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(54) Title: METHOD AND SYSTEM FOR A REMOTE CONSOLE FOR SECURE KVM SWITCH

(57) Abstract: A computing system, a secure peripheral sharing device, a remote console subsystem and a method for operating a remote console over a secure peripheral sharing device is disclosed. The computing system comprising a plurality of hosts; a console comprising at least a keyboard, a mouse and a display; a secure peripheral sharing device; and a remote console subsystem comprising at least another keyboard, another mouse and another display. The secure peripheral sharing device is configured to be connected to the console and the plurality of hosts, the peripheral sharing device is configured to be coupled to the remote console subsystem that is located away from the peripheral sharing device, and the secure peripheral sharing device is configured to connect or couple between either the console or the remote console subsystem and an active host of the plurality of hosts.

METHOD AND SYSTEM FOR A REMOTE CONSOLE FOR SECURE KVM SWITCH

FIELD OF THE INVENTION

[0001] The present invention, in some embodiments thereof, relates to KVM switches, and more particularly, but not exclusively, to secure KVM switch supporting a remote console.

BACKGROUND OF THE INVENTION

[0002] During the corona pandemic many workers started to work from home. In many companies and organization that uses cloud computing and SaaS (Software as a Service) the shift to work from home was easy, simply connecting from your home desktop or laptop to the company resources over the Internet. For these organizations who have some software/hardware that are needed to run from the host located in the company premises, a remote terminal software that operate the in-premises computer from remote location over the internet is also a feasible solution. However, workers in organization that need to handle classified data were left without a good solution. Usually, these workers have access from their office to two or more computers, one that is less classified, typically connected to the Internet, and one or more hosts that are connected only to internal, more classified, local area network of the organization. To work efficiently with the plurality of the host, these workers use a secure peripheral sharing device, e.g., KVM switch. Due to security restrictions, working remotely with a remote terminal software is not acceptable option. The objective of the invention is to allow these workers, or users, the ability to securely work from their homes.

SUMMARY OF THE INVENTION

[0003] According to aspects of some embodiments of the present invention, a securing method and computing system with remote console operation is provided.

[0004] According to an aspect of some embodiments of the present invention there is provided a computing system comprising: a plurality of hosts; a console comprising at least a first keyboard, a first mouse and a first display; a secure peripheral sharing device; and a remote console subsystem comprising at least a second keyboard, a second mouse and a second display, wherein the secure peripheral sharing device is configured to be connected to the console and the plurality of hosts, the peripheral sharing device is configured to be coupled to the remote console subsystem that is located away from the peripheral sharing device, and wherein the secure peripheral sharing device is configured to connect or couple between either the console or the remote console subsystem and an active host of the plurality of hosts, and wherein the peripheral sharing device is configured to switch any one of the plurality of host to become the active host, and wherein a video stream from the active host is transferred to either the first display or the second display, and a keyboard and mouse data is transferred to the active host from either the first keyboard and the first mouse or the second keyboard and the second mouse.

[0005] According to an aspect of some embodiments of the present invention there is provided a secure peripheral sharing device comprising: a plurality of ports to be configured to be connected to a plurality of hosts; and a port to be configured to be connected to a console comprising at least a first keyboard, a first mouse and a first display; and a remote console port configured to be coupled to a remote console subsystem comprising at least a second keyboard, a second mouse and a second display, wherein the remote console subsystem is located away from the peripheral sharing device, and wherein the peripheral sharing device is configured to connect or couple between either the console or the remote console subsystem and an active host of the plurality of hosts, and wherein the peripheral sharing device is configured to switch between any one of the plurality of hosts to become the active host.

[0006] According to an aspect of some embodiments of the present invention there is provided a remote console subsystem comprising: a port configured to be coupled to a secure peripheral sharing device; and a remote console, wherein, the secure peripheral

sharing device is configured to be connected to a plurality of hosts, and to a console comprising at least a first keyboard, a first mouse and a first display, the remote console comprising at least a second keyboard, a second mouse and a second display, the remote console subsystem is located away from the peripheral sharing device, the peripheral sharing device is configured to connect or couple between either the console or the remote console and an active host of the plurality of hosts, and condition upon a switching command from the remote console subsystem, the peripheral sharing device is configured to switch any one of the plurality of hosts to become the active host.

[0007] According to some embodiments of the invention, the peripheral device is a secure KVM switch.

[0008] According to some embodiments of the invention, at least one peripheral device in the console or the remote console is shared using simultaneous use operation.

[0009] According to some embodiments of the invention, at least one peripheral device in the console or the remote console is at least on of or any combination of: a biometric sensor, an identification device, a printer, an audio device, a camera, an external mass storage device, a USB dongle, a phone, and a smartphone.

[0010] According to some embodiments of the invention, the connection between the secure peripheral sharing device and the console, and the connection between the remote console subsystem and the remote console is provided by peripheral devices communication protocols, and peripheral devices communication protocols comprises at least one of or any combination of: USB, SPI, I2C, SCSI, FC, IDE, ATA, Firewire, Ethernet, Thunderbolt, InfiniBand, VGA, DVI, HDMI, DisplayPort Wi-Fi, Bluetooth, and Zigbee.

