Evaluation of EuQoS System by Simulation: Tools and Results

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D2.1.2: Validation of the EuQoS system by simulation

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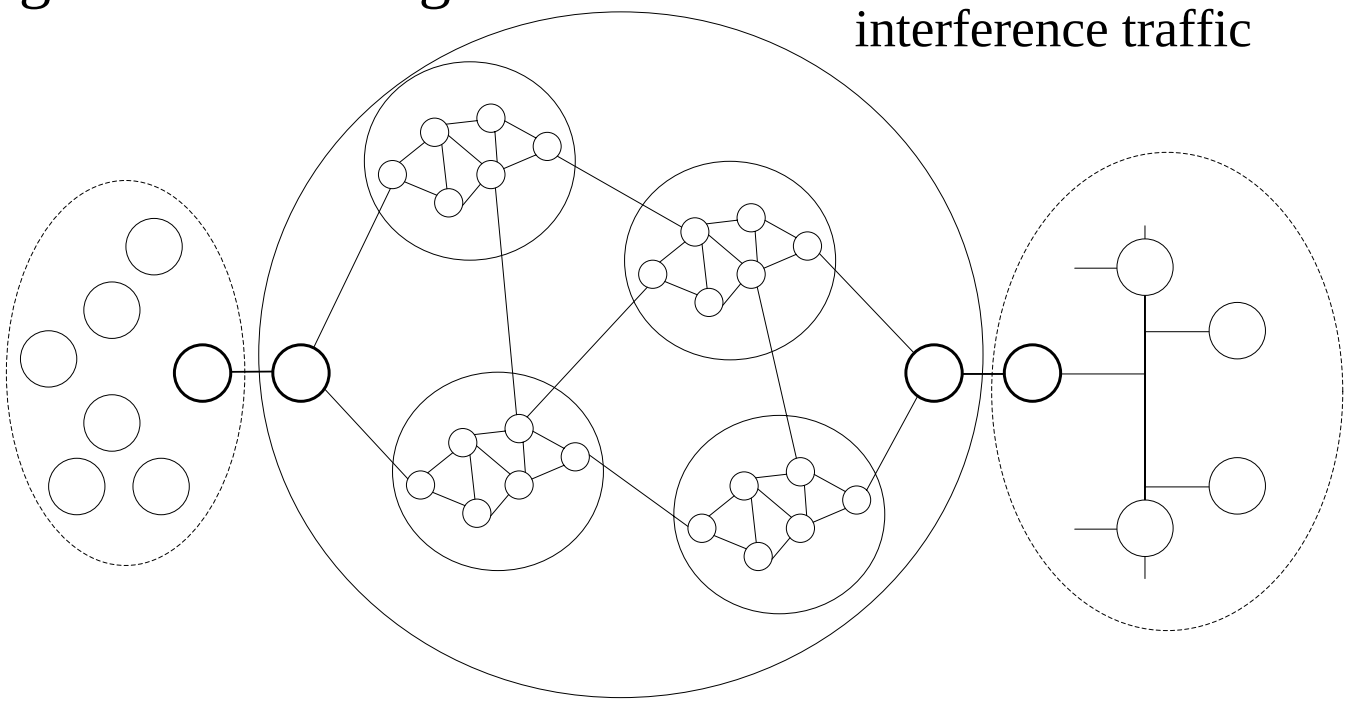
Simulation model for the EuQoS system

- Motivation:
  - validate & verify the EuQoS architecture;
  - provide guidelines based on simulation results.

- Simulation tools:
  - SiM-EuQoS-PTL: Packet transmission level;
  - SiM-EuQoS-CIL: Call invocation level;
  - SiM-EuQoS-PL: Provisioning level.

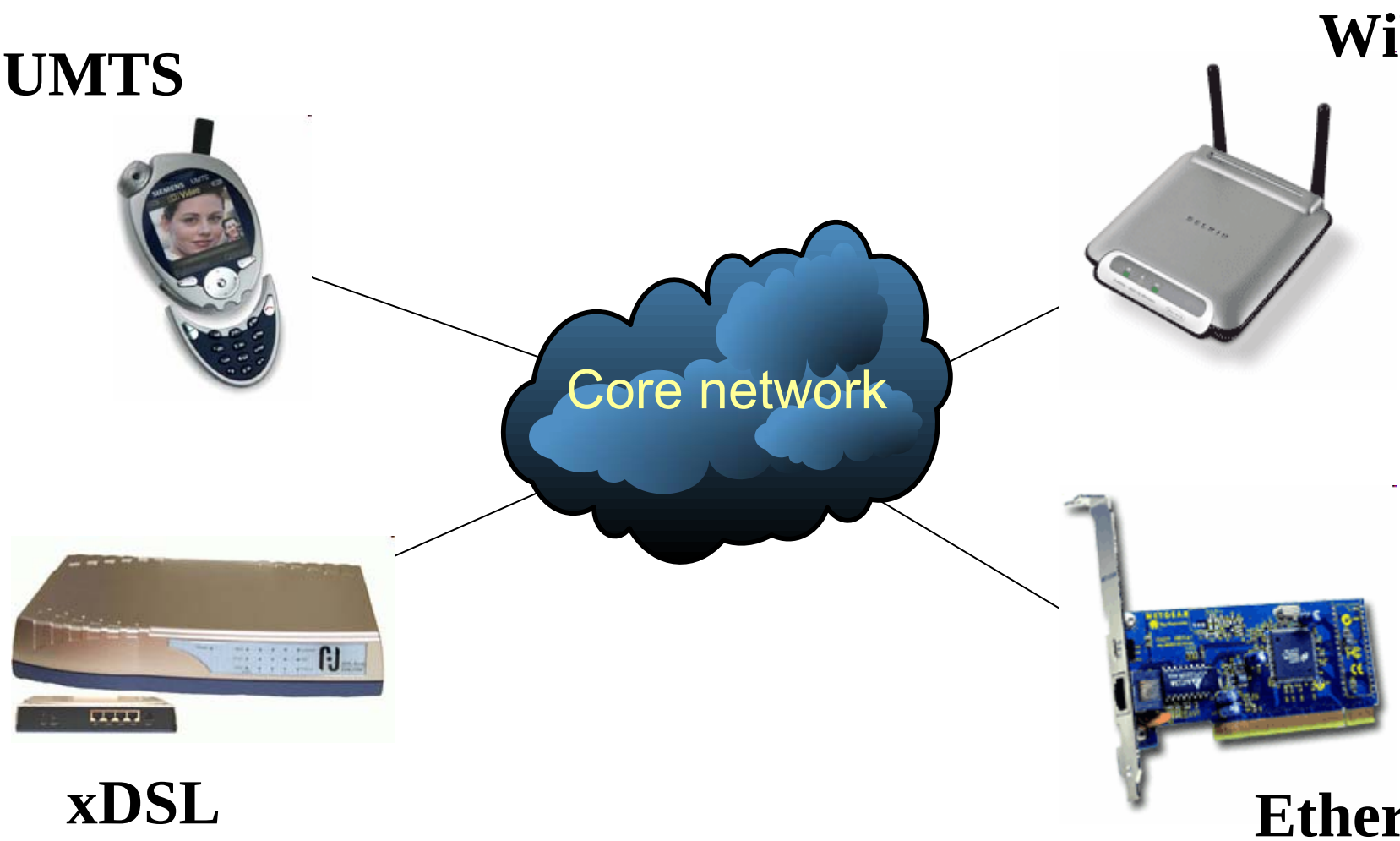
Hypotheses

- Access networks connected to the core through a single link
- No. of flows is fixed
- Routing does not change
- Traffic distinguished into
  - *Foreground*, i.e. applications which are actually measured
  - *Background*, i.e. aggregated interference traffic



