Analysis of the Implementation of LTE-Advanced in a Low Exposure Perspective

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Outline

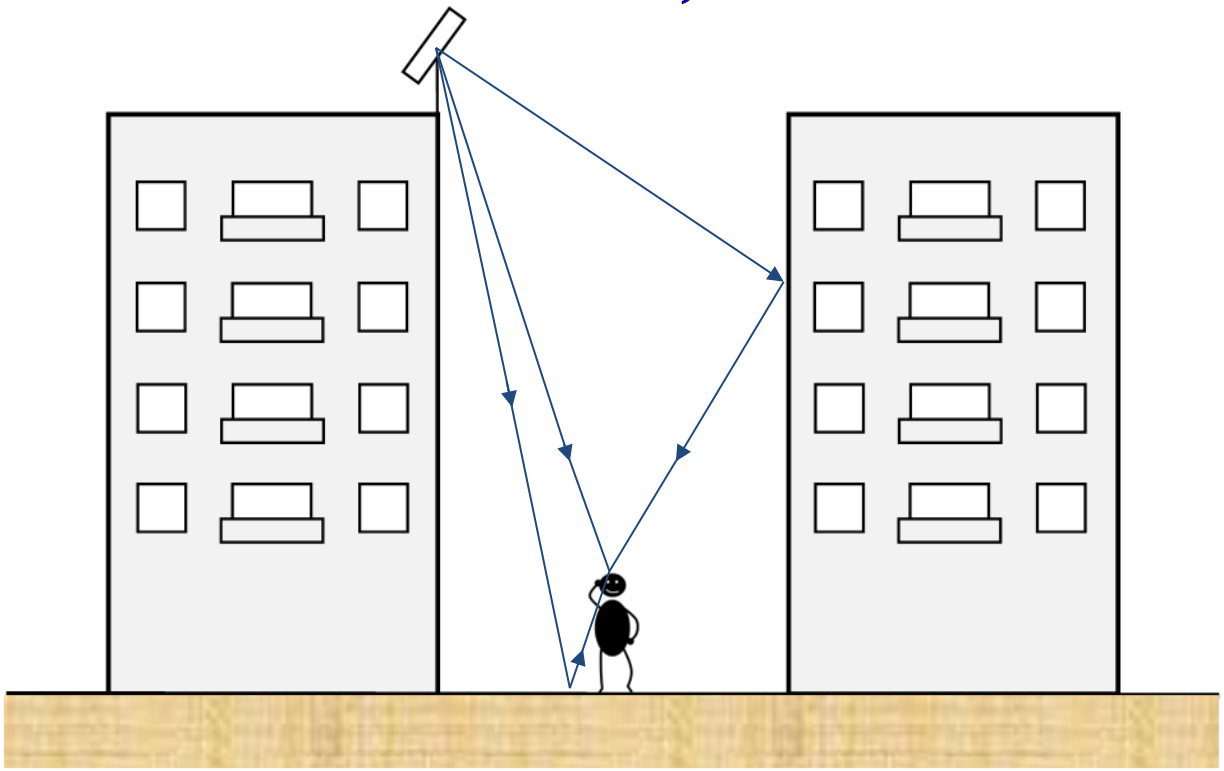
- Motivation.
- Model Development.
- Results Analysis.
- Conclusions.

Motivation

- The need for providing users with a higher data throughput leads to the deployment of heterogeneous networks.
- The coexistence of LTE with other systems impacts on the electromagnetic field existing in public areas.
- One needs to evaluate the multiple exposure, considering LTE coexisting with other systems, in order to assess its influence and to verify if the values comply with the guidelines.

DL Model for Outdoor Exposure (1)

- The power available at the receiving antenna is determined by taking the two first-order reflected rays, besides the direct one, into account.



DL Model for Outdoor Exposure (2)

- To compare the DL exposure with the reference levels, one converts the received power in power density:

$$S_{DL[\mathrm{W/m^2}]} = \frac{P_{r[\mathrm{W}]}}{A_{e[\mathrm{m^2}]}}$$

where:

- S_{DL}: DL power density;
- P_r: power available at the receiving antenna;
- A_e: antenna effective area.

