



Time series based simulation

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Overview



- **Motivation**
- **Domain model & border routers**
- **Representing traffic by time series**
- **Border router models**
- **Comparison to ns2**
- **Conclusion**



Motivation



- **InterMON project:**
 - **Advanced architecture for INTER-domain quality of service MONitoring, modelling and visualisation**
 - **Working in broadband environment**
 - **Modelling inter-domain traffic**
 - **Simulating inter-domain scenarios**



Motivation



- **'Classical' simulators:**
 - **Packet based method (ns2)**
 - Offers detailed analysis on packet level
 - Operates on a low abstraction level
 - May be too detailed
 - Simulation time can be long
 - **Fluid flow simulators**
 - Higher abstraction level (flow level)
 - Use analytical models
 - Event driven \Rightarrow simulation time can be too long



Objectives

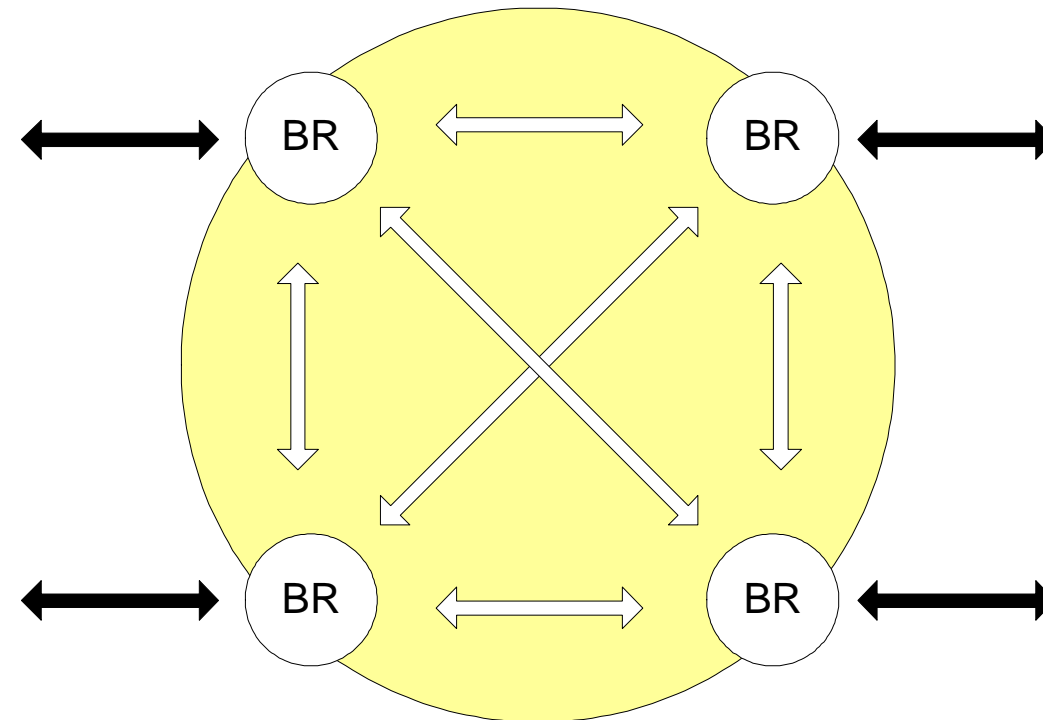


To propose a simulator architecture that

- **operates on aggregate level;**
- **the simulation time does not depend on the volume or the variability of the traffic (not event but time driven);**

