NETWORKING AND WEB-BASED APPLICATION INFRASTRUCTURE

2110684 Information System Architecture
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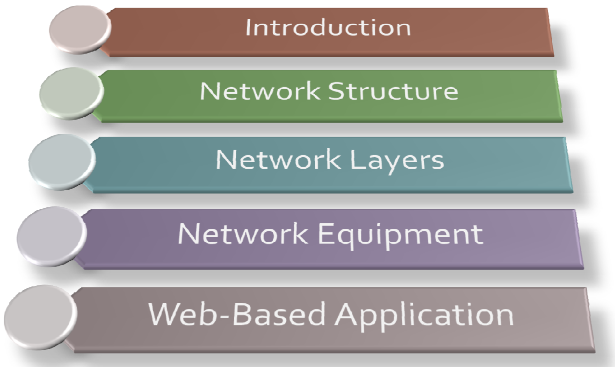
Agenda



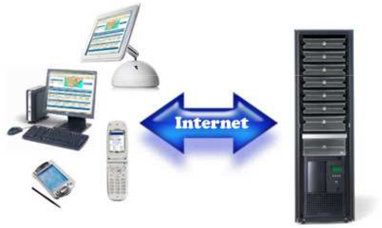
- Introduction
- Network Structure
- Network Layers
- Network Equipment
- Web-Based Application

INTRODUCTION

Internet – Global Connectivity

- Internet architecture is very scalable
  - Connecting people and contents from all over the world
  - 2,000 M users (30% of human race)
  - Contents
    - > 100 M web sites
    - > 45,000 M web pages
- Thailand Statistics
  - Internet Penetration: 17.5M (26.3%) in 2010
    - World = 28.7%, Falkland Islands = 100% (1)
    - Asia = 21.5%, South Korea = 81% (13), (Vietnam = 27.1%)
  - Broadband: 1M in 2007 (1.5%) and 10M in 2009
    - Bermuda = 36.5% (1), South Korea = 27.4% (9)

Internet Components

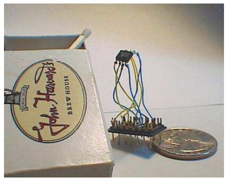


- Internet clients
  - Can be computer, mobile phones, etc.
  - Web browser, email client, etc.
- Internet servers
  - Web servers

"Cool" internet appliances

IP picture frame
http://www.ceiva.com/

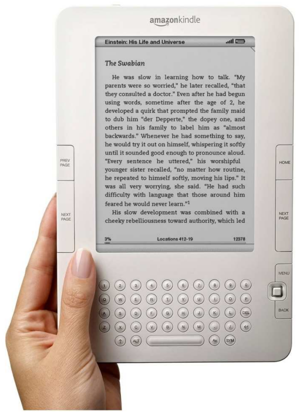
Web-enabled toaster+weather forecaster



World's smallest web server
http://www-ccs.cs.umass.edu/~shri/iPic.html

Mobile Internet Device

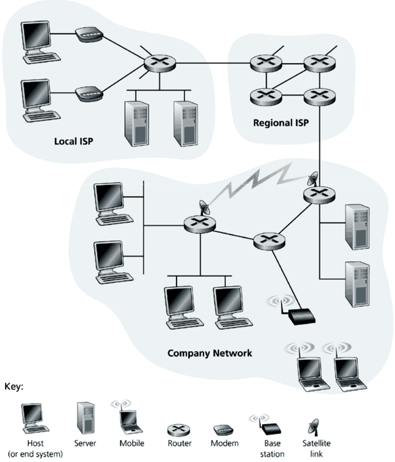
Other Internet Devices



Other Internet Device

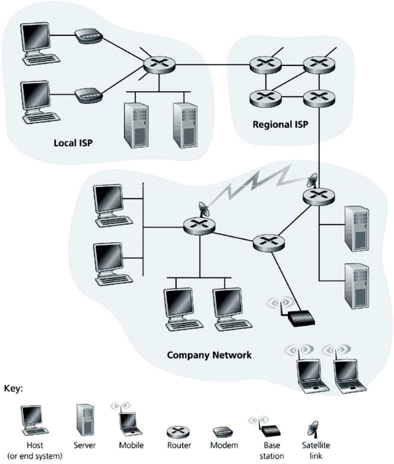
Internet Architecture

- Internet is "network of networks"
  - Millions of connected devices (*hosts = end systems)*
  - Running network apps
  - communication links
    - fiber, copper, radio, satellite
    - transmission rate = *bandwidth*
  - routers: forward packets (chunks of data)



