Dynamic Dual Mode for ASTRO® 25 Systems:

Greater Capacity and Seamless Interoperability with Project 25 Phase 1

New technology promises to boost the capacity of your radio communications to support more users and applications. The airwaves are crowded and you need room to grow, but questions remain…

- *Will you be able to interoperate with existing radio users?*
- *Will your network coverage degrade?*
- *Will you have a clear upgrade path for the future?*

Motorola's Dynamic Dual Mode (DDM) allows you to significantly increase the voice calling capacity of your Project 25 (P25) network and opens the possibility of adding more services such as data within your current bandwidth allocation. All of this while maintaining interoperability with your P25 Phase 1 equipment. Learn how to gain the benefits of DDM - part of Motorola's Technology That's Second Nature™.

Executive Summary

Public safety networks are straining under rapid growth in voice and data traffic. With limited spectrum available from the FCC, agencies must find a way to make more efficient use of the radio channels they already have.

Bridge to P25 Phase 2
Motorola is and will continue to be a leading member and contributor to the Project 25 standards program.

The Project 25 committee is working on a Phase 2 standard including TDMA technology (time division multiple access) to increase spectrum efficiency, although it will be some time until the standard is finalized. In the interim, agencies are looking for ways to gain the extra capacity they need, without compromising future standards compliance.

Motorola has a solution built upon the proven ASTRO® 25 platform. By adding Dynamic Dual Mode (DDM), ASTRO 25 systems are able to use advanced TDMA to double voice channel capacity as well as free up spectrum to add new services such as data. Alternatively, by allowing fewer base stations, DDM can reduce site costs in such areas as space, power, cooling, etc.

ASTRO 25 Customers

DDM gives ASTRO 25 customers a way to cost effectively increase voice calling capacity without having to abandon Phase 1 equipment. DDM is designed to fit gracefully into existing ASTRO 25 Phase 1 systems. It preserves Phase 1 interoperability and maintains the coverage footprint.

Motorola's Commitment to P25 Phase 2

Motorola continues its commitment to Project 25 standards. After the Phase 2 standard is finalized, Motorola will introduce an upgrade path to Phase 2 compliance for the ASTRO 25 platform. Motorola will continue to support the development of both Phase 1 and Phase 2, and customers may upgrade at their convenience.

As always, customers can count on Motorola for support throughout the system lifecycle. From advanced voice…to advanced broadband data… the MOTOA4™ mission-critical portfolio gives public safety organizations access to the full range of today's wireless technologies, including DDM and beyond, to give users dependable access to the information they need to do their jobs safely and effectively.

MOTOA⁴™

4
ADVANCED
BROADBAND
DATA

3
ADVANCED
WIDEBAND DATA

2
ADVANCED DIGITAL VOICE
& INTEGRATED DATA

1
ADVANCED VOICE
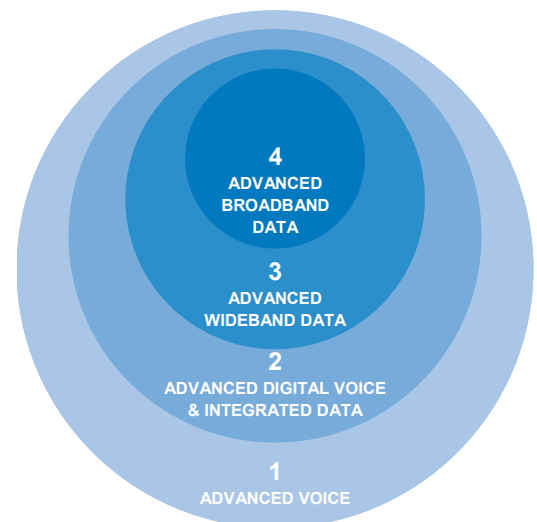
Dynamic Dual Mode allows two voice paths to share the same 12.5 kHz voice channel. Among other advantages, it enables you to meet upcoming FCC requirements.

Spectrum Efficiency
In a world of high tech and high risk, citizens expect first responders to have state-of-the-art voice and data connectivity. And yet, in many locations there simply aren't enough available radio frequencies to allow agencies to improve their communications.

