

SmarTrunk II

System Overview

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Things You Always Wanted to Know About Trunking...

Introduction

This section is directed to the system owner who is considering converting conventional 450 MHz repeaters to trunked operation. Perhaps you are an operator of shared community repeaters who would like to achieve higher customer loading (and greater profits) from your existing system. Or perhaps you operate a private “campus” system of two or more VHF or UHF conventional channels used for plant security or maintenance. Either way, converting your conventional channels to trunked operation will significantly increase your system capacity while providing privacy, system security, and advanced features such as selective and emergency calling.

What is Trunking?

The term “trunking” originated decades ago in the telephone industry to describe the process of selecting one clear communications path from many possibilities. It is based on the premise that if 100 users are sharing a certain communications network, only 10 users will actually use the network at any one time. Therefore, it is not necessary to install 100 trunk lines to serve 100 telephone customers; only 10 lines will be sufficient to provide a high level of service.

Trunking in Land Mobile Radio (LMR) Systems

Trunked LMR systems were introduced in the early 1980’s on the same premise. By “trunking” together groups of frequencies (channels), a communications network could serve a large number of users with a very high level of service.

The efficiencies and features of trunked radio are well known to experienced 800 MHz system operators.

“The Trunking Advantage”

- .. Efficiency
- .. Privacy
- .. Selective Calling

The primary advantages of any trunked radio system can be summarized as follows:

- .. **Automatic selection of a clear channel:** In a conventional radio system, the user may only have access to a single channel. By FCC regulation, if the user wishes to make a call, he must first monitor the channel to make sure it's clear. If the channel is busy, the user must continue to monitor the channel until the co-channel user has terminated the conversation. By contrast, in a trunked system the channel selection is automatic. When the user initiates a call, the trunking system electronically "monitors" each channel and selects one clear (unused) channel from many possible channels.
- .. **Channel Privacy:** In a conventional system, other co-channel users can easily eavesdrop on conversations. In fact, channel monitoring is required by the FCC when initiating a call, as described above. In a trunked system, other system users cannot listen in on other conversations. A radio can only join a conversation when directed by the trunking controller.
- .. **Channel Exclusivity:** In a conventional system, discourteous co-channel users can "jump" on a channel in the middle of another conversation, thereby interrupting the call in progress. In a trunked system, once a channel is selected, it becomes exclusive for the duration of the transmission. Other users cannot interrupt or interfere with the call.
- .. **Selective Calling:** In most conventional radio systems, selective calling is an expensive add-on option or may not be available at all. On the other hand, some trunked radio systems provide extensive selective calling capabilities as a standard feature. This means that users can selectively call different groups or individuals in the system. Each user is typically assigned a unique individual ID code and one or more group ID codes. These codes can be dialed by other users in the system to select only the specific groups or individuals with whom they wish to communicate.

The Trunking Advantage

The advantages of trunking can be illustrated by a very simple example. Most of us are familiar with problem of standing in line for a bank teller or at a ticket window, as illustrated in Figure 1 below. Queuing analysis shows that more people (customers) can be handled with the same level of service when all servers (channels) are available to all customers.

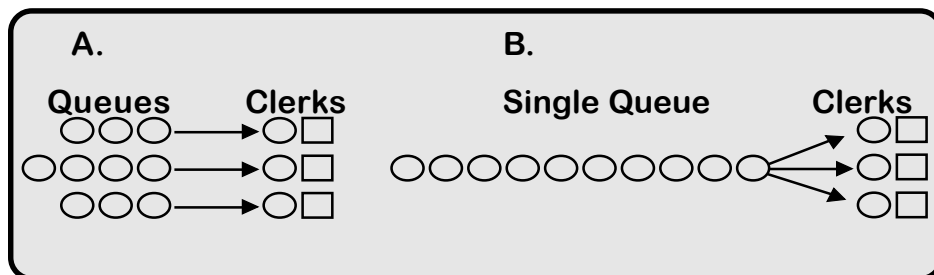


Figure 1 - Which kind of line would you prefer to stand in?

Rules Regarding VHF and UHF Trunking in the United States

The FCC has authorized the use of “centralized” trunked systems for VHF and UHF frequency bands where at least one frequency must have a Protected Service Area (PSA). This frequency is identified with a station class designation of FB8 for the Repeater. While FB8 codes are used only with trunked (YG or YW) systems, an FB8 frequency may not be used for conventional systems.

Centralized trunking refers to trunking systems that use dedicated (exclusive) control channels for data communication between the mobiles and the trunked repeaters. In such systems, the mobiles constantly monitor the control channel for channel assignment instructions. When a group call is initiated, the trunking controller transmits instructions telling the mobiles in the group to switch to a voice channel assigned for that conversation. Thus, the “brains” of the system are in the system controller at the repeater site.

Most trunking systems such as MPT-1327, Motorola’s Smartnet, E. F. Johnson’s LTR, Trident’s Passport, etc are centralized systems. As they are designed to use clear frequencies, these trunking formats are not as well suited as SmarTrunk or as easy to license at VHF and UHF frequencies because of the lack of exclusive channels in those bands.

To get around this problem, the FCC requires potential centralized system operators. . . “to obtain some form of exclusivity in their respective service areas”. This requires the operator to obtain written permission from all other licensees within a 70 mile radius of the proposed base station, similar to the FCC rules for telephone interconnect in major metropolitan areas. However, due to the frequency congestion in these bands, this requirement is extremely difficult to meet. All other users on the proposed trunked channels and immediately adjacent channels would have to agree to convert to trunked operation. Since, by definition, centralized trunked systems require exclusive channels, the other affected users would have to agree to a simultaneous conversion of their radio systems, which would require scrapping their conventional equipment and purchasing all new mobile radios.

Centralized vs. Decentralized Trunking Systems

Unlike centralized trunking systems, decentralized (scan based) systems such as SmarTrunk II do not require exclusive channels. Because the channel selection intelligence is in the mobiles, decentralized systems can co-exist with conventional users on the same channels. When a call is initiated by a mobile unit, the channel assignment is determined by the logic in the mobile, not by a controller at the repeater site. So if the channel is busy with a conventional user (or even a co-channel user on another system), the mobile will consider the channel as busy and select another channel. Per FCC rules, all frequencies of a de-centralized trunked system would use the less restrictive station class designation of either FB6 or FB2, which does not require a Protected Service Area (PSA). FB6 is for private carrier systems such as radio dealers that would place additional users on the system. FB2 is for private in house systems such as a manufacturing facility that would use the system for their own use.

The advantages of decentralized system can be summarized as follows:

- “ Since they do not require exclusive channels, the onerous FCC frequency coordination requirements described above do not apply.*
- “ Decentralized trunking systems have always been “legal” for use below 800 MHz because they fully comply with the FCC requirements to monitor the channel before transmitting and do not utilize dedicated data channels for system control.*
- “ Decentralized trunking is the only trunking protocol which will operate on non-exclusive channels. This not only allows the system to operate in the presence of conventional users on the same channel, but it also allows a system operator to gradually convert conventional users to trunked operation.*
- “ They are more economical due to the lower cost of both the trunking controllers and the mobile radio equipment.*
- “ They require less technical training to install and maintain.*

System Highlights

SmarTrunk II is a decentralized two way radio trunking system that is widely used both for telephone interconnect and business dispatch applications at frequencies below 800 MHz.

First introduced in 1994, **SmarTrunk II** combines a proprietary digital signalling format with existing two way radio technology—creating a communications system that is low cost, yet provides many of the features of higher cost trunked radio systems.

Today **SmarTrunk II** provides local area wireless solutions to over 500,000 subscribers in over 98 countries throughout the world. Due to its growing popularity, **SmarTrunk II** is sold in partnership with international radio manufacturers such as ICOM, Kenwood, Motorola and Vertex.

Wireless Solutions Supported by SmarTrunk II

*Virtually any organization which seeks to provide local area communications can benefit from **SmarTrunk II**:*

- ▶ *Community repeater operators can upgrade to group dispatch and selective mobile to mobile calling to existing customers or expanding markets.*
- ▶ *Rural telephone operators can provide telephone service to individual subscribers in remote areas without investing in the enormous cost of a wireline or cellular infrastructure.*
- ▶ *Radio dealers can offer a combination of telephone and radio dispatch services, depending on the needs of individual customers.*
- ▶ *Large industrial companies can use **SmarTrunk II** as a wireless PABX, connecting all employees, in addition to supporting group calling capabilities.*

APPLICATIONS

- | | |
|---|--|
| • Small police and fire departments | • Government agencies |
| • Public telephone systems | • Mining operations |
| • Large industrial manufacturing facilities | • Oil & gas pipeline operations |
| • Colleges or university campuses | • Petro chemical operations/oil refineries |
| • Airports | • Forestry and fishing fleets |
| • Casinos and Hotels | • Hospitals |

System Requirements

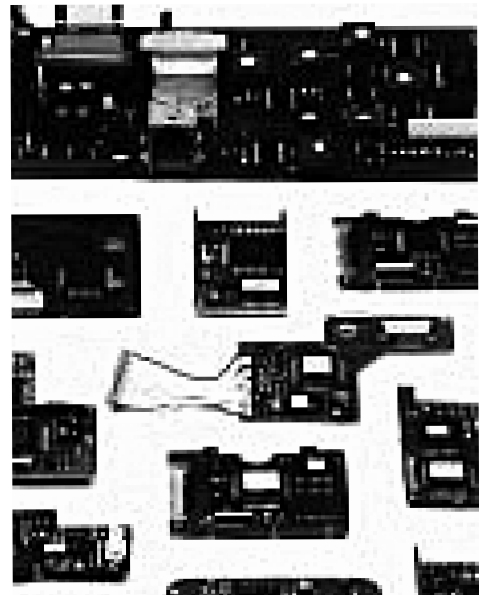
*A **SmarTrunk II** radio trunking system employs low cost radio communications equipment and SmarTrunk II technology, which is installed at both the base station and the subscriber radios.*

The base station equipment required for each channel consists of a



***SmarTrunk II** controller connected to a standard VHF or UHF radio repeater. For telephone interconnect applications, the controller is also connected directly to a standard telephone line via a RJ-11 jack. Each channel can support one individual conversation. Therefore, a three channel system can support three simultaneous private conversations.*

*Since **SmarTrunk II** is an “overlay” system, each of the subscriber radios must have a customized logic board to control the radio’s operations. **SmarTrunk Systems, Inc.** manufactures customized logic boards for over many different radios. Please see the “**SmarTrunk II Logic Board Collection**” (Appendix A) which lists all the mobile and portable radio models that are compatible with **SmarTrunk II**.*



Types of Calls and Methods of Operation

Using SmarTrunk II For Radio Dispatch Applications

Mobile to Group Call

SEQUENCE OF EVENTS:

1. *Mobile subscriber presses the PTT (Push To Talk) button to initiate a group call to the subscriber's own group. Alternatively, mobile subscriber enters desired group number followed by routing code 3 and * on the radio keypad.*
2. *Mobile radio searches for an idle channel and signals the controller.*
3. *Base station controller acknowledges the mobile and signals all subscriber radios that are a part of the called group.*
4. *Subscriber radios assigned to the called group open squelch, connection is established, and a group conversation begins.*
5. *Any subscriber in the group presses the "#" key to terminate the call, or repeater disconnects at the expiration of the Group Activity Timer.*

SPECIAL FEATURES:

- .. **Automatic PTT (Push To Talk) Mode** - subscribers may initiate group calls to their own subscriber group by pressing the PTT button.
- .. **Call Limit Timer** - programmable call limit timer on a per user (group) basis.
- .. **Group Activity Timer** - acts like a "hang timer" to retain channel for the duration of a call.
- .. **Multiple PTT Group** can be selected without keypad in some radios (see Omni Features, Section 6).
- .. **Memory Speed Dial** - convenient, cellular like, dialing including a redial function.
- .. **Clear Channel Alert** - notifies the subscriber when a channel becomes available after the subscriber has attempted to access the system when all channels are busy.
- .. **Radio Kill** - eliminates unauthorized users of the system.
- .. **Conventional Mode Operation** - "talk around" communications available in certain subscriber radios.

