Final Report

National QoS QoE Framework in Greater Sepik Region

National Information & Communication Technology Authority of Papua New Guinea (NICTA)

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ABBREVIATIONS

ADSL – Asymmetric Digital Subscriber Line

CSFB – Circuit Switched Fall Back

CPE – Customer Premise Equipment

CSR – Cell Site Router

EU-STREIT – European Union Support to Rural Entrepreneurship, Investment and Trade in Papua New Guinea

ETSI- European Telecommunications Standards Institute

FAO - Food and Agriculture Organization of the United Nations

FTP – File Transfer Protocol

GPON – Gigabit Passive Optical Network

GSO – Geo-Stationary Orbit

HTTP – HyperText Transfer Protocol

ILO – International Labour Organisation

IMT – International Mobile Telecommunications

IP – Internet Protocol

ISND – Integrated Services Digital Network

ITU – International Telecommunication Union

IX – Internet Exchange

LTE – Long Term Evolution

MEF – Metro Ethernet Forum

MOS – Mean Opinion Score

NICTA – National Information and Communications Technology Authority ITU

OTT – Over-The-Top

PDP – Packet Data Protocol

PSTN – Public Switched Telephone Network

QoS – Quality of Service

QoE – Quality of Experience

RAT – Radio Access Technology

SDK – Software Development Kit

UE – User device

UNCDF – United Nations Capital Development Fund

UNDP – United Nations Development Programme

VoLTE – Voice over LTE

VoNR – Voice over New Radio

WCDMA – Wideband Code Division Multiple Access

ACKNOWLEDGEMENT

Support to Rural Entrepreneurship, Investment and Trade in Papua New Guinea (EU-STREIT PNG) programme is the largest grant-funded programme of the European Union in the country and in the Pacific sub-region. The programme was developed under the umbrella of 11th European Development Fund (2014-2020) and is being implemented as a United Nations joint programme including the Food and Agriculture Organisation of the United Nations (FAO), the International Labour Organization (ILO), the International Telecommunication Union (ITU), the United Nations Capital Development Fund (UNCDF) and the United Nations Development Programme (UNDP) in close collaboration with the Government and local partners.

As one of the implementing agencies, the International Telecommunication Union (ITU) is responsible for development of the telecommunications and ICT innovations and partnerships within Component 2 of the programme. National Information and Communications Technology Authority (NICTA) is a government agency responsible for the regulation and licensing of Information Communications Technology (ICT) in Papua New Guinea (PNG). NICTA has requested ITU assistance on developing a QoS/QoE framework of the quality-of-service exercise in the Greater Sepik Regionas a part of the European Union (EU) funded Support to Rural Entrepreneurship and Trade (STREIT) Programme.

Mr Farid Kasim, ITU Expert, has been tasked with the development of National QoS/QoE standards in the Sepiks while acknowledgements are due to the officer from NICTA, Regional Director of the ITU and EU STREIT Project Officer.

EXECUTIVE SUMMARY

As basic connectivity has been established in major parts of PNG, the concern on Quality of Service (QoS) and Quality of Experience (QoE) of the ICT networks has taken center stage as usage of the network has increased. Recently, the number of complaints has increased for ICT network users, which results in concern for the QoE of the services provided by the operators.

As of now, there is no formally adopted framework of QoS/QoE that can be used to evaluate the service providers. This lack of or inadequate parameters and measurements related to QoS/QoE is a challenge for NICTA to undertake a technical audit and assess the causes of problems and interruptions that are being faced by consumers of ICT services.

In this matter, ITU is assisting NICTA on developing and implementing relevant QoS/QoE policies and regulations in order to improve coverage, enhance service quality delivery and provide means of network quality assessments in the Sepiks.

The strategies is also aligned with the government approach set out by the national government's Digital Transformation Policy 2020. Amongst the outcomes of this consultation, that is expected to be deliver are as follows:

- Review existing standards and international best practices on key performance metrics, measurement and reporting process.
- Establish national framework of minimum technical parameters for QoS/QoE of ICT services with emphasis on customer centric Key Performance Indicators (KPI).
- Provide technical guidance for stakeholders to measure QoS/QoE.
- Develop detailed guidelines for fair and representative measurement of QoS/QoE parameters.
- Develop the reporting framework for QoS/QoE measurement in the region.

The development of QoS/QoE framework is the first steps towards positive contribution for the improvement of the quality of life for the people and national digital economic growth.

This report shall provide details of the QoS/QoE standards for multiple services including mobile telephony, mobile broadband, fixed telephony, fixed broadband and customer-related services. In addition, detailed guidelines on measurement methodologies, reporting and enforcement of the QoS/QoE standards are also part of this report.

1.0 INTRODUCTION

Internet are means of delivering and receiving information, connecting people, working, studying and leisure. To be able to enjoy these, the internet services regardless of wired or wireless, need to be at a minimum level, in-lined with the applications that consumers are using. In order to ensure that the minimum Quality or Service (QoS) and Quality of Experience (QoE) of the ICT networks are accessible and reliable, the regulator and service providers have to work together and strive for better network performance. This includes service coverage and quality.

The number of increasing complaints received by NICTA is a result of low quality of network performance provided. At the moment, there is no formally adopted framework on QoS/QoE that can be used to evaluate the network performance. Hence, the need to have QoS/QoE framework in place is crucial.

There are several different methods of ensuring QoS delivered and QoS received are on par, depending on the situation of a country. One common way is by having national network performance benchmarking. The first step in benchmarking network performance is to establish a good ground of QoS standards. The regulators and service providers would be able to refer to a common reference for QoS/QoE parameters and perform a standardized measurement exercises. Undertaking technical audits in assessing causes of problematic areas and interruptions that are faced by the consumer will be more efficient.

2.0 SCOPE OF WORK

The objective of the consultation work by the expert is mainly to assist NICTA in PNG in developing a national framework for QoS/QoE. Under the guidance of ITU Regional Officer for Asia and the Pacific Region, in coordination with EU STREIT Officer and inputs from NICTA, the scope of work for ITU expert in this project are as follows:

1. Study the ICT/Telecommunications laws, regulations and other relevant government decrees and issuances.
2. Review existing standards and international best practices on key performance metrics, measurement and reporting process for the ICT Network Service providers.
3. Establish national framework of minimum technical parameter for QoS/QoE of ICT services with emphasis on customer centric Key Performance Indicators, conducting and reporting prepare consultation on implementing the drive test such as:
    i. Coverage

ii. Internet Access

iii. Internet Speeds Tests

iv. Data throughput.

4. Assist NICTA within the ongoing arrangement of the Technical Assistance for the implementation of QoS/QoE regulatory framework and support to produce a detailed plan to encompass implementation and monitoring of the current framework.

5. Provide technical guidance for stakeholders to measure Quality of Service / Quality of Experience (QoE) group.

6. Draw up detailed guidelines for fair and representative measurement of QoS/QoE parameters for each of the four services covered by the proposed rules which are (a) mobile telephony, (b) mobile broadband, (c) fixed telephony and (d) fixed broadband;

7. Develop the reporting framework for QoS/QoE measurements in the Sepiks

8. Develop the technical plan for QoS/QoE measurements guidelines based on international examples and ITU study groups including amongst other the work of SG12 of ITU-T in particular ITU-T Recommendation: Strategies to establish quality regulatory frameworks, https://www.itu.int/rec/T-REC-E.805).

9. Prepare materials to conduct a national stakeholder workshop on the suggested QoS/QoE framework.

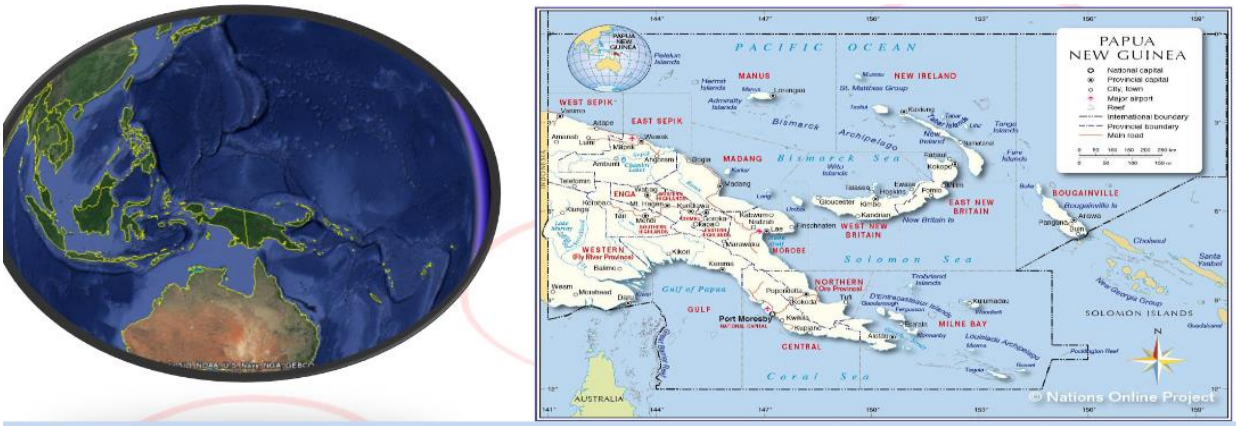
10. Prepare final report with findings, recommendations reference and workshop materials and attaching the proposed updated template of reporting.

The following subsections will discuss in details on all the items listed above and submitted to ITU and NICTA representatives once the project has been completed including this final report.

3.0 STATE OF ICT IN PNG

Before going into the strategies in developing the national standards for PNG, the current state of ICT progress and infrastructure readiness will need to be established. Infrastructure readiness includes amongst others, geographical conditions, service penetration rate, population coverage, spectrum allocations, number of service providers or operators, network technologies and spectrum holders.

Figure 3.1: State of ICT industry in PNG (2019)



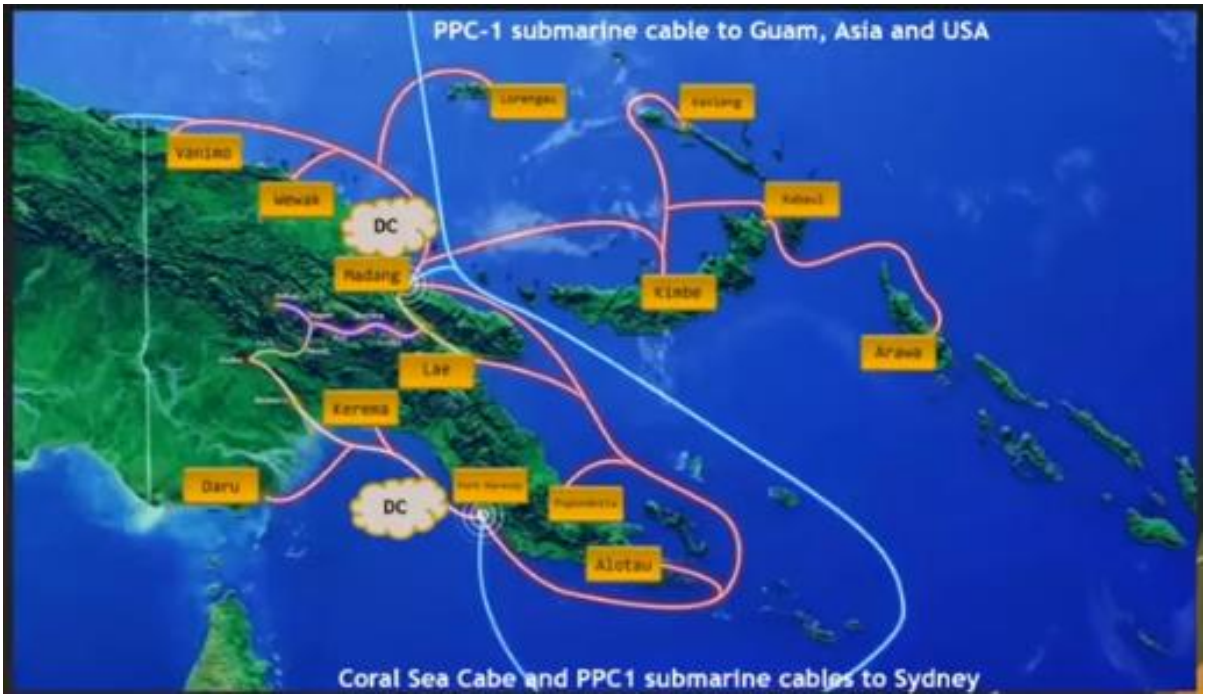
- Land Mass - 462 840 sq km
- Population - 8 million (Appro)—87% live in rural villages and remote areas.
- Geography - Rugged terrain with high mountain ranges and very steep and deep valleys and over 600 associated islands.

Source: NICTA

Based on the information gathered, the state of ICT industry in PNG is depicted in Figure 3.1 above. Population in PNG was at 8 million in 2019 and now in 2021 moving just over 9 million with mostly living in rural villages and remote areas. The geographical areas are filled with high mountain ranges, valleys and over 600 islands, which makes it a challenging landscape for network penetration. With this geographical landscape, highly likely that most areas are connected via microwave and satellite in remote places.

With the majority of population living in remote areas, the use of low spectrum band will be very beneficial where it can cover wider coverage areas and better indoor penetrations. The number of population has the potential to create sufficient demand for the network service provided.

Figure 3.2: Submarine cable connection in PNG



Source: DataCo

Based on information from DataCo Ltd, the state owned wholesale fiber provider in PNG, there are more than 7000 km of fiber connecting different regions of PNG and the major islands. There are 16 Point of Presence (PoP) around the countries with 14 cable-landing stations and 5 international PoPs. It is a good ICT backbone infrastructure needed for the improvement of service quality to cover all 22 regions in PNG.

Table 3.1: Population coverage for mobile services 2020

Mobile Technology	**Population Coverage**	
	2020	**Percentage**
2G (Voice service + very slow internet)	**90%**	
3G (Voice + fast internet)	**69%**	
4G (Voice + very fast internet)	**36%**	

Source: NICTA

Table 3.1 above shows the population coverage for PNG as of 2020. The coverage for 2G is very good and 3G is picking up fast. However, the 4G or LTE network still has a lot of ground to cover. Although this number may have gone up by 2022, there are still a lot of improvement needed in

terms of coverage in order to provide better service quality because 4G will be able to provide higher speed, lower network latency, more robust and less prone to interference.

