radisys

LTE MME Reference Application

Functional Specification
1091417 1.12a

LTE MME Reference Application

Functional Specification

1091417 1.12a

LTE MME Reference Application
Functional Specification
1091417 1.12a

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Preface

Objective

This document provides a functional description of the LTE MME Reference Application software (1091417 1.12a) designed by the Continuous Computing Corporation. This product is referred to as LTE RLC PDCP in the rest of the document.

Audience

Continuous Computing assumes that the readers of this document are familiar with telecommunication protocols, specifically LTE.

Document Organization

This document is organized into the following sections.

Section	Description
1 Introduction	Provides an overview of the product, including the product description and features.
2 Application	Describes the network architecture and protocol stacks.
3 Product Highlights	Defines Trillium Advanced Portability Architecture (TAPA) and describes the product-specific features.
4 Licensing Options	Describes the licensing information for this software.
5 Memory Size	Gives the products memory size which includes the total code sizes.

Section	Description
6 Open Source Software Usage	Gives the details about the open source software products used during the development.
Appendix A: Addendum	Describes the list of changes in this release.

Document Set

The suggested reading order of this document set is:

1. *LTE MME Reference Application Functional Specification*

    Describes the features and highlights the protocol and system characteristics, including the memory characteristics and conformance details.

2. *SZT Interface Service Definition*

    Describes the internal lower layer primitives for the SZT interface with Trillium LTE S1AP Product. The Interface Primitives section describes the software services. The Interface Service Definition describes the interface procedures defined for the service provider software.

3. *S1AP Service Definition*

    Describes the procedures for S1AP at the layer manager interface. The layer manager interface is used to configure, control and collect the status and statistics information from the S1AP software.

4. *EGT Interface Service Definition*

    Describes the internal lower layer primitives for the EGT interface with Trillium eGTP Product. The Interface Primitives section describes the software services. The Interface Service Definition describes the interface procedures defined for the service provider software.

5. *eGTP Service Definition*

    Describes the procedures for eGTP at the layer manager interface. The layer manager interface is used to configure, control and collect the status and statistics information from the eGTP software.

6. *SCTP Service Definition*

    Describes the procedures for SCTP at the layer manager interface. The layer manager interface is used to configure, control, and collect the status and statistics information from the SCTP software.

7. *TUCL Service Definition*

Describes the procedures for TUCL at the layer manager interface. The layer manager interface is used to configure, control, and collect the status and statistics information from the TUCL software.

Using Continuous Computing® Documentation

The following figure shows the various user approaches to using the software documentation. First time users must read the documents under the **Getting Started** column, where important sections and subsections are listed to the right of each document. For users familiar with the documentation, but who need to look up certain points concerning software use, **Understanding the Software** column is suggested. The **Porting** column is for users familiar with Continuous Computing Trillium software and related telecommunications protocols and wish to install the software immediately onto their development environments.

Continuous Computing Documentation

Getting Started	**Understanding the Software**	**Porting**

TAPA TC — TAPA Training

TC — Onsite/Offsite Training

PG — Porting

FS — Environment / Protocol Characteristics / System Characteristics

SD ISD — Interface Primitives / Interface Procedures

TC — Functional Description / Software Organization

STS — Sample Configuration / Test Description

SD ISD — Environment

PG — Files

STS — Stack Architecture

FS   Functional Specification
TC   Training Course
ISD   Interface Service Definition
PG   Porting Guide
SD   Service Definition
STS   Software Test Sample

Notations

The following table displays the notations used in this document:

Notation	Explanation	Examples
Arial	**Titles**	**1.1 Title**
Book Antiqua	Body text	This is body text.
Bold	**Highlights information**	**Loose coupling, tight coupling, upper layer interface**
ALL CAPS	CONDITIONS, MESSAGES	AND, OR CONNECT ACK
Italics	Document names, emphasis	LTE RLC PDCP Functional Specification This adds *emphasis*.
`Courier New Bold`	`Code Filenames, pathnames`	`PUBLIC S16 UeMiLvbCfgReq(pst, cfg) Pst *pst; UeMngmt *cfg;`

Release History

The following table lists the history of changes in successive revisions to this document.

Version	Date	Author name	Description
1.12a	January 25, 2012	Manoranjan Sahu	Addendum release for CNE Feature Support updated
1.11a	October 10, 2011	Naveen Dcruz H	Addendum release for Radisys logo and template upgrade.
1.1	June 06, 2010	Raja Kumar DT	Initial release. Conforms to LTE RLC PDCP software release, version 1.1

1

Introduction

1.1 Company Introduction

Continuous Computing is the only company deploying uniquely architected systems comprised of telecom platforms and Trillium software. Leveraging more than 20 years of innovation, the company enables network equipment providers to rapidly deploy carrier-class LTE, DPI, and Femtocell applications with reduced risk, cost, and complexity. Only Continuous Computing combines open-standards systems, Trillium protocol software, and expert professional services to create fully-integrated solutions that empower more than 150 customers worldwide to accelerate new product delivery and maximize return on investment. Find more details at www.ccpu.com

1.1.1 Continuous Computing Trillium Product-line

Trillium$^{®}$ protocol software is synonymous with high quality and superior performance. Trillium originally built its strong reputation with flexible and powerful ATM, SS7, and SIGTRAN software. Trillium innovation continues today with complete and easy-to-use solutions in the Femtocell, IP Multimedia Subsystem (IMS), and Long Term Evolution (LTE) arenas.

Experts view Trillium as "the standard" for protocol stack solutions. Trillium software empowers telecom equipment manufacturers to develop reliable, high-performance 3G / 4G network nodes such as PDN GW, x-CSCF, eNodeB, xGSN, x-PCRF, ePDG, MME, Serving GW, ePDG, and many more. Key customer benefits are accelerated time-to-market, reduced development costs, and decreased project risk and complexity.

