simoco Xd

Simoco DMR
System Overview

Introduction

Simoco Xd is a full suite of DMR products; infrastructure; terminals and applications; offering the latest in highly featured, frequency efficient and cost effective digital radio technology for professional applications.

All Simoco products are developed and supported in-house by highly experienced R&D teams with expert knowledge of DMR radio technology, ensuring full compliance with the ETSI DMR open standards (ETSI TS 102-361-1 to 4) both at Tier II (conventional) and Tier III (trunking).

Simoco Xd and the DMR Standard

Simoco Xd is an implementation of the DMR (Digital Mobile Radio) digital radio standard specified for professional mobile radio (PMR) users developed by the European Telecommunications Standards Institute (ETSI), and first ratified in 2005.

The DMR protocol covers unlicensed (Tier I), licensed conventional (Tier II) and licensed trunked (Tier III) modes of operation, although in practice commercial application is today focussed on the Tier II and Tier III licensed categories.

Simoco Xd operates as either a Conventional DMR Tier II radio system or as a Trunked DMR Tier III system and in both cases the use of proprietary extensions has been avoided to give the highest possible standards compliance, resulting in strong assurance of system interoperability.

The DMR standard is designed to operate within the existing 12.5kHz channel spacing used in licensed land mobile frequency bands globally and to meet future regulatory requirements for 6.25e (6.25kHz channel equivalence). The primary goal is to specify affordable digital systems with a rich feature set. DMR provides voice, data and other supplementary services. DMR has been adopted by all regions of the world.

Benefits of Simoco Xd

Frequency Efficiency & Compatibility

Simoco Xd uses TDMA (Time Division Multiple Access) digital technology to provide 6.25kHz equivalence. This means that each 12.5kHz channel is logically divided up into 2 timeslots, each providing a useable communications channel. Simoco Xd will therefore deliver double the capacity of an analogue radio system using the same amount of frequency spectrum.
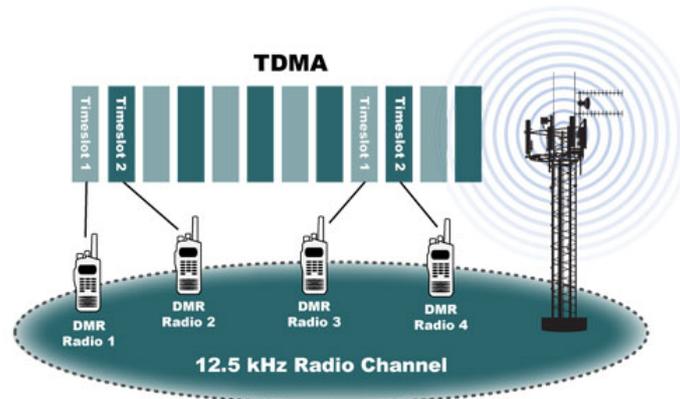

Since the TDMA technology enables the 2 digital timeslots to fit within a standard 12.5kHz analogue channel, this means that Simoco Xd can be deployed within existing analogue frequency spectrum. Users can therefore easily migrate from analogue radio systems to take advantage of Simoco Xd without any re-licensing issues and can benefit from increased capacity and/or reduced license costs immediately.

Further cost reduction compared to analogue systems results from the reduced number of base stations, antenna combining and power supplies required by Simoco Xd systems.

Voice Quality and Coverage

Simoco Xd equipment is designed to offer almost identical RF propagation properties as the analogue equipment that it replaces. This is complimented by advanced forward error correction techniques and digital voice encoding which enables the system to deliver superior voice quality to the end user. This is particularly evident in weak signal areas where the audio quality of analogue radio systems is at its poorest.
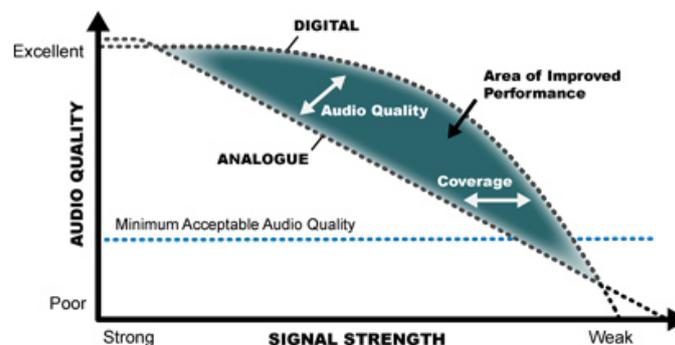
The graph above shows that the digital audio quality of Simoco Xd is considerably higher than the analogue equivalent, creating a better user experience in all signal areas.

