ANNEX 1-A: A SUMMARY OF QOS ASSESSMENT FRAMEWORK FOR MOBILE VOICE, SMS, MMS & DATA SERVICES at Year 1

Item No.	Service Type	Main KPI	Sub KPI	Parameter	Maximum Sourcing Frequency	Remarks
1.	Mobile Telephony	Network Coverage information.	Coverage per (Pop. & Geographic)	Coverage ≥ -103 dBm	Quarterly	System & Data Extraction Source Exists at CA
		Network Performance. [Operators' Self-Assessment based on own data.] *Overall QoS aggregate Contribution 30%)*	Network Availability	Rv Signal Level ≥ -95 dBm	Quarterly	MNOs to provide Reports based on analyzed data and simultaneously submit raw data for verification/audit
			Network Accessibility	Unsuccessful Calls ≤5%	Quarterly	
			Service Retainability	Handover Success Rate ≥ 96%	Quarterly	
			Service Integrity	• Call Setup Time ≤12s	Quarterly	

Item No.	Service Type	Main KPI	Sub KPI	Parameter	Maximum Sourcing Frequency	Remarks
				(4G) Time ≤8s (Others) • Voice Quality ≥3.4 (SWB)		
			Service Retainability	Dropped Calls ≤2%	Quarterly	
		End-to-End QoS [Independent QoS Field Assessment by CA or its agents] *Overall QoS aggregate Contribution (70%)*	Network Availability	Rv Signal Level ≥ -95 dBm	Quarterly	
			Network Accessibility	Unsuccessful Calls ≤5%	Quarterly	
			Service Retainability	Handover Success Rate ≥ 96%	Quarterly	
			Service Integrity	• Call Setup Time ≤12s	Quarterly	

Item No.	Service Type	Main KPI	Sub KPI	Parameter	Maximum Sourcing Frequency	Remarks
				(4G) Time ≤8s (Others) Voice Quality≥3.4 (SWB)		
			Service Retainability	Dropped Calls ≤2%	Quarterly	
		Quality of Experience (QOE) [Based on Customer Satisfaction surveys] *Overall QoS aggregate Contribution (0% first two years)*	Network Availability	% Rating	Annually	• CA does Customer Satisfaction Survey annually. These QoE components to be included in the said survey
			Service Quality	% Rating	Annually	
			Service Tariff	% Rating	Annually	
			Customer Care Services	% Rating	Annually	

Item No.	Service Type	Main KPI	Sub KPI	Parameter	Maximum Sourcing Frequency	Remarks
2.	SMS	Network Performance. Operators' Self-Assessment based on own data. *Overall QoS aggregate Contribution 30%)*	Network Accessibility	Successful SMS Ratio ≥95%	Quarterly	MNOs to provide Reports based on analyzed data and simultaneously submit raw data for verification/audit
			Service Availability	Completion Rate for SMS ≥95%	Quarterly	
			Service Integrity	End-to-End delivery time for SMS ≥95% in less than 30s	Quarterly	
		End-to-End QoS [Independent QoS Field Assessment by CA or its agents] *Overall QoS aggregate Contribution (70%)*	Network Accessibility	Successful SMS Ratio ≥95%	Quarterly	
			Service Availability	Completion Rate for SMS ≥95%	Quarterly	
			Service Integrity	End-to-End delivery time for SMS ≥95% in less than 30s	Quarterly	

Item No.	Service Type	Main KPI	Sub KPI	Parameter	Maximum Sourcing Frequency	Remarks
		Quality of Experience (QOE) [Based on Customer Satisfaction surveys carried out by CA or its agents] *Overall QoS aggregate Contribution (0% until after 2 years)*	Network Availability	% Rating	Annually	• CA does Customer Satisfaction Survey annually. These QoE components to be included in the said survey
			Service Quality	% Rating	Annually	
			Service Tariff	% Rating	Annually	
			Customer Care Services	% Rating	Annually	
			Service Availability	Completion Rate for MMS >=95%	Quarterly	
			Service Integrity	End-to-End delivery time for MMS >95% in less than 180s	Quarterly	
3	Data Transfer/ Internet	Network Performance. [Operators' Self-Assessment based on own data.]	Network Accessibility	Latency 100ms	Quarterly	Network Operators & Service Providers to provide reports based on analyzed data and simultaneously submit raw data continuously for verification/audit
				Jitter 50ms	Quarterly	
			Service	Data transfer	Quarterly	

