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(54) **Title**: AN APPARATUS

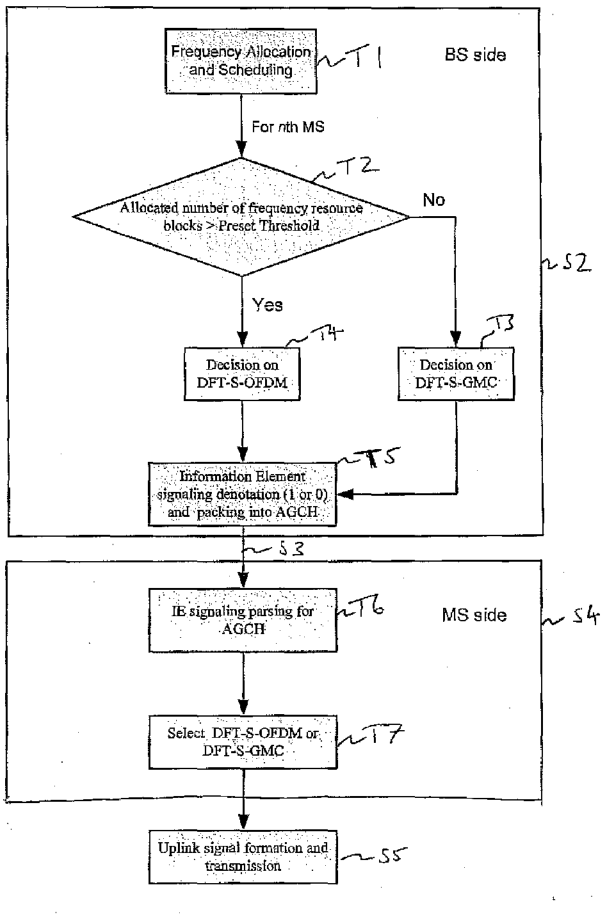

Figure 9

(57) **Abstract**: An apparatus comprising a processor configured to select a first multiple access technique or a second multiple access technique for a connection.

WO 2009/127262 A1

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AN APPARATUS

FIELD OF INVENTION

The present invention relates to a method and apparatus.

BACKGROUND TO THE INVENTION

A communication apparatus can be understood as apparatus provided with appropriate communication and control capabilities for enabling use thereof for communication with other parties. The communication may comprise, for example, communication via voice, electronic mail (email), text messages, data, multimedia and so on. A communication apparatus particularly enables a user to receive and transmit communications via a communication system and thus can be used for accessing various services and applications.

A communication system is a facility which facilitates communication between two or more entities such as the communication apparatus, network entities and other nodes. A communication system may be provided by one or more interconnected networks.

Communication between the entities (i.e. the communication apparatus, network entities and other nodes) is typically performed by modulating a data stream on to a carrier frequency. The modulated data stream may then be transmitted via a wired or a wireless interface. Examples of communication techniques used for wireless interfaces include Global System for Mobile communications (GSM), Third Generation Partnership Project Long Term Evolution (3GPP-LTE), Universal Mobile Telecommunications System (UMTS), Enhanced Data rates for GSM Evolution (EDGE), High-Speed Packet Access (HSPA), High Speed OFDM Packet Access (HSOPA), Wideband Code Division Multiple Access (W-CDMA), WiMax.

In a typical wireless system the radio resources used for communication is shared between multiple communication entities. Such systems are known as multiple access systems since, to communicate, the communication entities need to share the radio resources. Techniques exist to allow the communication entities to communicate without interfering with the communications of other entities. These techniques are typically called multiple access techniques and shall be referred to henceforth as such.

In, for example, a mobile or cellular communication system, a base station, base transceiver station (BTS) or "node B" (henceforth base station) may have a plurality of connections with a plurality mobile apparatus. Examples of such apparatus include mobile or cellular telephones, modems, PDAs, or computers.

The base station may determine what resources are made available to each mobile apparatus. The "resource" in this case being a division of the total communication bandwidth which is made available to the mobile apparatus.

Communication between the entities is provided by connections. Connections may be identified as being uplink and downlink connections. Typically an uplink connection is used to send data to e.g. the base station, and a downlink connection is used to send data in the opposite direction.

In some communication systems, connections may be asymmetric, in other words the allocated resources may be different for the uplink and downlink connections. Similarly, each connection may be allocated a different amount of bandwidth or resources.

One multiple access technique which may be used is Orthogonal Frequency Division Multiplex (OFDM). This has been chosen as the main multiple access technique for downlink in Level 1 and Level 2 of the 3GPP-LTE standard.

Another technique which has been considered is Discrete Fourier Transform – Spread – OFDM (DFT-S-OFDM) due to better peak to average power ration (PAPR) performance than pure OFDM Access (OFDMA).

Another technique, referred to as Generalized Multiple Carriers (GMC), has also attracted attention due to better PAPR and high spectral containment of the adjacent sub-carriers. The spectral containment leads to less Inter-Carrier Interference (ICI) as compared to to the classical OFDM modulation schemes.

PAPR is a measure of the performance of a connection. Impacts of PAPR on systems include:

Clipping of the signal voltage in a D/A converter

Saturating the power amplifier

Inducing in-band distortion and out-of-band radiation

Reducing the battery lifetime in, for example, mobile applications

Good PAPR performance provides the possibility of wider radio coverage and higher power efficiency.

Methods exist for reducing PAPR, for example Tone Reservation (TR), Selected Mapping (SLM), and Partial Transmit Sequence (PTS). By using these techniques, the PAPR can be reduced with expense of additional signaling overhead or complexity.

SUMMARY OF INVENTION

According to an aspect of the present invention, there is provided an apparatus comprising a processor configured to select a first multiple access technique or a second multiple access technique for a connection.

According to another aspect of the present invention, there is provided an apparatus comprising a processor configured to select one of a first and second multi-carrier modulation scheme for a connection.

According to a further aspect of the present invention, there is provided a method comprising selecting a first multiple access technique or a second multiple access technique for a connection.

According to a further aspect of the present invention, there is provided a method comprising selecting one of a first and second multi-carrier modulation scheme for a connection.

BRIEF DESCRIPTION OF DRAWINGS

For a better understanding of the present invention and as to how the same may be carried into effect, reference will now be made by way of example only to the accompanying drawings, in which:

Figure 1 shows a schematic view of a communications system within which an embodiment of the invention may be employed;

Figure 2 shows a schematic view of a two electronic apparatus within which an embodiment of the invention may be employed;

Figure 3 shows a graph of the PAPR performance of various communication techniques under a first set of conditions;

Figure 4 shows a graph of the PAPR performance of various communication techniques under a second set of conditions;

Figure 5 shows a graph of the PAPR performance of various communication techniques under a third set of conditions;

Figure 6 shows a graph of the PAPR performance of various communication techniques under a fourth set of conditions;

Figure 7 shows a hybrid multiple access technique according to an embodiment of the invention;

Figure 8a shows a mobile originated access method according to one embodiment of the invention;

Figure 8b shows a mobile terminated access method for a standby mobile management (MM) state according to one embodiment of the invention;

Figure 8c shows a mobile terminated access method for a ready MM state according to one embodiment of the invention;

Figure 8b shows a mobile terminated access method for a standby MM state according to one embodiment of the invention;

Figure 9 shows a flow chart of one embodiment of the invention in which a decision is taken at a base station;

Figure 10 shows a flow chart of one embodiment of the invention in which a decision is taken at a mobile apparatus; and

Figure 11 shows a schematic view of an apparatus in which embodiments of the invention may be employed.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

The invention will now be further described by way of example only, with reference to the following specific embodiments.

Figure 1 shows a schematic view of a communications system within which same embodiments of the present invention can be implemented. The system comprises at least one mobile apparatus 1. Mobile apparatus 1 can be for example a user equipment such as, a mobile telephone, a communication capable laptop, a personal digital assistant (PDA), or any other suitable device. The Figure show four mobile apparatus, 1a, 1b, 1c and 1d, however in practice more or less may be provided.

Mobile apparatus 1 communicates wirelessly by radio with a series of radio base s (BS) 3. The radio base stations may also be known as base transceiver stations (BTS) and as Node-Bs in the UMTS standard. In the following description base station shall be used.

Each mobile apparatus 1 is arranged to be able to communicate to more than one BS 3 and similarly each BS 3 is arranged to be capable of communicating to more than one mobile apparatus 1.

The mobile apparatus and the base station may form one or more connections in order to communicate. Each of these connections may be allocated a specific amount of radio resources. This will be described in more detail below.

The BS 3 further communicates with a radio network controller (RNC) 5 (which is also known in the GSM standard as a Base station controller (BSC)). The RNC 5 can further communicate to a core network (CN) 7. The CN 7 can further communicate with other networks, for example further public land mobile networks (PLMNs) or to the network of computers known as the 'Internet'.

Figure 2 shows a schematic view of one of the mobile apparatus and one of the base stations shown in Figure 1.

The mobile apparatus 1 may be provided with at least one processor 9 and at least one memory 11 for storing data and instructions used by the processor 9. In addition, one or more circuits comprising dedicated hardware 13, such as a hardware modulator may be provided. The data processor 9, memory 11 and dedicated hardware 13 may be provided on an appropriate circuit board and/or in one or more chip sets 15. In addition the mobile apparatus 1 may be provided with a suitable antenna arrangement 17.

In some embodiments, if the mobile apparatus 1 is, for example, a user equipment, the user may control the operation of the electronic device by means of a suitable user interface such as a keypad, voice command, touch-sensitive screen or pad, or a combination thereof or the like. A display, a speaker and/or a microphone may also be provided. Furthermore, an electronic device may comprise appropriate connectors (either wired or wireless) to other electronic devices and/or for connecting external accessories, for example hands-free equipment, thereto. Similarly the mobile apparatus 1 may be provided with one or more media interface units capable of receiving and reading from and/or writing to storage media placed therein. Examples of such media interface units include optical disk drives and/or non-volatile memory device readers (such as flash card readers). Such interface units may be used to provide data to and/or read data from the mobile apparatus.

Alternatively or additionally, the mobile apparatus 1 may be capable of being controlled by remote operation, and as such the user interface capabilities may be optional.

A signal to be transmitted may be generated within the mobile apparatus. This signal may have been stored, inputted by a user of the apparatus or generated by circuitry within the apparatus in response to other stimuli (such as a received signal or a time signal generated by an internal clock).

The processor 9, memory 11 and dedicated hardware 13 may serve alone or in combination to encode and modulate signal. The encoded and modulated signal may then be passed to antenna arrangement 17 from which it is transmitted over the air interface to a further antenna arrangement 19. The signals may be encoded and/or modulated by using any one or a plurality of communication techniques.

This further antenna arrangement 19 may be part of the base station. This base station, in a similar manner to the mobile apparatus, may include one or more processors 21, one or more circuits comprising dedicated hardware 23, and one or more memories 25. In addition, interface unit 27 may be provided.

In operation the received signal will be demodulated and decoded by one or more of the processor 21, dedicated hardware 23, and memory 25. The decoded signal may then be processed within the BS and a response signal generated therein. Alternatively or additionally the decoded signal may be transmitted, via interface unit 27, to one or more external entities such as RNC/BSC 5, as shown in Figure 1.

