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Technical Report

3rd Generation Partnership Project;
Technical Specification Group (TSG) RAN;
Working Group 2 (WG2);

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3GPP

Postal address

3GPP support office address

650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Internet

http://www.3gpp.org

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Contents

Foreword

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of this TS, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version 3.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 Indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated;

Introduction

This clause is optional. If it exists, it is always the third unnumbered clause.

No text block identified.

1 Scope

This clause shall start on a new page. No text block identified. Should start:

The present document …

TBD

2 References

This text block applies to ALL deliverables. The sub-division below applies optionally to TSs.

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

> References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
>
> For a specific reference, subsequent revisions do not apply.
>
> For a non-specific reference, the latest version applies.
>
> A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] 3GPP Homepage: www.3GPP.org
[2] 25.301, Radio Interface Protocol Architecture
[3] 25.302, Layer 1; General requirements
[4] 25.303, UE States and Procedures in Connected Mode
[5] 25.304, Description of procedures in idle Mode
[6] 25.322, Description of RLC protocol
[7] 25.321, Description of RRC protocol
[8] 25.340, Description of principles for error handling and message description
[9] ETSI UMTS 25.XX: ”Vocabulary for the UTRAN”

3 Definitions, symbols and abbreviations

Delete from the above heading those words which are not applicable.

See [9] for a definition of fundamental concepts and vocabulary.

3.1 Definitions

Clause numbering depends on applicability.

For the purposes of the present document, the [following] terms and definitions [given in ... and the following] apply.

Definition format

<defined term>: <definition>.

example: text used to clarify abstract rules by applying them literally.

3.2 Symbols

Clause numbering depends on applicability.

For the purposes of the present document, the following symbols apply:

Symbol format

<symbol> <Explanation>

3.3 Abbreviations

Clause numbering depends on applicability.

For the purposes of the present document, the following abbreviations apply:

OCCCH	ODMA Common Control Channel
ODCCH	ODMA Dedicated Control Channel
ODCH	ODMA Dedicated Channel
ODMA	Opportunity Driven Multiple Access
ORACH	ODMA Random Access Channel
ODTCH	ODMA Dedicated Traffic Channel
TDD	Time Division Duplex
UE	User Equipment
UE_R	User Equipment with ODMA relay operation enabled
UL	Uplink
UMTS	Universal Mobile Telecommunications System
URA	UTRAN Registration Area
UTRA	UMTS Terrestrial Radio Access
UTRAN	UMTS Terrestrial Radio Access Network

4. Opportunity Driven Multiple Access (ODMA)

ODMA is a communications relaying protocol, which may be used to increase the efficiency of UMTS. One way in which this is achieved is by increasing the range of high data rate services. The concept of ODMA was introduced at ETSI SMG2 in 1996, after which a number of contributions have been presented.

In summary, in an ideal telecommunications system the minimum amount of transmit power that can provide satisfactory service will always be used to overcome the radio path. In wireless telecommunications systems that have a large number of subscribers, an opportunistic method of transmission can take place where information is relayed between a number of nodes. It has been shown that the most efficient method of communicating is to break a larger path down into a number of smaller hops. However, the efficient routing of data in such a system without incurring the large overhead that is usually associated with ad-hoc routing systems is not trivial. ODMA is a relay protocol designed to address this shortfall.

ODMA may be regarded as an expansion of the current UMTS TDD mode[, although further studies are taking place to examine is application to UMTS FDD environments]. One of the aims of ODMA is to increase the capacity and efficiency of radio transmissions towards the boundaries of the cell. At these regions due to the hostile losses in the channel only relatively low data rates can normally be achieved. ODMA provides TDD with a mechanism to provide high data rate coverage by relaying these transmissions over a number of hops.

Each relaying node must be within the planned coverage of the cell, so that it may receive essential layer 1 synchronisation information. Each node also has to authenticate itself with the network, which will enable it to be used as a relay. Therefore, any ODMA relay node that is within the planned coverage area may be used to relay communication, but any ODMA relay node outside of the planned coverage area will not be able to be used to relay communications; as shown in Figure 1. Therefore, the regulation of ODMA transmissions at the border regions should be NO more complex than the planning that will have to be applied to the TDD mode of operation.

