Broadband Internet – Quality of Service Framework

Consultation Document

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Table of Contents

Definitions

In this document the following definitions are used:

"Internet Service Provider" is a company or entity which provides access to the Internet to its subscribers.

"Point of Presence" means an access point which connects an Internet Service Provider to the Internet.

"Subscriber" means any person who avails himself to all contracts which are offered by the Internet Service Provider, excluding tailor made contracts.

"End user" means any person who makes use of applications which are available over the Internet.

"Time Consistent Busy Hour" The 1-hour period starting at the same time each day for which the average traffic of the resource group concerned is greatest over the days under consideration.

Executive Summary

In June 2011, the Malta Communications Authority being aware of the importance of broadband Internet as a means of promoting social inclusion and competitiveness published a decision on functional internet access[1]. This decision established the provision of broadband Internet access at a specified minimum data rate as a universal service obligation. Furthermore, it recognised that apart from the physical capability of the access connection, the speed and quality of the end-to-end internet service is an important aspect that affects the end-user experience.

To date, the scenario under which broadband internet is sold may be captured as follows:

a) ISPs sell broadband internet packages based on:
   - The download and upload speeds; these speeds are all quoted on an "up-to" basis and therefore, ISPs are not guaranteeing any minimum level of service performance of the connection in terms of speed.
   - The volume of data that is permissible to transfer over the connection.
   - The platform over which the access network is based.

b) ISPs do not publicly state the methodology and/or standards which they use when measuring the quality of the service they provide.

The Authority is of the view that this gives rise to a situation in which:

- Broadband services are sold without a guarantee of a minimum performance being given to the subscribers.
- The technical characteristics which are in use today are limited and may not necessarily be adequate to describe the broadband service on offer.
- Performance figures quoted by different ISPs cannot be directly compared.
- Subscribers are not well informed of the performance that the broadband connection is capable of. Therefore, it is difficult for subscribers to make informed choices when agreeing to a contract with an ISP.

In order to address the above scenario, the Authority, is proposing a Quality of Service Framework tailored for broadband Internet service provided using both wired and fixed wireless access. The proposed framework is guided by the following principles:

- Broadband subscribers have a right to choose the service provider which best suits their needs. A subscriber therefore needs to have access to the right information that will enable an informed decision to be taken and that will facilitate comparison of services being offered on the market.

[1] http://www.mca.org.mt/article/provision-access-fixed-location-requirements-be-complied-universal-service-provider-usp

- Broadband subscribers have a right to know the performance of the broadband service that they are subscribed to.
- ISPs should only market broadband packages which they can physically provide.

The key components of the proposed Quality of Service Framework are outlined below.

It is proposed that the parameters used to characterise a broadband service are extended to include:

- Upload and Download data transmission speeds.
- Availability of Internet service which denotes the percentage of time that the broadband service is available.
- Latency which denotes the time taken for a packet of data to arrive at its destination. This parameter is important for applications which are real time and interactive in nature such as online gaming and Voice over IP.
- Packet Loss which denotes the number of packets which are lost during transmission. A connection with poor packet loss performance reflects in the end-user experience vis-a-vis applications which do not afford retransmission of data. Such applications include video streaming of live content.

It is proposed that ISPs offering fixed broadband internet access (both wired and wireless) be required to publish the performance of their different broadband packages in terms of the proposed QoS parameters on a quarterly basis. The passive data collection technique is proposed as the method to be used by the ISP to collect the QoS data, which data is to be based on an analysis of the flow of traffic over the network.

The measurements of these parameters are to be based on a statistical sample chosen such that the resultant statistics enjoy a margin of error which is not larger than 5%. The sample base should be representative of:

- the individual broadband package offered by the ISP;
- the distribution of its subscribers across the whole territory of Malta; and
- the distribution in time over a 24 hour basis, 7 days a week with the exclusion of periods in which there is no service due to preventive maintenance.

ISPs should also publish on a quarterly basis the QoS information related to each individual broadband package. On doing so, it is proposed that ISPs should as a minimum include in their publication the following:

- The margin of error of the published statistical figures.

- The methodology used during the collection of data including any limitations which apply to the same statistical information.
- A clear identification of the location points between which the measurements were taken.
- The QoS information of each broadband package per geographical region.

Additional to the measurement and publication of QoS information the Authority is expecting that an ISP, prior to propose any new broadband packages on the market, would have carried out its own internal studies on the resource availability of its network(s) in order to ensure that it can support both the existing and new services.

The Authority recognises that not all the network elements are under the direct control of the ISP. The Authority is therefore proposing that where issues of QoS are encountered it will review the network adequacy in terms of:

- the access network;
- the core network;
- the international and local connections of an ISP

with a particular focus on:

- Available data rate;
- Connection utilization;
- Packet drop ratio;

as applicable for the access and the international and local connections and

- Bandwidth Utilization
- Packet drop ratio

as applicable for the core network.

b) The Authority is also putting forward an interpretation to the term "does not differ significantly from the marketed upper levels" in the context of Regulation 35(1)(b)(iv) subparagraph (5) of the ECNSR. The Authority is proposing that ISPs should establish and include in their contracts a range of expected speeds referred to as Typical Speed Range (TSR) for each broadband package offered to its subscribers.

- The Authority is proposing that the TSR is based on the 20th and the 80th percentiles of performance figures of the connections sold under the various packages. For packages already on the market the TSR figures should be based on actual performance statistics. In the case of new packages, ISPs

are expected to use network performance statistics to estimate a realistic TSR.

- The MCA is also proposing that the ISP should review the TSR for the different packages on a quarterly basis and use the latest TSR figures for the marketing of new packages.

c) The Authority is also proposing that contracts regulating the agreements between the upstream and the downstream providers will need to include as a minimum, the necessary performance commitments in terms of the Network Performance parameters, that will allow the downstream provider to offer to its subscribers the required level of service as put forward in this consultation.

d) The MCA is also proposing a time frame, spread over a period of nine months from the publication of the final decision, for the implementation of the proposed QoS framework.

1 Introduction

Today broadband Internet has become an essential component of electronic communication services, with Malta enjoying multiple networks that can provide access to broadband connections through both fixed and mobile networks. As the take up of broadband services and the reliance on this service as a means of promoting social inclusion and competitiveness continues to grow, the performance of these networks has also become of significant importance.

As the provision of Internet connectivity developed from narrow band dial-up connections to broadband connections, one of the main initiatives which was taken by the Authority in 2002 was the drafting of a voluntary Code of Practice[2]. This code of practice was adopted by a number of local ISPs. The main principles of the code are to:

- establish confidence in and encourage the use of the Internet;
- improve the completeness and accuracy of disclosure to users of the Internet;
- provide standards of confidentiality and privacy afforded to users of the Internet;
- provide a transparent mechanism for complaint handling for the Internet industry;
- ensure that complaints against ISPs are handled in a fair and efficient manner;
- promote positive user relations with the Internet industry.

