



MOTOROLA INTELLIGENT RAIL TRANSPORTATION SOLUTIONS

EXECUTIVE BRIEF



STRENGTHENING CORRIDORS OF COMMERCE, DELIVERING INSPIRED PASSENGER JOURNEYS

Linking increasingly complex supply chains through corridors of commerce and delivering inspired passenger experiences for safe and desired journeys, modern rail transportation is a vital pillar for driving the economic development of cities and nations.

Rail service providers shoulder this phenomenal responsibility with a duality of purpose; managing the reliability, safety and security of millions of journeys, while simultaneously delivering a personalized experience for each individual and the timely delivery of every freight.

With the velocity of urbanization straining and stretching our cities into megaregions spanning hundreds of kilometers and supporting tens of millions of citizens, the demand for rail solutions that operate efficiently in dense urban areas and extend economically to the outward reaches of population sprawls has never been more pronounced. With this trend in focus, governments around the world are prioritizing critical infrastructure investments into modernizing and extending their rail transportation solutions.

To meet the heightened expectations of next generation rail service, operators are aggressively pressing upon the most advanced technologies and exploring the most ambitious future-state possibilities to create a new vision for Intelligent Rail Transportation Solutions.

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A SINGLE, CONVERGED COMMUNICATIONS ARCHITECTURE FOR RAIL

Central to delivering on the promise of Intelligent Rail Transportation Solutions is a single, converged communications architecture capable of supporting the full array of mission critical and business critical rail communications requirements:

- | Voice and multimedia workforce collaboration
- | Signaling, control and train protection systems
- | Passenger information and entertainment services
- | Public safety and emergency incident response
- | Video surveillance along tracks, stock, aerial, and stations
- | Intelligence-Led Operations Control Centers
- | Station, retail and customer services

TETRA AND LTE-R HAVE BECOME THE DE FACTO INDUSTRY TECHNOLOGY STANDARDS FOR RAIL COMMUNICATIONS

TETRA brings a proven voice and data communication platform, trusted by a vast population of rail deployments around the world and benefitting from a rich ecosystem of products and applications optimised for rail. Advanced rail operators looking to accelerate their future vision through a broadband enabled, IP multimedia communications framework are selecting LTE-R for the next generation of rail communications.

With a state-of-the-art, converged IP data transport network serving the entirety of rail operations and powerful TETRA radio and LTE-R broadband connections, we will mobilize intelligence and deliver real-time situational awareness across stations, lines, cars and operational control centres. The reliability, safety and security of passenger and freight travel will be guaranteed while reaching new heights of service, productivity, and profitability.

BUILDING THE FOUNDATIONS OF A NEXT GENERATION MISSION CRITICAL RAIL COMMUNICATIONS PLATFORM

Implementation of a state-of-the-art, mission critical rail communications platform extends beyond network technologies. Rail service operators will need to consider the full span of highly complex systems being integrated and coordinated across multiple technology assets and a platform that can be managed to measured performance indicators defined by the operational outcomes required by the users.

Motorola manages the complex systems integration working with a strong ecosystem of local partners to support the radio and broadband deployments along with the applications integration, managed service, training and change management.

The end-to-end system designs include highly resilient IP transport networks to serve as the backbone of the communications platform. Along with access traffic, the backhaul transport networks carry information feeds from video surveillance and sensor networks, command and control centers, and can support enterprise voice and video telephony applications.

Directive antennas and radiating cables enable deepened coverage and capacity for main line and branch line propagation through tunnels, underground facilities, stations and depots. Self organizing network technology and fast handover protocols dynamically manage system resources, frequencies and relays between cells to support seamless transmission to on-board units during transit.

Multi-megabit connections are maintained at the furthest edge of a cell, radio to broadband interoperability deliver shared group communications, military grade security frameworks protect the confidentiality of all communications and data, and revolutionary devices and applications deliver a user experience optimised for mission critical operations.

OPTIMIZED NETWORKS, DESIGNED FOR RAIL

Communications systems designed for the massive peak loads of critical rail workflows as well as engaging in emergency incident responses must be designed to exceptional standards. These systems must ensure availability and performance under the worst possible circumstance – thousands of rail workers, first responders and municipal agencies communicating simultaneously in highly challenging coverage locations.

With this clear understanding, rail operators around the world are looking to dedicated, standards-based TETRA and LTE-R networks designed for exceptional capacity and performance and with dedicated spectrum resources to ensure the coverage, capacity and capability needed from their wireless installations.

