

Smart Hotel Solution — Technical Whitepaper

Real-time bed usage detection for hospitality operations

VMANX INDUSTRIAL CO., LIMITED

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1. Executive Summary

VMANX INDUSTRIAL CO., LIMITED presents a purpose-built bed occupancy sensor system for the hospitality industry. Our solution leverages Force-Sensing Resistor (FSR) technology to deliver real-time, binary occupancy detection — enabling hotels to capture ground-truth room usage data without cameras or privacy concerns.

Key Benefits:

- Real-time bed occupancy — know exactly which rooms are in use
- Invisible installation — sensor hidden under mattress, zero guest awareness
- Multi-protocol wireless — WiFi, BLE, LoRa, Zigbee, or RS485 (client choice)
- Scalable — one gateway covers up to 50 rooms, unlimited properties
- OEM-ready — full white-label from sensor to dashboard

2. The Challenge

Traditional hotel systems rely on check-in data and key card logs. These methods suffer from fundamental blind spots:

- **Check-in does not equal occupancy** — a guest may check in but spend the night elsewhere.
- **Key card logs are unreliable** — multiple cards, lost cards, staff overrides create noise.
- **No real-time status** — housekeeping lacks live bed-usage data for efficient scheduling.
- **Privacy barriers** — camera/motion-sensor solutions face guest objections and regulations.
- **Energy waste** — HVAC and lighting run in rooms assumed occupied based on booking alone.

A 100-room hotel losing 30 minutes per room per day wastes over 18,000 staff hours annually.

3. Solution Overview

The VMANX Bed Occupancy Sensor is a thin (3mm) flexible pressure-sensitive mat placed between mattress and bed base. When a guest lies down (>15 kg), the sensor transmits 'Occupied' via wireless TX module. When they leave, it resets to 'Vacant' within 5 seconds.



Figure 1: VMANX FSR Bed Occupancy Sensor

Three-Layer Architecture:

- **Detection Layer:** FSR sensor mat (3mm, IP65, 50K+ cycles)
- **Network Layer:** Wireless TX + Multi-protocol gateway (50 rooms per unit)
- **Application Layer:** Real-time dashboard + RESTful API + MQTT + Modbus + Relay

4. Application Scenario

The sensor mat is placed between the mattress and bed base, completely hidden under hotel linens. A wireless signal is transmitted to a wall-mounted gateway receiver. No wires. No visible hardware. No guest experience compromise.



Figure 2: Hotel Bed Sensor Installation — Mattress Cross-Section

Signal Flow:

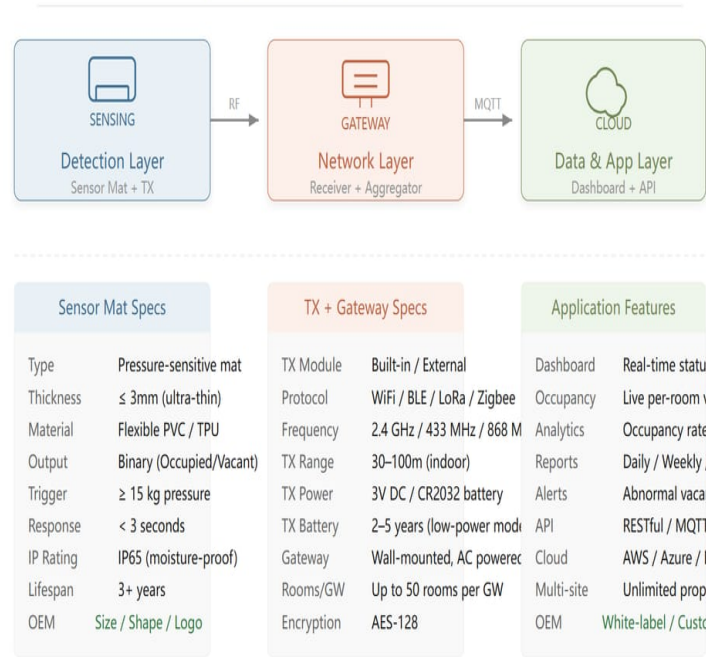
- **1. Guest lies down** — pressure triggers sensor mat (response < 3 seconds)
- **2. TX module transmits** — wireless Occupied signal to gateway
- **3. Gateway aggregates** — collects data from up to 50 rooms simultaneously
- **4. Dashboard updates** — real-time occupancy visible on management console

5. System Architecture

Three-layer IoT architecture optimized for hospitality:

Layer	Component	Function
1. Detection	FSR Sensor + TX	Detects guest presence; binary Occupied/Vacant signal
2. Network	Wireless Gateway	Aggregates 50 rooms; protocol conversion; cloud upload
3. Application	Dashboard + API	Real-time visualization; analytics; PMS integration

Bed Occupancy Sensor System — Technical Architecture



Communication Protocol Options (Client-selectable)

Protocol	Range (Indoor)	Power	TX Battery Life	Best For
WiFi (2.4G)	30–50m	Medium	1–2 years	Existing WiFi hotels
BLE 5.0	10–30m	Ultra-low	3–5 years	Battery priority
LoRa (868/915)	100–500m	Ultra-low	5+ years	Large resorts
Zigbee 3.0	30–70m (mesh)	Low	2–4 years	Mesh network
RS485 (Wired)	≤ 1200m (bus)	Bus-powered	Unlimited	New construction

OEM Customization: Sensor Size · Protocol · Gateway · Branding · API · Full White-label Available

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Figure 3: System Architecture — Data Pipeline



Figure 4: Full Ecosystem — Detect. Connect. Insight.

