Mobile TV Workload Characterization

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Presented at WiMAX Forum Meeting
Washington DC, 19th November 2007

These slides are available on-line at:
http://www.cse.wustl.edu/~jain/mtv711.htm

- Analyzing 1 Mbps Mobile TV Trace
- Comparison of Lognormal and normal distributions
- R2 Calculations
- Future Work

Objectives

- Develop models for packet generation that can be used with analytical and simulation models and in application optimization studies
- Understand and analyze available Mobile-TV trace

Mobile TV Trace

- 1 Mbps and 350 Kbps trace files have been provided by Alan Moskowitz of MobiTV.
- Trace files consists of RTP packets as shown below.
- “Mark” $\Rightarrow$ End of the media packet
- The screen size determines the compression algorithm and the bit rate. For cell phones 350 kbps, IPTV 1 Mbps.
- This is the analysis of 1 Mbps trace with MJPEG.

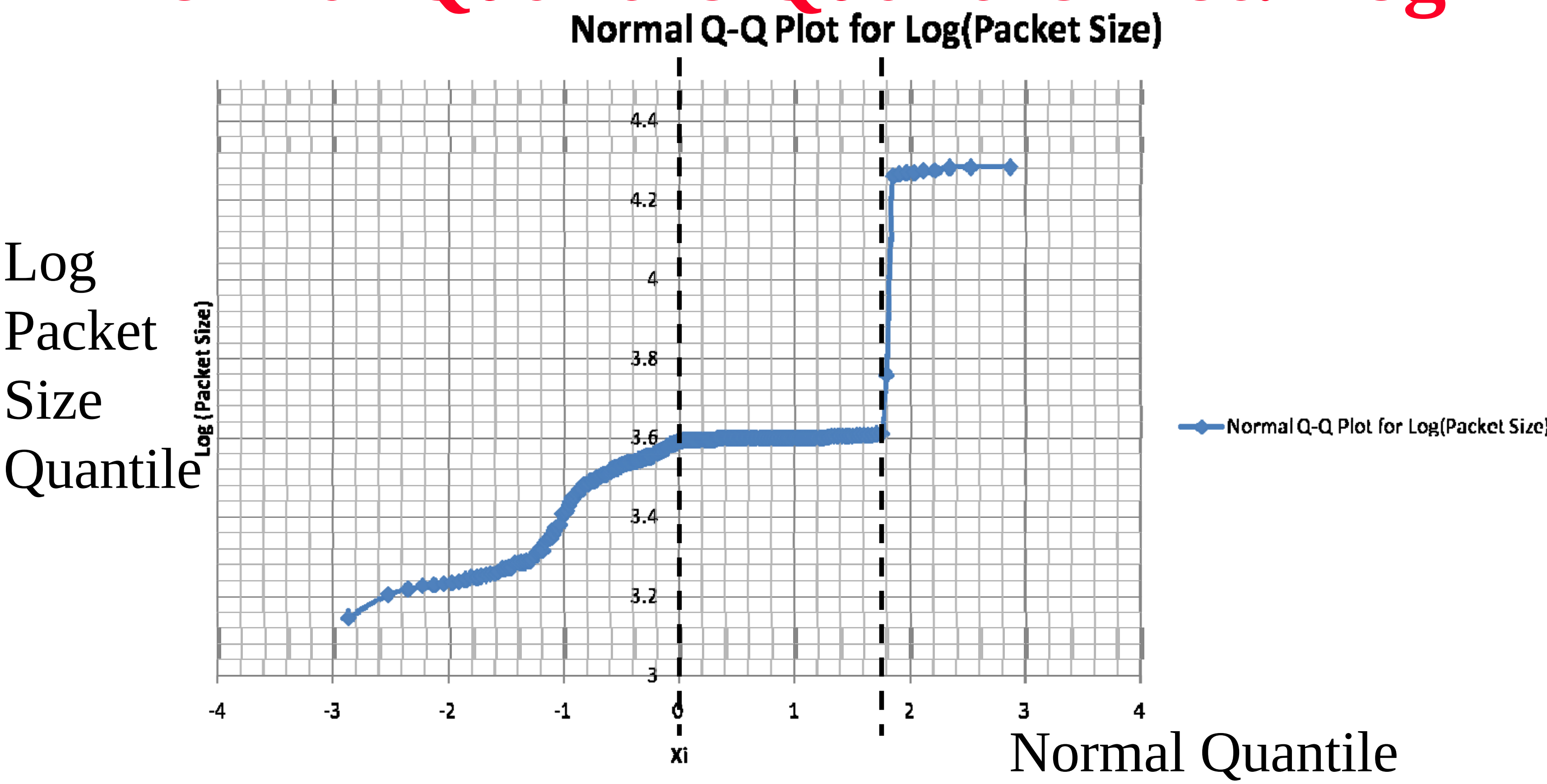
	A	B	C	D	E	F	G	H	I	J	K	L
1	No.	Time	Source		Destination	Protocol	Informatoin					Length
2	1	0	172.16.230.93		224.2.4.1	RTP	Payload type=Unknown (96)	SSRC=1727235052	Seq=45647	Time=1442975067	Mark	257
3	2	0.002032	172.16.230.93		224.2.4.1	RTP	Payload type=Unknown (96)	SSRC=1727235052	Seq=45648	Time=1442978070		1033
4	3	0.011757	172.16.230.93		224.2.4.1	RTP	Payload type=Unknown (96)	SSRC=1727235052	Seq=45649	Time=1442978070		568
5	4	0.015821	172.16.230.93		224.2.4.1	RTP	Payload type=Unknown (96)	SSRC=1727235052	Seq=45650	Time=1442978070	Mark	1427
6	5	0.028448	172.16.230.93		224.2.4.1	RTP	Payload type=Unknown (96)	SSRC=1727235052	Seq=45651	Time=1442981073		1172
7	7	0.038173	172.16.230.93		224.2.4.1	RTP	Payload type=Unknown (96)	SSRC=1727235052	Seq=45652	Time=1442981073		674
8	8	0.043253	172.16.230.93		224.2.4.1	RTP	Payload type=Unknown (96)	SSRC=1727235052	Seq=45653	Time=1442981073		1490
9	9	0.056752	172.16.230.93		224.2.4.1	RTP	Payload type=Unknown (96)	SSRC=1727235052	Seq=45654	Time=1442981073	Mark	595
10	10	0.061687	172.16.230.93		224.2.4.1	RTP	Payload type=Unknown (96)	SSRC=1727235052	Seq=45655	Time=1442984076		1332
11	12	0.073589	172.16.230.93		224.2.4.1	RTP	Payload type=Unknown (96)	SSRC=1727235052	Seq=45656	Time=1442984076	Mark	1359
12	13	0.084185	172.16.230.93		224.2.4.1	RTP	Payload type=Unknown (96)	SSRC=1727235052	Seq=45657	Time=1442987079		1105
13	14	0.093765	172.16.230.93		224.2.4.1	RTP	Payload type=Unknown (96)	SSRC=1727235052	Seq=45658	Time=1442987079		540
14	16	0.097829	172.16.230.93		224.2.4.1	RTP	Payload type=Unknown (96)	SSRC=1727235052	Seq=45659	Time=1442987079		1490
15	17	0.110456	172.16.230.93		224.2.4.1	RTP	Payload type=Unknown (96)	SSRC=1727235052	Seq=45660	Time=1442987079	Mark	395

