Commercializing Public Safety Technology, A Roadmap and Case Study for LMR to Broadband Dispatch and Interworking

From Catalyst Communications Technologies, Inc.

THE PATH FROM RESEARCH TO PROTOTYPE TO PRODUCT

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Introduction and Executive Summary

The Small Business Innovation Research (SBIR) program is a highly competitive program that encourages domestic small businesses to engage in Federal Research/Research and Development (R/R&D) with the potential for commercialization. The program is administered in three Phases. Phase I is a research phase, Phase II is a prototype development phase, and Phase III is a commercialization phase. Having successfully completed both Phase I and Phase II Small Business Innovative Research (SBIR) projects to research and develop Interworking technologies for the Department of Homeland Security (DHS), Science & Technology (S&T) Directorate, Catalyst was awarded Phase III funding from the National Institute of Standards and Technology's (NIST) Public Safety Communications Research (PSCR) Division for commercialization of these technologies.

The adoption of new technologies has always benefitted from a "seeding" of the marketplace to show early adopters what is possible. The introduction of wine into the United States and its subsequent growth provides a good model and metaphor for the task that Catalyst has undertaken. We must educate the marketplace about the benefits of broadband based communications and the need for interworking between these new broadband devices and Land Mobile Radios. In the 1930's, the United States was primarily a "cocktails and beer" society, with little use or knowledge of wine. Entrepreneurs from France traveled to the US with wine samples, touted wine's benefits to bartenders and hotels, trained wine directors and sommeliers, and created an environment that encouraged influencers and decision-makers to first sample and later promote wine. Today, the wine industry is a 65-billion-dollar industry in the US.

Seeding the mission critical marketplace by deploying systems to end user influencers who need to be educated on how Broadband and LMR/Broadband Interworking can improve their communications formed the foundation of our commercialization efforts. Promotion, speaking opportunities, trade show demonstration and video marketing augmented the "try it first" seeding activities. It is a time-honored and proven strategy for adoption, but it is rolling-up-the-sleeves hard work.

Lessons Learned

Throughout the Phase III execution there were many important lessons learned and best practices uncovered. Over the three-year period of performance, our efforts to commercialize the results from our research and prototype development phases included a wide variety of field trials. The field trials were conducted with various types of agencies using different LMR systems and interfaces with varying hardware configurations of the Catalyst products, primarily on Southern Linc's MCPTT and later on AT&T's FNPTT service. We also deployed a number of permanent installations that cover a variety of implementations; some of these were funded through the PSCR grant and others, more recently, through sales of our technology.

In addition to overcoming a broad range of business, sales, and marketing challenges, we made significant technological advancements to both interworking and seamless LMR to broadband dispatch to compete more effectively against Radio over Internet Protocol (RoIP) providers, donor handset solutions and the Interworking Function (IWF).

This paper describes the processes and activities that Catalyst undertook to commercialize technology developed under the federal SBIR program with DHS S&T, lessons learned, and feature enhancements identified through this initial commercialization effort.

Environment and Industry Need

The First Responder Network Authority (FirstNet®) was created under the Middle-Class Tax Relief and Job Creation Act in 2012, to establish, operate, and maintain the interoperable National Public Safety Broadband Network (NPSBN). AT&T was awarded the contract to develop this broadband network. A clear requirement for any broadband-based solution targeted to the First Responder community is communications between existing LMR subscribers and users of new broadband push to talk (PTT) solutions, including FirstNet®. Adoption of broadband-based PTT continues to be gradual, and communications between these different network technologies will be vital both during

Acronyms useful to understand while reading this White Paper

- **LMR** – Land Mobile Radio
- **Broadband** – Wireless LTE/5G Networks
- **3GPP** – Third Generation Partnership Project
- **P25** – Project 25
- **IWF** – The Interworking Function
- **MCPTT** – 3GPP's Mission Critical Push to Talk
- **FNPTT** – FirstNet® Push to Talk, a PoC solution utilizing the 3GPP MCPTT standard
- **PoC** – Push to Talk over Cellular
- **ISSI** – Inter Sub-System Interface
- **EPTT** – Enhanced Push to Talk
- **OTT** – Over the Top Push to Talk
- **NPSBN** – National Public Safety Broadband Network
- **PSCR -** Public Safety Communications Research (PSCR) a division of the National Institute of Standards and Technology
- **DHS S&T –** Department of Homeland Security Science and Technology Directorate

the transition and in the decades to come since some agencies may never transition to broadband.

