# A Glance at QoS in Mobile Ad-Hoc Networks (MANETs)

A report by

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Resources: http://www.cs.ucr.edu/~csyiazti/cs260.html

# Introduction

- MANETs were initially proposed for battlefield communication & disaster recovery applications.
- The evolution of the Multimedia Technology & the Commercial Interest of Companies to reach civilian applications have made QoS in MANETs an unavoidable task.
- MANETs : 3 new problems!
  - Dynamic Topology.
  - Bandwidth Constrains.
  - Limited Processing & Storing capabilities of Devices.
- QoS and Overhead are synonyms ☺!. The idea of providing QoS in MANETs is not to extinct Overhead but to keep it as low as possible.
- What happens with QoS in Wire-based Networks?. Can we port ideas / protocols to MANETs?



# Outline of Presentation

- IP QoS & Successful IP QoS Models/Protocols.
- QoS Model for MANETs – *FQMM.*
- QoS Signaling in MANETs – *INSIGNIA.*
- QoS Routing in MANETs – *QOS for AODV.*
- Conclusions.



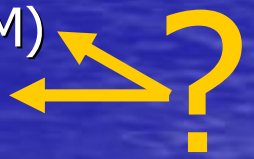
# IP Quality of Services 1/2

- *QoS definition*

  "The collective effect of service performance which determines the degree of satisfaction of a user of a service".

  *The United Nations Consultative Committee for International Telephony and Telegraph (CCITT) Recommendation E.800*

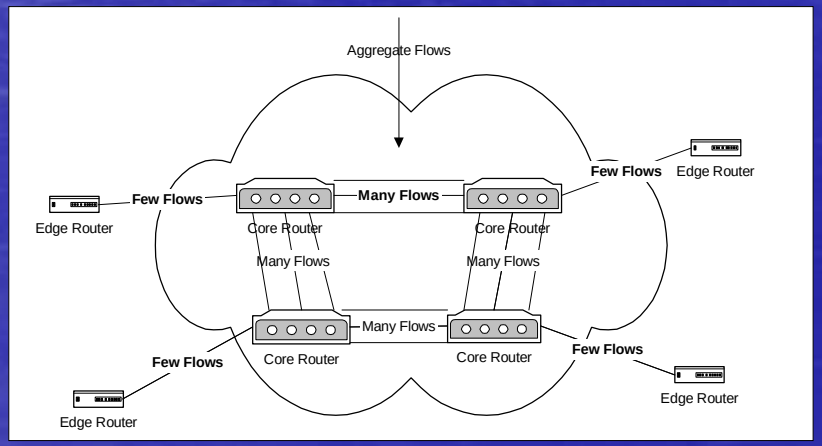
- How is QoS achieved?
  - ~~"Over Provisioning". Add plentiful capacity to the network.~~
    - ~~Easy! (e.g. upgrade from 10Mb to 100Mb)~~
    - ~~Can be done gradually.~~
    - ~~But we remain at 1 service class (best effort) again.~~
  - "Network Traffic Engineering". Make the Network more sophisticated! (e.g. Traffic Classes, Connection Admission Control, Policy Managers,…)
    - Reservation-based Engineering. (e.g. RSVP/IntServv, ATM)
    - Reservation-less Engineering. (e.g. DiffServ)





# IP Quality of Services 2/2

- IntServ/RSVP
  - Huge Storage and Processing overhead for each host to maintain flow state information
  - RSVP reservation process is a network consuming procedure.
- DiffServ (Differentiated Services)
  - Lightweight model for interior routers since individual flows are aggregated.
  - In MANETs though there is no clear definition what is an ingress, egress and core router since nodes are changing location.

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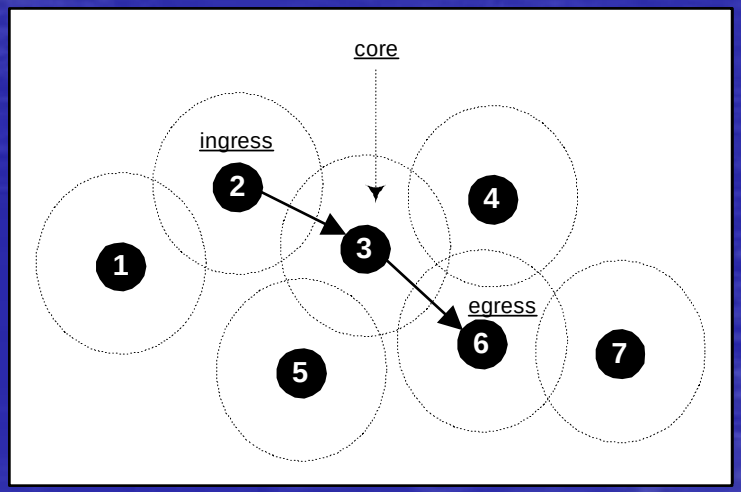
# Flexible QoS Model for MANETs (FQMM)