[0011] According to some embodiments of the invention, the coupling between the secure peripheral sharing device and the remote console subsystem is provided by remote console communication protocols, and the remote console communication protocols comprises at least one of or any combination of: Ethernet, SDH, SONET, OTN, FC, InfiniBand, USB, Firewire, Thunderbolt, GSM; CDMA, LTE, 3G; 4G; 5G, TCP/IP, UDP, FTP, HTTP, and SNMP.

[0012] According to some embodiments of the invention, the remote console communication protocol transfers video stream, the keyboard and mouse data, and active host selection commands.

[0013] According to some embodiments of the invention, the remote console communication protocol further transfers: additional video streams, session control and authentication data, and data of additional peripheral devices.

[0014] According to some embodiments of the invention, the communication between the remote console subsystem and the secure peripheral sharing device is encrypted.

[0015] According to some embodiments of the invention, the secure peripheral sharing device comprises a security unit that perform at least one or any combination of (a) encrypt data sent to the remote console subsystem, (b) decrypt data received from the remote console subsystem, and (c) authenticate the remote console subsystem.

[0016] According to some embodiments of the invention, an authentication procedure is performed between secure peripheral sharing device and remote console subsystem, and the authentication procedure comprises at least one of or any combination of: (a) Hardware ID authentication, (b) biometric authentication, (c) smart card authentication, (d) password authentication, (e) one time password authentication, and (f) multi-factor authentication.

[0017] According to some embodiments of the invention, the secure peripheral sharing device communicates with the remote console subsystem using at least one of: (a) Ethernet modem, (b) Wi-Fi modem, and (c) 5G cellular modem.

[0018] According to some embodiments of the invention, the paths between peripheral devices and hosts in the system comprises device emulators and host emulators.

[0019] According to some embodiments of the invention, the secure peripheral sharing device comprises device emulators and host emulator for peripheral devices.

[0020] According to some embodiments of the invention, the remote console subsystem comprises host emulators configured to communicate with device emulators for any one of the peripheral devices of the remote console subsystem.

[0021] According to some embodiments of the invention, the video processing between hosts and displays comprises at least one of or any combination of: (a) compression, (b) decompression, (c) packetizing, (d) video format conversion, and (e) display EDID emulation.

[0022] According to some embodiments of the invention, the remote console subsystem comprises at least one of: (a) a desktop computer, (b) a laptop computer, (c) a notebook computer, (d) a tablet, (e) a PDA, (f) a smartphone, and (g) a thick, a thin or a zero client.

[0023] According to some embodiments of the invention, the remote console subsystem comprises front panel or auxiliary front panel to receive active host selection commands from these panels.

[0024] According to some embodiments of the invention, the secure peripheral sharing device comprises of ordinary secure KVM switch and auxiliary remote console adapter.

[0025] According to some embodiments of the invention, the secure peripheral sharing device comprises of basic secure KVM switch and add-on adapter, wherein matching form-factor between basic secure KVM switch and add-on adapter is extension form-factor or bay form-factor.

[0026] According to some embodiments of the invention, the secure peripheral sharing device or the remote console subsystem comprises anti-tampering circuitries.

[0027] According to some embodiments of the invention, the secure peripheral sharing device is configured to receive enable remote console operation mode from control center.

[0028] According to some embodiments of the invention, the remote console subsystem comprises a smartphone and remote console accessory.

[0029] According to some embodiments of the invention, the secure peripheral sharing device comprises Ethernet switch to aggregate communication from first Ethernet port and remote console communication to a second Ethernet port.

[0030] According to an aspect of some embodiments of the present invention there is provided a method for providing a remote console capability to a secure peripheral sharing device using a remote console subsystem, the secure peripheral sharing device comprises: a plurality of ports to be configured to be connected to a plurality of hosts; a port to be configured to be connected to a console comprising at least a first keyboard, a first mouse and a first display; and a remote console port configured to be coupled to a remote console system, the remote console subsystem comprises: a port configured to be coupled to a secure peripheral sharing device; and a remote console comprising at least a second keyboard, a second mouse and a second display, the method comprises the step of: receiving requests for open new remote console sessions and upon such a request, open a remote console session in both the sides of the secure peripheral sharing device and the side of the remote console subsystem, as long as the remote session is active perform continuously in both the sides the steps of: receiving video stream from the active host and transferring the video stream to the second display; receiving a keyboard and mouse data from the second

keyboard and the second mouse and transferring the keyboard and mouse data to the active host; and upon receiving active host switching commands from a user, switching the active host, receiving requests for close remote console sessions and upon such request, close the remote console session and resume working of active host with the console.

[0031] According to some embodiments of the invention, the secure peripheral sharing device is a secure KVM switch.

[0032] According to some embodiments of the invention, /*3*/

[0033] at least one peripheral device in the console or the remote console is shared using simultaneous use operation.