Previous implementations of push to talk over cellular (PoC) have exposed issues that introduce complexity when attempting to solve this technical challenge. The biggest issue with proprietary PoC solutions is that once a vendor is selected, everyone needs to have that vendor's application. For instance, a Harris BeOn PTT system cannot directly communicate with a Motorola Wave PTT system, and neither can communicate with an ESChat over-the-top (OTT) PTT system. Incompatible, one-of-kind technologies destroy interoperability and create an untenable management problem. Therefore, published, open standards such as MCPTT that adheres to the Third Generation Partnership Project (3GPP) standards organization should be implemented. While AT&T has implemented different PTT technologies on FirstNet®, their FirstNet® Push to Talk (FNPTT) service is a service which is fully 3GPP standards compliant.

The proposal that Catalyst presented to DHS S&T in response to a solicitation for communications between standards compliant MCPTT and Land Mobile Radio systems in the marketplace was the subject of our Phase I and Phase II Awards. Activities described throughout the remainder of this paper pertain to our Phase III commercialization efforts.

Project Overview: Tasks Summary

Our commercialization effort was executed over the period from February 1, 2021, to March 1, 2024. The goal of this project was to advance the work previously completed in our Phase I and Phase II contracts to include commercialization and live field deployments, proving to the industry the value of LMR/Broadband Interworking and Dispatch. We organized our effort through a series of tasks to accomplish:

Task 1: Develop four (4) standard operational packages for product deployment that meet the architectural needs of different types of public safety agencies.

Task 2: Conduct twenty (20) system field trials with public safety agencies.

Task 3: Provide ten (10) operational systems permanently fielded to public safety agencies.

Task 4: Provide two (2) operational systems to NIST/PSCR - one (1) for the PSCR lab and one (1) for the DHS lab to enable NIST/PSCR and DHS continued collaborative research efforts.

Task 5: Provide training sessions to the public safety agencies selected from Task 3 and one (1) training session for NIST/PSCR in the operation of deployed systems.

Task 6: Refine final products to use standards consistent with typical expectations of public safety products of this type.

Preparing for Commercialization

Catalyst understood that initial deployments needed standardization and simplicity if these initial solutions were to gain acceptance in the marketplace.

<u>From Prototype to Commercial Products – The Need for Standardized Packages</u>

Implementations of LMR to broadband communications are typically "systems" requiring individual design and implementation. This is primarily due to the disparate LMR systems in the marketplace and the individual requirements of First Responder organizations. Understanding this, Catalyst's initial deployments needed standardization and simplicity if these solutions were to gain acceptance in the marketplace. Our strategy was to create product packages to address the greatest percentage of the installed LMR system base with the fewest number of packages possible. The result was a mix of multi-mode, multi-technology offerings allowing us to demonstrate and/or integrate with LMR systems including VHF, UHF, 700-800Mhz, Conventional and Trunked with options for both wireless and wireline connectivity. We also understood that the user interfaces for these initial users needed to be simple and to accommodate organizations that needed to establish interworking as part of Dispatch operations and organizations as well as in-place Dispatch systems that needed a stand-alone user interface separate from an existing Dispatch console. Therefore, all of the packages were productized with either Catalyst's IntelliLink™ Gateway Dashboard or with our Propulsion™ dispatch console. This approach allows for interworking and/or dispatching across communications domains.