MOTOROLA SOLUTIONS COMPREHENSIVE APPROACH TO INTELLIGENT RAIL TRANSPORTATION SOLUTIONS

RAIL SOLUTIONS INTEGRATION SERVICES

Network and Systems Integration, Operations Control Centres, Trainbourne Systems

TETRA & LTE-R NETWORK DESIGN SERVICES

Coverage, capacity, performance in challenging propagation environments

MANAGED COMMUNICATIONS SERVICES

Lifecycle management, communications-as-a-service, cloud-based services

RAIL OPTIMIZED DEVICES

Rugged, context-aware, smart handhelds and trainbourne equipment

INTEGRATED RAIL OPERATIONS CONTROL CENTER

Multimedia Rail CAD, communications console, monitoring and route planning

RAIL NETWORK OPERATIONS CENTERS

Real-time management and performance analytics across all communications

VIDEO SURVEILLANCE AND SECURITY

Video management, analytics in command theaters and in the field

SECURITY AND ENCRYPTION FRAMEWORK

Protections across IP transport, radio network, applications and device data

DYNAMIC PRIORITIZATION

Real-time QoS managed on workflow priority, incident severity, user profile

INTEROPERABLE COMMUNICATIONS

Multimedia group communications across TETRA, LTE-R, Carrier 3G/4G

HIGH PERFORMANCE BROADBAND STREAMING

Multi-megabit edge performance, downlink and uplink traffic optimisation

HIGHLY RESILIENT BACKBONE

Secure, self-healing fiber, microwave, satellite IP data transport network

VOICE AND VIDEO TELEPHONY

Unified, digital IP telephony for advanced voice and video conferencing

LTE-R DEPLOYABLES

Rapidly transportable coverage to manage planned or unplanned events

An aerial photograph of a city skyline, likely Los Angeles, with a prominent vertical line and a black dot in the center. The text "FUTURE RAIL COMMS" is overlaid in large white letters.

FUTURE RAIL COMMS

MOBILIZING INTELLIGENCE FOR NEXT GENERATION RAIL OPERATION



To meet the heightened expectations of next generation rail service, operators are aggressively pressing upon the most advanced technologies and exploring the most ambitious future state possibilities to create a new vision for Intelligent Rail Transportation Solutions.

Central to delivering on this promise is a single, converged communications architecture capable of supporting the full array of mission critical and business critical rail communications requirements.

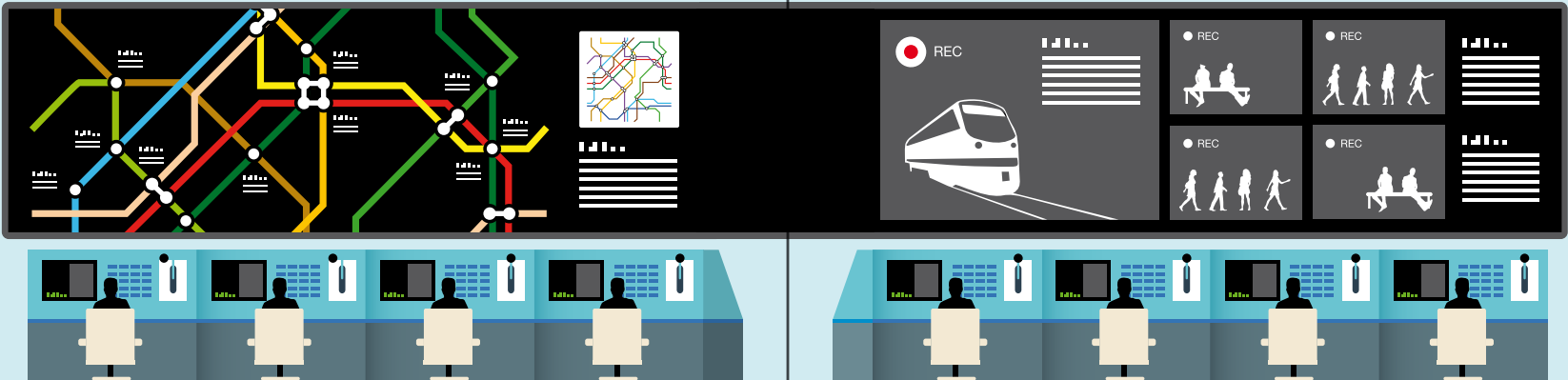
With a state-of-the-art, converged communications architecture, we will mobilize intelligence and deliver real-time situational awareness across stations, lines, cars and operational control centres. The reliability, safety and security of passenger and freight travel will be guaranteed while reaching new heights of service, productivity, and profitability.



INTEGRATED RAIL CONTROL CENTRE

The Integrated Rail Operations Control Centre scales instantly from real-time monitoring, route planning and dispatch of rolling stock to mass coordination across every level of the public transport security command to provide one unified, real-time operational picture.

With video surveillance, the power of real-time sight and analytics secures critical rail infrastructure and high density passenger locations while simultaneously integrating to create highly intelligent operations-wide surveillance systems that sees through cameras connecting trains, tracks, stations, and main-line aerial vehicles.



INTELLIGENCE-LED RAIL OPERATIONS

By bringing automated intelligence and data analytics into the rail command environments, rail operations teams are able to synthesize information and interpret the mass amounts of data coming from real-time passenger and driver information systems, rolling stock and infrastructure monitoring systems, signaling and sensor networks, video surveillance feeds, passenger-generated inputs, records and timetables. Rail service providers are better prepared to anticipate problems, make intelligent predictions, offer more targeted counteractions and plan optimal operating strategies.



RAIL NETWORK AND SECURITY OPERATIONS CENTRE

Centralized dashboards deliver real-time management information and metrics to the Rail Networks Operations Center to provide a view into the well-being of the entire system-wide communications network and application services. Strict information assurance and system-wide encryption protect the confidentiality, security and integrity of critical communications and data resources extending from the IP data transport network to the entirety of the TETRA and LTE-R communications platform. Performance analytics tuned to key mission critical indicators allow operators to forecast where trouble may arise before an alarm sounds to focus proactive troubleshooting.