While the above has been described in terms of a signal being transmitted from the mobile apparatus to the BS, a signal may be transmitted from the BS to the mobile apparatus. In this case, a signal to be transmitted may be received at the BS via interface 27. Alternatively or additionally a signal may be generated within the BS by, for example, the processor. The signal may be generated in response to a time signal. The signal may also be generated in response to a signal received by the BS at either of the antenna 19 or interface unit 27.

One or more of the processor 21, dedicate hardware 23, and memory 25 serve to encode and modulate the signal. The signal is then passed to antenna arrangement 19 where it is transmitted.

The signal may be received by antenna arrangement 1 of mobile apparatus 17. There one or more of the processor 9, dedicate hardware 13, and memory 11 serve to demodulate and decode the signal.

When the signal is encoded and modulated as described above, the encoding and modulating may be performed using one of a number of different multiple access techniques. Examples of such techniques may include Orthogonal Frequency Division Multiplex (OFDM), Discrete Fourier Transform – Spread – OFDM (DFT-S-OFDM) and Discrete Fourier Transform – Spread – Generalized Multiple Carriers (DFT-S-GMC). GMC is known as Generalised Multi-carrier. GMC is a filter bank multiple carriers scheme, also referred to as Filtered Multi Tone (FMT). GMC shows the features of low-PAPR, low latency, high data rates, high mobile speed and scalable bandwidth for basic uplink transmission. DFT-S-OFDM implements a simple small DFT in front of the IFFT (Inverse Fast Fourier Transforms) which are used for OFDM scheme to reduce the PAPR.

In addition, one of a plurality of modulation techniques may be used. Examples include quadrature phase shift keying (QPSK) and quadrature amplitude modulation (QAM). Each of these modulation techniques converts data into a symbol to be transmitted. The symbol typically takes a value defined by a number of binary bits. For example a QPSK modulation typically transmits a 2-bit (4 level) symbol. QAM modulation can transmit a symbol having one of a number of levels, however typically 16, 64 or 256 levels are chosen (corresponding to 4, 6 and 8 bits per symbol). The symbol is converted into a phase and amplitude shift which is then used to modulate a radio frequency signal.

A modulation technique is not restricted to be implemented in conjunction with a specific multiple access technique. For example, it is possible to use the quadrature phase shift keying (QPSK) modulation technique in conjunction with the DFT-S-OFDM multiple access technique or DFT-S-GMC multiple access technique. Similarly, for example, is it possible to use the DFT-S-OFDM multiple access technique with either QPSK or QAM modulation techniques. The different multiple access techniques display different characteristics depending on the type of modulation technique with which they are used in conjunction.

A modulation technique may be inherent to a system, in which case the multiple access technique implemented is for optimal performance. In one embodiment of the present invention the most appropriate multiple access technique for use in conjunction with a specific modulation technique can be selected and implemented. In another embodiment of the present invention it is possible to select the modulation technique to be used in conjunction with the selected multiple access method.

In each of the multiple access techniques described, a varying amount of resources may be provided to a particular connection. The amount of resources may be considered as the amount of bandwidth a connection is provided with. The resources may be provided in blocks, in other words, discrete amounts of a defined size, or as a continuous spectrum. A specific connection may be allocated a number of resource blocks depending on its requirements and/or network or user preferences.

The performance in terms of PAPR of a number of multiple access techniques will be described with reference to Figures 3 to 6. These figures show a PAPR performance simulation example. Each figure shows the PAPR performance of a simulated transmission using each of DFT-S-OFDM, OFDM and DFT-S-GMC in combination with each of QPSK and 16 level QAM or 16QAM to give six separate result sets. Each of these Figures show the PAPR performance of the above mentioned techniques when a different amount of resources or resource blocks are allocated to the simulated transmitter. In each of Figures 3 to 6 the lines showing the simulation results are marked A to F, which correspond to the techniques shown on the legend.

The simulation conditions for DFT-S-OFDM and OFDM are the same as the 3GPP-LTE specification, where sub-carrier spacing is 15 kHz. The system parameters providing the simulation conditions for DFT-S-GMC are show in Table 1. All simulations are carried out under the following specifications. Sub-carrier/Sub-band mapping: Localized

Modulation : QPSK/16QAM
Square root raise cosine (SRC) pulse shaping filter
Roll-off factor = 0.22
The number of taps: 81
Oversampling factor: 4

Parameter	Carrier Bandwidth (MHz)
	10
Frame duration (ms)	0.5
Sampling rate: M/N x 3.84MHz	4/1
Sampling frequency (MHz)	15.36
Sample duration (us)	0.0651
# of sub-bands	64
# of used sub-bands	40
# of virtual sub-bands	24
Upsampling rate:	72
Sub-band BW (kHz)	240
Sub-band 3dB-BW (kHz)	213.3
Occupied BW (MHz)	9.6
BW Efficiency (%)	85.3
# of symbols in Long block	14
TTI length (samples)	7680
Long block length (us/samples)	66.67/1024
Short block length (us/samples)	33.33/512
FFT size for FDE	1008
First CP length (us/samples)	4.62/71
CP length (us/samples)	4.1/63
(CP+Ramp)/TTI (%)	8.13

Table 1 system parameters for DFT-S-GMC

The bandwidth occupied by 16 sub-carriers of DFT-S-OFDM and OFDM is the same as that occupied by one sub-band of DFT-S-GMC. Consequently for a fair comparison, DFT-S-OFDM, OFDM and DFT-S-GMC, as shown, have the same occupied bandwidth. These measures of bandwidth may be described as "resource blocks", "frequency resource blocks" or "minimum frequency allocation units". Resource block shall be used below, and 1 resource block shall be taken as being equal to 1 sub-band or 16 sub-carriers. However, this is by way of example only and the size of a resource block can be defined in any other way.

In one embodiment a resource block is defined in terms of the largest single resource unit of one of the multiple access techniques to be selected. In the example which is being described, the size of a single sub-band for DFT-S-GMC is selected as the size of a resource block.

Figure 3 shows a PAPR performance comparison in which DFT-S-OFDM and OFDM use 16 sub-carriers and DFT-S-GMC uses 1 sub-band (i.e. where 1 resource block is used).

Figure 4 shows a PAPR performance comparison in which DFT-S-OFDM and OFDM use 32 sub-carriers and DFT-S-GMC uses 2 sub-bands (i.e. where 2 resource block are used).

Figure 5 shows a PAPR performance comparison in which DFT-S-OFDM and OFDM use 64 sub-carriers and DFT-S-GMC uses 4 sub-bands (i.e. where 4 resource block are used).

Figure 6 shows a PAPR performance comparison in which DFT-S-OFDM and OFDM use 512 sub-carriers and DFT-S-GMC uses 32 sub-bands (i.e. where 32 resource block are used).

As it can be seen, given a specific bandwidth, i.e. an equivalent number of resource blocks, DFT-S-OFDM and DFT-S-GMC exhibit the different PAPR performance in dependence on the bandwidth.

As can be seen from the figures above

When only one resource block is used (equivalent to 1 sub-band and to 16 sub-carriers), the PAPR of DFT-S-GMC is better than that of DFT-S-OFDM for both QPSK and 16QAM;

When 2 resource blocks are used (equivalent to 2 sub-bands and to 32 sub-carriers), the PAPR of DFT-S-GMC is close to than that of DFT-S-OFDM for both QPSK and 16QAM;

When more than 2 resource blocks are used (equivalent to more than 2 sub-bands and to more than 32 sub-carriers), the PAPR of DFT-S-GMC is worse than that of DFT-S-OFDM for both QPSK and 16QAM.

Thus, in some embodiments of the invention, adaptive selection of one multiple access technique from DFT-S-OFDM and DFT-S-GMC according to the allocated number of resource blocks is provided.

Accordingly, in some embodiments of the invention, for a specific system parameter set, a threshold number of resource blocks may be specified. The multiple access technique may then be chosen based on a comparison of this threshold with the number of resource blocks which may be allocated to a connection.

As an example, based on the given simulation results above, the threshold number may be set at 2. Therefore, if the allocated number of resource blocks for a specific connection is more than 2, the DFT-S-OFDM technique may be selected. If the allocated number of resource blocks for a specific connection is less than or equivalent to 2, the DFT-S-GMC technique may be selected.

Alternatively, if the allocated number of resource blocks for a specific connection is equal to 2, the DFT-S-OFDM technique may be selected. If the allocated number of resource blocks for a specific connection is equal to 2, either of DFT-S-OFDM or DFT-S-GMC may be selected, the decision may be taken based on and/or one or more the multiple access technique which was most recently used, or other conditions or parameters.

Other conditions or parameters comprise one or more of terminal profile(s) in terms of modules implemented in the transceiver chain, power consumption etc, and available resource units taking into account the guard band needed by the GMC modulation scheme. The conditions or parameters may be one or more of those of one or more of the user equipment and the base station. In other words the conditions or parameter may be UE condition(s) or parameter(s) and/or base station condition(s) or parameter(s)

It should be appreciated that the conditions or parameters may alternatively or additionally be used to assist in the selection of the technique to be used, regardless of the number of allocated resource blocks with respect to the threshold. In one embodiment, these conditions or parameters may be used instead of the number of the resource blocks in order to determine the technique to be used.

It will be appreciated that above simulations are by way of example only and the selection may be based other results obtained. The selection criteria will be based on the most appropriate multiple access technique for the modulation technique used.

Such an adaptive technique may be considered as a hybrid multiple access system.

With reference now to Figure 7, there is demonstrated a resource allocation for such a hybrid multiple access system.

The vertical axis shows the index number of each resource block. In any practical system there will be a number M of resource blocks. While Figure 7 implies that M must be greater than 7, it will be realized that M can take any value in practice.

The horizontal axis shows the index of the transmission time interval (TTI). The TTI is related to the minimum time length of an independently decodable transmission on the connection. Consequently the index of the TTI represents time.

In each TTI, one or more resource blocks are shown allocated between a number of communication apparatus. For simplicity only 5 different apparatus are shown in the figure, these being marked 1 to 5. In practice, any number of apparatus may be used.

Each TTI is shown having a separate allocation of resource blocks. However in practice a specific apparatus (and therefore a specific connection) may be allocated a resource block for more than one TTI. In such a case, the apparatus may use the full length of the multiple TTIs to transmit data, without dividing the data into separately decodable transmissions, one for each TTI.

As is shown in Figure 7, in the first TTI, communication apparatus 1, 2, and 4 have been allocated two or less resource blocks. Consequently these apparatus may use DFT-S-GMC. Communication apparatus 3 has been allocated 3 resource blocks and may consequently use DFT-S-OFDM since the allocated number of resource block is greater than 2.

In the second TTI, apparatus 2 uses DFT-S-OFDM, having been allocated 4 resource blocks. The other apparatus use DFT-S-GMC having been allocated two or less resource blocks.

In the above example, the switching threshold number was chosen as 2 in accordance with the simulation results shown in Figures 3 to Figure 6. It will however be realized that the choice of threshold may be any other number. If system parameters are given, the choice of switching threshold number may be set by link level simulation or by real networks measurement. The choice of threshold may be determined based on system parameters, conditions and the multiple access techniques which are available to be used.

It will further be realized that the above embodiment is only exemplary, and that in other embodiments more than two multiple access techniques may be a used. In such a case two or more thresholds may be set, with the choice of technique being based on a comparison of the number of resource blocks with the two or more thresholds.

