

PRINCIPLES OF MODERN COMMUNICATIONS NETWORKED APPLICATIONS

based on 2011 lecture series by Dr. S. Waharte.
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Outline

Modern
Communications

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Introduction

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- Networked Applications
 - Applications that require a network to function, such as e-mail and the World Wide Web
- Application Architectures
 - Where the processing is done
 - Terminal-Host processing
 - Client/Server processing
 - Cloud computing
 - Service-Oriented Architectures (SOAs)
 - Peer-to-peer (P2P) computing





Multiprotocol Label Switching (MPLS)

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- Implementing MPLS is difficult.
- Many individual ISPs and corporations do it.
- Some individual ISPs have “peering” arrangements with other individual ISPs to do it.
- There is no general way to move MPLS out to all ISPs and organizations.





Introduction

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- Application Architectures
 - Critical to network design
 - The newest architectures involve communication between multiple transmissions between multiple machines.
 - Driven primarily by growing desktop processing power
 - Ever-increasing role for PC processing, storage, and network connection speeds





Simple Terminal–Host System

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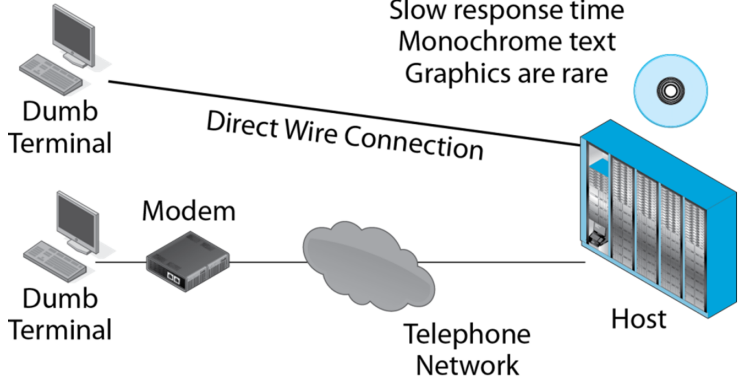
All processing is done on the host

Transmission is expensive

Slow response time

Monochrome text

Graphics are rare

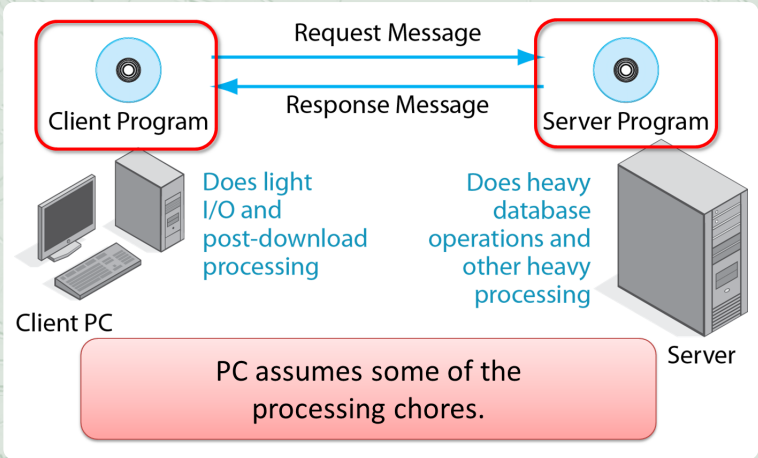




Client/Server Computing

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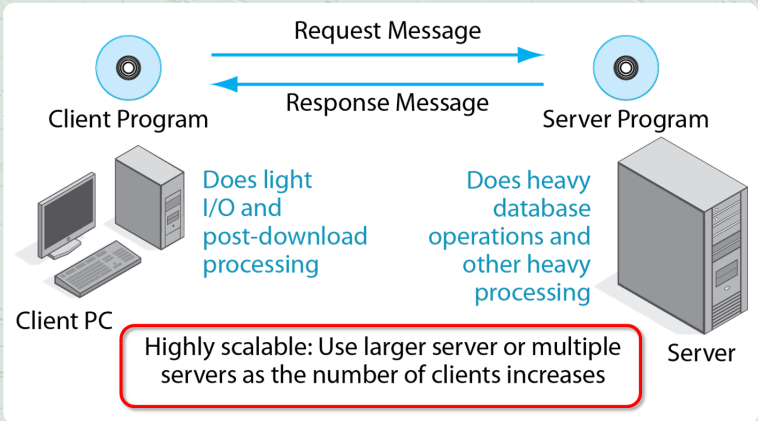




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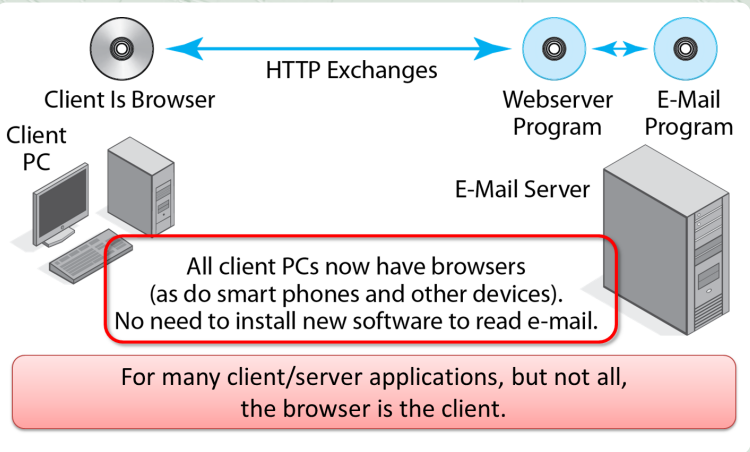




Web-Enabled Application (E-Mail)