Message Transmission

- Source host creates the message to send
- Message is transmitted via the local network to the local router (gateway)
- Message travels from router to router until the destination's gateway is reached
- Message is transmitted across the destination's LAN to the destination host.
- Destination host receives and acts upon the message

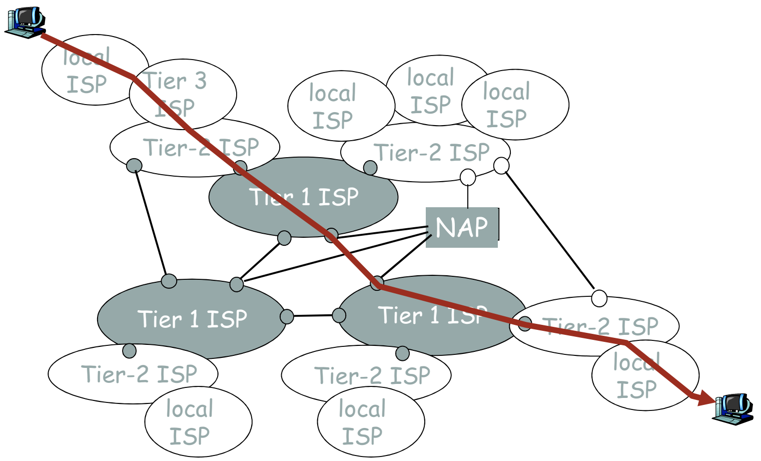


NETWORK STRUCTURE

Internet Service Providers (ISPs)

- Tier 1 ("backbone")
  - AT&T, Sprint, UUNet, etc.
  - National & international connections
- Tier 2
  - Provide regional connections, e.g. Uninet, CAT
  - Purchase services from Tier 1 providers
- Tier 3 and local
  - "Last mile" connections e.g. ChulaNet, True
  - Purchase services from Tier 2
  - Sell services directly to individual & small business customers

Message Path through Internet



Residential "gateway" connections

- Dialup modem
  - Standard analog telephone line
  - <= 56Kbps
- Digital subscriber line (DSL)
  - Standard phone lines, restricted distance to modem
  - 3 Frequency channels (downstream, upstream, voice)
  - 384K–1.5Mbps downstream, 128K-256Kbps upstream
- ADSL: asymmetric digital subscriber line
  - up to 1 Mbps upstream (today typically < 256 kbps)
  - up to 8 Mbps downstream (today typically < 1 Mbps)
  - FDM: 50 kHz - 1 MHz for downstream
    4 kHz - 50 kHz for upstream
    0 kHz - 4 kHz for ordinary telephone

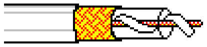
Local Area Networks

- Ethernet (most common wired technology)
  - 10 Mbps , 100 Mbps, 1Gbps even now 10Gps
  - Twisted pair copper wire or coax cable
- Wireless LAN
  - Base station (access point) connected to wired LAN
  - IEEE 802.11b is 11Mbps (802.11g is faster)
  - Typically good for 10s of meters
- WAP (Europe, US) and I-mode (Japan)
  - Extend cell-phone network to Internet
  - Eg. GPRS / EDGE
- Upcoming 3G
  - HSDPA

Building Links: Guided Media

- Twisted pair copper wire (phone, CAT-5)
  - 2 wires twisted around each other to help limit interference
  - CAT-5 cable has more twists, better insulation
- Coaxial Cable

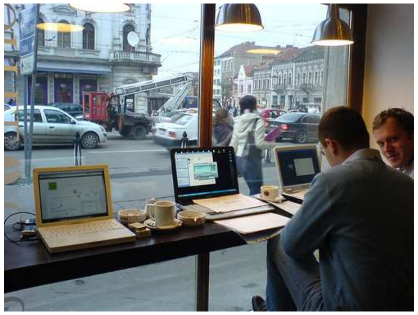
  - Cable wrapped by insulation surrounded by another conductor
- Fiber optics



  - Thin flexible "glass pipe"
  - Require optical rather than electrical transmitters, receivers, switches, amplifiers, etc.

