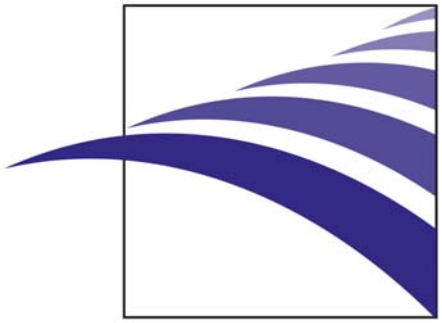
Issue: Draft for Consultation



Republic of Lebanon
Telecommunications
Regulatory Authority

Broadband Network Requirements

May 4, 2009

This document is issued by the Telecommunications Regulatory Authority of the Republic of Lebanon (the Authority). It is not a final, officially adopted document and will only become so upon completion of the consultation process and publication of the final draft.

This consultation draft is made publicly available on the Authority's web site to allow interested parties to submit comments and other relevant information. All decisions, regulatory requirements, opinions, recommendations and other information set out by the Authority in this consultation draft are tentative, and, based in part on the input received during the consultation process, are subject to being modified, supplemented or withdrawn by the Authority in its final draft. Interested persons may respond in writing to the Authority during the public consultation period. To be considered, responses must be received no later than 5.00pm Beirut time on the 15th of June 2009.

The address for responses sent by post or hand delivery is:

Telecommunications Regulatory Authority
Marfaa 200 Building
Beirut, Lebanon
Attention: The Chairman

Responses may also be sent to the Authority by email to broadband_network_requirements@tra.gov.lb or by fax to +961 1 964 341.

As part of its process to develop a complete record and allow open public access to the information that forms a basis for its actions and decisions, the Authority will generally publish all comments as received, unless respondents expressly ask that their responses be treated as confidential, in whole or in part. If any respondent wants the whole or any part of its submission kept confidential, then it should state its request, set out clearly the basis for its request, and enclose the information that it wants to be treated confidentially in a separate sealed envelope. If the Authority agrees that the circumstances warrant confidential treatment, then it will notify the respondent of the same and will open and consider the submission confidentially in this consultation process. If the Authority disagrees, then it will destroy the sealed materials without opening or reviewing them, not consider them in this consultation process, and notify the respondent of the same.

Responses for which confidentiality is requested must be submitted by post or hand delivery and not by email or fax. Failure to comply with this requirement may result in loss of confidentiality.

Draft for Consultation

Contents

Draft for Consultation

1. Background and purpose

This document sets out the network requirements that will be applicable to licensees under the broadband licensing plan of the Telecommunications Regulatory Authority of the Republic of Lebanon (the Authority). Reference is made to the broadband licensing plan and the other documents referenced therein. Terms defined in Telecommunications Law No. 431 of 2002 (the Telecommunications Law) or the decrees, regulations and decisions interpreting or implementing the same will have the same meaning when used in this document even though not capitalized herein.

This document has two primary purposes:

(1) To elaborate the network and service related conditions of the licenses, which will, to the extent possible, be technology neutral, in accordance with the Authority's policy of allowing licensees to build their networks using the technology of their choice. The broadband network and service description and standards detailed in this document are based on best industry practices and standards for ensuring interoperability and quality of service, and in particular those espoused by the Broadband Forum, ITU and WiMAX Forum.

(2) To specify the information that applicants must submit as part of their license applications about their proposed networks, services and operations. This information will be required: (a) to ensure that applicants are suitably qualified to hold the applicable licenses; (b) to ensure that planned networks comply with all requirements set forth in this document, the applicable license and any other applicable law, decree, regulation or decision; (c) to provide the Authority with information necessary to monitor the fulfillment of such obligations; and (d) to allow the Authority as a general matter to remain fully up to date regarding the planned and installed network infrastructure in Lebanon in order to carry out its regulatory responsibilities.

2. Licensing framework

The Authority's broadband licensing plan sets out the overall framework for the issuance of two types of licenses: national broadband carrier licenses (NBCLs) and national broadband licenses (NBLs), including the various obligations and privileges that will attach to each type of license and the exceptions that will be made with respect to those existing data services providers (DSPs) operating existing networks. As used herein, the terms NBCL and NBL may refer either to the license or the licensee as the context may require.

The following diagram (Figure 1) sets forth the general network architecture that the Authority anticipates will develop under its broadband licensing framework and the inter-relationships of the multiple participants in providing services to the public using that network architecture. This anticipated architecture is based on the Broadband Forum's TR-144 "Multi-Service Architecture and Framework Requirements."

Draft for Consultation

Figure 1: Broadband Network Architecture (based on Broadband Forum Document TR-144)

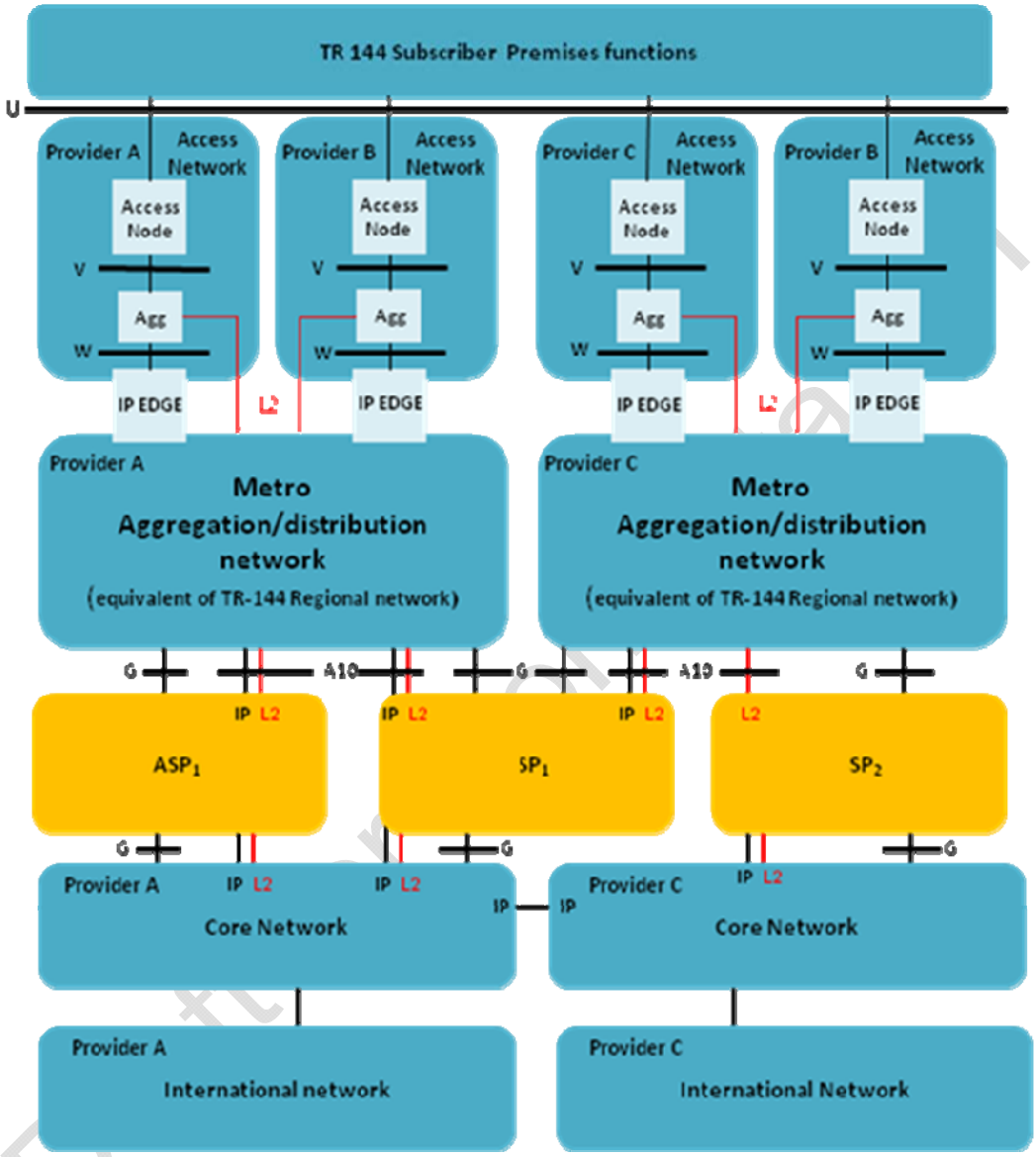


Figure 1 shows four main sub-networks that will together comprise the national broadband network under the Authority's broadband licensing plan. These are:

(1) An "**access network**" will provide end-user access and correspond to the "access network" as defined in the Broadband Forum's document TR-144 "Broadband Multi-service Architecture and Framework Requirements." The Authority intends to base the architecture and other requirements for access networks in Lebanon on the standards for access networks contained in TR-144.

(2) A "**metro network**" will provide local area transport of telecommunications traffic between access networks and the aggregation of telecommunications traffic between

access networks and core networks and corresponds to the "regional network" described in TR-144. The Authority uses the term "metro" rather than "regional" to better reflect the relatively dense geography of Lebanon, and the anticipation that such networks will largely be confined to distinct metropolitan areas. The Authority intends to base the architecture and other requirements for metro networks on the standards for regional networks contained in TR-144.

(3) A "**core network**" will provide intercity transport of telecommunications traffic between points of presence (POPs) in the major population centers in Lebanon and offer interconnection at each POP. As more fully set out in this document, each core network must be a high capacity, high reliability, QoS enabled, all optical transport network. The Authority intends to base the architecture and other requirements for core networks in Lebanon on the standards contained in ITU *recommendation Y.2061* (12/2006) "Fundamental Characteristics and Requirements of Future Packet Based Networks."

