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Analysis of Joint and Partial Component Carrier Assignment Techniques in LTE and LTE-A

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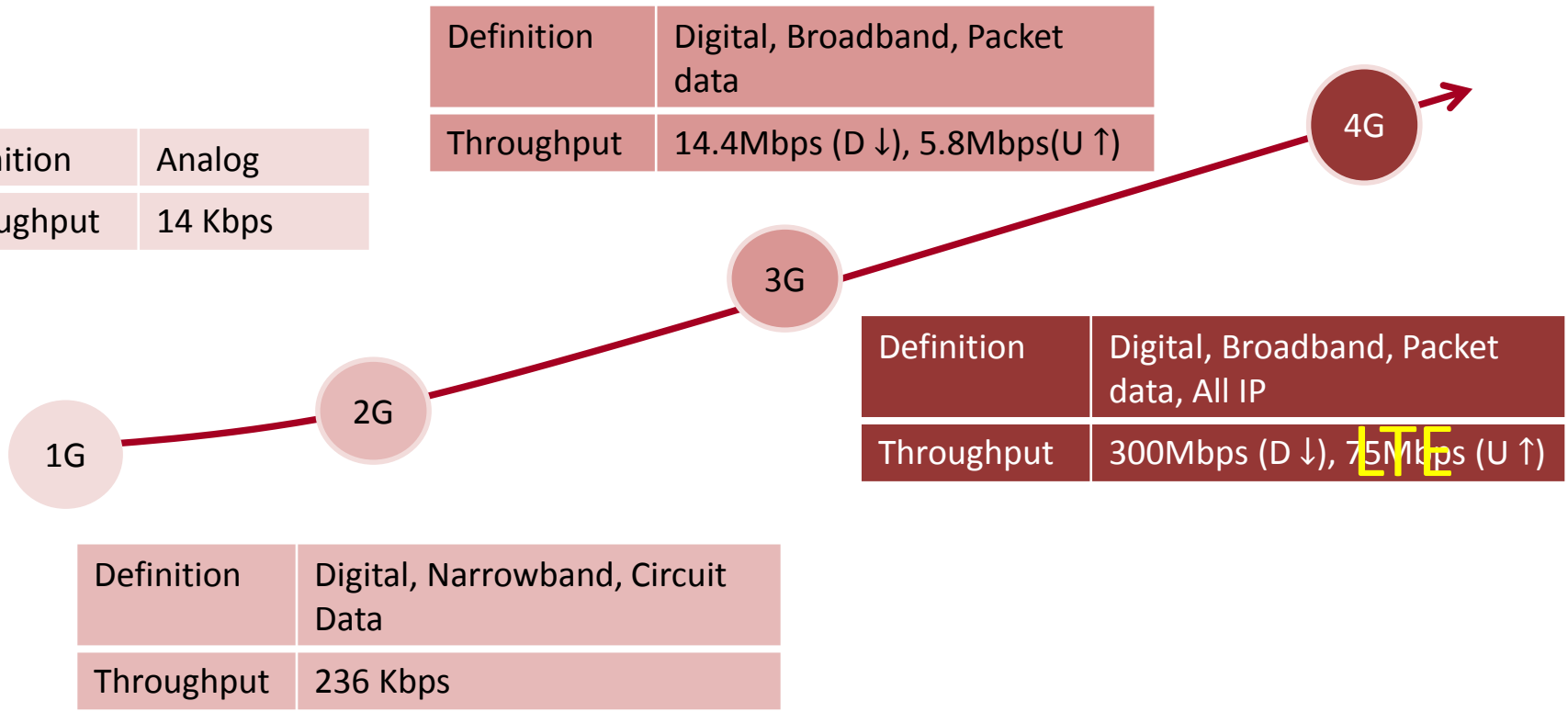
Outlines

- Introduction
- Joint and Partial Carrier Assignment Techniques
- Analysis
- Results
- Conclusion

Communication Speed Over Generation



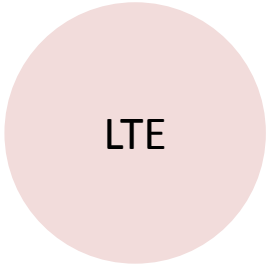
Definition	Analog
Throughput	14 Kbps

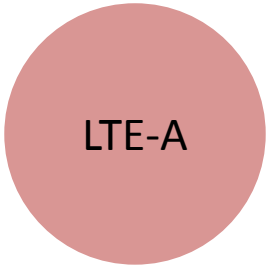
Definition	Digital, Narrowband, Circuit Data
Throughput	236 Kbps

