

## Proposal of an IP QoS framework:

### Scalable Services – ScalServ

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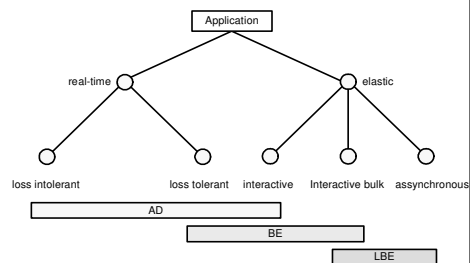
## ScalServ – Classes of Service

- **Best Effort (BE)** → reference service. Majority of the applications

- **Assured Delivery (AD)** → Real time applications; applications demanding minimum bandwidth

- Don't guarantee a maximum end-to-end delay
- No packet loss in router queues
- Packet transit delay equals transmission + propagation times (controlled queue lengths)
- Resources explicitly reserved using end-to-end signalling protocol (E2ESP)

- **Less than Best Effort (LBE)** → best effort service with lower priority. LBE packets transferred only after BE or AD packets; residual bandwidth reserved to avoid LBE starvation.

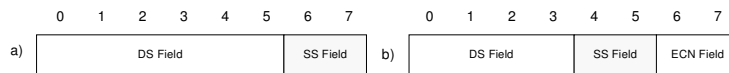


## Code Points

- Service class has a code point (SSCP); marked in packets
- Code Points are **global**
- Remarking due to
  - congestion
  - inexistence of reservation (AD)
  - impossibility of guarantee AD service (AD → NG-AD).

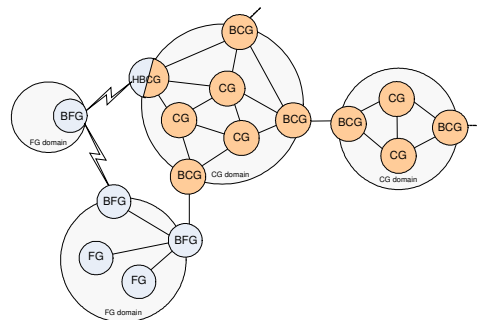
Description	SSCP
Best Effort	00
Less than Best Effort	01
Assured Delivery	10
Non-Guaranteed Assured Delivery	11

- ScalServ field: 2 bits



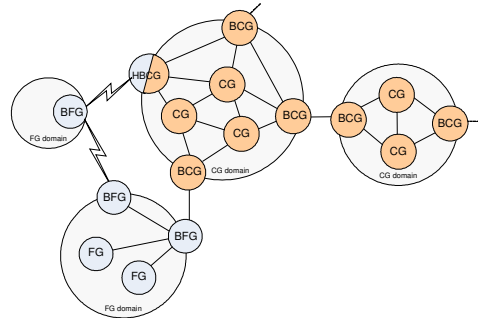
## Architecture

- Nodes classified based on QoS granularity:
  - Fine Granularity (FG)
  - Coarse Granularity (CG)
- FG nodes
  - adequate for networks having complex resource management
  - LAN, ad-hoc networks
- CG nodes
  - Adequate processing an high number of flows
  - Core networks



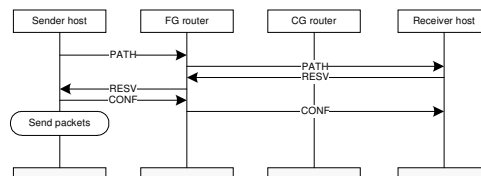
## Architecture

- FG nodes process
  - AD packets per flow
  - AD signalling
  - BE and LBE packets per class
- CG nodes
  - process all packets per class
  - do not process AD signalling

