

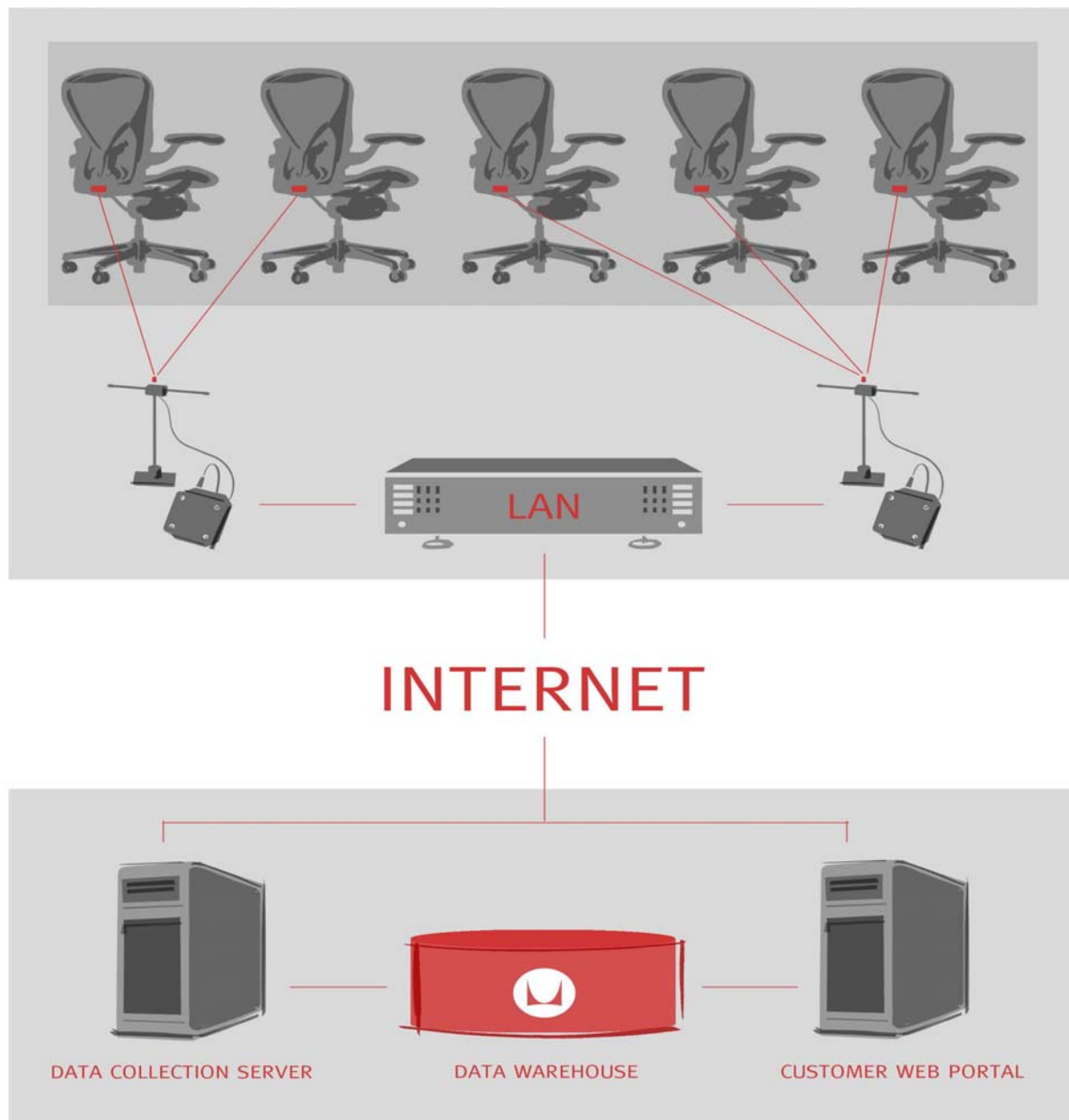
# Echo 2G System User Manual

## HMS Space Utilization Service



## 1. System Overview

Echo 2G is a redeployable and scalable multi-tier sensing system that is installed at a customer facility for a period of 3 to 5 weeks to capture space utilization rates. The system employs three technology tiers to capture, aggregate, and transmit workplace utilization data for analysis and trend reporting. **Figure 1** Echo 2G System Diagram illustrates the relationship between those tiers.



