# Dankort, the Danish National Debit Card System from the Early 1980s

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**Keywords: Abstract.** In the mid-1970s the Danish banks saw problems in controlling national payments. The use of checks had increased dramatically, as had the cost of check clearing. The national postal giro system was a cheap and popular payment system across a large part of the population, and foreign payment card companies were interested in the Danish market. Facing these challenges, the Danish banks and savings banks agreed to establish a shared national electronic debit card system (Dankort), the first in the world. The Dankort project faced much public and political attention, which produced a parliament act on payment card systems. The Dankort project encompassed development of new hardware and software and a new payment procedure in the Danish retail. Dankort now covers more than 80 % of all retail payments in Denmark (2014).

Keywords: Dankort, payment card, debit card, electronic payment, encryption.

## Introduction

The Danish financial market of the 1960s and 1970s was fragmented. Many banks and many savings banks were operating. No single bank or savings bank dominated the market and no foreign bank was established in the Danish retail market. Businesses primarily used the banks, and private people mainly used the savings banks. Savingsbanks were by regulation restricted in their business opportunities. Traditionally all banks and savings banks cooperated, and checks were accepted all over the country and could be cashed at the branch office of any bank and savings bank. The branch office was responsible for storing all cashed checks. They were not sent to the issuing sent to the issuing bank. Bookkeeping and clearing was done electronically on a daily basis. All medium size and small banks and saving banks were members of one of about 15 IT-centers, and each large bank had its own computer center.

All Danish employees were by a parliament act required to have an account in a bank or savings bank within the Danish income tax system. The employers delivered salary and income tax information electronically to the banks. For this end the banks and savings banks had produced a common IT-salary system and offered it to the employers. They also introduced an IT based common monthly payment service.

The costs of handling the rapidly increasing number of checks led to studies and negotiations in the Association of Danish Banks and the Association of Danish Saving Banks. During several years they both had tried to agree upon a fee for each issued check, but this had met great resistance from private customers as well as retailers. The customers would not pay a fee to the banks and savings banks for using their own money. A new payment solution had to be found.

## A new Payment Solution

The two financial associations established a task force, in 1975, to come up with ideas for an electronic solution. The existing international card systems, e.g. Eurocard, were brought into consideration. After about two years of discussions the common "payment systems committee" agreed to suggest that banks and savings banks developed a common Danish debit card, to be called "Dankort", and banks and savings banks concurred. In this process two key questions emerged: paper based or electronic processing and how to pay the costs of the system and its operation.

Analyses had shown that the cost of cash payments was DKK 7.50 per transaction. Cost for a check was DKK 5.00, and cost for an electronic transaction would be DKK 1.25. But the committee reasoned that two Dankort transactions would be needed to replace a check transaction. The committee suggested that the costs for the new Dankort should be split between the retailers and the consumers. The retailers should pay DKK 1.50 and the consumers DKK 0.50 per transaction

The publication of this suggestion nearly started a "revolution" because neither retailers nor consumers would pay anything for a new payment system. Signs with "Reject the Dankort" were posted in many retail shops, and consumers asked why they should pay money for paying for goods in a shops? So far using cash has been free of charge.

Although the retailers could see benefits from the suggested electronic system, they were not willing to make the needed investments and to pay transaction fee. So they took the "say no" attitude. However later in the development phase there was a fair and professional cooperation between the Dankort development group and the retailers IT-departments.

The basic idea of the payment system was to introduce a standard plastic card and a four-digit PIN-code (not to be chosen by the user) plus electronic terminals in the shops and encrypted communication to a central computer. There was no balance control against the consumer's bank or savings bank account. Like in the check system, book-keeping would take place every night in the banks' computer centers.

The banks and savings banks stuck to their proposal and a new shared company was established on September 3, 1979. It was named the Financial Institutions' Debit

and Credit Card Company (Pengeinstitutternes Købe- og Kreditkort Selskab, abridged PKK). The first CEO was recruited from retail. Two years later he was replaced by a person from the banks' association.

