US000001802H

United States Statutory Invention Registration [19]

[11] Reg. Number: H1,802

[45] Published: Sep. 7, 1999

Erwin et al.

[54] **SYSTEM AND METHOD FOR AUTOMATICALLY PROVISIONING A TELECOMMUNICATIONS SWITCH**

[75] Inventors: **Jenny W. Erwin**; **Yoogin Lean**, both of Collierville; **Dexiang J. Xu**, Cordova, all of Tenn.

[73] Assignee: **DSC/Celcore, Inc.**, Plano, Tex.

[21] Appl. No.: **09/026,479**

[22] Filed: **Feb. 19, 1998**

Related U.S. Application Data

[60] Provisional application No. 60/060,107, Sep. 26, 1997.

[51] **Int. Cl.**[6] **H04M 3/00**

[52] **U.S. Cl.** **379/243**

[56] **References Cited**

U.S. PATENT DOCUMENTS

5,487,101	1/1996	Fletcher	379/60
5,521,961	5/1996	Fletcher et al.	379/59
5,623,532	4/1997	Houde et al.	379/58
5,627,881	5/1997	Fletcher	379/60

OTHER PUBLICATIONS

Steve Chen, "*Hybrid MicroSystems: The Ultimate Flexibility in Cellular Applications*", 1996, pp. 1–16, Celcore, Inc., Memphis, Tennessee.

"*GlobalHub Mobility Manager –Enables "One Number" PCS Service Via Motorola PPS Residential Products*" pp. 1–2, Celcore, Inc., Memphis, Tennessee, 1996.

"*IS –41 Network Hub –The Mobility Manager for Celcore's GlobalSystem*" pp. 1–2, Celcore, Inc., Memphis, Tennessee, 1996.

"*GlobalHub*" pp. 1–10, Celcore, Inc., Memphis, Tennessee, 1996.

John Scourias, "*Overview of the Global System for Mobile Communications*", Mar. 27, 1996, pp. 1–16, John Scourias.

Martin A. Iroff & Steve Chen, "A distributed GSM Architecture for Low–Traffic Density Markets ", *Mobile Communications International*, Oct. 1996, pp. 1–3, IBC Business Publishing, London, England.

Information pamphlet, Feb. 1997, pp. 1–7, Version 1.0, Celcore, Inc., Memphis, Tennessee.

"*BS–20/BS–21, D900/D1800 Base Transceiver Station*", pp. 1–2, Geschaftszweig Mobilfunknetze, Munchen, Germany, 1997.

"*Unique Solutions to Complex Challenges of Wireless Carriers*" pp. 1–9, Celcore, Inc., Memphis, Tennessee, 1997.

Michel Mouly and Marie–Bernadette Pautet "*The GSM System for Mobile Communications*", 1992, pp. 79–122, pp. 261–646, Cell & Sys, France.

Lawrence Harte, Stever Prokup, and Richard Levine "*Cellular and PCS, The Big Picture*", 1997, pp. 61–181, McGraw–Hill, United States of America.

George Lamb "*GSM made SIMple*", 1997, pp. 3–158, Regal Printing, United States of America.

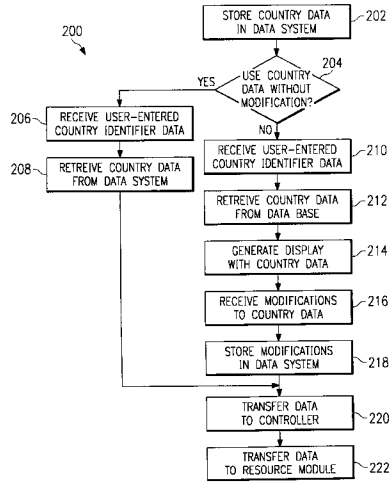
Primary Examiner—Daniel T. Pihulic

Attorney, Agent, or Firm—John G. Flaim

[57] **ABSTRACT**

A system for providing country-specific data for a telecommunications system is provided. The system includes a data storage system and a user interface. A controller is connected to the data storage system and the user interface, and is configured to retrieve country data from the data storage system in response to a country identifier received from the user interface, and to store the country-specific data in one or more predetermined memory locations.