Analyzing 1 Mbps Trace

Attribute	Value
Mean Packet Size	3962 B
Minimum Packet Size	1400 B
Maximum Packet Size	19264 B
Sample Variance	8402640.1 B^2
Sample Standard Deviation	2898.7 B
Coefficient of Variation	0.73
Coefficient of Skewness	4.55

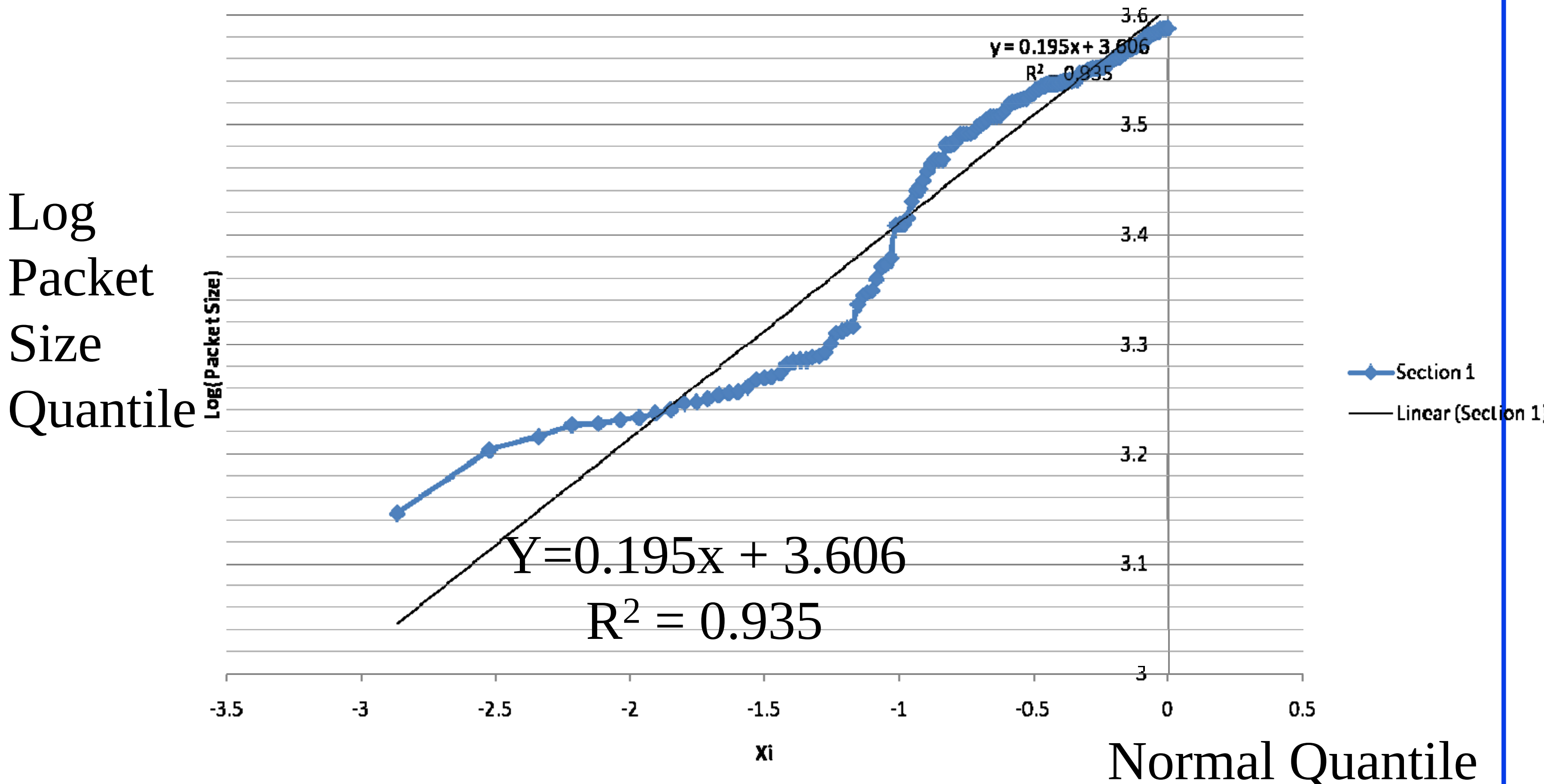
- **Observation**: Large range, small CoV, High skewness $\Rightarrow$ Not Normal
- Past Model: Log-normal distribution in Methodology doc

