

## Testbed and Prototypes Breakout

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### Discussion Questions:

- 1) Hardware testbed development: What're the key requirements? What are the use cases?
- 2) What are the available mmWave testbeds for research use? What's the cost and programmability?
- 3) Why does most mm-wave (prototype) hardware remain out of the hands of most academics? Can we find no way to prototype arrays faster and cheaper to get these in the hands of more researchers? Is there a CAD gap?
- 4) What the key roadblocks to the development of a publicly accessible and programmable phased-array for networking/communications research? How can NSF-funded research lower barriers in the future?
- 5) How should we motivate the industry to open their commercial mmWave devices' driver, just like Qualcomm did for the 2.4GHz/5GHz band WiFi driver?
- 6) Are there any research issues involved in the design of the testbed itself? e.g., hardware architecture, programming language, low power design? Will this motivate researchers to participate in the testbed design?
- 7) What would be a practical way of testing mmWave solutions at large-scale in practical environment? How should the large-scale testbed look like?
- 8) How should simulators (e.g., ray tracing simulation or numerical simulator of channel propagation) help/complement hardware testbed?
- 9) How does one generate a known test field for multiple-element antenna arrays?
- 10) What is the role of statistics in testing arrays that operate in more states than you can count?
- 11) What are measurement issues related to distributed array timing and synchronization?
- 12) How to calibrate large-scale, system-level hardware testbeds, separating out non-idealities due to the infrastructure hardware from nonidealities of the DUTs? Do you see a role for uncertainty and/or traceability?