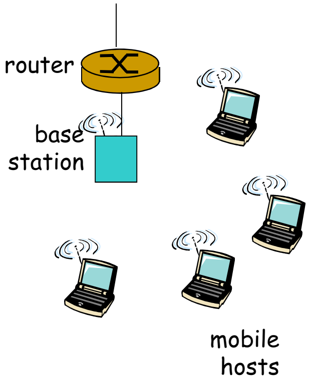
Wi-Fi : Internet without wire

- High-Speed "wireless" internet
  - AKA. Hot-Spot
- Allow users with wireless-enabled device to access internet
  - Notebook, PDA, media boxes, game console
  - No setup needed
  - Available in many places (shopping centers, hotels, coffee shops, campus, home)



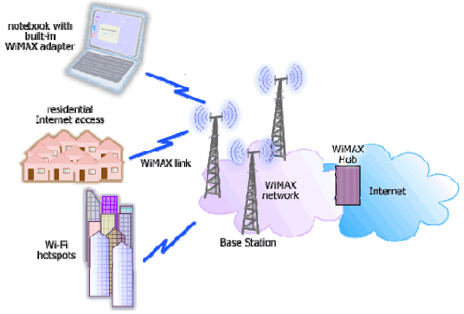
Wireless access networks

- Wireless access network connects end system to router
  - via base station aka "access point"
- Wireless LANs:
  - 802.11b (WiFi): 11 Mbps
- Wider-area wireless access
  - provided by telco operator
  - 3G ~ 384 kbps
  - WAP/GPRS in Europe



Wimax : Wi-Fi on Steroid

- Up-coming "very high-speed" wireless networks
- Long-range (10km or more)



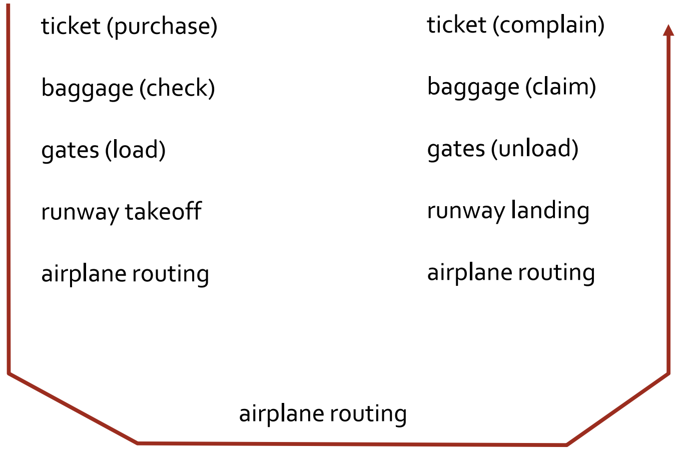
Wimax on Bike

NETWORK LAYERS

Dealing with Complexity

- The path a message takes is complex; dealing with hosts, switches, packets, media, etc.
- Therefore we use an *abstract* model to divide the transmission into *layers*
- The sender at each layer uses the lower layers (as a black box) to send information directly to the recipient at that layer.
- Each layer considers information from layers above to be "data bits"

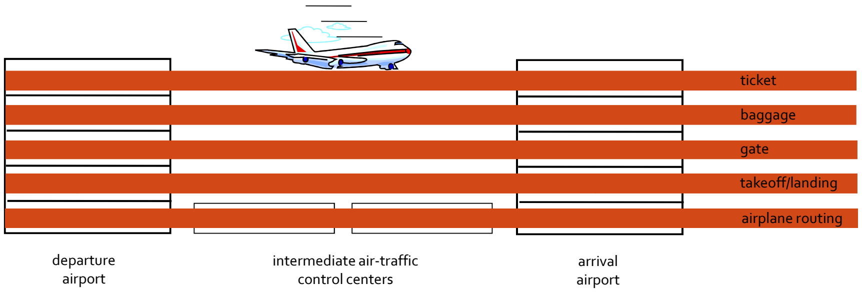
Example: Airplane Routing



ticket (purchase)	ticket (complain)
baggage (check)	baggage (claim)
gates (load)	gates (unload)
runway takeoff	runway landing
airplane routing	airplane routing

airplane routing

Layering of airline functionality



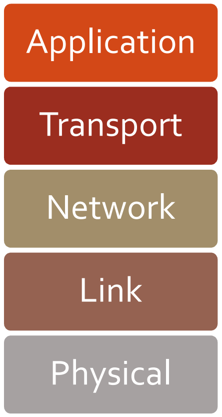
- Layers: each layer implements a service
  - via its own internal-layer actions
  - relying on services provided by layer below

