TSG-RAN Meeting #7
Madrid, Spain
13-15 March 2000

TSGR#7(00)0083

Agenda Item: 8.4

Source: Allgon AB, Mikom GmbH

Title: Proposed work item "UTRA Repeater Specification"

Document For: Approval

This document contains the description of the work item "UTRA repeater specification".

A feasibility study of repeaters in UTRA have been performed and presented at RAN WG4 #10 meeting as document R4-000012. This document was endorsed by RAN WG4 in San Jose, US.

1 3GPP work area

Radio Access

2 Linked work items

None

3 Justification

Repeaters have proven to be useful for extending the coverage into buildings, train/car tunnels, subways, highways, etc in 2nd generation systems. Also, by installing repeaters at the sector borders or in highly dense areas, the transmitted power from the MS and the BS could possibly be lowered, leading to an improvement in C/I and thereby capacity.

For the installation of repeaters in cellular networks a specification is needed in e.g. Europe due to regulatory requirements.

For operators without the capability of handover to 2nd generation systems, extending the coverage of UTRA will be of importance especially at the initial rollout stage. For operators with capability of handover to 2nd generation systems, user requirements (e.g. high data rates) may not be met by those systems and extended UTRA coverage might be needed.

4 Objective

The objective of the work item is to create a technical specification of the UTRA repeater's minimum RF characteristics which, at least, should include:

- Spurious emissions
- Intermodulation products
- Out of band gain

- Frequency stability
- Modulation accuracy
- Blocking characteristics

In addition to the minimum RF characteristics, conformance requirements and Electro Magnetic Compatibility (EMC) shall also be specified.

5 Service Aspects

The use of repeater in a network may reduce the performance of the LCS method OTDOA. This is addressed in more detail in document R4-000012.

6 MMI-Aspects

None

7 Charging Aspects

None

8 Security Aspects

None

9 Impacts

Affects:	USIM	ME	Access Network	Core Network	Others
Yes			**X**		
No	**X**	**X**		**X**	
Don't know					

10 Expected Output and Time scales

New specifications						
Spec No.	Title	Prime rsp. WG	2ndary rsp. WG(s)	Presented for information at plenary#	Approved at plenary#	Comments
TS 25.xxx	UTRA Repeater; Radio transmission and reception	WG4		RAN#8	RAN#10	Repeater minimum RF characteristics
TS 25.yyy	UTRA Repeater; Conformance testing	WG4		RAN#8	RAN#10	Repeater conformance testing

Affected existing specifications				
Spec No.	CR	Subject	Approved at plenary#	Comments
TS 25.113		UTRA Repeater EMC	RAN#10	Repeater EMC requirements

Note: This current separation of radio requirements and conformance testing into two separate specifications is in order to be inline with the 3GPP specification structure. In order to minimise the amount of new technical specifications these two specifications could also be merged into one based on opinion of the RAN delegates.

11 Work item rapporteurs

Martin Nilsson, Allgon AB
Thomas Kummetz, Mikom GmbH

12 Work item leadership

3GPP TSG RAN WG4 (Radio)

13 Supporting companies

- Allgon AB
- BMWi
- Mikom GmbH
- Telenor AS

14 Classification of the WI (if known)

Stand-alone work item.

TSG-RAN Working Group 4 (Radio) Meeting #10 ***TSGR4#10(00)012***
San Jose, CA, US
18-21 January 2000

Agenda Item:

Source: Allgon

Title: Repeater Feasibility Study

Document For: Information & Discussion

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1 Introduction

At RAN plenary #5, it was decided to start a feasibility study within RAN WG4 to see if a repeater specification could be added as a RAN Work Item for Release 2000. In this document the function of repeaters in WCDMA networks is addressed by studying repeater specific parameters and co-existence with other services.

2 General

A repeater simultaneously receives, amplifies and transmits both the radiated RF carrier in the downlink direction, and in the uplink direction, without detecting the baseband information.

Repeaters can be divided into several different classes, depending on e.g., if the repeater functions over a whole band or selected channels.

Channel selective repeaters are commonly implemented by filtering the signal at IF-frequencies. This technique enables an efficient implementation of channel selective filters, without having to detect the signal at baseband.

Currently repeaters exist for, and operate in, several 2nd generation FDD based TDMA and CDMA networks (e.g. GSM and IS-95).

3 TDD mode

It is unknown, to the authors of this document, on how to construct a repeater for the UTRA TDD mode using current repeater technology.

