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Technical Report

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Foreword

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

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

Version x.y.z

where:

- x the first digit:
  - 1 presented to TSG for information;
  - 2 presented to TSG for approval;
  - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

1 Scope

This document is related to the technical report for the study item "Study on Network Assisted Interference Cancellation and Suppression for LTE" [1]. The purpose of this TR is to capture the findings from TSG RAN WG1 and WG4 according to their respective objectives, and to draw a conclusion on way forward.

This activity involves the Radio Access work area of the 3GPP studies and has potential impacts both on the Mobile Equipment and Access Network of the 3GPP systems.

This document is a 'living' document, i.e. it is permanently updated and presented to TSG-RAN meetings.

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] RP-130404, "Study on Network Assisted Interference Cancellation and Suppression for LTE".

[2] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

3 Definitions, symbols and abbreviations

3.1 Definitions

Void

3.2 Symbols

Void

3.3 Abbreviations

For the purposes of the present document, the abbreviations defined in 3GPP TS 21.905 [2] and the following apply:

IC	Interference Cancellation
IS	Interference Suppression
IRC	Interference Rejection Combining
SIC	Successive Interference Cancellation
ML	Maximum Likelihood

4 Introduction

[Editor's note: Pasted directly from the Justification section of [1].]

To boost capacity in coping with the exponential traffic growth, both denser cell deployment and improved cell spectral efficiency are required. Co-channel interference, either from inter-cell or co-scheduled intra-cell users, is expected to become the dominant limiting factor for achieving higher network capacity.

Historically much effort has been spent on transmission coordination to mitigate inter-user and inter-cell interference, for example via enhanced CSI feedback. However, one of the Rel-11 studies (Advanced Receivers) showed promising performance gain from practical linear interference suppression (IS) receivers that do not require any transmission coordination. Specifying interference rejection combining (IRC) receiver UE performance requirements in RAN4 is just a first step towards increasing the receiver role in the system design. In another Rel-11 work item (feICIC), non-linear interference cancellation receivers that mitigate strong CRS/PSS/SSS/PBCH interference have been shown to provide significant gain over linear receivers.

Further enhancements to intra-cell and inter-cell interference mitigation at the receiver side could be achieved by increasing the degree of knowledge about interfering transmissions with possible coordination in the network. For example, linear IS receivers and iterative/non-iterative explicit IC receivers could be evaluated with participating transmitters coordinating and providing side knowledge of the interference such as, but not limited to, the presence and characteristics of interference, its transmission schemes including resource allocation, its reference symbols for possibly enabling channel estimation, and its modulation format and/or coding rate.

Compared to transmission-side techniques whose performance degrades under imperfect channel knowledge at the transmitter side due to limited feedback, IS/IC receivers can alleviate the burden of channel feedback.

Network-assisted IS/IC might require standardization effort, especially on the signalling aspects that can enable more effective and robust UE-side interference cancellation and/or suppression with possible network coordination, as well as on the physical layer changes that can translate link-level improvement of these advanced receivers to system-level capacity gain. It is also important to study the trade-off, in terms of performance, complexity, and signalling overhead, when enabling feasible and robust interference cancellation/suppression at the UE side with and without network assistance.

5 Study Objectives

[Editor's note: Pasted directly from the Objective section of [1].]

The objectives of the study item are the following:

1. (RAN1) For data/control channels of interest, identify and agree on realistic deployment scenarios and co-channel inter- and intra-cell interference conditions (including corresponding network/transmission parameters) for evaluating different interference cancellation (IC) or interference suppression (IS) receivers, including the following two main scenarios:
    - Intra-cell interference resulted from current SU-/MU-MIMO operation
    - Inter-cell interference based on deployment scenarios prioritized in Rel-11, taking into account scenarios, once defined, under Rel-12 WIs/SIs such as small cells.
2. (RAN4) Identify reference IS/IC receivers with and without network assistance, and evaluate their performance/complexity trade-off and implementation feasibility
    - Analyze complexity and feasibility of basic receiver structures
        - Receiver structures based on linear MMSE IRC, successive interference cancellation, and maximal likelihood detection are considered as a starting point for reference IS/IC receivers
        - Work can be conducted in parallel to step-1
    - Based on the RAN1 scenarios agree on co-channel inter- and intra-cell interference models for link-level simulation
    - Evaluate the link-level gain over baseline Rel-11 linear MMSE-IRC receivers and Rel-11 non-linear receivers required for FeICIC
    - Indicate (to RAN1) assumptions on the network assistance information for the evaluated receivers under possible network coordination
3. (RAN1) Study and evaluate the feasibility and potential system level gain as well as specification impact of further advanced receiver:
    - Develop system level modelling methodologies for the IS/IC receivers identified in step-2 including input from RAN4 on relevant impairments

- Evaluate the system-level gain of advanced receivers over LTE Rel-11 receivers
- Identify any physical layer changes and network signalling needed to achieve the system level gain.
- Trade-off study between gain, robustness, and signalling/coordination complexity. If significant gain is identified for solutions with network assistance compared to solutions without network assistance, study the system and specification impact of network-assisted IS/IC
- Work can start at different time for different reference receivers

Note 1 - All evaluations shall take into account practical transmission and feedback overhead/error/delay and realistic eNB and UE impairment modelling including timing/frequency error and backhaul delay.

Note 2 – The study will cover both TDD and FDD deployments, and both CRS based transmission (including PDSCH and PDCCH) and DMRS-based transmission (including PDSCH and EPDCCH). The study should take into account the co-channel interference scenarios arising from homogeneous and heterogeneous networks including small-cell related WI/SI in Rel-12.

Note 3 – The study should consider techniques and operation scenarios in other SI/WI (e.g., enhanced DL-MIMO, enhanced CoMP, New Carrier Type, and small cell enhancement), and duplication of work should be avoided.

6 Scenarios and Targeted/Interference Channels

[Editor's note: This section will capture the findings from objective #1, including (1) channel of interest (2) network scenarios (3) interference conditions (including corresponding network/transmission parameters)]

6.1 Network Deployment Scenarios

6.2 Targeted and Interference Channels

[Editor's note: This section will describe the targeted data/control channel of interest and interference channels with possible prioritization (if any).]

7 Receiver Structures and Assumptions

[Editor's note: This section will describe the general receiver structures studied under objective #2, including any assumption on the required parameters to for the receiver to work and how to obtain them.]

8 Link-level Performance Evaluation

[Editor's note: This section will capture the link level interference modeling and performance evaluated under objective #2]

8.1 Interference Modelling

[Editor's note: This section will describe the link-level interference modeling based on the inter-cell interference scenario and considered inter-cell coordination schemes, as well as the intra-cell interference scenario and considered SU/MU transmission schemes.]

8.2 Link-level Performance Characterization

[Editor's note: This section will capture the performance and robustness evaluation results for the different types of receivers considered in section 7. Subsections will be created based on receiver types and different receiver assumptions for each receiver type.]

9 System-level Performance Evaluation

[Editor's note: This section will capture the system level performance evaluated under objective #3]

9.1 System-level Modelling Methodologies

[Editor's note: This section will capture the system-level modeling for different types of receivers.]

9.2 System-level Performance Characterization

[Editor's note: This section will capture the system-level performance for different types of receivers under different scenarios. Subsections will be created based on scenarios studied, receiver types, and the different receiver assumptions for each receiver type.]

10 Potential Specification Impact

[Editor's note: This section will capture the study of the following bullet in objective #3: Identify any physical layer changes and network signalling needed to achieve the system level gain; and trade-off study between gain, robustness, and signalling/coordination complexity. If significant gain is identified for solutions with network assistance compared to solutions without network assistance, study the system and specification impact of network-assisted IS/IC]

Annex A: Evaluation Assumptions

Annex B: Change history

Table B.1: Draft History

Change history					
Date	**TSG #**	**TSG Doc.**	**Subject/Comment**	**Old**	**New**
	RAN1#73		Draft skeleton TR		0.1.0