



# QoS-enhanced Border Gateway Protocol for enabling inter-domain QoS Services



June 2005

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# Motivations



- ▶ Leverage the deployment of new inter domain QoS delivery services
- ▶ Discover inter-domain QoS routes
- ▶ Provide more information to the route selection process for a more flexible tuning
- ▶ Select and enforce optimal QoS paths

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# IDQ solutions categories



## ▶ Two categories of IDQ solutions have been defined:

- ▶ Category 1: groups IDQ solutions that need propagating **only an identifier**. This identifier is sufficient to signal the requested QoS treatment when crossing upstream domains
- ▶ Category 2: groups IDQ solutions that need propagating a set of **QoS performance characteristics associated with an identifier**.

(Unrestricted)



# Impact on BGP



- ▶ **Must exchange QoS-based information**
  - ▶ QoS identifier:
    - This identifier is used to differentiate extended QCs
  - ▶ QoS performance characteristics:
    - Set of QoS parameters like loss rate, (min, max, average) one-way packet delay and one-way delay variation
  
- ▶ **Must enhance the current route selection process**
  - ▶ To select a route for a destination per QC plane
  - ▶ To consider QoS performance guarantees information as additional preference parameters
  
- ▶ **But preserve backward compatibility**

(Unrestricted)



# What is q-BGP?



- ▶ **q-BGP is an enhanced BGP which:**
  - ▶ Implements new capabilities;
  - ▶ Supports new messages;
  - ▶ Supports new route selection processes;
  - ▶ Requires new inbound and outbound policies;
  - ▶ Manages several Routing Information Bases (RIB);
  - ▶ Requires extensions of FIB structures

(Unrestricted)



# q-BGP attributes



## ▶ QoS Service Capability

- ▶ QoS Service capabilities are useful for a q-BGP peer to know the capabilities of a q-BGP neighbour with respect to the BGP protocol extensions and supported attributes
- ▶ A q-BGP speaker should use this capabilities advertisement in order to indicate the group it belongs to.

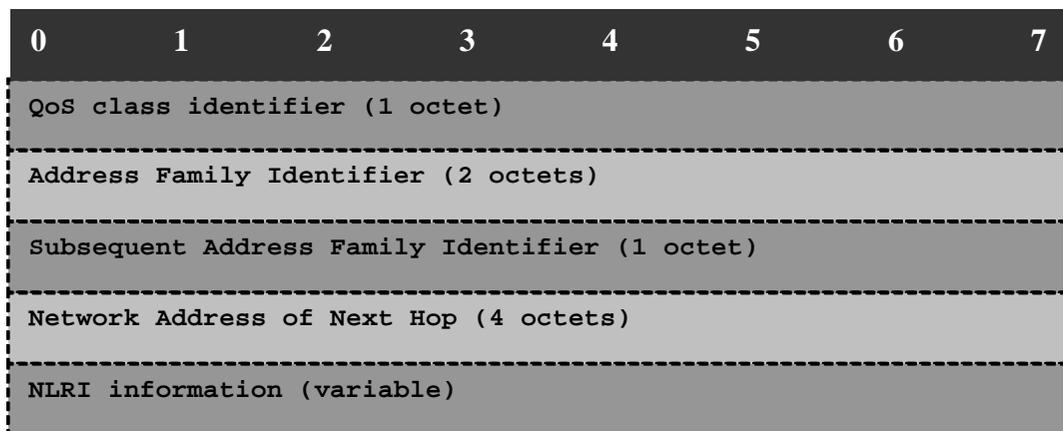
## ▶ QoS\_NLRI attribute:

- ▶ This attribute is used to advertise QoS-enabled routes and is enclosed in UPDATE messages of q-BGP
- ▶ Two flavours of this attribute are defined (group-1, group-2)

(Unrestricted)



