

(12) PATENT
(19) AUSTRALIAN PATENT OFFICE

(11) Application No. **AU 199472627 B2**
(10) Patent No. **714192**

(54) Title
Local ISDN radio transmission system

(51)⁶ International Patent Classification(s)
H04Q 007/24 H04Q 011/04
H04Q 007/30

(21) Application No: 199472627 (22) Application Date: 1994 .07 .28

(87) WIPO No: W095/05053

(30) Priority Data

(31) Number	(32) Date	(33) Country
P4326749	1993 .08 .05	DE

(43) Publication Date : 1995 .02 .28
(43) Publication Journal Date : 1995 .04 .13
(44) Accepted Journal Date : 1999 .12 .23

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(56) Related Art
US 5608780
US 5325419
US 5274694

OPI DATE 28/02/95 APPLN. ID 72627/94
AOJP DATE 13/04/95 PCT NUMBER PCT/DE94/00878



AU9472627

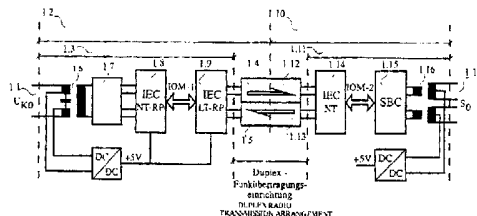
(51) Internationale Patentklassifikation ⁶ : H04Q 7/24, 11/04, 7/30		A1	(11) Internationale Veröffentlichungsnummer: WO 95/05053
		(43) Internationales Veröffentlichungsdatum:	16. Februar 1995 (16.02.95)
(21) Internationales Aktenzeichen:	PCT/DE94/00878		
(22) Internationales Anmeldedatum:	28. Juli 1994 (28.07.94)		
(30) Prioritätsdaten:	P 43 26 749.1 5. August 1993 (05.08.93) DE		
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(54) Title: LOCAL ISDN RADIO TRANSMISSION SYSTEM

(54) Bezeichnung: LOKALES ISDN-FUNKÜBERTRAGUNGSSYSTEM

(57) Abstract

A local ISDN radio transmission system is organised as a local radio cell that consists of a central stationary radio station and of a plurality of decentralised subscriber radio sets. The radio transmission system is connected to the access connection elements (ISDN base access ports) of a local central office, subcentre or private branch exchange. The number of radio subscribers is larger than the number of used duplex radio channels. The invention ensures to the radio subscribers a connection with a So-interface. The radio transmission in the subscriber area allows covering range limitations to be lifted, which otherwise result from attenuation and propagation time problems encountered in the case of wire transmission. According to the invention, the radio transmission arrangement is inserted into a ISDN two-wire access connection circuit with an intermediate repeater, in the section that extends between the intermediate repeater and the network termination. After an activation request, a radio channel is allocated within the carency and monitoring times for activating the ISDN two-wire access connection circuit. In order to ensure an efficient use of the available transmission bandwidth, an independent radio channel for control, organisation and monitoring purposes is dispensed with. The required instructions and information are transmitted in the free radio channels. The subscriber radio sets recognize free channels thanks to a special arrangement of the synchronisation word that differs from that of the ISDN transmission.



(57) Zusammenfassung

Die Erfindung betrifft ein lokales ISDN-Funkübertragungssystem, welches als eine lokale Funkzelle, bestehend aus einer zentralen Funkfeststation und einer Vielzahl von dezentralen Teilnehmerfunkgeräten, organisiert ist. Das Funkübertragungssystem ist an die Teilnehmerports (ISDN-Basisanschlüsse) einer Ortsvermittlungsstelle, Teilvermittlungsstelle oder Nebentelleneinrichtung angeschlossen. Dabei ist die Zahl der Funkteilnehmer größer als die Zahl der genutzten Duplex-Funkkanäle. Die Erfindung sichert dem Funkteilnehmer einen Teilnehmeranschluß mit So-Schnittstelle. Durch die Funkübertragung im Teilnehmerbereich wird gesichert, daß Reichweitenbegrenzungen aufgehoben werden, die sich bei einer leitungsgebundenen Übertragung durch Dämpfungs- und Laufzeitprobleme ergeben. Erfindungsgemäß wird die Funkübertragungseinrichtung in eine ISDN-Zweidraht-Teilnehmeranschlußleitung mit Zwischenregenerator in die Teilstrecke Zwischenregenerator-Network Termination eingefügt. Nach einer Aktivierungsanforderung erfolgt die Zuweisung eines Funkkanals innerhalb der Karenz- und Überwachungszeiten für die Aktivierung des ISDN-Zweidraht-Teilnehmeranschlusses. Zur effektiven Ausnutzung der zur Verfügung stehenden Übertragungsbandbreite wird auf einen eigenständigen Funkkanal für Steuerungs-, Organisations- und Kontrollzwecke verzichtet. Die erforderlichen Befehle und Informationen werden in den freien Funkkanälen übertragen. Die Teilnehmerfunkgeräte erkennen freie Kanäle durch eine spezielle von der ISDN-Übertragung abweichende Anordnung des Synchronwortes.

- 1 -

Local ISDN Radio Transmission System

Technical Field

5 The invention relates to a local ISDN transmission system which is organized as a local radio cell, consisting of a central fixed radio station and a plurality of subscriber radio terminals and is connected to the subscriber ports (ISDN base connections) of a local switching center, store-and-forward center or private branch exchange, and provides subscribers with access to the public ISDN telephone system through an interface by the use of wireless transmission,
10 and in which, for the operation of the system in the case of a number of subscribers greater than the number of the duplex radio channels (hereinafter called communication channels) in use, a radio switching system is present in a central fixed radio station (base station BS) which, in the event of an activation request (PH-ACTIVATE REQUEST), opens to the subscriber radio terminal (TL), by means of a special radio communication process, any one
15 of the available and free communication channels for communication.

Background Art

Multi-user systems for radio-supported connection of telephone subscribers to the public
20 telephone network are in wide use. They come under mainly the following categories:

1. Mobile radio networks

These are characterized mainly by roaming and handover (overload) facilities with all of the resultant consequences for the network control and the demand for the ability
25 to use mobile equipment at high road speeds of up to 200 km/h and the resultant demands placed on the radio transmission process.

2. Trunking networks

These have roaming and handover facilities like the mobile radio networks, but as regard subscriber spectrum, territorial extent, functionality and especially access to



- 2 -

the public networks they are subject to the limitations referred to above.

3. Networks based on cordless telephone technology

These networks are intended to dispense with the connection of the cordless telephone to a specific main line and to extend the territorial range of use to the range of a PABX by inserting a handover.

4. DAL (wireless loop)

These are characterized by wireless connection of stationary subscribers in the case of a connection of the radio transmission system that is equal for all subscribers. This means that in the switching system each radio subscriber has a subscriber line of its own, and the radio transmitter is inserted between these subscriber connections and the radio subscriber.

5. Rural networks

These are characterised by the fact that, from a central node exchange or secondary exchange, they make a point-to-multipoint connection in territorially very remote areas, and radio connections are used. Channel groups are transmitted which can be split up on several planes en route and are sent to several end points. From these end points the subscribers are connected usually via cable, and if radio is used, equal-channel connection is usually performed. In the rural networks no switching functions are performed.