Item No.	Service Type	Main KPI	Sub KPI	Parameter	Maximum Sourcing Frequency	Remarks
		Overall QoS aggregate Contribution 30%)	Availability	failure ratio ≤10 for upload ≤10% for download Throughput of successful data transfer ≥85% of contractual throughput		
			Service Integrity	Ratio of Packet Loss 1/1000	Quarterly	
			Network Accessibility	Internet Accessibility ≥98%	Quarterly	
			Service Availability	HTTP set-up failure ratio ≤2% HTTP set-up time 95%	Quarterly	

Item No.	Service Type	Main KPI	Sub KPI	Parameter	Maximum Sourcing Frequency	Remarks
				HTTP Completion failure ratio ≤90% HTTP Completion Time >95% in less than 20s	Quarterly	
				HTTP generic scenario availability 85%	Quarterly	
		End-to-End QoS [Independent QoS Field Assessment by CA or its agents] *Overall QoS aggregate*		Latency 100ms	Quarterly	
				Jitter 50ms	Quarterly	
				Data transfer failure ratio ≤10 for upload ≤10% for download	Quarterly	

Item No.	Service Type	Main KPI	Sub KPI	Parameter	Maximum Sourcing Frequency	Remarks
		Contribution (70%)		Throughput of successful data transfer ≥85% of contractual throughput		
				Ratio of Packet Loss 1/1000	Quarterly	
				Internet Accessibility ≥98%	Quarterly	
				HTTP set-up failure ratio ≤2% HTTP set-up time 95%	Quarterly	
				HTTP Completion failure ratio ≤90%	Quarterly	

Item No.	Service Type	Main KPI	Sub KPI	Parameter	Maximum Sourcing Frequency	Remarks
				HTTP Completion Time 95% in less than 20s		
				HTTP generic scenario availability 85%	Quarterly	
		Quality of Experience (QOE) [Based on Customer Satisfaction surveys] *Overall QoS aggregate Contribution (0% until after 2 years)*	Network Availability	% Rating	Annually	CA does Customer Satisfaction Survey annual. These QoE components to be included in the said survey
			Service Quality	% Rating	Annually	
			Service Tariff	% Rating	Annually	
			Customer Care Services	% Rating	Annually	

END TO END QOS KPI ASSESSMENT FOR MOBILE VOICE, SMS, MMS & DATA SERVICES

A. TELEPHONY

KPI No.	KPI Name	Related indicator definition	Target	Comment / Reference
1.	Unsuccessful call ratio	An unsuccessful call is a call attempt to a valid (and supposed not busy) number, properly dialled following dial tone, where no ringing tone, or answer, is recognized on the access line of the calling user within 30 seconds from the instant when the address information required for setting up a call is sent from the user equipment. Unsuccessful telephony call ratio is defined as the ratio of unsuccessful calls to the total number of call attempts in a specified time period. The following statistics shall be provided: The percentage of unsuccessful telephony "on-net" (inside the same network) calls (including Mobile to Mobile calls), together with the number of observations made and the accuracy limits for 95 % confidence calculated from this number.	≤ 5%	Due to network problems and despite B-party being not busy, it may even be possible for the A-party to receive a busy or not reachable signal. In this case, since no "Alerting" or "Connect" message will be sent, the test sample will be treated as a failure. References: ETSI ES 202 765-2, clause 7.3 ETSI EG 201 769 ETSI EG 202 057-3 V1.1.1 ITU-T E.804, clause 7.3.6.1 (trigger point 7.3.6.1.3) / ETSI EG 202 057-2 V1.3.2, clause 6.6.1 (trigger point 6.6.1.3)
2.	Dropped call ratio	The dropped call telephony dropped call ratio is the probability that a successful call attempt is ended during a standard duration of the communication by a cause other than the intentional termination by the calling or called party.	≤ 2%	References: ETSI ES 202 765-2, clause 7.4