The Document was limited mainly to the non technical aspects of the service bar from a reference to speed. With respect to speed, which was and still is, the key characteristic by which ISPs differentiate their broadband packages, the Authority took the initiative to set up an independent internet speed testing facility[3] which could measure the upload and download speed of an internet connection from the end-user to the Malta Internet Exchange (MIX)[4], a point that is considered equidistant to all ISPs.

The larger ISPs, which together encompass 99% of the broadband internet market share, have also taken the initiative and partnered with Ookla Metrics to provide a local test point which is available on www.speedtest.net.

Both the MCA and ISP's speed test facilities provide subscribers with an essential tool to measure their broadband service at a point in time.

To date, a broadband internet connection is characterised at point of sale on the basis of:

- upload and download speed;
- the volume of data to be transferred over the connection;
- the platform over which the access network is based.

[2] ISP Code of Practice - http://www.mca.org.mt/article/mca-and-isps-launch-%E2%80%98-isp-code-practice%E2%80%99

[3] Health Monitoring System (IHMS) http://www.nethealth.net.mt

[4] The MIX is an interconnection point which is used by the local service providers to interconnect together. Such interconnection allows the transfer of data between service providers without the need to use international connectivity points.

In addition, all speeds are quoted on an "up-to" basis.

This situation gives rise to two concerns; the first relates to whether the qualities currently used, namely upload and download speed and volume of data are adequate to appropriately characterise the service and second, what are the acceptable methodologies which should be employed to measure these qualities.

There is therefore a need to establish a QoS framework that will ensure that:

- subscribers have adequate information that will allow them to subscribe to a broadband service that meets their needs;
- the ISP has adequate measures in place to be able to provide the service sold; and
- all ISPs are publishing information using the same measuring methodology thereby allowing for direct comparison of the services on offer by different ISPs.

This document puts forward for consultation a **Quality of Service Framework** in respect of broadband Internet services and addresses the following three objectives:

- the identification of a minimum number of parameters considered suitable to characterise a broadband Internet service;
- the establishment of the relevant methodology to measure these parameters; and
- the establishment of a set of obligations that will be incumbent on ISPs and which will establish with a level of confidence, that the service available to the subscriber is the service contracted.

At this stage it is not the intention of the Authority to specify the absolute minimum acceptable values for each parameter mentioned in this consultation process. It is up to the ISPs to tailor their own packages in order to reflect the needs of their subscribers and the market in general. The Authority is however proposing a minimum level of service relative to any performance figure included in service contracts that a service provider must respect.

This is without prejudice to any future decisions the Authority might issue under its legal powers under regulations 39(c) of SL399.28 which provides for the establishment of minimum quality of service levels.

2 Legal Background and Scope of Consultation

Regulations 39[1] and 39[2] of the "Electronic Communications Networks and Services (General) Regulations" SL399.28 of the Laws of Malta[5] (hereinafter "ECNSR") empowers the Authority, subject to a public consultation, to require ISPs to measure and publish a set of QoS parameters suitable for the service they offer, which information must be published in a manner which is comparable, adequate and up-to-date.

Further to the provisions in Reg 39, Reg 37 of the ECNSR specifies that service or network providers must publish the QoS information specified in Regulation 39 in at least the following channels:

- at the point of sales, either verbally by the representative or through material easily accessible by the subscriber available at the retail outlet;
- on a website if the network or service provider owns one.

Regulation 35[1][b][iv] of the ECNSR requires the service providers to include the following information in the contracts concluded with their subscribers:

- the service availability;
- the minimum access speed, which should not be significantly lower than the marketed upper limit;
- information about the forms of traffic management and other restrictions on traffic which the ISP adopts on its connections.

Regulations 35, 37, and 39 of the ECNSR are equally applicable to ISPs without distinction to the platform over which the Internet service is delivered. Also, Regulations 35 and 37 of the ECNSR, do not distinguish between broadband subscribers who avail themselves to contracts offered by the ISPs and those subscribers which negotiate tailored contracts with the ISPs.

The proposals presented in this consultation should, at least at this stage, and without prejudice for the Authority to issue further decisions under its legal powers under Regulations 35, 37 and 39 of the ECNSR to extend the scope of quality of service, are limited to:

a) Broadband Internet service which is delivered using fixed access networks; these include both wired services and fixed wireless access networks. For the avoidance of doubt, broadband internet which is delivered over mobile networks is not within the scope of this consultation.

b) Any reference to the term subscriber is restricted to individuals or entities which avail themselves to contracts on offer by the ISP. Individuals or entities which

[5] As per S.L. 399.28 of the Laws of Malta

negotiate a tailored contract with their ISPs are beyond the scope of this consultation.

3 Quality of Service Framework

3.1 Guiding Principles

The QoS framework which is presented in this document is based on the following four principles:

- Broadband subscribers have a right to choose the ISP which best suits their needs. A subscriber therefore needs to have access to the right information that will enable an informed decision to be taken and that will facilitate comparison of services being offered on the market.
- Broadband subscribers have a right to know the performance of the broadband service that they are subscribed to.
- ISPs should only propose broadband packages on the market which they can physically provide. They should also ensure that their networks are appropriately designed /configured to provide the service sold for the duration of the contract term.
- Competition between ISPs should be based on information which represents realistically the service that ISPs are providing.

3.2 Establishing the Boundaries

3.2.1 Type of QoS parameters

There are two primary categories of QoS parameters;

- Technical parameters are those that characterise the performance of the network. E.g. download speed attainable;
- Non technical parameters, such as those which reflect on the way that the ISP delivers his service. E.g. the time taken to connect and disconnect a user from the network.

Without diminishing the importance of the non technical aspects of QoS measures, this Consultation is limited to the technical aspects of QoS parameters related to the performance of networks utilised for the provision of a broadband Internet service.

3.2.2 Delineation of network points

The term QoS has been traditionally attributed to voice and telephony related services. It is generally used to quantify the level of service that a user at 'Point A' gets when connecting

to 'Point B'. In extending this concept to broadband services, either of the points can be web application server(s), or a person, or a mixture of both.