(4) An "**international gateway**" will provide transport of telecommunications traffic between POPs in Lebanon and POPs outside of Lebanon.

Under the broadband licensing plan, each NBCL will be obligated to deploy all four sub-networks in accordance with the requirements set out in this document. Each NBL will be permitted (but not obligated) to deploy all four sub-networks except that during the Initial Period (as defined in the broadband licensing plan) NBLs will be permitted only to provide an access network and not the other three sub-networks (subject to certain exceptions described in the Authority's broadband licensing plan for existing DSP operating metro and core networks). To the extent it deploys an access network, an NBL must meet the applicable requirements set out in this document.

During the Initial Period, an NBCL would correspond to either Provider A or Provider C in Figure 1, and a NBL would correspond to Provider B. The boxes in Figure 1 labeled ASP and SP refer to the possibility of application providers and value added resellers who may use the broadband networks to provide services to subscribers. Such persons will not require telecommunications service licenses unless they are providing ISP services. Both NBCLs and NBLs will be authorized to provide any telecommunications services to subscribers subject to compliance with all applicable legal and regulatory requirements and certain exclusions for services for which Liban Telecom will have exclusivity for a specified period.

The Authority emphasizes that the Broadband Forum's terminology as used in TR-144 is intended to be descriptive of typical roles played by different market participants, and serves neither as a regulatory prescription or description, whereas the terminology used in the Authority's broadband licensing plan and in this document is intended to be prescriptive, meaning that specific categories of licensed service providers will have specific privileges and obligations. Unless otherwise indicated, all terminology used in this document will have the meaning set forth in the Telecommunications law and the decrees, regulations and decisions interpreting such law.

As discussed in the broadband licensing plan, NBLs that held an interim DSP license will have the same obligations and privileges as other NBLs, but with the additional privilege to continue using their existing microwave networks. Such existing microwave networks may perform functions considered in Figure 1 to be those of metro or core networks to connect their access networks with each other and with other metro, core and international networks. However, during the Initial Period, NBLs that held an interim DSP license:

Draft for Consultation

(a) will not be permitted to offer connectivity over such existing networks to any persons other than subscribers to their access networks;

(b) will not be permitted to build, own or operate international gateways;

(c) will not be granted new microwave frequencies below the 15 GHz bands for their existing microwave backhaul networks; and

(d) must otherwise rely on the NBCLs for metro, core and international network connectivity.

The boundaries of an access network may depend on the technology deployed, but in general will extend from the demarcation point between the end user's customer premises wiring or customer antenna used for access (fixed or mobile) up to a point deemed by the Authority to be equivalent to the "IP Edge" function as shown in Figure 2 below as shown by the red dotted line. The Authority will define this boundary as follows with respect to the following technologies:

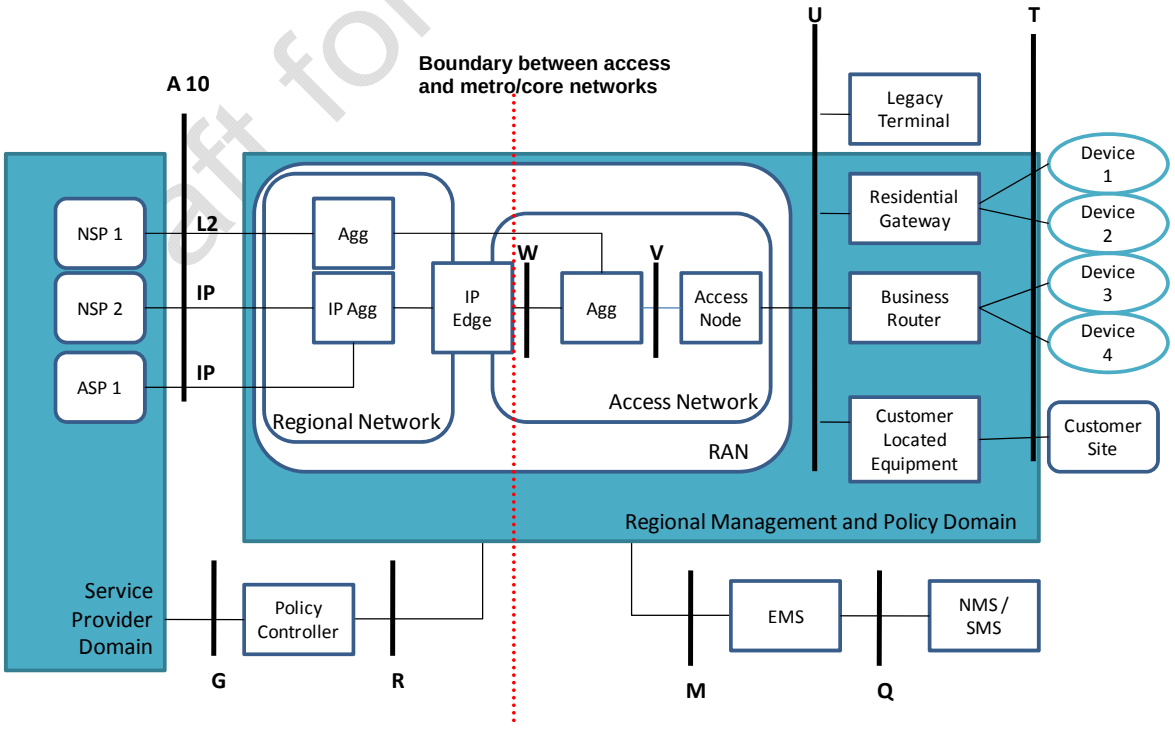
(x) The A10 interface of the BRAS (broadband remote access server) / BNG (broadband network gateway) as defined in the Broadband Forum's documents TR-101 and TR-059. BLs will be permitted to deploy the BRAS/BNG but not permitted to build links beyond the IP Edge interface.

(y) The R3 and R4 Reference Points defined in the WiMAX forum's document "WiMAX Forum Network Architecture, Stage 2: Architecture Tenets, Reference Model and Reference Points, Part 1." BLs will not be permitted to build links beyond either the R3 or R4 reference points.

The Authority will determine the access network - metro/core network boundary with respect to all other technologies as and when proposed by any applicant or license.

Draft for Consultation

Figure 2: Broadband Multi-service Reference Model (based on Broadband Forum Document TR-144)



3. NBCL exclusive license obligations

3.1 International gateway

Each NBCL will be required to provide an international gateway with:

- diverse terrestrial/submarine/earth station optical/wireless transport paths to and from POPs within and outside Lebanon; that is, without the leasing or renting of active telecommunications facilities from other public network operators and service providers;
- restoration and reconfiguration according to current standards (i.e. restoration of operation within 50ms) of the network to accommodate traffic load changes and to compensate for link and/or node failures;
- support of open standard protocols and interfaces for customer traffic presentation; and
- an offering, at a minimum, of point-to-point links over the native transport structure and access to customers at the landing station/Lebanon termination of any international cable systems it builds and owns.

Each NBCL's international gateway must be fully operational in compliance with the above requirements no later than 12 months after license award.

3.2 Core network

Each NBCL will be required, as a minimum, to build a core network with at least one POP having the following transmission capacity at service launch in each of the following towns and cities:

Table 1: Core Network Point-of-Presence and Capacity Requirements

LOCATION	TRANSMISSION CAPACITY AT SERVICE LAUNCH
Beirut (2 Nodes)	≥10Gb/s
Tripoli	≥2.5Gb/s
Jounieh	≥2.5Gb/s
Baalbek	≥2.5Gb/s
Zahle	≥2.5Gb/s
Saida	≥2.5Gb/s
Tyre	≥2.5Gb/s
Nabatieh	≥2.5Gb/s

Draft for Consultation

Each NBCL's core network must also:

- have an all fiber based transport, easily scalable beyond 40 Gb/s;
- meet all requirements for both connectionless and connection oriented packet services in ITU-T recommendation Y.2601(12/2006) "Fundamental characteristics and requirements of Future Packet Based Networks" ;
- feature Quality of Service mechanisms to support the Core Network Requirements given in the Broadband Forum's document TR-144;
- have full capacity redundancy through a minimum of two substantially different geographic paths between any two core network POPs and between any core network POP and the international gateway;
- support open standard interfaces and protocols at each POP;
- be designed and deployed to recover from link or node failure within 50 milliseconds;
- be based on two main layers, an IP/MPLS layer and an optical transport layer;
- utilize IP MPLS edge/core with clear separation of edge and core functionalities; and
- have a transport layer based on scalable DWDM (dense wave division multiplexing) technology.

In terms of redundancy and network resiliency, the Authority recommends that licensees utilize dual homing whenever possible, with duplication and redundancy at both IP MPLS edge (PE) and core (P) layers. For network and service scalability, the Authority recommends that licensees terminate real-time and non-real time network services on different PEs.

Each NBCL must launch service for all core network POPs within 24 months after the award of its NBCL license.

3.3 Metro networks

Each NBCL will be required, as a minimum, to build and launch service on metro networks within 24 months after the award of its NBCL license that:

- meet all requirements for a regional network defined in the Broadband Forum's document TR-144;
- are fully compliant with ITU-T recommendation Y.2601(12/2006) "Fundamental characteristics and requirements of Future Packet Based Networks",
- provide traffic redundancy by at least two geographically different paths to the core network fiber transport from each metro network POP;
- protect transmission to the core network with less than 50ms recovery time from a link or node failure; and

Draft for Consultation

- support high speed connection to the Access Network at Layer 2 and Layer 3 through the Metro Point-of-Presence using open standard interfaces and protocols.

