Modeling the Spatio-Temporal Resolution of Directional Channel Sounders

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Interest in directional channel measurements was originally motivated by the development of smart antennas and multiple-input multiple-output antenna systems in the 1990's. Until the mid-2000's, most efforts focused on bands below 6 GHz. Current interest in directional channel measurements is strongly linked to recent efforts to develop millimetre-wave wireless technology for Wi-Fi and 5G wireless systems. Because millimetre-wave directional channel measurements are time-consuming and expensive to collect, there is considerable interest in comparing and possibly combining measurement data obtained with different channel sounders in order to yield more comprehensive datasets. In such cases, the type and quality of the metadata that accompanies the data must be carefully defined.

Spatio-temporal resolution is essential metadata for directional channel measurements. It may be used for: 1. *Planning* – a simple spatio-temporal resolution model provides simple estimates of the temporal and angular resolution of the instrument, 2. *Visualization* – given a simple ray tracing simulation of a scene, a spatio-temporal resolution model can be applied to provide an indication of the degree to which the resolution of the spatial channel response degrades, 3. *Deconvolution* – the spatio-temporal resolution model is a key component of CLEAN and similar deconvolution algorithms that can be used to iteratively deblur a measured spatial channel response. However, surprisingly little effort has been devoted to determining the factors that affect the form of the spatio-temporal resolution model or how it can best or most consistently be represented.

The impulse response of a channel sounder is relatively easy to capture but is complicated in dynamic scenes where significant Doppler shifts occur. However, most of the complexity comes from the three-dimensional nature of the antenna pattern, including the effort required to measure it and the amount of data required to represent it. The complexity of the model further increases when the directional channel sounder is equipped with an electronically steered phased array that has an antenna pattern that depends upon the scan angle. There is an urgent need to define the accuracy requirements for such models and to develop conventions or standards for measuring and representing them. The most useful approach will likely be to define minimum, acceptable and best practices so that the effort required can be balanced against the manner in which the spatio-temporal resolution model will be used.