Investigation on the IP Flow Inter-arrival Time in Large-scale Network

Wu Hua

College of Computer Science & Engineering

Southeast University

Outline

- Introduction
- Distribution of the IP flow Inter-arrival Time
- Autocorrelation Studying on the IP flow inter-arrival Times
- Conclusion

Introduction

- The number of TCP packets dominates the IP Packets
- Two main viewpoints about the TCP flow inter-arrival times
  - The TCP flow inter-arrival is a Weibull distribution
  - The TCP flow inter-arrival is a Poisson process
- Researchers are wondered whether it is a Weibull distribution or a Poisson distribution.

Description of the Traces

TRACE	Duration	Avail_BW
Cernet_a	Nov.10, 2005 00:40(20 minutes)	1G*2*3(6Gb)
Cernet_b	Nov.10, 2005 21:00 (1 hour)	1G*2*3(6Gb)
Abilene I (IPLS-CLEV)	Aug 14, 2002 09:00(2 hours)	OC48(2.5G)
Abilene III (IPLS-KSCY)	Jun 01,2004 19:31(30 minutes)	OC192(10Gb)
Leipzig-I	Nov 22,2002 20:00 (10 hour)	OC3(155M)
AucklandII_a	Dec 01,1999 19:25 (24 hours)	100M

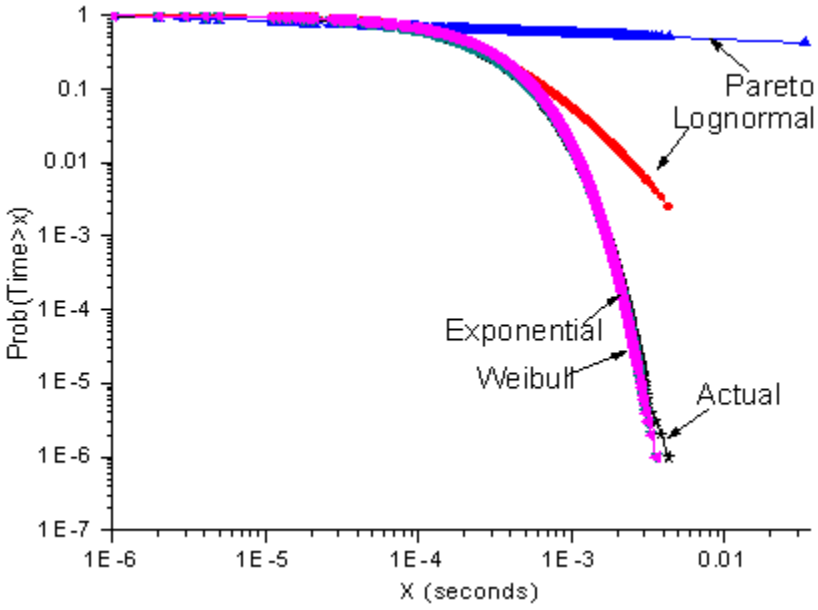
- Complementary Cumulative Distribution Function (CCDF)
- CCDF of Weibull distribution

$$\Pr[X \le x] = 1 - \exp\{-(\lambda x)^{\alpha}\}$$

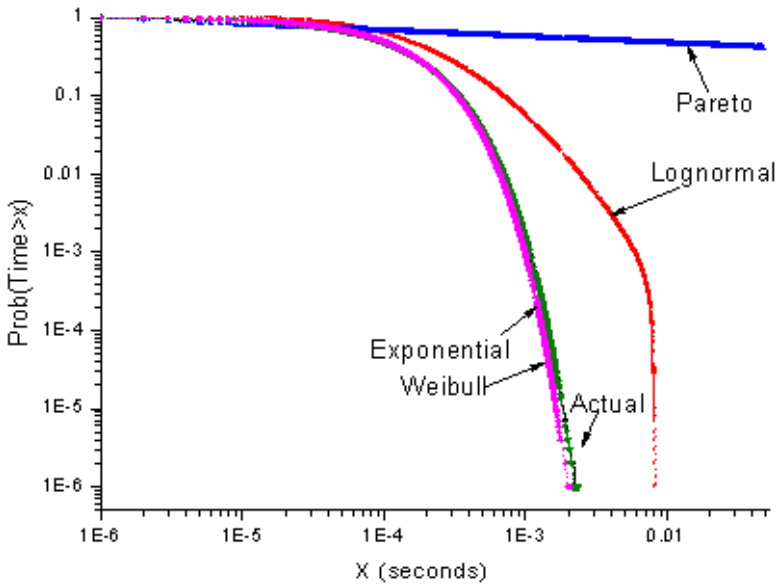
$$x > 0, \lambda > 0, \alpha > 0$$

- when α equals to 1, the Weibull distribution degrades to the Exponential distribution