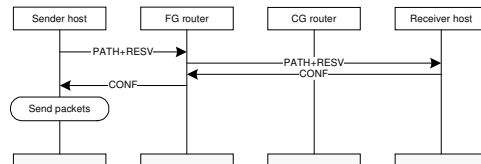


## End-to-end Signalling protocol (E2ESP)

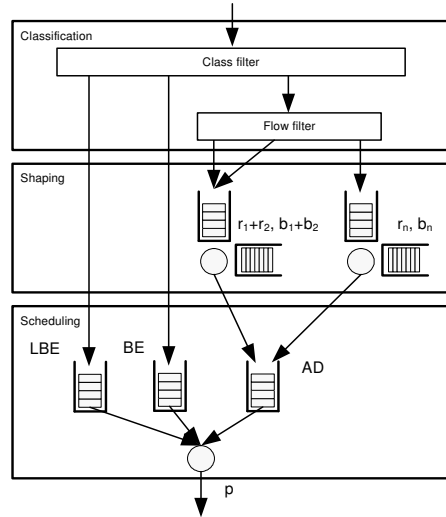
Receiver-initiated



Sender-initiated



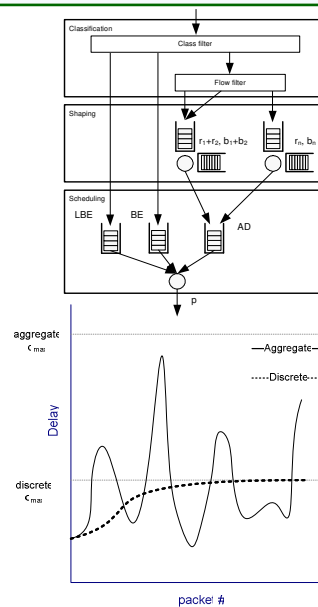
## FG - Data Plane



## FG - Data Plane

### Shaping

- AD class only
- Discrete shaping
  - control over individual flows
  - control of the maximum shaping delay per flow
  - implemented by the source host and the first next router (policing)
- Aggregate shaping
  - less control over each flow
  - lower average delay per aggregate

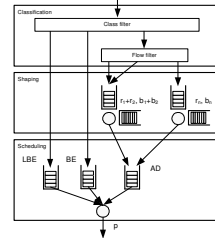


## FG - Data Plane

### Scheduling

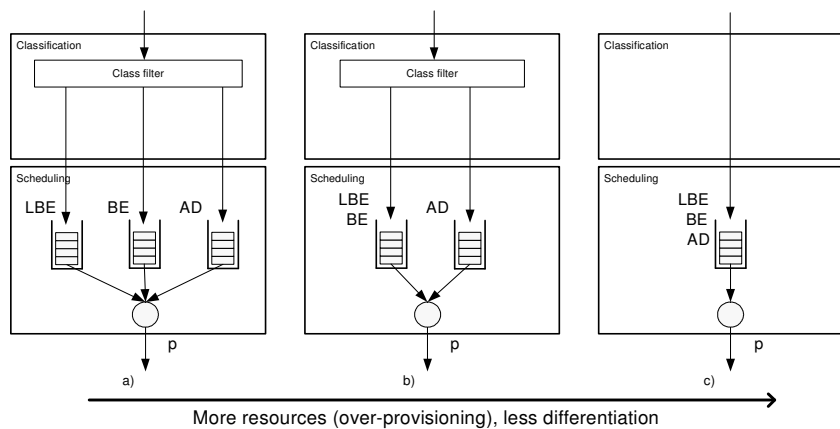
```

While (1){
  if (ADQueue not empty) transmit ADpacket;
  else if (LBQueue not empty and (BEQueue empty or LBEcredit >= LBEpacket.length)){
    transmit LBEpacket;
    LBEcredit -= LBEpacket.length;
    if (LBEcredit < 0) LBEcredit = 0;
  } else if (BEQueue not empty) {
    transmit BEpacket;
    if (LBQueue not empty) LBEcredit += BEpacket.length * LBEresidualRate;
  }
}
    
```



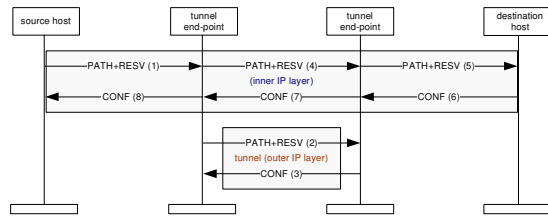
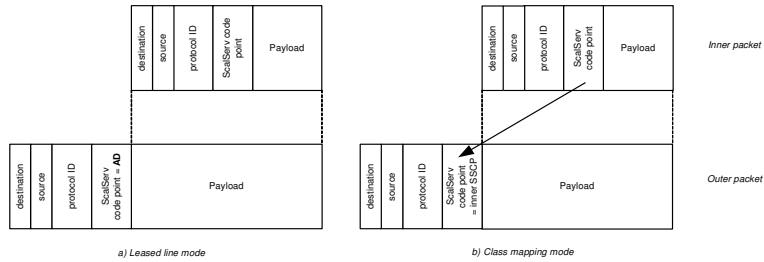
## CG - Data Plane