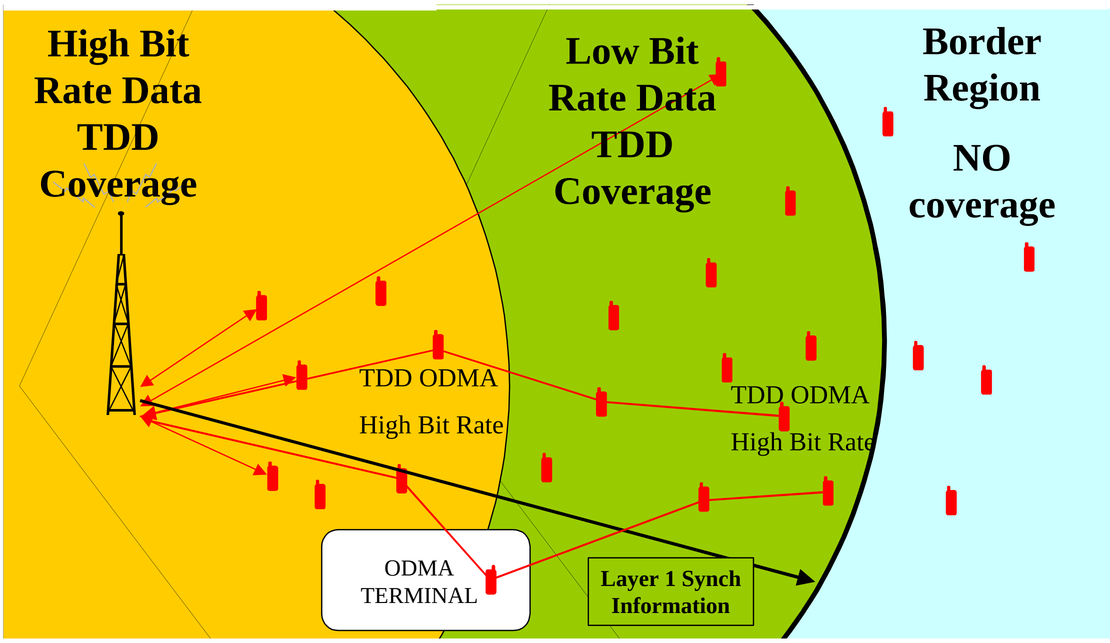

Figure 1: ODMA Border Coverage

4.1 ODMA Infrastructure Configurations

The UTRAN consists of three core elements; UE, NodeB, and RNC. However, ODMA may be introduced into this core infrastructure via a number of configurations. The configurations are systems with integrated TDD/ODMA NodeB, and systems employing last hop Gateway ODMA relay nodes.

Systems with integrated TDD/ODMA NodeB

One implementation of ODMA would be to use an integrated TDD system that contains ODMA procedures built into the infrastructure. This implementation results in system information such as synchronisation and paging messages being readily available from the standard TDD system.

One of the aims of ODMA is to extend the range of the high rate data coverage, e.g. to match that offered by TDD and FDD for speech coverage. Increased high data rate coverage can be achieved both by deployed seeds and relay terminals that happen to fall into the regions requiring increased capacity. A simplistic view of this concept is illustrated in Figure 2.

