Predicting the performance of Conformal and Sparse Arrays in the Built Environment

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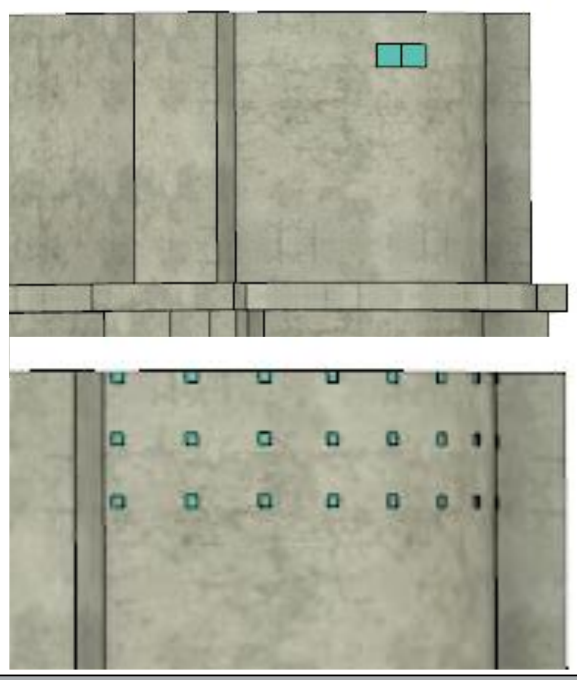
Introduction: Addressing the challenges of integrating mobile communications basestations into the built environment, array synthesis and raycasting techniques are combined to provide a method with allows the performance of an arbitrary array integrated into the built environment to be assessed. Planar, conformal, and sparse arrays are presented to highlight the flexibility of this technique.

Challenge:

- As the demands for increased spectral and energy efficiency continue, the use of additional base stations brings up challenges in terms of planning consent, and coverage planning within the built environment [1]. The increasing availability of 3D datasets of the inner cities presents a possible solution to this problem. A combination of raycasting and beam pattern synthesis allows the far-field performance of a given antenna array to be predicted, integrated into the built environment, "invisible basestations".

Array Integration in the Built Environment:

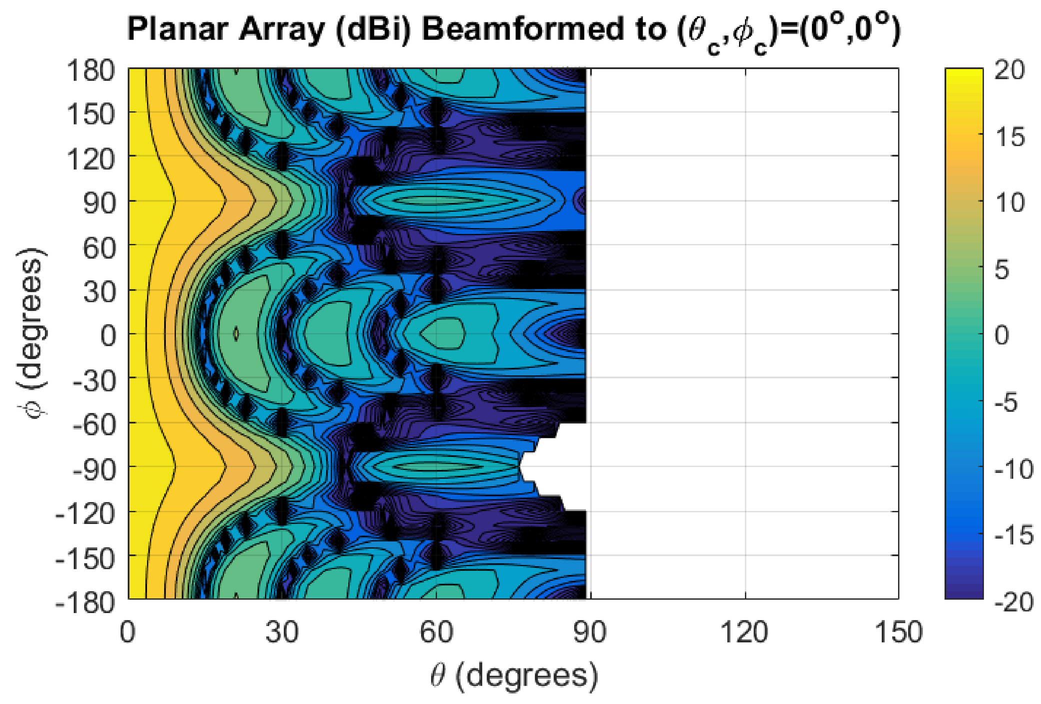
- Planar, Conformal, and Sparse array (24 element, 8 by 3) was modelled integrated into the upper surface of the Merchant Venturers Building. Based upon the recent 5G auction, a frequency of operation of 3.5GHz was used [2].
- Raycasting used to generate a `shadow map' for each array, establishing the line of sight coverage, [3]



