Unlicensed Carrier Selection and User Offloading in Dense LTE-U Networks

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Problem

- eNodeB-1 wants to select a channel and it has both the channel CH2 and CH3 are free.
- Selecting best channel among free channels is necessary as CH2 is better compared to CH3 (Less user affected).
- As it is unlicensed channel it can be used by different operators and RATs (No cooperation).

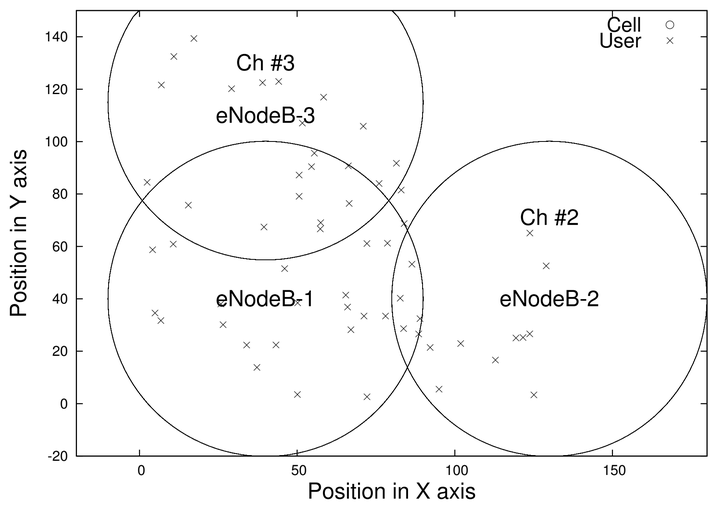

Fig. 1: Motivational example scenario.

- Hence, A distributed and uncoordinated approach is proposed for dynamic channel selection.

Proposed Work

A dynamic UCCS algorithm is proposed which uses CQI feedback given by UEs.

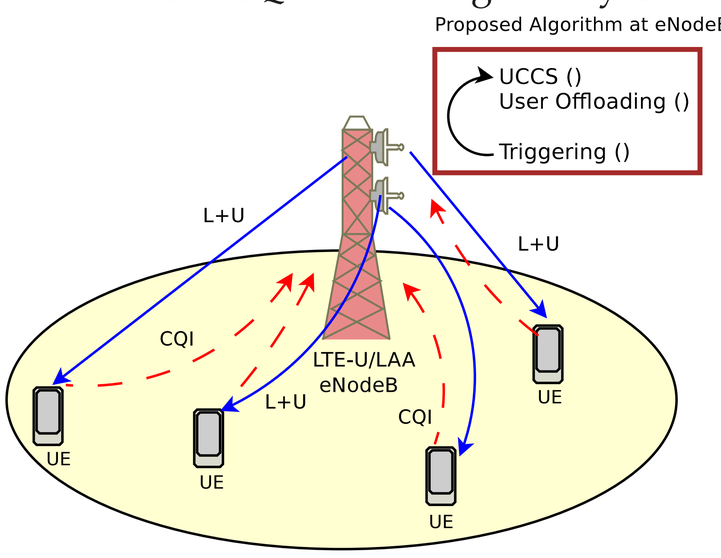

Fig. 2: System model.

UCCS Algorithm

Inputs: k, N_u, $CQI_{i,j}$
Outputs: CCS, $MCUE_j$, $CQI_{avgFinal}$

Initialization: $\alpha_{max} \leftarrow 0$, $MCUE_j \leftarrow 0$;
for $i = 1$ to k **do**
  $CQI_{sum} \leftarrow 0$;
  for $j = 1$ to N_u **do**
    $CQI_{sum} \leftarrow CQI_{sum} + CQI_{i,j}$;
    /* Find Max CQI of UE over channels */
    if $CQI_{i,j} > MCUE_j$ **then**
      $MCUE_j \leftarrow CQI_{i,j}$;
    end if
  end for
  $CQI_{avg} \leftarrow \frac{CQI_{sum}}{N_u}$;
  $f_i \leftarrow$ Standard deviation of CQI
  $\alpha_i \leftarrow 2 * CQI_{avg} - f_i$;
  if $\alpha_{max} < \alpha_i$ **then**
    $\alpha_{max} \leftarrow \alpha_i$;
    $CCS \leftarrow i$;
    $CQI_{avgFinal} \leftarrow CQI_{avg}$;
  end if
end for