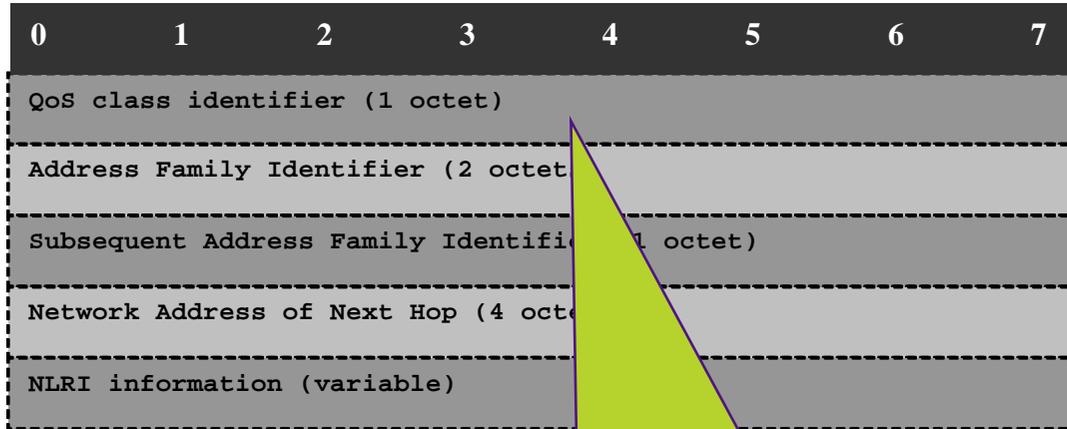
# QOS\_NLRI attribute for group-1(1)



(Unrestricted)



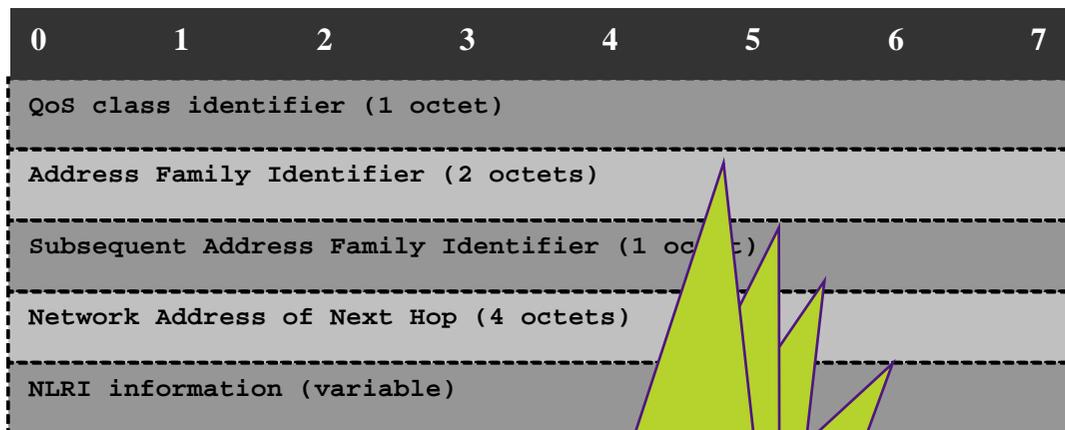
# QOS\_NLRI attribute for group-1(2)