## Act on Payment Card (Lov om betalingskort) of June 6, 1984

The public reaction to the proposal caused a debate in parliament. The responsible minister was confronted especially by the left wing parties. They were worried about the possible registration of data about where and for what each consumer was spending money. They were worried about the system's security, e.g. during the communication process. They asked about consequences of possible breakdowns of an electronic system, about responsibility when a card was stolen and used by the burglar etc. Several members of parliament found that such an important system should not be established and controlled by private companies. It should be controlled by government. There were also discussions about the information on the receipt issued to the customer. It was argued that the receipt should contain no information about the single items bought, and no name of the shop, only a shop number, a date and the total amount. (Today you wonder.)

In June 1984 an act was adopted to operate starting on January 1, 1985. Banks and savings banks were not allowed to charge transaction fees from consumer or retailer. The act decided the distribution of responsibility between the card issuer and the consumer. It regulated security and registration of data and readable information on the plastic card.

During the political discussions and the parliament's readings of the new act, a technical project group from retailers, banks and savings banks worked on developing a technical solution, which could benefit both parties.

However, despite the original idea of a completely electronic system, the Dankort system was first introduced as a note based for political reasons. Notes were embossed in the shops and signed by the customer.

## The Technical Solution

In addition to the plastic card, the elements in the system were a payment terminal in the shop, a communication system between the shop and the central Dankort computer system, a central Dankort computer system and a communication system to the IT-centers of the banks and savings banks. For the complete system, PKK demanded high security both against break downs and fraud, quick response time and simple to use. Further, the retailers demanded that the response time for a transaction should be no more than one second. This was an extreme demand in 1984.

### 4.1 The Plastic Card

At first it would seem an easy job to make the specifications for the Dankort. The content of the magnetic strip would follow international standards, but what about the visible information on the card?

Banks and savings bank found that their name and logo was the most important information. The developers in PKK had the Dankort logo as the most important visible information. The compromise was to have the bank or savings bank's logo on one side and the Dankort logo on the other side.



**Fig. 1.** Early Dankort. Name of bank or savings bank on one side; Dankort logo on the other side.

There was also a discussion about having a portrait photo and the social security number on the card. The credit card act banned the social security number from the card. Since 1985 the card's layout has changed 4 or 5 times. A few years ago all cards were replaced by chip cards, mainly for security reasons which involved introduction of terminals with a chip reader.

### 4.2 Terminals for the Shop

Early in the development phase the technical project group in PKK saw that a complete new terminal had to be designed, primarily because of need for encryption. Transmission would be based on landline telephones, because even the smallest retailer had a telephone, and the PKK development team established cooperation with the telephone companies. At that time Denmark had four regional telephone companies each covering a "telephone region". The four telephone companies and PKK established a common project group to design standards for transmission.



Fig. 2. The Dankort terminal. To the left the shop cashier's terminal, where she entered the amount and printed the receipt. To the right the customer terminal with card reader and key-board for the PIN-code.

A technical description including an encryption module was written. A completely new design by Henning Andreasen, a well-known Danish designer, was agreed upon by PKK and the retailers. It included a two part terminal, one part to be used by the customer and one part to be used by the shop. (Some years later the functions of the latter could be performed by an electronic cash register). A Danish telephone manufacturer, GNT, was selected. GNT demanded an order for minimum 10,000 terminals before starting production. In addition PKK had to issue a warranty for the production.

The first terminals were simple. They could only read the Dankort – no other payment cards could be used. The receipt to the customer printed on the shop-part of the terminal was a small one with a minimum of information. However, this reduced the transaction time.

## 4.3　　The Communications System

At that time telephone communication was one technical system and another was data communication. The maximum speed for telephone communication was 300 baud. Anything higher was called data communication, and it was only available on leased lines supplied by the Danish Post and Telegraph (PTT). Leased lines were expensive.