Domain model

- No need to simulate internal behaviour
- Only border routers are modelled

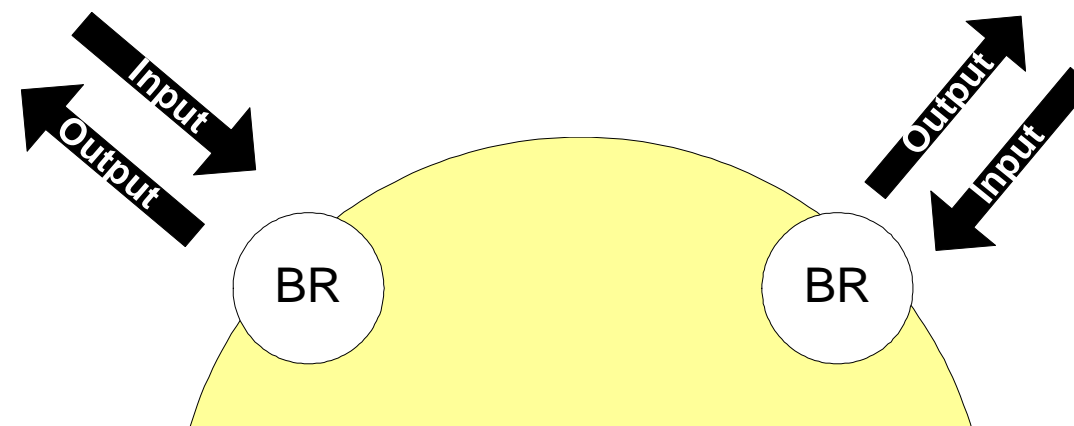




Border routers



- **Two kinds of traffic:**
 - Traffic that enters into the domain
 - Traffic that leaves the domain





Input traffic



- **Not treated by any router model**
- **Directed towards the other border routers**
 - **Some kind of 'aggregate' routing information**
 - **Route changes or link failures can be simulated by changing the distribution values**



Output traffic



- **Treated by 'router models' that**
 - **realize the effect of a real router on the traffic**
 - Rate constraint
 - Drop
 - Delay
 - ...
 - **could be:**
 - Simulated model
 - Analytical model
 - Soft-computing model



Traffic model



- **Time series:**

<time> <load>

<time> <load>

...

- **Can be:**

- Measured data
- Generated data (by a traffic model)
- Predicted by ARIMA



Traffic distribution



- **Time series**

	<router[1]>	<router[2]>	<router[N]>
<time>	<portion[1]>	<portion[2]>	<portion[N]>

...

$$\sum_1^N portion[i] = 1$$

- **Can be:**
 - **Measured**
 - **Generated**



Class based traffic



- **Time series:**

<time> <load_class[1]> <load_class[2]> <load_class[3]>

<time> ...

...

- **Can be**

- Measured
- Generated
- Predicted



QoS state



- **Time series:**

<time> <throughput> <drop> <delay>

<time> ...

...

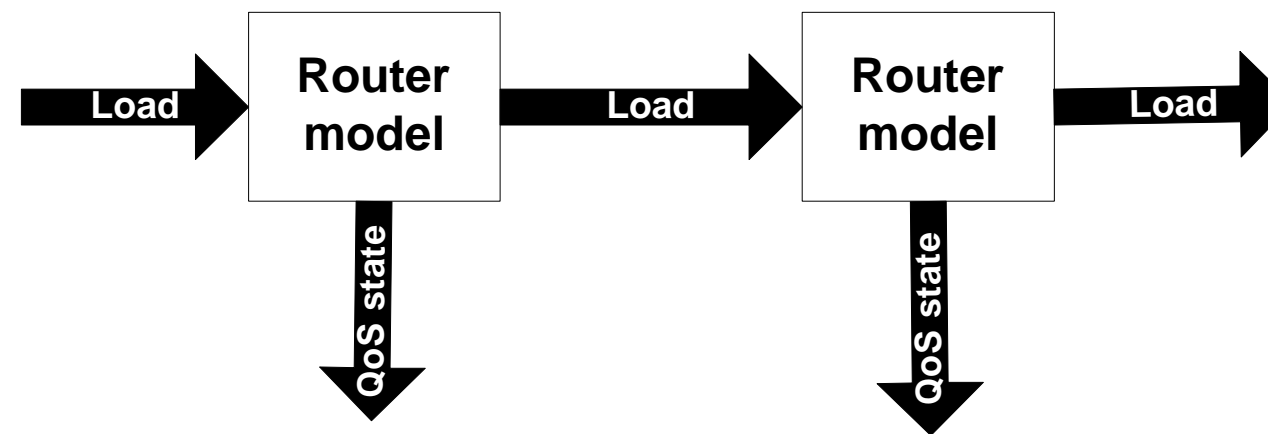
- **Generated by router models**
- **E2e QoS can be computed**