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E-Mail

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- Importance of E-Mail
 - Universal service on the Internet
 - Attachments deliver files

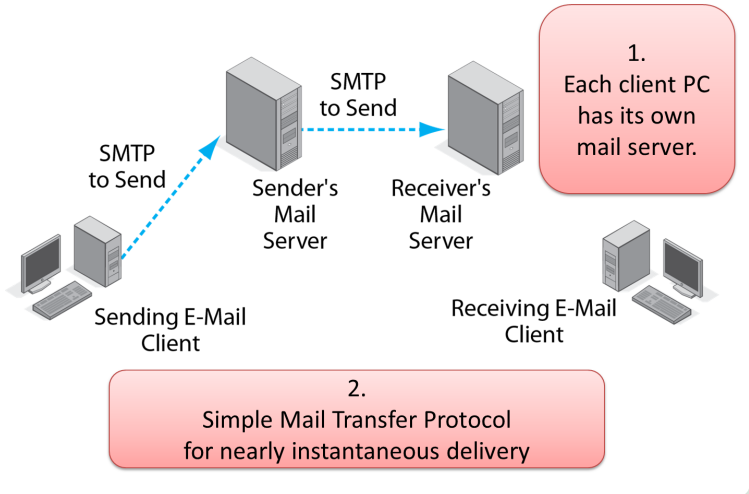




E-Mail Standards

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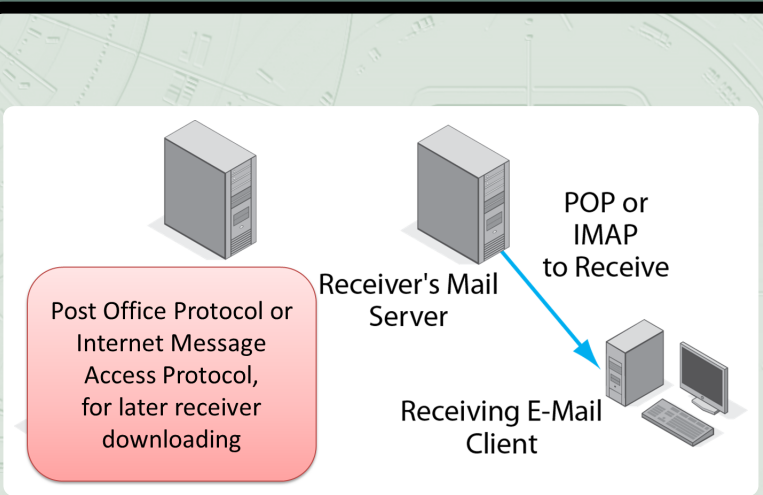




E-Mail Standards

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E-Mail Standards

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There are
separate
transmission
and document
standards



RFC 822 or 2822
HTML Body
UNICODE



Document standards:
RFC 822/2822 for plain text messages.
HTML bodies for formatting.
UNICODE can represent text in any language.





E-Mail Standards

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- Many applications have two types of standards.
- Delivery standards
 - SMTP, POP, IMAP
- Message format standards
 - RFC 822/2822, HTML, UNICODE
 - It does no good to deliver messages if the receiver cannot understand them.





Web-Based E-Mail

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- Either or both clients can use web-based e-mail instead of SMTP and POP or IMAP.
- All interactions for that client take place via HTTP instead.
- Message documents are HTML-based.





Interactions in SMTP

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- A complex step-by-step protocol
- Initial Steps
 - The sender sets up a TCP connection.
 - The receiver indicates that it is willing to communicate.
 - The sender identifies itself, and the receiver responds, indicating willingness to proceed (or not).





Interactions in SMTP

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- Sending a Message
 - The sender indicates that it has mail to send.
 - Receiver gives permission.
 - Sender indicates the author.
 - Receiver gives permission to continue.
 - For each addressee
 - The sender indicates the addressee on the receiving mail server.
 - Receiving mail server accepts or rejects each.





Interactions in SMTP

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- Sending a Message
 - The sender indicates that it has data to send (the body).
 - The receiver grants permission.
 - The sender sends the body, ending with a blank line to indicate that the body is finished.
 - The receiver indicates acceptance.





Interactions in SMTP

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- Final Steps
 - The sender sends a QUIT message.
 - The receiver indicates that the transaction is ended.





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- Viruses, Worms, and Trojan Horses
 - Widespread problems; often delivered through e-mail attachments
 - Use of antivirus software is almost universal, but ineffective, given the number of malware infections.
 - “Antivirus” programs are not limited to viruses. They scan for many types of malware.

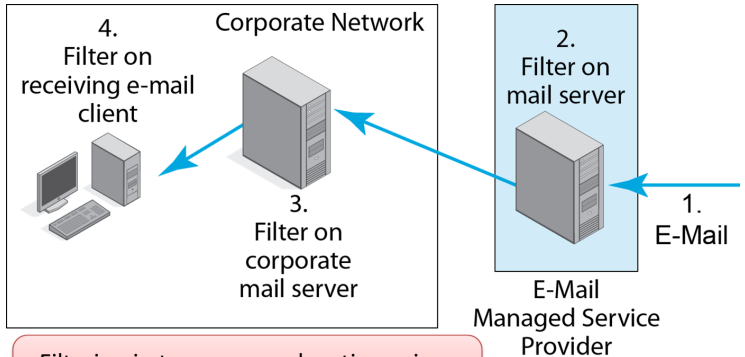




Scanning Locations for E-Mail

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Filtering in two or more locations gives defense in depth.