Definition	Digital, Broadband, Packet data
Throughput	14.4Mbps (D ↓), 5.8Mbps(U ↑)

Definition	Digital, Broadband, Packet data, All IP
Throughput	300Mbps (D ↓), 75Mbps (U ↑)

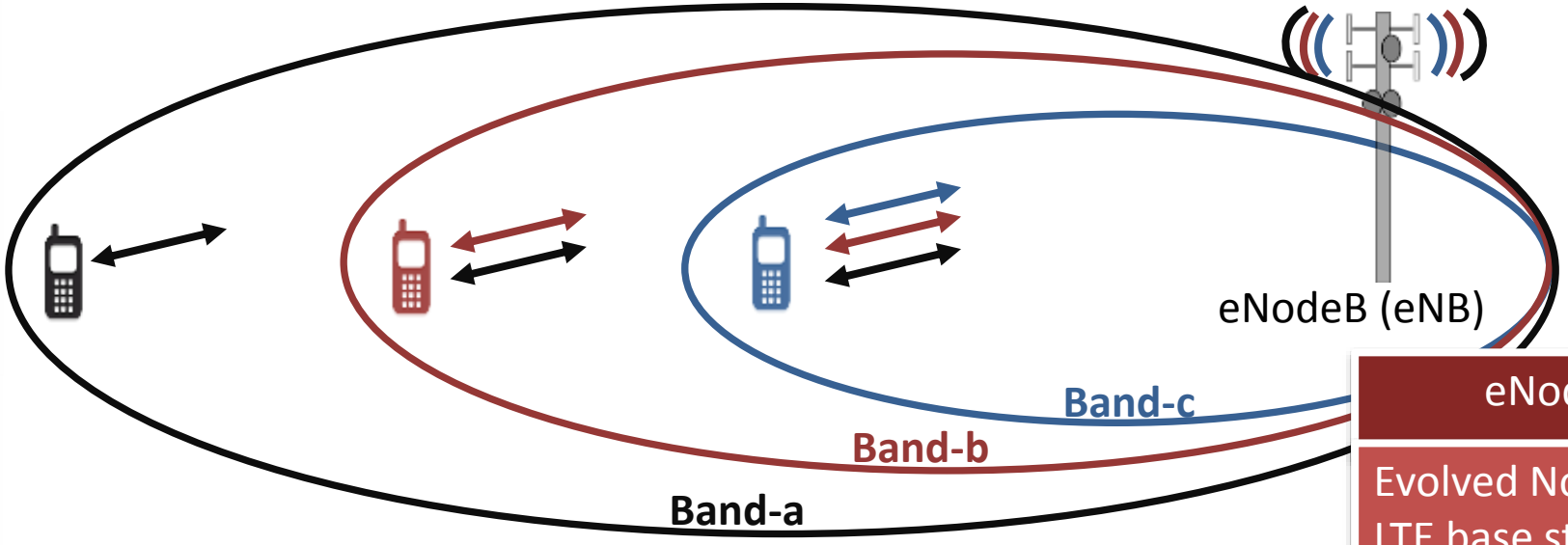
LTE and LTE-A





Theoretical Throughput	300Mbps (D ↓) - 75Mbps (U ↑)	3Gbps (D ↓) - 1.5Gbps (U ↑)
Experienced Throughput	13Mbps (D ↓) crowded area	
Technology	OFDMA (D ↓), SC-FDMA (U ↑)	OFDMA, CA, RN, MIMO

Carrier Aggregation (CA)



