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CENTRE FOR ADVANCED INTERNET ARCHITECTURES

# Evaluation of FAST TCP in Low-Speed DOCSIS-based Access Networks

by

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## Presentation Outline

- Motivation
- Background on some previous results
- Experimental setup
- Results and analysis
- Conclusions

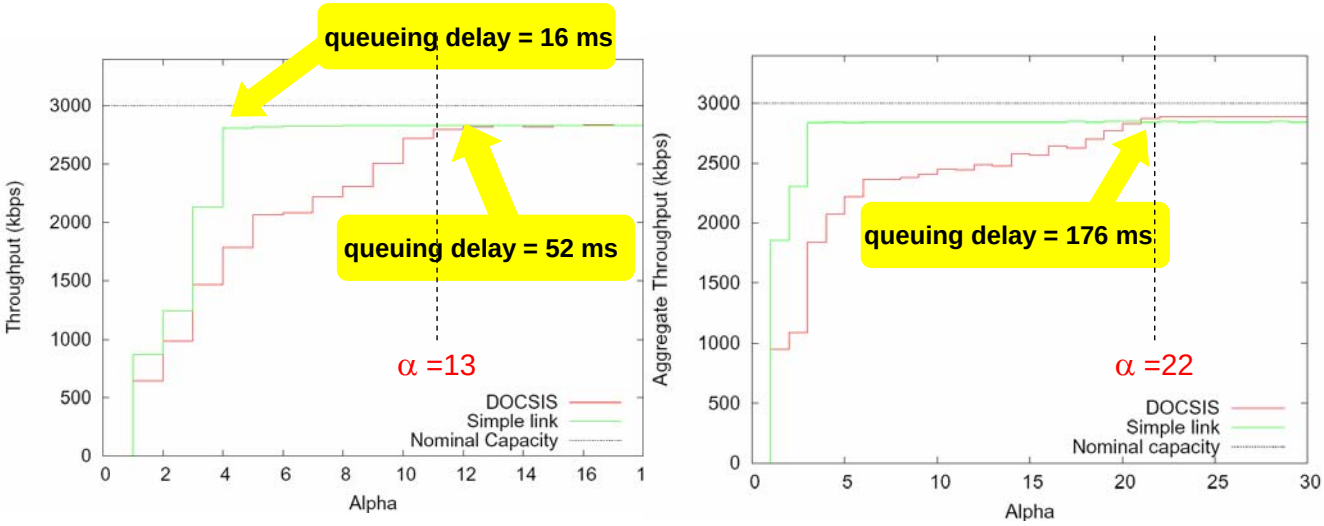
# Motivation

- Tencon'05 paper - evaluated the performance of FAST in two low speed environments (0.5 – 3 Mbps): *DOCSIS cable modem system* and *simple low rate links*
  - One of the main findings – DOCSIS introduces "phantom" queuing delay on an underutilized link which results in the need for W >> B-D product & increased target queue size parameter $\alpha$
  - The study only considered static scenarios involving 1 or 2 flows in a single CM system
- This project extends the analysis of the Tencon paper to:
  - Multiple flows of FAST interacting over a single bottleneck link in a single, as well as multiple CM system
  - Multiple protocols (i.e., standard Reno & FAST)



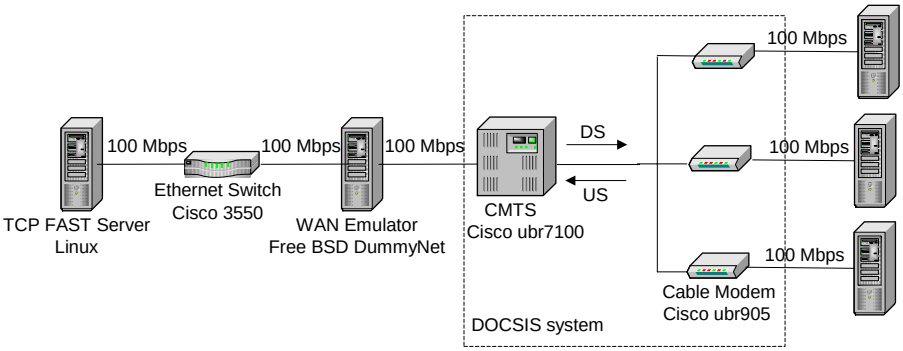
# Tencon'05 result – the trend of increasing $\alpha$

Throughput vs. $\alpha$ parameter for DS = 3 Mbps and US = 512 Kbps




1. The rule for setting $\alpha$, applied in high speed regime, does not work for low-speed especially in DOCSIS system
- The required $\alpha$ value *does not scale inversely with n* where n is the number of flows on the bottleneck link