UL Model for Outdoor Exposure (1)

- Optimum power control is used at the transmitter.
- The power that is absorbed by the user, P_{abs}, is obtained by:

$$P_{abs\,[\mathrm{W}]} = P_{EIRP\,[\mathrm{W}]}^{UL}\left(1 - \frac{1}{L_u}\right)$$

where:

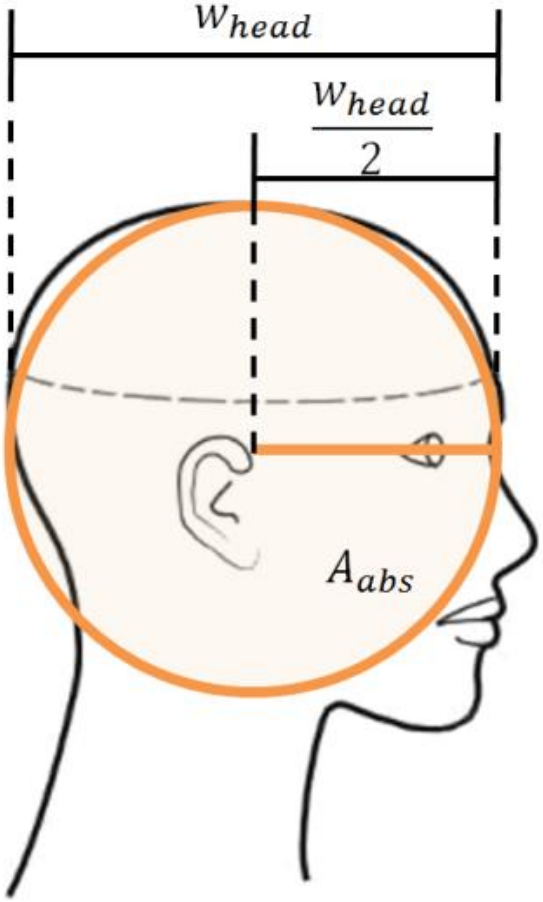
- P_{EIRP}^{UL}: UL EIRP;
- L_u: user losses.

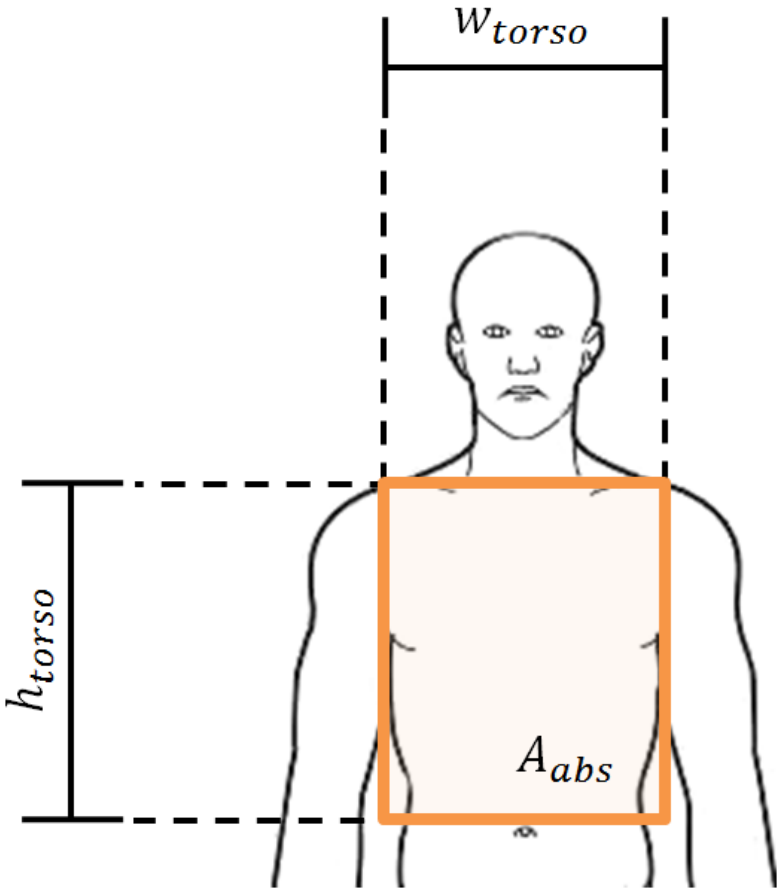
UL Model for Outdoor Exposure (2)

- The UL power density is calculated using the same model as in DL.

- For the surfaces of absorption, one takes the lateral area of the head and the torso's front area, depending on the service.

UL Model for Outdoor Exposure (3)





Global Exposure Model

- ICNIRP's requirement for power density is:

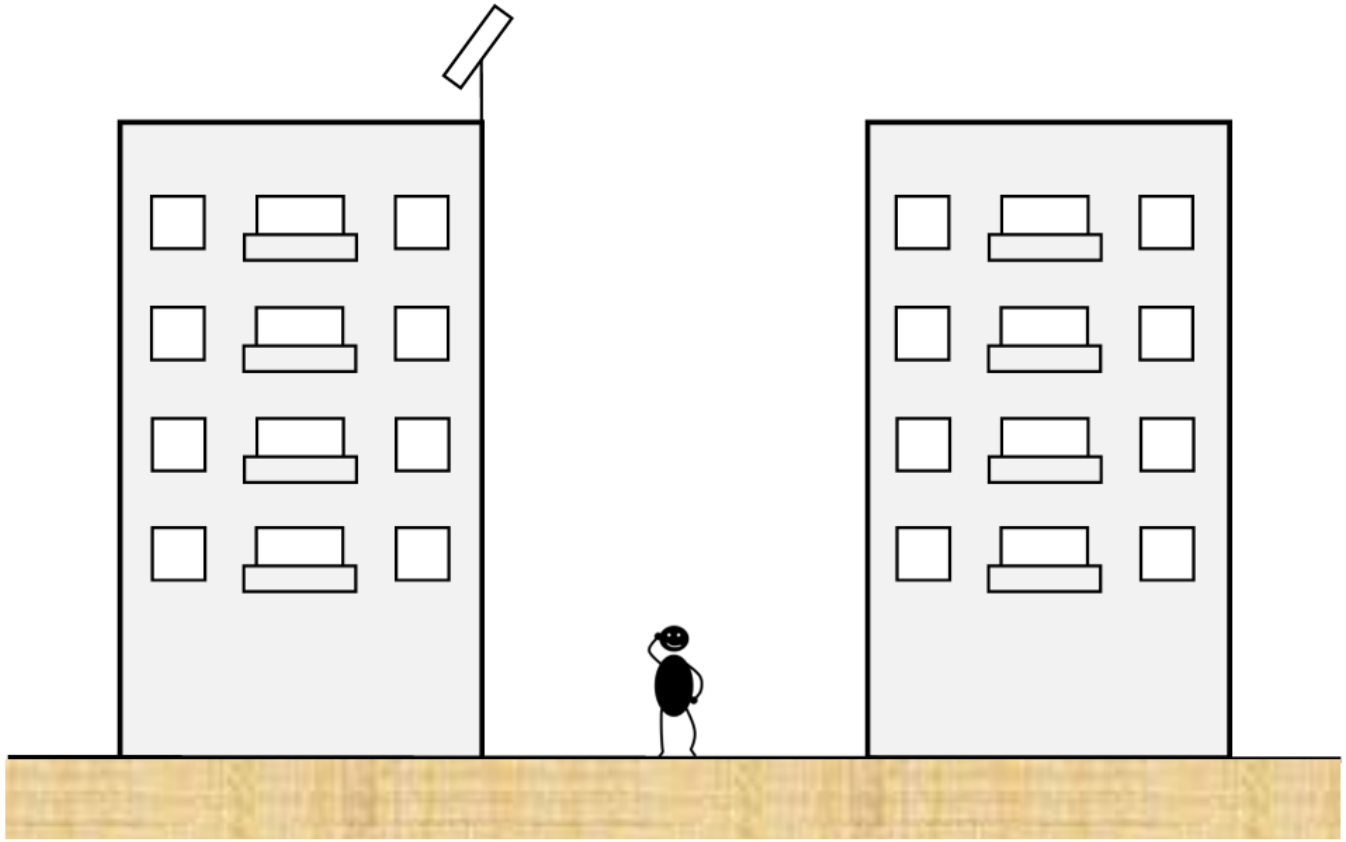
$$\gamma = \sum_{i>800\ MHz}^{2600\ MHz} \frac{S_{i[\mathrm{W/m^2}]}}{S_{L,i[\mathrm{W/m^2}]}} \leq 1$$

where:

- γ: total exposure parameter;
- S_i: power density at frequency i;
- $S_{L,i}$: power density ref. level at frequency i.

Simulation Scenarios (1)

- A typical urban street scenario is used.