Mobile to Mobile Private Call

SEQUENCE OF EVENTS:

1. *Mobile subscriber enters desired subscriber number followed by routing code 3 and * on the radio keypad.*
2. *Mobile radio searches for an idle channel and signals an available controller.*
3. *Base station controller acknowledges incoming call and signals desired subscriber radio, which responds by ringing.*
4. *Called subscriber answers call by pressing the * key, establishing the connection.*
5. *Either subscriber presses the “#” key to terminate the call.*

SPECIAL FEATURES:

- .. **Call Limit Timer** - *programmable call limit timer on a per user basis.*
- .. **Channel Privacy** - *other users cannot interfere with or eavesdrop on calls.*
- .. **Memory Speed Dial** - *convenient, cellular like, dialing including a re-dial function.*
- .. **Clear Channel Alert** - *notifies the subscriber when a channel becomes available after the subscriber has attempted to access the system when all channels are busy.*
- .. **Radio Kill** - *eliminates unauthorized users of the system.*
- .. **Conventional Mode Operation** - *“talk around” communications available in certain subscriber radios.*

Mobile Operator Call

SEQUENCE OF EVENTS:

1. *Mobile subscriber enters 9 and * on the radio keypad.*
2. *Mobile radio searches for an idle channel and signals the controller.*
3. *Base station controller acknowledges incoming call and signals the established mobile operator radio, which responds by ringing.*
4. *When the called party answers, the conversation begins.*
5. *Mobile subscriber presses the “#” key on the radio keypad to terminate the call.*

SPECIAL FEATURES:

- .. *Two touch dialing to access the subscriber radio that has been programmed as the mobile operator.*
- .. *Programmable emergency call override status.*

Using SmarTrunk II for Telephone Interconnect Applications

Mobile to Telephone (Landline) Call

SEQUENCE OF EVENTS:

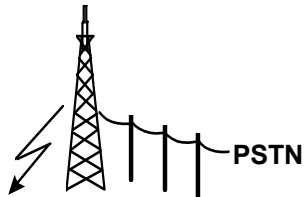
1. *Mobile subscriber dials desired telephone number followed by routing code 1 and * on the radio keypad.*
2. *Mobile radio searches for an idle channel and signals an available controller.*
3. *Base station controller acknowledges incoming call and dials the desired telephone number over the landline connected to the back of the controller.*
4. *When the called party answers, the conversation begins.*
5. *Mobile subscriber presses the “#” key on the radio keypad to terminate the call.*

SPECIAL FEATURES:

- .. **Selective Toll Restriction** - programmable on a per user basis to allow or prevent long distance or toll calls.
- .. **Call Limit Timer** - programmable call limit timer on a per user basis.
- .. **Line 1 or Line 2 Telephone access** - programmable access to telephone line 1 or line 2 on a per subscriber basis.
- .. **Memory Speed Dial** - convenient, cellular like, dialing including a redial function.
- .. **Last Number Redial** - pressing *, * on the radio keypad automatically redials a busy number.
- .. **Priority Call Override** - allows priority users to gain access to a busy system.
- .. **Clear Channel Alert** - notifies the subscriber when a channel becomes available after the subscriber has attempted to access the system when all channels are busy.
- .. **Radio Kill** - eliminates unauthorized users of the system.

Telephone (Landline) to Mobile Call

SEQUENCE OF EVENTS:



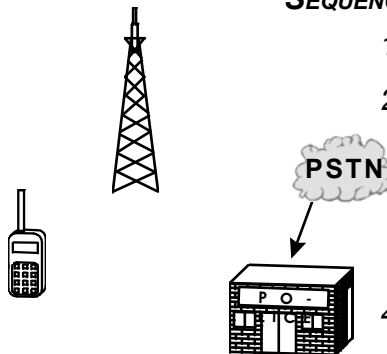
1. Telephone user dials the phone number of the landline connected to a controller.
2. Controller answers the call with two beeps. Telephone user dials desired mobile subscriber number (1-5 digits).
3. Controller signals desired subscriber radio which responds by ringing.
4. Mobile subscriber answers call by pressing the * key on the radio keypad, establishing the connection. Conversation begins.
5. Mobile subscriber presses the “#” key on the radio keypad to terminate the call.

SPECIAL FEATURES:

- **Call Limit Timer** - programmable call limit timer on a per user basis.
- Landline callers may also initiate calls to a group of mobile subscribers.

Emergency Telephone Number Call

SEQUENCE OF EVENTS:



1. Mobile subscriber enters 0 and * on the radio keypad.
2. Mobile radio searches for an idle channel and signals an available controller.
3. Base station controller acknowledges incoming call and dials the established emergency telephone number over the landline connected to the back of the controller.
4. When the called party answers, the conversation begins.
5. Mobile subscriber presses the “#” key on the radio keypad to terminate the call.

SPECIAL FEATURES:

- Two touch dialing to access the emergency phone number programmed by the system operator. Can be programmed for police, fire, or any other emergency telephone number.
- Programmable emergency call priority override.

SmarTrunk II Controller

The heart of the SmarTrunk II System is the **ST-853 SmarTrunk II Digital Trunking Controller** which performs all signalling and trunking functions, including subscriber validation and call record

accounting. The ST-853 features a

communications databus linking all the channels at a single site, an expanded memory for subscriber and call accounting records and many other new features and functions that have been requested by SmarTrunk system operators throughout the world.



ST-853 FEATURE SUMMARY

- Subscribers per system 4,096
- Call records per controller 4,500
- Paging code combinations available 320,000
- Communication between controllers Serial databus
- Single access point for uploading Yes
or downloading system data
- Programming software Menu driven PC DOS application
- Off-line programming sessions Yes
- Local transfer speed 9600 baud
- Modem transfer speed 9600 baud
- Security password for programming 2 password levels, up to 8
alpha numeric characters
- Method of assigning parameters Assigned to profiles which are assigned
to subscribers to subscriber
- Direct connect without over dial for Yes
incoming telephone calls
- Total number of toll restriction 8 restricted prefixes and 8 override
prefixes per system prefixes

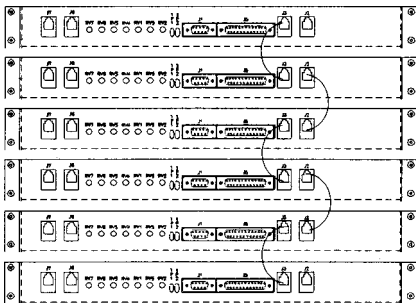
Expanded Capacity

An ST-853 system can support up to 4,096 individual subscribers or groups. In addition, most features are programmable on a per subscriber basis, such as the mobile activity timer, telephone line access, courtesy beep and expanded toll restriction options. Each controller can store up to 4,500 call records. The programmable call records feature insures only the desired types of calls are recorded.

In the subscriber database, each subscriber or group may be assigned a different System ID. For radiotelephone applications, this provides up to 320,000 paging code combinations for added security. This feature also allows an ST-853 system to be programmed with subscribers from other systems for roaming applications.

Databus Communication between Controllers

All of the ST-853 controllers at a site are connected through a serial databus which enables the controllers to communicate. This allows the subscriber database and all call records data to be accessed from a single controller.



The databus is also used by the controllers to automatically coordinate signaling when needed. If multiple calls are placed simultaneously in an ST-853 system, the signalling is coordinated to prevent missed calls or split groups. If a call is placed to an individual or group that is already engaged in a call, the caller will receive a busy tone indicating that a call is in progress. If the called individual is out of range or powered off, a fast busy tone is generated.

Greater Ease of Programming

The programming software for the ST-853 is a menu driven, PC based application which offers much more power and flexibility than the internal software used to program the previous controller.

- .. *User-friendly programming software supports off-line programming.*
- .. *Subscriber profiles allow the calling privileges of similar subscribers to be changed collectively.*
- .. *Clone feature allows the creation of multiple subscribers.*
- .. *Site View displays status information about the controllers while on-line.*
- .. *Call records are automatically stored to disk when downloaded.*
- .. *Enhanced call record management marks records as new or old.*
- .. *Two-level expanded password scheme allows supervisor to control system access.*
- .. *Database conversion utility eliminates the need to re-key an existing ST-852 subscriber database when converting to the ST-853.*
- .. *External modem option offers error-free data transfer.*

Enhanced Telephone Interconnect Features

The ST-853 offers enhanced telephone interconnect features which can be used to support a variety of new applications.

- .. *Auto Route feature routes incoming calls to a designated subscriber who can transfer the call to any subscriber in the system.*
- .. *PageBack feature allows entire group to participate in outgoing or incoming telephone calls.*
- .. *Up to 8 restricted prefixes and 8 override prefixes can be selected on a per subscriber basis.*
- .. *Telephone lines may be programmed to accept incoming or outgoing calls on a per controller, per line basis.*
- .. *Voice Clears Activity Timer allows telephone users to prevent the Mobile Activity Timer from expiring.*
- .. *Overdial Length and Connect on DTMF * offers faster connect times for incoming telephone callers.*
- .. *Busy, Dialtone and DTMF # Disconnect features allows telephone callers to terminate a call.*
- .. *Enhanced dialing procedure supports compatibility with PBXs or nonstandard telephone switches requiring special delays or prefixes.*
- .. *Leading 0 Dial Click Detector reduces errors caused by line noise and improves the ability to detect pulse overdial.*

Options and Accessories

502-3501 Users Guide and Programming Software - Complete documentation and PC-DOS programming software required for installing, aligning and programming the ST-853 controller. **One P/N 502-3501 is required for each system.**

ST-910 CTCSS Decoder Option - A miniature CTCSS decoder which may be added to the ST-853 controller to provide additional protection from intermod or co-channel interference. Recommended for use in the United States and other areas of high RF activity or where there is possible interference from a distant repeater on the same channel.

