Internetworking and the Internet

U U U U

One of the world's most rapidly growing and important communications media:

What, How and Why is it happening ?
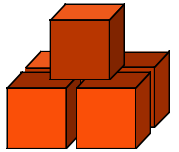
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What is internetworking ?

VALUE ADDED: protocols that "ride on top" of all other transport and network technologies (e.g., clear channel, dialup, X.25, frame relay, Sonet, SMDS, Appletalk, etc...)

Designed to facilitate a "network of networks" these protocols transparently "glue" diverse networks and end systems together. Provide <u>real</u> open systems interconnection.

Technology & market originally fostered by DOD, now commercial - similar scenario as X.25 network progression

Principal applications are: fast easy file sharing, news broadcast, EMail, remote logon, messaging gateways (e.g., SprintMail), network management, directory services, knowledge discovery

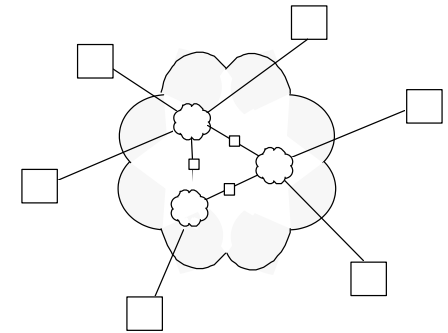**In the works: advanced EMail, security features, multimedia**

Internet software (TCP/IP + basic applications) now comes bundled with many computer/ workstation operating system platforms and is available for all systems.

Has spawned explosive growth in network equipment (routers), enterprise networks, universal networking

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What are internets ?

Networks of networks built using internet protocols

> **TCP/IP suite is the most common, but many other protocols also exist.**

General physical architecture

> **wide area transport subnetworks, transmission links, routers, LANs, and hosts (mainframes, minis, workstations, PCs)**
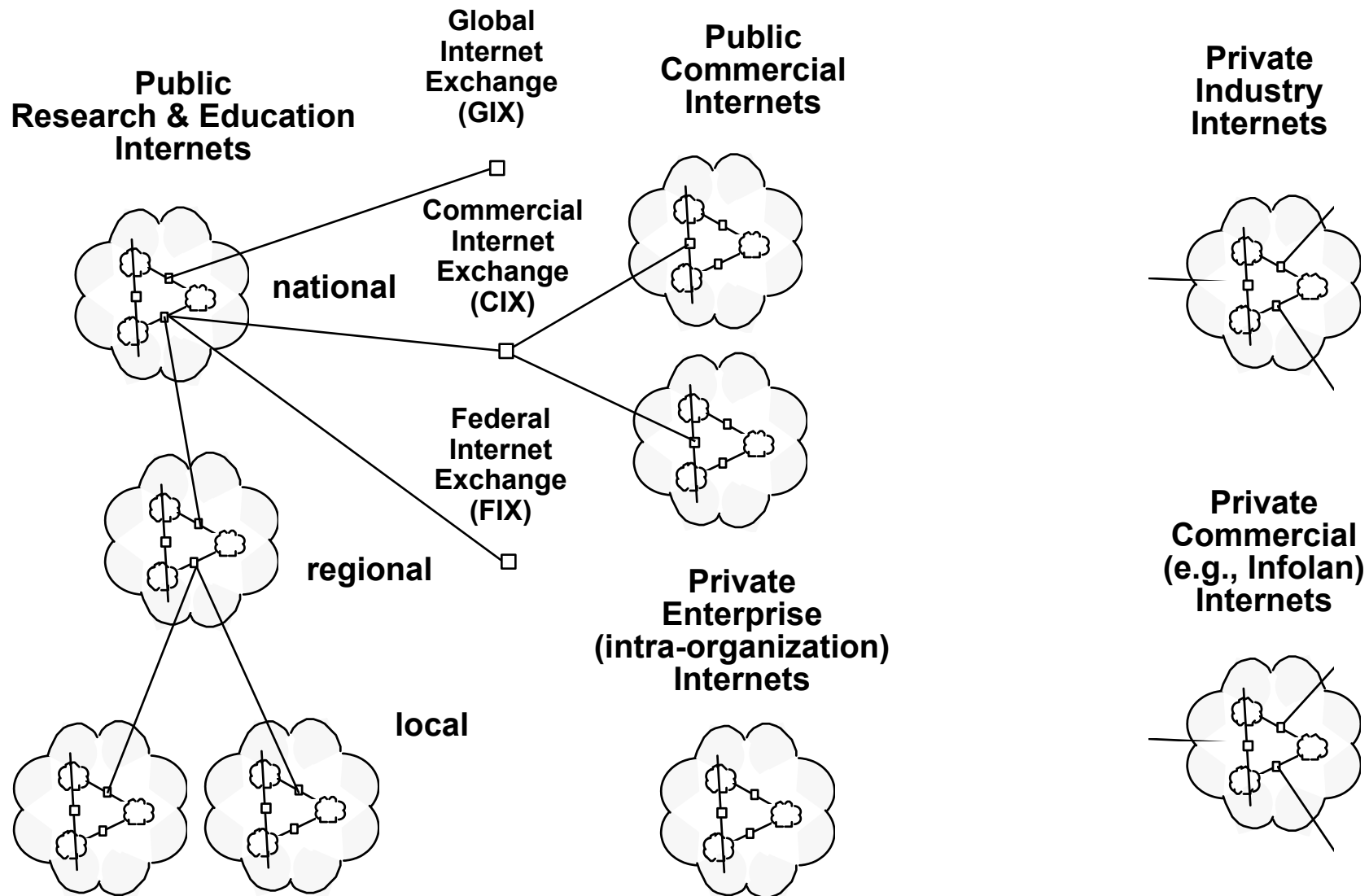
End-to-end transport techniques are connectionless (a/k/a datagram).