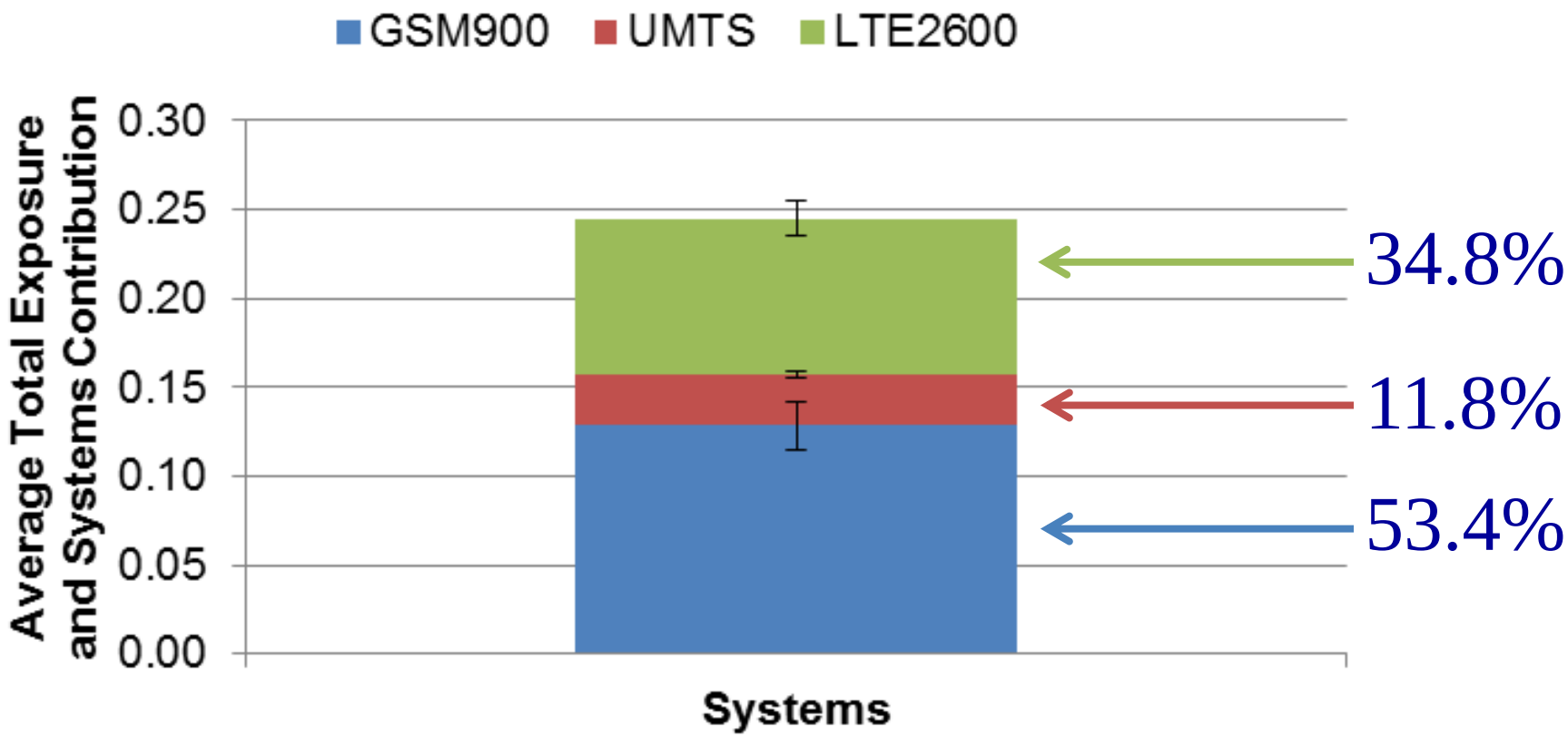


Simulation Scenarios (2)

- One assumes that each BS supports the three cellular systems (GSM, UMTS and LTE).
- Typical values are used in the reference scenario.
- Besides the reference scenario, tests are done regarding the influence of:
  - mobile communications systems;
  - services;
  - number of BSs;
  - MIMO configurations.

