Impact of Relay-to-Relay Interference on the Performance of LTE-Advanced Relay Networks

Abdallah Bou Saleh[1], Ömer Bulakci[1,2], Simone Redana[2], Bernhard Raaf[2], and Jyri Hämäläinen[1]

1. Aalto University School of Electrical Engineering, Helsinki, Finland (formerly *Helsinki University of Technology-HUT*)

2. Nokia Siemens Networks, NSN-Research, Radio Systems, Munich, Germany

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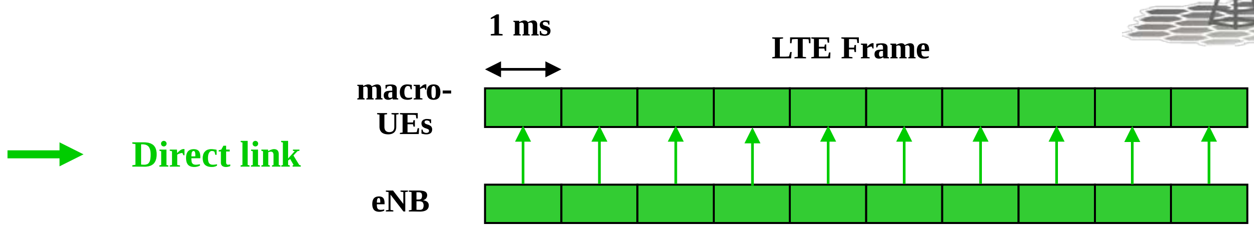
Relaying in LTE-Advanced: Characteristics

RECALL

eNB-only Deployments

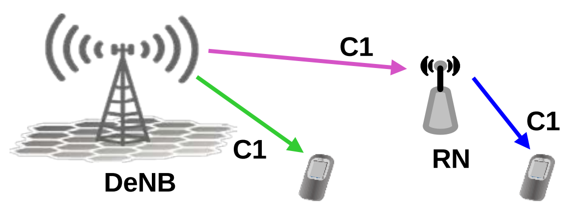


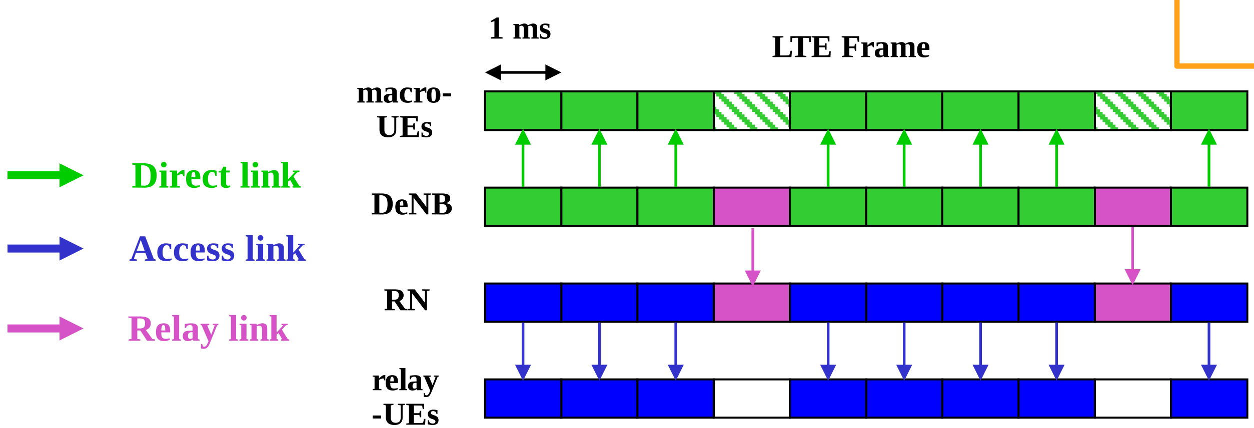
Macrocell (eNB-only) Deployment

"Type 1" Relay Deployments

– Same carrier for backhaul and access links
– Time division multiplexing backhaul ↔ access

In-band "Type 1"