These systems offer the subscriber in general a two wire a/b connection or adequate functions as regards speech communication and modem and fax transmission. To some extent, special connections are offered for data transmission (data terminals). The data rates can amount to up to 64 kbit/s. These system are designed on the network side for connection to the ISDN and sometimes they provide a few select functions of the ISDN right through to the subscriber. The preparation of an unlimited S_0 interface, however, is not one of the performance features of this system.



- 3 -

So a process is described in (1) for offering GSM subscribers access to performance features of the ISDN. The process presented, however, is limited by the fact that the ISDN subscriber plane with $2B+D(2 \times 64 \text{ kbit/s})$ cannot be transmitted 1:1 to the GSM subscriber plane with $B_m+D_m(13 \text{ or } 12 \text{ or } 9.6 \text{ kbit/s})$ (see(1), Figure 3 and page 1, lines 10 to 19).

5

So-called DAL (wireless subscriber line) systems are already widely in use and under the above-given premises they have proven their usefulness. The systems up to now, however, offer the radio subscriber only one subscriber line with an a/b interface. Examples are given in (2) and (3).

10

In (4) a solution is described which is based on the DECT standard and by using a TDM/TDMA/TDD process permits the wireless connection of subscribers to PABX's or PSTN's. In the system a digital transmission at 32 kbit/s per channel is used, 8 channels being transmitted with an RF carrier, requiring a total gross data rate of 640 kbit/s. This system would be suitable if several channels were to be assigned to one subscriber for the processing of S_0 lines by the subscriber, but it has two basic consequences.

15
20

1. A TDMA frame with a duration of 16 ms is divided into 8 channel pulse frames for the direction from the base station to the subscriber terminal and 8 channel pulse frames for the direction from the subscriber terminal to the base station, resulting in a duration of 1 ms for the individual channel frames.

25

Thus, there are no reserves for delay equalisation (different distances between the subscriber terminals and the base station), and the system is limited to very short distances of up to 300 metres.

For the quantification of these statements: The achievement of a service range of 30km radius calls for intermissions of 0.2ms between the transmissions of two successively transmitting subscriber terminals.

30



- 4 -

2. The transmission of 8 channels in duplex operation occupies a radiofrequency band width of 1 MHZ, which is acceptable only at the minimum ranges and the low transmission powers of 80mW which they entail.

5 **Disclosure of the Invention**

It is an object of this invention to use wireless transmission to provide improved access to the public ISDN telephone system for subscribers not connected via standard subscriber lines.

- 10 Accordingly in one aspect this invention provides a claim 1\



The invention described herein offers the radio subscriber a subscriber line with an S_0 interface in order to be able to use all of the power features of this modern communications technology. In addition to the premises set forth above which appear to make the use of radio

- 15 transmission for subscribers practical, there is also the fact for the ISDN subscriber line that radio transmission overcomes distance limitations which arise due to attenuation problems in transmission over wires. Furthermore, limitations of distance due to transit time problems are overcome by radio transmission, since the S_0 interface is not used for radio transmission.



20 **Best Modes for Carrying out the Invention**

A practical embodiment of the invention will now be described by way of example only with reference to a ISDN two-wire subscriber line with a U_{K0} interface. The principles of the solution, however, are valid for all other ISDN two-wire subscriber lines with U interfaces

- 25 if it is adapted to the adequate signals used in them.

Details of the invention are further described with the aid of the circumstances represented in the drawings.



Fig. 1 shows the principle of the connection of ISDN subscribers by radio;

- 5 -

Fig. 2 the standard performance of the wake-up procedure for an incoming call;

Fig. 3 the modified performance of the wake-up procedure for an incoming call;

Fig. 4 the block diagram of the base station of an ISDN-DAL system;

Fig. 5 the standard wake-up procedure for an incoming call including display of the
5 IOM interface;

Fig. 6 the modified wake-up procedure upon an incoming call including display of
the IOM interface;

Fig. 7 the block diagram of the base station of an ISDN-DAL system upon
intervention into the IOM interface according to Figure 6;

10 Fig. 8 the block diagram of a subscriber terminal of an ISDN-DAL system upon
intervention into the S_0 interface;

Fig. 9 the block diagram of a subscriber terminal of an ISDN-DAL system upon
intervention into the IOM interface;

Fig. 10 the data frame for radio communication in an ISDN-DAL system.

15

It is another important aim of the invention to provide for a greater economy of frequency of
the radio transmission system. This requirement has a high priority since the net bit rate of
the ISDN subscriber line, at $(B1 + B2 + D) = 144$ kbit/s, no matter how the channel is formed,
results in wide-band radio channels.

20

This requirement is met by making the number of radio channels substantially lower than the
number of radio subscribers, and the ratio must be made variable in order to permit
adaptation to different traffic levels according to the subscriber structure.

25 For this purpose a solution is used in which the ISDN two-wire subscriber line between line
termination (LT) in the ISDN communication and network termination (NT) at the
subscriber's is divided into two sections by the use of an intermediate repeater (ZWR), and
the ZWR-NT section the wired transmission is replaced by radio transmission. The ZWR is
a component of the base station (BS) of the local radio cell and the NT a component of the
30 subscriber terminal (TL). Both are so made up that, when an activate request (PH



- 6 -

ACTIVATE REQUEST) is present, the assignment of a communication channel is performed within the waiting and monitoring period for the activation of the ISDN two-wire subscriber line.

- 5 The schematic diagram of a connection made to a subscriber is contained in Figure 1. The diagram abstracts from all components which are not functionally involved in a radio connection.

The U_{K0} subscriber connection 1.1 created by the ISDN-TVSt is made to a channel group of
10 the base station 1.2, which consists of a U_{K0} repeater (ZWR) 1.3 and the transmit group 1.4 and receive group 1.5. The U_{K0} repeater is conventionally constructed with a U_{K0} transmitter 1.6, hybrid 1.7, and two IEC-T circuits 1.8 and 1.9 connected through an IOM interface. The coupling of the U_{K0} repeater to the radio system is made to separate downstream and upstream lines, omitting the hybrid. The radio system can, if necessary, also contain groups
15 for code conversion, insertion of redundancy for error detection and error correction, and cryptographic processing of the signal.

The subscriber radio terminal 1.10 (see Fig. 1) consists of the receiving group 1.12 and the transmitting group 1.13 which are coupled to separate downstream and upstream lines,
20 omitting the hybrid, to a network termination (NT) 1.11. The NT is conventionally composed of an IEC-T circuit in the NT mode 1.14 and circuit SBC or SBCX 1.15, which are connected through an IOM interface, and an S_0 transformer 1.16. The subscriber radio terminal presents an S_0 interface 1.17 at its output.

- 25 A design of this kind can be wired only as a dedicated line without additional measures, which would require a radio channel for each radio subscriber, but it had to be avoided as far as the aims are concerned. To achieve the established aim it is necessary to allocate a free radio channel for every call request (always referred to hereinafter as radio service switching). The communication internal to the system that is required for radio service
30 switching between the channel component of the base system and the subscriber radio



- 7 -

terminal, and the operation of subscriber switching units, transmitting and receiving units, etc., calls for a finite time which, according to the invention, has to be inserted into the wake-up procedure of the U_{K0} circuit such that the activation of the U_{K0} circuit is not thereby impaired and the information processing can be performed on-line after the wake-up
5 procedure.

