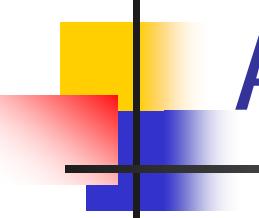


# Introduction

BUPT/QMUL

2010-9-21





# Agenda

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- What is the Internet?
- How does it work?
- When & how did it come about?
- Who controls it?
- Where is it going?

*Refer to Chapter 1 and Chapter 3 of the Textbook*



# Q1: What is the Internet?

# Q1: What is

- So many different websites:
  - <http://www.whatis.com>
  - <http://www.wikipedia.org>
  - <http://www.webopedia.com>
  - <http://linux.about.com>
  - <http://www.boutell.com>
  - ... ... ...

Simply put, the Internet is a **network** of **linked computers** allowing participants to share **information** on those computers. You should want to be a part of it because the Internet literally puts a world of information and a potential **worldwide** audience at your

Internet: A **worldwide network of networks**. It is also the network of

"The Internet" refers to the **worldwide network** of **interconnected computers**, all of which use a common protocol known as **TCP/IP** to **communicate** with each other.

*network*

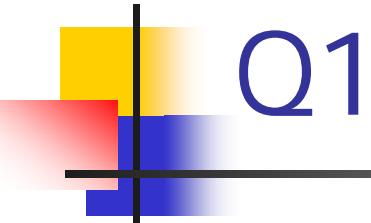
*computers*

*interconnected*

*worldwide*

*communicate*

*TCP/IP*

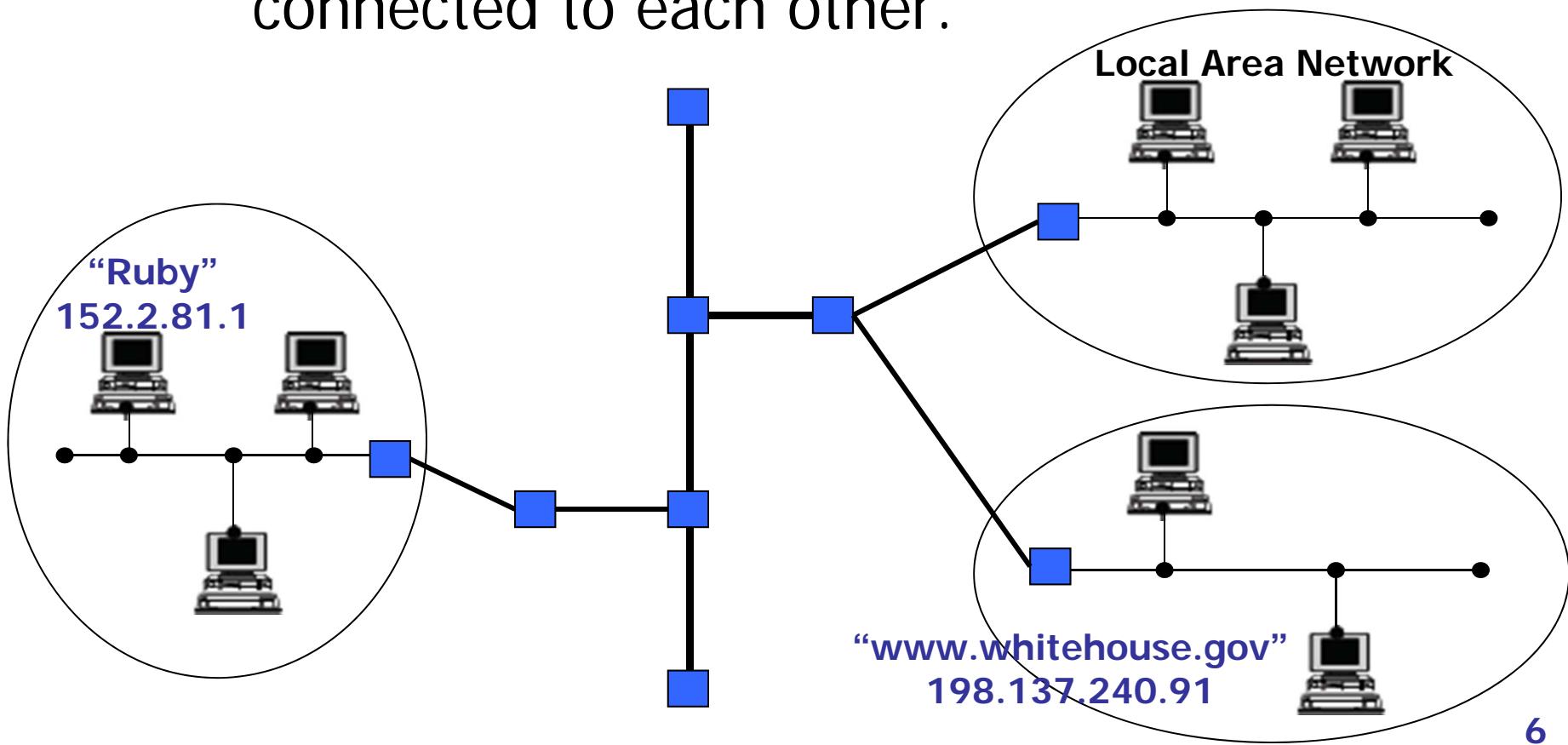


# Q1: What is the Internet?

- Internet vs. internet
  - Internet
  - internet ►
- Internet vs. WWW (World Wide Web)
  - Internet
  - WWW ►
- Internet vs. Intranet
  - Internet ►
  - Intranet

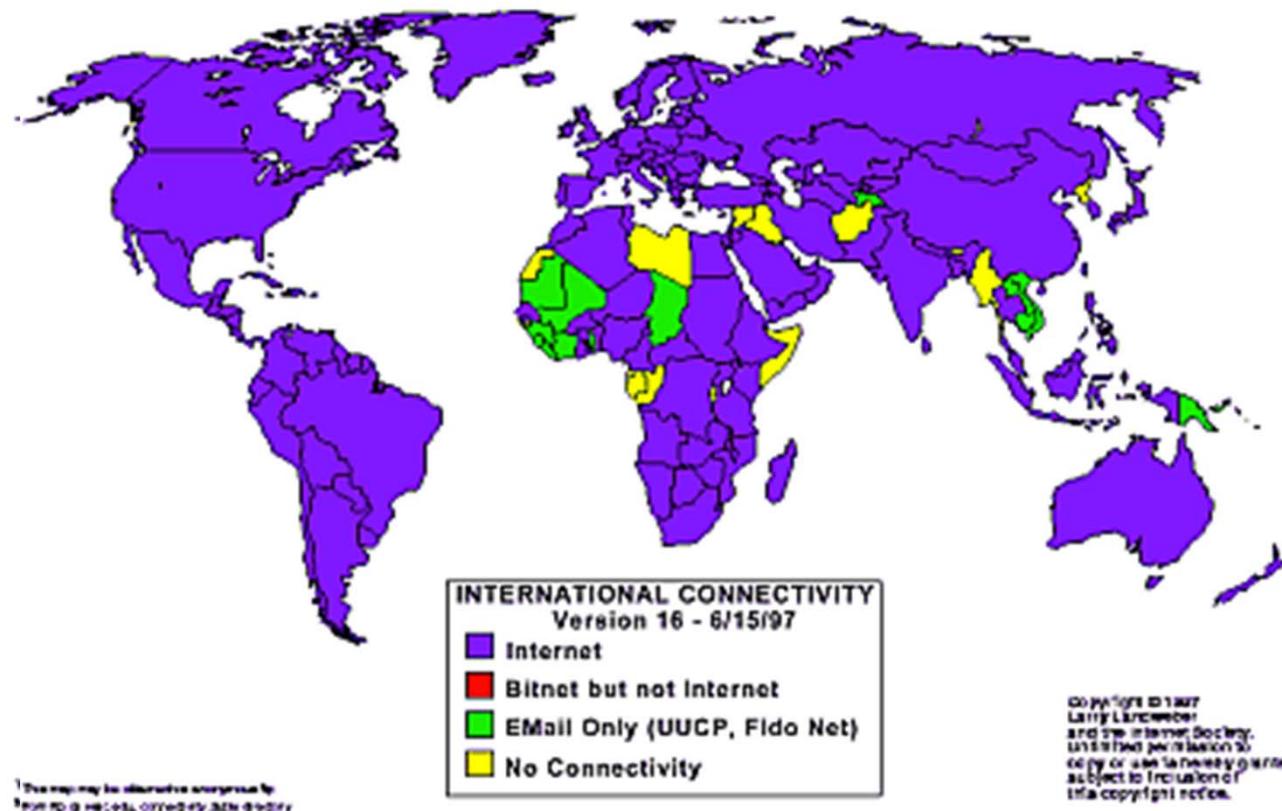
# internet vs. Internet

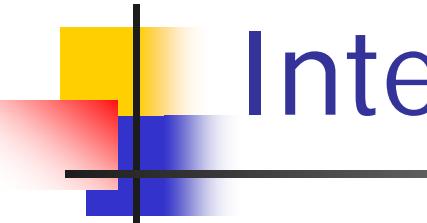
- **internet:** a set of computer networks that are connected to each other.