# Experimental Setup



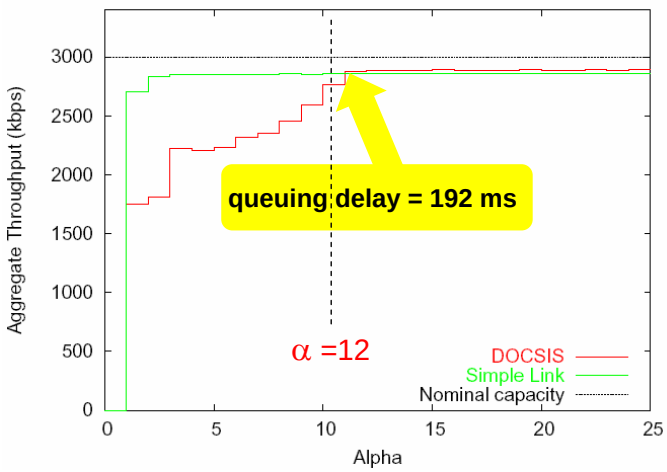

| DS | US |
|---|---|
| 3 Mbps | 512 Kbps |

- DOCSIS link:
  - Dummynet: RTT=100ms, no bandwidth limitations, buffer size of 2048 Kbytes
  - Maximum buffer size at CMTS set to the max Cisco value of 1024ms
- Simple rate-limited link:
  - DOCSIS system was bypassed. Dummynet emulated system with equivalent US and DS capacities and buffering. Also, RTT=100ms.
- Extended testbed- involved inclusion of multiple cable modems i.e., 2 CM system and 3 CM system

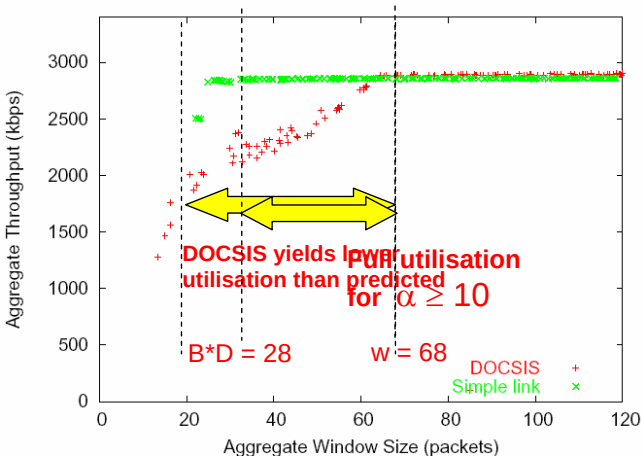


# One CM Results – 4 Flows

Aggregate throughput vs. individual α parameter for 4 flows and one cable modem (DS=3Mbps, US=512Kbps)

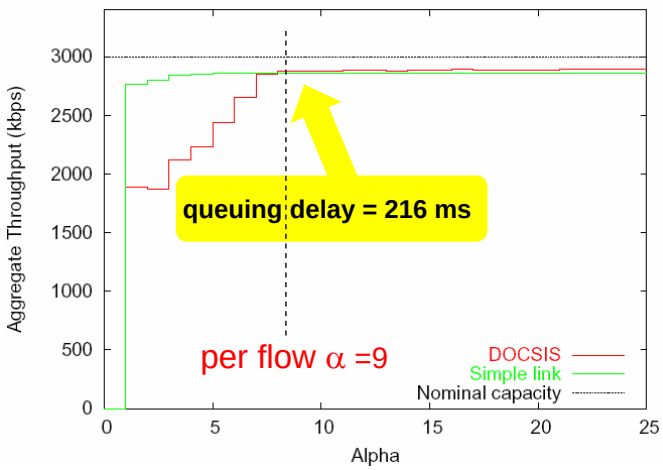


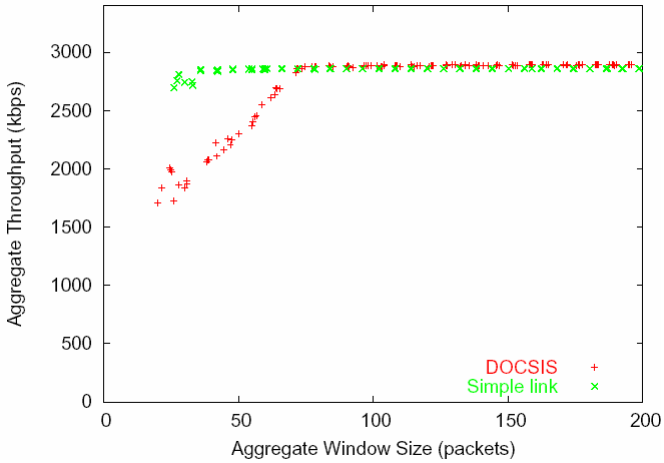

FAST ability to accurately set its window size is unaffected by the latency fluctuations introduced by DOCSIS