CONNECTED PASSENGER EXPERIENCE

Connected passenger solutions allowing for smart ticketing and effortless planning with real-time journey information across the total, integrated trip bring new levels of convenience. Applications on passengers' smart devices enable highly personalized service provisions while ubiquitous broadband connectivity and on-board entertainment enhance the passenger experience. Digital signage, advertising and cross-platform passenger information systems increase engagement and offer a platform for new revenue sources. With better services tailored to individual preferences driving increased loyalty, passengers choose rail for its convenience, comfort, speed and reliability.



ON-BOARD COMMUNICATIONS AND CONTROL EQUIPMENT

High resolution touchscreen interfaces, high performance audio accessories, and intuitive controls are designed with a holistic understanding of the driver's operating environment. A unified presentation of critical information across various information streams provides a real-time view of the condition and mechanical operations of the train, situational awareness of the physical characteristics of the track and movement authorities, and assured communication access to the Operational Control Center.



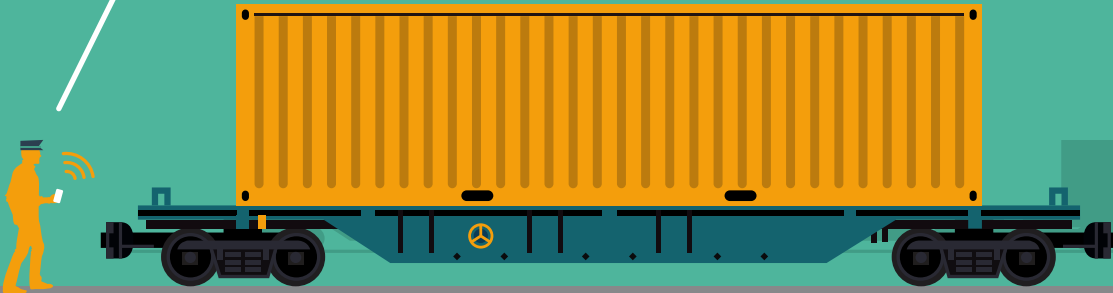
THE HEIGHT OF INNOVATION WITH DRONE ROBOTICS

Unmanned Aerial Vehicle (UAV) technology, known as drones, enable remote teams to inspect tracks and monitor trains. Live video feeds are transmitted over hard to reach areas such as bridges or tunnels, increasing worker safety and delivering real-time situational awareness on the health and performance of the rail lines. Equipped with an ultra-portable LTE system, the drones are capable of providing a secure, rapidly deployable broadband network over several square kilometers, giving field teams or emergency crews access to aerial photos and high definition video. A ground-to-air microfilament tether provides power as well as transporting high-definition video streams from an incident area, allowing the drones to stay aloft for multiple days.



CONNECTED RAIL WORKER EXPERIENCE

Radio and broadband innovations transform rail operations by providing front-line rail workers with increased situational awareness, enhanced workforce collaboration and greater in-field productivity. Intuitive handheld devices and trainborne equipment optimally designed for transportation environments mobilize intelligence, connecting conductors and station agents to train dispatchers and operations teams. Context-aware user interfaces and intelligent information management prioritizes and proactively pushes the right information to the right user at the right time with the needed insurance of availability, capacity, interoperability and security required to run mission critical railway operations.



ASKING THE IMPORTANT QUESTIONS

Rail Service Operators planning their next generation core communications investments are selecting between the established TETRA standard and the newly emerging LTE-R broadband standard. Both technologies position the operator with assurances of harmonized innovation and scale economies afforded by standardization. To help determine the right technology track, rail operators should consider the following questions to guide their decision criteria:

- | What allocations of dedicated spectrum have regulatory authorities made available for rail communications?
- | What technology requirements are mandated in the appropriation of the spectrum allocations?
- | What profile mix of users will be utilizing the rail communications network?
- | What range of applications is intended to be offered?
- | What role is intended for mobile video transmission?
- | How will the network be shared and what interoperability requirements exist with public safety and service agencies?
- | What is the desired roadmap for evolving passenger services, control room operations and workforce management?

Carefully considering these questions will offer rail service operators the opportunity to work with experienced rail communications integration providers to develop customized business modeling and network dimensioning scenarios.

By working with an experienced provider that understands the trade-offs between coverage, capacity, capability and cost, rail operators can make the most informed and advantageous decision to meet their specific needs.

**MOTOROLA SOLUTIONS
BRINGS SIGNIFICANT DOMAIN
EXPERIENCE HAVING WORKED
WITH RAIL SERVICE OPERATORS
AROUND THE WORLD TO GUIDE
THE NEXT GENERATION OF RAIL
COMMUNICATIONS.**

WHEN YOUR
OPERATION IS ON THE
LINE AND CRITICAL
COMMUNICATIONS
MUST GO THROUGH

TETRA FOR RAIL

Next to Public Safety, Transportation has consistently been the fastest growing application of TETRA technology around the globe. With Motorola Solutions Dimetra IP TETRA system, rail service operators have confidence in a state-of-the-art, mission critical communications platform providing the most comprehensive suite of advanced voice and data features. Built on an advanced IP network architecture, the platform offers maximum flexibility to support the mission critical requirements of rail operations while maintaining enterprise-wide security and manageability. A highly scalable architecture, the TETRA rail systems are designed and deployed to meet today's needs, plus scale over time to address future line expansions, increased data utilization and growth in rich-media services.

Motorola Solutions provides the world's only true TETRA platform future-ready for LTE. Rail operators have the benefit of a converged radio, core and transport architecture that is ready to support an end-state network optimized for next-generation LTE broadband services and applications.

