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Addressing FirstNet Collaboration Challenges

Version: 1.0

August 6, 2014

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Executive Summary

A fundamental goal of the First Responder Network Authority (FirstNet) is to enable multimedia communication and collaboration capability between all first responder agencies. As envisioned under the National Response Framework (NRF) and National Emergency Communications Plan (NECP), a scalable "all hazards, all disciplines" response capability should be implemented at all levels to enhance emergency response and recovery. This desired capability also extends to Critical Infrastructure and Key Resources (CIKR) throughout all identified sectors of a community under the National Infrastructure Protection Plan (NIPP). Furthermore, to capitalize on agencies' existing investments, this capability should be inclusive of existing communication and collaboration systems. It is essential to the success of FirstNet that it achieve operational necessity within the context of the multi-agency, multi-discipline environment in which first responders are expected to interact, communicate, and collaborate. To this end, it is important that FirstNet avoid the pitfalls encountered with P25 public safety radio, where some vendors effectively excluded open standards for interoperability and created barriers that potentially limited interconnection, access to essential functions and capabilities and negatively impacted competitive innovation.

These goals can be quickly achieved by implementing a Media Cohesion Framework (MCF) as described in this paper. The MCF is a flexible and agile system that enables ad-hoc, on-demand, secure, multimedia interoperability among FirstNet users as well as with legacy or non-FirstNet users and systems. By connecting and bridging to existing capabilities residing on or using other networks, such as mobile radio systems, video surveillance systems, telephone systems, sensor systems and beyond, the MCF positions FirstNet as not only a critical transport network but also a necessary content-based network to be utilized by first responders.

Another goal of FirstNet is to enable agencies to use whatever apps they deem necessary to facilitate access to the agencies' private data. Although this is a critical function, taken to an extreme this could result in a fractured application environment where every agency is using different applications and none can communicate with each other. The MCF mitigates this issue by acting as a unifying framework for media/data between disparate applications and external systems.

Furthermore, it is critical that FirstNet continue to provide service even during major system impairment such as large-scale natural disasters, network or power outages, etc. The MCF described herein is a highly-resilient system implemented in a distributed peer-to-multi-peer architecture that operates over all types of IP networks; this architecture guarantees best-effort service to any surviving/reachable segments of the network. An additional benefit of this distributed architecture is that media flows are optimized throughout the system to minimize congestion during high-utilization scenarios.

This MCF has been successfully tested and deployed in FirstNet trial systems in Las Vegas, NV and Harris County, TX, providing local and wide-area voice, radio, video, and GIS interoperability among participating agencies, including LMR-LTE voice interoperability and Band14-Commercial LTE cross-band collaboration.

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Introduction

The Middle Class Tax Relief and Job Creation Act of 2012 created the First Responder Network Authority (FirstNet) as an independent authority within NTIA in order to provide emergency responders with the first high-speed broadband national network dedicated to public safety. With advanced mobile broadband connectivity, first responders will have access to situational information, and can securely communicate and collaborate using advanced mobile applications in the field.

Although it is envisioned that FirstNet will eventually provide mission-critical voice services, the first phase of deployment will be a data-only service[1]. However, real-time media applications such as non-mission-critical voice and video sharing are highly-desired capabilities. A fundamental goal of FirstNet is to enable multimedia communication and collaboration capability between all first responder agencies as called upon by the National Response Framework (NRF) and National Emergency Communications Plan (NECP) - a scalable "all hazards, all disciplines" response capability. This desired capability should also extend to Critical Infrastructure and Key Resources (CIKR) throughout the entire community as envisioned under the National Infrastructure Protection Plan (NIPP).

Given the objective and intent of FirstNet, it will be essential its success that it achieve operational necessity within the context of the multi-agency, multi-discipline environment in which first responders are expected to interact, communicate, and collaborate. To this end, it is important that FirstNet avoid the pitfalls encountered with P25 public safety radio, where some vendors effectively excluded open standards for interoperability and created barriers that potentially limited interconnection, access to essential functions and capabilities and negatively impacted competitive innovation.

This paper describes some of the challenges that FirstNet system deployments will face in achieving rapid usability associated with content assimilation and discusses various solutions to those challenges. The primary focus is on solving these challenges for real-time audio and video applications, since these applications are essentially the most demanding form of data applications - if the real-time media challenges are addressed then the rest of the data applications will follow. In this discussion, we address the continuity in the FirstNet ecosystem that spans from the tactical field environment up through command and control and beyond to higher level network delivery and administrative functions within a dynamic multi-peered agency response environment.

[1] Congressional Research Service. (March 12, 2014). The First Responder Network (FirstNet) and Next-Generation Communications for Public Safety: Issues for Congress [CRS Report]

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Background: Regional Public Safety LTE System

The diagram in Figure 1 below depicts the major components of a typical regional public safety LTE system. This may represent a multi-state system, a single statewide system, or a metro region within a state, etc.

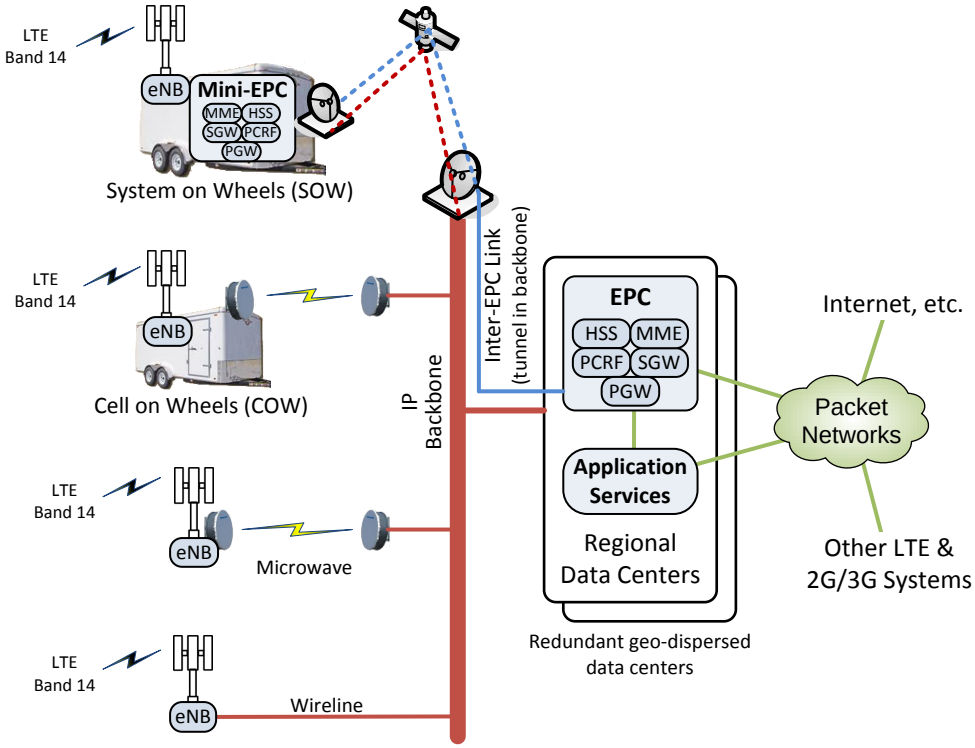

Figure 1: Regional Public Safety LTE System

Major components include:

- An IP network backbone throughout the region to interconnect all other components. This may consist of fiber, copper, microwave, satellite, and other links deployed in a redundant topology.
- LTE Band 14 radios and Evolved Node Bs (eNodeBs or eNBs). eNBs are the RF entry point into the LTE system for all user devices.
- Multiple geo-dispersed regional data centers (for redundancy) hosting the following critical shared services: EPC and Application Services.
- Evolved Packet Core (EPC). The EPC is the brain of an LTE system; the eNodeBs coordinate with the EPCs to provide service to user devices. Note that all user data traffic (i.e. application data from user devices) must transit through the PGW (Packet Gateway) in the EPC to reach its final destination.
- Application Services. The LTE network provides the data pipes to/from user devices, however those pipes are useless without applications to run on them. The applications on a user device typically need to talk to a common service to be able to communicate between multiple user devices. These services may reside at the same location as the EPC, in a remote/private data center, or in an internet-based data center.

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Providing Ubiquitous Band 14 Coverage

For Public Safety to rely on Band 14, it must be available everywhere. While more dense population areas will be covered by fixed towers, it is not cost-effective to blanket rural areas with enough fixed towers to guarantee 100% coverage. This means that there will inevitably be rural coverage gaps that must be filled when public safety responds to incidents in those areas. For this reason, Band 14 build-outs may include portable components called Cell on Wheels (COWs) or System on Wheels (SOWs).

COWs include the radio and eNodeB along with one or more backhaul transports (such as microwave or satellite) to reach back to the system EPC; a COW cannot provide service unless it is able to reach back to a remote EPC. SOWs include a mini EPC as well so they can act as a standalone LTE system that does not depend on any backhaul to provide service to local users. SOWs are typically used in service areas where high-bandwidth backhaul is not guaranteed, whereas COWs are typically used where such backhaul is guaranteed.

COWs and SOWs are also used in standard LTE systems to supplement existing fixed towers to provide additional over-the-air bandwidth for large-scale events or incidents. With Band 14, however, this is potentially problematic since there is only one shared frequency band available in any given RF footprint.

Challenge #1: Collaborating with Non-FirstNet Users

FirstNet will provide a secure and reliable data access network for public safety and other approved users. However, for many multi-agency incidents, and especially in large-scale incidents, there is a need to collaborate with non-FirstNet agencies such as schools, utilities, mass transit, industry, etc. including any public safety agencies that have not yet migrated to FirstNet. This is a non-trivial challenge that will need to be addressed to achieve truly ubiquitous multi-agency collaboration.

Such collaboration could be in many forms such as voice interoperability, video sharing, mapping and geospatial awareness, file and data sharing, etc.

One approach to achieving cross-system collaboration is to utilize an “infrastructure bridge” as shown in Figure 2 below. This requires at least one data center that is reachable from all desired networks to host the Application Services required to interconnect the users from all networks. In addition, a Technology Bridge may be required to adapt each network to a common format, e.g. an IP gateway to an LMR system.

One advantage to using this approach is that no additional on-scene equipment is required, since the inter-connection occurs within the Wide Area Network infrastructure. This works well as long as all agencies involved have such connections in place prior to their need for collaboration. However, the reality is that most large-scale incidents require collaboration among many agencies that have not necessarily foreseen the need to collaborate prior to that incident. Moreover, the type of information that may need to be shared may originate in systems that are not interconnected or accessible, even if some level of collaboration is foreseen. Hence, an additional method may be required for such agencies.

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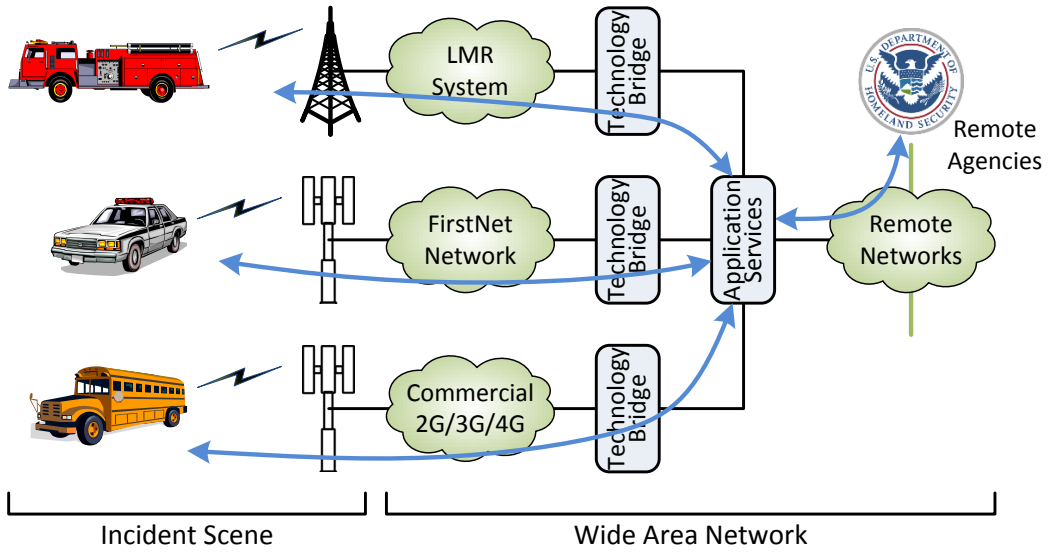

Figure 2: Collaboration via Infrastructure Bridges

Another approach to achieving cross-system collaboration is to use an ad-hoc on-scene system as shown in Figure 3 below. Although this could be used as the sole means of collaboration for a small number of agencies, the primary advantage of this method is to supplement the above infrastructure method, for agencies that are outside their network footprint, or for times that backhaul to the wide-area infrastructure is unavailable.