Simulation Scenario

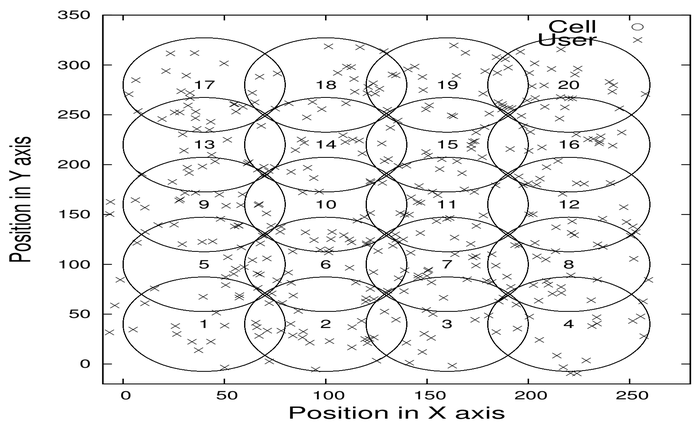

Fig. 3: Positions of 20 eNodeBs with 400 UEs in the network.

Table 1: Simulation Parameters

Parameter	Value
Number of Cell	20
UEs per Cell	20 (Random Deployment)
Transmit Power	20 dBm
Traffic	Downlink (Full Buffer)
Free Channels, BW	3, 20 MHz
Pathloss Model	$37 + 30Log_{10}(d[meter])$
UE Mobility,TH_{time}	1 m/s, 100 ms
λ_{min}, λ_{max}	1,15
C_0, λ	126, λ_{min}

Results without user mobility

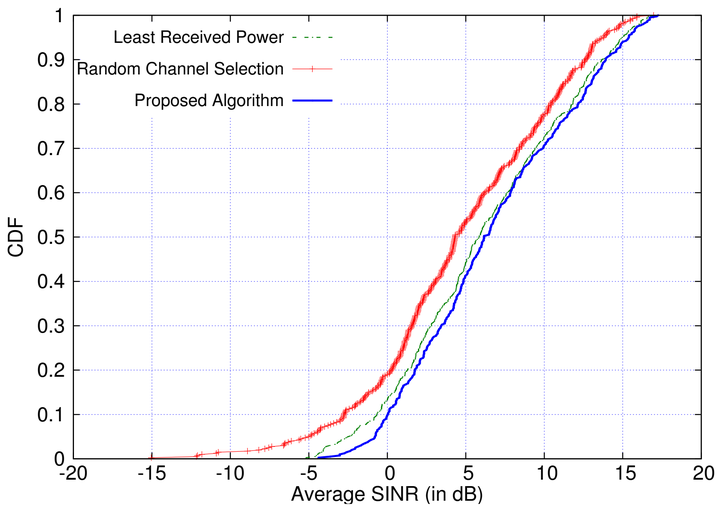

Fig. 4: CDF of avg SINR of all users in the network.

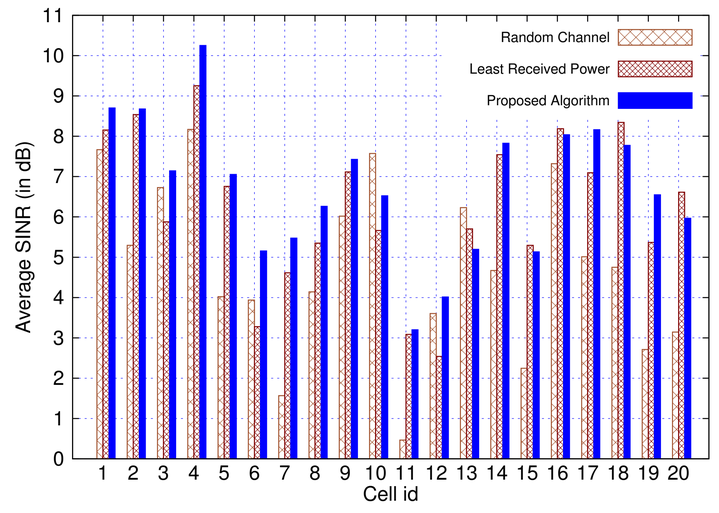

Fig. 5: Variation in avg SINR across cells in the network.