KPI No.	KPI Name	Related indicator definition	Target	Comment / Reference
		Dropped telephony call ratio is defined as the ratio of unintentionally terminated telephony calls to the total of successful call attempts in a specified time period. The following statistics shall be provided: The percentage of dropped telephony "on-net" (inside the same network) calls (including Mobile to Mobile calls), together with the number of observations made and the accuracy limits for 95 % confidence calculated from this number.		ETSI EG 201 769 ETSI EG 202 057-3 V1.1.1 ITU-T E.804, clause 7.3.6.5 (trigger point 7.3.6.5.3) / ETSI EG 202 057-2 V1.3.2, clause 6.6.5 (trigger point 6.6.5.3)
3.	Call Set-up time	The period starting when the address information, properly dialled following dial tone, to a valid (and supposed not busy) number required for setting up a call is sent from the calling party and finishing when the called party ringing tone, or answer signal, is received by the calling party. The following statistics should be provided: The following statistics shall be provided: The mean value in seconds for "on-net" (inside the same network) calls (including M-M calls) together with the number of observations made and the accuracy limits for 95 % confidence calculated from this number.	Mean value ≤ 8 s (For GSM) (≤ 12s For LTE/4G)	"Alerting" or "Connect" message received by the called party. ETSI ES 202 765-2, clause 7.1 (post dialling delay) ETSI EG 201 769 ETSI EG 202 057-2, clause 5.2} ITU-T E.804, clause 7.3.6.2 (trigger point 7.3.6.2.3) / ETSI EG 202 057-2 V1.3.2, clause 6.6.2 (trigger point 6.6.2.3)
4.	Voice Quality	Represents the intrinsic quality of speech signal after transmission. This indicator takes into account the degradations generated on the signal by the transmission links. The following statistics shall be provided: The mean value for "on-net" (inside the same network) calls (including M-M calls) together with the number of observations	≥ 3.4 NB Narrow band	Voice quality should be measured using a special equipment enabling to handle ITU-T P.863 (POLQA) References: ITU-T P.863 (09/2014)

KPI No.	KPI Name	Related indicator definition	Target	Comment / Reference
		made and the accuracy limits for 95 % confidence calculated from this number.		
5.	Handover Success Rate	The capacity to sustain connection while in motion. Mobility test	$\geq$ 96%	

B. SMS

KPI No.	KPI Name	Related indicator definition	Target	Comment / Reference
1	Successful SMS Ratio	Probability that a user can send a SMS successfully from a terminal equipment to a SMS centre. The following statistics should be provided separately: a) The percentage of successfully sent short messages; b) Number of observations used and the absolute accuracy limits for 95 % confidence calculated from this number.	≥ 95%	References: EG 202 009-2 V1.3.1 ETSI EG 202 057-2 V1.3.2 (5.6.1)
2	Completion Rate for SMS	Ratio of correctly sent and received SMS between two terminal equipment. The following statistics should be provided separately: a) Ratio of successfully sent and received short messages; b) Number of observations used and the absolute accuracy limits for 95 % confidence calculated from this number.	≥ 95%	This rate is the probability of an SMS to be successfully delivered to its destination, i.e., the rate between the number of messages successfully received at the destination terminal equipment and the number of message sent. Error messages and messages not delivered within a previously-defined time frame (175 s) are considered failed messages. An SMS is considered to be received with an error when it has at least one incorrect bit upon reception. Message sent without receiving notification “message sent” are considered failed message.

