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CHARACTERISTICS OF SPEECH INTERPOLATION SYSTEMS AFFECTING SIGNALLING

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NOTES

1 CCITT Recommendation Q.100 Supplement No. 2 was published in Fascicle VI.1 of the *Blue Book*. This file is an extract from the *Blue Book.* While the presentation and layout of the text might be slightly different from the *Blue Book* version, the contents of the file are identical to the *Blue Book* version and copyright conditions remain unchanged (see below).

2 In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Recommendation Q.100 Supplement No. 2

CHARACTERISTICS OF SPEECH INTERPOLATION SYSTEMS AFFECTING SIGNALLING

1 CELTIC system

1.1 *General*

The first generation CELTIC system (concentrator exploiting the idle time of circuits) has been in operation since 1977. A second generation system, to come into operation in 1983, is now being developed (1980).

CELTIC is a fully digital system (see Figure 1).

Connection and service messages can be routed on a CELTIC signalling circuit between terminals A and B.

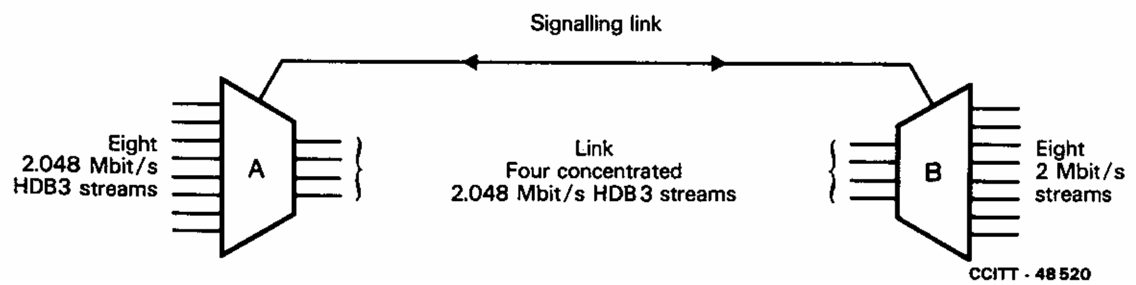

FIGURE 1

1.2 *Summary description of CELTIC*

The incoming PCM streams are synchronized and then multiplexed (possibly with a jump or doubling of the PCM frame, if the clocks of the incoming PCM streams are not synchronous).

The signal is then sent to a speeh detector unit and to a delay line (see Figure 2).

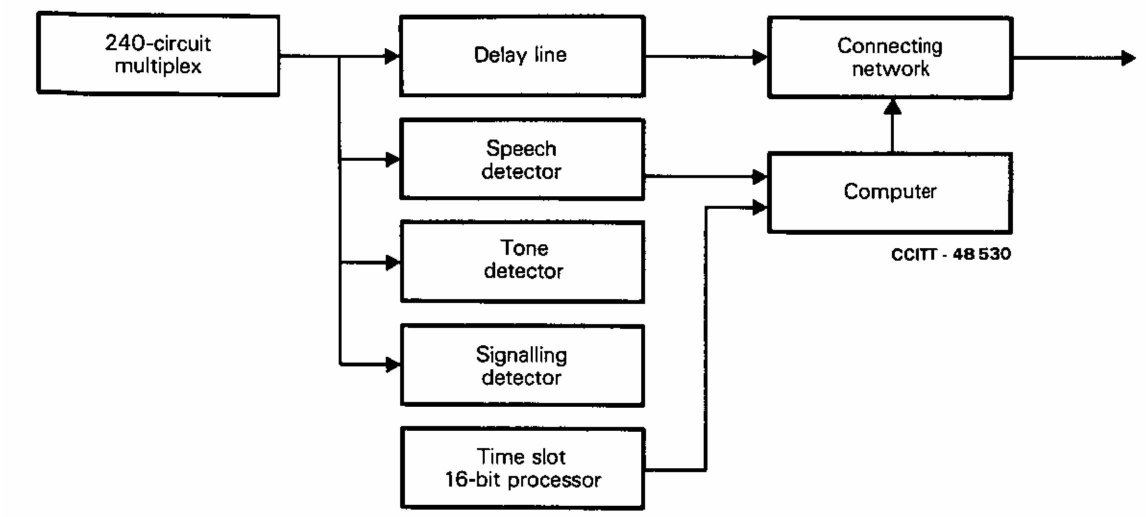

FIGURE 2

1.2.1 *Delay line*

The delay line is used to offset delay due to the decision time of the speech detector, the answering time of the computer (search for an available channel and its assignment to an active circuit) and the processing time taken by the CELTIC signalling unit to set up the connecting message. The delay line is the same for all circuits (adjustable from 0 to 32 ms). Its nominal value is *32 ms*.

