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Technical Report

3rd Generation Partnership Project;
Technical Specification Group Radio Access Network;
Evolved Universal Terrestrial Radio Access (E-UTRA);
Further enhancements to LTE Time Division Duplex (TDD) for Downlink-Uplink (DL-UL) interference management and traffic adaptation
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Contents

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

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x the first digit:

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

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Introduction

TDD offers flexible deployments without requiring a pair of spectrum resources. For TDD deployments in general, interference between UL and DL including both basestation-to-basestation and UE-to-UE interference needs to be considered. One example includes layered heterogeneous network deployments, where it may be of interest to consider different uplink-downlink configurations in different cells. Also of interest are deployments involving different carriers deployed by different operators in the same band and employing either the same or different uplink-downlink configurations, where possible interference may include adjacent channel interference as well as co-channel interference such as remote basestation-to-basestation interference.

Currently, LTE TDD allows for asymmetric UL-DL allocations by providing seven different semi-statically configured uplink-downlink configurations. These allocations can provide between 40% and 90% DL subframes. The semi-static allocation may or may not match the instantaneous traffic situation. The current mechanism for adapting UL-DL allocation is based on the system information change procedure. Additional mechanisms could include e.g. dynamic allocation of subframes to UL or DL.

1 Scope

The scope of this study item is given in [2]

2 References

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. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

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

[2] RP-110450, Study Item Description for Further Enhancements to LTE TDD for DL-UL Interference Management and Traffic Adaptation

3 Definitions, symbols and abbreviations

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

Clause numbering depends on applicability and should be renumbered accordingly.

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [x] 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 [x].

Definition format (Normal)

<defined term>: *<definition>.*

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

3.2 Symbols

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

Symbol format (EW)

<symbol> <Explanation>

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [x] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

4 Objectives of study

Objectives of the study item include:

For the isolated cell scenario, i.e. without co-channel interference:

- RAN1 should evaluate the benefits of uplink-downlink re-configuration dependent upon traffic conditions.
  - Identify the proper simulation assumptions, including traffic models.
  - Assess the appropriate time scale for uplink-downlink re-configuration.
  - Assess the benefits at least in terms of performance and energy saving.
- RAN4 should perform coexistence analysis with multiple operator deployments in adjacent channels.

For the multi-cell scenario, i.e. with co-channel interference:

- RAN1 should evaluate the benefits of uplink-downlink re-configuration dependent upon traffic conditions.
  - Identify the proper simulation assumptions, including traffic models.
  - Assess the appropriate time scale for uplink-downlink re-configuration.
  - Assess the benefits at least in terms of performance and energy saving.
- RAN1 and RAN4 should identify the multi-cell scenarios for which TDD DL-UL interference may arise and additional TDD DL-UL interference mitigation would be beneficial.
  - Deployments comprising the same or different uplink-downlink configurations should be investigated.
- RAN4 should perform co-existence analysis for the above identified scenarios, including co-channel and adjacent channel interference, where adjacent channel interference may be from other operator(s).
- For all the studies above, deployment scenarios should include regular homogeneous macro deployments and layered heterogeneous deployments.

For both isolated cell scenario and multi-cell scenario:

- If significant benefits are identified by RAN1 evaluations, RAN1 should identify potential air interface solutions, including necessary EUTRAN/UE measurements, to mitigate DL-UL interference, taking into account the RAN4 co-existence analysis.
- Backward compatibility of Rel-8/9/10 terminals should be maintained.
- Specification impact should be identified and assessed.

5 Feasibility study

5.1 Methodologies

The following two approaches are used for the feasibility study.

- Approach 1: Deterministic calculations mainly for BS-BS interference case
  - Obtain the minimum required site separation distance in certain scenarios when different TDD configurations are applied in neighbouring cells.
  - 0.8dB de-sensitivity criteria is applied for negligible interference level for BS.
- Approach 2: Monte Carlo simulations for both BS-BS and UE-UE interference case

- Obtain the DL/UL geometry and/or throughput to see the performance loss due to different TDD configurations in the network based on the agreed simulation assumptions.

For approach 2, the difference of the DL/UL geometry with and without different TDD configurations and the absolute DL/UL geometry with different TDD configurations are used as criteria to evaluate the feasibility of applying different TDD configurations in different cells. Further studies of the criteria are not precluded. It is noted that the feasibility study in this section assumes full buffer traffic model.

5.2 Scenario 1

This scenario assumes multiple Femto cells deployed on the same carrier frequency. The simulation assumptions are included in Annex A.

5.2.1 Deterministic evaluations

The evaluation results using the deterministic approach are shown in Tables 5.2.1-1, 5.2.1-2, and 5.2.1-3

Table 5.2.1-1: Results of deterministic approach

Minimum separation distance (km)				
Source 1	**Source 2**	**Source 3**	**Source 4**	**Source 5**
0.04	0.07	0.040	0.04	0.057

Note: the reference sensitivity of 10MHz BW is taken as the victim acceptable interference, i.e. -98.5 dBm

Table 5.2.1-2: Results of deterministic approach from Source 6

Minimum separation distance (m)	
HeNB placed in 1st next apartment	2523.48
2nd next apartment	633.87
3rd next apartment	159.22
4th next apartment	39.99
5th next apartment	10.046

Table 5.2.1-3: Results of deterministic approach from Source 7

Minimum separation distance (km)	
Requirement 1	0.040
Requirement 2	0.0046

Note: Requirement 1 means Interference signal mean power is 7 dB lower than noise floor; Requirement 2 means Interference signal mean power is the level in dynamic range requirement.

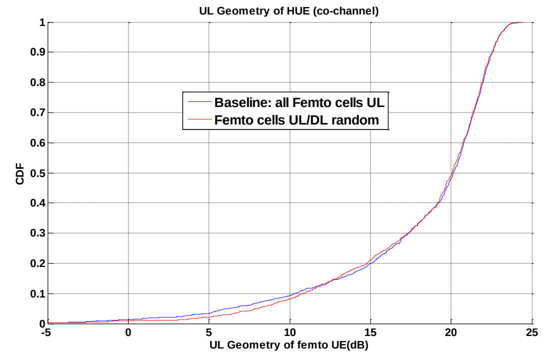
5.2.2 System simulation evaluations

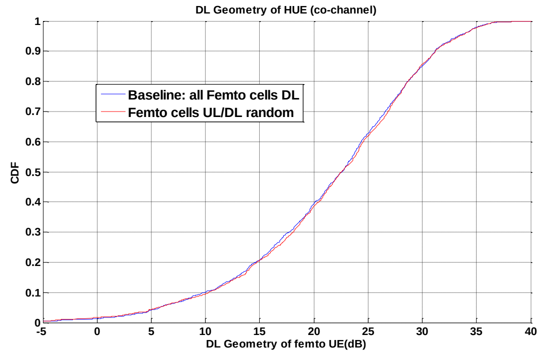
The evaluation results by system simulations for scenario 1 are shown in Figures 5.2.2-1 to 5.2.2-6. The following cases are simulated:

- Case 1: Baseline is the transmission directions of all cells are the same

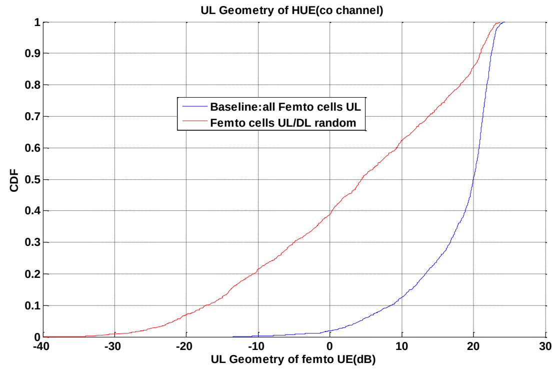
- Case 2: The transmission direction of Femto cells is randomly set as DL and UL with a 50% probability.

Femto-Femto co-channel with DL power control





Femto-Femto co-channel without DL power control



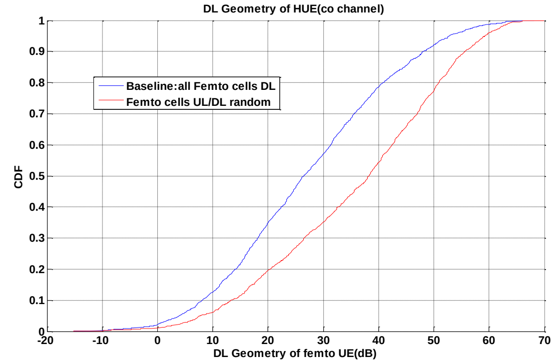
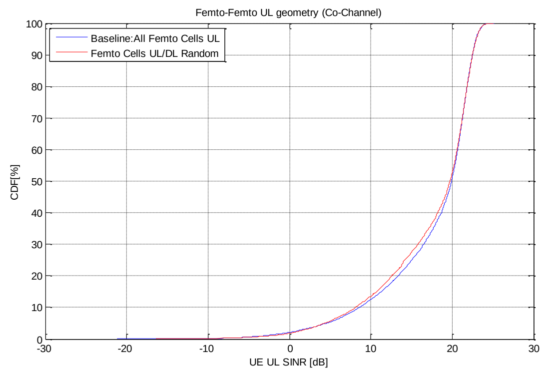
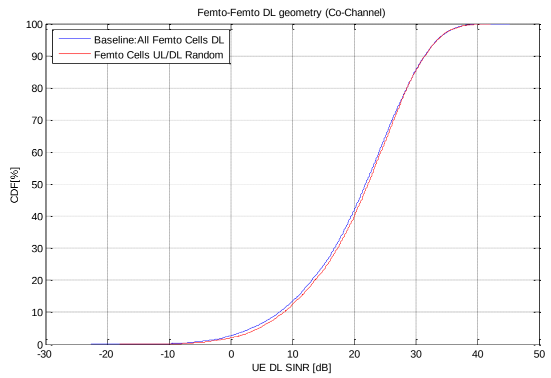


Figure 5.2.2-1: Simulation results from Source 1

Femto-Femto co-channel with DL power control





Femto-Femto co-channel without DL power control

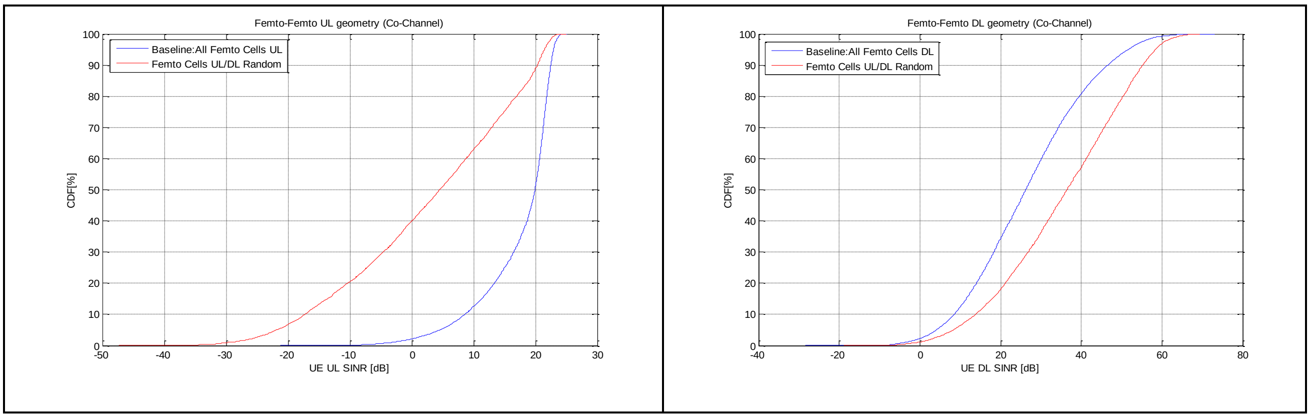


Figure 5.2.2-2: Simulation results from Source 2

Femto-Femto co-channel without DL power control

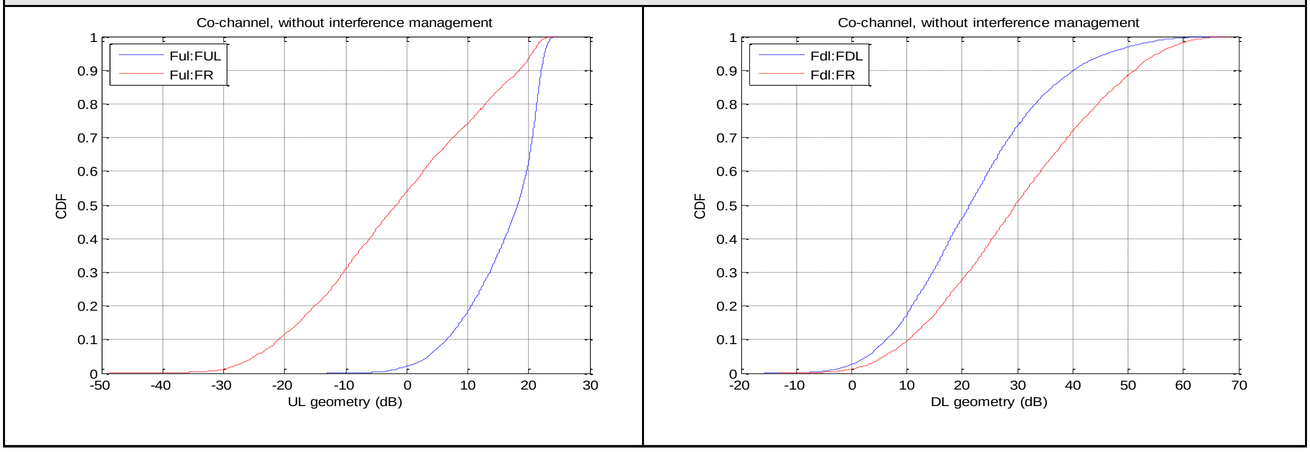


Figure 5.2.2-3: Simulation results from Source 3

Femto-Femto co-channel with and without DL power control

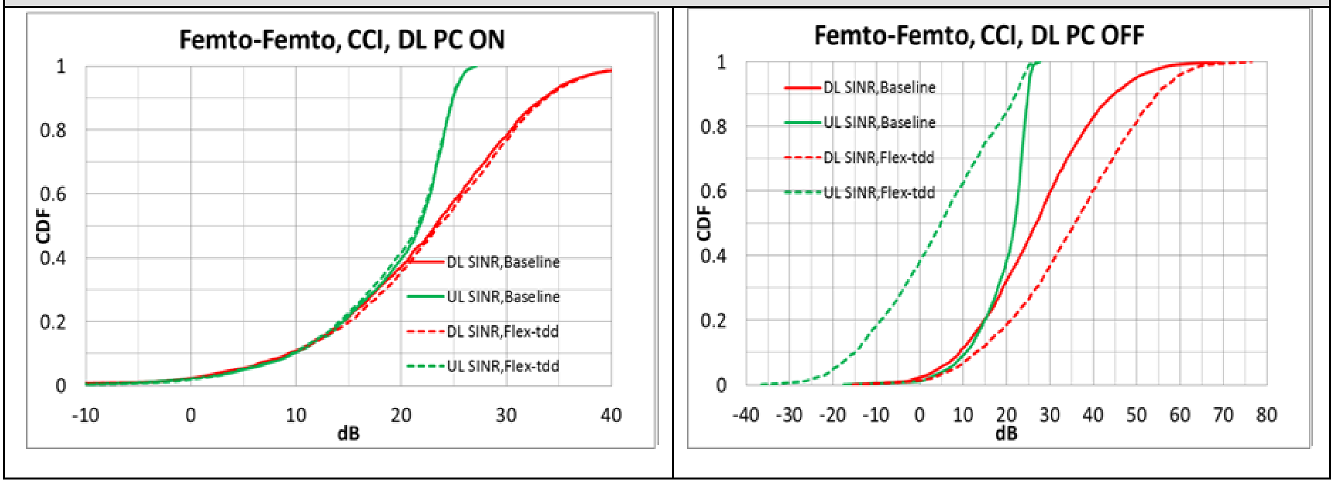
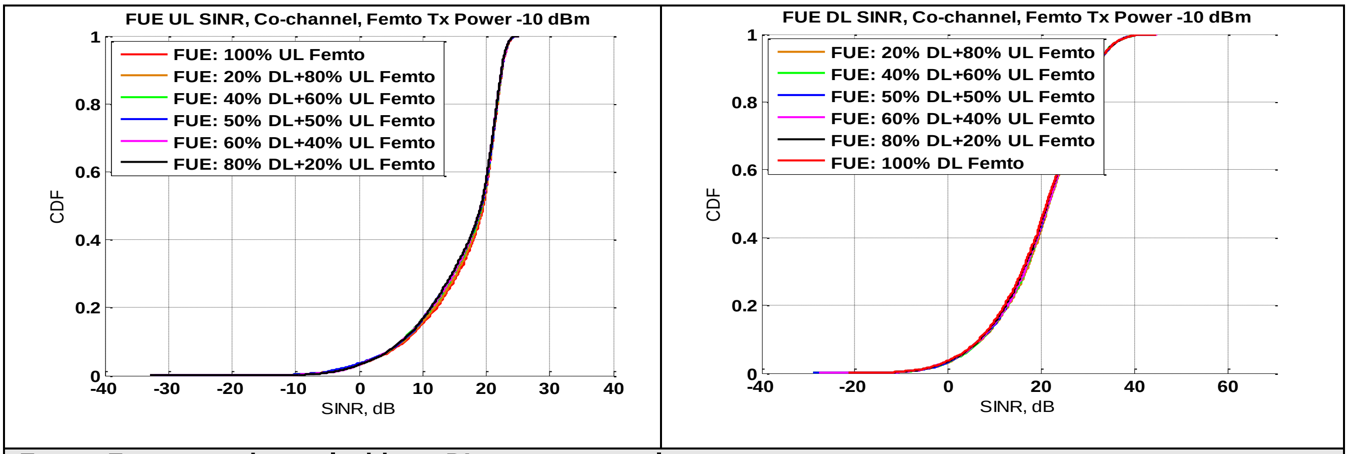


Figure 5.2.2-4: Simulation results from Source 4

Femto-Femto co-channel with DL power control



Femto-Femto co-channel without DL power control

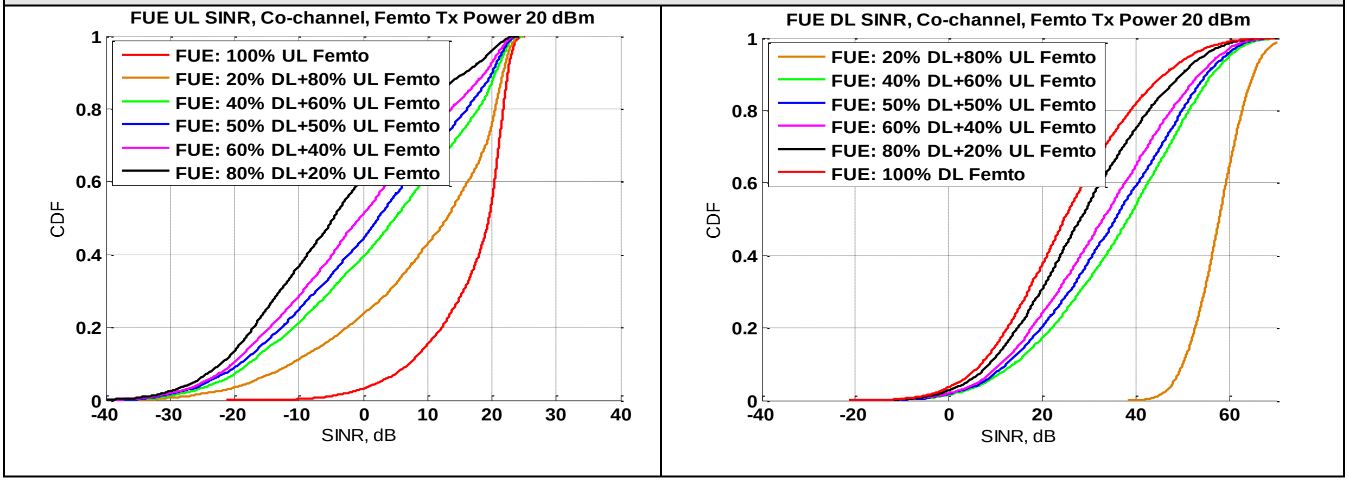
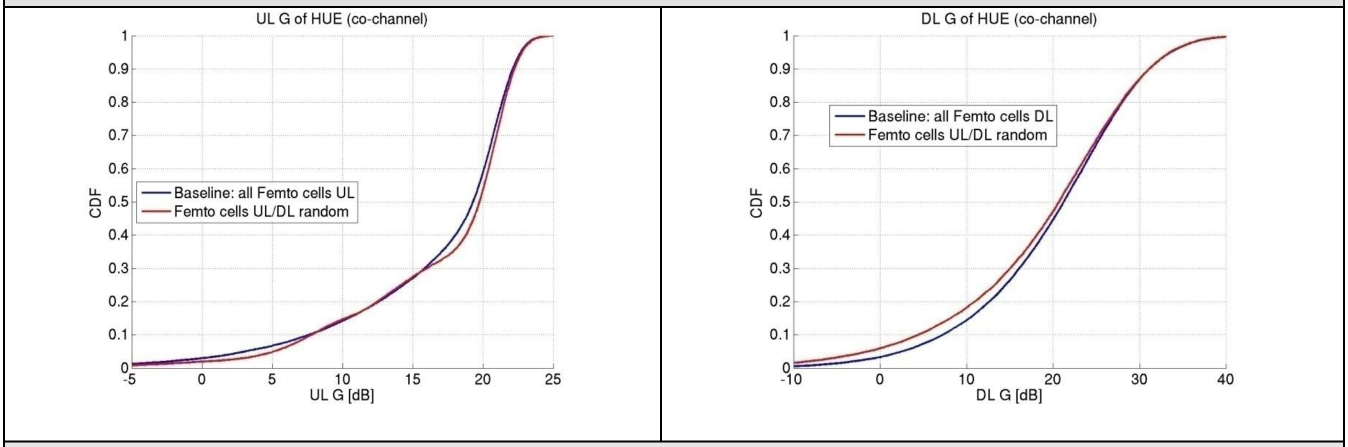


Figure 5.2.2-5: Simulation results from Source 5

Femto-Femto co-channel with DL power control



Femto-Femto co-channel without DL power control

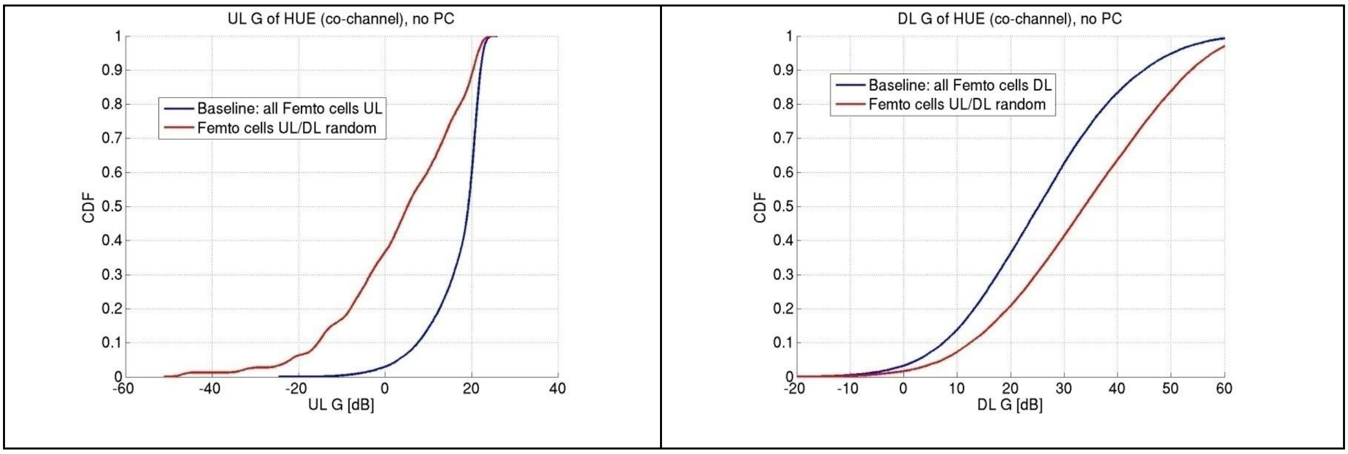


Figure 5.2.2-6: Simulation results from Source 6

5.3 Scenario 2

This scenario assumes multiple Femto cells deployed on the same carrier frequency and multiple Macro cells deployed on an adjacent carrier frequency where all Macro cells have the same UL-DL configuration and Femto cells can adjust UL-DL configuration. The simulation assumptions are included in Annex A.

5.3.1 Deterministic evaluations

The evaluation results using the deterministic approach are shown in Tables 5.3.1-1 to 5.2.1-5.

Table 5.3.1-1: Results of deterministic approach

aggressor -> victim	Aggressor Tx power (dBm)	Victim Acceptable Interference (dBm)	Minimum separation distance(km)	
			Source 1 & 2	Source 3 & 4 & 5
Femto ->Macro	20	-106.5	0.05	0.048
Macro ->Femto	46	-98.5	0.14	0.144

Table 5.3.1-2: Results of deterministic approach from Source 6

	aggressor -> victim	minimum distance R (km)
1st adjacent channel	Macro->Femto	0.49
	Femto->Macro	0.16
2nd adjacent channel	Macro->Femto	0.36
	Femto->Macro	0.12
Spurious domain	Macro->Femto	0.16
	Femto->Macro	0.05

Table 5.3.1-3: Results of deterministic approach from Source 7

aggressor -> victim	Minimum separation distance(km)	
	Requirement 1	**Requirement 2**
Macro-> Femto	0.144	0.003
Femto ->Macro	0.048	0.009

Note: Requirement 1 means Interference signal mean power is 7 dB lower than noise floor; Requirement 2 means Interference signal mean power is the level in dynamic range requirement.

Table 5.3.1-4: Required Additional Isolation, ISD = 500m from Source 8

Deployment Scenarios		BS-BS Isolation (dB)	Notes
Macro-Femto	Co-channel	19.2 dB	Indoor BS with 20dB wall loss
	Adjacent channel	- 25.8 dB	
	Non Adjacent Channel	-31.8 dB	

Table 5.3.1-5: Required Additional Isolation, ISD = 1732m from Source 8

Deployment Scenarios		BS-BS Isolation (dB)	Notes
Macro-Femto	Co-channel	- 1.1 dB	Indoor BS with 20dB wall loss
	Adjacent channel	- 46.1 dB	
	Non Adjacent Channel	- 52.1 dB	

5.3.2 System simulation evaluations

The evaluation results by system simulations for scenario 2 are shown in Figures 5.3.2-1 to 5.3.2-6. The following cases are simulated:

- Case 1: Baseline is the transmission directions of all cells (including Macro and Femto) are the same.
- Case 2: All Macro cells are of the same transmission direction (i.e. either DL or UL) and the transmission direction of Femto cells is randomly set as DL and UL with a 50% probability.

Femto-Macro adjacent channel without DL power control

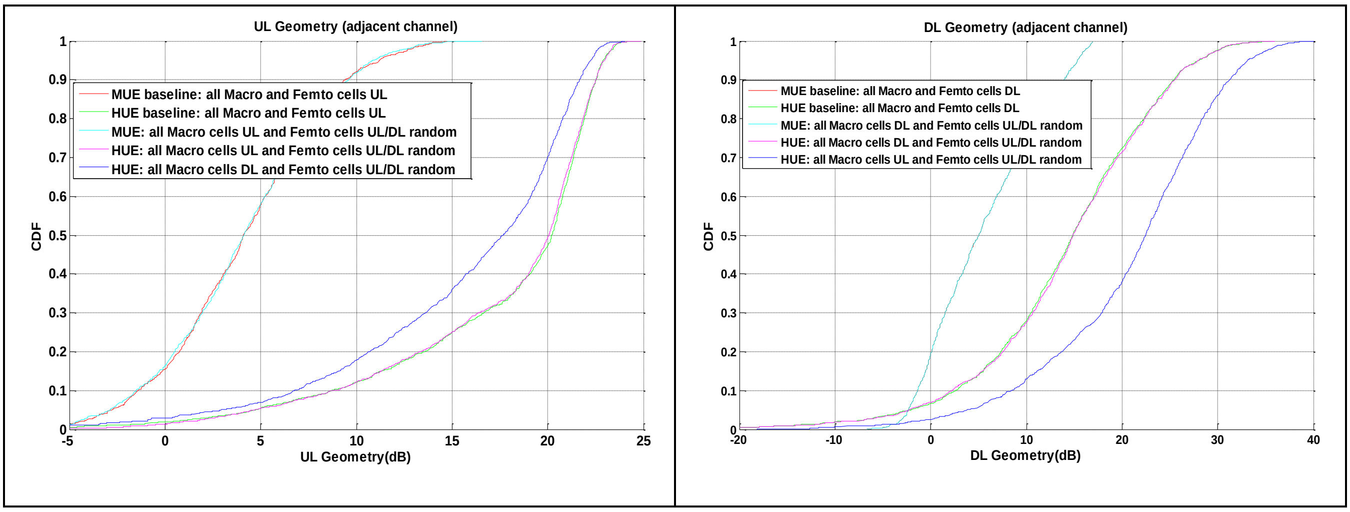
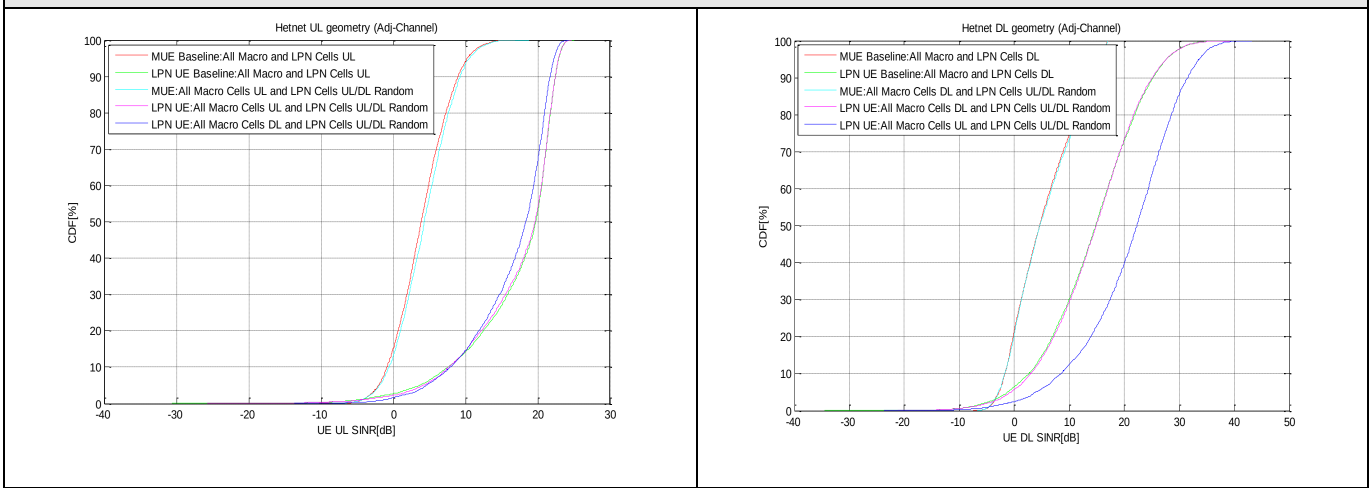


Figure 5.3.2-1: Simulation results from Source 1

Femto-Macro adjacent channel without DL power control



Femto-Macro adjacent channel without DL power control

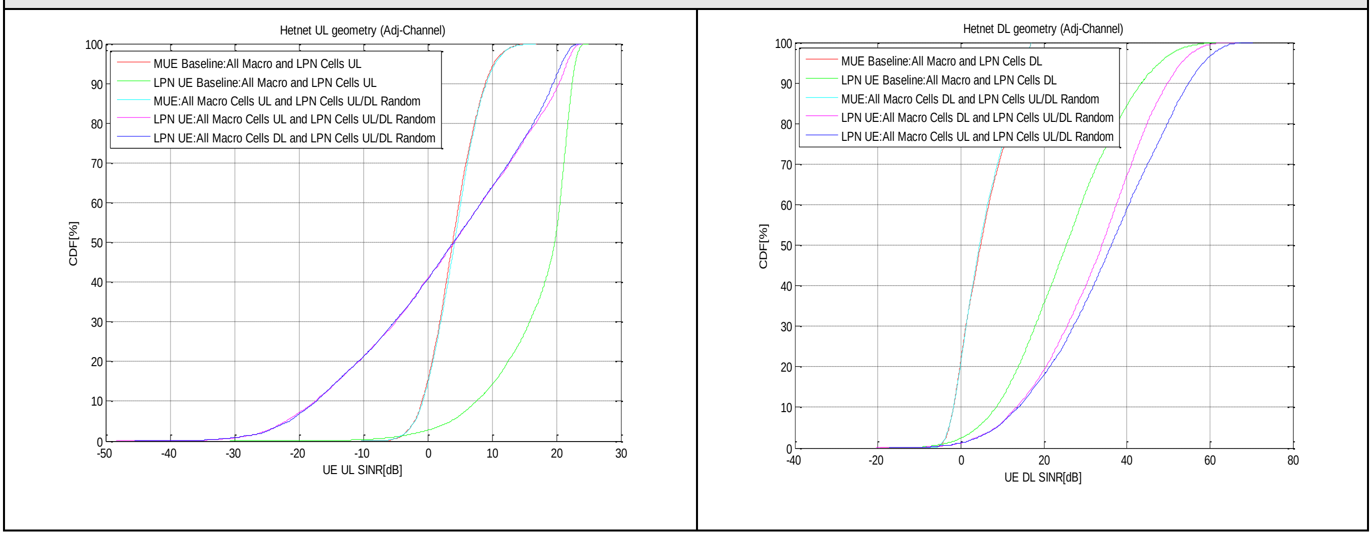


Figure 5.3.2-2: Simulation results from Source 2

Femto-Macro adjacent channel without DL power control

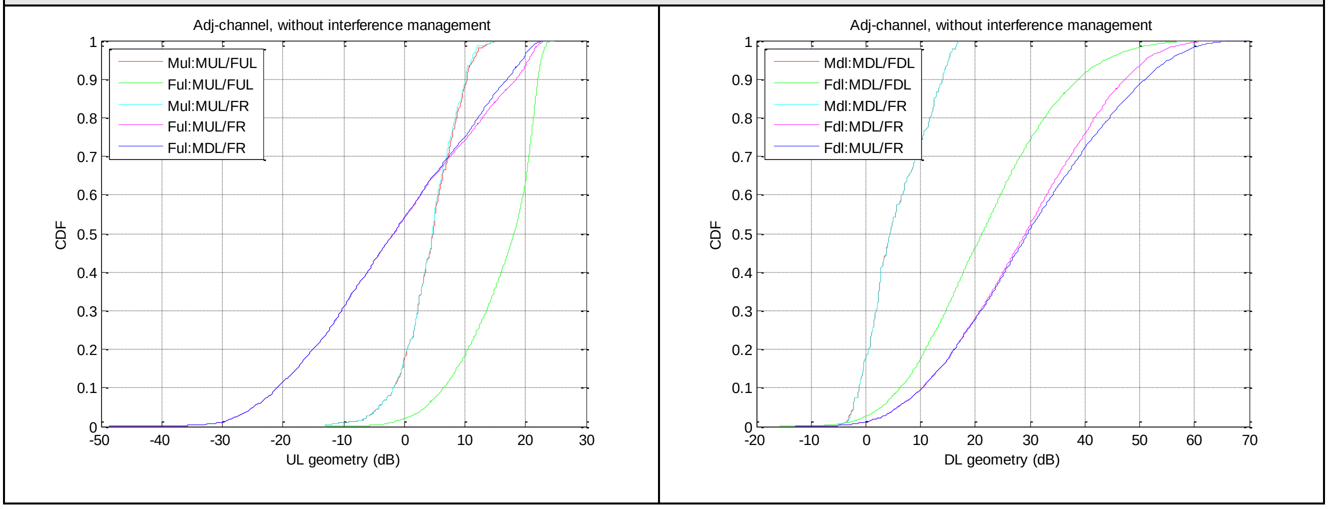
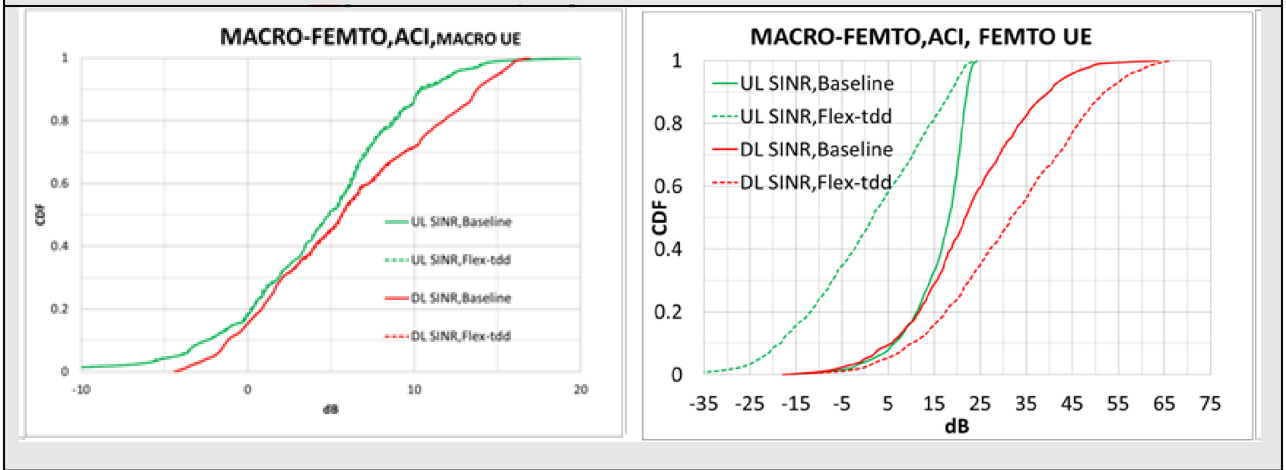


