

# Management of Inter-domain Quality of Service

Authors : S. Bakkali, H. Benaboud, M. Ben Mamoun

Presented by : Sara Bakkali

Faculty of Sciences of Rabat  
Mohammed V-University, Rabat, Morocco.

menog16, Istanbul.

24 March 2016

- 1 General Context
- 2 Management of QoS in IP networks
- 3 The QoS-CMS Mechanism
  - Architecture and Operation
  - Security
  - Advantages
- 4 Study of the QoS-CMS performance
- 5 QoS-CMS in BGP Protocol
- 6 Conclusion and Perspectives

- 1 General Context
- 2 Management of QoS in IP networks
- 3 The QoS-CMS Mechanism
  - Architecture and Operation
  - Security
  - Advantages
- 4 Study of the QoS-CMS performance
- 5 QoS-CMS in BGP Protocol
- 6 Conclusion and Perspectives

- 1 General Context
- 2 Management of QoS in IP networks
- 3 The QoS-CMS Mechanism
  - Architecture and Operation
  - Security
  - Advantages
- 4 Study of the QoS-CMS performance
- 5 QoS-CMS in BGP Protocol
- 6 Conclusion and Perspectives

- 1 General Context
- 2 Management of QoS in IP networks
- 3 The QoS-CMS Mechanism
  - Architecture and Operation
  - Security
  - Advantages
- 4 Study of the QoS-CMS performance
- 5 QoS-CMS in BGP Protocol
- 6 Conclusion and Perspectives

- 1 General Context
- 2 Management of QoS in IP networks
- 3 The QoS-CMS Mechanism
  - Architecture and Operation
  - Security
  - Advantages
- 4 Study of the QoS-CMS performance
- 5 QoS-CMS in BGP Protocol
- 6 Conclusion and Perspectives

- 1 General Context
- 2 Management of QoS in IP networks
- 3 The QoS-CMS Mechanism
  - Architecture and Operation
  - Security
  - Advantages
- 4 Study of the QoS-CMS performance
- 5 QoS-CMS in BGP Protocol
- 6 Conclusion and Perspectives

# General Context

## IP Networks Evolution

- Applications diversity (Multimedia, Visioconference, Peer-to-peer sharing).
- Burst of traffic volume (Huge number of mobile terminals, Massive use of social networks).

## Objectif

- Ensure end to end QoS in an IP network **across multiple domains**



# General Context

## IP Networks Evolution

- Applications diversity (Multimedia, Visioconference, Peer-to-peer sharing).
- Burst of traffic volume (Huge number of mobile terminals, Massive use of social networks).

## Objectif

- Ensure end to end QoS in an IP network [across multiple domains](#)

# General Context

## IP Networks Evolution

- Applications diversity (Multimedia, Visioconference, Peer-to-peer sharing).
- Burst of traffic volume (Huge number of mobile terminals, Massive use of social networks).

## Objectif

- Ensure end to end QoS in an IP network **across multiple domains**

- 1 General Context
- 2 Management of QoS in IP networks
- 3 The QoS-CMS Mechanism
  - Architecture and Operation
  - Security
  - Advantages
- 4 Study of the QoS-CMS performance
- 5 QoS-CMS in BGP Protocol
- 6 Conclusion and Perspectives

# QoS in an IP network

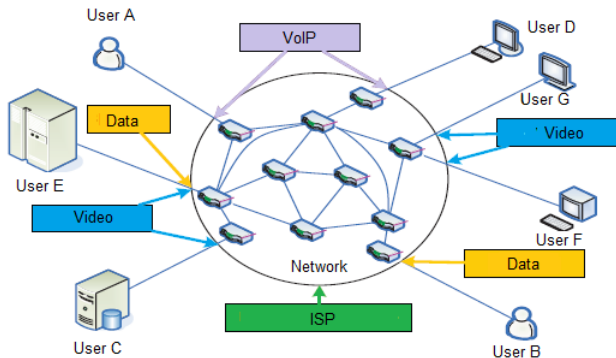
## QoS Definition

QoS is the capability of a network to provide **better service to selected network traffic**, and it's described by parameters such as **bandwidth, packet delay, jitter and packet loss rate**