### CG Interior Node

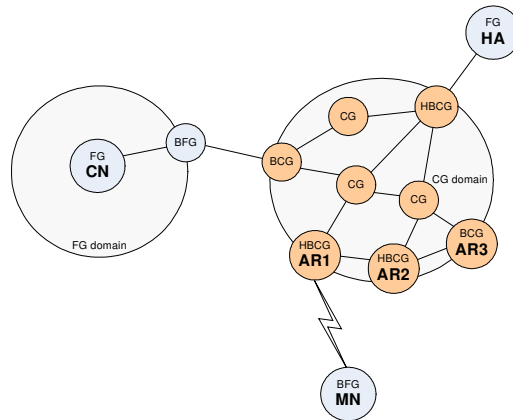


## IP tunnelling

- Two modes:
  - *Leased Line* → adequate for VPNs
  - *Class mapping* → adequate for IPv4-IPv6 transition tunnels e MIP tunnels



## Mobile IP



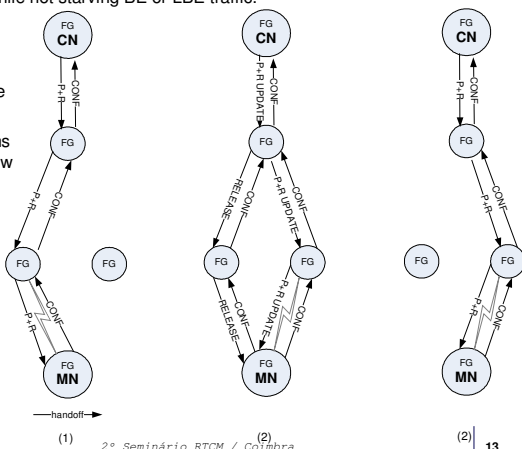
## Mobile IP

- **Tolerant AD forwarding** → forwards AD packets with no reservation.

- AD packets without reservation pass through a default shaper ( $r_0, b_0$ )
- AD packets of rejected reservation are discarded
- No guarantees that AD packets continue receiving the same service
- Moderate AD service during handoff, while not starving BE or LBE traffic.

- **E2ESP end-node address update**

- Some FG nodes in the new path are the same.
- FG nodes common to old and new paths only update the Filter SPEC with the new CoA address.

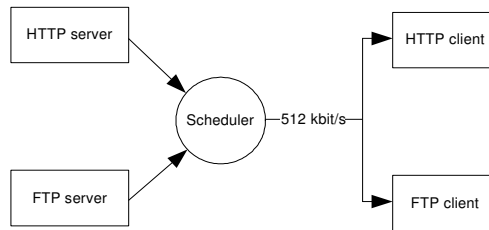


## Simulations

- **BE/LBE differentiation** enables interactive and background applications to share the same link, using work-conserving scheduling
- **AD/BE differentiation** allows real-time applications to share the same link with bursty applications, providing QoS to real-time (AD) flows
- **Discrete shaping** provides a firm control of the maximum reshaping delay per AD flow; **aggregate shaping** provides low average reshaping delays per aggregate