Analogue Compatibility

Simoco Xd equipment works in conventional analogue mode to assist customers in a smooth migration to digital technology. All Simoco Xd radio terminals are dual mode as standard, enabling them to communicate with other DMR terminals as well as legacy analogue radios. The Simoco Xd infrastructure can automatically detect whether each transmission is digital or analogue and automatically switch between the two modes to provide seamless communication during the migration phase.

Distributed Architecture

The Simoco Xd infrastructure is a fully distributed architecture which is inter-connected using an IP backbone. This is made possible by the SDB670 DMR base station which features a powerful controller in each unit in addition to the digital RF platform. Since there are no other infrastructure components (e.g. site controllers, switches, servers etc.) required in a Simoco Xd infrastructure, it is cost efficient and simple to deploy and maintain.

The distributed architecture also enables the system to be extremely fault resilient with no single point of failure and the IP backbone enables remote monitoring, configuration and even software updates to be managed remotely without any requirement to visit radio sites.

Tier III Software Upgrade

As described by the 'Distributed Architecture' section above, Simoco Xd features the generic SDB670 base station which means that all hardware elements of the infrastructure are identical. This is true of both Tier II and Tier III equipment.

This generic approach makes it possible to upgrade a system from DMR Tier II to DMR Tier III with only a software upgrade and requires no additional hardware elements. This applies to infrastructure, terminals and applications, all of which can be software configured to operate in either Tier II or Tier III modes.

Power Efficiency

Simoco Xd delivers power efficiency in both the infrastructure and the terminals through a number of different techniques.

The example below shows equivalent analogue and DMR infrastructures providing two communication channels. The analogue example has two 25W base stations, requiring a power supply capable of driving them to produce 50W of RF power output. Due to combining losses, this results in less than 12.5W at the antenna. The equivalent Simoco Xd system would require half the power supply requirements for a single 25W base station and would suffer no combining losses to deliver 25W to the antenna.
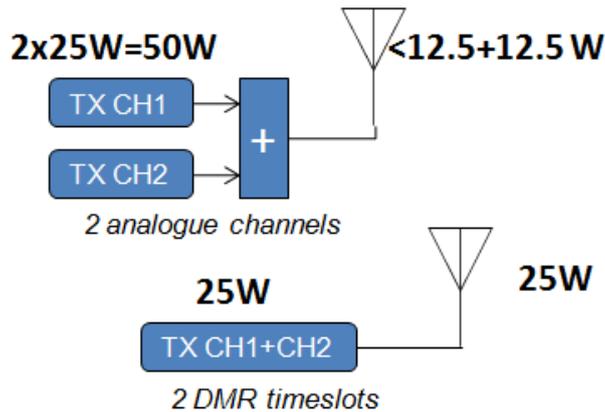
Simoco Xd in Tier III mode also provides a hibernation facility which allows base stations to enter a low power mode when not in use. Terminals then wishing to use the radio site can then 'wake up' the base station automatically, making this power saving seamless from the user.

In addition, the TDMA operation requires that the terminals only transmit within the single timeslot that they use. This means that they transmit for only half of the time of an equivalent analogue terminal, which results in dramatically increased battery life for Simoco Xd portables.

Scalable Network Management

Included with the Simoco Xd infrastructure is the DMT (DMR Management Terminal), a powerful network management application which can be used to configure individual base stations, manage an installed system and will also enable systems integrators to manage multiple discreet networks from a single instance of the application.

