



Single and Dual Transit Buffer Interactions

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Goals

- **Standard shall allow single and dual transit path implementations**
- **Same Fairness algorithm shall be used for both**
- **Nodes should interoperate with minimum effects on fairness, utilization and HP delay jitter**

Requirements for Single Buffer

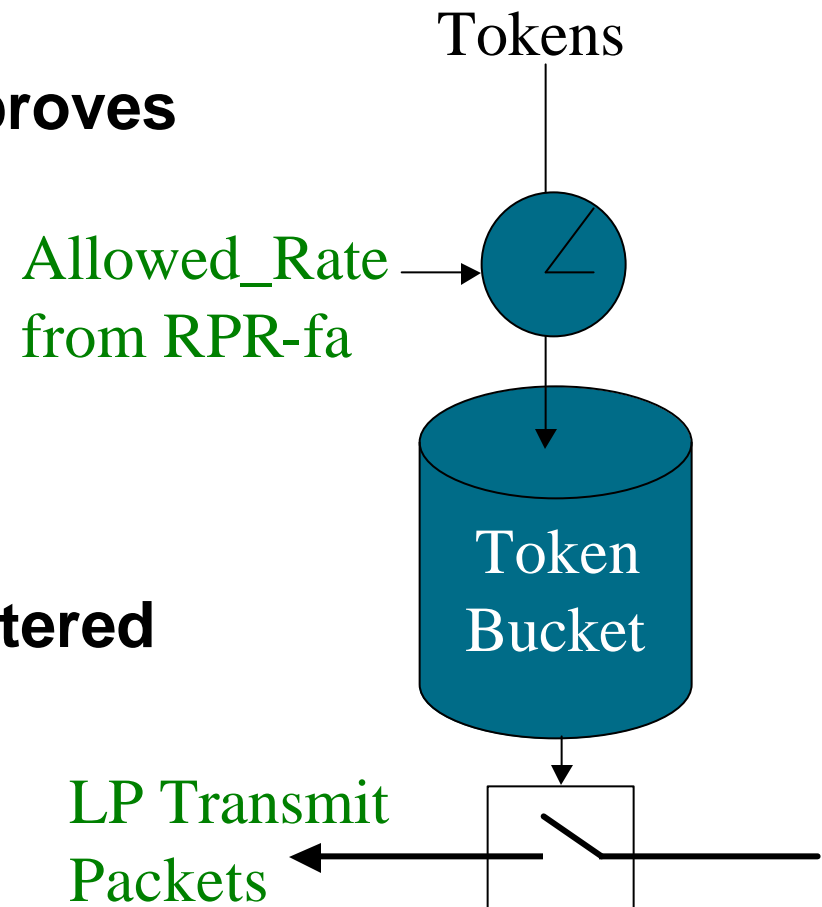
- **Basic RPR fairness scheme**
- **Congestion detection:**
 - Ingress HoL timer expires
 - Link utilization threshold reached
- **Dynamic rate shapers on add traffic**
- **Rate Limiter on low priority add traffic**

Congestion Triggers

- **Link Util and HOL timer based**
 - **Byte counter on outgoing link (*util_cnt*)**
 - **Low pass filtered:**
$$lp_util_cnt = lp_util_cnt + (util_cnt - lp_util_cnt) / k$$
 - **Congestion state entered when:**
 - $lp_util_cnt > (high_congestion_th * LRATE)$
 - OR
 - *HOL Timer on add path expires*
 - **Congestion state left when:**
 - $lp_util_cnt < (low_congestion_th * LRATE)$

Dynamic Rate Shaper

- Smooths bursts thus improves delay jitter
- Simple leaky bucket
- Rate based on low pass filtered RPR-fa *allowed_rate* value