The foundation of all Trillium products is the Trillium Advanced Portability Architecture (TAPA$^{®}$), which ensures complete independence from the target system's compiler, processor, operating system, or architecture. In addition, TAPA provides a consistent Application Programming Interface (API), code organization, and debugging and trace capabilities. Benefits include reliability, consistency and compressed learning curves.

Trillium software solutions also include the Distributed Fault-Tolerant / High Availability (DFT/HA) architecture, a patented model for software scalability and reliability which distributes processing loads across multiple processors and magnifies performance.

Trillium's latest innovation is a proven multi-threaded design that minimizes locking and optimizes performance in today's multi-core / multi-threaded environments. Trillium Multi-Core is a significant technology advantage which enables customers to leverage rapid advancements in silicon processing power quickly and easily.

1.1.2 Quality

The Continuous Computing Corporation is certified and registered as compliant with the CMMI Level 3 and the ISO 9001 quality system requirements. These certifications signify that the Continuous Computing Corporation processes related to the design, development, testing and distribution of communications software products and services for the next-generation network infrastructure successfully meet internationally recognized quality management systems requirements.

1.2 Product Description

This document provides functional description for LTE MME Reference Application.

The LTE RLC PDCP software provides the following basic capabilities:

- MME Stack Configure all protocol layers.
- Configure and setup MME.
- Setup S1AP signalling connection with eNodeB.
- Supports encoding/decoding of EMM/ESM messages.
- Supports co-located HSS.
- Supports single session per UE.
- Supports multiple Attach and Detach procedures.
- Supports Data transfer between two end applications.
- Extensive debugging support to ease system integration and testing.

1.3 Abbreviations

The following abbreviations are used in this document:

Abbreviation	Expansion
ANSI	American National Standards Institute
LI	Lower Interface
LMI	Layer Manager Interface
OSI	Open Systems Interconnection
PDU	Protocol Data Unit
SAP	Service Access Point
SDU	Service Data Unit
SSI-SDK	System Services Interface - Software Development Kit
TAPA	Trillium Advanced Portability Architecture
UI	Upper Interface

For a list of commonly used terms, refer to the Engineering Glossary (part number PREN026) at http://www.ccpu.com/search/glossary/

Product-specific Glossary

Abbreviation	Expansion
CNE	Core Network Emulator
eGTP/e-GTP	Evolved GTP
ENB/eNB/eNodeB	Evolved Node B
FDD	Frequency Division Duplex
MAC	Medium Access Control
MME	Mobile Management Entity
NAS	Non Access Stratum
P-GW/PGW	PDN Gateway
RB	Radio Bearer
RLC	Radio Link Control
RRC	Radio Resource Control
S1AP	S1 Application Protocol

Abbreviation	Expansion
SCTP	Stream Control Transmission Protocol
SRB	Signalling Radio Bearer
SG	Serving Gateway
SM	Stack Manager
LTE	Long Term Evolution
TDD	Time Division Duplex
TUCL	TCP/UDP Convergence Layer
UE	User Equipment

2

Application

2.1 LTE MME Reference Application Architecture

Figure 2-1 shows the architecture of LTE MME Reference.
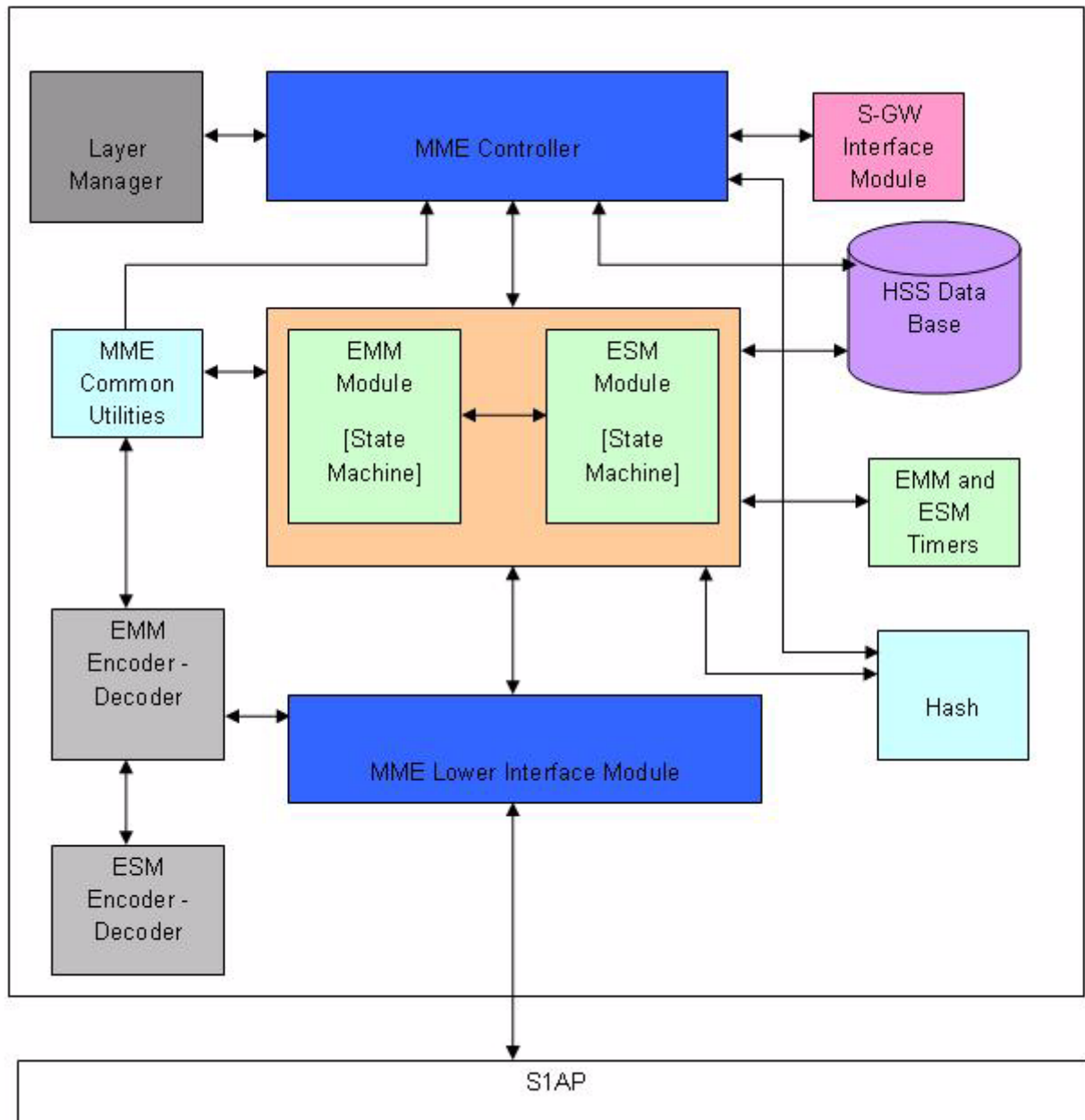
Figure 2-1: LTE MME Reference Application Architecture

