



What computers talk about and how. (Networking & the Internet.)

COS 116

4/6/2006

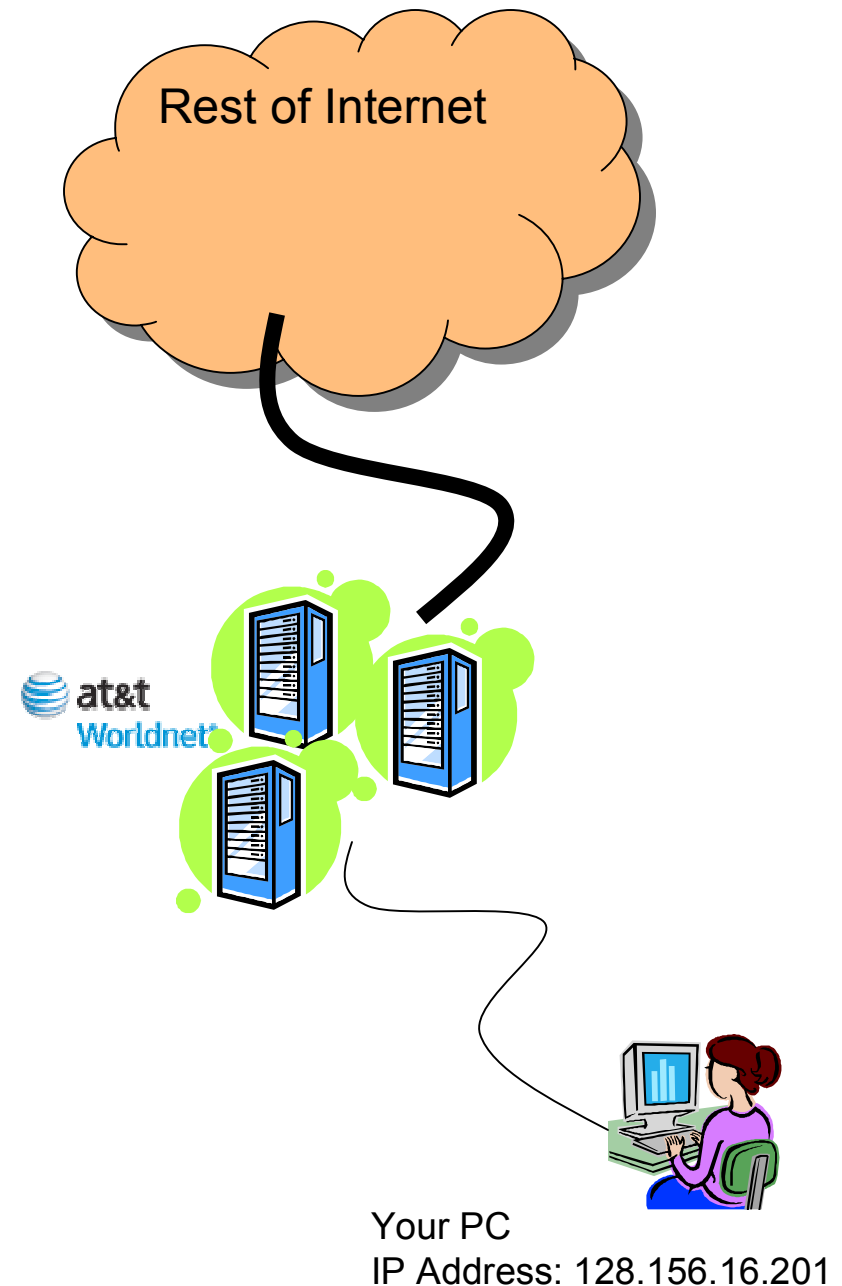
Instructor: Sanjeev Arora

Brief history

- Local area networks & university networks
- Military communication networks
 - ARPANET ['68] (a.k.a. DARPANET), etc.
- Early 1980s: US government decides on new way to connect various networks: the “Internet”
- 1989: World Wide Web; html, browsers
- 1998: Responsibility for Internet naming system handed over to private non-profit corporation ICANN.