26 Claims, 5 Drawing Sheets



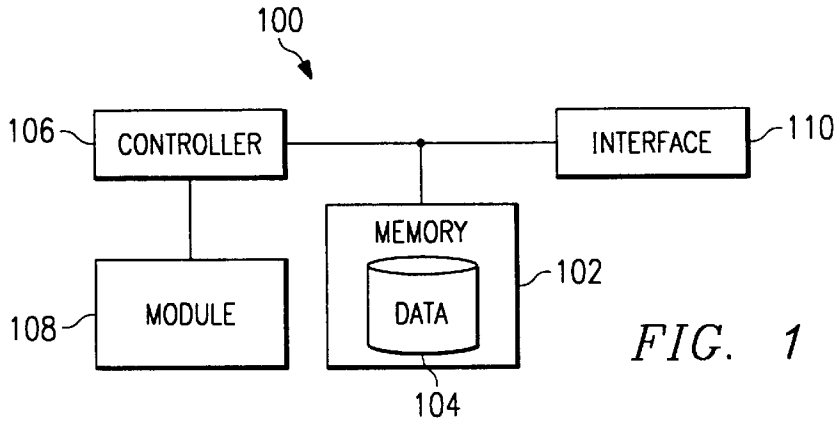

100
106
CONTROLLER
INTERFACE
110
MEMORY
DATA
102
108
MODULE
104

FIG. 1

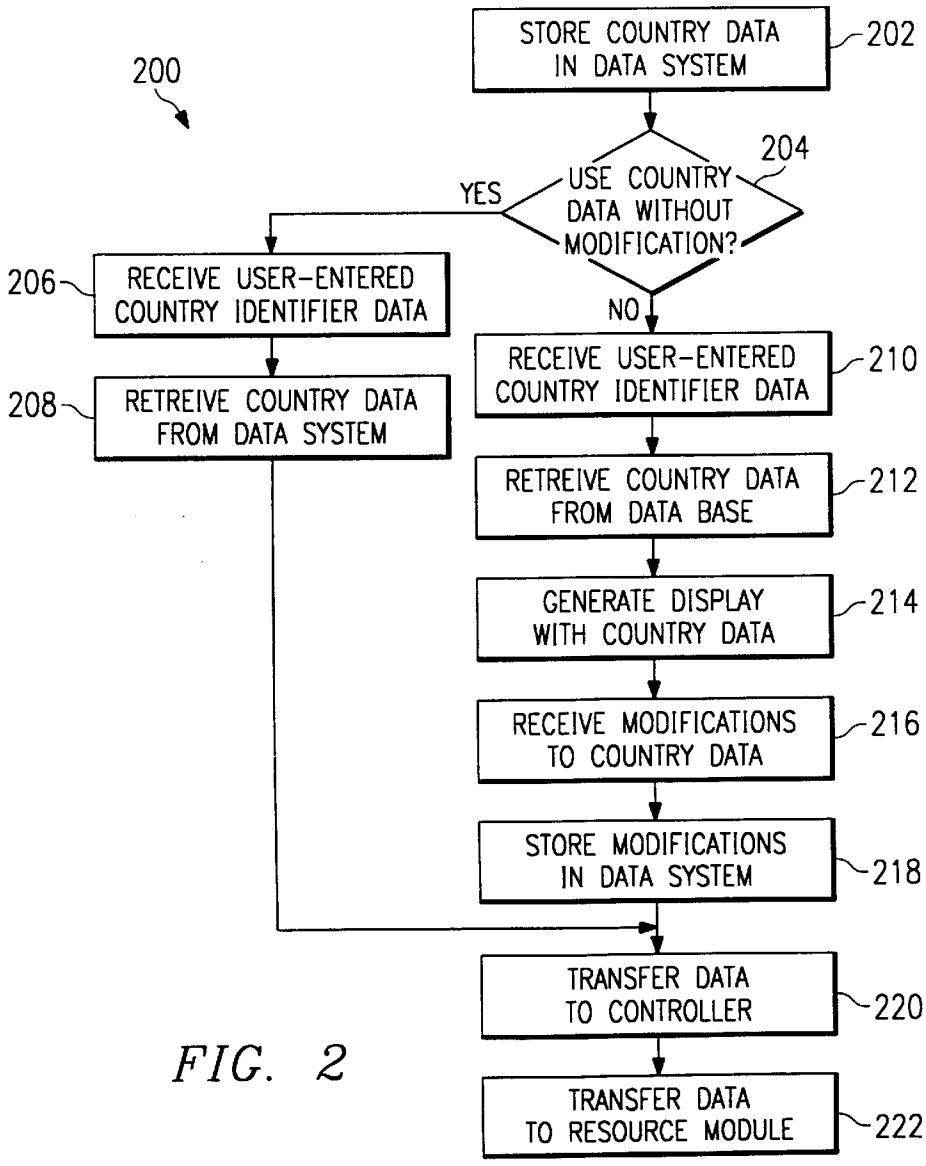

200
STORE COUNTRY DATA IN DATA SYSTEM
202
USE COUNTRY DATA WITHOUT MODIFICATION?
204
YES
NO
206
RECEIVE USER-ENTERED COUNTRY IDENTIFIER DATA
208
RETREIVE COUNTRY DATA FROM DATA SYSTEM
RECEIVE USER-ENTERED COUNTRY IDENTIFIER DATA
210
RETREIVE COUNTRY DATA FROM DATA BASE
212
GENERATE DISPLAY WITH COUNTRY DATA
214
RECEIVE MODIFICATIONS TO COUNTRY DATA
216
STORE MODIFICATIONS IN DATA SYSTEM
218
TRANSFER DATA TO CONTROLLER
220
TRANSFER DATA TO RESOURCE MODULE
222

FIG. 2

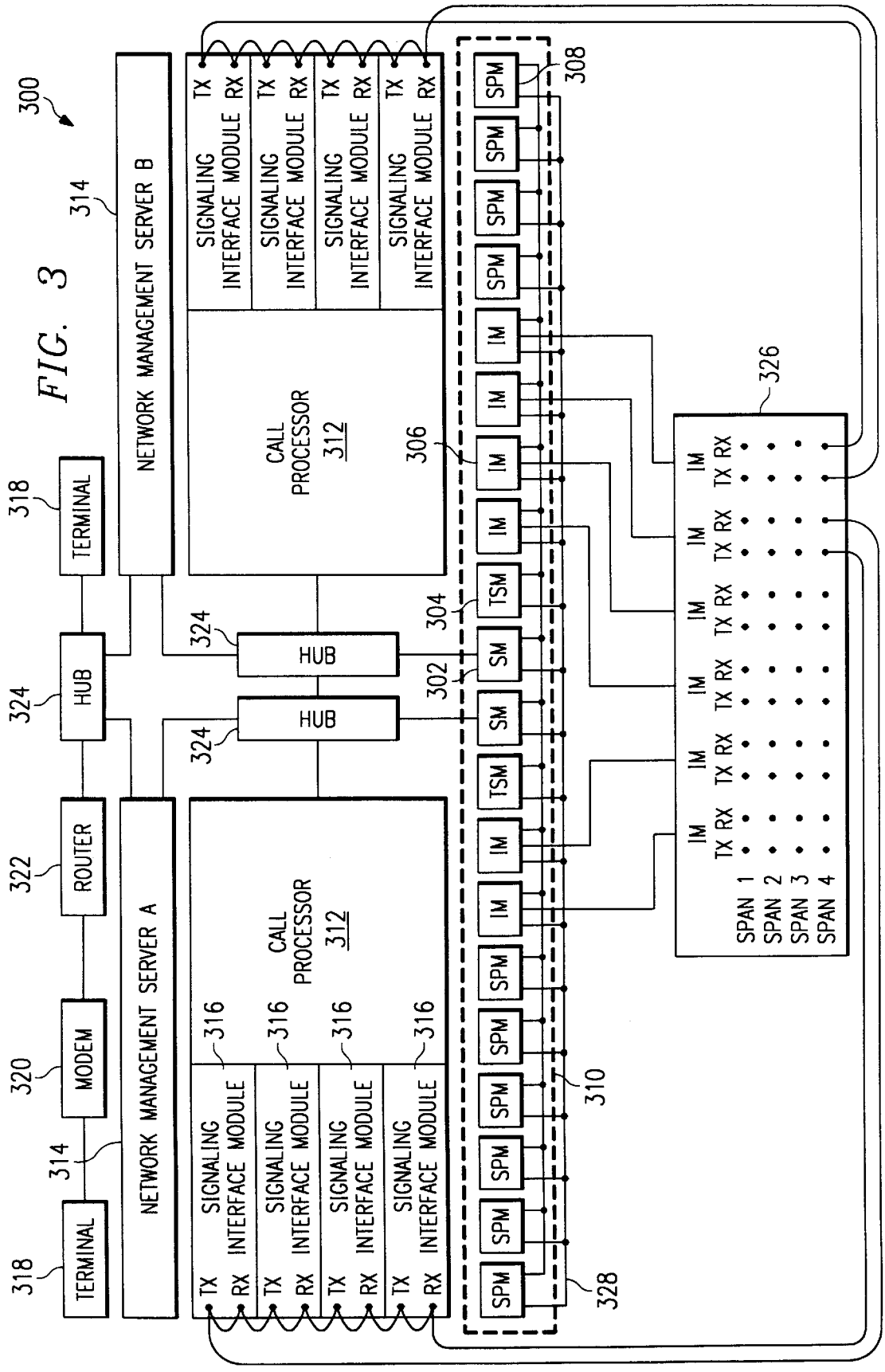

300
314
NETWORK MANAGEMENT SERVER B
NETWORK MANAGEMENT SERVER A
SIGNALING INTERFACE MODULE
TX
RX
CALL PROCESSOR 312
306
308
310
TERMINAL
318
ROUTER
322
MODEM
320
HUB
324
SPM
IM
TSM
SM
304
302
326
SPAN 1
SPAN 2
SPAN 3
SPAN 4
328

