

Flexi Multiradio BTS TD-LTE Commissioning and Integration TD-LTE 15A

Student Guide

RA4151-15A-LTE

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Presents information to identify and warn of a potentially hazardous situation to help avoid the possibility of property damage.

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Course Description

Course name

Flexi Multiradio BTS TD-LTE Commissioning and Integration TD-LTE 15A

Target Group

Audience

This course was created for:

 Personnel who operate and maintain the Flexi Multiradio BTS TD LTE throughout its lifetime

Objectives

Upon completion of this module, the participant will be able to:

- describe the LTE/EPS Architecture and Interfaces
- describe the EPS Bearer Concept
- explain EPS Mobility and Connection States
- explain E-UTRAN Functionalities
- recognize the Nokia LTE/EPC solution
- identify the Nokia OAM Solution
- recognize the Nokia SON solution
- · explain the use of IP addressing
- explain the use of subnetting and subnet masks
- describe IPv4 routing principles
- list some useful IP commands
- list the local IP addresses in the Flexi Multiradio BTS
- identify the IPv4 header
- explain the IPv6 notation
- describe how IPv6 is utilized in the Flexi Multiradio BTS
- · explain IPv6 subnetting and routing
- describe IPv6 headers
- · recall the LTE system and Flexi Multiradio BTS LTE products
- list the Flexi Multiradio BTS installation options
- list the modules of the Flexi Multiradio BTS LTE
- describe the main function of each module in the Flexi Multiradio BTS LTE
- describe the installation configuration options for the Flexi Multiradio BTS LTE
- · describe the additional modules for the Flexi Multiradio BTS TD-LTE
- describe the Flexi Multiradio 10 BTS installation process
- describe how to Install Flexi Multiradio 10 BTS optional sub-modules
- explain how to Install stand-alone Flexi Multiradio 10 BTS on the floor

- · explain how to Mount stand-alone Flexi Multiradio 10 BTS on the wall
- explain how to Mount stand-alone Flexi Multiradio 10 BTS on a pole
- describe how to install the Indoor Flexi Multiradio 10 BTS (FSIH)
- · describe the Transport Security problems and solution
- define Transport Overhead, Dimensioning, and Synchronization
- interpret Quality of Service in IP transport
- explain the Flexi Multiradio BTS Transport Configuration Options
- describe the FTIF and its Configuration
- describe the BTS Site Manager Installation
- demonstrate the manual Flexi Multiradio BTS LTE software update
- demonstrate the manual commissioning of the Flexi Multiradio BTS LTE
- demonstrate the integration of the Flexi Multiradio BTS LTE

Duration

02:00:00

Delivery method

Virtual Class

Prerequisites

Prerequisites

The following training course(s) or knowledge is recommended:

- General electrical, telecommunications transmission, radio equipment, and antenna systems. Basic personal computer skills.
- The strongest recommendation is made for all participants to complete following Learning Paths:
- Prerequisite LTE and EPC curriculum CURA3000

Learning Modules

- · LTE Radio Access System Review
- IP Essentials
- Flexi Multiradio BTS TD-LTE and Module Overview
- Flexi Multiradio BTS TD-LTE Installation Review
- Flexi Multiradio BTS TD-LTE Transport
- Flexi Multiradio BTS LTE Commissioning, Configuration Management and Integration

Learning module objectives

LTE Radio Access System Review

- · describe the LTE/EPS Architecture and Interfaces
- describe the EPS Bearer Concept

- · explain EPS Mobility and Connection States
- · explain E-UTRAN Functionalities
- · recognize the Nokia LTE/EPC solution
- · identify the Nokia OAM Solution
- · recognize the Nokia SON solution

IP Essentials

- · Explain the use of IP addressing.
- · Explain the use of subnetting and subnet masks.
- · Describe the IPv4 routing principles.
- · List some useful IP commands.
- · List the local IP addresses in the Flexi Multiradio BTS.
- Identify the IPv4 header.
- Explain the IPv6 notation.
- · Describe how IPv6 is utilized in the Flexi Multiradio BTS.
- Explain IPv6 subnetting and routing.
- · Describe IPv6 headers.

Flexi Multiradio BTS TD-LTE and Module Overview

- Recall the LTE system and Flexi Multiradio BTS LTE products.
- List the Flexi Multiradio BTS installation options.
- List the modules of the Flexi Multiradio BTS LTE.
- Describe the main function of each module in the Flexi Multiradio BTS LTE.
- Describe the installation configuration options for the Flexi Multiradio BTS LTE.
- Describe the additional modules for the Flexi Multiradio BTS TD-LTE.

Flexi Multiradio BTS TD-LTE Installation Review

- Describe the Flexi Multiradio 10 BTS installation process.
- · Describe how to install Flexi Multiradio 10 BTS optional sub-modules.
- Explain how to install stand-alone Flexi Multiradio 10 BTS on the floor.
- Explain how to mount stand-alone Flexi Multiradio 10 BTS on the wall.
- Explain how to mount stand-alone Flexi Multiradio 10 BTS on a pole.
- Describe how to install the Indoor Flexi Multiradio 10 BTS (FSIH).

Flexi Multiradio BTS TD-LTE Transport

- · describe the Transport Security problems and solution
- define Transport Overhead, Dimensioning, and Synchronization
- · interpret Quality of Service in IP transport
- · explain the Flexi Multiradio BTS Transport Configuration Options
- · describe the FTIF and its Configuration

Flexi Multiradio BTS LTE Commissioning, Configuration Management and Integration

- Describe the BTS Site Manager Installation.
- Demonstrate the manual Flexi Multiradio BTS LTE software update.
- Demonstrate the manual commissioning of the Flexi Multiradio BTS LTE.
- Demonstrate the integration of the Flexi Multiradio BTS LTE.

LTE Radio Access System Review

Module Objectives

- · describe the LTE/EPS Architecture and Interfaces
- describe the EPS Bearer Concept
- · explain EPS Mobility and Connection States
- explain E-UTRAN Functionalities
- recognize the Nokia LTE/EPC solution
- · identify the Nokia OAM Solution
- · recognize the Nokia SON solution

LTE/EPS Architecture and Interfaces

Nokia Network Architecture Evolution

Closely associated with LTE is the evolution towards a flat network architecture.

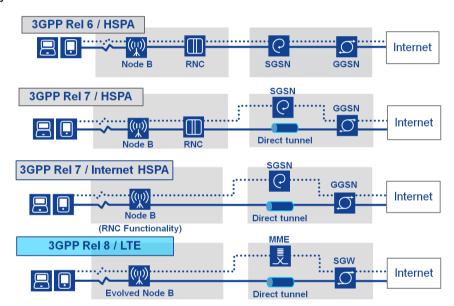


Figure 1: Nokia Network Architecture Evolution

In a traditional 3GPP network both the user plane data and control plane signalling is carried between the UE and GGSN via the BTS, RNC and SGSN. The High-Speed Packet Access (HSPA) solution in 3GPP release 6 provides greatly increased radio access capacity when compared to earlier solutions.

As a next step in the network architecture evolution, 3GPP release 7 offers the possibility of implementing a direct GTP tunnel for carrying user data between the RNC and GGSN. The control plane signalling still takes place via the SGSN.

The basic idea of the Internet HSPA (I-HSPA) solution is to integrate the RNC packet switched functionality into the base stations. At the same time, the GTP tunnel for the user plane traffic is extended to the I-HSPA adapter in the BTS. The direct tunnel solution offers high bitrates in a very cost efficient manner and reduces the Round Trip Time (RTT) in the user plane.

The LTE network architecture is similar to the I-HSPA architecture, although the functionality and names of the network elements have changed. Also, the LTE radio interface provides greatly increased radio access capacity when compared to HSPA.

LTE/EPS Network Architecture Subsystems

The 3GPP LTE/EPS network architecture consists of the Evolved Packet Core (EPC) and Evolved UMTS Terrestrial Radio Access Network (Evolved UTRAN), as defined by the 3GPP technical specification TS 23.401 - General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access.

Interfaces are provided among others towards:

- the packet-switched core (PS Core) of a 3GPP non-LTE 3G/2G network
- the Home Subscriber Server (HSS) managing the user profiles
- various types of packet data networks

Main features of LTE/EPS network architecture are as follows:

- 3GPP LTE/EPS network architecture consists of the Evolved Packet Core (EPC) and Evolved UMTS Terrestrial Radio Access Network (Evolved UTRAN)
- Defined by the 3GPP technical specification TS 23.401
- LTE/EPS architecture is driven by the goal to optimize the system for packet data transfer
- No circuit switched components
- New approach in the inter-connection between radio access network and core network (S1 interface)

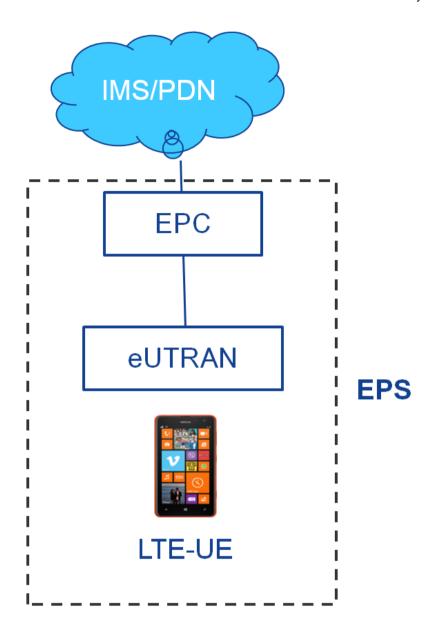


Figure 2: LTE/EPS Network Architecture Subsystems

The EPS architecture is made up of an EPC (Packet Core Network, also referred as SAE) and an eUTRAN Radio Access Network (also referred as LTE).

The EPC provides access to external packet IP networks and performs a number of CN related functions (for example, QoS, security, mobility and terminal context management) for idle (camped) and active terminals.

The eUTRAN performs all radio interface related functions.

The basic task of the EPS network is to provide IP connectivity and it is highly optimized for this purpose only. All services in LTE will be offered on top of IP. IP is also used for transport.

Simpler Architecture to reduce OPEX

The following figure illustrates how the simpler, flat, IP based architecture reduces network cost:

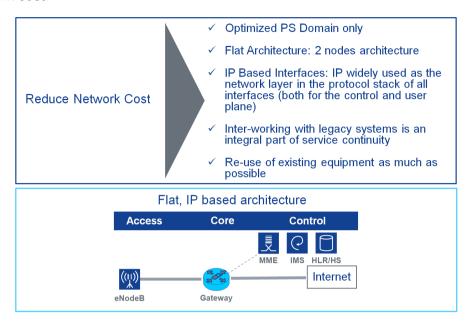


Figure 3: Simpler Architecture to reduce OPEX

Cost per MByte decreases with introduction of new technologies. From HSPA to LTE, the cost per MByte will reduce with more than 70%.

The reasons are:

- Flat architecture.
- All-IP transmission network.
- Increased spectral efficiency > bits per Hz per cell for LTE (2X2 MIMO) ~ 1.7
- Reuse of spectrum > Refarming of existing 900 MHz band in rural areas possible. For urban larger bandwidth expected in 2.6 GHz.

LTE/EPS Network Elements

The LTE/EPS architecture is mainly referenced in following 3GPP specifications:

- 3GPP TS23.401 General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access
- 3GPP TS23.402 Architecture enhancements for non-3GPP accesses
- 3GPP TS36.300 Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2

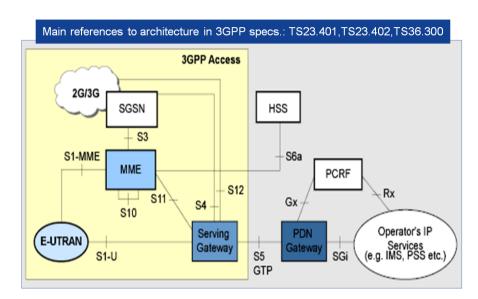


Figure 4: LTE/EPS Network Elements

ANOTE

Some reference points are not shown in the example figure, as they are used for inter-RAT to CDMA / HSRPD or IETF scenarios.

The EPS reference points as specified in *TS36.300*, *TS23.401* and *TS23.402* include:

S1-MME	Control plane reference point between E-UTRAN and MME.
S1-U	User plane reference point between E-UTRAN and the S-GW.
X2	Control and user plane reference point between two E-UTRAN nodes.
S2	Group of reference points between P-GW and non-3GPP access network (for example, WLAN, cdma2000), used for control and mobility support for non-3GPP access interworking.
S3	Reference point between MME and SGSN, used for user and bearer information exchange for inter-3GPP access network mobility.
Gn	Reference point between pre-release 8 SGSN and MME/P-GW.
Gp	Reference point between pre-release 8 SGSN and P-GW in roaming scenario.

S4	Reference point between S-GW and release 8 SGSN, used for U plane tunneling and related mobility support as S GW is anchor point for 3GPP handover.
S5	Reference point between S-GW and P-GW but not crossing a PLMN boundary, used for U plane tunneling and tunnel management and for S-GW relocation. S5 includes both GTP and IETF variants.
S6a	Reference point between MME and HSS, used for transfer of subscription and authentication data.
S6b	Reference point between P-GW and 3GPP AAA Server/proxy for mobility related authentication and retrieval of mobility/QoS related parameters.
Gx	Reference point between P-GW and the PCRF, used to transfer QoS policy and charging rules.
	Note that Gxc is reference point between S-GW and PCRF to transfer QoS policy and charging rules, if IETF variant is utilized for S5/S8.
S8	Roaming reference point between S-GW and P-GW across a PLMN boundary, used for U-plane tunneling and tunnel management and S-GW relocation; similar to S5.
S9	Reference point between the vPCRF and the hPCRF, used to transfer QoS policy and charging rules; similar to S7.
S10	Reference point between MMEs, used for information transfer, for example, during MME relocation.
S11	Reference point between MME and S-GW, used for control information such as EPS bearer management.
S12	Reference point between S-GW and the UTRAN, used for U-plane tunneling when Direct Tunnel is established.
S13	Reference point between MME and EIR to enable UE identity check.
SGi	Reference point between P-GW and PDN, based on the UMTS Gi.
Sta	Reference point between trusted non-3GPP access and 3GPP AAA Server/Proxy to carry out AAA procedures.
Swa	Reference point between untrusted non-3GPP access and 3GPP AAA Server/Proxy to carry out AAA procedures.
SWd	Reference point between 3GPP AAA Server and 3GPP AAA Proxy.
SWx	Reference point between 3GPP AAA Server and HSS for transfer of authentication data.
Rx	Reference point between PCRF and AF in the PDN, based on the Rx interface of UMTS.

LTE Radio Interface and the X2 Interface

LTE Radio Interface

The following figure illustrates the LTE Radio Interface:

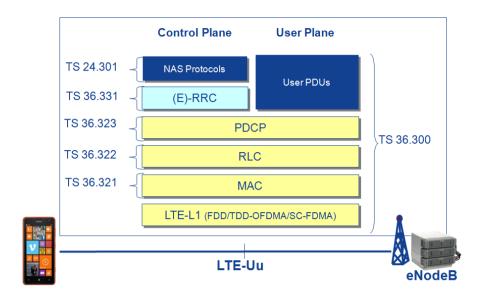


Figure 5: LTE Radio Interface

LTE-Uu Interface:

- · Air interface of EUTRAN
- Based on OFDMA in downlink and SC-FDMA in uplink
- FDD and TDD duplex methods
- Scalable bandwidth: from 1.4 up to 20 MHz
- Data rates up to 150 Mbps(DL), 50Mbps (UL)
- MIMO (Multiple Input Multiple Output) is a major component although optional

The LTE-Uu Interface features are as follows:

- NAS stands for Non-Access Stratum, specified in 3GPP TS 24.301.
- This signaling messages handled on this layer are transparent for the eNodeB.
- The NAS Protocol is further split into 2 sub-protocols:
 - EPS Mobility Management (EMM)
 - EPS Session Management (ESM)
- RRC (Radio Resource Control) manages UE signaling and data connection.
 Includes handover functions.

- 18
- PDCP (Packet Data Convergence Protocol) is responsible for IP header compression (User plane: UP), encryption and integrity protection (Control Plane: CP).
- RLC (Radio Link Control) is responsible for segmentation and concatenation of the PDCP-PDUs for radio interface transmission. It also performs error correction with Automatic Repeat Request (ARQ)
- MAC (Medium Access Control) is responsible for:
 - Scheduling of data according to priorities
 - Multiplexes the data to Layer 1 transport blocks
 - Error correction with Hybrid ARQ
- LTE-Uu physical Layer is based on OFDMA in downlink and SC-FDMA in uplink.
 It also supports Frequency Division Duplex(FDD) and Time Division Duplex
 (TDD). Added to that, this layer also allows scalable bandwidth from 1.4 up to 20
 MHz.LTE-Uu physical Layer is based on OFDMA/SC-FDMA.

LTE X2 Interface

The following figure illustrates the LTE X2 Interface:

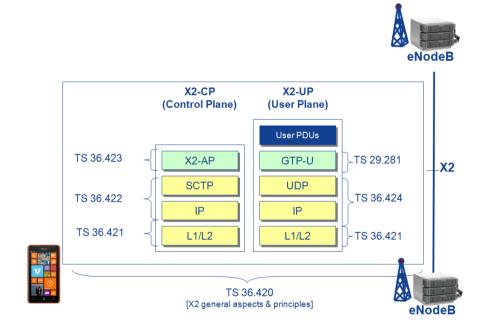


Figure 6: LTE X2 Interface

X2:

- Inter eNodeB interface
- Handover coordination without involving the EPC
- X2-AP: special signaling protocol

- During HO, source eNodeB can use the X2 interface to forward downlink packets still buffered or arriving from the serving gateway to the target eNodeB
- Avoids loss of a huge amount of packets during inter-eNodeB handover

X2 Interface features are as follows:

- X2-AP is the Control Plane (CP) Application Protocol.
- It includes functions for handover preparation and maintenance of the relationship between neighbor eNodeBs.
- SCTP/IP signaling transport: the Stream Contol Transmission Protocol (SCTP) and Internet Protocol (IP) represent standard IP transport suitable for signaling messages. SCTP provides the reliable transport and sequenced delivery functions. IP itself can be run on a variety of data link (L2) and physical (L1) technologies.
- The UP in the X2 interface allows to move DL packets from the source eNodeB to the target eNodeB when the S1-U bearer section has not been reallocated yet.

S1-MME and S1-U Interfaces

S1 Interface general aspects and principles is described in 3GPP TS 36.410 -Evolved Universal Terrestrial Radio Access Network (E-UTRAN); S1 general aspects and principles.

S1-MME Interface

S1-MME:

- Control interface between eNodeB and MME
- MME and UE will exchange non-access stratum signaling via eNodeB through this interface
- S1-AP: S1 Application Protocol
- S1-flex is supported. A single eNodeB can connect to several MMEs

The following figure illustrates the S1-MME Interface:

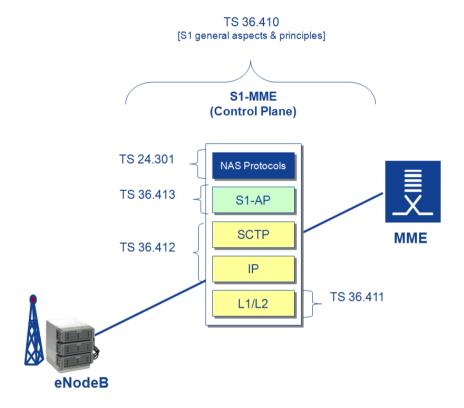


Figure 7: S1-MME Interfaces

S1-MME Interface features are as follows:

- NAS protocol messages are transparent to the eNodeB and are intended for direct communication to the LTE UE.
- S1- AP is the S1-MME interface application protocol. It handles the CP and UP between the e-UTRAN and the EPC, including handover related messages when the EPC is involved.

 SCTP/IP signaling transport: the Stream Control Transmission Protocol (SCTP) and Internet Protocol (IP) represent standard IP transport suitable for signaling messages. SCTP provides the reliable transport and sequenced delivery functions. IP itself can be run on a variety of data link (L2) and physical (L1) technologies.

S1-U Interface

- User plane interface between eNodeB and Serving Gateway
- It is a pure user data interface (U=User plane)
- S1flex-U is also supported. A single eNodeB can connect to several Serving GWs
- Which Serving GW a user's SAE bearer will have to use is signaled from the MME of this user

The following figure illustrates the S1-MME Interface:

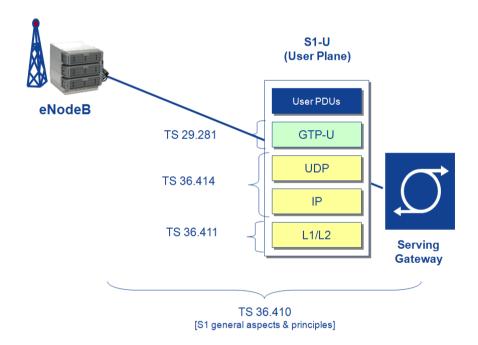


Figure 8: S1-U Interface

LTE/EPS Mobility Areas

Two areas are defined for handling of mobility in LTE/EPS: Cell and Tracking Area. The following figure illustrates the LTE/EPS Mobility Areas:

The Cell

- · Smallest entity regarding mobility
- When the UE is in *connected* mode, the MME will know the UE's position on cell level
- Cells are identified by the Cell Global Identification (CGI), at the system level, and by the Physical Cell Identification (PCI), at the physical layer

Tracking Area (TA)

- It is the successor of location and routing areas from 2G/3G
- When a UE is registered to the network, the MME will know the UE's position on tracking area level
- In case the UE has to be paged, this will be done in the full tracking area
- Tracking areas are identified by a Tracking Area Identity (TAI)



Figure 9: LTE/EPS Mobility Areas

LTE Mobility and Connection States

The following figure illustrates the LTE Mobility and Connection States:

1. EPS Mobility Management (EMM) states

- Deregistered
- No location information in MME, no IP address or Default Bearer
- Registered
- MME knows location at cell or tracking area level, Default Bearer and IP address allocated for UE

2. EPS Connection Management (ECM) states

- ECM Idle
 - No NAS connection between UE and MME, mobility is based on tracking area and cell reselection, no E-RAB (S1 and Uu), but EPS Default Bearer is still allocated (S5 / S8)
- ECM Connected
 - NAS connection established, E-RAB (S1 and Uu) is allocated, mobility based on handover a cell level



Figure 10: LTE Mobility and Connection States

More about LTE Mobility and Connection States on 3GPP TS23.401 - General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access.

EPS Bearer Concept

LTE/EPS Bearer: Identity and Architecture

In the Evolved Packet System (EPS), so-called EPS bearers are employed for carrying the user data between the UE and the PDN Gateway, or between the UE and the Serving Gateway.

In the first option, the EPS bearer consists of a radio bearer, an S1 bearer and an S5/S8 bearer. Between the eNodeB and PDN Gateway, the transport of the user data takes place within a GPRS Tunnelling Protocol (GTP) tunnel.

In the second option, the GTP tunnel extends to the Serving Gateway only. Over the S5/S8 interface the IETF Proxy Mobile IP (PMIP) solution is used instead for carrying the user data traffic. Each EPS bearer is associated with a certain Quality of Service (QoS) profile.

- An EPS bearer identity uniquely identifies an EPS bearer for one UE. The EPS Bearer Identity is allocated by the MME.
- LTE/EPS Bearer spans the complete network, from UE over EUTRAN and EPC up to the connector of the external PDN.
- The SAE bearer is associated with a Quality of Service (QoS) usually expressed by a label or QoS Class Identifier (QCI).

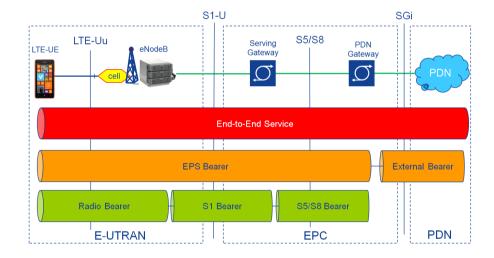


Figure 11: LTE/EPS Bearer: Identity and Architecture

There is a one to one mapping between EPS Radio Bearer (RB) and EPS Bearer, and the mapping between EPS RB Identity and EPS Bearer Identity is made by E-UTRAN.

The E-RAB ID value used at S1 and X2 interfaces to identify an E-RAB is the same as the EPS Bearer ID value used to identify the associated EPS Bearer.

EPS Bearers Establishment

The following figure illustrates the EPS Bearers Establishment:

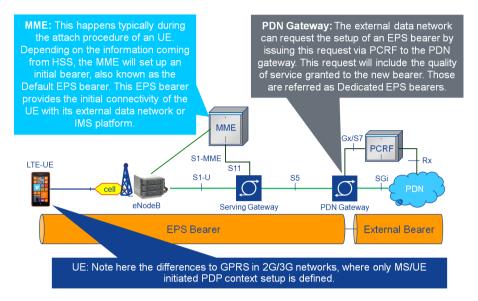


Figure 12: EPS Bearers Establishment

Default bearer is established during the attach phase. Dedicated bearers are established based on the services running between the UE and the PDN/IMS.

A comparison can be made between the dedicated bearer in EPS and the secondary PDP context in UMTS. 3GPP TS 29.274 - 3GPP Evolved Packet System (EPS); Evolved General Packet Radio Service (GPRS) Tunnelling Protocol for Control plane (GTPv2-C); Stage 3 defines the create bearer request message. This request is used to establish dedicated bearers but not default bearer.

Reading from the specs, it may lead to a confusion the following sentence: the dedicated bearers are network initiated. Because LTE/EPS is all on IP and if you are receiving a call then network may initiate dedicated bearer to forward that call to you. This doesn't mean that UE cannot ask for dedicated bearers. UE can ask for dedicated bearers by sending out bearer modification command but UE cannot send create bearer request. Bearer modification command will make PDN trigger a dedicated bearer.

Default Bearer Concept

Default Bearer Concept main aspects are as follows:

- Each UE that is attached to the LTE network has at least one bearer available, that is called the *default bearer*.
- Its goal is to provide continuous IP connectivity towards the EPC (*always-on* concept).
- From the QoS point of view, the default bearer is normally a guite basic bearer.
- If an specific service requires more stringent QoS attributes, then a dedicated bearer should be established.

The following figure illustrates the Default Bearer Concept main aspects:

- Each UE that is attached to the LTE network has at least one bearer available, that is called the default bearer
- Its goal is to provide continuous IP connectivity towards EPC (always-on concept)
- From the QoS point of view, the default bearer is normally a quite basic bearer
- If an specific service requires more stringent QoS attributes, then a dedicated bearer should be established

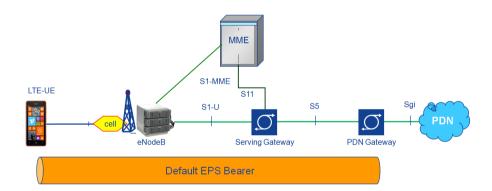


Figure 13: Default Bearer Concept

A default Evolved Packet System (EPS) bearer is the bearer that is established during the attach process. It will give the UE an IP address and packet data resources so that the UE can do limited packet services.

One of the best examples of a service that would be good for the default EPS bearer is an IMS registration.

The characteristics of the default EPS bearer will be defined by the subscription and established by the Mobility Management Entity (MME) upon receiving the attach message based on the subscriber profile in the Home Subscriber Server (HSS).

Default bearers are created on a per PDN basis. So if a UE is connecting to two PDNs it will need to establish two default bearers.

EPS Bearer QoS Attributes

The following table illustrates the EPS Bearer QoS Attributes:

Table 1: EPS Bearer QoS Attributes

EPS Bearer	QoS Parameters
EPS Bearer QoS Parameters	Default Bearer / Dedicated Bearer
(to be defined per Bearer)	GBR / N-GBR
	MBR
	UL / DL-TFT
	QCI
	ARP
EPS Bearer QoS Parameters	AMBR
(to be defined per User)	

For every EPS bearer the following QoS parameters are available:

- Dedicated or default EPS bearer
- Guaranteed Bit Rate (GBR) or Non-Guaranteed Bit Rate (N-GBR)
- Maximum Bit Rate (MBR)
- Traffic Flow Control (UL/DL-TFT)
- Integer number indicating QoS category: Label or QoS Class identifier (QCI)
- Allocation/Retention Priority (ARP)

For all bearers together for one user, following QoS parameter is available:

Aggregate Maximum Bit Rate (AMBR)

QoS Class Identifier (QCI) Table in 3GPP

The following table illustrates the QoS Class Identifier (QCI) in 3GPP:

Table 2: QoS Class Identifier (QCI) Table in 3GPP

QCI	Guarantee	Priority	Delay budget	Loss rate	Application
1	GBR	2	100 ms	1e-2	VoIP
2	GBR	4	150 ms	1e-3	Video call
3	GBR	5	300 ms	1e-6	Streaming
4	GBR	3	50 ms	1e-3	Real time gaming
5	Non-GBR	1	100 ms	1e-6	IMS signalling
6	Non-GBR	6	100 ms	1e-3	Interactive gamimg
7	Non-GBR	7	300 ms	1e-6	TCP protocols:
8	Non-GBR	8	300 ms	1e-6	browsing, e- mail, file
9	Non-GBR	9	300 ms	1e-6	download

Nine pre-configured classes have been specified in 2 categories of Bearers: GBR and N-GBR. In addition, Operators can create their own QoS Class Identifiers (QCI).

The QoS attributes associated with the QCI parameter are:

- Priority: used to define the priority for the Packet Scheduler function in the eNodeB.
- **Delay Budget**: helps the packet scheduler to ensure that users are scheduled sufficiently often to guarantee the delay requirements of the Bearer.
- Loss Rate tolerance: is primarily intended for setting the RLC protocol settings (for example, number of RLC retransmissions). The label will most likely also include a priority parameter, which the packet scheduler can use for differentiation.

EPS Mobility and Connection States

EMM and ECM States Transitions

The following figure shows EMM and ECM States Transitions.

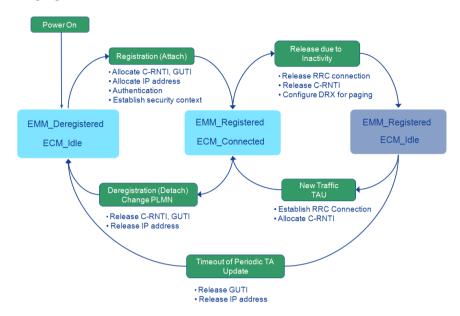


Figure 14: EMM and ECM States Transitions

There are two sets of states defined for each UE based on the information held by the Mobility Management Entity.

The two EPS Mobility Management (EMM) states, *EMM-DEREGISTERED* and *EMM-REGISTERED*, describe whether or not the UE is registered in the MME and can be reached by paging. In the *EMM-DEREGISTERED* state, the MME holds no valid location information for the UE. The UE is not reachable, since its location is not known.

The UE enters the *EMM-REGISTERED* state via either the *attach* or *tracking area update* procedure. In this state, the UE location is known in the MME with the accuracy of the tracking area. The UE can be reached by paging within this tracking area.

The two EPS Connection Management (ECM) states, *ECM-IDLE* and *ECM-CONNECTED*, describe the signalling connectivity between the UE and evolved packet core.

In the *ECM-IDLE* state, there exists no signalling connection between the UE and the MME.

In the *ECM-CONNECTED* state, there exists a signalling connection between the UE and the MME. The signalling connection is made up of two parts: an RRC connection between UE and eNodeB, and an S1-MME connection between eNodeB and MME.

E-UTRAN Functionalities

E-UTRAN Functionalities

The following figure illustrates E-UTRAN Functionalities:

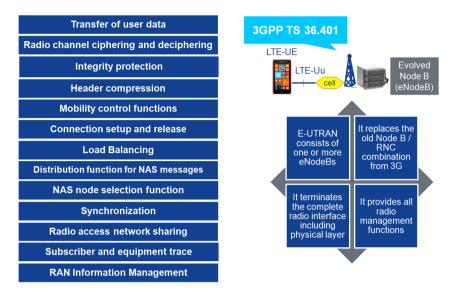


Figure 15: E-UTRAN Functionalities

The E-UTRAN functionalities are as follow:

function

Transfer of user data	Transfers data across E-UTRAN between S1 and Uu interfaces.
Radio channel ciphering and deciphering	Radio transmitted data is protected against non-authorized third party.
Integrity protection	Transmitted data can be protected against alteration from non-authorized third party.
Header compression	Minimized header size for the network, transport, or upper layer combination.
Mobility control functions	Handover – mobility of radio interface, based on radio measurements and used to maintain QoS requested by EPC. May be directed to or from another RAT. Positioning – provides the capability to determine UEs current EUTRAN CGI.
Connection setup and release	Participates in end-to-end connection setup and release, and manage and maintain the Uu and S1 connections.
Load Balancing	Distributes traffic load over multiple cells to maintain QoS of sessions and effectively utilize radio resources.
Distribution function for NAS messages	Via RRC and S1 protocols transparently transfer Access Stratum messages.
NAS node selection	E-UTRAN may be connected to multiple MME for NAS, this function determines MME association of UE based on TMSI.

on

Synchronizati Maintains timing synchronization among nodes in the network.

Radio access

network sharing

Enables multiple PLMNs to share a radio network. UEs will be directed to appropriate PLMN and measurements and

reselections restricted to cells associated with that PLMN.

Subscriber

and

equipment

trace

Will be initiated by the core network.

RAN Information Management Allows for request and transfer of RAN information between two RAN nodes via core network elements (for example, GERAN

system information).

Nokia LTE/EPC solution

Nokia LTE / EPC Portfolio

The following figure illustrates the Nokia LTE / EPC Portfolio:

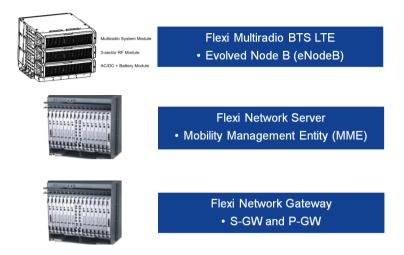


Figure 16: Nokia LTE / EPC Portfolio

Flexi Multiradio BTS LTE

The following figure illustrates the Flexi Multiradio BTS LTE:

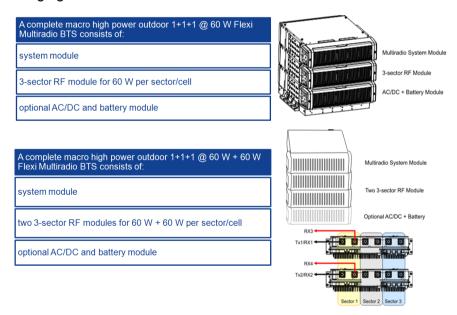


Figure 17: Flexi Multiradio BTS LTE 1/2

The Flexi Multiradio BTS provides very high radio downlink output power when using the Flexi 210W 3-sector Radio Module. In the 3-sector BTS, all RF functions are integrated to one single outdoor installable 3U high module. With two 3-sector RF Modules in 2TX MIMO configuration, TX power is 120W per sector/cell (60 W + 60 W).