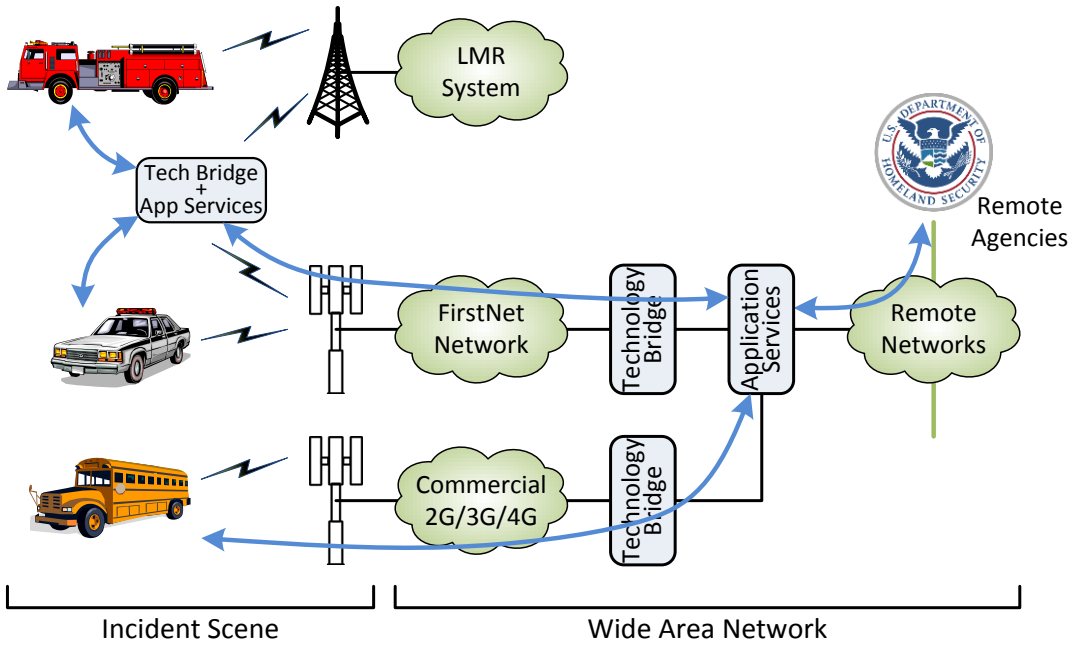

Figure 3: Collaboration via On-scene and Infrastructure Bridges

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One significant benefit of using an ad-hoc on-scene system is that it enables dynamic collaboration between responding agencies, with no need for prior connections requiring inter-agency MOUs, etc. This system would include a variety of cables to attach any local voice, video, etc. equipment to the system.

One historical lesson learned is that emergencies are not predictable especially with respect to collateral effects. Maintaining flexibility and agile collaboration capabilities is critical; the ad-hoc on-scene dynamic collaboration system shown below in Figure 4 enables this flexibility.

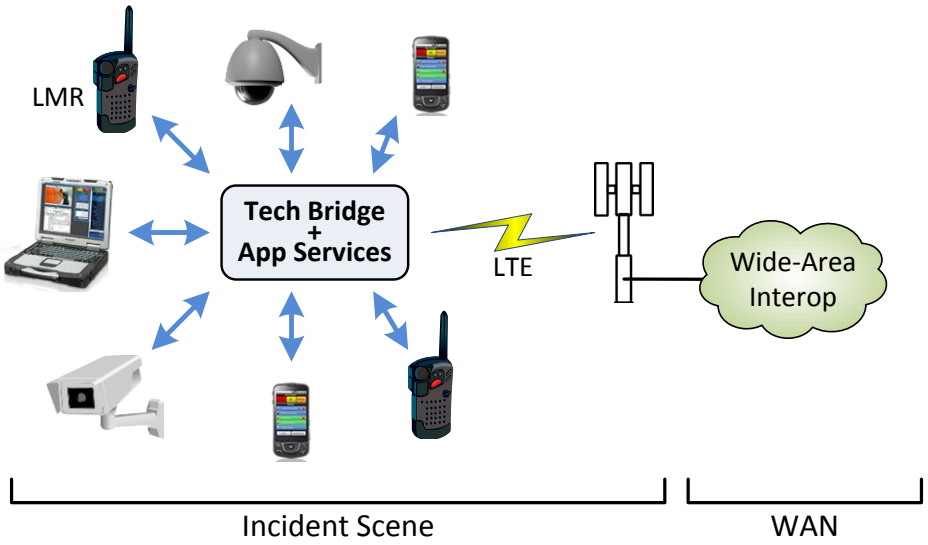

Figure 4: On-scene Dynamic Collaboration

Challenge #2: Avoiding Congestion

While the allocated FirstNet spectrum provides substantial bandwidth for public safety data applications, this bandwidth is not unlimited - there will be times when network congestion occurs. This congestion may occur on the RF link, or it may occur anywhere in the network infrastructure where insufficient bandwidth is available for the desired application load.

For example, one of the most anticipated capabilities that FirstNet will enable for first responders is the capability to video conference or share video feeds within and between agencies. Since video is a very bandwidth-consuming application, it serves as a good example to evaluate the possible congestion points within a FirstNet system.

Shown in Figure 5 below is an example of a single video feed from a helicopter being shared to first responders at an incident scene. The LTE system is using a standard remote EPC model where the EPC is located at a centralized data center some distance from the incident scene. Since video is an Over-the-Top (OTT) application and all user data traffic must egress the EPC, this means that all video traffic must pass through the EPC to reach the application services being used to share the video. Furthermore, since LTE is currently a unicast-only medium, each on-scene user viewing that video requires a separate video stream from the application services back to the user. This places a load of (1 + #viewers) video streams on the backhaul as well as the over-the-air link. Obviously as the number and quality of video feeds and viewers increase, so too does the load on the network.

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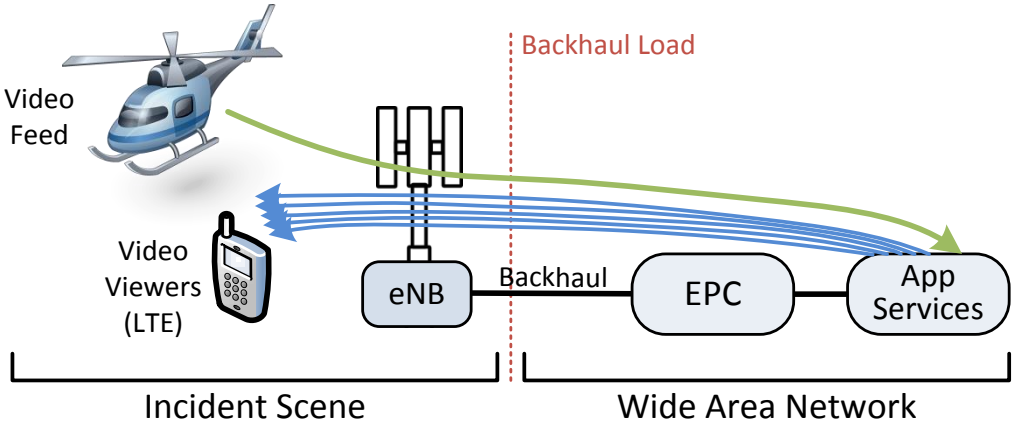

Figure 5: Video sharing with a remote EPC

One method of reducing the load on the backhaul connection (e.g. when a backhaul may not be available or is bandwidth-limited) is to place a small-capacity EPC and appropriate Application Services on-scene as shown in Figure 6 below. This is the System-on-Wheels (SOW) approach and has the advantage that it is a standalone system that does not depend on a backhaul and hence may be used in remote locations, etc. where no or limited backhaul is anticipated. In addition, this method provides for enhanced local resiliency and reduced latency of the media.

