FIXALIA UNVEILS THE INTELLIGENT SIGNALING AND CONTROL NODE (*NISC*): A STEP FORWARD IN TRANSFORMING ROAD SAFETY ON SECONDARY ROADS

FIXALIA introduces the **Intelligent Signaling and Control Node (NISC)**, an innovative and fully autonomous system designed to enhance road safety, especially on secondary roads. At its core is a **Variable Message Sign (VMS) equipped with cutting-edge 5G-VX technology**. This VMS serves as a modular hub that integrates various devices capable of collecting real-time environmental and traffic data. In addition to the VMS, the system can incorporate elements such as a weather station, video analytics camera, visibility sensor, air quality monitor, pavement sensor, among others.

Powered by solar energy and equipped with 5G connectivity, the NISC communicates in real time using standard protocols, enabling the remote management of a distributed network of nodes across different road segments. Its self-sufficient design, low cost, and advanced connectivity make it an ideal solution for dynamic signage in rural areas that lack traditional power and communication infrastructure.

WHY IS THIS NEEDED?

Road safety remains a critical issue on local and rural roads, where infrastructure and resources are often scarce. Global statistics reveal that these areas account for a disproportionately high number of traffic accidents, often caused by poor weather conditions, reduced visibility, and the lack of dynamic signaling systems.

In Spain alone, the majority of road fatalities occur on conventional roads. In 2022, there were 1,145 road deaths, with 849 (74%) on secondary roads and 296 (26%) on high-capacity roads. In 2023, the trend remained consistent, with 1,140 fatalities, of which 850 (74.5%) occurred on secondary roads and 290 (25.5%) on highways and motorways. Despite handling higher traffic volumes, motorways are significantly safer, while secondary roads continue to account for nearly 75% of annual road deaths [1].

Several European countries have successfully reduced fatalities on secondary roads through the deployment of ITS solutions. In Sweden, under the "Vision Zero" initiative, ITS measures such as speed cameras, traffic control systems, and safety barriers have led to a 50% reduction in fatalities on secondary roads [2]. In the UK, rural roads in Scotland have seen a 30% drop in deaths and serious injuries thanks to ITS-based speed enforcement and real-time warning systems [3]. The Netherlands

has achieved a 40% reduction in road fatalities in high-risk rural areas through real-time traffic monitoring, adaptive speed control, and dynamic signage [4].

These cases demonstrate the effectiveness of ITS in enhancing road safety on secondary roads. Against this backdrop, the NISC emerges as a smart, autonomous, and modular solution designed to bring technological innovation to where it's needed most.

WHAT IS IT?

In 2010, the Spanish company Alba Electrónica pioneered a low-power VMS-based system integrated with multiple sensors. This early version collected real-time environmental data and responded with immediate signaling using a decision tree programmed into the sign itself. It also allowed for remote management, providing significant operational flexibility [5].

Building on this innovation, Fixalia has reimagined and updated the concept to meet modern urban and interurban needs. The result is the Intelligent Signaling and Control Node (NISC), a modular and versatile system that transforms the traditional VMS from a passive information display into an active traffic management component.

Figure 1: General Diagram of NISC with a VMS

Thanks to advancements in connectivity and data processing—especially with the introduction of 5G-VX—modern VMS devices now offer a range of powerful capabilities:

- **The NISC is a fully autonomous system that communicates wirelessly and is powered by solar energy.**

- **Enhanced Processing Power**: Next-generation VMS units are equipped with advanced processing capabilities, enabling them to handle large volumes of real-time data and execute complex algorithms efficiently. This allows for dynamic, data-driven signage and the integration of new functions.
- **Remote Communication**: Real-time connectivity with control centers via Internet, VPN, or other advanced technologies enables centralized management and rapid response to unexpected events such as accidents, congestion, or adverse weather. It also allows for seamless updates and system maintenance.
- **Peripheral Device Integration**: The VMS can now serve as a sophisticated data collection node by integrating sensors, cameras, and other smart devices. These components gather information on traffic flow, lane occupancy, pavement condition, weather, air quality, and more—enabling better decision-making.
- **Strategic Deployment**: Positioned at critical points such as junctions, high-risk zones, or traffic hotspots, VMS units become key surveillance and control assets, offering a comprehensive real-time overview of road conditions.
- **Adaptability to Changing Conditions**: Perhaps the VMS's most valuable feature is its ability to dynamically adjust its messaging based on real-time traffic density, incidents, roadworks, or weather conditions. This boosts both traffic flow and safety.

