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ERICSSON INC.
6300 LEGACY DRIVE
M/S EVR 1-C-11
PLANO, TX 75024

FILING RECEIPT



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Title

MIB for MTC

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Additional inventors are being named on the _____ separately numbered sheets attached hereto		
TITLE OF THE INVENTION (500 characters max):		
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MIB for MTC

1 Introduction

1.1 Technical Overview

Cellular systems like WCDMA and LTE transmit broadcast information on a regular basis. Such broadcast information is needed in order for the mobile terminal to be able to determine permission to camp on a cell as well as connection setup parameters. In both LTE and WCDMA the broadcast information is divided into Master Information Block (MIB) and System Information Block (SIB). In the MIB, the most important system information like frame timing is transmitted. The MIB could also, as in WCDMA, give a pointer to time instances for when different SIBs are transmitted on the P-CCPCH. In LTE however, the SIB redundancy versions are always transmitted in a certain order, on the PDSCH in sub frame 5. SIB then includes more cell specific information, for instance information needed for the mobile terminal to be able to do random access, via the RACH. The information here could be time for RACH as well as RACH power parameters and RACH signatures to be used.

The MIB is, regardless of the system, transmitted at a certain time instant (and frequency). For instance, in LTE the MIB is transmitted in the central 6 RB in sub frame 0, and consists of 4 parts, all possible to recover individually (provided sufficiently good SNR). The SIB redundancy versions are, as mentioned above always transmitted in sub frame 5, in a specific order. However, the frequencies used could vary over the whole system bandwidth between different frames. The position used for the SIB redundancy versions are determined by decoding the PDCCH, which points out the RBs used on the PDSCH. The modulation and coding scheme (MCS) used for the SIBs are also signalled on the PDCCH. The PDCCH itself occupies the whole system bandwidth, which forces current LTE terminals to adapt its receiver bandwidth to the system bandwidth in order to be able to receive the SIB.

1.2 Problems Addressed

Machine type communication (MTC) devices utilizing a cellular system for communication has become increasingly popular. MTC typically requires only low data rate for signaling of small amount of data. One example of an MTC device is sensors. An important requirement of such devices is that they should have low cost as well as low power consumption. Examples of cellular system parameters that typically drive cost and power consumption are the system bandwidth as well as response time. Using LTE as defined according to current standardization releases requires support of up to 20 MHz system bandwidth. Such large BW support increases the cost for LTE MTC devices. Furthermore, MTC devices supporting low data rates only need a small system bandwidth (up to some few MHz). LTE has furthermore short response times, in terms of short time for HARQ response, as well as short time between the control signaling and data information (PDCCH pointing out data in the PDSCH is included in the same sub frame). This puts requirements on the processing speed (which drives power) and the need for parallel processing (increasing baseband chip area and thereby the cost). MTC devices supporting low data rates and with low power requirements optimally should use long response time (for example longer time for decoding of control and data) in order to reduce the required clocking speed or parallel processing requirements.

According to the arguments above, it is beneficial to restrict MTC devices to operate at lower system bandwidths than 20 MHz. At the same time, it may be too restrictive to require that all cellular networks supporting power and cost efficient MTC devices need to use only small bandwidths. Instead it may be beneficial to make MTC Devices supporting only low bandwidth being able to operate in an LTE network with larger system bandwidth. Similar arguments can be used for MTC devices with restrictions in decoding performance, for instance requirements of a delay between the PDCCH and possible data in the PDSCH staggering needed, which will fail to connect to an LTE system according to current 3GPP standard already in the connection phase. Cell search and MIB could be received assuming only 1.4 MHz bandwidth. However, reception of further broadcast information (SIBs) in order to be able to e.g. do a random access via the RACH requires that full bandwidth is supported as well as the possibility to decode PDCCH and PDSCH without any additional delay restrictions compared to the current standard.

Hence, there is a need for the introduction of a new signaling method in LTE taking the above shortcomings into account.

