

Distributed Systems

Introduction

- IT architecture versus IT infrastructure
 - Architecture (conceptual)
 - Blueprint ← shows how a system will look and how the parts interrelate
 - Infrastructure (physical)
 - Implementation (hardware, software, networks)
- Evolution of Distributed Systems
 - Mainframe → Client-server → Web
 - *What do you think: evolutionary or cyclical?*

Definition of a Distributed System (Tanenbaum):

- A distributed system is:
A collection of independent computers that appears to its users as a single coherent (logical) system.

Attributes of Distributed Systems

- Degree to which a system is distributed is dependent on 4 factors:
 1. Where the processing is done
 - Spread out the workload to other machines
 - Requires system interoperability
 2. How processors and other devices are interconnected
 - Redundancy (at least one alternative route)
 - Electronic communication links to send data

Attributes of Distributed Systems cont'd

3) Where the information is stored

- Distributed databases without duplication

4) What rules or standards are used

- Need system-wide rules
 - Technical (if-then-else)
 - Management (e.g. security)

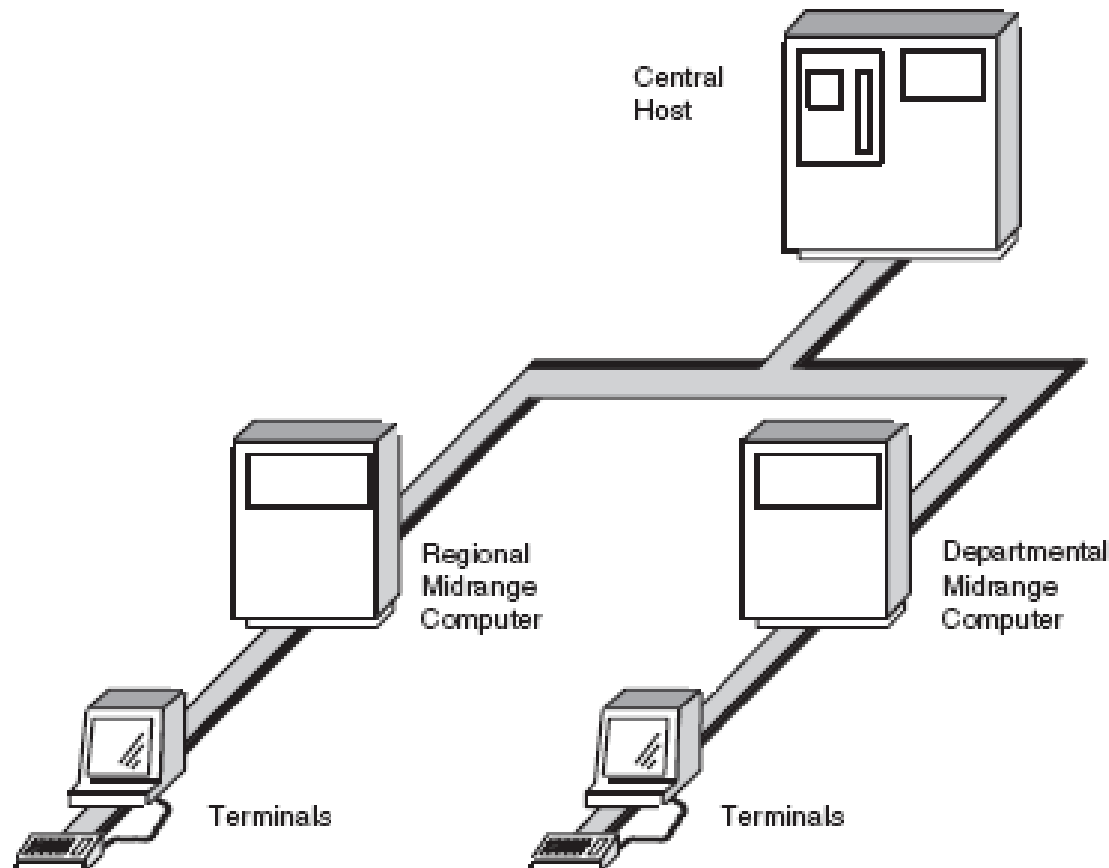
Types of Enterprise Distributed Systems

- Host-based Hierarchy
 - Master-slave architecture
- Decentralized Stand-Alone Systems
 - “Islands of Computing” (not distributed really)
- Peer-to-Peer LAN-Based Systems
 - No hierarchy or ‘superior’ computer
- Hybrid Enterprise-Wide Systems
 - Combination hierarchy (mainframe connected to a few departmental level LANs via WANs)

