

Patching and Dynamic Regrouping: Project 25 Inter-RF Subsystem Interface and Console Subsystem Interface Features and Functions

This document is part of a series of Project 25 (P25) Inter-Radio Frequency (RF) Subsystem Interface (ISSI) and Console Subsystem Interface (CSSI) Features and Functions white papers designed to increase awareness of P25 features, terminology, and implementation considerations learned during ongoing discussions with the Federal Partnership for Interoperable Communications (FPIC) ISSI/CSSI Focus Group. This document uses vendor neutral P25 Standards terminology, but the reader should be aware that different manufacturers and user communities often use different terms to describe these features.

FEATURE OVERVIEW

Problem Statement

Patching wide-area talkgroups (TGs) without disrupting operations can be challenging and complex. Dynamic regrouping (i.e., creating a “supergroup”) or wide-area TGs – the most resource-efficient type of patch – does not currently provide the level of interoperability needed by public safety. Depending upon the systems manufacturers and the selected configuration of the system’s feature sets, dynamically regrouping (specifically group regrouping) wide-area TGs can tie up multiple channels or inadvertently disconnect existing supergroups. These terms are explained on pages 2-4 (**Defining the Terms**).

What are these features?

“Patching” is a generic term for connecting the audio of multiple RF channels, talkgroups, and individual subscriber units (SUs) that normally cannot talk to one another. Dynamic regrouping is a type of patch that temporarily brings multiple TGs and/or individual units together into a single temporary group. Used with trunked systems, dynamic regrouping efficiently uses system resources by re-directing all participating SUs to a single channel/talkpath, thus reducing the number of active channels/talkpaths used.

Why is this feature important?

System capacity (i.e., RF frequencies) is often a scarce resource for public safety. In mutual aid and large-scale responses where interoperability is most essential, the inability to use dynamic regrouping (specifically group regrouping) can deplete system resources and reduce available capacity.

What are the primary issues?

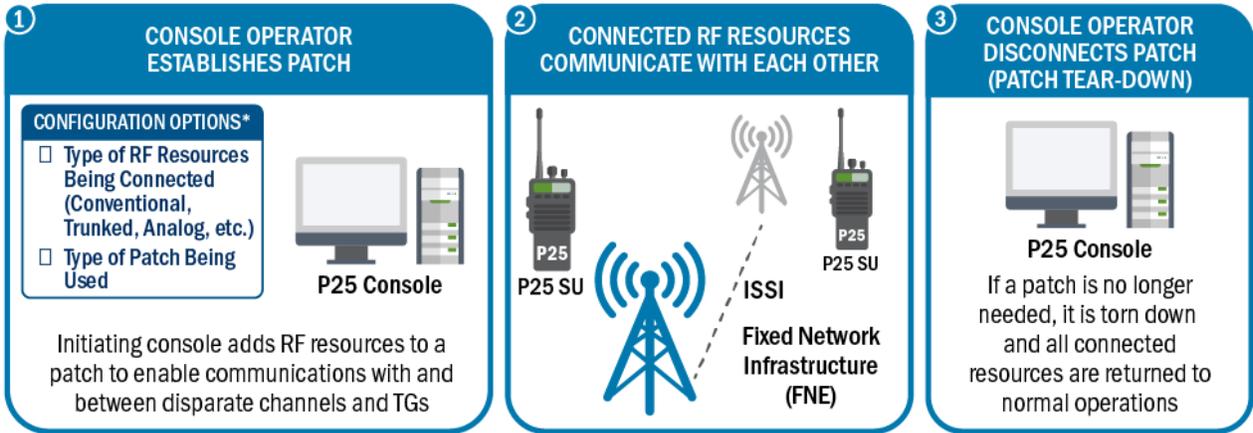
Dynamic regrouping is available on many systems but is implemented differently among manufacturers. Due to these variations, cross-manufacturer dynamic regrouping in an ISSI/CSSI environment – specifically in situations where wide-area TGs are group regrouped with home or other wide-area TGs – is challenging, inefficient, and generally unusable in operational scenarios.

What is being done about this?