Figure 1 - The IntelliLink Gateway and Propulsion Dispatch User Interfaces

A dispatch or interworking system is typically configured to connect components as shown here:

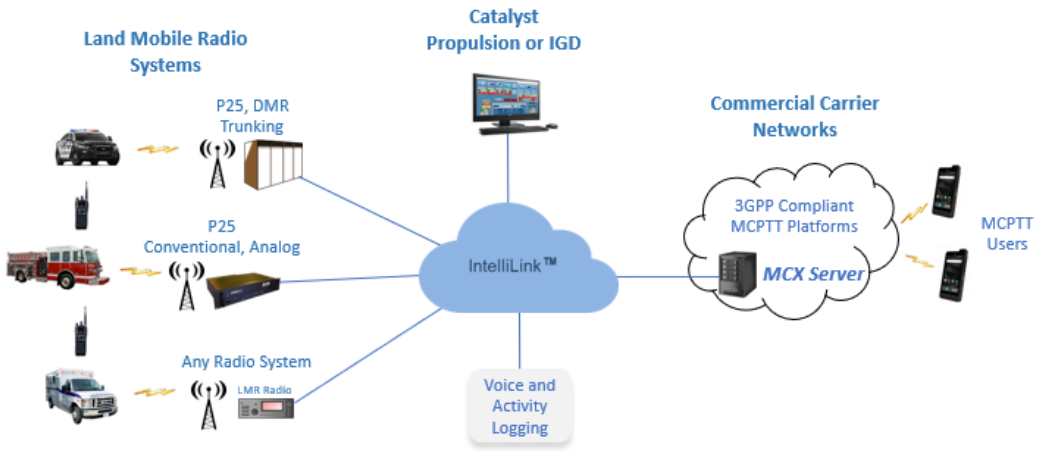

Figure 2 Typical Interworking Network Configuration

To prepare for commercialization, the prototypes developed for Phase II had to be expanded and enhanced to implement commercial products ready for use by Public Safety organizations. Some of this activity included:

- Software Licenses Required for a Commercial Product
- Catalyst Security Key Modifications
- Configuration Enhancements for the MCPTT Interface
- “Shrink Wrap” Enhancements
- Radio Interface Enhancements
- Installation Kits and Packages

Deploying Field Trials

As expected, we learned many things from our initial field deployments. While the first priority of this project was commercialization with AT&T's FirstNet® Push-to-Talk service (FNPTT), AT&T was not ready for production deployment, so we began deployments using Southern Linc's CriticalLinc™ network with their Linc MCPTT service. Southern Linc deployments were followed by implementations with Canadian carrier TELUS's MCPTT service. When AT&T FNPTT became available in late 2023, we began trials with that service on AT&T's production network. Catalyst provided onsite installation and training for all field trials with the exception of a few remote deployments. Also included were permanent installations in both PSCR and FirstNet Authority facilities which resulted in both of these agencies providing extensive feedback to Catalyst.

Earlier in this paper we indicated our understanding of the need for standardization and simplicity of the initial installations to promote customer acceptance of the technology. Therefore, we designed and built various Portable Operational Demonstration (POD) systems to demonstrate capabilities while also enabling incorporation directly within an agency's current LMR operational model. The POD program was able to equip our sales, marketing and operations teams with highly portable, fully functional systems that could be easily transported across the country.

Figure 3 POD System images

Permanent Installations and Sales

Subsequent to, and in some cases in parallel with the field trials, Catalyst deployed several permanently installed systems including sales of FNPTT based systems. As with the field trials, the feedback continues to be very positive. Customer feedback is essential as we develop improvements that allow better utilization of the capabilities of the technology.

Carrier Onboarding

Perhaps the greatest change to public safety communications resulting from the establishment of the FirstNet® Authority is the introduction of the nation's telecommunications carriers into First Responder organizations' decision tree, once dominated by radio manufacturers such as Motorola, L3Harris, Kenwood and EFJohnson. Through the Phase III commercialization process, we learned that end users have a strong preference to obtain technology that Catalyst creates from the carrier providing their MCPTT service.