Host-Based Hierarchy

Master-slave architecture

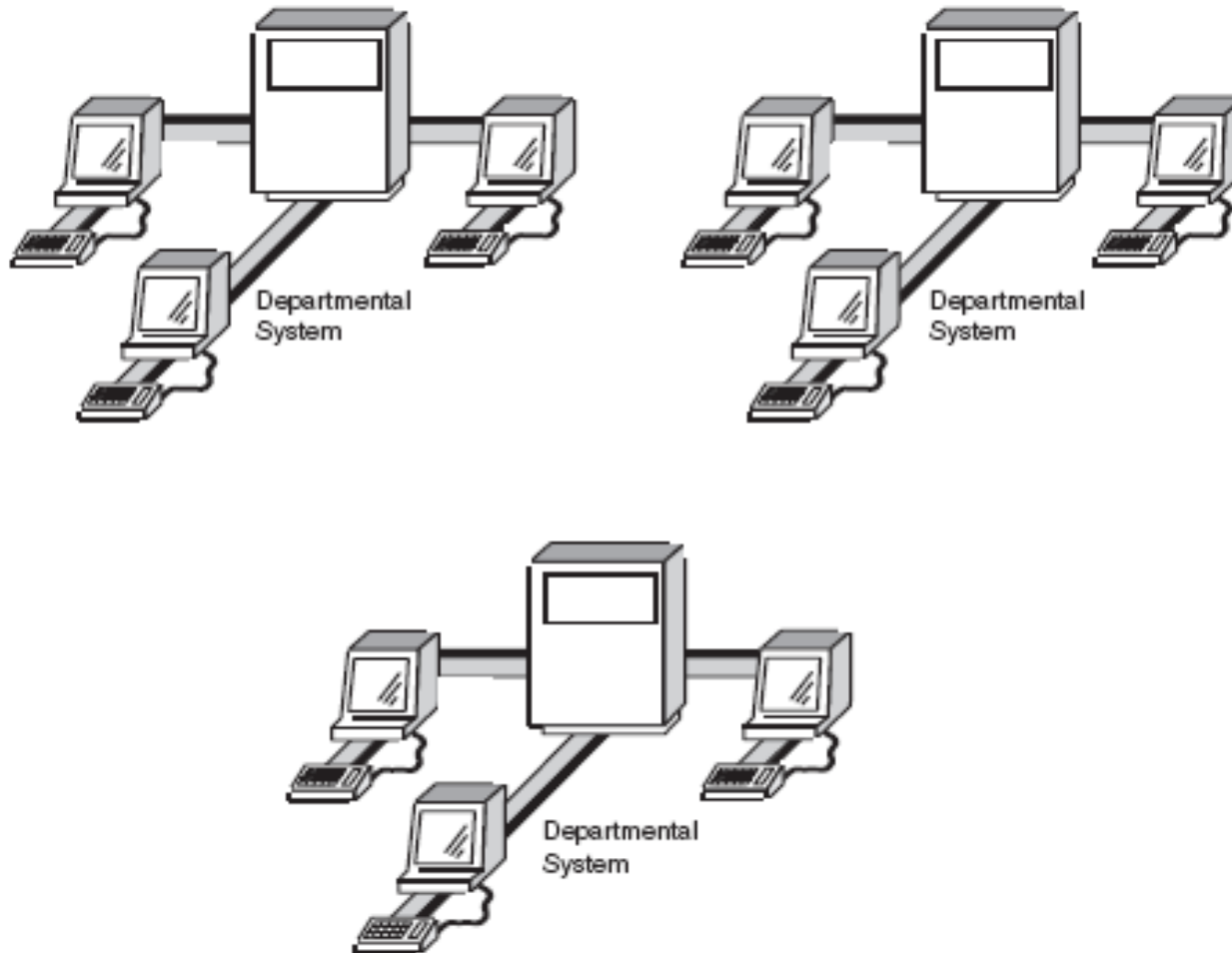
FIGURE 5-1 Host-Based Hierarchy



Decentralized Stand-Alone Systems

