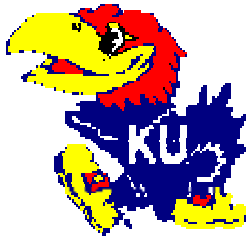


In-Band Flow Establishment for End-to-End QoS in RDRN

Saravanan Radhakrishnan

Organization

- Introduction
- Motivation
- QoS architecture
- Flow Establishment Protocol
- QoS Layer
- Experiments and Results
- Conclusion and Future Work

Introduction - QoS

- Best Effort
  - No guarantees
  - All packets are treated equally
- Service Differentiation
  - Consistent Service Quality
  - End-to-end guarantees
- Components of service quality
  - Throughput, Jitter, Delay and Reliability

QoS in Wireless Mobile systems

- QoS provisioning in wireless mobile systems is very challenging because of
  - Wireless channel characteristics
  - Mobility
- Wireless Channel Characteristics
  - High Bit Error Rate, which results in packet loss, which in turn translates into delay and jitter
- Mobility
  - Roaming node changes point of connectivity, resulting in resource fluctuation

Introduction - RDRN

- Rapidly Deployable Radio Networks (RDRN) is
  - multi-hop wireless ATM network.
  - highly dynamic networking environment.
- RDRN consists of
  - a low bandwidth, high reliability, omni-directional orderwire link, for node discovery and topology configuration.
  - a high bandwidth radio link for high speed data transfer.
- RDRN consists of two types of nodes
  - Mobile Access Point (MAP)
  - Mobile Node (MN)

RDRN Protocol Stack

Application
TCP/UDP
IP
CLIP/SWITCH
AAL
SAR
DLC
Virtual Device
Physical Device

Motivation

- Propose, Implement and Evaluate a QoS Architecture for RDRN
- Existing QoS architectures are not suited for a highly dynamic networking environment like RDRN.
  - Integrated Services
  - Differentiated Services

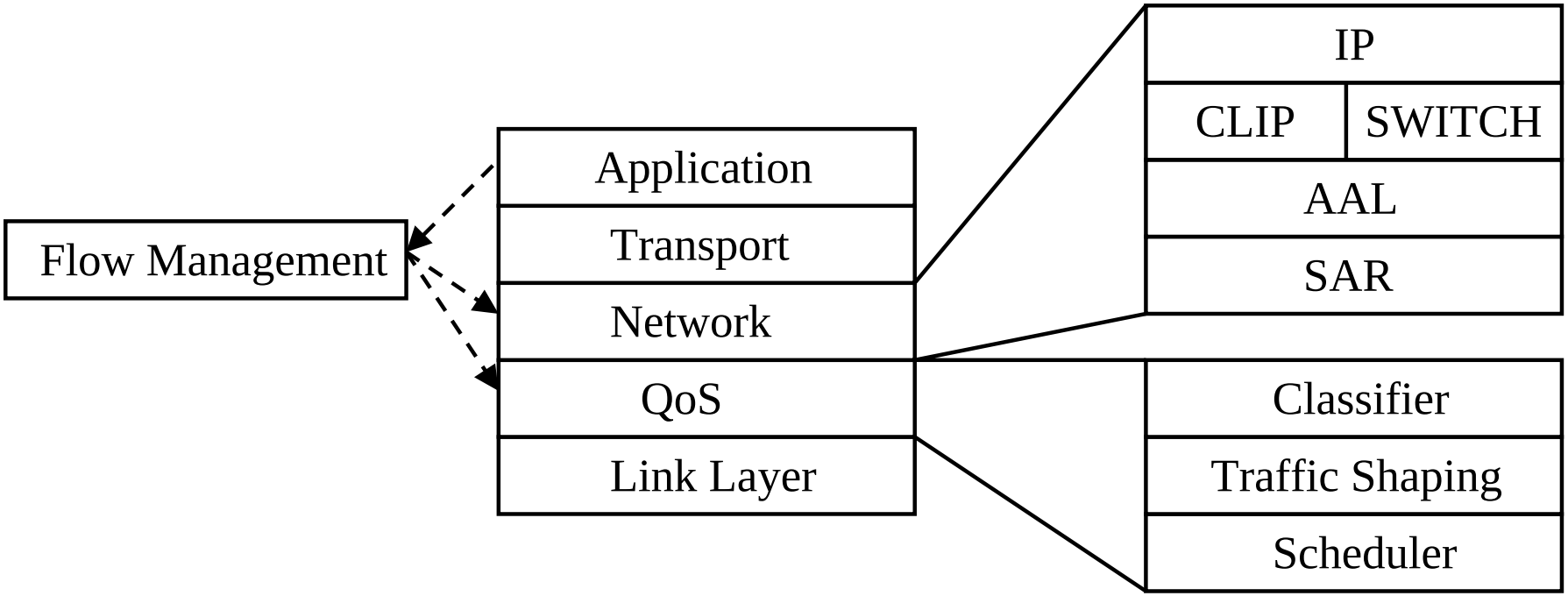
Motivation

- Out-of-Band Signaling is not efficient for highly dynamic networking environments like RDRN because
  - High Signaling overhead involved in connection setup.
  - Link failures result in connection breakdown. Re-establishment of the connection involves more signaling overhead
- ATM not suited to handle dynamic conditions that arise in the network.
- IP is robust, therefore it is more suited to handle mobility.
- Need to differentiate and prioritize traffic based on the requirements of the application.

QoS Architecture - Requirements

- Configure, predict and maintain the requested QoS during the lifetime of the flow.
- Shield the application from the complexity of the underlying QoS specification.
- Set up resources in all the MAPs from the source to the destination, i.e., set up an end-to-end flow.

