Signalling In Telecom

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ABSTRACT:

This handout discusses the growth of signalling and various type of signalling codes used in Indian Telecommunication. A signalling system uses a language which enables two switching equipments to converse for the purpose of setting up calls. Like any other language. it possesses a vocabulary of varying size and varying precision, ie. a list of signals which may also vary in size and a syntax in the form of a complex set of rules. governing the assembly of these signals.

INTRODUCTION:

Telephony started with the invention of magneto telephone which used a magneto to generate the ringing current, the only signal, sent over a dedicated line between two subscribers. The need for more signals was felt with the advent of manual switching. Two additional signals were, therefore, introduced to indicate call request and call release. The range of signals increased further with the invention of electro-mechanical automatic exchanges and is still growing further at a very fast pace, after the advent of SPC electronic exchanges.

Signaling is defined as the mechanism by virtue of which network entites exchange information among themselves .Signaling System is defined as the set of methods or rules followed by network entities to exchange information required for connection setup. The network establishes and realizes temporary connections, in accordance with the instructions and information received from subscriber lines and inter- exchange trunks, in form of various signals. Therefore, it is necessary to interchange information between an exchange and it external environment i.e. between subscriber lines and exchange, and between different exchanges. A signalling system uses a language which enables two switching equipments to converse for the purpose of setting up calls. Like any other language. it possesses a vocabulary of varying size and varying precision, ie. a list of signals which may also vary in size and a syntax in the form of a complex set of rules governing the assembly of these signals. The main examples of signalling system are Common Channel Signaling7, Channel Associated Signaling, Dual Tone-Multi Frequency.

The rapid growth of telecommunication in recent years has necessitated the creation of increasingly powerful and complex signaling systems. The scope of study of this write-up is to provide coverage of subscriber signaling and concept of channel associated signaling (CAS).

Fig.1 Manual Switching

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A signaling system uses a language which enables two switching equipments to converse for the purpose of setting up calls. Like any other language. It possesses a vocabulary of varying size and varying precision, i.e. a list of signals which may also vary in size and syntax in the form of a complex set of rules governing the assembly of these signals.

To understand these features take the example of a situation you wanted to talk and pass a message to some other person. First you must get the attention of that person. To get the attention you call out his name. After verifying that he is listening you pass the message. While passing the message you want to know whether he is aware of what you are saying or in other words paying attention to your message (i.e. eye contact).Same thing happens in telecommunication signalling. Every telephone is connected to the telephone network all the time. But when the subscriber does not need its service, the connection is disabled. In other words, the telephone exchange is sleeping relative to that appropriate telephone.

When the subscriber wants to take a call to another person, first he picks up the receiver. The telephone and the exchange are connected with two copper wires.One copper wire is connected to a relay and a negative battery while the other is earthed, making a loop. But the loop is open when the receiver is in its cradle. When the receiver is picked up, the loop gets completed and announces its need to the exchange. By picking up the receiver the subscriber wakes the exchange and gets its attention.

Two kinds of signals are introduced
I. Register signals
II. Supervisory signals

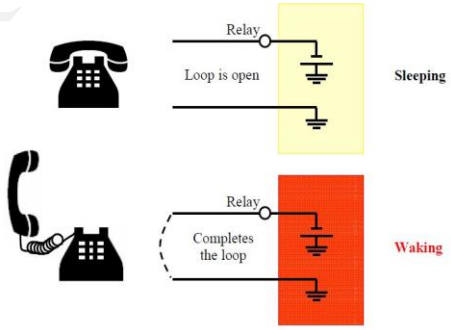


Fig2:Phone receiver status

Although our telephones are connected to the exchange, the exchange is inactive until the receiver is picked. By picking up the receiver the subscriber gets the attention of the exchange. Supervisory signals are used from this moment until the receiver is back on the cradle. The exchange then wakes up and sends out a dial tone. Then dialing take place which is like calling the person's name in the example. Register signals are used for this purpose. Therefore register signals are always prior to voice. After getting connected the subscriber will be able to pass any message. From picking up the receiver until the end of the connection, the exchange should be

aware of this call which is like checking whether the receiver is paying attention in the example on previous page. Supervisory signals are used for this purpose. Hence supervisory signals are ON throughout the whole time until the connection is cut.

