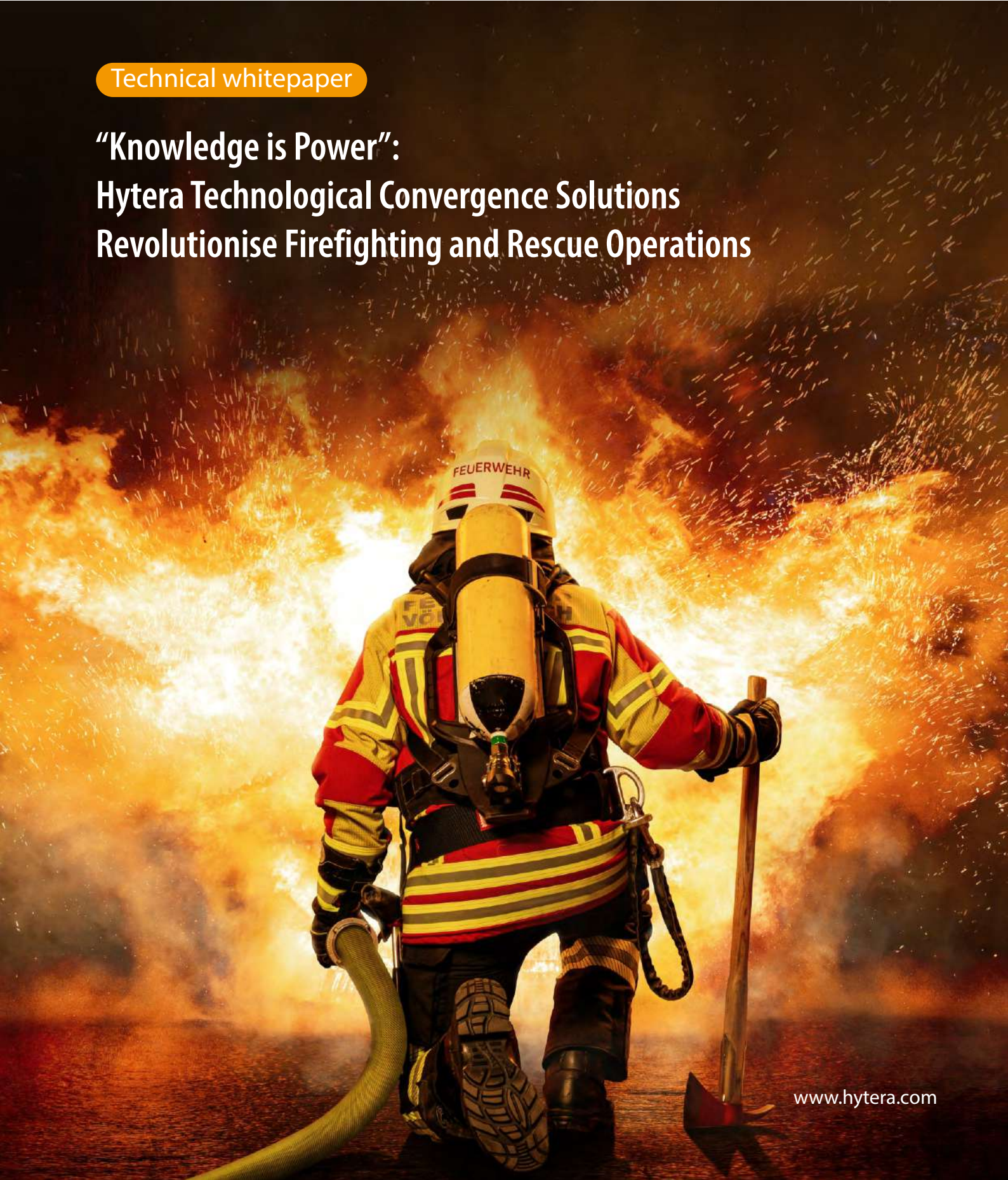


Technical whitepaper

**“Knowledge is Power”:
Hytera Technological Convergence Solutions
Revolutionise Firefighting and Rescue Operations**





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Executive Summary

As entering an increasingly hybrid network environment, we must adopt a technological-convergence approach to address the challenges we encounter in mission-critical firefighting communications, similar to many other industries. The experts at Hytera have developed a comprehensive convergence solution for next-gen mission-critical communication by embracing the cyber-physical systems (CPS) concept through a holistic framework. Our vision is to assist fire departments in addressing their challenges and transforming voice-dominated operations into smart firefighting of the future. With decades of industry-leading expertise and dedication, we have been helping our customers resolve problems by exploiting mature and emerging technologies. With our recently developed innovative convergence ecosystem, we leverage our extensive research and initiatives to provide resilient, seamless, interoperable communication solutions. Our goal is to enable our customers to accelerate their service transformation while keeping firefighters connected and ensuring their safety at all times.

The firefighting profession involves dealing with some of the most difficult and hazardous conditions imaginable, making it one of the world's most challenging and dangerous occupations in protecting people from life-threatening situations. In addition, firefighters must use different tactics as they face various types of disasters, including urban fires, wildfires, floods, earthquakes, storms, environmental hazards and many other types of emergencies.

Incidents are hard to predict, safety and timely response are paramount, and firefighters rely on reliable, fast communication and well-informed decisions. This only can be achieved by embracing technologies through a comprehensive and flexible approach, which can mean the difference between success and failure, life and death. As we turn to insights into the future, beyond continuing the two-way radios digitisation and the upgrade of equipment and fire apparatus, professionals have been exploiting emerging technologies and developing new approaches to revolutionise fire services. These initiatives will shift the paradigm from traditional and experiential-based firefighting to data-driven smart firefighting by leveraging CPS and next-generation MC communications.

With a deep understanding of best practices, industry insight, and research in this sector, we elaborate on how to reassure firefighters can get through their communication even under the

most strenuous emergency circumstances and how to harness the data to enable smart firefighting through our proposed approaches. Drawing on the convergence innovation ecosystem, we will illustrate our holistic converged communication system that connects isolated systems, computing and IoT sensors. It seamlessly combines the three main subnetworks: WAN, LAN and PAN. It features a wide range of fire industry-specific functionalities as a standard inclusion, making them uniquely capable of forming an integral part of CPS in the firefighting sector. By providing resilient, robust, secure, high-performing, and interoperable connectivities, our solution is set to empower firefighters with "knowledge is power" and help achieve the objectives of smart firefighting of the future, unlocking the enormous potential of the profound shift.

The following aspects, among many functionalities, differentiate our focus from others in keeping firefighters connected and safe, and taking fire communications into the future, harnessing the power of our convergence innovation.

- Enhance voice-only communications by adding broadband capability with LTE and 5G, delivering mission-critical PTTtoC, incorporating smart sensors, and accessing critical information through converged smart devices.
- Using new powerful platforms with software suits addresses the broad-scale implementation of interoperability and compatibility among vertical systems by different roles to support seamless cooperation and deliver optimal responses with real-time information sharing.
- When deployed on different platforms such as vehicles, boats, trailers, aircraft, and backpacks, e-Fusion provides the quick and flexible establishment of tactical communications on fire ground through hybridised networks. Combining DMO, e-pack, Mesh, deployable LTE, Wi-Fi, satellite, and aerial is crucial to ensure firefighters have a continuity of service through highly accessible communication, reliable fallback features, and robust data transmission when fighting a fire at the scene.
- Especially when faced with "new extreme events", the future-proof solution converging hybrid networks, including PMR, LTE/5G, e-Fusion and more, ensures the creation of



high-resilience wireless networks and the delivery of next-gen MC communication. As a result, end users benefit from the most valuable features: seamless mobility without disruption and roaming between two MNOs with improved resiliency.

With those unique capabilities specific to the industry, the solution has been at the forefront in supporting fire departments and other emergency agencies with increased safety of firefighters and broader cooperation among responders, improving operational efficiency and effectiveness with enhanced situational and incident awareness. Specialising in a wide range of wireless technologies, fully interoperable communications, customised connectivity tools, and unified dispatch and cloud platforms, Hytera has been serving many of the most vital organisations for decades. As a result, our products and solutions have gained widespread trust from police, fire, emergency management and other public agencies, physical security organisations, and industrial enterprises across the globe, helping them better plan their response and be ready for the unexpected.

This whitepaper discusses:

- Ongoing and future challenges in firefighting include a lack of complete, real-time data, information knowledge and limited communication links and sensors.
- Reviewing the transformation towards smart firefighting, which promises to enhance firefighting efficiency and effectiveness while improving safety and health in this high-risk profession.

- Perceive the search priorities to address communications demands and focus on developing systematic connectivity approaches and solutions to work with cyber-physical systems (CPS) to gather, process, and utilise data, aiming for data-driven decision-making.
- Explain how we help customers design, organise and create next-gen MC systems through our innovation to address their unique challenge and enhance firefighting beyond other solutions.
- Lastly, the approaches and solutions are well-proven through a number of use cases, successful examples and best practices, including in China firefighting and rescue.

In this document, we provide insights on approaching the best future MC systems and our innovative initiatives for particular fire operations, helping re-examine your organisation's transformation strategies on future-proofing your network to withstand challenges appropriately. With the right technologies, innovation and processes in place, our solutions will enable you to reshape and evolve your MC communications and gradually achieve smart firefighting and rescue, ensuring your communications system is poised to save lives and protect your teams. We also look forward to continuing to meet your requirements in the future.

Gerald Zhang
 Director of Global Marketing and Solutions
 Hytera

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CPS enables the evolution of fire service towards smart firefighting and rescue

Fire and rescue services are critical to ensuring public safety, beyond fighting a structural fire, responding to a range of other emergencies, such as wildfires, structural collapse, search and technical rescue, animal rescue, natural disaster rescue, maritime and aircraft rescue, road accidents, and emergency medical assistance.

Firefighting is hazardous and has unique challenges. The fire ground can be chaotic, with dynamically changing conditions that are hard to predict. Fire losses worldwide remain high, and natural disasters have increased in size and number. During the past 50 years, the number of recorded natural disasters worldwide, such as wildfires, floods and earthquakes, has surged nearly five-fold, causing extensive damage. In addition, firefighters are confronted with "new extreme events" with increased complexity and diversity and need to take new initiatives to protect people from these growing threats: synthetic materials in indoor fires produce more toxic smoke and fumes, thereby increasing the hazard; overoccupancy in the city increases the potential frequency of fire incidents and dramatically increases the life hazard; grass fires can spread very quickly, while forest fires can become a raging inferno in a matter

of an hour which is highly destructive and can cause severe loss of life; search and rescue usually operate across less-populated, larger and remote areas; as disasters such as an earthquake can occur everywhere and affect a large number of people.

Swiftly and effectively responding to emergencies can mean a difference between the death and life of civilians, whole villages, firefighters and other emergency responders. The losses can be reduced, and safety and health can be improved by exploiting new technologies and introducing new types of systems called Cyber-physical systems (CPS), which have been proven successful in several industries, such as manufacturing. It is commonly referred to as the fourth industrial revolution, which began with industry 1.0 in 1784, as shown in the following diagram, resulting in improved productivity, efficiency, prediction, and resilience. These advantages can also be leveraged for fire protection and fighting and rescue, where CPS can help transform traditional firefighting into smart firefighting, aiming the vision: to save more lives and further minimise injuries and loss, improve firefighter occupational health and safety, enhance the overall operational efficiency in the fire and rescue service and the effectiveness of prevention, protection and response.