ST-911 Cable Assembly Option - A 4' long (122cm) shielded cable assembly terminated with a DB-25 connector which mates to the ST-853. Provides all the connections necessary between the ST-853 and the host repeater. **Note: A DB-25 connector kit (without cable) is provided with each ST-853.**

ST-956 External Modem and Cable - An external high speed modem and interface cable used to program an ST-853 site remotely over a telephone line (if remote access is desired). This option may be used to install a modem at the site (only one modem required per site) or at the local computer used for programming.

SmarTrunk II Logic Boards with Omni™ Features

SECTION 5

The other key component of the SmarTrunk II system is a miniature logic board which installs inside the mobile or portable radio equipment. These logic boards are custom designed for each radio and control all the signaling and trunking functions, including scan, PTT, and monitor. In most cases, the logic boards are easily installed by plugging into the host radio; however, soldering may be required in some older radios (See SmarTrunk II Logic Board Collection, Appendix A).



ST-865KW4

Kenwood 'G' Series Radios offer new Omni Features

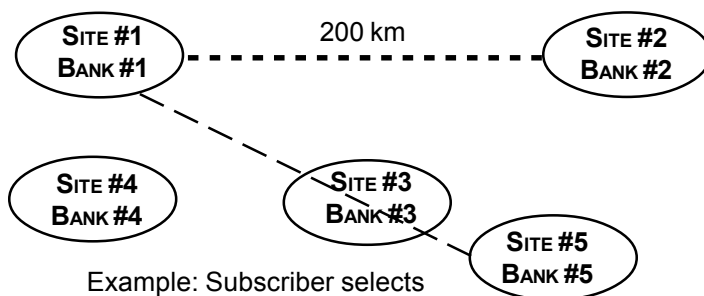


ST-865M5

Motorola Professional Series Radios offer New Omni Features

Highlights of the Omni feature set includes Channel Banks for multi-site applications, multiple talk and receive groups, faster channel access, positive radio kill, and greater use of the radio's display.

The Omni feature set is currently available for radio models from Icom, Kenwood, Motorola, Standard, and Yaesu/Vertex (see Appendix A for details). A summary of the Omni features is listed below:



Example: Subscriber selects bank #5 when moving to site #5.

Channel Banks

The Channel Banks feature allows subscribers to access different sites which may use different frequencies. Channel Banks are accessed via the radio's Channel select switch i.e. Channel 1 would become Frequency Bank 1.

By programming the frequencies of different SmarTrunk II or conventional sites as Channel Banks on the subscriber radio, system operators may offer access to multiple sites or even allow the radio to operate in conventional Talk-Around mode. To access a remote site, the subscriber selects the Channel Bank of the desired site. The diagram shown on the left explains a typical Channel Banks application.



ST-865S4

Standard HX290 Portable Radio offers new Omni Features

In order to access a SmarTrunk II site, the subscriber must be programmed as a valid user by the system operator of the site. Channel Banks may also be used to access conventional channels. When a subscriber selects a Channel Bank programmed with conventional channels, the radio automatically enters into the conventional mode.

This feature is useful in cases with the system operator allows talk-around operation among the user's radio. Talk-around can be used for short range direct radio-to-radio communications without going through the trunking system.

Multiple PTT Groups

The Multiple PTT Groups feature allows subscribers to call different groups of subscribers simply by pressing the PTT (Push-To-Talk) button. Previously, a subscriber could call only one group by pressing PTT.

The system operator may program up to 16 Group Codes in the radio logic board which may be selected by the subscriber by using one of the spare function switches on the radio which becomes the group switch when the radio is programmed for SmarTrunk operation. The subscriber selects the desired group with the Group Switch. When the subscriber presses PTT, the selected group is called. In addition, the radio will receive calls placed to the selected group.

This feature enables subscribers who are not equipped with a DTMF keypad to call different groups. In addition, this feature allows subscribers to join different PTT groups on different days. For example, changing PTT groups is useful in applications where a subscriber regularly changes project groups or where a mobile radio is frequently used by employees who are in different groups.



ICOM IC-F3/F4, IC-F1020/F2020 and IC-F30/F40 offer new Omni features

Multiple Receive Groups

The Multiple Receive Groups feature enables system us to receive individual calls and/or calls placed to several different groups. “The Block Decode Function”: In logic boards without the Omni feature set, a subscriber can rec only individual calls and calls placed to one group. The receive groups are programmed in the radio logic board the system operator.

This feature is useful in applications where a subscriber needs to receive any call placed to several different groups or sub-groups. For example, a dispatch subscriber could receive an individual call, one or more sub-group calls and an ‘all call’ placed to all of the subscribers in the business.



VTP-40



**Yaesu/Vertex VX-10
offers new Omni Features**

SmartScan™

The SmartScan feature provides faster channel access in a busy system. During idle operation, the radio keeps track of which channels are busy while scanning for incoming calls. When a subscriber places a call, the radio immediately vectors to an available channel. As a result, channel access time is reduced considerably, especially in larger systems.

Dialed Number Display

When a subscriber dials a telephone number or Subscriber Number using the radio keypad, the dialed number is displayed on radios equipped with an LCD display. In addition, the current PTT Group Code is also displayed.

Positive Radio Kill

The Positive Radio Kill feature allows a system operator to initiate an over-the-air “kill” command from the base station. If the target is turned on and within range, the “kill” command will disable the radio and confirm the action in the system data base. The “killed” radio must be returned to the dealer or system operator for re-activation. This feature is useful to disable a specific lost or stolen radio within a group without disabling the entire group.

Turbo Speedial™

The Turbo Speedial feature offers one-touch speed dial. Subscribers may program up to four telephone or subscriber numbers which may be dialed by pressing a single button on the keypad, either A, B, C or D.

Note: *Exact features, including the number of Channel Banks available, may vary from radio to radio. Contact factory for details.*

Memory Speed Dial

Allows users to place calls to up to 10 frequently called groups, individuals or telephone numbers. Dealers have the option of allowing users to program these memory locations. Dealers may also restrict keypad calls to memory speed dial calls.

*Speed Dial calls are dialed by pressing * and the memory location.*

Caller ID

When an individual call is made to a radio, the display on the radio (if so equipped) will show the unit ID of the user who is calling. At the present time, this feature will only be available for mobile-to-mobile calls, but not incoming landline calls. The group ID is displayed during a group call. This feature is functional in ST-853 stand-alone systems. A side benefit of this feature is that it is also used as an ANI. With the optional Dispatch Console, a radio's individual ID can be displayed on the Dispatch Console screen even during Group calls.

Speech Scrambler

The new 3G family of logic boards supports voice inversion encryption for secure speech. This feature can be enabled or disabled by the user once the call is established. This feature is presently not available for landline calls. Secure speech can work with ST-853 (stand-alone) or ST-510 based systems. (May not be available for all models).

Beyond The Simple “Controller only” System

SECTION 6

INTRODUCTION

The ST-510 is a computerized modular switch designed exclusively for use with the SmarTrunk II™ Trunking System. The ST-510 allows system operators to offer advanced features and services. In addition to providing multi-site, wide area coverage, the ST-510 offers voice prompts, voice mail, call forwarding and many other advanced features listed below.

The ST-510 Network Switch is compatible with the ST-853 SmarTrunk II controller and all SmarTrunk II Omni™ logic boards. This makes it possible for SmarTrunk II system operators to expand their existing systems without having to add new controllers, repeaters, or subscriber radios. The only modification required to existing SmarTrunk II controllers is the replacement of the controller's firmware EPROM.

KEY SYSTEM FEATURES

The ST-510 allows SmarTrunk II system operators to add the following high performance features and services. Please note that many of these features may require optional hardware, software and/or operating firmware, as described on page 38.

- * Voice Mail
- * Call Forwarding to Another Radio or Telephone
- * Real Time landline Call Transfer to Another Radio
- * Pre-Recorded Information Service for Subscribers (Weather, Traffic, Schedules)
- * Very Detailed Usage Data Base and Billing Package
- * Network Airtime Statistical Reports
- * Dispatch Console
- * Searchable Voice Logger
- * Wide Area Multi Site Roaming
- * Simplified Linking
- * Remote Site Telemetry
- * Late to Join and Lost Radio Rejoin Capability (3G)
- * One Time Groups are Joined on One Channel (Dynamic regrouping) (3G)
- * Automatic User Registration on Power On or at New Site
- * Can Provide Gateway to Another Radio System (3G)

The ST-510 also adds valuable features to the basic SmarTrunk II protocol:

- Multi site Roaming
- No Routing Digit required
- Sharing of PSTN lines
- Larger Call Record database
- More customer profiles available
- More Subscriber ID codes
- Local & remote system management
- Remote site telemetry late to join radio is automatically sent to group call if call is in progress
- Lost radio can rejoin a group while call is in progress

ST-510 SYSTEM COMPONENTS

CPU: The heart of the ST-510 is a rugged, fault tolerant industrial PC with DSP (digital signal processing) resources. The PC runs all the software routines required for the switch control and the services supported. The switch also assumes many functions normally supported by the SmarTrunk II controller, such as data base maintenance, subscriber validation and call record accounting.

Switch Rack & Power Supply: The ST-510 system components are mounted in a standard 19" rack panel with eleven slots to accommodate the switching components plus the power supply. Additional rack panels may be added to the system as required.

Each rack panel includes a power supply that provides the required system voltages and supervises the overall system performance and serve as back-up to power supplies of other racks.

ST-422 Switch Board: All system switching and interface functions are performed by the ST-422 Switch Board. The ST-422 contains a micro-controller, an analog matrix switching structure, plus a highly versatile analog input/output with adjustable levels for each incoming or outgoing path. The ST-422 also has an RS-232 data port for digital interconnection with any external device.

By use of an on-board DIP switch, the ST-422 can be easily configured for several different system functions:

-
- ST-852/853 controller gateway
 - Voice prompt/voice mail DSP gateway
 - PSTN/PBX gateway
 - Roaming Bus gateway
 - Inter-site link gateway
 - Dispatch console gateway
 - Interoperability radio gateway

SYSTEM OPERATION (BRIEF EXAMPLE)

When a call request arrives at a SmarTrunk II controller, a short data packet will be sent from the controller's RS-232 data port to the ST-422 board which serves as the switch gate for that controller. This packet is processed by the main ST-510 CPU and software, which decodes all information such as subscriber number, required service, etc. Once the subscriber name is decoded, the program will access the main database, looking for the subscriber profile and checking if the service request is valid for that particular subscriber.