Figure 2: Example of NISC with a Mobile VMS

In short, the VMS evolves into a central hub for road, traffic, and environmental data, playing a pivotal role in mobility management. In the near future, such systems could autonomously or semi-autonomously manage responses to collected data—always under the supervision of traffic control centers—offering more efficient and adaptive road signaling. By doing so, the VMS becomes not just an information tool, but an active node in the intelligent transport ecosystem, contributing directly to road safety and traffic optimization.

This innovative and modular approach not only enhances the functionality of the VMS but also marks the beginning of a new era in which road signaling systems can be more effectively integrated with smart infrastructure, thereby improving the user experience and the operational efficiency of the transportation system.

NISC FUNCTIONALITIES AND APPLICATIONS

Building on the capabilities of next-generation Variable Message Signs (VMS) previously described, the The **Intelligent Signaling and Control Node (NISC)** introduces a new layer of intelligent, adaptive, and efficient control. Below are the core functionalities and applications this system enables

Real-Time Event Management

The NISC integrates advanced **sensors and processing algorithms** capable of instantly detecting critical events. These include accidents, adverse weather conditions such as fog or ice, wrong-way driving, and localized traffic congestion. The collected data is analyzed in real time, allowing the system to automatically trigger immediate response protocols—such as displaying warning messages on VMS panels or sending alerts to the traffic control center. This rapid response capability significantly reduces risks and enhances driver safety.

Figure 3. Autonomous VMS with embedded LPR camera (La Gomera, Canary Islands, Spain)

Dynamic Signage Adaptation

The NISC dynamically **adjusts the messages displayed on VMS** units based on current traffic and environmental conditions. For example, it can reduce speed limits in high-density traffic areas, recommend alternative routes in the case of congestion, or communicate temporary closures due to roadwork or emergencies. This adaptive approach ensures that drivers receive timely, relevant, and accurate information—promoting safer and more efficient driving behavior

Reduced Operational Costs

One of the most significant advantages of the NISC is its potential to substantially **lower implementation and maintenance costs**. By eliminating the need for complex civil works—such as extensive trenching or the installation of additional physical infrastructure—and enabling full remote management, the NISC minimizes both upfront investment and ongoing operational expenses. This cost-effective solution is especially appealing to local and regional administrations and traffic management authorities looking to modernize infrastructure with minimal budgetary impact

Data Capture and Analysis

Beyond being a signaling manager, **the NISC serves as a central data collection node**. It consolidates inputs from a wide range of connected sensors and devices—such as cameras, weather stations, and environmental detectors—to analyze patterns in traffic flow, meteorological conditions, air quality, and driver behavior. This data can be processed and used to improve infrastructure planning, identify high-risk accident zones, and support the development of safer, more efficient mobility policies.

In summary, the NISC represents a significant step forward in smart mobility management. By combining the advanced capabilities of modern VMS technology with real-time processing and response, this system not only enhances road safety and the driving experience, but also offers a sustainable, scalable, and cost-efficient solution for the mobility challenges of tomorrow.

REFERENCES

[1] Dirección General de Tráfico. (2023). 1.145 personas fallecieron en siniestros de tráfico en carretera durante 2023. Recuperado de https://www.dgt.es/comunicacion/notas-de-prensa/1.145-personas-fallecieron-en-siniestros-de-trafico-en-carretera-durante-2023.

[2] Dirección General de Tráfico. (2024). Visión Cero y sistemas ITS en carreteras secundarias. Revista DGT. Recuperado de https://revista.dgt.es/es/reportajes/2024/06JUNIO/0620-N270-siniestralidad-carreteras-secundarias.shtml.

[3] Government of the United Kingdom. (2023). Sistema de control de velocidad en carreteras rurales de Escocia. Recuperado de https://www.gov.uk/government/news.

[4] European Commission. (2023). Mejoras en la infraestructura vial y monitoreo ITS en carreteras secundarias en los Países Bajos. Recuperado de https://ec.europa.eu/transport/themes/road-safety.

[5] Fernández Alonso, F. C., Belda Esplugues, E., Herranz Torres, J. C., Hoyo González, G., & Bernaldo González, J. (2009). *Paneles de mensaje variable de bajo consumo, para tráfico*. *Carreteras: Revista técnica de la Asociación Española de la Carretera*, (167), 31-43.