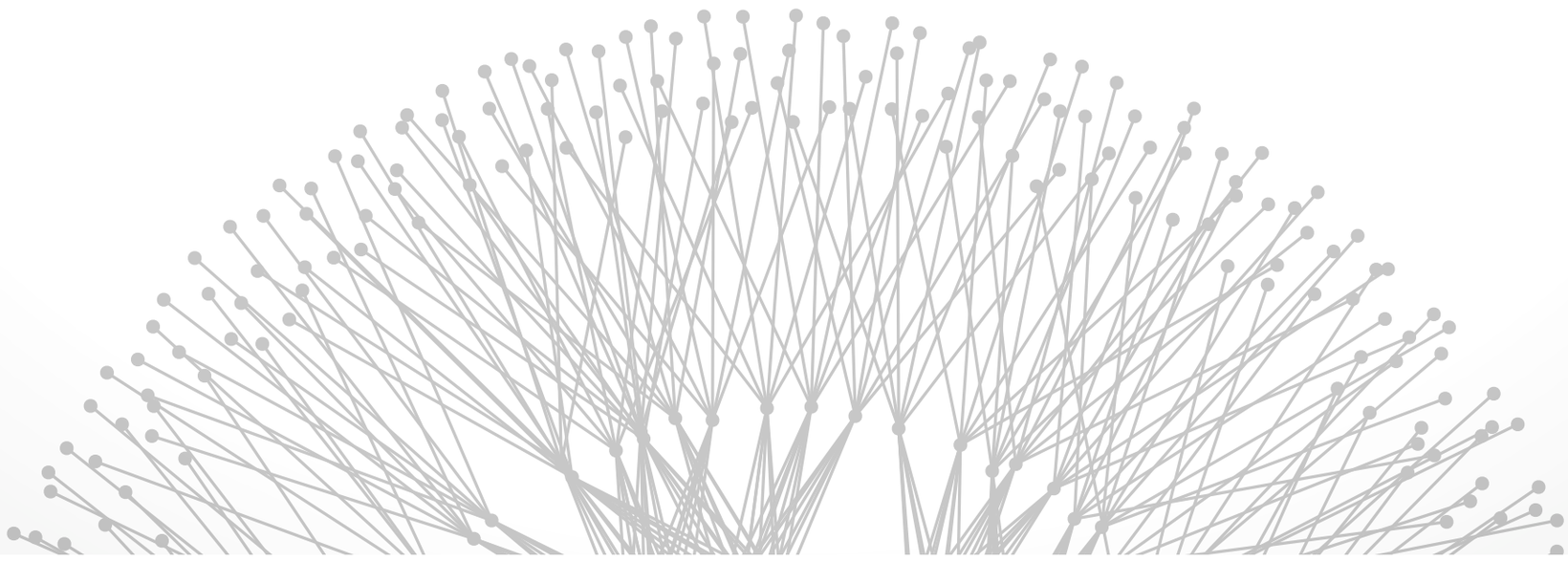
Network Measurement

Brighten Godfrey

CS 538 November 15 2012



Science of network measurement

Measurement goes back to the inception of the Internet

By the mid-1990s: Internet and its protocols were big, wild, organic

- Complex system: hard to predict global effects of interacting components
- Distributed multi-party system: can't see everything that's happening

