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Physical Realisation of Next Generation Networks

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Draft New Supplement 64 “Physical Realisation of Next Generation Networks”

Summary

The NGN architecture defined in Recommendation ITU-T Y.2012 [1] is a generalized architecture in which abstract functional entities are specified. However, to address the issues of interoperability within an NGN network, there is a need to identify physical realizations showing which functional entities are implemented in a network component and by implication the interfaces that are important to ensure the interoperability of systems. This document is intended to give guidance on the physical realisation of Next Generation Networks by describing a number of possible physical entities corresponding to a functional entity or a group of functional entities specified in the generalised functional architecture of NGN.

Chapter 2 describes the NGN architecture and functions defined in terms of various functional entities and chapter 3 gives examples of physical components in which these functional entities may be realised. Reference is made to Recommendation ITU-T Q.3900 [2] that describes the mapping of NGN functional entities into physical components for the purpose of defining a model for the testing of NGN equipment and Supplement 2 to Recommendation ITU-T Y.2012 that describes the realisation of Session Border Controllers in an NGN environment [15].

More detailed information on NGN, in particular on the protocol mechanisms employed, can be found in the ITU-T Handbook on NGN “Converging Networks” [3].

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1 Introduction

The NGN architecture defined in Recommendation ITU-T Y.2012 [1] is a generalized architecture in which abstract functional entities are specified. However, to address the issues of interoperability within an NGN network, there is a need to identify physical realizations showing which functional entities are implemented in a network component and by implication the interfaces that are important to ensure the interoperability of systems. This document is intended to give guidance on the physical realisation of Next Generation Networks by describing a number of possible physical entities corresponding to a functional entity or a group of functional entities specified in the generalised functional architecture of NGN.

Chapter 2 describes the NGN architecture and functions defined in terms of various functional entities and chapter 3 gives examples of physical components in which these functional entities may be realised. Reference is made to Recommendation ITU-T Q.3900 [2] that describes the mapping of NGN functional entities into physical components for the purpose of defining a model for the testing of NGN equipment and Supplement 2 to Recommendation ITU-T Y.2012 that describes the realisation of Session Border Controllers in an NGN environment [15].

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2 Next Generation Network Architecture

2.1 Overview

One of the main characteristics of the NGN architecture is the decoupling of services from the transport infrastructure allowing services to be offered separately and to evolve independently. There is therefore a separation between the service control functions and the transport functions in the NGN architecture. This is illustrated in Figure 1. Service control functions reside in the service stratum and the transport stratum provides connectivity with an appropriate quality of service for the various services.