Modern Internet

- Collection of computers (including devices, servers, etc.) connected by wires, optical cables, wireless, etc.
- To join, need:
 - Device capable of “speaking the right protocol” (TCP/IP)
 - IP “address” given by an Internet provider
 - Connection to provider’s servers (via modem, DSL, wireless, etc.)



Today: A Peek Underneath the 'Net

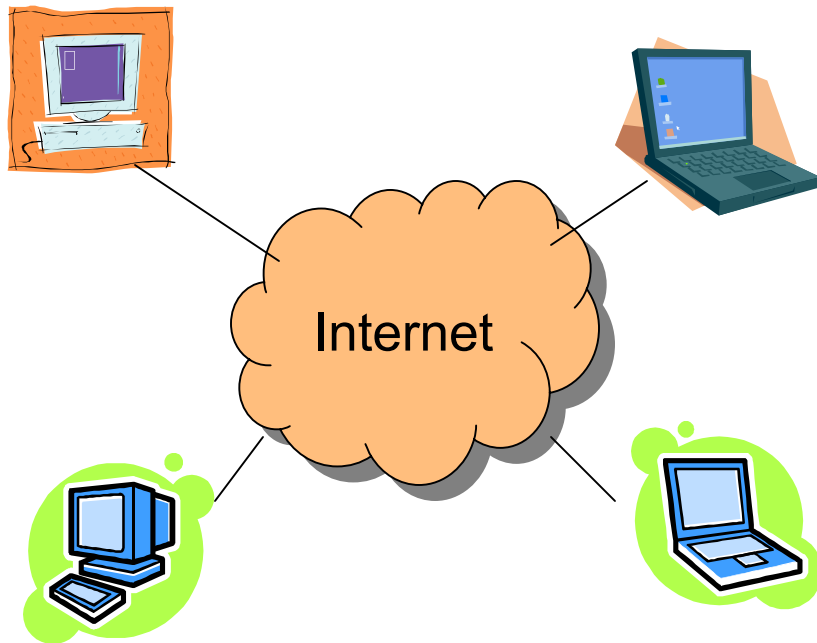
Why?



- Dominant technological artifact of second half of 20th century
- Interesting example of design of large heterogeneous system (decentralized, yet fairly robust).

Caveat: Internet \neq W W W

- Internet: network connecting computers, devices, etc.



- WWW: hyperlinked content (webpages) stored on servers; requested and served using http protocol
- Built *on top of Internet*



Theme 1:

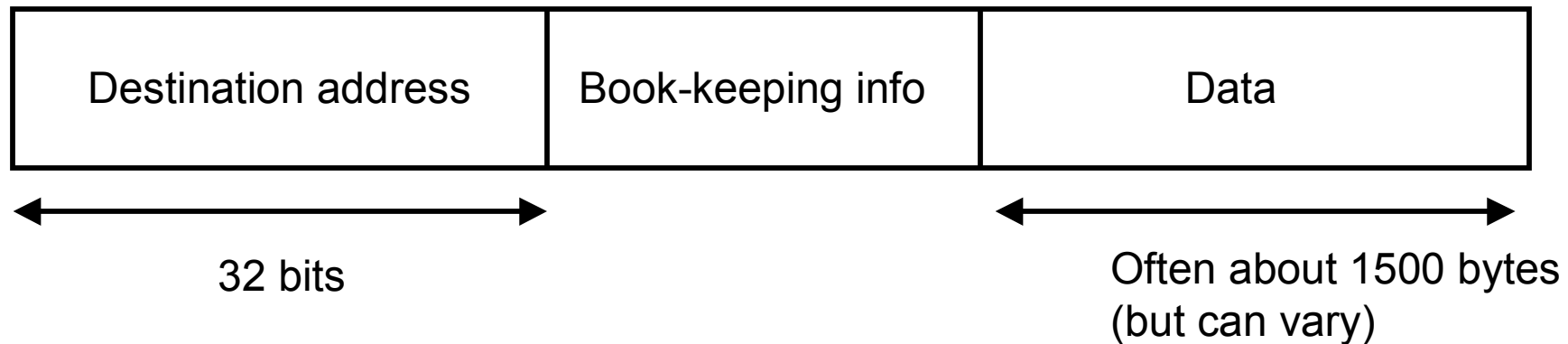
Building reliability
on top of
unreliable
protocols