Figure 5.3.2-3: Simulation results from Source 3

Femto-Macro adjacent channel without DL power control



Femto-Macro adjacent channel with DL power control

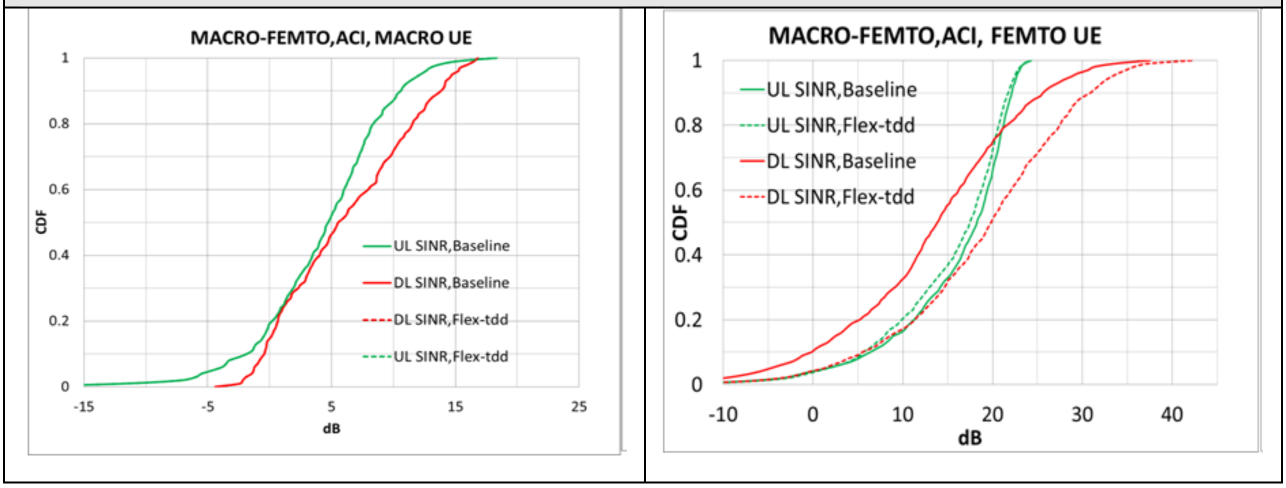
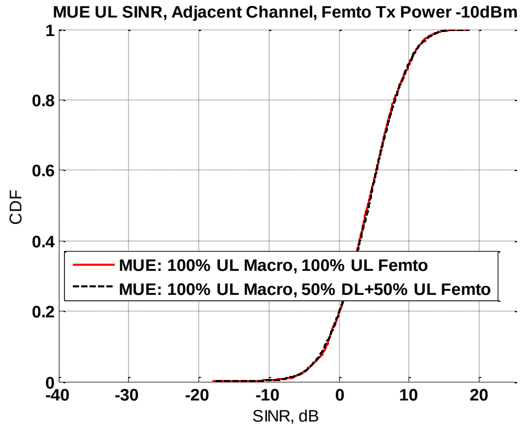
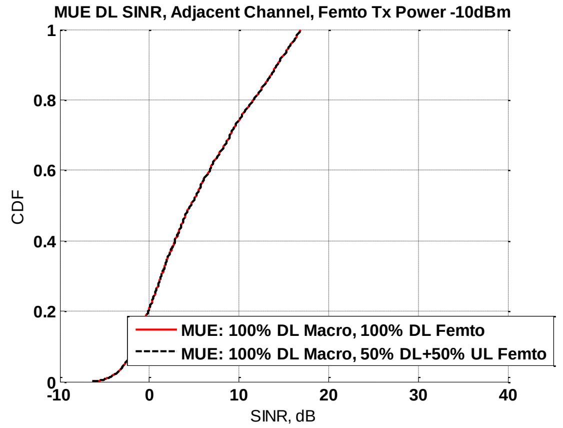
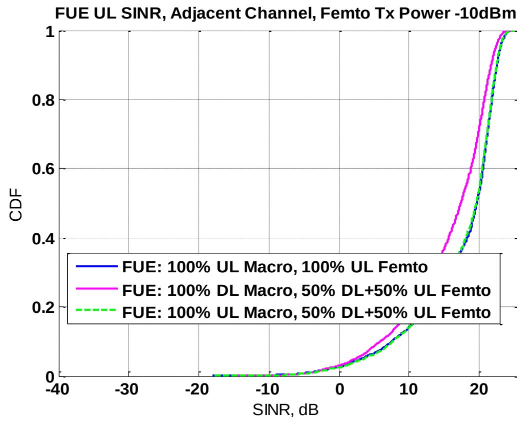


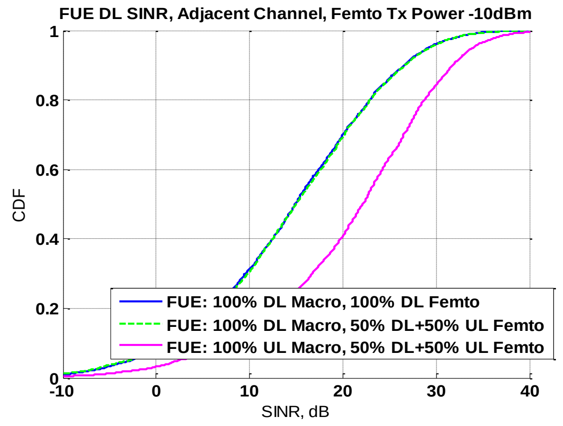
Figure 5.3.2-4: Simulation results from Source 4

Femto-Macro adjacent channel with DL power control

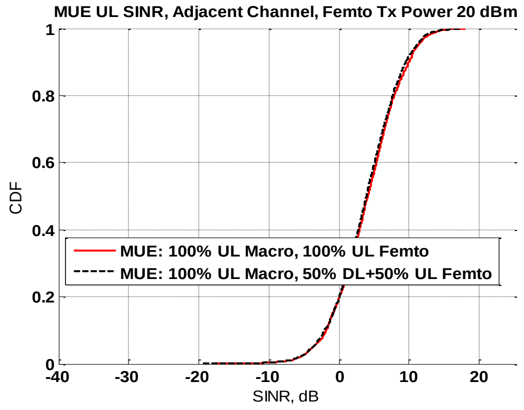


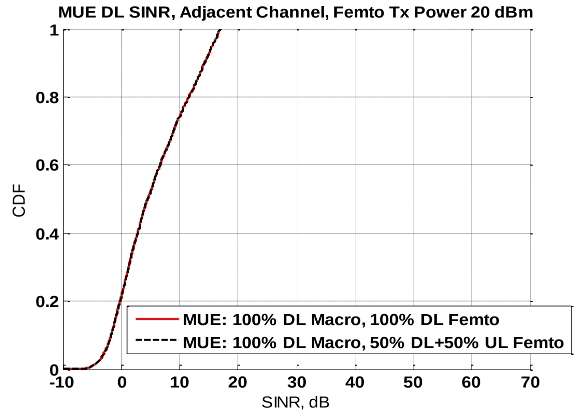






Femto-Macro adjacent channel without DL power control





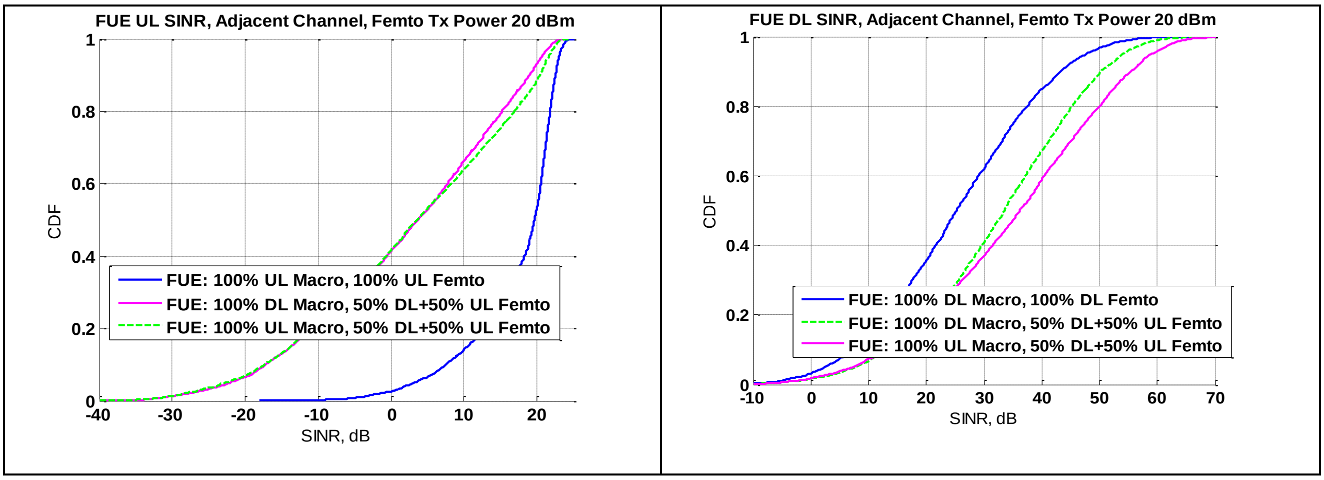


Figure 5.3.2-5: Simulation results from Source 5

Femto-Macro adjacent channel without DL power control

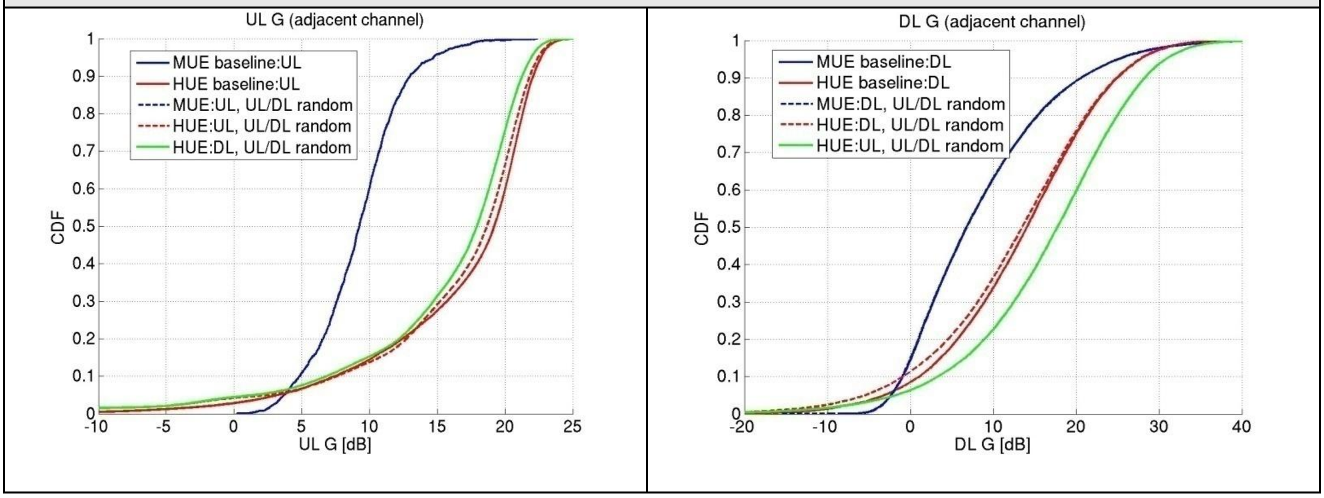


Figure 5.3.2-6: Simulation results from Source 6

5.4 Scenario 3

This scenario assumes multiple outdoor Pico cells deployed on the same carrier frequency. The simulation assumptions are included in Annex A.

5.4.1 Deterministic evaluations

The evaluation results using the deterministic approach are shown in Tables 5.4.1-1 and 5.4.1-2.

Table 5.4.1-1: Results of deterministic approach

aggressor -> victim	Pathloss model	Aggressor Tx power (dBm)	Victim acceptable interference (dBm)	Minimum separation distance (km)
				Sources 1 – 7

Outdoor Pico->outdoor Pico	LOS	24	-98.5	5.8
	NLOS			0.12

Table5.4.1-2: Results of deterministic approach from Source 8

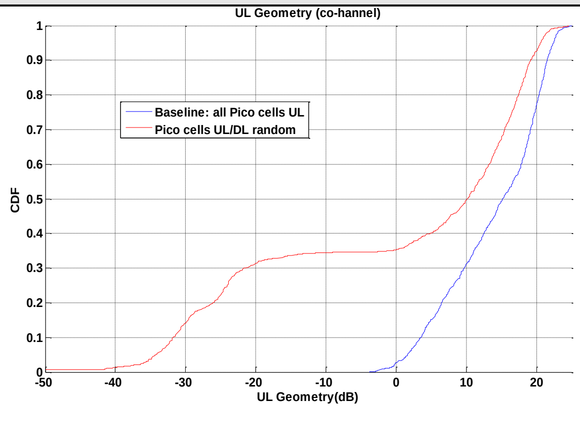
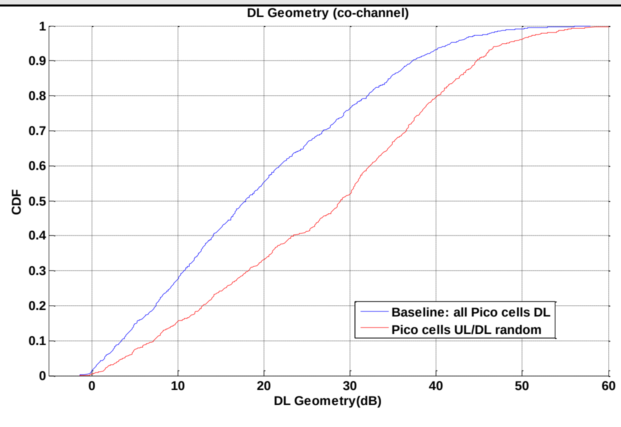
aggressor -> victim	Minimum separation distance (km)			
	Pathloss - LOS		Pathloss - NLOS	
	Requirement 1	Requirement 2	Requirement 1	Requirement 2
Outdoor Pico->Outdoor Pico	5.807	1.2307	0.120	0.025

Note: Requirement 1 means Interference signal mean power is 7 dB lower than noise floor; Requirement 2 means Interference signal mean power is the level in dynamic range requirement.

5.4.2 System simulation evaluations

The evaluation results by system simulations for scenario 3 are shown in Figures 5.4.2-1 to 5.3.2-9. The following cases are simulated:

- Case 1: Baseline is the transmission directions of all cells are the same
- Case 2: The transmission direction of outdoor Pico cells is randomly set as DL or UL with a 50% probability.
- Case 3 (optional): Pico with interference management. The transmission direction of outdoor Pico cells shall be controlled by the interference management method.

Pico-Pico co-channel without any interference mitigation scheme	
	
Pico-Pico co-channel with interference mitigation scheme	

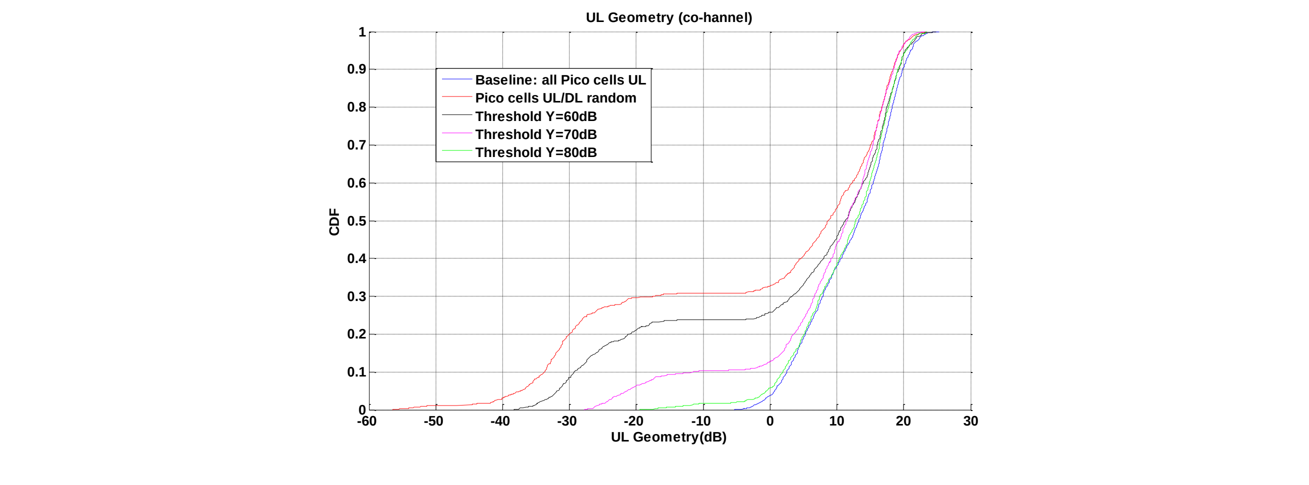


Figure 5.4.2-1: Simulation results from Source 1

Pico-Pico co-channel without any interference mitigation scheme

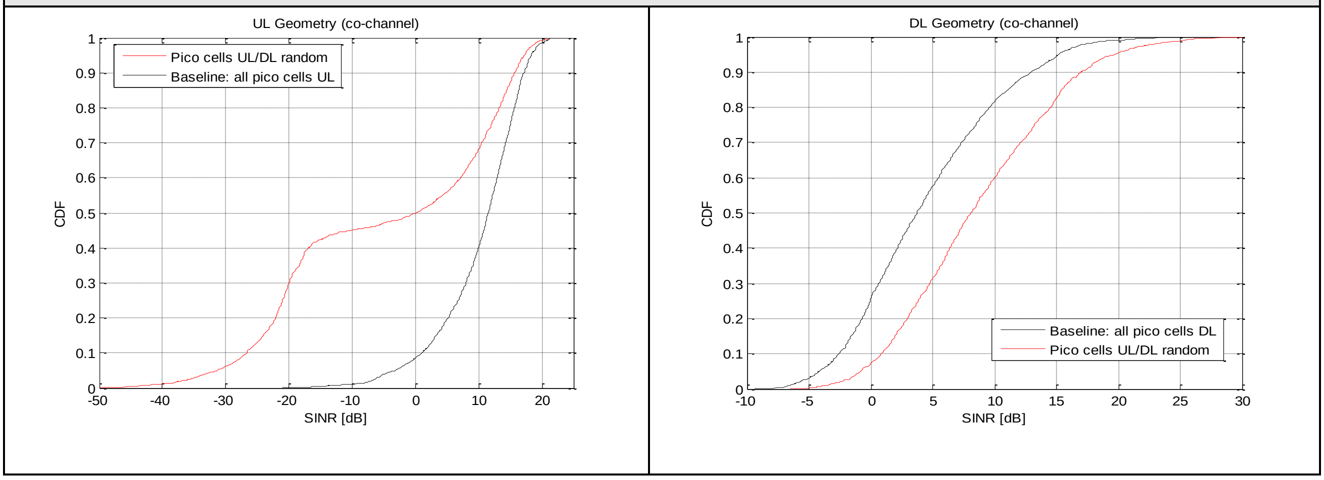


Figure 5.4.2-2: Simulation results from Source 2

Pico-Pico co-channel without any interference mitigation scheme

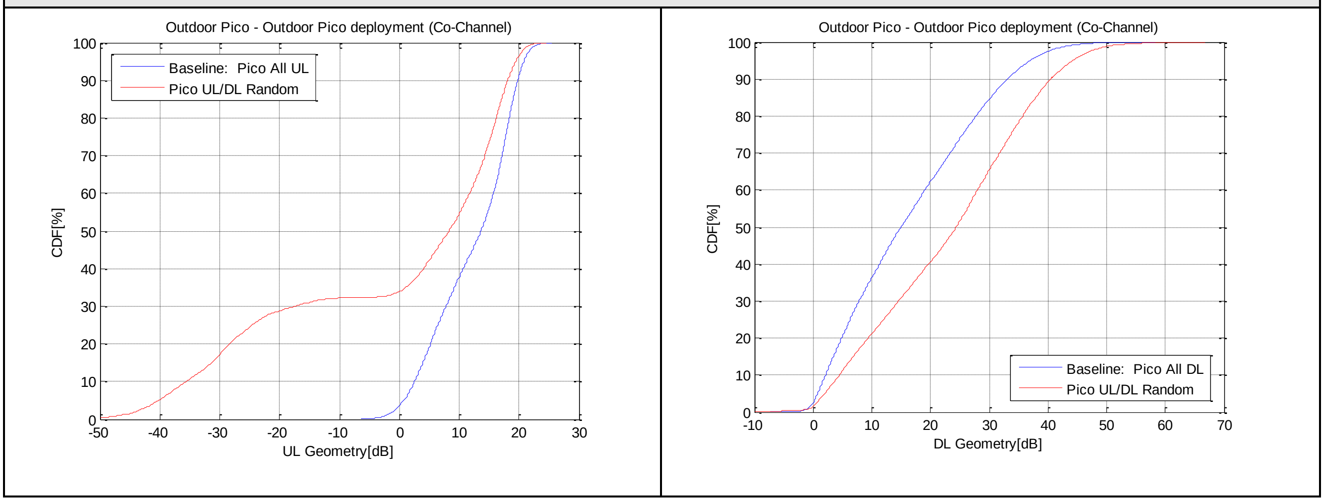


Figure 5.4.2-3: Simulation results from Source 3

Pico-Pico co-channel without any interference mitigation scheme

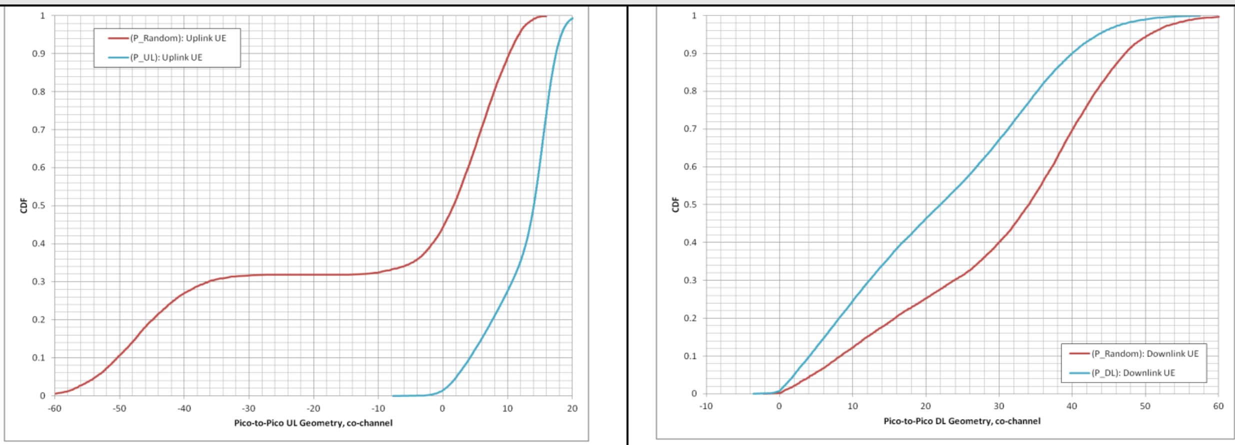
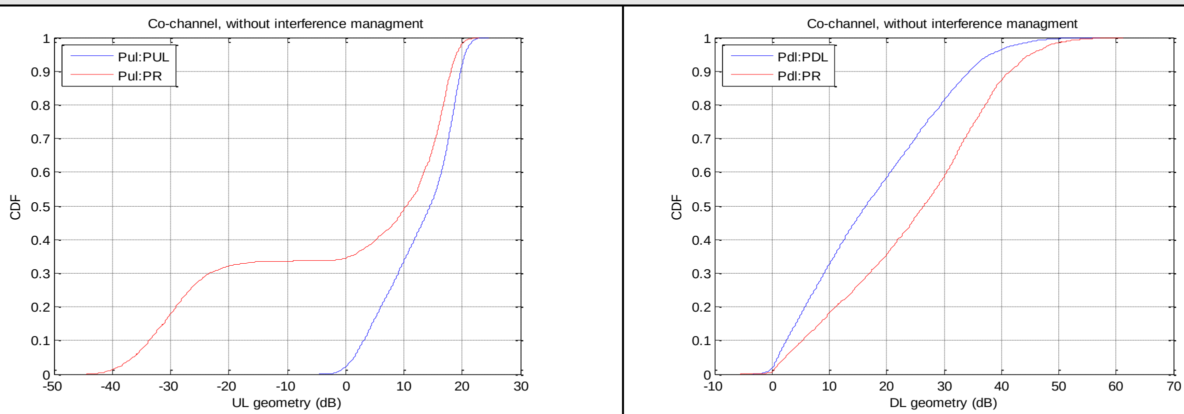


Figure 5.4.2-4: Simulation results from Source 4

Pico-Pico co-channel without any interference mitigation scheme



Pico-Pico co-channel with interference mitigation scheme

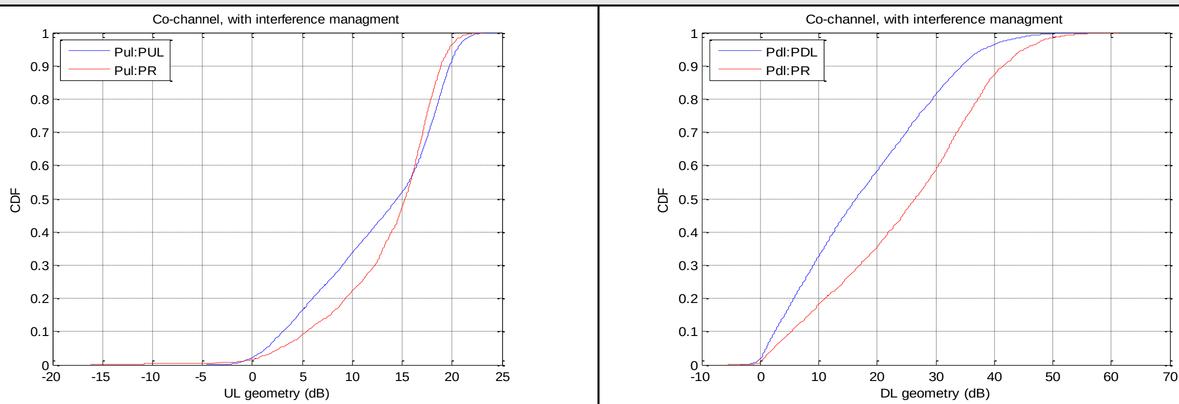


Figure 5.4.2-5: Simulation results from Source 5

Pico-Pico adjacent channel with and without interference mitigation scheme

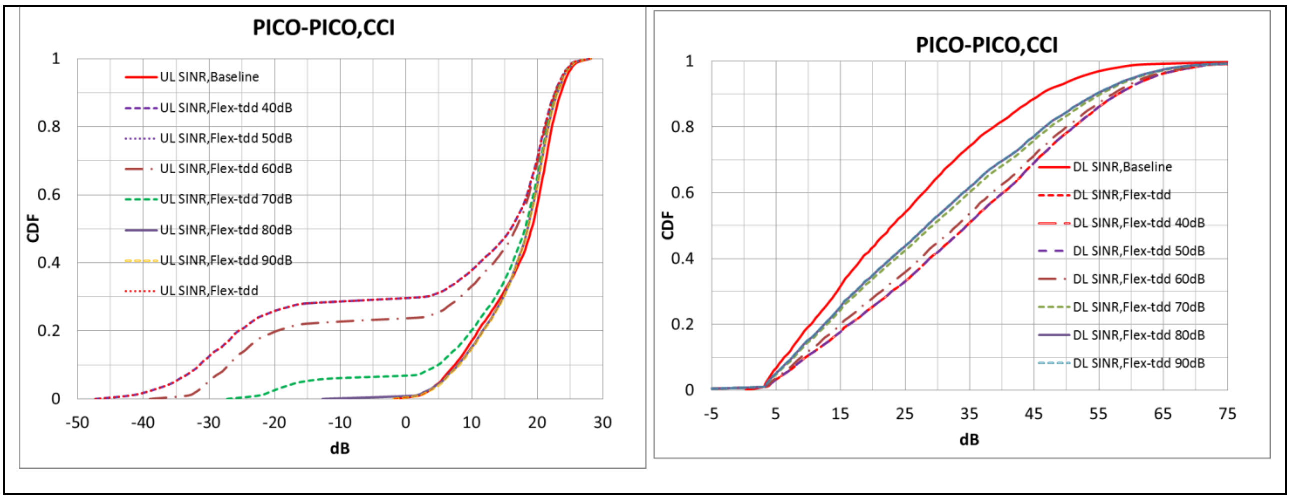
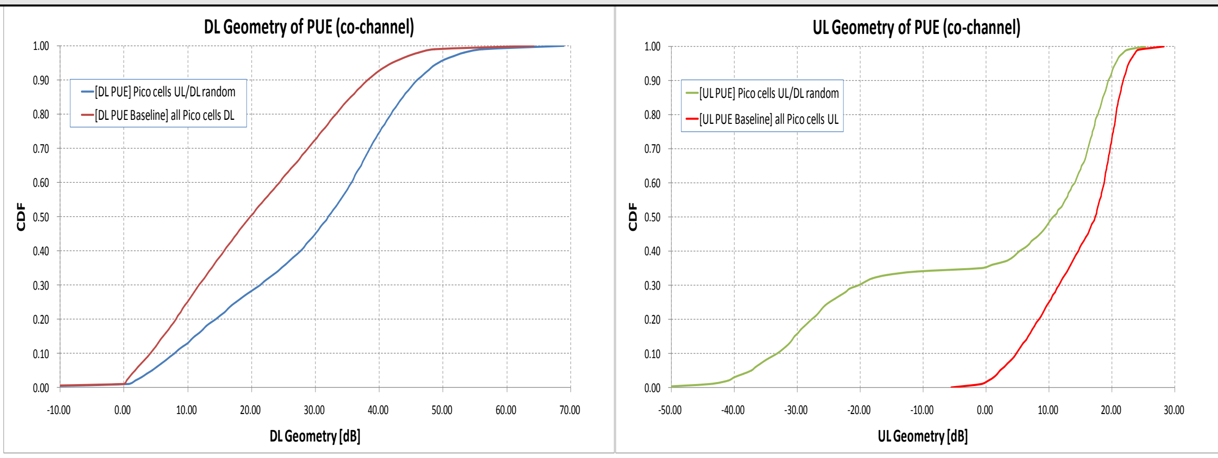


Figure 5.4.2-6: Simulation results from Source 6

Pico-Pico co-channel without any interference mitigation scheme



[Note 1]: In all these simulations, UEs are connected to Pico base stations.

[Note 2]: Pico cells UL/DL random in above figures refers to the case where the transmission direction of a Pico cell is randomly set as DL or UL with a probability of 50%.

Figure 5.4.2-7: Simulation results from source 7

Pico-Pico co-channel without any interference mitigation scheme

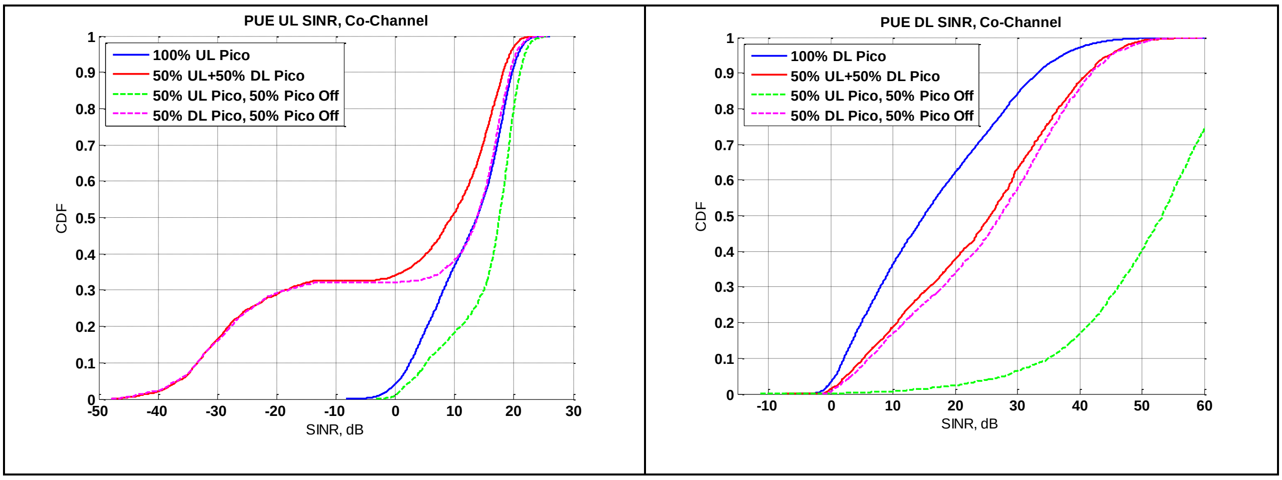


Figure 5.4.2-8: Simulation results from Source 8

Pico-Pico co-channel without any interference mitigation scheme

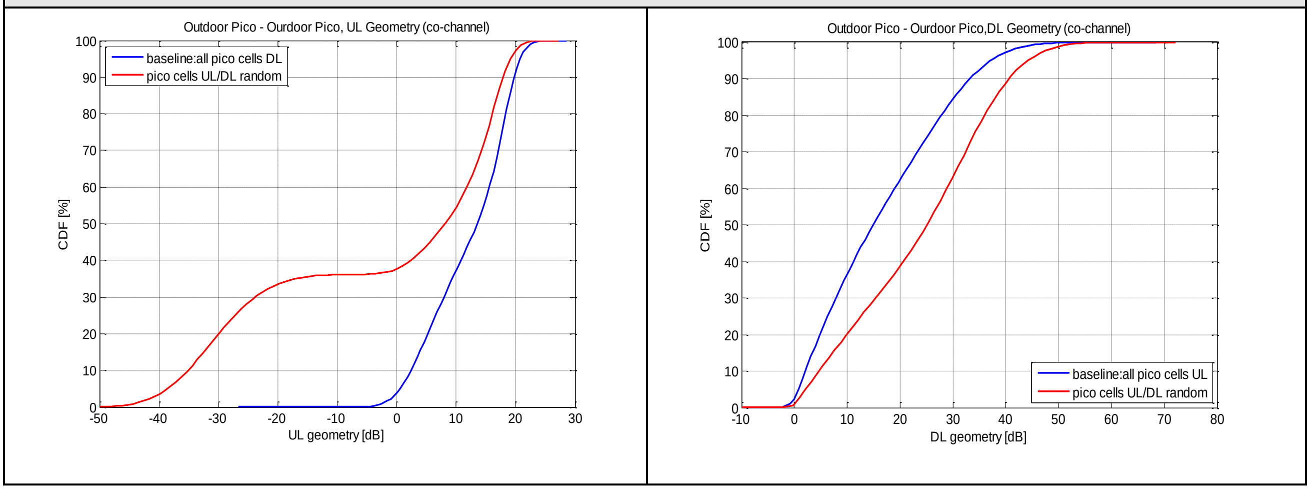


Figure 5.4.2-9: Simulation results from Source 9

5.5 Scenario 4

This scenario assumes multiple outdoor Pico cells deployed on the same carrier frequency and multiple Macro cells deployed on an adjacent carrier frequency where all Macro cells have the same UL-DL configuration and outdoor Pico cells can adjust UL-DL configuration. The simulation assumptions are included in Annex A.

5.5.1 Deterministic evaluations

The evaluation results using the deterministic approach are shown in Tables 5.5.1-1 to 5.5.1-5.

Table 5.5.1-1: Results of deterministic approach

aggressor -> victim	Pathloss model	Aggressor Tx power (dBm)	Victim acceptable interference (dBm)	Minimum separation distance (km)	
				Source 1 – 5	Source 6

Outdoor Pico ->Macro	LOS	24	-106.5	1.95	0.73
	NLOS			0.33	0.33
Macro BS ->outdoor Pico	LOS	46	-98.5	7.68	7.68
	NLOS			0.79	0.79

Table 5.5.1-2: Results of deterministic approach from Source 7

	aggressor -> victim	**used path loss model**	**minimum distance R (km)**
1st adjacent channel	Macro->Pico	100.7+23.5log10(R)	7.68
		125.2+36.3log10(R)	0.79
	Pico->Macro	100.7+23.5log10(R)	1.95
		125.2+36.3log10(R)	0.32
2nd adjacent channel	Macro->Pico	100.7+23.5log10(R)	4.7
		125.2+36.3log10(R)	0.58
	Pico->Macro	100.7+23.5log10(R)	1.19
		125.2+36.3log10(R)	0.24
Spurious domain	Macro->Pico	100.7+23.5log10(R)	1.32
		125.2+36.3log10(R)	0.25
	Pico->Macro	100.7+23.5log10(R)	0.33
		125.2+36.3log10(R)	0.1

Table 5.5.1-3: Results of deterministic approach from Source 8

aggressor -> victim	**Minimum separation distance (km)**			
	Pathloss - LOS		**Pathloss - NLOS**	
	Requirement 1	Requirement 2	Requirement 1	Requirement 2
Macro->Pico	7.644	0.545	0.789	0.143
Pico->Macro	1.939	0.138	0.325	0.0587

Note: Requirement 1 means Interference signal mean power is 7 dB lower than noise floor; Requirement 2 means Interference signal mean power is the level in dynamic range requirement.