E-Mail

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- Spam
 - Unsolicited commercial e-mail
 - Why filter?
 - Potential sexual harassment suits
 - Time consumed by users deleting spam
 - Bandwidth consumed
 - Time consumed by networking staff deleting spam





E-Mail

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- Spam
 - Separating spam from legitimate messages is very difficult
 - Many spam messages are allowed through to users
 - Some legitimate messages are deleted
 - Some firms merely mark messages as probable spam





Voice over IP (VoIP)

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- VoIP
 - Sending voice over IP networks.
 - Codec converts voice to a bit stream.
 - Codec reduces the traffic generated to reduce network loads.
 - Packet switching is more efficient than circuit switching.

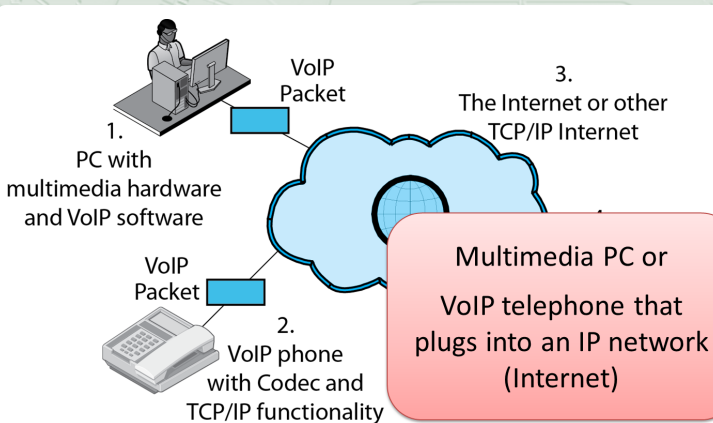




Voice over IP (VoIP)

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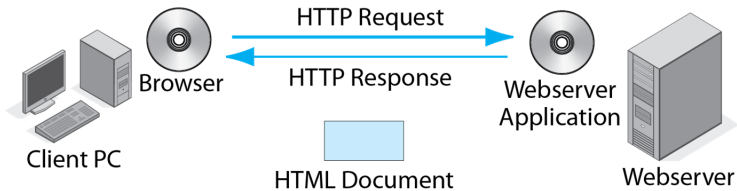




HTTP and HTML

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HTTP is a file transfer standard.
HTML is a document format standard.

Again, we see an application with transmission and document standards.

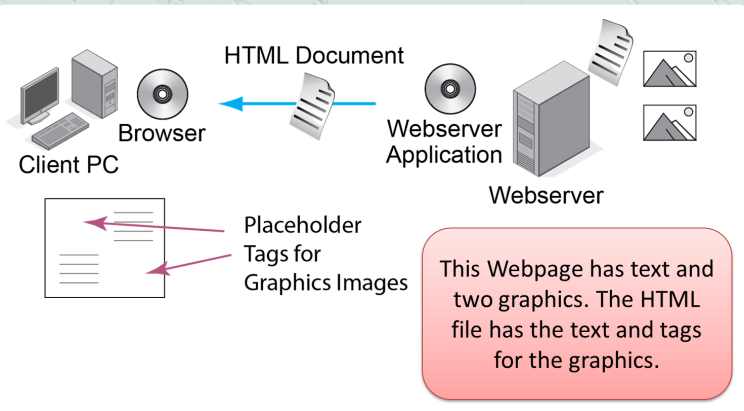




Downloading a Complex Webpage

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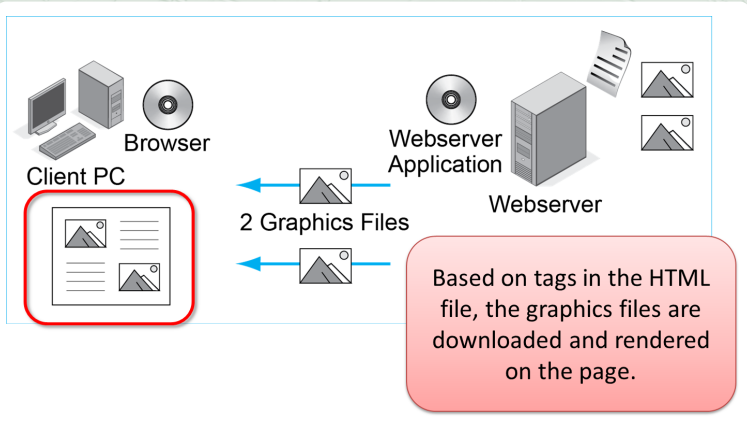




Downloading a Complex Webpage

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Based on tags in the HTML file, the graphics files are downloaded and rendered on the page.





Downloading a Complex Webpage

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- Question: How many files will a browser have to download if the webpage has three graphics?





Examples of HTTP Request and Response Messages

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- HTTP Request Message
 - GET /panko/home.htm HTTP/5[CRLF]
 - Host: voyager.shidler.hawaii.edu[CRLF]
- Note:
 - GET is the method. It asks for a file.
 - /panko/home.htm is the path to the file.
 - The browser speaks HTTP version 5.
 - CRLF means “carriage return/line feed.” It means to start a new line.





Examples of HTTP Request and Response Messages

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- HTTP Response Message:
 - HTTP/5 200 OK[CRLF]
 - Date: Tuesday, 20-MAR-2011 18:32:15 GMT[CRLF]
 - Server: name of server software[CRLF]
 - MIME-version: 1.0[CRLF]
 - Content-type: text/plain[CRLF]
 - .[CRLF]
 - File to be downloaded. A string of bits that may be text, graphics, sound, video, or other content.





Examples of HTTP Request and Response Messages

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- Note that most fields (lines) have a variable name, a colon, and then the value of the variable.
 - Example:
 - MIME-version: 1.0[CRLF]
 - MIME is a standard for describing file contents.
 - The browser speaks MIME version 1.0.
 - This is like e-mail headers with To:, From:, and other fields





Cloud Computing

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- A Shared Project
 - Google Docs
 - Shea and Melinda can share documents.
 - Before, they had used e-mail attachments.
 - There was often confusion over who had the most recent version.

