IT Infrastructure and Emerging Technologies
Content

• IT Infrastructure
• Infrastructure Components
• Contemporary Hardware Platform Trends
• Contemporary Software Platform Trends
• Management Issues
IT infrastructure

• Set of physical devices and software required to operate enterprise

• Set of firmwide services including:
  – Computing platforms providing computing services
  – Telecommunications services
  – Data management services
  – Application software services
  – Physical facilities management services
  – IT management, standards, education, research and development services

• “Service platform” perspective more accurate view of value of investments
CONNECTION BETWEEN THE FIRM, IT INFRASTRUCTURE, AND BUSINESS CAPABILITIES
Evolution of IT infrastructure

• General-purpose mainframe & minicomputer era: 1959 to present
  – 1958 IBM first mainframes introduced
  – 1965 Less expensive DEC minicomputers introduced

• Personal computer era: 1981 to present
  – 1981 Introduction of IBM PC
  – Proliferation in 80s, 90s resulted in growth of personal software

• Client/server era: 1983 to present
  – Desktop clients networked to servers, with processing work split between clients and servers
  – Network may be two-tiered or multitiered (N-tiered)
  – Various types of servers (network, application, Web)
STAGES IN IT INFRASTRUCTURE EVOLUTION

- **Mainframe/Minicomputer**: (1959–present)
- **Personal Computer**: (1981–present)
- **Client/Server**: (1983–present)
Evolution of IT infrastructure (cont.)

• Enterprise computing era: 1992 to present
  – Move toward integrating disparate networks, applications using Internet standards and enterprise applications

• Cloud Computing: 2000 to present
  – Refers to a model of computing where firms and individuals obtain computing power and software applications over the Internet or other network
  – Fastest growing form of computing
STAGES IN IT INFRASTRUCTURE EVOLUTION (cont.)
A MULTITIERED CLIENT/SERVER NETWORK (N-TIER)
Technology drivers of infrastructure evolution

• Moore’s law and microprocessing power
  – Computing power doubles every 18 months
  – Nanotechnology:
    • Shrinks size of transistors to size comparable to size of a virus

• Law of Mass Digital Storage
  – The amount of data being stored each year doubles
MOORE’S LAW AND MICROPROCESSOR PERFORMANCE

Moore’s Law Means
More Performance

- 1970
- 1974
- 1978
- 1982
- 1986
- 1990
- 1994
- 1998
- 2002
- 2006
- 2010

Processing power (MIPS)

Number of transistors

2 billion

15,000
FALLING COST OF CHIPS

Moore's Law Means Decreasing Costs

Transistor Price in U.S. Dollars

- Ten
- One
- One Tenth
- One Hundredth
- One Thousandth
- One Ten Thousandth
- One Hundred Thousandth
- One Millionth
- One Ten Millionth

Moore's Law Begins 1965
EXAMPLES OF NANOTUBES
THE COST OF STORING DATA DECLINES EXPONENTIALLY 1950–2010
Technology drivers of infrastructure evolution (cont.)

• Metcalfe’s Law and network economics
  – Value or power of a network grows exponentially as a function of the number of network members
  – As network members increase, more people want to use it (demand for network access increases)
Technology drivers of infrastructure evolution (cont.)

• Declining communication costs and the Internet
  – An estimated 1.5 billion people worldwide have Internet access
  – As communication costs fall toward a very small number and approach 0, utilization of communication and computing facilities explodes
EXPONENTIAL DECLINES IN INTERNET COMMUNICATIONS COSTS
Technology drivers of infrastructure evolution (cont.)

