Introduction to telecommunication systems

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Survey Nr. 27

Course: INTRODUCTORY SEMESTER 1991
Telecommunication Engineering

Subject: Introduction to Telecommunication Systems

Lecturer: Prof. Ir. C. de Jong

Surveyed by: Mr. B. Nagy

Copy:
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I. Introduction

The main objective of the course is to show the historical evolution of telecommunications in big steps, help to understand how communication systems and equipments work, to give a little help in crossroads of standards, expressions and network solutions. We are very close to the true saying telecommunications rule the world.

Somebody may ask what the telecommunications are? In common words we may answer that telecommunications mean the transportation (electronic transport in most cases) of information (or signals), while information may be:

- speech/voice
- video/image
- data
- text

This is not the exact definition of telecommunications (as you can read later on).

Because telecommunications also consist of many subparts we can take a look at the same problems from different viewpoints. Just to mention some of the aspects:

- technical
- economical/commercial
- legal/regulation
- management
- organizational

Society is the almost important point for the existence of Telecommunications (later TT). Without society we cannot talk about telecommunications, because it is the most needed (but not the only one) aspect when talking about TT.

Telecommunications of our days made by the combinations of two flows
- voice transmission and networks/telephony
- computer science/computer networks

Untill 1960 we can speak only about the voice transmission. First both technologies must have reached a certain level of evolution to realize the advantages of mutual cooperation.

In the 50-s no combination of the two technologies really existed. The necessity of data transfer between two computers or communication between a remote terminal and the central computer introduced some technological inconvenience in the 60-s. For the computer scientists the best way to overcome this was to use lines of the telephone network. The latest
achievement in TT is the ISDN system (Integrated Services Data Network) which unites separate networks into one for any type of information we need.

Following the last sentence we can understand the world Telematics. Telematics stand for Telecommunication and Informatics. In other words, it is a merging of transmission and information science.

In Fig. 1.1 we can see the simple presentation of the modern TT system. It consists of a central switching system and subnetworks with terminals. Thus communication between different terminals is possible via subnetworks and a central switching system.

The change of information may be realized between

- man - man (telephone)
- man - machine (terminal-computers)
- machine - machine (EDI) (Fig. 1.2)

Communication can be realized on networks based on:

- wires
- radio waves
- satellite systems
- optical fibres

We can split TT equipment into different classes:

- terminals
- switching systems
- transmission systems

TT systems consists of

- trunknetworks
- local lines
- local exchanges
- private/end systems/terminals

Standardised interface between TT system components (or subsystems) overcomes the differences between the network and the terminals. It is easy to understand the task of an interface when we realize that both the input and the output parameters of the network and the terminal respectively have to be strictly defined. The only world-wide accepted standard is the ISDN standard. This standard, however, is starting to be introduced, but is hundred by all the different viewpoints mentioned on page 1. The interface must handle all defined parameters.
Fig. I.1

Introduction to Telecommunication Systems 1991
The way of the signal from the terminal to the other terminal as well as the relation between the subsystems can be seen in Fig. I.3.

**Terminals** - the equipment at the very end of the network.
**R** - interface between terminals and house network.
**Inhuisnet/house network** - the network, we use for internal communications.
**S** - interface (PTT interface).
**Lokale transmissie/local network** or local transmission block. With the help of local network we transport the information from the inhouse net to the local switchboard and vice versa...
**V** - interface.
**Lokale centrale/local switchboard** - switching system for a group of subscribers located in one (small) region.

From the local switchboard signals are transmitted either back to the local networks or into the upper levels (trunk network).

**Trunk Verkeersnetten/Trunknetwork**
The trunknetwork connects the local networks. It consists of transmission- and switching systems. The structure is a connection of area, national, international and intercontinental levels. The levels are connected via switching systems.

We can see a similar situation in Fig. I.4 that concerns the interaction and cooperation between public telecommunication and computernetworking. In this case it becomes obvious where to draw the borderline between the domain networks and the public network. The biggest difference between them is that the domain network belongs to a private organization with the architecture, and signals involved as well as many other attributes of network designed to meet the requirements of the private organization. An important point is that when the private network enters the public network the signals must correspond to the standards, given by CCITT.

Now some words about the rules of architecture in networks. In the pioneer times of networking every manufacturer made his different set of rules which causes no problems if we think in terms of closed networks with subsystems manufactured by the same supplier. Later on the systems became more sophisticated and the users wanted them to be capable of communicating with different systems. Communicating with other systems gave rise to the idea of open systems. When we open the systems and want to connect them with other systems, we must define new rules valid for each system. Fig. I.5 shows an open system interconnection model made by ISO (International Standardization Organization). We can see that the first three layers are separated from the higher ones. The first three levels provide the basic control functions of the network. At the higher levels we define the control functions for the information hardly.
LOCAL DOMAIN

LOCAL DOMAIN

LOCAL DOMAIN

DCN = DOMAIN COMMUNICATION NETWORK

TELECOM CENTRE

COMPUTING CENTRE

PRIVATE DOMAIN

PCN = PUBLIC COMMUNICATION NETWORK

TC

CC

LD

LD

TC

CC

LD

LD

PUBLIC DOMAIN

PTT'S

DIAGRAM 1
Open system interconnection model
van ISO

ISO = International Standardisation Organization

Fig. I.5

Introduction to Telecommunication Systems 1991
Layer 1  - physical  - includes transmission of signals and the activation and
deactivation of physical connections.

Layer 2  - link  - includes synchronization and some controls over the
influence of errors within the physical layer.

Layer 3  - network  - includes routing and switching but not the inhouse-
network. It is the interface (when public networks are used) between public- and inhouse-network.

The example of Fig. 5 concerns a packet-switched network based on CCITT standard x 25.

Layer 4  - transport  - user layers 1 to 3 to provide end to end services
between terminals with the required characteristics for the higher
layers.

Layer 5  - session  - allows presentation entities to organise and synchronise
their dialogue and to manage their data exchange.

Layer 6  - presentation  - includes data formats and code conversion.

Layer 7  - application  - provides the means by which the user programs
access the OSI environment and may contain part of these user
programs.

Fig. I.6 shows the way we must imagine the work of the seven layers in
practice. Every level provides its special functions to handle information and
control of information flow. Fig. I.8 shows two types of information exchange
in the light of O.S.I, layer 4
- multiplexing - the multiple input signals are directed to the intended services
- splitting - one output signal proceeds to more outputs to receive the same
information.

Fig. I.7 shows the path of signal in the TT system. When it gets out of the end
system (where control functions for all layers are provided) it proceeds into
the first three layers. The relay systems provide control only over network, link
and physical part, making them hold their values in the defined regions.

Summarizing the information flow control can be seen in Fig. I.9. Be aware
that this diagram reflects the old manufacturers viewpoint: there is no
distinction/interface between inhouse network and public networks. The
network as a whole makes only use of leased lines and not of the switching
functions in the public network.

Fig. I.10 shows service terms of layers.
Higher layers (4 to 7) depend on the type of service. The lower levels depend
on the type of public network: telephone/data network - circuit
switched/ backed switched. The difference between various levels from the
commercial point of view can be seen in Fig. I.11. But we must be aware that
the the contrasts between K3 and K2 and K2 and K1 respectively have to
Introduction to Telecommunication Systems 1991
<table>
<thead>
<tr>
<th>INFO</th>
<th>EDI, ETC</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>ELECTRONIC MAIL</td>
</tr>
<tr>
<td>6</td>
<td>VIDEO TEX</td>
</tr>
<tr>
<td>5</td>
<td>TELETEX</td>
</tr>
<tr>
<td>4</td>
<td>&quot; &quot;</td>
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<thead>
<tr>
<th>DOEL: DIENST VERLENNING</th>
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<td>3</td>
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<table>
<thead>
<tr>
<th>DOEL: VERKEER</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

TELEFOON NET - TELEX - DATA - HUURLIJN - SATELLIET
HISTORIE:
- Grens \( K_3/K_2 \) en \( K_2/K_1 \) diffuus
- Onduidelijke markt => "handel"
Figure 5: Technische EDI-Infrastructuur
become clearer is to stimulate market activities. There is an important commercial difference between:
- network operators
- informative providers
- telematic services providers.

Fig. I.12 shows a chart of EDI infrastructure.
Bedrijfsfunctie - economic function
Applicatiegegevens - application data
Bericht processor - ward processor
Electronische postbus - electronic mail.
Assignment: relate the OSI-model with this model

Types of traffic

a) conversation (telephone call)

b) broadcast (TV, radio broadcast)

c) consultation (database)
The information is sent from the basis system to the user upon his request.

d) registration (telemetering)
We collect data into the basis system from different points.
Now we will show some examples on the types of information traffic.

Fig. 1.13 is a database network where we may ask for information from a central system (in this case especially from a Viditel network).

Fig. 1.14 shows possible structures of the CATV-network (cable television) where we build a tree down to the simple users. The CATV-network is a network parallel at the PTT-networks, sometimes there is competition.

Fig. 1.15 shows that we can define users in the same system who use it for the registration of traffic (give information to the central system) and users who use this information. (Thus they use the system for the consultation of traffic.) It is applicable to the Videotex service.

Definitions:

Public

An attribute indicating that the application of the so qualified item, e.g. a network, a unit of equipment, a service, is offered to the general public.

