SICK AG WHITE PAPER

3D SNAPSHOT CAMERA DATA IN INDUSTRY: HOW EDGE COMPUTING CAN ENABLE OPTIMAL DATA PROVISIONING

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Sensor Intelligence.

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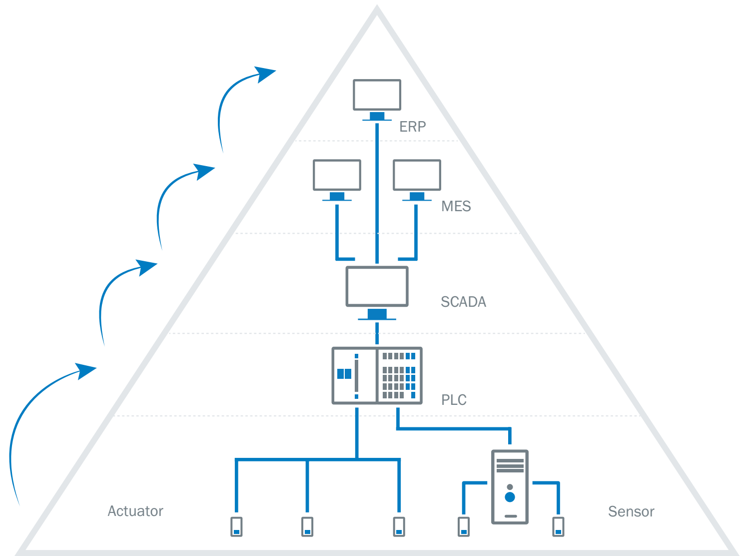
Introduction

SICK AG is one of the world's leading manufacturers of sensors and sensor solutions for industrial applications. Its diverse product portfolio ranges from photoelectric retro-reflective sensors to temperature sensors as well as vision solutions. This enables SICK to interface with the existing expertise within the customer's company in order to offer each customer individually customized sensor solutions to meet their requirements for plant, logistics and process automation across a wide range of sectors. The accelerating digitization process opens up many new opportunities for SICK AG, yet also poses some challenges. In the future, all parties involved at the various levels of a company, such as field operations, Supervisory Control and Data Acquisition (SCADA), Manufacturing Execution Systems (MES) and Enterprise Resource Planning (ERP) will be networked together in order to facilitate communication and data exchange. Yet this shift is accompanied by a growing tendency to blend production and IT networks together. In the digitization process, sensors represent one of the most vital sources of information. One of the main challenges is to rethink and restructure the existing factory automation structures in order to implement new forms of communication. In the classic automation pyramid (Figure 1, above), at the field level, sensors can only communicate with a programmable logic controller (PLC) which in turn communicates with the company software at higher levels of the hierarchy. Although this type of cascading communication is highly structured and straightforward, it is actually too rigid and impractical to meet the requirements of digitization. With these older systems, data relevant to higher levels of the company is often lost.



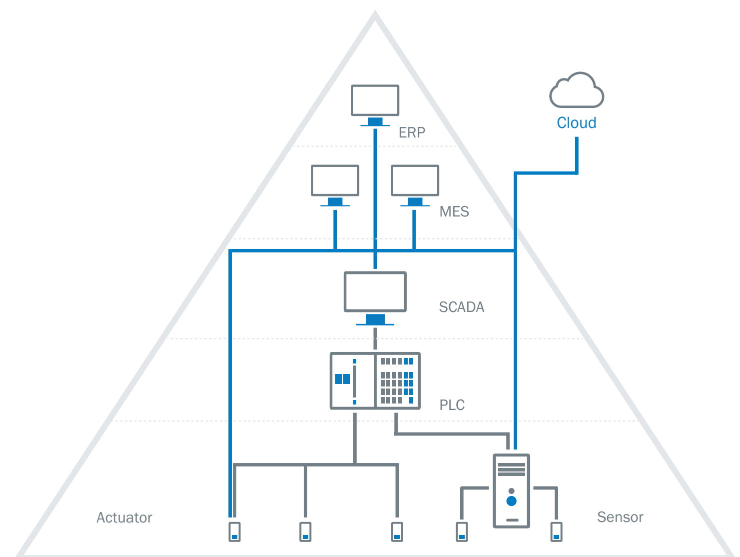


Figure 1: Classic automation pyramid (above) vs. automation pyramid transformed by digitization (below).

