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(54) **WIDEBAND WIRELESS BASESTATION MAKING USE OF TIME DIVISION MULTIPLE-ACCESS BUS TO EFFECT SWITCHABLE CONNECTIONS TO MODULATOR/DEMODULATOR RESOURCES**

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(56) References cited:
EP-A- 0 189 822 EP-A- 0 497 083
EP-A- 0 590 412 US-A- 5 289 464

- **MOBILE RADIO CONFERENCE, 13 November 1991 - 15 November 1991 VALBONNE, FR, pages 161-168, XP 000444231 BEHAGUE ET AL. 'Modularity and Flexibility: The Keys to Base station System Configuration for the GSM Network'**
- **VEHICULAR TECHNOLOGY SOCIETY, 10 May 1992 - 13 May 1992 DENVER, US, pages 47-50, XP 000339680 HO 'Architecture Design of a Code Division Multiple Access Cellular System'**

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EP 0 763 309 B9

Description

FIELD OF THE INVENTION

[0001] This invention relates generally to communication networks, and in particular to a wireless communication system basestation making use of a wideband, multichannel digital transceiver having incorporated therein a time division multiple-access (TDM) bus for providing digital samples of a plurality of wireless communication channels, wherein the TDM bus is used as a cross-bar switch to permit dynamic allocation of modulator and demodulator signal processing resources.

BACKGROUND

[0002] The basestations used by the providers of current day multiple channel wireless communication services, such as cellular mobile telephone (CMT) and personal communication systems (PCS), typically designate signal processing equipment for each single receiver channel. This is probably a result of the fact that each basestation is configured to provide communication capability for only a limited predetermined number of channels in the overall frequency spectrum that is available to the service provider.

[0003] A typical basestation may thus contain several racks of equipment which house multiple sets of receiver and transmitter signal processing components that service a prescribed subset of the available channels. For example, in an Advanced Mobile Phone Service (AMPS) cellular system, a typical basestation may service a pre-selected number of channels, such as 48, of the total number, such as 416, of the channels available to the service provider.

[0004] Certain types of wireless service providers would prefer, however, to employ equipment that would be more flexible, both in terms of where it can be located, as well as in the extent of the available bandwidth coverage provided by a particular transceiver site. This is particularly true in rural areas where cellular coverage may be concentrated along a highway, and for which the limited capacity of a conventional 48 channel transceiver may be inadequate. This may also be true in other instances, where relatively large, secure, and protective structures for multiple racks of equipment are not necessarily available or cost effective, such as for PCS applications.

[0005] One way to resolve this difficulty is to implement a basestation transceiver using a high speed analog-to-digital (A/D) converter and equipment which makes use of efficient digital filtering algorithms such as the Fast Fourier Transform (FFT), to separate the incoming signal energy into multiple ones of the desired channels. On the transmit side, this basestation implementation includes an inverse FFT processing combiner which outputs a combined signal representative of the contents of the communication channel signals proc-

essed thereby. In this manner, relatively compact, lightweight, inexpensive, and reliable digital integrated circuits may be used to cover the entire channel capacity offered by the service provider, rather than only the subset of the available channels. For a more detailed description of such a system, please refer to our United States patent No. 5 537 435 entitled "Transceiver Apparatus Employing Wideband FFT Channelizer with Output Sample Timing Adjustment and Inverse FFT Combiner for a Multichannel Communication Network".

[0006] Thus unlike prior art basestations, the wideband digital basestation is capable of receiving any channel. While this provides a certain number of advantages as described above, it also poses a number of unique problems to the service provider.

[0007] Perhaps most importantly, there exists a need to efficiently support a varying number of active channels and the required connections into the public switched telephone network.

[0008] These connections should be made in such a way as to simplify call control. Indeed, it would be desirable for as many of the call set up control functions required by such a basestation were handled to the maximum extent possible by the basestation itself.

[0009] By so simplifying the network interface, the Mobile Telephone Switching Office (MTSO) and/or Mobile Switching Center (MSC) through which the basestation is connected to the Public Switched Telephone Network (PSTN) may be freed, as much as possible, from the details of maintaining a proper connection from the PSTN to the remote subscriber unit.

[0010] Secondly, the basestation should make efficient use of the available resources to process each call. In particular, while the wideband channelizer separates the signals into channels, certain other signal processing resources such as demodulators and modulators are also required.

[0011] Using the wideband front end, any channel in the bandwidth available to the service provider is available at any time. However, it is desirable for such a basestation to only activate as many of the other, per-channel resources as is required to support the present call density.

[0012] By making the basestation's implementation of call processing resources as modular as possible, the basestation could initially be configured to support a limited number of channels. Then, as the demand for services grows, additional channels could be supported by the addition of the necessary resources.

[0013] In other instances, the basestation should be reconfigurable in the event of an interruption or expansion in one type of service. For example, given the emergence of several air interface standards such as code division multiple access (CDMA) as well as time division multiple access (TDMA) standards for cellular, it is desirable for a given wideband basestation to be able to support each such standard, thereby reducing the number of such basestations that need to be deployed.

However, it would be desirable if the resources allocated to one particular air interface, when no longer needed, could then be made available to process signals formatted using the other air interface. That is, as the demands of one type of service or the other come and go, the basestation should be automatically reconfigured.

[0014] US-5,289,464 describes a cellular telephone basestation having a radio receiver for receiving signals received from an antenna. The signals are converted by an analog to digital converter and fed to a filter bank analyser which demultiplexes multiplexed FM signals by exponentially modulating each signal to its original spectral position followed by low-pass filtering and decimation. The filter bank analyser produces a plurality of complex signals, each of which is fed to a demodulator for demodulating the signal supplied to it in accordance with the manner in which the signal was modulated.

[0015] The document from the MOBILE RADIO CONFERENCE, 13 November 1991 - 15 November 1991 VALBONNE, FR, pages 161-168, XP000444231 Behague et al.; "Modularity and Flexibility: The Keys to Basestation System Configuration for the GSM Network", discusses the various ways of distributing data with a basestation including having a plurality of buses, each one going from one frame processor to all of the transmitters of the basestation.

[0016] EP-0,590,412 describes a cellular communication system comprised of a plurality of narrowband transmitters and receivers which communicate with signal processing units using digital addressing data packets, the addressing packets being added to the signal.

[0017] Thus, several difficulties exist with a wideband digital basestation that can process at any time, any one of many channels in the RF bandwidth available to a service provider.

[0018] The invention is a basestation as defined in Claim 1, and a wideband basestation transceiver as defined in Claim 16.

[0019] In the preferred form, the receiver portion of the basestation includes a digital channelizer which provides digital samples of multiple wireless channel signals, and a time division multiplexed (TDM) data bus to provide switching functionality between the various channel outputs and other basestation receiver resources such as digital demodulators.

[0020] On the transmitter side, basestation signal processing resources such as digital modulators are also connected to a multichannel digital combiner over the TDM bus. Thus, the same flexibility in switching functionality is provided between transmitter signal processing resources and the transmitter channel inputs.

[0021] More particularly, the wideband basestation transceiver includes a receive antenna and one or more digital tuners that provide wideband digital signal energy to a digital channelizer. The digital channelizer, in turn, produces a plurality of channel signals, with each channel signal representing the signal energy in one of the radio frequency channels. The channel signals each

consist of a series of digital samples.

[0022] The digital samples of each channel signal are, in turn, connected to a time division multiplex (TDM) bus. A basestation controller grants access to the TDM bus by each channel signal in a predetermined timeslot, in a predetermined order.

[0023] The samples of the digital channel signals are then forwarded to an available one of the associated receiver resources, such as a demodulator. The demodulators, typically implemented in a digital signal processor (DSP), are then connected to an outgoing landline such as a T1 line to a telephone switching office (MTSO) or mobile switching center (MSC) for further connection into the PSTN.

[0024] As a result of the switching functionality provided by the TDM bus, the basestation controller is thus capable of assigning receiver resources dynamically, to any channel, at the time the channel becomes active.

[0025] The invention provides other advantages as well.

[0026] For example, the invention allows various air interface standards, even those having different channel bandwidths, to be serviced by the same basestation. For example, the basestation may efficiently service both code division multiple access (CDMA) and time division multiple access (TDMA) signals at the same time. In such an arrangement, there are at least two digital channelizers, with one allocated to separating the incoming RF energy into the channel bandwidths required by TDMA, and another channelizer dedicated to separating the energy into the bandwidth required by CDMA. As the channels are activated, they are then serviced by the pool of demodulator resources, by allocating the correct number of additional time slots to accommodate each standard.

[0027] If, for example, a wideband CDMA mobile unit goes off line, the timeslots as modulators and demodulators freed thereby can be allocated to processing TDMA signals. This results in automatic on-demand redistribution of basestation resources to one signaling standard or another, without intervention by an MTSO, MSC, or the service provider in any way.

[0028] Such a system architecture also exhibits scalability, in the sense that additional DSP processors may be added to support additional channels as traffic increases, without having to change the RF front configuration. This is unlike the prior art, where each basestation had a fixed channel allocation, and, to add capacity, one must add additional narrowband receivers and transmitters.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] For a fuller understanding of the advantages provided by the invention, reference should be had to the following detailed description together with the accompanying drawings, in which:

Fig. 1 is a block diagram of wideband digital basestation making use of a time division multiplex (TDM) bus according to the invention;

Fig. 2 is a more detailed block diagram showing addressable bus drivers and receivers which permits access to the TDM bus;

Fig. 3 is a detailed diagram of an addressable bus driver using a dual-port random access memory (DP-RAM);

Fig. 4 is a detailed diagram of an addressable bus driver using a first-in, first-out (FIFO) memory;

Fig. 5 is a detailed diagram of an addressable bus receiver using a FIFO;

Fig. 6 is a detailed diagram of an addressable bus transmitter using a FIFO;

Fig. 7 is a sequence of operations performed by a basestation control processor in setting up a connection; and

Fig. 8 is an alternate embodiment of the invention making use of multiple tuners and channelizers to support multiple air interface standards while making maximum use of basestation resources.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0030] Fig. 1 is a block diagram of a wideband wireless digital basestation 10 according to the invention. Briefly, the basestation 10 consists of a receive antenna 11, one or more wideband digital tuners 12, one or more digital channelizers 14, a time division multiplex (TDM) bus 16, a control bus 17, a plurality of digital signal processors (DSPs), a first subset of which are programmed to operate as demodulators 18-1-1, 18-1-2, ..., 18-1-P (collectively, demodulators 18-1); a second subset of which are programmed to operate as modulators 18-2-1, 18-2-2, ..., 18-2-Q; and a third subset 18-u of which are presently idle, transport signal (T-1) encoder 20, a T-1 decoder 22, one or more digital combiners 24, one or more wideband digital exciters 26, a power amplifier 28, a transmit antenna 29, a basestation control processor (controller) 30, and a TDM synchronization clock generator 32.

[0031] More particularly, the basestation exchanges radio frequency (RF) signals with a number of mobile subscriber terminals (mobiles) 40a, 40b. The RF carrier signals are modulated with voice and/or data (channel) signals which are to be coupled to the public switched telephone network (PSTN) by the basestation 10. The particular modulation in used may be any one of a number of different wireless (air interface) standards such as the well known Advanced Mobile Phone Service (AMPS), time division multiple access (TDMA) such as IS-54B, code division multiple access (CDMA) such as IS-95, frequency hopping standards such as the European Groupe Speciale Mobile (GSM) also known as "Global System for Mobile Communications", personal communication network (PCN) standards, and the like.

Indeed, in a manner that will be described below, the basestation 10 may even be configured to simultaneously process RF signals formatted according to more than one such air interface at the same time.

[0032] On the receive side (that is, with respect to the basestation 10), RF modulated signals are first received at the receive antenna 11, and forwarded to the wideband digital tuner 12. The digital tuner 12 downconverts the RF signal received at the antenna to a intermediate frequency (IF) and then performs an analog to digital (A/D) conversion to produce a digital composite signal 13.

