



The UNIVERSITY of NORTH CAROLINA
at CHAPEL HILL

The Internet of 2024... Is the Internet of 2004!

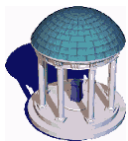
Kevin Jeffay

Department of Computer Science
University of North Carolina at Chapel Hill

October 2004

<http://www.cs.unc.edu/Research/dirt>

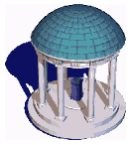
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The Internet of 2024 Lessons from other industries

- In 1955, what was the vision of air travel in 1980?
 - Supersonic passenger aircraft
 - Space travel?
 - Personal aircraft, hybrid plane-cars, “lightweight” air travel
- Reality was fantastic-but-“mundane” innovation in infrastructure and implementation
 - Cheaper, faster, safer, more reliable
 - Massive growth and adoption
- The Internet of 2024?
 - Cheaper, faster, safe, more reliable
 - Massive growth and adoption
 - But no space travel...

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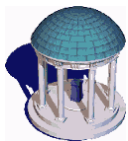


The Internet of 2024

Lessons from the last century

- Innovation and revolution in computer science rarely comes from computer scientists
 - We're the infrastructure guys, not the visionaries
 - » Personal computing, the web — pioneered by physicists!
 - » Computer architecture, packet switching, distributed systems
 - In fact, we often complain about the things that make a difference...

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A Historical Digression on the Web

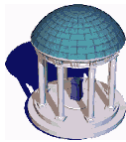
Van Jacobson's Web flame

How to Kill the Internet

Van Jacobson
Lawrence Berkeley Laboratory
Berkeley, CA 94720

SIGCOMM '95 Middleware Workshop
Cambridge, MA
28 August 1995

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A Historical Digression on the Web

Van Jacobson's Web flame

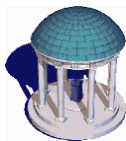
The Internet was designed to survive
a nuclear war.

It lives up to its design.

How might you kill it?

vj-Middleware WS-2

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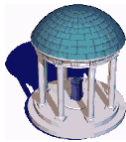
A Historical Digression on the Web

Van Jacobson's Web flame

Easy — Invent the Web.

vj-Middleware WS-3

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A Historical Digression on the Web Van Jacobson's Web flame

Web traffic is destroying the Internet.

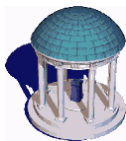
Not because it's popular — there are benign popular protocols — but because the application-level protocols are abysmal.

With a lot of effort and cooperation, we may be able to fix the Web without changing its user interface.

But it would be nice if application designers didn't make this painful set of mistakes again.

vj-Middleware WS-4

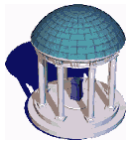
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The Internet of 2024 Making the Internet faster, cheaper, ...

- What's "killing" the Internet of 2004?
 - SPAM
 - DoS and DDoS
- What's the solution?
 - Long term — fix the protocols
 - Short term — throw bandwidth at the problem
 - » Stay 3 orders of magnitude ahead of SPAMers/hackers in terms of processing speed/bandwidth

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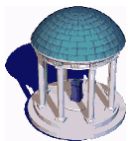


The Internet of 2024

What we will and won't see in 2024

- Parallel networks
 - The FedEx (couriers) versus governmental mail delivery view
 - Key: Opening up the broadband equivalent of the local loop
- No...
 - (Interoperable) QoS
 - True “integrated services” (voice/video/data)
 - » They will be “integrated” but only at the jack that connects your house to the local broadband
- Why is this so?