Tier II System Examples

Radio-to-Radio / Direct Mode Operation
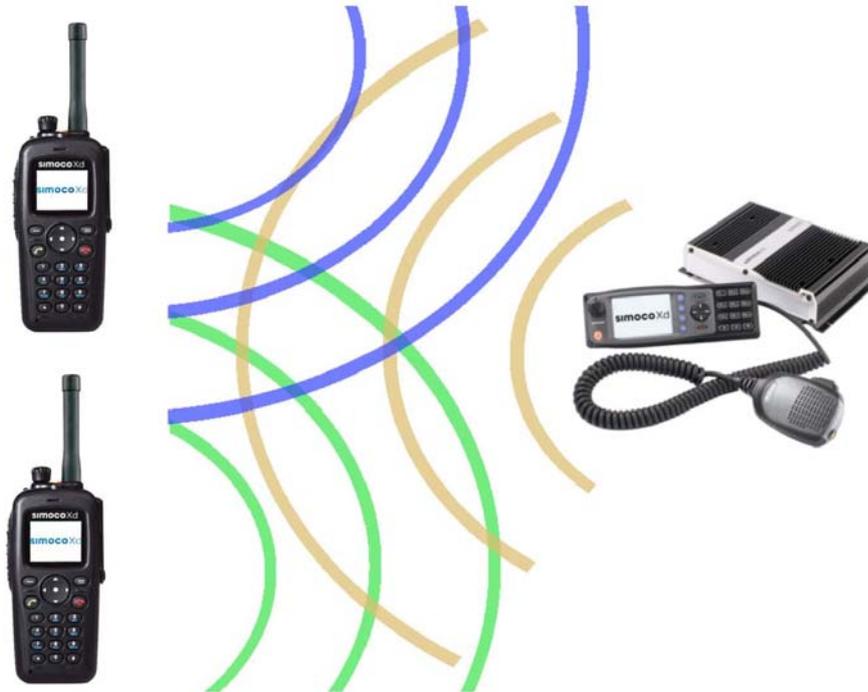
The simplest use of Simoco Xd products is where DMR radios are deployed without any fixed infrastructure and communicate using direct mode operation. Both portable and mobile radio terminals can operate in this mode, either in environments where a small operational area means that coverage can be achieved without a base station repeater or in situations where terminals need to work outside of their normal system coverage area for a period of time.

DMR Tier II / Conventional Operation

Tier II Single Site

A single base station is usually installed where the coverage area is required to be extended beyond the range that can be achieved with terminals working in direct mode. Provision of a base station also enables the connection of dispatchers, network management and third party applications. Each base station can be configured with a SIP telephony trunk to enable radio to telephone calls.

A base station will require one 12.5kHz frequency pair and will provide two independent timeslots to enable both TDMA channels to be used concurrently.

A single base station can be installed either with two antennas (for transmit and receive) or more commonly using a duplexer for single antenna working.
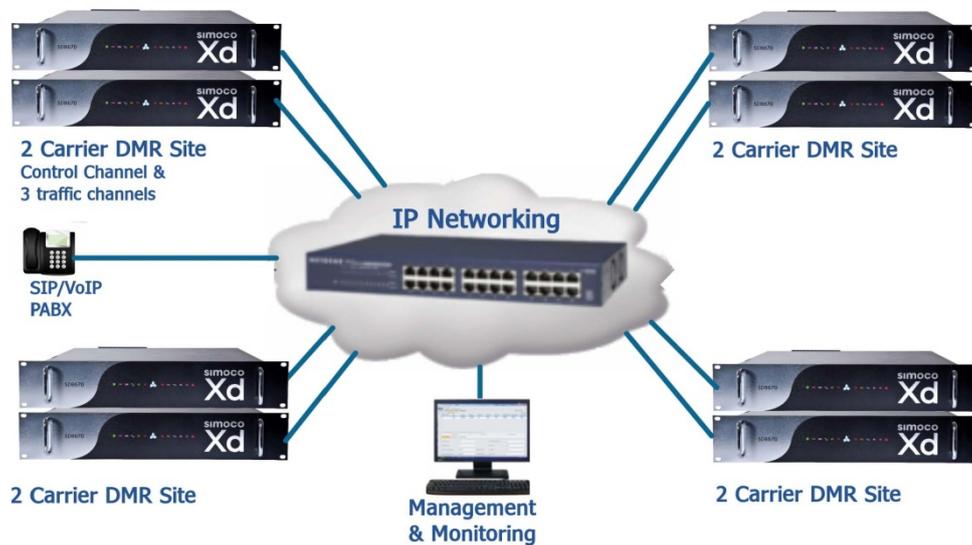
Tier II Single Site, Multiple Base Station