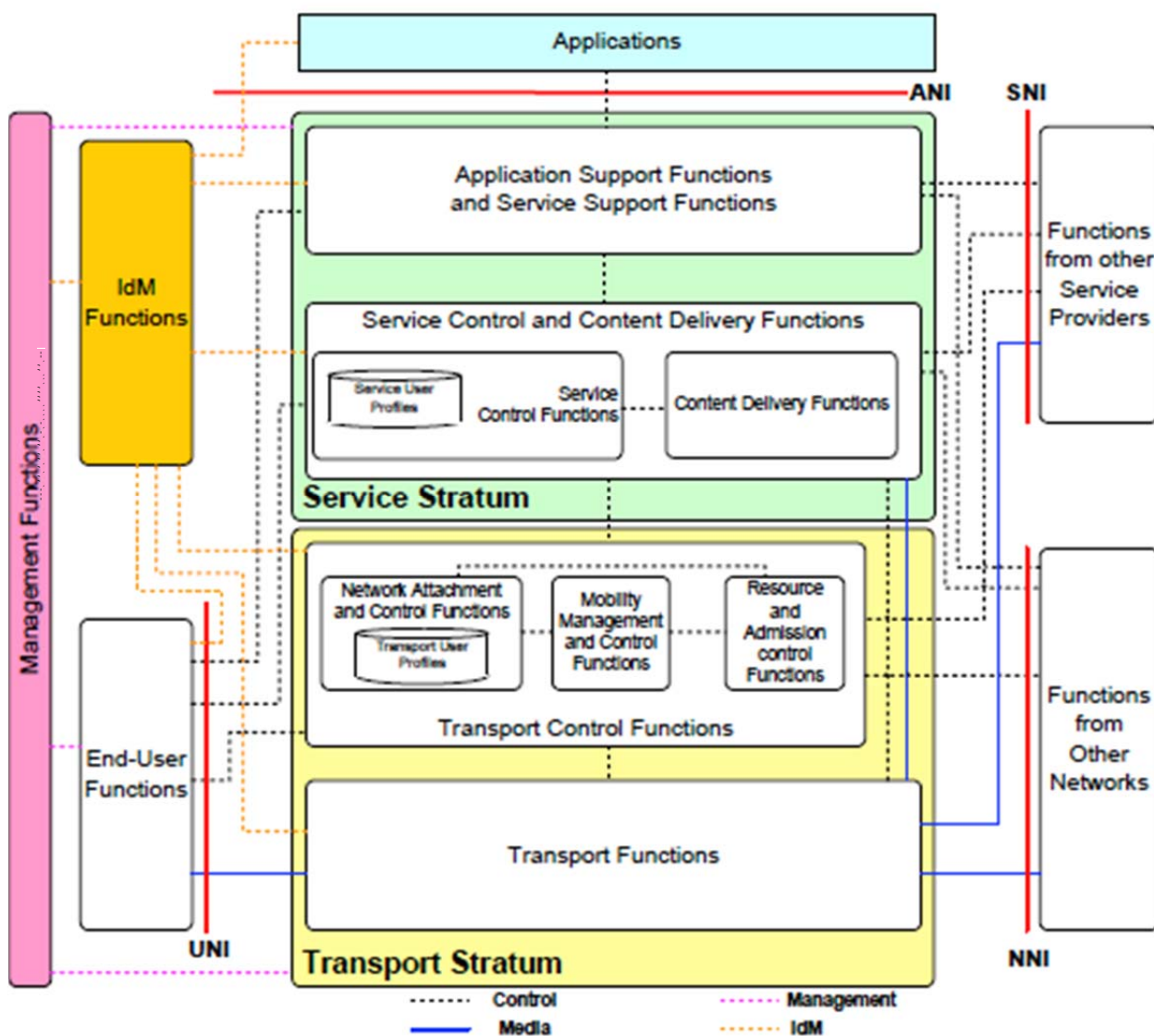


Figure 1. NGN Architecture Overview.

The Transport stratum is composed “Transport functions” and “Transport control functions”. The “Transport functions” provide connectivity between all NGN network elements, including the access network, edge and core transport elements, and gateway functions for the transfer of media, control and management information. All services are carried over the Internet Protocol (IP),

although IP itself may in turn be carried over a number of underlying technologies, such as ATM (Asynchronous Transfer Mode) or Ethernet.

The “Transport control functions” are those of controlling network attachment (Network Attachment Control Functions – NACF), the use of transport resources (Resource and Admission Control Functions – RACF) and mobility management (Mobility Management and Control Functions – MMCF).

The Network Attachment Control Functions (NACF) provide dynamic provisioning of IP addresses and other user equipment configuration parameters; authentication prior to or during the IP address allocation procedure; authorisation based on user profiles (e.g. access transport subscription); access network configuration based on user profiles; and may in addition provide the addresses of NGN Service stratum components (such as an IMS P-CSCF (Proxy - Call / Session Control Function) to the customer premises equipment.

The Resource and Admission Control Function (RACF) acts as the arbitrator for resource negotiation and allocation between the Service control and Transport functions within the NGN architecture. Service control functions supporting various NGN services interact with the RACF to provide capabilities for the control of NGN transport resources. Resource reservation, admission control and gate control can be used to provide an appropriate Quality of Service for specific information flows and it is possible to control NAPT (Network Address and Port Translation) and firewall traversal.

The RACF interacts with transport functions to control one or more of the following functionalities in the transport stratum: packet filtering; traffic classification, marking and policing; bandwidth reservation and allocation; prevention of IP address spoofing; network address and port translation (NAPT), firewall traversal; and usage metering.

Admission control can be performed on the basis of authorisation checks based on user profiles, Service Level Agreements (SLAs), operator specific policy rules, and the availability of resources within the access and core transport networks.

