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Interactive Workshop 2: KPIs for end-to-end broadband QoS/QoE

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QoS Management Philosophy and Metrics

Key performance indicators

- Key performance parameters for each hop of an IP-based network:
  - **Bandwidth:** the maximum number of bits that a transmission path can carry.
  - **Propagation delay:** The time that a packet requires, as a function of the combined length of all transmission paths and the speed of light through the transmission path.
  - **Queuing delay:** The time that a packet *waits* before being transmitted. Both the *average delay* and *variability of delay (jitter)* matter, since the two together establish a confidence interval for the time within which a packet can be expected to arrive at its destination.
  - **Packet loss:** The probability that a packet never reaches its destination. This could be due to transmission errors, but errors are quite rare in modern fibre-based fixed networks. More often, packets are lost because the number of packets waiting for transmission is greater than the available storage capacity (*buffers*).

Key performance indicators

- These correspond closely to parameters (defined by ETSI) whose use is recommended by European regulators in BEREC (2014), “Monitoring quality of Internet access services in the context of net neutrality”.
  - Upload / download speed
  - Delay
  - Jitter (variability of delay)
  - Packet loss ratio
  - Packet error ratio

QoS, QoE, and application needs

- The relationship between QoS at the IP network level and the end user *Quality of Experience (QoE)* is strongly dependent on the application.
  - E-mail is tolerant of high delay or loss, since users do not expect instant delivery.
  - The QoE of voice conversations (such as in IP telephony) depends on packet delay, delay variation (jitter), and packet loss.
    - A well-known criterion is that for a proper experience, the one-way delay through the network should not exceed roughly 150 milliseconds.
    - Longer delays may cause users on both sides of the connection to begin speaking at once (as with telephone conversations using geosynchronous satellites, where round trip delay is 270 milliseconds).
  - For interactive gaming, delay and delay variation can also be important, especially for so-called first person shooter games.

Ways to manage QoS

- Controlling QoS does not make the transmission links any faster.
- Network designers and engineers can, however, control:
  - the **relative priority** with which each router processes the IP packets / datagrams waiting to be sent over each transmission link; and
  - during periods where more packets are waiting than a given router is able to store or buffer, ***which* packets** are to be dropped.
- It is often forgotten that effects similar to prioritisation can be achieved by **caching** (storing frequently used static data close to the user) and by **replication** (where the same dynamically generated results can be produced in more than location in the network – cloud services can represent an example of this kind of distribution or replication of function). The use of caching **Content Delivery Networks (CDNs)** represents an increasingly common and important means of improving QoE.

How prevalent is delay sensitive application traffic?

- It is clear that:
  - **Real-time** bidirectional **speech** benefits from bounded **delay**.
  - **Real-time** bidirectional **video** benefits from bounded **delay**.
  - For **streaming one-way** speech or video, delay plays little role (as long as the user is prepared to accept a second or two of delay at the outset while the jitter butter is filled).

- Real-time bidirectional speech is a low bandwidth service, to the point where the Cisco VNI no longer bothers to estimate the volume.

- **Streaming video is a huge** and growing fraction of Internet traffic.

How prevalent is delay sensitive application traffic?

- **Video content represents a huge fraction of Internet traffic**; however, only real-time bidirectional video (presumably a small fraction of the total) places high demands on delay.
- The **traffic load** associated with **VoIP is negligible**.

Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

Aggressive Imposition of QoS Standards vs. Light Touch Approaches

QoS and monopoly providers

- Historically, in countries where voice telecommunications was a **regulated monopoly** or government monopoly, both **quality and prices** for voice services tended to be **very high**.

- Compensation was typically *rate of return* based, which meant that the incumbent provider was permitted to charge so as to recover its costs and achieve a percentage profit above them.

- This creates perverse incentives – the incumbent is motivated to maximise its costs in order to maximise its profits.

- It typically results in **"gold plating"** of services, i.e. delivery of services in excess of what many consumers strictly require.

QoS in countries with competition

- In countries with **greater competition**, or at least with strong prospects of competitive entry, it is often **preferable** to **leave QoS to market forces**.
- One would expect that **different levels of quality** will emerge in the market in such countries, with **correspondingly different prices**.
- The reasons for this are:
  - Different consumers have **different willingness to pay (WTP)** for **different level of quality**, or even different WTP for QoS for different conversations.
  - **Price and quality differentiation benefit the network operators** overall, since they can capitalise on these differences and extract more revenue.
  - **Consumers also benefit** from differentiated services that on balance better accord with their preferences.
  - Aggregate consumption tends to be higher, benefiting the broader society.

Network Neutrality

Network Neutrality

- Introduction
- What harms are known to date? Regulatory views
- Attitudes of market players and consumers to network neutrality
- How special are "specialised services"?
- Interconnection and QoS
- The "dirt road" effect
- Regulatory goals for net neutrality

Conflicting definitions of network neutrality

- Network neutrality has taken on various meanings:
  - The ability of all Internet end-users '… to access and distribute information or run applications and services of their choice.'
  - Traffic '… should be treated equally, without discrimination, restriction or interference, independent of the sender, receiver, type, content, device, service or application.'
  - Absence of unreasonable discrimination on the part of network operators in transmitting Internet traffic.
- These definitions are not exactly equivalent, and their implications for public policy are not exactly equivalent.
- In particular, for "all traffic to be treated equally" potentially runs counter (in the more extreme interpretations) to any form of differentiated QoS, while the other definitions do not necessarily prohibit differentiated QoS.

