Best Practice: Intelligent Traffic Management and Control System

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CITY: TEL AVIV-YAFO **POLICY AREA: TRANSPORTATION**

BEST PRACTICE

AVIVIM is Tel Aviv-Yafo's Intelligent Traffic Management and Control system that aims to alleviate adverse traffic conditions while ensuring mobility and accessibility. The systems' sophisticated reporting and analysis capabilities provide necessary information to generate timing programs to optimize traffic flow.

ISSUE

Road infrastructure in most metropolitan and urban areas cannot keep up with the increased demand for road use. Since expansion of the road infrastructure network is limited, it is necessary to develop methods and technologies to make existing road infrastructure more efficient, allowing for smooth running traffic and road safety.

Tel Aviv-Yafo had an outdated and expensive traffic control system which made it difficult to integrate new technologies. Tel Aviv Municipality required a system that was flexible enough to accommodate disparate hardware platforms as well as provide the opportunity for future growth and innovation.

GOALS AND OBJECTIVES

The main goal of this initiative is to promote urban mobility. Emphasis was placed increasing the efficiency of existing transport infrastructures to minimize the adverse effects of traffic.

Traffic management and control systems should reflect the unique characteristics of the urban transportation network, the acquired local knowledge in handling traffic events and the organizational structure of the municipality in which they are implemented. AVIVIM was developed within this framework. Its objectives are:

Develop a new and innovative traffic management system – To meet present and future traffic needs, this system incorporates evolving traffic management methodologies and technological advancements, as well as local knowledge and requirements.
Versatility – A traffic system able to promote sustainable development, prioritize public transport and pedestrian movement.
Independence of the equipment suppliers – Many existing traffic management and control systems meet their entire technical capabilities only when the hardware components are of a specific brand. This makes equipment upgrading and adjustments expensive. The AVIVIM system enabled the updating of a proprietary traffic control system within an open architecture. All the main components of the new traffic-management and control system were developed using standard software tools, mainly application generators. These tools have proven to be efficient in a dynamic software-development environment.
Expand system capabilities – The methodology provides the system with flexibility to exploit technological developments that evolve over time. Such developments are reflected both in the increased functionality of existing devices (such as signal controllers) and in the emergence of new devices that can be utilized for traffic management. CitectSCADA software is a suitable tool for assimilating new control devices and improving system performance.
Real time response –The AVIVIM system includes algorithms for identification of non-recurrent congestion and gives the operators tools, such as recommendations regarding appropriate signal programs, to relieve congestion.
Reduce delay times – Incorporating programs for optimal allocation of the green light between different movements in the intersection and for an efficient green wave to enable continuous flow of traffic and a reduction of delay times.
Assist traffic management decision making process – Extracting meaningful traffic related information based on the processing and analysis of historical data.

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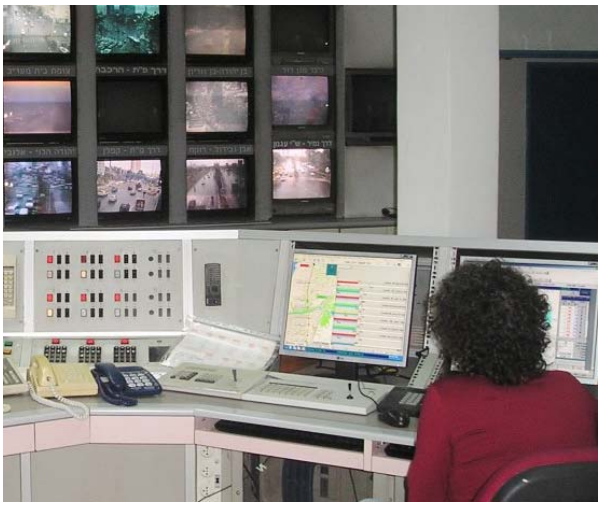
Improve the signal program library – Improved traffic programs are derived from the analyses of the traffic flow in relation to the timing program in use. This generates an ever-expanding signal program library.
Improve maintenance and reduce maintenance costs - Continuous and ongoing troubleshooting is built into the AVIVIM system. Software faults and faults of the electronic components are automatically identified by the system even before notification is received from the field. Messages pop-up on the operators' screen that include the type of fault and the time the event started.
Quality control of the execution of traffic light programs – The AVIVIM system is a closed feedback system where information is received in the central system in real time regarding the actual execution of the traffic light program. The information is used to identify deviations between the plan and the execution while the system carries out corrections accordingly.

IMPLEMENTATION



Tel Aviv traffic management & control center

Main video display: Multiple Formats

Brief description of the system:
The AVIVIM system's sophisticated reporting and analysis capabilities provides engineers with the necessary information to generate timing programs to optimize traffic flow according to the day of the week and the time of day. When the signal-planning process is complete, AVIVIM provides the necessary interface to input the planning data, store it in the program-library database and instantly download the planning parameters to every intersection's controller. The system contains a rule-based logic that makes it possible to adjust to traffic patterns in real time by selecting the most appropriate signal-program. The hybrid approach implemented within AVIVIM for signal-program selection integrates an automated process with a manual tool for defining intersection-specific criteria.