Finally, with reference to Figure 4, it can be seen that the performance in terms of PAPR of DFT-S-OFDM, and DFT-S-GMC is substantially the same for the case where two resource blocks are allocated. Consequently in some embodiments of the invention, DFT-S-OFDM may be chosen for cases where more than two resource blocks are allocated; DFT-S-GMC may be chosen for cases where less than two resource blocks are allocated; and in the case where two resource blocks are allocated, either of DFT-S-OFDM or DFT-S-GMC may be chosen. In this last case, the choice may be based on other parameters, for example the technique used in a previous transmission.

In the above example, DFT-S-GMC and DFT-S-OFDM were adjusted TTI by TTI. In practice, the selection of which techniques to use may be changed less frequently. The decision to change the technique may be based on the change of the allocated number of resource blocks. Therefore, the actual frequency of change for multiple access techniques is related to the system resource scheduler and service requirement of communication apparatus.

Moreover, in some embodiments, the system may allow interworking between scheduling and PHY mode to avoid reconfiguration failure.

The signaling procedures for multiple access technique selection will now be described with reference to Figures 8a to 10.

Figures 8a to 8c show three methods by which a connection may be established between a mobile apparatus (labeled MS) such as a mobile station and a base station (labeled BS).

In a first embodiment, typically described as a mobile originating procedure, the mobile apparatus initiates a connection establishment. In step S1, the mobile apparatus sends a channel resource request on a random access channel (RACH).

In step S2, the base station, after receiving the request, may assign a connection to the mobile apparatus. This connection may be allocated one or more resource blocks.

In step S3, the base station may send an assignment response on the access granted channel (AGCH). As will be described below, this assignment response may contain an indication of the resource blocks allocated to the connection, alternatively or additionally the response may contain an indication of the technique to be used for the connection.

In step S4, the mobile communication apparatus may select a multiple access technique for the connection according to the signaling on the AGCH.

Finally in step S5 the mobile apparatus may communication with the base station over the connection.

In alternative embodiments, typically known as mobile terminated access, the base station may initiate the connection. The choice of method to use may depend on the current mobile management (MM) state of the mobile apparatus. In the MM READY state, a mobile apparatus performs cell updates, and no paging is needed. In the MM STANDBY state, the network knows only the routing area of the mobile apparatus and it has to send paging request in all the cells within the routing area in order to contact the mobile apparatus.

Figure 8b shows a method for an embodiment in which the mobile apparatus is in the MM standby state. In this case, an additional step, S0, is performed in which the base station sends a paging request message to the mobile apparatus. The other steps S1 to S5 may be the same as for the above described embodiment, with the exception that step S2, the resource assignment decision, may be made at any time prior to step S3. In other words, step S2 may be initiated or even completed before the RACH message is received at the base station.

Figure 8c shows a method for an embodiment in which the mobile apparatus is in the MM ready state. In this case, steps S1 and S0 may be omitted. The base station may allocate resources to the connection (step S2) without receiving a resource request. Steps S3 to S5 may subsequently be the same as for the previous embodiments.

Since, in the above embodiments, the resource allocation decision and scheduling is implemented in base station (BS), resources allocated or the chosen technique needs to be signaled to the mobile apparatus. In certain embodiments one of two methods may be used. These are described with reference to Figures 9 and 10.

A first method, which may be described as an explicit signaling scheme, is described with reference to Figure 9. In this method, the decision of which multiple access technique to use is made at the base station according to the allocated number of resource blocks. The decision may then be signaled to the mobile apparatus one the AGCH. For two candidates of DFT-S-GMC and DFT-S-OFDM, just one bit signaling is enough, e.g. 1 for DFT-S-OFDM and 0 for DFT-S-GMC. At the mobile apparatus, the signaling on the AGCH may be parsed and corresponding multiple access technique may be selected.

While the above method describes an example in which there are two candidates of DFT-S-GMC and DFT-S-OFDM, it will be appreciated that there may be more than two candidates for the multiple access technique. In this case the number of signaling bits needed to signal the decision to the mobile apparatus will correspond to the number of candidates.

Figure 9 shows steps S2 and S4 in more detail. The boxes are correspondingly marked to identify the steps detailed in Figures 8a to 8c. In a first step, T1, the base station schedules and allocates resources to the connection.

In step T2, the base station compares the allocated number of resource blocks with the threshold and determines which multiple access technique may be used. Step T3 represents the decision to use DFT-S-GMC while step T4 represents the decision to use DFT-S-OFDM.

In step T5 an indication of the chosen technique may be included in a message on theAGCH. This message may include other signaling information as is already known in the art.

The message on the AGCH may then be sent in step S3 as described in Figures 8a to 8c.

At the mobile apparatus side, the message on the AGCH is received and parsed in step T6. The indication of which technique to use is extracted and used in steps T7 to select an appropriate technique.

Then in step S5 (as described above) the selected technique is used in communication with the base station.

A second method which may be described as an implicit signaling method will now be described with reference to Figure 10. In this method a denotation of a chosen multiple access technique is not contained in a message on the AGCH. However, the message on the AGCH may still include the conventional resource allocation information, i.e. an indicator of the number of resource blocks.

At the mobile apparatus, the number of resource blocks may be parsed and then the decision on multiple access technique to use may be made. The base station may additionally determine the multiple access technique which may be selected at the mobile apparatus since the resource allocation and scheduling information is known to the base station.

With the implicit signaling method, it is not necessary to modify the signaling format and/or the information element sent on the AGCH. Therefore, from the compatibility point of view, such a method is advantageous since the base station may not require modification and it is flexible and straightforward to exploit adaptive multiple access techniques between DFT-S-OFDM and DFT-S-GMC. An advantage of implicit signaling is to support backward compatibility. This can be carried out as the resource allocation behavior is known by both the terminal and the base station.

Figure 10 shows steps S2 and S4 in more detail. It will be realized that these steps correspond to the same steps S2 and S4 referred to in Figure 9, however the detailed method used within steps is different. Either of the method detailed in Figures 9 and 10 may be used in conjunction with the method described in Figures 8a to 8c.

In a first step, T1, the base station schedules and allocates resources to the connection.

In step T5′ the base station creates an information element to be transmitted on the AGCH. Unlike step T5 in Figure 9, this information element may not include in indication of a selected technique. The message may include other signaling information as is already known in the art.

The message on the AGCH may then be sent in step S3 as described in Figures 8a to 8c.

At the mobile apparatus side, the message on the AGCH is received and parsed in step T6′. This parsing step may include parsing the message for the resources which have been allocated to the connection.

In step T8, the base station compares the allocated number of resource blocks with the threshold and determines which multiple access technique may be used. Step T7b represents the decision to use DFT-S-GMC while step T7a represents the decision to use DFT-S-OFDM.

Then in step S5 (as described above) the selected technique is used in communication with the base station.

While the two above embodiments have been described separately, it will be realized that they may be used in conjunction. In other words, the comparison with a threshold and selection of a technique may be performed in both the base station and the mobile apparatus. In this case, it becomes optional to send an indication of the chosen technique on the AGCH. The base station may use the knowledge of the chosen technique for other purposes.

A layout of functional blocks in accordance with embodiments of the invention will now be described with reference to figure 11. This figure shows a switch mechanism between DFT-S-GMC and DFT-S-OFDM.

One difference between DFT-S-GMC and DFT-S-OFDM is that the former depends on filter bank transform (FBT) & inverse filter bank transform (IFBT) for sub-band shaping, while the latter on the Fast Fourier Transforms (FFT) and inverse fast Fourier transforms (IFFT) for sub-carrier shaping. Hence, for practical implementation there are some processing differences between them.

However, DFT-S-GMC also applies direct Fourier transforms (DFT) for spectrum spreading, frequency division multiple access (FDMA) for separation of uplink simultaneous terminals, and frequency division equalization (FDE) for channel equalization at the BS side. From such aspects, they are very similar to each other in principle. Main differences can be summarized as follows:

Inverse filter bank transform (IFBT) in DFT-s-GMC and IFFT in DFT-S-OFDM

Guard band exploited between sub-bands in DFT-S-GMC

Functional blocks for buffering and shift cumulating 44 and circulated data blocking 46 may be used in DFT-S-GMC. However, these two functional blocks may be optional for DFT-S-OFDM

In Figure 11, the arrangement is capable of switching between DFT-S-OFDM or OFDMA and DFT-S-GMC.

The functional blocks marked referenced 30, 32, 36, 42, and 48 correspond to those used for DFT-S-OFDM and DFT-S-GMC commonly. Function blocks 38, 40, 44 and 46 are exclusive for DFT-S-GMC and may be switched on or off based on the chosen multiple access technique the transmitter should used..

A controller 50 may operate to control the functional blocks in accordance with the selected technique. The controller can be implemented in the GMC terminal to support multimode. The controller may have connections (not shown) to each of the functional blocks so as to switch them on or off as described above.

The controller 50 may determine the multiple access technique to be used. Alternatively or additionally the controller 50 may receive a message indicating the multiple access technique to be used. The controller 50 may have one or more connections to one or more further functional blocks which may, for example, determine the multiple access technique which is to be used and may provide a signal to the controller 50. The controller 50 and/or any of the above mentioned functional blocks may receive a message on the AGCH and parse this message to determine the multiple access technique to the used.

Once the multiple access technique to be used is known, the controller 50 then turns the functional blocks on or off according to the multiple access technique. If for example DFT-S-OFDM is selected, then the controller 50 will turn on the functional blocks not shared with the DFT-S-GMC and the circuit will function as a DFT-S-OFDEM circuit. If the DFT-S-GMC technique has been selected, the controller 50 will turn off the functional blocks inherent to the DFT-S-OFDM and the circuit will function as a DFT-S-GMC circuit.

For example, as mentioned previously, both the DFT-S-OFDM and the DFT-S-GMC techniques apply direct Fourier transforms (DFT) and the K-point DFT 30 is shared by both techniques. The output of the K-point DFT 30 is then mapped by the Mapping block 32. These first two functional blocks are present for both techniques and so are turned on by the controller when either the DFT-S-GMC or DFT-S-OFDM technique is chosen.

As mentioned previously one of the differences between the techniques is that the DFT-S-GMC applies an IFBT, whereas the DFT-S-OFDM applies an IFFT. The third functional block is an M-band IFBT 34. If the DFT-S-GMC technique has been chosen, the controller turns on blocks 38 and 40 in the M-band IFBT 34. For the DFT-S-GMC technique the M-band IFBT 34 consists of an M-point IDFT 36, oversampling 38, filterbank 40 and a Parallel to Serial converter (P/S) 42. If, however the DFT-S-OFDM technique has been chosen, the controller turns off oversampling 38 and the filterbank 40 blocks. The M-band IFBT will only consist of an M-point IDFT 36 and P/S 42. Because the controller can turn blocks 38 and 40 on and off, an IFBT is present for the DFT-S-GMC technique and an IFFT is present for the DFT-S-GMC technique.

The Buffering and Shift Cumulating block 44 and Circulated data blocking block 46 need only be present when the DFT-S-GMC technique is being used. The controller will turn these blocks on once it has determined that the DFT-S-GMC technique is to be used. If the controller determines that the DFT-S-OFDM is to be used, these blocks are turned off.

