



GROUP SPECIFICATION

Next Generation Protocols (NGP); NGP Reference Model

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Foreword

This Group Specification (GS) has been produced by ETSI Industry Specification Group (ISG) Next Generation Protocols (NGP).

Modal verbs terminology

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1 Scope

The present document defines the NGP Reference Model for protocols and protocol architectures. The model provides a common reference that is to be used to specify and inform about enhancements to existing protocols and new protocol designs, across the scope of both NGP contributions and approved documented output.

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 referenced document (including any amendments) applies.

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

- [1] ETSI GS NGP 001: "Next Generation Protocol (NGP); Scenario Definitions".
- [2] ISO/IEC 7498-1:1994: "Information technology -- Open Systems Interconnection -- Basic Reference Model: The Basic Model".
- [3] IEEE 802.3TM: "IEEE Standard for Ethernet".

2.2 Informative references

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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 TR 121 905: "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; Vocabulary for 3GPP Specifications (3GPP TR 21.905)".
- [i.2] 3GPP TR 23.799: "Study on Architecture for Next Generation System" (NexGen).

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in ETSI TR 121 905 [i.1], 3GPP TR 23.799 [i.2], ETSI GS NGP 001 [1], ISO/IEC 7498-1 [2] and the following apply:

application protocol: entity that resides inside an application that specifies and handles the protocol type to which it is communicating

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI TR 121 905 [i.1] and the following apply:

NEt()	Network Equipment
NEy()	Network Entity
PoA	Point of Attachment

4 NGP Reference Model

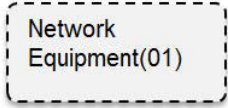
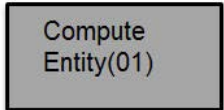
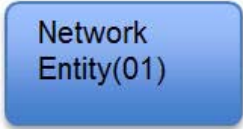

4.1 Introduction

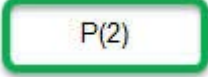




The NGP Reference Model is a generic protocol model that should be used to describe proposed NGP protocols and protocol architectures.






4.2 Model Components

The NGP Reference Model includes the following component parts, as illustrated in Table 1.

Table 1: Model Components

Model Component	Description	Graphical Description	Illustration
Network Equipment	A logical collection of compute entities.	The Network Equipment is represented as a rounded corner rectangular object, with grey fill and a dotted black outline. The Network Equipment should be named with a text label and if there are more than one of these equipments in the illustration then it should include a numeric reference too.	
Compute Entity	An entity that can support one or more Network Entities.	The Compute Entity is represented as a square corner rectangular object, with coloured fill and a dotted solid black outline. The entity should be named with a text label and if there are more than one of these entities in the illustration then it should include a numeric reference too.	
Network Entity	An entity that represents one or more network functions and includes protocols with which it communicates to other protocol peers at other Network Entities. Addresses can be carried in protocols, but are assigned to network entities. Addresses are unambiguous within a layer. (also known as a Network Function in a virtualised 3GPP environment.)	The Network Entity is represented as a rounded corner rectangular object, with coloured fill. The Network Entity has a dotted solid black outline. The entity should be named with a text label and a reference to a valid address.	
Layer	A collection of two or more network entities that share state using one or more protocols. Where: Network Entity is a NEy as defined in the present document NGP Reference Protocol Model definition.	Oblong dotted green outline encompassing the protocol scope of the layer.	

Model Component	Description	Graphical Description	Illustration
Protocol Node	<p>The container of protocol instances within a network entity, which interpret and operate on the header of a particular protocol type. If the header is empty then there are other cases that may operate as follows:</p> <ul style="list-style-type: none"> i) It is assumed that there is either a default local port-id connected that this entity automatically passes the packet to. ii) There is only one port-id and application connected for the protocol node to pass per flow. iii) The packet is passed to a particular port-id by some other aspect of the communication such as time or frequency. 	<p>Represented as a zero fill circle object with a green coloured solid outline.</p> <p>The text label should include an abbreviation of the name of the protocol. It contains zero or more protocol instances inside.</p>	
Protocol Instance	<p>An instantiation of a protocol node (an individual protocol machine). One end of a Connection operating within a Protocol Node and handling its communications state. Identified by a CEPI, unambiguous within the scope of the network-entity.</p> <p>For an NGP compliant protocol there is a one to one mapping between a Port-Id and a Protocol Instance.</p>	<p>Represented as a solid fill circle object with a green coloured dashed outline</p> <p>The text label should include the CEPI.</p>	
Port	<p>The binding between an instance of an application or an instance of a protocol and an instance of this protocol.</p> <p>A Port is identified by a Port-ID unambiguous within the scope of the network-entity.</p> <p>An application or (N+1)-network-entity can have one or more Port-IDs.</p> <p>See note.</p>	<p>Represented as a zero fill circle object with a purple coloured solid outline.</p> <p>The text label should include the Port-ID.</p>	
Application	<p>An entity that performs one or more functions and connects to a protocol node via a port.</p> <p>An application may be i) performing part of the tasks of a network entity and therefore be part of it or ii) managing the network entity (configuration, monitoring) or iii) just using the communication services provided by a network entity via a port-id.</p>	<p>Represented as a zero fill circle object with a turquoise coloured solid outline.</p> <p>The text label should include the Application Name.</p>	
User	<p>An entity (such as a human) that uses an application.</p>	<p>Represented as a zero fill circle object with a cyan coloured solid outline.</p>	

