Speaking clock

The speaking clock in Sweden 'Fröken Ur' got a new voice on March 8, 2000. The clock was at the same time moved from Telia in Stockholm to the time and frequency laboratory at SP. SP is responsible for the time synchronisation and the maintenance of the speaking clock in the laboratory.

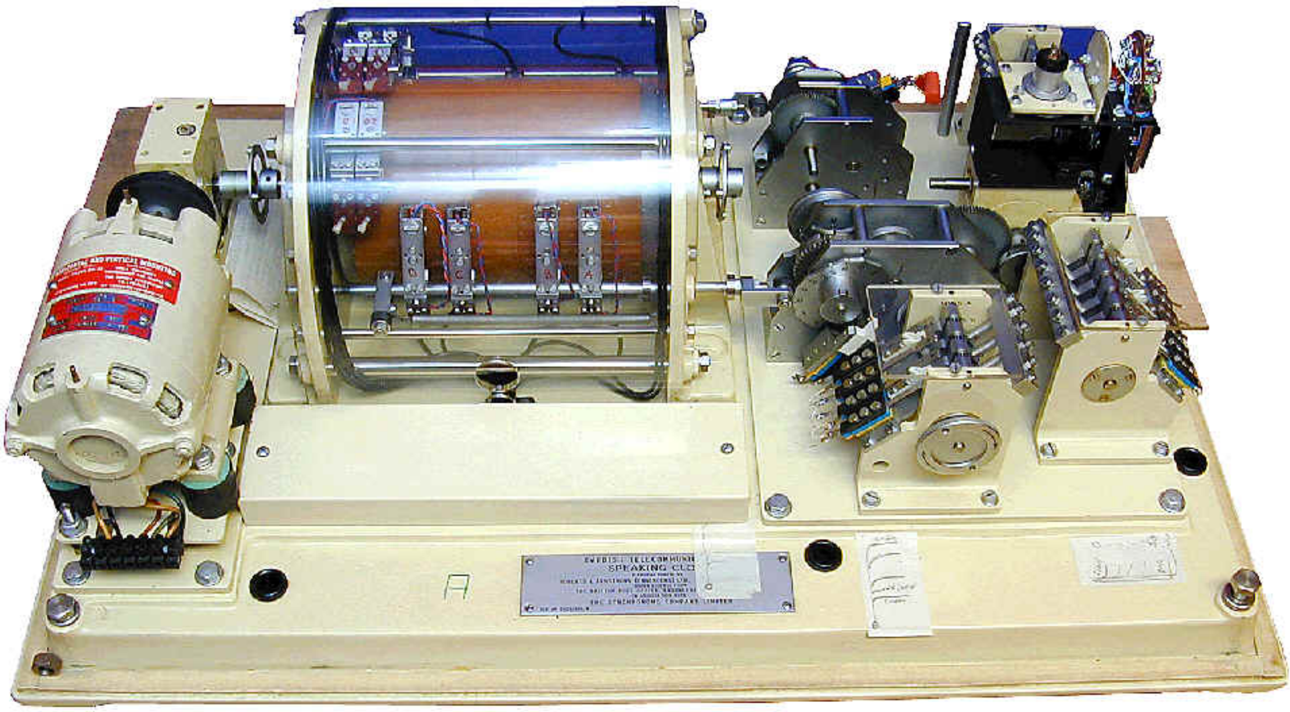
Telia is responsible for the the distribution of the time stamps from the laboratory to the end users. It is not only the voice and the location that is new. The tape recorder that had been operating since 1968 was replaced by a computer-based system developed at SP on commission by Telia. There has been a close co-operation trough the different development phases of the system with Guide (Communicator) that has developed the parts of the software and Cendio Systems that has developed the computer system. The voice recording has been supplied by Telia.

Due to the move of 'Fröken Ur' the speaking clock is now connected to the atomic clocks at SP that maintain the Swedish National time scale, UTC(SP). The speaking clock announces apart from hour, minute and every tenth second with a tone, also the day, the month and the year every minute. Changes between Standard time and daylight savings time are also announced a day before and a day after the present date of change. The telephone number to the service is 90510 in Sweden. The service is also accessible from abroad Sweden by dialing +46 33 90510.

The time stamp accuracy when leaving SP is normally better than 100 milliseconds. The accuracy at the end user depends on the propagation delay of the public phone system. To compensate on average for the delay SP distributes the time stamp 20 milliseconds before it starts to be in effect. The 1-kHz tone that indicates the valid instance of the time stamp is 100 milliseconds long and it is the front edge of the tone that indicates correct time.

Statistics of the accuracy of 'Fröken Ur' is available in deferred time from a webpage that is updated once every month, normally shortly after the and of a month.

Historical information (in Swedish) about 'Fröken Ur' and earlier versions of the speaking clock are available from Telemuseum, Tekniska Museet in Stockholm.



