WAVESCAPE™

Network & Economic Modeling Tool

mmWaveSolved

INFOSHEET

PIVOTAL COMMWARE®

v2021.1

5G is PIVOTAL™

v2021.1

OVERVIEW

Millimeter wave (mmWave) can deliver on capacity-intensive and low-latency applications that subscribers expect from 5G. Limited line-of-sight (LOS) conditions and propagation challenges associated with mmWave dictate denser networks than ever before and significant planning is required to balance densification with responsible CAPEX. Legacy macro-cell planning tools are not up to the task of modeling small-cell deployments and many of the fundamental assumptions break down when simulating mmWave. To fully unlock the potential of this, spectrum carriers need an accurate and scalable modeling tool that is built natively on the physics of mmWave.

Pivotal Commware, inventor of Holographic Beamforming® (HBF), has created an mmWave ecosystem of products that extend millimeter wave coverage at a fraction of the cost of gNB-only networks. This ecosystem includes two smart repeaters, the Pivot 5G™ outdoor network repeater, and Echo 5G™ indoor subscriber repeater, plus Intelligent Beam Management System (IBMS) and WaveScape™, a software solution for modeling and optimizing the placement of Pivots, Echos and all other mmWave network transmitters. WaveScape orchestrates this ecosystem by allowing users to plan their mmWave networks and quantify both the physical and economic impact each component has on the network.

KEY FEATURES

WaveScape is a network planning platform built with the needs of 5G mmWave and FWA at its core. It can model any set of network elements, including Pivotal's HBF network repeaters, and allows users to explore the tradeoffs of different network deployment strategies. Furthermore, WaveScape is built to ingest the highest resolution GIS data available, utilize the latest 3GPP propagation models and run natively in the cloud. This allows it to make accurate and deterministic predictions with near-infinite scalability. See Figure 1.

Figure 1: Two examples of mmWave signal degradation identified by WaveScape's use of high-resolution GIS data.

FWA Qualification

WaveScape ingests network elements that have been deployed within a region as well as the physical layout of that region. The tool then identifies buildings that subscribers occupy and determines the coverage level within and just outside those buildings, thus allowing carriers to qualify them for FWA based on minimum signal-level, antenna beamwidth and placement requirements of different customer premise equipment (CPE). It also allows the carrier to see if an additional subscriber repeater, such as Echo, or higher-gain CPE is required to bring service to a home.

Network Placement Optimization

WaveScape allows users to set coverage targets for a region which can be based on FWA scenarios or mobility scenarios. By ingesting utility poles, lampposts and private building corners that a carrier may have access to, the tool recommends placement and orientation of new network elements (including Echos, Pivots, gNBs or other equipment in use by the carrier) to reach a given target coverage level. Furthermore, the tool can dynamically ingest and re-optimize based on updated real estate requirements, new target metrics and newly deployed equipment. Recommendations are driven on a cost per incremental coverage basis and the tool allows users to update and refine their costing models.

Deployment Strategy & Unit Economics Exploration

WaveScape allows carriers to explore different hypothetical deployment scenarios so they can uncover the most effective deployment strategy for a specific region. By tracking the incremental cost and incremental coverage of each network element, a carrier will be able to select economical coverage targets for each region. Furthermore, WaveScape's ability to ingest specifications for any network element allows carriers to compare the costs and benefits of all available equipment, including Pivots and Echos.

USE CASES:

Identifying and Qualifying a Multi-Dwelling Unit (MDU) for FWA

- WaveScape has identified and targeted an MDU for FWA that is ten stories high and contains 70 units (seven units per floor). All units have a window on the west side of the building. See Figure 2.

Figure 2

- WaveScape models the baseline coverage of the gNBs and predicts both mobility coverage and FWA qualification. Using the latest 3GPP propagation models on the highest-available resolution GIS data, the tool sees that while the northern (left side of the MDU) face of the building has coverage, most of the potential subscribers are left in the dark. This prediction is validated by live measurements in the field showing little to no coverage on the west face of the building. See Figures 3a and 3b.

