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Intelligent reversible bus lane in Gävle

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Abstrakt

The Swedish City of Gävle was hardly able to cope in recent years with the numbers of visitors to events and sports matches in the city. A consortium including Technolution was commissioned to develop an intelligent reversible bus lane. This lane is now finished – and it involves Dutch technology, such as DVM-Exchange and MobiMaestro.

Background

With 70,000 inhabitants, Gävle is a relatively small municipality. But this city, situated 200 kilometers north of Stockholm, does fulfill an important role in the region as the host of all kinds of events: it is home to an ice hockey stadium, a football stadium, a racecourse and a large events hall.

At peak moments it was a real challenge for the city of Gävle to ensure the smooth flow of traffic to and from the events area. The access road to the area is a normal, undivided two-lane road. There is a system in place with changeable message signs to adapt the use of the road to 'arriving traffic' or 'departing traffic', with a dedicated bus lane in one direction. But the lack of a second bus lane and the clearing of large numbers of vehicles often led to delays and congestion. Gävle therefore looked for a new solution that would facilitate at least bus traffic in *both* directions.

The invitation to tender

The layout of the existing infrastructure left no space to add another bus lane. To be able to adapt flexibly to departing *and* arriving buses, Gävle issued an invitation to tender for a solution with a *dynamic* reversible bus lane that can be used in both directions. The normal situation would be for the reversible lane to accommodate buses that are departing the event area. However, to allow (returning) buses to reach the area, the direction of travel on the bus lane would have to be reversible – see figure 1. Reversal should of course be safe: under no circumstances must buses on the lane travel in opposite directions at the same time. Gävle also

wanted a fully automated solution, but with the option of manual operation of the reversible lane in case of any unexpected situations.

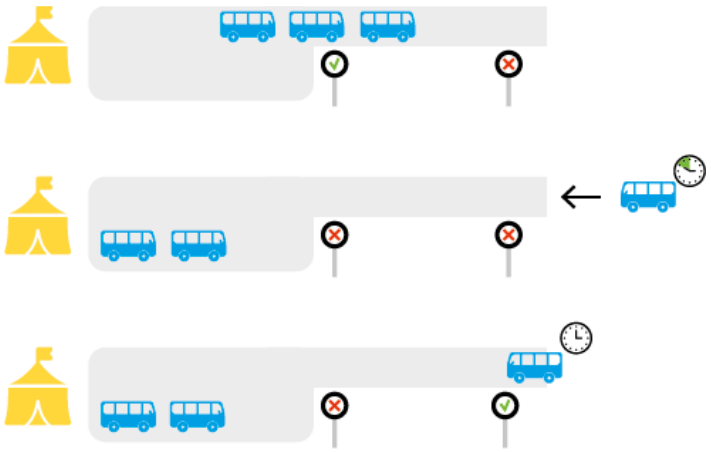

Figure 1. The intended situation of the automatic reversible bus lane in Gävle

On the basis of Gävle's invitation to tender, in the summer of 2019 Technolution proposed a system that would operate the dynamic reversible bus lane safely and entirely automatically. Technolution used existing technology for this, including aspects of Dutch innovation that provide both *central* and *local* intelligence. The reversible bus lane solution that was offered and accepted, and that has now also been implemented, consists of the following components:

- **Sensors.** Radar detectors carefully monitor occupancy of the bus lane. This means that the system 'knows' when the lane is free and it is safe to reverse the direction of travel.
- **Variable Message Signs (VMSs).** Technolution uses VMSs to provide accurate information to buses and other road users. They are placed at crucial locations and indicate the current use of the lane, including (if applicable) a no-entry sign.
- **PLCnext.** Local intelligence was realized using a Phoenix-supplied PLCnext system: Technolution implemented the operating application for the bus lane on this system. The PLC is connected locally to sensors and VMSs. The system is also connected to central control (remote) – see below.
- **Network server.** A special network server automatically maps the GPS locations of the buses on the underlying map. On the basis of this information, the server calculates an estimate of their arrival at the bus lane.
- **MobiMaestro.** This traffic management system by Technolution manages the central control of the system. The network server feeds bus arrival times to the system, which determines on the basis of this information when the reversible bus lane must be opened for traffic in the direction of the event. MobiMaestro then sends a request to the PLCnext, which handles the request locally: it checks whether the lane is actually free of traffic (using the radar sensors) and operates the VMSs to implement the bus lane reversal request. MobiMaestro also handles communication with the traffic control centers through a graphic user interface.

