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Family SL Satellite Radio Interface (Release 1);
Part 1: General Specifications;
Sub-part 2: System Operation Overview

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Satellite Earth Stations and Systems (SES).

The present document is part 1, sub-part 2 of a multi-part deliverable. Full details of the entire series can be found in ETSI TS 102 744-1-1 [i.11].

Modal verbs terminology

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Introduction

This multi-part deliverable (Release 1) defines a satellite radio interface that provides UMTS services to users of mobile terminals via geostationary (GEO) satellites in the frequency range 1 518,000 MHz to 1 559,000 MHz (downlink) and 1 626,500 MHz to 1 660,500 MHz and 1 668,000 MHz to 1 675,000 MHz (uplink).

1 Scope

The present document provides an overview of the Family SL system operation, and describes fundamental UMTS elements such as mobility management, numbering and addressing, and idle mode behaviour as they apply to the Family SL satellite network. In general, these elements are the same for both terrestrial UMTS and the satellite network. Where appropriate, references to 3GPP documents are given, otherwise the text highlights the areas where the terrestrial UMTS and Family SL elements differ.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

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The following referenced documents are necessary for the application of the present document.

[1] ETSI TS 123 003: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Numbering, addressing and identification (3GPP TS 23.003 Release 4)".

[2] ETSI TS 123 060: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); General Packet Radio Service (GPRS); Service description; Stage 2 (3GPP TS 23.060 Release 4)".

[3] ETSI TS 123 122: "Universal Mobile Telecommunications System (UMTS); Non-Access-Stratum functions related to Mobile Station (MS) in idle mode (3GPP TS 23.122 Release 4)".

[4] ETSI TS 125 413: "Universal Mobile Telecommunications System (UMTS); UTRAN Iu interface Radio Access Network Application Part (RANAP) signalling (3GPP TS 25.413 Release 4)".

[5] ETSI TS 102 744-1-4: "Satellite Earth Stations and Systems (SES); Family SL Satellite Radio Interface (Release 1); Part 1: General Specifications; Sub-part 4: Applicable External Specifications, Symbols and Abbreviations".

[6] Recommendation ITU-T E.164: "The international public telecommunication numbering plan".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI TS 122 101: "Universal Mobile Telecommunications System (UMTS); Service aspects; Service principles (3GPP TS 22.101 Release 4)".

[i.2] ETSI TS 123 221: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Architectural requirements (3GPP TS 23.221 Release 4)".

[i.3] ETSI TS 124 007: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Mobile radio interface signalling layer 3; General Aspects (3GPP TS 24.007 Release 4)".

[i.4] ETSI TS 124 008: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Mobile radio interface Layer 3 specification; Core network protocols; Stage 3 (3GPP TS 24.008 Release 4)".

[i.5] ETSI TS 125 331: "Universal Mobile Telecommunications System (UMTS); Radio Resource Control (RRC) protocol specification (3GPP TS 25.331 Release 4)".

[i.6] ETSI TS 133 102: "Universal Mobile Telecommunications System (UMTS); 3G security; Security architecture (3GPP TS 33.102 Release 4)".

[i.7] Recommendation ITU-T E.212: "The international identification plan for public networks and subscriptions".

[i.8] ETSI TS 122 060: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); General Packet Radio Service (GPRS); Service description; Stage 1 (3GPP TS 22.060 Release 4)".

[i.9] ETSI TS 122 011: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Service accessibility (3GPP TS 22.011 Release 4)".

[i.10] ETSI TS 125 304: "Universal Mobile Telecommunications System (UMTS); User Equipment (UE) procedures in idle mode and procedures for cell reselection in connected mode (3GPP TS 25.304 Release 4)".

[i.11] ETSI TS 102 744-1-1: "Satellite Earth Stations and Systems (SES); Family SL Satellite Radio Interface (Release 1); Part 1: General Specifications; Sub-part 1: Services and Architectures".

[i.12] ETSI TS 102 744-3-1: "Satellite Earth Stations and Systems (SES); Family SL Satellite Radio Interface (Release 1); Part 3: Control Plane and User Plane Specifications; Sub-part 1: Bearer Control Layer Interface".