Model Component	Description	Graphical Description	Illustration
Point of Attachment (PoA)	A Port that binds this protocol to a physical interface. A PoA is identified by a Port-ID .	Represented as a zero fill circle object with a purple coloured solid outline. The text label should include the Port-ID. Each PoA has a text label as follows: i) 'P' for Point of Attachment. ii) A letter to indicate which interface technology; this and the outline colour should be as below: - Electrical: e, red. - Optical: o, orange. - LTE (Radio): L, black. - Wi-Fi™ (Radio): W, purple. - 5G new radio: 5, green. iii) The Port-ID in brackets.	
Flow	An instance of a communications service provided by a layer to an application or protocol node. A port-id locally identifies a specific flow within a Network Equipment.	A dotted line between Port-IDs.	
Virtual Connection	The shared state between two data transfer Protocol Instances that supports a flow. Identified by a connection-id (CID) unambiguous within the scope of the communicating network-entities. It is generally formed by concatenating the CEP-ids associated with the communicating protocol-instances.	A dashed line between Protocol Instances.	
Physical Connection	A physical connection between two PoA.	A solid line between PoA of colour matching that of the PoA type.	
Internal software communication	Illustration of intra-NEy communication between model parts.		
NOTE:	Some legacy protocols enable multiple applications to be connected to the same 'Port' via multiple local bindings. In this case: - NGP Port (bound to single App(x) instance and identified by NGP Port-ID) = Legacy protocol 'Port' + Local Binding(s). - In this manner managed application multiplexing on to a single NGP Port is able to be modelled in the NGP reference model.		

4.3 Protocol Model

4.3.1 Identification

Each component shall have an identifier which identifies it uniquely within a defined scope.

In the case of a component that is contained within another component, the scope may be the containing component.

4.3.2 Protocol Layers

Multiple Network-Entities may be used to model a layered architecture.

4.3.3 Addressing

Each Network-Entity has an address that is distinct for the scope of the layer.

4.4 Example Cases using the NGP Reference Model

4.4.1 Introduction

This clause introduces common cases that occur in communications systems.

4.4.2 Case(Single Network Equipment, Physical Network Connectivity)

The basic NGP protocol model structure is illustrated in Figure 1.

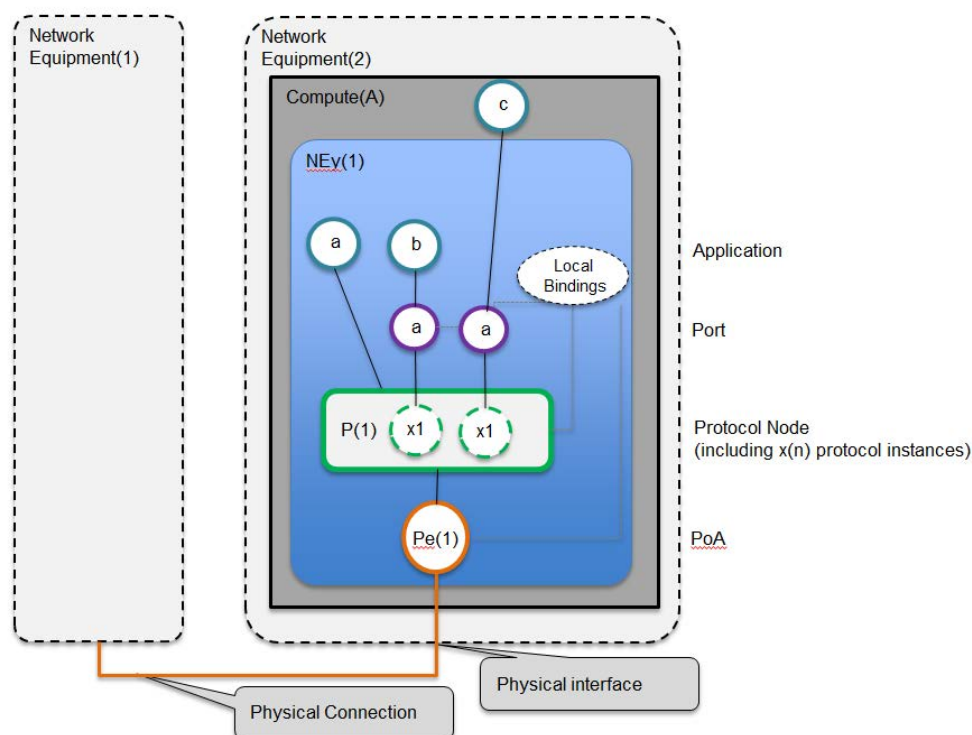


Figure 1: Single Network Equipment, Physical Network Connectivity

Figure 1 introduces the basics of the generic NGP protocol reference model, by showing how it represents two physically separate Network Equipment instances or NEt()'s.

Several different application options are illustrated in Figure 1, as follows:

- App(a) is a local function that is part of the NEy(1) that manages protocol node P(1) e.g. 3GPP CM or PM.
- App(b) is a communicating function in NEy(1) that uses P(1) to communicate with another peer.
- E.g. a mobility manager in a cellular core NEy.
- App(c) is an application that uses NEy(1) to communicate via its implementation of P(1) with another peer. E.g. a browser.

Inside each physical Network Equipment are compute entities on which logical Network Entities, NEy() may be instantiated that enable network connectivity for the Network Equipment.

Applications that use network connectivity at the Network Equipment may be instantiated on any of the compute entities and connected to a network entity containing a communications protocol via a Port.

In cases where a Network Entity has multiple addresses all of the addresses shall resolve to the same Network-Entity.

Network entities can support multiple NGP protocol Ports. A Port provides Applications or other protocols with a communication service provided by a Network Entity. A Port-id is unambiguous within the scope of an entity named by the Address.

Each Network Equipment has one or more Points of Attachment (PoA) which give physical connectivity to other Network Equipment instances. Each which may be Wired, Optical, or Radio of example types: RF-Cellular, Millimetric and/or Wi-Fi™.

Each Application sends and receives data via one or more of the ports in the same Network Entity via a nominated application protocol.

Applications may be user applications or protocol applications that implement various protocol functions in order to adapt the network service provided (e.g. configuring from an unreliable packet service to a reliable byte stream service) and multiplexing data flows for several different applications.

The NGP protocol extent is defined as operating between a Protocol Node, its Ports and any associated applications that implement protocol functionality.