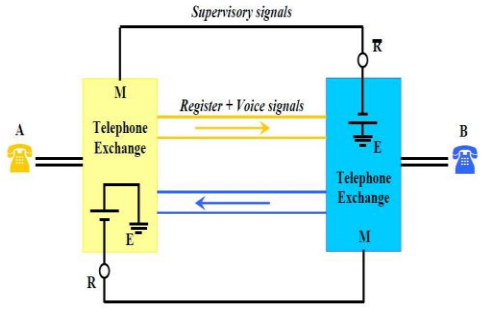


Fig3:Types of Signals

As can be seen in figure register signals can be sent using the voice path as register signals are always prior to voice. But supervisory signals are present even with the voice.

2. TYPES OF SIGNALLING INFORMATION

The signaling information can be categorized under four main heads.

2.1.Call request and Release information:

Call request information i.e. calling subscriber off hook or seizure signal of an incoming trunk, indicates a new call. On its receipt. the exchange connects an appropriate equipment for receiving address information (called number).

Release information i.e. on hook or release signal on a trunk indicates that the call is over. The exchange releases all the equipment held out for the call, and clears up any other information used for setting up of the call.

2.2. Selection (Address) information:

When the exchange is ready to receive the address information, it sends back a request which is known as proceed to send (PTS) signal in trunk signaling and dial tone in subscriber signaling.

Address information essentially comprises of full or part of the called subscribers number and possibly additional service data.

2.3. End of selection information:

This information indicates the status of the called line, or the reason for non completion of the call attempt, essentially indicating called line free or busy.

2.4. Supervisory information:

It specifies the on/off hook condition of a called subscriber after the connection has been setup

i) Called subscriber off hook: - Called subscriber has answered and charging may commence.
ii) Called subscriber on hook: - Called subscriber has hung up to terminate the call, and the call is disconnected after a time delay if the calling subscriber does not hang up.

The on/off-hook conditions of the calling subscriber are covered by call request and release information.

2.5. Call connection:

The interchange of signaling information can be illustrated with the help of a typical call connection sequence. The circled number in Fig below corresponds to the steps listed below.

i) A request for originating a call is initiated when the calling subscriber lifts the handset.
ii) The exchange sends dial-tone to the calling subscriber to indicate to him to start dialing.
iii) The called number is transmitted to the exchange, when the calling subscriber dials the number.
iv) If the number is free, the exchange sends ringing current to him.
v) Feed-back is provided to the calling subscriber by the exchange by sending.

a. Ring-back tone, if the called subscriber is free (shown in fig.1)

b. Busy tone if the called subscriber is busy (not shown in figure), or

c. Recorded message, if provision exists, for non completion of call due to some other constraint (not shown in figure).

vi) The called subscriber indicates acceptance of the incoming call by lifting the Handset
vii) The exchange recognizing the acceptance and terminates the ringing current and the ring-back tone, and establishes a connection between the calling and called subscribers.
viii) The connection is released when either subscriber replaces the handset.

When the called subscriber is in a different exchange, the following inter-exchange trunk signal functions are also involved before the call can be set up.

ix) The originating exchange seizes an idle inter exchange trunk, connected to a digit register at the terminating exchange.
x) The originating exchange sends the digit. The steps iv to viii are then performed to set up the call.