Another option especially for feederless and distributed LTE BTS sites is the Flexi Multiradio Remote Radio Head (RRH) that can support one sector with the following integrated features illustrated in the following figure:



Figure 18: Flexi Multiradio BTS LTE 2/2

Flexi Network Server

Flexi Network Server (Flexi NS) is a high transaction capacity product on top of Advanced TCA (ATCA). It is optimized for all-IP flat architecture, and is used for control plane-only mobility management entity (MME) functionality.

The Flexi NS is an essential part of the Nokia LTE and EPS end-to-end offering. The MME has a similar role in LTE as 2G/3G SGSN has in 2G/3G networks.

The Flexi NS is designed to serve as a pure control plane element for all-IP flat networks. Therefore, R8 S4 3G SGSN is considered as a natural evolution step for Flexi NS, leveraging the all-IP, control plane only optimized design.

Flexi NS implements high transaction and connectivity capacity to accommodate the increased signaling load and higher service penetration in an operators' subscriber base. The product footprint is small, so you can install up to three high capacity units in a standard 19" rack. Flexi NS is power efficient, offering reduction in energy consumption.

Nokia SGSN has demonstrated market leading reliability levels in live networks over a time period of several years. The same DMX software platform is applied also as a basis for the Flexi NS.

Innovative control plane-only architecture of Flexi NS allows implementing session redundancy within a single Flexi NS network element. In case of a failure of any single hardware unit, the subscriber session can be preserved.

The following figure illustrates Flexi Network Server:

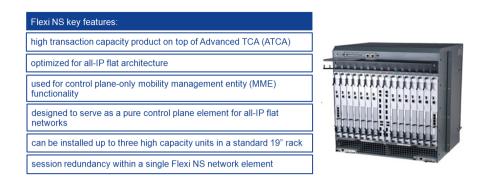


Figure 19: Flexi Network Server

Flexi Network Gateway

The new Flexi NG product family targets current and future mobile networks as well as converged networks. It is targeted to support high-speed packet access (HSPA), evolved high-speed packet access (HSPA+), Internet high-speed packet access (I-HSPA) and Long Term Evolution (LTE) access networks. Different applications, such as gateway GPRS support node (GGSN) or Evolved Packet Core (EPC) gateway, can be installed on same platform.

Flexi NG provides high throughput and signaling capacity to accommodate the traffic growth in next generation networks. The key to Flexi NG performance is in the use of multi-core packet processor (MPP) technology in the control plane and in the user plane. MPPs are designed for fast networking applications and contain several hardware units that accelerate packet data processing. MPP technology is highly flexible and scalable, and enables faster development cycles.

Flexi NG is based on the Nokia Advanced TCA (ATCA) hardware platform and Nokia Flexi Platform operating software and middleware. Flexi Platform is a robust, carrier grade Linux based platform, offering versatile services for Operation and Maintenance (OAM), networking and platform services using the latest technologies available.

The following figure illustrates Flexi Network Server:

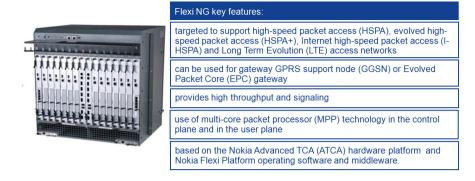


Figure 20: Flexi Network Gateway

Flexi Zone Solution

The Nokia Flexi Zone Solution is the natural Small Cells Capacity deployment option.

The main application of this solution is to boost the coverage and capacity both outdoors and indoors.

- For outdoor scenarios: the Flexi Zone Micro/Pico BTS and the Flexi Zone Micro/Pico Enhanced BTS modules can be used.
- For indoor scenarios: the Flexi Zone Indoor Pico BTS is the logical option.

The following figure illustrates the Flexi Zone Solution:



Figure 21: Flexi Zone Solution

Nokia OAM Solution

Nokia OAM Solution - NetAct and iOMS

The following figure illustrates the Nokia OAM Solution – NetAct and iOMS:

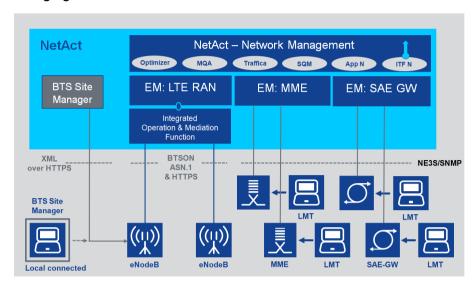


Figure 22: Nokia OAM Solution – NetAct and iOMS

NetAct is a network and service management framework that specifically addresses operators' challenges in the following way when deploying LTE networks.

The NetAct Operations Support System (OSS) framework provides sophisticated and field-tested applications for LTE management, such as Traffica, Configurator and Optimizer. As a new approach, key operational processes will be extensively automated using Self-Organising Network (SON) solutions. This will lead to improved visibility to network quality and end user behavior.

The high level of automation will also result in OPEX savings since fewer people are needed for network planning and for Operation and Maintenance (OAM) activity. Also, the higher service availability and increased end-user-quality-of experience provides the potential to increase revenues.

As far as evolution aspects are concerned, NetAct customers can manage LTE networks from day one using familiar applications. The NetAct framework is field-proven and supports multi-vendor integration. Last but not least, NetAct allows network operators to manage multi-technology and multi-vendor networks seamlessly using a single network management system.

The Nokia LTE network management solution, based on the NetAct Operations Support System (OSS) framework, is highly scalable, supporting various network sizes and a large variety of applications.

The Nokia LTE RL70, RL60 and RL45TD are managed by NetAct 15.

NetAct 15 is a completely renewed version of NetAct. It has many applications that are related to configuration management, fault management, performance management, optimization, security management, network administration and NetAct administration.

Moreover, there are several related standalone products and tools such as NetAct Advanced Configurator, NEBR Server, NetAct Audit Trail, Service Quality Manager, Nokia Performance Manager, Operations on-Demand and iSON Manager.

Nokia SON Solution

SON - Self-Organizing Networks

Due to the large number of network parameters and the expanding number of eNodeB nodes, it is necessary to increase the degree of automation during the roll-out and operation of LTE networks in order to decrease operational expenditures. This observation resulted in the following self-organising network solutions.

Self-configuration effectively means *plug and play* behavior when installing network elements in order to reduce costs and simplify the installation procedure. Moreover, it off-loads the operator from provisioning and managing neighbor cells.

Self-optimisation means automatic parameter optimisation based on network monitoring and measurement data obtained from various network nodes and terminals. Therefore, benefits like power saving, better mobility, better quality of service and minimization of drive tests required can be all promised.

Self-healing means that the system detects and try to solve the network problems autonomously. This ensure higher operational efficiency.

The following figure illustrates LTE SON key operational benefits:

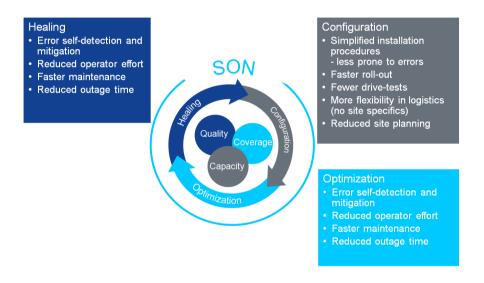


Figure 23: LTE SON Key Operational Benefits

OSS for SON is aligned with NGMN operations requirements.

Nokia SON

Nokia's SON is built on our detailed understanding of how networks operate.

The following figure illustrates Nokia SON:

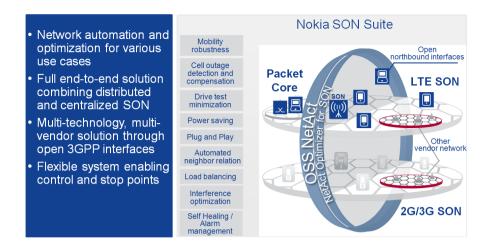


Figure 24: Nokia SON

SON Use Cases

In all SON use cases the features reside in both element and OSS level. The following figure illustrates SON use cases:

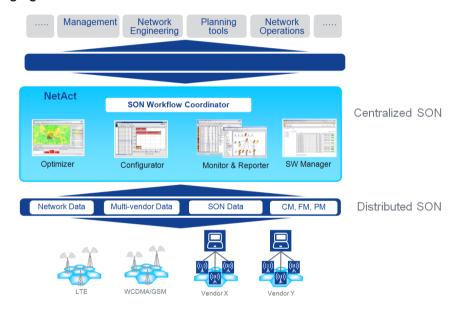


Figure 25: SON Use Cases

A Self-configuration Subsystem will be created in OAM to be responsible for the self configuration of eNodeB. For self-optimization functions, they can be located in OAM or eNodeB or both of them. So according to the location of optimization algorithms, SON can be divided into three classes: Centralized SON, Distributed SON and Hybrid SON.

Centralized SON: In Centralized SON, optimization algorithms are executed in the OAM System. In such solutions SON functionality resides in a small number of locations, at a high level in the architecture. In Centralized SON, all SON functions are located in OAM systems, so it is easy to deploy them. But since different vendors have their own OAM systems, there is low support for optimization cases among different vendors. And it also does not support those simple and quick optimization implement Centralized SON, existing Itf-N interface needs to be extended.

Distributed SON: In Distributed SON, optimization algorithms are executed in eNodeB. In such solutions SON functionality resides in many locations at a relatively low level in the architecture. In Distributed SON, all SON functions relocated in eNodeB, so it causes a lot of deployment work. And it is also difficult to support complex optimization schemes, which require the coordination of lots of eNodeBs. But in Distributed SON it is easy to support those cases, which only concern one or two eNodeBs and require quick optimization responses. For Distributed SON, X2 interface needs to be extended.

SON Suite Features

The following figure illustrates SON Suite Features:

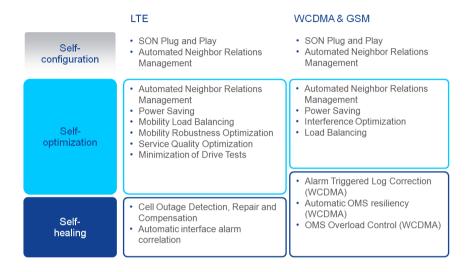


Figure 26: SON Suite Features

Presented features are not *OSS only* features. Part of the features are system level features, for example SON Plug and Play. Adjacency neighbor management is presented in two categories (self-configuration / -optimization). The difference is in the algorithm: adjacencies are created / optimized based on location in self-configuration and based on measurements in self-optimization.

Self-Configuration for LTE:

- SON Plug and Play
 - Auto-connection
 - Auto-configuration
 - Automated Physical Cell ID assignment (Optimizer)
- Automated Neighbor Management
 - Automated neighbor list configurations of Intra and inter LTE neighbor cells , 2G and 3G neighbor cells (Optimizer)
 - Automated update of neighbor list configuration in case of 2G and 3G neighbor cells removals/additions (Optimizer)

Self-Configuration for WCDMA and GSM:

SON Plug and Play

- Auto-connection
- Auto-configuration
- Automated Neighbor Management
 - Automated neighbor list configurations of intra and inter LTE neighbor cells, 2G and 3G neighbor cells (Optimizer)
 - Automated update of neighbor list configuration in case of 2G and 3G neighbor cells removals/additions (Optimizer)

LTE Radio Access System Review

Module Summary

This module covered the following learning objectives:

- describe the LTE/EPS Architecture and Interfaces
- describe the EPS Bearer Concept
- explain EPS Mobility and Connection States
- explain E-UTRAN Functionalities
- recognize the Nokia LTE/EPC solution
- identify the Nokia OAM solution
- recognize the Nokia SON solution

IP Essentials

Module Objectives

- · Explain the use of IP addressing.
- · Explain the use of subnetting and subnet masks.
- Describe the IPv4 routing principles.
- List some useful IP commands.
- · List the local IP addresses in the Flexi Multiradio BTS.
- Identify the IPv4 header.
- Explain the IPv6 notation.
- Describe how IPv6 is utilized in the Flexi Multiradio BTS.
- · Explain IPv6 subnetting and routing.
- Describe IPv6 headers.

Use of IP addressing

Introduction to IP addresses (V4)

The following is an introduction to IP addresses:

- The IP address version 4 (V4) consists of a 4-octet number.
- For example: 142.68.213.167
- Each octet has a range of 0-255 because it is build of 8 bits (2⁸ = 256). With this range there can be 256⁴ = 4.294.967.296 different values.
- Even with almost 4.3 Billion IP addresses, there cannot be an individual IP address assigned to each computer (or IP device) in the world.
- To sort out this problem, the Internet Engineering Task Force (IETF) has
 reserved certain IP address ranges for multiple use in private networks. These
 addresses are not routed on the internet.
- For additional reference on IETF, check the following http://tools.ietf.org/html/rfc1918

IP addresses for private networks (V4)

- The network range defines the number of blocks.
- The host range defines the total number of IP addresses that can be assigned to computers (hosts).
- The following IP addresses have been defined to be used in private networks.

		octet			octet						
Class	1	2	3	4		1	2	3	4	no. of blocks*	no.of addresses
А	10	0	0	0	-	10	255	255	255	1	16,777,216
В	172	16	0	0	-	172	31	255	255	16	1,048,576
С	192	168	0	0	-	192	168	255	255	256	65,536
networ range	k	host	rang	е							

*each block can be further devided into smaller portions (=subnets)

Figure 27: IP addresses for private networks (v4)

Use of subnetting and subnet masks

Subnetting (V4)

- Subnetting means to create groups of consecutive IP addresses of certain sizes.
- Communication between IP hosts of the same subnet does not require routing.
- The size of a subnet is always 2ⁿ. For example: 1, 2, 4, 8, 16, 32
- The size of a subnet is defined by its subnet mask.
- Subnets are separated / connected through routers.
- In each subnet, the first IP address is the *subnet ID* (=subnet address) and the last address is the *Broadcast address*.
- The Subnet ID can be calculated from any IP address of the subnet and the subnet mask by a binary *AND* operation.

Table 3: IP Subnetting V4 Example

	IP Subnetting V4 Example						
IP address	10.67.123.35	00001010	01000011	01111011	00100011		
	AND						
Subnet mask	255.255.255.2 40	11111111	11111111	11111111	11111111		
	=						
Subnet ID	10.67.123.32	00001010	01000011	01111011	00100000		

Subnet Mask (V4)

The Subnet Mask defines the size of a subnet.

The format of the subnet mask is similar to an IP (V4) address.

- Subnet mask consists of 4 Bytes (octets), 1 Byte = 8 bits.
- In binary notation, the subnet mask is *always* a consecutive group of 1 bits, followed by a consecutive group of 0 bits.
- The size of the subnet is defined by the decimal range of the 0 bits.
- The size of a subnet is always 2ⁿ, where n is the number of 0 bits in the subnet mask.
- The number of host addresses is then: subnet size 2.

Table 4: Subnet Mask V4 Example

	Subnet Mask V4 Example					
binary	11111111 11111111 11111111 11110000					
decimal	255 255 255 240					
short notation	/number of 1 bits -> /28					
size of the subnet	2^4=16					
number of hosts	16-2=14					

Subnet Mask examples (V4)

The follwing table illustrates Subnet Mask examples:

Table 5: Subnet Mask examples (V4)

Subnet Mask examples (V4)	Subnet mask binary	Subnet mask short notatio n	subn et size in no. of IP addr.	No. of hosts	Commen ts
255.255.255.255	11111111. 11111111. 11111111. 11111111	/32	0	1	no subnet, only 1 host
255.255.255.254	11111111. 11111111. 11111111. 11111110	/31	2	0	no subnet, only for point-to- point links between 2 hosts
255.255.255.252	11111111. 11111111. 11111111. 11111100	/30	4	2	smallest possible subnet, sufficient as BTS subnet without external IP devices
255.255.255.248	11111111. 11111111. 11111111. 11111000	/29	8	6	
255.255.255.240	11111111. 11111111. 11111111. 11110000	/28	16	14	
255.255.255.224	11111111. 11111111. 11111111. 11100000	/27	32	30	
255.255.255.192	11111111. 11111111. 11111111. 11000000	/26	64	62	
255.255.255.128	11111111. 11111111. 11111111. 10000000	/25	128	126	
255.255.255.0	11111111. 11111111. 11111111. 00000000	/24	256	254	
255.255.254.0	11111111. 11111111. 11111110. 00000000	/23	512	510	

BTS Subnet Interface

The following figure illustrates the BTS Subnet interface:

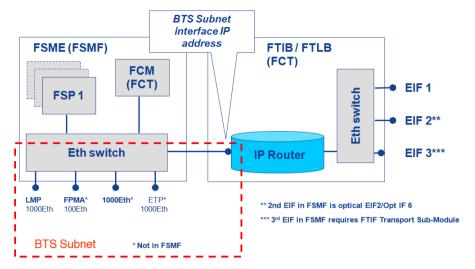


Figure 28: BTS Subnet Interface

IPv4 routing principles

IP Routing principles (V4)

Routing is necessary to ensure an IP packet reaches its destination.

Routing destinations can be all IP addresses (default gateway), a single IP address (host routing) or a subnet (subnet routing). Subnet routing can reduce the number of routing entries.

The netmask defines whether the destination is a host or a subnet.



Туре	Destination	Netmask dec.	Netmask bits	Gateway
Default Gateway	0.0.0.0	0.0.0.0	0	10.67.123.46
Host routing	10.0.0.1	255.255.255.255	32	10.67.123.46
Subnet routing	10.0.0.0	255.255.255.224	27	10.67.123.46

Figure 29: IP Routing principles (V4)

IP commands

Useful IP commands in Windows

To check the own computer's IP settings, type ipconfig

To check the IP connectivity to another computer (or RAN network element), type ping <ip address>

Figure 30: Useful IP commands in Windows© 1/2

To check the complete path between PC and the destination usable to trace the path to the BTS in remote connections, type tracert <ip address>

```
Command Prompt
                                                                                                                       •
C:\Documents and Settings\ashauer>tracert 10.48.33.34
Tracing route to 10.48.33.34 over a maximum of 30 hops
                                                        10.138.68.2
172.31.196.137
172.31.196.129
172.31.196.66
10.0.36.106
10.48.0.33
                            <1 ms
<1 ms
<1 ms
                                             <1 ms
                                           1 ms

1 ms

1 ms

2 ms

2 ms

*
            1 ms
1 ms
1 ms
2 ms
2 ms
                             1 ms
1 ms
1 ms
                                                         Request timed out.
Request timed out.
10.48.0.41
10.48.0.42
                                              4 ms
6 ms
3 ms
5 ms
                             3 ms
4 ms
                 ms
                 ms
                             4 ms
4 ms
                                                         10.48.0.62
10.48.23.194
10.48.34.39
10.48.33.33
 11
12
13
14
15
                 ms
                 ms
                            4 ms
15 ms
                                             10 ms
                 ms
           16
19
                                             16 ms
                            18 ms
frace complete.
C:\Documents and Settings\ashauer>
                                                                                                                  1 //
```

Figure 31: Useful IP commands in Windows© 2/2

Local IP addresses in Flexi Multiradio BTS

Local IP addresses in Flexi Multiradio BTS

The following tables represents the Local IP addresses in Flexi Multiradio BTS:

Table 6: Local IP addresses in Flexi Multiradio BTS for FSMD/E

FSMD/E					
Unit/Module	local IP address	comment			
TRS	192.168.255.129	Transmission unit			
FCM	192.168.255.1	Flexi Control / MUX			
	192.168.255.16	Module in FSMx			
FSPC 1	192.168.255.33	Signal processor			
FSPC 2	192.168.255.34	Signal processor			
FSPC 3	192.168.255.35	Signal processor			

Table 7: Local IP addresses in Flexi Multiradio BTS for FSMF

FSMF					
Unit/Module	local IP address	comment			
FCT (TRS)	192.168.255.129	Transmission unit			
FCT (FCM)	192.168.255.1 192.168.255.16	Flexi Control / MUX Module Part			
FSPD 1	192.168.255.18	Signal processor			
FSPD 2	192.168.255.19	Signal processor			
FSPD 3	192.168.255.20	Signal processor			

RF Modules / RRH IP addresses from RL30 - RL50

The following table illustrates RF Modules / RRH IP addresses from RL30 – RL50:

Table 8: RF Modules / RRH IP addresses from RL30 - RL50 (LN3.0_ENB_1103_146_00 onwards) 1/2

Radio Module ID	Radio Module IP address	Radio Modules Filter controller IP address
RFM1-1-1	192.168.254.129	192.168.254.153
RFM1-1-2	192.168.254.130	192.168.254.154
RFM1-1-3	192.168.254.131	192.168.254.155
RFM1-1-4	192.168.254.132	192.168.254.156
RFM1-2-1	192.168.254.133	192.168.254.157
RFM1-2-2	192.168.254.134	192.168.254.158
RFM1-2-3	192.168.254.135	192.168.254.159
RFM1-2-4	192.168.254.136	192.168.254.160
RFM1-3-1	192.168.254.137	192.168.254.161
RFM1-3-2	192.168.254.138	192.168.254.162
RFM1-3-3	192.168.254.139	192.168.254.163
RFM1-3-4	192.168.254.140	192.168.254.164

Table 9: RF Modules / RRH IP addresses from RL30 - RL50 (LN3.0_ENB_1103_146_00 onwards) 2/2

Radio Module ID	Radio Module IP address	Radio Modules Filter controller IP address
RFM1-4-1	192.168.254.141	192.168.254.165
RFM1-4-2	192.168.254.142	192.168.254.166
RFM1-4-3	192.168.254.143	192.168.254.167
RFM1-4-4	192.168.254.144	192.168.254.168
RFM1-5-1	192.168.254.145	192.168.254.169
RFM1-5-2	192.168.254.146	192.168.254.170
RFM1-5-3	192.168.254.147	192.168.254.171
RFM1-5-4	192.168.254.148	192.168.254.172
RFM1-6-1	192.168.254.149	192.168.254.173
RFM1-6-2	192.168.254.150	192.168.254.174
RFM1-6-3	192.168.254.151	192.168.254.175
RFM1-6-4	192.168.254.152	192.168.254.176

Modules / RRH IP addresses from RL60 onwards

- Radio Module / RRH IP addresses are dynamically allocated.
- Subnet is 192.168.253.0 /24
- The actually assigned IP addresses can be found from the Snapshot
 LTEBTS ► BTSLogFiles ► BTSxx_RMOD _L_x_ram_startup.zip ► startup.log
- There is one file per Radio Module (2 radio Modules exist in the eNodeB from the below example).

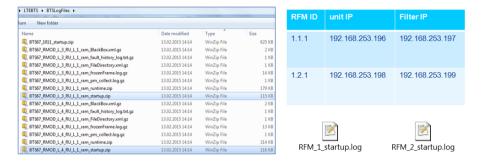


Figure 32: Modules / RRH IP addresses from RL60 onwards

IPv4 header

IPv4 header (RCF791) with Differentiated Services field (RCF2472)

The following figure illustrates the IPv4 header (RCF791) with Differentiated Services field (RCF2472).

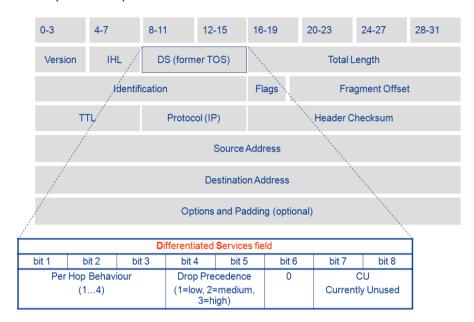


Figure 33: IPv4 header (RCF791) with Differentiated Services field (RCF2472)

The following are the IPv4 header fields:

Version	The first	header field	in an IP	packet is	the four-bit	version field.

For IPv4, this has a value of 4 (hence the name IPv4).

Internet Header Length (IHL) The second field (4 bits) is the Internet Header Length (IHL) telling the number of 32-bit words in the header. Since an IPv4 header may contain a variable number of options, this field specifies the

size of the header (possible lengths: 5...15 x 32 bits).

Differentiated Point (DSCP)

The Flexi Multiradio BTS LTE supports QoS differentiation based Services Code on DiffServ Code Points (DSCP values).

Explicit Congestion **Notification** (ECN)

Defined in RFC 1368 and allows end-to-end notification of network congestion without dropping packets. ECN is an optional feature that is only used when both endpoints support it and are willing to use it. It is only effective when supported by the

underlying network.

Total Length This 16-bit field defines the entire datagram size, including header

and data, in bytes.

Identification This field is an identification field and is primarily used for uniquely

identifying fragments of an original IP datagram.

Flags A three-bit field follows and is used to control or identify

fragments.

Fragment Offset

The fragment offset field, measured in units of eight-byte blocks, is 13 bits long and specifies the offset of a particular fragment

relative to the beginning of the original unfragmented IP datagram. The first fragment has an offset of zero. This allows a maximum offset of $(213 - 1) \times 8 = 65,528$ bytes which would exceed the maximum IP packet length of 65,535 bytes with the header length included (65,528 + 20 = 65,548 bytes).

Time To Live (TTL)

An eight-bit time to live field helps prevent datagrams from persisting (for example, going in circles) on an internet. This field limits a datagram's lifetime. It is specified in seconds, but time intervals less than 1 second are rounded up to 1. In latencies typical in practice, it has come to be a hop count field. Each router that a datagram crosses decrements the TTL field by one. When the TTL field hits zero, the packet is no longer forwarded by a packet switch and is discarded. Typically, an ICMP message (specifically the time exceeded) is sent back to the sender that it has been discarded. The reception of these ICMP messages is at the heart of how traceroute works.

Protocol

This field defines the protocol used in the data portion of the IP datagram. The Internet Assigned Numbers Authority maintains a list of protocol numbers which was originally defined in RFC 790.

Header Checksum

The 16-bit checksum field is used for error-checking of the header.

IPv6 notation

IP Version 6 (IPv6) introduction

- IPv6 expands the address space to 2^128 (IPv4: 2^32) addresses.
- An IPv6 address consists of 128 bits.
- There are three types of addresses:
 - Unicast An identifier for a single interface. A packet sent to a unicast address is delivered to the interface identified by that address.
 - Anycast An identifier for a set of interfaces (typically belonging to different nodes). A packet sent to an anycast address is delivered to one of the interfaces identified by that address (the nearest one, according to the routing protocols' measure of distance).
 - Multicast An identifier for a set of interfaces (typically belonging to different nodes). A packet sent to a multicast address is delivered to all interfaces identified by that address.
- There are no broadcast addresses in IPv6, their function being superseded by multicast addresses.

For additional reference, check the following http://tools.ietf.org/html/rfc4291

IP Version 6 (IPv6) notation

- The preferred form is x:x:x:x:x:x:x, where the xs are one to four hexadecimal digits of the eight 16-bit pieces of the address.
- In IPv6, all zeros and all ones are legal values for any field, unless specifically excluded. Specifically, prefixes may contain, or end with, zero-valued fields.
- For example, the following are legal representations of the 60-bit prefix 20010DB80000CD3 (hexadecimal):
 - 2001:0DB8:0000:CD30:0000:0000:0000:0000/60
 - 2001:0DB8::CD30:0:0:0:0/60
 - 2001:0DB8:0:CD30::/60
- The following are NOT legal representations of the above prefix:
 - 2001:0DB8:0:CD3/60 may drop leading zeros, but not trailing zeros, within any 16-bit chunk of the address
 - 2001:0DB8::CD30/60 address to left of /expands to 2001:0DB8:0000:0000:0000:0000:0000:CD30
 - 2001:0DB8::CD3/60 address to left of / expands to 2001:0DB8:0000:0000:0000:0000:0000:0CD3

For additional reference, check the following http://tools.ietf.org/html/rfc4291

IPv6 utilized in Flexi Multiradio BTS

IPv6 addressing supported by eNodeB in RL60

- IPv6 adresses can be used for the following IP interfaces:
 - Transport Ethernet interface
 - **VLAN Control Plane**
 - **Application Address**
 - **User Plane Application Address**
- The following address space is available by the eNodeB:
 - From 2000:: /3 Global Unicast [RCF3587], the equivalent to the public address range in IPv4 or
 - From FC00:: /7 Unique Local Unicast [RFC4193], the equivalent to the private address space in IPv4

IPv6 subnetting and routing

IPv6 Subnetting

Definition of subnets works in a similar way as in IPv4.

- The prefix (aka subnet mask, short notation) defines the size of a subnet.
- Examples:
 - /128 indicates subnet size 1 address
 - /127 indicates subnet size 2 addresses
 - /126 indicates subnet size 4 addresses
 - /125 indicates subnet size 8 addresses ...
- Since dealing with HEX-numbers is less convenient, the use of a IPv6 subnet calculator helps avoiding errors, for example, :

http://www.gestioip.net/cgi-bin/subnet_calculator.cgi

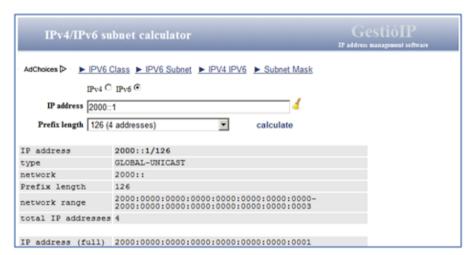


Figure 34: IPv6 Subnetting

IPv6 Routing

- Routing works in a similar way as in IPv4.
 - Dedicated routes to hosts use their IPv6 address and the prefix 128.
 - Dedicated routes to subnets (networks) use their Network address as the destination and their size as the prefix.
 - Default gateway is specified by the destination :: and the prefix 0.

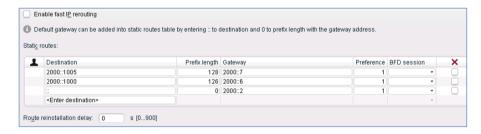


Figure 35: IPv6 Routing

IPv6 headers

IPv6 Header

The following are main aspect of IPv6 Header:

- Version 4-bit Internet Protocol version number = 6.
- Traffic Class 8-bit traffic class field. Like the DS /DSCP) field in IPv4.
- Flow Label 20-bit flow label.
- Payload Length 16-bit unsigned integer. Length of the IPv6 payload, that is, the rest of the packet following this IPv6 header, in octets.



Any extension headers [section 4] present are considered part of the payload that is, included in the length count.

- Next Header 8-bit selector. Identifies the type of header immediately following the IPv6 header. Uses the same values as the IPv4 Protocol field [RFC-1700 et seq.].
- Hop Limit 8-bit unsigned integer. Decremented by 1 by each node that forwards the packet. The packet is discarded if Hop Limit is decremented to zero.
- Source Address 128-bit address of the originator of the packet.
- Destination Address 128-bit address of the intended recipient of the packet (possibly not the ultimate recipient, if a Routing header is present).

The following figure illustrates the IPv6 Header:



Figure 36: IPv6 Header

For additional reference, check the following http://www.ietf.org/rfc/rfc2460

IPv6 Header extensions

- In IPv6, the optional internet-layer information is encoded in separate headers that may be placed between the IPv6 header and the upper- layer header in a packet. There are a small number of such extension headers, each identified by a distinct Next Header value.
- As illustrated in these examples, an IPv6 packet may carry zero, one, or more extension headers, each identified by the Next Header field of the preceding header.

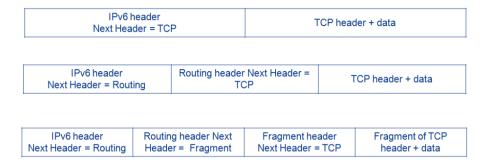
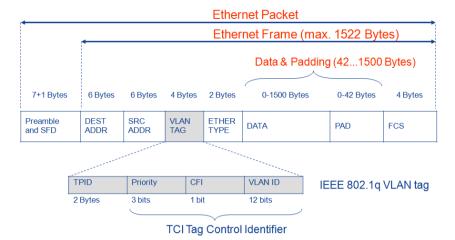


Figure 37: IPv6 Header extensions

For additional reference, check the following http://www.ietf.org/rfc/rfc2460

Ethernet frame (IEEE802.3)

The following figure illustrates the Ethernet frame:



TPID – Tag Protocol Identifier, fixed value 0x8100 indicates the frame carries the IEEE 802.1q VLAN tag. Priority – User defined VLAN Priority (lowest 0...7 highest) according to IEEE 802.1p. CFI – Canonical Format Indicator describes the MAC-Address format CFI=0 -> canonical format (=LSB first) VLAN ID – VLAN identifier (0...4095)

Figure 38: Ethernet frame (IEEE802.3)

Following are the Ethernet Fields with VLAN Tag (IEEE802.3):

Preamble an alternating 7 Byte long bit sequence 01010101...0101, followed by the SFD Start Frame Delimiter, 1 Byte (10101011)

DEST ADDR Destination MAC address 6 Bytes, usually shown in HEX format, for example, 00-21-70-BC-56-F9

SRC ADDR Source MAC address

ETHER TYPE Describes the type of data carried in the DATA field, for example,

0x0800 IP -> Internet Protocol, Version 4 DATA User data, max.

42-1500 Bytes

PAD Padding bits, used to fill the DATA field to min 42 Bytes, if actual

data is less than 42 Bytes.

FCS Frame check sequence, the CRC32 checksum, build from the

Ethernet frame bits excluding FCS itself.

Summary: IP Essentials

Module Summary

This module covered the following learning objectives:

- Explain the use of IP addressing.
- Explain the use of subnetting and subnet masks.
- Describe IPv4 routing principles.
- List some useful IP commands.
- List the local IP addresses in the Flexi Multiradio BTS.
- Identify the IPv4 header.
- Explain the IPv6 notation.
- Describe how IPv6 is utilized in the Flexi Multiradio BTS.
- Explain IPv6 subnetting and routing.
- Describe IPv6 headers.

Flexi Multiradio BTS TD-LTE and Module Overview

Module Objectives

- · Recall the LTE system and Flexi Multiradio BTS LTE products.
- List the Flexi Multiradio BTS installation options.
- · List the modules of the Flexi Multiradio BTS LTE.
- Describe the main function of each module in the Flexi Multiradio BTS LTE.
- Describe the installation configuration options for the Flexi Multiradio BTS LTE.
- Describe the additional modules for the Flexi Multiradio BTS TD-LTE.