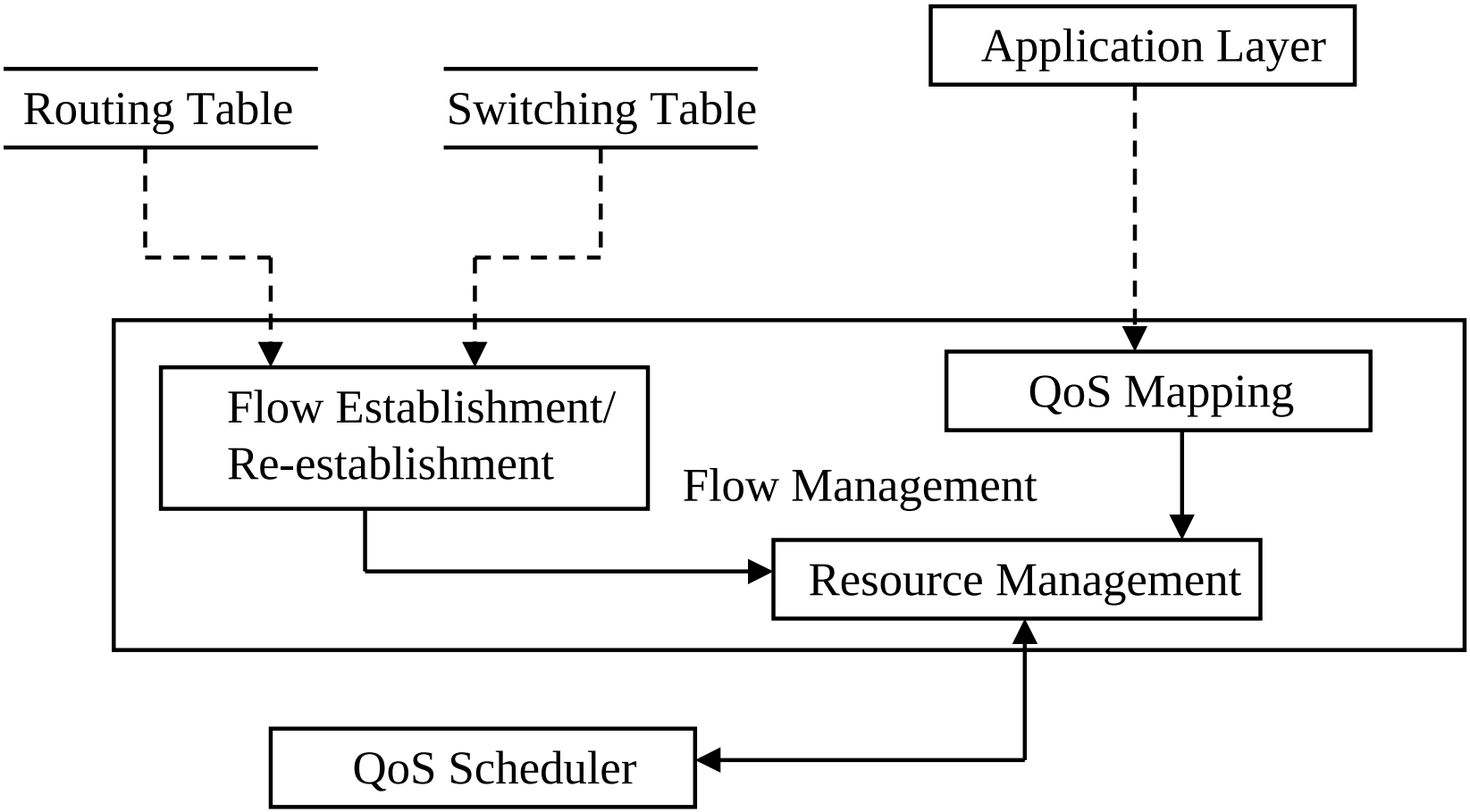
RDRN QoS Architecture



RDRN QoS Arch (contd.)

- Flow Management Block
  - QoS Mapping
  - Flow Establishment
  - Resource Management
- QoS Layer
  - Classifier
  - Traffic Shaper
  - Scheduler

Flow Management



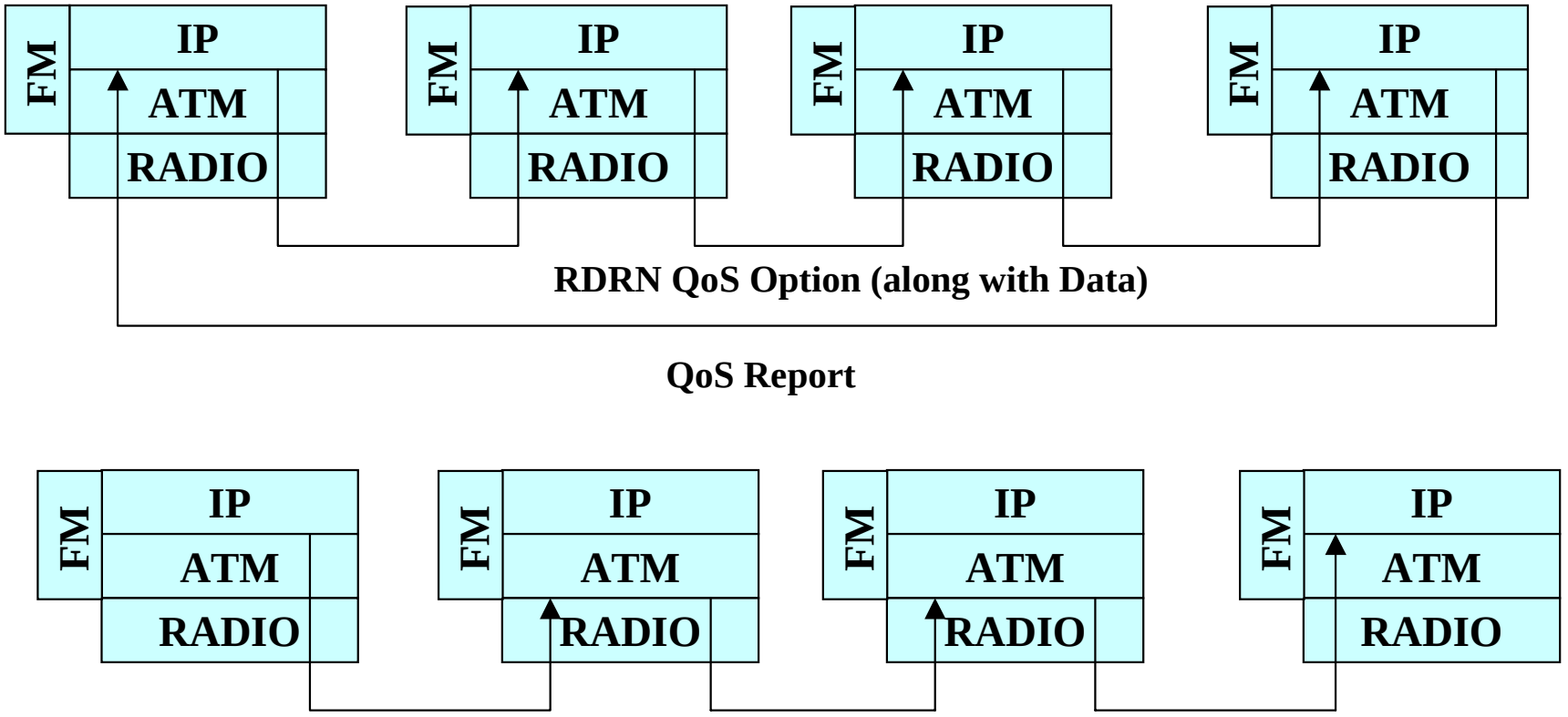
Flow Establishment

- *In-Band* Signaling, i.e., end-to-end flows are established along with the transfer of data.
- Flows are established through the introduction of a new IP option field, referred to as the *RDRN QoS* option field.
- Uses the robustness of IP to handle the dynamic conditions that arise in the network.
- Uses ATM for layer 2 switching.
- Sets up resources for the flow, in all the nodes from the source to the destination.

RDRN QoS Option Field

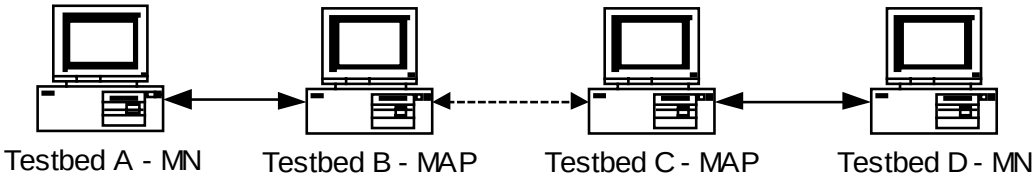
REQ/RES - To indicate if resources have been allocated for this.
MAX/MIN/BEST - To specify the requirements of the flow.
ALLOC/DE-ALLOC - To allocate/de-allocate resources for the flow
VPI/VCI - Specific VPI/VCI that will be used for this flow.