[0033] Digital tuner 12 is wideband in the sense that it covers a substantial portion of the bandwidth available to the wireless service provider who is operating the basestation 10. For example, if the air interface implemented by the basestation 10 is IS-54B, the wideband digital tuner may downconvert as much as a 12.5 MegaHertz (MHz) bandwidth in the 800-900 MHz range which contains as many as 416 receive and transmit channel signals, each having an approximately 30 kilohertz (kHz) bandwidth.

[0034] The digital channelizer 14 implements a channel bank to separate the downconverted composite digital signal 13 to a plurality, N, of digital channel signals 15.

[0035] This digital sampled signal is then further filtered to separate it into the individual 30 kHz channel signals. The digital channelizer 14 can thus be considered as a bank of digital filters with each filter having a 30 kHz bandwidth. The digital channelizer 14 may implement the filter bank using any of several different filter structures, and no particular digital filter structure is critical to the operation of the invention.

[0036] However, our co-pending United States patent application entitled "Transceiver Apparatus Employing Wideband FFT Channelizer with Output Sample Timing Adjustment and Inverse FFT Combiner for a Multichannel Communication Network" filed April 8, 1994 and which is assigned to Overture Systems, Inc. the assignee of this application describes several particular embodiments of the digital tuner 12 and digital channelizer 14 in detail.

[0037] In any event, the channelizer 14 provides N individual digital channel signals 15, wherein each of the N outputs represent information in one of the radio frequency channels originated by the mobile 40. Usually, one-half of the channels are used for transmitting signals and one-half for receiving signals. Thus, in the IS-54B example being described, N is 208, and thus there are 208 receive and 208 transmit channels implemented by the basestation 10.

[0038] These N digital channel signals are then provided over the time division multiplex (TDM) bus 16 to a plurality of digital signal processors (DSPs) 18-1-1, 18-1-2, ..., 18-1-P (collectively, demodulator-DSP 18-1). In a manner that will be understood in greater detail shortly, the TDM bus 16 operates as a time division multiplexed cross-bar switch. That is, any one of the N

digital channel signals 15 may be connected to any one of the demodulator DSPs 18-1 via the TDM bus 16.

[0039] The DSPs 18-1 are each programmed to remove the modulation on each channel signal 15 specified by the air interface standard. There typically is not a one-to-one correspondence between the number of DSPs 18-1 and the number of channel signals, N, provided by the channelizer 14. For example, the DSPs may each process a number, such as 24, of digital channel signals 15 at the same time.

[0040] The basestation controller 30, using the VME bus and TDM synchronization clock generator 32, manages access by individual digital channel signals 15 to the TDM bus 16, in a manner that will be described shortly.

[0041] The outputs of the digital signal processors 18-1, representing demodulated audio or data signals, are then forwarded over the VME bus 17 to the encoder 20. The VME bus 17 is a well known industry standard relatively high frequency bus for interconnecting digital processors and components.

[0042] The encoder 20, in turn, reformats the demodulated signals as necessary for transmission to a local Mobile Telephone Switching Office (MTSO). The demodulated signals may be reformatted according to any one of a number of well-known time multiplex telephone signal transport protocols, such as the so-called T1 span (or E1). The T1 signals are then processed by the MTSO in a known fashion, to ultimately complete a telephone call from the subscriber unit 40 to a desired destination, such as another telephone subscriber who is connected to the Public Switched Telephone Network (PSTN).

[0043] Since each T1 span has a limited capacity, there may be more than one T1 signal necessary to accommodate all of the channels serviced by the basestation 10. In the example being discussed, each T1 signal may be formatted to carry up to 96 IS-54B bandwidth-compress signals to the MTSO, assuming that the demodulated signals remain as compressed audio. Thus, as few as five T1 lines can be used to carry all of the 416 transmit and receive channels. When not all of the channels are busy, however, on as many of the T1 line resources as are necessary are connected to the MTSO, in a manner that will be understood shortly.

[0044] In other words, the demodulated signals output by the DSPs 18-1 may each be sub-rate (e.g., sub-DS0 frequency signals) which still contain additional encoding other than the air interface standard, such as impressed by a bandwidth compression scheme, which is not removed by the basestation 10. Rather, to minimize the required number of time slots used by the T1 signals, such compression may be removed at the MTSO.

[0045] The signal flow on the transmit side of the basestation 10 is analogous. Signals are received from the MTSO and provided to the T1 decoder 22, which removes the T1 formatting.

[0046] The unformatted T1 signals are then coupled to the DSPs 18 over the bus 17. A subset of the DSPs

18-2-1, 18-2-2, ..., 18-2-Q (collectively, modulators 18-2) then modulate these signals and presents them to the TDM bus 16. Ultimately, these are then each coupled to one of the N digital channel signals 23 input to the combiner 24. As was true in the receive direction, being a cross-bar switch, the TDM bus 16 permits any one of the modulator DSPs 18-2 to be connected to any one of the channel signal inputs 23.

[0047] Although each modulator DSP 18-2 typically processes multiple channel signals, each such channel signal generated by the modulator DSP 18-2 is typically assigned one or more unique time slots on the TDM bus 16, with no two channel signals thus occupying the same time slot. Similarly, no two channel signals on the receive side ever occupy the same timeslot on the TDM bus 16.

[0048] Other DSPs 18-u may be unused at a particular point in time. However, these unused DSPs remain as an available resource to the basestation 10, should a new mobile 40 request access. The manner in which DSPs are allocated at the time of setting up a call will be described in detail below.

[0049] The digital combiner 24 combines the TDM bus outputs to produce a composite IF digital signal 25 representing the N channels to be transmitted. The digital combiner 24 then feeds this combined signal to a digital exciter 26, which generates an RF signal 27. This RF signal 27 is then amplified by the power amplifier 28 and fed to the transmit antenna 29.

[0050] A more detailed description of the digital combiner 24 and wideband digital exciter 26 is contained in the above-mentioned co-pending patent application.

[0051] In order to set up each call, the basestation control processor 32 must exchange certain control information with the MTSO. For example, when a mobile unit 40 wishes to place a call, the mobile unit 40 indicates this by transmitting on one or more control signal channels. These control signals may be exchanged in one of several ways. As shown, the control signals may be in-band or out of band signals present in one or more of the channel signals output by the channelizer 14 or input to the combiner 24. Alternatively, a separate control signal transceiver 35 may be used to receive and transmit such control signaling.

[0052] In either event, the basestation 10 forwards the request for access by the mobile 40 to the MTSO, to set up the end to end connection. Upon receiving an indication from the MTSO that the connection can be made at the remote end, the basestation 10 then performs a number of steps, to insure that the appropriate data path through the TDM bus is then enabled to support communication with between the newly enabled mobile 40 and the MTSO.

[0053] For example, the MTSO typically returns a pair of T1 span line and T1 time slot identifiers. These inform the basestation controller 30 on which outgoing T1 line and time slot to place the received signal, and on which incoming T1 line and time slot it can expect to obtain the

transmit signal for the mobile 40.

[0054] However, before proceeding with a detailed explanation of this call set-up process, a bit more detail of the operation of the TDM bus 16 will be provided. As shown in Fig. 2, the digital channelizer 14 consists of a convolutional digital filter 140, a fast Fourier transform (FFT) 142, as well as a TDM dual port (DP) driver 144.

[0055] The operation of the convolutional filter 140 and FFT 142 is not critical to the present invention, and is explained in the co-pending application. It is sufficient here to say that the convolutional filter 140 and FFT 142 make use of multirate digital signal processing techniques, such as overlap and add or polyphase, to efficiently implement a digital filter bank by (1) grouping samples of the downconverted signal 13 together and multiplying them by a weighting function, and then (2) forwarding them to the FFT 142 for conversion into the N individual channel signals.

[0056] An exemplary DSP demodulator 18-1-1 and modulator 18-2-1 are also shown in Fig. 2. The demodulator DSP 18-1-1 includes a TDM first-in first-out (FIFO) driver 180-1, a TDM FIFO receiver 182-1, a DSP central processing unit 184-1 and program memory 186-1. Similarly, the modulator DSP 18-2-1 includes a TDM FIFO driver 180-2, a TDM FIFO receiver 182-2, a DSP central processing unit 184-2 and program memory 186-2.

[0057] Indeed, the modulator and demodulator DSPs may share the same hardware architecture, with the only difference being the in the program which is enable in the program memory 186, which in turn may control whether the TDM receiver or TDM driver hardware is enabled.

[0058] Thus, in the DSP demodulator 18-1-1, only the TDM receiver 182-is enabled (as indicated by the dashed lines around the driver 180-1), since the demodulator 18-1-1 only receives data from the TDM bus 16. Likewise, only the TDM driver 180-2 is enabled in the DSP modulator 18-2-1, since it only transmits data on the TDM bus 16.

[0059] On the transmit side, the digital combiner 24 consists of a TDM dual port (DP) receiver 244, an inverse FFT 242, and deconvolutional digital filter 240. In a manner that is described below, the TDM DP receiver 244 reads each of the data samples off the TDM bus 16 in their assigned time slot, and provides them to the inverse FFT 242 in the required order.

[0060] The samples are then operated on by the inverse FFT 242 and deconvolutional filter 240, to provide the composite digital signal 25 (Fig. 1). Again, further details of the operation of the inverse FFT 242 and deconvolutional filter 240 are not necessary here, and they are discussed in the co-pending patent application should the reader be interested.

[0061] Returning attention now to the channelizer 14, a detailed diagram of the TDM DP driver 144 is shown in Fig. 3. Briefly, it operates to assert the output samples from the FFT 142 in the proper time slots on the TDM

bus 16. In order to simply the implementation of the TDM bus 16, these time slots are fixedly assigned to particular channels (such as in ascending order by frequency and time slot number). Thus, a sample of a given one, k, of the N channel signals, will always appear in a particular time slot, k, when it is active.

[0062] The DP driver 144 consists of a TDM slot counter 200, a first Dual Port Random Access Memory (DP-RAM) referred to as the enable DP-RAM 202, a second DP-RAM referred to as the data DP-RAM 204, and a driver 208 having an enable input EN.

[0063] As is conventional, each of the DP-RAMs have two separate address and data ports for reading and writing data, namely, input address and data ports AI and DI, and output address and data ports AO and DO.

[0064] In operation, the TDM slot counter 200 receives a pair of signals generated by the TDM synchronization circuit 32 (Fig. 1). The first signal, TDM CLK, is a digital clock signal identifying the clock periods, or time slots, on the TDM bus 16. The second signal is a TDM FRAME SYNC signal, indicating when a new frame starts on the TDM bus 16.

[0065] The TDM slot counter 200, which is a standard digital counter, receives the TDM FRAME SYNC signal at a reset input R, and the TDM CLK signal at a clock input (denoted by a chevron in the Figures). Thus, the TDM slot counter 200 continuously keeps track of which consecutively numbered slot on the TDM bus 16 is presently active.

[0066] The enable RAM 202 generates an enable signal 203 indicating when the TDM DP driver 144 may assert data on the TDM bus 16. The AI and DI inputs to the enable DP-RAM 202 are typically written into by the basestation controller 30 during the process of setting up a new call. In particular, as shown in the table depicting the contents of the enable DP-RAM 202, a location in the RAM is associated with each time slot on the TDM bus 16 (e.g., if the TDM bus contained 512 time slots, then the RAM 202 has 512 locations).

[0067] A logical "0" in the associated enable DP-RAM 202 location indicates that the TDM driver is inactive in the time slot, that is, no data is to be asserted at that time. A logical "1" in the associated location indicates that the time slot has been assigned to this particular TDM driver 144.

[0068] Thus, to enable a connection through the TDM bus 16, one step for the basestation controller 30, via the VME bus 17, is to write a logical "1" into the DP-RAM 202 location "x" associated with the newly enabled digital channel signal "x". In the example, shown, a "1" has been written at locations "27" and "30", indicating that this particular TDM driver 144 is now active in timeslot numbers 27 and 30.