3.4 Services

Each NBCL will be required, at a minimum, to provide the following services:

- Secure, Transport Layer/Layer 2, point-to-point and point-to-multipoint line between:
    - Any two Core Network Points-of-Presence and between any Core Network Point-of-Presence and the International Network;
    - Any Metro Point-of-Presence and any other Point-of-Presence regardless of type.
- Secure Layer 3 (IP) services between any Metro Point-of-Presence and any other Point-of-Presence, regardless of Point-of-Presence type;
- Provide wholesale access to 3rd party providers enabling them to build and offer the following services, through the Metro Points-of-Presence, to users of any access network connected to the NBCL Metro network :
    - Basic Internet Access;
    - A range of multi-media services with appropriate bandwidth and Quality of Service, including real time voice and video applications;
    - Secure, Point-to-point, point-to-multipoint, and any-to-any Layer 2 and Layer 3 VPNs with QoS.

An NBCL designated as having Significant Market Power (SMP) may be required to meet reasonable requests for services from access seekers, in addition to those services specified above.

3.4.1 Point-to-point transport layer/layer 2 lines

These must meet minimum performance standards, which are shown for Ethernet and SDH (synchronous digital hierarchy) / PDH (plesio-synchronous digital hierarchy) user connections (i.e. customer edge) in Table 3.

Exemption from having to provide either of these interfaces requires a justification to be presented in the application, with full details of the proposed alternative to edge technologies and associated Quality of Service guarantees. These must, in the Authority's judgment, be consistent with its telecommunications development strategy to be allowed as substitutes.

Draft for Consultation

Table 2: Quality of service requirements for Private Lines between Points of Presence

Service		Maximum Available Line rate	Frame Delay	Frame Delay Variation	Frame loss ratio
Line between any two core Points-of-Presence or between a Core Point-of-Presence and the International Network	SDH/PDH[1]	≥ STM -1	Must meet applicable ITU-T Recommendations for delay, jitter and error performance such as G.823 and G.825.		
	Ethernet[2]/ MPLS	1Gb/s	< 7 ms	< 1.5ms	$< 10^{-5}$
Line between any Metro Point-of-Presence and a Core Network Point-of-Presence	Ethernet[2]	1 Gb/s	< 1.5 ms	< 0.75 ms	$< 10^{-5}$

The Authority considers point-to-point lines at the transport layer/layer 2 to be leased lines and they must therefore meet the additional requirements in the Authority's Technical Quality of Service and Key Performance Indicators Regulation for availability and time to repair.

3.4.2 Layer 3 or IP services

Layer 3 (IP) services must provide at least three classes of service suitable for applications as shown in Table 3.

Table 3: Application by Quality of Service Class

Class of Service	Applications
Class 0	Real time jitter sensitive, high interaction applications such as voice telephony and Video Conferencing.

[1] Includes circuits implemented through circuit emulation and pseudo-wire techniques such as those specified in Metro Ethernet Forum Standard N°. 3.

[2] Ethernet Frame Delay, Frame Variation and Frame Loss Ratio are as defined by Metro Ethernet Forum standard 10.1, for 99th percentile and 15 minute interval.

Draft for Consultation

Class 1	Highly Transactional interactive data which is insensitive to delay variation and also adequate for inter-active gaming.
Class 2	Applications insensitive to delay variation but with delay tolerance greater than Class 1 applications. More than adequate for good quality Streaming Video, and corresponding to the maximum allowable delay to meet the delay requirements given in the Authority's "Quality of Service and Key Performance Indicators Regulation" for Internet transit.

Each Class of Service must meet the minimum performance requirements in Table 4.

Table 4: Quality of Service requirements for IP based services

Service		IP Packet Transfer Delay[3]	IP packet Delay Variation[3]	IP packet Loss Ratio[3]
Between any two core Points-of-Presence or any core Point-of-Presence and the international network	Class 0	< 11ms	< 9 ms	$< 2 \times 10^{-5}$
	Class 1	< 15ms	N/A	$< 2 \times 10^{-5}$
	Class 2	< 18 ms	N/A	$< 2 \times 10^{-5}$
Between any Core Point-of-Presence/International Network and any Metro Point-of-Presence	Class 0	< 13 ms	< 12 ms	$< 4 \times 10^{-5}$
	Class 1	< 18 ms	N/A	$< 4 \times 10^{-5}$
	Class 2	< 21 ms	N/A	$< 4 \times 10^{-5}$

4. NBCL and NBL joint license obligations

4.1 Access networks

Each NBCL must deploy an access network that fully complies with the Requirements for the Access Network defined in the Broadband Forum's document TR-144. Any access network deployed by an NBL must also comply with such requirements.

[3] Calculated according to the method in ITU-T Rec. Y.1541 "Network performance objectives for IP based services."

Draft for Consultation

Radio access technologies will also have to meet certain requirements. Applicants must submit full details of performance and evolution path for the technologies they intend to use, including:

(1) IEEE 802.16-2004;

(2) IEEE802.16e-2005; and

(3) 3GPP (3rd Generation Partnership Project), UMTS and LTE.

If any applicant for an NBCL license intends to deploy an access network based on any other standards, then the applicant must demonstrate to the Authority that its technical plans are comparable or superior to those set out above, especially in respect of performance, service support and evolutionary path.

Each NBCL must meet the following minimum coverage rollout obligations for its access networks:

(a) Cover 241 suburban towns out of 1500 towns in Lebanon and representing 25% of the suburban geotypes in 4 years (Appendix A defines the criteria used to categorize towns as suburban, and also lists the 234 towns that constitute 25% of all the towns in the suburban geotype); and

(b) Cover 45 towns out of 2000 towns in Lebanon and representing 10% of the rural geotypes in 5 years (Appendix A defines the criteria used to categorize towns as rural, and also lists the 45 towns that constitute 10% of all the towns in the rural geotype).

NBLs will not be subject to minimum coverage rollout obligations for their access networks.

4.2 Interconnection, interoperability, non-discrimination and network access

Each NBCL and NBL will have a duty:

(1) to interconnect its networks directly or indirectly with the Internet and with the facilities and equipment of other service providers and requesting providers of information services and other network-based applications (whether or not the same constitute telecommunications services);

(2) not to install network features, functions or capabilities intended to be, or having the effect of being, inconsistent with the goals of promoting nondiscriminatory accessibility by the broadest number of users and vendors of telecommunications products and services and of ensuring the ability of users and information providers to seamlessly and transparently transmit and receive information between and across networks;

(3) to cooperate with the Authority and other service providers to promote the greatest economically and technically feasible interoperability of networks, equipment and services; and

(4) not to unreasonably or unlawfully block, or discriminate against, the transport over its network and facilities of any telecommunications traffic or other communications between or among one or more of its subscribers and the Internet or the network of any interconnecting service provider or other person.

Draft for Consultation

Subject to the parameters set out in the Telecommunications Law and in the decrees, regulations and decisions implementing and interpreting the same, nothing in the preceding requirements will prevent or limit the right of any NBCL or NBL to establish non-discriminatory tariffs and fees, and other reasonable terms and conditions, for providing interconnection and for terminating and/or transporting traffic on its networks.

Licensees designated as having significant market power (SMP) may be required to meet reasonable requests for services from access seekers, in addition to those services specified above, and may have their tariffs, fees and other terms and conditions subject to review and regulation by the Authority.

4.3 Billing and provisioning related systems

To ensure that a vibrant wholesale market develops as envisioned in the Authority's broadband licensing plan, each NBCL must meet the following conditions:

- ability to charge for any service by volume or time;
- use of recognized scalable, carrier class billing and provisioning applications;
- provision of nearly real time mirroring/redundancy, at two geographically separated sites, of all customer billing, accounting, service subscriptions and other customer related data, such as email repositories;
- data to be held in centers compliant with international best practices for physical protection and security (e.g., fire detection and suppression, secured building access);
- compliance with the Quality of Service and KPI Regulation as amended by the Authority from time to time.

5. Information required from NBCL applicants

5.1 International gateway

Each applicant for an NBCL license must provide a description of its international gateway which must include the following information with regard to the system at launch and its development over the initial five years of operation:

- the intended use of the CADMOS, BERRYTAR, UGARIT and ALETAR cable systems stating for each:
    - the expected capacity requirements;
    - the ultimate international destinations to be served;
    - the arrangement for use of the half circuits outside of Lebanon i.e. procured directly from the owners by the licensee or through a third-party service provider;
- the capabilities for restoring and re-configuring international capacity to accommodate for traffic load changes and compensate for link/node failures;

Draft for Consultation

- the name of any international transit service providers to be used together with:
    - the location of the associated traffic peering and inter-connection points with the licensee; and
    - the capacities between each peering and inter-connection point and each of the final international destinations it serves;
- the construction and operation as either a full or co-owner of new cable systems with regard to:
    - the ownership structure, prospective partners and expected amount of the licensee's share;
    - the intended landing locations both inside and outside of Lebanon; and
    - system capacity and the protection and restoration capabilities;
- the construction and operation of new satellite earth stations with regard to:
    - the location of the earth stations; and
    - the satellite(s) to be used and the expected up and downlink capacity requirements, frequency band(s) of operation and the final international destinations to be served; and
- the protocols and interfaces for customer traffic presentation.

5.2 Core Network

5.2.1 Information required from all NBCL applicants

Each applicant for an NBCL license must supply a description of its proposed core network which must address:

- The expected evolution of network topology during the first five years of operation after launch including:
    - the number and location of POPs;
    - the elements such as IP core switches / routers, optical cross connects, and add/drop multiplexers, with their capacity, at each routing/switching location;
    - the general geographic route of the fiber between POPs and the underlying optical transport capacity on each link;
    - how traffic will be routed/switched between POPs, such as use of optical cross connects for inter-POP bypass; and
    - the underlying traffic forecast to support the sizing of network elements and routes; and
- Protection and restoration of the network to accommodate for traffic load changes and to compensate for link and/or node failures, such as the protection configuration (i.e. 1+1, 1:1), use of load balancing, dual homing and the relevant features of the implemented control plane.

