Urban propagation study for improving communications and radar systems from 250 MHz to 6 GHz

We present here the results of a recent study conducted for DSO and which aims at analyzing the interest and feasibility of using simulations as well as measurements of the propagation channel in order to improve the performances of RF systems in different applications. Among them, we paid a special interest to indoor UHF communications and especially the estimation of the availability of UHF communications systems in complex indoor environments, considering different configurations (rooms, floors, corridors…) in buildings.

The problematic of this scenario has been analyzed and a literature survey of existing simulations models or measurements has been performed. The panel of models available to predict the impact of the propagation channel on indoor communications is shown in Table 1.

Applications	models	Pros	Cons	Input Parameters	Estimated Parameters (Output)	Expected Accuracy
Comms (Indoor UHF)	Exact methods	Purely physical. Adapted to the indoor configuration and frequency	Difficulty to provide a precise description of the environment Environment should not be too large High numerical complexity	Precise description of the configuration	Attenuation Delay if multiprocessing on all the bandwidth	High if the scene and simulation description is good enough
	ITU-R	Simplicity Based on measurement	Specific to given scenario and environments	Rough description of the geometric configuration	Attenuation	Low : only general behaviours will be reproduced
	Simulator based on ray-tracing and asymptotic methods	Purely physical simulation, requiring only the asymptotic assumption	Complexity to provide the environment description Complexity to run properly the simulation Not suited for low frequencies No experience in indoor simulations	Precise description of the configuration	Attenuation Angle of arrival Doppler	High if the scene and simulation description is good enough

Table 1 : Models available for indoor communications

Finally, indoor environments are too different and complex for:

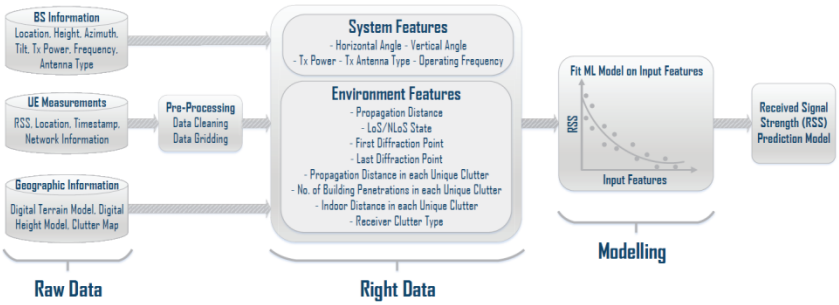
- Empirical and statistical prediction methods (e.g. ITU-R recommendations) to give accurate results,
- advanced simulators implementing physical deterministic models to be fully reliable: the relevant environment description will not be available so physical computation will not be appropriate.

Therefore, we proposed possible measurement campaigns and simulation methodologies that could be carried out in the future to improve propagation knowledge and system performance. Those proposals are currently being discussed in order to define the framework of cooperation in this area in the near future.

The road map under discussion involves especially:

- Measurement campaigns, complemented if necessary by simulations

- Large data set creation
- Use of standard (statistical) regression techniques and innovative approaches based on deep learning ([1])
- Objective : availability prediction in new environments in Singapore



Example of Deep learning architecture for propagation prediction, [1]

[1] U. Masood, H. Farooq and A. Imran, "A Machine Learning Based 3D Propagation Model for Intelligent Future Cellular Networks," 2019 IEEE Global Communications Conference (GLOBECOM), Waikoloa, HI, USA, 2019, pp. 1-6.