Note:
The term does not include legal or regulatory aspects, nor does it indicate any aspects of ownership.

Private

An attribute indicating that the application of the so qualified item, e.g. a network, a unit of equipment, a service, is offered to or is in the interest of a determined set of users.

Note:
The term does not include legal or regulatory aspects, nor does it indicate any aspects of ownership.

Telecommunication Network

All the means of providing telecommunication services between a number of locations where the services are accessed via equipment attached to the network.
cascade van truckversterkers (repeaters) ≤1200 m

cascade structuur (recouversie) wijkcentrum ≤8 uitgangen

KOPSTATION

2
3
4
n

tap n<50

lokaal verdeelnet (LVN)

groepversterker 2 uitgangen

eindversterker 2 uitgangen

≤ ca. 350 m

groepversterker 2 uitgangen

eindversterker 2 uitgangen

1*12 + 2*8 mini-ster

3*12 mini-ster

3*8 mini-ster

= splitter

CATV-net
Telecommunicatie-net

Informatie-leveranciers

Dienstenaanbieder

Telecommunicatie-net

Informatie-gebruikers

registratie

videotex

consultatie
Figure 1.16 is a block chart of the Videoex system and the connection between TV-televised home information terminal, PC, etc. Be aware there are three modes of making use of the CATV and subsystems (or also more ways for the information stream to get to the home...
Private Telecommunication Network Exchange PTNX

A nodal entity in a private telecommunication network which provides autonomous and automatic switching and call handling functions used for the provision of telecommunication services which are based on the definitions for those of the public ISDN.

Note 1:
If applicable, PTNX provides:
- telecommunication services within its own area and/or
- telecommunication services from the public ISDN and/or
- telecommunication services of other public or private networks and/or
- within the context of a private telecommunication network,
  telecommunication services from other private telecommunication network exchanges
to users of the same and/or other private telecommunication network exchanges.

Note 2:
A PTNX may be represented by an ISPBX, or by equipment which is physically part of the equipment of a Public ISDN, e.g. public local exchange. The functions of such equipment are still considered part of the PTN and not part of the public ISDN.

Integrated Services Private Branch Exchange

An implementation of a private telecommunication network exchange located on the premises of a private network operator.

Integrated Services Centrex

An implementation of a private telecommunication network exchange that is not located on the premises of the private network operator. It may be co-located with or physically part of a public ISDN local exchange.

Terminal equipment: terminal

An item of equipment attached to a telecommunication network to provide access for a user to one or more services.

Link

A means of telecommunication with specified characteristics between two points. (Reference: IEC 50 chapter 715 item 01-04)

User

Introduction to Telecommunication Systems 1991
An entity using a terminal equipment.

Note:
A user may be a person or an application process.

Private Network Operator

An authority responsible for the provision and management of a private telecommunication network.

Port

A point of a telecommunication equipment where an access link can be attached.

Intervening network

Any means of providing inter-PTNX connections for the purpose of interconnecting two or more PTNXs.

Note:
Examples of an intervening network are dedicated transmission systems and public ISDN.

Connection

An association of transmission channels or telecommunication circuits, switching and other functional units, set up to provide for the transfer of information between two or more points in a telecommunication network.

Note:
The connection may be established on a temporary, semi-permanent or permanent basis.

Inter-PTNX Connection

A connection between two PTNXs of (a) private telecommunication network(s).

Note:
An inter-PTNX connection is provided by an intervening network.
Telecommunication

Any transmission and/or emission and reception of signals representing signs writing, images and sources or intelligence of any nature by wire, radio optical or other electromagnetic systems.

(Red Book Rec.I.112)

Telecommunication network

A set of nodes and links that provides connection between two or more defined points to facilitate telecommunication between them.

(Red Book Rec.I.112)

Telecommunication services

That which is offered by an administration of RPOA to its customers in order to satisfy a specific telecommunication requirement (Bearer service, teleservice).

Bearer service

A type of telecommunication service that provides the capability of transmitting the signals between user-network interfaces.

Teleservice

A type of telecommunication services that provides the complete capability of including terminal equipment functions for communication between users according to protocols established by agreement and/or RPOA.

These definitions are given by CCITT. Compare these definitions with the on OSI based market model which we considered in the foregoing put of this chapter. (Telecommunications in the light of telematic services).
II. Society and telecommunication

Telecommunications and its use reflect to a certain extend some characteristics of a society.

a. First we will show as an example the relation between the density of telephone lines and gross national product (GNP) (Fig. II.1). We can see various countries distributed along the mean line. The telephone lines density of the countries below/above the line is smaller/larger than density appropriate to their GNP, respectively. (The graph is from 1989). The general trend is that the higher the wealth of a country, the higher the density is. Some development plans therefore, formulate aims to reach a density-level over a certain period. I.E. from 10 to 15 in a period of 6 to 8 years. This works only when in the same time also attention is given to other economic aspects as industry, trade, etc. Between economic activities and telecommunication exist a close relation.

Next figure (Fig. II.2) provides information on exploitation of telephone lines. The values show the number of calls per year per subscribers. If a growth of lines exploitation is required one must enlarge the number of services offered and/or stimulate use of the network for normal telephone calls. Canada as well as the USA (Verenigde Staten) show that Germany (West-Duitsland) and Holland can expect grow by stimulating normal telephone use. The high use of Syrie has to do with intensive us by lack of a high density network (Compare countries in Fig. II.1, II.2 and II.3).

Fig. II.3 and II.4 show the number of telephone lines per hundred (thousand) inhabitants. These figures give a more realistic information on development of TT in the countries involved.

b. In the first part we mentioned importance of TT for society. TT’s make life easier and save time for us. All successfull TT services have been based on these facts. Fig. II.5 shows the evolution of some telematic services in the world.

We see that today telephone and television broadcasting development is flattening. Their growth now is not as fast as that of some younger services (teletext, BTX = bildschirmtext = Videotext). Seen from the businesspoint of view the nowadays speechcommunication gives the "big money" for developing other services.
Fig. II.1

Introduction to Telecommunication Systems 1991
<table>
<thead>
<tr>
<th>Land</th>
<th>Aantal gesprekken per abonnee 1991</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zwitserland</td>
<td>870</td>
</tr>
<tr>
<td>Denemarken</td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>1629</td>
</tr>
<tr>
<td>Verenigde Staten</td>
<td></td>
</tr>
<tr>
<td>West-Duitsland</td>
<td>3422</td>
</tr>
<tr>
<td>Australië</td>
<td>1100</td>
</tr>
<tr>
<td>Nederland</td>
<td>1357</td>
</tr>
<tr>
<td>Italië</td>
<td>1025</td>
</tr>
<tr>
<td>Tsjecho Slowakije</td>
<td></td>
</tr>
<tr>
<td>Uruguay</td>
<td>1037</td>
</tr>
<tr>
<td>Oost-Duitsland</td>
<td>3319</td>
</tr>
<tr>
<td>Syrië</td>
<td>2314</td>
</tr>
<tr>
<td>Syrië</td>
<td>1399</td>
</tr>
<tr>
<td>Syrië</td>
<td>1587</td>
</tr>
</tbody>
</table>

*aantal*
One of the biggest problems in IT today is the network. We have nice new services, but sometimes old networks. Problem is that new networks and switching systems are expensive. Figures II.6 to II.8 show us some information on telecommunications costs.

Fig. II.6 - shows countries which spend much money in the TT.

Fig. II.7 - gives information how much the different parts of TT are costs.

Fig. II.8 - shows the same thing from different point of view; gives information the biggest sellers of TT systems.

From these facts we understand how tremendous the TT business is. (We are close to the truth, declaring it the world's business). So, not only the use of the telephone system itself, but also production of telephone equipment and operating a network contributes to the wealth of a country.

Strategic aspects of TT (conditions for profitable telecommunication industry).

A. Support the development of a country (good infrastructure is a good base for (new) services).
B. Stimulates industry because investments in TT are high (very attractive for industry). Investments per subscriber about ~ 2000 $.
C. Profitable business for the operator of the network by good running exploitation
D. Means of transform knowledge (if TT industry is highly developed, many inventions may be used in other parts of industry spin-off).
E. Speed and money saving (if personal contact costs say 120 $, the same contact over telephone costs 40 $, and using even sophisticated telematic services only 3 $.

