Internetworking and the Internet

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

What, How and Why is it happening ?

A.-M. Rutkowski
Vice-President, Internet Society <amr@nri.reston.va.us>
Director, Technology Assessment, Sprint <amr@sprint.com>

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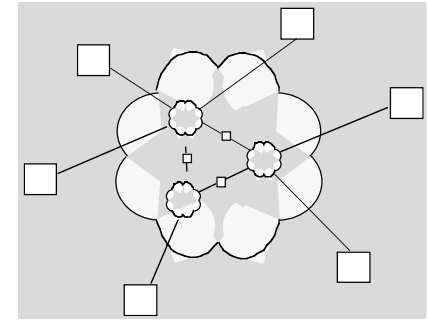
⇨ **VALUE ADDED: protocols that "ride on top" of all other transport and network technologies (e.g., clear channel, dialup, X.25, frame relay, Sonet, SMDS, Appletalk, etc...)**

⇨ **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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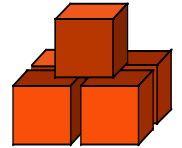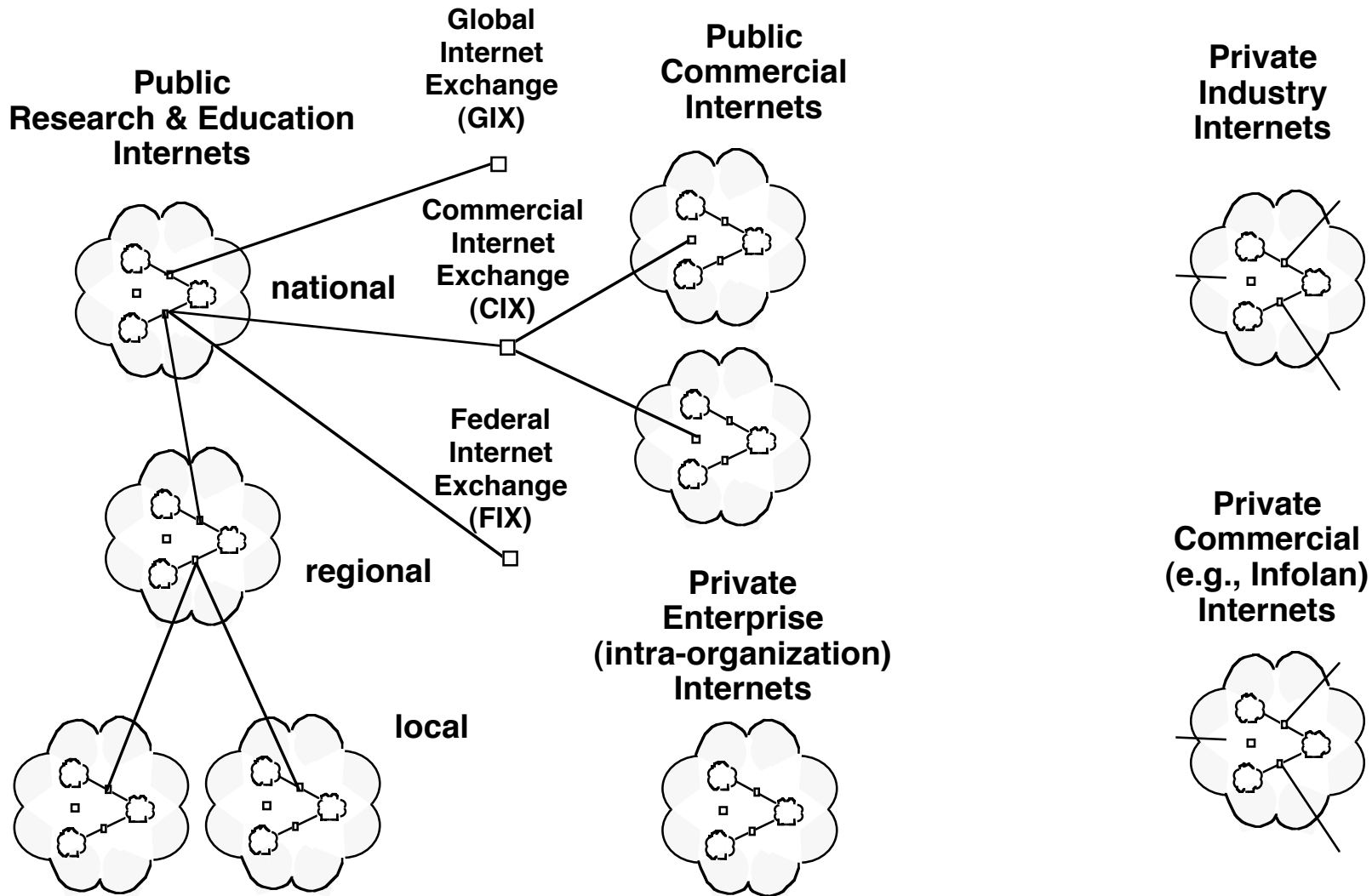
What are internets ?