Table 3.2: Spectrum Allocation for mobile service in PNG

Frequency band (MHz)	Frequency Block (MHz)		Operator	Technology	Total DL bandwidth (MHz)
	Uplink	Downlink			
703 – 748 / 758 – 803	703 – 718	758 – 773	Digitec	LTE	15
	718-733	773-788	Digicel PNG	LTE	15
	733 - 748	788 - 803	Telikom PNG	LTE	15
806 – 834 / 851 – 879	806 - 824	851- 869	Under re-farming		18
	824 - 835	869 -880	Telikom PNG	WCDMA	11
880 – 915 / 925 – 960	880 – 899	925 – 944	Digicel PNG	GSM WCDMA	19
	899 – 915	944 – 960	Bmobile	LTE	16
1710 – 1785 / 1805 –1880	1710 – 1740	1805 – 1835	Digicel PNG	LTE	30
	1740 - 1760	1835 -1855	Under Allocation	LTE	20
	1760 - 1785	1855 - 1880	Telikom PNG	LTE	25
1920-1980 / 2110-2170	1920-1940	2110-2130	Under Allocation	WCDMA	20
	1940-1950	2130-2140	Bmobile	WCDMA	10
	1960-1980	2150-2170	Digitec	WCDMA	20

Source: NICTA

Looking at the allocation of spectrum for mobile service, most of the lower frequency bands for IMT network has been allocated including the newly 700 MHz LTE network that would be essential in providing mobile broadband at rural areas.

Currently, there are 3 mobile operators that is Telikom PNG, Digicel PNG and Bmobile. Digitec is the new mobile player and has been allocated both coverage capacity bands (700 MHz and 2100 MHz). The allocation of spectrum able to provide opportunity for new entrance. In this case, Digitec. The number of mobile players in the market seems to be just right, considering the potential demand that is available in PNG. The penetration rate for mobile in 2019 was at 39%.

As for fixed service, there is only 1 single service provider, which is Telikom PNG who is providing both fixed and mobile services. The penetration rate for fixed broadband is quite low at 1.5% in 2019.

In view of the ICT scenario in PNG, QoS/QoE standards parameter and measurement method need to take into account all limitation and challenges.

4.0 STRATEGIES IN ESTABLISHING QUALITY REGULATORY FRAMEWORK

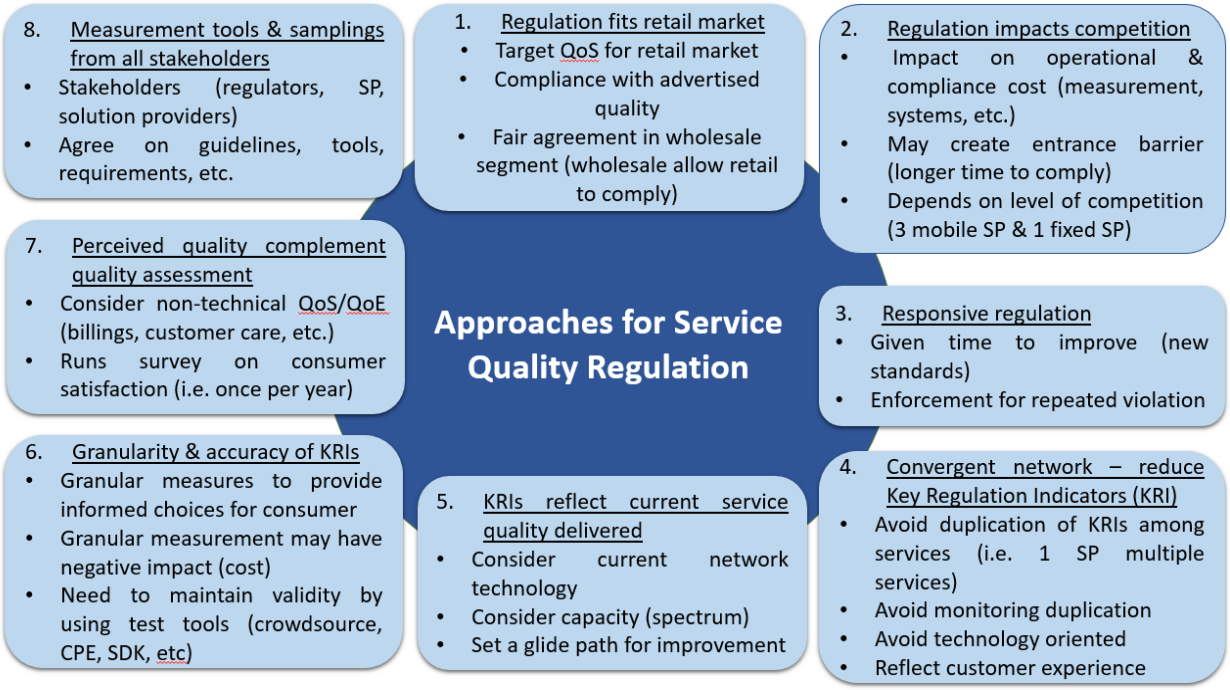
The process of developing the QoS/QoE framework has been conducted by referencing to Recommendation ITU-T E.805, "Strategies to establish quality regulatory frameworks". This recommendation provides guidance to regulators aiming to establish national or regional regulatory frameworks to monitor and measure quality of service (QoS) and quality of experience (QoE).

There are 3 main strategies in developing national QoS/QoE framework covered by the recommendation which are:

i. high level quality regulatory approaches;
ii. enforcement strategies; and
iii. strategies to raise consumer awareness.

Approaches for Service Quality Regulation

Figure 4.1: Approaches for Service Quality Regulation



Source: ITU-T E.805

There are eight approaches that should be taken into consideration by regulators when establishing or revising national service quality regulatory framework. The first is that service quality regulation must be better fits for retail markets. The information provided by the operator marketing strategies is what the consumers are expecting and will determine their operator of choice. Therefore, compliance with advertised quality conditions is important and in order to make sure that it is being practiced by the operators, the service quality standards need to target retail market. Wholesale part of the network is equally important, but market failure in not common because most of the time, both side of the wholesale provider and the access seeker will have a service level agreement (SLA) in place to guarantee the performance of the network provided. Transparency and fair agreement to the wholesale segment is needed in order for the retail segment to achieve the QoS advertised.

Secondly, the service quality regulation will influence competition in the market. The main impacts of service quality regulatory to the operators are operational impact such as measurement operational cost, system cost, etc. and compliance cost which is the network upgrades cost, penalties, etc. In the case where competition is low, regulator should take precautionary measures in establishing regulatory framework that would not hinder new entrance to the market. At the moment, there are 1 fixed service providers and 3 mobile operators with an additional mobile operators coming up. Therefore, regulators should consider longer timeframe or exempting (either wholly or partially) for the new player to comply with the standards.

The third strategy is for regulators to adopt responsive regulation for effective enforcement. Differing enforcement strategies will help to improve operators' compliance and cooperation with regulators. Operators who repeatedly did not comply with the standards to be closely monitored and penalized. For operators with low non-compliance cases or first-time violations, regulators should start with warnings and improvement plans. In the case of PNG, since the service quality regulation will only be established now, regulator should provide some time for the operators to adopt and make necessary preparations concerning operational costs, procurement of measurement systems and reporting mechanism.

Convergent of networks and services also need to be considered in determining the number of Key Regulatory Indicators (KRI). Regulatory framework need to adapt to the scenario where access network, transport networks, customer service platforms and billing systems for different services are all merged together. For instance, mobile telephony and mobile broadband users are using the same network either 2G, 3G or LTE, using the same access device and receiving a single bill by end of the month. In some cases, a single operator is providing both mobile and fixed broadband services with a combined internet package. Therefore, when developing KRIs for service quality framework, regulators have to avoid duplication of KRIs amongst services, avoid monitoring duplications, avoid technology oriented and focus on customer-related KRIs, which reflect customer experience, especially for the non-technical part of the QoS.

Networks technology is evolving rapidly. Countries are adopting to these changes in different pace. Regulators are recommended to consider the actual capability of the network in order to define the appropriate KRIs. Network capacity can be the amount of spectrum allocated, the number of fiber for IP backbone available, the number of potential demands and other limitations, which can be unique to a specific country.

One of the key approach of establishing service quality regulatory framework is the granularity and accuracy of the KRIs. This is important for consumers to make informed decision based on the performance of the network that can be achieved by having an accurate measurement of the network performance and detail enough for the consumer to be able to make sense of it. However, bear in mind that too granular results may transform into a negative impact and may increase operational cost. Furthermore, on-field measurement tools and reports need to be statistically valid and referring to a common methodology.

Sometimes, satisfactory results in technical KRIs may not reflect hundred percent the quality perception of consumers. For this reason, the non-technical KRIs is also important. A combination of good network performance and user-related KRIs ensure overall consumer satisfaction. On top of these KRIs, regulators are recommended to run user satisfaction surveys periodically to gauge overall user experience to complement service quality assessments.

Lastly, the important approach in service quality regulatory is the measurement tools and sampling plans. In order to efficiently measure the service quality, inputs should be gathered from the relevant stakeholders which involve regulators, service providers and measurement system providers. This would enable regulators to establish detailed operational guidelines, measurement tools, data sampling, database, reporting and other requirements.

Enforcement Strategies

Different enforcement strategies have been adopted by different part of the world. Enforcement strategies depends on various context such as economic aspect, legal certainty, culture, level of completion and consumer awareness, of a specific country.

The strategy behind enforcing a regulatory framework is compel operators to deliver better service quality to consumers. This process can be relying on applying penalties or providing improvement through dialogue between regulators and operators. Either way, the principle of enforcement strategies is to solve issues harming the consumers.

Enforcement strategies is highly depending on 2 markets scenario.

Figure 4.2: Enforcement strategies and market competition

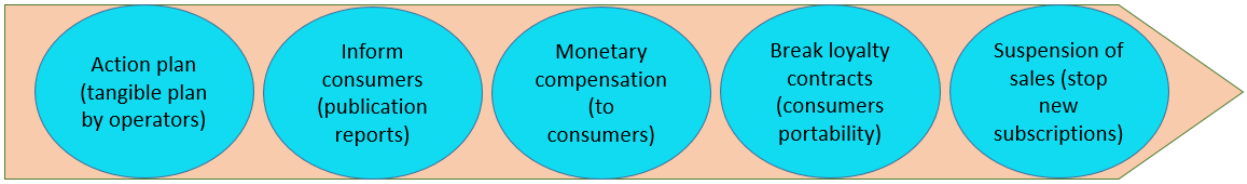
Source: ITU-T E.805

In greater market competition amongst service providers, regulators may adopt less quality control. In these type of telecommunication markets, service quality differs for service providers, and consumer may be able to choose between quality of service and price of service, which is commonly a trade off in the high market competition. However, it should be noted that lesser regulatory measures must not allow any abusive practice by the service providers to protect the consumer.

In contrast, low market competition such as PNG, would require more regulatory intervention and in most cases, the regulators have to establish a minimum quality parameters required to be adhere to by the service providers. On top of that, regulators and service providers have to conduct measurement and data samplings to ensure that service providers are meeting the required standards. Nevertheless, these minimum requirements should not create substantial impact to the economic attractiveness for new entrance into the market.

There are non-exhaustive enforcement responsive measures that could be taken based on the effectiveness in improving service quality in a specific region, following non-compliance to the standards. It ranges from operators providing concrete and tangible action plan to improve network performance and publication of reports for consumers' information. If minimum network performance unable to be met after network upgrades, monetary compensation to the consumers may be applicable. Failure which, would enable consumers to break loyalty contract to port out to other service providers. Furthermore, the sales for new subscription within a specific region or area may be suspended. If operators refuses or fails to adopt to responsive enforcement measures or fail to comply with the minimum KRI, penalties should be applied.

Figure 4.3: Responsive enforcement measures

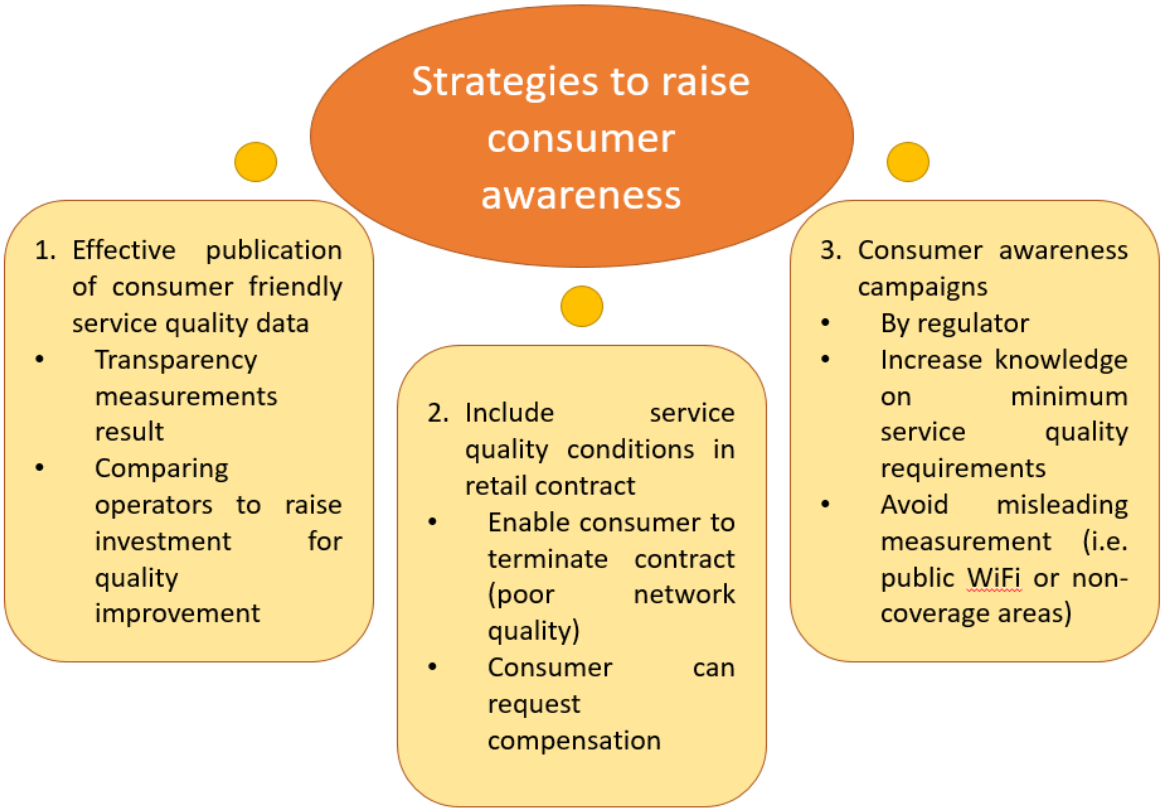


Source: ITU-T E.805

Strategies to Raise Consumer Awareness

Measurements and reports provided by the service quality regulatory framework provides valuable information for the consumers and could support them in choosing the best service providers.