**This field contains the value of the QC-identifier**



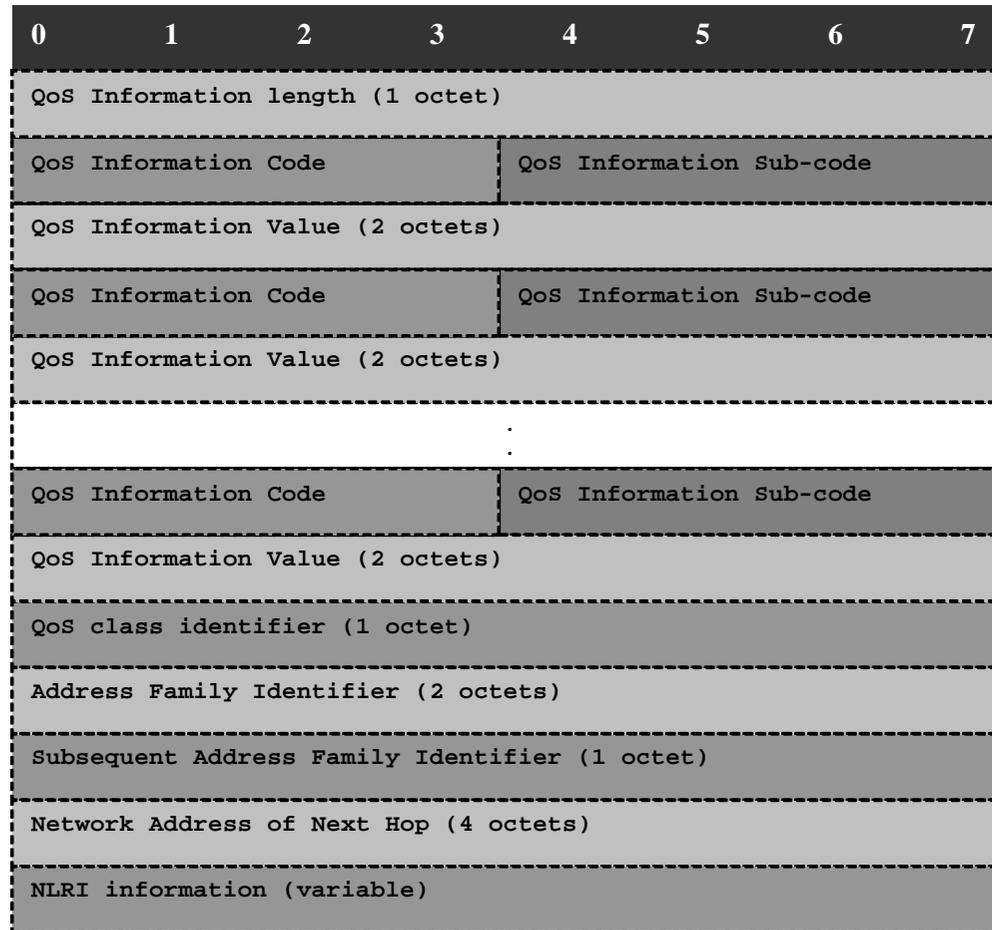
# QOS\_NLRI attribute for group-1(3)



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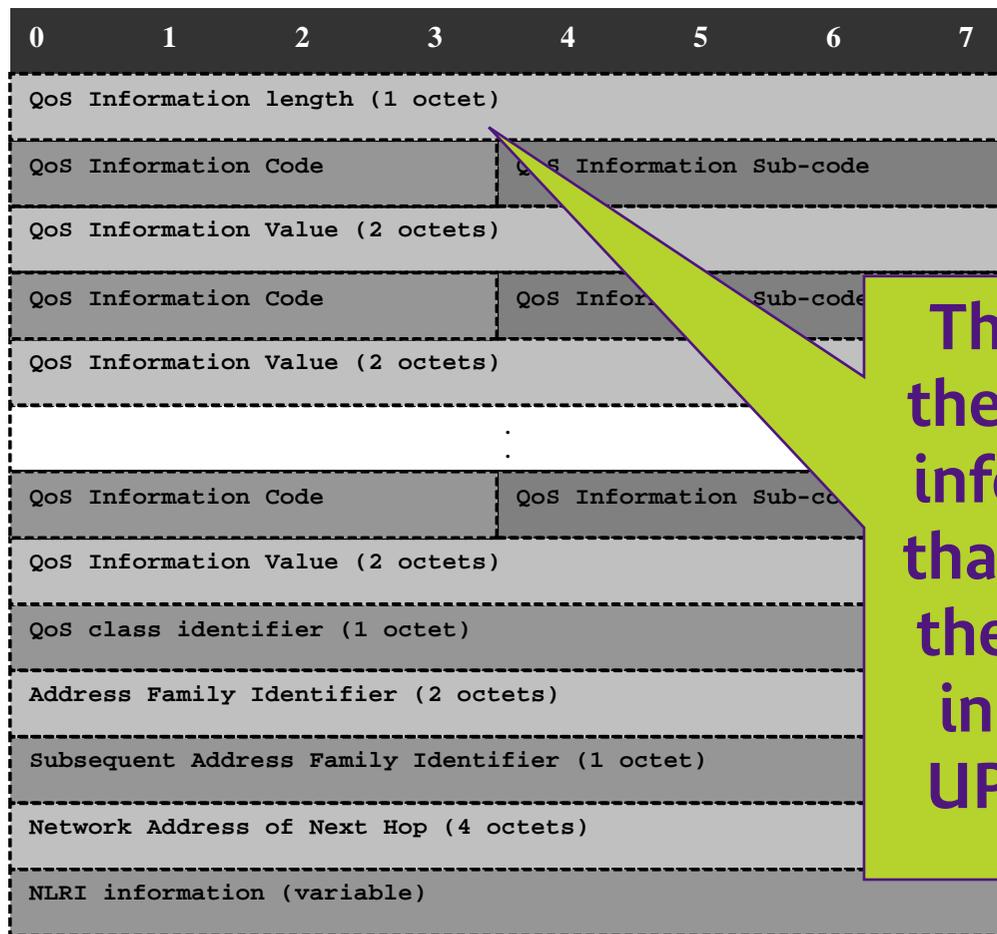
# QoS\_NLRI attribute for group-2 (4)