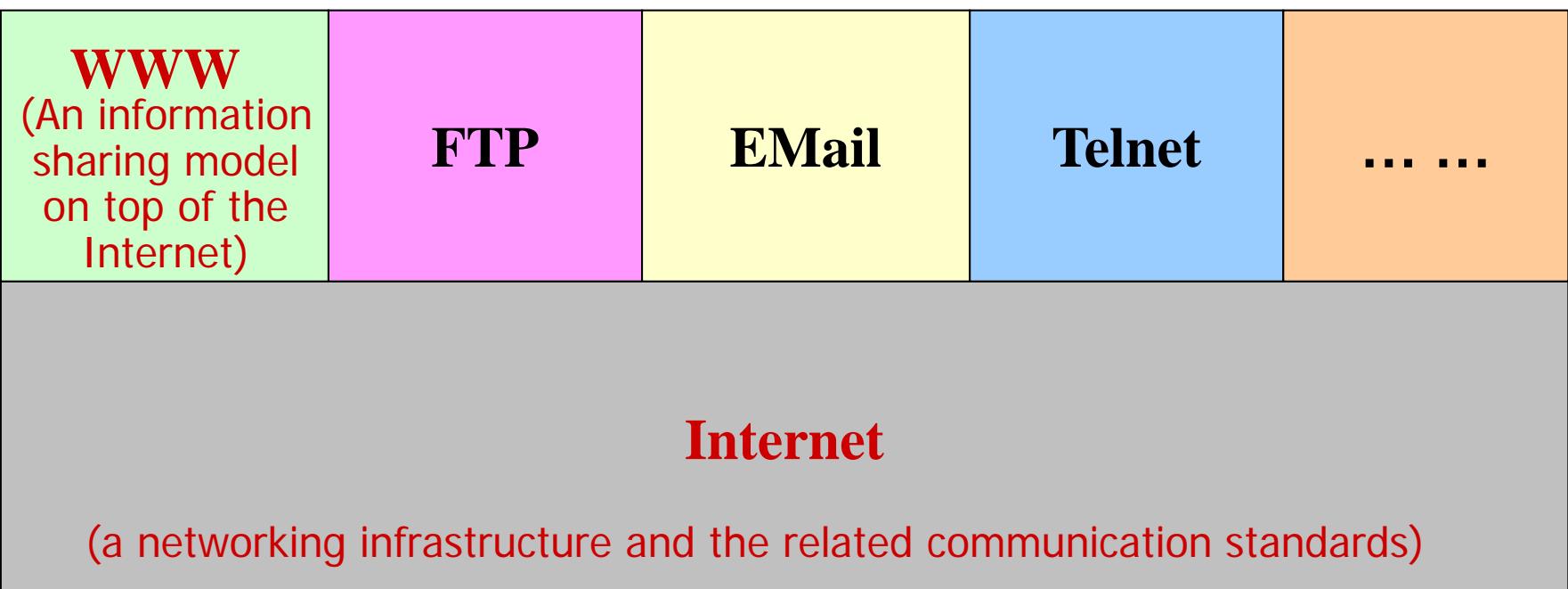
# internet vs. Internet

- Internet: a worldwide sets of networks that interoperate using TCP/IP protocols.



