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Technical Whitepaper – Radio Systems

How AVLC and Radio System Integration Adds Value to Operations

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Executive Summary

Voice radio is an essential part of managing a public transport network. Whilst the introduction of digital communications and in-vehicle tracking has removed the need for voice calls to establish vehicle location, where it is heading, and how it is adhering to the planned journey, voice communications are still an essential tool for coordinating the network.

A modern Automatic Vehicle Location Control (AVLC) system integrates voice facilities into the fleet management system and provides your dispatcher with direct access to the vehicles that are being controlled. Dispatchers need only select the vehicles and click the talk icon, and the system takes care of establishing the call to the correct devices. Select a route, and a call goes out to the vehicle currently operating on the route without any need for the dispatcher to look up any information. Multiple selections and ad-hoc groups of vehicles, as well as groups of routes, can be selected to ensure controllers have the flexibility to manage operations.

A secondary data radio used for the AVLC introduces the possibility to dynamically push announcements to the vehicles - freeing capacity on the critical voice radio system. Making announcements through the data radio enables these messages to be made to large vehicle groups without consuming undue radio resources. Announcements can be configured to be automatically triggered at specific times, locations, or a combination of both.

This technical whitepaper describes the Trapeze LIO AVLC radio system control as it might apply to public transport operations. It assumes a 4G connection to the vehicles via the Trapeze Intelligent Data Router (IDR), and a separate digital radio system (DMR, TETRA etc.) supplied by other parties that connects to the IDR via control lines. We look at the system architecture, how the radios interface, and how calls are made in the control room and on the vehicle. Finally, we look at how redundancy is implemented and what the future might bring for your operations.

What is the Solution?

System Architecture

LIO uses an IDR to track vehicle location, control peripheral devices, and manage information within the vehicle.

In addition to AVLC functions, the IDR is used to facilitate communications between the driver and the control centre, and communications from the driver or the control centre to passengers.

To achieve this, the IDR communicates using both the LIO control centre and the Trapeze Parity radio control system. Parity is a separate, but integrated radio control system, with the potential for high availability configuration, which supports the integration of a range of radio systems into one integrated console.

While normally operated from within the LIO system, via the standard dispatcher interface, voice calling is also possible directly from within Parity (Figure 1).

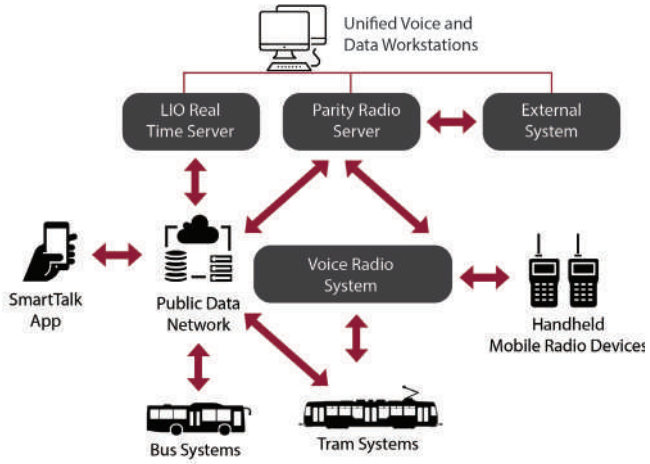

Figure 1 Radio Control - Illustrative System Configuration

This radio system architecture is very flexible, allowing the integration of many radio systems into one integrated solution for your service controller. In most cases, radios are a customer's existing PMR, DMR and 4G PLMN. In operation, your dispatcher simply requests a call, and the system chooses the most appropriate communication path. This can be used to extend coverage, add functionality, or reduce the load on the PMR system. For instance, where a vehicle is under private radio system coverage, the call is connected via this system. When the vehicle is outside of the coverage area, the connection is made using VoIP on the 4G data network. Calls to a group of vehicles might result in a mixture of radio systems being used.

As well as supporting both the mobile data channel and digital radio systems, the radio solution includes facilities to integrate with a range of external systems via SIP trunk connections, for example, a PSTN telephone system. Thus, calls can be directed to external systems, or external calls can be routed through to radio participants.