In order to provide additional capacity on a site for larger numbers of users, additional base stations can be installed, each providing an additional two timeslots and requiring its own 12.5kHz frequency pair. Base stations are connected to the antenna through a combiner. An Ethernet switch is installed at the site if there is a requirement for communications between base stations or for the DMT/applications to connect to the base stations over IP.

Tier III System Examples

Simoco Xd can be deployed in DMR Tier III mode to provide greater functionality and system efficiency than Tier II systems.

Simoco Xd Digital Base stations are connected together via an IP network to create a single trunked radio system. The intelligence for providing facilities like site control and trunked call routing/switching are distributed among each of the base stations giving a highly flexible, but essentially simple architecture. This removes the need for individual site controllers or central switching equipment, so each site deployment simply consists of one or more base stations.

The example below shows a four site trunked system with two RF carriers per site, which gives 1 control time slot and 3 slots for voice calls on each site. The deployment of base stations on each site is completely flexible and can be customised to the amount of traffic use in each area.

Tier III Single Base Station

The fact that Simoco Xd delivers two timeslots in a single base station makes it viable to provide trunked radio with this minimal installation where one timeslot provides a control channel and the other timeslot is available for voice and data traffic.

It is also possible to configure the base station to use a non-dedicated control channel which enables the it to utilise both timeslots for traffic when required.

Tier III Single Site, Multiple Base Station

In order to provide additional capacity on a site for larger numbers of users, additional base stations can be installed, each providing an additional two timeslots and requiring it's own 12.5kHz frequency pair. Base stations are connected to the antenna through a combiner. An Ethernet switch is installed at the site to enable control signalling to be passed between base stations and for the DMT/applications to connect to the base stations over IP.

A single site Simoco Xd trunking system is designed to have up to 16 base stations which will provide 1 control channel and 31 traffic channels.

Tier III Multiple Site

Systems covering a larger geographical area will consist of multiple radio sites. Ethernet switches at each site are used to inter-connect base stations on the site and also to connect into the IP backbone which provides the inter-site communications link.

Large systems, in excess of 25 sites, will be arranged into logical groups called 'virtual areas'. Simoco Xd is designed to support up to 25 sites within each virtual area and there may be up to 32 virtual areas in a single system.

The largest standard system with Simoco Xd consists of 800 sites providing 12,800 base stations and 25,600 timeslots. However, the distributed architecture is highly scalable and therefore projects requiring larger systems than this can be scoped.

Trunking Features

Overview

The following features are only available in true digital trunking architectures and are provided in Simoco Xd as an implementation of the DMR Tier III open standard. Simoco Xd provides a unique and coherent set of features that results in a feature-rich and highly resilient radio system.

Stun & kill

User radios register with the system infrastructure in order for the infrastructure to accept their communications. Authorised elements within the infrastructure (e.g. authorised dispatchers or management terminals) can permanently or temporarily disable user radios to ensure the security of the system. In the case of a lost or stolen radio, the integrity of the system is preserved by being able to quickly and remotely disable the specific device. This feature is only available in trunked radio systems.

Priority calling

Simoco Xd provides a flexible approach to priority calling, allowing the administrator to define different call priorities based on the type of call and the type of user. Multiple priority levels ensure that important calls get through in all situations and that essential information is not missed. This feature is only available in trunked radio systems.