If the requested service was a mobile-to-mobile call, the system software will search for the profile and status of the called party, checking if the party is busy or free and if this type of call is valid for the called party. If valid, the ST-510 will send a new data packet (via Roaming Bus) to each site in the network where the called party is authorized to roam. The ST-510 at the remote site(s) will then direct a free SmarTrunk II controller to page the called party.

The SmarTrunk II controller will look for the acknowledgment signal from the called party. If the called party is out of range or his/her radio is turned off, the main ST-510 computer will immediately transfer the caller to Voice Mail.

If the called party is within range, the main ST-510 CPU opens an audio path from the original controller (calling party) to the second controller (called party) in a process which requires no more than one-half second beyond the normal SmarTrunk II signaling time. If the called party answers, the conversation takes place as normal. If the called party does not answer within a programmed time, the calling party is directed to Voice Mail. When either party ends the call, all resources are released and the call information is reported to the call record account file.

SYSTEM REQUIREMENTS

Operators considering a ST-510 Network Switch should first be thoroughly familiar with the SmarTrunk II signaling protocol and basic operation, as described in the operating manual for the ST-853 Trunking Controller. The ST-510 system operates with the SmarTrunk II protocol using the same ST-853 controllers as a conventional SmarTrunk System; however, a new firmware EPROM is required for each controller.

Each local SmarTrunk II controller is connected to the local ST-510 switch by two links: an RS-232 data cable and an audio link from the controller's line 1 TELCO port to the audio port of the ST-422 board assigned to that controller.

If the system has more than one site, an ST-100 multiplexers are used to connect to remote ST-853's. For PSTN or PBX interconnection, the ST-510 has a conventional line termination for an analog TELCO line (2 wire, loop start).

The system power supply is available in 110 or 220 VAC (50/60 Hz) versions.

FEATURES AND SERVICES PROVIDED

Note: Some features are optional. Please see page 38.

Wide Area Roaming

The ST-510 supports two roaming scenarios:

- ***Single ST-510 Switch:***

It is most often the case to have a single ST-510 Network Switch support multiple repeater sites. In this case, the SmarTrunk controllers (up to 128 maximum) are linked to a central ST-510 site. Different roaming areas may be defined which correspond to the different repeater sites.

This is the most economical scenario because only one ST-510 switch is required to support the entire network. There must however, be a link for each repeater/ST-853 channel at the remote site(s). For more details, refer to page 37.

- **Multiple ST-510 Switches:**

Larger networks may use multiple ST-510 switches, requiring only one low speed data bus (from 4800 baud) to link the switches. As with the single switch scenario, this service allows customers to locate any subscriber in the entire network simply by dialing the subscriber's number. In this scenario, the number of audio paths (links) required in the system depends on the anticipated roaming traffic between the sites.

The definition of the roaming areas and the associated subscriber profiles are created automatically using the comprehensive management software included with the system.

Voice Mail

If a subscriber is unable receive a call, the ST-510 will connect the calling party to an audio file containing the subscriber's voice prompt messages. The system has three voice mail greetings for each of the following situations:

- Mobile is powered off or is out of range
- Mobile is in range but the subscriber does not answer the call
- All incoming calls automatically forwarded to voice mail service

After the system plays the appropriate greeting message, it will record the caller's message. The length of the message is programmable for each subscriber.

All subscriber messages are digitally recorded on the hard disk of the ST-510. When a subscriber wishes to listen to his/her messages, he/she will dial 111* from their radio and the system will play back the number of messages in memory and will indicate the date and time of each message.

During message playback, the subscriber can command the system to request a new message, repeat the last message, delete messages, etc., using the radio keypad. The quantity of messages in memory for each subscriber will depend of the hard disk capacity of the system. If necessary, a hard disk array can be added to the system.

Call Forwarding

If a mobile subscriber is out of range or away from his radio, he may choose to have incoming calls forwarded to another radio, a PABX extension, or to any PSTN number. When an incoming call arrives for the subscriber, the ST-510 automatically intercepts the call and re-directs it according to the subscriber's instructions.

In order to program the call forwarding service, the user dials 211* from their radio. A friendly voice prompt will guide the user to enter all required parameters, such as the telephone number or SmarTrunk extension to be called, and how long the current parameters are to remain active (optional).

There are three ways to forward a call:

- To any PSTN number or PABX line extension
- To another radio or group of radios in the network
- To the voice mail service (do not disturb service)

Call Transfer

When a user receives an incoming call from the PBX or PSTN, the user can transfer the call to another radio or group in the network. The external call will remain on hold until the new radio is on line. After the transfer, the first radio will return to standby mode while the second radio receives the call. One new entry in the call records account will be added for each partial call.

Subscriber Toll Restriction

The ST-510 maintains a full profile in memory for each user radio. One of the fields of this profile is used for toll restriction, which can be implemented in one of two ways:

- List the restricted numbers
- List the allowed numbers

In the first case, the system operator may enter a list of restricted numbers or prefixes (up to 100). If the subscriber dials any of the restricted numbers or prefixes, the system will deny access.

In the second case, the system operator enters only the allowed (valid) numbers. All other numbers will be denied access to the system.

Access to the toll restriction parameters is password protected.

Emergency Routines & Dynamic Regrouping

With the addition of the ST-510 Network Switch, and Dispatch Console, the system operator may define a dynamic (virtual) group number for critical emergency situations.

For example, in an airport communications system, it may be necessary to make an emergency call between all the supervisors of different forces (firefighters, police, ambulance, traffic control, etc.). When the emergency begins, the dispatcher will place a call to a virtual number which represents the pre-defined emergency group. The ST-510 will then gather all the defined group members on one free channel in all coverage areas in the network.

In order to do this, the system will automatically terminate any call which may be in progress by the designated users so they will be able to participate in the emergency call. The emergency call will remain on the air until terminated by the dispatcher. In this virtual call, some PSTN or PABX resources may also be included. If desired, the special call may be recorded for security purposes.

Subscriber Usage information

A service provider may allow each subscriber to periodically check certain usage data so that there are no surprises at the end of the billing period. By dialing 311*, the system will dictate, by voice response, all the usage for any radio, including details such as air time used, minutes of local or international calls, and the amount of the subscriber's credit balance.

If this service is active, any subscriber may also program a usage alarm so that when a pre-defined target has been reached (e.g., air time minutes, remaining credit balance, etc.), the system will automatically call the subscriber to report this information.

Critical Messages

For special applications, the ST-510 provides 90 message boxes for the system operator to record important information of interest to users. For example, by dialing 411* plus a message box number, a user could hear the latest highway conditions, weather forecast, financial reports, or upcoming shift schedules. If desired, these messages could be recorded and updated by a commercial sponsor who would compensate the system operator for providing this service. Access to these message boxes may be made through the PSTN, PABX, or radio.

Queued Traffic (Call Manager)

In peak traffic periods, subscribers may often not be able to access a free channel when they attempt to make a call. With the addition of a simplex or semi-duplex radio on an extra channel, the ST-510 will add the attempted call to a queue, so that when a channel becomes available, the user will automatically be called and given access to the free channel. This channel would only handle call requests in the event of all normal system channels being busy; the call manager would never carry voice traffic.

A priority user analyzer module of the ST-510 software will process the queued traffic by priority of the users. In the event of an emergency call arriving in the queue while all channels are busy, the system automatically drops the lowest priority and oldest active call and places the emergency call immediately.

By the use of this feature, the system loading may be increased significantly in accordance with the queued traffic model of Erlang C.

Dispatch Consoles



The dispatch console is a common PC connected directly to an ST-510 or one or more on a network. With this software, the dispatcher can make high-speed calls, monitor calls, receive calls (radio or landline), do dynamic regrouping, call up pre-programmed emergency routines. All this activity can be performed from the screen of the dispatch terminal to the PC's sound card via ethernet. Any type of call may be made from the dispatch console.

The dispatch software offers several security levels and accessibility layers for different dispatchers. For example, one dispatcher may work only with his/her fleet, while the dispatch supervisor may work with any subscriber or group in the network.

If the system requires more than one dispatch console in one site, dispatch server software is available which will support multiple dispatch positions on a network.

The following is an example of the dispatch screen:

Security Recording

Subscribers			Subscribers			Emergency			
1001			Group5000			911		Example Console	
1002			Group5100			Group2000		Operator ID <input type="text" value="1000"/>	
1003								User ID <input type="text"/> REC	
1004	Joe							Voice Menu Messages	
1005	Tony							Incoming Call	
1006								User ID <input type="text"/> Answer	
1007	Fred							Hang Up	
1008				Ext. 443				Status	
1009				Ext. 522	619548996	Dynamic Regrouping		Subscriber's ANI	
1010						Other Numbers		<input type="text"/>	
1011						<input type="text"/> Call		Emergency Call	
1012						<input type="text"/> Call		Radio Kill	
						<input type="text"/> OK			
								Config Admin Exit	

For some security applications it is very important to keep a log of all calls into the system. If this option is desired, an additional package is available which includes extra DSP ports and software. Any call into the network will be recorded and a database will be created with a register of each call, including:

- Date of the call
- Time of the call
- Originating user
- Second user involved
- Call length
- Audio of the call

These records are managed by the ST-REC play back software. This software is a database search engine which has all tools required for filtering and play back of any recorded call. The software runs on any multimedia PC and uses a standard telephone to listen to the recorded calls.

The audio files may be backed up using any data storage media. A special file restore utility is included in the software package to restore archived files into the system in order to listen to a specific call or call sequence.

Voice prompts

When an incoming landline call is received, a voice prompt will answer the call and direct the caller to dial the desired users number. If a user forgets how to use a particular service or feature, he/she may dial 01* which will activate an interactive voice response system to reach the desired service.

Operator services for lost calls

If somebody wishes to call a user but has lost the users number or does not have a DTMF radio or telephone, the call can be automatically transferred to a radio in the network designated as the Operator. The Operator can then be transferred to the called user. Any number in the network, including a PSTN or PABX number or the dispatch console, may be designated as the Operator.

Remote system access

All the services and features of the ST-510 Network Switch can also be accessed from the PSTN or PABX. So for example, if a users radio has a dead battery, he or she may place an incoming call from the PSTN or any PABX extension and program the call forwarding service. The system administrator provides a confidential password for each subscriber to remotely access the system.

Comprehensive billing software package

An optional billing software package is available for the ST-510 which provides a host of different features and billing options such as variable rate schedules, multiple billing time periods, fixed recurring charges, customized formats for invoices and statements and prepaid billing options. Available in both English and Spanish versions, the billing software may be run "on line" for real time accounting of prepaid calling cards, or offline in a conventional "batch" mode.

