



People Counting Technology:

The Buyer's Guide

- 01 — Cameras
- 02 — Active Infrared (AIR) or 'Break Beam' Sensors
- 03 — WiFi Tracking or "WiFi / MAC Address Tracking"
- 04 — Seat Sensors
- 05 — Thermal
- 06 — Ultrasonic
- 07 — Density

Technology Questionnaire

About Density



Introduction

For decades, people-counting technologies were used primarily by retailers to correlate marketing efforts with foot traffic and sales. That's changing. In recent years, businesses of all kinds have discovered new ways that people-counting technology can improve operations, reduce costs, enhance the workplace experience and drive growth.

Hotel operators use people-count analytics to set staffing and service levels to match forecasted guest counts, avoiding shortfalls and improving the guest experience. Corporate real estate teams can quantify and repurpose under-utilized meeting rooms and other spaces, saving tens of millions of dollars in operating expenses. Commercial spaces of all kinds can easily manage occupancy, improving occupant safety and avoiding costly fines from fire code violations. Physical security teams can detect entrance tailgating and improve emergency response efforts by knowing the real-time occupancy of every space in their buildings. The list goes on.

This document provides an overview of 7 of the most commonly used technologies for counting people.

Please send any questions or feedback to hq@density.io.

AT A GLANCE

	Accuracy	Privacy	APIs & Integrations	Real-Time	Cost
Cameras					\$\$
Break-beam IR					\$
MAC Address Tracking					\$\$
Seat Sensors					\$
Thermal					\$\$
Ultrasonic					\$\$\$
Density (overhead infrared + A.I.)					\$\$\$

KEY

Better



Worse



01

Cameras



How It Works

Most cameras see in flat color images, analyzing changes in pixel color to determine movement and identify people or other objects in a scene. Buyer's tip: sometimes cameras will be referred to as an "optical sensor," but don't be confused: it's just a camera.

Industries	Average Cost	Data Type
<ul style="list-style-type: none"> Retail Building Security 	Variable based on the device's intelligence and the analytics system behind it. Companies usually charge a hardware fee and an analytics or dashboard fee.	RGB video or flat images
	Range: \$250 - \$1,500 per device	

PROS

Cost—Cameras are relatively inexpensive and they come in a wide variety of form factors.

Analytics—The most capable cameras use powerful computer vision algorithms to track people, and enable facial recognition and object detection. They capture huge amounts of visual information from their surroundings. With advances in computer vision and machine learning, cameras' object tracking and facial recognition capabilities will continue to improve.

CONS

The Handoff Problem—When pointing multiple cameras into a room, you have to overlap their fields of view. If you don't, or if you're using multiple cameras, they have to intelligently make sense of the people that disappear in-between the FOVs. This is called the Handoff Problem and it requires additional processing. Many camera systems are designed specifically for physical security use cases, and therefore the video management software designed to run them often does not solve for the Handoff Problem.

Privacy—Lack of privacy is a camera's biggest limitation for many locations. Some smart cameras will "anonymize data locally," meaning they will blur or obscure a person's face or downsample the image's resolution so it looks fuzzy. Anonymized is not the same as anonymous.

Culture—In an office setting, it can be difficult to get beyond the pilot stage with camera solutions for counting people. Simply put, employees often do not like the idea of being recorded at their desk or in other work spaces.

Network Security—Many camera systems rely on insecure practices and protocols, such as port-forwarding and unencrypted data connections, making them an ideal target for hacking. For buyers with strong information security requirements, or those with sensitivities around capturing personally identifiable information (PII) of their employees, cameras may not be a viable option.



02

Active Infrared (AIR) or 'Break Beam' Sensors



How It Works

Break beam sensors have an infrared emitter and an infrared receiver. The sensors are typically placed on one side of a doorway (or both sides). Standard AIRs count the number of times infrared light is “broken” or passed through. At the end of the day, the user divides the number by 2 to determine the total number of people that came and went. The AIR approach requires manual effort but may be a fit, depending on the use case. More intelligent AIRs claim to do bidirectional movement, though in practice they typically fail to achieve high accuracy.