Figure 4.4: Strategies to raise consumer awareness



Source: ITU-T E.805

One of the strategies to raise consumer awareness is to have an effective publication of consumer friendly service quality results. The results would enable consumers to make sense of the network performance within their respective areas and help them to make better decisions. An effective service quality data are transparent to the consumers and meaningful. In addition, by comparing

service providers' network performances, will create a competitive environment where service providers will increase investment for quality improvement. Publication of service quality data should not be limited to the regulator's website, but in the service providers' websites, social media, press release, etc.

Regulators are also recommended to include service quality conditions in retail contracts. This will enable consumers to obtain compensation or request for contract termination with exemption of fees in case of poor service quality results.

Lastly, regulators will be able to raise consumer awareness by undertaking consumer awareness campaigns with the aim to increase their knowledge and clarify to the consumer the minimum service quality conditions that should be expected and contracted by the service providers. The awareness campaigns would also be able to prevent from misleading consumers with wrong information. For instance, measurement of service quality cannot be taken on public Wi-Fi networks or non-coverage areas.

5.0 QUALITY REGULATORY BENCHMARKING

In view that no QoS/QoE regulatory framework has been formally adopted in PNG to evaluate the service providers, one of the strategy in developing service quality regulatory framework is benchmarking other countries. Information on regulatory framework of countries in the Asia Pacific region are considered and compared. The countries are Malaysia, Brunei, Indonesia, Thailand and Viet Nam.

Malaysia

Malaysia has a combination of technical QoS standards and non-technical (user-related) QoS standards such as billings, network downtime, etc as shown in table 5.1 below. Note that user-related QoS standards are not bound by any specific services due to the convergent of the network. In Malaysia, the network performance measurements are being done by service providers and regulators.

Table 5.1: Malaysia QoS Regulatory Framework

QoS Parameters	Network	Standards
Call Setup Success Rate	2G, 3G & VoLTE	≥ 98%
Drop Call Rate	2G, 3G & VoLTE	≤ 2% (2021/22)
	2G, 3G & VoLTE	≤ 1% (from 2023)
Download throughput	Mobile	≥ 2.5Mbps, ≥ 90%

Latency (RTT)	Mobile	≤ 150ms, ≥ 90%
Packet loss	Mobile	≤ 0.5%
Download & Upload throughput	Fixed (fiber)	≥ 90% subscribed, ≥ 90%
	Fixed (DSL)	≥ 70% subscribed, ≥ 90%
Latency (RTT)	Fixed (fiber)	≤ 50ms, ≥ 95%
	Fixed (DSL)	≤ 85ms, ≥ 95%
Packet loss	Fixed (fiber)	≤ 0.5%
	Fixed (DSL)	≤ 1.0%
eNB utilization	LTE	≤ 80%
Links utilization	Mobile & fixed	≤ 80%
Billing complaints	All network	≤ 5% (quarterly)
Non-billing complaints	All network	≤ 5% (quarterly)
Billing complaints resolved	All network	≥ 70% (3 Business day)
		≥ 90% (10 Business day)
Non-billing complaints resolved	All network	≥ 70% (3 Business day)
		≥ 90% (10 Business day)
Call to customer hotline (human operator)	All network	≤ 30 sec (answered)
Service restoration	Fixed broadband All network	≥ 95% (≤ 24 hours)
		≥ 100% (≤ 48 hours)
Downtime notification	To customer	≥ 24 hrs (scheduled)
		≤ 90 mins (unscheduled)

Source: mcmc.gov.my

Brunei

Brunei at the moment is drafting new QoS regulations. The information shown in table 5.2 below reflects the existing regulatory standards for service quality that is enforced. Additionally, a QoE measurement on Mean Opinion Score (MOS) for speech quality is also conducted in Brunei.

Table 5.2: Brunei QoS Regulatory Framework

QoS Parameters	Network	Standards
Grade of Service (Network congestion – busy hour)	Public fixed line	≤ 1%
	Public cellular	≤ 2%
Network effectiveness ratio (Call Setup Success ratio)	Public fixed line	≥ 95%
	Public cellular	
Call Drop Rate (wireless networks)	Urban	≤ 2%
	Islands	≤ 3%
Service Coverage in populated areas (2G & 3G: ≥ -95 dBm) (Near-4G & 4G: ≥ -100 dBm)	Urban	≥ 80%
	Islands	≥ 60%
Speech quality (MOS)	Fixed & mobile	≥ 3
Call Setup Time	Fixed & mobile	< 7 seconds
Network availability (network outage per year)	Core network	≤ 1 day
	Local access	≤ 2 days
International bandwidth capacity	Busy hour	< 75 %
Contention ratio	Fixed broadband	< 10:1
Avg. download speed	Copper-based	≥ 80% subscribed
	Fiber-based	≥ 90% subscribed
	Wireless broadband	> 100 kbps, ≥ 80% test samples
Avg. upload speed	Copper-based	≥ 30% subscribed
	Fiber-based	≥ 30% subscribed
	Wireless broadband (3G)	> 10% of download speed
	Wireless broadband (4G)	> 30% of download speed
Latency (RTT)	Terrestrial broadband	< 50 ms
	Non-terrestrial	< 800 ms, 300 ms
Packet loss	All broadband access	< 1%

SMS failure ratio	All type of service	< 1%
Network restoration	Any single outage	≤ 2 hours

Source: aiti.gov.bn

Indonesia

Indonesia also adopting technical and user-related service quality standards as shown in table 5.3 and 5.4 below. Similar to Brunei, Indonesia perform measurement on MOS, based on ITU-T P.835. On top of packet delay and packet loss, the network jitter is also measured.

Table 5.3: Indonesia QoS Regulatory Framework (technical QoS parameters)

QoS Parameters	Network	Standards	Measurement
Voice call quality (MOS)	Fiber	≥ 4, ≥ 90%	ITU-T P.835
	Satellite	≥ 3, ≥ 90%	
Packet delay (national)	Fiber	≤ 50 ms, ≥ 90%	IP analyzer
	Satellite	≤ 300 ms, ≥ 90%	
Packet delay (international)	Fiber	≤ 150 ms, ≥ 90%	IP analyzer
	Satellite	≤ 400 ms, ≥ 90%	
Jitter	Fiber	≤ 5 ms, ≥ 90%	IP analyzer
	Satellite	≤ 10 ms, ≥ 90%	
Packet loss	Fiber	≤ 0.1 %, ≥ 90%	IP analyzer
	Satellite	≤ 2.0 %, ≥ 90%	

Source: kominfo.go.id

Table 5.4: Indonesia QoS Regulatory Framework (user-related QoS parameters)

QoS Parameters	Standards
% of complaints on billing accuracy in 1 month	≤ 5%
% of complaint resolution on billing accuracy within 15 days	≥ 90%
% of complaint resolution on billing accuracy within 30 days	≥ 95%

Source: kominfo.go.id

Thailand

Thailand is another country with implementing technical QoS and user-related QoS standards. In Thailand, the performance of mobile network is segregated in terms of technology, such as 2G, 3G and 4G. In addition, Thailand also measures the SMS and MMS delivery quality, as shown in table 5.5 below.

Table 5.5: Thailand QoS Regulatory Framework

QoS Parameters	Network	Standards
Success call ratio	Fixed line	≥ 90% (on-net)
	Fixed line	≥ 85% (off-net)
Success call ratio	Mobile	≥ 90% (time based)
Drop call ratio	Mobile	≤ 2% (8-9pm)
Speech quality (MOS)	Mobile	≥ 2.5
Latency (RTT)	Mobile	2G: ≤ 1s, 3G: ≤500ms, 4G: ≤150ms
FTP success ratio	Mobile	DL ≥ 80%, UL: ≥ 70%
FTP mean data rate	Mobile	4G: DL≥ 2.5Mbps, UL≥ 0.5Mbps 3G: DL≥ 750kbps, UL≥ 300kbps 2G: DL≥ 48kbps, UL≥ 20kbps
HTTP success ratio	Mobile	3G: ≥ 90%, 2G: ≥ 80%
SMS delivery	Mobile	≤ 90s
SMS completion ratio	Mobile	≥ 90%
MMS delivery	Mobile	≤ 5 minutes
MMS completion ratio	Mobile	≥ 80%
Initial connection time	Fixed line	≤ 10 days, >90%
Billing inaccuracy	Fixed line	≤ 1% (quarterly)
Customer service center response time	Fixed line	≤ 60 s
	Mobile	
# of faults reported (quarterly)	Fixed line	≤ 5 per 100 customers
Fault repair time	Fixed line	≤ 24 hours
Billing complaint	Mobile	≤ 0.3%

# outages (> 4 hours)	Mobile	≤ 15 (in 1 month)
% outages (> 24 hours)	Mobile	≤ 3% (in 1 month)
% outage (cumulative)	Mobile	≤ 1% (in 1 month)
Service activation	Mobile	90% (<3hrs) – Prepaid
		90% (<5hrs) - Postpaid

Source: ITU Workshop 2019

Viet Nam

Table 5.6 below depicts the service quality regulatory standards adopted by Viet Nam. Telephony measurements conducted by regulator on quarterly basis. For mobile-to-mobile call test, Viet Nam is using a 60s-180s call duration. File transmission test is using FTP from UE to a dedicated server. On top of this, Viet Nam is using Nemo CEM system for crowdsource QoE measurements.

Table 5.6: Viet Nam QoS Regulatory Framework

QoS Parameters	Network	Standards
Radio network availability	Mobile telephony	≥ 95%
Call Setup Success Ratio	Mobile telephony	≥ 95%
Call Cut-off ratio	Mobile telephony	≤ 2%
Speech quality	Mobile telephony	≥ 3 MOS, ≥ 90%
Radio Network availability	Internet service	≥ 95%
Service availability (PDP)	Internet service	≥ 90%
Service access time	Internet service	≤ 10sec
Session failure ratio	Internet service	≤ 10%
Minimum signal level	WCDMA	≥ -100dBm
	LTE	≥ -121dBm
Mean data rate	Internet service	≥ 95%, declared by SP
Charging accuracy	Mobile telephony	≤ 0.1% (quarterly)
Billing accuracy	Mobile telephony	≤ 0.1% (quarterly)

Source: APT, ASTAP Report 42

Different countries has different service quality standards requirements. Some are more stringent than others. This is because when regulators are developing service quality regulatory framework, one important strategy is to gauge the capabilities of owns country in terms of how advance the network technology, how well the infrastructure, how much spectrum has been allocated and so on. The common thing is most countries combine the technical (network performance) and non-technical (user-related) service quality regulatory standards.

6.0 NICTA KEY QUALITY REGULATORY STANDARDS

One of the deliverables of this project is to develop the Quality of Service Rule for PNG. Prior to the consultation project, NICTA has conducted initial work in drafting QoS/QoE standards, the 'Telecommunications Quality of Service Rule'. The draft QoS/QoE standards covers mobile telephony, mobile broadband, fixed telephony and fixed broadband services. Each of these services contains network performance and user-related QoS/QoE standards as shown in table 6.1, 6.2, 6.3 and 6.4 below.