FIG. 3

FIG. 4

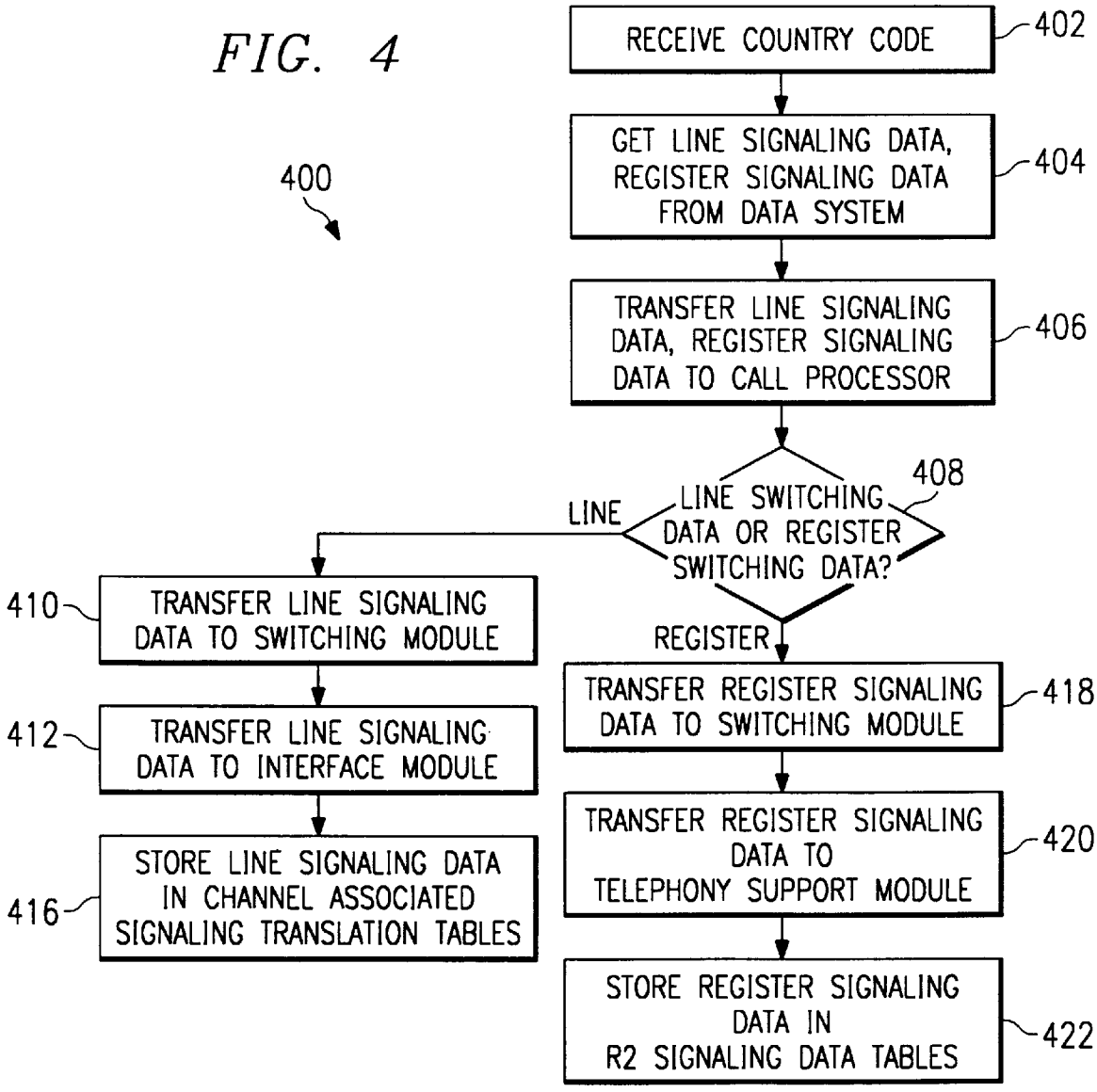

400
RECEIVE COUNTRY CODE
402
GET LINE SIGNALING DATA, REGISTER SIGNALING DATA FROM DATA SYSTEM
404
TRANSFER LINE SIGNALING DATA, REGISTER SIGNALING DATA TO CALL PROCESSOR
406
LINE SWITCHING DATA OR REGISTER SWITCHING DATA?
408
LINE
REGISTER
410
TRANSFER LINE SIGNALING DATA TO SWITCHING MODULE
412
TRANSFER LINE SIGNALING DATA TO INTERFACE MODULE
416
STORE LINE SIGNALING DATA IN CHANNEL ASSOCIATED SIGNALING TRANSLATION TABLES
TRANSFER REGISTER SIGNALING DATA TO SWITCHING MODULE
418
TRANSFER REGISTER SIGNALING DATA TO TELEPHONY SUPPORT MODULE
420
STORE REGISTER SIGNALING DATA IN R2 SIGNALING DATA TABLES
422

FIG. 5

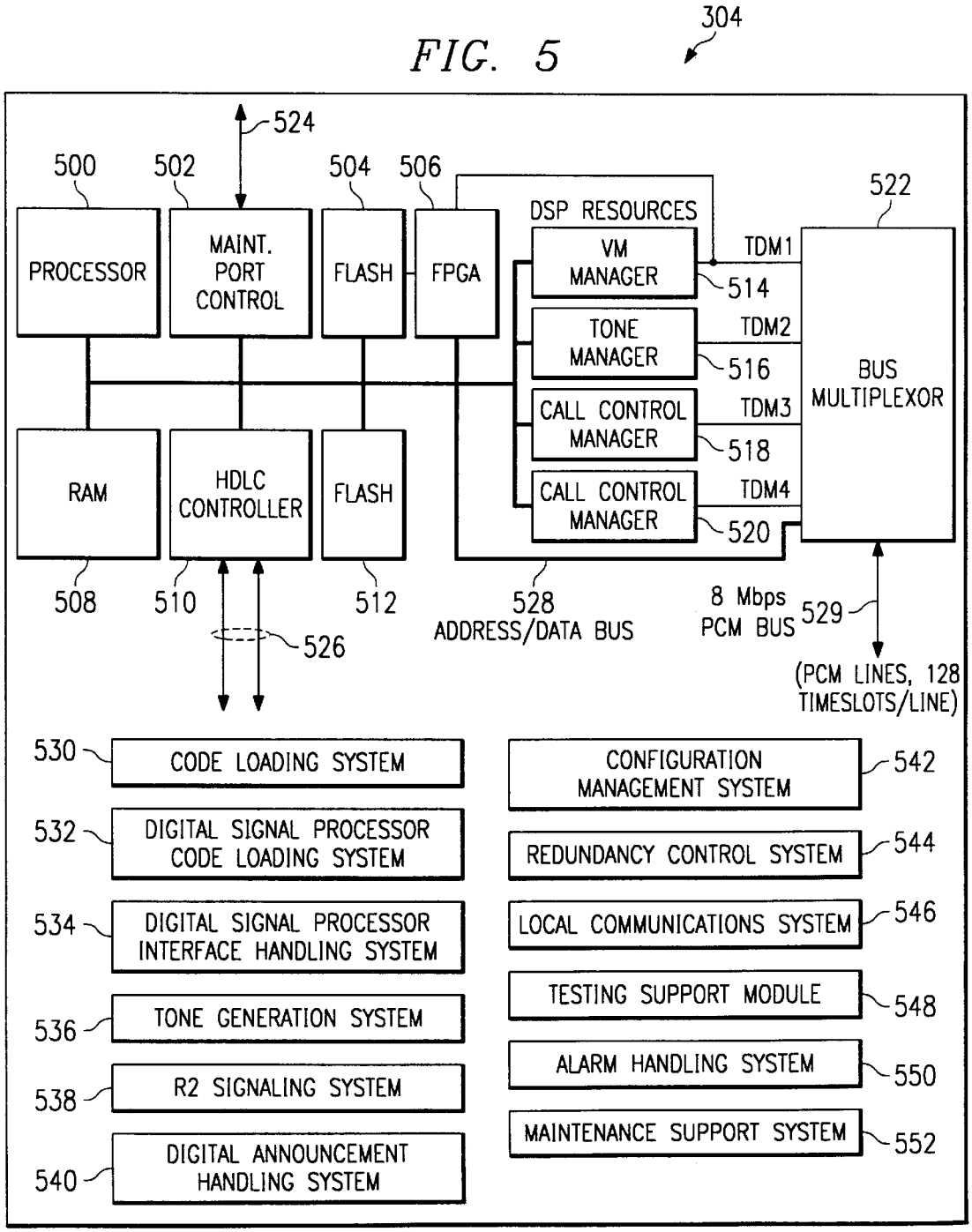
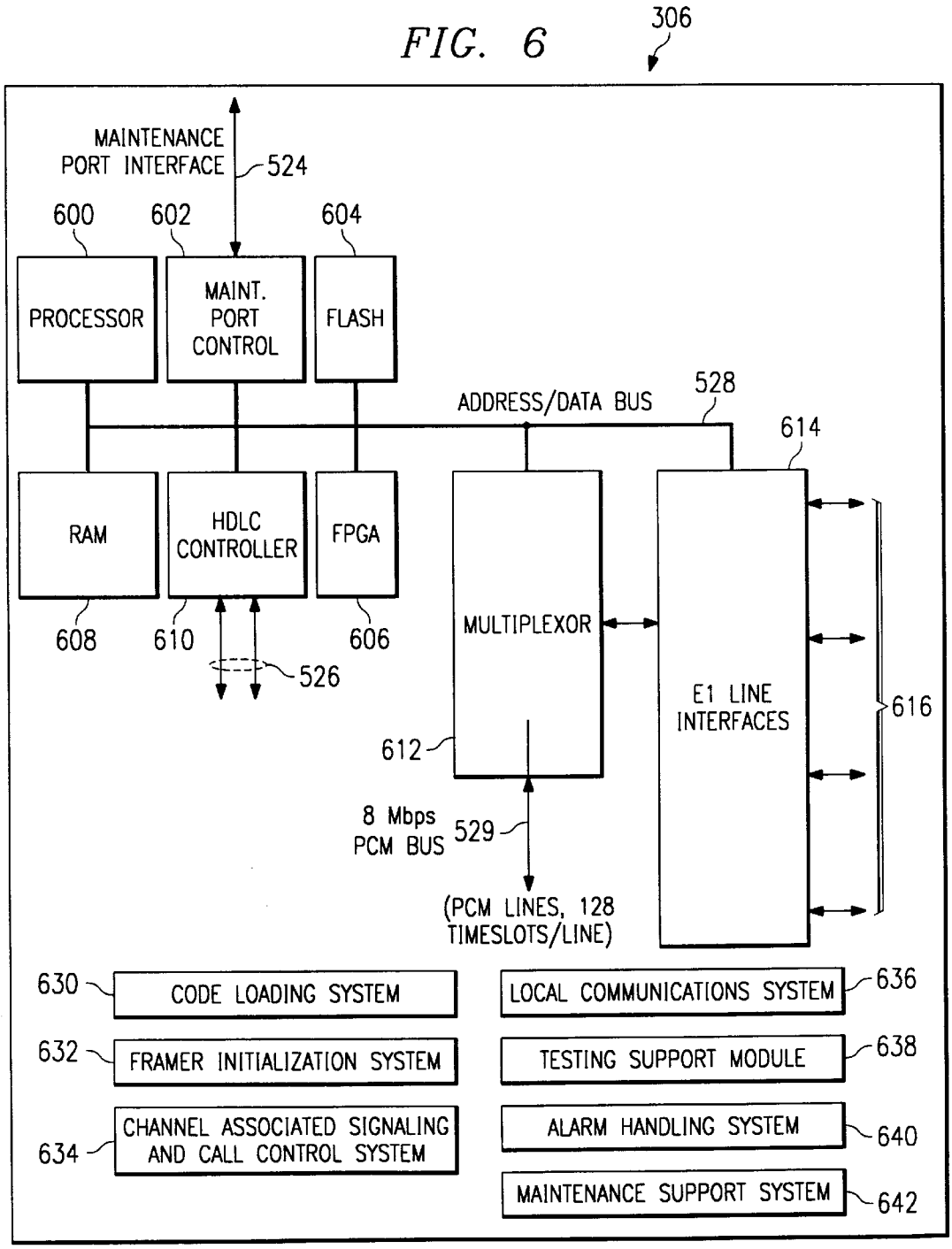