Industries	Average Cost	Data Type
• Retail	Range: \$50 - \$150	Signal and signal processing algorithm

PROS

Inexpensive, anonymous, battery operated.

CONS

Inaccuracy—Break beam sensors are inaccurate. The sensor becomes blind when two people enter at the same time (side-by-side) or enter and exit at the same time. As a result, it’s impossible to generate an accurate, real-time count of how many people are in a space.

Privacy—Because of technology limitations, aggregating people-count data often requires manual effort. Even at the scale of a dozen of doors, AIR sensors are not a good fit for counting people.

Data is complex—Break beam sensors rely on signal processing to sort out when a person has entered. The signal, which looks like the figure below is hard to make sense of when lines form or people bring boxes and bags with them.



03

WiFi Tracking or “WiFi / MAC Address Tracking”



How It Works

- Your phone is always looking for known WiFi networks (home WiFi, work WiFi, etc). It does this out of convenience so you can automatically connect to a known network without manually selecting it.
- The way your phone finds a WiFi network is by sending out what’s called a “probe request.” This probe request is like your phone saying, “Hey my name is, Andrew.” But instead of “Andrew” it sends “40:68:AD:80:D3:A0,” which is a MAC Address unique to your phone and your phone only (it’s globally unique). You can look yours up in the Settings › About section of your smartphone. Fun fact: Bluetooth has one, too.
- Technicalities aside, it’s important to know that almost all WiFi routers are capable of tracking your phone. In fact, your MAC address is how a WiFi router or access point serves internet to all of your devices: your laptop, smartwatch, Fitbit, phone, Nintendo Switch, etc. They all have MAC addresses, they can all be tracked, and you do not need to be connected to the internet. All you need is to have your WiFi turned on.
- So, you’re in a building and your phone is reaching out saying, “I’m here!” Multiple routers are listening and triangulating. They compare the relative strength of that signal to one another and can approximate where you are in the building. They also know what other devices you usually carry with you (i.e. smartwatch, iPad, etc). Most important, they can tell if they’ve seen you before (even if the last time they saw you was in another country during a business trip).
- The routers roll up this data and send it to an analytics platform.

Industries

- Retail
- Corporate Offices

Average Cost

Varies widely by platform. Depending on the analytics, it can vary from tens of dollars / month to tens of thousands of dollars / month. Your existing enterprise WiFi system will have this as an upgrade option.

Data Type

MAC address detection

PROS

Low cost, widely available, and ambient.

CONS

Invasive—Depending on the environment you’re deploying the technology into, this can be an invasive technology. It is not “opt-in;” meaning, the users the system tracks haven’t given their permission.

Inaccurate—The real downfall of WiFi tracking, though, is inaccuracy. The system usually isn’t granular enough to determine the use of a specific room. So you end up with heatmaps and approximation.



04

Seat Sensors



How It Works

- Seat sensors are battery-operated motion detectors that are taped or otherwise affixed to desks and tables.
- The sensors run in low-power mode waiting for movement. When they see movement, they transmit “Movement!” back to another device nearby. That device is powered and usually has a 4G internet connection.
- If you have 1,000 employees, you stick these beneath 1,000 desks, and also beneath however many conference room tables you might have.

Industries

- Corporate Offices

Average Cost

Varies by provider. Some bundle it with their service. Others charge separately for the hardware. It’s a pretty low cost solution, though.

Range: \$10 - \$100s

Data Type

Motion detection

PROS

Seat-specific data, battery operated, low cost.

CONS

Battery—If this is a long-term solution and you’ve deployed them in the thousands, when a battery operated device dies, you will have to retrieve and redeploy them in the thousands.

Privacy—Technically, you can use this system to track how long someone is at their desk. The privacy issue is dependent on how you structure your analytics and how you use the data. Know that systems like this have the ability to track an individual’s time-at-desk if you associate an employee’s identity with a device. Used benevolently, they can be helpful in understanding the use of certain furniture.



