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RP-161484

Motivation for new SI on Interference cancellation receiver for LTE BS

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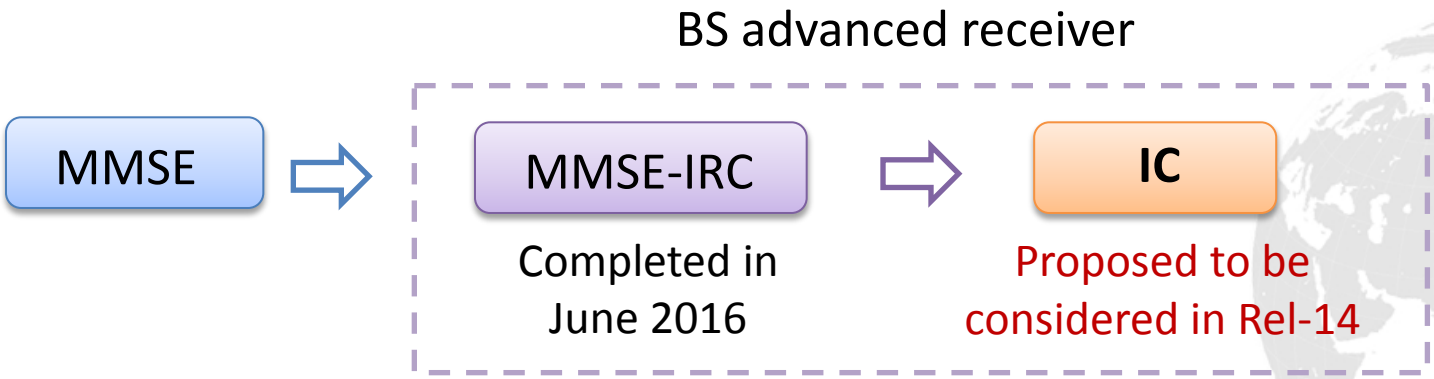
Motivation for BS IC receiver

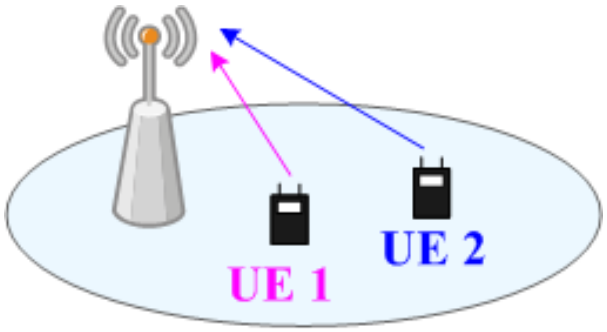
- **Importance of LTE UL throughput improvement**
  - With the wider usage of mobile applications like cloud services, social networking and point to point video/file sharing, UL traffic load is becoming much heavier.
- **LTE UL is interference limited in typical networks, and co-channel interference has substantial impact on UL cell average and cell edge throughput**
  - BS MMSE-IRC receiver can bring in significant SINR gain over MMSE receiver by suppressing the inter-cell interference, in both homogeneous and heterogeneous networks, as concluded in TR 36.884 [1].
  - Consider the further evolution of BS receiver, such as interference cancellation (IC) receiver, to mitigate the intra-cell inter-user interference.

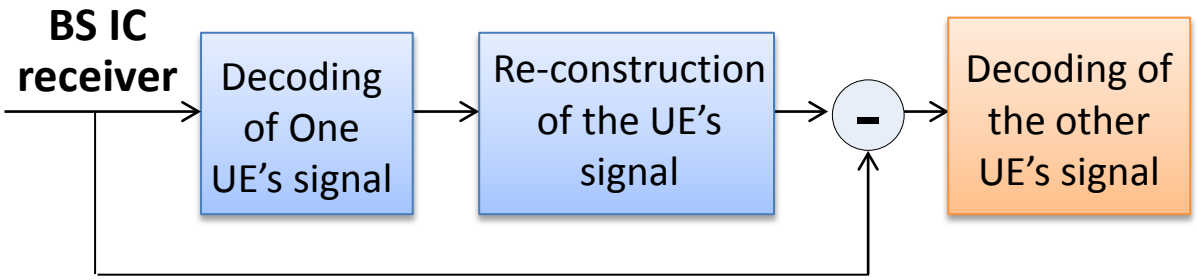


Target scenario

Intra-cell inter-user interference scenario

- Multiple users are co-scheduled on the same resource elements





- Full knowledge of interference parameters is available at the target cell, and code-word level IC receiver is feasible.
- The utilization of BS IC receiver is transparent to the users, and the performance gain of BS IC receiver can also be enjoyed by legacy users.