Digitization is giving rise to different models that will shape the factory of the future. The classic automation pyramid will change and gradually develop into an intelligent and flexible automation network. This means that the sensor no longer exchanges data with the controls exclusively at the field level, but rather also communicates directly with the superordinate company levels and the Cloud (Figure 1, below).

3D camera data

The data from a vision camera, especially a 3D snapshot vision camera, takes on a special role. Due to their physical properties, some sensors produce low quantities of data that can be supplemented with data such as temperature information. In contrast, streaming cameras, such as Visionary-T or Visionary-B supply large quantities of 3D data that can be used and processed in different ways. Each snapshot provides a comprehensive depth image composed of many thousands of distance, intensity and confidence values, which must be processed. While the quantity of data produced by some sensors is equivalent to just a few kB per second, with 3D camera data, data quantities of 20 MB per second are considered normal (see figure 2).

Figure 2: SICK sensors categorized by data quantity.

Data quantities at this scale pose significant challenges to existing industrial automation infrastructure. Due to their limited computing power, classic controls are incapable of processing the data quantities supplied by such 3D snapshot cameras. Moreover, communication with other systems via the IT infrastructure usually fails in most cases due to the sheer quantity of data. In turn, this means makes it impossible not only to perform the specific field-level application analysis, but also the analysis, preparation and provisioning of the data in connected information systems.

The edge computing approach

The solution to the challenges described above is to rely on data pre-processing on the edge. Edge computing refers to performing data pre-processing at the edge of the newly arising automation network, which makes it possible to provide the data to the systems in the automation network in an appropriately pre-processed form. 3D streaming cameras often require additional hardware to perform data processing as well as to provision the 3D data. On the other hand, product lines such as the Visionary-T make it possible to filter and process relevant data directly within the device itself. The data can therefore be individually tailored and provided to the production network as well as the company's information systems.

For what was formerly known as the field level, the Visionary-T DT makes it possible to perform certain applications completely within the device. On the other hand, the Visionary-T AG enables intelligent data reduction. This is accomplished through individually adapting the required data in advance, as needed. This has the effect of significantly reducing the original quantity of data by a factor of 1000 or more – without loss of any relevant 3D data. The Visionary-T AG currently integrates two options for intelligent data reduction. On the one hand, the 3D data can be represented two-dimensionally by projecting the data into the shape of a line that is presented by just a few points (polar data reduction, Figure 3). On the other hand, data reduction can also be achieved by choosing a specific volume of interest and outputting the data in the form of suitable Cartesian global coordinates (see Figure 4).

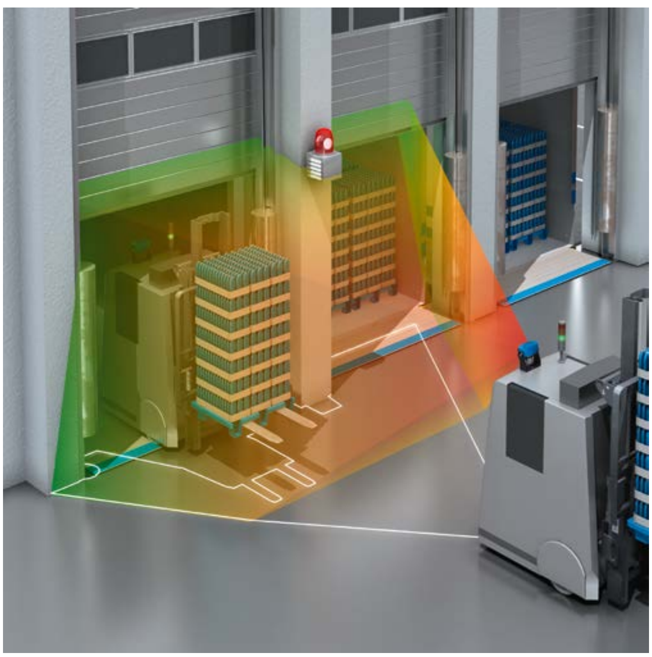


Figure 3: Polar data reduction. Projection of more than 25,000 distance points into just several points (shown in white).