“Islands of Computing” (not distributed really)

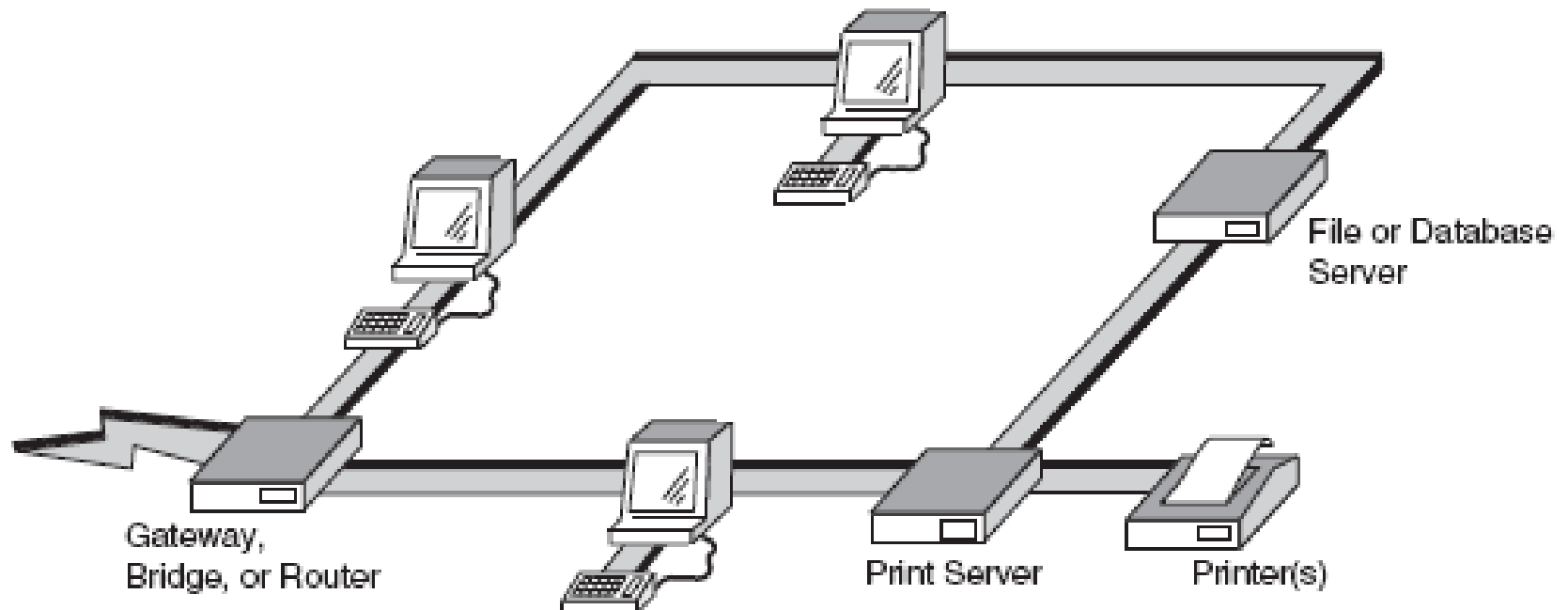
FIGURE 5-2 Decentralized Stand-Alone Systems