Normal Quantile-Quantile Plot: Log



- Observations: For log-normal distribution [See Jain91] This Q-Q plot should be a straight line ⇒ Not log normal Three part distribution: Small, medium, large packet sizes

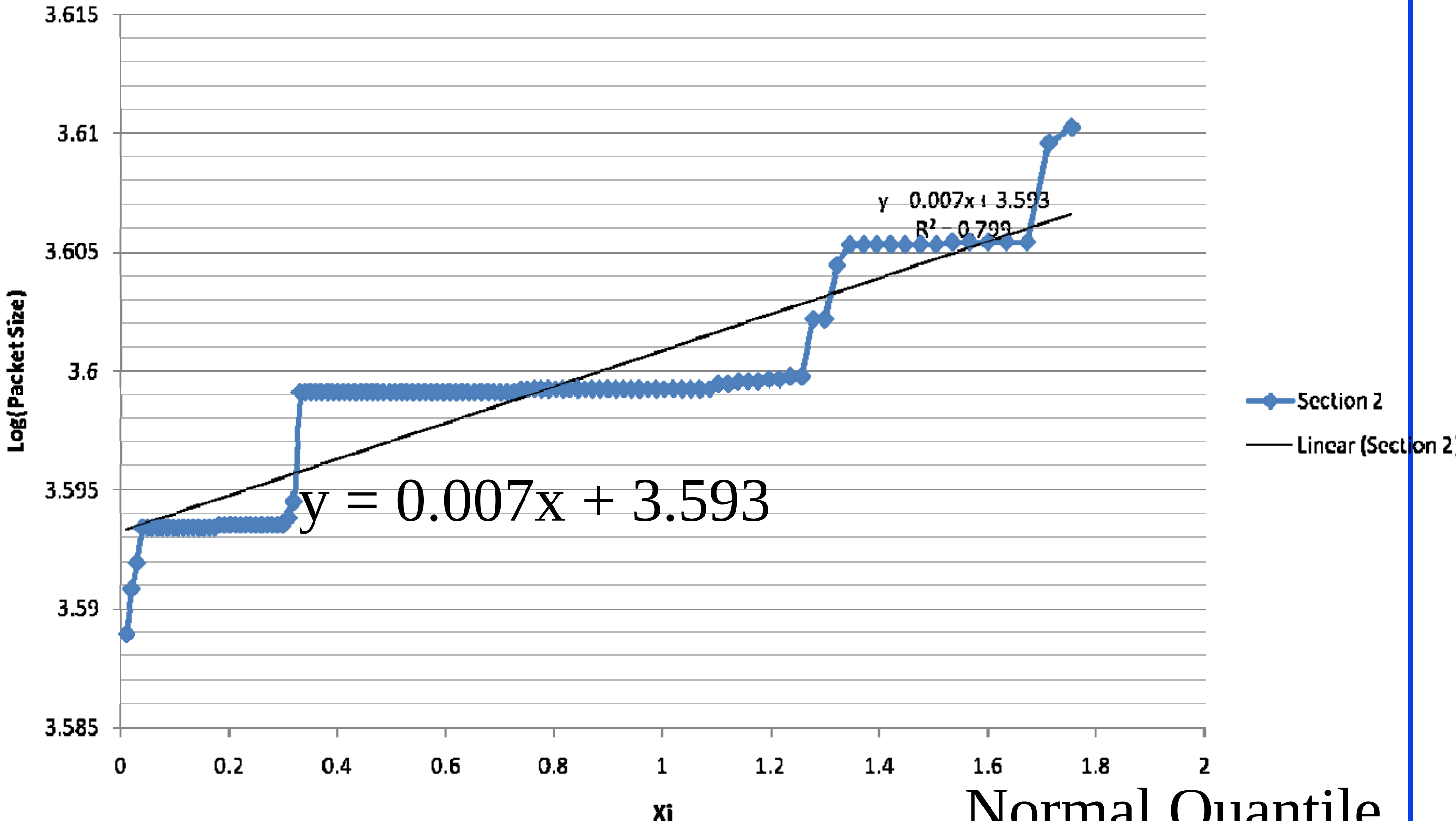
Log Q-Q Section 1: Small Packets



- Observation: Smaller 50% of packets follow an approximate log-normal distribution.