				References: ETSI EG 202 009-2 V1.3.1 ETSI EG 202 057-2 V1.3.2 (5.6.2) ETSI TS 102 250-2 V2.3.1 (7.4.4 – completion failure ratio) ETSI TS 102 250-5 V2.4.1
3	End-to-End delivery time for SMS	The end-to-end delivery time for SMS is the period starting when sending a SMS from a terminal equipment to a Short Message centre and finishing when receiving the very same SMS on another terminal equipment. The following statistics should be provided separately: a) the mean value in seconds for sending and receiving short messages; b) number of observations used, the time in seconds within which the fastest 95 % of short messages are sent and received	≥ 95% Rate of SMS completed in a delay of less than 30 s. (best practice)	A message is received within less than 30 seconds if the message is received matching the criteria of the metric 'Completion rate for SMS" and if the receiving time of the received message does not exceed 30 seconds. References: ETSI EG 202 009-2 V1.3.1 ETSI EG 202 057-2 V1.3.2 (5.6.3) ETSI TS 102 250-2 V2.3.1 ETSI TS 102 250-5 V2.4.1

C. **DATA/INTERNET**

KPI No.	KPI Name	Related indicator definition	Target	Comment / Reference
1	Latency	Amount of time it takes for a packet to reach the receiving endpoint after being transmitted from the sending endpoint. This metric includes the definition of Delay (one way transmission time) defined in clause 5.5 of EG 202 057-4 [1], for the ping delay. The following statistics should be provided: o The mean values of the latency in milliseconds The latency is calculated from the ping echo responses delay. Latency [milliseconds] = One_way_delay = average (½ time (Echo Reply Message)) (refer to UIT-T Y.1540 and UIT-T Y.1541 for definition, conditions and calculation)	100 ms (1)	Tests are carried with a remote test-server in the close vicinity of the Licensee networks Ping (using IP address of the test-server) can be used to measure this latency, in this case delay is half the time, in milliseconds, that is needed for an ICMP Echo Request/Reply Ping delay = average (time (Echo Reply Message)) References: ETSI EG 202 057-4 ETSI ES 202 765-4 RFC 792 UIT-T Y.1540 UIT-T Y.1541
2	Jitter	The difference in the end-to-end latency between packets. The jitter is assessed by the standard deviation of the delay	50 ms (1)	References: ETSI EG 202 057-4 ETSI ES 202 765-4

KPI No.	KPI Name	Related indicator definition	Target	Comment / Reference
		when ping delay measurements are performed (see latency metric above) Jitter [milliseconds] (refer to UIT-T Y.1540 and UIT-T Y.1541for definition, conditions and calculation)		RFC 792 UIT-T Y.1540 UIT-T Y.1541
3	Data transfer failure ratio and Throughput of successful data transfer	The average throughput of successful data transfer over a communication channel (client/server measurement). o Download in failure ratio [%] = (Download in failure / number of tests) x 100 o Upload in failure ratio [%] = (Upload in failure / number of tests) x 100 o Download throughput in bps, kbps or mbps o Upload throughput in bps, kbps or mbps Extra measurements shall also be provided: i) The lowest (i.e. better) 5 % Download rate achieved (3) ii) The lowest (i.e. better) 5 % Upload rate achieved (4) iii) The highest (i.e. worst) 95% Download achieved (3) iv) The highest (i.e. worst) 95% Upload achieved (4)	Data transfer failure ratio (download): ≤ 10 % Data transfer failure ratio (Upload): ≤ 10 % Throughput: Highly dependent of access technology Shall be linked to a commercial offer: shall reach 85 % of the contractual throughput during	Throughput shall be computed (and are significant) for successful data transmission only. Tests are therefore only valuable if the data transmission in failure ratio is low enough Measurement will be made with the most common customer data access profile for each Licensee. The target server will be placed in the vicinity of the Licensee networks such that the throughput is not hampered by interconnection considerations. The protocol used for measuring the throughput shall be discussed and agreed with Licensees (HTTP recommended but may be FTP)

