Electronic switching system (ESS)

In telecommunications, an electronic switching system (ESS) is a telephone switch that uses solid-state electronics, such as digital electronics) and computerized common control, to interconnect telephone circuits for the purpose of establishing telephone calls.

The generations of telephone switches before the advent of electronic switching in the 1950s used purely electro-mechanical relay systems and analog voice paths. These early machines typically utilized the step-by-step technique. The first generation of electronic switching systems in the 1960s were not entirely digital in nature, but used reed relay-operated metallic paths or crossbar switches operated by stored program control (SPC) systems.

Reed relays

Reed relays contain a reed switch, a coil for creating a magnetic field, an optional diode for handling back EMF from the coil, and an encapsulating package with connection terminals. In many ways, a reed relay, if used correctly, is a near perfect device with a low-resistance metallic switch path and inherent isolation between the control voltage operating the coil and the signal being switched.

The reed switch has two shaped metal blades made of a ferromagnetic material (roughly 50:50 nickel iron) and a glass envelope that holds the metal blades in place and provides a hermetic seal that prevents any contaminants from entering the critical contact area inside the glass envelope. Most (but not all) reed switches have open contacts in their normal state.

If a magnetic field is applied along the axis of the reed blades, the field is intensified in the reed blades because of their ferromagnetic nature, the open contacts of the reed blades are attracted to each other, and the blades deflect to close the gap. With enough applied field, the blades touch, and electrical contact is made (**Figure**).