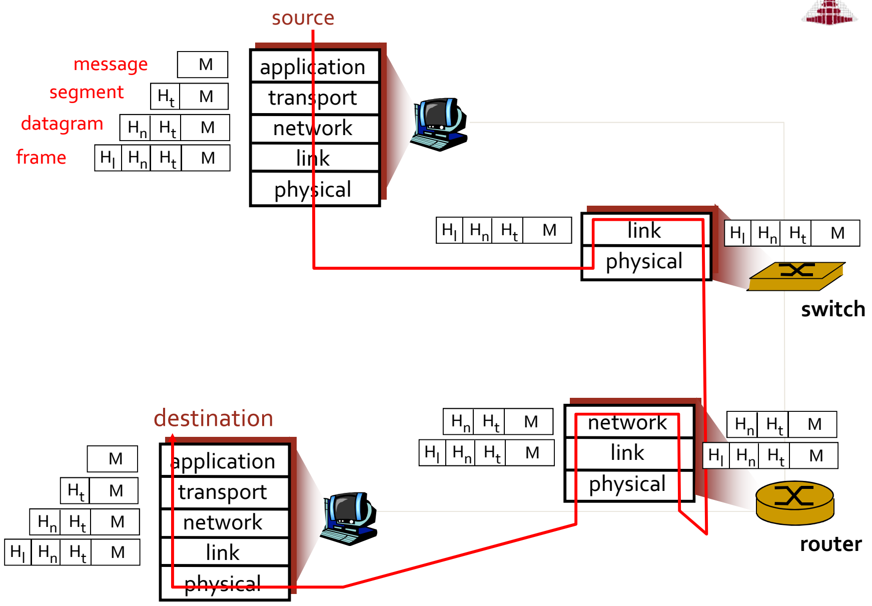
Enveloping a Message

- Each layer takes data from the above layer
  - Breaks it apart if necessary (e.g. packetizing)
  - Adds an "envelope" = header and/or footer bits
  - Passes it to the next layer below, which will treat envelope as part of the data

Internet protocol stack

- application: supporting network applications
  - HTTP, FTP, SMTP
- transport: host-host data transfer
  - TCP, UDP
- network: routing of datagrams from source to destination
  - IP, routing protocols
- link: data transfer between neighboring network elements
  - PPP, Ethernet
- physical: bits "on the wire"


Application
Transport
Network
Link
Physical


source
message M
segment H_t M
datagram H_n H_t M
frame H_l H_n H_t M
application
transport
network
link
physical

H_l H_n H_t M
link
physical
H_l H_n H_t M
switch

destination
M
H_t M
H_n H_t M
H_l H_n H_t M
application
transport
network
link
physical

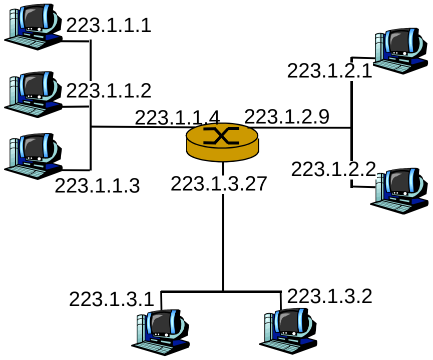
H_n H_t M
H_l H_n H_t M
network
link
physical
H_n H_t M
H_l H_n H_t M
router

IP Addressing: introduction

IP address: 32-bit identifier for host, router *interface*

interface: connection between host/router and physical link

- router's typically have multiple interfaces
- host may have multiple interfaces
- IP addresses associated with each interface



$223.1.1.1 = \underbrace{11011111}_{223}\ \underbrace{00000001}_{1}\ \underbrace{00000001}_{1}\ \underbrace{00000001}_{1}$

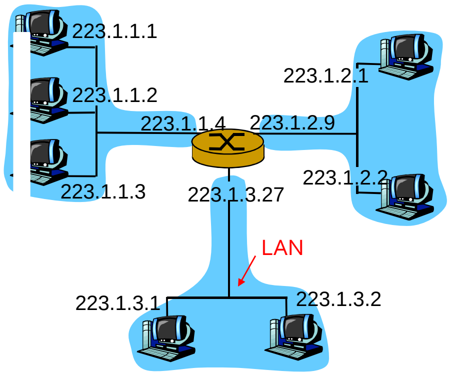
Subnets

IP address:

- subnet part (high order bits)
- host part (low order bits)

What's a subnet ?

