Public Data Networks in the Nordic Countries

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Abstract. Public data networks were introduced in many countries app. 1980. Norway, Finland, Sweden and Denmark evolved common networks in the Nordic countries. The project was named NPDN (Nordic Public Data Network). It was a circuit switched network based on the X.21 recommendation from CCITT. NPDN is described and placed as an element in the ongoing development of data transmission via the public telecommunications networks – from analogue modems to fiber and IP.

1 Data Transmission via Public Telecommunications Networks

Data transmission via the telecommunications network using modems evolved from the mid 1960s. The modems were standardized by CCITT (Commité Consultatif International Télégraphique et Téléphonique) under ITU (International Telecommunication Union).

In those days standardization of the telecommunication industry was performed mostly through ITU with telecommunication operators as the driving force. Any success in the market for new products relied on adoption of standards by ITU, where CCITT produced recommendations for the fixed network.

Modems for data transmission used leased analogue lines (300-3400 Hz) or similar dial-up connections via the public telephone network. For speeds at 48 kbit/s and more the so-called group connections were used. A group was 48 kHz bandwidth in the core network, which was normally used by 12 telephone channels in the FDM (Frequency Division Multiplex) hierarchy in the backbone analogue network. From a telecom station to the customer baseband transmission technology was used (biphase, AMI etc.) at higher speeds - similar to the technique later used in ISDN.

Modem technology and interfaces were standardized by CCITT in the V-series[1]. Today the interface specification in V.24 and V.28 are the best known, while the modulation standards for different speeds now are history with today's fully digital telecom networks.

Most modems at higher speeds were expensive. I recall that a 9.6 kbit/s modem in 1979 was priced at 30– 40.000 Dkr. That was similar to an engineer's salary for 5-6 months. In addition the leased lines were expensive, and by 1979 Denmark therefore had only approximately 10.000 such lines and less than a handful connections of more than 48 kbit/s.

2 The Birth of Public Data Networks

In 1968 CCITT established a new study group (no. 7) in order to evolve standards for public data networks in the X-series of recommendations.

Two types of public data networks were defined in the 1970s, namely circuit switched public data networks with X.21 as the basic synchronous interface standard and packet switched public data networks with X.25 as the basic interface.

Both types of networks were influenced by the philosophy known from the telephone network. They offered connection oriented services, where connections are established by a call request/call procedure. This allowed the network to manage resources and guarantee resources for established connections, while requests for new connections could be rejected during overload situations – exactly as the main philosophy of the telephone network.

In X.21 the network offered direct transparent circuit connections at 600, 2400, 4800 and 9600 bit/s in full duplex mode. In X.25 the network offered logical connections of packet forwarding based on HDLC framing of the packets. A X.25 subscriber could therefore establish several logical connections at the same time, and the packet mode allowed transformation to other types of terminals such as teletype[2] terminals in a packet assembly/ disassembly function as standardized in X.3/X.28/X.29.

X.21 and X.25 recommendations were stabilized by 1980 together with almost 100 supporting X-series recommendations for network to network interfaces, service elements, numbering etc.

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[1] In CCITT each study group evolved recommendations with a specific letter. X was used by study group 7 and V by study group 16

[2] A teletype terminal is a terminal, where each character is transmitted and received asynchronous framed by a start and a stop element. Such terminals was originally electromechanical

3 The NPDN (Nordic Public Data Networks)

The telecom administrations of Norway, Sweden, Finland and Denmark decided in 1975 to establish national circuit switched public data networks in a common process. Ericsson was chosen as the main system contractor with a system based on AXE[3] in the switches. But Nokia, EB (Elektrisk Bureau) of Norway and Søren T. Lyngsø A/S from Denmark also participated in the development and production of equipment to the network.

The networks opened commercially in 1982 under the name Datex in the Nordic countries. But the networks were individual national networks with no common operation except interconnection according to X.71 and X.61 (based on common channel signaling as a user part of SS7[4]). In fact X.61 was the first international usage of SS7, which now is the most common signaling system for telephone and mobile networks.

The networks offered circuit switching with X.21, X.21bis (V.24 interface) or X.20bis (asynchronous) at 600, 2400, 4800 and 9600 bit/s.

In Denmark two exchanges (Århus and Copenhagen) were established. Nationwide coverage was ensured from the start with a range of decentralized equipment using analogue (FDM) or digital (PCM) connections. But most customers were connected via cheap base band modems to a multiplexer or concentrator at the local exchange. A connection could be established in 200-500 msek dependent on the speed chosen by customer . This was considerably faster than the later ISDN, where call setup time was 3-6 seconds. By 1987 Datex had 10.000 subscribers in Denmark and app. 50.000 in the Nordic countries.

Similar public networks were established in Germany and Austria (called Datex-L), but most other countries opened only X.25 networks during the 1980s. X.25 networks were also opened in the Nordic countries, but there was no common Nordic effort to develop these networks, and different vendors were chosen.

X.21 was primarily used for national communication, while X.25 was used primarily for international communication as the only switched data transmission service with global coverage (except telex). The IP- based internet was not available for commercial companies as a service in the 1980s.

With its high stability due to redundancy in the design Datex was used for critical applications established in the banking sector and other sectors in the 1980s. For the first time many of these applications in regional offices were fully dependent on data communications with centralized IT applications. One of the systems in Den-

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[3] AXE was the product name of Ericson's digital telephone exchange, where all telephone circuits are switched as 64 kbit/s streams.