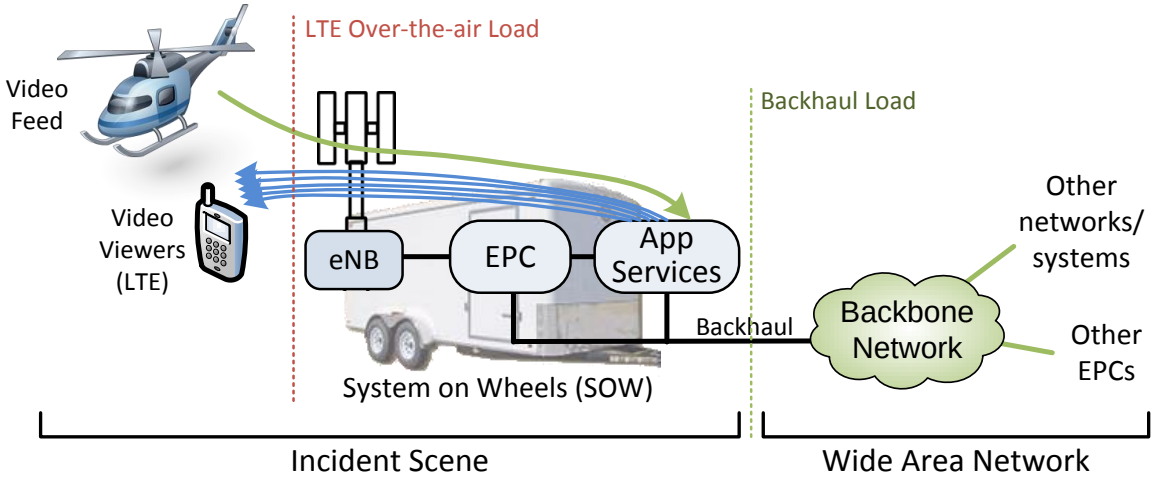

Figure 6: Video sharing with an on-scene EPC

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Although the above method greatly reduces the backhaul load, it does not address the over-the-air congestion potential. One approach to addressing that is to utilize an on-scene LAN including a WLAN or "WiFi bubble" as shown in Figure 7 below. This LAN would include an LTE-client router that acts as the gateway to the rest of the world. Appropriate Application Services would also be available on this LAN to serve local wired and wireless clients as well as connect to higher-level Application Services. This method requires just one video stream on the LTE over-the-air link for all LAN/WLAN viewers, so the potential offload of the LTE over-the-air link onto the WLAN is significant.

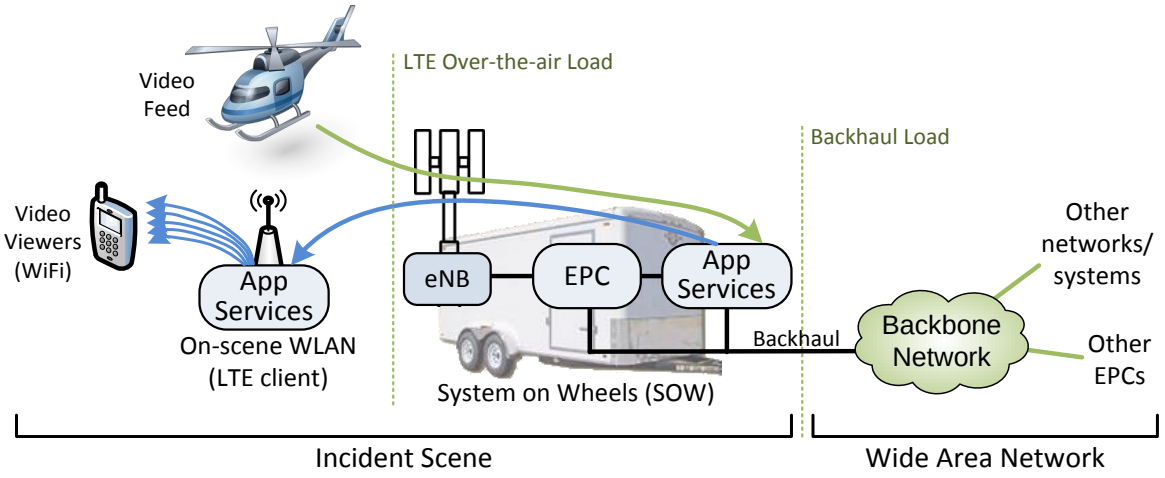

Figure 7: Video sharing with On-scene WLAN

Challenge #3: Operating During System Impairment

Since FirstNet will be most needed during times of crisis, it is critical that the network be as resilient as possible and operate in a best-effort mode during system impairments such as network/backhaul outages, power grid failures, loss of data center, etc.

To mitigate potential network and backhaul outages, standard system design principles dictate the inclusion of redundancy and backup strategies so that the system will continue to operate if any component fails; this is known as the "no single point of failure" principle. One example of this is the use of redundant data centers and EPCs in case one fails. Another example is the use of satellite backhaul from a remote System-On-Wheels if a wired or microwave connection has failed or is not available.

Issues are more problematic when multiple system failures occur simultaneously, as can happen during wide-area events such as natural disasters, power grid failures, acts of war, etc. In these events, large-scale systems can become segmented into "islands of connectivity" where components can communicate with geographically- and/or logically-adjacent components, but may not be able to communicate reliably outside of their segment. This implies that in a resilient system design, these segments should be capable of autonomous operation to provide best-effort functionality to users within that segment. Ideally, these segments should also be able to establish connectivity to any other segment that is still reachable.

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One challenge in designing a resilient system is to anticipate what the isolated segment boundaries may be during a wide-area event. Although there is no magic formula for this, lessons may be learned from the historical resilient LMR system experience. Various analogies may be drawn between LMR and FirstNet systems:

- LMR direct/talk-around modes allow communication between users in the absence of any infrastructure. A FirstNet data equivalent would be an on-scene LAN/WLAN with Application Services that allows ad-hoc peer-to-peer communication.
- LMR "standalone repeater" mode is used to provide communication between users within range of a single radio site even when no backhaul is available. A FirstNet data equivalent would be an EPC and Application Services resident at the local LTE radio site, e.g. a System-on-Wheels.
- LMR multi-zone systems allow communication between users in a single zone even when connectivity to other zones is unavailable. A FirstNet data equivalent would be a regional LTE system with Application Services that allows communication between users in that region even when connectivity to other LTE systems or data centers is unavailable.

Note that many of these resiliency strategies are the same strategies used to reduce congestion as discussed previously. This means that a good multi-tier system design not only increases system resiliency, it also optimizes the data load throughout the system.

Bringing It All Together

We have discussed the value of having Application Services (AS) and Technology Bridge (TB) functions resident at various places in the network. But instead of being just application islands, it is critical that these AS+TB functions work tightly together in an integrated fashion to provide a reliable and seamless experience to all users.

A distributed system of tightly-integrated AS+TB functions is what we refer to as the Media Cohesion Framework (MCF) with each enhanced AS+TB function forming a single Media Cohesion (MC) node in the system. As shown in Figure 8 below, typical wide-area systems will use MC nodes at each level of the network hierarchy to connect users at that respective level. When collaboration with users at different levels is desired, the MC nodes can work together to transparently provide such collaboration.