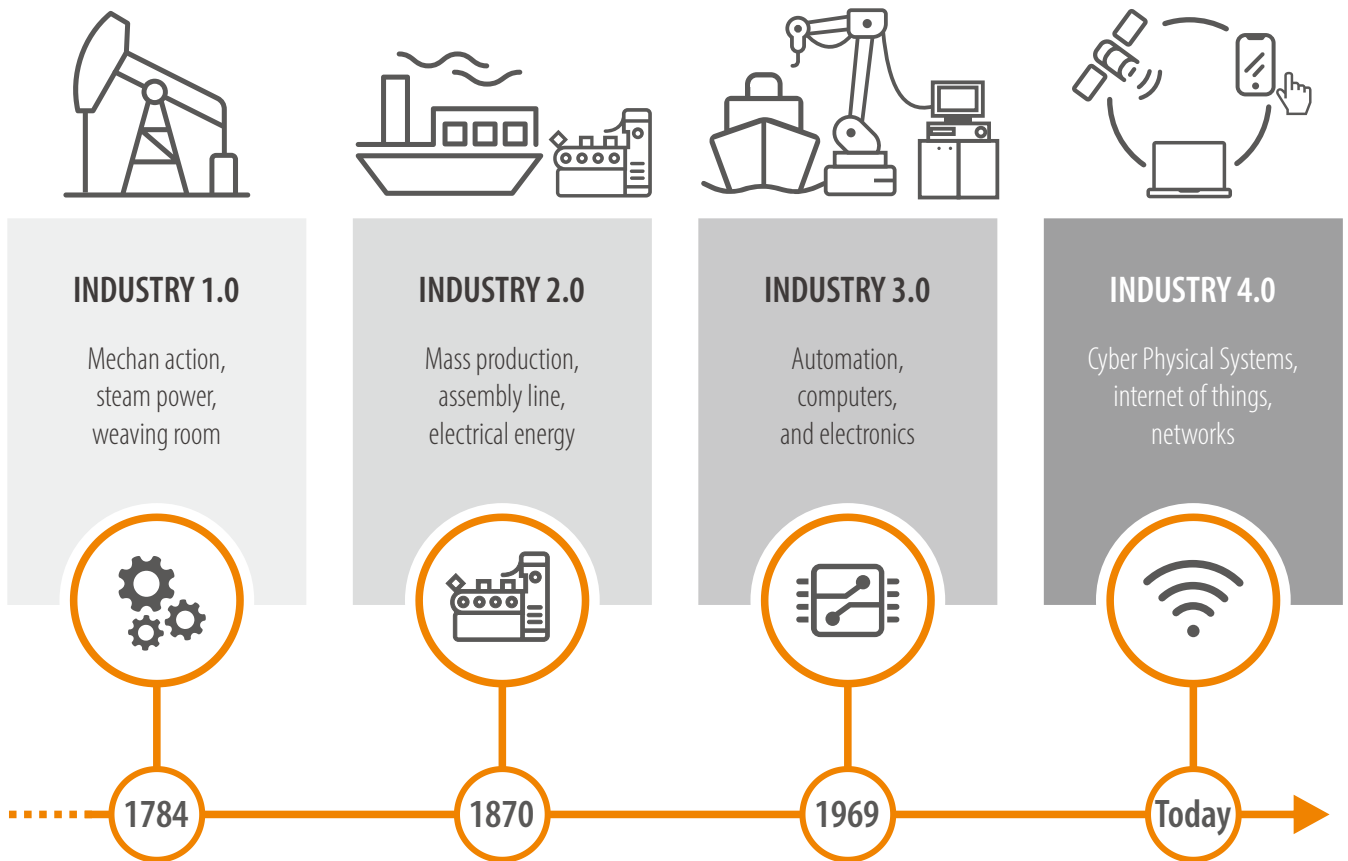


Figure 1: The industrial evolution towards CPS-powered industry 4.0

The framework for smart firefighting covers all areas of firefighting engineering and phases of fire service: pre-incident, during-incident, and post-incident. Through the fusion of emerging IoT sensors, computing technologies and advanced communication systems and the use of a wide array of real-time data from the community, building, fire ground, firefighters, equipment, and firefighting apparatus, and information from

the cloud, CPS will revolutionise fire services by fully exploiting the power of data, enabling enhanced situational awareness of the fire ground, better predictions of likely evolution of incidents and better-informed decisions by collecting the data globally, processing the information centrally, and distributing the results locally.

3

Next-gen mission-critical communications are fundamental to the transformation of smart firefighting and rescue

Mission-critical communications can be defined as the ability to deliver a fast and reliable response to an emergency, for example, a fire or a natural disaster, which means the difference between death and life. For decades, narrowband voice-based PMR systems have been implemented globally to support reliable communication for first responders. In recent years, new solutions have emerged in mission-critical communications, enabled by the advancement of mobile broadband technologies (i.e., LTE/5G) and the prevalence of smart devices and sensors. These solutions offer a range of new features and capabilities,

from HD video streaming to IoT applications, that have the great potential to enhance the effectiveness and efficiency of first responders in an emergency.

As public safety organisations and fire departments transition towards mission-critical broadband communications, the pivotal attributions, including availability, reliability, resiliency, and interoperability, become more paramount for the function of public safety networks. As shown in figure3, the following considerations will be prioritised in the near and middle term.

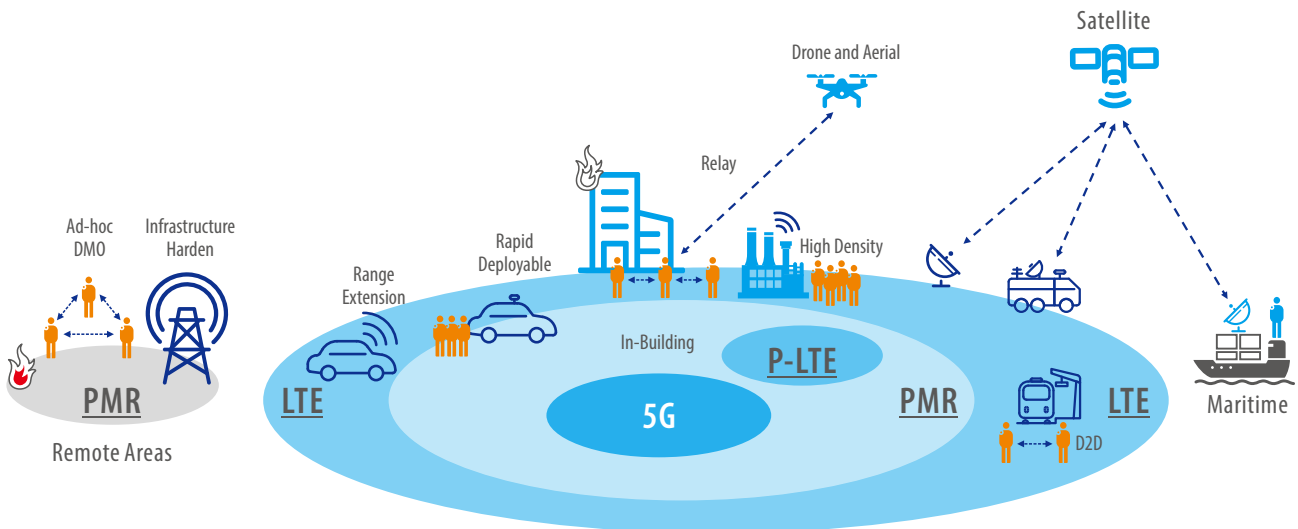


Figure 2: The evolution of public safety network of across ground, aerial and space domains

Coverage

Emerging public safety operation increasingly requires connectivities with anything, anytime and anywhere, driving the development of three-dimensional networks: terrestrial (ground), aerial, and non-terrestrial (space). Therefore, deploying a nationwide network that covers all operational areas, including outdoors, indoors, airborne and maritime environments, can ensure a successful response to large-scale events, enabling responders to access the networks from anywhere and providing seamless mobility. In addition, a dependable tactical system is crucial to the network as it provides quick coverage in case the primary network is unavailable and delivers critical communication and data transmission.

Resiliency

Prioritising the implementation of the convergence of PMR and LTE is critical in building a nationwide network and laying a foundation for integrating hybrid networks in the future. Furthermore, the extensive integration of wireline, Mesh, microwave, satellite, Wi-Fi, HF radio, 5G and more will create a more resilient network with densification and ubiquitous connectivity, preparing for better national security and emergency preparedness.

Interoperability

The communication network is fundamental to smart firefighting, providing connectivity to support data gathering, processing, and targeted communications. However, fire departments must create seamless and fully interoperable communications among team members, dispatchers, IC and other emergency responders, regardless of location, roles and devices. Convergence-driven solutions coupled with industry-specific features will facilitate the implementation of next-gen MC communications and ensure the flow of critical information where and when needed, enabling a successful transition and improving the effectiveness of firefighting operations.

Cellular mobile network

Driven by improving efficiency and effectiveness and minimising investment, cellular 4G LTE and 5G networks are increasingly integrated with narrowband PMR systems to form a convergence network. As a result, public safety organisations can take advantage of substantial and tangible benefits: addressing interoperability of inter-jurisdictions during large-scale events, complementing PMR indoor coverage, extending the existing PMR network's geographical coverage, adding new MCX services and other intelligent applications, and importantly, harmonised ecosystem with large-scale.

Future 5G

With ultra-high capacity and ultra-low latency, 5G has the potential to help firefighters enhance their senses through thermal imaging and augmented reality (AR). Mounted to a helmet or mask, it provides a hands-free vision of the heart of fire, allowing firefighters to see heat levels, navigate the hazardous environment, and share this data with the team through combining MESH Link. Synergy with Wi-Fi or Bluetooth devices, 5G can overcome most current challenges of indoor locations. Being incorporated into IoT infrastructure, 5G will enable fully connected firefighters, such as fire self-driving vehicles, bio-connected wearables and more. All these will point to a new path forward to inspire smart firefighting.

4

The essential five communication stages throughout an incident response process

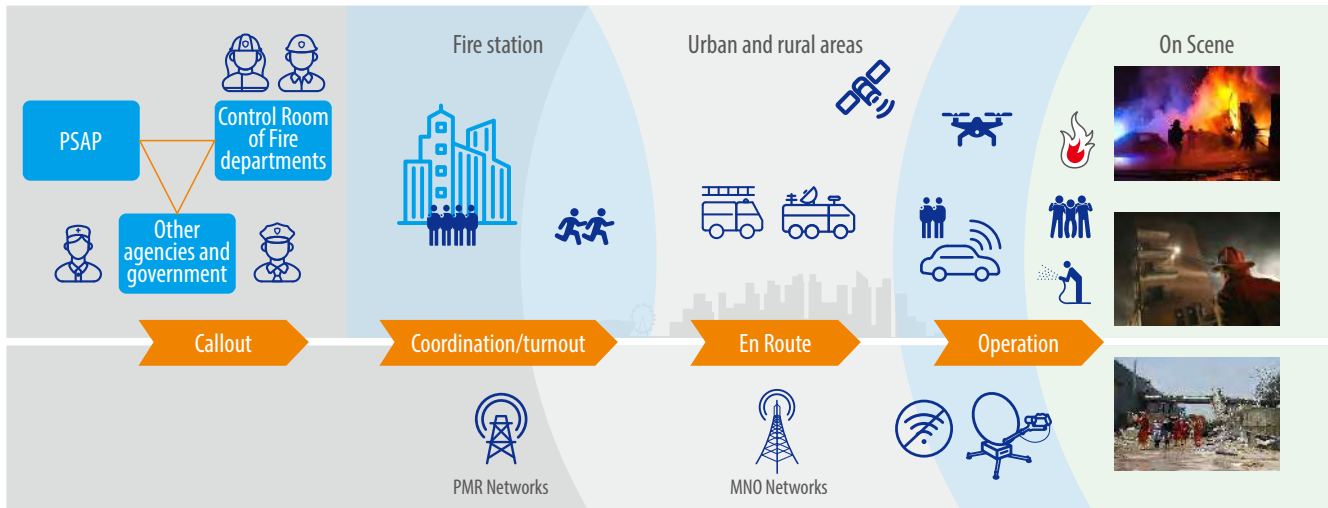


Figure 3: Five essential communication states in responding to fire incident and natural disaster

As incidents become more complex and challenging, fire services worldwide merge with other emergency response agencies, such as disaster management, medical emergency service and more. In China, for example, since firefighters joined emergency management agencies, they have taken on a broader range of tasks, including prevention, early warning, coordinating and responding to both man-made incidents and natural disasters, and post-incident investigations.

To meet the challenges and adapt to changes, firefighters must respond quickly to extinguish fires and perform search and rescue, which is crucial for saving lives. Moreover, personnel and equipment must be dispatched as fast as possible. Modern fire departments are exploiting new abilities involving automation, AI and analysis to improve efficiency, effectiveness and safety. Intelligent command and control are increasingly important to coordinate the right resources rapidly in ever-changing situations to initiate a successful response plan. The data-driven process relies on a contemporary control room encompassing computer-aided dispatch (CAD), actionable tools, and streamlined emergency management processes. Collecting data from various sources over ubiquitous connectivity is also essential for success throughout an event.