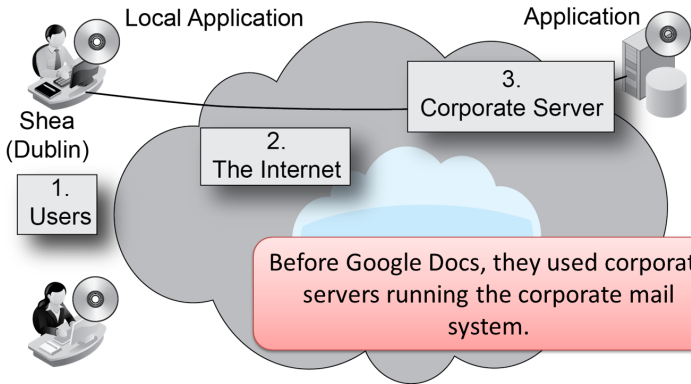




Cloud Computing: Software as a Service (SaaS)

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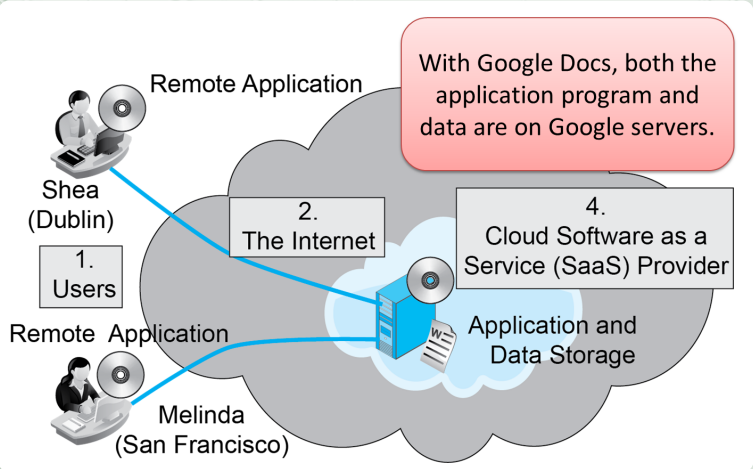


Cloud Computing: Software as a Service (SaaS)



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- Cloud Computing
 - For users, showing the network as a cloud indicates that they do not have to understand it.
 - In cloud computing, there is a second cloud—a cloud service provider.
 - In cloud computing, the company outsources some combination of servers, server applications, and client PC software to a cloud service provider. If client PC software is outsourced, the client PC only needs a browser.
 - Google Docs is a cloud provider of Software as a Service.
 - Usually metered service—pay as you go.





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- Software as a Service
 - In Software as a Service (SaaS), an application service provider (ASP) supplies an application to customers on demand.
 - In cloud SaaS, the user typically has a browser only.
 - The application and data are downloaded to the client PC as needed.
 - With cloud SaaS today, there is a broad range of applications available.





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- SaaS
 - Attractions of SaaS
 - Reduces cost and risk because user only pays for software as needed
 - Saves money because company does not have to manage the application
 - Mobility—users can access the software wherever there is Internet access
 - Collaboration: sharing is easy





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- SaaS
 - Issues with SaaS
 - If there is no Internet access, the application is unusable.
 - The cloud SaaS provider may go out of business.
 - Loss of control: may be locked into proprietary vendor software.





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- SaaS
 - Issues with SaaS
 - Security: will company's data be vulnerable if cloud service provider is attacked or has software vulnerabilities?
 - Legal complications: if user company is required by law to be secure, how can this be satisfied with SaaS?





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- Cloud Utility Computing
 - In traditional utility computing, a company offloads server processing work to another company at a remote site.
 - In cloud utility computing, the company that receives this processing job is a cloud service provider, and the data is sent over the Internet to be processed.
 - Unlike in SaaS, the application is not managed by the cloud provider—only processing power and storage.

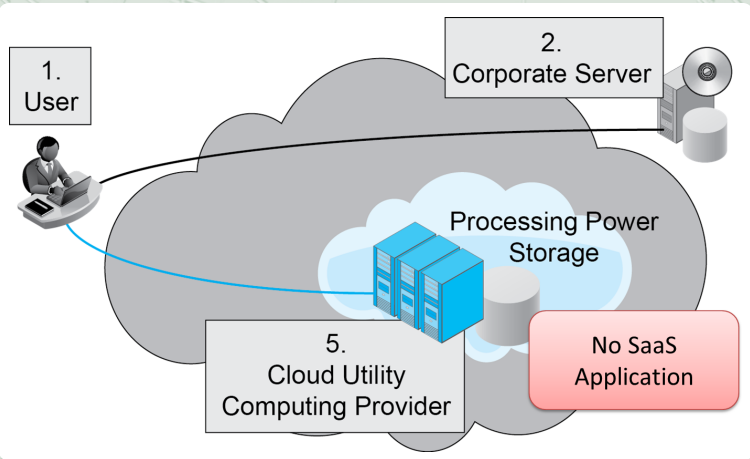




Cloud Utility Computing

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- Cloud Utility Computing
 - Attractions
 - Saved cost and risk of long-term investment
 - No need to hire staff
 - No need to purchase and manage servers





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- Cloud Utility Computing
 - Attractions
 - Flexibility—can get extra capacity quickly when needed for a short period of time
 - Scalability—will not outgrow the service provider's capacity





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- Cloud Utility Computing
 - Issues
 - As in cloud SaaS, loss of control and legal and security concerns