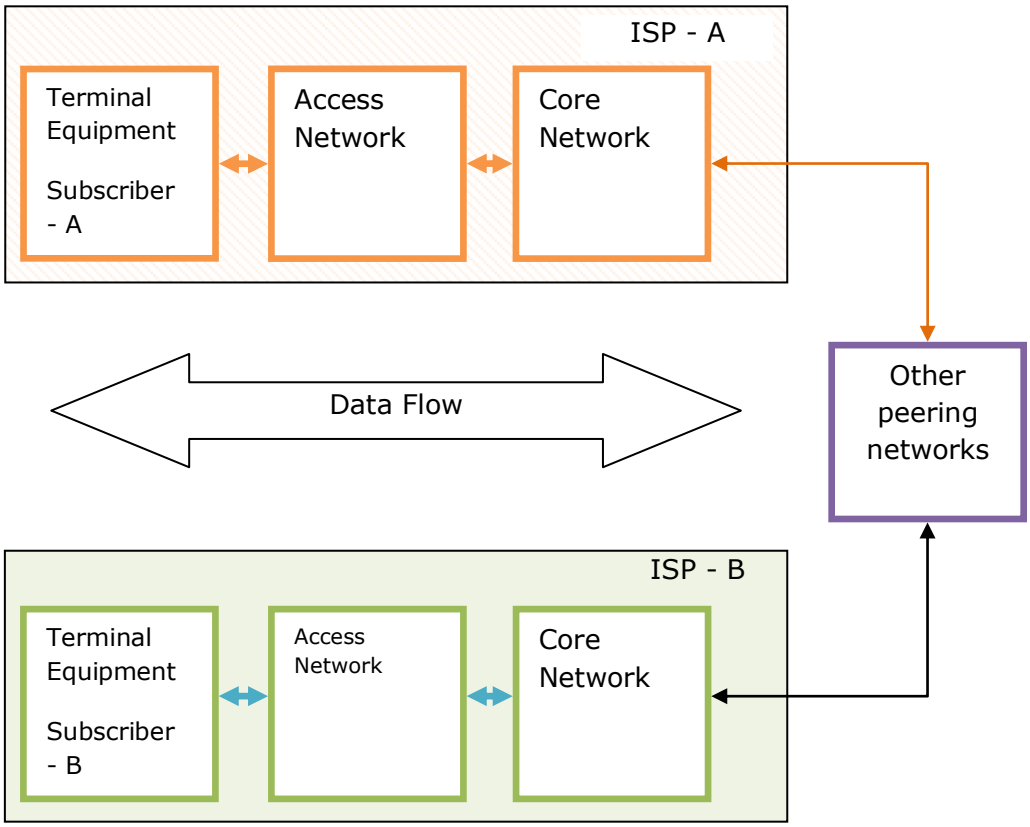


Figure 1 Schematic contribution towards end to end quality of service

In order to illustrate better the concept of QoS in the context of broadband services, Figure 1 above presents a simplified block diagram of the elements which are required to establish a broadband connection between two parties. A description of the main function of these elements is given in Appendix 2.

As data flows from point A to point B and vice-versa the QoS between these two points will be a result of the impact on quality of the various elements.

An ISP therefore has full and direct control over its QoS only when it owns all the network elements. This would be the case when Subscriber A is accessing a site hosted on his ISP's network. However, subscribers use their broadband service to access, at large, sites that are hosted on networks other than those of their ISP. In this case, the level of control that such an ISP has on the QoS, is impacted by the service level agreements which the ISP has with its upstream providers.

In view of the above, a clear delineation of the network boundaries applicable to the measurement of internet QoS is therefore essential.

Any performance figures will therefore need to clearly identify the points between which the measurements are made.

3.2.3 Different aspects of QoS

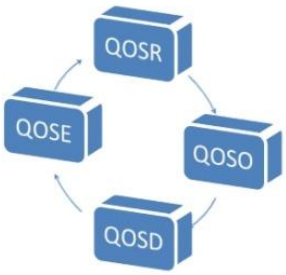
ITU-T E.802 Framework and Methodologies for the Determination and Application of QoS Parameters (International Telecommunications Union, 2007)[6] presents four distinct viewpoints of QoS. In general, a service such as broadband internet is collectively characterised by a group of parameters and it is their application at the different stages of the subscription cycle which gives rise to the difference in the types of QoS. Each QoS viewpoint is discussed below.

- **QoSR - Customer's QoS requirements -** Each application available on the Internet requires a level of performance form the Internet connection in order for it to operate satisfactorily. In turn, every subscriber has his preferred applications, and inherently a requirement of the level of performance of his Internet service.

- **Service Provider's offering of QoS – QoSO** - These parameters relate to the QoS that the ISP pledges to offer its subscribers. This point of view is of particular interest since it forms the basis upon which the subscriber is buying the service. QoSO should also serve as a reference to both the subscriber, and the ISP when benchmarking the level of service which is provided (Refer to QoSD below). To date at the point of sale the service is primarily being characterised in terms of upload/download speeds of the internet connection on sale and even here there are no quality of service commitments included.

- **QoS achieved or delivered - QoSD** - These parameters establish the actual level of the service being delivered to the subscriber. A comparison between the QoSO and the QoSD indicates the level of performance achieved by the ISP in terms of specific parameters. While the end-user is only able to observe the delivered QoS of its own connection, the ISP can measure the level of service delivered over the larger scale of the whole network or of a statistically significant part thereof. By comparing the QoSD with the QoSO, the subscriber is better equipped to determine whether there is a significant mismatch between the promised and the delivered services.

- **Subscriber/End-User perception - QoSE -** End-Users are generally not interested in the technical aspects of their connection but they are interested in what they can do with the connection, and the quality of their experience when accessing the different applications over their internet service. Given the variability and subjectivity of users' assessment of experience, it is not



[6] http://www.itu.int/rec/dologin_pub.asp?lang=e&id=T-REC-E.802-200702-I!!PDF-E&type=

possible to correlate directly any measured quality of service with the level of user satisfaction.

QoSR and QoSE tackle QoS from aspects that are more subjective given that they are highly driven by the subscribers' preferred uses and their expectations. On the other hand QoSO and QoSD are more quantifiable and therefore more suitable in establishing the quality of service being delivered. Furthermore, being quantifiable, a measurement mechanism which can be applied uniformly across different ISPs can be established.

This QoS framework will focus on Quality of Service Offered and Quality of Service Delivered.

3.3 Quality of Service Offered and Quality of Service Delivered

To date, the information which accompanies the sale of an internet connection consists of:

- upload and download speed;
- the volume of data to be transferred over the connection;
- the platform over which the access network is based.

It is however recognised that it is complex to characterise the service in full due to the following aspects which are specific to broadband Internet service. In an ideal scenario, a set of performance parameters are considered complete if the parameters are able to capture the net effect of the different network conditions which may affect the actual performance of a service. However ISP do not have the full control over all the elements involved in the network. Therefore, it is possible for those elements which are beyond the control of the ISP to influence, possibly even negatively, the QoS actually being delivered to an ISP's subscriber.

The current practices used by the ISPs, give rise to a situation in which:

- the characteristics which are currently used by ISPs are not necessarily adequate to define the service;
- services are normally sold without providing their subscribers with a guarantee on the minimum performance;
- subscribers are not given any guidelines on how the quoted service characteristics should be interpreted; and
- performance figures quoted by different ISPs cannot be directly compared.

In order to mitigate such a situation this QoS framework:

- puts forward a minimum set of parameters which characterise a broadband service and which are feasible to measure;
- proposes the general mechanism by which the parameters should be measured, thus ensuring the uniformity of the data across different measurement and reporting sources;
- proposes the establishment of a mechanism by which ISP conformance to the contractual obligations with their subscribers can be validated;
- proposes, adequate statistical boundaries linked directly to quoted service contract parameters.