Network measurement moves from "just" monitoring to a science

Challenge #1: Emergent behavior

Example: Model packet arrivals over time at a link

Simplest common model: Poisson process

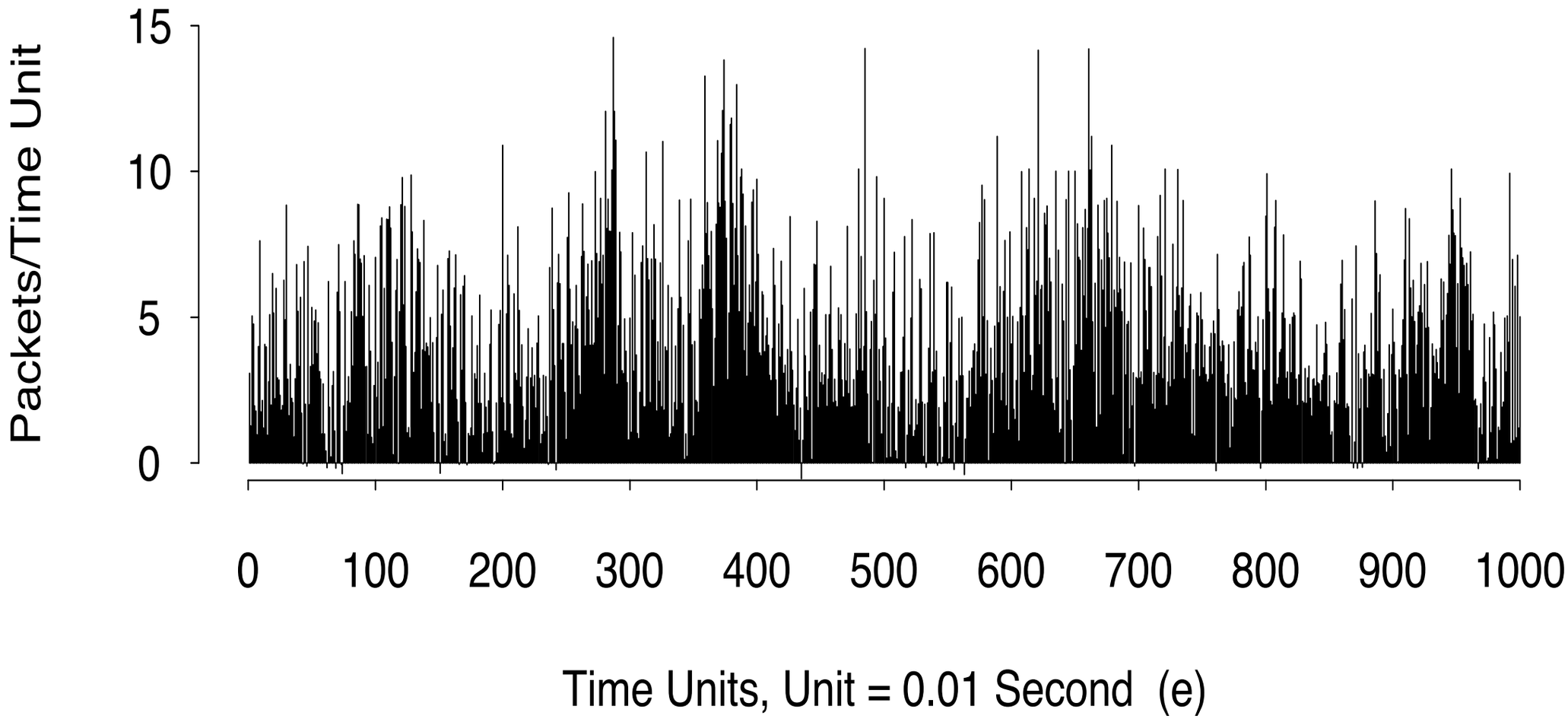
- Parameter: rate λ (mean arrivals per unit time)
- Pr[time till next arrival > t] = $e^{-\lambda t}$ (exponential dist.)

Properties

- Memoryless: Even knowing entire history gives no clue as to next arrival time
- Number of arrivals in a given time interval concentrates around expected value

Temporal patterns of traffic

"On the Self-Similar Nature of Ethernet Traffic"
Leland, Taqqu, Willinger, Wilson, SIGCOMM 1993



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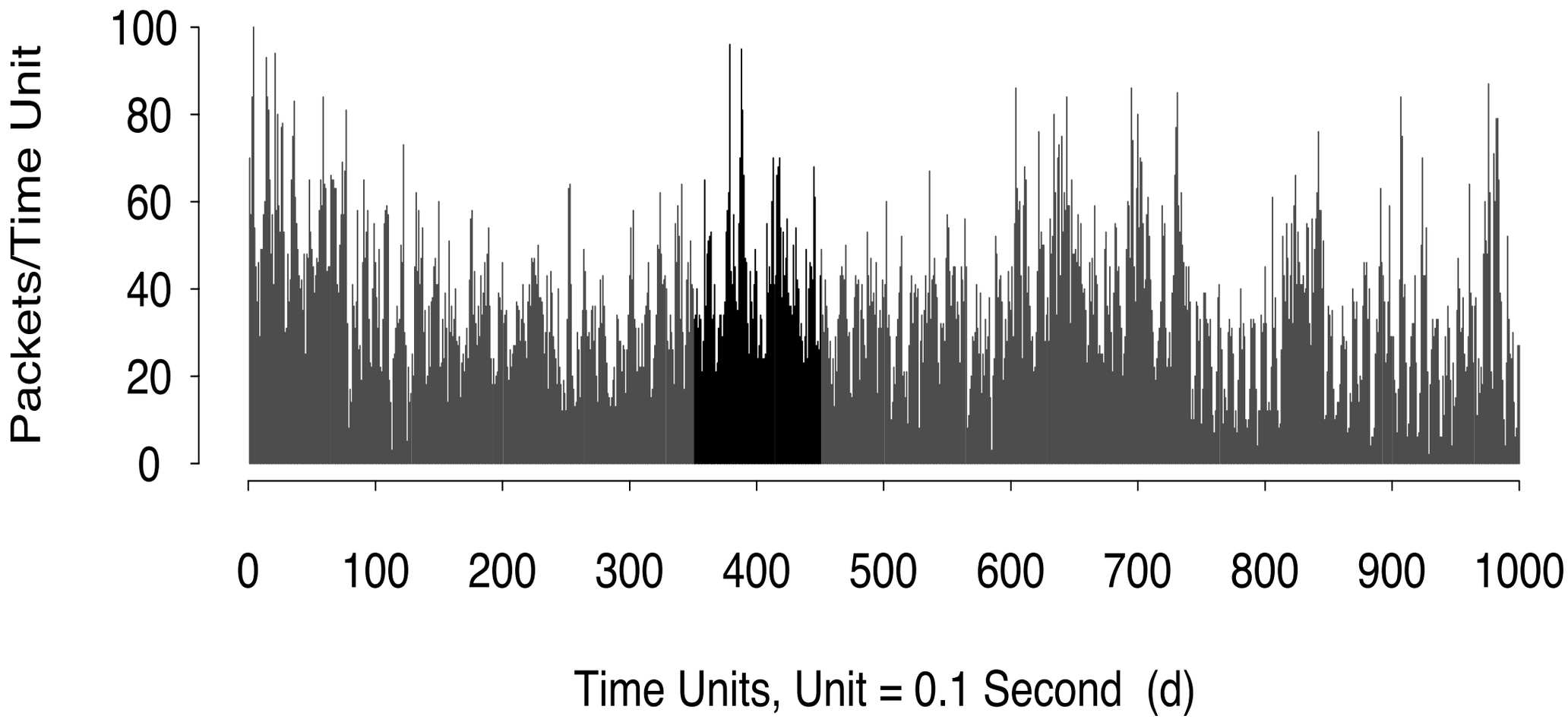