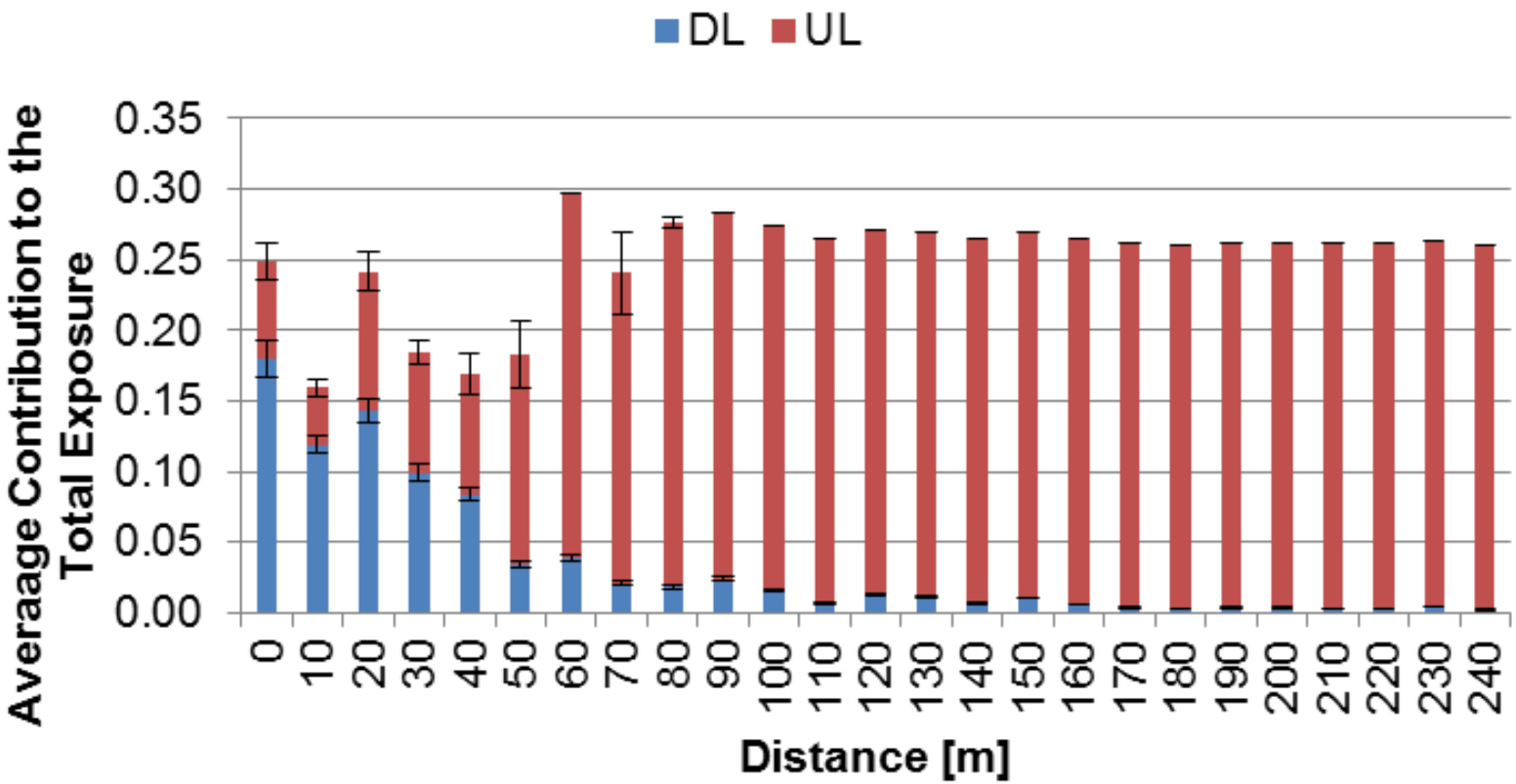
Systems' Contribution

- The total exposure is 0.245, 4 times below the requirement; GSM900 has the highest contribution.