[0034] According to some embodiments of the invention, at least one peripheral device in the console or the remote console is at least on of or any combination of: a biometric sensor, an identification device, a printer, an audio device, a camera, an external mass storage device, a USB dongle, a phone, and a smartphone.

[0035] According to some embodiments of the invention, the connection between the secure peripheral sharing device and the console, and the connection between the remote console subsystem and the remote console is provided by peripheral devices communication protocols, and peripheral devices communication protocols comprises at least one of or any combination of: USB, SPI, I2C, SCSI, FC, IDE, ATA, Firewire, Ethernet, Thunderbolt, InfiniBand, VGA, DVI, HDMI, DisplayPort Wi-Fi, Bluetooth, and Zigbee.

[0036] According to some embodiments of the invention, the coupling between the secure peripheral sharing device and the remote console subsystem is provided by remote console communication protocols, and the remote console communication protocols comprises at least one of or any combination of: Ethernet, SDH, SONET, OTN, FC, InfiniBand, USB, Firewire, Thunderbolt, GSM; CDMA, LTE, 3G; 4G; 5G, TCP/IP, UDP, FTP, HTTP, and SNMP.

[0037] According to some embodiments of the invention, the remote console communication protocol transfers video stream, the keyboard and mouse data, and active host selection commands.

[0038] According to some embodiments of the invention, the method is further comprising the steps of transferring additional video streams to additional displays in the remote console subsystem, transferring remote console session control data, transferring data from or to additional peripheral devices.

[0039] According to some embodiments of the invention, the method is further comprising the steps of encrypting of the communication between the remote console subsystem and the secure peripheral sharing device.

[0040] According to some embodiments of the invention, the method is further comprising the steps of authentication between secure peripheral sharing device and remote console subsystem.

[0041] According to some embodiments of the invention, the authentication step comprises at least one of or any combination of: (a) Hardware ID authentication, (b) biometric authentication, (c) smart card authentication, (d) password authentication, (e) one time password authentication, and (f) multi-factor authentication.

[0042] According to some embodiments of the invention, the steps of transferring data are using at least one of: (a) Ethernet modem, (b) Wi-Fi modem, and (c) 5G cellular modem.

[0043] According to some embodiments of the invention, the method is further comprising the steps of emulating host in front of peripheral devices and emulating peripheral devices in front of hosts.

[0044] According to some embodiments of the invention, the method is further comprising at least one of or any combination of the steps of: (a) video compression, (b) video decompression, (c) video packetizing, (d) video format conversion, and (e) display EDID emulation.

[0045] According to some embodiments of the invention, the remote console subsystem comprises at least one of: (a) a desktop computer, (b) a laptop computer, (c) a notebook computer, (d) a tablet, (e) a PDA, (f) a smartphone, and (g) a thick, a thin or a zero client.

[0046] According to some embodiments of the invention, the remote console subsystem comprises front panel or auxiliary front panel to receive active host selection commands from these panels.

[0047] According to some embodiments of the invention, the method is further comprising the step of enabling remote console operation mode from control center.

[0048] Unless otherwise defined, all technical and/or scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which the invention pertains. Although methods and circuitries similar or equivalent to those described herein can be used in the practice or testing of embodiments of the invention, exemplary

methods and/or circuitries are described below. In case of conflict, the patent specification, including definitions, will control. In addition, the circuitries, methods, and examples are illustrative only and are not intended to be necessarily limiting.

[0049] Implementation of the method and/or system of embodiments of the invention can involve performing or completing selected tasks manually, automatically, or a combination thereof. Moreover, according to actual instrumentation and equipment of embodiments of the method and/or system of the invention, several selected tasks could be implemented by hardware, by software or by firmware or by a combination thereof using an operating system.

[0050] For example, hardware for performing selected tasks according to embodiments of the invention could be implemented as a chip or a circuit. As software, selected tasks according to embodiments of the invention could be implemented as a plurality of software instructions being executed by a computer using any suitable operating system. In an exemplary embodiment of the invention, one or more tasks according to exemplary embodiments of method and/or system as described herein are performed by a data processor, such as a computing platform for executing a plurality of instructions. Optionally, the data processor includes a volatile memory for storing instructions and/or data and/or a non-volatile storage, for example, a flash memory and/or removable media, for storing instructions and/or data.

BRIEF DESCRIPTION OF THE DRAWINGS

[0051] Some embodiments of the invention are herein described, by way of example only, with reference to the accompanying drawings. The subject matter regarded as the invention is particularly pointed out and distinctly claimed in the concluding portion of the specification. The invention, however, both as to organization and method of operation, together with objects, features, and advantages thereof, may best be understood by reference to the following detailed description when read with the accompanying drawings.

[0052] With specific reference now to the drawings in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of embodiments of the invention. In this regard, the description taken with the drawings makes apparent to those skilled in the art how embodiments of the invention may be practiced.