MME Application constitutes of the following modules:

Table 2-1: MME Application Modules

Module Name	Module Description
MME Controller	It is the master module of MME. It controls the complete functionalities of MME application.
EMM Module	Responsible of processing EMM messages and maintain EMM state machine.
ESM Module	Responsible of processing ESM messages and maintain ESM state machine.
EMM Encoder/ Decoder	Responsible of encoding and decoding of EMM messages.
ESM Encoder/ Decoder	Responsible of encoding and decoding of ESM messages.
EMM/ESM Timers	Responsible to handle EMM/ESM timers.
Layer Manager	Responsible to configure and manage all the lower layers in the MME Protocol Stack
S1AP	Responsible to relay NAS signaling messages between CNE and UE entities
MME Common Utilities	MME utilities to build EMM/ESM messages and other utility functions.
HSS DataBase	Responsible of storing and updating when necessary. The database containing all the user subscription information.
MME Lower Interface Module	Handles all the upper interface primitives to send the message to S1AP and receive from S1AP.
S-GW Interface Module	S-GW interface module has dummy eGTP-C wrapper functional primitives to controlling the Tunnel management functions.

2.2 MME Protocol Stack

The following diagram depicts the MME protocol stack architecture.
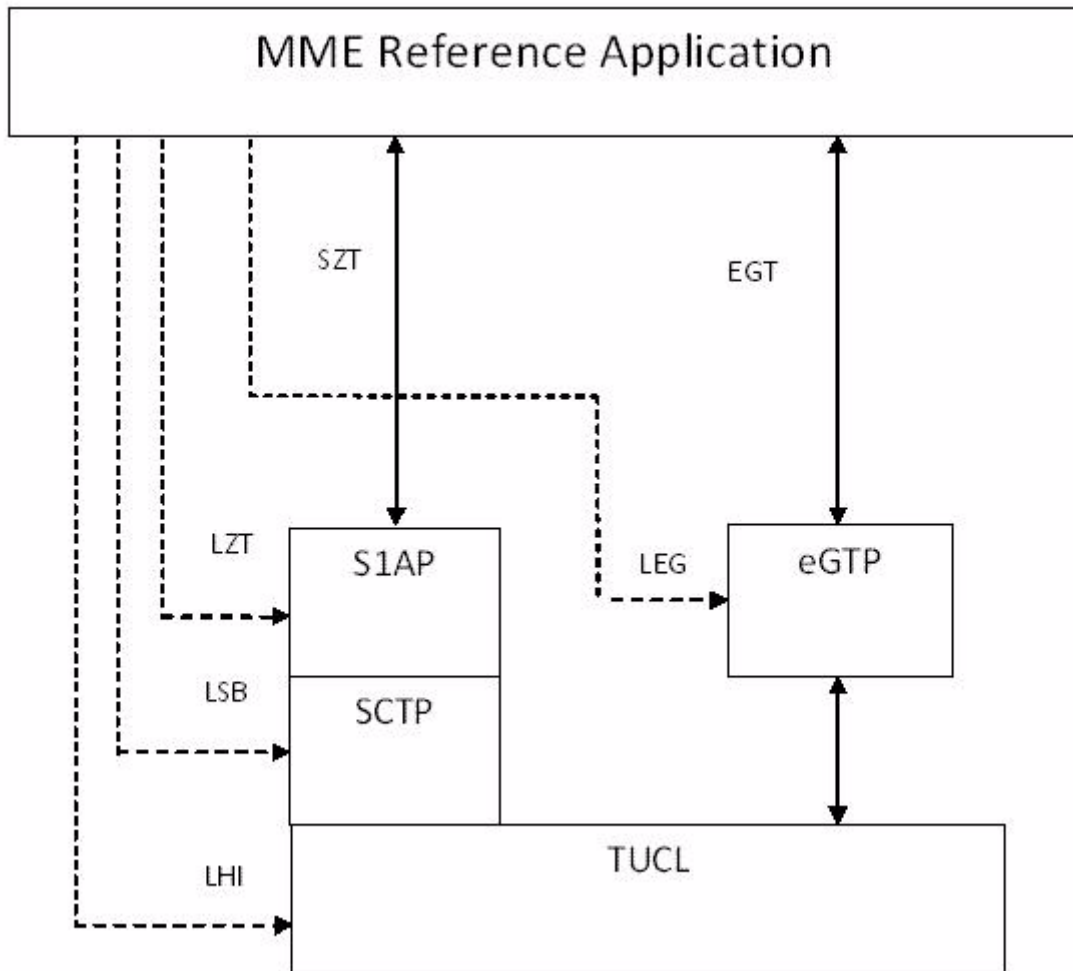
Figure 2-2: MME Protocol Stack Architecture

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Product Highlights

3.1 Protocol Conformance

The LTE RLC PDCP software complies with the basic LTE signaling and data call flow provided by the Figure 3-1.