Perhaps the greatest change to public safety communications resulting from the establishment of the FirstNet® Authority is the introduction of the nation's telecommunications carriers into First Responder organizations' decision tree, once dominated by equipment manufacturers including Motorola, L3Harris, Kenwood, EFJohnson, and a number of radio manufacturers.

AT&T

On July 5, 2023, Catalyst and AT&T entered into a Joint Marketing Agreement whereby AT&T will offer its customers support for FirstNet® push-to-talk services through Catalyst's Dispatch and Interoperability solutions.

Being a very large corporation, rooted in telecommunications, AT&T is naturally a very process heavy organization. This project required us to analyze and understand their internal processes, then meld our existing internal processes into one cohesive, complementary customer lifecycle process.

Our efforts to onboard AT&T included many professional presentations to a vast number of employees whereby we heard repeatedly things like "this is a game-changing solution that really steps us up with FirstNet®" and "this fills a unique product gap and we are very excited to have Catalyst as a fully qualified partner." The AT&T sales force continues to be trained on the value of our solutions. Catalyst has purchase orders from multiple AT&T FNPTT customers as well as from AT&T itself. We are continuing to add new opportunities to our Sales Funnel and

are scheduling sales demonstrations and field trials with AT&T's customers in coordination with AT&T. The outlook for additional sales is bright.

Southern Linc

On June 15, 2022, Catalyst and Southern Linc announced a partnership whereby Southern Linc would promote and sell Catalyst's solutions within Southern Linc's operating territory of Georgia and Alabama. As a result, this partnership has allowed us to provide best-in-class LMR/MCPTT dispatch and interworking solutions to several Southern Linc's customers, proving the effectiveness of this technology and the overall importance of this Phase III program to the Public Safety industry.

Similar to AT&T (though on a smaller scale), commercialization efforts leading up to this launch included developing pre-sale through post-sale support processes, documentation, sales collateral and planning of many co-marketing activities.

In coordination with Southern Linc, we continue to add new opportunities to our Sales Funnel and schedule sales demonstrations and field trials with Southern Linc's customers. The outlook for additional sales with Southern Link is also bright.

TELUS

In parallel with our work with Southern Linc and AT&T, we did a substantial amount of work with the Canadian carrier TELUS in preparation for commercialization. These activities included both business operations accomplishments and technology accomplishments in preparation for TELUS' rollout of their MCPTT service offering in 2024.

Establishing a Partner Ecosystem

Since the inception of our LMR to broadband Interworking efforts we have understood that the mission critical marketplace has many interconnected pieces that accomplish the overall system level goals and mission of public safety. Each of these suppliers understood that the migration from LMR to MCPTT systems needed coordination and cooperation among

these players. Catalyst developed and promoted an "ecosystem" of companies working together towards this migration, providing the marketplace with confidence that their existing equipment would interoperate with new broadband technology as it was developed and deployed.

Figure 4 - The Catalyst Interworking Ecosystem

Especially at industry trade shows, Catalyst and its ecosystem partners promoted this cohesion of interconnected solutions, demonstrating to the industry that multiple players in the mission critical marketplace were aligned to provide new communications solutions centered on broadband networks.

All these efforts help further Industry Buy-In for this exciting new technology which promises to significantly improve mission critical communications for First Responders.

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Positioning and Messaging

In addition to our education and promotion activities to commercialize new innovative technology, the industry needs to understand the differences between competing solutions for solving the interworking challenge. For Catalyst and our technology, we needed to clearly articulate our advantages against 1) the 3GPP InterWorking Function (IWF), 2) Radio over

Internet Protocol (RoIP) and donor handset solutions and 3) dual mode radio offerings.

Relative to the IWF

The IWF is a standards-based interworking solution primarily suited for the largest P25 radio systems. As such, there are no immediate planned provisions for direct interface to any non-P25 systems which precludes all non-P25 systems in use today throughout the LMR industry. Catalyst's solution uses the 3GPP standard MCX Client Interface and a variety of LMR interfaces to maximize the breadth of agencies and technologies that we can serve.