> **Ability to globally address individual machines and processes - even on LANs - is very valuable**

Technology widely used for internal company networks known as *Enterprise Networks*.

> **Sets the stage for widespread connectivity and the market for interoperation with other internets.**

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internets: many flavours

**Global
Internet
Exchange
(GIX)**

**Public
Commercial
Internets**

**Private
Industry
Internets**

**Public
Research & Education
Internets**

**Commercial
Internet
Exchange
(CIX)**

national

**Federal
Internet
Exchange
(FIX)**

regional

**Private
Commercial
(e.g., Infolan)
Internets**

local

**Private
Enterprise
(intra-organization)
Internets**

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Internet: what is it?

+**A global open internet metanetwork (a network of networks)**

+**Began in late 70s as DARPA testbed to meet DOD research needs and for developing internetworking technology. (Many of same people and scenarios as packet switching evolution.)**

+**Divested in 1986 to other agencies in USA (NSF, DOE, NASA) and around the world for educational & research purposes with intent to commercialize**

+**Initial three-tier national architectures: regionals, mid-levels, and national backbones**

+**First commercial carriers appear in 1990 in U.S. and Europe**

+**Connected hosts became predominantly industrial in mid-1991 as commercial demand for Internet connectivity increases**

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Internet: what is happening ?

nMassive, Unprecedented, Consistent Growth

- **networks**
- **hosts**
- **users - using and reachable**
- **traffic**
- **information**

