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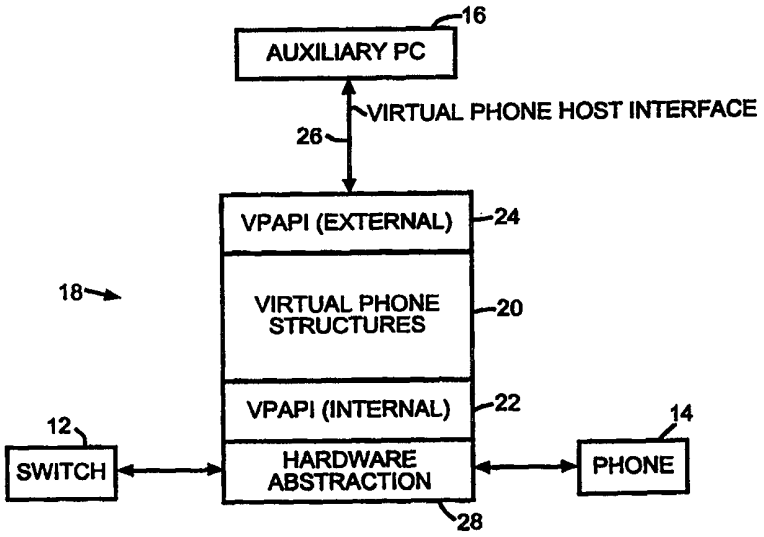

(57) Abstract

A telephone communication system utilizing a virtual phone (18) wherein a telephone switch or similar digital switching device (12), a digital telephone (14) and an external device such as a personal computer (PC) or other processor (16) are generically interfaced. The virtual phone generic interface is configurable and comprises a set of virtual phone data structures (20), internal virtual phone application program interfaces (VPAPI) (22), external VPAPI (24), and an external transfer protocol. The generic interface converts proprietary telephone switch or external application protocols into a common format and functions as a protocol interpreter between proprietary switching system protocols and protocols of various applications.

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VIRTUAL PHONE GENERIC CONFIGURABLE INTERFACE

BACKGROUND OF THE INVENTION

1. Field of the invention

The present invention relates generally to a telephone communication system and, in particular, to a device that provides a generic software interface to a digital line on one of many different types of digital phone switches. A telephone with such a generic interface is a "virtual phone" that has the flexibility to represent the majority of features of any digital phone, regardless of the switch type or the number of features in a digital phone.

The general concept of a virtual telephone has been in existence in various forms across different product lines. In some cases a virtual phone has been used to represent a specific digital phone, such as Rolm Phone 400 or a Meridian 2616. Those phones represent a superset of phones for their respective switches. In other cases a virtual phone has been used to represent only the necessary portions, or a subset, of a digital telephone.

2. Prior Art

One of the important characteristics of a telecommunication system is the ability of different interconnected components of the system to effectively communicate with each other. Many business-oriented telecommunication systems have PBX (Private Branch Exchange) switches that link internal telephones with each other and with external telephone networks.

Even though today most vendors build the PBXs around common available processors running common

operating systems (such as UNIX) and use common programming languages (such as C or C++), unfortunately different vendors' switching devices use proprietary communication protocols. Thus, it is virtually impossible to integrate one vendor's switching device with other vendors' applications.

Therefore, it becomes highly desirable to provide a telecommunication system with a feature that would convert proprietary PBX or external application protocols into a common format, and thus would function as a "protocol interpreter" between proprietary switching system protocols and the protocols of various applications.

A number of solutions to that problem have been disclosed in the prior art. For example, U.S. Patent No. 4,873,718 "Feature Telephone Integration Device" issued to Barnett et al discloses a device and method for integrating one vendor's application (a voice mail system) into a PBX environment of a different vendor. In that patent the interconnection was achieved by equipping the PBX vendor's feature phone with additional circuitry to monitor telephone communication between the PBX, the feature telephone and the external application. An obvious disadvantage of the disclosed system is its inability to provide a generic interface between many possible proprietary protocols of different PBX switching systems and an external application. The disclosed invention provided integration only between a PBX and a voice mail system, it did not provide for the possibility to integrate a PBX with a variety of different external applications. Moreover, any exchange of information about a call or a change of the status of the call occurs "one-way" only: from the PBX to the telephone set.

U.S. Patent No. 5,440,616 provides an improvement over the device of Patent No. 4,873,718 in the form of apparatus for interconnecting a messaging system (voice, facsimile, etc.) with a PBX which offers entirely digital transmission and provides high bandwidth and redundant transmission of control information between the messaging system and the PBX. The apparatus of Patent No. 5,440,616 includes a digital voice terminal adapter which is a combination of hardware and software which emulates a digital feature phone and which interconnects a messaging system and a PBX to provide full integration of the messaging system with the PBX. The disclosed adapter does not, however, convert proprietary PBX or external application protocols into a common format and thus does not function as a protocol interpreter between proprietary switching system protocols and the protocols of various applications.

U.S. Patent No. 5,255,314 "Switch Adjunct Integration Device" issued to Applegate et al discloses a device that uses multiple line appearances of one or more digital telephone lines to gather information on calls designed for an adjunct voice mail system. After receiving the required information the device transfers the calls to analog phone lines leading to the voice mail system. That device, again, provides no more than a communication tool between a PBX switch and a voice mail system. The disclosed device does not integrate any type of the known PBX switches with any type of external device via a generic interface.

SUMMARY OF THE INVENTION

Advantageously, the present invention overcomes the "protocol conversion" difficulties which existed in the

prior art. The virtual phone generic interface of the present invention comprises three distinct modules: a virtual phone data structure, a program interface, and a host interface. All three modules can work independently of a specific type of integration. The data structure and the program interface software of the virtual phone are built into the embedded processor that controls the Private Branch Exchange (PBX) digital phone switching system interface integration. The interface between the switch and the virtual phone data structure is different for each integration, but once the interface is completed, it can be reused for many different types of applications. The interface between the virtual phone structures and the external application is the same regardless of the type of integration.

The implementation of the virtual phone provides for an external interface through any type of transport medium. A phone application residing on an auxiliary PC can show the current status of the virtual phone, and can also do call control. This illustrates the common external interface and also provides a method for diagnostics. The interface to the auxiliary PC is accomplished in different ways based on the system configuration. It can be done via a serial port, ISA bus, PCI bus, universal serial bus, Ethernet, or any other type of transport configurable. An internally designed protocol is used to communicate between the virtual phone and the auxiliary PC. In essence, the virtual phone acts as a protocol converter between the proprietary switch messages and the external serial interface.

The virtual phone of the present invention provides a common interface between any of the digital phone

switches and any number of end devices. The virtual phone represents the current state of some theoretical phone and has buttons, lights, a hook switch, display, ringer, and anything else typical of a standard digital phone. The main component of the virtual phone is a set of structures that represent the state of the phone at any given time. The virtual phone structures can be accessed via a set of Virtual Phone Application Program Interface (VPAPI) function calls. The virtual phone status and events are transmitted externally via a custom virtual phone host interface.

When a packet is received from a switch, an abstraction layer parses the data and calls an internal VPAPI function. The internal VPAPI function is responsible for updating the virtual phone structure and passing the information about any state changes to an auxiliary PC through the virtual phone host interface. An internally designed protocol is used to provide communication between the virtual phone and the auxiliary PC through the host interface such as a standard RS232 communications port. A phone application residing on the auxiliary PC can show the current status of the virtual phone and accomplish call control tasks. So, in essence, the virtual phone functions as a "protocol interpreter" between the proprietary switch messages and the external interface.

When an event is received from the auxiliary PC , an external VPAPI function is called to update the virtual phone. The event is passed to an abstraction layer where it is converted to a command format in accordance with a specific virtual phone integration. The command is then subsequently passed to the switch.

The foregoing and additional advantages and characterizing features of the present invention will become clearly apparent upon a reading of the ensuing detailed description together with the included drawing wherein:

BRIEF DESCRIPTION OF THE DRAWING FIGURES

Fig. 1 is a block diagram of the telephone communication system of the present invention;

Fig. 2 is a block diagram illustrating the system of Fig. 1 in different types of phone integration implementations;

Fig. 3 is a block diagram further illustrating the virtual phone application program interface of the systems of Figs. 1 and 2;

Fig. 4 is a block diagram of an illustrative implementation of the abstraction layer in the systems of Figs. 1 and 2; and

Fig. 5 is a block diagram illustrating a generalized form of the system of Fig. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Telephone Communication System

A telephone communication system utilizing the virtual phone of the present invention is shown in Fig.

1 wherein a PBX or similar digital switching device 12, a digital telephone 14 and an external device such as a personal computer (PC) or other processor 16 are interfaced by the arrangement 18 of the present invention. The virtual phone generic interface 18 of the present invention comprises a set 20 of virtual phone data structures, internal and external virtual phone application program interfaces 22 and 24, respectively, and a virtual phone host interface 26. Software designated hardware abstraction layer 28 provides communication between the internal virtual phone application program interface 22, PBX 12 and the telephone set 14.

Switch 12 can be a PBX, KSU, service provided by a central office (such as Centrex or ISDN) and does not even have to be digital. Digital telephone 14 is representative of other communication devices like phones using emerging network interface technologies like internet protocol (IP), isoethernet, various forms of wireless, ATM, etc. Various types of additional telephones (ex. switch dependent phones, analog phones, cordless phones, conference phones), modems, fax machines or computers can be connected to the primary communications device 14.

Virtual Phone Structure

The actual virtual phone is represented by a set 20 of data structures, for example "C" language data structures that maintain the current status of the theoretical, i.e. virtual, phone. The data in these structures may change when an event occurs on the switch 12 or an adjunct digital phone 14, and the data get passed up through the abstraction layer 28 and VPAPI 22. Also, the virtual phone structure information can change

if an authorized external device 16 sends a VPAPI command 24.

The virtual phone structure 18 requires several bytes of RAM within the address range of an embedded microcontroller. The current state of the structures 20 matches what the switch 12 believes the digital phone 14 to be. Since it is possible for applications in processor 16 to take control away from the digital set 14, the virtual phone 20 and the digital phone 14 will not always have matching states. For example, if a digital phone and a cordless phone are connected to the same line, and voice is routed to the cordless, the switch thinks voice is active, and the digital phone does not.

The messages sent from the telephone switch 12 provide a representation of the state of the telephone 14 as it resides internally in the switch. The virtual phone 18 translates this state into a form that is not switch or phone dependent, but one that can represent any desired telephone or communications device. The virtual phone 18 is protocol and transport dependent.

The virtual phone system of the present invention is designed to fit the needs of different types of phone integration implementations. Of the three major components of the software system (Virtual Phone Structure 20, VPAPI 22, 24 and VPHI 26), not all need to be used in every system implementation. This is illustrated in the overview of Fig. 2.

In a first typical implementation, there is a case where the host interface is not needed. When an external communications device 34 is integrated into the system, the host protocol is unused. The external

device 36 can be controlled directly from the system software within the micro-controller via the VPAPI 24 via an integrated link 38.

The auxiliary PC 16 from the arrangement of Fig. 1 is shown connected to host interface 26' via an RS232 link 40.

In another example, all three major components are used. The external communications device is a computer 44 with an ISA link 46 to the virtual phone system. This host computer 44 runs a TAPI application. As messages are received from the switch 12, the abstraction layer 28 calls VPAPI functions which update the virtual phone structures 20 and convert the commands into a generic protocol that can be easily understood by the host system 44. Optionally, the data does not even need to be maintained in the virtual phone structures. The system can act simply as a protocol converter.

Also shown in the example of Fig. 2 is a network application 50 linked to the virtual phone system via a TCP/IP protocol link 52.

The virtual phone data structures 20 of the virtual phone system 18 of Figs. 1 and 2 first will be described in detail, followed by description of the virtual phone application program interfaces 22, 24 and the abstraction layer 28. Accordingly, the following represents a description of all of the structures and defined variables that make up the structures 20 of the virtual phone system 18.