Log Q-Q Section 2: Medium Packets

Log
Packet
Size
Quantile

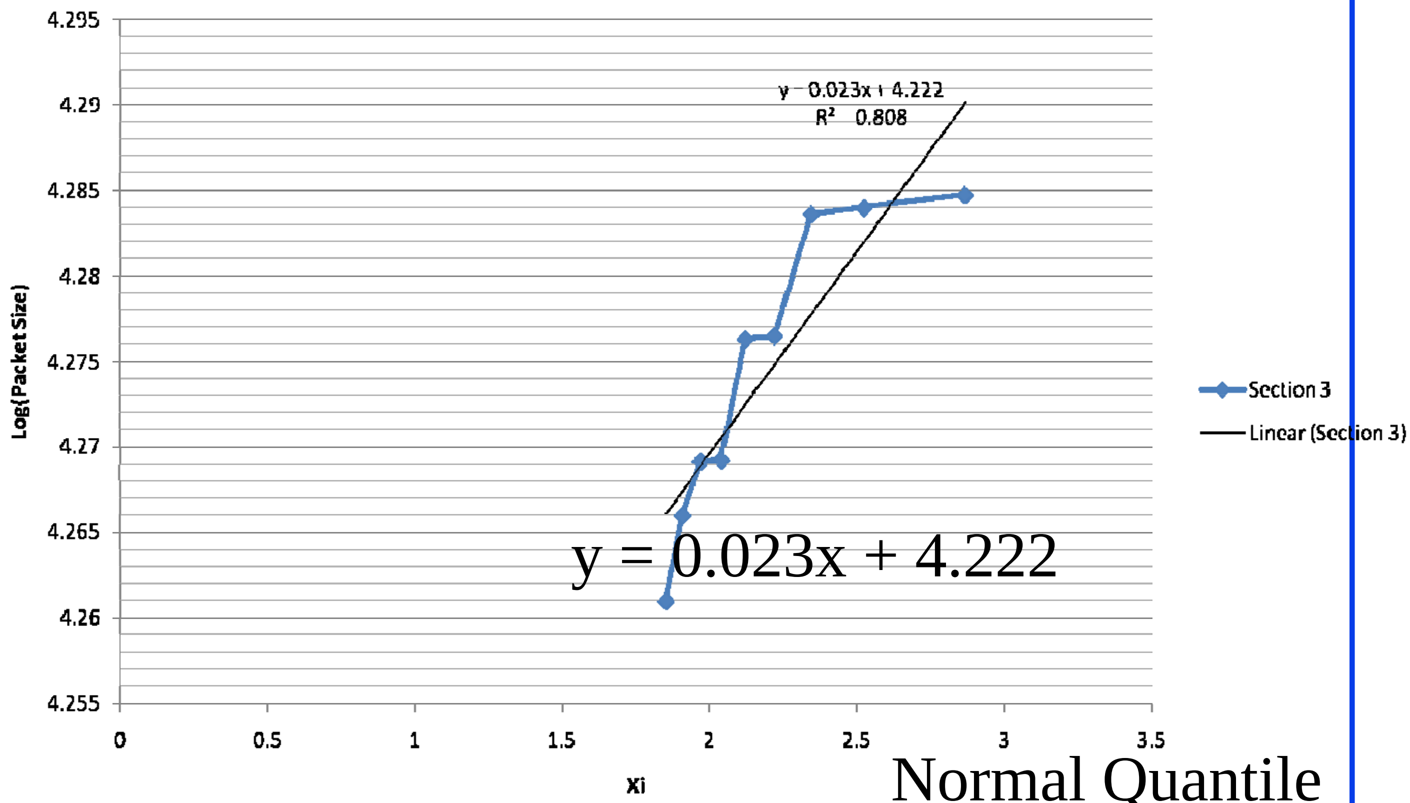


Normal Quantile

- **Observation**: Middle 47% of packets follow another approximate log-normal distribution.
  Very flat ⇒ Close to uniform