[0053] In the drawings:

Fig. 1 is a schematic view of the system in accordance with the present invention;

Fig. 2 is a schematic view of the system with a more detailed design of a secure peripheral sharing device in accordance with some embodiment of the present invention;

Fig. 3 is a schematic view of the KM unit presented in Figure 2 accordance with some embodiments of the present invention;

Fig. 4 is a schematic view of the video unit presented in Figure 2 accordance with some embodiments of the present invention;

Fig. 5 is a schematic view with more detailed design of a remote console subsystem in accordance with some embodiment of the present invention;

Fig. 6 is an isometrical view of a user's desk comprising the remote console side of the system in accordance with an exemplary embodiment of the present invention;

Fig. 7 is a schematic view of another embodiment of the remote console subsystem in accordance with some embodiment of the present invention;

Fig. 8 is a schematic view of yet another embodiment of the remote console subsystem in accordance with some embodiment of the present invention;

Fig. 9 is a schematic view of another embodiment of the secure peripheral sharing device side in accordance with some embodiment of the present invention;

Fig. 10 is a schematic view of yet another embodiment of the secure peripheral sharing device side in accordance with some embodiment of the present invention; and

Fig. 11 is a flowchart view of a method for providing remote console to a secure KVM switch in accordance with some embodiment of the present invention;

Fig. 12 is a simplified block diagram of a remote desktop system in accordance with some embodiment of the present invention;

Fig. 13 is a conceptual remote desktop solution system using a remote desktop isolator in accordance with some embodiment of the present invention;

Fig. 14 is a conceptual block of the remote desktop isolator in accordance with some embodiment of the present invention; and

Fig. 15 is a block diagram presenting several deployment options for remote desktop systems incorporating remote desktop isolators in accordance with some embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0054] In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the invention. However, it will be understood by those skilled in the art that the present invention may be practiced without these specific details. In other instances, well-known methods, procedures, and components, modules, units and/or circuits have not been described in detail so as not to obscure the invention. Some features or elements described with respect to one embodiment may be combined with features or elements described with respect to other embodiments. For the sake of clarity, discussion of same or similar features or elements may not be repeated.

[0055] Although embodiments of the invention are not limited in this regard, discussions utilizing terms such as, for example, "processing", "computing", "calculating", "determining", "establishing", "analyzing", "checking", or the like, may refer to operation(s) and/or process(es) of a state machine, a micro-controller, a computer, a computing platform, a computing system, or other electronic computing device, that manipulates and/or transforms data represented as physical (e.g., electronic) quantities within the computer's registers and/or memories into other data similarly represented as physical quantities within the computer's registers and/or memories or other information non-transitory storage medium that may store instructions to perform operations and/or processes.

[0056] Although embodiments of the invention are not limited in this regard, the terms "plurality" and "a plurality" as used herein may include, for example, "multiple" or "two or more". The terms "plurality" or "a plurality" may be used throughout the specification to describe two or more components, devices, elements, units, parameters, or the like. The term set when used herein may include one or more items. Unless explicitly stated, the method embodiments described herein are not constrained to a particular order or sequence. Additionally, some of the described method embodiments or elements thereof can occur or be performed simultaneously, at the same point in time, or concurrently.

[0057] The present invention, in some embodiments thereof, relates to KVM switches, and more particularly, but not exclusively, to secure KVM switch supporting remote console.

[0058] The trend of working from home becomes very popular during the coronavirus pandemic and cause difficulties in organizations that need to handle classified data. Typically, in these organizations, workers have two or more host computers at their office's

desktop, one that is less classified, typically connected to the Internet, and one or more host computers that are connected to local or internal, more classified, local area networks (LANs) that deployed inside the organization. To work efficiently with the plurality of the host computers, the workers use a secure peripheral sharing device, e.g., secure KVM switch. In the following embodiment and examples, we present an apparatus and method to allow workers, or users, to work with their office's computers from home using a new, modified, upgraded or extended secure peripheral sharing device.

[0059] Reference is made first to Figure 1. Figure 1 illustrates a typical configuration of a computing system. The system comprises a secure peripheral sharing device **20**, supports two hosts **10** and a console **50**. The secure peripheral sharing device **20**, in accordance with the invention, also supports a novel port, a remote console port **22**. The remote console port **22** is connected using remote console communication protocol **35** to a Wide Area Network (WAN) **40**, usually the Internet. The WAN **40** is connected to a remote console subsystem **60**. Remote console **60** resides away or outside the premises of the organization so several security issues need to be taken care for working with this remote console subsystem **60**, these issues will be discussed later on.

[0060] As used herein the term "console" means a collection (a set) of peripheral devices, such as keyboard **30K**, mouse **30M**, one or more displays **30V** and, optionally, other peripheral devices **30**. Console's **50** peripheral devices are used by a user to interact with hosts **10**. The peripheral devices **30** of console **50** typically reside on the user's desktop or in a close proximity to the user, e.g., in a single room, single office, or on or more adjacent desks. The console may include a display **30V**, or a plurality of displays **30V**. Console devices **30** may include printers, cameras, microphones, speakers, smart card readers, biometric sensors, identification devices, external mass storage devices, USB dongles, mobile terminals such as smartphones and the like. The console **50** devices are connected to host **10** using peripheral devices communication protocols **25**.