Peer-to-Peer LAN-Based Systems

No hierarchy or 'superior' computer

FIGURE 5-3 Peer-to-Peer LAN-Based System



Hybrid Enterprise-Wide Systems

Combination hierarchy
(mainframe connected to a few
departmental level LANs via
WANs)

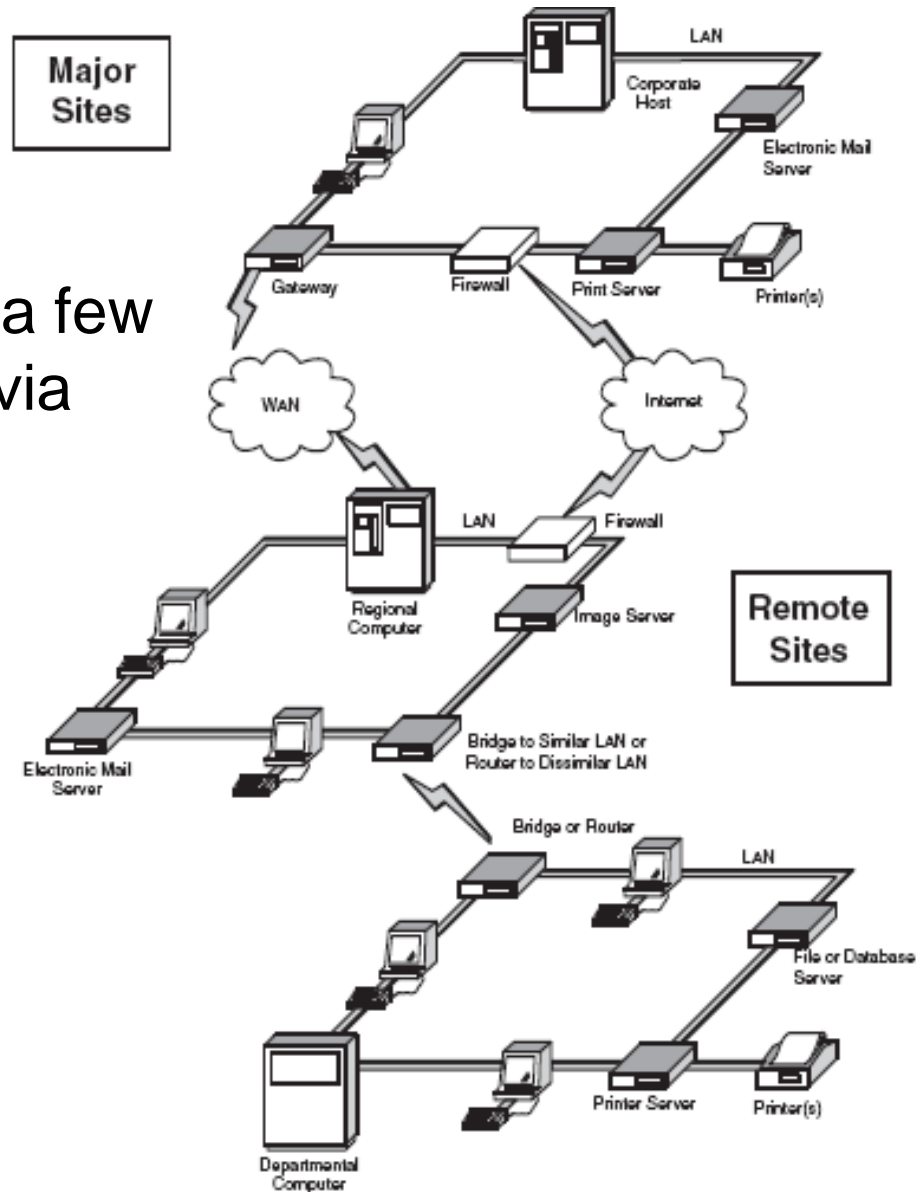


FIGURE 5-4 Hybrid Enterprisewide System

Types of Enterprise Distributed Systems cont'd

- Client-Server Systems
 - Splits computing workload between client and server (e.g. Lotus Notes)
 - Presentation
 - Application
 - Data
 - Three-tier architecture (another way to look at it)

Benefits & Drawbacks of Client-Server Systems

- Benefits
 - **Increases organizational flexibility**
 - **System scalability** - allows new technology to be added more easily without affecting rest of system
 - Encourages people to work together via networks
 - **Better access to information:**
 - Improved customer service
 - Ability to communicate customer needs, and
 - Anticipate customer needs.
 - Allow companies to compete better.