Log Q-Q Section 3: Large Packets

Log Packet Size Quantile



y = 0.023x + 4.222

Normal Quantile

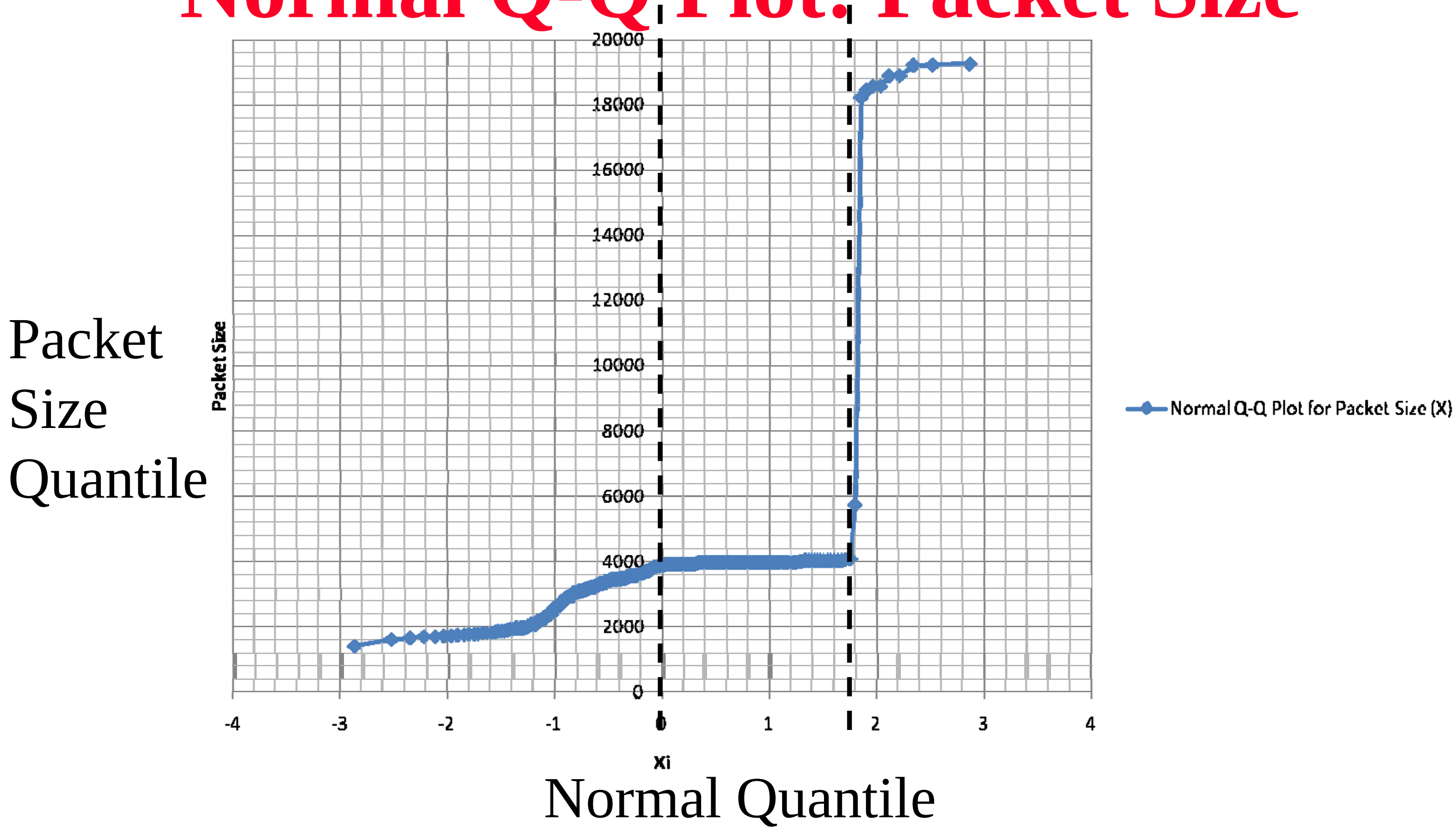
- **Observation**: Large 3% of packets follow another approximate log-normal distribution

Statistical Model for 1 Mbps Mobile TV

$$y = \log(PacketSize) = \begin{cases} -2.866 \le x_i \le 0 \quad \rightarrow \quad y = 0.195x + 3.606 \\ 0 \le x_i \le 1.754 \quad \rightarrow \quad y = 0.007x + 3.593 \\ 1.754 \le x_i \le 2.866 \quad \rightarrow \quad y = 0.023x + 4.222 \end{cases}$$

- If we were to follow this model, the packets would be generated as follows:
  - Generate a N(0, 1) random variable
  - If the number is negative use the first formula
  - If the number is positive but less than 1.754, use 2nd formula
  - If the number is positive but more than 1.754 use 3rd formula