How special are "specialised services"?

- Whether this distinction will ultimately prove to be useful or sustainable remains to be seen.
- The concept of specialised services is linked to concerns about possible "dirt road" effects, as we explain shortly.
  - The concern is that high priced prioritised services might somehow "crowd out" normal priority services.
  - Given that prioritisation makes sense for a range of services, some of which are "specialised" while others are not (e.g. do not have capacity that is fenced off or distinct from capacity used for best efforts traffic), it is once again not clear that this definition (or non-definition) serves in the end to add clarity.

How special are “specialised services”?

- In the US, then specialised services are *defined by what they are not*, namely broadband Internet access services (BIAS).
- Per the US FCC‘s Open Internet Order of 2014, BIAS is defined as: “A mass-market retail service by wire or radio that provides the capability to transmit data to and receive data from all or substantially all Internet endpoints, including any capabilities that are incidental to and enable the operation of the communications service, but excluding dial-up Internet access service. This term also encompasses any service that the Commission finds to be providing a functional equivalent of the service described in the previous sentence, or that is used to evade the protections set forth in this Part.”
- BIAS also “does not include enterprise services, virtual private network services, hosting, or data storage services.”

The "dirt road" effect

- The concern here is that Internet traffic management and prioritisation might somehow motivate network operators to degrade non-prioritised traffic, thus turning the best efforts Internet into a "dirt road" of poor capacity and quality.
- Like many terms in the network neutrality discussion, there is no universally accepted definition of the "dirt road" effect; however, work by BEREC provides a good staring point.
- An integrated broadband provider that also offers services such as video may wish to positively differentiate in favour of its upstream services, which '[does] not necessarily raise competition problems'. (BEREC (2012))
- Negative differentiation is characterised as a 'hypothetical situation' that 'when it negatively affects a large number of content providers, is referred to in the net neutrality literature as the "dirt road"'. (BEREC (2012))

Scenarios of traffic management

- If all packets were of high priority, or all of low priority, then prioritisation would have no effect whatsoever.
- If few packets were of high priority, and most were of low priority, then prioritisation would accelerate the small number of high priority packets by moving them to the head of the queue, but the low priority packets would experience only a small additional delay as a result.
- If most packets were of high priority, and few were of low priority, then prioritisation would *only slightly* accelerate the small number of high priority packets by moving them to the head of the queue (although the variability of delay would be reduced), but the low priority packets might experience substantial additional delay as a result.
- The business logic of prioritising traffic seems weak if nearly all traffic is high priority in any case. We assume that 30% of the capacity of the link is a generous practical upper limit on the level of prioritised traffic.

Regulation in the EU: The Telecoms Single Market Regulation

- On 11 September 2013, the European Commission proposed a Telecoms Single Market (TSM) Regulation to the European Parliament.
- Network neutrality was a small but important part of the original legislative proposal; however, it and mobile roaming are the only portions of the TSM proposal that survived the subsequent legislative process.
- After intense negotiations between the Council and the European Parliament, the Regulation was enacted on 27 October 2015.

New Legislation and Raising Issues 1/2

- The new legislation allows the creation of internet fast lanes for "specialized services" and lets ISPs offer so-called "zero-rating" products — i.e. apps and services that don't count toward monthly data allowances — without restrictions.
  - Critics of the legislation say that the latter loophole will allow big internet companies to favor certain services in commercial deals.
  - For example, an ISP could agree with Apple to make Apple Music "zero-rated," leaving rival music streaming services at a disadvantage.
- Proponents of the bill argue that letting "specialized services" use an internet fast lane makes sense for devices that deserve priority, such as self-driving cars and remote medical operations,
  - but critics say the legal language used is too vague and will allow big firms to pay for faster access.
  - Companies have reportedly tried to exploit a similar loophole in net neutrality legislation adopted in the US to create fast lanes for TV streaming services.

New Legislation and Raising Issues 2/2

- The newly adopted EU legislation also allows ISPs to speed up or slow down traffic depending on what sort of data is being sent –
  - allowing them to make video calls more important than emails, for example.
  - There are worries that this will lead to encrypted internet traffic receiving slower speeds as ISPs can't determine what sort of data it contains.
  - The legislation also allows ISPs to preemptively throttle traffic before times of increased demand.

- Despite these four loopholes, the new laws do state that **ISPs should "treat all traffic equally, without discrimination, restriction or interference."**

Article 2: Definitions

- **Provider of electronic communications to the public** means an undertaking providing public communications networks or publicly available electronic communications services.
  - So, we have network providers and service providers
  - Single entity can be at the same network and service provider.

- **Internet Access Service** means a publicly available electronic communications service that provides access to the internet, and thereby connectivity to virtually all end points of the internet, irrespective of the network technology and terminal equipment used.
  - This refers to network neutral traffic (not to managed traffic such as QoS-enabled VoIP as PSTN/ISDN replacement or QoS-enabled IPTV).