Refer to respective lower layer (S1AP, TUCL, SCTP) Functional Specification documents for the protocol conformance.

3.2 Feature Support

Table 3-1 lists the features supported by the software.

Table 3-1: Features

Option	Feature	Supported
01	Supports all lower layer's Configurations and Trigger binding Procedures. Supports S1AP, S1-U interfaces. Supports encoding and decoding of EMM/ESM messages. Supports S1AP Initial Context Setup (during Attach) and Release Procedures (during Detach). Supports path management procedure (echo procedures) between multiple core network nodes at S11 interface. Supports multiple UEs and sessions [single session per UE]. Supports multiple of UEs subscription data as HSS functionality at MME. Supports multiple Attach and Detach procedures of UEs. Supports EMM procedures like UE Attach Procedure, UE Detach Procedure, Authentication Procedure, Security Mode Procedure and Identity Request and Response Supports ESM procedures like Activate Default Bearer Context and PDN Connectivity. Supports eGTP tunnel management-Creation, Management, Deletion. ERAB Setup Release from CNE. CNE initiated Detach Procedure. Multiple UE, each with single Dedicated Bearer support. GUTI Attach Support. Supports Data Transfer between two end applications. Tested PING, video-streaming (VLC player and iperf), FTP, HTML web-browsing, VNC server application in end-to-end demo setup involving `ueSIM`, `eNB`, `CNE`s (for single UE).	Yes

Refer to the *LTE MME Reference Application PICS* document for additional details on conformance.

ATTACH PROCEDURE (END-TO-END)

UE	eNB	MME	SGW	PDNGW

S1 Setup Req() →

← **S1 Setup Resp()**

(RACH Preamble) →

← **Random Access Resp**

RRC Connection Req →

← **RRC Connection Setup**

RRC Connection Setup Complete →

UL Info (NAS (Attach Req+PDN Conn Req)) →   **Init UE (Attach + PDN Contrl Req)** →

← **DL Info (NAS (Auth Req))**   ← **DL NAS (Auth Req)**

UL info (NAS Auth Resp)) →   **UL NAS (Auth Resp)** →

← **DL info (Security Mode Command)**   ← **DL NAS (Security Mode Command)**

UL info (Security Mode Complete) →   **UL NAS (Security Mode Complete)** →   **Create Session Request** →   **Create Session Request** →

Init Ctxt Setup Req (attach Accept + Act Def Bearer Ctxt Request ←   **Create Session Response** ←   **Create Session Response** ←

← **AS (Security Mode Command)**

AS (Security Mode Complete) →

← **RRC Connection Reconfig Req()**

RRC Connection Reconfig Comp() →   **Init Ctxt Setup Resp** →   **Modify Bearer Request** →

UL Info (NAS Attach Comp +ACT Def Bearer ACC) →   **UL Info (NAS Attach Comp +ACT Def Bearer ACC)** →   **Modify Bearer Response** ←
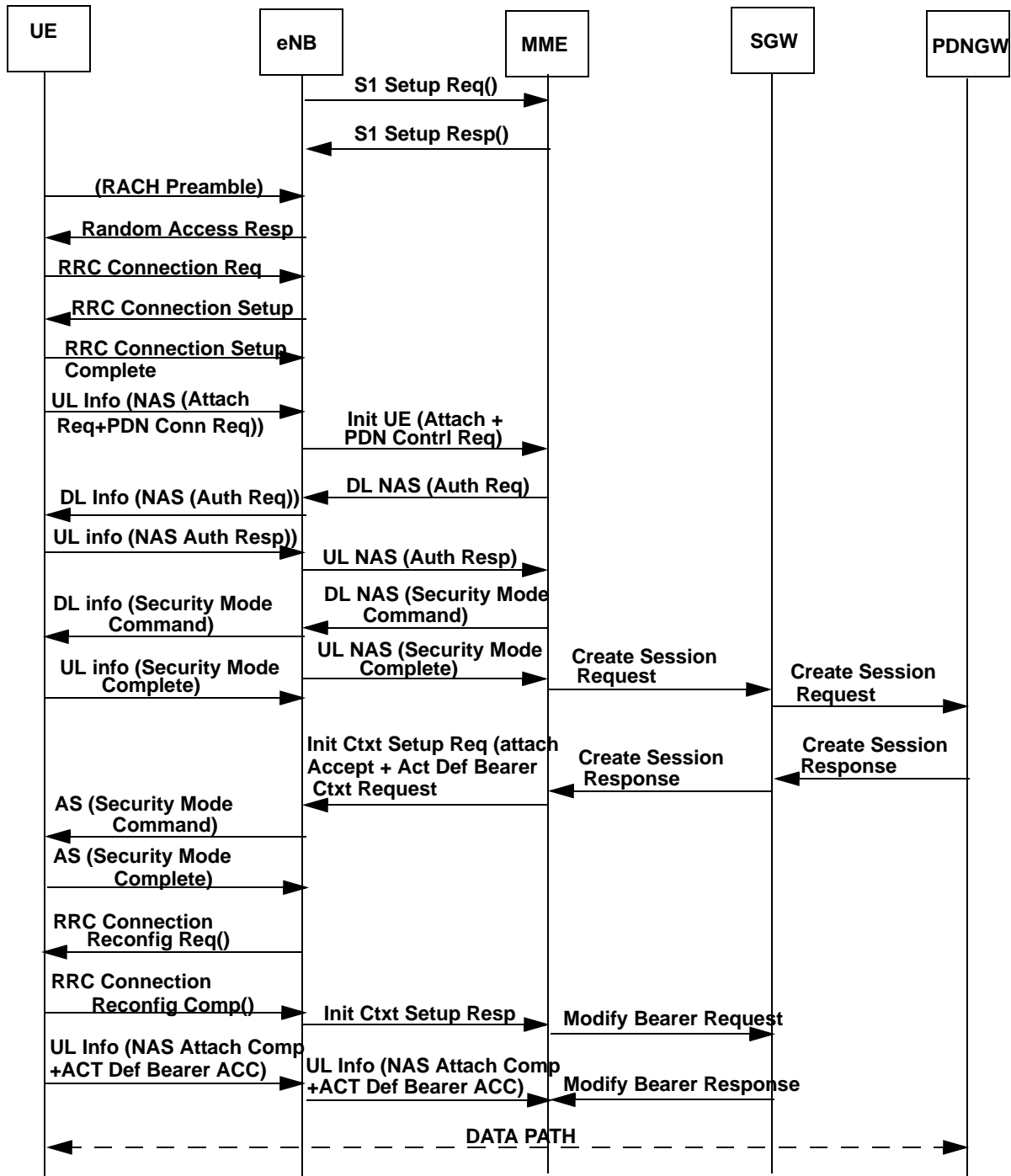
← - - - **DATA PATH** - - - →

