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Characterizing Power Emissions Behavior Across LTE's Physical Uplink Channels

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DRAPER

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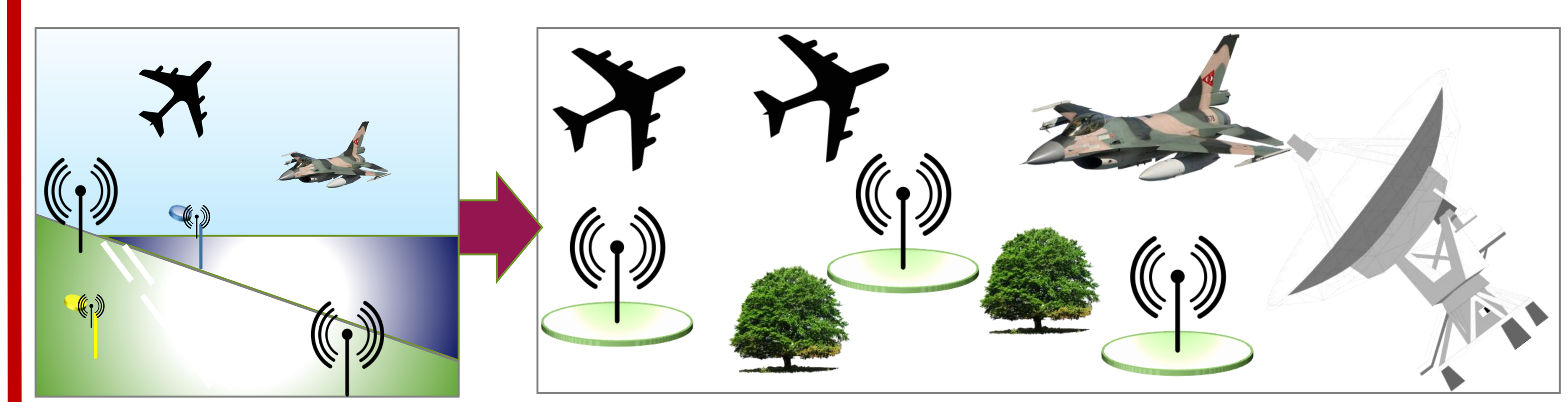
Motivation and Objective

Spectrum sharing between LTE and the incumbent networks poses a unique challenge for current users, as they need to understand how incoming LTE systems could interfere with existing services. We present a simulation suite that incumbent users can use to assess LTE's impact on existing services.

Some Challenges

- The 3GPP LTE specification does not provide exact procedures to configure several important parameters given in the standard, for example path-loss compensation factor α and cell-specific component P_0_NOMINAL.
- Implementation of scheduling mechanisms are not mandated by 3GPP standards and are typically vendor specific.