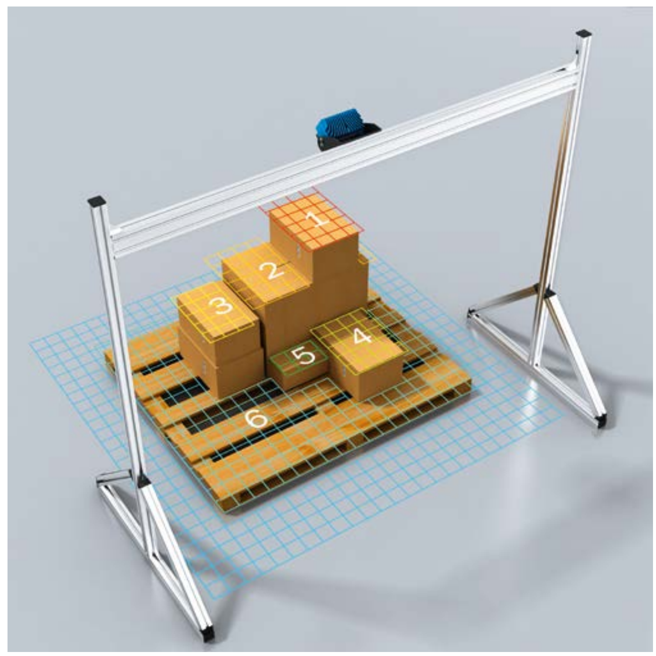


Figure 4: Cartesian data reduction. Selection of the required measurement volume and output of data in Cartesian global coordinates (X-Y-Z) (shown by the colored grid lines).

Such a reduction enables the data to be forwarded without the restrictions caused by the described problems with regard to overloading the PLC or IT infrastructure. This means that applications such as monitoring the position and fill level of a container can be carried out completely within the Visionary-T, without having to rely on a PLC (see figure 5).

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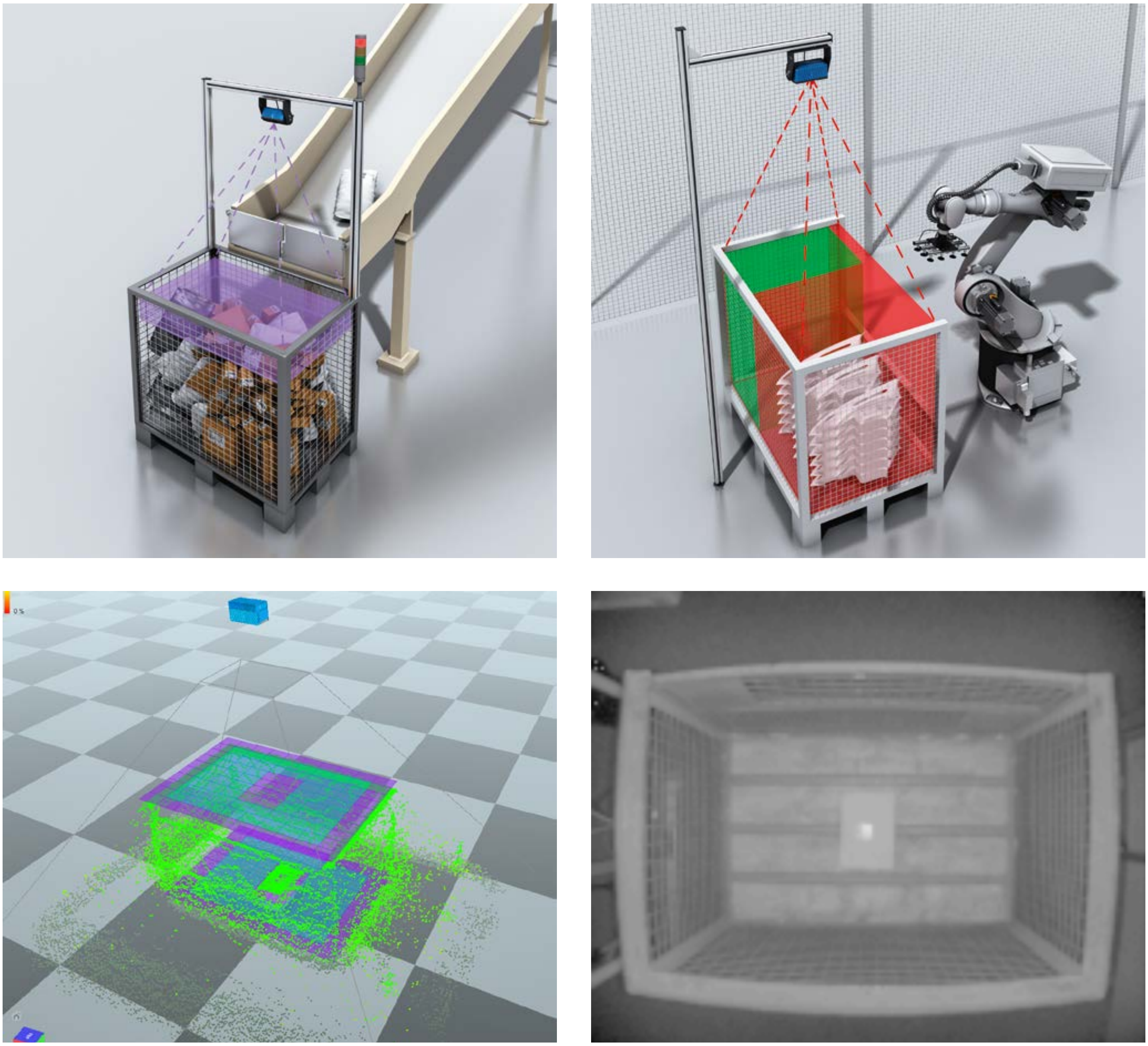