The Cyclic prefix (CP) padding block 48, like the K-point DFT 30, Mapping block 32 containing an M-point IDFT 36 and P/S 42, will be present for both the DFT-S-GMC and DFT-S-OFDM techniques.

By turning functional blocks on and off, the controller 50 switches to the most preferable technique. In this way an apparatus may be used for a technique determined by the controller.

Any or all of the functional blocks (including the controller 50) may be implemented by hardware or software. Similarly, any or all of the functional blocks (including the controller 50) may be implemented in either or both of the dedicated hardware 13 and processor 9 as illustrated in Figure 2.

Some embodiments of the presently described invention may provide a number of advantages, such as:

Improved PAPR performance, by adaptive switching between DFT-S-OFDM and DFT-S-GMC, the optimal PAPR performance for different allocated number of resource blocks may be obtained.

No impact on resource scheduling and allocation

In real systems, the allocated number of resource blocks for a specific user depends on the required data rate and system scheduling constraints. In the proposed adaptive multiple access, the decision on multiple access only depends on the allocated number of resource block directly. Therefore, there is no impact on the existing resource scheduling methods.

While the above embodiments have been described with reference to a mobile communication apparatus and a base station, it will be recognized that these are only two possible electronic apparatus in which embodiments of the invention may be implemented. Similarly while the decisions of what radio resources to allocate to the connection and thus what multiple access technique to use have been described as being taken in one or both of the mobile communication apparatus and base station, the decision may be taken in any other apparatus or node, for example, in the radio network controller 5 as shown in figure 5.

While embodiments of the invention have been described with reference to DFT-S-OFDM and DFT-S-GMC, other embodiments of the invention can be applicable to other multiple access techniques. Alternatively or additionally, there may be selection between three or more multiple access techniques as required. In this latter case, two thresholds may be defined. Embodiments of the invention are thus applicable to other multiple access techniques. For example a system or apparatus can indicate a selection of multiple access techniques, for instance:- FDMA, TDMA, CDMA formulated by signature assignment (from mathematics, a mass function can be associated to each user, then any multiple access can be realized). Alternatively or additionally embodiments of the invention can be used with SDMA (Space Diversity Multiple Access) and single user MIMO (Multiple Input Multiple Output) and single user diversity can be selected for multiple antenna system.

In one or more embodiments of the invention, one or more of the selectable multiple access techniques may be a DFT technique.

In one or more embodiments of the invention, one or more the selectable techniques is an OFDM technique. In one or more embodiments of the invention, one or more the selectable techniques is a GMC technique. In one or more embodiments of the invention there may be at least one or more OFDM technique and at least one or more GMC technique.

In one or more embodiments of the invention, selection is between two or more multi-carrier modulation schemes. OFDM and GMC are two examples of multi-carrier schemes.

In one or more embodiments of the invention, one or more of the selectable techniques is a filter bank multiple carrier scheme.

Similarly while the above embodiments have been described with reference to the multiple access technique to be used for an uplink connection (i.e. for signals transmitted from a mobile communication apparatus to a base station) it may equally be used for a downlink connection.

While the above embodiments describe the using the number of resource blocks to make decision of what multiple access technique to use, it will be apparent that any other measure of the bandwidth to be used by a connection may be used. The measure may be an integer, bandwidth, frequency allocated or any other suitable measure.

While the threshold has been described as being in terms of resource blocks in some of the above embodiments, the threshold may be defined in different terms such as frequency allocated, number of sub-bands, number of sub-carriers or the like. Similarly, in some embodiments the threshold may reflect the measure being used, and therefore may be any integer or non-integer.

Whilst the described embodiments have used one or other or both of QAM and QPSK, it should be appreciated that alternative embodiments may use any other suitable technique or techniques. If should be appreciated that in those embodiments which use a common modulation technique for the first and second multiple access techniques, the same version or different versions of that modulation technique may be used. For example 16 and 64 QPSK may be respectively used with the different modulation techniques.

It should be appreciated that where embodiments of the invention are at least partially implemented on software, that software may be at least partially run on one or more processors. Accordingly, various of the functions which are described as being carried out on a processor may be carried out in practice by one or more processors. Where more than one processor is provided, different functions may be provided by different ones of the processors.

The methods which are shown and described with reference to the Figures may be at least partially carried out by one or more processors. All the steps carried out in a given entity may be carried out by a single processor by two or more processors.

Thus the selection of the access technique may take into account at least one and in some embodiments both of the amount of resource required for a connection and the available amount of resource.

In general, the various embodiments of the invention may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. For example, some aspects may be implemented in hardware, while other aspects may be implemented in firmware or software which may be executed by a controller, microprocessor or other computing device, although the invention is not limited thereto.

For example the embodiments of the invention may be implemented as a chipset, in other words a series of integrated circuits communicating among each other. The chipset may comprise microprocessors arranged to run code, application specific integrated circuits (ASICs), or programmable digital signal processors for performing the operations described above.

Some embodiments of this invention may be implemented by computer software executable by a data processor of the mobile apparatus, such as in the processor entity, or by hardware, or by a combination of software and hardware. Further in this regard it should be noted that any blocks of the logic flow as in the Figures may represent program steps, or interconnected logic circuits, blocks and functions, or a combination of program steps and logic circuits, blocks and functions.

The memory may be of any type suitable to the local technical environment and may be implemented using any suitable data storage technology, such as semiconductor based memory devices, magnetic memory devices and systems, optical memory devices and systems, fixed memory and removable memory. The data processors may be of any type suitable to the local technical environment, and may include one or more of general purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs) and processors based on multi core processor architecture, as non limiting examples.

The foregoing description has provided by way of exemplary and non-limiting examples a full and informative description of the exemplary embodiment of this invention. However, various modifications and adaptations may become apparent to those skilled in the relevant arts in view of the foregoing description, when read in conjunction with the accompanying drawings and the appended claims. However, all such and similar modifications of the teachings of this invention will still fall within the scope of this invention as defined in the appended claims.

CLAIMS

1. An apparatus comprising:

a processor configured to select a first multiple access technique or a second multiple access technique for a connection.

2. The apparatus of claim 1, wherein said processor is configured to select one of said first and second multiple access techniques in dependence on an amount of available resource.

3. The apparatus as claimed in claim 1 or 2, wherein said processor is configured to select one of said first and second multiple access techniques in dependence on an amount of resource allocated to a connection.

4. The apparatus of claim 3, wherein the processor is configured to select the first multiple access technique or the second multiple access technique in dependence on a number of resource blocks allocated to the connection.

5. The apparatus of claim 4, wherein a resource block correspond to at least one of a predetermined number of sub-bands and a predetermined number of sub-carriers.

6. The apparatus of any of claims 3 to 5, wherein the processor is configured to compare an amount of resource allocated to a connection with a threshold.

7. The apparatus of claim 6, wherein the processor is configured to select the first multiple access technique if the amount of allocated resource is greater than the threshold.

8. The apparatus of claim 6 or 7, wherein the processor is configured to select the second multiple access technique if the amount of allocated resource is less than the threshold.

9. The apparatus of any of claims 6 to 8, wherein the processor is configured to select a predetermined one of said first and second multiple access techniques if the amount of allocated resource blocks is equal to the threshold.

10. The apparatus as claimed in any of claims 6 to 8, wherein the processor is configured to select one of the said first and second multiple access techniques in dependence on at least one of:

the previously used one of said first and second access techniques;

a condition;

a parameter of said apparatus; and

a parameter of a second apparatus of said connection

11. The apparatus of any preceding claim, wherein at least one of said first and second techniques comprises an orthogonal frequency division multiplexing technique.

12. The apparatus of any preceding claim, wherein a at least one of said first and second techniques comprises a discrete fourier transform technique.

13. The apparatus as claimed in claim 11 or 12, wherein one of said multiple access techniques comprises a Discrete Fourier Transform – Spread – Orthogonal Frequency Division Multiplexing technique.

14. The apparatus as claimed in any preceding claim, wherein at least one of said first and second techniques comprises a filter bank multiple carrier scheme.

15. The apparatus as claimed in any preceding claim, wherein at least one of said first and second techniques comprises a generalised multi carrier technique.

16. The apparatus of any preceding claim, wherein one of said first and second multiple access techniques comprises a Discrete Fourier Transform – Spread – Generalized Multiple Carrier technique.

17. The apparatus of any preceding claim, comprising:

first circuitry configured to generate a signal using the first multiple access technique;

second circuitry configured to generate a signal using the second multiple access technique; and

said processor is configured to control the first and second circuitry in dependence on whether the first or the second multiple access technique has been selected.

18. The apparatus as claimed in claim 17, wherein at least part of said first and second circuitry is shared circuitry.

19. The apparatus as claimed in any preceding claim, wherein said processor is configured to receive information defining which of said first and second multiple access technique is to be selected.

20. The apparatus as claimed in any of claims 1 to 18, wherein said processor is configured to provide information defining which of said first and second multiple access technique is to be selected.

21. The apparatus as claimed in any preceding claim, wherein said first and second multiple access technique use a common modulation scheme.

22. The apparatus as claimed in any of claims 1 to 19, wherein said first and second multiple access technique use different modulation schemes.

23. The apparatus as claimed in claim 21 or 22, wherein said modulation scheme comprises one or more of quadrature shift keying and quadrature amplitude modulation.

24. The apparatus of any preceding claim, wherein said processor is configured to select one of said first and second multiple access techniques in dependence on one or more parameters of said apparatus.

25. The apparatus of any preceding claim, wherein said processor is configured to select one of said first and second multiple access techniques in dependence on one or more parameters of a second apparatus of said connection.

26. An apparatus comprising:

a processor configured to select one of a first and second multi-carrier modulation scheme for a connection.

27. A mobile terminal comprising apparatus as claimed in any preceding claim.

28. A base station comprising apparatus as claimed in any of claims 1 to 25.

29. A method comprising:

selecting a first multiple access technique or a second multiple access technique for a connection.

30. The method of claim 29, comprising selecting one of said first and second multiple access techniques in dependence on an amount of available resource

31. The method as claimed in claim 29 or 30, comprising selecting one of said first and second multiple access techniques in dependence on an amount of resource allocated to a connection.

32. The method of claim 31, comprising selecting the first multiple access technique or the second multiple access technique in dependence on a number of resource blocks allocated to the connection.

33. The method of any of claims 31 or 32, comprising comparing an amount of resource allocated to a connection with a threshold.

34. The method of claim 33, comprising selecting the first multiple access technique if the amount of allocated resource is greater than the threshold.

35. The method of claim 33 or 34, comprising selecting the second multiple access technique if the amount of allocated resource is less than the threshold.

36. The method of any of claims 33 to 35, comprising selecting a predetermined one of said first and second multiple access techniques if the amount of allocated resource blocks is equal to the threshold.

37. The method as claimed in any of claims 33 to 35, comprising selecting one of the said first and second multiple access techniques in dependence on at least one of:

the previously used one of said first and second access techniques;

a condition; and

a parameter of one or more apparatus for said connection.

38. The method of any of claims 29 to 37, wherein at least one of said first and second techniques comprises an orthogonal frequency division multiplexing technique.

39. The method of any of claim 29 to 38, wherein a at least one of said first and second techniques comprises a discrete fourier transform technique.

40. The method as claimed in claim 38 or 39, wherein one of said multiple access techniques comprises a Discrete Fourier Transform – Spread – Orthogonal Frequency Division Multiplexing technique.