eNodeB

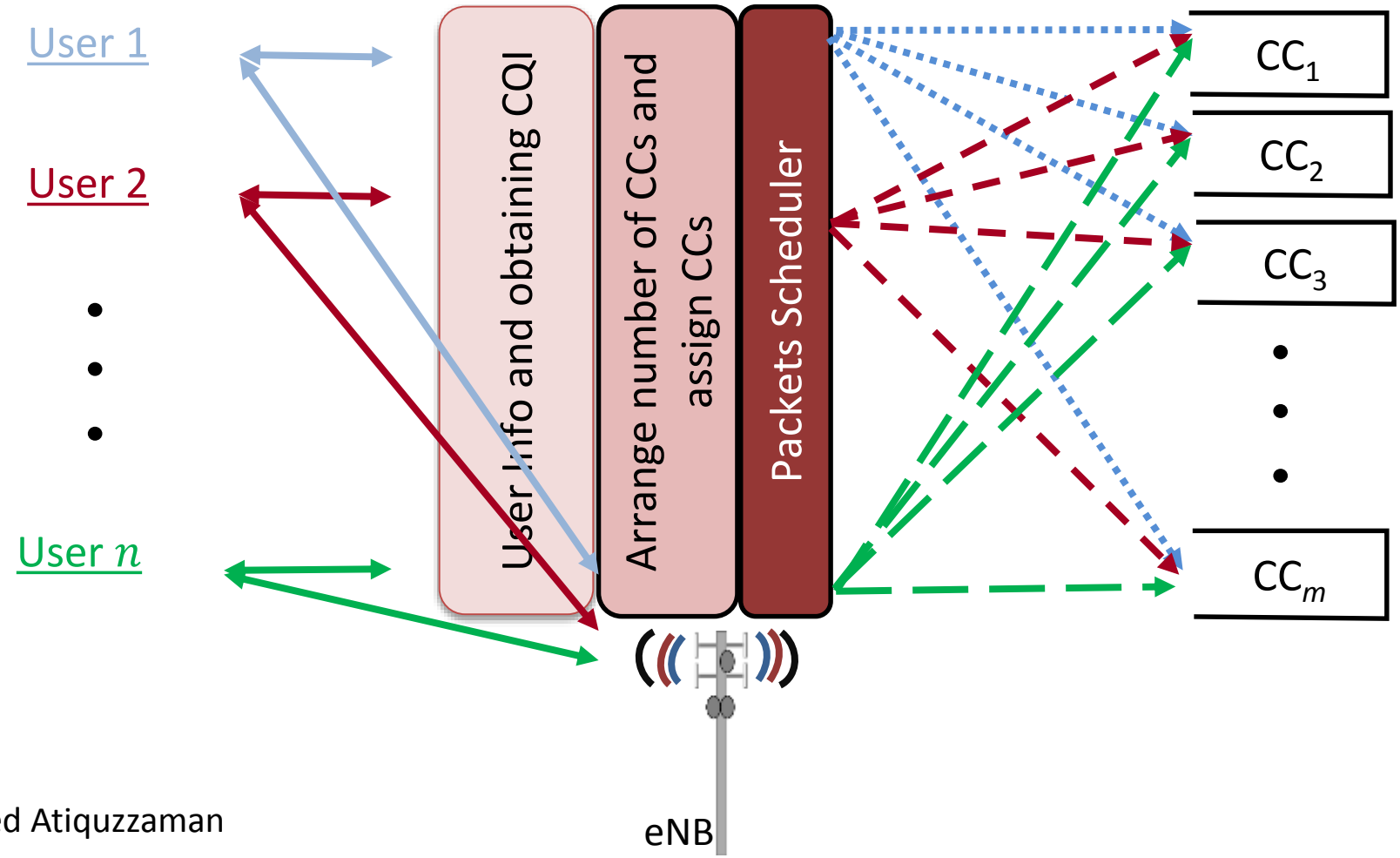
Evolved Node B:
LTE base station

Secondary Component Carriers

Primary Component Carrier

Up to 5 Carrier Components (CC) for downlink and uplink

Carrier Assignment with Packet Scheduling



Objective

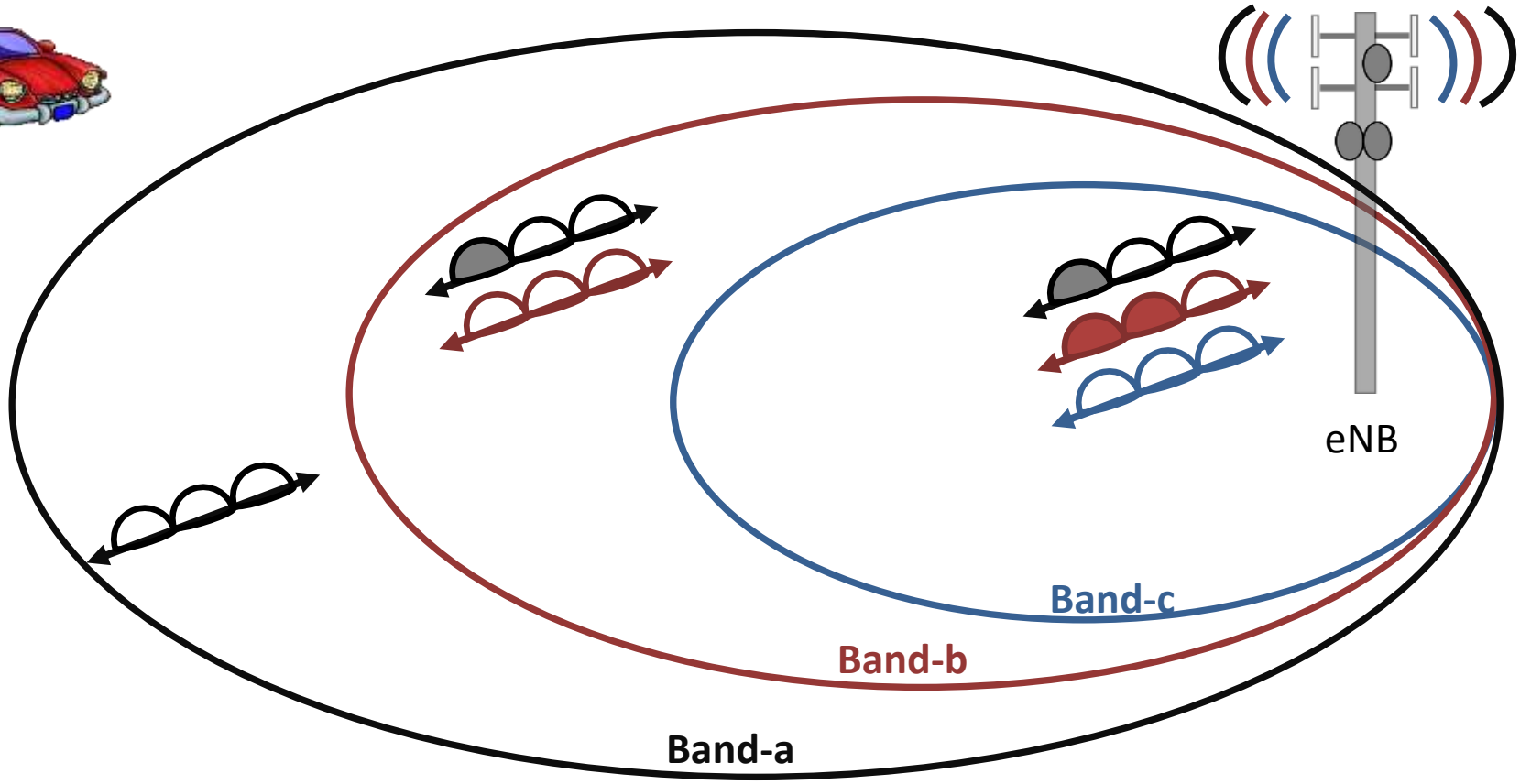
Analyzing the impact of packet drops and delay experienced by users during the secondary component carrier assignment operations on systems performance.

Component Carrier Assignment

- Case 1: PCC needs to be updated, therefore all SCCs need to be updated.
- Case 2: All SCCs need to be updated but PCC does not need to be updated.
- *Case 3: Some SCCs need to be updated but PCC does not need to be updated.*
  - Joint
  - Partial