4 Minimum Parameters for defining a Broadband Service

In its guide[7] on quality aspects related to internet access ETSI characterises a broadband service in a number of relevant parameters. The International Telecommunications Union ('ITU') in its recommendation on Transmission Systems and Media, Digital Systems and Networks[8] also identifies the key quality aspects that influence the delivery of different Internet based services.

The parameters that are presented below take into account the above reference documents. It is proposed that this is established as the minimum list of parameters required to characterise a broadband Internet service. In establishing this list of parameters the Authority has also taken account of the different types of applications that are currently accessed via the internet.

4.1 Data Transmission Speed

- Upload direction as available to the end user.
- Download direction as available to the end user.

As highlighted earlier, data transmission speed has long been established as a key quality parameter of broadband internet.

4.2 Availability of Internet Access

Internet is nowadays an 'always-on' service to which the user can log onto at anytime without restrictions. This parameter intends to quantify the amount of time for which the service is available to the end user.

ETSI ES 202 765-4 defines Availability of Internet Access as the metric which represents the probability that the end user is able to access Internet applications via his Internet connection.

In general, service downtime due to planned maintenance is not considered as downtime as such maintenance is required for the well being of the network and it is generally undertaken during the off-peak hours of the network. Nevertheless, ISPs are obliged under Article 8[b] of the Electronic Communications (Regulations) Act Chapter 399 of the Law of Malta (hereinafter ECRA) to notify the Authority and publish in the media any planned down time.

[7] ETSI EG 202 057-4 Speech Processing, Transmission and Quality Aspects (STQ);User related QoS parameter definitions and measurements; Part 4: Internet access

[8] ITU G.1010 http://www.itu.int/rec/dologin_pub.asp?lang=e&id=T-REC-G.1010-200111-I!!PDF-E&type=items

4.3 Latency

Latency is a measure of the time interval between the instance that a packet was launched from machine 'A' to the moment it was received by machine 'B'. It is a measure of the delay incurred due to network related distance and the time taken for the routers involved in the data transmission path to buffer the datagrams in their storage area before these are processed and transferred to the appropriate network.

The QoS experienced when accessing applications such as video-on-demand services, Voice over IP (VoIP), online gaming and similar applications that require a real time response, is highly dependent of this parameter. The lower the latency figure is, the better the performance of these applications is.

4.4 Packet Loss

Packet Loss relates to the failure of one or more transmitted packets of data to arrive at their destination. Packet loss could be experienced as a result of a number of situations such as network congestion, network equipment problems, and traffic prioritisation.

Packet loss is cited as a percentage ratio of the packets that did not arrive at their destination to the total number of packets transmitted over a specific time interval.

The importance of this parameter lies with the fact that although a connection may enjoy high throughput speeds, the connection may be rendered useless if the number of packets lost in the system is high. All Internet based applications suffer under high packet loss conditions. In non-real time applications, packet loss manifests itself into slow service, while in real time applications such as video streaming packet loss would manifest itself in disruption of the application.

Therefore, the lower the Packet Loss is, the better the broadband connection and service are.

4.5 Proposals

At present the "Electronic Communications Networks and Services (General) Regulations[9]", establishes that, as a minimum, ISPs should include in their contract reference to

- Availability of internet access; and
- Access speed.

[9] Regulation 35 of SL 399.28 Electronics Communications Networks and Services (General) Regulations

Specifically with regards to speed the ECNSR establish that the actual access speed provided to the end user must not differ significantly from the sold service. This point is developed later in section 6.3.

Providing the subscribers with a comprehensive list of QoS parameters in their contracts may be considered too detailed and too technical for the majority of users and the two characteristics already captured in legislation as listed above are currently considered sufficient. However, there is a growing segment of users whose specific needs warrant a broadband service that meets certain performance in areas other than speed.

It is therefore proposed that:

Proposal 1

1. The ISP will be required to measure and maintain records of:
    a. Speed (Download & Upload);
    b. Internet access (Network Availability);
    c. Latency;
    d. Packet Loss;
2. ISPs will be required to publish these figures on a quarterly basis as a minimum.
3. The method used to collect and present the information should respect the proposed procedures as described later in section 5.

5 Measuring Actual Performance

An appropriate and transparent measurement methodology needs to be in place in order for any performance figures published by different entities to be meaningful. In addition, the use of methods harmonised across different ISPs allow for comparable results.

This section puts forward a method for measuring each QoS parameter identified in section 4 and the statistical method by which the data about each parameter is to be collected.

5.1 Parameter Measurement Methodology

5.1.1 Data Transmission Speed

This parameter can be measured by using data transfers of non-compressible files such as files containing randomly generated data or highly compressed media files (e.g. JPEG and MPEG files). The size of the file should be such that the time taken for the connection speed to reach its peak from zero (initial ramp-up period), and zero from peak (final period) is insignificant when compared with the time taken from the connection to work at its peak performance. ETSI ES 202 765-4 V1.1.1 suggests that the test time of ten seconds is appropriate.

Alternatively, the data transmission speed of a connection can be estimated by making use of network tools such as the polling of SNMP counters that are normally maintained by routers from specific concentration points within the core network of the ISP. This is possible since concentration points normally have the visibility of the packets originating from or terminating to all the subscribers of the ISP and the rate which packets arrive to and leave from these concentration points reflects the speed experienced by the end-user.

5.1.2 Availability of Internet Access

Availability of Internet access is a measure of the periods of time during which the service is available during an established time period. This equates to the ratio between the times during which the Internet service is not available as a ratio of the complete period of analysis. Availability of Internet Access = (Total Operational Minutes – Total Minutes of service downtime)/Total Operational Minutes *100% on a quarterly basis.

This parameter can be measured by checking the accessibility of different web services both within and outside the ISPs network. The mixture of the chosen web services should include services which are hosted both on local and internationally sited servers. The number of web services checked should be such that it is ensured that a false negative is not generated due to a single server being inaccessible.

All scheduled downtime for the purposes of maintaining and upgrading the network will be excluded from the calculation provided that the ISPs inform both their users and the Authority of such service downtimes in advance in the manner(s) as specified at Law.

Any downtime caused by upstream service providers should be included in the calculation.

It is also recognised that the Customer Premises Equipment providing internet access to the end-user could be switched off by the same end-user during certain periods of the day leading to a significant skewing of the measured parameter. For this reason any measure of availability can exclude the CPE.

5.1.3 Latency

In line with ETSI ES 202 765-4 and ETSI ES 202 057-4 latency is equivalent to the time taken for a packet to travel from point A to point B. It is estimated as half the time taken for an ICMP Echo request/reply between the subscriber's CPE and the ISP's core network.

Provided that there is a possibility that a number of ICMP requests between two points do not follow the same path, then the average latency figures collected over a number (minimum of 5 successive pings) of ICMP Echo request/reply pairs would be necessary.

5.1.4 Packet Loss

Packet Loss is measured as the ratio of the number of ICMP echo/reply packets (minimum of 5 successive pings) which are lost during the transmission as opposed to the total number of ICMP requests. An ICMP ping request which does not generate a counter reply is deemed to be lost.

