TELEGRA
SMART TRAFFIC MANAGEMENT

Tunnel Safety Systems Total Integration

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INTRODUCTION

Tunnels, especially the long ones, are parts of the road where no one feels comfortable. Several hundreds of miles of rock and concrete with two tiny entrances on both sides of the tunnel tube are neither a natural nor a relaxing surrounding for any human being.

Thinking about driving through a tunnel, everybody, at least for a second, thinks about the possible dangers. Some people even try to find alternative routs to their destinations just to avoid tunnels all together.

However, today tunnels are the essential parts of major highways and we have to make them as safe and as comfortable as possible.

We are used to seeing tunnel equipment like electricity and ventilation system since long tunnels have started to be built. But today, in the age of such high traffic density, that is not enough to keep the drive through the tunnel safe. Today tunnels are equipped with other sophisticated systems that raise the safety level much higher than before.

Good lighting, well organized and visible red and white LED markers, dense placement of Variable Message Signs, clearly marked exit signs and Emergency Roadside Telephones are just the technological part visible to the drivers that makes them feel safe. Of course, all the technology has to be under a tight control of well organized highway patrol teams.

Does all this visible technology in tunnels really make people safer or is it just a smokescreen?

To answer that question one has to truly know how tunnel traffic control technology works and how reliable it is.

Analyzing the safety systems of a tunnel, the main focus are quality, reliability, and technical specifications of each element, or subsystem. However, to make a true distinction between seemingly safe, and truly safe tunnels, focus should be on integrating these technologies according to safety rules and procedures of a tunnel.

Proper integration of safety systems ensures that no critical situation escalates to an accidental situation.

Functional Levels of Tunnel Safety Systems

- Programmable Logic Controller (PLC) System
- Ventilation System
- Lighting Control System
- Air Quality Systems
- Powering Control
- Fire Control System
- Video System
- Traffic Signalization System
- Emergency Road Telephony System
- Water Supply System
- Public Announcement (PA) System
- Re-broadcasting System
- Data Transfer System

All of these systems can be summed up in two functional levels

- equipment and controlling device located inside the tunnel
- central operating device and computers located inside the command center

The two functional levels, the head and the body of the system, are connected by communication network.

The most important question that poses itself is what happens if the head and the body of the system stop communicating?

FUNCTIONAL INTEGRATION LEVEL

To avoid chaos if the head and the body stop communicating, the system body should be equipped with sufficient intelligence designed according to predetermined rules for irregular situations. This means the system should be integrated at the lowest functional level. The main functions of the entire system – Air Quality Control/Ventilation and Fire Alert System – shouldnćt be compromised even if command center loses all communications/surveillance with the systems in the tunnel.

To achieve this independence, the intelligent parts of different systems have to be connected with one another using so called cross connection architecture. This architecture ensures the exchange of data and alarming situations which trigger execution of elementary predetermined algorithms.

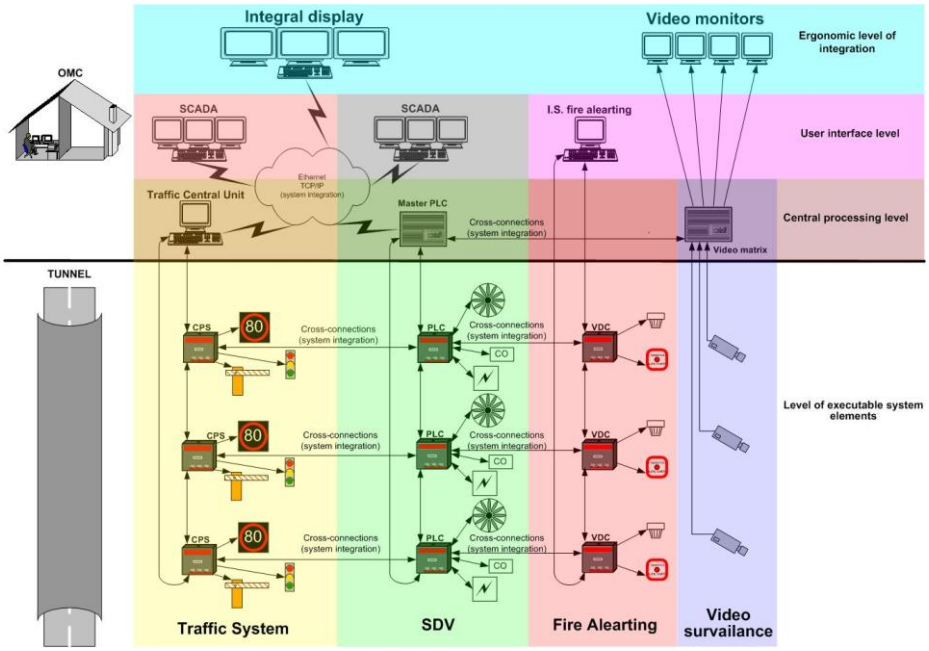
Besides achieving independence from the command center, the cross connection architecture also speeds up the system response time. In case of systems precisely defined automatic reactions (like shutting down/closing the tunnel in case of fire), systems can response much faster via cross connection architecture than if the information was to travel to the command center first and awaits its commands to be sent back to those systems in the tunnel. Using the cross connection architecture, the command center becomes aware of the alarm cause at the same time it becomes aware of the systems response.