KPI No.	KPI Name	Related indicator definition	Target	Comment / Reference
			the peak period	References: ETSI ES 202 765-4 V1.1.1 (as example for FTP Upload/Download transfer rate)
4	Ratio of Packet Loss	The number of packets lost as a percentage of the total number of packets transmitted Packet loss ratio [%] = (Total number of packet lost / Total number of packet transmitted) x 100 (Refer to UIT-T Y.1540 and UIT-T Y.1541for definition, conditions and calculation)	1 / 1,000 (1)	Packet loss is impacting for real time data like VoIP/ToIP, video conferencing or gaming regarding end user perception of the quality of service. It is also impacting web browsing regarding delays/slowness. Tests are carried out with a remote test-server in the close vicinity of the Licensee networks or on a remote (foreign) location or both. Pack loss measurement in the Licensee network assesses the quality of the Licensee own network. Pack loss measurement outside the Licensee (remote server test case) assesses the quality of the service provided to the customers of the Licensee (not considered here). References: UIT-T Y1540 UIT-T Y1541

KPI No.	KPI Name	Related indicator definition	Target	Comment / Reference
5	Internet Accessibility	The probability for a customer that Internet applications are reachable from his Internet access. The Internet access will be considered as accessible if the two following criteria are met: o Successful DNS resolution o The IP address resolved by the DNS is reachable (using ping) Internet Accessibility [%] = (Total number of successful test/Total number of test) x 100	≥98 %	References: ETSI EG 202 009-2 V1.3.1
6	HTTP set-up failure ratio and HTTP set-up time	The HTTP set-up time is the period of time between the instant when the request of the web page is sent to the instant when the beginning of the web page is received. A connection will be considered as "established" when the HTTP handshake is successfully achieved. Therefore, the "Set-up" is the duration between the time the HTTP connection is initiated (Ti) and the time the HTTP connection is established (Te). The ratio of connections to web pages that failed to be established will also be recorded. Set-up time [s] = Te – Ti HTTP set-up failure ratio [%] = (Total number of unsuccessful setup test/Total number of setup test) x 100 Extra measurements shall also be provided:	HTTP set-up failure ratio: ≤ 2% HTTP set-up time: 95 % within 5 seconds	HTTP-Set-up can only be measured for "established" HTTP connection. This test is performed in the same time that the HTTP generic scenario availability test (see below) References: ITU-T E.MQoS (§7.3.8.2)

KPI No.	KPI Name	Related indicator definition	Target	Comment / Reference
		i) The lowest (i.e. better) 5 % Set-up time achieved (3) ii) The highest (i.e. worst) 95% Set-up time achieved (4)		
7	HTTP Completion failure ratio and HTTP Completion Time	The HTTP completion Time is the period of time starting from the instant when the connection to the web page is requested to the instant when the complete web page content is fully received. The ratio of web pages that failed to be successfully downloaded / completed is also recorded. T = period of time from the instant when the connection to the web page is requested to the instant when the complete web page content is fully received W = size of the web page in Mbytes Because all web pages do not have the same size it is necessary to scale the download period to the size of the downloaded page. HTTP completion Time [s] = T x 1/W HTTP completion failure ratio [%] = (Total number of successful completed downloaded page/Total number of requested pages) x 100 Extra measurements shall also be provided:	HTTP Completion failure ratio: ≤90% HTTP Completion Time: 95 % within 20 seconds	HTTP completion Time can only be measured for “established” HTTP connection. This test is performed in the same time that the HTTP generic scenario availability (see below)

KPI No.	KPI Name	Related indicator definition	Target	Comment / Reference
		i) The lowest (i.e. better) 5 % completed time achieved (3) ii) The highest (i.e. worst) 95% completed time achieved (4)		
8	HTTP generic scenario availability	The HTTP generic scenario availability assesses the probability that a subscriber can successfully browse the web during a defined duration. A connection will be considered as valid if: o Each web page is retrieved (downloaded) successfully within 30 seconds o It is possible to navigate on web sites for 5 minutes after the establishment of the connection HTTP generic scenario availability [%] = (Total number of valid tests / Total number of tests attempts) x 100	≥ 85 %	References: ETSI EG 202 009-2 V1.3.1