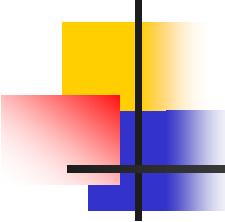


# Internet vs. WWW





## Q2: How does the Internet work?

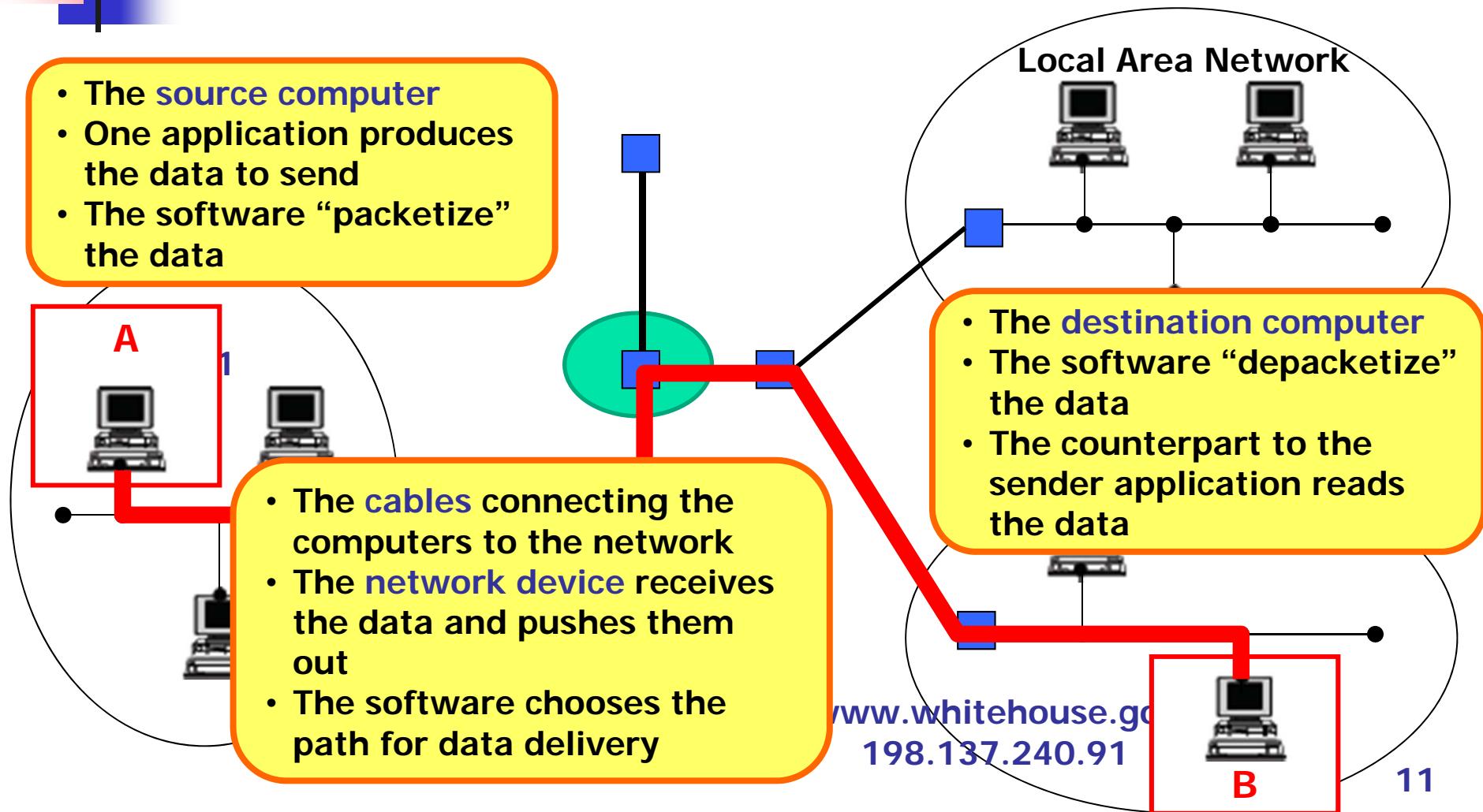


## Q2: How does the Internet work?

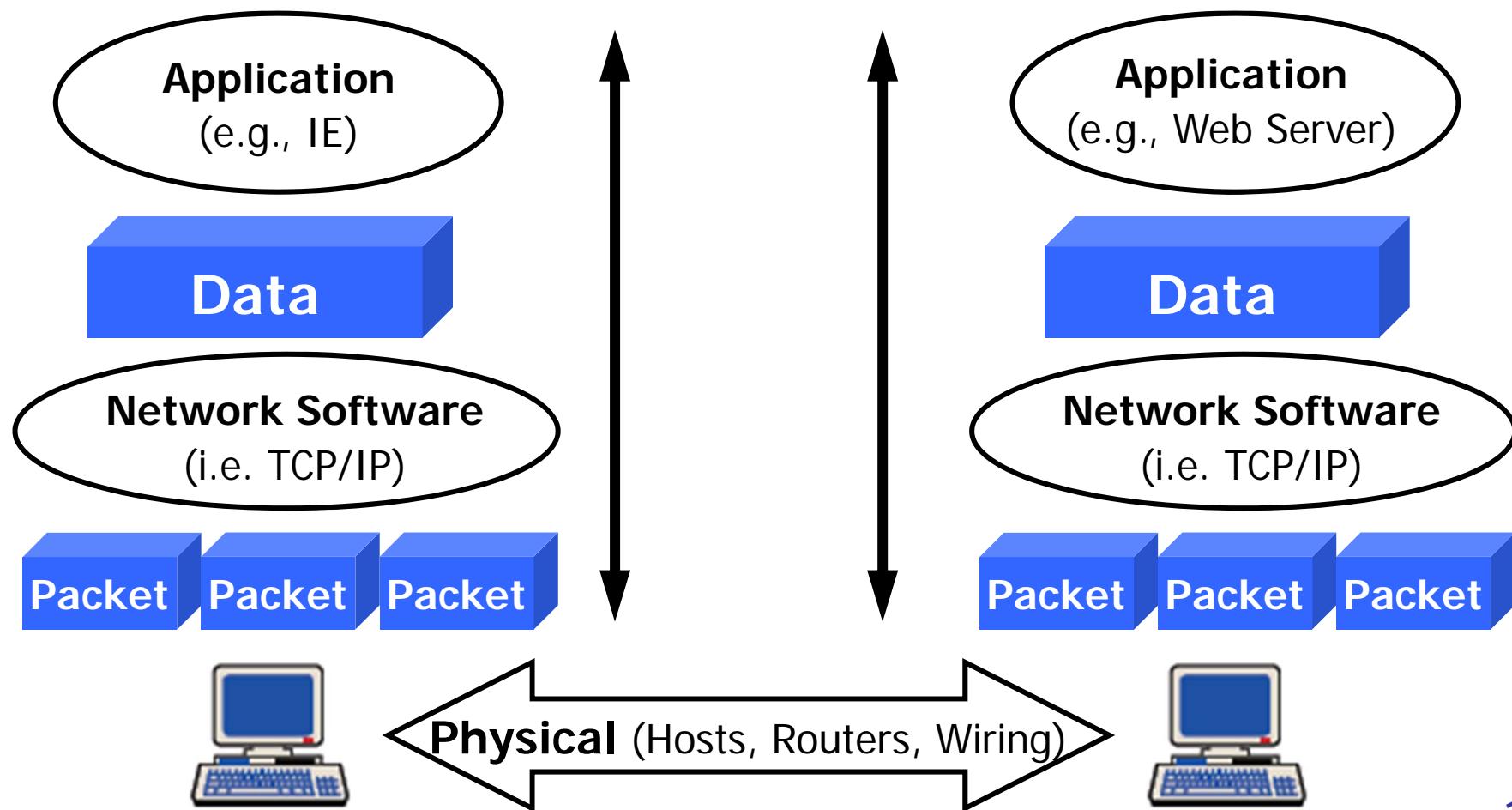
- How do machines communicate with one another on the Internet? 
- What are the components of the Internet?
  - Physical infrastructure
  - Domain Name System
  - Internet protocols
  - Internet applications
- Important design concepts
  - Layered model of networking
  - Client-server paradigm

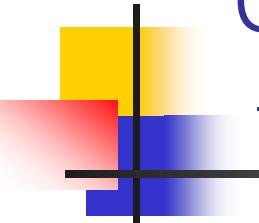
# Q2: How does the Internet work?

## — communication on the Internet



## Q2: How does the Internet work? — communication on the Internet





## Q2: How does the Internet work?

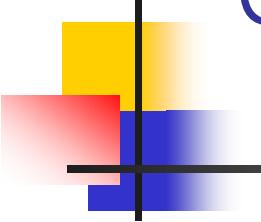
— the minimum requirements for communication on the Internet

- Postal Analogy

- A common language
- A letter
- A stamped and addressed envelop
- Physical delivery via the postal stream

- Internet counterpart

- Applications speaking a common language
- Digitized data (eg. packet)
- Communication protocols
- Physical connection to the Internet

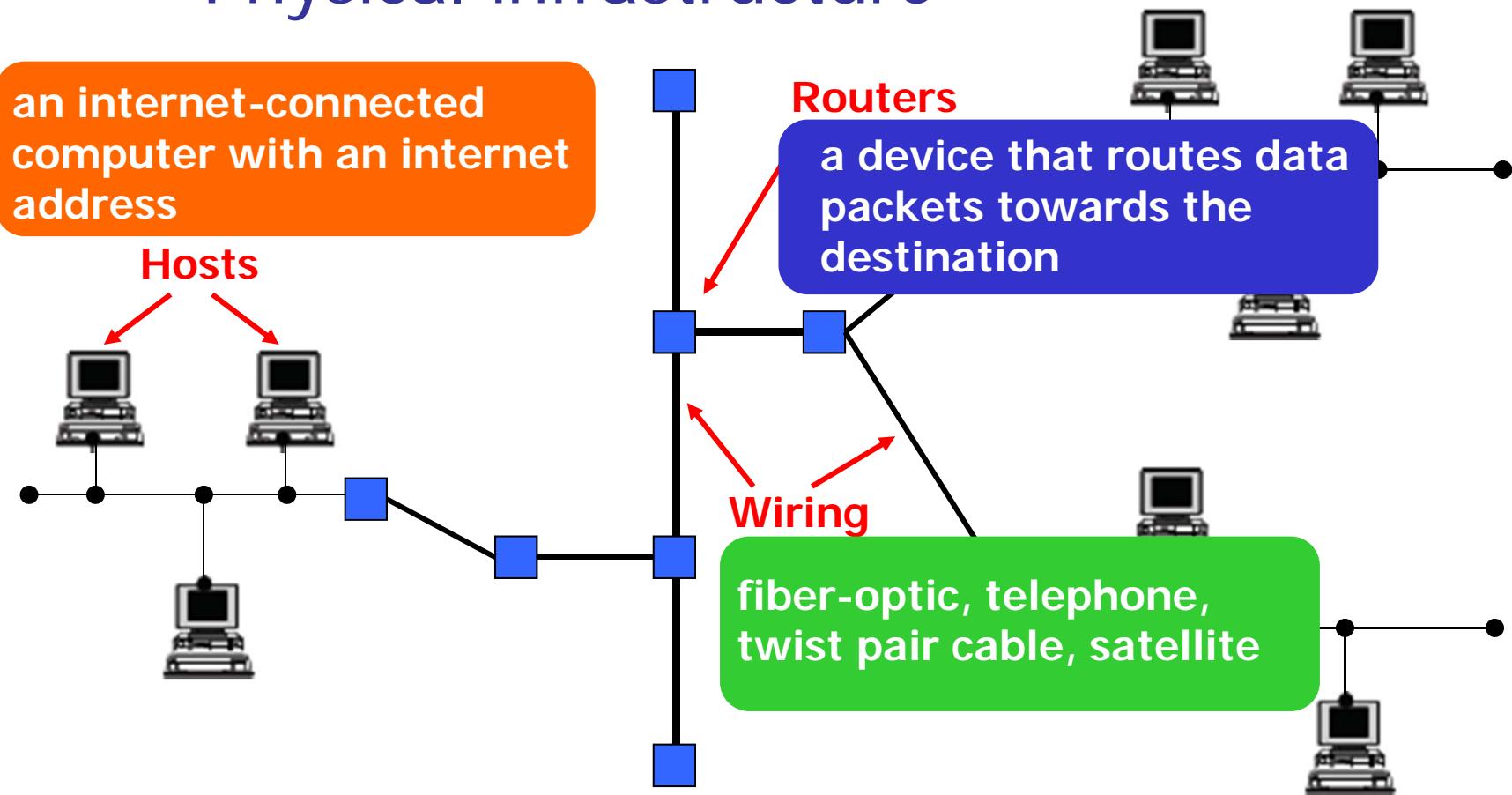


## Q2: How does the Internet work? — the components of the Internet

- Internet applications
  - Telnet, Email, Web browser etc.
- Internet protocols
  - TCP/IP, FTP, SMTP, HTTP etc.
- Internet addresses
  - IPv4, IPv6, Domain Name System
- Physical infrastructure
  - hosts, routers, wiring