Table 5.5.1-4: Required Additional Isolation, ISD = 500m from Source 9

Deployment Scenarios		**BS-BS Isolation (dB)**	**Notes**
Macro-Outdoor Pico	Co-channel	46.7 dB	NLOS path loss model is used
	Adjacent channel	1.7 dB	

	Non Adjacent Channel	- 4.3 dB	

Table 5.5.1-5: Required Additional Isolation, ISD = 1732m from Source 9

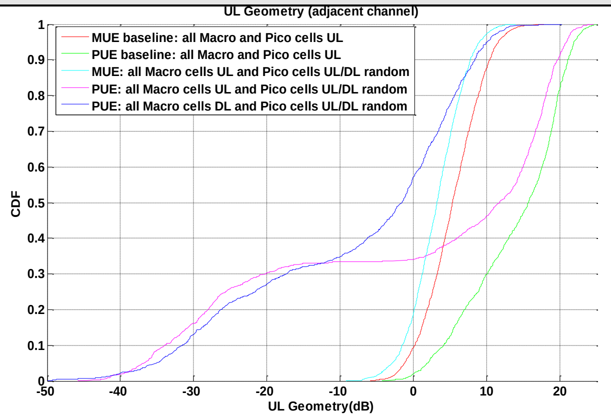
Deployment Scenarios		BS-BS Isolation (dB)	Notes
Macro-Outdoor Pico	Co-channel	27.1 dB	NLOS path loss model is used
	Adjacent channel	- 17.9 dB	
	Non Adjacent Channel	- 23.9 dB	

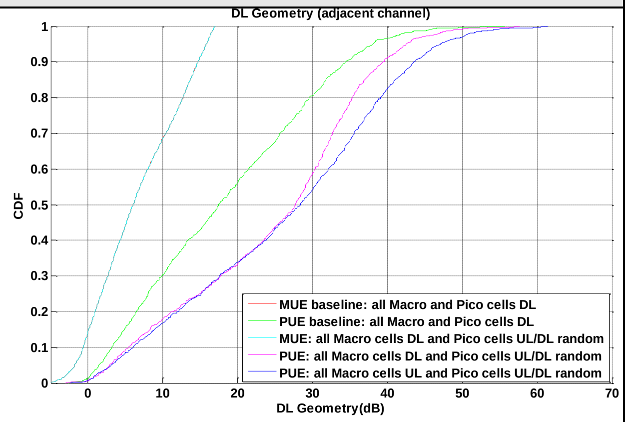
5.5.2 System simulation evaluations

The evaluation results by system simulations for scenario 4 are shown in Figures 5.5.2-1 to 5.5.2-9. The following cases are simulated:

- Case 1: Baseline is the transmission directions of all cells are the same
- Case 2: The transmission direction of outdoor Pico cells is randomly set as DL or UL with a 50% probability.
- Case 3 (optional): Pico with interference management. The transmission direction of outdoor Pico cells shall be controlled by the interference management method

Pico-Macro adjacent channel without any interference mitigation scheme





Pico-Macro adjacent channel with interference mitigation scheme

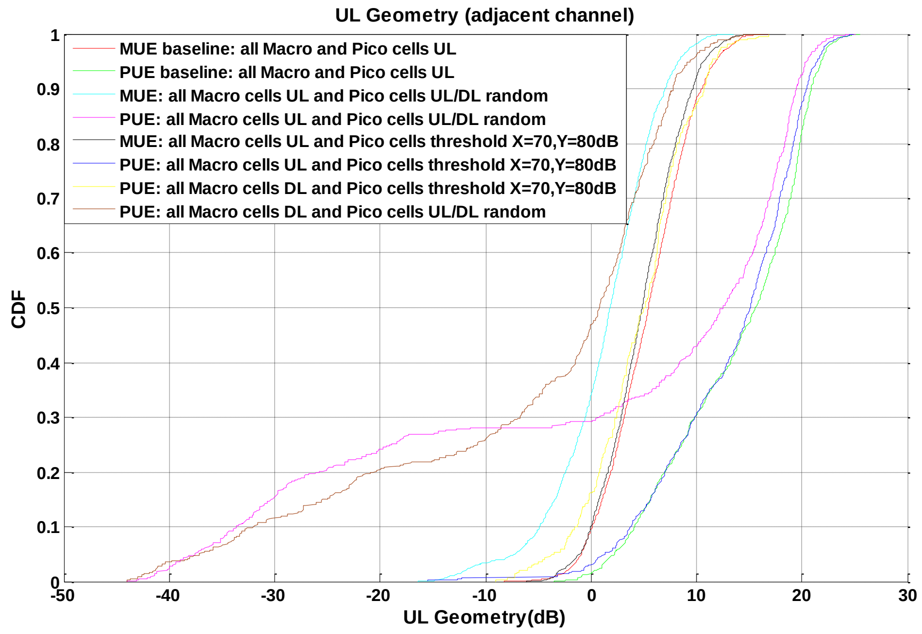


Figure 5.5.2-1: Simulation results from Source 1

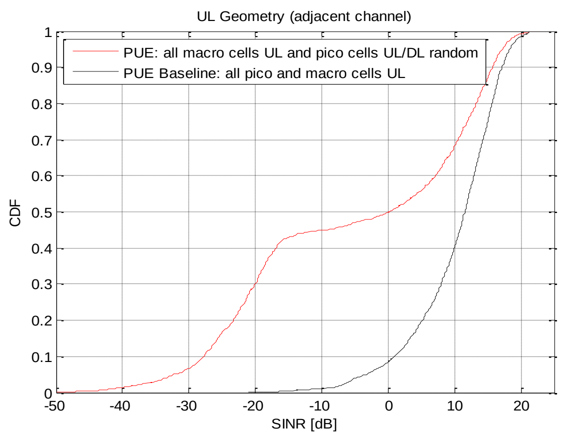
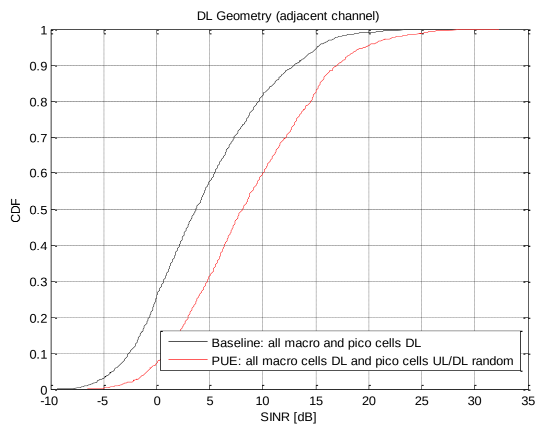
Pico-Macro adjacent channel without any interference mitigation scheme	
	

Figure 5.5.2-2: Simulation results from Source 2

Pico-Macro adjacent channel without any interference mitigation scheme

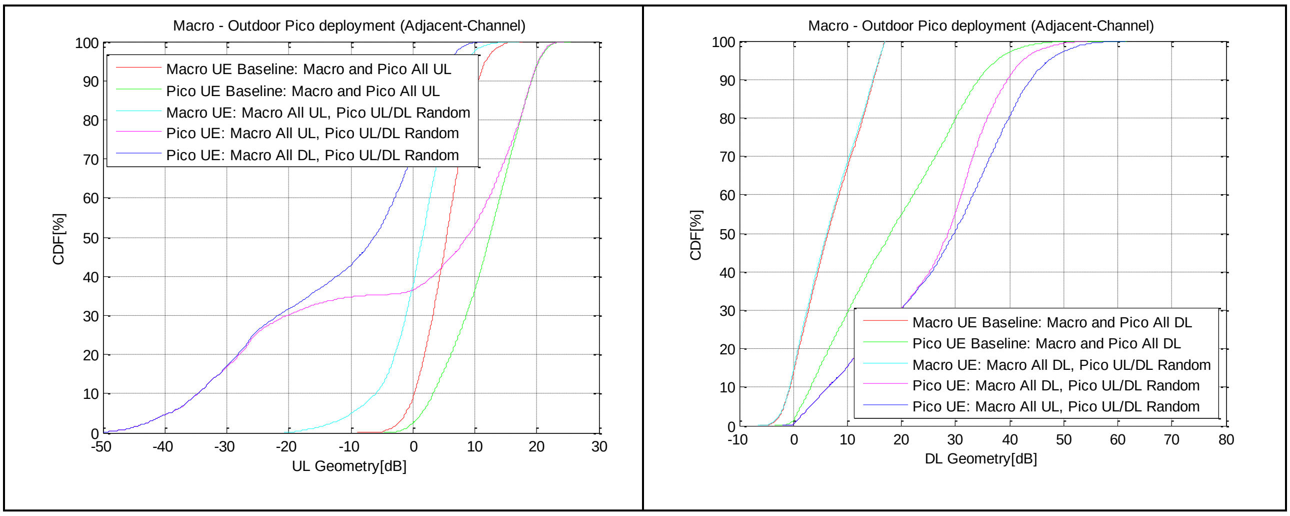


Figure 5.5.2-3: Simulation results from Source 3

Pico-Macro adjacent channel without any interference mitigation scheme

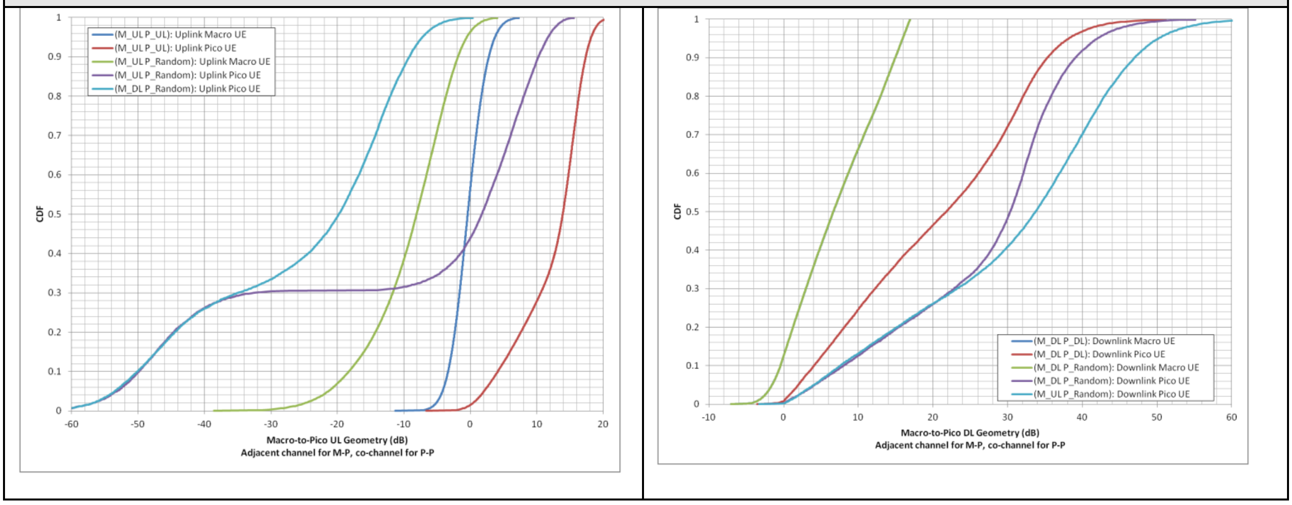
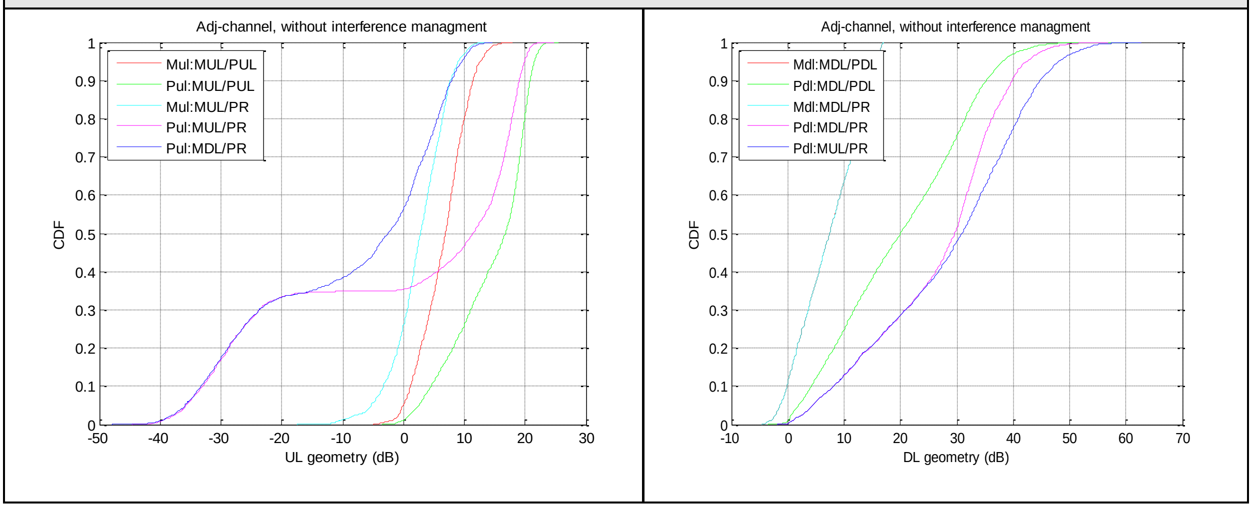


Figure 5.5.2-4: Simulation results from Source 4

Pico-Macro adjacent channel without any interference mitigation scheme



Pico-Macro adjacent channel with interference mitigation scheme

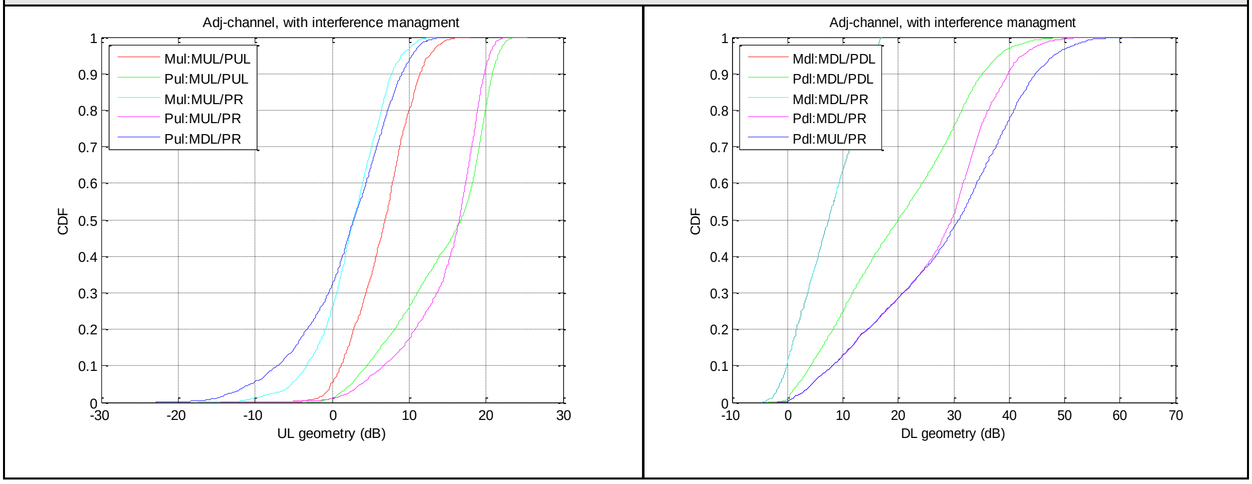


Figure 5.5.2-5: Simulation results from Source 5

Macro-Pico adjacent channel with/without any interference mitigation scheme

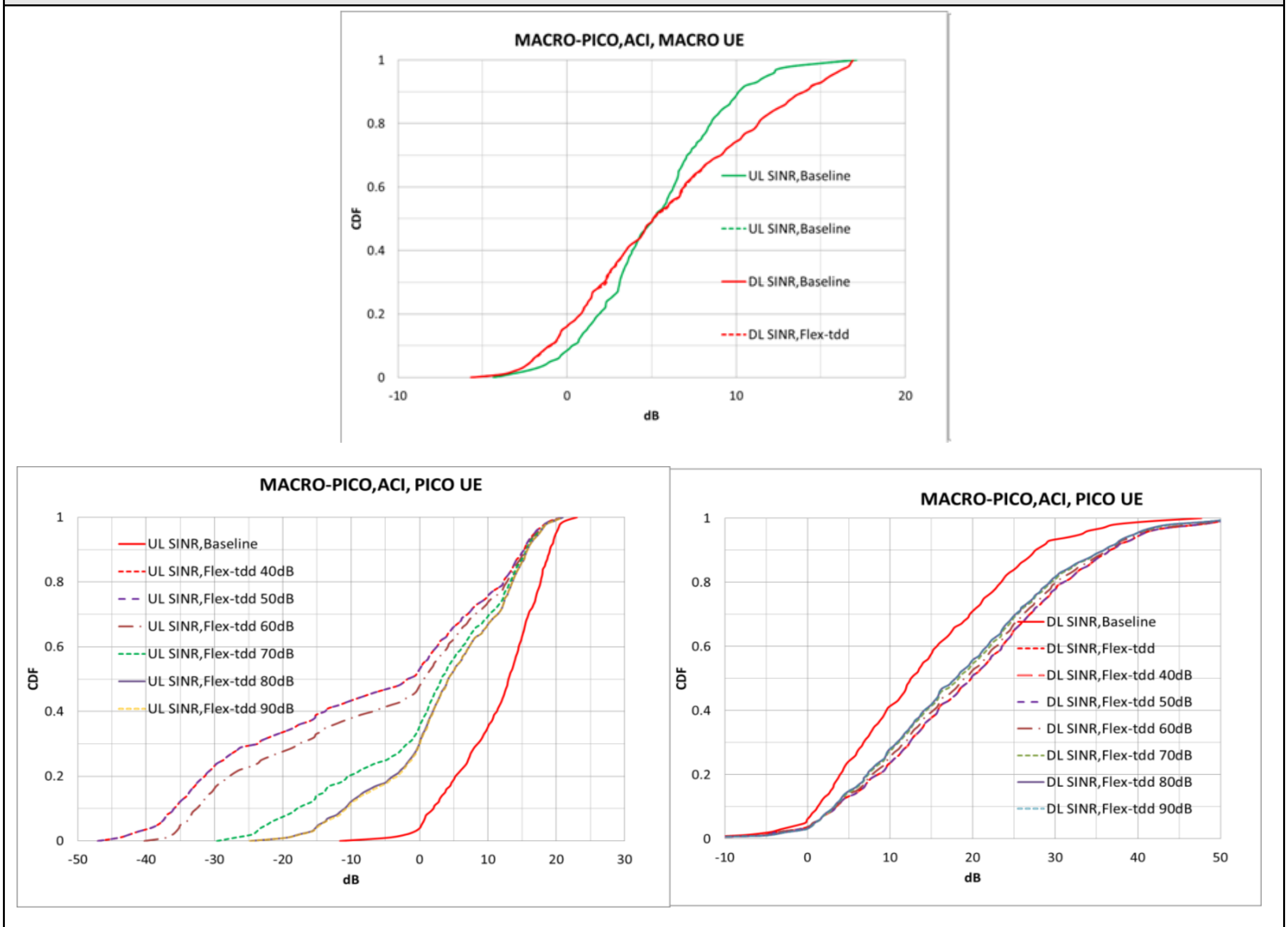
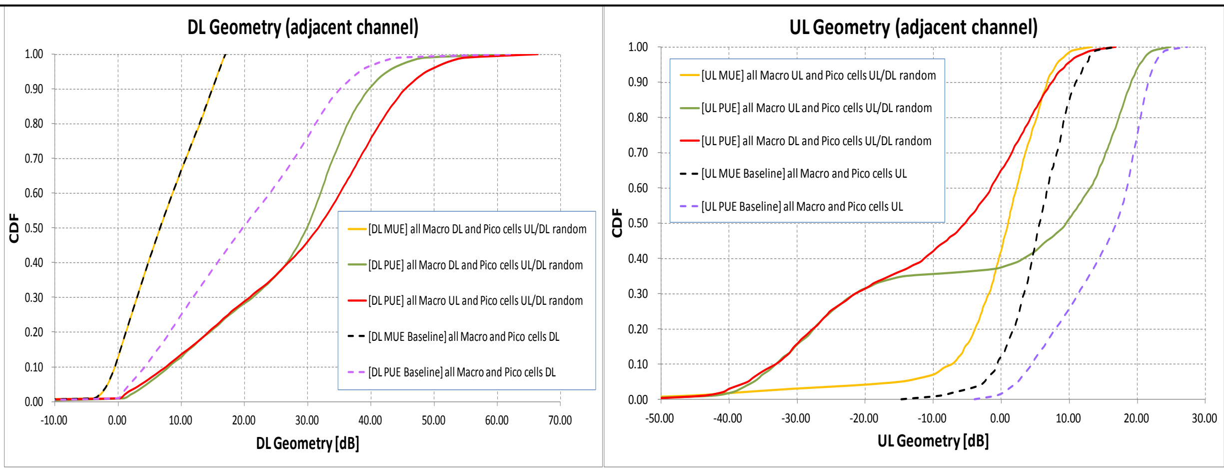


Figure 5.5.2-6: Simulation results from Source 6

Pico-Macro adjacent channel without interference mitigation scheme



[Note 1]: Pico cells UL/DL random in above figures refers to the case where the transmission direction of a Pico cell is randomly set as DL or UL with a probability of 50%.

Figure 5.5.2-7: Simulation results from Source 7

Pico-Macro adjacent channel without interference mitigation scheme

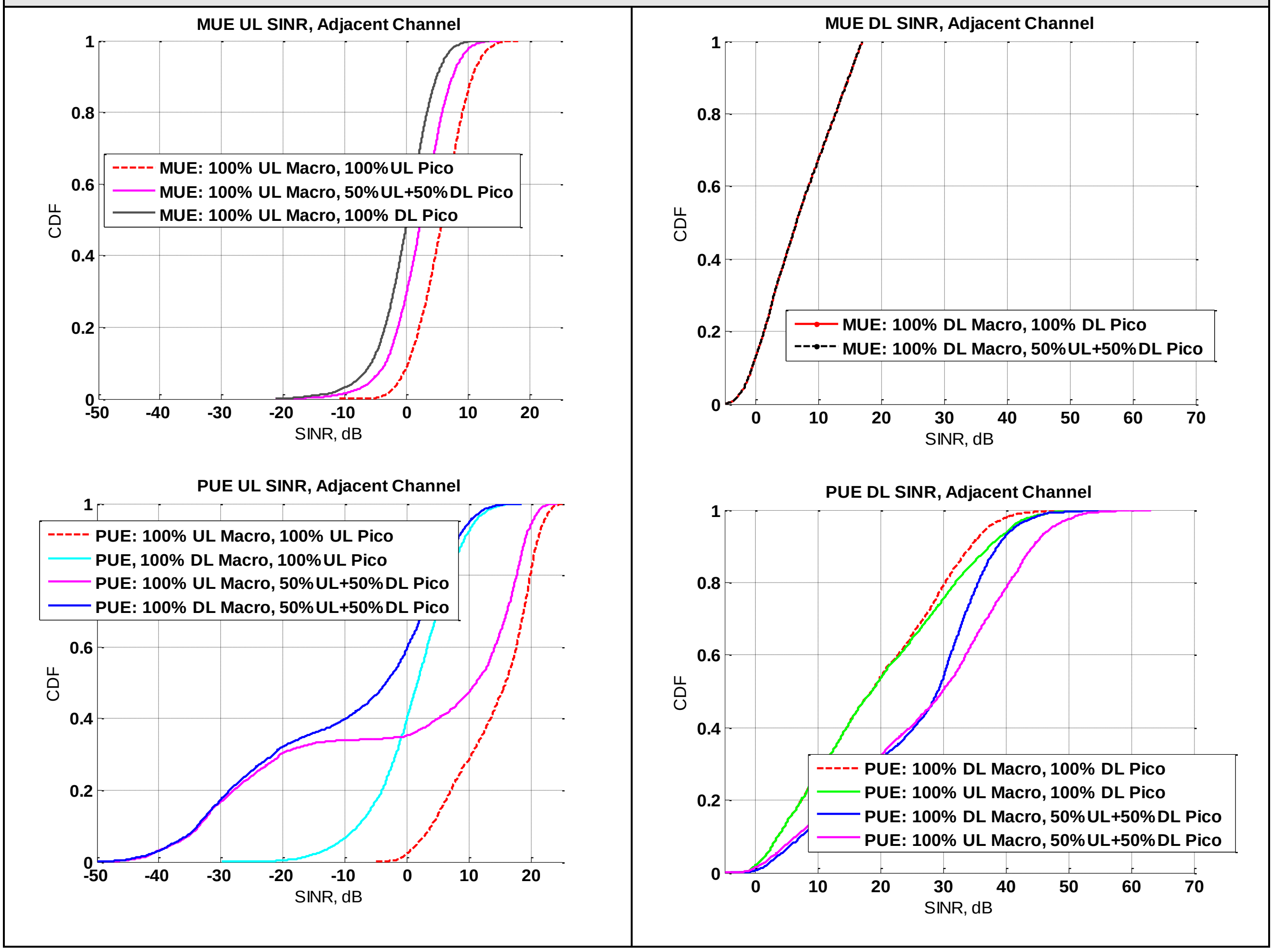
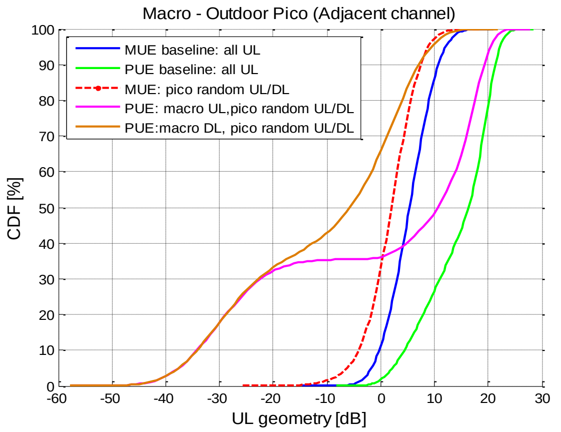
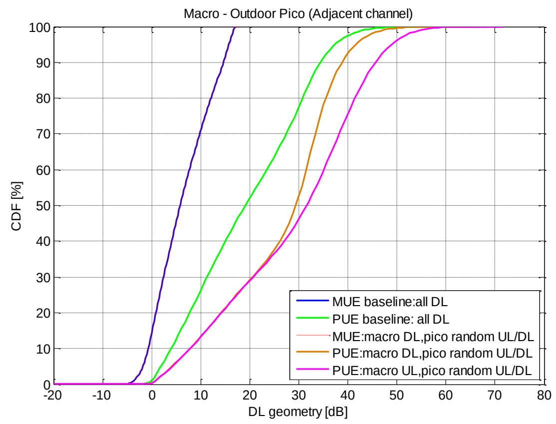


Figure 5.5.2-8: Simulation results from Source 8

Pico-Macro adjacent channel without interference mitigation scheme





Pico-Macro adjacent channel with interference mitigation scheme

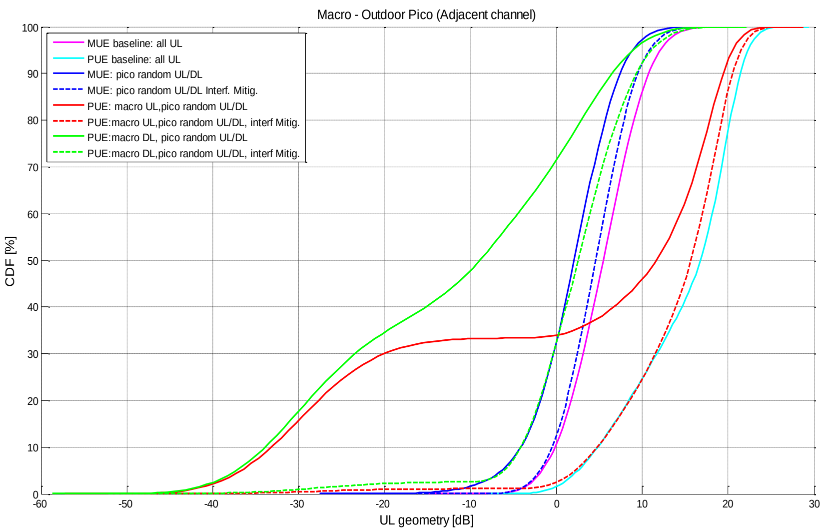


Figure 5.5.2-9: Simulation results from Source 9

5.6 Scenario 5

This scenario assumes multiple Femto cells and multiple Macro cells deployed on the same carrier frequency where all Macro cells have the same UL-DL configuration and Femto cells can adjust UL-DL configuration. The simulation assumptions are included in Annex A.

5.6.1 Deterministic evaluations

The evaluation results using the deterministic approach are shown in Table 5.6.1-1.

Table 5.6.1-1: Results of deterministic approach

aggressor -> victim	Aggressor Tx power	Victim cell acceptable interference (dBm)[1]	Minimum BS separation distance

	(dBm)		(km) Sources 1 – 4
Femto ->Macro	20	-106.5	0.67
Macro ->Femto	46	-98.5	2.0

5.6.2 System simulation evaluations

The evaluation results by system simulations for scenario 5 are shown in Figures 5.6.2-1 to 5.6.2-5. The following cases are simulated:

- Case 1: Baseline is the transmission directions of all cells (including Macro and Femto) are the same.
- Case 2: All Macro cells are of the same transmission direction (i.e. either DL or UL) and the transmission direction of Femto cells is randomly set as DL and UL with a 50% probability.

Femto-Macro co-channel with Femto DL power control

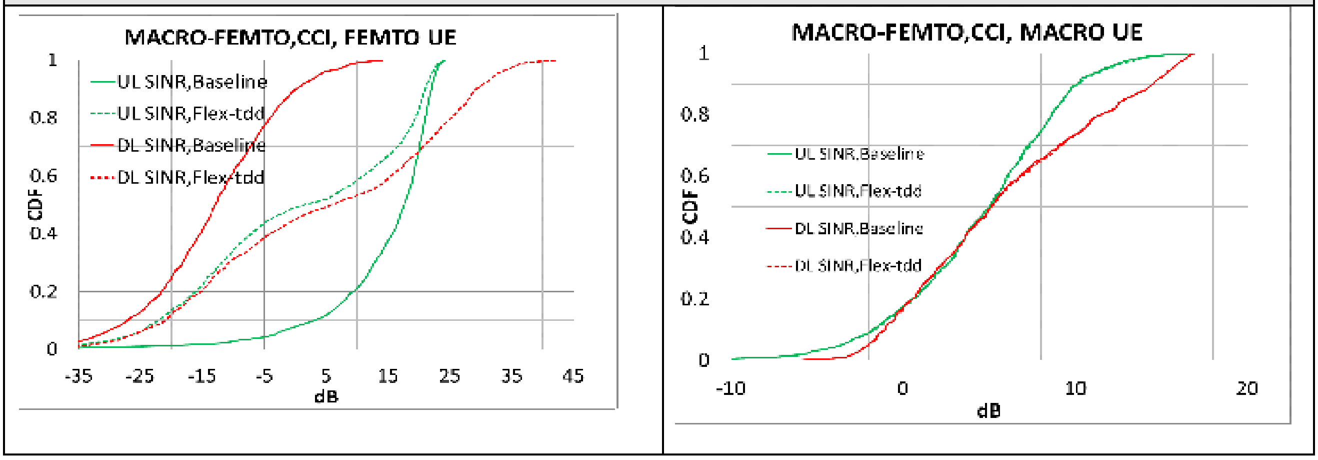


Figure 5.6.2-1: Simulation results from Source 1

Femto-Macro co-channel with Femto DL power control

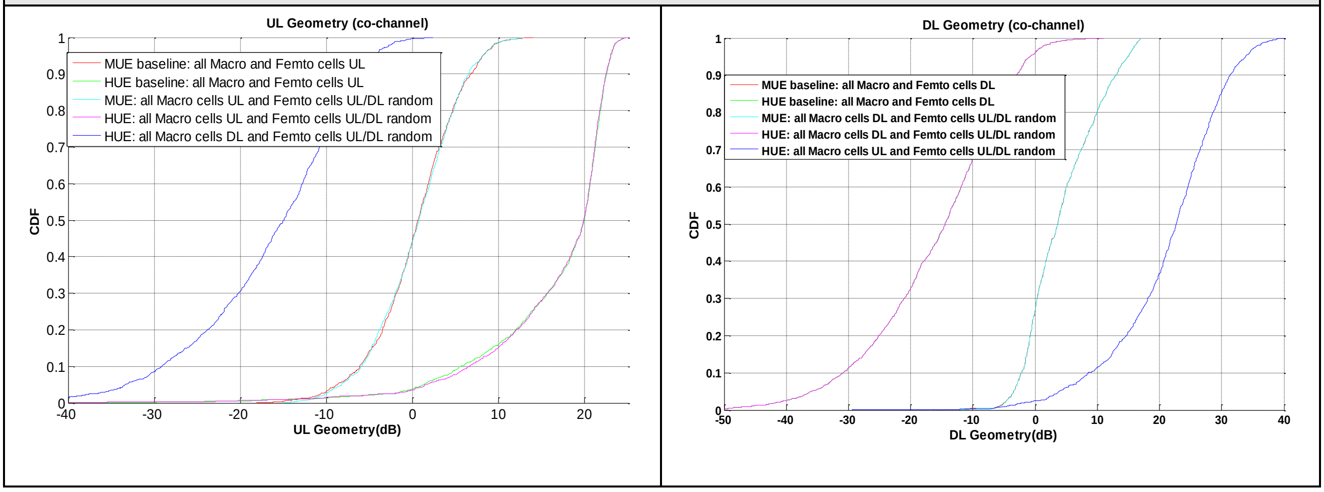


Figure 5.6.2-2: Simulation results from Source 2

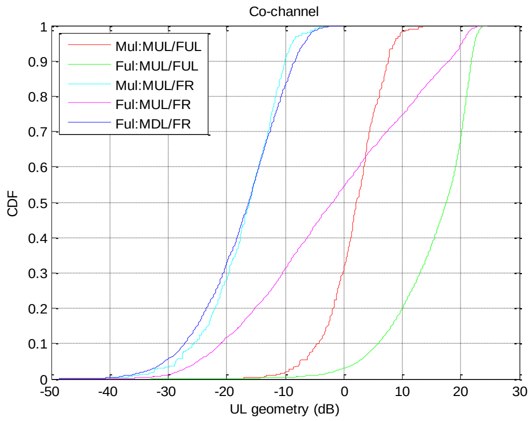
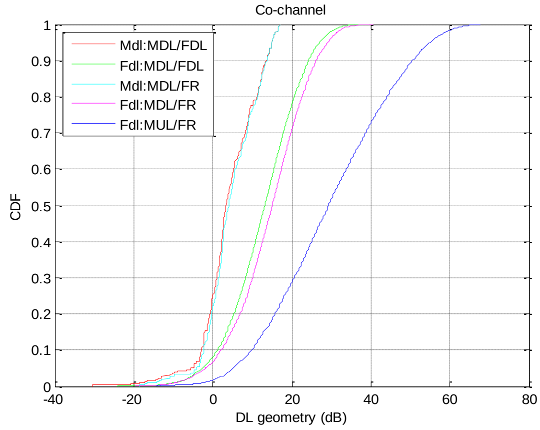
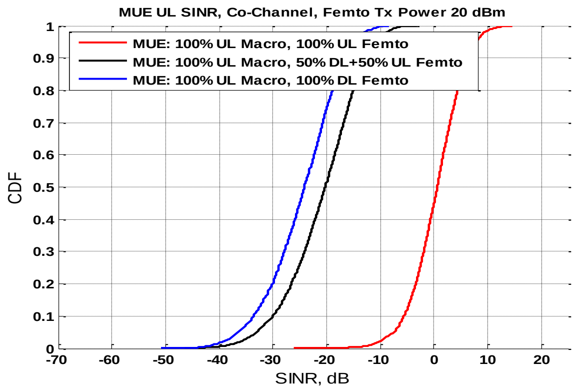
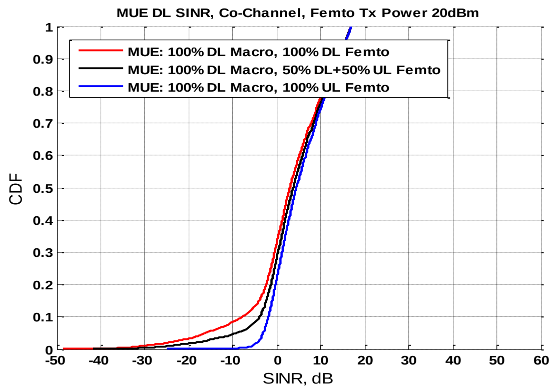
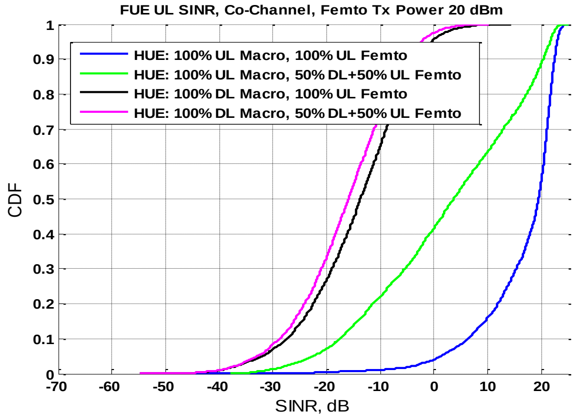
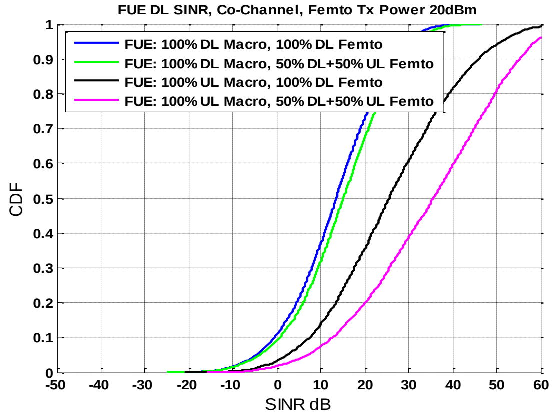
Femto-Macro co-channel without Femto DL power control	
	

Figure 5.6.2-3: Simulation results from Source 3

Femto-Macro co-channel without Femto DL power control	
	
	
Femto-Macro co-channel with Femto DL power control	

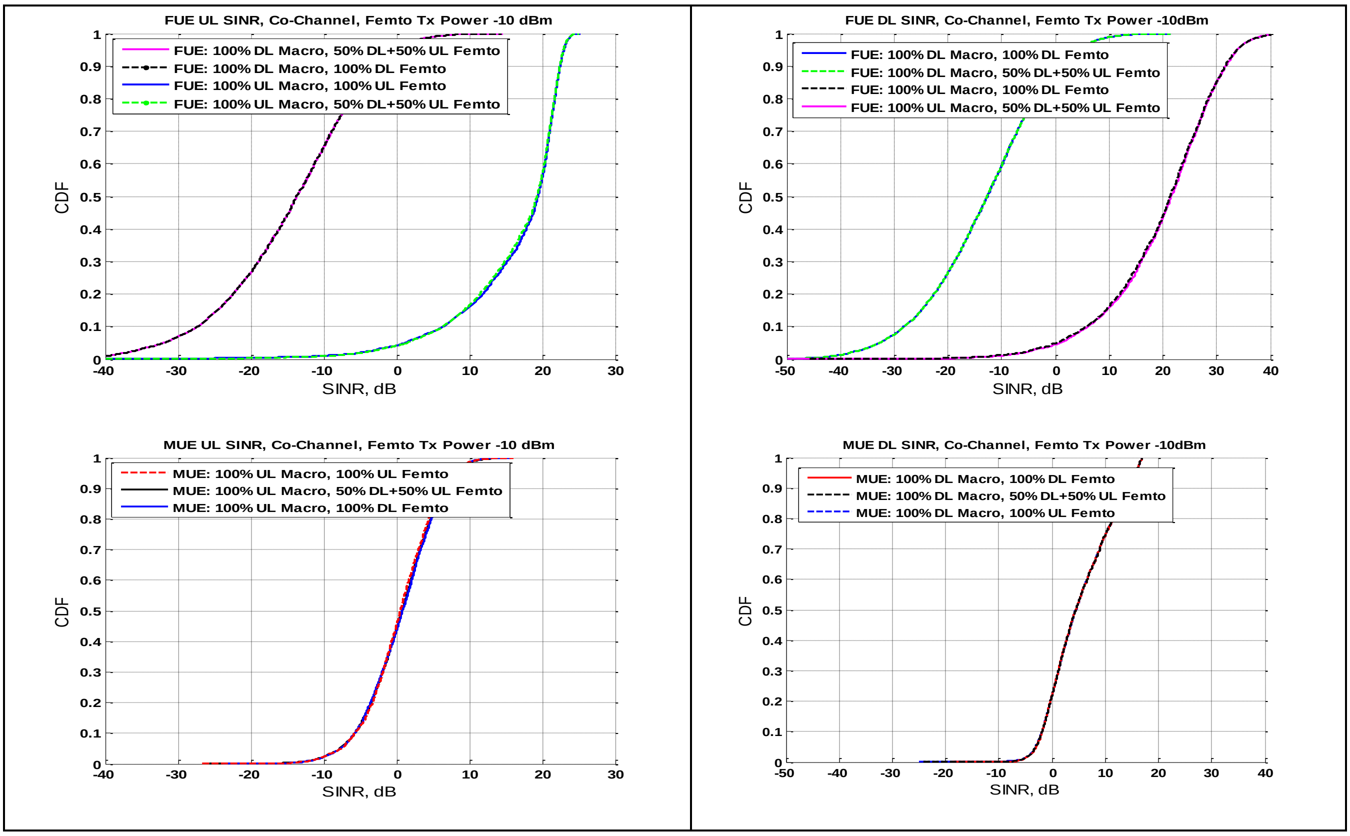


Figure 5.6.2-4: Simulation results from Source 4

Femto-Macro co-channel without Femto DL power control

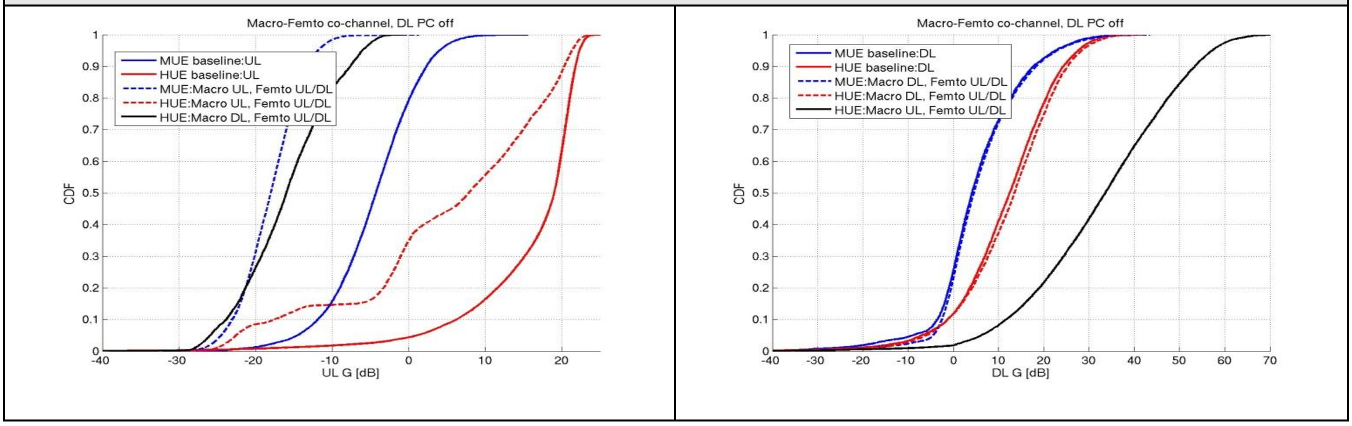


Figure 5.6.2-5: Simulation results from Source 5

5.7 Scenario 6

This scenario assumes multiple outdoor Pico cells and multiple Macro cells deployed on the same carrier frequency where all Macro cells have the same UL-DL configuration and outdoor Pico cells can adjust UL-DL configuration. The simulation assumptions are included in Annex A.