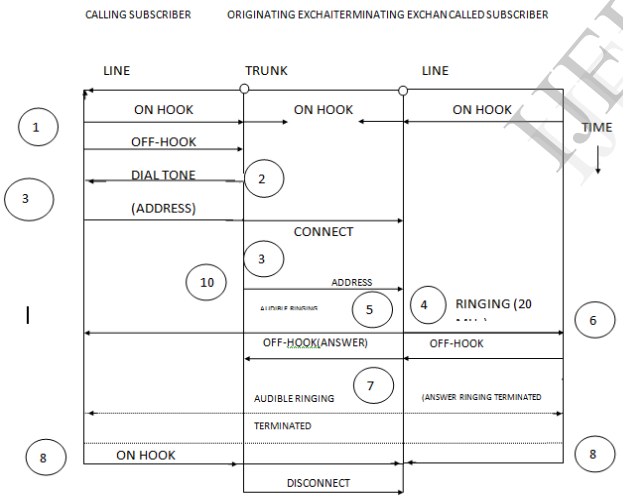


Fig4:Typical Signaling on call connection

3. SUBSCRIBER SIGNALLING

Subscriber Line signaling

3.1. Calling Subscriber Line Signaling

In automatic exchanges the power is fed over the subscriber's loop by the centralized battery at the exchange. Normally, it is 48 V. The power is fed irrespective of the state of the subscriber, viz., idle, busy or talking.

3.1.1. Call report

When the subscriber is idle, the line impedance is high. The line impedance falls, as soon as, the subscriber lifts the hand-set, resulting in increase of line current. This is detected as a new call signal and the exchange after connecting an appropriate equipment to receive the address information sends back dial-tone signal to the subscriber.

3.1. 2. Address signal

After the receipt of the dial tone signal, the subscriber proceeds to send the address digits. The digits may be transmitted either by decade dialing or by multifrequency pushbutton dialing.

3.1.2.1 Decadic Dialing

The address digits may be transmitted as a sequence of interruption of the DC loop by a rotary dial or a Decadic push-button key pad. The number of interruptions (breaks) indicates the digit, exept0, for which there are 10 interruptions. The rate of such interruptions is 10 per second and the make/break ration is 1:2. There has to be a inter-digital pause of a few hundred milliseconds to enable the exchange to distinguish between consecutive digits. This method is, therefore, relatively slow and signals cannot be transmitted during the speech phase.

3.1.2.2. Multifrequency Push-button Dialing

This method overcomes the constraints of the decadic dialling. It uses two sets of four voice frequencies. Pressing a button (key) generates a signal comprising of two frequencies, one from each group. Hence, it is also called Dual-Tone Multi-

frequency (DTMF) dialing. The signal is transmitted as long as the key is kept pressed. This provides 16 different combinations. As there are only 10 digits, at present the highest frequency, viz., 1633 Hz is not used and only 7 frequencies are used, as shown in Fig

By this method, the dialing time is reduced and almost 10 digits can be transmitted per second. As frequencies used lie in the speech band, information may be transmitted during the speech phase also, and hence, DTMF telephones can be used as access terminals to a variety of systems, such as computers with voice output. The tones have been so selected as to minimize harmonic interference and probability of simulation by human voice.

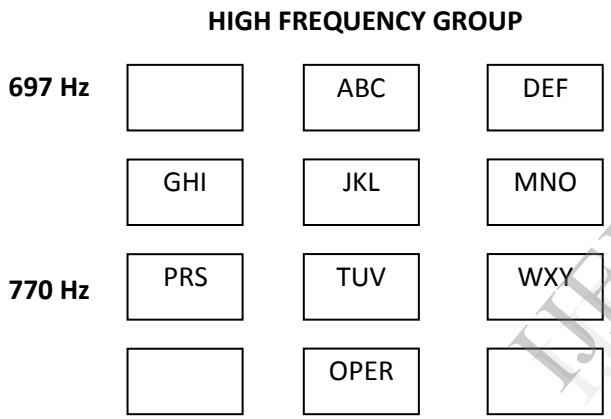


Figure5:Tone –Dialling frequency groups

3.1.3. End of selection signal

The address receiver is disconnected after the receipt of complete address. After the connection is established or if the attempt has failed, the exchange sends any one of the following signals.