[4] SS7 (Signaling System no. 7) was the first signaling system, where signaling protocols used specific data channels instead of the traffic channels. Also called out of band signaling.

mark was SDC (Sparekassernes datacenter) connected to app. 2000 sites via Datex. Another application was the Dankort-system with online money transactions. It was established with dial-up telephone connections and modems to the local exchange and further transmission through Datex to the central book-keeping system.

4 The Dream of Public Data Networks

Public data networks offered digital connectivity globally and nationwide in a period, where the public telecom networks were undergoing transformation from analogue to digital transmission. In Denmark digitalization started commercially with rural connections in 1974, and digitalization of the backbone began in 1978, while the first digital telephone exchanges were put into service in 1982. The full digitalization of exchanges and connections was completed in 1998.

Public data networks offered nationwide and international direct connectivity of reliable "data paths" between customers during the transformation. Public data networks were also based on the idea, that direct connectivity among customers would be as important to data communication as the similar connectivity known from the telephone service.

But until today the need for full connectivity at the transmission level has not been the most important requirement for the market. Connectivity is typically achieved by centralized services and not by direct connections between end customers. Just think of services such as e-mail, centralized IT applications of companies etc.

Therefore public data networks were gradually overtaken by services without full connectivity (and therefore cheaper) such as frame relay and later typically VPN on the internet etc.

Teletex was an attempt to use public data networks to transport documents (like telex) based on the end-to-end direct transmission through public data networks, X.21 or X.25. But Teletex never really caught on. In reality public data networks were used mainly to replace fixed connections as a cheaper, unified and more stable alternative.

In Denmark Datex was mostly used as transmission solution from thousands of terminals nationwide to one or a few data centers. The most used facilities were direct calls, where the customer always establishes connection to a specific number and closed user group[5], where transmission can be limited to a group of numbers.

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[5] Closed user group is a security facility in X.21 and X.25. Only members of a group can connect with each other and call attempts from others are rejected by the network.

5 The End of NPDN

During the last 10 years all X.21 networks in NPDN have been closed. In Denmark Datex was closed in 2012, thirty years after the opening of the service. The last major application was the Dankort system, which now fully relies on internet access at the point of sale. It is astonishing, that this application of Datex existed more or less unchanged for nearly 30 years.

Also most X.25 networks are now closed or overtaken by specialized international providers with few customers.

6 X.21 and X.25 still exists

Although the public data networks are no longer widely used, the interface specifications are still often used. X.21 physical interface is used for synchronous direct connection of equipment. X.25 in its DTE-DTE version is similarly often used as a layer 3 protocol to connect equipment directly. X.25 is also used in specialized networks, for example in packet radio and as backbone capacity for specialized applications such as teller machines.

Public data networks played a role for the internet and further development in telecommunications. For example HDLC was shaped to practical standards (LAPB[6]) through X.25, which is also often still considered the mother of all layer 3 protocols, even if IP is a simpler connectionless protocol.

7 The Development of Switching Technologies

During the 30 years period since the introduction of NPDN nearly all data transmission has moved to packet based transmission and switching.

The underlying reason is that cost of transmission has declined less than processor costs. It is therefore beneficial to optimize use of transmission by organizing data in packets, where several communications can share the same transmission resource on a statistical basis.

To illustrate the technological status in 1980 a common European packet switched network, Euronet, opened in 1980 with a node in Copenhagen. The total capacity of a node in that network proved to be only 50 packets/second. With the further development of processor capacity and dedicated hardware this changed dramatically during the 80s with typical capacities of a packet switching node growing to

[6] Link Access Protocol Balanced mode of operation

several thousand packets/second.

ATM was an attempt to raise the capacity of switching in a way very similar to circuit switching. In circuit switching the basic element is an envelope with 6 or 8 bits of data and 2 overhead bits (status and alignment). In ATM the basic element is a cell with a fixed length of 53 bytes. As in circuit switching the switching in ATM can be performed in a switching block with little use of processing power. ATM also contains resource management through connection oriented mode of operation. Unlike connectionless mode as in IP overbooking cannot happen.

But even ATM did not expand as a public service, and IP with variable length packets is now the dominant mode for transmission and switching of data.

With fiber connections all the way to the end users and future optical switching some form of new switching technology may be needed. The balance between processor power and transmission capability may be changed. But it is perhaps too early to even talk about it. So I will abstain from that subject.

8 Benefits from Nordic Cooperation

NPDN was one of many concrete common projects born in the spirit of Nordic cooperation formally based on groups established under Nordisk Ministerråd. There was intense Nordic cooperation in international bodies such as ITU, CEPT, ETSI, ISO, Cenelec etc. Sometimes with common positions, sometimes without. But always with collection and sharing of information. Other areas were cooperation in satellite communications and mobile communication (NMT - Nordic Mobile Telephone).

Nordic telecommunication operators and Nordic industry benefitted both practically and through the evolving of competence in many specialized areas of the telecom sector. In the 1990s it was even considered to merge Nordic operators to form a stronger international player, but only Telia and Sonera merged in practice. Today the standardization is fully in the hands of key industrial players.

Hopefully the spirit of Nordic cooperation still exists. Telecommunications is still a complex and fast evolving sector for the individual small Nordic countries.

References

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