Internetworking and the Internet

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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 _real_ 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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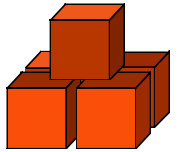
What are **i**nternets ?

- **Networks of networks built using internet protocols**
  - **TCP/IP suite is the most common, but many other protocols also exist.**
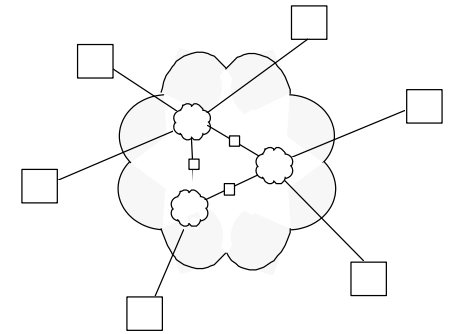
- **General physical architecture**
  - **wide area transport subnetworks, transmission links, routers, LANs, and hosts (mainframes, minis, workstations, PCs)**

- **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

local

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

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

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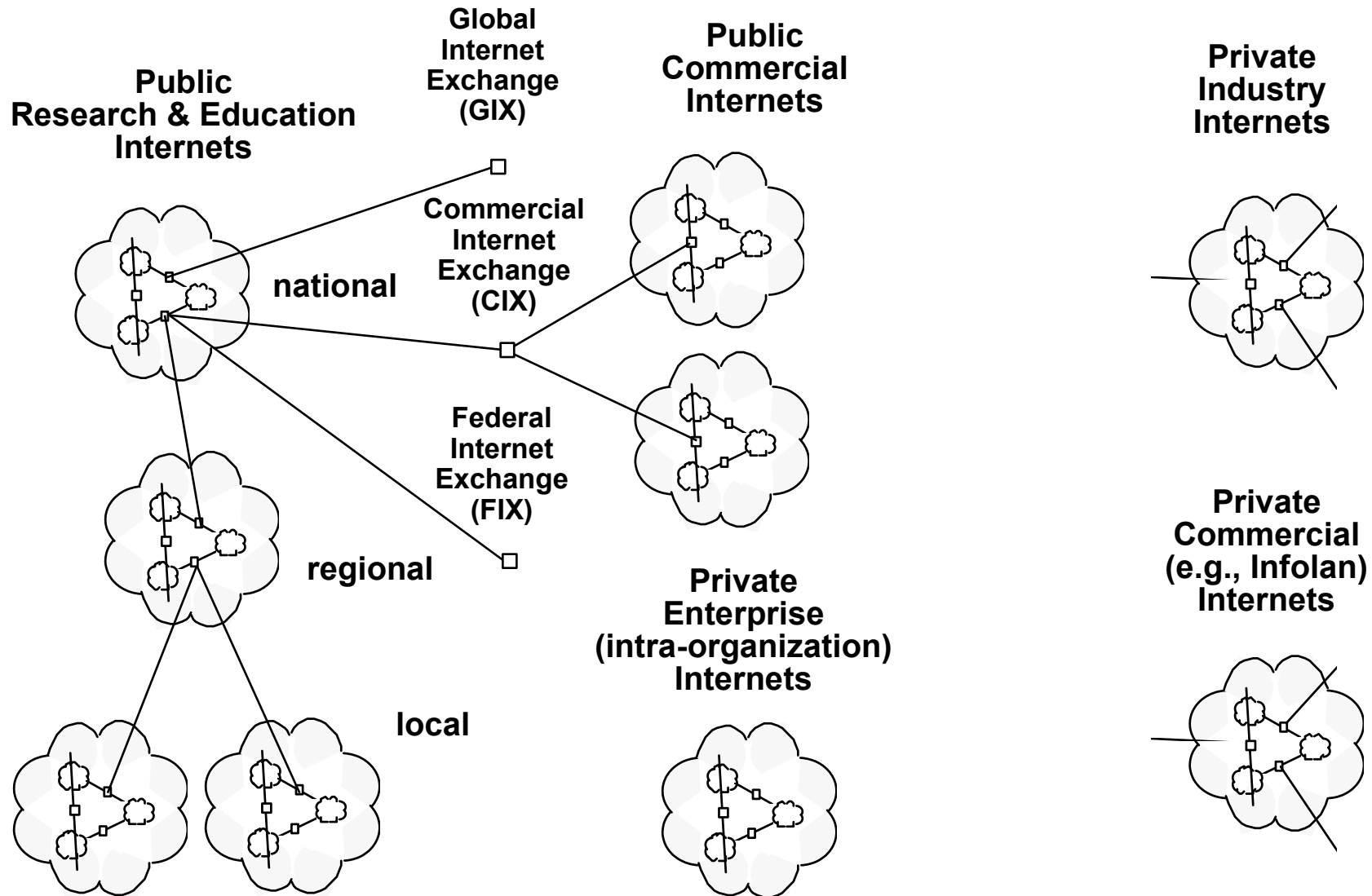
Internet: what is it?

