Radio Access Network Architecture

Jussi Tuominen
UMTS Terrestrial Radio Access Network (UTRAN)

WCDMA Radio Interface Key Change from GSM
UTRAN elements are comparable to GSM BSC & BTS
Common Interface (Iu) for both PS and CS Core
Core elements do not change dramatically
- 3G SMSC/VLR provides ATM based Iu-CS interface
- 3G SGSN supports ATM based Iu-PS interface

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Hierarchical Architecture

Radio Network Subsystem (RNS)

UTRAN Elements:
  - Radio Network Controller
  - Node B (Base Station)

One RNC controls number of Node B’s

Node B is only connected to one RNC

New interface Iur for Macrodiversity
Macro Diversity

Softer Handover

- 1 BS
- 1 RNC
Macro Diversity

Soft Handover
- Number of BSs
- 1 RNC (MDC)

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Macro Diversity

Soft Handover
- Number of BSs
- 1 Serving RNC (MDC)
- Number of Drift RNC

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Macro Diversity

Node B

DRNC

Iub

Uu

Node B

SRNC

Iur

Iu

Node B

DRNC

Iub

Iu

Node B

Node B

RNS

UTRAN

UE

SRNC Anchoring

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Macro Diversity

Node B

RNC

Node B

SRNC

Node B

Iur

Node B

Iub

Iu

UE

Uu

Node B

RNS

UTRAN

SRNC Relocation

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Node B

- Standardisation term (normally called as Base Station)
- Comparable to Base Transceiver Station in GSM
- Responsible for Air Interface Layer 1
- Key Node B Functions:
  - Modulation and spreading
  - RF Processing
  - Inner-loop power control
  - Rate matching
  - Macro diversity combining/splitting inside Node B
Radio Network Controller (RNC)

- Comparable to Base Station Controller in GSM
- Responsible for L2 processing of user data
- Responsible for Radio Resource Management
- Key RNC Functions:
  - Closed loop power control
  - Handover control
  - Admission control
  - Code allocation
  - Packet scheduling
  - Macro diversity combining/splitting over number of Node Bs
3GPP Release 99 Reference Architecture
Radio Access Network Application Part (RANAP)

Key RANAP functions:

- Radio Access Bearer (between UE-CN)
  - RAB Set-UP
  - RAB Modification
  - Clearing RAB
- Iu Bearer Release
- SRNC Relocation
- Paging Commands
Iu-UP Protocol

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Lähde: 3GPP TS 25410-360
Iu-BC

- Between RNC and Common Broadcast Center CBC
- Service Area Broadcast Protocol (SABP)

Lähde: 3GPP TS 25410-360
3GPP Release 99 Reference Architecture

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Radio Network Subsystem Application Part (RNSAP)

Key RNSAP Functions:

• Radio Link
  • Management (between SRNC and DRNC)
  • Reconfiguration (between SRNC and DRNC)
  • Supervision (reports from DRNC to SRNC)
• Common Control Channel (CCCH) Signalling Transfer
• Paging
• Relocation Execution
Iur

Radio Network Layer

Control Plane

User Plane

Transport Network Layer

Transport User Network Plane

Transport Network Control Plane

Transport User Network Plane

Physical Layer

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Lähde: 3GPP TS 25420-340
Node B Application Part (NBAP)

Key NBAP Functions:

• Cell Configuration Management
• Common Transport Channel Management
• System Information Management
• Configuration Verification/Alignment
• Measurements on Common Resources
• Radio Link Management & Supervision
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Lähde: 3GPP TS 25420-340
3GPP Release 99 Reference Architecture

Node B → RNC → Node B

Iu-CS → Iu-PS

SGSN → GGSN

SS7

SMSC/VLR → SS7

GMSC

HLR

EIR

Auc

Gi

PSTN

PDN
3GPP Release 4 Reference Architecture

Node B

RNC

Node B

Iub

Iur

Node B

RNC

Node B

Iub

RNS

UTRAN

UGW

HLR

EIR

Auc

SGSN

GGSN

PSTN

PDN

SS7

PSTN

PDN

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3GPP Release 5 Reference Architecture

NOTE: Standardisation on-going!
SS7 signalling in UMTS Core

The original MTP stack. Commonly used in GSM Core interfaces.

The ATM based SS7 stack provides Broadband SS7 architecture.

The IP based stack uses Stream Control Transmission Protocol (SCTP) to deliver SS7 signalling over IP networks.
MTP3 User Adaptation Layer (M3UA)

• M3UA is an User adaptation sublayer that provides functions, required by signaling application protocols.

• IETF is currently standardising five adaptation sublayers: M2PA, M2UA, M3UA, SUA, and IUA.

Note that each protocol can be implemented separately from other protocols, e.g., M3UA do not require services from M2UA!
Stream Control Transmission Protocol (SCTP)

Why use SCTP instead of simply utilising TCP?

1. Although, the TCP provides reliable delivery of data it often adds unnecessary signalling and thus causes unwanted delay of service.

2. TCP applications have an inconvenience requirement to manage and mark the sequence numbers of each packet.

3. The limited scope of TCP sockets does not support the data transfer capability using multi-homed hosts.

4. Security of TCP is limited. For example, the TCP is relatively vulnerable to denial of service attacks, such as SYN attacks.
Stream Control Transmission Protocol (SCTP)

What does SCTP do?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Acknowledged, error-free and non-duplicated packet-oriented delivery of signalling messages.</td>
</tr>
<tr>
<td>2</td>
<td>In sequence delivery of user messages within multiple streams, with an option for order-of-arrival delivery of individual messages.</td>
</tr>
<tr>
<td>3</td>
<td>Optionally, multiplexing multiple user messages into a single SCTP datagram.</td>
</tr>
<tr>
<td>4</td>
<td>Network level fault tolerance by supporting multi-homing.</td>
</tr>
<tr>
<td>5</td>
<td>Advanced congestion mechanisms for resistance to flooding and masquerade attacks.</td>
</tr>
</tbody>
</table>

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Stream Control Transmission Protocol (SCTP)

What is the structure of SCTP?

4 Bytes (= 32 bits)

<table>
<thead>
<tr>
<th>Source Port Number</th>
<th>Destination Port Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verification Tag</td>
<td></td>
</tr>
<tr>
<td>Checksum</td>
<td></td>
</tr>
<tr>
<td>Chunk Type</td>
<td></td>
</tr>
<tr>
<td>Chunk Flags</td>
<td></td>
</tr>
<tr>
<td>Chunk Length</td>
<td></td>
</tr>
<tr>
<td>Chunk Value field</td>
<td></td>
</tr>
</tbody>
</table>

( information to be transferred in the chunk)

1 Row

MTP-3 User Part

2 Row

M3UA

3 Row

SCTP

4 Row

IP

SCTP Header

SCTP Payload (e.g., M3UA message)

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<table>
<thead>
<tr>
<th>MAP</th>
<th>CAP</th>
<th>INAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCAP</td>
<td>BSSAP</td>
<td>RANAP</td>
</tr>
<tr>
<td>SCCP</td>
<td>BICC</td>
<td>ISUP</td>
</tr>
<tr>
<td>M3UA</td>
<td>H.248</td>
<td>RTP</td>
</tr>
<tr>
<td>SCTP (16+Bytes)</td>
<td></td>
<td>TCP(20) UDP (8)</td>
</tr>
<tr>
<td>IPv4 (20 bytes), IPv6 (40 bytes)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gbe, ATM, etc.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>