

WHITE PAPER

# Axis counting solutions

Aspects for system integrators and end customers

June 2025

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# 1 Introduction

Counting solutions are widely used in many types of businesses and public locations. They provide visitor statistics that enable businesses to analyze trends and optimize their operations.

This white paper presents the basics of video-based counting analytics. It pays attention to the factors that influence accuracy and what you as a system integrator or end customer can do to ensure an optimal installation. This paper also outlines the counting solutions in Axis portfolio and their typical use cases.

## 2 Background

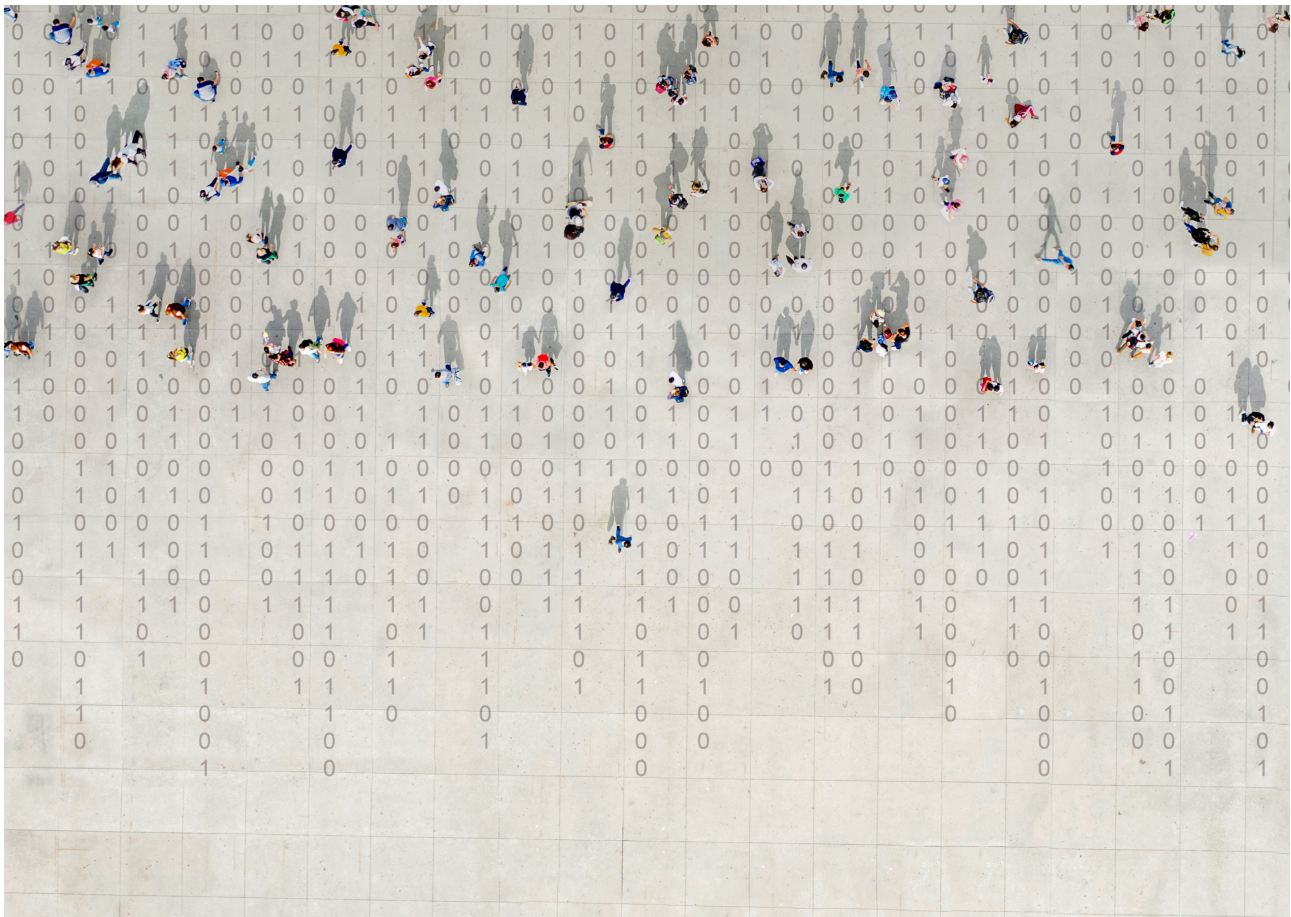


Figure 2.1 *Object counting offers various industries a way to capture and analyze counting data from their locations.*

Accurate visitor and vehicle counting is essential for various organizations to optimize their operations, improve customer experience, and make data-driven decisions. For instance, in retail, knowledge of the number of visitors in different stores, as well as in different areas of a store can help calculate conversion rates, evaluate campaigns, and allocate staff effectively. Similarly, museums and libraries may require visitor statistics to secure government funding. Sports facilities and event companies often need to monitor the number of visitors to optimize ticket pricing while other types of organizations monitor foot traffic for effective crowd control.