LTE system and Flexi Multiradio BTS LTE products

3GPP Rel 8 network architecture

The following figure illustrates the 3GPP Rel 8 network architecture:

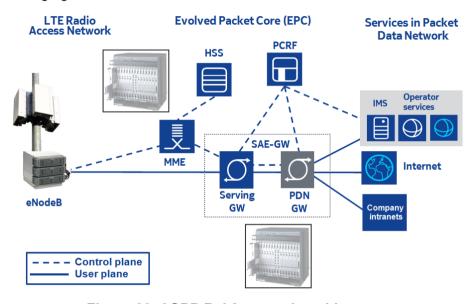


Figure 39: 3GPP Rel 8 network architecture

The EPC network architecture is composed of the following main elements compliant with 3GPP Release 8 specifications:

Mobility Management Entity (MME)

- Control Plane traffic handling
- Session and mobility management
- Idle mode mobility management
- Paging
- AAA Proxy
- NAS signaling
- SAE GW

System Architecture Evolution (SAE)

Serving GW

- User plane anchor for mobility between the 2G/3G access system and the LTE access system
- Lawful Interception
- PDN GW (Packet Data Network Gateway)
 - Gateway towards Internet/Intranets
 - User plane anchor for mobility between 3GPP and non-3GPP access systems (Home Agent)
 - Charging Support
 - Policy and Charging Enforcement (Policy and Charging Rules Function communicates with Policy and Charging Enforcement Function within PDN GW)
 - Packet Filtering Lawful Interception

A NOTE

Serving GW and MME may be implemented in one physical node or separated physical nodes.

PDN and Serving GW may be implemented in one physical node or separated physical nodes.

Home Subscriber Server (HSS)

The HSS is the Core Network entity responsible for managing user profiles, performing the authentication and authorization of users.

Policy and Charging Rule Function (PCRF)

The PCRF is responsible for brokering QoS Policy and Charging Policy on a perflow basis.

Flexi Multiradio BTS for TDD LTE

The following figure illustrates the Flexi Multiradio BTS for TDD LTE:

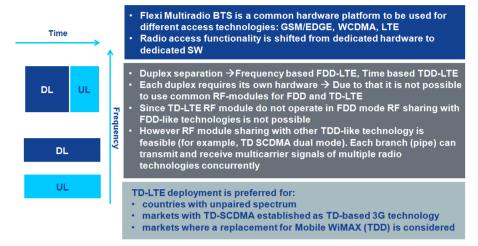


Figure 40: Flexi Multiradio BTS for TDD LTE

Flexi Multiradio LTE BTS Architecture Overview

The following figure illustrates the Flexi Multiradio LTE BTS architecture overview:



Figure 41: Flexi Multiradio LTE BTS Architecture Overview

- A Flexi LTE BTS consists of one System Module and up to 18 RF Modules or up to 18 Remote Radio Heads.
- RF Modules are available with
 - 3 TX/RX and 3 RX paths
 - 6 TX/RX paths
- LTE carriers with maximum 20 MHz bandwidth.
- Remote Radio Heads are optimized for 1 sector with 2TX/RX or 4TX/RX pathes with up to 20 MHz LTE bandwidth.
- BTS configurations are up to 9 cells with 20 MHz or up to 18 cells with maximum 10MHz.
- Module weight: 19-25 kg per Module.
- The Base Station can be installed by one person.

Flexi Multiradio LTE BTSB Architecture Properties

Flexi BTS introduces a new platform:

- The modular design doesn't use any backplanes.
- Modules are interconnected through front panel cabling.
- Modules can be installed separate from each other (Feederless / Distributed Sites).

The Flexi Multiradio LTE BTSB consists of:

- System Module FSM
- Two PA RF Module FRGA
- One PA RF Module FRGB
- One PA RF Module FRGB

The following table lists the Flexi Multiradio LTE BTS Architecture Properties:

Table 10: Flexi Multiradio LTE BTS Architecture Properties

Property	Value			
High ambient air temperature limit [°C]	+50			
High ambient air temperature limit with sun radiation heat load [°C]	+45			
Nominal DC voltage [V]	48			
Permitted DC operating voltage fluctuation (external supply range)[V]	40.5 57			
Optional Nominal DC voltage with DC-	+24			
DC Module [V]	(with Release 2 HW module FPDA)			
Optional Permitted 24 V DC operating	+ 18 + 32			
voltage fluctuation (external supply range) [V]	(with Release 2 HW module FPDA)			
Nominal AC voltage with optional AC	240 (US 1-phase)			
Module [V]	230 (EU 1-phase)			
	202 (Japan delta)			
Optional Permitted AC operating voltage	184 276 V			
and freq. fluctuation (external supply range) [V] [Hz]	45 66 Hz			
	0 184 V,			
	520 minutes when using FPBA with FPAA (time depends on AC Voltage input)			

Nokia Flexi LTE BTS Modules

The following figure illustrates the Nokia Flexi LTE BTS modules:



Weight: 19-25 kg

Figure 42: Nokia Flexi LTE BTS Modules

All Nokia Flexi LTE modules are outdoor capable hermetically sealed and IP 55 class protected.

The number of modules is minimised, e.g. for typical a 1+1+1 configuration only 3 modules are needed.

The following are the Nokia Flexi LTE BTS module mechanic parts:

Module core

The Core mechanics with optional front and back covers shield the module against water, snow, and solid foreign objects and makes the module IP 55 weatherproof.

The Core mechanics provide EMC shielding.

All connectors are at front with weather protecting covers.

Module casing

Casing supports the pile of modules.

Module Core can be changed even when the module is at the bottom of the module stack.

Fan sub-module

Fan sub-module provides fresh air cooling to the module.

The module controls the fan according to the temperature information.

Two redundant fans enable module operation in normal temperature even with one fan.

The Fan sub-module can be changed in the operational module at site where back access is provided.

Optional Front and Back covers

Optional Front and Back covers are used for BTS site installations without cabinet.

Optional Outdoor Cabinet

The outdoor cabinet includes door lock and door alarm switch.

Flexi Multiradio BTS installation options

Flexi Multiradio BTS installation options

Installation options: Stack installation

The following figure illustrates the installation options for Stack installation:



Figure 43: Installation options: Stack installation

- BTS modules are placed in a stack (Example: floor or shelves)
- Outdoor and indoor installations
- Modules in casings with back and front covers
- Plinth needed (same plinth for all cabinetless installations stack, pole and wall)
- Max 22 Height Units (HU) per plinth for zone 2 earthquake zones, max 15 HU for zone 4 earthquake zones

Installation options: Wall installation

The following figure illustrates the installation options for wall installation:



Figure 44: Installation options: Wall installation

- BTS modules installed on a wall
- Outdoor and indoor installations
- Modules in casings with back and front covers
- Plinth needed
- Up to 2 modules per plinth
- Modules installed covers sideways
- 100 mm space recommended between plinths to enable cabling (see picture)
- Standard Flexi BTS clearances apply

Installation options: Pole installation of Modules

The following figure illustrates the installation options for pole installation:

- · BTS modules installed on a pole
 - Outdoor and indoor installations
- Modules in casings with back and front covers
- · Plinth and pole mounting bracket needed
- Up to 2 modules per plinth and 4 per pair of brackets
- Modules installed covers sideways
- · Standard Flexi clearances apply





Figure 45: Installation options: Pole installation of Modules

Installation options: Flexi Cabinet installation

The following figure illustrates the installation options for Flexi Cabinet installation:

Flexi BTS Indoor Cabinet FCIA



Flexi BTS Outdoor Cabinet FCOA



Figure 46: Installation options: Flexi Cabinet installation

Cabinet can simultaneously house LTE, GSM/EDGE, LTE/HSPA and BBU modules:

There are no limitations on how to mix LTE, GSM and WCDMA in one cabinet

Optional Flexi Cabinets for indoor and outdoor installations:

- Open 19" mechanics with 1 HU fixing steps for flexible module installations
- No motherboards or electronics (fans)
- Not part of EMC shielding
- Only front cabling
- Module casings and covers are not used
- Cooling fans remain in modules
- Modules are grounded through rack
- Same footprint and cabinet fixing points as with UltraSite and Talk Family
- Outdoor: 1550 x 770 x 770 (H x W x D), space for 38HU
- Indoor: 1800 x 600 x 600 (H x W x D), space for 36HU

Modules of the Flexi Multiradio BTS LTE

Flexi Multiradio System Module FSMF + Flexi Baseband Modules FBBA

The following figures illustrate the Flexi Multiradio System Module FSMF + Flexi Baseband Modules FBBA:

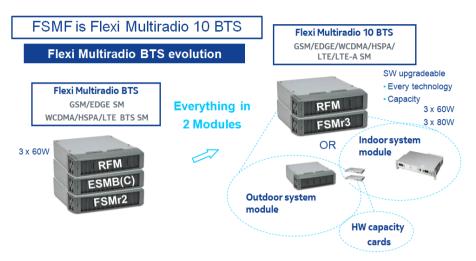


Figure 47: Flexi Multiradio System Module FSMF + Flexi Baseband Modules FBBA 1/2



Figure 48: Flexi Multiradio System Module FSMF + Flexi Baseband Modules FBBA 2/2

- The Flexi Multiradio BTS System Module FSMF consists of a 3HU high casing, which can accommodate in addition to the base module, optionally
 - up to 2 baseband sub-modules (FBBA)
 - 1 additional transport sub-module (FTxx)
 - 1 power distribution sub-module (FPFD)
- The FSMF itself can be used as:
 - a stand alone System Module
 - · in combination with additional sub-modules or

- in a multi System Module configuration
- The following functions are integrated in the FSMF:
 - ethernet transport
 - baseband processing
 - clock and control functions
 - fan control status LEDs

Generally the FSMr3 O&M behavior is the same as the O&M in FSMr2.

FTM is kept as a single topology object (FTM object).

Auto connection and Auto configuration is supported same way as with FSMr2.

RF sharing of WCDMA-LTE does support the mixture of FSMr2 and FSMr3.

NetAct topology does not distinguish between FSMr2 and FSMr3.

Existing RFM modules with rel2.2 and rel2.1 will be supported as from FSMr2.

Plugin units

- Plugin units do exist for system module extensions, transport units and power supply units.
- Plugin units can be plugged into system module under power.
- Plug-in units are automatically detected.
- For activation (taking into service) of plug-in units, a restart is acceptable.

Main function of each module in the Flexi Multiradio BTS LTE

Baseband extension concept FSMF

The following figure illustrates the baseband extension concept FSMF:



Figure 49: Baseband extension concept FSMF

- FBBA Optional high capacity WCDMA/LTE extension sub-module (0-2 pieces)
- For WCDMA or LTE 20 MHz
- Support WCDMA 720CE Rel99 and 756/208 Mbps DL/UL or LTE 450/150 Mbps DL/UL

FSMF and FBBA Capacity

Single 6Gbps OBSAI RP3-01 cable supports 80MHz Tx / 80MHz Rx

- System Module rel. 3 (FSMF) is supported (with up to 2 FBBA extensions)
- Only 6 Gbps optical connection is supported
- Baseband Extension FBBA (LTE972) provides a hardware baseband capacity to support higher number of cells
- FBBA provides also more connectivity towards FSMF due to additional optical ports

The following figure illustrates the FSMF and FBBA capacity:

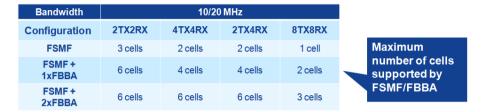


Figure 50: FSMF and FBBA Capacity

FSM Release 3 HW Architecture

FSMF

- FSP has 3 Turbo Nyquists, 3 Nyquists and MCU.
- FCT(Control+Transport): Cavium CN6335 MCU for control and transport processing.
- Multiplexed RP3-01 and optical TRS 1GE, SGMII port to Murkku for TRS traffic.
- Four RP3-01 ports and one sRIO in FSMx.
- Combined LPT and SiSo Ethernet ports.

FBBx

- Can be used for capacity expansion.
- FBBA has 3 Turbo Nyquists, 3 Nyquists and MCU.
- FBBB has 1 Turbo Nyquist, 2 Nyquist and MCU.
- One RP3-01 port and one sRIO per FBBx.
- Architecture enables productization of new FBBs to support better future requirements and business needs.

The following figure illustrates the FSM Release 3 HW architecture:

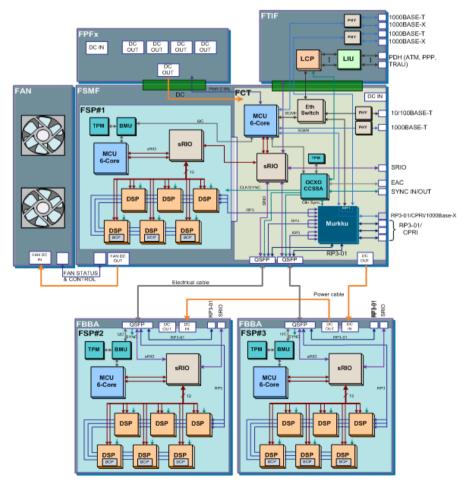


Figure 51: FSM Release 3 HW Architecture

DSP: Nyquist from TI

- Quad core at 1 GHz each
- 1 MB local L2 cache for each core
- 2 MB shared L2 cache

Acceleration

- TCP3d: turbo decode accelerator (>100Mbps)
- TCP3e: turbo encode accelerator (>200Mbps)
- 4 x VCP2 for voice channel decoding
- RAC, TAC for chip rate acceleration (TCI6498 Only)
- FFTC: FFT/iFFT and DFT/iDFT (for RACH) Co-processor
- RSA for chip rate acceleration on 2 cores
- Crypto & Packet Accelerator

Peripherals

- AIF2 Six 6-Gbps lanes (WCDMA, LTE, GSM?, TD-SCDMA?)
- 4x sRIO, SGMII, DDR3 (2x32bit), GPIO, UART
- 2x PCIe Gen II, I2C, SPI
- Embedded Trace Buffer (ETB)
- 40nm High Performance Process

Cavium Octeon 6334

- 6 cores @ 1.2 GHz
- 1 MB L2 cache
- Security engine
- **IEEE1588**
- 3 sRIO
- **PCI-Express**
- 4x SGMII

Murkku

- 6 RP3-01 at 6 Gbps
- 12 RP3 at 6 Gbps
- **SGMII**
- NEC 90 nm process
- RP3 routing, muxing and summing

FSMF, FPFD, FTIF and FBBA interfaces

The following figure illustrates the FSMF, FPFD, FTIF and FBBA interfaces:

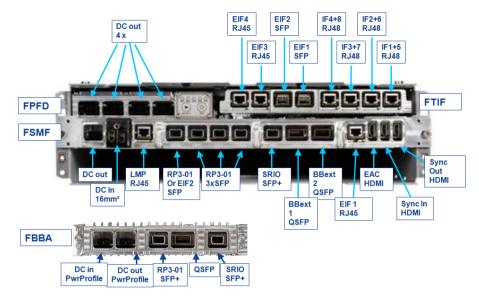


Figure 52: FSMF, FPFD, FTIF and FBBA interfaces

FBB, FSMF Rel.3 System Module for Outdoor

FPFD Optional Power Distribution Module for FSMF

FTIF Optional Transport Sub-Module for FSMF

FBBA Optional Baseband extension Module for FSMF

FSIH/FBIH System Module

Indoor Flexi System Module with Holistic Technology Evolution:

- Compact modular design for indoor usage
- To enhance RF connectivity of Flexi System Module
- To improve baseband capacity of Flexi System Module
- To support enhanced features
- FSIH/FBIH is commercially available in RL45TD
- Full connectivity will be enabled in RL55TD



Figure 53: FSIH/FBIH System Module Overview 1/2

- FSIH Module:
 - Height: 43.6mm, Depth: 266mm,
 - Width front plate: 442mm, Inner Width rail: 416mm
 - Weight: approximately 5.0kg
- FBIH Module:
 - Height: 25.8mm, Depth: 277mm,
 - Width front plate: 442mm, Inner Width rail: 416mm
 - Weight: approximately 3.0kg

Both active and passive GPS input support with improved synch holdover performance.

There is no I/Q compression and delay adjustment for OBSAI mode.

IQ compression algorithm support 15->12 bit and 15->9 bit two types. User can configure the IQ compression type based on the scenarios.

The ¾ down-sampling is used for the TDL 20M bandwidth.

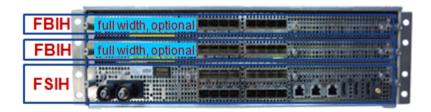
The IQ compression function and $\frac{3}{4}$ down-sampling function can be configured independently.

The IQ compression and ¾ down-sampling function is optional and can be configured based on the requirements.

According to the CPRI basic frame sample, the TDL 20M one pipe IQ data in one basic CPRI frame is 30.72*15*2/3.84=240bit. To CMCC 8 pipe requirement, there are total 8*240=1920 bits. To 6.144G, one basic CPRI frame is 5*240=1200bits. it cannot carry all 8 pipe TDL 20M IQ data. So it needs 2 CPRI link to carry

TDL 20M 8 pipe IQ data bit in one CPRI basic frame is 30.72/3.84*15*2*8=1920bit. If IQ bit width is compressed from 15bit to 12bit + $\frac{3}{4}$ downsampling. The total bit is:30.72/3.84*12*3/4*2*8=1152bit, in one 9.8G CPRI basic frame, W is 1152/128=9. If IQ bit width is compressed from 15bit to 9bit. The total bit is:30.72/3.84*9*2*8=1152bit. In one 9.8G CPRI basic frame, W is 1152/128=9.

The following figure illustrates the FSIH/FBIH System Module overview:



Volume: 18L

(HxWxD: 111x448x360mm)

Weight: 15kg

Indoor, IP20

Temperature: -5 to +55 °C

• Humidity: 15% \sim 85%

Figure 54: FSIH/FBIH System Module Overview 2/2

- Indoor System module with compact modular design
 - Standard 19 inch, 2.5 U height and 360 mm depth
 - 1 FSIH Core Module and up to 2 FBIH capacity extension modules
 - Backplane connection between core and extension module
- Single FSIH/FBIH module has high capacity
 - 3 cells @ 20 MHz 8T8R or
 - 3 cells @ 20 MHz 4TX and 4RX or
 - 4 cells @ 20 MHz with 2TX and 2RX
- Support both OBSAI and CPRI RF interface
 - Total 24 RF ports with FSIH +2*FBIH (12 at FSIH and 6 at FBIH module)
 - Up to nine 9.8G CPRI interfaces with FSIH +2*FBIH
- Support both active and passive GPS input
- Holdover performance enhancement
- HW ready for IQ compression and down-sampling
- RL45TD SW enables 6 RP3 port
- RL55TD SW enables all RF ports

FSIH Mechanical Structure

Electrical connection from FSIH to FBIHs is done via a backplane, so there will be no external cabling between these units.

The cooling system will have three individual 90 mm Fans which are connected to the rear side of the Back Plane.

The following figure illustrates the FSIH mechanical structure:

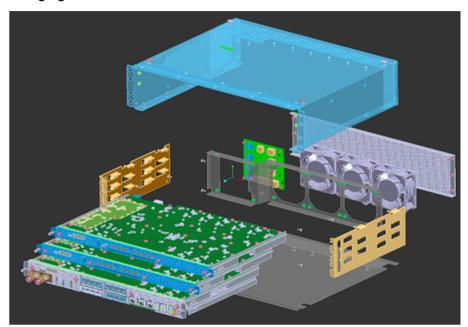


Figure 55: FSIH Mechanical Structure

- FSIH consists of the following main building blocks:
 - FSIH enclosure, including fans
 - FSIH core (FCTF + 1 FSPM + heat sinks)
 - Up to two FBIH (1 FSPM + heat sink)
 - Backplane

FSIH block diagram (FSIH + 2x FBIH)

FSIH and FBIH are made of two electrical assemblies, namely FCTF and FSPM plus additional mechanical items. The structure is as follows:

- FSIH core = FCTF + FSPM + mechanical items (including enclosure and fans)
- FBIH extension = FSPM + mechanical items

There are 6 SerDes links between FPGA and MURKKU2 and each support max 6.144G line rate. If they are for CPRI interface, the 6 CPRI link is combined in FPGA to support the 9.8G. If they are for OBSAI interface, the 6 link are bypassed by FPGA directly to SFP connector. Also, the fiber link delay adjustment is done in FPGA buffer; it supports at most 30km distance delay.

The following figure illustrates the FSIH block diagram:

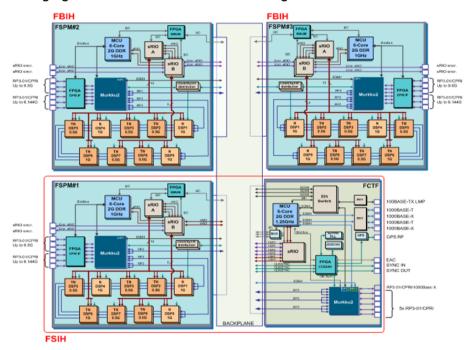


Figure 56: FSIH block diagram (FSIH + 2x FBIH)

Functionalities of different HW components: FCTF main features

The following figure illustrates the functionalities of different HW components: FCTF main features:

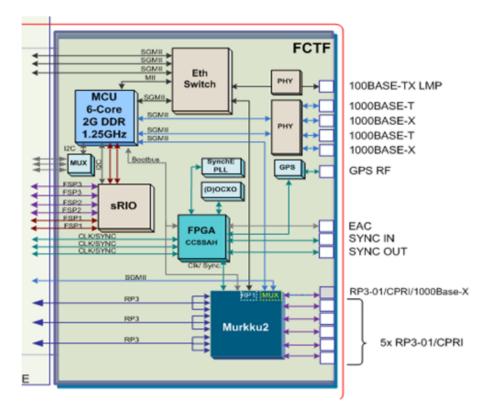


Figure 57: Functionalities of different HW components: FCTF main features

FCTF takes care of controlling of System Module O&M features, including intelligent temperature control, clock distribution to the BTS, baseband- and RF-synchronization, platform for user plane resource manager, Ethernet transport interfaces, optical interfaces to/from other modules, BTS and System Module O&M functions and summing & multiplexing for baseband pooling.

- Run O&M / CC&S SW
- 30.72MHz/SF BURST generation for MURKKU interface
- System frame clock (SFCLK) generation
- System frame number (SFN) generation for FSPs
- SFCLK for testing purposes
- 10/100 Base-T LMP port for local BTS handling and commissioning
- Master/extension information
- External alarms handling
- FAN Control, including intelligent temperature control
- Software storage (flash disk) for all sub-modules
- L3 RF-module alarm and control handling
- System Module operational state visual indication
- Control Plane Software
- Transport SW (incl. packet processing)
- Low latency traffic switching (sRIO)

Functionalities of different HW components: FSPM main features

The following figure illustrates the functionalities of different HW components: FSPM main features:

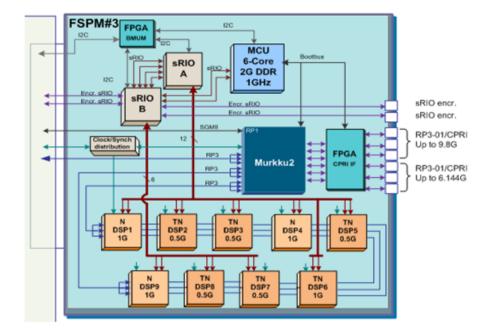


Figure 58: Functionalities of different HW components: FSPM main features

- Adds Digital Signal Processing Power to FSIH
- Provides 6 RP3-01 / CPRI RF interfaces
- Provides a maximum number of 3 x 9.8G CPRI interfaces
- Multi-Radio Capability: LTE, WCDMA and GSM supported
- Adds one 6-core MCU
- Scalability: Up to 3 FSPM-Boards in FSIH (maximum configuration)
- Partial power-down and DSP hibernation mode

Backplane Printedwireboard (PWB)

The Backplane consists of connectors corresponding to the plugs of the FCTF- and FSPM-PWB(s) mounted on the Backplane-PWB. The connectors are routed on the PWB to interconnect both the power and the signals between the FCTF- and FSPM-PWB(s). Additionally there are connectors on the backside of the Backplane-PWB interconnecting the power and control from the FCTF-PWB to the plugged in fans.

The following figure illustrates the Backplane PWB:

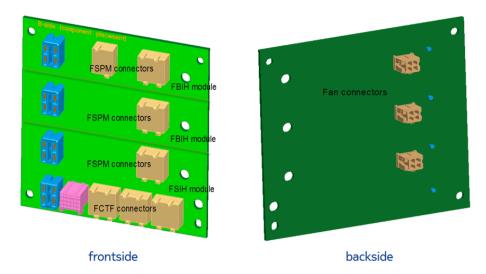


Figure 59: Backplane PWB

Backplane

Slots 0 and 1 are used for FSIH core (FCTF+FSPM) and slots 2 and 3 are used for FBIH extension modules. Slot 3 has a special role, as there are some extra pins (TRS, connector X10) that can be used for a future transport module. As of now, this feature is not supported by any SW.

The following figure illustrates the Backplane :

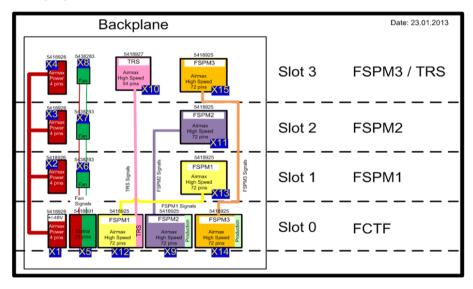


Figure 60: Backplane

FSIH/FBIH System Module Interfaces

The following figure illustrates the FSIH/FBIH System Module interfaces:

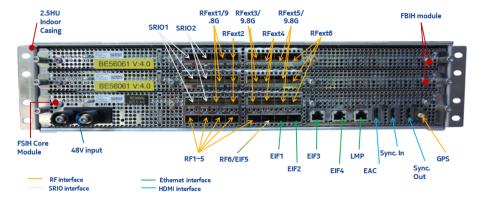


Figure 61: FSIH/FBIH System Module Interfaces

The following tables illustrate the FSIH/FBIH System Module interfaces:

Table 11: FSIH External Interfaces (1/2)

Name	Initials	Details	#	Level	Connects to	I/O
Power Supply In	DC IN 48V	Fuse, surge and polarity protected. 500V insulation	1	POWER 48V	Site support cabinet, Battery backup, Power distributio n panel	I
Radio interface FCTF	RF1RF5	RP3- 01/CPRI, 6.144G	5	SFP+	RF- Module	I/O
Radio interface FCTF shared with transport port	RF6	RP3- 01/CPRI, 6.144G / 1000Base -X (no autonegoti ation)	1	SFP+	RF- Module / Core Network	I/O
Radio interface FSPM	RFEXT1/1 0G RFEXT3/1 0G RFEXT5/1 0G	RP3- 01/CPRI, 6.144G and CPRI 9.8G	3	SFP+	RF- Module	I/O
Radio interface FSPM	RFEXT2 RFEXT4 RFEXT6	RP3- 01/CPRI, 6.144G	3	SFP+	RF- Module	I/O
Low Latency interconne ction	SRIO1 SRIO2		2	SFP+	Co-site Extension System Module	I/O
Transport interface	EIF1EIF 2	1000Base -X	2	1000Base-X	Core Network	I/O
Transport interface	EIF3EIF 4	1000Base -T	2	1000Base-X	Core Network	I/O
Local Managem ent + Site Support IF	LMP	100Base- TX+MIBB U Alarm	1	100Base- TX+Open Collector (pull-up to 5V)	Service laptop+Ba ttery backup system	I/O

Table 12: FSIH External Interfaces (2/2)

Name	Initials	Details	#	Level	Connects to	I/O
Synchroniz ation Input	Sync In	Refer to FCTF implementa tion specificatio n for details	1	LVTTL, RS485	External synchroniza tion reference signals and GPS	_
Synchroniz ation Output	Sync Out	Refer to FCTF implementa tion specificatio n for details	1	LVTTL, RS485	External synchroniza tion reference signals and GPS	0
External Alarms and Controls	EAC	12 alarm signals: 6 control outputs and 6 alarm inputsOR12 alarm inputs+seri al bus interface	1	LVTTL, CAN	Alarm and control signals (e.g. smoke detector, door alarm,)+serial bus interface supports FSEB alarm box	I/O
GPS antenna	GPS	RF antenna input to integrated GNSS receiver	1	RF with 5V phantom feed	GPS external antenna	l
Reset Button	RESET	BTS reset	1	-	-	_
Visual Indicators	STATUS FAN RF1RF6 EIF1EIF2 RFEXT1RFE XT6 SRIO1SRIO2	System status LED FAN status LED Link status LED	2 1 6 2 6 2	-	One System Status LED on FCTF and one on FSPM	0

Table 13: FBIH External Interfaces

Name	Initials	Details	#	Level	Connects to	I/O
Radio interface	RFEXT1/1 0G RFEXT3/1 0G RFEXT5/1 0G	RP3- 01/CPRI, 6.144G and CPRI 9.8G	3	SFP+	RF- Module	I/O
Radio interface	RFEXT2 RFEXT4 RFEXT6	RP3- 01/CPRI, 6.144G	3	SFP+	RF- Module	I/O
Low Latency interconne ction	SRIO1 SRIO2		2	SFP+	Co-site Extension System Module	I/O
Visual Indicators	STATUS RFEXT1 RFEXT6 SRIO1S RIO2	System status LED Link status LED Link status LED Link status LED	1 6 2	-	-	0

FSMF/FBBA VS FSIH/FBIH

The following figure illustrates the FSMF/FBBA VS FSIH/FBIH:



Figure 62: FSMF/FBBA VS FSIH/FBIH

Table 14: FSMF/FBBA VS FSIH/FBIH

Items	FSMF/FBBA	FSIH/FBIH		
Configurations / Capacity	3*20MHz 8-pipe or 6*20MHz 2-pipe *)	9*20MHz 8-pipe or 12*20MHz 2-pipe		
S1 interfaces	1-3 GE(e) / 1-3GE(o)	2 GE(e) / 2GE(o)		
Optical line rates	6 × 6G	24×6G OR 6x6G+9x9.8G		
Synchronization	Integrated GPS box (Opt.) / 1588V2	Integrated GPS receiver / 1588V2		
Dimensions	3U / 19 inch (447×130x422mm)	2.5U / 19 inch (448×111x360mm)		
Weight (kg)	15kg	15kg		
Volume (L)	24L	18L		
Power consumption	Max. 330W (S111)	Max. 378W (S111)		
		Max. 934W (S333)		
Operating Temperature	-33 ~ +55°C	-5 ~ +55°C		
Protection	IP65	IP20		
Availability	Today	1Q /2014		

^{*)} Hardware capacity is 9x20MHz at 2T2R, but site configuration is maximum 6 cells at 2T2R according to actual customer demand.