Mobile Telephony:

Table 6.1: Draft mobile Telephony QoS/QoE standards

Column 1	**Column 2**	**Column 3**	**Column 4**
Criterion	**Parameter**	**Definition of parameter**	**Measurement method**
Availability	Telephony service non-accessibility	ITU-T E.804 (02/2014) cl.7.3.6.1	ITU-T E.804 (02/2014)
Call Setup time	Telephony set up time [s]	ITU-T E.804 (02/2014) cl.7.3.6.2	ITU-T E.804 (02/2014)
Reliability	Telephony cut-off call ratio [%]	ITU-T E.804 (02/2014) cl.7.3.6.5	ITU-T E.804 (02/2014)
Accuracy	Bill Correctness complaints (%)	ETSI ES 202 057-1 cl.5.11	ETSI ES 202 057-1
Reliability	Accessibility of the complaint management desk (%)	ETSI EG 202 843 cl.5.6.4	ETSI EG 202 843

Mobile Broadband:

Table 6.2: Draft mobile Broadband QoS/QoE standards

Column 1	Column 2	Column 3	Column 4
Criterion	**Parameter**	**Definition of parameter**	**Measurement method**
Availability	HTTP Service non-accessibility [%]	ITU-T E.804 (02/2014) cl.7.3.8.1	ITU-T E.804 (02/2014)
Speed	HTTP mean data rate [kbit/s]	ITU-T E.804 (02/2014) cl.7.3.8.7	ITU-T E.804 (02/2014)
	FTP {download | upload} mean data rate [kbit/s]	ITU-T E.804 (02/2014) cl.7.3.1.7	ITU-T E.804 (02/2014)
Latency	Ping round trip time	ITU-T E.804 (02/2014) cl.7.3.3	ITU-T E.804 (02/2014)
Reliability	HTTP IP-service access failure ratio [%]	ITU-T E.804 (02/2014) cl.7.3.8.3	ITU-T E.804 (02/2014)
	FTP {download | upload} data transfer cut-off ratio [%]	ITU-T E.804 (02/2014) cl.7.3.1.8	ITU-T E.804 (02/2014)
Accuracy	Bill Correctness complaints (%)	ETSI ES 202 057-1 cl.5.11	ETSI ES 202 057-1
Reliability	Accessibility of the complaint management desk (%)	ETSI EG 202 843 cl.5.6.4	ETSI EG 202 843

Fixed Telephony:

Table 6.3: Draft fixed telephony QoS/QoE standards

Column 1	Column 2	Column 3	Column 4
Criterion	**Parameter**	**Definition of parameter**	**Measurement method**
Speed	Call set up time (Successful calls only)	ETSI EG 202 057-2 Cl.5.2	ETSI EG 202 057-2
Reliability	Unsuccessful call rate %	ETSI EG 202 057-2 Cl.5.1	ETSI EG 202 057-2
Accuracy	Bill Correctness complaints (%)	ETSI ES 202 057-1 cl.5.11	ETSI ES 202 057-1
Reliability	Accessibility of the complaint management desk (%)	ETSI EG 202 843 cl.5.6.4	ETSI EG 202 843

Fixed Broadband

Table 6.4: Draft fixed broadband QoS/QoE standards

Column 1	Column 2	Column 3	Column 4
Criterion	**Parameter**	**Definition of parameter**	**Measurement method**
Availability	Availability of internet access	ETSI ES 202 765-4 cl.6.1	ETSI ES 202 765-4
Speed	Data transmission speed achieved	• ETSI EG 202 057-4 cl.5.2 • ETSI ES 202 765-4 cl.6.10	• ETSI EG 202 057-4 • ETSI ES 202 765-4
	Web page download Speed	• ETSI EG 202 057-4 cl.5.2 • ITU-T Rec.G.1010 (11/2001) Table I.2	• ETSI EG 202 057-4 • ITU-T Rec.G.1010 (11/2001)
Latency	IP packet transfer delay	ITU-T Y.1540 (07/2016) cl.6.2	ITU-T Y.1540 (07/2016)
Reliability	IP packet loss ratio (IPLR)	• ITU-T Y.1540 (07/2016) cl.6.4 • ITU-T Y.1541 (12/2011), cl.8.2.2 • ETSI EG 202 765-3 (2009-12), cl. 4.4	• ITU-T Y.1540 (07/2016) • ITU-T Y.1541 (12/2011) • ETSI EG 202 765-3 (2009-12)
Accuracy	Bill Correctness complaints (%)	ETSI ES 202 057-1 cl.5.11	ETSI ES 202 057-1
Reliability	Accessibility of the complaint management desk (%)	ETSI EG 202 843 cl.5.6.4	ETSI EG 202 843

In addition to the draft QoS/QoE standards, reference is also made to the 'Standard and Special Conditions of Individual Licenses Rule, 2011'. This instrument specifies the operating conditions for Applications Licensees in PNG and act as regulatory instrument in governing telecommunication services in PNG, under the National Information and Communication Technology Act 2009 ('NICT Act 2009'). The license conditions amongst others, listed the following obligations by Public Cellular Mobile providers:

i. Mandatory coverage obligation
ii. Minimum level of Network Performance:
    a. Call Drop Rate: ≤ 2%;
    b. Call Failure Rate: ≤ 2%;
    c. Network Availability: ≤ 99.99% in main centres and mid-sized centres;
    d. Network Availability: ≤ 98.00% in administrative district centres and localities.

iii. Network Fault Repair:
   a. 95% network fault repair within 6 hours in main centres;
   b. 95% network fault repair within 24 hours in mid-sized centres;
   c. 95% network fault repair within 2 working days in administrative district centres;
   d. 95% network fault repair within 3 working days in small population centres.

The draft QoS/QoE standards and license conditions mentioned above is used as a baseline in establishing the service quality regulatory framework for PNG. The following sections will discussed on the proposals for QoS/QoE standards, parameters and measurement methodologies.

7.0 USER-RELATED QUALITY STANDARDS

User-related QoS parameters (i.e. billing accuracy & accessibility of complaint management desk) is the non-technical QoS criteria that is equally important to determine the complete level of user satisfaction or user experience.

Based on the benchmarks of other countries, the user-related QoS/QoE parameters are combined for all of the different services. For PNG all user-related QoS/QoE parameters from mobile telephony, mobile broadband, fixed telephony & fixed broadband services are to be merged into a single service quality schedule base on the following:

- Convergent of network technology and services: Telephony & broadband from the same subscription (i.e. mobile telephony or voice call can be initiated in 2G, 3G or using VoLTE network).
- Single operator may introduce a combine package of fixed and mobile broadband for the same subscriber (i.e. Telikom PNG both provide fixed and mobile services).
- Avoid duplication of enforcement action or penalties from the same set of users with complaints for voice and broadband services.
- Avoid technology-centric measurement.
- Single and streamlined reporting.

On top of billing accuracy and access to helpdesk, the ‘network fault repair time’ should also be included as part of the user-related QoS/QoE standards. ‘Network fault repair time’ will be measure based on the type of network, from access network to transport network, all the way to the core network. Hence, the ‘network fault repair time’ will be applicable for each services.

The applicable areas for ‘network fault repair time’ will be aligned to the license conditions as follows:

- Areas of 'network fault repair time' is in accordance to **Schedule 7, 8, 9 and 10** of the 'Standard and Special Conditions of Individual Licenses Rule 2011'.
- Any other areas not specified in the abovementioned schedules is included as well.

Although the network fault repair time is already in the license conditions, by having it in the QoS/QoE standards will provide NICTA with proper reporting and measurement. The user-related QoS/QoE parameters are shown in table 7.1 below:

Table 7.1: User-related QoS parameters

QoS Parameter	Parameters description	QoS requirements	Measurement method	Formula
Bill correctness complaints (%) (ETSI ES 202 057 -1 cl.5.11)	Inaccuracy in data or call usage Incorrect charges or calculation	**≤ 5%** of billing inaccuracy complaints per half year	Report by service providers	X = (number of billing errors / number of subscribers) x 100%
Accessibility of the complaint management desk (%) (ETSI EG 202 843 cl.5.6.4)	ratio of the number of successful attempts to the total number of attempts to reach this support line	**≥ 90%** of the call to customer support line (operated by human) must be answered within 60 seconds per half year	Report by service providers	X = (number call > 60s to helpline / number of call to helpline) x 100%
Network fault repair for mobile telephony, fixed telephony, mobile broadband and fixed broadband	Percentage of network fault repair for all networks in areas specified in Schedule 7, 8, 9 and 10 of Standard and Special Conditions of Individual Licenses Rule 2011	**95%** network fault repair within **6 hours in main centres** **95%** network fault repair within **24 hours in mid-sized centres** **95%** network fault repair within **2 working days in administrative district centres**	Report by service providers	X = (number of site or network down / number of site or network in a specified areas) x 100%

		95% network fault repair within **3 working days in small population centres** **95%** network fault repair within **5 days in all other areas not specified in schedule 7, 8, 9 or 10**		

Additional requirements

NICTA also suggested to include the minimum benchmarking of Over-The-Top (OTT) service. The OTT QoS parameters may need to be included as these services are becoming common for users especially in main towns, i.e. live streaming service through social media platforms, voice/video calling, instant messaging, etc.

In respond to the request, user-related QoS covers the services that is provided by the operators, which are non-technical part of QoS. The OTT services/applications are part of overall IP network services. Therefore, all IP based requirements is covered under Mobile Broadband Service. With a minimum of 2.5Mbps download throughput, OTT services can be used for instant messaging, video streaming, IP calls and many more with good experience.

In addition, OTT is not within the control of mobile or fixed service providers in terms of quality of the service, which mainly depends on capacity and location of servers. Therefore, it is proposed that OTT services are not part of the QoS/QoE regulations.

8.0 MOBILE TELEPHONY QUALITY STANDARDS

With the merging of user-related QoS parameters into a single schedule, there are 3 parameters left for mobile telephony which are:

- Telephony service non-accessibility.
- Telephony set up time [s].
- Telephony cut-off call ratio [%].

8.1 Mobile Telephony QoS Standards:

Table 8.1 below depicts the service quality standards proposal for mobile telephony.

Table 8.1: Mobile telephony QoS parameters

QoS Parameter	Parameters description	QoS requirements	Measurement method	Formula
Telephony service non-accessibility (ITU-T E.804_cl.7.3.6.1)	Ratio of number of unsuccessful call attempt to the number of call attempted	Call Failure Rate must be **≤2%** (NICTA license condition) - Applicable for both intra and inter network calls	Drive/static test using test tools	X = (number of unsuccessful call / number of call attempts) x 100%
Telephony set up time	Time period between sending of complete address information and receipt of the call set-up	Set up time is proposed to be part of the call window under measurement methods (call initiation). In the case where service providers is unable to meet call set up time, it will results in call failure.		
Telephony cut-off call ratio (ITU-T E.804_cl.7.3.6.5)	Ratio of number of unintentional call cut-off to the number of call successfully established	Call Drop Rate must be **≤2%** (NICTA license condition) - Applicable for both intra and inter network calls	Drive test/static using test tools	X = (number of call drop / number of successful call) x 100%

The 'Telephony set up time' parameter is proposed not to be included as part of the QoS standards for mobile telephony because this parameters will contribute directly to the Call Failure Rate (as specified in table 8.1). Part of the strategy in establishing service quality regulatory framework is to avoid duplication of enforcements criteria.

Additional Parameters:

In addition to the above QoS parameters, NICTA has suggested to include several QoE parameters for mobile telephony service. These additional parameters was suggested for benchmarking of mobile voice services due to complaints from the public in terms of voice quality and SMS drop with service providers. Therefore benchmarking such parameters can assist NICTA in monitoring and improving on voice service. The parameters suggested are as follows:

i. SMS delivery time;
ii. Coverage signal level;
iii. Handover success rate; and
iv. Connection speech quality (MOS).

Based on the input from NICTA, the abovementioned QoS and QoE parameters were studied and further developed. However, the "Handover Success Rate" parameter is already part of the measurement for "Call Failure Rate" and "Call Dropped Rate". Any handover failure will be reflected in call fail or call dropped. Therefore, it is proposed not to be included as part of the service quality parameters.

The SMS delivery time is proposed to be conducted through network statistics reported by the service providers, similar to what AITI of Brunei. The speech quality is proposed to be conducted through drive test or static test, based on Mean Opinion Score (MOS) using perceptual objective listening quality prediction, describes in Recommendation ITU-T P.863. These parameters are shown in table 8.2 below:

Table 8.2: Additional mobile telephony QoS/QoE parameters

QoS Parameter	Parameters description	QoS requirements	Measurement method	Formula
SMS delivery time	Mean time for SMS delivery	SMS delivery must be completed within 90s for more than 95%	Network statistics reported by operator	X = (number of SMS completed ≤ 90s / total SMS sent) x 100%
Minimum received signal level (coverage)	Average received signal measured by mobile device (GSM, WCDMA and LTE)	Average received signal level (RSRP) must be not less than **-110dBm** for LTE, for at least **80%** of the sample Average received signal level (RSCP) must be not less than **-100dBm** for WCDMA, for at least **80%** of the sample Average received signal level (RxLev) must be not less than **-100dBm** for GSM, for at least **80%** of the sample	Drive test or static test using test tools (Recorded based on drive test or static test measurement samples)	X = (LTE received signal ≥ -110dBm / No. of test sample) x 100% X = (WCDMA received signal ≥ -100dBm / No. of test sample) x 100% X = (GSM received signal ≥ -100dBm / No. of test sample) x 100%

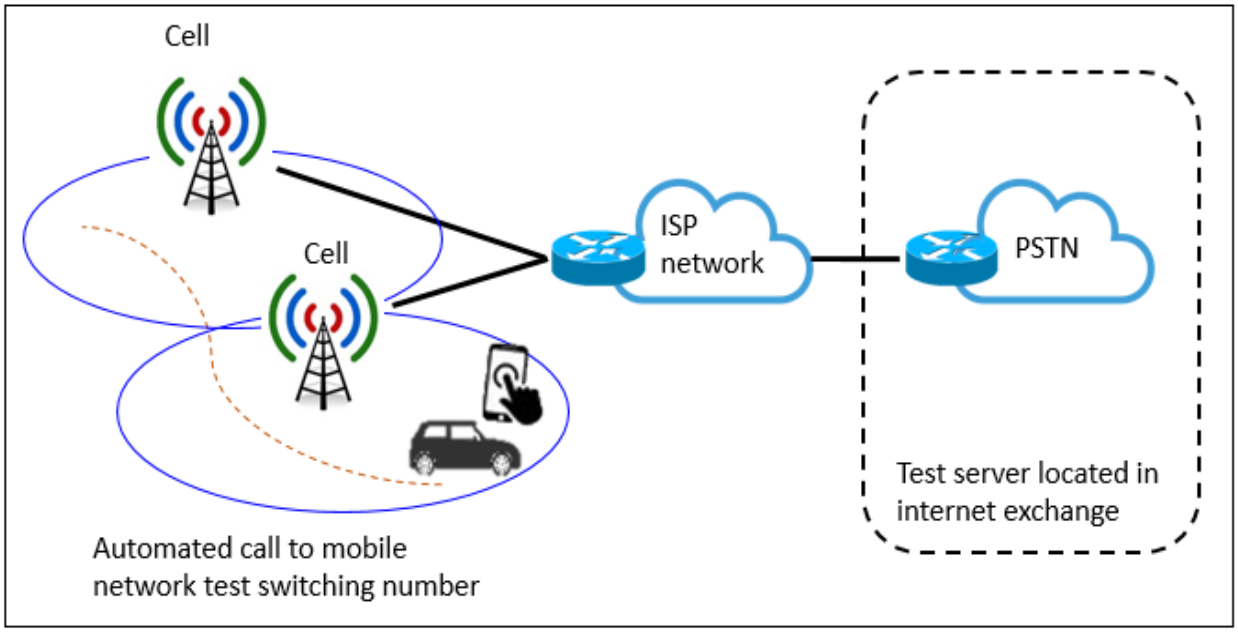
Call speech quality (MOS) ITU-T P.863	Percentage of connections with good voice quality	Average MOS for voice calls must be more than 3, for not less than 95% of call samples	Drive test or static test using test tools	X = Calls with MOS ≥ 3.0 / total number of calls) x 100%

Even though the minimum received signal level (coverage) parameter for mobile telephony is included in the draft QoS rules, it will be very difficult to manage the operational part of the work. For mobile broadband, the measurement is conducted by static test, therefore, it is easier to ascertain whether the measurement is within coverage of mobile operators. However, for mobile telephony, the method of measurement is through a drive test. In the case where coverage is spotty or not continuous, it will be hard to separate the test samples within coverage and test samples for out of coverage areas. The measurement system will calculate all the samples in a drive test and in order to verify, users will have to manually separate the areas of interest (within coverage). Therefore, implementation of this parameter may not be feasible to be implemented for drive test because it will be difficult to verify and enforce.