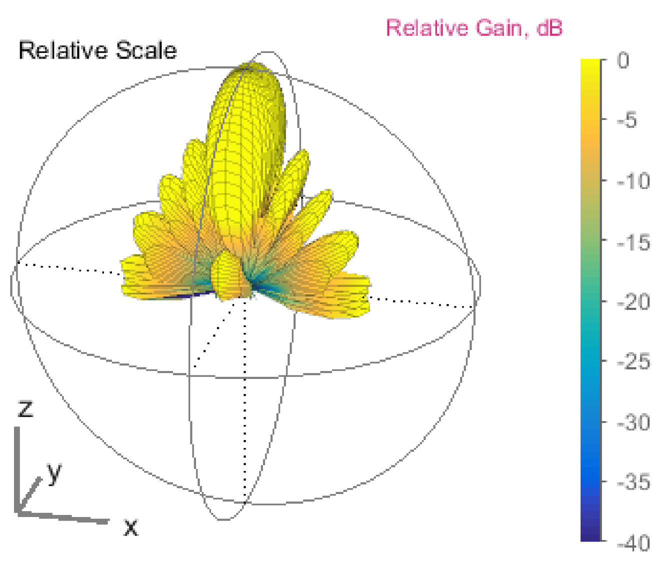
Uniform Illumination:

- Each element is modelled as a vertically polarized electric current source
- Raycasting data is combined with the element patterns to produce a 3D prediction of the overall array patterns, which can the be beamformed to the desired command angle.

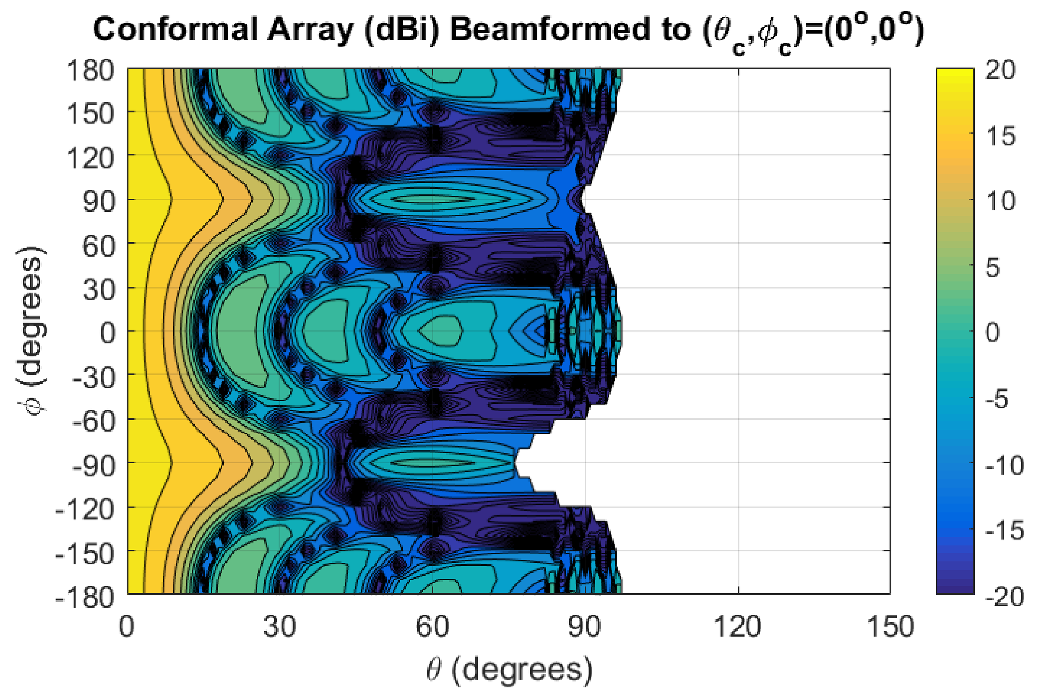
Planar Array (dBi) Beamformed to $(\theta_c,\phi_c)=(0^o,0^o)$