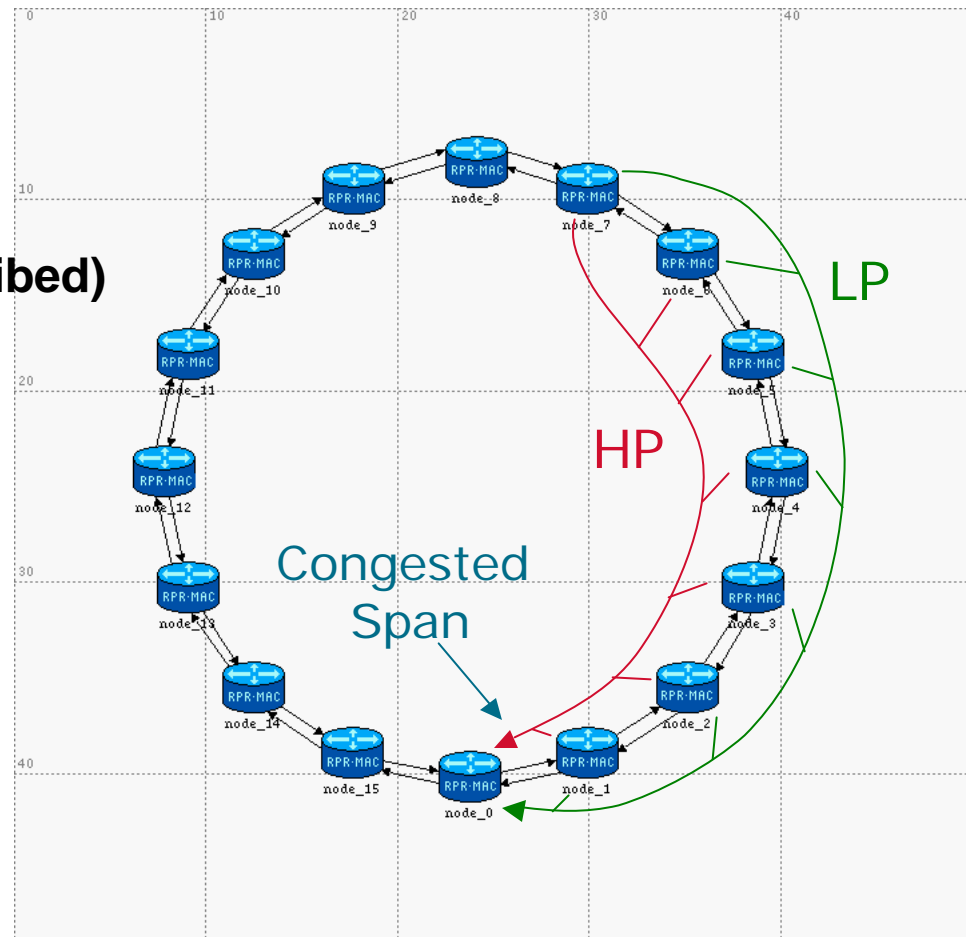


Fixed Rate Limiter

- **Reserves percentage of outgoing link**
 - Needed to ensure packet train does not stall HP add traffic for long periods of time on SPB nodes
- **Single Pass-through Buffer (SPB) implementation**
 - Limits LP add traffic if: $util_counter > pct * LR$
- **Dual Pass-through Buffer (DPB) implementation**
 - Limits LP add traffic & LP passthrough traffic.

Scenarios

- 16 node, 100Km, OC12 dual ring
- Packet size: 64B(%60), 512B(%20), 1518B(%20)
- Each node sources:
 - 31.3Mbps HP
 - Starts at 0.22s
 - 711Mbps LP (oversubscribed)
 - Starts at 0.2s
- Single PB
 - Tb = 32KB
- Dual PB
 - HTb = 32KB
 - LTb = 256KB
- Last span congested
 - 35% HP