304
524
500
502
504
506
522
PROCESSOR
MAINT. PORT CONTROL
FLASH
FPGA
DSP RESOURCES
VM MANAGER
TONE MANAGER
CALL CONTROL MANAGER
CALL CONTROL MANAGER
TDM1
514
TDM2
516
TDM3
518
TDM4
520
BUS MULTIPLEXOR
RAM
HDLC CONTROLLER
FLASH
508
510
512
526
528
ADDRESS/DATA BUS
8 Mbps PCM BUS
529
(PCM LINES, 128 TIMESLOTS/LINE)
530
CODE LOADING SYSTEM
532
DIGITAL SIGNAL PROCESSOR CODE LOADING SYSTEM
534
DIGITAL SIGNAL PROCESSOR INTERFACE HANDLING SYSTEM
536
TONE GENERATION SYSTEM
538
R2 SIGNALING SYSTEM
540
DIGITAL ANNOUNCEMENT HANDLING SYSTEM
CONFIGURATION MANAGEMENT SYSTEM
542
REDUNDANCY CONTROL SYSTEM
544
LOCAL COMMUNICATIONS SYSTEM
546
TESTING SUPPORT MODULE
548
ALARM HANDLING SYSTEM
550
MAINTENANCE SUPPORT SYSTEM
552

FIG. 6


306
MAINTENANCE PORT INTERFACE
524
600
602
604
PROCESSOR
MAINT. PORT CONTROL
FLASH
ADDRESS/DATA BUS
528
614
RAM
HDLC CONTROLLER
FPGA
MULTIPLEXOR
E1 LINE INTERFACES
616
608
610
606
526
612
8 Mbps PCM BUS
529
(PCM LINES, 128 TIMESLOTS/LINE)
630
CODE LOADING SYSTEM
632
FRAMER INITIALIZATION SYSTEM
634
CHANNEL ASSOCIATED SIGNALING AND CALL CONTROL SYSTEM
LOCAL COMMUNICATIONS SYSTEM
636
TESTING SUPPORT MODULE
638
ALARM HANDLING SYSTEM
640
MAINTENANCE SUPPORT SYSTEM
642

SYSTEM AND METHOD FOR AUTOMATICALLY PROVISIONING A TELECOMMUNICATIONS SWITCH

CLAIM OF PRIORITY

The instant patent application claims priority from the United States provisional patent application designated with Ser. No. 60/060,107, entitled "Cellular Communication System," naming Anthony G. Fletcher and Scott D. Hoffpauir as inventors, and which was filed on Sep. 26, 1997.

RELATED PATENT APPLICATIONS

The instant patent application is directly related to the following patent application: "Integrated Telecommunications Switch," DSC Case No. 834-00, attorney docket no. 24194000.180, naming Scott D. Hoffpauir and Anthony G. Fletcher as inventors, commonly owned and assigned with the present application and which is filed contemporaneously with this application.

FIELD OF THE INVENTION

The present invention relates generally to switching systems for telecommunications, and more particularly to a system and method for automatically provisioning a telecommunications switch that allows country-specific data to be stored at the switch and to be automatically downloaded to components of the switch.

BACKGROUND

Switching systems are used to provide telecommunications services between two or more user interfaces. User interfaces may include telephone handsets, facsimile machines, computers, and other equipment, and may be connected to the switching system by fixed land-based conductors or wireless services. Telecommunications services are provided by establishing a telecommunications channel between two user interfaces, such that encoded analog or digital data may be transmitted between the user interfaces until a state of completion is reached.

When a switching system is set up for operation in a country, it is often necessary to store country-specific protocols and data at predetermined locations of the switching system to allow the switching system to interface with the existing telecommunications systems of the country. Although international standards exist for switching systems, protocols, and interfaces for many countries have variations from those standards that require service personnel to determine and modify the standard software and data on a country-by-country basis.

SUMMARY OF THE INVENTION

Therefore, a need has arisen for a system and method for transferring data to redundant components that reduces or eliminates the need to perform country-specific software code modification of software for a telecommunications system.

In accordance with the present invention, a system and method for controlling a telecommunications system are provided that substantially eliminate or reduce disadvantages and problems associated with previously developed systems and methods for controlling a telecommunications system.

One aspect of the present invention is system for provisioning country-specific data for a telecommunications system. The system includes a data storage system and a user interface. A controller is connected to the data storage system and the user interface, such as a personal computer or other program editor and compiler, and is configured to retrieve country data from the data storage system in response to a country identifier received from the user interface, and to store the country-specific data in one or more predetermined memory locations in switch modules.

Another aspect of the present invention is a method for providing country-specific data for a telecommunications system. The method includes receiving a user-entered country designation at a telecommunications switch. Country-specific data is then retrieved from a data storage system. The country-specific data is stored at predetermined locations of the telecommunications switch modules.

Yet another aspect of the present invention is a method for providing country-specific data for a telecommunications system. The method includes storing register signaling data for two or more countries in a data storage system of a telecommunications switch. Line signaling data for two or more countries is also stored in the data storage system of the telecommunications switch. A user can select different countries and the register signaling and line signaling data tables are then transferred to predetermined locations of the telecommunications switch.

The present invention provides many important technical advantages. One important technical advantage of the present invention is a system for provisioning a telecommunications switch that allows all country-specific data to be stored at the switch and easily provisioned upon selection of a suitable country. The system of the present invention thus eliminates the need to have trained personnel travel to a remote location to set up a telecommunications switch, which results in a significant savings in time and personnel resources. The system of the present invention also eliminates the need to manufacture multiple switches or products that comply with the standards and protocols of different countries, and allows a single switch to be manufactured for use in the different countries.

Another important technical advantage of the present invention is a method for automatically provisioning a telecommunications switch that allows country-specific data for the telecommunications switch to be remotely updated. In this manner, changes to country-specific data that occur from time to time may be automatically updated for all switches from a single remote location, thus eliminating the need to send personnel to remote locations to effect changes in the country-specific data.

Another important technical advantage of the present invention is a system for configuring country-specific protocol data for different trunk groups in a switching system. When a switch system is deployed in a country, it is often necessary to modify PSTN interface protocols and tone tables to allow the switching system to interface with the existing telecommunications systems of that country. The telecommunications switch must also be able to interface with switch systems of other countries, simultaneously using different protocol and tone data for the other countries. The present invention eliminates the need for different switching equipment manufactured for each country, and allows a single switching system to provide the multiple-country functionality.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and the advantages thereof, reference is now made to

the following description taken in conjunction with the accompanying drawings, wherein like reference numerals represent like parts, in which:

FIG. **1** is a block diagram of a system for automatically provisioning a telecommunications switch in accordance with one embodiment of the present invention;

FIG. **2** is a flow chart of a method for automatically provisioning a telecommunications switch in accordance with one embodiment of the present invention;

FIG. **3** is a block diagram of a telecommunications switch in accordance with one embodiment of the present invention;

FIG. **4** is a flow chart of a method for provisioning a telecommunications switch in accordance with one embodiment of the present invention;

FIG. **5** is a block diagram of a telephony support module in accordance with one embodiment of the present invention; and

FIG. **6** is a block diagram of an interface module in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a system **100** for automatically provisioning a telecommunications switch in accordance with one embodiment of the present invention. System **100** may used in conjunction with a telecommunications switch, such as a wireless system switch, a central office system switch, a transmission system switch, or other suitable telecommunications switches.