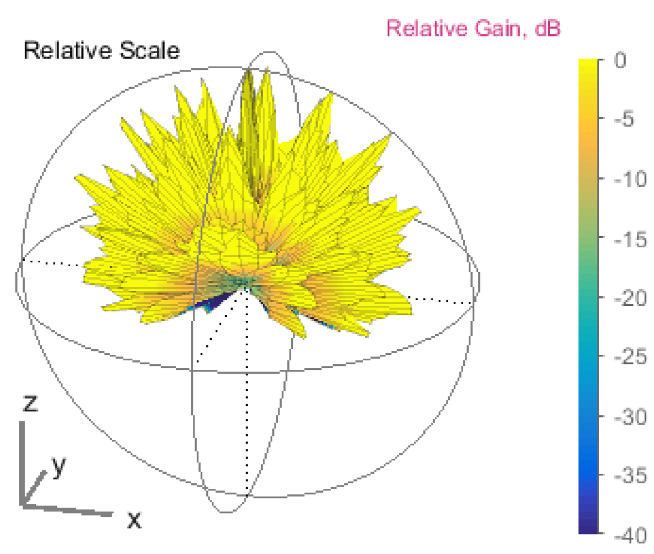
Conformal Array



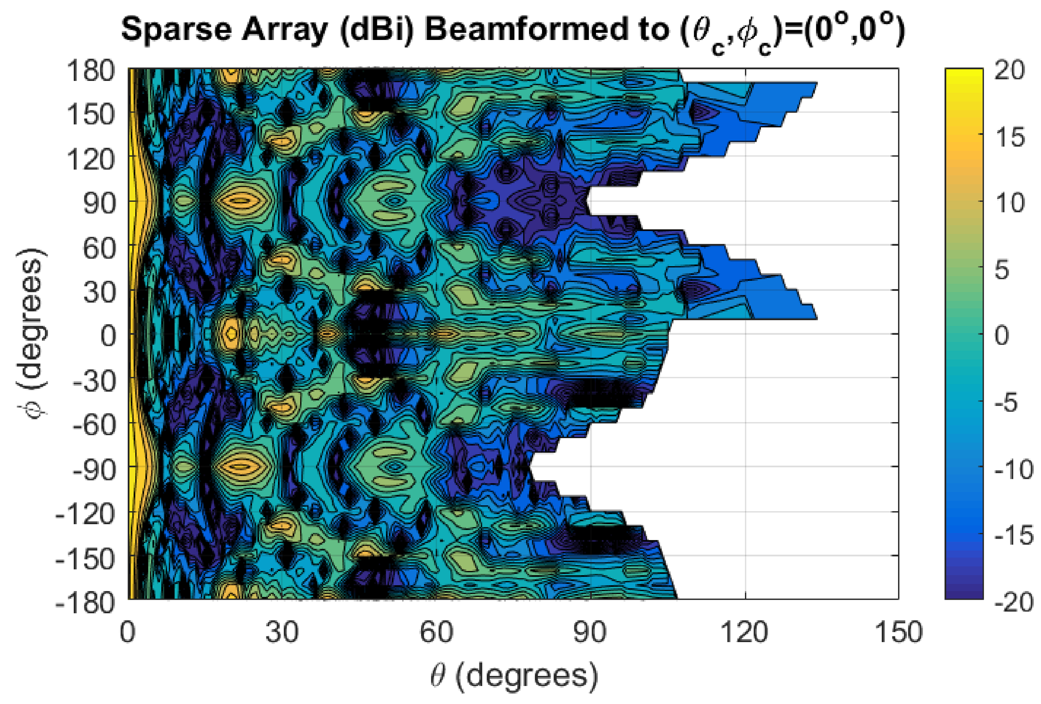
Conformal Array (dBi) Beamformed to $(\theta_c,\phi_c)=(0^o,0^o)$