The (shaky) foundation of the Internet: TCP/IP Protocol

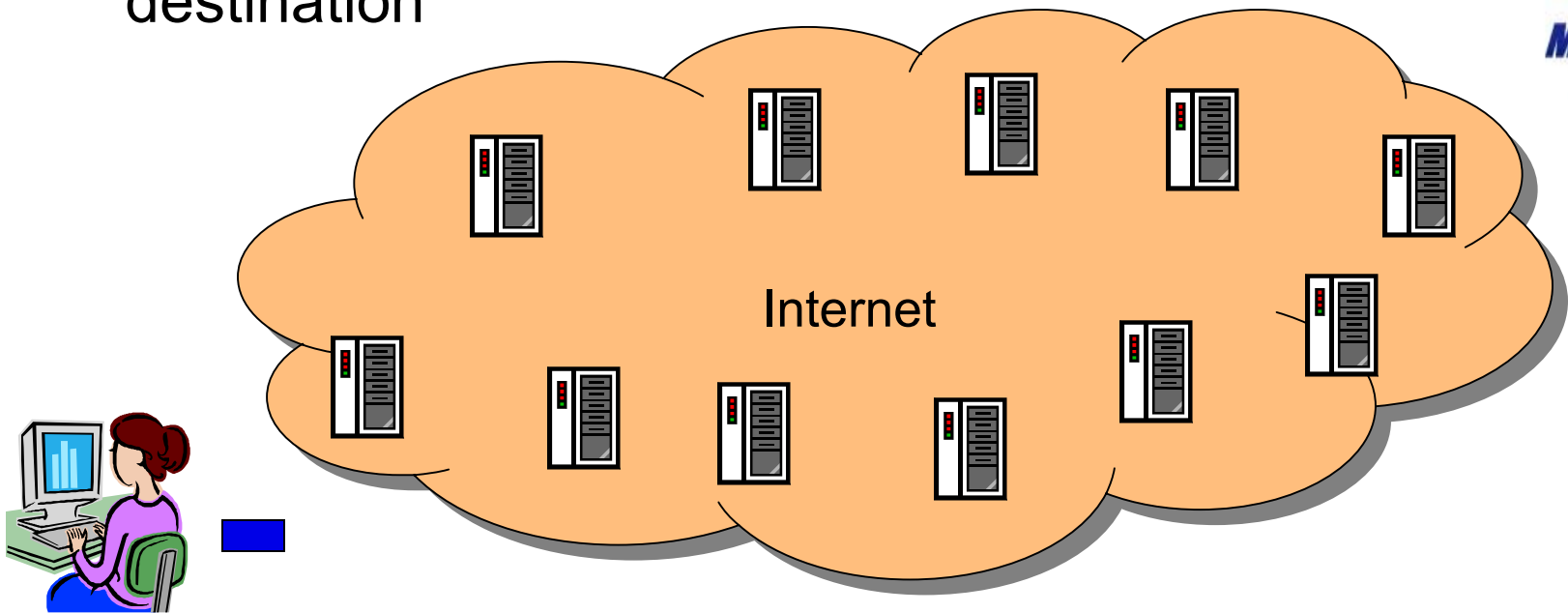
- All transmissions broken up into packets

A Packet:

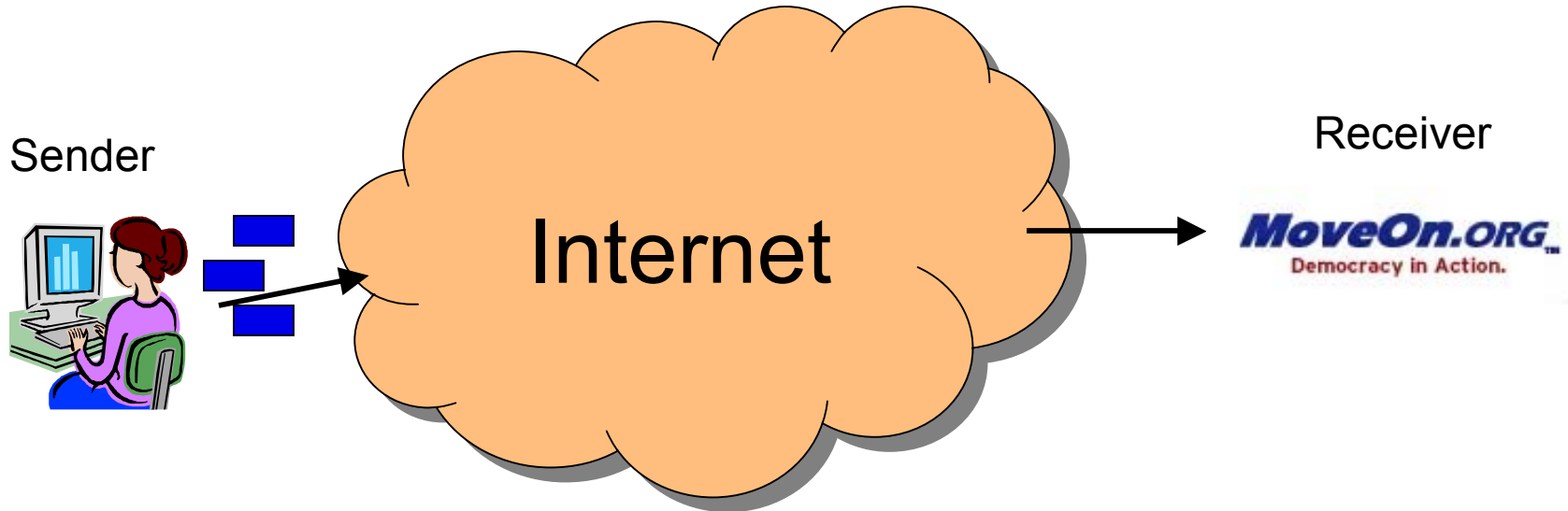


Hopping along

- Internet is actually a bunch of connected computers called *routers*
- Packets hop from router to router until they reach destination



“Best effort transmission”



- Packet not guaranteed to arrive in a timely fashion (or ever!)
- If many packets sent, may arrive out of order



Discussion

- Is there some unreliable communications device you use everyday?
- How do you cope with the cellphone's unreliability?

Some mechanisms

- Retransmission (“Could you say that again?”)
- Timeout (“Let me hang up and try redialing?”)
- Acknowledgements (“Finally understood you. Go on.”)