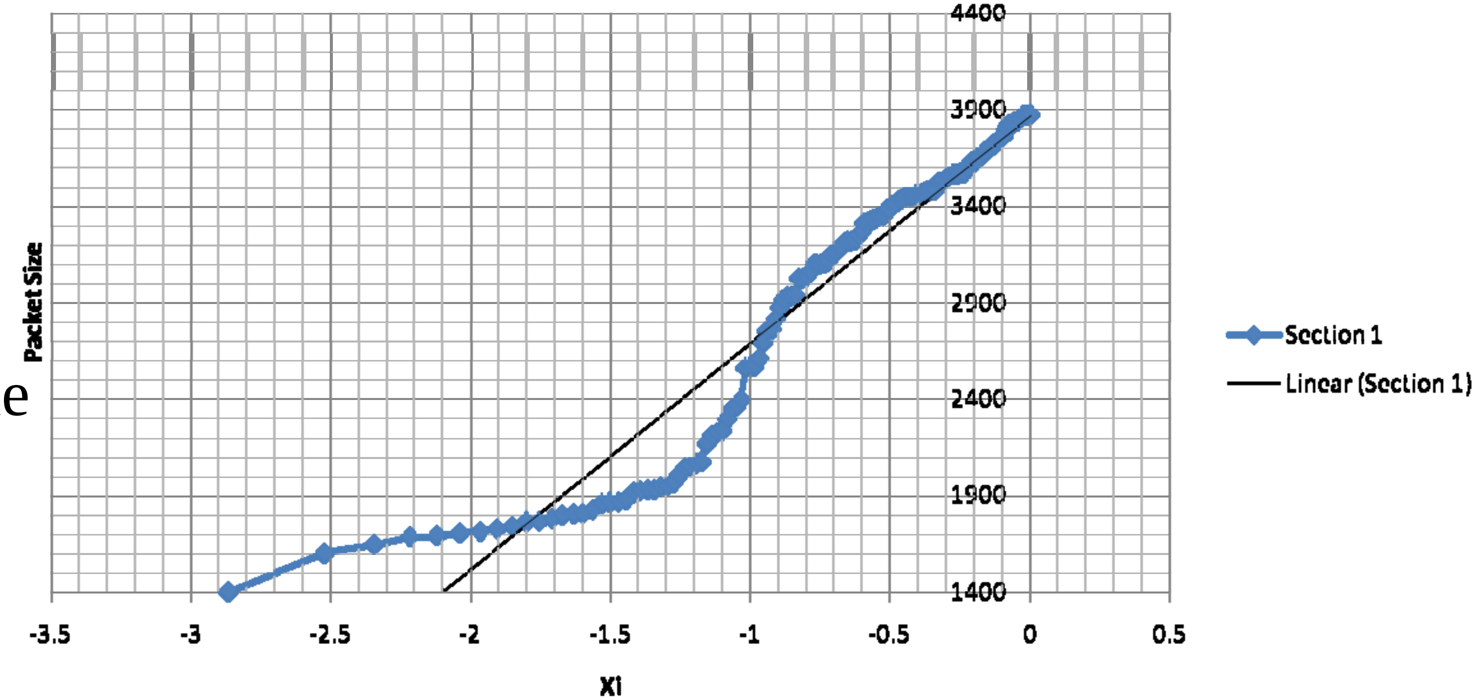
Normal Q-Q Plot: Packet Size



- For normally distributed variables: Q-Q plot is a straight line
- The packet size distribution has 3 different sections