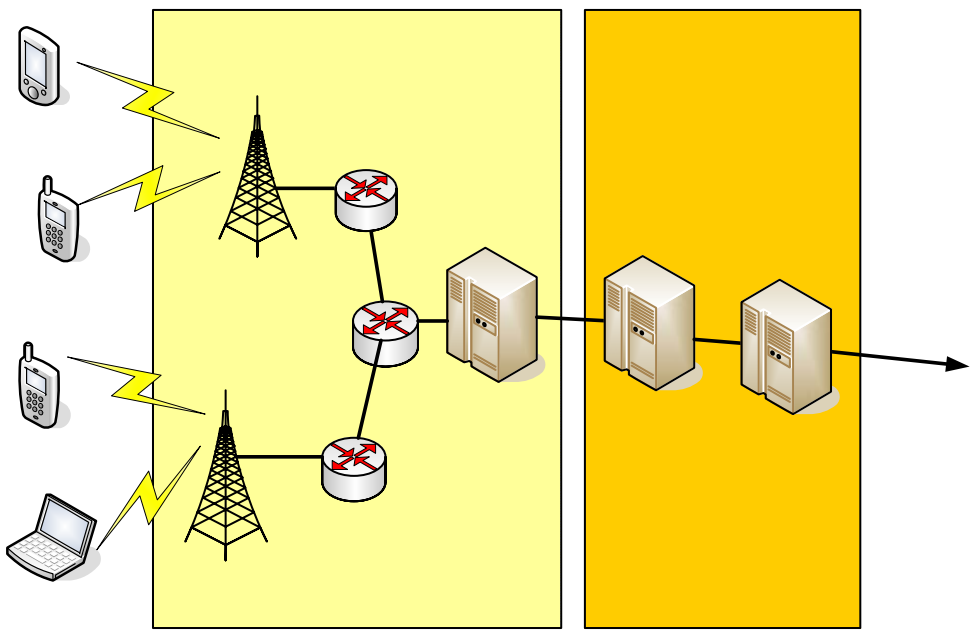
Access networks

- Four different access networks are considered:



Access Networks: UMTS

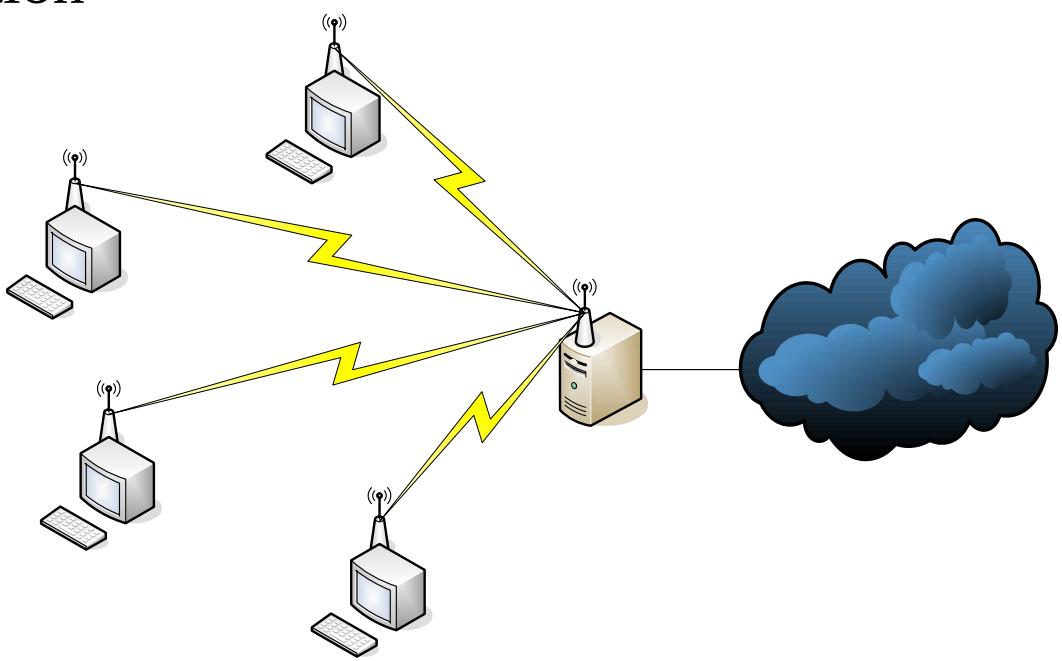
- *Urban* and *rural* scenarios considered
  - Different propagation and mobility models
- Single Node B
  - Intercell interference accounted for by using interference models
- DSCH and DCH implemented



Access Networks: WiFi

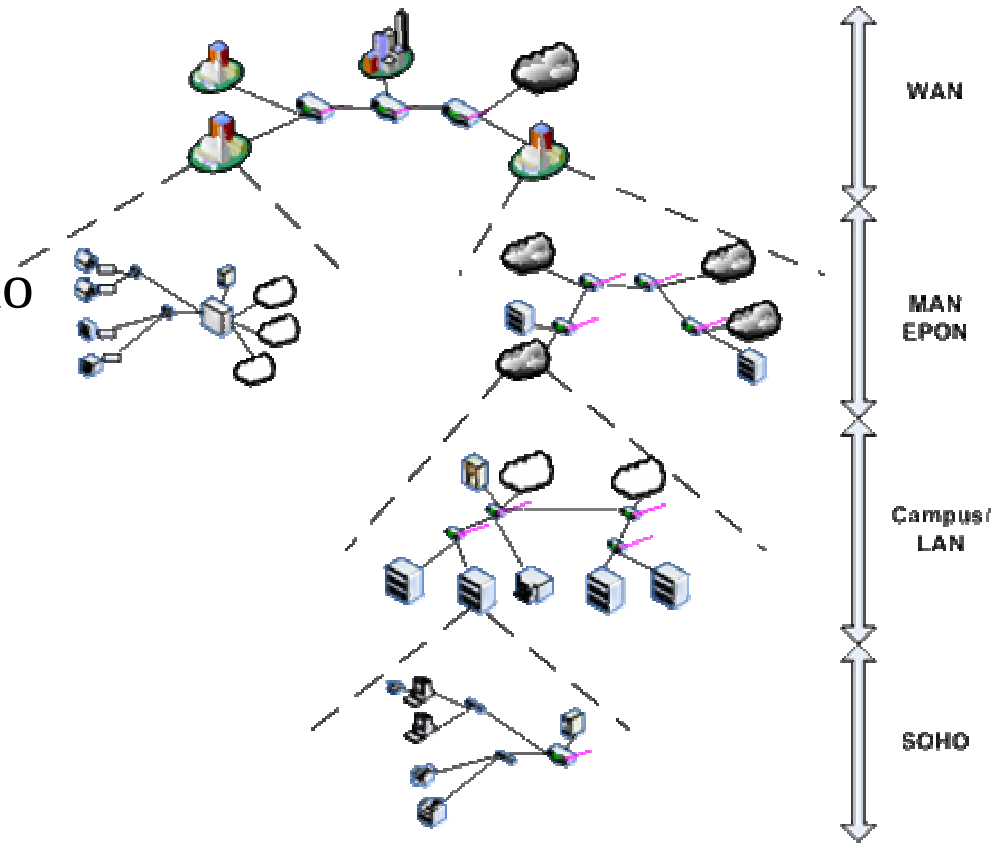
- Nodes using DCF in an 802.11 infrastructure mode network (802.11e left for the 2nd phase)
- RTS/CTS handshake
- Fragmentation

- No mobility simulated
- Channel error models to be added
- No power saving nor rate switching