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# QOS\_NLRI attribute for group-2 (5)

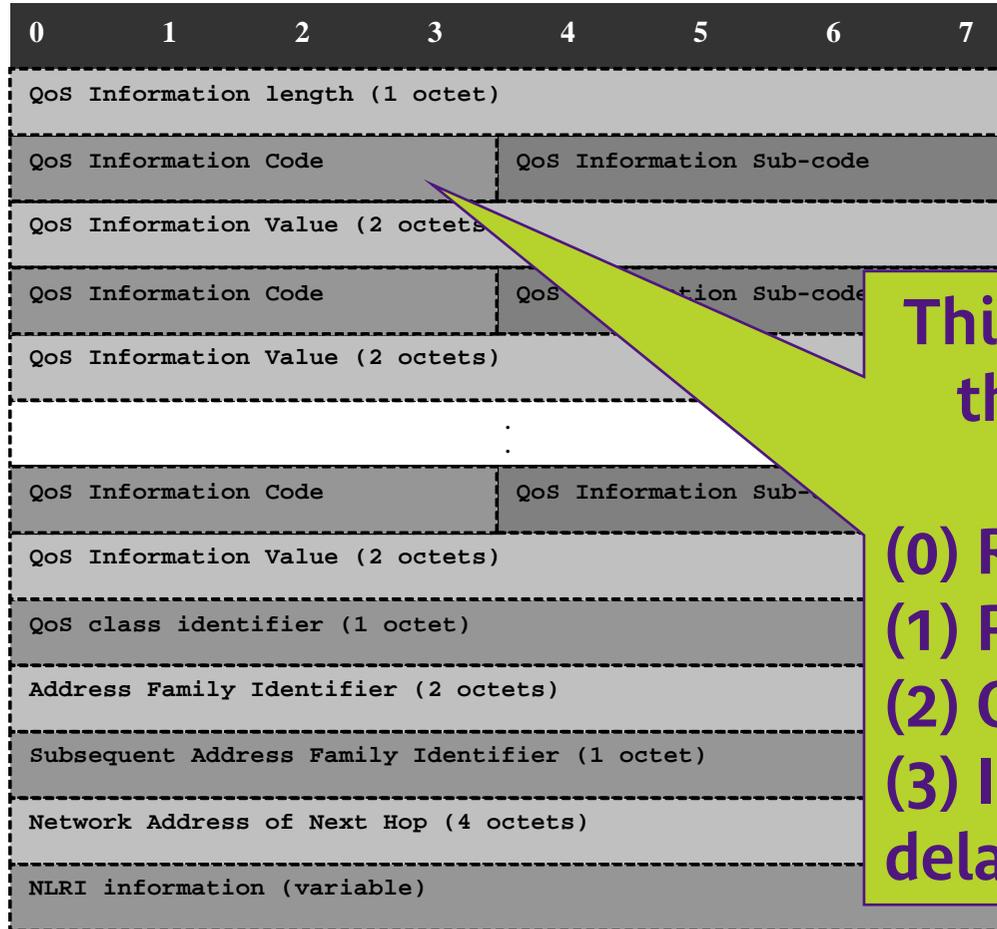


This fields carries the number of QoS information Codes that will be sent by the q-BGP speaker in a single q-BGP UPDATE message

(Unrestricted)