Article 3: Safeguarding of open Internet access

- "End **users** shall have the right to access and distribute information and content, use and provide applications and services, and use terminal equipment of their choice, irrespective of the end user's or provider's location or the location, origin or destination of the information, content, application or service, via their internet access service.“

- "**Providers** of internet access services shall treat all traffic equally, when providing internet access services, without discrimination, restriction or interference, and irrespective of the sender and receiver, the content accessed or distributed, the applications or services used or provided, or the terminal equipment used."

Article 4: Transparency measures for ensuring open internet access

- Providers of internet access services shall ensure that any contract which includes internet access services specifies at least the following:
  - **information on how traffic management measures applied by that provider could impact on the quality of the internet access services**, on the privacy of end users and on the protection of their personal data;
  - a clear and comprehensible **explanation** as to how any volume limitation, speed and other quality of service parameters may in practice have an **impact on internet access services**, and in particular on the use of content, applications and services;
  - a clear and comprehensible explanation of the **minimum, normally available, maximum and advertised download and upload speed** of the internet access services in the case of fixed networks, or of the estimated **maximum and advertised download and upload speed of the internet access services in the case of mobile networks**, and how significant deviations from the respective advertised download and upload speeds could impact…
  - a clear and comprehensible explanation of the **remedies available** to the consumer in accordance with national law in the event of any continuous or regularly recurring discrepancy between the actual performance of the internet access service regarding speed or other quality of service parameters…

Article 5: Supervision and enforcement

- **National regulatory authorities** shall closely monitor and ensure compliance with Articles 3 and 4, and shall promote the continued availability of non-discriminatory internet access services at levels of quality that reflect advances in technology.
  - What this means to you?

- National regulatory authorities shall publish reports on an annual basis regarding their monitoring and findings.

Article 6: Penalties

- Member States shall lay down the rules on **penalties** applicable to infringements of Articles 3, 4 and 5 and shall take all measures necessary to ensure that they are implemented.
  - Are penalties really necessary in developed markets, what about the Willingness To Pay by the end users?

- The penalties provided for must be effective, proportionate and dissuasive. Member States shall notify the Commission of those rules and measures by 30 April 2016.
  - The strict QoS was targeted in 1990s in Europe with standardization of ATM, but it failed in the battle with the Internet and its openness to different services and applications with speedy innovations:
    - Short time to the market
    - No need for approval by national regulators if it is not against national applicable legislation (which is country by country dependent)

Issues and Challenges

- From a regulatory perspective, the management of Quality of Service poses numerous challenges.
- **Differentiated management of QoS** (and with it, QoE) potentially offers **benefits** not only to network operators, but also to content and application providers, and also to consumers and other end-users.
- Quality differentiation can be used in ways that harm consumers, especially when applied in conjunction with market power that has not been addressed through other regulatory means.
- Striking a sensible balance in QoS approaches is not easy!
- Recently enacted measures in the EU (Telecoms Single Market Regulation), the US (The Open Internet Order of 2015), but it is too soon to say how effective they will be in practice.

Key Performance Indicators
- mobile services case -

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KPIs from Users' Perspective = KQIs

- **KPIs (Key Performance Indicators) = internal indicators**
  - part of **network performance**
  - based on **network counters**
  - essential for **operation, maintenance, business model**
  - could be **reported, audited** etc.
  - however, **meaningless when out of context**.
- **KQIs (Key Quality Indicators) = external indicators**
  - basis for **QoS assessment** as **perceived by the user**
  - **vendor independent**
  - **operator independent**
  - ideal to **compare** different **operators** on a **statistical basis**
  - **cannot be reported** from the **system itself**
  - requires some kind of **field testing**, **drive**, **walk** etc.
  - For **monitoring and regulation** a **subset** can be selected
    - **applicable** across **all vendors and operators**
    - **not limited to mobile**, but also for **broadband** in general.

Enforcement of Quality of Service

- Requirements so as to enforce the **Quality of Service**:
  - **Law for ICT/Electronic communications**:
    - Adopted and published in the Official Gazette (in the country)
  - **Regulations/Guidelines of QoS in mobile networks**:
    - **With a purpose**:
      - Improve / maintain service quality;
      - make QoS Information available to customers;
      - assist the development of telecommunication markets and;
      - improve operation and performance of interconnected networks.
    - **Guidance about**:
      - Methodologies for measuring, reporting and recording.
      - QoS parameters definitions and thresholds.
  - **Reports of QoS submitted Monthly or Quarterly by Telecom Operators to the Regulatory Authority**:
    - Include technical and non technical parameters
  - **QoS monitoring tools for auditing the QoS of mobile networks independently**
  - **Staff in charge well trained**

Mobile KPIs for Telephony

Telephony KPIs	Definitions
Call Setup Success Rate (CSSR)	CSSR denotes the probability that the end-user can access the mobile telephony service when requested if it is offered by display of the network indicator on the user equipment
Call Setup time (CST)	CST describes the time period between sending of complete address information by the MOC and receipt of call set-up notification or an alerting message.
Call Drop Rate (CDR)	CDR denotes the probability that a successful established attempt is ended unintentionally by MOC or MTC party
Speech Quality	Speech quality on sample basis: is an indicator representing the quantification of the end-to-end speech transmission quality of the mobile telephony service.
Service coverage Area (Signal level): ≥ -95 dBm.	The Service coverage area verification depends on Operator's coverage plan.