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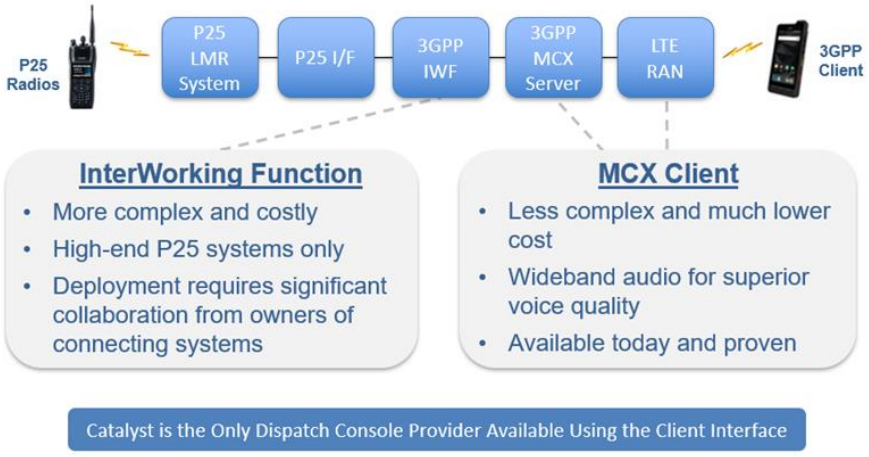

Figure 5 - The InterWorking Function compared to the Catalyst Interworking Solution

Relative to RoIP Devices

Competitors have offered simple Radio over IP devices to connect LMR and broadband. These fall short for many applications as shown below:

Capability	RoIP Devices	Catalyst Intellilink™ Interworking	Catalyst Intellilink™ Interworking Plus Dispatch
PTT Control	Y	Y	Y
Talk Group Patching (bi-directional)	Y	Y	Y
# of Channels Supported	12	100s	100s
User Control / Interface	Remote Access Login	Intellilink™ Gateway Dashboard	Propulsion Dispatch Console
Uni-directional Talk Group patching	N	Y	Y
Recording (Instant Recall, BDRI & ADRI)	N	Y	Y
Intelligent Audio Buffering	N	Y	Y
Caller ID / Alias	N	Y	Y
Call Metadata	N	Y	Y
Group & User List Retrieval	N	Y	Y
Dynamic & Pre-defined Patches	N	Y	Y
Talkgroup Plus Individual Calling	N	N	Y
Location Mapping with Integrated Calling	N	N	Y
Text Messaging	N	N	Y
Emergency Alerting/Calling	N	N	Y
Simultaneous, Multi-channel Broadcast	N	N	Y

Figure 6 - Radio over IP advantages and disadvantages

Relative to Dual Mode broadband LMR Radios

While these devices don't present a direct competitive threat, we found that there were misconceptions in the marketplace regarding the approach that caused a perceived threat. To address this, we created messaging and training tools to explain the differences and help position these offerings as complementary to our offerings rather than as alternatives. Both solutions, working together in their respective realms, provide the greatest benefits to public safety agencies.

