



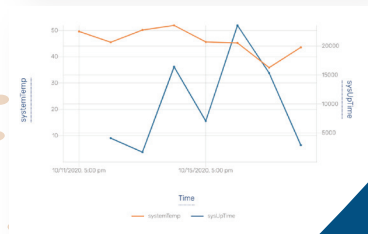
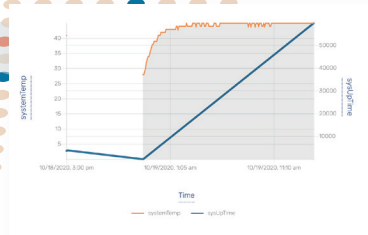
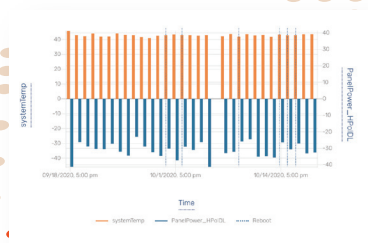
# Intelligent Beam Management System

Cloud-based platform for customization and innovation

mmWaveSolved

**P** Pivot 5G

**e** Echo 5G



5G is PIVOTAL™

## OVERVIEW

Millimeter wave (mmWave) can deliver on low-latency applications that subscribers expect from 5G and on the capacity that carriers need to deliver them. Limited line-of-sight conditions and propagation challenges associated with mmWave mean that carriers' traditional gNB networks are either very limited in coverage or very costly in terms of capital expenditure (CAPEX) due to the high numbers of gNBs. Coverage in this environment has become a new problem that requires a new solution to achieve effectiveness and efficiency.

Pivotal Commware, inventor of Holographic Beam Forming®, has created the world's first smart repeater ecosystem that extends millimeter coverage at a fraction of the cost of gNB-only networks. This ecosystem includes the Pivot 5G™ outdoor network repeater, Echo 5G™ indoor subscriber repeater, WaveScape™ network modeling and optimization tool and Intelligent Beam Management System (IBMS), a software solution to manage and optimize the smart repeaters using Holographic Beam Forming (HBF) technology.



## KEY FEATURES

IBMS is a cloud-based solution that links all the network elements of the extended radio access network (RAN) through an (Internet of Things) IoT network. This implementation offers security, responsiveness and scalability. IBMS covers the essentials noted below and provides carriers a platform for customization and innovation.

### Configuration Management

IBMS provides access to the network configuration including reading device statuses, configuration parameter values and setting the configuration of the devices remotely.

It includes methods for doing sanity checks, remote commissioning and embedded software updates.

### Fault Management

IBMS collects alarms generated by all devices from all severity levels as defined in the International Telecommunications Union's standard ITU-X.733: *Systems Management: Alarm reporting function*.

This allows a user to point to devices with issues and act on critical problems in a timely manner.

## Performance Management

IBMS periodically collects measurements from connected devices with a configurable periodicity starting as low as every minute. It allows performance analyses and troubleshooting through graphs, as well as an overview of the normal operating performance.

## Security

All exchanges between the network elements and the management software are done over secured channels.

Each network element is registered through X.509 certificate handshakes with proof of possession. All communications are done on top of TLS/SSL protocols (e.g. HTTPS, MQTT).

IBMS allows different user roles and permissions, from monitoring the network to acting on it, so that each user's account is configured to their needs.

## GUI and SDK

IBMS can be accessed through its own Graphical User Interface (through a web server and web browser such as Chrome, Firefox or Edge).

It can also be interfaced through its set of APIs (SDK) for direct integration in legacy and customized systems, enabling the use cases below and allowing for innovation. This allows for rapid-value creation and profitable differentiation by and for operators.

In both cases the access uses credentials and tokens to set secure channels between the cloud and the external requester (browser or application).

## USE CASE: operational setup for deployment

When deploying an extended access network to repeat the millimeter wave signal for subscribers not covered by the traditional gNB network, the network elements are installed and commissioned in the field (Pivot 5G) or at the client location (Echo 5G).

IBMS is used to monitor and control the network remotely (if necessary). This improves deployment quality and reduces needed truck rolls by remotely accessing all deployed devices starting from the commissioning process.

1. When the network elements are switched on, they register to IBMS in a secure manner.
2. Once registered, they are routed to the proper IBMS instance, specific to the carrier and in isolation of any other running instances in the cloud (e.g. no connection with the development environment).
3. Remote commissioning allows fine-tuning the device settings to reach optimal performance.

4. The network elements will start reporting their configuration, monitoring data and alarms (if any) through a secure channel.
5. The deployment team can monitor the alarms to spot any issues with network elements just deployed.
6. A configuration sanity check can be done by looking at the main parameter values and verifying that they are within a typical range.
7. Performance metric charts give feedback on the current operational performance of the network elements within the network.
8. Embedded software versioning can be checked and the latest release can be downloaded and installed remotely if there are version discrepancies or last-minute updates.

## USE CASE: proactive self-healing and self-optimization

IBMS stores performance measurements, configuration changes and alarms. This allows the user to access the network history and build trends, correlate events and detect anomalies across the life of the extended network.

By applying classical machine-learning algorithms it is possible to detect typical patterns, predict anomalies and service impacting issues before they are critical. Proactive changes can be made automatically to mitigate such situations.

By keeping lists of beam candidates up to date and inferring the usage pattern from performance measurements, it is possible to change and select the best signal to be repeated depending on the time of the day (e.g. rush hour vs. light traffic hours).

Following trends allows for warnings about coming capacity issues that would require hardware upgrades or network extensions.



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