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Mobile KPIs for SMS

KPIs for SMS	Definitions
SMS Service Accessibility	SMS service accessibility denotes the probability that the end-user can access the SMS when requested while it is offered by display of the network indicator on the user equipment.
SMS Completion Ratio	SMS Completion Ratio is the ratio of successfully received and sent messages from the sending UE (user equipment) to the receiving UE, excluding duplicate received and corrupted messages.
SMS End-to-End Delivery Time [s]	SMS end-to-end delivery time is the time period between sending a short message to the network and receiving the very same short message at another UE.

Mobile KPIs for Data Services

KPIs Data services	Definitions
Attach failure ratio	Attach failure ratio denotes the probability that a subscriber cannot attach to the Packet Switched (PS) network.
Attach Setup time	Attach setup time describes the time period needed to attach to the PS network
PDP Context Activation Failure Ratio	PDP context activation failure ratio denotes the probability that the PDP context cannot be activated. It is the proportion of unsuccessful PDP context activation attempts and the total number of PDP context activation attempts.
PDP Context Activation Time	PDP context activation time describes the time period needed for activating the PDP context.
PDP Context Cut-off Ratio	PDP context cut-off ratio denotes the probability that a PDP context is deactivated without being initiated.

Some Best Practice and Some Additional Challenges

- **Some Advantages** *(postulated)*
  - **QoS Regulation not needed**
  - **Market Powers regulate** overall **Quality**

- Some **Requirements** *(obvious)*
  - All **stakeholders** stick to **standards**
  - Appropriate **standards** are **available** in time
  - **QoS responsibilities** must be **clear** defined

- Some additional **challenges** on **QoS for mobile services regulation**:
  - **New emerging mobile services**, such as **Internet of Things** (IoT)/ **Web of Things** (WoT) –based services or **Cloud Computing** services, both offered **with QoS** guarantees by mobile operators (**not OTT** applications), over mobile broadband access networks.

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Experiences from Mobile QoS Regulation Practices

- Some **regulators' experiences** are the following:
  - Quality **is extremely fluctuating** in **mobile networks** and it is **not predictable** (at least, to certain extent)
  - An global **average quality value** across one mobile network has no meaning for the customer
    - e.g. if top donwload speed is 42 Mbit/s in certain urban UMTS areas, which is advertised, the average download speed per user can be 2-3 Mbit/s
      - and it will be different for different users at different locations in the network.
  - **Customer** wants to know **quality at current location**
  - **High resolution required** for **measurements** to be of **any use for customer**
  - **Measurements of quality** and display of **results must** always **reference Time and Location**
  - **Averaging** across **entire infrastructures** is **not permitted**

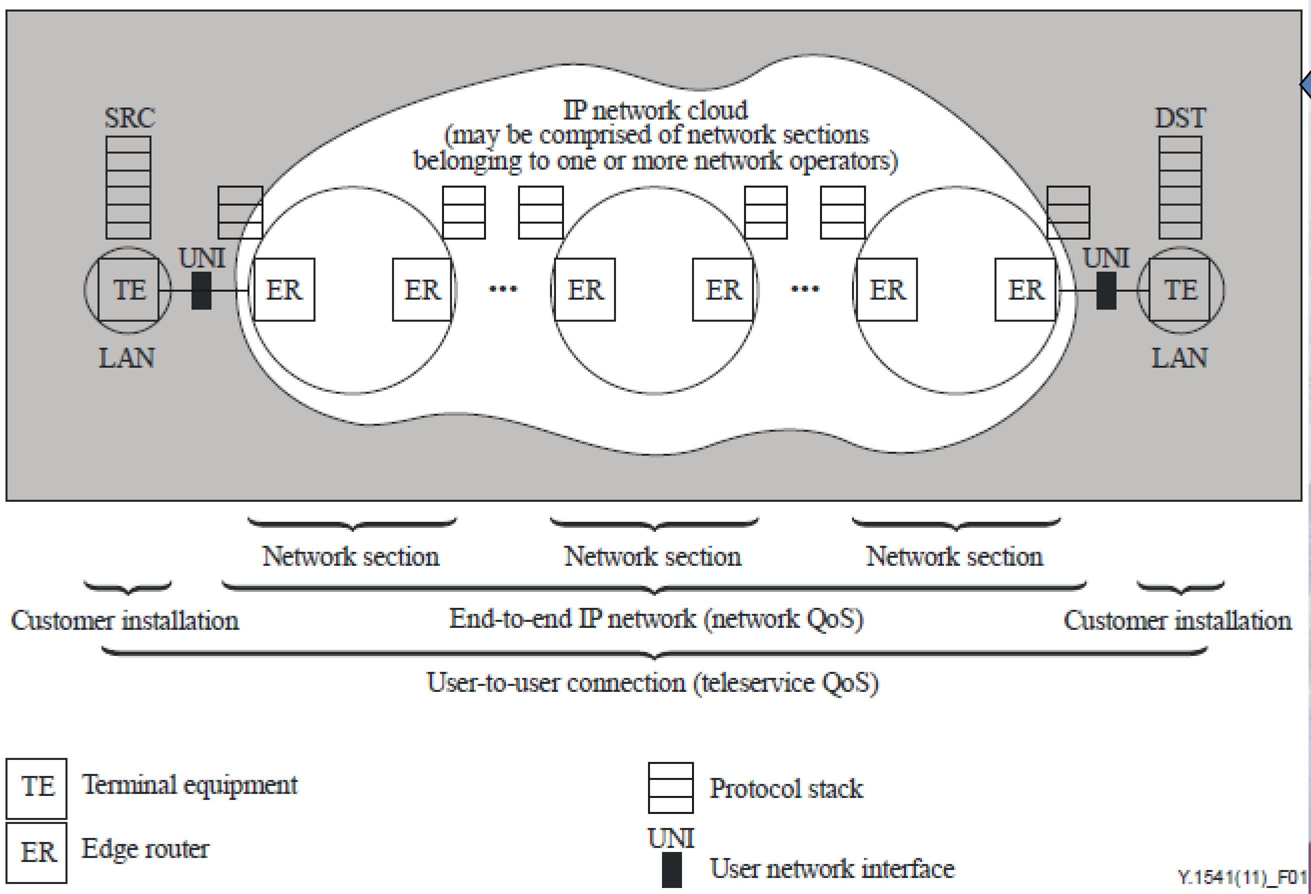
Possible Future Mobile QoS Regulation Developments