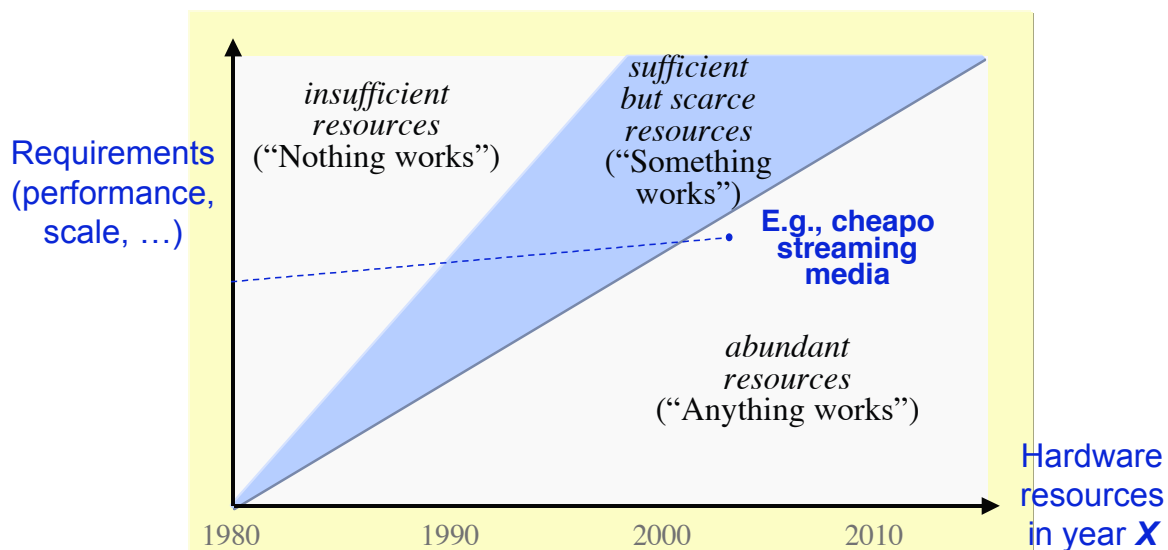
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The Internet of 2024

The “window of scarcity” argument

- Persistent dilemma: Clever resource allocation or over-provisioning?



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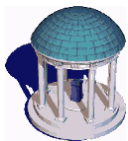


The Internet of 2024

Example: Quality-of-service research

- Debates of the last century (*e.g.*, NOSSDAV/IWQoS in the '90s):
 - Virtual circuits *v.* best-effort delivery
 - » (Elastic applications carried the day for best-effort)
 - ATM *v.* IP
 - » We all know what happened here...
 - (Hard) Real-time *v.* high performance OS services
 - » Better priority management, more efficient, but still no real-time
 - Will the end-system add value to delivered media or just store/display it?
 - » Still very little (substantive) processing of media
 - Where's the "multi" in multimedia?! (What's beyond audio and video?)
 - » DVEs, high-interaction gaming, tele-operation, still awaiting "QoS"

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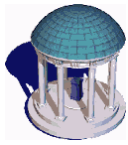


Quality-of-Service Research

The status quo

- The (end-to-end) quality-of-service morass:
 - Anything is possible on the intranet
 - » Stay within a *managed network* and you can have it all: IP telephony, VOD, ..
 - On the Internet...
 - » Bandwidth/connectivity is way up
 - » But is it strange that apps that work over a modem (*i.e.*, a really slow point-to-point connection) can't work (reliably) over the Internet?
- End-system support for quality-of-service seems stuck in a chicken & egg situation
 - Intel *et al.* has made it easy to support the best-effort multimedia transmission/processing/storage problems
 - » (1994 NOSSDAV Panel: Operating systems MUST support real-time services!)
 - Network service differentiation will require rethinking comm APIs, OS services, and implementations

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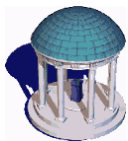


The Internet of 2024

Quality-of-service research

- QoS research
 - Keep pulling lint out of our navels
 - » New mechanisms, new policies, new algorithms, ...
 - Challenging problems remain in the middle ground between VCs and pure best-effort
 - All the while boring, proprietary, vendor solutions eat our (Internet researcher's) lunch
- So the *Intranet* seems like a rich source of problems
 - Just don't view this as IP research
- What about the *Internet*?

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The Internet of 2024

Quality-of-service research

- Need to heed to Dave Clark's advice re: business models
 - True QoS is about end-to-end operation
 - End-to-end operation is about interoperability
 - Interoperability is about making networks look the same
 - Making one's network look the same as another's is not a recipe for success for an ISP
 - (ISPs would rather compete on service differentiation than low price)
- So how do ISPs make (new) money by supporting inter-provider QoS?
 - When they can have it all by recruiting QoS clients (folks with real money, not universities) to just stay within their network?

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