Main Control Structure

The following "C" language code illustrates the main virtual phone structure. One instance of this data structure is used to represent a single digital port.

```
typedef                                 /* Main Virtual Phone
struct                                  Structure */
VP_VOICE    voice;                      /* voice status */
VP_RINGER   ringer;                     /* ringer status */
VP_DISPLAY  display;                    /*LCD display status*/
BYTE        num_buttons;                /* number of buttons actually
                                        in use */
VP_BUTTON   button[VP_MAXBUTS];         /* button/lamp status */
BYTE        StandAlone;                 /* operate without digital
                                        set */
BYTE        SwitchType;                 /* type of switch connected */
BYTE        DigSetType;                 /* Type of configured digital
                                        SET, if */
BYTE        Connections;                /* Which Phone Units are
                                        physically connected */
BYTE        ActivePhone;                /* Which Physical Phone Unit
                                        is active */
BYTE        TouchedPhone;               /* Which Physical Phone Unit
                                        was last touched */
BYTE        Carrier[2];                 /* 0=switch  1=digital set */
BYTE        PassThroughFlags;           /* event block flags */
BYTE        Voicemux;                   /* Bearer channel direction */

VIRTUAL_PHONE;
```

`VP_VOICE voice;` References the voice control element of the virtual phone. This is described in greater detail in the section titled "Voice control structure".

VP_RINGER ringer;	References the ringer control element of the virtual phone. This is described in greater detail in the section titled "Ringer control structure".
VP_DISPLAY display;	References the display control element of the virtual phone. This is described in greater detail in the section titled "Display control structure".
BYTE num_buttons;	The number of virtual buttons actually in use by the virtual phone. Although the virtual phone can support many buttons, some applications may limit the number of buttons in use.
VP_BUTTON button[VP_MAXBUTS];	References the button control element of the virtual phone. This is described in greater detail in the section titled "Button/Lamp control structure".
BYTE StandAlone;	When TRUE, the system is operating without an adjunct digital phone.

When FALSE, an adjunct digital phone is connected and operating.

BYTE SwitchType; The brand of PBX (or KSU) connected to the system. The valid phone types are represented by the following defines:

```
#define   PBX_NONE      0     /* No PBX connected */
#define   PBX_ATT       1     /* At&T switch connected */
#define   PBX_M1        2     /* Meridian switch connected */
#define   PBX_NORSTAR   3     /* Norstar switch connected */
#define   PBX_ROLM      4     /* Rolm switch connected */
#define   PBX_ISON      5     /*ISON switch connected*/
```

BYTE DigSetType; The type of digital phone connected to the system. The valid phone types are represented by the following defines:

```
#define   SET_NONE      0     /* Only when no PBX */
#define   SET_UNKNOWN   1     /* Connection, Unknown type */
#define   SET_ROLM_400  10    /* Rolm Phone 400 */
#define   SET_ROLM_240  11    /* Rolm Phone 240 */
#define   SET_ROLM_120  12    /* Rolm Phone 120 */
#define   SET_ROLM_600  13    /* Rolm Phone 600 */
#define   SET_ROLM_300  14    /* Rolm Phone 300 */
#define   SET_M1-2616   30    /* M1 2616 */
#define   SET_NOR_7310  50    /* Norstar 7310 */
#define   SET_NOR_7208  51    /* Norstar 7208 */
#define   SET_NOR_7100  52    /* Norstar 7100 */
```

```
#define    SET_NOR_7310B   53    /* Norstar 7310 BLF */
           LF
#define    SET_NOR_7324    54    /* Norstar 7324 */
#define    SET_ATT_7405    70    /* AT&T 7405 */
#define    SET_ATT_7406    71    /* AT&T 7406 */
#define    SET_ATT_7407    72    /* AT&T 7407 */
#define    SET_ATT_7434    73    /* AT&T 7434 */
#define    SET_ISON_1      90    /*ISON 1 */
```

BYTE Connections; A mask of all of the physical phone connections made to the system. Multiple phones may be connected at any time. If the bit represented by the following defines is set in this field, the associated unit considered connected.

```
#define    PHONE_NONE      0x00   /* No phones connected */
#define    PHONE_ADJUNCT   0x01   /* the Standard digital set */
#define    PHONE_AUX       0x02   /* phone app via debug port */
#define    PHONE_CONF      0x04   /* conference speaker phone */
```

BYTE ActivePhone; Identifies which physical phone unit is currently active. A phone is defined to be active if it has control of the voice channel. The valid values for this field are the same as those defined for the "Connections" field above.

BYTE	TouchedPhone;	Identifies which physical phone unit was last used by the operator. This is used to determine the unit to receive "active" status. The valid values for this field are the same as those defined for the "Connections" field above.
BYTE	Carrier [2]	Identifies the carrier status of the switch and the phone. The first set of defines indexes the unit, the second set represents the status.

```
#define    CARRIER_DEVICE_SWITCH    0/* switch device */
#define    CARRIER_DEVICE_ADJUNCT   1/* phone carrier
device */
#define    CARRIER_LEVEL_LOSS       0/* No carrier */
#define    CARRIER_LEVEL_GAIN       1/* Carrier */
#define    CARRIER_LEVEL_UNKNOWN    2/* Unknown carrier state */
```

BYTE	PassThroughFlags	A bit mask used to inform the abstraction layer which types of events should be passed between the switch and the phone, and which should be blocked.

```
#define    PASS_HOOK      0x01    /* hook switch from set */
#define    PASS_BUTTON    0x02    /* buttons from set */
#define    PASS_LAMP      0x04    /* lamp updates from switch */
```

```
#define    PASS_DISPLAY   0x08    /* display update switch */
#define    PASS_RINGER    0x10    /* ring updates switch */
```

BYTE VoiceMux;	Identifies the direction of each of the available bearer channels. This is a bit mask with each bit representing each of the channels. There is typically one bit for the voice channel, and at least one bit for available data channels. When the bit is low, the channel is directed to the adjunct digital telephone. When the bit is high, the channel is directed to the alternate device.

```
#define  VMUX_ADJUNCT   0       /* channel to digital set */
#define  VMUX_AUX       1       /* channel to alternate */
#define  VMUX_VOICE     0x01    /* bit 0 : voice channel */
#define  VMUX_DATA      0x02    /* bit 1 : 1st data channel */
#define  VMUX_DATA1     0X02    /* bit 1: 1st data channel */
#define  VMUX_DATA2     0x04    /* bit 2 : 2nd data channel */
```

Voice control structure

The following "C" language code defines the structure used to represent the state of the voice channel. A single instance of this structure is built into the main virtual phone structure.

```
typedefstruct           /* Virtual Phone Voice Structure */
BYTE          active;   /* 1=active 0=not active */
BYTE          unit;     /* mask active unit VOICE_???? */
BYTE          volume;   /* voice mute, low, high, etc. */
VP_VOICE
```

BYTE active; When TRUE, the voice path is currently active. When FALSE, the voice path is not active.

BYTE unit; Which unit (within the confines of the digital set) is currently used as the communications source.

```
#define  VOICE_HANDSET   0x10   /* Phone Handset Unit */
#define  VOICE_SPEAKER   0x20   /* Phone Speaker Unit */
#define  VOICE_HEADSET   0x30   /* Phone Headset Unit */
```

BYTE volume; The current sound level at which the system is operating.

```
#define    VOICE_MUTE      0x01      /* Volume is muted */
#define    VOICE_NORMAL    0x02      /* Volume is normal */
#define    VOICE_LOW       0x03      /* Volume is low */
#define    VOICE_HIGH      0x04      /* Volume is high */
```

Ringer control structure

The following "C" language code defines the structure used to represent the ring state of the virtual phone. A single instance of this structure is built into the main virtual phone structure.

```
typedefstruct             /* Virtual Phone Ringer Structure */
BYTE          active;     /* 1=active 0=not active */
```

```
BYTE            cadence;    /* list of current cadence type */
BYTE            tone;       /* list of current tone type */
VP_RINGER;
```

BYTE	active;	When TRUE, the ring state of the virtual phone is on. Typically, an audible ring indication can be heard. When FALSE, the ring state is off.
BYTE	cadence;	One of the many difference types of ring cadence patterns a phone may select. This is valid when the ring state is active.

```
#define   RINGER_CAD_OFF      1      /* ring off */
#define   RINGER_CAD-ON       2      /* ring on steady */
#define   RINGER_CAD_2        3      /* ring some on/off comb. */
```

BYTE	tone;	Once of the many different ring tones a phone may select. This is valid when the ring state is active.

```
#define   RINGER_TONE_OFF   1   /* tone off */
#define   RINGER_TONE_A     2   /* tone A */
#define   RINGER_TONE_B     3   /* tone B */
#define   RINGER_TONE_C     4   /* tone C */
#define   RINGER_TONE_D     5   /* tone D */
#define   RINGER_TONE_E     6   /* tone E */
#define   RINGER_TONE_F     7   /* tone F */
#define   RINGER_TONE_G     8   /* tone G */
#define   RINGER_TONE_H     9   /* tone H */
```

Display control structure

The following "C" language code defines the structure used to represent the LCD display of the virtual phone. A single instance of this structure is built into the main virtual phone structure.

```
typedefstruct                    /* Virtual Phone Display
                                 Structure */
BYTE        grid[VP_MAXROWS]     /* The display text */
            [VPD_MAXCOLS];
VP_CURSOR   cursor[VPD_          /* current cursors*/
            MAXCURSORS];
BYTE        NumRows;             /* Number of Rows on this page */
BYTE        NumColumns;          /* Number of Columns on this page */
BYTE        NumCursors;          /* Number of available cursors */
BYTE        IsStable;            /* True if the display has
                                 stabilized */
BYTE        IsClear;             /* True if the display is clear */

VP_DISPLAY;
```

BYTE grid[VP_MAXROWS] [VPD_MAXCOLS];	The 2 dimensional array containing the characters on the display of the virtual phone. Each cell of the grid contains the character value in ASCII format. VPD_MAXROWS and VPD_MAXCOLS can be defined to support virtual displays of various sizes.
VP_CURSOR cursor [VPD_MAXCURSORS];	A list of cursors that are used

		by the display. Some displays have a single cursor, some have multiple cursors. This structure gives the abstraction layer control of all used cursor positions.
BYTE	NumColumns;	Number of columns on the display for the current virtual phone implementation.
BYTE	IsStable;	This is true if the display has been stable for a period of time determined by the abstraction layer. Only when the display goes stable does the information get transferred to the host.
BYTE	IsClear;	True if the display is clear.

The following "C" language code defines the structure used to represent a cursor device of the virtual phone. The display functions may use several cursors which must be maintained in order to generate the correct display. This structure is part of the main display structure.

```
typedef struct                  /* Virtual Phone Cursor Structure */
{
    BYTE    row;    /* Current row for this cursor */
```

```
                BYTE    col;    /* Current column for this cursor */
} VP_BUTTON;
```

BYTE row; Current row for this cursor within the current display.

BYTE col; Current column for this cursor within the current display.

Button/Lamp control structure

The following "C" language code defines the structure used to represent a button/lamp device of the virtual phone. The main virtual phone structure uses a list of these items to represent all of the possible buttons/lamps on a phone.

```
typedefstruct                   /* Virtual Phone Button/Lamp
                                Structure */
BYTE            deviceMask;     /* mask showing which of next 4 are
                                valid */
BYTE            press ID;       /* ID of button press info */
BYTE            release ID;     /* ID of button release info */
BYTE            lamp1ID;        /* ID of first lamp */
BYTE            lamp2ID;        /* ID of second lamp */
BYTE            buttonState;    /* state of button: 1=down  0=up */
BYTE            lamp1State;     /* state of first lamp */
BYTE            lamp2State;     /* state of second lamp */
VP_BUTTON;
```

BYTE deviceMask; A mask which identifies the available components of the button/lamp. In some cases, button may exist without a lamp, in others, 2 lamps may relate to a single button.

Also, some buttons have press and release codes, while others only have a press code. This mask validates the fields "pressID", "releaseID", "lamp1ID", and "lamp2ID" by setting the associated defined bit.

```
#define    VDP_MASKPRESS     0x01   /* "pressID" is valid */
#define    VDP_MASKRELEASE   0x02   /* "release ID" is valid */
#define    VDP_MASKLAMP1     0x04   /* "lamp1ID" is valid */
#define    VDP_MASKLAMP2     0x08   /* "lamp2ID" is valid */
```

`BYTE pressID;` The raw integration dependent ID sent to the switch when the button is pressed. This field is only valid when the VDB_MASKPRESS bit is set in the "deviceMask" field. Typically, all keys have this field active.