4.4.3 Case(Network Equipment, Protocol Connectivity)

4.4.3.1 Protocol Connectivity Introduction

The basic NGP protocol connectivity model is illustrated in Figure 2.

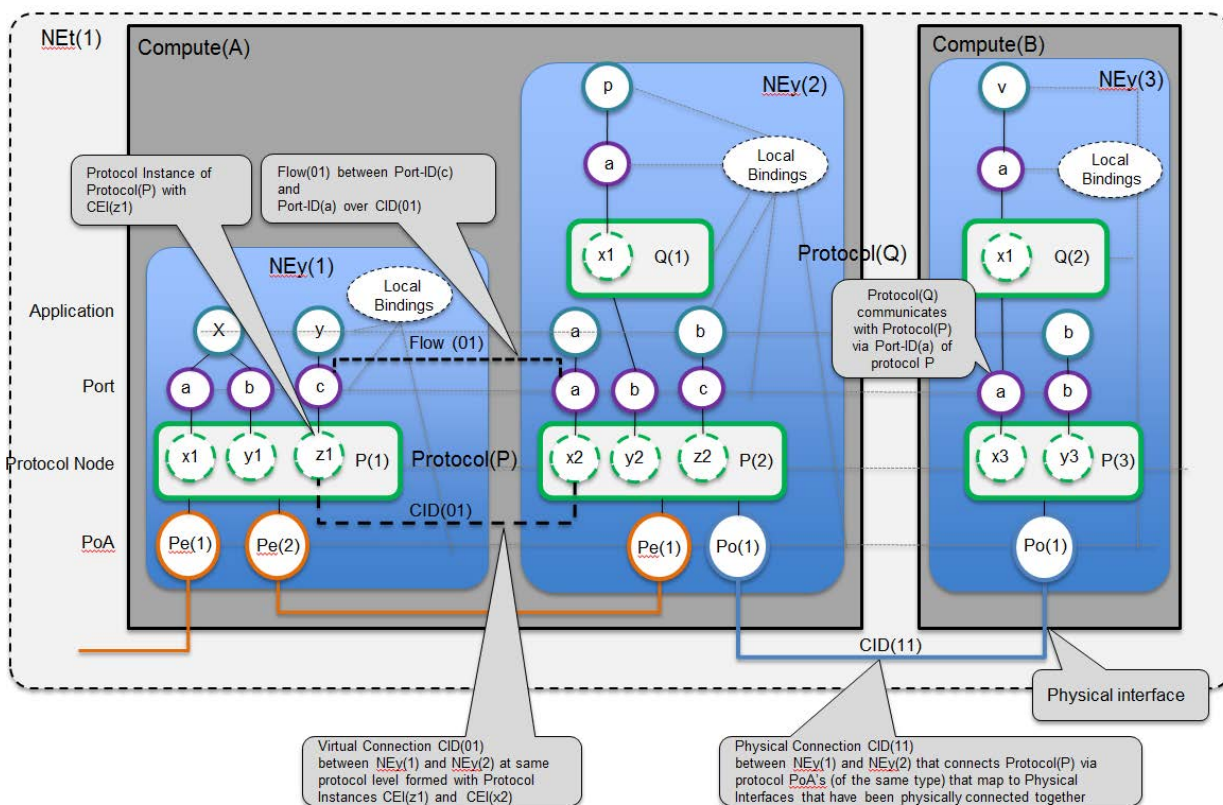


Figure 2: Single Network Equipment, Protocol Connectivity

Figure 2 introduces the case where a single Network Equipment NET(1) contains a Network Entity NEy(1) and NEy(2) that are both instantiated on the same Compute entity Compute(A).

Each NEy contains a Protocol Node of the same type 'P' with different addresses (1) on NEy(1) and (2) on NEy(2).

4.4.3.2 Virtual Connection

Figure 3 illustrates that a Virtual Connection with Connection ID CID(01) is established between NEy(1) and NEy(2) for the protocol 'Q' by Protocol Instance X(1) at Q(1) and Protocol Instance X(1) at Q(2).

The Network Entities NEy(1) and NEy(2) share state across a layer(n) of rank(2) which includes protocol(Q).

The Network Entities NEy(1) and NEy(2) also share state across a layer(m) of rank(1) which includes protocol(P).

Although protocol nodes P and Q are part of the same network entity, there is in no shared state between the NEy(1) and NEy(2) across Protocol(Q) and Protocol(P). This is often the case for protocols that have the same scope but perform independent sets of functions.

This is often how some network interfaces are envisaged in 3GPP.

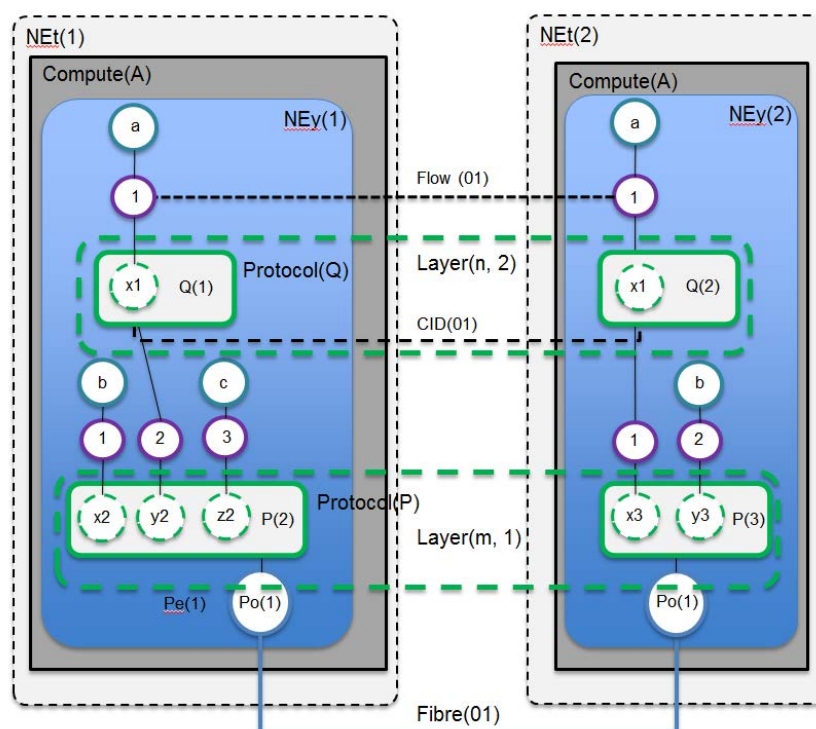


Figure 3: Inter-NEt Protocol Connections(a)

Figure 4 illustrates that a Virtual Connection with Connection ID CID(01) is established between NEy(1) and NEy(2) for the protocol 'Q' by Protocol Instance X(1) at Q(1) and Protocol Instance X(1) at Q(2).