1. Ring-back tone to the calling subscriber and ringing current to the called subscriber, if the called line is free.

2. Busy-tone to the calling subscriber, if the called line is busy or otherwise inaccessible.

3. Recorded announcement to the calling subscriber, if the provision exists, to indicate reasons for call failure, other than called line busy.

Ring back, tone and ringing current are always transmitted from the called subscriber local exchange and busy tone and recorded announcements, if any, by the equipment as close to the calling subscriber as possible to avoid unnecessary busying of equipment and trunks.

3.1.4. Answer Back Signal:

As soon as the called subscriber lifts the handset, after ringing, a battery reversal signal is transmitted on the line of the calling subscriber. This may be used to operate special equipment attached to the calling subscriber, e.g., short-circuiting the transmitter of a CCB, till a proper coin is inserted in the coin-slot.

3.1.5. Release signal

When the calling subscriber releases i.e., goes on hook, the line impedance goes high. The exchange recognizing this signal, releases all equipment involved in the call. This signal is normally of more than 500 milliseconds duration.

3.1.6. Permanent Line (PG) Signal

Permanent line or permanent glow (PG) signal is sent to the calling subscriber if he fails to release the call even after the called subscriber has gone on-hook and the call is released after a time delay. The PG signal may also be sent in case the subscriber takes too long to dial. It is normally busy tone.

3.2. Called subscriber line signals

3.2.1. Ring Signal

On receipt of a call to the subscriber whose line is free, the terminating exchange sends the ringing current to the called telephone. This is typically 25 or 50Hz with suitable interruptions. Ring-back tone is also fed back to the calling subscriber by the terminating exchange.

3.2.2. Answer Signal

When the called subscriber lifts the hand-set on receipt of ring, the line impedance goes low. This is detected by the exchange which cuts off the ringing current and ring-back tone.

3.2.3. Release Signal

If after the speech phase, the called subscriber goes on hook before the calling subscriber, the state of line impedance going high from a low value is detected. The exchange sends a permanent line signal to the calling subscriber and releases the call after a time delay, if the calling subscriber fails to clear in the meantime.

3.2.4. Register Recall Signal

With the use of DTMF telephones, it is possible to enhance the services, e.g., by dialing another number while holding on to the call in progress, to set up a call to a third subscriber. The signal to recall the dialing phase during the talking phase is called Register Recall Signal. It consists of interruption of the calling subscriber's loop for duration less than the release signal. it may be of 200 to 320 milliseconds duration.

3.3. Inter-Exchange Signaling

Inter-exchange signaling can be transmitted over each individual inter exchange trunk. The signals may be transmitted using the same frequency band as for speech signals (in band signaling), or using the frequencies outside this band (out-of-band signaling). The signaling may be

i. Pulsed

The signal is transmitted in pulses. Change from idle condition to one of active states for a particular duration characterizes the signal, e.g., address information

ii. Continuous

The signal consists of transition from one condition to another; a steady state condition does not characterize any signal.

iii. Compelled

It is similar to the pulsed mode but the transmission is not of fixed duration but condones till acknowledgement of the receiving unit is received back at the sending unit. It is a highly reliable mode of signal transmission of complex signals.

3.3.1 Analog Signaling Systems

3.3.1.1 E & M Signals:

E & M lead signaling may be used for signaling on per-trunk basis. An additional pair of circuit, reserved for signaling is employed. One wire is dedicated to the forward signals ((M-Wire for transmit or mouth) which corresponds to receive or R-lead of the destination exchange, and the other wire dedicated to the backward signals (E-wire for receive or ear) which corresponds transmit or send wire or S-Lead of the destination exchange.This type of signaling is normally used in conjunction with an interface to change the E & M signals into frequency signal to be carried along with the speech.

3.3.1.2Register Signals

It was, however felt that the trunk service could not be managed properly without the trunk register which basically is an address digit receiver, with such development, the inter-exchange signaling was sub-divided into two categories.