Phases of an incident (pre-, during-, and post-incident) are vital in describing the entire response stages. In addition, technological evolutions have enabled new use cases and changed how things operate. For example, awareness and assessing the situation are critical to coordinate resources quickly and adequately when a disaster happens before firefighters arrive on the scene. Commanders or dispatchers need to collect real-time information in a range of ways. This includes gathering footage of the incident from CCTV and video streaming from eyewitnesses via mobile phones, remote-controlled UAVs or unmanned vehicles inside structures. Additionally, satellite remote sensing services with advanced imagery can detect wild or forest fires despite barriers. For communications in areas where infrastructure is damaged, satellite communication such as voice via satellite phone, real-time videos via broadband satellite devices and cameras used by a task force assigned to explore the situation of a large-scale disaster like an earthquake are critical.

Despite the diversity in fire and rescue services, an event chain with five essential stages forms an underlying pattern: call-out, coordination/turnout, en route, operation and return to base. The following details what smart firefighting might look like, using firefighting in China as an illustrative example (figure3).

1

The first stage is when emergency alerts are received by public safety answering points (PSAPs) through various means, such as voice calls, multimedia calls, apps, IoT sensors and more. These alerts are immediately routed to dispatch centres through 119 IP networks in China. The dispatchers then categorise the incident and develop a response plan through informed decision-making using the information collected in the control room. Once the response is developed, a call-out is initiated by one touch through intelligent CAD to dispatch firefighters and equipment from fire stations near the incident.

2

During the coordination and turnout stage, once on-duty crews are alerted and apparatus is assigned, firefighters at the fire station don their protective gear, collect communication devices, and depart for the incident site. In the case of large-scale events, additional firefighters and resources might need to be dispatched from multiple fire stations across different regions.

3

During the en route state, the Incident commander(IC) and firefighters must arrive at the scene as quickly as possible while keeping connected with the control room to view dispatchers' comments through PMR or cellular networks. Smart devices and LTE-connected mobile data terminals (MDT) allow team members to access data-intensive information such as building information, fire hydrants locations, and real-time video of the scene when they move to the cellular network coverage area. Advanced location services assist teams in navigating through heavy traffic to find the best route to an unfamiliar location. Real-time location awareness enables dispatchers to trace all personnel and vehicles for quick dispatch and ensured safety. During large-scale events, a mobile command and conference centre with satellite links is utilised for mapping and planning firefighting operations and directing crews as they arrive on the scene, forming a task force team.

4

The fourth state begins when teams arrive on site. The IC establishes a command post and a primary ground-based temporary communication network. If necessary, this tactical network may include aerial and satellite communication, especially in complex terrain or large geographical areas. IC will become the focal point of communications on the scene, using comprehensive information and analytical tools to assess incident and risk and initiating a series of action plans: suppressing fire and rescuing victims, alerting the community, creating a contingency plan, managing and dispatching resources, coordinating the task, and overseeing the firefighters' safety. Localisation services can pinpoint the firefighters on the scene with building layout and safe exit and escape paths. The dispatchers in the control room support the IC, monitoring and logging fire ground events, processing requests for more resources, and recording the fire ground's traffic for post-event review and research. Establishing and maintaining reliable connectivities among IC, firefighters, and dispatchers can be challenging but critical in keeping firefighters safe.

5

The final stage is post-incident management, including cleaning up, returning to the fire station, repairing equipment, debriefing, and providing feedback. Accurate assessment of the effectiveness of equipment, tactics, and resources can best be achieved by observing, recording, and archiving information about incident characteristics, resource capabilities, location and operation through fire service apps and other tools.

5

The development of a communication framework for converging three-level networks

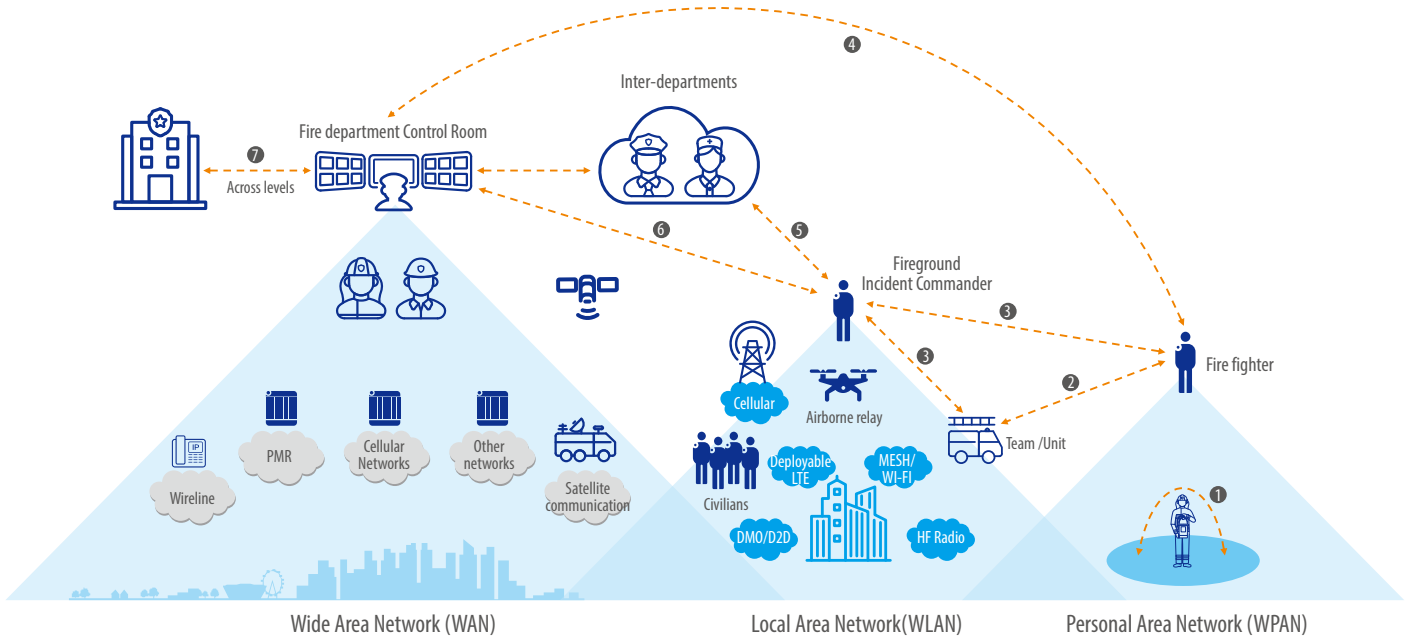


Figure 4: the comprehensive framework for building next-gen MC communication and smart WSNs network for Firefighting and Rescue Operations

Effective communication systems are crucial for emergency operations and incident command and control. While two-way radios remain the primary voice communications for fire departments, the shift to digital radio is ongoing. However, smart firefighting will require reliable voice, high-performing data communication and integration of smart sensors as a distributed CPS. Therefore, new technologies and delivery methods are needed to collect and transmit real-time data across a wide area network (WAN), a local area network (LAN) and a personal area network (PAN). In China, these are known as "three-level communication networks" for firefighting and rescue, comprising fire control coverage networks in the city, command and control networks on the fire ground, and fire fighting communication networks. The key challenge is identifying appropriate technologies and prioritising research initiatives to meet the diverse fire operation needs. In addition, while transitioning to next-gen MC communication, global public safety organisations converge various technologies and networks, necessitating

multi-layered comprehensive solutions to adapt to complex technological convergence environments and the growing adoption trends.

We propose a holistic communications approach to support smart firefighting and rescue by developing an innovative convergence framework. This will help fire departments to shift towards data-centric firefighting and expand their wireless communication capabilities, including interoperable communications between IC, crews, firefighters and dispatchers. The framework also includes enhancements to improve the network's resilience, including enhancing WAN macro networks, boosting LAN and PAN networks, and introducing a single "converged" device that seamlessly works across all networks. By implementing this framework, fire departments can establish a "disaster-resilient" communication system that meets the requirements of public safety grade networks and smart firefighting and rescue operations:

1

A personal area network (PAN, i.e., body area subnet) connects a firefighter's various sensors through Wi-Fi, Bluetooth, etc. Examples include a helmet camera, SCBA air-level alarm, tracking and locating devices, bio-vital signs monitoring and hazmat sensors. A smart device manages sensors, some data is stored locally, and some are transmitted to the IC, such as monitoring the firefighter's health. A robust PAN communication system with multi-transmitting paths, a long-duration battery and a ruggedised device, is crucial to secure data transmission. Furthermore, increasing attention has focused on reducing the number of devices and the overall weight of the apparatus. The perceived priority of industry research in this area is to develop a converged smart device that combines existing and emerging wireless technologies as both a primary communication device and a sensor access hub.

2

A local area network organised by IC combines multiple wireless technologies for tactical communications, allowing responders to communicate inside a building or over a large area. DMO is preferred for voice communications due to signal penetration and HF radio long-range propagation. Ad-hoc PMR repeaters can increase coverage range in a multi-hop manner, while promising MESH offers fast deployment, self-configuration, and self-organisation for dynamic data communication. MESH can penetrate dense construction, materials, and thick smoke in structure fire scenarios and work with satellites and aerial vehicles for natural disasters across large areas.

Generally speaking, candidate LAN technologies include MESH, Wi-Fi, DMO, LTE/5G cellular or D2D, deployable LTE, satellite, microwave, and airborne relays. However, integrating and organising them to avoid is particularly challenging to prevent reliance on a single technology. For example, an aggregation node is required to connect different networks with disparate radio technologies and ensure all information routes through IC's terminal. In addition, the frontline command centre requires a rugged design with multiple transmission paths, backup backhaul and ideal duplication to prevent major point failure.

3

Multi-agencies and cross-levels of the fire department's communications for large-scale events.

The growing number of large-scale emergencies highlights the need for better coordination between agencies and the development of interoperable solutions to ensure seamless connectivity and real-time data sharing across different technologies.

Fire departments have improved their fixed-line communication systems, allowing portable digital radios to connect directly to dispatch audio systems. However, when firefighters or ICs are out of the coverage range of the PMR macro network, they can lose connection with dispatchers. To combat this, fire departments should leverage cellular networks to supplement PMR's limited coverage through a network convergence approach. This converged macro network also depends on short-range LAN equipment, such as repeaters, relays, and MESH, to extend coverage in remote areas and address complex and evolving situations.

Here is a clear need: A basic framework and specific work program are required to enhance communications between firefighters and achieve interoperable multimedia communications nationwide; Integrated networks will provide the essential infrastructure for ubiquitous connectivity, collection, computing, and creation of mission-critical IoT; and end-to-end integration of supported communications will facilitate the implementation of smart firefighting.

In the pursuit of smart firefighting, global public safety organisations have explored next-gen MC communications, cyber-physical systems (CPS), and mission-critical IoT use cases. For example, in China, experts have developed a comprehensive methodology and framework for smart firefighting, leveraging emerging technologies and convergence approaches to achieve seamless connectivity and real-time data sharing in dynamic heterogeneous networks.