- Development of a **measurement methodology** for **broadband access speed**, including **mobile broadband** networks (e.g., 3G, 4G):
  - **measurement** to be done **by customers**
  - creation of a **public data base** across **all mobile providers**
  - enable **customers to know** the **quality** before signing the **contract**
  - enable **customers to check** the contracted **quality**
    - However, the **quality is variable in mobile environments** (e.g., access bitrates may vary due to radio signal strength, installed capacity, congestion in the radio access network, etc.).
- Consequences for **Mobile Operators**:
  - make your own drive test with very high granularity "postal code level" or
  - make software measurement on your customers' phones
- Approach via **customers' phones** requires **huge data base**
  - On average results per location will "true values"
  - **Software** must account for **terminal aspect** in **intelligent manner**
  - Currently **under development** by some **regulators**.

End-to-End QoS Parameters

End-to-End Reference Path for Network QoS Objectives

- **End-to-end network model** is also referred to as **UNI-to-UNI** (UNI is User-Network Interface).



UNI-to-UNI reference path for network QoS objectives

Source: ITU-T Rec, Y.1541, "Network performance objectives for IP-based services", December 2011.

End-to-End Reference Path Attributes

- IP clouds may support user-to-user connections, user-to-host connections, and other endpoint variations.
- Network sections may be represented as clouds with edge routers on their borders, and some number of interior routers with various roles.
- The number of network sections in a given path may depend upon the class of service offered, along with the complexity and geographic span of each network section.
- The scope of ITU –T Recommendation Y.1541 allows one or more network sections in a path.
- The network sections supporting the packets in a flow may change during its life.
- IP connectivity spans international boundaries, but does not follow circuit switched conventions (e.g., there may not be identifiable gateways at an international boundary if the same network section is used on both sides of the boundary).

Composing UNI-UNI Values 1/2

- UNI-UNI performance of a path can be estimated knowing the performance of sub-sections, which is well covered in ITU-T Y.1541.
- **Mean transfer delay (ITU-T Y.1541)**
  - For the mean IP packet transfer delay (**IPTD**) performance parameter, the UNI-UNI performance is the sum of the means contributed by network sections.
- **Delay Variation (ITU-T Y.1541)**
  - The relationship for estimating the UNI-UNI delay variation (**IPDV**) performance from the network section values, must recognize their sub-additive nature and it is difficult to estimate accurately without considerable information about the individual delay distributions.
    - This detailed information will seldom be shared among operators, and may not be available in the form of a continuous distribution.
    - Hence, the UNI-UNI IPDV estimation may have accuracy limitations.

Composing UNI-UNI Values 2/2

- **Error packet ratio (ITU-T Y.1541)**
  - For the IP packet error ratio (**IPER**) performance parameter, the UNI-UNI performance may be estimated by inverting the probability of error-free packet transfer across *n* network sections, as follows:

$$IPER_{UNI-UNI} = 1 - \{ (1 - IPER_{NS1}) . (1 - IPER_{NS2}) . (1 - IPER_{NS3}) . ... . (1 - IPER_{NSn}) \}$$

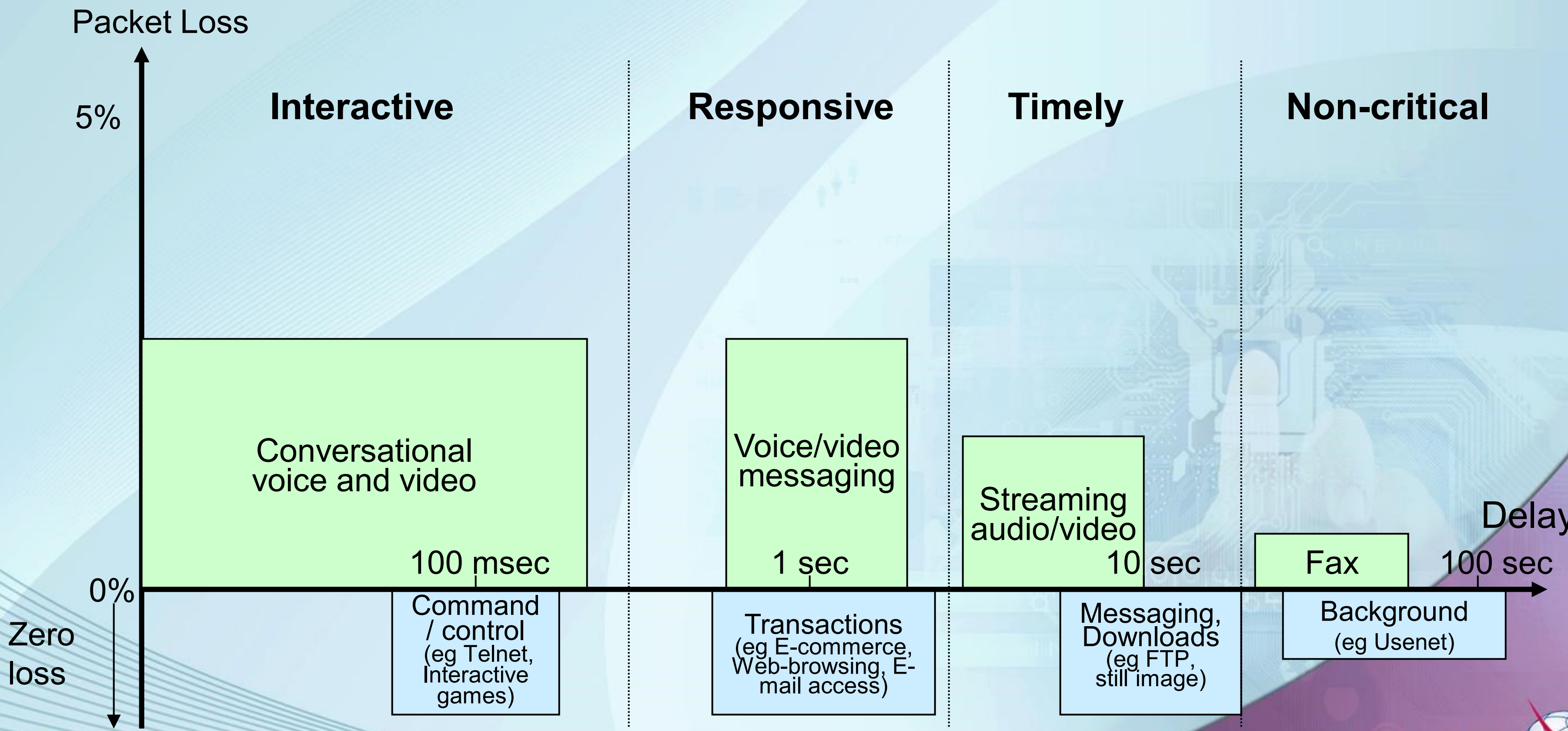
  - The units of IPER values are errored packets per total packets sent, with a resolution of at least 10^{-9}.
- **Loss ratio (ITU-T Y.1541)**
  - For the IP packet loss ratio (**IPLR**) performance parameter, the UNI-UNI performance may be estimated by inverting the probability of successful packet transfer across *n* network sections, as follows:

$$IPLR_{UNI-UNI} = 1 - \{ (1 - IPLR_{NS1}) . (1 - IPLR_{NS2}) . (1 - IPLR_{NS3}) . ... . (1 - IPLR_{NSn}) \}$$

  - The units of IPLR values are lost packets per total packets sent, with a resolution of at least 10^{-9}.

Mapping of User-centric QoS Requirements on Delay

- The size and shape of the boxes provide a general indication of the limit of delay and information loss tolerable for each application class (ITU-T G.1010).



Source: ITU-T Rec, G.1010, "End-user multimedia QoS categories", November 2011.