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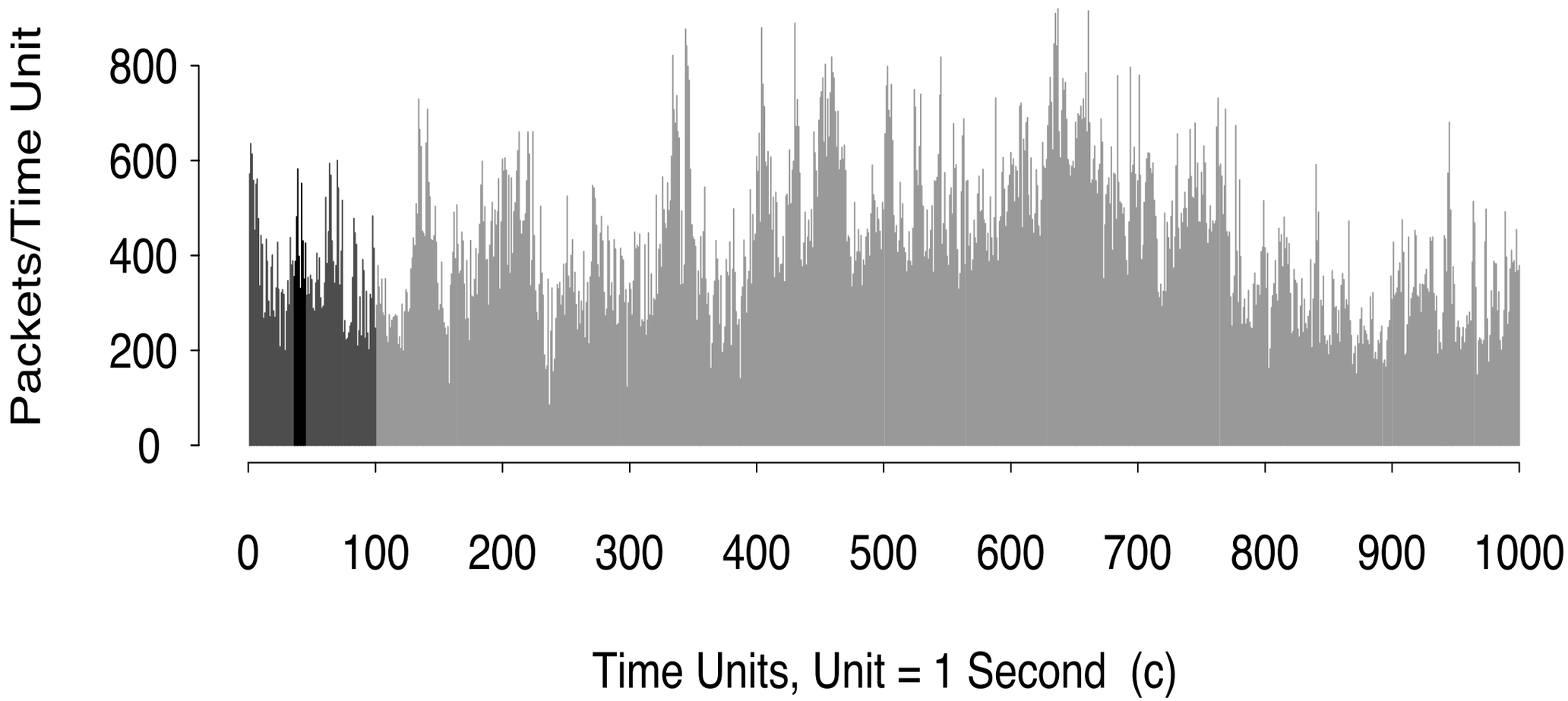