# Q2: How does the Internet work? — the components of the Internet

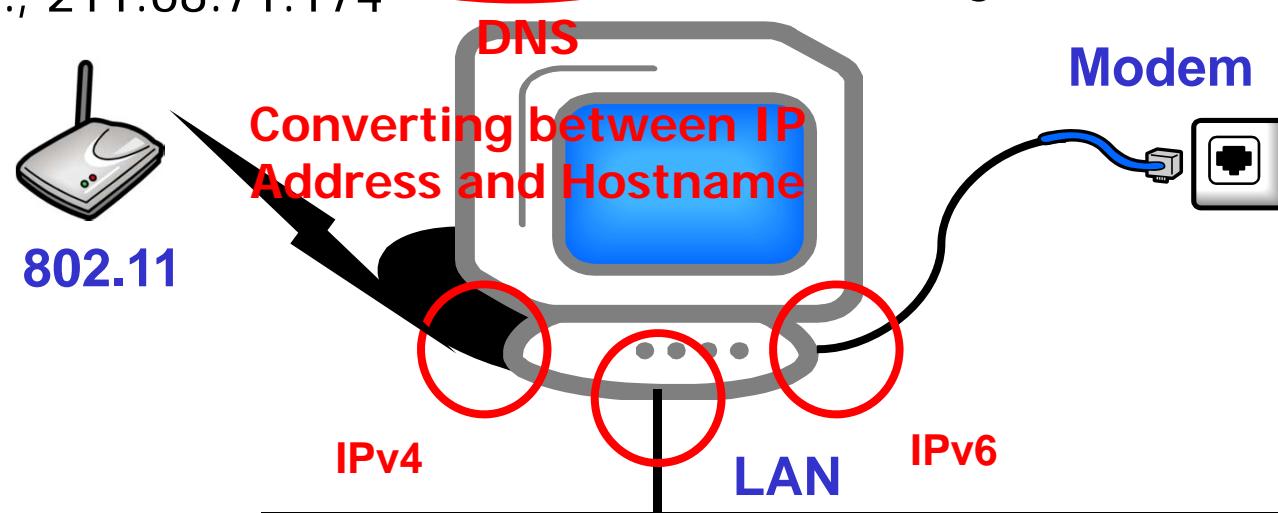
## ■ Physical infrastructure



# Q2: How does the Internet work? — the components of the Internet

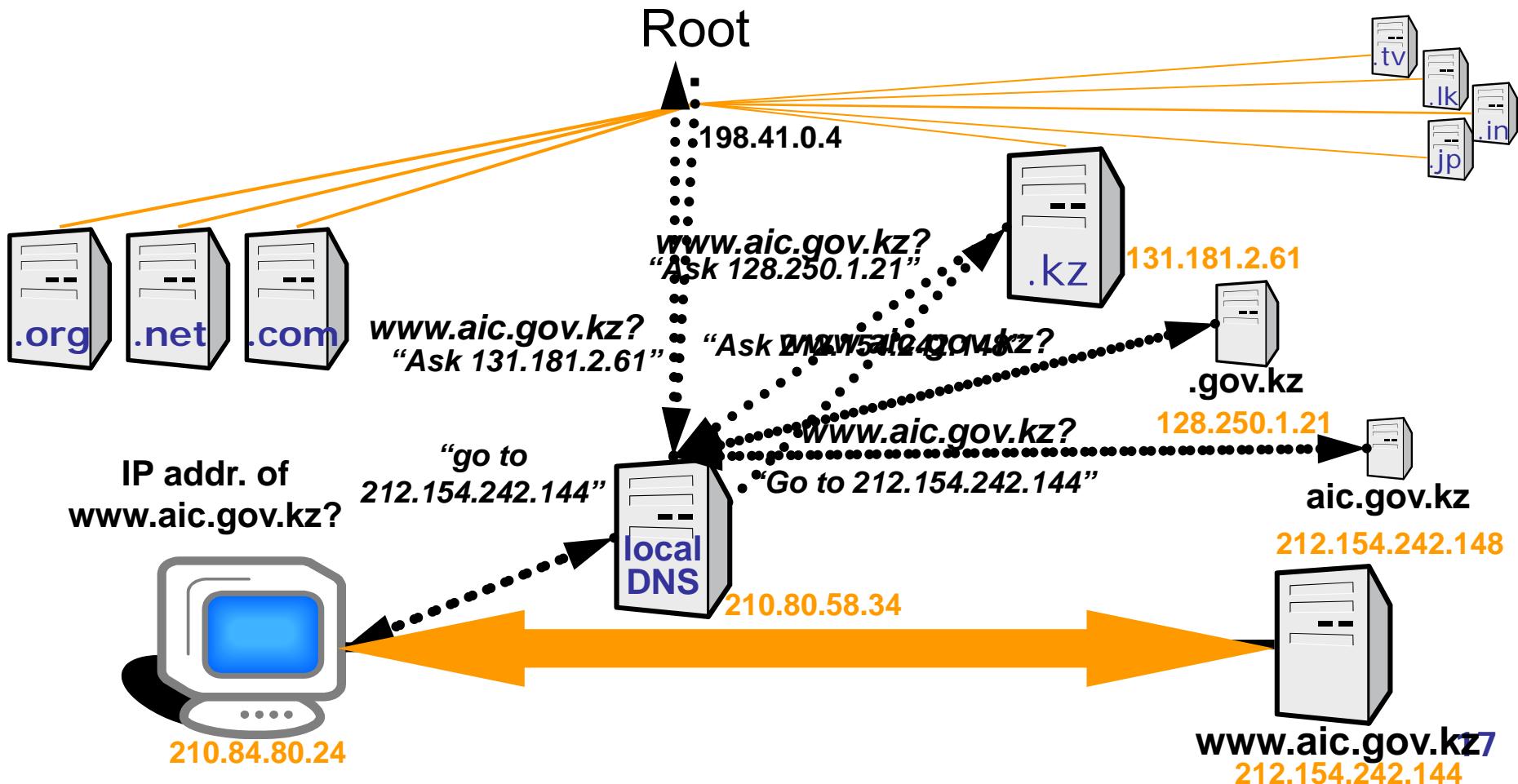
## ■ Internet addressing

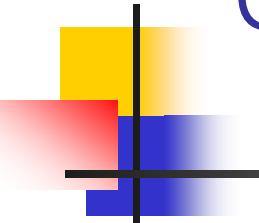
- Machines want identity
- IP Address
  - = network interface address
  - Be assigned by IANA
  - E.g., 211.68.71.174
- Humans want names
- Hostname
  - Be assigned to a host for the benefit of humans
  - E.g., www.is.bupt.cn



# Q2: How does the Internet work? — the components of the Internet

## Internet addressing: an example of DNS





## Q2: How does the Internet work? — the components of the Internet

- Internet protocols
- Protocol = A set of rules for communicating

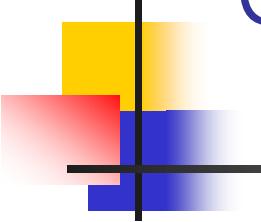
### Network layer

- Internet Protocol (IP)
  - Basic data transport: the glue of the Internet
  - Unreliable delivery
  - Versions
    - IPv4 with 32 bit/4 Byte address
    - IPv6 with 128 bit/16 Byte address

***All Internet Applications  
use at least IP, most use  
TCP/UDP and IP***

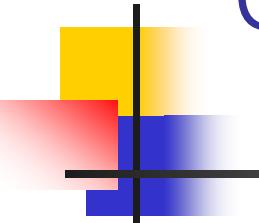
### Transport layer

- Transmission Control Protocol (TCP)
  - Reliable data transmission
  - Connection-oriented
- User Datagram Protocol (UDP)
  - Unreliable data transmission
  - Connectionless-oriented



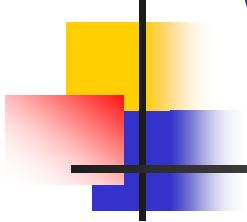
## Q2: How does the Internet work? — the components of the Internet

- Internet Protocols
- *Application protocols*
  - File Transfer Protocol (FTP)
    - Used by file exchange applications
  - Simple Mail Transfer Protocol (SMTP)
    - Used by email applications
  - HyperText Transfer Protocol (HTTP)
    - Used by WWW applications
  - ....