Flexi RF Module Introduction

The following figure illustrates the Flexi RF Module introduction:

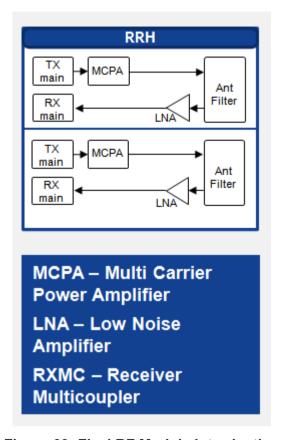
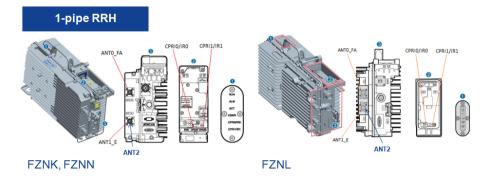


Figure 63: Flexi RF Module Introduction

- Each Flexi Radio Module consists of several independent branches (pipes) which can support several carriers (frequency blocks for TD-LTE) within the available RM's bandwidth.
- FRM branch (pipe) contains:
 - · Transmitter and receiver chains and the front end
 - OBSAI / CPRI connectivity
- Note: Since for TD-LTE duplex is in the time domain duplex filter for UL/DL separation is not needed (only passband antenna filter)
- Flexi Radio Module FRM is optimized for multi-sector Macro BTS
- Remote Radio Head RRH is optimized to support single sector 1, 2, 4 or 8 pipes (MIMO / Beamforming)

Hardware Layouts

The following figures illustrate the Hardware layouts:



- Only ANT1_E is used for TD-LTE. Namely ANT2 in TDL system
 CPRI0/IR0 and CPRI1/IR1 are used for optical connection
- FZNN may not look like this in reality

Figure 64: Hardware Layouts 1/4

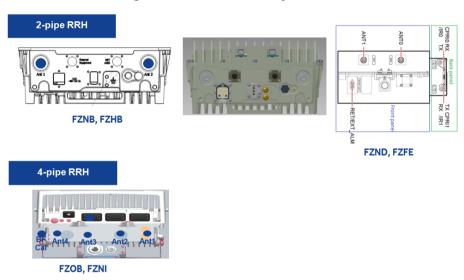


Figure 65: Hardware Layouts 2/4

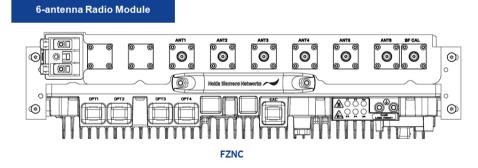


Figure 66: Hardware Layouts 3/4

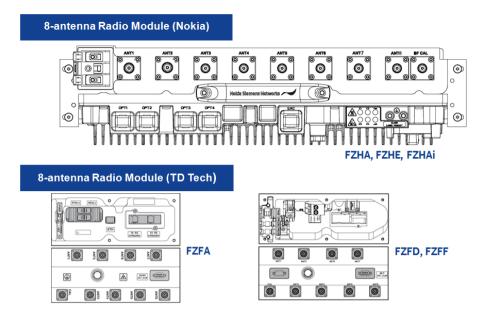


Figure 67: Hardware Layouts 4/4

RRH Tx and Rx Antenna Connectors

The following figure illustrates the RRH Tx and Rx antenna connectors:

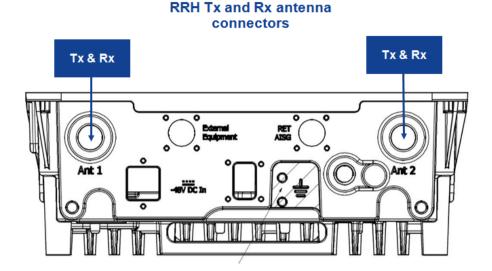


Figure 68: RRH Tx and Rx Antenna Connectors

The following figure illustrates the 6-pipe Radio Module Tx and Rx antenna connectors:

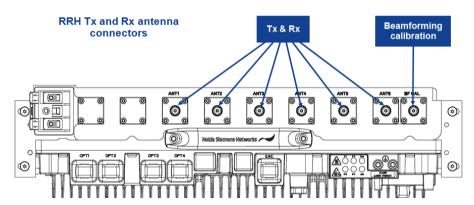


Figure 69: 6-pipe Radio Module Tx and Rx Antenna Connectors

The following figure illustrates the 8-pipe Radio Module Tx and Rx antenna connectors:

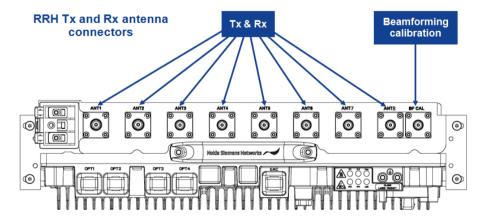


Figure 70: 8-pipe Radio Module Tx and Rx Antenna Connectors

Flexi Radio Naming Convention

The following figure illustrates the Flexi Radio naming convention:

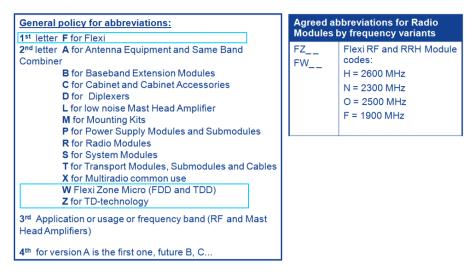


Figure 71: Flexi Radio Naming Convention

RF Modules

Supported Remote Radio Head in TL15A

The following tables list the supported Remote Radio Head in TL15A:

Table 15: Supported Remote Radio Head in TL15A 1/2

Variant	Module	Module product code (Core code or HW type)	Freq band	Supported Power per Pipe (Watt)	DFE chip	E- UTRA Band
FZHM	Flexi RFM 8TX 2600	473011A(086984A)	2600 MHz	20/15/10/5	Broadcom	38,41
FZHS	Flexi RRH 2T2R 2600	473175A(087556A)	2600 MHz	5/2.5/1/0.5	Broadcom	41
FZHQ	Flexi RRH 8- pipe 2600 160W Q	473106A	2600 MHz	20/15/10/5/	Broadcom	41
FZFH	Flexi RRH 4- pipe 1900 & 2600	DC:473256A AC:473257A(RRU3 182-fad)	1900 & 2600 MHz	1900(ANT0 ,1): 30/20/10/5 2600(ANT2 ,3): 40	3rd party	39,41



For FZFH variant, TL15A supports band 39 on ANT0, ANT1 only and TL16 supports extra band 41 on ANT2, ANT3

Table 16: Supported Remote Radio Head in TL15A 2/2

Variant	BTS Release	TX & RX Band	HW s	HW supported 3GPP bandwidths			
	where Supported		5 MHz	10 MHz	15 MHz	20 MHz	
FZHM	TD-LBTS5.0	B38: 2575- 2615 MHz	yes	yes	yes	yes	TE184 7
		B41: 2555- 2655 MHz					
FZHS	TL15A	2555- 2655 MHz	no	no	no	yes	LTE217 6
FZHQ	TL15A	2595- 2645MH z	no	no	no	yes	LTE218 7
FZFH	TL15A	B39: 1885- 1915 MHz	no	yes	no	yes	LTE236 5
		B41: 2555- 2635 MHz					

ANOTE

For FZFH variant, TL15A supports band 39 on ANT0, ANT1 only and TL16 supports extra band 41 on ANT2, ANT3

Flexi RRH 8-pipe 2600 160W M

Utilized together and useful with:

- LTE505 Transport separation for RAN sharing
- In case IPsec is not applied
- LTE1771 Dual U-plane IP addresses

High Output Power and Optimized Three Carrier ready RF for 8 path Beamforming:

- Flexi RF Head 8TX 2555-2655MHz
- 8 x 20W output power
- Beamforming support
- Up to 60MHz/pipe occupied bandwidth
- Weight <23kg
- Size 26L

- Up to 3 x 9.8Gbps CPRI
- Pole, Wall and Tower mounting
- · Natural convection cooling
- Outdoor IP65 protection
- 48V DC



Figure 72: Flexi RRH 8-pipe 2600 160W M

HW Layouts- FZHM

8-pipe radios

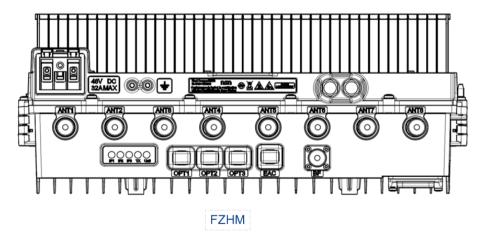


Figure 73: HW Layouts-FZHM

Flexi RRH 2-pipe 2600 10W S

Utilized together and useful with:

- LTE505 Transport separation for RAN sharing
- In case IPsec is not applied
- LTE1771 Dual U-plane IP addresses

Low output power for single sector with 2TX covering China Band 41:

- Band 41, 2555-2655MHz
- 2 x 5W output power
- Instantaneous Bandwidth 100MHz
- Useful Bandwidth 40MHz
- Size 5L; Weight 5kg
- Pole, Wall and Ladder mounting, and so on.
- Natural convection cooling
- AC power input
- Outdoor IP65 protection



Figure 74: Flexi RRH 2-pipe 2600 10W S

HW Layouts-FZHS

The following figure illustrates the HW Layouts– FZHS:

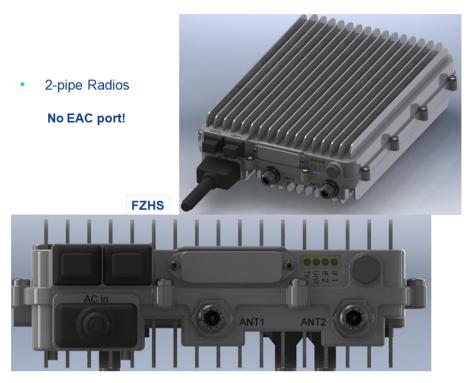


Figure 75: HW Layouts-FZHS

Flexi RRH 8-pipe 2600 160W Q

High Output Power and Optimized Three Carrier ready RF for 8 path Beamforming:

- Flexi RF Head 8TX 2595-2645MHz
- 8 x 20W output power
- Beamforming support
- Up to 8T8R 50MHz bandwidth
- Weight <24kg; Size 32L
- Up to 3 x 9.8Gbps CPRI
- Pole, Wall and Tower mounting
- Co-location with WiMax
- Natural convection cooling
- Outdoor IP65 protection
- 48V DC



Figure 76: Flexi RRH 8-pipe 2600 160W Q

HW Layouts-FZHQ

8-pipe radios

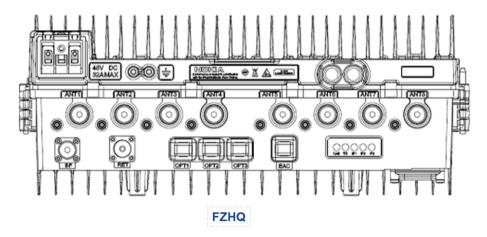


Figure 77: HW Layouts- FZHQ

HW Layouts- FZFH

The following figure illustrates the HW layouts- FZFH:

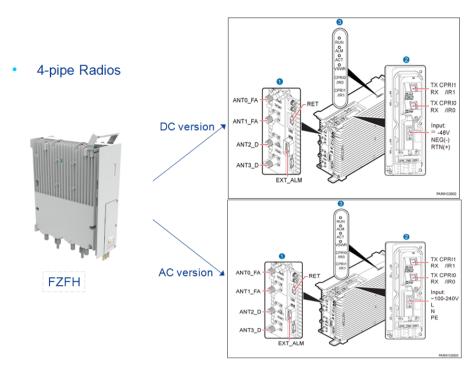


Figure 78: HW Layouts- FZFH

Installation configuration options for the Flexi Multiradio BTS LTE

Sector Configurations

A Type Sector Configuration

The following figure illustrates the A Type Sector Configuration:

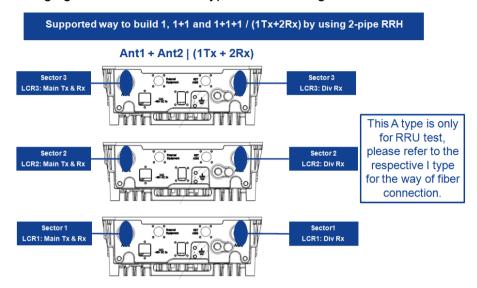


Figure 79: A Type Sector Configuration

F Type Sector Configuration

The following figure illustrates the F Type Sector Configuration:

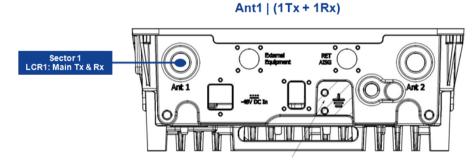


Figure 80: F Type Sector Configuration

I Type Sector Configuration

The following figure illustrates the I Type Sector Configuration:

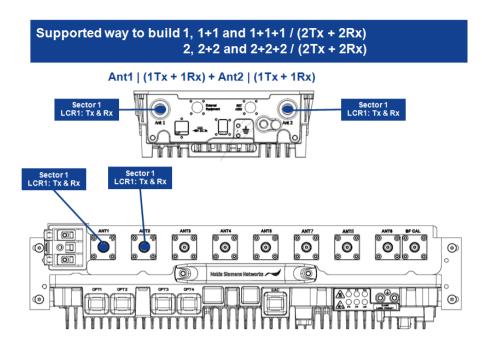


Figure 81: I Type Sector Configuration

L Type Sector Configuration

The following figure illustrates the L Type Sector Configuration:

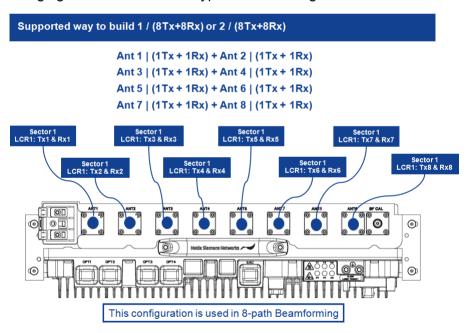


Figure 82: L Type Sector Configuration

M Type Sector Configuration

The following figure illustrates the M Type Sector Configuration:

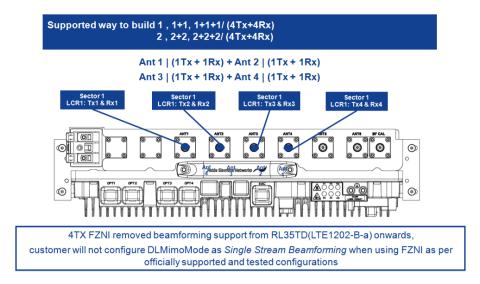


Figure 83: M Type Sector Configuration

N Type Sector Configuration

The following figure illustrates the N Type Sector Configuration:

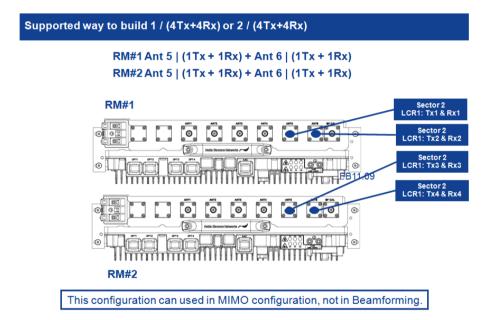


Figure 84: N Type Sector Configuration

O Type Sector Configuration

The following figure illustrates the O Type Sector Configuration:

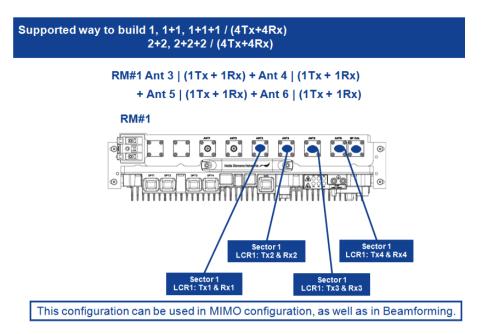


Figure 85: O Type Sector Configuration

S Type Sector Configuration

The following figure illustrates the S Type Sector Configuration:

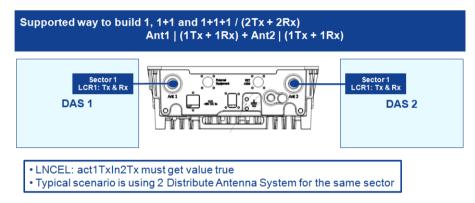


Figure 86: S Type Sector Configuration

T Type Sector Configuration

The following figures illustrates the T Type Sector configuration:

```
Supported way to build 1, 1+1, 1+1+1 / (2Tx+4Rx)
                           2, 2+2, 2+2+2 / (2Tx+4Rx)
                           Ant 1 | (1Tx + 1Rx) + Ant 2 | (1Rx)
                           Ant 3 | (1Tx + 1Rx) + Ant 4 | (1Rx)
 Sector 1
LCR1: Tx1 & Rx1
                    Sector 1
LCR1: Rx2
                                  Sector 1
LCR1: Tx3 & Rx3
        0
                                                            0
        ©
                                                                                            (#)
                                                           (10)
   (‡)
                                                                                           ($)
                   This configuration can be used in MIMO configuration
```

Figure 87: T Type Sector Configuration 1/4

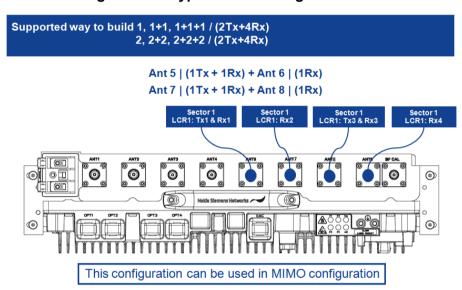


Figure 88: T Type Sector Configuration 2/4

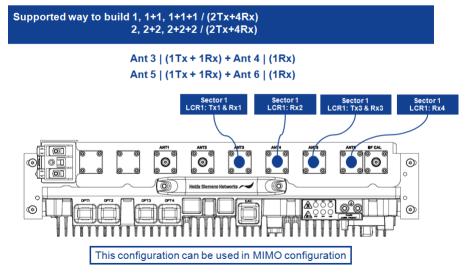


Figure 89: T Type Sector Configuration 3/4

Supported way to build 1, 1+1, 1+1+1 / (2Tx+4Rx) 2, 2+2, 2+2+2 / (2Tx+4Rx)

> Ant 1 | (1Tx + 1Rx) + Ant 2 | (1Rx) Ant 3 | (1Tx + 1Rx) + Ant 4 | (1Rx)



This configuration can be used in MIMO configuration

Figure 90: T Type Sector Configuration 4/4

I Type Sector Configuration for super cell

The following figure illustrates the I Type Sector Configuration for super cell:

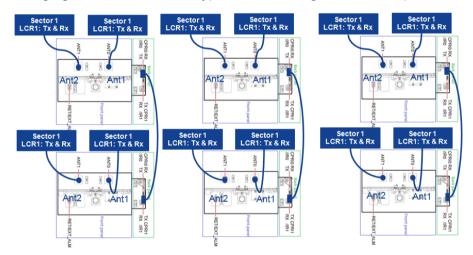


Figure 91: I Type Sector Configuration for super cell

Additional modules for the Flexi Multiradio BTS TD-LTE

Flexi Power Module FPMA

FPMA is the casing for the AC input and DC output cable connector box and a support frame for the actual power sub-modules FPAA, FPBA and FPDA.

- Flexi Power AC-DC Sub-Module (FPAA) The main function of the FPAA is to provide the BTS modules with 48 V DC power from an AC current. The FPMA can house up to three AC/DC rectifiers, each of which has an output power of 1 kW.
- Flexi Power Battery Sub-Module (FPBA) The FPBA is a separate optional sub-module used together with AC-DC Module (FPAA). The FPMA can house up to three Battery sub-modules.

Battery sub-module provides up to 10 minutes battery back-up time when the Flexi BTS site AC power mains is down. FPBA is a maintenance free Lithium-lon battery which brings significant OPEX savings over its ten-year battery lifetime.

The figure shows fully equipped Flexi Power Module (FPMA) with AC/DC converters (FPAA) and Batteries (FPBA).



Figure 92: Flexi Power Module FPMA

Example configuration with: 1 x Flexi Power Module FPMA

- 3 Flexi Power AC/DC sub-modules FPAA (230VAC -> 48VDC)
- 1 Flexi Power Battery FPBA

2 FPMAs can be operated in parallel

FPMA Battery Sub-Modules Types

The following figure illustrates the FPMA Battery Sub-Modules types:



Figure 93: FPMA Battery Sub-Modules Types

Flexi Power Module FPRA

The following figure illustrates the Flexi Power Module FPRA:



Figure 94: Flexi Power Module FPRA

- High power alternative to FPMA
- Up to 3 rectifiers
- Output power 2 kW per rectifier, 6 kW total DC output power
- External batteries supported

Flexi mounting kit for floor, wall and pole (FMFA)

The following figure illustrates the Flexi mounting kit for floor, wall and pole (FMFA):

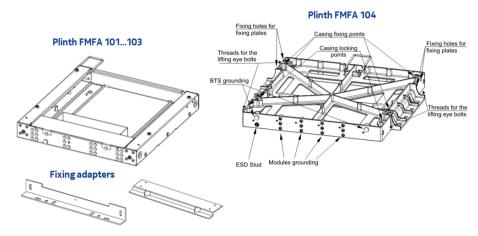


Figure 95: Flexi mounting kit for floor, wall and pole (FMFA)

Alarm Box and OVP options

The following figure illustrates the Alarm Box and OVP options:



Figure 96: Alarm Box and OVP options

Flexi External Alarm Box (FSEB)

The following figure illustrates the Flexi External Alarm Box (FSEB):

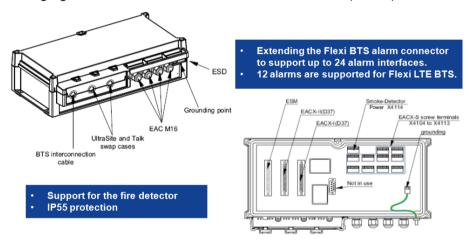


Figure 97: Flexi External Alarm Box (FSEB)

GPS for Flexi eNodeB

The following figure illustrates the GPS for Flexi eNodeB:

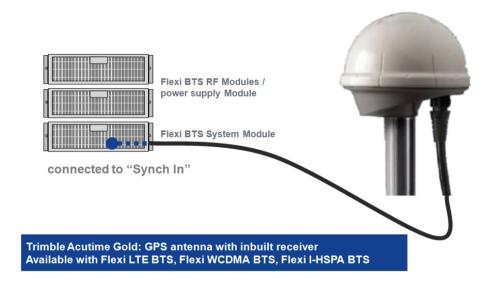


Figure 98: GPS for Flexi eNodeB

Feederless / Distributed Site concept

Introduction

- Standard Flexi Multiradio BTS modules support the Feederless BTS site application where one 3-sector RF Module or Remote Radio Head, or the entire Flexi BTS is installed close to the antennas.
- For a feederless site, the traditional long antenna feeders or Mast Head Amplifiers are not needed, thus optimizing the BTS site RF performance in both uplink and downlink.
- A standard IP65 outdoor Flexi 3-sector RF Module can be installed close to an antenna leading to:
 - best RF performance because no downlink and uplink feeder losses
 - easiest installation because only one optical and DC cable to tower
 - no long antenna feeders (typically six for a three-sector site)
 - · no mast head amplifiers/tower-mounted amplifiers
 - lowest total wind load and weight
 - lowest total power consumption

Flexi 3-sector RF Module can be software-activated and configured to support one, two or three sectors, or one sector with 2TX MIMO with optional four-way uplink diversity.

In the Distributed solution, 3-sector RF Module(s) or Remote Radio Head(s) are located up to 20 km away from the main Flexi System Module site. Typically, an existing optical fiber infrastructure is used.

Feederless BTS Site example using Radio Modules

The following figure illustrates the Feederless BTS Site example using Radio Modules:

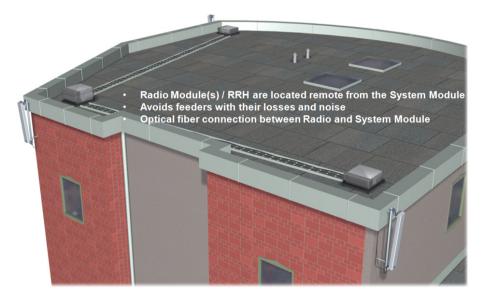


Figure 99: Feederless BTS Site example using Radio Modules

Feederless BTS Site power option 2: DC with/without short term BBU from System Module

The following figure illustrates the Feederless BTS Site power option 2 for DC with/without short term BBU from System Module:

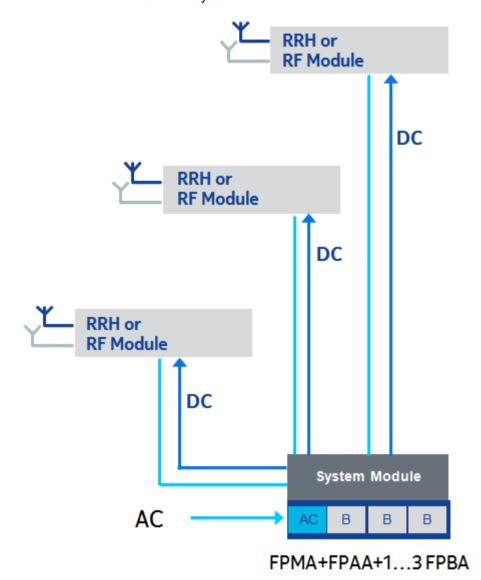


Figure 100: Feederless BTS Site power option 2: DC with/without short term BBU from System Module

- RF Module DC input from System Module
- Maximum Length of the optical cable with Multimode SFPs is is 200 m
- Maximum DC cable length is 200m*, when DC voltage at the FSMx side is 48V.
- System BBU time with FPMA+ 2 FPAAs+ 2 FPBAs about 10 minutes with typical 1+1+1 @ 40 W
- * In case of full support for battery operation, the max. DC cable may only be 145m due to the lower input voltage to the FSMx.

Feederless BTS Site power option 1: AC with full BBU

The following figure illustrates the Feederless BTS Site power option 1 for AC with full BBU:

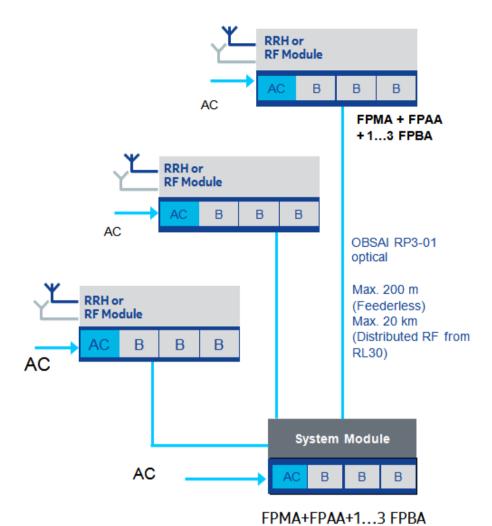


Figure 101: Feederless BTS Site power option 1: AC with full BBU

- Feederless
- System Module AC powered
 - optional battery back up
 - FPMA + FPAA + 1...3 FPBA
 - up to 3 hours with 3 FPBAs
- RF Module/RRH AC powered
 - 1 or 3 sector RF Module
- optional battery back up
 - FPMA + FPAA + 1...3 FPBA
 - up to 2 hours with 3 FPBAs
 - (1 sector RF Module typical)

Feederless BTS Site power option 3

The following figure illustrates the Feederless BTS Site power option 3:

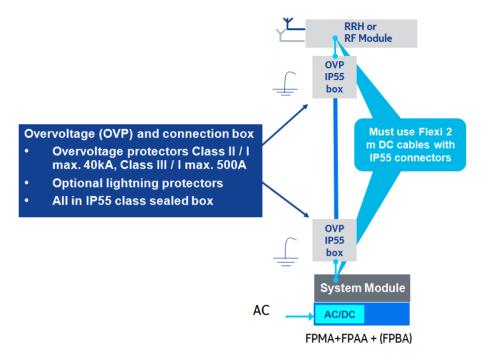


Figure 102: Feederless BTS Site power option 3

Summary: Flexi Multiradio BTS TD-LTE and Module Overview

Module Summary

This module covered the following learning objectives:

- Recall the LTE system and Flexi Multiradio BTS LTE products.
- List the Flexi Multiradio BTS installation options.
- List the modules of the Flexi Multiradio BTS LTE.
- Describe the main function of each module in the Flexi Multiradio BTS LTE.
- Describe the installation configuration options for the Flexi Multiradio BTS LTE.
- Describe the additional modules for the Flexi Multiradio BTS TD-LTE.

Flexi Multiradio BTS TD-LTE Installation Review

Module Objectives

- Describe the Flexi Multiradio 10 BTS installation process.
- Describe how to install Flexi Multiradio 10 BTS optional sub-modules.
- Explain how to install stand-alone Flexi Multiradio 10 BTS on the floor.
- Explain how to mount stand-alone Flexi Multiradio 10 BTS on the wall.
- Explain how to mount stand-alone Flexi Multiradio 10 BTS on a pole.
- Describe how to install the Indoor Flexi Multiradio 10 BTS (FSIH).

Flexi Multiradio 10 BTS installation process

Installation Overview

Main tasks of the Flexi Multiradio BTS installation process:

- 1. Unpack and check the contents of the delivery
- 2. Install the plinth
- 3. Connect the plinth to the site main ground
- 4. Install the modules
- 5. Ground the modules
- 6. Connect the necessary cables
- 7. Commission the BTS
- 8. Complete the installation

Preparing modules for installation

The main purpose of this procedure is to fix the module back covers and cable entries before the installation (except for the System Module).



FMCF Flexi mounting covers for back and front must be used with Flexi Multiradio 10 BTS Outdoor System Module. Make sure you always use FMCF covers.

The following figures illustrate preparing the modules for installation:

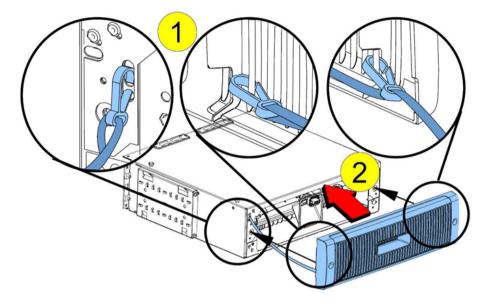


Figure 103: Preparing modules for installation 1/2

- 1. Fix the maintenance strap (pole or wall installation only).
- 2. Fix the module back cover with two screws.

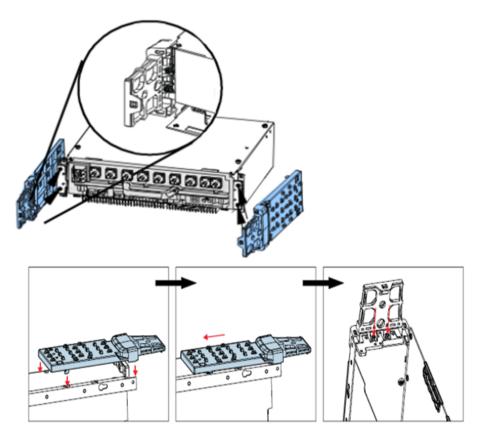


Figure 104: Preparing modules for installation 2/2

- 3. Fix the two cable entries as follows:
- Insert the cable entry hooks to the slots on the casing.
- Push the cable entry and make sure the hooks are at the right location.
- Secure the cable entry by fastening the two screws at the front of the casing.

Grounding principle of Flexi Multiradio 10 BTS

Before you start

A site grounding cable is not included in the delivery. Make sure you have the necessary grounding cables. Do not chain the grounding cables.

When modules are installed inside a cabinet, no separate earthing (grounding) cable for the modules is required. The cabinet provides adequate earthing (grounding).

If the Base Transceiver Station (BTS) has more than one plinth, connect the main earth (ground) to one of the plinths and earth (ground) all the modules to that plinth. Alternatively, earth (ground) the modules to their own plinths and then connect the plinths to the main earth (ground).

The use of dual-hole grounding lugs (up to six) is supported from Flexi Mounting kit for Floor, Wall and Pole (FMFA) v. 105 onwards.

The following figure illustrates the grounding principle of Flexi Multiradio 10 BTS:

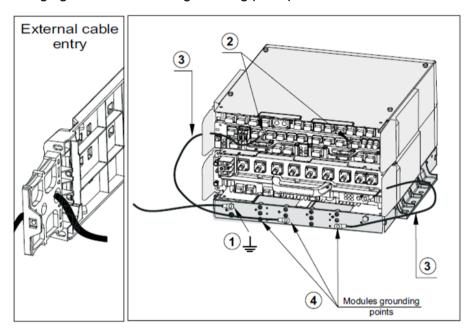


Figure 105: Grounding principle of Flexi Multiradio 10 BTS

- 1. Ground the plinth to the site main ground.
- 2. Connect the grounding cable to the grounding point in the module front panel.
- **3.** Route the grounding cable through the cable entry.
- **4.** Connect the other end of the cable to the grounding point in the plinth.
- **5.** Repeat steps 2-4 for each module.
- **6.** Fix the excess cables to the cable support plates with cable ties.

Installation of Flexi Multiradio 10 BTS optional sub-modules

Installing Power Distribution Sub-Module (FPFD)

The following figures illustrate installing power distribution sub-module:

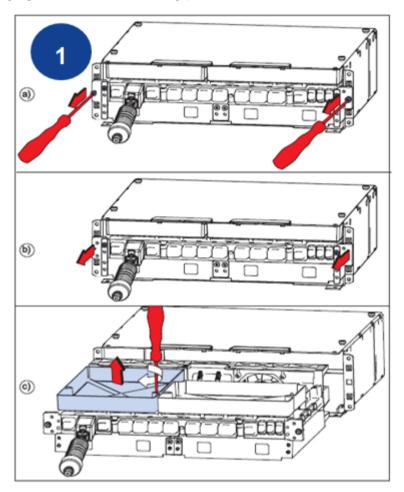


Figure 106: Installing Power Distribution Sub-Module (FPFD) 1/7

- 1. Remove the FPFD dummy unit as follows:
- a) Undo the screws holding the FSMx core in place.
- b) Pull out the core.
- c) Remove the three screws holding the FPFD dummy unit in place.

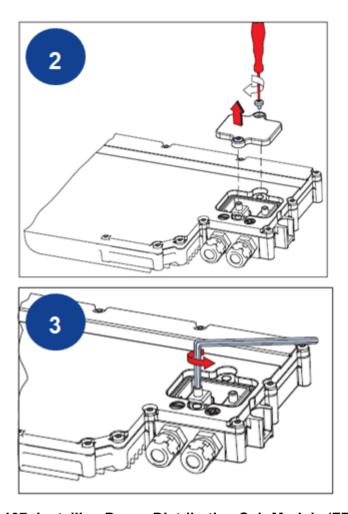


Figure 107: Installing Power Distribution Sub-Module (FPFD) 2/7

- 2. Remove the DC screw terminal cover.
- 3. Loosen the screw terminals with an Allen key.

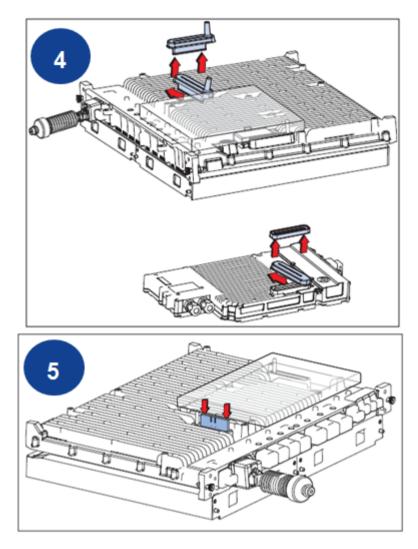
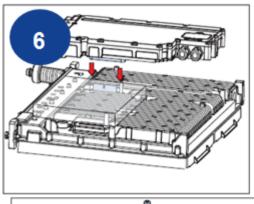


Figure 108: Installing Power Distribution Sub-Module (FPFD) 3/7

- 4. Remove the rubber plugs on the core and the FPFD.
- 5. Insert the connection card to the slot on the FSMx core.



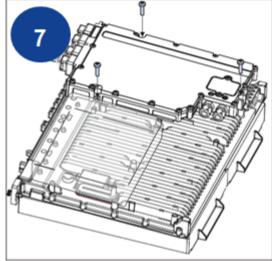


Figure 109: Installing Power Distribution Sub-Module (FPFD) 4/7

- 6. Align the FPFD with the guide pin on the FSMx core, and push the FPFD in place.
- 7. Fix the FPFD with 3 x M5x25 screws (included in the accessory bag) and tighten to 4.0 Nm.

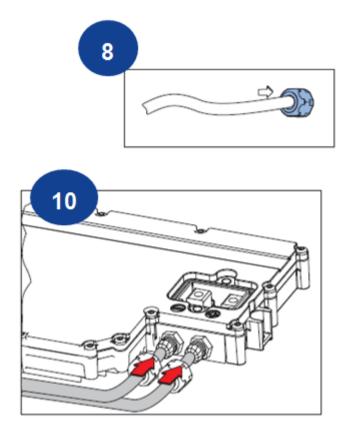
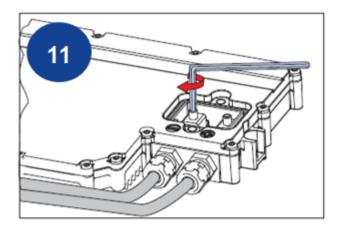


Figure 110: Installing Power Distribution Sub-Module (FPFD) 5/7

- 8. Strip the DC input cable as needed.
- 9. Take the two cable glands off and thread your DC input cable through the glands.
- 10. Replace the cable glands with the DC input cable routed through them.