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- Why is Cloud Utility a Hot Topic Now?
 - The Internet is now fast, reliable, and accessible nearly everywhere
 - Web services (discussed later)
 - Virtualization (discussed later)





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- Managing Cloud Computing
 - Many advantages
 - Loss of control
 - Must consider security
 - Must have Service Level Agreements (SLAs) for performance



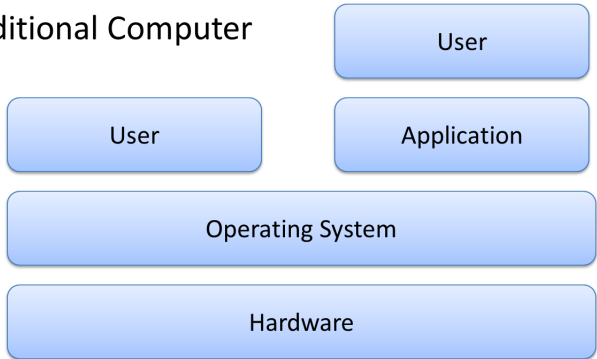


Virtualization

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- Traditional Computer



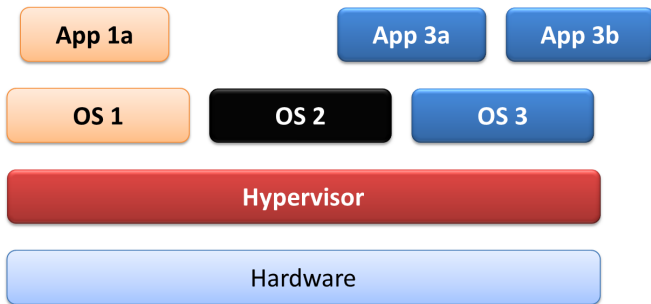


Virtualization

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▶ Virtualized Computer





Service-Oriented Architectures

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- Service-Oriented Architectures (SOAs)
 - Traditionally, in client/server computing, a single client program calls a single server program.
 - In service-oriented architectures, a client program may contact many small service objects on many different machines to do the work the client needs.
 - In addition, a service object may serve many clients.
 - Service objects usually do small chunks of work, like computing a currency exchange rate.

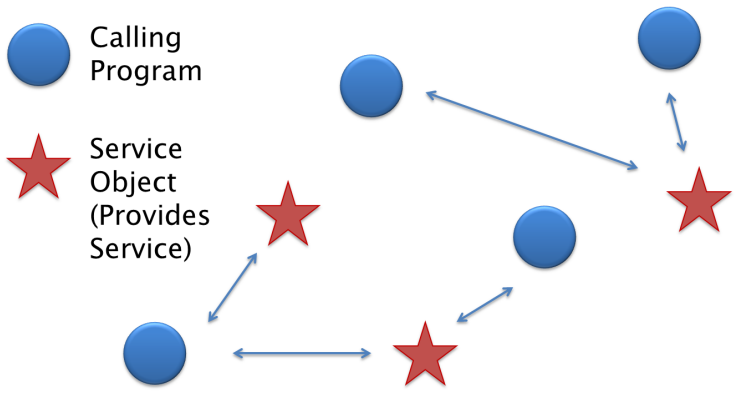




Service-Oriented Architectures

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Service-Oriented Architectures (SOA)

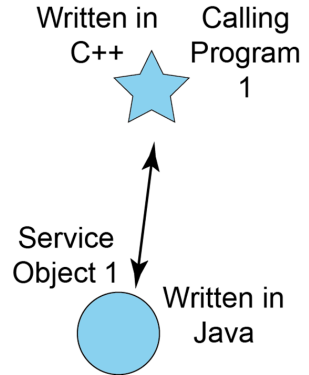
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- Service objects provide services to programs that call them.

SOAs are language-independent.

The calling program and the service objects may be written in different languages.



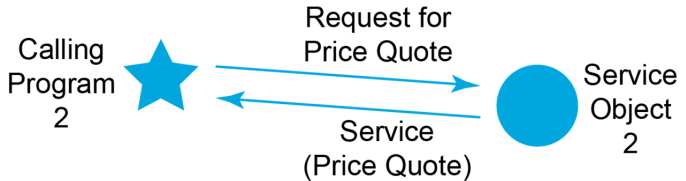


Service-Oriented Architectures (SOA)

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- SOAs use requests and responses.



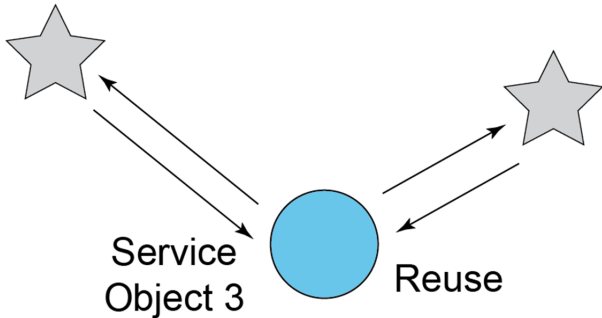


Service-Oriented Architectures (SOA)

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- Individual service objects can provide service to multiple calling programs.