## Q2: How does the Internet work? — the components of the Internet

- Internet applications
  - E.g., ftp, telnet, email, www, ... ...
  - Most are based on client-server model
  - Different applications use different protocols in addition to TCP/UDP and IP
    - ftp: FTP
    - Email: SMTP
    - WWW: HTTP

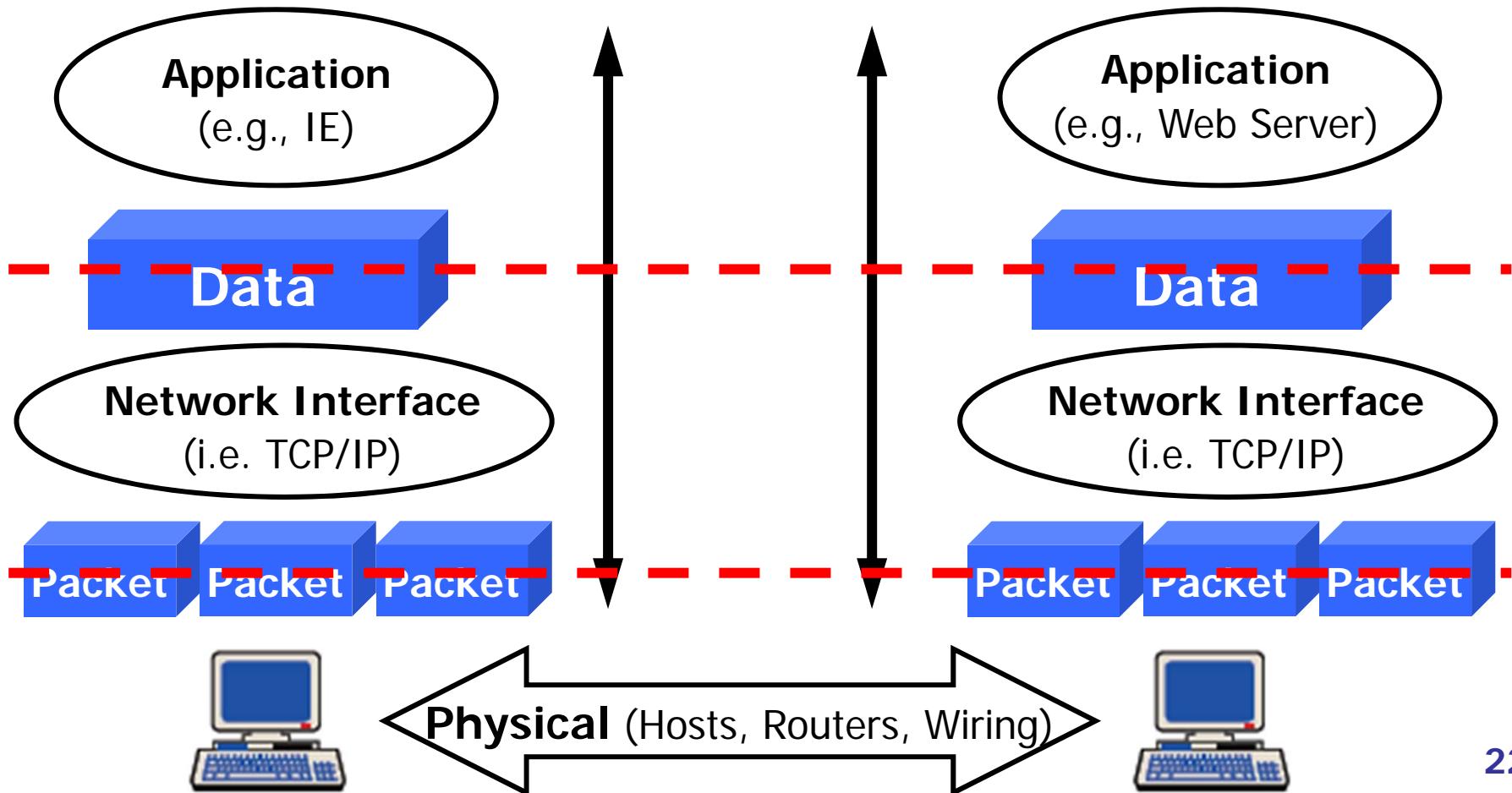


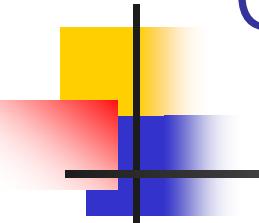
## Q2: How does the Internet work? — important concepts

- Layered networking model
- Client-server paradigm

## Q2: How does the Internet work? — important concepts

### ■ Layered networking model





## Q2: How does the Internet work? — important concepts

- Layered networking model

Postal Analogy

Network Counterpart

Layer

Common language

Applications (Telnet,  
FTP, HTTP etc.)

**APPLICATION**

Envelop and return  
address

Reliable delivery  
(TCP)

**TRANSPORT**

Address

Source to destination  
(IP)

**NETWORK**

Mail boxes, trucks,  
planes; physical  
delivery

Wires, cables,  
hardwares etc

**PHYSICAL**

## Q2: How does the Internet work? — important concepts

- Layered networking model
  - ISO's 7 layer model



# Q2: How does the Internet work? — important concepts

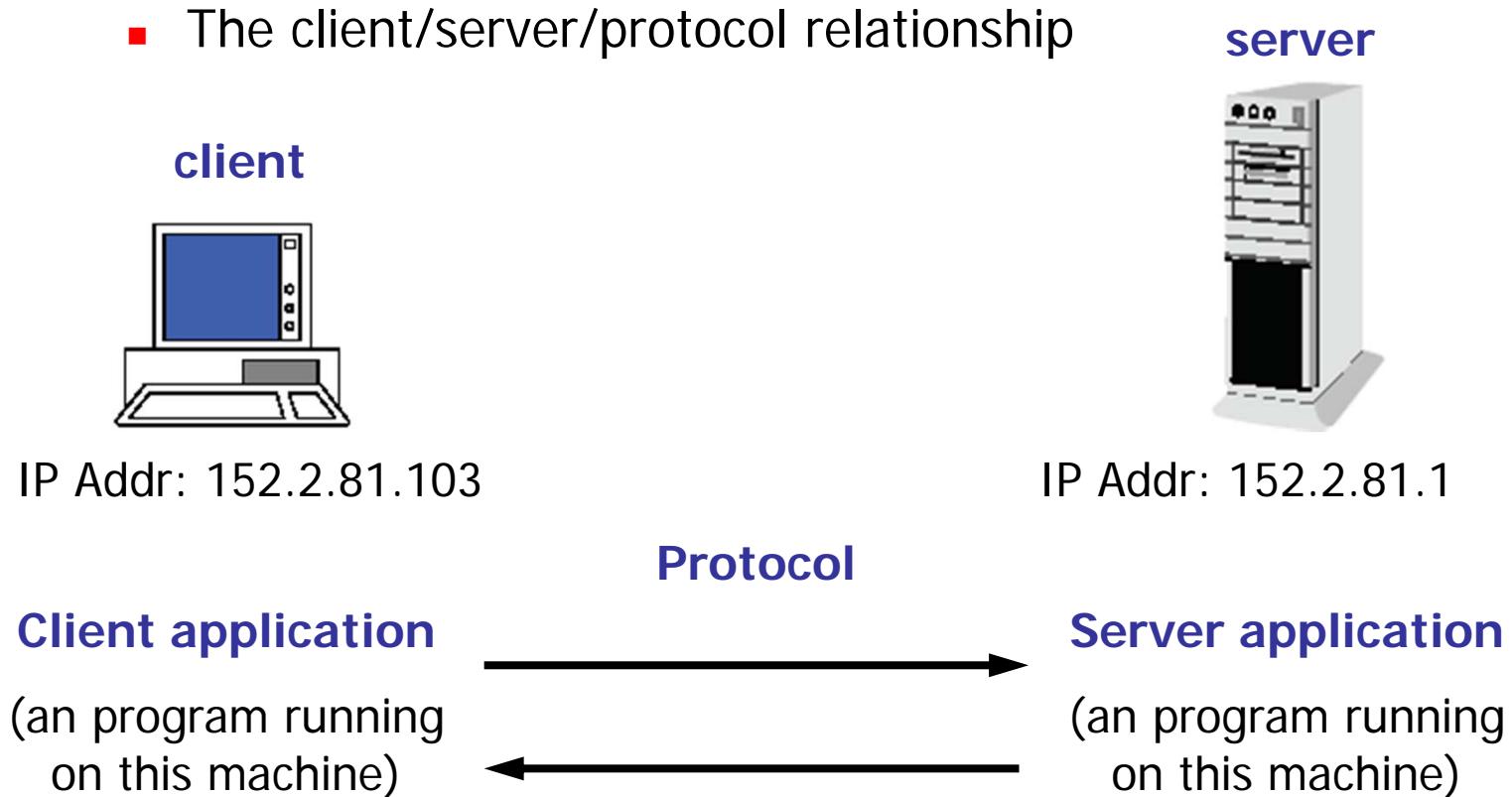
- Client-server paradigm
  - Client – the user of the service
    - Initiated interaction through requests
  - Server – the provider of the service
    - Must be listening
    - Waits and responds to the incoming requests



- Clients and servers need a protocol that defines the interaction between them

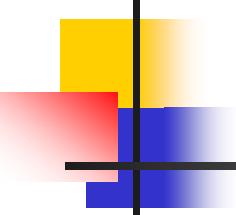
# Q2: How does the Internet work? — important concepts

- Client-server paradigm
  - The client/server/protocol relationship





Q3: When and how did the Internet come about?