Q-Q Section 1: Small Packets

Packet Size Quantile

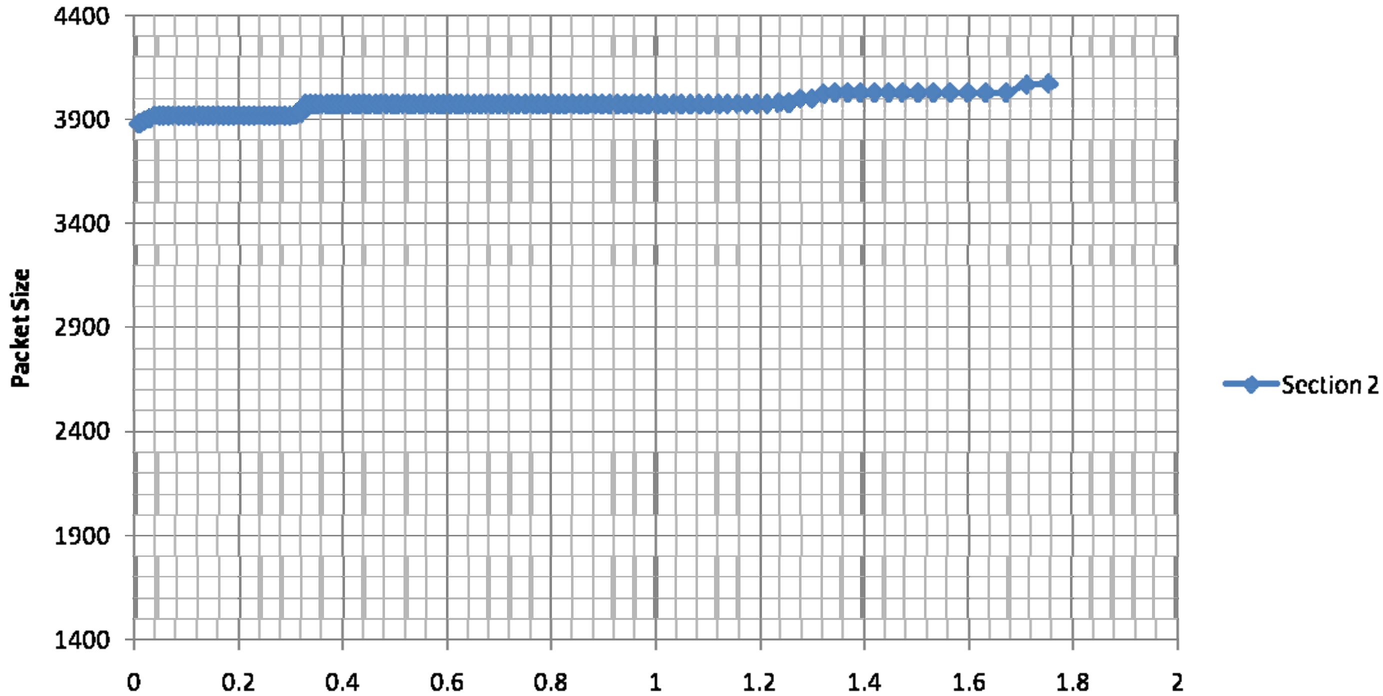


Normal Quantile

- Linear trend-line for the first section: **Y**= 1172 **X** + 3861

Q-Q Section 2: Medium Packets

Packet Size Quantile

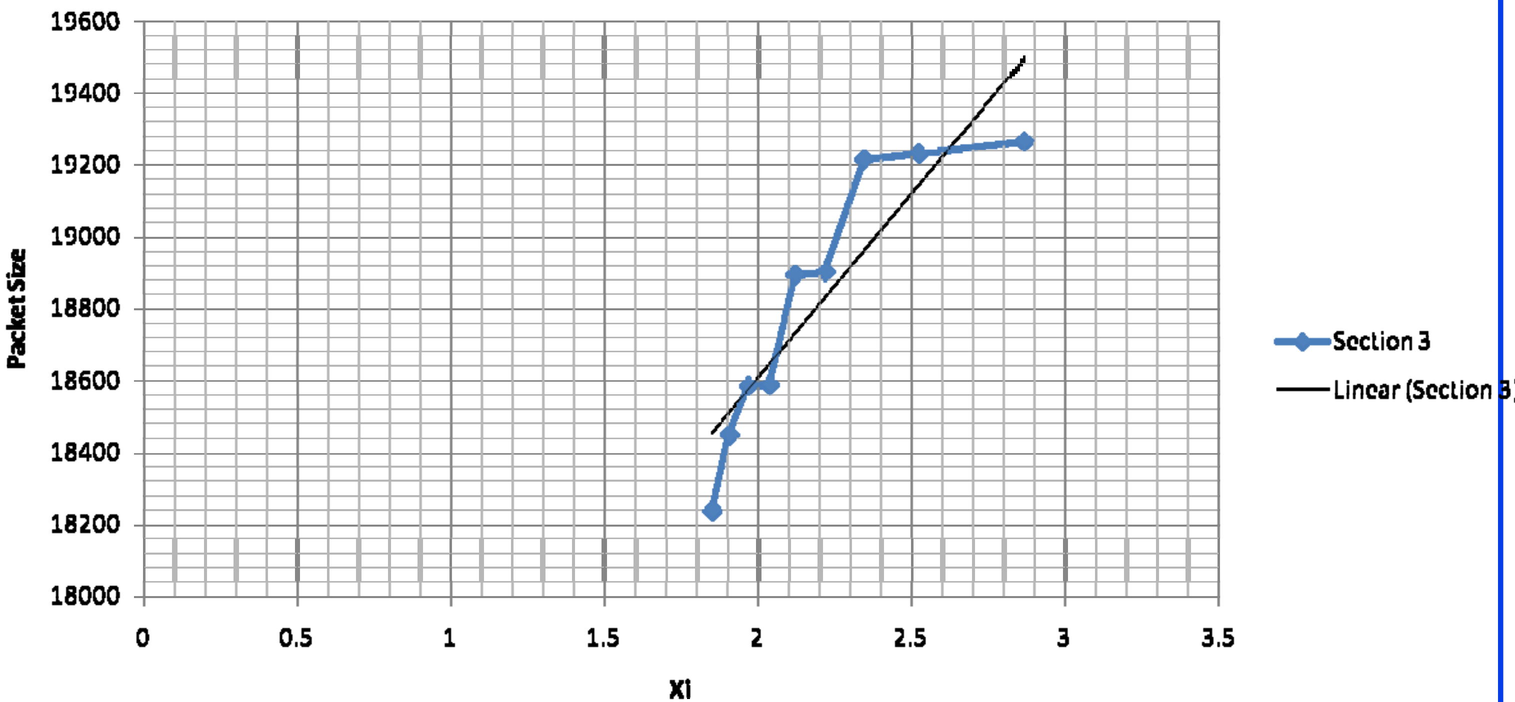


Normal Quantile

- Almost a constant value for the packet size $\cong$ 4000

Q-Q Section 3: Large Packets

Packet Size Quantile



Normal Quantile

- The linear trend-line of the third section represent the following equation: **Y** = 1026 **X** + 16556.
- Again slope = 0.16 = small

Statistical Model for 1 Mbps Mobile TV

$$y = PacketSize = \begin{cases} -2.866 \le x_i \le 0 \quad \rightarrow \quad y = 1172x + 3861 \\ \hline 0 \le x_i \le 1.754 \quad \rightarrow \quad y = 4000 \\ \hline 1.754 \le x_i \le 2.866 \quad \rightarrow \quad y = 1026x + 16556 \end{cases}$$

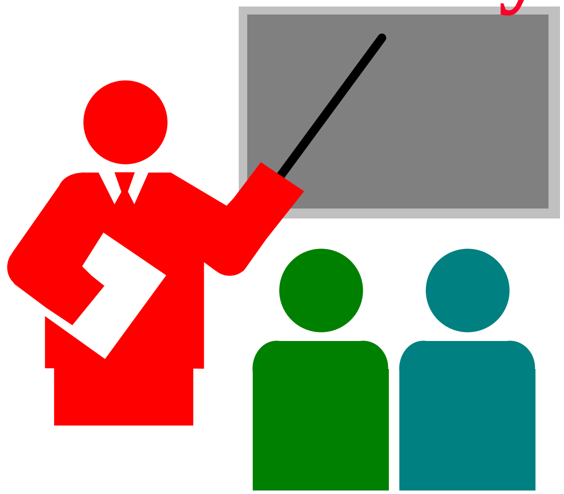
- If we were to follow this model, the packets would be generated as follows:
  - Generate a N(0, 1) random variable
  - If the number is negative use the first formula
  - If the number is positive but less than 1.754, use 2nd formula
  - If the number is positive but more than 1.754 use 3rd formula