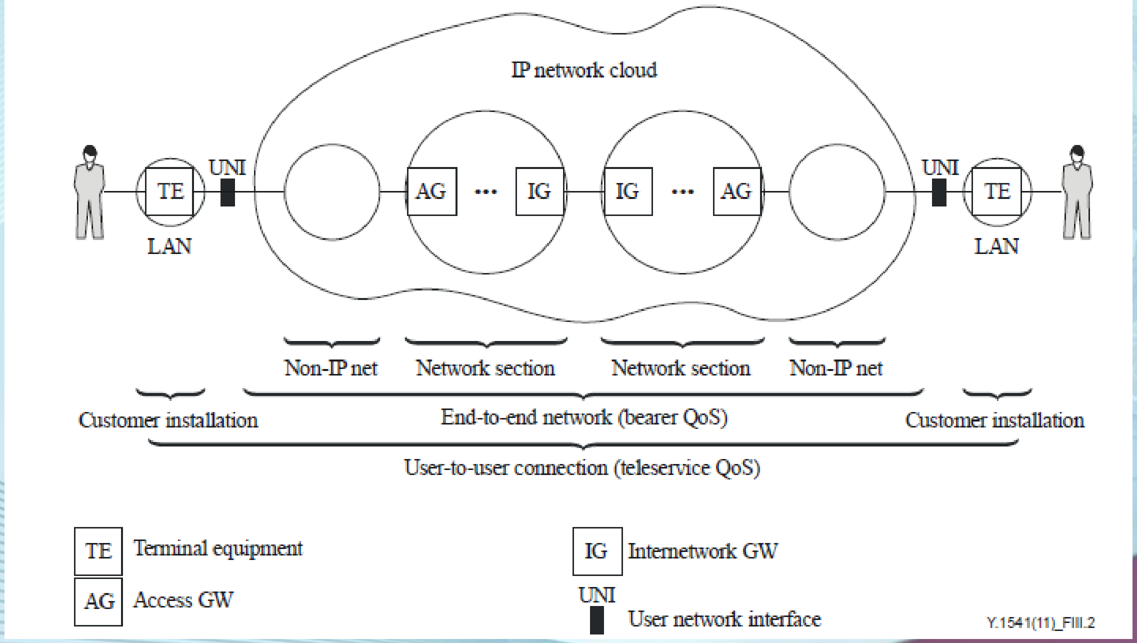
Example: End-to-End Delay Computation

- When a flow portion does not contain a satellite hop, its computed IPTD is (ITU-T Y.1541):

IPTD (in microseconds) ≤ (Rkm × 5) + (N_A × D_A) + (N_D × D_D) + (N_C × D_C) + (N_I × D_I)

where:

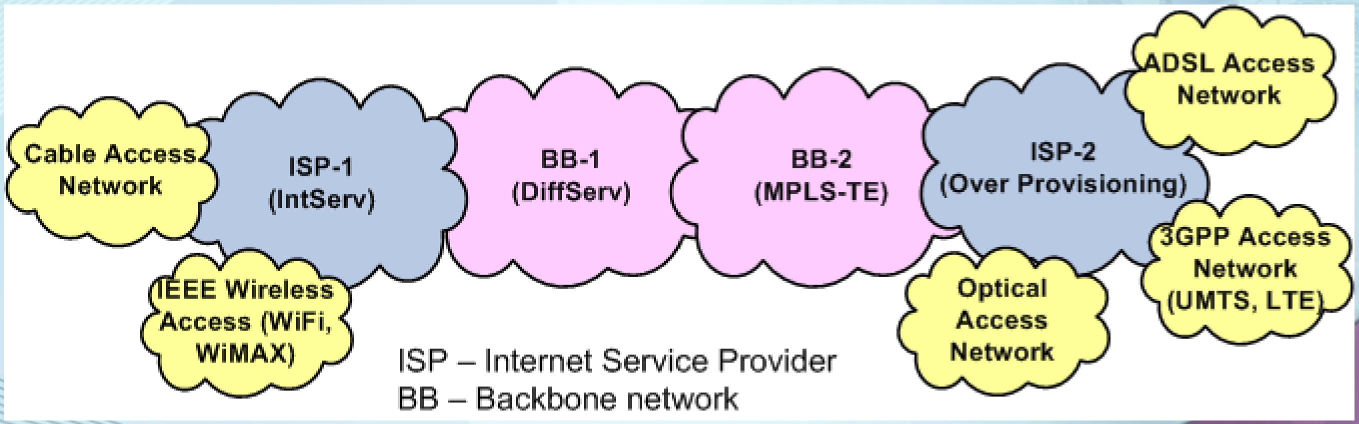
- R_{km} represents the route length assumption computed above,
- (R_{km} . 5) is an allowance for "distance" within the portion,
- N_A, N_D, N_C, and N_I represent the number of IP access gateway, distribution, core and internetwork gateway nodes respectively;
- D_A, D_D, D_C, and D_I represent the delay of IP access gateway, distribution, core and internetwork gateway nodes respectively.



Source: ITU-T Rec, Y.1541, "Network performance objectives for IP-based services", December 2011.

IP Platforms and Networks with Heterogeneous QoS Mechanisms

- There is a fundamental difficulty in the IP based platforms and networks due to **heterogeneity**.
- Just use of IP as a transport technology does not mean networks and platforms are same even compatible.
  - An extreme case of configuration among different networks but using IP as a transport mean.
  - In this case, it is hard to provide services from one end to other end with certain level of quality, because each network has different mechanism and the level of control and provision are also different
    - e.g., ISP-1 uses IntServ, BB-1 uses DiffServ, BB-2 uses MPLS-TE, ISP-2 uses over provisioning.



Source: ITU-T Technical Paper, “How to increase QoS/QoE of IP-based platform(s) to regionally agreed standards”, March 2013.