# Q3: When & how did it come about? —the evolution of the Internet

- The history of the Internet

a DARPA (Defense Advanced Research Projects Agency) research project

**ARPANET**

a NSF (National Science Foundation) -sponsored research project

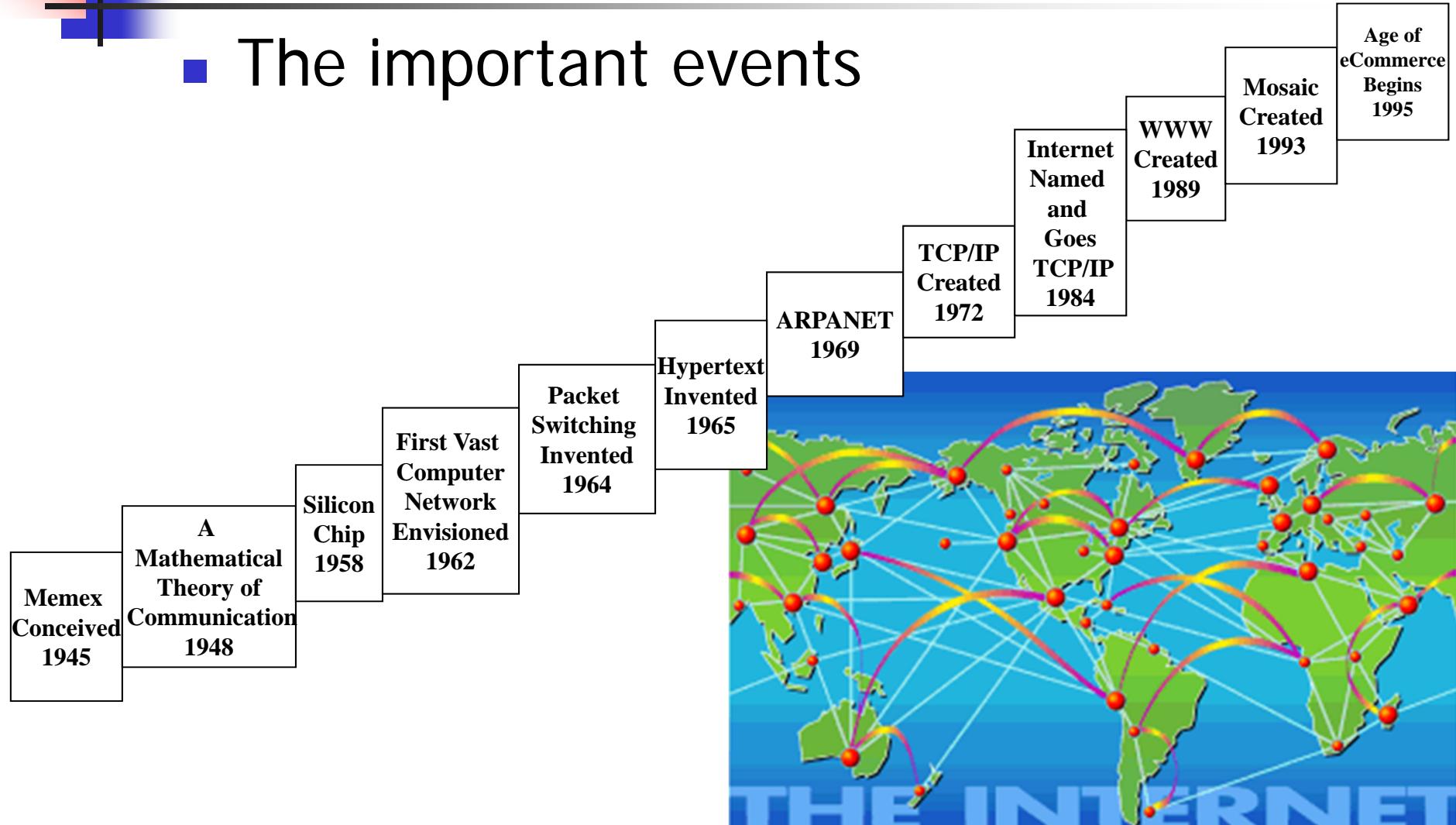
**NSFNET**

a full global infrastructure

**INTERNET**  
(the most  
important  
information  
source today)  
**28**

# Q3: When & how did it come about? —the evolution of the Internet

## ■ The important events



# Q3: When & how did it come about? — the evolution of the Internet

## ■ ARPANET — a packet switching network

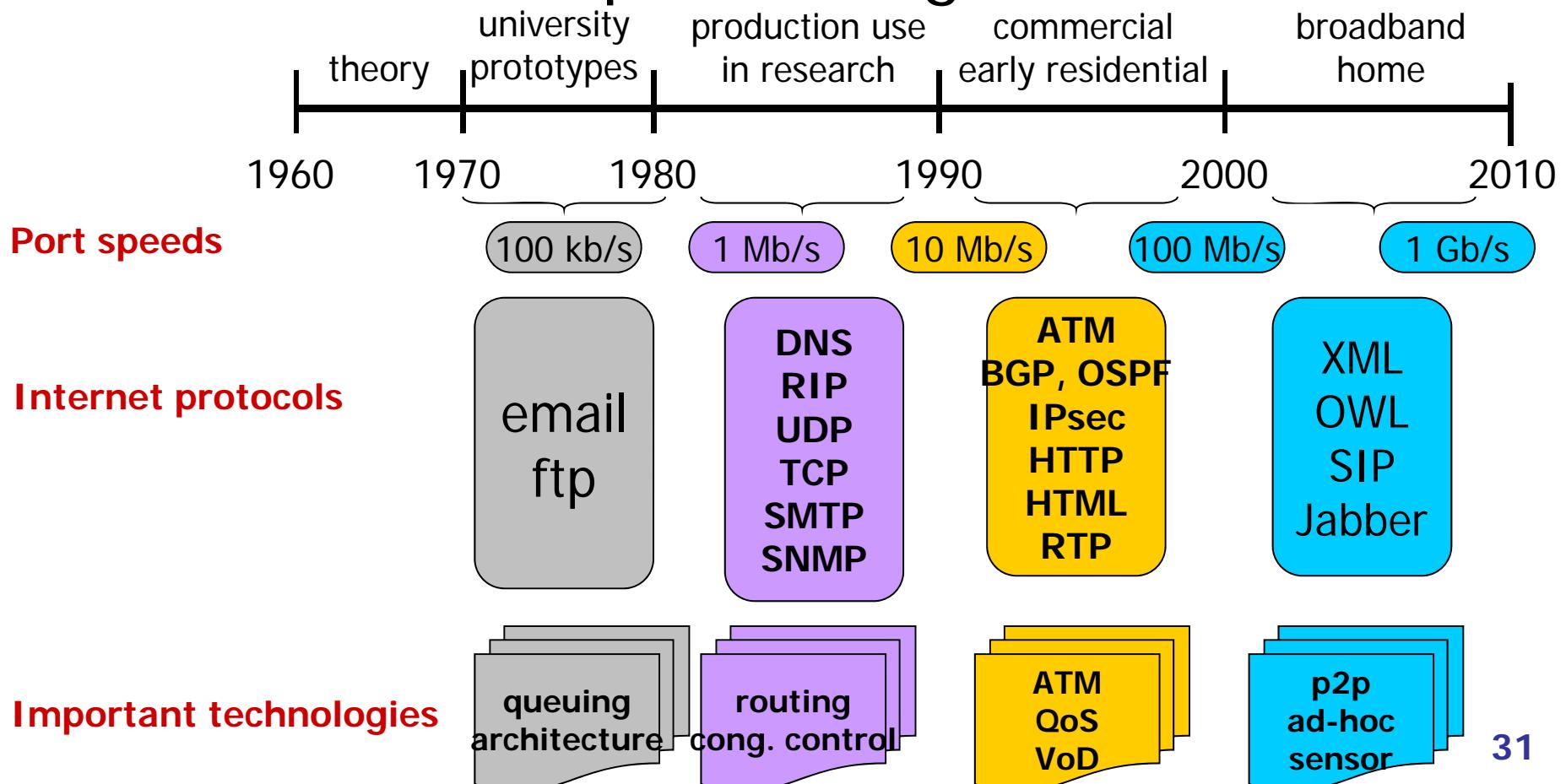
- **1964** Paul Baran realized packet switching in the military network.
- **1965** the experiments by MIT showed the packet transmission in the circuit switching network was slow, unreliable and with high cost.
- **1967** ARPA of USA planned ARPANET.
- Lawrence Roberts proposed that ARPANET adopted packet switching network based on the queuing theory of Leonard Kleinrock.