- FQMM is the first QoS Model proposed in 2000 for MANETs by Xiao et al.
- The model can be characterized as a "hybrid" IntServ/DiffServ Model since
  - the highest priority is assigned per-flow provisioning.
  - the rest is assigned per-class provisioning.
- Three types of nodes again defined
  - Ingress (transmit)
  - Core (forward)
  - Egress (receive)



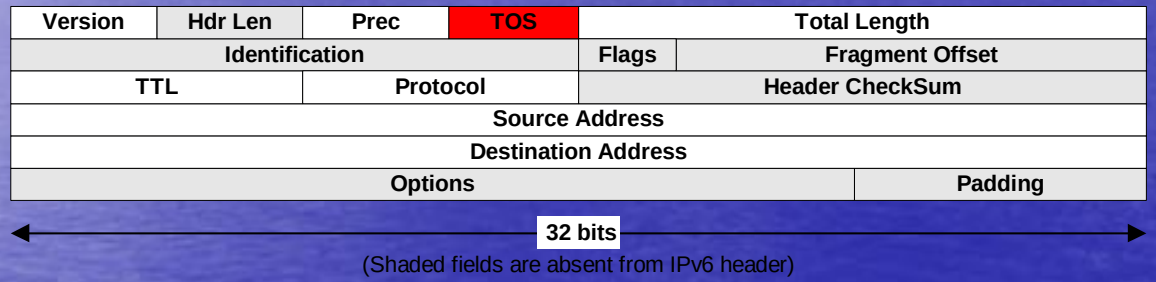
# QoS Signaling

- Signaling is used to reserve and release resources.
- Prerequisites of QoS Signaling
  - Reliable transfer of signals between routers
  - Correct Interpretation and activation of the appropriate mechanisms to handle the signal.
- Signaling can be divided into "In-band" and "Out-of-band".
- Most papers support that "In-band" Signaling is more appropriate for MANETs.



# In-band VS Out-of Band Signaling

- In-band Signaling, network control information is encapsulated in data packets
  - \+ Lightweight
  - – Not Flexible for defining new Service Classes.




(Shaded fields are absent from IPv6 header)

- Out-of-band Signaling, network control information is carried in separate packets using explicit control packets.
  - – Heavyweight
  - – signaling packets must have higher priority to achieve on time notification => can lead to complex systems.
  - \+ Scalability. Signal packets don't rely on data packets
  - \+ We can have rich set of services, since we don't need to "steal" bits from data packets

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# INSIGNIA – MANETs QoS Signaling

- INSIGNIA is the first signaling protocol designed solely for MANETs by Ahn et al. 1998.

- Can be characterized as an "In-band RSVP" protocol.

In-band
- It encapsulates control info in the IP Option field (called now INSIGNIA Option field).

RSVP
- It keeps flow state for the real time (RT) flows.
- It is "Soft State". The argument is that assurance that resources are released is more important than overhead that anyway exists.

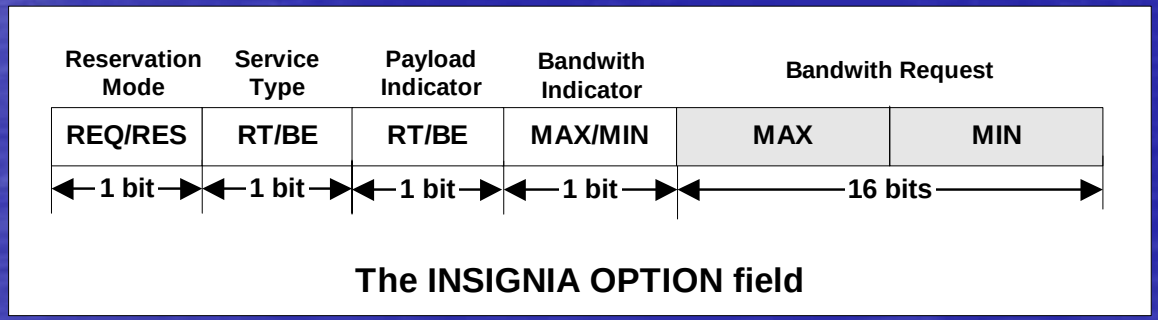


# INSIGNIA – OPTION Field

- *Reservation Mode (REQ/RES):* indicates whether there is already a reservation for this packet.
  - If "no", the packet is forwarded to INSIGNIA Module which in coordination with a AC may either:

    grant resources ➔ Service Type = RT (real-time).

    deny resources➔ Service Type = BE (best-effort).
  - If "yes", the packet will be forwarded with the allowed resources.
- *Bandwidth Request (MAX/MIN):* indicates the requested amount of bandwidth.

