
Understanding Networked Applications:
A First Course

Chapter 4

by
David G. Messerschmitt

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Technical properties of information

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Two fundamental concepts

- The computer is the first machine whose functionality is not determined at the time of manufacture
 - added by software later
- Any form of information can be represented or approximated within the information technology infrastructure

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Key concept

- The key commodity manipulated by information technology is information
- To be manipulated in a computing/networking environment, information must be represented by data

What is information?

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Information

- From a user (human) perspective...
....recognizable patterns that influence you in some way
(perspective, understanding, behavior...)
- In the computing infrastructure, information has a somewhat different connotation as structure and interpretation added to data

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Data

- A bit is “0” or “1” — the atom of the information economy
- Data is a collection of bits, like
 - “0101110111010110”
 - “0000011”
 - “111011101011010110111011011010”
- Note: the terms data and information are not always used consistently!

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Representation

- Take the place of the original
- Equivalent to, in the sense that the original can be reconstructed from its representation
- Often the original can only be approximately reconstructed, although it may be indistinguishable to the user
 - e.g. audio or video

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ASCII

Alphabet	Hex	Binary
<D>	/x37	00110111
<E>	/x38	00111000
<F>	/x39	00111001
<G>	/x3A	00111010
<H>	/x3B	00111011
<I>	/x3C	00111100
<J>	/x3D	00111101
<K>	/x3E	00111110
<L>	/x3F	00111111
<M>	/x40	01000000
<N>	/x41	01000001
<O>	/x42	01000010
<P>	/x43	01000011
<Q>	/x44	01000100

Interpretation Structure

Note that this representation is
not unique...

....this one happens to be a standard
(ANSI X3.110-1983)

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A picture



This picture conveys information

This information is represented in this computer, but how?

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Representation of picture: image



An approximation!

Expanding a small portion of the picture, we see that it is represented by square pixels....

....300 tall by 200 wide.....

....with a range of 256 intensities per pixel

$$300 \cdot 200 \cdot 8 \text{ bits} = 480,000 \text{ bits} \text{ (but it can be compressed)}$$

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Color picture

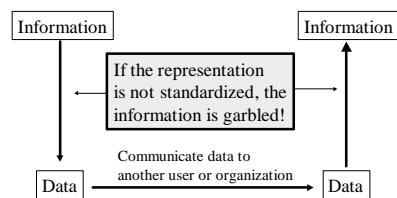


A color picture can be represented by three monochrome images...

At the expense of three times as many bits

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Representation needs to be standardized



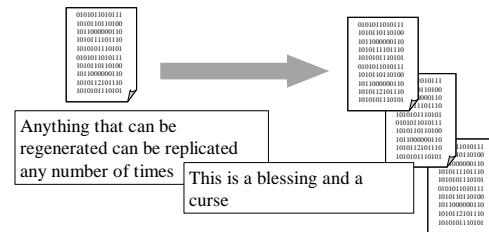
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Regeneration

- Make a precise copy of the data (copy bit by bit)
- If you know the representation, this is equivalent to making a precise copy of the information
- Each such precise copy is called a generation, process is called regeneration

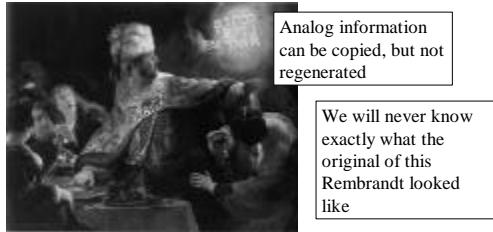
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Replication of information



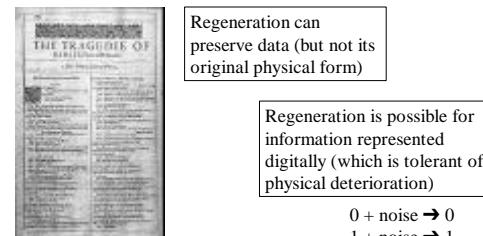
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Analog information cannot be regenerated



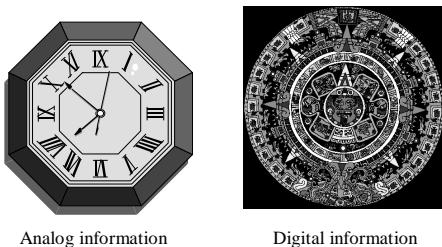
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Discrete information can be regenerated