Flow Establishment

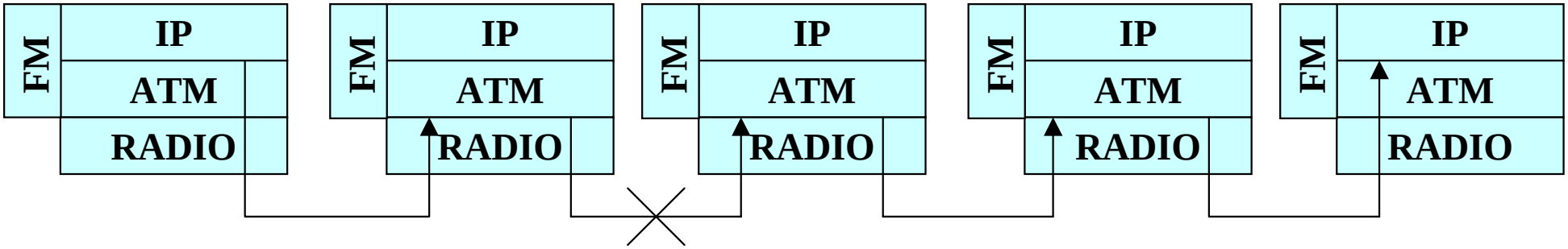


A Short Demo

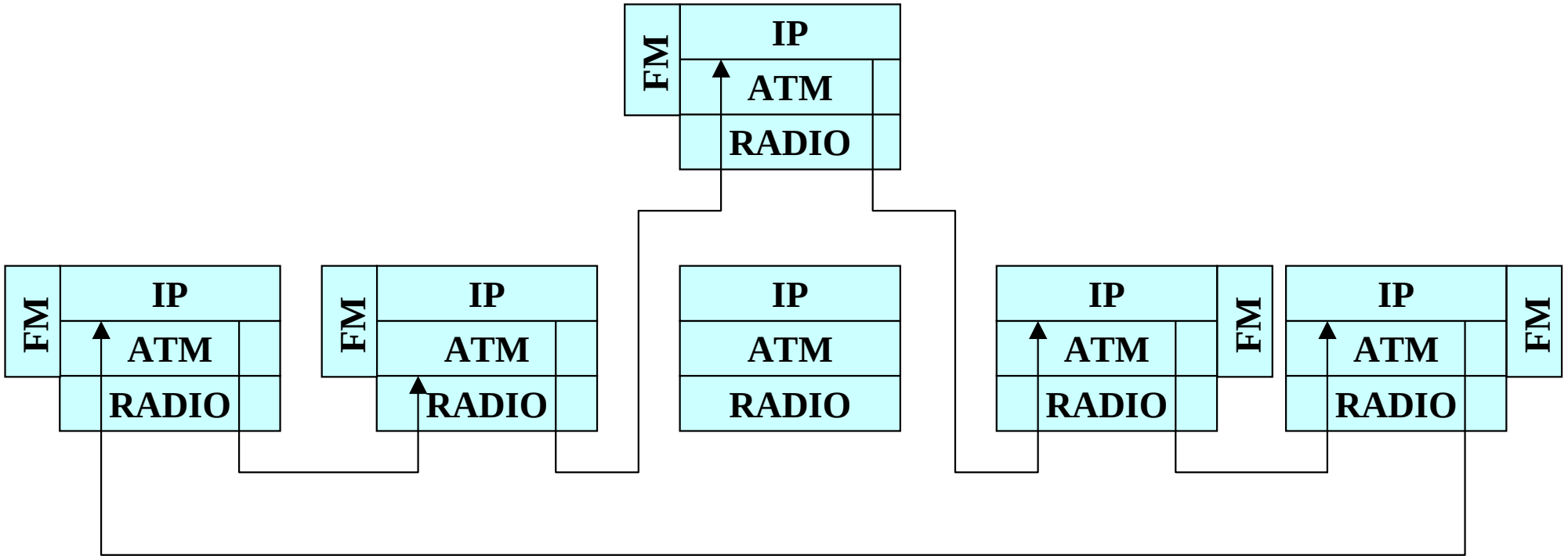
Demo - Test Configuration



Flow Re-Establishment Failure of Link

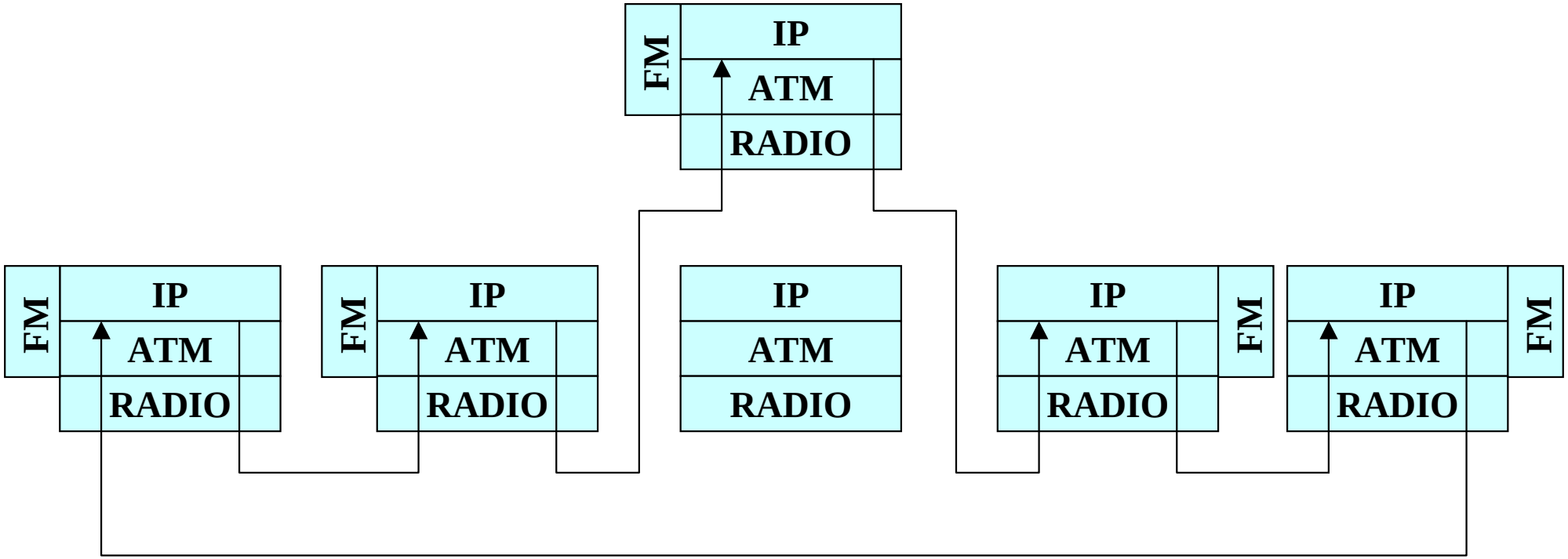


Flow Re-Establishment
Re-assembly of IP datagram

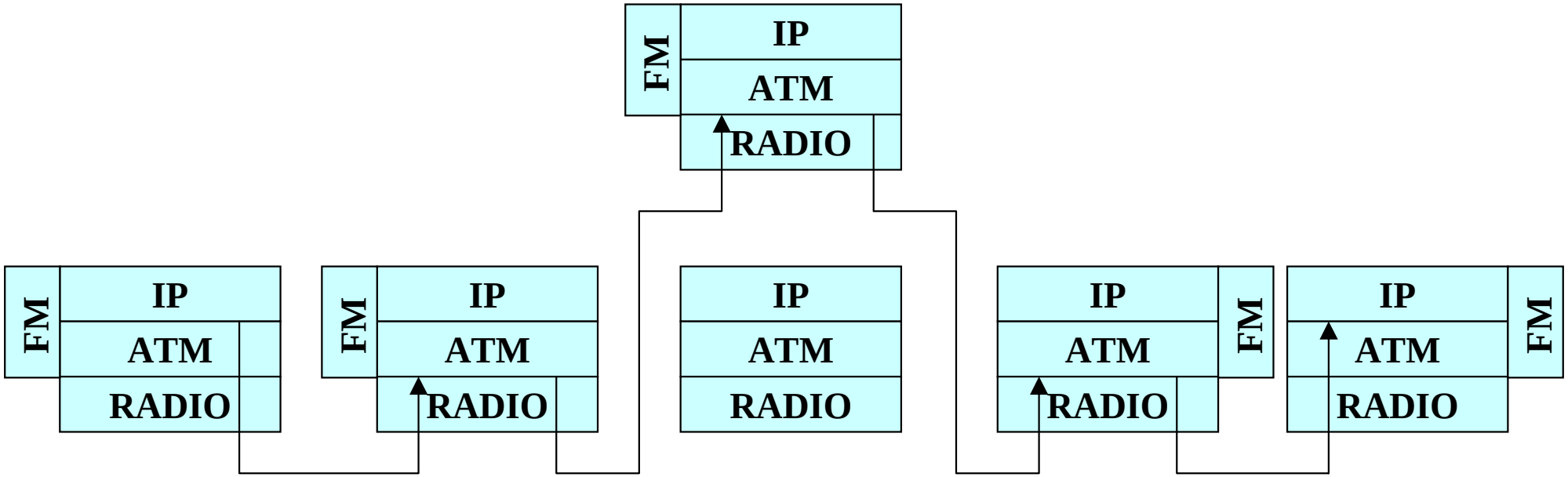


QoS Report

Flow Re-Establishment
Re-establishment of end-to-end flow

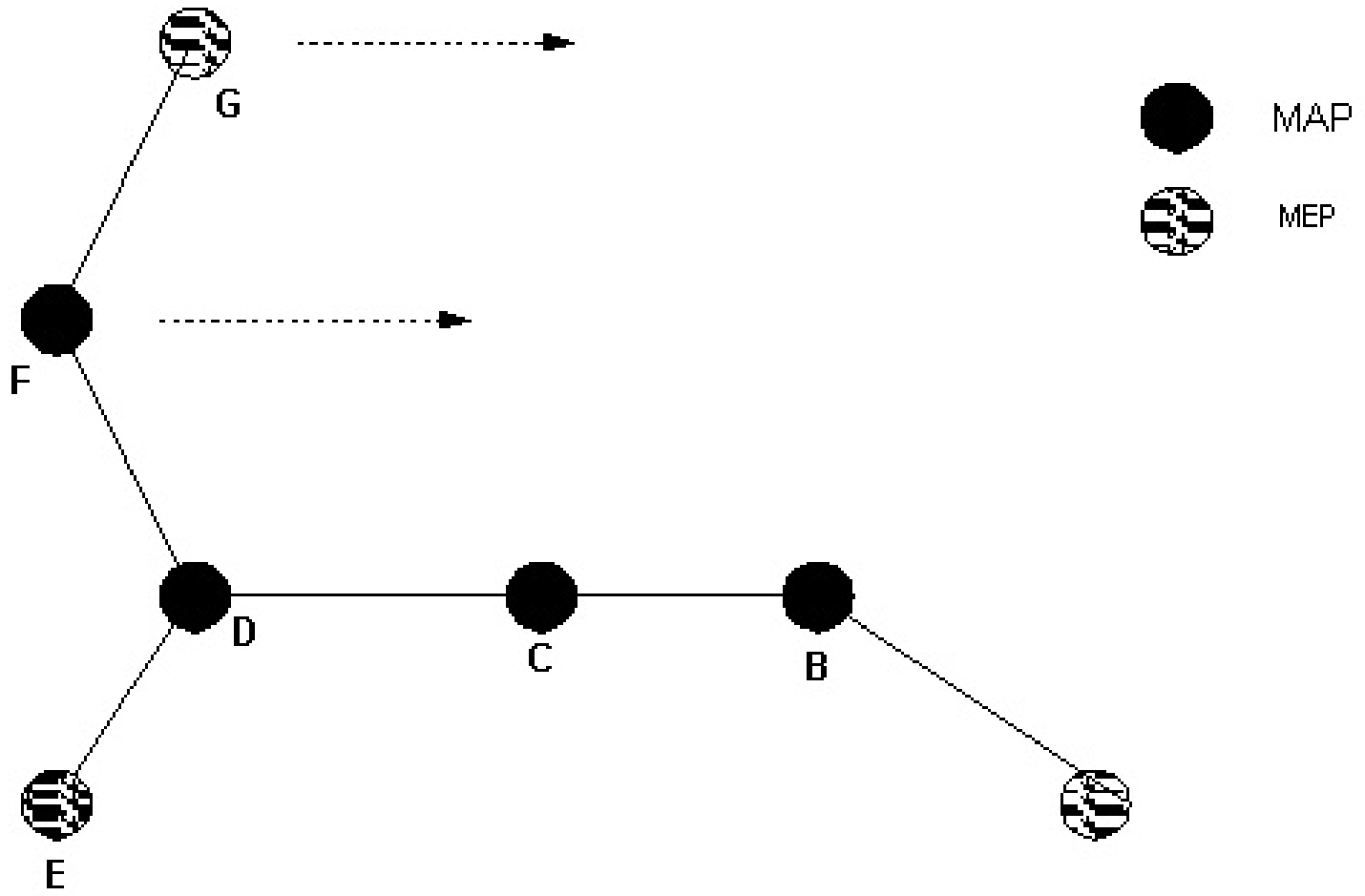


Flow Re-Establishment