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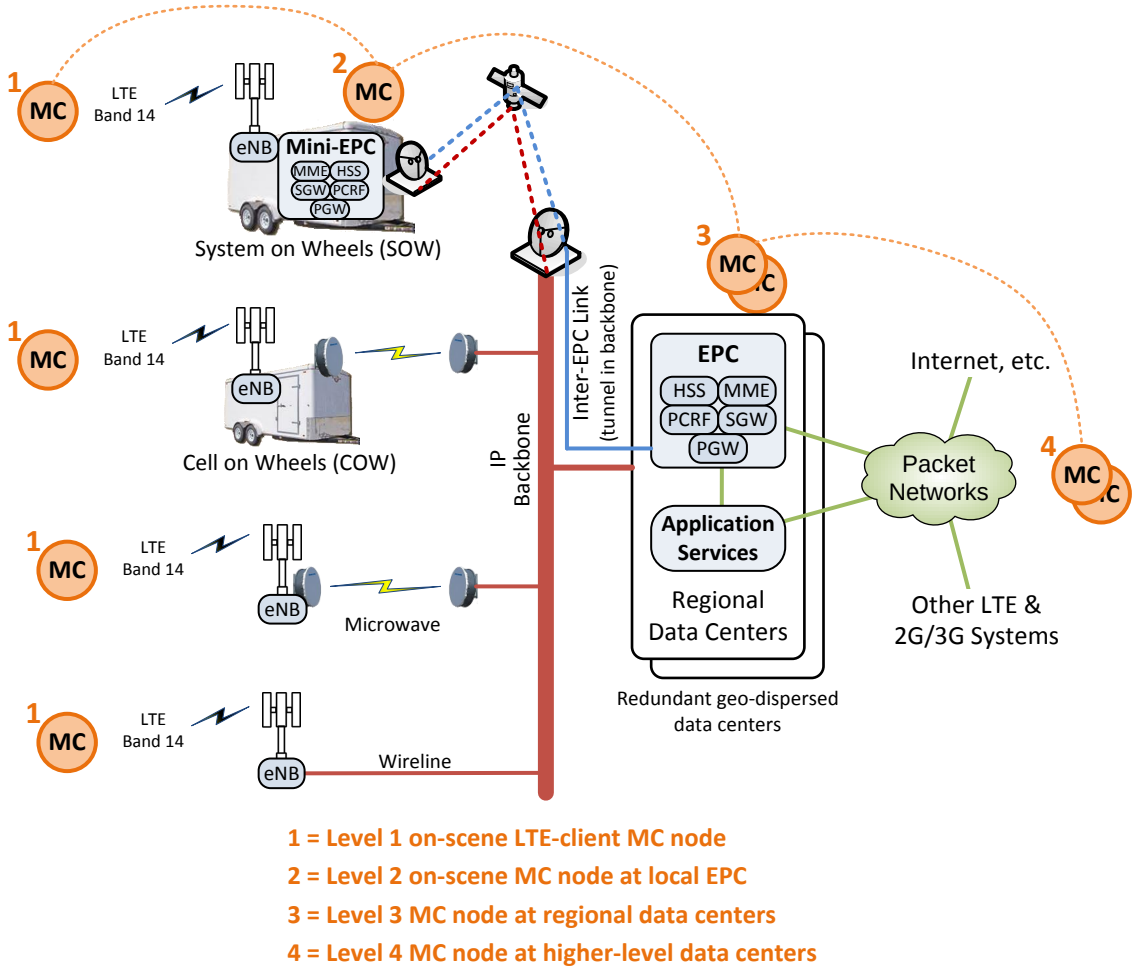

Figure 8: Media Cohesion nodes coordinate at all Network Levels

One of the more complex aspects of building out a large-scale multi-level system can be coordinating the MC nodes required throughout the system, including MC cross-connects with other systems. Due to the potential dynamic nature of the inter-level, inter-segment, and inter-network connectivity, the MC nodes must effectively work together as a wide-area distributed system. To accomplish this, each MC node should:

- Provide functionality to the users in its respective tier/segment/network.
- Dynamically connect to similar MC nodes at the same or higher tiers. This would ideally include an auto-discovery capability for deployments that may require ad-hoc connectivity between non-fixed MC nodes, e.g. on-scene tactical or Systems-On-Wheels.
- Allow connectivity from similar MC nodes at the same or lower tiers.
- Automatically detect when any system impairments are resolved and seamlessly auto-heal the inter-MC topology.
- Optimize the flow of media/data between various MC nodes for the most efficient utilization of the underlying network.
- Implement security services to allow for the encryption of all media/data as well as distributed and/or federated authentication of all MC users.

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The Mutualink Solution

The Mutualink solution was designed from the ground up as a highly-reliable distributed system to specifically address the above challenges faced by public safety and critical infrastructure users. Initially developed as an LMR interoperability platform, this system has evolved and has been enhanced over the past number of years into a full multi-media solution enabling multiparty multimodal inter-agency collaboration with voice, video, text, and data.

To fully enable community-wide inter-agency collaboration, the system was built on the foundational principle of sovereignty - that every participating agency should always maintain complete control of the assets they are sharing with others. This means that the Technology Bridges connected to radio, video, and other existing systems can only be controlled by the owning agency. The Technology Bridges and Application Services components form Media Cohesion (MC) nodes that communicate in a peer-to-peer mode; there is no centralized server/switch that systems must be connected to in order to interoperate, and only an IP network is required.

This key differentiator along with full multi-media capability and distributed resiliency make the Mutualink system a unique solution to the challenges described in this paper.

Significant aspects of the Mutualink solution include:

- Application Services (AS) and Technology Bridge (TB) functions are included and tightly integrated within MC nodes. This allows the AS to optimize for the specific technology/media being bridged.
- Technology Bridges are available to bridge the following media and system types:
    - LMR: Analog and Digital. Donor radio (tactical) and core system (fixed) interfaces.
    - Telephony: Analog (POTS) and Digital (VoIP, RTP, SIP).
    - Audio: PA systems, Intercom systems.
    - Video: Analog (Composite, VGA) and Digital (HDMI, DVI, IP).
    - GIS: CAD/AVL systems, location-aware radios, etc.
    - Data: Text/Chat systems, TCP/UDP clients/servers.
- All MC nodes can inter-connect over any type of IP network link such as wired, WiFi, commercial 3G/4G, Band 14 LTE, microwave, tactical satellite, etc. These links may be mixed in any combination and can provide backup for each other (e.g. satellite is a backup for microwave).
- All MC nodes communicate and coordinate with each other in a distributed peer-to-peer mode for enhanced resiliency. This includes an advanced Auto-Discovery capability that allows the MC nodes to automatically detect and account for system impairments as well as to detect when the system has healed.
- The MC nodes work together to optimize the data flow throughout the entire system to send media/data only when and where it needs to go. This ensures that the system load remains minimized to avoid network congestion.
- Security: All users are securely mutually-authenticated with each other and all shared media/data is transmitted using high-strength encryption

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Mutualink's Experience in FirstNet-related Projects

Mutualink has been used in several key FirstNet-related trials and demonstrations. In Q2/Q3 2013, Mutualink was used by multiple public safety and enterprise entities connected to the Band14 LTE network deployed in Las Vegas, NV by Alcatel-Lucent and the Las Vegas Metro PD. Participating agencies that used Mutualink in this trial included the LVMPD police department using stationary and mobile vehicle systems (see Figure 9), a utility/electric company, a large casino shopping mall, a transportation facility, and an alarm monitoring facility. Users attached to the Band14 system were able to communicate and collaborate with themselves as well as with many other non-FirstNet agencies.

