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Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

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 the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater 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 in the document.

1 Scope

The present document is intended to capture the output of the study item on improvements of distributed antenna for 1.28Mcps TDD, which was approved at TSG RAN#47. The objective of this study item is to study the potential enhancement techniques for the distributed antenna.

2 References

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

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TR 25.225: “Physical layer Measurements (TDD) ".

[3] 3GPP TS 25.433: "UTRAN Iub interface NBAP signalling".

[4] 3GPP TS 25.331: "RRC Protocol Specification".

3 Definitions, symbols and abbreviations

3.1 Definitions

(Void)

3.2 Symbols

(Void)

3.3 Abbreviations

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

AOA Angle of Arrival
FACH Forward Access Channel
ISCP Interference Signal Code Power
RSCP Received Signal Code Power
RTWP Received total wide band power
SIR Signal-to-Interference Ratio
TDD Time Division Duplex
UE User Equipment

4 Deployment scenarios for distributed antenna

4.1 In-door coverage scenario

Distributed antenna can be deployed in the in-door scenario to overcome the penetration and shadowing losses.

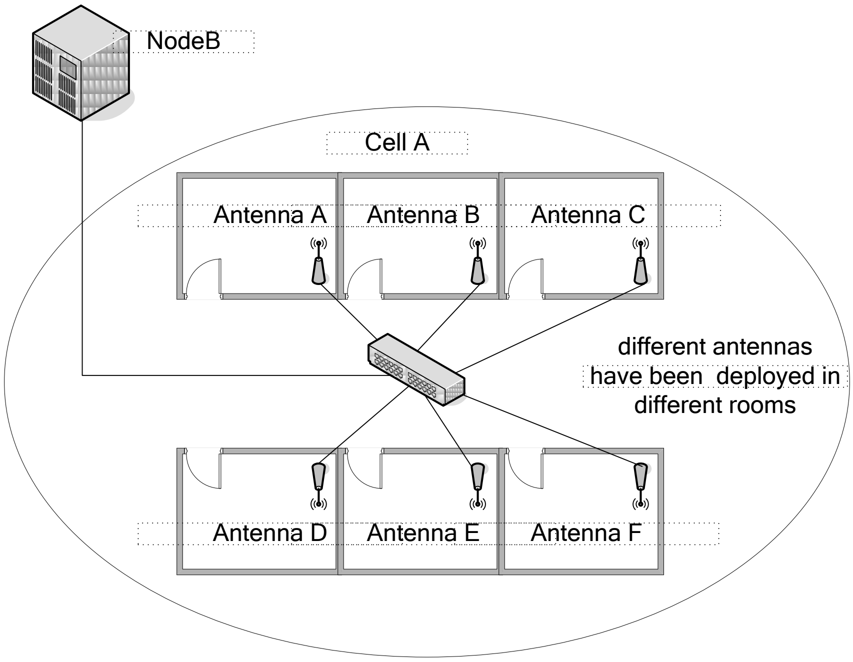

Figure 1: In-door Coverage

In this scenario, each antenna will be used to coverage a different area (maybe different rooms or different floors of the building), and the different areas can provide a natural spatial isolation, which may give some possibility to reuse the physical resource among different areas.

4.2 High-speed coverage scenario

High-Speed Coverage is another typical scenario for the distributed antenna. In this scenario, the distributed antenna will be used to provide the coverage for the high-speed railway. Nowadays , the speed of the high-speed railway can reach up to 400km/h， which is about 111m/s. In this case, if the distributed antenna is not used, the coverage radius of each cell in the High-Speed scenario may be less than 1500m, considering the overlap area of the coverage, the UE have to handover among different cells less than every 10s. The frequently handover will increase the risk of drop of UE. In order to save the handover times, the distributed antenna can be used in the High-Speed scenario; several antennas can be deployed within one cell to extend the radius of the cell.