Figure 5: Detection of object configurations and statuses. Monitoring of the fill level and position determination for the robot arm (above). Monitoring of the container position and contents, shown in purple in the illustration, as well as a 2D visualization of the scene (below).

With the pre-processed 3D data, more complex applications, as well as new industrial ones, can be carried out conventionally at the field level by a programmable logic controller. Another attractive option provided by digitization, however, is that the pre-processed and individually tailored data from a 3D snapshot camera makes it possible to communicate directly with IT systems such as the ERP and MES via the existing Ethernet interface. One application at the ERP level, for instance, is that when a container reaches a certain fill level, a new container is automatically ordered. The reduced data quantities also make it possible to provision the data for analysis and processing in the Cloud. In order to delimit areas or obtain finer resolution, the type of data pre-processing can be reconfigured depending on the application. In the future, once the infrastructure has attained the capability of transferring the complete data quantities into the Cloud in order to perform complex image processing or analysis, the Visionary-T will then also be able to provision the complete raw data stream. Currently, at the field level this raw data can be used for complex image processing, such as object detection, by an industrial PC or Sensor Integration Machine (SIM) from SICK AG (see Figure 6).

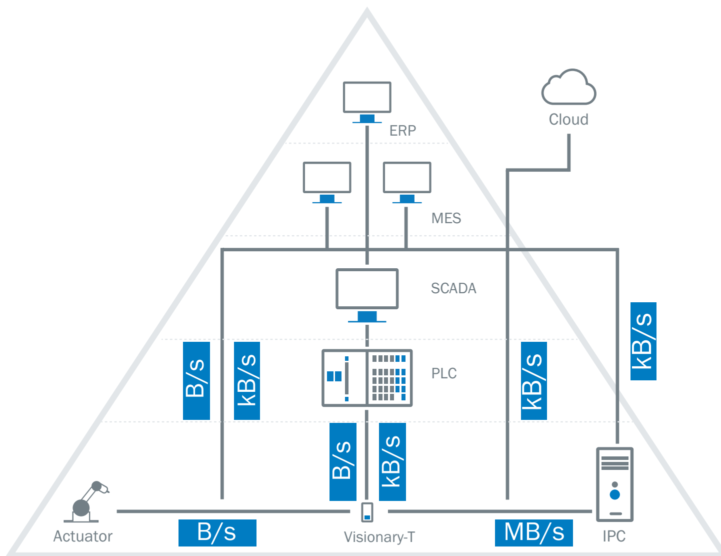
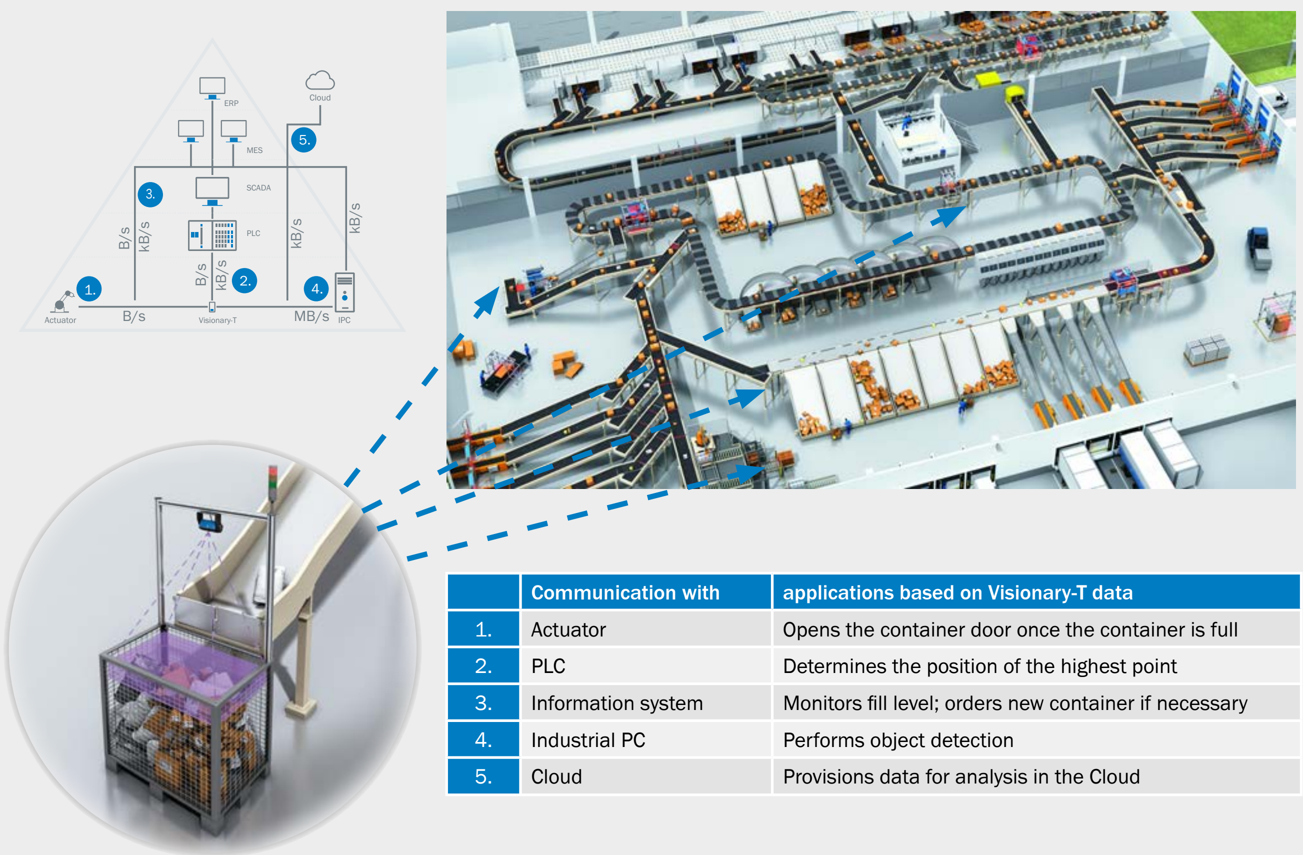


