Driving forces behind client/server

business perspective: need for

- increased productivity
- superior quality
- improved responsiveness
- focus on core business

technology perspective: enabled by

- intelligent desktop devices
- computer network architectures
- technical advances
- trends in computer usage

Business pressures

globalization & deregulation

→ increased competition & new demands for products/services

example: AT&T breakup (1984)

- AT&T used to monopolize the telecommunications industry
  including local service, long distance, and equipment
- Telecommunications Act of 1996 opened up the industry
- now competition exists between
  major companies (AT&T, MCI, Sprint)
  cable TV service providers, wireless cellular, radio frequency
- changing requirements requires changing technology
  new vendors, shorter product life cycle
  common for ½ of revenue to come from products < 3 yrs old

Increasing productivity

business has traditionally focused on industrial productivity

e.g., new capital equipment & manufacturing processes

small room for improvement

remaining option: streamline administrative & decision making tasks

client/server can help: central database reduces support costs,
provides up-to-date, consistent info to all

Note: cost-cutting does not necessarily increase productivity

e.g., reducing field service staff for an elevator manufacturing company

fewer servicemen → fewer calls serviced, more travel for each

Otis elevator cut costs & improved customer satisfaction with client/server

Other business needs

produce superior quality products/services

often difficult to measure:

- compare with self? with competition?
- government/industry standards (e.g., ISO) can be useful

be responsive to customer needs and desires

- respond to customers with fast, accurate information/service
- develop new, innovative products to meet customer needs

focus on core business activities

- outsourcing non-core business can save 5-15%

Business process reengineering

new economic priorities → rethinking IT organizations

productivity vs. efficiency

- productivity: measurable at business level (lower cost, higher quality)
- efficiency: measurable at individual level (less time/effort per task)

- increasing efficiency does not necessarily increase productivity
  e.g., more powerful email server → saves 10 min/day per employee
  unless company produces more goods/services or can reduce head count,
  no increase in productivity!

  e.g., faster CPU?

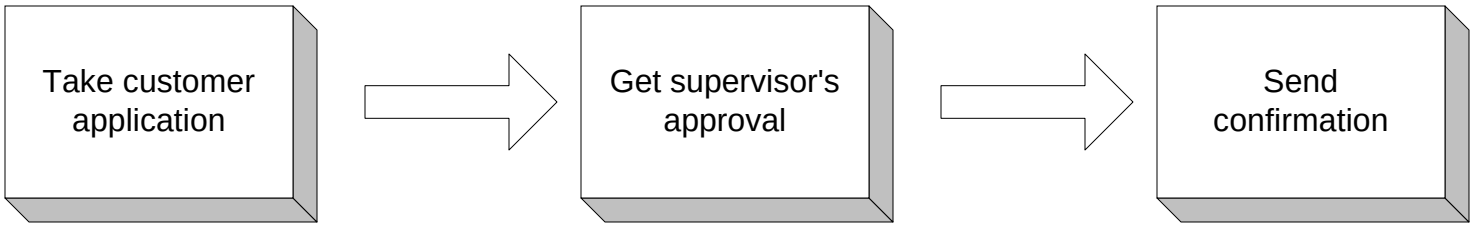
- automating non-labor-intensive tasks rarely yields significant improvements

Shaping the business process

work flow is often adapted to its environment

- reautomating an already automated process yields only minor improvements
- technology, organizational politics, personalities, local practices can influence flow

e.g., Consider an online credit application system



if existing technology precludes fast authorization,
improving efficiency of other tasks may not matter

for a multi-step process, improving a single step may not help much

Steps A → B → C → D → E

assuming equal, 50% reduction in any step yields 10% reduction overall

Reengineering work flows

"The easiest, but perhaps also the greatest, productivity gains in [knowledge and service] work come from defining the task and especially from eliminating what does not need to be done."