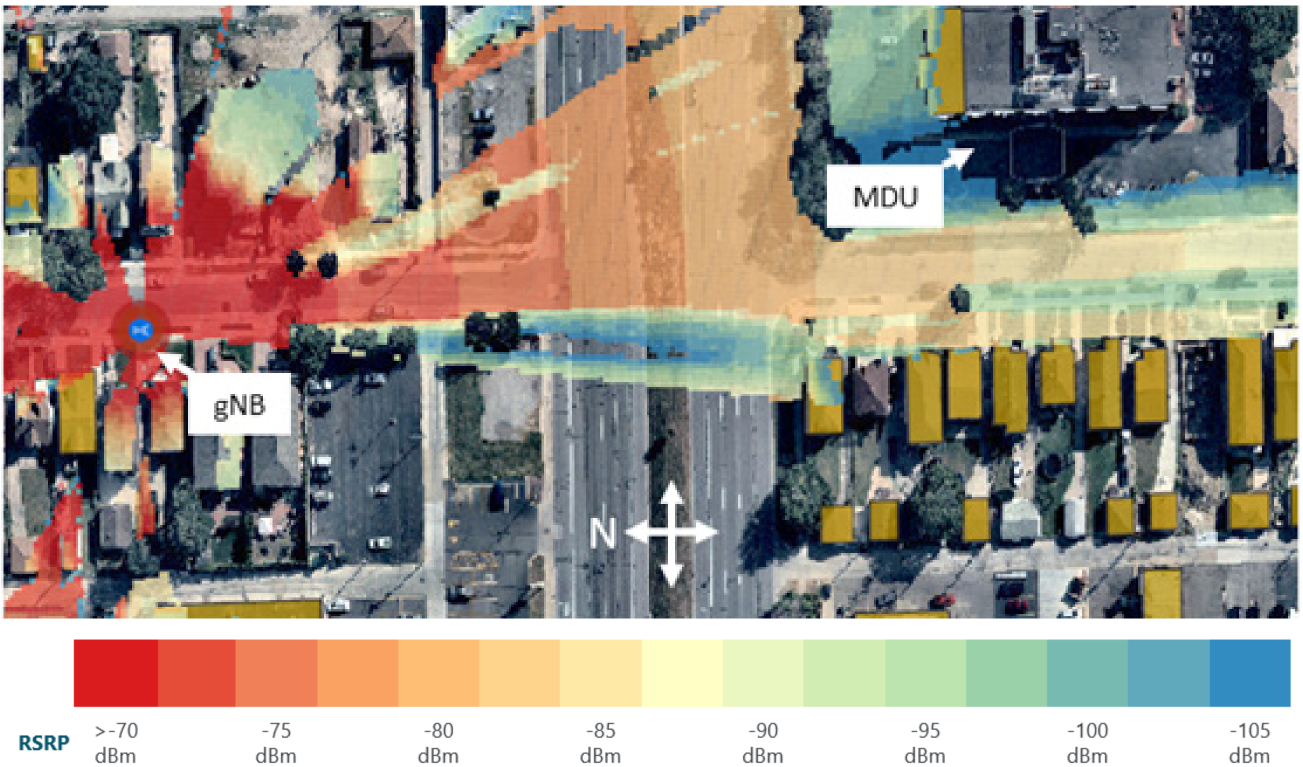

Figure 3a

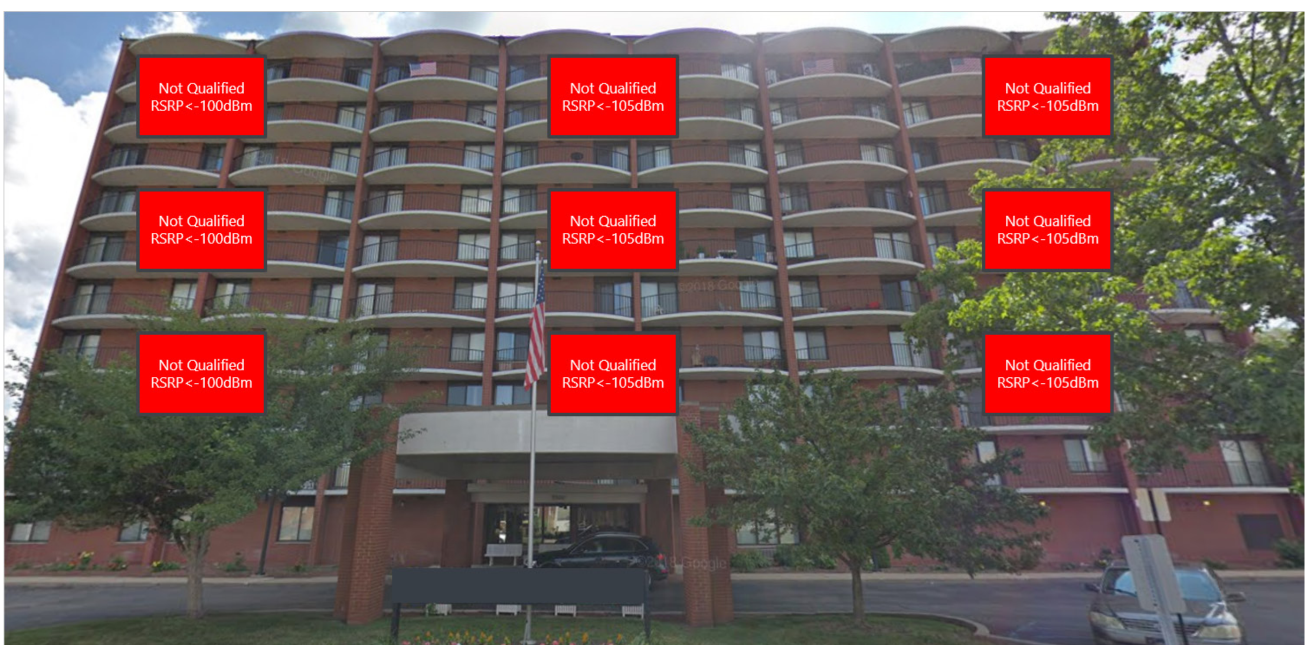

Figure 3b

- WaveScape then ingests all the lampposts, utility poles, building corners and any other locations in the area where Pivot repeaters can be mounted. It then automatically calculates which of these candidate locations have adequate signal for Pivots to repeat, ensuring the repeaters' effectiveness. In this scenario, WaveScape has determined that the pole closer to the MDU does not have line of sight to the gNB, and thus is not eligible for a Pivot, but the poles across the street and to the southwest of the building do have sufficient coverage. See Figure 4, left side.

Figure 4

- Now that WaveScape has found two poles in the area where a Pivot can be placed, it optimizes the configuration and orientation of the repeaters to provide maximum coverage at the lowest cost. WaveScape has found a configuration where only one of the poles is needed to provide coverage. See Figure 4, right side.
- When WaveScape's recommended configuration was put to the test at this MDU, its RSRP level predictions were accurate enough to correctly qualify 100% of the units on this face of the building. See Figure 5.