6

The holistic convergence communication solution uniquely supports smart firefighting for all disaster and emergency responses

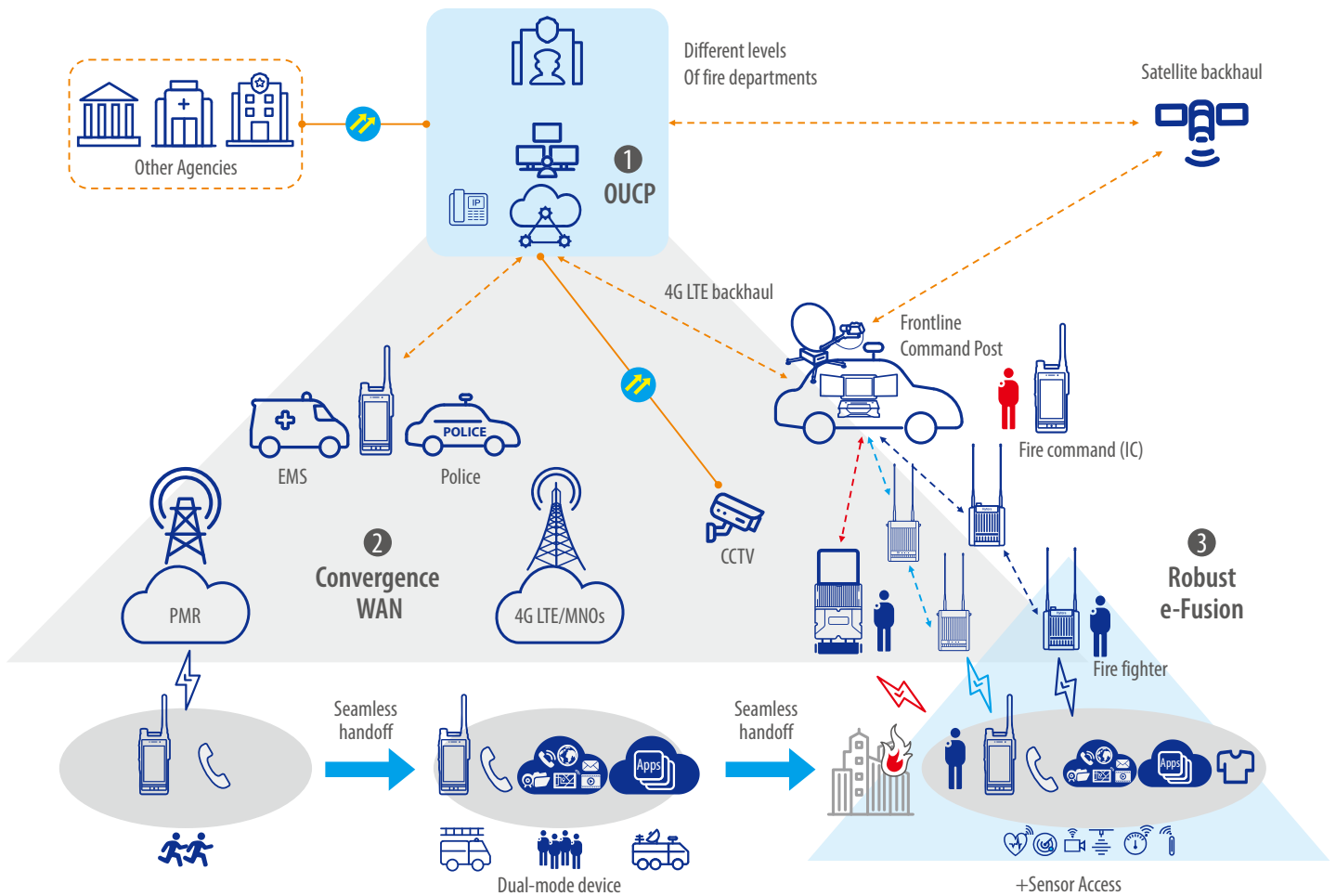


Figure 5: the convergence solutions for the next-gen MC communication and smart WSNs network

Since the industry embarked on the long transformation journey, Hytera has pioneered innovative solutions that support public safety and fire departments to achieve unprecedented collaboration capabilities by deploying next-gen MC communication systems. With resilient and seamless connectivity, the new system will also help accelerate the transformation from traditional tactics and strategies relying on experimental, exclusive voice and limited data to smart firefighting with CPS-based data-driven informed decision-making and intelligent command.

To make it possible, creating necessary standards and

harmonising the ecosystem are only part of the solution; delivering services that take advantage of such capabilities in a timely, cost-effective and affordable manner is a significant task. As described in the previously released white paper, Hytera's "convergence-native solution enables next-gen mission-critical communication" that fundamentally addresses these concerns, making it a vital part of the solution. As part of this complete solution, a converged ad-hoc-centric ground system aligned with aerial and satellite will form a robust 3D tactical network in affected areas to provide services where it would usually not be available whenever needed.

Drawing on the holistic approaches as mentioned before and the convergence ecosystem (refer to convergence-native whitepaper), Hytera developed a comprehensive end-to-end solution that consists of four functional subsystems, as shown in figure 5:

- The OUCP platform integrates a wide range of disparate networks for supporting fully interoperable communications and real-time information sharing;
- The Convergence-Native innovation to deeply converge PMR and 4G LTE networks to form as an enhanced WAN, enabling seamless connectivity and mobility;

- The e-Fusion quickly deploys an integrated but flexible tactical network that combines various wireless technologies to support robust LAN and PAN at the scene to substitute or complement WAN whenever needed;
- The dual-mode smart device stays connected at all times and handoffs across all networks and technologies.
- The following is a summary of each of the subsystems. seamlessly handoff between communication networks.

☑ To better support firefighting and rescue operations during extreme events and low-severity but high-probability emergencies, a wide range of systems must be integrated, including fixed-line networks, traditional radio, PMR networks, cellular networks, tactical networks, CCTV systems, and more. OUCP, a modular and comprehensive platform that combines multimedia unified communication, unified dispatch, centralised management, and recording, is a crucial department.

☑ Hytera has designed a multi-layered solution to embrace the deployment of mission-critical broadband communications over MNO infrastructures. This solution helps fire departments accelerate the evolution of their communication systems from traditional radio to converged PMR/LTE networks. Leveraging existing 4G/5G high-performing networks provides them numerous benefits, such as reducing TCO, sharing large-scale ecosystems, and roll-out broadband services widely with ubiquitous coverage. In addition, the converged network and device synergy enable firefighters to take advantage of advanced features such as real-time multimedia communication, mobile video conferencing, and receiving images and videos from the scene. Other benefits include keeping teams connected anywhere, advanced location services, and seamless mobility. Finally, the system offers firefighters access to the workflow for incident reporting, viewing dispatchers' comments and collecting information on mobile devices while en route to an incident.

☑ E-fusion is a next-gen tactical communication system that converges e-pack2.0, e-mesh2.0 and deployable LTE, supporting firefighters in setting up a network quickly and flexibly on the scene. With seamless integration with other networks, e-Fusion ensures operational continuity by extending coverage and providing resilient voice and multimedia communications. Additionally, it leverages MESH, LTE, and Wi-Fi for robust connectivities for video and data-intensive resources, such as biometric and environmental sensors around a firefighter, transmitting real-time streaming data to IC. E-Center also provides frontline ICs with centralised command and control to coordinate all firefighters and resources on the scene via its all-in-one platform.

☑ Developing a next-gen communication device is a key priority in the evolution of smart firefighting. Hytera's dual-mode rugged radio is designed to evolve current PMR-based devices with a smart, adaptable, and converged voice and data communication device. This device combines multiple radio access technologies such as LTE, PMR, DMO, Wi-Fi, and Bluetooth; it can automatically attach them and handoff between them to deliver reliable voice, data, and fire apps. In addition, with fire-specific hardware and software enhancements, the device creates a robust PAN that enables firefighters to carry fewer devices. In a word, Hytera's dual-mode smart radio can easily connect to e-Fusion and converged LTE/PMR networks, connect various sensors and

7

E-Fusion, the next-generation field communication solution

Connectivity is crucial to IC and firefighters as they battle moving and changing threats. Hytera convergence solution not only enhances the reliability, availability and resiliency of WAN but also adds new abilities, including traffic prioritisation, multi-band devices and multi-operator roaming, which are indispensable in the presence of interference, lack of coverage and during network congestion. These features are essential in areas with interference, lack of coverage, and network congestion. Furthermore, e-Fusion is a next-generation field communication solution that provides robust connectivity when macro WAN network coverage is unavailable. We provide a full range of products to support the specific needs of smart firefighting and enhance LAN and PAN connectivity.

7.1 E-Fusion, a leading field communication solution, is poised to establish robust LAN and PAN.

Occupational health and safety is a top priority for firefighters, and real-time situational awareness and data exchange is crucial to improving their effectiveness, efficiency, and safety. While two-way radios have traditionally been used for communication and safety purposes, they have limitations when it comes to navigating unfamiliar and hazardous environments. To address this, fire departments are integrating smart sensors into firefighters' protective equipment, including oxygen level sensors, infrared cameras, environmental sensors, biometric

sensors, and positioning sensors. These sensors require low latency and high-bandwidth links for instant readability and sharing among on-board personnel, units, IC and firefighters, and multi-jurisdictional teams. There is also a need to access information such as building plans, maps, and weather conditions on the scene. Therefore, a reliable and interoperable field communication system is essential to collect, process, and convey real-time data across platforms.



Figure 6: End-to-End Industrial-Leading e-Fusion field communication solution

E-Fusion is a compact, advanced field communication system that uses emerging wireless technologies like multi-hop DMO repeater, MESH/D2D, LTE and more, along with Norsat satellite terminals and aerial relay, to provide comprehensive and flexible connectivity solutions for diverse needs. It offers super-fast, super-light and broader range coverage and stands out with its focus on ad-hoc DMO and Mesh networking approaches and network convergence. E-Center, a part of e-Fusion, provides an all-in-one platform for centralised command and control,

combining unified frontline dispatching, video surveillance and GIS map. By using personal and field sensor networks and distributed computing tools, the system also enables real-time data transmission between IC, dispatchers and firefighters. In a word, It is a robust, flexible and intelligent system that can address the diverse needs of smart firefighting and rescue. Its implementation is described with two basic variants for typical structure fires and large-scale disasters like wildfires and earthquakes.

7.2 The e-Fusion-compact solution supports small teams in responding to typical structure fires quickly and efficiently

In structure fires, quick suppression is crucial due to the increased use of synthetic materials that cause fires to escalate faster and produce more toxic smoke. Hytera's e-Fusion-compact solution is designed to address this need for faster dispatch, quicker deployment, and smarter communications in hybrid network environments. The solution integrates e-pack2.0, dual-mode devices and a built-in enhanced Hy-talk Pro app and seamlessly

works with the Hy-talk Pro platform, offering numerous features tailored to firefighting needs, which includes one-button switch, one-button call, seamless handoff, DMO repeater, and dual-channel transmission. As a result, e-fusion-compact simplifies operations for firefighting teams while providing them with reliable, interoperable voice communication and critical sensor data transmission across WAN and LAN networks.

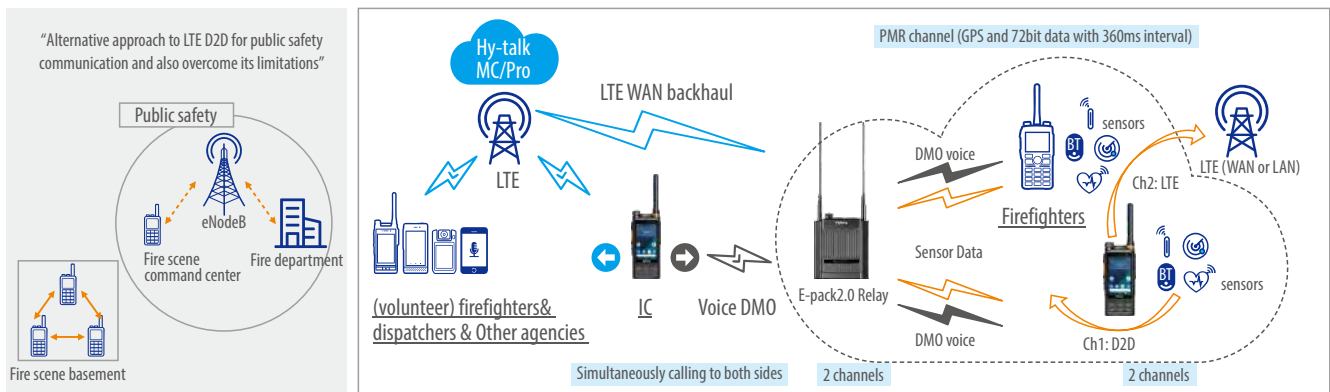


Figure 7: e-Fusion compact solution leverages the enhancement of Hy-talk pro to enable fast, interoperable communications during common structural fires response

E-pack 2.0 is a lightweight multiple-hop repeater unit that creates an ad hoc LAN network compatible with PMR devices for voice and short sensor data transmission. Weighing only 3kg, it has an optimised design and a 9-hour high-capacity battery, making it easy to carry and quickly deploy in the field. With 10W RF power and multiple-hop repeaters, it provides powerful signal penetration, making it suitable for firefighting communications. It also features two radio channels for separate voice and data transmission and an integrated gateway function with LTE backhaul for easy connection to back-end WAN.

The dual-mode rugged radio is a key component, serving as a primary communications device and hub. It offers comprehensive connectivity capabilities such as access, handoff, and roaming between PMR and cellular networks, e-pack2.0 tactical networks, and Wi-Fi/Bluetooth for sensor management. It also supports one-button calls between LTE and DMO and offers innovative capabilities and actionable tools to firefighters through open app-based computing with apps like Hytalk-pro and Fire apps. The radio is designed to withstand harsh environments with an IEC IP67 rating, is resistant to dust and water, and has military-level durability. It is also intrinsically safe (IS) for environments with explosive gases.