Peter Drucker

most successful approach: eliminate handoffs

(bottlenecks when work flows between organizational units)

e.g., IBM reengineered work flow in credit approval department
determined that 6-day approval process only took 90 minutes of work

client/server system gave workers access to credit ratings, databases, etc.
→ 80% of approvals required no handoffs, avg. time reduced to 4 hours

e.g., USAA insurance reengineered policy transaction process
→ 90% of transactions required no handoffs
→ 50% reduction in sales/admin cost per policy

Technology perspective

client/server made possible by:

intelligent desktop devices

+

computer network architectures

+

technological advances

+

trends in computer use

Enabling technologies

in mid 1970's, personal computing emerged

- inexpensive microcomputer technology
- general purpose operating systems

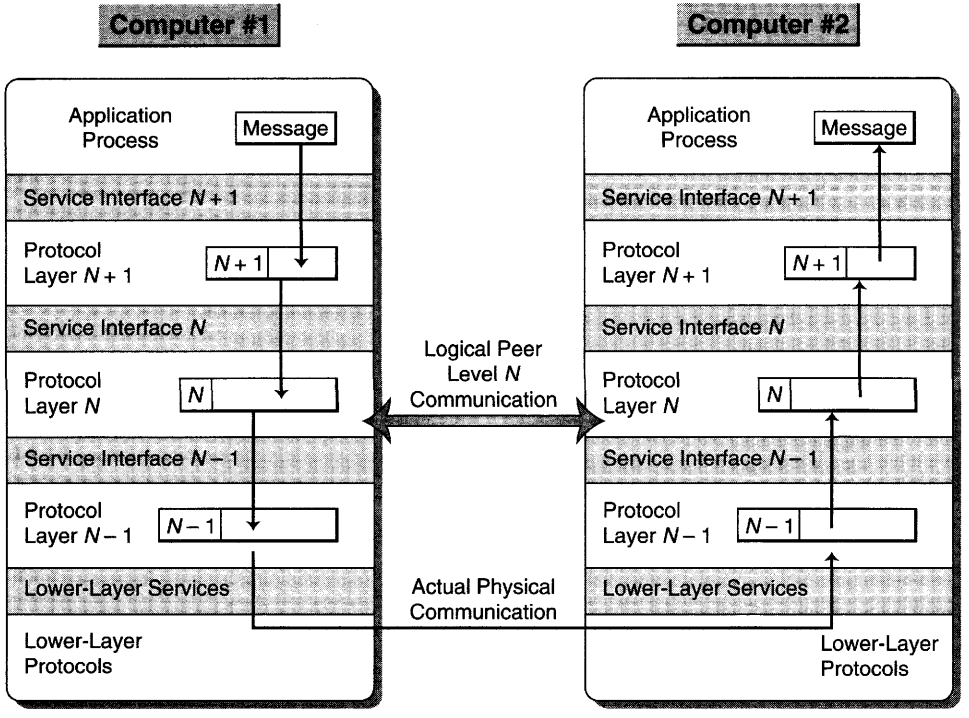
intelligent desktop devices changed the way people thought about computing
stand-alone computing, networking, file/application sharing

in late 1970's, standardized network architectures emerged

- before then, networks were monolithic, proprietary, inflexible
- inter-protocol & multi-protocol networks were impractical

standardized architectures made network development feasible
e.g., SNA, DNA, OSI

Layered communication protocols

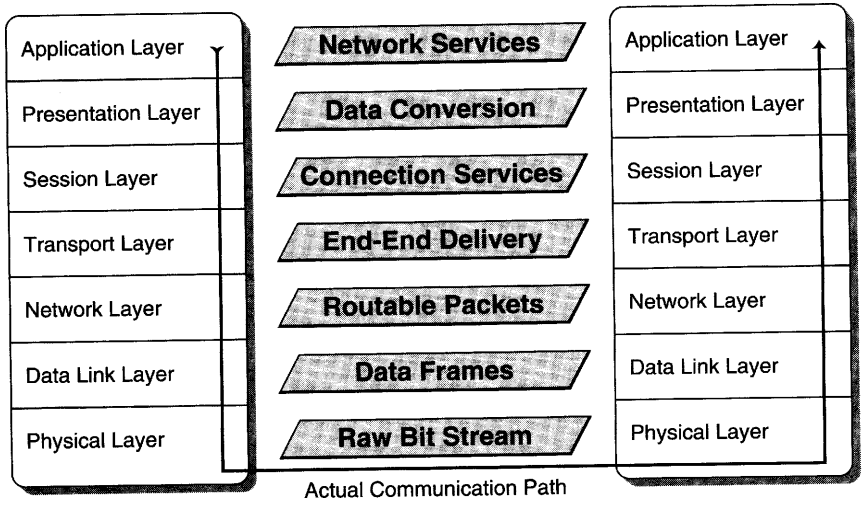


networking functions are modularized into layers of protocols

key concepts

- separation of functionality using layers
- well-defined interfaces for each layer
- peer-level communication between equiv. layers
- encapsulation of messages at each layer

