

An Evaluation of Network Response Time using a Coloured Petri Net Model of Switched LAN

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Abstract

The enterprise class model of switched LAN in the form of a coloured Petri net is represented. The components of the model are switches, servers and workstations. For the evaluation of network response time a special measuring workstation model is proposed. It counts response times for each request and calculates the average response time. For the simulation of network behaviour and accumulation of statistical information, CPN Tools was applied. Hierarchical nets usage allows the convenient representation of an arbitrary given structure of LAN.

Keywords: LAN; Switch; Response time; Colored Petri net; Evaluatio

Keep it simple...

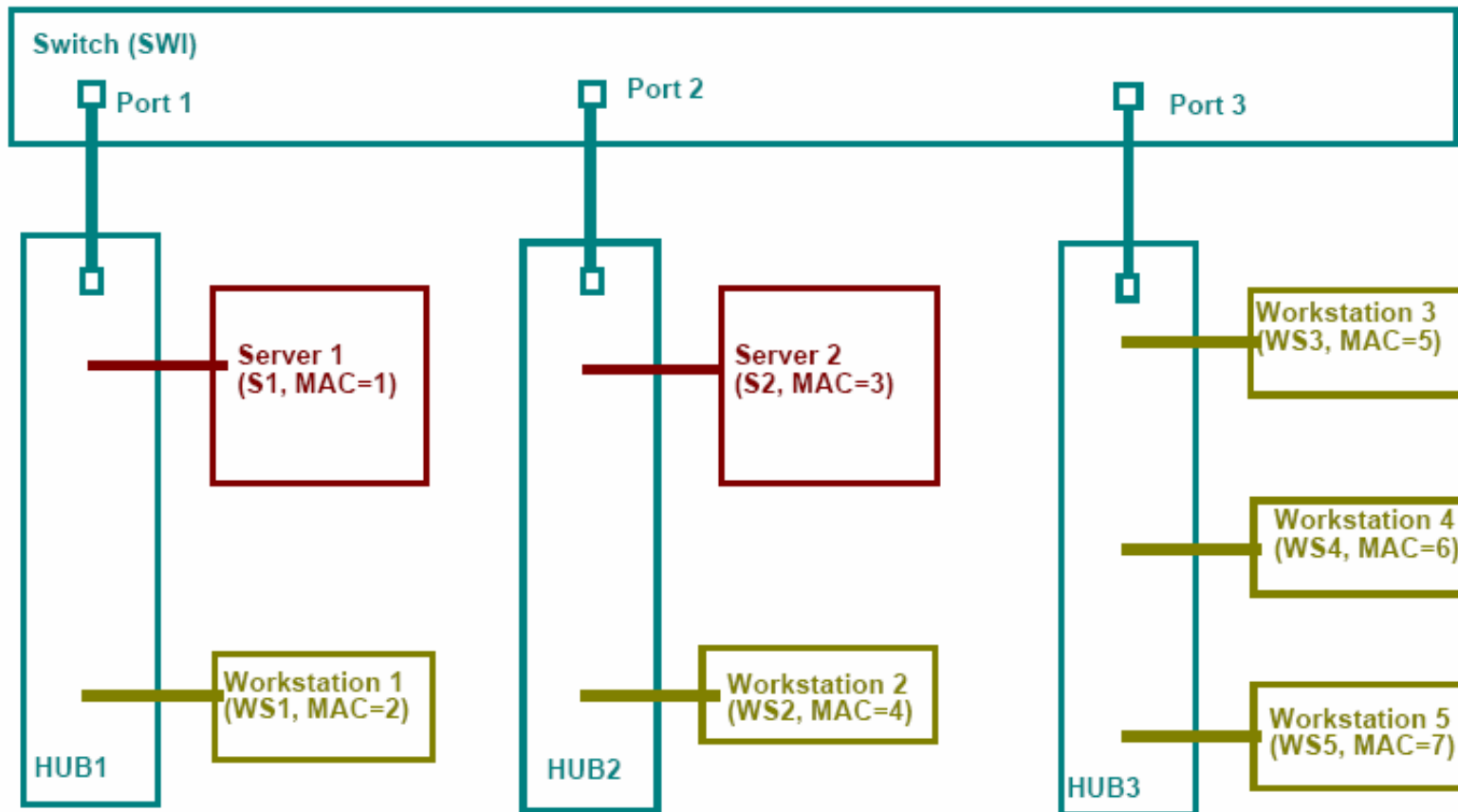
- Scheme of LAN
- Model
- Components – sub models of: Switch, Workstation, Server

