Internet Applications

Introduction

BUPT/QMUL

2014-2-18

北京郵電大學 BEIJING UNIVERSITY OF POSTS AND TELECOMMUNICATIONS

Electronic Engineering

Agenda

- 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

2

Q1: What is the Internet?

3

Q1: What is

- So many diff
  - http://www.wh
  - http://www.we
  - http://www.we
  - http://linux.ab
  - 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***

*"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*

4

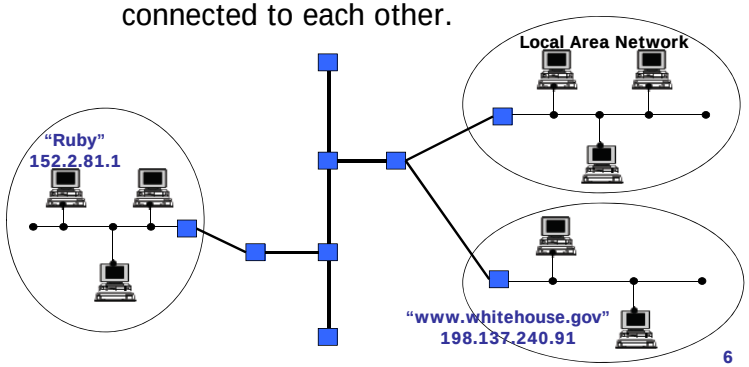
Q1: What is the Internet?

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

5

internet vs. Internet

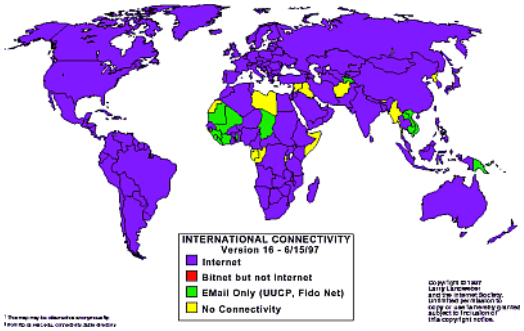
- internet: a set of computer networks that are connected to each other.



6

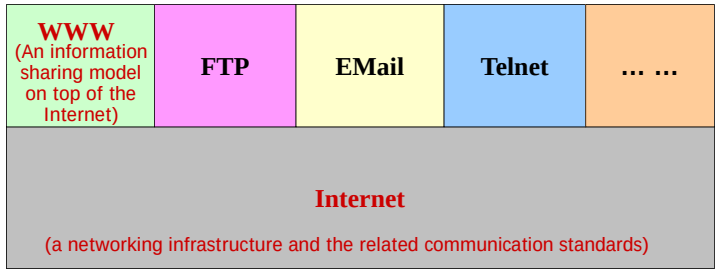
internet vs. Internet

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



7

Internet vs. WWW



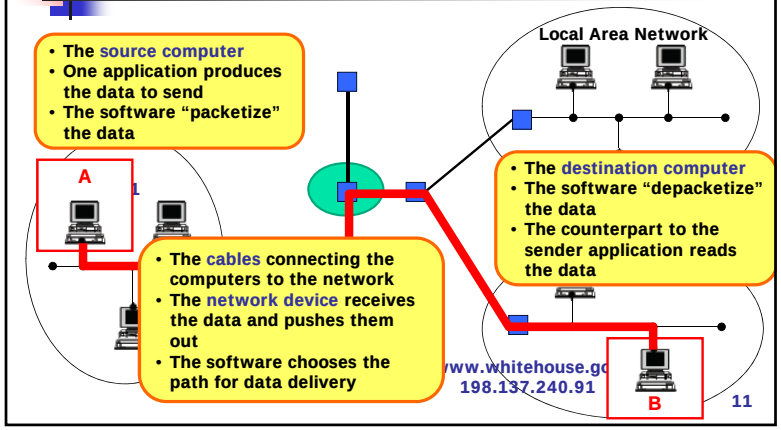
8

Q2: How does the Internet work?