[0069] The data DP-RAM 204 acts as a buffer, writing the digital channel signal samples output by the FFT at the DI input of the data DP-RAM 204. The DP-RAM 204 then stores the data samples until addressed by the TDM slot counter at the output side.

[0070] A data dual port (DP) RAM 204 is as a buffer in the case of processing the FFT output. This is because although the samples do come in bursts, or frames, the samples are not necessarily provided by the FFT 142 in the same order as they must be output onto the TDM bus 16. This is a particular phenomenon of at least one of the channelizer algorithms used. Thus, an address associated with each output sample from the FFT is used to determine at which location each sample is written in the data DP-RAM 204.

[0071] However, the input data is already in the correct order for the TDM FIFO driver 180-2 used by the DSP modulator. Such a TDM driver 180-2 can thus use a first-in first out memory (FIFO) 210 in the place of a data DP-RAM. As shown in Fig. 4, the configuration and operation of such as TDM FIFO driver 180-2 is somewhat similar to the DP driver 144.

[0072] In particular, the TDM slot counter 200, enable DP-RAM 202 and driver 208 operate in the same way as for the embodiment of Fig.3. The only difference is in the connection of the clock signals to the FIFO 210. On the input side, a clock signal is provided by the data source (e.g., the DSP processor 184-2) to cause data to be stored in the FIFO. The signal from the enable DP-RAM 202 is used to clock the FIFO output, DO.

[0073] A detailed diagram of the TDM FIFO receiver 140-2 is shown in Fig. 5. It includes a TDM slot counter 200, enable DP-RAM 202, bus receiver 212, and FIFO 214. The TDM slot counter 200 and enable DP-RAM 202 operate as for the TDM FIFO driver 180-1 shown in Fig. 4, to identify when the receiver 212 is to be active. The FIFO 214 is connected to the output of the receiver 212, having its input port connected to the enable DP-RAM 202 output. The output side of the FIFO is clocked as needed by the destination for the data (such as the DSP processor 184-1 in Fig. 2).

[0074] The TDM DP receiver 244 is shown in detail in Fig. 6. As for each of the other driver/receivers, it includes a TDM slot counter 200, enable DP-RAM 202. It includes a data DP-RAM 220 operating similarly to the data DP-RAM in the TDM DP driver 144 (Fig. 3) and bus receiver 218.

[0075] With this background in mind, the details of how the basestation control processor 30 effects the switching operation of the TDM bus 16 can now be better understood.

[0076] Fig. 7 is a flowchart of these operations. This sequence of steps is initiated (step 300) when the basestation controller 30 receives control signals from the mobile 40 (Fig. 1) indicating that the mobile wishes to have access to the PSTN. The controller 30 then determines whether a free transmit and receive frequency (step 302) are available among the N channels.

[0077] An available modulator DSP and demodulator DSP resource are then identified (step 303) by examining a list 33 of free DSP resources maintained in a memory portion 31 of the basestation controller 30 (Fig. 1). The list 33 is updated by removing the two DSPs once

allocated.

[0078] Access to an MTSO T1 channel (e.g., access to one or more T1 time slots as needed on a particular T1 span line) is then requested from the MTSO by issuing the appropriate MTSO control signaling (step 304). The MTSO then returns T1 span and time slot identifiers to be used for the transmit and receive channels for this connection.

[0079] In the next step (306), the appropriate destination and source information is written into the various TDM bus drivers and receivers.

[0080] In particular, given a receive channel identification, a receive channel signal time slot on the TDM bus is thus identified. The corresponding location of the enable DP-RAM 202 in the TDM DP driver 144 associated with this time slot is then set to a logical "1" in the manner already described.

[0081] Next, a logical "1" is also written into the enable DP-RAM in the TDM receiver 182-1 associated with the DSP demodulator 18-1 which was identified as being an available resource. If the per-channel bandwidth is greater than that which can be supported by a single timeslot, then a sufficient number of logical "1"s are written into the appropriate locations.

[0082] Also, now given a transmit channel identification, the free DSP modulator 18-2 is enabled (step 306) to use the TDM bus 16, by writing a logical "1" into the enable DP-RAM of the TDM driver 180-2 connected to the available one of the DSP modulators 18-2. To complete the connection, a logical "1" is also written into the location of the TDM DP receiver 244 associated with the identified transmit channel.

[0083] Finally (step 308), the basestation controller 30 issues control signals to the mobile 40 and MTSO to indicate that the connection has been set up.

[0084] The invention can also be used to advantage in implementing a basestation 10 which simultaneously services mobiles 40 which use different air interface standards. That is, the basestation 10 may at the same time process signals from a first mobile 40a which uses TDMA (IS-54B) signaling, as well as a second mobile 40b which uses CDMA signaling (IS-95).

[0085] As shown in Fig. 8, to support this implementation, the basestation 10 includes a pair of wideband digital tuners 12-1, 12-2. The first digital tuner 12-1 downconverts a bandwidth, such as 5 MHz, from an RF bandwidth which is occupied by TDMA signals. A second digital tuner section 12-2 downconverts a bandwidth, such as 7.5 MHz, which is occupied by CDMA signals.

[0086] Next, the tuners 12-1, 12-2 forward the downconverted signals to respective channelizers 14-1, 14-2. The TDMA channelizer 14-1 is configured to separate the received signal into the 30 kHz bandwidth channels specified by IS-54B. Likewise, the CDMA IS-95 channelizer 14-2 is configured to provide 1.25 MHz channels as specified by that standard.

[0087] The modulators and demodulators are then

grouped according to the air interface modulation they must deal with. For example, at any given instant in time, a certain number of DSPs 18-1-T will have been allocated to operate as demodulators for the TDMA channels provided by the TDMA channelizer 14-1. A different set of DSP processors 18-1-C will be serving as demodulators for the CDMA channels provided by the CDMA channelizer 14-2. The active modulator DSPs will likewise be so allocated.

[0088] Thus, assuming that each of the DSPs 18 can be configured to execute either a TDMA modulation/demodulation program or a CDMA modulation/demodulation program by simply accessing the correct program memory, the available DSP resources are only allocated as needed.

[0089] In other words, the DSPs (and associated T1 connections, for that matter) are allocated according to user demand automatically, and without intervention by the service provider. Thus, for example, as more customers migrate to using CDMA, additional CDMA channels are automatically made available and processed by the DSPs, at the expense of the unused TDMA channels.

[0090] A number of advantages can now be seen for a basestation 10 configured according to the invention. By disposing the TDM bus 16 between the output of the wideband digital channelizer 14 and the demodulator DSPs 18-1, the demodulator DSPs 18-1 may be allocated only as needed. Similarly, the modulator DSPs 18-2 are allocable as needed, since the TDM bus 16 is disposed between them and the digital combiner 24 as well.

[0091] Thus, if the basestation 10 is expected to service only a small number of channels, a correspondingly small number of modulator and demodulator DSPs can be installed in the basestation 10. As the basestation's demands increase, these additional RF channels can be serviced by simply adding more DSPs, and without having to reconfigure the RF front end.

[0092] Another advantage is provided in that this switching functionality is distributed at the basestation level as much as possible. In particular, unlike certain prior cellular signal switching techniques, the MTSO need not be concerned with the details of how the mobile units 40 are connected through the basestation. Indeed, the MTSO need not even know or care about which transmit and receive frequencies have been assigned to a particular mobile. All the MTSO need provide is identification of a T1 transport line and time slot on which it expects to receive and provide signals from and to the mobile.

[0093] Furthermore, because the basestation may efficiently allocate its demodulator/modulator resources, a number of different air interface standards may be supported by the basestation at the same time, without the need to determine in advance an exact plan for allocating receiver/transmitter resources for each air interface type. Upon detecting a request by a new mobile

for access, the basestation simply determines the type of air interface used by the mobile, and then signals the appropriately programmed DSPs, or even initiates the DSPs to run a different modulator/demodulator program, as required to support the additional mobile.

Claims

1. A basestation (10) for processing signals in a multiple mobile subscriber unit wireless communication system comprising:

an antenna (11) for receiving signals from a plurality of the mobile units (40a, 40b) as a composite radio frequency (RF) signal; wideband digital tuner means (12), connected to the antenna, for downconverting a selected bandwidth of the RF signal to an intermediate frequency (IF), and for performing an analog to digital conversion on the IF signal, to provide a wideband digital tuner output signal (13); digital channelization means (14), being connected to receive the wideband tuner output signal, and providing multiple digital channel signal outputs (15), each digital channel signal output having a predetermined channel bandwidth, and each digital channel signal corresponding to one of the signals received from one of the mobile units; and a plurality of digital signal processing means (18), for providing digitally processed channel signal outputs; **characterized in that** the basestation further comprises a single common time division multiplex switching means (16), disposed between the multiple digital channel signal outputs and the plurality of digital signal processing means (18), the switching means including a single common interface (16) for interconnecting all of the multiple digital channel signal outputs to the switching means, the switching means being arranged to connect any one of the multiple digital channel signal outputs (15) to any one of the plurality of digital signal processing means (18) by mapping specific ones of said multiple digital channel signal outputs into specific time slots which are known to said plurality of digital signal processing means.

2. The basestation of claim 1 wherein the signals received from the mobile units contain air interface modulation, and the digital signal processors include demodulators to remove the air interface modulation.

3. The basestation of claim 1 additionally comprising:

signal-transport encoding means, connected to the output of the digital signal processing means, for encoding the digitally processed channel outputs for further transmission to a mobile telephone switching office (MTSO).

4. The basestation of claim 3 wherein the signal-transport encoding means is a T1 encoder.

5. The basestation of claim 1 additionally comprising:

second digital channelization means, being connected to receive the wideband tuner output signal, and providing a second set of multiple digital channel signal outputs, each one of the second set of the digital channel signal outputs having a predetermined channel bandwidth which is different from the predetermined channel bandwidth of said above mentioned first digital channel signals, and each one of the second set of digital channel signals corresponding to one of the signals received from one of the mobile units.

6. The basestation of claim 1 additionally comprising:

second wideband tuner means, connected to the antenna, for downconverting a second selected bandwidth of the RF signal to a second intermediate frequency (IF), and for performing an analog to digital conversion on the second IF signal, to provide a second wideband digital tuner output signal; and

second digital channelization means, being connected to receive the second wideband tuner output signal, and providing a second set of multiple digital channel signal outputs, each one of the second set of the digital channel signal outputs having a predetermined channel bandwidth which is different from the predetermined channel bandwidth of said above mentioned first digital channel signals, and each one of the second set of digital channel signals corresponding to one of the signals received from one of the mobile units.

7. A basestation as in claim 6 wherein the first and second set of digital channel signals are modulated in accordance with first and second access methods, respectively.

8. A basestation as in claim 7 wherein the digital signal processors include a first set of digital signal processor means for demodulating said first set of digital channel signals, and a second set of digital signal processors for demodulating said second set of digital channel signals.

9. A basestation as in claim 7 wherein said first and second access methods are each different, the access methods selected from: time division multiplex, TDMA; code division multiplex, CDMA, or selected from access methods of the standards: Advanced Mobile Phone System, AMPS; Personal Communications System, PCS; or Groupe Speciale Mobile; GSM.

10. A basestation as in claim 1 additionally comprising:

basestation controller means, connected to the time division multiplex switching means and the digital signal processing means, for maintaining a list of unused digital signal processing means that are not presently interconnected through the time division multiplex switching means to one of the digital channel outputs, and for dynamically allocating digital signal processing means from the list of unused digital signal processing means to be interconnected to one of the digital channel outputs only when the digital channel output contains an active signal being transmitted by the mobile unit which has not yet been assigned to one of the digital signal processing means.