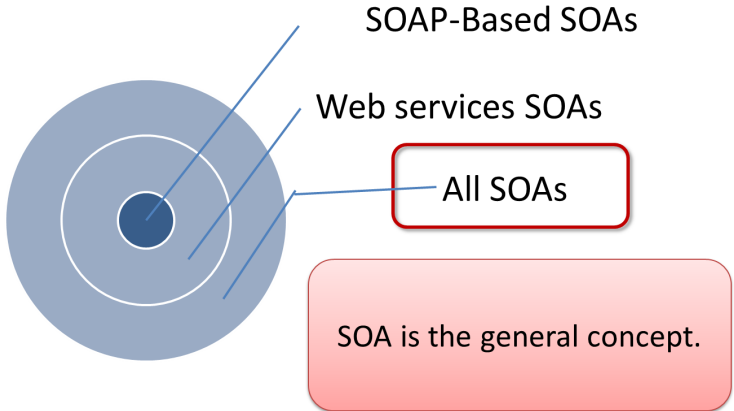




SOA versus Web Services

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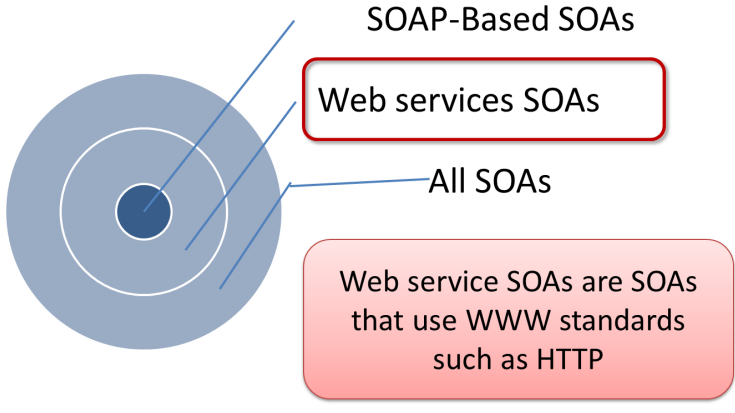




SOA versus Web Services

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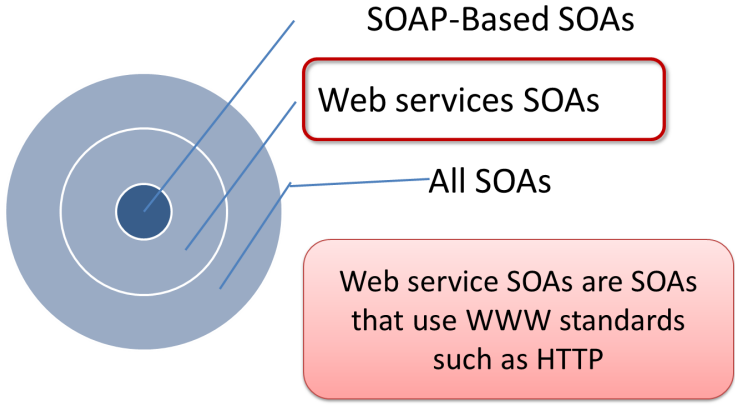




SOA versus Web Services

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SOAP Messages

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- SOAP is a common way to format requests for services and responses.
 - Simple Object Access Protocol
 - Quite simply, a general way to access (use) service objects
 - Specifically, SOAP standardizes the syntax of request and response message syntax and semantics in SOA interactions.





Peer-to-Peer (P2P) Architectures

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- Clients provide services to other clients.
- Servers are not used or are used only for secondary tasks such as helping a client find another client.
- Made possible by growing desktop processing power
 - Terminal-Host: no desktop processing power
 - Client/server: some desktop processing power
 - P2P: extensive desktop processing power

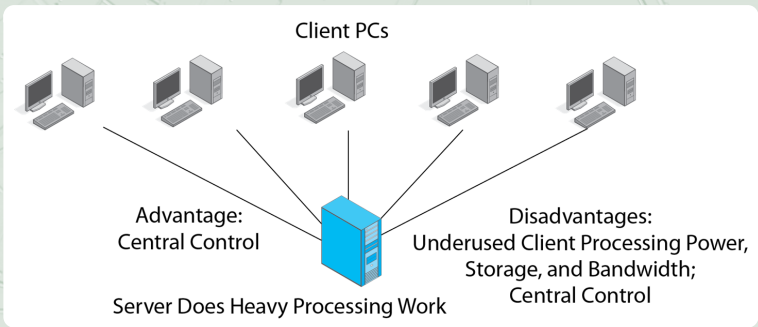




Traditional Client/Server Application

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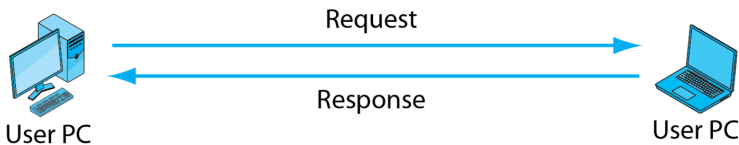




Simple Peer-to-Peer (P2P) Application

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Advantages:
End User Freedom
Wastes Less Client Capacity

Disadvantages:
Transient Presence of Clients
Transient Client IP Addresses
Security (No Central Control)