IP flow inter-arrival time CCDF



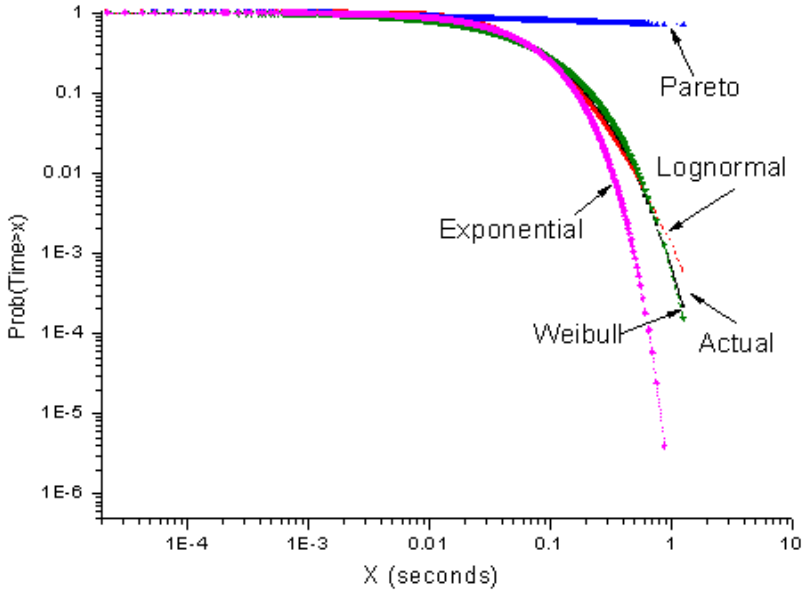
Cernet_b



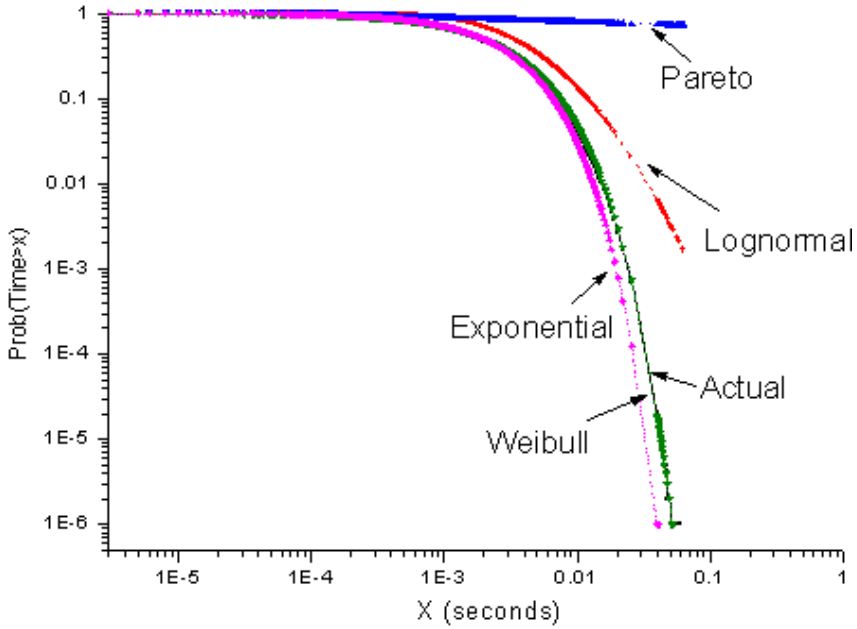
Abilene III

- The most fitted model is the Weibull distribution
- The Weibull curves and the Exponential curves overlap with each other.
- The parameter α of the Weibull distribution function are all very close to 1 .