Router models

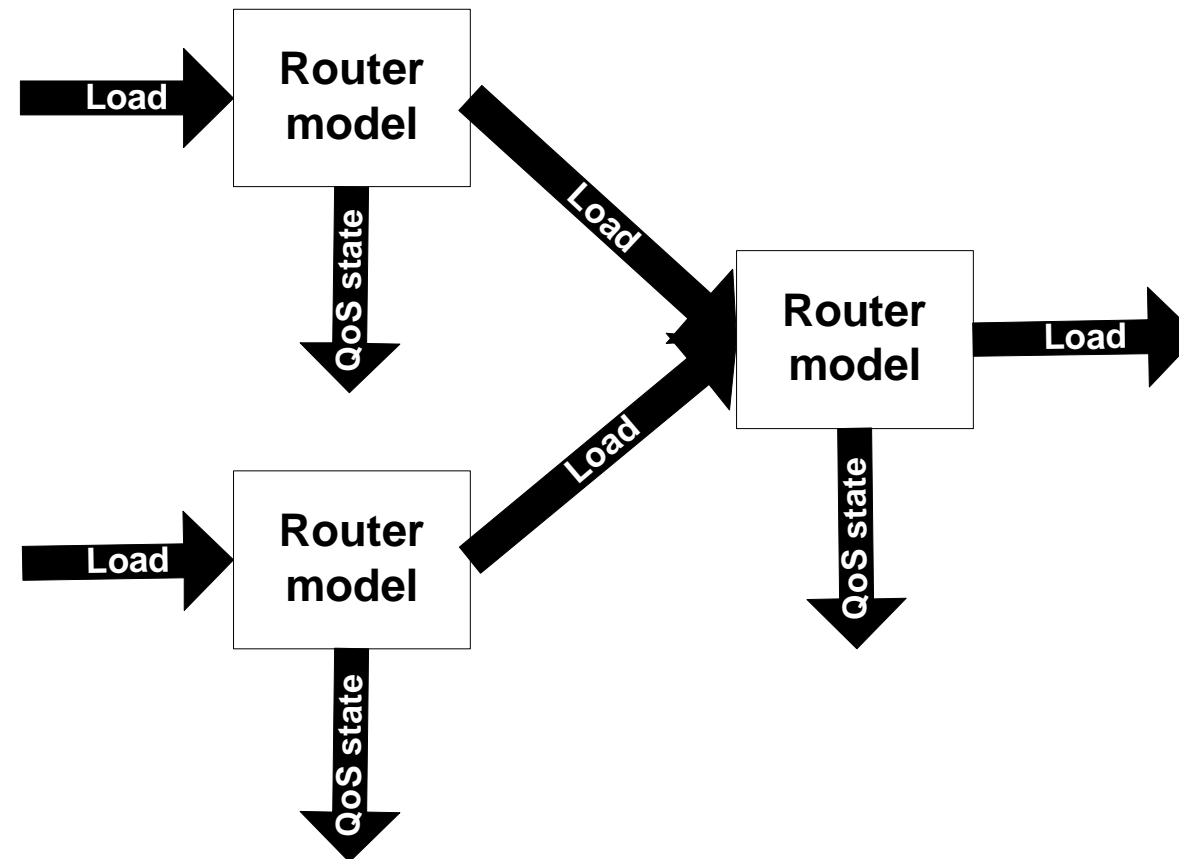


- Processes time series
- Input: time series (load)
- Output: time series (load + state)