Type 1 RN Deployment

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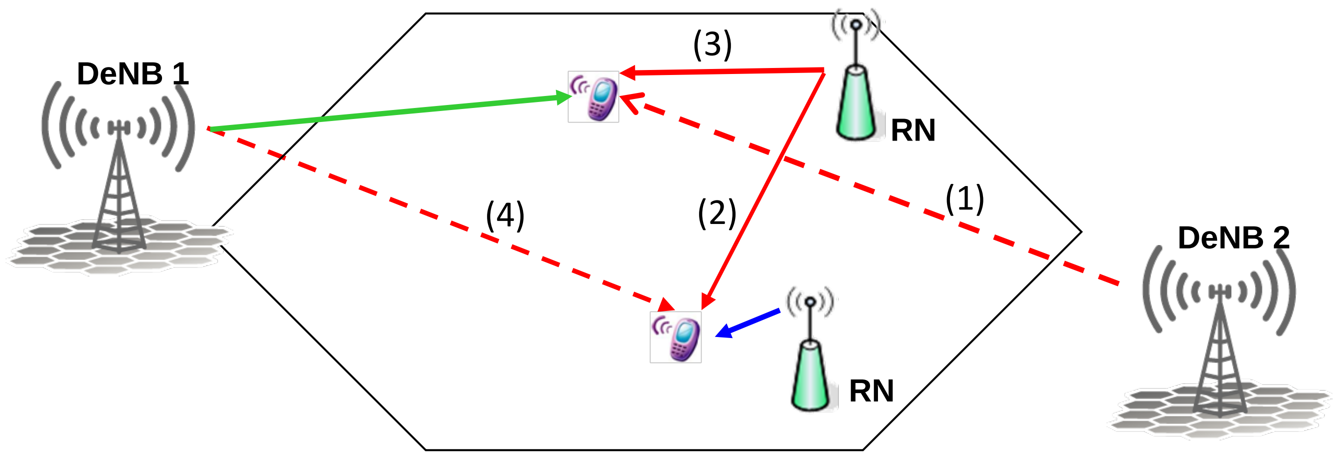
- Introduction
- Problem Definition and Objective
- Subframe Configuration Alignment Schemes
- Performance Evaluation
- Conclusions

Interference Models (1/2)

Types of Interference:

A. Traditional Inter-cell Interference: Access-to-Access

1. Inter-(DeNB-DeNB)-cell
2. Inter-(RN-RN)-cell
3. Inter-(RN-DeNB)-cell
4. Inter-(DeNB-RN)-cell

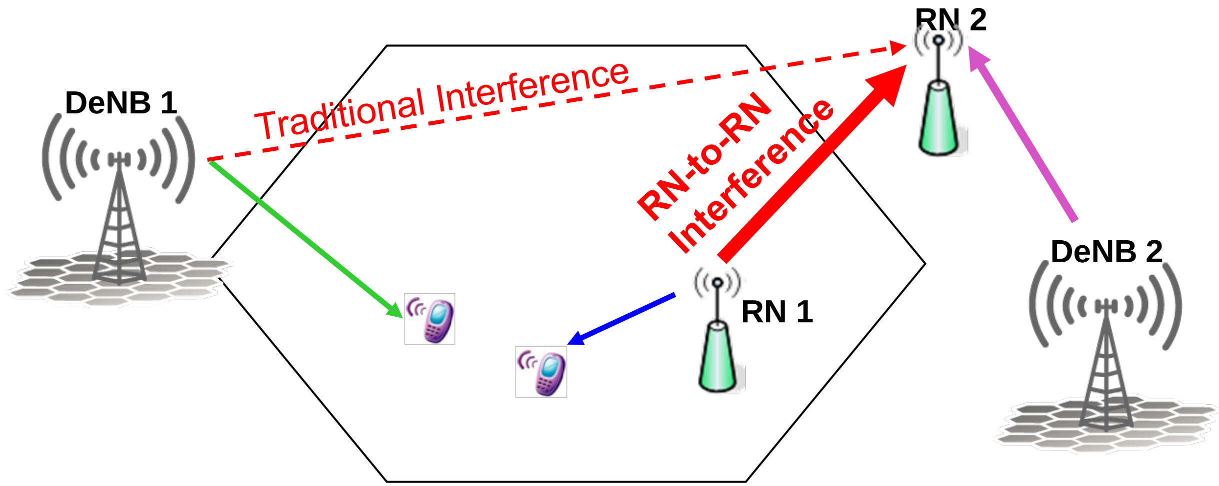


Interference Models (2/2)