# QOS\_NLRI attribute for group-2 (6)



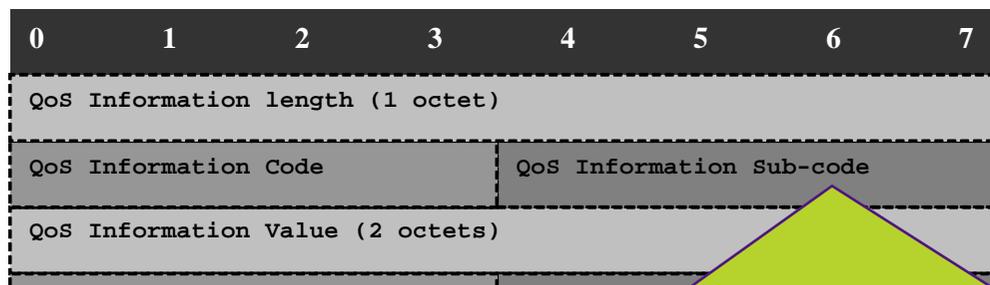
This field identifies the type of QoS information

- (0) Reserved
- (1) Packet Rate
- (2) One-way delay
- (3) Inter packet delay variation

(Unrestricted)



# QoS\_NLRI attribute for group-2 (7)



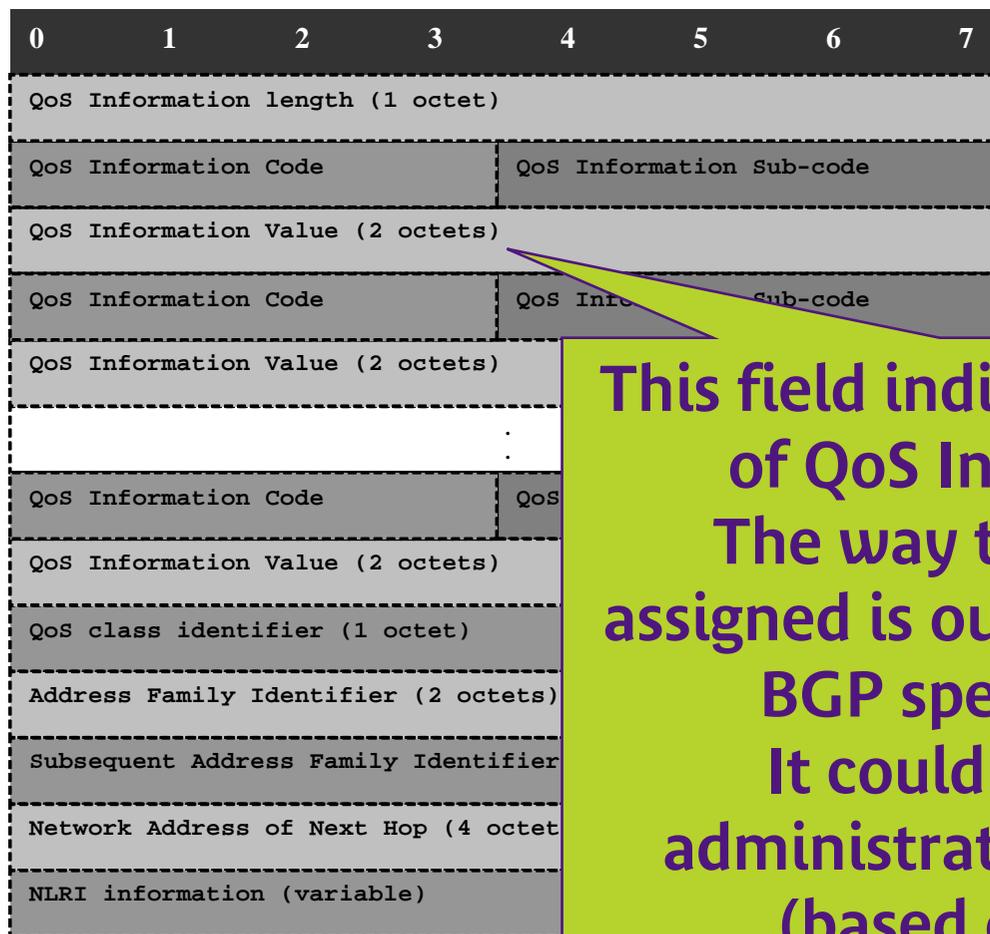
**This field identifies the sub-type of QoS information**

- (0) None**
- (1) Reserved Rate**
- (2) Available Rate**
- (3) Loss Rate**
- (4) Minimum One-way delay**
- (5) Maximum One-way delay**
- (6) Average One-way delay**

