Figure 2: PdG-L3 Plattforms. [3]

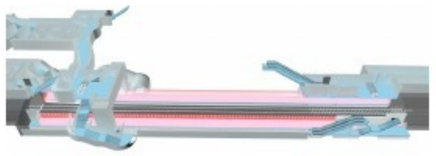

Figure 3: PdG-L3 Schematic [3]

(a) Camera in a PdG transit area. [3]

(b) Camera in PdG-L3 platform. [3]

Figure 4: Installed cameras

The PdG-L3 platforms are depicted on Figure 2.

A schematic representation of PdG-L3 is drawn in Figure 3, where the platforms are highlighted in red. At the beginning and end of the platforms, the accesses to the platforms are visible.

CCTV System
Throughout the station a Closed Circuit Television (CCTV) surveillance system is installed. 20 CCTV cameras on different locations provide images for security reasons. Figure 4 show exemplary CCTV cameras on the platform (Figure 4(a)) as well as in the transit area (Figure 4(a)).

The CCTV System provides the basis for the predictive passenger model. In the following the data extraction is explained.

Count of persons extraction

The SEAM4US system utilizes prediction model for proactively controlling the subsystems. Besides others, the passenger model is a part of the predictive controlling architecture. To predict count of persons for a point in future, the model utilizes the output from the CCTV monitoring. The count of persons is extracted by enhancing the CCTV-system with image processing.

Whenever camera pictures are processed privacy issues are tackled. In order to ensure the passengers privacy several design constraints where defined:

1. All CCTV images are processed within the station.
2. All CCTV images are processed "on the fly". For the purpose of count of persons extraction, no CCTV image is saved.
3. The image processing is performed on a separate computer, which is not connected to other TMB Systems and is only accessible via a dedicated VPN connection.
4. The image processing works without human interaction.
5. The image data are filtered to avoid recognisability of individuals.
6. The image processing results are transmitting only in terms of integer numbers to the database.

With respect to these design constraints, the count of persons extraction was implemented. The workflow is described briefly in the following.

First, the video streams coming from all cameras are combined into one single video stream by a video recorder. The video recorder creates a carousel video composed of intervals for the individual camera, appearing in a predefined order. The duration of the camera intervals is set to 3 seconds. With 20 cameras and 3 seconds hold on each, one turn of the carousel is completed in one minute.

The video recorder is connected to a local computer and transfer the images subsequently. On the local computer, a extraction algorithm processes the transferred images and extracts the count of persons. The extraction algorithm uses a combination of edge detection and background subtraction. In the following, the algorithm is described briefly. First the algorithm separates background and foreground. Followed by creating the foreground mask. Through filtering the edges of the foreground only are extracted. The foreground edges are combined with the foreground mask. Finally, the result is refined by dilating (and then eroding) the segmented the blobs. For different reasons, e.g. occluded or damaged camera, the