Types of Distributed Systems:

5. Client-Server Systems cont.

- Drawbacks
 - No cost differential (with regard to mainframe systems). Economically cost is much alike
 - IS job more complex → Easier for users, far more complex for IS

Types of Distributed Systems:

6. Internet-Based Computing

- In the late 1990s, the client-server trend was 'interrupted' (augmented?) by the 'Internet'
- Model of a distributed system includes the Internet

Types of Enterprise Distributed Systems cont'd

- Internet-Based Computing
 - Extension of client-server (via Internet)
 - Software updates
 - Java Web applets
 - Moves toward Thin Clients - that depends heavily on another computer (its server) to fulfill its computational roles.
 - Mandatory for everywhere computing
 - New ways of doing business



FIGURE 5-11 Internet-Based System

IBM, Nokia and Sabre Project: Pervasive Computing

Case example: Internet-Based Computing

- Real-time interactive travel services provided via the mobile phone using WAP.
 - XML
 - Connect Sabre's online traveling system to Nokia's wireless network and Internet-enabled phones.
 - Java applets
 - Deliver applications over Internet
 - WML: Wireless Markup Language, based on XML
 - Present XML information to mobile device

Types of Internet-Based Computing

- **Server-based Computing (Thin Client)**
 - Mobile workers and laptops
 - Software update difficulties
 - Data security
 - Applications and sensitive data reside on server
 - e.g. Citrix Server (remote desktop)
 - Easier management
 - Lower cost

THE SABRE GROUP

Case example: Internet-Based Computing

- Sabre airline reservation company is working with Nokia (the handheld phone manufacturer) to create a real-time, interactive travel service delivered via mobile phone
- The service draws on SABRE's online corporate travel purchasing system and Nokia's server (which transmits the travel information to a wireless network and to its Internet-enabled phones)

Types of Internet-Based Computing

- Peer-to-Peer Computing (P2P)
 - Task distributed to wide number of computers (peers) connected over the Internet
 - The main issue now is how to make money in this environment. One answer: subscriptions, where people pay for access rather than for ownership

Types of Distributed Systems:

7. Web Services

- This second-generation Internet-based distributed system gives software modules URLs (Internet addresses) so they can be called upon to perform their function as a service via the Internet
- This development will permit widespread computer-to-computer use of the Internet. One computer program or Web Service makes a request of another Web Service to perform its task (or set of tasks) and pass back the answer

Types of Enterprise Distributed Systems cont'd

- Web Services (Web-based SaaS)
 - Software as a Service (SaaS) is a software delivery method that provides access to software and its functions remotely as a Web-based service.
 - Second-generation Internet-based distributed system
 - URLs embedded in software modules
 - e.g. Google Apps, Salesforce

Types of Distributed Systems:

7. Web Services cont.

- Web Services Standards:
 - Three software standards:
 - **XML (eXtensible Markup Language)**
 - **WSDL (Web Services Definition Standard)**
 - **UDDI (Universal Discovery, Description, and Integration)** - XML-based registry for businesses worldwide to list themselves on the Internet. Defines which software system should be contacted for which type of data.