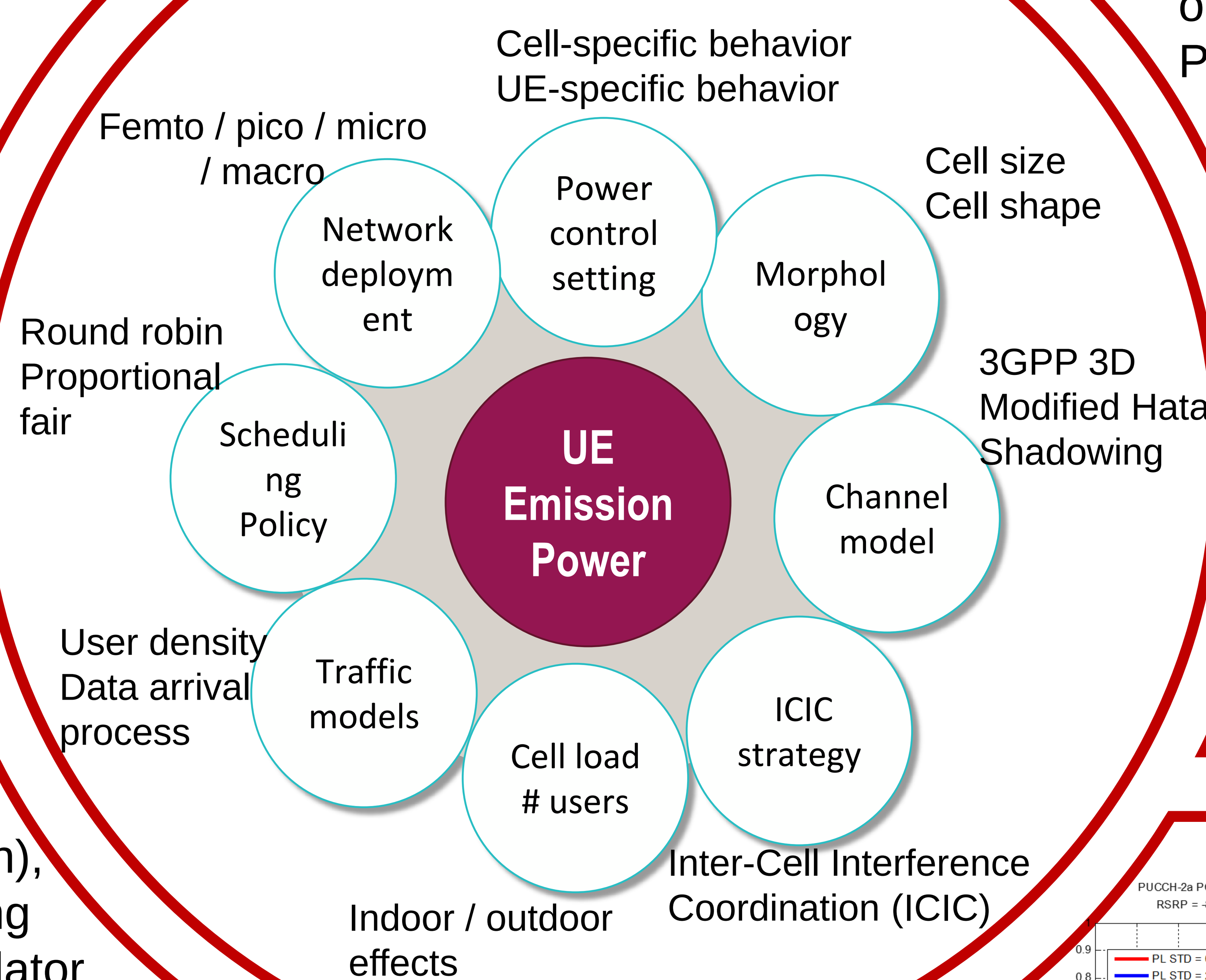
Co-existence of AWS-3 and DoD systems



Advanced wireless services (AWS)-3 Auction

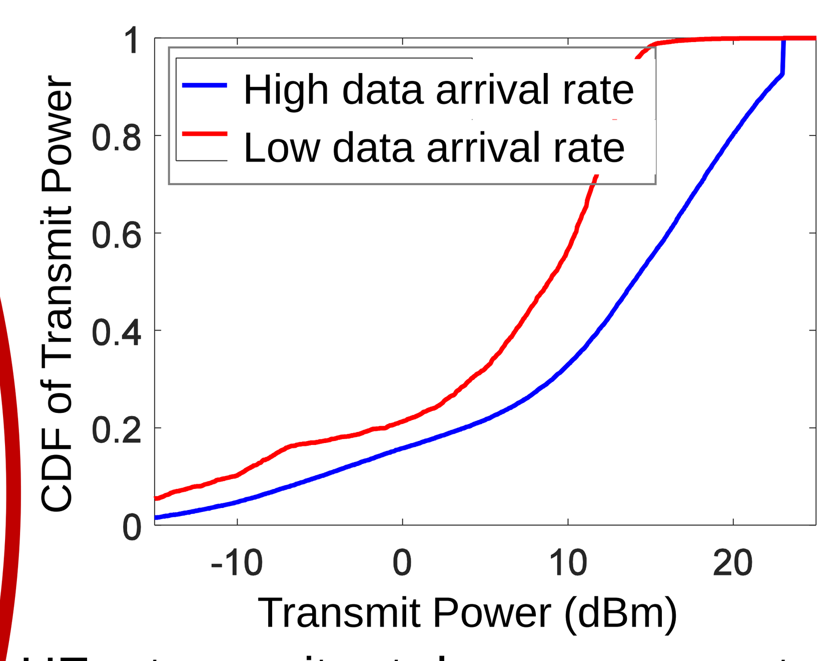
SST&D program: DoD system and commercial LTE co-existence

Modeling Summary



Traffic Models

The figure illustrates the impact of varying arrival rates in a Poisson data arrival process.