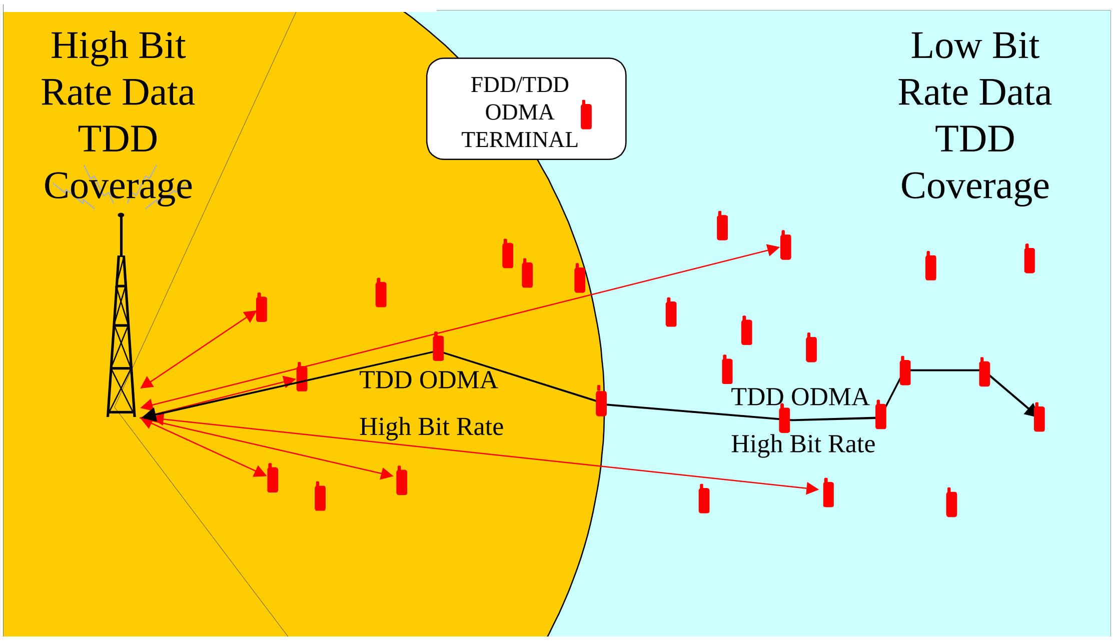

Figure 2: ODMA concept diagram with integrated TDD/ODMA NodeB

Figure 1 illustrates a scenario where the Node B may provide extended data service coverage directly through the use of ODMA.

Systems employing Last Hop Gateway ODMA Relay Nodes

In systems where FDD infrastructure may be extensive but limited TDD infrastructure is available then last hop gateway ODMA relay nodes should be deployed. Last Hop Gateway ODMA Relay Nodes provide the ability to extend high data rate communications within 3G systems by interworking ODMA functionality with standard FDD infrastructure (requiring only nominal changes to the RNC). A simplistic view of this concept is illustrated in Figure 3.