On the fire ground of a common structure fire, firefighting teams (20 or so members) typically operate in a hybrid environment involving LTE commercial networks and e-pack2.0 DMO, along with various devices such as two-way (IS) handheld radios, dual-mode handhelds, different types of PoC radios, and even smartphones for volunteer firefighters. The dual-mode radio has been enhanced to meet the specific communication needs of firefighters, enabling the IC to initiate simultaneous voice calls to DMO radios and various PoC devices via the PTT button for fast communication across all devices. Sensor data is also reliably and efficiently transmitted wirelessly to local or back-end computing platforms through LAN or WAN using two transmitting paths for redundancy through e-pack2.0 and dual-mode radio.

The e-Fusion-compact solution integrates e-pack2.0 and dual-mode radio and works with the Hytalk-pro cloud platform, accessible for PoC and traditional (IS) radios. This innovative solution resolves the problem of fast communication between different devices used by different roles during a structure fire. In addition, it provides reliable transmission of sensor data for some IoT use cases, such as monitoring environmental conditions and tracking firefighters.

7.3 The e-Fusion solution empowers comprehensive cooperation among multi-disciplinary teams during large-scale disasters

The importance of a comprehensive field communication system becomes apparent during large-scale disasters, where infrastructure damage or lack of cellular coverage can make it challenging to share information among responders over a vast geographical area or hard-to-reach terrain. Such a system, spanning dozens of kilometres, is needed to ensure service continuity and interoperability between jurisdictions to enable

coordination and evacuation. However, limited network coverage and isolated regional systems may impede its implementation. Fire departments must, therefore, explore emerging technologies, integrate a range of networks, and organise the entire system for high availability and performance communication in real-world use and future planning.

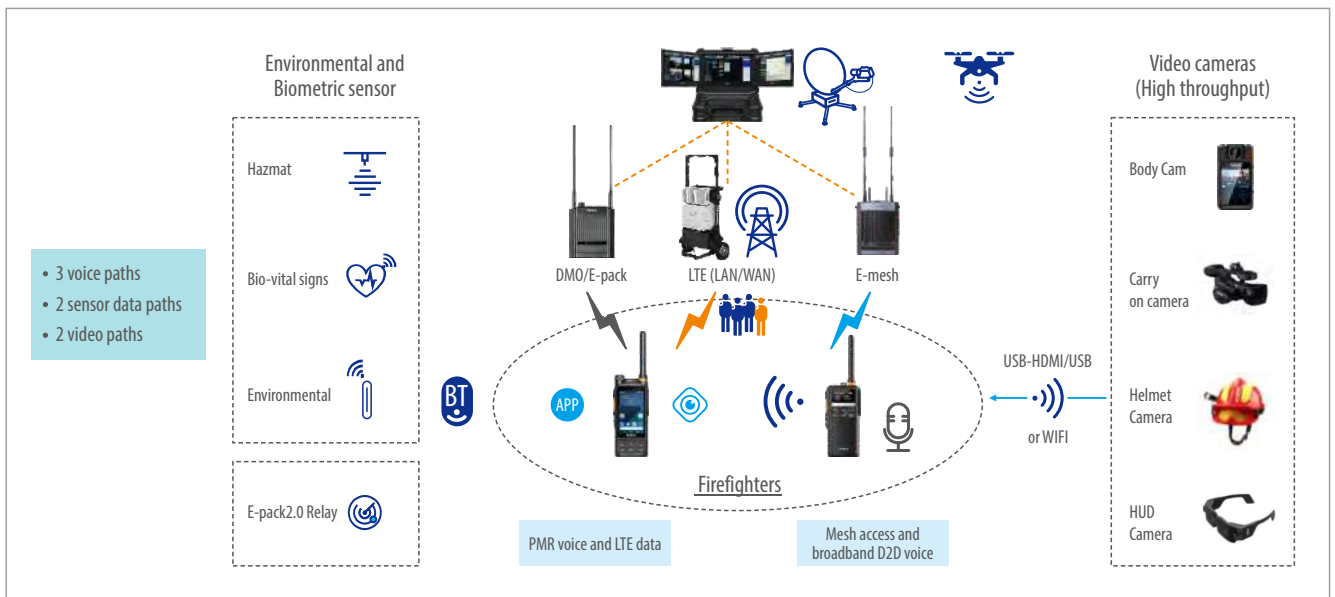


Figure 8: Completed e-Fusion resilience solution enables comprehensive voice, data and video transmissions during large-scale disasters

By seamlessly integrating e-Fusion and Convergence-Native WAN, Hytera uniquely addresses the broad-scale implementation of interoperability issues across WAN, LAN and PAN and other systems (i.e., fixed lines) when responding to large-scale events. As a result, it increases the overall reliability, availability and resilience of the next-gen emergency communication system, enabling seamless connectivity over the truly converged mission-critical network and accelerating the smart firefighting transformation,

When faced with interference, lack of coverage and network congestion on the scene, the e-Fusion, a next-gen field communication solution, can quickly deploy a LAN communication system within 5-10 mins. It has exceptional network coverage, very high capacity, high performance of low latency, and an all-in-one frontline command system. By effectively organising and integrating a wide range of

components, including e-mesh, e-pack and deployable LTE, e-Center and Norsat satellite terminal and converged devices, the comprehensive e-Fusion establishes robust and resilient tactical communication on demand in fields and connections to dispatchers, other agencies and other jurisdictions through multi-path. Deployable LTE can be used for the coverage of the command post to add additional capacity. The dual-mode rugged radio can automatically attach, access and handoff across sub-networks and roam to WAN networks through a mini-core convergence platform locally within the e-Center.

The e-pack2.0 is a PMR-compatible manpack repeater, while the E-MESH-2.0 is a 4th generation manpack broadband mesh that leverages advanced technologies like HPUE, MIMO, and UL OFDMA and even some of 5G technologies. It is an infrastructure-less network that can support up to 32 nodes with IP links to other networks, converging data, video, and D2D voice

service, featuring self-organisation, self-configuration, intelligent routing, and seamless mobility. In addition, it offers interference-free communication through cognitive and smart radio to adapt to complex RF environments. It is lightweight (3.5kg) and rugged (IP67), with a replaceable battery lasting up to eight hours, making it ideal for harsh operational conditions. In addition to ground-based networks, a tailored aerial relay that takes advantage of the MESH2.0 compelling features delivers tactical data in real-time with up to 15-20km long-distance coverage, allowing for quick decisions in case of, for example, bushfires or floods.

Furthermore, it enables responders to share information with other emergency agencies more seamlessly by connecting the ground network, supporting a smooth response to any situation. Being easy to carry and simple to use, it is particularly suited for use in complex structure fires, large-scale wildfires, and earthquakes, providing reliable voice, data, and video connectivity. By leveraging advancements in drone technology, self-driving cars, bio-connected wearables, and other cutting-edge technologies in conjunction with the 4th generation of the MESH2.0 system and future 5G, the future of emergency response to natural disasters is poised to be transformed

When time is critical, a picture is worth more than a thousand words. In addition to voice and data capability, by combining rugged MESH handheld and dual-mode smart radio, e-Fusion creates a more robust, resilient and higher bandwidth PAN, capable of transmitting pictures and HD/4K videos from a range of video sensors, including body cameras, carry-on cameras, head-up display (HUD) cameras, and helmet cameras. In addition, combining DMO repeater, MESH, LTE, Wi-Fi, Bluetooth,

cellular 4G and satellite solutions into optimised and resilient LAN and PAN transmission paths to deliver more secure data and critical voice communication. As a genuinely multi-path connectivity solution, e-Fusion provides the following:

E-Fusion optimises LAN and PAN transmission paths by combining solutions such as DMO repeater, MESH, LTE, Wi-Fi, Bluetooth, cellular 4G and satellite to provide secure data and critical voice communication. When time is critical, a picture is worth more than a thousand words. Through rugged MESH handheld and dual-mode smart radio, e-Fusion forms robust access points for transmitting pictures and HD/4K videos from various video sensors, including body and carry-on cameras, head-up display (HUD) cameras, and helmet cameras. This makes e-Fusion a genuinely multi-path connectivity solution to support:

- Keep firefighters constantly connected while moving in the field through 3 voice paths.
- Transmit (infrared) images to ICs' terminals to enhance situational awareness for more informed decision-making through 2 video paths.
- Alert of imminent dangers and individual locations to enhance contextual awareness of firefighters' situations and surrounding environments to ensure safety through 2 data paths.

With those capabilities, the solution will significantly deliver secured critical voice, video and data services, enabling smart fire fighting and rescue and assisting fire departments to improve overall safety and effectiveness during large-scale events.

7.4 How the Hytera communication solution supports smart firefighting and rescue

The CPS allows for a comprehensive system that integrates command and control, communications, sensing and computing, and actuates to realise complex distributed situation awareness, analysis and decision-making. A comprehensive yet flexible communication solution is vital to seamless cooperation and coordination across responders or agents by leveraging next-gen MC communication and exchanging real-time information regarding firefighters' situations and

surrounding environments to enhance situational awareness and ensure safety.

In the following section, we will articulate three scenarios—a structure fire, a large-scale wildfire and a flood to understand how Hytera's communication solution addresses these operational needs, problems and challenges and meets the goal and criteria of smart fighting and rescue in the future.

7.5 Responding to a typical structure fire

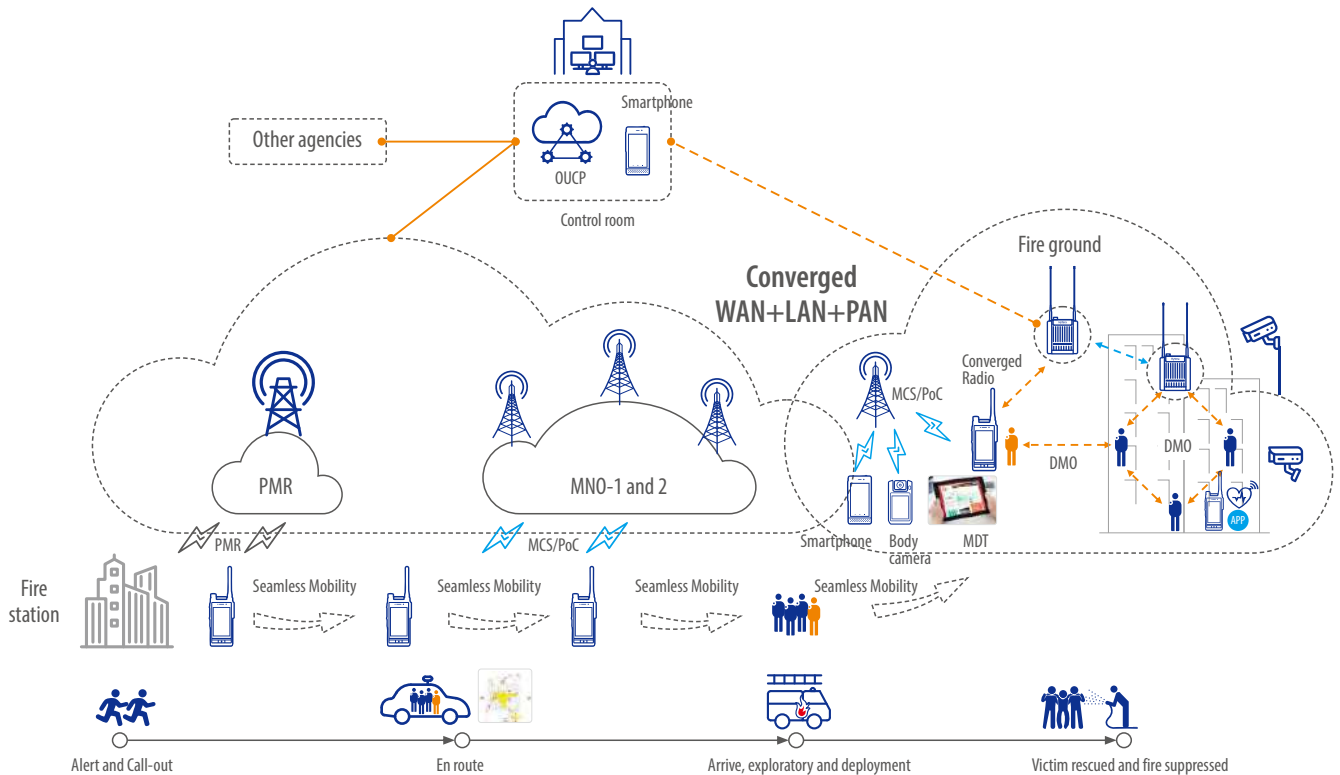


Figure 9: How compact system uniquely addresses firefighting demands for fast and seamless communications and data transmitting

In the case of an emergency such as a structure fire, a call centre may receive a report via smartphone, including videos, images, or text. This alert can also come from a connected alarm or sensor in the building, thanks to IoT technology. The dispatcher categorises the incident as, for example, grade 2 and PSAP and CAD route the assignment to the nearest fire station and call out firefighters.

