Chapter 1

Networks— An Introduction (Excerpt)

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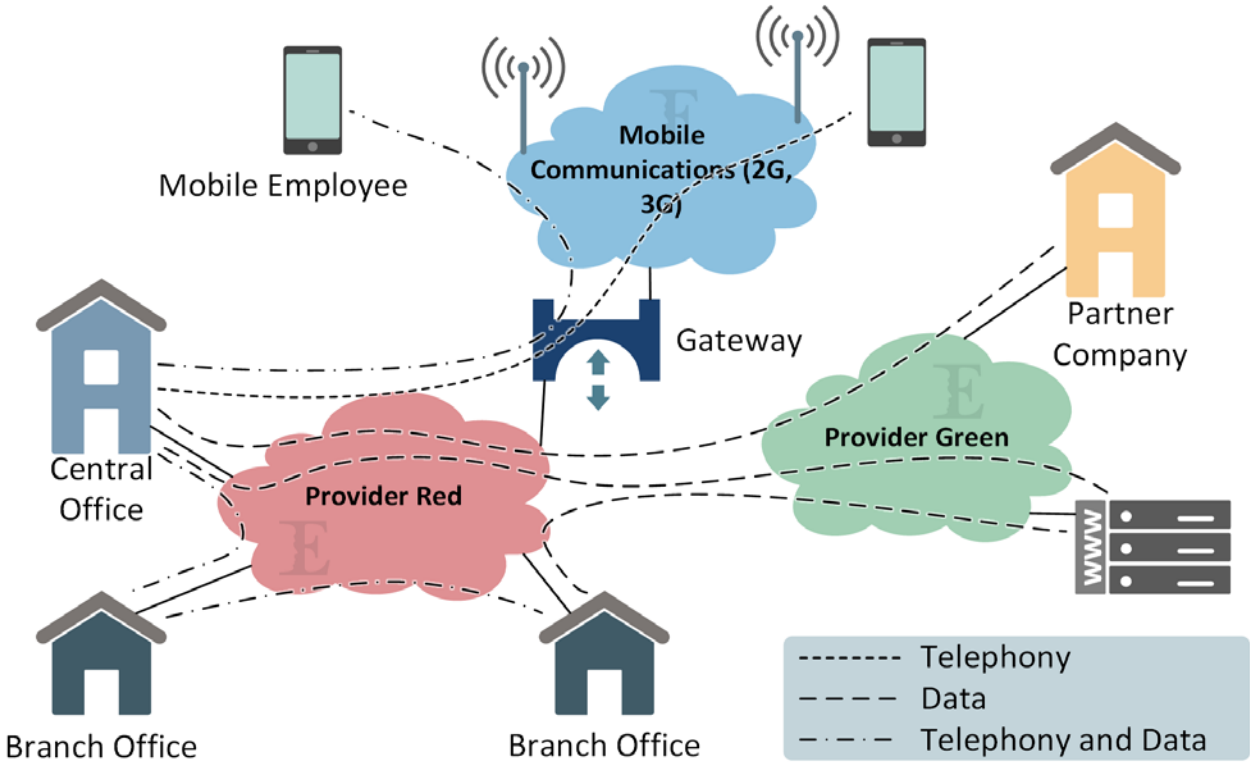
1.1 A Typical Scenario: Corporate Network



- Inter- and intra-site data streams
- Communication with partners and mobile workers
- Diversity: voice, data, and video, if required

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A Typical Scenario: Corporate Network

Headquarters and Branch Offices

A company with several branch offices shall serve as an example of the network technology world. There is a head office, several branch offices, and mobile workers.

Data Streams

Data streams are flowing between the different sites. Employees located in the various branches access central servers and databases. Mobile workers using smart phones or laptops also require fair access to the central servers. Data needs to be streamed within the sites to allow information to flow from the workstations to the servers, printers, and other end devices.

External Destinations

Apart from company-internal data streams, streams to external destinations are also needed. The company operates a shared supplier platform for e-trade with its partners, and access to Web servers is needed for research purposes. E-mail traffic with customers and partners is indispensable for business relations.

Telephony and Video

Telephony makes yet more demands on the network, both within the sites, between the sites, and to external destinations. If required, it can be supplemented by video-communication—be it for video-conferences, for education or monitoring purposes.