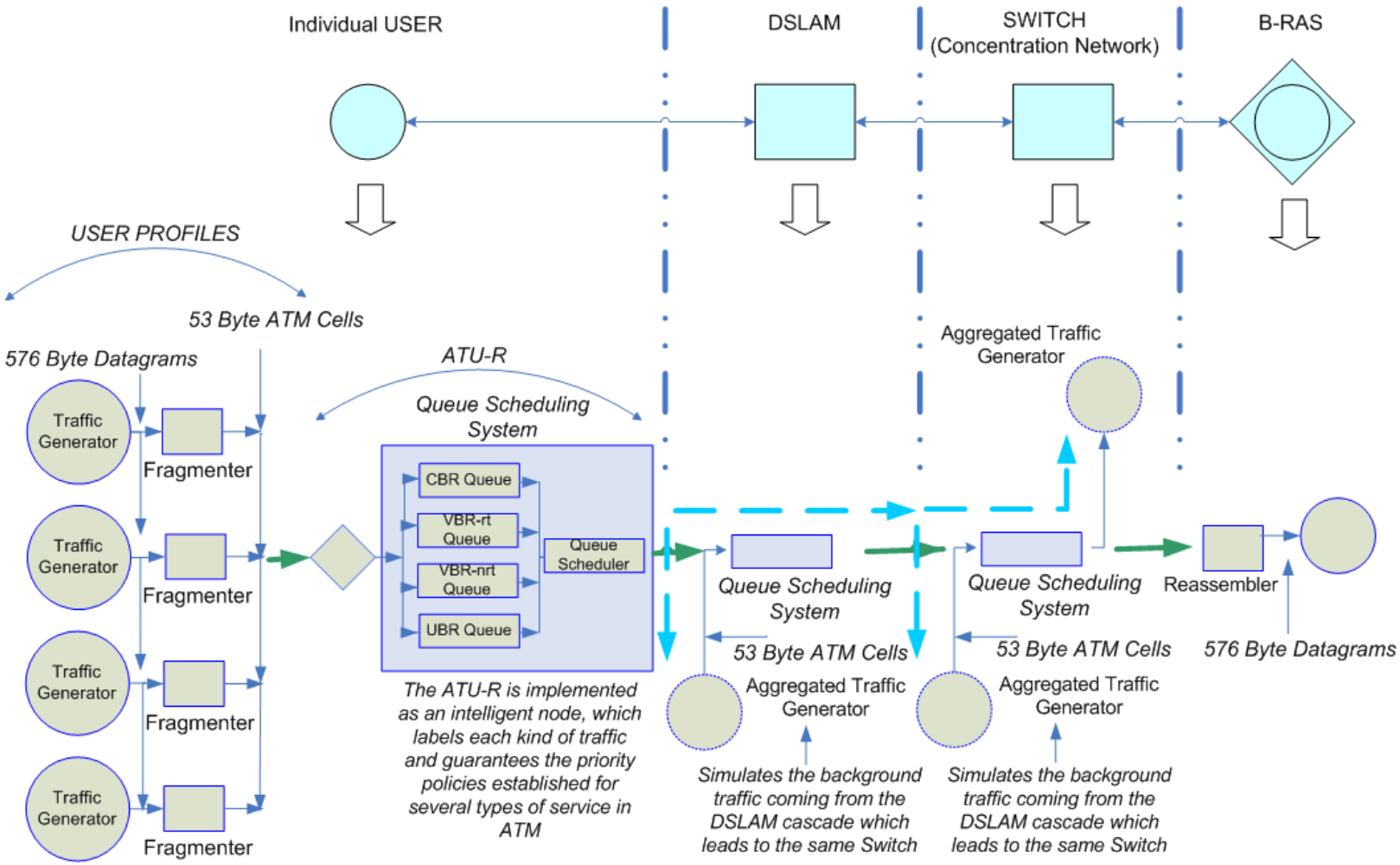


Access Networks: Ethernet

- *Switched* Ethernet:
  - Small Office Home Office (SOHO)
  - Campus/LAN scenario
  - MAN organization scenario
  - MAN residential scenario (EPON)
- 802.1p and 802.1q standards implemented

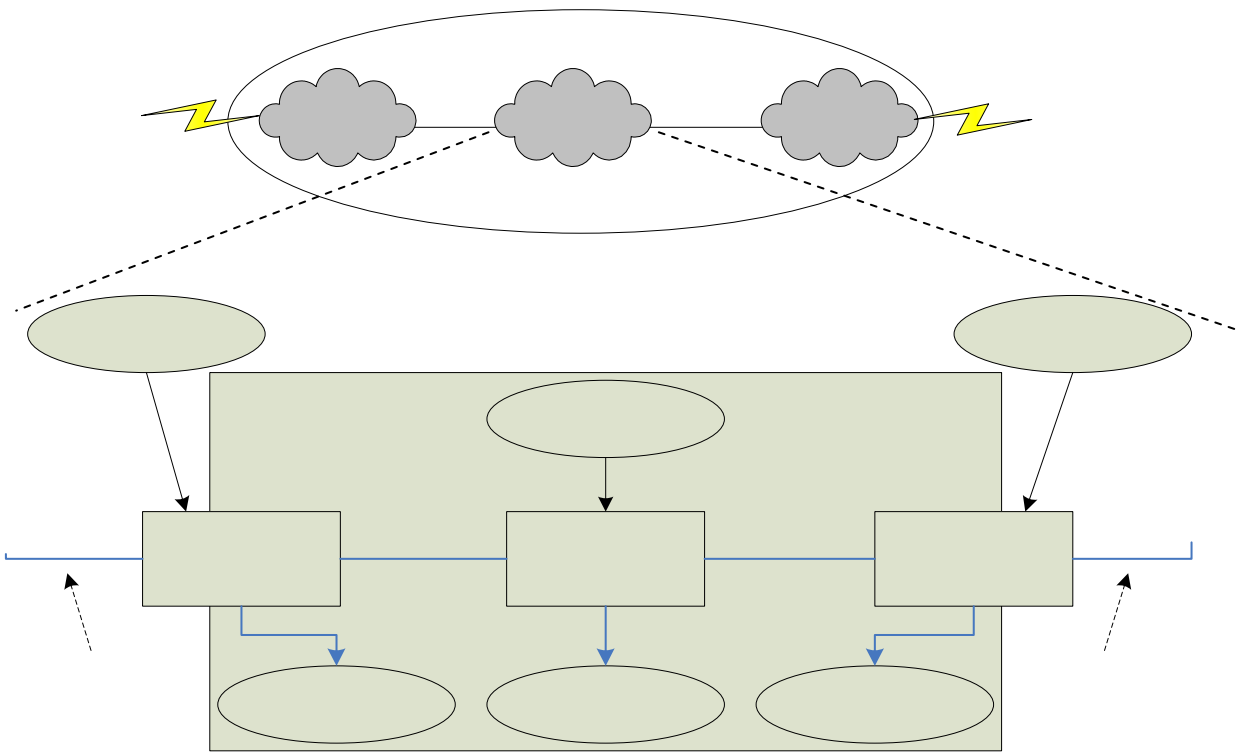


Access Networks: xDSL

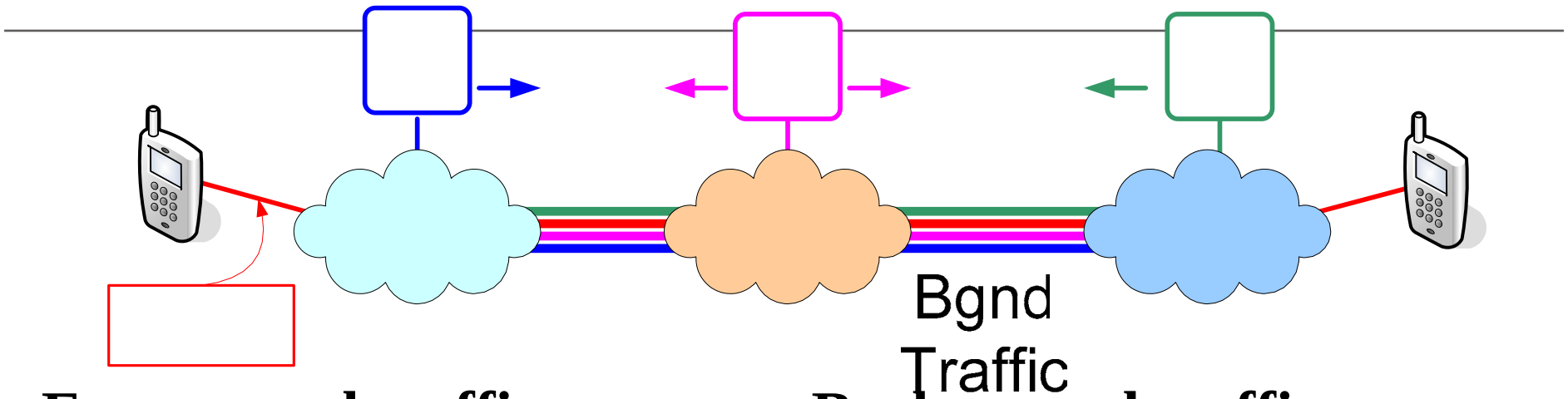


Core Network

- DiffServ-capable routers with (at least) 2 PHBs
- QoS-oriented classification, policing and scheduling mechanisms enforced
- Interfering traffic represents aggregated traffic from access networks and core domains
- Bottlenecks are at the inter-domain links