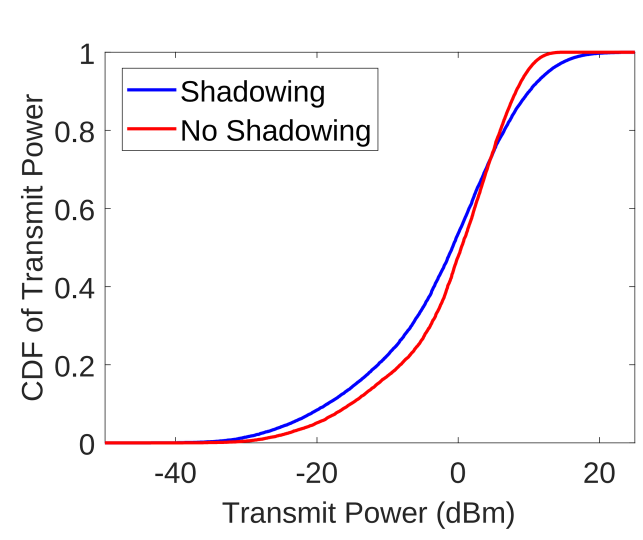
UEs transmit at lower aggregate power when data arrival rate is low since fewer RBs are associated to each UE.

Solution Approach

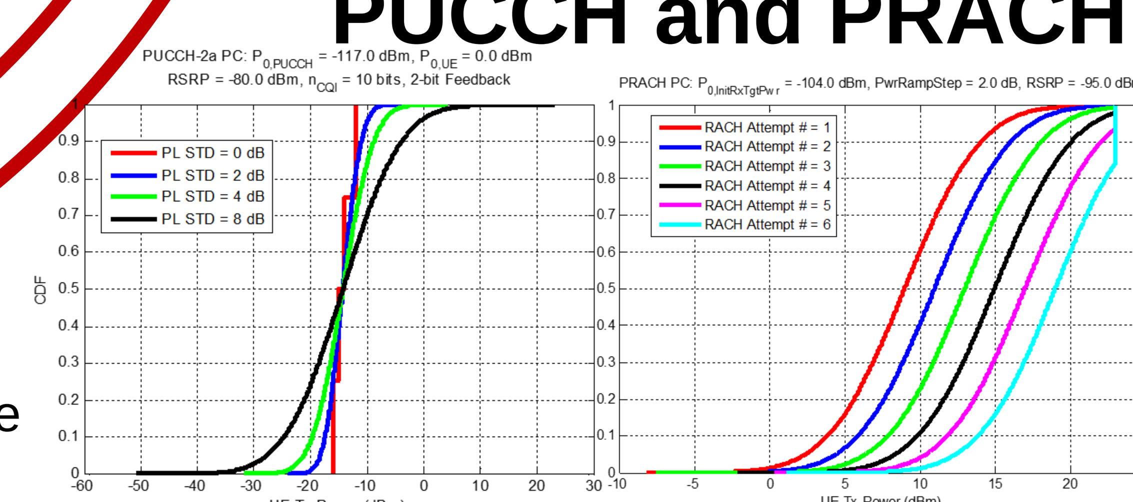
The simulator emphasizes extensibility, where the simulator can model different LTE morphologies (e.g., rural, urban), channel models, and scheduling algorithms. Currently, the simulator supports three physical uplink channels: Physical Uplink Shared CHannel (**PUSCH**), Physical Uplink Control CHannel (**PUCCH**) and Physical Random Access CHannel (**PRACH**).

The figure here captures the impact of independent Gaussian distributed shadowing.

Smoothening effect: Virtual filter derived from PDF of Gaussian distribution has low-pass-filter (LPF) effect on CDF curves.