nCommercialization

nCreating *Flat Information Space*

nInstitutionalization - the Internet Society

nProfound Effects

- **Infrastructure**
- **Organizations**
- **Professions**
- **People**

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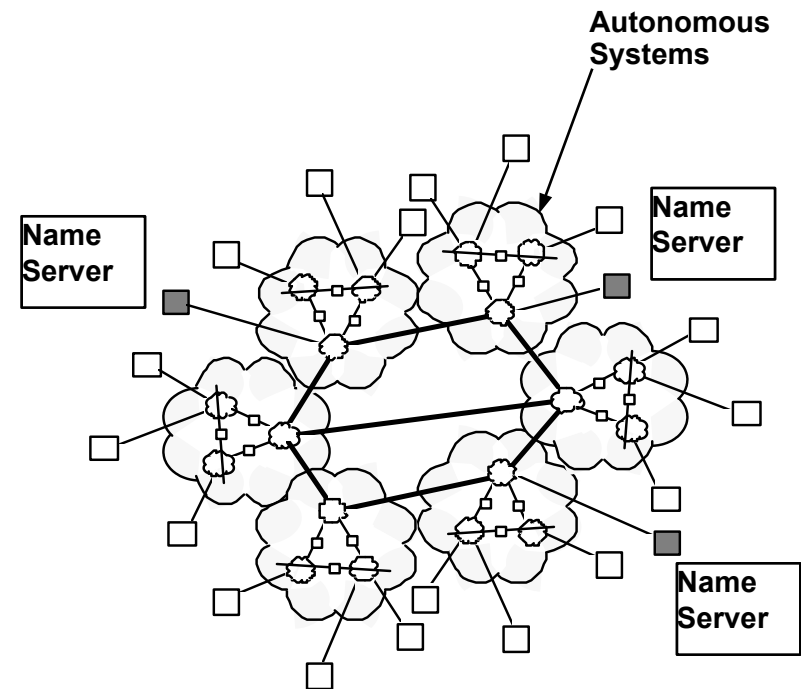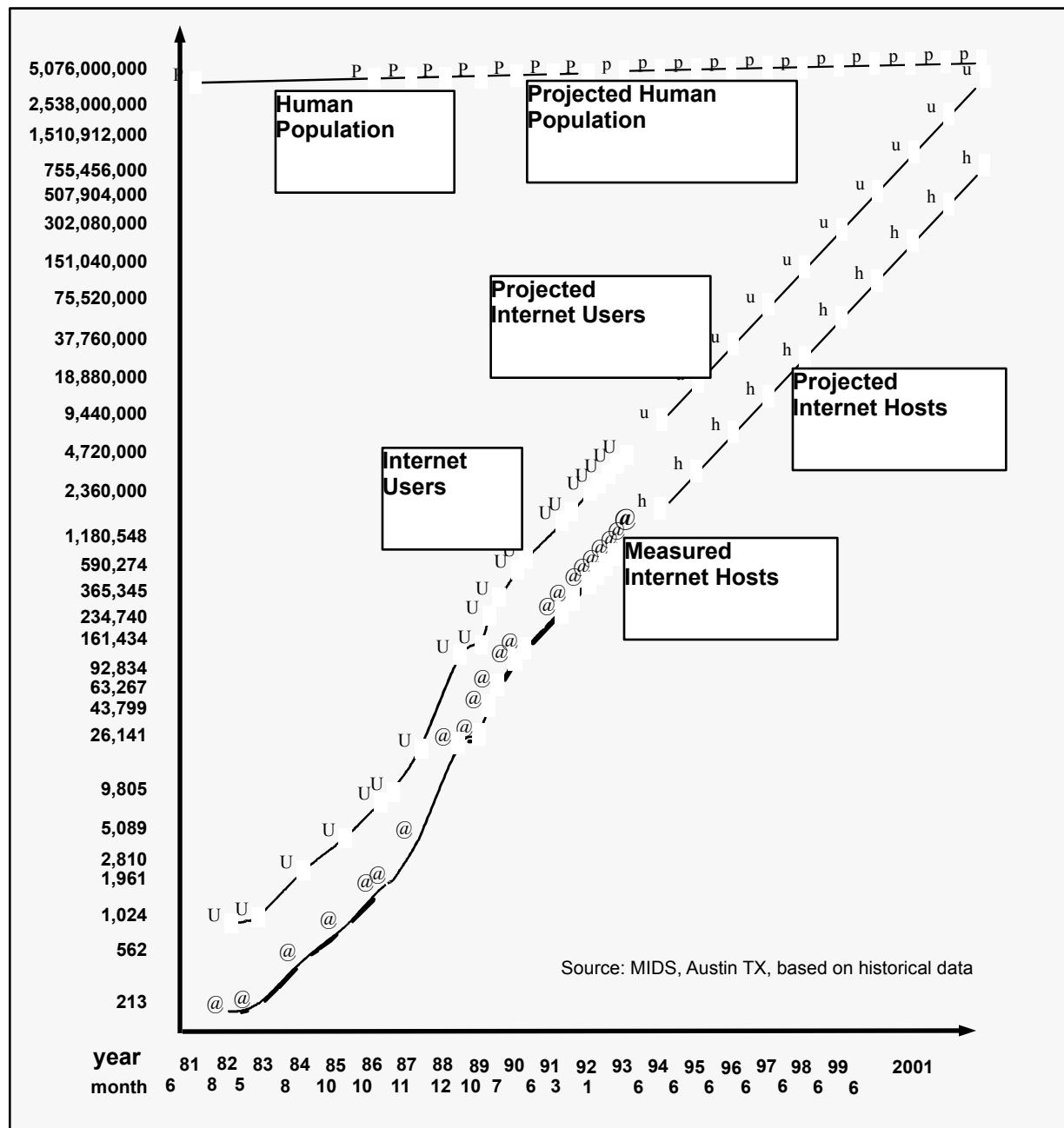
Internetworking: why is it happening?