This is due to that the repeater only converts the signal down to IF-frequencies. In the case of asynchronous slot transmission, between the up- and downlink, the information on when to amplify a certain direction is in the baseband information, and without detection, it is impossible to obtain this information.

For the case of UTRA TDD mode repeater it seems be necessary to obtain the signal information, and difference in technology compared to the UTRA FDD repeater seems to be to such an extent that a separate feasibility study should be conducted.

4 Repeater Characteristics

The technical specification of the repeater's minimum RF characteristics for GSM is included as Annex E in GSM 05.05 [1]. This includes specifications over spurious emissions, intermodulation products, out of band gain, frequency error and modulation accuracy. It is believed that all of these characteristics are important for UTRA networks as well. Furthermore, in addition to these characteristics it is suggested that the technical specification for repeaters in UTRA also should include requirements on blocking characteristics. I.e. the repeater's ability to receive, amplify and transmit a wanted signal in the presence of interference from other frequencies (a requirement similar to that of the UTRA FDD BS [2]).

It is hence suggested that a technical specification of the UTRA repeater's minimum RF characteristics, at least, should include:

- Spurious emissions
- Intermodulation products
- Out of band gain
- Frequency stability
- Modulation accuracy
- Blocking characteristics

RF test methods and conformance requirements should also be specified.

5 Time delays and Multipaths

Using common narrowband filter technologies (SAW) the IF-filtering process introduces a time delay of about 5 μs to the signal. This puts a requirement on the length of the receiver's search window. It is, however, believed that the channel models now specified in TS 25.104 [2] are sufficient for guaranteeing the receiver's performance in an area covered by both a repeater and a BS.

Fig. 1, illustrates a case where the UE receives multipath signals, both from the repeater and from the BS. Here, the repeater will introduce artificial multipaths. This could possibly reduce the effects from fading, but also increase the number of paths that are needed to capture a certain percentage of the energy is increased and it is therefore important to have a sufficient amount of RAKE fingers in the receiver.

However, traditionally the repeater is deployed to cover a smaller area compared to the BS and the number of resolvable multipaths could therefore be believed to lower compare to that of macrocellular deployment.

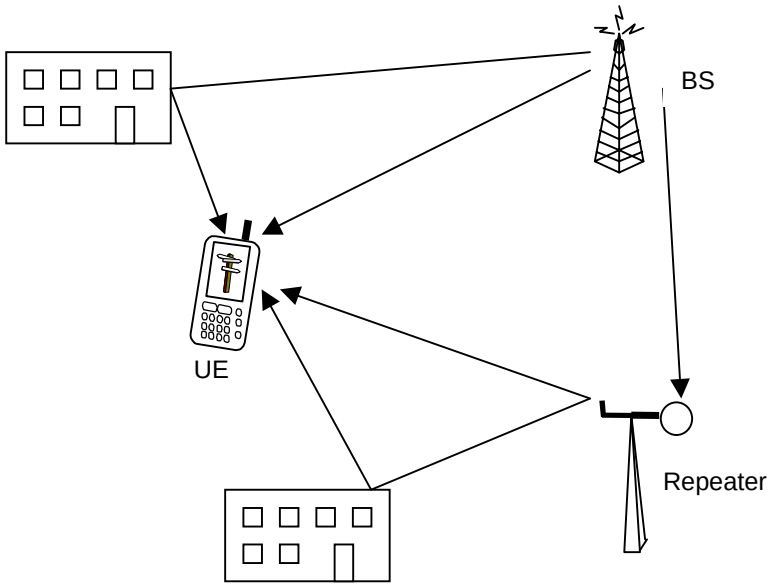

Fig. 1 Illustration of the excess multipaths that are introduced by the repeater in a scenario where the UE is receiving the signal, both from the BS and via the repeater.

6 Location Services (LCS)

The co-existence between repeaters and location services (LCS) is an area, which recently has received attention in ETSI SMG2, see e.g. [3]. For 3GPP release 99, 3 methods for location services are specified [4]. These are OTDOA-IPDL, Cell coverage based positioning and Network assisted GPS.

6.1 OTDOA-IPDL

The OTDOA-IPDL method is based on measurements of the UTRA pilot signal (CPICH) made by the UE and the Location Measurement Unit (LMU). The position of the UE is estimated by using the observed time difference of arrival (OTDOA) from three, or more, base stations.

Fig. 2 is an illustration of a network using repeaters. In this case the signal path from BS4 to the UE can be either the direct path, with a time delay of τ_4, or the path through the repeater, with a time delay of $\tau_{RB}+\tau_d+\tau_R$, where τ_d is introduced by the repeater. This extra time delay introduces an ambiguity when performing the location estimation.