05

Thermal



How It Works

Thermal devices use body heat and computer vision to identify and classify objects.

Industries	Average Cost	Data Type
<ul style="list-style-type: none">• Retail• Corporate Offices	<p>The most popular thermal people counter is about \$1,500 per device. Price varies by vendor.</p> <p>The underlying technology is relatively inexpensive: \$10s-\$100s of dollars off the shelf.</p>	Heat sensing

PROS

Anonymous, good at identifying movement.

CONS

Requires objects in motion to count, cannot distinguish from heat signatures too close to one another, does not do well when people linger.

Thermal systems rely on motion to distinguish humans. It has difficulty when people stand still, when they overlap, and when they carry warm things (like laptops).



06

Ultrasonic



How It Works

Ultrasonic sensors bounce inaudible sound off people as they walk by. Each one has an emitter and a receiver.

Industries	Average Cost	Data Type
<ul style="list-style-type: none">Robotics	Inexpensive Range: \$50 - \$100	Sound wave

PROS

Low power requirements.

CONS

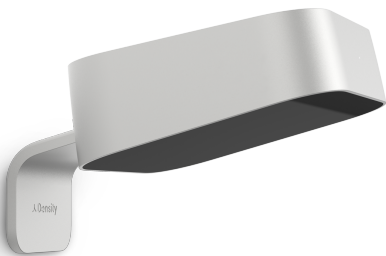
Inaccurate

- Ultrasound is good at detection but ineffective at counting people.
- The system is unable to make sense of soft clothing and carried objects making it better at detecting motion than it is at determining count.
- Interestingly, it does very well with denim.



07

Density



How It Works

Density uses depth data, machine learning, and computer vision to anonymously count people. Its device is installed above a doorway, using overhead infrared sensors to generate a highly detailed 3D render based on hundreds of thousands of depth measurements. The technology offers the primary benefits of being real-time, fully anonymous and highly accurate.

Industries	Average Cost	Data Type
<ul style="list-style-type: none"> • Retail • Corporate Offices • Hospitality • Higher Education 	No hardware fee. Annual data fee, variable by volume of units deployed.	Depth data and infrared lasers

PROS

Anonymous, accurate, real-time, purpose-built dashboard analytics, PoE+, RESTful API.

- At no point is personally identifiable information (PII) captured; platform is GDPR-compliant
- Density's API hosts real-time and historical people count data for your Density-enabled spaces
- Standard PoE+ connectivity; low bandwidth consumption
- Enterprise-grade security (data encrypted at rest and in transit; device makes only outbound connections via Port 443)
- Automatic firmware and software upgrades: device always has the latest capabilities and security enhancements
- Unlimited users for Density's software dashboard and mobile application included as part of the service

CONS

Not battery powered, premium option.



Technology Questionnaire

Question	Response (Y/N, N/A)	Notes
Does the device capture personally identifiable information (PII)?		
How real-time is the count data?		
Can the device accurately count many simultaneous entrance and exit events?		
Is there browser-based software that you can use to access the count data?		
Does the device encrypt data at rest and in transit?		
Is the device kept up-to-date with automatic firmware updates?		
Is count data available via RESTful APIs?		
Does the technology provide analytics at the room, floor, building and multi-property levels?		
Can the system send alerts when a space reaches a defined occupant load?		
Does the system send an alert if it goes offline?		
Does the system provide predictive analytics?		
Does the system allow users to create and share reports via email?		
Does the manufacturer or system provider conduct a count accuracy audit of every device that it deploys?		



About Density

Density is the new occupancy analytics platform for connected spaces. Using proprietary sensors and software, the platform accurately measures foot traffic throughout buildings. Enterprise teams use density to eliminate underutilized real estate, deliver exceptional workplace experiences, and strengthen physical security. Unlike alternatives—which are either invasive or imprecise—Density is both anonymous by design and the industry’s most accurate system.

Together, Density’s customers manage over 100 million square feet of corporate real estate. Density was founded in 2014, with offices in San Francisco, New York City, and Syracuse, New York.

Want to Learn More?

Get a Demo at density.io