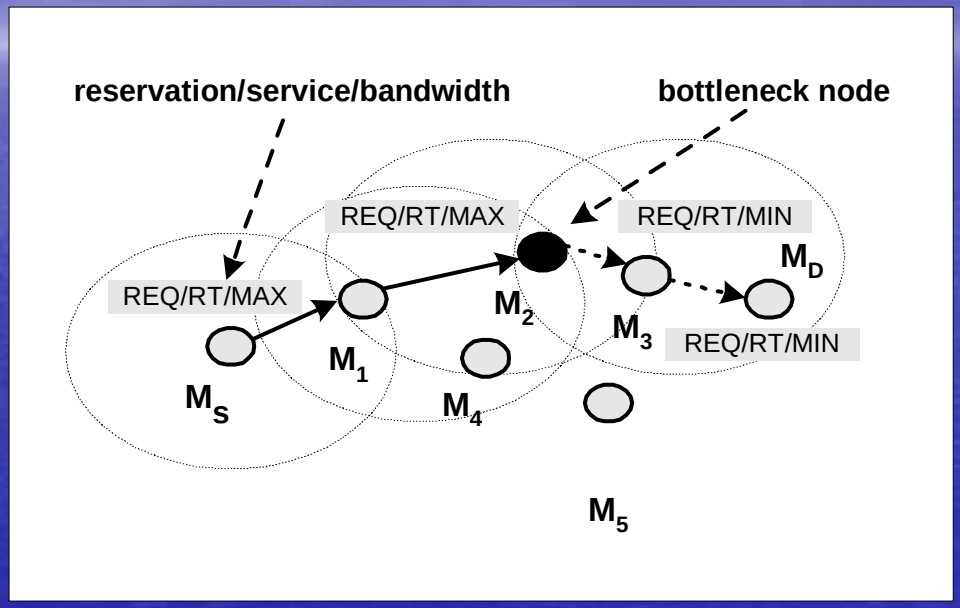



The INSIGNIA OPTION field

# INSIGNIA – Bottleneck Node

- During the flow reservation process a node may be a bottleneck:

  The service will degrade from RT/MAX -> RT/MIN.




- If M2 is heavy-loaded it may also degrade the service level to BE/MIN where there is actually no QoS.



# INSIGNIA

- INSIGNIA is just the signaling protocol of a complete QoS Architecture.

- INSIGNIA Drawbacks.
  - Only 2 classes of services (RT) and (BE).
  - Flow state information must be kept in mobile hosts.

- To realize a complete QoS Architecture we also need many other components as well as a Routing Protocol (e.g. DSR, AODV, TORA).



# QoS Routing and QoS for AODV

- Routing is an essential component for QoS. It can inform a source node of the bandwidth and QoS availability of a destination node
- We know that AODV is a successful an on-demand routing protocol based on the ideas of both DSDV and DSR.
- We also know that when a node in AODV desires to send a message to some destination node it initiates a Route Discovery Process (RREQ).



# QoS for AODV

- QoS for AODV was proposed in 2000 by C. Perkins and E. Royer.
- The main idea of making AODV QoS enabled is to add extensions to the route messages (RREQ, RREP).
- A node that receives a RREQ + QoS Extension must be able to meet the service requirement in order to rebroadcast the RREQ (if not in cache).
- In order to handle the QoS extensions some changes need to be on the routing tables
- AODV current fields.