UPGRADES TO A BASIC SMARTRUNK II SYSTEM

Over the air activation

New network users can be temporarily enabled in the database over the air. This makes it easy to add radios to the network since they can be added to the database at any time but only activated when the users is ready to begin service. A five digit password assigned by the system administrator is required for over the air activation.

Automatic Routing Path

In a normal SmarTrunk II system, the user must dial a routing digit for certain calls, e.g., 1* for a PSTN/PABX call; 3* for mobile-to-mobile, etc.

With the ST-510, routing digits are not required because the system is able to recognize different numbering plans and automatically route each call accordingly.

Sharing PSTN Resources

A stand-alone SmarTrunk II system requires that PSTN/PABX lines be connected directly to specific controllers. This means that only those controllers with lines connected can be used for PSTN/PABX calls.

When using the ST-510 Switch, PSTN/PABX lines are connected to the switch rather than individual controllers, so that PSTN/PABX resources can be shared by any controller in the network. It may also be possible to reduce long distance charges by routing long distance calls to a target city through the network.

Larger Call Records Database

With the ST-510, call records are stored on the hard disk of the main CPU where they can be maintained indefinitely, depending on disk capacity. This eliminates the need to frequently download these records from the individual ST-852/853 controllers.

More users profiles

Because users data is stored on the hard disk of each ST-510 in the network, the number of users profiles is virtually unlimited. The new users profiles are also enhanced because of the many additional parameters for each users.

Larger users Capacity

A normal SmarTrunk II system is limited to 4,096 users per site. With the ST-510, up to 320,000 users can be activated on the network.

Local & remote management

The ST-510 includes a Windows® based management software package which can be run locally on a PC at any site, or remotely. In addition to adding new users, this software can be used to maintain and report high-level technical information such as peak period usage, system usage by channel, system loading by site, grade of service, balance of traffic between channels, etc.

Special routines permit the system administrator to detect potential system problems such as low remaining disk storage area and poor communication efficiency into the switch. This information is essential to allow system administrators to optimize system efficiency.

Late to Join

If a user is busy on another call, and a call of his group (or sub group) originates on another channel, the system will move the "late to join" user to the group call in progress whenever that user completes his other call.

If the user was powered off when the group call started, and powers on the radio while the group call is still on the air, that radio will also be merged automatically to the group call in progress.

Lost Radio Re-Join

If a user that is involved in a group call enters a "shadow" area (area of no radio coverage), the radio of course will miss the call while the user is out of range. Realizing this, the user can easily rejoin the group by calling the group as the radio re-enters radio coverage area.

NETWORK INTERCONNECTION

Networking over E1/T1 link

The Figure below shows a standard method to link multiple ST-510's using a shared or fractional E1/T1 link. At the ST-510, there is only one data connection for the Roaming Bus and in this example, four simultaneous audio ports that may be multiplexed by a digital MUX and inserted into the E1/T1 scheme.

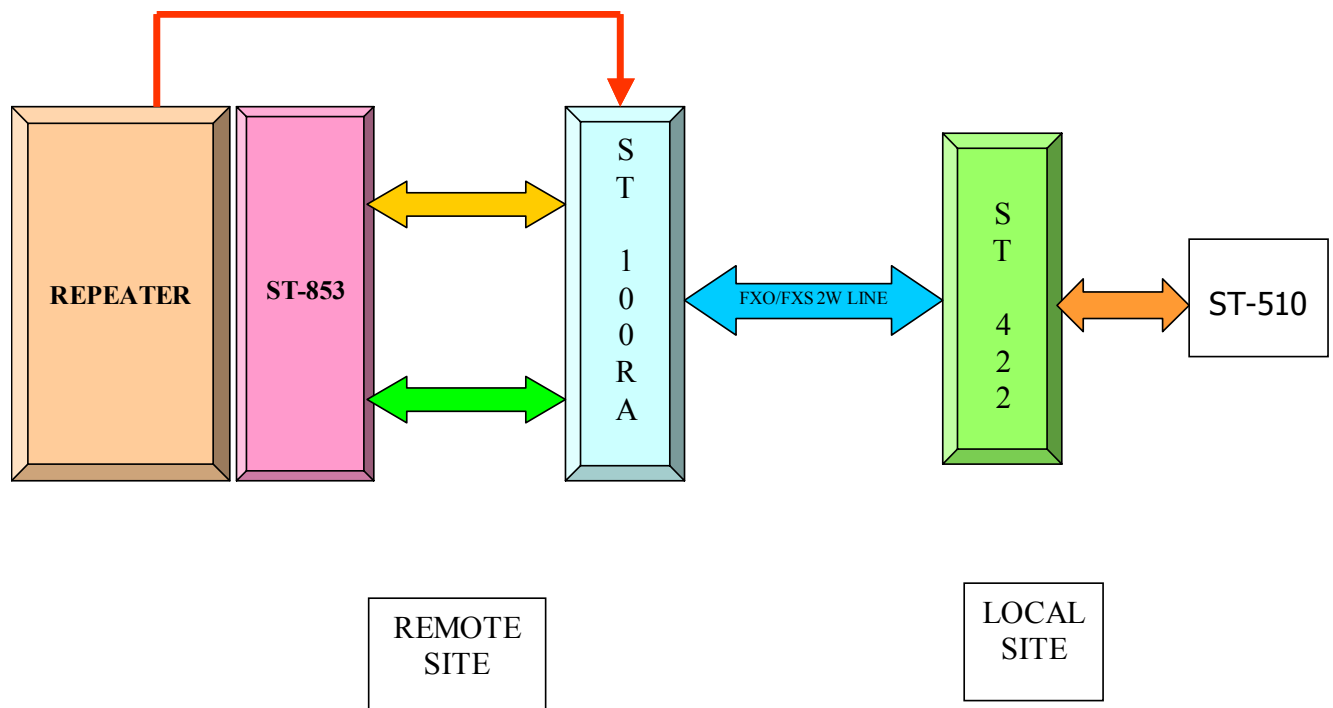
In the system it is necessary to install as many audio ports as the inter site traffic will require but only one data port for each ST-510 to be connected with any node in the network.

LINKING TO REMOTE AREAS

The ST-100N Multiplexer is used to link any remote ST-853 trunking controller/repeater combination and the ST-510 switch. One ST-100N is required per remote channel. The ST-100N converts data and audio to and from the ST-853, to a signal, which can be carried by the equivalent of a 2-wire voice grade audio circuit.

At the ST-510 side, ST-422 Multifunction Interface Cards provide the gateways to the link(s) and therefore the remote ST-100N(s). The ST-100 also has remote site linking capability. Some features of the ST-100 Multiplexer are:

- Simplifies linking requirements.
- ST-853 audio and data transfer can be done over "voice grade" circuits
- Allows many linking options (leased lines, spread spectrum, microwave, T1/E1, RF phone line extenders etc.
- Contains remote site telemetry ports (4 analog, 2 digital in, 2 digital out)
- Analog input range is between 0 and up to 12VDC (adjustable)
- Fast voice/data switching
- Voice over iP capability



OPTIONAL FEATURES

Many of the features and services of the ST-510 Network Switch require optional hardware, software, and/or operating firmware. In most cases, these features are customized to meet the exact requirements of the specific application.

The features below are options that can be added to an ST-510.

- **Call Recording for Security Applications:** This option provides software in the ST-510 which adds the features of a digital recording system to record and store audio passing through the switch. Calls are recorded in a compressed format. All channels into the switch are recorded simultaneously. The storage capacity of the hard disk of the main computer is sufficient to save 711 hours of continuous audio. The oldest calls will be erased when the disk is full, saving the most recent 600 hours of calls. This feature includes the ST-REC software designed to search and play back only the calls that the system operator wishes to hear.
- **ST-500 Dispatch Console:** This optional software may be installed in any PC, directly connected to the ST-510 or several PC's on a network. The system operator or any user can do fast fleet dispatch, look at fleet status on line, enable an emergency call, assign aliases, and many more functions. One ST-510 can support as many consoles as necessary.
- **Emergency routines:** Emergency regrouping routines can be pre-programmed as an overriding control feature for the entire system. When enabled, they will free up channels throughout the network and regroup all subscribers on a unique simul-cast call covering all sites in the network. This feature can be accessed from the dispatch console or a subscriber radio that is properly programmed.
- **Statistic and supervisory remote software:** A complement of the standard management software, this optional package provides system performance information to the system administrator about system loading, traffic balance between channels, time duration of calls, ranking by use, grade of service for network node, and much more.
- **Dynamic Regrouping:** Allows a dispatcher or system administrator to establish and control dynamic virtual groups, which can be rearranged from any console in the system. A dynamic group can be composed of up to 10 different groups or individual subscribers.
- **DID Service:** If analog trunk lines are available, the SmarTrunk Network can offer Direct Inward Dialing, allowing each subscriber radio to be addressed as a common PABX extension.

Frequently Asked Questions

Q. What is SmarTrunk II?

A The SmarTrunk II Digital Trunking System is a reasonably priced, wireless communications system which supports group dispatch, individual selective calling and telephone interconnect applications. It is widely used for applications below 800 MHz, with over 6,000 systems and 500,000 subscribers in over 98 counties worldwide. By relying on low cost, conventional radio equipment and add-on logic boards, SmarTrunk II is able to offer many advanced features typically found in much higher cost systems.

Q. How does SmarTrunk II differ from other trunking formats?

A The most recent FCC interpretation of “trunking” found in the Part 88 rules uses the word “centralized” to describe a trunking system which utilizes a dedicated control channel to provide mobile control. Since the SmarTrunk system does not utilize a dedicated control channel, we have chosen to call SmarTrunk II a “decentralized” or “Scan-Based” system.

Because there is no central controller required, SmarTrunk II is generally much less expensive and easier to license than centralized trunking systems.

Q. What is a “Scan Based” system?

A Unlike centralized systems, scan based systems do not require exclusive RF channels. The channel selection intelligence is located in the mobiles. When a subscriber initiates a call, the mobile unit searches for a clear channel based on the absence of either system CTCSS tone or carrier. When a clear channel is located, the mobile unit places a request for service. After validating the subscriber’s ID, the channel controller completes the connection and provides a talk path for the duration of the call.

Q. How are incoming calls processed?

A When the mobile unit is in an idle condition, the receive audio and the PTT functions are disabled. During this time the mobile is scanning for a system “call collect” tone. When the call collect tone is detected, the mobile stops scanning and listens for its correct digital data pack. When the correct data pack is detected, the receive audio and the PTT function is enabled and normal radio operation begins. All unaddressed radios resume scanning. At the end of the call the repeater disconnects and the mobiles that were communicating resume scanning.

Q. What type of signalling format does the SmarTrunk system use?

A SmarTrunk II is a proprietary BPSK digital signalling format which is not compatible with any other trunking or signalling protocols. Over the air ID's are encrypted to discourage piracy. As such, it is highly immune to "hackers" and unauthorized system users.