`BYTE releaseID;` The raw integration dependent ID sent to the switch when the button is released. This field is only valid when the VPB_MASKRELEASE bit is set in the "deviceMask" field. Typically, keypad buttons do not use a release ID.

`BYTE lamp1ID;` The raw integration dependent ID sent by the switch during a lamp update. This field is only valid when the

VPB_MASKLAMP1 bit is et in the "deviceMask" field. Buttons that do not have associated lights (such as keypad buttons) will not use this field.

BYTE lamp2ID; The raw integration dependent ID sent by the switch during a lamp update. This field is only valid when the VPB_MASKLAMP2 bit is set in the "deviceMask" field. AT&T is the only integration known to use a second lamp for a button/lamp device.

BYTE buttonState; Current state of the button. All buttons can be pressed or released. The hook switch is considered pressed when off hook, and released when on hook.

```
#define BUTTON_PRESS    1    /* button press */
#define BUTTON_RELEASE  2    /* button release */
```

BYTE lamp1State; Current state of the first (primary) lamp. The lamp can be in any of the following states.

```
#define LAMP_STATE_OFF      1   /* lamp off */
#define LAMP_STATE_ON       2   /* lamp on */
#define LAMP_STATE_FLASH    3   /* lamp flashing */
```

```
#define  LAMP_STATE_FLUTTER   4   /* lamp fluttering */
#define  LAMP_STATE_WINK      5   /* lamp winking */
#define  LAMP_STATE_FLICKER   6   /* lamp flickering */
#define  LAMP_STATE_MISC1     7   /* lamp misc */
```

BYTE lamp2State; Current state of the second lamp (AT&T is the only switch that uses this). The lamp can be in any of the states as in the "lamp1State" field.

Button/Lamp index descriptions

In the main virtual phone structure, the field "VP_BUTTON button [VP_MAXBUTS]" is used to store the button/lamp information for the virtual phone. The define VP_MAXBUTS determines the maximum number of buttons/lamps the virtual phone can contain. There are standard buttons in all configurations of the virtual phone. There are also additional buttons that may vary from phone to phone. The values shown below define the indices into the array of button/lamp control structures within the main virtual phone.

```
#define  KEY_HOOK         0    /* Hook switch key */
#define  KEY_HOLD         1    /* Hold key */
#define  KEY_XFER         2    /* Transfer key */
#define  KEY_RELEASE      3    /* Release key */
#define  KEY_PAD          4    /* Key Pad 0-9, *, # */
#define  KEY_NONFIXED     16   /* -start of non-fixed buttons- */
#define  KEY_PRIME        16   /* Prime Line */
#define  KEY_OTHER        17   /*   */
```

KEY_HOOK	The hook switch. When pressed, it is considered off hook. When released, on hook. All integrations have this key.
KEY_HOLD	The standard hold key. All integrations have this key.
KEY_XFER	The transfer key. Some integrations have this key.
KEY_RELEASE	The release key. Some integrations have this key.
KEY_PAD	The start of the key pad keys. The sequence of keys are in the following order. 0 through 9, *, and #. All integrations have these keys.
KEY_NONFIXED	The starting ID of the non-fixed keys. Keys at this index for higher can be custom configured.
KEY_PRIME	The key associated with a prime line. When the switch has a prime line configured for a phone, this index should reference that key.
KEY_OTHER	Additional keys. Configuration is flexible.

VPAPI (Virtual Phone Application Program Interface)

Access to the virtual phone structures is available through a set of symmetric functions known as the VPAPI 22 and 24. The VPAPI 22, 24 provides a mechanism to transfer data between the virtual phone data structures

20, and all devices (such as the switch 12, phones 14, and the external device 16). The data structures 20 are changed only via this interface, never directly by an external function 16. All elements of the data structures 20 can be modified, and read through the VPAPI 22, 24. Whenever the abstraction layer software 28 receives a change from the switch 12, digital phone 14, or external device 16, a call is made to a VPAPI function with parameters specifying the update request. The VPAPI function first validates the command request, and then makes the appropriate modification to the virtual phone structure.

As shown in Fig. 3, for different switches 12a, 12b, 12c and 12d and phones 14a, 14b, 14c, 14d from various vendors different abstraction layers 28a, 28b, 28c and 28d are provided. The VAPI 22, 24 also provide data transfer between the virtual phone data structures 20 and various devices such as serial devices 60, DSP 62, conference phones 64 and other devices 66.

Whenever a valid state change is made to the virtual phone structure 20, the VPAPI 24 calls a second function which is responsible for converting the information into a generic protocol (Host Interface 26), and transmitting it via the host interface 16 to the host system.

The abstraction layer 28 (and external device queries) often need information on the current state of the virtual phone. Symmetric VPAPI 22, 24 functions are used for this purpose and for all aspects of data access. In order to retrieve current status information and pass that information to the abstraction layer 28 and an external device 16, a function beginning with "vp_Get" is used. To modify data, "vp_Set" is used,

which in turn automatically calls a function beginning with "vp_Send" for external transfer. Or, for example, to set a light state in the virtual phone structure, a call is made to "vp_SetLampState" with the lamp ID and state as parameters. For the abstraction layer 28 or external device 16 to get the light state, a call to the symmetric function "vp_GetLampState" is made.

The abstraction layer 28 (and external device queries) often need information regarding the current state of the virtual phone. Symmetric VPAPI functions are available for this purpose. Thus, during the processing of switch and phone packets, the abstraction layer 28 often calls the VPAPI functions 22, 24 to maintain current status of the digital phone 14 in the virtual phone data structures 20. Primarily, the "vp_Set" type functions are used. When a simulated event occurs, such as a generic cordless unit going off hook, the application code may also make a call to the "vp_Set" function, causing the system to be in the off hook state. Also note that in order for the simulated event to affect the switch, it must pass through the abstraction layer through an API function of the form "vprolm_DoButton" for example.

The hardware abstraction layer 28 is not part of the virtual phone, but is a system component used to interface between the switch 12 (and phone 14) and the virtual phone 18. The specifications for building this block vary for each switch type. In the example of Fig. 4, building of an ISDN integration is shown for use with an ISDN switch 72 and ISDN phone 74.

The first layer 80 (Physical layer) of the hardware abstraction can be build based on the international standards ITU I-series and ITU G-series documents. The

second layer 82 (Data Link layer) is defined in the ITU Q.920 through Q.923 documents. The third layer 84 (Network layer) is defined in the ITU Q.930 through Q.939 documents. These specifications taken together define how to build the hardware abstraction block 28 for virtual phone support built on top of an ISDN switch.

Initialization Functions

The following functions are used for initialization and are typically only called system on startup.

vp_init()	Performs general virtual phone initialization such as allocating data and variable initialization. This function is called by the main application once during startup.
vp_init_pbx_type()	Performs initialization specific to a particular switch. This function is called automatically by the virtual phone system when the VPAPI function "vp_SetPbxType" is called. Normally, this happens only once at startup.
vp_init_set_type()	Performs initialization specific to a specific digital telephone. This function is called automatically by the virtual phone system when the VPAPI function "vp_SetSetType" is called. Normally, this happens only once at startup.

Configuration Control Functions

These functions are used to manage system configuration information between the main application and the virtual phone.

```
vp_SendPbxType(BYTE resp)
vp_GetPbxType(BYTE *type)
vp_SetPbxType(BYTE type)
```

The foregoing three functions configure the virtual phone 20 with the current physically connected type of switch 12. After the main application determines which switch is connected, it calls the Set function. The Set function automatically call vp_init_pbx_type().

type One of the following defined variables representing the switch type.

PBX_NONE	No switch connected (default)
PBX_ATT	AT&T switch connected
PBX_M1	Meridian switch connected
PBX_NORSTAR	Norstar switch connected
PBX_ROLM	Rolm switch connected

resp The type of data to be transmitted to the serial port.

QUERY_RESPONSE	No change, serial packet is due to a query
DELTA_RESPONSE	The state of the virtual phone has changed

```
vp_SendSetType(BYTE resp)
```

vp_GetSetType(BYTE *type)
vp_SetSetType(BYTE type)

The foregoing three functions configure the virtual phone 20 with the current physically connected type of digital telephone. After the main application 16 determines which digital phone is connected, it calls the Set function. The Set function automatically calls vp_init_set_type().

type One of the following defined variables representing the switch type.

SET_NONE	No digital phone connected (default)
SET_UNKNOWN	Digital set of unknown type connected
SET_ROLM_400	Rolm RP400 set connected
SET_ROLM_240	Rolm RP240 set connected
SET_ROLM_120	Rolm RP120 set connected
SET_ROLM_600	Rolm 600 series set connected
SET_ROLM_300	Rolm 300 series set connected
SET_M1_2616	Meridian 2616 set connected
SET_NOR_7310	Norstar 7310 set connected
SET_NOR_7208	Norstar 7208 set connected
SET_NOR_7100	Norstar 7100 set connected
SET_NOR_7310BLF	Norstar 7310 BLF set connected
SET_NOR_7324	Norstar 7324 set connected

resp The type of data to be transmitted to the serial port 26.

QUERY_RESPONSE	No change, serial packet is due to a query
DELTA_RESPONSE	The state of the virtual phone has changed

vp_SendConnections(BYTE resp)
vp_GetConnections(BYTE *mask)
vp_SetConnections(BYTE mask)

The foregoing three functions configure the virtual phone 20 with a list of physically connected phones. The main application 16 will determine the types of phone units that will have access to the system. Once determined, it calls this functions with a mask representing current connections.

mask A bit mask used to correspond to up to 8 phone units. If the bit for given phone type is on in the mask, that phone is connected in the system.

PHONE_NONE	No phones connected (default)
PHONE_ADJUNCT	The compatible digital phone is connected
PHONE_AUX	The serial link based phone is connected
PHONE_CS1000	The analog conference phone is connected

resp The type of data to be transmitted to the serial port 26.

QUERY_RESPONSE	No change, serial packet is due to a query

DELTA_RESPONSE The state of the virtual phone has changed

Voice MUX Control Functions

When multiple phones are connected to the system at one time, it is necessary to maintain which of the phones is physically in use. The virtual phone 20 needs this information so that it can direct voice data to the proper phone. Once a phone has "control" of the voice, the virtual phone 20 is responsible for blocking other units from taking dangerous actions (such as terminating the call).

The key elements the virtual phone 20 is concerned with are the current control, and the last touched unit. These values enable the virtual phone to manage call control seamlessly between connected phone units.

```
vp_SendActivePhone(BYTE resp)
vp_GetActivePhone(BYTE *type)
vp_SetActivePhone(BYTE type)
```

The foregoing three functions configure the virtual phone 20 with the current active phone 14. A phone is considered active if the voice path is active, and is directed toward that phone. The active phone is also known to be the phone with "control".

type The phone type ID of the connected phones that currently has control. The phone type must be in the connections mask list.

PHONE_NONE Idle, no phones have control (default)

PHONE_ADJUNCT	The compatible digital phone has control
PHONE_AUX	The serial link based phone has control
PHONE_CS1000	The analog conference phone has control

resp The type of data to be transmitted to the serial port.

QUERY_RESPONSE	No change, serial packet is due to a query
DELTA_RESPONSE	The state of the virtual phone has changed

```
vp_SendTouchedPhone(BYTE resp)
vp_GetTouchedPhone(BYTE *type)
vp_SetTouchedPhone(BYTE type)
```

The foregoing three functions configure the virtual phone 20 with the last touched phone. When the user presses a button, or goes off hook on a particular phone, it is considered touched. When a call is terminated, no phones are considered touched. The phone to go active will always be the phone with the current touched status.

type The phone type ID if the connected phones that was last used by the operator. The phone type must be in the connections mask list.

PHONE_NONE	Idle, no phones have control (default)

	PHONE_ADJUNCT	The compatible digital phone has control
	PHONE_AUX	The serial link based phone has control
	PHONE_CS1000	The analog conference phone has control

resp The type of data to be transmitted to the serial port.