- Standards and network effects

  Technology standards:

  - Specifications that establish the compatibility of products and the ability to communicate in a network
  - Unleash powerful economies of scale and result in price declines as manufacturers focus on the products built to a single standard
IT Infrastructure has 7 main components

1. Computer hardware platforms
2. Operating system platforms
3. Enterprise software applications
4. Data management and storage
5. Networking/telecommunications platforms
6. Internet platforms
7. Consulting system integration services
THE IT INFRASTRUCTURE ECOSYSTEM

- **Internet Platforms**
  - Apache
  - Microsoft IIS, .NET
  - Unix
  - Cisco
  - Java

- **Computer Hardware Platforms**
  - Dell
  - IBM
  - Sun
  - HP
  - Apple
  - Linux machines

- **Operating Systems Platforms**
  - Microsoft Windows
  - Unix
  - Linux
  - Mac OS X
  - Google Chrome

- **Data Management and Storage**
  - IBM DB2
  - Oracle
  - SQL Server
  - Sybase
  - MySQL
  - EMC Systems

- **Networking/Telecommunications**
  - Microsoft Windows Server
  - Linux
  - Novell
  - Cisco
  - Alcatel-Lucent
  - Nortel
  - AT&T, Verizon

- **Consultants and System Integrators**
  - IBM
  - EDS
  - Accenture

- **Enterprise Software Applications**
  - (including middleware)
  - SAP
  - Oracle
  - Microsoft
  - BEA
Computer hardware platforms

• Client machines
  – Desktop PCs, mobile devices – PDAs, laptops

• Servers
  – Blade servers: ultrathin computers stored in racks

• Mainframes:
  – IBM mainframe equivalent to thousands of blade servers

• Top chip producers: AMD, Intel, IBM
• Top firms: IBM, HP, Dell, Sun Microsystems
Operating system platforms & Enterprise software applications

• Operating system platforms
  – Operating systems
    • Server level: 75% run Windows; 25% run Unix or Linux
    • Client level:
      – 90% run Microsoft Windows (XP, 2000, CE, etc.)
      – Handheld device OS’s (Android, iPhone OS)
      – Cloud computing OS’s (Google’s Chrome OS)

• Enterprise software applications
  – Enterprise application providers: SAP and Oracle
  – Middleware providers: BEA
Data management and storage

• Database software:
  – IBM (DB2), Oracle, Microsoft (SQL Server), Sybase (Adaptive Server Enterprise), MySQL

• Physical data storage:
  – EMC Corp (large-scale systems), Seagate, Maxtor, Western Digital

• Storage area networks (SANs):
  – Connect multiple storage devices on dedicated network
Networking/telecommunications platforms

• Telecommunication services
  – Telecommunications, cable, telephone company charges for voice lines and Internet access
  – AT&T, Verizon

• Network operating systems:
  – Windows Server, Novell, Linux, Unix

• Network hardware providers:
  – Cisco, Alcatel-Lucent, Nortel, Juniper Networks
Internet platforms

• Hardware, software, management services to support company Web sites, (including Web hosting services) intranets, extranets

• Internet hardware server market: Dell, HP/Compaq, IBM

• Web development tools/suites: Microsoft (FrontPage, .NET) IBM (WebSphere) Sun (Java), independent software developers: Adobe, RealMedia
Consulting and system integration services

• Even large firms do not have resources for a full range of support for new, complex infrastructure
• Software integration: ensuring new infrastructure works with legacy systems
• Legacy systems: older TPS created for mainframes that would be too costly to replace or redesign
• Accenture, IBM Global Services, EDS, Infosys, Wipro
The emerging mobile digital platform

• Cell phones, smartphones (BlackBerry, iPhone)
  – Have assumed data transmission, Web surfing, e-mail and IM duties

• Netbooks:
  – Small, low-cost lightweight notebooks optimized for wireless communication and core computing tasks

• Tablets (iPad)

• Networked e-readers (Kindle)
Grid computing & Virtualization

• Grid computing
  – Connects geographically remote computers into a single network to combine processing power and create virtual supercomputer
  – Provides cost savings, speed, agility

• Virtualization
  – Allows single physical resource to act as multiple resources (i.e., run multiple instances of OS)
  – Reduces hardware and power expenditures
  – Facilitates hardware centralization
Cloud computing

• On-demand (utility) computing services obtained over network
  – Infrastructure as a service
  – Platform as a service
  – Software as a service

• Cloud can be public or private

• Allows companies to minimize IT investments

• Drawbacks: Concerns of security, reliability
Green computing & Autonomic computing

- Green computing
  - Practices and technologies for manufacturing, using, disposing of computing and networking hardware