III. Technical realization of TT

In this section we show the TT technical overview. First we must understand the difference between types of information and their transmission. Fig. III.1 shows a general view on this problem. Horizontal axis gives the transmission (from the simplest form by speech information processing), and the vertical axis shows the size of the class of users (the simplest is the personal media e.g. two students and the complex ones are the massmedia products). We can see that the simplest telecommunication is the spoken word and the most sophisticated ones are the education systems. From the figure we also can see where the evolution of TT is today, as well as the trends for the future.
European telephone development

<table>
<thead>
<tr>
<th>Country</th>
<th>Telephone lines per 100 inhabitants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td></td>
</tr>
<tr>
<td>West Germany</td>
<td></td>
</tr>
<tr>
<td>Luxembourg</td>
<td></td>
</tr>
<tr>
<td>France</td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td></td>
</tr>
<tr>
<td>United Kingdom</td>
<td></td>
</tr>
<tr>
<td>Belgium</td>
<td></td>
</tr>
<tr>
<td>Greece</td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td></td>
</tr>
<tr>
<td>Ireland</td>
<td></td>
</tr>
<tr>
<td>Portugal</td>
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<td>Sweden</td>
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<td>Switzerland</td>
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<tr>
<td>Finland</td>
<td></td>
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<tr>
<td>Norway</td>
<td></td>
</tr>
<tr>
<td>Iceland</td>
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<tr>
<td>Austria</td>
<td></td>
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<tr>
<td>Bulgaria</td>
<td></td>
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<tr>
<td>Yugoslavia</td>
<td></td>
</tr>
<tr>
<td>Czechoslovakia</td>
<td></td>
</tr>
<tr>
<td>East Germany</td>
<td></td>
</tr>
<tr>
<td>USSR</td>
<td></td>
</tr>
<tr>
<td>Hungary</td>
<td></td>
</tr>
<tr>
<td>Poland</td>
<td></td>
</tr>
<tr>
<td>Romania</td>
<td></td>
</tr>
</tbody>
</table>

Source: Yearbook of Public Telecommunication Statistics (Geneva, 1990)

Note: Figures are for 1988, except UK (1987), Bulgaria (1983), United States and USSR (1982), and Romania (1979). Albanian information was not available.
Hoofdaansluitingen per 1000 inwoners in de wereld:

<table>
<thead>
<tr>
<th>Rang</th>
<th>Gebied</th>
<th>Aantal per 1000 inwoners</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Noord-Amerika</td>
<td>520</td>
</tr>
<tr>
<td>2.</td>
<td>Oceanië</td>
<td>434 (Australië en Nieuw Zeeland)</td>
</tr>
<tr>
<td>3.</td>
<td>West-Europa</td>
<td>392 (-Turkije)</td>
</tr>
<tr>
<td>4.</td>
<td>Azië I</td>
<td>344 (Japan, Z-Korea, Taiwan, Singapore, Hong-Kong, Israël)</td>
</tr>
<tr>
<td>5.</td>
<td>Oost-Europa</td>
<td>102</td>
</tr>
<tr>
<td>6.</td>
<td>Latijns-Amerika</td>
<td>56</td>
</tr>
<tr>
<td>7.</td>
<td>Afrika I</td>
<td>37,5 (Zuid-Afrika, Marokko, Algerije, Tunesië, Libië, Egypte)</td>
</tr>
<tr>
<td>8.</td>
<td>Oceanië II</td>
<td>21</td>
</tr>
<tr>
<td>9.</td>
<td>Azië II</td>
<td>9 (+ Turkije)</td>
</tr>
<tr>
<td>10.</td>
<td>Afrika II</td>
<td>3,5</td>
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Gemiddelde 5: 102 (422.000.000 inw.)
Gemiddelde 6-10: 15 (3.736.691.000 inw.)

Bron: NotelocomTIU

Introduction to Telecommunication Systems 1991

Fig. II.4
<table>
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<th>Country</th>
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Source: International Telephony/Market Research

TELEPHONY / JANUARY 22, 1990
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*Source: Arthur D. Little Inc.; estimates.*
Fabrikanten van telecommunicatie apparatuur, gerangschikt naar omzet in 1989 in miljarden dollars.

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Bron: Dataquest.
Mass media

Phonographic record

Advertisement

Newspapers

Education

Radio broadcasting

Television broadcasting

Electronic newspapers

Radio

Television

Electronic

broadcasting broadcast.

Lecture

Cable television

Video Response System (Moving videotex)

Video

conference

Video Response System (Still videotex)

Direct mail

Video conference

CAPTAIN system

Communication

Mail

Facsimile

Electronic mail

Database

Data transmission

Video transmission

Data communication

Mail

Data transmission

Video transmission

Information processing

Paging system

Videophone

Personal computer

Personal

Spoken word

Document

Transmission

Information processing

© Present range of telecommunications

Directions of telecommunications development
Introduction to Telecommunication Systems 1991  Fig. III.2
Compare different aspects of this diagram with the developments of the network in the remaining part of this chapter (ISDN, IN, ATM, SDH, mobile, etc).

Fig. III.2 illustrates the relation between time, speed and information content of services. (For better understanding let us make an example from the video entertainment field). We watch a movie for a time that is shorter than a day but longer than a minute, and we need hundreds of megabits per second for the quality information.

a. The Telephone network

The invention of the telephone in 1876 led to an explosive outgrowth of engineering developments. These developments continue to thrive to this date. Over 1400 independent telephone companies exist today making up what has become as the public switched telephone network (hereafter TN).

The TN has been called the "world's most complex machine". It is truly one of the modern wonders of the world. At the touch of a dial any two people, virtually anywhere in the world, can communicate with each other in a matter of seconds.

a.1. The local loop and the centralized switching.

For individual telephones to be useful, they must be interconnected to other telephones to establish a communication link. Fig. III.3 illustrates a simplistic method of interconnecting six parties together. The noticeable problem here is the overwhelming number of interconnecting lines necessary for each party to have the ability to call any one of the other parts. To provide service for n number parties, the number of lines required for this method of interconnection is governed by the following equation:

$$\text{No of lines} = \frac{n(n-1)}{2}$$

In our case it is 15. Imagine a TN of this type having to provide service to 50 000 subscribers. This would be quite impractical. Furthermore it is not necessary for telephone systems to assume that every telephone connected to the network is in use 100% of the time.

Given the situation just presented, it makes sense to devise a centralized form of switching that is capable of establishing a temporary connection between two parties wishing to communicate with each other (Fig. III.4). This, indeed, has been the established method since the days of the first telephone networks. Only the manner in which the connection is made
Fig. III.3

Fig. III.4

Introduction to Telecommunication Systems 1991
has become more sophisticated. Each telephone subscriber is connected to a central office through a pair of wires used as the transmission medium. This is a star-shaped network. The pair of wires referred to is the subscriber loop. The exchange in the center of the (local) star network is the local exchange. They are the "ports" to the trunk network.

a.2 The trunk network

Similar considerations as for the local network lead to two basic models in the trunk network:
- star-shaped, to contribute traffic from the local exchanges to higher levels in the trunk network (Fig. III.5).
- mesh-shaped on the higher levels to connect on a national and international level (Fig. III.6).

Factors affecting the choice of the basic model are:
- cost effectiveness (ratio switching/transmissions)
- reliability - transition/new equipment
- traffic handling.

We may imagine that each switchboard in the mesh network is the central switchboard from the star shaped network on Fig. III.5.

The architecture of a TN network is also based on the numbering plan, which means that different subscribers are assigned with different digit sequences = numbers (in our theoretical case, in Fig. III.7, we can see a plan of four-digit coded network).

Compare this paragraph with the lay out of a public network in chapter I.

Fig. III.8 illustrates a typical structure of a local network in a country with high telephonedensity. New build houses are always pre-wired and these wires are connected to the distribution unit (kabelverdeler). When a residential wishes to enter into the group of subscribers, his wires have in the distribution unit to be connected with the wires in the cable laying between the distribution unit and the exchange. This last cable route has a capacity in accordance with the real number of subscribers and can have a length ranging from some 100 meters to some km's.

The distance between the distribution unit and the houses is not more than some 100 meters.

A general view on transmission network is given in Fig. III.9 and in Fig. III.10. Fig. III.9 gives a simple view at the problem, Fig. III.10 is more complicated. We use the following notation:
Star shaped structure of the lower levels
Maasvormige structuur in de hogere netvlakken
stervormige structuur
binnen de districtsnetten
Het lokale kabelnet.
Transmission networks

interdistrict network

district exchanges

primary network

sector exchanges

secondary network

terminal exchanges

local network

business exchanges

overflow exchanges

stations

Introduction to Telecommunication Systems 1991 Fig. III.9
Introduction to Telecommunication Systems 1991

Fig. III.10
Fig. 4.26
Modulation plan for transposition of 3
speech channels into a 12–24 kHz
subgroup and then 4 subgroups into a
60–108 kHz basic group. The arrows
in the figure show the position of the
carriers on the frequency scale.

Supergroup

Fig. 4.27
Modulation plan for transposition of 5
basic groups into one 312–552 kHz
basic supergroup.
D - districts exchange (capitals)
K - nodal (sector) exchange
W - low mesh network - local exchange
E - distribution unit (mostly not a switch).

(dwarsverbinding = crossconnection: special case of exchange (contact)
if traffic from one nodal network to the other one is heavy.

a.3. Speech in the network

CCITT defined bandwidth between 300 Hz and 3400 Hz for the voice
transmission in TN with defined parameters. But capacity of wires is
much larger (see Fig. III.9, Fig. III.10). Symmetric wire pair has a
frequency limit at 500 kHz (what is enough for 120 telephone channels).
We can transmit 10800 telephone channels over coaxial cable at the same
time. In both cases we use frequency multiplexing (FDM). The basic idea
of the FDM is shown in the Fig. III.11. In multiple steps we are able to
produce bigger and bigger groups from the subgroups with the help of
frequency transposition.