B. RN-to-RN Interference: Access-to-Backhaul Interference

Misalignment in Subframe Configuration –

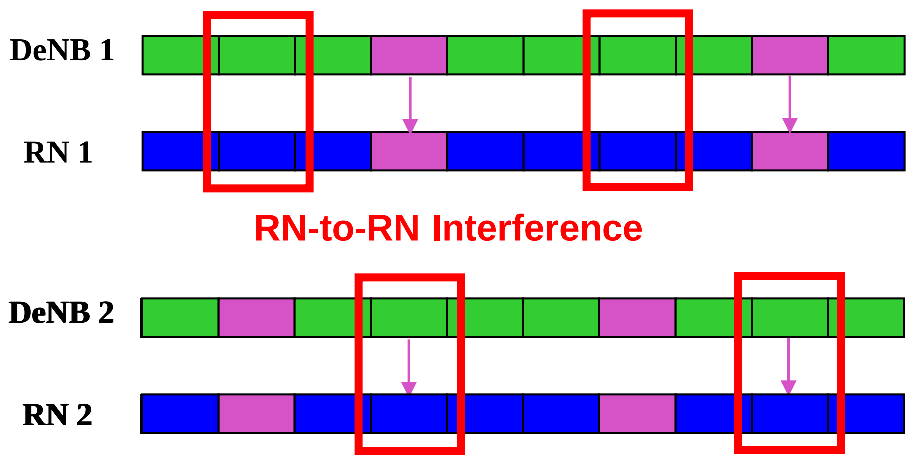
Backhaul subframes can be configured independently for each RN within a cell or in different cells



Direct link

Access link

Relay link



RN 2 creates RN-to-RN Interference on RN 1 as well!

Problem Definition & Objective
RN-to-RN Interference

- **Reason:** Concurrent access/relay link transmissions due to asynchronous and/or misaligned subframe configuration.

- **Solution:** Subframe configuration alignment among RNs.
  - Tradeoff: Flexibility in backhaul subframe configuration versus level of RN-to-RN Interference
    - Higher level of alignment implies better interference resilience but lower flexibility in adapting to network variations and vice versa.

- **Objective:** Investigate the performance of simple backhaul subframe configuration alignment schemes
  - Network-wide alignment
  - Intra-cell alignment
  - Intra-site alignment

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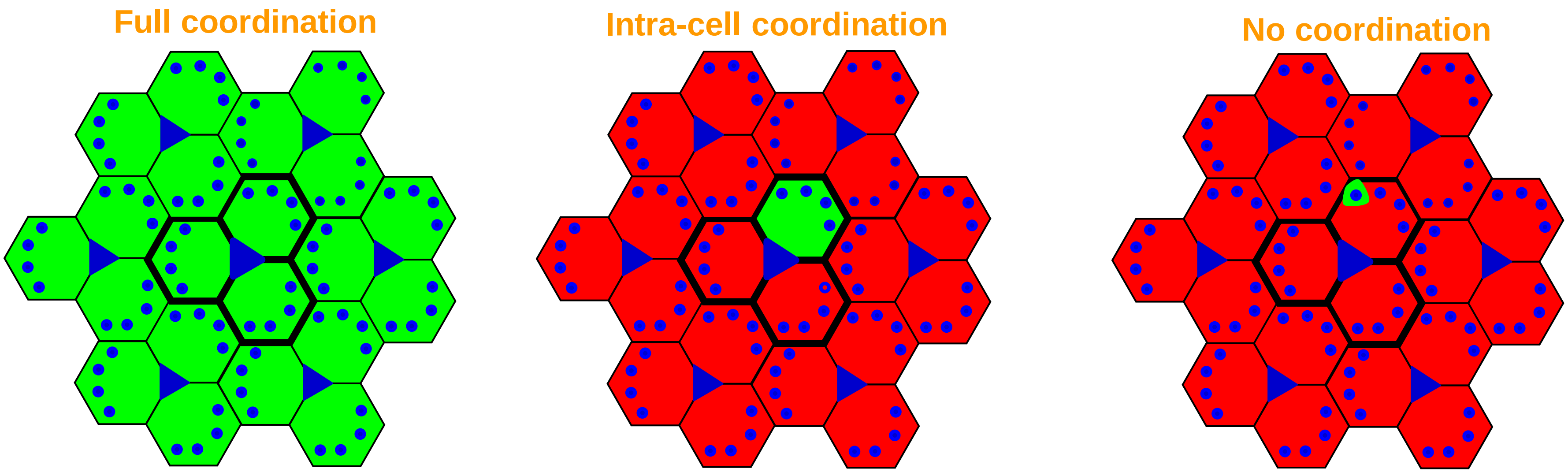
Subframe Configuration Alignment Schemes (1/2)