1.3 Basic Concept

This disclosure proposes an extended Master Information Block including a bit sequence pointing out a subset of Resource Elements (RE) and/or Resource Blocks (RB) in the time and frequency grid. This can easily be made by utilizing a subset of the 10 spare bits in the LTE MIB currently not used to carry information. This subset of REs and/or RBs pointed out by the bit sequence could include information suitable for MTC devices operating on a smaller (a subset) of the (LTE) system bandwidth than the cell system bandwidth, to still be able connect to the cell. Examples of such information in the MIB are:

1. The RBs and/or MCS allocated to the first system information block (SIB 1) that is transmitted in subframe 5
2. The RBs (or subset REs in certain RBs) and/or MCS allocated to a specific MTC-SIB that is transmitted in a certain sub frame
3. The RBs and/or MCS allocated to a specific MTC-MIB or SIB that is valid for a virtual cell included in the current cell, handling MTC devices
4. A set of MTC-specific RACH sequences and/or RACH regions in the time/frequency grid to be used by the MTC device for connection setup.
5. The RBs, reference signal sequence or search space allocated to a specific MTC-PDCCH, which should be different than the legacy PDCCH locations, where an MTC can receive and detect control information, including the MTC specific SIBs or downlink assignments pointing to the SIBs.
6. A direct or indirect reference to a set of different RB and/or MCS allocations among which the device can perform blind decoding in order to find system information mentioned above.

Figure 1 depicts examples of how the extended MIB refers to the time/frequency positions where the MTC can obtain further system information. The numbers at the arrows refer to the numbers in the list above. It should be noted that the extended MIB can contain more than one of the items 1-6 above.

2 Detailed Description

Figure 2 shows a flow chart over an eNB embodiment according to particular embodiments of the disclosure. The eNB generates the MIB. First MIB information according to (Rel-10) standard (Mobile broadband devices) of the LTE is generated (100). Then MIB information related to MTC devices (110) is generated (the order could be changed between (110) and (100)). A subset of the spare bits in the MIB is used for this message. The MTC information points out some RBs or REs in the time frequency grid an MTC device needs to receive and decode for further information to be able to connect to the cell/eNB. Then the MIB is coded, according to prior art methods (120) and transmitted, according to the LTE standard (130).

Figure 3 shows a first embodiment of how an MTC device utilizes the extended MIB for connection to the cell. The MTC device only needs to support a subset of the cell system bandwidth, and might also have different requirements on response time compared to legacy LTE mobile broadband devices. First the MTC device does on regular basis perform cell search in order to find a suitable cell to camp on/connect to (200). This is done using synchronization signals defined by LTE (PSS/SSS), and only requiring a system bandwidth of 6 RBs (corresponding to a system bandwidth of 1.4 MHz, the signal itself occupying approximately 1 MHz). The cell search algorithm that can be used is not limited by the disclosure. Once a cell is detected, the cell ID and timing (which is determined from the synchronization signals) are stored in the MTC device. Then the MTC device receives and decodes the MIB (210) (also only occupying a bandwidth of 6 RBs, i.e., 1.4 MHz). From the MIB, the device extracts the MTC specific information, the bit sequence points out a time/frequency position for RBs or REs including more broadcast information needed to be decoded by the device in order to connect to the cell (210), using the specific capabilities covered by the MTC. Then the MTC device reads this extended MTC broadcast information, which could be of different forms as discussed in Section 1.3 above (220). This extended broadcast information conveys information for the MTC device RACH procedure (i.e. information about how the MTC device should connect to the cell). Then the MTC device makes a random access according to defined procedure (230).

Figure 4 shows a second embodiment of how an MTC utilizes the extended MIB for connection to the cell. The MTC device only supports a subset of the cell system bandwidth, and might also have different requirements on response time compared to mobile broadband devices. First the MTC device on regular basis performs cell search in order to find a suitable cell to camp on/connect to (300). This is done using synchronization signals defined by LTE (PSS/SSS), and only requiring a system bandwidth of 6 RBs, i.e., 1.4 MHz. The algorithm for this synchronization is not limited by the disclosure. Once a cell is detected, the cell ID and timing (which is determined by the synch signals) are stored in the MTC device. Then the MTC device receives and decodes the MIB (310) (also only spanning 6 RBs, 1.4 MHz). From the MIB, the device extracts the MTC specific information, the bit sequence points out a time/frequency position for RBs or REs giving information on time and frequency position on where the MTC device should make the random access (RACH) (320). The RACH sequence to use could be an implicit function of the cell identity, but the MIB could also include information about which RACH sequence to use. Then the MTC makes a random access according to defined procedure determined from the MIB (330).