8.2 Mobile Telephony QoS Measurement Methodologies:

The method of measurement for mobile telephony service is drive testing, as illustrated in figure 8.1 below.

Figure 8.1: Mobile telephony measurement methodology



- Measurement is conducted using test phones installed with QoS measurement software.
- The point of measurement is from any location within coverage of service provider to a PSTN switching terminating number, provided by the service provider.
- The test will measure mobile originated calls only. In order to perform speech quality measurement, two test phones is needed to measure a single service provider (1 phone for calling and the other for receiving).
- In terms of test call window, there is 2 options recommended by ITU-T E.804 as shown in table 8.2 below.

Table 8.2: ITU-T E.804 test call duration options

Option 1		Option 2	
Call set up	: 10 s	Call set up	: 30 s
Typical call duration	: 120 s	Typical call duration	: 120 s
Call time out	: 30 s	Call time out	: 30 s
Total	: 160 s	Total	: 180 s

Source: ITU-T E.804

- The difference between the 2 options is the call set up time, from 10s for option 1 to 30s for option 2. The 2nd option provides more call setup time for a cell handover in the case of Circuit Switched Fall Back (CSFB) where handover occurs during call setup from a Radio Access Technology (RAT) to a different RAT.
- Based on the above, the proposed test call window is as follows:
    - Total test call window = 170s
    - Call setup time = 20s
    - Call holding time = 120s
    - Interval time = 30s

The call set up time is chosen to be 20s. This is in between the values recommended in ITU-T E.804. The call set up time is also chosen based on typical consumer behavior and expectation. Most people may not want to wait 30s for a call to be connected. Therefore, striking the right balance is the key. In real network situation, CSFB from VoLTE to 3G or VoLTE to 2G should not take more than 20s if the signal quality and coverage level is good during handover.

8.3 Mobile Telephony QoS Guidelines:

In order to provide more clarifications for mobile telephone measurements standards and methodology, below are a set of additional guidelines that act as reference to the regulator and service providers:

a. Mobile operators need to make available publicly, a coverage service map for consumers' reference and act as reference for regulator (NICTA) to assess the coverage areas.
b. Mobile telephony measurement shall be conducted by way of drive test or static test.
c. The measurement system shall be able to record and analyze call events with GPS location, etc.
d. Test phones of the measurement system shall comply with relevant ETSI and 3GPP standards.
e. The measurement shall be conducted in areas where coverage is ascertain from the coverage prediction map published by the mobile operators for the consumers.
f. Measurement is performs on mobile originated calls only.
g. Measurement shall include 2G, 3G and VoLTE calls or any other future voice service technology (i.e. VoNR).
h. Measurement shall be conducted by operators or representatives of the operators. Regulators or third party authorized by the regulator may perform measurement where and when necessary.
i. Minimum measurement samplings shall be at least 100 call samples per region.

9.0 MOBILE BROADBAND QUALITY STANDARDS

Based on NICTA's draft QoS/QoE rules, there are six parameters that are available to be measured as follows:

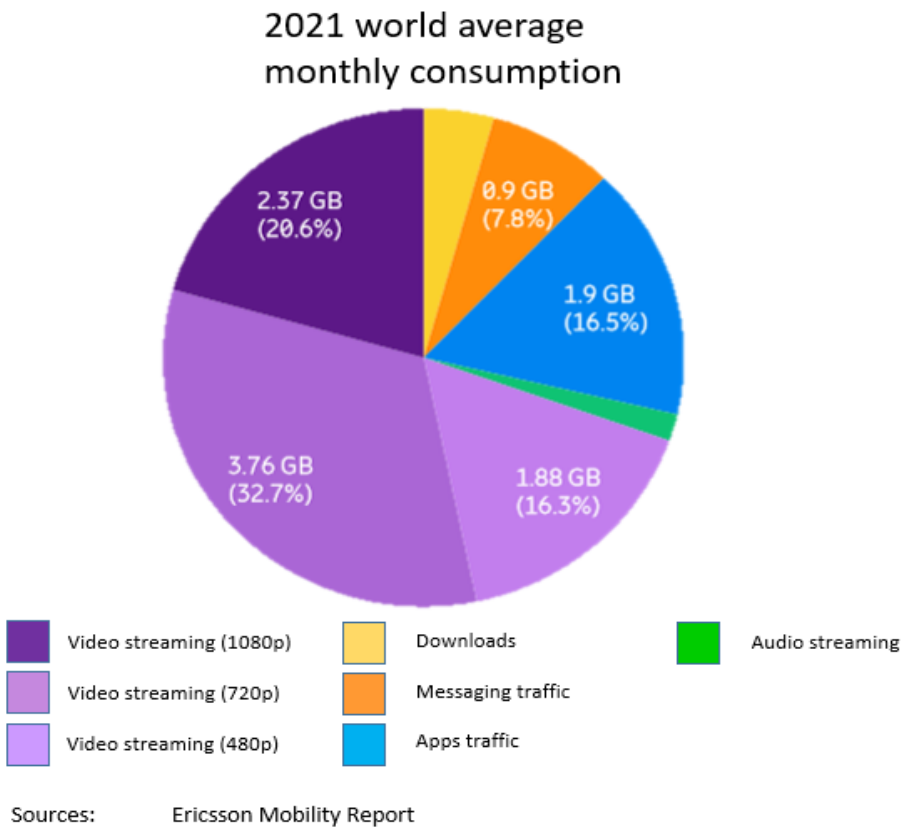
- HTTP Service non-accessibility [%]
- HTTP mean data rate [kbit/s]
- FTP {DL|UL} mean data rate [kbit/s]
- Ping round trip time
- HTTP IP-service access failure ratio [%]
- FTP {DL|UL} data transfer cut-off ratio [%]

9.1 Mobile Broadband Throughput QoS Standards

Prior to setting any service quality standards for mobile broadband measurement, consideration should be given on the consumers' point of view. In addition to benchmarking other countries, the most popular applications used by consumers nowadays may be use as a baseline to determine the QoS standards.

According to Ericsson's Mobility Report for 2021, 69.6% of monthly data consumption by users worldwide is on video streaming.

Figure 9.1: 2021 world average monthly data consumption



Source: Ericsson Mobility Report, 2021

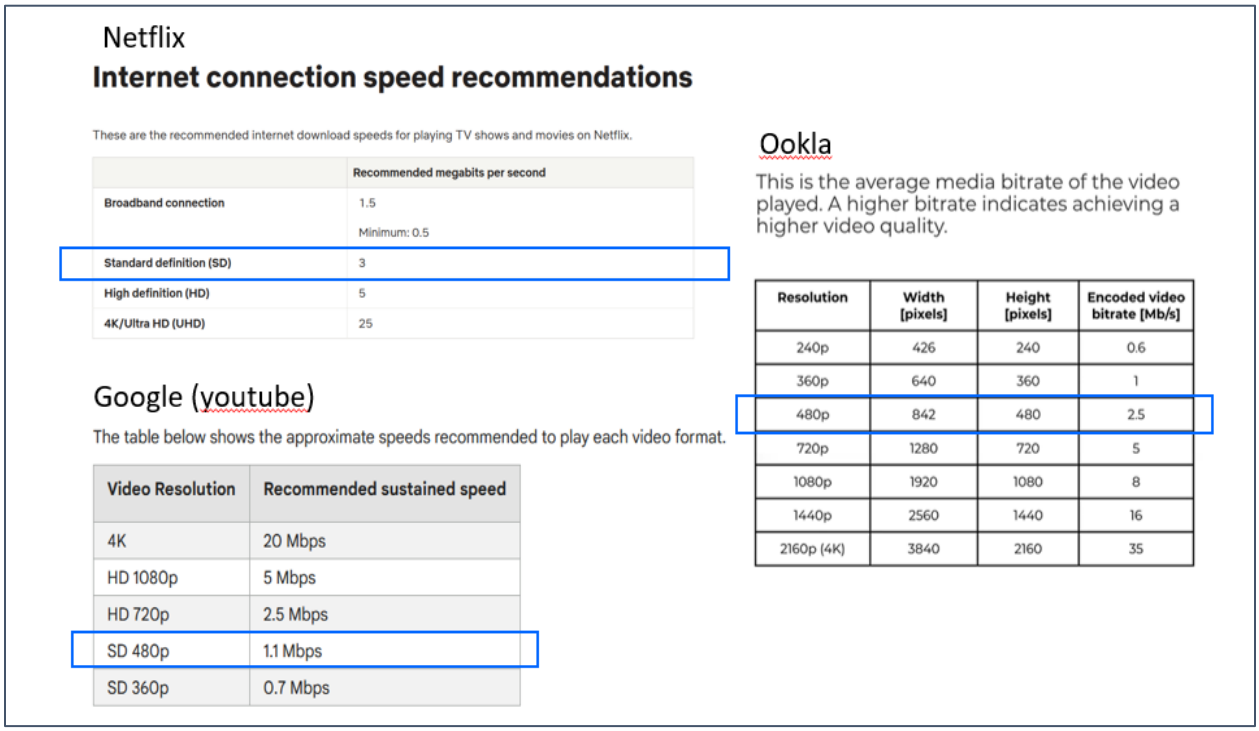
Therefore, service quality standards for mobile broadband is proposed based on the following consideration:

- minimum requirement for video streaming bandwidth on mobile devices.
- current penetration rate for mobile broadband in PNG that is not too high.

- current LTE population coverage, which is still expanding in PNG.
- new entrance for mobile broadband service provider.

Regarding the minimum download bandwidth requires for online content streaming set by providers such as YouTube and Netflix, and also by one of the major crowdsource provider, Ookla, the minimum download speed needed to stream Standard Definition (SD, 480p) online content is in the range of 1.1 Mbps to 3 Mbps and High Definition (HD, 720p) content is 2.5 Mbps to 5 Mbps.

Figure 9.2: Video streaming download speed requirements by major online content providers and crowdsource provider



Netflix

Internet connection speed recommendations

These are the recommended internet download speeds for playing TV shows and movies on Netflix.

	Recommended megabits per second
Broadband connection	1.5 Minimum: 0.5
Standard definition (SD)	3
High definition (HD)	5
4K/Ultra HD (UHD)	25

Google (youtube)

The table below shows the approximate speeds recommended to play each video format.

Video Resolution	Recommended sustained speed
4K	20 Mbps
HD 1080p	5 Mbps
HD 720p	2.5 Mbps
SD 480p	1.1 Mbps
SD 360p	0.7 Mbps

Ookla

This is the average media bitrate of the video played. A higher bitrate indicates achieving a higher video quality.

Resolution	Width [pixels]	Height [pixels]	Encoded video bitrate [Mb/s]
240p	426	240	0.6
360p	640	360	1
480p	842	480	2.5
720p	1280	720	5
1080p	1920	1080	8
1440p	2560	1440	16
2160p (4K)	3840	2160	35

Sources: netflix.com, support.google.com/youtube/answer/78358?hl=en, Ookla Webinar: video experience metrics

Mobile phone screen sizes are too small for human eye to differentiate the quality of SD-480p, HD-720p and Full HD-1080p videos. On top of that, online content applications are using Adaptive Bitrate Streaming (ABS), which are able to reduce the bitrate of a content according to the quality of network service received by users' devices.

Based on the benchmarking of other countries, minimum user requirements and capabilities of network, the QoS standards proposed for download and upload speed is as shown in table 9.1 below. The minimum mobile broadband throughput is set with a glide path to ensure that network shall be further enhance as the coverage and penetration rate expands.

Table 9.1: Mobile broadband QoS standards on download and upload throughput

QoS Parameter	Parameters description	QoS requirements	Measurement method	Formula
FTP Download mean data rate (ITU-T E.804_cl.7.3.1.7)	Download data transfer rate measured throughout the entire connection time	From 2022 – 2023: FTP download speed must be **≥2.5Mbps** for **≥80%** of test samples From 2024 onwards: FTP download speed must be **≥2.5Mbps** for **≥90%** of test samples	Static test using test tools. Minimum 10 samples per location	X = (average FTP DL data rate ≥ 2.5Mbps / No. of test sample) x 100%
FTP Upload mean data rate (ITU-T E.804_cl.7.3.1.7)	Upload data transfer rate measured throughout the entire connection time	From 2022 – 2023: FTP upload speed must be **≥0.5Mbps** for **≥80%** of test samples From 2024 onwards: FTP upload speed must be **≥0.5Mbps** for **≥90%** of test samples	Static test using test tools. Minimum 10 samples per location	X = (average FTP UL data rate ≥ 0.5Mbps / No. of test sample) x 100%
FTP {DL | UL} data transfer cut-off ratio [%] (ITU-T E.804_cl.7.3.1.8)	The proportion of incomplete data transfers and data transfers that were started successfully	Recommended NOT to be imposed as part of service quality standards Avoid creating multiple possibility for non-compliance and penalties		

The FTP download and upload data transfer cut-off ratio is not to be included as part of the QoS standards to avoid multiple non-compliance penalties for the same nature of test.

9.2 Mobile Broadband Latency QoS Standards

Network latency highly dependent on the location of the destination server due to the distance of fiber connection and the number of microwave hops. Additional latency will be added at each network router whether at the Cell Site Router (CSR) of Radio Access Network (RAN), microwave hops or interconnection points. SO, the further the test location from the destination test server, the higher the latency will be. For this reason, service providers are designing a flatter network architecture with lesser hops. For the purpose of QoS measurement standards, the location of

the test server is important. It should be standardized for the purpose of network performance audits by the regulator and comparison between service providers.

