A closer look at the M/G/R PS model for TCP traffic

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Outline

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- Sojourn Time Formulas
- Investigated Scenarios
- Simulation Results
- Conclusion and Further Issues

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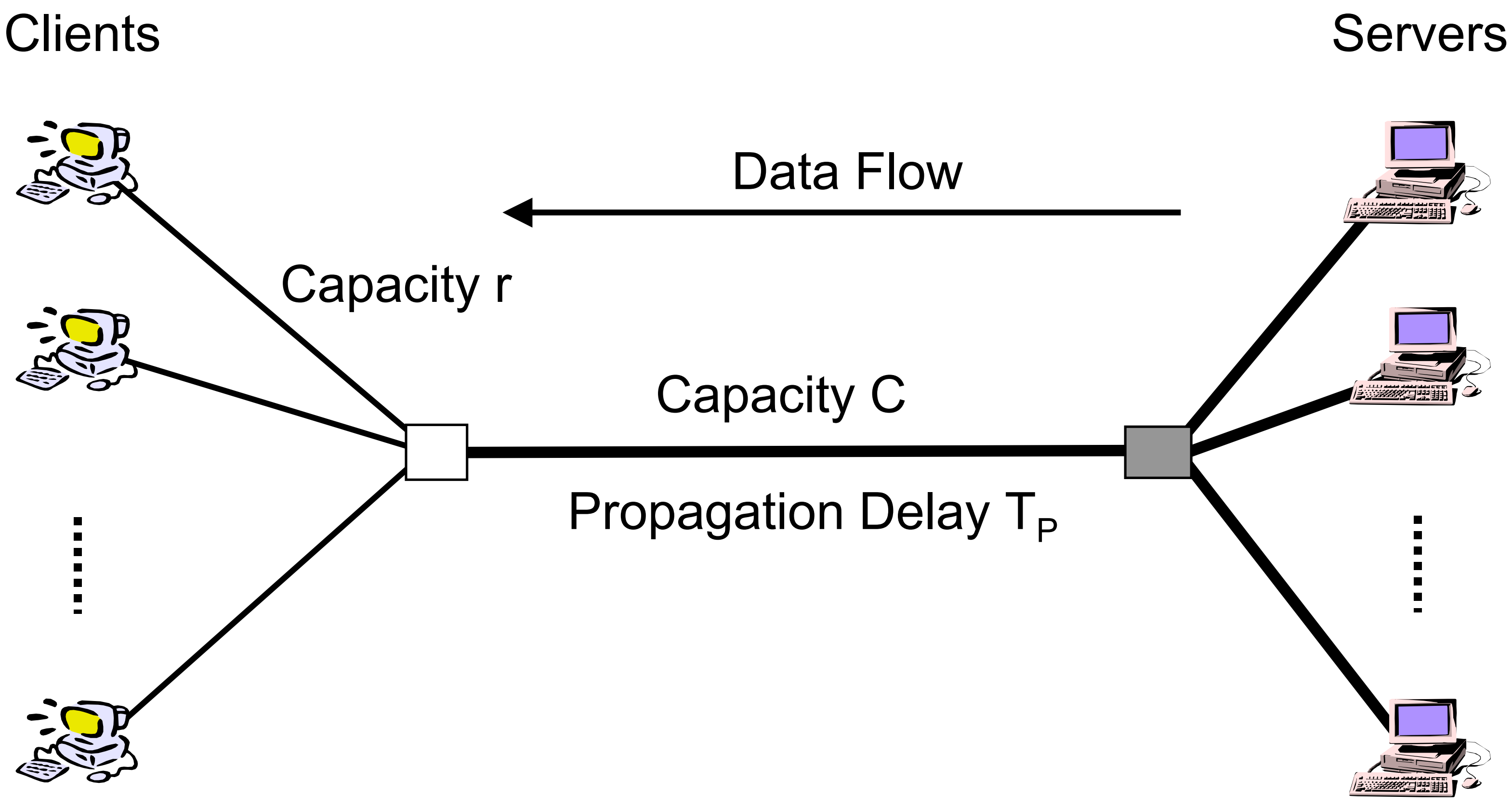
Simulation Scenario – Important Parameters



Simulation environment: network simulator version 2.1b7, TcpReno

File interarrival time: neg. exp. distributed

File length: hyperexp. distributed, mean: 22 kbytes

Buffer size = 500 packets

MSS = 500 bytes

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Sojourn Time Formulas

Pure M/G/R PS Model

$$E_{M/G/R}\{T(x)\} = \frac{x}{r}\left(1+\frac{E_2(R,R\rho)}{R(1-\rho)}\right) = \frac{x}{r}\cdot f_R$$

x	file length
R	C/r
ρ	link utilization
f_R	delay factor

Extended M/G/R PS Model (see PGTS 2000)

$$E_{extended}\{T(l)\} = \begin{cases} \left\lfloor \log_2\left(\left\lceil \frac{l}{MSS} \right\rceil\right)\right\rfloor \cdot RTT + E_{M/G/R}\{T(l-l_{start})\} & l < l_{slow-start} \\ n^* RTT + E_{M/G/R}\{T(l-l_{slow-start})\} & l \geq l_{slow-start} \end{cases}$$

with $l_{start} = \left(2^{\left\lfloor \log\left(\left\lceil \frac{l}{MSS}\right\rceil\right)\right\rfloor} - 1\right)\cdot MSS$

$l_{slow-start} = \left(2^{n^*} - 1\right)\cdot MSS$, $n^* = \lceil \log_2 w^* \rceil$, $w^* = \left\lceil \frac{C_{available}\cdot RTT}{MSS} \right\rceil = \left\lceil \frac{r_{peak}\cdot RTT}{f_R \cdot MSS} \right\rceil$