- device interfaces with same subnet part of IP address
- can physically reach each other without intervening router



← subnet part → ← host part →

11001000 00010111 00010000 00000000

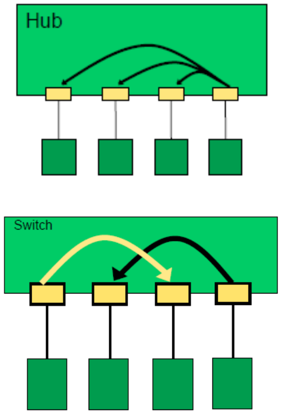
200.23.16.0/23

IPv6

- "Next generation" internet addressing
- 128 bits (rather than 32 in IPv4)
  - Not as big a deal as originally thought (NAT, CIDR)
  - "Every grain of sand on the planet can be internet-addressable)
  - Multicast and anycast (pick-1) addressing now supported
- Simplified header (next slide)
- From IPv4 to IPv6 (until all IPv6)
  - Dual stack router
  - Tunneling

NETWORK EQUIPMENT

Equipment: Hub / Switch

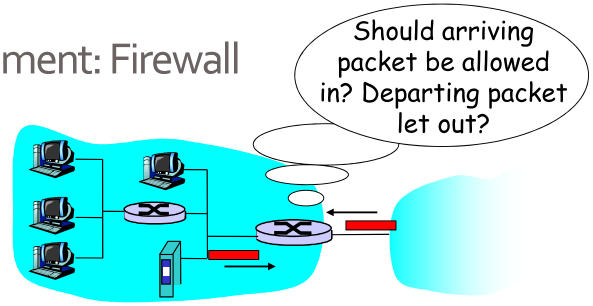


- Transmission of data of physical layer
- Connect several LANs of the same type
- Switch is more intelligent than hub

Equipment: Router / Layer-3 Switch

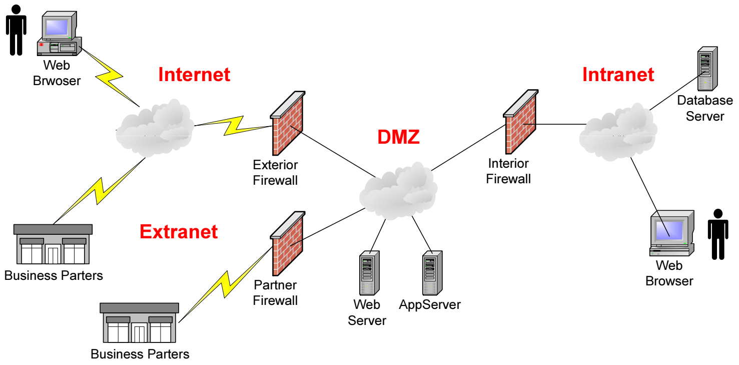
- Connect 2 or more logical subnets
- Usually support multiple interface types (e.g. UTP, FC)
- Layer-3 Switch is router with less functions (e.g. only 1 interface type)

Equipment: Firewall

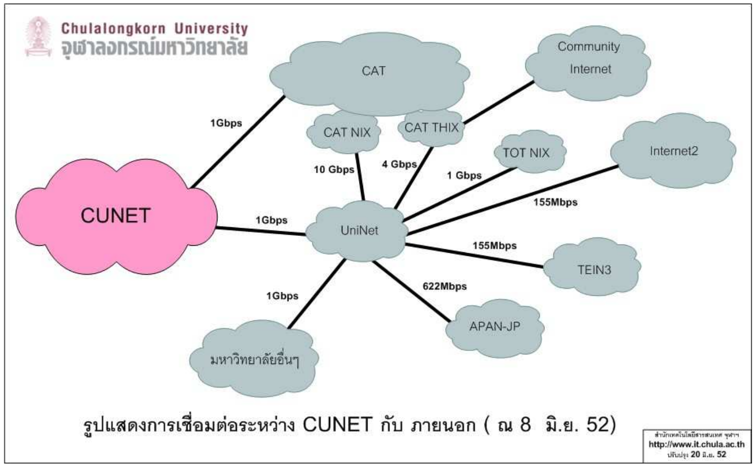

Should arriving packet be allowed in? Departing packet let out?

- internal network connected to Internet via router firewall
- router filters packet-by-packet, decision to forward/drop packet based on:
  - source IP address, destination IP address
  - TCP/UDP source and destination port numbers
  - ICMP message type
  - TCP SYN and ACK bits

System Zones



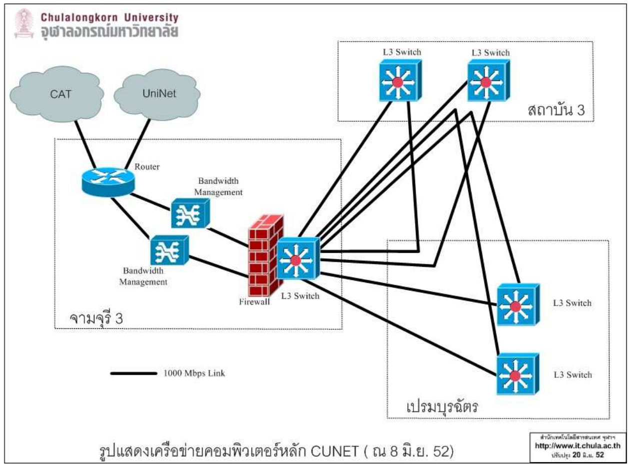
Real World: ChulaNet



รูปแสดงการเชื่อมต่อระหว่าง CUNET กับ ภายนอก (ณ 8 มิ.ย. 52)

