



# Hamburger Hochbahn AG

V2X optimises traffic light preemption at HOCHBAHN



Vehicle-to-Everything technology (V2X) is heralding a new era for traffic light preemption in urban public transport: V2X boosts efficiency, reduces energy consumption and enhances passenger comfort. It facilitates direct, intelligent, real-time, bidirectional communication between vehicles and the infrastructure. Hamburger Hochbahn has recognised the innovation potential of V2X and is one of the first major transport operators in Germany to implement a pilot project for introducing V2X – as part of the ITS CUBE funded project.

## Initial situation and motivation

Up to now, classic traffic light preemption in urban public transport was based on radio messages sent by analogue or digital radio, using fixed reporting points pursuant to VDV Recommendation 420/426. This system was complicated to set up and inflexible in case of route path changes. Nor did it offer drivers any feedback about successful prioritisation.

Moreover, the basic analogue radio frequencies in Germany will be restructured by 2028 at the latest, so that long-term use won't be possible without further investment. Radio devices (transmitters in the vehicles, receivers at the junctions) will have to be reprogrammed or even replaced. The system also had operational drawbacks, such as premature door closures or unnecessary energy losses from frequent starting and stopping due to the lack of feedback about the traffic light phases.

Given the possible advantages offered by V2X, Hamburger Hochbahn decided early on to test this technology in cooperation with ebblo and LBSG (Hamburg state authority for roads, bridges and waterways) with the intention of changing over to V2X technology.



(Image: HOCHBAHN)

## What is V2X?

V2X (vehicle-to-everything) is a digital communication technology where vehicles communicate directly with traffic lights, traffic infrastructure and other vehicles. It facilitates real-time information about prioritisations, traffic light phases and the traffic situation, thus replacing analogue systems with fixed reporting points. In urban public transport, V2X provides greater efficiency, flexibility and energy savings, as well as enhancing passenger comfort.

### Intelligent control with V2X: how it works

#### 1. Communication with the traffic lights (SRM/SSM):

The vehicle automatically recognises the junction layout and sends a digital request for prioritisation. The traffic lights answer whether the request was successful – with flexible adjustment if needed, e. g. for a delay or diversion.

#### 2. Traffic light assistant (GLOSA):

The vehicle is also informed about the current traffic light phase and when it will change. This lets the driver adjust speed accordingly, such as carrying on across the junction when the light is green, or not leaving passengers at stops too early.

#### 3. Temporary solution for existing systems:

Older traffic lights can also be connected. They are still triggered using the tried-and-tested reporting point method as with analogue radio, but communication is already digital. This allows for a gradual changeover without interrupting ongoing operations.

## Solution: V2X in theory and practice

V2X facilitates cooperative communication between vehicles and infrastructure elements such as traffic lights. Standardised V2X messages are used for data transfer, each fulfilling different functions:

- **SRM (Signal Request Message):**  
The vehicle makes a digital prioritisation request.
- **SSM (Signal Status Message):**  
Feedback whether the request was accepted or rejected.
- **SPAT (Signal Phase and Timing):**  
Real-time information about current and pending traffic light phases.
- **MAP (Map Message):**  
Detailed description of the junction layout.

The system uses modern in-vehicle technology (on-board unit, Navigation Assistant) and V2X-capable infrastructure elements (RSU at junctions).



Image: ebblo / V2X operating live during the Technical Visit at the UITP Summit 2025

“Bidirectional communication with V2X improves traffic light preemption compared to the existing system. And data provision with V2X allows an energy-optimised approach to junctions, time-optimised departure from stops and prioritisation, also for changed routes. These advantages result in more efficient and flexible operations, and more satisfied passengers.”

Alex Zimmermann,  
Planning Engineer | System Concepts &  
Data Analytics, Hamburger Hochbahn

ebblo also offers a **temporary solution** for existing systems: after being transmitted in the usual way (analogue/digital radio), the R09.16 message is also embedded in a CAM message (or in an SREM or SRM). This facilitates uninterrupted transition without having to adapt all junction controllers straight away.

### Central functions in pilot operation

- **Traffic Signal Priority (TSP):** Dynamic prioritisation of buses at junctions, also for diversions or dispatches
- **Traffic light assistant (GLOSA):** Displays the remaining time to the phase change for optimum use of the green phase
- **Energy-optimised approach and time-optimised departure:** Helpful recommendations for the driver based on phase information

### Technical framework:

- MQTT-based interface between the V2X on-board unit (OBU) and the ebblo on-board computer IDR-f2
- Real-time data about traffic light phases and junction layouts on V2X
- Information visualised on the driver terminal

### Pilot phase in Hamburg: Implementation and live presentation

The project was officially launched in February 2025, with the aim of fully integrating the V2X interface in the existing system landscape of Hamburger Hochbahn, including a presentation during the **UITP Summit in June 2025**.

Attendees at the summit were able to experience the advantages of V2X for themselves during the “Technical Visit” entitled “**Transition to C-ITS Prioritisation in Public Transport**”.

### A system with noticeable added value – advantages for transport operators

Introducing V2X brings concrete, measurable advantages on several levels – for operations and passengers, and also for the transport operator in its strategic further development:

## CASE STUDY

### The company Hamburger Hochbahn AG

Hamburger Hochbahn AG is the largest transport operator in Hamburg. The company has more than 6,900 employees and carries around 551 million passengers in subways and buses. The traffic network encompasses four subway routes covering 105.8 kilometres and 119 bus routes covering around 1,000 kilometres. Hamburger Hochbahn AG invests large amounts in expanding its infrastructure and vehicle fleet.



#### Operational flexibility and optimisation:

- Buses are prioritised at traffic lights also for spontaneous diversions or short turns.
- Real-time feedback about traffic light preemption gives the driver greater confidence to proceed.
- Reduced communication effort thanks to standardised MQTT PTX interface between OBU and on-board computer.
- Seamless integration in existing AVLC systems such as LIO by ebblo.

#### Saving energy and costs:

- Experience at Dresdner Verkehrsbetriebe shows that energy savings of up to 30 % are possible with GLOSA.
- Less braking and accelerating reduces wear-and-tear.

#### Enhanced passenger comfort:

- Longer active door release periods make it easier to board the vehicles, particularly at stops before junctions.
- Starting just-in-time to the green phase allows more punctual departures.
- Fewer travel time interruptions result in smoother journey flows.

#### Fit for the future with investment protection:

- The system is based on standardised V2X components and is open for future function upgrades.
- Authenticated communication for high IT security – manipulation protection.
- Open interfaces make it possible to use various vendor solutions.

### Conclusion and outlook

Hamburger Hochbahn's successful V2X pilot project illustrates the contribution that modern technology makes to enhancing efficiency and sustainability in urban public transport. The advantages are verifiable, the integration has been tried and tested in practice. Transport operators in Germany and in German-speaking countries now have the opportunity to change over to this technological standard, with a reliable partner, open interface and concrete experiential knowledge.

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