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Investigated Scenarios

	C	r	T_{prop}	ρ	f_R
"Reference"	4100 kbps	256 kbps	10 ms	0.87	1.24
"Long Delay"	4100 kbps	256 kbps	100 ms	0.87	1.24
"Long Queuing"	1150 kbps	64 kbps	10 ms	0.87	1.21
"High Utilization"	3800 kbps	256 kbps	10 ms	0.95	2.05

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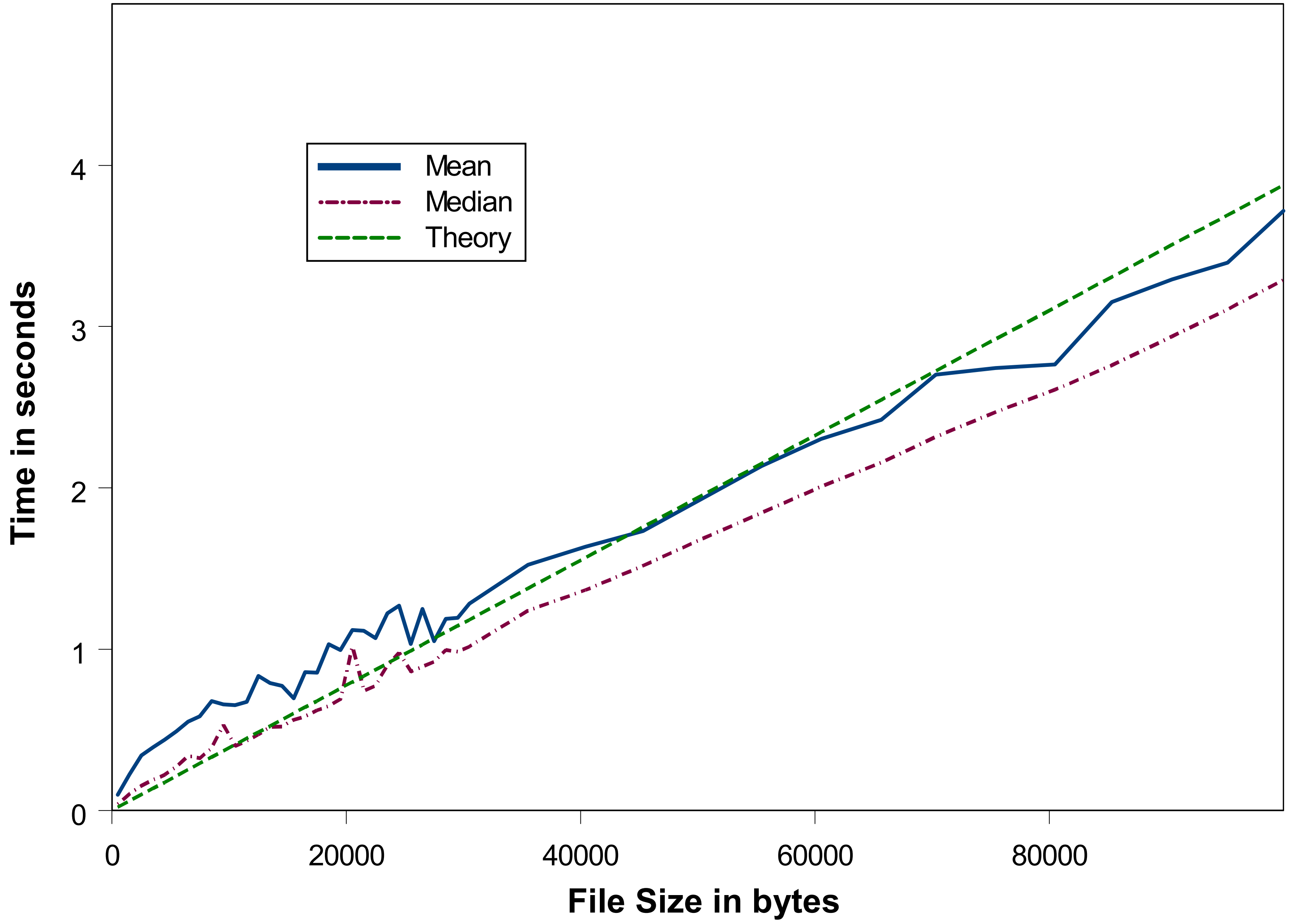
"Reference" – Transfer Time