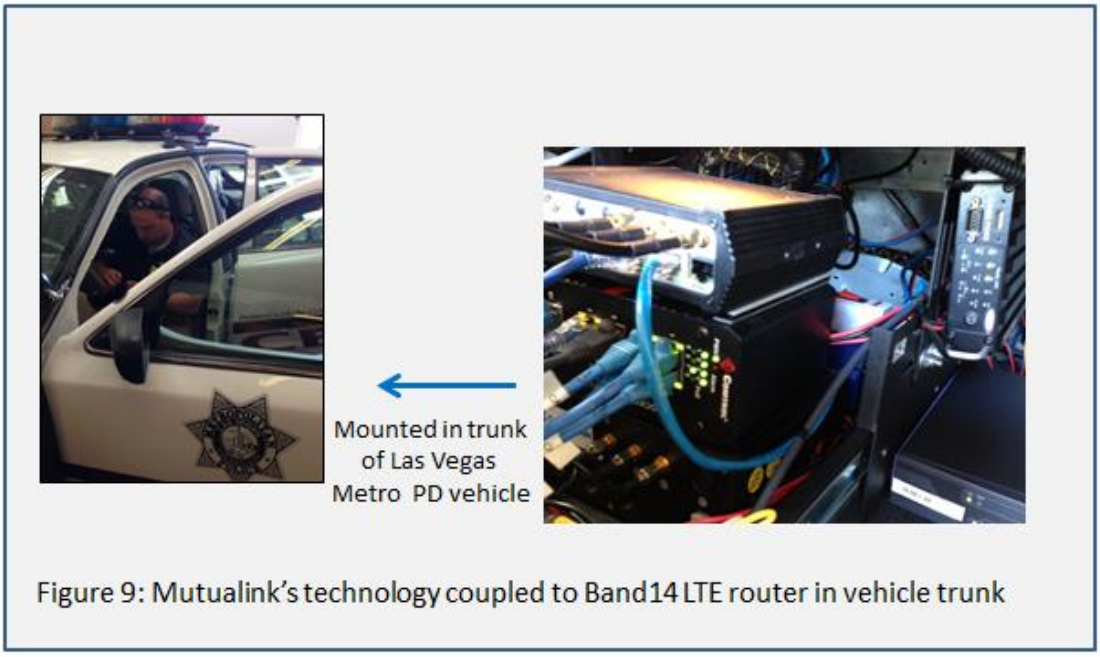

Figure 9: Mutualink's technology coupled to Band14 LTE router in vehicle trunk

A demonstration of capabilities, including fixed and mobile smartphone/tablet devices controlling and viewing the sovereign sharing of radio, video, voice and data between multiple agencies connected to this FirstNet deployment and dozens of other agencies connected via other means (wired, satellite, public 4G, etc.) was shown to more than 40 key agencies and key federal observers in Sept 2013, and a presentation of results was delivered by Mutualink at an IWCE Mar 2014 presentation entitled "Next Generation Wireless Networks: Las Vegas Case Study".

Most recently, Mutualink has been deployed and is in current use on the Band14 LTE system operating in Harris County, TX. The installations are in the Transtar Emergency Operations Center and in a Harris County deployable vehicle that connects to the Band14 EPC core installed in College Station, TX. The system is being used to securely bridge Harris County radios and real-time video surveillance cameras around the city of Houston and the port area with other local and national entities. A demonstration of capabilities, including a mock emergency exercise with video sent to/from a mobile device with a Mutualink client, was shown in an presentation to several hundred first responders, the Texas Department of Public Safety, and FirstNet executives at the TDEM Conference in San Antonio in June 2014. Figure 10 below shows the Band14 deployable vehicle installation, and the live video feed from a surveillance camera being shared out to a Mutualink mobile client.

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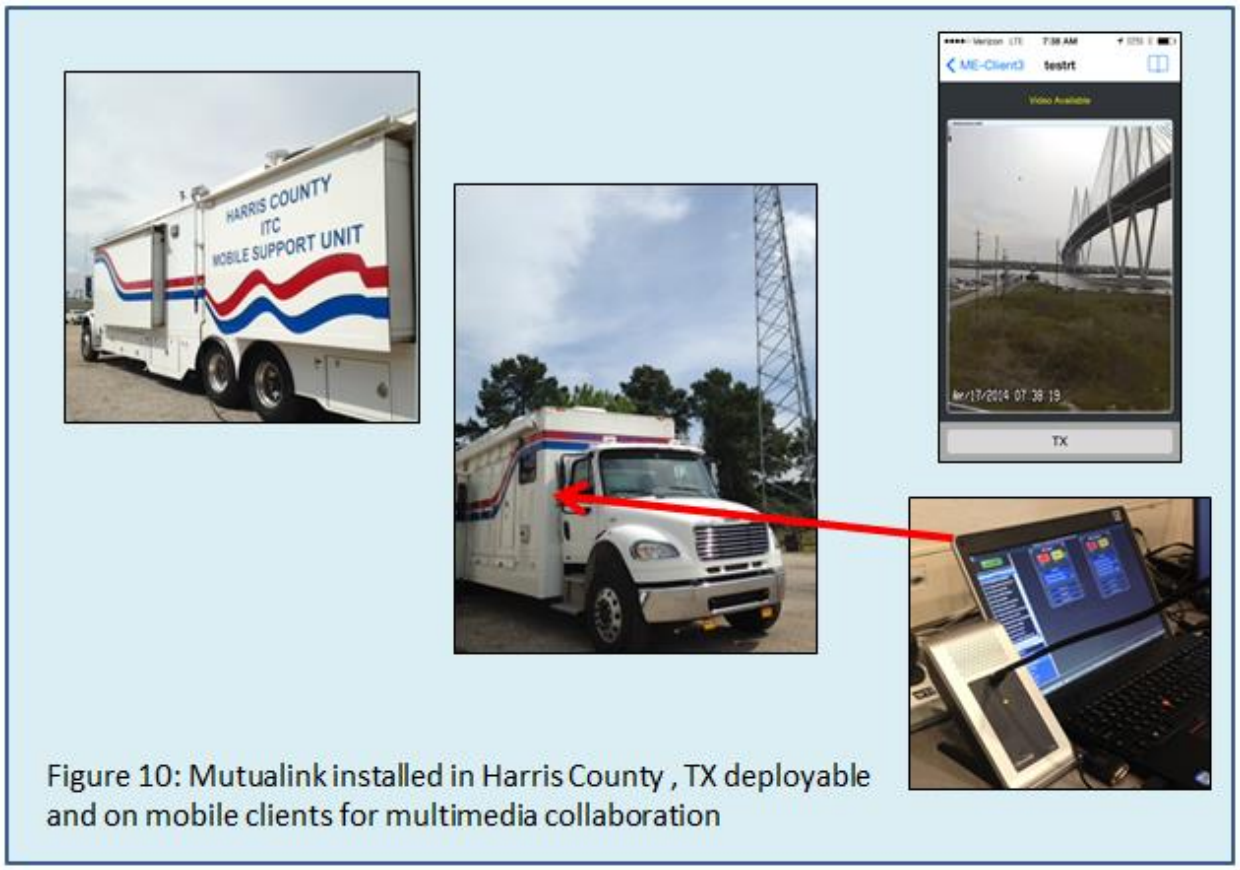

Figure 10: Mutualink installed in Harris County , TX deployable and on mobile clients for multimedia collaboration

Potential Application: New Jersey LTE Deployable System

Based upon publically available information, we describe how the New Jersey LTE Deployable System (NJLDS), planned for 2014/2015, could be enabled by integrating the Mutualink Media Cohesion Framework (MCF) enhancements described above.