Traffic models



Foreground traffic

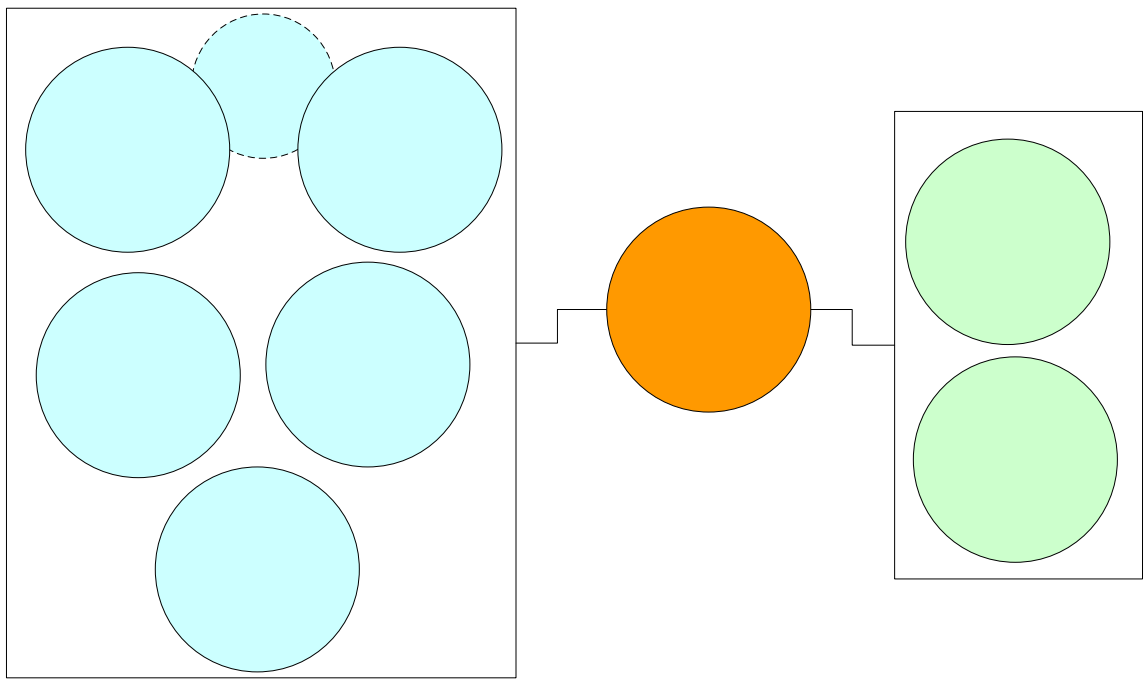
- VoIP
  - G.711, G.729 codecs with VAD
- Video Conference
  - MPEG4 and H263 VC traces
- Video streaming
  - MPEG 4 encoded movies
- Input expected from application developers in EuQoS

Background traffic

- Depends on the network (access tech. and core)
- Depends on what applications are actually used
- Many models available in the literature
- Input expected from measurement activities in EuQoS

Implementation of the packet level simulator

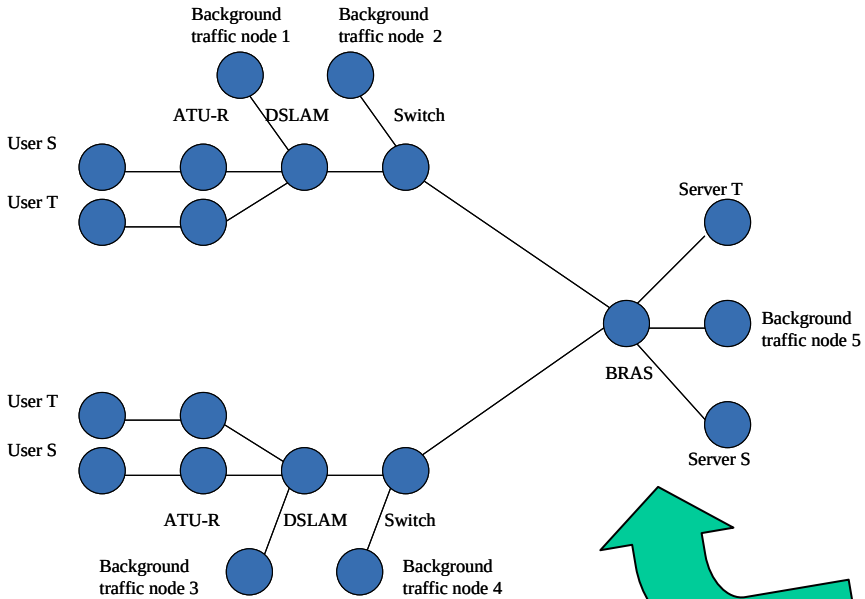
- Ns-2 has been used
- Devised a framework that allows the seamless addition of new modules
- Simulation scenarios can be built incrementally

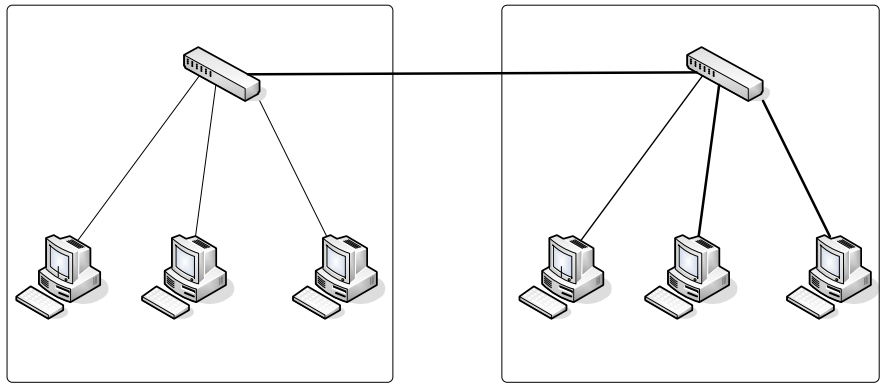


First simulation results

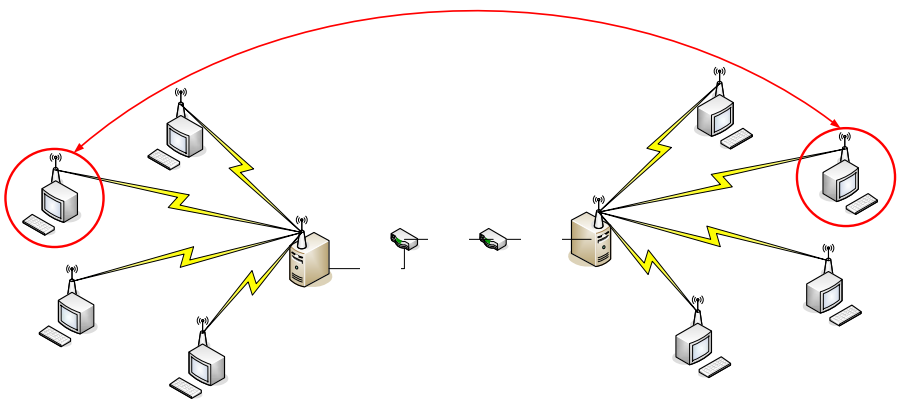
- Objectives:
  - Validate the PTL simulator
  - Assess the level of QoS provided by the existing "bare" access and core technology
    - What do we get *without* EuQoS
    - What do we need from EuQoS
  - Test QoS in *heterogeneous* access networks
    - Do different QoS mechanisms interoperate correctly?
  - "lay the ground" for simulating the effectiveness of EuQoS mechanisms at all relevant layers