In PNG, the test server is proposed to be located at an internet exchange (IX) at Port Moresby where all service providers can be present. Service providers also have to perform measurements to their respective test servers in the same vicinity, i.e. Ports Moresby. The test shall be conducted from any location in PNG with service coverage.

The type of transport network (fiber, microwave and satellite) plays an important role. Geo-Stationary Satellite (GSO) requires 500ms-600ms for a return trip. Therefore, the regulator has to consider the measurement at locations where the serving site is using satellite backhaul. WCDMA or 3G network latency is slightly higher compared to LTE. Therefore, consideration should be given where LTE coverage that is quite low compared to WCDMA at the moment. ITU-T Rec G.114 suggests most applications, both speech and non-speech, will experience essentially transparent interactivity with latency less than 150ms ('mouth-to-ear' – one way trip). In addition, real time gaming experience requires latency of not more than 250ms end-to-end. With that in mind, the proposal for QoS standards on Ping Round Trip Time (RTT) is as shown in table 9.2 below.

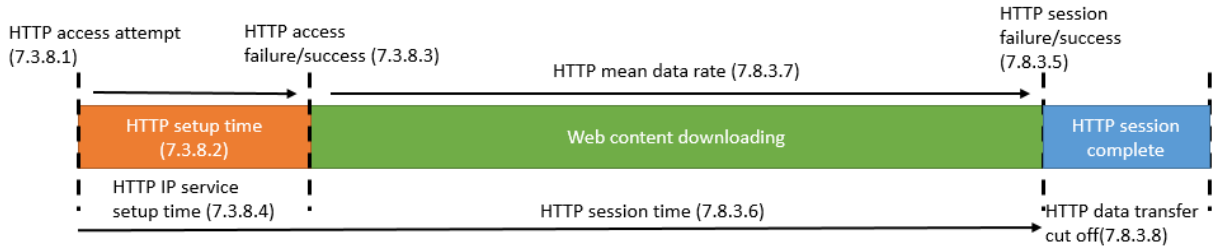
Table 9.2: Mobile broadband QoS standards on Ping Round Trip Time

QoS Parameter	Parameters description	QoS requirements	Measurement method	Formula
Ping round trip time (ITU-T E.804_cl.7.3.3)	The time required for a packet to travel from a source to a destination and back	Ping RTT (latency) must be **≤250ms**, **≥80%** of test samples (for fiber and microwave backhaul)	Static test using test tools. Minimum 100 samples per location	X = (ping RTT ≤ 250 ms/ No. of test sample) x 100%

9.3 Mobile Broadband HTTP Session QoS Standards

NICTA's draft QoS/QoE rules specifies 3 different HTTP session parameters namely HTTP Service non-accessibility, HTTP mean data rate and HTTP IP-service access failure ratio. All three of these parameters are referring to HTTP connection session in clause 7.8.3.1 to clause 7.8.3.8 in ITU-T E.804. As shown in figure 9.3 below, there are various HTTP parameters starting with HTTP access attempt, set up time, access failure or success, service set up time, session failure, session time, mean data rate and data transfer cut off.

Figure 9.3: Various QoS parameters corresponding to HTTP session (ITU-T E.804_clause 7.8.3)



Source: ITU-T E.804

There are various potential point of failures for a single HTTP session and the QoS standards has captured the mean data rate (throughput) using FTP download and upload measurements. Hence, duplicity of potential non-compliance should be avoided. However, the web-page loading is one way of measuring the real user experience. For this reason, the QoS standards on HTTP session is proposed below in table 9.3.

Table 9.3: Mobile broadband QoS standards on HTTP session

QoS Parameter	Parameters description	QoS requirements	Measurement method	Formula
HTTP Service non-accessibility [%] (ITU-T E.804_cl.7.3.8.1)	% of a subscriber would not be able to establish a connection to the server of a service successfully	• It is proposed to have 1 HTTP service quality parameters which is **HTTP mean data rate (ITU-T E.804_cl.7.3.8.7)** • Avoid duplication of FTP service quality parameters		
HTTP mean data rate [kbit/s] (ITU-T E.804_cl.7.3.8.7)	Average data transfer rate measured (time for complete webpage download)			
HTTP IP-service access failure ratio [%] (ITU-T E.804_cl7.3.8.3)	Probability that a subscriber would not be able to establish a TCP/IP connection to the server			

In order to gauge the webpage loading time for top webpages visited by the consumers, table 9.4 below shows the size of the webpages on mobile devices and the time to complete downloading of webpage with 2.5 Mbps download speed as specified in the standards for user download throughput in para 9.1 above.

Table 9.4: Webpage downloading time for top webpages visited

Webpage	Webpage size for mobile**	Time to load on mobile device with 2.5Mbps DL speed
Google.com	**285kB**	**1s**
Facebook.com (not logged in)	196.2kB	1s
Youtube.com (no browsing)	8.16MB	26s
Instagram.com (not logged in)	33.3kB	1s
Bsp.com.pg (Bank of South Pacific)	**1.98MB**	**6.3s**
pacificracingmx.com (pacific racing)	**984kB**	**3.1s**
Nrl.com (National Rugby League Australia)	**2.81MB**	**9s**
Nicta.gov.pg (NICTA website)	**978kB**	**3.1s**

Source: **ssitechecker.pro/speed-test

As indicated by the webpage size and loading time, to complete downloading YouTube webpage requires more than 10s. ITU-T Rec G.1010 states for webpage loading, any delays of several seconds are acceptable by the consumer, but not more than about 10 seconds. Therefore, the webpage measurement shall focus on:

a. top 5 webpages that are able to load under 10s with 2.5Mbps download speed; and
b. webpages that do not use mobile apps.

5 webpages highlighted in table 9.4 above may be chosen as the benchmark for QoS measurement standards. However, these webpages may be change from time to time, as and when NICTA think that it is necessary.

Table 9.5: Mobile broadband QoS standards on HTTP mean data rate (web browsing)

QoS Parameter	Parameters description	QoS requirements	Measurement method	Formula
HTTP mean data rate (web browsing) (ITU-T E.804_cl.7.3.8.7 & ITU-T G.1010_cl.5.3.1)	Average time for complete downloading webpage	Webpage download time must be **≤10s, ≥80%** of test sample	Static test using test tools. Minimum 10 samples per location	X = (average webpages download time ≤ 10s/ No. of test sample) x 100%

9.4 Mobile Broadband Coverage QoS Standards

Mobile network coverage is another basis requirement to provide good service quality. In PNG, the coverage for mobile broadband is still expanding. Therefore, coverage QoS standards will be beneficial to the consumers.

In establishing QoS standards on mobile broadband coverage, table 9.6 below shows the coverage standards benchmarks of other countries.

Table 9.6: Benchmarking other countries on mobile coverage standards

Country	Network	Received signal level
Vietnam (Minimum signal level)	3G	≥ -100dBm
	LTE	≥ -121dBm
Brunei (≥80% for urban, ≥60% for islands)	2G & 3G	≥ -95 dBm
	Near-4G & 4G	≥ -100 dBm
Singapore (Service coverage)	3G (outdoor >99%)	≥ -109 dBm
	3G (indoor >85%)	
	4G (outdoor >99%)	≥ -109 dBm
	4G (indoor >85%)	
UK (Minimum RSRP for 700MHz & 3.5GHz bands)	4G	≥ -105 dBm

Sources: APT, ASTAP Report 42
Aiti.gov.bn
Imda.gov.sg
Ofcom.gov.uk

LTE network provides higher data throughput at a lower received signal level compared to 3G network, with the same amount of spectrum. Hence, regulators specifies different standards for 3G and 4G.

In order to achieve the 2.5 Mbps of download throughput specifies in para 9.1 above, certain received signal level is required. Therefore, the standards proposed for coverage QoS parameters are shown in table 9.7 below.

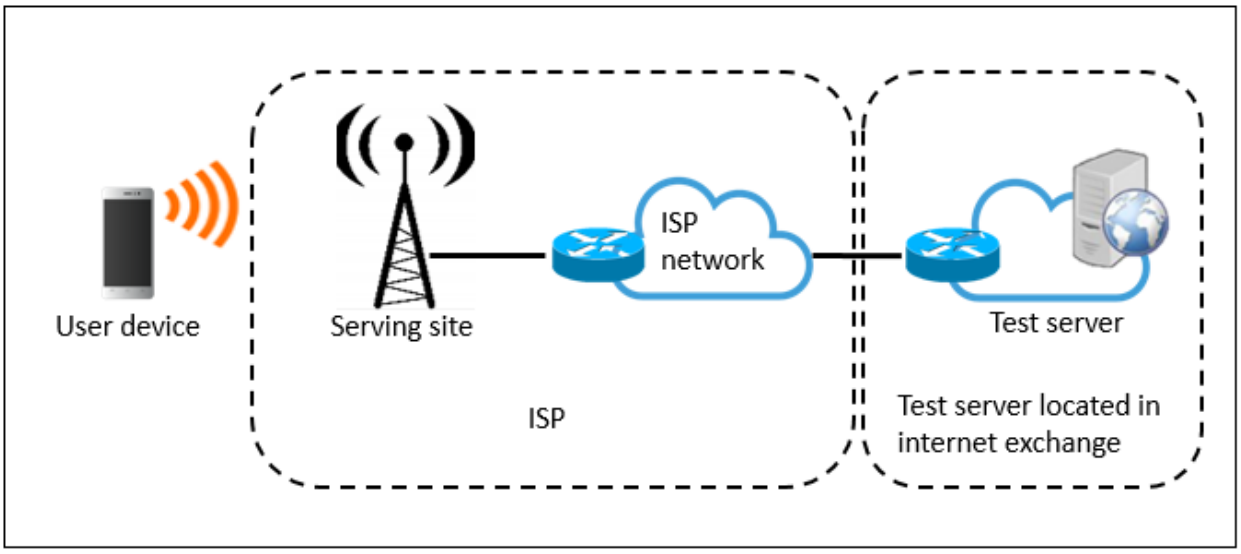
Table 9.7: Mobile broadband QoS standards on minimum received signal level

QoS Parameter	Parameters description	QoS requirements	Measurement method	Formula
Minimum received signal level (coverage)	Average received signal measured by mobile device (LTE and WCDMA)	Received signal level (RSRP) must be **≥ -110dBm** for LTE, **≥ 80%** of the sample Received signal level (RSCP) must be **≥ -100dBm** for WCDMA, **≥ 80%** of the sample	Static test using test tools. Minimum 10 samples per location (Recorded based on FTP measurement samples)	X = (LTE received signal ≥ -110dBm / No. of test sample) x 100% X = (WCDMA received signal ≥ -100dBm / No. of test sample) x 100%

9.5 Mobile Broadband QoS Measurement Methodologies

The methods in measuring service quality for mobile broadband is shown in figure 9.4 below.

Figure 9.4: Mobile broadband QoS measurement methods



- Measurement conducted using test phones installed with QoS measurement software.
- Measurement can be done by static test or walk test
- Point of measurement is from any location within coverage to test server located at internet exchange in Port Moresby.
- Test server hosted by regulator (NICTA) will be used for audits measurement.

- FTP test server must have proper specifications and sufficient bandwidth to handle incoming measurement data traffic from the available number of test equipment.
- Network latency test may use data packet size of between 32 and 128 bytes.
- Download and upload throughput measurement is using File Transfer Protocol (FTP).
- FTP file size must not be too small and not too large. It is suggested that for LTE, 100 MB file is used and for 3G, 50 MB file size.
- Minimum of 10 FTP download test and 100 Ping test samples for every location is required.

9.6 Mobile Broadband QoS Guidelines

In addition to the measurement methodology stated above, below are the guidelines for the mobile broadband QoS standards:

a. Mobile operators shall make available a coverage service prediction map for consumers' reference and act as reference for regulator (NICTA) to assess the coverage areas.

b. Published coverage service level by operators shall be based on RSRP (LTE network) of not less than **-110dBm** and RSCP (WCDMA network) of not less than **-100dBm**.

c. The measurement system shall be able to perform, records and analyze Packet Data Protocol (PDP) test with GPS location, etc.

d. Test phones of the measurement system shall comply with relevant ETSI and 3GPP standards.

e. The measurement shall be conducted in areas where coverage is ascertain from the coverage prediction map published by the mobile operators for the consumers.

f. Point of measurement shall be from any location within mobile operators' coverage areas to the test server located at an internet exchange (i.e. in Port Moresby) where all operators are presence.

g. Measurement shall be conducted by operators or representatives of the operators. Regulators or 3rd party authorized by the regulator may perform measurement where and when neccesary.

h. Measurement shall be perform at a minimum of 30 locations per region within a measurement period specified.

10.0 FIXED TELEPHONY QUALITY STANDARDS

The fixed telephone service transmission is being carry by Asymmetric Digital Subscriber Line (ADSL) and Integrated Service Digital Network connections. Moving into IP world, the fixed telephone has been integrated into IP data packets in the Gigabit Passive Optical Network (GPON) transmission system.

There are 2 service quality standards drafted for fixed telephony service.

- Call set up time (Successful calls only)
- Unsuccessful call rate %

Table 10.1 below shows the proposed QoS standards for fixed telephony service. Unlike other service, the fixed telephony service performance is gauge by network statistic reporting by the service providers.

Table 10.1: Fixed telephony QoS standards

QoS Parameter	Parameters description	QoS requirements	Measurement method	Formula
Call set up time (successful calls only) (ETSI EG 202 057-2 cl.5.2)	The period starting when the address information required for setting up a call is received by the network and finishing when the called party busy tone or ringing tone or answer signal is received by the calling party	Call set up time for successful calls must be **≤10s, ≥ 90%** of total successful calls during busy hours - Applicable for national calls (both for intra and inter network calls)	Network statistics reported by service providers	X = average calls set up time **≤ 10s** (number of unsuccessful call / number of call attempts) x 100%
Unsuccessful call rate (ETSI EG 202 057-2 cl.5.1)	The ratio of unsuccessful calls to the total number of call attempts	Unsuccessful call rate must be **≤ 1%** during busy hours - Applicable for national calls (both for intra and inter network calls)	Network statistics reported by service providers	X = (number of unsuccessful call / number of call attempts) x 100%

The network statistics is applicable for calls originated from PSTN and terminated to PSTN. This is to ensure that any unsuccessful calls to mobile network due to low quality or poor coverage is not being penalized.