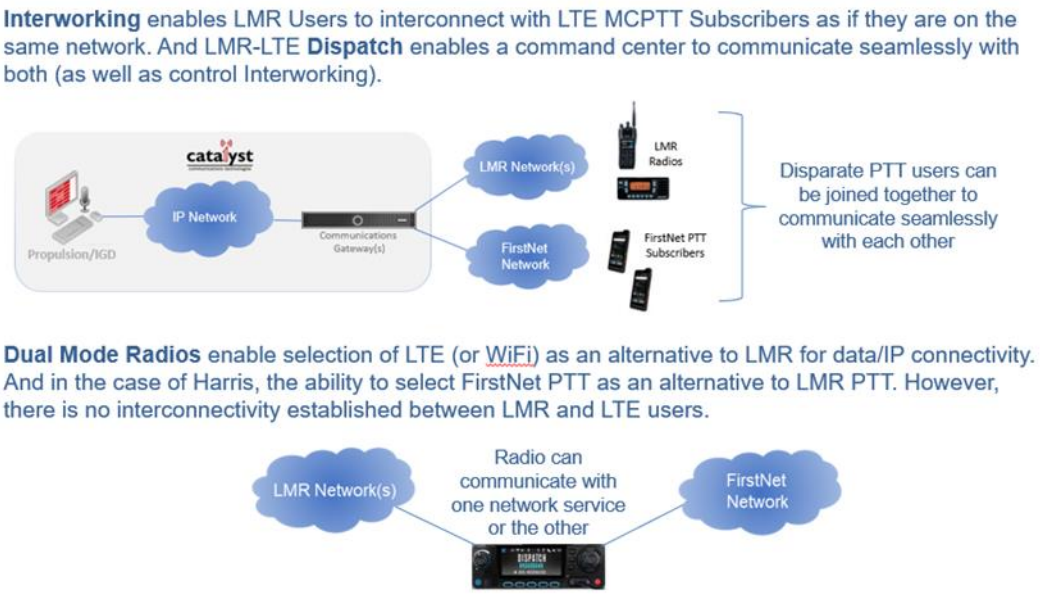

Figure 7 - Dual Mode Radios provide a communications interoperability function

Technology Advancements Derived from the Commercialization Effort

Throughout this document, we have referenced many technological advancements. Catalyst maintains a very active product roadmap at all times; significant achievements throughout the course of this project are part of a continuously updated development schedule that prioritizes and incorporate these advancements into products focused on improving communications for First Responders. The commercialization effort also motivated advancements in our business practices, including our move to an Enterprise Resource Planning tool, NetSuite® from Oracle, which will improve our ability to meet and serve customer demand for our Platform.

Patent Activity

Some of these advancements are patent-worthy. The development of LMR/Broadband Interworking technology and its subsequent commercialization efforts have produced innovations whose development was required to solve problems facing public safety communications. For example, First Responders are used to knowing who they are speaking with on LMR networks, but the present 3GPP standards have not fully addressed how to address this in a technology agnostic way across disparate networks. Catalyst has filed three provisional patent applications for innovations related to our interworking development work and converted the first into a utility patent.

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Notable Results and Lessons Learned

Throughout our commercialization efforts, we heard frequently from our partners and early users that the perceived value of our technology is high. An often-quoted benefit realized by the Public Safety community as a result of our Field Trials was that we demonstrated a viable solution to replace existing Interop solutions and an effective way to augment existing network and Dispatch centers. We also summarized our "lessons learned" and, while they often confirmed various market assumptions we held prior to the onset of the project, two topics were especially insightful:

- Market education remains a significant challenge, especially with the proliferation of non-standards based PoC solutions. Even FirstNet® users can select proprietary PoC solutions from the FirstNet® catalog, and the compelling advantages of a standards-based solution must be made clear to this industry.
- End users seem genuinely aware of the advantages of broadband over legacy LMR radio systems, but each of the capabilities that perform well on LMR systems need to be demonstrated on broadband before these users will be comfortable moving from their LMR radios to broadband smartphones.

Conclusion

The PSCR SBIR Phase III project has been completed with completion of each of the 6 project tasks plus a significant number of additional accomplishments including carrier partnerships, broad market awareness and customer endorsements of new advanced interworking technologies. As a result, we are very well positioned to continue our momentum providing innovative LMR/Broadband dispatch and interworking solutions that are proving to help transform the Public Safety communications industry. As the market becomes more willing to adopt MCPTT, our robust and reliable products stand ready to meet the stringent requirements that Public Safety defined for Interworking in the NPSTC report.

For solutions to your unique Interworking, Dispatch, and Interoperability needs, please contact Catalyst at 434-582-6146 or info@catcomtec.com.