Topology constraint

- Only tree – no directed circles allowed





Router models



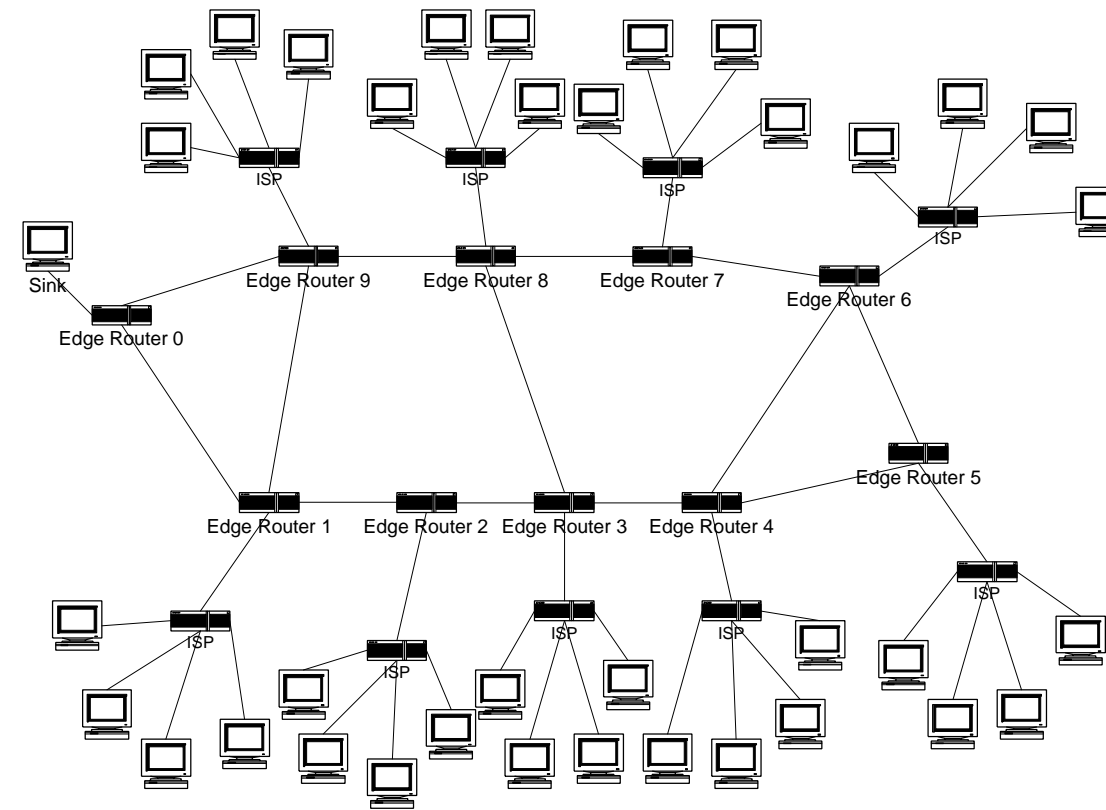
- **Simulated model (tried)**
 - 1 server with a buffer
- **Analytical model**
- **Soft-computing model (under development)**



Ns2 test scenario



- **Topology:**





Comparison



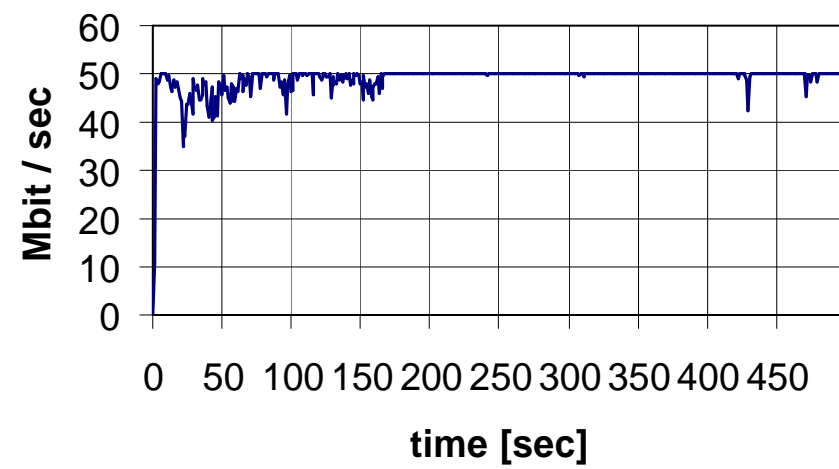
- The backbone is simulated by tssim
 - Traffic Ü ns2 'queueMonitor'
- Compared:
 - Throughput
 - Drop
 - Delay