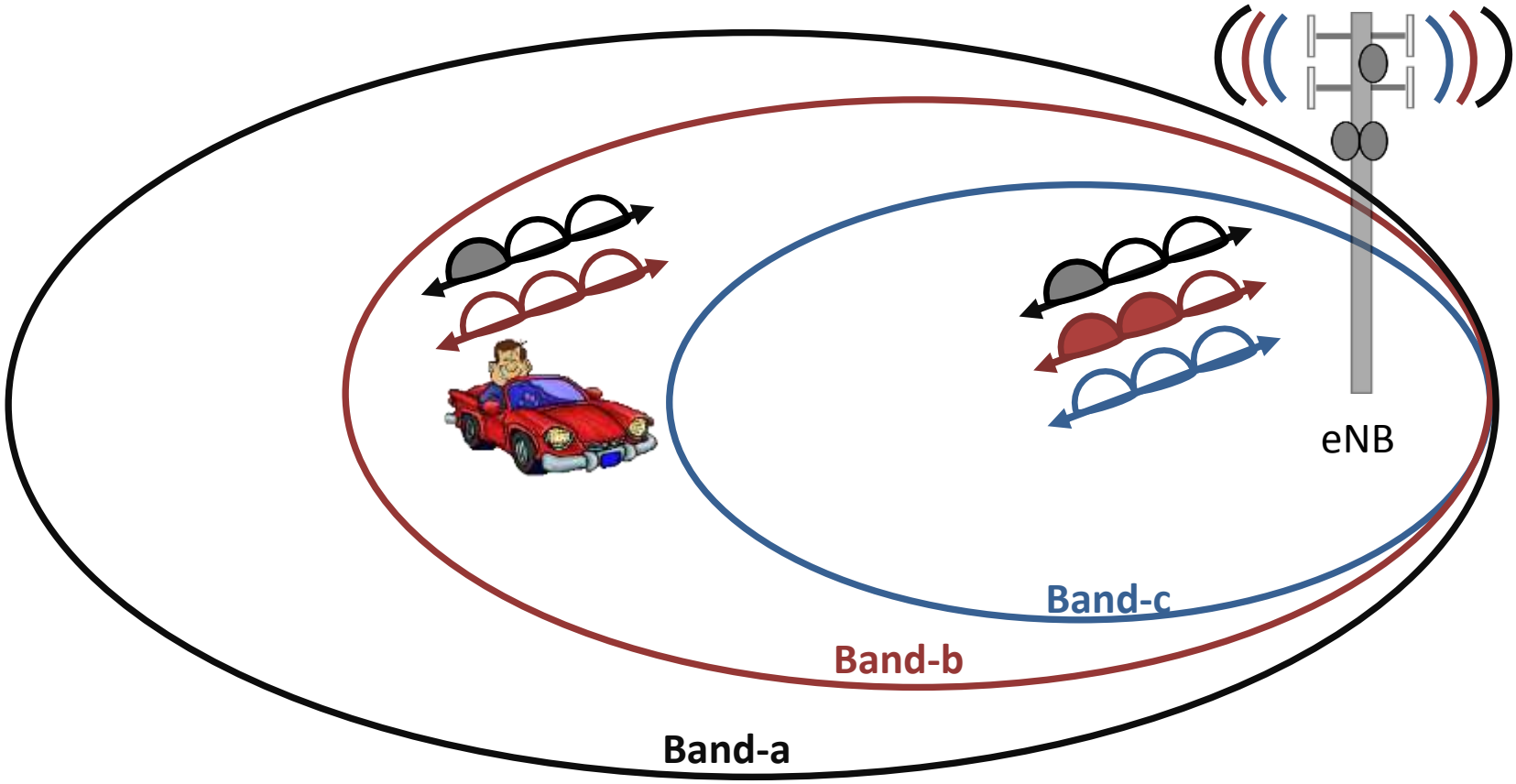
Joint

What is the effects of Joint Reassignment of secondary component carriers on carrier assignment?



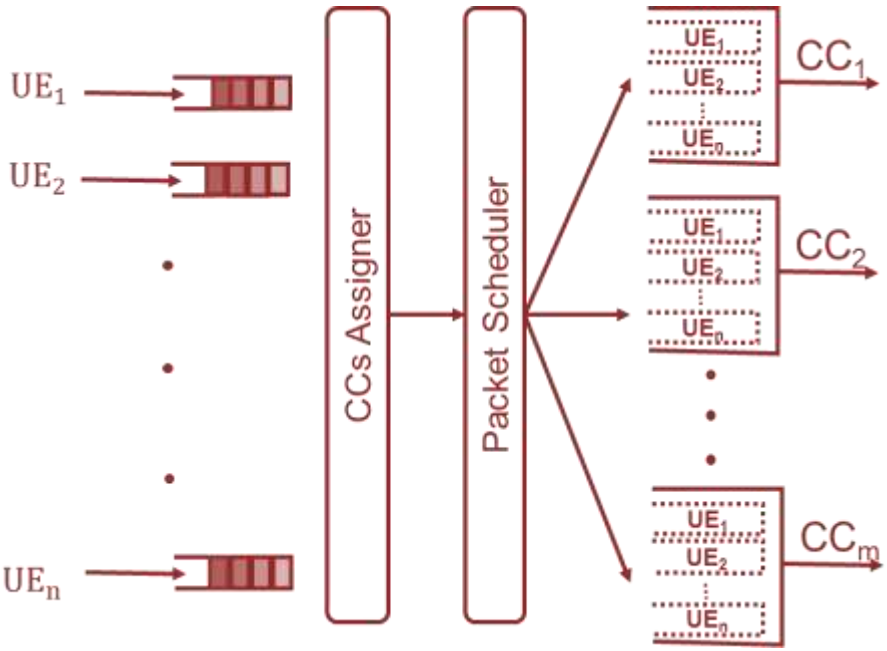
Partial

What is the effects of Partial Reassignment of secondary component carriers on carrier assignment?