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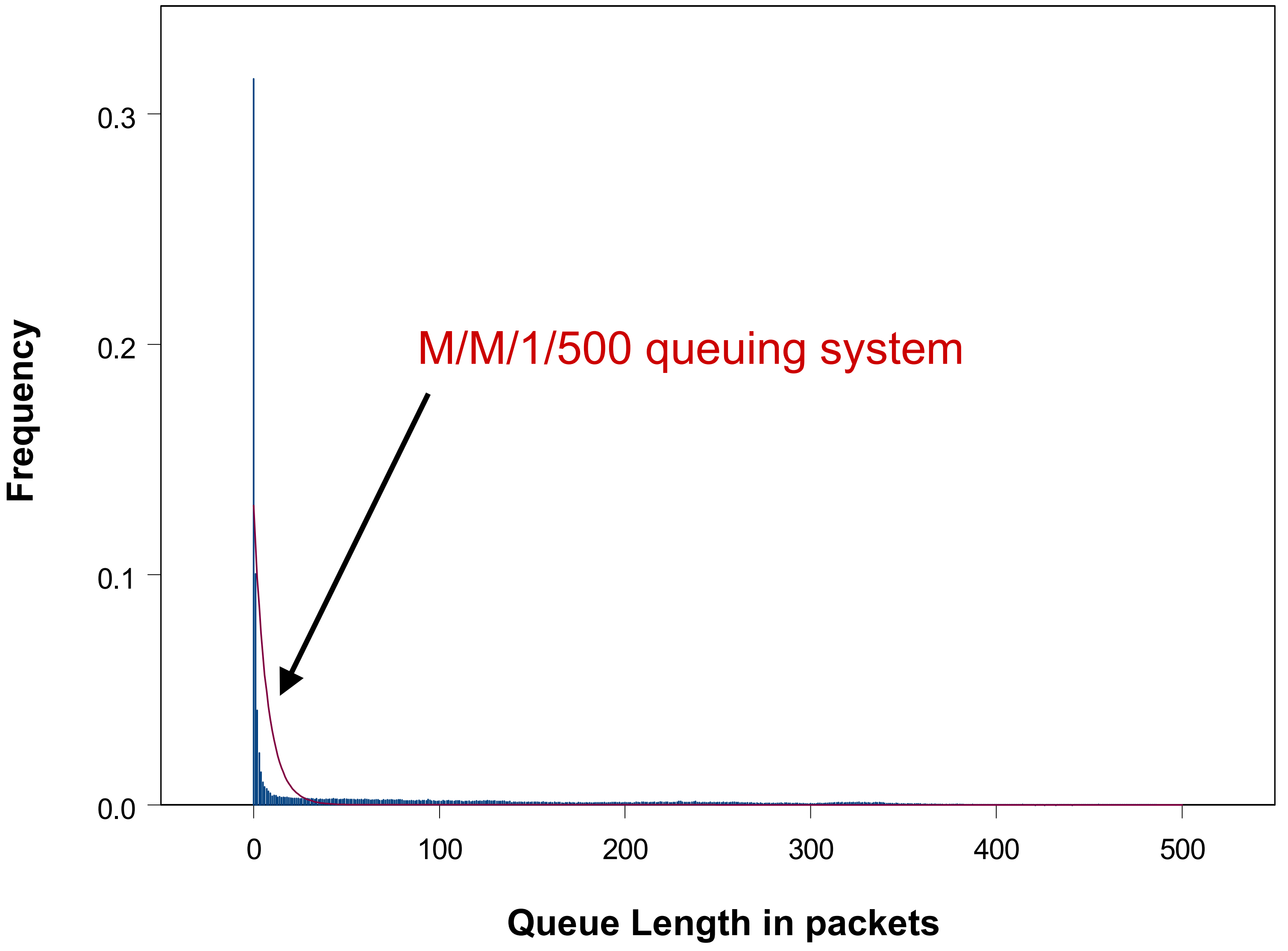
"Reference" – Queue Length Distribution



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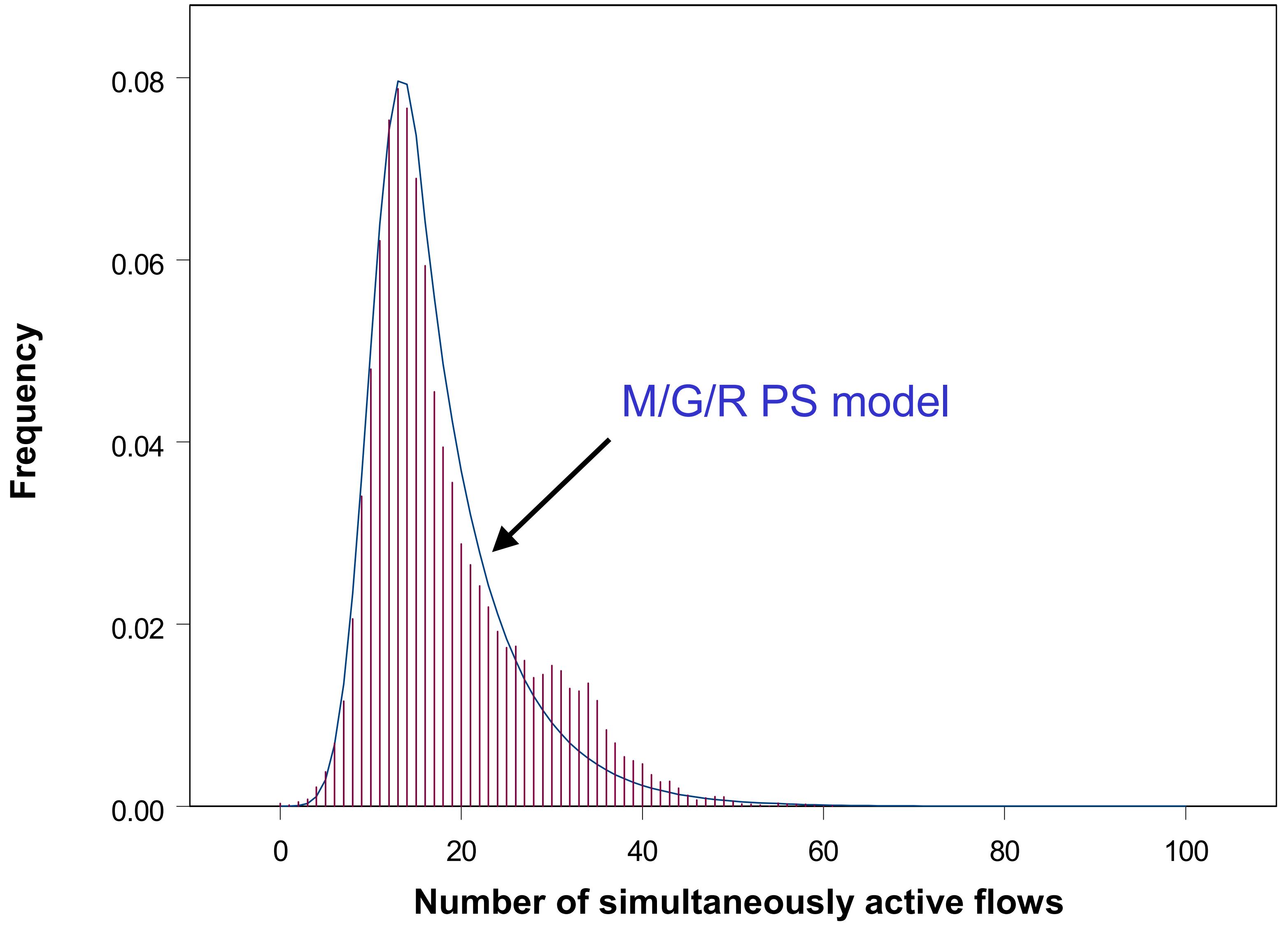
"Reference" – Number of Active Flows