Types of Distributed Systems:

7. Web Services cont.

- Three communication standards
 - SOAP (Simple Object Access Protocol)
 - HTTP (HyperText Transfer Protocol)
 - TCP/IP (Transmission Control Protocol / Internet Protocol)

Significance of Web Services

- How does it impact business and work?
 - Changing from proprietary IT architecture to Web Services based on openness of Internet
 - Faster market response
 - Companies can obtain the functionality they need from the Internet
 - Pay only for needed functionality
 - Reduces the number of IT assets companies need to house and maintain

GENERAL MOTORS

Case Example: Web Services

- One General Motors executive believes that the Web Services architecture could be used to move GM from its supply-driven, build-to-stock business model to a demand-driven, build-to-order business model – an otherwise impossible feat
- To begin, GM first enhanced its supply-driven model by offering new functions via a Web Services architecture
- One Web Service is a locate-to-order service that dealers can use to easily find a specific car a customer might want in the inventory of other GM dealers

GENERAL MOTORS

Case Example: Web Services cont.

- Another Web Service is order-to-delivery which shortens the time to deliver a custom-ordered vehicle
 - Paving the way to eventually convert to a make to order business model
- The 'Rewards'?:
 - Cut its \$25B inventory in half
 - Potentially shave \$1,000 off the cost of each vehicle

Defining the Overall IT Architecture

- Helps in the management of complex information systems
- Supports firm operations and therefore reflects business strategy
 - Needs to keep pace with business change
- Chief Technology Officer can control.

The Structure of the IT Infrastructure

- What is an IT infrastructure?
 - The shared and reliable services that provide the foundation for enterprise IT portfolio.
 - Four layers of IT infrastructure
 - Technical component ← *computers and database management system packages.*
 - Human IT ← *translates the components (which technologists can understand) into services (which business users can understand).*
 - Shared IT services ← *present the infrastructure as a set of services that users can draw upon and share to conduct business.*
 - Shared and standard applications ← *which includes stable applications (such as accounting and HR)*