**Figure 1** Echo 2G System Diagram

### ***Furniture Tier***

This tier determines occupancy by sensing movement of a chair in the customer facility. Motion data is transmitted wirelessly to receivers.

### ***Room Tier***

This tier aggregates motion data from the furniture tier. The data is periodically transmitted to Herman Miller over the Internet via either: 1) the customer LAN or 2) a wireless network comprising a 900 MHz wireless backhaul network, a wireless gateway and a cellular router.

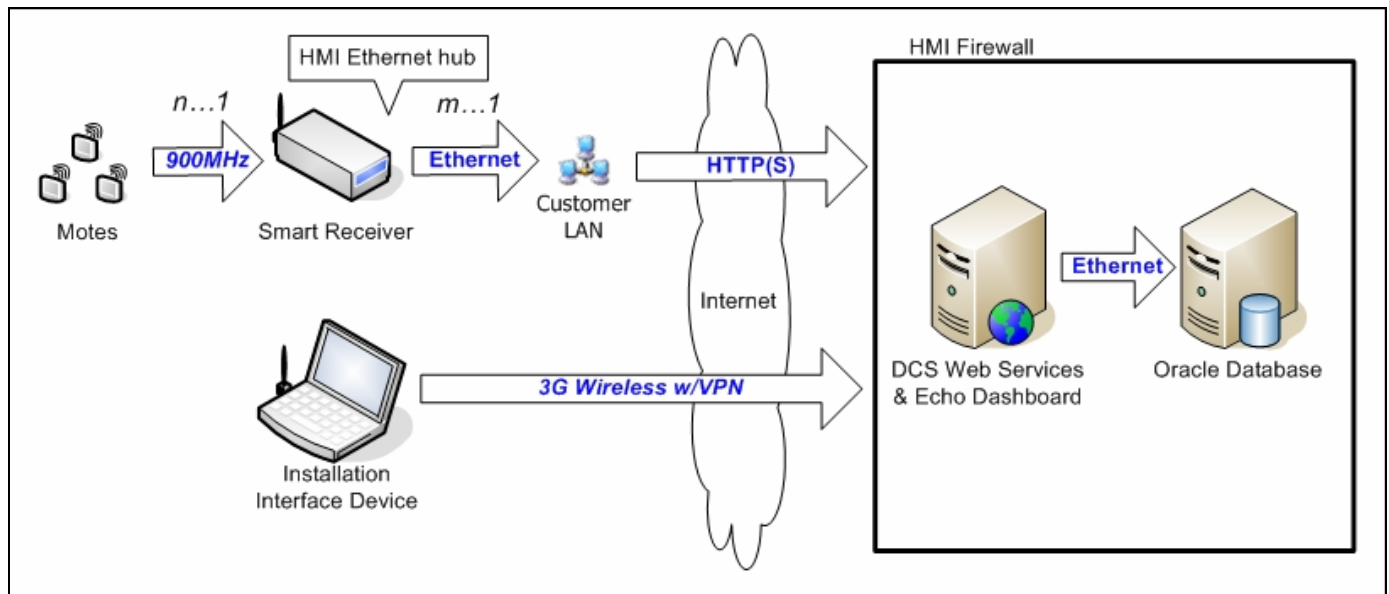
### ***Analysis Tier***

This tier stores all customer data on a secure server at Herman Miller for value-added analysis and reporting.

## **2. System Deployment and Operation Overview**

The Echo 2G system is designed to be easily deployed and operated at customer facilities. Receivers are first deployed across the customer study site, and then motes are deployed to predefined spaces in the customer study area. Motes communicate occupancy data to receivers, receivers communicate occupancy data to the Herman Miller DCS over the Internet, and the DCS stores occupancy data in a database, where it is later used to generate customer reports.

The communication protocols between components are illustrated in **Figure 2** Data flow diagram with protocols.



**Figure 2** Data flow diagram with protocols

Two types of messages are transmitted from receivers to the DCS (data collection server). First, raw occupancy data is encapsulated in an HTTP or HTTPS POST request, which contains binary data from linked motes. Second, a short heartbeat packet containing operational metrics is transmitted every 10 minutes; this heartbeat packet is used to monitor system status and connectivity. The DCS acknowledges all messages. These acknowledgements may include receiver commands.

### **3.1. RF Environment**

The wireless motes communicate with receivers in the 902-928MHz band, so will not interfere with WiFi, Bluetooth, or Zigbee wireless networks, all of which operate in the 2.4GHz band.