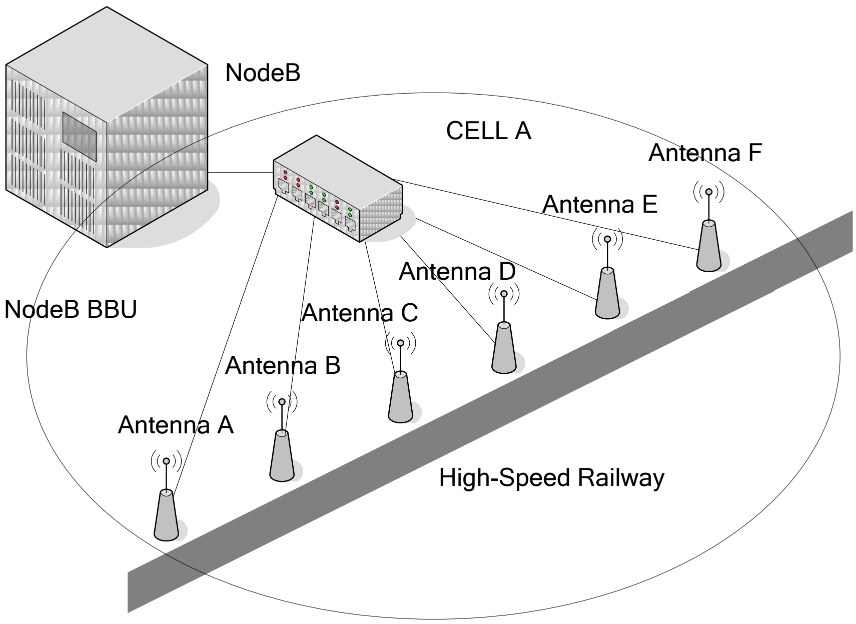

Figure 2: High-Speed Coverage

In this scenario, each antenna will cover a different area, UE can move among these areas without any L3 signalling, which can save the handover times. Also, by knowing the movement of UE among the antennas, some optimisation to handover algorithm (e.g. unidirectional handover, pre-handover prepare) can be taken by RNC to accelerate the handover process and increase the successful rate of handover procedure.

4.3 Blind spot coverage scenario

In 1.28Mcps TDD network, smart antenna is widely used in the macro cell, and some of them will be placed on the roof of building or on the top of tower (e.g. antenna A in the figure 3). In this case, the area right down of the smart antenna, which can be treated as a blind spot, is hard to be covered by the smart antenna itself. In order to improve the coverage of the blind spot, a potential solution is to deploy distributed single antenna (antenna B) right down of the smart antenna to cover the blind spot.

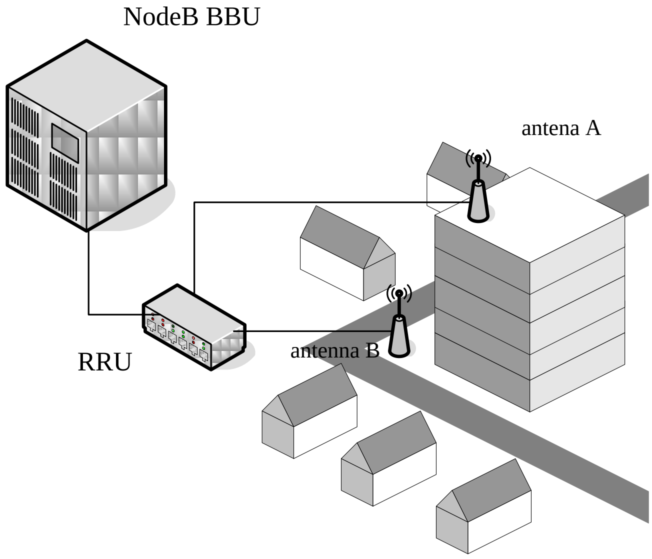

Figure 3: Blind spot coverage

In this scenario, the distributed antenna within the cell may consist of two types of antennas: the smart antenna and the single antenna. Using the single antenna as compensation to the smart antenna can improve the blind spot coverage and reduce the complexity of the network optimisation.