The P25 Standards Development Organization is currently developing a dynamic regrouping standard to reconcile the two primary methods for dynamic regrouping (see [MFIDA4](#) and [MFID90 Methods](#)). If implemented, this updated standard should enable dynamic regrouping across disparate manufacturer systems. In the meantime, agencies looking to create patches or use dynamic regrouping in an ISSI/CSSI environment with multiple manufacturer’s connected systems will need to conduct extensive testing to understand the current feature’s limitations and identify operational workarounds to ensure seamless audio patching and avoid system capacity issues. Some of these approaches for audio patching are described in the next sections.

SECTION 1: TALKGROUP PATCHING

“Patching” is a widely used function that allows public safety telecommunicators to connect channels, talkgroups, and individual SUs that normally cannot talk to each other. Patches are invaluable for cross-domain or cross-jurisdictional responses when telecommunicators and users on different radio systems or frequencies need to communicate (e.g., mutual aid, automatic aid, task forces, large incident responses). Figure 1 provides an overview of a temporary communications patch between P25 systems.



* Console operator (telecommunicator) has choices of various system-level resources that effect how patches are established.

Figure 1 - Patching and Dynamic Regrouping Overview

Many valid patching methods have been developed to account for operational needs and technical advancements. Patches can be used to connect radio users using different frequencies, system types (e.g., P25 phase 1, phase 2, conventional, trunking), and both P25 and non-P25 infrastructures. **While many patches are available to public safety, this document primarily focuses on dynamic regrouping and its use within ISSI/CSSI environments.**

Because of its resource efficiency, dynamic regrouping has been identified as the standardized patching method within ISSI/CSSI environments and a focal point of ongoing P25 Standards development.

Defining the Terms

“Patching,” “console patching,” or “cross-patch” are generic terms used to define the connection of two or more channels or talkgroups that otherwise cannot communicate with one another. Similar to a group call, the patched groups operate in a one-to-many mode where only one user can speak at a time. This function is typically controlled by the console operator/telecommunicator and activated at their discretion, or as requested by radio users in response to operational needs.

Wide-area TGs: Sometimes referred to as “ISSI TGs,” wide-area TGs are available on multiple ISSI-connected systems. These TGs are homed to one of the ISSI-connected systems and foreign on the other ISSI-connected systems. With the ISSI, telecommunicators and users can select these wide-area TGs and even patch them to other TGs, depending on radio and system configurations.

Types of Patching

The two major patch types included in the P25 Standards are the generic audio patch and dynamic regrouping. These terms are often used interchangeably in public safety operations but have important and distinct differences.

Audio Patching: Traditional audio patches can be used to connect trunked and/or conventional resources. In its simplest form, an audio patch uses standard switching functions to either manually or logically connect multiple channels or talkpaths. A traditional audio patch will continue to transmit and receive on active channels for all groups in the patch.

Dynamic Regrouping: *Dynamic regrouping* is a trunking feature used to temporarily add multiple TGs and/or individual units into a single TG. The primary benefit of dynamic regrouping lies in its ability to maximize system resources. *Dynamic regrouping* includes both *individual regrouping* and *group regrouping*.

- **Individual Regrouping:** *Individual regrouping* allows the system to assign an individual SU to a new TG without intervention from the radio user.
- **Group Regrouping:** *Group regrouping* assigns two or more TGs to a single supergroup. The supergroup represents a completely new TG with its own supergroup ID. All users affiliated to the original TGs are directed to the new supergroup. **In general, P25 users view group regrouping as the more essential part of dynamic regrouping.**
 - Only a single channel/talkpath per site is used to support voice communications between supergroup members, making *group regrouping* more resource efficient than an audio patch.