Draft for Consultation

5.2.2 Information required from NBCL applicants proposing an alternative solution

The Authority has assessed that a core network architecture with an ITU G.709-based user plane (as defined in ITU-T Rec. G.709 "Interfaces for the Optical Transport Network (OTN)") and a GMPLS based control plane (meaning "generalized multi-protocol label switching" as defined by the IETF) will meet the requirements of section 3.2. At the request of an applicant or licensee, other technologies will be permitted, in accordance with the Authority's technology neutral policy, provided they are determined by Authority to meet the section 3.2 general core network requirements.

The assessment method will be a comparison of the proposed technology with the G.709/GMPLS architecture according to the following categories:

- service transport capabilities;
- capacity;
- reliability characteristics; and
- Operation, Administration and Maintenance features.

The applicant is therefore required to provide a full and complete description of the user, control and management plane architecture, of their proposed solution, with regard to:

- The ability to efficiently transport the following services with the required QoS:
  - Layer 3 VPNs;
  - Ethernet E-Line and E-LANs (i.e. carrier Ethernet services)[4];
  - STM point-to-point links;
  - Conversational voice and video conferencing services;
  - Video-on-demand and multicast TV services;
- Support of High capacity point-to-point links from 2.5 to 10Gb/s with guaranteed QoS;
- Scalability of total transmission capacity on individual routes to upwards of 40 Gb/s;
- Performance monitoring, fault detection and isolation capabilities, particularly those for non-SDH services and the wavelength domain;
- Service protection and restoration; and
- Rapid provisioning for all supported services.

Draft for Consultation

[4] As defined in MEF Technical Specification 6.1 "Ethernet Services Definition-phase II" and with the attributes specified in MEF Technical Specification 10.1 "Ethernet Services Attributes – phase II".

5.3 Metro networks

Each applicant for an NBCL license must supply a description of its proposed metro network transport layer which must address:

- The expected evolution of the network topology, for the first five years after launch of service, in terms of how traffic is aggregated, switched or routed from the access network to the core network and Metro Points-of-Presence, and the function and location of the different network elements involved;
- The Structure of the data/physical layer and control plane layers covering supported bit rates, Quality of Service support, protection mechanisms and the applicable standards such as IEEE802.17 Resilient Packet Ring; and
- The expected location of each of the Metro Points-of-Presence, capacities of the switching and routing elements, and the capacity of the underlying transport media between Points-of-Presence.

5.4 Service implementation

The applicant must provide details of all additional services it intends to offer at launch in addition to those mandated. For each service offering, mandated or otherwise, the applicant must describe:

- The implementation method, and the applicable standards such as IETF's RFC (request for comment) 3985 "Pseudo-wire Edge-to-Edge Emulation (PWE3) Architecture" and RFC 4364 "BGP (border gateway protocol) / MPLS IP VPNs"; and Metro Ethernet Forum standards 3, 6 and 8;
- The interfaces at Layers 1-3 of traffic presentation at the Metro and Core Network Points-of-Presence including line rates, protocols and applicable standards;
- The quality of service guarantees with specific reference to:
    - Absolute Delay, data loss rates and delay variation or jitter; and
    - Service availability.

6. Information required from all NBCL and NBL applicants

6.1 Access networks

Each applicant for an NBCL or NBL license must provide a description of its proposed access networks which must address:

- The technologies to be deployed, and the applicable standards, for:

Draft for Consultation

- optical transport, such as: point-to-point systems (see IEEE 802.3ah 100/1000 base LX/BX); xPON systems GPON (gigabit passive optical network) (see ITU-T Rec. G.984 series) and EPON (Ethernet passive optical network) (see IEEE 802.3ah 1000 base PX); and Ethernet LANs (see IEEE 802.3ae and 802.3z);
- copper transport, such as: xDSL (variant x digital subscriber loop) and the supporting connection/multiplexing technologies; and ethernet LANs (see IEEE 802.3u, 802.3y and 802.3ab); and
- wireless transport, such as: IEEE802.16e-2005; 3GPP (3rd Generation Partnership Project); and point-to-point microwave technologies.

- The topology of the network from end user through to aggregation onto the metro/core networks, with reference to:
  - the demarcation point of fiber feeds when the final link to the customer premises or customer equipment is by copper or wireless, such as fiber-to-the-curb, fiber-to-the-base-station;
  - the technology of the final links to the customer's premises, or customer equipment, in terms of: the type of area, urban or rural; type of customer, residential or business; and type of premises, multi- or single-tenant/owner; and
  - the nodes where the traffic of the different access technologies is aggregated and mapped onto layers 1-3 of the metro/core fiber transport;
- the architecture and mechanisms for meeting all requirements of section 7 in the Broadband Forum's document TR-144;
- network protection and restoration against failure; and
- full performance and evolutionary path details of any proposed radio access technologies not otherwise listed and described.

6.2 Network operations and management systems

Network operations and management systems are those systems to support the following processes:

- configuration management;
- security management;
- fault management; and
- performance management.

Each applicant for an NBCL or NBL license must provide a description of its network and operations management systems for all components of its networks with regard to:

- the systems for all of the given categories, including those to support workforce and task management, as well as operational support systems from equipment vendors;
- the applicant's plan to integrate the various systems to efficiently support the operational processes (i.e. network operations center integration); and
- systems to support disaster recovery and business continuity covering:

Draft for Consultation

- back-up practices; and
- mirroring, redundant and/or standby configurations and their geographic separation.

6.3 Billing systems

The applicant must describe the billing and provisioning support systems which will address its requirements for the following functions:

- customer administration;
- service provisioning;
- device mediation;
- data back-up;
- rating, billing and inter-provider reconciliation, including pre- and post-paid options, and "real time" capabilities; and
- customer payment tracking.

7. Certain abbreviations

As used in this document, the following terms have the following meanings:

Term	Meaning
NBL	broadband license(e) as defined in the Authority's broadband licensing plan
IEEE	Institute of Electronic and Electrical Engineers
IETF	Internet Engineering Task Force
IP	Internet protocol
ITU	International Telecommunications Union
ITU-T	ITU Standardization Sector
MPLS	multi-protocol label switching as defined by the IETF
NBCL	national broadband carrier license(e) as defined in the Authority's broadband licensing plan
QoS	quality of service
TR-144	Broadband Forum document TR-144 entitled "Broadband Multi-Service Architecture and Framework Requirements"
VPN	virtual private network

Draft for Consultation

APPENDIX A: Minimum rollout obligations

As part of its effort to extend the benefits of broadband to persons in higher cost-of-service areas, the Authority will require each NBCL to meet minimum rollout coverage requirements in those areas where it may not otherwise be economically attractive for the NBCL to deploy a network. Accordingly, these minimum coverage requirements focus on suburban and rural areas. In an effort to facilitate the business plan for the NBCLs, the authority has devised a methodology for defining the suburban and rural geotypes according to the level of density (based on population and households per square kilometer) and has identified the list of towns for both geotypes to be covered by the NBCLs.

Geotype	Pop/km2	Household/km2
Rural	0-150	0-35
Suburban	150-1,000	35-234
Urban	1,000-10,000	234-2,342
Dense Urban	>10,000	>2,342

The requirements of covering 241 suburban towns and 45 rural towns out of a total of 1500 to 2000 towns in Lebanon as set out in the list below and representing 25% of the suburban geotype and 10% of the rural geotype. The list of towns represents the densest areas in each mohafaza.

NBCLs must cover all suburban towns listed below in 4 years, i.e. 60 towns every year for the first five years and 61 towns in the fourth year. The NBCL may select which towns to cover in which year based on its business plan and other factors it deems appropriate. The Authority encourages a fair distribution of these towns between 5 Mouhafazat (Bekaa, Mount Lebanon, Nabatieh, North and South; the list excludes Beirut).

NBCLs are required to cover rural towns listed below in 5 years, i.e. 9 towns per year chosen as per the Operator's Business Plan. The Authority encourages a fair distribution of these towns between the 5 Mouhafazat (Bekaa, Mount Lebanon, Nabatieh, North and South; the list excludes Beirut).