- **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.**

internets: many flavours

**Global
Internet
Exchange
(GIX)**

**Public
Research & Education
Internets**

**Public
Commercial
Internets**

**Private
Industry
Internets**

**Commercial
Internet
Exchange
(CIX)**

national

**Federal
Internet
Exchange
(FIX)**

regional

local

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

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

■ **Massive, Unprecedented, Consistent Growth**

    networks

    hosts

    users - using and reachable

    traffic

    information

■ **Commercialization**

■ **Creating Flat Information Space**

■ **Institutionalization - the Internet Society**

■ **Profound Effects**

    Infrastructure

    Organizations

    Professions

    People
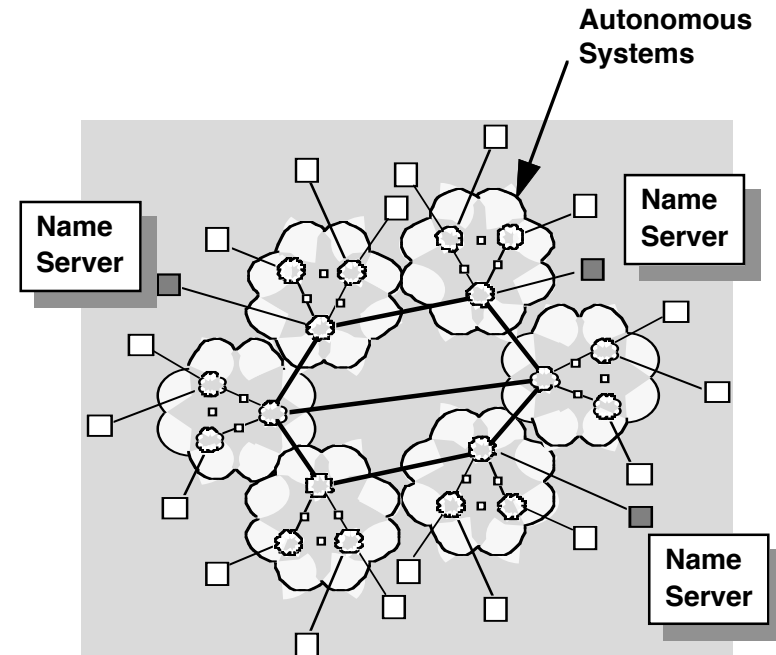
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Internetworking: why is it happening?