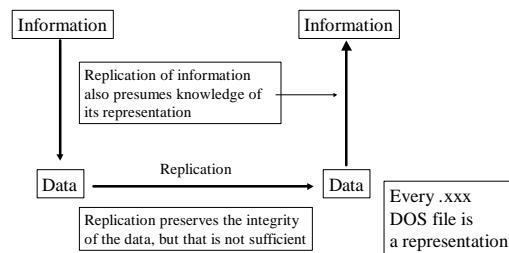
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Example



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Replication of information requires knowledge of representation



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Implications

- Digitally represented information can be preserved over time or distance in its precise original form by occasional regeneration
 - digital library
 - digital telephony
- Replication of data is easy and cheap

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Implications (con't)

- Replication of information requires knowledge of the structure and interpretation
 - Standardization or some other means
- Extreme supply economies of scale
- You can give away or sell and still retain
- Unauthorized replication or piracy relatively easy

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Architecture

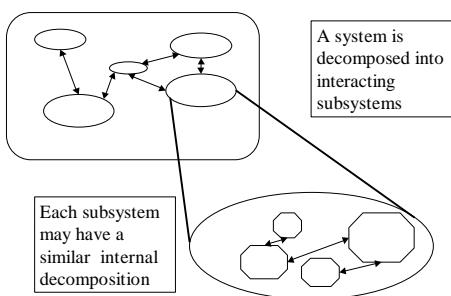
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Outline

- Architecture
 - Decomposition
 - Modularity
 - Interfaces
- Hardware
- Software

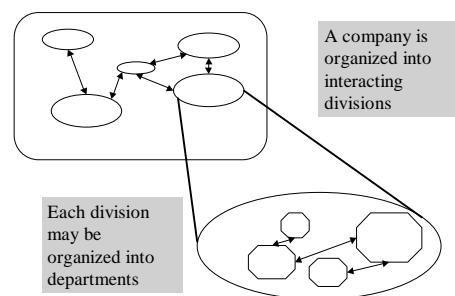
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Architecture



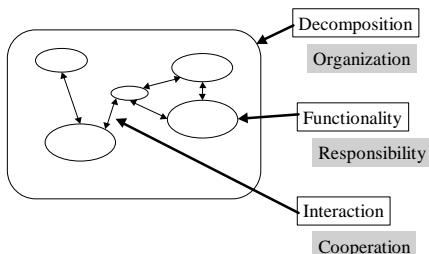
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Organization design



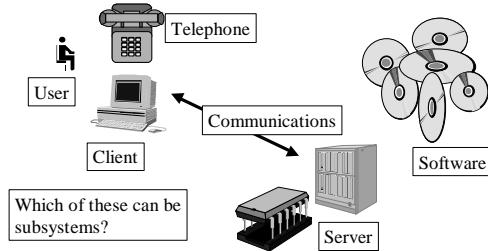
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Three elements of architecture



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Some building blocks



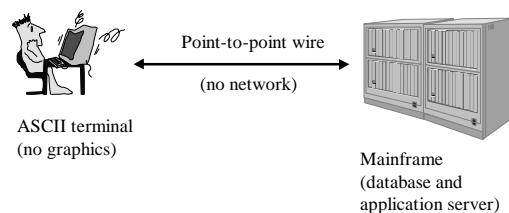
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System examples

- Let's quickly look at some system decomposition examples
 - Quick tour of information technology systems

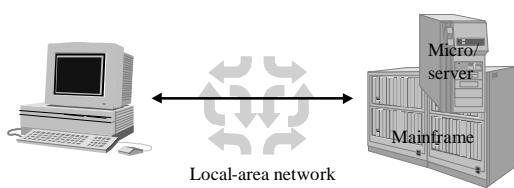
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Time sharing



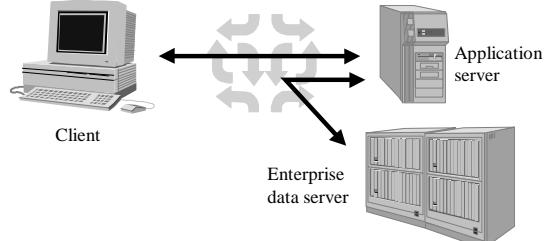
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Two-tier client/server