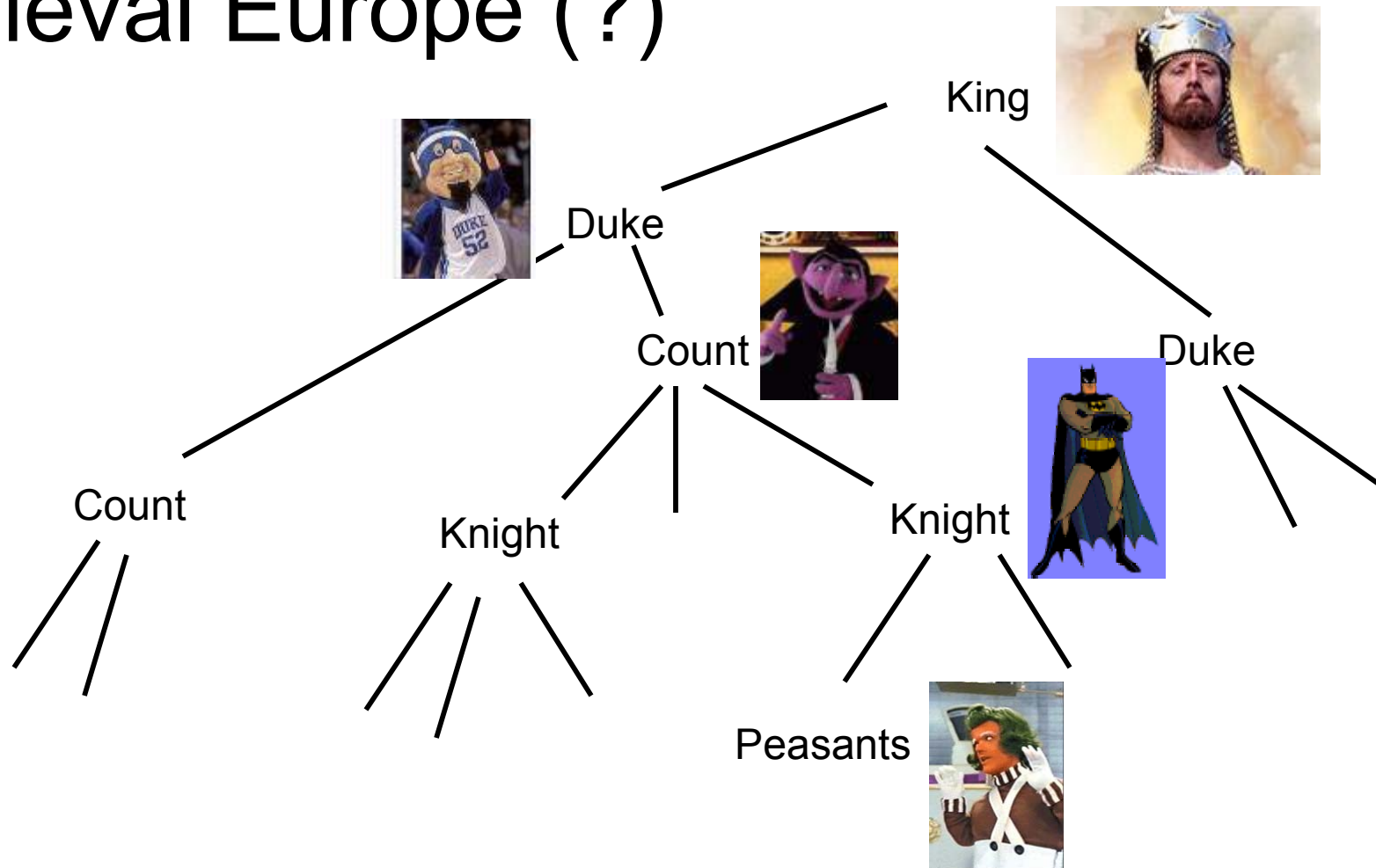
(In TCP/IP: if sequence of packets, number them and sort at receiver end.)



Theme 2:

Decentralized control

Political and Military Setup in Medieval Europe (?)



- What is a suitable postal system for this “army”?



Discussion

- How should a peasant in one town send mail to a peasant in another town?
- What happens if a knight joins/leaves the army?