Kleinrock and the first node of ARPANET 30

# Q3: When & how did it come about? —the evolution of the Internet

## ■ The development stages



# Q3: When & how did it come about? —the famous persons

- Father of the Internet (by the Charles Stark Draper Prize of NAE in 2001)



Roberts

Kahn

Kleinrock

Cerf

- **Lawrence G. Roberts**
  - The creator of ARPANET
- **Leonard Kleinrock**
  - The creator of the packet switching protocols for network information exchange
- **Vinton G. Cerf**
- **Robert E. Kahn**
  - The inventors of TCP/IP
  - The Turing Award in 2004

# Q3: When & how did it come about? ——the famous persons

- Douglas E. Comer



- The internationally recognized expert on computer networking and the TCP/IP protocols
- The Vice President of Research for Cisco System Inc.
- The Distinguished professor of Computer Science in Purdue University

# Q3: When & how did it come about? —the famous persons

- The inventor of WWW — Tim Berners Lee



- The Director of the World Wide Web Consortium
- Senior Research Scientist at MIT's CSAIL
- In March 1989, he proposed the idea of sharing information through hypertext
- In the summer of 1989, he developed the first web server and web client in the world
- In December 1989, he named his invention WWW(World Wide Web)
- In May 1991, WWW began to be used in the Internet
- In 1994, he founded the WWW Consortium

# Q3: When & how did it come about? —the famous persons

- The representative of eCommerce (Electronic Commerce) — Jeff Bezos



- The founder of the famous Amazon
- A great Internet strategist
- In 1994 he began to think about how to create infinite commercial chance in the Internet with surprising high growth speed
- In July 1995, the Amazon Inc. was founded as a network bookshop

# Q3: When & how did it come about? —the famous persons

- The founders of IM (Instant Messaging)



- ICQ means “I seek you”
- The first one IM software in the world, and OICQ, QQ etc. later
- Invented by four young Jews without any professional educations or trainings -- Yair Goldfinger (26 years old), Arik Vardi (27), Sefi Vigiser (25), Amnon Amir (24) Only in 3 months
- They found the Mirabilis Inc. at Israel in Nov. 1996.
- Purchased by AOL with \$300,000,000 in 1999.

# Q3: When & how did it come about? —the famous persons

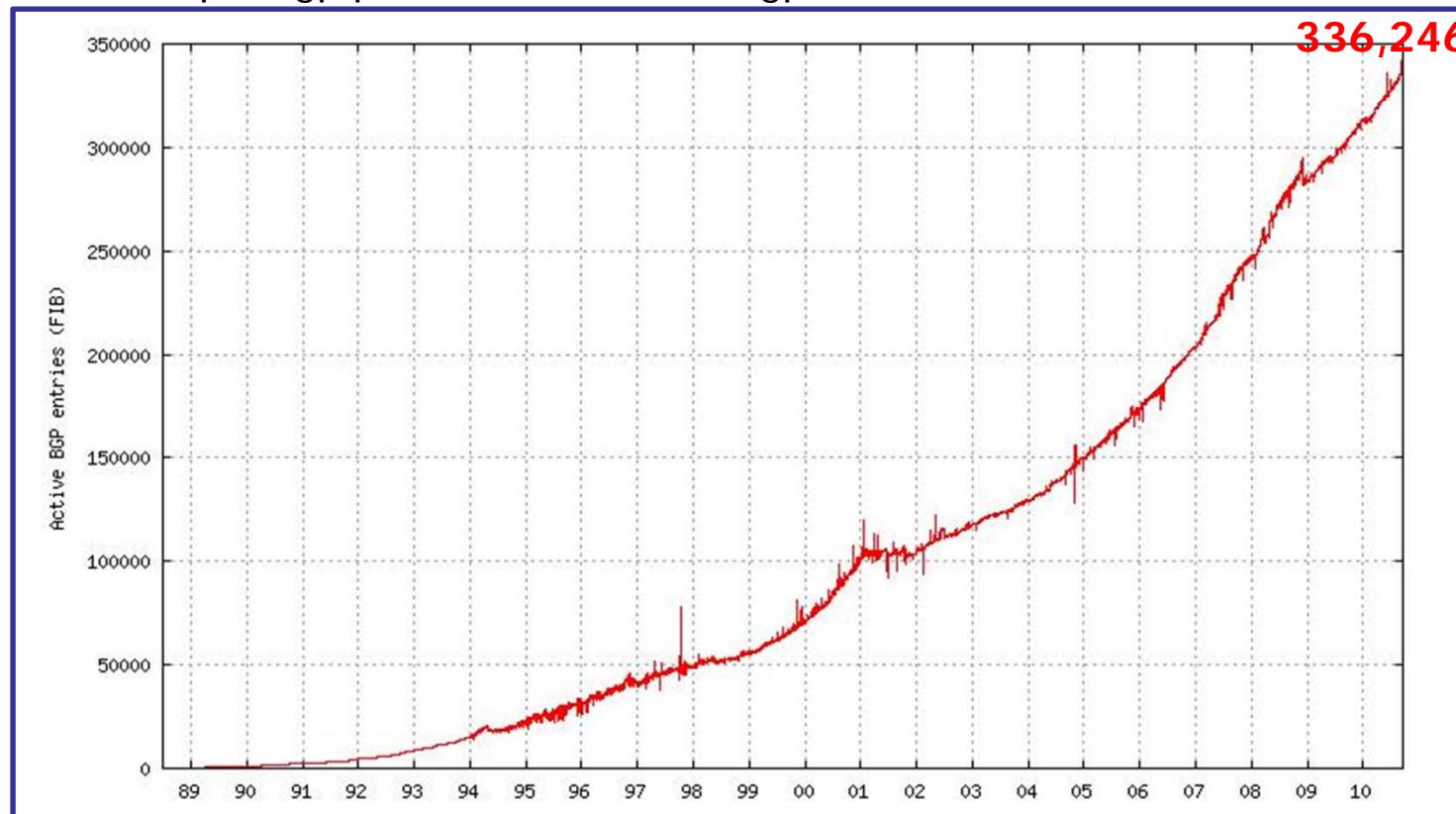
- The inventor of BT (BitTorrent) — Bram Cohen



- The concept of seed is used for data sharing between users in the network firstly in 1999.
- The Beta version of BT was completed in 2001.
- Bram opened the source codes of BT in 2002 and gained lots of users.
- BT has become the preferred downloading tools
- Still be a disputed topic today

# Q3: When & how did it come about? —Internet today

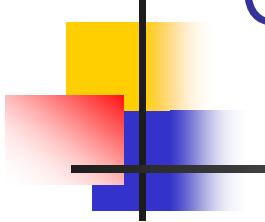
- How many networks running are there: Active BGP Entries (Forwarding Table: FIB)
- By Geoff Huston , at Sat Sep 18 15:10:09 2010 (UTC+1000).
- URL: <http://bgp.potaroo.net/as1221/bgp-active.html>



# Q3: When & how did it come about? ——Internet today

- How many Internet users are there in China?
- By CNNIC, July 2010.
- URL: <http://research.cnnic.cn/img/h000/h11/attach200907161306340.pdf>





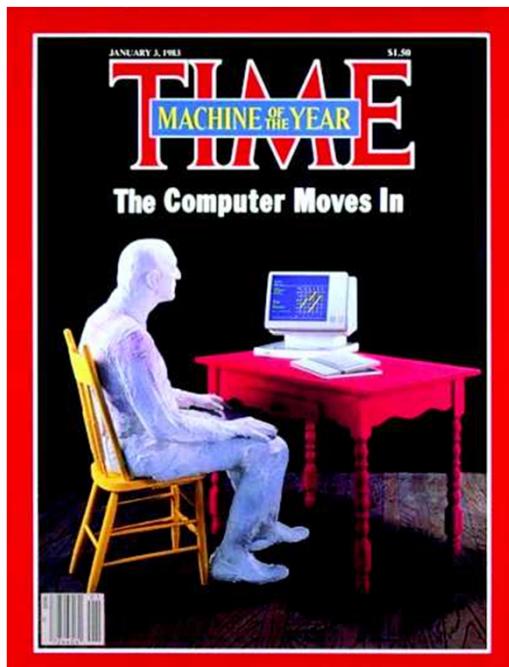
## Q3: When & how did it come about? —Internet today

- More and more ordinary people can access it
- The speed is faster
- More information
- More applications

## Q3: When & how did it come about?

—the elicitations from the success of the Internet

- A process full of innovations
- Open standards
- The broad application is the vitality of the Internet



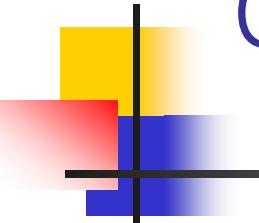
1982: "PC"



2006: "You"

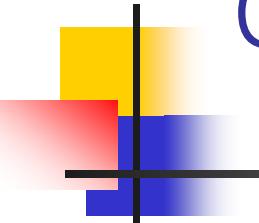


## Q4: Who controls it?



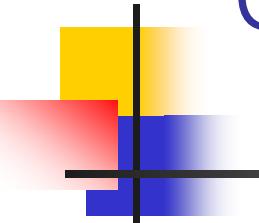
## Q4: Who controls it? — who is in charge?