The RACF also interacts with the NACF to configure parameters; perform network access registration, authentication and authorization; and to check user profiles against service level agreement.

At present, similar services are offered to users on both fixed accesses and on mobile networks. A major feature of NGN is generalized mobility in which services are consistently realised to a user independent of network access technology. The Mobility Management and Control Functions (MMCF) support IP-based mobility within the transport stratum.

The Service stratum comprises service control functions. These are typically registration, authentication and authorization functions at the service level, session control and resource control coordination.

An illustration of how the various services are supported is given in Figure 2.

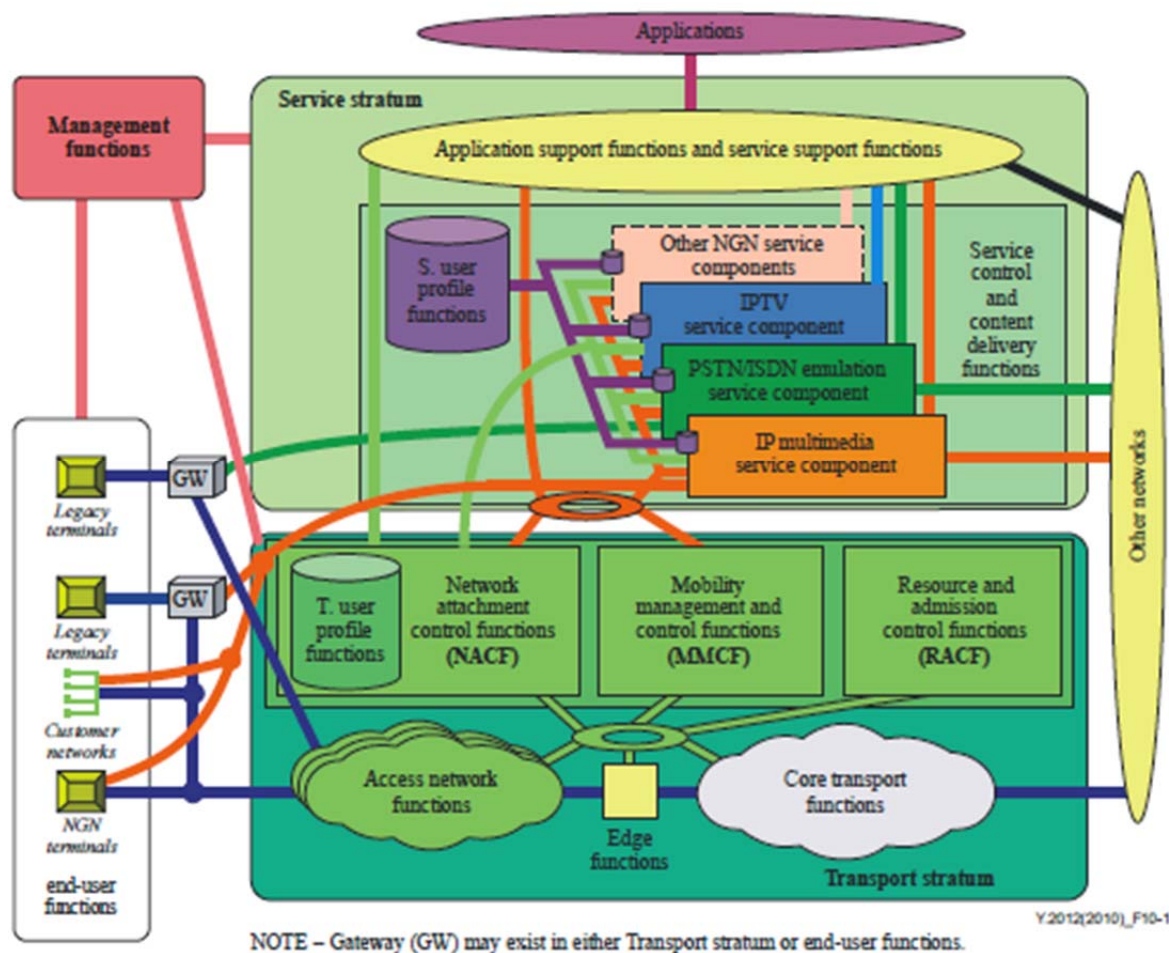


Figure 2. NGN components

The service control layer includes support of the IP Multimedia Subsystem (IMS). IMS was initially developed by the 3rd Generation Partnership Project (3GPP) for non-voice applications, such as Presence and push-to-talk, and was then adopted by ETSI TISPAN and the ITU-T as a session control mechanism for voice and other services, such as IPTV, in NGN. The IMS is extended in NGN to support additional access network types such as xDSL and WLAN. IMS is a system specification based on the use of the Session Initiation Protocol (SIP) defined by the IETF.