[0061] Peripheral devices communication protocols **25** may be parallel buses, serial buses, Universal Serial Bus (USB), and many other types of communication protocols, such as, SPI, I2C, CAN bus, SCSI, Fiber Channel (FC), IDE, ATA, PCI, PCI-x, IEEE 1394 (Firewire), Ethernet, Thunderbolt, InfiniBand and the like. In some cases, peripheral devices communication protocols **25** may be used to coupled host **10** to display **30V**.

Video communication protocol, in this case may be VGA, DVI, HDMI, DisplayPort (DP) or the like. The video communication protocol may include data transfer for "plug and play" experience, e.g., Display Data Channel (DDC).

[0062] Peripheral devices communication protocols **25** may aggregate communication between host **10** to several peripheral devices **30**. For example, a single USB 3.0 communication protocol **25** may be used to connect host **10** to display **30V,** keyboard **30K** and mouse **30M**.

[0063] In an exemplary embodiment of the invention, peripheral devices communication protocols **25** may be wireless protocols such as Wi-Fi, Bluetooth, Zigbee and the like.

[0064] As used herein, the term "remote console subsystem" or alternatively in brief "remote console" means the subsystem that support the remote operation of a collection (a set) of peripheral devices, such as keyboard **63K**, mouse **63M**, one or more displays **63V** and, optionally, other peripheral devices **63**. Typically, the term "remote console subsystem" is more intended to describe various types of embodiments that include one or more devices that operate together in the remote console location and enable the remote console operation, while "remote console" is more intended to describe the peripheral devices **63, 63K, 63V, 63M** themselves. However, in some embodiments, full separation between the two terms is not always possible so the terms are used interchangeably and it might be referred both to the peripheral devices as well as to the supporting subsystem around the peripheral devices.

[0065] In an exemplary embodiment of the invention, remote console communication protocol **35** may be Ethernet, optical communication protocols, such as, SDH; SONET; OTN; Fiber Channel (FC); InfiniBand, Universal Serial Bus (USB), IEEE 1394 (Firewire), Thunderbolt, cellular communication protocols, such as, GSM; 3G; 4G; 5G, and the like. Remote console communication protocol **35** may use network protocols, such as, IP, IPsec, and the like, transport layer protocols, such as TCP/IP, UDP and the like, and application layer protocols, such as, FTP, HTTP, SNMP, and the like. It should be noted that typically remote console communication protocol is multiplexed or running over, communication infrastructure that carry other communication use. For example, if Remote console communication protocol **35** is IP based, typically some of the packets in the link will be part of remote console communication protocol **35** while other packets will be part of other applications/protocols.

[0066] Peripheral device **30** may be shared between hosts **10** by two type of operations: (1) switching the connection to the active host, referred as switching operation, or (2) by simultaneous working with all hosts **10**, referred as simultaneous use operation. For example, a biometric sensor, such as fingerprint reader peripheral device may keep an authentication session with all hosts so when the active host is changed, i.e., switched, the authentication session is still active, i.e., alive, in all authenticated hosts. The same biometric sensor may be provided with switching operation as well, so that when the user switch to another active host, the authentication session with the previous active host is closed or disconnected, and a new authentication session is initiated or opened with the selected current active host.

[0067] Other examples for simultaneous use operations versus switching operations, are given herein for cameras, and speakers. For camera peripheral device, when the camera is open in simultaneous use operation, the camera video stream is split and transferred to all hosts. In switching operation, the video stream is routed, i.e., switched, only to the active host. Sharing may be done with data that are transmitted from the hosts too. For the speakers, simultaneous use operation may be performed by mixing the audio signals from all hosts so regardless of the active host the user can hear simultaneously the audio signals from all the hosts **10**. In switching operation, only the audio signals from the active host are played to the speakers in console **50**.

[0068] Remote console **60,** In similar way to console **50**, may be coupled to either hosts **10** through the secure KVM switch **20**. The sharing of hosts 10 may be performed by switching operation so that the coupling in any given moment is to the active host or by simultaneous use operation where the coupling is done to a plurality of hosts.

[0069] The remote console **60** comprises the same or similar peripheral devices, such as keyboard **63K**, mouse **63M** and one or more display **63V**. Similarly, remote console **60** may comprise additional peripheral devices **63**. The peripheral devices **63** may be processed by the secure peripheral sharing device **20** as devices that are shared using simultaneous use operation or shared by switching operation.

[0070] The three essential peripherals: keyboard, **30K** and **63K**, mouse, **30M** and **63M** and display, **30V** and **63V**, are usually operated in switching operation mode. The peripheral sharing device that provides the sharing for these three essential peripheral devices, i.e., the switching operation, is known as a KVM switch. For the sake of clarity and brevity this

document focuses mainly to the support of a remote console to KVM switch **20**. Functions, block diagrams, operations, setup and processing of sharing devices and simultaneous use operations that may be supported by remote console version of a more general secure peripheral sharing device **20** are not in the scope of this document, however the additions and modification that are needed, are apparent to those skilled in the art.