41. The method as claimed in any of claims 29 to 40, wherein at least one of said first and second techniques comprises a filter bank multiple carrier scheme.

42. The method as claimed in any of claims 29 to 41, wherein at least one of said first and second techniques comprises a generalised multi carrier technique.

43. The method of any of claims 29 to 42, wherein one of said first and second multiple access techniques comprises a Discrete Fourier Transform – Spread – Generalized Multiple Carrier technique.

44. The method of any of claims 29 to 43, comprising controlling first circuitry configured to generate a signal using the first multiple access technique and second circuitry to generate a signal using the second multiple access technique in dependence on whether the first or the second multiple access technique has been selected.

45. The method as claimed in any of claims 29 to 44, comprising receiving information defining which of said first and second multiple access technique is to be selected.

46. The method as claimed in any of claims 29 to 45, comprising providing information defining which of said first and second multiple access technique is to be selected.

47. The method as claimed in any of claims 29 to 46, comprising using a common modulation scheme with said first and second multiple access technique.

48. The method as claimed in any of claims 29 to 47, comprising using different modulation schemes with said first and second multiple access technique

49. The method as claimed in claim 47 or 48, wherein said modulation scheme comprises one or more of quadrature shift keying and quadrature amplitude modulation.

50. The method of any of claims 26 to 49, comprising selecting one of said first and second multiple access techniques in dependence on one or more parameters of said apparatus.

51. The method of any of claims 26 to 50, comprising selecting one of said first and second multiple access techniques in dependence on one or more parameters of a second apparatus of said connection.

52. A method comprising:

selecting one of a first and second multi-carrier modulation scheme for a connection.

53. A computer program comprising computer code means arranged to perform any of the steps of any of claims 29 to 52 when run.

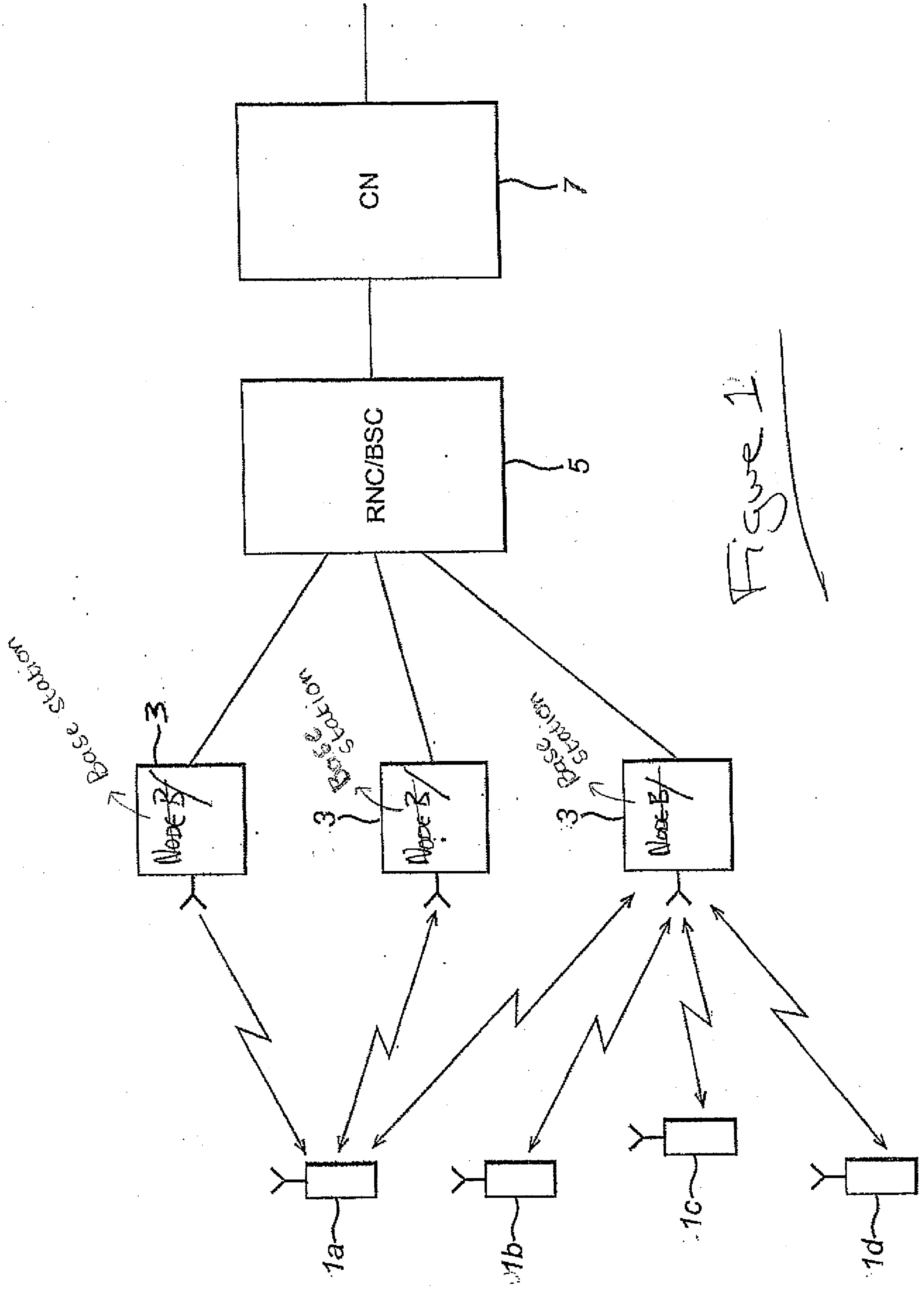


Figure 1

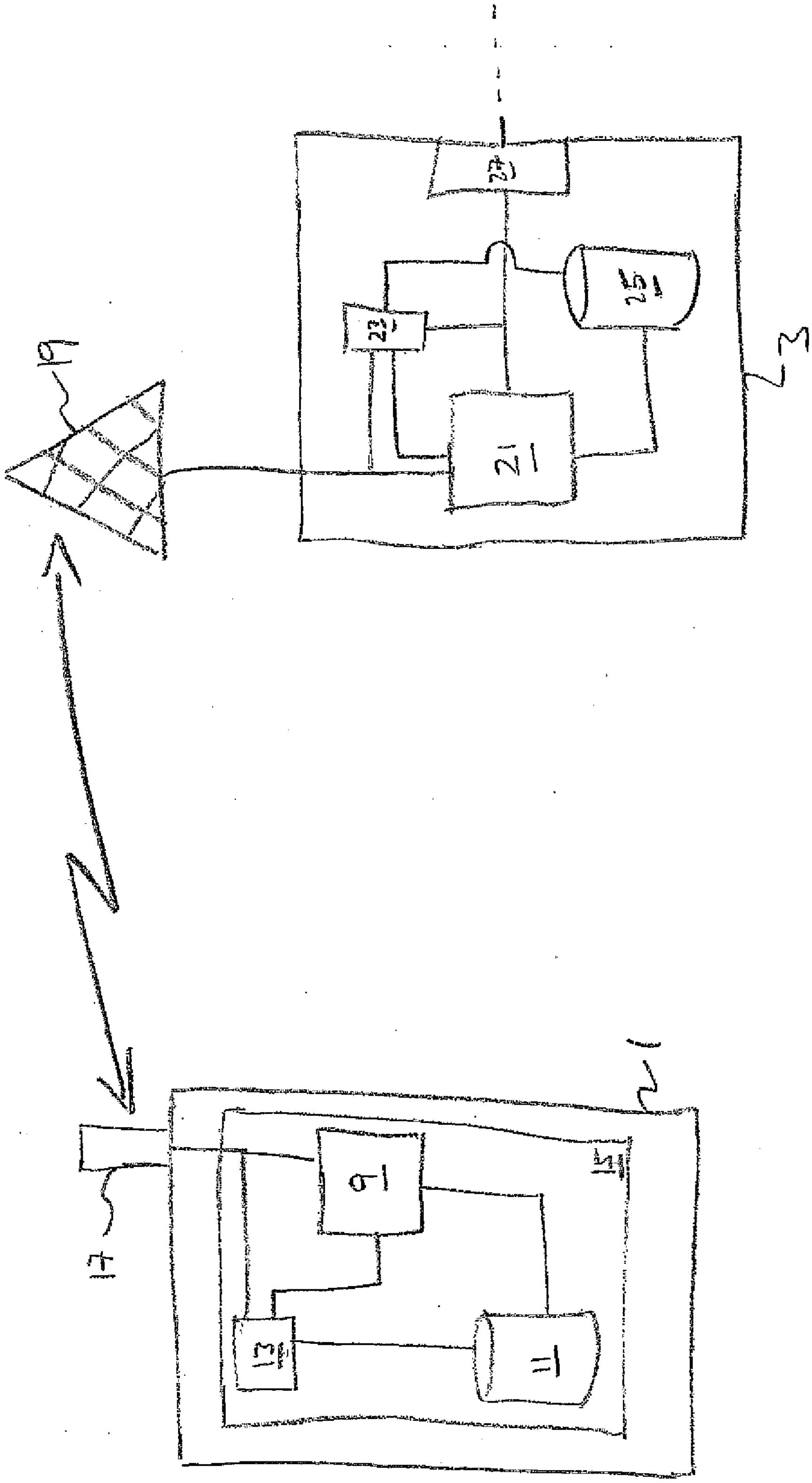
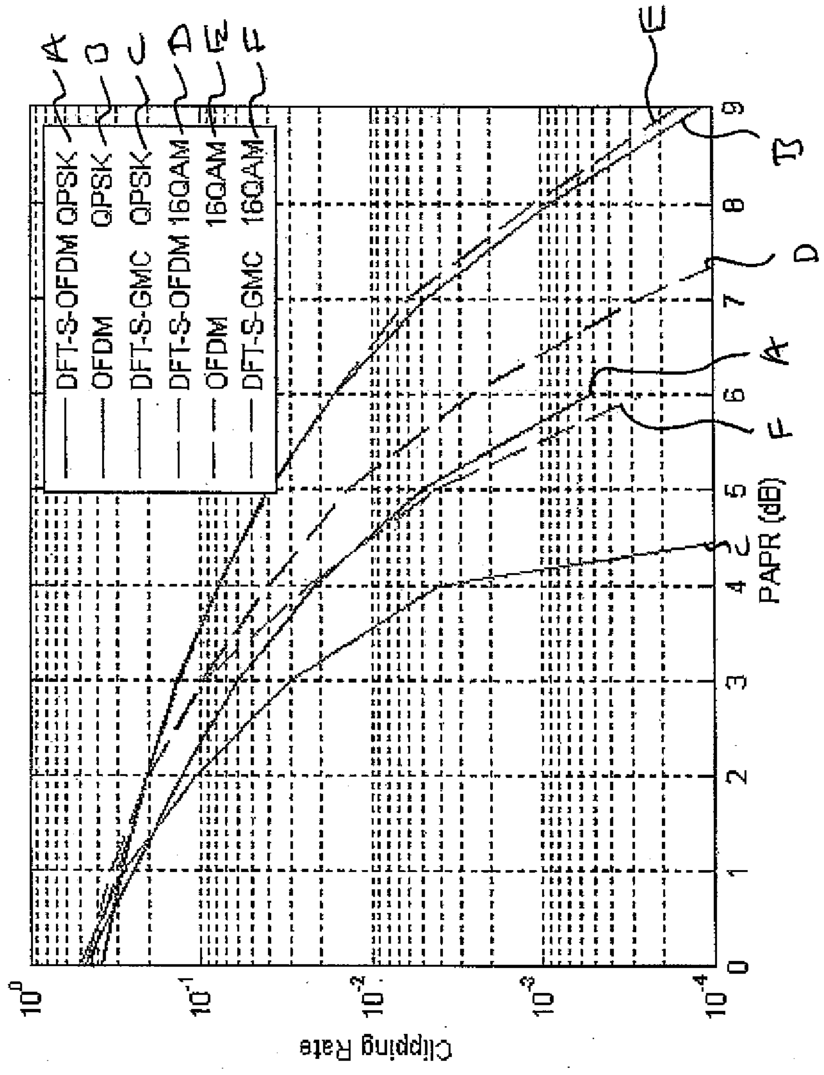
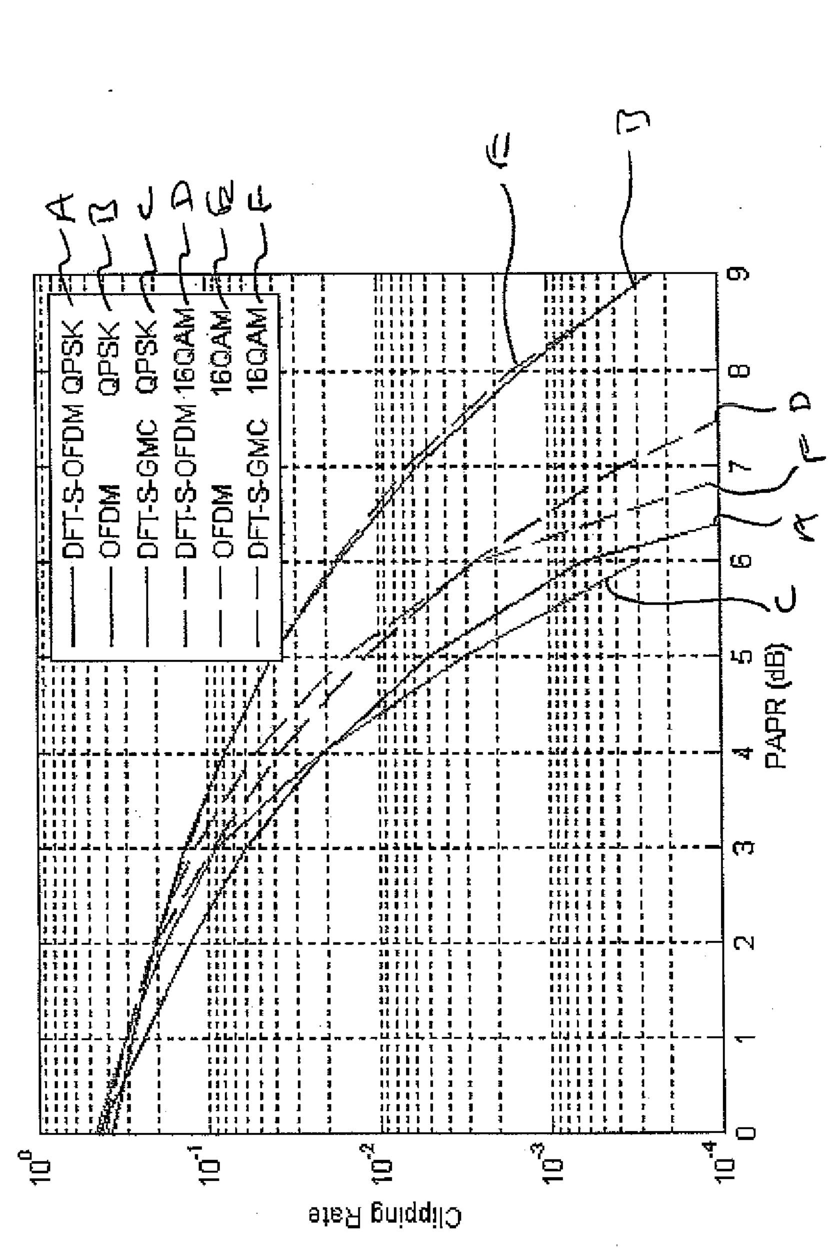