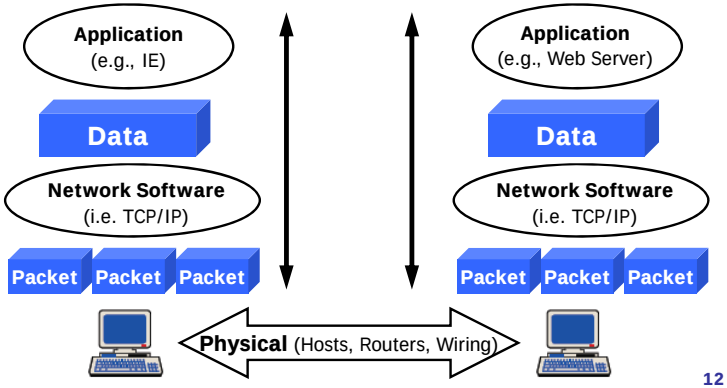
Q2: How does the Internet work?

- 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

13

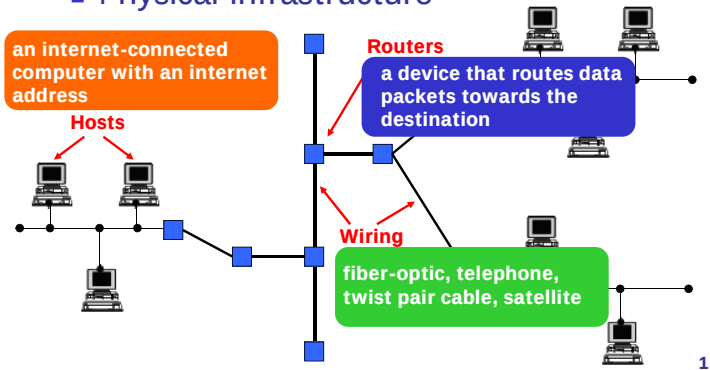
Q2: How does the Internet work?
—— the components of the Internet

- 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

14

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

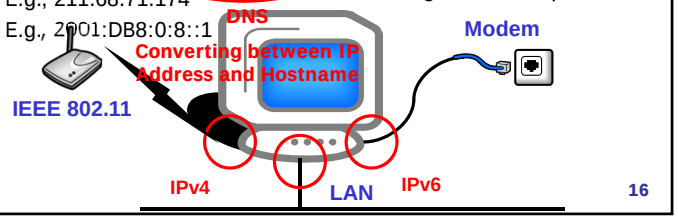
- Physical infrastructure



15

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

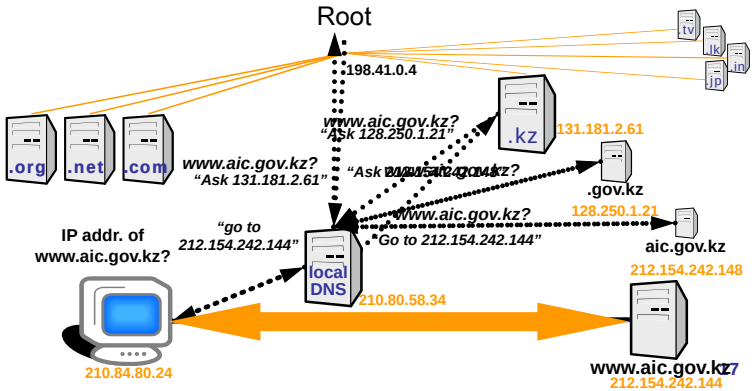
- Internet addressing
  - Machines want identity
  - IP Address
    - = network interface address
    - Be assigned by IANA
    - E.g., 211.68.71.174
    - E.g., 2001:DB8:0:8::1
  - Humans want names
  - Hostname
    - Be assigned to a host for the benefit of humans
    - E.g., www.is.bupt.cn



16

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

Transport layer

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

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

18

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
  - **… …**

19

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
    - telnet: TELNET
    - Email: SMTP
    - WWW: HTTP