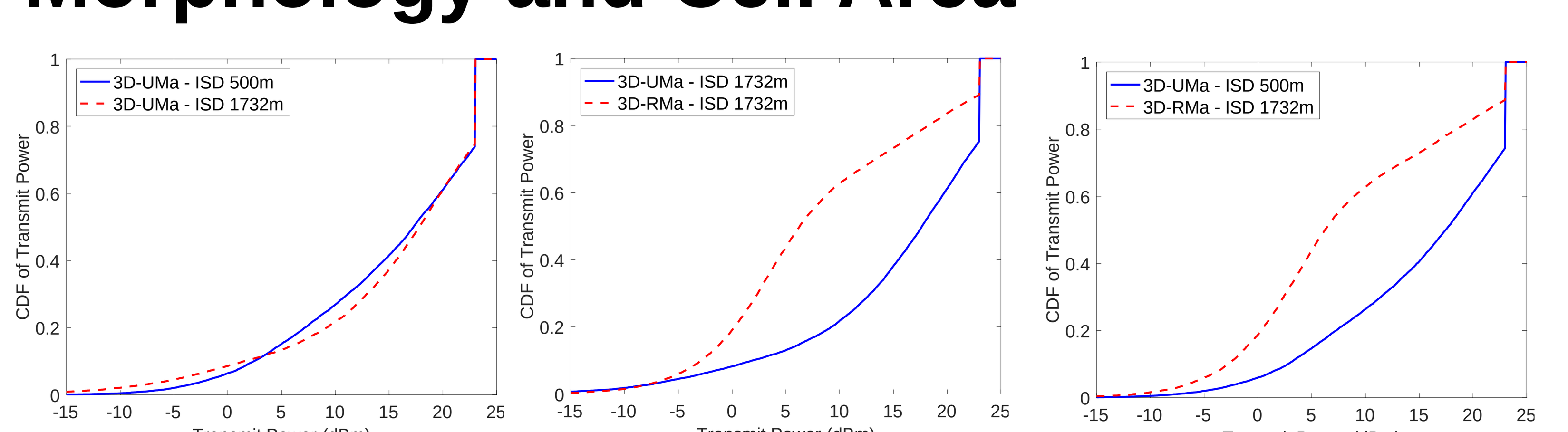


PUCCH and PRACH



The two figures on the right show the impact of control and random access channel parameters on the PUCCH and the PRACH UE emission distributions. The PUCCH UEs are modeled to explicitly include both the channel quality information (CQI; 10 bits) and 2 bits of ACK/NACK feedback. The PRACH UEs are modeled to capture the effects of PRACH power steps and the number of retransmissions. We see from the emission CDFs that the PUCCH UEs in general transmit at a much lower power level compared with the PRACH UEs. For the PRACH, we see that increasing the number of RACH attempts adversely affects the UE emission power levels.

Morphology and Cell Area



(i) Same Channel Environment Different ISD

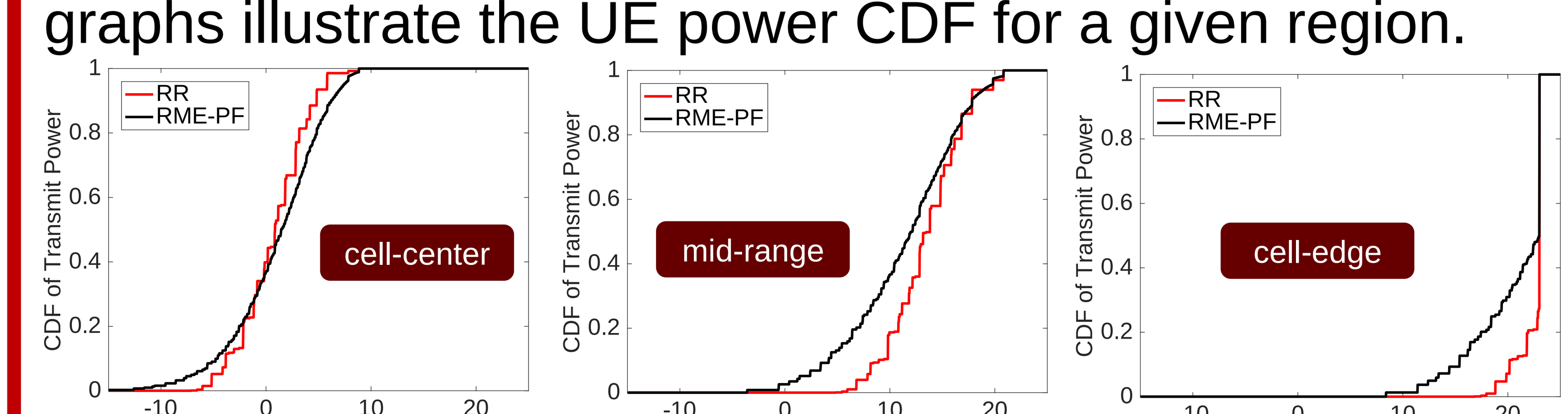
(ii) Different Channel Environment Same ISD

(iii) Different Channel Environment Different ISD

The impact of channel models on uplink power distribution will vary strongly with different channel environments and the ISD. (i) For Urban Macro with varying ISD there is not much variation in power distribution (ii) and (iii) Comparison between Urban Macro and Rural Macro shows huge variation in power distribution.

Schedulers

Recursive Maximum Expansion (RME) is a PF variant with an added constraint of contiguous RB allocation. All graphs illustrate the UE power CDF for a given region.



(a) (b) (c)

The UEs in the cell-center (a) tend to show similar behavior regardless of the scheduler used. UEs in the mid-range (b) and cell-edge (c) regions are more likely to emit less power when the PF scheduler is used, due to higher PL in these regions.