In a third embodiment, the MIB points out where the MTC device is able to read a MTC-PDCCH, which in turn points out SIBs intended for this device. This MTC-PDCCH typically occupies a bandwidth lower than the full system bandwidth, e.g. 6 RB or less, and it may comply with the legacy PDCCH format for this lower bandwidth, or it may be encoded using a new format, e.g. R-PDCCH.

In a fourth embodiment the MIB points out a set of possible resources and MCS for SIB, special MTC-SIB or MTC-PDCCH where the device applies blind decoding over the set to find the information. In a special case of this embodiment a single bit of information can be used to indicate whether the system supports narrow band devices or not. If the system supports limited band devices, the device then searches a predefined set of possible SIB, MTC-SIB or MTC-PDCCH configurations to read system information.

In all embodiments mentioned above, additional MIB bits are used to point out how to obtain further MTC specific information. These additional MIB bits can be encoded in any suitable way, where a specific bit pattern e.g. corresponds to one specific location in the time/frequency grid out of a set of pre-defined locations.

3 Advantages of Described Solutions

With the proposed MTC devices, with capabilities of only supporting a smaller bandwidth and/or longer response time than the current standardized LTE system, can be able to do connection set up to an LTE cell.

4 Example Implementations

Although the described solutions may be implemented in any appropriate type of telecommunication system supporting any suitable communication standards and using any suitable components, particular embodiments of the described solutions may be implemented in an LTE network, such as that illustrated in Figure 5.

As shown in Figure 5, the example network may include one or more instances of user equipment (UEs) and one or more base stations capable of communicating with these UEs, along with any additional elements suitable to support communication between UEs or between a UE and another communication device (such as a landline telephone). Although the illustrated UEs may represent communication devices that include any suitable combination of hardware and/or software, these UEs may, in particular embodiments, represent devices such as the example UE illustrated in greater detail by Figure 6. Similarly, although the illustrated base stations may represent network nodes that include any suitable combination of hardware and/or software, these base stations may, in particular embodiments, represent devices such as the example base station illustrated in greater detail by Figure 7.

As shown in Figure 6, the example UE includes a processor, a memory, a transceiver, and an antenna. In particular embodiments, some or all of the functionality described above as being provided by mobile communication devices or other forms of UE may be provided by the UE processor executing instructions stored on a computer-readable medium, such as the memory shown in Figure 6. Alternative embodiments of the UE may include additional components beyond those shown in Figure 6 that may be responsible for providing certain aspects of the UE's functionality, including any of the functionality described above and/or any functionality necessary to support the solution described above.

As shown in Figure 7, the example base station includes a processor, a memory, a transceiver, and an antenna. In particular embodiments, some or all of the functionality described above as being provided by a mobile base station, a base station controller, a node B, an enhanced node B, and/or any other type of mobile communications node may be provided by the base station processor executing instructions stored on a computer-readable medium, such as the memory shown in Figure 7. Alternative embodiments of the base station may include additional components responsible for providing additional functionality, including any of the functionality identified above and/or any functionality necessary to support the solution described above.

5 Abbreviation

3GPP	Third generation partnership project
HARQ	Hybrid automatic repeat request
LTE	Long term evolution
MCS	Modulation and coding scheme
MIB	Master information block
MTC	Machine type communication
P-CCPCH	Primary common control physical channel
PDCCH	Physical downlink control channel
PDSCH	Physical downlink shared channel
PSS	Primary synchronization signal
RACH	Random access channel
R-PDCCH	Relay physical downlink control channel
RB	Resource block
RE	Resource element
SIB	System information block
SNR	Signal to noise ratio
SSS	Secondary synchronization signal
WCDMA	Wideband code division multiple access