Provider

The infrastructure for long-distance communication is set up by network providers. Their minimum service comprises the transport of all kinds of data streams (telephony and video included). Various providers are interlinked—depending on the technology, with or without gateway as translator.

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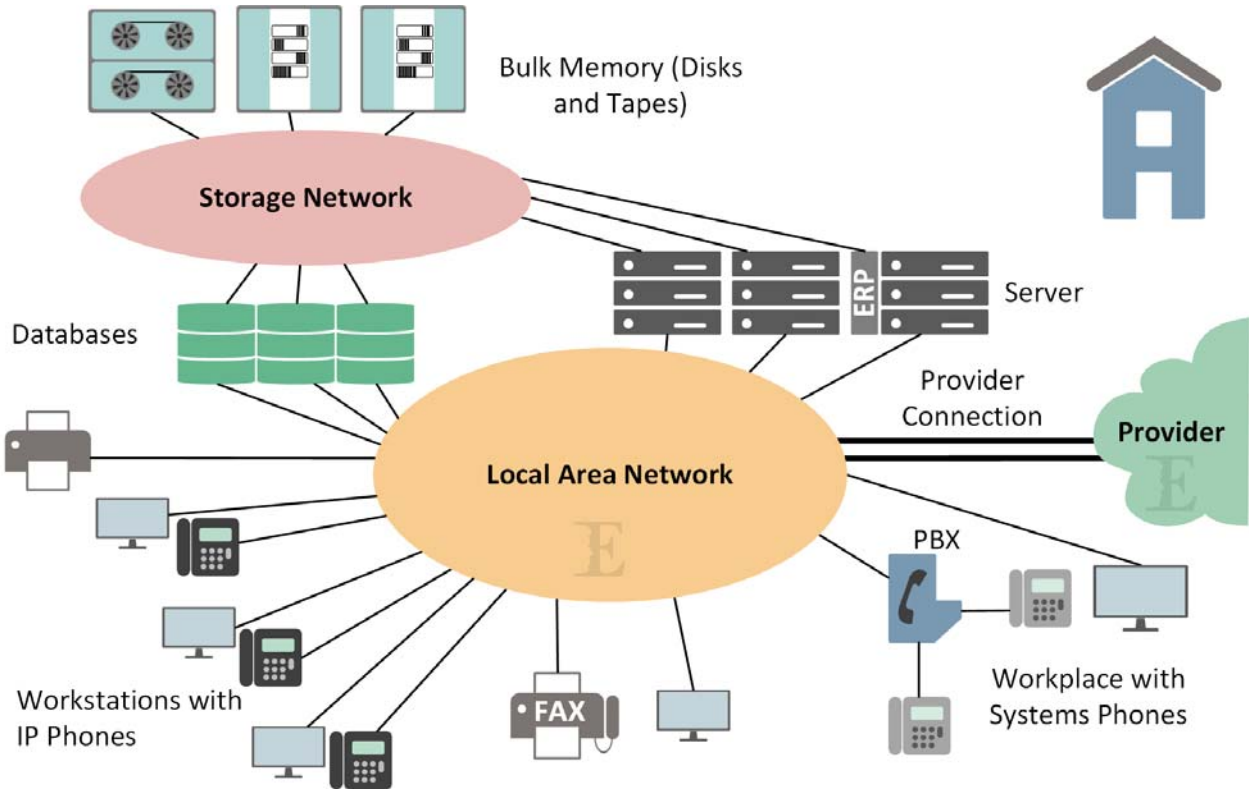
1.1.1 The Head Office



- **Workstations with telephones, PCs, and peripheral devices (printer, fax)**
- **Servers and databases**
- **Mass storage**
- **Redundant provider connection**

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The Head Office

Databases, Servers, etc.

The head office commonly houses databases, servers, and mass storage devices. The databases may, for instance, include the data inventory needed by Enterprise Resource Planning (ERP) systems, such as SAP or Oracle.

Workstations and LAN

Furthermore, there are workstations equipped with PCs, telephones, and peripheral devices, such as printers, copy machines, scanners or fax machines. The head office requires an infrastructure able to cope with data streams between the PCs, the servers and databases as well as the peripheral devices. Such an infrastructure is called LAN (Local Area Network).