From secure and assured radio communications, Rail Operation Control Centre applications, trainbourne equipment and field personnel communications, Motorola Solutions continues to drive the TETRA innovations trusted by the world's leading rail service operators.

TRANSFORM RAIL
OPERATIONS WITH
BROADBAND INNOVATIONS
AND INTELLIGENT
TRANSPORT SOLUTIONS

LTE-R 4G BROADBAND

Today, the most advanced mobile broadband technologies on the planet are available to rail operations, delivering unprecedented access to real-time, multimedia intelligence and workforce collaboration along mainline tracks, station houses, drone robotics, and onboard rail stock. Fueled by open standards, shared intellectual property, a rich ecosystem of developers and the promise of scaled economies, LTE-R has been selected for the future of Intelligent Rail Transportation.

Rail operations entrusted with safe and reliable movement of people and cargo have unique, specialized communications needs. Leveraging decades of domain expertise and a significant research and development focus working directly with mission critical communications users, Motorola Solutions has developed an unparalleled portfolio of LTE-R solutions optimised for rail operations.

With LTE-R we enable powerful solutions for safeguarding the security of rail travel while delivering increased workforce collaboration with the priority, control, security and performance at the core of mission critical rail communications. Connecting advanced multimedia services to today's critical voice and offering a new collection of innovative data devices to join trusted two-way radio communications, LTE-R is a critical ingredient in delivering the next generation of rail communications.

LTE-R BROADBAND INNOVATIONS

INNOVATIVE DEVICES AND SMART RAIL APPLICATIONS

INTELLIGENT LTE-R BROADBAND DEVICES

Motorola is delivering a new breed of highly innovative LTE-R devices featuring a revolutionary user interface that is context aware, intelligently adapting based on the user's role and activity to aggregate, filter and prioritize information

Sleek and ergonomic designs allow one-handed operation, exceptionally loud and clear audio performance through advanced acoustics and state-of-art noise cancellation, security enhanced operating system and hardware-based encryption, secure touch-pairing with radios and an expansive accessories ecosystem to enable a Personal Area Network.

MOBILIZED INTELLIGENCE WITH SMART RAIL APPS

Purpose-built applications maximize the utility of LTE-R providing dispatchers real-time situational awareness of operating conditions while front line personnel benefit from multimedia-enhanced collaboration and in-field productivity

Applications built for mobile workgroup operations enable instant multimedia messaging, collaboration tools, and live event video feeds to orient teams to the situation at hand and coordinate an optimal response strategy. Procedural efficiency applications reduce workloads and improve passenger engagement through identity management, in-field queries and automated reporting.

ONBOARD COMMUNICATIONS AND CONTROL EQUIPMENT

A purpose-built train control panel provides intuitive interfaces with communications, control, video and passenger information systems to provide train operators with real-time, situational awareness and instant, assured communications

High resolution touchscreen user interface with intuitive controls, lighting and indicators provide train crews access to vital information and communications designed especially for those periods of extreme concentration or stress. Train control management, CCTV systems and passenger information services integrate into a scalable, future-proof platform.

HIGH PERFORMANCE PUSH-TO-TALK INTEROPERABILITY

Users will connect with secure, near-instant voice and push-to-talk communications from their LTE-R device with full interoperability with two-way radio, public carriers, and enterprise data networks

High performance push-to-talk interoperability securely connects LTE-R users to mobile workers, teams and passengers across any network or device from two-way radios to smartphones, laptops to landlines, tablets to rugged handhelds, removing barriers to multi-agency operations and ensuring greater workforce connectivity and collaboration.



PERSONAL AREA NETWORKS DESIGNED FOR HIGH VELOCITY PERFORMANCE

Motorola Solutions looks at the entirety of the communications platform as a holistic system centered around an individual user. A Personal Area Network, where the radio and broadband device are tethering the individual's communications to the team and the command center. An array of smart devices connected on the individual helps him be more aware of his environment and more intuitively engage with the information available to him. Environmental sensors automatically trigger emergency alerts to the command center, wearable cameras immediately capture the scene and stream live video to the team, heads-up displays provide unobtrusive access to information through overlays, and biomonitoring devices can measure heart rate, blood pressure and detect if a user is standing, running, or inactive.

ADVANCING THE INTELLIGENT EDGE WITH THE NEXT GENERATION USER INTERFACE

Motorola Solutions brings its groundbreaking Public Safety Experience (PSX) user interface, optimized for mission critical mobile workers, to rail operations. With Motorola's PSX, LTE devices and application consoles become a virtual partner, always monitoring the user's environment, gathering and prioritizing information, and maintaining context-awareness of the user's circumstance. With the PSX, LTE devices reconfigure dynamically based on the individual's activity, spring to attention when the user is called to action, and bring focus to the most relevant, possibly life-saving information. It's an intuitive interface that puts safety above everything else by adapting and focusing only on what's needed.



HIGHLY SECURE AND SURVIVABLE COMMUNICATIONS

DYNAMICALLY PRIORITIZED COMMUNICATIONS

The Motorola LTE-R system will immediately prioritize those users most critical to serving an incident, de-prioritize non-essential users, and where necessary pre-empt

Safeguard capacity for critical resources with Dynamic Prioritization and Pre-Emption. The LTE-R system maintains a profile for every user determined by their work group, role, the incident level and the user's participation to distinguish the appropriate service tier and dynamically adjust the quality of service (QoS) and prioritization tailored to the individual, application and event.