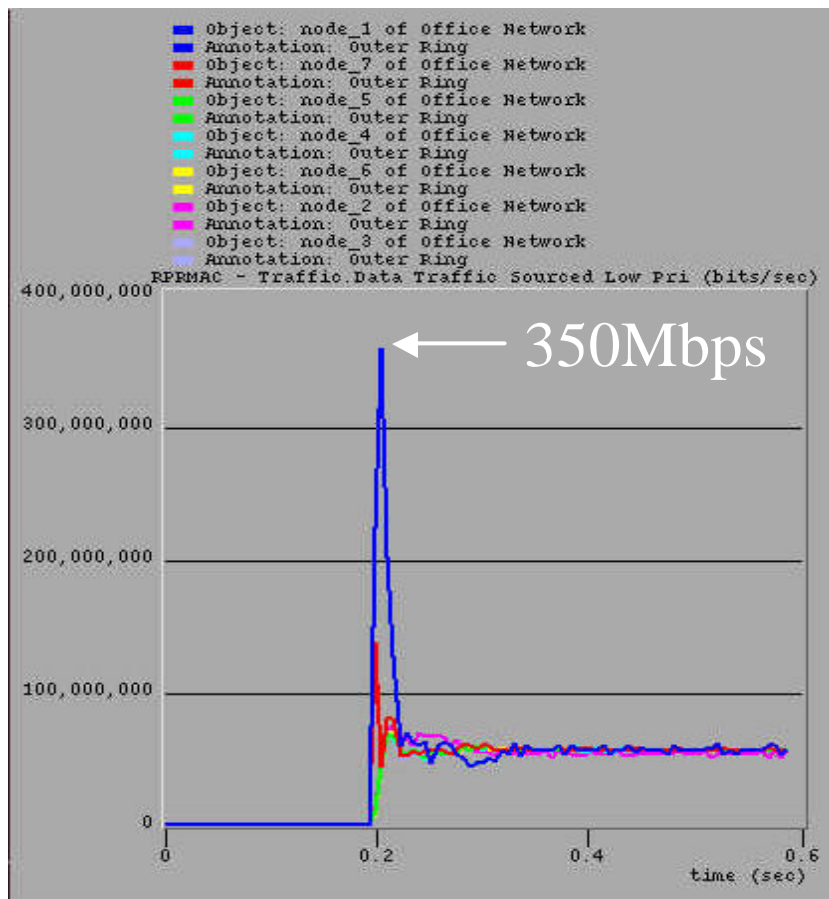


Configurations

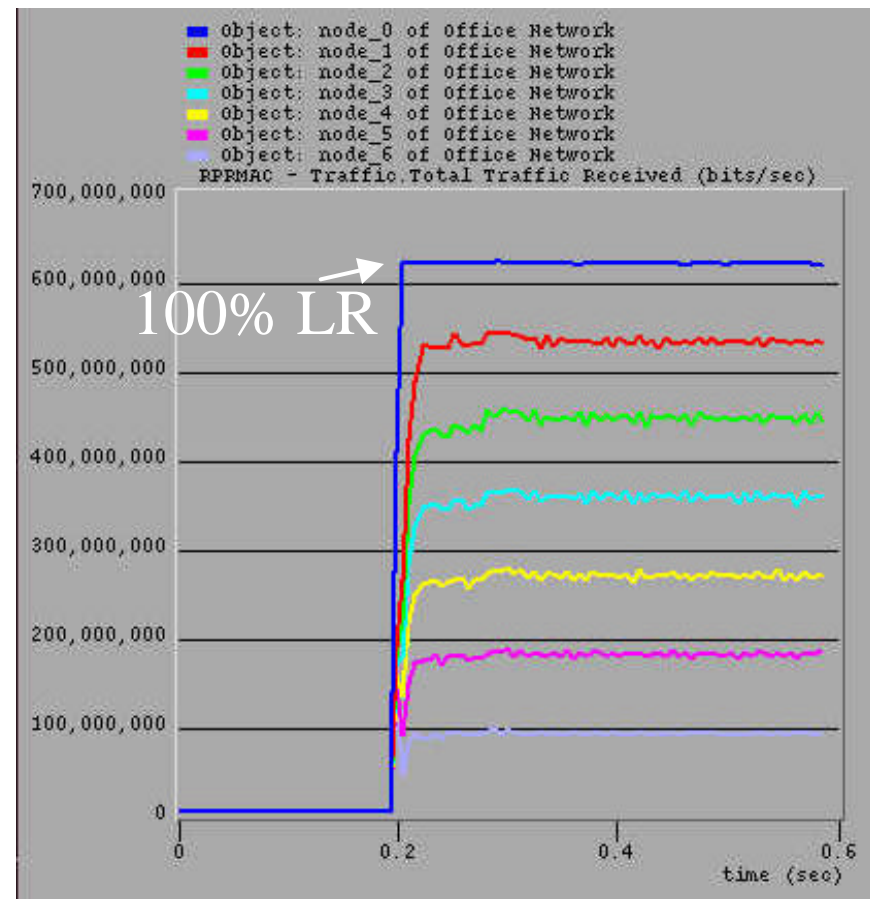
Name	DPB Nodes	SPB Nodes
AllDPB	All	
AllSPB	All	
DPBinBack	7,6,5	4,3,2,1
SPBinBack	4,3,2,1	7,6,5
Mixed	6,4,2	7,5,3,1