List of Suburban Towns:

Draft for consultation

Mohafazat	Kaza	Town	Latitude	Longitude
Bekaa	Baalbeck	**AAIN - BAALBEK**	34 13 32.01	36 22 57.89
Bekaa	Baalbeck	**BEIT CHAMA**	33 55 14.08	36 1 12.39
Bekaa	Baalbeck	**BRITAL**	33 38 45.2	35 51 40.9
Bekaa	Baalbeck	**CHMISTAR**	33 58 32.6	36 01 12.1
Bekaa	Baalbeck	**FEKHE & JDAIDET EL FEKHE**	34 14 52.95	36 23 15.80
Bekaa	Baalbeck	**HAOUCH EN NABI**	33 56 4.66	36 3 54.74
Bekaa	Baalbeck	**NABI CHIT**	33 52 02.	36 06 37.3
Bekaa	Baalbeck	**QAA - BAALBEK**	34 19 56.60	36 27 10.28
Bekaa	Baalbeck	**QASRNABA**	33 54 22.05	35 59 46.89
Bekaa	Baalbeck	**TEMNINE ET TAHTA**	33 52 38.34	35 59 48.77
Bekaa	Hermel	**HERMEL**	34 22 11.00	36 19 41.30
Bekaa	Rachaya	**AAQBET RACHAIYA**	33 30 49.43	35 48 31.10
Bekaa	Rachaya	**RACHAIYA EL OUADI**	34 10 32.00	35 37 52.00
Bekaa	West Bekaa	**GHAZZE**	33 40 44.47	35 50 0.42
Bekaa	West Bekaa	**HAOUCH EL HARIME**	33 42 38.61	35 51 18.94
Bekaa	West Bekaa	**MACHGHARA**	33 30 03.5	35 39 11.
Bekaa	West Bekaa	**QARAAOUN**	33 36 33.9	35 41 39.
Bekaa	West Bekaa	**SAOUIRI**	33 40 58.03	35 54 35.14
Bekaa	West Bekaa	**SOHMOR**	33 30 41.33	35 41 29.74
Bekaa	Zahle	**AANJAR**	33 45 52.49	35 54 41.43
Bekaa	Zahle	**ABLAH**	33 51 54.73	35 58 30.39

Bekaa	Zahle	**BOUAREJ**	33 49 14.93	35 48 54.77
Bekaa	Zahle	**JDITA**	33 49 2.94	35 50 26.37
Bekaa	Zahle	**MRAYJAT - ZAHLE**	33 48 30.87	35 48 13.97
Bekaa	Zahle	**TAANAYEL**	33 48 2.60	35 52 9.26
Mount Lebanon	Aley	**AABEY**	33 44 12.92	35 31 32.51
Mount Lebanon	Aley	**AAIN DARA**	33 46 52.94	35 45 29.95
Mount Lebanon	Aley	**AAIN EL HALAZOUN**	33 46 13.61	35 38 54.56
Mount Lebanon	Aley	**AAYNAB**	33 46 0.69	35 32 47.97
Mount Lebanon	Aley	**BINNAY**	33 44 7.97	35 32 54.23
Mount Lebanon	Aley	**BLAYBEL**	33 48 24.53	35 33 27.58
Mount Lebanon	Aley	**BSATINE / FSAQINE - AALEY**	33 45 10.31	35 31 35.59
Mount Lebanon	Aley	**BSERRINE**	33 45 30.54	35 38 15.13
Mount Lebanon	Aley	**BTALLOUN**	33 47 16.68	35 38 20.67
Mount Lebanon	Aley	**BTATER**	33 45 57.29	35 37 23.57
Mount Lebanon	Aley	**CHAROUN**	33 46 18.45	35 41 11.07
Mount Lebanon	Aley	**DFOUN**	33 44 50.80	35 33 28.45
Mount Lebanon	Aley	**GHABOUNE**	33 47 5.01	35 35 45.22
Mount Lebanon	Aley	**HABRAMOUN**	33 45 37.42	35 38 42.20
Mount Lebanon	Aley	**IGHMID**	33 45 41.00	35 42 00.00
Mount Lebanon	Aley	**MAASRITI**	33 44 53.05	35 38 4.23
Mount Lebanon	Aley	**MANSOURIYET BHAMDOUN**	33 46 48.06	35 37 46.34
Mount Lebanon	Aley	**MECHERFE**	33 45 35.73	35 39 21.66

Mount Lebanon	Aley	**SELFAYA**	33 44 0.24	35 34 9.70
Mount Lebanon	Aley	**SIRHMOUL**	33 46 16.82	35 31 45.40
Mount Lebanon	Baabda	**AABADIYE**	33 50 8.04	35 37 33.70
Mount Lebanon	Baabda	**BTEKHNAY**	33 50 26.76	35 43 4.86
Mount Lebanon	Baabda	**FALOUGHA**	33 50 15.86	35 44 28.73
Mount Lebanon	Baabda	**HAMMANA**	33 49 8.20	35 44 6.93
Mount Lebanon	Baabda	**HLALIYE BAABDA**	33 50 3.32	35 38 17.39
Mount Lebanon	Baabda	**KHREIBET BAABDA**	33 49 27.36	35 42 46.54
Mount Lebanon	Baabda	**QORNAYEL**	33 50 44.0	35 42 02.0
Mount Lebanon	Baabda	**RAS EL MATN**	33 50 53.48	35 39 24.72
Mount Lebanon	Baabda	**SALIMA BAABDA**	33 52 19.59	35 41 59.03
Mount Lebanon	Chouf	**AAIN ZHALTA**	33 45 42.	35 42 00.6
Mount Lebanon	Chouf	**AANOUT**	33 37 47.90	35 30 54.22
Mount Lebanon	Chouf	**BAASSIR & HARET BAASSIR**	33 39 45.65	35 26 23.64
Mount Lebanon	Chouf	**BAROUK**	33 41 56.4	35 40 09.7
Mount Lebanon	Chouf	**BATER**	33 36 28.4	35 37 29.4
Mount Lebanon	Chouf	**BOURJEIN**	33 39 26.98	35 29 11.12
Mount Lebanon	Chouf	**BRIH**	33 43 38.36	35 39 13.28
Mount Lebanon	Chouf	**DALHOUN**	33 37 40.01	35 27 52.19
Mount Lebanon	Chouf	**DAMOUR**	33 43 50.19	35 27 17.03
Mount Lebanon	Chouf	**DEIR EL QAMAR**	33 41 49.96	35 33 38.10
Mount Lebanon	Chouf	**DEIR KOUCHE**	33 43 13.65	35 33 50.21

Mount Lebanon	Chouf	**DMIT**	33 41 36.00	35 29 36.10
Mount Lebanon	Chouf	**JOUN**	33 34 51.18	35 27 2.78
Mount Lebanon	Chouf	**KFAR HAY**	34 14 56.52	35 44 35.34
Mount Lebanon	Chouf	**KFAR NABRAKH**	33 41 56.90	35 37 33.43
Mount Lebanon	Chouf	**KFAR QAAuthority**	33 42 42.22	35 35 17.76
Mount Lebanon	Chouf	**MAZRAAT ECH CHOUF**	33 38 08.9	35 34 57.9
Mount Lebanon	Chouf	**NAAME**	33 44 35.	35 27 23.
Mount Lebanon	Chouf	**NIHA ECH CHOUF**	33 35 43.0	35 37 29.0
Mount Lebanon	Chouf	**OUADI BNEHLAY**	33 41 36.66	35 30 28.72
Mount Lebanon	Chouf	**OUARDANIYE**	33 36 39.57	35 25 33.74
Mount Lebanon	Chouf	**OUARHANIYE**	33 43 23.52	35 40 43.70
Mount Lebanon	Jbeil	**EHMEJ**	34 07 28.	35 46 28.
Mount Lebanon	Jbeil	**HALATE**	34 5 15.50	35 39 31.50
Mount Lebanon	Jbeil	**HBOUB**	34 7 43.09	35 41 19.71
Mount Lebanon	Jbeil	**JEDDAYEL JBAYL**	34 9 48.14	35 38 47.50
Mount Lebanon	Jbeil	**QARTABA**	34 5 36.17	35 51 3.04
Mount Lebanon	Keserwan	**AAZRA OUEL AAZR**	34 3 43.10	35 42 14.43
Mount Lebanon	Keserwan	**BEQAATAT AACHQOUT**	34 0 25.73	35 44 0.65
Mount Lebanon	Keserwan	**DARAIYA KESROUANE**	33 38 51.37	35 30 29.96
Mount Lebanon	Keserwan	**FARAYA**	34 0 45.18	35 49 24.38
Mount Lebanon	Keserwan	**FAYTROUN**	34 00 00.	35 40 52.1
Mount Lebanon	Keserwan	**HARHARAYA & QATTINE**	33 31 45.66	35 31 41.87

Mount Lebanon	Keserwan	**HRAJEL**	34 1 49.93	35 48 2.60
Mount Lebanon	Keserwan	**KFAR DIBIANE**	33 59 42.73	35 47 34.08
Mount Lebanon	Keserwan	**KFOUR KESROUANE**	34 01 40.0	35 41 25.8
Mount Lebanon	Keserwan	**ZAAITRE**	34 4 14.06	35 41 53.94
Mount Lebanon	Metn	**AAINTOURA EL MATN**	33 57 45.2	35 37 48.5
Mount Lebanon	Metn	**AAYROUN**	33 54 26.28	35 42 9.62
Mount Lebanon	Metn	**BAABDAT**	33 53 31.03	35 40 32.71
Mount Lebanon	Metn	**BASKINTA**	33 56 35.56	35 48 6.51
Mount Lebanon	Metn	**BNABIL**	33 53 59.91	35 44 12.15
Mount Lebanon	Metn	**BTEGHRINE**	33 55 36.95	35 45 15.61
Mount Lebanon	Metn	**CHOUAYA EL MATN**	33 55 47.91	35 42 59.46
Mount Lebanon	Metn	**CHRINE**	35 47 34.08	35 43 51.11
Mount Lebanon	Metn	**DAYCHOUNIYE**	33 50 46.73	35 34 31.17
Mount Lebanon	Metn	**HIMLAYA**	33 56 29.19	35 42 38.82
Mount Lebanon	Metn	**JOUAR EL MATN**	33 55 42.34	35 43 52.53
Mount Lebanon	Metn	**NABAY**	33 54 7.63	35 37 24.14
Mount Lebanon	Metn	**QAAQOUR**	33 53 27.71	35 42 58.42
Mount Lebanon	Metn	**ROUMIE**	33 52 40.00	35 36 10.10
Mount Lebanon	Metn	**ZAKRIT**	33 56 16.30	35 37 48.54
Mount Lebanon	Metn	**ZIGHRINE EL MATN**	33 55 31.79	35 42 51.19
Nabatieh	Bent Jbeil	**AAYTA ECH CHAAB**	33 5 53.13	35 20 36.46
Nabatieh	Bent Jbeil	**AAYTAROUN**	33 6 34.35	35 29 1.38