QUERY_RESPONSE	No change, serial packet is due to a query
DELTA_RESPONSE	The state of the virtual phone has changed

Voice Control Functions

The functions are used to manage all voice related information within the virtual phone 20. Voice active status, volume, and physical unit on a phone are all maintained.

```
vp_SendVoiceState(BYTE resp)
vp_GetVoiceLevel(BYTE *level)
vp_GetVoiceUnit(BYTE *unit)
vp_GetVoiceVolume(BYTE *volume)
vp_SetVoiceLevel(BYTE level)
vp_SetVoiceUnit(BYTE unit)
vp_SetVoiceVolume(BYTE volume)
```

The foregoing seven functions configure the virtual phone 20 with the current voice status. Whenever the switch 12 activates or deactivates the voice path, these functions are called. Some switches and phones have

the ability to activate the voice path at different volumes, and on different units (such as headset or speakerphone).

level When TRUE, the system voce path is active. When FALSE, it's inactive. See vp_GetActivePhone to determine which phone has control of the voice path.

unit The unit on the phone which is in use by the operator.

VOICE_HANDSET	The standard handset found on most phones
VOICE_SPEAKER	The speaker/microphone (found on some phones)
VOICE_HEADSET	An auxiliary headset unit (usually a separate plug in device)

volume The volume at which voice can be heard through the phone.

VOICE_MUTE	Voice active, but volume muted
VOICE_NORMAL	Normal voice volume
VOICE_LOW	Volume audible, but lower than normal
VOICE_HIGH	Volume higher than normal

resp The type of data to be transmitted to the serial port.

QUERY_RESPONSE	No change, serial packet is due to a query

DELTA_RESPONSE The state of the virtual phone has changed

Ringer Control Functions

These functions are used to manage all ringer related information within the virtual phone 20. Ringer active status, cadence, and tone during ring are all maintained.

```
vp_SendRingerState(BYTE resp)
vp_GetRingerLevel(BYTE *level)
vp_SetRingerCadence(BYTE *cadence)
vp_GetRingerTone(BYTE *tone)
vp_SetRingerLevel(BYTE level)
vp_SetRingerCadence(BYTE cadence)
vp_SetRingerTone(BYTE tone)
```

The foregoing seven functions configure the virtual phone 20 with the current ringer status. Whenever the switch 12 turns the audible ringer on or off, these functions are called. Different switches use different ring cadences and ring tones. The virtual phone 20 maintains this information.

level When TRUE, the ringer is considered active. On some switches, the ringer may be active for the full duration of a ring cycle. In others, it may be active only when the audible ringing sound is heard. When FALSE, the ringer is not active.

cadence The cadence at which the switch is sending the ring signal.

RINGER_CAD_OFF	No ring cadence
RINGER_CAD_ON	Standard ring cadence active
RINGER_CAD_2	Alternate ring cadence active

tone The tone at which the ring is heard.

RINGER_TONE_OFF	No audible tone
RINGER_TONE_A	Tone A
RINGER_TONE_B	Tone B
RINGER_TONE_C	Tone C
RINGER_TONE_D	Tone D
RINGER_TONE_E	Tone E
RINGER_TONE_F	Tone F
RINGER_TONE_G	Tone G
RINGER_TONE_H	Tone H

resp The type of data to be transmitted to the serial port.

QUERY_RESPONSE	No charge, serial packet is due to query
DELTA_RESPONSE	The state of the virtual phone has changed

Lamp Control Functions

These functions are used to manage all lamp (LED or light) related information within the virtual phone 20. Many lamps typically exist on a given system. The virtual phone has the facility to store the state of any of these lamps. It is also possible to pass the lamp update information directly to the host system. In this case, the virtual phone just passes the information through without maintaining it.

In the case where the lamp is stored in the virtual phone, any of the functions can be used to read or write data. The functions with the "V" in the name require the virtual phone index of the lamp. The remaining functions work directly with the raw ID. The "Ex" of extended functions allow for multiple bytes of raw ID information.

When the lamp status is not maintained within the virtual phone structures, only the functions working with the raw IDs can be used. These functions will simply pass the update information directly to the host without storing any information within the virtual phone structures.

```
vp_SendVLampState(BYTE resp, BYTE vid)
vp_SendLampState(BYTE resp, BYTE len, BYTE*rawidlist,
BYTE state)
vp_GetVLampState(BYTE vid, BYTE *state)
vp_SetVLampState(BYTE vid, BYTE state)
vp_SetLampState(BYTE rawid, BYTE state)
vp_SetLampState(BYTE len, BYTE *rawidlist, BYTE state)
```

rawid The raw ID sent from the switch. The virtual phone checks to see if this lamp is configured as part of the defined phone. If so, a look up is done to get the virtual index (vid) of the correct button/lamp index.

rawidlist A list of raw IDs sent from the switch. This is used when more than one byte of information is needed to reference the lamp. The "len" parameter is used to define the number of bytes in this list.

len The number of bytes in the "rawidlist".

state The state of the lamp.

LAMP_STATE_OFF	Lamp is dark
LAMP_STATE_ON	Lamp light is on steady
LAMP_STATE_FLASH	Lamp is on in a flashing pattern
LAMP_STATE_FLUTTER	Lamp is on in a fluttering pattern
LAMP_STATE_WINK	Lamp is on in a winking pattern
LAMP_STATE-FLICKER	Lamp is on in a flickering pattern
LAMP_STATE_MISC1	Lamp is on in an unknown pattern

vid The ID within the virtual phone 20 for the lamp. Each Button/Lamp control structure has fields for lamp information. Only certain buttons/lamps are defined to be as part of the virtual phone 20. This field is an index into the virtual phone's button/lamp structure. (see section Button/Lamp index descriptions)

resp The type of data to be transmitted to the serial port 26.

QUERY_RESPONSE	No change, serial packet is due to a query
DELTA_RESPONSE	The state of the virtual phone has changed

Button Control Function

These functions are used to manage all button and hook switch related information within the virtual phone. A hook switch and many buttons typically exist on a given system. The virtual phone has the facility to store the state of any of these buttons. It is also possible to pass the button press/release information directly to the host system. In this case, the virtual phone just passes the information through without maintaining it.

The hook switch is considered a button and is always defined as button number zero in the virtual phone.

In the case where the button is stored in the virtual phone, any of the functions can be used to read or write data. The functions with the "V" in the name require the virtual phone index of the button. The remaining functions work directly with the raw ID. The "Ex" of extended functions allow for multiple bytes of raw ID information.

When the button status is not maintained within the virtual phone structures, only the functions working with the raw IDs can be used. These functions will simply pass the update information directly to the host without storing any information within the virtual phone structures.

```
vp_SendVButtonState(BYTE resp, BYTE vid)
vp_SendButtonState(BYTE resp, BYTE len, BYTE*rawidlist,
BYTE state)
vp_GetVButtonState(BYTE vid, BYTE *state)
```

```
vp_SetVButtonState(BYTE vid, BYTE state)
vp_SetButtonState(BYTE rawid, BYTE state)
vp_SetButtonState(BYTE len, BYTE *rawidlist, BYTE state)
```

rawid The raw ID sent from the switch. The virtual phone 20 checks to see of this button is configured as part of the defined phone. If so, it is used to reference the correct button/lamp index.

rawidlist A list of raw IDs sent from the switch. This is used when more than one byte of information is needed to reference the button. The "len" parameter is used to define the number of bytes in this list.

len The number of bytes in the "rawidlist".

state The state of the button or hook switch. Buttons can be either pressed or released. The hook switch is considered pressed when off hook, and released when on hook.

BUTTON_PRESS	Button has been pressed
BUTTON_RELEASE	Button has been released

vid The ID within the virtual phone 20 for the button or hook switch. Each Button/Lamp control structure has fields for button information. Only certain buttons/lamps are defined to be as part of the virtual phone. This field is an index into the virtual phone's button/lamp structure. (see section Button/Lamp index descriptions)

resp The type of data to be transmitted to the serial port.

QUERY_RESPONSE	No change, serial packet is due to a query
DELTA_RESPONSE	The state of the virtual phone has changed

Hook Switch Control Functions

The hook switch is just a button. Button index zero is always fixed to the hook switch. Because of this, the button API calls can be used for hook switch control. However, for simplication sake, a set of API function are provided for direct hook switch control.

```
vp_SendHookState(BYTE resp)
vp_SetHook State(BYTE state)
vp_GetHookState(BYTE *state)
```

state The state of the book switch.

HOOK_OFF	Off hook (Same as button press)
Hook_ON	On hook (Same as button release)

resp The type of data to be transmitted to the serial port.

QUERY_RESPONSE	No change, serial packet is due to a query
DELTA_RESPONSE	The state of the virtual phone has changed

Display Control Functions

The virtual phone supports the ability to maintain a flexible display. These functions provide the abstraction layer the ability to build the display in a way similar to how the switch puts information on the display.

The abstraction layer calls the "update" functions to send text changes to the display as they are received from the switch. Addressing is either direct (by row and column number), or based on a cursor position. The switch often clears single rows or even the entire display with one command. An API function exists for each of these tasks.

Often, more than one cursor exists for a given display. The abstraction layer passes the cursor index whenever a display update at cursor type command is given. An API command exists to maintain each current cursor position.

When the display has been stable (has not changed) for a given period of time, or the switch sends a "display stable" command, the abstraction layer calls the "vp_dDisplayIsStable" function. This triggers the virtual phone to send the display contents to the host.

```
vp_SendDisplay(BYTE resp)
vp_dDisplayIsStable()
vp_dClearDisplay()
vp_dClearRow(BYTE row)
vp_dSetCursor Position(BYTE cindex, BYTE row, BYTE col)
vp_dUpdateCharAtCursor (BYTE cindex, BYTE ch)
vp_dUpdateTextAtCursor (BYTE cindex, BYTE *txt, BYTE
len)
```

vp_dUpdateCharAbsolute (BYTE row, BYTE col, BYTE ch)
vp_dUpdateTextAbsolute (BYTE row, BYTE col, BYTE *txt, BYTE len)

cindex The index of the cursor to be used to execute the function. This index is maintained separately and contains a row and column of where the text will be displayed.

row The row number on which the text will be displayed.

col The column number on which the text will be displayed.

resp The type of data to be transmitted to the serial port.

QUERY_RESPONSE No change, serial packet is due to a query

DELTA_RESPONSE The state of the virtual phone has changed

ch The ASCII character to be displayed.

txt The ASCII text string to be displayed.

len The number of characters in the ASCII text string to be displayed.

Carrier Control Functions

The virtual phone maintains the carrier state of the switch, and the adjunct digital phone. This information is available via the following functions.

```
vp_SendCarrier(BYTE resp, BYTE device)
vp_SetCarrier(BYTE device, BYTE level)
vp_GetCarrier(BYTE device, BYTE *level)
```

device The physical device.

CARRIER_DEVICE_SWITCH	The switch
CARRIER_DEVICE_ADJUNCT	The adjunct digital phone

level The carrier level

CARRIER_LEVEL_LOSS	No carrier for the device
CARRIER_LEVEL_GAIN	The device has carrier
CARRIER_LEVEL_UNKNOWN	Carrier state unknown

resp The type of data to be transmitted to the serial port.

QUERY_RESPONSE	No change, serial packet is due to a query
DELTA_RESPONSE	The state of the virtual phone has changed

Pass Through Control Functions

It is possible to block certain types of messages between the switch and the digital phone. The pass through flags set which messages are allowed to pass through, and which are blocked. The following APIs provide this functionality.

```
vp_SendPassThroughFlags(BYTE resp)
vp_SetPassThroughFlags(BYTE flags)
vp_GetPassThroughFlags(BYTE *flags)
```

flags A bit mask with each bit representing a different pass through mode. If the bit is set, the message is allowed to pass. If cleared, the message is blocked.

PASS_HOOK	hook switch from digital set
PASS_BUTTON	button presses/releases from digital set
PASS_LAMP	lamp updates from switch
PASS_DISPLAY	display updates from switch
PASS_RINGER	ringer updates from switch

resp The type of data to be transmitted to the serial port.

QUERY_RESPONSE	No change, serial packet is due to a query
DELTA_RESPONSE	The state of the virtual phone has changed

Bearer Channel Control Functions

The voice and data channels can be routed normally to the adjunct digital phone, or to another device. These functions control the routing of these bearer channels. The system may want to instruct the virtual phone to send voice or data information to a unit other than the adjunct phone such as a conference phone or a DSP for processing.