AIISPB Bandwidth – No Shapers

Low Pri Sourced Traffic

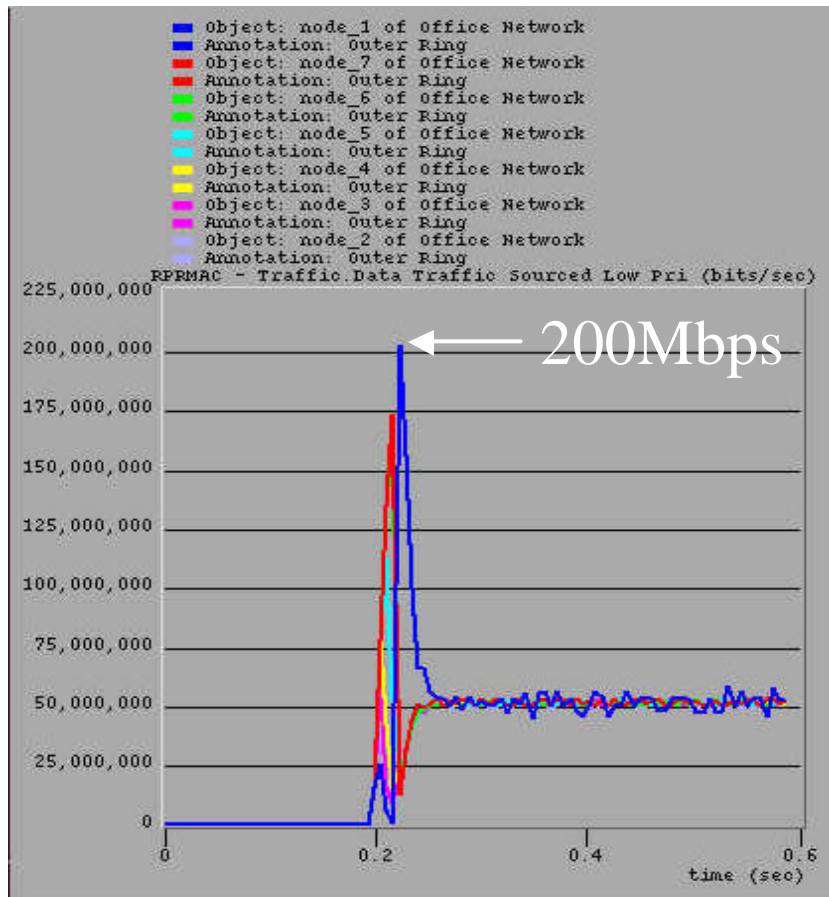


Received Bandwidth

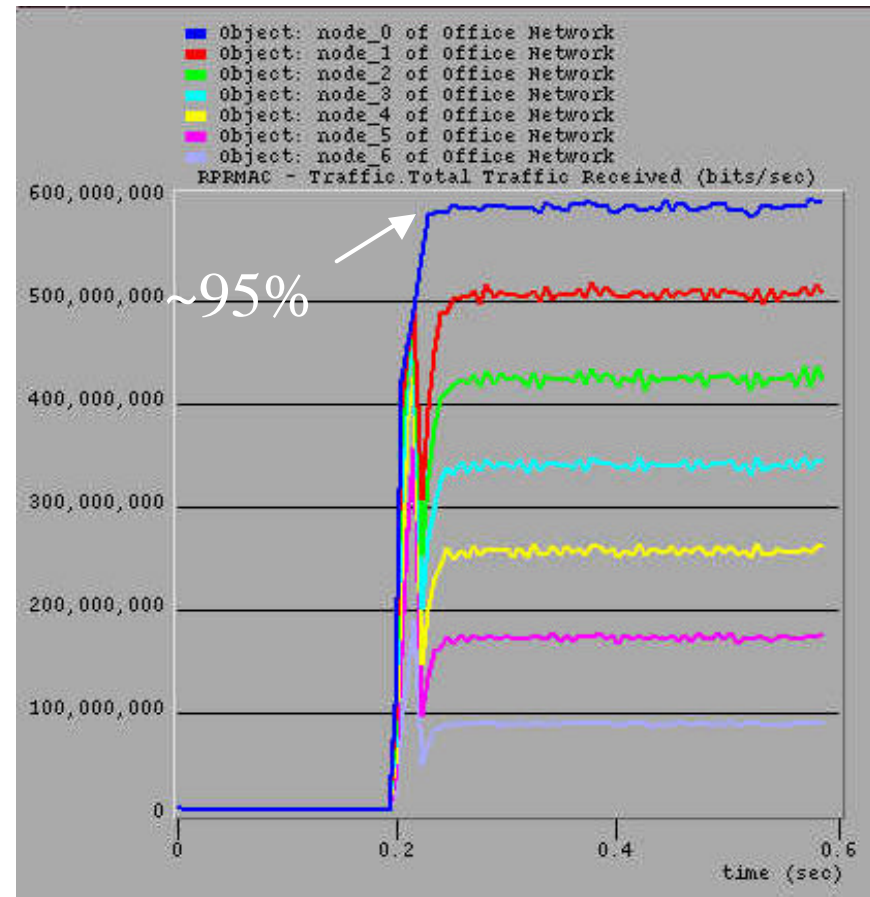


AIISPB Bandwidth – Shapers

Low Pri Sourced Traffic



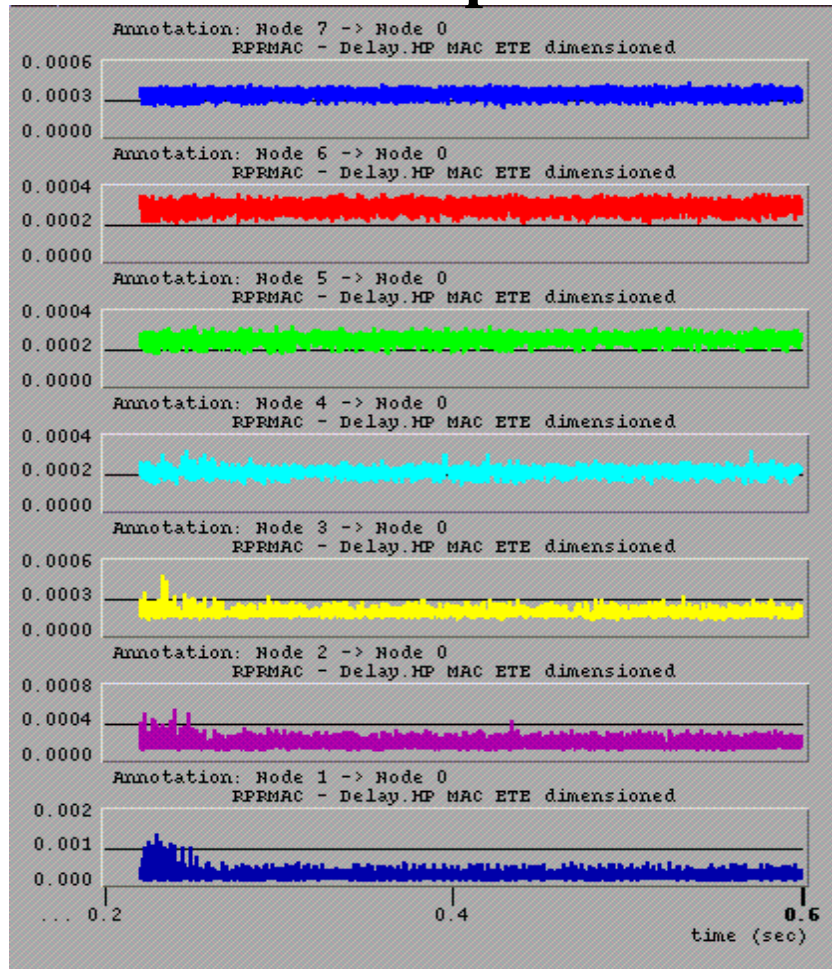
Received Bandwidth



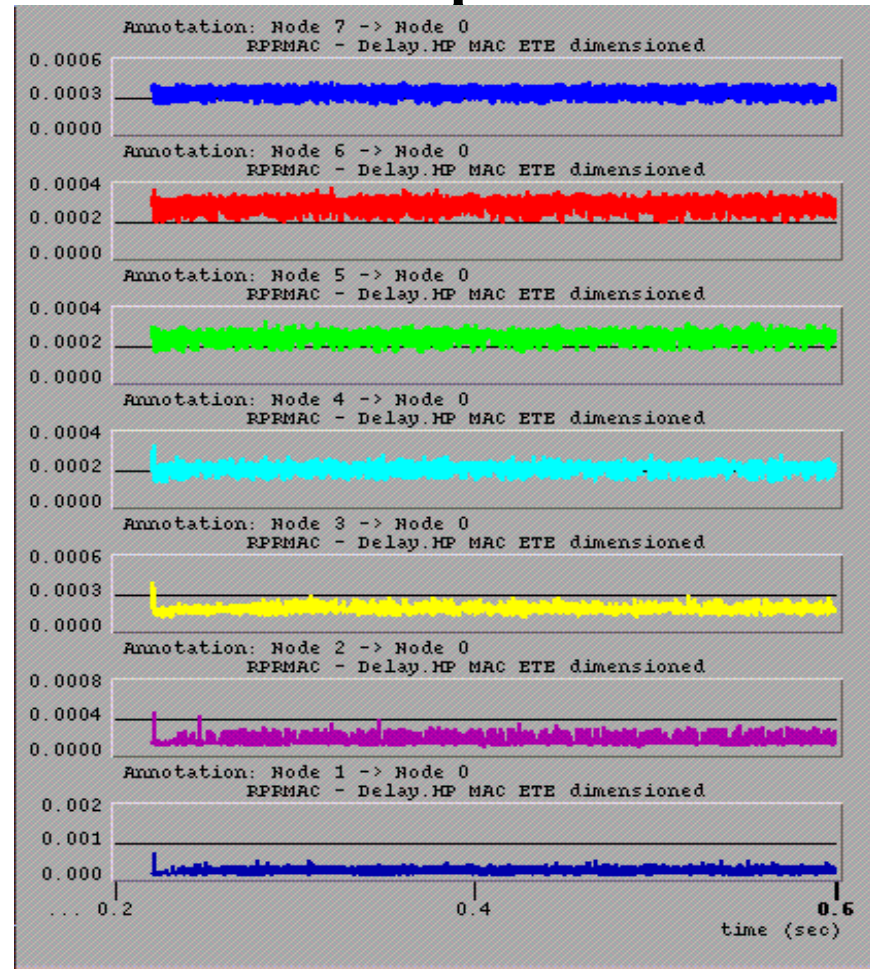
Effects of Shapers on Delay