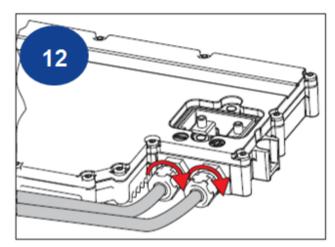


Figure 111: Installing Power Distribution Sub-Module (FPFD) 6/7

- 11. Insert the DC input cable to the screw terminals and tighten them to 6 Nm with an Allen key
- 12. Tighten the cable glands.

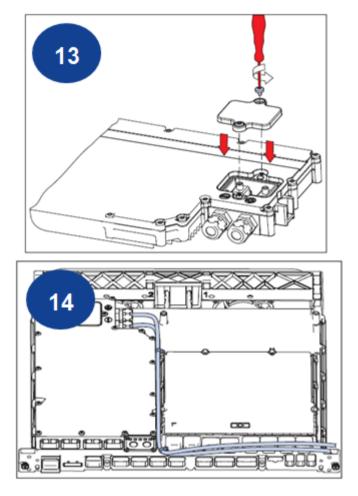


Figure 112: Installing Power Distribution Sub-Module (FPFD) 7/7

- 13. Replace the DC screw terminal cover.
- 14. Route the DC input cable between the FPFD and dummy unit or transmission submodule (depending on your configuration).
- 15. Re-insert the module core and fix the screws.

Installing one Capacity Extension Sub-Module (FBBA)

The following figures illustrate installing one Capacity Extension Sub-Module (FBBA):

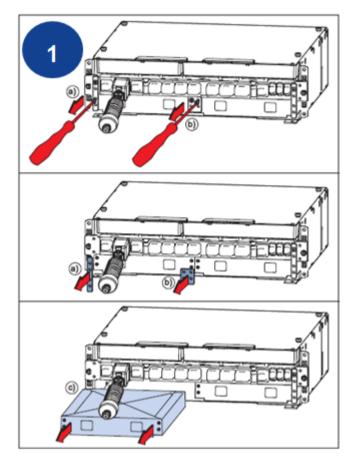


Figure 113: Installing one Capacity Extension Sub-Module (FBBA) 1/2

- 1. Remove the dummy unit as follows:
- a) Remove the side flange.
- b) Remove the middle flange between the dummy units.
- c) Pull out the dummy unit.

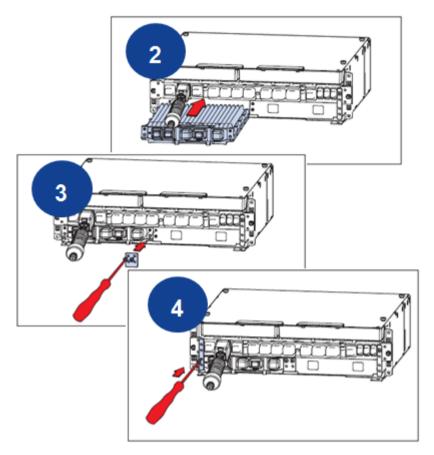


Figure 114: Installing one Capacity Extension Sub-Module (FBBA) 2/2

- 2. Insert the extension sub-module.
- 3. Fix the middle flange back in place between the extension sub-module and the remaining dummy unit.
- 4. Fix the side flange back in place.

ANOTE

Tighten the screws as follows:

Dummy unit (plastic): 0.8 Nm

Metal parts: 2.4 Nm

Installing two Capacity Extension Sub-Module (FBBA)

The following figures illustrate installing two Capacity Extension Sub-Module (FBBA):

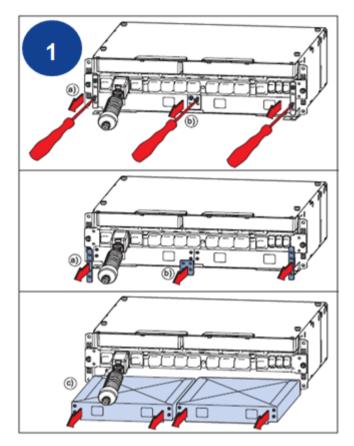
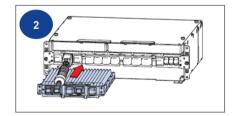


Figure 115: Installing two Capacity Extension Sub-Module (FBBA) 1/3

- 1. Remove the dummy unit as follows:
- a) Remove the side flanges on each side of the FSMx core.
- b) Remove the middle flange between the dummy units.
- c) Pull out the dummy units.



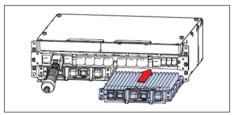
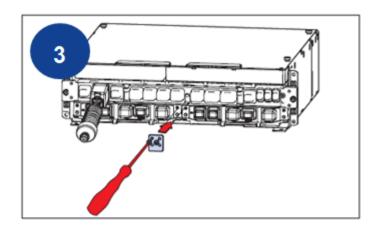


Figure 116: Installing two Capacity Extension Sub-Module (FBBA) 2/3

2. Insert the extension sub-modules.



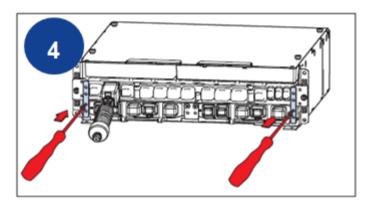


Figure 117: Installing two Capacity Extension Sub-Module (FBBA) 3/3

- 3. Fix the middle flange back in place between the extension sub-modules.
- 4. Fix the side flanges back in place on each side of the FSMx core.

ANOTE

Tighten the screws to 2.4 Nm.

Installation of stand-alone Flexi Multiradio 10 BTS on the floor

Anchoring the plinth on the floor

The following figure illustrates anchoring the plinth on the floor:

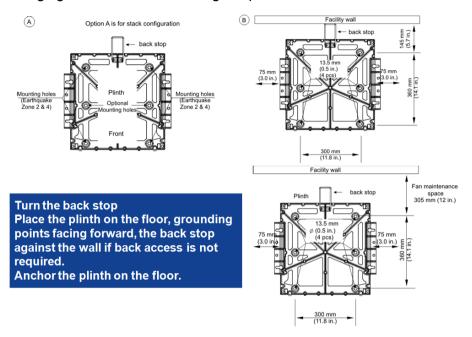


Figure 118: Anchoring the plinth on the floor

The plinth is mandatory when the modules are not mounted in an optional cabinet or 19 inch rack.

Anchor the plinth on the floor with four anchoring bolts, 12 mm (0.47 in) in diameter, and tighten it to 49 Nm. The plinth must be fixed to the floor to meet the Earthquake Zone 4 requirement.

Next, ground the plinth to the site main ground. For more information, see section *Grounding principle of Flexi Multiradio 10 BTS*.

Stack Installation

The following figure illustrates the stack installation:

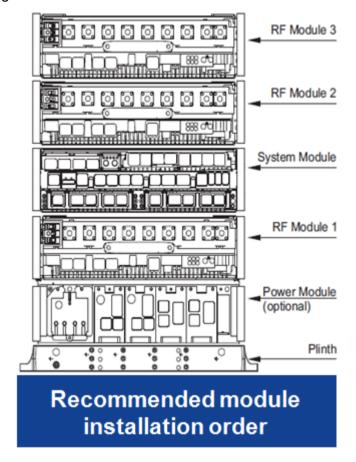


Figure 119: Stack Installation

The four module fixing screws between the module core and the module casing must be tightened to 5 Nm (factory default is 2.2 Nm).

- The stand-alone BTS (without a cabinet) can be installed on the floor in a stack of up to **9** modules (maximum height **22U**).
- Max. 5 modules (maximum height 15U) for the earthquake requirement for Zone
- Max. 6 modules in a stack meets the vibrational requirements for earthquake Zone 2.

Installing modules on the floor

The following figures illustrate installing the modules on the floor:

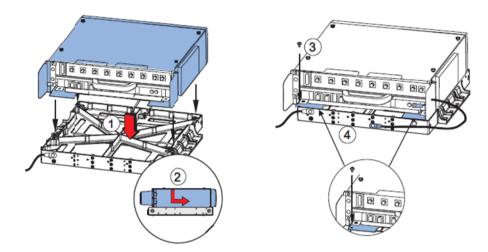


Figure 120: Installing modules on the floor 1/2

- 1. Align the holes on the first module bottom with the fixing studs on the plinth. Line up the locating marks on the side of the module to help aligning the holes with fixing studs.
- 2. Align the module markings and push the module back until it stops.
- 3. Attach the module to the plinth with two screws.
- 4. Connect the module grounding cable between the module front panel and the plinth.

Route the cable through an external cable entry. See *Grounding principle of Flexi Multiradio 10 BTS* for more information.

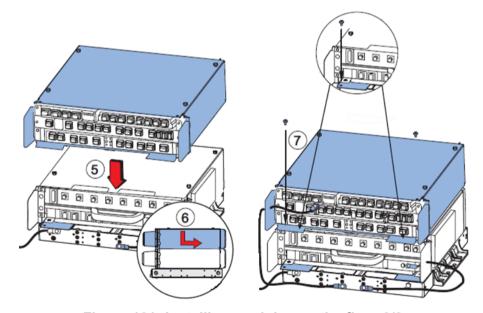


Figure 121: Installing modules on the floor 2/2

- 5. Align the holes on the second module bottom with the fixing studs on the first module.
- 6. Push the module back until it stops.

- 7. Attach the modules to each other with two screws.
- 8. Connect the module grounding cable between the module front panel and the plinth. Route the cable through an external cable entry.
- 9. Repeat the steps for each subsequent module.

Installation example: modules on the floor

An example of the basic configuration of one System Module and three RF Modules installed on the floor.

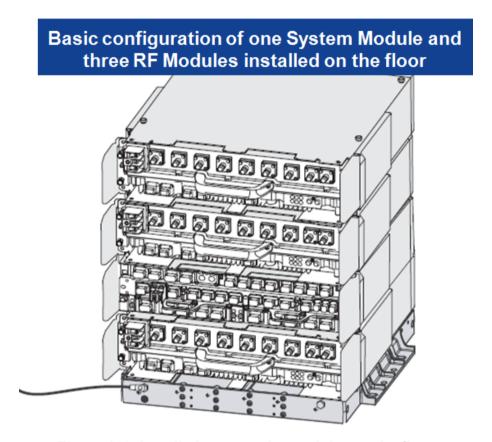


Figure 122: Installation example: modules on the floor

Mount stand-alone Flexi Multiradio 10 BTS on the wall

Mounting the plinth on a wall

A plinth is required for mounting the modules on a wall.

If installing additional plinths one upon the other, the distance between the upper mounting screw holes in first and second plinth must be 550 mm (21.7 in) minimum.

A NOTE

A Flexi Multiradio 10 BTS can only be installed as a right-hand installation due to optical cable routing reasons. Take this into account when installing the plinth.

The following figures illustrate mounting the plinth on a wall:

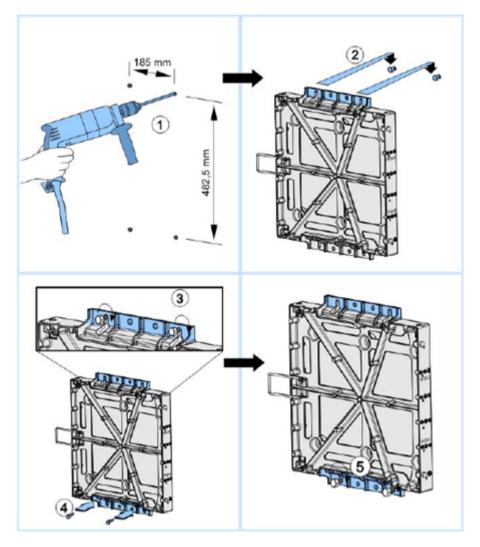


Figure 123: Mounting the plinth on a wall 1/2

- 1. Mark the mounting screw locations on the wall and drill the holes for the screws.
- 2. Fix the upper mounting screws to the wall, lift the plinth on the wall and fit it to the mounting screws. Check that the plinth is level.
- 3. Tighten the upper mounting screws.
- 4. Insert the lower mounting screws.
- 5. Tighten the lower mounting screws.

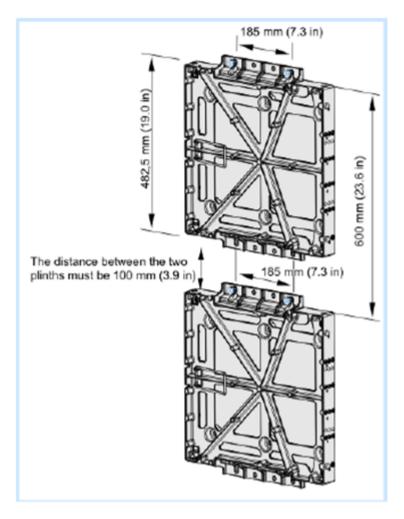


Figure 124: Mounting the plinth on a wall 2/2

- 6. Make sure that the plinth is not twisted.
- 7. If you are installing more than one plinth, repeat steps 1-6 for each plinth. *Note that the required space between the plinths is 100 mm*.
- 8. Next, ground the plinth to the site main ground.

Wall installation

The stand-alone BTS can be installed on a wall.

To meet the earthquake requirement Telcordia GR-63-CORE and the vibrational requirements for Earthquake Zone 4, the four module fixing screws between the module core and the module casing must be tightened to 5 Nm (factory default is 2.2 Nm).

The following figure illustrates the wall installation:

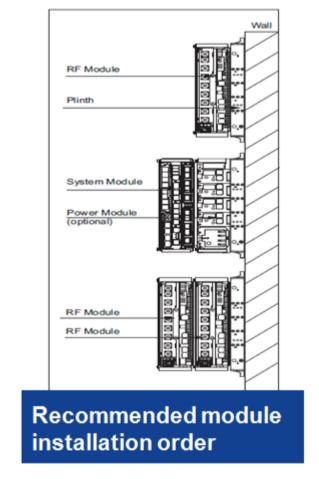


Figure 125: Wall installation

- The maximum number of modules per plinth is two.
- If you are going to install Flexi Power Module (FPMA), it should be installed on the same plinth as the System Module.

Correct and Incorrect installation

The following figure illustrates the correct and incorrect installation:

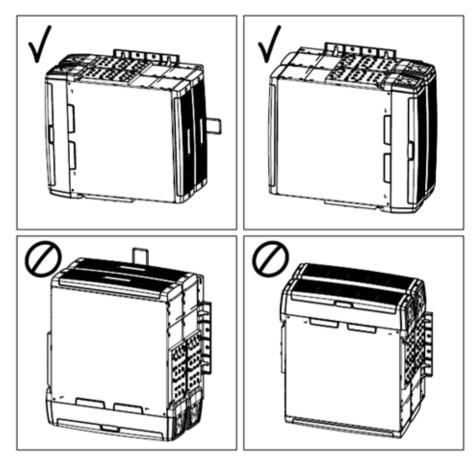


Figure 126: Correct and Incorrect installation

- Incorrect installation may lead to damage to the modules.
- The modules must be installed with the front panels facing left or right.
- Do not install the modules with the front panels facing up or down.

Mounting the modules to the wall

When you attach the module casing to the plinth with two screws, secure the screws with a thread-locking compound in pole and wall installations.

Use non-permanent thread-locking compound of medium strength (for example Loctite 243 or equivalent).

The following figures illustrate mounting the modules to the wall:

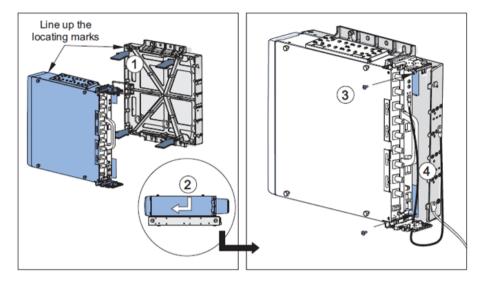


Figure 127: Mounting the modules to the wall 1/3

- 1. Align the holes on the first module's bottom with the fixing studs on the plinth. Line up the locating marks on the side of the module to help aligning the holes with fixing studs.
- 2. Push the module back until it stops.
- 3. Attach the module casing to the plinth with two screws.
- 4. Connect the module grounding cable between the module front panel and the plinth.

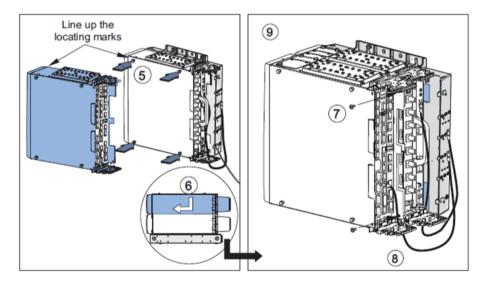


Figure 128: Mounting the modules to the wall 2/3

- 5. Align the holes on the second module's bottom with the fixing studs on the first module.
- 6. Push the module back until it stops.
- 7. Attach the module casings to each other with two screws.
- 8. Connect the module grounding cable between the module front panel and the plinth.

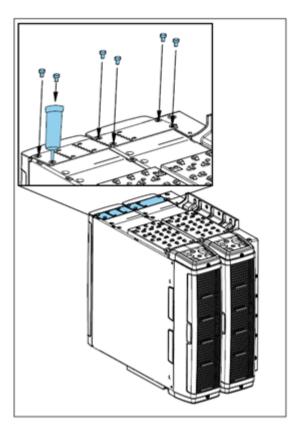


Figure 129: Mounting the modules to the wall 3/3

- Attach the fixing plates across the module casings on both sides of the modules and fix with six screws and spring washers.
- Repeat the steps above to install the remaining modules to a separate plinth or plinths.
- One plinth can have two modules installed. A configuration of one System Module and three RF Modules therefore requires two plinths.

Installation example: modules on the wall

The following figure illustrates the installation example for modules on the wall:

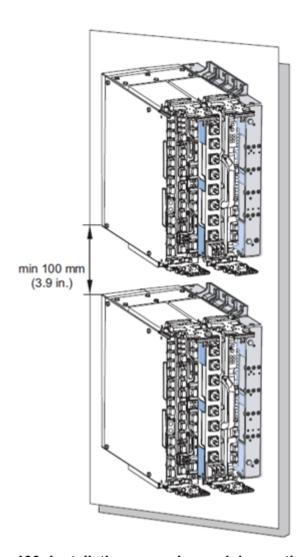


Figure 130: Installation example: modules on the wall

- An example of the basic configuration of one System.
- Module and three RF Modules installed on the wall.
- The installation in the figure is a right-hand installation.

Mount stand-alone Flexi Multiradio 10 BTS on a pole

Mounting the plinth on a pole with FPKA

A plinth and Flexi Pole Mounting Kit (FPKA) are required for mounting modules on the pole.

FPKA is designed for poles between 60 mm (2.4 in) and 120 mm (4.7 in) in diameter.

FPKA has room for four 3U modules. The modules can be installed on the opposite sides of FPKA.

The following figures illustrate mounting the plinth on a pole with FPKA:

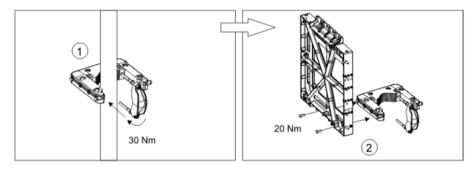


Figure 131: Mounting the plinth on a pole with FPKA 1/3

- 1. Fix the upper mounting bracket on the pole and tighten the mounting bracket screws (M10) to 30 Nm.
- 2. Fix one side of the lower pole mounting bracket on the plinth with the mounting screws (M8). Tighten the screws to 20 Nm.

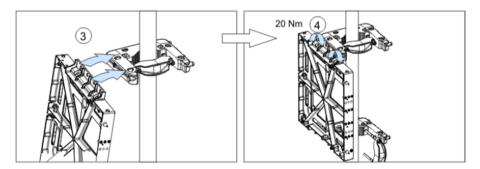


Figure 132: Mounting the plinth on a pole with FPKA 2/3

- 3. Lift the plinth on the pole and fit it to the pole mounting bracket's mounting screws.
- 4. Tighten the screws (M8) to 20 Nm.

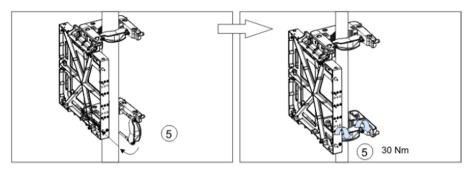


Figure 133: Mounting the plinth on a pole with FPKA 3/3

- 5. Fix the lower mounting bracket on the pole and tighten the mounting bracket screws (M10) to 30 Nm.
- 6. Make sure that the pole mounting brackets are aligned and the plinth is not twisted.



If a second plinth is required, install it on the other side of the pole mounting bracket (if there is enough space).

Pole Installation

Perform the installation as completely as possible before lifting the modules especially when installing the BTS to a high location.

Secure the screws with a thread-locking compound in pole and wall installations. Use non-permanent thread-locking compound of medium strength (for example Loctite 243 or equivalent).



Incorrect installation may lead to damage to the modules. The modules must be installed with the front panels facing left or right. Do not install the modules with the front panels facing up or down.

Excess torsion damages the casings. In wall and pole installations, do not install more than two modules per plinth.

The following figure illustrates the pole installation:

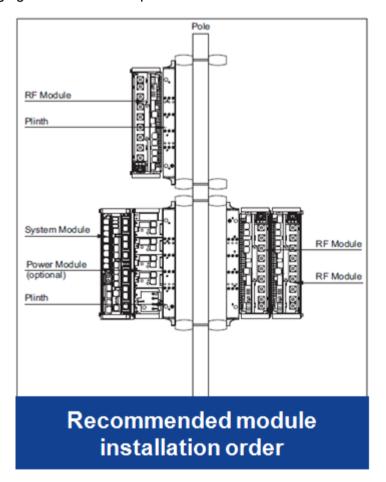


Figure 134: Pole Installation

- Before you start, please check that:
 - The plinth is grounded.
 - One mounting plinth per two modules is installed on a pole.
 - The four module fixing screws between the module core and the module casing have been tightened to 5 Nm (factory default is 2.2 Nm).

If you are going to install Flexi Power Module (FPMA), it should be installed on the same plinth as the System Module.

Mounting modules on a pole

The following figures illustrate mounting the modules on a pole:

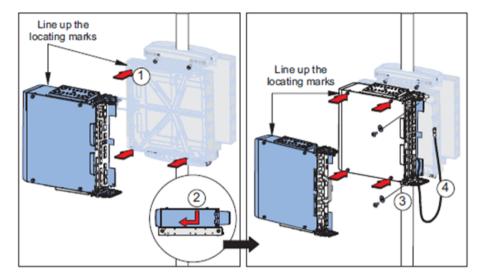


Figure 135: Mounting modules on a pole 1/3

- 1. Align the holes on the first module's bottom with the fixing studs on the plinth. Line up the locating marks on the side of the module to help aligning the holes with fixing studs.
- 2. Push the module back until it stops.
- 3. Attach the module casing to the plinth with screws and spring washers.
- 4. Connect the module grounding cable between the module front panel and the plinth.

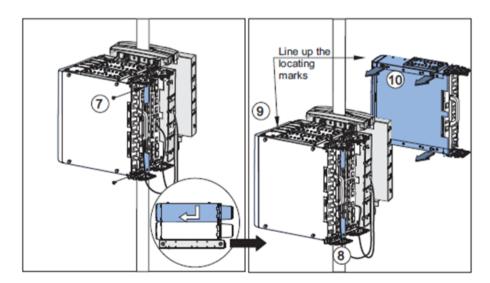


Figure 136: Mounting modules on a pole 2/3

- 5. Align the holes on the second module's bottom with the fixing studs on the first module. Line up the locating marks on the side of the module to help aligning the holes with fixing studs.
- 6. Push the module back until it stops.
- 7. Attach the module casings to each other with screws and spring washers.

8. Connect the module grounding cable between the module front panel and the plinth.

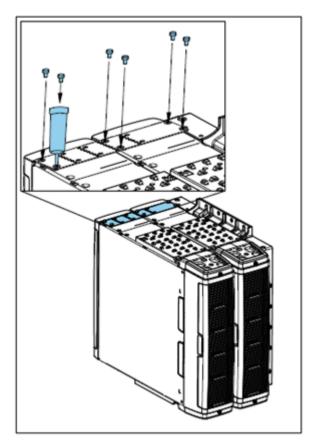


Figure 137: Mounting modules on a pole 3/3

- In case of two modules on one plinth, attach the fixing plates across the module casings on both sides of the modules and fix with six screws and spring washers.
- Repeat the steps above to install the remaining modules to a separate plinth.
- One plinth can have a maximum of two modules installed. A configuration of one System Module and three RF Modules therefore requires two plinths.

Installation example: modules on the pole

The following figure illustrates the installation example for modules on the pole:

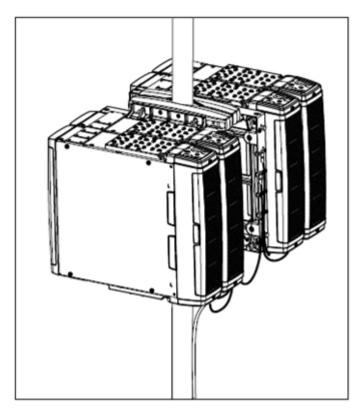


Figure 138: Installation example: modules on the pole

- An example of the basic configuration of one System Module and three RF Modules installed on a pole.
- The installation in the figure is a right-hand installation.

Installation of Indoor Flexi Multiradio 10 BTS (FSIH)

Grounding Principles

The following figure illustrates the grounding principles:

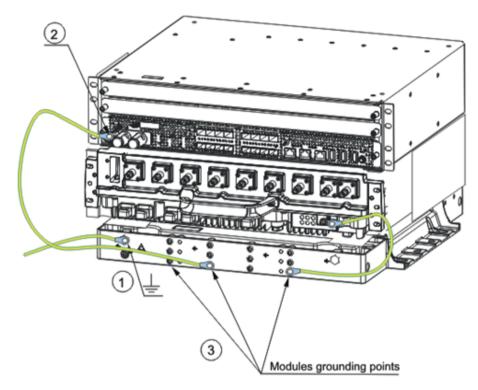


Figure 139: Grounding Principles

- 1. Ground the plinth to the site main ground.
- 2. Connect the grounding cable to the grounding point on the module front panel. There is a factory-installed M5 screw on one of the System Module grounding points.
- **3.** Connect the other end of the cable to the grounding point on the plinth.
- **4.** Repeat steps 2-3 for each module in your configuration.
- **5.** Fix the excess cables to the sides of the casings with cable ties.

Installing First Capacity Extension (FBIH)

The following figure illustrates installing first capacity extension (FBIH):

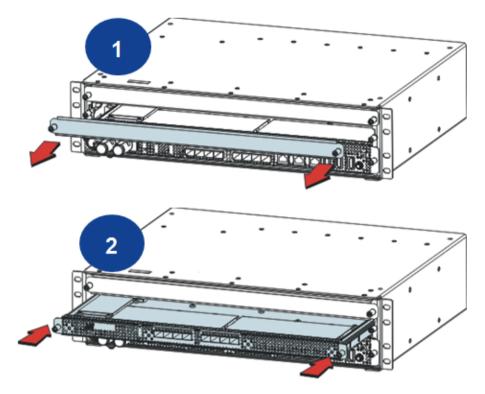


Figure 140: Installing First Capacity Extension (FBIH)

- **1.** Remove the dummy panel in the middle. Leave the other dummy panel in place if you are not installing any other optional sub-modules.
- 2. Insert the capacity extension sub-module into the free slot.

Installing Second Capacity Extension (FBIH)

The following figure illustrates installing second capacity extension (FBIH):

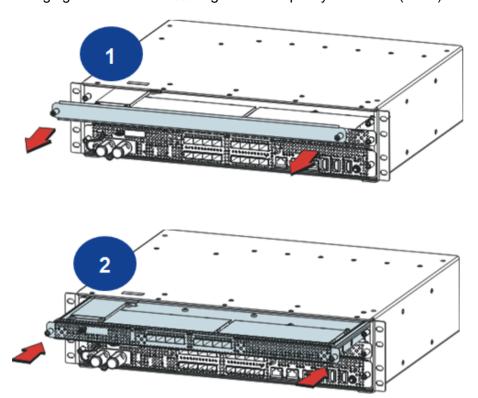


Figure 141: Installing Second Capacity Extension (FBIH)

- **1.** Remove the top dummy panel.
- 2. Insert the capacity extension sub-module into the upper slot.

Wall installation

The following figures illustrate the wall installation:

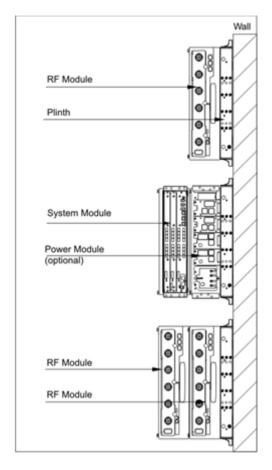


Figure 142: Wall Installation 1/2

Check that:

- The plinth is installed as instructed. See Mounting the plinth on a wall for plinth installation instructions.
- The plinth is grounded.
- There is one plinth per two modules.
- If applicable, other modules in the configuration have been installed.

A NOTE

Flexi Multiradio 10 BTS can only be installed as a right-hand installation because of optical cable routing reasons.

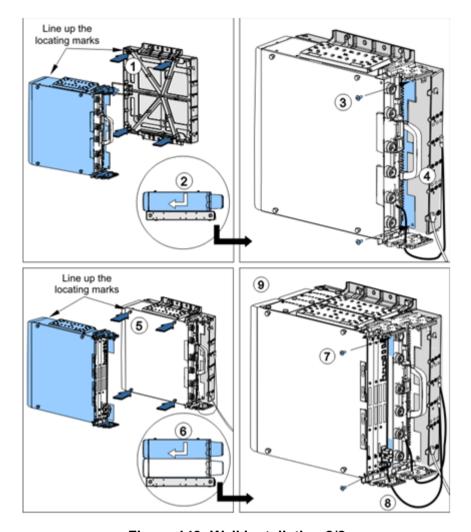


Figure 143: Wall Installation 2/2

- **1.** Remove the two fixing studs from the front of the plinth or topmost casing.
- 2. Remove the two screws at the bottom at the back of the casing.
- **3.** Fix the two plinth brackets at the back of the casing.
- **4.** Align the plinth brackets with the remaining two fixing studs on the plinth and slide the module in place.
- 5. Fix the plinth bracket screws.
- 6. Check final steps on last graphic.
- **7.** At the front, fix the casing to the plinth or casing with screws.
- **8.** Make sure a grounding cable is connected between the module front panel and plinth.

Summary: Flexi Multiradio BTS TD-LTE Installation Review

Module Summary

This module covered the following learning objectives:

- Describe the Flexi Multiradio 10 BTS installation process.
- Describe how to install Flexi Multiradio 10 BTS optional sub-modules.
- Explain how to install stand-alone Flexi Multiradio 10 BTS on the floor.
- Explain how to mount stand-alone Flexi Multiradio 10 BTS on the wall.
- Explain how to mount stand-alone Flexi Multiradio 10 BTS on a pole.
- Describe how to install the Indoor Flexi Multiradio 10 BTS (FSIH).

Flexi Multiradio BTS TD-LTE Transport

Module Objectives

- describe the Transport Security problems and solution
- · define Transport Overhead, Dimensioning, and Synchronization
- interpret Quality of Service in IP transport
- explain the Flexi Multiradio BTS Transport Configuration Options
- describe the FTIF and its Configuration

Transport Security problems and solution

EUTRAN Interfaces

The following figure represents the EUTRAN Interfaces:

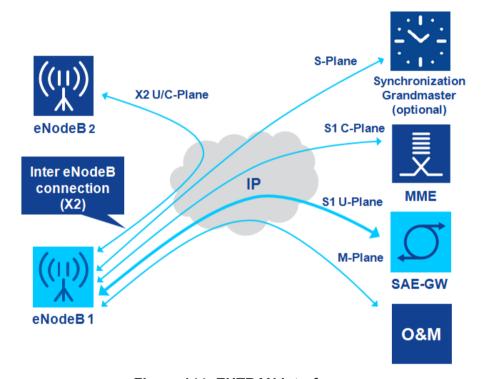


Figure 144: EUTRAN Interfaces

Transport Security – New Threats

The following figuere represents the Transport Security – New Threats:

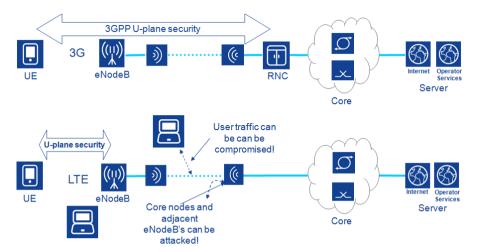


Figure 145: Transport Security – New Threats

Location of base station changes:

- · Traditionally in secure, locked sites
- In future increasingly in public places or homes

Attack methods evolve:

- · Better attack tools are widely available
- Higher processing power to break algorithms
- Higher processing power to break algorithms

IPSec with PKI is the Standardized Solution

The following figure represents the IPSec with PKI is the Standardized Solution:

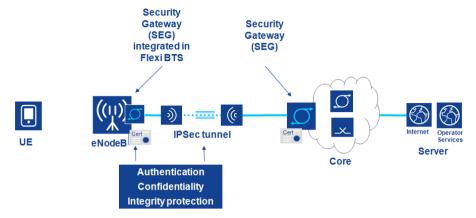


Figure 146: IPSec with PKI is the Standardized Solution

Relevant 3GPP standards:

- TS 33.210 Network Domain Security
- TS 33.310 Authentication Framework
- TS 33.401 Security Architecture

Asymmetric Cryptography: Public and Private Keys

The following figure represents the Asymmetric Cryptography: Public and Private Keys:

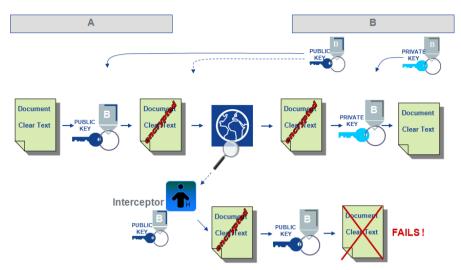


Figure 147: Asymmetric Cryptography: Public and Private Keys

Digital Certificate Concept



Figure 148: Digital Certificate Concept

- · It includes no secrets
- It is issued by a trusted authority which states "I guarantee that this particular public key is associated with this particular user, trust me!"
- It binds the entitys identity to the public key
- It contains at least:
 - Name of the user respectively subject certificate owner
 - A copy of the user's public key
 - Name of the trusted Authority respectively issuer Certificate Authority (CA)
 - Digital signature of the Certificate Authority

A subject could be any end entity that has an unique identity like:

- People
- Executable programs / SW
- Network elements like Web servers, a LTE Flexi Multiradio BTS ,...