Link Layer Switching



A Video Clipping

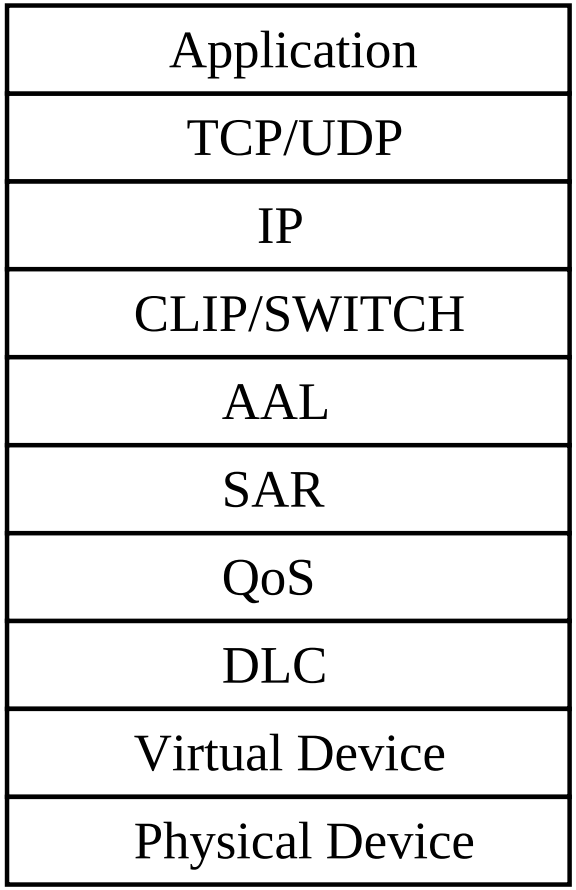
Test Scenario



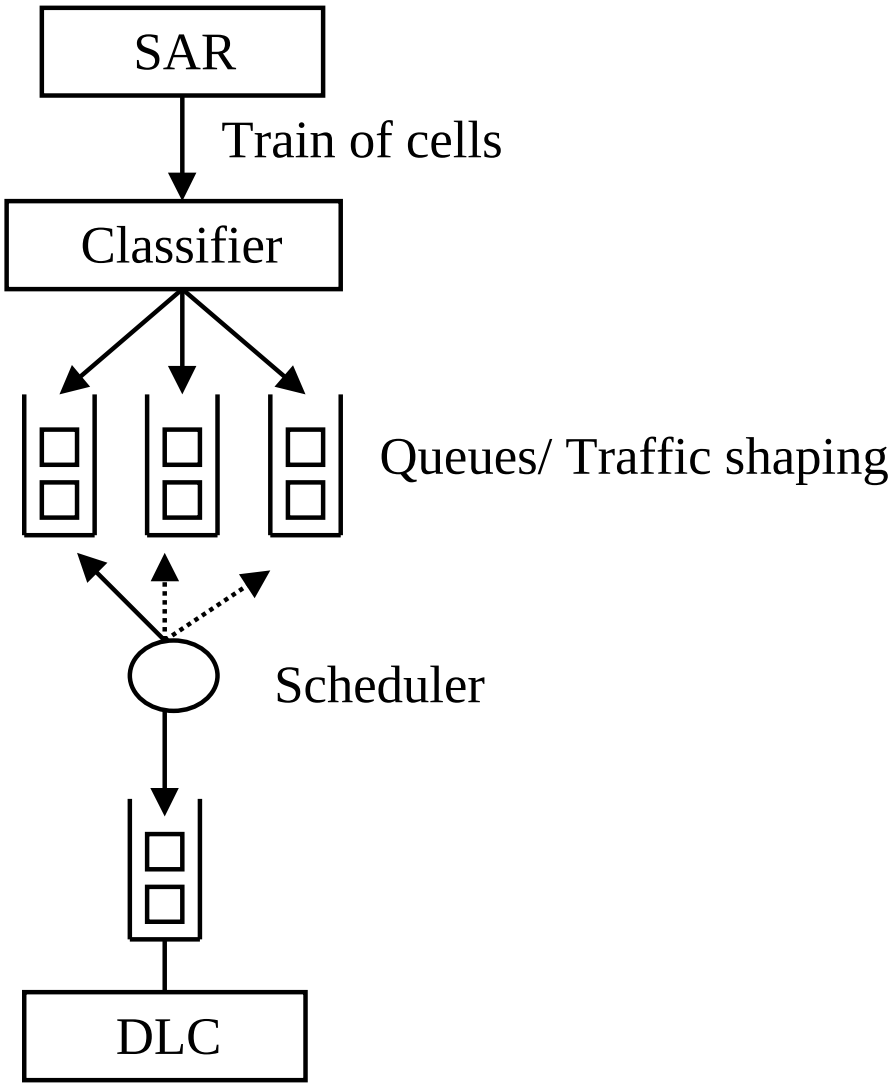
QoS Layer

- Provides QoS at the ATM layer.
- Does multiplexing of cells.
- Receives a train of ATM cells from the SAR layer and puts them in the appropriate queue based on the priority.
- Weighted Round Robin Scheduler to schedule the transmission of cells.
- A train of cells sent to the DLC layer for framing and transmission.