For the purposes of measurement of Packet Loss, the ICMP echo/reply packets are originated from the ISP's core network.

5.2 Measurement Data Collection Methodology

In this section, two distinct data collections techniques are presented which may be applicable in different scenarios.

5.2.1 Passive Data Collection Method

The passive data collection technique refers to a mechanism by which QoS measurement data is collected from the flow of data that occurs naturally on the connection through normal usage, without the need of any specific software and hardware at the subscriber's side. This is considered to be the least invasive manner to collect statistical data as unlike active data collection techniques, this mechanism does not make use of injected test data into the network. This removes any possibility of over filling the network resources with test data. Additionally, since passive measurements do not require data generators, QoS can be successfully measured through appropriate data analysis at concentration points within the ISPs core network.

This method to collect information relies on the data which occurs on the network and therefore, this data is not engineered to emulate the flow of data packages over the network due to pre-determined usage of specific services on the basis of an individual user. However, it is assumed that with the appropriate sample base, and duration of data measurement period, the test data used to collect QoS performance would be representative of the data which the network is normally subjected to.

In its strictest form, passive data collection technique cannot be applied to measure latency and packet loss, since the nature of the measurement of the two parameters is based on the transmission and reception of the ICMP echo request. However, since the correct execution of the test does not require any specific hardware or software on the client side and the ICMP echo request can be originated from the ISP's side then, for the purposes of this consultation, both tests are considered to be possible using passive techniques.

5.2.2 The Active Data Collection Method

In this data collection method the QoS data is assessed by observing how the connection would behave when injected with a data stream which is specifically tailored to simulate the usage of different applications normally available over the Internet in a manner which is consistent throughout the whole duration of the test period. This mechanism consists of a setup in which two active points are placed at the end-points of the network to be observed. One of the points would be able to request the transfer of data in either direction, while the other active point would be tasked with meeting the requests. Either of the points may measure the flow of data and thus estimate the quality of service of the portion of the network between the two points. In order to measure the QoS between the ISP and its subscriber, the observation points need to be located at both entities.

The main advantage of this method is that the data is originating from a controlled source and therefore its frequency, volume, target machines and types of services can be fully controlled. Each of the mentioned variables is considered to be fundamental towards a coherent QoS measurement and therefore the controlled data source allows the comparison between the measurements obtained by different users, and different ISPs.

The main disadvantage of this approach is that the test data can only be launched from the end-user premises and therefore specific resources either in the form of software, or in hardware are required at the end user premises. This can pose a limitation in terms of scalability of the measurements due to cost.

5.2.3 Proposals

Proposal 2

The Authority recognises that although the active testing technique produces the most accurate results in terms of broadband internet QoS measurement, this may also be the most expensive method to collect QoS information. Therefore, without prejudice to future decisions that the Authority may need to consider it is proposed that the ISPs should employ the passive method technique to collect all the QoS data indicated under section 5.2.1.

It is also proposed that measurements are carried out in line with established technical standards as outlined in sections 5.3 and 5.4.

It is further proposed that the location points of any measurements are retained for all measurement data.

From its end, the Authority is planning to conduct a periodic measurement exercise using the active measurement approach as identified above to quantify the QoS level of broadband Internet service as offered locally on the basis of the established QoS parameters. The main aim of such campaigns is to obtain a comprehensive picture of the level of service which is experienced by the subscribers.

The Authority shall, conduct a separate consultation process on the method it shall be using to collect the QoS information and the level of detail it would use in the publication of the results obtained.

5.3 Statistical Methodology of Data Collection

Given the large volume of data transfer and the size of the networks, a statistical basis for parameter measurements is required. A sound statistical methodology will need to appropriately factor the population size and the variability in the internet service. The main variables in the broadband Internet services relate to:

- the network load, which is generally a variable of time;
- a geographical aspect which may be influenced by contention ratios in the case of shared access networks or distance of the subscriber to the exchange in the case of DSL networks.

Proposal 3

It is therefore proposed, that the sample size used to collect the data should be such that the resultant statistics would enjoy a margin of error which is not larger than 5%, provided that the sample base is representative of:

- Each individual broadband package offered by the ISP;
- The distribution of the subscribers across the whole territory of Malta and Gozo;
- The distribution in time over a 24 hour basis, 7 days a week with the exclusion of periods in which there is no service due to preventive maintenance, provided that the subscriber is advised of such downtime with an adequate notice period.

5.4 Presenting Measurement Results

The following basic principles apply to the presentation of results:

- Measurement information should be easily accessible and should be made available to the subscriber with the same ease that sales information is available to him.

  One of the most feasible areas to insert such information is the web page of the ISP.

- The information presented should be easily understandable, presented in a user friendly format and using non technical language.

  The presented information should be accompanied by the necessary explanation notes and clarifications which render the same published information meaningful to the subscriber.

- Information originating from different ISPs should be formatted in such a way that the subscriber can easily compare different services either from the same provider or from different providers.

The Authority is of the view that at this stage, it should not establish detailed rules regarding the format in which the QoS measurements are to be published. It is only establishing the basic principles that undertakings will be required to adhere to when publishing this information. This does not preclude the possibility that the Authority will intervene at a later stage if it is established that more prescriptive requirements need to be laid down particularly to ensure that the information is understandable to the subscriber and can easily be compared across different providers.

Proposal 4

The Authority is proposing that ISPs should be allowed to present the information in a format they deem appropriate, provided that this reflects the above principles and that the statistical information is collected and processed as proposed earlier in section 5.3.

Such information should, as a minimum include:

- the margin of error of the published statistical figures;
- the methodology used during the collection of data including any limitations which apply to the same statistical information;
- a clear identification of the location points between which the measurements were taken;
- the QoS information of each broadband package per geographical region. A geographic region is represented either on the basis of locality as established by the Local Councils, or in regions as commonly used by the National Statistics Office, which is found in The Demographic Review of 2010 and reproduced in Appendix 3.

6 Network Performance Considerations

The previous sections have focused on proposals leading to the measurement of key characteristics that give a reliable representation of the quality of service delivered to end users. As explained earlier this performance is however influenced by the performance of network elements that are outside the control of the ISP.

In this section of the consultation, a set of network performance parameters are presented to compliment the end-to-end QoS parameters discussed earlier. The main aim of these parameters is to propose a mechanism which measures the performance of the ISP's network in isolation from the performance of third party networks[10].

In the case of substantial deviation between the QoS delivered and the service contract obligation, the Authority will take into consideration the network performance measured on the basis of the proposals put forward in this section.

6.1 Network Performance Parameters

As discussed earlier, since the ISP can only control its own network elements, a set of distinct, yet complimentary parameters are required to assess the suitability and availability of the resources of the ISP to deliver the offers it places on the market to its subscribers.

[10] In the context of this document, networks belonging to third parties include the networks which the ISP does not have a direct or indirect control on. These include foreign networks beyond the first international Point of Presence of the ISP and the subscriber's network.