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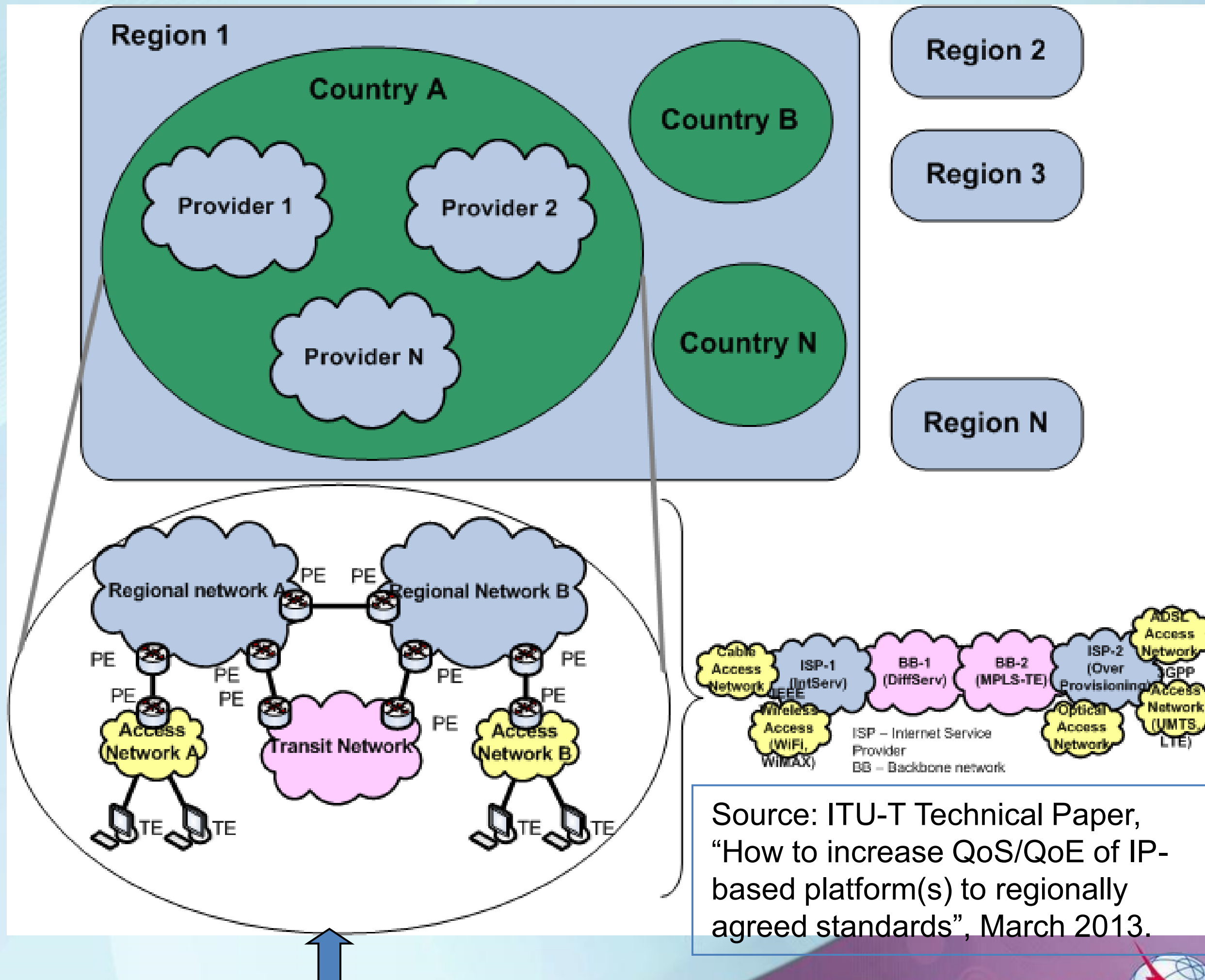
QoS/QoE End-to-End Environment in the Region and Global

- A **basic network model** should be applied commonly to the providers,
  - but the detailed technologies to compose such network model would be **different by providers and countries**.
  - also, there are various differences on **regulation environment** which are fundamental framework for such as **SLAs, QoS and QoE**.



Source: ITU-T Technical Paper, "How to increase QoS/QoE of IP-based platform(s) to regionally agreed standards", March 2013.

Basic Network Model

Mapping between DiffServ, MPLS and Ethernet

Mapping between differentiated service, Multi-Protocol Label Switching (MPLS) and Ethernet, is shown in following table (ITU Y.1545):

Packet network QoS class	Description	Layer 3 packet marking: DSCP (Diffserv Code Point)	Layer 2 packet marking		Applications
			MPLS (class of service)	Ethernet (priority code point)	
Classes 0, 1	Jitter sensitive	EF (Expedited forward)	5	5 (default) or 6	Telephony
Classes 2, 3, 4	Low latency	AF (Assured forward)	4, 3 or 2	4, 3 or 2	Signalling, interactive Data
Class 5	Best efforts	DF (Default forward)	0	0	Web browsing, Email

Source: ITU-T Recommendation Y.1545, "Roadmap for the quality of service of interconnected networks that use the Internet protocol", May 2013.

Recommendation for Development of Relevant Standards for QoS/QoE

- **Common standard** applying **in the region** should be developed.
- In this sense, followings are recommended to be considered in the region for the development of relevant standards for QoS/QoE:
  - **Common understanding** about the nature of **NP, QoS, QoE and SLAs** including relationships among them including common terminology;
  - Ensuring the **SLA for end-end** is an important objective but it is quite difficult to realize this practically in the regional level.
    - So it is **recommended** to develop common parts of parameters identify **NP and QoS** based on **global standards**.
  - Agreed details in QoS building blocks
    - Special attention should be needed in the **management plane mechanism** because this provide a tool for communication between providers and countries.
  - Building **consensus** on the **measurement** objectives and methodologies are crucial to **verify and evaluate** the practical **operation of the networks** and provision of **services**.
  - Develop **reference network model** of **IP** based for the development of detailed standards in the region.

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Topics for Discussion

KPIs for end-to-end broadband QoS/QoE Topics for discussion

- Selecting targets for service level agreements for broadband QoS
- Working with operators on meaningful and easy-to-track indicators
- Monitoring broadband performance metrics
- Country experiences