Potential gain by BS IC receiver

In the intra-cell inter-user interference scenario, compared to MMSE receiver, BS IC receiver is expected to achieve noticeable throughput gain for cell center and cell edge UEs, based on the theoretical analysis [3].

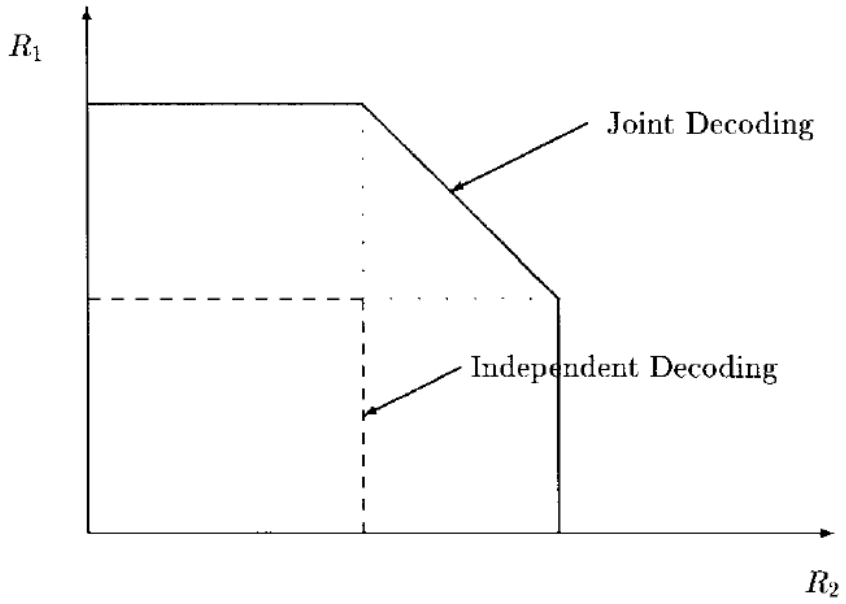
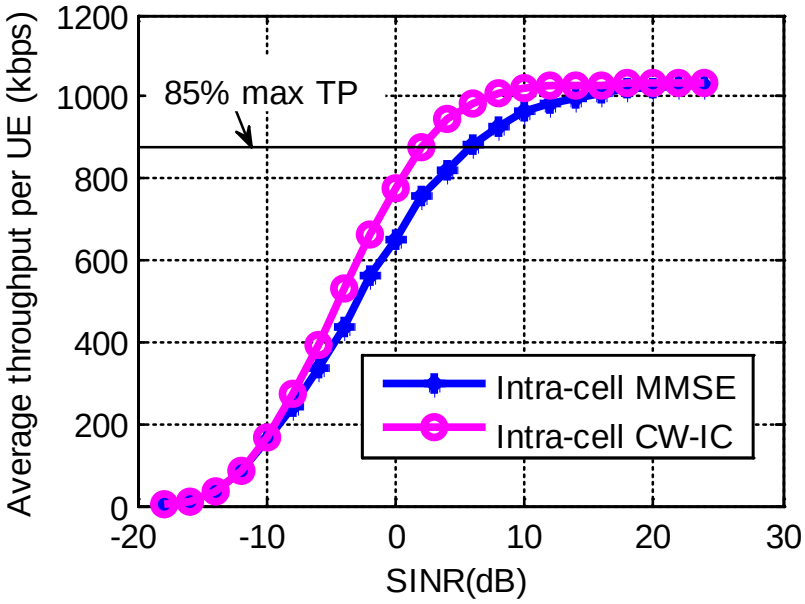


