Announcements

- Teaching Evaluations
  - Monday, May 26 at 12:01 am and closing Sunday, June 8 at 11:59 pm.

- Final Business Papers Due 6/5

- Final Exam
  - Wednesday June 11, 8am - 11am
Networks
OSI Layers

- Physical
- Link
- Network
- Session
- Transport
- Presentation
- Application

Modulation Schemes: QAM, OFDM, etc...

Internet Protocol (IP), ...

TCP, UDP

Ethernet, Wi-Fi, SONNET, ...

Internet Explorer, Outlook Email, Real Player, ...
Some Typical Topologies

Home Network

- DSL Modem
- Telephone Line
- Router
- Ethernet Switch
- (to local Office)
Small/Medium Business

Router with Firewall

T1 Line

T1 Modem

Web Site Server

Ethernet Switch

To Local Office
ISP Topology

Telephone Company
Local Office

Local Loop

Telephone Switch

ISP Point of Presence

DSL Modem
DSL Modem
DSL Modem

DSLAM

Leased Line to NAP

To Telephone Network

Local Loop

Local Loop

Local Loop

ISP Point of Presence
Network Service Provider

Network Access Point

Network Access Point
Large E-Business

Load Balancer

Incoming HTTP Requests

Load Balancer

Interconnected with Gigabit Ethernet or other technology

Presentation Logic (Assembling Web page)

Web Servers

Logic Flow of Interaction

Application Servers

Customers

Merchandise

Orders

Databases
Web Caching

- Speed up web page loading by storing previously seen components locally

http://www.ucsc.edu

Cache on Hard Drive
Content Distribution Networks (AKAMAI)

Local Office or ISP

Akamai Server

INTERNET

NSP 1

NSP 2

Web Page

Large Company

Web Server

Text....
The World Wide Web

• Search engines
  - Started in early 1990s as relatively simple software programs using keyword indexes

• search engine marketing – major source of revenue
  - Keyword auctions
The World Wide Web

- **Web 2.0**
  - Refers to more interactive Internet-based services enabling people to collaborate, share information, etc.
- **Blogs**: chronological, informal Web sites created by individuals using easy-to-use Weblog publishing tools
- **RSS (Really Simple Syndication)**: syndicates Web content so content can be automatically placed into another setting
- **Wikis**: collaborative Web sites where visitors can add, delete, or modify content on the site
Intranets and Extranets

- **Intranets**
  - Use existing network infrastructure with Internet connectivity standards software developed for the Web.
  - Create networked applications that can run on many types of computers.
  - Protected by firewalls.

- **Extranets**
  - Allow authorized vendors and customers access to an internal intranet.
  - Used for collaboration.
  - Also subject to firewall protection.
Cloud computing
Cloud Computing

- **Cloud Computing**: refers to both
  - applications delivered as services over internet
    - aka *Software as a Service (SaaS)*
  - hardware / software in data centers providing those services -- a *cloud*
Cloud Computing

- 2 flavors:
  - Public Cloud, available to public
    - provides utility computing
  - Private Cloud
    - internal to company
Advantages

- **SaaS**
  - Control of Versioning
  - Users access anywhere
  - Ease of data sharing
  - Pay as you go

- **Additional +’s of Cloud Computing**
  - Deploy new services without building and provisioning data centers
    - E.g. Zynga Farmville
  - Scale up/down resources as needed
2000’s

- Large investments by web giants (e.g. Google, Amazon) in infrastructure
  - Giant data centers
  - Software Infrastructure for such data centers
    - MapReduce -- allows computations to be distributed to multiple machines “map”, and then results collected for further processing “reduce.”
    - Hadoop - open source version of above

- Above pieces prerequisites to become a cloud provider
Reasons to be a cloud provider

- A big player enjoys economy of scale advantage
- Leverage existing investments for new revenue stream (e.g. Amazon)
- Defend existing markets (e.g. MS enterprise apps with Azure)
- Become a platform (facebook)
- Leverage relationships (IBM)
Why is the Cloud becoming big only now?

- shift from large commitment models to contactless short term model

- Mobile interactive applications that need huge data sets

- Parallel batch processing - software like Hadoop makes it easier to do this

- Analytics - less growth in plain transaction processing, more growth in analyzing trends / predictions from large data sets
Types of Utility Computing

- **Amazon EC2** - to programmer, each instance looks like physical hardware
  - Can control whole layer stack
  - Other managed services provided (e.g. SimpleDB)

- **Application Domain specific platforms**
  - **Google AppEngine** (software dev. platform for web applications)
  - **Force.com** (Salesforce.com) - platform for business apps that use salesforce.com DB

- **MS Azure** -
  - Provides developers a general purpose software framework .NET
  - Compiled to a managed environment (rather than to specific hardware)
Economics

- “pay as you go” model
- add and remove resources at a fine time scale
  - proprietary data centers have to provision for peak
  - hard to predict demand of new services
  - poor service quality can alienate customer
  - large data centers have significant eco. of scale advantage
Challenges

- **Availability**
  - Can actually be better than in-house data centers
  - More robust to DDOS (Distributed denial of service) attacks by being so large

- **Lock-in**
  - Data lock-in - online storage services have gone bust
  - Application programming interfaces not common
Challenges

- **Confidentiality and Audits**
  - Sarbanes Oxley, HIPPA
  - Can use encryption
  - Audibility can be added as layer

- **Data Transfer bottlenecks**
  - Slow transfer can offset faster processing
  - Ship hard drives
  - Upload once, use multiple times
Discussion

- Imagine you are the CIO of a supermarket chain with a loyalty card. Your loyalty card collects sales data from your customers. You want to run complex algorithms to do targeted marketing to your customers.
  - Would you do this in a public cloud, or internal data center?

- You are launching a new web service to provide restaurant reviews in a locality. You do not know how much traffic your new service will generate.
  - Would you do this in a public cloud, or internal data center?