# One CM Results – 6 Flows

Aggregate throughput vs. individual α parameter for 6 flows and one cable modem (DS=3Mbps, US=512Kbps)





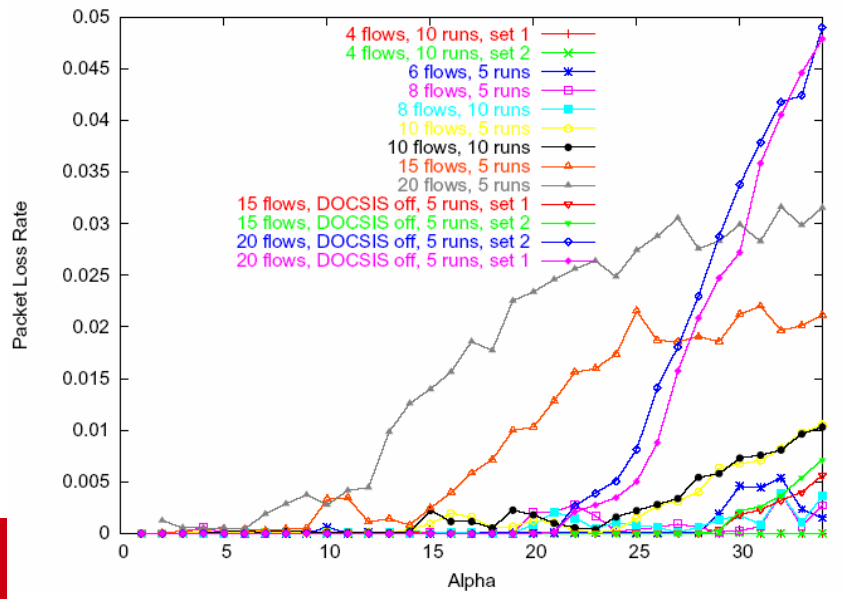

# Summary of One CM

| # of Flows | Total alpha required | Target Queuing Delay (ms) |
|---|---|---|
| 1 | 13 | 52 |
| 2 | 44 | 176 |
| 4 | 48 | 192 |
| 6 | 54 | 216 |
| 8 | 72 | 288 |
| 10 | 80 | 320 |

Total target queuing delay increases as the number of flows increases.

# Packet Loss

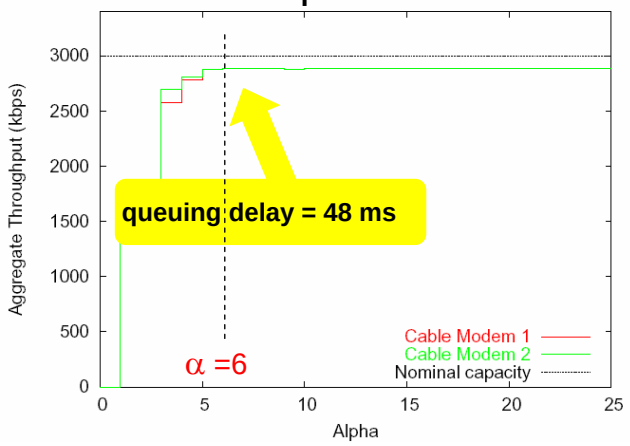
Packet loss occurs if the alpha parameter is set too high. This graph shows loss occurring at different alpha values for each different number of flows.