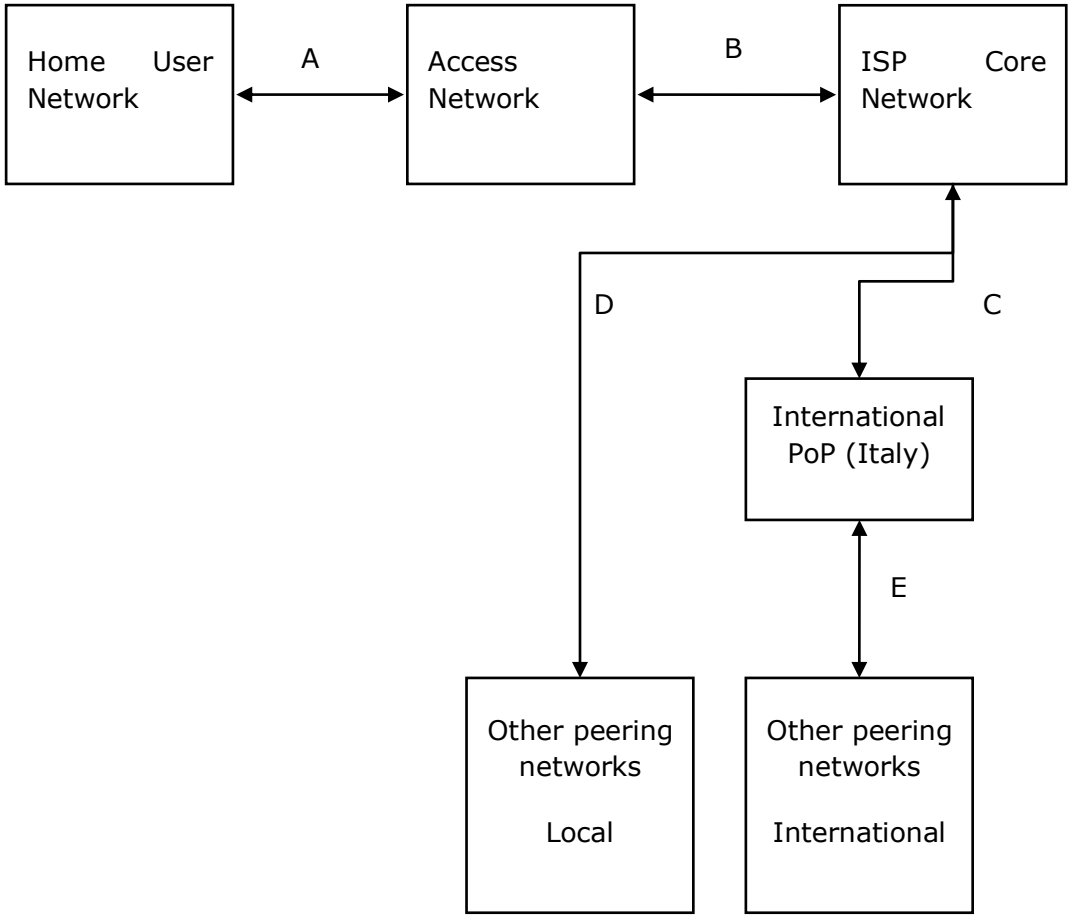


Figure 2 High level schematic diagram of a generic ISP setup

6.1.1 Connection Oriented Parameters

Quality of service is directly influenced by the availability of resources in the connections between the ISPs and other third party networks. On the basis of this, connection oriented parameters are being restricted to:

- Access network
- International Connection
- Local Connection

The Access network is delineated in Figure 2 above, by connections labelled "A" and the component labelled Access Network. This delineation encompasses the connection of each individual subscriber, up to the point where these are aggregated to the point of connection of the core network.

The performance of the access network in the same geographical area is typically similar. It is therefore considered practical to aggregate any performance measurements either on the

basis of locality as established by the Local Councils, or in regions as commonly used by the National Statistics Office, and which is found in The Demographic Review of 2010[11] reproduced in Appendix 3.

Under normal circumstances, an ISP would have at least one International connection to be shared among all of its subscribers. Additionally, the ISP may opt for another connection to peer with local ISPs (local connection) without the need to use the international bandwidth. Therefore it suffices that even in cases whereby an ISP has more than one connection (for say resilience purposes), the information about these connections is aggregated as one connection. Connections labelled C and D in Figure 2 above refer to the local and international connections respectively.

In order to delineate the area of influence of the ISP and isolate the ISP's network from the remaining parts of the Internet, the boundaries that are appropriate for the international connectivity point should be extended to the first international Point of Presence (PoP) where the international connection is terminated.

The following connection oriented network performance parameters are considered to be representative of the general QoS being achieved and are considered to be applicable to the Access, Local and International Connections as delineated above.

- Available Data Rate – the data rate, measured in bits per second that a connection can handle.
- Connection utilization – the ratio between the actual bandwidth which is committed and that is in use as a percentage of the Available Data Rate of a given connection. Low connection utilization rates of a specific connection are indicative that this is not the cause of bottlenecks, while high utilization rates are indicative of possible congestion.
- Packet Drop Ratio - A congested data connection manifests itself by dropping packets out of the system. This parameter is defined in a similar way to Packet Loss as in section 4.4 above however, the parameter is measured only on a single connection.

The measurement of these parameters can be carried out by various means such as the use of dedicated equipment and/or the polling of SNMP counters as maintained by the relevant routers, as well as the use of proprietary management software. All these methods are considered valid measurement mechanisms.

6.1.2 Core Oriented Parameters

The core network of any ISP also impacts the quality of service given that it links all the separate network elements altogether. Any under dimensioning in this element will result in performance issues that could impact the whole network.

[11] http://www.nso.gov.mt/statdoc/document_file.aspx?id=3173

In Figure 2 above, the core network has been depicted by links labelled B and the component labelled ISP Core Network. These two elements, represent all the connections originating from the Access network, and are concentrated onto the points which connect the ISP to the Internet. This representation is described in more detail in Appendix 2. For the purpose of the measurement of the parameters related to the core network, the different elements comprising the core network are to be aggregated such that all the interfaces related to the access network are averaged out together and considered as one. Likewise, the interfaces connecting the core network to the international and local connection are aggregated together. The two most significant parameters identified to be used to quantify the performance of the core network are:

- Bandwidth Utilization – the ISP can only offer a good quality of service to the subscribers if there is enough bandwidth in the segments between the Access and the Core layers and between the Core and International Gateway layers. The bandwidth utilisation measured during the Time Consistent Busy Hour (TCBH) is a good indicator of the performance of the core network.

- Packet Drop Ratio – Packets which are dropped out of a system are symptomatic of instances in which the network is overloaded either due to bursts in traffic patterns or due to a chronic under-dimensioning of the core network.