DISASTER RESILIENCY AND AVAILABILITY

Multiple layers of geographic and site redundancies, fallback operation modes, and hardened sites with extended backups and video site security ensure a highly survivable communications platform

Advanced redundancy and failover mechanisms pair with best-in-class equipment reliability to provide the strongest protection against catastrophic network failures. Innovative disaster recovery solutions leverage redundant and geographically separated network elements that are always active and ready for instantaneous takeover to provide seamless continuity of critical voice and data services.

EMERGENCY COMMUNICATIONS TRAFFIC MANAGEMENT

The LTE-R IP network architecture will be designed for optimal carriage of emergency communications, ensuring strict system-wide bandwidth management and traffic priority policies for key mission critical performance indicators

Extensive packet marking, complex contention negotiation and prioritization capabilities will recognize emergency voice traffic and ensure highest priority delivery; minimizing impacts of latency and jitter and managing available bandwidth during high density incident loading to guarantee near-instant delivery of potentially life-saving information.

END-TO-END SECURITY FRAMEWORK

End-to-end security framework will secure sensitive communications, protect signaling identities, shield operational information, and safe-house agency data without compromising operational agility

Military-grade security measures, strict information assurance and system-wide encryption will defend against threats and protect data resources for gap-free security across the entire communications platform from applications, IP transport, LTE-R, radio networks, down to the data on a user's device.

ON-BOARD COMMUNICATIONS AND CONTROL EQUIPMENT

TECHNOLOGY THAT'S SECOND NATURE TO OPERATE, EVEN UNDER THE MOST STRESSFUL AND DEMANDING CIRCUMSTANCES

The dynamics of operating a train can be extreme. To ensure safe passage of people and freight, train operators must have a real-time view of the condition and mechanical operations of the train, situational awareness of the physical characteristics of the track and movement authorities, and assured communication access to the Operational Control Center. Maintaining concentration and focus during high-stress circumstances is vital, and the operator's interactions with information derived from the on-board equipment must be intuitive and second nature to operate.

Motorola Solutions designs the on-board equipment bringing a strong understanding of high velocity human factors research. High resolution touchscreen interfaces, high performance audio accessories, and intuitive controls are designed with a holistic understanding of the driver's operating environment. For driverless trains, all of the required intelligence gathered from the onboard equipment is delivered with the highest levels of reliability over the TETRA and LTE-R network and presented to the remote line operator's position in the Operational Control Center.

AN ENTERPRISE IT SERVICE ORIENTED ARCHITECTURE

The Train Communication Interface System (TCI) becomes part of an On-Board Communications and Control Service Architecture allowing the flexibility to integrate a host of subsystems and applications using an Enterprise IT Service Oriented Architecture. The Train Control Management System (TCMS), Train Onboard Communication System (TOCS), Train Video Control System (TVCS) and Passenger Information/Entertainment System (PIS) can communicate directly into the service interface. The Train Communications and Control Panel (TCCP) provides a unified presentation of critical information across the various information streams to better guide and inform the train operator.