HP MAC ETE Delays

No Shapers



Shapers



Effect of Shapers on Delay (2)

AllSPB Configuration - No Shapers

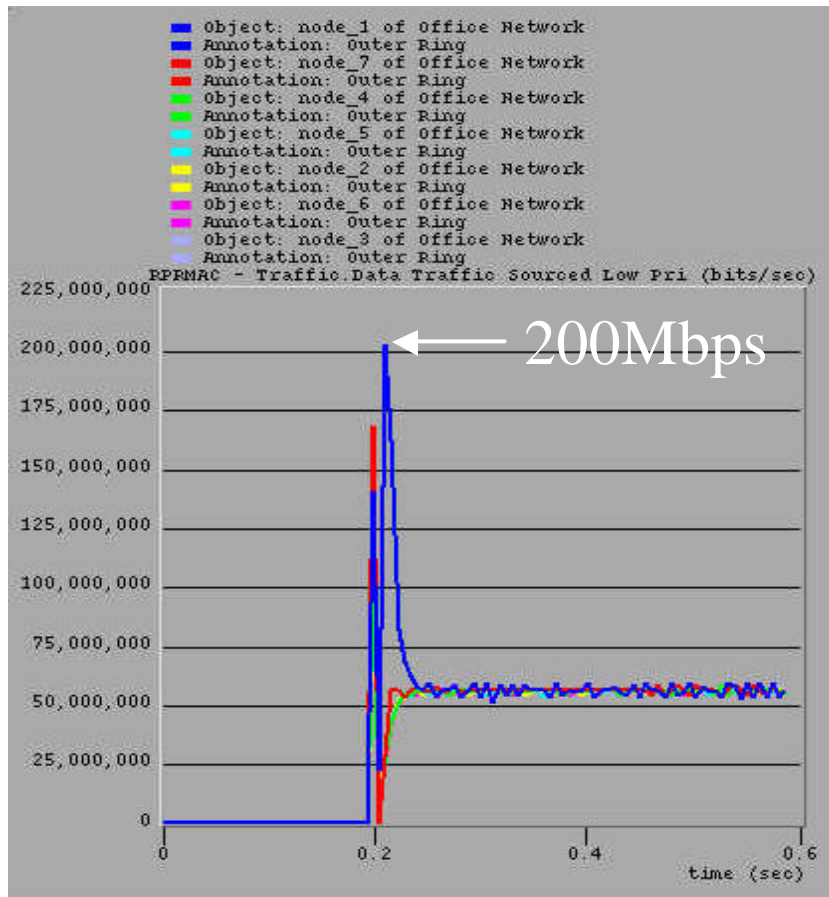
	Minimum	Average	Maximum	Std Dev	Jitter (Max-Min)
Node 7 -> Node 0	0.0002270	0.0003180	0.0004400	0.00004100	0.0002130
Node 6 -> Node 0	0.0001950	0.0002800	0.0003800	0.00003400	0.0001850
Node 5 -> Node 0	0.0001620	0.0002430	0.0003300	0.00002800	0.0001680
Node 4 -> Node 0	0.0001290	0.0002050	0.0003300	0.00002500	0.0002010
Node 3 -> Node 0	0.0000980	0.0001630	0.0004900	0.00003200	0.0003920
Node 2 -> Node 0	0.0000650	0.0001190	0.0005400	0.00005700	0.0004750
Node 1 -> Node 0	0.0000320	0.0000610	0.0013800	0.00013300	0.0013480