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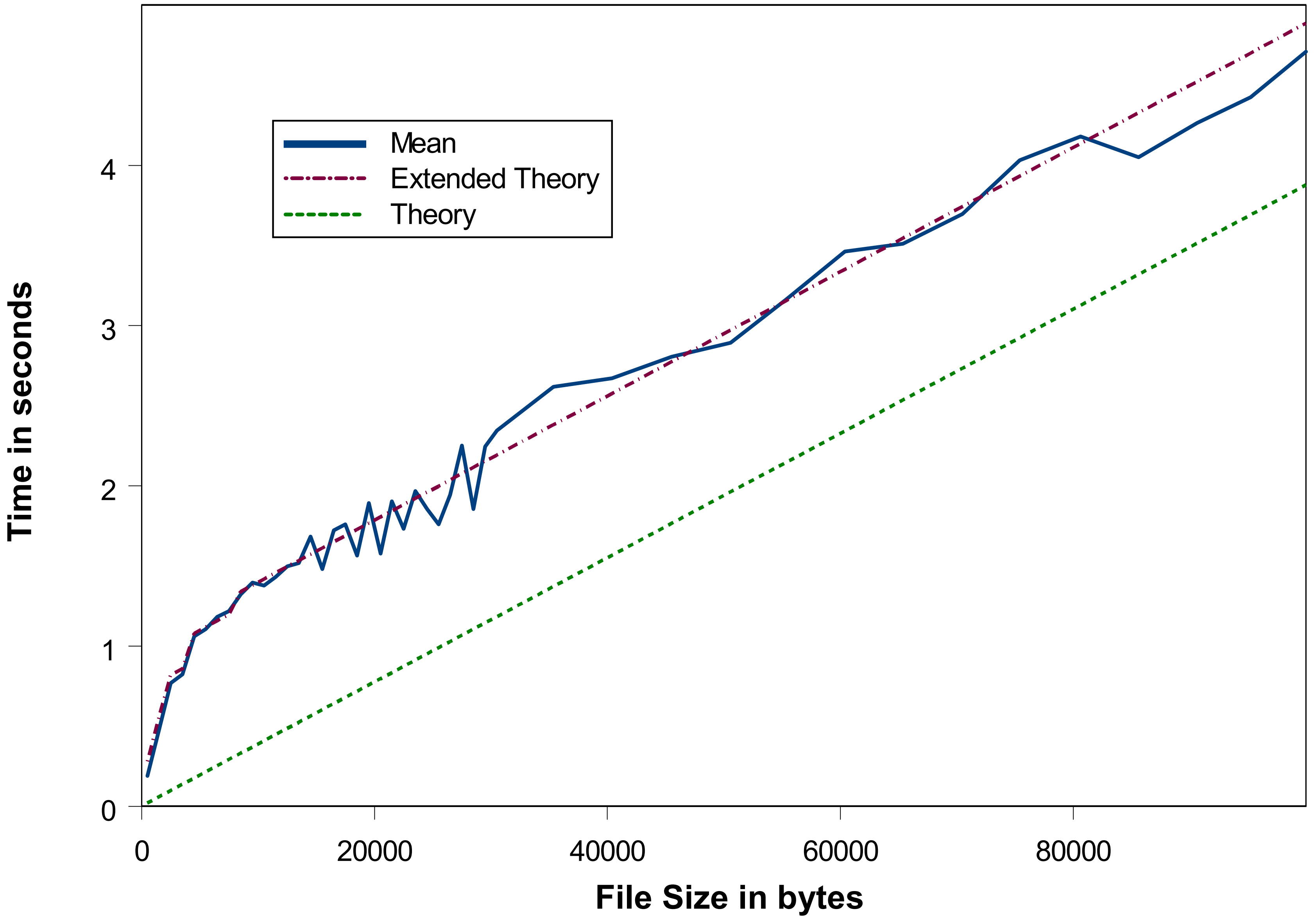
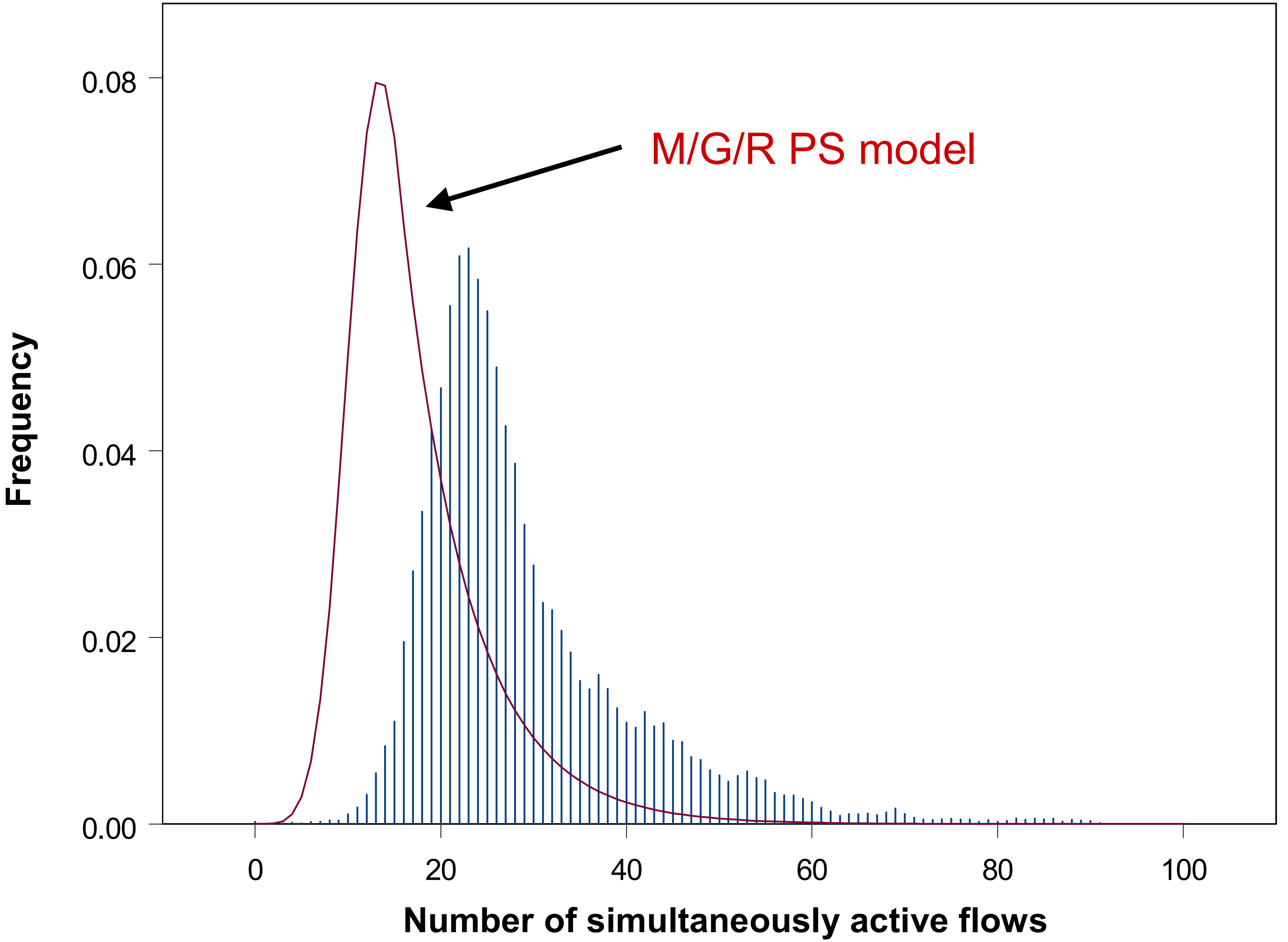
"Long Delay" – Transfer Time