- Characteristics of hardware and software
- Parameters of model

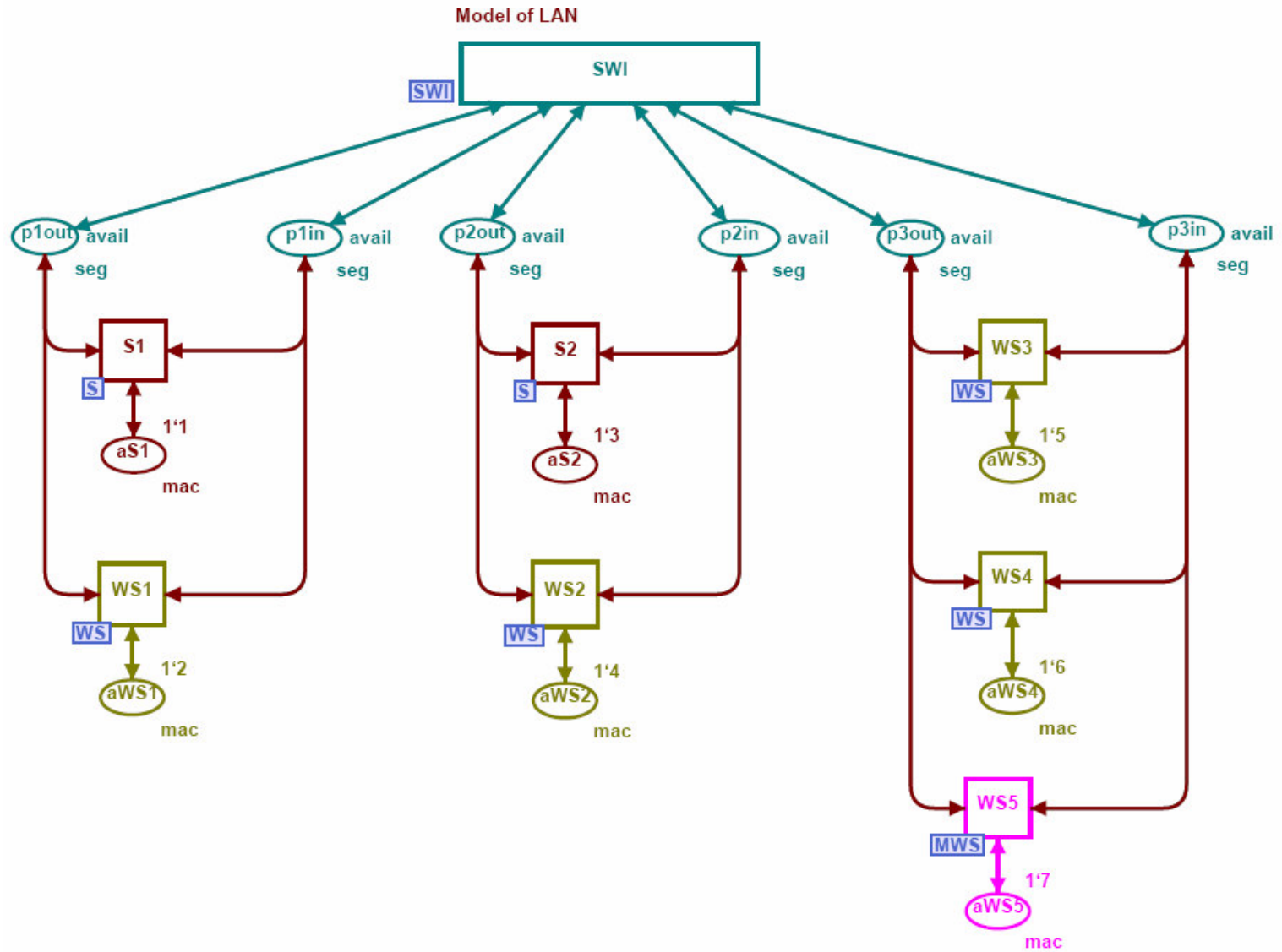
- Measuring Workstation
- Simulation
- Evaluation of network response time
- Steady-state conditions