FDM is an old fashioned technique and now we prefer time division
multiplexing (TDM) base a digital technique. In contrast to FDM, TDM
involves the transmission of signals in the time domain, whereas in FDM
these signals are transmitted in the frequency domain. Another major
distinction between these two forms of multiplexing is that FDM is an
analog process, whereas TDM is a digital process. In TDM, several
analog signals are sampled and converted to digital bit streams through
the use of analog-to-digital (A/D) converters. The process of converting
the analog signal into an encoded digital value is referred to as pulse-
code modulation (PCM). In time division multiplexing, signals from
several sources are digitized and interleaved to form a higher order
PCM channel. The time division multiplexed PCM signal is then
transmitted onto a single channel. When the digital bit stream is
received, the reverse process is performed. The bit stream is
demultiplexed and converted back to the original analog signals. The
analog signals are routed to their final destination.

Fig. III.12 illustrates a simple block diagram of the TDM transmission
system and the first three levels in hierarchy of digital frames:
1. time slot - 8 bits - for one channel
2. frame - 256 bits - 32 time slots: - 30 PCM channels
   - 1 synchronization channel
   - 1 signalling channel
3. primary multiplex
Fig. III.13 shows hierarchy of TDM systems. We can see that each of the higher order digital multiplexers is made from the four lower order stages.

IV Telex network (TXN)

The telex network is a system making use of the transmission capacity of the telephone networks, but not of the telephone exchanges. The telex network has its own exchanges, permitting adapted procedures for call handling etc. between the telex terminal and the telex network. The basic speed of TX is 50 Bd (baud). Fig. IV.1 shows one half of connection in TN and in TXN. Because telex has $10^3 \sim 10^4$ users in a country, (TN has $\sim 10^6$ end equipments). TXN uses switchboards of 2nd and 3rd order only.

V Types of switching (Fig. V.1 to V.5)

Fig. V.1 - circuit switching - based on a real connection between users. During the call the channel is reserved for the partners to communicate.

Fig. V.2 - message switching - user gives the complete message (information) into the network. Network finds the optimal way and then it starts the transmission (of the whole message) between the two switchboards.

Fig. V.3 - packet switching - information (message) is chupped into the smaller units (packets). Packets are transmitted in optimal way to the destination point where the original information is restored.

Fig. V.4 - shows relationships between the length of information and time delay of connection.

Fig. V.5 - shows parts of the information included in switching system.
Introduction to Telecommunications Systems 1991

Fig. III.12

Fig. 2.14: Frame structure of the 30-channel primary multiplex
Structure of the transmission networks

Introduction to Telecommunication Systems 1991

Fig. IV.1
Openbare netten

- circuit geschakelde netten
- store-and-forward netten
- message switching

Fig. V.1.
Packet switching
vertraging (s)

message switching

packet switching

0,1 Kb  1 Kb  10 Kb  100 Kb  1 Mb

berichtlengte

Introduction to Telecommunication Systems 1991 Fig. V.4
Switching System

3 types of information

Signaling Information

Release Occurred Information

Management Operating ReArranging the Network
V.1. Packet Switching.

In a digital network, the network itself comprises means to transport the digital data through the transmission system. One type of a digital network is a packet network. The message offered to the network has to be split in packets of fixed length. A packet is about 2 k bits of binary information when it includes data, address, and error control information etc. The packet transmission concept is not used for voice but for data only, because the transmission is not carried out continuously as a voice signal would have to be.

When the message, or more general said, the whole data block is parcelled into packets, with all information needed to convey its contents to the desired destination. Each unit of data carries an address to tell where it is going and some identification as to the sequence it belongs when it arrives.

Packets may be sent by the datagram technique or the virtual circuit technique. In both a group of packets is sent out in some order from a computer-based switching center.

Each packet is routed over a path chosen according to a scheme called adaptive routing, in which the path is chosen that gives the best performance. A message consisting of several packets may arrive in a different order than it was sent, because each packet may have traveled along a different route. Some packets may have been dropped to ease system congestion and will need to be transmitted again by the transmitting terminal.

We need a standard interface protocol to exchange packets between the network and its terminals, computers, and host processor.

Now we can see the packet format on Fig. V.6.

Legend: - F/A/C: link level overhead. In these bits we give information for the network about numbering, addressing and class of connection.
- Packet header: in this part we have address of both the receiver and the sender.
- information: part of the message given by the capacity of the packet length.
- FCS: fault control set. Here we code a message on errors in the information part.
- F: flag. End of one packet (information for the link).

Because in the case of packet switching we have not connected only two wires, but this connecting form involves more streams distinguished by the additional information of the packet concerning destination. In one physical connection we have many logical channels (max. number is 4095 by CCITT).
FRAME VOLGENS X25/HDLC

packet length ≤ 1024 bits

Fig. V.6
A kan met een hogere snelheid zijn aangesloten dan B
Fig. V.7 gives a good view on the problem. In the figure we can see three physical ways (A, B, C). Information flows from A to B and C. Logical channel 1 in A is renamed and moved into the B wire as channel 5. Logical channel 2 got on the 10th address in C way. Logical channels provide information on which position our packet in the wire travels. We may change it more times in the network because it does involve information outside the packet. (We put the packet onto free place on the flow of bits places).

Fig. V.8 shows the same thing from another viewpoint. We can see that while packets head from one side of network through one physical way in the network the positions of the logical channels can be switched and we have the same information on the other end but in different sequence.

Fig. V.9 illustrates the configuration of the combination of a circuit switched analogue network and of packet transmission over a datanetwork.

Legend:  
- DTE: data terminal equipment.  
- PAD: packet assembler/disassembler  
- X3, X25, X28, X29: CCITT recommendations on the signed network part.

In this case the telephonenetwork and the datanetwork are linked by the PAD. The reason will be made clear in the following. The principle aspect is "costs". Users of datanetwork can be divided into four groups: 
- big business  
- small business  
- bureaus  
- residential

Because only the big business has large enough traffic for the datanetwork connecting, we must find a way to connect the other groups (with their small traffic) into the datanetwork. The solution is in the figure V.10 where we specified a packet assembler/disassembler for the connection between TN and DN (datanetwork).

VI. Signalling

Signalling guides, directs and supervises the flow of information. The media that carry information and signalling determine what form that information and signalling may take.

Three technological types of signalling are used in telecommunications: 
- analog signalling  
- DC signalling  
- digital signalling.
ten behoeve van de routering door het openbare net moeten adresseringsgegevens worden toegevoegd aan het pakket.

dit is zoals voorgeschreven door X.25, het zgn. logisch kanaalnummer.

maximaal per aansluiting 4095 logische kanalen.
Pakketschakelend datanet 1 met PAD-faciliteit

**DTE =** Data Terminal Equipment (de terminal)

**PAD =** Packet Assembler Disassembler

**X.. =** betreffende CCITT-aanbeveling

**CCITT =** Comité Consultatif International Télé-grafique et Télé-phonique

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*Introduction to Telecommunication Systems 1991*  Fig. V.9
Introduction to Telecommunication Systems 1991  Fig. V.10
Two application fields have to be distinguished in a connection:
a. between subscriber trunk network
b. between the subsystems of the trunk network.
Both have a different nature depending on their function and physical characteristics of the involved part of the network.

**Analog signalling** involves the use of tones or sounds that are transmitted in the same way, and on the same wires, as ordinary voice transmissions (dial tone, busy signal, etc.). These are carried as part of the audio signal and can be heard on the phone. For the most part, such signals are supposed to be heard on the telephone, as in the case of the dial tone and the busy signal, which are, after all, signals for the human user (category a). There are also classes of signals that are not intended for subscribers, but automatic equipment instead. Some of these signals are out of band, (beyond or above the range of human hearing)(category b).

**DC-signalling** takes advantage of the fact that the (carbon) microphone in a phone needs direct current feeding. Variations in the value of the current produce the sound at the receiver. Reversing the direction of the current, or altering its average value is a method of signalling (category a).

**Digital signalling** is used where digital data are being transmitted instead of analog voice signals. The signalling information bits appear between blocks of digitized voice transmission data, or blocks of digital information originating at a terminal or computer. As with some other methods mentioned, digital signalling is for automatic equipment and is not intended to be heard by the human user at the receiver (category a and b).

In figures VI.1, VI.2, VI.3 we show the evaluation of the signalling from the system’s point of view.
Figure VI.1: A well known way of transporting signalling information is the use of the same way for signalling as well as for information (voice) transport. The signalling information is transported step by step in the system and after it the communication between the caller and called party may start. This method of signalling is called: associated signalling. In more complicated modern systems signalling is provided by processors connected by special data link (fig. VI.2). This way of signalling where stored program control is used together with a separate signal is called: common channel signalling. These data channels are combined in a special network: the signalling network, which is "parallel" to the "speech" network.

The future trend is to divide the trunk network into two layers:
- speech layer
- signalling network (fig. VI.3)
The characteristics of the signalling network are standardised in CCITT. It has different names, but all names comprises 7. In the USA it has the name: SS7, in Europe C7. Seven means the seventh by CCITT standardised system.

It is a powerful system intended to support
- operating of the network
- supporting (new) services
- transmitting signalling information during the call

Question: What are the reasons to do this?
What network services can be supplied?
Which are comparable with those of a packet switched datanet?

VII Mobile systems

Mobile systems has at the moment great attention from the side of manufacturers and network operators. Developments in technology allow the production of smaller equipment and the use of higher frequencies. In this way it is possible to design "handhold" and "portable" equipment. These developments stimulate the trend of "personal communication". This means in stead of contact an address anywhere in a house, a building or an organisation, but to contact a person.
Besides this aspect, mobile communication can also replace wiring and cabling in offices. We are only at the beginning of the developments. Advantages and drawbacks are not yet well known.