# QoS in an IP network

## QoS Definition

QoS is the capability of a network to provide **better service to selected network traffic**, and it's described by parameters such as **bandwidth, packet delay, jitter and packet loss rate**



# QoS in an IP network

## Models for QoS

- IntServ
  - In 1994 (RFC 1633)
  - flow control and resource reservation
- DiffServ
  - In 1997 (RFC 2475)
  - Flows Aggregation in CoS, DSCP (DiffServ Code Point)
- MPLS-TE
  - In 1999 (RFC 2702)
  - Traffic Engineering
- MPLS-DiffServ
  - In 2002 (RFC 3270)
  - Support of DiffServ CoS

# QoS in an IP network

## Models for QoS

- IntServ
  - In 1994 (RFC 1633)
  - flow control and resource reservation
- DiffServ
  - In 1997 (RFC 2475)
  - Flows Aggregation in CoS, DSCP (DiffServ Code Point)
- MPLS-TE
  - In 1999 (RFC 2702)
  - Traffic Engineering
- MPLS-DiffServ
  - In 2002 (RFC 3270)
  - Support of DiffServ CoS

# QoS in an IP network

## Models for QoS

- IntServ
  - In 1994 (RFC 1633)
  - flow control and resource reservation
- DiffServ
  - In 1997 (RFC 2475)
  - Flows Aggregation in CoS, DSCP (DiffServ Code Point)
- MPLS-TE
  - In 1999 (RFC 2702)
  - Traffic Engineering
- MPLS-DiffServ
  - In 2002 (RFC 3270)
  - Support of DiffServ CoS



# QoS in an IP network

## Models for QoS

- IntServ
  - In 1994 (RFC 1633)
  - flow control and resource reservation
- DiffServ
  - In 1997 (RFC 2475)
  - Flows Aggregation in CoS, DSCP (DiffServ Code Point)
- MPLS-TE
  - In 1999 (RFC 2702)
  - Traffic Engineering
- MPLS-DiffServ
  - In 2002 (RFC 3270)
  - Support of DiffServ CoS

# QoS in an IP network

- The QoS constraints defined in the SLA (Service Level Agreement) are assigned to the CoS.
- CoS are specific and valid only within the initial domain.

*These models do not guarantee end to end inter-domain QoS*

## QoS in an IP network

- The QoS constraints defined in the SLA (Service Level Agreement) are assigned to the CoS.
- CoS are specific and valid only within the initial domain.

*These models do not guarantee end to end inter-domain QoS*

- 1 General Context
- 2 Management of QoS in IP networks
- 3 The QoS-CMS Mechanism**
  - Architecture and Operation
  - Security
  - Advantages
- 4 Study of the QoS-CMS performance
- 5 QoS-CMS in BGP Protocol
- 6 Conclusion and Perspectives

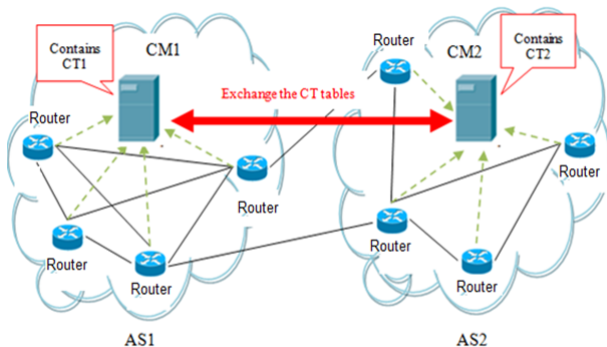
# The QoS-CMS Mechanism

- Ensure QoS in inter-domain environment.
- Implement in each domain a server named server CM (Class Manager) to exchange all QoS information.

# The QoS-CMS Mechanism

- Ensure QoS in inter-domain environment.
- Implement in each domain a server named server CM (Class Manager) to exchange all QoS information.

