Lecture 3

History of Digital Communication

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The Computer as a Universal Personal Communication Manager

The Inseparable Story of the Internet and the Web
- The ARPANET
- The Internet Goes Public
- The WWW Revolutionizes the Internet
- Web 2.0 and the Semantic Web – The Future of the WWW
Developments in the past twenty-five years have allowed the computer the capabilities of processing analog, acoustic or optical information. But first with the advent of the Internet and WWW did the computer come to the forefront as a medium offering the integrative transport of multimedia information.
Fig. 2.18 The personified arithmetic (Arithmetica) with Pythagoras (left) and Boethius (right), as they carry on a contest of calculation using the abacus and modern Arabic numerals (1504).
Fig. 2.19 Conceptual sketches for Charles Babbage’ Difference Engine (1833).
The Computer as a Universal Personal Communication Manager

Fig. 2.21 ENIAC – the first completely electronic digital, universal computer.
The Computer as a Universal Personal Communication Manager

The Five Generations of the Modern Computer

First Generation (1945 – 1956)
The development of the modern computer started at the beginning of World War II. It was based on the efforts of individual governments in the hope of gaining a strategic advantage. The machine commands and work instructions implemented in computers of this first generation were especially designed for the specific purpose of the computer. Every computer had a different set of instructions (machine code), which was binary coded in different ways. This made programming a costly and time-consuming endeavor. Basic technology in computers of the first generation were: vacuum tubes, punch cards, and magnetic drum memory storage.

Second Generation (1956 – 1963)
The 1947 transistor revolutionized the design and development of the computer. Computers constructed on the basis of a transistor were more reliable, more energy efficient and smaller than their tube predecessors. With the second generation of the computer, programming languages, such as COBOL or FORTRAN made their debut. Programming turned out to be much easier now than with cryptic machine code. Computers allowed only so-called batch processing, i.e., the jobs to be processed could only be done individually, one after another. With its cost significantly lowered, the computer was gaining a foothold in the business world. Punch cards continued to be used for input and output but now magnetic tape was used as well.
The Computer as a Universal Personal Communication Manager

**Third Generation (1964 – 1971)**
While transistors had clear advantages over vacuum tube technology, the surplus heat they produced was often so great that it damaged the computer. In the next step of miniaturization and with the introduction of integrated switching circuits, a much larger number of switching elements could be built in a much smaller space and implemented in a more energy efficient way. As a result the computer became more powerful, smaller and also cheaper. Operating systems were simultaneously developed that allowed a multiprogram operation. In this way, different jobs could be processed at the same time using the computer’s resources.

**Fourth Generation (1971 – present)**
Since the development of the first microprocessor, miniaturization has continued to advance rapidly. The high integration (VLSI – Very Large Scale Integration) at the beginning of the 80s, and the subsequent ULSI (Ultra Large Scale Integration), allow for the possibility of millions of transistors on a single integrated switching circuit. Due to the steady drop in prices computers entered private households in the form of the PC. The easy to use graphical interface makes it possible for even a layperson to operate a computer. Internet and local networks enter the computer world.

**Fifth Generation (present – )**
The end of the 80s saw the fifth generation of computers developed further in terms of artificial intelligence as well as the arrival of the super computer. This development is characterized by a parallelization of computation in multi-processor systems combined with speech recognition and natural language understanding.
The Inseparable Story of the Internet and the Web

◦ The ARPANET
◦ The Internet Goes Public
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◦ Web 2.0 and the Semantic Web – The Future of the WWW
ARPANET was developed during the cold war in 1969. It was named after its sponsor the American government authority (ARPA).

Different American universities were involved from the onset in the basic research.

ARPANET was soon split up into a subnetwork, one area used purely for military purposes and another area used for civilian scientific communication.

The civilian section developed rapidly, especially after the National Science Foundation (NSF) began supporting its own high speed network between American universities and research institutions (NSFNET).

As a result, the original ARPANET gradually lost its importance and was finally deactivated in 1989. The NSFNET become the new, central backbone of the Internet as we know it today.
The ARPANET

*Interface Message Processors (IMP)*

Fig. 2.22 ARPANET – network model with communication subnet.
There are **two primary reasons** for the Internet’s triumph as a mass communication medium.

- the opening of the new medium for the general public
- the provision of a simple user interface – the WWW browser.

The valid network protocol of the ARPANET – NCP changed to the new protocol family **TCP/IP**.

The three basic protocols of the TCP/IP protocol family are:
- IP (Internet Protocol)
- TCP (Transmission Control Protocol)
- ICMP (Internet Control Message Protocol)
Internet Design Principles

In 1974, Vinton Cerf and Robert Kahn publish architectural principles known as **Open Network Architecture**. These principles remain the foundation of today’s Internet:

**Minimalism and autonomy:** A network should be able to work in autonomously. No internal modifications should be necessary in order to link to other networks.

**Best possible service:** Crosslinked networks are designed to offer the best possible service from one terminal to another. So that reliable communication can be guaranteed, corrupted or lost messages are retransmitted by the sender.