User Plane Protocol Stack

The following figure represents the User Plane Protocol Stack:

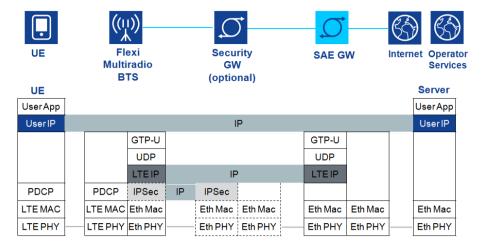
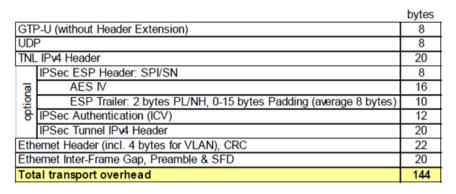


Figure 149: User Plane Protocol Stack

Transport Overhead, Dimensioning, and Synchronization

Transport Overhead

The following table represents the transport overhead:



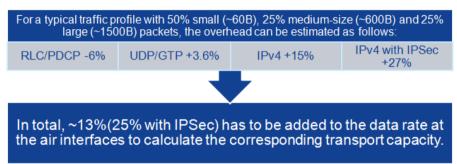


Figure 150: Transport Overhead

M-plane (~1Mbit/s) and C-plane (~0.3Mbit/s) capacity requirements are negligible compared to U-plane.

PDCP protocol for user plane data supports Robust Header Compression (ROHC) in order to minimize the amount of header data transmitted over the air interface. It is designed to improve performance and is particularly useful for transmitting small amounts of payload data, such as VOIP, where the amount of payload may be smaller than the header.

Third and fourth generation wireless systems are being designed to support a wide range of services, including audio and video applications. This service flexibility is achieved by relying on the Internet Protocol (IP), typically in conjunction with the User Datagram Protocol (UDP) and the Real Time Protocol (RTP).

One major problem with the IP based protocol architectures is the large overhead, which affects the limited bandwidth of wireless channels. A low bit rate speech application can result in IP packets with a ratio of 30 bytes of payload to 60 bytes of overhead. RObust Header Compression (ROHC) has been proposed to compress the protocol headers for packet transmission over a wireless link. To quote from RFC3095,Bandwidth is the most costly resource in cellular links.

Processing power is very cheap in comparison. Implementation or computational simplicity of a header compression scheme is therefore of less importance than its compression ratio and robustness. With IPv4 protocol overhead for voice may be reduced by as much as 85%.

The overall reduction depends heavily on the size of the payload. For GSM Voice overall BW is reduced by almost 50%. The saving in overhead varies depending on the traffic models used.

Dimensioning Based on Air Interface Capacity

The following figure represents the Dimensioning Based on Air Interface Capacity:

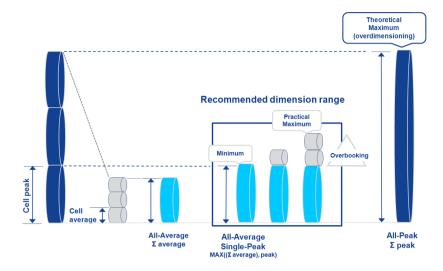


Figure 151: Dimensioning Based on Air Interface Capacity

In most cases, *All-Average/Single-Peak* is a reasonable trade-off between user service capabilities and transport capacity requirements, which may have a great impact on the operating costs. With that approach, advertised user service peak rates up to the cell peak rate can be momentarily supported in one cell.

The advertised user service rate will be, however, only a fraction of the cell peak rate. It is mainly driven by fixed broadband user experience (xDSL service rates) and applications and will be enforced by LTE QoS parameters. This also means that multiple users can be supported with that rate simultaneously.

With service differentiation, different maximum rates could be applied to different users. For example, premium users could be served with highest rates. If the number of users is low, transport costs could be reduced even further if the user service rate will be applied for dimensioning instead of the cell peak rate.

In summary, All-Average/Single Peak is a good trade-off in general, but it may be under-dimensioned for hot spots where users are located close to the antenna in multiple cells of the same eNodeB. The practical maximum of air interface throughput could be achieved under such conditions, adding average capacity of the remaining cells to the one cell operating with peak rate.

As illustrated in the above figure, this defines the recommended dimensioning range. Additional transport capacity beyond that range cannot be utilized realistically. In particular, the *All-Peak* concept will always lead to over-dimensioning, thus usually extra costs. However, if fiber is available at eNodeB sites, the incremental cost impact may be tolerable. So, there will be cases where the operator requires that the transport sub-system shall be no bottleneck at all.

Dimensioning Example: All-Average/Single-Peak Throughput 1+1+1/10MHz

The following figure represents the Dimensioning Example: All-Average/Single-Peak Throughput 1+1+1/10MHz:

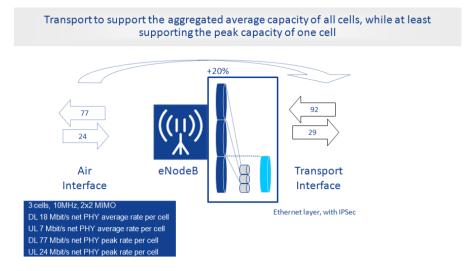


Figure 152: Dimensioning Example: All-Average/Single-Peak Throughput 1+1+1/10MHz

Dimensioning: Max (3 x average rate, peak rate). M-plane (~1Mbit/s), C-plane (~0.3Mbit/s), X2 U-plane (~30ms bursts) not included.

Dimensioning Example: All-Peak S1 Throughput 2+2+2/20MHz

The following figure represents the Dimensioning Example: All-Peak S1 Throughput 2+2+2/20MHz:

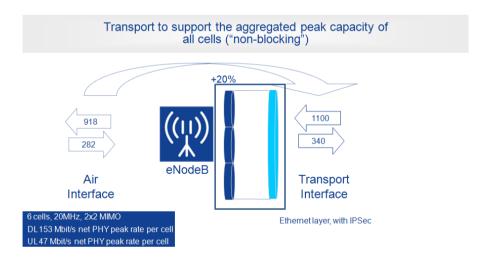


Figure 153: Dimensioning Example: All-Peak S1 Throughput 2+2+2/20MHz

Dimensioning: 6 x peak rate. M-plane (~1Mbit/s), C-plane (~0.3Mbit/s), X2 U-plane (~30ms bursts) not included.

Frequency Synchronization via Transport Network

The following figure represents the Frequency Synchronization via Transport Network Overview 1/2:

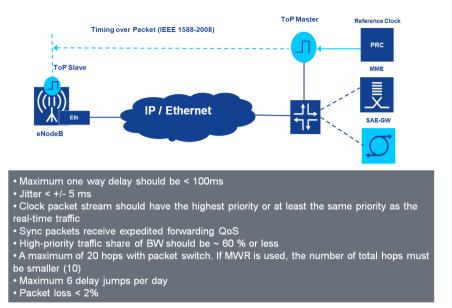


Figure 154: Frequency Synchronization via Transport Network Overview (1/2)

The following figure represents the Frequency Synchronization via Transport Network Overview 2/2:

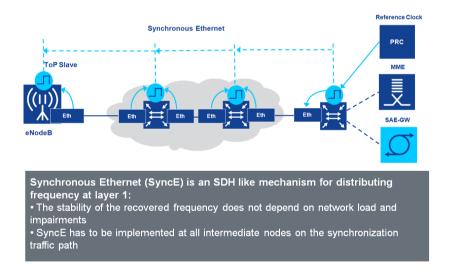


Figure 155: Frequency Synchronization via Transport Network Overview (2/2)

Synchronization Hub (LTE612)

The following figure illustrates the Synchronization Hub (LTE612):

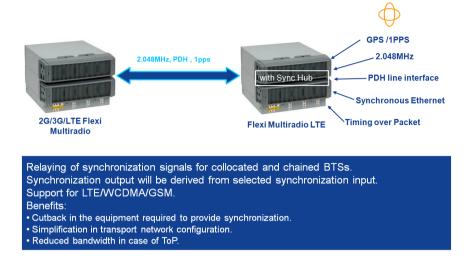


Figure 156: Synchronization Hub (LTE612)

In practice the number of chained eNodeBs depends on the input signal quality at the first eNodeB. If the jitter/wander level is within the ITU-T limits in the whole chain, a maximum of 20 Flexi System Modules can be used. In SyncE networks, SyncE-filtered Ethernet Equipment Clock (EEC) is more reliable than ToP and fulfills Maximum Time Interval Error (MTIE) limit for E1 (G.823) and T1 (G.824). Therefore SyncE networks use EEC to synchronize PDH and 2.048MHz interfaces.

The ToP clock is additionally filtered by collocated system clock to fulfill G.823 requirements (packet delay variation, delay jumps) under all possible network conditions.

Synchronizing PDH and 2.048MHz outputs with eNodeB OCXO guarantees that potential disturbances caused for example by ToP (like extensive wander) are filtered appropriately. However, output clock is no longer traceable to Primary Reference Clock (PRC) in such case.

If eNodeB loses all sync sources, it switches to hold-over mode. Then the eNodeB OXCO keeps running with the last known control value and the sync output becomes squelchable. The 2.048MHz output signal can be squelched when the ext2M048ClkOutOn flag is set to false.



Note that the parameter controls can be switched ON/OFF in hold-over mode.

Synchronization Type

The following figure illustrates the Synchronization Type:

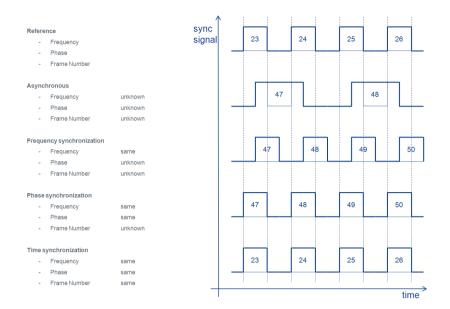


Figure 157: Synchronization Type

Quality of Service in IP transport

Quality of Service

Quality of Service Requirements

The following table lists the LTE user plane QoS requirements:

Table 17: LTE user plane requirements

QCI	Resource Type	Priority	Packet Delay Budget	Packet Loss Rate	Example Services
1	GBR	2	100 ms	10-2	Conversatio nal voice
2	GBR	4	150 ms	10-3	Conversatio nal video (live streaming)
3	GBR	5	300 ms	10-6	Non- conversatio nal video (Buffered streaming)
4	GBR	3	50 ms	10-3	Real time gaming
5	Non-GBR	1	100 ms	10-6	IMS Signaling
6	Non-GBR	7	100 ms	10-3	Voice, Video (Live Streaming) Interactive Gaming
7	Non-GBR	6			Video (Buffered Streaming)
8	Non-GBR	8	300 ms	10-6	TCP-based (for example, www, e- mail, chat, ftp, p2p file sharing, progressive video, etc.)
9	Non-GBR	9			

LTE Control and Management Plane QoS Requirements:

 In contrast to WCDMA, where RNL related requirements are imposed by a number of RAN functions over lub/lur (for example, Macro-Diversity Combining, Outer Loop Power Control, Frame Synchronization, Packet Scheduler), only HO performance is affected by transport latency Related C-planes protocol timers give implicitly an upper bound for the S1/X2 transport RTT (50ms default, configurable 10...2000ms)

U-plane delay requirements are determined by user service quality expectations. In general, the LTE system is designed for low latency. 3GPP 25.913 specifies ≤ 5ms one-way transit time for a 32 byte payload packet from UE to RAN edge node and vice versa. This defines a design target with respect to LTE system performance rather than a hard limit.

In contrast to that, 3GPP 23.401, Appendix B (Table 2), defines end-to-end service related QoS parameters which are associated with a Quality Class Identifier (QCI) per Service Data Flow (SDF) or per SDF aggregate.

Even though indicated in the table above otherwise, services using the reliable TCP transport 1 layer (e.g. web browsing using HTTP, FTP) may be very sensitive against transport delay. Due to its acknowledgement mechanism, a single TCP connection is rate limited by the ratio between the TCP window size and the round trip time (RTT).

Given a standard 64KB TCP window size (RFC793), 20ms RTT would limit the achievable service data rate at ~25Mbit/s for a single TCP connection. This limitation could be overcome with multiple TCP connections in parallel (typically the case for web browsing) and/or TCP Window Scaling (RFC1323), but other delay sensitive behavior (TCP slow start) will still affect the user experience.

Real-time end user applications For example VoIP, audio/video streaming) are typically designed so that they can tolerate jitter in the order of some tens of milliseconds, using a properly dimensioned jitter buffer.

LTE Radio to Transport QoS Mapping

The following table represents the LTE Radio to Transport QoS Mapping:

LTE Radio o		LTE	main					
LTE Traffic Class	QCI	Resource Type	→	DSCP	DiffServ PHB	Ethernet p-bits		
Conversational Voice	1	- GBR		46	EF	6		
Conversational Video	2			36	AF42	5		
Non-conversational Video	3			26	AF31	4		
Real Time Gaming	4			46	EF	6		
IMS signaling	5	non-GBR		34	AF41	5		
Voice, video, interactive gaming	6			28	AF32	4		
Video (buffered streaming)	7			18	AF21	3		
TCP-based (e.g. www, e-	8			10	AF11	1		
mail, ftp, p2p file sharing, etc.	9			0	BE	0		
Exemplary configuration (default)								

Figure 158: LTE Radio to Transport QoS Mapping

Transport Admission Control

In order to support a guaranteed bit rate, it is common practice to permit GBR connections (traffic) only up to a certain committed bit rate.

Connection Admission Control(CAC). CAC gives the possibility to restrict the number of connections (or, the bandwidth allocated to users) that is handled by the system.

Transport Admission Control (TAC) differentiates between the call types: emergency calls, handover calls, and normal GBR calls. By using different bandwidth limits for the admission of these calls, it is possible to implement different priorities for handover, emergency, and normal GBR calls

Example of Restriction of the GBR traffic to Metro Ethernet CIR

- Assuming that Metro Ethernet is used as a transport network with a total bandwidth of 100 Mbit/s and a CIR of 10 Mbit/s and TAC is configured as follows:
 Emergency treshold value (OAM parameter: TAC limit GBR emergency) is set to 9.5 Mbit/s
 Handover treshold value (OAM parameter: TAC limit GBR handover) is set to 8.5 Mbit/s
 Normal treshold value (OAM parameter: TAC limit GBR normal) is set to 7 Mbit/s

- All new GBR connections are accepted as long as the aggregated sum rate of GBR traffic does not
 exceed 7Mbit/s. Handover and emergency traffic would be accepted if the sum rate is between 7 and 8.5 Mbit/s. Only emergency calls would be accepted if the sum is between 8.5 and 9.5 Mbit/s. No connections would be accepted if the aggregated sum of GBR traffic exceeds 9.5 Mbit/s

Figure 159: Transport Admission Control

Radio Admission Control (RAC) is in charge of controlling admittance based on resources available for the air interface. (Information on available radio resources is obtained in C-plane via Radio Resource Management and via Radio Bearer Management units.)

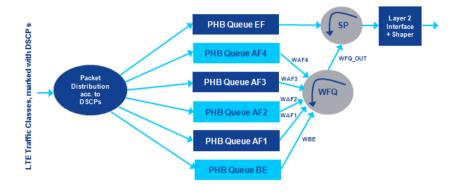
Transport Admission Control (TAC) is in charge of controlling admittance based on available resources on the transport network.

Transport Admission Control is limited by five major factors which are inherent to the approach and need to be clearly understood:

- TAC has no information about the traffic situation for any other eNodeB, routers in the transport backhaul network, nor about core network elements (SAE gateway, MME). It cannot work on a per-route basis, but only use the information it has available at the eNodeB where it is located
- TAC makes a decision to accept or reject a connection only at the moment it is requested. For GBR traffic, information about the expected bit rate is available at this moment, but for non-GBR traffic, there is no knowledge and no control about the future user behavior. There is no "policing" functionality that enforces user behavior as announced at connection set-up time
- TAC expects that GBR traffic will be handled with higher priority than non-GBR traffic in the transport scheduler and in the transport network. Non-GBR should be always suppressed there. However, mapping of traffic types to priorities (DSCP or PCP values) is configured by the operator. Inappropriate assignments may lead to unexpected behavior
- TAC is applied to the user traffic only. Other traffic which is not necessarily visible on the air interface, but provides additional load on the transport network, like for example: Timing over Packet data, must be considered in the dimensioning of TAC

Packet Scheduling

The following figure represents the Packet Scheduling:



The Flexi Transport sub-module performs packet scheduling using 6 queues with SPQ (Strict Priority Queuing) and WFQ (Weighted Fair Queuing).

- · Each Per-Hop-Behavior (PHB) is mapped to a queue
- Expedited Forwarding (EF) is served with Strict Priority Queuing (SPQ)
- Assured Forwarding (AF1...4) and Best Effort (BE) PHBs are served with Weighted Fair Queuing (WFQ)
- The highest priority queue is rate limited by Connection Admission Control

Figure 160: Packet Scheduling

Traffic Prioritization

The following figure represents the Traffic Prioritization:

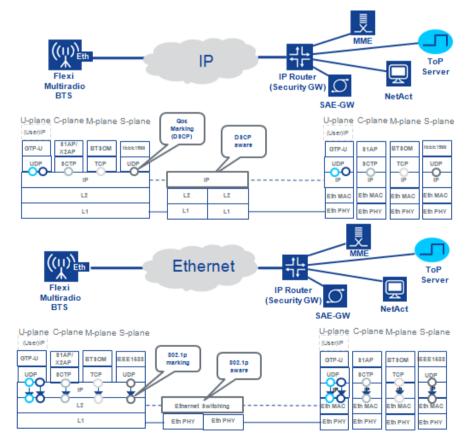


Figure 161: Traffic Prioritization

Flexi Multiradio BTS Transport Configuration Options

Flexi Multiradio BTS IP Address Model

The following figure represents the Flexi Multiradio BTS IP Address Model:

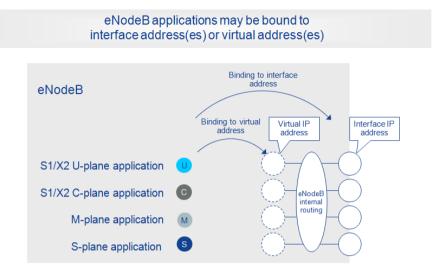


Figure 162: Flexi Multiradio BTS IP Address Model (1/2)

The eNodeB can be configured with separate IP addresses for User, Control, Management and Synchronization Plane applications.

Configurations where eNodeB applications are bound to virtual addresses are typically used in scenarios where the transport link (VLAN, IPsec tunnel) shall be terminated with one IP address while application separation on L3 is also required.

IP Addressing Examples

The following figure represents the IP Addressing Examples:

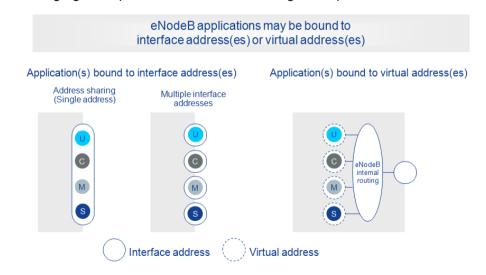


Figure 163: IP Addressing Examples

Address sharing, for example, configuration with the same IP address, is possible. In the simplest configuration, the eNodeB features a single IP address.

Flexi Multiradio BTS IP Address Model (2/2)

The following figure represents Flexi Multiradio BTS IP Address Model (2/2):

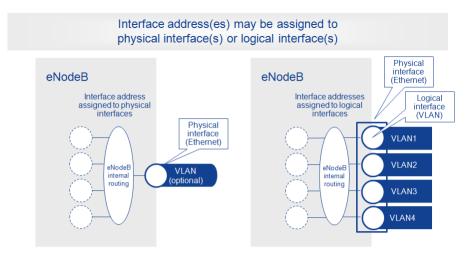


Figure 164: Flexi Multiradio BTS IP Address Model (2/2)

Possible data link layer interface types are Ethernet (physical interface) or VLAN (logical interface).

• RL10 supports one physical interface and maximum 4 logical interfaces

A physical interface is provided by an Ethernet port, whereas a logical interface is provided by a VLAN termination. Different interfaces belong to different IP subnets.

IP Addressing with IPSec Tunnel Mode

If IPSec Tunnel Mode is enabled, IPSec tunnel termination is bound to an interface address

Application(s) bound to interface address
Collapsed "inner" and "outer" address

Collapsed "inner" and "outer" address

Tunnel terminated at the interface address
("outer" address)

Single tunnel per eNodeB

Multiple tunnels per eNodeB

IPSec tunnel

W Tunnel

Single tunnel per eNodeB

VLAN optional

Figure 165: IP Addressing with IPSec Tunnel Mode

IP Addressing Example with VLAN and IPSec

U User plane

Separate interface IP address for IPSec tunnel termination, IP addresses per functional plane for traffic separation

• U/C/M-plane
• Bound to virtual addresses
• Forwarded via IPSec tunnel
• Assigned to VLAN

• S-plane
• Bound to interface address
• Bypassing the IPSec tunnel
• Assigned to the same VLAN

Application
IP address

Interface
IP address

Figure 166: IP Addressing Example with VLAN and IPSec

C Control plane

Management

plane

Synchronization

plane

S-plane binding to interface address is recommended to avoid additional jitter due to IPSec processing. It is required for on-path support to enable accurate phase synchronization.

Configuration options

X2 Star Architecture

- Simplest configuration with single IP address
- X2 traffic routed through (central) Security Gateway (SEG)
- No direct IPSec tunnels between eNodeBs
- Can be implemented with E-Line or E-Tree (both recommended)

The following figure represents the X2 Star Architecture:

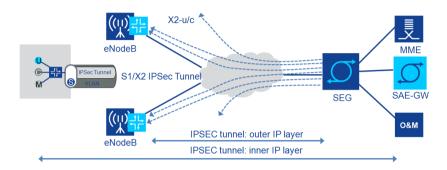


Figure 167: X2 Star Architecture

E-Line

The mobile backhaul network can be purely based on L2 (Ethernet) transport. Point-to-point Ethernet Virtual Connections (EVC) between a User Network Interface (UNI) at the eNodeBs and another UNI at the (redundant) edge router are the straightforward solution.

EVC attributes can be well controlled (see [MEF10.1]) and commercial services are commercially available in many markets, known as E-Line services (Ethernet leased lines). In this scenario each VLAN would identify a individual eNodeB.

E-Tree

Point-to-multipoint Ethernet Virtual Connections (EVC) between UNI at the edge router and UNI at the eNodeB. Similar to E-Line in that eNodeBs will not be able to communicate directly to each other (traffic separation similar to point-to-point), but simpler to provision due to common point at the edge router.

E-LAN

As an alternative, the Mobile Backhaul Network could be built based on multipoint-to-multipoint EVCs (E-LAN service). Most appropriately, eNodeBs belonging to one group should be assigned to one E-LAN (Figure 18). At the UNI between Mobile Backhaul and Core Network, the VLAN ID identifies an eNodeB group.

X2 Star Use Case: IP VPN

The following figure represents the X2 Star Use Case: IP VPN

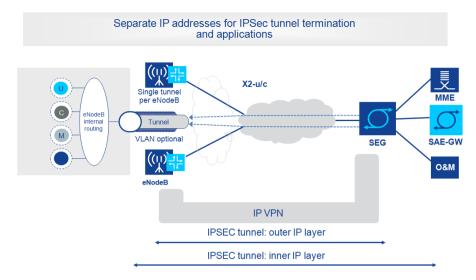


Figure 168: X2 Star Use Case: IP VPN

X2 Mesh Architecture (Not recommended)

- X2 traffic switched or routed in mobile backhaul network
- Direct IPSec tunnels between eNodeBs
- Requires E-LAN (not recommended)

The following figure represents the X2 Mesh Architecture (Not recommended):

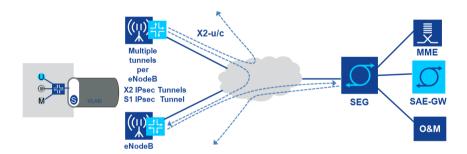


Figure 169: X2 Mesh Architecture (Not recommended)

Architecture Comparison

Recommendation

X2 Star with E-Line / E-Tree

- Simpler Traffic Engineering
- Easier troubleshooting
- Impact of DoS attacks is limited to one eNodeB

X2 Mesh with E-LAN

- Higher complexity
- · Perceived advantages are questionable
 - Marginal backhaul traffic savings. X2 traffic <5%
 - X2 latency optimization. S1 transport should be designed for low latency anyhow
- IP-VPN use case not possible with 3GPP Rel.8 ANR

Figure 170: Architecture Comparison

IPv6 for U/C-Plane

The following figure represents IPv6 for U/C-Plane:

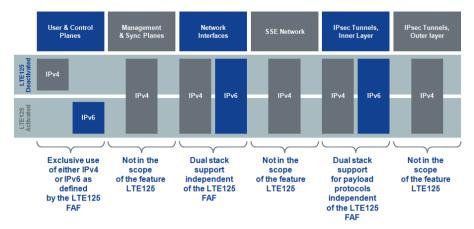


Figure 171: IPv6 for U/C-Plane

Overview of IPv6 for U/C-Plane

The following figure represents the Overview of IPv6 for U/C-Plane:

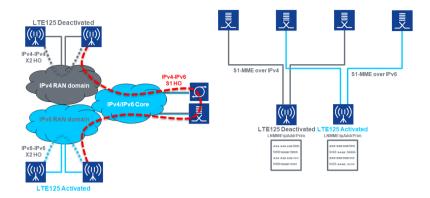


Figure 172: Overview of IPv6 for U/C-Plane

FTIF and its Configuration

FTIF Transport PDH/Ethernet Overview

- FTIF is a plug-in unit exclusively designed for FSM3 outdoor variants in LTE and WCDMA applications.
- FTIF module provides additional transport interfaces to the FSM outdoor module.
- FTIF is a cost optimized, newly to be developed module with 8xE1/T1 and 4xGEthernet.



Figure 173: FTIF Transport PDH/Ethernet Overview

FTIF External Connectors

The following figure represents the FTIF External Connectors:

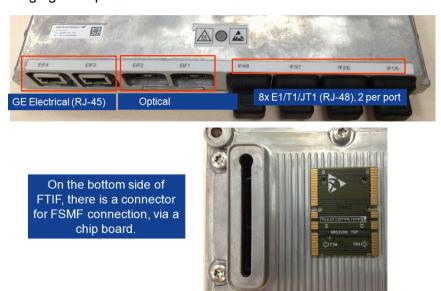


Figure 174:

FTIF Physical Interfaces

The following figure represents the FTIF Physical interfaces:

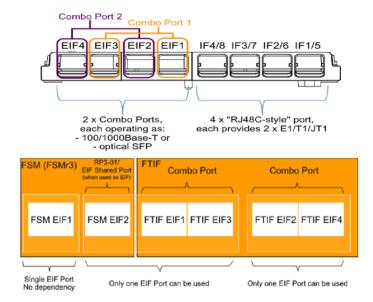


Figure 175: FTIF Physical Interfaces 1/2

The following figure represents the FTIF Physical interfaces:

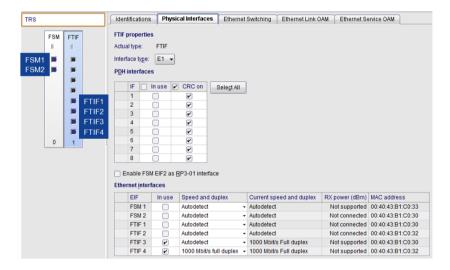


Figure 176: FTIF Physical Interfaces 2/2

Flexi Multiradio BTS TD-LTE Transport

Module Summary

This module covered the following learning objectives:

- describe the Transport Security problems and solution
- define Transport Overhead, Dimensioning, and Synchronization
- interpret Quality of Service in IP transport
- explain the Flexi Multiradio BTS Transport Configuration Options
- describe the FTIF and its Configuration

Flexi Multiradio BTS LTE Commissioning, Configuration Management and Integration

Module Objectives

- Describe the BTS Site Manager Installation.
- · Demonstrate the manual Flexi Multiradio BTS LTE software update.
- Demonstrate the manual commissioning of the Flexi Multiradio BTS LTE.
- · Demonstrate the integration of the Flexi Multiradio BTS LTE.

Describe the BTS Site Manager Installation

BTS Site Manager Installation

Context

Follow the procedure for BTS Site Manager installation:



Figure 177: BTS Site Manager Installation

Procedure

- 1 Download the BTS Site Manager installation file. Save the file on your PC.
- 2 If you have BTS Site Manager running on your PC, close it before starting the installation.

3 Double-click the file to start the installation (for example: BTSSiteEM-LTE20-2.0.33.exe).

Result of this step

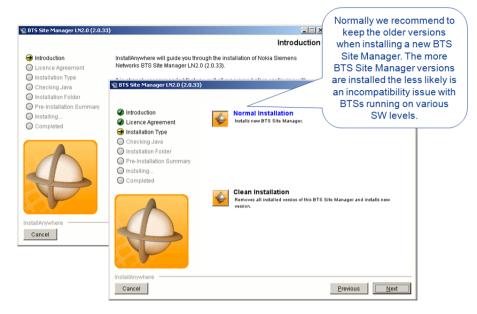


Figure 178: BTS Site Manager

- 4 Click **Next**, and read and accept the terms of the license agreement.
- 5 Click Next.

Information

Define the location where to install the BTS Site Manager. If you have earlier versions of the BTS Site Manager on your PC, you need to remove the installed versions before you can change the location. It is not required to remove earlier versions of the BTS Site Manager when a new version is installed. The correct BTS Site Manager version is selected automatically when the connection to the BTS is established. If the installation of the BTS Manager is unsuccessful, use the Clean installation option to remove all BTS Site Manager versions from your PC and start the installation again.

- **6** Click **Next**, and inspect the summary information for the installation procedure.
- 7 Click Next.

Information

The BTS Site Manager installer installs the software to the specified location.

8 Click Finish.

Information

The BTS Site Manager installer closes and you can use the BTS Site Manager.

Demonstrate the manual Flexi Multiradio BTS LTE software update

Launching BTS Site Manager

The following figure illustrates launching of BTS Site Manager:

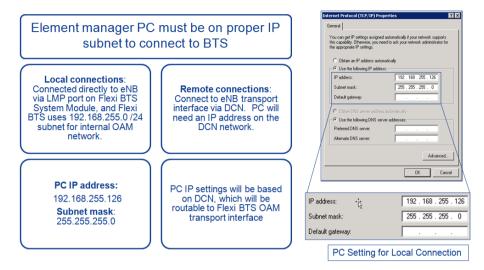


Figure 179: Launching BTS Site Manager

Flexi Multiradio LTE BTS Commissioning Overview

The following figure illustrates the overview of Flexi Multiradio LTE BTS Commissioning:

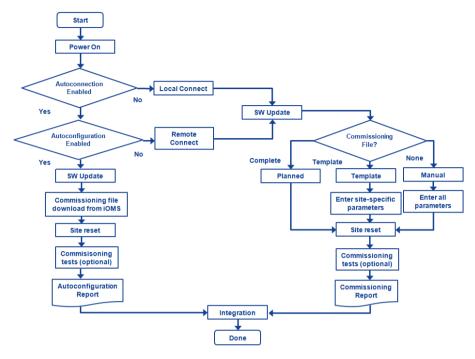


Figure 180: Flexi Multiradio LTE BTS Commissioning

Autoconnection enabled

This step is automatic if the autoconnection feature is enabled. If autoconnection is not enabled, the connection to the BTS must be done locally.

This feature enables automatic connection to servers in the network, and an automatic establishment of the O&M connection of the BTS to the O&M system. Only HW and cabling need to be installed at the site. No personnel with telecom experience needs to be at the site to commission the BTS, as the integration of a newly installed BTS is fully automated. When the BTS is powered up, it will automatically check the BTS commissioning status, establish IP connectivity and retrieve operator certificate and trust anchors (optional). As soon as the final certificates are available, the BTS starts the secure O&M plane connection to the NetAct framework.

Autoconfiguration enabled

This step is automatic if autoconnection is enabled. If autoconfiguration is not enabled, the connection to the BTS must be established remotely.

The BTS autoconfiguration feature provides automatic commissioning and configuration of new or re-homed base stations from a remote network operation centre with minimal manual intervention. The automated configuration is initiated by the eNodeB auto configuration agent and controlled by the NetAct auto configuration application, which belongs to the overall NetAct SON coordinator application.



Prior to start of commissioning, there should be a visual check and inspection.

The following items are checked:

Grounding

- Power cabling and supply voltage
- Other cables and fibers
- LED status during power up
- TX/RX antenna connector torque check

Lab exercise: Launching BTS Site Manager

Context

Follow the procedure for launching BTS Site manager:

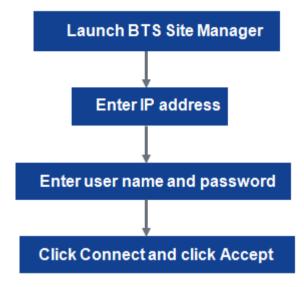


Figure 181: Launching BTS Site Manager

Procedure

- Launch BTS Site Manager by clicking on the shortcut created during installation.
- Enter IP address. For local connections, select Local. For remote connections, 2 enter IP address of BTS OAM interface.

3 Enter user name and password.

Information

The default user name is **Nemuadmin** and the default password **nemuuser**. Using web interface at 192.168.255.129, local user account information can be reset to factory defaults (Nemuadmin/nemuuser) via local connection. The FTM transport module provides a service to recover the transport module.

Recovery will delete the configuration except:

- Super user account credentials
- NE account credentials (if existing)
- BTS keypair (BTS certificate and BTS private key, if existing)
- CA certificate (if existing)

Recovery will reset the transport module.

Result of this step

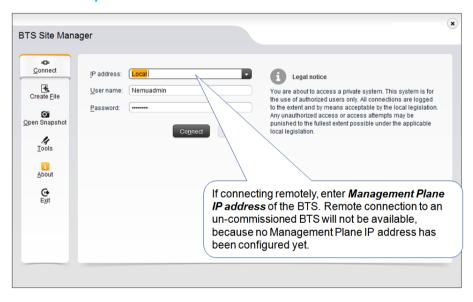


Figure 182: Launch BTS Site Manager

4 Click Connect.

Information

The progress of the operation is displayed in the Task Selection view. If multiple versions of BTS Site Manager are installed on the PC, the appropriate BTS Site Manager version is selected automatically.