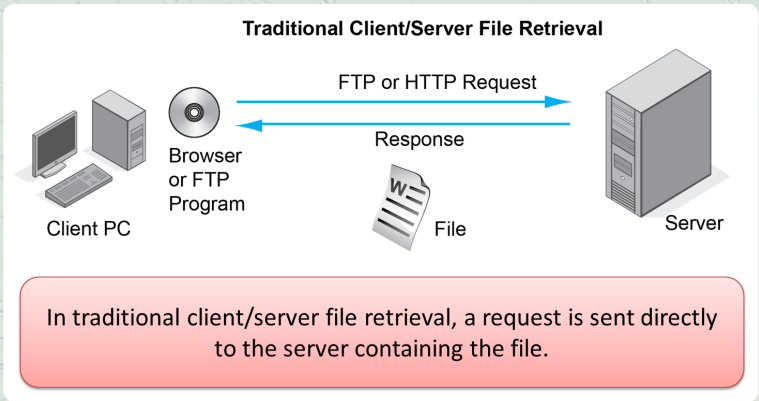




Traditional Client/Server File Retrieval

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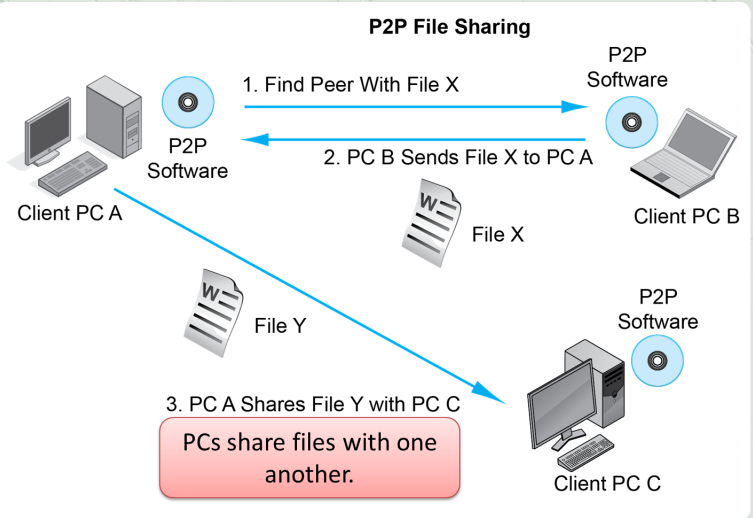




P2P File Sharing

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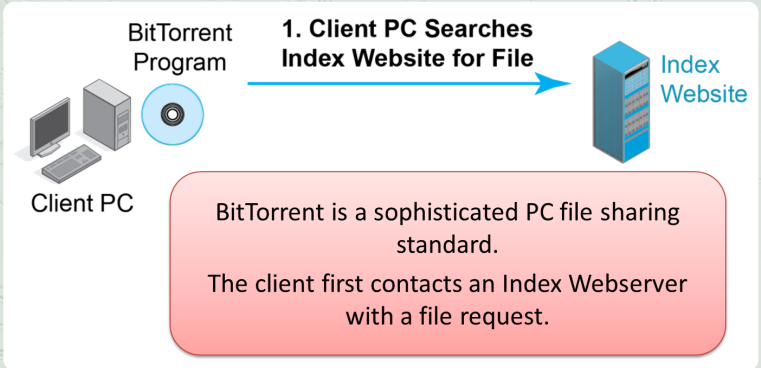




BitTorrent Protocol for P2P File Sharing

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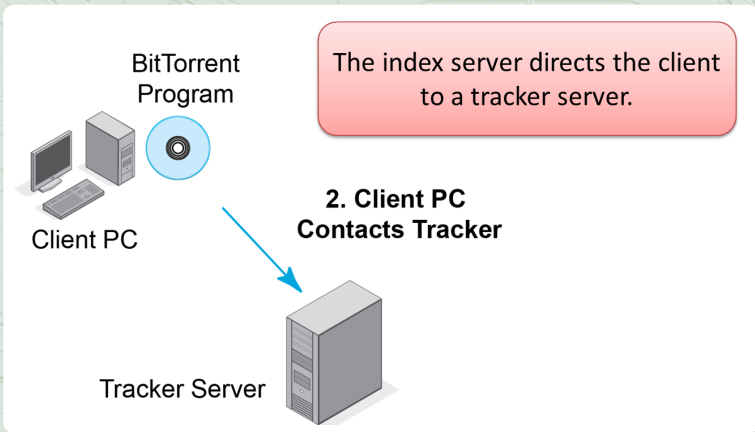




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BitTorrent Protocol for P2P File Sharing

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The swarm consists of client PCs that have parts of the desired file.

**3. Tracker
Identifies the Swarm.
Have the file?**

BitTorrent
Program

Yes

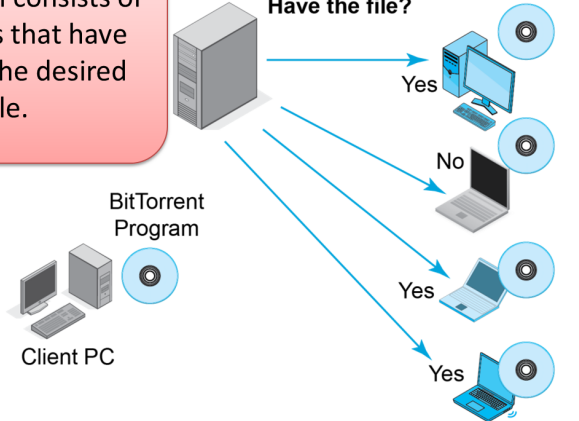
No

Yes

Yes

BitTorrent
Program

Client PC

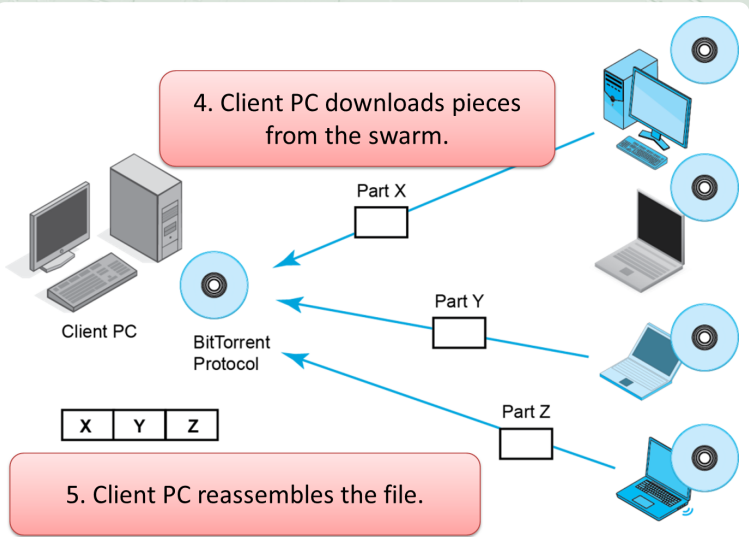




BitTorrent Protocol for P2P File Sharing

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BitTorrent Protocol for P2P File Sharing

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- Question: What do you think is the advantage of downloading the file from multiple sources instead of a single source?