VII.1.Cordless telephone (fig. VII.1 and VII.2)

As its name implies, the cordless telephone is operated without an attached cord. There are two units that makes this possible: a base unit and a portable unit. Each unit contains an FM transmitter and receiver. The base unit is directly connected to the subscriber loop. It transmits and receives all signals between the portable unit and the central office. This includes both voice and control such as ringing and dial tone. A serious point is security.
The cordless set is developed straight from the need of residential for use in restaurants, gardens, etc. Another development has started as a spin-off of the European GSM activities. This CEPT group has developed a mobile, continent-wide, cellular radio system for telephony (see VII.2).
Channel associated signalling:

- **speech**
- **speech path**
- **signal**
- **signal path**
- **switching exchange**
- **step-bij-step control**
Common channel signalling:

exchange A

P = Processor

special data link

stored program controlled

exchange B

Circuits
Common channel signalling network

SW = Switch Block

speech path

special centres

P = Processor

signal path

common channel signalling network

PTT telecom
Cordless telephone

Analog cordless

Residential
CEPT-900
CT1+

PTT

Dialer
Speech

Radio
Modem

Micro-

Display

Radio
Modem

Micro-

Display

Handset (around subscriber's premises)
Introduction to Telecommunication Systems 1991  Fig. VII.2
Stimulated by as well the cordless set, as by the cellular technology, handhold systems are developed (CTI and CT2) which can be used in a short distance of telepoints which allow the connection between the wired (trunk) network and the radio way to and from the handhold set. With a handhold set calls can only be set up from the mobile post to the network.

VII.2 Cellular technology (fig. VII.3, VII.4, VII.5, VII.6)

Mobile telephony has been around for many decades, providing the luxury and convenience of placing calls through the TN directly from one's automobile. The shortcomings of the first systems was that the mobile unit can travel only within regions with a 30/50 km radius of the base station and reliably communicate with a transmission power output of up to 25 W (extreme amounts of power have caused interference between adjacent channels when mobile units are in proximity to each other or the base, also number of frequency channels was limited). Leaving the regions meant that special (technical) measures were needed to continue the call.

The large regions gave rise to congested frequency bands because of the increased demands for mobile communications. This has given rise to a new technology, called cellular telephone. The basic concept behind this new technology is to divide heavily populated areas into many small regions called cells. As depicted in Fig. VII.3 each cell is linked to a central location called the cellular telephone switching office (MSC). The MSC's coordinates all mobile call between an area comprised of several cell sites and the central office. At the cell site, a base station is equipped to transmit, receive, and switch calls to and from any mobile unit within the cell to the MSC. The cell itself encompasses some ten's square kms. Thus reducing the power requirements necessary to communicate with mobile units. This permits the same frequencies to be used by cells, separated by cells laying in between and using other frequencies since the power levels emitted diminish to a level that does not interfere. In this manner, heavily populated areas can be serviced by several transmission stations, rather than one, as used by conventional mobile techniques.

Some of the nowadays cellular network principles are:
- GSM/CEPT: group special mobile: fully standardizied system (about to be finished in 1992)
- C-net: (cellular mobile): system used in Germany
- NMT/NORDIC: (cellular mobile): system used in Scandinavie/Benelux
- DCT 900: digital system: office oriented
- CT 1: British system handhold via telepoint
- CT 2: handhold via Telepoints (standardised)
Last figure (VII.6) from this chapter shows the position of mobile systems plotted against two functions. One shows the system's mobility and the second one the sphere of using.

PCN (personal communication network) is the underlaying principle of person directed communication making use of wired systems, cellular networking and Telepoints. Some people are inclined to think that Telepoint technology for a large extend will replace local networks. The future, however, is not clear. New technologies mostly gave rise to the idea that older systems will be replaced. Reality in most cases is that it gets a new place, with new applications, besides existing possibilities.

VIII. Satellite systems

The satellite is essentially a microwave relay station, for telephony up till now placed in orbital space. Telephone and television broadcast signals are beamed up to the satellite from an earth station through the use of a highly directive microwave disk antenna that is synchronized to the position of the satellite. A device called a transponder is used on board of the satellite to receive the weak microwave signal, amplify and retransmit the signal back to another earth station in a different location on the earth. Technological development, as mentioned before, makes it suitable and possible to work with smaller receiving antennas without synchronisation. Many new applications are possible in this way (road transport, etc).

Modern telecommunication satellites are positioned in orbit at an elevation of approximately 36,000 kilometres above the plane of the equator (fixed in one point).

It is possible to communicate virtually anywhere in the world through the use of the satellite link. One adverse effect, however, is if person wanted to communicate to another person outside of the designated coverage region of the satellite, the signal would have to hop between satellites and earth stations a few times before it can arrive at its destination (it takes an average of about 270 seconds for a signal to propagate from earth to satellite and back to earth. The round trip delay time for a response is therefore a minimum of 540 seconds). This is most undesirable. Fiber optic cables are better for voice transmission than satellite systems. Satellite systems have their future in broadcasting and in communication in low-populated parts of the earth (Oceania, ship communication on the seas), but also in private networks of companies. The general trend is that regulations restrictions will be taken away. Besides the above mentioned applications in road transport, the
A cellular telephony system is an extension of the regular PSTN/ISDN. The network is made up of cells, which use different frequencies. However, the radio frequency spectrum is a limited resource, so the same frequency is re-used in many cells.

There are three basic components in the network: Mobile Station (MS) — a transportable, car-mounted or pocket telephone; Radio Base Station (RBS) — a relay station covering one, or several cells in the network; Mobile Services Switching Centre (MSC) — an AXE exchange for mobile telephony.

The MS communicates by radio waves with an RBS, which relays the signal to the MSC — by means of cable or microwave. The MSC then connects the mobile call to the regular telephone network.
Cellular mobile

Analog cellular
Introduction to Telecommunication Systems 1991

Fig. VII.5
flexibility and freedom of certain regulation aspects will yield a lot more new applications.

IX Digitalization of networks

The future trend is an "end to end" digital connection. The biggest advantage of digital network is the economic one. We save money because information in digital form can better be handled than in analog form. We have a less error rate in message, because in digital technique we can use faultcorrecting coding. Moreover digital networks provide more services.

A set of protocols for digital network and transmission (as for the analog media) was worked out by CCITT.

The nowadays trend in IT is the ISDN system with pure digital transmission, including the local network. The principle of the ISDN connection is on the Fig. IX.1. We have an interface between ISDN and the home system. The standard comprises two basic channels B only (64 kbit/s) and one signal channel D (because signal network in the new system is separate from the voice part (see chapter VI)). The combination of the D-channel and the C7 system signalling will show to be the base for many new applications.

Intelligent network (IN)

The introduction of a new network service means mostly that the software of most of the controlsystems of the switching machines have to be adapted and/or replaced. This is a costly, dangerous and timeconsuming activity. New network architectures are looking for ways to avoid this problem by installing non-switching intelligence in separate computers. This is shown in Fig. IX.2a. The service is handled by a entity ESP with has a contract with the network operator. The information for the service is stored and managed in SMS/SCP. Handling, storing and managing is carried out via the C7-signalling system. The user can make use of the service by special numbers and/or by the network. In both cases information concerning the service is transmitted also by C7.

Elements to supply the service are:
- capacity of the system memory
- system speed
- serving program (because in the program we define all the new services)
- external system database.
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Fig. IX.1
figuur 31 Bellcore's IN/2 concept.
Voorbeeld werking
Intelligent Network

SLP - 07
Lees-gegevens

SLI
NID

SMS

SSP
SSP

07 - 89632
Jansen
8.00 - 17.00
43892
17.00 - 8.00
25876

neher laboratorium

Introduction to Telecommunication Systems 1991  Fig. IX.2b
Fig. IX.2b illustrates one of the extra services. The subscriber namely Mr. Jansen, wants to redefine his telephone number as a function of time. At workhours if somebody dials his own number, system redefines it into another number of his office. After workhours the IT system changes the number into Mr. Jansen's private number and calls arrive at this station. The service number to change a desired "follow me" number (in this case 43982 and/or 25876) is 07-89632. This last number is the number of the supplier of the "follow me" service.

Parts of system: SMS: service maintenance system
SLI: service logic interpreter
NID: network information database
SLP: service logic program

The switching system itself are the service switching points (SSP). All others are additional to the switching network and transform the network in an "intelligent network".

X Coupling of the networks

In chapter V we discussed the connection between the TN and the DN. This case of interchange is not characteristic for TN and DN only. Any subnetworks may step into the other network (but only with defined accomodations and specified interface). Fig. X.1 shows connection between datanetwork, telexnetwork and telephone network. Fig. X.2 shows connections between ISDN and various subnetworks. This structure exists only until the day of the total integrating of subnetworks into the ISDN system. The feeling, however, grow that for economic and practical reasons this integration in ISDN has to go a very very long way.