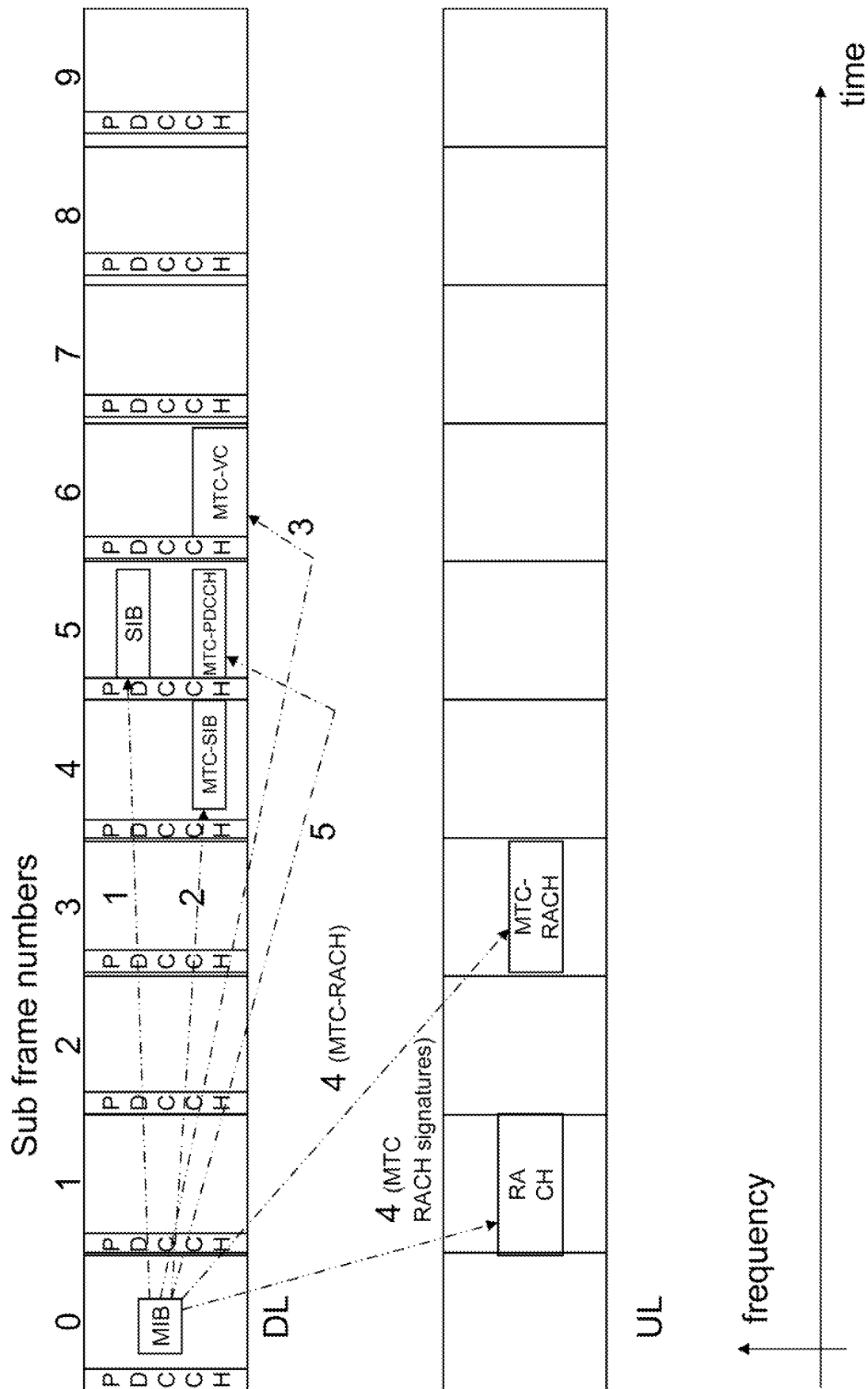
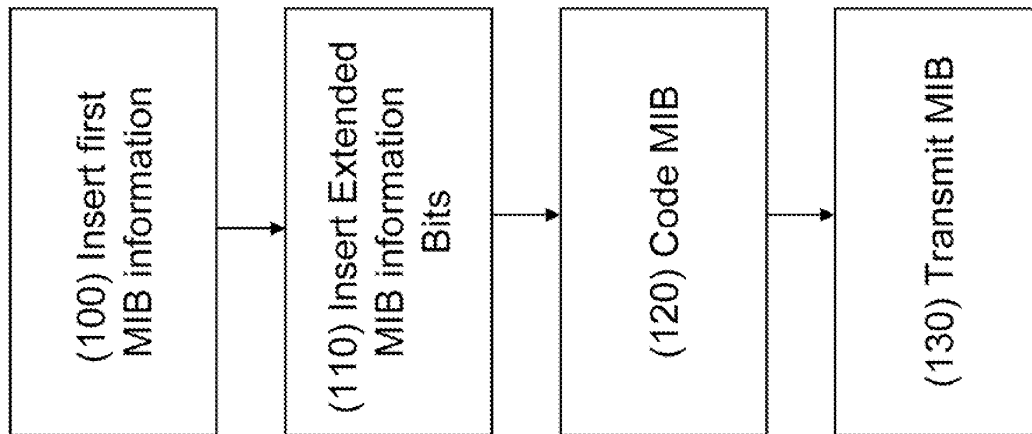