This is achieved according to the invention for an incoming call for a radio subscriber (activation by the telephone communication) by delaying the INFO U2W signals. The starting point is the standard execution of the wake-up procedure of the U_{K0} section by the
10 intermediate repeater (see Fig. 2). As part of this procedure, after a PH-ACTIVATE REQUEST, the line termination (LT)2.1 emits the wake-up signal INFO U2W 2.4 to the intermediate generator 2.2, whereupon acknowledgment is given by the intermediate generator with INFO U1W 2.5. In the standard timing 5.32 ms after the emission of 2.4 starts, the acknowledgment QE2.6 is given in the LT. QE2.6 is recognised as being in good
15 order if it takes place before the end of the wake-up repeat time $Tu13=12$ ms 2.7, which was started at the beginning of the emission of 2.4 in the line terminal LT. This signifies that QE2.6 may be delayed by no more than 6.68 ms from the standard timing (waiting period) without any disturbance of the wake-up procedure. The same conditions as for the U_{K0} section LT-ZWR apply to the U_{K0} section ZWR-NT 2.3. Parallel to the emission of the
20 acknowledgment 2.5 to the LT the ZWR transmits to the NT the wake-up call INFO U2W 2.8 and simultaneously starts the wake-up repeat time $Tu13=12$ ms 2.11. Thus the acknowledgment INFO U1W 2.9 of the NT and QE2.10 in the ZWR can be delayed (waiting period) by a maximum of 6.68 ms from the standard timing also on the second U_{K0} section ZWR-NT without any disturbance of the activation of the U_{K0} section. The two waiting
25 periods can be used together or independently of one another.

Using the waiting periods of the wake-up procedure results in the performance of the U_{K0} section corresponding to Figure 3. The INFO U2W 3.4 emitted from the LT 3.1 (see Figure 3) is transferred by a suitable device with a delay to the LT input of the ZWR 3.2, and the
30 INFO U2W 3.6 generated by the ZWR is sent with delay by a suitable device to the second



- 8 -

U_{K0} section. At the moment 3.8 of the beginning of this emission the radio communication must be completed so that 3.6 can be transferred to the NT 3.3 and the activation of the U_{K0} section can be continued properly.

5 These functions are performed in the base station by channel units 4.0 (see Figure 4), which are associated with each U_{K0} subscriber connection 4.1. The incoming line signal is divided in a termination hybrid 4.2 into a downstream and an upstream. Into the downstream line a delay system 4.3 and 4.5 is inserted at the input and output of the SWR 4.4 and are controlled by the channel controller 4.6. When the U_{K0} section is in the deactivated state the delay
10 systems 4.3 and 4.5 constitute an interruption of the line. A wake-up signal entering on the up side of the delay system 4.3 is recognized by the channel controller 4.6, which thereupon starts the process of the radio communication, and after the maximum permissible delay or after the radio communication is complete it feeds the same wake-up signal on the down side of the delay system and then cancels the division of the line (on this, see also Figure 3 and
15 the description corresponding to Figure 3). If after the maximum allowable delay time of the delay system 4.3 the radio communication is not yet completed, the same process can be repeated at the delay system 4.5. The base station is completed, in a manner known in mobile telephone technology, by a radio communication computer 4.7 which controls all channel units 4.0 and the switching matrices of the transmission direction 4.9 and reception
20 direction 4.10 through a central bus 4.8. Transmission units 4.11 and receiving units 4.12, which operate through a switching network 4.13 on a common antenna 4.14, are switched to the switching matrix units 4.12.

According to the invention, in another variant embodiment, when a call arrives for a radio
25 subscriber (activation by the telephone communication) the time needed for the radio connection is obtained through the delayed transfer of the activation request between the LT-side input circuit and subscriber-side output circuit of the ZWR. For this purpose, one must first consider the standard execution of the activation of the U_{K0} section with ZWR as represented in Figure 5. Comprised in this execution is that, after entry of an INFO U2W
30 5.4 from the line termination 5.1 the input circuit 5.5 of the ZWR 5.2 sends the Info RSYD



5.6 to the output circuit 5.7. The output circuit 5.7 acknowledges with the Info ARU 5.8 and by emitting Info U2W 5.9 initiates the activation of the second section of ZWR 5.1 to the NT 5.3. The exchange of the signals ARN 5.10 and AIU 5.11 completes the activation through the IOM interface of ZWR 5.2.

5

For the embodiment of the invention, an interface processor UPC 6.14 is inserted into the IOM interface as represented in Figure 6 and the IOM interface is thus divided into two sections 6.12 and 6.13. After receiving an INFO U2W 6.4 from the line termination 6.1, the input circuit 6.5 of the ZWR 6.2 emits the Info RSYD 6.6, which is received by the UPC 6.14. The UPC 6.14 acknowledges with the signal ARU 6.8 and transmits the activation instruction ARX 6.16 to the radio switching system RPX 6.15. After the radio connection is made to the desired subscriber radio receiver, the RPX 6.15 sends the activation acknowledgement AIX 6.17 to the UPC 6.14. Not until then does the UPC 6.14 send the signal RSYD 6.18 delayed to the output circuit 6.7 of ZWR 6.2. The output circuit 6.7 of ZWR 6.2 acknowledges with the info ARU 6.19 and now, by issuing the INFO U2W 6.9, it activates the second section of the ZWR 6.2 to NT 6.3.

This procedure runs over the already activated radio connection to the desired subscriber terminal. After the Info ARU 6.19 is received, UPC 6.14 also sends the Info ARN 6.20 delayed to the output circuit 6.7 of the ZWR 6.2. From this moment UPC 6.14 switches the connection between input circuit 6.5 and output circuit 6.7 of ZWR 6.2 to transparent and all subsequent signals are transmitted without variation or delay.

This variant of the invention is likewise made in the base station by channel components 7.1 (see Figure 7), which are associated with each U_{k0} subscriber connection 7.2. It is an important feature that in ZWR 7.3 the IOM bus between the circuits IEC 7.4 and IEC 7.5 is entirely or partially interrupted and bus portion 7.6 of IEC 7.4 as well as bus portion 7.7 of IEC 7.5 are connected each to the channel controller /RPX 7.9. The line signal arriving from the LT is divided in a termination hybrid 7.8 into downstream and upstream and the latter are connected directly to IEC 7.4. When an activation request of the LT (INFO U2W) is present,



- 10 -

the activation request issued from the IEC 7.4 through the IOM interface 7.6 is recognized by the channel controller /RPX 7.9 which thereupon starts the process of radio switching (see also Figure 6 and the description relating thereto). After successful radio switching, the channel controller transfers the activation request through the IOM interface 7.7 for the
 5 second U_{K0} section to the IEC 7.5. The base station is completed in a manner known in mobile telephone technology and identical to the representation in Figure 4 and corresponding description.

According to the invention, in the case of an outgoing call by a radio subscriber (activation
 10 request by terminal equipment) the time for the radio switching is achieved by the delay of the signal INFO S1. The starting point is the standard execution of the wake-up procedure of the S_0 section which sets no time limit for the emission of the acknowledgement INFO S2 by the NT after detection of the INFO S1 (except for the total supervision time $TsI = 30 \dots$
 35 s for completion of the activation in the TE with PH-ACTIVATE INDICATION).