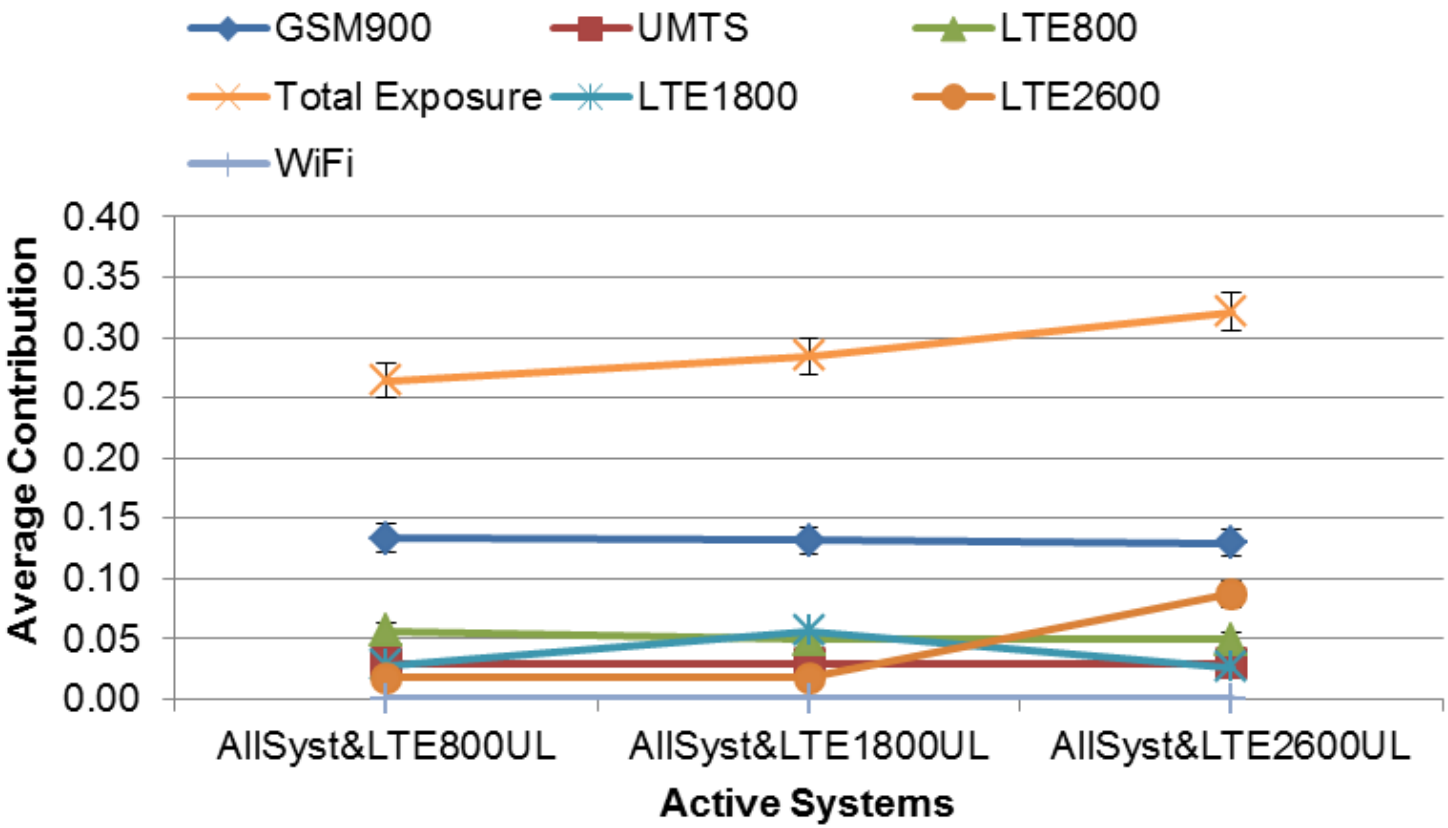
DL vs. UL Contributions

- The UL contribution increases with distance, having predominance in the total exposure.