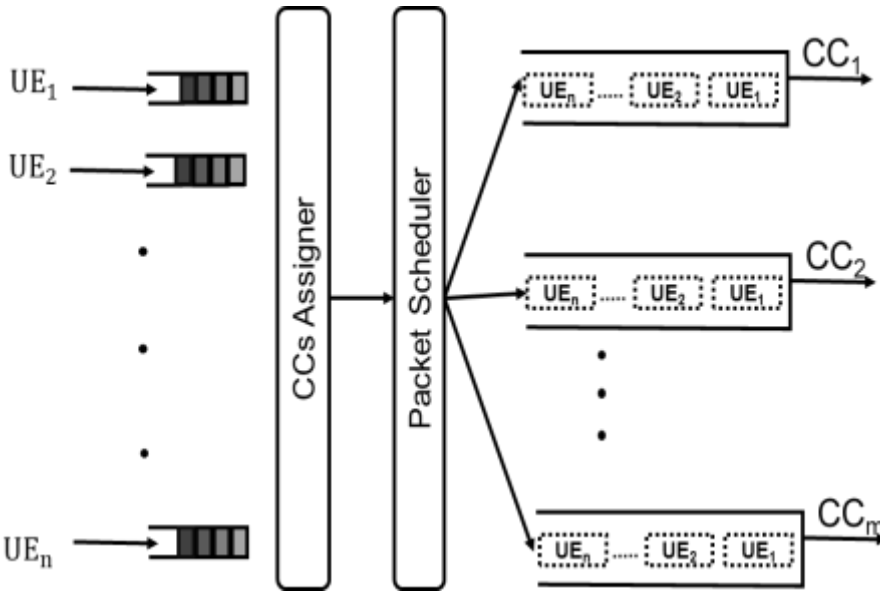


Queuing Analysis

Disjoint Queue Model



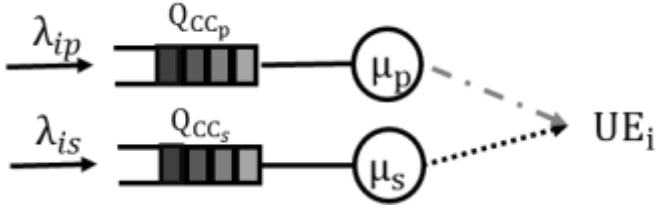
Joint Queue Model



Simplification for Queuing Analysis

Case 3: Some SCCs need to be updated but PCC does not need to be updated.

- Assume, one user



For Partial SCCs assignment

$$\rho(t) = \begin{cases} \dfrac{\lambda_i(t)}{\mu_p(t) + \mu_s(t)} & if\ \mu_s(t) \neq 0 \\ \dfrac{\lambda_i(t)}{\mu_p(t)} & if\ \mu_s(t) = 0 \end{cases}$$

For Joint SCCs assignment

$$\rho(t) = \frac{\lambda_i(t)}{\mu_p(t)}$$

ρ shows that Partial is better than Joint during the carrier assignment process.

Simulation parameters

Num. of eNB	1
Bands Used	800MHz, 1.8GHz, 2.6GHz
Num. of CCs in Each Band	4
Total Num. of CCs	12
Queue Length of Each Q_{CC}	50 packets
Pareto Shape Parameter	1
Pareto Scale Parameter	20
Bandwidth of CCs	10MHz
Modulation	QPSK, 16QAM, and 64QAM
CQI	3, 5, 7, and 11
Transmission Time Interval	1 ms
CCA operation Time	20 ms

- LTE (1 CC), LTE-A (4 CCs)
- 1/2 of users are LTE-A.
- Users are freely move around of eNB
- Min-delay packet scheduling is used.
- Packet arrival follows Pareto Distribution with shape par = 1 and scale par = 20.