q*Bundling.* The TCP/IP osi suite was bundled into every workstation and mini sold; and is now invading every PC

q*Development.* It is developed by a highly unique applications development and standards process that promises continued rapid innovation and development

q*Bottom-up activity.* It is just the kind of osi that users want

q*New paradigms.* The network architecture is an ideal match to today's heterogeneous, non-hierarchal technology, provisioning and organizational environment

q*Corporate synergy.* Nearly every enterprise internet uses the TCP/IP osi suite and they now want to plug into the Matrix for <u>inter</u>-organization communication

q*Education/youth synergy.* Every recent college student has been given an Internet address with their student ID

q*Technological/economic synergy.* Connectionless internetworking offers a good cost-performance match for the PC workstation-LAN environment now dominant

q*Government synergy.* Government has encouraged it as critically important infrastructure
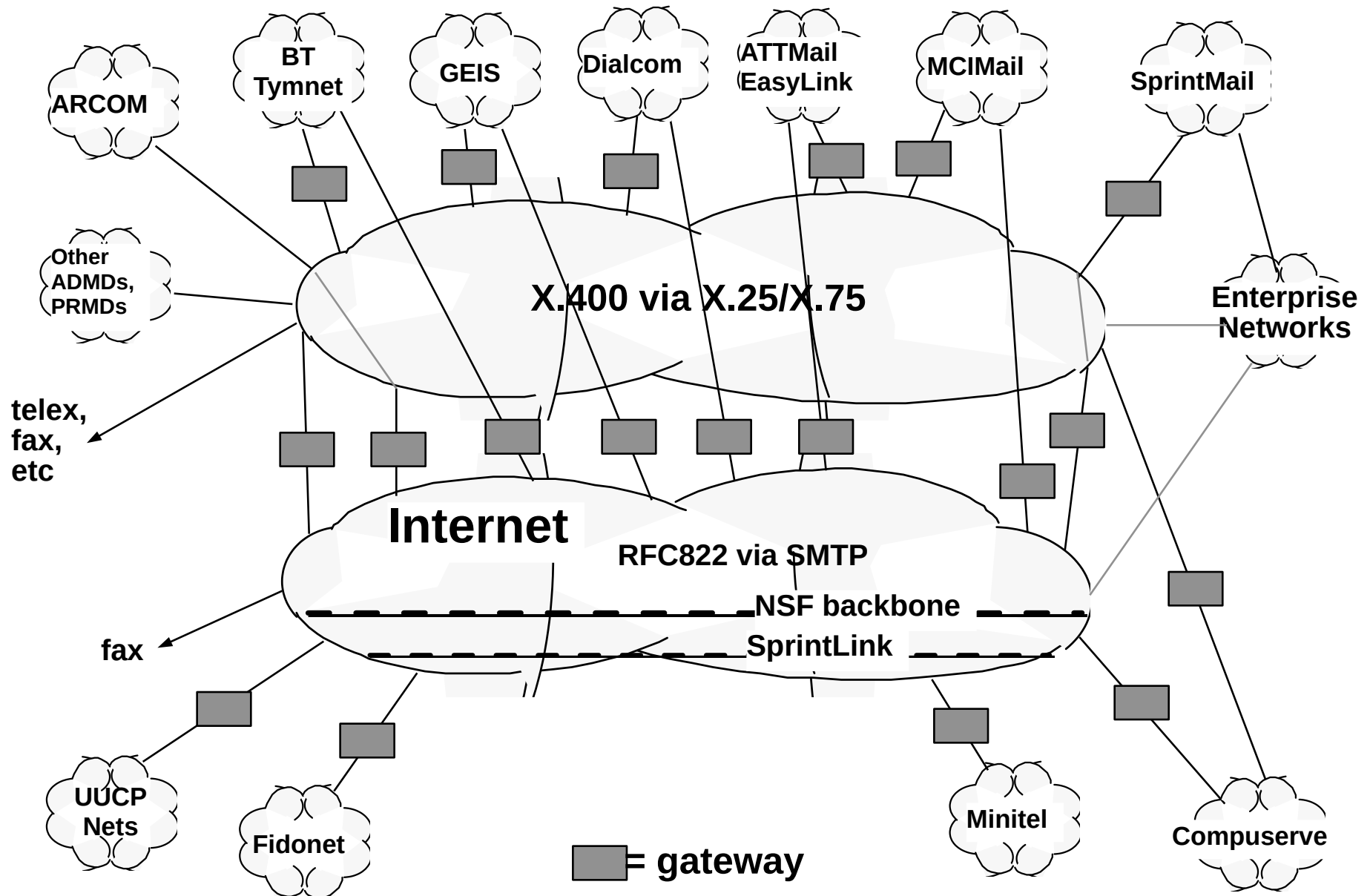
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Internet: under the hood

- **Managed through cooperation among autonomous systems (i.e., internet administrative domains)**

- **Everyone follows certain addressing and naming practices**

- **Portability and user-friendliness achieved through use of domain name servers**