In addition, SIP UNI (User-Network Interface) and NNI (Network-Network Interface) signalling profiles have been defined to ensure interoperability of equipment at these interfaces.

The content delivery functions (CDF) receive content from the application and service support functions (for IPTV for example) and then store, process, and deliver this content, under control of the service control functions, to the end-user using the capabilities of the transport functions.

Identity Management is the set of functions and capabilities used for the assurance of identity information (e.g. identifiers, credentials, attributes) and of the identity of an entity (e.g. users/subscribers, groups, user devices, organizations, network and service providers, network elements and objects, and virtual objects).

The NGN functional entities controlling policy, sessions, media, resources, service delivery, security, etc., may be distributed over the infrastructure. When they are physically distributed, they communicate over open interfaces. Interworking between the NGNs of different operators and

between NGNs and existing networks such as the PSTN (Public Switched Telephone Network), ISDN (Integrated Services Digital Network) and GSM (Global System for Mobile communications) is provided by means of gateways.

2.2 NGN functional architecture

The NGN functional architecture is defined in Recommendation ITU-T Y.2012 [1]. Functional entities are described to realize the access and core packet transport; network access control, resource and admission control, mobility management; service control and content delivery; application and service support; identity management; charging and end-user customer premises equipment capabilities.

The functional architecture is dissected and its components described in more detail in the following sections.

2.2.1 Transport stratum

2.2.1.1 Access and core transport functions

The access network includes functions for the connection of user equipment to the network using a variety of technologies (such as cable, xDSL, wireless and optical) and also the aggregation of traffic from a number of users. For example, Supplement 6 to the Y.2000-series of Recommendations [4] describes how the DSL (Digital Subscriber Line) technology defined by the DSL Forum (now the Broadband Forum) can be used for NGN access. QoS control mechanisms, such as buffer management, queuing and scheduling, packet filtering, traffic classification, marking, policing and shaping, are supported in the access and core transport sections.

The processing functional entities of the transport stratum are shown in Figure 3.