Figure 3-1: LTE Control and Data Call flow

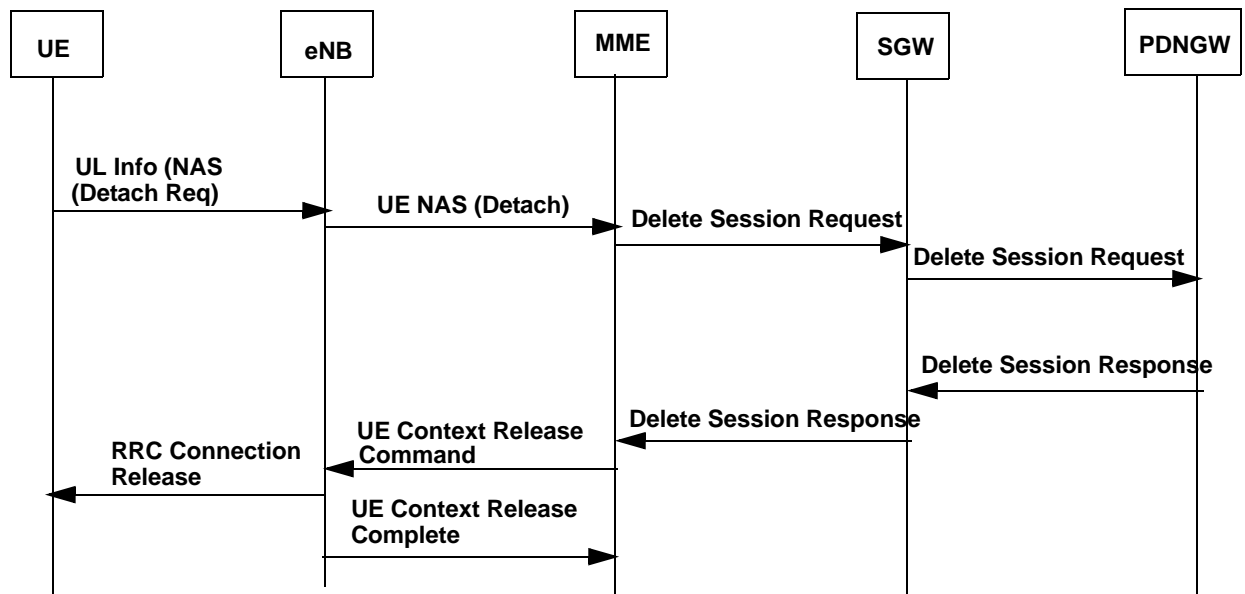**UE INITIATED DETACH (when UE is switched off)**

Figure 3-2: LTE Detach Call flow

3.3 TAPA

Trillium Advanced Portability Architecture (TAPA) defines the software architecture that ensures portability of Continuous Computing Trillium products across various platforms. Each Trillium product, represented by the box in the center of Figure 3-3, is equivalent to an Open Systems Interconnection (OSI) layer. The product has four interfaces that enable it to communicate with the other software modules in the system: the upper layer interface (UI), lower layer interface (LI), layer manager interface (LMI), and system services interface (SSI).
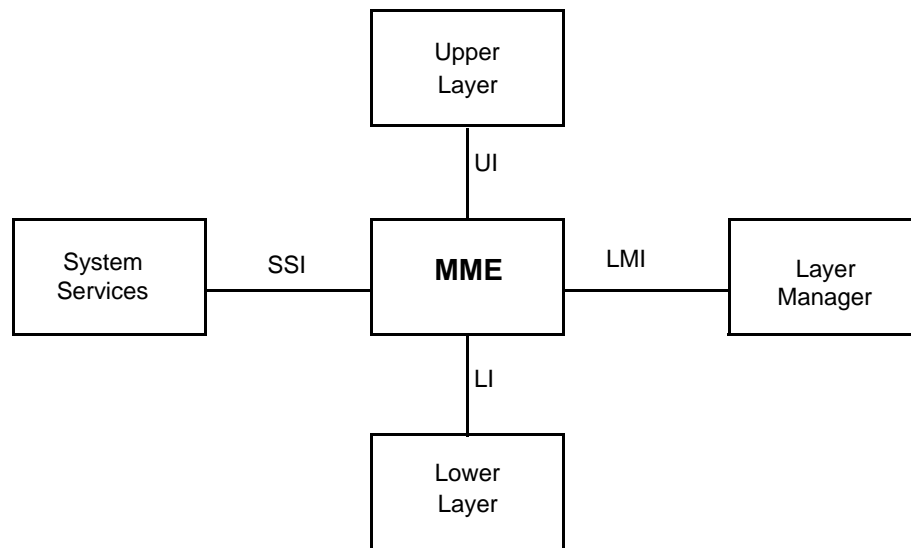
Figure 3-3: Trillium Advanced Portability Architecture (TAPA)

Interfaces

An interface is shared between two layers and used for the exchange of primitives between the layers.