Sparse Array

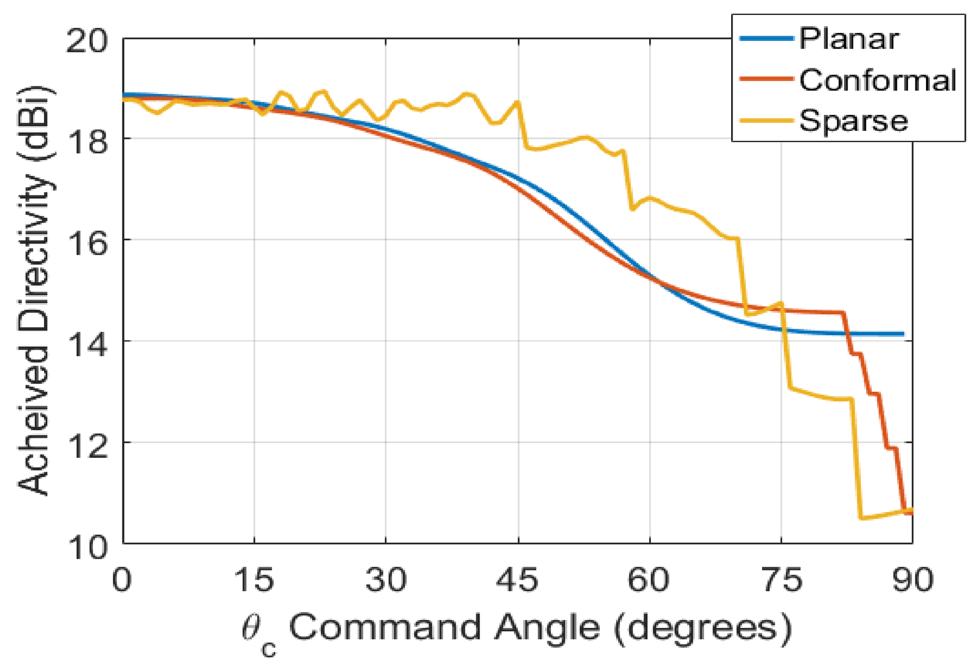


Sparse Array (dBi) Beamformed to $(\theta_c,\phi_c)=(0^o,0^o)$



Array Performance:

- The beam steering characteristics of each array were tested by selecting the maximum achieved directivity out of four different algorithms at each command angle (θ_c), [4-5].
  - Coherent Wavefront Beamforming
  - Equal Gain Combining
  - Successive Projection
  - Least Mean Squares
- This comparison shows the advantage of the sparse array, at the same level of complexity it delivers an increased scanning range and up to 3dBi compared to the conventionally populated arrays.



Conclusions/Future Work:

The use of this technique allows the performance of an antenna array to be assessed in the built environment. The utility of this method can be expanded by extending the model to beamforming architecture, such as steering by sub-arrays, or MIMO operation.

References:

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