White Paper: Implementing Paging on a P25 System

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OVERVIEW

Paging, in one form or another, has been in use since the 1950s. Beginning with a simple voice announcement transmitted over an analog channel, to Selective Call, 2/5 Tone Signaling in the 1970s, and sending alphanumeric messages in the early 1980s, paging continues to be used in critical messaging applications.

Today alphanumeric paging is used in healthcare, large enterprise and public safety applications supported on private and commercial paging networks. 2 Tone analog paging continues to be used predominately by volunteer fire departments, EMT and EMS personnel on private networks.

There is no reason to believe paging as we know it today will be replaced anytime soon given its advantages of reliability and message latency. However, as new critical messaging networks are being built a common question is, can paging be added??

In the ensuing sections adding paging functionality to a P25 Trunking system will be reviewed. This document will not be a P25 tutorial as there is considerable literature available on this subject however; it will describe how Unication's P25 Pager works in a P25 environment. In the final section a review of the G4/5 Features and capabilities will be provided.

P25 EVOLUTION

In response to the need for wireless communications interoperability between Public Safety organizations the APCO Project 25 was initiated in the 1989. A committee was formed consisting of various Federal Government and Public Safety agencies to provide guidance on the priorities and technical development of P25.

Over the years Open Standards have evolved (and continue to be enhanced as needed), best practices shared and over 800 systems have been built with more under construction.

A variety of manufacturers are now providing Portables, Mobiles and Infrastructure thus providing competition that will continuously improve the products and capabilities for critical messaging applications.

WHY PAGING ON P25?

There are a number of reasons; many address true shortcomings with current paging environments and others represent the practical and logical evolution of technology. Below are the most commonly discussed reasons:

- The P25 networks are built with a high degree of reliability, much more so than the older, private, analog 2 Tone or even most commercial alphanumeric paging systems.
- P25 Systems are professionally maintained and monitored.
- With an existing 2 Tone pager, Users are limited to the number of analog channels they can monitor. On a P25 system a pager can be programmed to monitor many Talk Groups.
- Users want to listen to P25 traffic while at an incident, but cannot afford an expensive Portable.
- P25 systems can offer improved RF coverage over many existing analog paging systems that experienced reduced RF coverage when they narrow banded.

- Many Public Safety groups migrated from 2 tone voice paging to alphanumeric paging for cost and coverage reasons. However, the End Users really miss receiving, hands off, voice messages versus trying to read a message on the small display of an alphanumeric pager. Paging on a P25 System will bring back voice paging.
- The cost of migrating to P25 paging has an excellent return on investment when one considers the savings related to not maintaining, not building out current system for improved coverage or for not building a replacement 2 Tone analog paging system.
- In Appendix 1 such a cost / trade-off analysis performed by Grand Traverse, Michigan is provided.
- P25 is where the money is going and from this new products and services will follow.

WHAT IS PAGING ON P25?

There are many reasons to want paging on P25, but is there a common understanding of what a P25 pager is and can do? Well, depends on who you ask.

For the First Responders, they want a P25 pager to behave like their current 2 Tone pagers. For the Dispatcher, they do not want to change their current dispatching process to accommodate a P25 pager. For the System Administrator, since there will be potentially many P25 pagers on their network they do not want it impact current system loading.

Are the above possible or are these conflicting? The good news is, all the above is possible and in the ensuing sections each will be covered.

Can a P25 Pager Replace the Current 2-Tone Pagers?

Since the basic functionality of a 2-tone pager has not changed in almost 40 years Users have become very familiar what it does and how to use it. New products with advanced functionality cannot be complicated or divert the attention of First Responders from their primary role of saving and protecting lives. Consequently, the P25 pager must be, in its basic

operation, almost transparent in its behavior to the older technology it is replacing.

Unication spent considerable time making sure this is the case. Current 2 tone pager function modes such as Selective Call, Monitor, Priority Scan and Normal Scan are duplicated and in some function modes such as Priority Scan the User experience is much improved in a P25 environment.

In addition to the function modes being duplicated, Unication has made the control switches on top and the Selector Knob function the same as the 2-tone pager.

Received pages can have their own alert tones (or custom wav files) and the Selector Knobs can be set to allow for an audible alert or vibrate.

