Understanding E-mail Delivery

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Dr. John A. Marshall is the Internship Coordinator for the Department of Technology at the University of Southern Maine. His areas of specialization include Power and Energy Processing, Electronic Control Systems, Plant Layout/Material Handling, and Industrial Distribution.

The Internet represents one of the most successful examples of the benefits of sustained investment, commitment to research, and development of an information infrastructure. It has revolutionized the computer and communications world unlike anything before.

The invention of the telegraph, telephone, radio, and computer set the stage for this unprecedented integration of capabilities. The Internet is at once a worldwide broadcasting capability, a mechanism for information dissemination, and a medium for collaboration and interaction between individuals and their computers without regard for geographic location (Mateer, 1998, p. 1).

The Internet continues to expand and impact our lives in ways that were never before imagined. The Internet's pace of growth in the 1990s was spectacular, almost ferocious: "It spread faster than cellular phones, faster than fax machines. In 1999 the Internet grew at a rate of twenty percent a month. The number of 'host' machines with direct connection to the Internet has been doubling every year since 1988" (Sterling, 1993, p. 7) and new users are logging-on every day.

In 1998, "electronic postal stamps became a reality, with the US Postal Service allowing stamps to be purchased and downloaded for printing from the Internet" and in 1999 the first full service bank available exclusively on the Internet came on-line (Zakon, 1999, p. 19). Activities leading up to the year 2000 found many international timekeepers using E-mail to coordinate Y2K preparation activities, and also utilizing E-mail to report Y2K incidents and events. E-mail has evolved into an essential form of communication in many professions during the past few years, and has become one of the Internet's most useful tools for business, research, and recreation.

Purpose

Most of us utilize the Internet on a regular basis, but do they really understand how information and messages are routed across the world from one point to another? According to Thomas Tadayon, president and CEO of the software firm ThemeWare, "Technology is moving faster than the average person, and big companies aren't stopping to slow down" (Mahoney, 1999, p. 2). There are two purposes of this document. In addition to an overview and encapsulated historical perspective of the Internet, the primary goal of this document is to provide an understanding of the mechanics involved in routing an E-mail message from a sender to the receiver. The research design for this article was descriptive, and the methodology was a literature review with analysis and syntheses of the findings.

What is the Internet?

The Internet is a meta-network, that is, a collection of many networks that span the globe. It is impossible to give the exact number of networks or users that comprise the Internet, but it is easily in the thousands and millions, respectively. Sets of standardized protocols are utilized on the Internet that allow different kinds of computers to communicate and share resources.

These standards, referred to as the Internet Protocol Suite, are the rules that developers adhere to when creating new functions for the Internet. The Internet is considered a distributed system because there is no centralized archive or storage facility. Technically, no single company or individual operates the Internet. Rather, the Internet is made up of thousands of smaller networks, and continues to expand as users find new ways to create, display and retrieve information.

History of the Internet

The evolution of the Internet has been remarkable and it has expanded at an unanticipated rate. This section presents a synthesized overview of this evolution that has resulted in the tremendous communication network we utilize extensively today. The Department of Defense originally conceived the Internet as a way to protect and distribute government communications systems in the event of a military strike. The original network dubbed DARPANET for Defense Advanced Research Projects Agency Network, evolved into a communications channel among contractors, military personnel, and university researchers who were contributing to the Advanced Research Projects Agency projects. The network employed a set of standard protocols to create an effective way for individuals and agencies to communicate and share data with each other.

"By 1966/67 Internet research had developed sufficiently for the new head of computer research, Leonard Roberts, to publish a plan for a computer network system called ARPANET" (Zakon, 1999, p. 5). "The infant network was named ARPANET after the Pentagon's Advanced Research Projects Agency" (Sterling, 1993, p. 2). "ARPANET's popularity continued to

spread among researchers, and in the 1980's the National Science Foundation (NSF), whose NSF network (NSFNET) linked several high speed computers, took charge of the what had come to be known as the Internet" (Leiner, 1998, p. 2).