AXIS Object Analytics can cater to these diverse needs by providing reliable data on people and vehicle traffic and can be applied in various scenarios such as:

- Monitoring visitor traffic in retail stores, museums, and libraries to optimize staffing, marketing, and operations.
- Tracking vehicle movements and traffic flow in parking garages, traffic monitoring agencies, and smart cities to inform urban planning, manage congestion, and optimize parking capacity.

- Counting vehicles in traffic to provide real-time data for city planners, officials, and stakeholders to make informed decisions on infrastructure development and resource allocation.
- Analyzing data on electrical charging station usage and adjusting capacity accordingly to optimize business performance in parking garages.
- Identifying peak periods and allocating resources effectively to enhance security in high-traffic areas.

By leveraging AXIS Object Analytics, organizations can gain valuable insights into visitor and vehicle traffic, ultimately leading to improved operational efficiency, enhanced customer experience, and data-driven decision making. AXIS Object Analytics allows a camera to serve multiple purposes simultaneously, enabling organizations to leverage the camera for both security monitoring and business intelligence applications like people counting, thereby maximizing the return on investment and streamlining operations.

Accurate counting of both visitors and vehicles is a key factor with a potentially large financial impact, and it's imperative that the counting algorithms are reliable and that the cameras are installed in a way that optimizes their operating conditions.

Camera-based object counting may give rise to concerns about privacy and data security. AXIS Object Analytics comes with the possibility to disable the video stream and store nothing but the numeric count data. There are also several privacy options such as using a privacy mask or AXIS Live Privacy Shield, if compatible with your camera.

## 3 Axis counting solutions

AXIS Object Analytics offers two counting scenarios, crossline counting and occupancy in area, which provide reliable results when properly installed in suitable locations.

- **Crossline counting:** Counts objects that cross a virtual line in a specific direction. With crossline counting, you can also set up events and collect data.

Crossline counting is useful for scenarios where you need to track the movement of objects in a specific direction, allowing you to analyze traffic flow and recognize trends in visitor patterns.

- **Occupancy in area:** Counts the number of objects in a defined area. A defined area is the specific part of your camera's field of view that you want to monitor.

Occupancy in area is useful for scenarios where you need to know the occupancy estimate and control the crowd. The data can also be useful for analyzing space utilization in a building or facility.

You can use both crossline counting and occupancy in area to generate an event that is based on a user-defined counting threshold.

### 3.1 How does counting work?

To accurately count people and vehicles, position the camera so that you have a clear view of the objects being detected. Authorized users can then view real-time and historical statistics from any device and location. It is easy to add the system to an existing IP network.

Crossline counting tracks objects crossing a virtual line in a specified direction, as defined by the user. The objects should be fully visible to the camera both before and after crossing the line.

Occupancy in area estimates how many objects are inside a user-defined area at any given time and detects both moving and stationary objects.