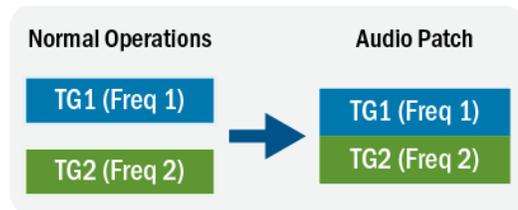


Figure 2 – Audio Patch of RF Resources

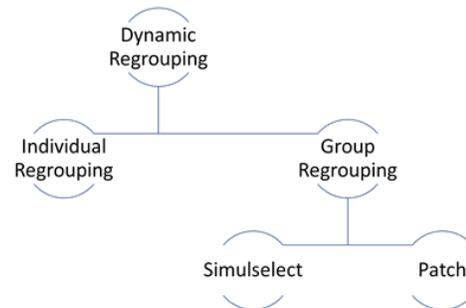


Figure 3 – Types of Dynamic Regrouping

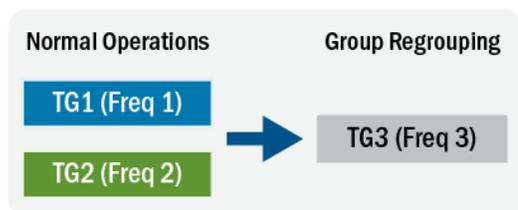


Figure 4 – Dynamic Regrouping RF Resources

- *Group regrouping* may be a **two-way regroup (also called a “patch”)** allowing bilateral audio between telecommunicators and SUs, or a **one-way regroup (also called “simulselect”)** only allowing audio from telecommunicators to SUs.

It should be noted that terms such as “simulselect,” “group select” or “multi-select” are often used to describe telecommunicators functions used to establish pre-determined or free-form patches and/or “supergroups” among TGs, regardless of system resource considerations. These terms are not limited to dynamic regrouping.

Table 1 (page 4) provides an overview of the two patching categories to illustrate their differences and provide additional context for the reader.

Table 1 – Differences Between Audio Patches and Dynamic Regrouping

	Audio Patching	Dynamic Regrouping
Description	Uses standard switching functions to either manually or logically connect multiple channels or talkpaths (i.e., tying together multiple active transmit and receive channels)	A trunking feature used to temporarily add multiple talkgroups and/or individual units into a single talkgroup/talkpath called a “supergroup”
How is the patch initiated?	<ul style="list-style-type: none"> • Telecommunicator selection • Manual connection 	<ul style="list-style-type: none"> • Telecommunicator selection
Where is the patch established?	<ul style="list-style-type: none"> • At the console/consolette/control station • Via remote connections to base station radios 	<ul style="list-style-type: none"> • At the system core/infrastructure (i.e., network level patch)
What interface is used to connect RF resources?	<ul style="list-style-type: none"> • Voice over Internet Protocol (VoIP) or Radio over Internet Protocol (RoIP) gateways • Legacy gateways or bridges • Console gateways • Digital Fixed Station Interface 	<ul style="list-style-type: none"> • CSSI gateway or proprietary IP connection (for console to core connection) • ISSI gateway (for core-to-core connection)
Used to connect P25 users to users on:	<ul style="list-style-type: none"> • P25 systems (conventional and trunked) • Analog systems • Other non-P25 systems • LTE (typically donor radio tied to RoIP gateway) 	<ul style="list-style-type: none"> • P25 systems (trunked) • LTE-LMR interworking may require some form of dynamic regrouping in the future. Work is underway to define an interworking function between LTE and LMR systems
Related Terms:	<ul style="list-style-type: none"> • Cross-patching • Supergrouping/supergroups • Simulselect • Multi-Select 	<ul style="list-style-type: none"> • Supergrouping/supergroups • Simulselect • Multi-Select • Group regrouping • Individual regrouping • Regrouping

Patching Across the ISSI/CSSI

ISSI/CSSI environments introduce additional complexities associated with multiple systems, sets of console operators (and console subsystems), and different home and serving Radio Frequency Subsystems (RFSS). The most important difference may be the addition of wide-area TGs that can span multiple RFSSs and be homed to different ISSI connected systems.

Group regrouping scenario: In Figure 5 below, a console operator (System B) may need to dynamically regroup a wide-area TG (TG1) with a local talkgroup (TG1, homed to System B). In this scenario, the wide-area TG could consist of users from multiple systems and may even be homed to System A. Dynamic regrouping would allow System B to regroup all users on System B TG1 and wide-area TG1 into a new supergroup. However, many ISSI/CSSI users have reported dynamic regrouping issues in these situations, resulting in work-arounds such as audio patches that tie up additional TGs/channels on the system, or the need to implement operational policies restricting wide-area TG patching.