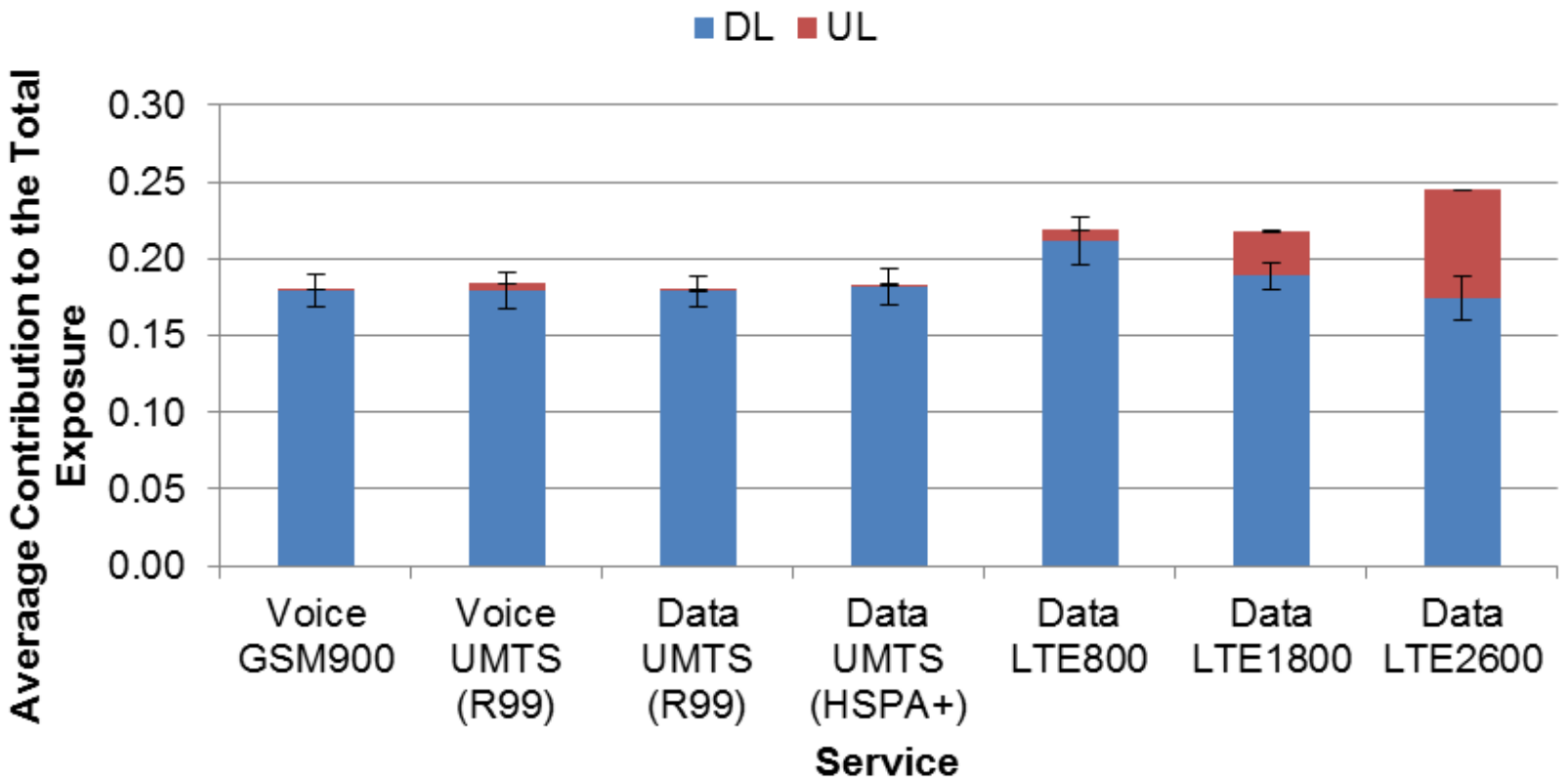
Mobile Communication Systems Scenario

- LTE2600 in UL leads to the highest total exposure value (0.321), 3 times below the reference value.



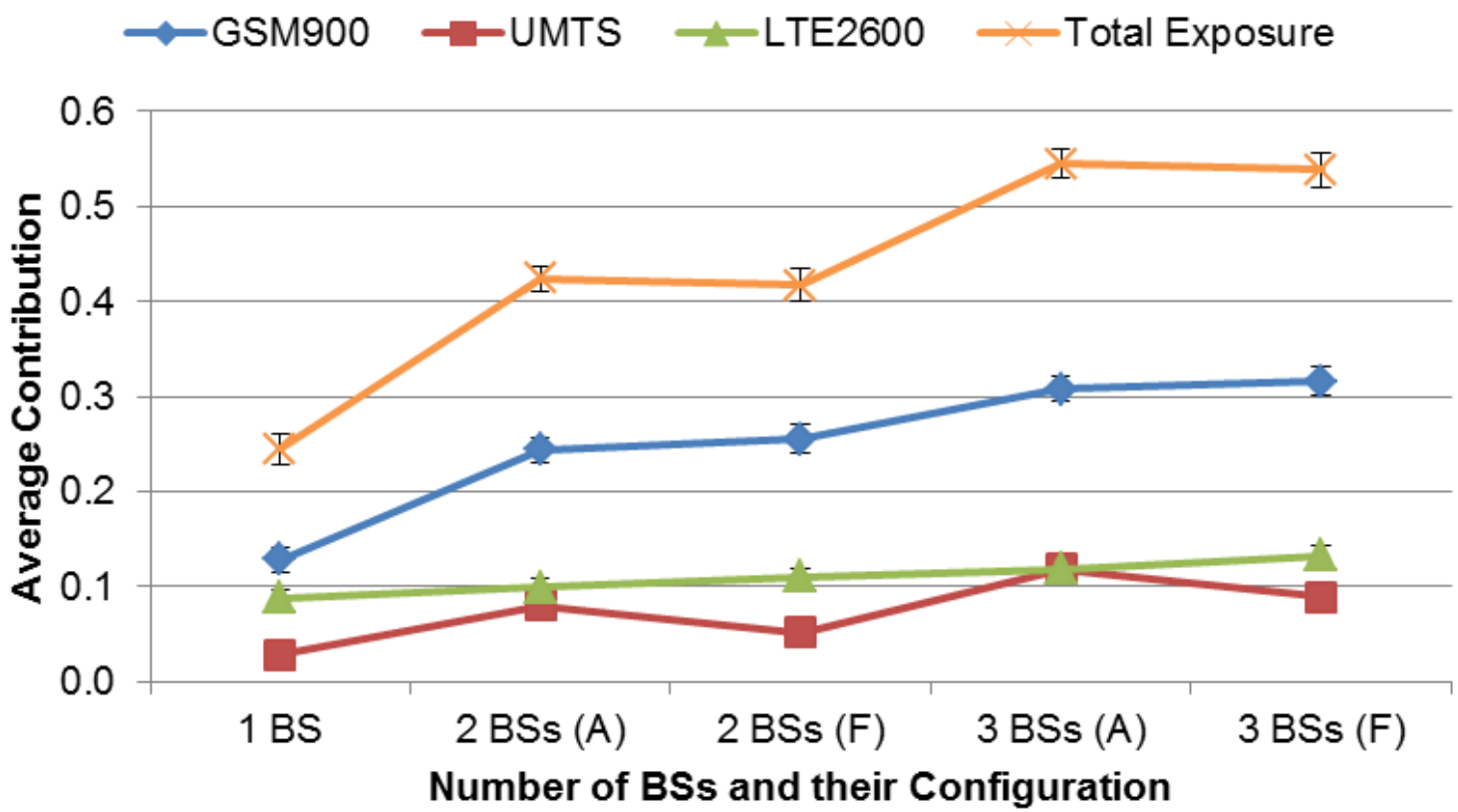
Services

- In UL, LTE1800 and LTE2600 contribute 13.2% and 28.8%, respectively, to the total exposure.