Although proprietary, SmarTrunk II is available for a wide range of radio models from ten different radio manufacturers. Therefore, unlike some other trunking formats, you are not "locked in" to a single source for radio infrastructure or subscriber equipment.

Q. What is the average connect time for SmarTrunk calls?

A The initial connect time is typically one to two seconds, depending on the type of call requested, the number of channels in the system, and the channel availability at the time of request. **Once a channel is acquired, it is held for the duration of the conversation; therefore, subsequent PTT's are instantaneous.**

Q. What base station equipment is required for a SmarTrunk system?

A A typical SmarTrunk channel would consist of the following items:

- One SmarTrunk Model ST-853 Station Controller per repeater.
- Any VHF or UHF radio repeater per channel - Alinco, Icom, Kenwood, Kyodo, Motorola, Standard, Tait, Yaesu/Vertex or other suitable station repeater.
- Antenna system - duplexer or combiner depending on the number of SmarTrunk channels. Coaxial cable and connectors as required.
- A power supply for the radio repeaters and the SmarTrunk controllers.

Each controller in the SmarTrunk system is capable of providing all system services. There is one SmarTrunk ST-853 controller required for each repeater in the system, up to a maximum of 16 channels per system.

Q. What modem do you recommend I use for my SmarTrunk system?

A An external modem is required to remotely program the ST-853 controllers via a phone line. We recommend either our ST-913 External Modem (which is a complete kit of all items required). SmarTrunk does not support all makes and models of modems. Please call the SmarTrunk factory if you have any questions.

Q. What mobile and portable radios are available for SmarTrunk operation?

A SmarTrunk supports over 50 makes and models of portable and mobile radios from ten different manufacturers. See Appendix A for a complete listing of radios supported by SmarTrunk II.

Q. What equipment is required to program the SmarTrunk II controllers and logic boards?

A The ST-853 SmarTrunk II controller is programmed with a PC compatible computer, using a DOS program available from SmarTrunk. (Mobile radio logic boards are programmed from the radio keypad or, in some cases, from a PC in conjunction with the radio programming software).

Q. Is any additional equipment required to support telephone interconnect?

A No. All ST-853 controllers come fully equipped with telephone interconnect capability. Each controller has two standard RJ-11 telephone jacks which accept normal two wire, loop start lines from a PBX or the PSTN.

Q. Do all SmarTrunk II subscriber radios require a DTMF keypad?

A No. Group dispatch calls are placed simply by pressing PTT (Push To Talk). Subscribers who place or receive only group dispatch calls do not need a keypad. Only those users placing telephone calls or private calls to other users require a radio equipped with a keypad.

Q. Is it possible to connect a mobile radio to a standard telephone instrument or a fax machine?

A Yes. A subscriber radio may be connected to a fax machine, a standard telephone instrument and even a computer modem if it is equipped with the ST-869 Radio/Telephone Interface Module. The ST-869 includes both the SmarTrunk II logic board and telephone interface circuitry providing talk battery, ring voltage and an RJ-11 phone jack. (A full-duplex subscriber radio is required when supporting modem applications.)

Q. Can the SmarTrunk system operate in a co-channel environment?

A Yes. In fact, this is one of the key advantages of the SmarTrunk II protocol. Due to the de-centralized system control concept, the system utilizes a distributed control method which is available on any channel in the system. This eliminates the need for a dedicated control channel to manage the system. The mobile radios perform the required “channel monitor prior to transmit” responsibility which is performed automatically by the SmarTrunk logic boards. The SmarTrunk channel monitor function may be programmed in the radio to detect either Carrier or CTCSS Tone as the channel busy status.

Q. How many users per channel can the SmarTrunk system accommodate?

A There are many factors which determine the practical number of users per channel in any trunking system, including: 1) The type of operation on the system, i.e., dispatch, mobile to mobile, mobile telephone; 2) The level of service desired; and 3) The number of channels in the system. For example, based on our Traffic Analysis Study and input from our system operators, the following loading figures may apply for a typical five channel system:

System:	Five SmarTrunk II channels.
Grade of Service:	10% (One in ten call attempts will receive a busy)
Approximate number of radios per channel:	
Operation:	100% mobile telephone = 25 to 40
Operation:	50% mobile telephone, 50% dispatch = 50 to 75
Operation:	100% dispatch = 100

Q. Who provides product warranty for SmarTrunk equipment?

A SmarTrunk products are warranted by SmarTrunk Systems, Inc., against defects in materials and workmanship for a period of two years from the date of shipment. This warranty policy is honored by the SmarTrunk factory. Radios and other system equipment are warranted by the respective manufacturers.

Q. Is SmarTrunk factory training available?

A Yes, we schedule factory technical training seminars at various times. Contact our sales department for specific information, or refer to our Internet Web Page for the current seminar schedule (www.smartrunk.com).

Appendices

Appendix A..... SmarTrunk II Logic Board Compatibility Chart

Appendix B SmarTrunk System Application Notes (SANS)

Appendix C SmarTrunk vs. LTR

Appendix D Simplified Customer Numbering Plan

Appendix E ST-510 Wide Area Network Switch

Appendix A - The SmarTrunk II Logic Board Collection

The **SmarTrunk II** digital trunking system is compatible with a wide variety of two-way radios made by the industry's leading manufacturers. The following table lists the model numbers of each of the radios compatible with **SmarTrunk II**. Also described are key features which apply to each radio in addition to the model number of the **SmarTrunk II** logic board required for operation.

Column Heading Descriptions

Compatible Radio Model No.: The manufacturer and model number of the radio described.

FCC: Indicates which radios have been FCC type accepted for sale in the United States.

* **Frequency Band (MHz):** The approximate frequency range of available configurations.

Radio Duplex: Indicates whether the radio is capable of half duplex or full duplex operation.

* **Number of Channels:** The maximum number of channels available for SmarTrunk operation.

* *Note: Contact the radio manufacturer for specific details.*

Feature Set:

.. **Basic** - The original **SmarTrunk II** feature set which includes automatic channel acquisition, PTT dispatch, and call privacy. Radios with keypads also support selective calling and telephone interconnect. Refer to a **SmarTrunk II** brochure for complete details.

.. **Basic / Banks** - Includes the "Basic" feature set listed above. In addition, users may select different banks of RF frequencies, allowing the radio to be used in different **SmarTrunk II** systems (i.e. supports multi-system applications). The number of different RF banks which may be selected is also shown.

.. **Omni / Banks** - Includes the "Basic / Banks" feature set listed above in addition to the Omni™ feature set, offering multiple PTT groups, multiple receive groups, SmartScan, and more. The number of different RF banks which may be selected is also shown. Refer to the "Omni Feature Set New Product Bulletin" for further information.

.. **Enhanced Omni / Banks** - Includes the "Omni / Banks" feature set listed above. Other features include PC programming software, enhanced flexibility for multi-system applications, and selective/interconnect calling for radios without keypads.

Conventional Operation:

.. **None** - Conventional operation is not supported.

.. **Limited** - Conventional operation is possible using the trunked channels of the **SmarTrunk II** system only.

.. **Flexible Operation** - Users may select different conventional channels outside of the **SmarTrunk II** system.

Install Ease:

A rating of how easy it is to install the **SmarTrunk II** logic board in the radio. An estimate of the time required for an experienced technician to perform the installation is also listed.

¶ **Simple plug-in.** Estimated installation time: 3-5 minutes.

· **Partial plug-in.** Estimated installation time: 5-10 minutes.

⤴ **Full solder.** Estimated installation time: 10-30 minutes.

1 **Full solder with modifications.** Estimated installation time: 20-45 minutes.

o **Full solder with modifications and additional parts required.** Estimated installation time: 30-60 minutes.

SmarTrunk Model No.:

The model number of the **SmarTrunk II** logic board compatible with the radio described.

PORTABLE RADIOS

Compatible Radio Model No.	FCC	Frequency Band (MHz)	Radio Duplex	No.Of Chan.	Feature Set	Conven. Oper.	Install Ease	SmarTrunk Model No.
Alinco DJ-195	No	136-174 400-470	Half	32	Basic/ 2 Banks	Flexible	1	EJ-38D ⁴
Alinco DJ-196	No	136-174 400-470	Half	40	Omni/2 Banks	Flexible	1	EJ-39D ⁴
Alinco DJ-680 (Cross Band)	No	Tx 150-174 Rx 450-470	Full	40	Basic / 4 Banks	Flexible	1	ST-865AL3
Icom IC-F3/S	Yes Yes	136-150 146-174	Half	32	Enhanced Omni 2 Banks	Flexible	1	ST-865IC (Icom p/n UT-105)
Icom IC-F4/S	Yes Yes Yes	400-430 440-470 470-50	Half	32	Enhanced Omni 2 Banks	Flexible	1	ST-865IC (Icom p/n UT-105)
Icom F3GT	Yes ¹ Yes ¹	136-150 146-174	Half	40	Enhanced Omni 2 or 5 Banks ²	Flexible	1	ST-865IC (Icom p/n UT-105)
Icom F3GS	Yes ¹ Yes ¹	136-150 146-174	Half	40	Enhanced Omni 2 or 5 Banks ²	Flexible	1	ST-865IC (Icom p/n UT-105)
Icom IC-F4GT	Yes ¹ Yes ¹ Yes ¹ Yes ¹	400-430 440-470 470-500 490-512	Half	40	Enhanced Omni 2 or 5 Banks ²	Flexible	1	ST-865IC (Icom p/n UT-105)
Icom IC-F4GS	Yes ¹ Yes ¹ Yes ¹ Yes ¹	400-430 440-470 470-500 490-512	Half	40	Enhanced Omni 2 or 5 Banks ²	Flexible	1	ST-865IC (Icom p/n UT-105)
Icom IC-F30/LT	No Yes	136-150 146-174	Half	96	Enhanced Omni 6 Banks	Flexible	1	ST-865IC (Icom p/n UT-105)
Icom IC-F40/LT	No Yes	400-430 440-470	Half	96	Enhanced Omni 6 Banks	Flexible	1	ST-865IC (Icom p/n UT-105)
Kenwood TK-270/278	Yes	136-150 150-174	Half	16	Basic	Flexible	3	ST-865KW2
Kenwood TK-370/378	Yes	403-430 450-470	Half	16	Basic	Flexible	3	ST-865KW2
Kenwood TK-260G	Yes	136-150 150-174	Half	128	Enhanced Omni 8 Banks	Flexible	1	ST-865KW4
Kenwood TK-270G/ 278G	Yes	136-150 150-174	Half	128	Enhanced Omni 16 Banks	Flexible	1	ST-865KW4
Kenwood TK-360G	Yes	403-430 450-512	Half	128	Enhanced Omni 8 Banks	Flexible	1	ST-865KW4
Kenwood TK-370G	Yes	403-430 450-470 470-490 490-512	Half	128	Enhanced Omni 16 Banks	Flexible	1	ST-865KW4
Kenwood TK-378G	No	400-420 450-470	Half	128	Enhanced Omni 16 Banks	Flexible	1	ST-865KW4

See notes next page. Specifications and descriptions are based on the information available at the time of publication and are subject to change without notice. Radio specifications should be verified with the radio dealer or manufacturer at the time of purchase.