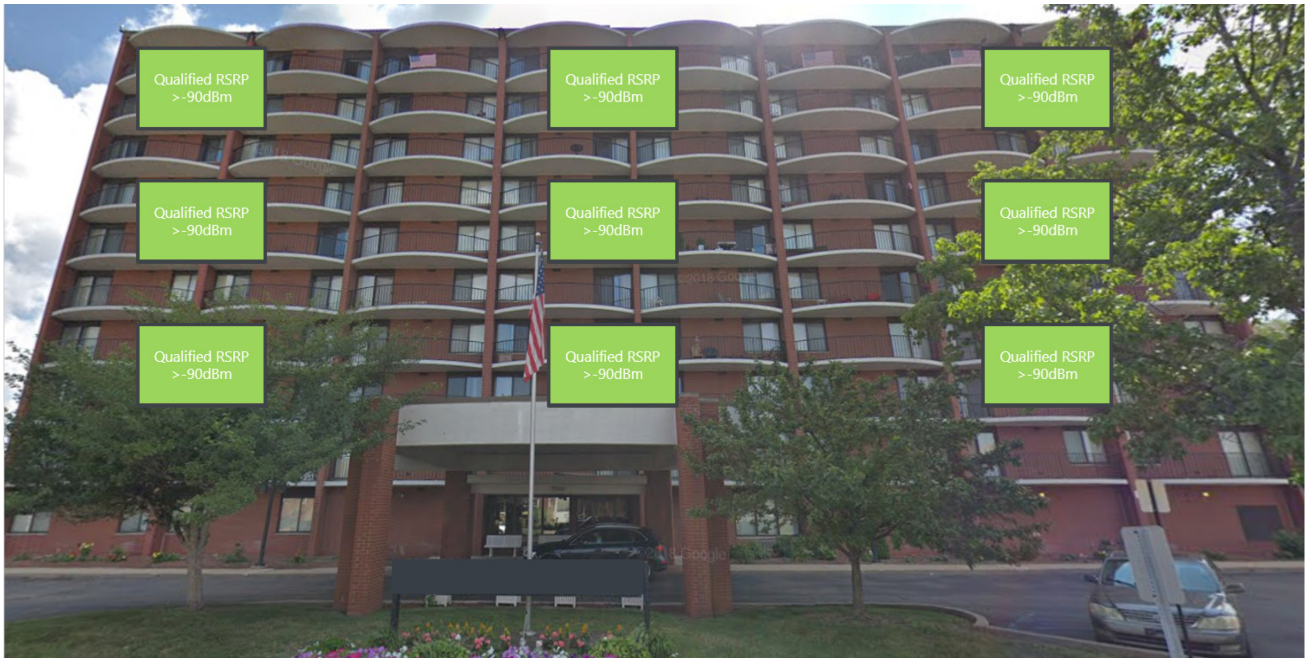

Figure 5

Evaluating Deployment Strategies and Economic Modeling

- As in the previous scenario, WaveScape ingests all gNB locations and orientations within a 1.5 square mile polygon containing 24 gNBs and 5,000 potential subscribers, then evaluates mmWave coverage based on 3GPP models and high-resolution GIS data. This modeling exercise identified 1,700 units with adequate coverage for FWA, or 35% of all dwelling units within the polygon.
- Hoping to boost FWA enablement and mobility coverage, the carrier made an agreement with the local power company to mount Pivot repeaters on existing utility poles. The locations and heights of over 5,000 poles within the polygon were ingested by WaveScape. WaveScape identified 1,750 poles that are covered by the existing gNBs. WaveScape can also account for "2-hop" scenarios, where a gNB provides coverage to a repeater, which then provides coverage to a second repeater, thus further extending the network range and allowing the tool to qualify an additional 1,250 poles. See Figure 6.