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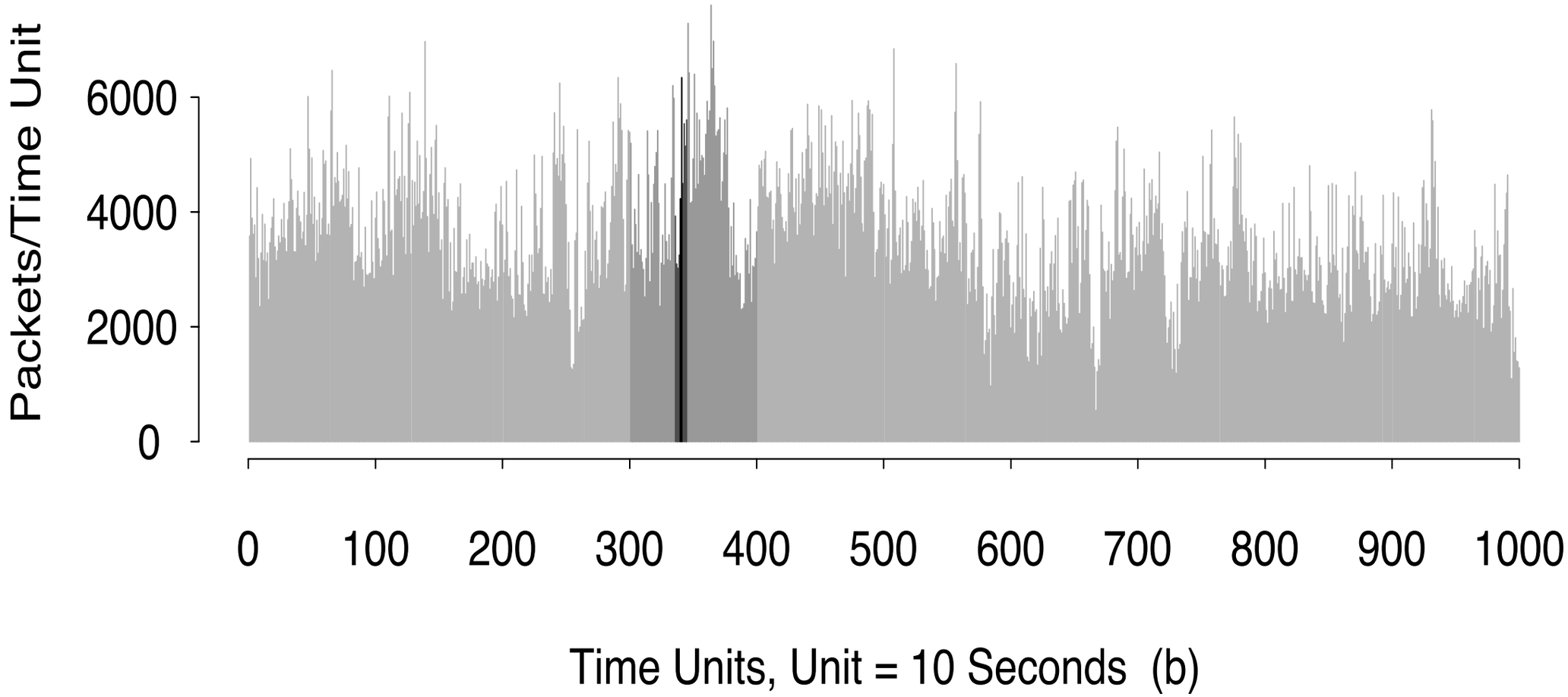