Interface	Description
Upper Interface	Provides the services of this protocol layer to the upper (service user) layers. The capabilities of the protocol layer are mapped to a set of primitive functions that the upper layer can access to provide higher level services. Functions provided at this interface include binding, unbinding, connection, disconnection, data transfer, and other functions specific to the protocol layer.

Interface	Description
Lower Interface (SZT, EGT)	Accesses the services of a lower (service provider) layer. Functions provided at this interface include binding, unbinding, connection, disconnection, data transfer, and other functions specific to the lower layer.
Layer Manager Interface (Lue)	Manages the layer resources and provides functions such as run-time configuration, control, statistics, status, alarm, and other management functions required and provided by the protocol layer.
System Services Interface (SSI)	Obtains operating system services using a generic, portable interface that isolates the protocol layer from the underlying platform. Functions provided at this interface include initialization, task management, inter-task communication, timer management, memory management, message and queue management, date and time management, and resource checking.

Coupling Options

Continuous Computing Trillium software can be coupled with other layers using one of the following option.

Coupling	Description
Tight	Uses a synchronous interface, where a primitive is mapped to a direct function call into the destination layer. Control is transferred to the destination layer immediately, in a nested fashion.
Loose	Uses an asynchronous interface, where a primitive is packed into a message and posted to the destination layer. Control returns to the source layer immediately. Later, the operating system schedules the destination layer with the posted message. The destination layer retrieves the primitive from the message and processes it.
Light-weight Loose	Uses an asynchronous interface, where a pointer to the event structure is packed into a message and posted to the destination layer. This is applicable if and only if the sender and the receiver are in the same address space. Control returns to the source layer immediately, like Loose Coupling. Later, the operating system schedules the destination layer with the posted message. The destination layer retrieves the event structure by unpacking the pointer.

The system services interface is always tightly coupled.

Continuous Computing Trillium software is event-driven. It handles an event to completion, then handles the next event. Outgoing messages are generated in the same order in which the events arrived.

LTE RLC PDCP Primitives

Interaction between the LTE RLC PDCP software and the upper layer, lower layer, and layer manager takes place using a set of **primitive functions.** The primitives either initiate, or are the result of, the interactions between two layers. These primitives completely define the interaction between layers in the form of:

- Requests (service user to service provider).
- Indications (service provider to service user).
- Responses (service user to service provider).
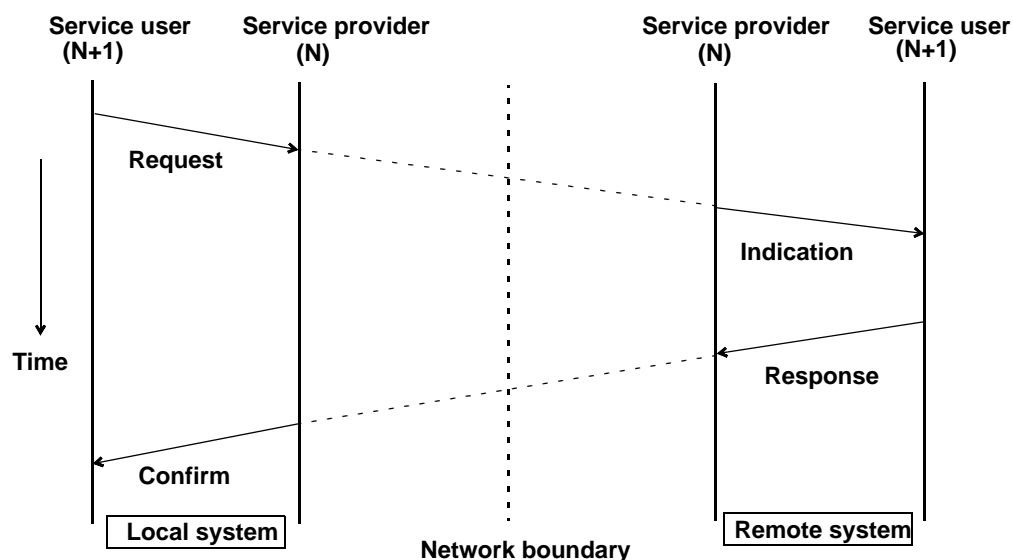- Confirmations (service provider to service user).

Figure 3-4: Exchange of primitives

Service Access Points

Information flows between layers across Service Access Points (SAPs). The standardized interface of primitives and SAPs allows layers to be defined independently. Modifications can be made to the peer-to-peer protocol of one layer without affecting any upper or lower layer protocol, if the requirements of the layer interface are met.

A detailed description of the primitives used and their associated procedures can be found in the *LTE MME Reference Application Service Definition*.

3.3.1 Portability

The software is written and delivered in the C programming language and can be compiled using any Kernighan and Ritchie or ANSI-compatible compiler.

Continuous Computing Trillium has compiled the software under native and cross compilers for many different processors. The software runs on various processors, operating systems, and architectures. While the software has not been compiled under all compilers or run on all combinations of processors, operating systems, and architectures, adherence to TAPA and its common coding and architectural standards ensures the portability of the software.

