



GROUP REPORT

Non-IP Networking (NIN); Implementing Non-IP networking over 3GPP cellular access (standards.itech.ai)

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 Reference

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Foreword

This Group Report (GR) has been produced by ETSI Industry Specification Group (ISG) Non-IP Networking (NIN).

Modal verbs terminology

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Executive summary

The present document describes and recommends approaches to test Non-IP Networking (NIN) over cellular radio access. This includes existing mechanisms specified by 3GPP for both LTE and 5G Radio Access Networks, as well as guidance on enabling a non-IP protocol stack directly atop the 3GPP PHY radio layer.

Introduction

The earliest digital cellular radio network ('2G') implemented circuit switching for voice and data services, providing a dedicated circuit between sender and receiver. Whilst this can guarantee bandwidth for the circuit, it is not an efficient use of network resources where communication flows are not constant and not at full capacity.

Hence cellular networks have implemented packet switching since the release of General Packet Radio Switching (GPRS) in 2000, allowing packets to share available routing resources. There has been a steady move towards an "all-IP" architecture with the releases of 3G, 4G (LTE) and 5G. The hypothesis was that this would drive down cost - since switch and router vendors were already producing IP kit for wired networks - and that it would enable interconnection with external IP networks and devices.

The result has been that 3rd Generation Partnership Project (3GPP) specifications for cellular networks necessitate the use of IP. The phrase "all-IP" networks is a misnomer, since the TCP/IP stack is encapsulated ('tunnelled') in a bespoke 3GPP protocol stack to isolate a user's traffic from other users; secure, compress and transport data over the radio air interface; and to support mobility.

The 'Efficient use of Spectrum' clause of ETSI GR NIN 001 [i.6] explains the issues these can cause in cellular networking. Non-IP networking aims to support native mobility and multihoming, security by design, shorter headers, and in-network congestion control for improved performance to mitigate these issues. This motivates investigation into what parts of the current 3GPP protocol stack can be considered redundant, and removed, in a Non-IP networking implementation; how to test such an implementation; and how to compare performance against the TCP/IP protocol suite.

The present document describes, compares and recommends approaches to test Non-IP Networking (NIN) over a 3GPP cellular network (LTE and 5G). This includes existing mechanisms specified by 3GPP for both LTE and 5G Radio Access Networks that account for non-IP protocol types. The present document also suggests the building blocks required to test fully 'clean slate' non-IP networking atop the 3GPP PHY radio layer, and includes example scenarios and non-technical considerations across all tests. Scalability of non-IP networking to live 5G networks is also discussed.

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1 Scope

1.0 Summary

The present document describes considerations for testing Non-IP Networking over 5G cellular Radio Access Networks. Although the LTE protocol stack is not explicitly considered the approach will be similar: either to use a clean-slate approach or one of the hooks provided by 3GPP to encapsulate non-IP PDUs. Fixed-line networks and Wi-Fi® are not in scope of the present document; although it may be that some of the material may be of relevance to those contexts.

The initial scope of testing is a simple proof of concept: to demonstrate communication between two remote processes over a radio air interface using Non-IP network protocols. This involves at minimum the UE, the air interface, the 3GPP gNb or eNb, and a data plane that communicates using Non-IP Networking. Depending on the test approach chosen (as described in clauses 6 and 7), certain elements of the 3GPP architecture may be utilized or adapted. If successful then this proof of concept should be extended to comparative testing against IP networking per the KPIs published in ETSI GS NGP 012 [i.7].

1.1 Access technologies

The present document covers testing over 3GPP 5G radio access networks, with LTE possible for the 'clean slate' approaches document in clauses 7 and 8.

1.2 Out of Scope

The present document does not cover interoperability with IP-based networks, including roaming scenarios between 3GPP mobile network operators. These may be covered in future documents following a successful test of the simple proof-of-concept.

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2 References

2.1 Normative references

Normative references are not applicable in the present document.

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 referenced 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.

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NOTE: Available at <https://www.ofcom.org.uk/manage-your-licence/radiocommunication-licences>.
- [i.18] CPRI: "Common Public Radio Interface", diagram of eCPRI protocol stack over IP/Ethernet.
NOTE: Available at <http://www.cpri.info/downloads/eCPRI-Presentation-for-CPRI-Server-2018-01-03.pdf>.
- [i.19] ETSI TS 123 501: "5G; System architecture for the 5G System (5GS) (3GPP TS 23.501)".
- [i.20] ETSI TS 138 300: "5G; NR; NR and NG-RAN Overall description; Stage-2 (3GPP TS 38.300)".

