Technical Developments in Telephone Engineering

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1. Push-Button Telephone

Although push-button touch-tone telephones made their debut to the general public in 1963, the rotary dial telephone still was common for many years. In the 1970s the majority of telephone subscribers still had rotary phones, which in the Bell System of that era were leased from telephone companies instead of being owned outright. Adoption of the push-button phone was steady, but it took a long time for them to appear in some areas. At first it was primarily businesses that adopted push-button phones. During the mid seventies, in the United Kingdom, Post Office Telecommunications, THQ (Telephone Headquarters), as it was then called, were investigating the replacement of the rotary dial with a push button telephone using different tones for each of the numbers 1 -0 on the existing rotary dial. A major problem with the dial telephone was premature dialling by the customer, which resulted in mis- directed or invalid calls. The correct procedure was on lifting the handset from the telephone cradle, the customer would wait until a dial tone was sent from the local telephone exchange, to indicate that the exchange equipment was ready to receive the dialled impulses transmitted by the customer. The customer then turned the dial clockwise with their finger placed in the appropriate hole of the dial, representing the number 1 to 0, until a finger stop was reached on the outside of the dial, preventing further movement. When the customer removed their finger, the dial would return to its original position, awaiting the next number, until all numbers had been forwarded for completion of the call. Often, customers would pick up the telephone and immediately commence dialling before the exchange equipment was ready, so that when dial tone was eventually forwarded by the local telephone exchange, a number of customer dialled digits would have been lost or clipped, and the call would either be part completed with

the exchange waiting for further pulses from the customers dial in order to route the call onwards (but none would be forthcoming) or prematurely route the call from the fewer pulses received to an unknown or invalid route. In both cases, the call would have to be abandoned.

Within Post Office Telecommunications, THQ, Holborn, London, the final design of the touch-tone telephone, which finally replaced the rotary telephone, was credited to **Roger TS Parr**, who introduced new electronic technology employing, among other sophisticated devices, FIFO chips (First in, First out). This overcame all problems which might be encountered by customers trying to beat the telephone exchange dial tone by prematurely transmitting the different tones for each of the numbers 1 to 0 on the telephone keypad. A prototype of the new design was taken to Hurstpierpoint telephone exchange in Sussex, where it underwent stringent trials, the outcome of which was successful. The design was then handed to Plessey Telecommunications (PTL) who, in turn, then designed the interface equipment, which was to be inserted in the telephone exchange to receive the tone pulses for onward routing of the call. It was during the testing phase with the new interface

that a major problem was encountered. As part of routine maintenance and testing of telephone exchange equipment by the telephone engineers, it was customary for the engineers to use a piece of equipment called a test lamp. This device, the body of which comprised a built-in lamp and a test probe, was plugged into a convenient power socket located near the piece of equipment to be tested and by means of a switch located on the test lamp, the engineer was able to determine different conditions on the equipment under test, e.g. a voltage, earth or disconnection present. One of these tests was to extend negative 50 volts from the probe of the test lamp to establish if an earth condition existed, which would complete or close an electrical circuit and light the test lamp. When this test lamp condition was used between the line connecting the new touch-tone telephone design and the interface within the exchange, due to the interface comprising diodes and transistors, the extension of negative 50 volts from the test lamp, blew these sensitive devices, rendering them useless. In collaboration with Plessey (PTL), Parr suggested the use of optical relays, a first of its kind to be employed in exchange interfaces and these devices provided the necessary barrier to allow the testing with a test lamp to be used with no fear of destroying the electronic devices, which were used to receive the tones from the touch-tone telephones for interpretation and decoding to route the call to its destination. By 1979, the touch-tone phone was gaining popularity, but it wasn't until the 1980s that the majority of

customers owned push-button telephones in their homes; by the 1990s, it was the overwhelming majority.

Some exchanges no longer support pulse dialling or charge their few remaining pulse-dial users the higher tone-dial monthly rate as rotary telephones become increasingly rare. Dial telephones are not compatible with some modern telephone features, including interactive voice response systems, though enthusiasts may adapt pulse-dialling telephones using a pulse-to-tone converter.

References

Roger T.S. Parr, BTUK/THQ (retired). See also by same author, Call Logging and BTOSS.

Call Logging

Call logging is the process of collecting phone call data, analysing this data, and then reporting on the telephone network's cost, performance, capacity and quality of service (QoS). It should not be confused with telephone tapping or call recording. The former refers to listening to calls, while the latter is about recording conversations.