5.7.1 Deterministic evaluations

The evaluation results using the deterministic approach are shown in Table 5.7.1-1.

Table 5.7.1-1: Results of deterministic approach

aggressor -> victim	Pathloss model	Aggressor Tx power (dBm)	Victim cell acceptable interference (dBm)[1]	Minimum BS separation distance (km)				
				Sources 1 – 2	Source 3	Source 4	Source 5	Source 6
Outdoor Pico ->Macro	LOS	24	-106.5	131.568	131	131.57	131.02	131.03
	NLOS			4.977	4.98	0.70	4.96	4.97
Macro ->outdoor Pico	LOS	46	-98.5	518.673	519	518.67	516.5	516.53
	NLOS			12.096	12	12.10	12.06	12.07

5.7.2 System simulation evaluations

The evaluation results by system simulations for scenario 6 are shown in Figures 5.7.2-1 to 5.7.2-10. The following cases are simulated:

- Case 1: Baseline is the transmission directions of all cells are the same
- Case 2: The transmission direction of outdoor Pico cells is randomly set as DL or UL with a 50% probability.
- Case 3 (optional): Pico with interference management. The transmission direction of outdoor Pico cells shall be controlled by the interference management method

Pico-Macro co-channel without interference mitigation scheme

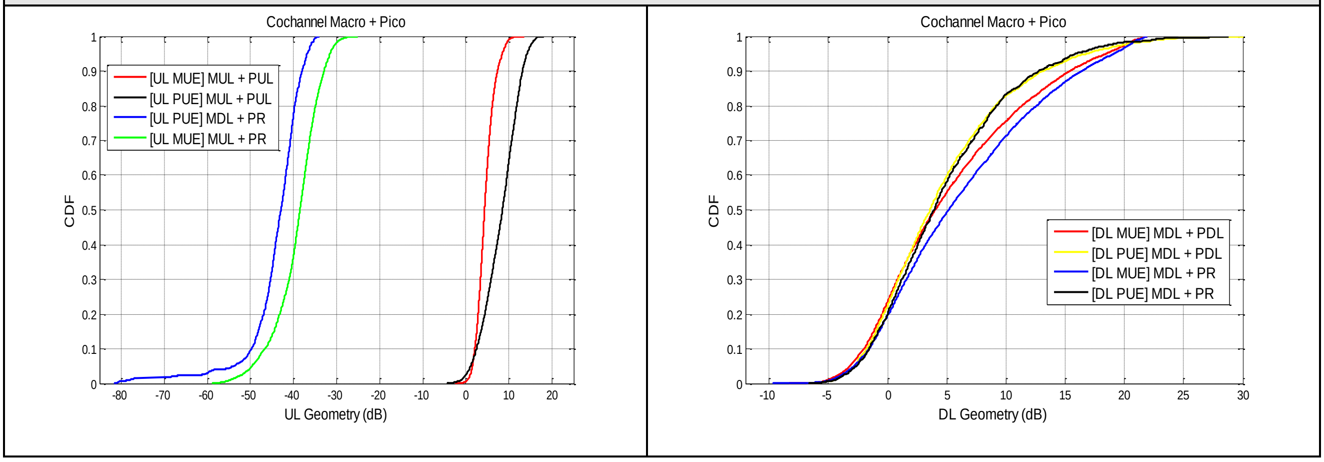


Figure 5.7.2-1: Simulation results from Source 1

Pico-Macro co-channel without interference mitigation scheme

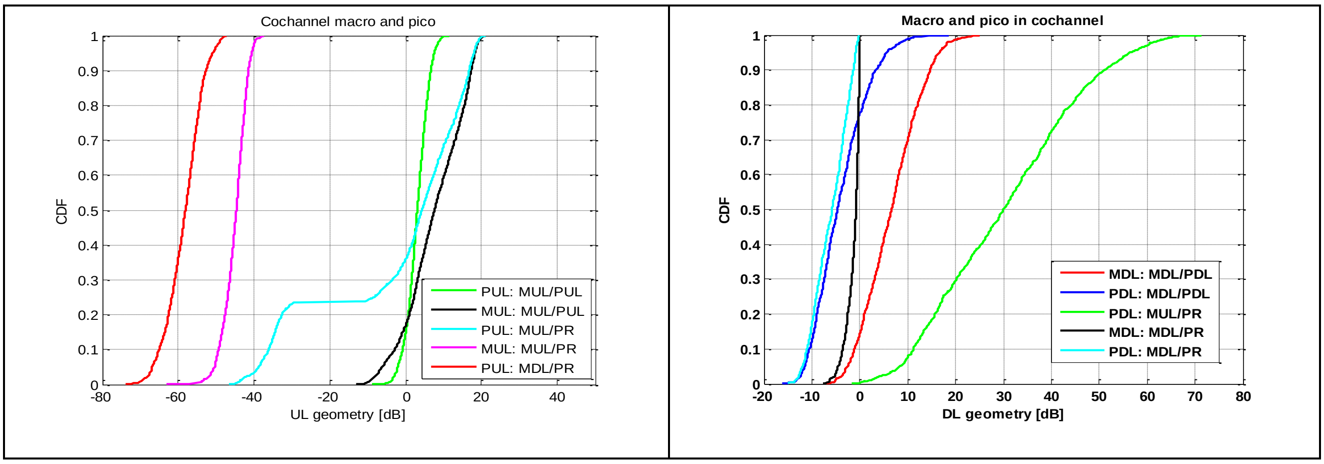


Figure 5.7.2-2: Simulation results from Source 2

Pico-Macro co-channel without interference mitigation scheme

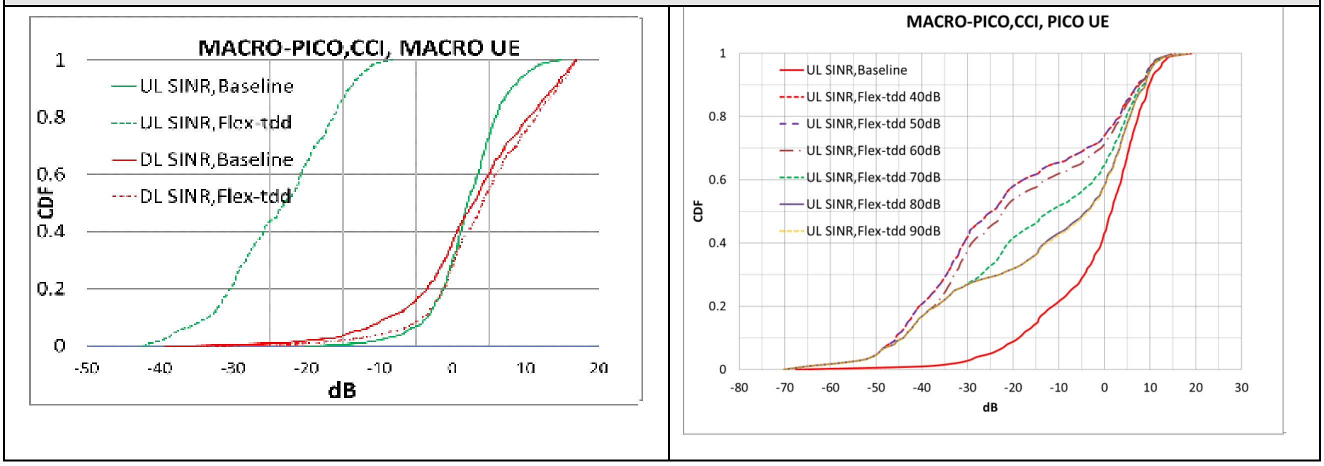


Figure 5.7.2-3: Simulation results from Source 3

Pico-Macro co-channel without interference mitigation scheme

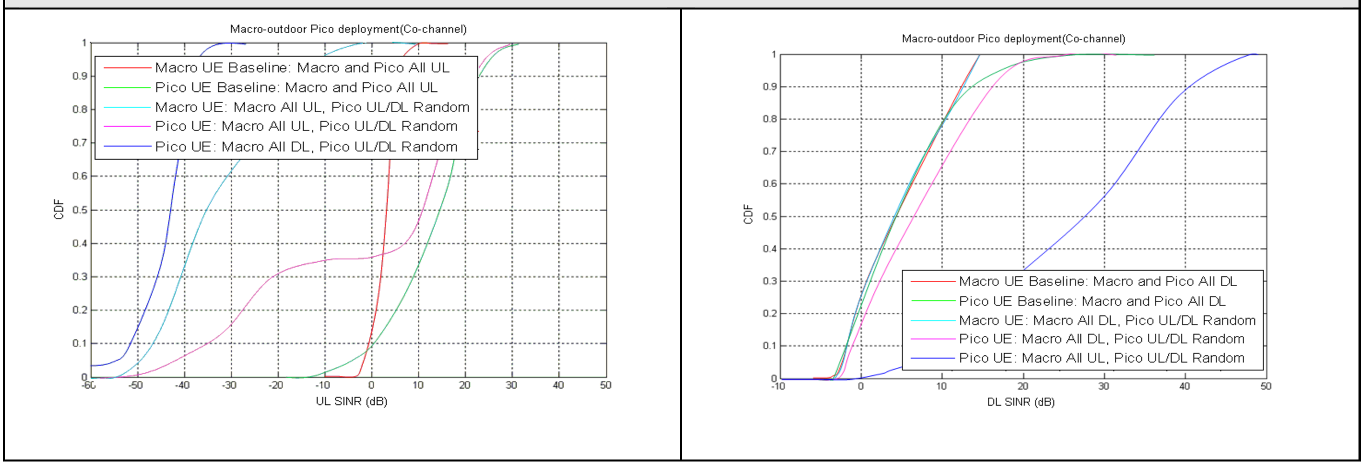
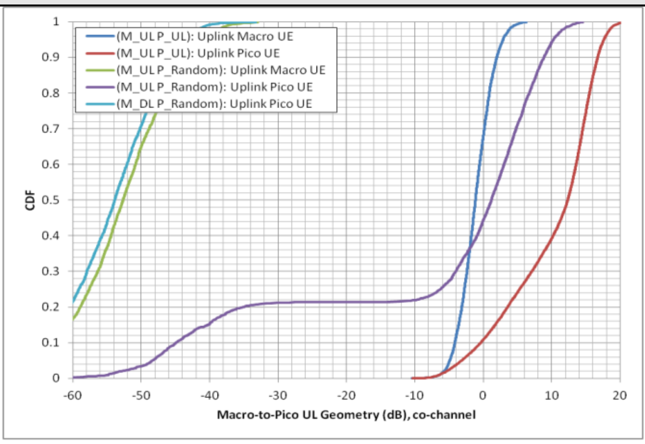


Figure 5.7.2-4: Simulation results from Source 4

Pico-Macro co-channel without interference mitigation scheme



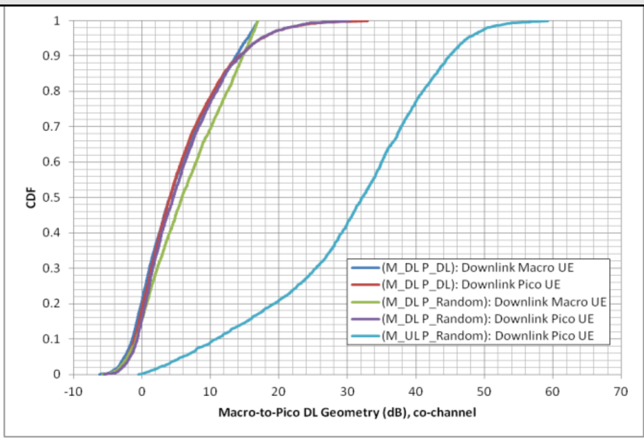
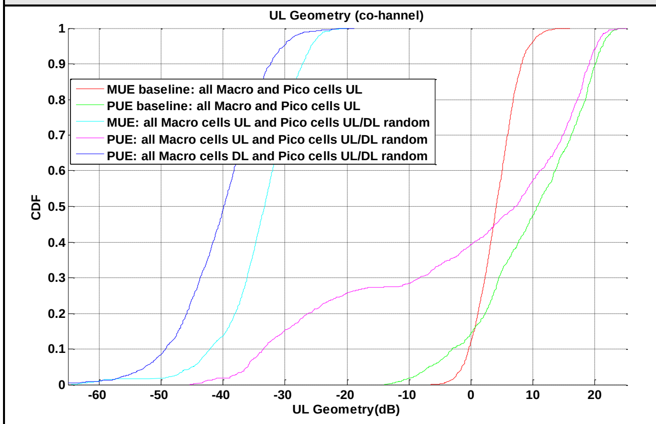
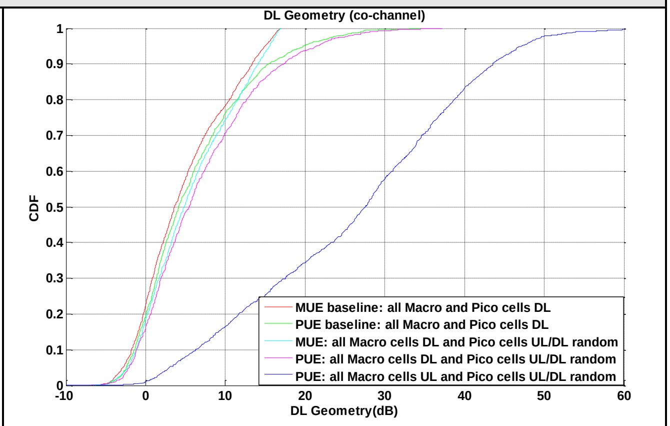


Figure 5.7.2-5: Simulation results from Source 5

Pico-Macro co-channel without interference mitigation scheme





Pico-Macro co-channel with interference mitigation scheme

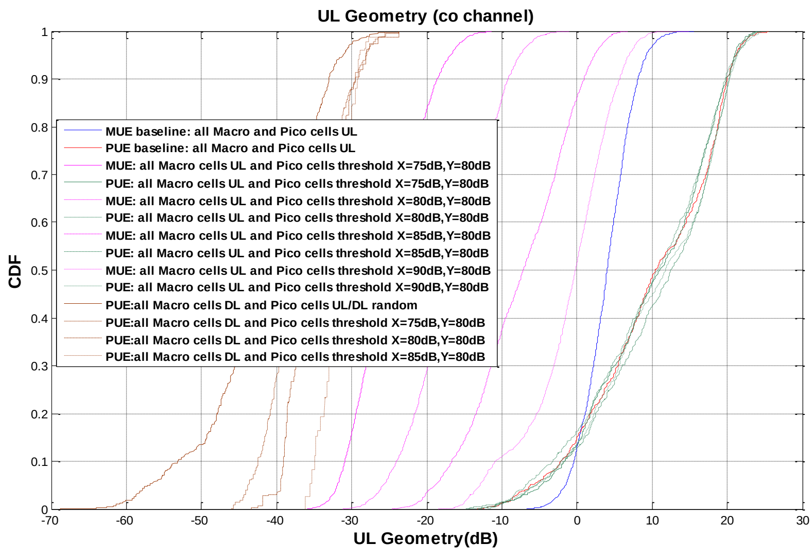
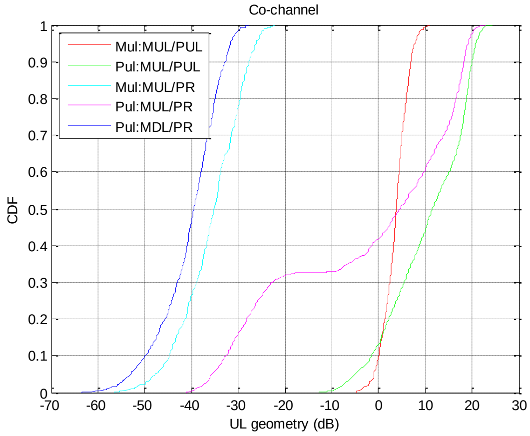
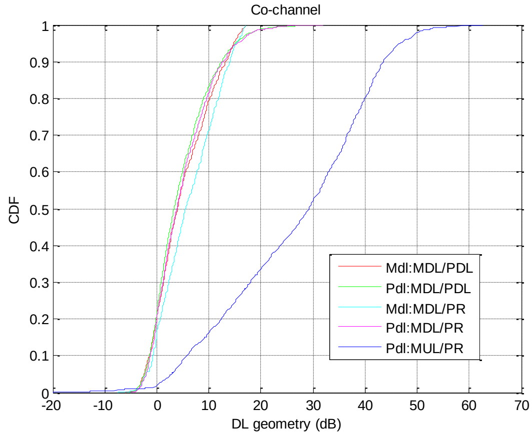


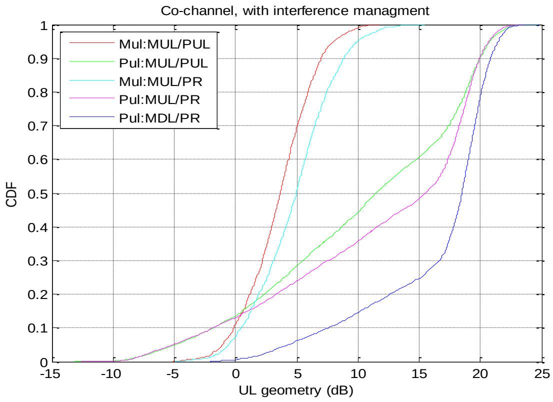
Figure 5.7.2-6: Simulation results from Source 6

Pico-Macro co-channel without interference mitigation scheme





Pico-Macro co-channel with interference mitigation scheme



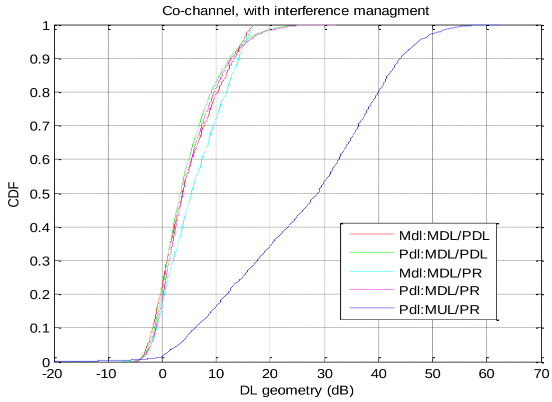
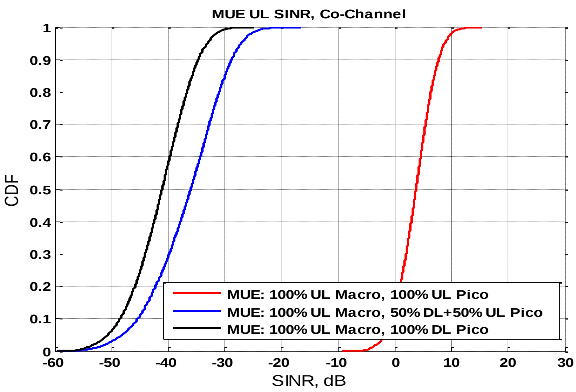
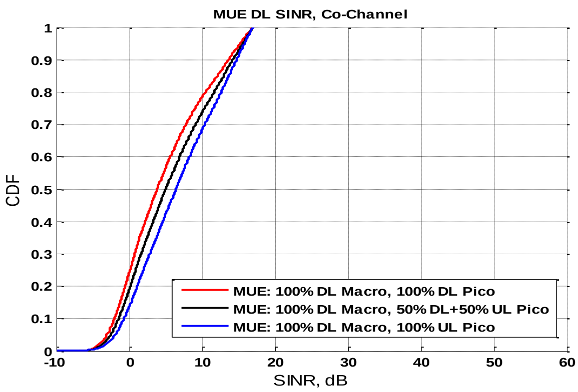
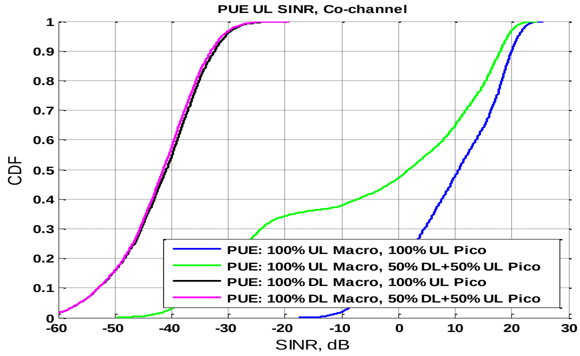


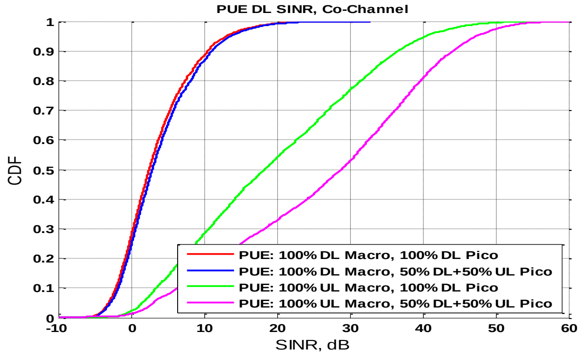
Figure 5.7.2-7: Simulation results from Source 7

Pico-Macro co-channel without interference mitigation scheme

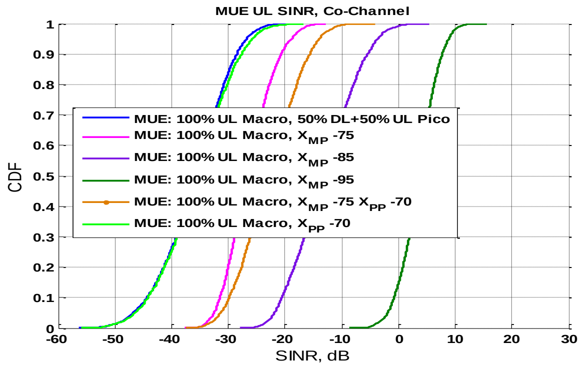








Pico-Macro co-channel with interference mitigation scheme



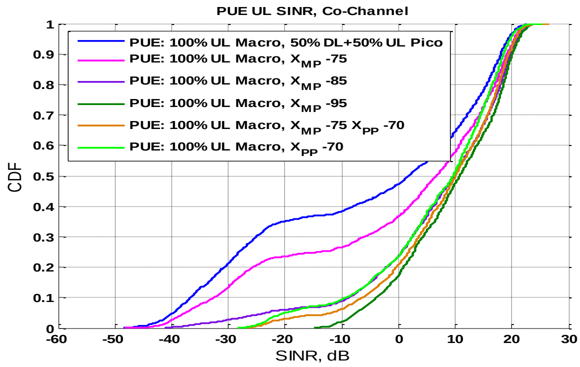
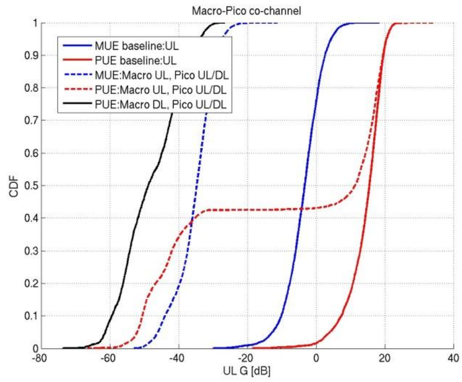


Figure 5.7.2-8: Simulation results from Source 8

Pico-Macro co-channel without interference mitigation scheme



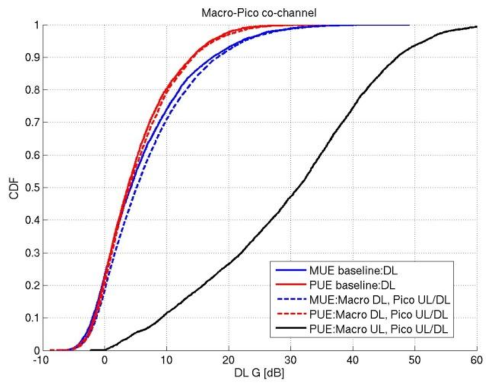


Figure 5.7.2-9: Simulation results from Source 9

Pico-Macro co-channel with and without interference mitigation scheme

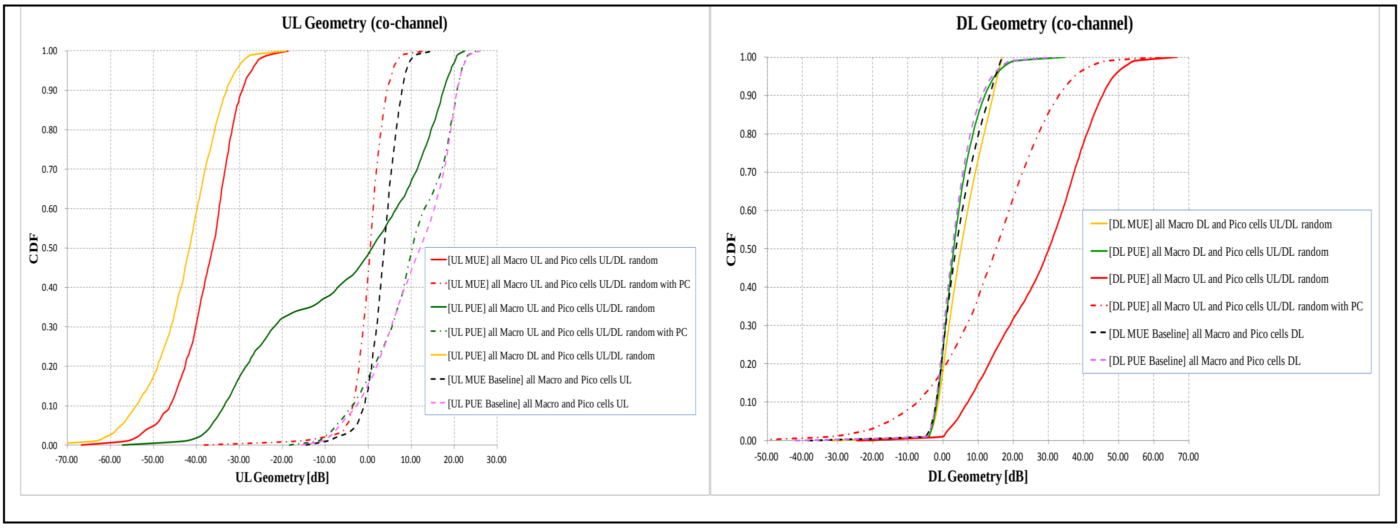


Figure 5.7.2-10: Simulation results from Source 10

5.8 Scenario 7

This scenario assumes multiple Macro cells deployed on the same carrier frequency for one operator and multiple Macro cells deployed on an adjacent carrier frequency for another operator, where all victim Macro cells deployed on the same carrier have the same UL-DL configuration and all aggressor Macro cells deployed on an adjacent carrier frequency can adjust UL-DL configuration. The simulation assumptions are included in Annex A.

5.8.1 Deterministic evaluations

The evaluation results using the deterministic approach are shown in Table 5.8.1-1.

Table 5.8.1-1: Results of deterministic approach

aggressor -> victim	Aggressor Tx power (dBm)	Victim cell acceptable interference (dBm)	Minimum BS separation distance (km)			
			Sources 1 – 2	Source 2	Source 3	Source 4
Macro->Macro	46	-106.5	112.850	113	112.8	112.3

Note: The results are calculated based on the Macro BS-BS pathloss model PL=98.45+20*log10(R), R in km

5.8.2 System simulation evaluations

The evaluation results by system simulations for scenario 7 are shown in Figures 5.8.2-1 to 5.8.2-7. The following cases are simulated:

- Case 1: Baseline is the transmission directions of all cells are the same.
- Case 2: All Macro cells of one operator are of the same transmission direction (i.e. either DL or UL) and the transmission direction of all Macro cells of another operator is different to the victim system.

Adjacent channel Macro-Macro cell and the aggressor (operator #1 on F1) and victim (operator #2 on F2) systems are offset by a cell radius

Macro-Macro adjacent-channel

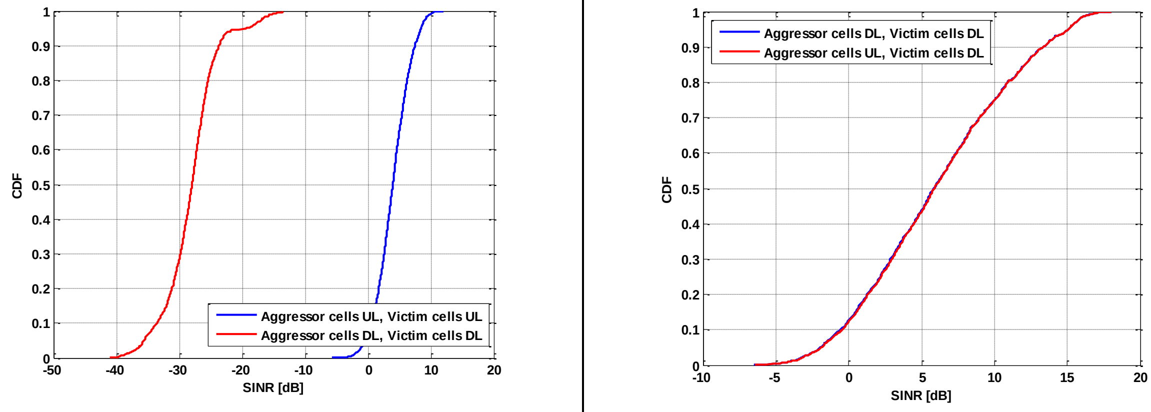


Figure 5.8.2-1: Simulation results from Source 1

Macro-Macro adjacent-channel

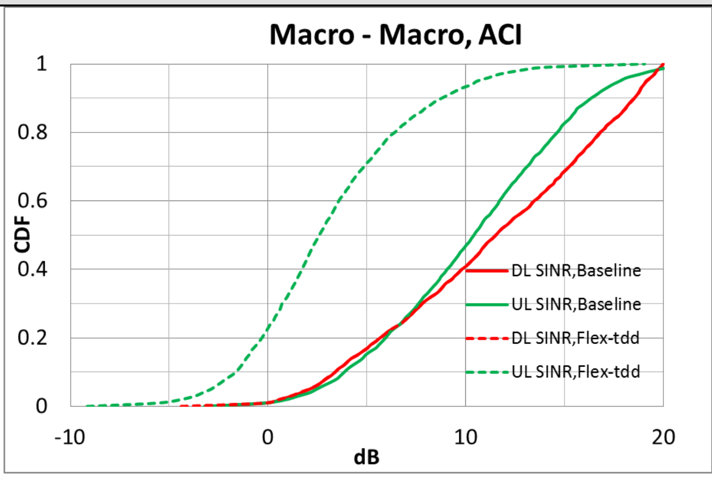


Figure 5.8.2-2: Simulation results from Source 2

Macro-Macro adjacent-channel

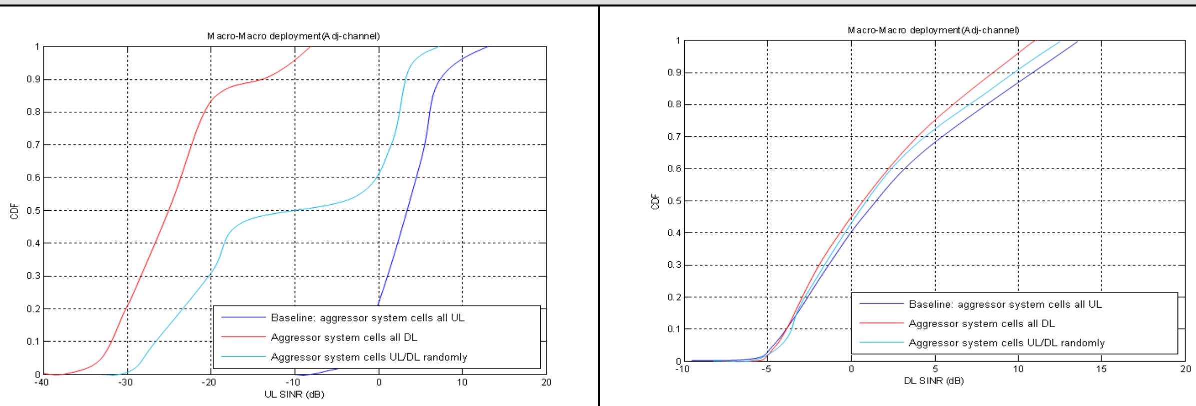
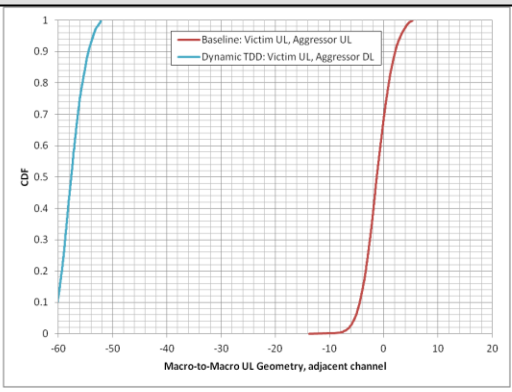


Figure 5.8.2-3: Simulation results from Source 3

Macro-Macro adjacent-channel



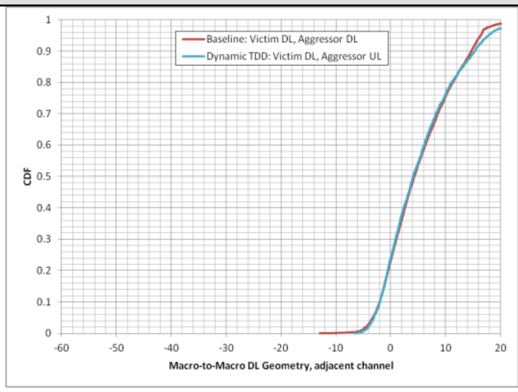
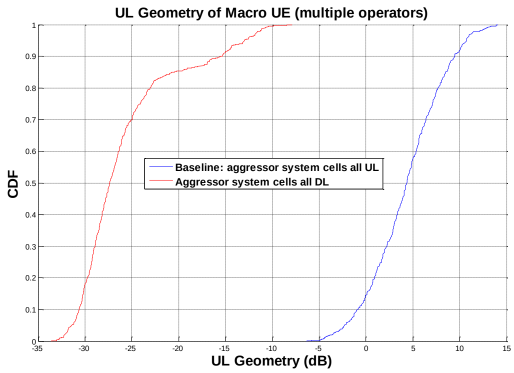


Figure 5.8.2-4: Simulation results from Source 4

Macro-Macro adjacent-channel



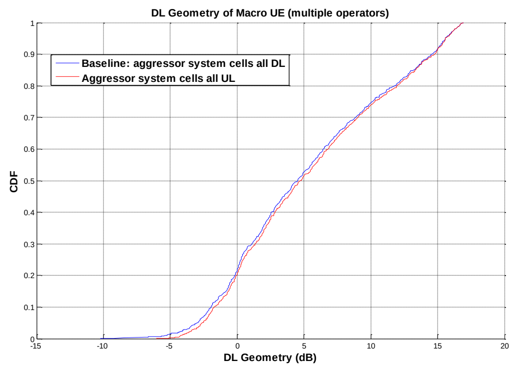
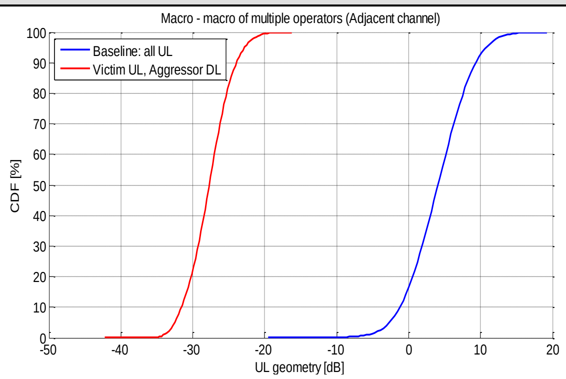


Figure 5.8.2-5: Simulation results from Source 5

Macro-Macro adjacent-channel



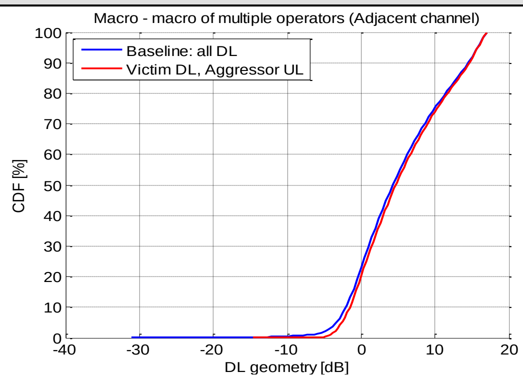


Figure 5.8.2-6: Simulation results from Source 6

Macro-Macro adjacent-channel

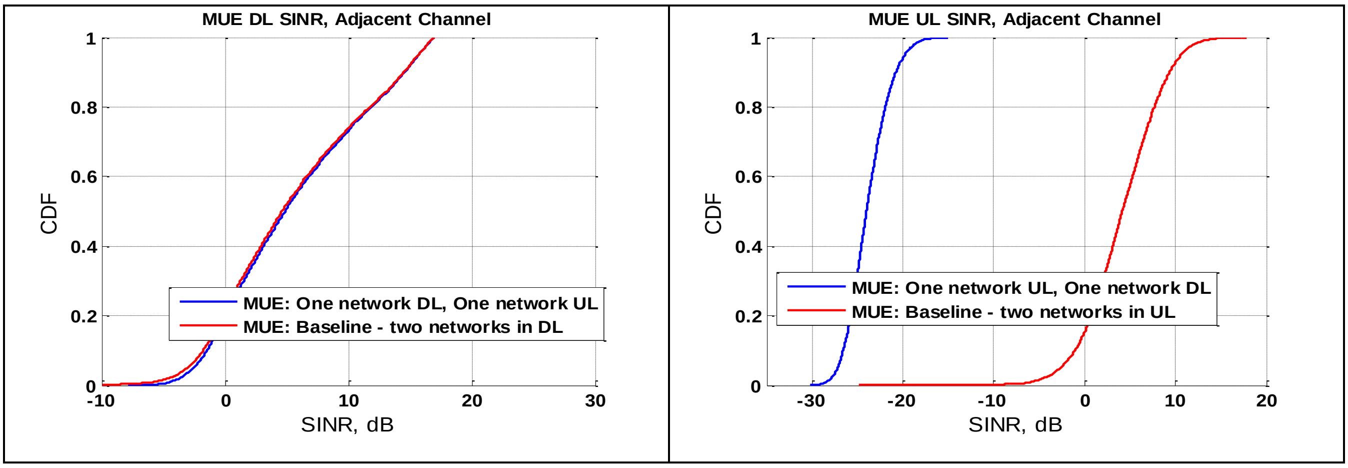


Figure 5.8.2-7: Simulation results from Source 7

5.9 Scenario 8

This scenario assumes multiple Macro cells deployed on the same carrier frequency for one operator. The simulation assumptions are included in Annex A. This scenario is studied mainly based on deterministic approach.