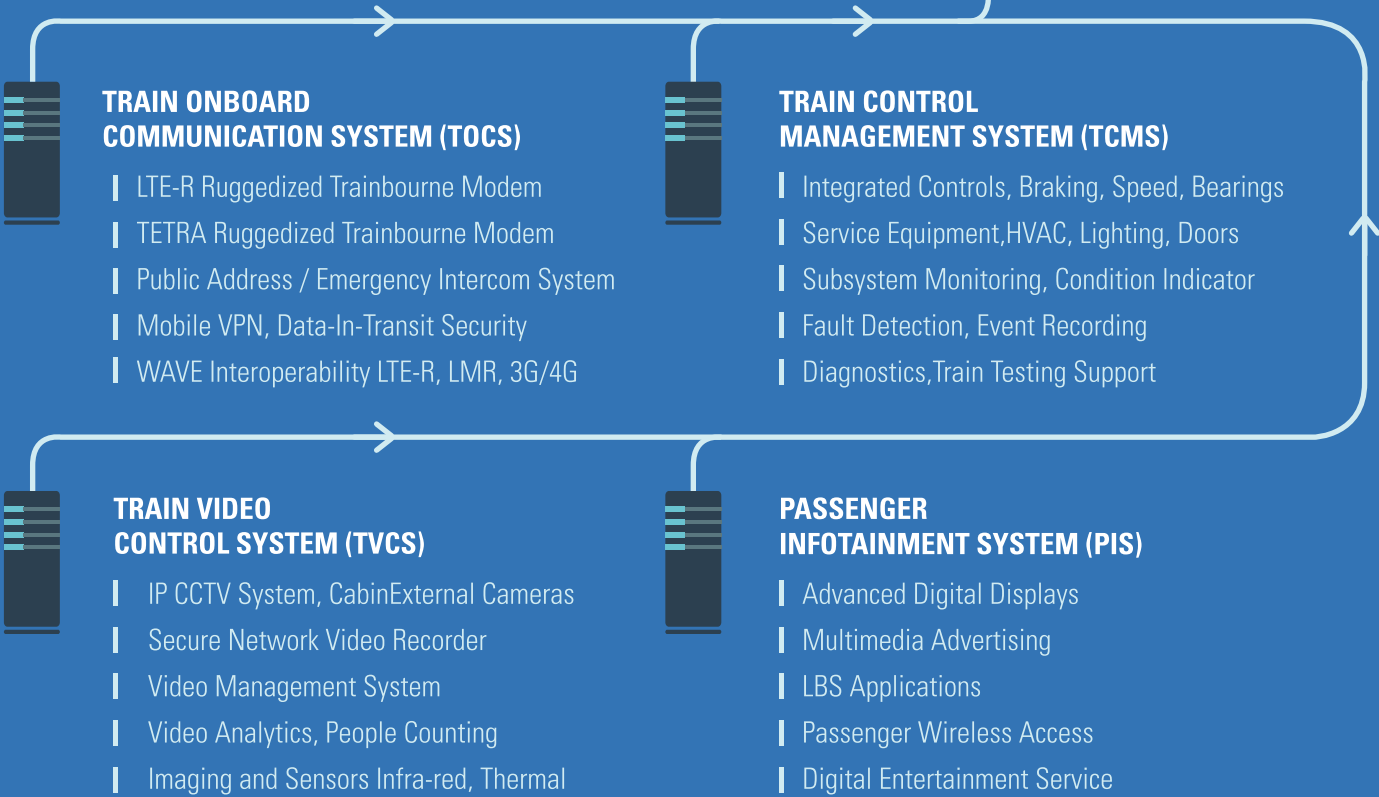


TRAIN COMMUNICATIONS AND CONTROL PANEL (TCCP)

- | High Resolution Touchscreen Interface
- | Intuitive UI/UX, Apps for High Velocity Operations
- | High Performance Audio Speaker and Microphone
- | Intuitive Control Buttons, Lighting, Indicators
- | Dedicated Emergency Button



ONBOARD COMMUNICATIONS AND CONTROL SERVICE ARCHITECTURE TRAIN COMMUNICATION INTERFACE SYSTEM (TCI)



INTEGRATED RAIL OPERATIONAL CONTROL CENTRE

ONE, REAL-TIME OPERATIONAL PICTURE FOR IMPROVED DECISION MAKING

Rail Operational Control Centres are increasingly looking to bring the operating advantages of next generation multimedia and intelligence-led command and control capabilities to improve decision making and ensure the safety and efficiency of all aspects of rail service.

Real-time monitoring of train location status, movement authorizations and schedule adherence as well as remote controls of wayside and trainborne equipment are foundational for dispatchers to safely manage rail service while delivering higher line speeds and shorter headways. Increasingly, Control Centres are also tasked with managing non-train operation elements such as CCTV video monitoring, electronic passenger and station information as well as security systems and intrusion alarms. With an Integrated Command and Control application platform, rail dispatchers will have access to an intuitive, unified operating picture where real-time information streams connect across Computer Aided Dispatch (CAD), communications consoles, video management systems and real-time data analytics for improved decision making and better outcomes.



CONVERGED COMMUNICATIONS IN THE COMMAND CENTER

A multimedia Rail CAD application provides a central convergence point for communications and resource management from multiple sources and systems vital to rail operations. Dispatchers will be able to monitor the location and status of all rail assets and personnel, deliver electronic instructions to crews via onboard equipment, and engage with operational teams at stations or service centers. As situations develop, the Integrated command system will enable voice and multimedia updates so response teams have up to the minute information at their fingertips. Operators will track incidents and response status in real-time on a single screen, rescheduling duties, initiating communications, and liaising with support agencies or Public Safety personnel. All for faster response and incident resolution.

STREAMLINED INCIDENT MANAGEMENT WORKFLOW

The Rail Operations Control Centre can scale from supporting the normal, real-time movement authorities of a main line operation to mass coordination across every level of the public transport security command when incidents evolve. Complete dispatch and incident management workflows will streamline the dispatch process from the moment an emergency incident is alerted, to dispatching rail field personnel, engaging with Public Safety agencies and updating field teams with new real-time information. The operating procedures supported by the integrated command system will be uniquely configured to align to the workflows of each of the participating agencies and work teams.

REAL-TIME DATA ANALYSIS FOR IMPROVED DECISION MAKING

A comprehensive records management and logging system will record all voice, data and video communications with strict information assurance and audit trail protections. Operators will have fast access to information coming from multiple databases with real-time analysis and correlation for effective, single-query search capabilities that link together all event-related information for improved decision making. With centralized data, rail operations teams will gain enterprise efficiencies in data management and retrieval and be enabled with enhanced information sharing.

EMPOWERING THE FIELD WITH SITUATIONAL INTELLIGENCE

The Integrated command solution extends communications center information to the field, and provides incident management and reporting capabilities to field personnel. With real-time information flow, frontline workers will have access to situational information for more prepared, more confident responses. Crucial information such as premise hazard and pre-plans, previous incidents, and access to remote technical resources will be quickly accessed in the field. Real-time distribution of bulletins and alerts will create immediate field awareness and supervisors will be able to monitor unit status and location through data feeds delivered to handheld devices.



INTELLIGENT VIDEO SOLUTIONS AND PREDICTIVE ANALYTICS

EYES ON THE TRACKS WITH RAIL VIDEO SURVEILLANCE SOLUTIONS

Intelligent video surveillance solutions are improving rail service decision making by adding the power of real-time sight and predictive analytics. Video surveillance solutions play an integral role in modern rail operations helping to secure critical rail infrastructure and high density public spaces while simultaneously integrating to create highly intelligent operations-wide surveillance systems that sees through cameras connecting trains, tracks, stations, and main-line aerial vehicles.