[0071] As used herein, the term "peripheral sharing device" means a device that connect a console comprising a set of peripheral devices to a plurality of hosts. Sharing the peripheral device may be provided by switching operation wherein the peripheral devices are connected via a switch to a single active host in any given time, or by simultaneous use operation where the peripheral device work simultaneous with a plurality of hosts.

[0072] As used herein, the term "KVM switch" means a device that connect a console comprising a keyboard, a mouse and one or more displays to a plurality of hosts. KVM switch is a specific type of peripheral sharing device where the console comprises a keyboard, a mouse and one or more displays and the sharing of the peripheral device is provided by switching operation. In most cases, the peripheral sharing device comprises a core functionality of a KVM switch.

[0073] A secure version of a peripheral sharing device or a KVM switch is a version that provides, among other things, security measures to prevent malicious code reside in one of the hosts (more likely, in the less classified host that is typically connected to the internet) to propagate to the more classified host, and to prevent leakage of data from the more classified host to the less classified host. For example, typical technics that are used in a secure version of a peripheral sharing device or a KVM switch are (1) unidirectional data enforcing devices to allow data flow only in one desired direction that is essentially needed, e.g., keyboard and mouse may be restricted to send data only from the peripheral device to the host, (2) providing emulators that are connected to the peripheral device or the host to mimic the other side while keeping some security measures, and (3) the like.

[0074] As used herein, the terms "secure KVM switch" or "secure peripheral sharing device" means KVM switch or peripheral sharing device that uses security measures to protect from cyber-attacks as described hereinabove. For the sake of clarity these elements that are known in the art for KVM switch or peripheral sharing device are no shown or describe in details in the embodiment unless it is closely related to the invention.

[0075] From now on, unless specifically mentioned or implicitly derived, when a KVM switch or peripheral sharing device is mentioned it is related to a secure version of the KVM switch or the peripheral sharing device.

[0076] As used herein, the term "connected" may be used to describe a direct connection, such as electrical, or mechanical connection between the things that are connected, without any intermediary components or devices or indirect connection in the same room or same building. In case of electrical connection, the term "connected" may also be used for a connection through cables, connectors, wires, PCB traces, pins, switches, devices or any other element used to establish electric signal connection between the things.

[0077] As used herein, the term "coupled" means indirect connection, between the things that are connected via indirect connection, through one or more intermediary cables, components, wireless link or devices and the things are away from each other typically reside in different buildings, or different residential areas.

[0078] As used herein, the term "circuitry" means one or more passive and/or active components that are arranged to cooperate with one another to provide a desired one or more functions.

[0079] In various embodiments, the mouse may be any type of pointing device, such as, a track ball, a touch pad or the like. In some embodiments, the display may also be referred as the computer monitor, may be any device presenting visual information to the user, including, but not limited to, cathode-ray tube CRT display, Plasma Display, Liquid Crystal Display (LCD), Light-Emitting Diode (LED) display and the like. The computer monitor may come in apparatus form-factor of computer monitor, TV set, head-mounted display, video projector and the like. In some embodiments, the host may also be referred as the host computer means a computer, a workstation, a set-top-box, a server, and the like.

[0080] In an exemplary embodiment of the invention, a computing system comprising a plurality of hosts; a console **50** comprising at least a first keyboard **30K**, a first mouse **30M** and a first display **30V**; a secure peripheral sharing device **20**; and a remote console subsystem comprising at least a second keyboard **63K**, a second mouse **63M** and a second display **63V**. The secure peripheral sharing device **20** is configured to be connected to the console **50** and the plurality of hosts **10**, the peripheral sharing device is configured to be coupled to the remote console subsystem **60** that is located away from the peripheral sharing device. The secure peripheral sharing device **20** is configured to connect or couple between

either the console **50** or the remote console subsystem **60** and an active host of the plurality of hosts **10**. The secure peripheral sharing device **20** is configured to switch any one of the plurality of hosts **10** to become the active host. The video stream from the active host is transferred to either the first display **30V** or the second display **63V**, and a keyboard and mouse data is transferred to the active host from either the first keyboard **30K** and the first mouse **30M** or the second keyboard **63K** and the second mouse **63M**.

[0081] Reference is made now to Figure 2. Figure 2 illustrates a more detailed view of the computing system with an internal block diagram of an exemplary embodiment of the secure peripheral sharing device, e.g., the secure KVM switch **20**. Secure KVM switch **20** is connected to two hosts **10a** and **10b** and to a display **30V,** a keyboard **30K** and a mouse **30M**. In addition, secure KVM switch **20** is coupled to a remote console **60**, via Ethernet type remote console port **226**.

[0082] Display **30V** is connected via protocol **25v** to a video unit **212**. Video unit **212** may transmit video to display **30V** via connection **214**. The video stream may be originated from hosts **10a** and **10b** and transferred using video protocol **25v**, e.g., HDMI. The two video sources from hosts **10a** and **10b** are received by video unit **212** via two video connections **216**. In addition, video unit **212** may transmit the video stream to display **63V** in remote console **60** via connection **218**. Connection **218** may use different video format and video protocols, and video unit **212** may convert the video to the desired video protocol. In an exemplary embodiment of the invention, connection **218** carries a compressed video stream protocol. The command to control which one of the video sources, either from hosts **10a** or from **10b**, and to which console, **50** or **60** to transmit the video stream, is provided from controller **220** using command lines **234**.