"Long Delay" – Number of Active Flows



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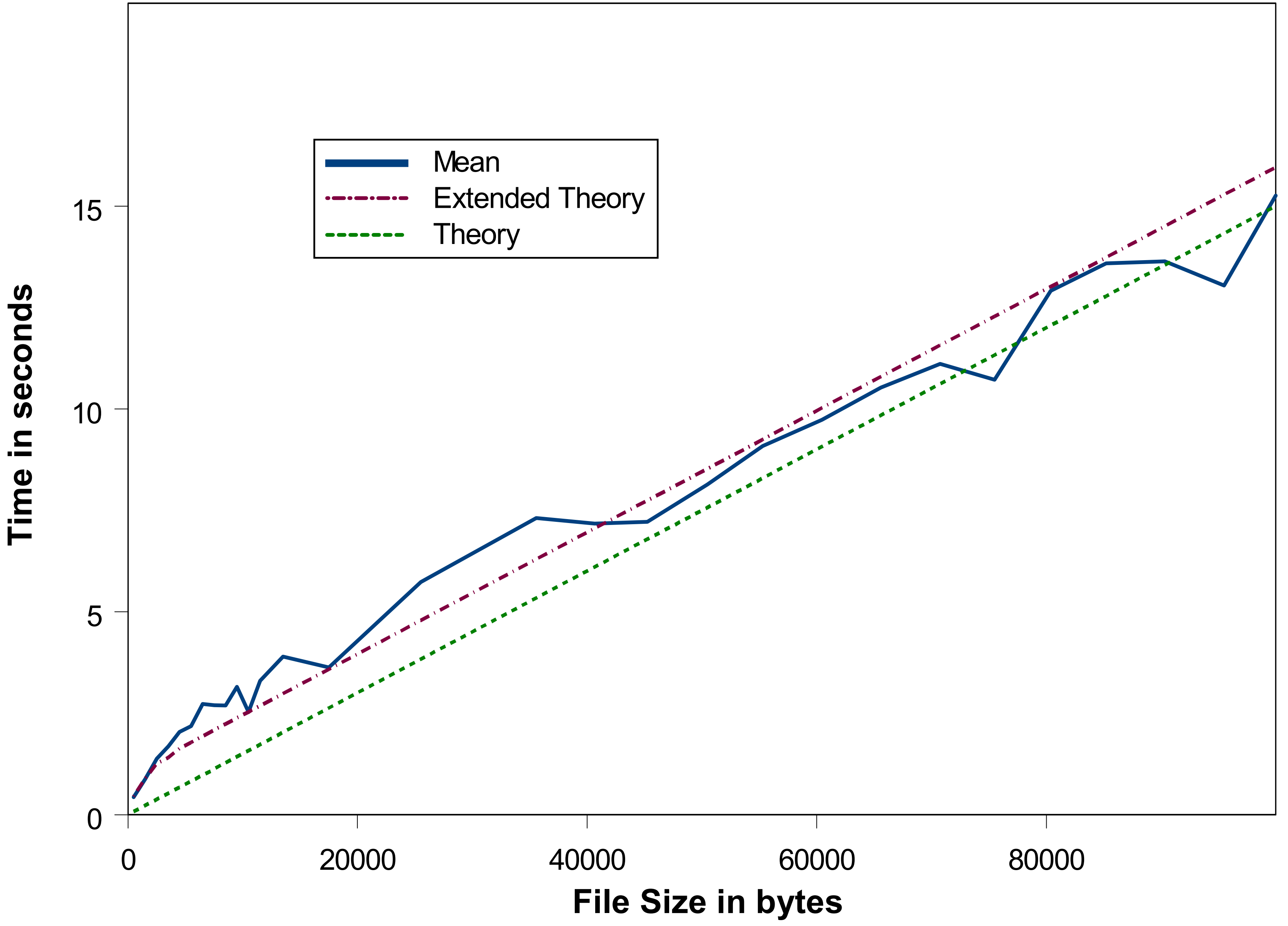
"Long Queuing" – Transfer Time