But now there is shared state between NEy(1) and NEy(2) that involves both Protocol(Q) and Protocol(P). One layer(n) of rank(1) is established with shared state across the NEy(1) and NEy(2) involving Q and P.

This is often how some network interfaces defined for 3GPP are practically implemented.

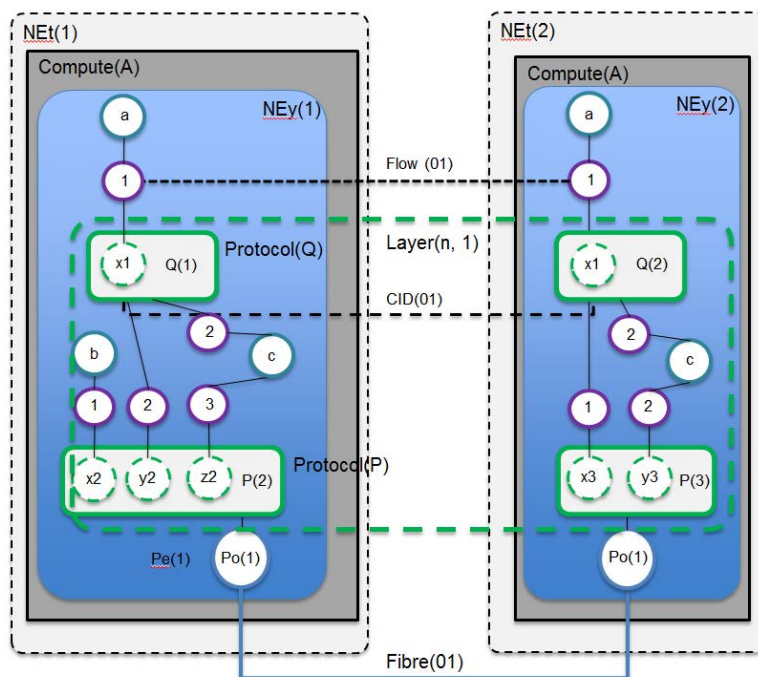


Figure 4: Inter-NEt Protocol Connections(b)

Figure 5 illustrates that a Virtual Connection with Connection ID CID(01) is established between NEy(1) and NEy(2) for the protocol 'Q' by Protocol Instance X(1) at Q(1) and Protocol Instance X(1) at Q(2).

Similarly virtual connections can also be setup by protocol instances of the same type between NEy that are instantiated at the same NEt but on different compute entities and according NEy, such as is the case for NEy(3) and NEy(4) where another layer may be setup to generate a Virtual Connection with another Connection ID between NEy(3) and NEy(4) for the protocol 'P' by Protocol Instance z(2) at P(2) and Protocol Instance z(3) at P(3).

The Network Entities NEy(1) and NEy(2) share state across a layer(n) of rank(2) which includes protocol(Q).

The Network Entities NEy(3) and NEy(4) share state across a layer(m) of rank(1) which includes protocol(P).

Figure 5 also illustrates the case where virtual connections can also be setup by protocol instances of the same type between NEy that are instantiated on different NEt and also have a Physical Interconnection via suitable PoAs.

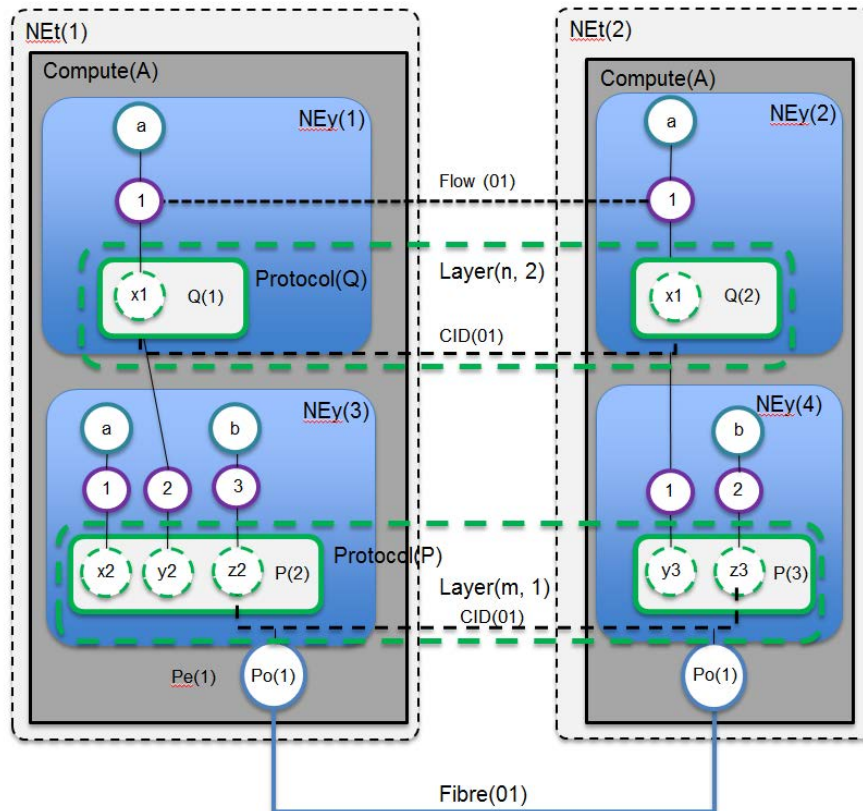


Figure 5: Inter-NEt Protocol Connections(c)

4.4.3.3 Flow

Once the user or protocol application requests a flow, port-ids are allocated, and a supporting connection is established between protocol instances of 'P' (the connection is effectively in place once synchronization is created among the CEP-ids). Flow(1) is supported by the associated connection CID(01) to enable the exchange of data for applications communicating via protocol application P at each NEy (Figure 2).