Fast and reliable communication is crucial for the safety of firefighters and those affected by the fire. Even a short communication failure can put lives at risk. No firefighters want to remain inside a building on the fire ground without communication or lose connections with dispatchers en route.

When firefighters and IC are en route to an incident, they need reliable communications. Hytera's convergence native solution creates an advanced WAN that integrates PMR and multiple MNO LTE networks cost-effectively, enabling high availability and resiliency. With dual-mode rugged radios build-in two MNO SIM

cards, IC and firefighters can coordinate teams, dispatch resources, and access information efficiently and seamlessly. In addition, they can take advantage of LTE capabilities empowered by the converged networks, such as multimedia services, advanced location services, and fast handoff across overlapped coverage. These tools help crews navigate city traffic and quickly arrive on the scene. All firefighters' locations must be known at all times, and dispatchers can trace individual responders' locations in real-time to ensure safety. In addition, high-performing and ubiquitous cellular networks allow IC to interact with dispatchers effectively by using images, video conferences, and other multimedia applications, collecting information such as fire buildings and hydrants and accessing videos from nearby CCTVs. Through dispatchers, PoC apps support IC or firefighters in receiving valuable data: videos, photos and more from the scene from the public. They even make video calls directly with them for real-time situational awareness. All those services enhance situation awareness and improve IC's abilities to make better-informed decisions.



When firefighters arrive at the fire ground, the IC establishes a command post at a safe location outside the hazard zone. If it is a typical structure fire, where cellular networks are usually available but may have limited coverage in certain areas. In that case, the IC deploys a multi-hop manpack epack2.0 repeater to extend the radio signal and cover the entire structure.

For years, there has been a need for interoperable communications for firefighters on the scene, as different roles may rely on different devices such as radios, PoC radios, dual-mode radios, connected body cameras, smartphones, and more. Hytera's e-Fusion-compact solution addresses the interworking issue between different devices and enables fast, seamless communication between IC, firefighters, and dispatchers. It achieves this using the Hytalk-pro platform and dual-mode radio, eliminating the need for additional hardware or dispatchers' involvement. This makes the solution simple, efficient, and flexible.

On the scene, the IC uses a mobile data terminal (MDT) to oversee the incident and a dual-mode radio to coordinate teams. The dual-mode radio allows IC to switch between PoC and DMO modes automatically or with one button press manually. It also connects to DMO and PoC radios simultaneously, regardless of location. This combination of dual-mode radio, two-way radio (IS), PoC radio, connected body camera radio, remote speaker microphones(RSM), rugged design, and fire and voice assistant apps forms a holistic solution. In addition, it provides hands-free operation, exaggerated control in bulky gloves, and extended battery life in harsh environments, intrinsically safe radios/dual-mode radios in hazardous environments like chemical plants.

Additionally, customers have the flexibility to incorporate MESH technology to enhance bandwidth and coverage when necessary, supporting a range of video-intensive applications. This includes transmitting thermal images from a firefighter's location to incident commanders and viewing actionable information on wearable heads-up displays (HUD). In highly populated cities in China, large-scale structural fires often occur in complex buildings such as high-rise buildings, large-span structures, and deep underground areas such as parking structures, underground malls, and metro systems. MESH technology is widely used in these cases because cellular network coverage is often unavailable or limited due to obstacles such as heavy concrete walls and basements that block radio signals or performance degradation because of network congestion.

The E-Fusion-compact solution is designed to provide a simple, fast, and robust voice, quickly responding to typical structure fires, which are low-severity but high-probability emergencies. Additionally, by leveraging the seamless integration of converged WAN, LAN, and PAN, as well as dual-mode radio, two-channel epack2.0, and optional Mesh devices, this resilient solution enables the transmission of biometric and environmental sensor data, as well as video data, through redundant transmission paths.

After crews complete searching and saving victims from residential fires, extinguish the fire, and overhaul the building, they return to base. All communications and data during the incident recorded through OUCP are essential for events reports, fire investigation, and evaluation.

7.6 Responding to Large-scale natural disasters

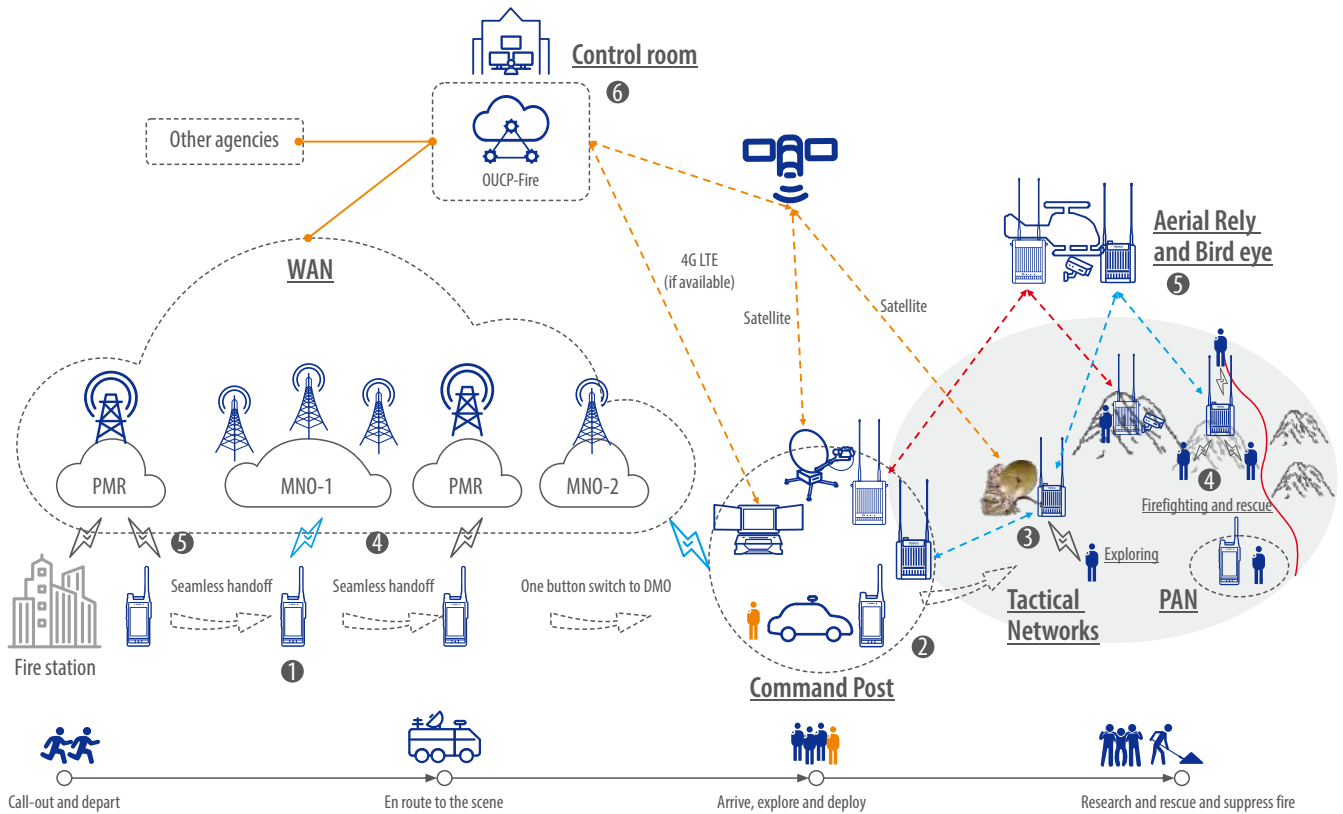


Figure 10: How comprehensive system uniquely addresses large-scale wildland firefighting and rescue communication demands

Disaster responses like wildland fire fighting and earthquake research and rescue present similar challenges but differ from those in a structure fire. They usually occur in much broader geographical areas or rugged terrain and cause high levels of devastation, e.g., severe damage to infrastructure and widespread loss of life. Wildland firefighting is a highly scalable type of incident, the biggest of which can last weeks or months.

Therefore, there is a critical need to establish a temporary network to substitute a cellular or PMR network to provide the service in remote areas. Moreover, firefighters might need much time to arrive on the scene as they drive through the unfamiliar countryside, including hard-to-reach areas. In China, these disasters are ranked as grade 4 and grade 5 emergency events. Such challenging and stressful events require multi-agency and multi-jurisdictional coordination, which involves firefighters, volunteer/assisted firefighters, police and emergency medical services across a large territory. Interoperable communication

and real-time information sharing are vital to enhancing situational awareness and collaborative decision-making during the event.

En route command is essential to effective incident response and coordination, particularly for large-scale disasters such as wildfires and earthquakes. The command communication system in a vehicle, equipped with dual-mode handheld devices, vehicle-mounted mobile devices, satellite-based communication, video conferencing systems, GPS-based advanced location services, and a command and control system, plays a vital role in keeping IC and firefighters connected and informed while en route to the fire ground. IC can make informed decisions and develop a better initial deployment plan by collecting critical information such as real-time weather updates, terrain, wind speed, and video images from an aerial vehicle. The en route command system is widely used in China and is essential to efficient coordination and response to large-scale disasters.

Hytera's "en route command" solution combines mobile and handheld dual-mode devices, PMR/LTE (future 5G) converged networks, satellite devices and vehicle command-and-control systems to deliver seamless user experiences and public safety-grade communications for ICs and firefighters. Norsat technology provides communications-on-the-pause (COTP) and communications-on-the-move (COTM) solutions, offering a high-performance flat panel satellite terminal with mechanical or pure electronic steering, high-speed vehicle tracking, and fast 3-minute pointing. Through the complete "en route command" solution, IC and firefighters can stay connected with dispatchers en route through various communication methods, including voice, location tracking, video conference, and data sharing.

During a fire emergency, the command post is quickly established, usually located a distance from the fire ground for safety and may relocate several times throughout the incident due to rapid fire spread and growth. Therefore, the equipment must have a small footprint, be easily transportable, easy to use and require no installation, setup, commissioning or provisioning whilst providing long-range coverage and high performance. With the following consideration, system design and capabilities, the e-Fusion solution uniquely helps fire departments create a robust tactical network that converges voice, video and data communications, enhancing the overall resiliency and reliability essential to successful emergency response.

- **Equipment:** by harnessing the advancement of ad hoc wireless technologies, all-in-one E-MESH 2.0 and E-pack2.0 feature slim, rugged, compact and super lightweight (3kg/3.5kg) design that makes them easy to carry and an integrated high-performance battery each with an 8hr duration of operation in a harsh environment.
- **Coverage:** in a typical hill terrain, the ground-mount unit with an external rack antenna can support long-distance coverage of up to 10km for video and data transmission (MESH) and up to 15km for voice transmission (e-pack 2.0). The unmanned aerial vehicle (UAV), a powerful platform that mounts e-mesh, e-pack and multiple camera sensors, delivers a bird's-eye view of the terrain. With a robust coverage of up to 15km for MESH and up to 30km for e-pack2.0 in a one-way repeater via UAV and multi-hop

capabilities, it broadly extends ground voice and data network coverage across wildfire areas.

- **Backhaul:** leveraging an integrated 4G LTE module, external 4G/5G router and manpack Norsat satellite terminal, the multi-path backhaul solution flexibly supports E-center, e-pack or e-mesh with a reliable, stable and high bandwidth link to OUCP, allowing responders to communicate to dispatchers and other jurisdictions and connect to cloud platforms to access weather conditions and public opinions.
- **Device:** The dual-mode radio that can access different networks has built-in apps that manage multiple mixed group calls between dispatchers and firefighters, optimising PMR/DMO voice and PoC/MCS multimedia services. It features valuable tools like an intelligent voice assistant, automatic voice recording, and playback on demand, allowing IC and firefighters to focus on critical missions without being distracted by listening to multiple radios at once.
- **Command:** this converged tactical field system combines multiple information streams from aircraft/UAV, firefighters, command posts and control rooms onto a shared digital map. The exact location of the personnel is visible on an E-center in the command post, which is a rugged portable computer featuring a long-lasting battery and three screens. E-centre can run separate functions simultaneously, including unified dispatching, video surveillance, and GIS, making it easier for IC to manage different operations.