Nabatieh	Bent Jbeil	**BARAACHIT**	33 10 56.90	35 26 23.43
Nabatieh	Bent Jbeil	**BORJ QALAOUIYE**	33 15 34.23	35 25 27.91
Nabatieh	Bent Jbeil	**CHAQRA**	33 11 35.72	35 28 8.58
Nabatieh	Bent Jbeil	**HADDATHA**	33 9 26.80	35 23 45.56
Nabatieh	Bent Jbeil	**HARIS**	33 10 33.56	35 22 36.61
Nabatieh	Bent Jbeil	**KAFRA BENT JBAYL**	33 10 24.1	35 19 59.2
Nabatieh	Bent Jbeil	**KFAR DOUNINE**	33 14 25.62	35 23 49.27
Nabatieh	Bent Jbeil	**QALAOUIYE**	33 15 0.41	35 25 14.38
Nabatieh	Bent Jbeil	**RMAICH**	33 04 49.00	35 24 59.100
Nabatieh	Bent Jbeil	**YATER**	33 8 57.17	35 19 48.71
Nabatieh	Hasbaya	**CHEBAA**	33 20 22.9	35 44 30.8
Nabatieh	Hasbaya	**HASBAIYA**	33 23 34.7	35 42 52.1
Nabatieh	Marjayoun	**AADAYSSE MARJAAYOUN**	33 14 55.99	35 32 18.93
Nabatieh	Marjayoun	**HOULA**	33 12 32.61	35 30 58.59
Nabatieh	Marjayoun	**KHIYAM MARJAAYOUN**	33 19 20.0	35 36 28.3
Nabatieh	Marjayoun	**MAJDEL SELM**	33 13 18.13	35 27 52.16
Nabatieh	Marjayoun	**MEISS EJ JABAL**	33 10 8.99	35 31 16.29
Nabatieh	Marjayoun	**QLAIAA**	33 19 37.87	35 33 55.75
Nabatieh	Marjayoun	**SAOUNET MARJAAYOUN**	33 14 13.43	35 26 39.83
Nabatieh	Marjayoun	**TAYBET MARJAAYOUN**	33 57 37.51	36 8 51.60
Nabatieh	Marjayoun	**TOULINE**	33 14 48.18	35 26 56.10
Nabatieh	Nabatieh	**AAIN BOU SOUAR**	33 28 10.21	35 31 11.81

Nabatieh	Nabatieh	**AAIN QANA**	33 27 48.53	35 30 10.19
Nabatieh	Nabatieh	**ANSAR**	33 22 37.	35 21 09.8
Nabatieh	Nabatieh	**CHARQIYE**	33 24 7.96	35 25 14.37
Nabatieh	Nabatieh	**HABBOUCH EN NABATIYEH**	33 24 26.73	35 28 42.92
Nabatieh	Nabatieh	**HOUMINE ET TAHTA**	33 28 36.14	35 26 1.63
Nabatieh	Nabatieh	**JBAA EN NABATIYEH**	33 36 25.61	35 38 41.65
Nabatieh	Nabatieh	**KFAR SIR**	33 19 31.25	35 23 59.46
Nabatieh	Nabatieh	**KFAR TIBNIT**	33 21 1.45	35 31 9.68
Nabatieh	Nabatieh	**MAYFADOUN**	33 20 55.07	35 28 35.02
Nabatieh	Nabatieh	**NABATIYEH EL FAOUKA**	33 21 38.50	35 29 51.19
Nabatieh	Nabatieh	**QAAQAAIYET EJ JISR**	33 19 24.62	35 25 43.97
Nabatieh	Nabatieh	**ZAOUTAR ECH CHARQIYE**	33 19 11.06	35 28 19.01
Nabatieh	Nabatieh	**ZEFTA**	33 26 30.85	35 24 15.16
North	Akkar	**AADBIL**	34 31 58.41	36 5 51.41
North	Akkar	**AAIN EZ ZAYT**	34 35 21.19	36 12 5.25
North	Akkar	**AAIYAT**	34 32 9.72	36 12 1.79
North	Akkar	**AAKKAR EL AATIQA**	34 32 7.68	36 14 3.14
North	Akkar	**AANDQET**	34 34 21.79	36 18 42.77
North	Akkar	**BEIT YOUNES**	34 28 31.83	36 8 57.76
North	Akkar	**BIRET AAKKAR**	34 35 15.13	36 14 9.89
North	Akkar	**CHADRA**	34 37 03.2	36 19 04 6
North	Akkar	**CHANE**	34 28 55.10	36 6 53.25

North	Akkar	**CHEIKH MOHAMMAD**	34 32 58.15	36 5 0.85
North	Akkar	**DINBOU**	34 28 43.52	36 5 17.56
North	Akkar	**FNAYDEQ**	34 27 42.13	36 12 51.33
North	Akkar	**HAYSSA**	34 35 17.05	36 2 54.83
North	Akkar	**HOKR ED DAHRI**	34 37 55.46	36 1 25.75
North	Akkar	**HRAR**	34 27 26.43	36 7 21.66
North	Akkar	**JDAIDET EL QAITAA**	34 27 30.53	35 59 48.74
North	Akkar	**KARM AASFOUR**	34 31 26.25	36 3 49.49
North	Akkar	**KHIRBET CHAR**	34 34 46.05	36 11 24.77
North	Akkar	**KROUM EL AARAB**	34 33 20.47	36 5 26.83
North	Akkar	**MACHHA**	34 32 27.07	36 6 57.21
North	Akkar	**NFISSE**	34 32 51.78	36 5 12.71
North	Akkar	**OUADI EJ JAMOUS**	34 29 54.52	36 0 54.89
North	Akkar	**QARQAF**	34 29 24.19	36 0 37.97
North	Akkar	**QBOULA**	34 31 56.67	36 10 49.23
North	Akkar	**QORNET AAKKAR**	34 28 53.52	36 10 0.33
North	Akkar	**RAHBE**	34 30 20.74	36 815.68
North	Akkar	**SINDIANET ZEIDANE**	34 34 34.99	36 14 43.79
North	Akkar	**TALL MEAAYANE**	34 35 4.78	36 2 34.09
North	Akkar	**TIKRIT**	34 31 7.66	36 9 35.90
North	Akkar	**ZOUQ EL HBALSA**	34 30 55.59	36 2 23.27
North	Batroun	**DARYA - EL BATROUN**	34 12 56.99	35 43 51.30

North	Batroun	**HERI**	34 18 34.20	35 43 2.93
North	Batroun	**KFAR AABIDA**	34 13 48.01	35 39 41.34
North	Batroun	**KOUBBA**	34 16 23.98	35 39 44.01
North	Bcharre	**BCHARRE**	34 14 21.	36 02 04.
North	Bcharre	**BLAOUZA**	34 15 44.96	35 57 7.73
North	Bcharre	**BREISSAT**	34 14 30.17	35 56 30.19
North	Bcharre	**HADATH EJ JIBBE**	34 14 55.	35 55 44.
North	Bcharre	**HADCHIT**	34 15 16.74	35 58 40.19
North	Bcharre	**HASROUN**	34 13 27.38	35 58 32.71
North	Koura	**AAIN AAKRINE**	34 17 8.11	35 50 48.72
North	Koura	**AMIOUN**	34 17 56.46	35 48 31.95
North	Koura	**DAR BAAECHTAR**	34 16 22.60	35 48 2.03
North	Koura	**DEDDE**	34 22 49.09	35 48 9.99
North	Koura	**ENFE**	34 21 18.33	35 43 55.23
North	Koura	**KFAR HAZIR**	34 18 29.28	35 46 26.37
North	Koura	**KOUSBA**	34 18 41.07	35 51 9.12
North	Koura	**NAKHLE**	34 21 54.05	35 49 35.97
North	Koura	**ZGHARTA EL MTAOUILE**	34 15 13.61	35 50 25.50
North	Minyeh-Donnieh	**AASOUN**	34 23 19.21	36 0 37.75
North	Minyeh-Donnieh	**BORJ EL YAHOUDIYE**	34 27 14.59	35 55 5.29
North	Minyeh-Donnieh	**BQARSOUNA**	34 22 39.39	36 2 35.25
North	Minyeh-Donnieh	**HAZMIYE - EL MINIE**	34 23 31.83	36 2 27.90

North	Minyeh-Donnieh	**SFIRE**	34 24 0.63	36 2 53.62
North	Minyeh-Donnieh	**TARANE**	34 24 37.00	36 1 56.95
North	Zgharta	**EHDEN**	34 18 34.53	35 57 46.81
North	Zgharta	**KFAR FOU**	34 19 3.53	35 52 48.06
North	Zgharta	**KFAR HATA ZGHARTA**	34 22 55.67	35 54 5.33
North	Zgharta	**KFAR SGHAB**	34 16 27.03	35 58 25.49
North	Zgharta	**KFAR ZEINA**	34 22 1.73	35 52 42.72
North	Zgharta	**MEJDLAIYA ZGHARTA**	34 25 18.04	35 52 37.52
North	Zgharta	**QARAH BACH**	34 22 36.50	35 53 31.79
North	Zgharta	**SEBAAL ZGHARTA**	34 18 44.64	35 54 27.74
South	Jezzine	**TAAID**	33 34 27.26	35 32 44.78
South	Jezzine	**AAIN EL MIR (EL ESTABL)**	33 32 11.82	35 27 32.47
South	Jezzine	**ANANE**	33 34 5.12	35 30 29.94
South	Jezzine	**BAYSSOUR - JEZZINE**	33 32 7.54	35 26 54.39
South	Jezzine	**BENOUATI - JEZZINE**	33 34 34.54	35 34 29.44
South	Jezzine	**JEZZINE**	33 34 15.00	35 33 58.00
South	Jezzine	**MRAH EL HBASSE**	33 33 4.24	35 27 47.26
South	Jezzine	**SEJOUD**	33 26 2.65	35 32 1.51
South	Saida-Zahrani	**TABBAYA**	33 29 17.61	35 26 23.51
South	Saida-Zahrani	**AADLOUN**	33 23 12.97	35 15 51.44
South	Saida-Zahrani	**KFAR BEIT**	33 29 44.80	35 27 37.40
South	Saida-Zahrani	**KFAR CHELAL**	33 29 29.52	35 27 57.12