1. Line signaling in which the signals operate throughout the duration of call, and

2. Register signaling during the relatively short phase of setting up the call, essentially for transmitting the address information.

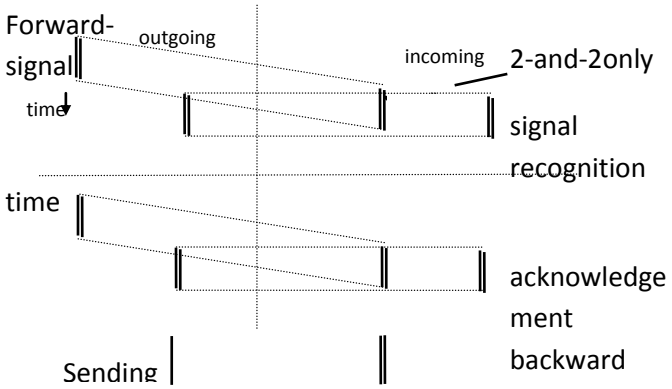


Fig.6. Compelled signaling procedure

In other words, register signals are interchanged between registers during a phase between receipt of trunk seizure signal and the exchange switching to the speech phase. These signals are proceed-to-send (PTS) signals, address signals, and signals indicating the result of the call attempt.

The register signals may be transmitted in band or out of band. however, in the latter case, the signaling is relatively slow and only limited range of signals may be used. For example, a single out-of-band frequency may be selected and information sent as pulses.

In-band transmission can be used easily as there can be no possible interference with the speech signals. To reduce transmission time and to increase reliability, a number of frequencies are used in groups. Normally 2 out of 6 frequencies are used. To make the system more reliable compelled sequence is used. Hence, this system is normally called compelled sequence Multi-frequency (CSMF) signaling as shown in Fig.3. In CCITT terminology it is termed as R2 system. As the frequencies need be transmitted only for a short duration to convey the entire information, the post dialing delay is reduced.

3.3.1.3.R2 Signaling

CCITT standardized the R2 signaling system to be used on national and international routes. However, the Indian environment requires lesser number of signals and hence, a slightly modified version is being used.

There is a provision for having 15 combinations using two out of six frequencies viz., 1380, 1500, 1620, 1740, 1860 and 1980 Hz, for forward signals and another 15 combination using two out of six frequencies viz., 1140,1020, 900, 780, 660 and 540 Hz, for backward signals. In India, the higher frequency in the forward group i.e., 1980 Hz, and the lower frequency in the backward group, i.e., 540 Hz are not used. Thus, there are 10 possible combinations in both the directions.

Note: Signals A2, and A7 to A9 are used in Tandem working only.

1. Forward signals are used for sending the address information of the called subscriber, and category and address information of the calling subscriber.

2. Backward signals are used for demanding address information and caller's category and for sending condition and category of called line.

R2 signaling is fully compelled and the backward signal is transmitted as an acknowledgement to the forward signal. This speeds up the interchange of information, reducing the call set up time. However, the satellite circuits are an exception and semi-compelled scheme may only be used due to long propagation time.

Register signals may be transmitted on end-to-end basis. It is a self checking system. Each signal is acknowledged appropriately at the other end after the receiver checks the presence of only 2 and only 2 out of 5 proper frequencies.

4. CHANNEL ASSOCIATED SIGNALLING

4.1 Digital Signaling

All, the systems discussed so far, basically, are on per line or per trunk basis, as the signals are carried on the same line or trunk. With the emergence of PCM systems, it was possible to segregate the signaling from the speech channel.

Inter exchange signaling can be transmitted over a channel directly associated with the speech channel, channel-associated signalling (CAS) , or over a dedicated link common to a number of channels, common channel signaling (CCS). The information transmitted for setting up and release of calls is same in both the cases. Channel associated signalling requires the exchanges to have access to each trunk via the equipment which may be decentralized, whereas, in common channel signaling, the exchange is connected to only a limited number of signaling links through a special terminal.