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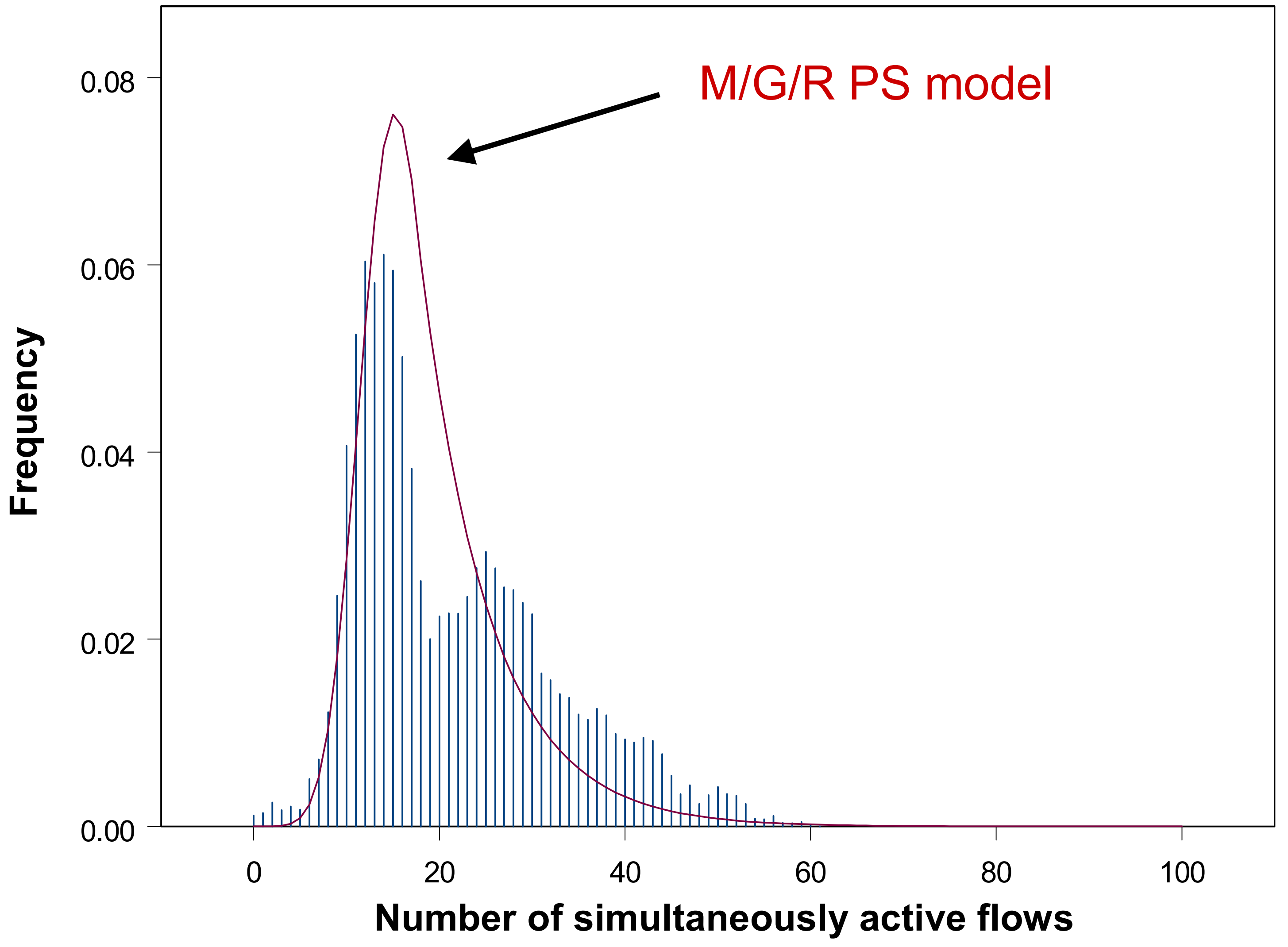
"Long Queuing" – Number of Active Flows