When the connection is established, the Task Selection view closes and the BTS Site Manager main view opens.

If you receive a message with the text *Cannot establish secure connection*, click the **Accept** button to connect to the BTS.

Result of this step

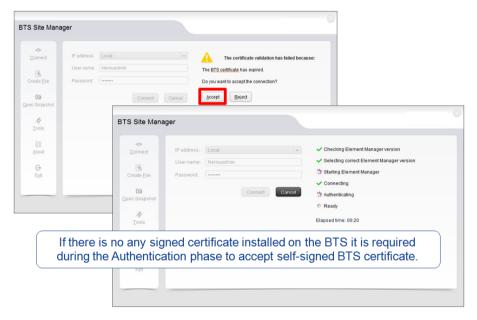


Figure 183: Accept self-signed Certificate

Verify BTS Software Level

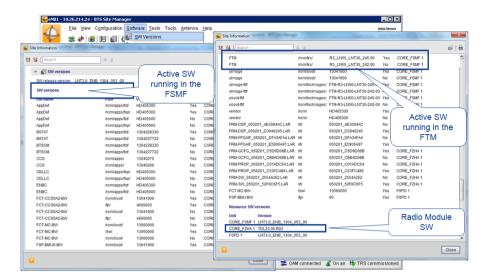


Figure 184: Verify BTS Software Level

To verify the software for all modules (RF, transport, system) you can select **Software** ► **SW Versions** to see a list of all of the binaries and versions which can be compared against release notes.

Software Update via BTS Site Manager

Context

Follow the procedure to update software via BTS site manager:

Prerequisites

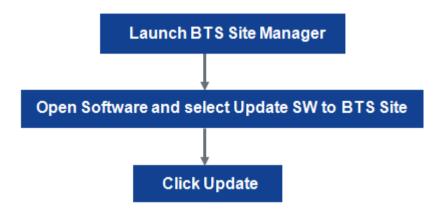


Figure 185: Software Update via BTS Site Manager

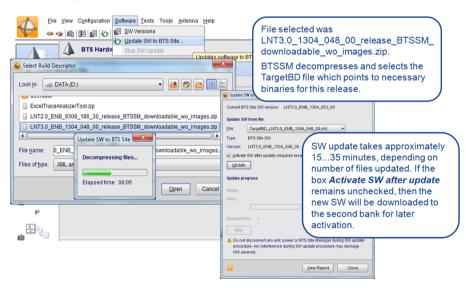


Figure 186: Software Update

The software for the transmission sub-module, radio modules and radio heads is included in the software package for the BTS site. BTS Site Manager will update the transport, RF module and system module SW as required.

If you do not check *Activate SW after update*, the SW update will be downloaded but not applied and you will have to perform the Update SW to BTS Site again, this time the files already stored on BTS do not have to be downloaded again.



If the BTS site has a connection to Nokia NetAct, the NetAct will manage the BTS site SW (that is, checks the SW version and, if it is different than the SW in the NetAct database, downloads new SW in the BTS site).

Procedure

1 Launch the BTS Site manger.

- 2 Open Software, select Update SW to BTS Site.
- 3 Click on Update.

Demonstrate the manual commissioning of the Flexi Multiradio BTS LTE

Commissioning

Commissioning Options

Commissioning is divided into BTS and TRS. One commissioning file is created that contains values for both BTS and transport.

Reconfiguration is only an option after initial commissioning has been completed. It allows you to update parameters from the existing configuration.

For Template or Planned commissioning, you need to select a commissioning file (XML format). This is not required for Manual or Reconfiguration.

ANOTE

Site commissioning can only begin after all modules are initialized. If there are SW problems, the modules cannot initialize and the commissioning options will be grayed-out and not be selectable.

The following figure illustrates the commissioning options:



Figure 187: Commissioning Options

Site Commissioning File Creation

The following figure illustrates the BTS Site Manager - Create File:

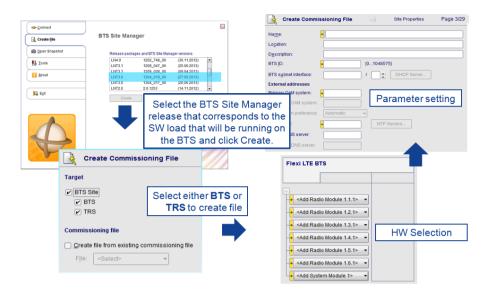


Figure 188: BTS Site Manager - Create File

TRS Commissioning Steps

The following figures illustrate the TRS commissioning steps:

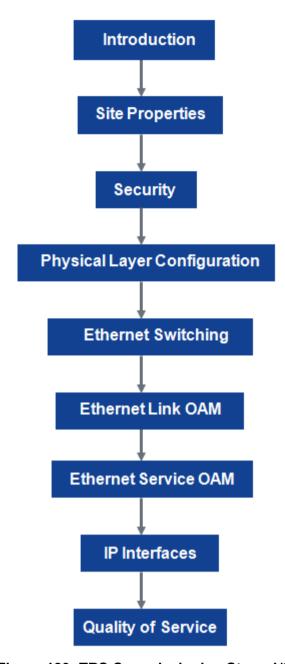


Figure 189: TRS Commissioning Steps 1/2

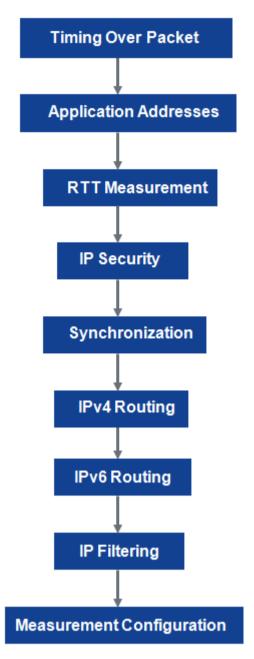


Figure 190: TRS Commissioning Steps 2/2

Site Properties

The following figure illustrates the site properties:

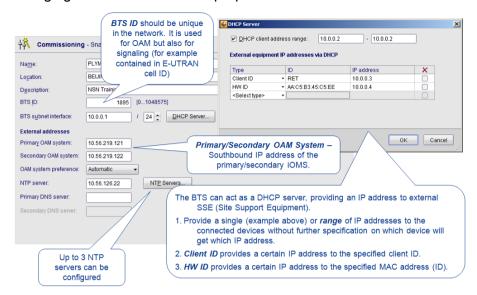


Figure 191: Site Properties

Name Enter the name for the BTS site in the Name field (maximum of 15

characters).

Location Enter the location of the element in the Location field (maximum of

50 characters).

Description Enter the description of the element in the Description field

(maximum of 128 characters).

Enter the BTS identifier in the BTS ID field. The BTS ID has to be defined according to agreed value, which is usually determined at the network planning stage. Do not assign arbitrary value for this

parameter.



BTS ID in MRBTS (mrbtsld), LNBTS (lnBtsld), BTSSC (btsld) and FTM: IPNO: (btsld) parameters must all have the same BTS ID value in commissioning file. If the value is changed it must be done in site commissioning.

IPNO: btsId (BTS ID) is set on Site Properties page. MRBTS: mrbtsId (Multiradio BTS site identifier) and LNBTS: InBtsId (Instance identifier of object LNBTS) are set on Radio Network Configuration page. BTSSC: btsId is set automatically by BTS Site Manager to commissioning file according to BTS Id value set to other related parameters.

BTS subnet interface

Enter the BTS subnet interface IP address in the BTS subnet interface field. The Subnet Mask IP address can be 1.0.0.0 - 255.255.255.255 / 1...30. The other IP addresses can be 0.0.0.0 - 255.255.254 but the following IP addresses should not be configured:

 default address (0.0.0.0) addresses in the subnet 127.x.x.x (reserved for loopbacks)

- addresses in the subnet 192.168.254.xxx (internal address)
- addresses in the subnet 192.168.255.xxx (internal address)
- multicast address (224.0.0.0 239.255.255.255)
- class E address (240.0.0.0 255.255.255.255)
- broadcast address (255.255.255.255)
- directed broadcast/network address (x.x.x.255/24 or x.x.x.0/24)

Primary OAM system	Enter the primary OAM system IP address in the Primary OAM system field.
Secondary OAM system	Enter the secondary OAM system IP address in the Secondary OAM system field.
OAM system preference	Select the OAM system preference from the OAM system preference drop-down list: Automatic, Primary forced or Secondary forced.
Primary DNS server	Enter the IP address for the primary DNS server.
Secondary DNS server	Enter the IP address for the secondary DNS server.

E-UTRAN Cell Identifier

The following figure illustrates E-UTRAN Cell Identifier:

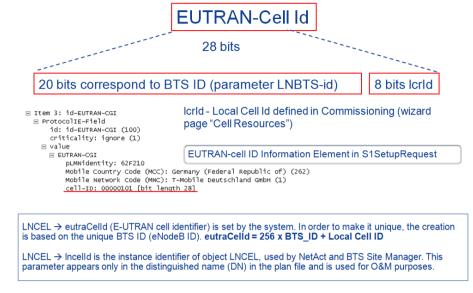


Figure 192: E-UTRAN Cell Identifier

The E-UTRAN cell identifier is unique within one PLMN and has a length of 28 bits. The leftmost 20 bits of the value correspond to the value of the eNodeB ID (parameter InBtsId) and the 8 rightmost bits correspond to the value of the local cell resource ID (lcrld). This parameter cannot be set by operator, it is calculated system internally and is only readable.

Security

The following figure illustrates security:

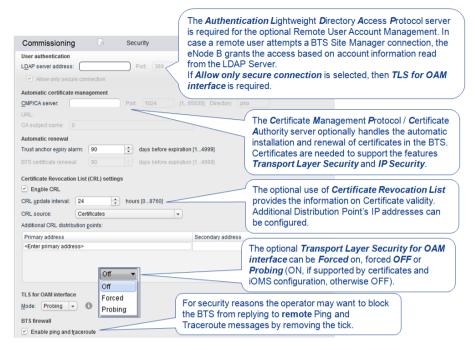


Figure 193: Security

CA Subject name

This parameter identifies the CMP server by its subject name. It may either be detected by DHCP upon autoconnection or configured by the management system.

CA certificate and trust anchor

This parameter specifies how many days before a CA certificate or Trust Anchor certificate expires the BTS autonomously triggers a CMP update sequence.

BTS certificate

This parameter specifies how many days before a BTS certificate expires the BTS autonomously triggers a CMP update sequence.

CRL update interval

This parameter specifies the period for executing a periodical update of the Certificate Revocation List. The value is given in hours. Value 0 means *no periodical update*.

Physical Layer Configuration

Physical interfaces with FTIF

The following figures illustrate the physical interfaces with FTIF:

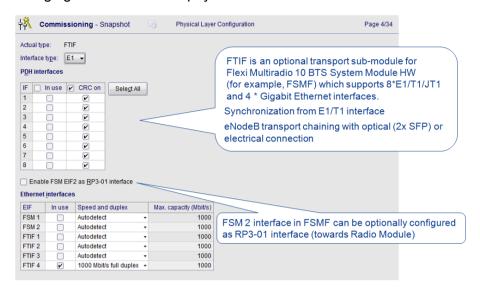


Figure 194: Physical interfaces with FTIF 1/2

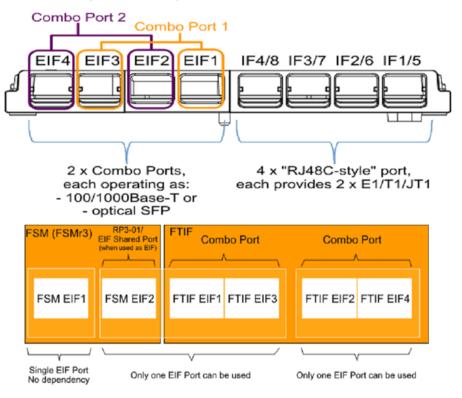


Figure 195: Physical interfaces with FTIF 2/2

Physical Interface with FSIH

The following figure illustrates the physical interfaces with FSIH:

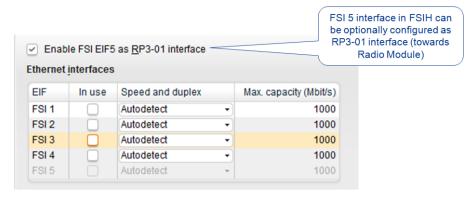


Figure 196: Physical Interface with FSIH

Physical Layer Configuration – New in TL15A LTE1244: Source based routing in BTS

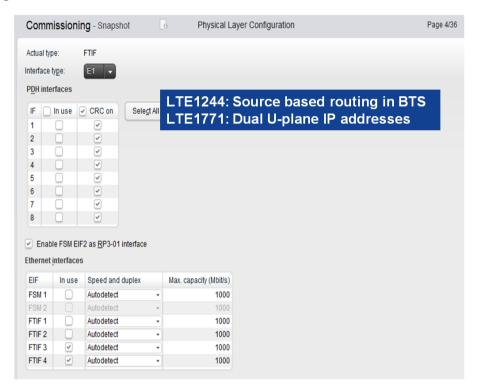


Figure 197: Physical Layer Configuration – New in TL15A LTE1244: Source based routing in BTS

LTE1244: Source based routing in BTS

LTE1771: Dual U-plane IP addresses

The eNodeB can enable 2 physical Ethernet ports for backhaul to support Dual Uplane IP and Source based routing.

Ethernet Switching with FTIF

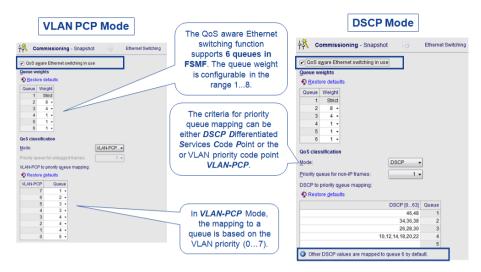


Figure 198: Ethernet Switching with FTIF (1/2)

- Ethernet switching in use
 - · Queue weights:
 - 1...8 QoS classification
- Mode: DSCP
- · Priority queue for non-IP frames
- DSCP to priority queue mapping: queue 1..3
- VLAN aware configuration
- Switch mode

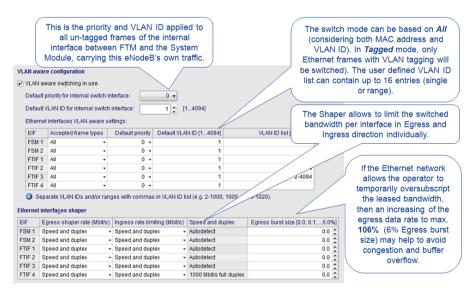


Figure 199: Ethernet Switching with FTIF (2/2)

- VLAN ID
- Keep untagged frames

- VLAN ID list
- Ethernet interface shaper
 - Egress shaper rate
 - Ingress rate limiting
 - Speed and duplex

Ethernet OAM

The following figure illustrates Ethernet OAM:

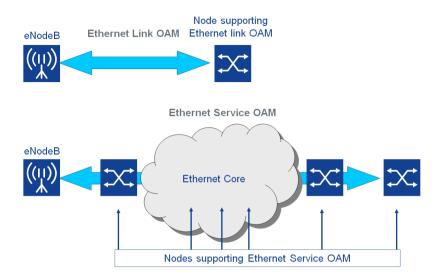


Figure 200: Ethernet OAM

Link OAM

Introduction to 802.3AH OAM as specified in IEEE 802.3ah-2004 Clause 57. 802.3ah OAM is implemented on any full-duplex point-to-point or emulated point-to-point Ethernet link. The frames (OAM Protocol Data Units or OAMPDUs) cannot propagate beyond a single hop within an Ethernet network and have modest bandwidth requirements (frame transmission rate is limited to a maximum of 10 frames per second).

The major features covered by this protocol are:

- Discovery
- Link Monitoring
- Remote Fault Detection
- Remote Loopback

Service OAM

Introduction to Connectivity Fault Management (IEEE 802.1AG) Protocols. Ethernet CFM comprises three protocols that work together to help administrators debug Ethernet networks. These are: continuity check, link trace and loopback protocols.

- Continuity Check These are heartbeat messages issued periodically by maintenance endpoints. They allow maintenance endpoints to detect loss of service connectivity amongst themselves. They also allow maintenance endpoints to discover other maintenance endpoints within a domain, and allow maintenance intermediate points to discover maintenance endpoints.
- Link Trace These are transmitted by a maintenance endpoint on the request of the administrator to track the path (hop-by-hop) to a destination maintenance endpoint. They allow the transmitting node to discover vital connectivity data about the path. Link trace is similar in concept to UDP Traceroute.

 Loopback – These are transmitted by a maintenance endpoint on the request of the administrator to verify connectivity to a particular maintenance point.
 Loopback indicates whether the destination is reachable or not; it does not allow hop-by-hop discovery of the path. It is similar in concept to ICMP Echo (Ping).

Ethernet Link OAM

Link Layer OAM (IEEE 802.3ah) operates at a single link. Flexi Multiradio BTS supports the following L-OAM functions:

- OAM Discovery: Identify peer device and its OAM capabilities (w/ active mode support)
- Remote Failure Indication: Mechanism to provide failure information to the peer.
 Includes Link Fault, Dying Gasp, Critical Events
- Remote Loopback: allows to check the quality of the link for diagnosis and troubleshooting (w/ active mode support).
- Link Monitoring: Event notifications, including diagnosis information (threshold alarms)

A detailed example setup of Ethernet Link OAM is described in eNodeB OAM.

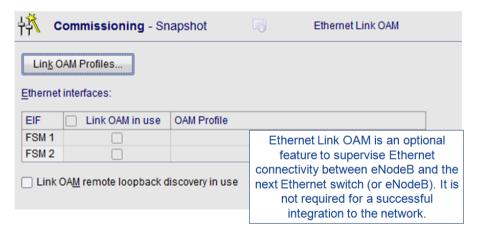


Figure 201: Ethernet Link OAM

Ethernet Service OAM

A detailed example setup of Ethernet Service OAM is described in eNodeB OAM.

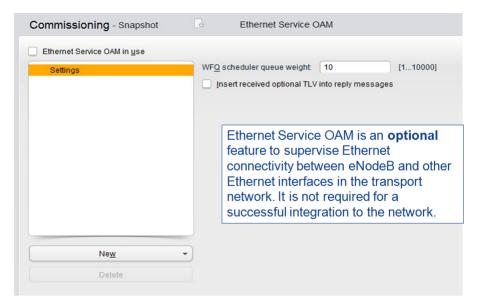


Figure 202: Ethernet Service OAM

Service Layer OAM (IEEE 802.1ag / ITU-T Y.1731) covers Ethernet end-to-end and network segment connectivity as well as service guarantees

- Ethernet Continuity Check: Reports loss of continuity between two Maintenance Endpoints (MEPs), within a Maintenance Entity Group (MEG) or unintended connectivity.
- Ethernet Alarm Indication Signal: Indicates alarms to next nodes and suppresses alarms to NMS if indicated alarms occur on lower levels.
- Ethernet Remote Defect Indication: Used by a MEP to communicate to its peer MEP that a defect condition has been encountered.
- Loopback: behavior in Ethernet similar to Ping on L3.
- Link Trace: behavior in Ethernet similar to Trace Route on L3.

IP Interfaces Configuration

IP Interfaces User Plane GBR Admission Control

The following figure illustrates IP Interfaces User Plane GBR admission control:

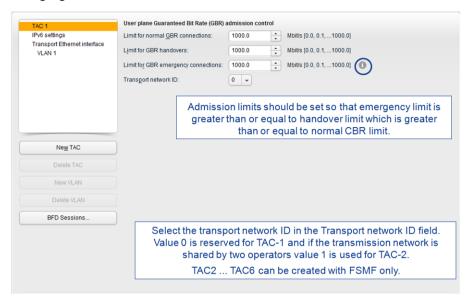


Figure 203: IP Interfaces User Plane GBR Admission Control

IP Interfaces - IPv6 Settings

The following figure illustrates IP interfaces for IPv6 settings:

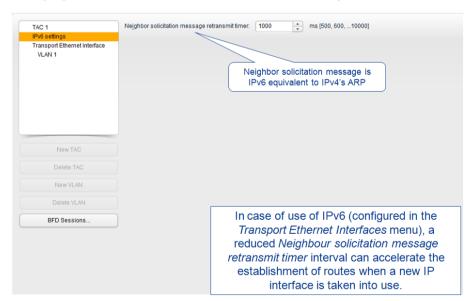


Figure 204: IP Interfaces - IPv6 Settings

IP Interfaces - Untagged interface

The following figure illustrates the IP interfaces for untagged interface:

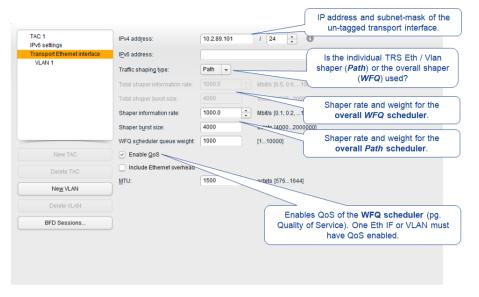


Figure 205: IP Interfaces - Untagged interface

IP Interfaces - VLAN interface

The following figure illustrates the IP interfaces for VLAN interface:

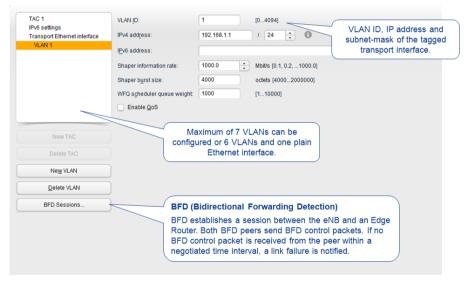


Figure 206: IP Interfaces - VLAN interface

Transport Ethernet / VLAN QoS

The following figure illustrates Transport Ethernet / VLAN QoS:

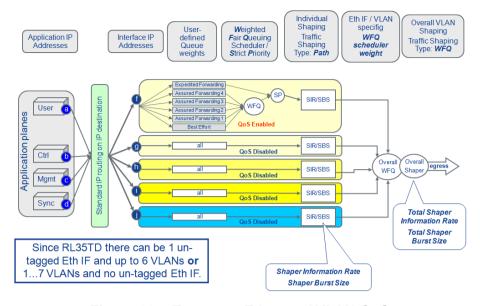


Figure 207: Transport Ethernet / VLAN QoS

IP interfaces - New in TL15A

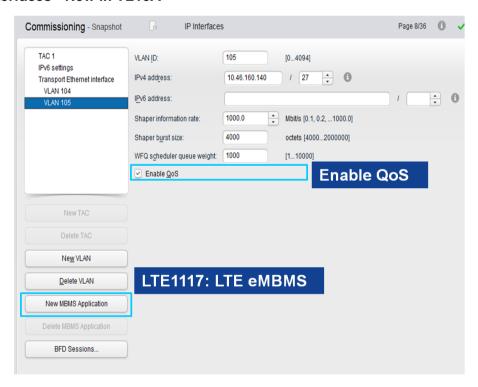


Figure 208: IP interfaces - New in TL15A

Enable QoS Can enable QoS for both VLANs because of dual U-plane IP addresses.

LTE1117: LTE Provides basic framework at eNodeB to support MBMS service. **eMBMS**

Quality of Service configuration

The following figure illustrates Quality of Service configuration:

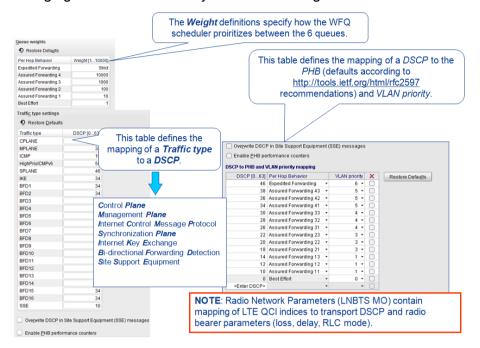


Figure 209: Quality of Service

The following figure illustrates Recommended Differentiated Services Code Points (DSCP):

Assur class	ed forwarding	Per Hop Behavior			Drop Pre	cedence		DSCP
PHB	Drop Precedence	binary			binary			decimal
Exped	Expedited Forwarding		0	1	1	1	0	46
4	3	1	0	0	1	1	0	38
4	2	1	0	0	1	0	0	36
4	1	1	0	0	0	1	0	34
3	3	0	1	1	1	1	0	30
3	2	0	1	1	1	0	0	28
3	1	0	1	1	0	1	0	26
2	3	0	1	0	1	1	0	22
2	2	0	1	0	1	0	0	20
2	1	0	1	0	0	1	0	18
1	3	0	0	1	1	1	0	14
1	2	0	0	1	1	0	0	12
1	1	0	0	1	0	1	0	10
Best E	ffort	0	0	0	0	0	0	0

Figure 210: Recommended Differentiated Services Code Points (DSCP)

For additional reference, check the following http://tools.ietf.org/html/rfc2597

Timing over Packet Configuration

The following figure illustrates the timing over packet configuration:

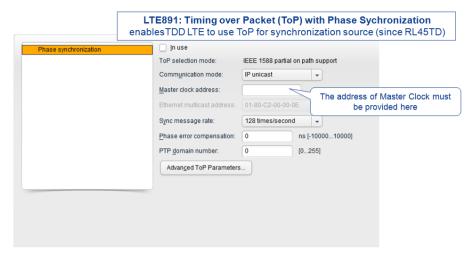


Figure 211: Timing over Packet Configuration

Application Addresses

The following figure illustrates the application addresses:

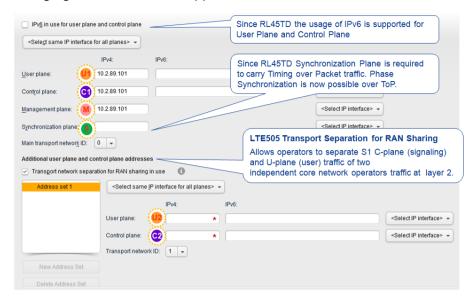


Figure 212: Application Addresses

Application Addresses - New in TL15A

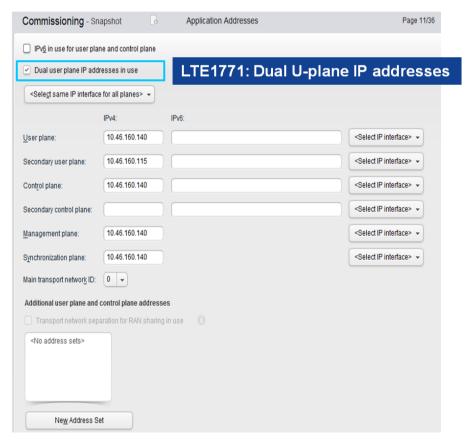


Figure 213: Application Addresses - New in TL15A

The S1 U-plane traffic is distributed to two IP addresses, which enables the utilization of two physical gigabit Ethernet interfaces and/or different paths through the network simultaneously while keeping UE flows intact.

RTT Measurement

The following figure illustrates the RTT measurement:

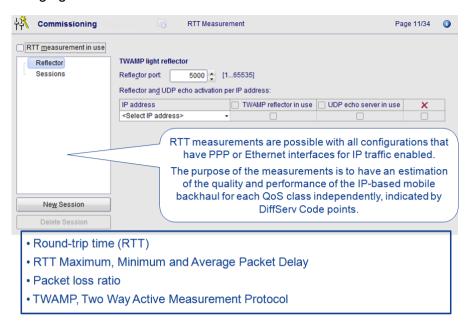


Figure 214: RTT Measurement

Functional Description

With this feature, an active measurement is done between two points in the mobile backhaul. One point performs test traffic generation and analysis. The other point must be able to send back the test traffic. The purpose of the measurement is to have an estimation of the quality and performance of the IP-based mobile backhaul for each QoS class independently, indicated by Diff Serv Code points.

In detail:

- The eNodeB provides Two Way Active Measurement Protocol (TWAMP) Sender functionality according to RFC5357. The received packets need to be analyzed and used for statistics whether the responding partner is capable to generate a TWAMP Response message or whether it returns the sent message unmodified (UDP echo server).
- The eNodeB provides TWAMP Responder functionality so that a supporting router in the network could use TWAMP test traffic to measure the connection from there towards the eNodeB. Up to 10 simultaneous measurement sessions can be started on the eNodeB. The sessions can be used to get measurements on different QoS classes. Once started, the measurements are gathered forever or till the measurements are explicitly stopped. The measurements are aggregated into PM counters that are uploaded every 15 minutes. If the network condition falls under a configurable threshold, alarms will be raised.

Measured values are:

- Round-trip time (RTT, presented as Maximum, Minimum and Average Packet Delay)
- Packet Loss Ratio
- In case of TWAMP responses additionally
- One way delay variation

One way packet loss

Configuration aspects

The following figures illustrate the configuration aspects:

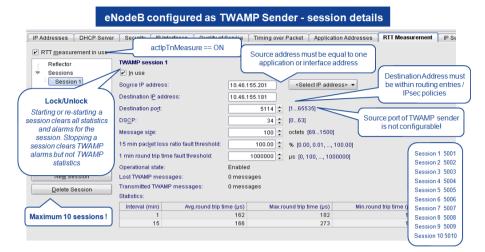


Figure 215: Configuration aspects 1/2

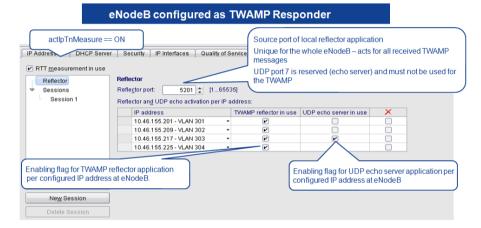


Figure 216: Configuration aspects 2/2

IP Security Policies

Activate IPsec and choose a profile

The following figure illustrates how to activate IPsec and choose a profile:



Figure 217: Activate IPsec and choose a profile

Policies

Commissionin In the Commissioning - IP Security Policies and Create g - IP Security Commissioning File - IP Security Policies pages you can define IP security options.



FTIB does not support IP security in RL10.

Select the check box to enable IP security processing in node. IPsec in use

Policy

Select Policy to see all IPsec policies in one table. Select one policy item in the tree to see and manage parameters of that policy. Parameters are shown in the parameter area next to the tree.

IPSec tunnel

The following figure illustrates IPSec tunnel:

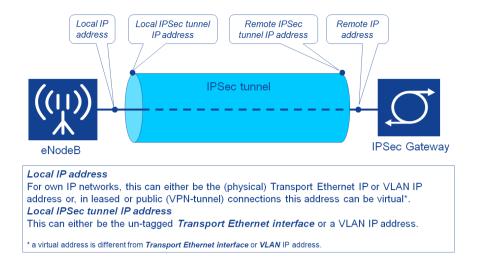


Figure 218: IPSec tunnel

Supported IPsec capabilities

- Services Data integrity protection, origin authentication and anti-replay protection
- Protocol ESP (RFC 4303)
- Transport Tunnel mode
- Confidentiality mandatory
- Encryption/Ciphering 3DES-192-CBC, AES-128-CBC and NULLModes: CBC, random chosen IV
- Integrity HMAC-MD5, HMAC-SHA-1-96Identification: IP addresses and Fully Qualified Do-main Names (FQDN) are supported for identification
- Authentication Digital certificates in X.509v3 format Key exchange: dual stack IKEv1 (RFC 2409) / IKEv2 (RFC 4306) Key Management: ISAKMP (utilizes IKEv2 for key exchange)
- Diffie-Hellman key exchange Group 2 (1024-bit MODP)

IPsec settings

The following figures illustrate IPsec settings:

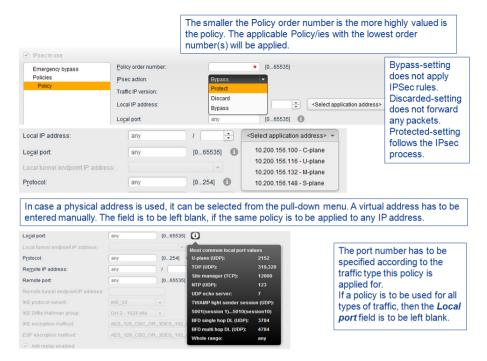


Figure 219: IPsec settings 1/5

Policy order number

Enter the policy order number in the Policy order number field. The smaller the order number is the more highly valued is the policy.

IPsec action

Select the IPSec action from the drop-down list. Bypass-setting does not process any packets, Discarded-setting does not forward any packets. Protected-setting follows the IPsec process.

Local IP address

Enter the local IP address in the Local IP address field. Enter also the address netmask bits. You can either define this address by selecting the Define address radio button (empty value means any address - whole range of addresses) or choose the address from the drop-down list if you select the Select application address option.

Local port

Enter the local port number in the Local port field. Empty value means any port - whole range of ports.

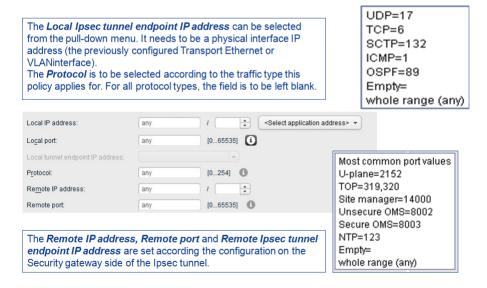


Figure 220: IPsec settings 2/5

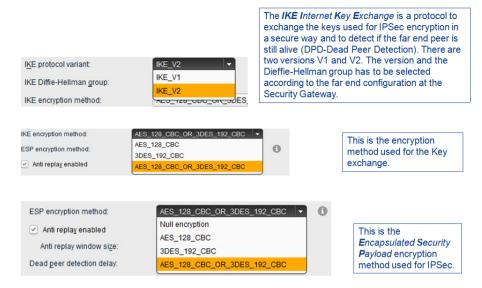


Figure 221: IPsec settings 3/5

Nokia Networks' suggestion on IPsec configuration IPSec implementation is optimized to provide best throughput and strongest security level when using ESP encapsulation with AES-CBS (128 or 256 bit key size) ciphers together with SHA-1 HMAC algorithm. There is no significant performance / throughput difference between AES-CBC-128 and AES-CBC-256, but 3DES is ignorantly slower than any AES algorithms, and because of this should be avoided when possible.