[i.13] ETSI TS 102 744-3-2: "Satellite Earth Stations and Systems (SES); Family SL Satellite Radio Interface (Release 1); Part 3: Control Plane and User Plane Specifications; Sub-part 2: Bearer Control Layer Operation".

[i.14] ETSI TS 102 744-3-5: "Satellite Earth Stations and Systems (SES); Family SL Satellite Radio Interface (Release 1); Part 3: Control Plane and User Plane Specifications; Sub-part 5: Adaptation Layer Interface".

[i.15] ETSI TS 102 744-3-6: "Satellite Earth Stations and Systems (SES); Family SL Satellite Radio Interface (Release 1); Part 3: Control Plane and User Plane Specifications; Sub-part 6: Adaptation Layer Operation".

[i.16] ETSI TS 102 744-3-7: "Satellite Earth Stations and Systems (SES); Family SL Satellite Radio Interface (Release 1); Part 3: Control Plane and User Plane Specifications; Sub-part 7: NAS Layer Interface Extensions for MBMS Services".

[i.17] ETSI TS 102 744-3-8: "Satellite Earth Stations and Systems (SES); Family SL Satellite Radio Interface (Release 1); Part 3: Control Plane and User Plane Specifications; Sub-part 8: NAS Layer and User Plane Operation for MBMS Services".

[i.18] Recommendation ITU-T E.213: "Telephone and ISDN numbering plan for land mobile stations in public land mobile networks (PLMN)".

3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI TS 102 744-1-4 [5], clause 3 apply.

4 Stratum introduction

For reference purposes, the functional aspects of the Family SL satellite network are shown in Figure 4.1. The Non-Access Stratum (NAS) groups together all protocols between the UE and the CN. The Access Stratum is divided into an Usl Stratum, which groups all protocols between the UE and RNS and an Iu Stratum, which groups all protocols between the RNS and CN. By definition the Usl and Iu Strata cross the Usl and Iu interfaces respectively.