Functional Integration at the lowest level has its limitations. Systems distributed control mentioned above can not comprehend more complex situations. Thus, this architecture needs to be utilized only in basic situations triggered by very dependable alarm signals (i.e. fire alert sensors). Less dependable alarm signals require further validation through various parameters and possible interaction with the command center.

The second level of functional integration is connecting different central processing levels of systems at the command center (Figure 1).

The second level integration is used to enable interaction among systems which cant be connected at the lowest level, or the low level connection doesnt make sense. For example, if one needs to show the exact location of the ERT from which the call has just been made, we would connect the controlling unit of CCTV system to the ERT Central Unit.

Using the Second Level of Functional Integration, we can connect all systems and get any information needed.



Picture 1 System integration of tunnel management

Ergonomic Integration

The two previously explained integrations allow us to design the necessary algorithms for automatic response, as well as exchange all of the information generated by the systems. However, these algorithms must be implemented in todays somewhat glitch technology. Because of this, human factor is extremely important in decision making and tunnel control processes.

Ergonomic Integration plays the major part in satisfactory interaction between the system technology and the operator in the Traffic Control Center.

Until now, almost every part of the controlling system (i.e. fire detectors, lighting, traffic signals, etc.) had its own user interface at the Traffic Control Center, leaving a lot of room for error in coordinating all of the system (especially in critical situations).

To help the operator stay focused, it is important to have all of the necessary interaction with the system through one user interface. This is what Ergonomic Interface is all about. To implement Ergonomic Interface, adequate equipment is needed.

TopXview was developed with the goal to satisfy the Complete Integration. It s capable of the following

- direct control of all of sub-systems included in tunnel supervision
- integration of video system within the softwares graphical user interface
- interactive guidance in critical situations
- recording and analysis of all system events
- automation of all alerting processes and sending of all important alerting messages to the appropriate emergency centers (i.e. fire department, emergency medial services, etc.)
- simulation and training

Picture 2: OMC with completely integrated system

The interface between the software and the user is usually designed through a central video wall or through large LCD screens. It is important that the controlled object is represented in a clear, precise, and unambiguous way at the central screen.

The integration should not be a pile of screens from different graphical user interfaces. It should be a unit that integrates the graphical representation of the situation in the tunnel with the picture from the video system. This kind of integration creates an organized and focused environment for the operator.

Procedures and Algorithms

Thus far weve mentioned the technological aspect of tunnel traffic control. Very important parts of traffic control are Action Plans and Traffic Control Procedures which directly contribute to traffic safety. Quality, implementation and validation of these plans and procedures are of great importance. These plans and procedures should at minimum cover the following

- regular/normal situations
- accidental situations
- malfunctions
- maintenance

Following all these procedures is a very difficult task for an operator. Realistically speaking, it is foolish to expect that the operator at the Traffic Control Center can handle and follow all of the procedures in detail, especially in critical situations. That is why topXview implements these algorithms and procedures within the software leaving no room for error. Implementing the algorithms and offering an interactive guidance through critical situations in a Completely Integrated System gives the operator the necessary assurance and time needed for situation analysis.

CONCLUSION

To accomplish tunnel traffic safety beyond just expensive and shiny technology, it is necessary to integrate systems which will enable the operators to optimally control tunnel traffic. Integrating all available systems ensures the maximum effectiveness of all technology employed inside a tunnel, as well as maximum tunnel traffic safety.