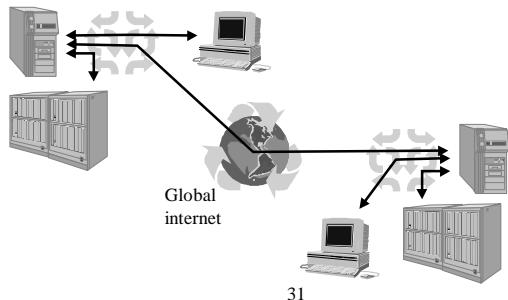
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Three-tier client/server



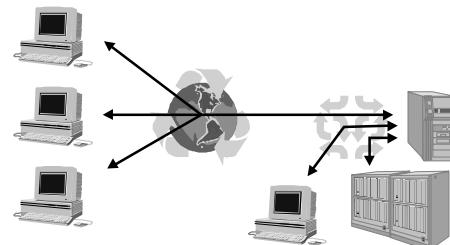
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Inter-organizational computing



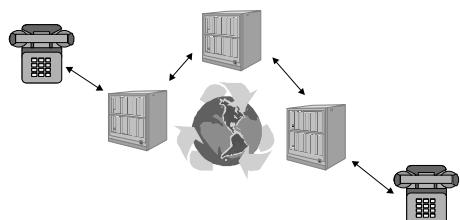
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Consumer access



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Telephone system



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Emergence

- Subsystems are more specialized and simpler functionality
- Higher-level system functionality arises from the interaction of subsystems
- Emergence includes capabilities that arise purely from that interaction (desired or not)
 - e.g. airplane flies, but subsystems can't

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System integration

- Architecture → subsystem implementation → system integration
- Bring together subsystems and make them cooperate properly to achieve desired system functionality
 - Always requires testing
 - May require modifications to architecture and/or subsystem implementation

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Why system decomposition?

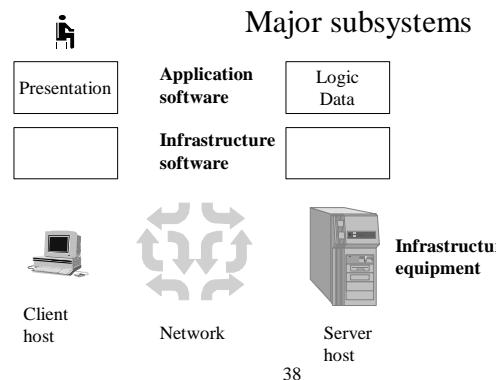
- Divide and conquer approach to containing complexity
- Reuse
- Consonant with industry structure (unless system is to be supplied by one company)
- Others?

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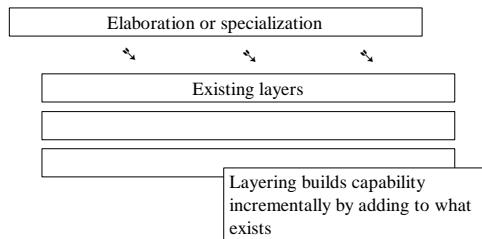
Networked computing infrastructure

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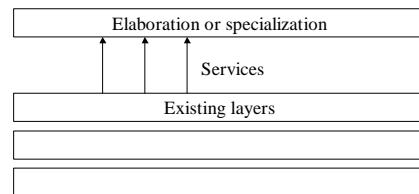
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Layering



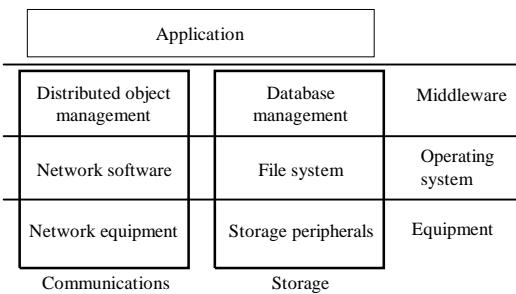
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Layering



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Simplified infrastructure layering



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Operating system functions

- Graphical user interface (client only)
- Hide details of equipment from the application
- Multitasking
- Resource management
 - Processing, memory, storage, etc
- etc

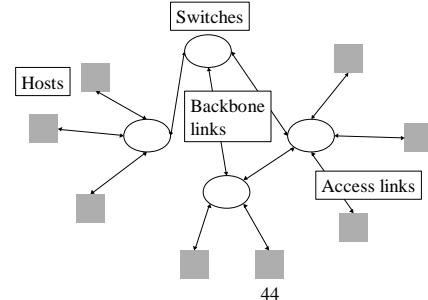
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File system