**(Unrestricted)**



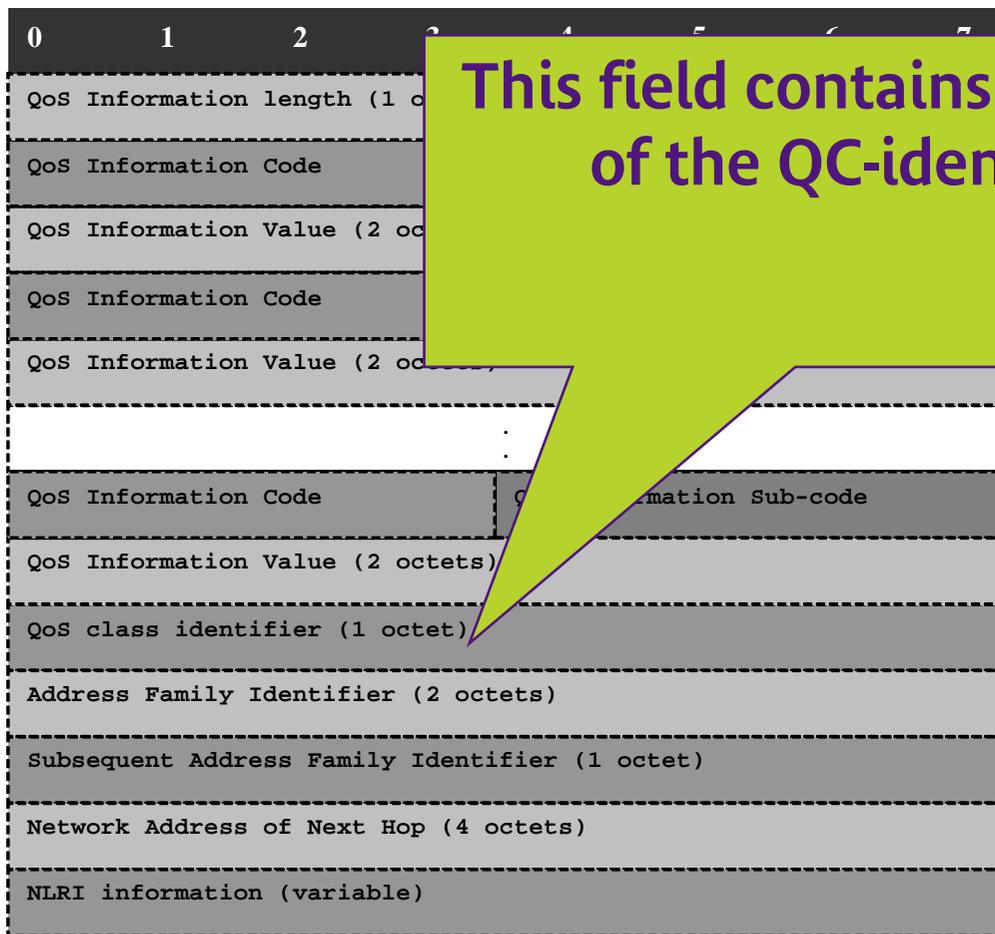
# QoS\_NLRI attribute for group-2 (8)



This field indicates the value of QoS Information. The way this value is assigned is out of scope of q-BGP specification. It could be static, administrative, dynamic (based on active measurement!)