Telephony

Telephony can be integrated into the LAN; in that case, the infrastructure expects the telephones to behave much like PCs. This is also called Voice over IP (VoIP). Telephony can, however, also be implemented separately using conventional PBX (Private Branch Exchange) systems.

SAN

Mass storage—such as business correspondence archives—makes special demands on the infrastructure. In many cases, an independent network dedicated solely to this purpose is created: a Storage Area Network (SAN).

Provider Connection

The connection between the head office and the provider(s) constitutes the company's linchpin for two reasons: Firstly, it has to be highly available and offer high performance to guarantee communication with branch offices, customers, and partners at all times. And secondly, a high level of security needs to be maintained to ward off any unauthorized access from outside. The connection is often set up using leased lines.

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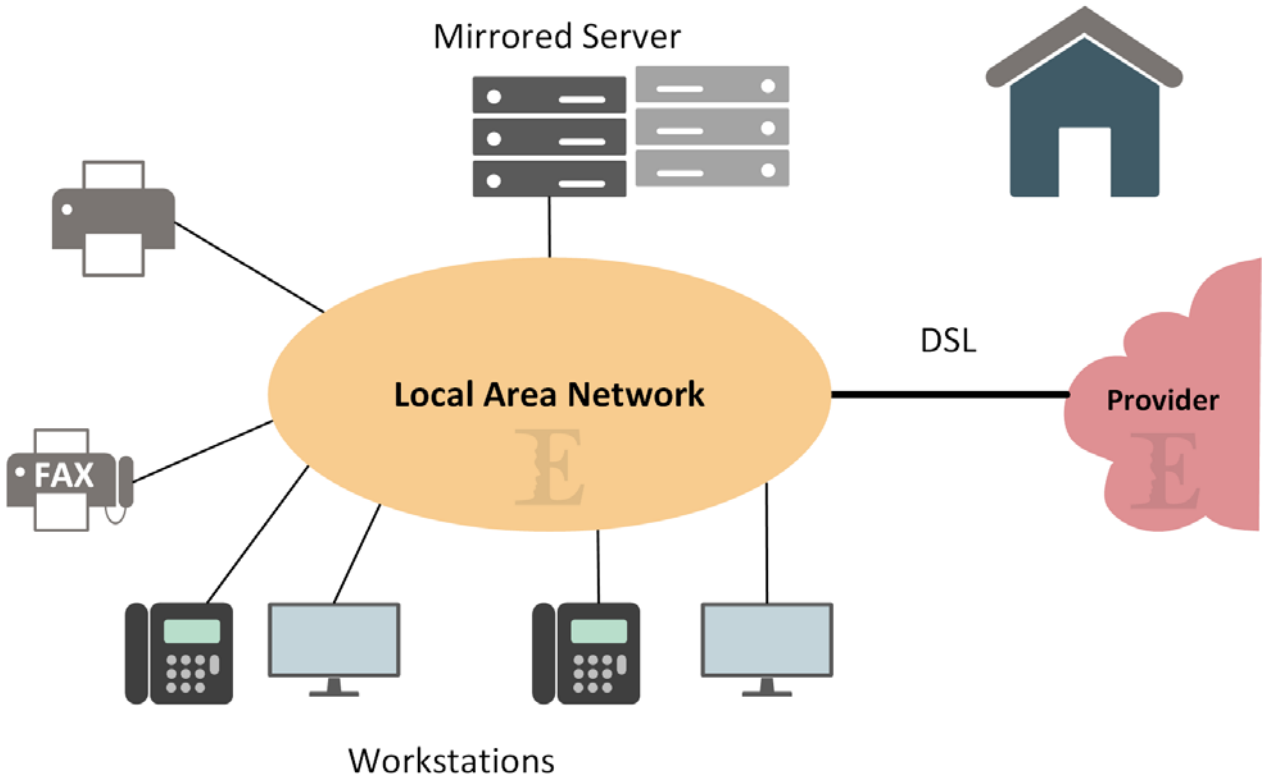
1.1.2 The Branch Offices



- Also workstations with telephones, PCs, and peripheral devices
- Some servers may be mirrored.
- Often large number of branch offices
- Provider connection therefore under strong cost pressure
- DSL as a cost-efficient option

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The Branch Offices

Similarities and Differences

The branch office infrastructure does not differ radically from the one at the head office. There are some differences in the detail, though.