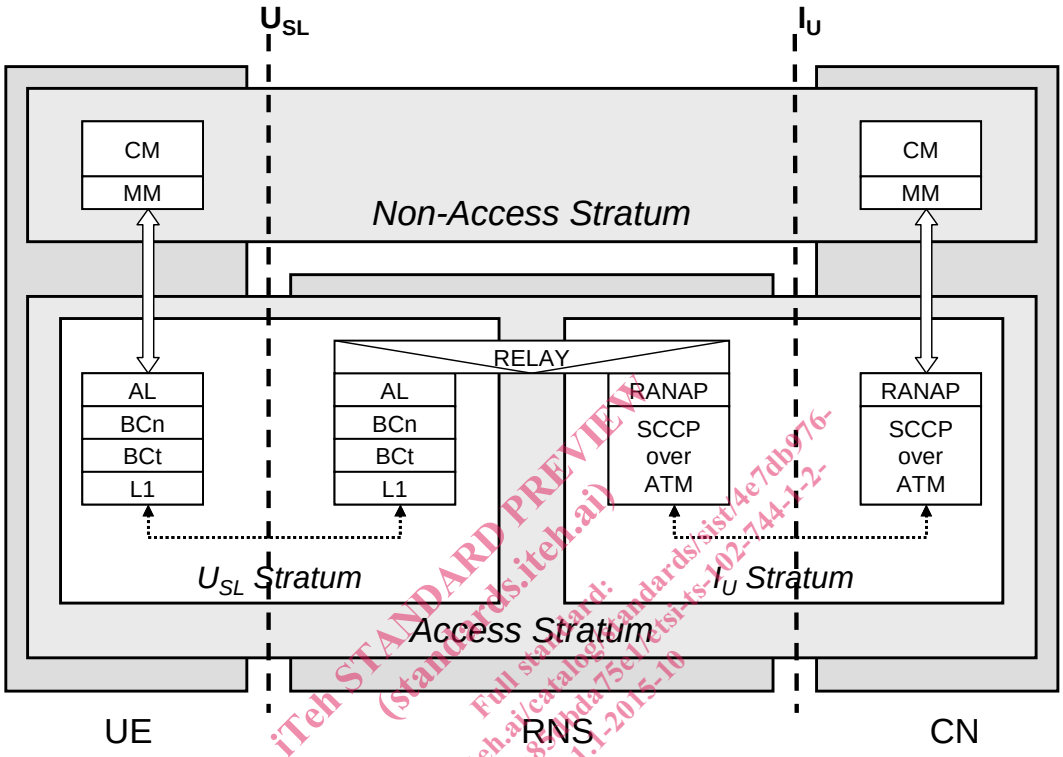

Figure 4.1: Stratum Divisions

5 Mobility Management (MM)

5.1 General principles

UMTS Layer 3 in the Control Plane contains two primary sublayers: Mobility Management (MM) and Connection Management (CM); see ETSI TS 124 007 [i.3], Figure 5.6. The CM sublayer controls access to circuit switched, packet switched, messaging, and other supplementary services. The MM sublayer is primarily responsible for tracking the location of the mobile subscribers within the satellite network and authorizing access to the network. MM provides services to entities in the CM sublayer (i.e. CM messages are transported by MM).

The MM sublayer contains two protocol entities: GPRS Mobility Management (GMM) for the PS domain and Mobility Management (MM) for the CS domain. There is one instance of GMM and one instance of MM in both the UE and the network (SGSN and MSC respectively).

As shown in Figure 5.1, the MM sublayer is entirely contained within the Non-Access Stratum. GMM and MM procedures and the contents of messages (PDUs) are fully transparent to the Access Stratum. Since the CM sublayer uses services from the MM sublayer, Call Control (CC), Session Management (SM), GPRS Short Message Service (GSMS) and Supplementary Service (SS) messages and procedures are also transparent to the Access Stratum.