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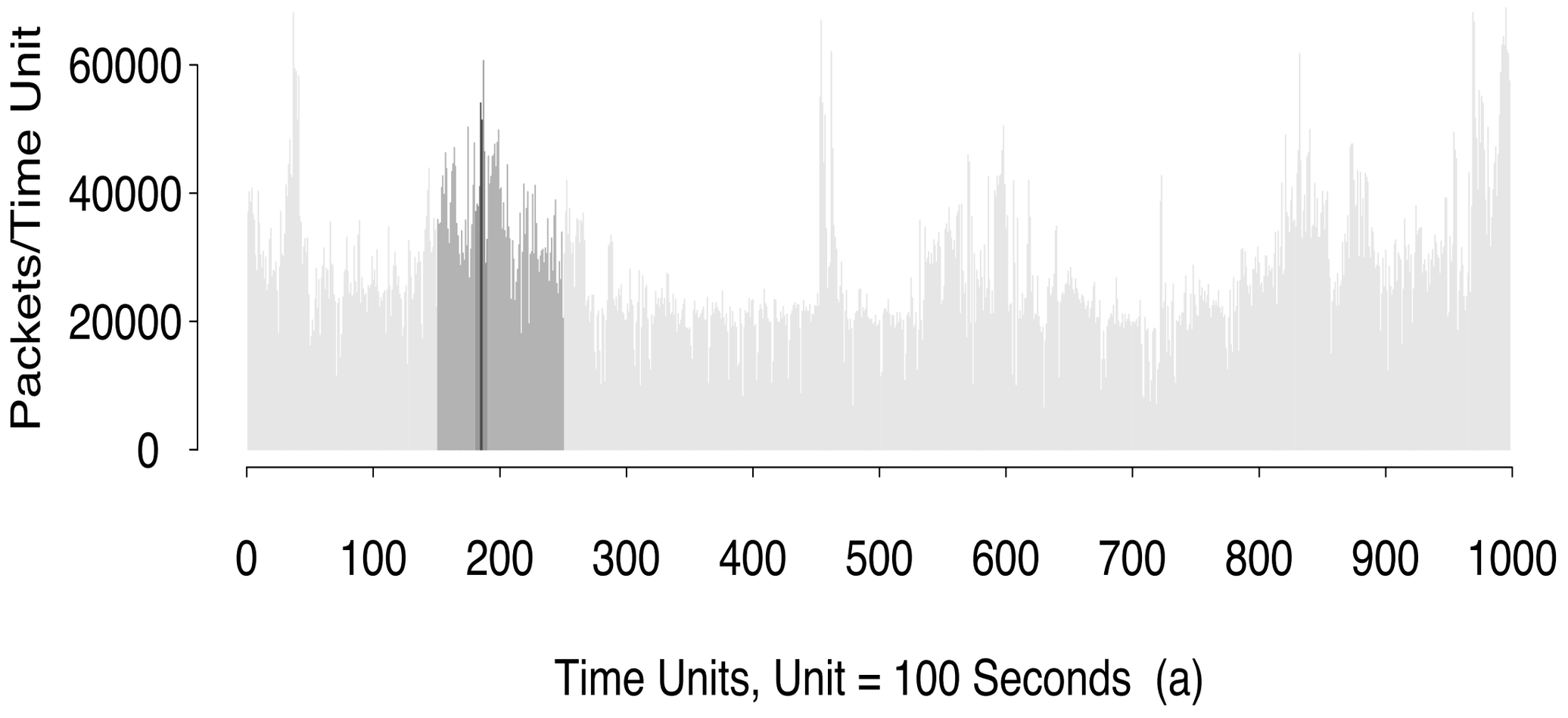