Since the digital data link between the switch and the phone typically provides a voice channel and at least one data channel, these functions use a bit mask to identify which of the channels to control.

```
vp_SendVoiceMux(BYTE resp)
vp_SetVoiceMux(BYTE devicemask, BYTE unit)
vp_GetVoiceMux(BYTE devicemask, BYTE*unit)
```

devicemask	A bit mask with each bit representing one of the bearer channels to direct with the command	
	VMUX_VOICE	voice channel
	VMUX_DATA	data channel
	VMUX_DATA1	primary data channel
	VMUX_DATA2	secondary data channel
unit	The device where the channel is to be directed.	
	VMUX_ADJUNCT	Adjunct digital telephone
	VMUX_AUX	The other connected unit (DSP, conference phone, etc.)
resp	The type of data to be transmitted to the serial port.	
	QUERY_RESPONSE	No change, serial packet is due to a query

DELTA_RESPONSE The state of the virtual phone has changed

Virtual Phone Host Interface Protocol

Communications between the virtual phone 20 and the external device, i.e. host system, is accomplished via an internally designed custom protocol called the Virtual Phone Host Interface Protocol (VPHIP) 26. Any time the virtual phone changes, a VPHIP packet is sent out to the host reflecting the update to the virtual phone structure. This keeps the auxiliary PC 16 up to date at all times with the current status of the virtual phone.

The auxiliary PC 16 also has the ability to manipulate the virtual phone by sending VPHIP packets across the link. The virtual phone parses the VPHIP packet and calls the appropriate VPAPI function, which in turn may update the virtual phone structure.

The functionality and structure of VPHIP is described as follows:

Packet Format

All packets adhere to the following format:

Length	Description	Value
1 Byte	Header	see note
1 Byte	Packet Length	variable
1 Byte	Packet Description	see below sections
Variable	Packet Data	see below sections

The header byte follows specific rules. Any message originating from the switch 12 has a header of 0x01. Messages from the adjunct phone 14 have header 0x02. Messages from the auxiliary PC 16 have header 0x04. Informational messages (such as PBX type) have header 0x00. Queries, and responses to queries turn on the upper most bit of the header which result in header codes of 0x08, 0x81 and 0x82.

System Information messages

System information packets are used to communicate phone status information between the internal virtual phone 20 and the auxiliary PC 16. All system information packets have a header value of 0x00.

Carrier State

These packet types are used to identify the carrier condition of the switch or the digital telephone.

Byte	Description	Value
0	Header	0x00
1	Packet Length	4
2	Carrier (Switch)	0xB0
3	Carrier Level	
	No Carrier	0
	Carrier	1
	Unknown	2
	Condition	

Byte	Description	Value
0	Header	0x00
1	Packet Length	4
2	Carrier (Digital Set)	0xB1
3	Carrier Level	

No Carrier	0
Carrier	1
Unknown	2
Condition	

Adjunct Phone Type

The adjunct phone type packet is used to identify the type of digital phone (if any) that is physically connected to the interface board.

Byte	Description	Value
0	Header	0x00
1	Packet Length	4
2	Adjunct Phone Type	0xF1
3	Phone Index	
	None	0
	Unknown	1
	Rolm RP400	10
	Rolm RP240	11
	Rolm RP120	12
	Rolm RP600	13
	Rolm RP300	14
	M1 2616	30
	Norstar 7310	50
	Norstar 7208	51
	Norstar 7100	52
	Norstar 7310 BLF	53
	Norstar 7324	54
	AT&T 7405	70
	AT&T 7406	71
	AT&T 7407	72
	AT&T 7434	73

Current Active Phone

When more than one phone is connected to the interface board at the same time, it is often necessary to know which unit is actively communicating with the switch 12. This is necessary to establish such things as voice routing, and button filtering. This packet returns the physical phone description that is currently active.

Byte	Description	Value
0	Header	0x00
1	Packet Length	4
2	Active Phone Type	0xF2
3	Unit Index	
	None	0x00
	Adjunct Digital Set	0x01
	Auxiliary	0x02
	Conference Phone	0x04
	future use	0x08...

Last Touched Phone

When more than one phone is connected to the interface board at the same time, the user may operate either unit to make and receive calls. Knowing which physical unit was last touched enables the virtual phone 20 to route voice and control to the appropriate unit.

Byte	Description	Value
0	Header	0x00
1	Packet Length	4
2	Touched Phone Type	0xF3
3	Unit Index	
	None	0x00

Adjunct Digital Set	0x01
Auxiliary	0x02
Conference Phone	0x04
future use	0x08...

Physical Connections

The virtual phone 20 may support several controlling and/or monitoring devices simultaneously. This command is used to transfer the current configuration information. The connection information is stored as a bit mask providing space for up to 8 physical devices.

Byte	Description	Value
0	Header	0x00
1	Packet Length	4
2	Physical Cncts Type	0xF4
3	Connections mask	
	None	0x00
	Adjunct Digital Set	0x01
	Auxiliary	0x02
	Conference Phone	0x04
	future use	0x08...

Messages from the switch

All messages originating from the switch 12 have a header value of 0x01.

Voice Status

The Voice Status packets are used to supply the current voice status to the auxiliary PC 16. The

physical unit being used, and the volume are also supplied.

Byte	Description	Value
0	Header	0x01
1	Packet Length	5
2	Voice Enable	0x10
3	Unit	
	Handset	0x01
	Speaker	0x02
	Headset	0x04
4	Volume	
	Mute	0
	Normal	1
	Low	2
	High	3

0	Header	0x01
1	Packet Length	3
2	Voice Disable	0x11

The Voice Enable command (0x10) explicitly activates the voice channel regardless of unit state. Voice Disable (0x11) explicitly de-activates voice. The Voice Status command (0x12) is a combination of the two where the presence of a bit in the unit mask is used to determine whether or not voice is active.

Byte	Description	Value
0	Header	0x01
1	Packet Length	5
2	Voice Status	0x12
3	Unit	
	Handset	0x01
	Speaker	0x02
	Headset	0x04
4	Volume	
	Mute	0
	Normal	1
	Low	2
	High	3

Ringer Status

The ringer status packets are used to supply ringer status to the auxiliary PC 16. In addition to ringer status, the cadence and ring tone are also supplied. In some switches, the ringer turns on and off with the audible sound while the calling party is attempting to connect. It may be beneficial to leave the ringer in the "on" state and have the virtual phone use the "cadence off" condition between audible rings. This will give feedback similar to that of using the LED for incoming call status.

Byte	Description	Value
0	Header	0x01
1	Packet Length	5
2	Ringer Active	0x20
3	Cadence	
	Off	0
	On	1
	#2	2
4	Tone	
	Off	1
	A	2
	B	3
	C	4
	D	5
	E	6
	F	7
	G	8
	H	9

Byte	Description	Value
0	Header	0x01
1	Packet Length	3
2	Ringer Inactive	0x21

Lamp Status (Generic)

The Lamp status packet is used to supply lamp (LED) information to the Auxiliary PC 16. The internal virtual phone lamp ID (not the switch's raw ID), and the flash rate are passed in the packet.

Byte	Description	Value
0	Header	0x01
1	Packet Length	5
2	Lamp Update	0x30
3	Flash Rate	
	Off	1
	On	2
	Flash	3
	Flutter	4
	Wink	5
	Flicker	6
	Misc1	7
4	Lamp ID	
	Prime Line	16
	Others	17

Lamp Status (Raw)

The Raw lamp status packet is used to supply lamp (LED) information to the auxiliary PC. The raw ID received from the switch (not the internal virtual phone ID), and the flash rate are passed in this packet.

In the case where lamps have multiple bytes for the ID, the additional bytes are placed at the end of the packet and the length is changed accordingly.

Byte	Description	Value
0	Header	0x01
1	Packet Length	4 + number of raw ID bytes
2	Lamp Update (Raw)	0x31

3	Flash Rate	
	Off	1
	On	2
	Flash	3
	Flutter	4
	Wink	5
	Flicker	6
	Misc1	7
4	Lamp raw ID byte #1	
5	[Lamp raw ID byte #2]	

Display Status

The Display status packets are used to supply display information to the auxiliary PC. These packets allow for portions of the display to be updated as they are received from the switch. The basis display packet supplies text and position information (the length can be extracted from the packet length byte). There are other special packets that can be used for scrolling of flashing characters on the auxiliary PC.

Byte	Description	Value
0	Header	0x01
1	Packet Length	5 + (length of text)
2	Display Update	0x40
3	Row	variable
4	Column	variable
5...	Text	"variable string"

The Clear Display packet can also be used to clear the entire display, or a single row of the display.

Byte	Description	Value
0	Header	0x01
1	Packet Length	4
2	Clear Display	0x41
3	Row	
	All rows	0
	Single row	row number

Messages from the Phone

All messages originating from the PBX 12 have a header value of 0x02.

Button Status (Generic)

The virtual phone 20 is configured with a set of generic buttons used across all switches. These buttons (and associated lamps, if any), have fixed identifiers. Only the buttons with identifiers assigned to the virtual phone function with this command.

The Button status packets are used to supply button press/release information originating from the adjunct phone to the auxiliary PC.

Byte	Description	Value
0	Header	0x02
1	Packet Length	4
2	Button Press (Generic)	0x50
3	ID	
	Hook Switch	0 (OFF hook)

Hold	1
Transfer	2
Release	3
Key Pad (0-9,*,#)	4-15
Prime Line	16
Others	17

Byte	Description	Value
0	Header	0x02
1	Packet Length	4
2	Button Press (Generic)	0x51
3	ID	
	Hook Switch	0 (ON hook)
	Hold	1
	Transfer	2
	Release	3
	Key Pad (0-9,*,#)	4-15
	Prime Line	16
	Others	17...

Button Status (Raw)

All buttons on all phones have a defined raw id. This command is used to transmit this raw id across the interface. Either this command, or the Generic button status command can be used to transmit button state changes.

In the case where buttons have multiple bytes for the ID, the additional bytes are placed at the end of the packet and the length is changed accordingly.

The Button status packets are used to supply button press/release information originating from the adjunct phone to the auxiliary PC.

Byte	Description	Value
0	Header	0x02
1	Packet Length	3 + # of bytes in raw ID
2	Button Press (Raw)	0x52
3	Raw ID byte #1	
4	[Raw ID byte #2]	

Byte	Description	Value
0	Header	0x02
1	Packet Length	3 + # of bytes in raw ID
2	Button Release (Raw)	0x53
3	Raw ID byte #1	
4	[Raw ID byte #2]	

Hook Switch Status

The virtual phone contains a single hook switch which represents the state of the physical hook switch on the phone. A packet is sent when the state of the hook switch changes.

Byte	Description	Value
0	Header	0x02
1	Packet Length	3
2	Hook Switch Up	0x54

Byte	Description	Value
0	Header	0x02
1	Packet Length	3
2	Hook Switch Down	0x55

Messages from the Auxiliary PC (Host)

All messages originating from the auxiliary PC 16 have a header value of 0x04. In many cases, the host 16 may emulate commands from the switch or the digital telephone. Any of the previously defined packets may be sent from the host. The header signals the virtual phone as to the source of the command so the appropriate action may be taken.

Button Control and Status

The virtual phone 20 is configured with a set of generic buttons used across all switches. These buttons (and associated lamps, if any), have fixed identifiers. Only the buttons with identifiers assigned to the virtual phone function with this command.

The auxiliary PC 16 uses the button control and status packets to transmit button change requests to the virtual phone. The effect of these packets on the virtual phone 20 is the same as if buttons were pressed on the adjunct phone directly. This protocol allows for auxiliary button press/release emulation.

Regardless if button changes originate on the adjunct phone or the auxiliary PC 16, the virtual phone 20 maintains the current button state. Whenever a button state changes, these same packets are used to transmit the new status to the auxiliary PC 16.

System State

When the host system is ready to receive messages from the virtual phone, it sends the enable command. This causes the virtual phone to send all virtual phone changes and system messages to the host via the host interface protocol. When the host is disabled, the virtual phone still maintains the state phone state, it just blocks the information from being transmitted to the host.

Byte	Description	Value
0	Header	0x04
1	Packet Length	4
2	System State	0x90
3	Level	
	Disabled	0
	Enabled	1

Pass Through Flags

The host system has the ability to request certain types of messages to be passed or blocked between the switch and the digital telephone. It is the responsibility of the virtual phone to maintain these flags and send only the specified packets between the units.

If the bit in the mask is set, the packet types are passed through. If cleared, they are blocked.