System **100** includes a data memory **102** that further includes a country data storage system **104**. Country data storage system **104** is used to store country-specific switch data for use by components of the telecommunications switch that is utilizing system **100**. Country data storage system may include country-specific data, such as signaling data, in a predetermined format such that all country-specific data that may need to be provisioned on the telecommunications switch components is wholly contained within country data storage system **104**.

System **100** also includes a controller **106** that is coupled to data memory **102** and country data storage system **104**. Controller **106** is configured to retrieve country-specific data from country data storage system **104** and to transfer the data to module **108**. Controller **106** is also or alternatively configured to receive programming from interface **110**, such that predetermined country data may be altered and replaced with new country data. In this manner, any changes that occur to the country-specific data may be updated at the switch. Controller **106** may be a call processor, a system or component manager, or other suitable controllers.

Module **108** is a switching system component that requires country-specific data for operation. Module **108** may include data registers that must be configured to accept country-specific data fields of predetermined size, data tables that contain country-specific data, or other country-specific data that must be transferred to module **108** before module **108** can function properly in the switching system. Module **108** may also or alternatively be dedicated to a single group of telecommunications channels, used in conjunction with multiple groups of telecommunications channels, or used for purposes not directly associated with individual trunk groups of telecommunications channels.

Interface **110** is coupled to data memory **102** and controller **106**. Interface **110** is configured to allow a user to select a country of operation so as to enable controller **106** to retrieve data for the selected country for transfer to module **108**. The data may also or alternatively be installed directly on module **108**. Interface **110** may also or alternatively be configured to allow a user to modify the country-specific data, and may also or alternatively be configured to receive country-specific data updates from a remote source.

In operation, a user enters a country identifier to cause country-specific data to be retrieved from country data storage system **104** and transferred to module **108**. Module **108** uses the country-specific to perform country-specific telecommunications processing functions. A user may also modify the country-specific data stored in country data storage system **104**, and data updates may be received through interface **110** to automatically update the data stored in country data storage system **104** without requiring user-entered commands.

FIG. **2** is a flow chart of a method **200** for automatically provisioning a telecommunications switch in accordance with one embodiment of the present invention. Method **200** may be used in a wireless communications switch, a remote terminal switch, a central office switch, a transmission switch, or other suitable telecommunications switches. Method **200** may also or alternatively be used to provision a component that is dedicated to a single trunk group of telecommunications channels, used in conjunction with multiple trunk groups of telecommunications channels, or used for purposes not directly associated with individual trunk groups of telecommunications channels.

Method **200** begins at step **202**, where country data is stored in a data system. For example, the country data may include one or more country-specific variations of an internationally-adopted standard for signaling, country-specific provisioning data, country-specific tone data, country-specific telecommunications channel format data, or other country-specific data. The method then proceeds to step **204**.

At step **204**, it is determined whether the country data may be used without modification. For example, if a predetermined period of time has passed since the country data was stored in the data system, then an automatic update process may be used to update the country data to the most recent country data. Also or alternatively, a user may wish to modify some of the country data. If the country data may be used without modification, the method proceeds to step **206**.

At step **206**, user-entered country identifier data is received. The country identifier data may also be automatically updated after receiving country identifier data over a public network or from another suitable source. The method then proceeds to step **208**, where country data corresponding to the country identifier data is retrieved from the data system. The method then proceeds to step **220**.

If it is determined that the country data should be modified at step **204**, the method proceeds to step **210** where user-entered country identifier data is received. The country identifier data may also be automatically generated after receiving country identifier data over a public network or from another suitable source. The method then proceeds to step **212**, where country data corresponding to the country identifier data is retrieved from the data system.

At step **214**, one or more displays are generated that present the country data in a user-readable format. If the country data updates are performed remotely, then this step may be omitted. The method then proceeds to step **216**, where modifications to the country data are received. The modifications are stored in the data system at suitable locations at step **218**. The method then proceeds to step **220**.

At step **220**, the country data is transferred to a controller, such as controller **106**. The controller then transfers the data to a resource module at step **222**. The controller may transfer the data with control data that causes the resource module to store the data in a suitable data memory location, the resource module may be configured to process the data as suitable, or other suitable methods may be used to incorporate the data within the resource module.

FIG. **3** is a block diagram of a telecommunications switch **300** in accordance with one embodiment of the present invention. Telecommunications switch **300** is configured for use as a wireless communications switch, but the present invention may also be implemented in other telecommunications switches, including but not limited to central office switches, transmission switches, remote terminal switches, and other suitable switches.

The telecommunications switch **300** preferably includes one or more switching modules **302**. The switching module **302** may be implemented in software, hardware, or a suitable combination of software and hardware. For example, the switching module **302** may comprise suitable digital data processing devices, such as a switching matrix, a processor (for example a Motorola 68360 telecommunications processor), random access memory, and other devices. The switching module **302** runs a suitable real time operating system such as pSOS+™.

The switching module **302** may also include one or more pulse code modulation bus interfaces, one or more control bus interfaces such as High Level Data Link Controller (HDLC) control bus interfaces, one or more Ethernet interfaces, and an arbitration bus interface to other switching modules **302**. The switching module **302** is coupled to a suitable data link **328**, such as one or more control buses such as High Level Data Link Control buses and one or more pulse code modulation buses.

The switching module **302** performs switching operations, clock operations, and local communications between the resource module assembly **310** components (the switching modules **302**, the telephony support modules **304**, the interface modules **306**, and the signal processing modules **308**). These functions may be performed using pulse code modulation switching and data transfer techniques, Link Access Protocol on the D Channel communications, Ethernet interface communications, and other suitable data transfer techniques.

The telecommunications switch **300** also preferably includes one or more telephony support modules **304**. The telephony support module **304** may be implemented in software, hardware, or a suitable combination of software and hardware. For example, the telephony support module **304** may comprise suitable telecommunications data processing equipment, such as a processor (for example, an Intel 80186 processor), random access memory, one or more redundant High Level Data Link Controller bus interfaces, one or more pulse code modulation buses, and an arbitration bus for establishing active telephony support module **304** status. The telephony support module **304** is coupled to a suitable data link **328**, such as one or more High Level Data Link Control buses and one or more pulse code modulation buses.

The telephony support module **304** may be used to provide tone generation, R2 protocol transceiver functions, and digitized announcement processing or generation for the telecommunications switch **300**. The telephony support module **304** may also provide call setup functions, such as digit collection and out-pulsing, and call completion functions, such as digitized announcement generation and call supervisory tone generation. A single telephony support module **304** provides the required functionality for the telecommunications switch **300**. One or more additional telephony support modules **304** are used to provide redundancy in the event of component failure.

The telecommunications switch **300** also preferably includes one or more interface modules **306**. The interface module **306** is an interface device that is used to interface a suitable number of telecommunications lines that carry data in a predetermined format, such as an E1 data format, with the telecommunications switch **300**. The interface module **306** may be implemented in software, hardware, or a suitable combination of software and hardware. For example, the interface module **306** may comprise suitable data processing equipment, such as a processor (for example an Intel 80186 processor), random access memory, up to four E1 ports, redundant High Level Data Link Controller bus interfaces, and pulse code modulation bus interfaces.

The interface modules **306** provide the physical interface between the telecommunications switch **300** and other switches, the switched network, and the wireless communications base stations. The interface modules **306** also support in-band trunk signaling for data channels that are configured for channel associated signaling, and transmit data to and receive data from the signaling interface modules **316**.

The interface module **306** is coupled to a suitable data link **328**, such as one or more High Level Data Link Control buses and one or more pulse code modulation buses. The interface module **306** is also coupled to an interface module panel **326**, which is used to connect the interface module **306** to external data links such as one or more transmission links. Each external data link typically includes a transmit lead and a receive lead.