Full Coordination / Network-wide Alignment

- Full synchronization among DeNBs
- Same backhaul subframe configuration is used for all RNs in the network, e.g. configured by OAM

Intra-cell Coordination / Alignment

- Same Un subframe configuration for RNs within each cell.
- Different cells have different Un sub-frame configurations.

Interference Source

Aggressor-Free Area

No Coordination - Reference

- All RNs have different Un subframe configuration, and hence RNs within the same cell and from neighboring cells may interfere each other
- This is a worst case that does not correspond to a real scenario.

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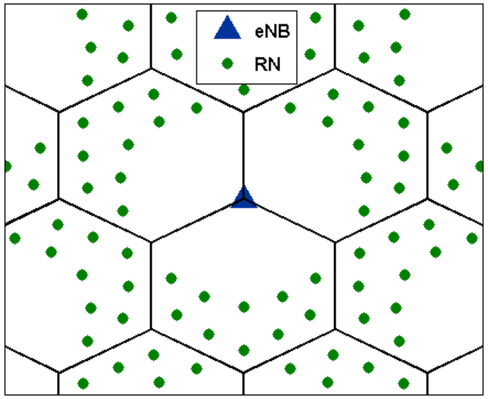
Performance Evaluation
System Model / Simulation Parameters

3GPP TR36.814 v9.0.0 channel models



System Parameters	System Layout	19 tri-sectored sites
	Bandwidth	10 MHz
	Traffic Model	Full Buffer
	Noise PSD	-174 dBm/Hz
	Shadowing	σ_{macro} = 8 dB $\sigma_{rn\ cell}$ = 10 dB $\sigma_{relay\ link}$ = 6 dB
	Penetration Loss	20 dB for UEs
	Highest MCS (AMC)	64-QAM – R: 9/10
	Resource partitioning	Reuse 1