The radio solution is not limited to vehicle-mounted equipment and can integrate with mobile devices both on the private radio system, and over the 4G data network. This enables on-street controllers to be integrated into calls. For example, a street controller can be quickly added into a call on a specified route, thus giving all those on the call additional eyes on the ground. Handheld devices can also call vehicles directly (if permitted), with the calls managed by the central Parity radio control system.

Many PMR systems do not allow the control room to conduct a driver call, or a public announcement call at the same time. Thus, when a public announcement is happening, a driver call cannot be made. The LIO and Parity system addresses this problem by supporting both real-time voice radio solutions, and recorded announcements. The voice radio solution provides live calls and announcements and can be loaded and triggered independently of any communication between the control room and the driver.

These announcements are either pre-recorded well ahead of time or recorded at the workstation in response to a current incident, and then distributed over the data radio to the vehicle. The announcement is then played to your passengers as defined by the operator. The recordings are managed in the dispatcher workstation.

In addition to any standard announcements (next stop, points of interest, etc.) that are normally presented along the route, announcements can be triggered at specific times or using the positional trigger feature at specific locations along the vehicle route. The result is that passengers receive a more relevant set of messages, enhancing the customer experience without putting critical driver communications at risk.

Description: Control Room Radio Interface

The Trapeze Parity radio control system in the control centre interfaces to your radio systems using industry-standard IP interfaces for both radio specific protocols and SIP connections. It can combine multiple communications channels into a single integrated solution. This maximises the use of existing radio infrastructure and allows the transition to new radio technologies.

For example, a conventional analogue radio system might be combined with a TETRA digital trunked system, or a DMR network with 4G used to provide fallback VoIP voice facilities. An existing PMR could be combined with a new DMR and the 4G from the AVLC. This would allow an organisation to transition from the PMR to the DMR without any service interruptions.

Because the voice radio server also integrates SIP connections, external trunks and PSTN switching systems can also be used to significantly expand the capabilities of the radio system.

Description: Radio Interface on the IDR

Onboard the vehicle, the IDR computer contains a digital audio switch and associated amplifiers to connect the external radio to the drivers' microphone and speaker. This also manages the VoIP connection to the driver speaker and MP3 playback of announcements to vehicle speakers. These connections are dynamically switched, depending on the operation being performed.

In a vehicle with its multiple carriages, longer signal lines, and increased speaker numbers, passenger announcements usually have higher power requirements than the IDR can directly supply. In this case, the IDR connects to an external amplifier (ELA) which provides the necessary amplification through the vehicle, as well as supporting the switching of the driver microphone and speaker circuits to the active driver head (Figure 2).

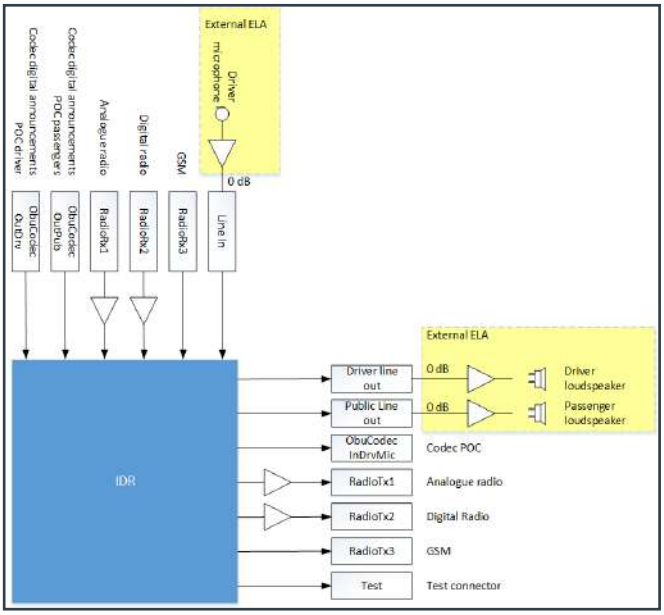

Figure 2 - Audio Integration with External Amplifier (ELA)

Digital Radio

The digital radio interface incorporates audio lines, digital control lines, as well as serial ports for radio device control. Generally, digital radios have a specific control interface that needs to be integrated into the vehicle software. This allows the operator to monitor the connection to the radio network, so that the on-board computer can determine if the radio or a VoIP connection should be used for a voice call.