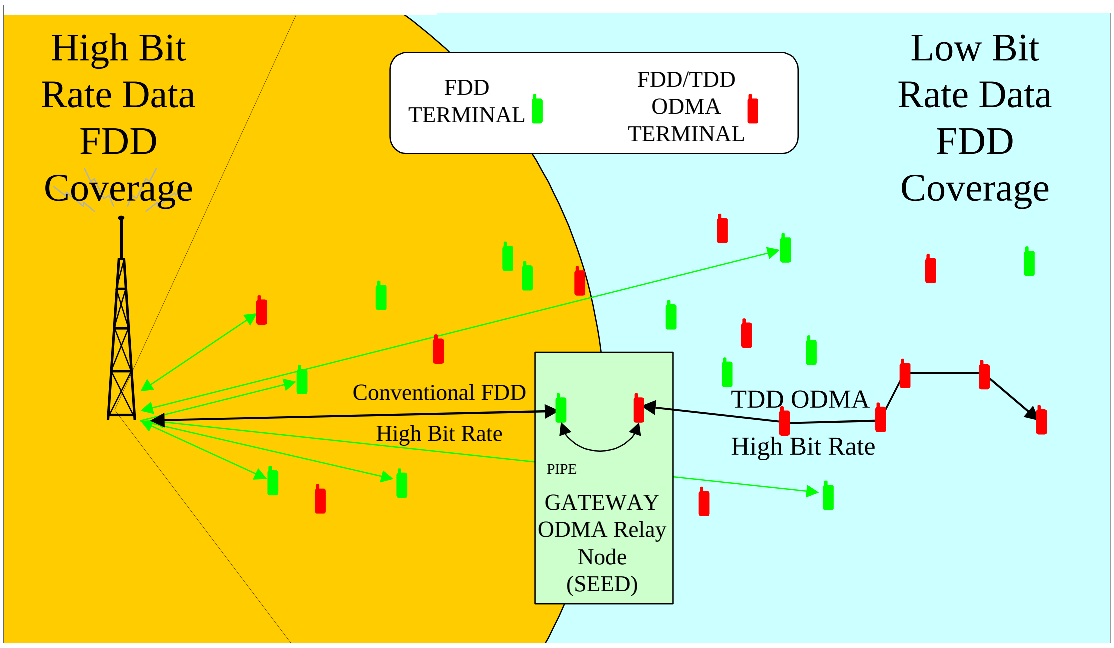

Figure 3: ODMA concept diagram with last hop

[Note that this approach is equally applicable to TDD NodeB's if it does not have ODMA capability.

4.2 ODMA Probing and Route Acquisition

Probing is a mechanism used by a relay to build a neighbour list which should contain at least a predefined minimum number of neighbours. This probing mechanism will be defined within the idle mode cell selection. In order to optimise power consumption the relay terminal will regulate probing activity.

A relays probing activity levels will be influenced by a number of key parameters such as

Number of neighbours

Gradient to the base information of the neighbours

Speed of the terminal - This may indeed represent a simplification for vehicle-mounted UE_R for which battery consumption is not at stake.

Battery power level

These probing activity levels will be characterised by three states. The probing states are full probing, duty maintained probing, relay prohibited.

Different Probing States

One aim of assigning probing rates is to ensure efficient power consumption. The functional difference between these states may generally be determined by the number of ORACH slots that may be used for probing within a superframe.

Full probing

The full probing mode is the case where the relay constantly uses the ORACH by monitoring and transmitting probe bursts. When this mode is chosen by a relay, then it means that the probing messages for the neighbours of that local area may be sent and received on any ORACH slot within a superframe.

Duty Maintained probing

This is the "normal" probing mode. This mode is designed to cope with dynamic changes within the terminals local connectivity and scheduling the probing accordingly. Note the assignment of the slots in a superframe allocated as an ORACH does not have to be consecutive.

Relay Prohibited

In this mode the relay ceases all its probing activities and would fall into non-relay TDD or FDD operation. Figure 4 illustrates probing on the ORACH during a 72-superframe cycle.