6.2 Network Performance Monitoring

The performance of the ISP's network establishes the QoS threshold that can be delivered to the subscriber. In other words, a subscriber can never experience a QoS that is better than that provided by his ISP's network. Therefore, it is justified to expect that an ISP

- would have carried out its own internal studies to establish its capability to provide new service offerings at the required level of quality; and
- would regularly monitor its network performance to ensure that the network is maintained properly to meet the service contract obligations.

Proposal 5

The Authority is proposing that in cases of

a) consumer complaints received at the Authority citing significant deterioration of broadband QoS; and/or
b) a deterioration of broadband QoS is observed by the Authority through studies which it may conduct from time to time or otherwise,

the Authority may deem necessary to request information from the relevant ISP about its Network Performance in order to establish the source of the said deterioration. In doing so, the Authority will be assessing the network performance of the ISP using the connection oriented and core network related parameters listed in sections 6.1.1 and 6.1.2

6.3 Service Contract Obligations

At present the minimum service contract obligations are established under Regulation 35(1)(b)(iv) subparagraph (4) and (5) of ECNSR. These require ISPs to include in the contract they offer to their subscribers the:

- minimum service availability;
- minimum access speeds in case of Internet service, ensuring that these do not differ significantly from the marketed upper levels; and where appropriate, other quality of service parameters as defined by the Authority.

However, to date a clear interpretation of the term "differ significantly from the marketed upper levels" has not been established. ISPs currently market their broadband speeds using the "up-to" proviso, indicating to their subscribers that the advertised speed, also known as headline speed, may not be reached in some instances. This is normally justified on the basis of fluctuations in the network load outside those catered for by the contention rations in use. However, the Authority has, in the past, received complaints from subscribers claiming that their broadband speeds were "low" at times indicating that the headline speed was never achieved. Such a situation while currently meeting contractual obligations does not reflect the spirit of the law. In addition it is recognised that:

- Subscribers need accurate and relevant information about the broadband package they are to contract to in order to make informed choices. The Authority views the expected performance of the broadband connection as information of crucial importance to the subscriber.

- The "up to" clause used in the description of current broadband packages, does not in itself set any limitations on the performance of the connection.

- ISPs are the suppliers of the broadband service and should therefore inform their subscribers about what level of performance they should expect from the service they have subscribed to.

Various approaches have been taken by different countries in their exercise to establish how broadband speeds should be specified and the level of service that should be offered to subscribers. Two approaches are particularly relevant. These are the Hungarian Law **on the requirements related to the quality of electronic communications services in relation to the protection of consumers**[12] and the voluntary code of practice on broadband speeds issued by Ofcom in 2010[13].

In the approach taken in the Hungarian law, it is specified that the ISP is expected to provide a minimum level of service, while, at the same time it is also allowed a margin in which the service delivered may not be exactly at par with that promised. In the quoted legislation, ISPs are to guarantee the performance of the connection for 80% of the cases.

In their code of practice on broadband speeds, Ofcom has adopted an approach in which ISPs should indicate at the point of sales, along with the headline speed, the typical speed which the advertised connection typically achieves. The ISP is required to derive the Typical Speed Range (TSR) from actual results achieved by connections on a particular broadband package. The TSR is to be chosen such that it falls within the 20th and the 80th percentile range of its actual results.

The Authority considers the mechanism adopted by Ofcom a reasonable proposal that allows an ISP to put on the market packages that reflect the capabilities of their networks while protecting the interest of the subscribers.

[12] http://www.nhh.hu/dokumentum.php?cid=16748&letolt
[13] http://stakeholders.ofcom.org.uk/telecoms/codes-of-practice/broadband-speeds-cop-2010/code-of-practice/

Proposal 6

- The Authority is proposing that ISPs should qualify the broadband access speed through the use of a TSR which is computed in line with procedure 6.3.1 in the case of existing connections and according to procedure 6.3.2 in the case of new broadband packages.

- The established TSR should be indicated to the subscriber
  - In any advertising material with importance similar to the headline speed
  - At the point of sale
  - In the subscriber's contract. It should be made clear, that ISPs will not required to include the TSR information in any of their existing contracts.

- An ISP should not sell to its subscribers connections which cannot perform within the limits of the TSR

  Provided that in the case whereby a subscriber insists in purchasing a particular package in spite of the fact that the ISP cannot guarantee the performance of the connection within the established TSR, the subscriber contract should reflect this particular scenario.

The Authority expects ISPs to calculate the TSR figures on a quarterly basis and to maintain the statistical data related to the latest TSR figures for audit purposes.

6.3.1 Estimating a Typical Speed Range for packages already on the Market

In this section, it is proposed that the TSR for broadband packages which are already on the market should be determined on the performance of the connections sold.

The ISP should, for each broadband package bearing a different headline speed, establish and publish the TSR according to the following procedure:

a) The ISP should choose a statistical sample out of the sold broadband connections which is representative of all the connections sold under the same headline speed. The chosen sample should be such that the resultant statistics would enjoy a statistical margin of error of 5% or better.

b) The access speed of the group is that measured over a period of time, which should not be less than a month. The access speed information should be representative on a 24/7 basis.

c) The 80th and 20th percentile marks should be then used as the TSR of the particular package.

6.3.2 Estimating a Typical Speed Range for new packages

In the case of new speed packages, the ISP should use realistic and prudent estimates to calculate the TSR using network information.

Following the launch of a new package, the ISP should monitor the performance of the broadband connections sold under an estimated TSR and ensure that the estimated TSR is met. Should the estimated TSR be significantly different from the actual TSR the ISP should inform its subscribers of that particular package with the revised TSR by way of changing the subscribers' contract using the established mechanism under decision "Modifications to the Terms and conditions of subscriber contract" issued by the MCA.

6.4 Obligations of Network providers versus ISPs

While the Authority notes that the largest ISPs which between them have over 99% of the local broadband market share, are fully vertically integrated the Authority is cognisant of the fact that some ISPs may rely on agreements with their upstream providers to be able to provide broadband connections to their subscribers.

Proposal 7

The Authority is therefore proposing that contracts regulating the agreements between the upstream and the downstream providers will need to include as a minimum, the necessary performance commitments in terms of the Network Performance parameters, that will allow the downstream provider to offer to its subscribers the required level of service as put forward in this consultation.

7 Implementation Timeframes

The MCA is proposing that the complete implementation of the QoS Framework would be spread out over a period of a year starting from the publication of the final decision of the QoS Framework as follows:

a) The ISP will be required to measure and publish performance figures on a quarterly basis of the four identified QoS parameters as per the proposed methodology by not later than nine months from the publication of the final decision of the QoS framework.

b) The ISP will be required to publish the TSR's and include them in all new contract as per Proposal 6 by not later than nine months from the publication of the final decision of the QoS framework.

8 Consultation Framework

The MCA invites comments from interested parties regarding this Consultation Document. The consultation period will run until 12:00pm on Wednesday 28th March 2012. Comments should be sent to:

Chief of Technology and Spectrum Management
Malta Communications Authority
Valletta Waterfront
Pinto Wharf
Valletta FRN 1913
Malta

Tel: +356 21 336 840
Fax: +356 21 336 846
E-mail: broadbandqos@mca.org.mt

Written representations will be made public by the MCA subject to the MCA's Internal Guidelines on Confidentiality published on 16 December 2004.