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Collecting Data

Data is collected from a PBX and is referred to as CDR data. On older, traditional PBXs, this is usually through a serial port. On newer models, an Ethernet connection is normally used. The CDRs are delivered via the appropriate method to a PC running the call logger software. Some PBX manufacturers provide their own basic call logging software but there are many other third party software packages available.

Call logging software

The job of the call logging software is to interpret the raw CDR data and allow the user to produce graphical reports. Call logging software packages differ in the sizes of PBX systems that they can support (from hundreds of extensions to hundreds of thousands of extensions). They also differ in reporting capability and support for specialised PBX features. In general terms, call logging reports can highlight such areas as:

- **Cost Control** – cost of calls, cost of trunk lines, costs by department or individual extension, number of unused extensions, etc. Call logging software can also discover instances of Telephone Fraud.
- **Performance Management** – looks at how long it is taking an organisation to answer phone calls by operator, department or extension and demonstrates whether they meet acceptable target levels for that organisation.

- **Capacity Management** – judges whether the system is being over or under utilised. It examines trunk usage and call patterns that show where extra capacity is required or where cost savings can be achieved.
- **QoS Reporting** – modern VoIP PBXs are able to output quality of service data in addition to standard CDRs. An up to date call logging package should be able to include this data along with its other reports to help monitor and improve system performance.

History

During the 1970s, Post Office Telecommunications, as it was then called, were embarking on upgrading the telephone network, with the view to modernising the various established mechanical switching devices (Strowger) employed in the UK telephone exchanges, and replacing them with an electronic system, which came to be known as System X. In parallel and as part of this network upgrade, a dedicated engineering group was formed within the division THQ (Telecoms) to design a call logging system and to establish its feasibility for integration within the various existing Strowger and Electronic exchanges, prior to their eventual replacement. A mix of different telephone exchange equipment was selected for trial within Scotland, comprising Strowger pre-2000, 2000 and 4000 type switches located in Director and non-Director areas. The call logging trial proved successful and while it was initially designed to gather phone call data and cost of billing details specific to the customers' calls, a hidden benefit emerged such that local management were also able to see a pattern of the types of calls being generated, i.e. calls to and from certain businesses in addition to billing information, which was used to ease flow of traffic during peak times in the exchange and to plan for future customer provision within a catchment area. The concept of this call logging equipment was also deployed in UXD exchanges for remote areas where a System X exchange was not considered feasible.

References (History)

1. Roger T.S.Parr, BTUK/THQ (retired). See also Push-Button Telephone & BTOSS.

BT Operator Services System (BTOSS)

BT Operator Services System (BTOSS) boards will improve service, as telephone operators will be able to give customers an improved service, thanks to a new digital operator services system, which is to appear nationally between autumn 1989 and March 1991.

Designed and manufactured by Plessey Telecommunications before it became part of GPT (GEC Plessey Telecommunications), BTOSS will be an "add-on" to a System X local exchange and will eventually enable the replacement of all existing operator assistance centres in the network, which will handle help, emergency and other facility calls not automatically available from the network.

Advantages of the BT Operator Services System - known as BTOSS - include speedier connection of calls and improved transmission. For operators, the system, with its Operator Call Handling Centres (OCHCs), brings about an almost paperless office environment and calls can also be diverted from one BTOSS unit to another, should it be necessary.

The system is designed to exploit recent advantages in technology. For example, an operator's workstation comprises a visual display unit (VDU) and keyboard, stored programme control and a link to the digital network, to achieve a highly flexible operator system that can evolve to meet future needs.

Chester, in the former North Wales and The Marches District, was the first to have the new system in October 1988. A month later, Guildford, Surrey, in Thamesway District, followed suit and a total of 56 units have now been ordered. Before Chester and Guildford ran the trials, tests were carried out at the GPT site in Poole, Dorset, in a "model environment", to validate the BTOSS product.

Potential benefits of the new system include reduced operational costs, improved call-handling times, service flexibility, remote location of operators and the ability to make the best use of modern technology. Major facilities on the operational side include elimination of paper records, comprehensive call queuing facilities, full system control, remote siting of operator call handling centres and operational alarms.

For the customer, the facilities provide speedier enquiry and connect services, emergency calls, pay phone calls, automatic call charging, call booking - alarm and fixed time, interception services, AD & C (Advice of Duration and Call) calls, administration of BT Chargecard calls and Freefone number calls. On the administration front, the facilities gained range from operational management, fraud resistance, charging and statistics to fault detection control, access to customer facility information and offline data file preparation.