Paging on P25 not only duplicates the behavior and operation of a 2-tone pager, but Users will benefit from:

- Improved voice quality
- Improved RF coverage
- A large number of groups to monitor

Dispatching Process

To say nothing will change is inaccurate, but some changes can actually be for the better.

For example, when sending a 2 Tone page the Dispatcher must press the desired icon and wait for the 2 tones to be sent before sending the corresponding voice message. A delay in sending the voice message after Tone B of the 2 Tone ID could cause the 2 Tone pager to reset and not receive the voice message. Also, if the Dispatcher has to alert multiple teams the 2 Tone IDs are then grouped and sent sequentially followed by the voice message. The consequence of this is that the first team receiving their 2 tone ID must hear all other 2 Tone IDs before the voice message.

With a P25 pager the Dispatcher will depress the appropriate icon and can begin speaking immediately. This is much simpler for the Dispatcher and reduces probability of the team missing the voice message. Also, depending on the Console, when the situation requires multiple teams the Dispatcher can create a Multi-select and begin speaking immediately after it is sent. All teams will receive the message at the same time.

Depending on the Console network interface there may be other considerations and this will be reviewed in a later section.

System Administrator Concerns

When someone says they are going to add hundreds if not thousands of pagers to a P25 network understandably this will raise a red flag to the System Administrator.

Two important clarifications will assuage their concerns:

- Unication's P25 pager does not register nor affiliate on the Network. This means traffic will not follow the pager as it moves throughout the network. This is critical for Sites that have a limited number of Traffic Channels.
- A pager is a "one to many" transmission and a dispatch message is typically 10- 15 seconds. This should not impact a vast majority of the systems unless the P25 Site has only one Traffic Channel (very unlikely). Michigan and Ohio, first to adopt Unication's P25 Pager technology, have considerable empirical data that confirms the impact has been minimal.

HOW DOES THE UNICATION PAGER WORK ON A P25 SYSTEM?

The pager is a P25 compliant, receive only device, meaning, it does not register or affiliate on the Network. There are multiple ways the pager can be configured on the P25 system depending on the application. The Unication pager can use TGIDs, Call Alerts and/or QCII Tones digitized over P25. Each approach has its "Pros" and "Cons" and must be evaluated accordingly. In the following paragraphs, each of these methods are reviewed.

TGIDs- Whereas a 2-Tone pager is programmed with 2-Tone or Long Tone IDs the pager can be programmed to use TGIDs (Talk Group IDs). Select TGIDs can be designated as "Paging" TGIDs meaning once decoded the pager will emit an alert tone and store the associated message. In addition to "paging" TGIDs it can be programmed to monitor one or more TAC or Interoperable TGIDs on a Selector Knob basis.

In a P25 System, TGIDs are affiliated to a specific Site, but System Administrators can configure their system to "Force" TGIDs to Critical Sites thus allowing for a larger geographical RF coverage for pager Users.

The System Administrator will then assign the "paging" TGIDs to specific Sites (or Simulcast Zone) over which they will be transmitted. These "paging" TGIDs are newly assigned TGIDs and are only used for transmitting short dispatch messages. Although the P25 Specification allows for up to 65K TGIDs Systems may be limited to a smaller number due to licensing, sub-system allocation reasons or concerns of running out of TGIDs.

The pager is then programmed for the "paging" TGID and any TAC or Interoperable TGIDs which will be monitored. It is also programmed with the System information (WACN/System ID) and Site information (RFSS, Site IDs and their associated Control Channels).

How does it alert?

The pager is programmed with the target system information and TGIDs. Paging TGIDs are ones that are dispatched initiated and these can be programmed for unique alerting tones (or customized wav files). When the pager detects the paging TGID it will do two things; it will begin storing the voice message and at the same time begin alerting for a specified (by the programming software for 1 to 4 seconds) period of time. Once the alert duration has expired the pager will begin playing the received voice message from the beginning.

How does it Monitor TAC or other Interoperable TGIDs?

Each selector knob setting can be assigned one or more TGIDs. If selector knob setting 1 is configured for a "paging" TGID and other types of TGIDs the pager will always prioritize the "paging" TGID (if the P25 System supports Priority). At the end of the paging message the pager will monitor other programmed TGIDs for activity and play the transmissions.