Fig. X.3 illustrates the evolution network topology. High systemlevel analog meshnetworks were built on the base of connecting switchboards one with each other in a real physical ways. Nowadays we are changing digital meshnetworks into the starnetworks with DXC switchboards in the centre. (DXC: direct crossconnection). DSC switchboard has only transfer functions between switchboards. It has not end equipment and terminals. Following this idea it also has not program for servicing end machines. The background of this is the need to react on peaks in traffic, calamities, possibilities for more network carriers, and so on.
telex-aansluitingen (t.b.v. teletex)

conversie faciliteit

X.25 aansluitingen

X.25 deel-aansluitingen

X.25 concentrator

PAD

niet X.25

vaste aansluitingen

gekozen aansluitingen

TELEFOONNET

toegangsmogelijkheden tot het datanet

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Fig. X.1
Fig. X.2

**Fig. 6** ISDN d.m.u. Interworking Units

**Legenda:**
- **TE1** = ISDN terminal
- **TAa/b** = Analog Terminal Adapter
- **TFX 4/3** = Telefax group 4/3
- **TTX** = Teletex
- **VTX** = Videotex terminal
- **TLX** = Telex
- **DTE** = Data Terminal Equipment
- **IWF** = Interworking Function
- **M** = Modem
- **PSTN** = Public Switched Telephone Network
Introduction to Telecommunication Systems 1991  Fig. X.3
The principle of switching on a higher level in the trunknetwork is called SDH synchronous digital hierarchy. The ultimate aim is to rerout bundles in a fast, flexible and reliable way as to support high quality of service of the network and lower the cost of installed equipment by directing technical means in the network to routes where they are needed for the moment.

XI Transfer modes

Based on the previous chapters we bring together our knowledge of networking in a flowchart (Fig. XI.1). It shows nowadays used transfer modes in TT systems. On the first level we divide information transferring into the circuit switched and the packet switched part. (We discussed it in chapter V).

We split circuit switched transferring into systems with space division and with time division. Today space division is believed to be an old-fashioned method (though many systems use it, dominantly on the lower system levels). Systems without PCM belong to this class (FDM analog systems).

Second form of information transfer with time division is based on PCM. Basic idea of PCM systems is the sampling, quantization and encoding of the analog signal. The analog input signal at speech transmission is sampled with a 8 kHz sampling pulse (from the Nyquist 1927 sampling theorem (f-sampling ~ \(2 f_{signal}\))). We use both the synchronous transfer mode and the time division in circuit switched systems (chapter X). Advantages and shortcomings of synchronous systems are as follows:
- high speed transmission
- maximum throughput advantages
- low overhead
- error detection methods are extremely reliable
- expensive to implement
- communication protocols must be compatible
- entire blocks may need to be retransmitted disadvantages
  if a single bit error occurs
- cannot be used with electro-mechanical teletype

Packet switched information transfer is also divided into two classes
- with fixed packet length
- with variable packet length (Variable packet length is a result of the additional information in the headers).

Nowadays most advanced technologies are the systems with fixed packet length.
The two most used protocols for data transmission are X.25 and datagram. Protocol X.25 has defined functions to take care of the transmission between two switch boards (link by link).

Datagram is a protocol set which supervises information routing in the same way as protocol X.25, but for the whole system. Another big difference between the mentioned protocols is that a datagram protocol does not imply a reaction from the receiver's side (from the called switchboard).

At the end of this chapter we summarize by saying every TT transmission system has its own place in Fig. XI.1. Physical realization of the systems exists in many ways but the basic form is one of the mentioned.

Fig. XI.2 illustrates the future of TT-s being in glassfiber systems for the local network. The figure shows the attenuation of the fibre according to the wavelength. It is apparent that attenuation is acceptable for telecommunications only in two regions. Todays TT networks use the 1300 mm's region. The 1550 mm's region is in the state of development. Field trials start with applications for POTS/ISDN in the $\gamma_1$ and $\gamma_2$ region. Future developments such as ATM switching can find their place in $\gamma_3$ very far from now possibilities as coherent-laser-technology can be applied in $\gamma_4$.

XII Planning

If you, for some moments, take down this survey and start thinking of a topic not mentioned so far, though almost present if you read between the lines. You know the answer for sure - yes it is planning.

TT systems are worldwide based on very sophisticated plans. This fact is more understandable if we imagine that switchboard and network components have lifetimes many decades. Telecommunications plans must be able to serve the operation of TT systems all the time. Fig. XII.1 shows the flowchard of TT plans.

Routing plan

Routing plan gives a set of rules on cables and switching systems. It provides standards, norms, and accomodations for networking, for reliable errorless routing of traffic, for services, etc.
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Fig. XII.1
Numbering plan

We basically discussed the numbering plan in chapter III. National TT organizations provide every subscriber with a code which identifies him - the phone number. Numbering plans are made on three levels:
- local (groups of subscribers connected to one exchange)
- country (regions, areas)
- international

Telephone numbers for international connection have a maximum of 12 digits (CCITT).

Structure of the phone number:

<table>
<thead>
<tr>
<th>international prefix</th>
<th>national country code</th>
<th>area trunk code</th>
<th>subscriber number</th>
</tr>
</thead>
<tbody>
<tr>
<td>OO(OX)</td>
<td>31</td>
<td>70</td>
<td>3868459</td>
</tr>
</tbody>
</table>

Prefix gives information to switchboards about our need to get into the higher level of TT system (national, international). The international prefix is standardised as 00, but sometimes have another form (often OX (X is a digit between 1 and 9) according to older plans of the national TT organization.

Country code has one, two, or (maximum) three digits. This number serves as identification code of the destination country.

Area code depends on the geographic location of the country, on the organization of the network and on the volume of traffic. The subscriber's number is a code which identifies the called area.
On all levels we must be very careful with planning. Lifetime of TT systems is more than twenty years and we must reserve enough number capacity for all this time (numbering plans are connected with the social, economical and industrial factors).
Numbering had two forms:
- closed numbering (the sum of the digits is constant)
- open numbering (the sum of the digits can variate).

Charging plan

Charging has many features in common with the numbering plan and with the political and economical aspects in the country. The called number includes all the information (which is analyzed in the switchboard's serving program) setting the counting rate. The biggest problem is, to define the cost for a telecommunication unit and the relation with tariffs. It depends on the social rights, on the subscriber categories (a category with extra services (rate of services), and on the economic situation in the country. The payment for the
telecom services can be also a stimulation factor for economy. Payments for the telecom. services are divided into three groups:
- installation fee : charge for the phone station installation
- subscription fee: a constant monthly payment for the equipment holding
- call charges : the variable part of the bill.

Two methods of charging for the call exist:
- pulse metering : provides us only with the simple information about the sum of the pulses a month
- tall ticketing : provides us with extra services (bill with a timechart of calls, destinations of calls, pulse sums for each separate call, etc.).

Signalling plan
A signalling plan is a set of rules concerning the different signalling systems we must respect on (inter)national cooperation. Signals used on the national level must cooperate worldwide with other systems (chapter VI). But on national systems different systems can be used as well.

The mentioned facts are the most important building blocks of the TT plansystem. The rest are norms and specifications for the synchronization of systems, for transmission parameters; and specified services in spotlight of their grade of complication, security of the service, operation rules etc.

XIII Protocols

Organizations making standards in use for telecommunication are:

- ISO: The International Standards Organization is the Standards Organization. ISO creates the OSI protocols.
- CCITT: The Consultative Committee for International Telephony and Telegraphy was over 100 years old. It is now an agency of United Nations. CCITT develops the recommended standards and protocols for TT. (V series specifications for interfaces, X series for data communications, and the I and Q series for ISDN).
- ANSI: The American National Standards Institute is the official U.S. agency.
- IEEE: The Institute of Electrical and Electronic Engineers. A professional organization of U.S. electronics, communication and computer engineers.
- ETSI: The European group, stimulated by the European Community)
Protocols

Communication between two end equipments needs to be coordinated. The set of rules that govern the manner in which the information flow is handled is called a protocol. Protocol concerns control over information route, error rate, code format, etc.

To support the developments of protocols, use is made of the OSI-model. The OSI-model is not a protocol itself, but gives the architecture of the way to construct protocols.

OSI 7 layers model. We try to show a more sophisticated view on OSI model. The analysis is based on our knowledge from the first chapter.

The model encourages an open system by serving as a structural guideline for exchanging informations between computers, terminals and networks. The OSI model categories data communications protocols into seven levels. The hierarchy of each level is based on a layered concept. Each layer serves a defined function in the network. Each layer depends on the lower adjacent layer's functional interaction with the network.

**Physical layer:** defines the electrical and mechanical rules governing how data are transmitted and received from one point to another (maximum and minimum voltage, current levels, circuit impedances etc.).

**Link layer:** defines the mechanism in which data are transported between stations in order to achieve error free communications (error control, formatting, framing and sequencing of the data).

**Network layer:** defines the mechanism in which messages are broken into data packets and routed from a sending mode to a receiving mode within a TT network. This mechanism is referred to as packet switching.

**Transport layer:** ensures the reliable and efficient end to end transporation of data within a network. It is the highest layer in terms of communication. Layers above the transport layer are no longer concerned about the technological aspect of network. (the functions served by the transport layer are ensuring the most simplified and efficient service, error detection and recovery, and multiplexing of end user information onto the network).

**Session layer:** concerns itself with the management of a session. This includes the recognition of a users request to use the network
for communications, as well as terminating the user's session. If a break occurs during the session, this layer addresses the full recovery of the session without any loss of data.