The telecommunications switch **300** also preferably includes one or more signal processing modules **308**. The signal processing module **308** may be implemented in software, hardware, or a suitable combination of software and hardware. For example, the signal processing module **308** may comprise suitable data processing equipment, such as a processor (for example an Intel 80186 processor), random access memory, one or more Super Harvard Architecture Computer (SHARC) digital signal processor circuits on each a predetermined number of daughter board modules, redundant High Level Data Link Controller buses, pulse code modulation matrix bus interfaces, and other signal processing application hardware.

The signal processing module **308** may be used to perform transcoding and rate adaption (TRAU) functions, such as converting from a wireless system speech encoding format to a pulse code modulation data format. For example, the telecommunications switch **300** may be used to provide switching services in a wireless telecommunications system that uses Groupe Speciale Mobile format data for a Global System for Mobile Telecommunications (GSM) switch, which processes telecommunications data using regular pulse excitation (RPE) and long term prediction (LTP) formats. Signal processing module **308** converts data from the GSM data format to an appropriate format, such as the pulse code modulation data format. Digital signal processor daughterboards may be used to allow the capacity of calls handled by the signal processing module **308** to be increased or decreased, as appropriate to support system requirements.

The telephony support modules **304**, the interface modules **306**, and the signal processing modules **308** are pref-

erably coupled through switching modules **302** and hub switches **324** to redundant call processor systems **312**. The call processor system **312** is operable to control the function of components of the telecommunications switch **300**.

The call processor system **312** is a general purpose computing platform, such as a Pentium II based computing platform, that includes suitable hardware and software systems to support telecommunications processing. The call processor system **312** may use a real-time operating system such as QNX™ to support the real-time call processing requirements of telecommunications switch **300**.

The call processor system **312** preferably includes one or more systems that allow it to perform the functions of a base station controller system and a message switching center system. In addition, the call processor system **312** may include other hardware and software elements that take part in processing calls directed to, or initiated by, the subscriber units. Specifically, the call processor system **312** includes a call processing application that provides various call processing and signaling functions, such as call origination and termination functions, as well as location updating and handover of mobile subscribers.

For example, the call processing application may provide GSM call processing functions and include a visitor location register system, a home location register system, a mobile application part system, a base station subscriber system, a mobile switching center system, an SS7 signaling system, and other suitable systems. An example of a GSM call processing application that may be used to provide the functionality of call processor system is provided by the patent application entitled "Integrated Telecommunications Switch," DSC Case 834-00, attorney docket no. 24194000.180, naming Scott D. Hoffpauir and Anthony C. Fletcher as inventors, commonly owned and assigned with the present application, filed contemporaneously with this application, and which is hereby incorporated by reference for all purposes.

The call processor system **312** is coupled to a primary network management server **314** and a secondary network management server **314**. The primary and secondary network management servers **314** are redundant network management systems servers that provide operation, administration, maintenance, and other functions for the components of the telecommunications switch **300**. The network management servers **314** incorporate the functionality of both an Operations Maintenance Center—Radio (OMC-R) and an Operations Maintenance Center—Switching (OMC-S).

The primary and secondary network management servers **314** are data systems that may be used to store country data for use by the components of telecommunications switch **300**. For example, the telephony support modules **304** and the interface modules **306** may require country-specific line and register signaling data to process R2 signaling or other suitable signaling. The call processor **312** is operable to retrieve the country data from the network management server **314** and to transfer it to suitable memory locations of the telephony support module **304** and the interface module **306**. The country data may also be modified by a user through terminal **318**, or may be automatically updated using data received from modem **320** or the switched network through interface modules **306**. The country data may also or alternatively be stored in a data system of call processor **312** or data systems of other suitable components of telecommunications switch **300**.

The signaling interface modules **316** are coupled to the call processor systems **312** and the interface modules **306**. The signaling interface modules **316** are used to provide an signaling system 7 (SS7) data format. For example, data in an SS7 data format may be received from a transmission link from the switched network or other switches **300**, and may be switched to another transmission link, such as an E1 telecommunications channel, from interface modules **306** to signaling interface modules **316** by switching modules **302**. The signaling interface modules **316** may also be incorporated into telecommunications switch **300** as resource modules **310**.

The terminals **318** are coupled to the primary and secondary network management servers **314** either directly or through a modem **320**, a router **322**, and hub switch **324**. The terminals **318** are used to interface with the primary and secondary network management servers **314**. The terminals **318** and the primary and secondary network management servers **314** include a network management system that allows a user to remotely monitor and manage telecommunications switch **300**.

In operation, a user of a wireless telecommunications system attempts to place a call using a telecommunications switch **300**. Signaling data and other call control data is received from a wireless base station in an E1 data format at an interface module **306**. This data is then switched through a switching module **302** to a telephony support module **304**, which performs call setup functions. A call processor system **312** receives the signaling data, and determines the call destination.

Depending upon the call destination, the call processor system **312** sends signaling and call control data to the switched network, another telecommunications switch **300**, or a wireless base station serviced by the telecommunications switch **300** containing the call processor system **312**. If a telecommunications channel can not be established, a busy signal, no answer message, or other appropriate response is generated by a telephony support module **304**, and the call attempt is terminated.

The signaling and control data is processed in a predetermined format, such as the R2 standard format, or in a country-specific format. Country-specific variations of standard formats, such as the R2 format, may also be used. Predetermined format data is stored in a memory device of telecommunications switch **300**, such as in call processor **312**, network management servers **314**, or other suitable locations, such that the format data for the country in which telecommunications switch **300** is operated may be installed in the components of telecommunications switch **300**, such as the telephony support module **304** and the interface module **306**, by selection of the country of operation. A menu of countries is presented to an operator over terminal **318**. The operator's input is transferred to network management server **314**, which further transfers the selection to call processor **312**.

Call processor **312** is operable to receive the country selection from a user, and to transfer the country-specific format data from the data storage device of the telecommunications switch **300** to switching module **302**, telephony support module **304**, interface module **306**, signal processing module **308**, and other components of telecommunications switch **300**. In this manner, telecommunications switch **300** may be easily transferred to a country of operation and provisioned for operation, and does not require country-specific data for individual components of telecommunications switch **300** to be programmed by an operator.

FIG. **4** is a flow chart of a method **400** for automatically provisioning a telecommunications switch in accordance

with one embodiment of the present invention. Method **400** may be performed at the manufacturing location, in the field after installation, or at other suitable locations. Method **400** begins at step **402** where country code data is received. The country code data is used to identify a country of operation for the telecommunications switch, and may include user-entered data, transmitted data, broadcast data, or other suitable data.

At step **404**, line signaling data and/or register signaling data is retrieved from a data system, such as network management server **314**. In addition, the code that is received from the data system may need to be translated for use in components of the switching system, or inserted into pre-existing code such that the code must subsequently be compiled. The line signaling data and/or register signaling data is transferred to the call processor system at step **406**, such as to a resource manager system of the call processor system that is used to interface with the resource modules. For example, the call processor may receive a message from the interface module or the telephony support module that line signaling or register signaling data is missing.

At step **408**, it is determined whether the data is line signaling data or register signaling data. If the data is line signaling data, the method proceeds to step **410** where the line signaling data is transferred to a switching module from the call processor. At step **412**, the line signaling data is then transferred to the interface module or modules. The method then proceeds to step **416**, where the line signaling data is stored in channel associated signaling translation tables of the interface module or modules.

If it is determined at step **408** that the data is register signaling data, then the method proceeds to step **418** where the register signaling data is transferred to the switching module from the call processor. The register signaling data is then transferred from the switching module to the telephony support module or modules at step **420**, and is stored in R2 signaling data tables of the telephony support module or modules at step **422**.

FIG. **5** is a block diagram of a telephony support module **304** in accordance with one embodiment of the present invention. Telephony support module **304** is used to provide tone generation, R2 transceiver functionality, and digitized announcement functionality for a telecommunications system. Telephony support module **304** supports standard tone sets.

Telephony support module **304** includes a processor **500**. Processor **500** may be a suitable processor including but not limited to a Intel 80186 processor. Processor **500** controls the activities and functions of telephony support module **304**. Processor **500** is coupled to the other components of telephony support module **304** via an address/data bus **528**. Telephony support module **304** also includes a maintenance port control module **502**. Maintenance port control module **502** provides an RS-232 communications interface for diagnostic and troubleshooting purposes. Maintenance port control module **502** is coupled to maintenance port interface **524**.