Fig. Capacity regions for a two-user *M*-receiver system

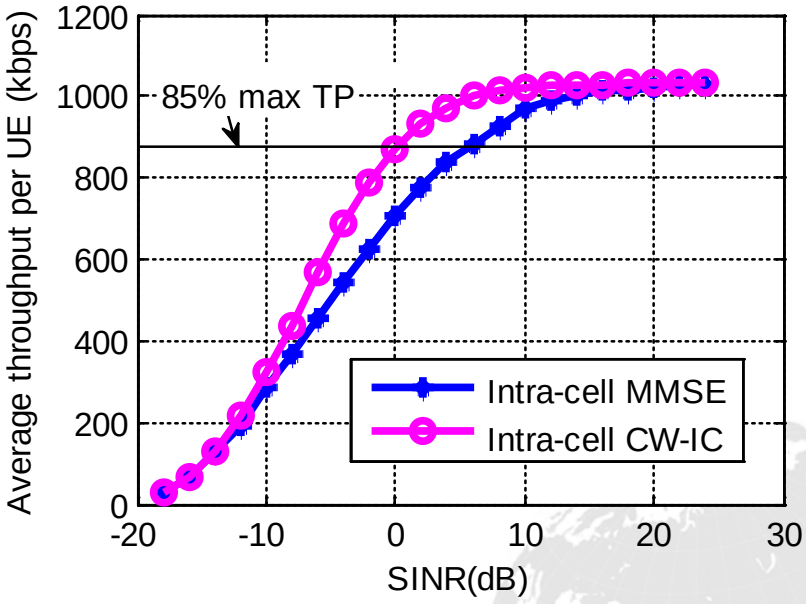
- Capacity region for joint decoding indicates the performance upper band for IC receiver.
  - Joint decoding: decoding of all signals is performed simultaneously.
- Capacity region for independent decoding indicates the performance upper band for MMSE receiver.
  - Independent decoding: different signals are decoded independently and in parallel.

Link-level simulations for BS IC receiver (1/2)

- **Case 1: 2 Rx antennas at BS**
  - 2 UEs, with the same wideband SINR, are co-scheduled by the target cell.
  - 2 explicit inter-cell interferers are modeled, and inter-cell interference IRC is enabled.
  - More detailed simulation assumptions are described in the Annex.