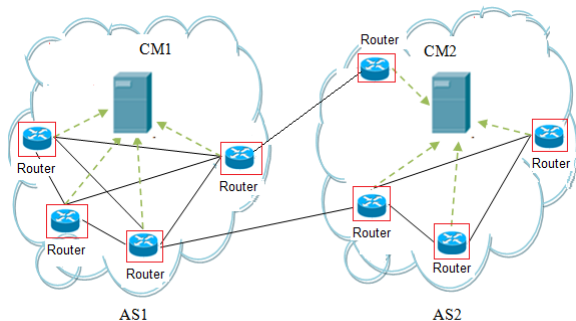
# The QoS-CMS Mechanism



# The QoS-CMS Mechanism

## Step 0

### Intra-domain classification

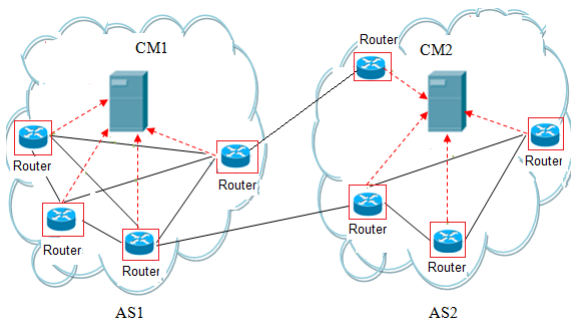




# The QoS-CMS Mechanism

## Step 1

Routers send all information about the different classes they had created to the CM servers of their domains.



# The QoS-CMS Mechanism

## Step 2

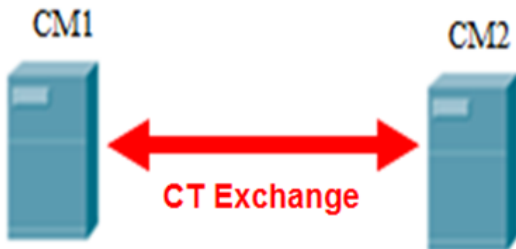
CM servers establish the class tables CT.

AS Number	Class Number	Bandwith	Priority	Queue-limit	Random-detect
-----------	--------------	----------	----------	-------------	---------------

## The QoS-CMS Mechanism

### Step 3

CM servers exchange their CT tables.



# The QoS-CMS Mechanism

- Identification Message : IP address , AS number.

message start indicator (1oct)	message length (2octets)	message type (1octet)
AS number (4 octets)		

- Announcement Messages : The CoS parameters.

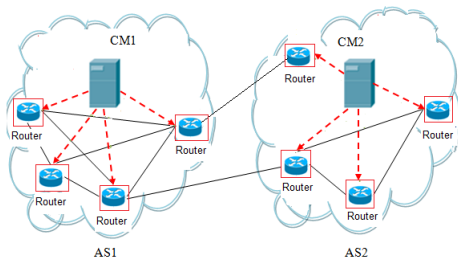
message start indicator (1oct)	message length (2octets)		message type (1octet)
class number (1oct)	Bandwidth (1oct)	Priority (1oct)	Queue-limit (1oct)
Random-detect (1oct)			

- Update Message : adding or modifying a CoS.

# The QoS-CMS Mechanism

## Step 4

Neighbour CM sends received CT to its router.

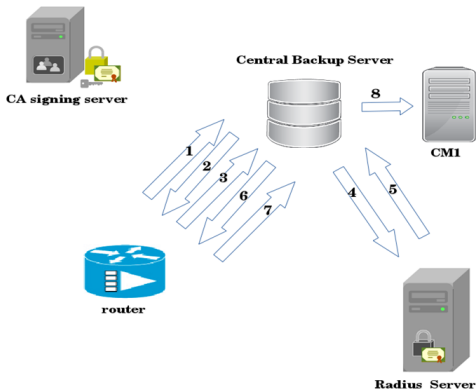


# The QoS-CMS Mechanism

## Step 5

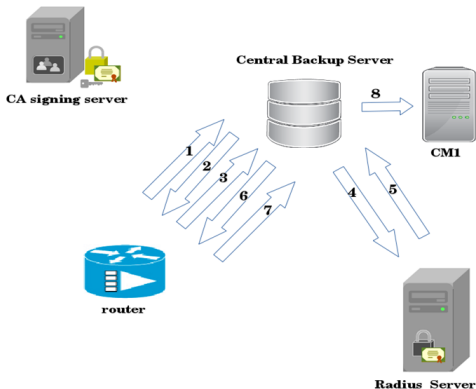
- Routers take into account the new CoS to define.
- The packet of neighboring domain is allocated to a CoS which has the same parameters as its initial CoS.