Continuous Computing Trillium has ported the software to the processors and operating systems listed as follows. This list does not constitute a recommendation for a particular operating system or processor, nor is it a complete list of operating systems and processors onto which Trillium software has been ported. It serves only to illustrate the flexibility and portability of Trillium software.

Continuous Computing Trillium provides a System Services Interface-Software Development Kit (SSI-SDK) for quick and efficient porting of the Trillium SSI to new operating system platforms.

Processors

Motorola 68xxx, Intel i960X, SPARC xxx, Intel x86, DEC Alpha, Power PC xxx, HP PA-RISC, LSI Logic LR33000.

Operating Systems

Solaris, VxWorks, pSOS, Windows NT, Lynx, Chorus, QNX, Enea OSE, Unix. Trillium has ported System Services to VxWorks, pSOS, Solaris, and Windows NT (user space and kernel space).

3.3.2 Debugging Capabilities

Continuous Computing Trillium software provides extensive debugging capabilities. If terminal printing support is available, debug printing can be enabled, using compile-time and run-time options, to print information about the data flow through the layer.

The software can trace function calls. Every function call contains a trace macro at its entry which can be mapped to print information about the function invocation. This is useful in embedded systems for which no other symbolic debugging is available. Tracing of messages can be enabled or disabled at run-time.

3.3.3 Error Checking

Continuous Computing Trillium software provides extensive error checking and recovery mechanisms to make the software robust and enable it to deal with normal error conditions. The software enables the user to control the level of error checking using compile-time options.

Error checking is done for:

- Protocol
- Interface
- Input
- Output
- Resource

More information on error checking, refer to the *LTE MME Reference Application Porting Guide*.

3.3.4 Run-Time Control

The layer manager interface controls many product capabilities at run-time. The configuration of the software can be changed dynamically to respond to the needs. For example, if the product supports multiple protocols, they are supported at run-time over separate SAPs. Management alarms and logging functions can be dynamically enabled and disabled. Also, where applicable, various protocol elements such as links can be enabled, disabled, deleted, or reconfigured at run-time.

3.4 Product Features

This section describes the primitives that the LTE RLC PDCP software uses to interact with the upper layer, lower layer, and layer manager. It also describes the procedures that the primitives enable.

3.4.1 Layer Interfaces

Several sets of primitives interface the software with the upper layer, lower layer, and layer manager.

3.4.1.1 Layer Manager Interface

The layer manager interface is used for managing layer resources. It provides run-time configuration, control, statistics, status, alarm, and other management functions required and provided by the protocol layer.

Refer to the *LTE MME Reference Application Service Definition* for details.

3.4.1.2 Upper Interfaces

MME Application is at top most layer in the protocol stack, it does not have any upper user.

3.4.1.3 SZT Interface

The SZT interface is used by MME Application for configuring S1AP layer parameters and transfer NAS Messages.

Refer to the *SZT Interface Service Definition* for details.

3.4.1.4 EGT Interface

The EGT interface is used by MME Application for configuring e-GTP Tunnels and transfer data to the CNE.

Refer to the *EGT Interface Service Definition* for details.

3.4.2 Configuration

Configuration procedures set parameters and environment options for the layer.

3.4.2.1 General Configuration

General configuration sets parameters for the entire LTE RLC PDCP layer. These parameters can be configured only once before the layer becomes operational.

3.4.2.2 Lower SAP Configuration

The Lower SAP configuration procedure allocates and configures a lower SAP. Typically, there is one lower SAP for each logical link that LTE RLC PDCP controls. If the SAP is allocated, this procedure can be used to reconfigure its parameters.

3.4.3 Alarms

Alarms are generated to indicate abnormal status changes of the software or SAP. Alarms can also be advisory in nature. Alarms are sent to the layer manager as unsolicited status indications whenever a condition requiring attention is detected.

Table 3-2 lists some of the generated alarms.

Table 3-2: Alarms

Alarms	Description
SAP Binding	Generated, if the lower SAP binding is successful

3.4.4 Control

Control functions activate and deactivate layer resources. The layer manager can invoke control functions at any time. The control feature of the layer manager gives the flexibility to dynamically modify the characteristics of a stack or a resource, such as a link.

For example, by using control, the user can:

- Turn tracing on or off at run-time. Once tracing is turned on, it provides the Service Data Units (SDUs) that are transmitted to the layer, and received from the layer, to the layer manager. This information can be used for debugging.
- Turn alarms on or off at run-time. When enabled, alarms provide useful information regarding the state of the protocol stack.
- Turn different debug levels on and off to aid product-specific system integration.
- Trigger Binding procedure towards lower layer.
- Trigger S1 Setup Request Procedure.

4

Licensing Options

For licensing purposes, LTE MME Reference Application is identified by a marketing part number, 1000421. Continuous Computing Trillium supplies a base option with each license to provide core protocol functionality. Additional options can be licensed for increased functionality, as described in Table 4-1.

Table 4-1: Licensing options

Part Number	Option	Description
1000417	01	MME Reference application - Binary of MME Reference application and configuration files.
1000417	02	MME Reference application - Source code of MME Reference application, configuration files, and libraries for protocol stacks (TUCL, SCTP, S1AP, eGTP).

5

Memory Size

Continuous Computing Corporation offers the industry's leading performer LTE MME Reference Application protocol software solution for LTE.

LTE MME Reference Application is a cornerstone technology that provides functionality of MME application. A key benefit of Continuous Computing's LTE MME Reference Application software is its capability to interwork with Continuous Computing Trillium's SS7, IP, ATM, SIP, GTP, RRC, and ISDN protocol stacks. Continuous Computing's LTE MME Reference Application software is scalable and supports distributed system architectures. Continuous Computing's LTE MME Reference Application software offers maximum portability and flexibility based on Continuous Computing Trillium's proven TAPA^{TM} software architecture.