# QoS\_NLRI attribute for group-2 (9)

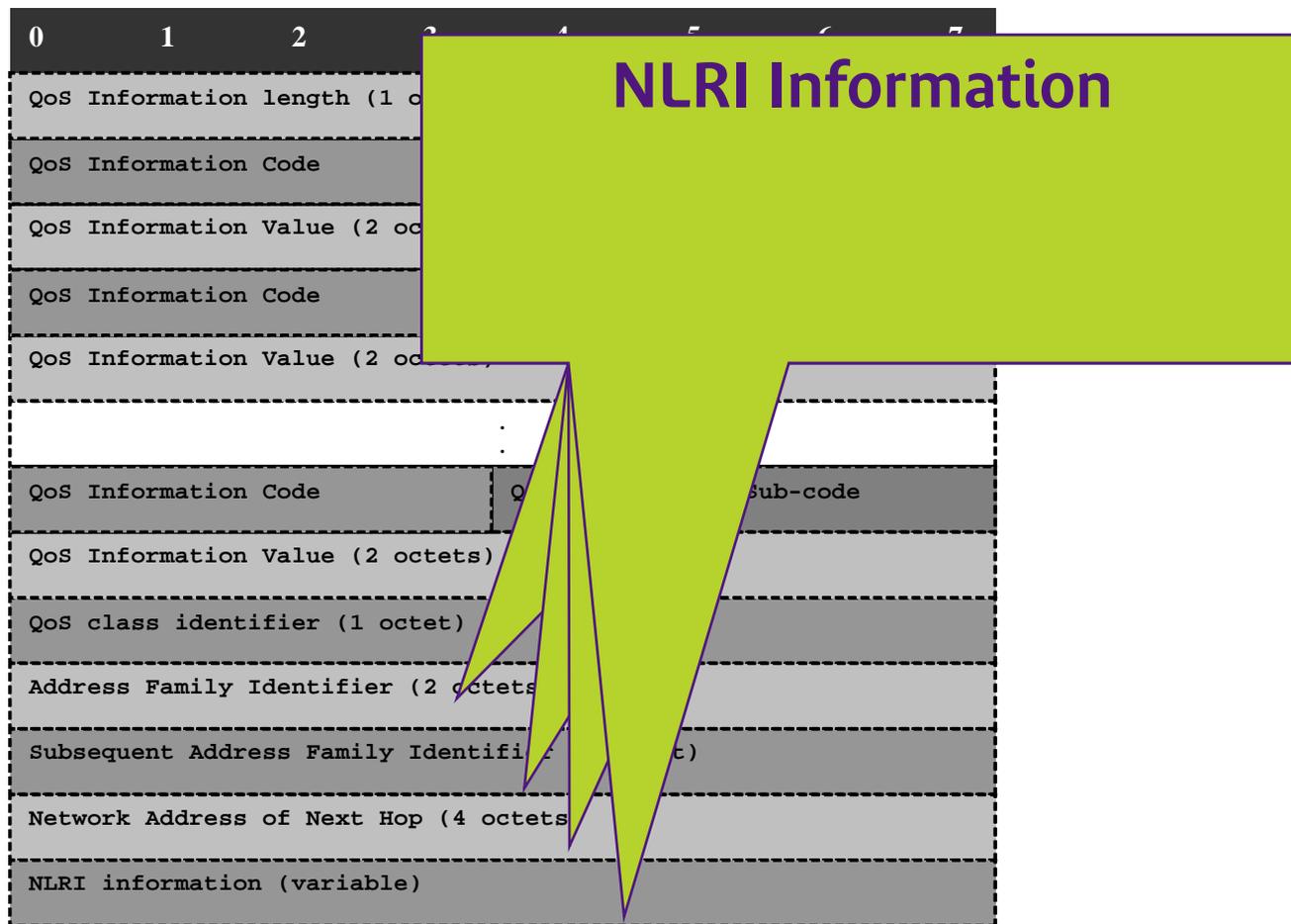


This field contains the value of the QC-identifier

(Unrestricted)



# QoS\_NLRI attribute for group-2 (10)



(Unrestricted)



# Processing QoS\_NLRI attribute



- ▶ **When sending a QoS\_NLRI attribute, the q-BGP speaker should:**
  - ▶ Set the QC identifier field with the value of the extended QC on the corresponding inter-domain link.
  - ▶ Set some QoS values, if it is a group-2 solution
- ▶ **When receiving a QoS\_NLRI attribute:**
  - ▶ q-BGP speaker applies its inbound policies
    - accept or reject the received announcements depending on its local QC binding list.
  - ▶ then updates the values of “QoS Information value” fields with the values of its own l-QC.

(Unrestricted)