15 The implementation takes place in the subscriber's radio apparatus (see Figure 8), since in the NT 8.2 between the S_0 transformer 8.3 and circuit SBC (SBCX) 8.5 in the upstream branch a switch element 8.4 is disposed which can be operated by the link controller 8.7 through a control line. The link controller 8.7 is connected to the upstream branch between
 20 S_0 transmitter 8.3 and switch means 8.4. The switch means 8.4 in the deactivated state of the S_0 section constitutes an interruption of the conduction train. A signal INFO S1 entering on the downside of the switch means 8.4 is detected by the link controller 8.7 which then starts the process of radio switching and, after the radio switching is finished, switches the switch means 8.4 to "ON" so that INFO S1 is applied to the NT and initiates the activation of the
 25 ISDN subscriber connection.

In another variant of the invention, the same problem is solved in the subscriber radio terminal as well (see Figure 9). An important feature is that in NT 9.2 the IOM bus between the circuits SBC (SBCX) 9.4 and the IEC 9.7 is wholly or partially interrupted and the bus
 30 portion 9.5 of the SBC 9.4 as well as the bus portion 9.6 of IEC 9.7 are connected each to



- 11 -

the link controller 9.8. The S_0 signal 9.1 is switched through an S_0 transmitter 9.3 to the circuit SBC (SBCX) 9.4 of NT 9.2. When an activation request from a TE (INFO S1) is present, the activation request emitted by the SBC (SBCX) 9.4 through the IOM interface 9.5 is detected by the link controller 9.8 which then starts the process of radio switching. After 5 successful radio switching the activation request is transferred to the circuit IEC 9.7 by the link controller through the IOM interface 9.6, thereby starting the activation of the ISDN subscriber connection.

In order to achieve the most effective possible utilization of the available transmission bandwidth, an independent radio channel for operation, organization and control purposes is dispensed with, in accordance with claim 7. All of the commands and information required for this purpose are transmitted in the free radio channels. To reduce the number of components used, data rates, block lengths and synchronization words are chosen to be identical with the particular U interface standard. To make it possible for a radio channel to be recognized as free in the subscriber terminal, the synchronizing words are inserted into the transmission in reverse order (beginning and end inverted), so that it can be clearly distinguished whether radio switching or ISDN transmission is involved. A data frame corresponding to these specifications is represented in Figure 10. The data frame begins with 5 ternary "O" steps as leader 10.1. This is followed by 11 ternary steps of synchronizing word 10.2. An 11-place Barker code is used as the synchronizing word which is transmitted from the BS to the radio subscriber in the form of:

$$- + - + - + +$$

In the direction away from the subscriber, the transmission is in the form:

25 + + + --- + -- + -

In ISDN transmission the Barker codes are inserted backwards into the data streams. The polarity in this case is of no importance, since the receiving circuits contain an automatic polarity detector. 16 ternary steps follow, the command part 10.3, since in BCH (8.4) coding 8 data bits can contain 256 commands. Another 16 ternary steps, address part 10.4, follow



which in BCH (8.4) coding can contain 8 data bits equal to 256 addresses. The remaining 72 ternary steps 10.5 are used as the data part and on the same basis as in 10.3 and 10.4 can transmit 36 data bits. As an example, free/busy messages for 36 channels can be contained in it as one-bit information.

5

From the technical radio communication point of view, it is practical to distribute inactive subscriber radio terminals evenly to the free radio channels, in order to have as few switching operations as possible in a desired connection set-up and reduce the probability of a random signal hazard. This problem is solved in that the subscriber radio terminals contain a random
10 generator which before any channel change determines an evenly distributed integer random number, which can be between 1 and 16, for example, depending on the size of the system, and which tells the number of the free channel that is to be used in cyclical scanning.

The channel changes are automatically performed by the subscriber radio terminal at variable
15 time intervals, also on instructions from the radio switching system, or if the channel actually in use is assigned to another subscriber terminal for active use.

When a call arrives the radio switching system allocates a free radio channel to the subscriber, according to claim 8, by transmitting an addressed inquiry into all free radio channels. This
20 is necessary if there is no a priori knowledge in the radio switching system regarding the radio channel occupied at that time by the subscriber radio terminal.

If this inquiry is recognised by the subscriber radio terminal, an acknowledgement is sent, which causes the radio switching system to allocate to the subscriber the radio channel
25 currently used by the subscriber radio terminal, and to set up a connection to the called subscriber for the active ISDN information transmitted, so that there will be no further losses of time due to channel changing etc. It is only on account of time-parallel processes or signal hazards that departures from this procedure can occur, in which case a disentanglement is performed in that, after a radio channel has been allocated to specific subscriber radio terminals, all other subscriber radio terminal leave this radio channel.



- 13 -

Inquiries and acknowledgements are controlled centrally by the radio switching system on the master-slave principle.

When a subscriber tries to make a call (outgoing call), a request to that effect is performed
5 by the subscriber's radio terminal in the radio channel that is free at that moment. If this call attempt is successfully recognised, this radio channel releases the base station to the subscriber radio terminal for active ISDN information transmittal. The procedure and restrictions of this procedure are as described above. To obtain a time-defined reaction of the subscriber terminal, the radio switching system emit free calls to which answer can be made
10 by a call attempt from a subscriber terminal. If a subscriber terminal is not assigned the respective radio channel after the call attempt is made, according to claim 10 an evenly distributed random integer number is generated which indicates the ordinal number of the following free call of the radio switching system that is to be used for another transmission of a call attempt, and accordingly repeats the call attempt.

15 This process assures that, on the basis of a possible signal hazard due to simultaneous call attempts by several subscribers a disentanglement of the individual subscriber calls will be made.

20 If an overlapping of requirements regarding incoming and outgoing traffic for two different subscriber terminals occurs within a radio channel, this does not result in traffic hazards, since in this case another, free radio channel is allocated to one of the subscriber terminals in question (see claim 11). The procedure of changeover to another free channel can result in losses, especially in cases of occurrence of relatively high traffic volume and relatively
25 large numbers of channels, which lead to the subscriber radio terminals requiring an appreciable amount of time to search for free radio channels if the search procedure involves the scanning of all of the radio channels. To forestall this, updated information regarding free radio channels is constantly transmitted by the radio switching system. This enables the subscriber radio terminals, when a change of channel is required, to designate a new target
30 channel without a search, thus reducing the technical communication losses.



- (1) PCT/EP91/00853 (International Publication Number WO 91/18483)
- (2) Mandel, Günter; Kercher, Klaus; "DAL in analog-zellularer Technik" Elektronik, Berlin 42 (1992) 4
- (3) Leipold, Peter: "DAL - Funktechnik im Teilnehmeranschlußbereich" NTZ 45 (1992) 4
- (4) Buckingham, Colin; Wolterink, Gé Klein, Akerberg, Dag; A Business Cordless PABX Telephone System on 800 MHz based on the DECT Technology, IEEE Communications Magazine, January 1991

10 The following abbreviations are terms from user documentation, type names and registered trademarks of the Siemens company:

- | | |
|----------|---|
| IOM | ISDN Oriented Modular Interface |
| IOM-1 | ISDN Oriented Modular Interface Version 1 |
| 15 IOM-2 | ISDN Oriented Modular Interface Version 2 |
| RSYD | Resynchronizing Indication Downstream |
| ARU | Activation Request Upstream |
| ARN | Activation Request no Loop |
| AIU | Activation Indication Upstream |
| 20 IEC | ISDN Echocancellation Circuit |
| IEC-T | ISDN Echocancellation Circuit |
| IEC-TD | ISDN Echocancellation Circuit/Digital Circuit |
| IEC-TA | ISDN Echocancellation Circuit/Analog Circuit |
| SBC | S-Bus Interface Circuit |
| 25 SBCX | S-Bus Interface Circuit, Extended |

Industrial Utility

The invention is industrially useful in the telecommunication industry.



THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A local ISDN transmission system which is organized as a local radio cell, including a central fixed radio base station and a plurality of remote subscriber radio terminals and is
5 connected to the subscriber ports of a local switching centre, a store-and-forward centre or a private branch exchange, and provides the subscribers with access to the public ISDN telephone system through a subscriber interface by the use of wireless transmission, and in which, for the operation of the system in the case of a number of subscribers greater than the number of radio communication channels in use, a radio switching system is provided in the
10 base station which, in the event of an activation request opens to the subscriber radio terminal, any one of the available and free communication channels for the communication, characterised in that the net bit rate of the ISDN subscriber terminal is transmitted unrestricted through the radio channel and the subscriber interface constitutes an unrestricted interface, that the ISDN two-wire subscriber connection line between line termination in the
15 ISDN switching and network termination is divided at the subscriber end by the use of an intermediate repeater into two sections, and that in a section between the intermediate repeater and network termination the wire-connected transmission is replaced by radio transmission, the intermediate repeater is a component of the base station of the local radio cell and the network termination being a component of the subscriber radio terminal that, upon the
20 occurrence of an activation request the allocation of a communication channel is performed within the waiting and monitoring periods for the activation of the ISDN two-wire subscriber connecting line, and that a system is provided which, in the presence of an activation request, delays its forwarding by a delay period which makes it possible to switch a communication channel for the called subscriber and activate radio systems of the subscriber radio terminal.
- 25
2. A local ISDN transmission system according to claim 1, characterised in that in the base station for establishing a radio connection for an incoming call for a radio subscriber, a system at the switching-side input of the intermediate delays the wake-up call issuing from the switching point in the direction of the intermediate repeater and/or a system on the
30 subscriber-side output of the intermediate repeater delays the wake-up call issuing from the



intermediate repeater in the network termination direction, and that these delay times individually or together are used in order to connect a communication channel for the called subscriber and activate the radio system of the subscriber's radio terminal.

5 3. A local ISDN transmission system according to claim 1, characterised in that for the establishment of a radio connection upon an incoming call for a radio subscriber, the base station includes in an interface between an input circuit on the line termination side and an output circuit of the intermediate repeater on the subscriber side, a system which delays the transfer of the activate request to the output circuit, and that this delay time is used in order
10 to connect a communication channel for the called subscriber and activate the radio systems of the subscriber radio terminal.

4. A local ISDN transmission system according to claim 1, characterised in that for the establishment of a radio connection upon an outgoing call of a radio subscriber, the subscriber
15 radio terminal at the subscriber interface connection of the network termination, includes a system which delays the activation request of a connected terminal, and that this delay time is used in order to connect the called subscriber and activate the radio systems of the subscriber radio terminal.

20 5. A local ISDN transmission system according to claim 1, characterised in that for the establishment of the radio connection in the case of an outgoing call from a radio subscriber connected to a subscriber radio terminal a system is inserted into an interface between an input circuit on the subscriber side and an output circuit of the network termination on the switching side, which delays the transfer of the activate request of a connected end terminal,
25 and that this delay time is used for the purpose of connecting a communication channel for the subscriber and activating the radio systems of the subscriber radio terminal.

6. A local ISDN transmission system according to any one of claims 1, 2, 3, 4 or 5, characterised in that after the delayed transmission of the activate requests the radio switching
30 system is connected transparent and on-line into the transmission path between the switching



- 17 -

centre subscriber's end terminal.

7. A local ISDN transmission system according to claim 1, characterised in that, for the switching of communication channels, no special organisation channel is used, but a distributed switching is performed in which switching, organisational and signalling procedures are performed in all free communication channels, and for this purpose the inactive subscriber radio terminals position themselves automatically in one of the free communication channels and a uniform distribution of the subscriber radio terminals to the free communication channels is assured by the fact that, prior to any communication channel change, a random whole number n is determined which indicates the ordinal number of the free communication channel that is to be used in cyclical scanning, and that communication channel changes are allocated automatically at time intervals upon instruction from the radio switching system of the base station, or in cases where the communication channel actually in use is assigned to another subscriber radio terminal for active use.

8. A local ISDN transmission system according to claim 1 or claim 7, characterised in that the radio switching system of the base station, upon an incoming call for a radio subscriber, issues an addressed query to all free communication channels and allocates to the subscriber terminal, on the basis of an acknowledgement, the communication channel in which it is currently located.

9. A local ISDN transmission system according to claim 1 or claim 7, characterised in that the radio switching system of the base station sends "free call" commands into the free communication channels if no other switching and signalling procedures are to be performed, which in the case of an activate request from a radio subscriber permit the subscriber radio terminal to issue an activate request command, and the base station allocates to the subscriber radio terminal, at its request, the communication channel in which it is currently located, for active use.



- 18 -

10. A local ISDN transmission system according to any one of claims 1, 7 or 9, characterised in that, in the subscriber radio terminal, after a call request which is not acknowledged by the radio switching system, a random integer n is determined, which indicates the ordinal number of the following free call of the radio switching system that is
5 to be used for a repeated transmission of an activate request.

11. A local ISDN transmission system according to any one of claims 1, 7, 8 or 9, characterised in that, in case of the simultaneous occurrence of incoming and outgoing activate requests for two subscriber radio terminals in the same information channel, or the
10 simultaneous occurrence of outgoing activate requests from two subscriber radio terminals in the same communication channel, the radio switching system can allocate to one of the subscriber terminals another free communication channel for active use.

12. A local ISDN transmission system according to any one of claims 1, 6 or 7,
15 characterised in that for data transmission for the purpose of radio switching, frame length, transmission speed and synchronizing word identical to the ISDN transmission can be used on the ISDN two-wire subscriber connection line, and that a clear distinction of transmissions for radio switching and ISDN transmissions is achieved by the fact that a synchronizing word in transmissions for radio switching is inserted into the transmission in reverse.

20 13. A local ISDN transmission system according to claim 1 or claim 7, characterised in that the radio switching system, in the case of data transmission for the purpose of radio switching in the data part of the data frame, transmits the updated information through free communication channels, so that subscriber radio terminals can specify another target
25 communication channel for the purpose of communication channel changing without a searching procedure.



- 19 -

14. A local ISDN transmission system substantially as described with reference to the accompanying drawings.

DATED this 12th day of August, 1998.