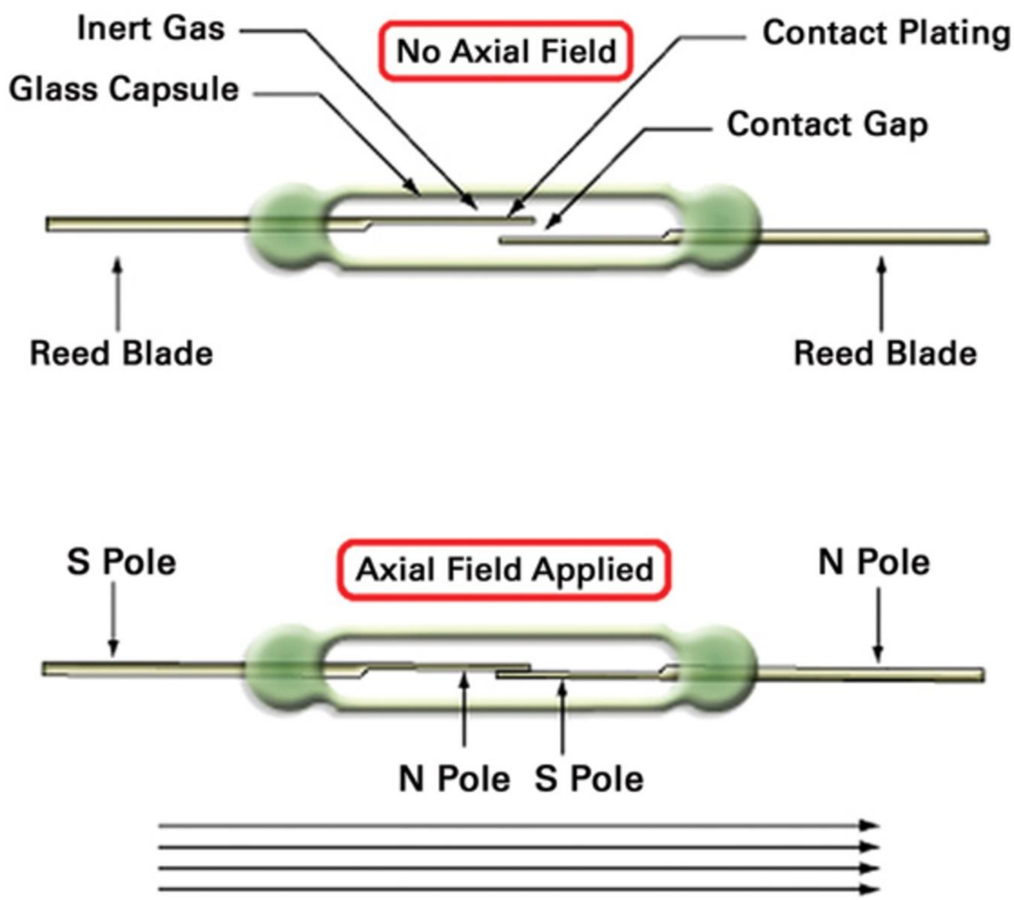

Figure: Reed relay without (top) and with (bottom) magnetic field applied

The only movable part in the reed switch is the deflection of the blades; there are no pivot points or materials trying to slide past each other. The contact area is enclosed in a hermetically sealed envelope with inert gasses, or in the case of high-voltage switches a vacuum, so the switch area is sealed against external contamination. This gives the reed switch an exceptionally long mechanical life.

First announced in 1955, the first customer trial installation of an all-electronic central office commenced in Morris, Illinois in November 1960 by Bell Laboratories. The first large-scale electronic switching system was the Number One Electronic Switching System (1ESS) of the Bell System, cut over in Succasunna, New Jersey, in May 1965.

1ESS

The adoption of metal–oxide–semiconductor (MOS) and pulse-code modulation (PCM) technologies in the 1970s led to the transition from analog to digital telephony. Later electronic switching systems implemented the digital representation of the electrical audio signals on subscriber loops by digitizing the analog signals and processing the resulting data for transmission between central offices. Time-division multiplexing (TDM) technology permitted the simultaneous transmission of multiple telephone calls on a single wire connection between central offices or other electronic switches, resulting in dramatic capacity improvements of the telephone network.

With the advances of digital electronics starting in the 1960s telephone switches employed semiconductor device components in increasing measure.

In the late 20th century most telephone exchanges without TDM processing were eliminated and the term electronic switching system became largely a historical distinction for the older SPC systems.

4ESS Electronic Switching System

The No. 4 Electronic Switching System (4ESS) is a class 4 telephone electronic switching system that was the first digital electronic toll switch introduced by Western Electric for long-distance switching. It was introduced in Chicago in January 1976, to replace the 4A crossbar switch.

The last of the 145 systems in the AT&T network was installed in 1999 in Atlanta. Approximately half of the switches were manufactured in Lisle, Illinois, and the other half in Oklahoma City, Oklahoma. At the time of the Bell System divestiture, most of the 4ESS switches became assets of AT&T as part of the long-distance network, while others remained in the Regional Bell Operating Companies (RBOC)

System architecture

The 4ESS has three major components: the processor, the file store, which was later known as the attached processor system (4EAPS), and the peripheral units.

Processor

The processor acts as the CPU for the switch; the processor includes a central control, call stores, and program stores. In addition it had access to additional units through the auxiliary unit bus (AUB) and peripheral unit bus (PUB). A master control console (MCC) provides office technicians access to the switch through the processor peripheral interface (PPI). Early versions used the same 1A processor as the contemporaneous improved 1AESS switch. All existing switches have been subsequently upgraded to use the 1B processor.

File store and CNI ring

The file store provides long term storage (disk storage) of the processor programs (program store) and office data (call store), it was first implemented using disk technology but was replaced by the 4E attached processor system (4EAPS). The 4EAPS is a 3B computer running 4EAPS application software on the DMERT operating system; the 4EAPS interfaces to the 4ESS processor via the attached processor interface (API) units. The "1A file store" became partitions on the 3B computer disks. At first the 4EAPS just provided "file store" but soon it also provided access to the common-network interface ring (CNI ring) to provide common-channel signaling (CCS); the 4EAPS originally used the 3B20D computer. These were all converted to the 3B21D around 1995.