The Structure of the IT Infrastructure

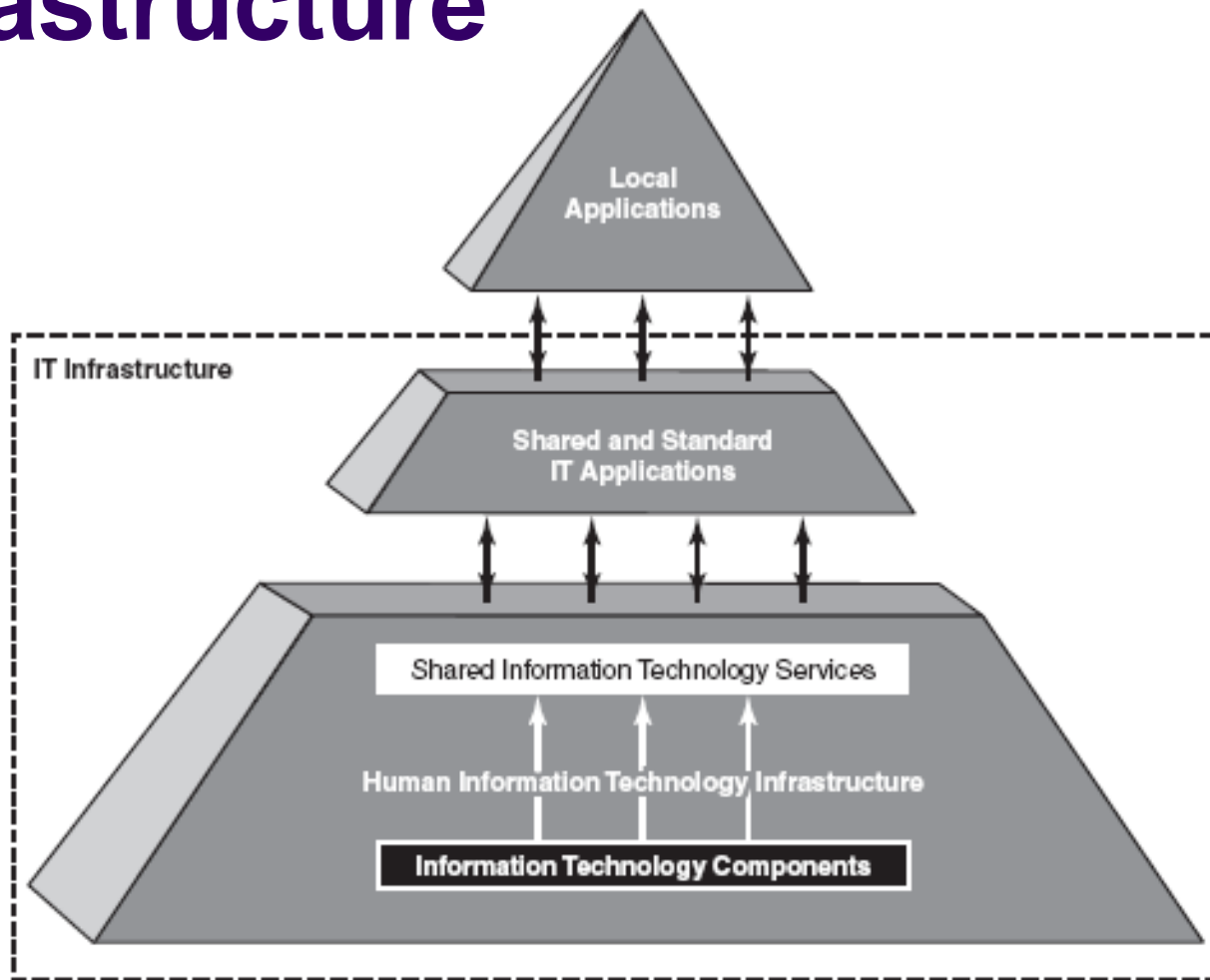


FIGURE 5-10 The Structure of the IT Infrastructure

Source: Adapted from Peter Weill and Marianne Broadbent, *Leveraging the New Infrastructure: How Market Leaders Capitalize on IT* (Boston: Harvard Business School Press, 1998).

The Importance of IT Infrastructure

- Similar to public infrastructure:
 - Roads
 - Hospitals
 - Sewers
 - Schools
 - etc.
- Everyone wants but no-one wants to 'pay'
 - E.g:- E-Mail Services, Search Engines
- Provided by a 'central authority'
 - Government or IT Department

Three views of Infrastructure

IT investments can provide:

1. Economies of scale (utility):
 - Infrastructure cost as an administrative expense
 - Minimize expense
 - Outsourcing may be viewed favorably because the IT infrastructure is not seen as strategic
2. Support for business programs (dependent):
 - Infrastructure treated as business expense
 - Measured by short-term business benefits
 - Infrastructure planning in current business plan
 - Network = critical

Three views of Infrastructure cont.

3. Flexibility to meet changes in the marketplace (enabling):
 - Primary benefit long-term flexibility
 - Intended to provide the foundation for changing direction in the future
 - IT cost seen as business investment

Three Views of IT Infrastructure

- Benefits realization depends on objectives for the IT infrastructure
 - Economies of scale (utility)
 - Necessary and unavoidable
 - Support for business programs (dependent)
 - Ties infrastructure investments to specific business programs
 - Flexibility to meet changes in the marketplace (enabling)
 - IT-business alignment (strategic)

The Digital Economy

- New business models, new products and services, new communication means, and new forms of community.
- Evolution of digital economy in 3 phases
 - Data processing revolutionized
 - Wide variety of electronic devices because of Moore's Law and decreasing costs
 - Exponential growth of electronic commerce

Corporate Infrastructure in the Digital Economy

- Influence Internet-enabled technologies to support business strategy in the digital economy
 - Extended enterprise
 - Value network
 - Strategic alliance
 - Value network
 - Virtual Organization
 - Globally distributed work

Summary

- Internet now at heart of distributed systems paradigm (Web services)
- Distributed systems extend outside of organization because of the Internet
- Effective implementation of distributed systems architecture requires top management commitment, realistic budgeting and strong project management