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GROUP SPECIFICATION

KPIs for Next Generation Protocols: Basis for measuring benefits of NGP

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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

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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1 Scope

The scope of the present document is to specify Key Performance Indicators (KPIs) that can be used to compare the efficiency, performance and security of Next Generation Protocols (NGPs) against current networking protocols.

The relative importance of each KPI depends on the scenario in which protocols are being compared. Therefore, this document provides guidelines for weighting the KPIS to help arrive at a meaningful comparison. Scenarios of particular relevance are detailed in ETSI NGP GS 001 [1], with resulting requirements listed in ETSI NGP GS 005 [2].

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.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference.

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 necessary for the application of the present document.

[1] ETSI GS NGP 001: "Next Generation Protocol (NGP); Scenario Definitions".

[2] ETSI GS NGP 005: "Next Generation Protocol (NGP); Next Generation Protocol Requirements".

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.

[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)".

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

Key Performance Indicator (KPI): measurable property that significantly impacts business operations as its value changes

3.2 Symbols

Void.

3.3 Abbreviations

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

3GPP™	3rd Generation Participation Project
CERT	Computer Emergency Response Team
IoT	Internet of Things
IP	Internet Protocol
ISG	Industry Specific Group
KPI	Key Performance Indicator
NAT	Network Address Translation
NGP	Next Generation Protocols
PDU	Protocol Data Unit
ROI	Return On Investment
TCP	Transmission Control Protocol

4 Overview

Next Generation Protocols aim to improve on existing protocols in various ways. Any improvement shall be demonstrable and measurable. Hence the need for a set of KPIs with which to measure, and compare, Next Generation Protocols against the protocols they intend to replace.

5 Methodology

Each KPI consists of several characteristics:

- An ID for reference.
- A definition and rationale, to explain why this is a Key Performance Indicator.
- A metric, to indicate the unit of measurement.
- Desired value.

For the most accurate comparison, only the protocols being tested should vary, and other elements (CPUs, network paths, access media, etc.) should remain fixed. This does not apply for hardware-only processing comparisons against software processing.

6 Key Performance Indicators for network protocols

6.1 KPIs for naming and addressing

Table 6.1

ID	Definition and rationale	Metric	Desired value
Add1	Scalability: the number of entities that can be uniquely addressed by the scheme. An address scheme should scale to support the projected addressable entities of the network. The measurement is the count of addressable entities supported by the address scheme itself without external mappings (e.g. NAT).	Integer	A higher number of addressable entities.
Add2	Allocation and reuse: the efficiency of allocating an address to an addressable entity, and of re-allocating that address as required. The latency incurred in allocating/re-allocating addresses impacts network scalability and flexibility.	Time (ms)	A shorter time taken to allocate *n* addresses to *n* entities; a shorter time taken to reallocate *n* addresses.
Add3	Encoding: the minimum bits required to encode the address per the addressing scheme specification.	bits	Fewer bits to encode the address.
Add4	Are the Address semantics overloaded? Host addresses are location-dependent; application names are location-independent. Loose coupling of these simplifies mobility and multihoming.	Yes/no	No.
Add5	Location-independent naming: does the application identifier persist when it has moved to a new host? This hides complexity from other communicating processes.	Yes /No	Yes.
Add6	Ability to set the lifetime of an address.	Yes/no	Yes.
Add7	Ability to allocate addresses to entities not yet attached.	Yes/no	Yes.
Add8	Ability to allocate static addresses.	Yes/no	Yes.

6.2 KPIs for performance

Table 6.2

ID	Definition and rationale	Metric	Desired value
Per1	Void.		
Per2	Latency: the delay between the encapsulation of application data into a network protocol datagram by the sending endpoint; the forwarding of those datagrams to the destination endpoint; and the subsequent decapsulation of the datagram to extract the application data.	Time (ms)	The lower latency (see note 1).
Per3	Predictability/reliability: the ability of the protocols to deliver datagrams without loss or corruption; and to deliver datagrams in order as required.	Lost/corrupted packets as a % of the flow total.	Lower error % (see note 2).
Per4	Jitter: any variation in latency over time. Lower jitter would indicate a more predictable network protocol.	Standard deviation from expected latency.	The lower jitter (see note 3).
NOTE 1: The latency testing for a given scenario may require consideration of, or set values for: • error rate • load • scalability • mobility NOTE 2: This measurement assumes that any network protocol retransmission mechanism is active. Therefore the measurement should allow for such mechanisms to detect and recover from any loss/corruption. NOTE 3: Measurements should be taken over a range of network conditions, including high network load and poor signal (for mobile access).			