Spectrum Demand is Soaring
Many forces have combined to make spectrum efficiency a critical issue for public safety. Departments are hiring more personnel and issuing more radios. Sprawling development requires larger coverage areas. New data applications – intranet access, remote reporting, mobile ID imaging, live video surveillance – demand scarce bandwidth resources. The need to interoperate across multiple agencies can bring in new users for systems that are often at or near capacity.

Particularly in crowded urban markets, spectrum is at a premium. Public safety competes with growing demand for spectrum from consumers, media, corporate enterprise networks, and carriers such as cell phone companies. As happens so often in public safety, it is necessary for agencies to find a way to accomplish more with the limited resources they have.

The FCC Mandates a Response
As part of its ongoing efforts to fairly allocate bandwidth in the United States, the FCC has mandated that radio system manufacturers – and their customers – must begin moving to more spectrum-efficient methods for over-the-air access. Designated as 6.25 kHz channel efficiency equivalence (or "6.25e"), the rule requires at least two voice paths to be supported within a single 12.5 kHz channel.

The rules are being phased in as follows:

Advanced Technology Provides an Answer
FDMA (Frequency Division Multiple Access) is a proven technology that is widely used today in radio systems. FDMA carries one call per channel.

TDMA (Time Division Multiple Access) is more advanced than FDMA and has the ability to significantly increase spectrum efficiency. TDMA allows more voice calls with the same number of base stations than comparable systems utilizing only FDMA technology.

With these advantages, TDMA has captured the attention of the public safety communications industry. TDMA will be part of P25 Phase 2 and many organizations are already looking for a TDMA solution. The challenge is to add TDMA functionality at a reasonable cost without disrupting the existing communications that users are counting on.

Year	Requirement for FCC certification
2011	All new VHF and UHF equipment must include a mode of operation that meets the 6.25e standard
2013	All VHF and UHF users must be at least 12.5e operational
2015	All 700 MHz equipment must meet the 6.25e standard
2017	All 700 MHz users must operate in 6.25e

ASTRO 25 with Dynamic Dual Mode combines FDMA, TDMA, Internet Protocol (IP), Trunking, and Simulcast technologies into a single flexible and dynamic solution that is highly efficient at using your available radio spectrum to deliver a full range of voice and data services to public safety users.

The Motorola Answer
Motorola's answer to the problem of spectrum efficiency encompasses a complete architecture for digital voice and data networking.

Interoperability
ASTRO 25 supports interoperability with P25 Phase 1 compliant systems from other agencies and jurisdictions. This seamless connectivity is at the heart of Motorola's vision for your agency's communications.

Dynamic Dual Mode with X2-TDMA

Motorola's implementation of TDMA is called X2-TDMA. DDM is an enhancement to the ASTRO 25 platform that enables a single system to operate using P25 Phase 1 and X2-TDMA. The system can dynamically reassign talkgroups to P25 Phase 1 and X2-TDMA in real time to reflect ever-changing user demand. ASTRO 25 system components which are capable of X2-TDMA are also P25 Phase 1 capable.

X2-TDMA uses a 2-slot TDMA voice interface operating on a 12.5 kHz bandwidth channel. It is designed for optimal performance and radio capacity while maintaining compatibility with ASTRO 25 and the many different technologies integrated within that platform.

DDM is backward compatible with P25 Phase 1 devices, including the equipment customers already own and use with ASTRO 25 and also preserves the network's coverage area.

The proven and inherent advantages of digital simulcast can help extend portable coverage in buildings and certain other hard-to-reach areas. By adding DDM to simulcast, the system goes one step farther by increasing capacity without jeopardizing coverage.

Advantages

Customers who add DDM to their ASTRO 25 systems benefit from:

- *Greater capacity* – By fitting more talk paths onto the same number of radio channels, DDM gives customers the freedom to add users, handle increased call traffic, and allow for new data applications to be added, without the need to acquire more spectrum.

- *Interoperability* – DDM maintains interoperability with Phase 1 radios through dynamic voice call assignment to FDMA or TDMA as needed.

- *Protected coverage* – Customers can add DDM without impacting their P25 Phase 1 network coverage and without incurring extra costs to maintain coverage at current levels. Indoors or out, urban or rural, if a location is covered today, customers can be confident that it is still covered with DDM.

- *Smaller site footprint* – Fewer base stations are required for the same amount of traffic, allowing customers to save on floor space, power, batteries, backup, and other related costs.