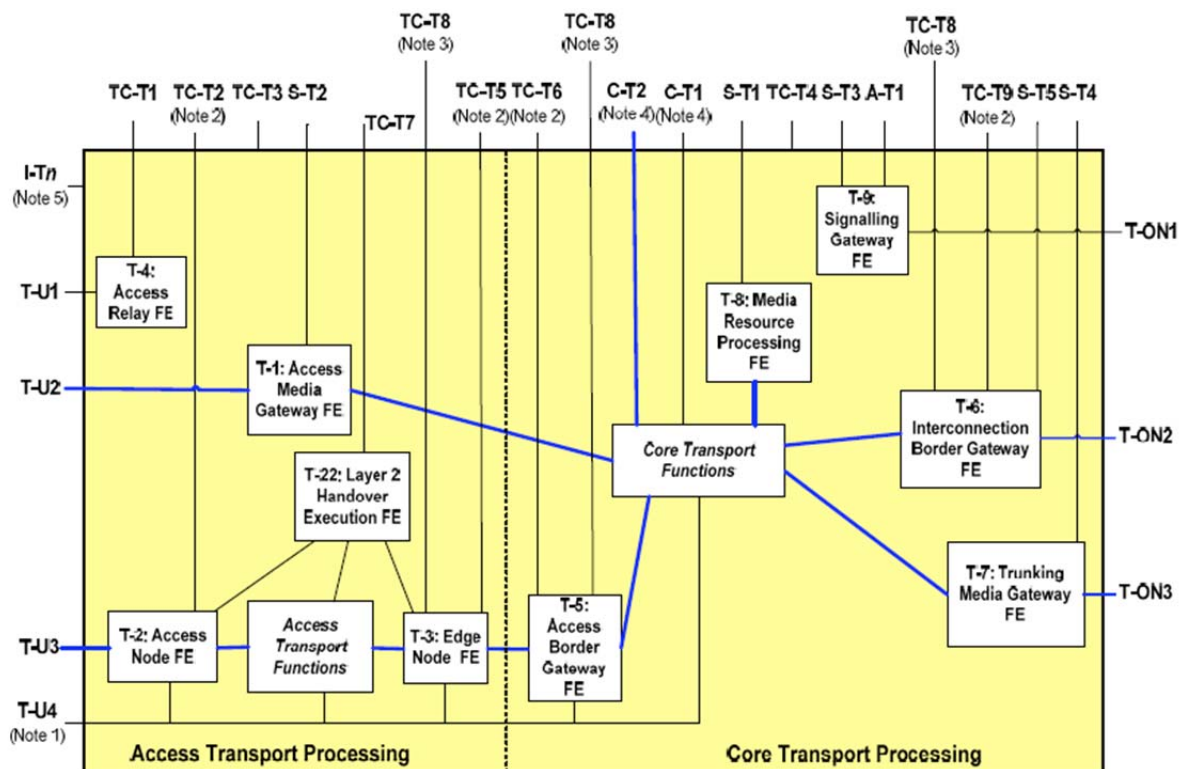


Figure 3. Transport processing functional entities (see Figure 9-2 of ITU-T Y.2012 for an explanation of the notes).

The access media gateway (T-1) provides an interworking function between PSTN /ISDN lines and packet-based transport for the connection of legacy terminal equipment. It has an interface to the access gateway control function in the service stratum that handles PSTN / ISDN call control signalling.

IP terminal equipment is connected to the access node (T-2). This is a layer 2 device that may also support layer 3 (i.e. IP) functions. It supports QoS functions under the control of the RACF such as packet filtering, traffic classification, marking, policing and shaping at the flow or user level, and if it is IP-enabled it may also support policy enforcement.

The edge node (T-3) is an IP-capable device that performs similar functions to the access node at the interface to the core network.

The access relay (T-4) inserts local pre-configuration information when this is necessary. For example, when using DHCP, the AR-FE acts as a DHCP relay agent and may add information before forwarding a message, such as inserting the identifier of an ATM virtual channel carrying IP traffic in a DHCP request.

The access border gateway (T-5) in the core transport section performs functions such as:

- the opening and closing of gates (allowing certain packet flows but blocking others);
- packet filtering based on the use of a firewall;
- traffic classification and marking;
- traffic policing and shaping;
- network address and port translation;
- media relay (i.e. media latching) for NAPT traversal, in which the destination IP address of packets forwarded in the outbound direction is derived from the source IP address of packets received in the inbound direction;
- the collection of traffic data (e.g. start-time, end-time, octets of sent data); and
- policy enforcement under the control of the RACF.

The Access Border Gateway-FE may in addition support IPv4 - IPv6 conversion.

The interconnection border gateway (T-6) supports the interconnection of one operator's core transport network with the core transport network of another operator. It has similar capabilities to the access border gateway.

The media resource processing functional entity (T-8) provides functions based on the processing of packet payloads. For example, it allocates specialized resources such as announcement servers, notification tones, voice recognition resources, voice menu and conference resources.

The trunking media and signalling gateways (T-7 and T-9 respectively) are used for interconnection with PSTN / ISDN networks.

The transport stratum also includes policy enforcement and transport resource enforcement functional entities under the control of the policy decision and transport resource control functional entities, respectively, of the resource and admission control subsystem; and the Layer 2 handover execution functional entity under the control of the handover control functional entity.

2.2.1.2 Transport control functions

The transport control functions are shown in Figure 4.