This delay line may be cancelled circuit by circuit.

1.2.2 *Speech detector*

– In the CELTIC 1G system, the speech detector has two hangover times:

  Short hangover: 50 ms (speech duration less than 50 ms)

  Long hangover: 180 ms (speech duration more than 50 ms).

– In the CELTIC 2G system, there will be only one hangover of 120 ms. The speech detector will be adapted to noise in a range between -40 and -55 dBm0.

The decision time of the speech detector varies according to the nature of the signal (between approximately 2 and 12 ms). The decision criteria are constituted mainly by the amplitude of the signal, but also by the presence of sibilants in the speech.

The speech detector takes into account the speech level in the receiving channel: a positive decision is given only if the level of the sample of transmitted speech is higher than the level in the receiving channel.

In the CELTIC 2G system, the speech detector is backed up by a *signalling detector*: when a signalling frequency is recognized, this detector suppresses the return channel protection and where necessary the delay line and disables the echo suppressors which may be integrated in CELTIC. This signalling detector reacts quickly and is adapted to the signalling pulses in the band (signal shape criterion).

The speech detector is associated with a *2100 Hz* tone detector (data transmission).

Tone detection suppresses *return channel protection*, effects *circuit-channel locking* and suppresses *the delay line of the circuit concerned*.

1.2.3 *Processing of TS-16 bits*

CELTIC contains a device for taking out the significant bits of the TS 16 (a, b, c) in the transmitting direction and reinserting them in the receiving direction.

This device has two functions:

– transmitting direction: it detects changes in the state of the significant bits of the TS 16 and informs the computer.

– receiving direction: it can modify one or more bits of the TS 16 according to information provided by the computer (command to block junctor or to disable echo suppressor).

1.2.4 *Echo suppressor*

An echo suppressor multiplexed on 240 circuits is provided with CELTIC, if desired (an inexpensive addition).

In this case, the echo suppressor should be disabled on a telephone signalling phased circuit (one of the purposes of the above mentioned signalling detector).

Note – The 32 ms delay introduced by CELTIC in any case necessitates the use of echo suppressors on all circuits.

1.3 *Links between CELTIC and the transit centre*

There are four types of link:

– speech links,
– signalling links,
– links for circuit blocking command,
– links for echo protection disabling command, where necessary.

The number and nature of the links depend on the operational conditions of CELTIC:

– nature of transit centre,
– signalling system (CCITT Nos. 4, 5 and 6, R1 or R2),

– position of CELTIC in relation to the transit centre,

– position of echo suppressors in relation to signalling sets.

Circuit blocking is requested circuit by circuit or for 30 circuits common to the same PCM, in case of alarm, in case of gradual stopping of the CELTIC or in case of dynamic load control.

1.4 *Operation of CELTIC with different types of signalling*

1.4.1 *Signalling System No. 4*

The 32 ms delay introduced by CELTIC necessitates the use of echo suppressors, which must be disabled if they are below the signalling sets in the signalling sequence (echo suppressors integrated in CELTIC). Pulse bridging would lead to a prohibitive hangover time.

Adoption of a *fixed hangover time of 120 ms* for the speech detector will lead to a lower concentration rate, by preventing the CELTIC from operating in "freeze-out", in order to limit the number of unsuccessful calls.

1.4.2 *Signalling System No. 5*

A hangover of 120 ms is suitable for this type of signalling. The signalling detector disables echo protection where necessary.

1.4.3 *Signalling System No. 6*

The echo suppressors are disabled during the continuity test. No particular problems.

1.4.4 *Signalling System R2*

In the digital version, line signalling is transmitted by 2 bits of the TS 16:

The CELTIC 2G system examines these bits and transmits through the CELTIC signalling channel to the other end *any change in the state of these bits*, circuit by circuit.