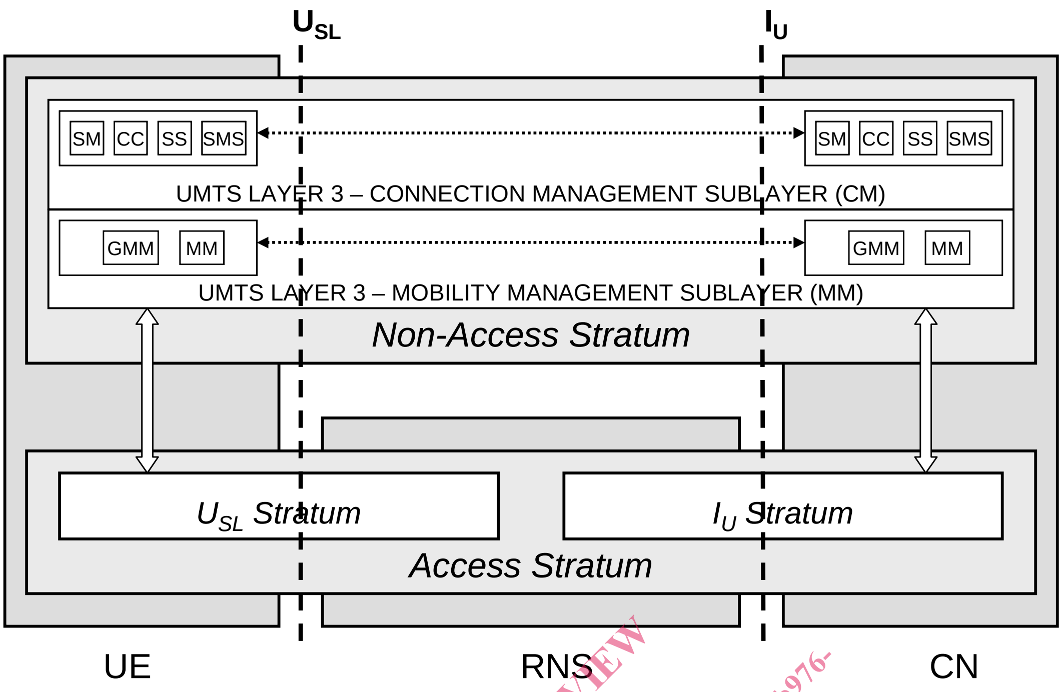

Figure 5.1: UMTS Layer 3 in Non-Access Stratum

5.2 RRC States (Idle and Connected Mode)

In terrestrial UMTS, the terms "idle mode" and "connected mode" refers to states of the Radio Resource Control (RRC) protocol layer (see ETSI TS 125 331 [i.5]). The RRC protocol [i.5] is not directly implemented in the satellite network; however, the Adaptation Layer (specifically the REGM entity, see ETSI TS 102 744-3-5 [i.14]) is responsible for maintaining the equivalent RRC state machine.

In the satellite network context, the RRC state (or mode) refers to the presence or absence of a UE-Specific Signalling connection between the UE and the RNC. This connection is established at the (successful) conclusion of the Registration procedure and released at the conclusion of the Deregistration procedure.

There are two main RRC states illustrated in Figure 5.2 and defined as follows:

- RRC-IDLE: no UE-Specific Signalling connection is established between UE and RNC.
- RRC-CONNECTED: a UE-Specific Signalling connection is established between the UE and the RNC which is serving the UE (the "Serving RNC" or SRNC).

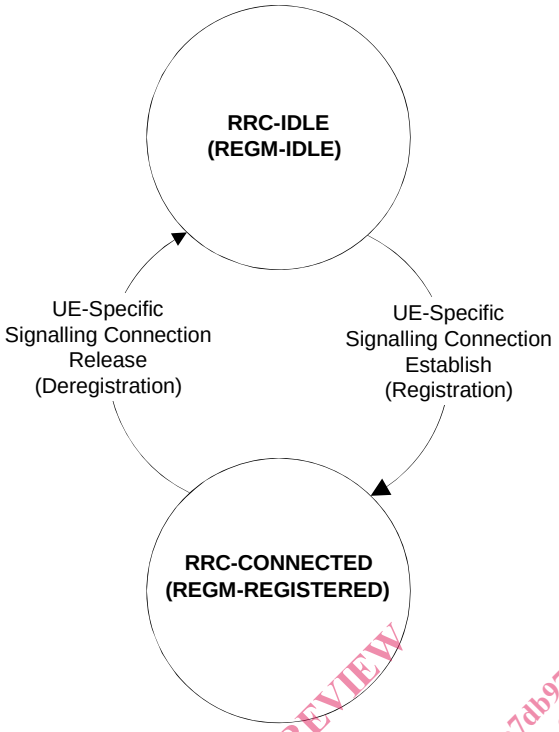

Figure 5.2: Equivalent RRC States in the satellite network

5.3 UE and Network Operation Modes

A UE can operate in one of three modes:

- PS/CS Mode: The UE is attached to both the PS domain and CS domain, and the UE is capable of simultaneously operating PS services and CS services. This mode of operation is equivalent to the GSM GPRS Class-A mode of operation.
- PS mode: The UE is attached to the PS domain only and may only operate services of the PS domain. However, this does not prevent CS-like services to be offered over the PS domain. This mode of operation is equivalent to the GSM GPRS Class-C mode of operation.
- CS mode: The UE is attached to the CS domain only and may only operate services of the CS domain. However, this does not prevent PS-like service to be offered over the CS domain.

The satellite network may operate either in Mode I or Mode II, i.e. the Gs interface between the MSC/VLR and SGSN may or may not exist for the purpose of coordinating GMM and MM functions (i.e. Attach, Location/Routing Area Update, Paging, etc.). The network mode of operation (NMO) is indicated to the UE as part of the broadcast system information.

Based on the mode of operation indicated by the network, the UE can then choose whether it can attach to CS domain services, to PS domain services, or to both, according to its mode of operation [i.8]. Furthermore, based on the mode of operation, the UE can choose whether it can initiate combined update procedures or separate update procedures, according to its capabilities. The combined GMM/MM functions avoid the need to send both MM and GMM messages when the PS domain can pass the necessary information to the CS domain privately within the CN.