Radio state signalling allows Trapeze to dynamically program the radio with the group call address for the current route. When an ad-hoc call is established from the control centre, a data telegram is sent to the on-board computer which then adds this dynamic ad-hoc group ID to the watch list of the radio, and then the radio joins the group call. The details of the interface operation are determined by the radio specifics.

Making a Call

How we Initiate a Call in the Vehicle

The IDR and driver display supports a Request to talk (RTT), and a Priority Request To Talk (PRTT) functions. These are normally assigned to the top two physical buttons on the right side of the driver's display. A separate input on the IDR is used to sense an emergency pushbutton activation (Figure 3).

Figure 3 - Driver Display (also known as the IPT)

When the RTT button is pressed on the driver display, or if the emergency button is triggered, a telegram is sent to the control centre over the 4G data channel.

The RTT message is shown in the LIO event queue to all "responsible" dispatcher workstations (workstations can be quickly configured to have System, Primary or Secondary responsibility for the route).

The dispatcher then processes the event to answer the call. Normally, a default action to make a call or set up an emergency call is configured in the system, and a voice connection is established. The controller is now able to have a conversation (Figure 4).

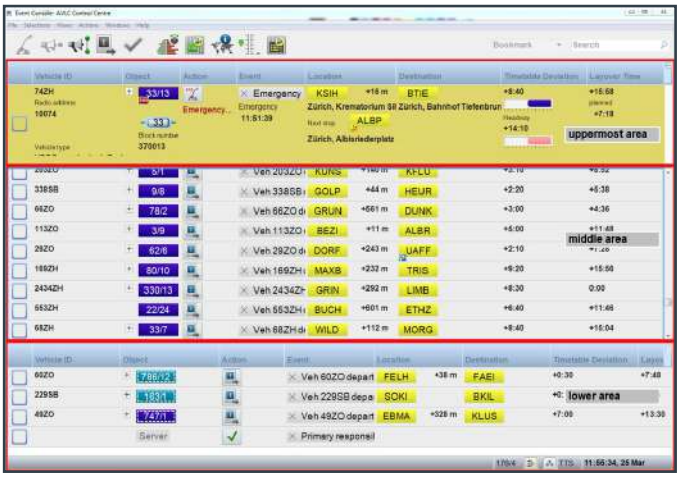

Figure 4 - Event List Showing Emergency Calls at the Top

When engaged in a conversation, information is displayed to the dispatcher to assist coordination. For a single vehicle, vehicle details are shown (Figure 5). When a group of vehicles is selected, the information shown is the list of all participants (Figure 6).

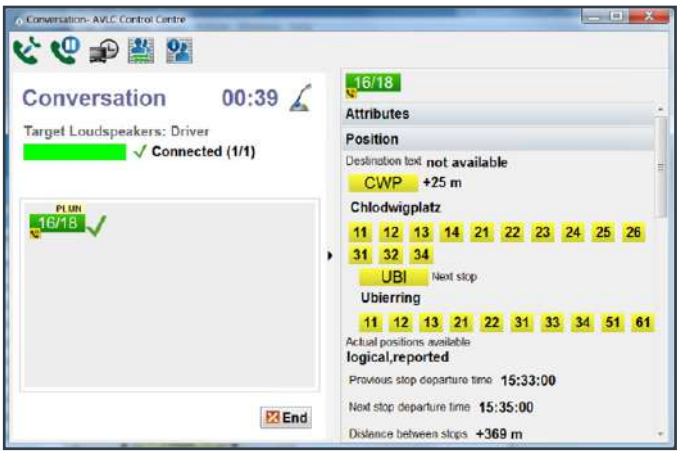

Figure 5 - Single Driver Conversation

Figure 6 - Conversation with a Group of Vehicles

How we Initiate a Call in the Control Room

Selecting one or more vehicles to talk to is not always as simple as it should be. By integrating the radio control and the AVLC into a single interface, Trapeze has made it easy for the control room to use their AVLC interface to communicate with vehicles. The control room graphical user interface can show:

- a map of the city with route overlays and trams at their actual position.
- the trams in their logical positions relative to other trams in the route using a linear route display, or
- route views that show overall route performance against timetables.