Integrated Telephony

Simoco Xd integrates telephony within the whole radio system, with Base Stations providing a bridge between the radio users and the telephone system. The ability to make telephone calls has been integrated into the user radios from the start so that users notice very little difference in making radio-to-radio or radio-to-telephone calls. Telephone interconnect is provided as a SIP VoIP connection directly on the IP Network that the radio system is connected to. This level of flexibility and integration of telephony is a strong feature of Simoco Xd and an area where digital trunking excels. Additionally full duplex telephony is on the Simoco Xd roadmap.

Full Duplex Calling

Simoco Xd will offer full duplex calls on trunked systems for calls between portables and SIP connected telephony. Full duplex calls with telephones use only one slot (using offset timing) and therefore have the same frequency efficiency of standard half duplex calls;
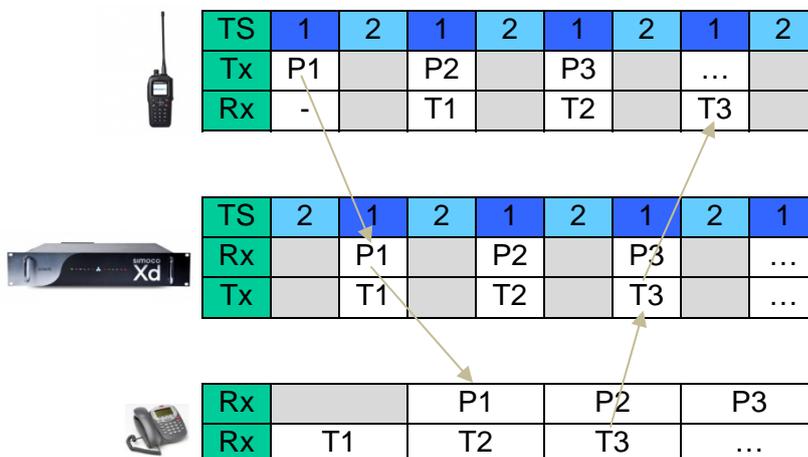
Network resilience

Infrastructure Architecture

Each Simoco Xd site consists of a group of Base Stations, which are fully Digital Signal Processor (DSP) based software programmable units. The Simoco Xd Base Station unit is a space saving 2U rack mount design with a full trunked site controller built in and does not require a separate Site Management Module or Channel Control Cards.

The number of elements in the Simoco Xd infrastructure are minimal, far less than any traditional trunked system as Simoco Xd removes the need for Central or Regional switches (Nodes) and incorporates all the functionality of;

- channel control cards
- site management modules
- associated rack frames
- associated back planes
- power supplies
- multiplexers
- telephone inter-connection

This unique design means that the system is scale-able to a far greater degree than a conventional trunked system. An added channel or indeed complete site just requires the appropriate IP connection to be made available – there is no upgrading of switches, adding cards or paths back to the switch. This amounts to a far more flexible, cost effective and easily upgradable system.

Since there are no central switching components, each radio site is simply connected to the rest of the network through any number of connections. Providing that each radio site has a connection to at least one other radio site then there is sufficient inter-site communication to enable the system to fully operate. The medium of site inter-connection is IP/Ethernet which means that the network between sites is completely flexible.

This resilient architecture design has been well proven through the successful Simoco Xfin MPT1327 systems which pioneered this approach.