The central server, which is the real-time data repository and control center of the system, contains application logic for alert and event management, as well as traffic response control algorithms that allow the system to adjust to new traffic conditions. At regular intervals, the communications' servers send activity-logging information to update the central server, from which operators extract information relating to system events and traffic patterns. Alerts and other critical messages are also relayed as needed. Controllers can operate independently, and with complete functionality, even if disconnected for a time from the central server.

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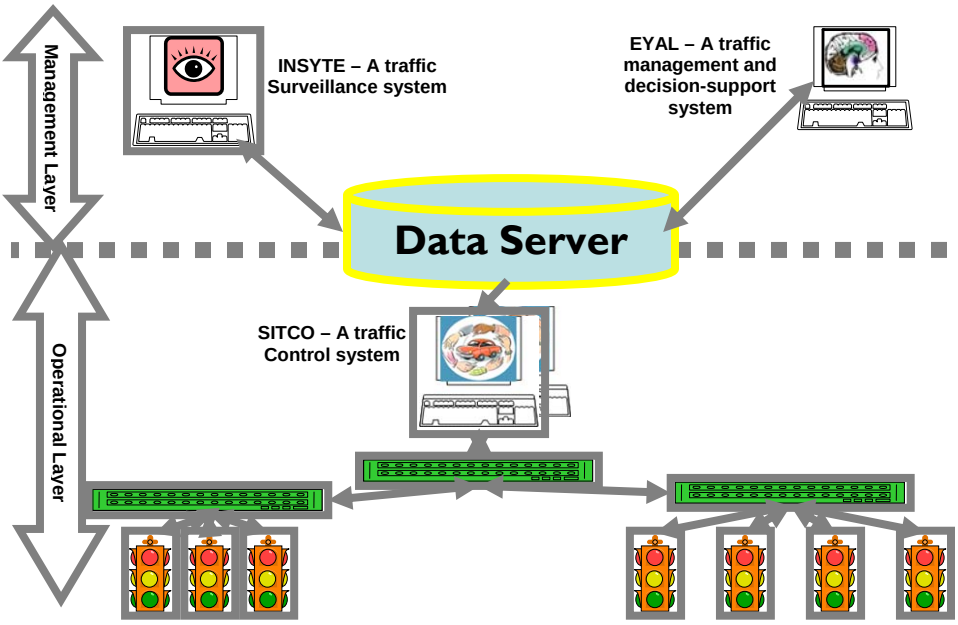
AVIVIM Architecture
The AVIVIM architecture reflects two layers of the traffic management and control process: the management layer and the operational layer. Segregation between the two layers is crucial for enabling the independence of the logic on which the traffic-management decision-making process is based.

The management layer consists of two systems – EYAL (Named in memory of Eyal Harrary) and Intelligent System for Traffic Evaluation (INSYTE). The operational layer is composed of a communication network and the central control application, System for Intelligent Traffic Control and Operation (SITCO).



Management layer:
EYAL is a decision-support system for traffic management. In operation since 1995, this system was originally developed to serve as a management layer for Tel Aviv's previous traffic control system. Only minor adjustments were required to integrate it into the AVIVIM system. INSYTE is a traffic-monitoring and analysis tool. INSYTE serves as the "eyes" and "ears" of AVIVIM. The information provided by this system is used as a baseline for the decision-making tasks carried out by all users involved in the traffic-management process.

Operational layer:
SITCO (System for Intelligent Traffic Control and Operation) is the central control application. SITCO is based on CitectSCADA, which is an industrial control application generator. The communication network is composed of routers, which serve as the communication coordinators, cables, adaptors, and more. The communication network hardware is based on industrial standards. SCADA (Supervisory Control and Data Acquisition) based applications perform control tasks via drivers to each device. The development of the operational layer of AVIVIM included the development of a driver for each type of signal controller used in Tel Aviv. The driver uses the native signal controller communication protocol.

Building and Testing Prototype:
Namir, a segment of one of the main arteries leading to the center of Tel Aviv containing eight major intersections, was connected to the prototype in such a way that did not necessitate disconnecting the intersections from the then existing

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traffic control system. Therefore, it was possible during the installation and trial run to operate both systems, minimizing system failures. The trial run proved successful demonstrating the full capabilities of the system.

Tel Aviv – Signaled Intersection with Grade Separation

Implementation of AVIVIM system:
The City of Tel Aviv-Yafo is the largest metropolitan area of the country. Most of the traffic in Tel Aviv-Yafo originates from towns in the vicinity and outside the metropolitan area. The majority of this traffic enters the city during the morning peak period. The City of Tel Aviv-Yafo is highly dependent on the efficiency of its transport system to move labor, consumers and freight between multiple origins and destinations. In order to preserve its predominant role as a major city, Tel Aviv-Yafo strives to improve the quality of all transportation modes and reduce congestion and the environmental impacts of traffic.