Example: OSI



Open Systems Interconnection reference model

ISO standard

- predominantly used for comparison with *de facto* standards (SNA, TCP/IP)
- defines 7 protocol layers

Technology advances

faster/smaller components

Consider PC's:

	1981	1996	2000
CPU	8088	P6	Pentium III
min. feature size	3 micron	0.6 micron	0.18 micron
# transistors	29K	5.5M	29M
clock frequency	4.77 MHz	133 MHz	933 MHz
typical RAM	256KB	16MB	128MB*
typical hard disk	10MB	512MB	12GB*

Note: 1994 prediction for 2000 (as quoted in the text):

800 MHz, 64 MB RAM, 7GB hard disk

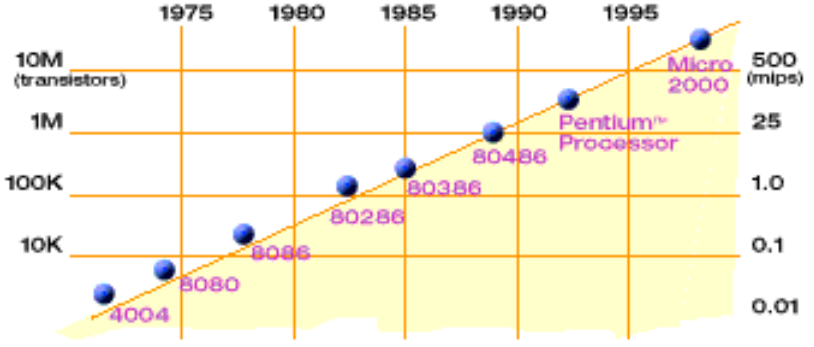
Technology advances (cont.)

VLSI advances

- microchip technology has evolved
  TTL → NMOS & ECL → CMOS → GaAs ?
- silicon fabrication & lithographic techniques have improved

result: increases in circuit speed and density

Moore's Law: chip density (i.e., # of transistors) doubles every 18 months



Technology advances (cont.)

CPU advances

- CISC vs. RISC
- superscalar & superpipelined RISC architectures can even process multiple instructions per clock cycle

Memory

- denser VLSI & improved manufacturing have increased chip capacity
- danger: memory access speeds have not kept up with memory densities or CPU speeds

- hard disk density has increased dramatically

  1970: 1 Mb / sq. in.
  1980: 8 Mb / sq. in.
  1990: 64 Mb / sq. in
  1998: 11.6 Gb / sq. in.

Trends in computer use

standardization

trend towards open systems, industry standards

- *de facto* standard: protocol or interface that is made public & widely accepted (e.g., SNA, TCP/IP, VGA)
- *de jure* standard: protocol or interface specified by a formal standards-making body (e.g., ISO's OSI, ANSI C)

Human-Computer Interaction (HCI)

trend towards GUI, user control

information dissemination

trend towards data warehousing, data mining

Computing vision

Enterprise computing

- all computing and communications resources are integrated
- function as a single, seamless system

maximizes productivity by providing universal, up-to-date information

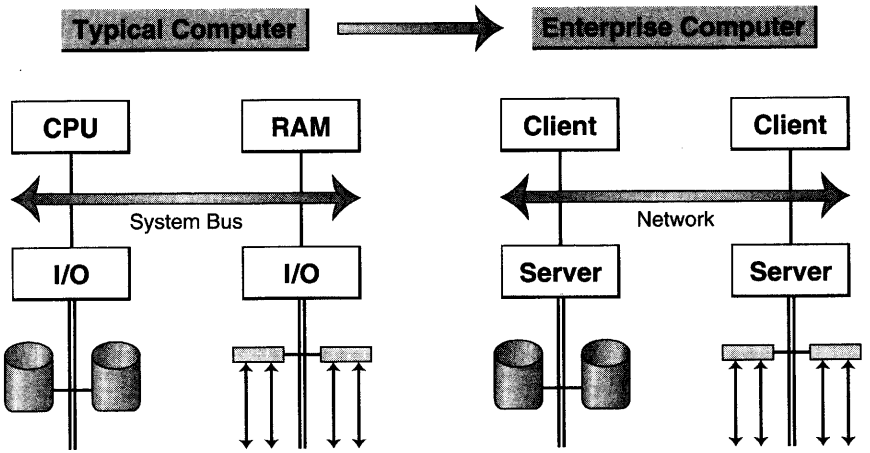
technology requirements

- computing technology must be widely deployed
- all computers must be networked together in a consistent architecture
- computing & networking resources must be reliable, secure, and capable of delivering accurate information in a timely manner
- maximum capture of information relating to the business & its customers must occur within every business process
- info must be normalized & within reach of all users
- mechanics employed to locate, access, & transmit data must be hidden
- applications must be flexible to user preferences & work styles
- applications must interwork with a common framework