No SAN

Mass storage is usually not found in the branch offices, making SANs unneeded.

Mirrored Servers

There are usually no independent servers in the branch offices, but in some cases it might be favorable for overall performance to provide mirrored versions of some servers located at the head office. In that case, workplace PC and server communicate on a local level, while the local server automatically synchronizes its data with its counterpart at HQ.

Workstations and LAN

Just like at the company's head office, a LAN is needed to inter-connect the workstations. The company's strategy will decide whether to connect the telephones directly to the LAN or to set up a PBX.

DSL Connection

The branch offices are usually connected to the provider in a much more cost- and time-efficient manner than the head office. The more branches that need to be connected, the more important the cost minimization for each connection becomes. A connection breakdown will be tolerated as long as it doesn't happen too often. DSL has become the most popular choice.

External Communication

Company policies determine the manner in which external communication (be it data or voice) is to be realized. Both centralized and decentralized solutions are conceivable.

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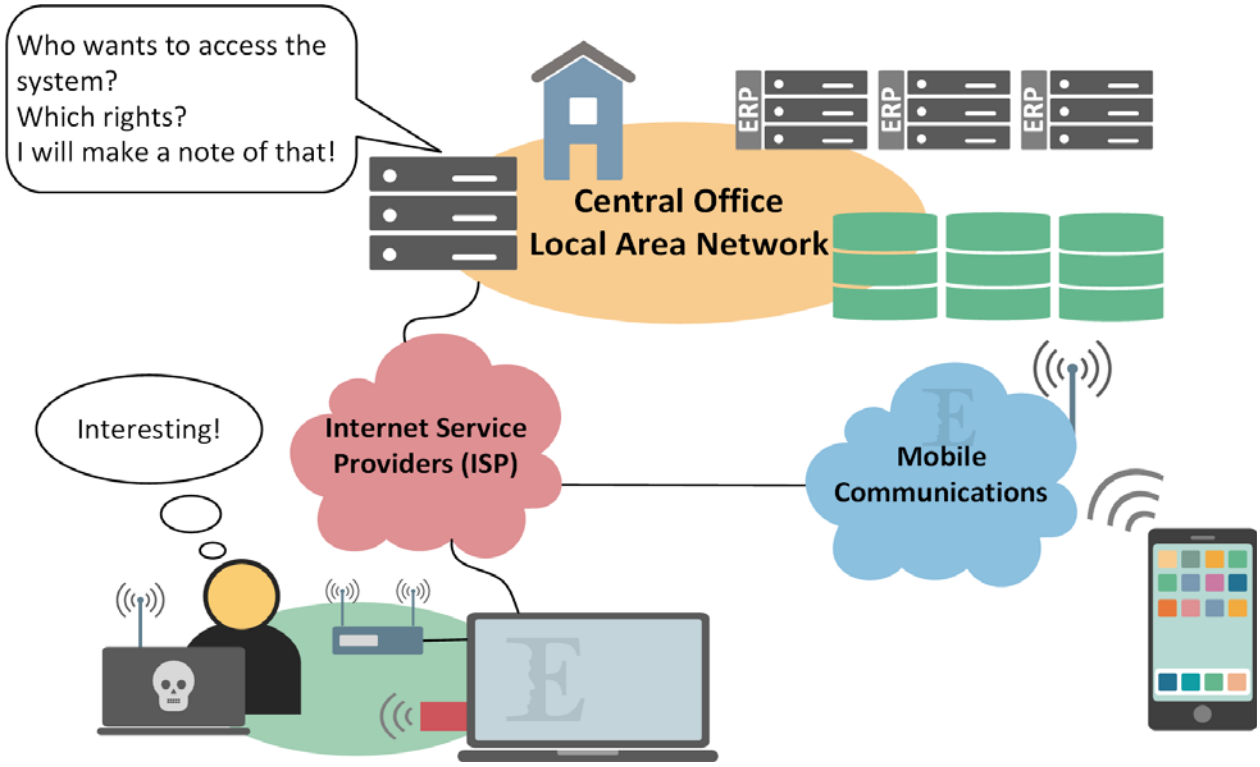
1.1.3 Mobile Workers



- Laptop, smart phone over telephone network, mobile radio or WLAN
- Central topic: security
- At the head office:
  - Authentication (who?)
  - Authorization (which rights?)
  - Accounting

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Mobile Workers

No Permanently Assigned Workplace

Field workers who spend a large part of their work day away from their assigned workstations need reliable and at the same time secure access to the central servers.