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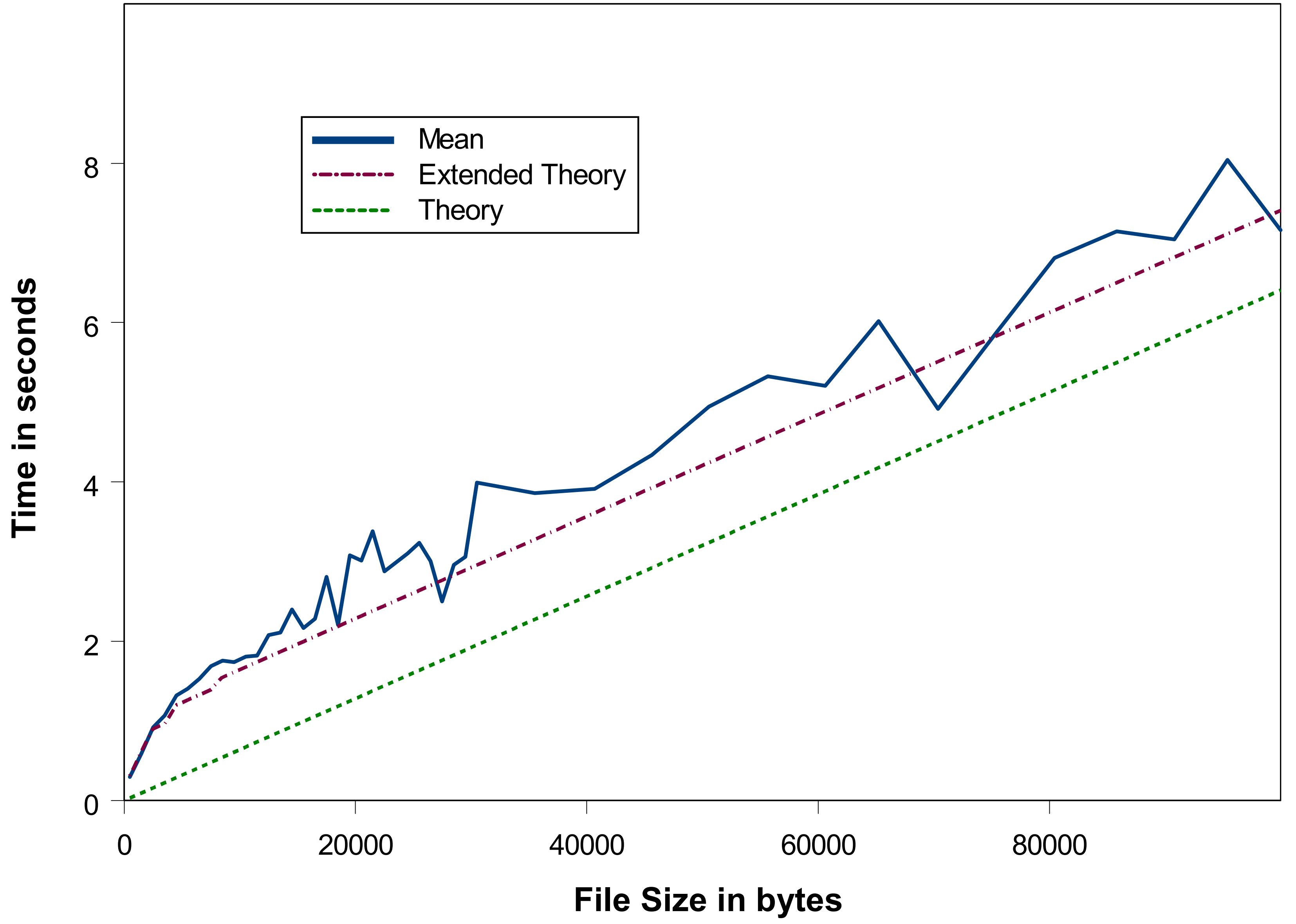
"High Utilization" – Transfer Time



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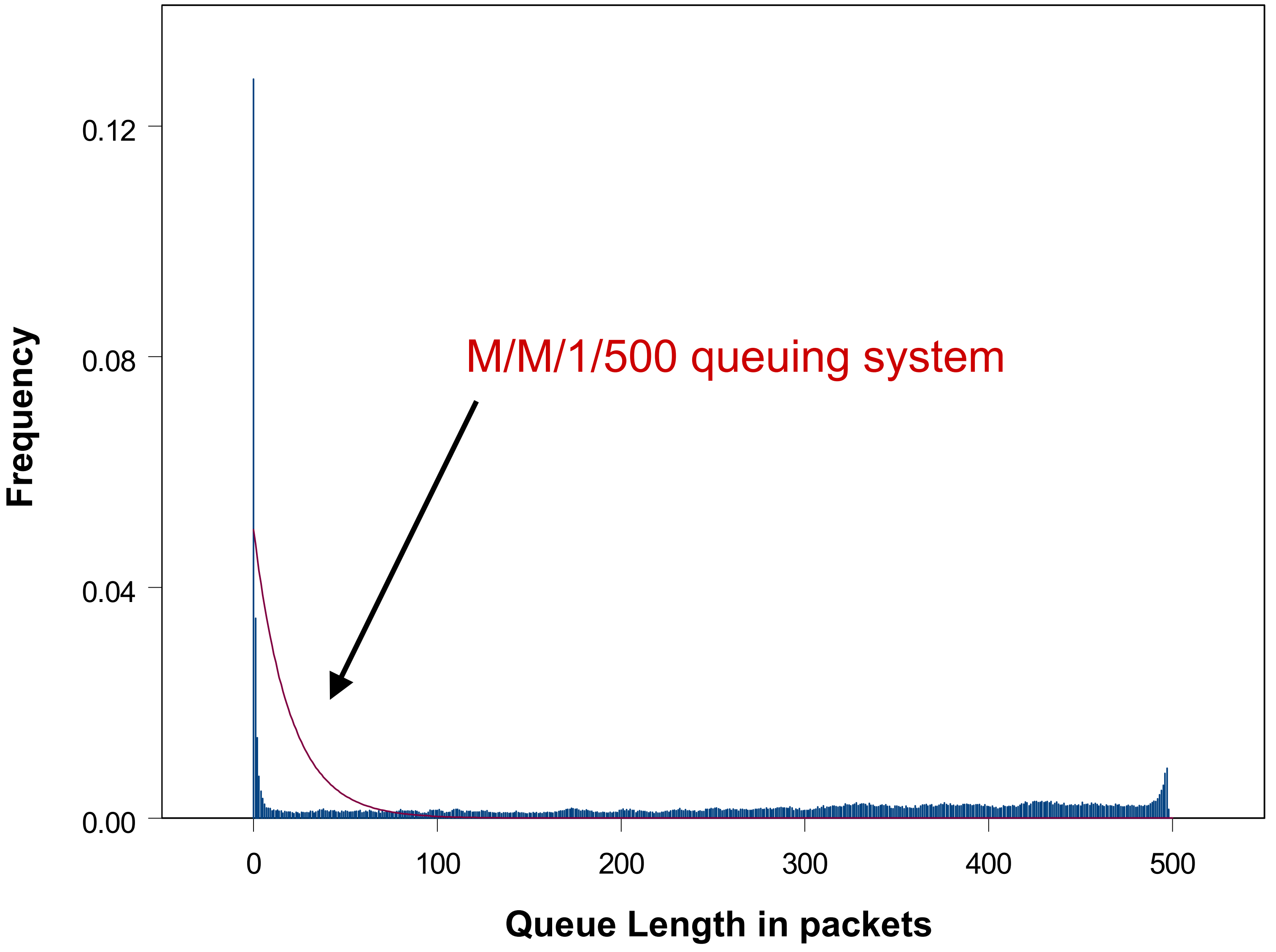
"High Utilization" – Queue Length Distribution