11. A basestation as in claim 1 wherein the time division multiplex switching means further comprises:

a time division multiplex (TDM) data bus including data lines;

basestation controller means, connected to the TDM bus, and to generated TDM bus synchronization signals and driver address signals, the TDM bus synchronization signals used to identify access timeslots on the TDM bus; and TDM bus driver means, connected to the TDM bus, the basestation controller means, and at least one of the digital channel signals, for receiving the TDM bus synchronization signals and the driver address signals, for storing the driver address signals, and for asserting the digital channel signal on the TDM bus when the value of driver address signals corresponds to the value of the bus synchronization signals, thereby indicating that a timeslot associated with the digital channel signal is currently active.

12. A basestation as in claim 11 wherein the basestation controller means, connected to the TDM bus, additionally generates receiver address signals, and the time division multiplex switching means additionally includes:

TDM bus receiver means, connected to the TDM bus, the basestation controller means,

and at least one of the digital signal processor means, for receiving the TDM bus synchronization signals and the receiver address signals, for storing the receiver address signals, and for reading a signal asserted on the TDM bus and providing such asserted signal to the digital signal processor means when the value of receiver address signals corresponds to the value of the bus synchronization signals, indicating that a timeslot associated with the digital signal processor is currently active.

13. A wideband basestation as in claim 6 wherein the first and second channelizers each comprise:

a convolutional digital filter, connected to receive the respective one of the digitized wideband signals; and
a fast Fourier transform (FFT) processor, connected to receive the output of the convolutional digital filter, and to provide the digital channel signals.

14. A basestation as in claim 1 additionally comprising:

a second plurality of digital signal processing means, connected to receive digital input signals from a communication signal source;
a wideband digital combiner, being connected to receive a second plurality of digital channel signals, and to provide a composite digital signal for transmission;

wherein the time division multiplex switching means is also disposed between the second plurality of digital signal processors and the wideband digital combiner, the switching means connecting any one of the second set of digital signal processors to any one of the digital channel signals input to the combiner;

a wideband digital exciter, connected to receive the composite digital signal and to provide a combined RF signal; and

a transmit antenna, connected to receive the combined RF signal and to radiate the combined RF signal.

15. A basestation as in claim 14 additionally comprising:

basestation controller means, connected to the time division multiplex switching means and the first and second plurality of digital signal processing means, for maintaining a list of all unused digital signal processing means that are not presently interconnected through the time division multiplex switching means to one of the digital channel outputs, and for dynamically allocating digital signal processing means

from the list of unused digital signal processing means to function as one of the first or second digital signal processing means only when the digital channel output contains an active signal being transmitted by the mobile unit which has not yet been assigned to one of the digital signal processing means, or when the digital inputs from the communications source are active.

16. A wideband basestation transceiver including:

a wideband digital tuner (12) that provides a wideband digital signal at an output; and
a digital channelizer (14), connected to the wideband tuner, to produce a plurality of sampled channel signals (15), with each channel signal representing signal energy in one of a plurality of radio frequency channels serviced by the basestation; **characterised by**
a single common time division multiple-access (TDM) data bus (16);

means for selectively connecting the digital samples of each channel signal, in turn, to the TDM bus, the means including a single common interface for interconnecting all the multiple sampled channel signals to the TDM data bus;

basestation controller means, for controlling the means for selectively connecting the digital samples of each channel signal to the TDM bus, by so connecting each channel signal in a predetermined timeslot, in a predetermined order;

means, coupled to the TDM bus, for selecting the digital samples in a particular timeslot, and for generating a reconstructed channel signal thereby, wherein specific ones of said multiple sampled channel signals are mapped into said predetermined time slots, said predetermined time slots being known by said means for selecting;

means for dynamically allocating any one of a plurality of demodulators to be coupled to the reconstructed channel signal when the associated radio frequency channel is active, the demodulator providing a demodulated channel signal;

means for allocating a T1 line encoder to the demodulated channel signal, to format the demodulated channel signal for transmission over a T1 span line; and

means for coupling the T1 line to a mobile telephone switching office, MTSO, or mobile switching center (MSC) for further connection into the public switching telephone network (PSTN).

Patentansprüche

1. Eine Basisstation (10) zum Verarbeiten von Signalen in einem Funkkommunikationssystem mit mehreren mobilen Teilnehmereinheiten, umfassend:

eine Antenne (11) zum Empfangen von Signalen von einer Mehrzahl der mobilen Einheiten (40a, 40b) als ein zusammengesetztes Hochfrequenz-(HF)-Signal;

einer digitalen Breitbandtunereinrichtung (12), die mit der Antenne verbunden ist, um eine ausgewählte Bandbreite des HF-Signals nach unten auf eine Zwischenfrequenz (ZF) umzusetzen, und um eine Analog-zu-Digital-Umwandlung des ZF-Signals auszuführen, um ein Ausgangssignal (13) des digitalen Breitbandtuners bereitzustellen;

eine digitale Kanalsiereinrichtung (14), die so angeschlossen ist, daß sie das Ausgangssignal des Breitbandtuners erhält, und die mehrere digitale Kanalsignalausgänge (15) bereitstellt, wobei jeder digitale Kanalsignalausgang eine vorbestimmte Kanalbandbreite aufweist und jedes digitale Kanalsignal einem der Signale entspricht, die von einer der Mobileinheiten eingehen; und

eine Mehrzahl digitaler Signalverarbeitungseinrichtungen (18) zum Bereitstellen digital verarbeiteter Kanalsignalausgänge; **dadurch gekennzeichnet, daß** die Basisstation ferner aufweist:

eine einzige gemeinsame Zeitmultiplexschalteinrichtung (16), die zwischen den mehreren digitalen Kanalsignalausgängen und den mehreren digitalen Signalverarbeitungseinrichtungen (18) angeordnet ist, wobei die Schalteinrichtung eine einzige gemeinsame Schnittstelle (16) aufweist, um alle der mehreren digitalen Kanalsignalausgänge mit der Schalteinrichtung zu verbinden, die Schalteinrichtung so ausgebildet ist, daß sie jedweden der mehreren digitalen Kanalsignalausgänge (15) mit jedweder der mehreren digitalen Signalverarbeitungseinrichtungen (18) verbindet, indem sie bestimmte Kanalsignalausgänge der mehreren digitalen Kanalsignalausgänge auf bestimmte Zeitschlitze abbildet, die den mehreren digitalen Signalverarbeitungseinrichtungen bekannt sind.

2. Die Basisstation nach Anspruch 1, bei der die von den Mobileinheiten eingehenden Signale eine Luftschnittstellenmodulation aufweisen, und bei der die digitalen Signalverarbeitungseinrichtungen Demodulatoren aufweisen, um die Luftschnittstellenmo-

dulation zu entfernen.

3. Die Basisstation nach Anspruch 1, ferner umfassend:

eine Signaltransportkodiereinrichtung, die mit dem Ausgang der digitalen Signalverarbeitungseinrichtung verbunden ist, um die digital verarbeiteten Kanalausgänge zur weiteren Übertragung an ein Mobiltelefonvermittlungsbüro (MTSO - *mobile telephone switching office*) zu kodieren.

4. Die Basisstation nach Anspruch 3, bei der die Signaltransportkodiereinrichtung ein T1-Kodierer ist.

5. Die Basisstation nach Anspruch 1, ferner umfassend:

eine zweite digitale Kanalsiereinrichtung, die so angeschlossen ist, daß sie das Ausgangssignal des Breitbandtuners erhält, und die einen zweiten Satz mehrerer digitaler Kanalsignalausgänge bereitstellt, wobei jeder digitale Kanalsignalausgang des zweiten Satzes von digitalen Kanalsignalausgängen eine vorbestimmte Kanalbandbreite aufweist, die sich von der vorbestimmten Kanalbandbreite der oben erwähnten ersten digitalen Kanalsignale unterscheidet, und jedes digitale Kanalsignal des zweiten Satzes digitaler Kanalsignale einem der Signale entspricht, die von einer der Mobileinheiten eingehen.

6. Die Basisstation nach Anspruch 1, ferner umfassend:

eine zweite Breitbandtunereinrichtung, die mit der Antenne verbunden ist, um eine zweite ausgewählte Bandbreite des HF-Signals nach unten auf eine zweite Zwischenfrequenz (ZF) umzusetzen, und um eine Analog-zu-Digital-Umwandlung des zweiten ZF-Signals auszuführen, um ein zweites digitales Breitbandtuner-Ausgangssignal bereitzustellen; und einer zweiten digitalen Kanalsiereinrichtung, die so angeschlossen ist, daß sie das zweite Breitbandtuner-Ausgangssignal erhält, und die einen zweiten Satz mehrerer digitaler Kanalsignalausgänge bereitstellt, wobei jeder digitale Kanalsignalausgang des zweiten Satzes digitaler Kanalsignalausgänge eine vorbestimmte Kanalbandbreite aufweist, die sich von der vorbestimmten Kanalbandbreite der oben erwähnten ersten digitalen Kanalsignale unterscheidet, und jedes digitale Kanalsignal des zweiten Satzes digitaler Kanalsignale einem der von einer der Mobileinheiten eingehenden Signale

entspricht.

7. Eine Basisstation wie in Anspruch 6, bei der der erste und der zweite Satz digitaler Kanalsignale gemäß einem ersten bzw. einem zweiten Zugriffsverfahren moduliert werden. 5
8. Eine Basisstation wie in Anspruch 7, bei der die digitalen Signalverarbeitungseinrichtungen einen ersten Satz digitaler Signalverarbeitungseinrichtungen zum Demodulieren des ersten Satzes digitaler Kanalsignale und einen zweiten Satz digitaler Signalverarbeitungseinrichtungen zum Demodulieren des zweiten Satzes digitaler Kanalsignale aufweisen. 10 15
9. Eine Basisstation wie in Anspruch 7, bei der das erste und das zweite Zugriffsverfahren sich voneinander unterscheiden und die Zugriffsverfahren aus der folgenden Gruppe von Zugriffsverfahren ausgewählt sind: Zeitmultiplex, TDMA; Kodemultiplex, CDMA; oder aus Zugriffsverfahren gemäß den folgenden Normen ausgewählt sind: *Advanced Mobile Phone System*, AMPS (fortschrittliches mobiles Telefonsystem); *Personal Communications System*, PCS (persönliches Kommunikationssystem); oder *Groupe Speciale Mobile*, GSM (besondere Mobilgruppe). 20 25
10. Eine Basisstation wie in Anspruch 1, ferner umfassend: 30

eine Basisstationssteuereinrichtung, die mit der Zeitmultiplexschalteinrichtung und den digitalen Signalverarbeitungseinrichtungen verbunden ist, um eine Liste ungenutzter digitaler Signalverarbeitungseinrichtungen, die gegenwärtig nicht über die Zeitmultiplexschalteinrichtung mit einem der digitalen Kanalausgänge verbunden sind, zu unterhalten, und um digitale Signalverarbeitungseinrichtungen aus der Liste ungenutzter digitaler Signalverarbeitungseinrichtungen dynamisch zuzuordnen, so daß sie nur dann mit einem der digitalen Kanalausgänge verbunden werden, wenn der digitale Kanalausgang ein von der Mobileinrichtung gesendetes aktives Signal enthält, das noch nicht einer der digitalen Signalverarbeitungseinrichtungen zugeordnet worden ist. 35 40 45 50
11. Eine Basisstation wie in Anspruch 1, bei der die Zeitmultiplexschalteinrichtung ferner aufweist:

einen Zeitmultiplex-(TDM - *time division multiplex*)-Datenbus, der Datenleitungen aufweist; 55
eine mit dem TDM-Bus und mit erzeugten TDM-Bussynchronisationssignalen und Treiberadreßsignalen verbundene Basisstations-

steuereinrichtung, wobei die TDM-Bussynchronisationssignale dazu verwendet werden, Zugriffszeitschlitze auf den TDM-Bus anzugeben; und

eine TDM-Bustreibereinrichtung, die mit dem TDM-Bus, der Basisstationssteuereinrichtung und mindestens einem der digitalen Kanalsignale derart verbunden ist, daß sie die TDM-Bussynchronisationssignale und die Treiberadreßsignale erhält, die Treiberadreßsignale speichert und das digitale Kanalsignal auf dem TDM-Bus bestimmt, wenn der Wert der Treiberadreßsignale dem Wert der Bussynchronisationssignale entspricht, wodurch angezeigt wird, daß ein dem digitalen Kanalsignal zugeordneter Zeitschlitz gegenwärtig aktiv ist.

