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International Telecommunication Union

Key Features of QoS study in NGN

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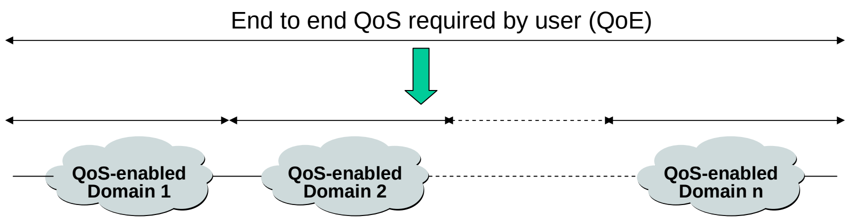
Why do we need QoS in NGN?

- To satisfy the customer (the one who pays the bill)
- Hence, need to understand end-user expectations for QoS
  - Quality of Experience (QoE)
- Use these to drive requirements for specific QoS mechanisms for individual domains



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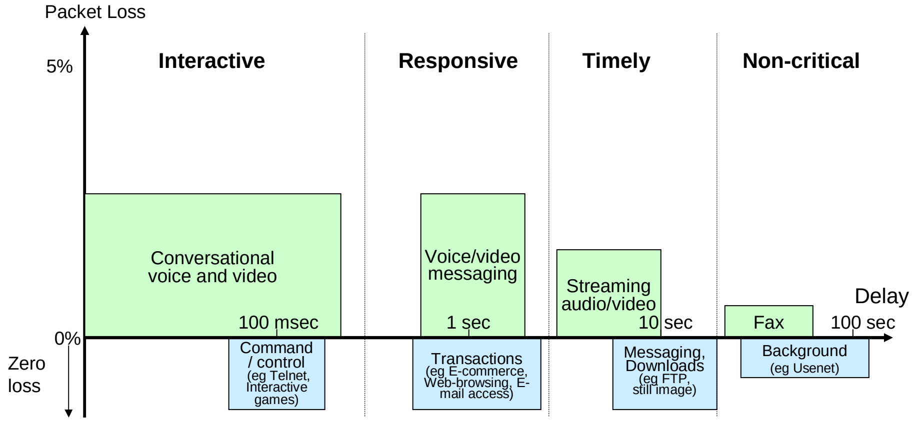
End-user requirements

- wide range of user requirements, depending on application



From ITU-T Rec. G.1010

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Rec. Y.1541 Network QoS Classes

- Consistent with Rec. G.1010
- Provide several network QoS classes to carry traffic having broadly similar requirements
- Doesn't try to meet specific QoS requirements for each application

Network Performance Parameter	QoS Classes					
	Class 0	Class 1	Class 2	Class 3	Class 4	Class 5 Un-specified
Transfer delay	100ms	400ms	100ms	400ms	1 s	U
Delay variation	50ms	50ms	U	U	U	U
Packet loss ratio	$1*10^{-3}$	$1*10^{-3}$	$1*10^{-3}$	$1*10^{-3}$	$1*10^{-3}$	U
Packet error ratio	$1*10^{-4}$					U

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Y.1541 provisional QoS classes

- These classes are intended to support the performance requirements of high bit rate user applications that have more stringent loss/error requirements than those supported by Classes 0 through 4

Network Performance Parameter	QoS Classes	
	Class 6	Class 7
Transfer delay	100 ms	400 ms
Delay variation	50 ms	
Packet loss ratio	1 × 10–5	
Packet error ratio	1 × 10–6	
Packet re-ordering ratio	1 × 10–6	

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Challenges in achieving end to end QoS

- multiple network providers are usually necessary to complete the path
- the number of networks in the path will vary request by request
- distances between users is generally unknown
- the impairment level of any given network segment is highly variable

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Basic approaches for achieving end to end QoS

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- Allocate performance requirements to a limited number of network segments
  - Allows operators to contribute known levels of impairments per segment, but restricts the number of operators that can participate in the path
  - Note that if a given segment does not need to use all of its allocation, the balance is wasted
- Impairment accumulation
  - Allows any number of operators to participate in a path
  - Based on each operator declaring what performance level it can offer, followed by decisions based on the resulting calculated estimate of UNI-UNI performance

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Rec. Y.1542 "Framework for achieving end-to-end IP performance objectives"