A UE operating in CS/PS mode may have two signalling connections to the CN: a CS signalling connection to the MSC/VLR and a PS signalling connection to the SGSN. Signalling connections have two components: an Iu connection (RNC to CN) and an UE-Specific Signalling Connection (UE to RNC). Even though two separate Iu connections are required for the CS and PS domains (i.e. Iu-CS and Iu-PS), a single UE-Specific Signalling Connection is used for both the PS and CS domain (see Figure 5.3). The Adaptation Layer is responsible for the routing of signalling to and from the correct domain.

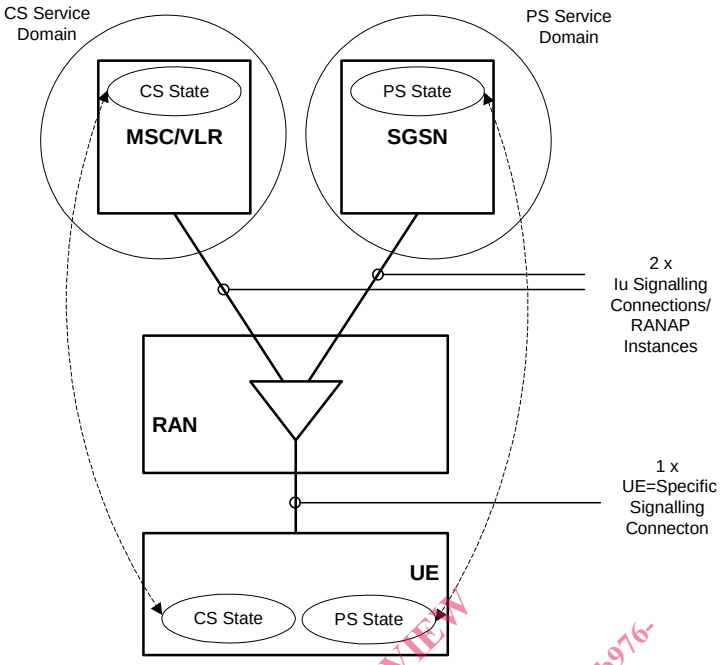

Figure 5.3: Relationship Between Service States and Signalling Connections

5.4 Mobility Management Service States

5.4.0 General

Each domain has its own service state machine (see Figure 5.3). An UE, that is supporting both CS services and PS services, has a CS service state machine and a PS service state machine. For every UE, there is a corresponding PS state machine and CS state machine in the SGSN and MSC respectively. The two peers of the service state machine are working independently to each other, although associated to the same UE. The UE-CN signalling aims to keep the peer entities synchronized.

5.4.1 PS Domain Service State Machine

5.4.1.0 General

The PS service state machine is called Packet Mobility Management (or PMM).

5.4.1.1 PMM-DETACHED State

In the PMM-DETACHED state there is no communication between the UE and the SGSN. The UE and SGSN PMM contexts hold no valid location or routing information for the UE. The UE MM state machine does not react on system information related to the SGSN. The UE is not reachable by a SGSN, as the UE location is not known.

In order to establish PMM contexts in the UE and the SGSN, the UE shall perform the (GMM) GPRS Attach procedure. When the PS signalling connection is established between the UE and the SGSN for performing the (GMM) GPRS Attach procedure, the state changes to PMM-CONNECTED in the SGSN and in the UE. A complete PS signalling connection is made up of two parts: an Iu connection (RNC to SGSN) and an UE-Specific Signalling Connection (UE to RNC).

5.4.1.2 PMM-IDLE State

In the PMM-IDLE state, a complete PS signalling connection is not established between the UE and SGSN, but the UE and SGSN have (previously) established PMM contexts. The UE location is known in the SGSN with an accuracy of a routing area. Paging is needed in order to reach the UE, e.g. for signalling. The UE shall perform the (GMM) Routing Area Update (RAU) procedure if the RA changes. Signalling towards the HLR is needed if the SGSN does not have a PMM context for this UE.

The UE and SGSN shall enter the PMM-CONNECTED state whenever the complete PS signalling connection is re-established between the UE and SGSN (required to initiate any GMM procedure).