The old speking clock

Technical description of the speaking clock

Comprehensive technical description

The new speaking clock is computer-based in distinction from the old one. Several components are necessary for the speaking clock to work. The chain of components is duplicated to guarantee redundancy. Two computers distribute time independent from each other. A third computer is controls the function of the other two but can also distribute time with a manual switch.
In the beginning of each chain an atomic clock sends sharp and accurate 1-second pulses to the main computer. In addition a time code generator tells the system of the current date. A time synchronisation software in the computer retrieves this information and synchronises the computer system clock with an accuracy of better than 1 millisecond.

Each of the three computers is a PC based server running GNU/Linux as operating system. A software reads the system clock and generates voice sequences which are distributed through analog soundcards.

The analog voice is digitized using a so-called mini node or NTU, which is Telia's equipment for the distribution of data from one point to another. In this case the voice is distributed via a digital X-line connection from SP to Telia's distribution point in Stockholm.

The X-line chain is duplicated and geographically separated. In Stockholm one of the two channels are distributed to the end user. If on chain goes down the other chain is automatically chosen.

How and to which time scale is the speaking clock synchronised?

The definition of the second is according to the SI-system based on the resonance frequencies of cond pulses according to the definition. The atomic clocks are very accurate and the time drift is one second during approximately 300 000 years. The clocks are also compared with over 200 other atomic clocks worldwide through observations against satellites within the GPS system. The coordination is done from the International Bureau of Weights and Measures (BIPM) outside Paris and the atomic clocks at SP and the Swedish National time scale UTC(SP) is therefore included in the calculations of the international atomic time scales TAI and UTC.

Time code generators are used to synchronise the speaking clock to UTC(SP). A time code generator distribute the time information in an ASCII-format to the computers with an accuracy of approximately 10 milliseconds. The accuracy is improved to better than 1 millisecond using the 1-second pulses from the atomic clocks. Each main computer is synchronised to an atomic clock and to the time code generator via two serial ports using software developed for NTP and time synchronisation over the Internet.

The two main computers of the system and a third one normally used for supervision of the other two are connected in a local network. The three computers can if necessary synchronise to each other if the external synch from the atomic clocks is not available. The third computer is synchronised to the two main computers.

Computer hardware and operating system

The two main computers are IBM Netfinity 5000 servers and are have duplicated hard drives, fans and power supplies. The computers are equipped with Intel Pentium III 550 MHz processors and 256 Mbytes of RAM memory. The hard drive system consists of a RAID controller and two 9 Gb SCSI-hard drives. The RAID controller is mirroring everything on the first hard drive onto the other one and will therefore manage a hard drive crash. Except that the computers have built-in functions for hardware supervise there is also a special expansion card that increases the possibility of supervising. The system with the two main computers is configured so that every alarm will be sent to a third computer, an IBM Netfinity 3000 for, setup mainly for supervising. The fast communication within the local network is managed with a 100 Mbit/s Ethernet controller in all three computers. The digital sound files are converted to analog sound in a soundcard, Hoontech 4D Wave-NX.

There is a special tailored distribution of Linux based on Redhat Linux 6.1 as operating system. The installations are strongly slimed to ensure performance and stability to reach a system that is minimal.

The speak program and the audio files

The speak program is written in C-code and uses the programming interface ALSA (Advanced Linux Sound Architecture) to be able to send the voice announcements to the soundcard. Every 10th second the program checks the system clock and chooses the proper audio files. The tone signal can be adjusted with an accuracy of a few microseconds to be able to compensate for the latency in the public phone system. The program is continuously logging to a system log what is going on to the supervising computer. There is also a configuration file that is read once every minute if any changes should be made in for example the latency correction. This makes it possible to configure the speaking clock without restarting it. The audio files are sampled with 44.1 kHz, 16 bytes unsigned, little endian.

The distribution through Digital X-line

There is an interface for A/D conversion in the so-called mini node or NTU at SP. The digital format used is an A-law 64 kbit/s, 8 kHz sample frequency and 8 bytes resolution. The data flow is transported from the mini node further into the Digital X-line network in a time slot according to the G.703-protocol. There is also a mini node at the distribution point in Stockholm which is working in the other direction, that is, collecting an A-law over the G.703 and converts the data flow to analog sound in its D/A interface.

Security, error handling and alarm

Since the system is redundant with duplicated hardware and distribution lines, two analog signals arrive to the distribution point at Telia in Stockholm. Which of the lines that is distributed to the end user is decided in a special designed line switch that is detecting the occurrence of a tone signal or not. An alarm is emitted if the tone signal fails and a switch will occur so that the other signal is distributed instead.

The supervising computer at SP is checking the functionality of a great number of hardware and processes using the software Netsaint which emits an alarm through the parallel port that is connected to SP's regular alarm system via an optointerface. In addition to the checks that is maintained by Netsaint, the occurrence of tone signals is also detected on all three computers' sound ports. With this, the whole link all the way to the sound generation is supervised. By the detection of the tone signal from the supervising computer an additional check is done of the supervising computer.

All alarms are also sent as an SMS-message to mobile phones using a GSM-card in the supervising computer. This makes it possible to find out in detail what kind of failure that has caused the alarm.

There is no connection to the Internet from the speaking clock system. The three computers is only connected in a local network. All the sensitive equipments in the time and frequency laboratory at SP get its power from prioritised power network with power reserve from a diesel engine generator.