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

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

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

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

❑ **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

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

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

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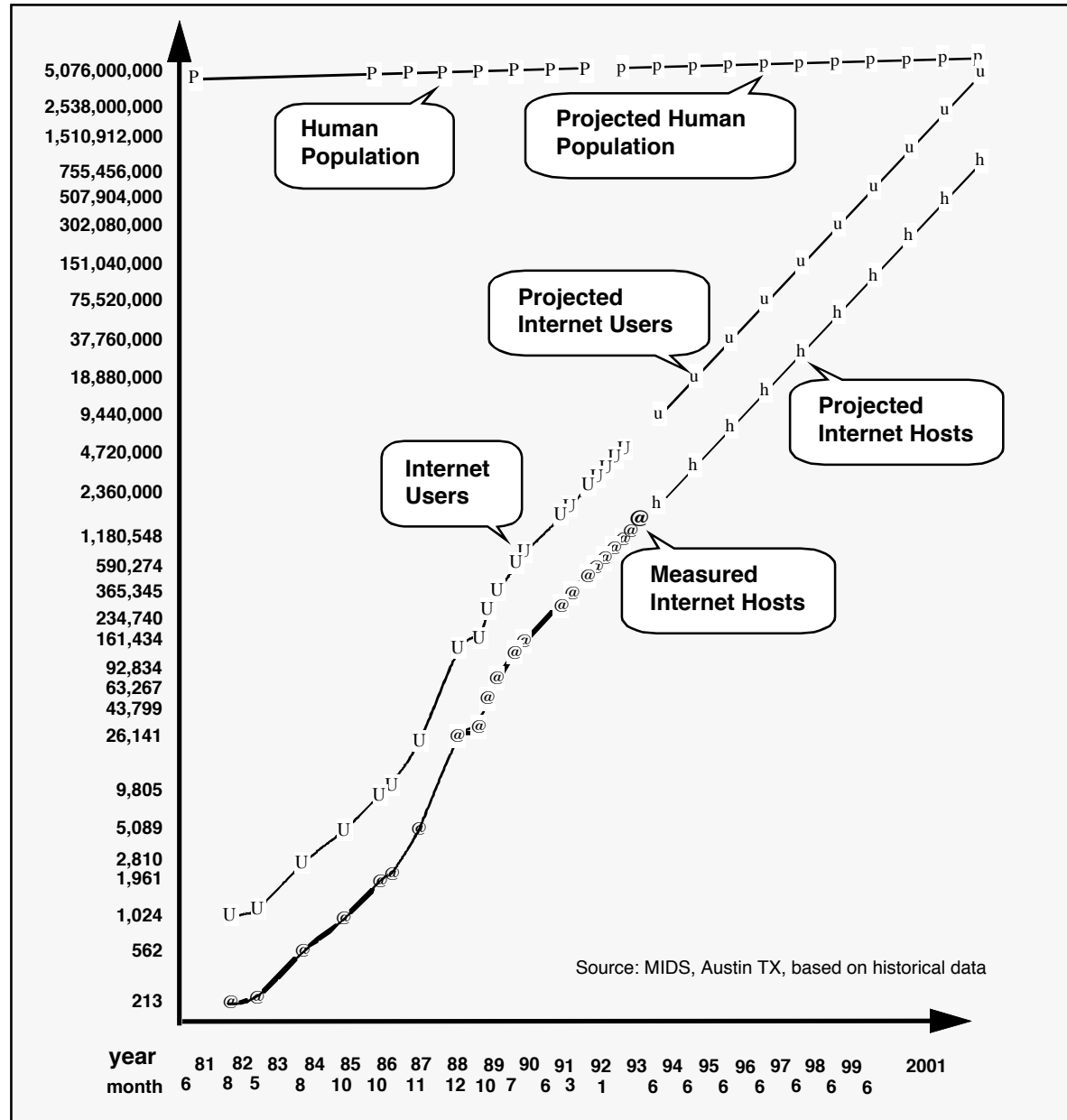
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Internet: under the hood