Appendix A • SmarTrunk II Logic Board Collection

PORTABLE RADIOS (continued)								
Compatible Radio Model No.	FCC	Frequency Band (MHz)	Radio Duplex	No.Of Chan.	Feature Set	Conven. Oper.	Install Ease	SmarTrunk Model No.
Motorola GP-68	No	150-174 403-520	Half	16	Basic	Flexible	1	ST-865M3
Motorola P1225	Yes	150-174 450-470	Half	64	Enhanced Omni 16 Banks	Flexible	1	ST-865M4
Motorola GP-300	Yes	136-174 403-520	Half	16	Basic / 8 Banks	Flexible	5	ST-865M
Motorola GP-350	Yes	146-174 438-470	Half	16	Basic / 8 Banks	Flexible	5	ST-865M
Motorola Pro3150/ CT250/CT450/P040/ P080/GP308/GP88S	Yes	136-174 400-520	Half	64	Enhanced Omni 16 Banks	Flexible	1	ST-865M6
Motorola Pro5150/7150 HT750/1250/GP140/ GP328/338	Yes	136-174 400-520	Half	64	Enhanced Omni 16 Banks	Flexible	1	ST-865M5
Standard HX-240/242/260	Yes (HX-240)	138-174 330-470	Half	16	Basic	Limited	2	ST-865S2
Standard HX-270	No	138-174 330-470	Half	32	Basic	Flexible	3	ST-865S3
Standard HX-290	No	138-174 330-470	Half	100	Omni / 1 Bank	Flexible	1	ST-865S4
Yaesu/Vertex VX-10	Yes	134-174 400-512	Half	102	Omni / 9 Banks	Flexible	1	VTP-40 ⁴
Yaesu/Vertex VX-210	Yes	134-174 400-512	Half	32	Enhanced Omni/2 banks	Flexible	1	VTP-50 ⁴
Yaesu/Vertex VX-400	Yes	134-174 400-512	Half	32	Enhanced Omni/2 banks	Flexible	1	VTP-50 ⁴
Yaesu/Vertex VX-500	Yes	134-174 410-512	Half	32	Basic / 2 Banks	Flexible	3	VTP-20 ⁴
Yaesu/Vertex VX-800	Yes	134-174 400-512	Half	32	Enhanced Omni/2 banks	Flexible	1	VTP-50 ⁴

Notes:

¹ FCC for IC-F3GT/F3GS/F4GT/F4GS is available only for narrow band.

² 2 banks of 16 channels each or 5 banks of 8 channels each.

³ 160 or 256 channels requires Option board (EX-1764).

⁴ OEM Logic Boards available only through radio manufacturers.

Specifications and descriptions are based on the information available at the time of publication and are subject to change without notice. Radio specifications should be verified with the radio dealer or manufacturer at the time of purchase.

MOBILE RADIOS

Compatible Radio Model No.	FCC	Frequency Band (MHz)	Radio Duplex	No.Of Chan.	Feature Set	Conven. Oper.	Install Ease	SmarTrunk Model No.
Alinco DR-130	No	136-174	Half	16	Basic	Limited	3	ST-868-02
Alinco DR-135	No	136-174 400-470	Half	100	Omni/5 ⁴ Banks	Flexible	1	EJ-39D ¹
Alinco DR-430	No	400-470	Half	16	Basic	Limited	3	ST-868-02
Alinco DR-605 (Cross Band)	No	138-174 420-470	Full	16	Basic	Limited	1	ST-868-07
Icom IC-F310	No No	136-155 146-174	Half	32	Enhanced Omni 2 Banks	Flexible	1	ST-865IC (Icom p/n UT-105)
Icom IC-F310S	No No	136-155 146-174	Half	8	Enhanced Omni 2 Banks	Flexible	1	ST-865IC (Icom p/n UT-105)
Icom IC-F320	Yes Yes	136-155 146-174	Half	32	Enhanced Omni 2 Banks	Flexible	1	ST-865IC (Icom p/n UT-105)
Icom IC-F320S	Yes Yes	136-155 146-174	Half	8	Enhanced Omni 2 Banks	Flexible	1	ST-865IC (Icom p/n UT-105)
Icom IC-F410	No No No No	400-430 440-470 470-490 490-520	Half	32	Enhanced Omni 2 Banks	Flexible	1	ST-865IC (Icom p/n UT-105)
Icom IC-F410S	No No	400-430 440-470	Half	8	Enhanced Omni 2 or 10 ³ Banks	Flexible	1	ST-865IC (Icom p/n UT-105)
Icom IC-F420	Yes Yes Yes Yes Yes	400-430 440-470 450-470 470-490 490-512	Half	32	Enhanced Omni 2 Banks	Flexible	1	ST-865IC (Icom p/n UT-105)
Icom IC-F420S	Yes Yes Yes	440-470 470-490 490-512	Half	8	Enhanced Omni 2 Banks	Flexible	1	ST-865IC (Icom p/n UT-105)
Icom IC-F1010/1020	Yes	146-174	Half	32 or 160 ³	Enhanced Omni 2 or 10 ³ Banks	Flexible	1	ST-865IC (Icom p/n UT-105)
Icom IC-F2010/2020	No No Yes	400-430 440-490 450-470	Half	32 or 160 ³	Enhanced Omni 2 or 10 ³ Banks	Flexible	1	ST-865IC (Icom p/n UT-105)
Icom IC-F1610	No No	136-155 146-174	Half	128 or 256 ³	Enhanced Omni up to 8 or 16 ³ Banks	Flexible	1	ST-865IC (Icom p/n UT-105)
Icom IC-F2610	No No	400-430 440-490	Half	128 or 256 ³	Enhanced Omni up to 8 or 16 ³ Banks	Flexible	1	ST-865IC (Icom p/n UT-105)
Kenwood TK-760/768	Yes	136-156 148-174	Half	16	Basic	Flexible	3	ST-865KW2 with ST-908
Kenwood TK-860/868	Yes	406-430 450-476 470-496 488-512	Half	16	Basic	Flexible	3	ST-865KW2 with ST-908
Kenwood TK-760G/ 768G	Yes	136-162 148-174	Half	128	Enhanced Omni 16 Banks	Flexible	1	ST-865KW4 with ST-909

See notes next page. Specifications and descriptions are based on the information available at the time of publication and are subject to change without notice. Radio specifications should be verified with the radio dealer or manufacturer at the time of purchase.

MOBILE RADIOS (Continued)								
Compatible Radio Model No.	FCC	Frequency Band (MHz)	Radio Duplex	No.Of Chan.	Feature Set	Conven. Oper.	Install Ease	SmarTrunk Model No.
Kenwood TK-762G	Yes	136-162 148-174	Half	128	Enhanced Omni 8 Banks	Flexible	1	ST-865KW4 with ST-909
Kenwood TK-860G	Yes	400-430 450-490 485-512	Half	128	Enhanced Omni 16 Banks	Flexible	1	ST-865KW4 with ST-909
Kenwood TK-862G	Yes	400-430 450-490 485-512	Half	128	Enhanced Omni 8 Banks	Flexible	1	ST-865KW4 with ST-909
Kenwood TK-868G	No	400-430 450-490	Half	128	Enhanced Omni 16 Banks	Flexible	1	ST-865KW4 with ST-909
Motorola SM-50	Yes	150-170 450-470	Half	2	Basic	Flexible	1	ST-868M50
Motorola SM-120	Yes	150-170 450-470	Half	16	Basic	Flexible	1	ST-868M50
Motorola M-216	Yes	136-174 403-520	Half	16	Basic	Limited	3	ST-868-05
Motorola GM-300	Yes	136-174 403-520	Half	16	Basic	Limited	3	ST-868-05
Motorola GM-350	No	136-174 403-470	Half	16	Basic	Limited	1	ST-868M350
Motorola M1225	Yes	150-174 450-474	Half	64	Enhanced Omni 16 Banks	Flexible	1	ST-865M4
Motorola Pro3100/ 5100/7100/CDM750/ 1250/1550/GM338	Yes	136-174 400-520	Half	64	Enhanced Omni 16 Banks	Flexible	1	ST-865M5 ²
Ranger SM-1630-US	Yes	406-512	Full	16	Basic	Limited	3	ST-868-04
Ranger SM-1645-HS	Yes	136-174	Full	16	Basic	Limited	3	ST-868-04
Standard GX-1608	No	138-170 400-470	Half	16	Basic	Flexible	1	ST-868SM
Supercom SC-1468	No	30-512	Full	16	Basic	Limited	3	ST-868-04
Tait T-2000 Series	Yes	66-470	Half	100	Basic	Limited	5	ST-868-05
Telemobile TM-MDT25	Yes	66-520	Full	32	Basic	Limited	3	ST-868-04
Yaesu/Vertex FTL-2011	Yes	135-174	Half	24	Basic	Limited	3	ST-868-01
Yaesu/Vertex FTL-7011	Yes	400-430 450-512	Half	24	Basic	Limited	3	ST-868-01

Notes:

¹ OEM Logic Boards available only through radio manufacturers.

² Under development. Contact factory for availability.

³ 160 or 256 channels requires Option board (EX-1764).

⁴ 5 banks of 16 channels each plus 20 conventional channels.

Specifications and descriptions are based on the information available at the time of publication and are subject to change without notice. Radio specifications should be verified with the radio dealer or manufacturer at the time of purchase.

System Overview

The ST-869 Radio/Telephone interface allows a standard telephone, fax machine, or modem to be used within a **SmarTrunk II** system. Telephone instruments are connected to the ST-869 through an RJ-11 interface. The Voice Operated Transmission (VOX) circuitry of the ST-869 supports telephone and fax machine operation using a half duplex radio. Full duplex configurations are required for modem operation. Conventional operation, channel banks, and the Omni feature set are not supported by the ST-869.