Example: impact of non QoS traffic on QoS traffic



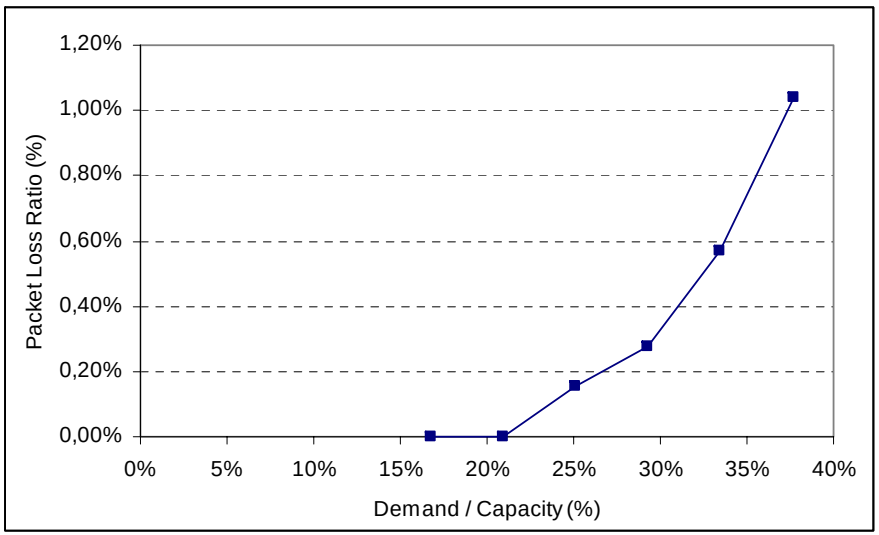


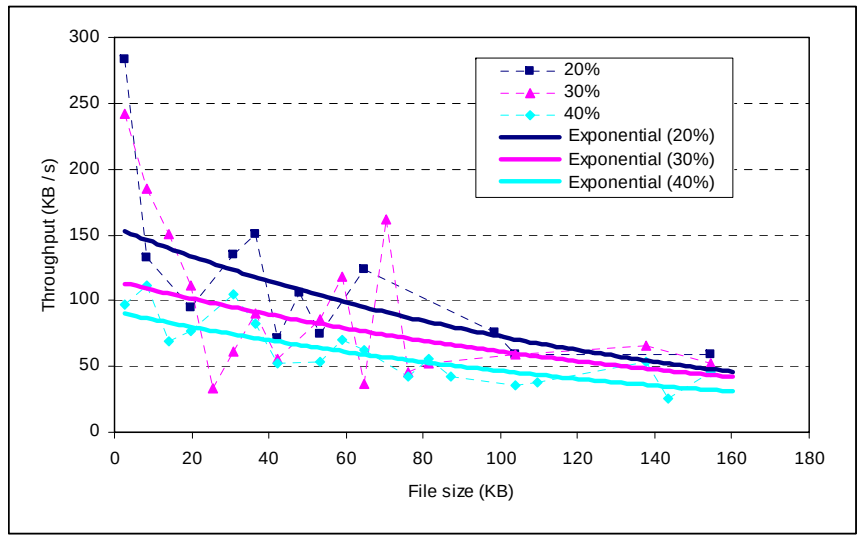
Negligible where native QoS differentiation exists



Arbitrarily large where no QoS differentiation exists

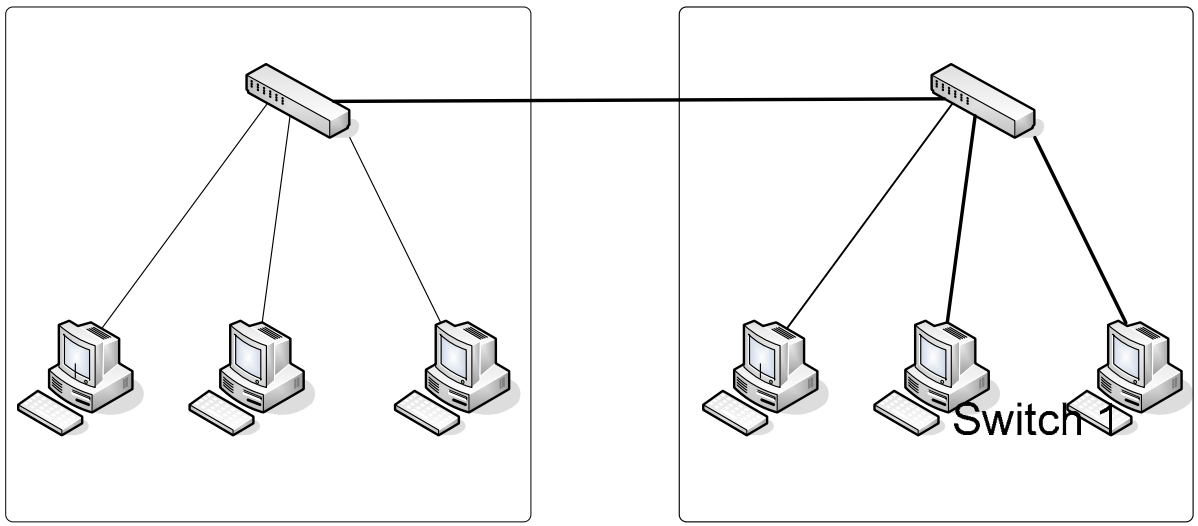
SiM-EuQoS-PTL: xDSL Results





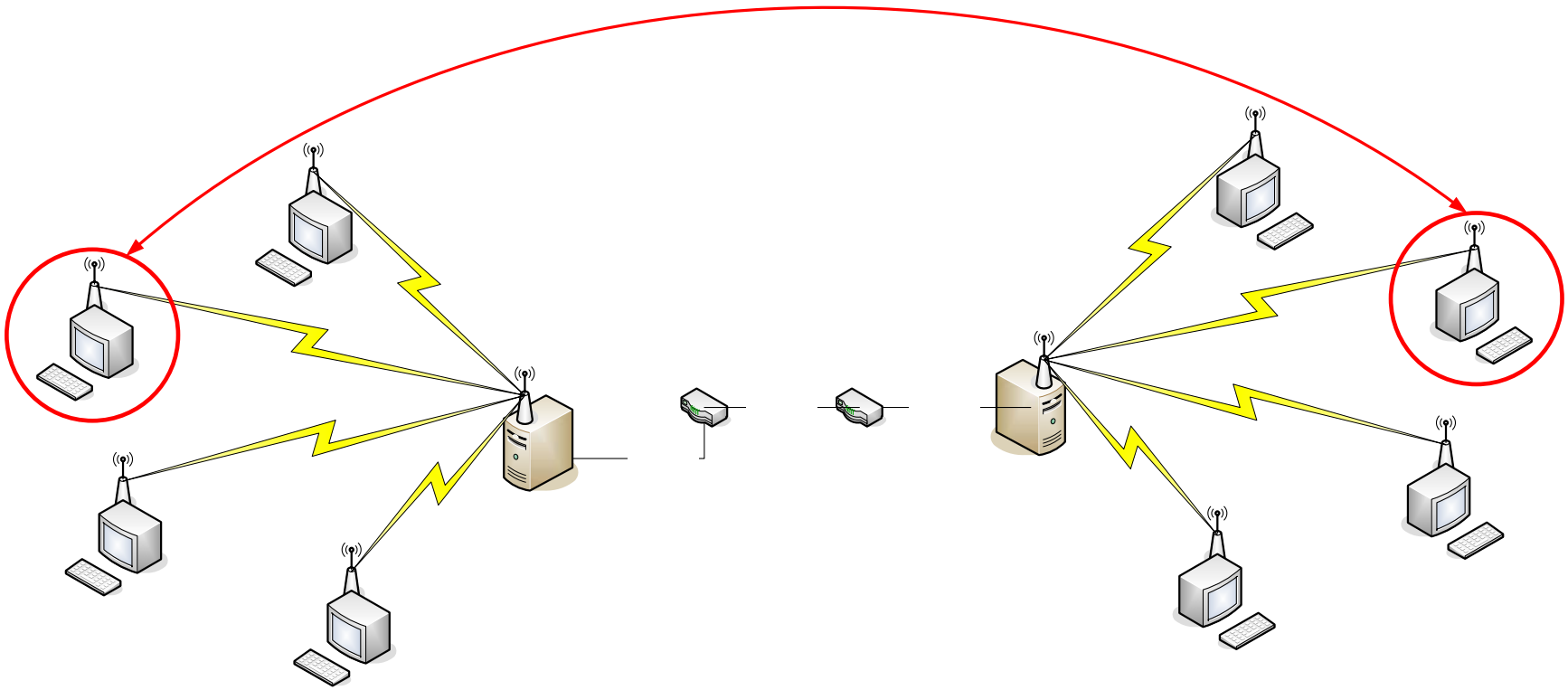
- The performance of CBR and VBR-nrt traffic depends on the amount of CBR traffic.
- Thus, AC algorithms for guaranteeing QoS are needed.