3 Definition of terms, symbols and abbreviations

3.1 Terms

Void.

3.2 Symbols

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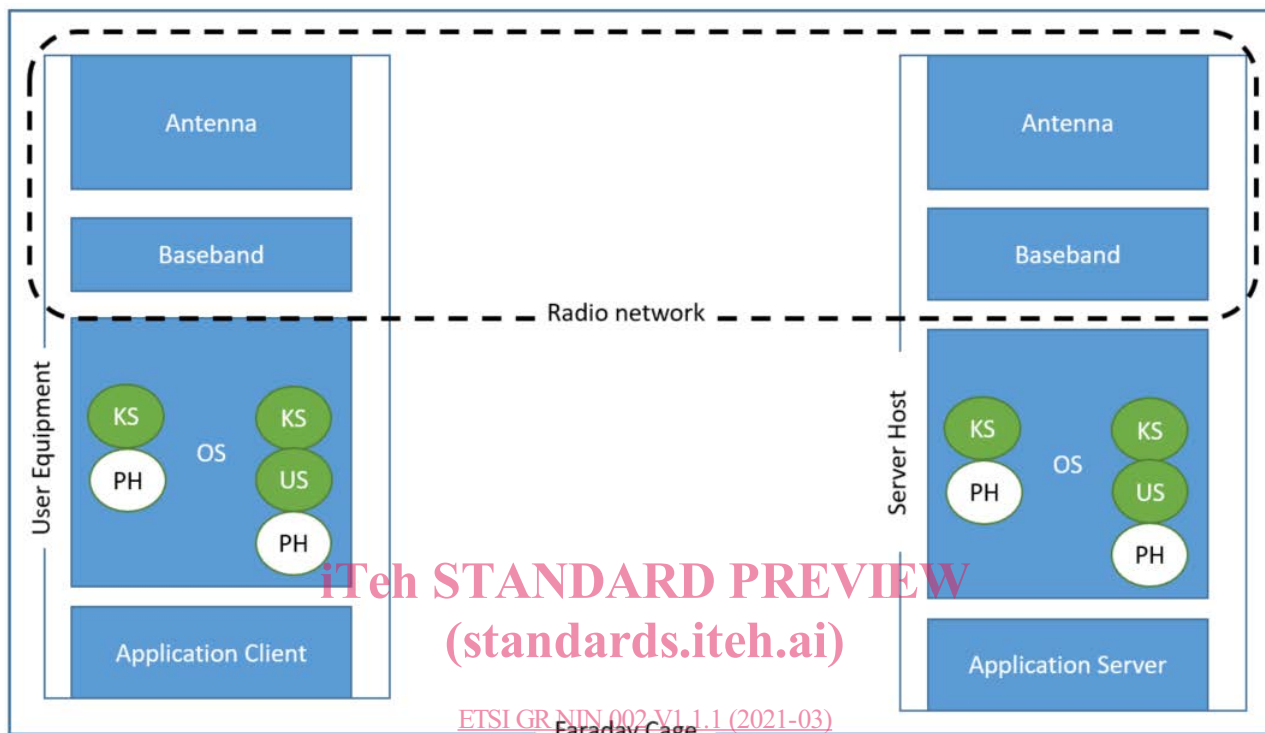
3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

5GCN	5G Core Network
BLE	Bluetooth Low Energy
CPRI	Common Public Radio Interface
DN	Data Network
EMF	Electro Magnetic Field Limits (Human Exposure)
FPGA	Field Programmable Gate Array
GPRS	General Packet Radio Service
GTP	GPRS Tunnel Protocol
ICNIRP	International Commission for Non-Ionizing Radiation Protection
IoT	Internet of Things
IP	Internet Protocol
KS	Kernel Space
L2CAP	Logical Link Control and Adaptation Protocol
LAN	Local Area Network
MAC	Media Access Control
MTU	Maximum Throughput Unit
NAS	Non-Access Stratum
NGP	Next Generation Protocols
NIDD	Non-IP Data Delivery
NIN	Non-IP Networking
NR	5G New Radio
OS	Operating System
PCI-E	Peripheral Component Interface Express
PDCP	Packet Data Convergence Protocol
PDU	Protocol Data Unit
PH	Protocol Handler library
PHY	PHYSical layer
PtP	Point-to-Point
QoS	Quality of Service
RAN	Radio Access Network
RF	Radio Frequency
RLC	Radio Link Control
RRC	Radio Resource Control
RTOS	Real Time Operating System
SBA	Service Based Architecture
SCEF	Service Capabilities Exposure Function
SDAP	Service Data Adaptation Protocol
SIM	Subscriber Identity Module
TCP	Transmission Control Protocol
TNGF	Trusted Non-3GPP Gateway Function
TSN	Time Sensitive Networking
UDP	User Datagram Protocol
UE	User Equipment
UPF	User Plane Function