6. Sensor Mat Specifications

Parameter	Specification	Notes
Type	Pressure-sensitive FSR mat	Binary detection only
Thickness	3 mm	Ultra-thin, invisible
Material	Medical-grade PVC / TPU	Waterproof, flexible
Output	Binary (Occupied / Vacant)	NO/COM equivalent
Trigger	15 kg (customizable 10-30 kg)	Per mattress calibration
Response	< 3 seconds	Contact to signal
Reset	< 5 seconds	Exit to vacant
IP Rating	IP65	Moisture resistant
Temperature	-10C to 60C	All climates
Standard Size	600 x 400 mm	Customizable
Lifespan	> 50,000 cycles	10+ years
Cable	1.5 m flat cable	To TX module

7. TX Module & Gateway

TX Module

Parameter	Specification
Size	45 x 30 x 12 mm
Power	3V DC / CR2032 battery
Battery (BLE)	3-5 years
Battery (LoRa)	5+ years
Battery (WiFi)	1-2 years
Report	On-change + 5min heartbeat
LED	Software-off stealth mode
Mounting	Under bed frame

Gateway

Parameter	Specification
Protocols	WiFi / BLE / LoRa / Zigbee / RF433
Outputs	MQTT, RESTful, Modbus, Relay, TTL
Capacity	50 sensors per gateway
Power	DC 5V/12V or PoE
Size	120 x 80 x 30 mm
Encryption	AES-128
Cache	24-hour local storage
Redundancy	Dual hot-standby (optional)

8. Communication Protocols

Client-selectable — we deliver matching hardware:

Protocol	Range	TX Power	Battery	Best For
WiFi 2.4G	30-50m	Medium	1-2 yr	Existing WiFi
BLE 5.0	10-30m	Ultra-low	3-5 yr	Battery priority
LoRa 868/915	100-500m	Ultra-low	5+ yr	Large resorts
Zigbee 3.0	30-70m mesh	Low	2-4 yr	Mesh network
RS485 Wired	1200m bus	Bus	Unlimited	New construction

9. Data Integration

Interface	Type	Best For
MQTT	JSON Push (QoS 1)	Cloud PMS / real-time
RESTful API	HTTP GET/POST	Web platforms
Modbus RTU	RS485 Register	BMS / PLC / DDC
Relay (NO/COM)	Dry Contact	Legacy systems
TTL UART	Serial 3.3V/5V	Embedded / MCU

MQTT is recommended for real-time applications. Gateway publishes to configurable topic (vmanx/hotel/property/bed/room_id/status) as JSON. REST API provides CRUD access to status, history, and analytics.

10. OEM Customization

Full white-label delivery under your brand:

- Sensor dimensions — custom LxW per bed type
- Trigger threshold — 10-30 kg adjustable
- Communication protocol — any from Section 8, hardware-adapted
- TX module housing — custom color, material, silkscreen
- Gateway housing — custom shell with your logo
- Firmware — custom report frequency and power strategy
- Data protocol — custom JSON fields for your software
- Dashboard — white-label (your logo, colors, domain)
- Packaging — branded box + multi-language manual
- Certifications — CE, FCC, RoHS, REACH compliance

11. Reliability & Scalability

Hardware

- TPU encapsulation — 50,000+ cycles rated, IP65 waterproof
- Wide temperature range (-10C to 60C) for all climates
- Low-battery alert at 15% — push to dashboard and email
- Hardware watchdog timer — automatic fault reset
- 72-hour factory burn-in per sensor before shipment

Communication

- 5-min heartbeat — gateway alerts after 15 min silence
- 24-hour local cache — zero data loss during outages
- MQTT QoS 1 — at-least-once delivery guarantee
- AES-128 encryption on all wireless links

Scalability

One gateway = 50 rooms. Multiple gateways per property. Cloud platform supports unlimited properties with role-based access. Wireless deployment — no construction. 100 rooms instrumented in under 4 hours.

12. Implementation Roadmap

Phase	Timeline	Deliverables
1. Requirements	Week 1	Protocol, size, OEM, integration path confirmed
2. Prototyping	Weeks 2-4	3 evaluation kits (sensor+TX+gateway)
3. Pilot	Weeks 5-6	20-unit live hotel deployment
4. Integration	Weeks 5-8	API docs + SDK + software testing
5. Production	Weeks 9-12	Mass production, branded packaging, certifications

13. About VMANX

VMANX INDUSTRIAL CO., LIMITED is a sensor manufacturer serving global OEM clients in automotive, medical, industrial, and hospitality sectors. Core competency: Force-Sensing Resistor (FSR) technology — thin, flexible, durable pressure sensors converting mechanical force into reliable electrical signals.

Certified: ISO 9001 (Quality), IATF 16949 (Automotive), RoHS, REACH (F3 Electronics Family). Every sensor undergoes 72-hour continuous pressure-cycling burn-in before shipment.

Contact

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