First example of decentralization: Physical network

- 12 major providers



USLEC

- Many local providers

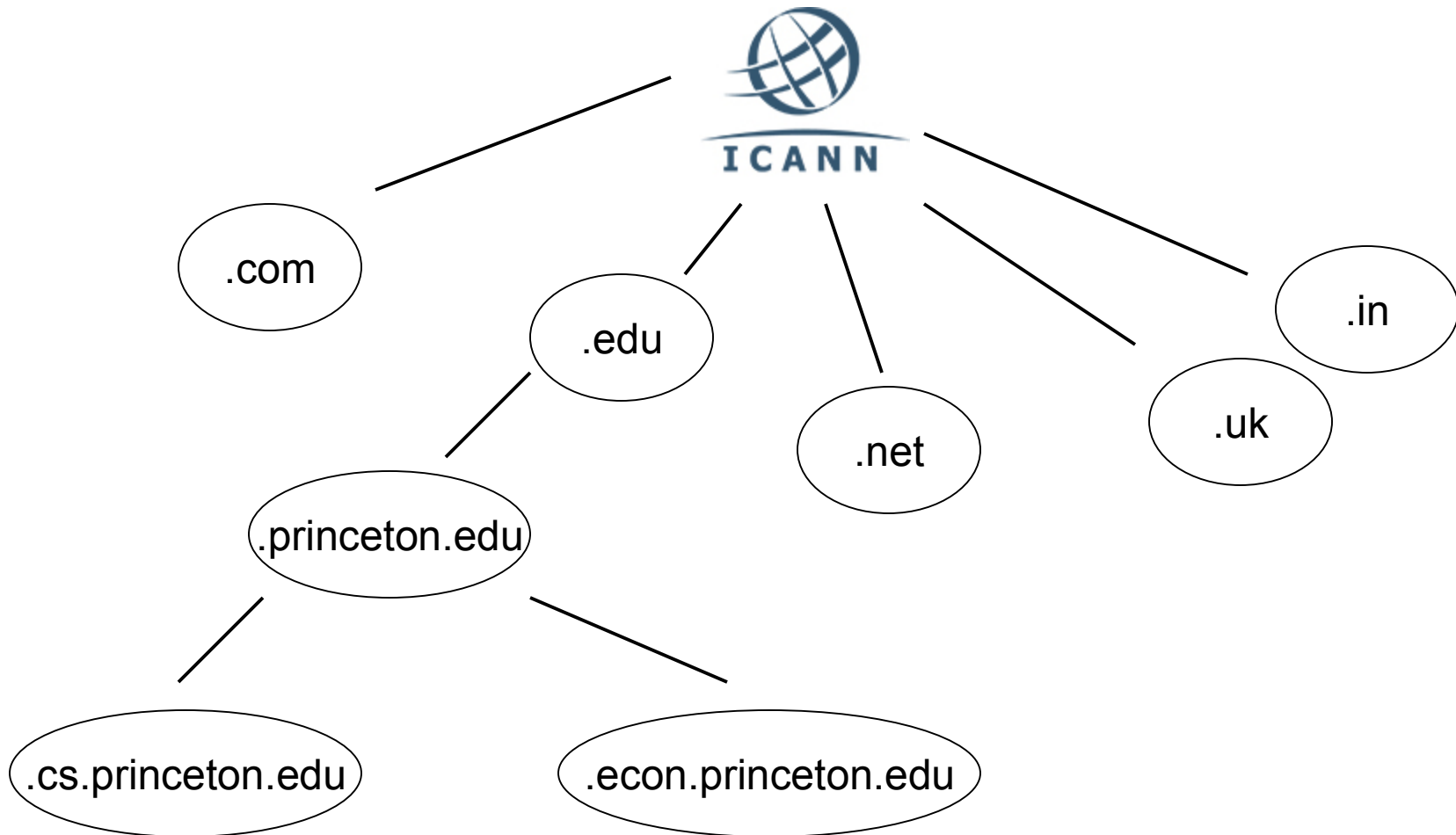


Princeton
Schools

McCarter

Princeton homes &
businesses

The Second Decentralization: Domain Name System

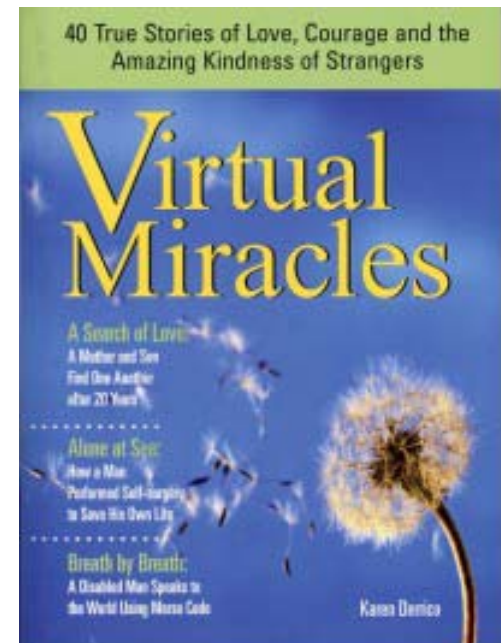


What happens when you type a URL?