สำนักเทคโนโลยีสารสนเทศ จุฬาฯ
http://www.it.chula.ac.th
ปรับปรุง 20 มิ.ย. 52

Real World: ChulaNet



รูปแสดงเครือข่ายคอมพิวเตอร์หลัก CUNET (ณ 8 มิ.ย. 52)

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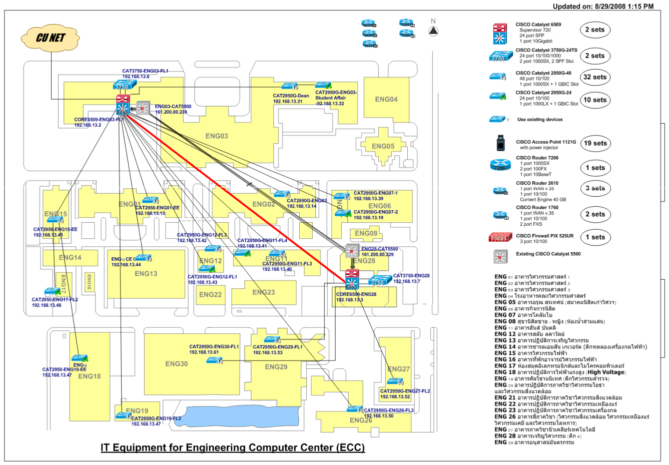
http://www.it.chula.ac.th
ปรับปรุง 20 มิ.ย. 52

Real World: EngNet

Updated on: 8/29/2008 1:15 PM



CISCO Catalyst 6509 — Supervisor 720, 24 port SFP, 1 port 10Gigabit — 2 sets
CISCO Catalyst 3750G-24TS — 24 port 10/100/1000, 2 port 1000SX, 2 SPF Slot — 2 sets
CISCO Catalyst 2950G-48 — 48 port 10/100, 1 port 1000SX + 1 GBIC Slot — 32 sets
CISCO Catalyst 2950G-24 — 24 port 10/100, 1 port 1000LX + 1 GBIC Slot — 10 sets
Use existing devices
CISCO Access Point 1121G — with power injector — 19 sets
CISCO Router 7206 — 1 port 1000SX, 2 port 100FX, 1 port 10BaseT — 1 sets
CISCO Router 2610 — 1 port WAN v.35, 1 port 10/100, Content Engine 40 GB — 3 sets
CISCO Router 1760 — 1 port WAN v.35, 1 port 10/100, 2 port FXS — 2 sets
CISCO Firewall PIX 525UR — 3 port 10/100 — 1 sets
Existing CISCO Catalyst 5500

ENG 01 อาคารวิศวกรรมศาสตร์ 1
ENG 02 อาคารวิศวกรรมศาสตร์ 2
ENG 03 อาคารวิศวกรรมศาสตร์ 3
ENG 04 โรงอาหารคณะวิศวกรรมศาสตร์
ENG 05 อาคารอรุณ สรเทศน์ (สมาคมนิสิตเก่าวิศวฯ)
ENG 06 อาคารกิจการนิสิต
ENG 07 อาคารโคลัมโบ
ENG 08 สุขานิสิตชาย / หญิง (ห้องน้ำสามแสน)
ENG 11 อาคารฮันส์ บันตลิ
ENG 12 อาคารสลับ ลดาวัลย์
ENG 13 อาคารปฏิบัติการเจริญวิศวกรรม
ENG 14 อาคารชารลเอมสัน เกเวอร์ต (ตึกทดลองเครื่องกลไฟฟ้า)
ENG 15 อาคารวิศวกรรมไฟฟ้า
ENG 16 อาคารที่พักอาจารย์วิศวกรรมไฟฟ้า
ENG 17 ห้องสมุดอิเลกทรอนิกส์และไมโครคอมพิวเตอร์
ENG 18 อาคารปฏิบัติการไฟฟ้าแรงสูง (High Voltage)
ENG 19 อาคารศัลวิธานนิเทศ (ตึกวิศวกรรมสำรวจ)
ENG 20 อาคารปฏิบัติการภาควิชาวิศวกรรมโยธา และวิศวกรรมสิ่งแวดล้อม
ENG 21 อาคารปฏิบัติการภาควิชาวิศวกรรมสิ่งแวดล้อม
ENG 22 อาคารปฏิบัติการภาควิชาวิศวกรรมเหมืองแร่
ENG 23 อาคารปฏิบัติการภาควิชาวิศวกรรมเครื่องกล
ENG 26 อาคารสี่ภาควิชา (วิศวกรรมสิ่งแวดล้อม วิศวกรรมเหมืองแร่ วิศวกรรมเคมี และวิศวกรรมโลหการ)
ENG 27 อาคารภาควิชานิวเคลียร์เทคโนโลยี
ENG 28 อาคารเจริญวิศวกรรม (ตึก 4)
ENG 29 อาคารอนุสาสน์ยันตรกรรม