+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 ?

nMassive, Unprecedented, Consistent Growth
  networks
  hosts
  users - using and reachable
  traffic
  information
nCommercialization

nCreating *Flat Information Space*

nInstitutionalization - the Internet Society

nProfound Effects
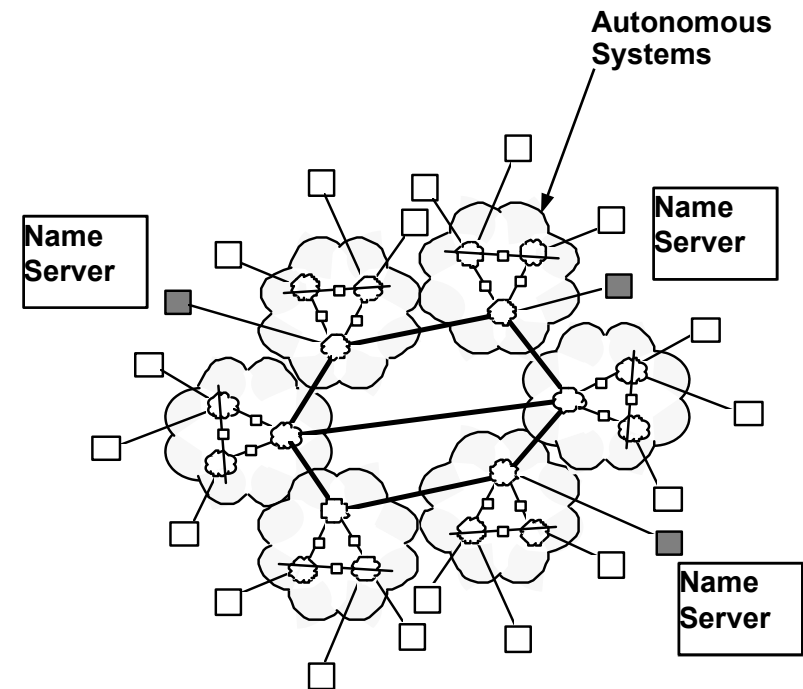 **Infrastructure**
  Organizations
  Professions
  People