6.3 KPIs for mobility

Table 6.3

ID	Definition and rationale	Metric	Desired value
Mob1	Latency to handover The delay to switch access networks whilst maintaining flow continuity.	Time (ms)	The lower time.
Mob2	Overhead of handover The buffer handover when switching access networks (including LTE mobility and LTE <->WiFi mobility).	Bytes	The smaller number of bytes.
Mob3	Packet loss of handover The packets dropped during access network handover.	Integer	The smaller number of packets.

6.4 KPIs for buffering

Table 6.4

ID	Definition and rationale	Metric	Desired value
Buf1	Void		
Buf2	Drop/queue support The ability of the protocol to request that the network either drop or queue packets under resource contention.	Yes/No	Yes
Buf3	Queue occupancy support when choosing optimal route.	Yes/No	Yes
Buf4	Support for configurable scheduling - queuing for a configurable time.	Yes/no	Yes

6.5 KPIs for multihoming

Table 6.5

ID	Definition and rationale	Metric	Desired value
MH1	Do the protocols name the node, and not the network interface? This allows native multihoming and reduces complexity, improves scalability, load balancing and session continuity.	Yes/No	Yes
MH2	Do the protocols support aggregation of content from different destination sources, to provide resilience?	Yes/No	Yes

6.6 KPIs for protocol efficiency

More efficient protocols will improve performance, and should reduce the energy consumed by processing and transmission.

Table 6.6

ID	Definition and rationale	Metric	Desired value
PE1	Protocol efficiency: The ratio of useful data in the payload to overhead has a direct financial impact on communication links; More performant protocols will deliver a higher value per second. NGP protocols shall minimize header complexity and overhead.	Application bits as a ratio of total bits. For cellular systems, protocols shall be compared when transmitted over the same frequency range and encoding scheme, at the point at which the PDU is sent to the radio scheduler, for the non-access stratum only (i.e. for the user data plane only)	A higher proportion of application bits as ratio of total bits
PE2	Processing overheads: instructions The number of instructions required to process the protocol headers. If software, how many machine instructions. If logic, how many gates.	Number of processing steps (Integer)	Lower number

ID	Definition and rationale	Metric	Desired value
PE3	Processing overhead: primary storage The size of the information to be stored and processed. A higher information size will use up more memory bandwidth and buffer space.	Bytes	Lower number
PE4	Increase in space in routing tables An efficient protocol will minimize increase in routing table size under multihoming, aggregation and traffic engineering.	Routing table entry insertions following a multihoming event or a mobility event (Integer)	Lower number
PE5	Connection establishment overhead For connection-oriented protocols: How many round trips are required to establish a connection. Note, the latency of round trips should be considered the same when comparing two protocols/ For connectionless protocols: the instructions required to bind the flow to a sender/receiver.	Integer	Lower number
PE6	Retransmission of already-queued data Endpoints should not retransmit information which is already queued upstream in the network path	Yes/No	No
PE7	Flow Control loops Reaction to loss or resource contention is most efficiently done at the point it occurs.	Number of network hops to report and react to congestion; number of decapsulations required to detect congestion signals (integer)	Lower number
PE8	Overhead of security: the transmission and processing burden of encrypting, including the process of securing a flow, decrypting and integrity checking the application bits	Processing overhead, Bytes overhead per PE2 and PE3	Lower processing steps and bytes
PE9	Is header re-encapsulation and modification required, such as checksum recalculation?	Yes/No	No
PE10	Does the scheme require the address to be encoded in every packet of a flow? This reduces transmission efficiency.	Yes/No	No

6.7 KPIs for security and privacy

Table 6.7

ID	Definition and rationale	Metric	Desired value
SEC1	Security by default. Security achieved without overlays.	Yes/No	Yes
SEC2	Crypto-agility for algorithms and key management independent of function invocation. Whilst "security by default" should identify a requirement for crypto-agility, this should be implemented in such a way that a change of the crypto solution should not impeded the functional capability of the NGP.	Yes/No	Yes
SEC3	Reporting of security events to a recognized standard. The NGP shall ensure that events that impact the operation of the NGP by any form of attack (accidental or malicious) are reported in such a way that partner organizations can take action to prevent such attacks. This should follow the models of security incident reporting standardized in ETSI CYBER and associated bodies (e.g. to follow the STIX/TAXII framework and adoption of CERT guidelines).	Yes/No	Yes