## • The Communication Between Routers and CM Server



- 1- The router seeks to connect to the Backup Server (CB)
- 2- SSL/TLS handshake is performed to authenticate both ends.
- 3- A secure channel is established and the credential is sent towards the backup server.
- 4- AAA flow begins using the credential in step 3.
- 5- Authentication successful.
- 6- and 7- The transfer begins.

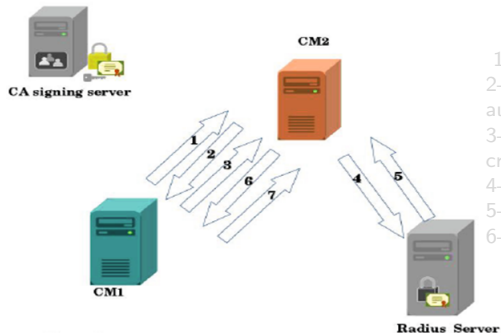
## • The Communication Between Routers and CM Server



- 1- The router seeks to connect to the Backup Server(CB)
- 2- SSL/TLS handshake is performed to authenticate both ends.
- 3- A secure channel is established and the credential is sent towards the backup server.
- 4- AAA flow begins using the credential in step 3.
- 5- Authentication successful.
- 6- and 7- The transfer begins.

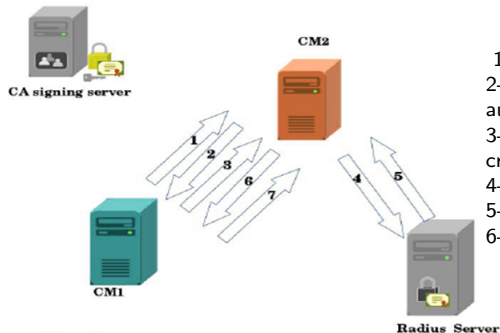


- The Exchange between Neighboring CM Servers



- 1-CM1 seeks to connect to CM2.
- 2- SSL Handshakes is performed to authenticate both ends.
- 3- A secure channel is established, and the credentials are sent towards CM2.
- 4- Transfer AAA flow begins
- 5- An authorization is sent towards CM2.
- 6- et 7- and The transfer begins.

- The Exchange between Neighboring CM Servers



# The QoS-CMS Mechanism

## Advantages

- Continuity of QoS.
- Reduced hardware cost.
- Secured Mechanism.
- Reduced Overhead.

# The QoS-CMS Mechanism

## Advantages

- Continuity of QoS.
- Reduced hardware cost.
- Secured Mechanism.
- Reduced Overhead.

# The QoS-CMS Mechanism

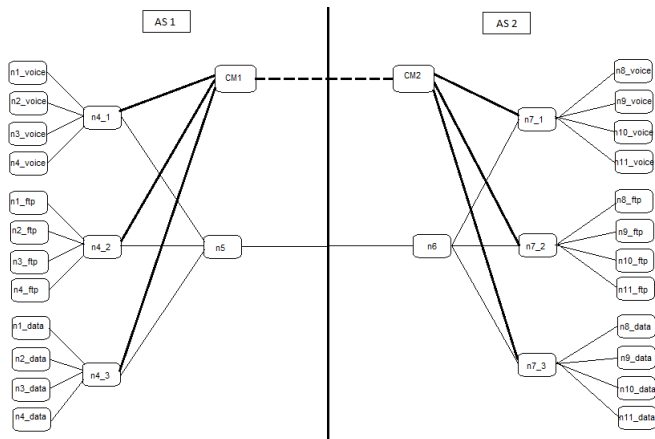
## Advantages

- Continuity of QoS.
- Reduced hardware cost.
- Secured Mechanism.
- Reduced Overhead.