Figure 2



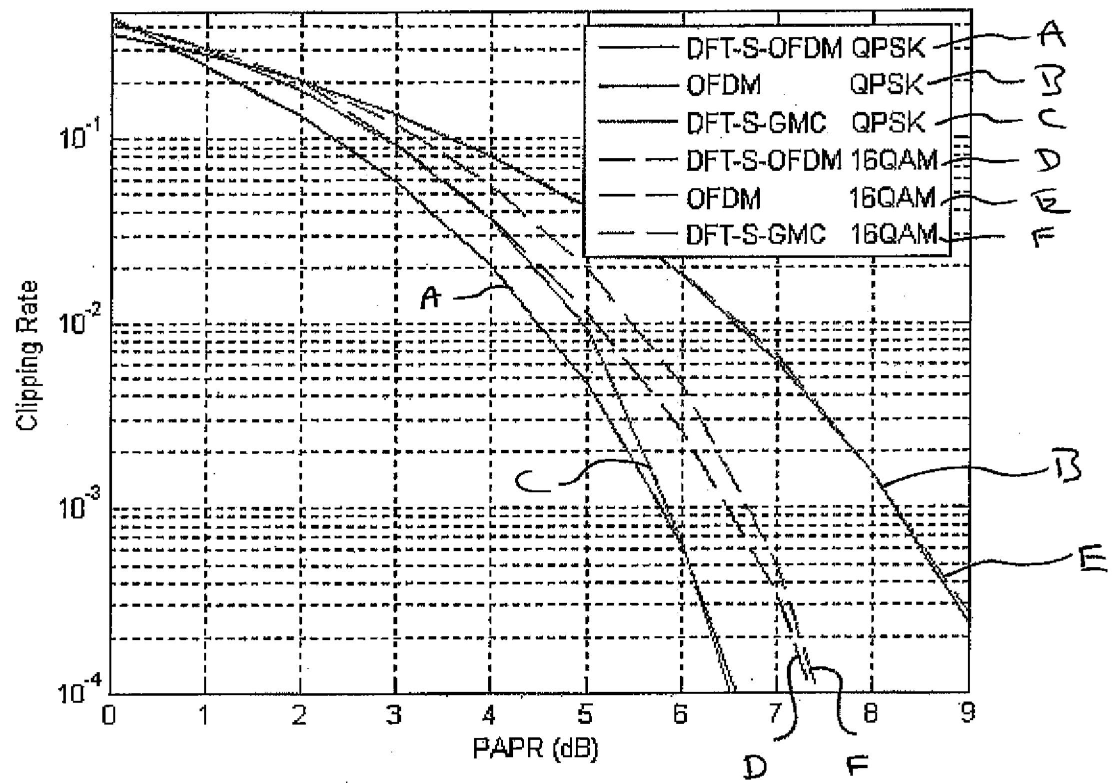
PAPR performance comparison,
DFT-S-OFDM and OFDM with 16 used sub-carriers, DFT-S-GMC with 1 used sub-band

Figure 3



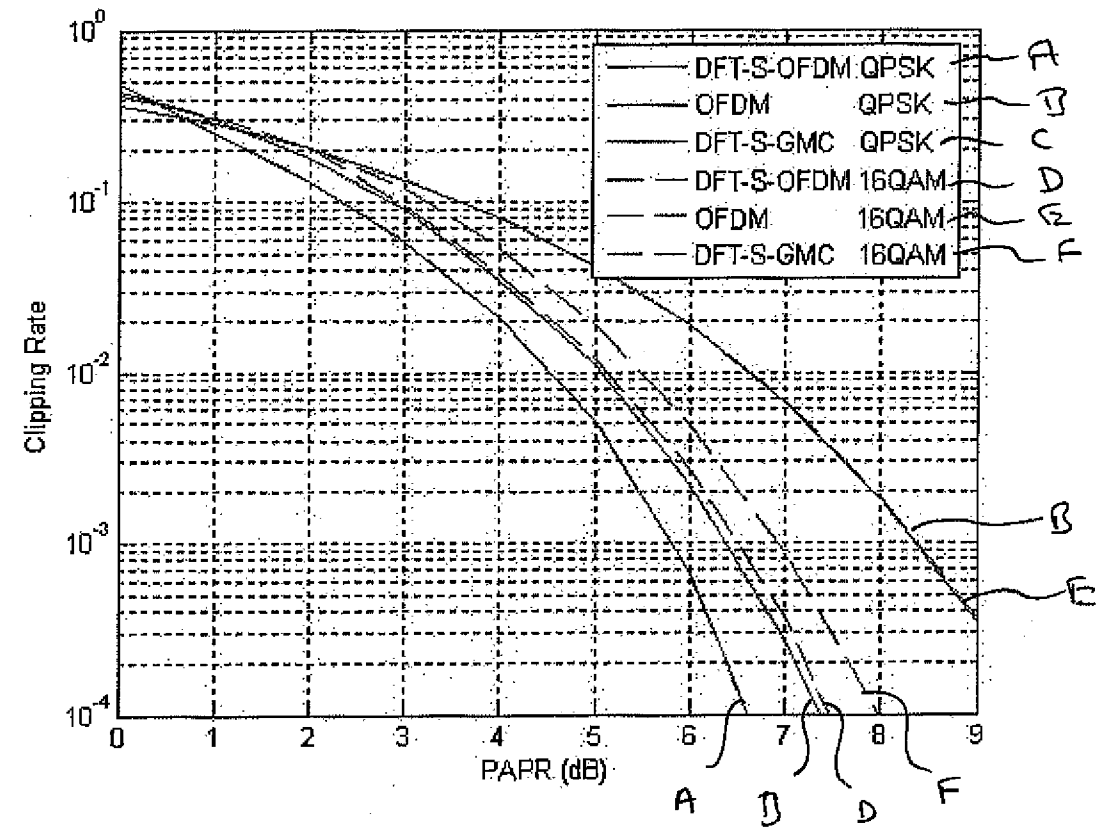
PAPR performance comparison,
DFT-S-OFDM and OFDM with 32 used sub-carriers, DFT-S-GMC with 2 used sub-bands

Figure 4



PAPR performance comparison,
DFT-S-OFDM and OFDM with 64 used sub-carriers, DFT-S-GMC with 4 used sub-bands

Figure 5



PAPR performance comparison,
DFT-S-OFDM and OFDM with 512 used sub-carriers, DFT-S-GMC with 32 used sub-bands