The telephone line communication protocol was analog. The telephone companies offered to double the communication speed to 600 baud. To speed transmission, communication was routed to leased digital data transmission lines at selected telephone exchanges across the country. At the exchanges, concentrators converted the signal from analog to digital form and communicated with the central computer system at a higher speed. A modified CCITT protocol (X21) was used for this communication. At the Dankort computer centre, a front end computer entered the communication from the network into the central processor.

## 4.4　　The Central Processor

The central processor had to support that 95 % of the transactions should be processed in less than 1 second (including decryption and encryption). It should operate non-stop 24 hours a day. It encompassed end-to-end control with any transaction to secure no loss of data and handling access from up to 50,000 terminals creating up to 600 transactions per second. These demands were overwhelming at that time and maybe also a little too exaggerated.

There were no off the shelf computer systems available in the market. Therefore, PKK negotiated with several suppliers, including IBM, NCR, Burroughs, Tandem and CRAS. CRAS, Christian Rovsing limited, was a Danish computer manufacturer and had success producing high performance systems and. CRAS just had achieved orders for a ticket reservation system to be used by an American and a Canadian airline. In PKK's negotiations with CRAS, the company suggested an extendable system based upon a standard microprocessor, which could process up to 40 transactions per second. CRAS also designed a front end processor, a processor for encryption and a virtual disk storage system. This was a perfect drawing board system, but a non-standard system with many completely new elements. PKK contracted with CRAS,

they established a project group, CRAS manufactured hardware and software. But three months before start of production CRAS went bankrupt.

Luckily CRAS had produced most of the hardware and software for the Dankort central processor. PKK bought the whole project group (about 15 persons), and they became employed by PKK. Thus the development process did not stop and processing of Dankort payments (called "production" at PKK) started in November 1984 with a very low number of daily transactions. The system was expanded over the next couple of years and ran production until the mid-1990s. By this time the processing capacity was about 100 transactions per second and the CRAS system was replaced by an IBM system. At that time the system had to be expanded to handle other kinds of debit and credit cards.

## 4.5    Encryption and Security

In the beginning of the 1980s encryption was exclusively used for military purposes. Nobody within banks and savings banks had any knowledge about encryption. The project group had to read public information, establish communication with technical universities, foreign specialists- etc. A DES-encryption based upon a 64 bit key was chosen. In theory the encryption key could be broken, but the encryption/decryption process was very fast and demanded little processor power. This was very important for the development of the terminal for the retailers. The specification of the encryption box was set up in cooperation with National Physical Laboratory in UK. A Dutch company made the security control of the box. Each encryption box was loaded with a unique encryption key. CRAS developed a front-end processor for decryption/encryption. This machine had a processing capacity second to none at the time.

## 4.6    A very Slow Start

The first Dankort transaction took place on September 1, 1983.  It was a paper or note based transaction. The customer signed a note with the card information, shop information and the amount. The signature had to be compared with the signature on the plastic card. Exactly as the well know procedure used for other payment card systems, like Master Card, Diners and American Express. Many retailers had experience with this procedure and during the first year after introduction, about 14,000 shops contracted for Dankort payment with PKK.

Still consumers were negative, and the last four months of 1983 only saw about 78,000 transactions.  In 1984 the number increased to about 580,000. In 1992 the number of Dankort transactions was higher than the number of check transactions (more than 200 million.). Today (2014) the yearly number of Dankort transactions have passed one billion. In addition a raising number of transactions are based on buying and selling on the Internet. In 2013 there were 74.3 million Dankort payments on the Internet.

About 4.5 million Danes (nearly the total number of grown-ups) have a Dankort, and more than 80 % of the turnover at the Danish retailers is paid by Dankort. Some retailers would prefer only to accept payments by Dankort or other cards in order to avoid handling cash money.