4.4.3.4 Connecting Protocols of Different Types

Figure 2 also illustrates how multiple protocols communicate between each other. NEy(2) and NEy(3) both have 2 protocols interconnected of type P and Q. These protocols communicate using ports in the same way as applications do. In this case Protocol Node Q(1) at NEy(2) is connected to Protocol Node P(2) via Port(b) and Protocol Node Q(2) at NEy(3) is connected to Protocol Node P(3) via Port(a).

4.4.4 Case(Mobile Device to Access Point)

This clause uses the NGP reference model to illustrate a simplified mobile network communications system in three figures:

- Figure 6 illustrates communications between a 3GPP Network Function(UE) and a 3GPP Network Function(eNB); and
- Figure 7 illustrates communications bridging at a 3GPP eNB, between the 3GPP Access Network and a 3GPP Core Network infrastructure; and
- Figure 8 illustrates part of the communications within the 3GPP Core Network.

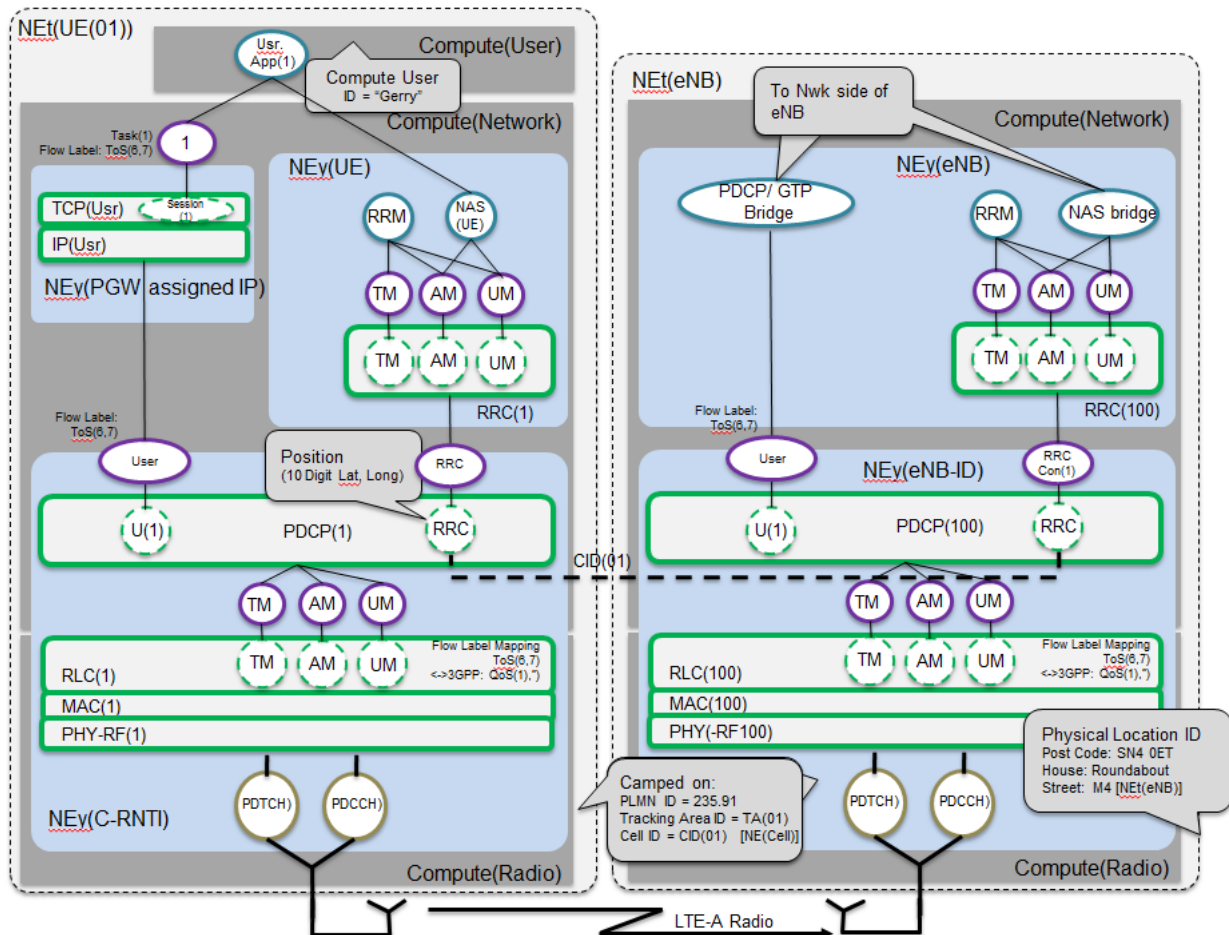


Figure 6: Simplified Model of 3GPP NE(UE) to 3GPP NE(eNB)

Figure 6 illustrates the 3GPP Network Equipment(UE) comprising multiple compute entities onto which are mounted multiple component NGP Network Entities that together render a 3GPP Network Function(UE).

In this model, multiple User applications run on a compute entity dedicated to the user. A typical User Application can start communications with the mobile network by triggering a service request towards the NAS application running on a separate NGP NEy(UE) that includes all of the 3GPP Control Plane applications to manage Non-Access Stratum control plane signalling towards the core via the Radio Resource Control towards the RAN.