SiM-EuQoS-PTL: LAN



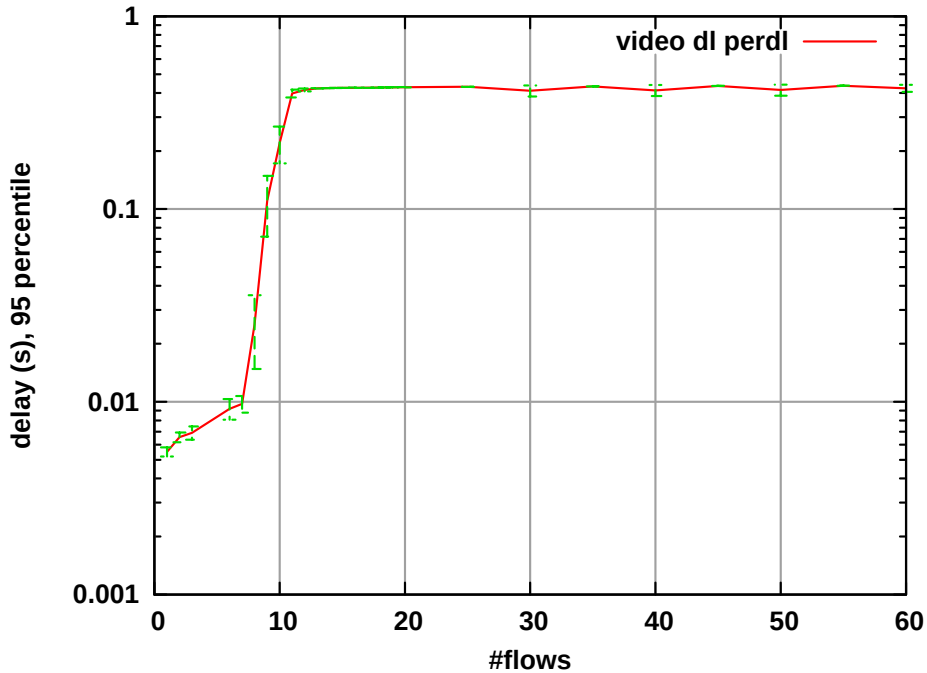
- SOHO scenario with full-duplex 10 Mbps links.
- QoS is supported by means of strict priority queueing.
- It is possible to provide EuQoS applications with full isolation from background traffic.

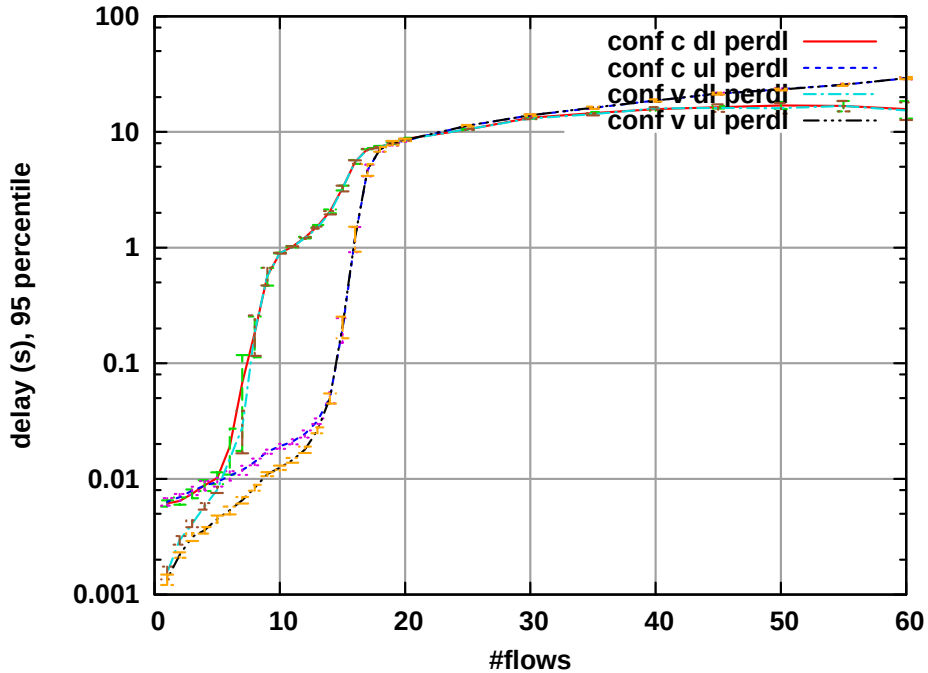
SiM-EuQoS-PTL: WiFi Description



- Two 802.11g @ 24 Mbps hot spots.
- No specific QoS mechanism has been simulated.

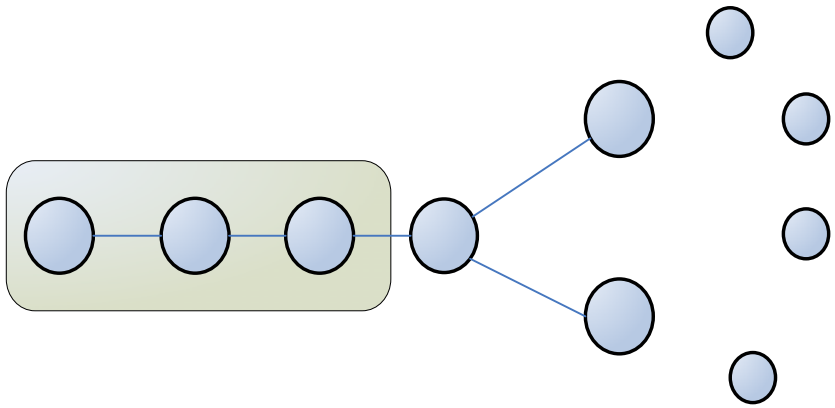
SiM-EuQoS-PTL: WiFi Results

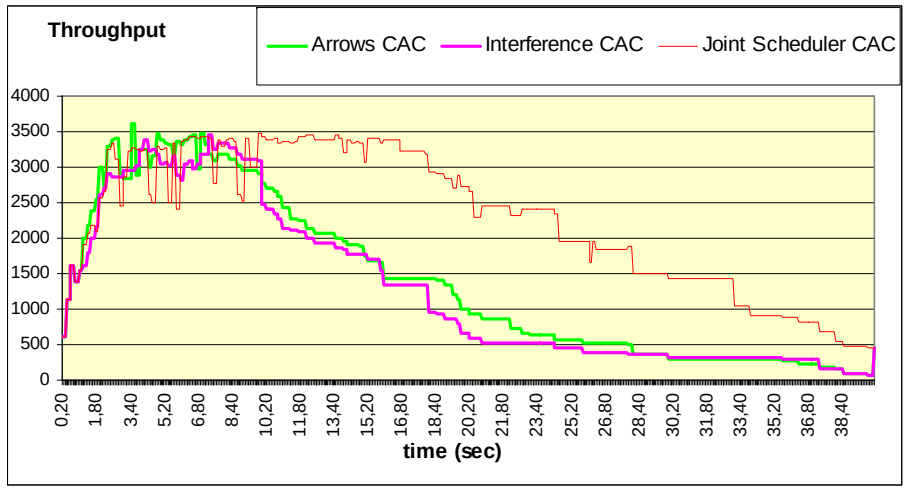




- Mixing QoS and non-QoS traffic leads to inacceptable performance degradation, even with low traffic.
- Special AC algorithms are needed.