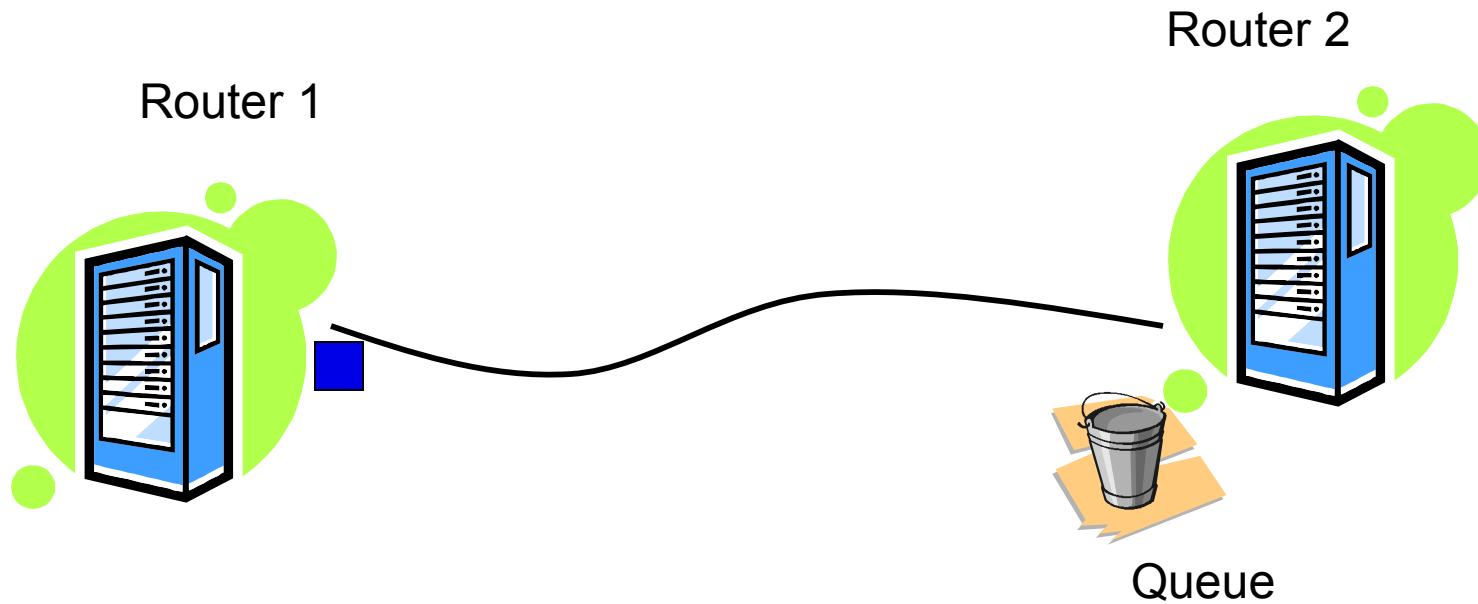
- Address translated by asking appropriate DNS server up/down the DNS hierarchy
 - www.nytimes.com → query to .com server
→ 199.239.136.200
- Physical routing of packets up/down the physical network hierarchy based upon address
- Other stuff

Theme 3.

Dependence upon the kindness of strangers



Congestion



- Queue full \rightarrow packets are dropped

How does a good netizen respond to congestion?

- Packets getting dropped? → Halve the transmission rate
- All packets getting through? → Increase transmission rate a little.
- **Done in all TCP/IP software, but, no enforcement mechanism!** (Allows “cheating”, as well as VoIP Telephony, Streaming media, etc.)



What's in the future?

- 128-bit instead of 32-bit addresses. (See handout)
 - “Can send email to your toaster.”
(Especially if it lives in Asia)
- Mechanisms for pricing, security, quality of service, etc.
 - NSF's GENI initiative