- **"Sender keeps all" flat rate accounting is universal norm**

- **Multiprotocol environment**

Autonomous Systems

Name Server
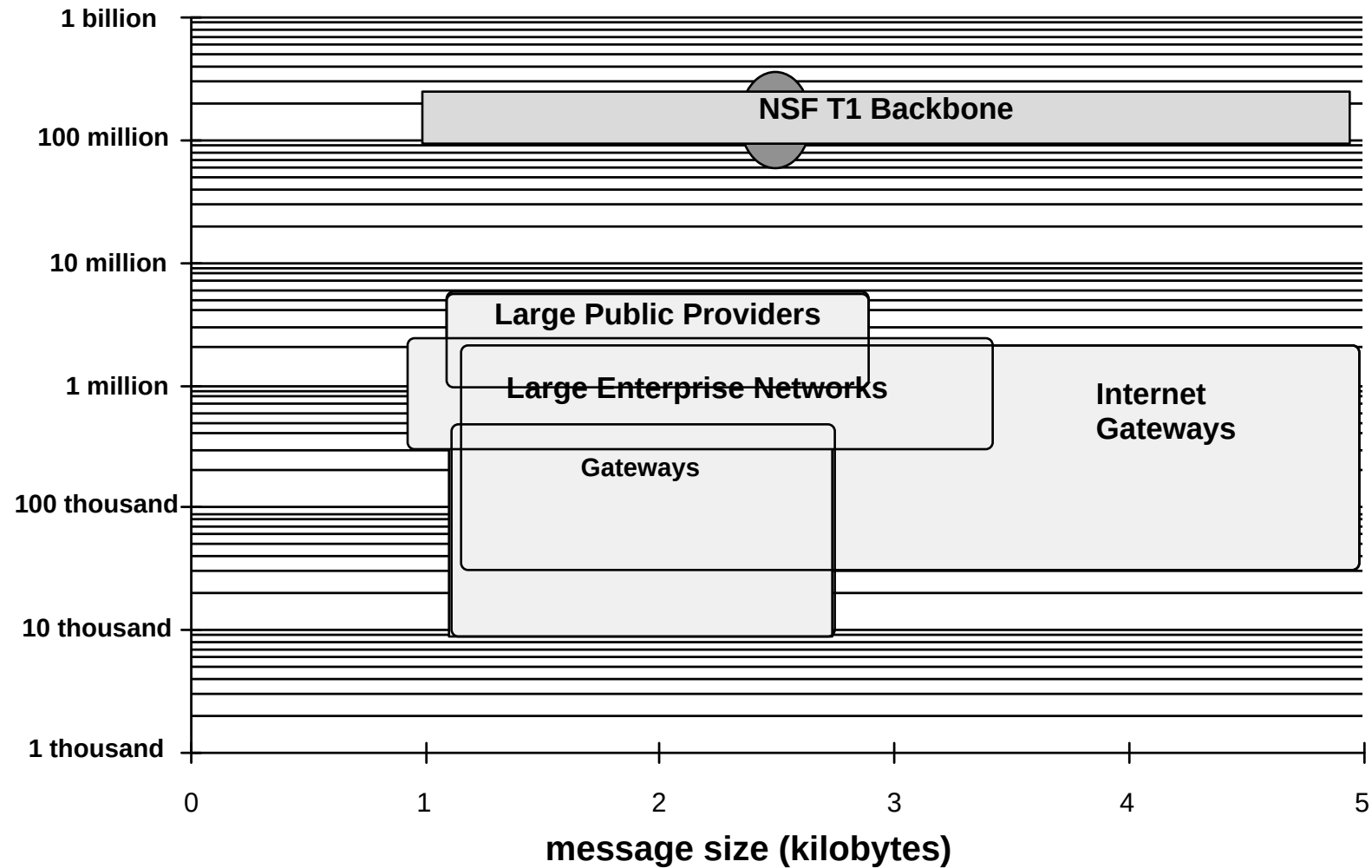
Name Server

Name Server

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2001: Users = Human Population ?

Source: MIDS, Austin TX, based on historical data

Today's global messaging internet architecture

ARCOM

BT Tymnet

GEIS

Dialcom

ATTMail EasyLink

MCIMail

SprintMail

Other ADMDs, PRMDs

X.400 via X.25/X.75

Enterprise Networks

telex, fax, etc

Internet

RFC822 via SMTP

NSF backbone

fax

SprintLink

UUCP Nets

Fidonet

Minitel

Compuserve

= gateway

Messaging metrics

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Where to Learn More

Periodicals

- *Internet Society News*
- *ConneXions*
- *Matrix News*
- *Internet Monthly Report*

- *Electronic Networking, Journal of*
- *Computer Communication Review (Journal)*
- *Computer Networks and ISDN Systems (Journal)*

Books and Monographs

- Albitz & Liu, *DNS and Bind*
- Comer, *Internetworking with TCP/IP*
- Frey & Adams, *!%@:: A Directory of Electronic Mail Addressing & Networks*
- Hood, *User Services Internet Resource Guide*
- Hunt, *TCP/IP Network Administration*
- Kehoe, *Zen and the Art of the Internet*
- Kroll, *The Whole Earth Internet*
- Lynch & Rose, *The Internet Systems Handbook*
- Malamud, *Exploring the Internet*
- Malamud, *Stacks*
- Marine, *Internet: Getting Started*
- Parker, *The Internet Companion*
- Rose, *The Internet Message*
- Rose, *The Simple Book*
- NNSC, *Internet Resource Guide*

Conferences, Meetings & Proceedings

- International Internetworking Conference
- Internet Engineering Task Force
- Sigcomm Conferences
- Interop
- Joint European Networking Conference