Figure 11 below shows a simplified summary of the required NJLDS system components. Multiple System on Wheels (SOWs) each containing a mini-EPC and an eNodeB are constructed and installed in trailers, mobile vehicles, and rack mounted chasses. As described above, the mini-EPC in each SOW, through its inclusion of the HSS, S/P Gateways, PCRF, and MME, provides the required connectivity intelligence, whereas the eNodeB provides the two-way Band14 RF capabilities. Each SOW is a standalone system that provides complete connectivity without the need for backhauling to a remote system across the wide area network. Multiple Cell on Wheels (COWs), also depicted in 11, are similarly planned for construction and deployment within trailers, mobile vehicles, and rack mounted chasses. Unlike the SOWs, COWs do not contain the connectivity intelligence, and therefore must be connected via backhaul to another EPC, such as the mini-EPC in a SOW, or to the common EPC deployed in a fixed location in New Jersey.

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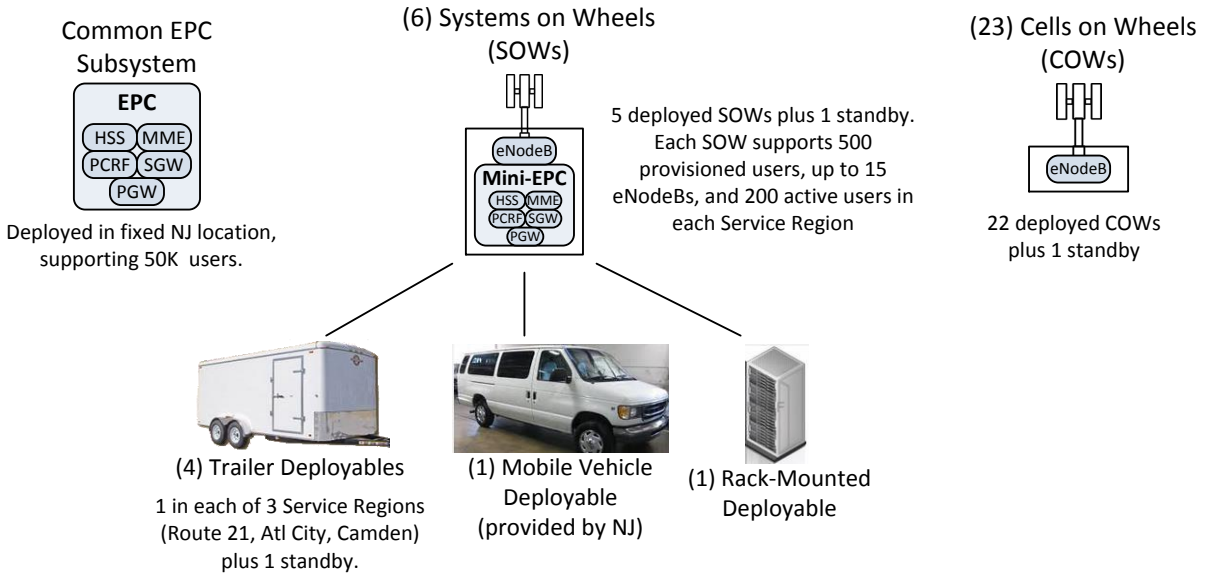

Figure 11: New Jersey LTE Deployable Project System Elements

Figure 12 below shows the simplified NJLDS network architecture. COWs typically connect across the WAN via Microwave through an IP-based MPLS network. SOWs can potentially support multiple types of connectivity including Microwave, Satellite, and Fiber. The overall network connects to the existing wired state networks already deployed, as well as to Network Operating Centers (NOCs) for OSS system monitoring and maintenance. Note that while the standalone SOWs, and COWs with associated backhaul connectivity to a remote EPC, provide the necessary connectivity intelligence, the overall system does not provide any application-layer intelligence.