5 Physical layer measurements in distributed antenna

5.1 Measure and Report mechanism

<u>Issue 1: How to describe the area covered by different distributed antenna?</u>

According to the definition of distributed antenna, different antenna may be used to cover different area, and these different areas may have different measurement result, so some mechanism shall be introduced to measure and report the measurement result from each area. In Rel-9, as an enhancement of beam-forming, the cell portion has been introduced, and according to the definition of cell portion in [2], the cell portion means a geographical part of a cell for which a Node B measurement can be reported to the RNC. A cell portion is semi-static and identical for both the UL and the DL. Within a cell, a cell portion is uniquely identified by a cell portion ID. Similar as beam-forming, the area covered by the distributed antenna can also be treated as a geographical part of a cell, so we one potential solution is:

<u>Solution:</u>

Reuse the definition of cell portion in the physical layer measurement to describe a specific area which is covered by a distributed antenna. Each cell portion consists of one antenna port including one or more antenna(s).

5.2 Definition of Physical layer measurements

Issue 2: How to define the measurement reference point in the distributed antenna system?

According to the definitions of measurement RSCP/Timeslot ISCP in [2], the reference point for RSCP/ Timeslot ISCP is the Rx antenna connector. But when the distributed antennas are deployed, one or more distributed antennas will be deployed within the cell to cover a specific area; in this case, the reference point can be the Rx antenna connector of each distributed antenna or the Rx connector of all the distributed antennas. According to the typical scenarios for distributed antenna given above, the coverage of each distributed area may be different (especially in the In-door Coverage scenario), knowing the RSCP of each distributed antenna will be helpful for the RNC to make the decision about the access control and load balance. So, one potential definition for the reference point is:

Solution:

For the RSCP/ Timeslot ISCP, in case the distributed antennas are deployed within the cell , if the cell portion is configured, the reference point shall be the Rx antenna connector of each distributed antenna port, otherwise, the reference point shall be the Rx antenna connector of all the distributed antennas.

Issue 3: How to define the Rx/Tx diversity in the distributed antenna system?

According to the definition of Timeslot ISCP and RTWP in [2], in case of Rx antenna diversity, the average of the linear values [W] of the ISCP and RTWP values measured for each antenna branch shall be reported. But if the distributed antennas are deployed, the definition of Rx/Tx diversity is not clear. Whether the multiple distributed antennas can be treated as Rx/Tx antenna diversity or the Rx/Tx antenna diversity only means the Rx antenna diversity within one distributed antenna need to be clarified. Considering the coverage of each distributed area may be different (especially in the In-door Coverage scenario), knowing the measurement result of each distributed antenna will be helpful for the RNC to make the decision about the access control and load balance. So, one potential definition for Rx/Tx antenna diversity is:

Solution:

In case the distributed antennas are deployed within the cell, if the cell portion is configured, the Rx/Tx antenna diversity only means the Rx/Tx antenna diversity within one cell portion; otherwise, the Rx/Tx antenna diversity means the Rx/Tx antenna diversity within the whole CELL.

Issue 4: How to define the SIR in the distributed antenna system?

The definition of SIR can be found as follows:

*** Definition**	* Signal to Interference Ratio, defined as: (RSCP/Interference) xSF. * Where: * RSCP = Received Signal Code Power, the received power on the code of a specified DPCH, PRACH, PUSCH, HS-SICH or E-PUCH. * Interference = The interference on the received signal in the same timeslot which can't be eliminated by the receiver. * SF = The used spreading factor. * * The reference point for the SIR shall be the Rx antenna connector.

According to the definition of the SIR, the SIR can be calculated by the RSCP and Interference. In the in-door coverage scenario, the RSCP may be different in each cell portion (different cell portion is covered by different distributed antenna), and the interference from one cell portion is isolated with the interference from the others. In this case, the RSCP and interference in the formula of SIR can be the RSCP and interference value from a specific cell portion (i.e. best cell portion). But in the blind-spot coverage scenario and high-speed scenario, the signal from multiple cell portion s can be combined by NodeB (e.g. join-detection), and in this case, the RSCP will be the linear sum of all the cell portion s and the interference will a value calculated based on the interference values measured from all the cell portion s (e.g. the join-detection may be used to eliminated the interference). Considering different scenario may have different requirement on the SIR definition, two different potential definitions for SIR are:

Solution 1:

When cell portions are configured in the cell, the SIR will be calculated according to the RSCP and interference from a specific cell portion (i.e. best cell portion).