The bus lane system also uses the Dutch DVM-Exchange protocol for the communication between MobiMaestro and PLCnext. Because PLCnext has an extensive set of software functions

and supports programming languages such as Java, it was possible to roll out the entire DVM-Exchange library on the system.

In the Netherlands this protocol has become customary: this open protocol has been in use here for about 10 years for the exchange of traffic engineering requests and information between network management systems. As far as we know, the Gävle project is the first instance of DVM-Exchange being used abroad.

System modes

The system delivered has two modes: a central and a local one. A physical key switch on the local user interface on the road determines which mode is in operation. This means that if, for instance, the internet connection is down, this switch gives users a fallback option: it can be switched to local operation.

In the central mode, the system uses the prediction module in the network server to determine when returning buses will be arriving at the start of the lane. By forwarding this information as soon as possible, there is sufficient time to clear the road so that arriving buses can immediately access the lane. After a bus has cleared the lane, the bus lane automatically reverts back to facilitate buses that are departing the events area. The operation of this central mode is performed by MobiMaestro: that is where all data comes together, where automatic strategies implement operation, and where the operator can monitor events through the interface.

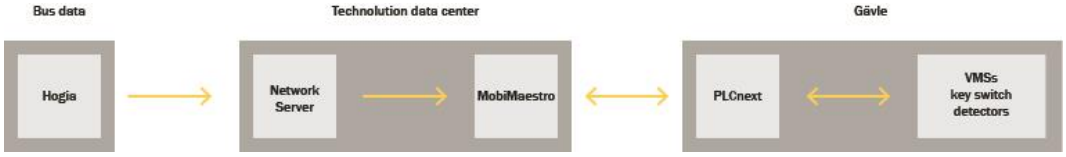

Figure 2. Central mode

In local mode, the entire system operates with no external connection. A returning bus is detected by a bus detector (radar), the bus lane is cleared, and the bus can proceed onto the lane. Of course the drawback is that returning buses cannot access the lane immediately but must wait until the bus lane is clear. This mode is therefore explicitly provided as a fallback option.

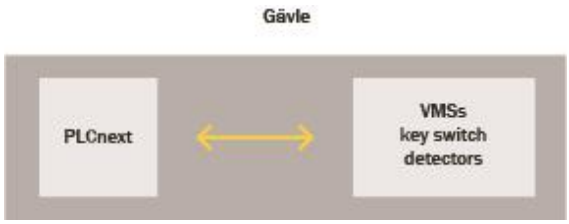

Figure 3. Local mode, used in Gävle as a fallback option

The flow of the system as described above is the so-called 'happy flow': the way the system should work. In case the system detects a problem, such as the malfunctioning of a sensor, it can fall back on regimes through strategies: the 'non-happy flows'. Per strategy, a check will be carried out to verify that the bus lane can operate safely. If the outcome is negative, the bus lane is closed and the current traffic situation is restored.

Obviously the operator will also be notified of the status of the bus lane. The purpose is to guarantee the safety of the reversible bus lane at all times, and it can therefore be regarded as a safety-critical system.

Cooperation with (local) partners

Technolution did not realize this bus lane solution for Gävle by itself. The physical installation was carried out together with the Swedish company Saferoad. This company has expertise in installations and knowledge of local legislation, and is also a supplier of on-street equipment, such as the necessary VMSs, radar detectors and other devices.

This allowed Technolution to concentrate on the integration and operation of the various sensors and actuators. In addition, Technolution developed the module to operate the reversible bus lane in the PLCnext as well as in MobiMaestro. Together with Gävle, Technolution developed strategies for the arrival and departure flows for events. And the custom work involved in the graceful degradation approach that was used was done in conjunction with Gävle's traffic engineers.

Finally, Technolution integrated DVM-Exchange with the PLCnext so that this can be deployed in a standardized manner.

Practice

Several tests on location allowed Technolution to demonstrate that the system was suitable for operation in Gävle. The municipal authorities are currently dealing with the last organizational challenges to make the reversible bus lane ready for regulating bus traffic during upcoming events. The City of Gävle expects to have to use the bus lane several times a week to facilitate visitors and athletes.