Results

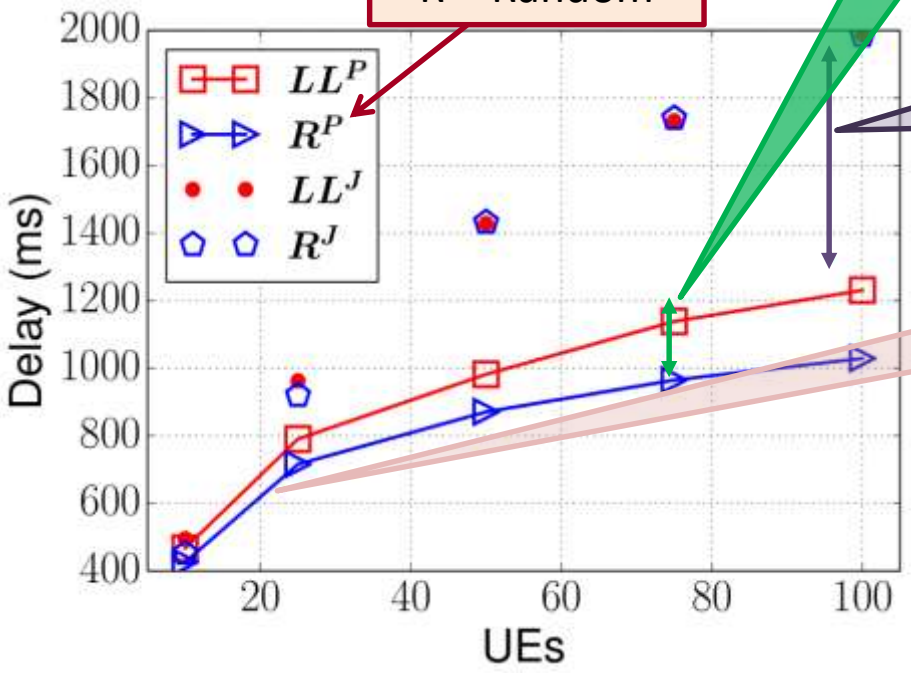
- Discrete event simulation for downlink process with carrier assignment methods.
- We compare
  - LL (Least Loaded) with 4 CCs assignment to LTE-A type users and 1 CC assignment to LTE type users) for Joint and Partial techniques.
    - LL^J represents Least load carrier assignment with joint technique.
    - LL^P represents Least load carrier assignment with partial technique.
  - R (Random) with 4 CCs assignment to LTE-A type users and 1 CC assignment to LTE type users) for Joint and Partial techniques.
    - R^J represents Random carrier assignment with joint technique.
    - R^P represents Random carrier assignment with partial technique.

Joint vs Partial

Objective

Observing effects of number of users on delay during carrier assignment for Joint and Partial.

P = Partial
J = Joint
LL = Least Load
R = Random



Delay in R is lower than delay in LL for partial.

Delay of joint is almost double of delay of partial when number of user is increased.

Not much delay differences between joint and partial when the number of user is low

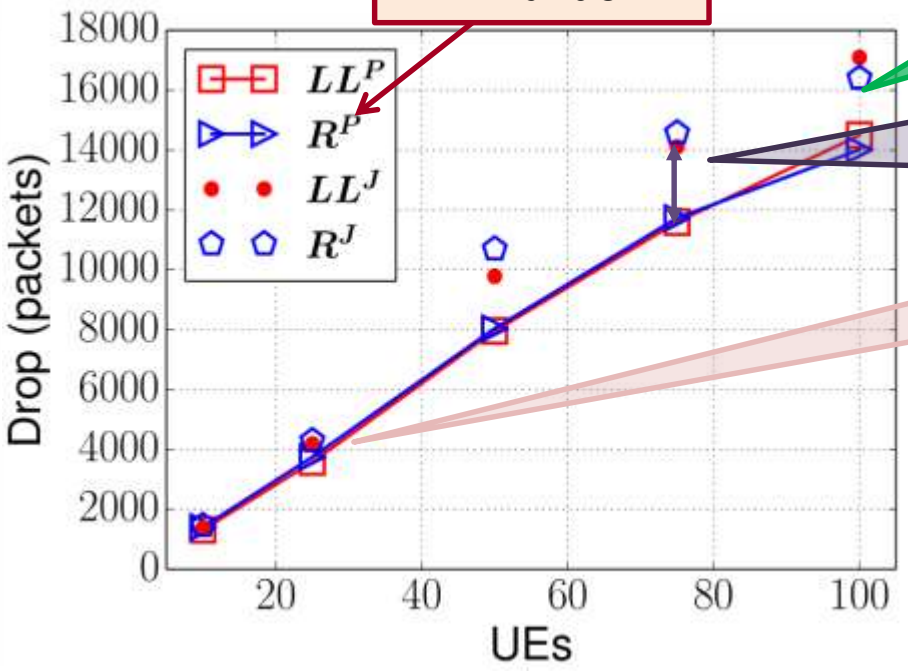
Partial technique is better than Joint technique during the carrier assignment process in terms of delay for both R and LL.

Joint vs Partial

Objective

Observing effects of number of users on drops during carrier assignment for Joint and Partial.

P = Partial
J = Joint
LL = Least Load
R = Random



Not much differences between R and LL for joint and partial.

Dropped packets of joint is higher than dropped packets of partial when the number of user is increased.

Not much packet drop differences between joint and partial when the number of user is low.