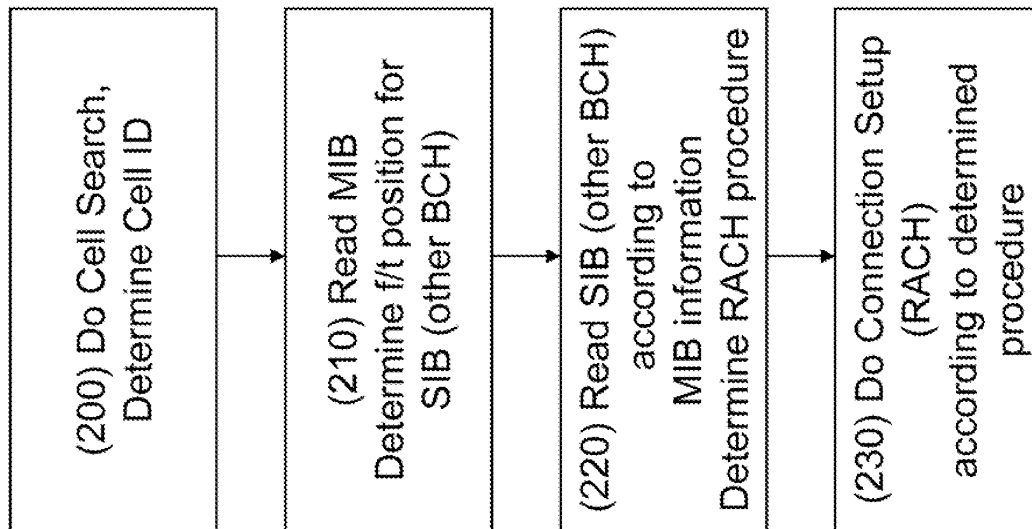
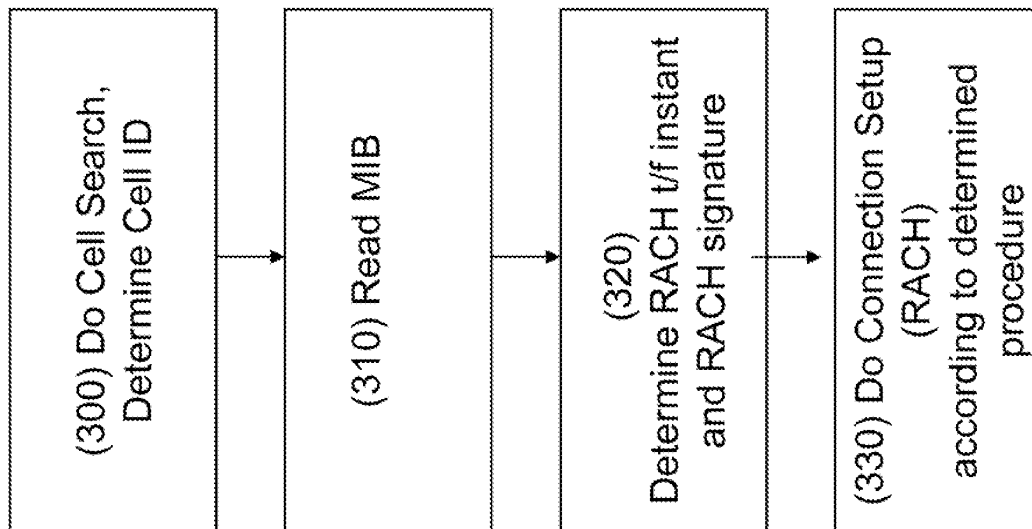