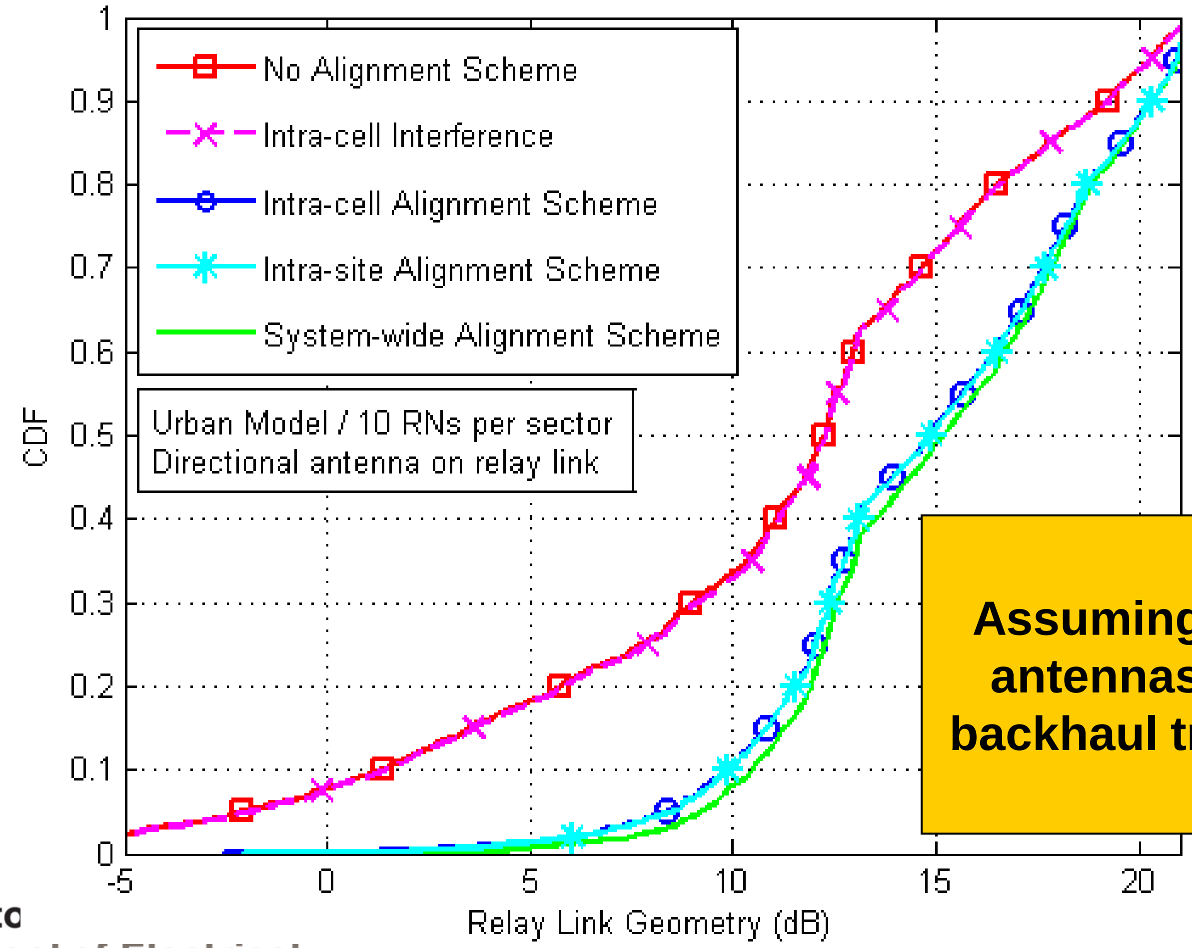
eNB Specific	Antenna configuration	1 Tx, 1 Rx
	Transmit Power	46 dBm
	Antenna gain	14 dBi
	eNB Antenna Pattern (Horizontal)	$-\min[12\,(\theta/\theta_{3dB})^2, A_m]$ $\theta_{3dB} = 70^o$ & $A_m = 25$ dB

UE Specific	Antenna configuration	1 Tx, 1 Rx
	Noise Figure	9 dB
	UE drops	Uniform - 25 UEs per sector – Indoor

RN Specific	Antenna configuration	1 Tx, 1 Rx
	Transmit Power	30 dBm
	RN-UE antenna gain	5 dBi
	RN-eNB antenna gain	7dBi
	Noise Figure	5 dB