AllSPB Configuration - Shapers

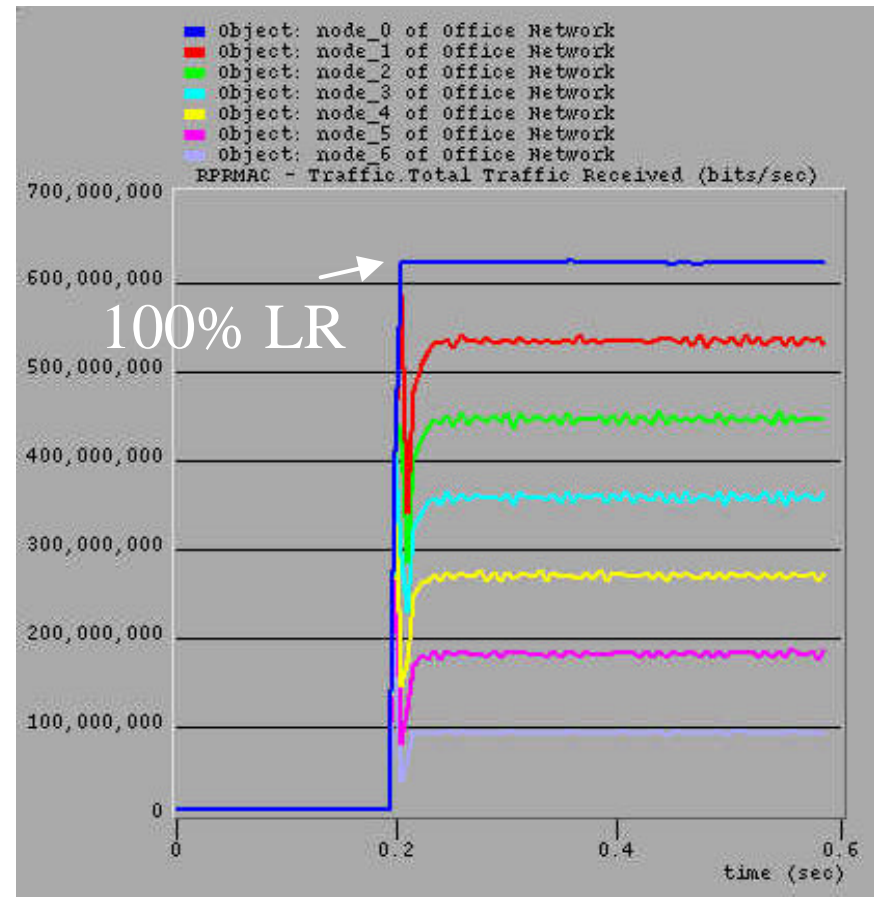
	Minimum	Average	Maximum	Std Dev	Jitter (Max-Min)
Node 7 -> Node 0	0.0002260	0.0003070	0.0004310	0.00004400	0.0002050
Node 6 -> Node 0	0.0001940	0.0002720	0.0003950	0.00003740	0.0002010
Node 5 -> Node 0	0.0001620	0.0002340	0.0003390	0.00003140	0.0001770
Node 4 -> Node 0	0.0001290	0.0001990	0.0003450	0.00002660	0.0002160
Node 3 -> Node 0	0.0000970	0.0001560	0.0003960	0.00002850	0.0002990
Node 2 -> Node 0	0.0000650	0.0001110	0.0004600	0.00004610	0.0003950
Node 1 -> Node 0	0.0000320	0.0000600	0.0006490	0.00008790	0.0006170