PROS AND CONS

On a positive side:
1. There are 65K TGIDs defined in P25
2. Efficient from a Dispatching Standpoint
3. Resource efficient when Multi-selects are used (i.e., 1 voice channel versus many when multiple TGIDs are to be sent for an incident)
4. Prioritization of Paging TGIDs is possible
5. Forcing to Critical Sites allows for improved RF Coverage

From a negative standpoint:
1. Number of TGIDs may be limited due to licensing, allocation or anticipated growth,
2. For Wireless Console applications where a Control Station or Mobile radio provides system access additional Stations/mobile radios may be required.

Call Alerts- There are applications where Fire Stations have a Control Station that receives a Dispatch generated Call Alert. The Control Station upon detecting the Call Alert enables a Siren or other alerting method. Then, over a common TGID, the Dispatch message is sent. In such applications, it has been requested that the Fire Team be alerted with this Call Alert and listen to the message on the defined TGID, with the Unication pager this is possible. In fact, the pager can be programmed for multiple Call Alerts in situations where other Station alerts are to be monitored. The important point to remember is the Unication pager does not transmit, it only monitors so it can be programmed for multiple SUIDs.

How Does It Alert?

The pager is programmed for the appropriate SUID and the desired Alerting Tone is selected. Upon receiving the Call Alert, the pager will emit the desired Alerting Tone. After a period, when the TGID is detected the pager will begin playing and storing the received message.

How does it Monitor TAC or other Interoperable TGIDS?

The pager is muted until a Call Alert is received. Once it is detected the pager "reverts" to the TGID assigned for the Call Alert's associated message. The pager can monitor other TGID generated traffic by switching to another Selector Knob setting on the pager.

PROS AND CONS

On the positive side:
1. Pagers can integrate seamlessly into an existing application.
2. No change in the Dispatching process
3. Pagers will shadow the SUID

From a negative standpoint:
1. Pager Users must be in the same coverage area as the Control Station
2. There is no SUID priority therefore to ensure a specific Call Alert is not missed it should be the only one programmed for that Selector Knob setting.

QCII Over P25- This feature is supported by several Portable radio manufacturers and now the Unication G4/5 Pagers. From a Dispatching process, it is similar to sending 2 tone IDs over an analog RF Channel, but in this case the 2 tone IDs are digitized and sent over a TGID.

How Does It Alert?

The received TGID is decoded and if a programmed 2 tone ID is detected the pager will alert and play back and store the associated Dispatch generated voice message.

How Does it Monitor TAC or Other Interoperable TGIDs?

If the System supports TGID Priority the pager can be set up to monitor select TGIDs along with the TGID the 2 tone IDs are transmitted over. Alternatively, the pager can be configured for a Selective Call with Revert Mode, a mode that is supported by the current 2 tone only pagers, where the pager is mute until its 2 tone ID is detected on the Dispatch TGID and then it will play the Dispatch initiated message followed by activity on programmed TAC TGIDs

PROS AND CONS

On the positive side:
1. Minimizes the use of TGIDs
2. Seamlessly integrates into current Dispatching operations

On the negative side
1. Stacked 2 tone IDs can take time to transmit (just like current analog paging)
2. For wireless console applications, another Control Station may be required.
3. Requires a unique 2 tone set (unique tone set is supported by Console Encoders).

WHAT DOES IT TAKE TO GET STARTED?

The good news is no one has added Sites or made major Infrastructure investments just to add paging. Any investments made at the system level have benefited Portable and Mobile Radio Users in addition to paging Users. However, there are some due diligence activities that are recommended.

a. Most P25 Systems are designed for Mobile Radio coverage and when paging is added the RF characteristics of the pager's receiver must be factored into the propagation tool in order to determine the "On Street" and "In Building" coverage. It is possible that BDAs may be needed for "In Building" coverage, but again, this will also benefit Portable Radio Users as well.

b. Once the above is done the Administrator can map the Paging TGIDs to specific Sites/Zones to provide the End Users appropriate RF coverage.

c. Perform field testing to verify coverage and monitor traffic impacts.

d. Review current policies such as fees and programming processes. Some Administrators charge a one-time programming fee and allow Users to program their own pagers

e. Get with 911 Dispatch Center managers to discuss changes that may be required in the Dispatching process. Of all the activities mentioned so far, this is the most important. There will be changes required, most for the better, but resistance to change may be the biggest hurdle.