Telephony support module **304** also includes flash memory module **504**. Flash memory module **504** is used to store digitized announcements, operational code, country-specific data, and other suitable data. Flash memory module **504** is operable to receive control commands to initiate playback of the digitized announcements. Field programmable gate array ("FPGA") module **506** of telephony support module **304** controls flash memory module **504** playback. For example, field programmable gate array module **506** may receive control commands for playback of a digitized announcement. Field programmable gate array module **506** then generates additional control commands that cause flash memory module **504** to play back the digitized announcement.

Random access memory module **508** of telephony support module **304** provides memory storage space for code execution and data storage. Random access memory module **508** is used by the components of telephony support module **304**. Telephony support module **304** also includes High Level Data Link Controller module **510**. High Level Data Link Controller module **510** is a two-port serial communications controller that provides communications over two redundant High Level Data Link Controller buses **526**. High Level Data Link Controller module **510** supports point-to-point local communications between the telephony support module **304** and the switching module **302**.

Flash memory module **512** of telephony support module **304** stores a non-volatile copy of boot code, operational code, country-specific protocol data tables, field programmable gate array data, digital signal processor code, programmable R2 data, and tone tables. The boot block of flash memory module **512** is hardware protected from inadvertent erasure. Voice message manager module **514** is a digital signal processor resource which is implemented in or more suitable digital signal processors. Voice message manager module **514** manages the recording and playback of digital announcements. Voice message manager module **514** provides control for both 8-second and 16-second messages.

Tone manager module **516** is a digital signal processor resource. Tone manager module **516** manages the generation and decoding of tones, including but not limited to dual tone multiple frequency (DTMF) tones, using a table downloaded from processor **500**. This table contains such data as the time slot data, tone generation class, frequencies, levels, and other suitable data for each of the tones to be generated.

Call control manager modules **518** and **520** are digital signal processor resources. The call control manager modules manage the trunk signaling for the purposes of transmitting and receiving the call routing data, such as dialed digits, the status of the called party, the identification of the calling party, the category of the calling party, and other suitable data. Signaling state engines are executed on the telephony support module **304** for the purpose of transmitting or receiving data over a public switch telecommunications network interface that is configured for channel-associated signaling. Multiplexer module **522** switches the time division multiplex buses **529**, operating at 8 megabits per second, from the pulse code modulation bus to the 2 megabit per second time division multiplex buses used by the digital signal processor resources and flash memory module **504**.

Telephony support module **304** also includes software systems that operate on the hardware components of telephony support module **304** described above, which perform operations required for the operation of the telephony support module **304**. These software systems include a code loading system **530**, a digital signal processor code loading system **532**, a digital signal processor interface handling system **534**, a tone generation system **536**, an R2 signaling system **538**, a digital announcement handling system **540**, a configuration management system **542**, a redundancy control system **544**, a local communications system **546**, a testing support module **548**, an alarm handling system **550**, and a maintenance support system **552**. Each of these systems is described in greater detail below.

The code loading system **530** of telephony support module **304** performs downloads via the switching module **302** of all software components, such as boot code, from a memory device of the call processor system **49**. The digital signal processor code loading system **532** loads digital signal processor code onto the digital signal processors and initializes the digital signal processors. When all the code has been written to the digital signal processors, the digital signal processors will execute the code from internal memory.

The digital signal processor interface handling system **534** interfaces the processor **500** to the digital signal processors to initially configure all digital signal processor channels. The tone generation system **536** initializes the tone generation table so that the digital signal processor can generate the required tones. The tone data may include country-specific data that must be retrieved from a data storage system and installed in tone generation system **536**. The tone data may be installed upon system startup, may be installed in response to a message generated by telephony support module **304** that indicates the absence of the tone data, or may be installed by other suitable methods.

The R2 signaling system **538** performs the R2 signaling function for the purpose of receiving and transmitting call routing, call status, and call identification data over a public switched telecommunications network interface. The R2 signaling system **538** may require country-specific register signaling data that must be retrieved from a data storage system and installed in R2 signaling system **538**. The country-specific register signaling data may be installed upon system startup, may be installed in response to a message generated by telephony support module **304** that indicates the absence of the register signaling data, or may be installed by other suitable methods.

The digital announcement handling system **540** manages the recording and playback of digital announcements. The configuration management system **542** manages the configuration of the individual digital processor channels. The redundancy control system **544** detects changes in the telephony support module **304** bus ownership status, such as from online to standby, and transmits a message to the switching module **302** when a change in status occurs. The redundancy control system **544** of telephony support module **304** also provides support for recovering from fail-over from an online telephony support module **304** to a standby telephony support module **304** without dropping established calls.

The local communication system **546** manages communications with the switching module **302** over High Level Data Link Controller buses **526**. The testing support module **548** generates a response to test commands and is also configured to make various connections required for built in tests and fault isolation tests. The alarm handling system **550** monitors the telephony support module **304** for alarm and error conditions and transmits an alarm or error message to the switching module **302** when an alarm or error condition is present. The maintenance support system **552** manages the diagnostic input and output to and from the telephony support module **304** via an RS232 port.

In operation, one or more software systems of telephony support module **304**, such as the tone generation system **536** or the R2 signaling system **738**, obtain country-specific data from a data storage system. The country-specific data may be transmitted in response to a request generated by the software systems of telephony support module **304**, may be transmitted automatically at system startup, or may be transmitted by other suitable procedures. The country-specific data is stored in suitable memory locations of telephony support module **304** so as to be utilized by the systems and components of telephony support module **304** so as to allow telephony support module **304** to operate in one or more countries.

FIG. **6** is a block diagram of an interface module **306** in accordance with one embodiment of the present invention. Interface module **306** is used to provide the physical interface between the telecommunications switch **300** and the wireless base stations, the switched network, and other suitable telecommunications system components. The interface module **306** is also used to support in-band signaling for telecommunications channels that are configured for channel associated signaling.

Interface module **306** includes a processor **600**. Processor **600** may be a suitable processor including but not limited to a Intel 80186 processor. Processor **600** controls the activities and functions of interface module **306**. Processor **600** is coupled to the other components of interface module **306** via address/data bus **528**. Interface module **306** also includes a maintenance port control module **602**. Maintenance port control module **602** provides an RS232 communications interface for diagnostic and troubleshooting purposes. Maintenance port control module **602** is coupled to maintenance port interface **524**.

Interface module **306** also includes flash memory module **604**. Flash memory module **604** is used to store a nonvolatile copy of boot code, operational code, and field programmable gate array data. Field programmable gate array ("FPGA") module **606** of interface module **306** provides logic to interconnect the interface module **306** components, including connections between E1 line interfaces **614** and processor **600**. The field programmable gate array also provides a clock detection function to determine the status of the system time division multiplex bus clock that is used to clock the line interfaces **614**. The clock detection function of the field programmable gate array **606** prevents the line interfaces **614** from going into a high impedance state during operation if clock failure occurs.

Random access memory module **608** of interface module **306** provides memory storage space for code execution and data storage. Random access memory module **608** is used by the components of interface module **306**. Interface module **306** also includes High Level Data Link Controller module **610**. High Level Data Link Controller module **610** is a two-port serial communications controller that provides communications over two redundant High Level Data Link Controller buses **526**. High Level Data Link Controller module **610** supports point-to-point local communications between the interface module **306** and the switching module **302**.

Multiplexer module **612** switches the time division multiplex buses **529**, operating at 8 megabits per second, from the pulse code modulation bus to the four 2 megabit per second time division multiplex buses that are routed to line interfaces **614**. Line interfaces **614** provide complete transceiver and framer functionality for a suitable number of external telecommunications lines, such as four telecommunications lines **616** carrying data in an E1 standard format. For each telecommunications line **616**, a framer element of line interfaces **614** locates the frame and multiframe boundaries and monitors the data for alarm conditions. Line interfaces **614** are also configured to insert and extract signaling data.

Interface module **306** also includes software systems that operate on the hardware components of interface module

306 described above, which perform operations required for the operation of the interface module **306**. These software systems include a code loading system **630**, a framer initialization system **632**, a channel associated signaling and call control system **634**, a local communications system **636**, a testing support module **638**, an alarm handling system **640**, and a maintenance support system **642**. Each of these systems is described in greater detail below.