"Throughout this period, the world was still fairly chaotic, with a plethora of competing techniques and protocols" (Griffiths, 1999, p. 8). The original standard for communication was known as Network Control Protocol (NCP), but as time passed and techniques advanced, NCP was superseded by a higher-level, more sophisticated standard known as Transmission Control Protocol/Internet Protocol (TCP/IP). In 1982 TCP/IP was finally adopted and "the Internet was born … a connected set of networks using a common standard" (Griffiths, 1999, p. 8).

"TCP converts messages into streams of packets at the source, then reassembles them back into messages at the destination. The Internet Protocol handles the addressing, seeing to it that packets are routed across multiple nodes and even across multiple networks with multiple standards," (Sterling, 1993, p. 2) including the current Ethernet standard.

By the late 1980's, thousands of cooperating networks were participating in the Internet, and in 1991, the U.S. High Performance Computing Act established the National Research & Education Network (NREN). NREN's goal was to develop and maintain high-speed networks for research and education, and to investigate commercial uses for the Internet.

Thus, the initial research and development in the 1960's by the Pentagon's Advanced Research Projects Agency was continued by the National Science Foundation and culminated in 1991 with the establishment of the National Research & Education Network. A major milestone during this period was the replacement of the initial Network Control Protocol communication standards in 1982 to the higher level Transmission Control Protocol.

Originally the Internet was predominantly thought of as a research oriented network. This is not the case today as it continues to grow as an informational, creative, and commercial resource utilized all over the world. In 1999 alone, the number of available web sites on the Internet doubled from 5 million to just over 10 million (Zakon, 1999, p. 5).

Bruce Sterling, author of "Short History of the Internet" identifies the four primary functions of the Internet as discussion groups, long-distance computing, file transfers, and mail. "Internet mail is 'E-mail' or electronic mail, faster by several orders of magnitude than the US Mail, which is scornfully known by Internet regulars as snail mail" (Sterling, 1993, p. 4). "E-mail has become a human communication medium with very important advantages over normal US mail and over telephone calls'" (Living Internet, 2000, p. 1).

Electronic Mail

"Electronic mail, or E-mail, is probably the most popular and widely used Internet function. E-mail is a fast and efficient way to communicate with friends or colleagues" (Mateer, 1998, p. 1). It is possible to communicate with one person at a time or thousands, and to receive and send files and other information. Users can send E-mail messages to people in the same building or on the other side of the world. An individual can even subscribe to electronic journals and newsletters.

E-mail is an asynchronous form of communication, meaning that the person doesn't have to be available at the precise moment the message is sent. This is a great convenience for both the sender and the recipient. The telephone, on the other hand, is a synchronous communication medium, requiring that both the speaker and listener be on the line at the same time in order to conduct a conversation (unless you play phone tag with disjointed voice messages).

There are many different types of E-mail tools available today. Most programs allow you to send and receive mail messages, save your messages in a file, print mail messages, reply to mail

messages, and attach a file to a mail message. A good place to begin in understanding the mechanics of E-mail delivery is with the addressing system.

Internet Addresses

The routing of E-mail is based on the format and content of its address. Fortunately, Internet addresses are no more complex than telephone numbers or postal addresses. And, like telephone numbers or street addresses, Internet addresses have rules and conventions that must be followed. Each E-mail address is unique, and is expressed in the form: name @ domain using lowercase characters (Living Internet, 2000, p. 1). Using this as an example, emily@northwest.com, we can identify the three primary components of an E-mail address.

1. a user name (emily in the example above)
2. an "at" sign (@)
3. the address of the user's mail server (northwest.com in the example)

The mail server's address (northwest.com) is called the domain name, and it is based on the server's Internet Protocol (IP) address. Every server that's connected to the Internet has a unique numeric IP address. The local Internet Service Provider (ISP) that you are using, has "obtained the required IP numbers from a central organization called the Internet Network Information Center" (MaranGraphics, 1997, p. 266). This IP address is comprised of four sets of numbers separated by periods. An example of a numeric IP address would be 154.381.137.7.

Since it is easier for humans to remember names rather than numbers, each server also has a corresponding domain name. This name associates the server's numeric IP address with a name that is easier to remember. Both the IP address and domain name should function the same.