Figure 6: Data provisioning options of the Visionary-T. Depending on digitization requirements, the Visionary-T is capable of supplying data quantities of MB/s or kB/s to B/s.



	Communication with	applications based on Visionary-T data
1.	Actuator	Opens the container door once the container is full
2.	PLC	Determines the position of the highest point
3.	Information system	Monitors fill level; orders new container if necessary
4.	Industrial PC	Performs object detection
5.	Cloud	Provisions data for analysis in the Cloud

Figure 7: Potential application scenarios for the various data from the Visionary-T.

Summary and outlook

The edge computing approach of cameras like the Visionary-T makes it possible to offer customers a product that possess the intelligence needed to provision the data for the various systems and actuators in the proper form, according to the digitization requirements. This intelligent and integrated data processing capability unburdens the IT infrastructure and renders additional hardware resources for data processing superfluous. As such, the Visionary-T is backwards compatible and be used in existing production systems. In cases where a purely edge computing approach reaches its limits, such as with complex image processing tasks, e.g., intelligent object detection, the data can be processed at the field level by an external processor.

Further developments in the future should make it possible to fully vertically integrate the Visionary-T within the framework of digitization, enabling simultaneous, in parallel communication with various systems. Standards and protocols such as OPC UA and MQTT will play a key role in the future. These should enable Industry 4.0 to support standardized communication between the various components and systems in the automation network, through to the Cloud. It's not clear at present, however, which standard will ultimately prevail. In any case, it's important to be prepared for these developments in order to flexibly provision data for numerous systems in parallel. The Visionary-T itself could perform such communication itself; or a suitable product from the SIM portfolio. For production control, the combination of the OPC UA Publish/Subscribe specification with Ethernet TSN shows potential. Thanks to data pre-processing in the device, Visionary-T data can also be used in alternative control concepts.

Going forward, the SICK portfolio will continue to pursue its Industry 4.0 orientation with the development of a SICK-AppSpace-capable device, Visionary-T AP. This enables SICK AG to offer an even more individually tailored product to each customer – supported by Cloud services from SICK AG.

www.sick.com/Visionary-T