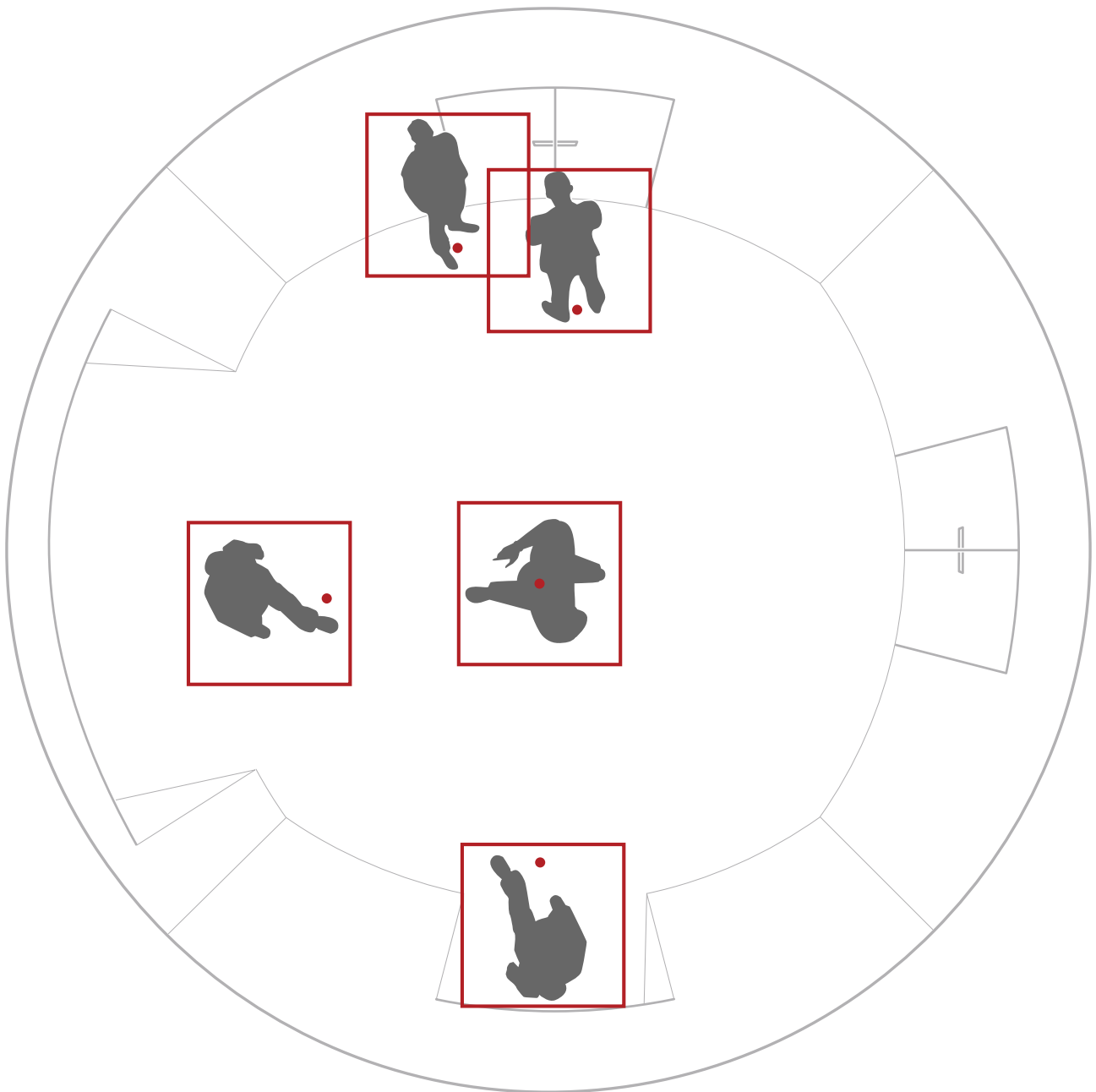


Figure 3.1 A 360° view of moving objects seen from above with a fisheye camera.

### 3.2 Crossline counting vs. occupancy in area

Your specific need determines the type of counting scenario to use. While both solutions provide valuable insights, a key difference between crossline counting and occupancy in area is in their application. Crossline counting is often used for general traffic analysis to count objects crossing a line in a specific direction across various environments, while occupancy in area detects and counts objects, both moving and static, that are visible within a defined area.

### 3.3 Choosing the right camera for your installation

There are several factors you should consider before you choose and install a camera for counting people and vehicles. You can use either angled or top-down mounting when installing your camera. A top-down installation requires a panoramic fisheye camera while an angled installation works with any Axis camera that is compatible with AXIS Object Analytics.

For a list of compatible cameras, see *compatible products*.

Choosing the right installation approach depends on certain factors such as the scene layout, potential obstructions, installation height, and object visibility.

When choosing a mounting angle, consider the scene's complexity. An angled mount provides a clearer view of object characteristics, making detection, tracking, and counting easier. However, in areas prone to frequent object obstructions, a top-down mount is a better choice. Angled views can increase the risk of occlusion, so objects are partially or completely hidden from view, leading to missed detections or inaccurate counts. In contrast, a top-down mount focuses on the head and shoulders for detection, reducing the likelihood of obstruction and improving accuracy.

The most important factor to consider when determining the installation height is the visibility of objects. The objects you want to count should be clearly visible when you have installed your camera at the selected height.

For indoor counting, a fisheye camera with top-down mounting should be mounted at a height of 2–4 m. For angled mounting, the height and angle is more flexible as long as the object of interest remains in clear view. There is no height limitation for angled mounting as the installation height is determined by the selected camera's zoom ability.

## 4 Data visualization and consumption

AXIS Object Analytics is edge-based, meaning that it analyzes and executes the data directly on each camera, requiring no other hardware. Edge-based counting has several advantages besides being cost-effective. At the location, there is less equipment that takes up space, needs to be maintained, and supported. Storing data on the edge also reduces the bandwidth requirements.