RADIOS COMPATIBLE WITH THE ST-869 RADIO/TELEPHONE INTERFACE						
Compatible Radio Model No.	FCC	Frequency Band (MHz)	Radio Duplex	No.Of Chan.	Install Ease	SmarTrunk Model No.
Alinco DR-108	No	136-174	Half	16	3	ST-869-02
Alinco DR-130	No	136-174	Half	16	3	ST-869-02
Alinco DR-430	No	400-470	Half	16	3	ST-869-02
Alinco DR-605 (Cross Band)	No	138-174 420-470	Full	16	3	ST-869-07
Motorola GM-300	Yes	136-174 403-520	Half Full*	16	3	ST-869-05
Motorola GM-350 (Requires application note #1009)	Yes	136-174 403-520	Half Full*	16	3	ST-869-05
Motorola M-216	Yes	136-174 403-520	Half	16	3	ST-869-05
Ranger SM-1645-HS	Yes	136-174	Full	16	3	ST-869-04
Seiki 9200 Series	No	VHF, UHF	Full	16	3	ST-869-04
Supercom SC-1468	No	30-88 136-174 215-245 300-512	Full	16	3	ST-869-04
Telemobile TM-MDT25	Yes	66-88 136-520	Full	32	3	ST-869-04
Yaesu/Vertex FTL-2011	Yes	135-174	Half	24	3	ST-869-01
Yaesu/Vertex FTL-7011	Yes	400-430 450-512	Half	24	3	ST-869-01

*Requires two radios, one used for continuous transmit and the other for continuous receive. Contact **SmarTrunk Systems, Inc.** to request System Application Note #1009 which explains this full duplex application.

Specifications and descriptions are based on the information available at the time of publication and are subject to change without notice. Radio specifications should be verified with the radio dealer or manufacturer at the time of purchase.

Appendix B - SmarTrunk System Application Notes

As part of our on going effort to respond to the individual needs of our customers, SmarTrunk Systems has developed System Application Notes (SAN's) to support specialized system configurations. SAN's may be obtained from the SmarTrunk sales department, your SmarTrunk Master Distributor or from our Internet website at www.smartrunk.com.

Cross-Connecting a SmarTrunk II Controller with a Conventional Tone Panel

SAN's #1002 and 1007 explain how to install a SmarTrunk controller in parallel with a CTCSS repeater panel. This configuration allows both conventional radios and SmarTrunk II radios to share the same repeater and is ideal for migration purposes or for mixed systems. Request SAN #1002 for the ST-852 controller or SAN #1007 for the ST-853 controller.

When the SmarTrunk II controller and tone panel are cross-connected, conventional users are blocked from the repeater when a SmarTrunk II conversation is taking place. When a conventional conversation is taking place, the SmarTrunk II users are blocked from that repeater and will automatically scan to the next repeater when making a call. Please note that this application requires ST-852 version 3.51 firmware or the ST-853.

Adding a CTCSS Decoder to a SmarTrunk II Controller

Also available is information about the ST-910 CTCSS Option Kit, which is used to support tone squelch operation during a standard SmarTrunk II conversation. This option is useful in systems susceptible to co-channel noise.

Normally, once a SmarTrunk II call has been initiated by a valid user, the ST-853 controller switches the repeater to open carrier squelch operator. This means the repeater will re-transmit any signal it receives throughout the SmarTrunk II conversation. By installing the ST-910 CTCSS Option kit, the repeater will only re-transmit the signal if it has the correct CTCSS tone, which can be programmed in the SmarTrunk II subscriber radios.

The ST-910 CTCSS Option kit, which includes a tone board, can be ordered through SmarTrunk distribution. In lieu of ordering the ST-910 kit addition, System Application Note #1001 may be used to install a generic CTCSS tone board to support this same option. Please note that the CTCSS option relies on the CTCSS features of the subscriber radio. Since not all SmarTrunk II compatible radios support this feature, please refer to the installation documents for more information.

Traffic Analysis for SmarTrunk II Systems

SAN #1006 presents charts, theory and analysis to help SmarTrunk II system operators analyze the trade-offs between the number of users, the number of channels and the percent of time a user will receive a busy signal. Examples are provided to aid in understanding how to use the charts. Also provided is a brief summary of the telephone traffic theory (queuing theory) used to develop the charts.

Appendix C - SmarTrunk vs. LTR

Because of its system security, flexibility, and low cost, the SmarTrunk II Digital Trunking System has become the world leader for trunked radio applications at VHF and UHF frequencies. But in the Americas, customers often ask how SmarTrunk II compares with LTR® (Logic Trunked Radio), which has been popular for use at 800 MHz for many years. This section presents a comparison of the two systems, with an overview of the advantages and disadvantages of each format.

A Difference in Channel Management

Perhaps the largest difference between LTR and SmarTrunk II is the way that the radios are assigned a channel when a call is initiated. In an LTR system, each mobile is managed by a home channel which sends a continuous, sub audible signal during all conversations. When a user initiates a call, the radio selects a channel based upon the information it receives from its home channel controller.

Each time the PTT switch is pressed, the system must acquire a new channel. And if all channels should become busy in the middle of a conversation, the users are forced to wait until a channel becomes available. This mode of operation is referred to as “transmission trunking”.

In contrast, SmarTrunk II uses a mobile scan based protocol where the mobiles, not the controller, select which channel to use. When a SmarTrunk II user initiates a call, the radio scans for an available channel and sends a digital datapack to the controller. The controller then sends a datapack to all of the mobiles in the system and the appropriate mobiles respond by answering the call. At that point, the conversation takes place on the same channel until a programmable hang timer expires or one of the users sends a disconnect signal.

Although the initial channel access time is slightly longer, once a channel is acquired, it is held for the duration of the conversation. This means that subsequent PTT's are instantaneous for the balance of the exchange. This is known as “message” or “conversation” trunking.

Operating in a Crowded VHF and UHF Environment

In an LTR system, the subscriber radio must receive instructions from its home channel before it can initiate a call. As a result, any home channels must be assigned to clear channels. Otherwise, whenever a co-channel user is on the air, all radios assigned to that home channel will be unable to receive instructions and, consequently, unable to initiate or receive calls of any kind.

Since the VHF and UHF spectrum is heavily populated in many countries, obtaining a clear channel may not be an option. With SmarTrunk II, all of the channels in the system may be shared with co-channel users since all the mobiles in the system automatically monitor for a foreign carrier before selecting a channel. As a result, SmarTrunk II is much better equipped to operate in a crowded RF environment than LTR.

System Security Considerations

One of the primary concerns of system operators is maintaining system security against hackers, pirates, and other unauthorized users. LTR relies on a sub-audible data stream that is easily monitored and duplicated. Many radio service monitors have the ability to read LTR codes over the air, so that an unscrupulous dealer can easily determine valid LTR codes. Once the LTR codes are determined, unauthorized radios can be easily programmed and loaded on a system without the knowledge or consent of the system operator.

By comparison, SmarTrunk II employs a highly encrypted, in-band proprietary digital data burst which is immune to hackers and pirates. As a “closed” system which can be accessed only by authorized users, SmarTrunk II provides the system operator very high security against non-paying customers and other unauthorized users. And if a radio should ever become lost or stolen, it can be remotely disabled without affecting the rest of the group or fleet.

Selective Calling

One of the key features of the SmarTrunk II system is the ability to make private calls to another mobile user. Unlike many LTR systems, all SmarTrunk II users are identified with an individual subscriber number as well as a group subscriber number. When using a radio with a DTMF keypad, a SmarTrunk II user can selectively call other users in his group or fleet by entering the mobile's subscriber number followed by a routing code, very similar to dialing a cellular phone.

Telephone Interconnect

The ability to make telephone interconnect calls is also a standard feature of SmarTrunk II. Each radio equipped with a DTMF keypad (and even some radios without keypads) can be used as a mobile telephone. Like private calls, the dialing procedure is very similar to using a cellular phone. And the telephone interconnect circuitry is built-in to every SmarTrunk II controller at no extra cost.

On the other hand, many LTR controllers are designed only for basic dispatch operation, so that telephone interconnect is an expensive option. On the mobile side, each subscriber who is authorized to make telephone interconnect calls must have an extra ID code assigned, which again squanders the limited ID codes available in the LTR scheme.

Converting Conventional Systems

*All 800 MHz trunking systems, including LTR, were designed for new systems on clear (exclusive) channels, using dedicated mobile and portable radio equipment. Below 800 MHz, however, the environment in most countries is quite different. VHF and UHF channels are already crowded with conventional users, and there may be two or more repeaters in the same service area operating on the same frequency. This means that in order to establish a trunked radio system at these frequencies, it is necessary to **gradually** convert existing community repeater systems from conventional to trunked operation.*

SmarTrunk II has two advantages in this environment. First, SmarTrunk II is more tolerant of conventional and co-channel users than LTR, as discussed above. Secondly, SmarTrunk II is an “overlay” system, which means that existing repeaters and most popular conventional radios can be converted to SmarTrunk II on a retrofit basis (see Appendix A).

By contrast, the LTR system uses dedicated LTR radios, so the system operator is forced to scrap his existing conventional equipment and make a substantial new investment in radios.

Which System Is Best for You?

Both SmarTrunk II and LTR have their advantages and disadvantages. The choice of system depends largely on the features and type of service to be offered and the availability of clear (exclusive) channels.

***In general,** LTR may be preferable for a new shared system offering dispatch-only service on exclusive channels with no conventional users. On the other hand, SmarTrunk II may be preferable for systems offering a mix of private calling, group calling, and telephone interconnect service on non-exclusive channels. In this respect, SmarTrunk II is ideally suited for private “campus” systems which are typically interconnected to an office PABX; for shared public systems in rural areas that can legally offer telephone interconnect service; for systems with extensive private calling requirements; and for existing conventional systems that are being gradually converted to trunked operation.*

SmarTrunk II vs. LTR Comparison Table

The following table summarizes some of the major similarities and differences between SmarTrunk II and LTR.

Feature/Specification	SmarTrunk II	LTR
Type of voice modulation	Analog	Analog
Subscriber equipment	Conventional two way radios equipped with add-on logic boards	Specialized LTR subscriber radios
Type of signalling	Digital BPSK audible databurst at call setup	Continuous sub audible digital signalling
Method of trunking management	Mobile scan based	Home channel controlled
Channel acquisition	Call takes place on one ch. after initial setup	Radios acquire a new ch after each PTT
Initial call set-up time	Approx. 1- 3 seconds	Approx. 300 milliseconds
Subsequent PTT access time during the same call	Instantaneous	Approx. 300 milliseconds
Home group dispatch	Push to talk (PTT) access	Push to talk (PTT) access
Individual selective calling	Yes	Limited - each call must be pre-programmed
Telephone interconnect	Yes	Optional
Secure against system pirates or unauthorized use	Yes	No
Co-channel tolerant	Yes	Limited - home channels must be assigned to clear channels
Can operate in parallel with a conventional tone panel	Yes	Limited - home channels cannot support parallel tone panel operation
Group inhibit	Yes	Yes
Selective calling inhibit	Yes	Limited - must be pre-programmed
Call record accumulation	Yes	Yes
Number of different subscriber IDs per system	Up to 4,096	Up to 250 per home channel
Remotely Disable Individual Radios	Yes	No-Groups only

SMARTRUNK NETWORK DIAGRAM