4.1.1. Channel- Associated signaling

In the PCM systems the signaling information is conveyed on a separate channel which is rigidly associated with the speech channel. Hence, this method is known as channel associated signaling (CAS). Though the speech sampling rate is 8 KHz, the signals do not change as rapidly as speech and hence, a lower sampling rate of 500 Hz, for digitization of signals can suffice. Based on this concept, TS 16 of each frame of 125 microseconds is used to carry signals of 2 speech channels, each using 4 bits.

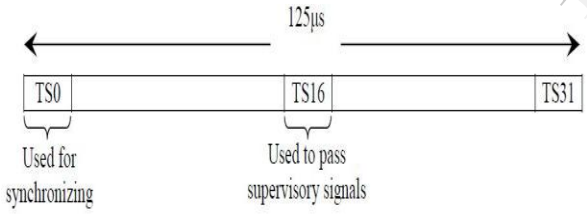


Figure7: CAS indication

Like every timeslot, TS16 is composed of 8 bits. The CCITT recommended that only the supervisory signals of two channels should be sent from a TS16. Therefore 4 bits of TS16 is used for one channel and the other 4 for another. Hence information of only two channels could be sent through TS16 in a single frame. Out of 30 subscribers only the information of two can be sent along within the same frame. This was a problem. To avoid this problem engineers came up with a multi frame concept where a multi-frame consists of 16 frames numbered 0-15. TS16 of frame 0 is used for multi-frame synchronizing. The first half of TS16 in frame 1 is used to pass the information of channel 1 while the other half is for channel 17.

Likewise TS16 of the last frame (frame 15) contains information on channel 15 and 31.

Hence, for a 30 channel PCM system, 15 frames are required to carry all the signals. To constitute a 2 millisecond multi frame of 16 frames. F 0 to F 15 TS 16 of the frame F 0 is used for multi frame synchronization. TS 16 of F1 contains signal for speech channels 1 and 16 being carried in TS 1 and TS 17, respectively, TS16 of F2 contains signals of speech channels 2 and 17 being carried in TS2 and TS 18, respectively and so on, Both line signals and address information can be conveyed by this method.

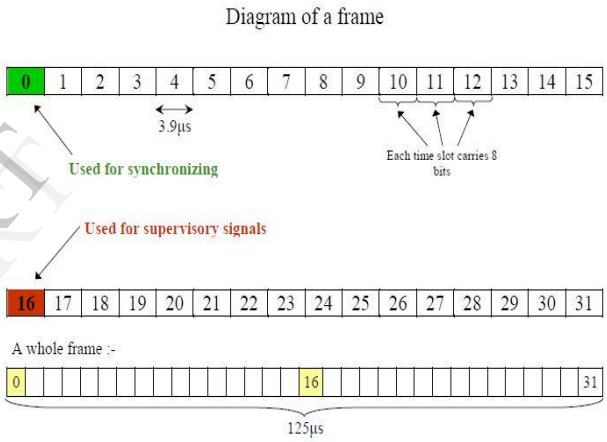
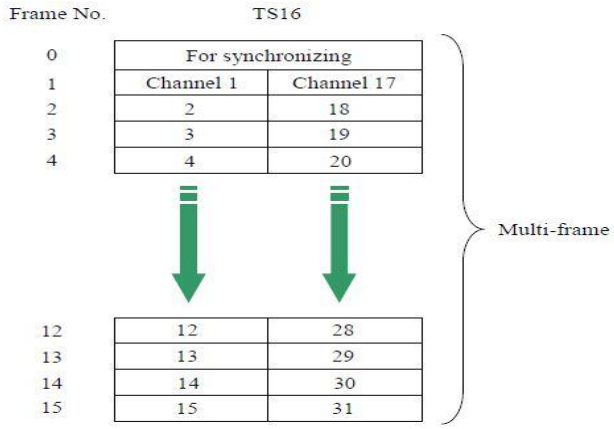


Figure8:Frame diagram



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