While in the PMM-IDLE state, the SGSN or the UE may perform an implicit detach (i.e. without signalling), after which the local PMM state only changes to PMM-DETACHED. The SGSN may perform an implicit GPRS Detach any time after the UE Mobile Reachable Timer expires. The UE's PMM context in the SGSN is deleted, preferably after a certain (implementation dependent) time. The HLR may be informed about the deletion. The UE may perform an implicit GPRS Detach when, for example, the battery or USIM are removed, or the UE is switched off.

5.4.1.3 PMM-CONNECTED State

The UE location is known in the SGSN with an accuracy of a serving RNC. In the PMM-CONNECTED state, the location of the UE is tracked by the serving RNC. The UE performs the (GMM) Routing Area Update procedure if the RA changes (or if the RAI in the System Information broadcast changes).

When an UE and a SGSN are in the PMM-CONNECTED state, a complete PS signalling connection is established between the UE and the SGSN and GMM procedures can be initiated. In the SGSN, PS signalling connection release or changes the state to PMM-IDLE.

The UE shall enter the PMM-IDLE state when its PS signalling connection to the SGSN has been released or broken (i.e. the Iu-PS connection and/or the UE-Specific Signalling connection is released or broken). The signalling connection release is explicitly indicated by the RNC to the UE or detected by the UE.

After a signalling procedure (e.g. Routing Area Update), the SGSN may decide to release the PS signalling connection, after which the state is changed to PMM-IDLE. Completion of the (GMM) GPRS Detach procedure (either initiated by the UE or the SGSN) changes the state to PMM-DETACHED.

5.4.1.4 State Transitions and Functions

Figure 5.4 shows the PMM state machine in both the UE and SGSN. Note that the PMM-IDLE and PMM-CONNECTED states are independent of the Session Management state. The activation or deactivation of PDP Contexts by the SM entity does not affect the PMM state.

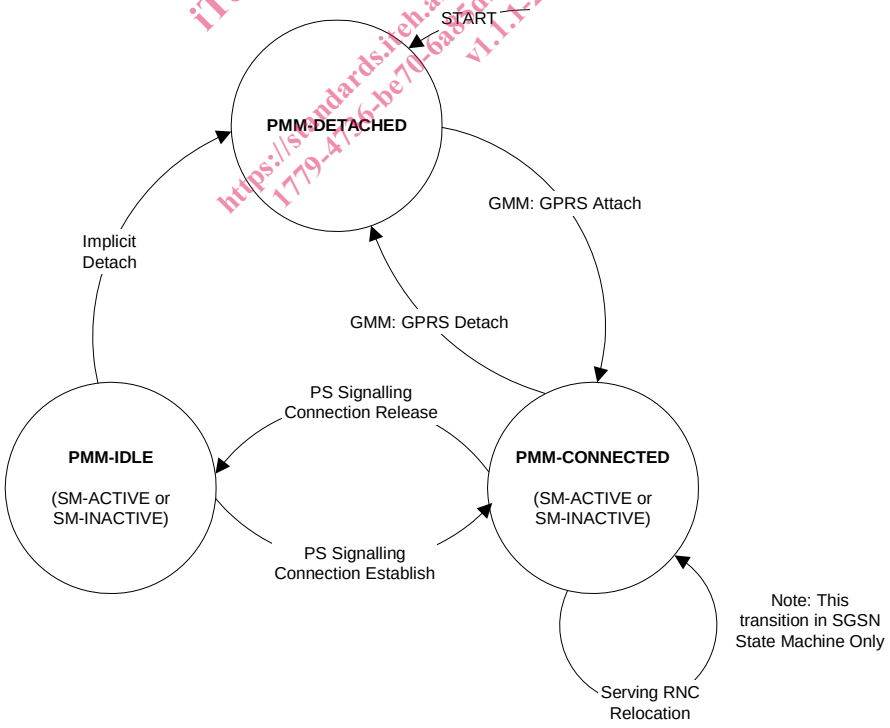

Figure 5.4: PS Domain Service State Machine in UE and SGSN