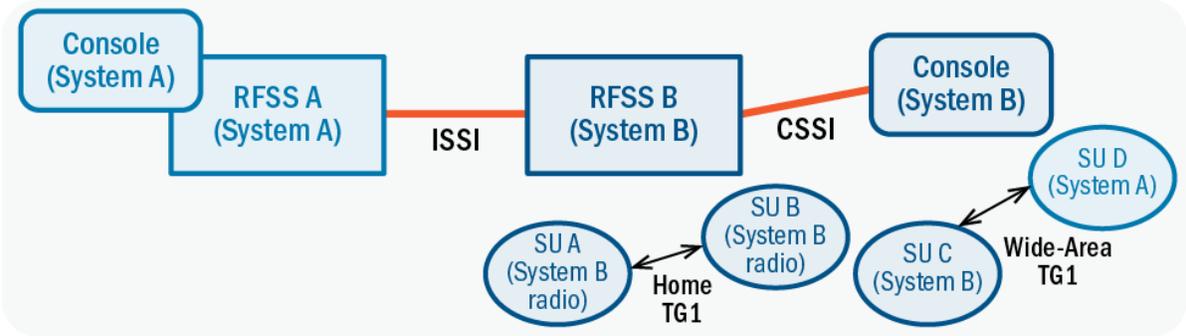


Figure 5 – ISSI/CSSI Dynamic Regrouping/Patching Scenario

Some other examples of group regrouping are captured in Table 2 below to illustrate possible TG combinations that could be relevant in an ISSI/CSSI environment.

Table 2 – Additional Dynamic Regrouping/Patching Scenarios

Group #1	Group #2	Serving RFSS	Initiating Console
Wide-Area TG1 (Home A)	Local TG1 (Home B)	System A and B	Console B
Wide-Area TG1 (Home B)	Local TG1 (Home B)	System B	Console B
Wide-Area TG1 (Home A)	Wide-Area TG2 (Home B)	System A and B	Console A or B
Wide-Area TG1 (Home B)	Wide-Area TG2 (Home B)	System A	Console A or B

Audio Patches: In situations where dynamic regrouping is unavailable due to implementation challenges, console operators can still create audio patches to connect TGs in Table 2. However, these audio patches may tie up multiple channels or encounter unforeseen issues due to the added complexity of accommodating wide-area TGs. Available ISSI/CSSI audio patching options depend on user needs, system configurations, and system type/capabilities.

SECTION 2: DYNAMIC REGROUPING CHALLENGES TO CONSIDER

Differences in manufacturer implementation and operational configurations may lead to interoperability challenges that must be resolved either through technology planning or operational policies. Due to these differences, comprehensive acceptance and recurring operational testing is recommended for users looking to implement these features across the ISSI or CSSI. Below is a list (not comprehensive) of possible implementation variables that should be considered when patching wide-area TGs (i.e., foreign TGs over the ISSI).

- Should a new patch break existing patches on each system?
- Which side of the ISSI/CSSI should control (e.g., add/remove users, tear-down) the patch?
- Should the patch be configurable on each side?
- Should it be possible to patch non-ISSI TGs to ISSI TGs?
- What is the protocol for recording patched communications?
- Encrypted Communications
 - Should cleared and encrypted TGs be patched together?
 - For encrypted calls, should there be a single patch key for entire system? If so, which key should be used?

MFIDA4 and MFID90 Methods

Beyond operational differences, the primary interoperability challenge is the manufacturer implementation of two *dynamic regrouping* methods – MFIDA4 and MFID90 – that are not currently compatible for group regrouping in an ISSI/CSSI environment. Over the common air interface, an RFSS may implement one or both methods, and subscriber manufacturers will implement both methods to ensure interoperability. However, in an ISSI/CSSI environment with multiple manufacturer’s systems and potentially different configuration of feature functionality, group regrouping over the wireline interface may not function as expected. Given that both methods are available on the market today, the P25 group regrouping standards (currently under development) will address this interoperability issue.