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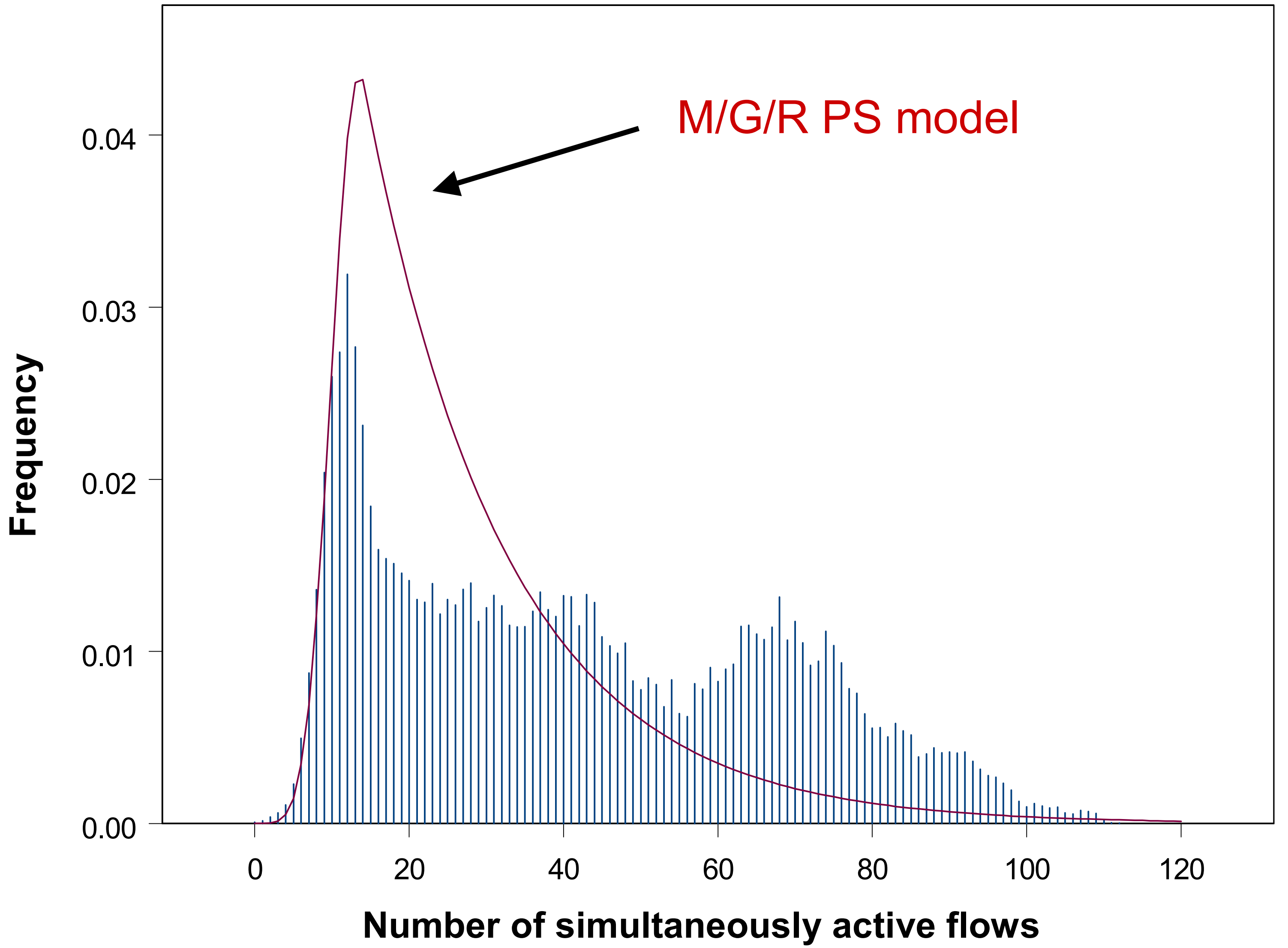
"High Utilization" – Number of Active Flows



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Conclusions and Further Issues

Pure M/G/R PS works fine for

- low utilization
- high bandwidth
- low propagation delay

Use Extended M/G/R PS

- if RTT > $E_{M/G/R}\{T(x)\}|_{small\ x}$ → use RTT estimates
- if T_{buffer} > $E_{M/G/R}\{T(x)\}|_{small\ x}$ → use buffer queue estimates

Further Issues

- effect of packet loss
- packet-level characteristics

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