# The QoS-CMS Mechanism

## Advantages

- Continuity of QoS.
- Reduced hardware cost.
- Secured Mechanism.
- Reduced Overhead.

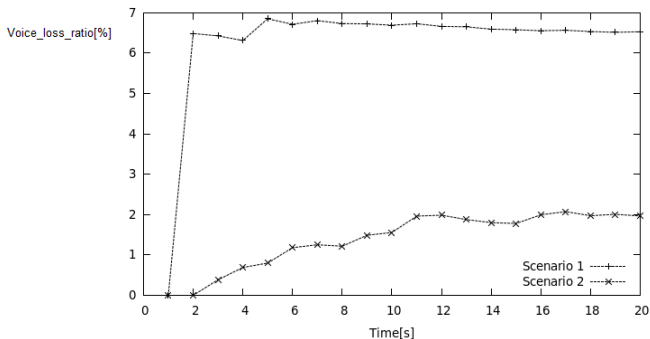


3 CoS : Gold for voice, Silver for ftp and Bronze for data.

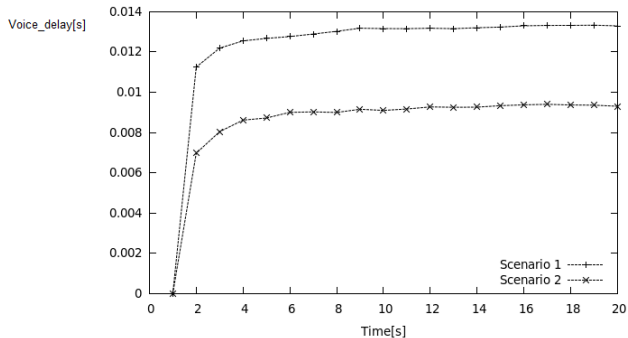
- Measure and compare the variations of the loss ratio and the delay between the two scenarios.
- Vary the QoS parameters (CIR : Committed Information Rate).
- Measure the improvement ratio in each case and for each type of traffic.



- Measure and compare the variations of the loss ratio and the delay between the two scenarios.
- Vary the QoS parameters (CIR : Committed Information Rate).
- Measure the improvement ratio in each case and for each type of traffic.



Reduced loss ratio  
in scenario 2 after  
implementation of  
QoS-CMS.



Reduced Delay in scenario 2 after implementation of QoS-CMS..

- 1 General Context
- 2 Management of QoS in IP networks
- 3 The QoS-CMS Mechanism
  - Architecture and Operation
  - Security
  - Advantages
- 4 Study of the QoS-CMS performance
- 5 **QoS-CMS in BGP Protocol**
- 6 Conclusion and Perspectives

# QoS-CMS in BGP Protocol

- Introduce an extension of CMS-QoS mechanism to be integrated into the BGP protocol.
- Promote the choice of a path through an AS with which we establish a QoS-CMS agreement.
- Automatically while taking routing decision that this path will be saved in the routing table.

# QoS-CMS in BGP Protocol

- Introduce an extension of CMS-QoS mechanism to be integrated into the BGP protocol.
- Promote the choice of a path through an AS with which we establish a QoS-CMS agreement.
- Automatically while taking routing decision that this path will be saved in the routing table.

## QoS-CMS in BGP Protocol

- Introduce an extension of CMS-QoS mechanism to be integrated into the BGP protocol.
- Promote the choice of a path through an AS with which we establish a QoS-CMS agreement.
- Automatically while taking routing decision that this path will be saved in the routing table.

## Integrating QoS-CMS in BGP path selection processus

### Definition of new attribut « QoS-agrmt »

- Indicates if at least one AS from those contained in the "AS-Path" attribute establishes the inter-AS QoS agreement with the current AS.
- The size of the "QoS-agent" is one bit :
  - 1- it is 0, if no agreement is established
  - 2- it is 1, if an agreement is established



## Integrating QoS-CMS in BGP path selection processus

### Definition of new attribut « QoS-agrmt »

- Indicates if at least one AS from those contained in the "AS-Path" attribute establishes the inter-AS QoS agreement with the current AS.
- The size of the "QoS-agent" is one bit :
  - 1- it is 0, if no agreement is established
  - 2- it is 1, if an agreement is established