Solution 2:

When cell portions are configured in the cell, the SIR will be calculated according to the RSCP and interference from all the cell portions.

Issue 5: How to define the AOA measurement in the distributed antenna system?

AOA defines the estimated angle of a user with respect to a reference direction and is determined at the BS antenna for an UL channel corresponding to this UE. In distributed antenna scenario, the AOA measurements value may be different in each portion. In some scenario (e.g. the blind-spot coverage scenario), the AOA measurement can be used for some location related function (e.g. use the AOA + Cell id to locate the UE). So, one potential solution for AOA is:

Solution:

When cell portions are configured in the cell, the AOA can be measured for a specific cell portion or for each cell portion.

Issue 6: How to define the Timing related measurement in the distributed antenna system?

The timing related measurement includes RX timing Deviation , SFN-SFN observed time difference, Cell Sync Burst Timing, Received SYNC-UL Timing Deviation for 1.28Mcps TDD. The definitions in 25.225 are listed below:

RX timing Deviation

Definition	'RX Timing Deviation' is the time difference $T_{RXdev} = T_{TS} – T_{RXpath}$ in chips, with T_{RXpath}: time of the reception in the Node B of the first detected uplink path (in time) to be used in the detection process. The reference point for T_{RXpath} shall be the Rx antenna connector. For 1.28 Mcps TDD only the first UL timeslot in the first subframe used by the UE is used for the calculation of T_{RXpath}. T_{TS}: time of the beginning of the respective slot according to the Node B internal timing

SFN-SFN observed time difference

Definition	SFN-SFN observed time difference = $T_{Rx\_Frame\_cell\ k}$ - $T_{Rx\_Frame\_cell\ i}$, in chips, where $T_{Rx\_Frame\_cell\ i}$: time of start (defined by the first detected path in time) of the frame boundary from the TDD cell i. $T_{Rx\_Frame\_cell\ k}$: time of start (defined by the first detected path in time) of the frame boundary from the cell k that is closest in time to the frame boundary of the TDD cell i.

Cell Sync Burst Timing

Definition	Cell sync burst timing is the time of start (defined by the first detected path in time) of the cell sync burst of a neighbouring cell. This measurement is applicable for 3.84Mcps TDD and 1.28Mcps TDD. For 1.28 Mcps TDD the DwPCH represents the cell sync burst. Type 1 is used for the initial phase of Node B synchronization. Type 2 is used for the steady-state phase of Node B synchronization. Both have different range. The reference point for the cell sync burst timing measurement shall be the Rx antenna connector. **Type 1:** Cell sync burst timing = T_{Rx} - T_{slot} in chips, where T_{slot}: time of start of the cell sync timeslot in the frame, where the cell sync burst was received. T_{RX} : time of start (defined by the first detected path in time) of a cell sync burst received from the target UTRA cell.

	Type 2: Cell sync burst timing = T_{Rx} - T_{slot}, in chips, where T_{slot} : time of start of the cell sync timeslot in the frame, where the cell sync burst was received. T_{RX} : time of start (defined by the first detected path in time) of a cell sync burst received from the target UTRA cell.

According to the definition of the physical layer measurements, the measurement value of the following measurements will be related to the location of the reference antenna. According to the definition of distributed antenna, different distributed antennas will be located in different place, which means different cell portion may have different measurement for these measurements. So, one potential solution for these measurements is:

Solution:

When cell portions are configured in the cell, the RX timing Deviation, SFN-SFN observed time difference and Cell Sync Burst Timing can be measured for a specific cell portion.