12. Eine Basisstation wie in Anspruch 11, bei der die mit dem TDM-Bus verbundene Basisstationsteuereinrichtung zusätzlich Empfängeradreßsignale erzeugt, und bei der die Zeitmultiplexschalteinrichtung zusätzlich aufweist:

eine TDM-Busempfängereinrichtung, die mit dem TDM-Bus, der Basisstationssteuereinrichtung und mindestens einem der digitalen Signalprozessoreinrichtungen derart verbunden ist, daß sie die TDM-Bussynchronisationssignale und die Empfängeradreßsignale erhält, die Empfängeradreßsignale speichert und ein auf dem TDM-Bus festgelegtes Signal ausliest und ein solches festgelegtes Signal der digitalen Signalprozessoreinrichtung bereitstellt, wenn der Wert des Empfängeradreßsignals dem Wert des Bussynchronisationssignals entspricht, was anzeigt, daß ein dem digitalen Signalprozessor zugeordneter Zeitschlitz gegenwärtig aktiv ist.

13. Eine Breitbandbasisstation wie in Anspruch 6, bei der der erste und der zweite Kanalisierer jeweils aufweisen:

einen konvolutiven digitalen Filter, der derart angeschlossen ist, daß er das jeweilige digitalisierte Breitbandsignal der digitalisierten Breitbandsignale erhält; und
einen Prozessor für eine schnelle Fourier-Transformation (FFT), der so angeschlossen ist, daß er die Ausgabe des konvolutiven digitalen Filters enthält und daß er die digitalen Kanalsignale bereitstellt.

14. Eine Basisstation wie in Anspruch 1, die ferner aufweist:

eine zweite Mehrzahl digitaler Signalverarbeitungseinrichtungen, die so angeschlossen

sind, daß sie digitale Eingabesignale von einer Kommunikationssignalquelle erhalten;
einen digitalen Breitbandkombinierer, der so angeschlossen ist, daß er eine zweite Vielzahl digitaler Kanalsignale erhält und ein zusammen-

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wobei die Zeitmultiplexschalteinrichtung auch zwischen der zweiten Mehrzahl digitaler Signalprozessoren und dem digitalen Breitbandkombinierer angeordnet ist, wobei die Schalteinrichtung jeden digitalen Signalprozessor des zweiten Satzes digitaler Signalprozessoren mit jedwedem digitalen Kanalsignal der dem Kombinierer zugeführten digitalen Kanalsignale verbindet;

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einen digitalen Breitbanderreger, der so angeschlossen ist, daß er das zusammengesetzte digitale Signal empfängt und ein kombiniertes HF-Signal bereitstellt; und

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eine Sendeantenne, die so angeschlossen ist, daß sie das kombinierte HF-Signal erhält und das kombinierte HF-Signal abstrahlt.

15. Eine Basisstation wie in Anspruch 14, ferner umfassend:

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eine Basisstationssteuereinrichtung, die mit den Zeitmultiplexschalteinrichtungen und der ersten und der zweiten Mehrzahl digitaler Signalverarbeitungseinrichtungen verbunden ist, um eine Liste aller ungenutzten digitalen Signalverarbeitungseinrichtungen, die gegenwärtig nicht über die Zeitmultiplexschalteinrichtung mit einem der digitalen Kanalausgänge verbunden sind, zu unterhalten, und um digitale Signalverarbeitungseinrichtungen aus der Liste ungenutzter digitaler Signalverarbeitungseinrichtungen dynamisch zuzuordnen, so daß diese nur dann als erste oder zweite digitale Signalverarbeitungseinrichtung arbeiten, wenn der digitale Kanalausgang ein aktives von der Mobileinheit gesendetes Signal enthält, das noch keiner der digitalen Signalverarbeitungseinrichtungen zugewiesen worden ist, oder wenn die Digitaleingaben von der Kommunikationsquelle aktiv sind.

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16. Ein Breitband-Basisstations-Transceiver, umfassend:

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einen digitalen Breitbandtuner (12), der ein digitales Breitbandsignal an einem Ausgang bereitstellt; und
einen digitalen Kanalisierer (14), der mit dem Breitbandtuner derart verbunden ist, daß er eine Mehrzahl abgetasteter Kanalsignale (15) erzeugt, wobei jedes Kanalsignal die Signalener-

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gie in einem einer Mehrzahl von Hochfrequenzkanälen, die von der Basisstation bedient werden, darstellt; **gekennzeichnet durch**

einen einzigen gemeinsamen Datenbus (16) für zeitgesteuerten Mehrfachzugriff (TDM - *time division multiple-access*);

eine Einrichtung zum wahlweisen Verbinden der digitalen Abtastwerte jedes Kanalsignals, der Reihe nach, mit dem TDM-Bus, wobei die Einrichtung eine einzige gemeinsame Schnittstelle zum Verbinden aller der mehreren abgetasteten Kanalsignale mit dem TDM-Datenbus aufweist;

eine Basisstationssteuereinrichtung zum Steuern der Einrichtung zum wahlweise Verbinden der digitalen Abtastwerte jedes Kanalsignals mit dem TDM-Bus, um somit jedes Kanalsignal in einer vorbestimmten Reihenfolge in einem vorbestimmten Zeitschlitz zu verbinden;

einer mit dem TDM-Bus gekoppelten Einrichtung zum Auswählen der digitalen Abtastwerte in einem bestimmten Zeitschlitz, und um **dadurch** ein wiederhergestelltes Kanalsignal zu erzeugen, wobei bestimmte abgetastete Kanalsignale der mehreren abgetasteten Kanalsignale in die vorbestimmten Zeitschlitze abgebildet werden, wobei die vorbestimmten Zeitschlitze der Einrichtung zum Auswählen bekannt sind;

einer Einrichtung zum dynamischen Zuweisen eines Demodulators einer Mehrzahl von Demodulatoren, zur Kopplung des Demodulators mit dem wiederhergestellten Kanalsignal, wenn der zugeordnete Hochfrequenzkanal aktiv ist, wobei der Demodulator ein demoduliertes Kanalsignal bereitstellt;

einer Einrichtung zum Zuweisen eines T1-Leitungskodierers für das demodulierte Kanalsignal, um das demodulierte Kanalsignal zur Übertragung über eine T1-Überbrückungsleitung zu formatieren; und

einer Einrichtung zum Verbinden der T1-Leitung mit einem Mobiltelefonvermittlungsamt, MTSO - *mobile telephone switching office*, oder einem Mobilvermittlungszentrum (MSC - *mobile switching center*) zur Weiterverbindung in das öffentliche Telefonnetz (PSTN - *public switching telephone network*).

Revendications

1. Station de base (10) pour traiter des signaux dans un système de communication sans fil à multiples unités mobiles d'abonné comprenant :

une antenne (11) pour recevoir des signaux en provenance de plusieurs unités mobiles (40a,

40b) en tant que signal composite à haute fréquence (HF) ;

un moyen formant syntoniseur numérique à large bande (12), relié à l'antenne, pour transposer une largeur de bande sélectionnée du signal HF vers une fréquence intermédiaire (FI), et pour effectuer une transformation analogique-numérique sur le signal FI, pour donner un signal de sortie de syntoniseur numérique à large bande (13) ;

un moyen de découpage en canaux numériques (14) relié pour recevoir le signal de sortie de syntoniseur à large bande, et procurant de multiples sorties de signal de canal numérique (15), chaque sortie de signal de canal numérique ayant une largeur de bande de canal prédéterminée, et chaque signal de canal numérique correspondant à l'un des signaux reçus en provenance d'une des unités mobiles ; et plusieurs moyens de traitement de signal numérique (18), pour procurer des sorties de signal de canal traitées de façon numérique ; **caractérisée en ce que** la station de base comprend de plus :

un unique moyen commun de commutation à multiplexage par répartition dans le temps (16), disposé entre les sorties de signal de canal numérique multiple et plusieurs moyens de traitement de signal numérique (18), le moyen de commutation comprenant une unique interface commune (16) pour interconnecter toutes les sorties de signal de canal numérique multiple au moyen de commutation, le moyen de commutation étant agencé pour relier n'importe laquelle des sorties de signal de canal numérique multiple (15) à n'importe quel moyen des plusieurs moyens de traitement de signal numérique (18) en faisant correspondre des sorties spécifiques desdites sorties de signal de canal numérique multiple dans des intervalles de temps spécifiques que l'on connaît auxdits plusieurs moyens de traitement de signal numérique.

2. Station de base selon la revendication 1, dans laquelle les signaux reçus en provenance des unités mobiles contiennent une modulation d'interface air, et les processeurs de signal numérique comprennent des démodulateurs pour enlever la modulation d'interface air.

3. Station de base selon la revendication 1, comprenant de plus :

un moyen de codage de transport de signal, re-

lié à la sortie du moyen de traitement de signal numérique, pour coder les sorties de canal traitées de façon numérique pour une transmission ultérieure à un centre de commutation de téléphonie mobile (CCTM).

4. Station de base selon la revendication 3, dans laquelle le moyen de codage de transport de signal est un codeur T1.

5. Station de base selon la revendication 1, comprenant de plus :

un second moyen de découpage en canaux numériques, relié pour recevoir le signal de sortie de syntoniseur à large bande, et procurant un second ensemble de multiples sorties de signal de canal numérique, chaque sortie du second ensemble de sorties de signal de canal numérique ayant une largeur de bande de canal prédéterminée qui est différente de la largeur de bande de canal prédéterminée desdits premiers signaux de canal numérique précédemment mentionnés, et chaque signal du second ensemble de signaux de canal numérique correspondant à un des signaux reçus à partir d'une des unités mobiles.

6. Station de base selon la revendication 1 comprenant de plus :

un second moyen formant syntoniseur à large bande, relié à l'antenne, pour transposer une seconde largeur de bande sélectionnée du signal HF vers une seconde fréquence intermédiaire (FI), et pour effectuer une transformation analogique-numérique sur le second signal FI, pour donner un second signal de sortie de syntoniseur numérique à large bande ; et un second moyen de découpage en canaux numériques, relié pour recevoir le second signal de sortie de syntoniseur à large bande, et pour procurer un second ensemble de multiples sorties de signal de canal numérique, chaque sortie du second ensemble de sorties de signal de canal numérique ayant une largeur de bande de canal prédéterminée qui est différente de la largeur de bande de canal prédéterminée desdits premiers signaux de canal numérique précédemment mentionnés, et chaque signal du second ensemble de signaux de canal numérique correspondant à un des signaux reçus à partir d'une des unités mobiles.

7. Station de base selon la revendication 6, dans laquelle les premier et second ensembles de signaux de canal numérique sont respectivement modulés selon des premier et second procédés d'accès.

8. Station de base selon la revendication 7, dans laquelle les processeurs de signal numérique comprennent un premier ensemble de moyens formant processeurs de signal numérique pour démoduler ledit premier ensemble de signaux de canal numérique, et un second ensemble de processeurs de signal numérique pour démoduler ledit second ensemble de signaux de canal numérique.

9. Station de base selon la revendication 7, dans laquelle lesdits premier et second procédés d'accès sont chacun différents, les procédés d'accès étant sélectionnés parmi : l'accès multiple par répartition dans le temps, AMRT ; l'accès multiple par répartition en code, AMRC, ou sont sélectionnés parmi les procédés d'accès des standards : Système de téléphonie Mobile Avancé, AMPS ; Système de Communications Personnelles, SCP ; ou Groupe Spécial Mobile, GSM.