Byte	Description	Value
0	Header	0x04
1	Packet Length	4
2	Hook Switch Up	0x91
3	Flags	
	Hook Switch from Set	0x01
	Buttons from Set	0x02
	Lamp updates from switch	0x04
	Display from Switch	0x08
	Ringer from Switch	0x10

Dial Command

The host can request the virtual phone to dial a given string of digits. The virtual phone implements the button presses/releases and the necessary delays based on the parameters to the dial command. The dial string can contain any of the keypad buttons and the comma. The keypad buttons represent themselves and the commas represents a specified delay.

The digit duration (byte 3) of the command represents the length in milliseconds that the key is to be held down. The inter-digit duration is the length between key presses. The pause duration is the length of the pause (comma) character.

When the virtual phone completes the dialing, it sends a 3 byte version of this packet back to the host with only the header, length, and commands bytes.

Byte	Description	Value
0	Header	0x04
1	Packet Length	6+# of digits in dial string
2	Dial Command	0x93
3	Digit Duration	
4	Inter-Digit duration	
5	Pause Duration	
6	Dial string	

Bearer Channel Direction either the abstraction layer or the host system has the ability to direct the voice mux to their desired device. This device is typically either the adjunct digital phone, or an auxiliary unit. The virtual phone maintains the direction of the voice mux. In addition to voice, a number of additional channels can be controlled. This command is used to transfer mux direction status of all the bearer channels.

If the bit in the mask is set, the mux is directed to the auxiliary unit. if cleared, the channel is directed to the adjunct digital telephone.

Byte	Description	Value
0	Header	0x04
1	Packet Length	4
2	Voice Mux	0x93
3	Device Mask	
	Voice	0x01
	Data	0x02
	Data1	0x02
	Data2	0x04

Queries

The auxiliary PC 16 can query the virtual phone 20 for current status at any time. This is done by sending a command symmetric to the receive command for each status type. These commands are the same as the receive commands with the exception of the upper most bit of the header byte. When this bit is high, the virtual phone interprets this as a query and automatically responds with the current status.

For example, if the auxiliary PC 16 is requesting the ringer status, it sends the packet [81 04 20##] (where ## is irrelevant data). The virtual phone 20 will respond by transmitting [01 04 20 ##] or [01 04 21] (where ## is valid data) back to the auxiliary PC.

The valid query command IDs are:

0x54 Query Hook Switch Status
0x91 Query Pass Through Flags Status
0xB0 Query Switch Carrier Status
0xB1 Query Digital Phone Carrier Status
0x10 Query Voice Status
0x20 Query Ringer Status
0x30 Query Lamp Status
0x40 Query Display Status
0x50 Query Button Status
0xF0 Query Switch Type
0xF1 Query Adjunct Phone Type
0xF2 Query Current Active Phone
0xF3 Query Last Touched Phone

In connection with the foregoing description, Table I lists the data structures of virtual phone 20 and Table II lists various serial commands.

Table I - Virtual Phone Structures

```
typedef struct                  /* Virtual Phone Voice Structure */
{
    BYTE  active;               /* 1=active 0=not active */
    BYTE  unit;                 /* mask active unit UPV_???? */
    BYTE  volume;               /* voice mute, low, high, etc */
{VP_VOICE;
typedef struct                  /* Virtual Phone Ringer Structure */
    BYTE active;                /*1=active 0=not active */
    BYTE cadence;               /* list of current cadence type */
    BYTE tone;                  /*list of current tone type */
{VP_RINGER;
typedef struct                  /*virtual phone display structure*/
   BYTE row;                    /*Current row for this cursor*/
   BYTE col;                    /*Current column for this cursor*/
}VP_CURSOR:
typedef struct                  /*Virtual Phone Display Structure*/
{VP_CURSOR;
typedef struct                  /* Virtual Phone Display Structure */
   BYTE                         /* The display text */
grid[VPD_MAXROWS]
[VPD_MAXCOLS];
   BYTE  cursor                 /* current cursors */
{VPD_MAXROWS};
   BYTE  NumRows;               /*Number of Rows on this page*/
   BYTE  NumColumns             /*Number of Columns on this page*/
   BYTE  NumCursors;            /*Number of available cursors */
   BYTE  IsStable;              /*True if the display has stabilized*/
   BYTE  IsClear;               /*True if the display is currently clear*/
```

```
{VP_DISPLAY;
typedef struct                  /* Virtual Phone Button/Lamp Structure */
   BYTE  deviceMask;            /* mask showing which of next 4 are valid */
   BYTE  pressID;               /* ID of button press info */
   BYTE  releaseID;             /* ID of button release info */
   BYTE  lamp1ID;               /* ID of first lamp info */
   BYTE  lamp2ID;               /* ID of second lamp info */
   BYTE  buttonState;           /* state of button; 1=down  0=up */
   BYTE  lamp1State;            /* state of first lamp */
   BYTE  lamp2State;            /* state of second lamp */
{VP_BUTTON;
typedef struct                  /* Main Virtual Phone Structure */
{
   VP_VOICE  voice;             /* voice status */
   VP_RINGER ringer;            /* ringer status */
   VP_DISPLAY                   /* LCD display status */
   display;
   BYTE Hook Switch             /* Hook switch status */
   BYTE  num_buttons;           /* number of buttons actually in use */
   VP_BUTTON button             /* button/lamp status */
         [VP_MAXBUTS];
   BYTE  StandAlone;            /* Operate without Digital set */
   BYTE  SwitchType;            /* Type of switch connected */
   BYTE  DigSetType;            /* Type of configured digital SET, if any
   BYTE  Connections;           /* Which Phone Units are physically
                                connected */
   BYTE  ActivePhone;           /* Which Physical Phone Unit is active
   BYTE TouchedPhone;           /* Which Physical Phone Unit was touched
   BYTE  Carrier(2);            /* 0=switch 1=digital set*/
```

```
    BYTE                    /* event block flags */
PassThroughFlags;
    BYTE  VoiceMux;         /* Bearer channel direction*/
{  VIRTUAL_PHONE;
```

Table II - Brief Host Command List

Description	Header	Length	Com-mand	Data1	Data2	Data3
Voice Enable	P	05	10	Unit		
Voice Disable	P	03	11			Volume
Voice State	P	05	12	Unit		Volume
Ringer Enable	P	05	20	Cadence	Tone	
Ringer Disable	P	03	21			
Lamp (Generic)	P	05	30	status	ID	
Lamp (Raw)	P	04+ count	31	status	raw ID #1	[raw ID#2]
Display	P	05+ txt len	40	row	col	text...
Display Clear	P	03	41			
Button Press (Gen)	SHX	04	50	ID		
Button Release (Gen)	SHX	SHX	04	51 ID		
Button Press (Raw)	SHX	03+ count	52	raw ID #1	[raw ID #2...]	
Button Release (Raw)		SHX	03+ count	53 raw ID #1	[raw ID #2]	
Hook Switch Up	SHX	03	54			
Hook Switch Down	SHX	03	55			
System State	HX	04	90	Level		
Pass Through Flags	HX	04	91	Flags		
Dial Command	HX	09= digits	92	see note 1		

Bearer Channel Ctl	HX	04	93	Device mask
Carrier state -PBX	X	04	B0	Level
Carrier State -SET	X	04	B1	Level
PBX type	X	04	F0	type
SET type	X	04	F1	type
Active Phone	X	04	F2	unit
Touched Phone	X	04	F3	unit
Physical Cncts	X	04	F4	mask

P-PBX generated message
S- SET generated message
H- Host generated message
X -Firmware system generated message

note 1: parameters for dial command
data1: digit duration (high byte)
data2: digit duration (low byte)
data3: inter-digit duration (high byte)
data4: inter-digit duration (low byte)
data5: pause duration (high byte)
data6: pause duration (low byte)
data7:? dial string

The system of the present invention can be generalized in the form of the system of Fig. 5 including media control proxy 100, communication switch 102 and communication device or terminal 104. Switch 102 is analogous to PBX 12 in Fig. 1, terminal 104 is analogous to phone 14 in Fig. 1 and media control proxy 100 is a generalized form of the virtual phone 18 of Fig. 1. The Media Control Proxy (MCP) 100 is used as a gateway between some communications switching system, i.e. switch 102, and some terminal, i.e. terminal 104. The main purpose of the MCP is to bridge any gap in the communication protocols between the server device (the switch) 102 and the client (the terminal 104).

Communication device 104 is any device which originates and/or receives media including audio and visual, and device 104 can be a physical terminal or an emulation of a physical terminal in computer hardware including an application residing in a system.

In the minimum configuration of Fig. 5, the MCP 100 resides between the switch 102 and the terminal 104. Bearer channel data (voice, video, etc) is passed through by the MCP 100 on channels 110 and 112. The information on the control channels 114 and 116 is processed and converted to a protocol understood by the terminal 104. Depending on the type of terminal connected, this could be a proprietary protocol specific to the terminal, or it could be the MCP's standard protocol designed to communicate with a wide range of devices. Control channel 116 also may be viewed as an application program interface (API).

The MCP 100 interprets the information it receives from the control channel 114 of the switch 102 and maintains the state of the terminal 104 as defined by

the switch 102. As far as the switch 102 is concerned, the MCP 100 is the terminal 104. The MCP 100 also transmits data on the control channel 114 to the switch 102. It does this in the protocols native to the switch 102. The switch 102 interprets any messages coming from the MCP 100 as those coming from the terminal 104.

The MCP 100 can be configured to function in many different ways. The main point is that it has the ability to communicate with not only the native terminal for the switch, but that it can communicate with an unlimited selection of terminals or communications devices. The fixed (and sometimes proprietary) control protocol used in the original connection between the switch and native terminal is converted to whatever communications method is necessary to support any given terminal.

The type of terminal that may be connected to the MCP 100 is so flexible that the type of medium in which the data and control channels reside is also limitless. A direct proprietary connection is possible, as is a connection over a computer bus. It is also possible to route data and control channel information across new or existing networks. Means of wireless communications is supported. In fact, this system is set up to be configurable to operate with any terminal in whichever transport is desired. The MCP 100 handles the data preparation for any such configuration.

It is therefore apparent that the present invention accomplishes its intended objects. A telephone communication system is provided which converts proprietary PBX or external application protocols into a common format and thus functions as a protocol interpreter between proprietary switching system

protocols and the protocols of various applications. The virtual phone generic interface of the present invention is configurable and works independently of a specific type of integration and provides a common interface between any of the digital phone switches and any number of end devices. Changes in the virtual phone interface are communicated to an external processor which, in turn, can command changes in the virtual phone interface.

While an embodiment of the present invention has been described in detail, that is done for purposes of illustration, not limitation.

What is claimed is:

THE CLAIMS

1. In a communication system comprising at least one telephone switch and at least one communication device: a virtual phone generic configurable interface serving as a protocol interpreter of the protocol of said telephone switch thereby enabling communication between said switch and said communication device.

2. A system according to claim 1, wherein said virtual phone generic configurable interface comprises means for providing a set of virtual phone data structures for representing the state of a phone as known to the telephone switch at any given time.

3. A system according to claim 1, wherein said virtual phone generic configurable interface comprises means for providing a virtual phone application program interface for providing data communication between said telephone switch and said communication device.

4. A system according to claim 1, wherein said virtual phone generic configurable interface comprises means for providing a communications protocol for the transfer of phone control information between said telephone switch and said communication device.

5. A system according to claim 1, wherein said virtual phone generic configurable interface comprises:

a) means for providing a set of virtual phone data structures for representing the state of a phone as known to the telephone switch at any given time; and

b) means for providing a program interface for accessing said data structures.

6. A system according to claim 5, wherein said means for providing a program interface for accessing said data structures comprises a virtual phone application program interface for providing data communication between said set of virtual phone data structures and said switch and said communication device.

7. In a telephone communication system comprising at least one telephone switch, at least one telephone and a computer for processing applications related to the operation of said telephone switch and said telephone: a virtual phone generic configurable interface serving as a protocol interpreter between protocols of said telephone switch and protocols of said applications.

8. A system according to claim 7, wherein said virtual phone generic interface comprises:

a) means for providing a set of virtual phone data structures for representing the state of a phone as known to the telephone switch at any given time;

b) means for providing a program interface for accessing said data structures; and

c) means for providing a protocol for establishing communication between said computer and said data structures.

9. A system according to claim 8, wherein said means for providing a program interface for accessing said data structures comprises:

a) an internal virtual phone application program interface for providing data communication between said set of virtual phone data structures and said telephone switch and said telephone; and

b) an external virtual phone application program interface for providing data communication between said set of virtual phone data structures and said computer.