### **3.2. Power and Data Lines**

All receivers require power and data connections. They must be placed within wireless range of a subset of motes, where the wireless range between a mote and a receiver is approximately 100 feet indoors. A receiver is capable of linking with over 300 motes, but on average, will link with about 30 motes. To achieve redundant mote coverage, a deployment of 600 motes requires approximately 30 receivers.

### **3.3. IP Addresses**

To simplify installation, receivers use dynamic IP addresses. These IP addresses are assigned by the DHCP server on the customer Local Area Network (LAN) along with a subnet mask and default gateway.

### **3.4. Internet Access**

Receivers send data via the Internet HTTPS. Heartbeat messages are transmitted every 10 minutes. Occupancy data is transmitted less frequently. If required, receivers may be configured to use a web proxy server.

### **3.5. Internet Services**

Receivers use several common Internet services to communicate the space utilization information to the DCS, including DNS to resolve the hostname of the DCS.

### **3.6. Deployment Laptop**

A wireless laptop is used to assign individual motes to predefined spaces. A barcode scanner is attached to the USB port of this laptop. This scanner functions as a secondary keyboard.

## **3. Detailed Process and Deployment Steps**

Conducting a Space Utilization Study using the Echo 2G system is a four-step process.

### **Step One: Gather Information**

The customer facility management team provides Herman Miller with information required to conduct the study.

This information includes study objectives, location, desired dates, number of motes required, desired reports, a floor plan, and a spreadsheet identifying all workspaces to be monitored during the course of the study. For each of these spaces, the spreadsheet should also contain any optional attributes that may be required to generate desired reports.

In this step, Herman Miller obtains the necessary customer IT approvals if the Echo 2G system is to be connected to the customer LAN.

### **Step Two: Setup**

The required equipment is sent to the customer study site in one or more shipping containers. The key pieces of equipment are the motes and the receivers.

**Important**

Changes not expressly approved by Herman Miller, Inc. could void the user's authority to operate the equipment.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an output on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This product complies with FCC OET Bulletin 65 radiation exposure limits set forth for an uncontrolled environment.

Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This Class B digital apparatus complies with Canadian ICES-003.  
Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

**Motes**

Motes are small, battery-powered motion sensors that attach beneath chairs using Velcro or zip ties. Each mote links with a single receiver and transmits wireless occupancy data to that receiver. The mote transmitter operates in the 902-928 MHz ISM band at 0.001 W with a 59% duty cycle per 100ms.

**Receivers**

Receivers collect occupancy data transmitted by the motes. A single receiver will receive and acknowledge data from all motes linked to it. The receiver transmitter operates in the 902-928 MHz ISM band at 0.001 W with a 36% duty cycle per 100ms.

To ensure reliable reception of mote data, receivers should be deployed at the customer site such that at least two receivers are within 100 feet of every mote; this redundancy allows a mote to relink with the second receiver if it loses its link with the first receiver. Note that 100 feet is a typical link range between mote and receiver; actual link range may vary depending on



obstructions or radio interference.

The receiver uses a unique antenna connector. The receiver is to be used only with a ½ -wave center fed dipole antenna with a gain of 2.2 dBi or less, such as the Antenna Factor ANT-916-CW-HWR-RPS.

## **Installation**

During installation, receivers are deployed across the customer study site and notes are deployed to predefined spaces in the customer study area.

### **I. Install Receivers**

Deploy receivers to designated spaces to ensure adequate mote coverage.

- If there is only one network port, deploy a network switch for connecting the receiver to the customer LAN

*Note: this ensures that customers still have access to the LAN*

- Deploy a multi-outlet power strip to supply power to the receiver and the optional network switch

### **Deploy Network Switches**

*Note: If there is only one network port, deploy a network switch for connecting the receiver to the customer LAN*

- Step 1.** Connect Network Switch to AC power via power adaptor
- Step 2.** Connect Network Switch to customer LAN port using CAT5 network cable
- Step 3.** Connect Receiver to Network switch using CAT5 network cable
- Step 4.** From main menu of Administrative User Interface under *Deploy Menu*, click on *Deploy Equipment*
- Step 5.** From drop down list, select current *Company* (customer)
- Step 6.** From drop down list, select current *Study*
- Step 7.** From drop down list, select *Deployment Type* of *Drop Down*
- Step 8.** Repeat Step 8.1 through Step 8.8 for each Network Switch
- Step 8.1** From drop down list, select current *Building*
- Step 8.2** From drop down list, select current *Floor*
- Step 8.3** From drop down list, select current *Area*
- Step 8.4** From drop down list, select current *Space*
- Step 8.5** Place cursor in the *Device Barcode*
- Step 8.6** Scan barcode on Network Switch
- Step 8.7** If you want to note comments either about the condition of the Network Switch or its environment, type those comments in the *Comments* section
- Step 8.8** Click *Submit*