Scheme of sample switched LAN

Scheme of sample switched LAN



Model of sample LAN

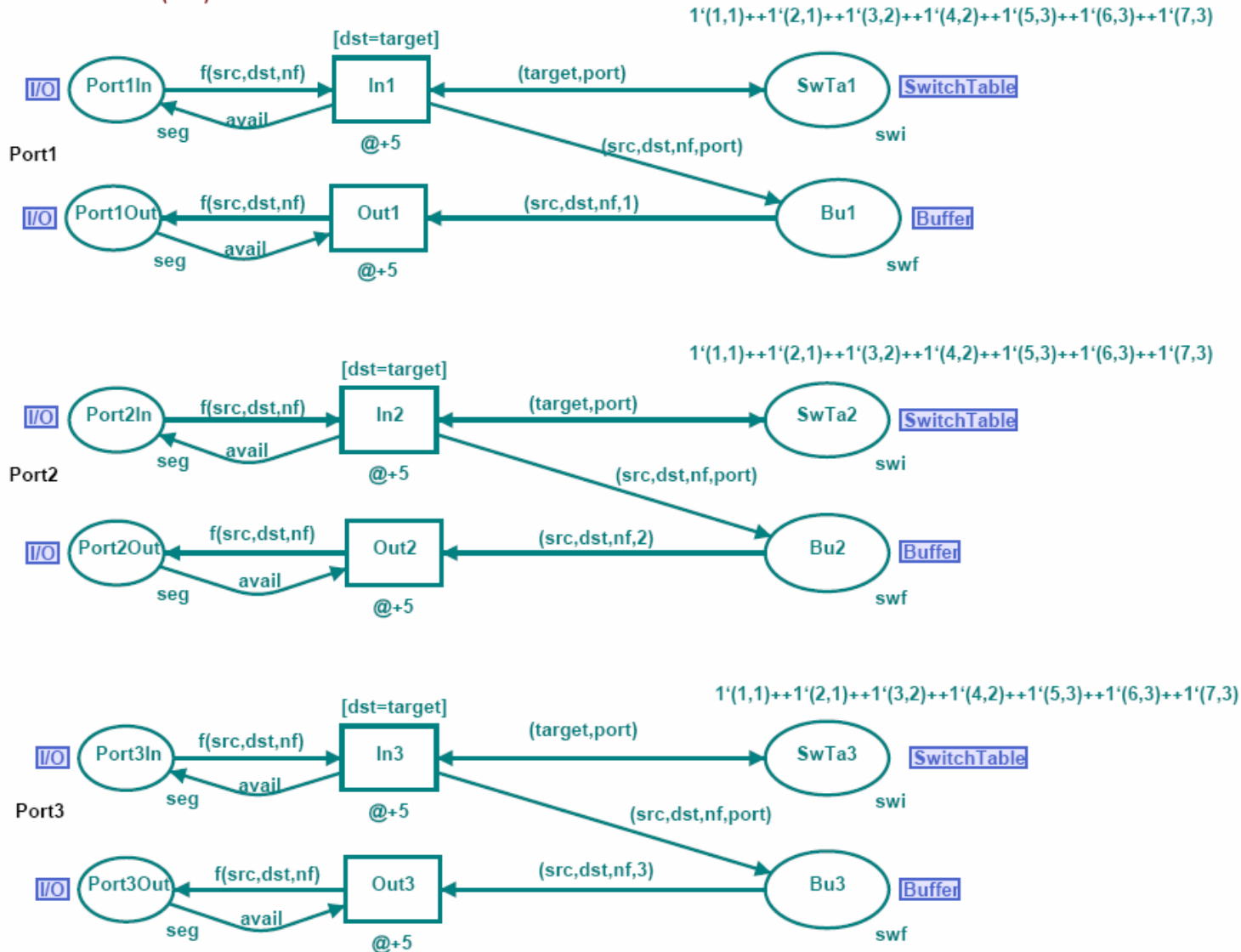


Declarations

```
color mac = INT timed;  
color portnum = INT;  
color nfrm = INT;  
color sfrm = product nfrm * INT timed;  
color frm = product mac * mac * nfrm timed;  
color seg = union f:frm + avail timed;  
color swi = product mac * portnum;  
color swf = product mac * mac * nfrm * portnum timed;  
color remsv = product mac * nfrm timed;  
var src, dst, target: mac;  
var port: portnum;  
var nf, rnf: nfrm;  
var t1, t2, s, q, r: INT;  
color Delta = int with 1000..2000;  
fun Delay() = Delta.ran();  
color dex = int with 100..200;  
fun Dexec() = dex.ran();  
color dse = int with 10..20;  
fun Dsend() = dse.ran();  
color nse = int with 10..20;  
fun Nsend() = nse.ran();  
fun cT()=IntInf.toInt(!CPN'Time.model_time)
```