The echo suppressors and the action of the delay line are disabled during the register signalling sequence (action of signalling detector).

1.4.5 *Conclusion*

The presence of delay lines implies systematic provision of echo suppressors. A single hangover time of about 120 ms in the speech detector will suffice, with a limitation for System No. 4, which requires a lower freeze-out rate.

2 DSI characteristics

The INTELSAT 120 Mbit/s time division multiple access (TDMA) system incorporates the use of digital speech interpolation (DSI). The TDMA/DSI system will be used with Intelsat V and post-Intelsat V satellites operating in 80-MHz hemisphere and zone beam transponders and will provide high quality service in accordance with CCIR Recommendation 522 [1].

The DSI system increases the capacity of the TDMA system by interleaving speech bursts from different terrestrial channels on the same satellite channel. Inputs to the DSI module are digitally encoded in accordance with Recommendation G.711 [2] using encoding referred to as "A-law" with alternate digit inversion.

The system is transparent to in-band Signalling System No. 5 and the speech detector hangover time is such as to avoid disconnection of the link between successive signalling packets.

Competitive clipping (of speech bursts) lasting more than 50 ms occurs on less than 2% of the voice spurts. This is made possible in part by appropriating (or stealing) the least significant bit (8th bit) of satellite channels to create overload channels when all normal satellite channels are in use.

A complete description of the INTELSAT TDMA/DSI system may be found in the INTELSAT document BG-42-65 [3].

3 TASI characteristics affecting signalling

3.1 During a normal telephone conversation each party usually speaks for only about 40% of the time (speech activity), 60% of his channel time being idle. TASI (Time Assignment Speech Interpolation) is an equipment which rapidly switches channels to talkers on a time-shared basis to make use of the otherwise idle channel time and thus permits a greater number of simultaneous calls than would otherwise be possible with the available channels in the cable.

TASI interpolates to associate an interchange circuit with a transmission channel when speech is detected on a circuit at one end and is required to be transmitted, over a channel, to the same circuit at the other end. Depending upon the need, circuit/channel association ceases, and the channel is made available to other circuits when the cessation of a burst of speech is detected.

When speech begins and a channel is available, but not yet associated, a time (the initial clip) elapses before detection of the speech (or signal) by the TASI speech detector and circuit/channel association at each end. Should the TASI system be heavily loaded, a channel may not be immediately available. In this situation a time (extended clip) in addition to the initial clip elapses before circuit/channel association.

To reduce the number of times clipping occurs, the TASI speech detector is given a hangover, maintaining circuit/channel association, to bridge the shorter gaps in speech, and thus reduce the interpolation. This feature permits the transmission of a sequence of short-pulse short-gap signals without signal clipping.

As signals must be detected by the TASI speech detector before transmission over the TASI system and as the total clip (initial clip + extended clip) reduces the duration of the received signal, TASI affects signalling.

3.2 There are three TASI systems in service. TASI-A and TASI-B make use of analogue - time division switching matrices while TASI-E uses a digital, time division matrix. Circuits can be connected directly from a digital switch to the TASI-E in digital format. A primary multiplex per Recommendation G.733 [4] must be placed between an analogue switch and the TASI-E to provide the conversion to PCM digital format. If the outgoing transmission channels are analogue, a primary multiplex per Recommendation G.733 must be placed between the TASI-E equipment and the analogue channels. TASI-E is designed to work with Signalling System No. 5 using the standard in-band line signalling, and of course with System Nos. 6 and 7 circuits. The continuous energy Signalling System R1 line signalling on each circuit is detected by the TASI-E terminal and then sent to the distant TASI-E terminal over the internal data links.

Clipping has been reduced in TASI-E by putting 50 ms fixed delay in each direction in the circuits so that processing and circuit/channel connections can be made while the inband signals are still in the delay circuits. The initial clip is thus eliminated and the extended clip reduced by about 20 ms.