You can access counting data from AXIS Object Analytics in these ways:

- **Counting overlays:** When using a counting overlay, the data is embedded into the video stream for visual confirmation. This means that the data cannot be updated and therefore, should only be for short-term use such as proof-of-concept demos.
- **Download:** With this method, you can export counting data through the AXIS Object Analytics application. We recommend it for small setups with few cameras. It is easy to operate and allows you to access data in CSV format which you can then export to Microsoft® Excel for easy management. To read about the application API, see *AXIS Object Analytics API*. It is suitable for advanced integrations when utilizing an API which enhances seamless connection with various Business Intelligence (BI) systems. Also, it requires direct access to the camera.
- **MQTT:** This is a protocol for pushing and integrating data. It is useful for pushing real-time data from the camera to external systems, such as BI platforms.
  - To integrate AXIS Object Analytics counting data, see *AXIS Object Analytics integration guide*.
  - To visualize crossline counting data in AXIS Object Analytics, see *AXIS Object Analytics visualization*.
- **AXIS Data Insights Dashboard:** This works efficiently for data visualization using graphs and charts. You can link the counts from multiple cameras into one and visualize them in AXIS Data Insights Dashboard. With the dashboard, you can get a better overview and visual representation of data from several cameras.

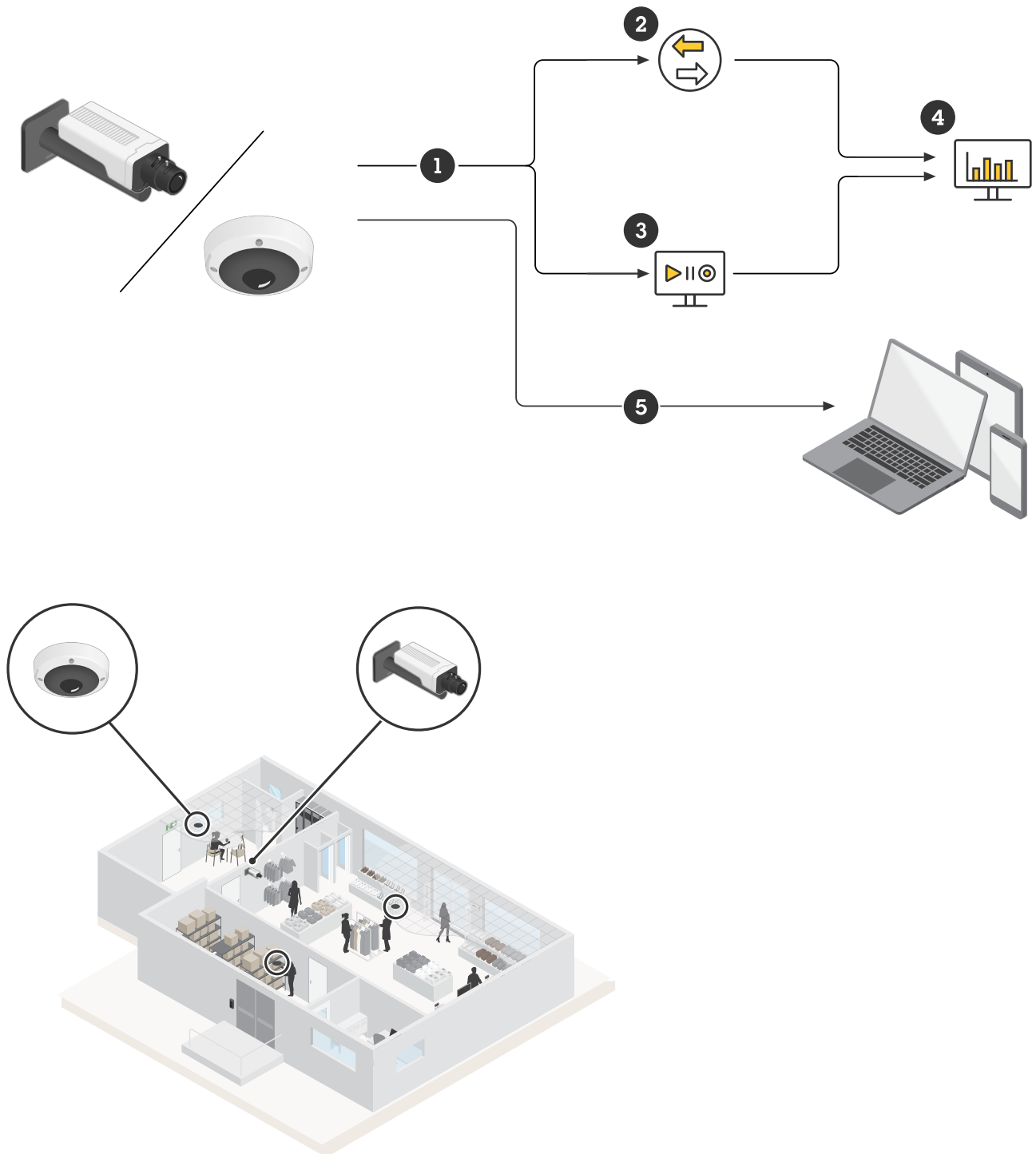


Figure 4.1 Object counting data can be integrated through automatic data push (1) to either an MQTT message broker (2) or AXIS Camera Station (3). The collected data can be visualized using a reporting platform such as AXIS Data Insights Dashboard (4). Alternatively, third-party applications request data directly from the device through a built-in API (5).

## 5 Accuracy

The accuracy of counting analytics is a complex matter that neither can nor should be reduced to a general accuracy percentage. Every installation is different, and the accuracy will depend on an intricate mix of environmental factors, which is not reproducible between sites.

Accuracy can vary depending on these factors:

- Camera placement and angle
- Lighting conditions
- Object visibility
- Scene complexity

Generally, placing the camera where it can see the object as clear as possible is essential for accurate counting result. For best analytics results, see *AXIS Object Analytics user manual*.

## 5.1 About general accuracy statements

At Axis, we don't provide an overall accuracy number. Such a number would be correct only in a laboratory test setup, which would inevitably vary between different installations. In order to be able to state a value, such as 97% accuracy, you would have to make estimations of so many factors that depend on the environment and the installation choices. In order to avoid any misleading accuracy declarations, Axis focuses on offering the expertise of our sales engineers, online tools, and recommendations regarding the installation environment to help our customers provide optimal conditions for reliable counting.