- Autonomic computing
  - Industry-wide effort to develop systems that can configure, heal themselves when broken, and protect themselves from outside intruders
  - Similar to self-updating antivirus software; Apple and Microsoft both use automatic updates

- High performance, power-saving processors
  - Multi-core processors
Software

• Linux and open-source software
  – Open-source software: Produced by community of programmers, free and modifiable by user
  – Linux: Open-source software OS

• Software for the Web
  – Java:
    • Object-oriented programming language
    • Operating system, processor-independent
  – Ajax
    • Asynchronous JavaScript and XML
    • Allows client and server to exchange small pieces of data without requiring the page to be reloaded
Web Services

• Software components that exchange information using Web standards and languages
• XML: Extensible Markup Language
  – More powerful and flexible than HTML
  – Tagging allows computers to process data automatically
• SOAP: Simple Object Access Protocol
  – Rules for structuring messages enabling applications to pass data and instructions
• WSDL: Web Services Description Language
  – Framework for describing Web service and capabilities
• UDDI: Universal Description, Discovery, and Integration
  – Directory for locating Web services
SOA: Service-oriented architecture

• Set of self-contained services that communicate with each other to create a working software application
• Software developers reuse these services in other combinations to assemble other applications as needed
  – Example: an “invoice service” to serve whole firm for calculating and sending printed invoices
• Dollar Rent A Car
  – Uses Web services to link online booking system with Southwest Airlines’ Web site
HOW DOLLAR RENT A CAR USES WEB SERVICES
Software outsourcing and cloud services

• Three external sources for software:
  1. Software packages and enterprise software
  2. Software outsourcing (domestic or offshore)
    • Domestic:
      – Primarily for middleware, integration services, software support
    • Offshore:
      – Primarily for lower level maintenance, data entry, call centers, although outsourcing for new-program development is increasing
Three external sources for software (cont.)

3. Cloud-based software services
   – Software as a service (SaaS)
   – Accessed with Web browser over Internet
   – Ranges from free or low-cost services for individuals to business and enterprise software
   – Users pay on subscription or per-transaction
   – E.g. Salesforce.com
   – Service Level Agreements (SLAs): formal agreement with service providers
CHANGING SOURCES OF FIRM SOFTWARE
Software outsourcing and cloud services (cont.)

• Mashups
  – Combinations of two or more online applications, such as combining mapping software (Google Maps) with local content

• Apps
  – Small pieces of software that run on the Internet, on your computer, or on your cell phone
    • iPhone, BlackBerry, Android
  – Generally delivered over the Internet
Dealing with platform and infrastructure change

• As firms shrink or grow, IT needs to be flexible and scalable

• Scalability:
  – Ability to expand to serve larger numbers of users

• For mobile computing and cloud computing
  – New policies and procedures for managing these new platforms
  – Contractual agreements with firms running clouds and distributing software required
Management and governance

• Who controls IT infrastructure?
• How should IT department be organized?
  – Centralized
    • Central IT department makes decisions
  – Decentralized
    • Business unit IT departments make own decisions
• How are costs allocated between divisions, departments?
Making wise infrastructure investments

• Amount to spend on IT is complex question
  – Rent vs. buy, outsourcing

• Total cost of ownership (TCO) model
  – Analyzes direct and indirect costs
  – Hardware, software account for only about 20% of TCO
  – Other costs: Installation, training, support, maintenance, infrastructure, downtime, space and energy
  – TCO can be reduced through use of cloud services, greater centralization and standardization of hardware and software resources
Competitive forces model for IT infrastructure investment

1. Market demand for firm’s services
2. Firm’s business strategy
3. Firm’s IT strategy, infrastructure, and cost
4. Information technology assessment
5. Competitor firm services
6. Competitor firm IT infrastructure investments
COMPETITIVE FORCES MODEL FOR IT INFRASTRUCTURE

1. Market Demand for Your Firm’s Customer Services, Supplier Services, and Enterprise Services

2. Your Firm’s Business Strategy

3. Your Firm’s IT Strategy, Infrastructure, and Cost

4. Information Technology

5. Competitor Firms’ IT Services

6. Competitor Firms’ IT Infrastructure Investments

Internal Factors

External Market Factors