10. A system according to claim 9, further including a communications protocol for providing communication between said external virtual phone application program interface and said computer.

11. In a telephone communication system comprising at least one telephone switch, at least one telephone and an external application device, a virtual phone interface comprising:

a) means for providing a set of virtual phone data structures for representing the state of a phone as known to the telephone switch at any given time;

b) means for providing a set of symmetric functions for transferring data between said virtual phone data structures and said telephone switch and said telephone and between said virtual phone data structures and communications medium associated with said external application device, said set of functions being the sole

means by which said virtual phone data structures are changed;

c) means for providing communication between said set of symmetric functions and said telephone switch and said telephone; and

d) means for providing communication between said set of symmetric functions and said communications medium associated with said external application device.

12. A virtual phone interface according to claim 11, wherein said external application device comprises a computer.

13. A virtual phone interface according to claim 7, wherein said means for providing a set of symmetric functions comprises:

a) an internal virtual phone application program interface for providing data communication between said set of virtual phone data structures and said telephone switch and said telephone; and

b) an external virtual phone application program interface for providing data communication between said set of virtual phone data structures and said external application device.

14. A virtual phone interface according to claim 13, further including a communications medium for providing communication between said external virtual phone application program interface and said external application device.

15. A method for providing communication in a system comprising at least one telephone switch and at least one communication device, said method comprising the steps of:

a) providing a virtual phone generic configurable interface to serve as a protocol interpreter of the protocol of said telephone switch; and

b) utilizing said virtual phone generic configurable interface to enable communication between said telephone switch and said communication device.

16. A method according to claim 15, wherein said step of providing a virtual phone generic configurable interface comprises providing a set of virtual phone data structures for representing the state of a phone as known to the telephone switch at any given time.

17. A method according to claim 15, wherein said step of providing a virtual phone generic configurable interface comprises providing a virtual phone application program interface for providing data communication between said telephone switch and said communication device.

18. A method according to claim 15, wherein said step of providing a virtual phone generic configurable interface comprises:

a) providing a set a virtual phone data structures for representing the state of a phone as known to the telephone switch at any given time; and

b) providing a program interface for accessing said structures.

19. A method according to claim 18, wherein said step of providing a program interface for accessing said data structures comprises providing a virtual phone application program interface for providing data communication between said set of virtual phone data structures and said switch and said communication device.

20. A method for representing features of any type of one or more digital telephones independent of the type of telephone switch operatively associated with said one or more telephones and independent of the number of features in said one or more telephones comprising the steps of:

a) providing a set of virtual phone data structures representing the state of said one or more telephones at any given time;

b) providing an external device generating applications related to operation of said telephone switch and said one or more telephones; and

c) changing said data structures in response to commands issued by said external device.

21. A method according to claim 20, further including changing said data structures in response to events in said telephone switch and in said one or more telephones.

22. A method according to claim 21, further including providing a set of symmetric functions which

issue function calls for accessing said data structures from said external device and from said telephone switch and said one or more telephones.

23. A method according to claim 20, wherein said step of changing said data structures in response to commands issued by said external device comprises:

a) receiving a command from said external device;

b) calling a symmetric function in response to said command to provide a function call;

c) converting the function call to a command format in accordance with a specific virtual phone integration to change one or more of said data structures; and

d) passing said command format to said telephone switch.

24. A method according to claim 21, wherein said step of changing said data structures in response to events in said telephone switch comprises:

a) receiving a packet from said telephone switch;

b) utilizing data in said packet to call a symmetric function;

c) updating one or more of said data structures by means of a function call issued by said symmetric function; and

d) passing information on said updating to said external device.

25. A method for representing features of any type of one or more digital telephones independent of the type of telephone switch operatively associated with said one or more telephones and independent of the number of features in said one or more telephones comprising the steps of:

a) providing a set of virtual phone data structures representing the state of the digital telephone as known to the telephone switch at any given time;

b) providing an external processor for generating applications related to operations of said telephone switch and said one or more telephones;

c) changing said data structures in response to events in said telephone switch and in said one or more telephones; and

d) changing said data structures in response to commands issued by said processor related to said applications.

26. A method according to claim 25, further comprising:

a) transferring information to said external processor relating to changes in said data structures in response to events in said telephone switch and in said one or more telephones; and

b) transferring information to said telephone switch relating to changes in said data structures in response to commands issued by said processes.

27. A method according to claim 25, further including providing a set of symmetric functions which issue function calls for accessing said data structures from said external processor and from said telephone switch and said one or more telephones.

28. A method according to claim 27, wherein said data structures can be changed only via said set of symmetric functions.

29. In a communication system comprising at least one communication switch and at least one communication device: a media control proxy serving as a gateway between said communication switch and said communication device to bridge any gap in communication protocols between said communication switch and said communication device thereby enabling communication between said communication switch and said communication device.

30. A system according to claim 29, wherein said media control proxy includes means for converting a fixed control protocol of an original connection between said communication switch and said communication device to a communications method for supporting any given communication device.

31. A system according to claim 29, wherein a first data bearer channel and a first control channel each are connected to said communication switch and to said media control proxy and a second data bearer channel and a second control channel are connected to

said media control proxy and to said communication device.

32. A system according to claim 31, wherein said media control proxy includes means for passing through data on said first and second data bearer channels.

33. A system according to claim 31, wherein said media control proxy includes means for processing information on said first and second control channels for conversion to a protocol understood by said communications device.

34. A method for providing communication in a system comprising at least one communication switch and at least one communication device, said method comprising the steps of:

a) providing a media control proxy to serve as a gateway between said communication switch and said communication device to bridge any gap in communication protocols between said communication switch and said communication device; and

b) utilizing said media control proxy to enable communication between said communication switch and said communication device.

35. A method according to claim 34, wherein said step of providing a media control proxy comprises connecting a fixed control protocol of an original connection between said communication switch and said communication device to a communications method for supporting any given communication device.

36. A method according to claim 34, wherein said step of providing a media control proxy comprises passing through bearer channel data between said communication switch and said communication device.

37. A method according to claim 34, wherein said step of providing a media control proxy comprises processing control information from said communication switch for conversion to a protocol understood by said communication device.

38. A method according to claim 34, wherein said step of providing a media control proxy comprises interpreting control information received from said communication switch and maintaining the state of the communication device as defined by the communication switch.

39. A method according to claim 34, wherein said step of providing a media control proxy comprises transmitting data to said communication switch on a control channel between said media control proxy and said communication switch in a protocol native to said communication switch so that said communication switch interprets a message form said media control proxy as a message from said communication device.

40. A computer readable memory device encoded with a data structure for providing a virtual phone generic configurable interface serving as a protocol interpreter of the protocol of a telephone switch thereby enabling communication between said switch and a communication device, the data structure having entries wherein each entry contains a representation of the state of the communication device as known to the telephone switch at any given time.

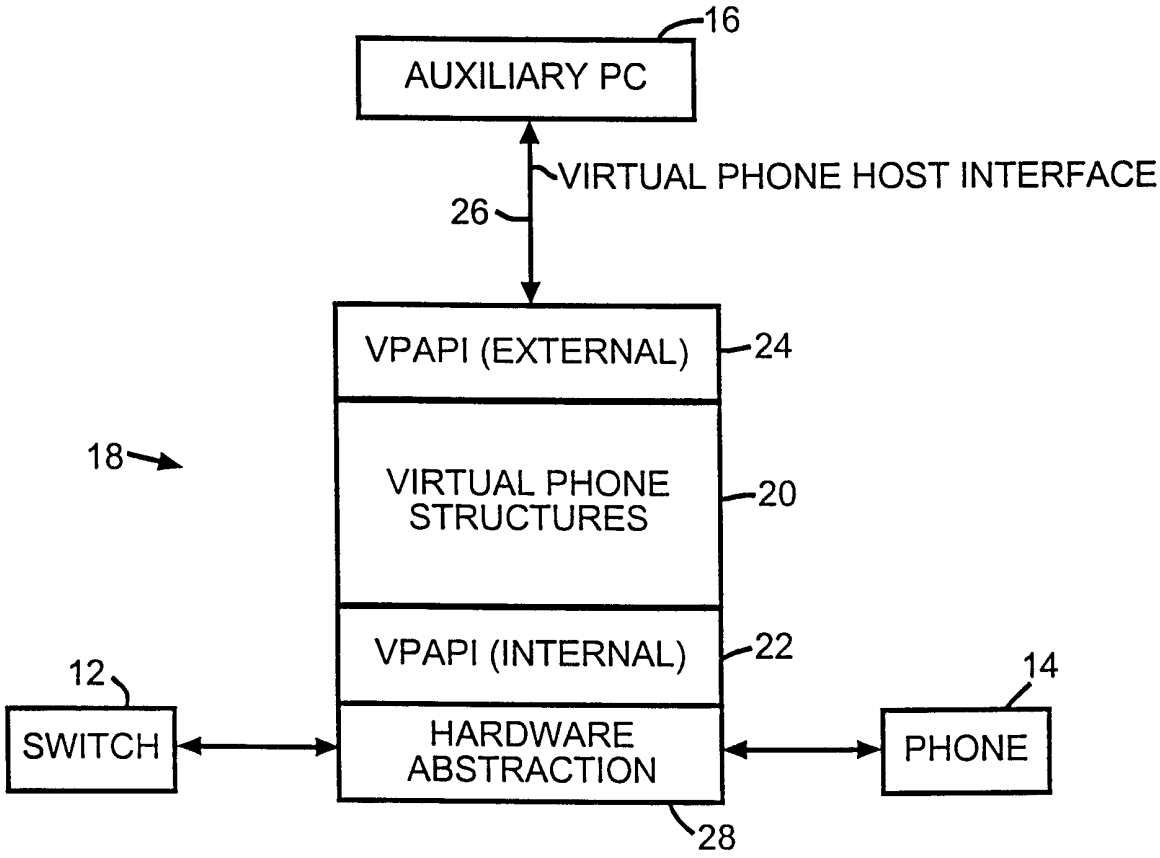
16
AUXILIARY PC
VIRTUAL PHONE HOST INTERFACE
26
VPAPI (EXTERNAL)
24
18
VIRTUAL PHONE STRUCTURES
20
VPAPI (INTERNAL)
22
12
14
SWITCH
HARDWARE ABSTRACTION
PHONE
28