3.3 The characteristics of TASI affecting signalling may be summarized as follows: TASI-A, TASI-B and TASI-E have similar characteristics except where noted:

3.3.1 TASI-A speech detector sensitivity; -40 dBm0.

TASI-B speech detector sensitivity: usually -36 dBm0 although it does change to -28 dBm0 if input level remains higher than -20 dBm0 in excess of 200 milliseconds. The TASI-E speech detector is made up of the basic speech detector, which adapts to the average speech level and background noise, and signalling-by-pass circuits which detect the presence of moderate level MF frequencies and provide extended hangover time to bridge the gaps between pulses.

3.3.2 To minimize speech activity on the RETURN channel due to reflection from the GO channel. The TASI speech detector on the RETURN channel is reduced in sensitivity in the presence of speech on the GO channel. This also applies to signalling. Thus in situations where simultaneous forward and backward signalling is required, the level of the backward signalling must be such as to take account of a reduction in the sensitivity of the speech detector at the end receiving the forward signal. TASI-A sensitivity may be reduced to as little as -25 dBm0. TASI-B sensitivity to -28 dBm0. In TASI-E the basic speech detector has echo protection but the signalling-by-pass circuits do not, thus allowing simultaneous signalling in both directions.

3.3.3 Nominal duration of speech detector hangover for a single burst:

TASI-A

a) 50 ms for input signals of 50 ms or less;

b) 240 ms for input signals greater than 50 ms;

TASI-B

c) 10 ms plus burst length for burst lengths up to 40 ms;

d) 180 ms for burst lengths greater than 40 ms.

TASI-E

e) 128 ms for input signals greater than -19 dBm0;

f) 88 ms for input signals between -19 and -25 dBm0;

g) 16 ms for input signals less than -25 dBm0.

3.3.4 Nominal duration of clip of a signal (including the 5 ms response time of the TASI-A or TASI-B speech detector):

a) initial clip: 18 ms;

b) total clip when TASI-A or TASI-B is heavily loaded and a free channel is not immediately available, expressed as a probability that a signal will be clipped for a certain time or longer: see Table 1.

TABLE 1

Total clip	**Number of TASI-A or TASI-B systems in series on one circuit**		
	1	**2**	**3**
125 ms	1/100	1/20	1/10
250 ms	1/700	1/140	1/60
500 ms	1/15 000	1/5000	1/1500

A total clip of 500 ms was assumed for the System No. 5 design, and the duration (850 ± 200 ms) of the forward-transfer pulse line signal concerned includes a 500-ms TASI prefix for TASI circuit/channel association.

3.3.5 For multiple pulses of short duration, a maximum duration of gaps between short-pulse signals has been determined to maintain continuous operation of the speech detector and thus continuous circuit/channel association. For TASI-A the maximum allowable duration of the gaps is twice the pulse duration over the pulse range 10 to 60 ms and over the operate level range of the speech detector.

This assumes prior energizing of the speech detector to give the 240 ms hangover [see § 3.3.3 b) above] before the short-pulse short-gap signalling is applied. Since TASI-A is more critical than either TASI-B or TASI-E in this respect, a short pulse signalling system designed to work properly over TASI-A circuits will also work properly over TASI-B or TASI-E circuits. For TASI-B prior energizing of the speech detector will give 180 ms hangover initially. The hangover for successive pulses will depend on the length of the pulse as given in §§ 3.3.3 c) and d). The hangover for TASI-E will depends on the level of the signal which energized the speech detector and will be up to 128 ms for the range of signalling frequency levels as shown in §§ 3.3.3 e) to g).

The register short-pulse short-gap multifrequency signalling adopted for the System No. 5 takes advantage of this continued speech detector operation and is transmitted without a TASI prefix, reliance being placed on the circuit/channel association due to the seizing signal.

References

[1] CCIR Recommendation *Allowable bit error rates at the output of the hyperthetical reference circuit for systems in the fixed satellite service using pulse-code modulation for telephony*, Vol. IV, Rec. 522, ITU, Geneva, 1978.

[2] CCITT Recommendation *Pulse code modulation (PCM) of voice frequencies*, Vol. III, Fascicle III.3, Rec. G.711.

[3] INTELSAT document, No. BG-42-65.

[4] CCITT Recommendation *Characteristics of primary PCM multiplex equipment operating at 1544 kbit/s*, Vol. III, Fascicle III.3, Rec. G.733.

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