Table 3 – Dynamic Regrouping Methods

MFIDA4 Explicit Encryption Group Regrouping	MFID90 Airlink Efficient Regrouping
Supports two-way regrouping (patch, TGs only) and one-way regrouping (simulselect, can regroup individuals and TGs).	Supports two-way regrouping (patch) and individual regrouping (used by a wireline device).
SUs remain on their working group IDs (WGID) and are directed by the RFSS to the supergroup.	TGs are directly added to a supergroup and SUs use the SG-WGID instead of their normal WGID.
A list of parameters selected by the RFSS will determine the type of regroup and group characteristics.	Options are to use either two-way regrouping (patch) or individual regrouping.
GRG_EXENC_CMD outbound messages are sent over the air to regroup TGs. ¹	MOT_GRG_ADD_CMD outbound messages are sent over the air to regroup TGs.
Outside of the GRG_EXENC_CMD message, there are no dedicated messages for group regrouping.	There are a number of dedicated group regrouping messages.

¹ Sample message headers are included to demonstrate some differences between the two dynamic regrouping methods.

MFIDA4 Explicit Encryption Group Regrouping	MFID90 Airlink Efficient Regrouping
Encrypted operation is supported by providing encryption information (algorithm ID and key ID) in the message that assigns the SP-WGID.	Encrypted operation is supported by pre-configuring the infrastructure and SUs with encryption information for the supergroup.

SECTION 3: ADDRESSING PATCHING AND REGROUPING CHALLENGES

Various efforts have been taken or are underway to address this topic, beginning with the development of P25 Standards documents to define and specify dynamic regrouping and the ISS/CSSI interface:

- **P25 Dynamic Regrouping Messages and Procedures (TIA-102.AABH) completed in 2014** to standardize both methods of *dynamic regrouping* over the common air interface.
- **Individual Regrouping Addendum (TIA-102.BACD-B-2) to Project 25 ISSI Messages and Procedures for Supplementary Data completed in 2018** to define wireline messages and procedures for *individual regrouping* involving the ISSI/CSSI.
- **ISSI/CSSI Group Regrouping standards currently under development** to address wireline interoperability for *group regrouping* involving the ISSI/CSSI.

Additionally, these topics have been discussed at various forums and working groups.

- **Compliance Assessment Program (CAP) interoperability testing** anticipated for *dynamic regrouping* across an ISSI/CSSI (i.e., ISSI/CSSI supplementary data interoperability testing), pending development of group regrouping standards and test procedures.²
- **Federal Partnership for Interoperable Communications (FPIC) ISSI/CSSI Focus Group activities** to discuss and share ISSI/CSSI implementation best practices.

However, interoperability will likely require the development and adoption of a Group Regrouping standard for the ISSI/CSSI. In the meantime, agencies have found technical and operational workarounds (i.e., other types of patching, operational planning) to establish communications capabilities between users from disparate systems. These solutions do not offer the flexibility of dynamic regrouping but are sufficient and cost-effective for many agencies' operational needs.

Group regrouping standards – once completed, implemented, and tested – would provide agencies with additional resource-efficient solutions in situations where inter-system patching is required.

² It should be noted that P25 CAP interoperability testing cannot commence until a) the ISSI/CSSI group regrouping standards are completed, b) the P25 ISSI/CSSI interoperability testing procedures are completed, and c) P25 CAP adopts relevant testing procedures and implements the accompanying testing program.

RESOURCES

- TIA-102.AABH, Dynamic Regrouping Messages and Procedures
- TIA-102.BACA-B, Inter-RF Subsystem Interface Messages and Procedures for Voice Services, Mobility Management, and RFSS Capability Polling Services
- TIA-102.BACD-B, Project 25 Inter-RF Subsystem Interface (ISSI) Messages and Procedures for Supplementary Data
- TIA-102.BACD-B-2, Individual Regrouping Addendum to Project 25 Inter-RF Subsystem Interface (ISSI) Messages and Procedures for Supplementary Data