5.9.1 Deterministic evaluations

The evaluation results using the deterministic approach are shown in Table 5.9.1-1.

Table 5.9.1-1: Results of deterministic approach

aggressor -> victim	Aggressor Tx power (dBm)	Victim cell acceptable interference (dBm)	Minimum BS separation distance (km)		
			Source1&2&4&5	Source 3	Source 1
Macro->Macro	46	-106.5	15940 [1]	16000 [1]	39.8 [2]

[Note 1] The results are calculated based on the Macro BS-BS pathloss model PL=98.45+20*log10(R), R in km

[Note 2] The results are calculated based on the Macro BS-BS pathloss model

$$PL = \begin{cases} 98.45 + 20\log_{10}(R) & R \le 10.6km \\ 98.45 + 20\log_{10}(10.6) + 40\log_{10}(R) & R > 10.6km \end{cases}$$

5. 10 Summary

Based on the co-existence evaluations for the eight scenarios, following conclusions are made:

- Significant BS-BS co-existence challenges have been observed to apply different TDD UL-DL configurations in different cells for scenarios 1-4 without any interference mitigation mechanisms.
- It is feasible to apply different TDD UL-DL configurations in different cells for scenarios 1 – 4, only provided sufficient interference mitigation mechanisms are adopted. The interference mitigation schemes need further study.
- Significant BS-BS coexistence challenges have been observed when different TDD UL-DL configurations are applied in different cells for scenarios 5-8 without any interference mitigation schemes. Preliminary results with interference mitigation mechanisms were submitted but it has not been discussed. No conclusion on coexistence feasibility with interference mitigation mechanisms has been made.

6 Performance evaluation

6.1 Methodologies

To evaluate the benefits of TDD UL-DL reconfiguration based on traffic adaptation at least in terms of performance and energy saving, the following metrics can be used:

- Packet throughput, defined as the packet size over the packet transmission time, including the packet waiting time in the buffer
- UE average packet throughput, defined as the average of packet throughput for the UE
- {5%, 50%, 95%} UE average packet throughput, from the CDF of average packet throughput from all UEs
- Cell average packet throughput, defined as the mean of average packet throughput from all UEs
- Other metrics, e.g.
    - Packet drop statistics
    - Packet delay statistics
    - Frequency resource (PRBs) utilizations
    - Time resource (subframes) utilizations
    - CDF of packet throughput
    - Total number of configured DL/UL subframes

The gain of TDD UL-DL reconfiguration is assessed by comparing its performance relative to a fixed reference TDD UL-DL configuration, where the gain is evaluated over different fixed reference TDD UL-DL configurations and different downlink/uplink traffic loads. Downlink and uplink transmissions are evaluated in an integrated simulator, with metrics collected separately for downlink and uplink. Different time scales for TDD UL-DL reconfiguration are also evaluated to show its impact on the performance.

6.2 Scenario 1: Isolated pico cell

This section captures the simulation assumptions and evaluation results for the isolated pico cell scenario. The evaluation assumptions are shown in Table 6.2-1.

Table 6.2-1: Evaluation assumptions for isolated pico cell scenario

Parameters	Assumptions
Pico deployment	single cell , with a radius of 40 m
Pico antenna gain	5 dBi
Pico antenna pattern	2D, Omni-directional
Pico noise figure	13 dB
UE antenna gain	0 dBi

UE noise figure	9 dB
UE power class	23 dBm (200 mW)
Minimum distance between UE and pico	10 m
Number of UEs per pico cell	10
Shadowing standard deviation	3dB for LOS and 4dB for NLOS
Pathloss	$PL_{LOS}(R)$=103.8+20.9log10(R) $PL_{NLOS}(R)$=145.4+37.5log10(R) For 2GHz, R in km Case1: Prob(R)=0.5-min(0.5,5exp(-0.156/R))+min(0.5, 5exp(-R/0.03))
Maximum pico TX power	30 dBm
Traffic model	• FTP model 1 in TR36.814 • Poisson distributed with arrival rate λ • Number of UEs according to the simulated scenario • A packet is randomly assigned to a UE with equal probability • Independent traffic modeling for DL and UL per UE • Fixed size of 0.5Mbytes and 2Mbytes as in TR36.814 • Possible range of file arriving rate (λ) shall cover both low and high load cases. Proposed value range of λ for DL is [0.25, 0.5, 1, 1.5, 2, 2.5, 5, 7.5] for 0.5 Mbytes file size, [0.06, 0.12, 0.25, 0.37, 0.5, 0.625, 1.25, 1.875] for 2 Mbytes file size. The arriving rate for UL file is derived by the ratio of DL and UL arriving rate.
Time scale for reconfiguration	infinity (i.e. fixed reference configuration), or TDD UL-DL reconfiguration every 10ms, 200ms, or 640ms,
Fixed reference TDD UL-DL configurations	• TDD UL-DL configuration 0 with ratio of DL and UL arrival rate = {1/2} • TDD UL-DL configuration 1 with ratio of DL and UL arrival rate = {1/1, 2/1} • TDD UL-DL configuration 2 with ratio of DL and UL arrival rate = {2/1, 4/1}
HARQ modeling and HARQ retransmission	Not modeled
eNB antenna configuration	1 Tx, 2 Rx
UE antenna configuration	1 Tx, 2 Rx
System bandwidth	10 MHz
Link adaptation	MCS selection with 10% BLER, assuming ideal CSI

	If the highest MCS is selected, the BLER may be less than 10%, which shall be modeled
Set of TDD UL-DL configurations	The seven TDD UL-DL configurations defined in Rel-8 can be used for reconfigurations
Small scale fading	Not modeled
Carrier frequency	2 GHz
Cyclic prefix length	Normal CP in both downlink and uplink
Special subframe configuration	Configuration #8
Packet drop time	The packet drop time is either not modeled or modeled according to 36.814 (i.e. 8s for 0.5MB and 32s for 2MB)
Downlink/uplink receiver type	MMSE for both downlink and uplink
UL modulation order	{QPSK, 16QAM, 64QAM}

Tables 6.2-2 to 6.2-6 show the evaluation results of isolated pico cell scenario for different fixed reference TDD UL-DL configurations and different downlink/uplink traffic loads. The values are relative gain or loss of TDD UL-DL reconfiguration based on traffic adaptation compared to the fixed reference TDD UL-DL configuration.

Table 6.2-2: Fixed reference TDD UL-DL configuration 0, ratio of DL/UL arrival rates of 1:2

DL arrival rate	Metric	Time scale	Relative gain			Number of sources
			Mean	Max	Min	
0.25	average DL PTP	10ms	115.48%	136.43%	94.54%	2
		200ms	65.13%	65.13%	65.13%	1
		640ms	42.53%	50.42%	34.64%	2
	average UL PTP	10ms	-2.41%	-1.41%	-3.41%	2
		200ms	-31.70%	-31.70%	-31.70%	1
		640ms	-24.90%	-4.45%	-45.36%	2
	5% DL PTP	10ms	83.75%	83.75%	83.75%	1
		640ms	28.21%	28.21%	28.21%	1
	5% UL PTP	10ms	-2.20%	-2.20%	-2.20%	1
		640ms	-34.78%	-34.78%	-34.78%	1
0.5	average DL PTP	10ms	113.30%	133.30%	72.00%	6
		200ms	77.75%	91.14%	67.10%	3
		640ms	36.32%	41.73%	23.00%	6
	average UL PTP	10ms	-2.32%	-0.50%	-3.61%	6
		200ms	-7.21%	-3.40%	-13.62%	3

		640ms	-10.01%	-1.00%	-26.73%	6
	5% DL PTP	10ms	105.47%	126.87%	75.00%	6
		200ms	73.53%	86.11%	62.20%	3
		640ms	31.29%	61.46%	5.80%	6
	5% UL PTP	10ms	-2.65%	-1.08%	-4.60%	6
		200ms	-8.01%	-4.96%	-12.86%	3
		640ms	-20.70%	-10.28%	-40.16%	6
1	average DL PTP	10ms	90.79%	122.70%	66.00%	5
		200ms	66.64%	81.20%	52.07%	2
		640ms	36.60%	54.50%	13.00%	5
	average UL PTP	10ms	-5.05%	-3.20%	-7.03%	5
		200ms	-22.32%	-9.50%	-35.14%	2
		640ms	-19.94%	-3.00%	-51.35%	5
	5% DL PTP	10ms	84.57%	118.54%	46.98%	4
		200ms	74.17%	74.17%	74.17%	1
		640ms	30.27%	48.06%	7.69%	4
	5% UL PTP	10ms	-3.32%	-1.41%	-5.16%	4
		200ms	-9.08%	-9.08%	-9.08%	1
		640ms	-17.14%	-7.51%	-32.66%	4
1.5	average DL PTP	10ms	96.91%	96.91%	96.91%	1
		640ms	51.36%	51.36%	51.36%	1
	average UL PTP	10ms	-7.87%	-7.87%	-7.87%	1
		640ms	-21.30%	-21.30%	-21.30%	1
	5% DL PTP	10ms	108.36%	108.36%	108.36%	1
		640ms	72.23%	72.23%	72.23%	1
	5% UL PTP	10ms	-4.42%	-4.42%	-4.42%	1
		640ms	-23.32%	-23.32%	-23.32%	1
2	average DL PTP	10ms	71.92%	75.34%	68.50%	2
		200ms	51.50%	51.50%	51.50%	1
		640ms	42.83%	46.55%	39.10%	2
	average UL PTP	10ms	-11.22%	-10.00%	-12.44%	2
		200ms	-17.50%	-17.50%	-17.50%	1
		640ms	-28.10%	-27.20%	-29.00%	2
	5% DL PTP	10ms	83.57%	100.34%	66.80%	2

		200ms	57.60%	57.60%	57.60%	1
		640ms	69.07%	91.84%	46.30%	2
	5% UL PTP	10ms	-6.92%	-6.75%	-7.10%	2
		200ms	-17.30%	-17.30%	-17.30%	1
		640ms	-22.02%	-16.44%	-27.60%	2
2.5	average DL PTP	10ms	36.18%	50.00%	7.29%	5
		200ms	29.69%	45.13%	1.04%	3
		640ms	21.87%	35.70%	0.52%	5
	average UL PTP	10ms	-17.15%	-11.00%	-21.50%	5
		200ms	-27.75%	-16.47%	-44.09%	3
		640ms	-33.44%	-25.39%	-50.54%	5
	5% DL PTP	10ms	45.83%	60.99%	31.24%	4
		200ms	34.52%	40.39%	28.64%	2
		640ms	37.99%	54.98%	19.70%	4
	5% UL PTP	10ms	-12.01%	-5.60%	-19.65%	4
		200ms	-23.31%	-21.64%	-24.98%	2
		640ms	-23.36%	-13.07%	-31.67%	4
5	average DL PTP	10ms	13.63%	13.63%	13.63%	1
		640ms	8.71%	8.71%	8.71%	1
	average UL PTP	10ms	-6.33%	-6.33%	-6.33%	1
		640ms	-5.68%	-5.68%	-5.68%	1
	5% DL PTP	10ms	0.00%	0.00%	0.00%	1
		640ms	0.05%	0.05%	0.05%	1
	5% UL PTP	10ms	0.00%	0.00%	0.00%	1
		640ms	0.00%	0.00%	0.00%	1
7.5	average DL PTP	10ms	4.94%	9.87%	0.00%	2
		200ms	0.00%	0.00%	0.00%	1
		640ms	1.12%	2.53%	-0.30%	2
	average UL PTP	10ms	-2.61%	0.00%	-5.22%	2
		200ms	-0.10%	-0.10%	-0.10%	1
		640ms	-0.97%	-0.20%	-1.75%	2
	5% DL PTP	10ms	-0.10%	-0.10%	-0.10%	2
		200ms	0.10%	0.10%	0.10%	1
		640ms	0.05%	0.10%	0.00%	2

	5% UL PTP	10ms	0.00%	0.00%	0.00%	2
		200ms	0.00%	0.00%	0.00%	1
		640ms	-0.01%	0.00%	-0.01%	1

Table 6.2-3: Fixed reference TDD UL-DL configuration 1, ratio of DL/UL arrival rates of 1:1

DL arrival rate	Metric	Time scale	Relative gain			Number of sources
			Mean	Max	Min	
0.25	average DL PTP	10ms	50.02%	57.00%	39.53%	3
		200ms	30.87%	45.80%	15.93%	2
		640ms	9.69%	16.10%	4.72%	3
	average UL PTP	10ms	45.17%	47.44%	43.30%	3
		200ms	20.75%	26.10%	15.40%	2
		640ms	5.88%	11.15%	1.50%	3
	5% DL PTP	10ms	42.96%	80.50%	5.41%	2
		200ms	43.10%	43.10%	43.10%	1
		640ms	-14.54%	1.60%	-30.67%	2
	5% UL PTP	10ms	45.48%	48.80%	42.15%	2
		200ms	14.60%	14.60%	14.60%	1
		640ms	-21.59%	-0.89%	-42.30%	2
0.5	average DL PTP	10ms	50.89%	85.92%	26.00%	8
		200ms	25.31%	43.70%	12.80%	4
		640ms	3.20%	15.90%	-10.30%	8
	average UL PTP	10ms	47.21%	51.14%	43.80%	8
		200ms	30.63%	45.70%	18.60%	4
		640ms	13.21%	39.30%	-0.10%	8
	5% DL PTP	10ms	43.42%	91.02%	14.92%	8
		200ms	16.59%	27.50%	8.50%	4
		640ms	-9.00%	13.25%	-28.60%	8
	5% UL PTP	10ms	62.06%	83.60%	45.10%	8
		200ms	40.12%	70.97%	25.12%	4
		640ms	2.27%	60.30%	-34.80%	8
1	average DL PTP	10ms	41.12%	58.60%	19.00%	3
		200ms	38.80%	38.80%	38.80%	1

		640ms	9.77%	14.00%	7.30%	3
	average UL PTP	10ms	44.48%	46.14%	42.30%	3
		200ms	14.60%	14.60%	14.60%	1
		640ms	6.12%	12.86%	-1.50%	3
	5% DL PTP	10ms	38.79%	56.20%	23.83%	3
		200ms	19.80%	19.80%	19.80%	1
		640ms	-0.43%	15.40%	-21.40%	3
	5% UL PTP	10ms	46.23%	50.10%	39.82%	3
		200ms	14.60%	14.60%	14.60%	1
		640ms	-9.79%	15.92%	-35.10%	3
1.5	average DL PTP	10ms	47.96%	55.10%	40.82%	2
		200ms	32.60%	32.60%	32.60%	1
		640ms	9.00%	11.40%	6.60%	2
	average UL PTP	10ms	47.44%	47.49%	47.40%	2
		200ms	17.30%	17.30%	17.30%	1
		640ms	9.02%	12.94%	5.10%	2
	5% DL PTP	10ms	26.05%	29.40%	22.70%	2
		200ms	10.00%	10.00%	10.00%	1
		640ms	-10.81%	-4.03%	-17.60%	2
	5% UL PTP	10ms	52.85%	63.09%	42.60%	2
		200ms	17.20%	17.20%	17.20%	1
		640ms	-2.47%	8.16%	-13.10%	2
2	average DL PTP	10ms	34.63%	55.00%	18.00%	4
		200ms	18.15%	26.00%	10.30%	2
		640ms	2.57%	4.10%	-1.20%	4
	average UL PTP	10ms	46.24%	50.26%	40.00%	4
		200ms	24.80%	33.00%	16.60%	2
		640ms	13.70%	17.50%	4.60%	4
	5% DL PTP	10ms	33.71%	46.50%	27.73%	4
		200ms	14.95%	20.70%	9.20%	2
		640ms	0.81%	20.57%	-15.90%	4
	5% UL PTP	10ms	62.05%	83.49%	39.70%	4
		200ms	27.55%	36.70%	18.40%	2
		640ms	17.65%	37.37%	-4.10%	4

2.5	average DL PTP	10ms	36.94%	69.96%	18.92%	6
		200ms	10.53%	20.20%	-4.39%	4
		640ms	0.04%	4.94%	-4.73%	6
	average UL PTP	10ms	51.15%	67.60%	35.41%	6
		200ms	35.58%	52.98%	17.20%	4
		640ms	18.16%	31.60%	3.00%	6
	5% DL PTP	10ms	37.87%	75.13%	18.75%	5
		200ms	19.47%	27.90%	10.75%	3
		640ms	0.76%	6.60%	-5.27%	5
	5% UL PTP	10ms	77.57%	113.51%	37.34%	5
		200ms	60.50%	95.26%	30.50%	3
		640ms	36.04%	59.02%	3.59%	5
5	average DL PTP	10ms	-46.68%	-23.41%	-63.06%	4
		200ms	-49.83%	-30.55%	-63.34%	3
		640ms	-49.99%	-32.53%	-64.01%	4
	average UL PTP	10ms	45.22%	110.31%	12.00%	4
		200ms	41.44%	108.32%	2.70%	3
		640ms	37.42%	103.99%	0.08%	4
	5% DL PTP	10ms	-40.96%	-34.58%	-49.11%	3
		200ms	-43.80%	-39.49%	-48.10%	2
		640ms	-41.26%	-34.55%	-48.85%	3
	5% UL PTP	10ms	45.94%	73.52%	29.64%	3
		200ms	51.89%	71.66%	32.11%	2
		640ms	42.64%	70.79%	28.02%	3
7.5	average DL PTP	10ms	-1.21%	1.50%	-3.93%	2
		200ms	1.60%	1.60%	1.60%	1
		640ms	-2.95%	0.50%	-6.40%	2
	average UL PTP	10ms	0.62%	4.73%	-3.50%	2
		200ms	-3.60%	-3.60%	-3.60%	1
		640ms	-3.75%	-3.00%	-4.50%	2
	5% DL PTP	10ms	0.31%	1.00%	-0.39%	2
		200ms	1.60%	1.60%	1.60%	1
		640ms	0.17%	0.60%	-0.25%	2
	5% UL PTP	10ms	-0.91%	-0.02%	-1.80%	2

		200ms	-2.20%	-2.20%	-2.20%	1
		640ms	-0.96%	-0.01%	-1.90%	2

Table 6.2-4: Fixed reference TDD UL-DL configuration 1, ratio of DL/UL arrival rates of 2:1

DL arrival rate	Metric	Time scale	Relative gain			Number of sources
			Mean	Max	Min	
0.25	average DL PTP	10ms	57.66%	60.30%	55.01%	2
		200ms	57.90%	57.90%	57.90%	1
		640ms	24.07%	38.40%	9.73%	2
	average UL PTP	10ms	43.66%	46.32%	41.00%	2
		200ms	9.00%	9.00%	9.00%	1
		640ms	0.31%	9.03%	-8.40%	2
	5% DL PTP	10ms	63.10%	93.50%	32.69%	2
		200ms	55.60%	55.60%	55.60%	1
		640ms	-3.62%	3.20%	-10.45%	2
	5% UL PTP	10ms	29.35%	48.40%	10.31%	2
		200ms	12.00%	12.00%	12.00%	1
		640ms	-30.18%	-21.77%	-38.60%	2
0.5	average DL PTP	10ms	54.94%	59.30%	49.30%	5
		200ms	34.59%	54.90%	12.80%	4
		640ms	12.21%	35.10%	-10.30%	5
	average UL PTP	10ms	43.43%	47.90%	37.30%	5
		200ms	22.40%	45.10%	9.30%	4
		640ms	4.77%	40.80%	-13.86%	5
	5% DL PTP	10ms	54.31%	63.50%	49.36%	5
		200ms	25.75%	37.72%	11.36%	4
		640ms	-5.29%	12.10%	-20.00%	5
	5% UL PTP	10ms	43.30%	46.80%	38.06%	5
		200ms	18.13%	41.95%	5.10%	4
		640ms	-14.56%	34.05%	-45.40%	5
1	average DL PTP	10ms	60.71%	67.80%	53.61%	2
		200ms	62.80%	62.80%	62.80%	1
		640ms	24.20%	35.30%	13.10%	2

	average UL PTP	10ms	40.10%	42.00%	38.20%	2
		200ms	8.80%	8.80%	8.80%	1
		640ms	-0.78%	7.25%	-8.80%	2
	5% DL PTP	10ms	66.92%	76.40%	57.43%	2
		200ms	44.20%	44.20%	44.20%	1
		640ms	-4.63%	9.15%	-18.40%	2
	5% UL PTP	10ms	47.74%	57.60%	37.88%	2
		200ms	20.00%	20.00%	20.00%	1
		640ms	-26.00%	-16.49%	-35.50%	2
1.5	average DL PTP	10ms	65.04%	76.30%	53.78%	2
		200ms	66.20%	66.20%	66.20%	1
		640ms	26.29%	37.60%	14.98%	2
	average UL PTP	10ms	36.72%	39.54%	33.90%	2
		200ms	4.50%	4.50%	4.50%	1
		640ms	-2.19%	5.63%	-10.00%	2
	5% DL PTP	10ms	59.40%	65.70%	53.11%	2
		200ms	29.00%	29.00%	29.00%	1
		640ms	-2.94%	7.42%	-13.30%	2
	5% UL PTP	10ms	39.20%	40.20%	38.20%	2
		200ms	9.40%	9.40%	9.40%	1
		640ms	-28.25%	-18.71%	-37.80%	2
2	average DL PTP	10ms	69.83%	89.70%	46.90%	4
		200ms	50.65%	72.50%	28.80%	2
		640ms	22.23%	37.10%	16.47%	4
	average UL PTP	10ms	33.60%	36.39%	28.90%	4
		200ms	9.61%	15.82%	3.40%	2
		640ms	-3.02%	3.90%	-10.30%	4
	5% DL PTP	10ms	79.50%	132.48%	46.40%	4
		200ms	39.45%	52.20%	26.70%	2
		640ms	10.89%	16.93%	6.71%	4
	5% UL PTP	10ms	27.30%	33.30%	19.30%	4
		200ms	9.20%	15.20%	3.20%	2
		640ms	-22.65%	-8.10%	-36.40%	4
2.5	average DL PTP	10ms	68.40%	107.30%	55.10%	4

		200ms	50.48%	81.30%	26.60%	3
		640ms	22.68%	48.20%	10.80%	4
	average UL PTP	10ms	29.12%	33.17%	22.00%	4
		200ms	11.63%	20.50%	-1.40%	3
		640ms	-1.74%	12.50%	-11.55%	4
	5% DL PTP	10ms	79.38%	127.30%	57.07%	4
		200ms	55.58%	92.00%	28.13%	3
		640ms	19.58%	29.00%	9.31%	4
	5% UL PTP	10ms	24.99%	32.26%	8.30%	4
		200ms	17.32%	24.45%	8.20%	3
		640ms	-10.61%	5.69%	-26.70%	4
5	average DL PTP	10ms	228.32%	285.70%	167.87%	3
		200ms	229.04%	242.90%	215.18%	2
		640ms	159.56%	200.00%	109.85%	3
	average UL PTP	10ms	0.95%	2.60%	-0.83%	3
		200ms	-4.60%	-3.90%	-5.30%	2
		640ms	-19.55%	-18.40%	-21.70%	3
	5% DL PTP	10ms	453.41%	622.52%	213.17%	3
		200ms	519.77%	546.69%	492.84%	2
		640ms	364.71%	464.11%	189.79%	3
	5% UL PTP	10ms	0.47%	20.55%	-16.10%	3
		200ms	3.01%	15.47%	-9.45%	2
		640ms	-16.05%	-0.27%	-24.04%	3
7.5	average DL PTP	10ms	35.38%	49.30%	21.45%	2
		200ms	29.90%	29.90%	29.90%	1
		640ms	14.51%	19.60%	9.41%	2
	average UL PTP	10ms	-59.99%	-45.98%	-74.00%	2
		200ms	-74.10%	-74.10%	-74.10%	1
		640ms	-62.28%	-49.76%	-74.80%	2
	5% DL PTP	10ms	27.82%	50.20%	5.44%	2
		200ms	24.00%	24.00%	24.00%	1
		640ms	8.39%	12.10%	4.69%	2
	5% UL PTP	10ms	-32.51%	-24.20%	-40.82%	2
		200ms	-24.70%	-24.70%	-24.70%	1

		640ms	-33.26%	-25.20%	-41.32%	2

Table 6.2-5: Fixed reference TDD UL-DL configuration 2, ratio of DL/UL arrival rates of 2:1

DL arrival rate	Metric	Time scale	Relative gain			Number of sources
			Mean	Max	Min	
0.25	average DL PTP	10ms	13.66%	14.52%	12.80%	2
		200ms	11.10%	11.10%	11.10%	1
		640ms	-1.38%	-0.16%	-2.60%	2
	average UL PTP	10ms	185.96%	192.43%	179.50%	2
		200ms	116.20%	116.20%	116.20%	1
		640ms	73.77%	81.60%	65.94%	2
	5% DL PTP	10ms	-4.71%	-4.32%	-5.10%	2
		200ms	-23.70%	-23.70%	-23.70%	1
		640ms	-42.38%	-35.36%	-49.40%	2
	5% UL PTP	10ms	194.72%	195.50%	193.93%	2
		200ms	123.10%	123.10%	123.10%	1
		640ms	29.33%	36.46%	22.20%	2
0.5	average DL PTP	10ms	10.70%	13.61%	7.20%	7
		200ms	-5.17%	7.20%	-20.10%	5
		640ms	-14.23%	-3.10%	-37.10%	7
	average UL PTP	10ms	194.71%	208.90%	179.45%	7
		200ms	139.17%	192.90%	87.67%	5
		640ms	100.16%	185.70%	58.90%	7
	5% DL PTP	10ms	4.41%	14.20%	-15.22%	6
		200ms	-10.15%	-1.11%	-22.07%	4
		640ms	-33.92%	-16.90%	-44.10%	6
	5% UL PTP	10ms	229.37%	281.45%	196.10%	6
		200ms	155.84%	193.22%	129.10%	4
		640ms	92.03%	176.75%	31.60%	6
1	average DL PTP	10ms	5.58%	11.53%	-4.30%	3
		200ms	6.20%	6.20%	6.20%	1
		640ms	-10.36%	-6.39%	-13.00%	3
	average UL PTP	10ms	164.80%	210.30%	86.00%	3

		200ms	144.40%	144.40%	144.40%	1
		640ms	76.12%	104.80%	33.00%	3
	5% DL PTP	10ms	5.41%	8.73%	-0.50%	3
		200ms	-11.70%	-11.70%	-11.70%	1
		640ms	-24.14%	-3.49%	-50.00%	3
	5% UL PTP	10ms	186.23%	241.60%	100.94%	3
		200ms	160.00%	160.00%	160.00%	1
		640ms	50.89%	81.92%	30.96%	3
1.5	average DL PTP	10ms	8.93%	9.66%	8.20%	2
		200ms	2.00%	2.00%	2.00%	1
		640ms	-12.31%	-9.12%	-15.50%	2
	average UL PTP	10ms	219.97%	230.50%	209.44%	2
		200ms	158.00%	158.00%	158.00%	1
		640ms	114.41%	122.20%	106.62%	2
	5% DL PTP	10ms	3.86%	4.80%	2.92%	2
		200ms	-18.40%	-18.40%	-18.40%	1
		640ms	-35.12%	-25.04%	-45.20%	2
	5% UL PTP	10ms	283.07%	283.40%	282.74%	2
		200ms	199.00%	199.00%	199.00%	1
		640ms	96.74%	123.47%	70.00%	2
2	average DL PTP	10ms	1.90%	7.32%	-9.80%	4
		200ms	-6.20%	-3.80%	-8.60%	2
		640ms	-17.70%	-11.89%	-23.50%	4
	average UL PTP	10ms	190.42%	263.50%	58.00%	4
		200ms	181.30%	191.50%	171.10%	2
		640ms	104.29%	153.00%	11.00%	4
	5% DL PTP	10ms	2.28%	9.20%	-3.58%	4
		200ms	-11.75%	-10.50%	-13.00%	2
		640ms	-20.75%	6.48%	-38.80%	4
	5% UL PTP	10ms	260.48%	350.64%	125.59%	4
		200ms	231.10%	263.20%	199.00%	2
		640ms	131.08%	187.72%	73.99%	4
2.5	average DL PTP	10ms	1.32%	4.93%	-0.75%	4
		200ms	-12.71%	-8.54%	-18.00%	3

		640ms	-24.55%	-14.83%	-28.26%	4
	average UL PTP	10ms	285.19%	308.95%	253.43%	4
		200ms	249.24%	268.41%	228.20%	3
		640ms	184.99%	208.50%	155.13%	4
	5% DL PTP	10ms	-2.85%	-1.15%	-5.20%	4
		200ms	-16.50%	-10.23%	-19.90%	3
		640ms	-34.15%	-28.55%	-46.20%	4
	5% UL PTP	10ms	378.72%	429.42%	293.63%	4
		200ms	340.51%	411.30%	270.39%	3
		640ms	238.22%	277.49%	212.78%	4
5	average DL PTP	10ms	-19.37%	-15.00%	-24.20%	5
		200ms	-28.30%	-23.55%	-32.60%	3
		640ms	-33.71%	-20.00%	-41.00%	5
	average UL PTP	10ms	718.34%	1528.36%	20.00%	5
		200ms	831.87%	1448.12%	237.50%	3
		640ms	509.21%	1211.82%	4.00%	5
	5% DL PTP	10ms	-24.12%	-13.12%	-34.12%	4
		200ms	-30.25%	-22.66%	-37.84%	2
		640ms	-35.73%	-28.38%	-45.90%	4
	5% UL PTP	10ms	904.80%	1922.28%	35.85%	4
		200ms	1509.81%	1837.00%	1182.63%	2
		640ms	727.45%	1573.06%	17.87%	4
7.5	average DL PTP	10ms	-37.62%	-33.20%	-40.00%	3
		200ms	-40.20%	-33.40%	-47.00%	2
		640ms	-42.70%	-34.80%	-50.00%	3
	average UL PTP	10ms	57.77%	111.00%	13.70%	3
		200ms	39.93%	66.66%	13.20%	2
		640ms	29.36%	44.44%	10.30%	3
	5% DL PTP	10ms	-21.23%	-10.70%	-31.76%	2
		200ms	-10.66%	-10.66%	-10.66%	1
		640ms	-21.73%	-11.30%	-32.16%	2
	5% UL PTP	10ms	4.72%	5.20%	4.24%	2
		200ms	4.70%	4.70%	4.70%	1
		640ms	3.60%	3.90%	3.29%	2

Table 6.2-6: Fixed reference TDD UL-DL configuration 2, ratio of DL/UL arrival rates of 4:1

DL arrival rate	Metric	Time scale	Relative gain			Number of sources
			Mean	Max	Min	
0.25	average DL PTP	10ms	14.62%	15.74%	13.50%	2
		200ms	17.70%	17.70%	17.70%	1
		640ms	4.20%	7.70%	0.70%	2
	average UL PTP	10ms	186.90%	191.19%	182.60%	2
		200ms	123.30%	123.30%	123.30%	1
		640ms	66.59%	75.40%	57.78%	2
	5% DL PTP	10ms	10.51%	14.82%	6.20%	2
		200ms	-13.50%	-13.50%	-13.50%	1
		640ms	-35.76%	-22.92%	-48.60%	2
	5% UL PTP	10ms	171.59%	226.40%	116.77%	2
		200ms	129.30%	129.30%	129.30%	1
		640ms	8.61%	17.10%	0.11%	2
0.5	average DL PTP	10ms	13.03%	16.28%	7.10%	6
		200ms	2.85%	15.90%	-18.30%	4
		640ms	-7.32%	6.50%	-37.50%	6
	average UL PTP	10ms	189.91%	207.10%	175.00%	6
		200ms	138.58%	200.00%	110.60%	4
		640ms	87.94%	185.70%	53.73%	6
	5% DL PTP	10ms	9.14%	15.63%	-4.28%	6
		200ms	-0.44%	12.10%	-21.15%	4
		640ms	-22.76%	-2.00%	-39.46%	6
	5% UL PTP	10ms	204.77%	277.57%	177.50%	6
		200ms	132.30%	185.28%	95.70%	4
		640ms	67.71%	168.09%	19.10%	6
1	average DL PTP	10ms	9.76%	14.29%	0.10%	4
		200ms	15.00%	15.00%	15.00%	1
		640ms	-1.86%	1.00%	-4.00%	4
	average UL PTP	10ms	164.79%	200.29%	83.00%	4
		200ms	120.90%	120.90%	120.90%	1

		640ms	70.82%	106.94%	25.00%	4
	5% DL PTP	10ms	7.46%	15.00%	0.01%	4
		200ms	8.30%	8.30%	8.30%	1
		640ms	-20.13%	-3.43%	-40.10%	4
	5% UL PTP	10ms	196.34%	243.68%	100.73%	4
		200ms	154.70%	154.70%	154.70%	1
		640ms	58.41%	128.76%	23.00%	4
1.5	average DL PTP	10ms	13.50%	13.70%	13.30%	2
		200ms	14.20%	14.20%	14.20%	1
		640ms	-3.33%	-3.10%	-3.55%	2
	average UL PTP	10ms	185.31%	190.30%	180.31%	2
		200ms	124.50%	124.50%	124.50%	1
		640ms	78.46%	80.30%	76.62%	2
	5% DL PTP	10ms	15.33%	17.50%	13.16%	2
		200ms	4.00%	4.00%	4.00%	1
		640ms	-25.63%	-12.65%	-38.60%	2
	5% UL PTP	10ms	205.26%	224.70%	185.82%	2
		200ms	136.50%	136.50%	136.50%	1
		640ms	42.69%	60.88%	24.50%	2
2	average DL PTP	10ms	9.77%	13.50%	0.20%	4
		200ms	9.25%	13.10%	5.40%	2
		640ms	-4.49%	0.80%	-7.50%	4
	average UL PTP	10ms	143.99%	184.70%	45.00%	4
		200ms	122.85%	123.40%	122.30%	2
		640ms	64.05%	83.00%	20.00%	4
	5% DL PTP	10ms	8.85%	16.90%	-2.26%	4
		200ms	2.40%	3.20%	1.60%	2
		640ms	-15.83%	-2.00%	-35.40%	4
	5% UL PTP	10ms	176.36%	199.40%	149.58%	4
		200ms	133.25%	136.00%	130.50%	2
		640ms	60.11%	77.07%	36.40%	4
2.5	average DL PTP	10ms	10.74%	13.20%	6.10%	4
		200ms	0.15%	10.10%	-14.30%	3
		640ms	-14.24%	-5.92%	-24.50%	4

	average UL PTP	10ms	173.34%	176.90%	167.81%	4
		200ms	140.48%	161.50%	116.00%	3
		640ms	93.45%	130.80%	75.55%	4
	5% DL PTP	10ms	9.15%	13.48%	4.70%	4
		200ms	-3.96%	5.03%	-15.01%	3
		640ms	-25.54%	-17.09%	-37.90%	4
	5% UL PTP	10ms	170.67%	177.97%	163.50%	4
		200ms	148.34%	161.72%	130.70%	3
		640ms	83.45%	119.98%	50.50%	4
5	average DL PTP	10ms	7.74%	15.77%	-3.10%	4
		200ms	1.10%	9.29%	-7.10%	2
		640ms	-14.12%	-10.89%	-22.20%	4
	average UL PTP	10ms	123.69%	162.85%	21.00%	4
		200ms	153.81%	157.63%	150.00%	2
		640ms	82.63%	118.80%	5.00%	4
	5% DL PTP	10ms	13.90%	27.10%	2.19%	4
		200ms	-4.98%	-0.36%	-9.61%	2
		640ms	-10.63%	8.73%	-22.78%	4
	5% UL PTP	10ms	143.18%	183.15%	58.53%	4
		200ms	168.72%	182.53%	154.92%	2
		640ms	101.87%	140.73%	14.08%	4
7.5	average DL PTP	10ms	14.51%	20.90%	8.11%	2
		200ms	17.50%	17.50%	17.50%	1
		640ms	-3.02%	-2.00%	-4.04%	2
	average UL PTP	10ms	-8.05%	17.10%	-33.20%	2
		200ms	-34.50%	-34.50%	-34.50%	1
		640ms	-19.00%	6.00%	-44.00%	2
	5% DL PTP	10ms	10.33%	14.65%	6.00%	2
		200ms	5.30%	5.30%	5.30%	1
		640ms	7.14%	13.08%	1.20%	2
	5% UL PTP	10ms	-6.09%	5.92%	-18.10%	2
		200ms	-19.10%	-19.10%	-19.10%	1
		640ms	-8.16%	6.19%	-22.50%	2

6.3 Scenario 2: Multi-cell pico scenario

This section captures the simulation assumptions and evaluation results for the multi-cell pico scenario. The evaluation assumptions are shown in Table 6.3-1.