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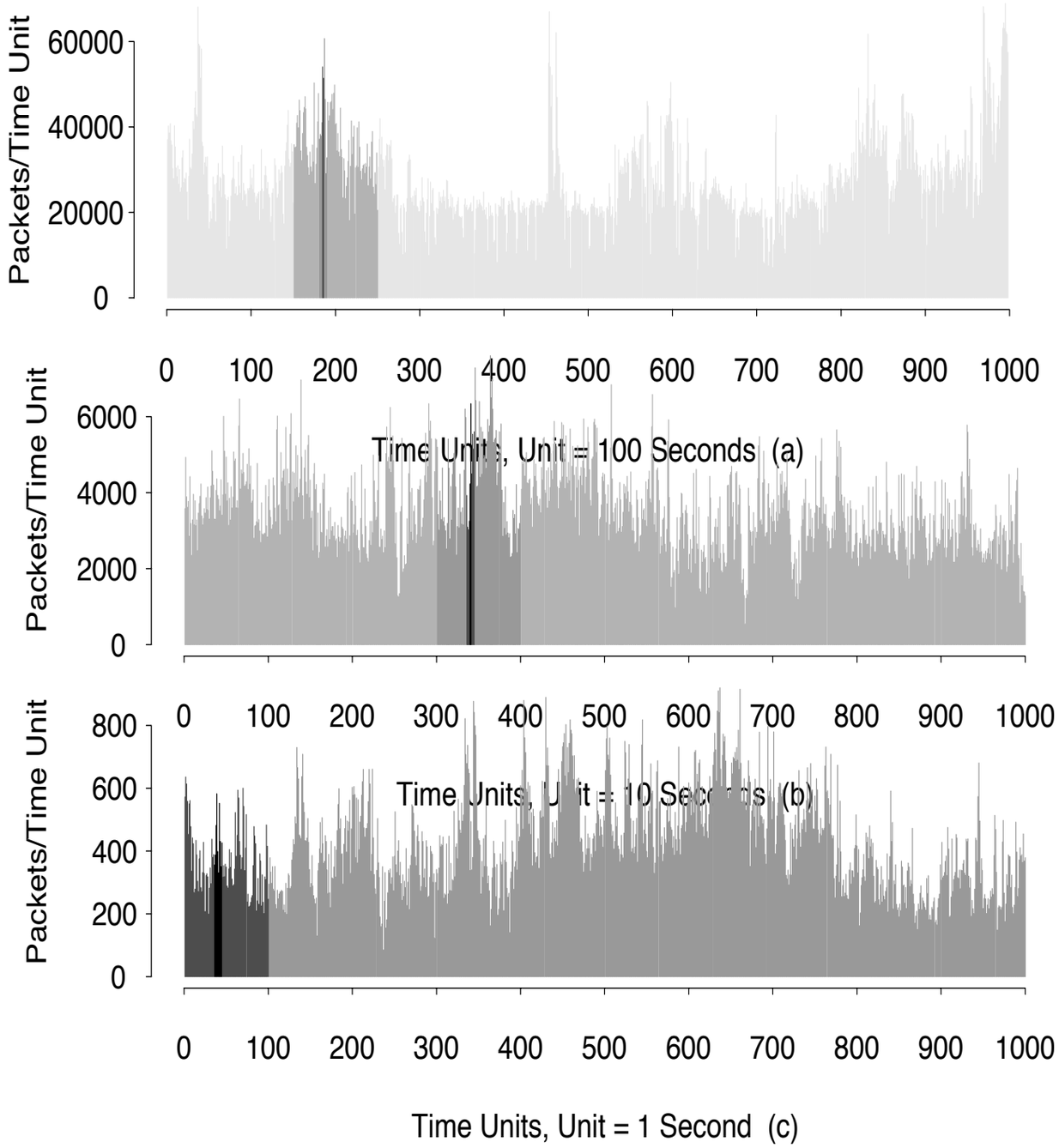
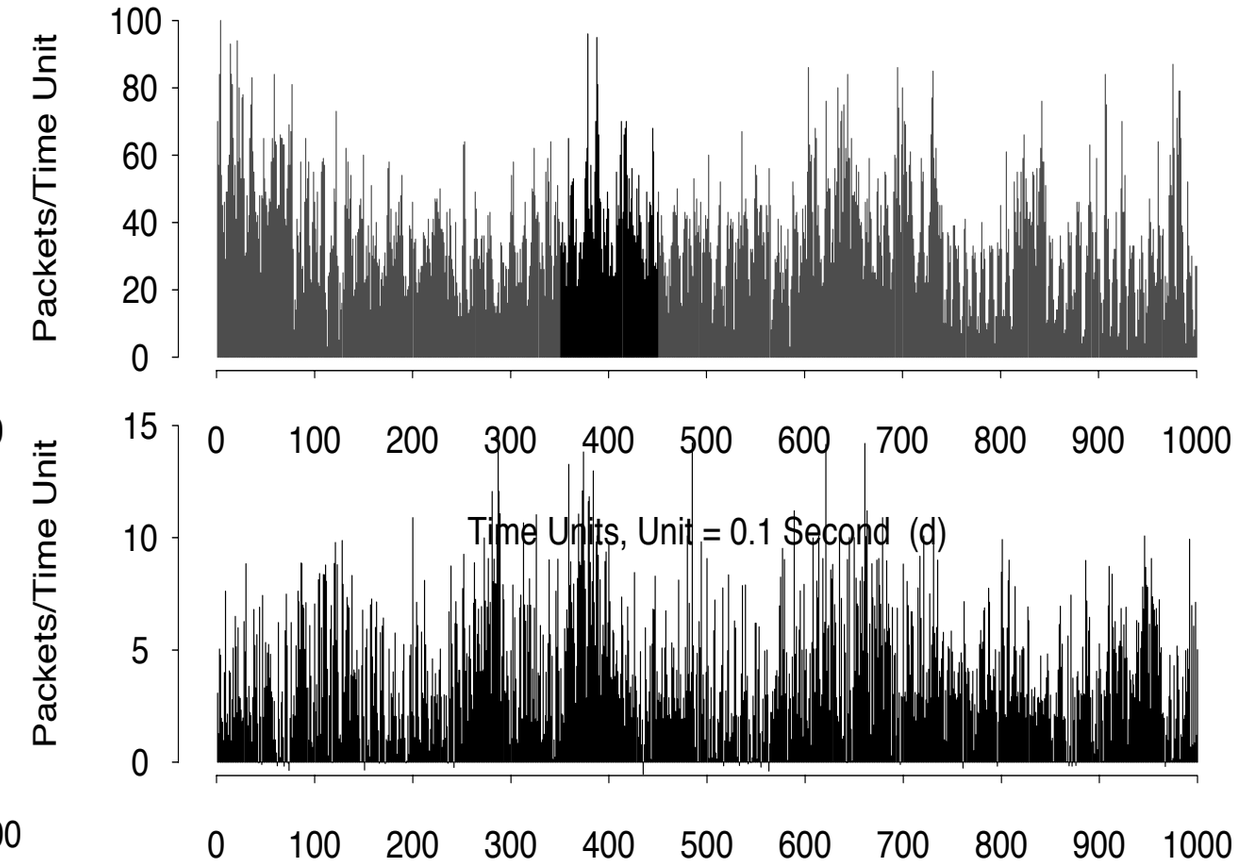




Bursty at all resolutions; Not captured by simple Poisson traffic model!