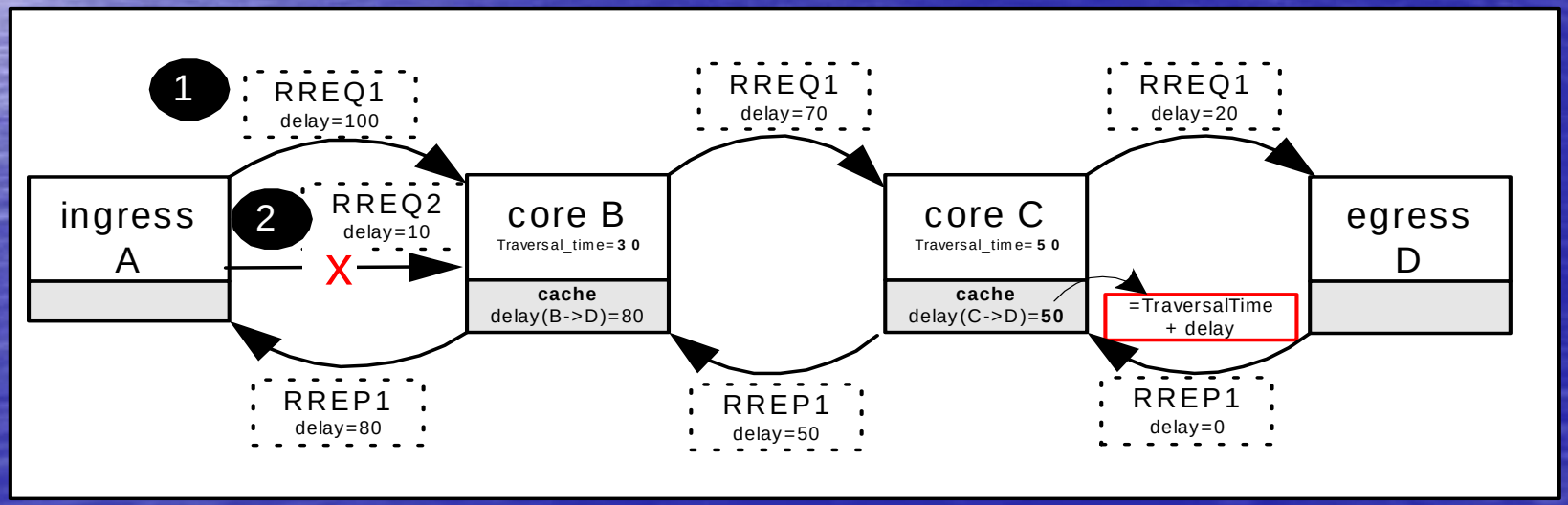
  Destination Sequence Number, Interface, Hop Count, Next Hop, List of Precursors
- AODV new fields. (4 new fields)

  1) Maximum Delay, 2) Minimum Available Bandwidth, 3) List of Sources Requesting Delay Guarantees and 4) List of Sources Requesting Bandwidth Guarantees



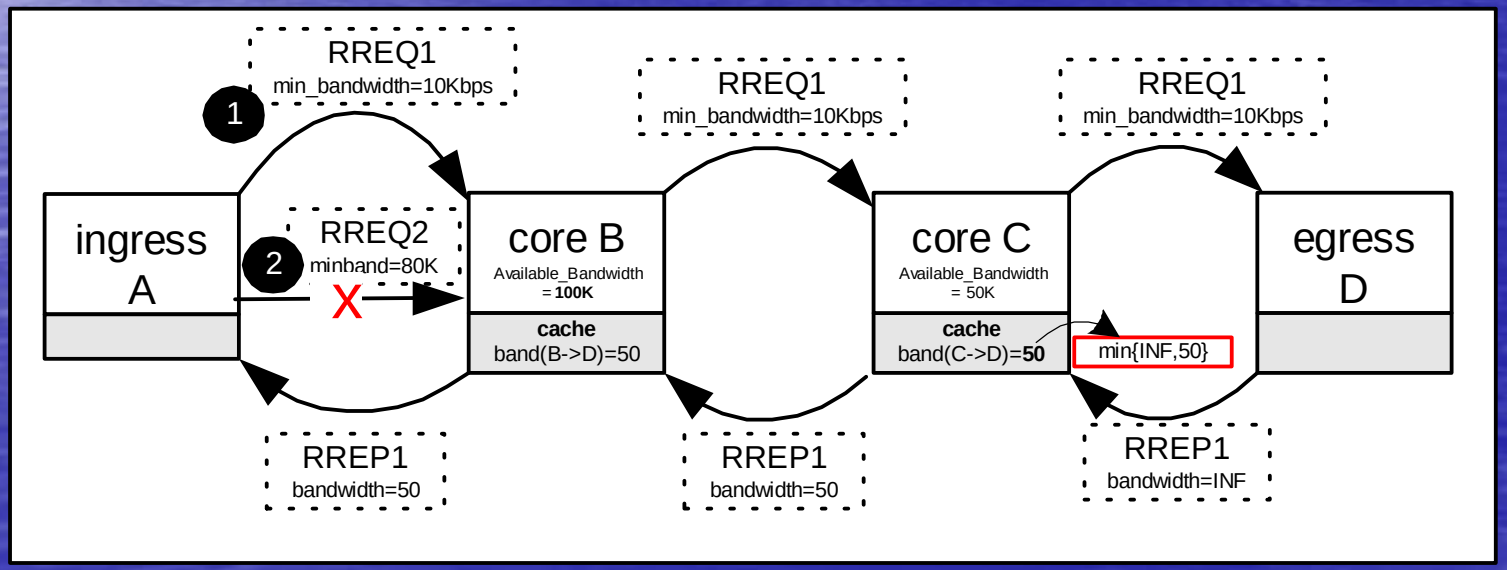
# QoS for AODV - Delay

- Handling Delay with the Maximum Delay extension and the List of Sources Requesting Delay Guarantees.
- Example shows how the with the Maximum Delay extension and the List of Sources Requesting Delay Guarantees are utilized during route discovery process.