- **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**
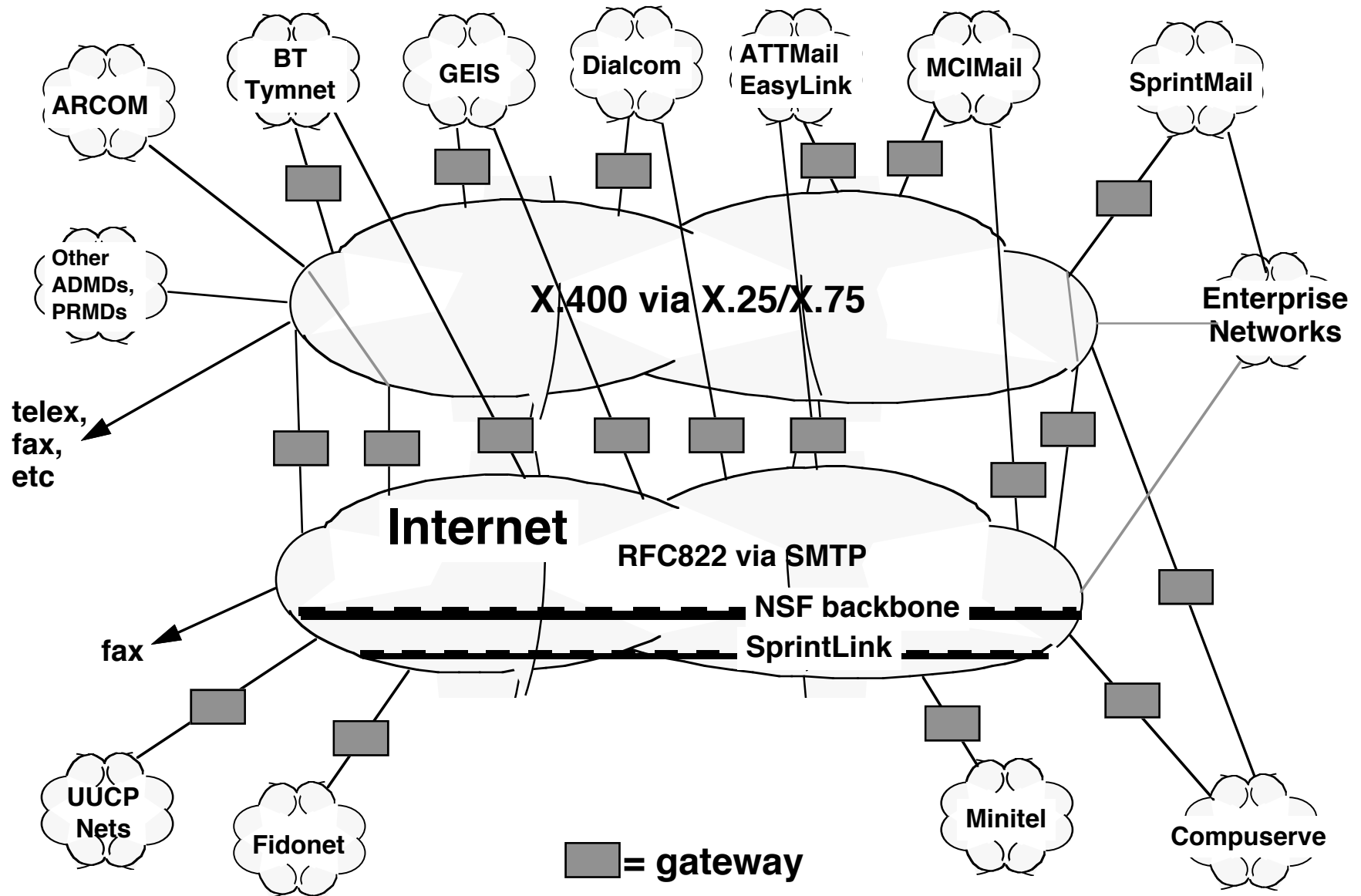
- **Multiprotocol environment**

