

5G NR Layer-2 PDU Structure Definitions

A 3GPP-Compliant C Implementation

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1 Overview

This project provides a comprehensive implementation of **5G New Radio (NR) Layer-2 Protocol Data Unit (PDU) header structures** in the C programming language. All definitions are strictly derived from official **3GPP Release 15/16 specifications** and are designed to be bit-accurate.

The implementation covers the following Layer-2 protocols:

- Service Data Adaptation Protocol (SDAP)
- Packet Data Convergence Protocol (PDCP)
- Radio Link Control (RLC)
- Medium Access Control (MAC)

2 Features

- 24+ PDU header structures across all Layer-2 protocols
- Bit-field accurate representations matching 3GPP specifications
- Multiple variants for different sequence number lengths
- Extensive in-code documentation
- Zero external dependencies (pure C implementation)

3 Structure Coverage

3.1 SDAP Layer (TS 37.324)

- SDAP Data PDU with RQI and RDI
- SDAP Data PDU without RQI and RDI

3.2 PDCP Layer (TS 38.323)

- PDCP Data PDU with 12-bit Sequence Number
- PDCP Data PDU with 18-bit Sequence Number
- PDCP Control PDU (Status Report)
- PDCP Control PDU (ROHC Feedback)

3.3 RLC Layer (TS 38.322)

- RLC Transparent Mode (TM)
- RLC Unacknowledged Mode (UM) – 6-bit and 12-bit SN
- RLC Acknowledged Mode (AM) – 12-bit and 18-bit SN
- RLC AM STATUS PDU

3.4 MAC Layer (TS 38.321)

- MAC Subheader with 8-bit Length field
- MAC Subheader with 16-bit Length field
- MAC Subheader for fixed-size Control Elements
- MAC Subheader with extension bit

4 Quick Start

4.1 Repository Cloning

```
1 git clone https://github.com/YOUR_USERNAME/5G-NR-Layer2-PDU-Structures.  
2     git  
2 cd 5G-NR-Layer2-PDU-Structures
```

4.2 Compilation and Testing

```
1 cd src  
2 gcc test.c -o abc  
3 ./abc
```

4.3 Expected Output

```
1 === 5G NR PDU Structure Sizes ===  
2  
3 SDAP Layer:  
4     SDAP Data PDU (with RQI/RDI):      1 byte(s)  
5     SDAP Data PDU (without RQI/RDI): 1 byte(s)  
6  
7 PDCP Layer:  
8     PDCP Data PDU (12-bit SN):          2 byte(s)  
9     PDCP Data PDU (18-bit SN):          3 byte(s)  
10  
11 === Total Structures Defined: 24 ===  
12 All 5G NR Layer-2 PDU structures compiled successfully!
```

5 Technical Details

5.1 Bit-Field Ordering

All bit-fields follow an **MSB-first** ordering as shown in 3GPP diagrams. Note that C bit-field ordering is compiler dependent and must be validated during deployment.

5.2 Multi-Byte Field Reconstruction

Sequence numbers spanning multiple bytes are reconstructed as follows:

```
1 uint16_t sn = (pdu->sn_high << 8) | pdu->sn_low;
```

5.3 Variable-Length PDUs

The following elements are documented but not fully implemented due to variable length:

- PDCP Status Report Bitmap
- RLC AM STATUS PDU NACK blocks
- MAC Control Element payloads

6 3GPP Specification References

Protocol	Specification	Title
SDAP	TS 37.324	Service Data Adaptation Protocol
PDCP	TS 38.323	Packet Data Convergence Protocol
RLC	TS 38.322	Radio Link Control Protocol
MAC	TS 38.321	Medium Access Control Protocol

7 Academic Context

This project was developed as part of an advanced wireless communications curriculum. It demonstrates:

- In-depth understanding of 3GPP specifications
- Low-level protocol engineering using C
- Systematic modeling of complex protocol stacks

8 Acknowledgments

- 3GPP for comprehensive technical specifications
- IIIT Bangalore for academic and research support
- The wireless communications research community

9 Project Statistics

- Lines of Code: ~1500+
- Structures Defined: 24
- Protocols Covered: SDAP, PDCP, RLC, MAC
- Documentation Coverage: 100%

10 Citation

```
@software{5g_nr_layer2_pdu,
  author = {Sathvika Koppu},
  title  = {5G NR Layer-2 PDU Structure Definitions},
  year   = {2025}
}
```