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Krone Aktiengesellschaft
DAVIES COLLISON CAVE
Patent Attorneys for the Applicant

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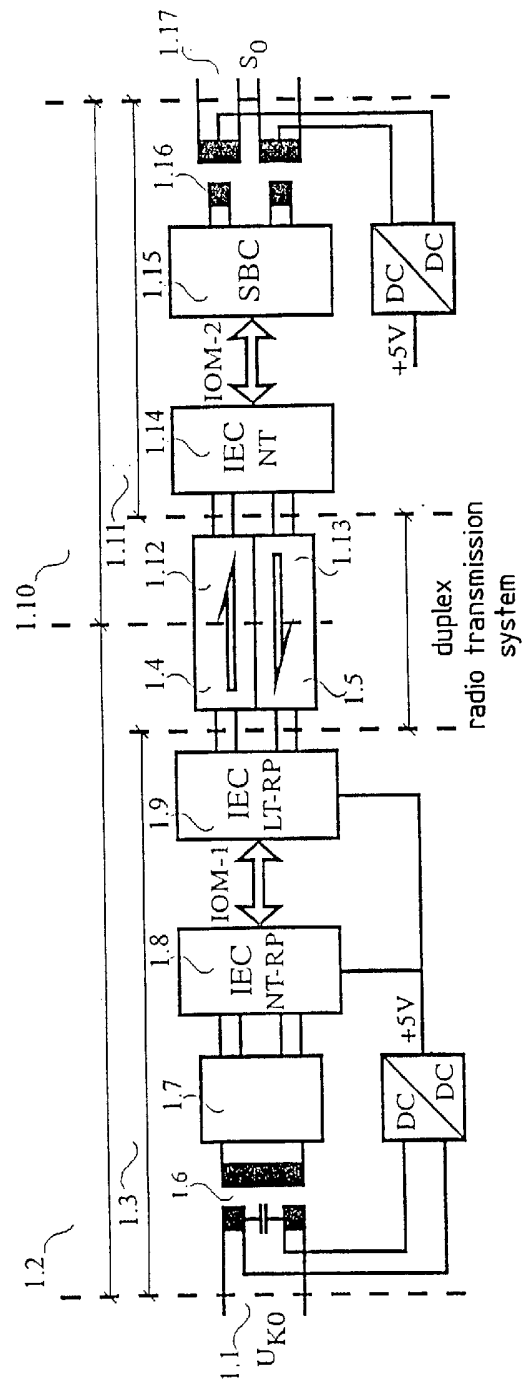


FIGURE 1

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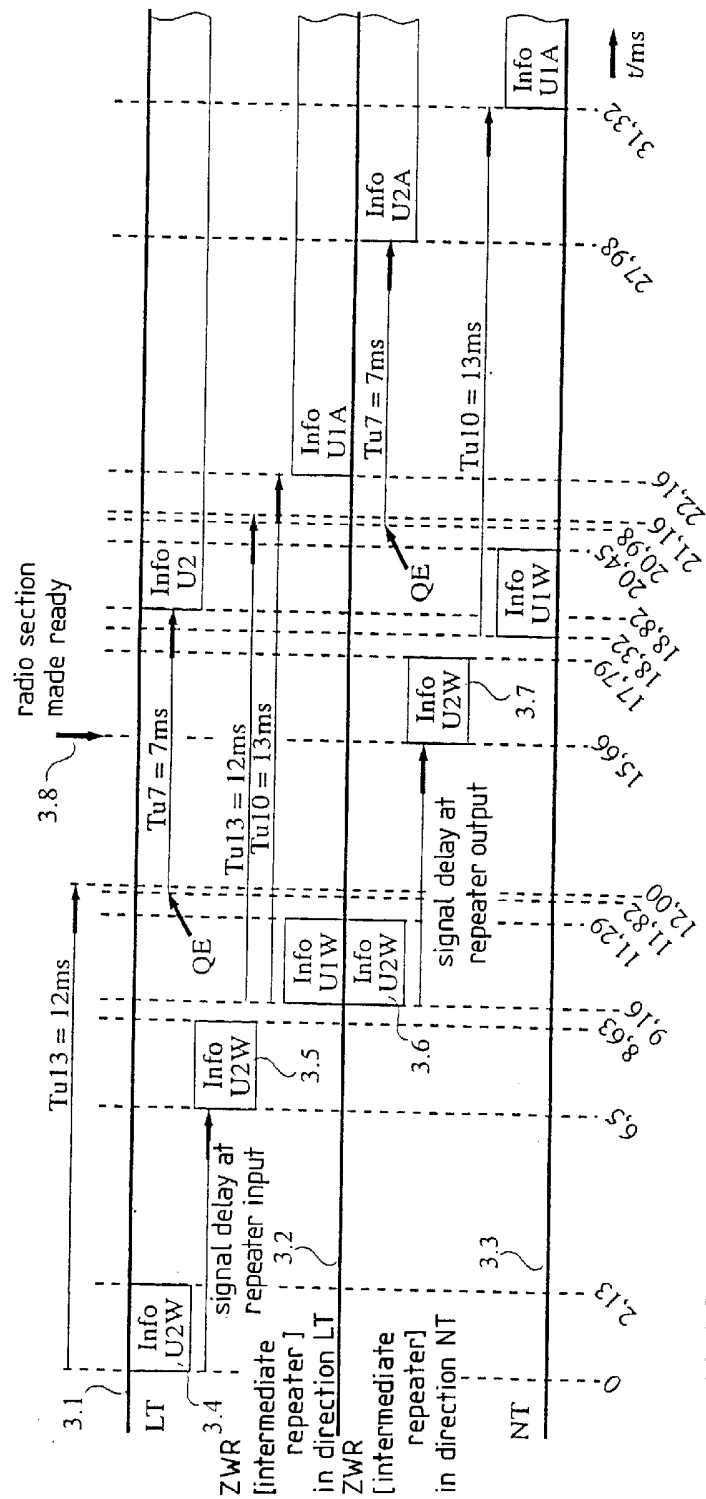


FIGURE 3
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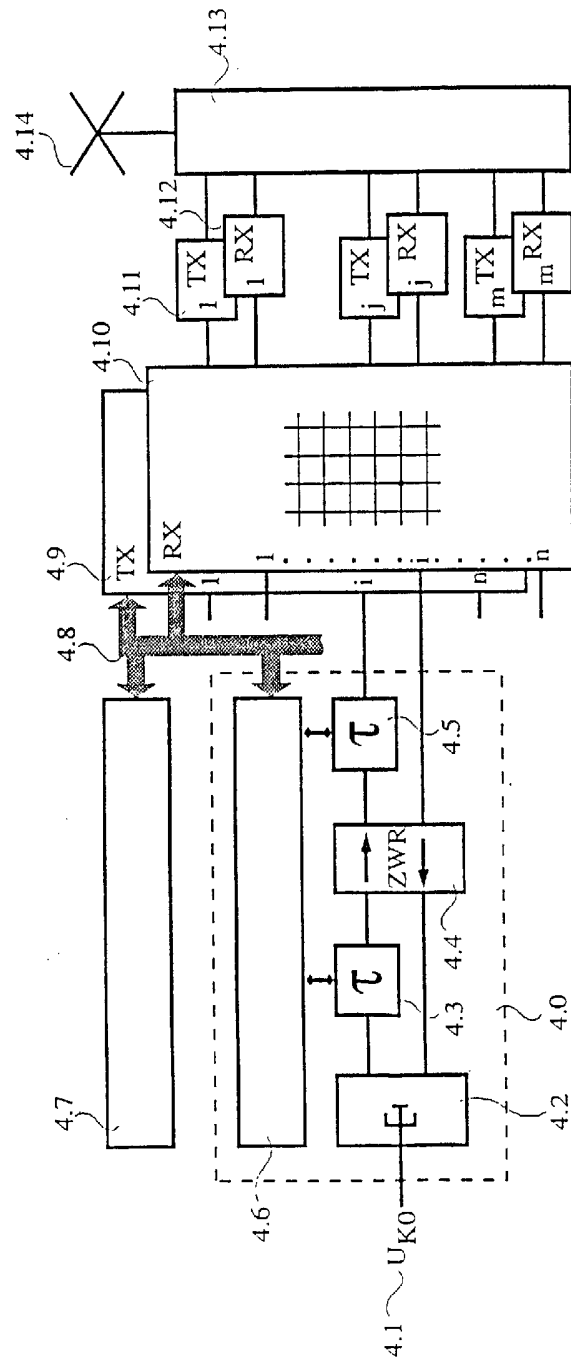