## Integrating QoS-CMS in BGP path selection processus

### Definition of new attribut « QoS-agrmt »

- Indicates if at least one AS from those contained in the "AS-Path" attribute establishes the inter-AS QoS agreement with the current AS.
- The size of the "QoS-agent" is one bit :
  - 1- it is 0, if no agreement is established
  - 2- it is 1, if an agreement is established

## Integrating QoS-CMS in BGP path selection processus

### Errors Handling

- Attribute "QoS-agrmt" is syntactically incorrect = the notification message error sub-code "Invalid QoS-agrmt attribute".
- The "Data" field of the notification message : type, length and value of the invalid attribute.
- New sub-code that indicates "Invalid QoS-agrmt Attribute" in the error sub-codes of the message update (No. 12)

## Integrating QoS-CMS in BGP path selection processus

### Errors Handling

- Attribute "QoS-agrmt" is syntactically incorrect = the notification message error sub-code "Invalid QoS-agrmt attribute".
- The "Data" field of the notification message : type, length and value of the invalid attribute.
- New sub-code that indicates "Invalid QoS-agrmt Attribute" in the error sub-codes of the message update (No. 12)

## Integrating QoS-CMS in BGP path selection processus

### Errors Handling

- Attribute "QoS-agrmt" is syntactically incorrect = the notification message error sub-code "Invalid QoS-agrmt attribute".
- The "Data" field of the notification message : type, length and value of the invalid attribute.
- New sub-code that indicates "Invalid QoS-agrmt Attribute" in the error sub-codes of the message update (No. 12)

## Integrating QoS-CMS in BGP path selection processus

### Errors Handling

- Attribute "QoS-agrmt" is syntactically incorrect = the notification message error sub-code "Invalid QoS-agrmt attribute".
- The "Data" field of the notification message : type, length and value of the invalid attribute.
- New sub-code that indicates "Invalid QoS-agrmt Attribute" in the error sub-codes of the message update (No. 12)

## Integrating QoS-CMS in BGP path selection processus

### Modifying the "breaking tie" algorithm

- include a new step in the algorithm (3rd criteria).
- Eliminate routes that have "QoS-agrmt" equal to 0 = prefer routes that cross a domain with which we have a QoS agreement to routes that are not.





## Conclusion and Perspectives

### Conclusion

- Proposition of QoS-CMS mechanism to ensure the QoS offered to the inter-domain traffic.
  - Flexibility and simplicity.
  - Coherence and extensibility.
- The performance studies results showed the interest and significant improvement ensured by QoS-CMS.

### Perspectives

- Implementation and study of the impact of "QoS-agrmt" attribute on BGP.
- Develop a module for management of QoS in multi-controller SDN architecture.

# Conclusion and Perspectives

## Conclusion

- Proposition of QoS-CMS mechanism to ensure the QoS offered to the inter-domain traffic.
  - Flexibility and simplicity.
  - Coherence and extensibility.
- The performance studies results showed the interest and significant improvement ensured by QoS-CMS.

## Perspectives

- Implementation and study of the impact of "QoS-agrmt" attribute on BGP.
- Develop a module for management of QoS in multi-controller SDN architecture.

# Conclusion and Perspectives

## Conclusion

- Proposition of QoS-CMS mechanism to ensure the QoS offered to the inter-domain traffic.
  - Flexibility and simplicity.
  - Coherence and extensibility.
- The performance studies results showed the interest and significant improvement ensured by QoS-CMS.

## Perspectives

- Implementation and study of the impact of "QoS-agrmt" attribute on BGP.
- Develop a module for management of QoS in multi-controller SDN architecture.

# Conclusion and Perspectives

## Conclusion

- Proposition of QoS-CMS mechanism to ensure the QoS offered to the inter-domain traffic.
  - Flexibility and simplicity.
  - Coherence and extensibility.
- The performance studies results showed the interest and significant improvement ensured by QoS-CMS.

## Perspectives

- Implementation and study of the impact of "QoS-agrmt" attribute on BGP.
- Develop a module for management of QoS in multi-controller SDN architecture.