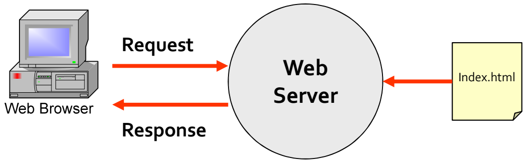
IT Equipment for Engineering Computer Center (ECC)

WEB-BASED APPLICATION ARCHITECTURE

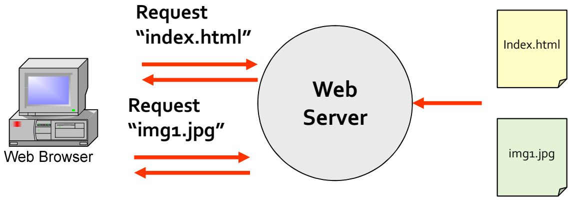
Static vs. Dynamic Pages

- Web-based applications consist of 2 page types
  - Static pages: HTML, picture, audio, text, etc.
  - Dynamic pages: result of search pages, form submission, etc.
- To serve a static page
  - Web server grabs a static page from a file in the server.

Serving a Static Page



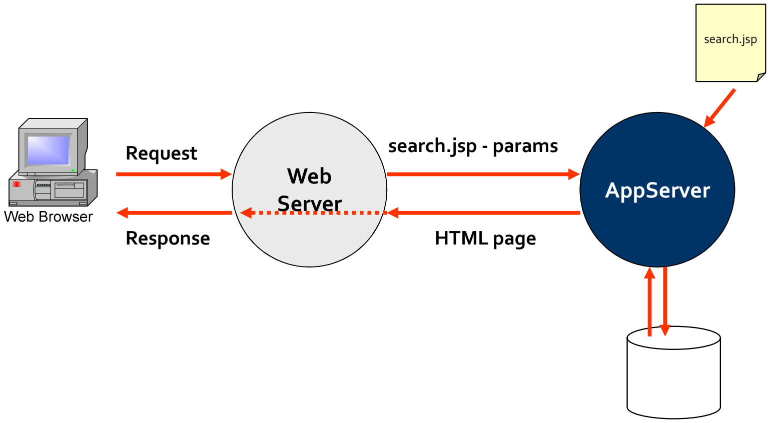
Serving a Static Page with Images



Serving a Dynamic Page

- Web server will activate designated user programs
  - Common Gateway Interface (CGI).
  - Server-sided Java program.
  - Used mostly to connect to database.
- File extensions
  - JSP, ASP, PHP, EXE, Class, etc.