Test specific QoS mechanisms: admission control in UMTS

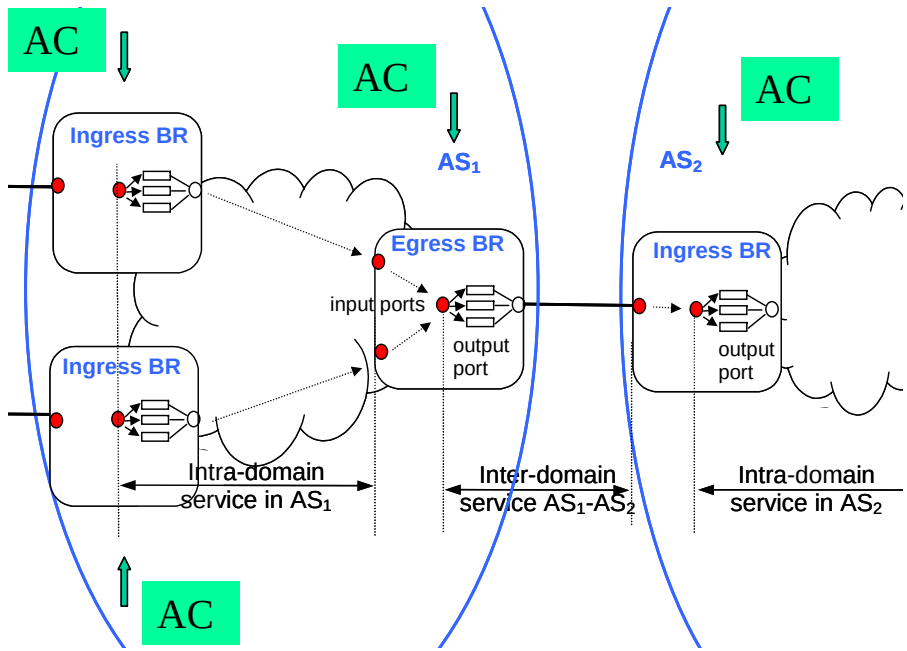




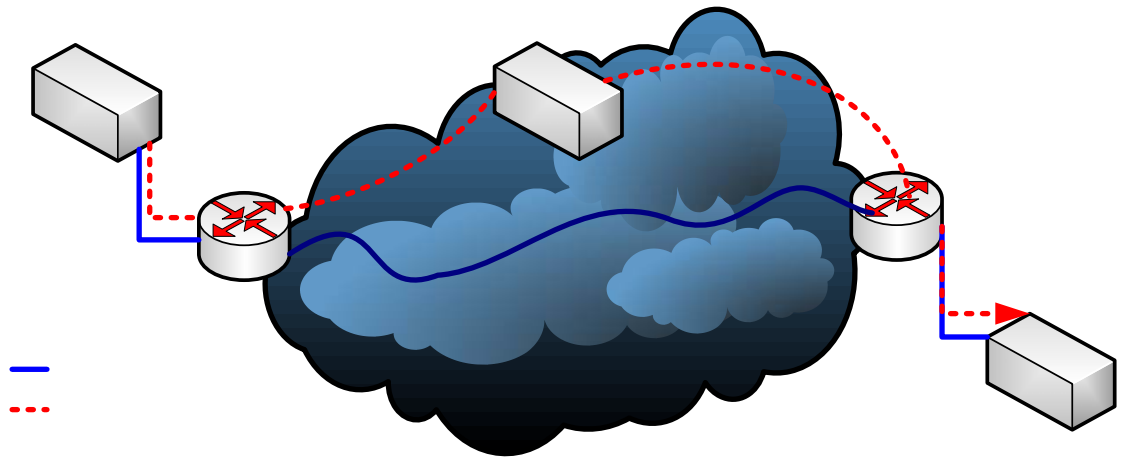
- Suburban environment mobility model for UEs.
- Node-Bs placed at 800m from each other.
- The bottleneck for providing QoS in UMTS is the UTRAN, for which special AC algorithms are needed.

SiM-EuQoS-PTL: IP Core

- Admission control performed online per flow.
- Router configuration on provisioning (long) time scale.
- No per-flow policing.
- AC algorithms based on enhanced rules for calculating admissible traffic load are needed.
- It is recommended for end-to-end simulations to test telephony CoS and video conference CoS as separated.



SiM-EuQoS-CIL



NE

NE /

- Implementation in the *Network Simulator 2*, based on the RSVP module.
- Current version:
  - UDP only;
  - simplified NSLP.