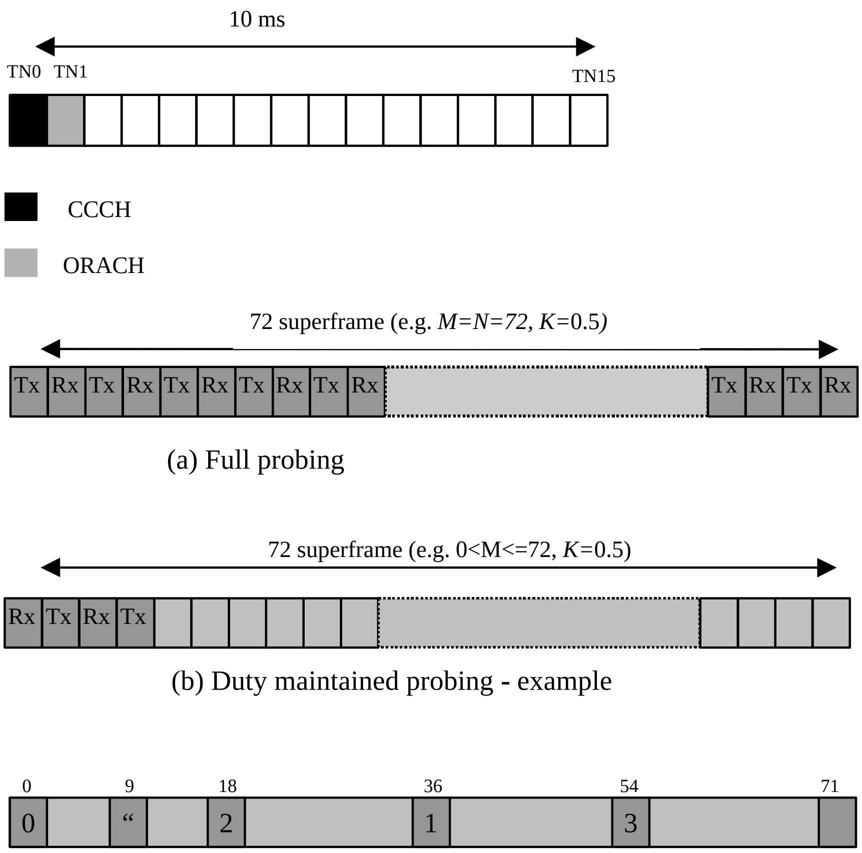

Figure 4: ORACH Superframe selection

Typical activity levels within an ODMA system are illustrated in Figure 5.

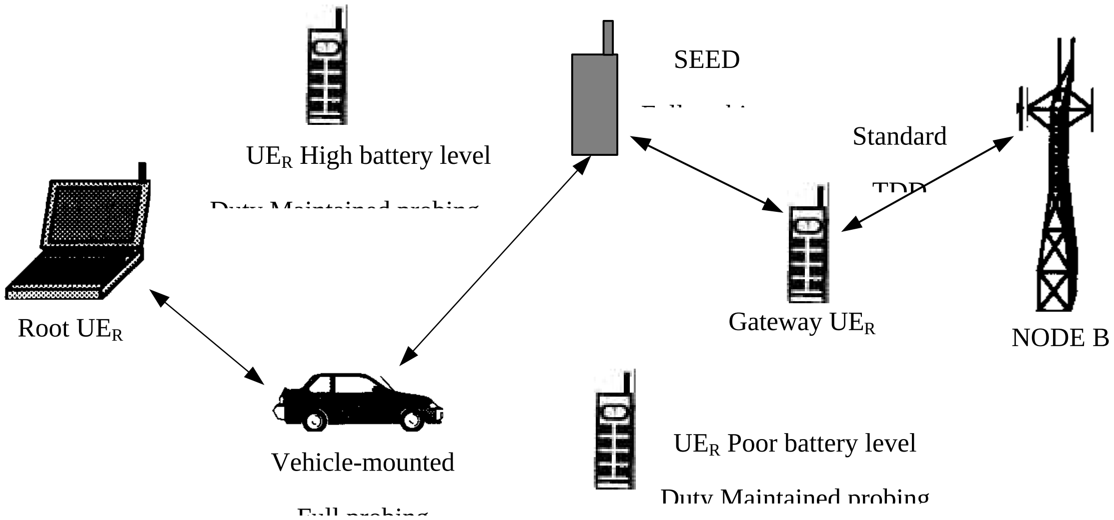

Figure 5: UERs with different probing states.

4.3 ODMA Efficiency and Power Requirements

FFS

4.4 ODMA Physical Layer Burst Mapping

FFS

4.5 ODMA Idle Mode Procedures

Neighbour Gathering

The concept of neighbour gathering must be understood for the ODMA routing process to become clear. Neighbour gathering is a process where the local connectivity of an ODMA relay node is assessed through the use of a background probing messages. This neighbour information is stored within a neighbour table. Gradient tables are also derived from the neighbour messages but are used to evaluate the end-to-end connectivity. [Example routeing tables are described in Tdoc180.] Gradients are effectively a cost function of the routeing messages over a particular path in terms of propagation conditions, number of hops, and other system parameters. In practice each mobile should have at least one gradient to a NodeB which will allow any call set-up procedures to be executed allowing for route acquisition.

4.6 ODMA Connected Mode Procedures

FFS

4.7 ODMA Synchronisation and Guard Bands

ODMA will operate in the TDD mode without adding any further constraints on the synchronisation of the TDD mode. This section highlights guard period requirements for the UMTS-TDD mode and the corresponding impact on ODMA.