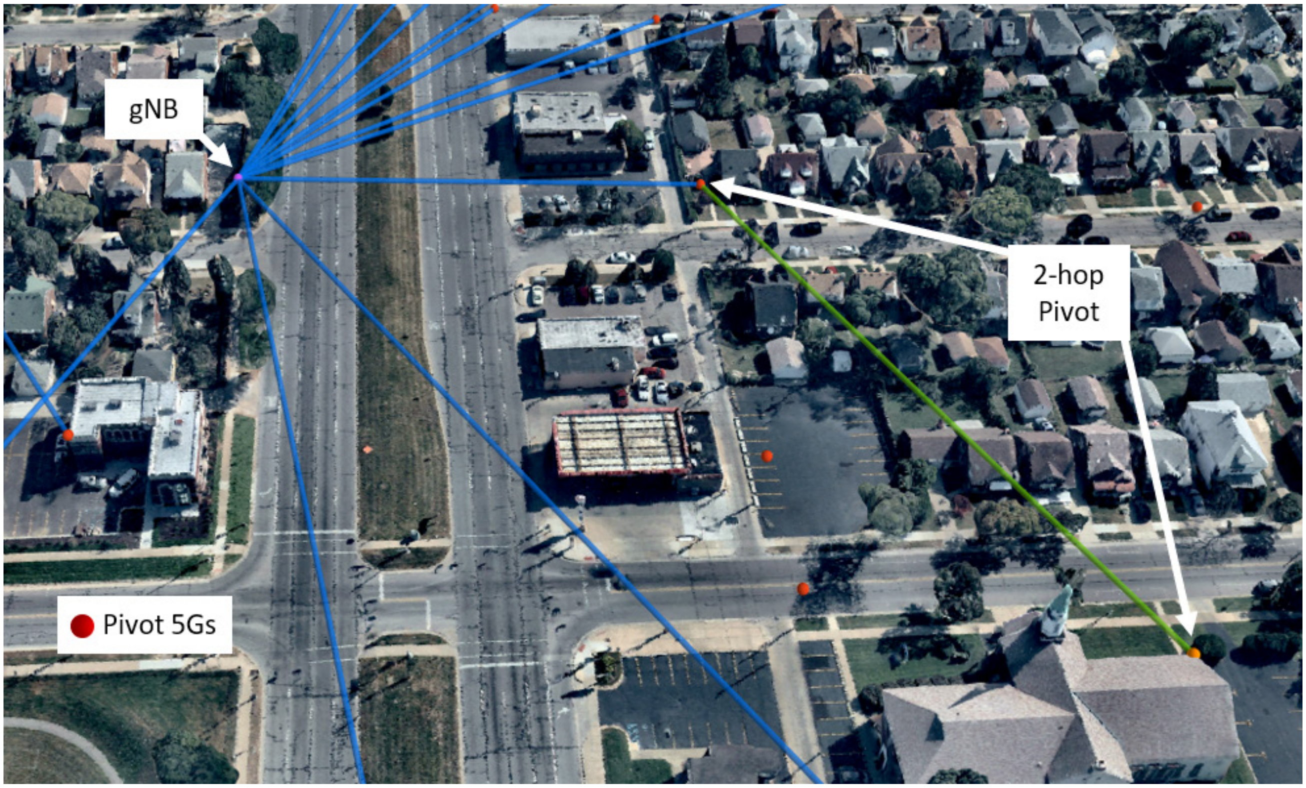

Figure 6

- WaveScape allows the user to define optimal deployment strategy logic by looking at outdoor coverage, FWA enablement and/or indoor coverage. In this scenario, the user elected to optimize the network around FWA enablement. With this user-defined target to optimize around, WaveScape utilizes cloud computing to determine the optimal repeater locations and orientations based on the coverage outcomes. As a cloud-native application, WaveScape has near-infinite scalability and can optimize coverage for any polygon. Out of the 3,000+ eligible Pivot locations available in this scenario, WaveScape selected 171 Pivot locations which allowed for 90% of the units within the polygon to be enabled for FWA (assuming that CPE or repeaters can be placed on the window).
- By tracking the individual contributions of each gNB and repeater within the network, WaveScape allows users to compare the number of repeaters needed to achieve different target coverage levels. For this polygon, alongside the 24 gNBs, 63 Pivots were required to reach 70% coverage, while 115 Pivots were required to reach 80% coverage, meaning that it is much more economical to target 70% coverage for this polygon. See Figure 7.