Figure 6

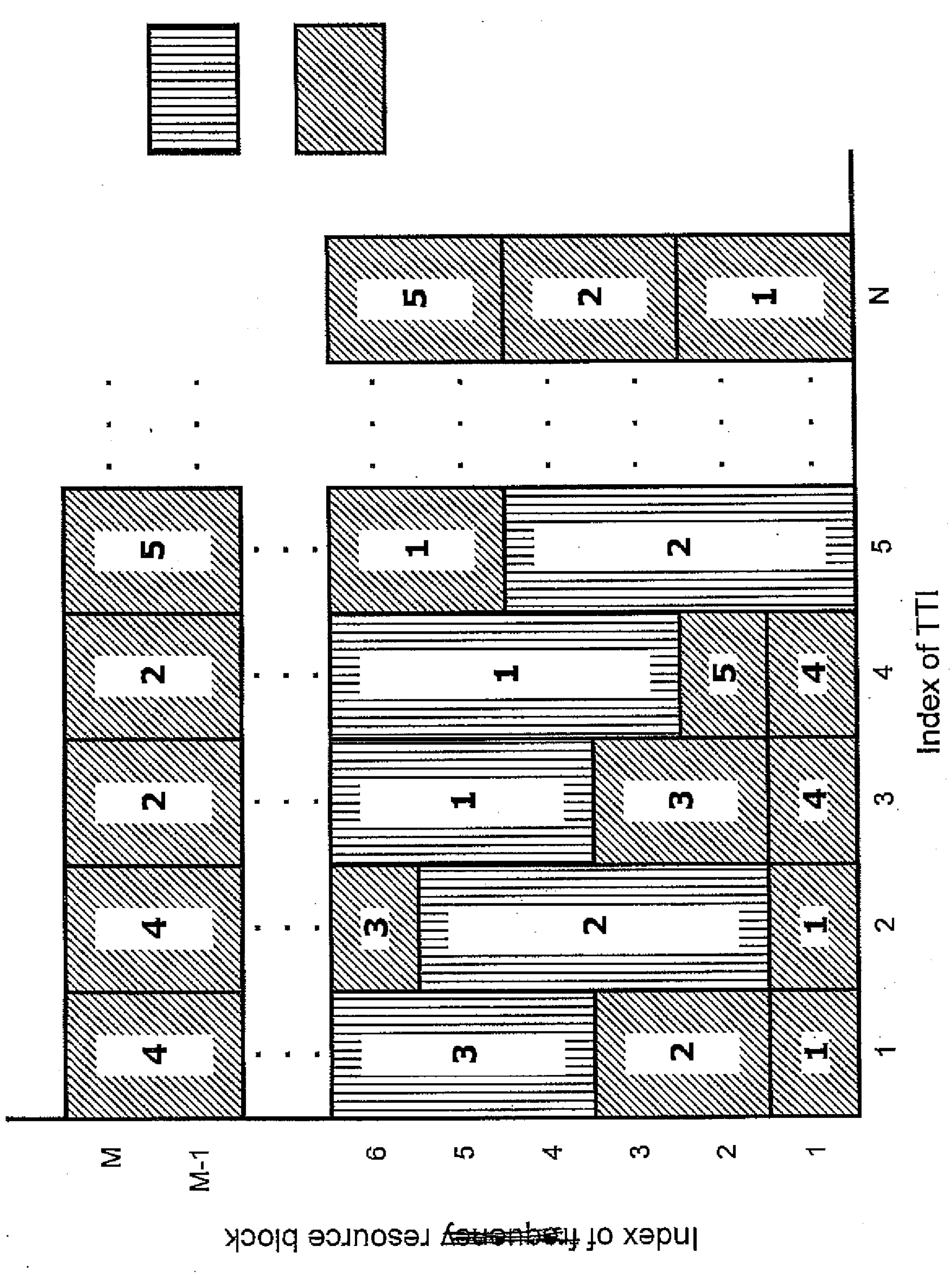

DFT-S-OFDM
DFT-S-GMC
Index of TTI
Index of frequency resource block
1
2
3
4
5
N
6
M-1
M

Figure 7

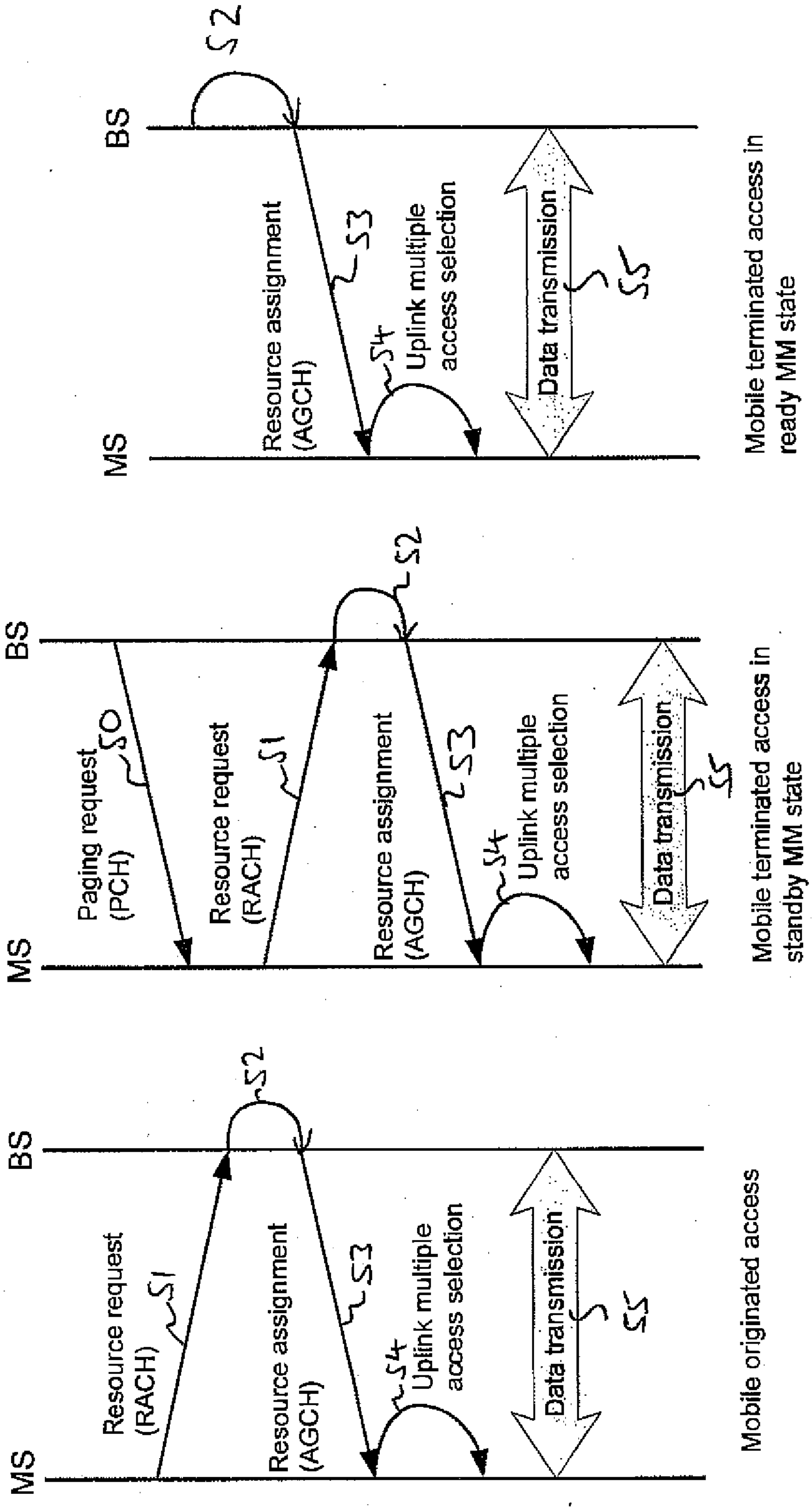


Figure 8a

Figure 8b

Figure 8c

RACH: Random Access Channel
AGCH: Access Granted Channel
PCH: Paging Channel
MM: Mobile Management

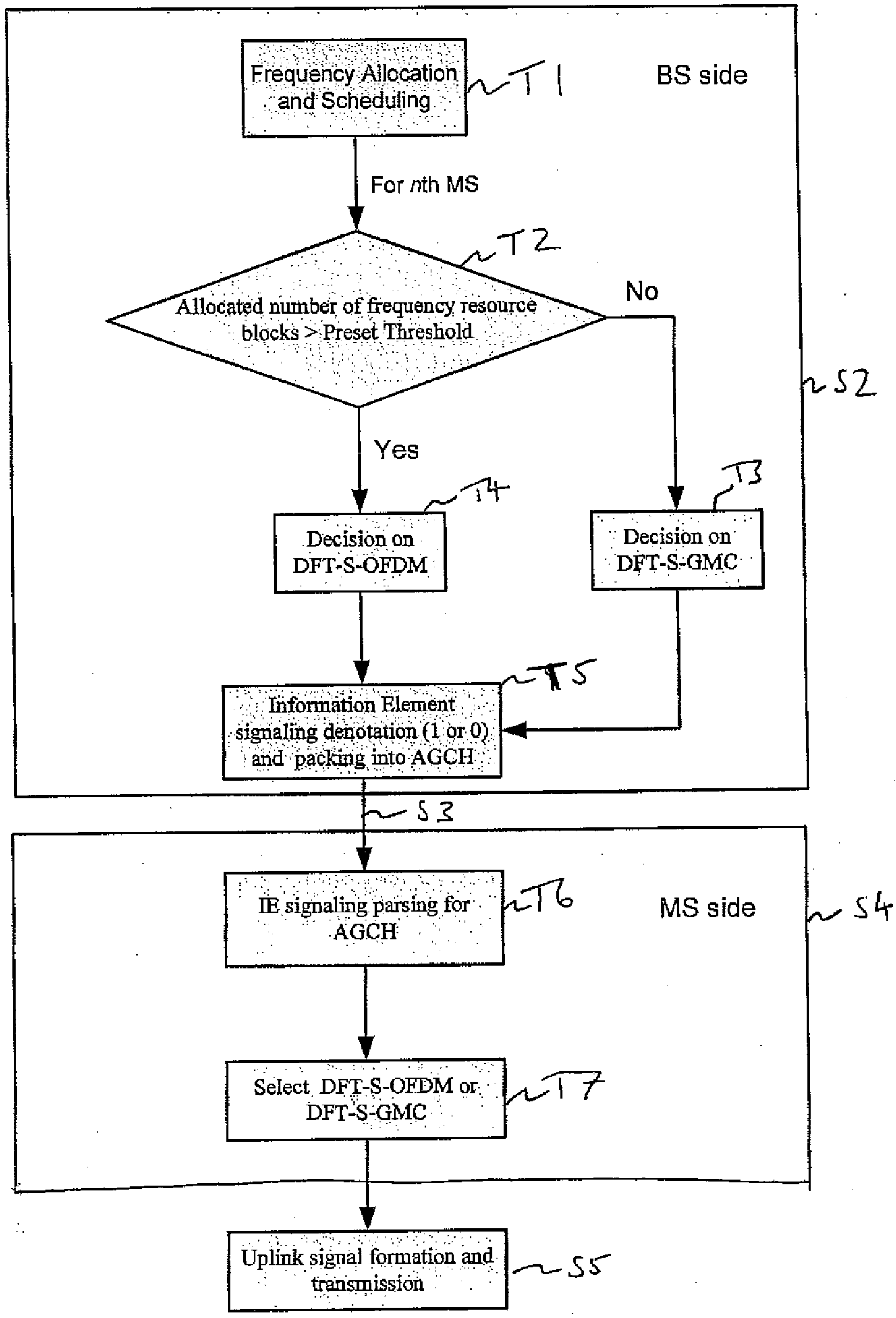

BS side
Frequency Allocation and Scheduling
T1
For nth MS
T2
Allocated number of frequency resource blocks > Preset Threshold
No
Yes
S2
T4
T3
Decision on DFT-S-OFDM
Decision on DFT-S-GMC
T5
Information Element signaling denotation (1 or 0) and packing into AGCH
S3
MS side
IE signaling parsing for AGCH
T6
S4
Select DFT-S-OFDM or DFT-S-GMC
T7
Uplink signal formation and transmission
S5