Revised RDRN Protocol Stack



QoS Layer - Implementation

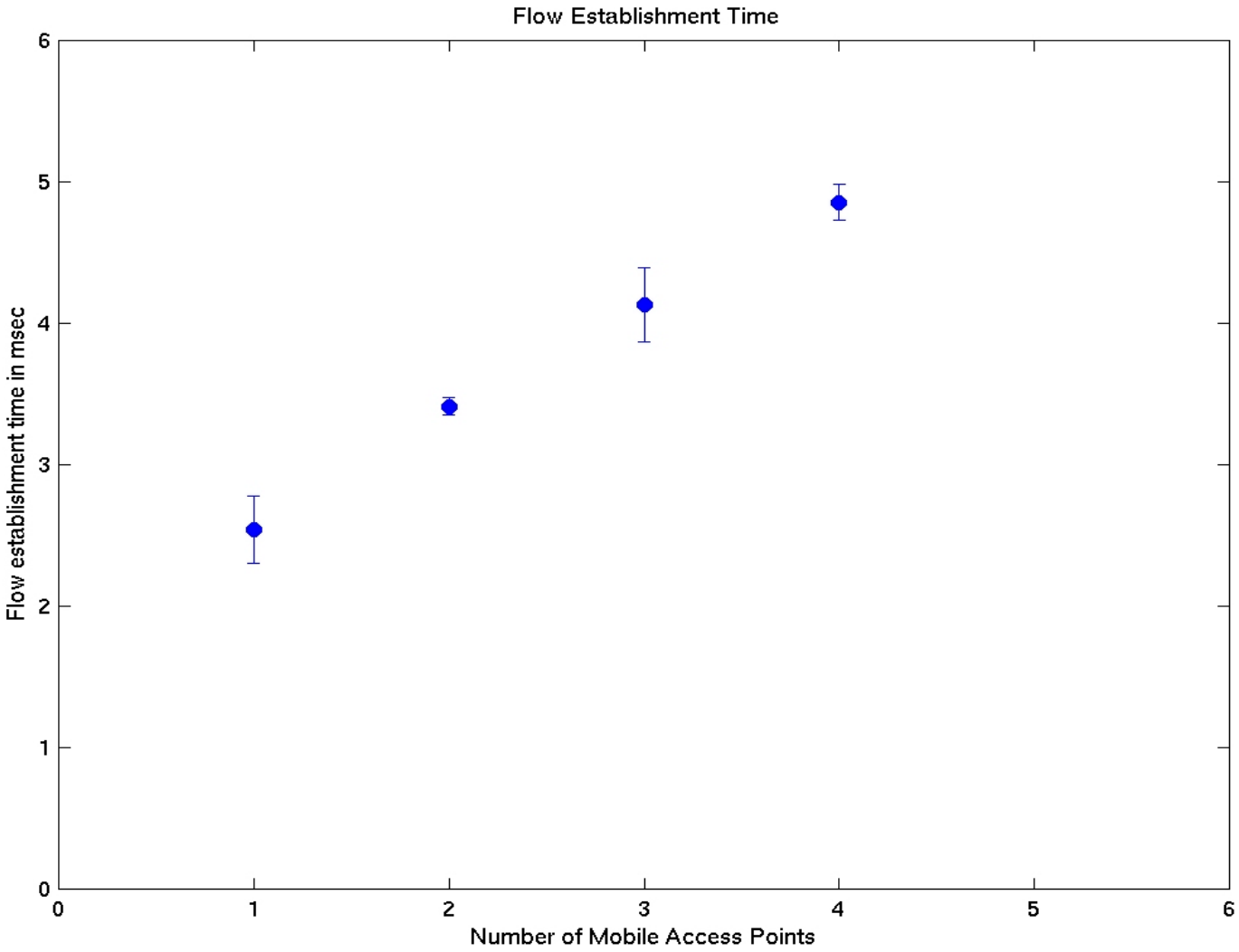


Experiments and Results

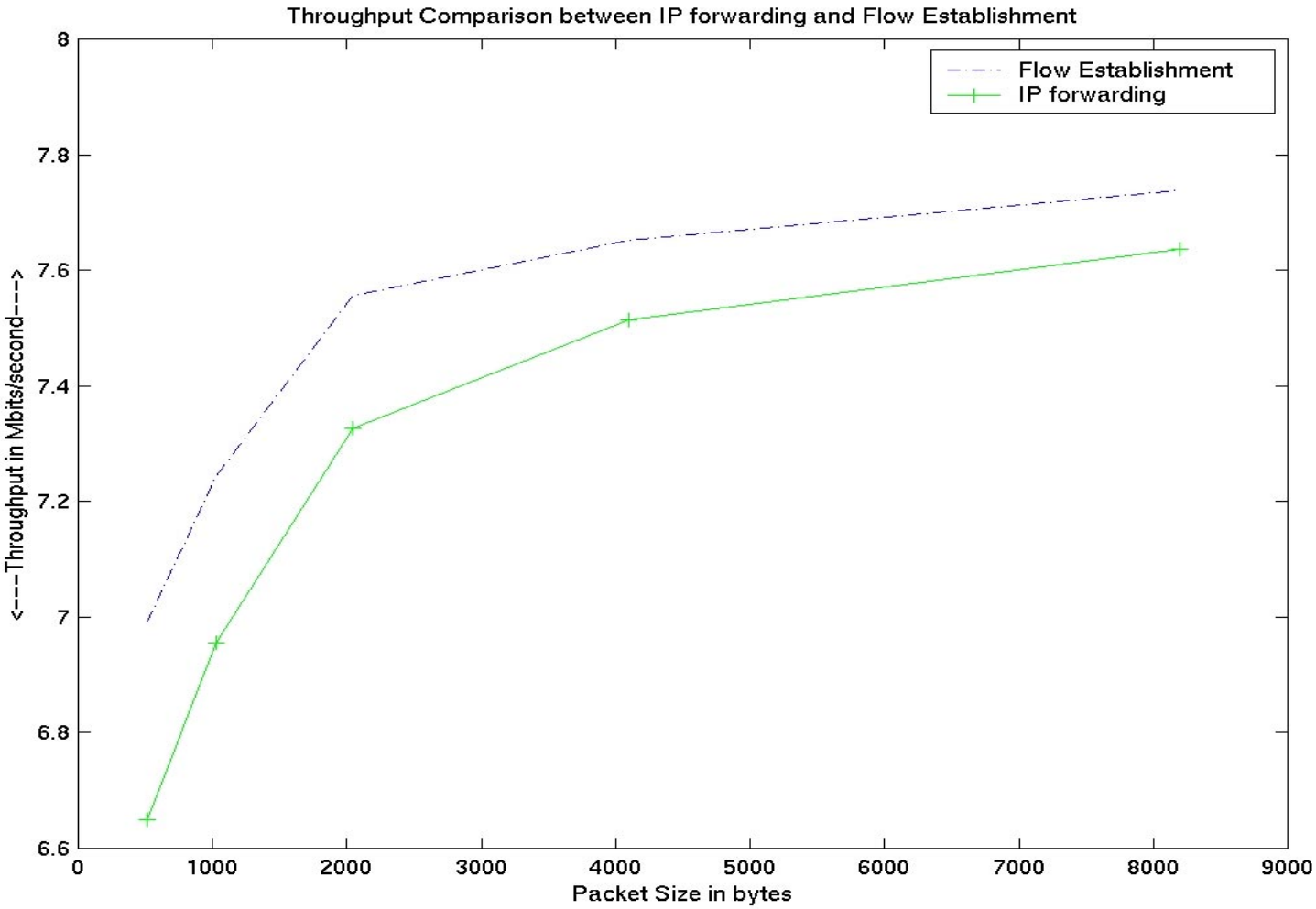
- Performance of the Flow Establishment Protocol
  - Throughput and flow setup time
  - Flow Re-establishment time
- Validity of the QoS Layer in RDRN
  - Absence & Presence of Congestion
  - Load testing
- Mobile QoS
  - Throughput