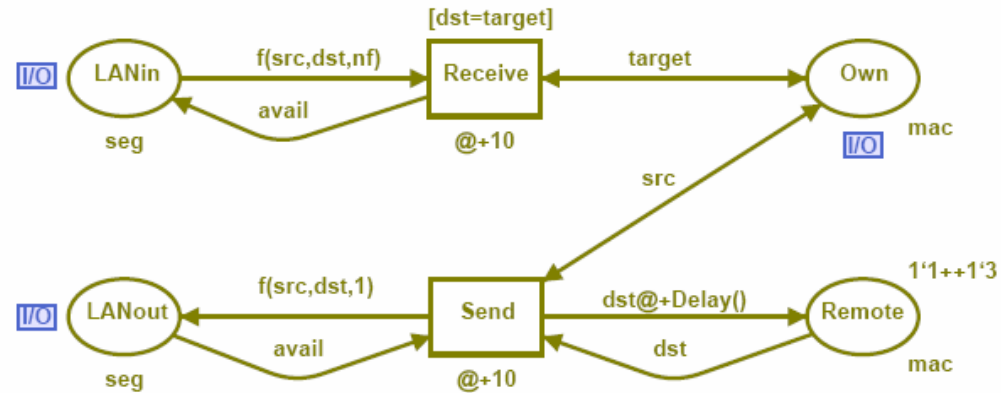
Model of switch

Model of Switch (SWI)