## 5.2 Environmental factors

### Installation considerations for optimal results:

- Virtual line: For accurate results, we recommend placing your virtual line where the camera can clearly see the object both before and after crossing the line. The virtual line doesn't need to be directly under the camera; placing it slightly off-center, while avoiding the outer parts of the field of view (FoV), can provide a better view of objects.
- Occupancy in area: For optimal results, we recommend defining an area of interest to estimate occupancy in where the risk of occlusion is minimized.

## 5.3 Testing the accuracy of your installation

You can test the accuracy by performing manual counting for a period of time, either in person or using live-streamed or recorded video and compare the count with the analytics-counted result for the same period. However, it should be noted that manual counting is far from 100% accurate, especially in crowded scenarios with many people entering and leaving at the same time.

The recommended way of assessing accuracy through manual counting is the following: start by measuring accuracy for people going in only. Make a note of the total count on the counting unit and immediately start counting people manually until reaching 200 people going in. Immediately note the total count on the counting unit and compute the difference which will be  $\#IN - 200$ . The error percentage is given by the formula  $(\#IN - 200)/2$ . Then repeat the same procedure for people going out.

Another method is to compare IN minus OUT for a period. You can apply this in a scenario where the in and out is expected to be a specific time. A simple measure is to compare the total number of people entering and exiting a facility over a day. The deviation between entering (IN) and exiting (OUT) is calculated to get an accuracy value each day of the month. A common formula is given by:  $(IN - OUT)/(IN + OUT) \times 200$  which gives the error percentage. This method is recommended for installations with the same entrance and exit. It may get complicated if there are several entrances to the facility. In that case, counting must be done at all entrances and exits and compared with the total count, and the accuracy of a single specific sensor unit can't be measured.

## 5.4 Installation support

The web manuals provide guidance on how to install AXIS Object Analytics for optimal counting accuracy. The product pages on [axis.com](http://axis.com) also link to other resources, for example:



- AXIS Site Designer: shows installation requirements, plans camera placement, and detection distance. With AXIS Site Designer, you can find the right Axis products that meets your needs and also visualize their coverage.
- Installation and configuration videos.
- *AXIS Object Analytics user manual*.

## About Axis Communications

Axis enables a smarter and safer world by improving security, safety, operational efficiency, and business intelligence. As a network technology company and industry leader, Axis offers video surveillance, access control, intercoms, and audio solutions. These are enhanced by intelligent analytics applications and supported by high-quality training.

Axis has around 5,000 dedicated employees in over 50 countries and collaborates with technology and system integration partners worldwide to deliver customer solutions. Axis was founded in 1984, and the headquarters are in Lund, Sweden.