6.8 KPIs for traffic management

Table 6.8

ID	Definition and rationale	Metric	Desired value
NET1	Latency of traffic identification Traffic identification shall be compared like-for-like, i.e. whether identification relates to the class of traffic (e.g. real-time service, download, etc.), the provider of the traffic, or other criteria. The time measured includes any latency overhead incurred in connection establishment, and may also account for latency incurred in securing the communication channel if appropriate.	Time (ms)	Lower time
NET2	Volume of data to be inspected for traffic identification Lowest volume of data in order to identify traffic in the early stage. (Different from latency which induces some processing of data). This includes control plane bits if used.	Bits	Lower number
NET3	Real-time traffic identification of traffic What is the latency incurred in identifying traffic classes?	Time (ms)	Lower time
NET4	"Accuracy" in identifying the proper class of traffic Based on tests that compare the "perceived" traffic class from the actual traffic class.	Percentage	Highest percentage
NET5	QoS support and levels.	Integer	Most number of traffic classes supported, for individual application or user

ID	Definition and rationale	Metric	Desired value
NET6	Scalability of management policies The intention is to reduce the complexity to manage policies.	Integer maximum number of network locations to apply traffic management. Note this does not apply to queue management.	Lowest number
NET7	Capabilities of traffic management policies (i.e. expressivity).	Integer, Number of operations and number of parameters per operations	Highest number
NET8	Prioritization: the ability of the network protocol to support both prioritization and non-prioritization when processing flows from different sources.	Yes/No	Yes

6.9 KPIs for interoperability

Table 6.9

ID	Definition and rationale	Metric	Desired value
INT1	Ability to support TCP/IP applications via interoperability.	Yes/No	Yes
INT2	Interworking with 3GPP R15/16 with minimal complexity.	Yes/No	Yes (see note)
NOTE: This KPI has a dependency on 3GPP.			

7 Assessment of return on investment

7.0 About this clause

This clause is informative and covers business goals which are not easily mapped to strict metrics. The goals below may inform networks in estimating a Return on Investment (ROI) for the implementation of NGPs, based on deployment cost and revenue opportunities.

7.1 Deployment effort

This list with KPIs is based on [i.1] and represents the ability to integrate the NGP using new and existing infrastructures.

Table 7.1: Factors affecting deployment effort

ID	Assessment	Estimate	Desired value
INT1	Integration effort with existing infrastructure (see note)	Rough Order of Magnitude 1 - 4, where: 1) Minor 2) Medium 3) Major 4) Not possible	Minor
INT2	Re-use of existing infrastructure	Percentage	Higher percentage
INT3	Licence conditions for use of protocols	Free or paid (with payment value)	Free
NOTE: This assessment can also be compared to the integration effort of evolutions to IP networking, such as IPv6, segment routing, etc.			

7.2 Revenue opportunities

This list with KPIs is based on [i.1] and represents the ability to improve business metrics (e.g. operational costs, efficiency, customer care, etc.).

Table 7.2: KPIs for Business Benefits

ID	Goal	Assessment	Desired value
BBE1	Business market needs: Type of benefits the NGP proponents expect to deliver to their possible business customers compared to existing solutions	Textual (List) (see note).	Higher the number of benefit types t
BBE2	Business impact	Rough order of magnitude Small/Medium/Large How NGP is impacting Business customers compared to existing solutions. This requires an *ex post* analysis of NGP deployment.	Large
NOTE: These can include results from the technical KPIs (e.g. improved performance, security, energy efficiency, etc.).			

Annex A (informative): Guidance on weighting of KPIs

A.0 Rationale for weighting

The importance of a given KPI is dependent on the scenario in which the candidate protocols are being compared. The KPIs, or KPI categories, should therefore be weighted according to the context in which the protocols are to be used. This may include particular networks (such as mobile access, fixed broadband, satellite, etc.) or scenarios (such as ultra-reliable low latency communications, low-power IoT sensor deployments, mobility, etc.). The requirements of the network or scenario will inform the weighting exercise when determining the most appropriate protocol. The following diagrams show example weightings (the numbers in the black circles) mapped to KPIs.