[0083] The keyboard **30K** and the mouse **30M** of console **50** are connected via connection lines **203** and **204** using USB peripheral device communication protocol **25u** to KM unit **202**. KM unit **202** aggregates keyboard and mouse data communication to a single composite USB device and sends the data via connection line **206** using USB peripheral device communication protocol **25u** to either host **10a** or host **10b**. In addition, keyboard and mouse data can be received by KM unit **202** from remote console **60** via line **208**. The command to control from which keyboard and mouse the keyboard and mouse data is transmitted, either console **50** or remote console **60**, and to which host, either host **10a** or

host **10b**, the keyboard and mouse data, is provided from controller **220** using command lines **232**.

[0084] To support operating with remote console **60**, secure KVM switch **20** comprises a mux unit **222**. Mux unit **222** combines all data communication that need to be communicated between remote console **60** and secure KVM switch **20** to a single bidirectional data stream. The data stream contains at least the video stream from either one of the hosts **10a** or **10b**, the keyboard and mouse data from remote console **60**, and a host selection commands from remote console **60**. The host selection commands are transferred from mux **222** to controller **220** via lines **236**. Upon receiving the host selection commands, controller **220** set KM unit **202** and video unit **212** via lines **232** and **234** respectively. In addition, data, such as, data from other peripheral devices, such as biometric sensors, identification device in remote console **60**, printing data from an active host to a printer peripheral device in the remote console **60**, admirative data between remote console client **60** and secure KVM switch **20**, and the like, may be provided through the mux unit **222**.

[0085] Controller **220** communicate with user interface (UI) **228** via lines **236**. User interface may be push buttons to select the active host locally, active host indicators, key to enable remote console operation, as well as, other peripheral sharing device controlling, setting and indications that are controlled or monitored by the user.

[0086] Mux unit **222** is connected to security unit **224**. Security unit **224** is responsible of all issues, actions and functions that are needed to provide the security and cyber-security features that enable secure remote working with secure KVM switch **20**, and through the secure KVM switch **20** with the hosts, in general, and with the classified one or more hosts, in particular. To allow secure operation, security unit **224** comprises cryptographic unit. The cryptographic unit assure that the data over remote console communication protocol **35** will be encrypted with strong encryption that is excepted by the operating organization security policy. The encryption unit encrypts data transmitted to the remote console **60** and decrypts the data received from the remote console **60**. Security unit **224** may authenticate the remote console **60** to the secure KVM switch **20**.

[0087] In an exemplary embodiment of the invention, security unit **224** may, additionally or alternatively, authenticate the user himself using biometric means, temporarily password generation dongles, passwords, or the like. Additionally, or alternatively, authentication may be performed directly with the active host.

[0088] The bidirectional data stream of security unit **224** is connected to remote console protocol **35**. In this exemplary embodiment, the remote console port is Ethernet port **226** and the remote console protocol is Ethernet protocol. The Ethernet cable **35e** is connecting between Ethernet port **226** and Ethernet port **72**, which is located in on the office's wall **70**.
[0089] The Ethernet port **72** is connected to the organization's local network **74**, that in turn, connected to a firewall **76**, which is connected to the Internet **40**. On the remote location the user operates with the remote console subsystem **60** that is connected to the Internet **40** via another, independent, remote console communication protocol **35.**

[0090] Reference is now made to Figure 3. Figure 3 is a simplified block diagram of KM unit **202**. KM unit **202** comprises two USB data stream switches **2022** and **2023**, host emulator **2021**, two unidirectional enforcing elements **2024**, and two device emulator **2025**. The communication with keyboard **30K** and mouse **30M** is performed by the host emulator which behave as a host in front of keyboard **30K** and mouse **30M** and send the relevant data, the combined keyboard and mouse data, to switch **2022**. When switch **2022** is passing through the host emulator **2021** data, this data will be targeted to the one of the two device emulators **2025**. The path of the keyboard and mouse data pass through the unidirectional data flow enforcing elements **2024** to ensure that no data can be leaked from the active host to other hosts or to the secure KVM switch elements. The device emulators **2025** acts as a keyboard and mouse in front of the host and ensure continuous and smooth operation of the keyboard and mouse even when the host is not the active host, i.e., switch **2023** pass the keyboard and mouse data to the other host. In addition, KM unit **202** may receive a keyboard and mouse data from remote console subsystem **60** through connection **208**. Conditioned upon proper command from the secure KVM switch controller **220**, shown in Figure 2 and provided via connection **232**, this keyboard and mouse data is transferred to one of the two device emulators **2025** through switches **2022**, **2023**, and unidirectional data flow enforcing element **2024**.