BTOSS architecture is split into two elements: the host exchange hardware (duplicated for security) and software - and remote equipment. The host exchange digital switch is used to connect calls to and from BTOSS and to and from operators. Although provided as a local exchange subsystem, BTOSS is treated as a separate network. Signalling between BTOSS and the network, including the host exchange, is provided by CCITT No.7 Message Transmission System (MTS).

REFERENCES

Author: Roger TS Parr, BTUK/THQ NSET424 (retired). Reproduced from British Telecom, Technical Review, Autumn 1989. See also by same author, Push-Button Telephone and Call Logging.

The Parr Barrier

The Strowger system was widely used for telephone exchange equipment until the development of the more reliable crossbar switch, an electromechanical switch with a matrix of vertical and horizontal bars and simpler motions.

The early introduction of these Crossbar telephone exchanges during the 1970s were known as TXK1 and TXK3. To gain access to the equipment, it was necessary to remove a clear plastic cover, which was fitted over the front of the frame housing the equipment, before inspection and work could be carried out.

Unfortunately, this method of covering allowed static electricity of up to 60,000 volts to build up on the surface of the cover, causing extreme shock to anyone attempting to remove the cover.

It was around this time that Roger Parr, a planning engineer, who previously worked in the LTR/ SW Area, arrived in THQ, Holborn, London. He was assigned to a group whose area of expertise centred around Crossbar switching systems. Having spent some time at Martlesham Heath Research Laboratories, near Ipswich, Suffolk, to research the problem in depth, Parr believed that, short of eliminating the cover, which had to remain for protection of the sensitive equipment it served, the way forward was to eliminate the static at source. Although the principle of a Faraday Cage was known to him, whereby an external electrical field is allowed to pass across the material of the cage, thereby protecting the sensitive equipment within the interior of the cage, it would not block static electricity.

It then occurred to him that if it was possible to earth the non-conducting plastic cover, the build up of static electricity could be eliminated altogether. To prove his point, a hole was drilled in a corner of the cover and wired to an earth point on the equipment rack. As expected, the static was still present due to the non-conductive property of the cover.

It was then that Parr had his Eureka moment. What if the cover could be made conductive and then earthed. This led him to think of a conductive material suitable for use with a plastic cover and carbon was his choice.

Further investigation led him to a company in Crawley, Surrey, who specialised in centrifugation. He enquired if it was possible to inject carbon

granules within a plastic TXK cover, which had never been done before, in a centrifuge and handed one to them for their experiment. Following several unsuccessful attempts, which resulted in irregular displacement of the carbon granules and instability of the plastic, the problems were finally resolved and resulted in a cover using Makralon , which had a slight tint, due in part to the process and infusion of the carbon, but retained its transparency.

Parr now returned to Martlesham to carry out tests on the new cover to prove his invention. The cover was now adapted with a metal braided strap attached to a corner, the other being connected to earth. This also had the added advantage that the cover did not have to be removed from the shelf equipment and forgotten to be replaced. The modified cover was then subjected to various external DC and AC fields of varying strengths up to and exceeding 60,000 volts and over different timescales and was an unqualified success.

This led to the invention being named “The Parr Barrier” and a patent was officially lodged with the BT Intellectual Property Rights department. However, due to the restrictions in place imposed by BT’s rules and regulations covering publication, privacy of innovations and inventions to any outside bodies during the course of an employee’s normal work practice, Parr’s invention, together with his other success of being credited with the first design circuitry for the push-button telephone adopted in the UK and detailed elsewhere in the technical section of the members pages, has not become widely known outside of BT. However, like many other discoveries by former employees, such as Tommy Flowers, whose work is well known, Parr has established his credentials in the pursuance of his work.

It is interesting to note that since his invention and the possible time elapse, that the concept of his barrier has been adopted alternately configured in certain railway carriages, where a quiet environment, free from mobile telephone signals, is required, where the incoming radio signal is blocked by the windows. Also, a company in the USA, (solarwindow.com) is developing a coating, which will be sprayed on to the surface of any window and allow it to conduct electricity into homes and thus revolutionise a whole industry.

References

Roger T.S. Parr, BTUK/THQ (retired). See also by same author,
Push-Button Telephone, Call Logging and BTOSS.