Laptops, Smart Phones

Laptops or smart phones are suited as end devices. The provider connection is set up via the telephone network, Wireless LAN (WLAN) or via mobile radio communications. Flexibility is desirable—depending on where the user is located, the most cost-efficient and at the same time most high-performance connection is to be set up.

In Focus: Security

Particular attention needs to be paid to the security aspect. If the end device is stolen, the thief must be prevented from obtaining valuable or confidential data or access to the corporate network at all costs.

Wireless?

If wireless technologies are used, care must be taken to ensure that no eavesdropper gets to read any confidential data.

Check in the Head Office

If the end device of the mobile worker contacts the head office, the identity of the caller needs to be authenticated, and the caller's user rights need to be assigned (authorization). For several reasons, an accounting system is desirable to keep track of who communicated with whom, from where, when, and for how long. Head office administrators have to make appropriate arrangements for this.

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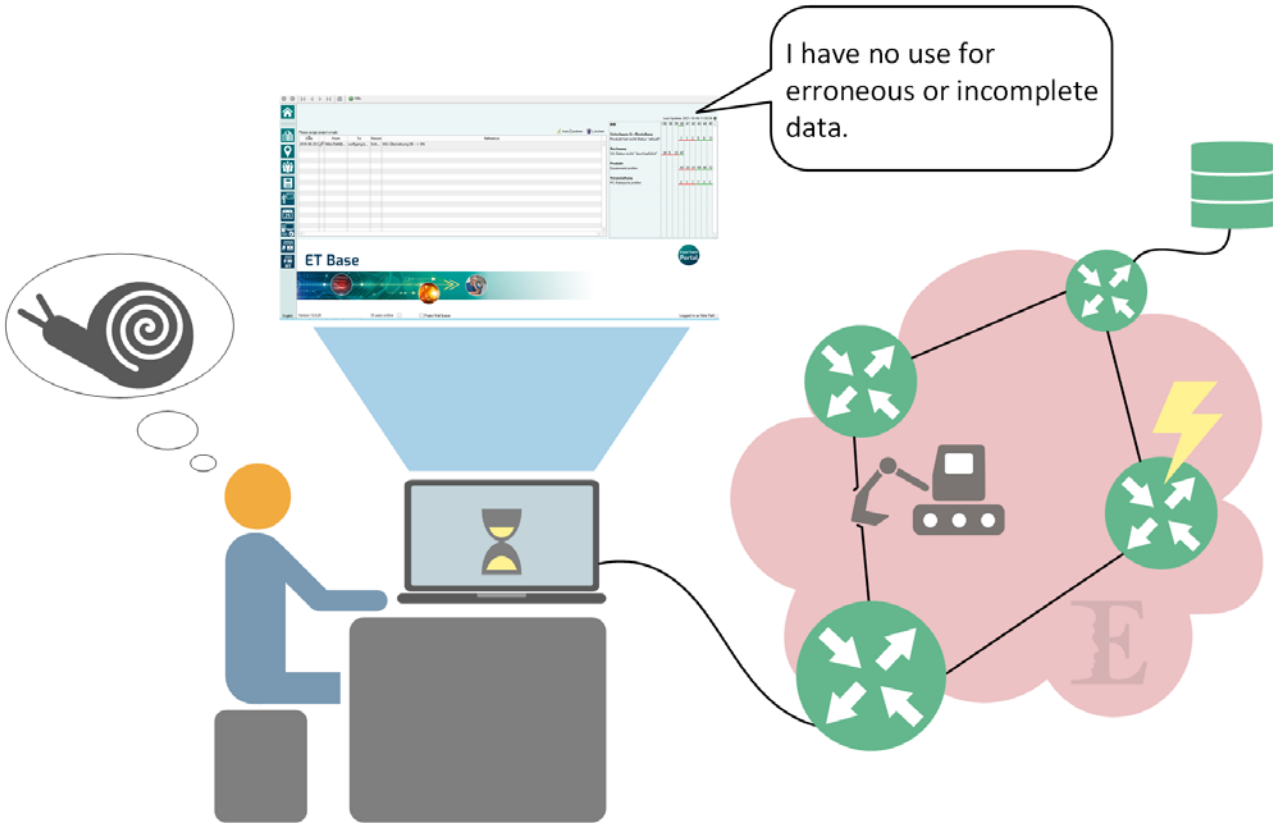
1.2 Applications and Requirements