**Stateless switching computer:** The switching computer in crosslinked networks should not store or process information on the state of an existing network.

**Decentralized control:** There should be no global control over individual crosslinked networks. Organization is carried out in a decentralized manner.
A great number of computer science institutes at American universities used UNIX as their computer operating system, in particular BSD-UNIX.

The development and spread of the operating system UNIX also played an instrumental role in the expansion of TCP/IP and in contributing to the popularity of the Internet.

Now a days, almost the whole internet is run by the Linux (a clone of UNIX).
The World Wide Web (WWW) and its easy to use interface, the browser, finally helped the Internet to achieve its legendary success and worldwide dissemination.

The basis of the World Wide Web is the networking of separate documents via what are called hyperlinks. A hyperlink is nothing more than the explicit reference to another document in the web or to another location within the same document.

As long as text-based documents are involved, one speaks of interlinked hypertext documents.
## The WWW Revolutionizes the Internet

### Table 2.5 The History of the World Wide Web

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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<tbody>
<tr>
<td>1945</td>
<td>Vannevar Bush describes the first hypertext system, Memex</td>
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<td>1965</td>
<td>Ted Nelson is the first to coin the word <strong>Hypertext</strong> at the ACM yearly conference</td>
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<td>1968</td>
<td>Douglas Engelbart develops a hypertext-based prototype system NLS and invents the mouse as its input device</td>
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<td>1980</td>
<td>Tim Berners-Lee writes a first notebook program (ENQUIRE) with hypertext links</td>
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<td>1989</td>
<td>Tim Berners-Lee writes a first memorandum about his documentation management system at the nuclear research center CERN</td>
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<tr>
<td>1990</td>
<td>Together with Robert Cailliau, Tim Berners-Lee develops the first WWW server and WWW browser: the WorldWideWeb is born</td>
</tr>
<tr>
<td>1993</td>
<td>NCSA Mosaic, the first WWW browser with graphic user interface introduced</td>
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<tr>
<td>1994</td>
<td>Netscape is founded</td>
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<tr>
<td>1994</td>
<td>The World Wide Web Consortium (W3C) is founded</td>
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<tr>
<td>1995</td>
<td>Microsoft debuts its operating system Windows95 together with the Internet Explorer as WWW browser</td>
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<tr>
<td>1998</td>
<td>Netscape is sold as AOL, the browser war comes to an end</td>
</tr>
<tr>
<td>2004</td>
<td>Dale Daugherty and Tim O’Reilly coin the term Web 2.0 and speak of a rebirth of the WWW</td>
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Table 2.6  The WWW – how it all began

<table>
<thead>
<tr>
<th>First WWW server in the world:</th>
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<tr>
<td>nxoc01.cern.ch</td>
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<table>
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<tr>
<th>First WWW page in the world:</th>
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<tbody>
<tr>
<td><a href="http://nxoc01.cern.ch/hypertext/WWW/TheProject.html">http://nxoc01.cern.ch/hypertext/WWW/TheProject.html</a></td>
</tr>
</tbody>
</table>
Fig. 2.24 WorldWideWeb – the first web browser for the WWW.
At the end of the 1990s the first attempts were made toward developing WWW accessibility on mobile devices and cell phones.

This variation of WWW data traffic could only find gradual success, due in part to the poor quality of the respective mobile user interface. Mobile devices as such offer a relatively small display for the WWW contents. Tight limitations were also set on mobile WWW traffic due to narrow bandwidths and weak display technology.

Today however advanced miniaturization and fast mobile networks of the third generation allow nearly comparable operation in the mobile area.
With the arrival of e-commerce, the focus of the WWW changed from a personal communication and publication medium for specialists to one of the mass communication.

Blogs, chatrooms, file sharing, tagging systems and wikis have conquered the WWW and opened up paths to the user leading to genuine interaction and participation in the digital world on a broad basis.

Tim O'Reilly presented the changed face of WWW, under the name Web 2.0.

The Internet has been transformed from a pure broadcast medium into a genuine interactive market place. The user is the information consumer and the information producer at the same time. This new interactivity also allows for the direct and indirect formation of new social networks.
Search engines, such as Google, were developed to lead the user through the mass of information in the WWW. For this purpose, Google manages a gigantic index that provides comprehensive access to the relevant web document in a matter of seconds, on input of a search word.

However, the result list only contains documents in which this term appears literally. In this way, *paraphrases and synonyms cannot be found*.

To do this it would be necessary to systematically supplement the web document with the relevant meaningful data (so-called *metadata*).
Web 2.0 and the Semantic Web

The Future of the WWW

The *Semantic Web* describes an expansion of the existing World Wide Web. In the Semantic Web every piece of information receives a well-defined and machine-readable meaning that enables programs acting autonomously to interpret the information contents and, based on this, to make decisions. The concept of the Semantic Web is rooted in a proposal by WWW founder Tim Berners-Lee.

This *semantic network* (Semantic Web) represents the next step in the evolution of the WWW and it is about to become a reality.