6 Further enhancement for distributed antenna

6.1 Initial downlink transmission

In the in-door coverage scenario, as shown in figure 4, three areas (area a, b and c) are covered by three different distributed antennas, the physical resource may be reused in these areas. According to the current specifications, the NodeB can not get the cell portion information for the UE in IDLE or legacy CELL_FACH/PCH state (without enhanced cell fach). In this case, if UE send the RRC Connection Request message in area a, the NW side will send the RRC Connection Setup message to UE, but due to the lack of information about the cell portion, the NodeB have to send the RRC Connection Setup message in all cell portions, and this will cause some waste of physical resource (both the power resource and the channel code will be occupied in all cell portions).

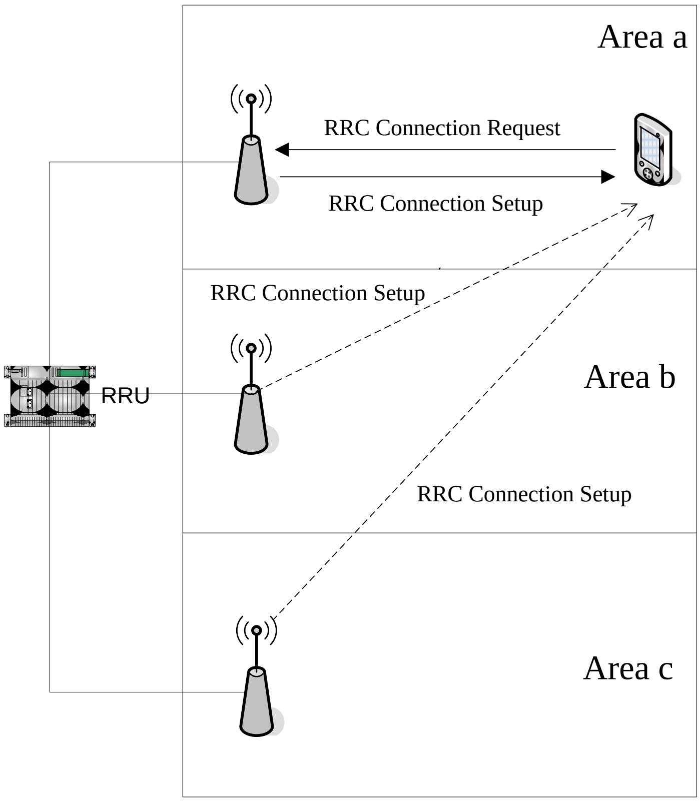

Figure 4. Initial downlink transmission in in-door coverage scenario

According to the analysis above, if NodeB can have the cell portion information for the UE before the initial downlink transmission, the NodeB can send the RRC Connection Setup message in the specific area (e.g. area a in the figure 4). In order to save the power and channel code resource of the other cell portion, one potential solution is:

<u>*Solution:*</u>

The cell portion information can be introduced in the FACH FP frame in the Iub interface. When cell portions are configured in the cell, the cell portion information can be send from RNC to NodeB by FACH FP frame.

6.2 RTWP control

In HSUPA, a target RTWP will be configured to NodeB and in the scheduling of E-PUCH transmission, NodeB will take this value into account in the resource allocation, and try to keep the current RTWP value lower than the target RTWP. In the cell portion WI in Rel-9, the cell portion has been introduced in the RTWP measurement. When cell portions are defined in the cell, the received total wide band power for each cell portion can be measured and reported to higher layers. In the distributed antenna scenarios, the RTWP can be measured and report per area. In this case, how to understand the target RTWP is not clear. An example of in-door coverage is given as follows in figure 5:

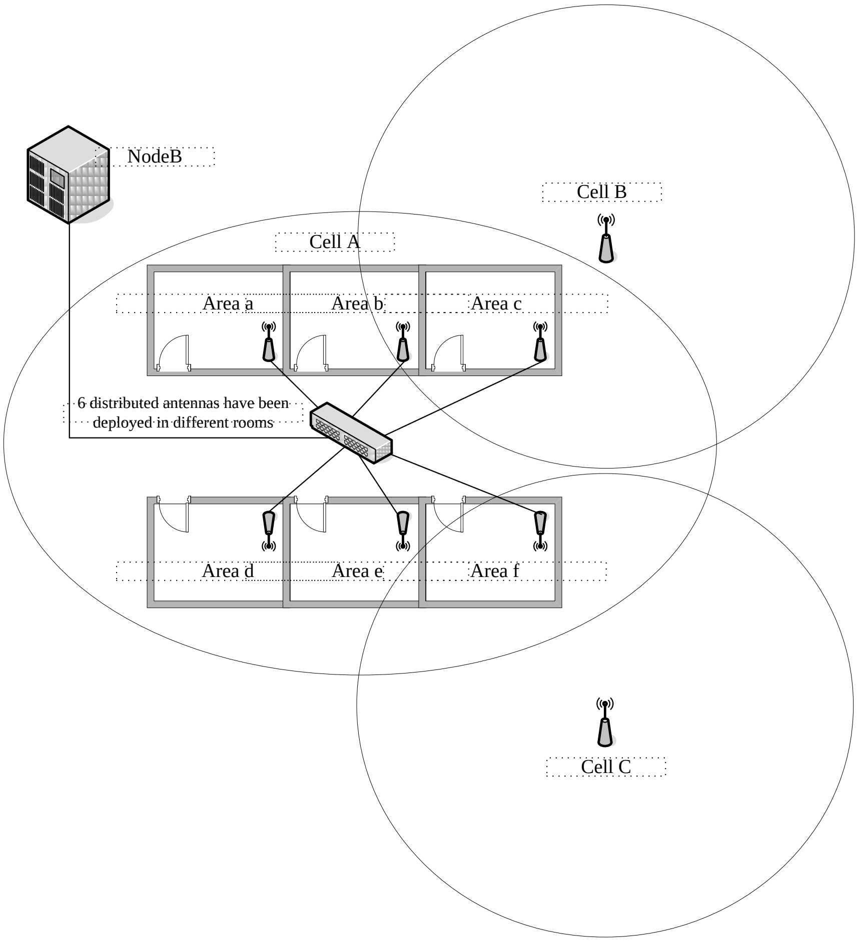

Figure 5. The in-door coverage of distributed antennas

In the example above, 6 distributed antennas are deployed in the CELL A to cover 6 different areas (a, b, c, d, e, and f). The CELL B and CELL C are macro cells, the CELL B has some overlap area with the area c within CELL A, and the CELL C has some overlap area with the area f within CELL A. According to the definition of RTWP, the RTWP measurement value in different areas within CELL A may be different, and in the example, the area a and d have no overlap areas with other cells, so it may be not necessary to limit the RTWP within this area; but for the area c and f, these areas have some overlap areas with the neighbour cells. In order to control the interference to the neighbour, the RTWP target in area c and f may be lower than the RTWP target in areas a and d, but in the current specification , only one RTWP target can be configured for one cell. In order to control the RTWP for each cell portion, one potential solution is:

Solution:

When cell portions are defined in the cell, the RTWP can be controlled in each cell portion separately and different Target RTWP can be configured to each cell portion.

6.3 Antenna Gain report

In UMTS, RNC should be responsible for the calculation and configuration of uplink and downlink initial power. The Initial DL Transmission Power will be configured to NodeB through NBAP specification [3] and the UL Desired Received Power will be configured to UE though RRC specification [4]. In case the distributed antenna is not configured, the antenna gain is a constant value. However, in the distributed antenna system, each cell portion may consist of one or more antennas, and the antenna type of distributed antenna within different cell portion may be different. For example, in Blind spot coverage scenario, smart antenna and distributed single antenna may be used in different cell portions, considering the gain of beam-forming, the antenna gain of smart antenna will be much higher than the single antenna. In order to consider the antenna gain in the uplink and downlink initial power calculation, one potential solution is:

Solution:

When Cell Portions are configured in the cell, the antenna gain of distributed antenna for each CELL PORTION can be informed to RNC.

Annex A (informative): Change History

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
30/11/10	-	-	-	-	Creation of TR	-	1.0.0
02/12/10	-	-	-	-	Correction of wording in section 5.1	1.0.0	1.0.1
07/12/10	RAN_50	RP-101286	-	-	Creation of Rel-10 further to approval by RAN_50	1.0.1	10.0.0