Results with user Mobility

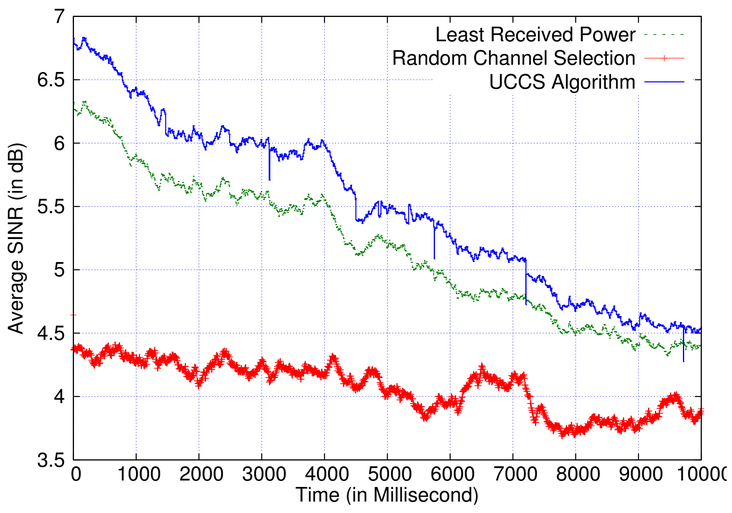

Fig. 6: avg SINR of all users in the network with mobility.

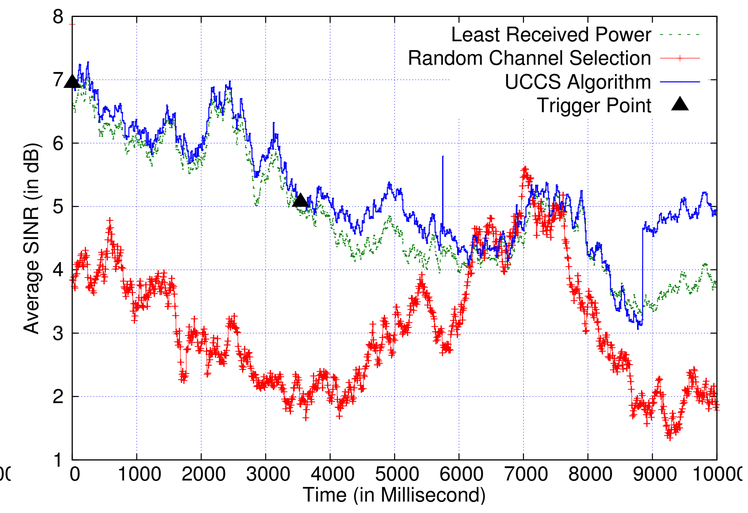

Fig. 7: avg SINR of all users in a cell over 10s with mobility.

User Offloading

Inputs: $MCUE_j, CQI_{CCS,j}, LR_{Available}$
Output: UE Offload from unlicensed to licensed.

Initialization: HashMap ⟨key, value⟩ HM =ϕ;
for $j = 1$ to N_u **do**
  if $MCUE_j > CQI_{CCS,j}$ **then**
    $\delta \leftarrow MCUE_j - CQI_{CCS,j}$;
    HM.put(j, δ);
  end if
end for
while $LR_{Available}$ *AND* HashMap not empty **do**
  $Offload_{user} \leftarrow$ Max(HM);
  Calculate Δ_{LR} of $Offload_{user}$ using (1) ;
  if $LR_{Available} > \Delta_{LR}$ **then**
    Allocate Δ_{LR} to $Offload_{user}$
    $LR_{Available} \leftarrow LR_{Available}$ - Δ_{LR};
  else
    $LR_{Available} \leftarrow 0$;
  end if
end while

$$Where, \Delta_{LR} = \frac{D_{min} * SB_{duration}}{C_0 * MCS_i * \beta} \quad (1)$$

Triggering Decision

- UCCS algorithm can be run periodically or based on channel condition we can trigger the UCCS algorithm.
- Our proposed triggering algorithm triggers UCCS if channel quality degrades beyond certain threshold.

Conclusions

- The proposed dynamic UCCS algorithm selects unlicensed channel that improves overall system performance and gives fairness among users.
- Results show that the UCCS can be used in dense deployment of LTE-U.

Acknowledgement

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