Motorola's end-to-end video solutions enable a wide range of powerful video-based capabilities, including:

- Streaming video to trains and handheld devices to increase real-time situational awareness and enable frontline personnel to assess events and circumstances while on the move.
- IP video architecture design supporting back office video management operations including mass-scaled video recording and storage, video distribution, analysis and retrieval.
- Integrating disparate analog and digital video networks into a single video management system accessible across Rail Operational Control Centres and Public Safety agencies.
- Utilising real-time and post-event analytics and correlation across voice, data and video information to recognize critical events that can help manage traffic and crowd behaviours and deter crime.
- Video wall matrices and integrated video control room applications enabling real-time monitoring at control centers.

As the world becomes increasingly security conscious, rail operators are increasingly discovering that there's safety in sight. Real-time video surveillance systems are proving to be one of the most effective methods of addressing a wide range of security challenges. Measured returns on these video surveillance investments have been extraordinary, factoring in savings from safety, security and efficiency.

AUTOMATED DATA ANALYSIS FOR MORE INTELLIGENT PREDICTIONS, TARGETED COUNTERACTIONS

By bringing automated intelligence and data analytics into the rail command environments, rail operations teams will be able to synthesize information and interpret the mass amounts of data coming from real-time passenger and driver information systems, rolling stock and infrastructure monitoring systems, signaling and sensor networks, video surveillance feeds, passenger-generated inputs and records and timetables.

Motorola Solutions combines enterprise data acquisition and analytics capabilities with proven design methodologies for extracting business intelligence from troves of raw data. A frontline team of domain experts and data scientists will help to define the customer requirements and guide the development of innovative business intelligence solutions within a customer's operating environment delivering quantifiable improvements in productivity, efficiency and safety.

Rail service providers will be better prepared to anticipate problems, make intelligent predictions, offer more targeted counteractions and plan optimal operating strategies.

Intelligent performance analytics will measure the real-time performance of the end-to-end communications platform and forecast where trouble may arise well before an alarm sounds. Enabling predictive maintenance and continuous improvement methodologies so levels of service consistently achieve sustained peak performance.

INTELLIGENT RAIL COMMUNICATIONS AS-A-SERVICE

BEHIND EVERY STEP THE POWER OF MOTOROLA

With the level of complexity and scale being considered with next generation rail communications solutions, rail service operators are increasingly looking to managed services to offload the burden of managing these complex platforms while ensuring uncompromising, mission critical performance and operational excellence. Motorola Solutions brings industry leading methodologies for managing communications, infrastructure, software and devices as a service. We have the highest accreditation and certifications in our governance model. And we direct tremendous investment toward developing the tools that allows us to manage the entire communications platform through a unified services delivery framework.

We serve large-scale, multi-service, multi-technology, multi-vendor environments which allow us to leverage our integration capability, logistical assets and footprint, and global infrastructure to deliver high levels of operational support for mission critical communication networks. As a full service provider to the rail operator, Motorola will provide a single point of accountability for service delivery and performance of the rail communications platform. This approach avoids the risks associated with multi-layer contracts and ensures a more responsive, cost effective end-to-end solution. With an outcome-based approach to measuring our performance we ensure that the focus is maintained on satisfying the organizational objectives of each functional work group and the operational requirements of the critical rail users.

Lifecycle management of the network will ensure that hardware and software stays current and delivers all features and capabilities to users while also ensuring that all network enhancements are directed toward an end-state network that achieves the long term vision of the rail service governance board.

DELIVERING SERVICE EXCELLENCE

Motorola Solutions brings a strong commitment to ensuring a holistic approach in delivering full lifecycle services, covering the entire Information and Communications Technology organization as well as all supporting operational components engaged in delivering services to the customer.

Motorola has embedded the industry recognized ITIL V3 management practices within our mission critical grade service delivery framework. The ITIL V3 methodology further brings a culture of continuous improvement to service delivery and performance. Motorola subcontractors are required to undergo a vendor validation process to ensure capability and value are qualified and that all services delivered are of the highest quality.

PROVIDING STRONG GOVERNANCE

Intelligent Rail Transportation Solutions require a sound operational framework to manage the communications resources, camera installations, edge appliances, mobile devices and applications management across the entirety of the rail service operations.

A Service Management Office (SMO) will provide governance and administration over the management and operating requirements of the converged rail communications platform. The SMO operations will be guided by the ITIL aligned service delivery framework. Activities of the SMO will include:

- ITIL Compliance
- Service Desk
- Resource Utilization
- Change and Release Management
- Incident and Problem Management
- Transition Management
- Quality Assurance
- Continual Service Improvement Management
- Managed Services Customer Portal
- Field Workforce Management

MAINTAINING THE HEALTH AND PERFORMANCE

Maintaining availability of critical communications resources is a foundational requirement of the rail service. Intelligent performance analytics tuned to key mission critical indicators, trend monitoring, and a structured continuous improvement plan will ensure sustained peak performance under the most challenging circumstances.