The NAS application initially requests service from the RAN by triggering an Attach(PDN Connectivity Request) towards the network.

The RRC sets up a connection from the UE to the eNB on a per Cell-/Radio Network Temporary ID (C-RNTI) basis.

The PDCP/ RLC/Phy-RF protocols are all instantiated on another NGP NEy(C-RNTI) which accesses individual PoA towards the Control Plane Radio channel of the mobile using channel Physical Dedicated Control Channel (PDCCH).

A port is provided onto PDCP for RRC connectivity to carry Radio and NAS signalling towards the RAN/CN.

Once an RRC connection is established to the RRC peer at the NGP NEy(eNB) then NAS signalling can be passed towards the core network at the eNB to setup an Attach and PDN connectivity towards for instance the Internet. The Core network provides an IP address for this Attach to the Network, that the UE applications can then use to communicate towards the Internet.

Once connectivity is CP and PDN connectivity is established for the UE then the application can send user data via a separate NGP NEy(PGW Assigned IP) that builds User IP packets.

A port is provided onto PDCP for User data towards the network.

Separate ports are provided at RRC for Acknowledged Mode (AM), Unacknowledged Mode (UM) and Transparent Mode(TM) (e.g. for voice frames and some signalling messages). These modes of communication are mapped onto the RLC protocol.

QoS is handled for the User by providing labels as ToS via the NEy(PGW assigned IP) entity.

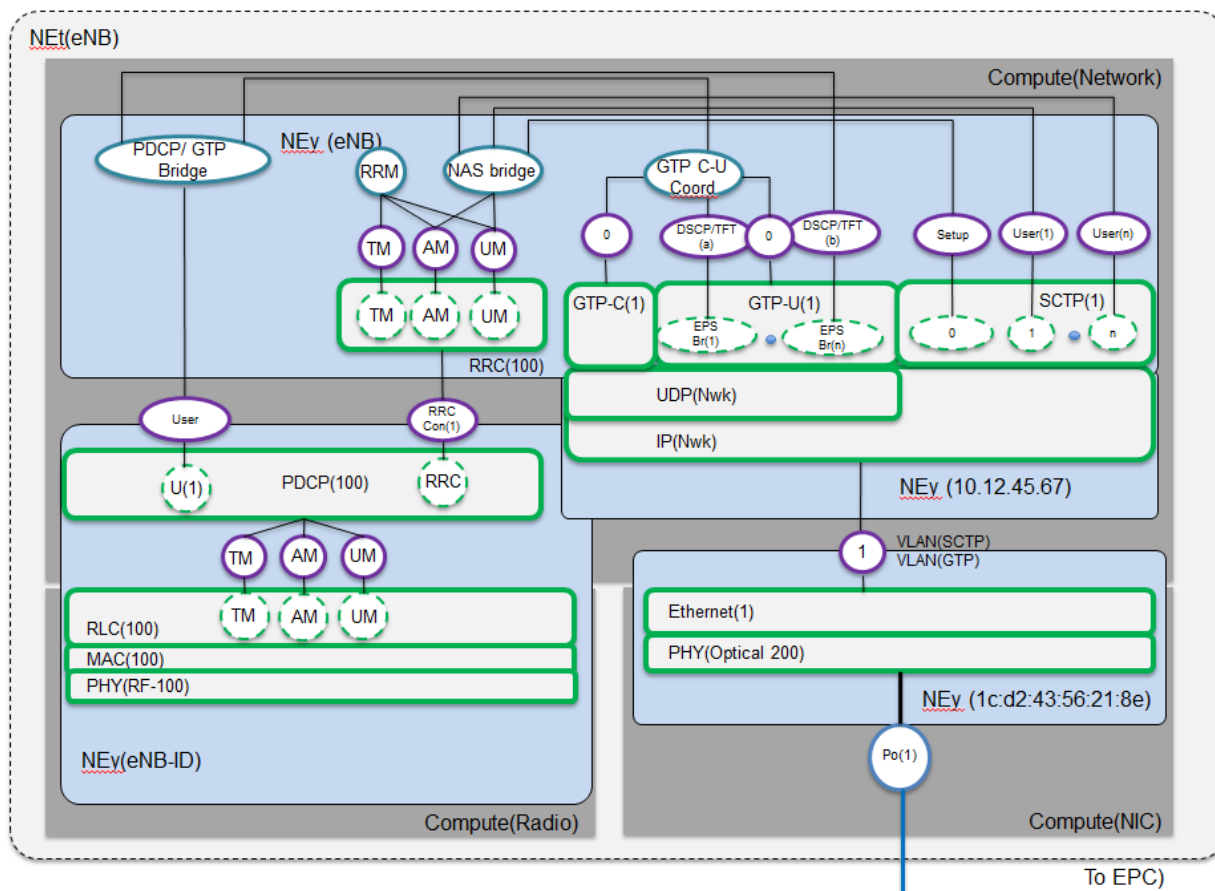


Figure 7: Simplified Model of 3GPP eNB bridging between AN and CN

Figure 7 illustrates a similar breakdown of NGP Network Entities that form a 3GPP Network Function eNB.

The NEy(eNB) operates a bridging function application that maps user packets between PDCP towards the UE and GTP towards the Core Network.

The NEy(eNB) operates a bridging function application that maps control messages between RRC towards the UE and S1-AP towards the Core Network using a control bridge.

The NEy(eNB-ID) is a specific RAN interface NEy that is specified according to the eNB-ID that the NEy has been configured to be.

The NEy(<IP Address>) is a specific Network Interface NEy that is specified according to the IP address within the cellular intranet that the NEy has been configured to be.

The NEy(<MAC Address>) is a specific network interface NEy that is specified according to the <MAC address> that the NEy has been configured to be.

A specific Protocol Instance is instantiated per UE at both the eNB RRC and PDCP Protocol Nodes.