Figure 9

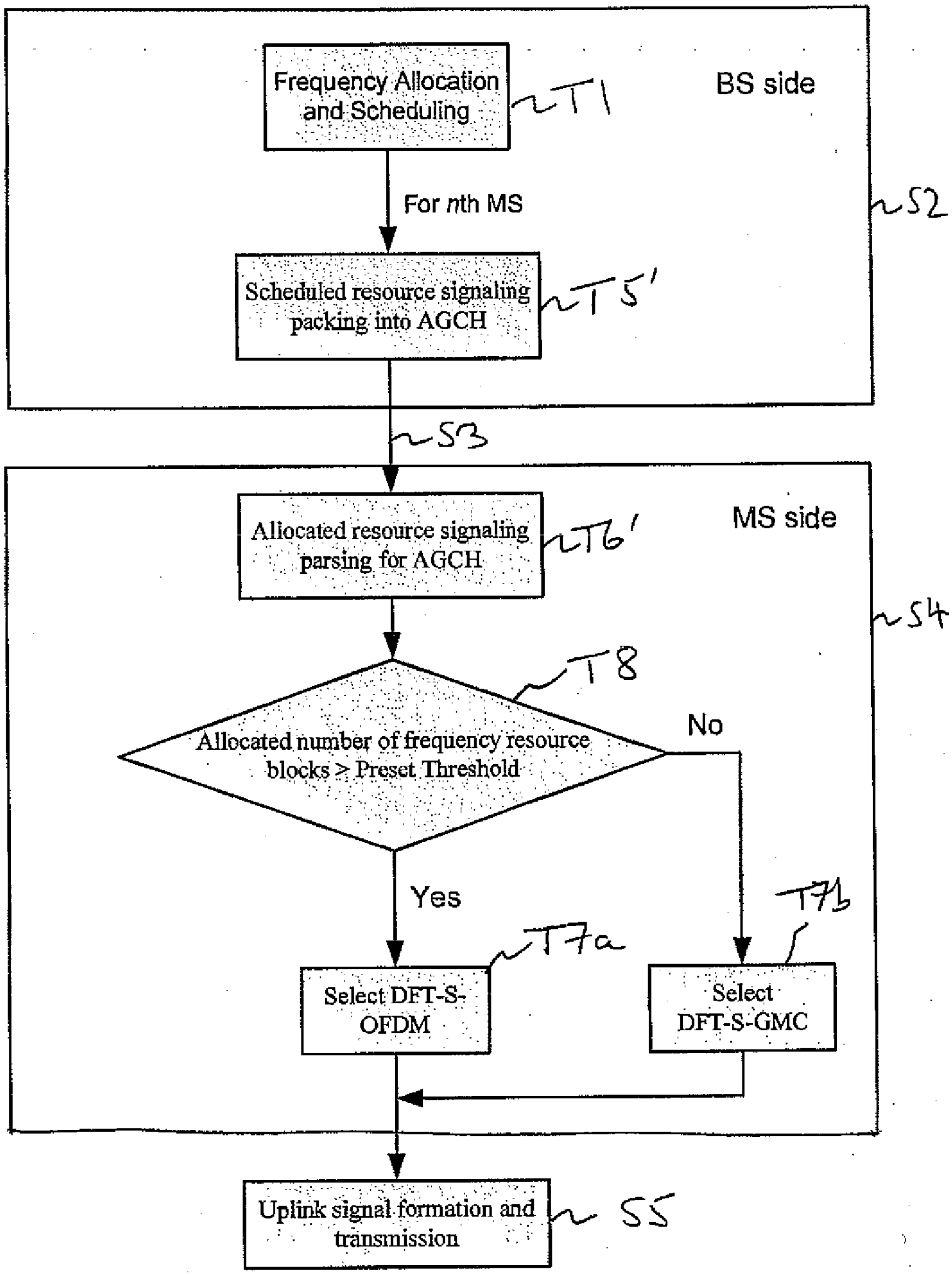

Frequency Allocation and Scheduling
T1
BS side
For nth MS
S2
Scheduled resource signaling packing into AGCH
T5'
S3
Allocated resource signaling parsing for AGCH
T6'
MS side
S4
T8
No
Allocated number of frequency resource blocks ≥ Preset Threshold
Yes
T7b
T7a
Select DFT-S-OFDM
Select DFT-S-GMC
Uplink signal formation and transmission
S5

Figure 10

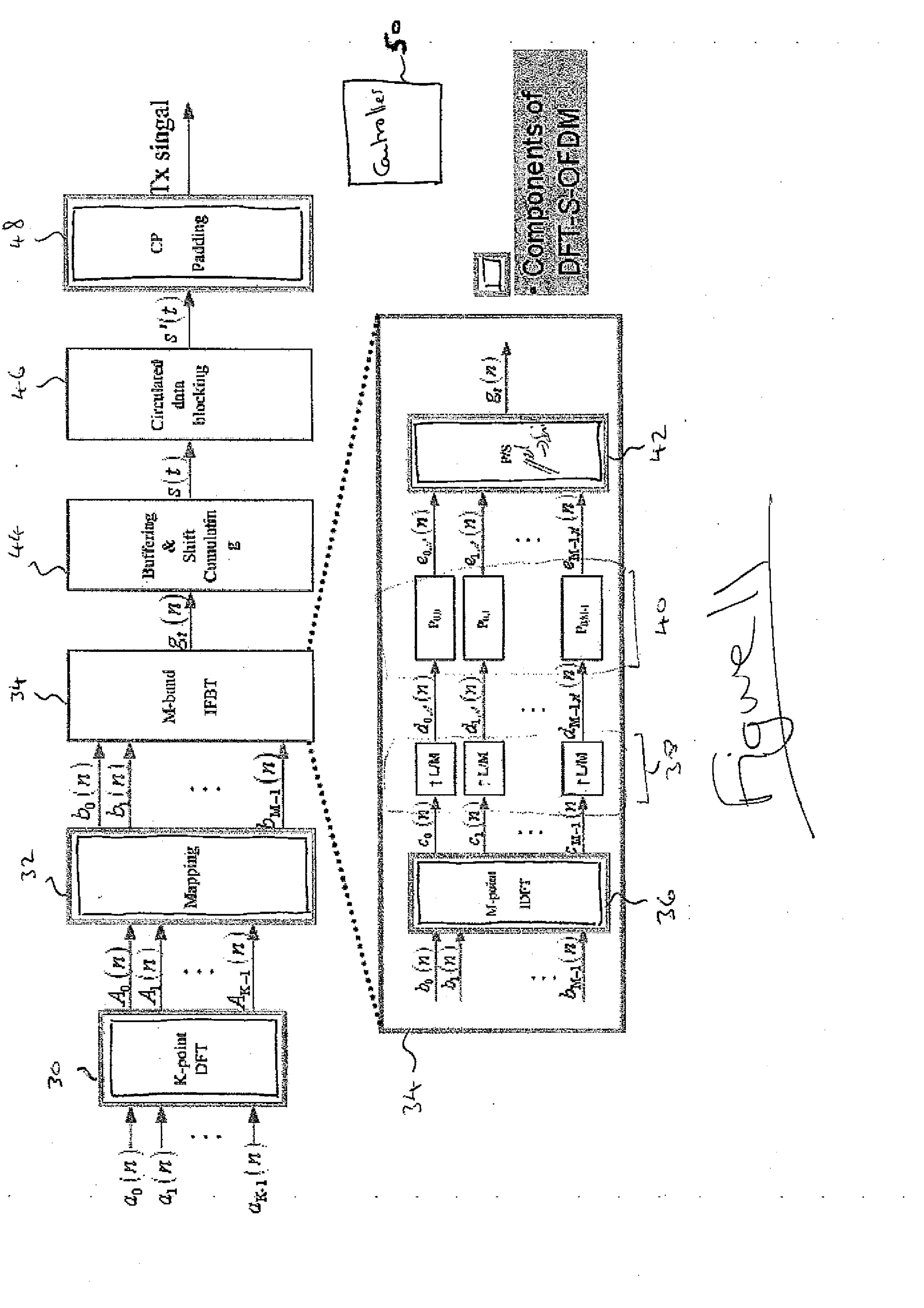

K-point DFT
Mapping
M-band IFBT
Buffering & Shift Cumulatin g
Circulated data blocking
CP Padding
Tx singal
Controller
Components of DFT-S-OFDM
M-point IDFT
P/S
30
32
34
36
38
40
42
44
46
48
50

Figure 11

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2008/054759

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W28/06 H04L27/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04W H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2007/146561 A (MOTOROLA INC [US]; YANG WEIDONG [US]; TAN JUN [US]; CLASSON BRIAN K [U) 21 December 2007 (2007-12-21)	1-11, 17-20, 24,25, 27-38, 44-46, 50,51,53
	claims 1,5,8; figure 2 page 4, line 21 - page 5, line 11 page 5, line 21 - page 6, line 17 page 7, lines 6-8,21-23 page 8, lines 1-13 page 9, line 3 - page 10, line 19 page 13, lines 3-12 page 14, line 14 - page 15, line 8 page 2, line 17 - page 3, line 13	
Y		12-16, 21-23, 39-43, 47-49
	-/--	

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 April 2009	29/04/2009

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Nogueroles Petersen

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2008/054759

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	SHRCWC: "R1-051386 On the PAR/CM Performance of DFT-S-GMC" 3GPP TSG-RAN WG1 MEETING #43, [Online] 31 October 2005 (2005-10-31), XP002511607 Seoul, Korea, 7-11 November 2005 Retrieved from the Internet: URL:http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_43/Docs/> [retrieved on 2009-01-22] the whole document	12-16, 21-23, 39-43, 47-49
X	WO 94/05130 A (ERICSSON TELEFON AB L M [SE]) 3 March 1994 (1994-03-03) page 2, lines 14-32; claim 1 page 4, lines 3-10,16-21 page 6, line 32 - page 7, line 34	1,2,29, 30
X	US 2005/152465 A1 (MALTSEV ALEXANDER A [RU] ET AL) 14 July 2005 (2005-07-14) paragraphs [0009], [0011], [0025], [0032], [0033]; claims 2,15,22	26,27, 52,53
X	DE 101 22 698 A1 (SIEMENS AG [DE]) 28 November 2002 (2002-11-28) paragraphs [0008], [0017]; claims 1,3; table 2	26,27, 52,53
X	WO 2006/040664 A (NOKIA CORP [FI]; NOKIA INC [US]; PRIOTTI PAOLO [JP]; TIRKKONEN OLAV [F) 20 April 2006 (2006-04-20) page 3, line 1 - page 8, line 15; claims 1,7,9,15,17; figures 1,4,5 page 12, line 22 - page 13, line 14	26,27, 52,53

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2008/054759

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers allsearchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search reportcovers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-25,27,28,29-51,53

   Selection of a multiple access technique among two possible multiple access techniques for a connection

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2. claims: 26,27,52,53

   Selection of a multicarrier modulation scheme among two different modulation schemes for a connection

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2008/054759

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