Challenge #2: Lack of visibility

Only a fraction of the system is visible

- For what we can observe, the cause is not obvious

Foundational work by Vern Paxson in the mid 1990s

- "End-to-End Routing Behavior in the Internet", SIGCOMM 1996
- Loops, asymmetry, instability
- Established Internet measurement methodology: "looking inside the black box" via end-to-end measurements

Name	Description
adv	Advanced Network & Services, Armonk, NY
austr	University of Melbourne, Australia
austr2	University of Newcastle, Australia
batman	National Center for Atmospheric Research, Boulder, CO
bnl	Brookhaven National Lab, NY
bsdi	Berkeley Software Design, Colorado Springs, CO
connix	Caravela Software, Middlefield, CT
harv	Harvard University, Cambridge, MA
inria	INRIA, Sophia, France
korea	Pohang Institute of Science and Technology, South Korea
lbl lbli	Lawrence Berkeley Lab, CA LBL computer connected via ISDN, CA
mid	MIDnet, Lincoln, NE
mit	Massachusetts Institute of Technology, Cambridge, MA
ncar	National Center for Atmospheric Research, Boulder, CO
near	NEARnet, Cambridge, Massachusetts
nrao	National Radio Astronomy Observatory, Charlottesville, VA
oce	Oce-van der Grinten, Venlo, The Netherlands
panix	Public Access Networks Corporation, New York, NY
pubnix	Pix Technologies Corp., Fairfax, VA
rain	RAINet, Portland, Oregon
sandia	Sandia National Lab, Livermore, CA
sdsc	San Diego Supercomputer Center, CA
sintef1 sintef2	University of Trondheim, Norway University of Trondheim, Norway
sri	SRI International, Menlo Park, CA
ucl	University College, London, U.K.
ucla	University of California, Los Angeles
ucol	University of Colorado, Boulder
ukc	University of Kent, Canterbury, U.K.
umann	University of Mannheim, Germany
umont	University of Montreal, Canada
unij	University of Nijmegen, The Netherlands
usc	University of Southern California, Los Angeles
ustutt	University of Stuttgart, Germany
wustl	Washington University, St. Louis, MO
xor	XOR Network Engineering, East Boulder, CO

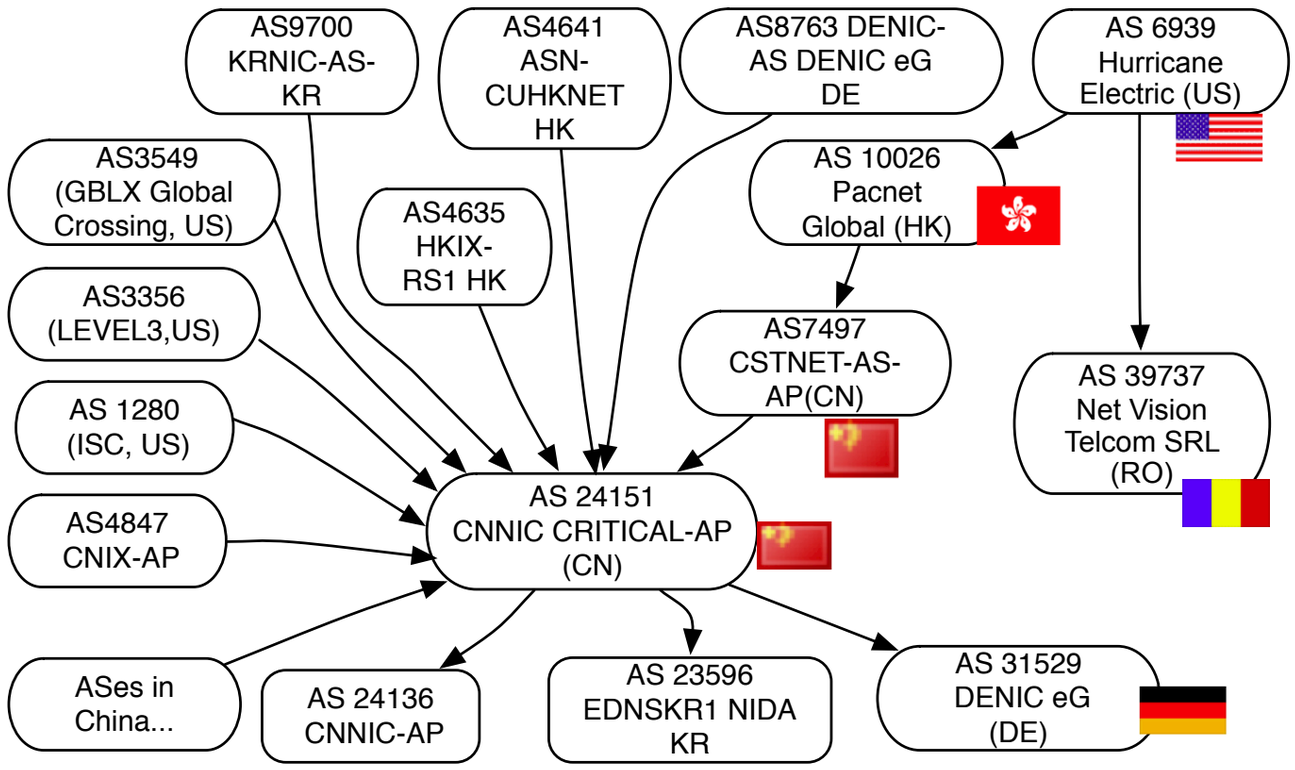
[Paxson's vantage points]

Discussion

"The Collateral Damage of Internet Censorship by DNS Injection" [Anonymous, CCR 2011]

What are the main take-away conclusions?