- *FCC compliance* –With DDM, the ASTRO 25 system meets the FCC 6.25e mandates.

- *Bridge to Phase 2* – DDM can get you a step closer to Phase 2 by enabling the benefits of TDMA today.

Flexible Integration

As the illustration shows, an ASTRO 25 system can interconnect a wide variety of services: voice, integrated voice and data (IVD), P25 Phase 1 and/or X2-TDMA, simulcast, high-performance data, dispatch systems and more.

Dynamic Dual Mode can be added to this network without sacrificing operability, availability, coverage, reliability or interoperability. DDM can be deployed in VHF, UHF, 700 and 800 bands.
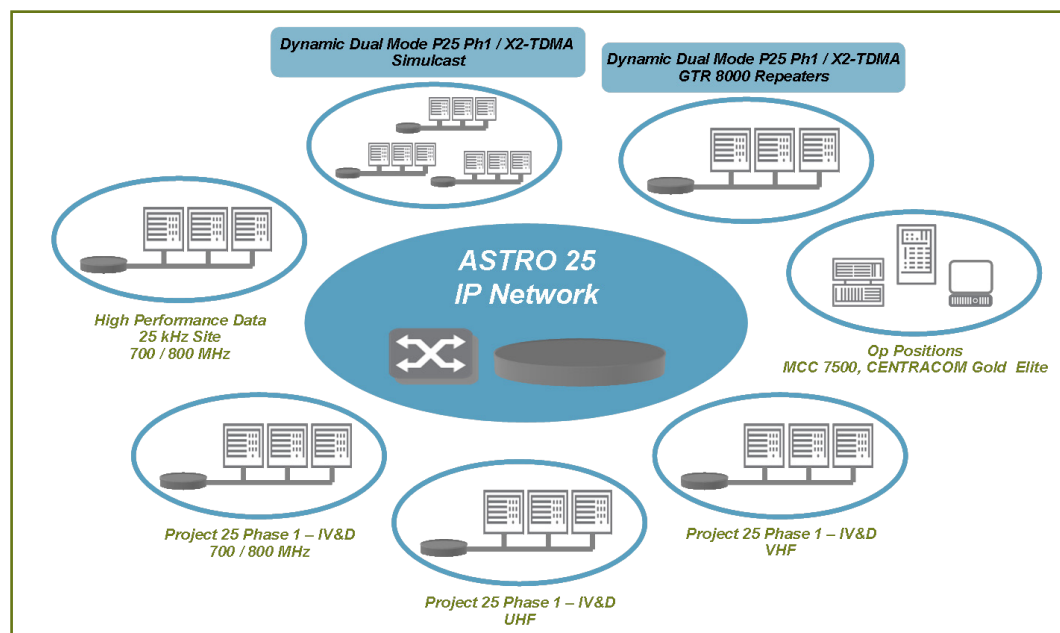
Anywhere, Anytime

With excellent coverage and the ability to carry both voice and data, ASTRO 25 allows users to share intelligence quickly across the entire organization. Agencies are free to deploy new applications using a range of services from conventional voice to high-speed data.

That's real-time information, allowing your personnel to make well-informed decisions at the scene

Dynamic Dual Mode P25 Ph1 / X2-TDMA
Simulcast

Dynamic Dual Mode P25 Ph1 / X2-TDMA
GTR 8000 Repeaters

**ASTRO 25
IP Network**

High Performance Data
25 kHz Site
700 / 800 MHz

Op Positions
MCC 7500, CENTRACOM Gold Elite

Project 25 Phase 1 – IV&D
700 / 800 MHz

Project 25 Phase 1 – IV&D
UHF

Project 25 Phase 1 – IV&D
VHF

Backward Compatibility and Interoperability

Customers who have invested in Project 25 Phase 1 compliant radios from Motorola or other authorized manufacturers can be confident those devices continue to function on the DDM capable network.

Advanced Control Channel

DDM uses an advanced control channel that can dynamically switch call assignments between P25 Phase 1 and X2-TDMA when needed. This allows P25 Phase 1 and X2-TDMA radios to coexist and interoperate on the same network.