### **Deploy Receivers**

*Note: Receivers must be configured for a study prior to deployment. Receivers must be deployed before notes are deployed.*

- Step 1.** Connect Receiver to Network switch using CAT5 network cable
- Step 2.** Connect Receiver to AC power via power adaptor
- Step 3.** Confirm that the Receiver LCD displays the following test results in sequence within 30 seconds:
  - host <version>...ok
  - sbc <version>...ok
  - radio module <version>...ok
  - backhaul...ok
  - network...ok



- DCS...ok
- Step 4.** From main menu of Administrative User Interface under *Deploy Menu*, click on *Deploy Equipment*
  - Step 5.** From drop down list, select current *Company* (customer)
  - Step 6.** From drop down list, select current *Study*
  - Step 7.** From drop down list, select *Deployment Type* of *Drop Down*
  - Step 8.** Repeat Step 8.1 through Step 8.9 for each Receiver
  - Step 8.1** From drop down list, select current *Building*
  - Step 8.2** From drop down list, select current *Floor*
  - Step 8.3** From drop down list, select current *Area*
  - Step 8.4** From drop down list, select current *Space*
  - Step 8.5** Place cursor in the *Device Barcode*
  - Step 8.6** Scan barcode on Receiver
  - Step 8.7** If you want to note comments either about the condition of the Receiver or its environment, type those comments in the *Comments* section
  - Step 8.8** Click *Submit*
  - Step 8.9** After clicking *Submit*, confirm that *Confirmation* box indicates *Proceed* within 5 seconds
  - Step 8.10** Hang/Place “**Study in Progress, Do Not Remove**” placard on Receiver

## II. Install Motes

Deploy motes to designated spaces to monitor occupancy

### *Deploy Motes*

- Step 1.** Press and hold Mote button for 3 seconds (a single beep tone will sound at 3 seconds) to power up Mote (exit Shutdown Mode)
- Step 2.** Confirm that Mote sounds 2 ascending beep tones to indicate power-up
- Step 3.** Confirm that Mote does NOT sound a 1-second Low Battery beep tone after 1 second

**IMPORTANT:** If the Mote sounds 1-second Low Battery beep tone, replace Mote battery with new battery or select a different Mote.

- Step 4.** From main menu of Administrative User Interface under *Deploy Menu*, click on *Deploy Equipment*
- Step 5.** From drop down list, select current *Company* (customer)
- Step 6.** From drop down list, select current *Study*
- Step 7.** From drop down list, select *Deployment Type* of *Drop Down*
- Step 8.** Repeat Step 8.1 through Step 8.8 for each Mote
- Step 8.1** From drop down list, select current *Building*
- Step 8.2** From drop down list, select current *Floor*
- Step 8.3** From drop down list, select current *Area*
- Step 8.4** From drop down list, select current *Space*
- Step 8.5** Place cursor in the *Device Barcode*
- Step 8.6** Scan barcode on Mote
- Step 8.7** If you want to note comments either about the condition of the Mote or its environment, type those comments in the *Comments* section
- Step 8.8** Mount Mote under front lip of task chair using Velcro, tie wrap or, if the Mote must be attached to fabric, a basting gun
- Step 8.9** Press and release Mote button within 0.5 second
- Step 8.10** Confirm that Mote sounds single beep tone indicating it is powered on
- Step 8.11** Confirm that within 3 seconds, the Mote sounds at least 3 additional beep tones, indicating Received Signal Strength (RSS) of Receiver signal is acceptable.

**IMPORTANT:** If the Mote sounds fewer than 3 beep tones, the RSS is too low to support reliable communications. Once the identity of the linked Receiver is known (see Step 8.13.2 below), this Receiver should be repositioned (placed closer to the ceiling) and/or relocated (closer to the Mote), and the Receiver RSS reassessed by pressing the Mote button again. Note that relocating the Receiver may affect the RSS of other Motes.