Flow Establishment Protocol Experiments and Results

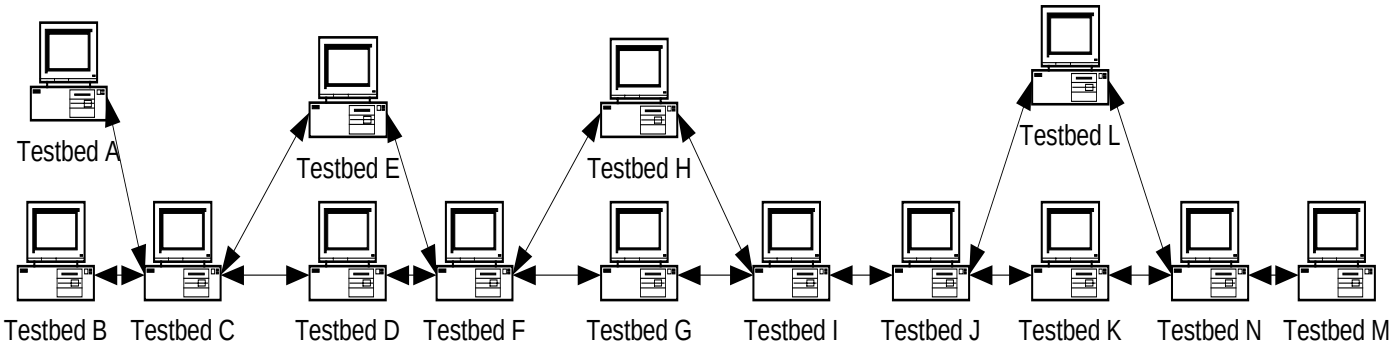
Flow Establishment Time



Flow Establishment Vs. IP forwarding



Flow Re-establishment Logical Test Configuration

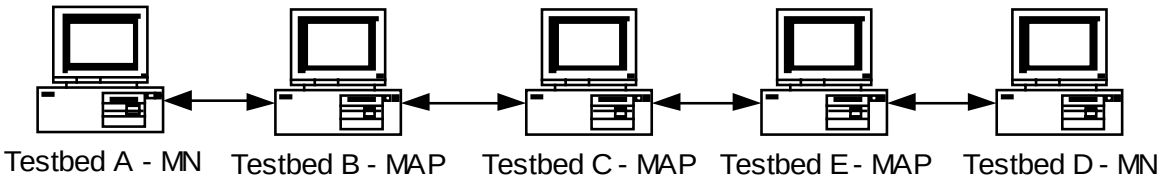


Flow Re-establishment Time

Distance of failing link from destination	Flow Re-establishment Time (in msec)
7	36.38
5	33.83
2	29.89