FIGURE 4
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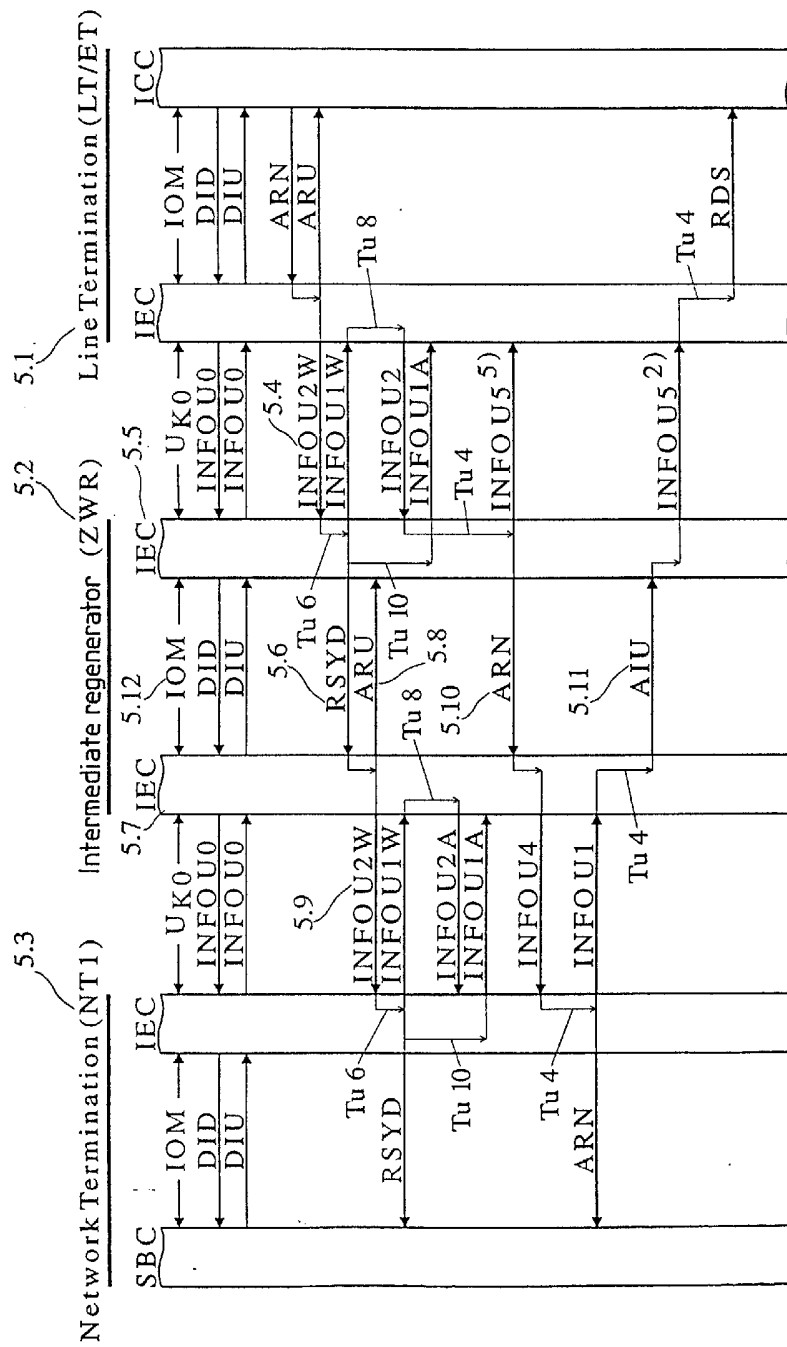


FIGURE 5 : Standard procedure for activation of the U_{k0} section with intermediate regenerator, showing the IOM interface/activation by LT.

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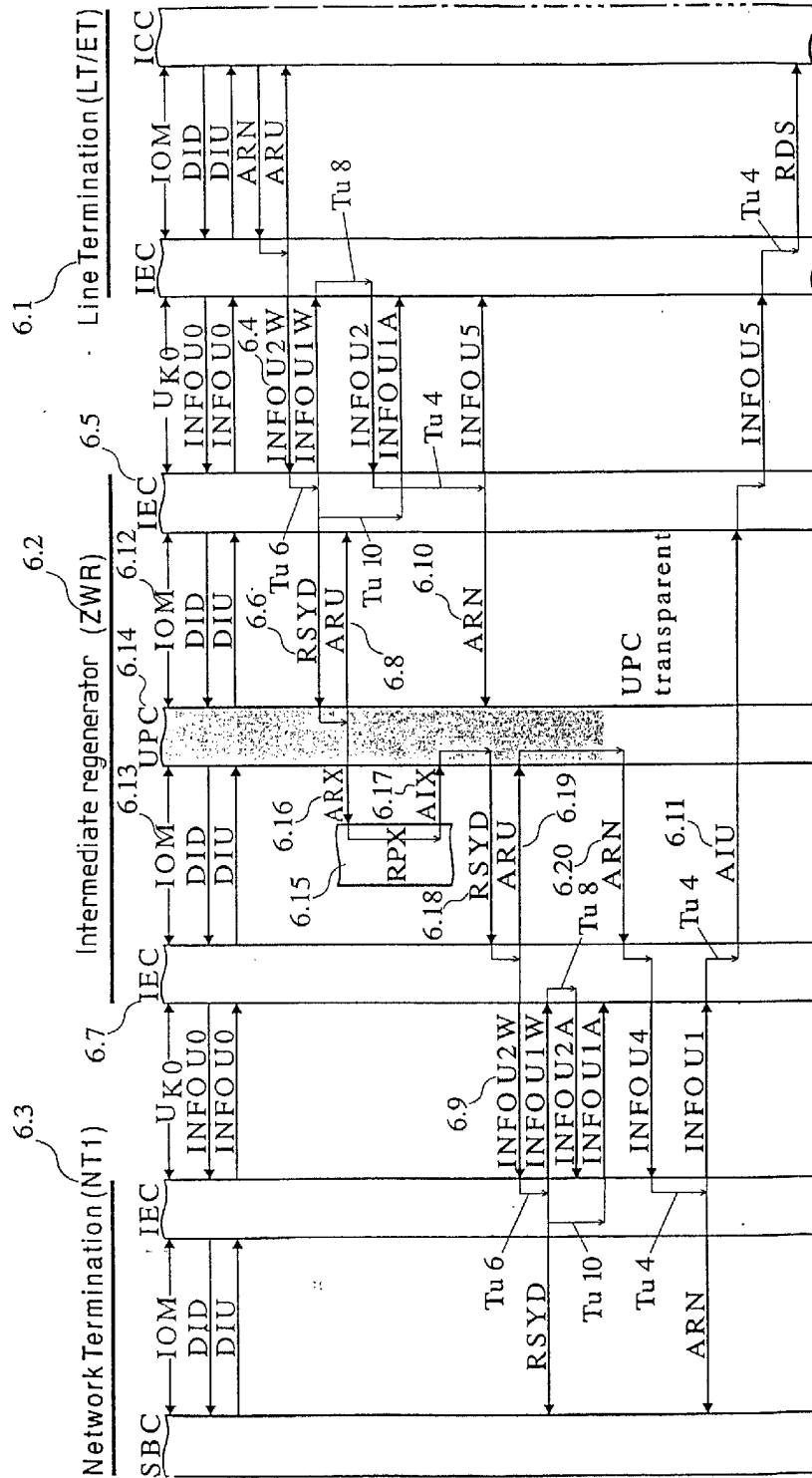


FIGURE 6 : Modified procedure for activation of the U_{k0} section with intermediate regenerator, showing the IOM interface/activation by LT.