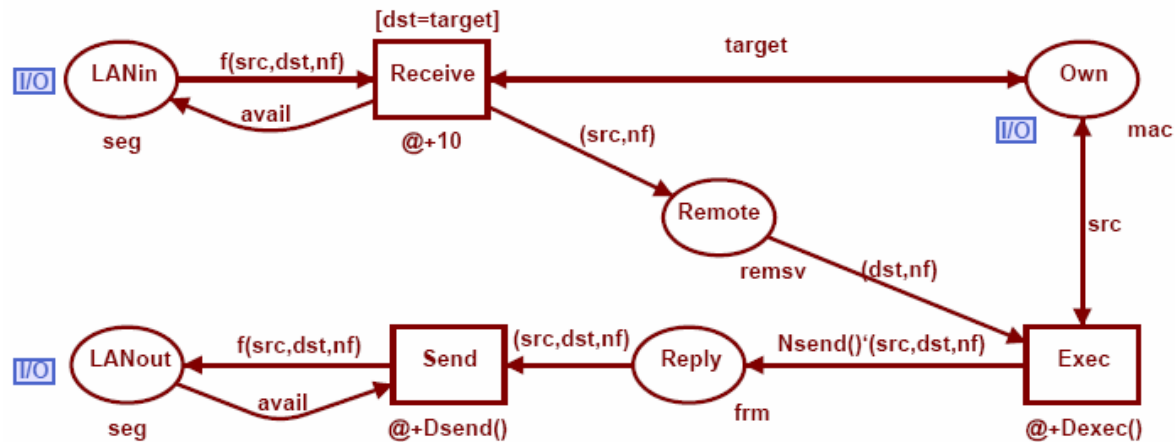


Models of Workstation and Server

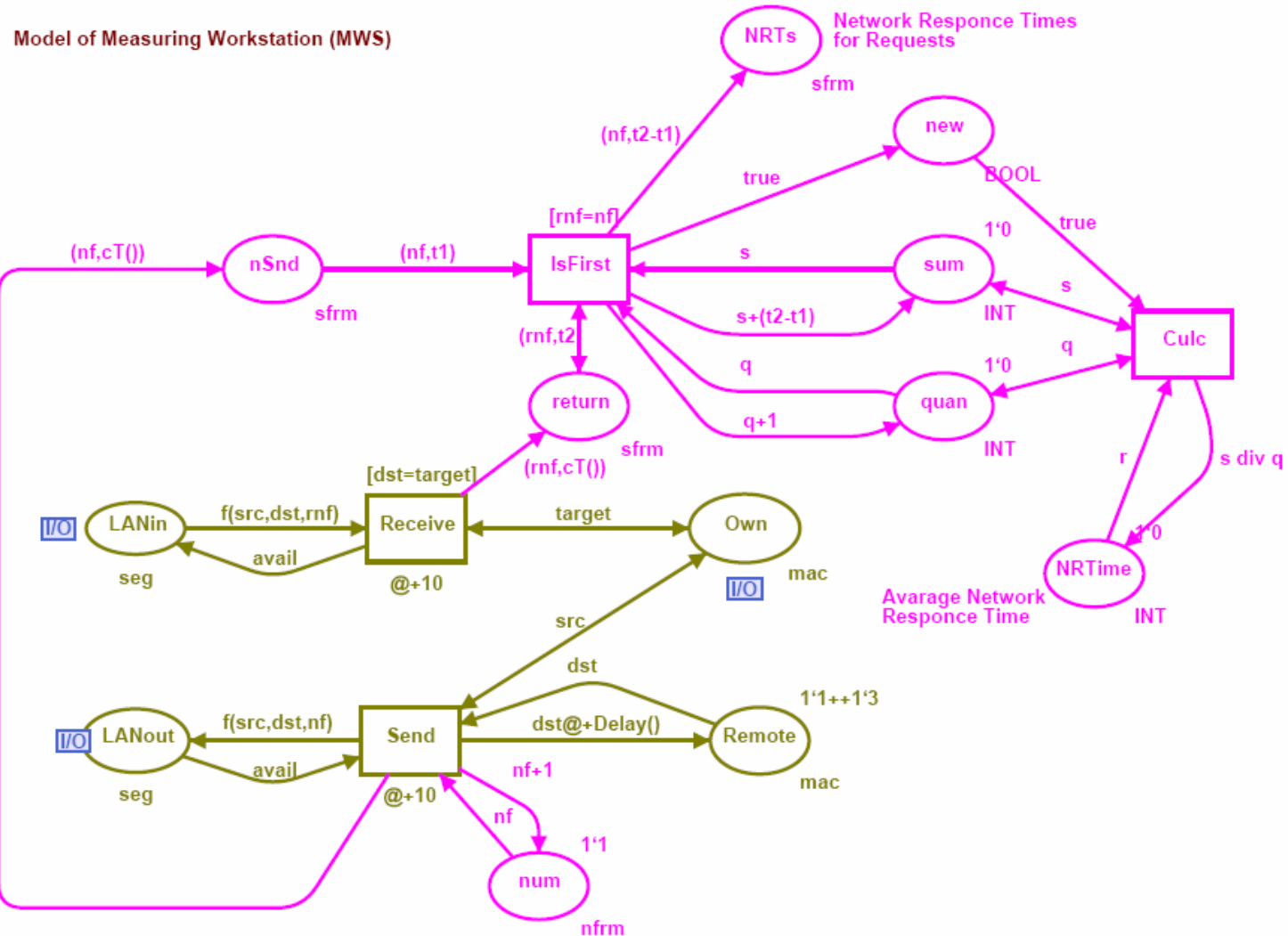
Model of Workstation (WS)



Model of Server (S)