Skype

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- Description and Main Features
 - P2P VoIP service
 - Very popular due to low costs
 - Free calling among Skype customers (computer-to-computer)
 - Reduced-cost calling to and from Public Switched Telephone Network customers





Skype

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- How Skype Works
 - Skype Network
 - Skype login server: the only centralized component in the Skype network
 - Host node: a Skype application that runs on a user's computer
 - Super node: a host node that takes on the work of signaling





Skype

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- How Skype Works
 - Three steps for user to place a call
 - ① Login: the Skype login server authenticates username and password, notes IP address.
 - ② Signaling/Directory Search: Skype application looks up the username and IP address of the party it wants to contact, using supernodes.
 - ③ Transport: handled by host nodes.





Skype

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- How Skype Works
 - Doing signaling and transport by peers rather than going through central server reduces Skype's operational costs
 - Results in low-cost calls



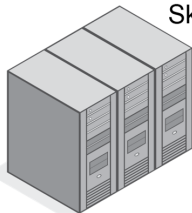


Skype Network Operation

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Users must log into
the network before
they receive service.



Skype Login
Server



1.
Message exchanges with the
central Skype login server
during login



Calling Client PC
(Ordinary Host)



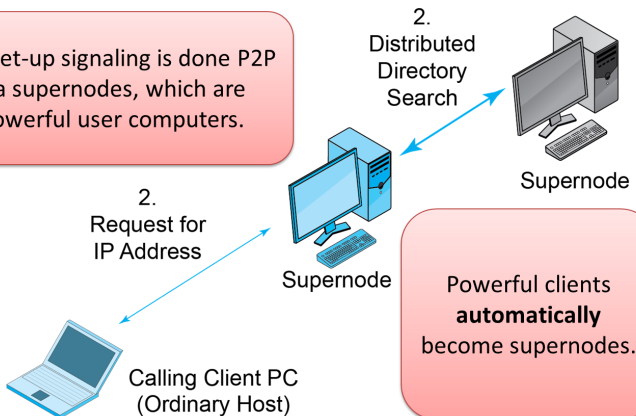


Skype Network Operation

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Call set-up signaling is done P2P
via supernodes, which are
powerful user computers.

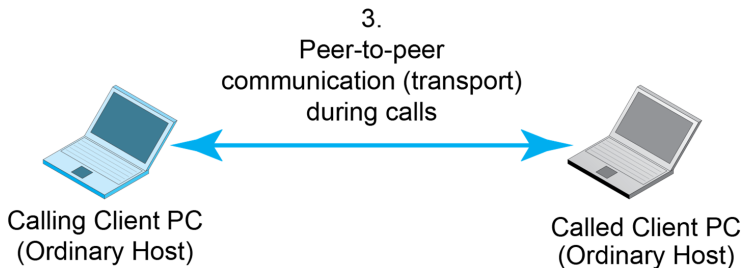




Skype Network Operation

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Once connected, the two parties
communicate entirely P2P.

This is transport.

So *most* transmission is P2P.





Skype

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- Skype Security
 - Many corporations ban use of Skype because:
 - Skype's proprietary software and protocols are not revealed to security professionals, change frequently.
 - Detailed method of Skype encryption is unknown.





Skype

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- Skype Security
 - Many corporations ban use of Skype because:
 - Registration is open and uncontrolled, so usernames mean nothing from a security standpoint.
 - Skype is almost impossible to control at firewalls.
 - Skype's file transfer mechanism does not work with most antivirus products.





Skype v Traditional VoIP

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Stage	Skype	Traditional VoIP
Registration	Server-based	Server-based
Signaling	P2P	Server-based
Transport	P2P	P2P

Skype differs from traditional P2P
only in signaling.

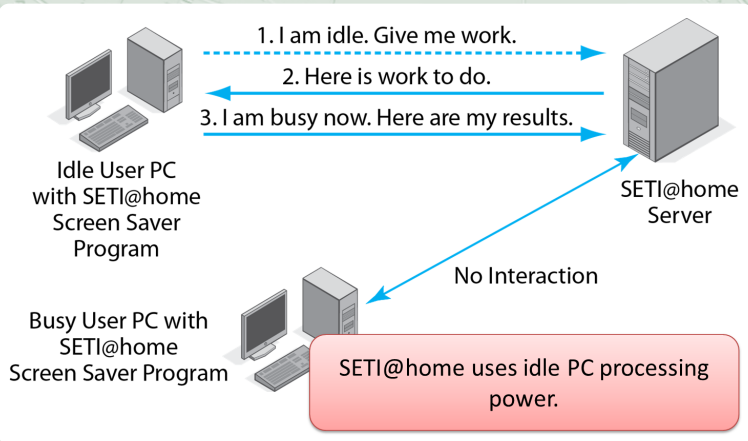




SETI@home Processor Sharing

Modern
Communications

David Goodwin
University of
Bedfordshire





P2P in Perspective

Modern
Communications

David Goodwin
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- Made possible by growing desktop processing power on PCs
- Types
 - File sharing
 - Communication
 - Processor sharing
- Potential cost savings by using idle PC resources
- Management and security issues