Enterprise computing

client/server technology gives cost-effective, logical, consistent architectural model for networking

- generalizes the typical computer model



Note: client/server interaction should be transparent to the user

client/server can simplify network interactions

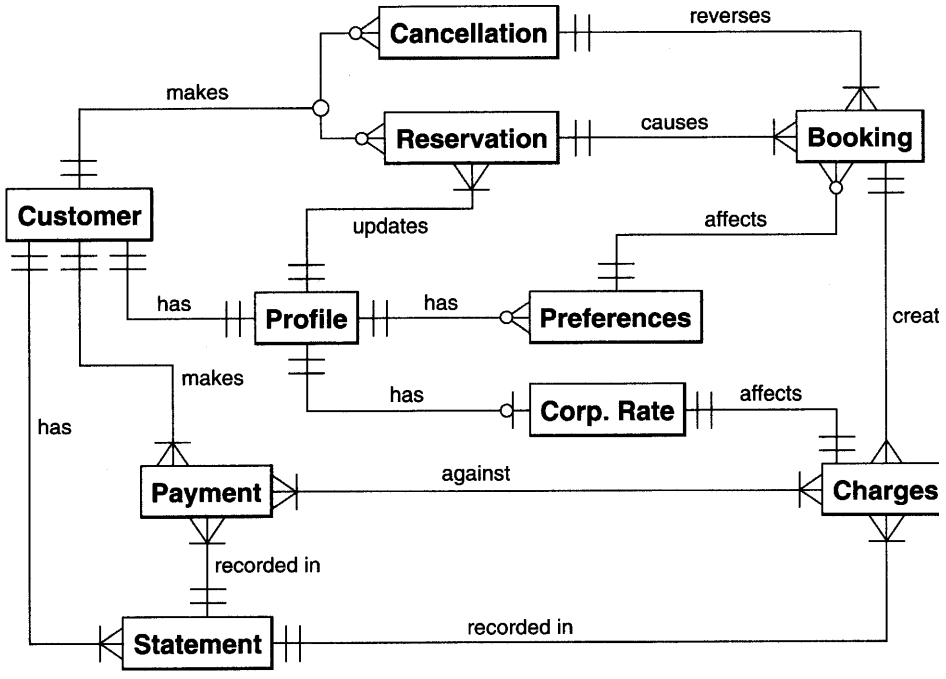
peer-to-peer network, N machines: N*(N-1) poss. interactions
client/server network, N = C + S: C*S poss. interactions

Information reachability

in large organizations, can have overlapping info jurisdictions

Information Resource Modeling (IRM) can help identify structure

- allows information partitioning & more effective sharing



Entity-Relationship (E-R) model for hotel reservations

Issues affecting information reachability

data interchange: data can exist on diff. machines in diff. formats

e.g., CR/LF in Windows vs. Mac vs. UNIX

must have tools for converting

data access: access methods for data may be incompatible across machines

e.g., hierarchical database vs. SQL database

most commercial apps have data access gateways to other apps

transparency: want client/server interaction hidden from user

- must have single name space for networked resources
- must be able to recover/reset after network failures

Information access

- relational access (e.g., SQL)
- text access (e.g., keyword searching)
- hypermedia

  graphical representation of information: nodes (files, images, …) + hyperlinks
  can traverse graph structure by viewing nodes & selecting links

  e.g., World Wide Web
  - multimedia files stored on a network of Web servers
  - client (browser) requests specific document/object via URL
  - server responds with MIME message containing document/object

  - uses HyperText Transfer Protocol (HTTP)

Advantages:	easy to maneuver through complex information
	highly extensible
	client/server interactions transparent to user
Disadvantage:	Web development still difficult