Preserving Coverage

Motorola chose to implement X2-TDMA to preserve customers' existing investments. This form of TDMA provides equivalent coverage as FDMA Phase 1. X2-TDMA preserves FDMA coverage advantages by using the family of over-the-air modulations used in all FDMA simulcast and P25 Phase 1 multicast systems. By reusing the modulation and the 9600 bps bit rate, X2-TDMA can be treated as just an enhanced "bit stream." Because of this, X2-TDMA does not impact site spacing (coverage), station RF power levels, antennas, or radio frequency distribution equipment.

Enhanced Vocoder

DDM uses an innovative dual-rate AMBE+2™ vocoder to manage the audio compression required for TDMA. This vocoder is backward-compatible with ASTRO 25 Phase 1.

The AMBE+2 vocoder is currently selected as the vocoder of choice by the Project Steering Committee for the Phase 2 TDMA standard. This is another way that DDM gives customers a head start on Phase 2 functionality while continuing to support their existing investments.

Dynamic Call Assignments
Dynamic Dual Mode supports Intelligent Call Services that allow users to achieve seamless mobility – the ability to interoperate and roam between P25 Phase 1 and X2-TDMA services. X2-TDMA operation can be enabled without impacting or changing the operation of Phase 1 radios.

Easy Talkgroup Configuration
DDM talkgroup operation is highly flexible and easy to configure. System Managers have complete control over how and when X2-TDMA operates. Managers can configure talkgroups via a network management application for one of three modes of operation: P25 Phase 1, X2-TDMA or Dynamic Dual Mode.

Since talkgroup configurations are managed via the infrastructure, changes do not require the radios to be reprogrammed, "touched" or even notified.

The illustration shows six active call sessions, all supported on a DDM site and using a mix of different modes.

Dynamic Dual Mode Site Operation
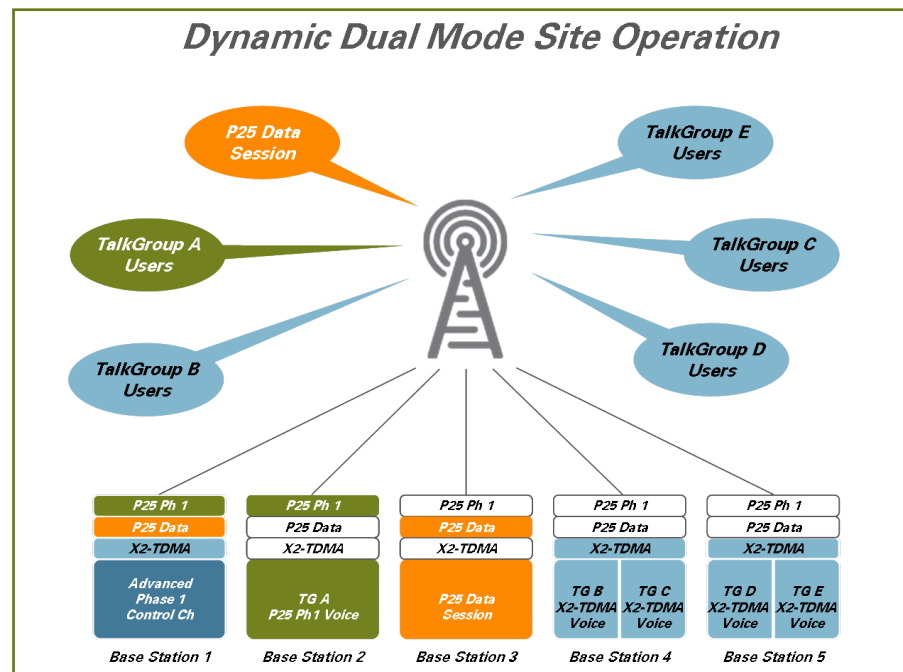
Seamless Roaming
Seamless roaming is part of the core call processing application. Roaming is transparent to users and requires no intervention from users or network operators. For example:

• A user in an active X2-TDMA talkgroup call roams onto a Phase 1 FDMA-only site. The system senses the situation and automatically initiates P25 Phase 1 mode at the next push-to-talk (PTT).

• While an active X2-TDMA talkgroup call is underway, a P25 Phase 1 only member of the talkgroup is added to (or "affiliated") with the call. The system senses the situation and automatically initiates P25 Phase 1 mode at the next PTT, so that the FDMA only user can be included in the call.

