Network measurement

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CS 538 November 8 2011
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 effects of interacting components
- **Distributed system:** can’t see everything that’s happening

Network measurement moves from “just” monitoring to a science
Measuring the Internet

Key challenge: lack of visibility

- Only a small fraction of the system is visible
- For what we can observe, the cause is not obvious

Foundational work by 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

Of course, internal data is nice if you can get it...
Temporal patterns of traffic

“On the Self-Similar Nature of Ethernet Traffic”
Leland, Taqqu, Willinger, Wilson, SIGCOMM 1993
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![Graph showing traffic patterns](image)
“On the Self-Similar Nature of Ethernet Traffic”
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The notion of self-similarity is not merely an intuitive

3.2 THE MATHEMATICS OF SELF-SIMILARITY

Packets/Time Unit

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<th>Time Units, Unit = 100 Seconds (a)</th>
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Packets/Time Unit

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Packets/Time Unit

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Pictorial “proof” of self-similarity:
Temporal patterns of traffic

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

Bursty at all resolutions; Not captured by simple traffic models!
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