- **Why connect devices and sites?**
- **The real objective: to enable applications to communicate**
- **Different applications make different demands on the network.**
- **User satisfaction is crucial.**

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Applications and Requirements

Sites? Devices?

Why take pains to inter-connect sites and to inter-connect devices within those sites? The question appears superfluous: To allow the devices to communicate with each other, of course. The following question is legitimate, however: What are the benefits of having devices communicate with each other? In most cases, the device itself is not as important as the application running on it.

Applications!

Applications may, for instance, include:

- browser,
- office software,
- ERP systems,
- telephony,
- video conference,
- access to file servers,
- databases,
- games, or
- e-mail.

Requirements

Different applications make different demands on the network design. These requirements are sometimes founded directly in an application's character, sometimes in the needs of the human user behind it.

The Application and the User

Database requests stipulate that transmission errors cannot be tolerated. Data displayed by the database must not have been falsified on its way through the network. For an application to function, the speed of the reply is less important to a certain extent. It might be the decisive criterion for an impatient user, however.

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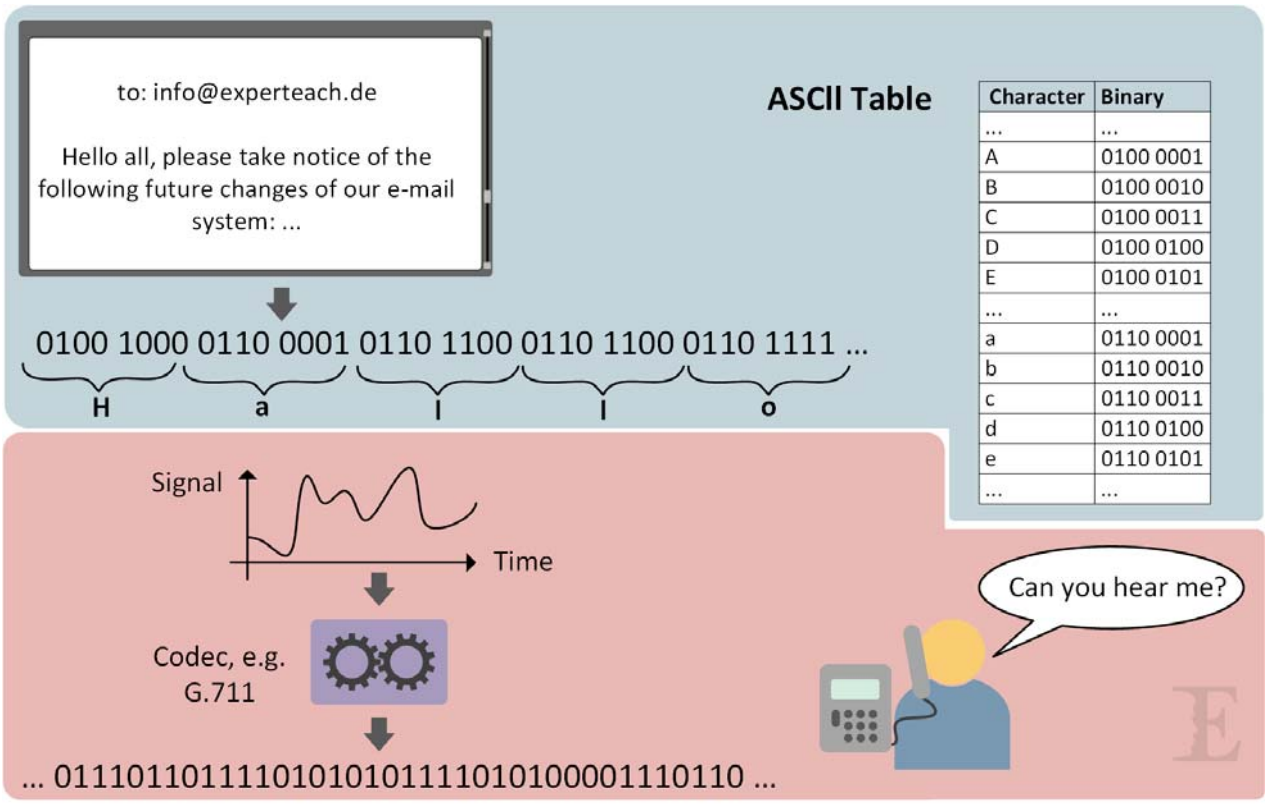
The Prerequisite of Modern Networks: All-Digital