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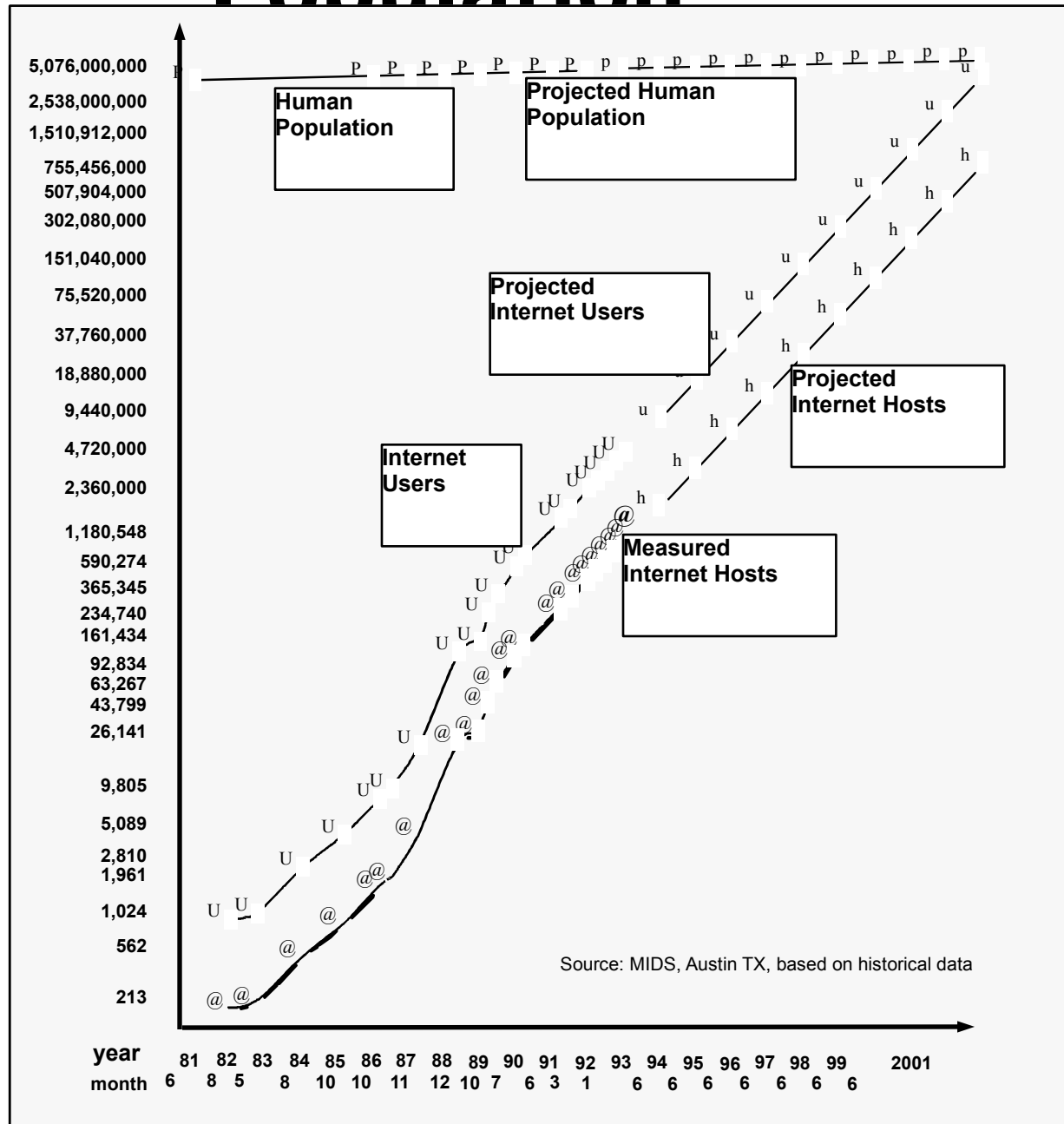
Managed through cooperation among autonomous systems (i.e., internet administrative domains)

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 SprintLink

fax

UUCP Nets

Fidonet

Minitel

Compuserve

= **gateway**

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Messaging metrics

messages per month

NSF T1 Backbone

Large Public Providers

Large Enterprise Networks

Internet Gateways

Gateways

- 1 billion
- 100 million
- 10 million
- 1 million
- 100 thousand
- 10 thousand
- 1 thousand

0   1   2   3   4   5

message size (kilobytes)

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Where to Learn More

Periodicals	Books and Monographs	Conferences, Meetings & Proceedings
Internet Society News *ConneXions* *Matrix News* *Internet Monthly Report* *Electronic Networking, Journal of* *Computer Communication Review (Journal)* *Computer Networks and ISDN Systems (Journal)*	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*	International Internetworking Conference Internet Engineering Task Force Sigcomm Conferences Interop Joint European Networking Conference