Presentation layer: The services provided on this level address any code or syntax conversions necessary to present the data to the network in a common format for communications. This includes code sets, data encryption, data compression, file formats, and so on.

Applications layer: At this level the specific applications program that performs the end-user task is defined. This includes, for example, data base management programs, word processing, spreadsheets, banking and E-mail.

XIII.1 Synchronous and asynchronous transmission (serial).

The transmission of serial data between two devices needs to be coordinated in the manner in which it is sent. The set of rules that govern the manner in which the data are both transmitted and received is called a protocol.

Asynchronous link protocol: The lack of synchronism in asynchronous transmission is solved by having the transmitting device insert framing bits at the beginning and end of each transmitted character (figure XIII.1). These framing bits are referred to as the characters start bit and stop bit. These bits mark the beginning and the end of the character, thereby allowing the receiving device a means of achieving frame sync with each character. (The startbit is always a logic 0 and the stopbit is always a logic 1). The character can be sent at any time. The time interval between characters is referred to as the "idle time". This time varies between characters depending on the speed of the typist.

Figure XIII.2 shows application of asynchronous transmission in TX, teletype and IBM systems.

Synchronous protocol.
Synchronous transmission of serial data involves the high speed transmission of data in the form of blocks. A block of data can represent a contiguous series of data bites. In contrast to asynchronously transmitted characters, the idle time between characters as well as the start and stop bits are eliminated making it possible to send data at higher rates. Synchronization of data is performed on a block-by-block basis. The transmitters device often provides a separate clock pulse that is in sync with the center of each transmitted databit (synchr. clock is carried on the separate line). For long distance communications via the TN the synchronizing clock on a separate circuit

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Figuur 4.1 Asynchroon karakter.
Telex (TTY)
1 startbit - 8 databits - 2 stopbits;
IBM 2741 terminal
1 startbit - 7 databits - 1,5 stopbits.
Figuur 2.10 Synchrone verbinding

Sendzijde

Ontvangzijde

Klok (send)

Data (send)

Klok (recv)

Demodulator

Klokextractie

Modem

Modem

Klok (recv)

Data (recv)

Terminal

Terminal
Synchronisatie

Analoge signaal

Aftastmomenten
detectie

Kloksignaal
diskpers

Momente van inklokkensampling

Received data
| Nr. v.d. combinatie | letters | cijfers | Nr. v.d. elementen
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>C</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>D</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>E</td>
<td></td>
<td>5</td>
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<tr>
<td>6</td>
<td>F</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>G</td>
<td></td>
<td>7</td>
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<tr>
<td>8</td>
<td>H</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>I</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td>J</td>
<td>bel</td>
<td>10</td>
</tr>
<tr>
<td>11</td>
<td>K</td>
<td></td>
<td>11</td>
</tr>
<tr>
<td>12</td>
<td>L</td>
<td></td>
<td>12</td>
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<tr>
<td>13</td>
<td>M</td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>14</td>
<td>N</td>
<td></td>
<td>14</td>
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<tr>
<td>15</td>
<td>O</td>
<td></td>
<td>15</td>
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<tr>
<td>16</td>
<td>P</td>
<td></td>
<td>16</td>
</tr>
<tr>
<td>17</td>
<td>Q</td>
<td></td>
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<td>18</td>
<td>R</td>
<td></td>
<td>18</td>
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<td>19</td>
<td>S</td>
<td></td>
<td>19</td>
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<tr>
<td>20</td>
<td>T</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>21</td>
<td>U</td>
<td></td>
<td>21</td>
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<tr>
<td>22</td>
<td>V</td>
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<td>X</td>
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<td>Z</td>
<td></td>
<td>26</td>
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<td>'</td>
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<td>31</td>
<td>'</td>
<td></td>
<td>31</td>
</tr>
<tr>
<td>32</td>
<td>'</td>
<td></td>
<td>32</td>
</tr>
</tbody>
</table>

Figuur 2.8

<table>
<thead>
<tr>
<th>Tekens</th>
<th>Betekenis</th>
<th>Combinatie</th>
<th>Notitie</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>&quot;met wie&quot;</td>
<td>4</td>
<td>na cijferwisseling</td>
</tr>
<tr>
<td>@</td>
<td>&quot;bel&quot;</td>
<td>10</td>
<td>na cijferwisseling</td>
</tr>
<tr>
<td>*</td>
<td>&quot;terugloopwagen&quot;</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>%</td>
<td>&quot;nieuwe regel&quot;</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>#</td>
<td>&quot;nletterwisseling&quot;</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>^</td>
<td>&quot;cijferwisseling&quot;</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>△</td>
<td>&quot;spatie&quot;</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>□</td>
<td>&quot;5 elementen start&quot;</td>
<td>32</td>
<td></td>
</tr>
</tbody>
</table>

Introduction to Telecommunication Systems 1991 Table XIII.5
![EBCDIC code table]

**Figure 2.3** EBBCDIC code.

*Introduction to Telecommunication Systems 1991* Table XIII.6
Figuur 2.2 ASCII-code.

Table XIII.7
Figuur 2.1  IA nr. 5 (ISO 7-bits code).

Introduction to Telecommunication Systems 1991  Table XIII.8
becomes impractical. In this case the clock is encoded with the data by a device called a modem (Fig. XIII.3). The modem modulates a carrier frequency with this information and sends it down the telephone lines. The receiving modem demodulates the synchronous clock along with the corresponding data. The clock is separated from the data and used to sample the data at the center of each bit, thus determining the state of each bit (Fig. XIII.4). Another method of achieving synchronization with the transmitted data is to insert a unique bit pattern at the beginning and end of each block. The receiver can synchronize with the data block by recognizing the occurrence of the unique bit pattern. This eliminates the need for a separate clock. This unique bit pattern and the number of bits contained in the block are a function of the synchronous protocol (example SDLC: Synchronous Data Link Control).

Many different synchronous protocols are used today. They have been developed by several manufacturers and standards organizations (BISYNC, DDCMP, HDLC, SDLC, etc.).

XIII.2 Transmission codes.

The intent of the code is to provide an alternative method of representing numbers, letters, and symbols. Coding is very closed with the protocols especially with the above mentioned asynchronous and synchronous protocols. Transmitted data are typically prearranged in accordance with various codes. Many of these codes are universally recognized and have become standards, whereas others are highly cryptic and applicable to unique and limited situations. The intent of this chapter is to present some codes which are most widely used in today's communication systems.

BAUDOT or ITA No. 2 Code (Table XIII.5).
The Baudot code is used worldwide within the international telex network. Baudot as shown in Table XIII.5 is a five bit alphanumeric code. This allows the possibility of 32 \((2^5)\) combinations of characters. Since there are more than 32 alphabetical and numerical characters, two of the 32 binary combinations are used for extending the character set. These two characters are the letters shift ("letterwisseling" in Dutch) and figures shift ("cijferwisseling") characters. Characters are transmitted as a series of electrical impulses. Each character is formed by a start and stop bit.
EBCDIC code (Table XII.6). This type of code is extensively used in IBM's computers and peripheral equipments. The code listed in table XIV.2 is a matrix that has been designed to group characters by function. Each row and column has been identified by a four bits character. The first four columns of the matrix contain control characters. Control characters are used to control the format and transmission of data. Columns 4 through 7 contain punctuation characters, and the remaining eight columns include alphabetical characters and decimal numbers.

ASCII code (Table XIII.7). ASCII code is the most widely used alphanumeric code for data transmission and data processing. ASCII is a seven bit code that can be represented by upper three and lower four bits character. As we can see in Table XIV.3, there are no empty spaces. Control character are grouped in the first two columns. Third and fourth columns include punctuation and decimal numbers. Rest of column are full with asphabets and nonalphabetical characters. (The ISO-7 code (Table XIII.8) is very similar to the ASCII code).

XIV VIDEOTEX

Videotex can be a public system, or a private one for a group of subscribers.

Basic structure of Videotex system is shown in Fig. XIV.1. We can enter the system via special Videotex terminal or via an adapted TV set, phoneset and videotex interface. Videotex system (if it does not have its own network) is often build using TN and/or datanetwork. A possibility also exists that a basic end set enters TN and from the telephone network we step into the datanetwork. The heart of the system is an external database system or a set of database systems. Here we collect the information. The way of how the system works is as follows. Essential is the information retrieval structure (tree structure).

We simply dial the identification number (code) of the system's subpart containing desired information (Fig. XIV.2). Two steps exist in Videotex
- Password system
- Numeric keyboard (telephone set, TV's remote control keypad)). Our action activates the database system. There exist both passive and active users of the system (classified as they may write information into the central database of only read it). The user's class is defined in the central videotex computer.
Videotex information has a tree structure (see Fig. XIV.2). Various areas where we use the system are: - shopping
- software transmission
- broadcasting
- mailbox (telex system also may be included in the system)
- response frames

Fig. XIV.3 shows the main Videotex system structure without end equipment (abbreviations are defined in the legend).

We can communicate with the system by means of a special codeset. We dial with the help of numeric keypad, keyboard or with buttons on the phoneset). Fig. XIV.4 shows the Videotex's code system. Fig. XIV.5 shows difference between the broadcast Videotex and wired system.

Protocol for Videotes standardized:
- information rate 1200/75 bit/s
- word structure: (startbit - 7 databit - 1 parity bit - 1 stopbit (10 bits)).