- **Modern networks transport voice and data in digital format only.**
- **Applications using analog source data need to digitize them.**
- **The network transports bits only (ones and zeros).**

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The Prerequisite of Modern Networks: All-Digital

Analog: Any Value Is Permitted

Some applications deliver their raw data in digital format, others in analog format. Analog data means that within a certain value range, parameters can have any interim value. Music is an example for this: Within certain boundaries, any pitch or volume is possible.

Digital: Discrete Values Only

Digital data have a discrete value stock. An example for an application with digital raw data would be e-mail. There is a clearly defined character set available for writing texts. Interim values are not possible.

Why Digital Only?

A final decision has been made in network technologies. Digital data is the only kind of data that is transported. Before being transported, however, it is translated into a binary signal. A binary signal is a sequence of bits—i.e. of ones and zeros. The reason for the limitation to binary signals can be explained in a simple way: they are particularly easy to transfer. They are easy to amplify, and noise can easily be filtered out. If you need proof, simply compare the sound of a dusty vinyl record with that of a dusty CD. If you turn up the volume, the noise on the vinyl record is amplified as well, whereas the CD does not have any noise level at all.

Digitization

Analog applications that want to use a digital network must first digitize their raw data. This can be done either in the end device (example: ISDN telephone), through an intermediate device (example: ISDN PBX with analog subscriber lines or Terminal Adapter, TA) or even at the network port (increasingly uncommon, example: ISDN PBX with analog subscriber line).

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Typical Applications

Mass Data	Delay	Jitter	Bitrate	Monitoring of Errors (Error /Loss)
E-Mail	–	–	••	•••/•••
File Transfer	–	–	••	•••/•••
Backups	–	–	••	•••/•••
Data, interactive				
WWW	–	–	•	•••/•••
Citrix	••	•	••	•••/•••
Database	••	•	••	•••/•••
SAP	••	•	••	•••/•••
Streaming				
Web Radio	•	••	•••	•/••
IP TV	•	••	•••	•• /•••
Video on Demand	•	••	•••	•• /•••
Real Time				
Telephony	•••	•••	•••	•/••
Video Conferencing	•••	•••	•••	•/••

Legend:

– : does not have to be monitored
•: should be monitored
••: has to be monitored
•••: has to be stricty monitored

- **Delay and jitter: time requirements**
- **Bit rate: data rate requirements (bandwidth)**
- **Error: falsified data**
- **Loss: lost data**

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Typical Applications

Standard Parameters

If we examine the requirements applications make on the network, we will keep finding just a handful of parameters that applications are sensitive to:

- Delay: What is the transit time of data through the network?
- Jitter: Does the delay remain constant, or does it change?
- Bit rate (often falsely called bandwidth): What is the data throughput?
- Bit error: Has the data been modified?
- Loss: Has everything arrived?

Example: SAP

An ERP application such as SAP is interactive by nature. Experiencing long delays is unpleasant for the user. The delay of the data is therefore an important issue. Since a certain transaction always moves a certain volume of data, the bit rate needs to be controlled to avoid delays. It is of great importance that all data arrive error-free. Users want to be able to rely on the transactions they perform.

Telephony

The dialog nature of the telephony application demands that delay and jitter be very low. It would be unacceptable for subscribers if the network were to cause noticeable or even different delays from one word to the next. If the detection of speech pauses feature is not used, telephony creates a continuous stream of data at a constant bit rate. That is why the bit rate in the network must be strictly controlled (i. e. guaranteed). The human ear would not notice individual bit errors—their frequency must be limited, though. Missing data may cause audible interferences or even lead to a connection breakdown.

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