The measurement method also removed the need for the regulator or service providers to perform measurement audit at consumers' premises and able to collect data for all calls made within a specified period. In this case, the period is selected as busy hour. Busy hour is varies for weekends and weekdays and may varies based on service providers. Selecting the busy hours is based on the network data.

11.0 FIXED BROADBAND QUALITY STANDARDS

In NICTA's draft QoS/QoE rule, there are five QoS standards, proposed for fixed broadband service as follows:

- Availability of internet access
- Data transmission speed achieved
- Web page download Speed
- IP packet transfer delay
- IP packet loss ratio (IPLR)

Prior to establishing QoS standards for fixed broadband, information on the available network technologies, types of subscription packages and any other network capabilities or limitations need to be gathered and analyzed.

Based on the data gathered, there is only 1 fixed broadband service provider, which is Telikom PNG. Telikom PNG is providing fixed broadband service by utilizing 3 different access network as follows:

a. fiber (GPON);
b. copper (DSL); and
c. Fixed Wireless Broadband (FWB) using WiMAX technology.

There are 2 types of fixed broadband plans available in PNG market which are based on:

i. limited data capacity with no internet speed cap. Volume-based subscription.

ii. Subscription to specific internet speed with no data limit. The available internet speed packages ranges from 1 Mbps to 50 Mbps. Speed-based subscription.

The data package offered is a tradeoff between having a dedicated internet speed with no data volume limitation or with no guaranteed speed, but limited data capacity.

Concerning the different data plans, the focus of the QoS standards for fixed broadband will be on the speed-based subscription, which supposed to provide a guaranteed internet speed to the consumer for both fiber and copper access networks.

Furthermore, the FWB network utilizing WiMAX technology is using a dedicated spectrum. The spectrum allocated for FWB network is as follows:

a. 2.3 GHz Band: 2,330 – 2,360 MHz (30 MHz spectrum bandwidth)
b. 3.5 GHz Band: 3,550 – 3,600 MHz (50 MHz spectrum bandwidth)

11.1 Fixed Broadband Data Speed QoS Standards

Based on the multiple types of access network, the QoS standards for fixed broadband service is proposed as in table 11.1 below.

Table 11.1: Fixed broadband QoS standards for data transmission speed

QoS Parameter	Parameters description	QoS requirements	Measurement method	Formula
Data transmission speed (ETSI EG 202 057-4 cl.5.2) (ETSI ES 202 765-4 cl.6.10)	Download of data transfer from user access equipment to network	FTP DL speed must be **≥80%** of subscribed speed, for **≥80%** of test samples for fiber and DSL connection FTP DL speed must be **≥5Mbps**, for **≥80%** of test samples for FWB	Measurement using test probe connected to CPE (router) Minimum 50 samples for download and 50 samples for upload per location	X = (FTP DL data rate ≥ [80% for fiber or 70%] for DSL) of subscribed speed / No. of test sample) x 100%
	Upload of data transfer from user access equipment to network	FTP UL speed must be **≥80%** of subscribed speed **≥80%** of test samples for fiber and DSL connection FTP UL speed must be **≥0.5Mbps** for **≥80%** of test samples for FWB		X = (FTP UL data rate ≥ [80% for fiber or 70%] for DSL) of subscribed speed / No. of test sample) x 100%

The QoS standards is set differently for GPON and DSL connection than for FWB. The focus of GPON and DSL is on the capability of the network to deliver the guaranteed speed offered to the consumers. Therefore, the QoS standards is designed to ensure that certain percentage of the speed subscribed by the consumer can be delivered for both download and upload.

In terms of FWB, the QoS standards is similar to the mobile broadband standards where the FWB service have to comply with a minimum of download and upload speed. The standards is proposed by taking into consideration the amount of spectrum available, Customer Premise Equipment (CPE) and consumer's usage.

11.2 Fixed Broadband Latency and Packet Loss QoS Standards

Similar to mobile broadband, the network latency for fixed broadband must take into consideration the location of the destination server, in this case the test server, which will be located in Port Moresby. Any measurements conducted within the country have to be able to travel from any consumers' household to the test server. The number of hops, length of fiber, should be taken into account. The same impact should be the case for packet loss.

Fiber connectivity provide much lower latency than copper. The performance of copper network degrades over lengthy distance much more compared to fiber, and due to this, may be more prone to packet loss. FWB latency is also higher than fiber connection due to the air-interface connection with UE and the number of microwave hops connecting the WiMAX sites. Therefore, the latency and packet loss QoS standards for fiber, copper and FWB network are segregated, as shown in table 11.2 below.

Table 11.2: Fixed broadband QoS standards for latency and packet loss

QoS Parameter	Parameters description	QoS requirements	Measurement method	Formula
IP packet transfer delay (latency) (ITU-T Y.1540_cl.6.2)	Time required for a packet to travel from a source to a destination and back	Ping RTT (latency) must be **≤80ms**, **≥80%** of test samples for fiber Average latency (ping RTT) must be **≤100ms**, **≥80%** of test samples for DSL and FWB	Measurement using test probe connected to customer premise equipment (router) Minimum 100 samples for per location	X = (ping RTT ≤ 250 ms/ No. of test sample) x 100%

IP packet loss ratio (ITU-T Y.1540_cl.6.2) (ITU-T Y.1541_cl.8.2.2) (ETSI EG 202 765-3 cl.4.4)	Ratio of total lost IP packet outcomes to total transmitted IP packets	Packet loss must be **≤0.5%** for fiber Packet loss must be **≤1%** for DSL and FWB	Measurement using test probe connected to customer premise equipment (router) Minimum 100 samples for per location	X = (no. of packet data received/ no. of packet data sent) x 100%

11.3 Fixed Broadband Webpage Loading and Internet Access QoS Standards

In order to include real user experience for fixed broadband QoS standards, consideration is given on the webpage download speed and availability of internet access. For the webpage download speed, the sizes of the top webpages on a laptop were collected, analyzed and compared with the lowest data speed package available. Table 11.3 below shows the sized of the webpages on downloaded using a laptop and its corresponding period to complete downloading on a 1 Mbps internet package.

Table 11.3: Top webpages download time on 1 Mbps internet speed package

Webpage	Webpage size on PC	Time to load on with 1Mbps DL speed (lowest package offered)
Google.com	1.5MB	**12s**
Facebook.com (not logged in)	989kB	8s
Youtube.com (no browsing)	10.9MB	**87s**
Instagram.com (not logged in)	3.3MB	**26s**
Bsp.com.pg (Bank of South Pacific)	5.3MB	**42s**
pacificracingmx.com (pacific racing)	1.9MB	**15s**
Nrl.com (National Rugby League Australia)	4.73MB	**37s**
Nicta.gov.pg (NICTA website)	9.42MB	**75s**

It shows that, almost all webpages will not be downloaded within less than 10s due to limited speed and bigger size of the webpage. A table extracted from ITU-T G.1010 (Table I.2) shown below that the acceptable page loading time is less than 4s for a small size data.

Table I.2/G.1010 – Performance targets for data applications

Medium	Application	Degree of symmetry	Typical amount of data	Key performance parameters and target values		
				One-way delay (Note)	Delay variation	Information loss
Data	Web-browsing – HTML	Primarily one-way	~10 KB	Preferred < 2 s /page Acceptable < 4 s /page	N.A.	Zero
Data	Bulk data transfer/retrieval	Primarily one-way	10 KB-10 MB	Preferred < 15 s Acceptable < 60 s	N.A.	Zero
Data	Transaction services – high priority e.g. e-commerce, ATM	Two-way	< 10 KB	Preferred < 2 s Acceptable < 4 s	N.A.	Zero
Data	Command/control	Two-way	~ 1 KB	< 250 ms	N.A.	Zero
Data	Still image	One-way	< 100 KB	Preferred < 15 s Acceptable < 60 s	N.A.	Zero
Data	Interactive games	Two-way	< 1 KB	< 200 ms	N.A.	Zero
Data	Telnet	Two-way (asymmetric)	< 1 KB	< 200 ms	N.A.	Zero
Data	E-mail (server access)	Primarily one-way	< 10 KB	Preferred < 2 s Acceptable < 4 s	N.A.	Zero
Data	E-mail (server to server transfer)	Primarily one-way	< 10 KB	Can be several minutes	N.A.	Zero
Data	Fax ("real-time")	Primarily one-way	~ 10 KB	< 30 s/page	N.A.	$<10^{-6}$ BER
Data	Fax (store & forward)	Primarily one-way	~ 10 KB	Can be several minutes	N.A.	$<10^{-6}$ BER
Data	Low priority transactions	Primarily one-way	< 10 KB	< 30 s	N.A.	Zero
Data	Usenet	Primarily one-way	Can be 1 MB or more	Can be several minutes	N.A.	Zero
NOTE – In some cases, it may be more appropriate to consider these values as response times.						

For the webpage download speed to be standardized, it must be applicable to all consumers' subscribed packages including the lowest speed package. However, this QoS parameter may not be feasible to be implemented across all fixed broadband service packages. Based on the above, webpage download speed for fixed broadband is not recommended to be included as part of the QoS standards.

The availability of internet access is another measurement of the data session. Since the data transmission speed has already been proposed as one of the fixed broadband QoS standards in para 11.1 above, the availability of internet access is also not recommended to be included. Furthermore, this is to avoid multiple possibility of non-compliance and penalties. Table 11.4 below shows the positions suggested for webpage download speed and availability of internet access QoS standards.

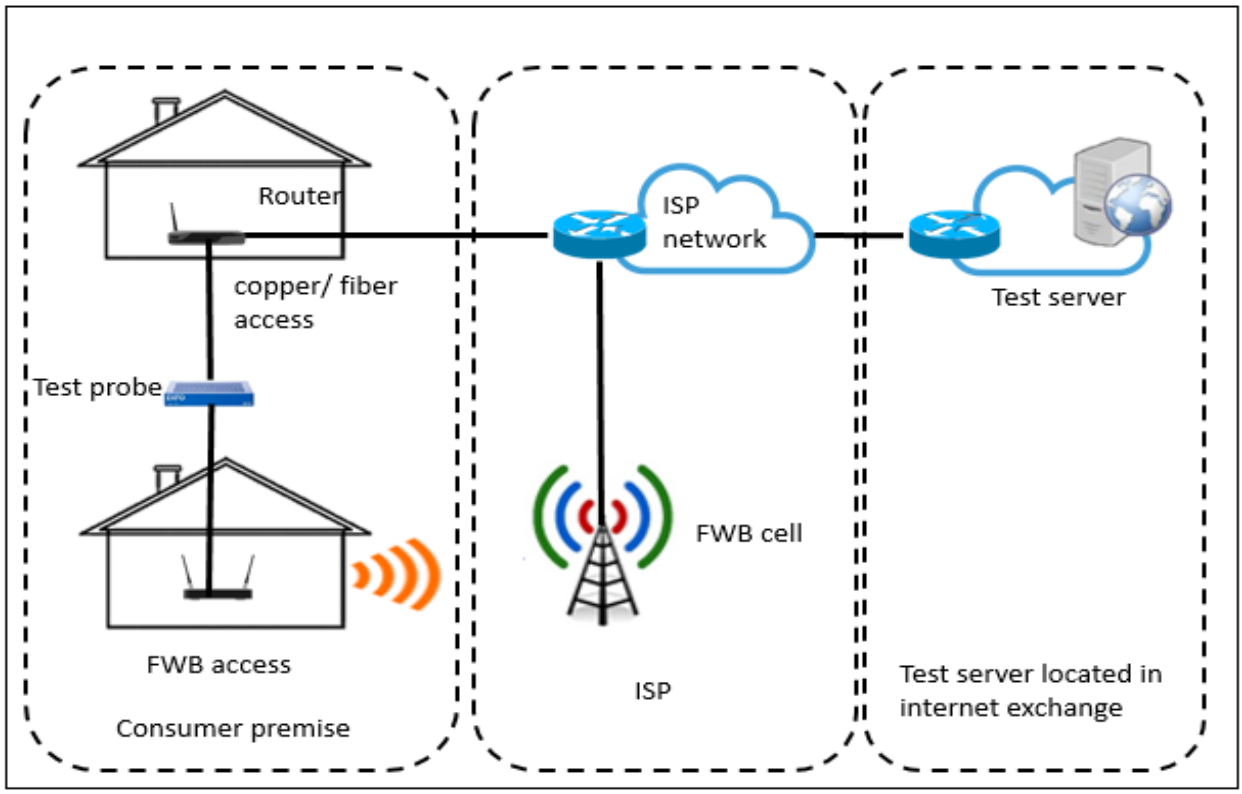
Table 11.4: Fixed broadband QoS standards on webpage download speed and internet access

QoS Parameter	Parameters description	QoS requirements	Measurement method	Formula
Webpage download speed (ETSI EG 202 057-4 cl.5.2 ITU-T Rec G.1010 Table I.2)	Average time for complete downloading webpage	• Not recommended to be standardized at this point of time • Size of webpages for PC is too big to be downloaded within 10 s for lowest subscription package offered		
Availability of internet access (ETSI ES 202 765-4 cl.6.1)	Percentage of time where access to the Internet services are available	• Not recommended to be standardized at this point of time • Avoid creating multiple possibility for non-compliance and penalties		

11.4 Fixed Broadband QoS Measurement Methodologies

The methodology for fixed broadband QoS measurement is illustrated in figure 11.1 below.