Real-time network monitoring services will provide 24/7 monitoring of the end-to-end rail communications network from the Network Operations Control Center (NOCC). Advanced detection and analytics will monitor network performance and stability in real-time for immediate event detection and advanced alarm filtering. Specialized staff will perform structured diagnosis and take immediate action to resolve the situation, escalate to operation engineers and communicate with operational users ensuring minimal disruption to operations.

A comprehensive preventative maintenance regime designed for mission critical services networks will maintain the health and performance of the entire communications platform. A carefully planned annual cycle of intrusive and non-intrusive testing on core elements and network sites will be planned to mitigate outage impacts and maintain accordance with service level agreements.

ENSURING DISASTER READINESS

Motorola's mission critical communications technology is defined by its ability to maintain assured communications to critical work teams when disaster strikes or a crisis forms. Advanced redundancy and failover mechanisms pair with best-in-class equipment reliability to provide the strongest protection against catastrophic network failures – whether resulting from a natural disaster or a targeted act of terrorism. Innovative disaster recovery solutions leverage redundant and geographically separated network elements that are always active and ready for instantaneous takeover to provide seamless continuity of critical voice and data services.

The availability and resiliency of our technology is further supported by a comprehensive Service Continuity Management (SCM) plan providing strict accordance to industry recognized Risk Management methodology and tools. The SCM provides assurances that a major incident disrupting the communications system is accompanied with a defined protocol that can be handled through the SCM at an operational level. The plan ensures training and accountability guidance for all affected personnel - from Motorola Operations Centre, Motorola staff, Motorola partners, rail operations staff, emergency services and key leadership stakeholders.

GLOBAL LEADER IN MISSION CRITICAL COMMUNICATIONS

**WORLD'S MOST COMPREHENSIVE PORTFOLIO OF
NEXT GENERATION MISSION CRITICAL SOLUTIONS**

GLOBAL LEADER IN TETRA COMMUNICATIONS

Motorola's deep commitment to developing industry-leading TETRA solutions for rail is guided by our role as prime TETRA critical communications provider to over 100 rail projects for over 40 years. As the world's largest supplier of TETRA radio communications, over 600 TETRA customers in over 100 countries trust in our technology for their critical communications.

Motorola Solutions deployed the first operational TETRA radio system for rail with Malaysia ERL as well as the first TETRA contract for high-speed rail in South Korea. Motorola's TETRA solutions for rail are serving over 3 million passengers a day in the London Underground, guiding driverless train operations across the Shanghai Metro, and covering the world's longest passenger railway system with Taiwan Railway Administration.

We have designed, deployed and operate the world's largest TETRA installations. This spans from the complex systems integration, managed service and looking through the entire supply chain and logistics management. Motorola is proud to be the leading supplier of nationwide TETRA systems, operating 30 nationwide systems and having won the last 9 nationwide contracts.

LEADING EDGE INNOVATOR IN MISSION CRITICAL LTE

As the pace of change in mobile communications accelerates, Motorola continues to be on its leading edge. Today Motorola Solutions is leading a new category of broadband innovations with mission critical LTE-R and Intelligence Led Rail Operations.

Motorola Solutions has placed a strong R&D focus on taking the industry's, standards-based LTE technology and developing on top of it the necessary capabilities to meet mission critical requirements for public safety, transportation and industrial applications. We have already invested over a quarter of a billion dollars to develop mission critical LTE.

Motorola Solutions has the great privilege of being awarded the role of prime contractor for the largest government Public Safety LTE contracts in the world. Bringing together an unparalleled ecosystem of the most recognized industry players in the Information, Communications and Technology sector, Motorola Solutions provides turnkey services to implement and manage Whole of Government networks.

UNMATCHED DOMAIN EXPERTISE, TRUSTED COMMUNICATIONS, STRONG RECORD OF INNOVATION

- | **12K+** Systems Worldwide
- | **100K+** Customers in 100+ Countries
- | **15K** Employees in 60 Countries
- | **27M+** Installed Base of Devices
- | **30** Nationwide Systems
- | **20+** Managed Service Networks
- | **7500+** Channel Partners
- | **5000** Design Engineers
- | **100+** Rail projects over 40 years

DIRECTING A PATH OF NATIONAL ECONOMIC DEVELOPMENT

Modern infrastructure projects of such scale and national consequence as rail development provide an unmatched environment for developing strong, local talent and elevating the capabilities of local industry.

Motorola Solutions feels strongly that the aspiring and talented local workforce should play a leading role in establishing the advanced communications platform that will help establish the foundation for national development and economic growth. By bringing together a strong consortium of local technology partners and training and engaging an in-country workforce, Motorola Solutions is committed to aid the high-valued job creation and human resource development that should stem from such important projects.

Motorola Solutions has seen great success working with nations around the world to align large-scale infrastructure projects with local industry development, identifying and partnering with local companies and helping them achieve dramatic, longstanding growth.



MOTOROLA SOLUTIONS IS A GLOBAL COMMUNICATIONS LEADER MOTIVATED BY A PASSION TO INNOVATE AND UNCEASING COMMITMENT TO ADVANCE THE WAY THE WORLD CONNECTS.

Government and Industrial leaders around the world turn to Motorola Solutions to help manage the aggressive pace of change in their communications environments. Our purpose is to help people be their best in the moments that matter.

Our team of industry leaders is committed to focusing our experience, expertise and resources to deliver the highest level of operational excellence to realise the full potential of next generation Intelligent Rail Transportation Solutions.



MOTOROLA SOLUTIONS