Sometimes it is useful to read an Internet address (emily@northwest.com) from right to left because it helps in determining

information about the source of the address. The right-most segment of domain names usually adhere to the naming conventions listed below:

1. *edu* - Educational sites in the United States
2. *com* - Commercial sites in the United States
3. *gov* - Government sites in the United States
4. *net* - Network administrative organizations
5. *mil* - Military sites in the United States
6. *org* - Organizations in the U.S. not covered by the categories above

In the example, emily@northwest.com, the 'com' would indicate a commercial site within the United States. The local Internet service provider for this person is a company named 'northwest'. And the individual who receives messages that are sent to this address is 'emily'.

Backbone providers

When the Internet was still a government-run system, there was only a single Internet backbone: the NSFNET, operated by the National Science Foundation, which connected the regional government-funded Internet networks that were run by various research universities. "When the government privatized the NSFNET in 1995, companies such as MCI, UUNET Technologies, GTE, and PSINet stepped into the breach by setting up commercial Internet backbone services" (How the Internet Works, 1998, p. 60). Now, instead of one NSFNET backbone, there are many backbones that are linked together to provide the global connectivity that is the Internet.

Backbone providers are the Internet players that typically own and lease long-haul fiber-optic cables spanning a large region. They also own the communications gear that directs traffic over the Internet. Even today "there are only a handful of major backbone providers, including MCI, World-Com, Sprint Corp., GTE,

and PSINET Inc." (How the Internet Works, 1998, p. 58).

Backbone providers connect to each other to exchange data between their customers. They also pick up and deliver traffic for a fee from the 7,000 or so smaller ISPs, who give residential and small-business users access to the Internet. Backbone carriers are like the highway system over which most of the freight of the Internet travels to reach its destination.

How E-mail Travels

When Sarah, who lives in Maine, wants to send an E-mail message to her sister Emily, who lives in Tukula, Washington, she uses a local ISP such as Downeast Communications (See Figure 1). Downeast gives Sarah access to the Internet, much in the way that an on-ramp puts a driver on the national highway system.

After Sarah's computer makes a telephone call to Downeast's local bank of modems, Sarah types in her email message and hits 'send.' Based on her sister's email address, Downeast will recognize that Emily is a customer of an ISP in Tukula called Northeast. Downeast will then send the E-mail to a Network Access Point (NAP) via a larger local ISP such as ATT. At the NAP, an Internet "backbone provider," such as MCI will route it to the NAP that services her sister's local ISP.

"The two E-mail servers then hold a brief conversation according to the rules defined by the Simple Mail Transfer Protocol (SMTP)" (Living Internet, 2000, p. 1). Sarah's server will ask Emily's server if the user name is valid, and if it is, then the E-mail will be transferred and stored until Emily logs on and downloads the message.

Conclusion

E-mail Internet delivery has changed the manner in which we communicate. Network literacy like computer literacy before it, has forced itself into the very texture of our lives (Sterling, 1993, p. 4). The Internet overview, E-mail journey, and the accompanying graphic provided in this document has illustrated the nature and function of this technology. It is

essential that we not only have the ability to utilize this powerful tool, but also understand the role of each of the major players.

The future of E-mail is extremely robust and is now being impacted by the move towards wireless technology. As telephony and other telecommunications technologies replace the need for a physical connection, Internet tools and applications such as E-mail are likely to experience an even greater rate of utilization.

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Figure 1. E-mail Transfer

emily@northwest.com

SMALL LOCAL
ISP NAMED
NORTHWEST

SMALL
LOCAL
ISP

SMALL
LOCAL
ISP

LARGE
LOCAL
ISP

SMALL
LOCAL
ISP

SMALL
LOCAL
ISP

LARGE
LOCAL
ISP

NETWORK
ACCESS
POINT

BACK BONE
PROVIDER

NETWORK
ACCESS
POINT

SMALL
LOCAL
ISP

SMALL
LOCAL
ISP

LARGE
LOCAL
ISP

SMALL
LOCAL
ISP

SMALL
LOCAL
ISP

SMALL
LOCAL
ISP

SMALL LOCAL
ISP NAMED
DOWNEAST

LARGE
LOCAL
ISP

SMALL
LOCAL
ISP

sarah@downeast.com