10. Station de base selon la revendication 1, comprenant de plus :

un moyen formant unité de commande de station de base, relié au moyen de commutation à multiplexage par répartition dans le temps et au moyen de traitement de signal numérique, pour maintenir une liste de moyens de traitement de signal numérique inutilisés qui ne sont pas actuellement connectés par le moyen de commutation à multiplexage par répartition dans le temps à l'une des sorties de canal numérique, et pour attribuer de façon dynamique un moyen de traitement de signal numérique à partir de la liste de moyens de traitement de signal numérique inutilisés à connecter à l'une des sorties de canal numérique seulement si la sortie de canal numérique contient un signal actif émis par l'unité mobile qui n'a pas encore été attribuée à l'un des moyens de traitement de signal numérique.

11. Station de base selon la revendication 1, dans laquelle le moyen de commutation à multiplexage par répartition dans le temps comprend de plus :

un bus de données à multiplexage par répartition dans le temps (MRT) comprenant des lignes de données ;
un moyen formant unité de commande de station de base, relié au bus MRT et à des signaux de synchronisation de bus MRT produits et à des signaux d'adresse de gestionnaire, les signaux de synchronisation de bus MRT étant utilisés pour identifier des intervalles de temps d'accès sur le bus MRT ; et
un moyen formant gestionnaire de bus MRT, relié au bus MRT, au moyen formant unité de

commande de station de base, et à au moins un des signaux de canal numérique, pour recevoir les signaux de synchronisation de bus MRT et les signaux d'adresse de gestionnaire, pour stocker les signaux d'adresse de gestionnaire, et pour affirmer le signal de canal numérique sur le bus MRT quand la valeur de signaux d'adresse de gestionnaire correspond à la valeur des signaux de synchronisation de bus, indiquant de ce fait qu'un intervalle de temps associé au signal de canal numérique est actuellement actif.

12. Station de base selon la revendication 11, dans laquelle le moyen formant unité de commande de station de base, relié au bus MRT, produit de plus des signaux d'adresse de récepteur, et le moyen de commutation à multiplexage par répartition dans le temps comprend de plus :

un moyen formant récepteur de bus MRT, relié au bus MRT, au moyen formant unité de commande de station de base, et à au moins un des moyens formant processeurs de signal numérique, pour recevoir les signaux de synchronisation de bus MRT et les signaux d'adresse de récepteur, pour stocker les signaux d'adresse de récepteur, et pour lire un signal affirmé sur le bus MRT et procurer ce signal affirmé au moyen formant processeur de signal numérique quand la valeur de signaux d'adresse de récepteur correspond à la valeur des signaux de synchronisation de bus, indiquant qu'un intervalle de temps associé au processeur de signal numérique est actuellement actif.

13. Station de base à large bande selon la revendication 6, dans laquelle les premier et second dispositifs de découpage en canaux comprennent chacun :

un filtre numérique à convolution, relié pour recevoir le signal respectif des signaux à large bande numérisés ; et
un processeur de Transformée de Fourier rapide (FFT), relié pour recevoir la sortie du filtre numérique à convolution, et pour donner les signaux de canal numérique.

14. Station de base selon la revendication 1, comprenant de plus :

des seconds plusieurs moyens de traitement de signal numérique, reliés pour recevoir des signaux d'entrée numériques en provenance d'une source de signal de communication ;
un circuit mélangeur numérique à large bande, relié pour recevoir des seconds plusieurs signaux de canal numérique, et pour donner un

signal numérique composite pour la transmission ;

dans laquelle le moyen de commutation à multiplexage par répartition dans le temps est également disposé entre les seconds plusieurs processeurs de signal numérique et le circuit mélangeur numérique à large bande, le moyen de commutation reliant n'importe quel processeur du second ensemble de processeurs de signal numérique à n'importe lequel des signaux de canal numérique entrés dans le circuit mélangeur ;

un excitateur numérique à large bande, relié pour recevoir le signal numérique composite et pour donner un signal HF combiné ; et

une antenne d'émission, reliée pour recevoir le signal HF combiné et pour émettre le signal HF combiné.

15. Station de base selon la revendication 14, comprenant de plus :

un moyen formant unité de commande de station de base, relié au moyen de commutation à multiplexage par répartition dans le temps et aux premiers et seconds plusieurs moyens de traitement de signal numérique, pour maintenir une liste de moyens de traitement de signal numérique inutilisés qui ne sont pas actuellement connectés par le moyen de commutation à multiplexage par répartition dans le temps à l'une des sorties de canal numérique, et pour attribuer de façon dynamique un moyen de traitement de signal numérique à partir de la liste de moyens de traitement de signal numérique inutilisés pour fonctionner comme l'un des premier ou deuxième moyens de traitement de signal numérique seulement si la sortie de canal numérique contient un signal actif émis par l'unité mobile qui n'a pas encore été attribuée à l'un des moyens de traitement de signal numérique, ou lorsque les entrées numériques en provenance de la source de communications sont actives.

16. Émetteur-récepteur de station de base à large bande, comprenant :

un syntoniseur numérique à large bande (12) qui procure un signal numérique à large bande au niveau d'une sortie ; et
un dispositif de découpage en canaux numérique (14), relié au syntoniseur à large bande, pour produire plusieurs signaux de canal échantillonnés (15), chaque signal de canal représentant une énergie de signal dans l'un des plusieurs canaux de fréquence radio desservis par la station de base ;

caractérisé par

un unique bus commun de données accès à accès multiple par répartition dans le temps (MRT) (16) ;

un moyen pour relier de manière sélective les échantillons numériques de chaque signal de canal, à son tour, au bus MRT, le moyen comprenant une unique interface commune pour connecter tous les signaux de canal échantillonnés multiples au bus de données MRT ;

un moyen formant unité de commande de station de base, pour commander le moyen pour relier de manière sélective les échantillons numériques de chaque signal de canal au bus MRT, en reliant ainsi chaque signal de canal dans un intervalle de temps prédéterminé, dans un ordre prédéterminé ;

un moyen, relié au bus MRT, pour sélectionner les échantillons numériques dans un intervalle de temps particulier, et pour produire un signal de canal reconstruit de ce fait, dans lequel des signaux spécifiques desdits signaux de canal échantillonnés multiples sont mis en correspondance dans lesdits intervalles de temps prédéterminés, lesdits intervalles de temps prédéterminés étant connus par ledit moyen de sélection ;

un moyen pour attribuer de façon dynamique n'importe lequel des plusieurs démodulateurs à relier au signal de canal reconstruit quand le canal de fréquence radio associé est actif, le démodulateur fournissant un signal de canal démodulé ;

un moyen pour attribuer un codeur de ligne T1 au signal de canal démodulé, pour formater le signal de canal démodulé pour la transmission sur une ligne de portée T1 ; et

un moyen pour relier la ligne T1 à un centre de commutation de téléphonie mobile, CCTM, ou à un centre de commutation mobile (MSC) pour une connexion ultérieure au Réseau. Téléphonique Public Commuté (RTPC).