To initiate a call, the dispatcher simply uses one of these displays and selects the vehicles they want to talk to by clicking on the GUI selection directly with the mouse, or via a lasso of multiple vehicles.

Vehicles can be called individually or by route (where all vehicles currently running that route will be selected), via a group of selected vehicles, or by a selection of multiple routes.

The system can also be configured to support service vehicles and mobile radio devices, integrated into the one common dispatch console.

Passenger Announcements

Announcements simplify communication with your passengers. Operators select one or more vehicles in the normal way, and then click on the "Announcements" icon. Announcements can be live or pre-recorded.

Pre-recorded announcements are often the best choice, as they can be tailored to convey a specific message and can be run automatically at a defined frequency.

They can be developed and loaded into the vehicle well ahead of time. These messages are excellent for routine activities and can be quickly selected from drop-down lists. Operators can send announcements to the passenger saloon and/or the driver, and/or an external speaker all without interfering with driver to control room communications. These recorded announcements are a "set and forget" activity, with automatic activation as and when defined.

Messages can also be recorded as part of incident response procedures, and then sent to the vehicles to be played. This is particularly useful for incident management where the controller has several specific details to manage. The messages are customised to reflect the needs of the incident, and then are automatically loaded and played on the vehicles without the controller having to announce the same message time after time. This keeps the passenger information flowing and frees the controller to help manage the incident.

Live announcements can also be made over the standard voice radio system, with the dispatcher able to choose the recipients - driver, passengers, or both. To highlight the announcement, a chime can optionally precede the announcement to alert listeners.

The driver can use the driver's microphone at any time to make an announcement to their passengers, triggering the action with the driver's display. Internal or external speakers can be selected depending on the driver's needs (see Figure 7 to Figure 10).