US	User Space
VLAN	Virtual Local Area Network
VPN	Virtual Private Network

4 Model for non-IP prototyping over radio



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Legend:
 KS = Kernel Space
 US = User Space
 PH = Protocol Handler library

Figure 4.1: Model for Non-IP prototyping over radio

The Protocol Handler may be implemented within kernel space or user space. The former requires kernel development, but can offer more control over networking operations. The user space option is easier to develop but requests networking resources from the kernel, and will hence reuse the existing TCP/IP network stack.

5 5G architecture summary

5.1 5G radio access user plane protocols

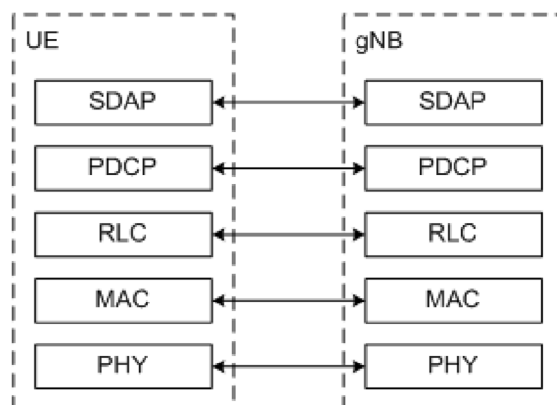


Figure 5.1: 5G radio protocol stack

The 5G New Radio (NR) user plane protocol stack [i.8] is responsible for transferring user plane data between a Radio Access Network (RAN) and User Equipment. Figure 5-1 shows the following protocols:

- the physical radio (PHY) where digital data is encoded as an analogue signal;
- Media Access Control (MAC) that handles transmissions and retransmissions;
- Radio Link Control (RLC), responsible for correcting MAC-layer errors to ensure in-order delivery of packets to the higher layers;
- The Packet Data Convergence Protocol (PDCP), which carries the IP stack user-plane traffic, supporting in-order packet delivery and queue handover during mobility between two cells, encrypting the payload and optionally compressing IP headers;
- the Service Data Adaptation Protocol (SDAP) manages uplink and downlink Quality of Service (QoS) markings for flows.

5.2 5G Service Based Architecture (SBA)

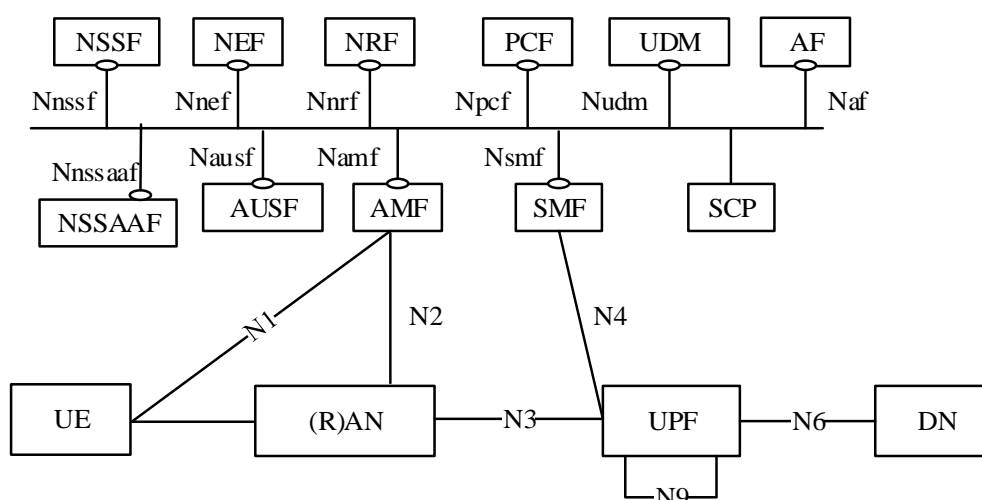


Figure 5.2: 5G Service Based Architecture (source: ETSI TS 123 501 [i.19])