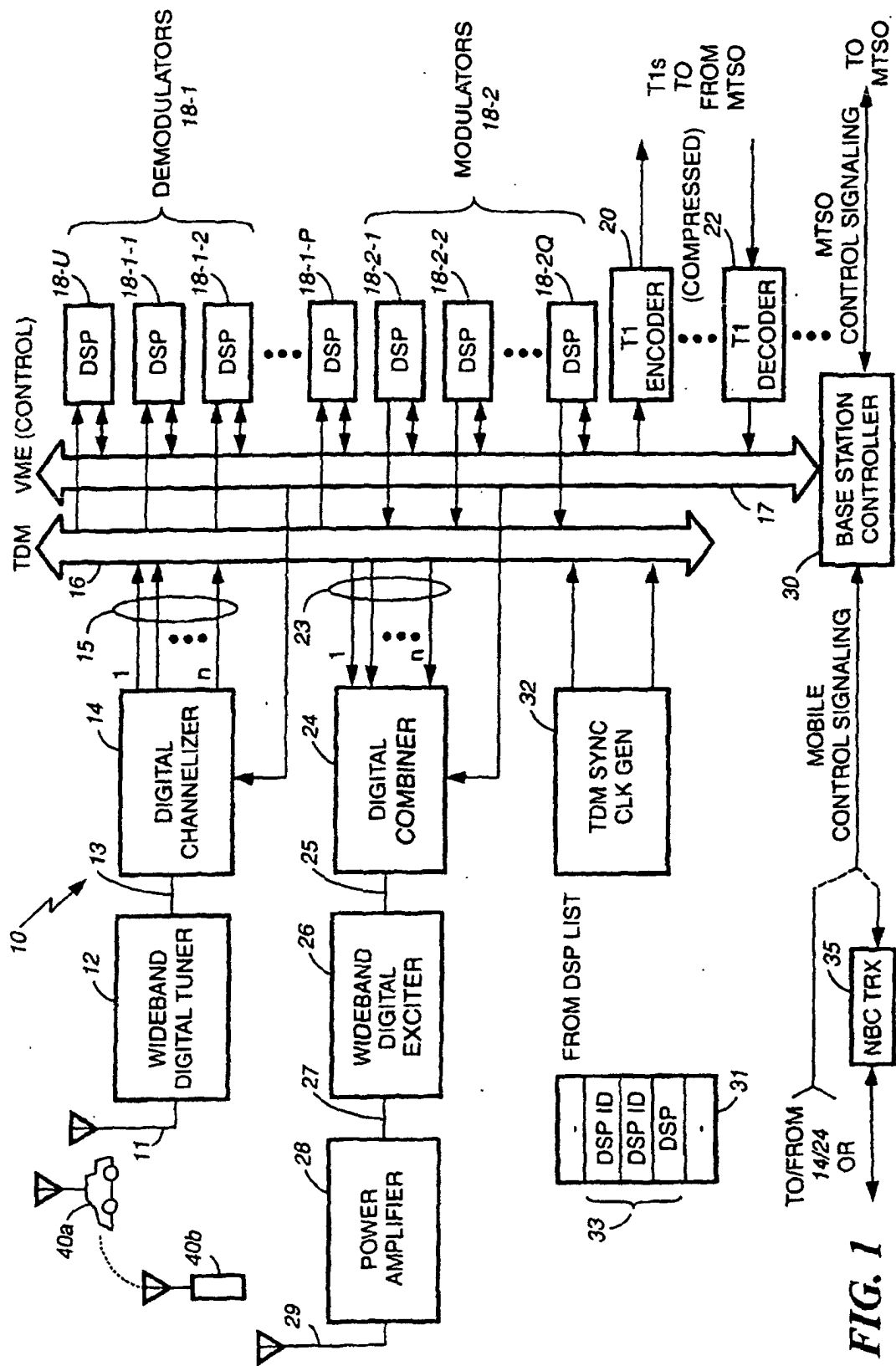


FIG. 1

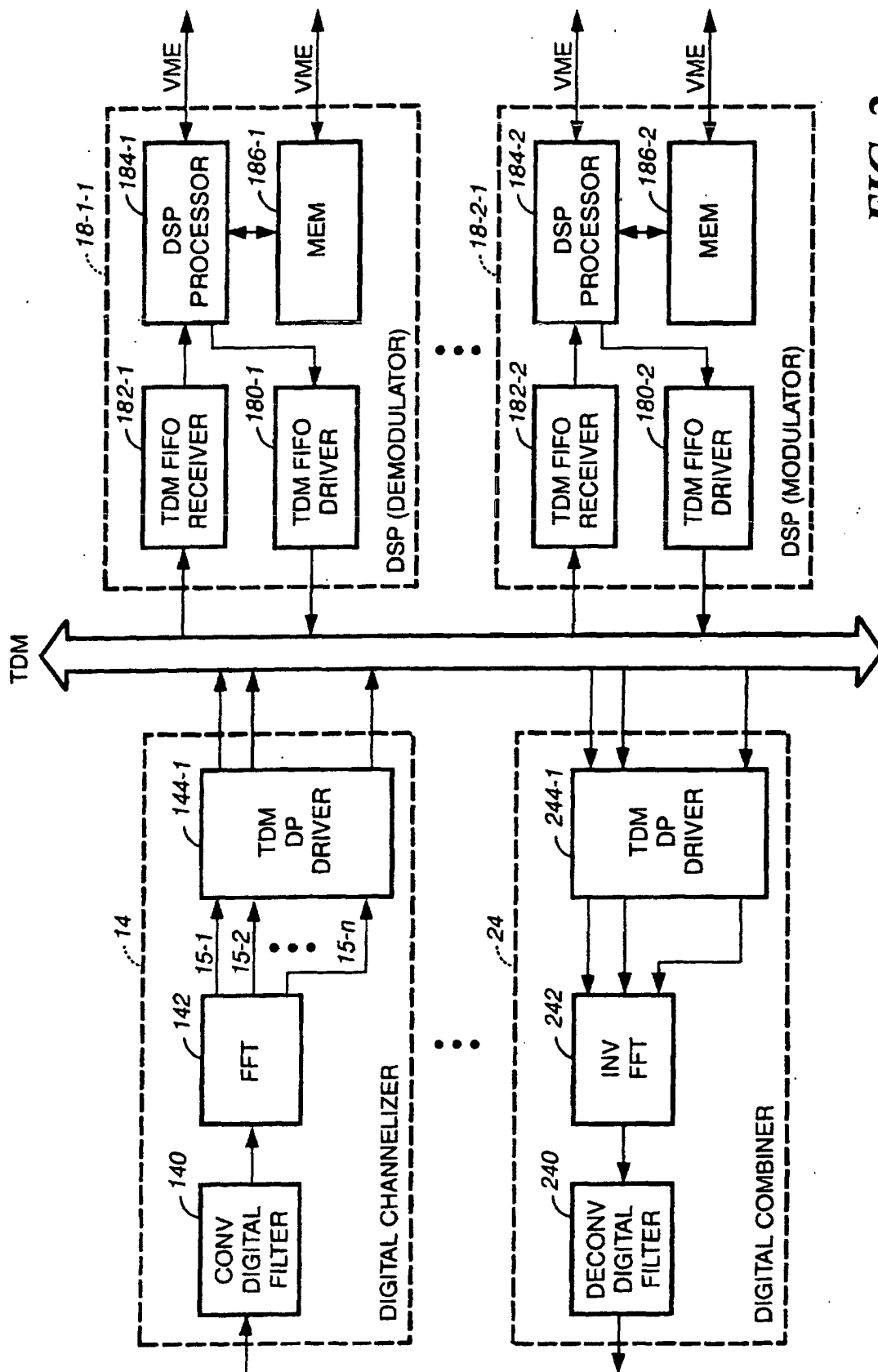
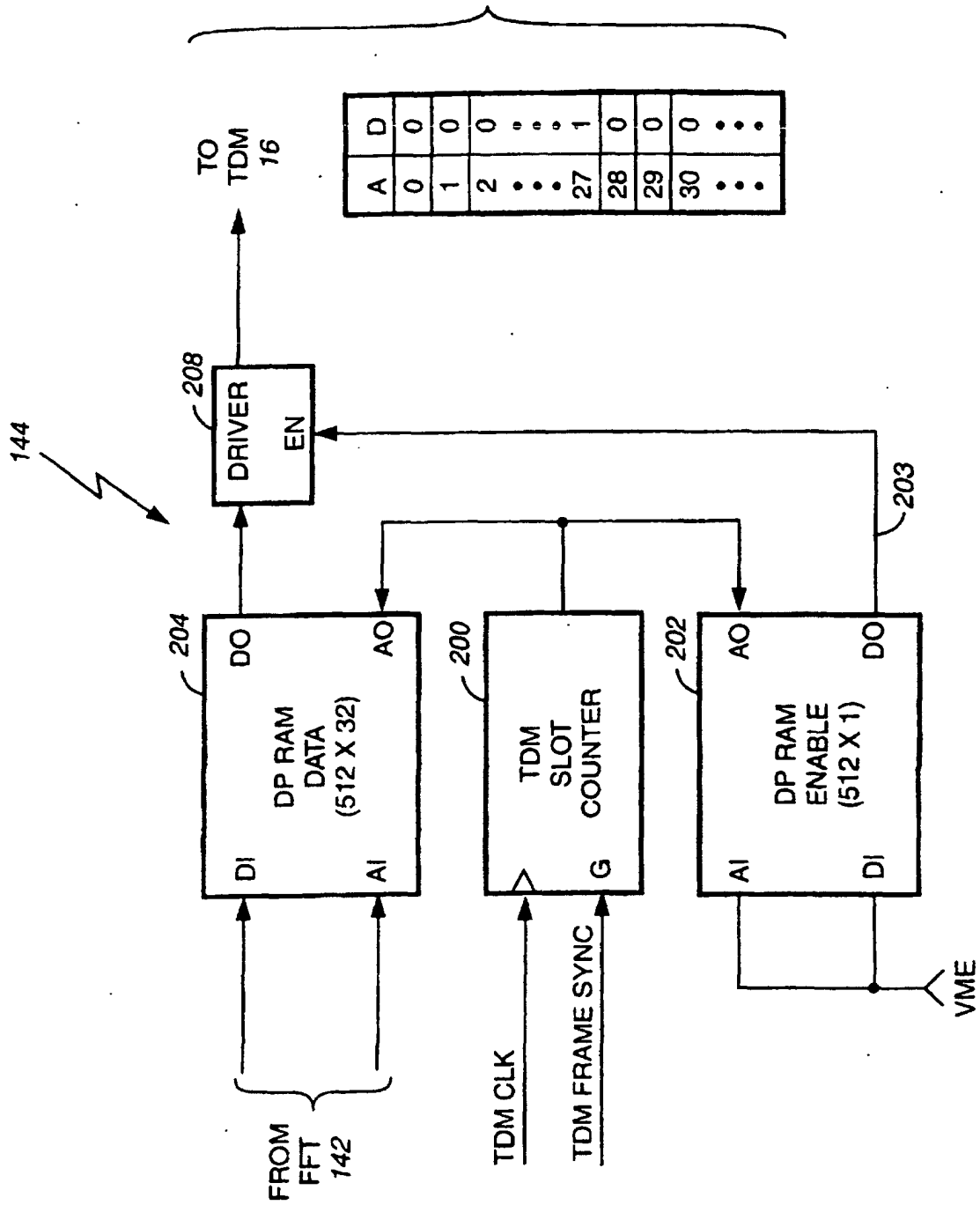
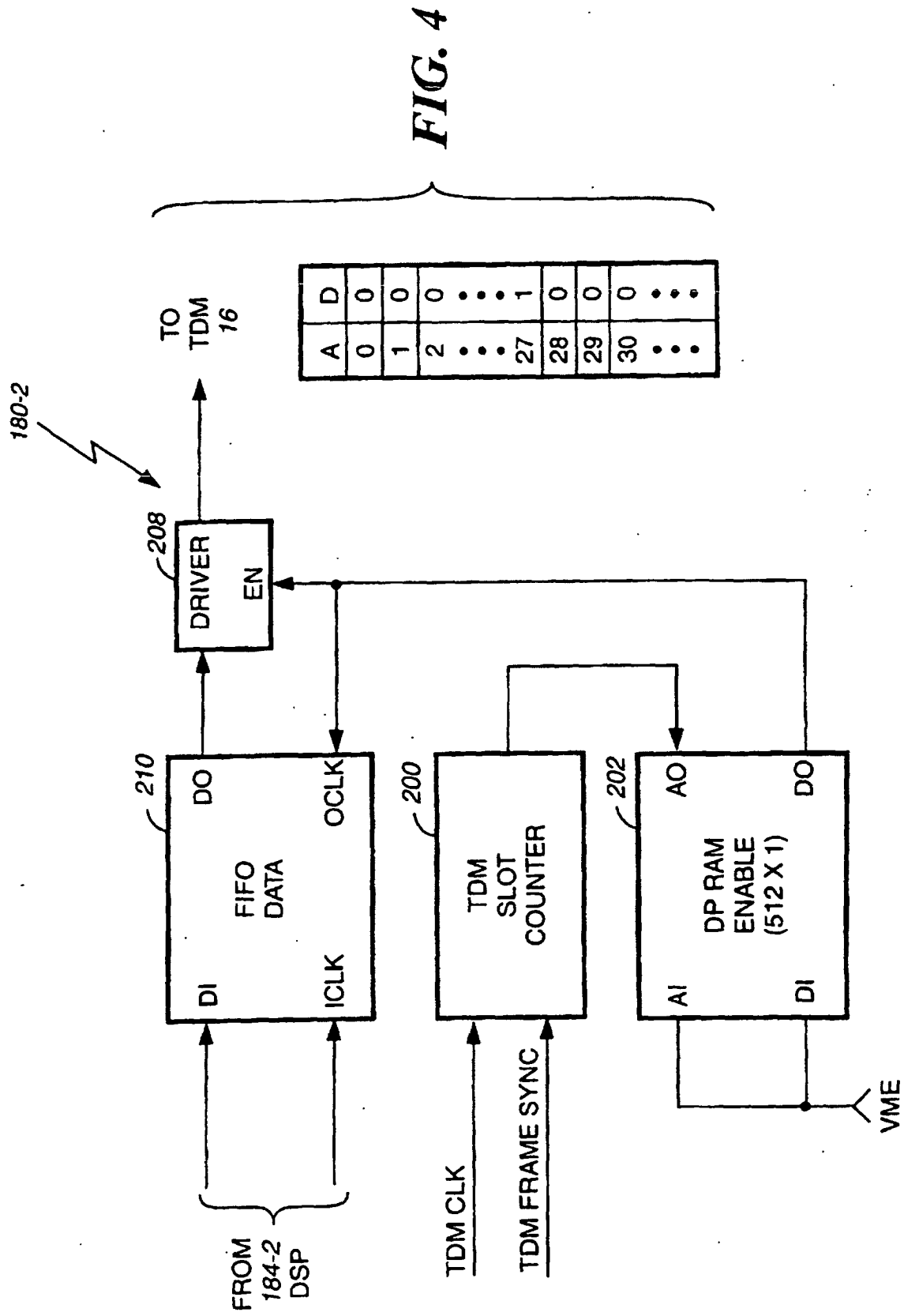