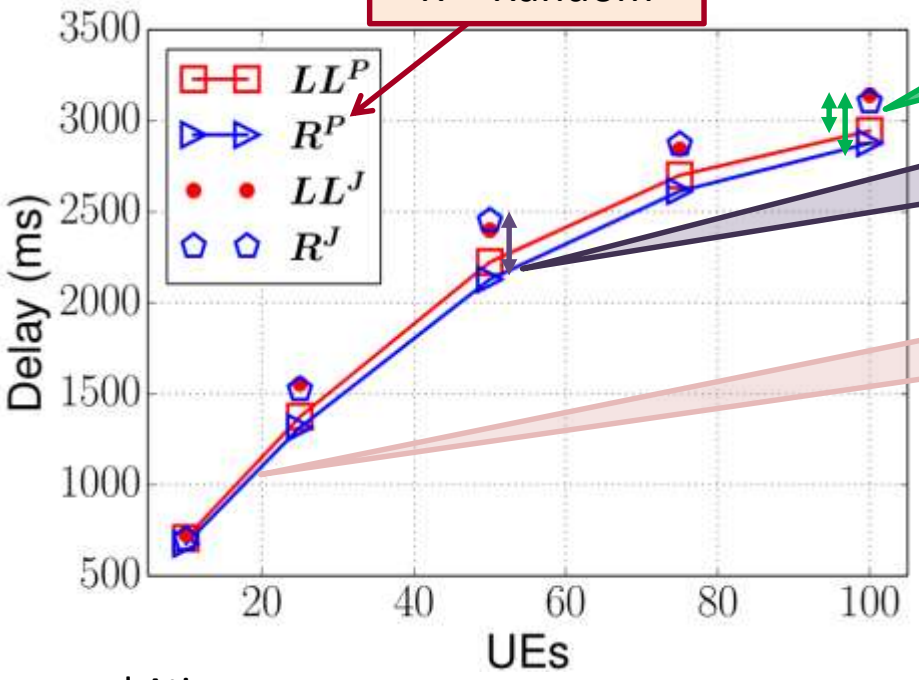
Partial technique is better than Joint technique during the carrier assignment process in terms of packet drops for both R and LL.

Joint vs Partial

Objective

Observing effects of number of users on overall delay for Joint and Partial.

P = Partial
J = Joint
LL = Least Load
R = Random



Delay gap between joint and partial in R is higher than delay gap between joint and partial in LL.

Delay of joint is higher than delay of partial when number of user is increased.

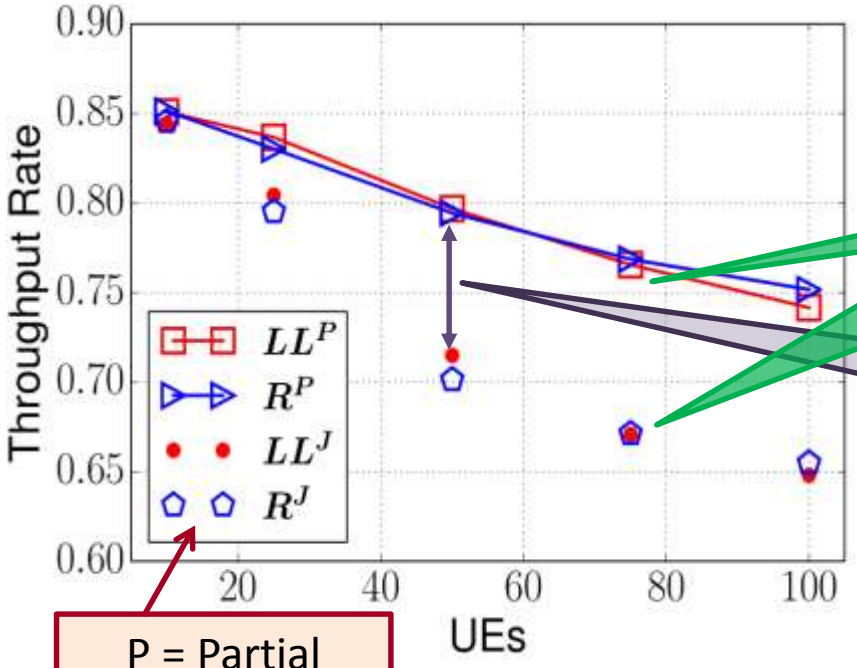
Not much delay differences between joint and partial when number of user is low.

Partial technique is better than Joint technique in terms of overall delay in both LL and R.

Joint vs Partial

Objective

Observing effects of number of users on system throughput for Joint and Partial.



Not much throughput differences between R and LL for joint and partial.

Throughput is higher in partial for both R and LL.

Partial technique is better than Joint technique in terms of the system throughput in both LL and R.

P = Partial
J = Joint
LL = Least Load
R = Random

Summary of Results

Throughput is higher up to 15% in partial comparing joint.

Partial vs Joint

Delay time can be decreased up to 12% for both R and LL in partial comparing joint.

Conclusion

Thank You

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