South	Saida-Zahrani	**KFAR MELKI - SAIDA**	33 30 5.43	35 28 48.17
South	Saida-Zahrani	**MAJDELYOUN**	33 33 40.16	35 24 39.49
South	Saida-Zahrani	**MEROUANIYE**	33 26 43.00	35 23 38.8
South	Saida-Zahrani	**NAJJARIYE**	33 28 58.81	35 20 18.22
South	Saida-Zahrani	**SARAFAND**	33 27 17.07	35 17 50.05
South	Saida-Zahrani	**ZEGHDRAIYA**	33 31 39.23	35 24 0.51
South	Saida-Zahrani	**ZRARIYE**	33 20 29.00	35 19 12.00
South	Sour	**AAYTIT**	33 13 39.15	35 18 23.28
South	Sour	**BARICH**	33 16 16.95	35 21 17.03
South	Sour	**BAZOURIYE**	33 15 14.67	35 16 17.56
South	Sour	**BIYAD**	33 12 24.36	35 19 38.72
South	Sour	**CHAAITIYE**	33 11 47.72	35 15 55.74
South	Sour	**CHEHOUR**	33 18 9.48	35 22 1.46
South	Sour	**DEIR QANOUN**	33 17 59.55	35 18 47.97
South	Sour	**HNAOUAY**	33 12 58.98	35 16 4.68
South	Sour	**MANSOURI - SOUR**	33 10 20.38	35 11 54.10
South	Sour	**NAQOURA**	33 07 15.5	35 08 00.3
South	Sour	**QANA**	33 12 30.11	35 18 0.85
South	Sour	**QLAILE - SOUR**	33 11 40.68	35 13 43.25
South	Sour	**RMADIYE**	33 12 11.27	35 16 41.06
South	Sour	**SELAA - SOUR**	33 15 40.62	35 22 16.72
South	Sour	**TAYR DEBBE**	33 16 26.72	35 16 42.61

List of Rural Towns:

Mohafazat	Kaza	Town	Latitude	Longitude
Bekaa	Baalbeck	**AARSAL**	34 11 5.85	36 25 37.41
Bekaa	Baalbeck	**BARQA**	34 10 17.28	36 8 32.01
Bekaa	Baalbeck	**CHAAT**	33 52 52.3	35 52 09.9
Bekaa	Baalbeck	**DEIR EL AHMAR**	33 56 11.	36 09 25.1
Bekaa	Baalbeck	**NABHA**	34 10 59.70	36 13 33.33
Bekaa	Baalbeck	**NAHLE - BAALBEK**	34 2 31.76	36 15 39.22
Bekaa	Baalbeck	**RAS BAALBEK**	34 15 36.48	36 25 5.26
Bekaa	Baalbeck	**TARAIYA**	33 59 0.11	36 1 23.04
Bekaa	Baalbeck	**YOUNINE**	34 4 39.26	36 16 30.08
Bekaa	Baalbeck	**ZABBOUD**	34 14 25.79	36 19 11.36
Bekaa	Rachaya	**BAKKIFA - RACHAIYA**	33 29 32.39	35 48 28.83
Bekaa	Rachaya	**BIRET - RACHAIYA**	33 36 7.80	35 50 4.52
Bekaa	Rachaya	**KAOUKABA**	34 12 50.8	36 24 38.9
Bekaa	West Bekaa	**RAOUDA (ISTABEL)**	34 27 55.84	35 58 59.79
Bekaa	Zahle	**KFAR ZABAD**	33 47 8.07	35 59 40.66
Bekaa	Zahle	**MAJDEL AANJAR**	33 43 20.6	35 54 28.8
Bekaa	Zahle	**NIHA - ZAHLE**	33 53 52.50	35 57 52.70
Bekaa	Zahle	**TERBOL - ZAHLE**	34 26 38.0	35 55 25.0
Mount Lebanon	Aley	**AAIN AuthorityZ**	33 43 54.26	35 34 46.36
Mount Lebanon	Baabda	**JOUAR EL HAOUZ**	33 51 47.88	35 45 36.39
Mount Lebanon	Baabda	**QORTADA**	33 51 36.74	35 37 24.91
Mount Lebanon	Jbeil	**AAIN ED DELBE JBAYL**	34 5 29.05	35 45 42.92
Mount	Jbeil	**AAQOURA**	34 07 21.0	35 53 23.0

Lebanon				
Mount Lebanon	Jbeil	**LAQLOUQ**	34 08 07.2	35 51 34.3
Mount Lebanon	Jbeil	**TARTIJ**	34 10 58.75	35 49 27.92
Mount Lebanon	Metn	**MTAIN**	33 52 00.00	35 45 11.00
Nabatieh	Bent Jbeil	**QAOUZAH**	33 7 21.89	35 20 37.98
Nabatieh	Bent Jbeil	**SROBBINE**	33 9 24.28	35 21 37.22
Nabatieh	Nabatieh	**ARNOUN**	33 19 54.8	35 32 08.2
North	Akkar	**AKROUM**	34 36 10.5	36 19 55.8
North	Akkar	**QBAIYAT AAKKAR**	34 33 14.55	36 16 28.98
North	Akkar	**SAYSSOUQ**	34 29 20.47	36 3 9.39
North	Akkar	**TESHAA & DAHR EL QANBAR**	34 29 52.93	36 11 33.16
North	Batroun	**RACHKIDA**	34 15 49.61	35 43 1.37
North	Batroun	**TANNOURINE EL FAOUQA**	34 10 44	35 53 38.
North	Batroun	**TANNOURINE ET TAHTA**	34 12 34.68	35 52 40.32
North	Koura	**BHABBOUCH**	34 16 41.65	35 50 11.24
North	Koura	**BTAABOURA**	34 16 29.04	35 45 35.29
North	Koura	**KFAR QAHEL**	34 21 25.33	35 51 8.68
North	Minyeh-Donnieh	**DEIR NBOUH**	34 22 22.98	35 55 47.78
North	Zgharta	**KARM SADDE**	34 18 27.74	35 53 32.04
North	Zgharta	**MIZIARA**	34 20 7.31	35 55 58.40
South	Jezzine	**RIHANE - JEZZINE**	33 27 33.01	35 35 08.02
South	Jezzine	**RIMAT**	33 31 53.84	35 30 9.63
South	Sour	**MAROUAHINE**	33 06 30.00	35 16 23.00

APPENDIX B: Background discussion on IP QoS methods

In this Appendix, the Authority discusses its understanding of currently available technologies and techniques for ensuring broadband quality of service (QoS) from an end-to-end network perspective. This discussion is intended to provide a framework for the Authority's expectations as to what is and is not achievable and in respect to QoS offered by NBCLs and NBLs.

How can a service provider ensure QoS for communication between the two endpoints of a broadband wireless packet network, which in addition to the wireless link includes several other links interconnected via routers, switches and other core network nodes? The links between intermediate nodes may use a variety of layer 2 technologies, such as ATM (asynchronous transfer mode), frame relay, and Ethernet, each of which may have its own methods to provide QoS.

The Authority will first provide a brief overview of the general requirements and methods for providing QoS in packet networks and then focus on how this is done end to end using emerging layer 3 IP QoS technologies. The performance level is typically specified in terms of throughput, packet loss, delay and jitter, and the requirements vary, based on the application and service. The form of assurance can also vary from a hard quantitative measure, such as a guarantee that all voice packets will be delivered with less than 100ms delay 99% of the time, to a soft qualitative guarantee that certain applications and users will be given priority over others.

Resource limitations in the network are what make providing assurances a challenge. Although, typically, the most-constrained resource is the wireless link, the other intermediate nodes and links that have to be traversed for an end-to-end service also have resource limitations. Each link has its own bandwidth-capacity limits, and each node has limited memory for buffering packets before forwarding. Overbuilding the network to provide higher bandwidth capacity and larger buffers is an expensive and inefficient way to provide quality, particularly when the quality requirements are very high. Therefore, more clever methods for providing QoS must be devised and these methods must take into account the particular needs of the application or service and optimize the resources used. Different applications require a different mix of resources. For example, latency-intolerant applications require faster access to bandwidth resources and not memory, whereas latency-tolerant applications can use memory resources to avoid packets being dropped,

Draft for Consultation

while waiting for access to bandwidth resources. This fact may be exploited to deliver QoS efficiently.

Providing end-to-end QoS requires mechanisms in both the control plane and the data plane. Control plane mechanisms are needed to allow the users and the network to negotiate and agree on the required QoS specifications, identify which users and applications are entitled to what type of QoS, and let the network appropriately allocate resources to each service. Data plane mechanisms are required to enforce the agreed QoS requirements by controlling the amount of network resources that each application or user can consume.

