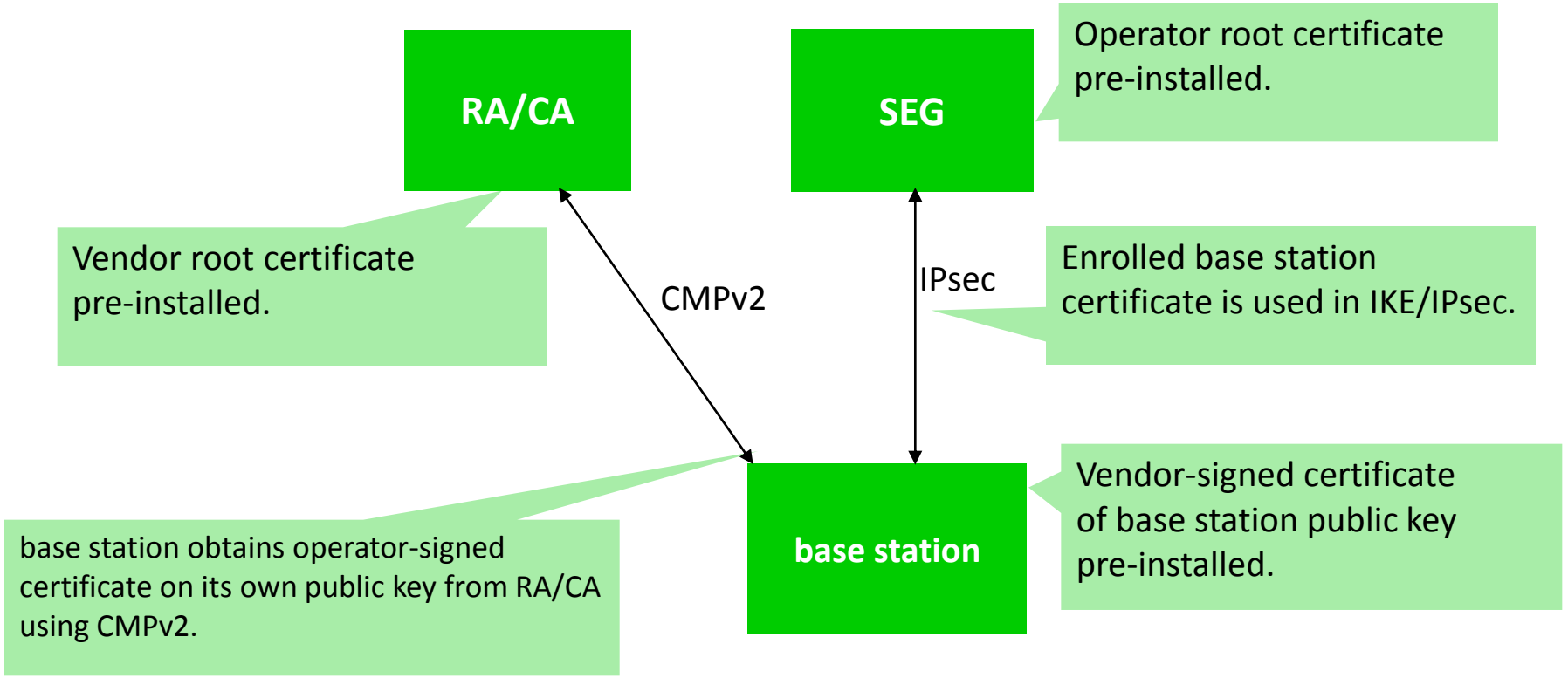
Backhaul Security

Backhaul Security

- Base stations becoming more powerful
  - LTE eNode B includes functions of NodeB and RNC
- Coverage needs grow constantly
- Infrastructure sharing

- Not always possible to trust physical security of eNB
- Greater backhaul link protection necessary

Certificate Enrollment for Base Stations

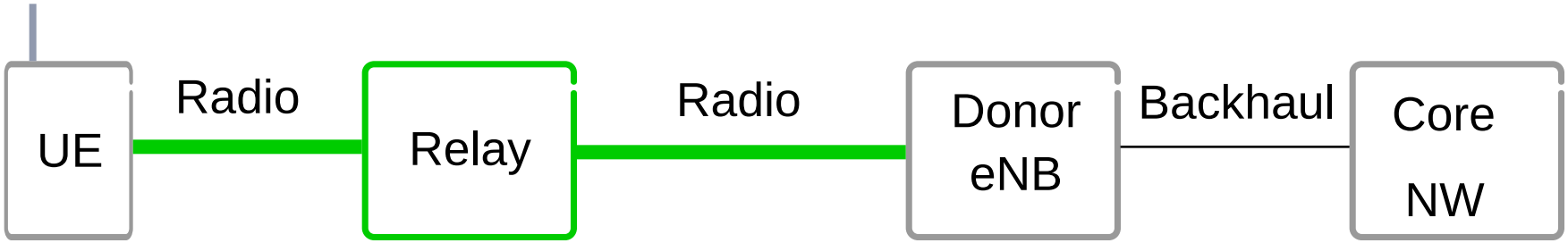


Picture from 3GPP TS 33.310

Relay Node Security

Relay Node Authentication

- Mutual authentication between Relay Node and network
  - AKA used (RN attach)
  - credentials stored on UICC
- Binding of Relay Node and USIM:
  - Based on symmetric pre-shared keys, or
  - Based on certificates



Relay Node Security

- Control plane traffic integrity protected
- User plane traffic optionally integrity protected
- Relay Node and network connection confidentiality protected
- Device integrity check
- Secure environment for storing and processing sensitive data

Conclusions

- LTE Security: building on GSM and UMTS Security
- Newer security algorithms, longer keys
- Extended key hierarchy
- New features, addressing new scenarios
  - Backhaul Security
  - Relay Node Security

Thank You!

dionisio.zumerle@etsi.org

More Information about 3GPP:

www.3gpp.org

contact@3gpp.org

Backup:
Selection of 3GPP Security Standards

LTE Security:
33.401 System Architecture Evolution (SAE); Security architecture
33.402 System Architecture Evolution (SAE); Security aspects of non-3GPP
Lawful Interception:
33.106 Lawful interception requirements
33.107 Lawful interception architecture and functions
33.108 Handover interface for Lawful Interception
Key Derivation Function:
33.220 GAA: Generic Bootstrapping Architecture (GBA)
Backhaul Security:
33.310 Network Domain Security (NDS); Authentication Framework (AF)
Relay Node Security
33.816 Feasibility study on LTE relay node security (also 33.401)
Home (e) Node B Security:
33.320 Home (evolved) Node B Security