# QoS for AODV - Bandwidth

- Handling Bandwidth is similar to handling Delay requests.
- Actually a RREQ can include both types.
- Example shows how the with the Minimum Available Bandwidth extension and the List of Sources Requesting Bandwidth Guarantees are utilized during route discovery process.

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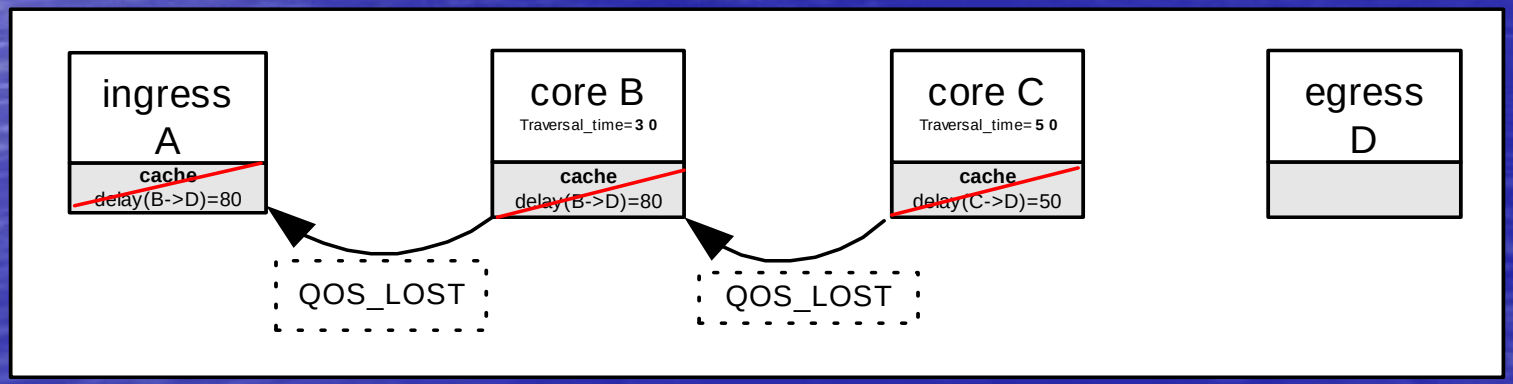
# QoS for AODV - Loosing QoS

- Loosing Quality of Service Parameters

  if after establishment a node detects that the QoS can't be maintained any more it originates a ICMP QOS_LOST message, to all depending nodes.

  == > Reason why we keep a List of Sources Requesting Delay/Bandwidth Guarantees.

- Reasons for loosing QoS Parameters.
  - Increased Load of a node.
  - Why would a node take over more jobs that it can handle?






# Conclusions 1/2

- QoS in MANETs is a new but rapidly area of interest.
- The effort of providing QoS in MANETs is difficult!.
- A complete solution requires:
  - An appropriate QoS Model.
  - A QoS Signaling Protocol.
  - A QoS Routing Protocol.
  - A QoS MAC Protocol.
  - Various supplementary mechanisms such as (CAC, Policy Managers, Queuing Mechanisms for congestion control and others).
- The Social Issue
  - If someone acquires QoS Parameters and moreover if he pays for them then there must be some "Entity" which will ensure his service.
  - In a completely Ad-Hoc topology where there is no concept of "Service Provider" and "Client" it is difficult to innovate QoS since there is no obligation from somebody to somebody else making QOS very difficult.



# Conclusions 2/2

- We have seen how various protocols and ideas of the IP QoS world have been ported or were used in MANETs.
- We have introduced FQMM, the first proposed QoS Model for MANETs
- We have also seen INSIGNIA, the first QoS Signaling Protocol for MANETs
- Finally we had a glance at QOS for AODV and showed how various extension can provide feedback to node for QoS availability of destination nodes.
- Much more work remains to be done since most experimentation is done without taking into consideration various real conditions and hence can't reveal accurate knowledge.



# References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# Thank You!