Also, as mentioned earlier, the nature of the Console interface to the System (Wireless or IP) may require different solutions and this is reviewed in a later section.

f. Do a soft rollout. As with any new service or product it is best to "crawl" before "running".   Select a beta test group and use their feedback to make improvements in the pager's programming (e.g., behavior, site coverage, etc.) and overall paging process.

Wireless or IP Connected Consoles?

The Consoles and their network interface can have a significant impact on the integration of paging.

Larger Dispatch Centers typically have IP connected Consoles and, although these Consoles can be very expensive, they have some significant advantages. Briefly:

- Examples are the Motorola MCC 7500 and Harris Maestro
- IP Interconnected to RFSS
- In some cases, they can interface to a Control Station for wireless access
- The CSSI or Ec interface supports Multi-select commands for efficient use of Traffic Channels
- Multiple TGIDs can be accessed and, through the RFSS, be directed to single or multiple Sites throughout the System.
- However, sending "Paging" TGIDs may be limited by TGIDs available (SW licensing or System allocations) or icon space on the Console display

Smaller Centers typically use Consoles interfacing with Control Stations (radios) for System interconnection and are, therefore, considered wireless. Briefly:
- Examples are the Avtec Scout and Zetron MAX
- Less expensive than the Motorola 7500 or Harris Maestro
- IP/Tone Remote/Direct Interconnected to Control Station(s)
- A Control Station affiliates a TGID to the area

- Some Control Stations support multiple TGIDs (selectable)
- Each TGID to be sent uses a Control Station
- The number of TGIDs to be sent simultaneously is limited by the number of Control Stations

Regardless of whether the Dispatch Center uses Wireless or IP connected Consoles it is imperative that the Directors of these Centers get involved and participate in the planning process to integrate paging.

Brief Overview of the G4/5 Capabilities

Unication has the single band, G4 P25 Voice Pager in 700/800MHz and the dual band, G5 Dual Band P25 Voice Pager in VHF or UHF + 700/800MHz. There is one model for the G4 and four (4) models for the G5 (1- VHF and 3- UHF). The models & operating frequency ranges for these products are listed below:

G4 P25 Voice Pager
A. 763-776MHz & 851-870MHz

G5 Dual Band P25 Voice Pager
B. VHF 136-174MHz & 700/800MHz
C. UHF 380-430MHz & 700/800MHz
D. UHF 400-470MHz & 700/800MHz
E. UHF 450-512MHz& 700/800MHz

The following are the features for all models:

- P25 Conventional is supported in all bands
- P25 Trunking is supported in all bands
- 2 Tone, 5 Tone, MDC 1200 are supported in all bands
- Supports multiple Signaling (e.g., P25T and 2 Tone) Types on a Selector Knob basis.
- Supports 32 Zones (8 Selector Knob positions per Zone and each can be configured)
- 32 minutes of received voice messages
- 32 minutes of personal voice memo messages
- Integrated Bluetooth
- IP67, Waterproof and Dustproof, Rating
- Software Defined
- Micro USB port for Charging and Programming

Unication provides the programming software at no charge and periodically provides Product Software Updates to our Dealer network.

Case Study: Countywide Transition to P25 Paging

Grand Traverse County, Michigan

Example of Potential Cost Savings

In early 2016 Administrators in Grand Traverse, Michigan were faced with a decision to replace their aging analog 2 Tone system. The Michigan MPSCS team presented them an attractive alternative which was to migrate all their paging onto the MPSCS P25 system. After undergoing extensive in field evaluation of the pagers and their performance on the Michigan MPSCS system the Administrators felt the G4 was a viable option. They then did a financial analysis for the two options.

Analog Option

- Cost to build a 6-site simulcast solution= $507,000
- Anticipated yearly maintenance cost= $29,000
- They would re-use current tower sites.
- Cost of new analog pagers would be extra

MPSCS Option

- No on-going Infrastructure maintenance related costs
- A onetime MPSCS set up fee for all pagers and the cost of pagers = $180,000

Looking at the above the financial decision was very clear and represented an over $300K initial outlay savings.