Improved Capacity

Dynamic Dual Mode allows each 12.5 kHz voice channel to support two simultaneous calls. Customers have the freedom to choose how to use the extra capacity to deliver needed services to end users.

Doubling Voice Channel Capacity

Current ASTRO 25 networks, like other P25 Phase 1 solutions, dedicate one radio frequency channel for each call as illustrated below. With the addition of DDM, the system can use TDMA to split the channels. Motorola uses a 9600 bps 2-slot TDMA voice interface operating on a 12.5 kHz bandwidth channel controlled by an advanced Project 25 Phase 1 Control Channel.

Mobile Intelligence
Motorola offers a full range of rugged and ergonomic equipment designed to meet the special needs of public safety personnel in the field.
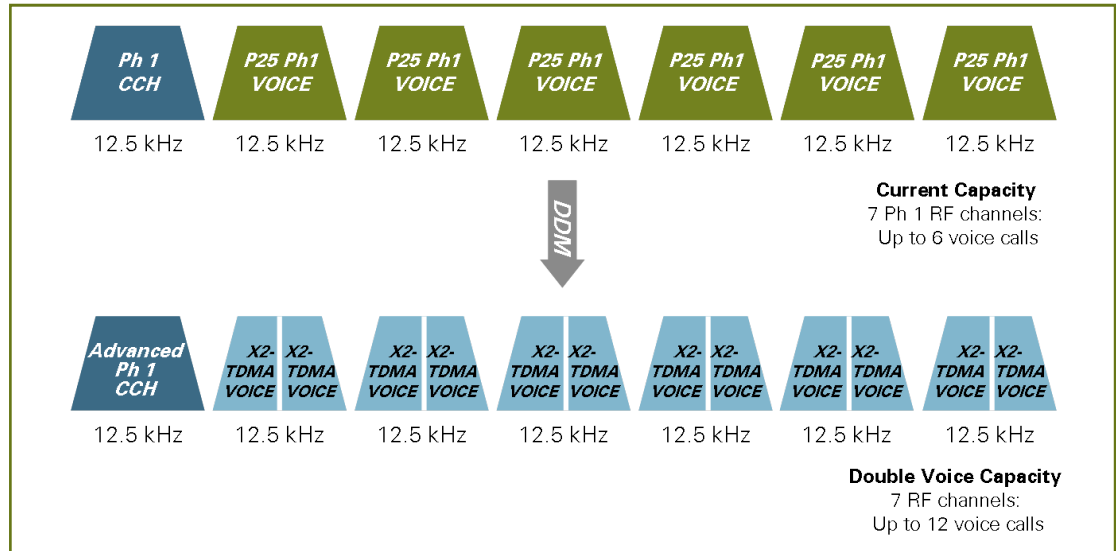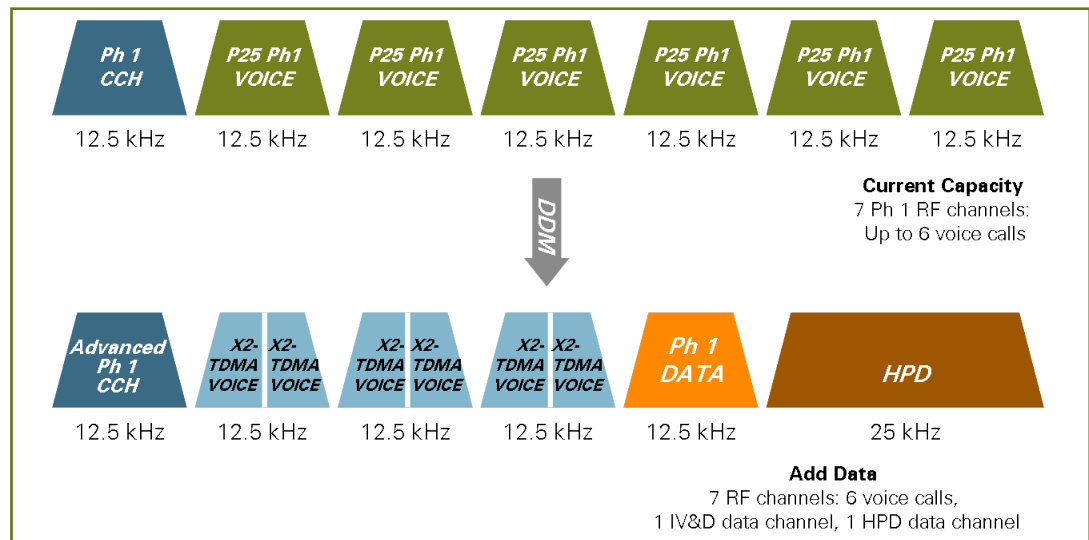
This equipment brings information straight into the hands of users, helping them to work with maximum effectiveness to save lives and serve the citizens of your community