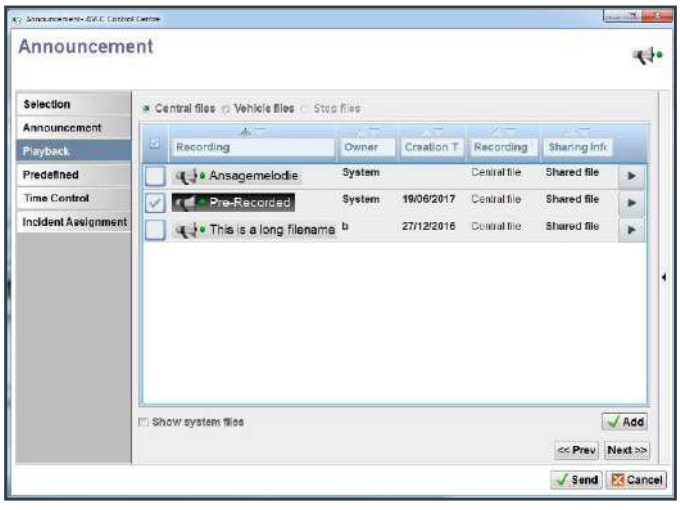

Figure 7 – Announcement Setup Dialog

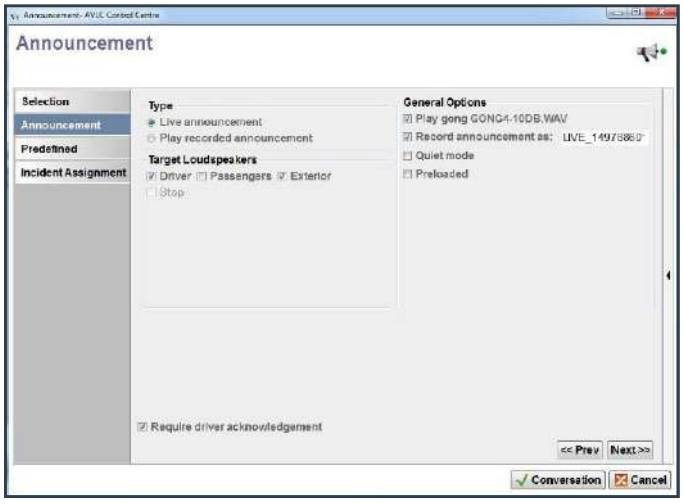

Figure 8 – Announcement Selection

Figure 9 – Record New Announcement

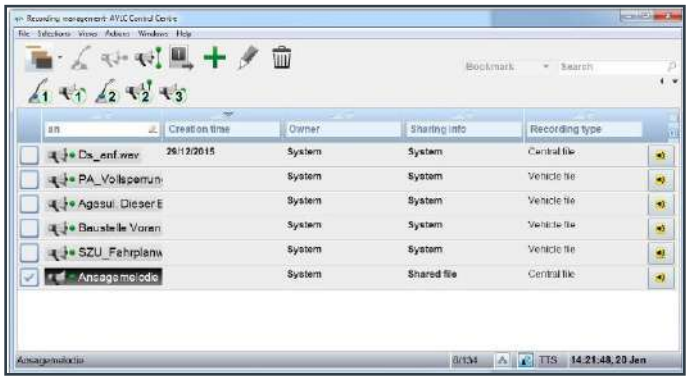

Figure 10 – Manage Announcements

Fallbacks

Radios are not infallible, yet communications between the control room and drivers are critical to effective operations. The Trapeze LIO AVLC provides an important layer of redundancy to the main DMR radio system. By default, LIO will route all driver audio communications through the main DMR/PMR radio. If this radio fails, then LIO will fall back to transmitting these messages over the 4G network using VOIP. Switching between systems is seamless and this will be transparent to both the driver and the control room.

Failure cuts both ways, so if it is the IDR software is inoperable and the radio device supports a simple calling mode, then when the driver presses the RTT button on their driver display, the fallback controller in the IDR can trigger a call directly via the radio, rather than relying on the RTT messages.

If the radio system does not support this mode of operation, then an alternative fallback that uses GSM calling to pre-defined numbers can also be configured and controlled by the fallback controller.

The Future

Keeping the real-time system and the voice radio system separate enables developments in either sphere to occur without necessarily involving changes to the other system. It can also allow one system to address deficiencies in the other system. For example, a radio system that does not support group calling inherently, like VoIP over a mobile data network, appears to do so as far as the real-time system is concerned.

Under the hood, the radio system server constructs the required number of individual connections, and then combines these into the one stream presented to the dispatcher workstation.

This abstraction extends to combining different radio systems, and also provides a degree of protection against radio system architecture future developments. While 5G is a data-only network, the radio system may be able to provide enhanced services to users, while maintaining the same compatibility with the real-time fleet management system.
Changing any part of the radio networks is also simplified, as the system will make use of both the old and the new radio systems, without the operator needing to know which system they are using.

The on-board computer used by the AVLC contains a wide range of interfaces, including serial, USB, and Ethernet connections. This means that it has the physical capability to integrate into different digital radio systems. Although not likely to be needed, it is good to know that the rack-mount IDR version can even be augmented by a built-in radio controller which can directly control a conventional analogue radio.

As communications become increasingly digital over IP networks, the IDR family will provide for this future integration. Already certified by ITxPT for hardware and defined services, the IDR family is the bedrock upon which your future applications can be built.

Conclusion

With the need to have a quality voice network between the control room and the driver, the Trapeze solution of combining the AVLC modem and the primary radio into a single integrated system makes a lot of sense.

An operation gains multiple levels of redundancy by making use of the 4G data network and VOIP. This also provides a smooth way to transition from older systems to newer solutions. Control room operators can view and monitor vehicles in real-time and communicating to these vehicles is a click away on the same interface.

Passengers benefit from this integrated control, as they receive automatic messages en route that are now easily supplemented by incident related messages that can be sent to the vehicle without interfering with driver communications.

The combination of the Trapeze LIO AVLC system and the Trapeze Parity Radio system is the right call for lowering delivery and operational risk whilst increasing the quality of service to operators and passengers alike.

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Trapeze Group works with public transport agencies and their communities to develop and deliver smarter, more effective public transport solutions. For more than 25 years we have been *Here for the Journey*, evolving with our customers around the world to help them move people from point A to Z and everywhere in between.

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