- Hides details of storage equipment from applications
- File is:
 - Unit of data managed for the benefit of the application
 - Size known, but unspecified structure and interpretation
 - Name
 - Location in naming hierarchy

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Network equipment



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Messages and packets

- Simplest network communication service is the message
 - Smallest unit of communicated data meaningful to application
 - Size, but unknown structure and interpretation
 - Analogous to file in storage
- Internally, the network may fragment a message into packets, and reassemble those packets back into a message

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Communication middleware

- New application-specific communication services
- Location independence
 - makes distributed application look similar to centralized
- Many possible other functions

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Storage middleware

- Database
 - File with specified structure
 - Example: relational table
 - Oriented toward business applications
- Database management system (DBMS)
 - Manage multiple databases
 - Basis of online transaction processing (OLTP)

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Year	City	Accommodation	Tourists
2002	Oakley	Bed&Breakfast	14
2002	Oakley	Resort	190
2002	Oakland	Bed&Breakfast	340
2002	Oakland	Resort	230
2002	Berkeley	Camping	120000
2002	Berkeley	Bed&Breakfast	3450
2002	Berkeley	Resort	390800
2002	Albany	Camping	8790
2002	Albany	Bed&Breakfast	3240
2003	Oakley	Bed&Breakfast	55
2003	Oakley	Resort	320
2003	Oakland	Bed&Breakfast	280
2003	Oakland	Resort	210
2003	Berkeley	Camping	115800
2003	Berkeley	Bed&Breakfast	4560
2003	Berkeley	Resort	419000
2003	Albany	Camping	7650
2003	Albany	Bed&Breakfast	6750

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Some DBMS functions

- Logical structure separated from physical structure
- Platform independence
- Implement standard queries
- Access from multiple users/applications
- Manage data as asset separate from applications

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The Internet

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What is the Internet

- Internet = the major global internet
- An internet is a “network of networks”
 - Interconnect standard for LAN’s, MAN’s, and WAN’s
- A private internet is called an intranet
- An extranet is an interconnection of intranets through the Internet

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Intranet

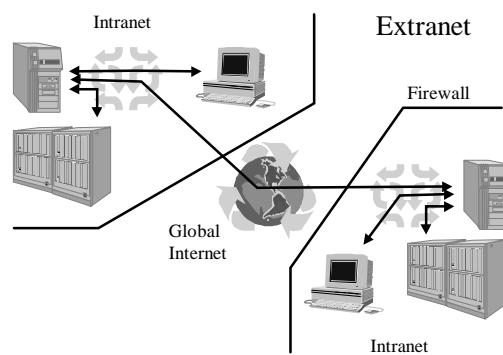
- Private internet
- May be connected to Internet
 - Firewall creates a protected enclave

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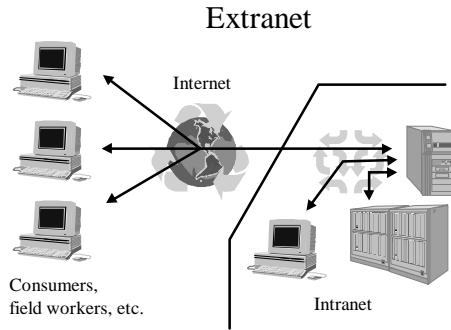
Extranet

- Intranets connected through an unprotected domain (typically the Internet)
- Encryption and other security technologies used to
 - protect proprietary information
 - prevent imposters, vandals, etc

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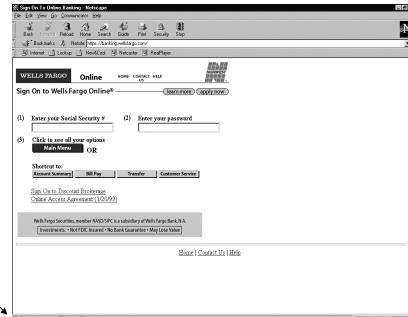


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Lock icon
indicates this
is an extranet



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Certificate is the server's credential

The top window displays the 'View A Certificate' page for `banking.wellsfargo.com`. It shows the certificate was issued by 'RSA Data Security, Inc.' and is valid from May 30, 1998 to Oct 09, 1999. The bottom window shows the 'Security Info' tab, which includes sections for 'Encryption' (not encrypted), 'Certificates' (view certificate or open page info), and 'Verification' (instructions to check the site's URL).

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Questions

- What business purposes do nomadic workers serve?
- Mobile?
- What advantage does direct Internet access have over long distance telephony?

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