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- Describes various approaches for achieving end-to-end (UNI-UNI) IP network performance objectives
  - Static divisor approach
  - Static Reference Allocation Approach
  - Weighted Segment Approach
  - Pseudo-Static Approach
  - Negotiated Allocation Approach
  - Ranged Allocation Approach
  - Impairment Accumulation Approach
- Detailed examples are provided as to how some approaches might work in practice, including how service providers might handle cases where the aggregated impairments exceed those specified in a requested QoS class

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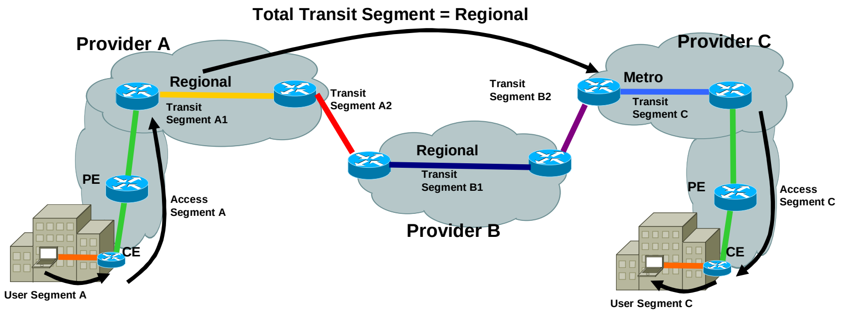
Example Y.1542 topology for impairment allocation

- The UNI-UNI performance is comprised of the edge-to-edge performance of each network segment.



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Static divisor approach

- This approach “divides” the UNI-to-UNI path into a fixed number of segments and budgets the impairments such that the total objective is met in principle
- Requires that individual segments have knowledge of the distance and traffic characteristics between the edges of their domains, as these properties of the segment affect the resulting allocations
  - For example, the delay budget allocated to a network segment depends on whether it is access or transit, and whether the transit distance is metro or regional
  - Similarly, packet loss and delay variation will have to be allocated according to whether the segment is access or transit, as the traffic aspects can differ significantly.

Static Reference Allocation Approach

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- This approach requires that individual segments have knowledge of the distance between the edges of their domains.
- Appendix III/Y.1541 example router delay values and the G.826 air-to-route distance conversion are used, which accounts for major delay contributions of each provider. This approach calculates the delay margin and allocates a proportion of that margin to each provider

Weighted Segment Approach

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- This approach allocates a significant proportion of the impairment budget to each access segment, with each core segment having a lesser fixed budget
- Allocates a fixed budget for core network segments, irrespective of the number of core network segments in any resulting services
- This core network segment budget can be concatenated within bounds to create end to end services that have a high probability of still being within the overall end to end class targets

Pseudo-Static Approach

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- In a "pseudo-static" approach, each provider would have knowledge of how many providers are present in the traffic path and allocate among each other without wasting part of the impairment budget
- Service providers may re-allocate their impairment target among the segments under their control

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Negotiated Allocation Approach

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- In some situations, for the Static and Pseudo-Static approaches, certain segments will not meet their formulaic targets, while others will, and thus have an "impairment budget" excess
- Access providers which require less than the normal allocation of impairments may be able to have the un-needed part of their allocation allocated instead to a transit or user link
  - They may re-allocate their impairment allocation within their control or negotiate the un-needed part to other segments
  - A transit provider may negotiate to use the un-needed part, or to make its un-needed part negotiable for other segments

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Ranged Allocation Approach

- In this approach, the range between the minimum and maximum of the allocated impairment budget for every segment along the data path is negotiated and calculated out by the use of resource management and signaling among the segments
- Any value within each segment impairment budget range, when added with those of other segments, can meet the total impairment budget target for the whole data path
- Thus every segment itself can choose an appropriate value within its allocated budget range under the consideration of optimizing its resource utilization

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Impairment Accumulation Approach

- In this approach, the customer-facing provider
  - Determines the path that packets will follow (e.g., based on inter-domain routing information)
  - Requests from each provider the performance level that they will commit to for each segment of the path for packets identified by source/destination pair, possibly using an on-path QoS signalling protocol
  - Receives a commitment from each provider which is good for the session
  - Combines the segment performance levels (according to rules that are defined in Y.1541)
  - Compares the estimated end to end performance with the desired UNI-to-UNI QoS Class/Objectives
- If the path does not meet the requested objectives, there are two opportunities for negotiation:
  - Path Negotiation: an alternative path might be sought, requiring a routing change based upon parallel or subsequent request of other providers
  - User Negotiation: an alternative Service Class or relaxed objectives could be offered to the user

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