TDD Guard Period Requirements

For the UMTS-TDD mode, where it is possible to have multiple switching points, this suggests that guard periods must be inserted at the end of every slot to avoid receiver capture. The guard period specified for each slot in the UMTS TDD mode is 96-chip duration, which allows a maximum two-way communication of approximately 3.5 km.

Since ODMA is intended for relatively short distances between ODMA nodes, which are adequately covered by the GP available within a slot. This means ODMA does not place any further constraints on the synchronisation or the GP requirements of TDD.

Due to the relatively short range of transmissions, the inclusion of ODMA does not impose any additional guard period or frame synchronisation requirements over those discussed above for standard TDD.

Any potential overlap caused by relay transmissions will be localised to a node and its neighbours by the ODMA protocol.

The inclusion of ODMA could relax the guard period requirements of a TDD system since neighbouring mobiles are regarded as relay opportunities and any communications between neighbours (on an ODCH) could be synchronised further

5 Annex

Frequently Asked Questions

Question 1

In highly connected networks, delay per hop decreases. Is it not likely in such cases the mean distance covered by each hop is shortened so that the reduced delay per hop is offset by an increase in the number of hops per path. The total end to end delay may actually increase. Have we examined this?

Answer 1

As the density of stations increases, the path loss between stations typically reduces as a 40 log D relationship. Therefore the data rate that can be used between stations increases at the same rate. The delay of a multi-hop network reduces as the density goes up, even if there are more relays. For example if the relay distance is halved, the number of hops is doubled, the path loss per hop is reduced by 12 dB and the data rate can be increased by ten times or so (at the same power level), and therefore overall delay is reduced by five. This is a non-intuitive conclusion and holds, providing the data rate can be continually increased. In addition, the amount of joules of energy required to move the data over the relays is reduced in total by five times. Overall there is an improvement in performance through using more relay hops.

At some point the maximum data rate is reached, due to bandwidth allocation or complexity problems, at which point the number of hops needs to be curtailed based upon the maximum delay.

Question 2

ODMA should not focus entirely on urban deployments. The large increase in the number of basestations that we suggest UMTS needs compared with GSM actually only applies to the rural (i.e. noise-limited) case - hence "universal" UMTS remains uneconomic. Surely if ODMA sticks to the non-fading wideband relaying the required ranges can be achieved - albeit at 100mW mean power?

Answer 2

Wide area coverage in the rural environment, particularly if this is used as an extension of the high data rate services within a rural cell, is an important application of ODMA. Particularly in rural environments where there are sparse population densities strung out along roads or in clusters, the use of seeds and subscriber relay to fixed subscribers or via fixed subscribers will provide significant advantages.

Question 3

What are the average sleeping patterns on 720 ms multi-frame?

Answer 3

FFS

Question 4

How many times and during how many slots and frames does the UE listen to the RACH, ORACH?

Answer 4

FFS

Question 5

What is the duty cycle of probing on the RACH, ORACH?

Answer 5

FFS

Question 6

Over how many slots are receive and transmit associated with relaying functionality?

Answer 6

FFS

History

Document history		
April 1999	0.0.1	Report was created with initial heading included from document R2-99287
May 1999	0.0.2	References 3GPP document numbers within the report were updated.
June 1999	0.1.0	Version 0.0.2 approved by WG2 over email.
July 1999	0.1.1	Expansion of sections ODMA, Probing and Route Acquisition, TDD Guard Period Requirements, and Idle Mode Procedures.
August 1999	0.1.2	Note: acceptance of change bars within 0.1.1 as proposed during email adhoc – received approval of TSG RAN WG2#6.
September 1999	0.2.0	Approved changes in 0.1.2

Rapporteur for 3GPP TSG RAN WG2 25.924 is:

Alan Law
Communications Security and Advanced Development
Vodafone Ltd
The Courtyard
2-4 London Road
Newbury
Berkshire
RG14 1JX
United Kingdom

Tel.: +44 (0)1635 676470
Fax: +44 (0)1635 234895

e-mail: alan.law@vf.vodafone.co.uk

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