The IC, dispatchers and firefighters can easily view live video feeds from aircraft/UAV and carry-on cameras, share information from sensors and cloud, and track each other's positions in real-time through seamless connectivity across WAN, LAN and PAN. All this information is collected, performed and distributed across different devices, including the E-center in the command post, Smart-one in the control room, and dual-mode devices carried by responders in the field. This enables firefighters to work together more effectively, with enhanced situational awareness, for successful and safe wildfire operations. In China, a "digital battlefield communications" framework using edge AI and bio-connected wearables was established, creating a new battle mode for firefighting and rescue to cope with complex situations during tactical and emergency response.

7.7 Responding to floods

There are no one-size-fits-all solutions. For example, When floods hit metropolitan areas, communication and road infrastructure often occur damaged or destroyed. Therefore, restoring communication by quickly deploying a dependable, standalone wireless network to connect search and rescue teams and enhance situational awareness support for recovery efforts is vital. As one of the essential components of e-Fusion, the LTE deployable subsystem is a portable, high-speed wireless solution mainly designed to provide significant capacity and broader

coverage, complimenting ad-hoc repeater and MESH in many scenarios.

Deploying a temporary LTE network in flood-prone areas poses several challenges. Firstly, they must be designed to withstand harsh environmental conditions. Second, they must operate on battery power as the electricity supply may be disrupted by a flood. Third, they must be able to provide coverage over a wide area, which can be difficult in areas with challenging topography.

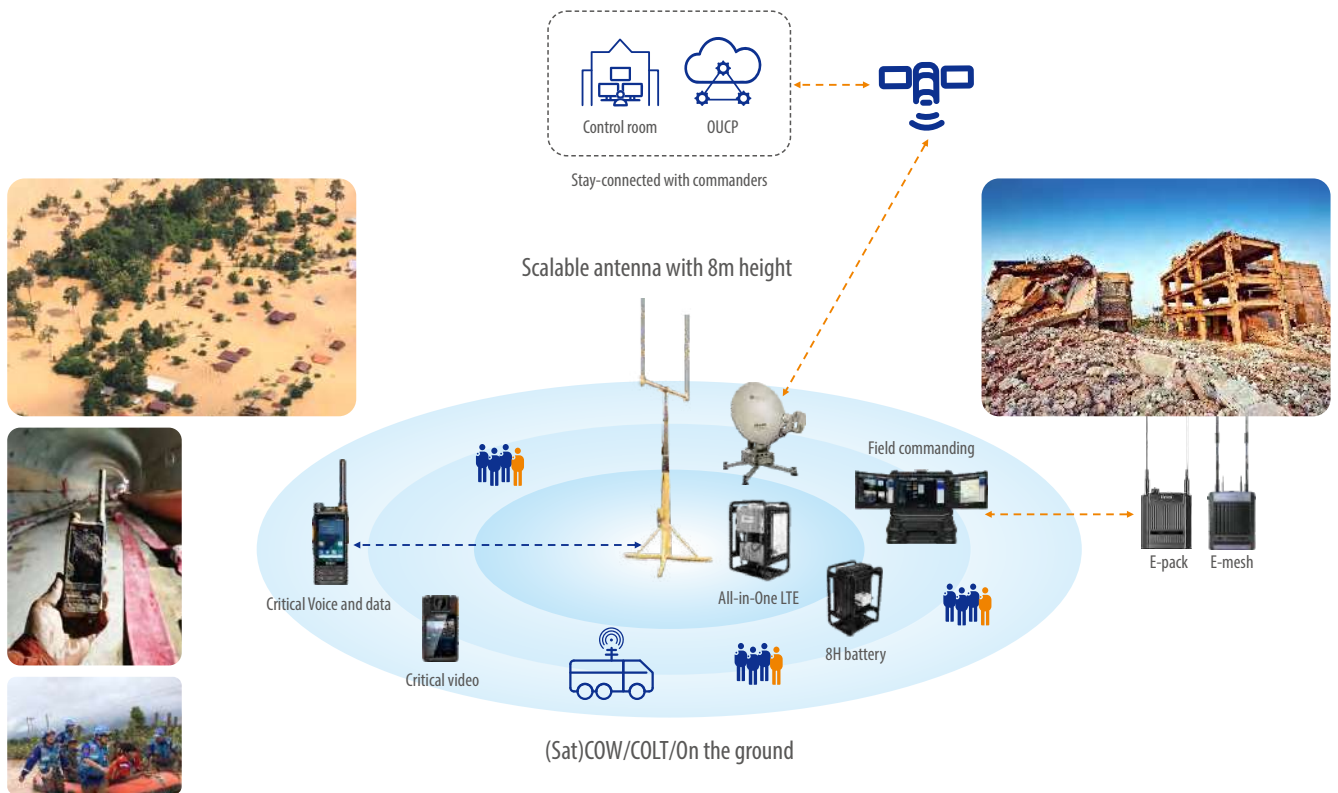


Figure 11: Deployable 3GPP-compliant LTE system bring abundant capacity and extended coverage for long duration operation in harsh environment

Hytera's deployable LTE solution is mainly designed to overcome the challenges of providing reliable communication. The following key points illustrate how this solution can be used to provide fast, secure and adaptable communication in a wide range of situations, including floods.

- All-in-one box: the all-in-one platform integrates all components, including BBU, RRU, core network and easy-to-use network management tools, making it to deploy an LTE network within 5 minutes. In addition, combined with a lack of fans, it can dramatically reduce power consumption and decrease the system's overall size and weight, making it ideal in remote and challenging environments where power and space are limited.
- Integrated LTE core: This critical feature allows users to quickly and easily turn on the system with "power on the button" without requiring extensive setup and configuration, enabling fast, reliable and secure communications.
- Rugged design with extended duration operations: It includes a range of other advanced features and capabilities designed to meet the specific needs in harsh environments, including ruggedised and weather-resistant construction (IP65), an additional easy-to-carry oil engine or battery with an entire daytime runtime and operations temperature from -40-50°C.
- The cutting-edge technologies: This system utilises the latest 3GPP standards-compliant technologies, including LTE radio access, PTTtoC/MCX services and isolated operation for public safety (IOPS) function, exceptionally incorporating a 2T4R transceiver, an up to 2*40 W power amplifier and a flexible antenna which can extend to 8 meters with windproof grade 8. These are vital to increasing coverage and capacity, reducing interference and ensuring signal quality in a dynamic situation.
- A wide range of frequency bands is available: including 700Mhz, 800Mhz, 450Mhz, 1.8G, 1.4G and more customised frequency bands, enabling the system to operate in a variety of different environments and scenarios.
- Flexible deployment: the LTE deployable system can be deployed as an independent or standalone system and easily integrated with the e-Fusion solution, allowing organisations to maximise their investments and enable seamless communications. Furthermore, it is available in three forms: the Cell-on-Wheel (COW) and the Cell-on-Light-Trunk (COLT) and on the ground, each with the support of satellite

backhaul which connects to the control room, allowing customers to choose the best solution for their needs.

- With an IP67 design, dual-mode devices responders carry can withstand the harsh environment and dynamic situations, for example, in the water, while accessing LTE deployable networks. In addition, the devices combine DMO voice communications and can leverage e-pack when available.

With these versatile features, the LTE deployable system is a valuable asset during a flood's response and recovery stage, enabling fast deployment with minimal effort and without extensive technical knowledge, ensuring communications are never disrupted, even in a power outage.

Furthermore, the solution provides a reliable communication solution in responding to other emergency scenarios; several successful examples of Hytera's LTE deployable system resolving customer challenges in the firefighting and disaster rescue sectors include:

- During a major wildfire, the local fire department deployed Hytera's LTE deployable system on COW/COLT to establish a temporary communication network with extensive coverage, which allowed first responders to coordinate their efforts and quickly contain the fire over a wide area.
- During a large-scale earthquake, the disaster response team utilised Hytera's LTE deployable system to provide communication with sufficient capacities in command post areas where traditional networks were unavailable. In addition, the system's all-in-one robust construction and backup power solution ensured communication within 8 hours of continuous operation, which is vital for ICs to coordinate response efforts.
- In a remote rural area, a volunteer fire department utilised Hytera's 3GPP standard LTE deployable system to establish a temporary communication network during a search, rescue, and recovery operation, allowing their own devices to access. The system's broad coverage and high-performance communication allowed them to coordinate efforts to assist first responders and ensure the safety of the public.

In conclusion, with its rapid deployment, rugged and durable construction, broader coverage, integration with e-Fusion, multiple frequency bands, and backup power, the LTE deployable solution provides the versatility and reliability that organisations need in emergencies or temporary situations.

8

Use case: Harness next-gen MC communications systems to transform fire services in China

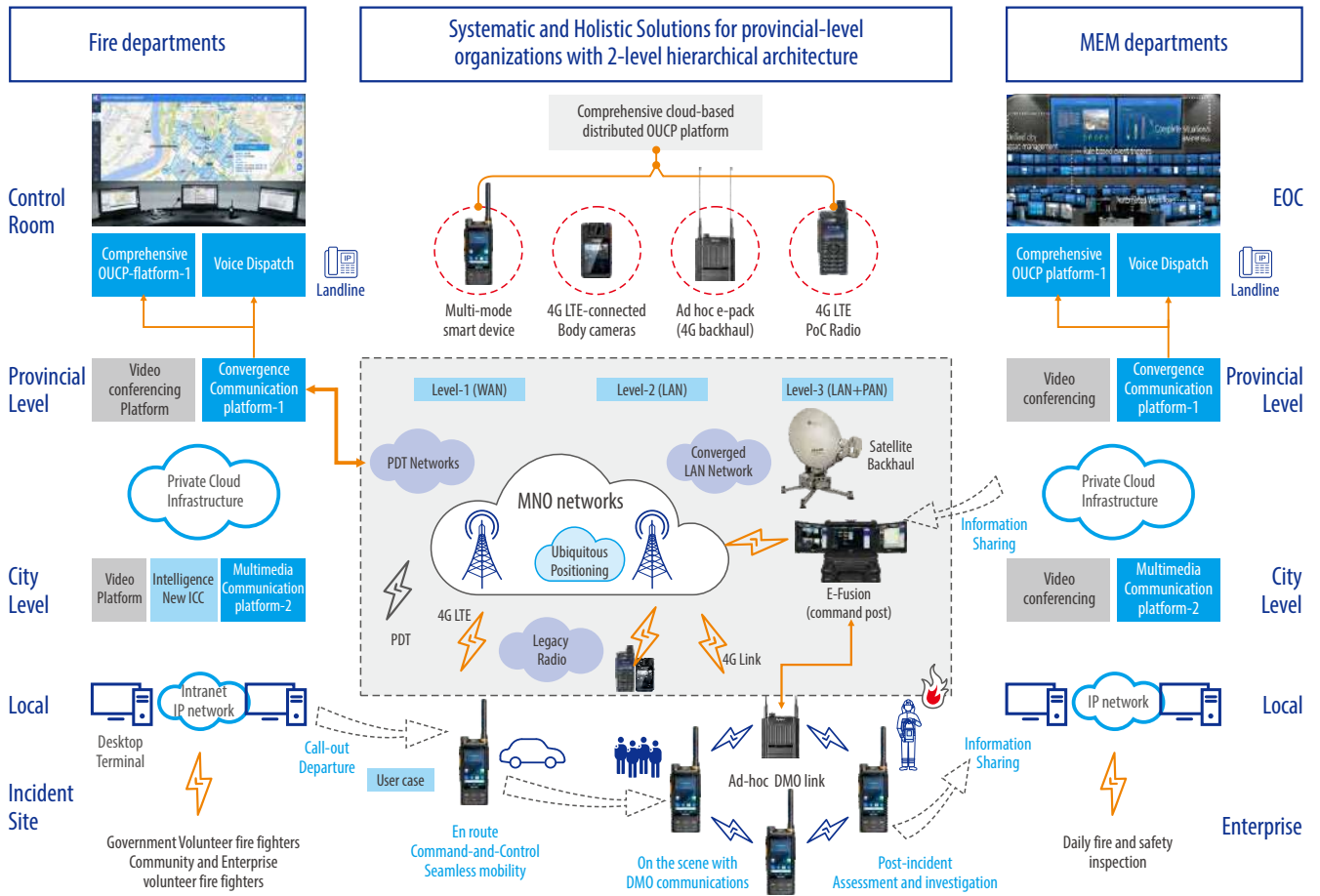


Figure 12: Supporting Chinese fire and M.E.M department to re-build a comprehensive system towards next-gen communications