Appendix 1 Legal Instruments

In this appendix a list of legal instruments available to the Authority under Chapter 399 of the Laws of Malta and related subsidiary legislation which refer to the obligations of broadband providers vis-a-vis quality of service.

Extracts from Electronic Communications Networks and Services (General) Regulations (SL 399.28 of the Laws of Malta)

Regulation 35

35. (1) In accordance with the provisions of article 23 of the Act an undertaking providing connection to a public communications network and, or publicly available electronic communications services shall provide its subscribers with a contract that shall specify in a clear and comprehensive manner at least:

.....

(b) details of the services provided, including in particular:

.....

(iv) The service quality levels offered, including as a minimum, the:

(1) maximum time for the initial connection and disconnection;

(2) maximum repair time for faults or other service failures;

(3) maximum response time for customer complaints and information requests;

(4) minimum service availability;

(5) minimum access speeds in case of Internet service, ensuring that these do not differ significantly from the marketed upper levels; and where appropriate, other quality of service parameters as defined by the Authority.

(v) information on any procedures put in place by the undertaking to measure and shape traffic so as to avoid filling or overfilling a network link and on how those procedures could impact service quality.

Regulation 37

37. (1) An undertaking providing connection to a public electronic communications network and, or publicly available electronic communications services shall, as a minimum, publish in a transparent, comparable, adequate and up-to-date manner:

(a) all the information specified in regulation 35(1);

(b) the information specified in accordance with regulation 39 (1), if so mandated by the

Authority;

(2) Without prejudice to any decisions that the Authority may take in this regard, the information referred to in subregulation (1) shall, be conveyed in a clear and comprehensive manner to end-users, at least:

(a) verbally by an authorized representative prior to take up of service and conclusion of a contract, if so requested;

(b) in writing at all retail outlets of the undertaking, such that it is readily available for inspection free of charge by the general public during normal office hours; and

(c) in writing on any website operated or controlled by the undertaking, preferably through the same page where the service is publicised or through a link set for this purpose, in a size and graphic presentation enabling the easy identification thereof.

Regulation 39.

(1) The Authority may, after taking account of the views of interested parties, require undertakings that provide connection to a public communications network and, or publicly available electronic communications services, to publish comparable, adequate and up-to-date information for end-users on the quality of their services and on measures taken to ensure equivalence in access for disabled end-users:

Provided that such information shall, on request, also be supplied to the Authority in advance of its publication.

(2) The Authority may specify, inter alia, the quality of service parameters to be measured, and the content, form, timing and manner of information to be published, including possible quality certification mechanisms, in order to ensure that end-users, including disabled end-users, have access to clear, comprehensive, comparable, reliable, up-to-date and user-friendly information:

Appendix 2 Essential Network Elements

The following are the key network elements that have a direct bearing on the Quality of Service.

Access Network

This refers to the network that provides the connection between the ISP and the end-user equipment. This connection is also termed as the last mile connection. There are two primary types of access network connections as follows:

- Fixed connections whereby the connection is restricted to a particular point, or
- Mobile connection with which, the end-user equipment can move freely in a specific geographic area which is defined by the covered radio network provides.

Each technology requires the use of different modulation techniques and hence a pair of modems is necessary, one modem is at the end-user premises (CPE) while its counterpart is at the ISP's premises.

Depending on the technology, resource management systems may also form part of this network so that the ISPs can control which users are entitled to access the network, and how resources should be shared in case of shared infrastructure.

Connections

An ISP needs to connect its network to other third party networks in order to offer Internet access to its subscribers. In order to achieve this, the ISP needs, as a minimum, a means of connection to other ISPs in the rest of the world. This is normally done by the ISP purchasing bandwidth on at least one of the international gateways. In Malta, the primary infrastructure for international connectivity consists of submarine cables between Malta and Sicily.

An ISP may also opt to make use of an additional connection to connect with other local ISPs without the need for such traffic to make use of the international connection.

Core Network

This may be considered as the 'glue' which binds the different elements together. In general the core network plays out the role of a gate-keeper in the sense that primarily it allows or denies connections to the network. Furthermore, the core network is also responsible for the traffic management which the ISPs normally employs in order to distribute the available resources, in line with the traffic management policies of the ISP, to meet the demand which the subscribers create.

The core network is, in general constructed of a number of IP routers which direct traffic from and to the different interfaces of the ISP. The detailed structure of the core network is tied with the logical and physical setup of each ISP, and therefore, no two core networks would be identical. However, at a high level, all core networks can be abstracted as a network which connects on one side to the access network and on the other to the outbound/upstream network.

Appendix 3 – Extract from the Demographic Review 2010 issued by the National Statistics Office

Referring document: Demographic Review 2010

Definitions and Methodological Notes

Section 6. Classifications pg XVII

Localities are classified into districts according to the Malta Geographical Codes (MGC) as follows:

Southern Harbour – Valletta, Senglea, Cospicua, Ħaż-Żabbar, Fgura, Floriana, Kalkara, Ħal Luqa, Marsa, Paola, Santa Luċija, Ħal Tarxien, Xgħajra

Northern Harbour – Ħal Qormi, Birkirkara, Gżira, Ħamrun, Msida, Pembroke, Tal-Pieta`, St Julian's, San Ġwann, Santa Venera, Tas-Sliema, Swieqi, Ta' Xbiex

South Eastern – Żejtun, Birżebbuġa, Gudja, Ħal Għaxaq, Ħal Kirkop, Marsaskala, Marsaxlokk, Mqabba, Qrendi, Ħal Safi, Żurrieq

Western – Mdina, Ħaż-Żebbuġ, Siġġiewi, Ħ'Attard, Ħal Balzan, Ħad-Dingli, Iklin, Ħal Lija, Rabat, Mtarfa

Northern – Ħal Għargħur, Mellieħa, Mġarr, Mosta, Naxxar, St Paul's Bay

Gozo and Comino – Victoria, Fontana, Għajnsielem and Comino, Għarb, Għasri, Ta' Kerċem, Munxar, Nadur, Qala, San Lawrenz, Ta' Sannat, Xagħra, Xewkija, Żebbuġ

Appendix 4 – Glossary

ICMP	Internet Control Message Protocol
ISP	Internet Service Provider
ECNSR	Electronic Communications Networks and Services (General) Regulations SL399.28 of the Laws of Malta
ECRA	Electronic Communications (Regulations) Act – Chapter 399 of the Laws of Malta
MCA	Malta Communications Authority
PoP	Point of Presence
QoS	Quality of Service
QoSD	Quality of Service Delivered
QoSE	Quality of Service Experience
QoSO	Quality of Service Offered
QoSR	Quality of Service Required
SNMP	Simple Network Management Protocol
TCBH	Time Consistent Busy Hour
TSR	Typical Speed Range