Continuous Computing's LTE MME Reference Application software solution enables communications equipment suppliers to deliver products that meet the requirements of next-generation networks.

5.1 Code Size

The code size is the number of bytes of memory needed for the executable code. The code size includes all function calls to system services, layer manager, and the upper and lower layers, but does not include the size of the actual code provided within these functions.

The code size depends on the options delivered, compiler, linker, locator, memory model, and whether delivered features – such as error checking, management capabilities, and protocol capabilities – are used. The code size can be determined from the software link map.

A sample compile under the following conditions, tightly coupled with error checking and trace printing disabled, yields the code size in Table 5-1.

Table 5-1: Code size

Type	Condition
Product	LTE RLC PDCP, version 1.1
Product options	01
Compiler	gcc compiler, version 4.1.2
Compiler options	`-Os -ansi -Wall -Wno-comment -pipe -Wshadow -Wcast-qual -Wstrict-prototypes -Wmissing-prototypes -pedantic -Wimplicit -Wunused`
Processor	Intel(R) Core (TM) i5 CPU M 520@2.40 GHz
Total code size (in Bytes)	**2685227**

5.2 Static Data Size

The static data size is the number of bytes of memory needed for:

*   Initialized variables and structures, such as state matrices or strings.
*   Uninitialized variables and structures, such as anchors for control points and SAPs.

Static data is allocated at compile time and represents the global variables and structures used by the software. Static data does not include any structures allocated at run-time.

The static data size depends on the options delivered, compiler, linker, and memory model. The static data size can be determined from the software link map.

A sample compile under the following conditions, tightly coupled with error checking and trace printing disabled, yields the code size in Table 5-2.

Table 5-2: Static data size

Type	Condition
Product	LTE RLC PDCP, version 1.1
Product options	01
Compiler	gcc compiler, version 4.1.2
Compiler options	`-Os -ansi -Wall -Wno-comment -pipe -Wshadow -Wcast-qual -Wstrict-prototypes -Wmissing-prototypes -pedantic -Wimplicit -Wunused`
Processor	Intel(R) Core (TM) i5 CPU M 520@2.40 GHz
Total static data size (in Bytes)	**1600848**

5.3 Dynamic Data Size

Dynamic data size is the number of bytes of memory needed for:

- Structures (for example, control points and SAPs) used to manage the interface and protocols.
- Buffers used to store messages.

Dynamic data is allocated at run-time and represents the memory managed by the operating system. Allocation of dynamic data depends on the compile-time configuration, run-time configuration, and the net flow of traffic through the software.

Dynamic data size depends on maximum allowable configuration (A), size of structures allocated for the configurable parameters (B), maximum number of messages per second (C), and the average size of a message buffer (D).

The dynamic data size can be estimated by using the formula:

$(A \times B) + (C \times D)$

The message buffer size depends on system services. The maximum allowable configuration and dynamically allocated structure size are given in Section 5.3.1 and Section 5.3.2.

5.3.1 Maximum Allowable Configuration

The maximum allowable configurations described in this section represent the capacity of the software. Actual maximums may be smaller, depending on the limitations of the system to which this software is ported, such as memory availability.

Table 5-3: Maximum allowable configurations

Entity	Maximum Number
Upper SAPs	Not Applicable
Lower SAPs	2

5.3.2 Dynamically Allocated Structure Size

This section describes the sizes of dynamically allocated structures, such as control points or SAPs.

A sample compile under the following conditions, tightly coupled with error checking and trace printing disabled, yielded the structure sizes in the following tables.

Table 5-4: Structure types

Structure Type	Condition
Product	LTE RLC PDCP, version 1.1
Product options	01
Compiler	gcc compiler, version 4.1.2
Compiler options	`-Os -ansi -Wall -Wno-comment -pipe -Wshadow -Wcast-qual -Wstrict-prototypes -Wmissing-prototypes -pedantic -Wimplicit -Wunused`
Processor	Intel(R) Core (TM) i5 CPU M 520@2.40 GHz

Table 5-5: Dynamically allocated structure sizes

Type	Bytes
S1AP SAP Control Block	432
eGTP SAP Control Block	504
MME UE Tunnel Control Block	120
MME EMM Control Block	328
MME ESM Control Block	328
MME UE Info Control Block	1496
HSS UE Info Control Block	1228
MME UE Control Block	2000
MME ENodeB Control Block	160
MME Control Block	4744

6

Open Source Software Usage

Open Source Software (OSS) components were not used during the development of LTE MME Reference Application.

Appendix A

Addendum

This section is an addendum to version 1.1 *Mobility Management Entity (MME) of Core Network.*

> **Note:** The material in this addendum is integrated into the body of the document and noted below.

Table A-1: Changes for this addendum

Description of Change	Section Reference
Updated Release History in Preface.	Preface
Updated Feature Support in Product Highlights.	Section 3.2, "Feature Support"

References

Refer to the following documents for additional information.

LTE MME Reference Application Service Definition, Continuous Computing Corporation (p/n 1092421).

System Services Interface Service Definition, Continuous Computing Corporation (p/n 1111001).

3GPP TS 24.301 V8.2.1 (2009-06): Non-Access-Stratum (NAS) protocol for Evolved Packe System (EPS)

3G TS 36.413, version 8.1.0 (2008-03), E-UTRAN S1 Application Protocol.

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3G TS 29.274, version 1.3.0 (2008-10), Evolved GPRS Tunnelling Protocol for Control Plane.

3G TS 29.281, version 8.1.0 (2008-10), GPRS Tunnelling Protocol -User Plane.

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