IP flow inter-arrival time CCDF



AucklandII_a



Leipzig-I

- The most fitted model is the Weibull distribution
- These Weibull distribution have the parameter α much less than 1,
- The Exponential distribution curves have large difference with the actual curves and the Weibull curves

Conclusion A

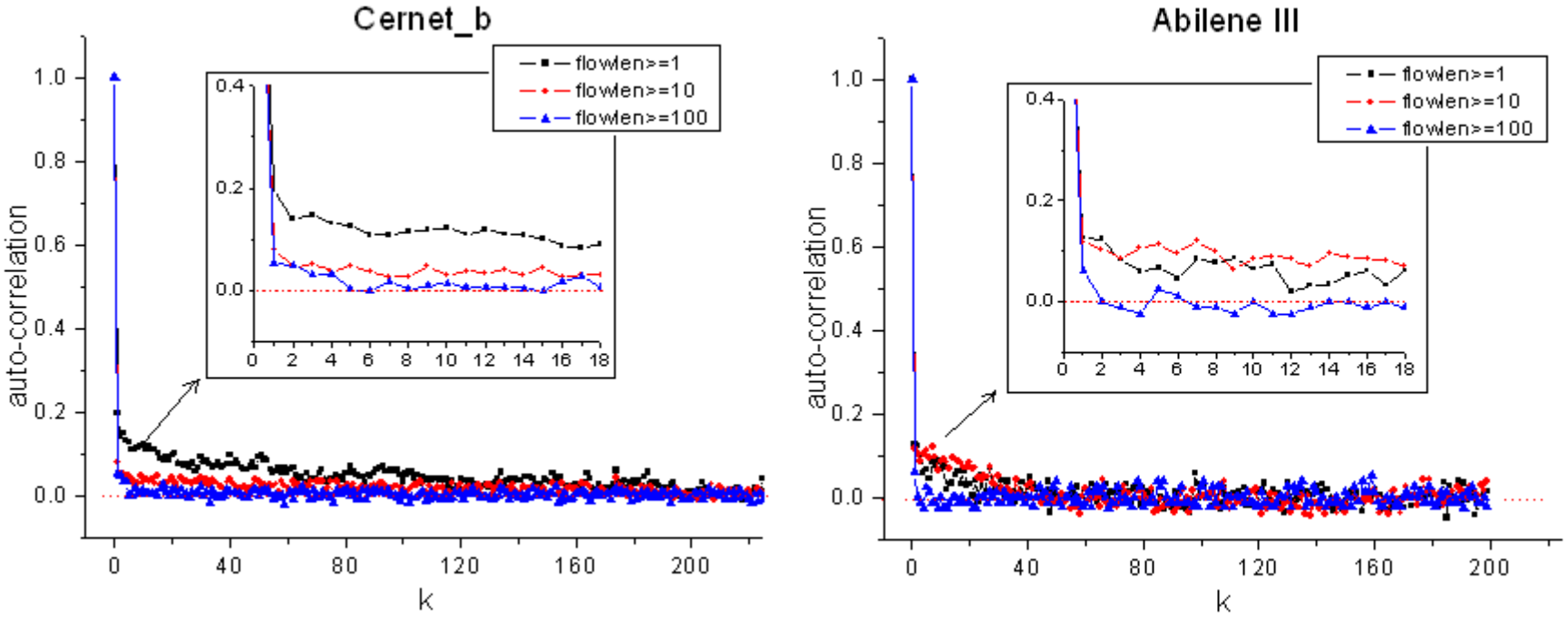
- The Weibull distribution can be used to describe the IP flow inter-arrival time distribution, when the IP flow arrivals' density reach to a certain threshold, it can be fitted to the Exponential distribution.

Autocorrelation Studying on the IP flow inter-arrival Times

- Requirements to analyze the correlation of the flow inter-arrival times :If the arrival of one series can be fit to a Poisson distribution, the arrive time of the elements should fit to the Exponential distribution and the elements should be independent.
- Autocorrelation was used to analyze the correlation of the flow inter-arrival times:

$$r_k = \frac{\frac{1}{n-k}\sum_{t=1}^{n-k}(x_t - \bar{x})(x_{t+k} - \bar{x})}{\frac{1}{n}\sum_{t=1}^{n}(x_t - \bar{x})}.$$

Autocorrelation of IP flow inter-arrival times of different flow length



- The IP flow inter-arrival times at least have a short-time correlation; some of the autocorrelation curves achieve the relatively equilibrium state when the lags k is relatively large
- The longer the flow length is the smaller the autocorrelation coefficient is

Conclusion B

- The IP flow inter-arrival time distribution fits to the Weibull distribution generally
- When the IP flow length exceed a certain threshold, the IP flow inter-arrival time fits to the Poisson distribution.

Thank you!