The Chinese fire departments have made tremendous achievements in managing fire threats and reducing loss through technological advancements. With emergency management reforms in China spanning years, fire departments have taken more roles and responsibilities in their new missions, responding to a more comprehensive range of disasters and emergencies, particularly catastrophic events, including natural and man-made disasters. This significant shift implied that firefighters must extend their operations from local and city-level areas to much broader regions, including provincial or national levels, and span large geographical areas for response and prevention. However, there are a number of remaining critical

issues to be addressed. The first challenge is enhancing cooperation and real-time information sharing across fire departments and volunteer firefighters at different levels and with emergency management and other government agencies during emergencies and prevention. In addition, despite continuous enhancements in firefighting, eliminating catastrophic natural disasters is still daunting. Therefore, a real need exists to innovate beyond the traditional paradigm, transforming from predominant voice-only communications to a comprehensive approach. It only can be achieved through a systematic approach with the following considerations of communications systems:



- Upgrade analogue radios with digital radios over initially established PDT systems, which continue expanding the radio coverage while leveraging existing commercial networks simultaneously via a shared PoC platform. An isolated, non-MC communication system initially built by MNOs needs to be deployed in a public safety context.
- Introducing a new MC communication-capable advanced PTTToC digital platform to replace the existing PoC one is necessary for delivering more reliable MC voice, video and data services via MNOs' LTE networks. In addition, to access super high-performance 5G networks, the platform needs to be upgraded to support 5G networks, allowing responders to carry new types of devices based on their different roles and adding new compelling applications to fire services.
- By equipping IC and firefighters with a new type of converged devices that support multiple radio access and specific features, fire departments can fulfil a number of new requirements throughout the entire process of fire services to address the critical aspect of their new mission, including avoiding carrying multiple devices to support voice and multimedia communications and sensor data access, autonomously attaching and seamless mobility across different wireless networks, being easy-to-use, intelligent and affordable.
- Address the broad implementation of interoperability among a wide range of isolated systems, including PSTN landline phones, video conferencing systems, CCTV systems, PDT radio systems, DMO communication and emergency tactical systems in the field. In addition, it is necessary to lay the foundations towards further converging innovations in smart sensors, AI modelling, distributed computation, and active human-in-the-loop communication networks.
- Efforts to streamline and enhance incident response with data systems have been undertaken for many years. With the GIS, automatic vehicle location (AVL), advanced routing and location of apparatus, computer-aided dispatch systems (CAD) become mature and are broadly used to improve dispatch resources by fire departments to tackle the challenges of an ever-increasing myriad of responses. Nowadays, visualisation of firefighters' location on a GIS map/floor plan, in conjunction with advanced localisation and mapping technologies, plays an increasingly vital role in providing the capabilities for IC and dispatchers to quickly and intuitively view where firefighters are located to ensure their safety. Converging a wide range of localisation technologies and advanced AI modelling, including GPS, A-GPS, Wi-Fi, Bluetooth beacons and cellular (i.e. 5G), can achieve more precise and real-time location tracking of firefighters.

Shenyang Fire Research Institute of MEM (SYRFI) has been our longstanding partner for consultancy, and we jointly serve the fire department's operations in China. Drawing on the experience of convergence innovation, Hytera delivers holistic and systematic solutions that comprise a comprehensive OUCP platform, a native convergence network of PDT and 4G LTE, a converged e-Fusion ad hoc tactical network and converged smart devices for fire departments to help them build a next-gen MC communication system on a broad-scale, addressing a number of challenging issues through many efforts on research and perception, evaluation and development, best practice and sustainable evolution of smart firefighting and rescue.

- Integrating horizontal and vertical systems by using the OUCP platform to integrate all resources enables fully interoperable communications and real-time information sharing among fire departments and emergency departments and assists firefighters and communities.
- Converging PDT and CMCC LTE 4G networks enable unleashing the full potential of broadband technologies. We deliver a range of advanced applications via converged smart handhelds, body cameras, and PoC radios: advanced PTTToC communications, video feeds from buildings in the field, body cameras capturing video at the scene, real-time access information of the building, and fire apps.
- Enhancing network resiliency by seamlessly combining various wireless access technologies, fire emergency communication networks with three levels of architecture, and an ad hoc communications system quickly established on the scene.
- Equipping IC and firefighters with all-in-one smart devices that combine multiple radios, including PDT, commercial/deployable LTE and DMO, and short-range PAN radios, including Wi-Fi and Bluetooth, enable them to communicate and share information across communication and sensor networks during all phases of fire response. This eliminates the need for carrying different devices and provides access to multimedia services and new features tailored for China fire departments. These include one-touch switch-off, one-touch simultaneous initiation of different types of calls, one-button triggering of SOS alerts and man-down automatic alarm, intelligent voice assistant, quick positioning and navigation app, and automatic voice call recording and playback on demand. These features enhance operational efficiency and safety.
- Ensuring service continuity with improved user experiences

across various networks, including seamless attaching to networks and seamless handoff between networks without distracting attention.

- Data collection is crucial to smart firefighting, particularly in tracking firefighters. With the use of a converged network that includes commercial LTE, PDT, and e-Fusion field networks, Hytera's solution provides reliable real-time location data transmission via connected devices. This data allows dispatchers and ICs to comprehensively view fire operations and firefighter locations on intuitive displays such as Smart-one and e-Center throughout the incident, ultimately improving command and control efficiency and firefighter safety. Location data is becoming an essential component of incident management systems, and its performance will continue to improve with advancements in communication technology and positioning systems.
- Significantly advancing the command-and-control via OUCP's comprehensive capabilities by featuring comprehensive capabilities: a distributed platform with module components and hierarchical architectures, unified dispatching of all resources with visualisation, advanced ubiquitous locations service with quick positioning and real-time tracing, system-level integration of multiple networks including native convergence of PMR/LTE, centralised MDM for all devices, and recording for all calls, benefiting the development of a complete suite of operational and decision-making tools.

As a leader in next-gen communication, Hytera has played a crucial role in supporting China's firefighting and rescue efforts. Their convergence solution has increased operational efficiency and firefighter safety in all aspects of their duties, not just on the fire ground. The new nationwide communication system has enabled emergency management departments to have unified command and control, resulting in more informed decision-making and improved cooperation at different levels. This system has also allowed fire departments to better coordinate with other government agencies in responding to extreme disasters and everyday emergencies, fulfilling their new mission of leading overall coordination. Going ahead, Hytera is playing an increasingly important role in supporting the development of the technological framework for smart firefighting. By staying up-to-date with architecture, standards, and pilot projects and designing and delivering advanced communication systems, Hytera is able to provide support at all levels of the hierarchical structure. This includes achieving unified and intelligent command and control from the edge to end and increasing emergency preparedness and response at all levels.



About the author

Chuan Chuan (Winter) Leng is an ICT specialist at Hytera with over 18 years of experience, including previous employment at Lucent/Alcatel-Lucent/Nokia working on industry research, digital transformation and mission-critical communications across various sectors, including MNO mobile networks, public safety, physical security, manufacturing, oil&gas and railway, with a current focus on next-gen mission-critical communications.

As a network architect with expertise in a wide range of technologies, he has designed and implemented numerous new ICT systems involving the convergence of PMR/LTE, ad-hoc tactical communications, 4G/5G private networks and network security. In addition, he writes technical white papers and journal articles and consults with real experience.

He is also a member of a number of professional institutes and has built credibility through numerous works and contributions, including developing innovative solutions and promoting industry standards.

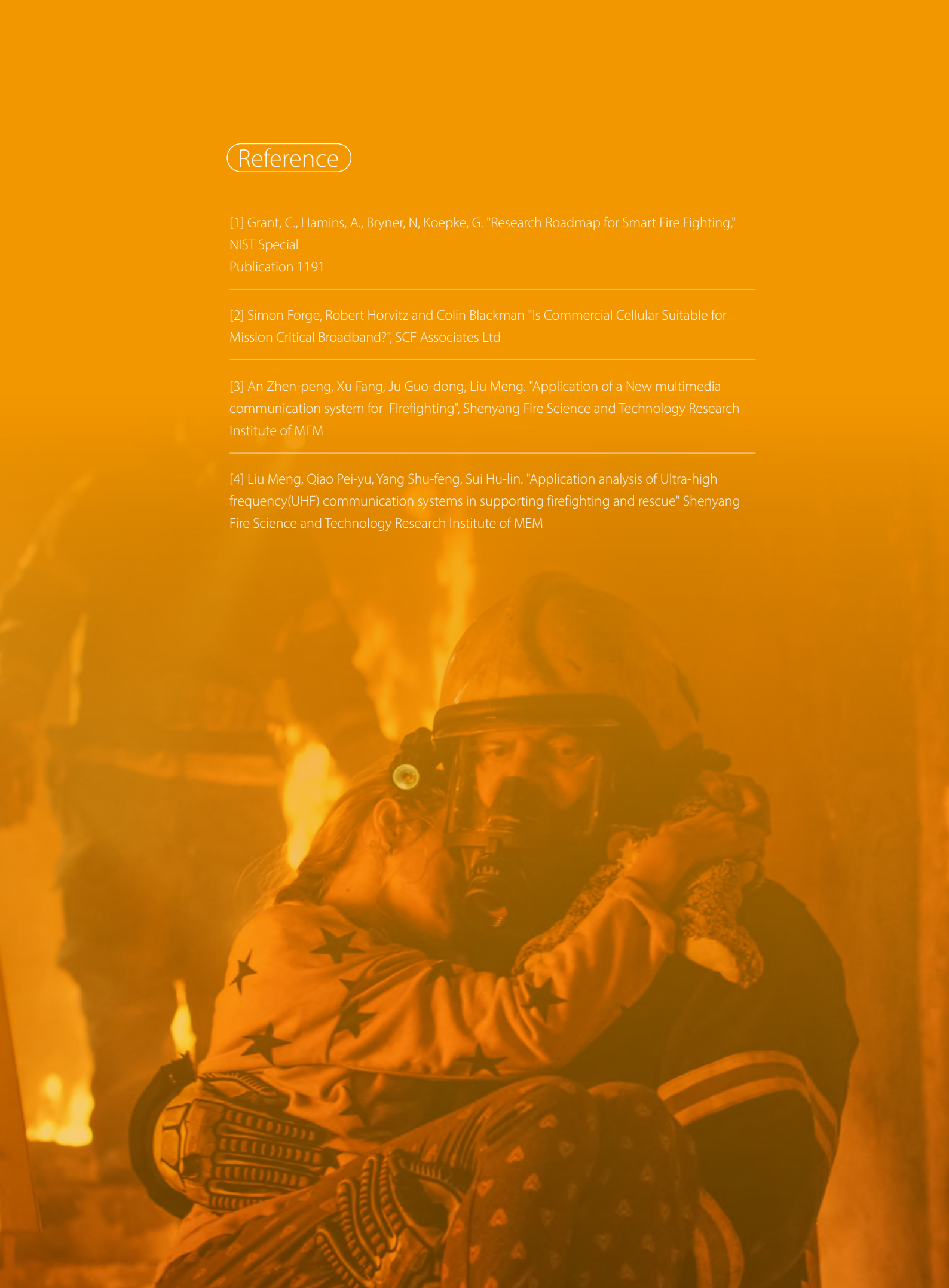
Reference

[1] Grant, C., Hamins, A., Bryner, N, Koepke, G. "Research Roadmap for Smart Fire Fighting," NIST Special Publication 1191

[2] Simon Forge, Robert Horvitz and Colin Blackman "Is Commercial Cellular Suitable for Mission Critical Broadband?", SCF Associates Ltd

[3] An Zhen-peng, Xu Fang, Ju Guo-dong, Liu Meng. "Application of a New multimedia communication system for Firefighting", Shenyang Fire Science and Technology Research Institute of MEM

[4] Liu Meng, Qiao Pei-yu, Yang Shu-feng, Sui Hu-lin. "Application analysis of Ultra-high frequency(UHF) communication systems in supporting firefighting and rescue" Shenyang Fire Science and Technology Research Institute of MEM





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