Table 6.3-1: Evaluation assumptions for multi-cell pico scenario

Parameters	Assumptions
Scenario	Co-channel and multiple pico cells
System bandwidth	10 MHz
Carrier frequency	2 GHz
Inter-site distance	500 m
Macro deployment	The typical 19-cell and 3-sectored hexagon system layout Note that macro cells are deployed but not activated
Pico deployment	40m radius, random deployment
Number of pico cells per sector	4
Minimum distance between pico cells	40 m
Minimum distance between UE and pico	10 m
Pico antenna pattern	2D, Omni-directional
Pico antenna gain	5 dBi
UE antenna gain	0 dBi
Pico noise figure	13 dB
UE noise figure	9 dB
Maximum pico TX power	24 dBm
UE power class	23 dBm (200 mW)
Number of UEs per pico cell	10 UEs uniformly dropped around each of the Pico cells within a radius of 40m
Shadowing standard deviation between outdoor Pico cells	6 dB
Shadowing correlation between UEs	0
Shadowing correlation between picos	0.5

Pico-to-pico pathloss	LOS: if R<2/3 km, PL(R)=98.4+20log10(R) [free space loss] else, PL(R)=101.9+40log10(R), R in km [Dual slop model TR25942 section5.1.4.3] NLOS: PL= 40log10(R)+169.36, R in km [25.942:section 7.4.1.2.1.4 TR 101 112(ETSI):Annex B1.8.1.2] Case1: Prob(R)=0.5-min(0.5,5exp(-0.156/R))+min(0.5, 5exp(-R/0.03)) [36.814: table A.2.1.1.2-3 the probability of Relay-UE case1]
Pico-to-UE pathloss	PL_{LOS}(R)=103.8+20.9log10(R) PL_{NLOS}(R)=145.4+37.5log10(R) For 2GHz, R in km Case1: Prob(R)=0.5-min(0.5,5exp(-0.156/R))+min(0.5, 5exp(-R/0.03)) [36.814: table A.2.1.1.2-3 Pico-UE]
UE-to-UE pathloss	If R<=50m, PL=98.45+20*log10(R), R in km If R>50m, PL=55.78 +40*log10(R), R in m (Xia model) [Section 7.4.1.2.1.4 of TS25942, Annex B1.8.1.2 of TR 101 112(ETSI), ETSI STC SMG2 UMTS L1#9 Tdoc 679/98]
Traffic model	• FTP model 1 in TR36.814 • Poisson distributed with arrival rate λ • Number of UEs according to the simulated scenario • A packet is randomly assigned to a UE with equal probability • Independent traffic modeling for DL and UL per UE • Fixed size of 0.5Mbytes and 2Mbytes as in TR36.814 • Possible range of file arriving rate (λ) shall cover both low and high load cases. Proposed value range of λ for DL is [0.25, 0.5, 1, 1.5, 2, 2.5, 5, 7.5] for 0.5 Mbytes file size, [0.06, 0.12, 0.25, 0.37, 0.5, 0.625, 1.25, 1.875] for 2 Mbytes file size. The arriving rate for UL file is derived by the ratio of DL and UL arriving rate. • Independent traffic generation per cell • Same arriving rate for all the cells
Time scale for reconfiguration	infinity (i.e. fixed reference configuration), or TDD UL-DL reconfiguration every 10ms, 200ms, or 640ms,
UE antenna configuration	1 Tx, 2 Rx
Fixed reference TDD UL-DL configurations	• TDD UL-DL configuration 1 with ratio of DL and UL arrival rate = {1/1, 2/1} • TDD UL-DL configuration 2 with ratio of DL and UL arrival rate = {2/1, 4/1}
Link adaptation	MCS selection with 10% BLER, assuming ideal CSI If the highest MCS is selected, the BLER may be less than 10%, which shall be modeled

Set of TDD UL-DL configurations	The seven TDD UL-DL configurations defined in Rel-8 can be used for reconfigurations
Cyclic prefix length	Normal CP in both downlink and uplink
Special subframe configuration	Configuration #8
Packet drop time	The packet drop time is either not modeled or modeled according to 36.814 (i.e. 8s for 0.5MB and 32s for 2MB)
Downlink/uplink receiver type	MMSE for both downlink and uplink
UL modulation order	{QPSK, 16QAM, 64QAM}
Shadowing standard deviation between Pico and UE	3dB for LOS and 4dB for NLOS

6.3.1 Evaluation results without interference mitigation

Tables 6.3.1-1 to 6.3.1-4 show the evaluation results of multi-cell pico scenario for different fixed reference TDD UL-DL configurations and different downlink/uplink traffic loads, without interference mitigation. The values are relative gain or loss of TDD UL-DL reconfiguration based on traffic adaptation compared to the fixed reference TDD UL-DL configuration.

Table 6.3.1-1: Fixed reference TDD UL-DL configuration 1, ratio of DL/UL arrival rates of 1:1

DL arrival rate	Metric	Time scale	Relative gain			Number of sources
			Mean	Max	Min	
0.25	average DL PTP	10ms	52.33%	52.33%	52.33%	1
		640ms	-14.58%	-14.58%	-14.58%	1
	average UL PTP	10ms	44.25%	44.25%	44.25%	1
		640ms	43.81%	43.81%	43.81%	1
	5% DL PTP	10ms	39.87%	39.87%	39.87%	1
		640ms	-22.14%	-22.14%	-22.14%	1
	5% UL PTP	10ms	29.54%	29.54%	29.54%	1
		640ms	4.82%	4.82%	4.82%	1
0.5	average DL PTP	10ms	41.41%	53.03%	17.00%	6
		200ms	20.64%	31.79%	9.50%	2
		640ms	-4.98%	4.90%	-12.50%	5
	average UL PTP	10ms	46.15%	65.88%	26.00%	6
		200ms	34.65%	44.50%	24.80%	2
		640ms	24.78%	49.74%	1.99%	5
	5% DL PTP	10ms	44.95%	66.00%	22.58%	6

		200ms	27.34%	42.08%	12.60%	2
		640ms	-4.27%	10.72%	-13.20%	5
	5% UL PTP	10ms	61.66%	131.14%	18.00%	6
		200ms	34.12%	45.00%	23.24%	2
		640ms	33.90%	83.95%	-4.80%	5
1	average DL PTP	10ms	36.01%	37.50%	34.52%	2
		640ms	-3.33%	-0.93%	-5.73%	2
	average UL PTP	10ms	34.67%	39.13%	30.20%	2
		640ms	25.99%	28.17%	23.81%	2
	5% DL PTP	10ms	23.34%	45.65%	1.03%	2
		640ms	-2.67%	6.25%	-11.58%	2
	5% UL PTP	10ms	21.13%	48.15%	-5.88%	2
		640ms	27.25%	43.98%	10.53%	2
1.5	average DL PTP	10ms	32.73%	39.90%	25.55%	2
		200ms	17.50%	17.50%	17.50%	1
		640ms	-1.22%	2.10%	-4.53%	2
	average UL PTP	10ms	45.64%	50.90%	40.38%	2
		200ms	47.20%	47.20%	47.20%	1
		640ms	32.26%	37.10%	27.42%	2
	5% DL PTP	10ms	53.20%	88.40%	17.99%	2
		200ms	74.40%	74.40%	74.40%	1
		640ms	23.18%	55.80%	-9.44%	2
	5% UL PTP	10ms	54.07%	105.60%	2.54%	2
		200ms	116.70%	116.70%	116.70%	1
		640ms	58.17%	111.10%	5.23%	2
2	average DL PTP	10ms	2.19%	11.00%	-6.63%	2
		640ms	-10.73%	1.70%	-23.16%	2
	average UL PTP	10ms	26.91%	41.62%	12.20%	2
		640ms	17.55%	29.10%	6.00%	2
	5% DL PTP	10ms	-15.19%	32.52%	-62.89%	2
		640ms	-30.01%	2.09%	-62.11%	2
	5% UL PTP	10ms	28.82%	44.98%	12.66%	2
		640ms	11.25%	17.72%	4.77%	2
2.5	average DL PTP	10ms	23.93%	24.76%	23.10%	2

		200ms	13.01%	17.02%	9.00%	2
		640ms	-2.62%	-2.60%	-2.64%	2
	average UL PTP	10ms	66.30%	70.90%	61.71%	2
		200ms	55.53%	62.50%	48.56%	2
		640ms	34.73%	45.70%	23.77%	2
	5% DL PTP	10ms	20.18%	23.67%	16.70%	2
		200ms	20.77%	24.84%	16.70%	2
		640ms	20.62%	24.54%	16.70%	2
	5% UL PTP	10ms	-12.75%	0.00%	-25.50%	2
		200ms	-12.39%	0.00%	-24.78%	2
		640ms	-12.62%	0.00%	-25.23%	2
5	average DL PTP	10ms	-79.83%	-79.83%	-79.83%	1
		200ms	-79.84%	-79.84%	-79.84%	1
		640ms	-79.87%	-79.87%	-79.87%	1
	average UL PTP	10ms	43.98%	43.98%	43.98%	1
		200ms	43.82%	43.82%	43.82%	1
		640ms	43.58%	43.58%	43.58%	1
	5% DL PTP	10ms	3.65%	3.65%	3.65%	1
		200ms	3.50%	3.50%	3.50%	1
		640ms	3.53%	3.53%	3.53%	1
	5% UL PTP	10ms	-3.86%	-3.86%	-3.86%	1
		200ms	-3.65%	-3.65%	-3.65%	1
		640ms	-4.41%	-4.41%	-4.41%	1

Table 6.3.1-2: Fixed reference TDD UL-DL configuration 1, ratio of DL/UL arrival rates of 2:1

DL arrival rate	Metric	Time scale	Relative gain			Number of sources
			Mean	Max	Min	
0.25	average DL PTP	10ms	42.65%	54.61%	30.70%	2
		640ms	-13.66%	-13.66%	-13.66%	1
	average UL PTP	10ms	41.86%	42.71%	41.00%	2
		640ms	41.86%	41.86%	41.86%	1
	5% DL PTP	10ms	50.49%	55.38%	45.60%	2
		640ms	-20.12%	-20.12%	-20.12%	1

	5% UL PTP	10ms	27.76%	45.60%	9.91%	2
		640ms	-12.49%	-12.49%	-12.49%	1
0.5	average DL PTP	10ms	44.97%	61.28%	32.10%	7
		200ms	22.77%	44.56%	11.00%	3
		640ms	1.51%	13.17%	-11.50%	5
	average UL PTP	10ms	39.29%	48.89%	29.13%	7
		200ms	22.25%	41.20%	9.13%	3
		640ms	10.42%	39.00%	-14.28%	5
	5% DL PTP	10ms	48.41%	71.00%	12.64%	7
		200ms	23.47%	55.82%	0.49%	3
		640ms	-1.13%	11.89%	-15.64%	5
	5% UL PTP	10ms	30.44%	77.17%	-14.77%	7
		200ms	8.65%	37.90%	-25.90%	3
		640ms	-3.10%	34.70%	-45.71%	5
1	average DL PTP	10ms	39.74%	50.86%	34.72%	4
		200ms	10.46%	10.46%	10.46%	1
		640ms	3.79%	7.75%	-0.24%	3
	average UL PTP	10ms	21.89%	27.60%	18.29%	4
		200ms	4.90%	4.90%	4.90%	1
		640ms	-1.57%	17.54%	-11.81%	3
	5% DL PTP	10ms	29.80%	47.80%	2.63%	4
		200ms	5.81%	5.81%	5.81%	1
		640ms	-6.21%	-3.09%	-11.65%	3
	5% UL PTP	10ms	-8.01%	18.10%	-31.77%	4
		200ms	-24.82%	-24.82%	-24.82%	1
		640ms	-26.13%	-10.30%	-44.16%	3
1.5	average DL PTP	10ms	61.37%	79.72%	38.00%	3
		200ms	34.30%	34.30%	34.30%	1
		640ms	27.71%	40.71%	14.70%	2
	average UL PTP	10ms	14.25%	21.80%	2.24%	3
		200ms	20.20%	20.20%	20.20%	1
		640ms	-3.45%	12.60%	-19.49%	2
	5% DL PTP	10ms	288.50%	550.79%	67.90%	3
		200ms	187.20%	187.20%	187.20%	1

		640ms	253.50%	368.69%	138.30%	2
	5% UL PTP	10ms	-14.98%	-1.00%	-33.34%	3
		200ms	-8.50%	-8.50%	-8.50%	1
		640ms	-25.34%	-9.60%	-41.07%	2
2	average DL PTP	10ms	51.51%	98.85%	28.29%	4
		200ms	10.50%	10.50%	10.50%	1
		640ms	20.82%	59.34%	-0.22%	3
	average UL PTP	10ms	0.25%	12.53%	-17.52%	4
		200ms	0.39%	0.39%	0.39%	1
		640ms	-17.20%	-7.94%	-32.71%	3
	5% DL PTP	10ms	65.94%	216.23%	-35.79%	4
		200ms	13.06%	13.06%	13.06%	1
		640ms	85.12%	286.78%	-24.21%	3
	5% UL PTP	10ms	-56.28%	-29.60%	-77.08%	4
		200ms	-55.93%	-55.93%	-55.93%	1
		640ms	-64.98%	-56.04%	-77.61%	3
2.5	average DL PTP	10ms	82.13%	92.00%	72.26%	2
		200ms	61.46%	62.70%	60.23%	2
		640ms	36.48%	44.00%	28.96%	2
	average UL PTP	10ms	-10.22%	-6.40%	-14.03%	2
		200ms	-15.38%	-9.60%	-21.15%	2
		640ms	-27.18%	-17.00%	-37.35%	2
	5% DL PTP	10ms	101.33%	152.67%	50.00%	2
		200ms	101.83%	153.66%	50.00%	2
		640ms	100.53%	167.77%	33.30%	2
	5% UL PTP	10ms	-90.02%	-82.20%	-97.83%	2
		200ms	-90.03%	-82.20%	-97.87%	2
		640ms	-89.97%	-82.20%	-97.73%	2
5	average DL PTP	10ms	496.78%	496.78%	496.78%	1
		200ms	470.56%	470.56%	470.56%	1
		640ms	402.12%	402.12%	402.12%	1
	average UL PTP	10ms	-37.95%	-37.95%	-37.95%	1
		200ms	-40.59%	-40.59%	-40.59%	1
		640ms	-47.73%	-47.73%	-47.73%	1

	5% DL PTP	10ms	19.69%	19.69%	19.69%	1
		200ms	19.50%	19.50%	19.50%	1
		640ms	19.51%	19.51%	19.51%	1
	5% UL PTP	10ms	-61.42%	-61.42%	-61.42%	1
		200ms	-61.48%	-61.48%	-61.48%	1
		640ms	-60.92%	-60.92%	-60.92%	1

Table 6.3.1-3: Fixed reference TDD UL-DL configuration 2, ratio of DL/UL arrival rates of 2:1

DL arrival rate	Metric	Time scale	Relative gain			Number of sources
			Mean	Max	Min	
0.25	average DL PTP	10ms	12.80%	12.80%	12.80%	1
		640ms	-37.01%	-37.01%	-37.01%	1
	average UL PTP	10ms	193.82%	193.82%	193.82%	1
		640ms	192.06%	192.06%	192.06%	1
	5% DL PTP	10ms	4.95%	4.95%	4.95%	1
		640ms	-46.05%	-46.05%	-46.05%	1
	5% UL PTP	10ms	175.19%	175.19%	175.19%	1
		640ms	119.11%	119.11%	119.11%	1
0.5	average DL PTP	10ms	9.03%	14.05%	3.00%	6
		200ms	-10.73%	2.23%	-18.70%	3
		640ms	-24.81%	-13.22%	-35.20%	5
	average UL PTP	10ms	199.72%	239.23%	159.77%	6
		200ms	155.70%	200.00%	119.54%	3
		640ms	135.57%	211.19%	81.75%	5
	5% DL PTP	10ms	3.41%	11.00%	-26.92%	6
		200ms	-17.66%	0.33%	-34.80%	3
		640ms	-33.17%	-19.74%	-45.27%	5
	5% UL PTP	10ms	203.87%	397.25%	139.00%	6
		200ms	158.94%	210.90%	112.61%	3
		640ms	129.26%	251.82%	55.78%	5
1	average DL PTP	10ms	3.91%	9.73%	-0.50%	4
		200ms	-18.42%	-18.42%	-18.42%	1
		640ms	-24.15%	-14.51%	-30.00%	4

	average UL PTP	10ms	190.37%	233.99%	145.09%	4
		200ms	117.36%	117.36%	117.36%	1
		640ms	145.40%	200.16%	82.72%	4
	5% DL PTP	10ms	-9.56%	8.97%	-25.19%	4
		200ms	-22.87%	-22.87%	-22.87%	1
		640ms	-31.60%	-19.61%	-40.85%	4
	5% UL PTP	10ms	148.93%	196.14%	69.53%	4
		200ms	86.79%	86.79%	86.79%	1
		640ms	112.74%	165.34%	38.73%	4
1.5	average DL PTP	10ms	8.85%	8.85%	8.85%	1
		640ms	-14.78%	-14.78%	-14.78%	1
	average UL PTP	10ms	207.83%	207.83%	207.83%	1
		640ms	142.40%	142.40%	142.40%	1
	5% DL PTP	10ms	16.36%	16.36%	16.36%	1
		640ms	-16.20%	-16.20%	-16.20%	1
	5% UL PTP	10ms	258.00%	258.00%	258.00%	1
		640ms	216.49%	216.49%	216.49%	1
2	average DL PTP	10ms	-4.48%	3.09%	-18.03%	4
		200ms	-19.37%	-15.80%	-22.94%	2
		640ms	-26.97%	-17.39%	-36.25%	4
	average UL PTP	10ms	217.34%	286.70%	149.28%	4
		200ms	199.55%	276.70%	122.40%	2
		640ms	175.48%	246.70%	97.27%	4
	5% DL PTP	10ms	-14.08%	44.73%	-68.72%	4
		200ms	-22.68%	-14.00%	-31.35%	2
		640ms	-14.00%	77.02%	-63.08%	4
	5% UL PTP	10ms	117.26%	328.60%	28.08%	4
		200ms	179.99%	328.60%	31.37%	2
		640ms	117.51%	314.30%	15.44%	4
2.5	average DL PTP	10ms	-7.35%	-1.40%	-13.31%	2
		200ms	-17.86%	-16.40%	-19.33%	2
		640ms	-30.47%	-26.00%	-34.93%	2
	average UL PTP	10ms	306.88%	319.00%	294.76%	2
		200ms	283.41%	304.80%	262.02%	2

		640ms	231.82%	276.20%	187.45%	2
	5% DL PTP	10ms	-52.63%	-10.00%	-95.26%	2
		200ms	-52.62%	-10.00%	-95.25%	2
		640ms	-52.49%	-10.00%	-94.98%	2
	5% UL PTP	10ms	44.72%	56.15%	33.30%	2
		200ms	43.33%	53.36%	33.30%	2
		640ms	48.18%	63.06%	33.30%	2

Table 6.3.1-4: Fixed reference TDD UL-DL configuration 2, ratio of DL/UL arrival rates of 4:1

DL arrival rate	Metric	Time scale	Relative gain			Number of sources
			Mean	Max	Min	
0.25	average DL PTP	10ms	13.33%	13.33%	13.33%	1
		640ms	-37.10%	-37.10%	-37.10%	1
	average UL PTP	10ms	187.18%	187.18%	187.18%	1
		640ms	185.47%	185.47%	185.47%	1
	5% DL PTP	10ms	6.63%	6.63%	6.63%	1
		640ms	-46.66%	-46.66%	-46.66%	1
	5% UL PTP	10ms	127.40%	127.40%	127.40%	1
		640ms	75.73%	75.73%	75.73%	1
0.5	average DL PTP	10ms	10.21%	16.41%	7.00%	4
		200ms	-4.77%	8.76%	-18.30%	2
		640ms	-26.41%	-14.09%	-34.80%	3
	average UL PTP	10ms	189.13%	207.76%	174.00%	4
		200ms	158.77%	188.20%	129.35%	2
		640ms	143.43%	190.18%	57.72%	3
	5% DL PTP	10ms	10.83%	18.47%	4.00%	4
		200ms	-4.54%	8.92%	-18.00%	2
		640ms	-30.64%	-20.53%	-36.40%	3
	5% UL PTP	10ms	177.71%	266.34%	97.00%	4
		200ms	152.17%	183.90%	120.44%	2
		640ms	111.59%	179.00%	25.55%	3
1	average DL PTP	10ms	5.50%	10.90%	0.10%	2
		640ms	-14.73%	-0.40%	-29.05%	2

	average UL PTP	10ms	91.37%	154.73%	28.00%	2
		640ms	80.53%	149.05%	12.00%	2
	5% DL PTP	10ms	1.62%	3.98%	-0.74%	2
		640ms	-19.30%	2.58%	-41.18%	2
	5% UL PTP	10ms	39.55%	58.20%	20.90%	2
		640ms	42.90%	68.17%	17.64%	2
2	average DL PTP	10ms	5.74%	13.80%	-2.32%	2
		200ms	-7.90%	-7.90%	-7.90%	1
		640ms	-24.16%	-20.10%	-28.23%	2
	average UL PTP	10ms	128.35%	138.90%	117.80%	2
		200ms	133.30%	133.30%	133.30%	1
		640ms	114.03%	116.70%	111.36%	2
	5% DL PTP	10ms	28.72%	104.20%	-46.77%	2
		200ms	75.00%	75.00%	75.00%	1
		640ms	-1.32%	41.70%	-44.34%	2
	5% UL PTP	10ms	8.11%	36.10%	-19.89%	2
		200ms	41.70%	41.70%	41.70%	1
		640ms	20.34%	33.30%	7.39%	2
2.5	average DL PTP	10ms	14.14%	14.50%	13.78%	2
		200ms	1.63%	7.55%	-4.30%	2
		640ms	-13.72%	-12.24%	-15.20%	2
	average UL PTP	10ms	108.16%	120.62%	95.70%	2
		200ms	96.56%	101.62%	91.50%	2
		640ms	64.63%	76.60%	52.65%	2
	5% DL PTP	10ms	50.35%	62.50%	38.20%	2
		200ms	50.23%	62.50%	37.97%	2
		640ms	35.54%	50.00%	21.08%	2
	5% UL PTP	10ms	-18.57%	22.86%	-60.00%	2
		200ms	-19.42%	21.15%	-60.00%	2
		640ms	-22.82%	14.36%	-60.00%	2
5	average DL PTP	10ms	11.92%	20.34%	3.50%	2
		200ms	14.12%	14.12%	14.12%	1
		640ms	-4.70%	-4.31%	-5.10%	2
	average UL PTP	10ms	59.40%	99.80%	19.00%	2

		200ms	96.01%	96.01%	96.01%	1
		640ms	36.51%	65.92%	7.10%	2
	5% DL PTP	10ms	14.52%	17.38%	11.65%	2
		200ms	11.58%	11.58%	11.58%	1
		640ms	6.21%	11.83%	0.60%	2
	5% UL PTP	10ms	-27.64%	-3.90%	-51.38%	2
		200ms	-51.35%	-51.35%	-51.35%	1
		640ms	-36.47%	-21.25%	-51.68%	2

6.3.2 Evaluation results with interference mitigation

Tables 6.3.2-1 to 6.3.2-4 show the evaluation results of multi-cell pico scenario for different fixed reference TDD UL-DL configurations and different downlink/uplink traffic loads, with interference mitigation. The values are relative gain or loss of TDD UL-DL reconfiguration based on traffic adaptation compared to the fixed reference TDD UL-DL configuration.

Table 6.3.2-1: Fixed reference TDD UL-DL configuration 1, ratio of DL/UL arrival rates of 1:1

DL arrival rate	Metric	Time scale	Relative gain			Number of sources
			Mean	Max	Min	
0.25	average DL PTP	10ms	47.56%	47.56%	47.56%	1
		640ms	-9.28%	-9.28%	-9.28%	1
	average UL PTP	10ms	46.46%	46.46%	46.46%	1
		640ms	38.72%	38.72%	38.72%	1
	5% DL PTP	10ms	28.21%	28.21%	28.21%	1
		640ms	-21.36%	-21.36%	-21.36%	1
	5% UL PTP	10ms	48.08%	48.08%	48.08%	1
		640ms	-13.84%	-13.84%	-13.84%	1
0.5	average DL PTP	10ms	33.72%	34.17%	33.26%	2
		640ms	-13.25%	-11.10%	-15.39%	2
	average UL PTP	10ms	50.26%	54.04%	46.48%	2
		640ms	43.42%	45.50%	41.33%	2
	5% DL PTP	10ms	18.65%	23.83%	13.47%	2
		640ms	-16.53%	-12.40%	-20.65%	2
	5% UL PTP	10ms	75.11%	83.18%	67.03%	2
		640ms	65.88%	84.82%	46.94%	2
1	average DL PTP	10ms	21.03%	27.07%	14.99%	2

		640ms	-10.81%	-3.31%	-18.32%	2
	average UL PTP	10ms	48.69%	49.75%	47.63%	2
		640ms	38.16%	45.06%	31.27%	2
	5% DL PTP	10ms	1.51%	11.58%	-8.56%	2
		640ms	-21.26%	-10.42%	-32.09%	2
	5% UL PTP	10ms	91.93%	102.74%	81.11%	2
		640ms	70.06%	98.01%	42.11%	2
1.5	average DL PTP	10ms	2.37%	12.15%	-7.41%	2
		640ms	-20.45%	-11.55%	-29.34%	2
	average UL PTP	10ms	60.35%	71.77%	48.93%	2
		640ms	46.36%	60.54%	32.18%	2
	5% DL PTP	10ms	-33.78%	0.00%	-67.55%	2
		640ms	-32.49%	0.00%	-64.97%	2
	5% UL PTP	10ms	111.81%	220.97%	2.65%	2
		640ms	152.66%	290.88%	14.44%	2
2	average DL PTP	10ms	-11.90%	-3.72%	-20.08%	2
		640ms	-26.88%	-18.47%	-35.29%	2
	average UL PTP	10ms	89.20%	110.14%	68.25%	2
		640ms	73.46%	96.65%	50.26%	2
	5% DL PTP	10ms	-32.91%	-18.97%	-46.84%	2
		640ms	-32.87%	-18.90%	-46.84%	2
	5% UL PTP	10ms	75.91%	102.53%	49.28%	2
		640ms	71.94%	94.94%	48.95%	2
2.5	average DL PTP	10ms	-1.95%	-1.95%	-1.95%	1
		640ms	-14.33%	-14.33%	-14.33%	1
	average UL PTP	10ms	54.89%	54.89%	54.89%	1
		640ms	42.02%	42.02%	42.02%	1
	5% DL PTP	10ms	0.00%	0.00%	0.00%	1
		640ms	0.00%	0.00%	0.00%	1
	5% UL PTP	10ms	0.00%	0.00%	0.00%	1
		640ms	0.00%	0.00%	0.00%	1

Table 6.3.2-2: Fixed reference TDD UL-DL configuration 1, ratio of DL/UL arrival rates of 2:1

DL arrival rate	Metric	Time scale	Relative gain			Number of sources
			Mean	Max	Min	
0.25	average DL PTP	10ms	52.04%	52.04%	52.04%	1
		640ms	-7.64%	-7.64%	-7.64%	1
	average UL PTP	10ms	43.93%	43.93%	43.93%	1
		640ms	36.64%	36.64%	36.64%	1
	5% DL PTP	10ms	38.53%	38.53%	38.53%	1
		640ms	-20.44%	-20.44%	-20.44%	1
	5% UL PTP	10ms	31.52%	31.52%	31.52%	1
		640ms	-28.15%	-28.15%	-28.15%	1
0.5	average DL PTP	10ms	41.59%	44.24%	38.36%	3
		200ms	21.11%	21.11%	21.11%	1
		640ms	6.98%	7.34%	6.61%	2
	average UL PTP	10ms	36.76%	46.40%	31.89%	3
		200ms	12.21%	12.21%	12.21%	1
		640ms	-2.49%	1.88%	-6.86%	2
	5% DL PTP	10ms	35.75%	46.02%	19.19%	3
		200ms	5.67%	5.67%	5.67%	1
		640ms	-2.21%	-1.58%	-2.84%	2
	5% UL PTP	10ms	28.82%	50.54%	-13.65%	3
		200ms	-21.29%	-21.29%	-21.29%	1
		640ms	-16.75%	11.47%	-44.97%	2
1	average DL PTP	10ms	39.48%	46.37%	31.17%	3
		200ms	13.48%	13.48%	13.48%	1
		640ms	4.17%	6.79%	-0.01%	3
	average UL PTP	10ms	19.82%	30.96%	7.18%	3
		200ms	6.89%	6.89%	6.89%	1
		640ms	-1.32%	16.67%	-10.48%	3
	5% DL PTP	10ms	34.61%	47.53%	14.10%	3
		200ms	24.09%	24.09%	24.09%	1
		640ms	-5.39%	-0.91%	-12.75%	3
	5% UL PTP	10ms	-4.79%	22.31%	-28.84%	3
		200ms	-24.14%	-24.14%	-24.14%	1

		640ms	-20.69%	-9.71%	-41.45%	3
1.5	average DL PTP	10ms	67.40%	73.92%	60.87%	2
		640ms	25.99%	25.99%	25.99%	1
	average UL PTP	10ms	-2.06%	13.72%	-17.83%	2
		640ms	-28.75%	-28.75%	-28.75%	1
	5% DL PTP	10ms	152.33%	304.65%	0.00%	2
		640ms	253.40%	253.40%	253.40%	1
	5% UL PTP	10ms	-49.00%	-42.35%	-55.64%	2
		640ms	-48.61%	-48.61%	-48.61%	1
2	average DL PTP	10ms	51.00%	67.22%	40.95%	3
		200ms	15.30%	15.30%	15.30%	1
		640ms	16.45%	31.96%	4.87%	3
	average UL PTP	10ms	-1.91%	18.68%	-40.22%	3
		200ms	3.94%	3.94%	3.94%	1
		640ms	-16.37%	5.81%	-46.77%	3
	5% DL PTP	10ms	52.67%	67.62%	36.84%	3
		200ms	36.00%	36.00%	36.00%	1
		640ms	30.14%	63.31%	2.37%	3
	5% UL PTP	10ms	-33.10%	18.27%	-76.12%	3
		200ms	-38.11%	-38.11%	-38.11%	1
		640ms	-38.12%	8.36%	-73.15%	3
2.5	average DL PTP	10ms	61.47%	61.47%	61.47%	1
	average UL PTP	10ms	-16.31%	-16.31%	-16.31%	1
	5% DL PTP	10ms	0.00%	0.00%	0.00%	1
	5% UL PTP	10ms	-32.14%	-32.14%	-32.14%	1

Table 6.3.2-3: Fixed reference TDD UL-DL configuration 2, ratio of DL/UL arrival rates of 2:1

DL arrival rate	Metric	Time scale	Relative gain			Number of sources
			Mean	Max	Min	
0.25	average DL PTP	10ms	10.92%	10.92%	10.92%	1
		640ms	-32.62%	-32.62%	-32.62%	1
	average UL PTP	10ms	196.32%	196.32%	196.32%	1
		640ms	181.32%	181.32%	181.32%	1

	5% DL PTP	10ms	-6.43%	-6.43%	-6.43%	1
		640ms	-46.26%	-46.26%	-46.26%	1
	5% UL PTP	10ms	229.28%	229.28%	229.28%	1
		640ms	79.90%	79.90%	79.90%	1
0.5	average DL PTP	10ms	6.22%	9.01%	3.42%	2
		200ms	-9.48%	-9.48%	-9.48%	1
		640ms	-19.00%	-17.69%	-20.31%	2
	average UL PTP	10ms	171.51%	177.47%	165.55%	2
		200ms	125.73%	125.73%	125.73%	1
		640ms	100.86%	114.35%	87.37%	2
	5% DL PTP	10ms	-7.76%	7.15%	-22.67%	2
		200ms	-31.44%	-31.44%	-31.44%	1
		640ms	-31.37%	-25.76%	-36.97%	2
	5% UL PTP	10ms	159.39%	171.01%	147.77%	2
		200ms	125.84%	125.84%	125.84%	1
		640ms	79.28%	100.68%	57.88%	2
1	average DL PTP	10ms	3.61%	4.08%	2.69%	3
		200ms	-16.19%	-16.19%	-16.19%	1
		640ms	-22.55%	-20.66%	-25.07%	3
	average UL PTP	10ms	174.98%	214.02%	151.34%	3
		200ms	121.47%	121.47%	121.47%	1
		640ms	127.57%	179.73%	86.16%	3
	5% DL PTP	10ms	-3.63%	3.65%	-9.19%	3
		200ms	-9.55%	-9.55%	-9.55%	1
		640ms	-31.85%	-27.62%	-39.01%	3
	5% UL PTP	10ms	181.86%	326.70%	76.79%	3
		200ms	88.47%	88.47%	88.47%	1
		640ms	131.16%	210.80%	45.48%	3
1.5	average DL PTP	10ms	-2.57%	-2.57%	-2.57%	1
		640ms	-23.70%	-23.70%	-23.70%	1
	average UL PTP	10ms	147.40%	147.40%	147.40%	1
		640ms	114.51%	114.51%	114.51%	1
	5% DL PTP	10ms	-27.65%	-27.65%	-27.65%	1
		640ms	-36.81%	-36.81%	-36.81%	1

	5% UL PTP	10ms	138.23%	138.23%	138.23%	1
		640ms	175.99%	175.99%	175.99%	1
2	average DL PTP	10ms	-7.42%	0.99%	-13.30%	3
		200ms	-19.59%	-19.59%	-19.59%	1
		640ms	-10.95%	26.86%	-31.59%	3
	average UL PTP	10ms	190.45%	283.13%	131.69%	3
		200ms	130.25%	130.25%	130.25%	1
		640ms	150.44%	241.56%	103.45%	3
	5% DL PTP	10ms	-21.13%	-6.77%	-33.33%	3
		200ms	-17.43%	-17.43%	-17.43%	1
		640ms	-28.01%	-6.95%	-39.23%	3
	5% UL PTP	10ms	195.60%	478.79%	33.44%	3
		200ms	84.50%	84.50%	84.50%	1
		640ms	176.89%	430.30%	50.05%	3

Table 6.3.2-4: Fixed reference TDD UL-DL configuration 2, ratio of DL/UL arrival rates of 4:1

DL arrival rate	Metric	Time scale	Relative gain			Number of sources
			Mean	Max	Min	
0.25	average DL PTP	10ms	-32.27%	-32.27%	-32.27%	1
		640ms	-32.27%	-32.27%	-32.27%	1
	average UL PTP	10ms	173.65%	173.65%	173.65%	1
		640ms	173.65%	173.65%	173.65%	1
	5% DL PTP	10ms	-45.11%	-45.11%	-45.11%	1
		640ms	-45.11%	-45.11%	-45.11%	1
	5% UL PTP	10ms	40.51%	40.51%	40.51%	1
		640ms	40.51%	40.51%	40.51%	1
1	average DL PTP	10ms	9.28%	9.28%	9.28%	1
		640ms	-22.29%	-22.29%	-22.29%	1
	average UL PTP	10ms	172.08%	172.08%	172.08%	1
		640ms	144.01%	144.01%	144.01%	1
	5% DL PTP	10ms	2.57%	2.57%	2.57%	1
		640ms	-37.79%	-37.79%	-37.79%	1
	5% UL PTP	10ms	178.14%	178.14%	178.14%	1

		640ms	88.10%	88.10%	88.10%	1
2	average DL PTP	10ms	5.25%	5.25%	5.25%	1
		640ms	-18.80%	-18.80%	-18.80%	1
	average UL PTP	10ms	159.28%	159.28%	159.28%	1
		640ms	130.87%	130.87%	130.87%	1
	5% DL PTP	10ms	-1.04%	-1.04%	-1.04%	1
		640ms	-23.90%	-23.90%	-23.90%	1
	5% UL PTP	10ms	186.93%	186.93%	186.93%	1
		640ms	152.84%	152.84%	152.84%	1

6.4 Scenario 3: Co-channel multi-cell macro-pico scenario

This section captures the simulation assumptions and evaluation results for the co-channel multi-cell macro-pico scenario. The evaluation assumptions are shown in Table 6.4-1.

Table 6.4-1: Evaluation assumptions for multi-cell macro pico scenario

Parameters	Assumptions
Scenario	Multi-cell macro-pico scenario
System bandwidth	10 MHz
Carrier frequency	2 GHz
Inter-site distance	500 m
Macro deployment	The typical 19-cell and 3-sectored hexagon system layout
Pico deployment	40m radius, random deployment
Number of pico cells per sector	4
Minimum distance between pico cells	40 m
Minimum distance between outdoor pico and macro	75m
Minimum distance between UE and pico	10 m
Minimum distance between UE and Macro	35m
Macro antenna gain	15dBi

Macro antenna pattern	$$A(\theta) = -\min\left[12\left(\frac{\theta}{\theta_{3dB}}\right)^2, A_m\right]$$ θ 3dB = 65 degrees, Am = 20 dB (65 degree horizontal beamwidth)
Pico antenna pattern	2D, Omni-directional
Pico antenna gain	5 dBi
UE antenna gain	0 dBi
Macro noise figure	5dB
Pico noise figure	13 dB
UE noise figure	9 dB
Maximum macro Tx power	46dBm
Maximum pico TX power	24 dBm
Macro DL power control	Not modeled, i.e. assuming max macro Tx power
UE power class	23 dBm (200 mW)
Number of UEs per macro cell	Non-uniform 60UE/macro cell (i.e. 20 Macro UEs randomly and uniformly dropped per Macro cell)
Number of UEs per pico cell	10 UEs uniformly dropped around each of the Pico cells within a radius of 40m
User distribution	Cluster, $P_{hotspot}$=2/3
Shadowing standard deviation between outdoor Pico cells	6 dB
Shadowing standard deviation between outdoor Pico and Macro	6 dB
Shadowing correlation between UEs	0
Shadowing correlation between picos	0.5
Shadowing correlation between outdoor pico and macro	0.5
Shadowing correlation between macro cells	A shadowing correlation factor of 0.5 for the shadowing between sites (regardless aggressing or victim system) and of 1 between sectors of the same site shall be used
Outdoor Pico to outdoor Pico pathloss	LOS: if R<2/3 km, PL(R)=98.4+20log10(R) [free space loss] else, PL(R)=101.9+40log10(R), R in km [Dual slop model TR25942

	section5.1.4.3] NLOS: PL= 40log10(R)+169.36, R in km [25.942:section 7.4.1.2.1.4 TR 101 112(ETSI):Annex B1.8.1.2] Case 1: Prob(R)=0.5-min(0.5,5exp(-0.156/R))+min(0.5, 5exp(-R/0.03)) [36.814: table A.2.1.1.2-3 the probability of Relay-UE case1]
Outdoor Pico to UE pathloss	$PL_{LOS}(R)=103.8+20.9\log10(R)$ $PL_{NLOS}(R)=145.4+37.5\log10(R)$ For 2GHz, R in km Case 1: Prob(R)=0.5-min(0.5,5exp(-0.156/R))+min(0.5, 5exp(-R/0.03)) [36.814: table A.2.1.1.2-3 Pico-UE]
UE to UE pathloss	If R<=50m, PL=98.45+20*log10(R), R in km If R>50m, PL=55.78 +40*log10(R), R in m (Xia model) [Section 7.4.1.2.1.4 of TS25942, Annex B1.8.1.2 of TR 101 112(ETSI), ETSI STC SMG2 UMTS L1#9 Tdoc 679/98]
Macro to UE pathloss	$PL_{LOS}(R)=103.4+24.2\log10(R)$ $PL_{NLOS}(R)= 131.1+42.8\log10(R)$ For 2GHz, R in km. Case 1: Prob(R)=min(0.018/R,1)*(1-exp(-R/0.063))+exp(-R/0.063) [36.814: table A2.1.1.5-2]
Macro to outdoor Pico	$PL_{LOS}(R) = 100.7+23.5\log10(R)$ $PL_{NLOS}(R) = 125.2+36.3\log10(R)$ For 2GHz, R in km. Case1: Prob(R)=min(0.018/R,1)*(1-exp(-R/0.072))+exp(-R/0.072) [36.814 table A.2.1.1.2-3 reuse the model of Macro-Relay]
Time scale for reconfiguration	infinity (i.e. fixed reference configuration), or TDD UL-DL reconfiguration every 10ms, 200ms, or 640ms, with 200ms optional
Simulation methodology	DL and UL shall be evaluated in an integrated simulator
Pico antenna configuration	Set 1: 2Tx, 2Rx (codebook-based SU-MIMO or fixed rank 1 transmission) Set 2: 1Tx, 2Rx
UE antenna configuration	1Tx, 2Rx
Link adaptation	* MCS selection with 10% BLER

	If the highest MCS is selected, the BLER may be less than 10%, which shall be modeled * DL based on CQI/PMI/RI reports and UL based on SRS measurement
DL CSI feedback	DL CSI modeled as following: -- PUCCH mode 1-1, wideband CQI/PMI reported every 10ms -- CSI reporting based on ideal channel estimation and ideal interference estimation in the reported subframe -- A minimum 5ms CSI feedback delay is modeled -- Error free feedback
UL CSI feedback	UL CSI modeled as following --1 symbol SRS per 10ms (Last UL symbol in subframe#1) -- UL CSI based on ideal channel estimation and ideal interference estimation in the SRS subframe -- A minimum 5 ms CSI delay is modeled
Channel estimation	Ideal
Small scaling fading channel	For set 1: Pico-UE/UE-Pico: TU or ITU; Macro-UE/UE-Macro: TU or ITU; UE-UE: TU or not modeled; Pico-Pico: not modeled. Macro-Macro: not modeled Macro-Pico/Pico-Macro: not modeled For set 2: Not modeled
CP length	Normal CP in both downlink and uplink.
Special subframe configuration	Special subframe configuration #8
Packet drop time	The packet drop time is either not modeled or model according to 36.814 (i.e. 8s for 0.5MB and 32s for 2MB).
Receiver type	MMSE receiver
UL modulation order	{QPSK, 16QAM, 64QAM}
Traffic model	● FTP model 1 in TR36.814 ● Poisson distributed with arrival rate λ ● Number of UEs according to the simulated scenario ● A packet is randomly assigned to a UE with equal probability ● Independent traffic modeling for DL and UL per UE ● Fixed size of 0.5Mbytes and 2Mbytes as in TR36.814 ● Possible range of file arriving rate (λ) shall cover both low and high load cases. Proposed value range of λ for DL is [0.25, 0.5, 1, 1.5, 2, 2.5, 5, 7.5] for 0.5 Mbytes file size, [0.06, 0.12, 0.25, 0.37, 0.5, 0.625, 1.25, 1.875] for 2 Mbytes file size. The arriving rate for UL file is derived by the ratio of DL and UL arriving rate. ● Independent traffic generation per cell Same arriving rate for all the cells
Reference TDD configuration	Evaluate at least the following TDD reference configurations for Pico cell TDD UL-DL configuration 1 with ratio of DL and UL arrival rate =

	{ 2/1, 4/1} Macro Cell TDD UL-DL configurations are fixed as TDD UL-DL configuration 1 with ratio of DL and UL arrival rate = { 2/1, 4/1} Other traffic ratios and reference configurations are optional
HARQ retransmission scheme	CC
Simulation cases	Case 1. All pico cells have the same UL-DL configurations Case 2. Applying adaptive UL-DL configuration in pico cells without any interference mitigation schemes. Case 3. Applying adaptive UL-DL configuration in pico cells with interference mitigation schemes.
Control channel and reference signal overhead	DL: • Overhead for CRS according to 36.211; • Overhead for PDCCH: 2 OFDM symbols; UL: • Overhead for SRS defined above; • Overhead for PUCCH: 2 PRBs; • Overhead for UL DMRS: 2 symbols per subframe.
Shadow fading for Macro-UE link	8dB
Shadowing standard deviation between outdoor Pico and UE	3dB for LOS and 4dB for NLOS [ITU-R M.2135 UMi]

6.4.1 Evaluation results without interference mitigation

Tables 6.4.1-1 to 6.4.1-4 show the evaluation results of co-channel multi-cell macro-pico scenario for different fixed reference TDD UL-DL configurations and different downlink/uplink traffic loads, without interference mitigation. The values are relative gain or loss of TDD UL-DL reconfiguration based on traffic adaptation compared to the fixed reference TDD UL-DL configuration.

