YESDR

Your Extensible Software Defined Radio

YesDR Technical Specification

YesDR TS 02.021

Version 1.0.0
Release 1

YesDR User Equipment (YUE)

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1 Scope

This specification defines the YesDR User Equipment (YUE).

YUE represents the terminal entity participating in the YesDR network, supporting registration, authentication, security procedures, PDU session establishment, and full protocol stack processing from NAS to PHY using Software Defined Radios (SDRs).

YUE is functionally aligned with the 3GPP UE defined in TS 23.501, TS 24.501, and TS 33.501, with simplifications for research, education, and experimentation.

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2 References

2.1 Normative

- YesDR TS 01.001: Overall Architecture
- YesDR TS 02.020: YesDR Base Station (YBS)
- YesDR TS 03.001: YesDR Access Control Protocol (YACP)

2.2 Informative

- 3GPP TS 23.501
- 3GPP TS 24.501
- 3GPP TS 33.501

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3 Abbreviations

Term	Description
YUE	YesDR User Equipment
YBS	YesDR Base Station
YAMF	YesDR Access Management Function
YSMF	YesDR Session Management Function
YUPF	YesDR User Plane Function
NAS	Non-Access Stratum
PDCP	Packet Data Convergence Protocol
RLC	Radio Link Control
PHY	Physical Layer
RES*	Authentication Response Star
GUTI	Globally Unique Temporary Identifier

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4 Functional Overview

YUE performs the following functions:

- Identity management using SUCI and GUTI
- UE authentication using Milenage and 5G-AKA

- NAS security setup (integrity and ciphering)
- Registration and mobility procedures
- PDU session establishment and IP configuration
- End-to-end user-plane protocol stack processing

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5 YUE Architecture

YUE consists of the following logical components:

5.1 NAS Layer

Handles registration, authentication, and mobility signaling using YACP-encapsulated NAS messages.

5.2 Security Layer

Implements Milenage, KDF functions, NAS key derivation, and access-stratum security context management.

5.3 PDCP Layer

Performs ciphering and deciphering of user-plane payloads using AES-CTR mode.

5.4 RLC Layer

Handles segmentation, reassembly, and sequence number management.

5.5 FEC and PHY Layer

Performs convolutional decoding, Viterbi decoding, and CRC verification for SDR-based reception.

5.6 IP and Application Layer

Assigns IP address to virtual interface and delivers decoded payloads to applications.

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6 Identity and Subscription Data

YUE SHALL store:

- SUCI / IMSI
- Permanent key (K)
- OP / OPc
- SQN and AMF
- Assigned GUTI

Subscription data SHALL be stored securely in a local database and updated dynamically.

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7 Authentication Procedure

YUE SHALL support 5G-AKA authentication using Milenage.

The procedure includes:

1. Reception of RAND and AUTN
2. MAC verification and SQN recovery
3. RES* computation
4. Key derivation (Kausf, Kseaf, Kamf)
5. Synchronization failure handling using AUTS

Authentication behavior SHALL follow TS 33.501 principles.

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8 NAS Security

YUE SHALL derive:

- K_NASenc
- K_NASint

Supported algorithms MAY include:

- 5G-EA0 / 5G-IA0
- 128-EEA1 / 128-EIA1

YUE SHALL verify selected algorithms against UE security capabilities.

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9 Registration Procedure

YUE SHALL perform:

1. Initial Registration using SUCI or GUTI
2. Authentication and security setup
3. Security Mode Complete
4. Registration Accept processing

YUE SHALL extract assigned GUTI and registration status from NAS responses :contentReference[oaicite:1]index=1.

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10 PDU Session Establishment

YUE SHALL initiate PDU session establishment by:

- Requesting a PDU session
- Receiving UE IP address
- Configuring virtual network interface

Multiple PDU sessions MAY be supported.

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11 User Plane Processing

YUE SHALL implement the following RX pipeline:

$$\text{UDP} \rightarrow \text{FEC} \rightarrow \text{Viterbi} \rightarrow \text{CRC} \rightarrow \text{RLC} \rightarrow \text{PDCP Decryption} \rightarrow \text{Application}$$

PDCP decryption SHALL be performed once after full RLC reassembly.

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12 Error Handling

YUE SHALL handle:

- Authentication failures
- SQN desynchronization
- CRC and decoding errors
- Session establishment failures

Errors SHALL be logged and SHALL NOT cause unexpected termination.

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13 Security Considerations

YUE SHALL:

- Protect permanent subscription keys
- Avoid persistent storage of derived session keys
- Isolate user-plane and control-plane processing

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14 Relationship to 3GPP UE

YUE aligns with the 3GPP UE architecture while:

- Using simplified NAS and RAN signaling
- Supporting SDR-based PHY experimentation
- Enabling end-to-end protocol visibility

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