Legend:
VIC: Videotex Intelligent Concentrator (ports, connects telephone lines to videotex system)
VOC: Videotex Info retrieval Center
VIC: Videotex Info input Center
VIC: internal database - external database (information is linked by a tree system and stored in an internal or external database).
VBC: Videotex Management Center
VAC: Videotex Administration Center
geëxporteerd.
Figure 2 The Prestel tree structure

Entertainment (10)

Theatres (101)

Cinemas (102)

Sporting events (103)

Cricket (1031)

Football (1032)

Athletics (1033)

Results (10311)

Fixtures (10312)

News (10313)

Etc

Etc
### Table 1: Character Codes

<table>
<thead>
<tr>
<th>ASCII Code</th>
<th>Character</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>NULL</td>
<td>End of String</td>
</tr>
<tr>
<td>1</td>
<td>BS</td>
<td>Backspace</td>
</tr>
<tr>
<td>2</td>
<td>HT</td>
<td>Horizontal Tab</td>
</tr>
<tr>
<td>3</td>
<td>LF</td>
<td>Line Feed</td>
</tr>
<tr>
<td>4</td>
<td>VT</td>
<td>Vertical Tab</td>
</tr>
<tr>
<td>5</td>
<td>FF</td>
<td>Form Feed</td>
</tr>
<tr>
<td>6</td>
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<td>8</td>
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<tr>
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<tr>
<td>109</td>
<td>'</td>
<td>single quote</td>
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</table>

### Figure XIV.1: Character Codes

![Figure XIV.1: Character Codes](image_url)
Figure 1 Broadcast Videotex (Teletext) and wired Videotex systems

Adapted TV Receiver

Normal TV signal containing Teletext

Keypad

Videotex Computer

Introduction to Telecommunication Systems 1991 Fig. XIV.5
XV  Electronic mail

Fig. XV.1 shows the basic concept of the system Electronic mail is an store and forward system.

Fig. XV.2 illustrates the system levels in the Electronic mail system. On MTS (Message Transfer Agency) level we have a mesh network where we connect MTA’s (Message Transfer Agencies). (A couple of MTA’s are forming the MTS). We connect user agencies (UA) into the MTA’s. User agencies present a lower level with the star structure (which is a difference between UA’s and MTA’s (MTA’s form a mesh network)). The star structure (UA’s are not connected between themselves) is necessary because UA’s are not standardized. On the lowest level there are users (terminals). The connection between the user and the VA is not standards required. (Between UA and MTA we need a standardized connection).

Fig. XV.3 shows structure of the system when we use an intelligent terminal on one end which also comprises the user agency level.

Fig. XV.4 gives another view on the structure of E-mail. In the figure we denoted borders between the levels with dated lines (also we defined protocols for each part).

Fig. XV.5 explains structure of E-mail in the OSI seven layers model. We have different protocols for connecting on the different levels (Fig. XV.4) (between MTA’s; P_1 (P_1 - protocol 1), between MTA and intelligent terminal P_3, between VA’s P_2).

Fig. XV.6 shows the E-mail network structure.
Introduction to Telecommunication Systems 1991

Fig. XV.1
Fig. XV.2
intelligente terminal

processing systeem 1

processing systeem 2

terminal

Fig. XV.3
Fig. XV.4
<table>
<thead>
<tr>
<th>OSI laag</th>
<th>Dienst</th>
<th>Message Handling Services</th>
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</thead>
<tbody>
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<td>7</td>
<td>toepassing</td>
<td>user agent layer X.420; X.430</td>
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<td></td>
<td></td>
<td>message transfer layer X.411</td>
</tr>
<tr>
<td>6</td>
<td>presentatie</td>
<td>X.408; X.409</td>
</tr>
<tr>
<td>5</td>
<td>sessie</td>
<td>X.225 (BAS)</td>
</tr>
<tr>
<td>4</td>
<td>transport</td>
<td>X.224 (klasse 0)</td>
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<tr>
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<td>netwerk</td>
<td>CSPDN</td>
</tr>
<tr>
<td>2</td>
<td>link</td>
<td>PSPDN, PSTN, ISDN</td>
</tr>
<tr>
<td>1</td>
<td>fysiek</td>
<td></td>
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Introduction to Telecommunication Systems 1991 Fig. XV.5
Introduction to Telecommunication Systems 1991

Fig. XV.6
In the next figures we give a basic view on ISDN system. Because the basic ideas on ISDN are considered to be the future in IT. In the figures we find the basic ideas of stepping into t1, world of ISDN communications. A deeper view is not necessary in this stage because the objective of our course was to give just a basic view over all TT communications.

**ISDN services**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>CL</td>
<td>calling line</td>
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<tr>
<td>I</td>
<td>information</td>
</tr>
<tr>
<td>P</td>
<td>presentation</td>
</tr>
<tr>
<td>R</td>
<td>restriction</td>
</tr>
<tr>
<td>CO</td>
<td>opposite caller</td>
</tr>
<tr>
<td>DDI</td>
<td>indialling MSN = multiple sub nr.</td>
</tr>
<tr>
<td>SNB</td>
<td>Subnumbering (Layer 4)</td>
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<tr>
<td>MCI</td>
<td>malicious call identification</td>
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<td>CT</td>
<td>call transfer</td>
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<tr>
<td>CF</td>
<td>call forward</td>
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<td>B</td>
<td>busy</td>
</tr>
<tr>
<td>NR</td>
<td>no replay</td>
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<td>U</td>
<td>unconditional</td>
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<td>D</td>
<td>deflection</td>
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<td>LH</td>
<td>line hold</td>
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<td>CW</td>
<td>call waiting</td>
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<td>CCBS</td>
<td>call completion busy subscriber</td>
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<tr>
<td>CON</td>
<td>conference call</td>
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<td>3 PTY</td>
<td>3 party</td>
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<td>CUG</td>
<td>closed user groups</td>
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<tr>
<td>PNP</td>
<td>private numbering plan</td>
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<tr>
<td>AOC</td>
<td>advice of change (display)</td>
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<tr>
<td>UUS</td>
<td>user to user signalling</td>
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</table>
**ISDN services**

- **Bearer services**
  - Layer 1 to 3

**Teleservices**

- Layer 1 to 7 of ISDN PRM (1,320)

### Interface Structures

- **B-channel interface structures at points S and T**
  - **Basic interface structure (basic rate access BA):**
    \[ 2B + D + f \quad (2 \times 64 + 16 + 48 = 192 \text{ kbit/s}) \]
    - \( f \) is framing
  - **Primary rate interface structure (primary rate access or PA):**
    \[ 30B + D + f \quad (30 \times 64 + 64 + 64 = 2048 \text{ kbit/s}) \]
**Integrated Services Digital Network**

- **CCS 7**
- **IDN**
- **Digital Subscriber Line**
- **Integrated Access to Multiple Services**

**ISDN Concept**

- **User to Network Signalling**
- **User to User Signalling**
- **Common Channel Signalling**
- **Circuit Switched Facilities**
- **Packet Switched Facilities**
intelligent network
isdn vans

isdn terminals on S-bus

Introduction to Telecommunication Systems 1991
terminal selection in isdn

an ISDN number identifies interfaces at point T

< 15 digits

<table>
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<tr>
<th>country code</th>
<th>national dest. code</th>
<th>ISDN subscr number</th>
<th>ISDN subaddress</th>
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</thead>
</table>

example: 20 digits

Netherlands Rotterdam pilot

31 10 499\%xxx X = MSN

isdn-application categories

B-applications

64 kbit/s

D-applications

16 kbit/s

2B-applications

64 kbit/s
B-application

LAN interconnection
BA  64 kbit/s
PA  2 Mbit/s

Database retrieval

Information provider

PC
fax 4
### teleservices

<table>
<thead>
<tr>
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<th>Description</th>
<th>Parameters</th>
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<td>1.241.1</td>
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<td>3.1 kHz, 7 kHz</td>
<td></td>
</tr>
<tr>
<td>1.241.2</td>
<td>teletex text</td>
<td>2 s/A4</td>
<td>64 kbit/s</td>
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<td>1.241.3</td>
<td>telefax images</td>
<td>9 s/A4</td>
<td>300-400 dpi</td>
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<td>1.241.4</td>
<td>mixed mode</td>
<td>text + images</td>
<td>64 kbit/s</td>
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### supplementary services

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<td>CT CFB CFNR CFU CD LH</td>
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<td>1.257</td>
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Introduction to Telecommunication Systems 1991
supplementary services in isdn-pilot

+ calling line identification presentation (clip)
+ calling line identification restriction (clir)
+ advice of charge cumulative
+ call waiting with clip
+ call forwarding unconditional
+ call forwarding no reply
+ closed user group
+ direct-dialling-in
+ terminal selection
+ change of service during call
+ terminal portability
+ call transfer on passive bus
+ traffic restrictions

service provider
generic orientation

+ telecommuting: rerouting calls (supp. services)
  data + voice on single line

+ telemarketing: calling line identification presentation
  ISDN Automatic Call Distributor
  callback when occupied / not present

+ POS / EFT: credit card verification
  account check
  check stock, turn-over, cash-flow

+ service plus: "dial-it" services (graphics, pictures)
  on-line database (finance, music)
  maintenance manuals (diagrams)
  X-ray services (pictures)
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