20

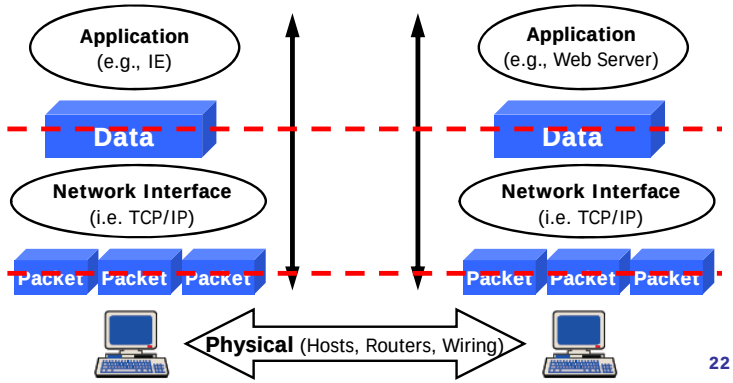
Q2: How does the Internet work?
—— important concepts

- Layered networking model
- Client-server paradigm

21

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

- Layered networking model



22

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

23

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

- Layered networking model
  - ISO's 7 layer model

24

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

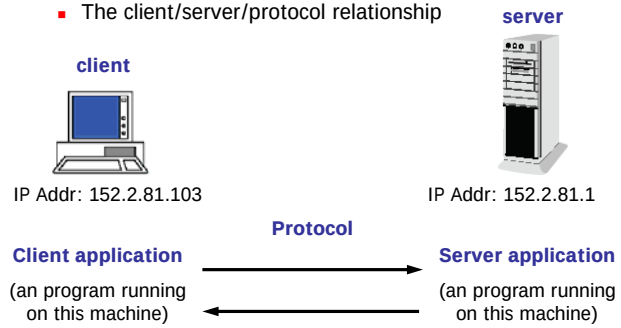
- Client-server paradigm
  - Client – the user of the service
    - Initiated interaction through requests
  - Server – the provider of the service
    - Must be listening
    - Waits and responds to the incoming requests

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

25

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

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



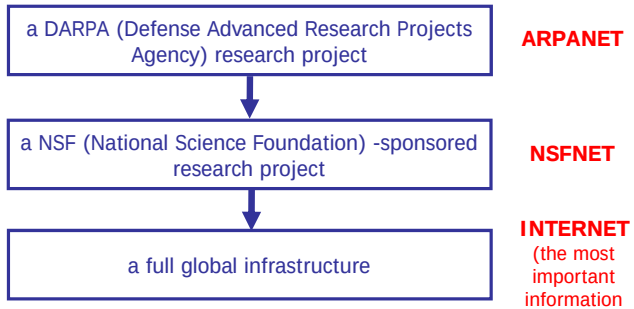
26

Q3: When and how did the Internet come about?