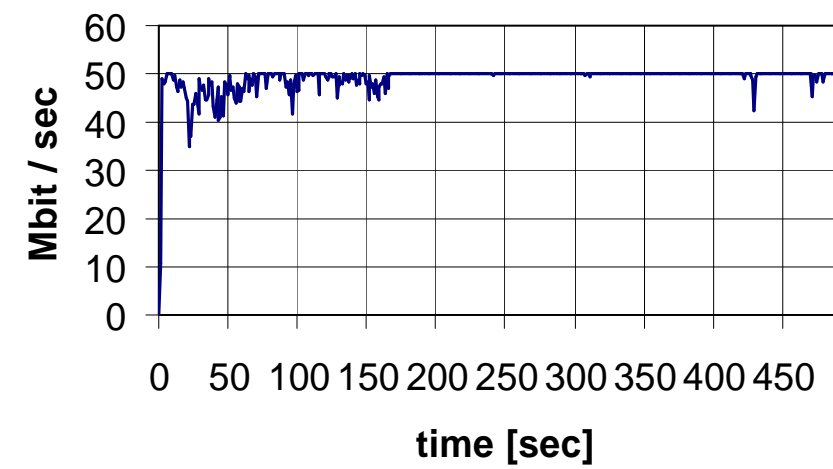
Throughput



Ns2



tssim



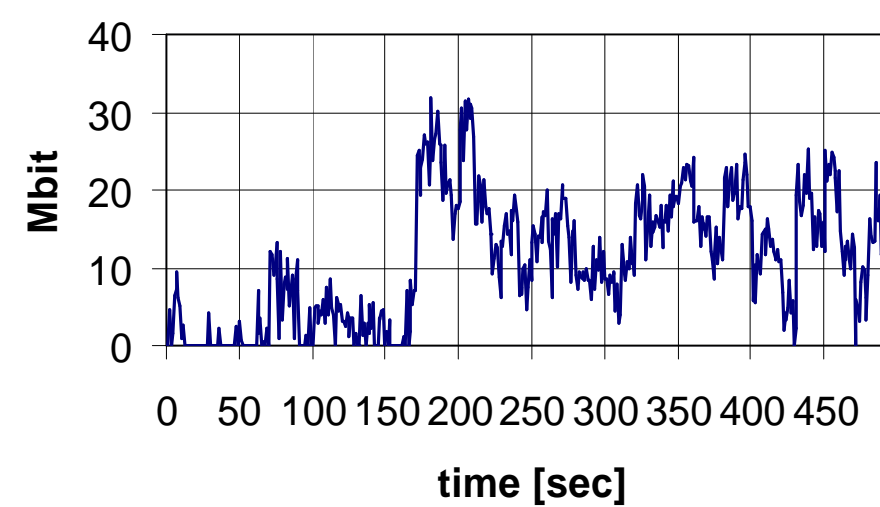
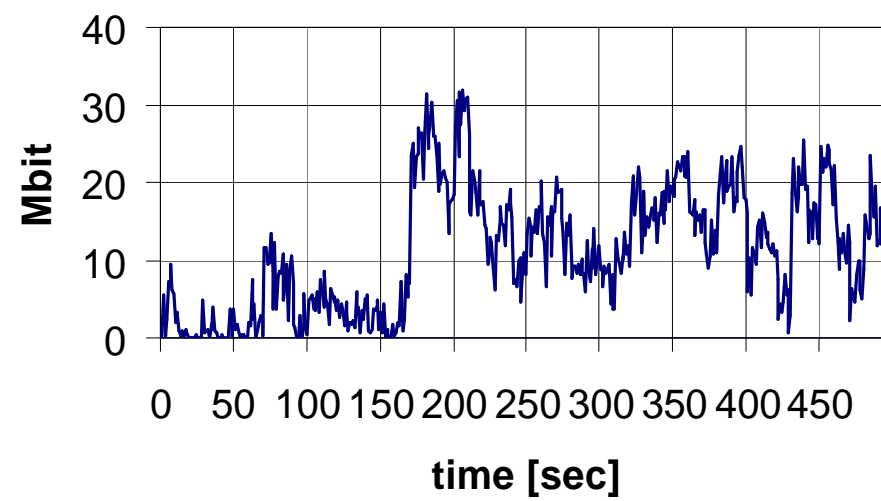