The following figure illustrates Internet Key Exchange protocol versions:

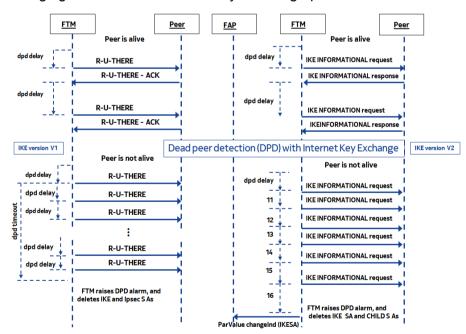


Figure 222: Internet Key Exchange protocol versions

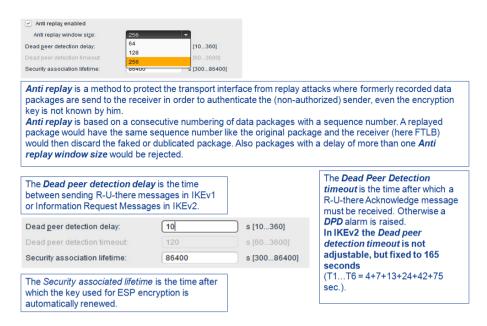


Figure 223: IPsec settings 4/5

ISAKMP SA and the IPsec SA(s) are regularly updated, the ISAKMP SA life time is set to 24 hours/86400 sec and the IPsec child SA(s) lifetime is adjustable from 5 Minutes/300 sec up 24 hours/86400 sec, common for all IPsec child SA(s).

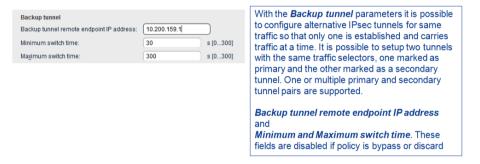


Figure 224: IPsec settings 5/5

TRS Synchronization

The following figure illustrates the synchronization:

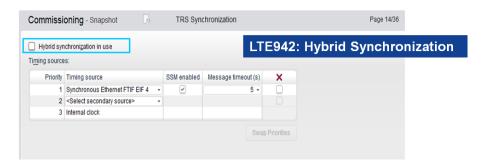


Figure 225: TRS Synchronization

Hybrid Synchronization combines the use of Synchronous Ethernet with either GPS or IEEE1588-2008 Timing over Packet (ToP) for Phase synchronization.

In case of ToP with phase, the combined use of SyncE is used to assist ToP with a stable estimation of frequency deviation.

It also extends the phase holdover capability when the phase synchronization source (GPS or ToP) has failed but SyncE is available.

Routing

Functional Description

LTE866 Fast IP Rerouting is an extension of LTE592 Link Supervision with BFD.

The eNodeB sees two routers connected to it. A BFD session is running between the eNodeB and one router.

Redirecting the downlink traffic:

The primary route in the routing table of the router R1 is connected to the BFD session. If the BFD session fails, the route is removed in the routing table of the router and the secondary route is selected (via R2).

Redirecting the uplink traffic:

The primary route in the routing table of the eNodeB is connected to the BFD session. If the BFD session fails, the route is removed in the routing table of the eNodeB and the next best route is selected (via R2).

In conjunction with the feature LTE649 QoS aware switching the solution provides two physical links to connect the eNodeB.

The following figures illustrate the routing:

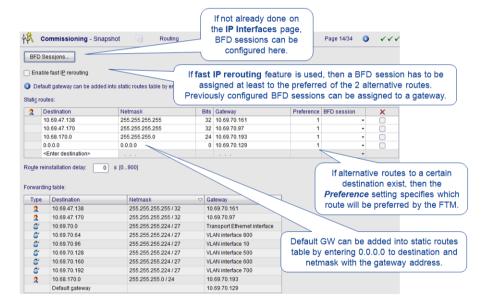


Figure 226: Routing 1/2

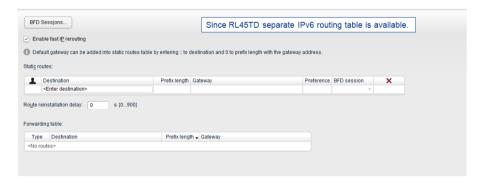


Figure 227: Routing 2/2

IPv4 Routing - New in TL15A

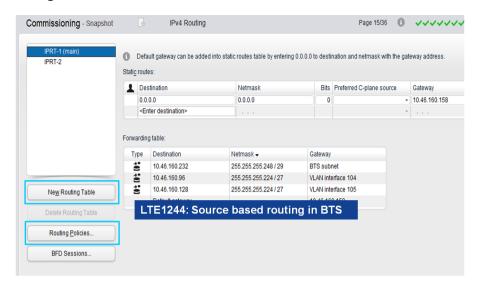


Figure 228: IPv4 Routing - New in TL15A

It is the source IP address based routing of BTS traffic.

This feature allows overlapping address spaces for LTE Core(s) and Controllers and so saves:

- Dedicated IP address planning process for LTE Core(s) and Controllers
- A dedicated IP router in the network between BTS and LTE Core(s) and controllers

IP Filtering

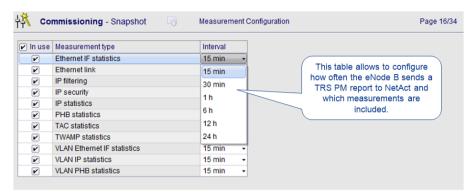
The following figure illustrates the IP filtering:



Figure 229: IP Filtering

Measurement Configuration for TRS

The following figure illustrates the measurement configuration for TRS:



Note: The Measurement Configuration for BTS Statistics is configure on the *Radio Network Configuration* page in the object *MRBTS – LNBTS – PMRNL-1*.

Figure 230: Measurement Configuration for TRS

BTS Settings

The following figure illustrates the BTS settings:

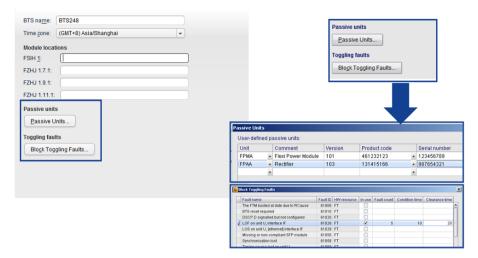


Figure 231: BTS Settings

Network synchronizati on mode

With this parameter the synchronization mode of the eNodeB can be selected.

LTE systems supporting MBSFN or co-operate with CDMA 2000 system require a tight timing on air interface transmission synchronization. In all those cases *Phase synchronization* should be selected. For LTE systems which do not require such accurate phase synchronization, the 50ppb frequency accuracy has met via normal *Frequency synchronization*. For those that value should be set.

Air frame timing as for 1PPS reference Different systems could have a difference in the frame synchronization to GPS PPS timing pulse. This parameter offers the possibility to adjust freely an air interface timing as for 1PPS synchronization pulse.

Cable length between GPS and eNodeB

This parameter defines the length of cable used between GPS receiver and eNB (fixed length as meters). The NSN official cable with length 30 meter (471606A) or 100 meter (471653A) is used. If this parameter is set, the *gpsTotalAntennaLineDelay* shall not be set.

Total GPS antenna line delay

This parameter shall be specified when Nokia official cable (30m or 100m) is replaced with an own proprietary cable between GPS receiver and eNodeB. The maximum lenght of cable shall be less than 200 meters. In this case an operator has obliged to measure the delay of cable. If this parameter is set, the value for *gpsCableLength* shall not be set.

BTS Synchronization Settings

The following figure illustrates the BTS synchronization settings:

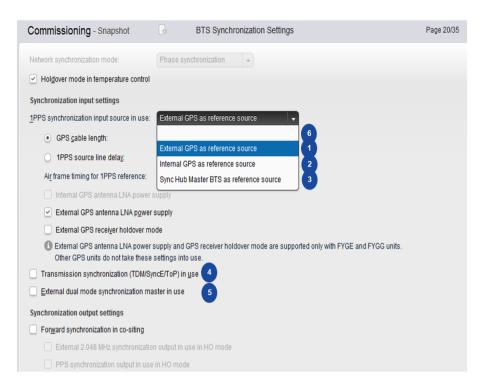


Figure 232: BTS Synchronization Settings

Sync source:

- 1. External GPS, GPS connected to SYNC IN HDMI port.
- 2. Internal GPS, GPS connected to SMA port (only on FSIH).
- 3. Sync Hub Master, from SYNC OUT of another SM to SYNC IN.
- 4. Transmission synchronization (ToP or SyncE).
- 5. External dual mode sync master, from TD-SCDMA FO.
- 6. Not applicable for 1PPS, when using four or five.

Module Settings

The following figure illustrates the Module Settings:

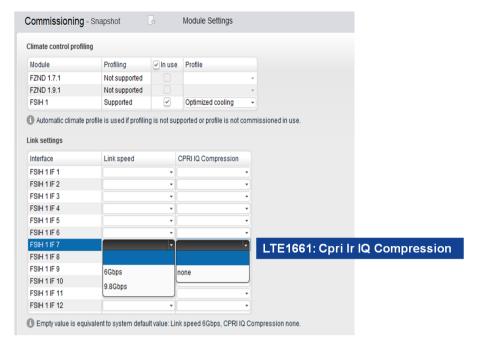


Figure 233: Module Settings

- I/Q compression increases CPRI link capacity and significantly reduces the number of SFP/fibers needed.
- IQ data bit-width from 15bits compressed to 12bits.

Cell Resources

The following figure illustrates the cell resources:

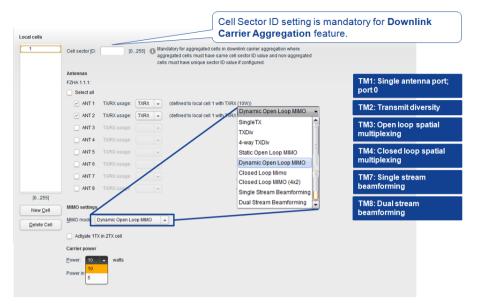


Figure 234: Cell Resources

Cell Resources - New in TL15A

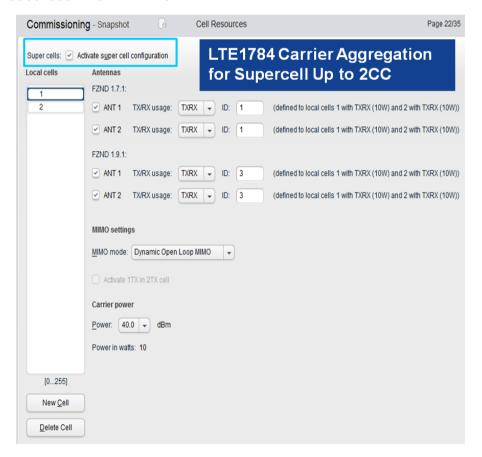


Figure 235: Cell Resources - New in TL15A

The LTE1784 Carrier Aggregation for Supercell Up to 2CC feature supports enhanced supercell interworking with carrier aggregation. It can provide higher peak rate for supercell users, e.g. indoor and outdoor cell with remote RRH.

LTE Carriers

The following figure illustrates the LTE carriers:

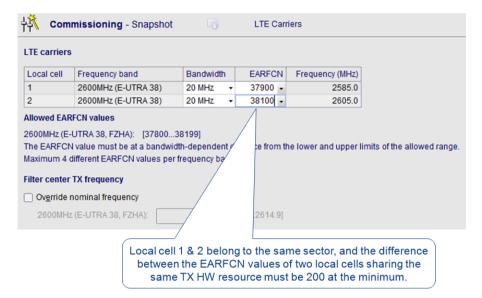


Figure 236: LTE Carriers

3GPP Frequency Bands

The following figures illustrate the 3GPP frequency bands:

Band	F Uplink low	eUARFCN ULlow	F Uplink high	eUARFCN ULhigh	F Downlink low	eUARFCN DLlow	F Downlink high	eUARFCN DLhigh	BW/ MHz	Duplex Freq.
1	1920	18000	1980	18599	2110	0	2170	599	60	190
2	1850	18600	1910	19199	1930	600	1990	1199	60	80
3	1710	19200	1785	19949	1805	1200	1880	1949	75	95
4	1710	19950	1755	20399	2110	1950	2155	2399	45	400
5	824	20400	849	20649	869	2400	894	2649	25	45
7	2500	20750	2570	21449	2620	2750	2690	3449	70	120
8	880	21450	915	21799	925	3450	960	3799	35	45
9	1749.9	21800	1784.9	22149	1844.9	3800	1879.9	4149	35	95
10	1710	22150	1770	22749	2110	4150	2170	4749	60	400
11	1427.9	22750	1452.9	22999	1475.9	4750	1500.9	4999	25	48
12	698	23000	716	23179	728	5000	746	5179	18	30
13	777	23180	787	23279	746	5180	756	5279	10	-31
14	788	23280	798	23379	758	5280	768	5379	10	-30
17	704	23730	716	23849	734	5730	746	5849	12	30
18	815	23850	830	23999	860	5850	875	5999	15	45
19	830	24000	845	24149	875	6000	890	6149	15	45
20	832	24150	862	24449	791	6150	821	6449	30	-41

Figure 237: 3GPP Frequency Bands 1/2

Band	F Uplink low	eUARFCN ULlow	F Uplink high	eUARFCN ULhigh	F Downlink low	eUARFCN DLlow	F Downlink high	eUARFCN DLhigh	Bandwidth	Duplex Freq.
21	1447.9	25050	1462.9	25199	1495.9	7050	1510.9	7199	15	48
33	1900	36000	1920	36199	1900	36000	1920	36199	20	Tdd
34	2010	36200	2025	36349	2010	36200	2025	36349	15	Tdd
35	1850	36350	1910	36949	1850	36350	1910	36949	60	Tdd
36	1930	36950	1990	37549	1930	36950	1990	37549	60	Tdd
37	1910	37550	1930	37749	1910	37550	1930	37749	20	Tdd
38	2570	37750	2620	38249	2570	37750	2620	38249	50	Tdd
39	1880	38250	1920	38649	1880	38250	1920	38649	40	Tdd
40	2300	38650	2400	39649	2300	38650	2400	39649	100	Tdd

Example from band 38 (2600 MHz)

 $F_{DL} = F_{UL} = F_{DL_low} + (eUARFCN_{UL} - eUARFCN_{ULlow}) = 2570 + 0.1(38000 - 37750) = 2595 \text{ MHz}$

Figure 238: 3GPP Frequency Bands 2/2

Antenna Configuration

Antenna Line Management

The following figure illustrates the antenna line management:

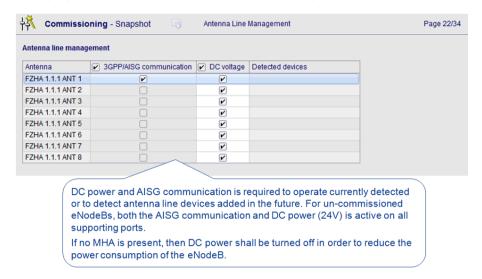


Figure 239: Antenna Line Management

Antenna Line DC voltage

Defines if antenna line DC power is enabled/disabled for an antenna line. The DC power is enabled by default (when the file or parameter is not available for an AL). This parameter is the most relevant for AL DC power.



The parameter can be changed on-line. To take the change into use, the radio module must be locked and unlocked or a BTS restart need to be initiated.

Antenna Line Settings

The following figure illustrates the antenna line settings:

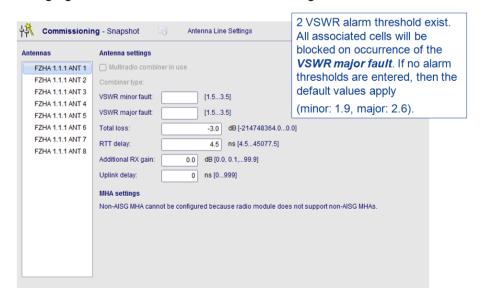


Figure 240: Antenna Line Settings

Additional Rx gain

In decibels, is used in gain calculation to compensate a Rx gain produced by an external device e.g. the base station when two radio modules are cross-connected together via RX diversity outputs sharing the antenna line. User shall know the gain produced by the external device to apply proper value here.



An MHA/TMA gain shall not be included in this parameter. The MHA/TMA gain is commissioned together with the MHA/TMA device commissioning and taken into account as default by the system.

Uplink Delay

In nanoseconds, is used to compensate the antenna line UL delay difference between main and diversity Rx branches of the cell. This is needed to avoid gain (i.e. performance) loss due to the time difference between Rx branches data. For example, offset of 1/2 chip period (130ns) introduces diversity gain degradation of about 1dB. Different delays are met e.g. when two radio modules are cross-connected together via RX diversity outputs. User may provide absolute UL delay values for all Rx branches of the cell, or optionally only the positive difference referred to the smallest delay branch and leave smallest delay branch value to zero. It's not required to apply the UL delay when the delay for Rx branches of the cell are about equal.

A NOTE

Multiradio Combiner (MRC) delay shall not be included in this parameter. The MRC delays are taken into account as default by the system when the Multiradio Combiner is commissioned into use.

Proprietary AISG 1.1 TMARET and RET settings

The following figure illustrates the Proprietary AISG 1.1 TMARET and RET settings:

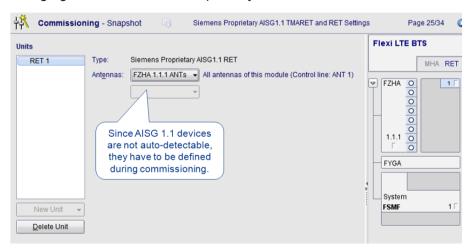


Figure 241: Proprietary AISG 1.1 TMARET and RET settings

RET Settings

The following figure illustrates the RET Settings:

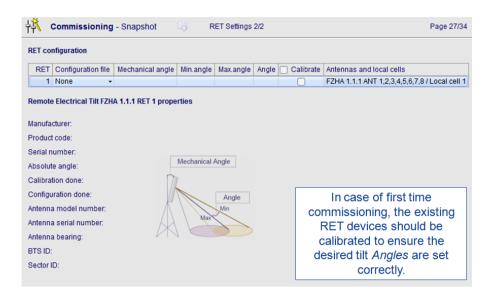


Figure 242: RET Settings

Modules I/O

System Module External Fault and Control Settings

The following figure illustrates the System Module External Fault and Control Settings:

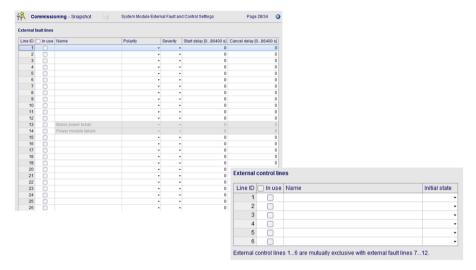


Figure 243: System Module External Fault and Control Settings

Radio Module External Fault and Control Settings

The following figure illustrates the Radio Module External Fault and Control Settings:

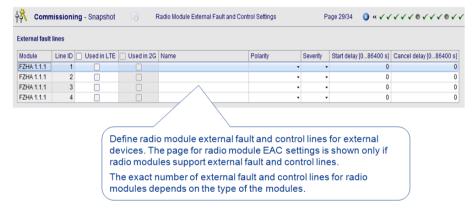


Figure 244: Radio Module External Fault and Control Settings

Radio Network Configuration

The following figure illustrates the Radio Network Configuration handling introduction:

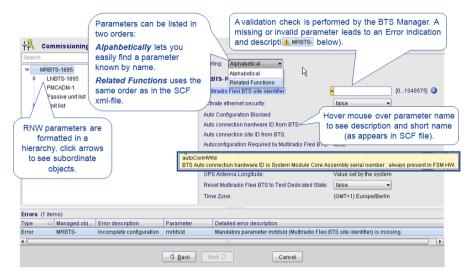


Figure 245: Radio Network Configuration handling introduction

LNBTS - LTE Node BTS Parameters

The following figure illustrates the LNBTS – LTE Node BTS Parameters:

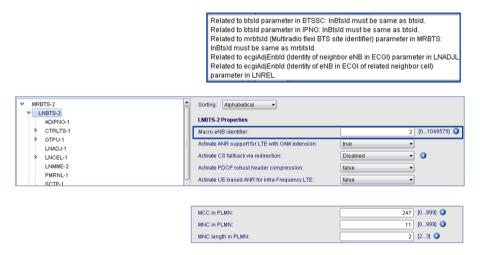


Figure 246: LNBTS – LTE Node BTS Parameters

LNMME: Primary IP address of MMEs

The following figure illustrates the LNMME: Primary IP address of MMEs:

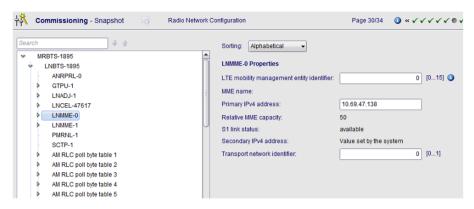


Figure 247: LNMME: Primary IP address of MMEs

LNADJ - LTE Node Adjacencies

enbControlled

The following parameters are defined for LNADJ – LTE Node Adjacencies:

IP address control

The parameter determines whether the C-Plane IP address of the neighbor eNB (X2 link) is statically configured or whether eNB is allowed to update the address based on information provided by ANR procedures.

enbControlled The IP address will be maintained by ANR procedures if ANR features are activated. It is the default value for neighbor eNBs which have been learnt via ANR procedures.

oamControlle d

It is the responsibility of the operator to configure the correct cPlanelpAddr. In terms of the limitation to maximum 32 X2 links oam controlled links have priority.

The following figures illustrate the LNADJ – LTE Node Adjacencies:



Figure 248: LNADJ – LTE Node Adjacencies 1/2

It is the responsibility of the operator to configure the correct cPlanelpAddr. In terms of the limitation to maximum 32 X2 links oam controlled links have priority. Commissioning - Snapshot 🕝 Radio Network Configuration Sorting: Alphabetical ▼ ▼ <u>▲</u> LNBTS-1895 LNADJ-1 Properties ANRPRL-0 GTPU-1 1 [0...63] Neighbour eNB identifier: C-Plane IP address control: oamControlled **-**▼ LNADJ-1 LNADJL-5 C-Plane IPv4 address of neighbor eNB: 10.69.70.103 Primary PLMN identity of neighbor LTE cell in ECG | Identity of neighbor eNB within PLMN: 1897 Broadcast PLMN identity list Primary PLMN identity of neigh 0 Neighbor eNB globally unique group ID list Neighbor eNB globally unique group ID list-1 Primary PLMN identity of neighbor eNB Primary PLMN identity of neighbor eNB-1

Figure 249: LNADJ - LTE Node Adjacencies 2/2

SCTP MO – Key Parameters

oamControlled

The following figure illustrates the SCTP MO – Key Parameters:

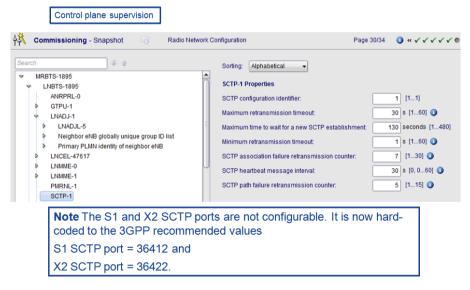


Figure 250: SCTP MO - Key Parameters

LNCEL MO - Key Parameters

The following figure illustrates the LNCEL MO – Key Parameters:

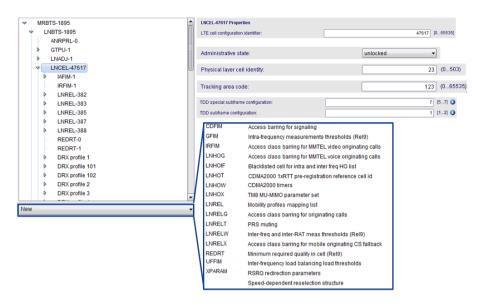


Figure 251: LNCEL MO - Key Parameters

BTS Performance Management Configuration

The following figure illustrates the BTS performance management configuration:

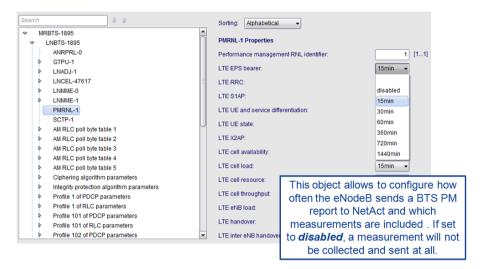


Figure 252: BTS Performance Management Configuration

Some New MO Class in TL15A

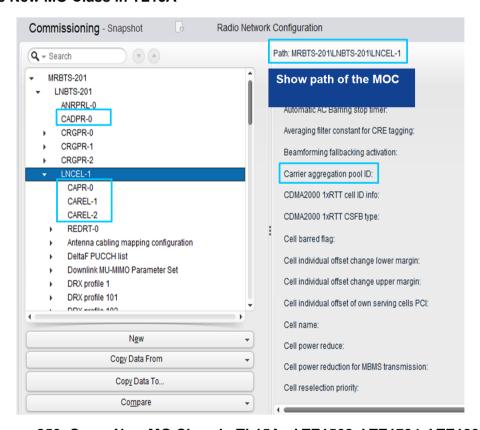


Figure 253: Some New MO Class in TL15A - LTE1562, LTE1784, LTE1836, LTE1838

LTE1562	Carrier aggregation for multi-carrier eNode Bs
LTE1784	Carrier Aggregation for Supercell Up to 2CC
LTE1836	TDD downlink carrier aggregation - 60Mhz
LTE1838	TDD downlink Inter-band Carrier Aggregation - 40Mhz

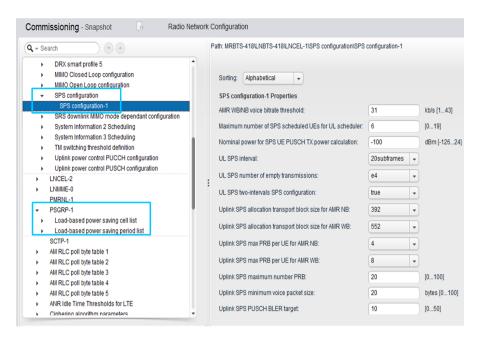


Figure 254: Some New MO Class in TL15A - LTE1929, LTE1103

LTE1929

UL Semi-persistent scheduling> Uplink semi-persistent scheduler provides increases the number of VoIP users per cell as less PDCCH signaling is required.

LTE1103

Load based Power Saving for multi-layer networks. Save energy in case of low load periods in the network and having more than one frequency available.

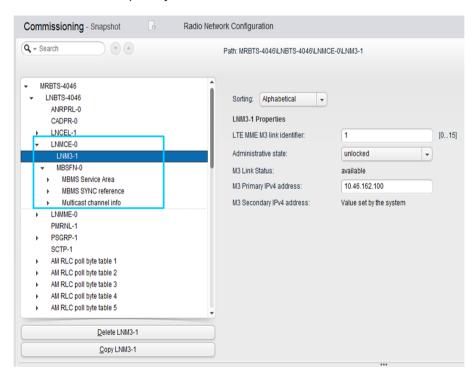


Figure 255: Some New MO Class in TL15A - LTE1117

LTE eMBMS concept and configuration:

MBSFN Multicast - Broadcast Single Frequency Network

MCE Multicast Co-ordination Entity

M3 Interface between MCE and MME

Send Parameters - View Changes

The following figure illustrates the Send Parameters – View Changes:

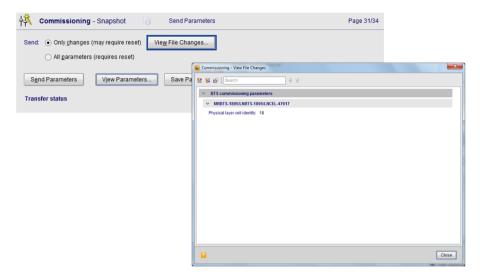


Figure 256: Send Parameters - View Changes

Send Parameters - View Parameters

The following figure illustrates the Send Parameters – View Parameters

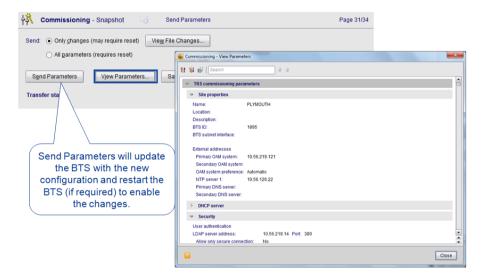


Figure 257: Send Parameters – View Parameters

BTS Commissioning: Send Parameters

The following figure illustrates the BTS Commissioning: Send Parameters:

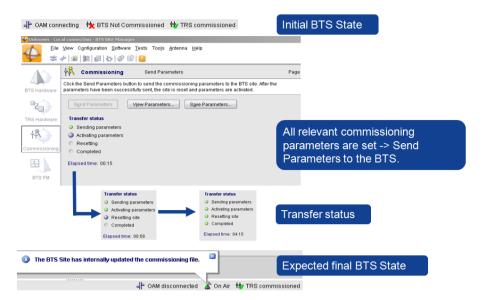


Figure 258: BTS Commissioning: Send Parameters

Lab exercise: Verify Commissioning

Context

Lab exercise to practice how to verify commissioning:

Prerequisites

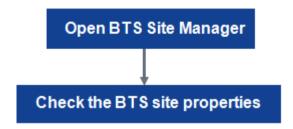


Figure 259: Verify commissioning

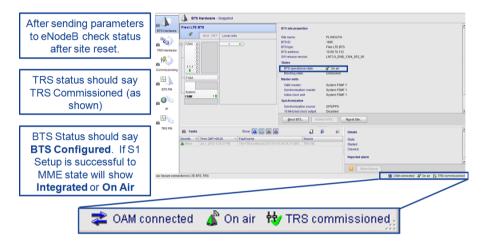


Figure 260: Verifying Commissioning

Procedure

- 1 Open the BTS Site Manager.
- **2** Check the BTS site properties.

Demonstrate the integration of the Flexi Multiradio BTS LTE

Integration

BTS Startup Overview

The following figure illustrates BTS Startup Overview:

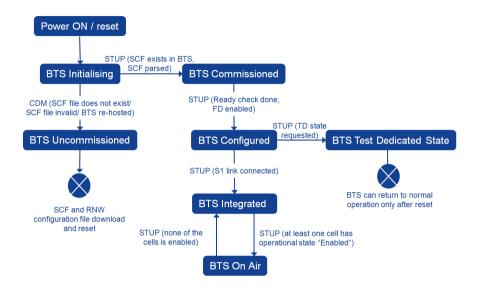


Figure 261: BTS Startup Overview

BTS status will not change to On Air until S1 Setup is successful with MME and at least one cell is enabled (unlocked and unblocked).

Test IP Connectivity

The following figure illustrates Test IP Connectivity:

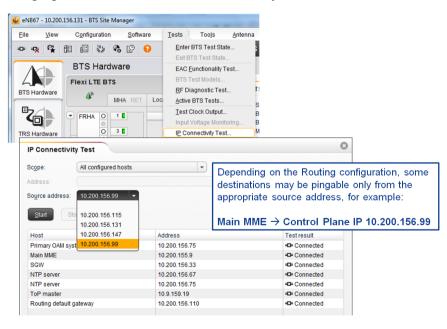


Figure 262: Test IP Connectivity

SCTP Association Establishment

The following figure illustrates SCTP Association Establishment:

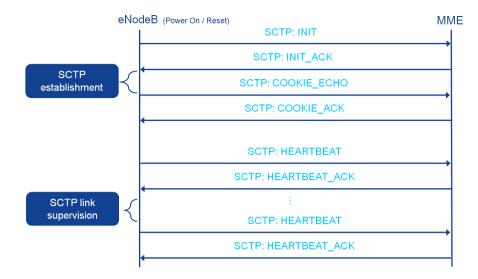


Figure 263: SCTP Association Establishment

The initialization of an association is completed on both sides after the exchange of four messages. The passive side (called server, MME in S1 case) does not allocate resources until the third of these messages has arrived and been validated.

MME receives an association setup request (an INIT chunk).

From the request, MME generates all the values needed at its side to enter an established association and put into the so-called COOKIE. This COOKIE is returned to the sender of the INIT chunk in an INIT-ACK chunk. Upon reception of a COOKIE-ECHO chunk, MME unpacks the data contained in this COOKIE to verify whether it was the originator of this COOKIE.

If it is a valid COOKIE, the MME will send a COOKIE-ACK to the eNodeB After all four messages have been exchanged, the SCTP association between MME and eNodeB is established and both are ready to exchange SCTP data (S1AP messages).

eNodeB sends HEARTBEAT messages to monitor the tranmission path. This message has to be acknowledged with HEARTBEAT ACK.

S1 Setup Procedure

The following figure illustrates S1 Setup Procedure:



Figure 264: S1 Setup Procedure

The S1 setup procedure shall be the first S1AP procedure triggered after the TNL association has become operational (after SCTP association establishment).

The eNodeB initiates the procedure by sending a S1 SETUP REQUEST message including the appropriate data to the MME. The MME responds with S1 SETUP RESPONSE including the appropriate data. All S1 messages are treated as SCTP data, thus everytime either eNodeB or MME receives S1 message, it shall send back selective acknowledge (SACK) chunk to its peer.

Lab exercise: Verify Integration

Context

Lab exercise to practice how to verify Integration.

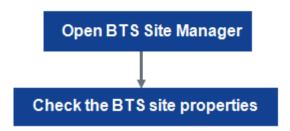


Figure 265: Verify Integration

The following figure illustrates a screenshot of successfull BTS Integration.

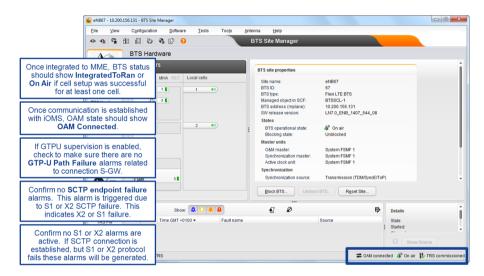


Figure 266: Verifying Integration

Procedure

- 1 Open the BTS Site Manager.
- **2** Check the BTS site properties.
- 3 Check that the BTS status show *IntegratedToRan* or *On Air* if cell setup was successful for at least one cell.
- 4 Check that OAM state shows OAM Connected.
- 5 Make sure there are no GTP-U Path Failure alarms related to connection S-GW.
- 6 Confirm no SCTP endpoint failure alarms.
- 7 Confirm no S1 or X2 alarms are active.

Summary: Flexi Multiradio BTS LTE Commissioning, Configuration Management and Integration

Module Summary

This module covered the following learning objectives:

- Describe the BTS Site Manager Installation.
- Demonstrate the manual Flexi Multiradio BTS LTE software update.
- Demonstrate the manual commissioning of the Flexi Multiradio BTS LTE.
- Demonstrate the integration of the Flexi Multiradio BTS LTE.