Figure 11.1: Fixed broadband QoS measurement methodology



- Measurement is conducted using test probe connected directly to Customer Premise Equipment, CPE or router.
- Point of measurement is from any premise passed or any location within FWB coverage, to test server located at internet exchange in Port Moresby.
- Test server hosted by regulator (NICTA) will be used for audits measurement.
- FTP test server must have proper specifications and sufficient bandwidth to handle incoming measurement data traffic from the available number of test equipment.
- Network latency test may use data packet size of between 32 and 128 bytes.
- Download and upload throughput measurement is using File Transfer Protocol (FTP).
- FTP file sizes must correspond to the bandwidth subscribed by user to allow sufficient time to achieve maximum network capacity (i.e. 10 Mbps subcription package to use at least 10MB file size, 50 Mbps subscription package to use at least 50 MB file size, etc.).
- Minimum of 50 FTP DL througput, 50 FTP UL throughput and 100 Ping test samples for every location/premise is required.
- Packet loss measurment will be calculated based on the data packets transmitted for Ping test

11.5 Fixed Broadband QoS Guidelines

In addition to the measurement methodologies, the guidelines for fixed broadband QoS measurement are listed below for reference.

1. Measurement for fixed broadband standards shall be conducted for fiber, copper (DSL) and FWB connections.
2. Fixed broadband measurement shall be conducted by connecting test probe via LAN cable to the CPE (router).
3. Measurement through WiFi connection is not performed due to the unlicensed band, which may has possible interference from nearby short range devices, distance to WiFi access point, etc.
4. No other devices (except for test probe) are connected to the CPE during measurement.
5. The measurement system shall be able to perform, record and analyze FTP, latency and packet loss measurements.
6. Measurement system shall comply with relevant ETSI and Metro Ethernet Forum (MEF) standards.

7. The measurement shall be conducted at premises where access network is provided and FWB service coverage has been ascertained from the coverage map published by service provider.
8. Measurement shall be conducted by operators or representatives of the operators. Regulators or 3rd party authorized by the regulator may perform measurement where and when neccesary.
9. Measurement samplings must be at least 5 locations per region for every network (fiber, DSL and FWB) where service is provided.

12.0 SERVICE QUALITY MEASUREMENT SYSTEMS

In view that the abovementioned QoS standards for mobile and fixed services are enforced, the service providers and NICTA may need to be equipped with the necessary network performance measurement systems. There are 2 QoS measurement system required for mobile service and fixed service.

Mobile QoS measurement system

For mobile telephony and mobile broadband measurement systems, the systems requires test phones for each service provider, a tablet that act as master controller and a pc to perform post processing analysis. There are a bunch of measurement system in the market including Nemo, TEMS, Qualipoc, Wind, etc.

The test phones must be able to support the existing mobile network in PNG such as 2G, 3G and 4G.

These test equipment is also 5G ready, which means the hardware supports 5G, but the software may be install with 5G measurement at a later stage depending on the 5G network configuration.

Measurement system must comply with ETSI/3GPP standards.

For the post processing software, it is to note that not all measurement logfiles can be analyze by using a different measurement system.

The same test equipment may be use for both mobile telephony and mobile broadband measurements. All the measurement methodologies and guidelines may be implemented using either of these test equipment.

Fixed QoS measurement system

For fixed broadband measurement system, the use of test probe (verifier) is required. No on-site measurement system is required for fixed telephony service because it is based on network statistical data reported by service providers.

Example of fixed broadband measurement system available in the market are Exfo, Juniper, etc.

The measurement equipment is basically a physical probe or can be a virtual verifier. Virtual verifier is basically using a high performance laptop with sufficient capabilities installed with verifier functionalities.

These probe or virtual verifier is connected directly to home user router.

Measurement system must comply with ETSI and MEF standards.

Take note that there is limitation to the capabilities of a verifier. Some are able to support up to a maximum of 500 Mbps download speed. Virtual verifier may be needed for higher throughput capacity, up to 1 Gbps. The limitation will be on the laptop hardware.

FTP test server and verifier server

For all FTP, latency and packet loss measurement, a dedicated test server supporting FTP file download and upload is needed. This test server must be located at an internet exchange where it can be connected to all service providers.

In addition to the FTP server, a verifier server is also required for Ping RTT and packet loss measurements for both mobile and fixed broadband services.

FTP server will be used for both mobile broadband and fixed broadband throughput measurement.

Verifier server is used for Ping RTT & packet loss tests.

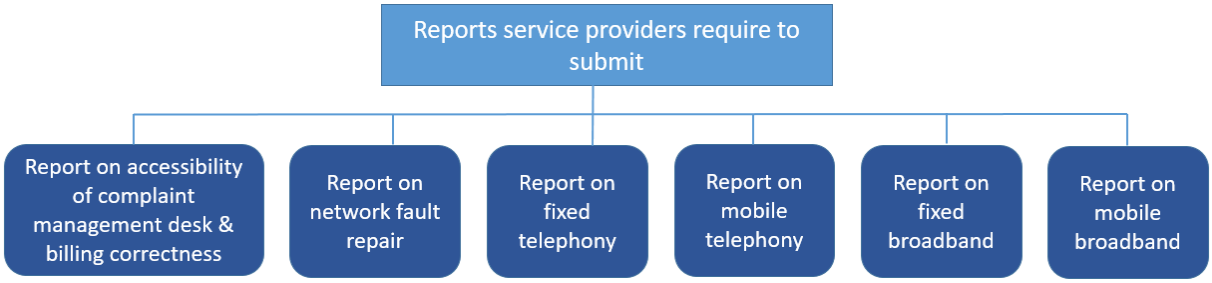
Regulator and service providers must ensure that the specification of the server performance must be able to cope with the numbers and capacity of the on-field measurement tools.

Sufficient bandwidth connection must be taken into account to ensure the validity and accuracy of QoS measurement results.

13.0 SERVICE QUALITY REPORTING

There are several reports that need to be submitted by service providers to NICTA. Figure 13.1 below summarizes the list of reports that is required to be submitted within each of measurement period.

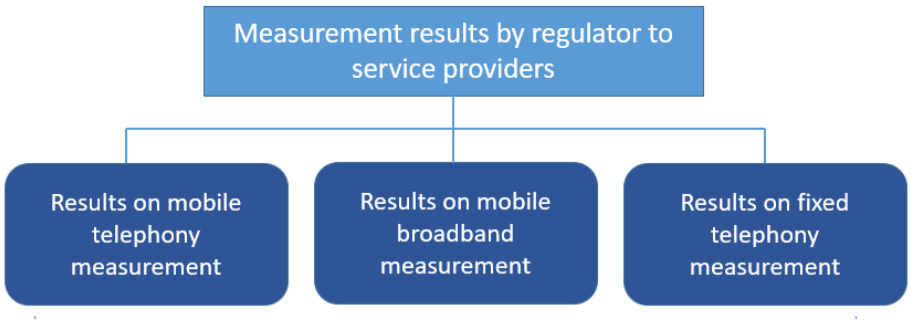
Figure 13.1: List of reports required to be submitted by service providers



- Submission of reports is on half yearly basis ("measurement period").
- Report must reach the regulator (NICTA) by the 30th of the following month after each halves (i.e. 30th July & 30th January of each year).
- Report shall be in electronic format for ease of checking.
- Measurement reports shall include summary of measurement results, locations of measurement and measurement logfiles.

In order to obtain validate the network performance measurement, the regulator will perform measurement audits at the locations measured by the service providers or at any new locations.

Figure 13.1: Measurement results to be shared by regulator to service providers



- Regulator may share the measurement results after measurement has been completed for each region or for specific areas.
- Results can be share together with measurement logfiles to the service providers.
- Service providers will need to provide improvement plans for non-compliance locations/premises within a required timeframe.

14.0 ENFORCEMENT OF SREVICE QUALITY STANDARDS

Once the QoS standards are in place, NICTA may be able to enforce the standards based on the measurement reports and on-site audits activities. Below are the list of guidelines proposed for enforcing the service quality regulatory standards

- Enforcement of QoS standards is at the discretion of the regulator.
- Enforcement may be taken based on submission of reports from operators or regulator's measurement audits.
- Prior to any enforcement action, the regulator may monitor the performance of the QoS results within every 6 months measurement period, to determine any network improvement within the next 6 following months.
- The enforcement timeframe is aligned with submission of reports on half-yearly basis.
- Service providers are not allow to conduct measurement at the same location within 2 calendar years except to reassess the network performance improvement after it has completed network improvement or upgrade.
- Enforcement action shall be based on accumulation of measurement results for each region.
- Accumulation of measurement results for enforcement action can be taken by the regulator (NICTA) for each region every half yearly (6 months) to provide sufficient time for operators to improve the non-compliance locations.
- NICTA may consider taking a light enforcement approach, based on the responds, tangible improvement plan and timeline of execution by the service providers. Any relevant information or limitation (i.e. geographical challenges, coverage at cell edge, type of transport network (fiber/microwave/satellite), Universal Service areas, etc.) for the improvement of the non-compliance locations will be taken into account.

- In the case of network failure due to force majeure or faults by 3rd party, the exclusion of test samples to be enforced shall be decided by the regulator. In this case, service providers are required to provide evident of the network failure events.

Considering that the QoS/QoE regulatory framework is newly developed, the regulator may allocate more time for all stakeholders to make necessary arrangement and preparation, prior to enforcing the standards.

15.0 LEVERAGING ON CROWDSOURCING

Nowadays, many regulators has opted for leveraging on crowdsource data to gather additional network performance information and user experience data. There are several crowdsource systems available in the market, which may be better suited for a specific country.

Crowdsource measurement can be implemented by:

i. Adopting an existing crowdsource apps and data available in the market (i.e. Ookla, Opensignal, nPerf, etc.).

ii. Using Software Development Kit (SDK) to be installed in a widely used app for much more data samples.

iii. Develop own crowdsource apps.

Publication of crowdsource data can:

- be segregated by each service providers.
- show the data for each regions.
- contain relevant and understandable service quality parameters for consumers' information.
- use for monitoring purpose, not for enforcement.

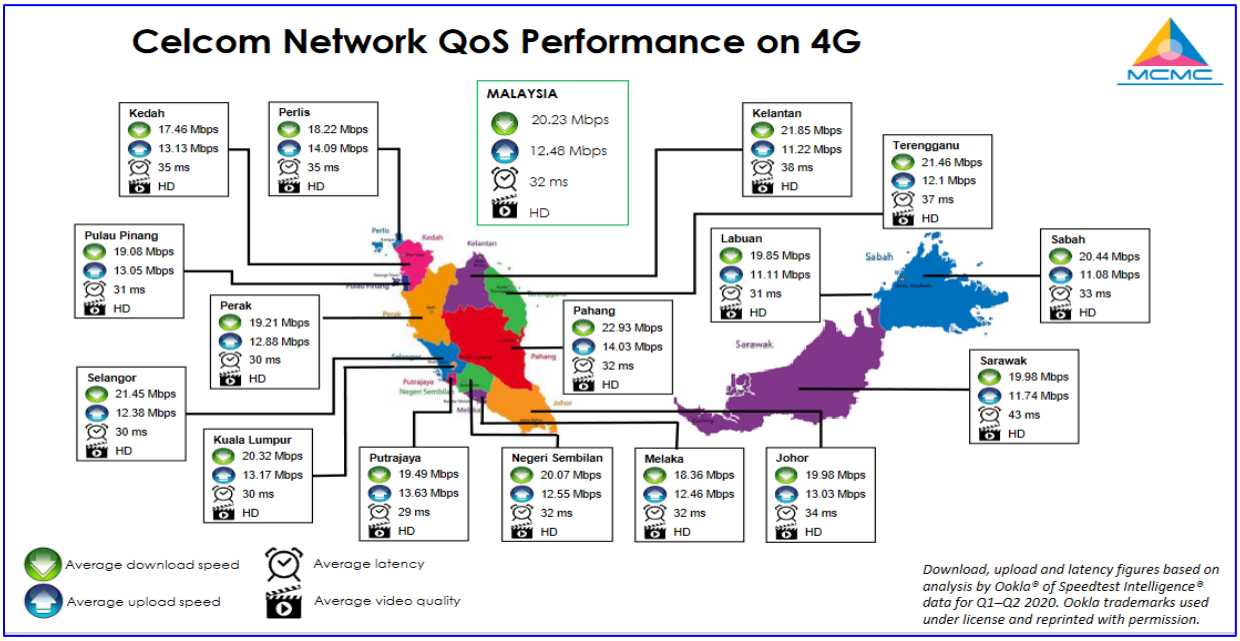
In Singapore, the regulator developed own apps, "IMconnected", for data gathering and publication of the data for the consumers. The limitation of this approach is the number of take-ups from the consumers. Figure 15.1 below shows the sample of data published by the regulator.

Figure 15.1: Crowdsource mobile signal strength data published in Singapore

Source: imda.gov.sg

In Malaysia, the regulators is leveraging on existing crowdsource data provider, Ookla Speedtest, to publish meaningful network performance data for the consumers. In this case, the sampling for Ookla users in Malaysia is quite high. However, the limitation is the ownership of the data is not by the regulator. Figure 15.2 below shows the network performance results using crowdsource data published by the regulator.

Figure 15.2: Crowdsource 4G network performance data published in Malaysia



Source: mcmc.gov.my

In summary, the user of crowdsource data may not be suitable for enforcement purposes. However, the regulator may be able to use crowdsource data to complement the on-site measurement data conducted by the service providers and regulator.

16.0 REFERENCES

NICTA

NICTA Draft Telecommunications Quality of Service Rule 2022

NICTA Act 2009

NICTA Standard and Special Conditions of Individual Licences Rule, 2011

ITU-T E.805

ITU-T E.804

ITU-T G.1010

ETSI ES 202 057-1

ETSI EG 202 843

ETSI EG 202 057-2

ETSI EG 202 765-3

ETSI EG 202 057-4

ETSI ES 202 765-4

ITU-T Y.1540

ITU-T Y.1541

mcmc.gov.my

aiti.gov.bn

imda.gov.sg

kominfo.go.id

ITU Workshop 2019 - nbtc

ofcom.gov.uk

Ericsson Mobility Report 2021

You Tube

Netflix

Ookla Speedtest

telikompng.com.pg

AWG-23/INP-33 (2018)

APT, ASTAP Report 42

DataCo Ltd

datareportal.com/reports/digital-2021-papua-new-guinea

sitechecker.pro/speed-test