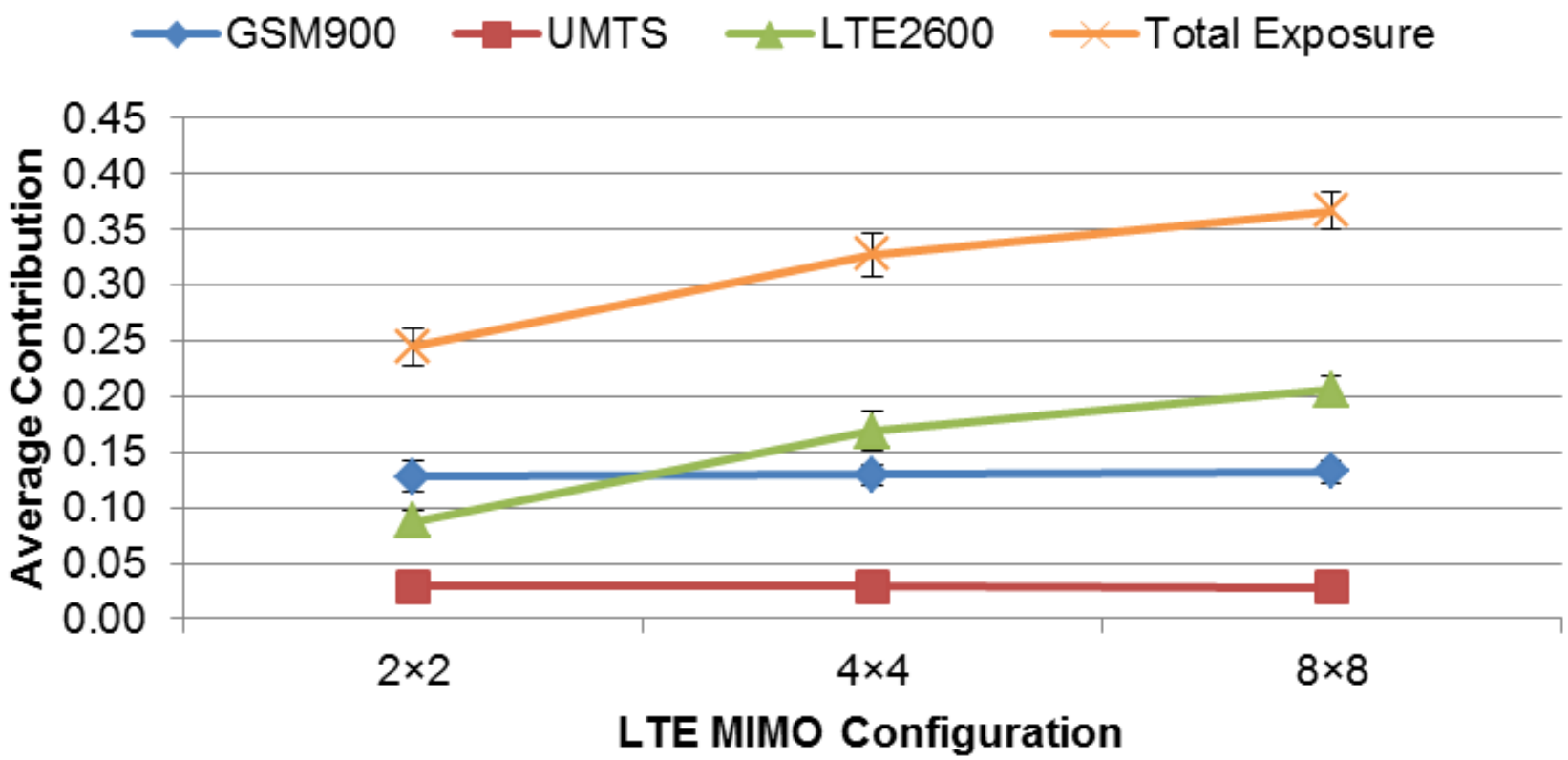
Number of BSs

- The highest value of the total exposure is around 0.545, when 3 BSs are used.



MIMO

- The total exposure increases 33.6% and 49.8%, from MIMO 2×2 to 4×4 and to 8×8, respectively.



Conclusions

- A model was developed in order to assess the exposure from both DL and UL in a typical urban scenario, which includes DL and UL models, evaluating the exposure of LTE in the presence of signals from other networks.

- All scenarios comply with ICNIRP's requirements, the highest value observed for the total exposure being 0.545, nearly ½ of the requirement.

Thank you!