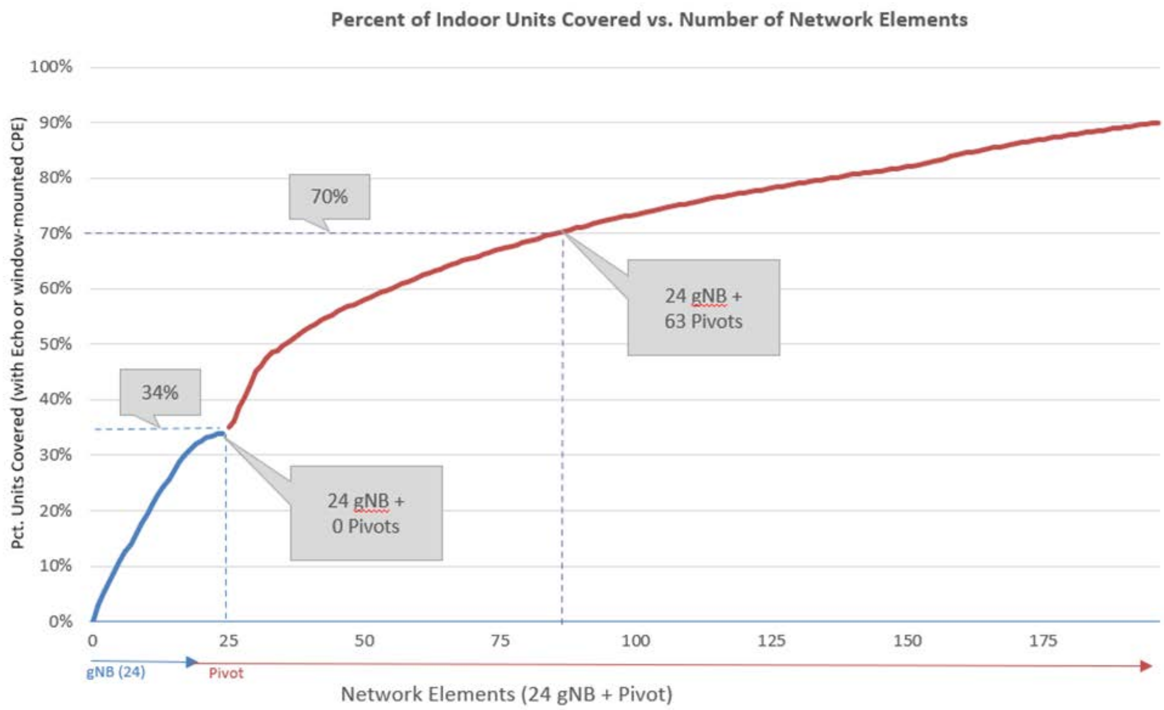

Figure 7

- The flexibility of WaveScape allows users to test different hypothetical scenarios. For example, by removing the five least impactful gNBs from the polygon being considered, WaveScape found that 70% coverage required 19 gNBs plus 70 Pivots. While more Pivots are required than in the 24 gNB scenario, trading five gNBs for seven Pivots allowed for a more economical deployment strategy overall. See Figure 8.

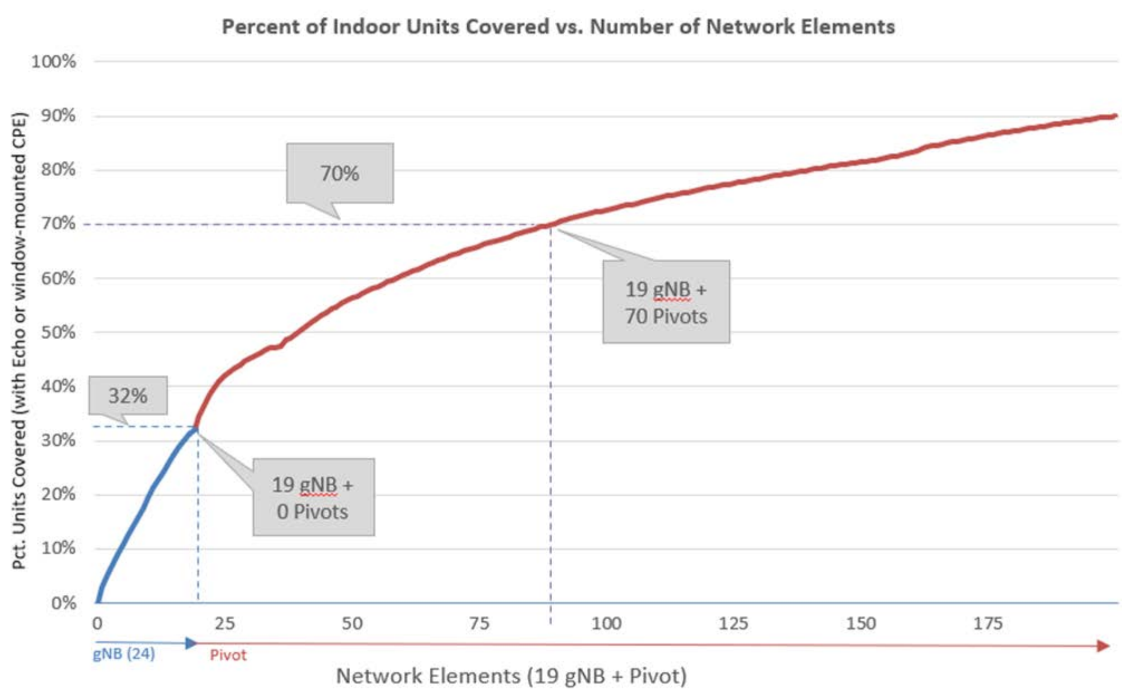

Figure 8

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