## ATM Cash Machines Spread over the Country

However back in 1984 something had to be done to change the population's negative attitude to the new payment system. The means was outdoor ATM machines, which were not known in Denmark at that time. Some banks and saving banks have had indoor ATMs for self-service. As an effort to teach the consumers to use the Dankort and remember their PIN-code, PKK decided to install 150 outdoor ATMs with the same design at highly crowded places in Denmark. They should for competitive reasons not be installed close to a bank or savings bank, but at so called neutral places such as railway and bus stations, shopping centers and market squares. The ATMs were called "Kontanten" ("The cash"). They were supplied by NCR. The ATMs provided customers of banks and savings banks access to cash money during non-opening ours. Many branch offices have very limited opening hours and only one weekly late opening until 19:00.

It is a little strange that a system introduced to minimize the use of cash money had to be helped getting started by a system which gave quick access to cash money. The 150 ATMs became very popular, and they were in operation for about 15 years. Today every bank has its own ATM-system.

## The Dankort System and the Impact on the Danish Society

In 1983 even employees at banks and savings banks had a negative feeling about the proposed electronic payment system. They feared for their employment. The customers' need for cash money would be reduced, which meant fewer employees in the banks. The handling and counting of the daily deliveries of checks and cash money from the retailers would be reduced. They did not understand that their work would be changed towards counseling, investment handling and other kinds of customer services.

Around the year 1980 the number of branch offices for banks and savings banks were much higher in Denmark than in other countries, and the numbers of customers per branch office were very low. A reduction was needed, which was aggravated by the economic crisis in 2008 and the following reduction of business and income for the banks. Simultaneously, the number of banks and branch offices and the number of bank employees have been reduced dramatically.

It was expected that a break-through in technology caused by the Dankort system would create export possibilities for Danish hardware and software companies. This did not happen despite strong efforts. The bankruptcy of the hardware manufacturer and the fact that a payment system similar to Dankort is difficult to introduce in countries with different financial marked and another infrastructure might be among the reasons. In many countries one or two dominating bank are operating with great market shares. They will not involve themselves in shared systems, which gives even their smallest competitor the same business opportunity in the payment market as they have.

The Dankort system has proved that Denmark can be proud of having probably the most effective and cheapest payments system in the world. The total cost for an elec-

tronic Dankort transaction is about €0.10 or $0.15. The price for cash payments and credit card payments are at least 10 times higher.

Despite the great success of the electronic Dankort system there has been no reduction in the number of coins and notes in Denmark. Especially the number of the highest denomination (DKK 1,000) has risen.

The extensive use of Dankort also means that a break down has tremendous impact on the consumer business in Denmark. On January 20, 2014 the system was down from 05:00 a.m. until about 04:00 p.m. No electronic payments could be processed. A note based back-up system is only available in shops with a very low number of transactions. Today no Danes are using checks and many do not even carry cash money. Luckily many of the new terminals in the shops can store data from the Dankort and print an extra receipt, which the customer can sign if a break down occurs. In general system availability is very high, approximately 99,9 % uptime in average for a system running 24 hours, 365 days. Fraud is very low. In 2013 it was 0,015% of the total turnover.

## What`s to Come?

In April 2014 the Dankort operator, Nets, was sold to two US-located investment companies (Bain Capital and Advent International) and the Danish national pension fund ATP. The previous owners were Danish banks and savings banks plus the Danish National Bank. Many Danes felt unsafe having an American owner of a system with such an importance for society. How would the security about the enormous amount of privately related and sensitive data be handled? Would a foreign government be able to demand access to Danish data? Would the new owners go for a higher return on investment and thus higher prices for use of the system?

The current agreement between Nets and the Danish organization for retailers is running from 2013 to 2020. Within this agreement retailers will gradually cover more and more of the costs for the system. By 2020 the retailers will have to pay all costs.

It might be expected that payments by the use of smart phones could be a severe competitor to Dankort payments. If the security will be approved and the price per transaction is acceptable, we probably will see Dankort transactions replaced by phone payments, especially from young people who have their smart phone on-line 24 hours a day.

But the Dankort will also be "upgraded". Mid-2014, NETS decided that from mid-2015 all issued Dankort will successively be replaced with cards having the NFC (Near Field Communication) technology.

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