Table 6.4.1-1a collects the metrics separately for pico and macro, and Table 6.4.1-1b collects the metrics jointly for pico and macro.

Table 6.4.1-1a: Fixed reference TDD UL-DL configuration 1, ratio of DL/UL arrival rates of 2:1

DL arrival rate	Metric	Time scale	Relative gain						Num of sources
			Mean		Max		Mean		
			Pico	Macro	Pico	Macro	Pico	Macro	
0.25	Average DL PTP	10ms	37.64%	1.65%	37.87%	3.51%	37.40%	-0.20%	2
	Average UL PTP	10ms	-48.01%	-72.24%	-20.50%	-60.50%	-75.53%	-83.99%	2
	5% DL PTP	10ms	-12.08%	7.99%	52.50%	15.07%	-76.66%	0.90%	2
	5% UL PTP	10ms	-67.66%	-78.18%	-46.80%	-70.70%	-88.52%	-85.65%	2

0.5	Average DL PTP	10ms	37.37%	-0.77%	99.22%	3.93%	-27.20%	-8.30%	8
		200ms	77.30%	-1.23%	77.30%	-1.23%	77.30%	-1.23%	1
		640ms	10.01%	-1.37%	55.67%	2.68%	-30.50%	-5.21%	4
	Average UL PTP	10ms	-49.75%	-74.08%	-33.00%	-61.20%	-89.70%	-92.20%	8
		200ms	-61.55%	-92.12%	-61.55%	-92.12%	-61.55%	-92.12%	1
		640ms	-62.50%	-67.96%	-41.90%	-54.20%	-91.90%	-92.12%	4
	5% DL PTP	10ms	41.67%	-0.65%	132.10%	23.70%	-34.40%	-13.15%	8
		200ms	59.69%	-1.31%	59.69%	-1.31%	59.69%	-1.31%	1
		640ms	9.46%	-4.16%	55.17%	3.70%	-37.80%	-11.44%	4
	5% UL PTP	10ms	-66.02%	-89.09%	-40.62%	-61.48%	-95.30%	-140.32%	8
		200ms	-65.65%	-69.26%	-65.65%	-69.26%	-65.65%	-69.26%	1
		640ms	-63.39%	-75.93%	-44.48%	-58.55%	-95.30%	-95.73%	4
1	Average DL PTP	10ms	43.52%	5.52%	134.31%	10.38%	-1.84%	0.82%	4
		200ms	107.84%	9.97%	107.84%	9.97%	107.84%	9.97%	1
		640ms	44.62%	1.86%	80.06%	3.45%	9.18%	0.27%	2
	Average UL PTP	10ms	-62.78%	-77.74%	-47.19%	-52.47%	-81.68%	-100.00%	4
		200ms	-64.94%	-76.85%	-64.94%	-76.85%	-64.94%	-76.85%	1
		640ms	-57.14%	-59.30%	-44.68%	-44.19%	-69.60%	-74.42%	2
	5% DL PTP	10ms	30.30%	11.55%	91.13%	34.62%	-18.24%	-3.18%	4
		200ms	147.39%	8.05%	147.39%	8.05%	147.39%	8.05%	1
		640ms	56.12%	-0.16%	98.96%	4.37%	13.27%	-4.69%	2
	5% UL PTP	10ms	-63.92%	-77.84%	-45.24%	-54.75%	-80.97%	-100.88%	4
		200ms	-72.18%	-67.63%	-72.18%	-67.63%	-72.18%	-67.63%	1
		640ms	-45.56%	-75.04%	-43.59%	-47.72%	-47.52%	-102.37%	2
1.5	Average DL PTP	10ms	77.86%	0.17%	132.82%	1.22%	28.25%	-0.76%	3
		200ms	105.20%	-3.69%	105.20%	-3.69%	105.20%	-3.69%	1
		640ms	87.37%	0.45%	87.37%	0.45%	87.37%	0.45%	1
	Average UL PTP	10ms	-73.14%	-57.38%	-58.31%	-25.24%	-94.37%	-96.81%	3
		200ms	-62.16%	-48.76%	-62.16%	-48.76%	-62.16%	-48.76%	1
		640ms	-64.23%	-36.74%	-64.23%	-36.74%	-64.23%	-36.74%	1
	5% DL PTP	10ms	12.15%	0.53%	17.56%	1.26%	8.30%	0.05%	3
		200ms	10.61%	-4.29%	10.61%	-4.29%	10.61%	-4.29%	1
		640ms	9.20%	0.43%	9.20%	0.43%	9.20%	0.43%	1

	5% UL PTP	10ms	-62.88%	-50.53%	-39.15%	-0.88%	-98.51%	-95.24%	3
		200ms	-40.46%	-45.58%	-40.46%	-45.58%	-40.46%	-45.58%	1
		640ms	-63.58%	-48.33%	-63.58%	-48.33%	-63.58%	-48.33%	1
2	Average DL PTP	10ms	52.12%	4.63%	123.43%	17.14%	1.74%	-2.52%	4
		200ms	100.89%	-2.83%	100.89%	-2.83%	100.89%	-2.83%	1
		640ms	81.62%	-5.38%	81.62%	-5.38%	81.62%	-5.38%	1
	Average UL PTP	10ms	-69.98%	-63.21%	-63.83%	-26.65%	-78.96%	-100.00%	4
		200ms	-66.36%	-19.39%	-66.36%	-19.39%	-66.36%	-19.39%	1
		640ms	-69.85%	-3.90%	-69.85%	-3.90%	-69.85%	-3.90%	1
	5% DL PTP	10ms	23.98%	-2.75%	44.39%	-1.84%	10.91%	-3.77%	3
		200ms	8.37%	-3.57%	8.37%	-3.57%	8.37%	-3.57%	1
		640ms	10.22%	-4.37%	10.22%	-4.37%	10.22%	-4.37%	1
	5% UL PTP	10ms	-61.24%	-42.42%	-45.97%	-8.62%	-75.08%	-100.00%	4
		200ms	-55.77%	-26.44%	-55.77%	-26.44%	-55.77%	-26.44%	1
		640ms	-67.01%	-4.02%	-67.01%	-4.02%	-67.01%	-4.02%	1
2.5	Average DL PTP	10ms	10.22%	3.81%	11.37%	7.70%	9.07%	-0.08%	2
	Average UL PTP	10ms	-78.15%	-53.44%	-58.85%	-42.75%	-97.45%	-64.12%	2
	5% DL PTP	10ms	0.84%	-1.74%	3.31%	-0.04%	-1.64%	-3.44%	2
	5% UL PTP	10ms	-43.43%	-36.40%	-9.85%	5.23%	-77.00%	-78.03%	2

Table 6.4.1-1b: Fixed reference TDD UL-DL configuration 1, ratio of DL/UL arrival rates of 2:1

DL arrival rate	Metric	Time scale	Relative gain			Num of sources
			Mean	Max	Mean	
0.25	Average DL PTP	10ms	21.00%	21.00%	21.00%	1
	Average UL PTP	10ms	-35.40%	-35.40%	-35.40%	1
	5% DL PTP	10ms	29.00%	29.00%	29.00%	1

	5% UL PTP	10ms	-69.40%	-69.40%	-69.40%	1
0.5	Average DL PTP	10ms	37.00%	45.00%	29.00%	2
		200ms	7.00%	7.00%	7.00%	1
	Average UL PTP	10ms	-30.50%	-14.00%	-47.00%	2
		200ms	-18.00%	-18.00%	-18.00%	1
	5% DL PTP	10ms	68.20%	69.00%	67.40%	2
		200ms	28.00%	28.00%	28.00%	1
	5% UL PTP	10ms	-82.00%	-64.00%	-100.00%	2
		200ms	-59.00%	-59.00%	-59.00%	1
1	Average DL PTP	10ms	29.00%	29.00%	29.00%	1
		200ms	10.00%	10.00%	10.00%	1
	Average UL PTP	10ms	-34.00%	-34.00%	-34.00%	1
		200ms	-32.00%	-32.00%	-32.00%	1
	5% DL PTP	10ms	42.00%	42.00%	42.00%	1
		200ms	26.00%	26.00%	26.00%	1
	5% UL PTP	10ms	-78.00%	-78.00%	-78.00%	1
		200ms	-77.00%	-77.00%	-77.00%	1

Table 6.4.1-2a collects the metrics separately for pico and macro, and Table 6.4.1-2b collects the metrics jointly for pico and macro.

Table 6.4.1-2a: Fixed reference TDD UL-DL configuration 1, ratio of DL/UL arrival rates of 4:1

DL arrival rate	Metric	Time scale	Relative gain						Num of sources
			Mean		Max		Min		
			Pico	Macro	Pico	Macro	Pico	Macro	
0.25	Average DL PTP	10ms	45.54%	3.70%	45.54%	3.70%	45.54%	3.70%	1
	Average UL PTP	10ms	-73.48%	-79.22%	-73.48%	-79.22%	-73.48%	-79.22%	1
	5% DL PTP	10ms	-79.95%	13.24%	-79.95%	13.24%	-79.95%	13.24%	1
	5% UL PTP	10ms	-82.70%	-83.36%	-82.70%	-83.36%	-82.70%	-83.36%	1
0.5	Average	10ms	85.13%	10.17%	137.20%	20.47%	56.00%	1.12%	4

	DL PTP	200ms	117.39%	12.91%	117.39%	12.91%	117.39%	12.91%	1
		640ms	99.17%	8.27%	99.17%	8.27%	99.17%	8.27%	1
	Average UL PTP	10ms	-40.06%	-76.31%	-30.27%	-62.20%	-51.67%	-93.29%	4
		200ms	-59.43%	-93.24%	-59.43%	-93.24%	-59.43%	-93.24%	1
		640ms	-68.53%	-93.23%	-68.53%	-93.23%	-68.53%	-93.23%	1
	5% DL PTP	10ms	100.06%	21.19%	149.85%	26.70%	62.97%	16.03%	4
		200ms	127.53%	17.14%	127.53%	17.14%	127.53%	17.14%	1
		640ms	139.81%	6.90%	139.81%	6.90%	139.81%	6.90%	1
	5% UL PTP	10ms	-55.12%	-83.57%	-37.19%	-73.41%	-75.79%	-95.93%	4
		200ms	-63.45%	-119.42%	-63.45%	-119.42%	-63.45%	-119.42%	1
		640ms	-82.62%	-82.13%	-82.62%	-82.13%	-82.62%	-82.13%	1
1	Average DL PTP	10ms	120.98%	8.45%	206.03%	15.48%	35.94%	1.41%	2
		200ms	181.12%	1.55%	181.12%	1.55%	181.12%	1.55%	1
		640ms	157.90%	6.64%	157.90%	6.64%	157.90%	6.64%	1
	Average UL PTP	10ms	-73.86%	-89.87%	-67.89%	-87.99%	-79.84%	-91.75%	2
		200ms	-69.93%	-91.51%	-69.93%	-91.51%	-69.93%	-91.51%	1
		640ms	-73.34%	-89.85%	-73.34%	-89.85%	-73.34%	-89.85%	1
	5% DL PTP	10ms	115.66%	17.13%	214.46%	33.09%	16.87%	1.17%	2
		200ms	207.73%	1.24%	207.73%	1.24%	207.73%	1.24%	1
		640ms	142.37%	6.13%	142.37%	6.13%	142.37%	6.13%	1
	5% UL PTP	10ms	-75.11%	-94.90%	-62.57%	-82.12%	-87.65%	-107.68%	2
		200ms	-86.79%	-64.28%	-86.79%	-64.28%	-86.79%	-64.28%	1
		640ms	-38.53%	-85.79%	-38.53%	-85.79%	-38.53%	-85.79%	1
1.5	Average DL PTP	10ms	134.92%	2.69%	218.55%	5.81%	75.17%	0.01%	3
		200ms	189.42%	6.22%	189.42%	6.22%	189.42%	6.22%	1
		640ms	168.51%	7.06%	168.51%	7.06%	168.51%	7.06%	1
	Average UL PTP	10ms	-75.18%	-75.81%	-69.95%	-43.10%	-85.42%	-97.01%	3
		200ms	-72.35%	-87.00%	-72.35%	-87.00%	-72.35%	-87.00%	1
		640ms	-74.35%	-77.59%	-74.35%	-77.59%	-74.35%	-77.59%	1
	5% DL PTP	10ms	33.26%	-1.25%	88.42%	2.57%	-12.57%	-6.33%	3
		200ms	22.16%	3.41%	22.16%	3.41%	22.16%	3.41%	1
		640ms	13.62%	8.07%	13.62%	8.07%	13.62%	8.07%	1
	5%	10ms	-79.71%	-77.69%	-57.73%	-46.27%	-94.08%	-97.10%	3

	UL PTP	200ms	-93.92%	-114.32%	-93.92%	-114.32%	-93.92%	-114.32%	1
		640ms	-81.21%	-87.84%	-81.21%	-87.84%	-81.21%	-87.84%	1
2	Average DL PTP	10ms	143.95%	2.43%	239.91%	3.29%	47.98%	1.58%	2
		200ms	205.05%	-0.96%	205.05%	-0.96%	205.05%	-0.96%	1
		640ms	183.38%	8.37%	183.38%	8.37%	183.38%	8.37%	1
	Average UL PTP	10ms	-77.48%	-79.74%	-72.56%	-78.34%	-82.40%	-81.15%	2
		200ms	-73.32%	-76.29%	-73.32%	-76.29%	-73.32%	-76.29%	1
		640ms	-75.07%	-26.59%	-75.07%	-26.59%	-75.07%	-26.59%	1
	5% DL PTP	10ms	13.90%	1.31%	18.87%	1.31%	8.93%	1.31%	2
		200ms	21.59%	-0.94%	21.59%	-0.94%	21.59%	-0.94%	1
		640ms	9.69%	6.29%	9.69%	6.29%	9.69%	6.29%	1
	5% UL PTP	10ms	-78.11%	-56.93%	-74.79%	-55.74%	-81.43%	-58.12%	2
		200ms	-79.46%	-65.69%	-79.46%	-65.69%	-79.46%	-65.69%	1
		640ms	-95.76%	-28.20%	-95.76%	-28.20%	-95.76%	-28.20%	1
2.5	Average DL PTP	10ms	104.31%	0.01%	195.42%	0.01%	13.20%	0.00%	2
	Average UL PTP	10ms	-80.94%	-59.85%	-70.05%	-20.83%	-91.83%	-98.86%	2
	5% DL PTP	10ms	0.30%	0.06%	6.39%	0.12%	-5.80%	0.00%	2
	5% UL PTP	10ms	-76.25%	-49.43%	-54.35%	-0.15%	-98.16%	-98.70%	2

Table 6.4.1-2b: Fixed reference TDD UL-DL configuration 1, ratio of DL/UL arrival rates of 4:1

DL arrival rate	Metric	Time scale	Relative gain			Num of sources
			Mean	Max	Min	
0.5	Average DL PTP	10ms	52%	52%	52%	1
		200ms	14%	14%	14%	1
	Average UL PTP	10ms	-16%	-16%	-16%	1
		200ms	-17%	-17%	-17%	1
	5% DL PTP	10ms	69%	69%	69%	1
		200ms	27%	27%	27%	1
	5%	10ms	-63%	-63%	-63%	1

	UL PTP	200ms	-53%	-53%	-53%	1
1	Average DL PTP	10ms	57%	57%	57%	1
		200ms	27%	27%	27%	1
	Average UL PTP	10ms	-27%	-27%	-27%	1
		200ms	-26%	-26%	-26%	1
	5% DL PTP	10ms	83%	83%	83%	1
		200ms	52%	52%	52%	1
	5% UL PTP	10ms	-68%	-68%	-68%	1
		200ms	-72%	-72%	-72%	1

Table 6.4.1-3: Fixed reference TDD UL-DL configuration 2, ratio of DL/UL arrival rates of 2:1

DL arrival rate	Metric	Time scale	Relative gain						Num of sources
			Mean		Max		Min		
			Pico	Macro	Pico	Macro	Pico	Macro	
0.5	Average DL PTP	10ms	-1.89%	-2.90%	-1.89%	-2.90%	-1.89%	-2.90%	1
	Average UL PTP	10ms	132.40%	2.24%	132.40%	2.24%	132.40%	2.24%	1
	5% DL PTP	10ms	-4.90%	-28.26%	-4.90%	-28.26%	-4.90%	-28.26%	1
	5% UL PTP	10ms	128.21%	-15.67%	128.21%	-15.67%	128.21%	-15.67%	1
1.5	Average DL PTP	10ms	-33.23%	-2.49%	-33.23%	-2.49%	-33.23%	-2.49%	1
	Average UL PTP	10ms	-0.51%	-9.30%	-0.51%	-9.30%	-0.51%	-9.30%	1
	5% DL PTP	10ms	-20.93%	-4.82%	-20.93%	-4.82%	-20.93%	-4.82%	1
	5% UL PTP	10ms	-11.90%	-17.67%	-11.90%	-17.67%	-11.90%	-17.67%	1
2.5	Average DL PTP	10ms	-10.59%	-1.86%	-10.59%	-1.86%	-10.59%	-1.86%	1

	Average UL PTP	10ms	-27.71%	24.34%	-27.71%	24.34%	-27.71%	24.34%	1
	5% DL PTP	10ms	-7.97%	-1.48%	-7.97%	-1.48%	-7.97%	-1.48%	1
	5% UL PTP	10ms	-17.13%	-85.72%	-17.13%	-85.72%	-17.13%	-85.72%	1

Table 6.4.1-4: Fixed reference TDD UL-DL configuration 2, ratio of DL/UL arrival rates of 4:1

DL arrival rate	Metric	Time scale	Relative gain						Num of sources
			Mean		Max		Min		
			Pico	Macro	Pico	Macro	Pico	Macro	
0.5	Average DL PTP	10ms	8.16%	-0.30%	8.16%	-0.30%	8.16%	-0.30%	1
	Average UL PTP	10ms	93.50%	-20.90%	93.50%	-20.90%	93.50%	-20.90%	1
	5% DL PTP	10ms	13.09%	-2.01%	13.09%	-2.01%	13.09%	-2.01%	1
	5% UL PTP	10ms	100.99%	-12.05%	100.99%	-12.05%	100.99%	-12.05%	1
1.5	Average DL PTP	10ms	-8.11%	1.20%	-8.11%	1.20%	-8.11%	1.20%	1
	Average UL PTP	10ms	5.53%	28.26%	5.53%	28.26%	5.53%	28.26%	1
	5% DL PTP	10ms	2.75%	0.00%	2.75%	0.00%	2.75%	0.00%	1
	5% UL PTP	10ms	-0.91%	-0.97%	-0.91%	-0.97%	-0.91%	-0.97%	1
2.5	Average DL PTP	10ms	-4.13%	-2.05%	-4.13%	-2.05%	-4.13%	-2.05%	1
	Average UL PTP	10ms	-6.49%	4.35%	-6.49%	4.35%	-6.49%	4.35%	1
	5% DL PTP	10ms	1.71%	0.04%	1.71%	0.04%	1.71%	0.04%	1
	5%	10ms	-0.77%	0.04%	-0.77%	0.04%	-0.77%	0.04%	1

	UL PTP								

6.4.2 Evaluation results with interference mitigation

Tables 6.4.2-1 to 6.4.2-2 show the evaluation results of co-channel multi-cell macro-pico scenario for different fixed reference TDD UL-DL configurations and different downlink/uplink traffic loads, with interference mitigation. The values are relative gain or loss of TDD UL-DL reconfiguration based on traffic adaptation compared to the fixed reference TDD UL-DL configuration.

Table 6.4.2-1a collects the metrics separately for pico and macro, and Table 6.4.2-1b collects the metrics jointly for pico and macro.

Table 6.4.2-1a: Fixed reference TDD UL-DL configuration 1, ratio of DL/UL arrival rates of 2:1

DL arrival rate	Metric	Time scale	Relative gain						Num of sources
			Mean		Max		Min		
			Pico	Macro	Pico	Macro	Pico	Macro	
0.25	Average DL PTP	10ms	31.47%	0.71%	63.94%	2.02%	-1.00%	-0.60%	2
	Average UL PTP	10ms	-4.93%	-40.28%	-3.30%	-0.50%	-6.55%	-80.06%	2
	5% DL PTP	10ms	41.82%	0.87%	84.44%	1.13%	-0.80%	0.60%	2
	5% UL PTP	10ms	-28.91%	-41.67%	-3.10%	-1.50%	-54.72%	-81.84%	2
0.5	Average DL PTP	10ms	20.20%	-0.24%	42.14%	1.78%	-0.30%	-2.50%	4
		640ms	8.42%	-1.83%	13.60%	-1.16%	3.23%	-2.50%	2
	Average UL PTP	10ms	5.21%	-35.19%	54.50%	1.10%	-27.81%	-62.12%	4
		640ms	14.15%	-31.31%	30.80%	-29.22%	-2.50%	-33.40%	2
	5% DL PTP	10ms	14.57%	0.69%	45.72%	6.86%	-27.55%	-6.42%	4
		640ms	-1.20%	-2.29%	10.34%	1.85%	-12.75%	-6.42%	2
	5% UL PTP	10ms	11.44%	-33.13%	103.86%	4.30%	-30.49%	-71.20%	4
		640ms	16.80%	-26.76%	54.94%	-0.88%	-21.33%	-52.64%	2
1	Average DL PTP	10ms	58.63%	8.68%	94.47%	16.13%	22.79%	1.23%	2
	Average UL PTP	10ms	-25.22%	-67.50%	-24.17%	-54.85%	-26.26%	-80.14%	2
	5% DL PTP	10ms	75.91%	19.28%	126.47%	36.15%	25.34%	2.41%	2

	5% UL PTP	10ms	-39.86%	-55.94%	-26.81%	-55.74%	-52.90%	-56.15%	2
1.5	Average DL PTP	10ms	11.60%	4.88%	11.60%	4.88%	11.60%	4.88%	1
		640ms	-1.60%	10.88%	-1.60%	10.88%	-1.60%	10.88%	1
	Average UL PTP	10ms	-4.30%	-39.08%	-4.30%	-39.08%	-4.30%	-39.08%	1
		640ms	-9.02%	-43.18%	-9.02%	-43.18%	-9.02%	-43.18%	1
	5% DL PTP	10ms	-4.70%	21.32%	-4.70%	21.32%	-4.70%	21.32%	1
		640ms	-3.19%	28.15%	-3.19%	28.15%	-3.19%	28.15%	1
	5% UL PTP	10ms	-46.43%	-72.17%	-46.43%	-72.17%	-46.43%	-72.17%	1
		640ms	-47.38%	-54.18%	-47.38%	-54.18%	-47.38%	-54.18%	1
2	Average DL PTP	10ms	113.43%	11.88%	156.45%	16.65%	70.41%	7.11%	2
	Average UL PTP	10ms	-41.88%	-53.30%	-38.80%	-50.93%	-44.96%	-55.67%	2
	5% DL PTP	10ms	63.32%	-1.92%	67.31%	3.28%	59.32%	-7.11%	2
	5% UL PTP	10ms	-37.15%	-13.21%	-33.50%	-6.90%	-40.80%	-19.53%	2
2.5	Average DL PTP	10ms	15.29%	12.17%	15.29%	12.17%	15.29%	12.17%	1
		640ms	37.68%	12.43%	37.68%	12.43%	37.68%	12.43%	1
	Average UL PTP	10ms	-0.49%	-4.53%	-0.49%	-4.53%	-0.49%	-4.53%	1
		640ms	-2.13%	-3.53%	-2.13%	-3.53%	-2.13%	-3.53%	1
	5% DL PTP	10ms	-0.70%	1.31%	-0.70%	1.31%	-0.70%	1.31%	1
		640ms	-0.98%	1.17%	-0.98%	1.17%	-0.98%	1.17%	1
	5% UL PTP	10ms	-5.24%	-5.59%	-5.24%	-5.59%	-5.24%	-5.59%	1
		640ms	-2.55%	-5.72%	-2.55%	-5.72%	-2.55%	-5.72%	1

Table 6.4.2-1b: Fixed reference TDD UL-DL configuration 1, ratio of DL/UL arrival rates of 2:1

DL arrival rate	Metric	Time scale	Relative gain			Num of sources
			Mean	Max	Min	
0.25	Average DL PTP	10ms	-0.80%	-0.80%	-0.80%	1
	Average	10ms	-2.30%	-2.30%	-2.30%	1

	UL PTP					
	5% DL PTP	10ms	-0.20%	-0.20%	-0.20%	1
	5% UL PTP	10ms	-4.20%	-4.20%	-4.20%	1
0.5	Average DL PTP	10ms	4.30%	9.00%	-0.40%	2
		200ms	-6.00%	-6.00%	-6.00%	1
	Average UL PTP	10ms	-3.05%	-2.10%	-4.00%	2
		200ms	-3.00%	-3.00%	-3.00%	1
	5% DL PTP	10ms	7.70%	14.00%	1.40%	2
		200ms	-2.00%	-2.00%	-2.00%	1
	5% UL PTP	10ms	-12.50%	1.00%	-26.00%	2
		200ms	-8.00%	-8.00%	-8.00%	1
1	Average DL PTP	10ms	3.00%	3.00%	3.00%	1
		200ms	-16.00%	-16.00%	-16.00%	1
	Average UL PTP	10ms	-15.00%	-15.00%	-15.00%	1
		200ms	-4.00%	-4.00%	-4.00%	1
	5% DL PTP	10ms	1.00%	1.00%	1.00%	1
		200ms	-21.00%	-21.00%	-21.00%	1
	5% UL PTP	10ms	-22.00%	-22.00%	-22.00%	1
		200ms	-28.00%	-28.00%	-28.00%	1

Table 6.4.2-2a collects the metrics separately for pico and macro, and Table 6.4.2-2b collects the metrics jointly for pico and macro.

Table 6.4.2-2a: Fixed reference TDD UL-DL configuration 1, ratio of DL/UL arrival rates of 4:1

DL arrival rate	Metric	Time scale	Relative gain						Num of sources
			Mean		Max		Min		
			Pico	Macro	Pico	Macro	Pico	Macro	
0.25	Average DL PTP	10ms	68.56%	2.56%	68.56%	2.56%	68.56%	2.56%	1
	Average UL PTP	10ms	-5.00%	-75.99%	-5.00%	-75.99%	-5.00%	-75.99%	1
	5% DL PTP	10ms	101.64%	4.47%	101.64%	4.47%	101.64%	4.47%	1

	5% UL PTP	10ms	-30.33%	-79.68%	-30.33%	-79.68%	-30.33%	-79.68%	1
1	Average DL PTP	10ms	127.73%	22.87%	127.73%	22.87%	127.73%	22.87%	1
	Average UL PTP	10ms	-28.57%	-86.42%	-28.57%	-86.42%	-28.57%	-86.42%	1
	5% DL PTP	10ms	234.34%	42.65%	234.34%	42.65%	234.34%	42.65%	1
	5% UL PTP	10ms	-68.52%	-81.46%	-68.52%	-81.46%	-68.52%	-81.46%	1
2	Average DL PTP	10ms	292.34%	13.15%	292.34%	13.15%	292.34%	13.15%	1
	Average UL PTP	10ms	-50.28%	-80.19%	-50.28%	-80.19%	-50.28%	-80.19%	1
	5% DL PTP	10ms	194.64%	5.08%	194.64%	5.08%	194.64%	5.08%	1
	5% UL PTP	10ms	-68.73%	-55.74%	-68.73%	-55.74%	-68.73%	-55.74%	1

Table 6.4.2-2b: Fixed reference TDD UL-DL configuration 1, ratio of DL/UL arrival rates of 4:1

DL arrival rate	Metric	Time scale	Relative gain			Num of sources
			Mean	Max	Min	
0.5	Average DL PTP	10ms	25%	25%	25%	1
		200ms	0%	0%	0%	1
	Average UL PTP	10ms	-8%	-8%	-8%	1
		200ms	-4%	-4%	-4%	1
	5% DL PTP	10ms	48%	48%	48%	1
		200ms	15%	15%	15%	1
	5% UL PTP	10ms	-25%	-25%	-25%	1
		200ms	-5%	-5%	-5%	1
1	Average DL PTP	10ms	7%	7%	7%	1
		200ms	1%	1%	1%	1
	Average	10ms	-10%	-10%	-10%	1

	UL PTP	200ms	-9%	-9%	-9%	1
	5% DL PTP	10ms	5%	5%	5%	1
		200ms	7%	7%	7%	1
	5% UL PTP	10ms	-27%	-27%	-27%	1
		200ms	-19%	-19%	-19%	1

6.5 Scenario 4: Adjacent-channel multi-cell macro-pico scenario

This section captures the simulation assumptions and evaluation results for the adjacent-channel multi-cell macro-pico scenario. The evaluation assumptions are the same as in Table 6.4-1, with the additional assumptions shown in Table 6.5-1.

Table 6.5-1: Additional evaluation assumptions for adjacent-channel multi-cell macro pico scenario

Parameters	Assumptions
ACIR BS-BS	43dB
ACIR BS-UE	33dB
ACIR UE-BS	30dB
ACIR UE-UE	28dB

Tables 6.5-1 to 6.5-5 show the evaluation results of adjacent-channel multi-cell macro-pico scenario for different fixed reference TDD UL-DL configurations and different downlink/uplink traffic loads, without interference mitigation. The values are relative gain or loss of TDD UL-DL reconfiguration based on traffic adaptation compared to the fixed reference TDD UL-DL configuration.

Table 6.5-2: Fixed reference TDD UL-DL configuration 1, ratio of DL/UL arrival rates of 2:1

DL arrival rate	Metric	Time scale	Relative gain						Num of sources
			Mean		Max		Min		
			Pico	Macro	Pico	Macro	Pico	Macro	
0.5	Average DL PTP	10ms	51.36%	1.38%	56.54%	2.67%	46.17%	0.09%	2
		200ms	14.72%	2.39%	14.72%	2.39%	14.72%	2.39%	1
		640ms	-7.82%	1.38%	-7.82%	1.38%	-7.82%	1.38%	1
	Average UL PTP	10ms	19.19%	-16.59%	34.07%	-16.47%	4.31%	-16.70%	2
		200ms	4.59%	-13.19%	4.59%	-13.19%	4.59%	-13.19%	1
		640ms	3.67%	-9.28%	3.67%	-9.28%	3.67%	-9.28%	1
	5% DL PTP	10ms	55.66%	4.24%	58.74%	6.58%	52.59%	1.90%	2
		200ms	30.41%	7.30%	30.41%	7.30%	30.41%	7.30%	1

		640ms	0.40%	5.72%	0.40%	5.72%	0.40%	5.72%	1
	5% UL PTP	10ms	9.69%	-20.86%	27.58%	-20.44%	-8.21%	-21.29%	2
		200ms	-5.68%	-19.29%	-5.68%	-19.29%	-5.68%	-19.29%	1
		640ms	-7.40%	-12.20%	-7.40%	-12.20%	-7.40%	-12.20%	1
1.5	Average DL PTP	10ms	37.43%	1.10%	52.30%	1.71%	22.57%	0.49%	2
		200ms	7.47%	2.26%	7.47%	2.26%	7.47%	2.26%	1
		640ms	-5.26%	1.58%	-5.26%	1.58%	-5.26%	1.58%	1
	Average UL PTP	10ms	-18.84%	-23.62%	10.28%	-10.30%	-47.97%	-36.94%	2
		200ms	-48.05%	-8.35%	-48.05%	-8.35%	-48.05%	-8.35%	1
		640ms	-49.99%	-6.46%	-49.99%	-6.46%	-49.99%	-6.46%	1
	5% DL PTP	10ms	53.52%	1.14%	65.53%	2.04%	41.51%	0.25%	2
		200ms	37.69%	0.19%	37.69%	0.19%	37.69%	0.19%	1
		640ms	25.30%	-0.04%	25.30%	-0.04%	25.30%	-0.04%	1
	5% UL PTP	10ms	-34.46%	-23.09%	8.34%	0.18%	-77.27%	-46.35%	2
		200ms	-78.23%	0.04%	-78.23%	0.04%	-78.23%	0.04%	1
		640ms	-76.54%	-0.23%	-76.54%	-0.23%	-76.54%	-0.23%	1
2.5	Average DL PTP	10ms	23.79%	-0.19%	53.63%	2.27%	-6.06%	-2.65%	2
		200ms	-14.34%	-1.79%	-14.34%	-1.79%	-14.34%	-1.79%	1
		640ms	-20.70%	-2.83%	-20.70%	-2.83%	-20.70%	-2.83%	1
	Average UL PTP	10ms	-35.53%	-31.63%	-7.12%	-4.56%	-63.94%	-58.69%	2
		200ms	-64.95%	-1.98%	-64.95%	-1.98%	-64.95%	-1.98%	1
		640ms	-65.04%	-2.88%	-65.04%	-2.88%	-65.04%	-2.88%	1
	5% DL PTP	10ms	52.38%	7.43%	84.99%	14.87%	19.77%	0.00%	2
		200ms	17.42%	0.08%	17.42%	0.08%	17.42%	0.08%	1
		640ms	17.85%	0.14%	17.85%	0.14%	17.85%	0.14%	1
	5% UL PTP	10ms	-30.35%	-34.69%	-17.05%	0.32%	-43.65%	-69.70%	2
		200ms	-43.67%	0.02%	-43.67%	0.02%	-43.67%	0.02%	1
		640ms	-43.31%	0.06%	-43.31%	0.06%	-43.31%	0.06%	1

Table 6.5-3: Fixed reference TDD UL-DL configuration 1, ratio of DL/UL arrival rates of 4:1

DL arrival rate	Metric	Time scale	Relative gain						Num of sources
			Mean		Max		Min		
			Pico	Macro	Pico	Macro	Pico	Macro	

0.5	Average DL PTP	10ms	54.79%	1.10%	60.25%	2.11%	49.33%	0.09%	2
		200ms	16.80%	1.98%	16.80%	1.98%	16.80%	1.98%	1
		640ms	-6.49%	0.68%	-6.49%	0.68%	-6.49%	0.68%	1
	Average UL PTP	10ms	17.11%	-14.22%	32.84%	-14.02%	1.38%	-14.42%	2
		200ms	1.64%	-14.16%	1.64%	-14.16%	1.64%	-14.16%	1
		640ms	0.46%	-10.31%	0.46%	-10.31%	0.46%	-10.31%	1
	5% DL PTP	10ms	58.01%	5.16%	58.79%	8.42%	57.23%	1.90%	2
		200ms	30.93%	10.63%	30.93%	10.63%	30.93%	10.63%	1
		640ms	3.85%	1.59%	3.85%	1.59%	3.85%	1.59%	1
	5% UL PTP	10ms	1.72%	-21.94%	19.85%	-19.11%	-16.42%	-24.78%	2
		200ms	-13.99%	-18.47%	-13.99%	-18.47%	-13.99%	-18.47%	1
		640ms	-19.31%	-13.23%	-19.31%	-13.23%	-19.31%	-13.23%	1
1.5	Average DL PTP	10ms	61.35%	2.90%	63.37%	4.81%	59.33%	0.98%	2
		200ms	35.28%	4.63%	35.28%	4.63%	35.28%	4.63%	1
		640ms	16.78%	1.22%	16.78%	1.22%	16.78%	1.22%	1
	Average UL PTP	10ms	-19.66%	-39.41%	7.63%	-36.54%	-46.96%	-42.28%	2
		200ms	-46.99%	-40.95%	-46.99%	-40.95%	-46.99%	-40.95%	1
		640ms	-47.89%	-39.84%	-47.89%	-39.84%	-47.89%	-39.84%	1
	5% DL PTP	10ms	90.29%	2.66%	106.16%	3.96%	74.42%	1.37%	2
		200ms	88.27%	1.10%	88.27%	1.10%	88.27%	1.10%	1
		640ms	78.33%	0.56%	78.33%	0.56%	78.33%	0.56%	1
	5% UL PTP	10ms	-42.03%	-32.80%	-1.10%	-21.44%	-82.96%	-44.16%	2
		200ms	-82.87%	-20.03%	-82.87%	-20.03%	-82.87%	-20.03%	1
		640ms	-83.15%	-21.04%	-83.15%	-21.04%	-83.15%	-21.04%	1
2.5	Average DL PTP	10ms	61.18%	1.23%	75.31%	2.74%	47.05%	-0.28%	2
		200ms	27.89%	-0.64%	27.89%	-0.64%	27.89%	-0.64%	1
		640ms	15.23%	-0.66%	15.23%	-0.66%	15.23%	-0.66%	1
	Average UL PTP	10ms	-36.96%	-36.88%	-11.93%	-25.74%	-61.99%	-48.03%	2
		200ms	-63.12%	-23.42%	-63.12%	-23.42%	-63.12%	-23.42%	1
		640ms	-62.52%	-20.05%	-62.52%	-20.05%	-62.52%	-20.05%	1
	5% DL PTP	10ms	73.18%	8.91%	112.03%	18.02%	34.32%	-0.20%	2
		200ms	32.66%	-0.16%	32.66%	-0.16%	32.66%	-0.16%	1
		640ms	30.35%	-0.04%	30.35%	-0.04%	30.35%	-0.04%	1