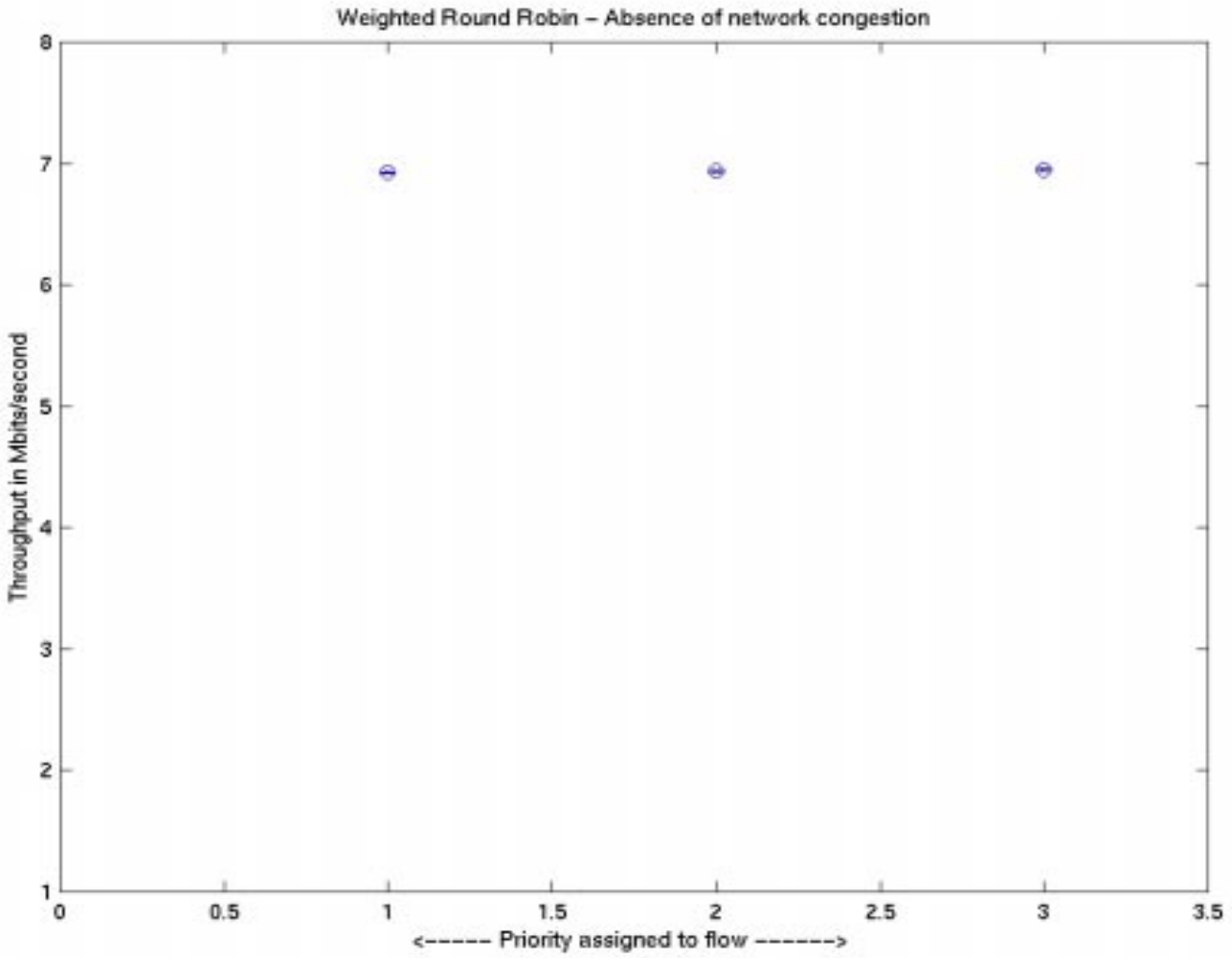
QoS Layer
Validity Experiments

Test Configuration

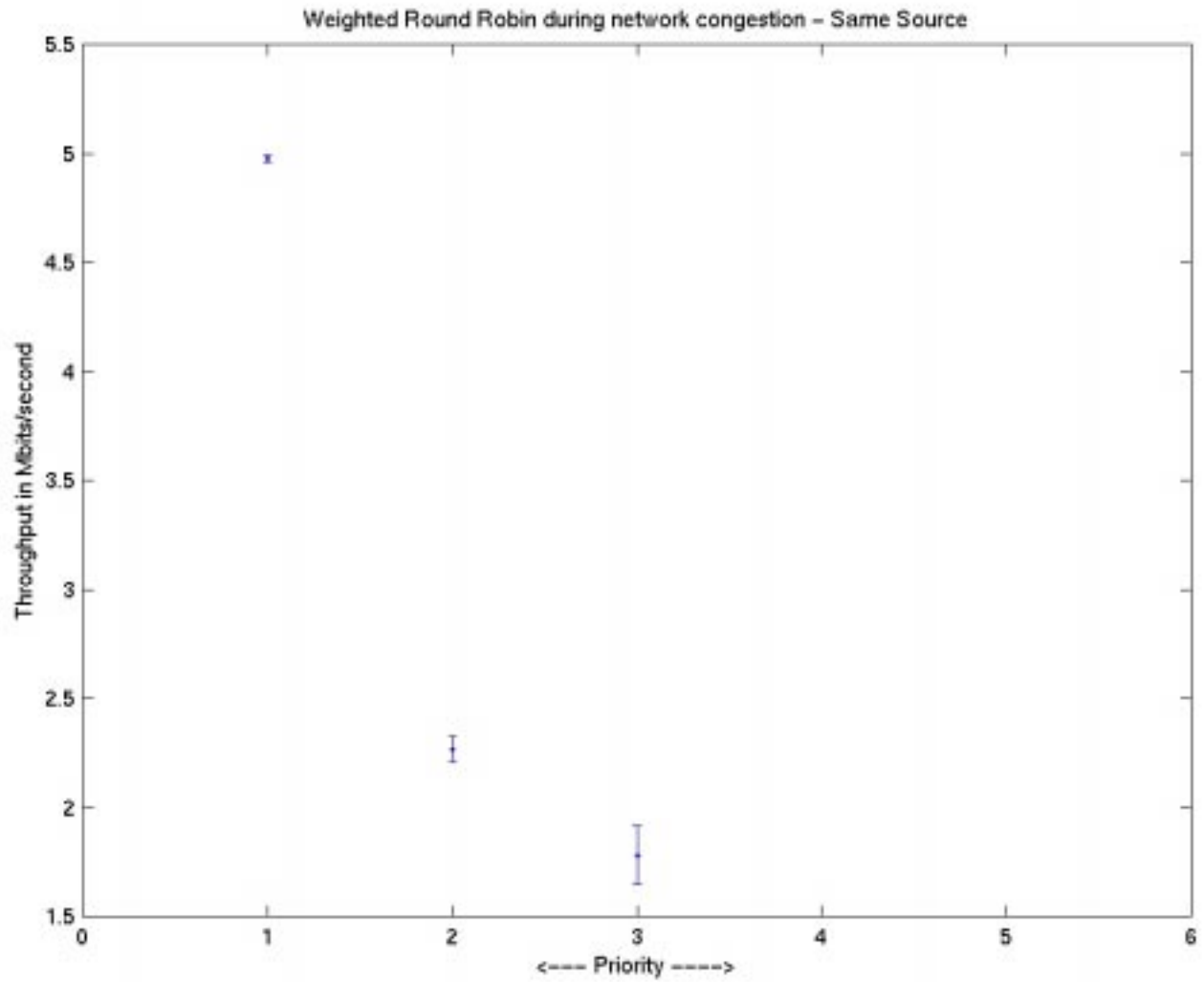


Peak Cell Rate - 10Mbits/second
Weights of priorities - 5:3:2

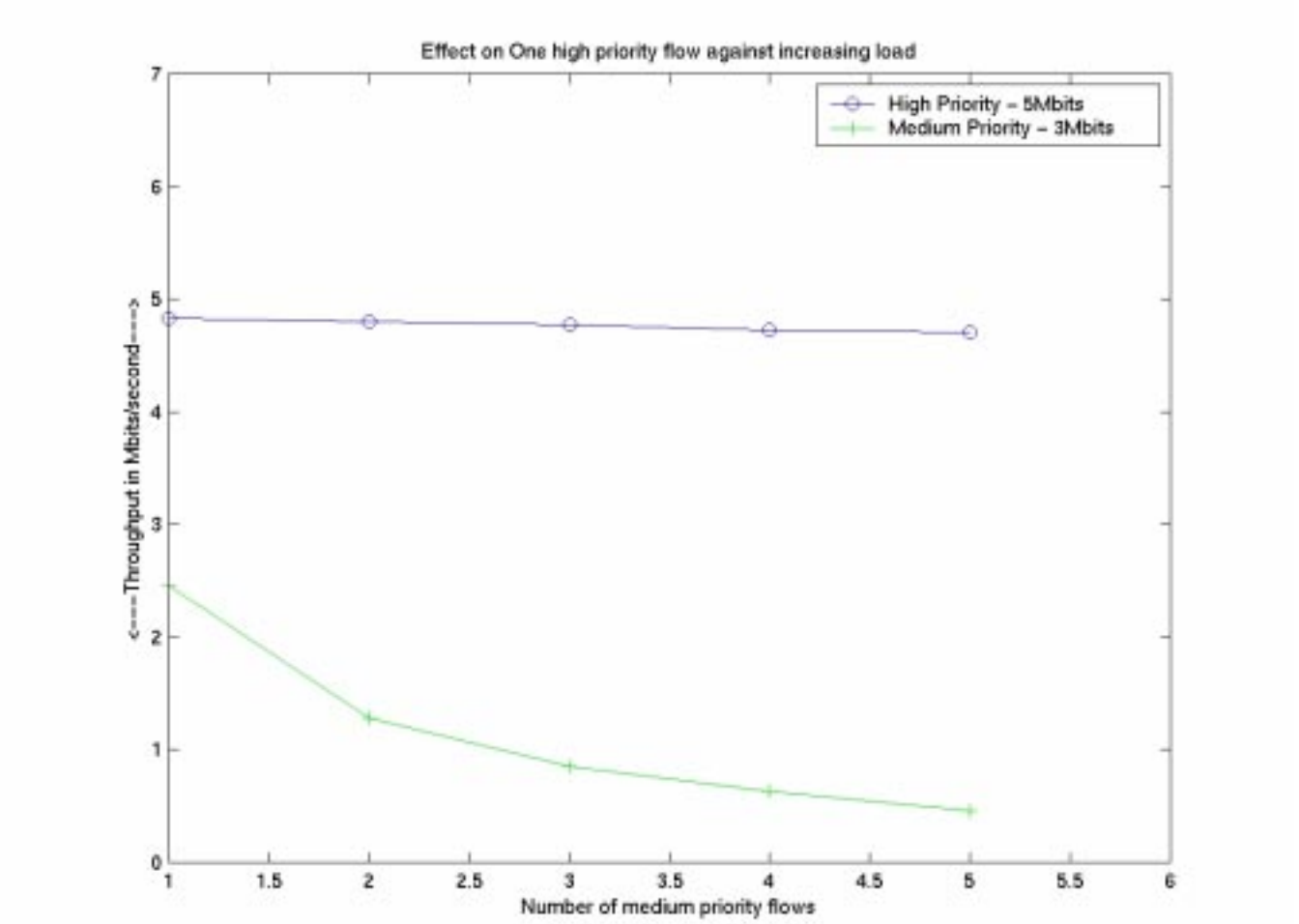
WRR Scheduler - Single Flows



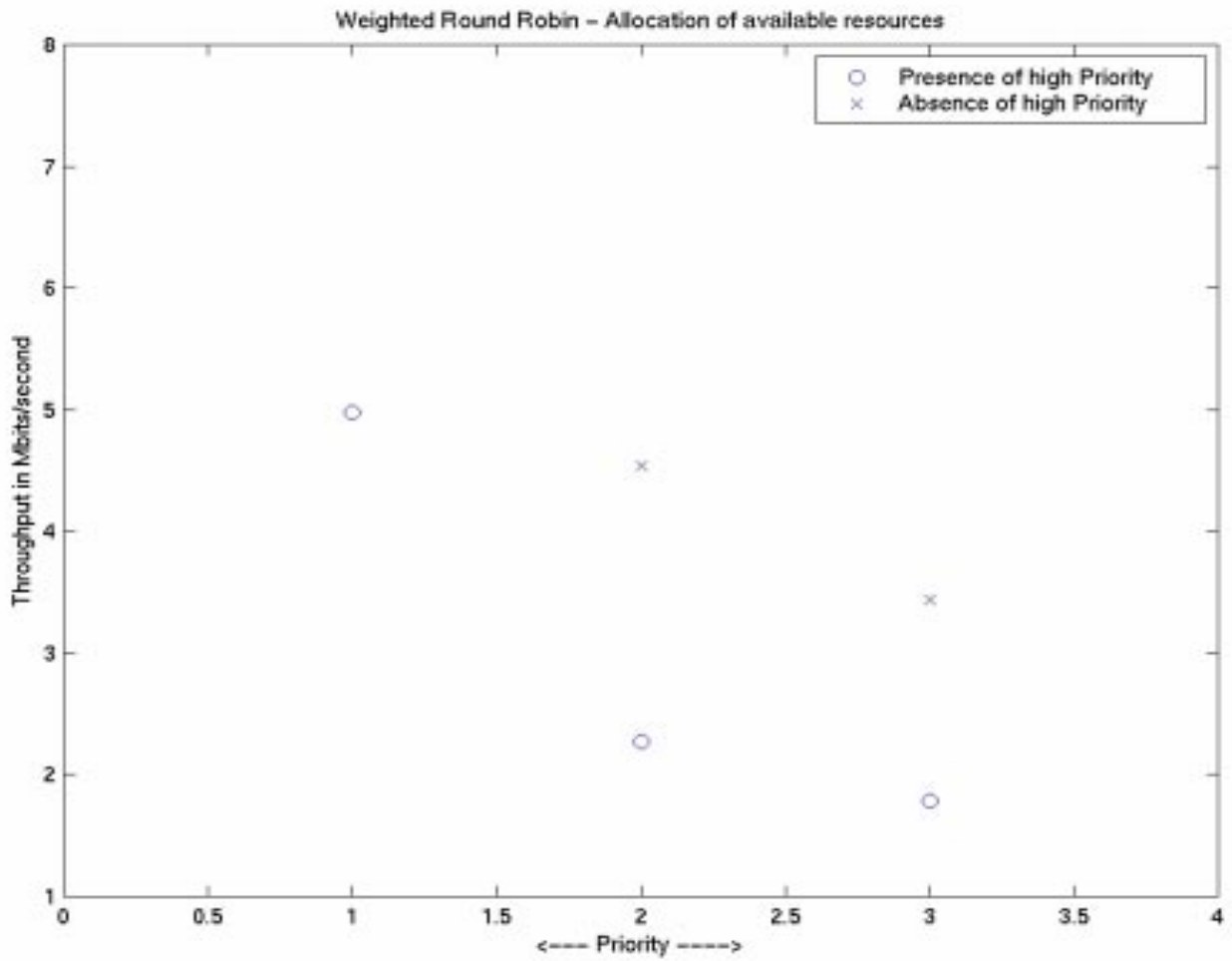
WRR Scheduler - Multiple Flows



High Priority under increasing load

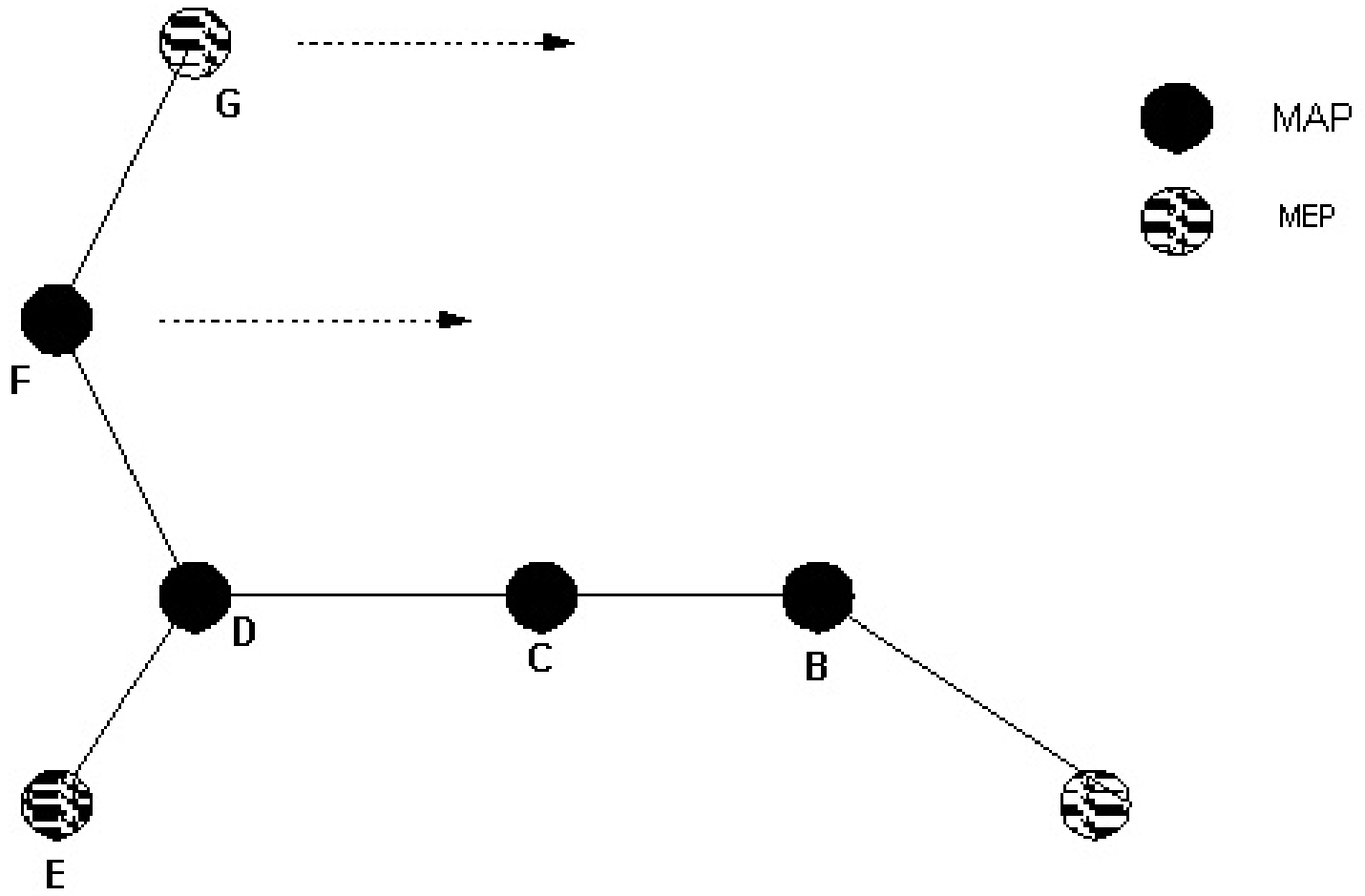


“Weighted” Round Robin



Mobile QoS
Experiments and Results

Test Scenario



End-to-end throughput

Single Flow

Sending Rate (in Mbits/second)	Receiving Rate (in Mbits/second)
3.6419	3.6417
3.5907	3.5905
3.6265	3.6265
3.6113	3.6095
3.6505	3.6499

End-to-end throughput

Multiple flows

Flow 1 - Priority 1

Flow 2 - Priority 2

Flow 1: Flow 2 = 5:2

Flow 1		Flow 2	
Sending Rate (in Mbits/second)	Receiving Rate (in Mbits/second)	Sending Rate (in Mbits/second)	Receiving Rate (in Mbits/second)
3.7761	3.6925	3.6419	3.0750
3.7481	3.6494	3.5905	3.1000
3.7766	3.6777	3.6312	3.0688
3.7588	3.7057	3.5769	3.0823

Conclusions

- A QoS architecture for highly dynamic networking environments like RDRN, has been proposed, implemented and evaluated.
- A flow establishment protocol tuned for IP-ATM mobile environments has been implemented and evaluated.
- A QoS Layer, which schedules the transmission of cells based on a WRR algorithm, has been introduced in the RDRN Protocol stack. Its validity has been tested.

Future Work

- Implement more scheduling algorithms and compare the performance.
- The scaling up feature that was discussed in the design has not been implemented. Since the framework is already available, this should be fairly easy.
- The handoff QoS parameters have not been used currently while doing the flow re-establishment.