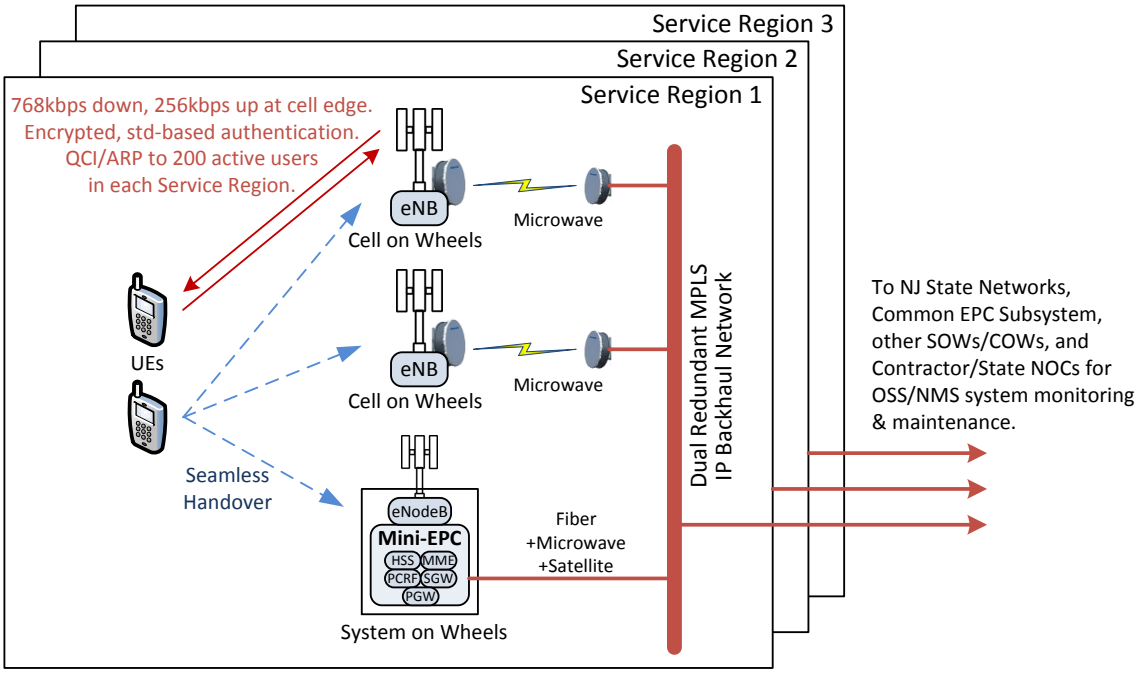

Figure 12: New Jersey LTE Deployable Simplified Network Architecture

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Figure 13 below depicts how Media Cohesion Framework (MCF) based intelligence might be added to the NJLDS system. An Enhanced System on Wheels (ESOW) is proposed that includes not only the elements of the existing SOW but includes additional components for application-layer intelligence in a Media Cohesion (MC) node. An Application Services component, such as that produced by Mutualink, provides ESOW-side capability that interworks with the advanced UE-side thin client app. Multiple UEs in the Band14 RF field-of-view and/or local WiFi zones can thereby communicate (voice, video, text messages/photos, dynamic location, etc.) with each other. In one example scenario, the camera in one user's mobile device can potentially be shared and seen by other user UEs – a package along a parade route, a suspicious vehicle, or an on-scene view after an explosion or during a fire can be shared with multiple other first-responders present in the ESOW RF vicinity. Similarly, compact video gateways in the MC node provide real-time video streamed from HD Pan-Tilt-Zoom cameras mounted on the vehicle and/or an attached/nearby pole. Interoperability with conventional LMR radios is also achieved via the compact radio gateway component in the MC node.

Note that the ESOW provides secure local, multimedia multiparty collaboration capability between UEs and legacy devices such as video cameras and LMR radios without requiring backhaul capability. The Media Cohesion Framework encompasses the RF bubble or region in the vicinity of the ESOW. In addition, when the backhaul from the ESOW becomes present, the ESOW automatically provides both local as well as wide area connectivity. That is the Media Cohesion Framework is automatically extended whenever the backhaul becomes available.

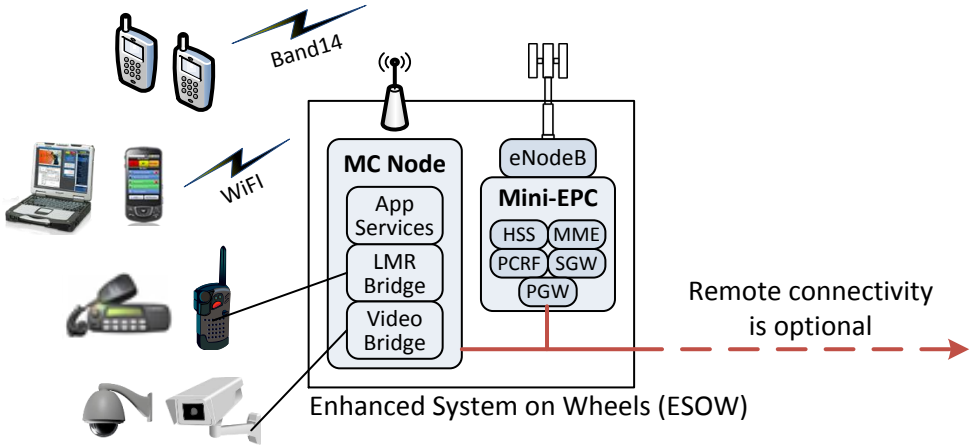

Figure13: Enhanced SOW with MCF

MCF enhancements can also be included in an Enhanced Cell on Wheels (ECOW) as depicted in Figure 14 below. ECOWs typically require remote WAN connectivity, since the EPC is not present locally. However UE devices can still continue to interact with each other, and with local camera resources and radios, via the WiFi connectivity, even if the WAN connectivity is disrupted. And, when WAN connectivity resumes local UEs can use Band14 to communicate locally, as well as remotely, to other New Jersey deployables as well as to other fixed CIKR facilities throughout the state of NJ and the US.

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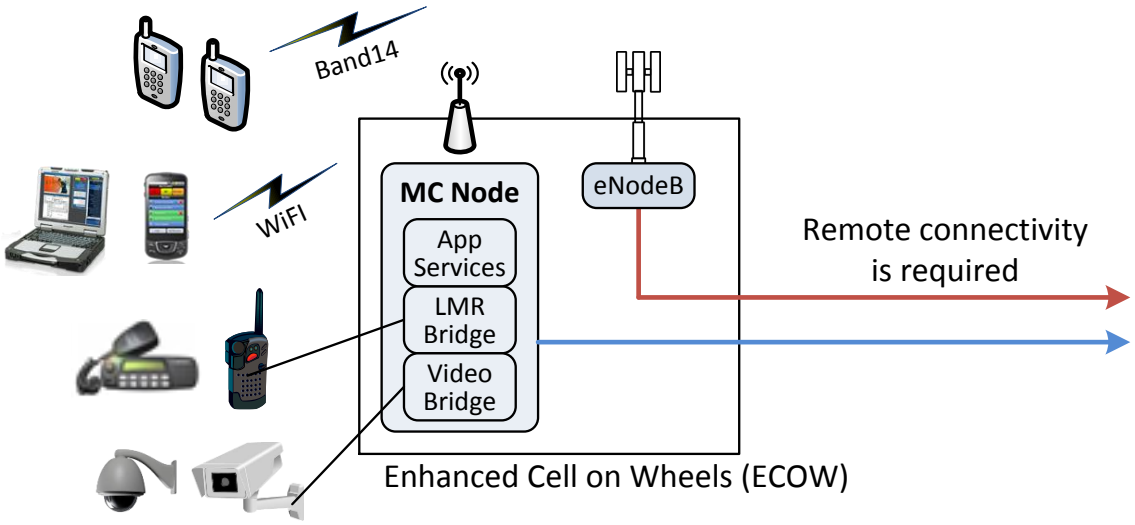

Figure 14: Enhanced COW with MCF

Conclusion

Mutualink produces advanced and affordable IP-based interoperable multimedia technology that connects disparate two-way radio, telephone, mobile phone, streaming video and data sources for real-time intra-and-inter-agency collaboration. Mutualink has already been comprehensively deployed in many regions in the US such as New Jersey, Boston and San Francisco with federal state and local public safety and emergency response agencies and critical infrastructure entities including utilities, malls, stadiums, schools, hospitals, and transit, and is rapidly growing. Mutualink's edge-of-network Media Cohesion based technology has been operationally deployed in hundreds of military, state, county, city and local facilities including police, fire, emergency operations centers, maritime patrol, stadiums, transit, malls, financial institutions, hospitals, casinos and schools, connecting all types of their existing disparate P25/LMR radio, video, and data resources within multi-party, highly-dynamic emergency incidents.

Although Mutualink has been most typically deployed in fixed dispatch environments with wired IP-networks, it has also been deployed using satellites, legacy mobile data systems, and across 4G/LTE mobile networks. Mutualink has proven that the DHS scalable, all hazards, all disciplines response and recovery framework can be affordably and effectively implemented on a community wide and cross regional basis, enabling seamless interoperability with both legacy and next generation communication systems. Mutualink's solution in conjunction with the FirstNet network can solve many of the communication and collaboration issues faced by public safety and critical infrastructure agencies that FirstNet was created to solve.

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