Performance Evaluation
3GPP Case 1 – ISD 500m – 10 RNs

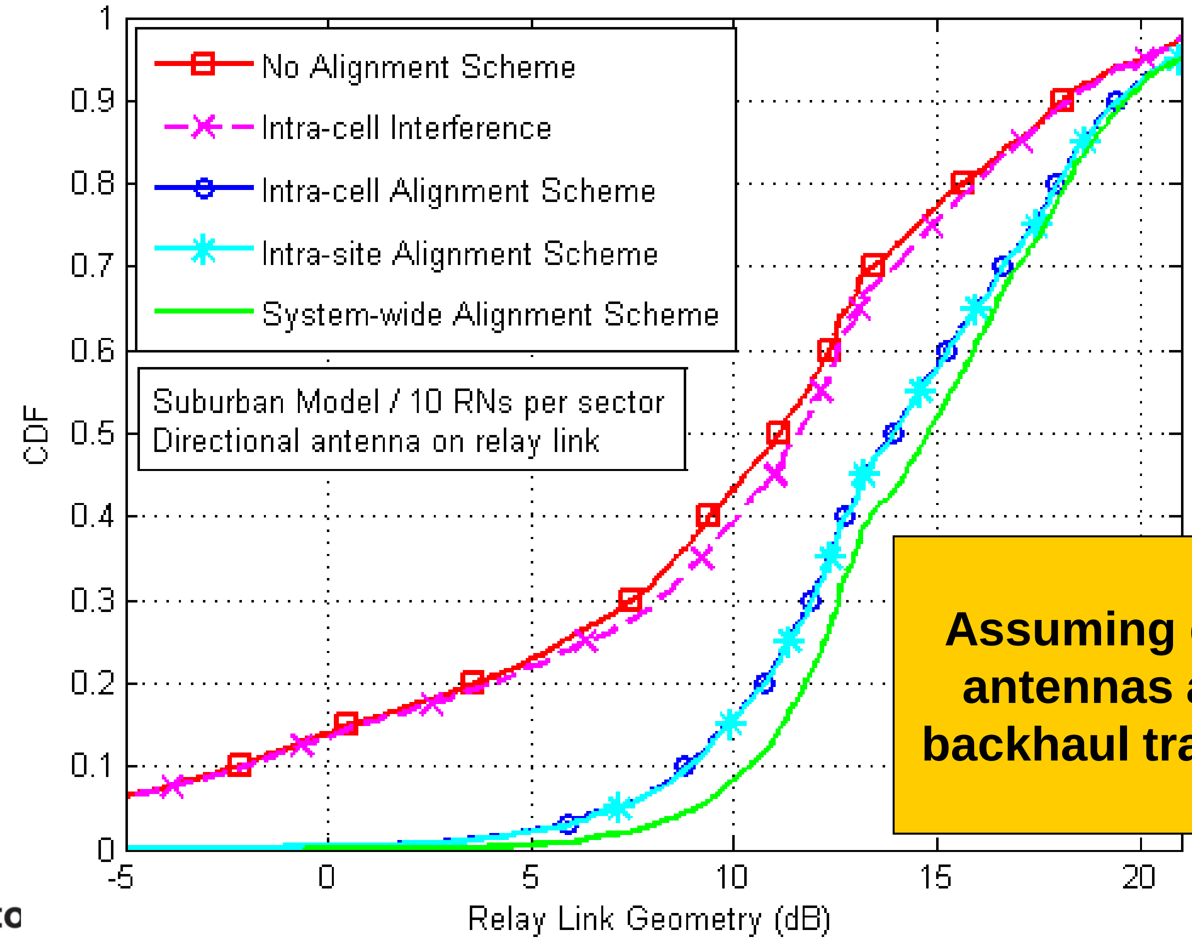
- Intra-cell subframe configuration alignment mitigates RN-to-RN interference in urban scenarios.



Assuming directional antennas at RNs for backhaul transmission.

Performance Evaluation
3GPP Case 3 – ISD 1732m – 10 RNs

- Intra-cell subframe configuration alignment achieve notable resilience against interference in suburban scenarios.



Assuming directional antennas at RNs for backhaul transmission.

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Conclusions

- **RN-to-RN interference may arise in inband Type 1 RN deployments due to misalignment in subframe configuration**
- **RN-to-RN Interference imposes significant loss in geometry in some scenarios.**
- **Intra-cell subframe configuration alignment offers good resilience against interference in case directional antennas are used at RNs.**

http://elec.aalto.fi/en/
Aalto University
ComNet
FIN-00076 Helsinki
Finland

Aalto University
School of Electrical Engineering

Abdallah Bou Saleh
Ph.D. Candidate
abdallah.bousaleh@ieee.org

Thank you for your attention!

Q & A