Information handling

in addition to providing greater access to & extraction of info,
must make it easy to use/manipulate

key: provide user with several ways to work with same data

e.g., raster images for easy viewing, OCR text for searching
e.g., audio recordings for listening, automated transcripts for scanning

- provide basic operations that ensure data integrity
  e.g., change in corporate directory automatically update personnel DB
- present information to user in its natural state, with flexible interface
- danger when dealing with loosely-coupled databases
  related accesses/updates may not be handled uniformly

Information-driven productivity

client/server can contribute to increased productivity in an information-driven enterprise

end-user computing

- maximize user performance over system performace
  e.g., intuitive GUI over efficient text-based interface
- stress usability
  e.g., client/server based context-dependent help
- emphasize information flow
  e.g., Volvo value-added teams over assembly line
- support mobility & adaptability
  e.g., restructure network to allow telecommuting, flexible interface

Information-based enterprises

computer networks often extend beyond a business

- company may link networks & share info with partners, suppliers, …
- creates a virtual enterprise encompassing all systems

e.g., Wal-Mart and Proctor & Gamble
formed corporate alliance to reengineer Wal-Mart's diaper inventories
client/server system shared sales, inventory information

Proctor & Gamble able to adapt to changing sales, inventories
supply stock with minimal warehousing, no shortages

Note: security can be an issue!

Information-centric products

information can be valuable, lead to new business opportunities

e.g., American Airlines
client/server SABRE system for booking flights on 3rd party airlines
could generate 3X profit compared to own flights

e.g., Von's grocery stores
introduced client/server based point-of-service card
easier for customers, allowed tracking sales & targeted marketing
sold customer information to market research companies for $10M

e.g., Progressive insurance company
client/server based mobile claims center
adjustor can access records, file claim, obtain authorization, write check

Mass customization

standardized, mass-produced products are often not competitive

with increased competition, companies must reduce

- cycle times for getting products to market
- costs of sale via shorter sales cycles
- cost of order fulfillment via just-in-time manufacturing

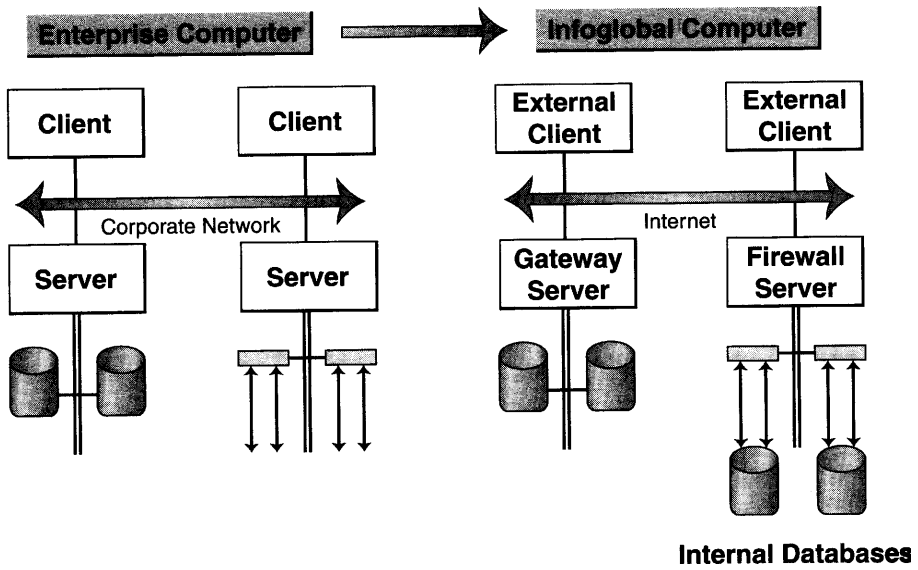
e.g., made-to-order computers (Dell, Gateway, Toshiba)

e.g., Motorola pagers
chose options from sales rep
specs are sent online to manufacturing center in Florida
programmable assembly process custom builds pager within 20 minutes
inspected, labeled within 60 minutes
shipped for next day delivery

Information-driven economy

we have seen: information is valuable

- allows for improved decision making
- allows for mass customization
- can often spawn profitable subsidiaries



client/server + LAN enables
enterprise computing

enterprise computing +
Internet enables
infoglobal computing

Next week…

Client/Server Communications

- message-passing concepts
- remote procedure calls
- message queueing

Read Chapters 4 and 9

- possibly supplemental readings (check online)

As always, be prepared for a short quiz