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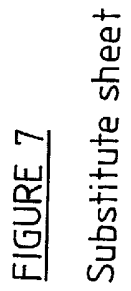


FIGURE 7

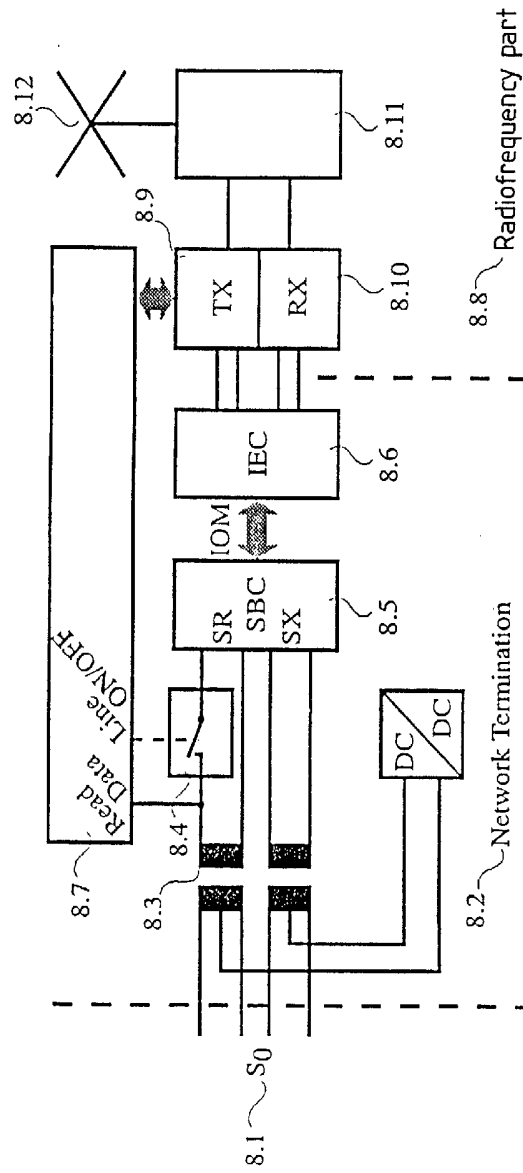


FIGURE 8

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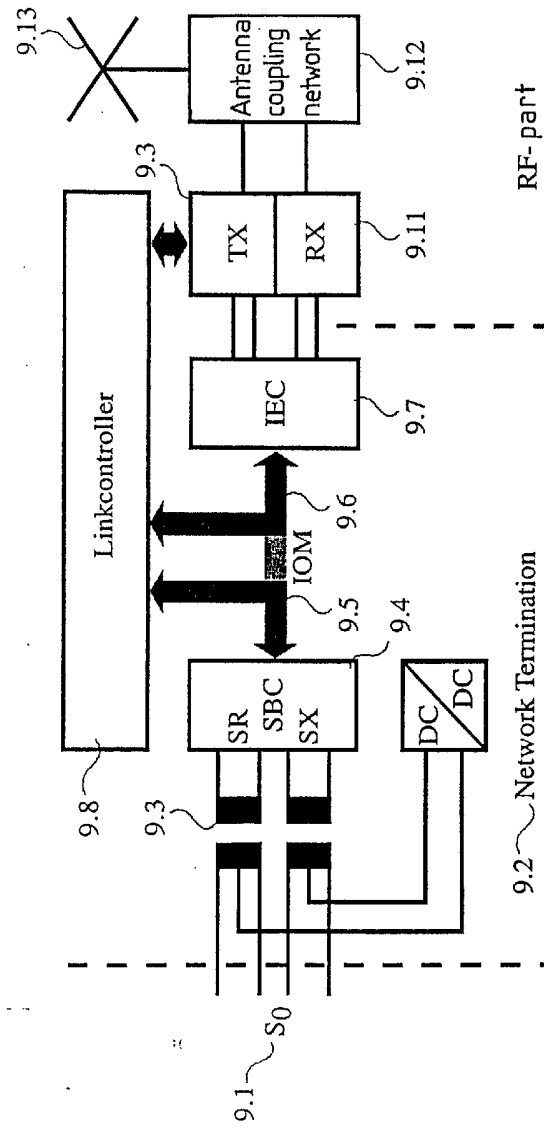


FIGURE 9: Circuit diagram of the subscriber station of an ISDN-DAL system
with delay in the IOM interface.

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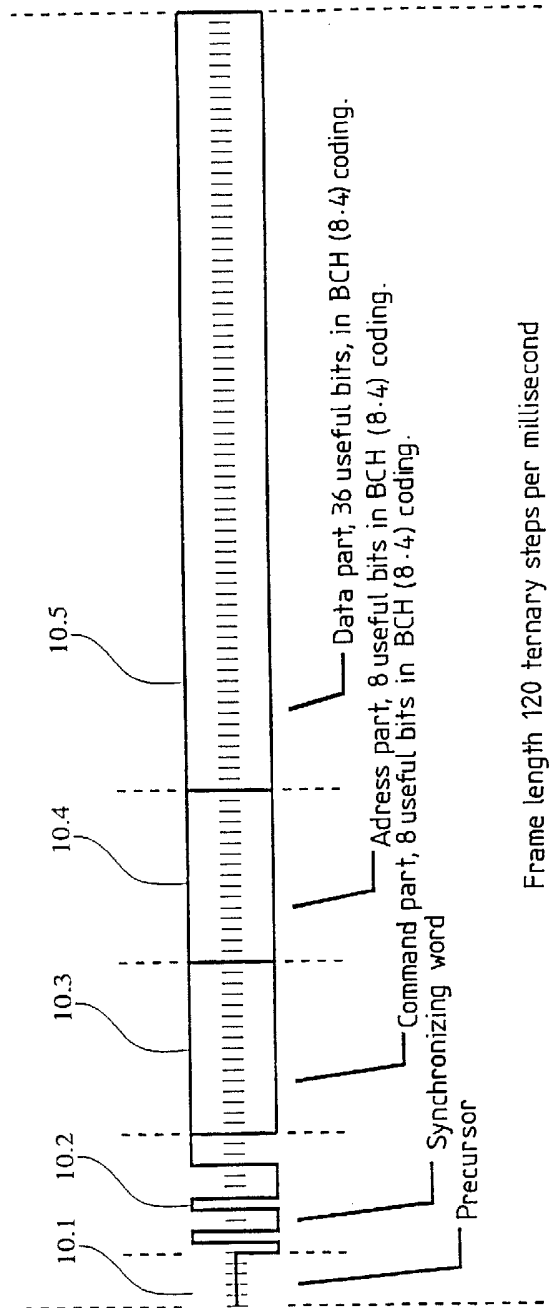


FIGURE 10

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