The development of AVIVIM followed the principal of agile development involving continuous assessment of intermediate results where necessary adjustments were made. Originating from a prototype, this initiative is now an operational version. Expansion of the system was carried out in a modular manner, in segments of eight intersections with traffic lights. Each new intersection connected to the proposed system was monitored both by the existing system and the new system. In addition, it was possible to maintain coordination between the intersections monitored by the existing system and the intersections monitored by the new system. AVIVIM was implemented from 2007 to 2008 throughout Tel Aviv-Yafo.

It should be noted that management of the project through modular implementation over increasing segments of the municipal network provided both stability and improved service.

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COST

Over the initial first two years, the program cost 12,000,000 NIS (New Israeli Shekels) (approximately $3.2 million USD).

The annual budget is 3,000,000 NIS (approximately $800,000 USD) for further development and 600,000 NIS (approximately $160,000 USD) for maintenance.

RESULTS AND EVALUATION

Users of the transportation network supported by the AVIVIM system benefit from fewer traffic jams, shorter wait times at intersections, increased safety, and reduced probability of signal downtime. Additionally, AVIVIM's open and improved architecture and components enable it to scale up to handle larger metropolitan transport systems.

The project's successes are in the following main areas:
Safety – Reduction of road accidents at intersections with traffic lights. In the first year (2008), this was reduced by 17%. In the second year (2009), the reduction was even greater at 36%. The reduction in road accidents is mainly due to the provision of a rapid and efficient response to both traffic events and software and hardware faults and failures.

Traffic flow – The delays at intersections in arteries where the monitoring system is in operation have decreased. For example, in the HaShalom artery, traffic delays decreased by 60%.

Maintenance – By shortening fault locating and handling times, in most cases, maintenance time was reduced by 20%.

Operations and maintenance costs – Tel Aviv Municipality benefits from a reduction in operations and maintenance costs by using the latest technologies, without having to overhaul the complete system every time an upgrade is performed on one component of the system. The use of application generators and standard software packages allow the system to easily connect with diverse components. The municipality can choose a variety of solution providers, as well as perform low-cost modifications and upgrades to parts of the system as needed.

TIMELINE

1995	First version of EYAL
2001	INSYTE development started
2004 - 2005	Development and building prototype
2006	Prototype testing
2007 - 2008	Implementation throughout the city
2009 - 2010	Further development, prioritization of public transportation

LEGISLATION

No statutory amendments were required in the planning, executing, and implementing of the AVIVIM system. However, when procuring controllers, the municipality requested that their protocols be open to enable communication, either by using built-in drivers or by using built-in tools for developing such drivers.

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LESSONS LEARNED

Agile Development
The development based on the principal of agile development proved to be successful in meeting traditional criteria, such as accuracy and response-time, as well as new criteria of flexibility and rapid adjustment to changing demands.

Standard Software Tools
Using standard software tools promoted flexibility in two ways. Firstly, to gradually expand the system's capabilities, application generators were designed to adapt to various working environments, providing tools for easy, low cost modifications. Secondly, the system can upgrade one or more of its components. As the life cycle of traffic management and control systems is usually rather long, it is often desirable to integrate new technologies into existing systems. Standard software tools are usually constantly improved by the supplier. Hence using the upgraded version is often satisfactory. If a need arises to replace one of the software components, replacing one standard tool by another is much easier than with a proprietary tool.

Shared Data
Another important ability achieved by using standard software infrastructure is the ability to share data with peripheral systems. Traffic management and control systems are characterized by incorporating various types of data and by the need to interact with various types of devices. These include the municipal GIS system, the signal-program planning system, and the traffic management systems of other transportation networks. Standard software tools often provide built-in tools for creating interfaces to other systems and easy communication with various input/output devices.

Cost Effectiveness
Standards open the way to larger markets and more competitive suppliers. The user, in this case the municipality of Tel Aviv, benefits from the lower costs engendered by competition and manufacturing economies of scale as well as greater innovation and choice of the equipment and services on offer.

TRANSFERABILITY

The AVIVIM system is based mainly on general-purpose software tools and is characterized by an open architecture. The system's modularity contributes to its versatility and its ability to grow and adjust its functionality to new technologies and to the evolving demands of traffic engineers.

One of the main advantages of using general-purpose control software and devices, such as specific drivers through the use of the CitectSCADA, is the ability to encompass the entire functionality of all types of controllers. The key benefit of this component is its transparency to system developers. This makes the system amenable to assimilation in other urban areas.

AVIVIM is highly transferable and can easily be implemented with a few adjustments in other cities and countries.
In fact, the Haifa Municipality was granted the permission to use AVIVIM. With minor adjustments, this system was successfully implemented in Haifa.

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