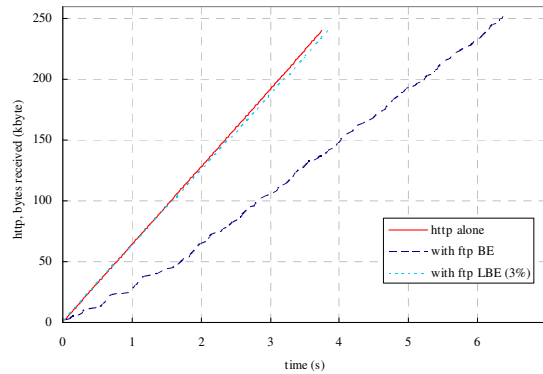
## Simulations

### BE/LBE differentiation



## Simulations

### BE/LBE differentiation

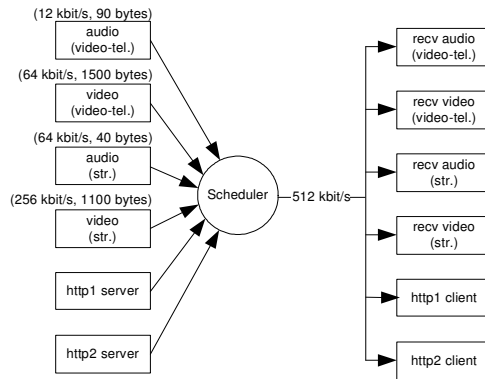


Scenario	Flow	Response time (ms)		Throughput (kbit/s)	
		Expected	Verified	Expected	Verified
HTTP alone	HTTP	3750	3750	512 (100%)	512 (100%)
	FTP	-	-	-	-
HTTP BE with FTP BE	HTTP	-	6374 (+70,0%)	-	316 (61,7%)
	FTP	-	-	-	196 (38,3%)
HTTP BE with FTP LBE	HTTP	3866 (+3%)	3843 (+2,5%)	497 (97%)	500 (97,7%)
	FTP	-	-	15 (3%)	12 (2,3%)



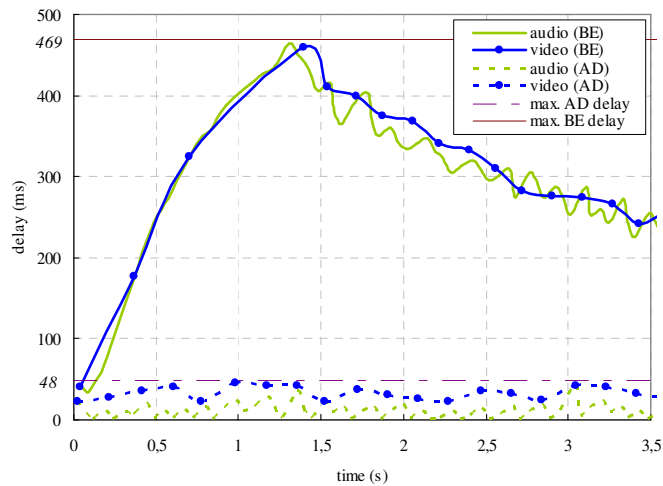
## Simulations

### AD/BE differentiation



## Simulations

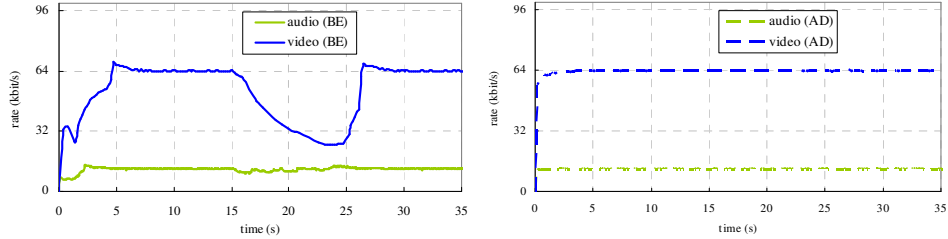
### AD/BE differentiation



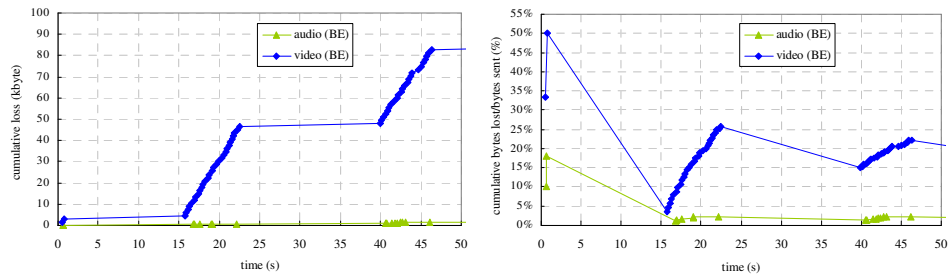
Scheduling delay of video-telephony flows without and with AD/BE differentiation