- DNS injection censorship causes collatoral damage, censoring outside its jurisdiction



Discussion

We typically use many vantage points in order to "see inside the black box" of the Internet. How did this paper use that technique and why was it rather easy?

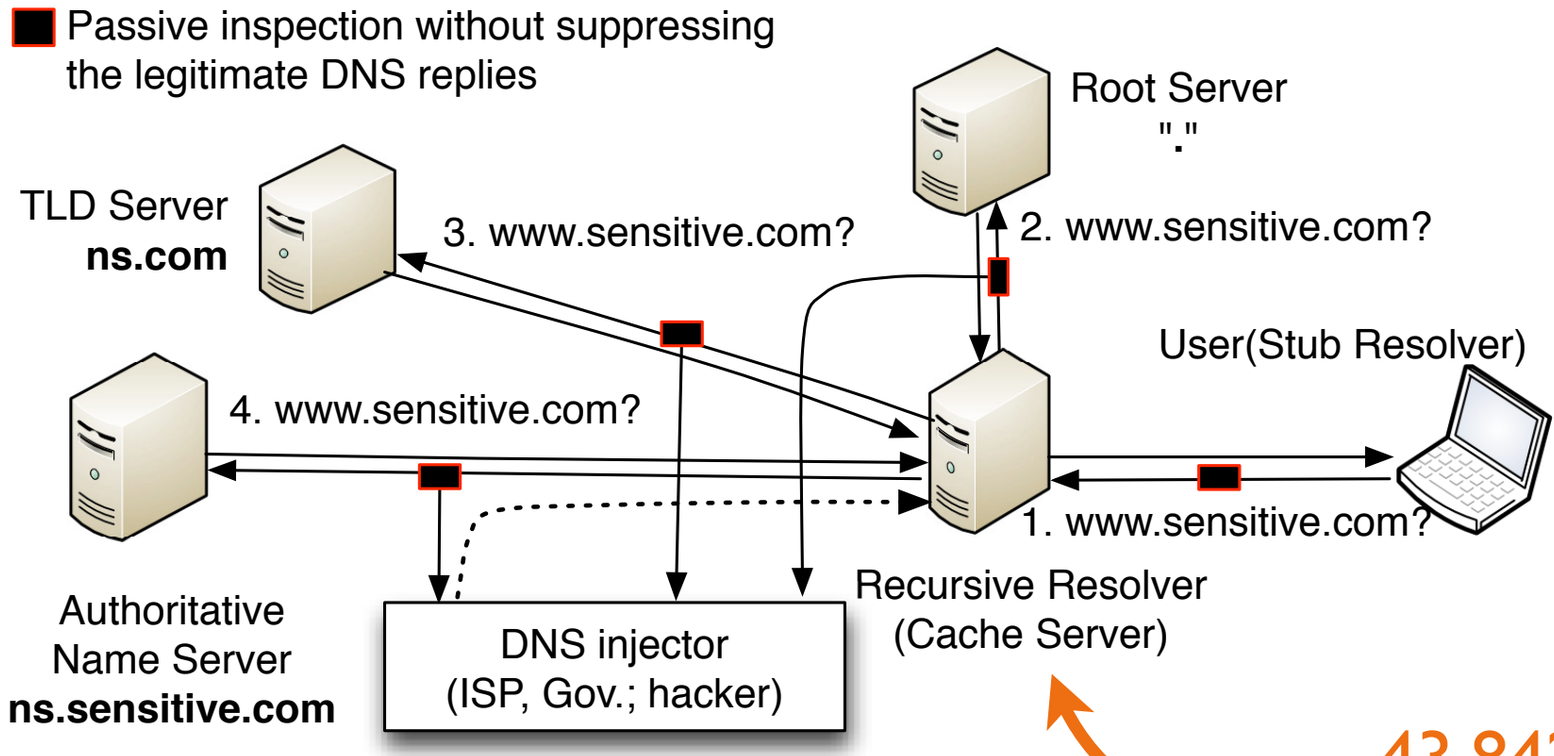


Figure 1: DNS query process and DNS injection

Discussion

How could you counteract this censorship?

- Threat of depeering?
- Interesting thought from Jonathan Gill: "It would be interesting to see if a DNS client could obfuscate the hostname they are requesting in such a way that would bypass censorship regular expressions, yet yield valid results."

A word of caution

> *The most important difference between computer science and other scientific fields is that:* We build what we measure. *Hence, we are never quite sure whether the behavior we observe, the bounds we encounter, the principles we teach, are truly principles from which we can build a body of theory, or merely artifacts of our creations. ... this is a difference that should, to use the vernacular, 'scare the bloody hell out of us!'*

– John Day