R^2 Calculations

Section	Packet Size	Log(Packet Size)
Section 1	0.925	0.935
Section 2	0.8	0.799
Section 3	0.811	0.808

- ❑ R^2 values for both y and log y models are almost same
  $\Rightarrow$ Use simpler model w/o log

Summary

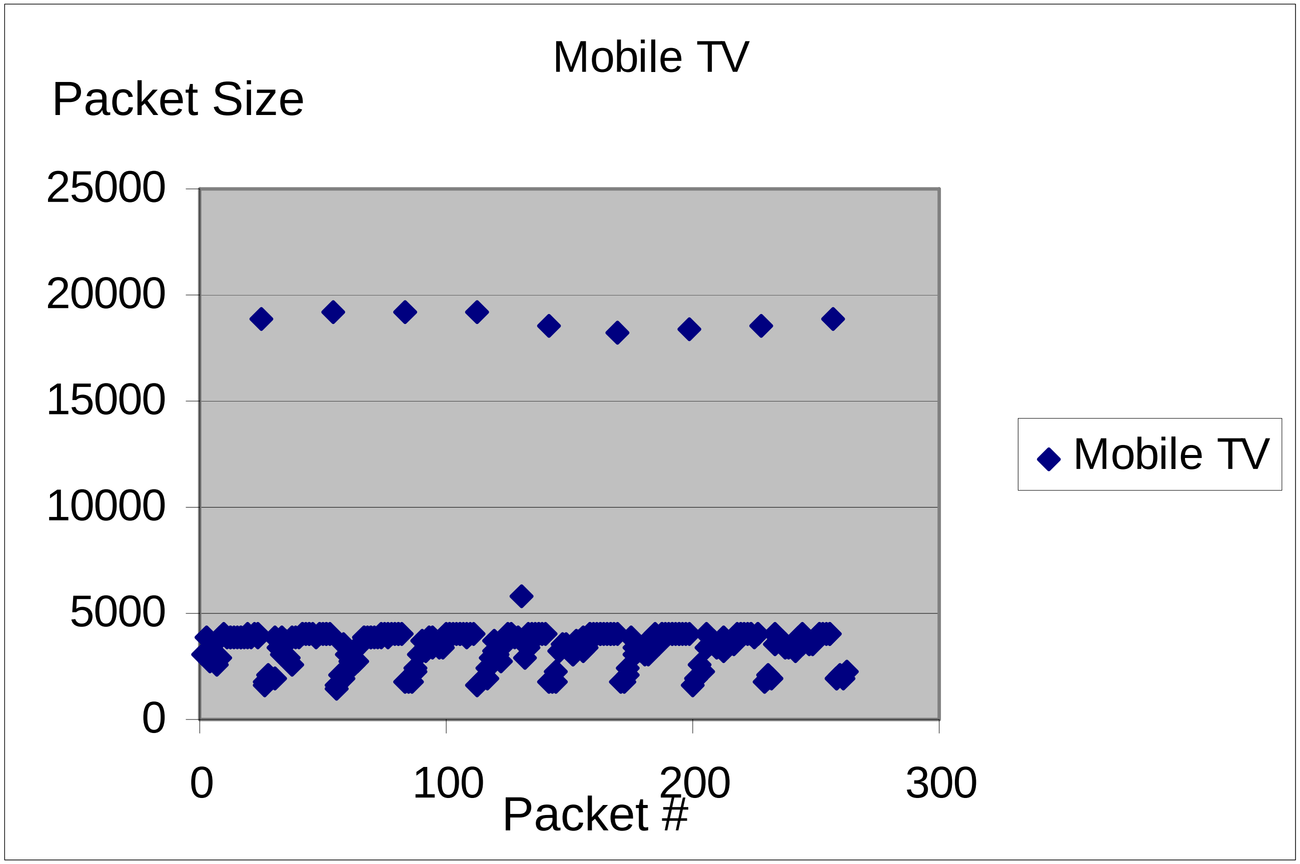


- We have started to characterize Mobile TV workload
- Packet size distribution is not log-normal.
- There seem to be three parts: Normal, Uniform, Uniform

Future Work

- No firm conclusions can be drawn from just one trace
  ⇒ Analyze more traces
  ⇒ Analyze different bandwidth sizes
  ⇒ Analyze different compression schemes (MPEG, MPEG-2, MPEG-4)
- Use more sophisticated model including time correlation
- Study performance
- Develop methods to optimize performance

Time Correlation



- Strong periodic behavior

References

- Kemal Ozdemir, Francis Retnasothie, "WiMAX Capacity Estimation for Triple Play Services including Mobile TV, VoIP, and Internet," Version 1.0, June 18, 2007.
- R. Jain, "The Art of Computer Systems Performance Analysis," Wiley, 1991, ISBN:0471503361