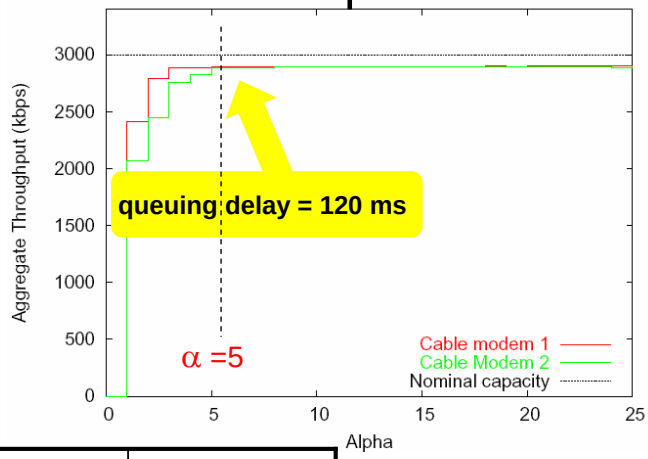



# Two CMs Results

## 1 Flow per CM



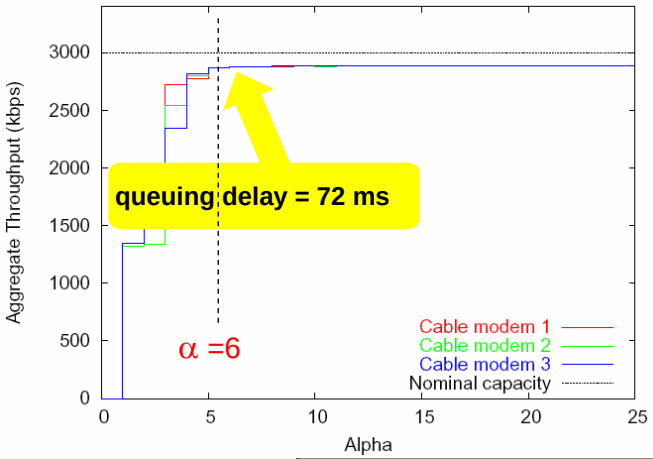

## 3 Flows per CM



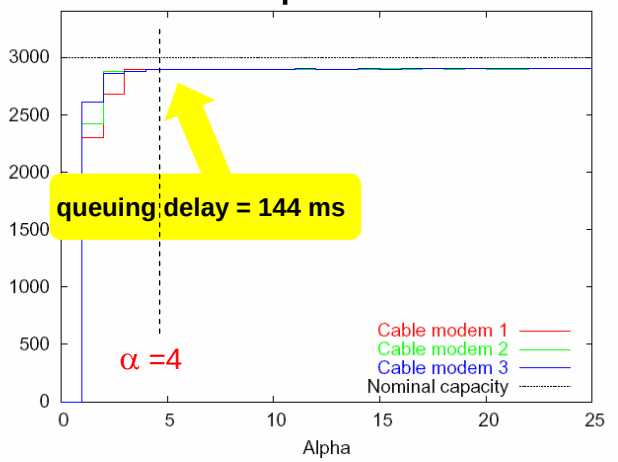

| # of Flows per CM | Alpha required | Target Queuing Delay (ms) |
|---|---|---|
| 1 | 12 | 48 |
| 2 | 16 | 64 |
| 3 | 30 | 120 |
| 4 | 32 | 128 |
| 5 | 30 | 120 |
| 10 | 60 | 360 |

# Three CMs Results

1 Flow per CM




3 Flows per CM

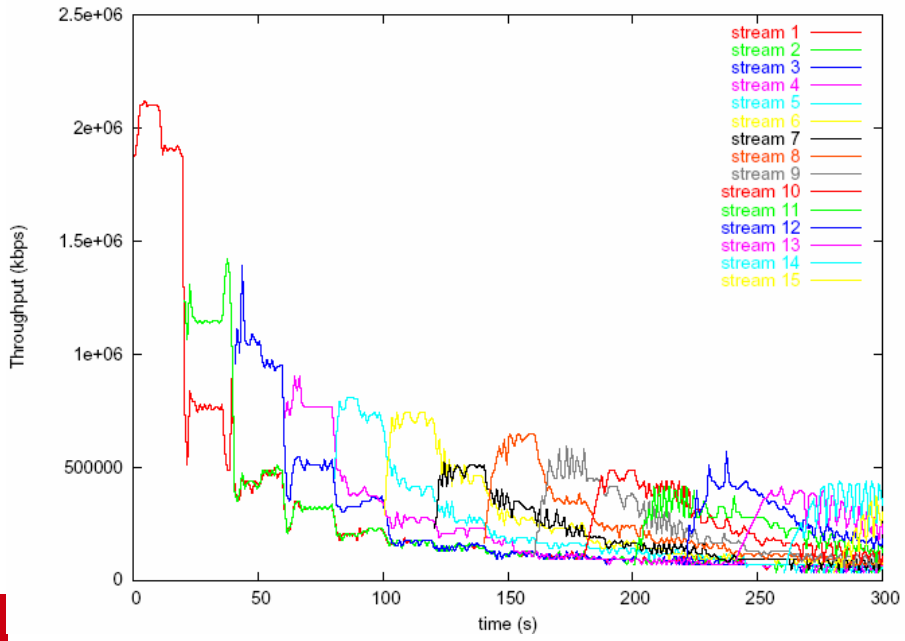



| # of Flows per CM | Alpha required | Target Queuing Delay (ms) |
|---|---|---|
| 1 | 18 | 72 |
| 2 | 32 | 128 |
| 3 | 36 | 144 |
| 4 | 48 | 192 |
| 5 | 45 | 180 |



# Fairness Analysis

Throughput vs. time for each flow, where new flows are introduced every 20 seconds



# Conclusion

- Performance of FAST over DOCSIS and simple low-rate link investigated with multiple flows and multiple cable modems
- Some insights were gained for setting the required alpha parameter to achieve full utilization
- It was observed that the total target queuing increases with the increase of the number of flows
- Some fairness issues observed as well
- Further investigation is required to better understand the system behaviour



# Thank You

…any questions?