Drop



Ns2

tssim



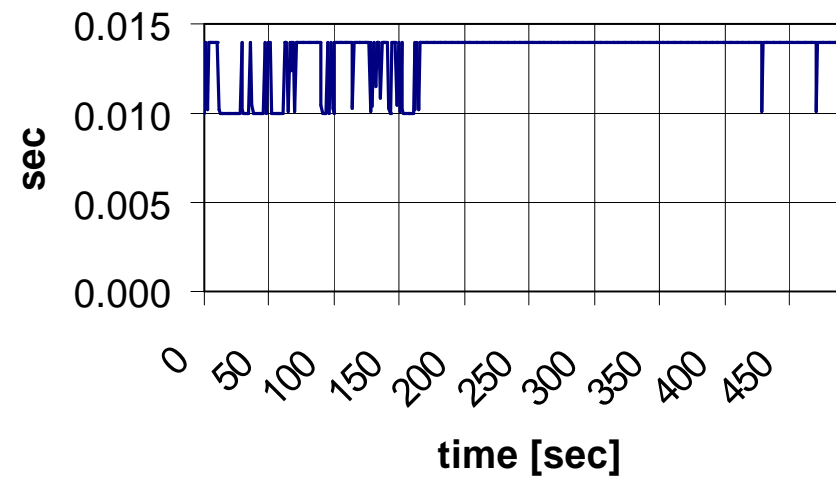
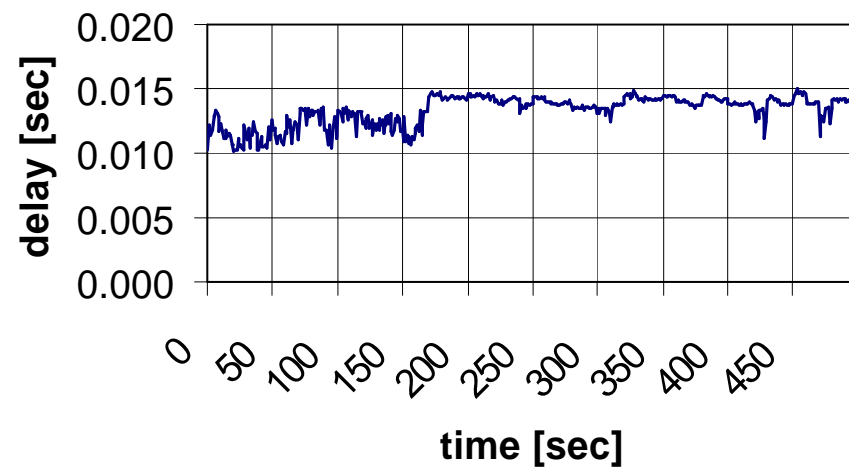


Delay



Ns2

tssim





Conclusion



- **The proposed time series based simulation architecture works on a high abstraction level (aggregate or classes).**
- **Information: time series (load, state).**
- **Simulation time depends: length of time series (simulated time) * border routers; (no bandwidth dependency).**