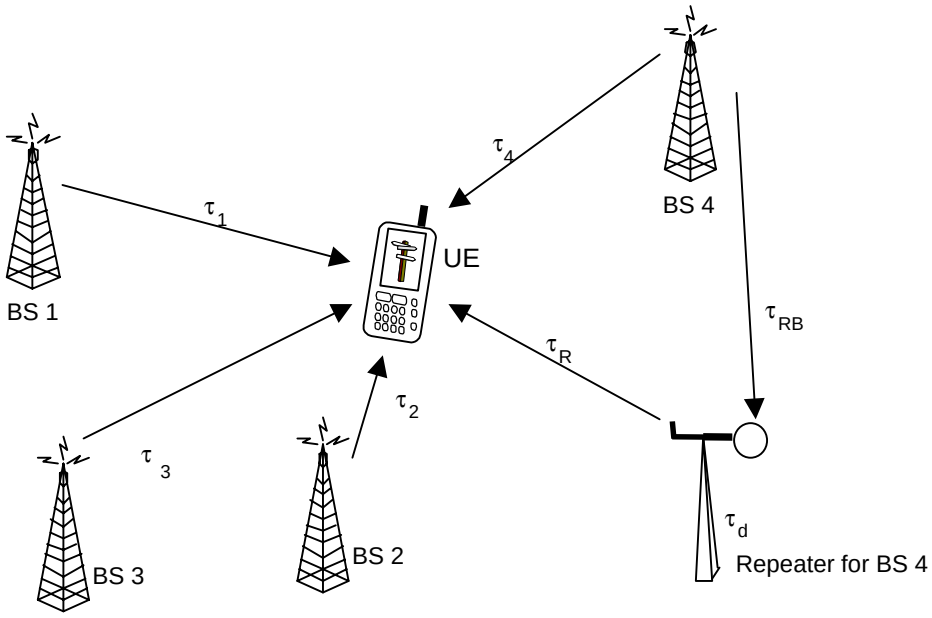

Fig. 2 Illustration of the effect of a repeater installation in a network using OTDOA based LCS.

To avoid this ambiguity different mechanisms can be implemented:

1. For small cells one can exclude one of the signals if it has to long path delay (i.e. passed through a repeater). Hence, for cells smaller than 1500 m (corresponding to 5 μs) it is detectable, whether or not, a repeater has transmitted the signal.
2. If the UE detects more than three sites, as the case is in Fig. 2, the measurement of the time delay from BS 3 can be excluded, based on a too large relative difference to the time delays from BS 1-3. As shown in [5] the probability of detecting three sites is much lower compare to that of detecting four or five sites. This result holds true for both the urban and the suburban environment, when the UE uses 16 ideal periods.

6.2 Cell coverage based positioning method

The only impact is that the cells become larger using repeaters and that this method thereby has less accuracy compared to a smaller cell. Other than that the repeater does not affect this LCS method.

6.3 Network assisted GPS methods

The UTRA network can assist the UE GPS receiver in several ways. E.g. by providing a frequency reference, since UTRAN has a better frequency stability compared to GPS (0.05 ppm frequency error compared to 20 ppm). UTRAN can also provide the UE with a timing reference to reduce the UE GPS search time and improve the accuracy.

If a repeater is deployed in the network this will lead to about 5 μs extra delay. This extra delay is not of the extent that it will affect the performance of GPS assisted method. It is however important that the frequency stability of UTRAN is maintained in the repeater.

7 Open Items

- Should the repeater specification be included into existing specifications or should new specifications be created?

If this initial feasibility study answers the WG4 delegates questions and concerns regarding repeaters in UTRA networks, the suggestion is to submit a work item description form to RAN#7 in Madrid in order to make the repeater specification an official RAN work item for release 2000.

- Are the clauses "Work item rapporteurs" and "Work item leadership" in the work item description form referring to working groups (e.g. RAN WG4) or individual members?

8 References

[1] ETSI SMG, GSM 05.05 v7.0.0, *Radio transmission and reception*

[2] 3GPP TSG RAN, TS 25.104 v3.0.0, *UTRA (BS) FDD, Radio Transmission and reception*

[3] ETSI SMG2, Tdoc 00/106

[4] 3GPP TSG RAN, TS 25.305 v3.0.0, *Stage 2 Functional Specification of Location Services in UTRAN*

[5] 3GPP TSG RAN WG1, Tdoc 99/346