Figure 1: Time/frequency grid and sketch over how MIB can point out relevant information for MTC devices according to the invention.



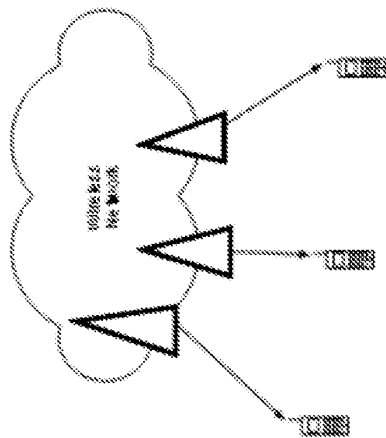


Figure 5: Example Communication System

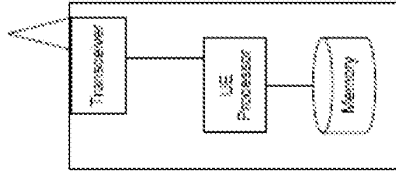


Figure 6: Example User Equipment (UE)

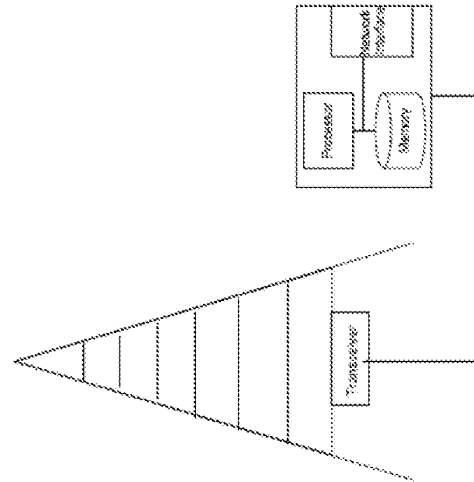


Figure 7: Example Base Station

Electronic Patent Application Fee Transmittal				
Application Number:				
Filing Date:				
Title of Invention:		MIB for MTC		
First Named Inventor/Applicant Name:		Anders Wallén		
Filer:		Steven Ware Smith/Pamela Shultz		
Attorney Docket Number:		P34745-US1		
Filed as Large Entity				
Provisional Filing Fees				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Provisional application filing	1005	1	220	220
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Miscellaneous:				
Total in USD (\$)				220

Electronic Acknowledgement Receipt	
EFS ID:	10396081
Application Number:	61501547
International Application Number:	
Confirmation Number:	2524
Title of Invention:	MIB for MTC
First Named Inventor/Applicant Name:	Anders Wallén
Customer Number:	27045
Filer:	Steven Ware Smith/Pamela Shultz
Filer Authorized By:	Steven Ware Smith
Attorney Docket Number:	P34745-US1
Receipt Date:	27-JUN-2011
Filing Date:	
Time Stamp:	17:10:14
Application Type:	Provisional

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	\$220
RAM confirmation Number	4034
Deposit Account	501379
Authorized User	
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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		P34745-US1_2011-06-27_11-7675_Provisional_Application_Pkg.pdf	2813575 bc4fb6437ce1881c26ec7c4b3b1925769c74131c	yes	13
Multipart Description/PDF files in .zip description					
	Document Description		Start	End	
	Transmittal of New Application		1	2	
	Authorization to access Appl. by Trilateral Office		3	3	
	Specification		4	10	
	Drawings-only black and white line drawings		11	13	
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	29206 be2af274c85394144795c41c261a080882f8fd7e	no	2
Warnings:					
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