Homogeneous scenario

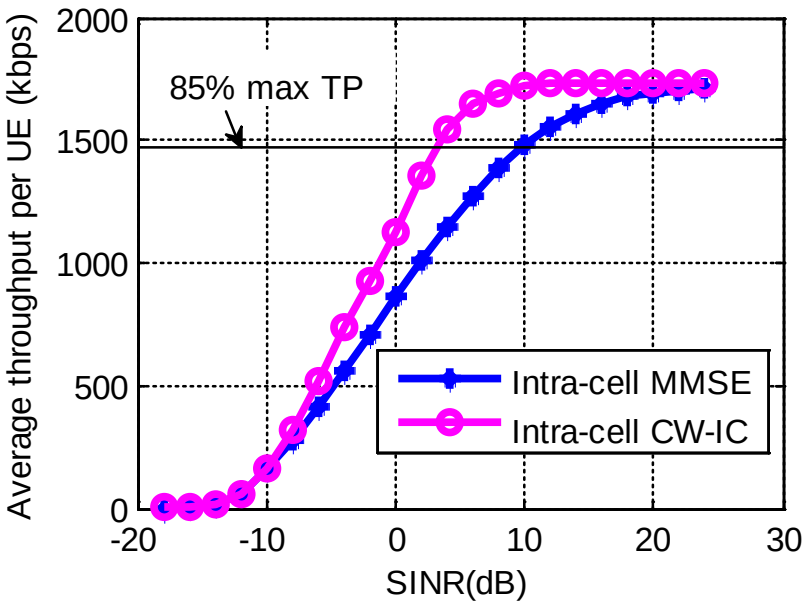


Heterogeneous scenario

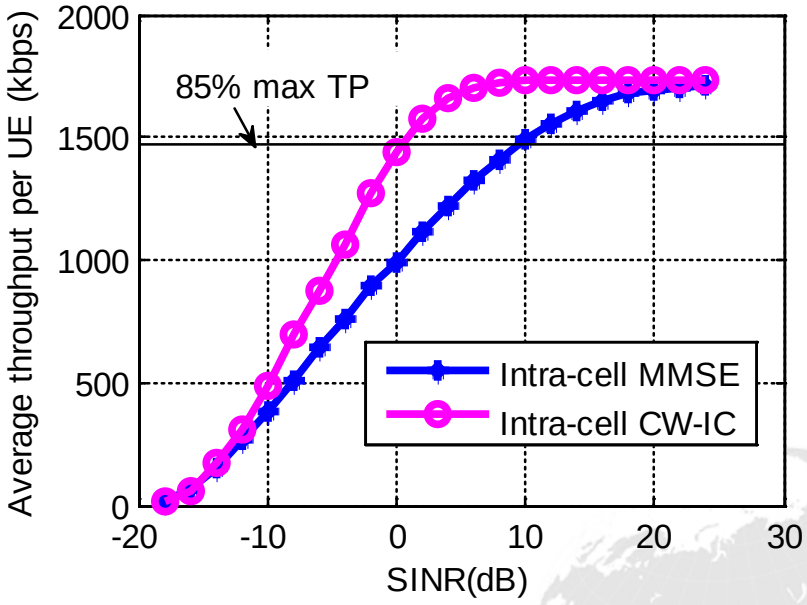
- With intra-cell inter-user CW-IC receiver, 3.9 - 5.5 dB gain can be achieved at 85% maximum throughput for 2Rx BS.

Link-level simulations for BS IC receiver (2/2)

- **Case 2: 4 Rx antennas at BS**
  - 4 UEs, with the same wideband SINR, are co-scheduled by the target cell.
  - 2 explicit inter-cell interferers are modeled, and inter-cell interference IRC is enabled.



Homogeneous scenario



Heterogeneous scenario

- With intra-cell inter-user CW-IC receiver, 6.6 - 9.0 dB gain can be achieved at 85% maximum throughput for 4Rx BS.

Proposal and scope

- **Proposal**
  - Start a RAN4-led SI in Rel-14 to study the performance benefits of BS IC receiver under typical deployment scenarios and with practical receiver implementation.
- **Scope**
  - Identify the target deployment scenarios and the co-channel intra-cell interference conditions
  - Identify the reference receiver structures for PUSCH
    - ✓ Receiver structures based on interference cancellation is considered as a starting point, and practical and realizable implementation should be taken into account.
  - Agree on the interference models, interference levels and simulation parameters for link level evaluations
  - Evaluate the link-level gain for PUSCH over baseline receiver
    - ✓ Evaluate the link-level gain over baseline Rel-8 MMSE receiver for intra-cell inter-user interference scenarios.

References

[1] 3GPP RP-160766, “TR 36.884 V2.0.0: Performance requirements of MMSE-IRC receiver for LTE BS”, RAN #72, Jun 2016.

[2] 3GPP RP-150206, “Revised WID: Performance requirements of MMSE-IRC receiver for LTE BS”, RAN #67, Mar 2015.

[3] Bruno Suard, Guanghan Xu, Hui Liu, et al., “Uplink Channel Capacity of Space-Division-Multiple-Access Schemes,” IEEE transactions on information theory, vol. 44, no. 4, July 1998.

Thanks!

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Annex: Link-level simulation assumptions

Parameters		Values
Cyclic prefix		Normal
HARQ RV sequence		0, 2, 3, 1
Maximal number of HARQ transmissions (including 1st Tx and re-Tx)		4
PRB number for PUSCH		6
Antenna number		1Tx at UE, 2/4Rx at BS
Number of co-scheduled UEs within the target cell		2/4 UEs respectively for 2/4Rx BS
MCS		10 for 2Rx, 15 for 4Rx
Frequency hopping, TTI bundling		Disabled
Modeling of inter-cell interferers	**Number of explicitly modelled inter-cell interferers**	2
	(DIP1, DIP2)	(-1,11, -10,91) for HomHet (-0,43, -13,78) for HetNet
	Modulation of inter-cell interferers	16QAM
	Timing delay	Aligned
Propagation condition (Serving, interferers)		EPA5