Autonomous Systems

Name Server
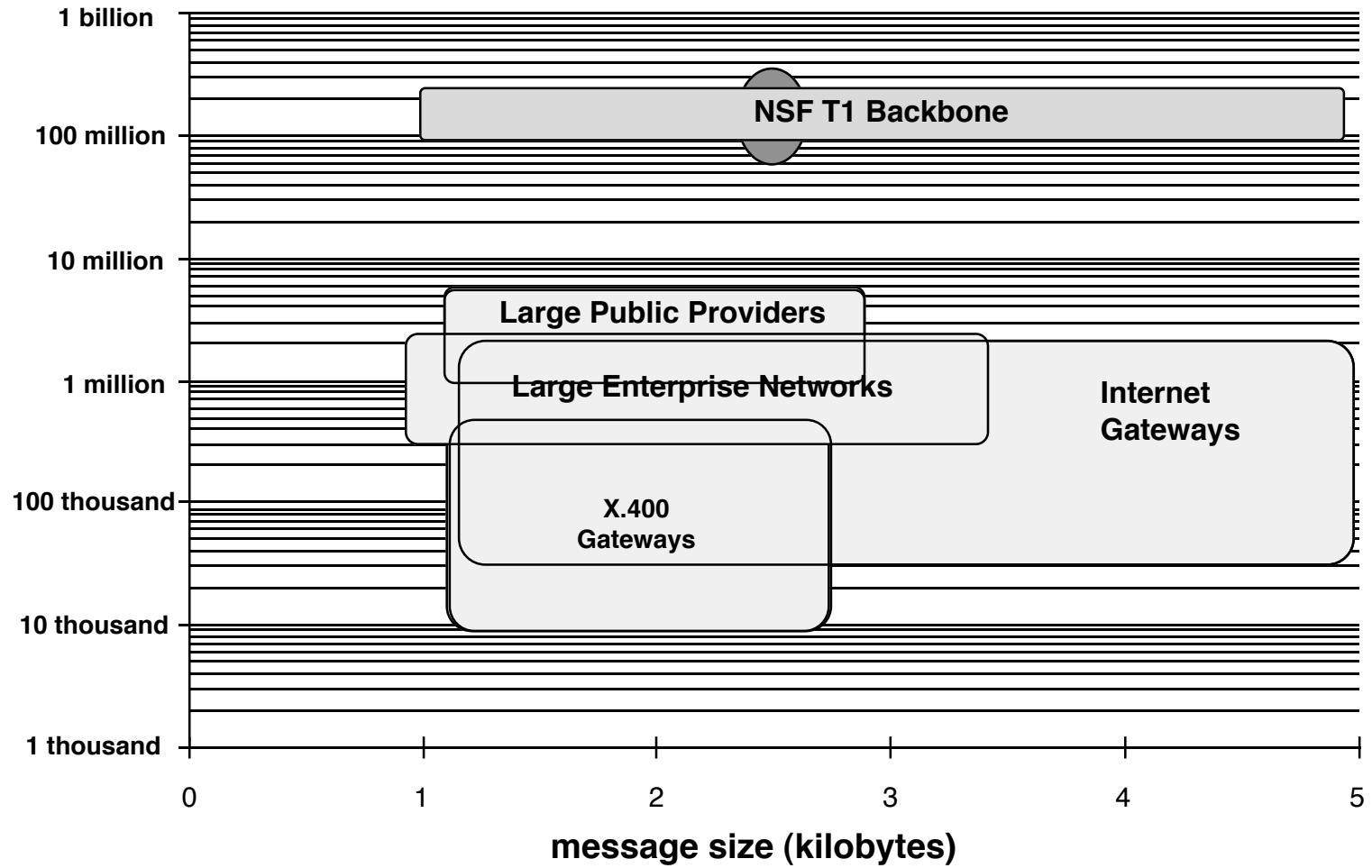
Name Server

Name Server

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2001: Users = Human Population ?

Source: MIDS, Austin TX, based on historical data

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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

SprintLink

fax

UUCP Nets

Fidonet

Minitel

Compuserve

▢ = gateway

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Messaging metrics

messages per month vs **message size (kilobytes)**

- NSF T1 Backbone
- Large Public Providers
- Large Enterprise Networks
- Internet Gateways
- X.400 Gateways

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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