- ARPA managed for 15+ years
- 1986: NSF took over
- 1994: NSF ceased direct support
  - Now funded by “the market,” government, industry
  - Internationally deployed
- 1998: ICANN
  - Internet Corporation for Assigned Names and Numbers
- 2004: WGIG
  - Working Group on Internet Governance
  - founded at the United Nations in Geneva



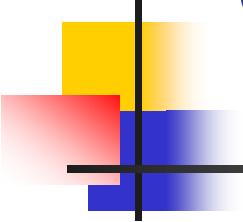
## Q4: Who controls it? — the major organizations

- **ISOC (Internet Society)**
  - Official gatekeeper
  - To promote evolution and growth of Internet
  - <http://www.isoc.org>
- **IAB (Internet Architecture Board)**
  - Technical oversight and coordination
  - ~15 international volunteers
  - ISOC oversees IAB
  - <http://www.isi.edu/iab>
- **ARIN/RIPE/APNIC/LacNIC/AfricNIC**
  - Regional Internet Registry (RIR) providing allocation and registration services
  - <http://www.nro.net/>
  - NRO (Number Registration Organizations)



## Q4: Who controls it? —— the major organizations

- **IETF (Internet Engineering Task Force)**
  - Develops near-term Internet standards
  - 9 areas, each with an area director
  - Areas are routing and addressing, security, etc.
  - Under the IAB
  - <http://www.ietf.org>
- **IRTF (Internet Research Task Force)**
  - Focuses on long-term research projects
  - Under the IAB
  - <http://www.irtf.org>
- **IETF & IRTF develop official Internet standards**
  - Technical working in WGs (Working Group)
  - Open to all
  - Documents progress through stages: RFCs, drafts

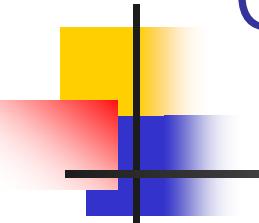


## Q4: Who controls it? —— the major organizations

- IANA (Internet Assigned Numbers Authority)
  - Hands out globally unique Internet addresses
  - Supported by U.S. government in the past
  - <http://www.iana.org/>
- ICANN (Internet Corporation for Assigned Numbers)
  - Replacement organization for IANA
  - Not-for-profit organization with international board
  - <http://www.icann.org/>

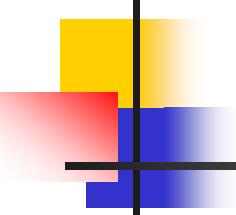


## Q5: Where is it going?



## Q5: Where is it going? — information growth

- 55,000 new books annually
- > 1,000,000 magazine articles
- 9,600 periodicals: > 800 new per year (some all digital)
- 40,000 scientific articles ( 1 every 30 seconds)
- 95% of all information is generated digitally
- Top libraries would have to double in size every 14 years
- Over 234 million websites worldwide by 2009



## Q5: Where is it going? — language of Internet growth

- Talk about exponential growth...
  - $10^0$  Ten Byte
  - $10^3$  Thousand Kilobytes
  - $10^6$  million megabytes
  - $10^9$  billion gigabytes
  - $10^{12}$  trillion terabytes
  - $10^{15}$  quadrillion petabytes
  - $10^{18}$  quintillion exabytes

## Q5: Where is it going?

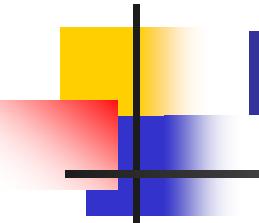
— are the original assumptions still tenable?

### Original assumptions

- End-to-end
- Host-centric
- Best effort service
- Trusty service stream
- Unrelated to commercial application

### Tenable today ?

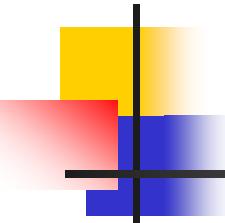
- No, maybe Peer-to-peer
- No, unfit for RFID and sensor networking
- No, QoS is important
- No, security is important
- No, appropriate profitable mode is needed



# IPv6: Motivation

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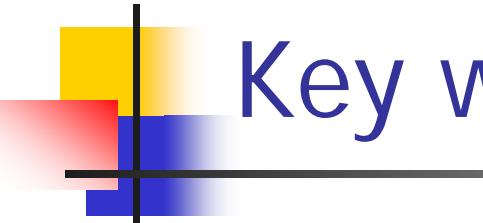
- Problems of IPv4
  - Insufficient addressing space
  - Real-time application is not provided
  - Short of security support
  - Short of mobility support



## Q5: Where is it going?

— research works of Next Generation Internet

- Patching on today's network
  - Resulting in more and more complexity
- Designing new architecture for the next generation network
  - NewArch
  - GENI
  - FIND
  - Ambient Network
  - ANA
  - HAGGLE
  - ... ...



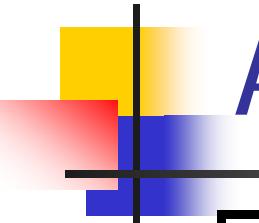
# Key words today

**Local definition:** A set of computer networks that are connected to each other (an **internet**)

**Global definition:** A world-wide set of networks that interoperate using TCP/IP protocols (the **Internet**)

**Protocol:** A set of rules to control the means by which information is communicated between entities

**TCP/IP:** A suite of protocols for transporting any data over an internet between access points



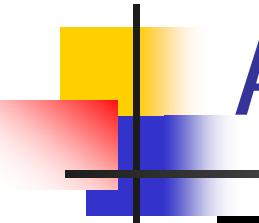
# Abbreviations (1)

<b>ARPA</b>	<b>Advanced Research Projects Agency</b>
<b>AS</b>	<b>Autonomous System</b>
<b>BGP</b>	<b>Border Gateway Protocol</b>
<b>CNGI</b>	<b>China Next Generation Internet</b>
<b>DARPA</b>	<b>Defense Advanced Research Projects Agency</b>
<b>DNS</b>	<b>Domain Name System</b>
<b>DSL</b>	<b>Digital Subscriber Line</b>
<b>FTP</b>	<b>File Transfer Protocol</b>
<b>HTML</b>	<b>HyperText Markup Language</b>
<b>HTTP</b>	<b>HyperText Transfer Protocol</b>
<b>IAB</b>	<b>Internet Architecture Board</b>
<b>IANA</b>	<b>Internet Assigned Numbers Authority</b>
<b>ICANN</b>	<b>Internet Corporation for Assigned Numbers</b>



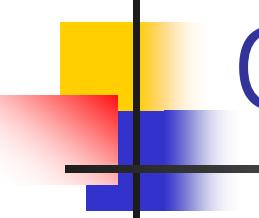
# Abbreviations (2)

<b>IE</b>	<b>Internet Explorer</b>
<b>IETF</b>	<b>Internet Engineering Task Force</b>
<b>IP</b>	<b>Internet Protocol</b>
<b>IRTF</b>	<b>Internet Research Task Force</b>
<b>ISDN</b>	<b>Integrated Services Digital Network</b>
<b>ISO</b>	<b>International Organization for Standardization</b>
<b>LAN</b>	<b>Local Area Network</b>
<b>MIME</b>	<b>Multipurpose Internet Mail Extensions</b>
<b>NSF</b>	<b>National Science Foundation</b>
<b>P2P</b>	<b>Peer to Peer</b>
<b>POP3</b>	<b>Post Office Protocol</b>
<b>RFC</b>	<b>Request for Comments</b>



# Abbreviations (3)

<b>RTCP</b>	<b>Realtime Control Protocol</b>
<b>RTP</b>	<b>Realtime Transport Protocol</b>
<b>SIP</b>	<b>Session Initiation Protocol</b>
<b>SMTP</b>	<b>Simple Mail Transfer Protocol</b>
<b>SNMP</b>	<b>Simple Network Management Protocol</b>
<b>TCP</b>	<b>Transmission Control Protocol</b>
<b>UDP</b>	<b>User Datagram Protocol</b>
<b>WGIG</b>	<b>Working Group on Internet Governance</b>
<b>WWW</b>	<b>World Wide Web</b>



# Questions

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- Internet/Intranet
- What are the problems incurred by the traditional design principles of the Internet?