A.1 Weighting KPIs within a KPI category

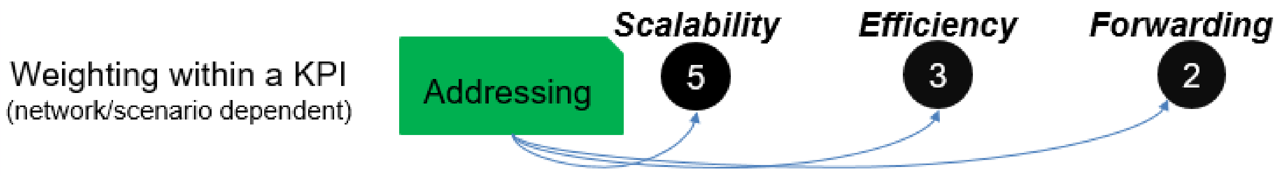

Figure A.1: Example of weighting within a KPI

A.2 Weighting for a network

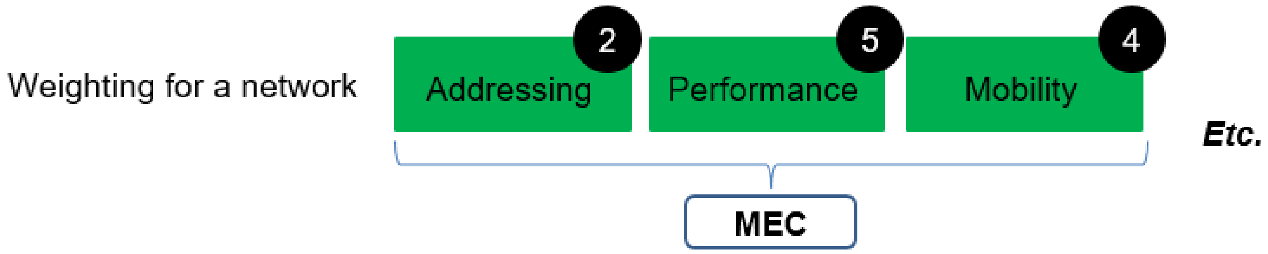

Figure A.2: Example of weighting for a network

A.3 Weighting for a scenario

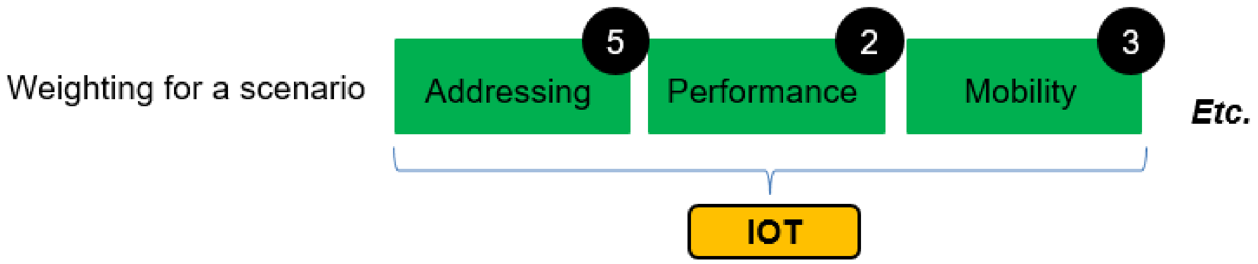

Figure A.3: Example of weighting for a scenario

Annex B (informative): Authors & contributors

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Annex C (informative): Bibliography

- Create-IoT Deliverable 01.04: "Common methodology and KPIs for design, testing and validation", H2020 - CREATE-IoT Project, Revision 1, 30/09/2017.

NOTE: Available at https://european-iot-pilots.eu/wp-content/uploads/2017/10/D01_04_WP01_H2020_CREATE-IoT_Final.pdf.

Annex D (informative):
Change History

Date	Version	Information about changes
November 2017	0.0.1	First Draft, structure and scope
November 2017	0.0.2	Incorporated inputs from John Grant
February 2018	0.0.3	Tabulated the KPIs and populated each clause
March 2018	0.1.0	Stable draft following integration of comments received from NGP 10
April 2018	0.1.1	Integration of comments from status call 41
	0.1.2	Incorporated security input from Scott Cadzow; summarized PE1 rationale text
	0.1.3	Incorporated network management input from Jérôme
May 2018	0.1.4	Incorporated feedback from NGP #43
	0.1.5	Incorporated feedback from NGP#44 and NGP(18)40
July 2018	0.1.6	Incorporated feedback from NGP#11
	0.1.7	Incorporated feedback from NGP#46
October 2018	0.1.8	(uploaded with erroneous changelog information, which 1.9 fixed)
	0.1.9	Fixed typos, moved PER1 to PE10, moved PER5 to NET8, added note on "energy efficiency" at start of 6.6
December 2018	0.1.10	Changes applied following editHelp comments/corrections

History

Document history		
V1.1.1	December 2018	Publication