Specific Protocol Instances are established per GTP Protocol Node, on a per Bearer and QoS(Default and Dedicated<QoS>) basis for all QoS operated by the UE towards the cellular Core Network (SGW) for user packet transfer.

The eNB sets up an SCTP protocol instance (0) between itself and the configured target MME for per user SCTP setup when the eNB is powered on and then establishes a specific SCTP protocol instance on a per UE basis as new RRC connections are established per UE.

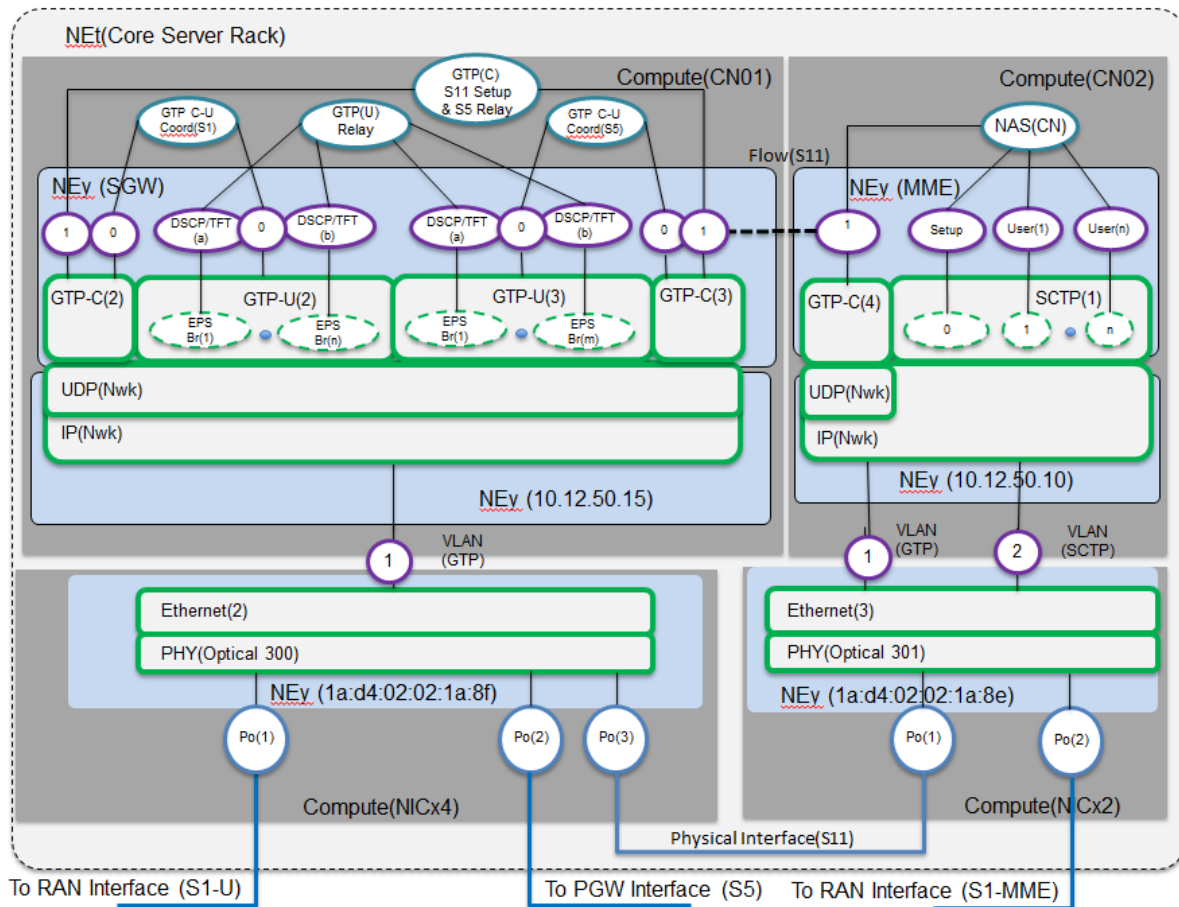


Figure 8: 3GPP Core Network (example part)

Figure 8 illustrates a Network equipment that comprises a small core network example of one server rack with multiple server blades configured as NFV compute nodes that enable multiple compute cores per VM (not detailed here).

Each compute entity illustrated typically comprises N x Cores across one or more blade servers as required per specific 3GPP Network Function instantiated.

The NEy(MME) communicates SCTP towards the RAN and manages NAS Connectivity (ECM) and Mobility (EMM) and Service ESM with a NAS application or applications on a per UE basis.

The NEy(MME), NAS application also bridges ESM NAS messages incoming from the RAN to stimulate setup of GTP-U(2) bearers towards the RAN southbound and GTP-U(3) northbound towards the PGW using GTP-C(4) to GTP-C(3) and GTP-C(2).

The NEy(SGW) bridges GTP-U traffic between the RAN, GTP-U(2) and PGW GTP-U(3). The bridging application functionality for GTP-U is on a per EPS bearer basis (/UE, /QoS & TFT) again with one protocol instance of GTP-U per EPS bearer.

4.4.5 Case(TCP/IPv4/v6 representation)

This model case is illustrated in Figure 9, This clause uses the NGP reference model to illustrate a simplified IP communications system example. Figure 9 illustrates an example of a typical home network scenario in which a NAT router in a private LAN provides a Host with access to the public Internet.

The NEt(Host(A)) represents the host with a single compute entity and two network entities: one with the "TCP/IP protocol suite" and another one with Ethernet (IEEE 802.3 [3]) protocols sitting on top of a PoA that provides a physical connection to NEt(NAT Router(B)). NEy(192.168.1.2) contains four different protocol nodes that allow applications connected to the NEy to connect to other applications in the Internet:

- N(IPv4) performs relaying and multiplexing of IP packets;
- N(ICMP) performs control functions related to error and diagnosis;
- N(TCP) provides multiple protocol instances of TCP, each one supporting a port-id by providing and error and flow controlled transport service;
- N(UDP) provides multiple protocol instances of UDP, each one supporting a port-id by providing and unreliable and non-flow controlled transport service.