27

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

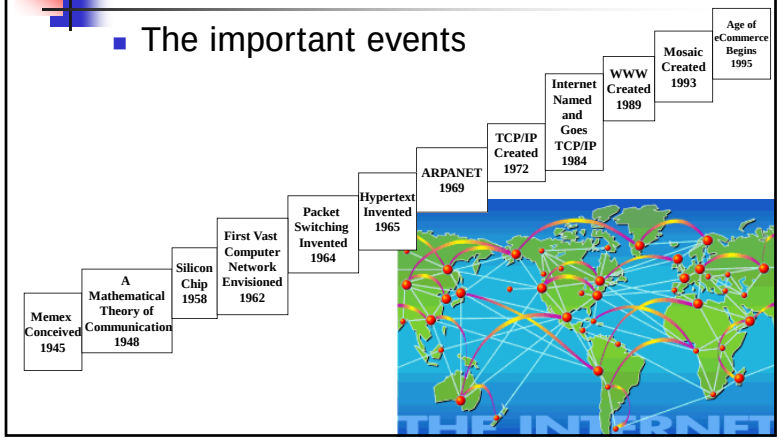
- The history of the Internet



28

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

- The important events



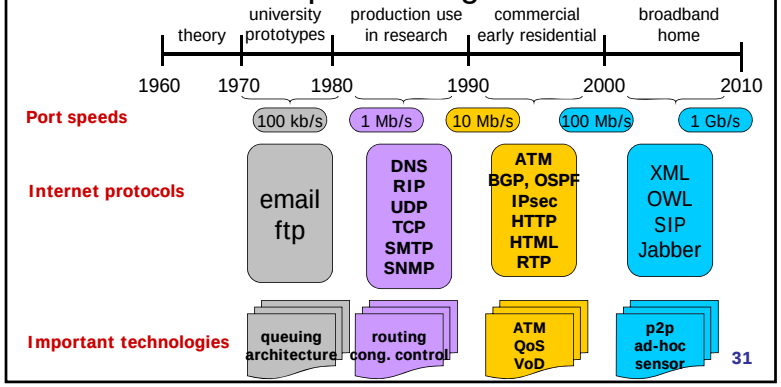
Q3: When & how did it come about?
——the evolution of the Internet

- 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

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

33

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 found the WWW Consortium

34

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

35

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

- The founders of IM (Instant Messaging)

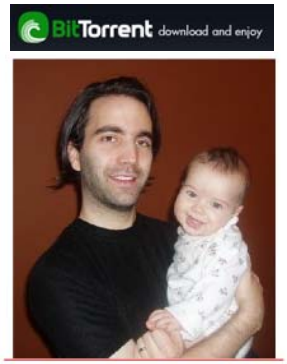
icq everybody, everywhere

- 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.

36

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

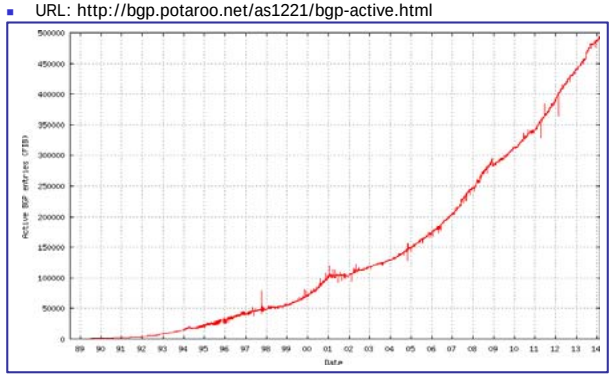
Q3: When & how did it come about? ——the famous persons

- The founder and CEO of Facebook -- Mark Zuckerberg

- Facebook is the first and biggest Internet social networking website.
- He started the website in his college dorm room in 2004 in Harvard.
- In 2010, he was named Time Magazine's Person of the Year.

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 Sun Feb 16 12:10:13 2014 (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, Jan. 2014.
- http://www.cnnic.cn/hlwfzyj/hlwxzbg/hlwtjbg/201401/t20140116_43820.htm

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
- Extended to IoT – Internet of Things

41

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”

42

Q4: Who controls it?

43

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

44

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)

45

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

46

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/

47

Q5: Where is it going?

48

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 634 million websites worldwide by 2012

49

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

- Talk about exponential growth...

10	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

50

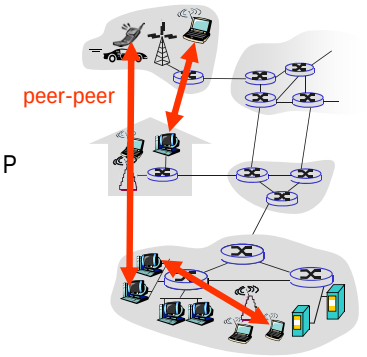
Q5: Where is it going?
—— are the original assumptions still tenable?

Original assumptions	Tenable today ?
End-to-end	No, maybe Peer-to-peer
Host-centric	No, data-centric is proposed
Best effort service	No, QoS is important
Trusty service stream	No, security is important
Unrelated to commercial application	No, appropriate profitable mode is needed

51

P2P: A glance

- *no* always-on server
- arbitrary end systems directly communicate
- peers are intermittently connected and change IP addresses
- Applications:
  - Skype
  - BitTorrent
  - QQ



52

IPv6: Motivation

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

53

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
  - … …

54

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

55

Abbreviations (1)

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

56

Abbreviations (2)

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

57

Abbreviations (3)

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

58

Questions

- Internet/Intranet
- What are the problems incurred by the traditional design principles of the Internet?
- What contribution could you do for Internet?

59