DPB Bandwidth – No Shapers

Low Pri Sourced Traffic



Received Bandwidth



HP MAC ETE Delay: Base Cases

AllDPB Configuration – No Shapers

	Minimum	Average	Maximum	Std Dev	Jitter (Max-Min)
Node 7 -> Node 0	0.0002270	0.0002900	0.0004540	0.00005140	0.0002270
Node 6 -> Node 0	0.0001940	0.0002530	0.0003840	0.00004320	0.0001900
Node 5 -> Node 0	0.0001620	0.0002200	0.0003260	0.00003310	0.0001640
Node 4 -> Node 0	0.0001290	0.0001900	0.0002660	0.00002740	0.0001370
Node 3 -> Node 0	0.0000970	0.0001450	0.0002310	0.00002420	0.0001340
Node 2 -> Node 0	0.0000650	0.0000970	0.0001790	0.00001960	0.0001140
Node 1 -> Node 0	0.0000320	0.0000490	0.0001060	0.00001110	0.0000740

AllSPB Configuration - Shapers

	Minimum	Average	Maximum	Std Dev	Jitter (Max-Min)
Node 7 -> Node 0	0.0002260	0.0003070	0.0004310	0.00004400	0.0002050
Node 6 -> Node 0	0.0001940	0.0002720	0.0003950	0.00003740	0.0002010
Node 5 -> Node 0	0.0001620	0.0002340	0.0003390	0.00003140	0.0001770
Node 4 -> Node 0	0.0001290	0.0001990	0.0003450	0.00002660	0.0002160
Node 3 -> Node 0	0.0000970	0.0001560	0.0003960	0.00002850	0.0002990
Node 2 -> Node 0	0.0000650	0.0001110	0.0004600	0.00004610	0.0003950
Node 1 -> Node 0	0.0000320	0.0000600	0.0006490	0.00008790	0.0006170

HP MAC ETE Delay: Mixed Configurations

DPBinBack - Shapers

	Minimum	Average	Maximum	Std Dev	Jitter (Max-Min)
Node 7 -> Node 0	0.0002270	0.0003080	0.0004230	0.00004220	0.0001960
Node 6 -> Node 0	0.0001940	0.0002720	0.0003870	0.00003590	0.0001930
Node 5 -> Node 0	0.0001620	0.0002350	0.0003210	0.00002900	0.0001590
Node 4 -> Node 0	0.0001290	0.0001990	0.0003450	0.00002590	0.0002160
Node 3 -> Node 0	0.0000970	0.0001550	0.0004440	0.00002860	0.0003470
Node 2 -> Node 0	0.0000650	0.0001120	0.0003840	0.00004650	0.0003190
Node 1 -> Node 0	0.0000320	0.0000590	0.0005460	0.00009110	0.0005140

SPBinBack – Shapers on SPD nodes

	Minimum	Average	Maximum	Std Dev	Jitter (Max-Min)
Node 7 -> Node 0	0.0002270	0.0002900	0.0004400	0.00005080	0.0002130
Node 6 -> Node 0	0.0001940	0.0002540	0.0003900	0.00004300	0.0001960
Node 5 -> Node 0	0.0001620	0.0002210	0.0003400	0.00003350	0.0001780
Node 4 -> Node 0	0.0001290	0.0001900	0.0002600	0.00002660	0.0001310
Node 3 -> Node 0	0.0000970	0.0001450	0.0002300	0.00002440	0.0001330
Node 2 -> Node 0	0.0000650	0.0000980	0.0001900	0.00001970	0.0001250
Node 1 -> Node 0	0.0000320	0.0000520	0.0051700	0.00009190	0.0051380

HP MAC ETE Delay: Mixed Configurations (cont)

Mixed - Shapers

	Minimum	Average	Maximum	Std Dev	Jitter (Max-Min)
Node 7 -> Node 0	0.0002270	0.0003030	0.0004310	0.00004450	0.0002040
Node 6 -> Node 0	0.0001940	0.0002660	0.0003700	0.00003780	0.0001760
Node 5 -> Node 0	0.0001620	0.0002270	0.0003230	0.00003180	0.0001610
Node 4 -> Node 0	0.0001290	0.0001940	0.0002620	0.00002490	0.0001330
Node 3 -> Node 0	0.0000970	0.0001520	0.0003070	0.00002640	0.0002100
Node 2 -> Node 0	0.0000650	0.0001030	0.0001900	0.00001720	0.0001250
Node 1 -> Node 0	0.0000320	0.0000600	0.0004940	0.00008910	0.0004620

Conclusions

- **RPR fairness scheme works with single passthrough buffer nodes**
 - *Small modifications to congestion trigger & rate limiter*
- **Single and dual PB nodes can coexist on the same ring**
 - *Good HP latency and Jitter*