## Simulations

### AD/BE differentiation



Throughput of video-telephony flows without and with AD/BE differentiation



Packet loss of video-telephony flows without AD/BE differentiation

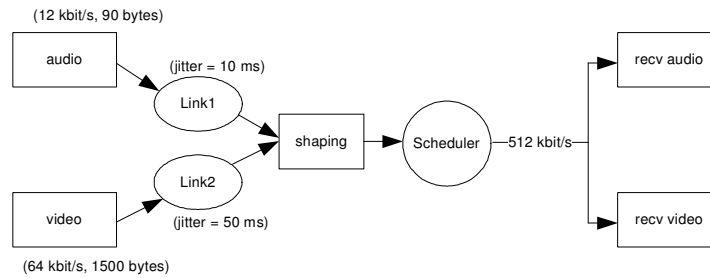
## Simulations

### AD/BE differentiation

Scenario	Flow	Scheduling delay (ms)		Throughput (kbit/s)			Packet loss
		Max.	Avg.	Max.	Avg.	Min.	Avg.
Flat BE	Audio (tel.) BE	468,3	289,1	14,0	11,8	6,0	1,8%
	Video (tel.) BE	468,4	267,3	69,0	51,1	24,8	20,0%
	Audio (str.) BE	468,7	290,0	127,6	63,5	4,7	0,7%
	Video (str.) BE	468,2	290,9	308,6	241,6	100,0	5,5%
AD/BE	Audio (tel.) AD	48,2	11,1	12,4	12,0	10,5	0,0%
	Video (tel.) AD	46,9	31,4	64,4	64,0	55,9	0,0%
	Audio (str.) BE	569,9	333,0	209,2	63,8	4,6	0,2%
	Video (str.) BE	550,3	324,8	324,3	235,5	98,0	7,8%

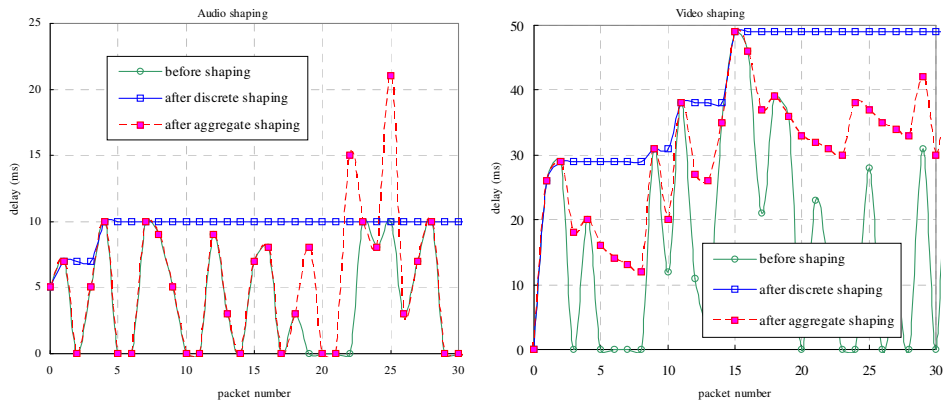
## Simulations

### Discrete and aggregate shaping



## Simulations

### Discrete and aggregate shaping



Scenario	Flow	Link jitter (ms)	Max. delay (ms)	Average delay (ms)
Discrete shaping	Audio	10	10	9
	Video	50	50	49
Aggregate shaping	Audio	10	49	6
	Video	50	50	37

## Conclusions

- Scalable Services → a replacement for current best-effort service.
- Scalable term used with two meanings:
  1. networks can be added/enlarged without compromising the services offered
  2. the framework applies to local, access and core networks; from an end-to-end perspective
- 3 global service classes: AD, BE and LBE
  - expected to serve all type of applications.
- Simulation results proved that
  1. discrete and aggregate shaping is valid, and
  2. the proposed scheduler is simple, effective and contributes for a good network efficiency.

## Future Work

- E2ESP specification
- Definition of a resource management model for CG domains
- Definition of business models
- Definition of a mobile IP framework with ScalServ and IP micro-mobility
- Deployment of ScalServ in ad-hoc networks with low resources; ex.: Body Area Networks (BAN) and Personal Area Networks (PAN).

## Commercial/Industrial Interests

- **IP + ScalServ = Always-On-with-QoS**

- Networks:

- *Heterogeneous L2 networks*
    - *Ad-hoc networks (PAN)*
    - *Corporate networks*
    - *ISP, Operator networks...*

- Terminals:

- *Desktop, laptop,*
    - *Mobile Phone, PDA...*

- **Effective and simple end-to-end QoS deployment**

- Easy to understand + Simple to deploy  
→ Wide-spreading of multimedia services → higher revenues

- **BE+LBE → Solution for ISPs overloaded core networks due to P2P applications**

Thanks!

Questions?

## Transition to ScalServ

- A ScalServ region is a set of one or more contiguous ScalServ domains.
- IP packets passing through a non-ScalServ region shall be marked, when entering a ScalServ region, as non-guaranteed (SSCP=11)
- When a FG node receives an E2ESP signalling packet from a non-ScalServ region it must indicate the reservation as non-guaranteed
- The acceptance of non-guaranteed AD flows is let to applications

## Transition to ScalServ

