Lecture 12: Smartcards

Memory cards - simple type of smartcard. Memory cards only have some amount of memory inside the card and this memory can be normally read and written. There is normally nothing really intelligent inside those cards. Typically the memory inside this kind of card is EPROM, EEPROM or FLASH memory. This card type is very widely used as a telehone card (telecards). Many countries use a telecard system which is very close to the first smartcard telephone system in use in France.

Real smartcards - have real microprocessor inside the card. There have been many different small microprocessors used inside smartcards including 8031/51 variants, PIC microcontrollers and some special microprocessors just designed for smartcard applications. Very many smartcards communicate using the protocols standardized in the ISO 7816 standard which defines many physical features, including card size, mechanical strength and electrical properties. The standard pinout is:

C1 : Vcc = 5V	C5 : Gnd
C2 : Reset	C6 : Vpp (programming voltage)
C3 : Clock	C7 : I/O (data in/out)
C4 : API	C8 : API

Pins marked with API are application specific pins defined in application standards.

The standard supports two transmission modes:

- Asynchronous transmission: In this type of transmission, characters are transmitted on the I/O line in an asynchronous half duplex mode. Each character includes an 8 bit byte.
- Synchronous transmission: In this type of transmission, a series of bits is transmitted on the I/O line in half duplex mode in synchronization with the clock signal on CLK.

There is a selection of different protocols available for communicating with the card. There is a method for selecting which communication protocol to use (one card can support one or more protocols). The most commonly used protocol seems to be asynchronous half duplex character transmission protocol.

Reading the data is from a serial EEPROM over a two-wire (I2 C) or three-wire SPI or microwire bus; the power, clock, and data lines are connected separately. Some wired smartcards use RS-232 type asynchronous communications, and in this case they supply power and communication through different wires.

Contactless smartcards – smartcards where communication and usually power are transferred wirelessly using RF signals and/or inductive coupling methods. For this, Passive Radio Frequency Identification (RFID) systems, called RFID tags, are needed that use radio frequency to identify, locate and track people, assets, and animals.

Passive RFID systems - composed of three components: an interrogator (reader), a passive tag, and a host computer. The 1/3 mm sized tag is composed of an antenna coil and a silicon chip that includes basic modulation circuitry, a uprocessor cpu, RAM, and non-volatile memory on an EEPROM. The uprocessor on the tag is energized by a time-varying electromagnetic radio frequency (RF) wave that is transmitted by the reader. This RF signal is called a carrier signal. When the RF field passes through an antenna coil, there is an AC voltage generated across the coil. This voltage is rectified to supply power to the tag. The information stored in the tag is put into RAM for temporary data storage and is transmitted back to the reader by the processor. This is often called backscattering. By detecting the backscattering signal, the information stored in the tag can be identified.

Passive RFID devices also use a serial bus, but the power, clock, and data are all in the same signal. Instead of wires, the signal is carried through wireless means. Typical RFID systems use inductive coupling between the card and the reader. Both of them have coils which interact with each other (magnetic coupling). This interaction makes it possible to transfer power to the card (through alternating magnetic field or pulses) and transfer information (modulating the magnetic field). Typically this kind of inductively coupled systems operate at 125-kHz to 13.56-MHz frequency range. ISO frequencies of 125 kHz and 13.56 MHz are generally used which utilize transformer-type electromagnetic coupling. For instance, Texas Instruments makes a RFid Tag-it chip that complies with the ISO15693 standard, operating at 13.56 MHz. Sometimes higher frequencies are used for RFID tagging also. Question: What practical uses of RFID tags make them an attractive alternative to other kinds of smartcards?

Trivia: Bar codes were patented in 1952; RFID tags were patented in 1973.

Magnetic cards or bar coded cards - examples of smartcards? No!