FIG. 2

FIG. 3





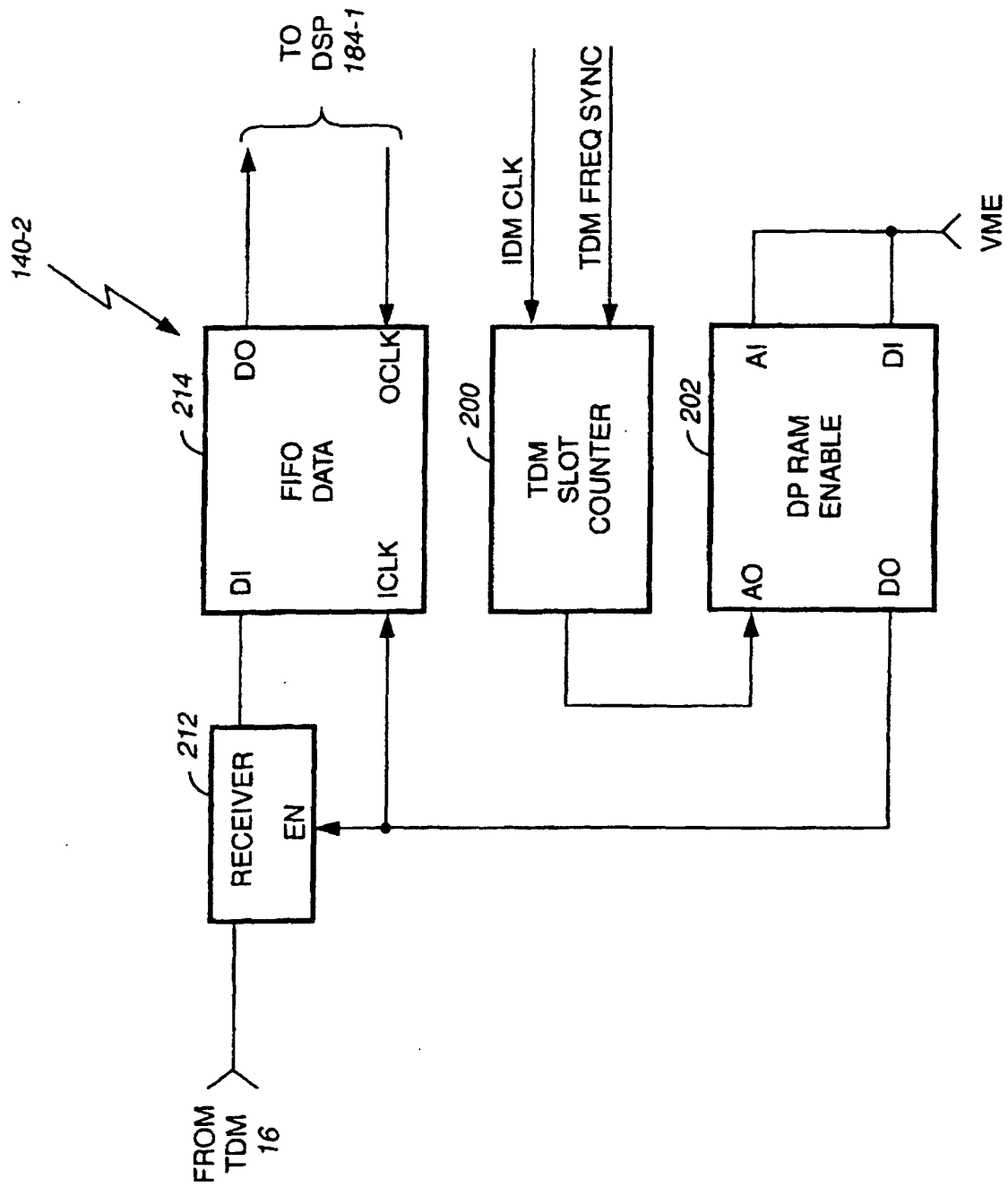


FIG. 5

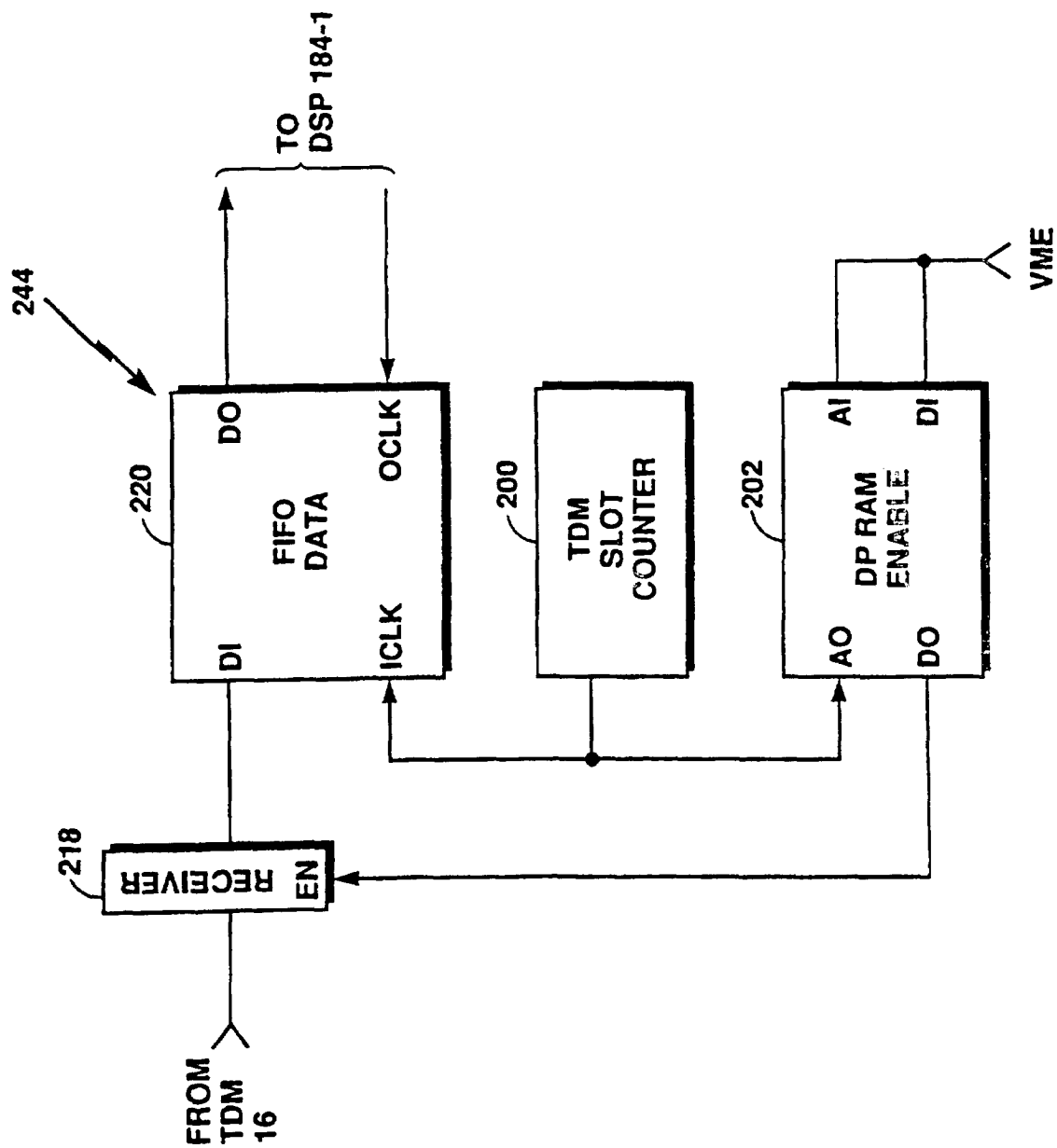


Fig. 6

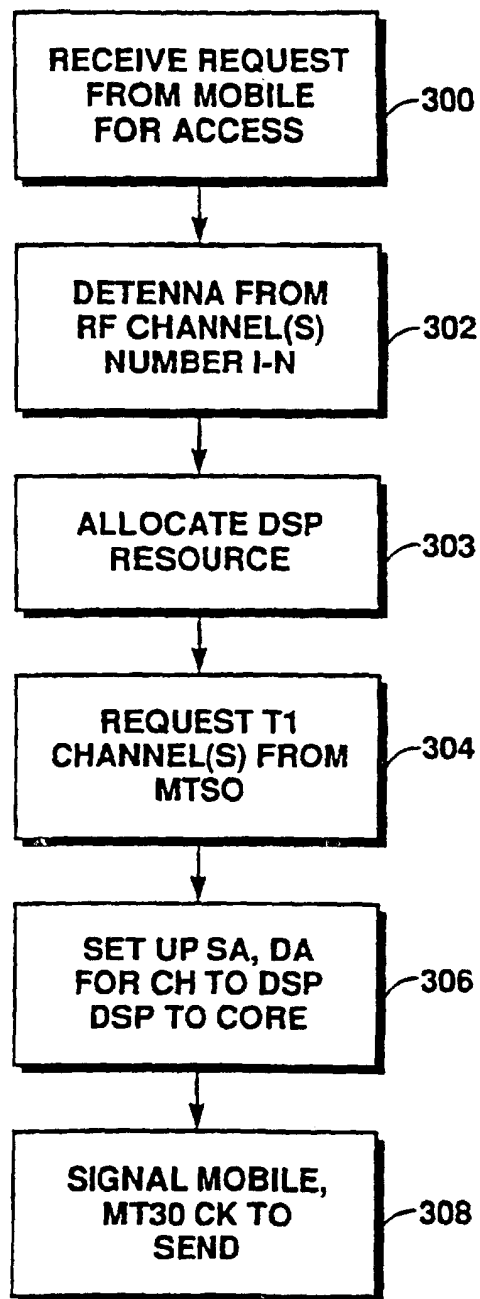


Fig. 7

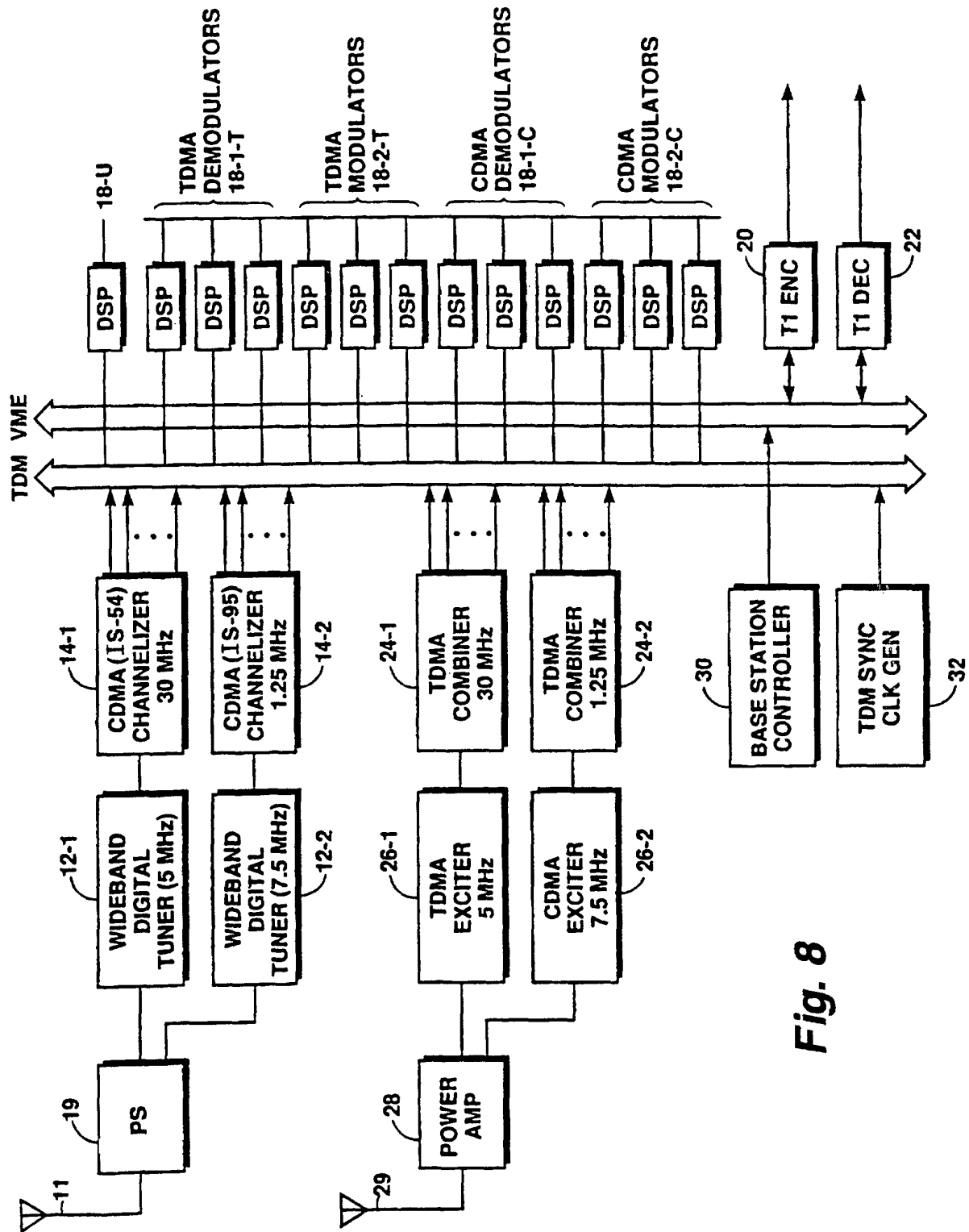


Fig. 8