Peripheral units

The peripheral units include units that interface to the central control over the peripheral unit bus; this includes the common channel interface signaling (CCIS) terminal, signal processors, time-slot interchanges (TSI) and time multiplexed switches (TMS). It also includes equipment not directly on the PUB including terminating equipment used to connect the switch to the transport network and the TSIs and TMSs, which actually perform the "time-space-time" switching function. Timing is provided by a high speed, high accuracy network clock

5ESS Switching System

The 5ESS Switching System is a Class 5 telephone electronic switching system developed by Western Electric for the American Telephone and Telegraph Company (AT&T) and the Bell System in the United States. It came into service in 1982, and updated versions are still produced today.

History

Architecture

The 5ESS switch has three main types of modules:

the **Administrative Module (AM)** contains the central computers; the **Communications Module (CM)** is the central time-divided switch of the system; and the **Switching Module (SM)** makes up the majority of the equipment in most exchanges. The SM performs multiplexing, analog and digital coding, and other work to interface with external equipment.

Each has a controller, a small computer with duplicated CPUs and memories, like most common equipment of the exchange, for redundancy. Distributed systems lessen the load on the Central Administrative Module (AM) or main computer.

Switching Module

Each Switching Module (SM) handles several hundred to a few thousand telephone lines or several hundred trunks or combination thereof. Each has its own processors, also called Module Controllers, which perform most call handling processes, using their own memory boards. Originally the peripheral processors were to be Intel 8086, but those proved inadequate and the system was introduced with Motorola 68000 series processors. The name of the cabinet that houses this equipment was changed at the same time from Interface Module to Switching Module.

Peripheral units are on shelves in the SM. In most exchanges the majority are Line Units (LU) and Digital Line Trunk Units (DLTU). Each SM has Local Digital Service Units (LDSU) to provide various services to lines and trunks in the SM, including tone generation and detection. Global Digital Service Units (GDSU) provide less-frequently used services to the entire exchange. The Time Slot Interchanger (TSI) in the SM uses random-access memory to delay each speech sample to fit into a time slot which will carry its call through the exchange to another or, in some cases, the same SM.

Administrative Module

The Administrative Module (AM) is a dual-processor mini main frame computer of the AT&T 3B series, running UNIX-RTR. AM contains the hard drives and tape drives used to load and backup the central and peripheral processor software and translations. Disk drives were originally several 300 megabyte SMD multi-platter units in a separate frame. Now they consist of several redundant multi-gigabyte SCSI drives that each reside on a card. Tape drives were originally half inch open reel at 6250 bits per inch, which were replaced in the early 1990s with 4 mm Digital Audio Tape cassettes.

The Administrative Module is built on the 3B21D platform and is used to load software to the many microprocessors throughout the switch and to provide high speed control functions. It provides messaging and interface to control terminals. The AM of a 5ESS consists of the 3B20x or 3B21D processor unit, including I/O, disks, and tape drive units. Once the 3B21D has loaded the software into the 5ESS and the switch is activated, packet switching takes place without further action by the 3B21D, except for billing functions requiring records to be transferred to disk for storage. Because the processor has duplex hardware, one active side, and one standby side, a failure of one side of the processor will not necessarily result in a loss of switching.

Communication Module

The Communications Module (CM) forms the central time switch of the exchange. 5ESS uses a time-space-time (TST) topology in which the Time-Slot-

Interchangers (TSI) in the Switching Modules assign each phone call to a time slot for routing through the CM.

CMs perform time-divided switching and are provided in pairs; each module (cabinet) belonging to Office Network and Timing Complex (ONTC) 0 or 1, roughly corresponding to the switch planes of other designs. Each SM has four optical fiber links, two connecting to a CM belonging to ONTC 0 and two to ONTC 1. Each optical link consists of two multimode optical fibers with ST connectors to plug into transceivers plugged into backplane wiring at each end. CMs receive time-multiplexed signals on the receive fiber and send them to the appropriate destination SM on the send fiber.

Signaling

The 5ESS has two different signaling architectures: Common Network Interface (CNI) Ring and Packet Switching Unit (PSU)-based SS7 Signaling.

OAMP: Operations, Administration, Maintenance and Provisioning