# Comparing QoS-enabled routes



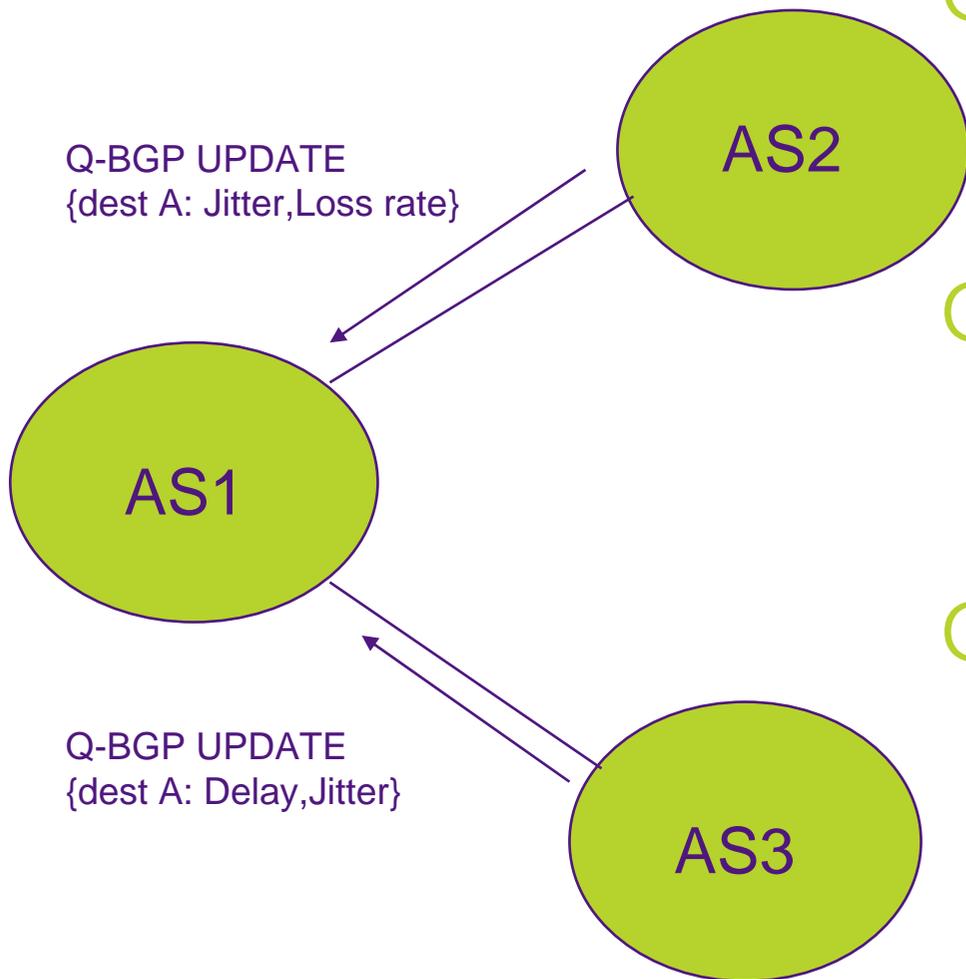
▶ In order to compare QoS enabled routes, several methods can be defined:

- ▶ **Lexicographical ordering**: the QoS attributes are compared in strict order. Thus if  $A_x > A_y$  then X is better than Y, irrespective of the relative values of  $B_x$ ,  $B_y$ ,  $C_x$  or  $C_y$ . If  $A_x = A_y$  then the second QoS attributes are compared: if  $B_x > B_y$  then X is said to be better than Y.
- ▶ **Simultaneous comparison**: X is better than Y if  $A_x > A_y$  and  $B_x > B_y$  and  $C_x > C_y$ . Similarly, Y is better than X if  $A_y > A_x$  and  $B_y > B_x$  and  $C_y > C_x$ .
- ▶ **Weighted ordering**: the QoS attributes are normalised to create dimensionless values, and summed. This results in a single value for each QoS tuple, which can be compared to determine which tuple is better.
- ▶ **Others...**

(Unrestricted)



# Route selection consistency (1)



- ▶ **If both q-BGP updates contain the same QoS attributes.**
  - ▶ **The comparison between these routes is consistent**
- ▶ **If not ?**
  - ▶ **How to compare routes characterised with different QoS parameters?**
- ▶ **Origin of the problem**
  - ▶ **Miss-configuration : local or remote**
  - ▶ **A QoS parameter is uncontrolled by a Service Provider in the chain**

(Unrestricted)



# Route selection consistency (2)



- ▶ **If QoS parameters cannot be computed, leaf ASes will not receive any QoS information leading Group 2 to become Group 1.**
  
- ▶ **In order to solve this consistency issue, the QoS information exchanged between SP need to be constrained :**
  - **Introduction of a Mandatory or Optional status for each QoS information**
  
  - **Impact on q-BGP route selection process**
    - **If a mandatory QoS information is missing, the route is deleted and the peer is notified**
  
    - **If an optional QoS information is missing: don't consider the unvalued routes but keep them all (for the next comparison step) if they are all unvalued**

(Unrestricted)