FIG.1

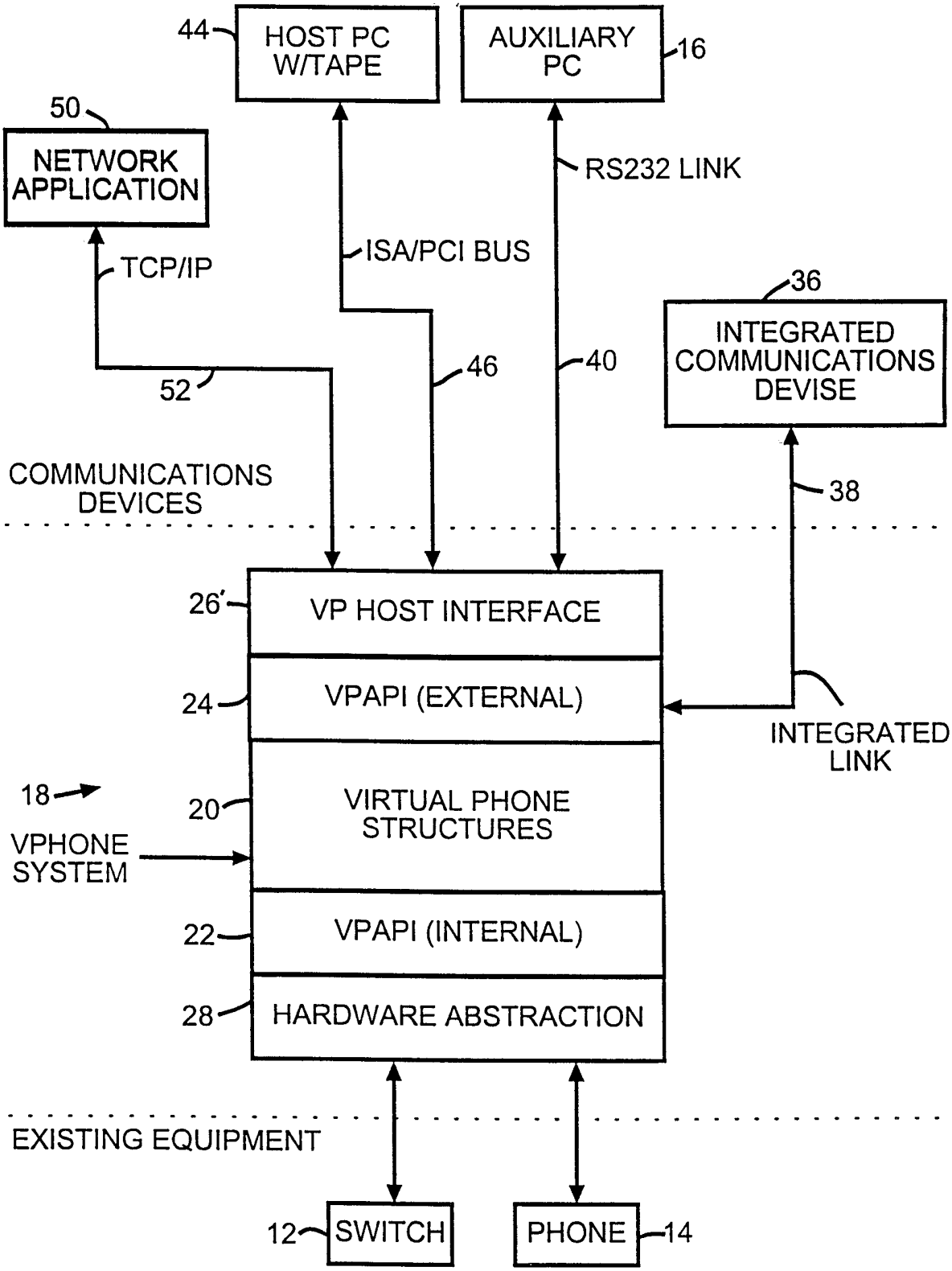
44
HOST PC W/TAPE
AUXILIARY PC
16
50
NETWORK APPLICATION
RS232 LINK
ISA/PCI BUS
TCP/IP
36
INTEGRATED COMMUNICATIONS DEVISE
46
40
52
COMMUNICATIONS DEVICES
38
26'
VP HOST INTERFACE
24
VPAPI (EXTERNAL)
INTEGRATED LINK
18
20
VIRTUAL PHONE STRUCTURES
VPHONE SYSTEM
22
VPAPI (INTERNAL)
28
HARDWARE ABSTRACTION
EXISTING EQUIPMENT
12
SWITCH
PHONE
14

FIG. 2

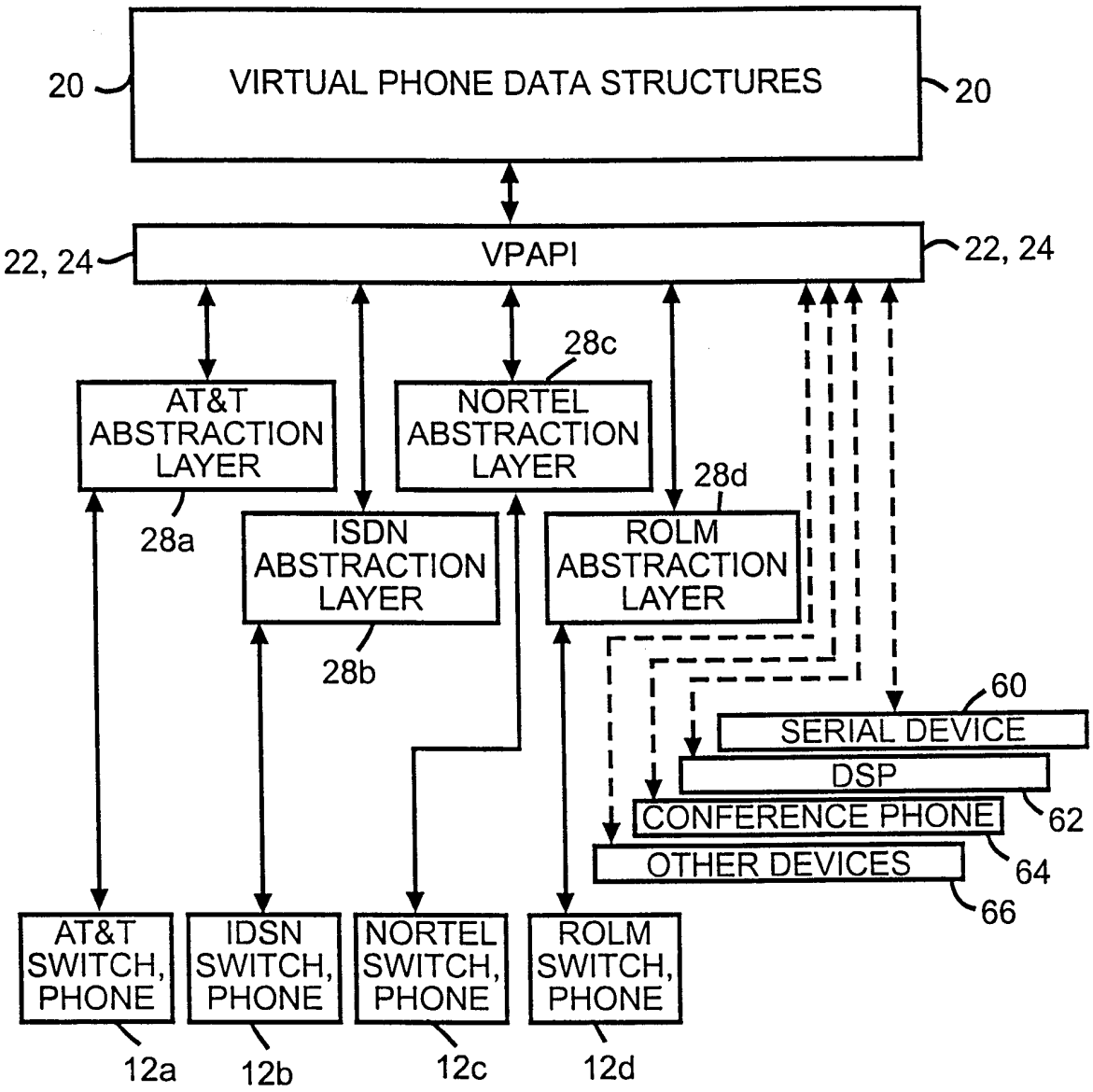
20
VIRTUAL PHONE DATA STRUCTURES
20
22, 24
VPAPI
22, 24
28c
AT&T ABSTRACTION LAYER
NORTEL ABSTRACTION LAYER
28d
28a
ISDN ABSTRACTION LAYER
ROLM ABSTRACTION LAYER
28b
60
SERIAL DEVICE
DSP
CONFERENCE PHONE
62
OTHER DEVICES
64
66
AT&T SWITCH, PHONE
IDSN SWITCH, PHONE
NORTEL SWITCH, PHONE
ROLM SWITCH, PHONE
12a
12b
12c
12d

FIG. 3

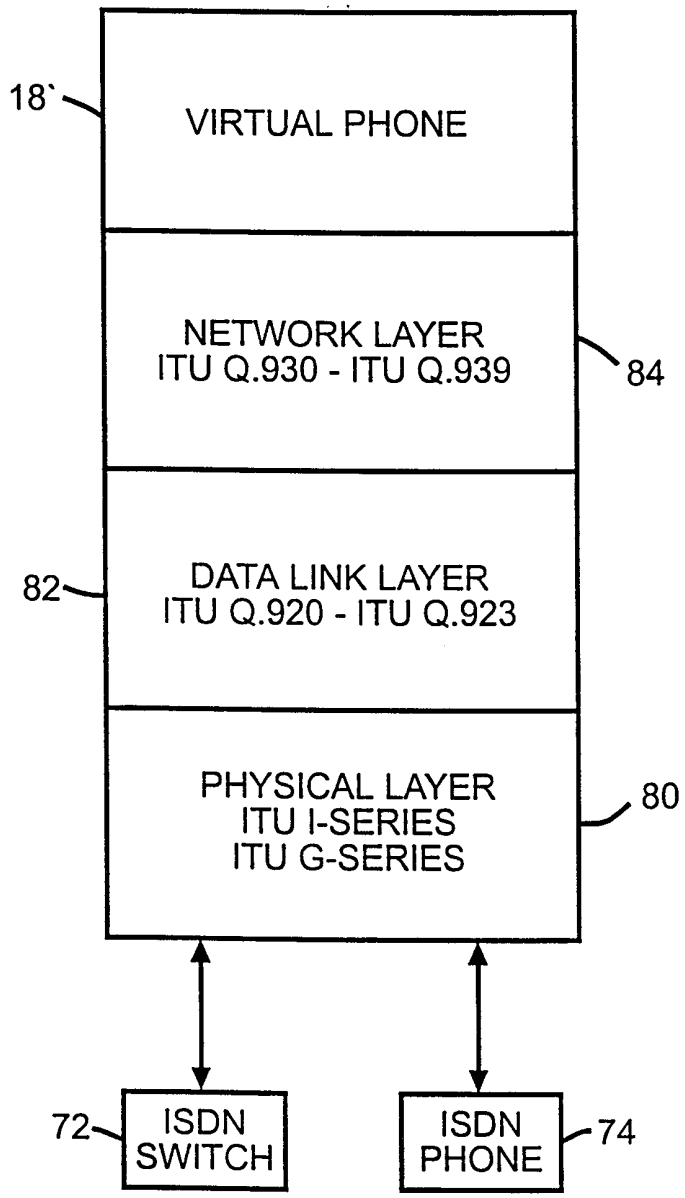
18
VIRTUAL PHONE
NETWORK LAYER
ITU Q.930 - ITU Q.939
84
82
DATA LINK LAYER
ITU Q.920 - ITU Q.923
PHYSICAL LAYER
ITU I-SERIES
ITU G-SERIES
80
72
ISDN
SWITCH
ISDN
PHONE
74

FIG. 4

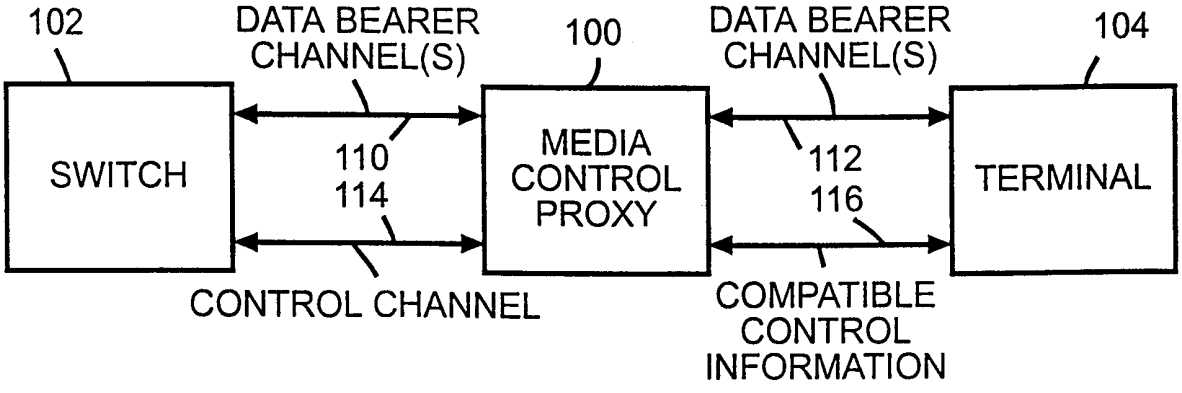
102
DATA BEARER
CHANNEL(S)
100
DATA BEARER
CHANNEL(S)
104
SWITCH
110
114
MEDIA
CONTROL
PROXY
112
116
TERMINAL
CONTROL CHANNEL
COMPATIBLE
CONTROL
INFORMATION

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/07537

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H04M 3/00
US CL :379/201

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 379/201, 207, 219, 220, 229, 230, 242, 243

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,404,396 A (BRENNAN) 04 April 1995, abstract; col. 2, line 5 through col. 26, line 13; and FIGs. 1-10C).	1-40

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 22 MAY 1999	Date of mailing of the international search report 06 JUL 1999
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer SCOTT WOLINSKY James R. Matthews Telephone No. (703) 308-6731

Form PCT/ISA/210 (second sheet)(July 1992)★