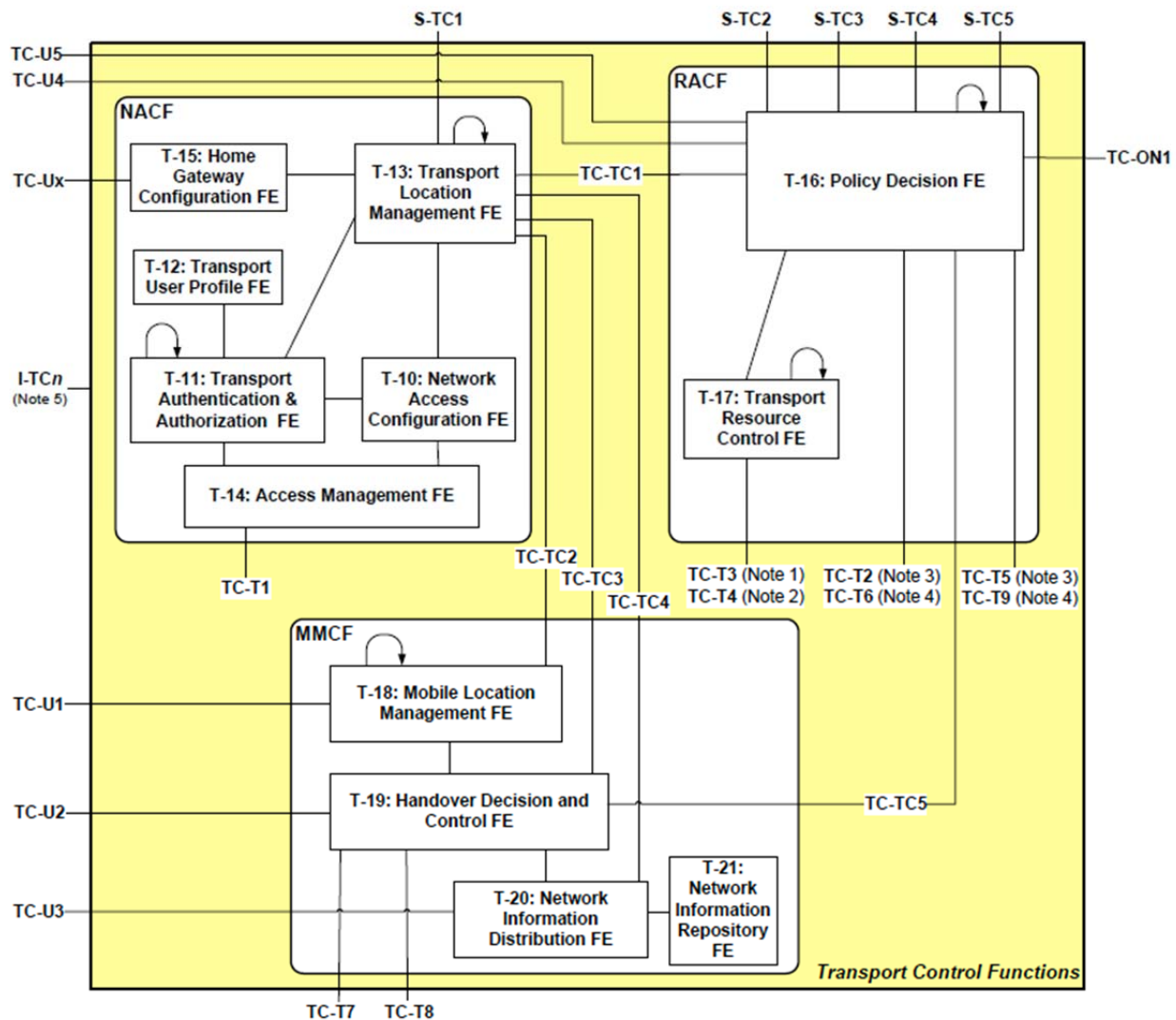


Figure 4. Transport control functional entities (see Figure 9-3 of ITU-T Y.2012 for an explanation of the notes)

2.2.1.2.1 Network Attachment Control Function (NACF)

When a user's device is turned on it requires an IP address to be assigned (if it has not been allocated a permanent address) and a number of other parameters to be configured. These are Network Attachment Control Functions. Apart from the dynamic provisioning of IP addresses and other CPE configuration parameters, procedures for mutual authentication between the end user and the network and the authorization of network access based on user profiles are supported. The NACF also supports location management at the IP layer.

Recommendation Y.2014 [5] describes the network attachment control functions and a number of access scenarios. The functional entities comprising the NACF are shown in Figure 5.