The N(IPv4) protocol node multiplexes the packets from the other 3 protocol nodes into the port-id provided by NEy(1c:95:22:8c:5e:4d). This NEy provides "static ports" that map to a protocol node of a certain type (only one instance of a Protocol Node can be differentiated by this port). NEy(1c:95:22:8c:5e:4d) has two protocol nodes, each one running a single instance of the corresponding protocol: N(ARP) provides a mapping of IPv4 address to 802.3 MAC addresses, while N(802.3) multiplexes ARP and IPv4 packets into the physical interface, providing an unreliable transport service over the Ethernet physical link.

The NEt(NAT Router(B)) represents a NAT router with a single compute entity and three network entities: one with the "TCP/IP protocol suite" and two more with Ethernet (IEEE 802.3 [3]) protocols - each one sitting on top of a different PoA. The "TCP/IP" network entity has two addresses: one representing its attachment to the LAN and another one its attachment to the public Internet.

As in the NEt(Host(A)) case it also has four protocol nodes, but in a different configuration: protocol nodes N(TCP) and N(UDP) do not provide individual protocol instances supporting external port-ids, but are connected to a "NAT application" internal to the network entity that changes the port-identifiers in the TCP and UDP headers as well as the addresses of IP packets when they are routed from the public Internet to the private LAN and vice-versa.

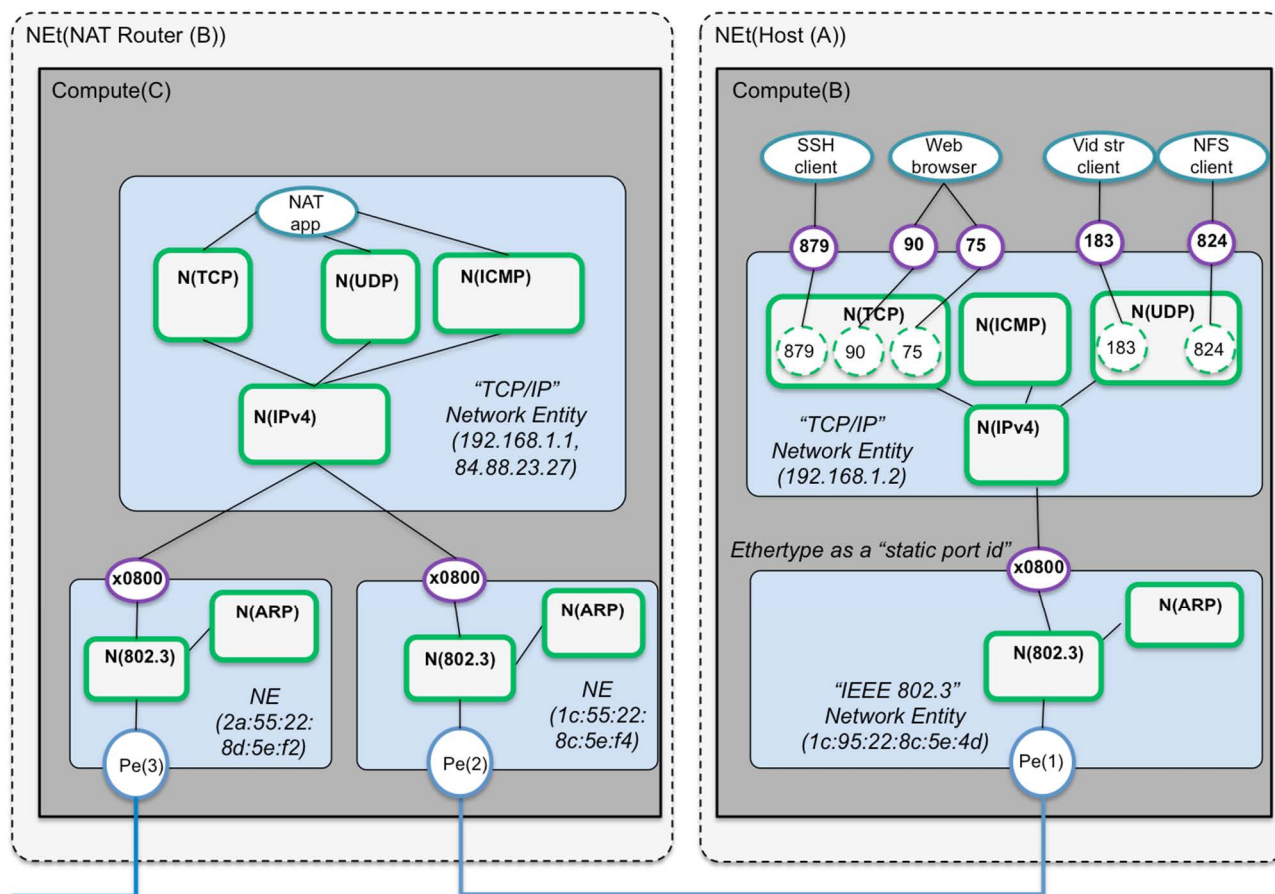


Figure 9: TCP/ IP Model

Annex A (informative): Authors & contributors

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Annex B (informative): Change History

Date	Version	Information about changes
10 th Mar 2017	1.1.1 Draft v1	First issue based on agreement of model at NGP#06 and NGP(17)000043
20 th Mar 2017	1.1.1 Draft v2	Incorporated agreed changes from NGP(17)000043 and NGP(17)000058
25 th Apr 2017	1.1.1 Draft v7	GF and EG updates to incorporate changes proposed in NGP(17)00066r1
27 th Apr 2017	1.1.1 Draft v8	GF, EG, JD, JG updates to incorporate Mobile Model, IP model examples moved to DEC013 and also updated layer and port definitions.

History

Document history		
V1.1.1	May 2017	Publication