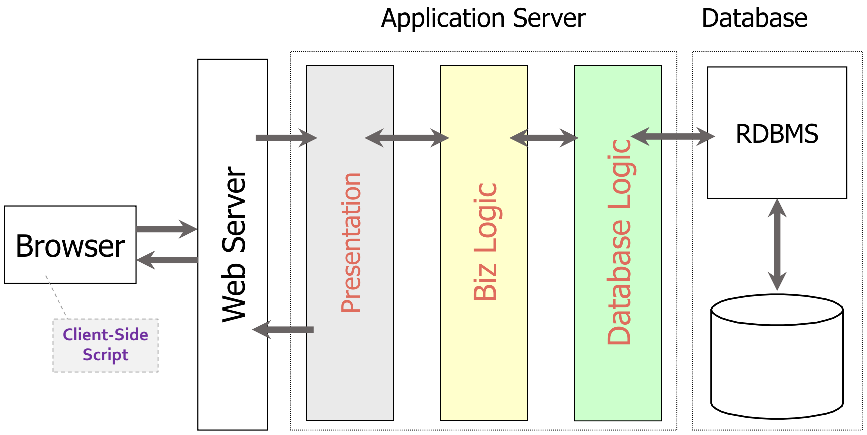
Serving a Dynamic Page



JSP Example

```
<TABLE WIDTH=60% BGCOLOR=lightblue BORDER=1 CELLPADDING=10>
<TR> <TH> Time </TH> <TH> Appointment </TH> </TR>
<%
    for(int i=0; i<table.getEntries().getRows(); i++) {
       cal.Entry entr = table.getEntries().getEntry(i);
%>
    <TR>
    <TD>
    <A HREF=cal2.jsp?time=<%= entr.getHour() %>>
         <%= entr.getHour() %> </A>
    </TD>
    <TD BGCOLOR=<%= entr.getColor() %>>
    <% out.print(util.HTMLFilter.filter(entr.getDescription())); %>
    </TD>
    </TR>
<%
    }
%>
</TABLE>
```

Generic Web-Based Architecture



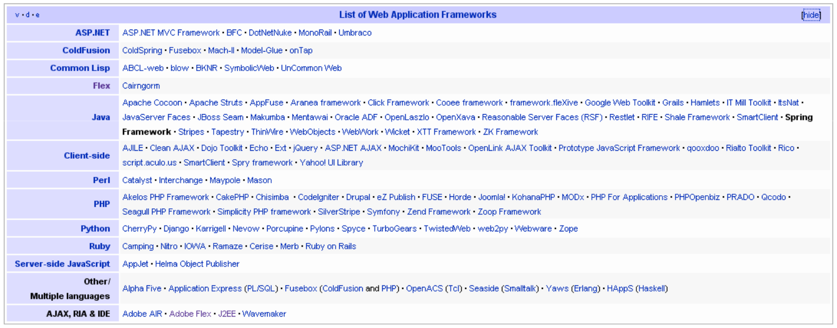
Software Framework

Source: Wikipedia

- ☐ Application Framework
  - a software framework that is used to implement the standard structure of an application for a specific operating system
  - Example: Microsoft MFC, Mac Cocoa, Widget toolkit
- ☐ Web Application Framework
  - a software framework that is designed to support the development of dynamic websites, Web applications and Web services
  - Example: JavaEE, .NET, Ruby on Rails, Struts, Spring, Seam

Other Web Application Frameworks

Source: Wikipedia



v • d • e	List of Web Application Frameworks [hide]
ASP.NET	ASP.NET MVC Framework • BFC • DotNetNuke • MonoRail • Umbraco
ColdFusion	ColdSpring • Fusebox • Mach-II • Model-Glue • onTap
Common Lisp	ABCL-web • blow • BKNR • SymbolicWeb • UnCommon Web
Flex	Cairngorm
Java	Apache Cocoon • Apache Struts • AppFuse • Aranea framework • Click Framework • Cooee framework • framework.fleXive • Google Web Toolkit • Grails • Hamlets • IT Mill Toolkit • ItsNat • JavaServer Faces • JBoss Seam • Makumba • Mentawai • Oracle ADF • OpenLaszlo • OpenXava • Reasonable Server Faces (RSF) • Restlet • RIFE • Shale Framework • SmartClient • **Spring Framework** • Stripes • Tapestry • ThinWire • WebObjects • WebWork • Wicket • XTT Framework • ZK Framework
Client-side	AJILE • Clean AJAX • Dojo Toolkit • Echo • Ext • jQuery • ASP.NET AJAX • MochiKit • MooTools • OpenLink AJAX Toolkit • Prototype JavaScript Framework • qooxdoo • Rialto Toolkit • Rico • script.aculo.us • SmartClient • Spry framework • Yahoo! UI Library
Perl	Catalyst • Interchange • Maypole • Mason
PHP	Akelos PHP Framework • CakePHP • Chisimba • CodeIgniter • Drupal • eZ Publish • FUSE • Horde • Joomla! • KohanaPHP • MODx • PHP For Applications • PHPOpenbiz • PRADO • Qcodo • Seagull PHP Framework • Simplicity PHP framework • SilverStripe • Symfony • Zend Framework • Zoop Framework
Python	CherryPy • Django • Karrigell • Nevow • Porcupine • Pylons • Spyce • TurboGears • TwistedWeb • web2py • Webware • Zope
Ruby	Camping • Nitro • IOWA • Ramaze • Cerise • Merb • Ruby on Rails
Server-side JavaScript	AppJet • Helma Object Publisher
Other/ Multiple languages	Alpha Five • Application Express (PL/SQL) • Fusebox (ColdFusion and PHP) • OpenACS (Tcl) • Seaside (Smalltalk) • Yaws (Erlang) • HAppS (Haskell)
AJAX, RIA & IDE	Adobe AIR • Adobe Flex • J2EE • Wavemaker

References

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