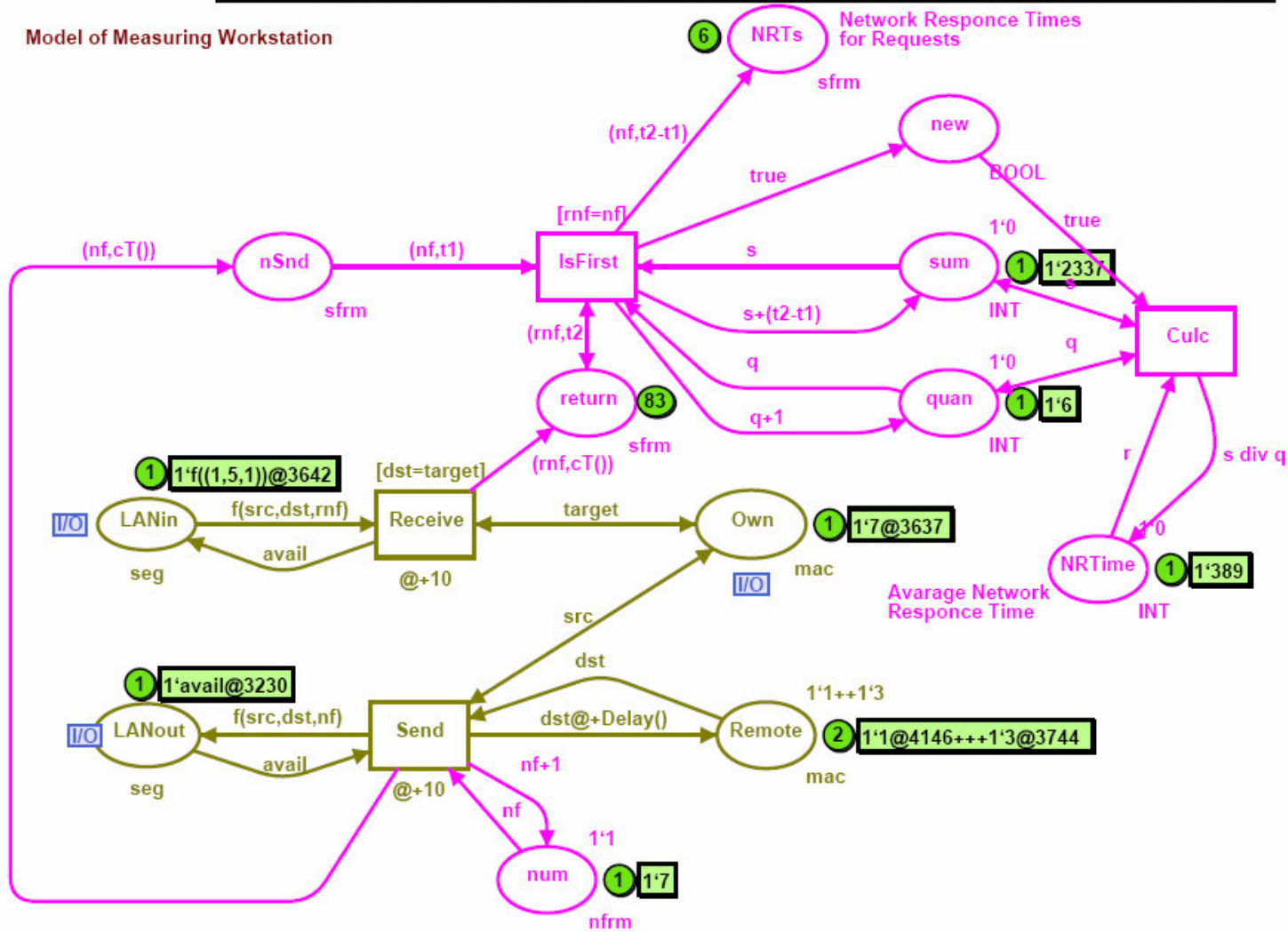
Model of Measuring Workstation



Estimation of network response time

1'(1,202)@212+++1'(2,737)@807+++1'(3,181)@1450+++1'(4,684)@2230+++1'(5,235)@2550+++1'(6,298)@3393

Model of Measuring Workstation



Parameters of model

Table 1. Types of hardware

Device	Type
LAN adapter	Intel EtherExpress 10/100
LAN switch	Intel SS101TX8EU
Server	HP Brio BA600
Workstation	HP Brio BA200

Software – railway CAM system GID Ural.

Table 2. Parameters of model

Parameter	Variable/Element	Real value	Model value
LAN switch read frame delay	In*	500 ns	5
LAN switch write frame delay	Out*	500 ns	5
LAN adapter read frame delay	Receive	1 ms	10
LAN adapter write frame delay	Send	1 ms	10
Server's time of request processing	Dex	10-20 ms	100-200
Client's delay between requests	Delta	100-200 ms	1000-2000
Length of request		1.2 Kb	1
Length of response	Nse	15-30 Kb	10-20

MTU (Unit of Model Time) = 100 ns.

Result: Network Response Time = 389 MTU or about 39 ms.

Conclusion

In the present work the technology of switched local area networks' models development was studied. The usage of coloured Petri nets allows the peculiarity of interaction within the client-server systems to be taken into account. The model reflects the major features of a real-life network. CSMA procedures, full-duplex mode and switching tables were modelled. A special measuring model of workstation was suggested and implemented to estimate the network response time.

The model developed is of enterprise class, so it allows easy and convenient adequate representation of LAN with an arbitrary given topology. The technique described is aimed at real-time applications, requiring the precise estimation of timed delays before implementation.