Sender

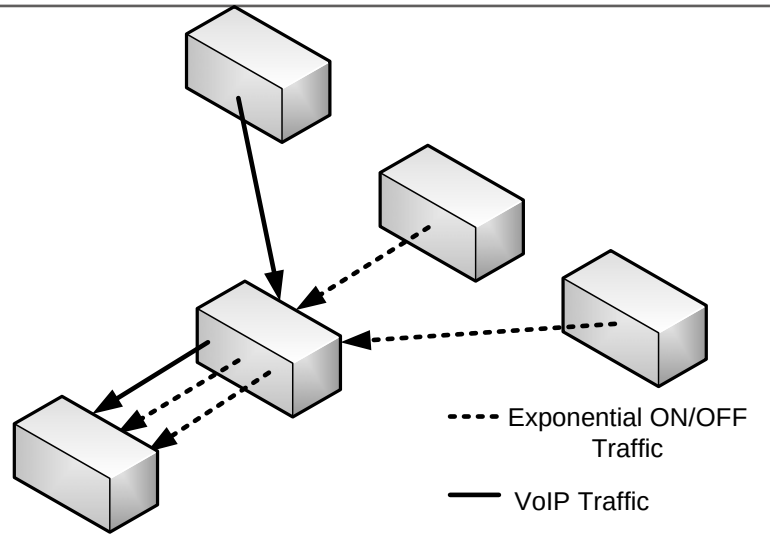
BR

DATA PATH

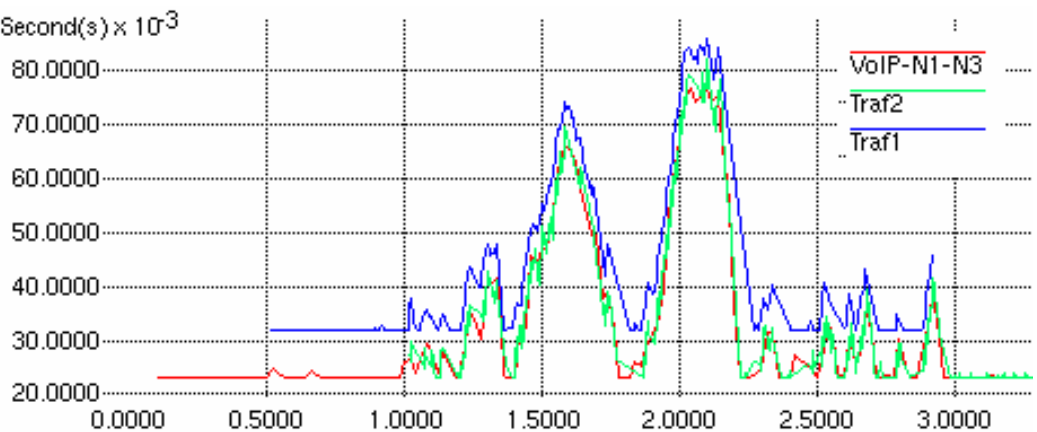
Signaling

SiM-EuQoS-CIL: Example of Results

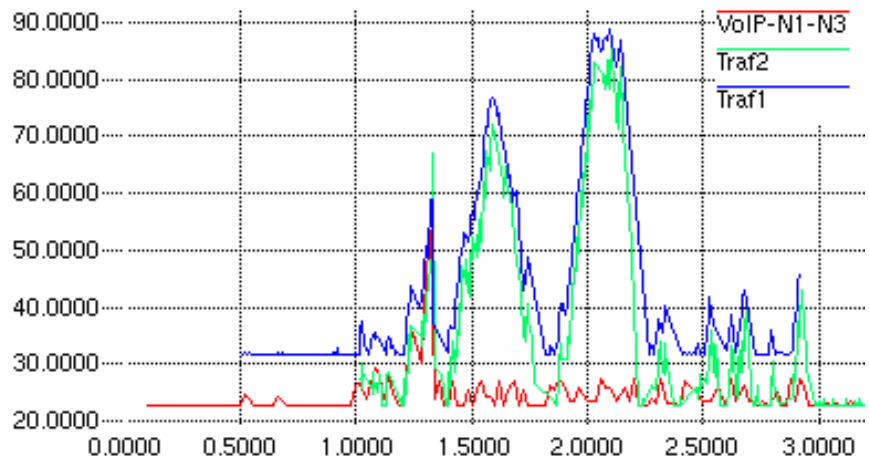
- SOHO scenario, with VoIP traffic.
- NSIS agents configure 802.11p priorities along the path.
- Advisable to carry NSIS messages as QoS traffic.



Without NSIS



With NSIS



SiM-EuQoS-PL (1): Objectives

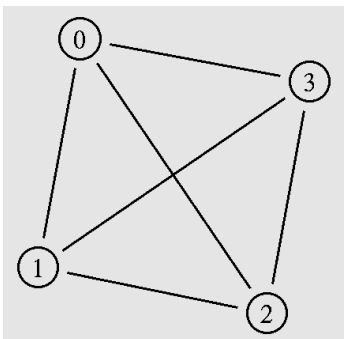
- **To evaluate the performance of EQ-BGP (convergence time, scalability), under:**

- announcement of previously unavailable network (route)
- withdrawing existing network (route)
- link or node failure (reliability)
- occurrence of route flapping
- degradation or improvement of QoS level offered by a given domain
- iBGP processing

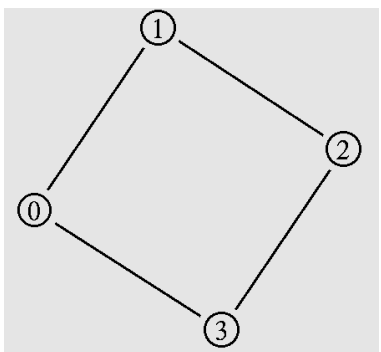
SiM-EuQoS-PL (2): Assumptions

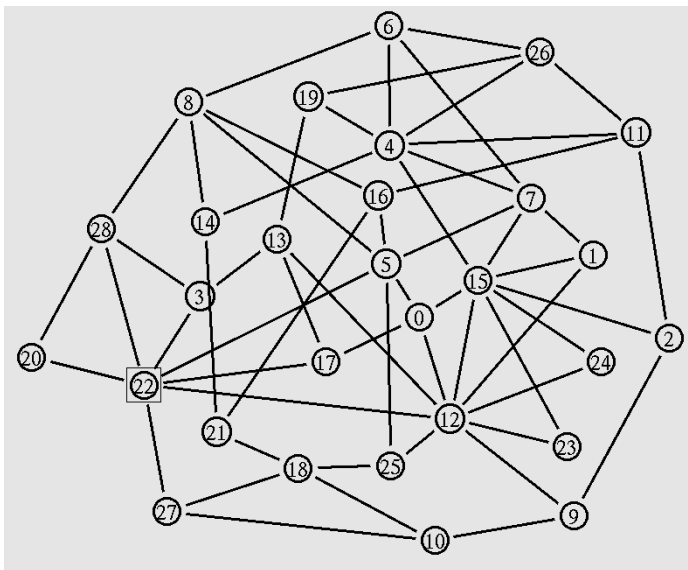
- fixed values of QoS offered by ASs
- different „QoS assembling” functions (delay losses, jitter)
- different decision algorithms
- different network topologies and size (4, 11, 20, 29, ASs)

full mesh

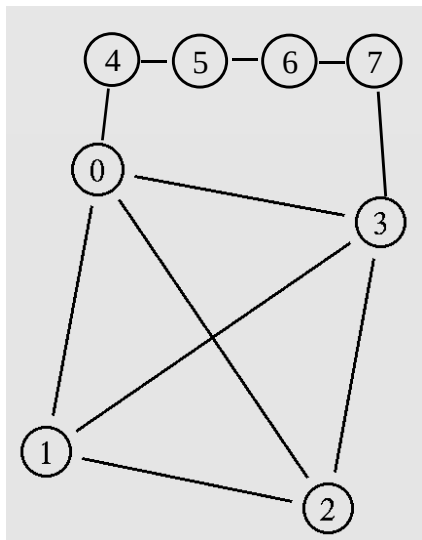


ring





Internet driven topology



B-clique

SiM-EuQoS-PL (3): Simulation tool

- NS2 with enhanced ns-BGP module:
  - QoS-NLRI attribute
  - new decision algorithm replacing AS path length by „cumulative" value of QoS
  - an algorithm for assembling QoS (calculating „cumulative" value of QoS

```
advertise start node 1 route 10.0.1.0/24
1.78075 send 1 -> 2 wds: -  ads: 10.0.1.0/24 (1)  3
1.78075 send 1 -> 0 wds: -  ads: 10.0.1.0/24 (1)  3
1.78252 rcv 2 <- 1 wds: -  ads: 10.0.1.0/24 (1)  3
1.78252 send 2 -> 3 wds: -  ads: 10.0.1.0/24 (2 1)  13
1.78252 rcv 0 <- 1 wds: -  ads: 10.0.1.0/24 (1)  3
1.78252 send 0 -> 3 wds: -  ads: 10.0.1.0/24 (0 1)  12
1.78431 rcv 3 <- 2 wds: -  ads: 10.0.1.0/24 (2 1)  13
1.78431 send 3 -> 0 wds: -  ads: 10.0.1.0/24 (3 2 1)  20
1.78431 rcv 3 <- 0 wds: -  ads: 10.0.1.0/24 (0 1)  12
1.78431 send 3 -> 0 wds: 10.0.1.0/24  ads: -
```

SiM-EuQoS-PL (4): Summary and conclusions

- EQ-BGP gives a stable routing establishing the e2e QoS paths
- The convergence time is at the similar level as in case of BGP-4, however:
  - It is longer after route advertisement
  - It is shorter after route withdrawal
- EQ-BGP protocol needs to exchange a large number of messages
- Further studies are required!

Conclusions and future work

- For the time being:
  - The software tools (with full documentation) for evaluating different aspects related to EuQoS architecture and QoS framework were developed.
  - Preliminary simulation results were collected and guidelines for other WPs have been devised.
    - Experimental limits to CAC algorithms evaluated
- Most exhaustive simulation studies will be performed, to be included in the next version of D2.1.2.
  - Take into account newly defined EuQoS CoS and apply QoS mechanisms

Thanks for your attention.

Comments or questions?