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Fault Tolerance

Fault	Effect
Control slot failure	If a Base Station fails while it is providing the control slot on a specific site, then a Base Station currently available for traffic will automatically assume the role of providing the control slot. The system is reduced in capacity by one base station and an alarm will be presented on the monitoring terminal.
Traffic slot failure	If the Base Station that fails is in use for a call, then the call will be cleared down and the users will re-establish the call. If the failed Base Station is available but not in traffic then existing calls are not affected. The system is reduced in capacity by one base station and an alarm will be presented on the monitoring terminal.
Loss of inter-site links	When a site loses connection with other sites, then it is able to continue operation independently as an isolated site and all calls will only operate on the local site.
Loss of intra-site links	When network connectivity within a site is lost the Base Stations are able to continue operating with reduced call capacity.
Management Terminal failure	A failure of the management terminal would have no impact on the operation of the system. The only effect would be that no call logging or alarm information would be presented by the management terminal while it was in a failed state. Note: there may be any number of Management Terminals connected to the system so this fault can be mitigated by the addition of a second Management Terminal.
Dispatcher failure	A failure of a dispatcher terminal would have no impact on the operation of the system. The only effect would be that the failed dispatcher could not be contacted, or initiate calls. The dispatcher provides a divert facility which would allow another dispatch position to take over any calls to the failed position seamlessly.

Dispatcher

Following the design concepts of the Simoco Xd infrastructure, the dispatcher is a software application which will run on a standard Windows PC or laptop and connects to the infrastructure over IP/Ethernet for all the voice and data requirements.
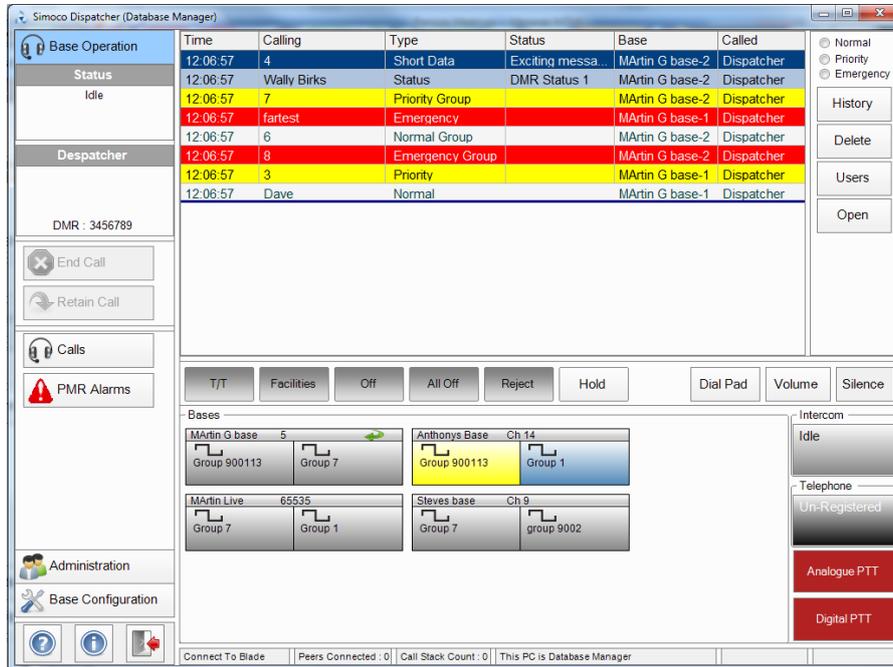
Each dispatcher is allocated a unique identity for presentation and identification of incoming and outgoing calls. Furthermore, they will also be allocated a college identity to enable them to operate within that college group. Incoming calls which are addressed to a college identity are presented on the call stack of each dispatcher within that college. When a dispatcher deals with each call it is removed from the call stack of all dispatchers within that college.

Voice calls are presented to the dispatch operator via a headset which is connected directly to the PC to give optimal voice quality. Alternatively, options are available for desk microphones, speakers and footswitches. The main screen hosts the call stack for incoming calls and function buttons to allow the access to all dispatch functions.

The dispatcher utilises a distributed networked database to ensure the integrity and consistency of all dispatch positions on the network. This database is used to store preferences such as the colour and descriptor text of status codes as well as diversions which may be put in place by dispatch operators for their own or third party identities.

An advantage of the IP/Ethernet connection of dispatch positions is that they may be located anywhere on the network. This enables them to be deployed at main control rooms, special incident rooms or in the event of emergencies, they may be dynamically deployed remotely or even home based staff residences.

Dispatcher software can either be supplied pre-installed on a suitable Windows PC or as software with a license key. A minimum PC specification is included on the product brochure.