Draft for consultation

Quality of service technologies

The traditional IP networks were designed for best-effort data and did not include any provision for QoS. Some form of QoS can be provided by relying on different end-to-end transport-layer protocols that run over IP. For example, TCP (transport control protocol) ensures that data is transferred end to end reliably without errors. Similarly, RTP (real time transport protocol) ensures that packets are delivered in sequence and in a manner that allows for continuous playout of media streams. These transport-layer protocols, however, do not have any mechanism for controlling the end-to-end delay or throughput that is provided by the network. For managing end-to-end latency and throughput, QoS mechanisms need to be in place in the network layer, and traditional IP did not have any. Recognizing this deficiency, the IETF developed a number of new architectures and protocols for delivering end-to-end QoS in an IP network. Three of the more important developments are (1) integrated services (IntServ), (2) differentiated services (DiffServ), and (3) multi-protocol label switching (MPLS).

Integrated service architecture

The IntServ architecture is designed to provide hard QoS guarantees on a per-flow basis with significant granularity by using end-to-end dynamic signaling and resource reservation throughout the IP network. The architecture supports three QoS levels:

(1) “Guaranteed services” provide hard guarantees on quality, including quantified upper bounds on end-to-end delay and jitter and zero packet loss owing to buffer overflows. This QoS level aims to emulate a dedicated rate circuit-switched service in an IP network.

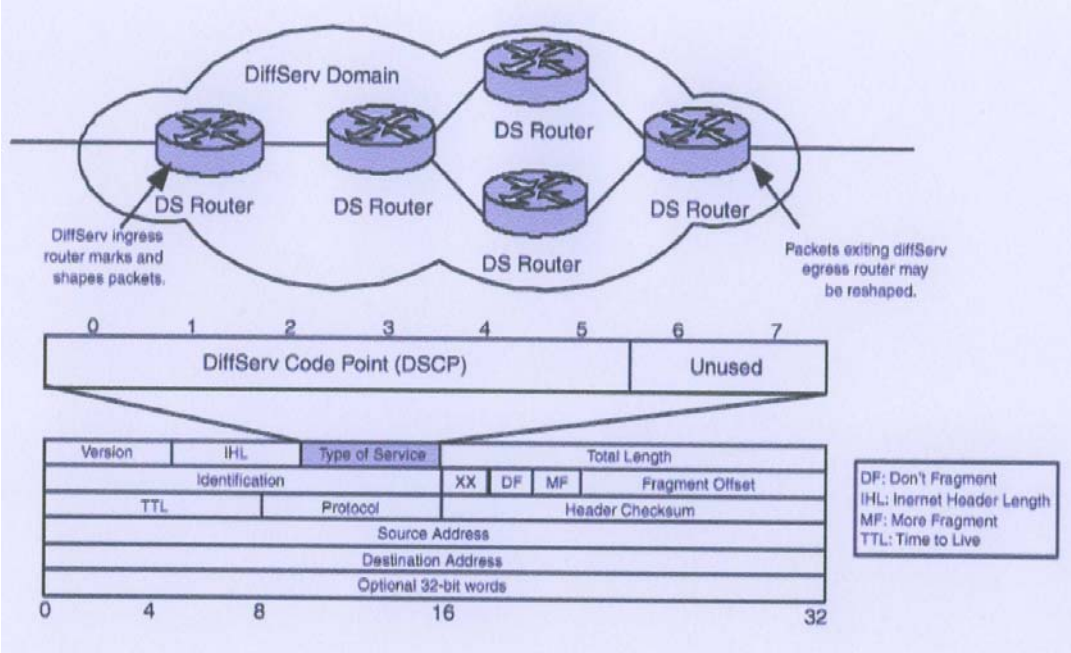
(2) “Controlled load services” provide qualitative guarantees aimed at approximating the service a user would experience from a lightly loaded best-effort network. This QoS level provides a guaranteed sustained rate but no assurance on delay or packet loss.

(3) “Best-effort services” provide no guarantees and require no reservation.

IntServ uses the resource reservation protocol (RSVP) for signaling end-to-end QoS requirements and making end-to-end resource reservations. RSVP messages carry information on how the network can identify a particular flow, quantitative parameters

describing the flow, the service type required for the flow, and policy information, such as user identity and application.

Differentiated service architecture

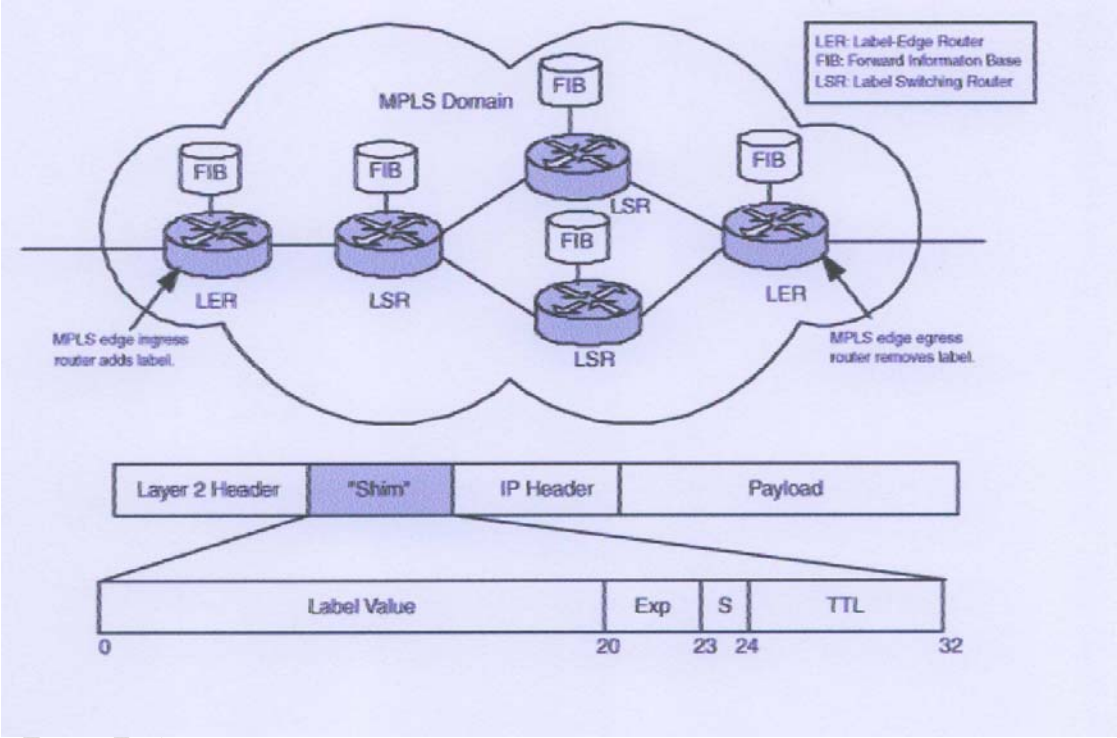


Recognizing the scalability problems that prevented the widespread deployment of IntServ, IETF started developing a new model in 1997 to provide QoS without the overhead of signaling and state maintenance. Called differentiated services, or DiffServ, the new model relies on aggregate traffic handling, not the per flow traffic handling used in IntServ. DiffServ divides the traffic into a small number of classes and treats each class differently. DiffServ uses the previously ignored type of service (TOS) field in the IP header for marking the packets to a particular class. The marking is a 6-bit label called DiffServ code point (DSCP).

Typically, a user or an application sending traffic into a Diffserv network marks each transmitted packet with the appropriate DSCP. The ingress-edge router classifies the packets into queues based on the DSCP. The router then measures the submitted traffic for conformance to the agreed profiles and, if packets are found nonconforming, changes the DSCP of the offending packets. The ingress-edge router may also regulate traffic by

delaying or dropping packets as necessary. In a DiffServ network, the edge router does admission control and ensures that only acceptable traffic is injected into the network. All other routers within the DiffServ network simply use the DSCP to apply specific queuing or scheduling behavior—known as a per hop behavior (PHB)—appropriate for the particular class.

Multi protocol label switching service architecture



MPLS is another recent development aimed at improving the performance of IP networks. Originally developed as a method for improving the forwarding speed of routers, MPLS is now being used as a traffic engineering tool and as a mechanism to offer differentiated services. MPLS also allows for tighter integration between IP and ATM, improving the performance of IP traffic over ATM networks. The basic idea behind MPLS is to insert between the layer 2 and IP headers of a packet a new fixed-length "label" that can be used as shorthand for how the packet should be treated within the MPLS network (see Figure above). Within an MPLS network, packets are not routed using IP headers but instead are switched using the information in the label.

The router at the ingress edge of an MPLS network is called the ingress label-edge router (LER) and is responsible for inserting the label into each incoming packet and mapping the

packet to an appropriate forward equivalence class (FEC). All packets belonging to an FEC are routed along the same path, called the label switched path (LSP) and given the same QoS treatment. The LSP is fixed prior to the data transmission via manual configuration or using signaling protocols.

By having predetermined paths, MPLS speeds up the forwarding process, albeit at the cost of additional processing at the edge router that converts IP packets to MPLS packets. MPLS can also be used to alleviate congestion through traffic engineering (TE). Unlike traditional IP networks that route traffic automatically through the shortest path, MPLS can route traffic through engineered paths that balance the load of various links, routers and nodes in the network. Along with such signaling protocols as RSVP-TE or LDP-CR, it is possible in an MPLS network to compute paths with a variety of constraints and to reserve resources accordingly. Dynamic traffic management allows the network to operate closer to its peak efficiency. It is also possible to engineer paths for specific applications—for example, to set up dedicated circuits by configuring permanent LSPs for voice traffic or for virtual private network (VPN) applications.

Although not by itself an end-to-end IP QoS mechanism, MPLS does provide a good infrastructure over which IP QoS may be implemented. Both IntServ and DiffServ mechanisms may be implemented on an MPLS infrastructure, though MPLS-DiffServ is a more common choice. MPLS, however, breaks the end-to-end principle of IP protocols and puts control in the hands of the network operator.

Draft for Consultation