The code loading system **630** of interface module **306** performs downloads via the switching module **302** of all software components, such as boot code, from a memory device of the call processor system **312**. The framer initialization system **632** performs all required initialization for all of the line interface modules **614**. The channel associated signaling and call control system **634** maintains the signaling status of individual telecommunications channels that are configured for channel associated signaling. The channel associated signaling and call control system **634** drives the signaling state of individual telecommunications channels, such as DSO format channels, in response to control data received from the switching module **302**. The signaling bits received at line interface **614** are translated using tables of line signaling data to decode the signaling data received over the telecommunications channel. Outgoing signaling data is also translated by the channel associated signaling and call control system **634**. The channel associated signaling and call control system **634** is operable to receive country data, such as R2 line signaling data, from a data system.

The local communication system **636** manages communications with the switching module **302** over High Level Data Link Controller buses **526**. The testing support module **638** generates a response to test commands and is also configured to make various connections required for built in tests and fault isolation tests. The alarm handling system **640** monitors the interface module **306** and the telecommunications lines **616** for alarm and error conditions and transmits an alarm or error message to the switching module **302** when an alarm or error condition is present. The maintenance support system **642** manages the diagnostic input and output to and from the interface module **306** via an RS232 port.

In operation, one or more software systems of interface module **306**, such as the tone generation system **536** or the R2 signaling system **738**, obtain country-specific data from a data storage system. The country-specific data may be transmitted in response to a request generated by the software systems of interface module **306**, may be transmitted automatically at system startup, or may be transmitted by other suitable procedures. The country-specific data is stored in suitable memory locations of interface module **306** so as to be utilized by the systems and components of interface module **306** so as to allow interface module **306** to operate in one or more countries.

Although several embodiments of the present invention and its advantages have been described in detail, it should be understood that changes, substitutions, transformations, modifications, variations, and alterations may be made therein without departing from the teachings of the present invention, the spirit and the scope of the invention being set forth by the appended claims.

What is claimed is:

1. A system for automatically provisioning country-specific data for a telecommunications system comprising:

a telecommunications switch operable to receive and process data;

a data storage system that further comprises country-specific data coupled to the switch;

a user interface to the telecommunications switch; and

wherein the telecommunications switch is operable to receive a user-entered country designation, to retrieve selected country-specific data from the data storage system, and to store the country-specific data in one or more predetermined memory locations.

2. The system of claim **1** wherein the telecommunications switch comprises:

a call processor system;

a resource module coupled to the call processor system; and

wherein the country-specific data is stored in one or more predetermined memory locations of the resource module.

3. The system of claim **1** wherein the telecommunications switch comprises:

a call processor system;

an interface module coupled to the call processor system; and

wherein the country-specific data is stored in one or more predetermined memory locations of the interface module.

4. The system of claim **1** wherein the telecommunications switch comprises:

a call processor system;

a telephony support module coupled to the call processor system; and

wherein the country-specific data is stored in one or more predetermined memory locations of the telephony support module.

5. The system of claim **1** wherein the telecommunications switch comprises:

a call processor system;

a switching module coupled to the call processor system;

two or more resource modules coupled to the switching module, where the country-specific data is stored in predetermined memory locations of the resource modules; and

wherein the switching module is operable to transfer data from the call processor system to predetermined resource modules.

6. The system of claim **1** wherein the data storage system further comprises an R2 signaling data system containing country-specific variations of the R2 signaling data standards.

7. The system of claim **1** wherein the user interface to the telecommunications switch comprises:

a network management server coupled to the telecommunications switch;

a user interface coupled to the network management server; and

wherein the user interface is operable to generate user input interfaces and to receive user-entered data in response to the user input interfaces.

8. The system of claim **1** further comprising an update system, wherein the update system is operable to receive update data from a telecommunications channel and to store the update data in the country-specific data system.

9. A method for providing country-specific data for a telecommunications system comprising:

receiving a user-entered country designation at a telecommunications switch;

retrieving country-specific data from a data storage system; and

storing the country-specific data at predetermined locations of the telecommunications switch.

10. The method of claim **9** wherein receiving a user-entered country designation at a telecommunications switch comprises:

receiving the user-entered country designation at a user interface of a network management server of the telecommunications switch; and

transmitting the user-entered country designation to a call processor system of the telecommunications switch.

11. The method of claim **9** wherein retrieving country-specific data from a data storage system comprises retrieving country-specific R2 data from the data storage system.

12. The method of claim **9** wherein storing the country-specific data at predetermined locations of the telecommunications switch comprises:

transmitting the country-specific data to a resource module of the telecommunications switch from a call processor system of the telecommunications switch; and

storing the country-specific data at predetermined locations of the resource module.

13. The method of claim **9** wherein storing the country-specific data at predetermined locations of the telecommunications switch comprises:

transmitting the country-specific data to an interface module of the telecommunications switch from a call processor of the telecommunications switch; and

storing the country-specific data at predetermined locations of the interface module.

14. The method of claim **9** wherein storing the country-specific data at predetermined locations of the telecommunications switch comprises:

transmitting the country-specific data to a telephony support module of the telecommunications switch from a call processor of the telecommunications switch; and

storing the country-specific data at predetermined locations of the telephony support module.

15. The method of claim **9** wherein storing the country-specific data at predetermined locations of the telecommunications switch comprises:

transmitting the country-specific data to a switching module of the telecommunications switch from a call processor of the telecommunications switch;

transmitting the country-specific data from the switching module to a resource module of the telecommunications switch; and

storing the country-specific data at predetermined locations of the resource module.

16. The method of claim **9** wherein storing the country-specific data at predetermined locations of the telecommunications switch comprises:

transmitting the country-specific data to a switching module of the telecommunications switch from a call processor of the telecommunications switch;

transmitting the country-specific data from the switching module to an interface module of the telecommunications switch; and

storing the country-specific data at predetermined locations of the interface module.

17. The method of claim **9** wherein storing the country-specific data at predetermined locations of the telecommunications switch comprises:

transmitting the country-specific data to a switching module of the telecommunications switch from a call processor of the telecommunications switch;

transmitting the country-specific data from the switching module to a telephony support module of the telecommunications switch; and

storing the country-specific data at predetermined locations of the telephony support module.

18. A method for providing country-specific data for a telecommunications system comprising:

storing register signaling data for two or more countries in a data storage system of a telecommunications switch;

storing line signaling data for two or more countries in the data storage system of the telecommunications switch;

receiving a user-entered country designation at the telecommunications switch;

transferring the register signaling data to predetermined locations of the telecommunications switch; and

transferring the line signaling data to predetermined locations of the telecommunications switch.

19. The method of claim **18** wherein storing register signaling data for two or more countries in the data storage system of a telecommunications switch comprises storing common R2 register signaling data and country-specific R2 register signaling variation data in the data storage system.

20. The method of claim **18** wherein storing line signaling data for two or more countries in the data storage system of a telecommunications switch comprises storing common R2 line signaling data and country-specific R2 line signaling variation data in the data storage system.

21. The method of claim **18** wherein receiving a user-entered country designation at the telecommunications switch comprises:

generating a country selection display at a user interface system;

receiving a user-entered country designation at the user interface system; and

transmitting the user-entered country designation to a call processing system.

22. The method of claim **18** wherein receiving a user-entered country designation at the telecommunications switch comprises:

receiving a user-entered country designation at a data channel interface from a data channel; and

transmitting the user-entered country designation to a call processing system from the data channel interface.

23. The method of claim **18** wherein transferring the register signaling data to predetermined locations of the telecommunications switch comprises:

transmitting the register signaling data from the call processor to a telephony support module; and

storing the register signaling data at predetermined locations of the telephony support module.

24. The method of claim **18** wherein transferring the register signaling data to predetermined locations of the telecommunications switch comprises:

transmitting the register signaling data from the call processor system to a switching module of the telecommunications switch;

transmitting the register signaling data from the switching module to a telephony support module; and

storing the register signaling data at predetermined locations of the telephony support module.

25. The method of claim **18** wherein transferring the line signaling data to predetermined locations of the telecommunications switch comprises:

transmitting the line signaling data from the call processor to an interface module; and

storing the line signaling data at predetermined locations of the interface module.

26. The method of claim **18** wherein transferring the line signaling data to predetermined locations of the telecommunications switch comprises:

transmitting the line signaling data from the call processor system to a switching module of the telecommunications switch;

transmitting the line signaling data from the switching module to an interface module; and

storing the line signaling data at predetermined locations of the interface module.

* * * * *