- Step 8.12** Click *Submit*
- Step 8.13** After clicking *Submit*, confirm the following:
- Step 8.13.1** *Confirmation* box indicates *Proceed* within 5 seconds
- Step 8.13.2** Deployment screen indicates that at least 2 Receivers provide acceptable RSS

**IMPORTANT:** If the Deployment screen indicates that fewer than 2 Receivers provide acceptable RSS, then the deployment does not have acceptable mote coverage redundancy. Reposition or relocate one or more Receivers and reassess Receiver RSS by pressing the Mote button again. Confirm that at least 2 Receivers provide acceptable RSS.

### **Step Three: Monitor**

Once all equipment has been installed, data will be transmitted to Herman Miller via the Internet for analysis. A Herman Miller analyst will determine whether data is being collected properly, and may contact the customer to assist in simple troubleshooting, e.g., to check whether a receiver's AC power plug has become unplugged.

At the conclusion of a customer study, Herman Miller will analyze the collected occupancy data data and create reports that present and interpret the findings.

### **Step Four: Remove**

At the conclusion of a customer study, all equipment must be collected, repackaged, and returned to Herman Miller. Customers are responsible for any lost equipment.

## **III. Remove Motes**

Return motes to shipping kit.

### **Remove Motes**

- Step 1.** Repeat Step 2 through Step 14 for each Mote
- Step 2.** Detach Mote from the underside of the front lip of the task chair.
- Step 3.** Press and hold Mote button for 3 seconds (a single beep tone will sound at 3 seconds) to power down Mote (enter Shutdown Mode)
- Step 4.** Confirm that Mote sounds 2 descending beep tones to indicate power-down
- Step 5.** From main menu of Administrative User Interface under Deploy Menu, click on Deploy Equipment
- Step 6.** From drop down list, select *Deployment Type* of *Drop Down*
- Step 7.** From drop down list, set *Building* to *Kit*
- Step 8.** From drop down list, set *Floor* to *Kit*
- Step 9.** From drop down list, set *Area* to *Kit*
- Step 10.** From drop down list, set *Space* to *Kit*
- Step 11.** Place cursor in the *Device Barcode*



- Step 12.** Scan barcode on Mote
- Step 13.** If you want to note comments either about the condition of the Mote or its environment, type those comments in the *Comments* section
- Step 14.** Click *Submit*

#### IV. Remove Receivers

Return receivers to shipping kit.

If a multi-outlet power strip was deployed, unplug the receiver and optional network switch from the power strip and return the power strip to the shipping kit.

**IMPORTANT:** Remember to return multi-outlet power strip, AC power adaptors, CAT5 cables and placards to kit.

##### *Remove Network Switches*

- Step 1.** Repeat Step 2 through Step 14 for each Network Switch
- Step 2.** Disconnect Network Switch from AC power
- Step 3.** Disconnect Network Switch from customer LAN port
- Step 4.** Disconnect Receiver from Network Switch
- Step 5.** From main menu of Administrative User Interface under *Deploy Menu*, click on *Deploy Equipment*
- Step 6.** From drop down list, select *Deployment Type* of *Drop Down*
- Step 7.** From drop down list, set *Building* to *Kit*
- Step 8.** From drop down list, set *Floor* to *Kit*
- Step 9.** From drop down list, set *Area* to *Kit*
- Step 10.** From drop down list, set *Space* to *Kit*
- Step 11.** Place cursor in the *Device Barcode*
- Step 12.** Scan barcode on Network Switch
- Step 13.** If you want to note comments either about the condition of the Network Switch or its environment, type those comments in the *Comments* section
- Step 14.** Click *Submit*

##### *Remove Receivers*

- Step 1.** Repeat Step 2 through Step 13 for each Receiver
- Step 2.** Disconnect Receiver from AC power
- Step 3.** Disconnect Receiver from customer LAN port
- Step 4.** From main menu of Administrative User Interface under *Deploy Menu*, click on *Deploy Equipment*
- Step 5.** From drop down list, select *Deployment Type* of *Drop Down*
- Step 6.** From drop down list, set *Building* to *Kit*
- Step 7.** From drop down list, set *Floor* to *Kit*
- Step 8.** From drop down list, set *Area* to *Kit*
- Step 9.** From drop down list, set *Space* to *Kit*
- Step 10.** Place cursor in the *Device Barcode*
- Step 11.** Scan barcode on Receiver
- Step 12.** If you want to note comments either about the condition of the Receiver or its environment, type those comments in the *Comments* section
- Step 13.** Click *Submit*