	5% UL PTP	10ms	-50.78%	-26.99%	-18.08%	-1.55%	-83.48%	-52.42%	2
		200ms	-83.31%	-1.88%	-83.31%	-1.88%	-83.31%	-1.88%	1
		640ms	-83.62%	-1.42%	-83.62%	-1.42%	-83.62%	-1.42%	1

Table 6.5-4: Fixed reference TDD UL-DL configuration 2, ratio of DL/UL arrival rates of 2:1

DL arrival rate	Metric	Time scale	Relative gain						Num of sources
			Mean		Max		Min		
			Pico	Macro	Pico	Macro	Pico	Macro	
0.5	Average DL PTP	10ms	9.50%	0.24%	12.66%	0.47%	6.34%	0.00%	2
		200ms	-16.54%	0.19%	-16.54%	0.19%	-16.54%	0.19%	1
		640ms	-32.94%	-0.80%	-32.94%	-0.80%	-32.94%	-0.80%	1
	Average UL PTP	10ms	194.48%	-2.75%	213.38%	1.96%	175.58%	-7.46%	2
		200ms	214.22%	6.25%	214.22%	6.25%	214.22%	6.25%	1
		640ms	211.45%	11.04%	211.45%	11.04%	211.45%	11.04%	1
	5% DL PTP	10ms	9.26%	0.31%	10.90%	0.62%	7.63%	0.00%	2
		200ms	-8.90%	1.30%	-8.90%	1.30%	-8.90%	1.30%	1
		640ms	-29.86%	-0.19%	-29.86%	-0.19%	-29.86%	-0.19%	1
	5% UL PTP	10ms	192.97%	-4.14%	212.05%	1.82%	173.90%	-10.10%	2
		200ms	220.67%	4.40%	220.67%	4.40%	220.67%	4.40%	1
		640ms	214.81%	13.58%	214.81%	13.58%	214.81%	13.58%	1
1.5	Average DL PTP	10ms	-10.80%	0.89%	2.91%	2.39%	-24.51%	-0.62%	2
		200ms	-33.81%	2.94%	-33.81%	2.94%	-33.81%	2.94%	1
		640ms	-41.65%	2.25%	-41.65%	2.25%	-41.65%	2.25%	1
	Average UL PTP	10ms	141.99%	-11.36%	150.29%	-2.84%	133.70%	-19.88%	2
		200ms	133.34%	-0.72%	133.34%	-0.72%	133.34%	-0.72%	1
		640ms	124.63%	1.32%	124.63%	1.32%	124.63%	1.32%	1
	5% DL PTP	10ms	-17.42%	-0.99%	4.48%	-0.35%	-39.32%	-1.63%	2
		200ms	-40.95%	-0.40%	-40.95%	-0.40%	-40.95%	-0.40%	1
		640ms	-46.27%	-0.63%	-46.27%	-0.63%	-46.27%	-0.63%	1
	5% UL PTP	10ms	89.51%	-14.76%	142.87%	0.72%	36.15%	-30.23%	2
		200ms	30.35%	0.59%	30.35%	0.59%	30.35%	0.59%	1
		640ms	40.48%	0.31%	40.48%	0.31%	40.48%	0.31%	1
2.5	Average	10ms	-28.36%	1.18%	-8.59%	2.84%	-48.13%	-0.49%	2

	DL PTP	200ms	-52.71%	3.75%	-52.71%	3.75%	-52.71%	3.75%	1
		640ms	-56.22%	2.64%	-56.22%	2.64%	-56.22%	2.64%	1
	Average UL PTP	10ms	99.09%	-28.28%	183.27%	-7.46%	14.91%	-49.09%	2
		200ms	11.69%	-4.96%	11.69%	-4.96%	11.69%	-4.96%	1
		640ms	11.40%	-5.83%	11.40%	-5.83%	11.40%	-5.83%	1
	5% DL PTP	10ms	-7.60%	-2.68%	-5.64%	-0.06%	-9.55%	-5.31%	2
		200ms	-11.33%	0.02%	-11.33%	0.02%	-11.33%	0.02%	1
		640ms	-11.00%	0.08%	-11.00%	0.08%	-11.00%	0.08%	1
	5% UL PTP	10ms	92.34%	-38.53%	185.57%	0.28%	-0.90%	-77.34%	2
		200ms	-0.93%	-0.02%	-0.93%	-0.02%	-0.93%	-0.02%	1
		640ms	-0.31%	0.02%	-0.31%	0.02%	-0.31%	0.02%	1

Table 6.5-5: Fixed reference TDD UL-DL configuration 2, ratio of DL/UL arrival rates of 4:1

DL arrival rate	Metric	Time scale	Relative gain						Num of sources
			Mean		Max		Min		
			Pico	Macro	Pico	Macro	Pico	Macro	
0.5	Average DL PTP	10ms	11.15%	1.62%	15.34%	3.23%	6.95%	0.00%	2
		200ms	-16.35%	3.11%	-16.35%	3.11%	-16.35%	3.11%	1
		640ms	-33.03%	1.79%	-33.03%	1.79%	-33.03%	1.79%	1
	Average UL PTP	10ms	156.14%	-4.04%	167.61%	-1.07%	144.67%	-7.01%	2
		200ms	145.29%	-0.76%	145.29%	-0.76%	145.29%	-0.76%	1
		640ms	142.45%	3.69%	142.45%	3.69%	142.45%	3.69%	1
	5% DL PTP	10ms	10.72%	1.53%	12.03%	3.05%	9.41%	0.00%	2
		200ms	-8.97%	5.15%	-8.97%	5.15%	-8.97%	5.15%	1
		640ms	-27.80%	-3.44%	-27.80%	-3.44%	-27.80%	-3.44%	1
	5% UL PTP	10ms	168.52%	-4.12%	198.06%	1.17%	138.98%	-9.41%	2
		200ms	206.72%	1.98%	206.72%	1.98%	206.72%	1.98%	1
		640ms	187.73%	8.52%	187.73%	8.52%	187.73%	8.52%	1
1.5	Average DL PTP	10ms	2.97%	2.83%	11.20%	5.66%	-5.27%	0.01%	2
		200ms	-19.57%	5.48%	-19.57%	5.48%	-19.57%	5.48%	1
		640ms	-30.57%	2.04%	-30.57%	2.04%	-30.57%	2.04%	1
	Average	10ms	106.82%	-13.25%	120.59%	-9.14%	93.05%	-17.35%	2

	UL PTP	200ms	92.93%	-7.06%	92.93%	-7.06%	92.93%	-7.06%	1
		640ms	89.65%	-5.30%	89.65%	-5.30%	89.65%	-5.30%	1
	5% DL PTP	10ms	-4.82%	0.01%	12.58%	0.46%	-22.21%	-0.45%	2
		200ms	-28.96%	0.19%	-28.96%	0.19%	-28.96%	0.19%	1
		640ms	-32.71%	-0.34%	-32.71%	-0.34%	-32.71%	-0.34%	1
	5% UL PTP	10ms	91.75%	-12.24%	113.12%	-2.76%	70.37%	-21.72%	2
		200ms	71.31%	-1.00%	71.31%	-1.00%	71.31%	-1.00%	1
		640ms	68.48%	-2.27%	68.48%	-2.27%	68.48%	-2.27%	1
2.5	Average DL PTP	10ms	-5.63%	4.04%	6.75%	8.03%	-18.02%	0.05%	2
		200ms	-28.70%	7.64%	-28.70%	7.64%	-28.70%	7.64%	1
		640ms	-35.76%	7.62%	-35.76%	7.62%	-35.76%	7.62%	1
	Average UL PTP	10ms	70.54%	-12.52%	86.70%	1.35%	54.37%	-26.38%	2
		200ms	49.76%	4.51%	49.76%	4.51%	49.76%	4.51%	1
		640ms	52.20%	9.10%	52.20%	9.10%	52.20%	9.10%	1
	5% DL PTP	10ms	-0.75%	-0.49%	10.91%	-0.18%	-12.40%	-0.80%	2
		200ms	-13.48%	-0.14%	-13.48%	-0.14%	-13.48%	-0.14%	1
		640ms	-14.98%	-0.02%	-14.98%	-0.02%	-14.98%	-0.02%	1
	5% UL PTP	10ms	42.44%	-16.02%	80.20%	0.23%	4.68%	-32.28%	2
		200ms	5.78%	-0.10%	5.78%	-0.10%	5.78%	-0.10%	1
		640ms	3.81%	-0.37%	3.81%	-0.37%	3.81%	-0.37%	1

6.6 Summary

For the evaluated isolated pico cell scenario (i.e. scenario 1), TDD UL-DL reconfiguration based on traffic condition provides benefits over a fixed reference TDD UL-DL configuration.

- The benefits at least include improved packet throughput
- The benefits may be observed in either DL or UL or both directions,
    - The less number of DL (or UL) subframes in the fixed reference TDD UL-DL configuration, the higher DL (or UL) packet throughput gain (if any) achieved by TDD UL-DL reconfiguration
- The benefits are mainly observed in low to medium cell traffic load region
- Faster TDD UL-DL reconfiguration provides larger benefits than slower TDD UL-DL reconfiguration
    - The gain of faster TDD UL-DL reconfiguration over slower TDD UL-DL reconfiguration reduces with the increase of cell traffic load and/or packet size

For the evaluated multi-pico cell scenario (i.e. scenario 2), TDD UL-DL reconfiguration based on traffic conditions without interference mitigation provides benefits over a fixed reference TDD UL-DL configuration.

- The benefits at least include improved average packet throughput in the low cell traffic load region

- The benefits may be observed in either DL or UL or both directions,
    - The less number of DL (or UL) subframes in the fixed reference TDD UL-DL configuration, the higher DL (or UL) packet throughput gain (if any) achieved by TDD UL-DL reconfiguration
- Faster TDD UL-DL reconfiguration provides larger benefits on average packet throughput than slower TDD UL-DL reconfiguration
    - The gain of faster TDD UL-DL reconfiguration over slower TDD UL-DL reconfiguration reduces with the increase of cell traffic load and/or packet size
- The 5% UE average packet throughput may be increased or decreased.

For the evaluated multi-pico cell scenario (i.e. scenario 2), with interference mitigation, TDD UL-DL reconfiguration based on traffic conditions provides higher packet throughput in UL than without interference mitigation. Meanwhile, depending on the interference mitigation scheme and cell traffic load, TDD UL-DL reconfiguration with interference mitigation may provide higher or lower packet throughput in DL than without interference mitigation, and for the latter case, the increase in UL packet throughput can be higher than the loss in DL packet throughput.

For the evaluated co-channel multi-macro/pico cell scenario (i.e. scenario 3), the following observations are made for TDD UL-DL reconfiguration based on traffic conditions without interference mitigation compared to a fixed TDD UL-DL configuration:

- Improved or reduced DL packet throughput for pico cells;
- Similar DL packet throughput for macro cells;
- Significantly decreased UL packet throughput for both macro and pico cells.

For the evaluated co-channel multi-macro/pico cell scenario (i.e. scenario 3), the following observations are made for TDD UL-DL reconfiguration based on traffic conditions with interference mitigation compared to without interference mitigation:

- Improved UL packet throughput for both macro and pico cells;
- Similar DL packet throughput for macro cells;
- Improved or decreased DL packet throughput for pico cells depending on the interference mitigation scheme.

For the evaluated co-channel multi-macro/pico cell scenario (i.e. scenario 3), the following observations are made for TDD UL-DL reconfiguration based on traffic conditions with interference mitigation compared to a fixed TDD UL-DL configuration:

- Reduced UL packet throughput for macro cells;
- Improved or decreased UL packet throughput for pico cells, partly depending on the interference mitigation scheme.

For the evaluated adjacent channel multi-macro/pico cell scenario (i.e. scenario 4), the following observations are made for TDD UL-DL reconfiguration based on traffic conditions without interference mitigation compared to a fixed TDD UL-DL configuration:

- Improved DL packet throughput for pico cells;
- Similar DL packet throughput for macro cells;
- Similar UL packet throughput for pico cells in low cell load;

- Significantly decreased UL packet throughput for pico cells in medium to high cell load and for macro cells.

For TDD UL-DL reconfiguration based on traffic adaptation, it is beneficial to configure TDD UL-DL configuration #0 when there is no traffic in the cell from the perspective of energy saving, which on the other hand may impact the packet throughput for medium/low speed adaptation time scales.

7 Methods to support different time scales for TDD UL-DL reconfiguration

Depending on the required adaptation time scale, different methods can be considered for TDD UL-DL reconfiguration. Independent of the signaling method, the non-coordinated change of transmission direction among neighboring cells may cause DL-UL interference in some subframes. Interference mitigation techniques as discussed in Section 8 can be utilized to avoid the negative impact of DL-UL interference on system performance.

7.1 Method 1 – System information signaling

7.1.1 Description

This method supports TDD UL-DL reconfiguration by system information (SI) change as in Rel-8, where the TDD UL-DL configuration is indicated by SIB. Two approaches can be considered. One is the Rel-8 system information change procedure and the other is reusing the Rel-10 ETWS (Earthquake and Tsunami Warning System) notification procedure.

With the Rel-8 system information change procedure, the supported time scale for TDD UL-DL reconfiguration is every 640ms or larger. It is noted that legacy UEs can enjoy the benefits of TDD UL-DL reconfiguration based on traffic adaptation, since the method to adapt the TDD UL-DL configuration is backward compatible. This method always affects all UEs connected to the cell, even those that do not have data to transmit or receive.

With reusing the Rel-10 ETWS notification procedure, the supported time scale for TDD UL-DL reconfiguration is every 320ms or larger depending on the configured default paging cycle. The ETWS notification is indicated by a paging message, but is updated regardless of the modification period unlike the Rel-8 system information change procedure. It is noted that legacy UEs cannot know the change of TDD UL-DL reconfiguration, since the notification procedure is transparent to legacy UE.

With this method, ambiguity exists between eNB and UE on the TDD UL-DL configuration, since the eNB does not know the exact time at which the UE correctly decodes the updated SI, eNB may apply scheduling restriction during this uncertain period, in order to properly maintain the communications between the eNB and the UE. Further study is required to assess its impact on performance. Possible enhancements can be specified to resolve the ambiguity. Note that such enhancements are not applicable to legacy UEs.

Given that PDSCH/PUSCH HARQ timeline in TDD is determined by the TDD UL-DL configuration, TDD UL-DL reconfiguration would impact the PDSCH/PUSCH HARQ during reconfiguration. Possible enhancements on HARQ timing can be specified to handle HARQ processes properly for TDD UL-DL reconfiguration.

The TDD UL-DL reconfiguration based on SIB modification may require eNB to transmit paging notification more frequently than in a typical Rel-8/9/10 system, and meanwhile may require UE to monitor paging more frequently. Possible enhancements can be specified to reduce the paging overheads due to TDD UL-DL reconfiguration based on traffic adaptation.

7.1.2 Specification impact

Rel-8 system information change procedure has no specification impact to enable TDD UL-DL reconfiguration by system information change, as it is already supported by Rel-8. Reusing the Rel-10 ETWS notification procedure has some specification impacts to enable the notification of TDD UL-DL reconfiguration, which is transparent to legacy UEs. For both approaches, new specification work may be required for enhancement(s) to resolve the ambiguity on the

TDD UL-DL configuration between eNB and UE, to handle the HARQ timing properly when UL-DL configuration is changed, and to reduce paging overheads.

7.2 Method 2 – RRC signaling

7.2.1 Description

This method supports TDD UL-DL reconfiguration by RRC signaling. The corresponding time scale supported by this method depends on how fast the reconfiguration can be performed. Typical time scale intended by this method is on the order of 200ms. This method requires one reconfiguration message per RRC connected user, unless a broadcast or a multicast approach is specified.

This method provides better traffic adaptation capability than Method 1, given the support of smaller time scale for TDD UL-DL reconfiguration. Method 2 is not applicable for the legacy UEs. Furthermore, if the higher layer signaled TDD UL-DL configuration is different from that signaled in SIB1, it may not be possible to schedule legacy UEs in all subframes since the legacy UEs' PDSCH/PUSCH HARQ timeline follows the TDD UL-DL configuration in SIB1. This may degrade the throughput of legacy UEs. In addition, if a specific subframe is a DL subframe according to the SIB1 indicated TDD UL-DL configuration, but is an UL subframe according to higher layer signaled TDD UL-DL configuration, legacy UEs will still assume presence of reference signals e.g. CRS in such subframes. This will for instance impact legacy UEs' RRM and RLM measurements. Schemes to handle these issues and guarantee backwards compatibility should be considered.

Ambiguity exists between eNB and UE on the TDD UL-DL configuration, if the eNB does not know the exact time at which the UE applies the updated TDD UL-DL configuration during reconfiguration. Further study is required to assess its impact on performance. Possible enhancements can be specified to resolve the ambiguity.

Similar to method 1, TDD UL-DL reconfiguration would impact the PDSCH/PUSCH HARQ during reconfiguration. Possible enhancements on HARQ timing can be specified to handle HARQ processes properly for TDD UL-DL reconfiguration.

7.2.2 Specification impact

New specification work is required to introduce the higher layer signaling for TDD UL-DL configuration. Additional specification may be required for enhancement(s) to resolve the ambiguity on the TDD UL-DL configuration between eNB and UE, and to handle the HARQ timing properly when UL-DL configuration is changed.

7.3 Method 3 – MAC Control Element Signaling

7.3.1 Description

This method supports TDD UL-DL reconfiguration by MAC Control Element (CE) signaling in the MAC header, with time scale of adaptation on the order of a few tens of ms.

Method 3 provides the better traffic adaptation capability than Methods 1 and 2, given the support of smaller time scale for TDD UL-DL reconfiguration. Method 3 is not applicable to legacy UEs. In case both legacy UEs and UEs supporting Method 3 are to be served on the same serving cell, the impacts on legacy UEs due to Method 3 are similar to those of Method 2 as discussed in section 7.2.1.

Ambiguity exists between eNB and UE on the TDD UL-DL configuration, if the eNB does not know the exact time at which the UE applies the updated TDD UL-DL configuration during reconfiguration, especially considering MAC CE signaling does not have its own error recovery process and the HARQ-ACK corresponding to the PDSCH containing the MAC CE signaling may be received incorrectly. Further study is required to assess its impact on performance. Possible enhancements can be specified to resolve the ambiguity.

Similar to method 1, TDD UL-DL reconfiguration would impact the PDSCH/PUSCH HARQ during reconfiguration. Possible enhancements on HARQ timing can be specified to handle HARQ processes properly for TDD UL-DL reconfiguration.

7.3.2 Specification impact

New specification work is required to introduce the MAC CE for TDD UL-DL configuration. Additional specification may be required for enhancement(s) to resolve the ambiguity on the TDD UL-DL configuration between eNB and UE, and to handle the HARQ timing properly when UL-DL configuration is changed.

7.4 Method 4 – Physical layer signaling

7.4.1 Description

This method supports TDD UL-DL reconfiguration by physical layer design, with time scale of adaptation on the order of 10ms. The TDD UL-DL configuration or the transmission direction of a subframe can be explicitly indicated by physical channel or signal. Alternatively, the transmission direction of a subframe can be implicitly derived by the UE based on the eNB scheduling and configurations for UL transmissions.

Method 4 provides the best traffic adaptation capability, given the support of smaller time scale for TDD UL-DL reconfiguration than Methods 1 – 3. Method 4 is not applicable to legacy UEs. In case both legacy UEs and UEs supporting Method 4 are to be served on the same serving cell, the impacts on legacy UEs due to Method 4 are similar to those of Method 2 as discussed in section 7.2.1.

Other aspects to consider for Method 4 include the CSI measurements and support of interference mitigation schemes. With each cell individually reconfiguring the subframe transmission direction on a radio frame basis, the dynamics of inter-cell interference due to eNB-to-eNB and/or UE-to-UE interference is expected to increase compared to Methods 1 – 3, which may make the CSI reporting less accurate. In addition, the traffic adaptation capability on the time scale of 10ms may not be fully exploited in combination with interference mitigation schemes requiring coordination among cells. In these cases, it is however up to implementation how fast the adaptation is performed.

The PDSCH/PUSCH HARQ timeline for UEs supporting Method 4 will not always follow the TDD UL-DL configuration in SIB1, which requires specification work.

7.4.2 Specification impact

Specification work is required for the PDSCH/PUSCH HARQ timeline, as well as methods to explicitly or implicitly determine the UL-DL configuration and/or the transmission direction of a subframe. Specification work for enhancement(s) to other physical channels and physical procedures may also be needed.

8 Potential interference mitigation schemes

The interference mitigation schemes provided in this section, though separately described, are not excluded to function jointly. Consideration of using some other interference mitigation schemes that are not listed in this section is also not precluded.

Interference mitigation for both data and control channels shall be considered. Additional control channel interference mitigation such as HARQ timeline change can be considered with other interference mitigation techniques.

8.1 Scheme 1: Cell clustering interference mitigation

8.1.1 Description

This interference mitigation (IM) scheme is named Cell Clustering IM (CCIM), which divides the cells into cell clusters according to some metric(s), such as coupling loss, interference level, etc between cells.

A cell cluster can comprise one or more cells. The active transmissions of all cells in each cell cluster shall be either uplink or downlink in any subframe or a subset of all subframes, so that eNB-to-eNB interference and UE-to-UE interference can be mitigated within the cell cluster. Hence, coordination between the multiple cells belonging to the same cell cluster is needed. Transmission directions in cells belonging to different cell clusters can be different in a subframe by selecting the different TDD configurations freely, in order to achieve the benefits of TDD UL-DL reconfiguration based on traffic adaptation. By forming the cell clusters, eNB-to-eNB and UE-to-UE interference between cells in different cell clusters can be controlled. An illustration is shown in Figure 8.1.1.

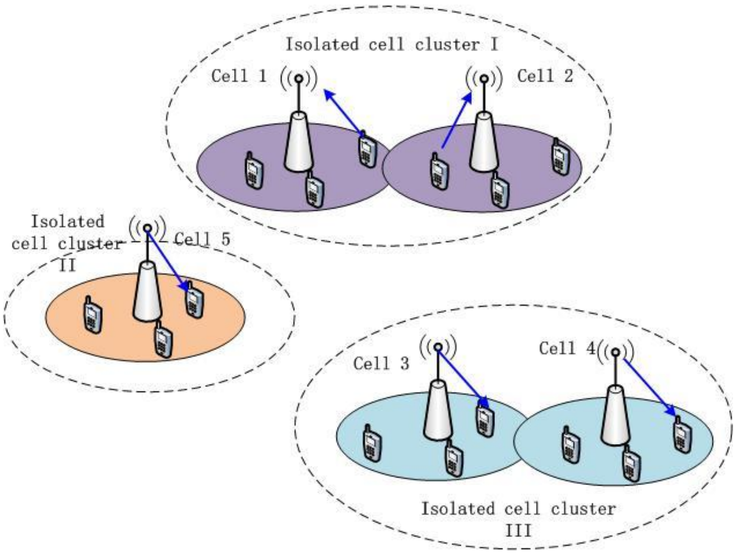


Figure 8.1.1: Illustration of cell clustering

8.1.2 Specification impact

CCIM essentially includes two functionalities, i.e. forming cell clusters and coordinating the transmission within each cell cluster. To properly form the cell clusters, eNB measurements need to be possible, where the purpose of the eNB measurements is to estimate the interference level from/to another eNB. In addition, necessary signaling and/or procedures related to the eNB measurements could be supported. For coordination within a cell cluster, further study is required on what needs to be specified as it depends on how coordination is performed.

8.2 Scheme 2: Scheduling dependent interference mitigation

8.2.1 Description

This interference mitigation (IM) scheme is named Scheduling Dependent IM (SDIM), where the eNB adjusts the scheduling strategies e.g. link adaptation, resource allocation, transmit power, transmission direction of a subframe, considering e.g. the DL and UL channel quality, the eNB-to-eNB and UE-to-UE interference, traffic load, etc. The adjustment of scheduling strategies can be based on the variation of the observed interference, the estimation of induced interference, inter-cell interference coordination information exchange, and/or cell load.

8.2.2 Specification impact

For SDIM, eNB measurements need to be possible, where the purpose of the eNB measurements is to estimate the interference level from/to another eNB. In addition, necessary signaling and/or procedures related to the eNB measurements could be supported. Additional UE measurements may also be needed, where the purpose of the UE measurement is to estimate the interference level from another eNB or UE. New signaling to support improved uplink and/or downlink power control or to support inter-cell interference coordination information exchange may be needed. Applying some of the scheduling strategies for interference mitigation, e.g. link adaptation, may not need to be specified.

8.3 Scheme 3: Interference mitigation based on eICIC/FeICIC schemes

8.3.1 Description

With different TDD UL-DL configurations in different cells, there are potential interferences from eNB-to-eNB and/or UE-to-UE due to the different transmission directions in adjacent cells. For Rel-10/11 eICIC/FeICIC, extensive specification work has been made to cope with the interference conditions caused in the HetNet deployment, where the interference condition is caused by the strong transmit signal from nearby cells. Although the causes of these interference conditions are different, it can be considered to reuse the interference mitigation schemes and procedures from eICIC/FeICIC to TDD UL-DL reconfiguration based on traffic adaptation, e.g., almost blank subframes, restricted RLM/RRM measurements, dual CSI measurement reports, etc..

8.3.2 Specification impact

Additional eNB measurements may need to be possible, where the purpose of the eNB measurements is to estimate the interference level from/to another eNB. In addition, necessary signaling and/or procedures related to the eNB measurements could be supported. Additional UE measurements may also be needed, where the purpose of the UE measurement is to estimate the interference level from another eNB or UE.

8.4 Scheme 4: Interference suppressing interference mitigation

8.4.1 Description

Interference suppressing interference mitigation (ISIM) may be considered for UL transmission of either Pico or Macro cells. Suppression of one or more of the dominant eNB-to-eNB interfering signals may be possible, e.g. by enhanced receiver such as MMSE-IRC, or by joint transceiver technologies such as interference alignment or interference nulling.

8.4.2 Specification impact

ISIM is largely implementation dependent, but may benefit from some signaling assistance. For example, collided subframes among pico/macro cells could be exchanged among interfering eNBs to assist in the interference suppression. Necessary signaling and/or procedures related to the eNB interference measurements could be supported.

9 Conclusion and recommendations

Based on the studies carried out, the following conclusions are made:

- TDD UL-DL reconfiguration based on traffic adaptation provides benefits in terms of packet throughput and energy saving in some of the evaluated deployment scenarios.
- The benefits on packet throughput, when present, are mainly observed for low to medium system loadings, and may be observed in either DL or UL or both directions.
- Decreased UL packet throughput for macro cells compared with the fix configuration is observed without any interference mitigation schemes due to severe eNB-to-eNB interference in multi-macro/pico cell scenarios.
- Interference mitigation is essential to reduce the negative impact on system performance caused by DL-UL interference due to opposite transmission directions in different cells.
- Significant coexistence challenges have been observed to apply different TDD UL-DL configurations in different cells for scenarios 1 – 8 in section 5 without any interference mitigation mechanisms. It is feasible to apply different TDD UL-DL configurations in different cells for scenarios 1 – 4 in section 5, only provided sufficient interference mitigation mechanisms are adopted. No interference mitigation schemes have been

agreed for scenarios 1 – 4 in section 5, and no conclusion on coexistence feasibility with interference mitigation mechanisms has been made for scenarios 5 – 8 in section 5.

- Faster TDD UL-DL reconfiguration time scale provides larger benefits than slower TDD UL-DL reconfiguration time scale. The amount of required specification changes varies depending on the supported reconfiguration time scales.
    - Potential PDSCH/PUSCH HARQ timeline related issues are identified with TDD UL-DL reconfiguration based on traffic adaptation, which may require specification changes especially for fast TDD UL-DL reconfiguration time scales.
- There exists impact on legacy UEs due to TDD UL-DL reconfiguration, on the aspects of achievable DL/UL throughput, RLM/RRM measurement, and/or CSI reporting. The impact on legacy UEs' DL/UL throughput is expected to increase as the reconfiguration is performed faster.

Based on the above conclusions, it is recommended to specify the necessary mechanism(s) to support TDD UL-DL reconfiguration based on traffic adaptation. Further study is needed to decide on the supported adaptation time scale and assess the impact on legacy UEs with TDD UL-DL reconfiguration based on traffic adaptation. It is also recommended to further study and specify interference mitigation schemes.

Annex A: Co-existence simulation assumptions

The annex captures the evaluation assumptions used for the co-existence studies.

All simulations are based on 10MHz bandwidth system with 2GHz carrier.

Table A.1-1: ACIR for the first adjacent channel

Parameter	Assumption/Value
ACIR BS-BS	43dB
ACIR BS-UE	33dB
ACIR UE-BS	30dB
ACIR UE-UE	28dB
Note: BS includes Macro eNB and low power nodes.	

Table A.1-2: Propagation model for deterministic analysis

Case	Pathloss model
Femto-Femto	PL(R) = 38.46 + 20 log10R + 0.7d2D,indoor+ 5q, R and d2D,indoor in m q is the number of walls separating apartments between HeNB and HeNB , q could be expressed as floor(R/10).
outdoor Pico-outdoor Pico	LOS: if R<2/3 km, PL(R)=98.4+20log10(R), else, PL(R)=101.9+40log10(R), R in km NLOS: PL= 40log10(R)+169.36, R in km Note: deterministic analysis could be provided based on LOS and NLOS model separately
Macro-Femto	PL(R)= 128.1 + 37.6log10(R)+ Low, R in kilometers Low is the penetration loss of an outdoor wall, which is 20dB.
Macro-outdoor Pico	PL_{LOS} (R) =100.7+23.5log10(R) PL_{NLOS}(R) = 125.2+36.3log10(R) Note: deterministic analysis could be provided based on LOS and NLOS model separately
Macro-Macro	PL(R)=98.45+20*log10(R),R in km

Table A.1-3: Propagation model for Monte Carlo simulation

Case		Path loss model
Macro-Femto		
UE to Macro BS	UE is outside	PL_{LOS}(R)= 30.8+24.2log10(R) PL_{NLOS}(R)= 2.7+42.8log10(R) For 2GHz, R in m. Prob(R)=min(18/R,1)*(1-exp(-R/63))+exp(-R/63)
	UE is inside an apt	PL_{LOS}(R)= 30.8+24.2log10(R) + L_{ow} PL_{NLOS}(R)= 2.7+42.8log10(R) + L_{ow} For 2GHz, R in m Prob(R)=min(18/R,1)*(1-exp(-R/63))+exp(-R/63)
UE to Femto BS	Dual-stripe model: UE is inside the same apt stripe as Femto BS	PL (dB) = 38.46 + 20 log10R + 0.7d2D,indoor+ 18.3 n ((n+2)/(n+1)-0.46) + q*L_{iw} R and $d_{2D,indoor}$ are in m n is the number of penetrated floors

		q is the number of walls separating apartments between UE and Femto BS
	Dual-stripe model: UE is outside the apt stripe	PL (dB) = max(2.7+42.8 log10 R, 38.46 + 20log10R) + 0.7d2D,indoor + 18.3 n ((n+2)/(n+1)-0.46) + q*L_{iw} + L_{ow} R and d2D,indoor are in m q is the number of walls separating apartments between UE and HeNB
	Dual-stripe model: UE is inside a different apt stripe	PL(dB) = max(2.7+42.8 log10 R, 38.46 + 20log10R) + 0.7$d_{2D,indoor}$ + 18.3 n ((n+2)/(n+1)-0.46) + q*L_{iw} + $L_{ow,1}$ + $L_{ow,2}$ R and $d_{2D,indoor}$ are in m q is the number of walls separating apartments between UE and HeNB
Femto-Macro	PLLOS(R)= 30.8+24.2log10(R) + Low PLNLOS(R)= 2.7+42.8log10(R) + Low For 2GHz, R in m Prob(R)=min(18/R,1)*(1-exp(-R/63))+exp(-R/63)	
Femto- Femto		
Reuse the UE to Femto BS model in TR36.814 according to the location of Femto station.		
HUE-HUE		
Reuse the UE to Femto BS model in TR36.814 according to the location of UE.		
Macro- outdoor Pico/outdoor Pico-outdoor Pico		
Macro-outdoor Pico	PL_{LOS}(R) = 100.7+23.5log10(R) PL_{NLOS}(R) = 125.2+36.3log10(R) For 2GHz, R in km. Case 1: Prob(R)=min(0.018/R,1)*(1-exp(-R/0.072))+exp(-R/0.072)	
Outdoor Pico- outdoor Pico	LOS: if R<2/3 km, PL(R)=98.4+20log10(R) else, PL(R)=101.9+40log10(R), R in km NLOS: PL= 40log(R)+169.36 R in km Case 1: Prob(R)=0.5-min(0.5,5exp(-0.156/R))+min(0.5, 5exp(-R/0.03))	
Macro-UE	PL_{LOS}(R)=103.4+24.2log10(R) PL_{NLOS}(R)= 131.1+42.8log10(R) For 2GHz, R in km. Case 1: Prob(R)=min(0.018/R,1)*(1-exp(-R/0.063))+exp(-R/0.063)	
Outdoor Pico-UE	PL_{LOS}(R)=103.8+20.9log10(R) PL_{NLOS}(R)=145.4+37.5log10(R) For 2GHz, R in km Case 1: Prob(R)=0.5-min(0.5,5exp(-0.156/R))+min(0.5, 5exp(-R/0.03))	
Outdoor UE-outdoor UE	If R<=50m;PL=98.45+20*log10(R),R in km If R>50m;PL=40log(R)+175.78 R in km (Xia model)	
Macro-Macro		
Macro BS to Macro BS	PL=98.45+20*log10(R),R in km	
Macro-UE	PL_{LOS}(R)=103.4+24.2log10(R) PL_{NLOS}(R)= 131.1+42.8log10(R) For 2GHz, R in km. Case 1: Prob(R)=min(0.018/R,1)*(1-exp(-R/0.063))+exp(-R/0.063)	
Note1: Unless otherwise stated the path loss model used for deterministic calculation is the LOS model. Note2: L_{iw} is the penetration loss of the wall separating apartments, which is 5dB. Note3: The term 0.7$d_{2D,indoor}$ takes account of penetration loss due to walls inside an apartment. Note4: L_{ow} is the penetration loss of an outdoor wall, which is 20dB. Note5: $Low_{,1}$ and $Low_{,2}$ are the penetration losses of outdoor walls for the two houses.		

Table A.1-4: UE parameters used in simulation

Parameter	Assumption
UE Antenna gain	0 dBi
UE Noise Figure	9 dB
UE power class	23 dBm (200 mW)
UL Power control	Macro UE: P0 = -82 dBm; alpha = 0.8 Femto UE: P0 = -75dBm; alpha = 0.8

	Pico UE: P0 = -76 dBm,alpha = 0.8
Minimum distance between UE and cell	Macro BS-UE >= 35 m Outdoor Pico-UE >= 10 m Indoor Pico-UE >= 2 m Femto-UE>= 3 m
Minimum distance between UE and UE	N/A

Table A.1-5: System assumptions for Macro cell

Parameter	Assumption
Cellular Layout	Hexagonal grid, 3 sectors per site
System bandwidth	10MHz
Inter-site distance	500 m
Number sites	19sites (=57 cells) with wrap-around.
MUE number	20ues per cell
Shadowing standard deviation	8 dB
Penetration Loss (assumes UEs are indoors)	20dB
BS antenna gain after cable loss	15 dBi
Antenna pattern for Macro eNBs to UEs (horizontal 2D)	$A(\theta) = -\min\left[12\left(\frac{\theta}{\theta_{3dB}}\right)^2, A_m\right]$ θ_{3dB} = 65 degrees, Am = 20 dB (65 degree horizontal beamwidth)
BS noise figure	5 dB
Total BS TX power (Ptotal)	46 dBm
Macro DL power control	Not modeled, i.e. assuming max Macro Tx power
Inter-cell Interference Modelling	Explicit modelling (all cells occupied by UEs)
Shadowing standard deviation between UE and Macro	8 dB
Shadowing standard deviation between UE and UE	12dB

Table A.1-6: Femto modelling parameters of Dual Stripe Model

Parameter	Assumption
Femto antenna gain	0 dBi
Femto antenna pattern	Omni-directional
Femto DL power control	Case1: Femto Tx power is set for a target SNR (e.g. 10 dB) at a Femto UE, within the max and min of Femto Tx power Case2: without Femto DL power control, i.e. with max Femto Tx power.
Femto min transmission power	-10dBm
Femto Noise Figure	13dB
Number of row per floor	4
max number of cells per row	10
number of blocks per cell	1
number of floors per block	6
deployment ratio *activation ratio	0.1
Femto UE number per active HeNB	1
Probability of Macro UE being indoors for Macro-Femto case	35%
Shadowing standard deviation between UE and Femto	4dB

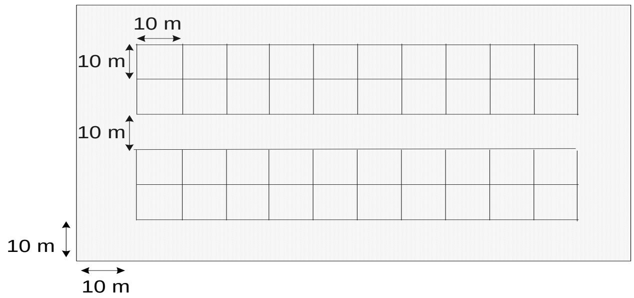


Figure A.1-1: HeNB dual strip model

Table A.1-7: system simulation assumptions for outdoor Pico cell

Parameter		Assumption
Pico number		4 Picos/cell
LUE per Pico		10UEs/Pico, cluster
Pico type		Hotzone
Pico TX power (Ptotal)		24dBm
Pico antenna pattern		Omni-direction
Pico antenna gain		5dBi
Pico radius		40m
Minimum distance between Pico and Pico		40m
Minimum distance between Pico and Macro		75m
Pico deployment		random deployment
Macro UE distribution for Macro-outdoor Pico case		randomly and uniformly dropped per Macro cell
Penetration loss		0dB
Shadowing standard deviation	Pico to UE	10dB
	UE to UE	12 dB
	Macro to Pico	6 dB
	Pico to Pico	6dB
Pico noise figure		13dB

Table A.1-8: shadowing correlation

Parameters	Assumptions
Shadowing correlation between UEs	0
Shadowing correlation between Femto cells	0
Shadowing correlation between Femto and Macro	0
Shadowing correlation between outdoor Picos	0.5
Shadowing correlation between outdoor Pico and Macro	0.5
Shadowing correlation between Macro cells	A Shadowing correlation factor of 0.5 for the shadowing between sites (regardless aggressing or victim system) and of 1 between sectors of the same site shall be used[36.942]

Annex B:
Change history

Change history							
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New
2012-03		R1-121835			TR skeleton endorsed at RAN1#68bis		0.1.0
2012-06	RAN_56	RP-120693			For approval at RAN#56	0.1.0	2.0.0
2012-06	RAN_56	-			Approved at RAN#56 as version 11.0.0	2.0.0	11.0.0