Ph 1 CCH	P25 Ph1 VOICE	P25 Ph1 VOICE	P25 Ph1 VOICE	P25 Ph1 VOICE	P25 Ph1 VOICE	P25 Ph1 VOICE
12.5 kHz	12.5 kHz	12.5 kHz	12.5 kHz	12.5 kHz	12.5 kHz	12.5 kHz

Current Capacity
7 Ph 1 RF channels:
Up to 6 voice calls

DDM

Advanced Ph 1 CCH	X2-TDMA VOICE / X2-TDMA VOICE	X2-TDMA VOICE / X2-TDMA VOICE	X2-TDMA VOICE / X2-TDMA VOICE	X2-TDMA VOICE / X2-TDMA VOICE	X2-TDMA VOICE / X2-TDMA VOICE	X2-TDMA VOICE / X2-TDMA VOICE
12.5 kHz	12.5 kHz	12.5 kHz	12.5 kHz	12.5 kHz	12.5 kHz	12.5 kHz

Double Voice Capacity
7 RF channels:
Up to 12 voice calls

Converting Voice Channels to Data Channels

The voice channels freed up by DDM can be used for other services besides voice. One alternative is to convert some of the channels to Phase 1 data or High Performance Data (HPD). Many customers can use DDM to support a combination of increased voice capacity and new data services.

Ph 1 CCH	P25 Ph1 VOICE	P25 Ph1 VOICE	P25 Ph1 VOICE	P25 Ph1 VOICE	P25 Ph1 VOICE	P25 Ph1 VOICE
12.5 kHz	12.5 kHz	12.5 kHz	12.5 kHz	12.5 kHz	12.5 kHz	12.5 kHz

Current Capacity
7 Ph 1 RF channels:
Up to 6 voice calls

DDM

Advanced Ph 1 CCH	X2-TDMA VOICE / X2-TDMA VOICE	X2-TDMA VOICE / X2-TDMA VOICE	X2-TDMA VOICE / X2-TDMA VOICE	Ph 1 DATA	HPD
12.5 kHz	12.5 kHz	12.5 kHz	12.5 kHz	12.5 kHz	25 kHz

Add Data
7 RF channels: 6 voice calls,
1 IV&D data channel, 1 HPD data channel

Making It Work

Ultimately, the question isn't whether your system has Dynamic Dual Mode or any other state-of-the-art technology. The question is how to fit that technology into your organization's overall communications strategy. This is where Motorola applies its expertise and 75+ years of experience in helping public safety professionals meet their communication and information needs.

Only Motorola enables agencies to confidently take the next step in mission critical communications – to move beyond the basics to achieve the most reliable and innovative wireless solutions that help save lives and protect communities. These technologies are delivered seamlessly into the hands of first responders: simply, reliably, and without distracting them from their work. This is technology that's second nature. Motorola has designed DDM to work for you in the real world:

- DDM gives you an easy **upgrade path** to achieve **spectrum efficiency** and **increase call** capacity while leveraging your existing equipment.

- It keeps your options open by allowing you to easily **upgrade to Phase 2** TDMA after the standard becomes final.

- It fits **seamlessly** into your current ASTRO 25 system and offers **P25 Phase 1 interoperability** without disrupting the communications your personnel depend on.

- It gives you room to **add data** in addition to voice, opening the door to applications that can help your personnel work faster, better, smarter

- And, like all members of the MOTOA4 portfolio, it delivers **mission critical performance** when lives depend on the speed, accuracy, and reliability of the information your people are getting in the field.

Technology That's Second Nature™

For more information about spectrum efficiency, Dynamic Dual Mode, ASTRO 25 systems, the MOTOA4 portfolio, and Motorola's commitment to P25 and the public safety industry, please visit our website or contact your Motorola representative. http://www.motorola.com/motoa4

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