[0091] Reference is now made to Figure 4. Figure 4 is a simplified block diagram of video unit **212**. video unit **212** comprises two video data stream switches **2122** and **2123**, two unidirectional data flow enforcing elements **2124**, and video processor **2121**. Switch **2123** transfers the video stream coming from the active host, either **10a** or **10b**, to switch **2122.**

Switch **2122** determines the direction that the video stream will be routed, either to display **30V** in console **50** or to remote console subsystem **60**. Optionally, if the video is routed to the remote console subsystem **60**, the video may be converted to different video format by video processor **2121**. The video stream may also be compressed and/or packetized to be in suitable format for transmission over remote console communication protocol **35.**

[0092] The video stream data path passes through the unidirectional data flow enforcing element **2124** to ensure that no data can be leaked from the non-active host to other hosts or from the secure KVM switch elements. Conditioned upon proper command from the secure KVM switch controller **220**, shown in Figure 2 and provided via connection **234**, the video stream from the active host is transferred to one of the two consoles, either **50** or **60**, through video stream switches **2122**, **2123**.

[0093] In an exemplary embodiment of the invention, video unit **212** further comprises secure circuitries to provide secure plug and play operation. These circuitries may include DDC or EDID data stored in non-volatile memories in front of hosts **10** and may initiate a preliminary stage of reading the DDC or EDID data from display **30V** and then storing the data to the non-volatile memories. Optionally, DDC or EDID data may be read from the display **63V** of remote console **60** at remote console session initiation and storing this data to the non-volatile memories. Alternatively, the video unit **212** set the DDC or EDID data in the non-volatile memories with default video format and video unit **212** or remote console subsystem **60** converts the video stream to a video stream format supported by display **63V**.

[0094] Focusing the attention now to the remote console side details. Reference is now made to Figure 5. Figure 5 is a simplified block diagram of the remote console side in accordance to an exemplary embodiment of the present invention. The bidirectional data stream between the remote console **60** and the secure peripheral sharing device, e.g., the secure KVM switch **20,** is carried by remote console communication protocol **35** connected to a wide area network, e.g., the Internet **40**. The remote console communication protocol **35** is connected to a home router **62**. Home router **62** may provide communication services to other devices at the remote console location, e.g., a desktop home computer, by using wired remote console communication protocols **65e**, such as, Ethernet, and/or by using wireless remote console communication protocols **65w**, such as, Wi-Fi.

[0095] As used herein, the term "home router" means any apparatus that provides communication services to connects a home, or in general a location, to a wide area network (WAN), such as, the Internet. The home router may be referred also as, a modem, an access point, a router, a wireless router, a hub, a switch, a gateway, and the like, depend on the home router architecture, the communication protocol, and other (auxiliary) functions.

[0096] To enable the remote KVM console operation, the remote console subsystem **60** comprises a remote KVM console controller **64**. The remote KVM console controller **64** communicates with the secure KVM switch **20** in the KVM switch side through the home router **62**. Additionally or alternatively, remote KVM console controller **64** may have the ability to connect directly to the Internet. For example, remote KVM console controller **64** may comprise a cellular modem to connect the internet using a cellular network.

[0097] Remote KVM console controller **64** is connected to a client **66** using remote console communication protocols **65u**, e.g., USB. Client **66** may be a desktop or laptop computer used for local, i.e., not remote, uses, such as, reading or writing documents. Client **66** may be connected directly to home router **62,** for example, to browse the internet. Client **66** may also be a thin client or a zero client which are used only to connect to remote computing services. Client **66** may be integrated with remote KVM console controller **64** to become a single integrated device. Client **66** may be connected to a keyboard **63K**, mouse **63M** and display **63V**. In some embodiments, e.g., wherein client **66** is a laptop device, the keyboard, the pointing device, e.g., a mouse, and the display are integrated in the client **66** (the laptop). In general, client **66** may run software applications, and in specific, client **66** may run a software application that performs the functions needed to provide the user the remote console services and functionality.

[0098] This software application, refer also as the remote KVM console application, performs at least the functions of: receives the video stream from remote KVM console controller **64** and send it to display **63V**, receive the data from keyboard **63K** and mouse **63M** and send it to the remote KVM console controller **64**.

[0099] In this exemplary embodiment, remote KVM console controller **64** is also responsible for all types of security management and enforcement of the remote console subsystem **60**, including cryptography, authentication, and the like.

[0100] client **66** may perform many kinds of operations including controlling devices and interacting with the user as needed to provide the remote access to the active host running

on the KVM switch side of the system. One such important operation is to select remotely the active host. This can be done by software user interface means, such as, presenting a menu on the display or by axillary device comprises push button keys to select the active host. Such a device is referred as Axiality Front Panel (AFP) **630**. The AFP **630** may be connected or integrated to client **66.** Optionally**,** AFP **630** may be connected to remote KVM console controller **64**.

[0101] A typical home environment with remote console subsystem **60** is illustrated next.

[0102] Reference is now made to Figure 6. Figure 6 is an isometrical view of a user's desk comprising the remote console side of the system in accordance with an exemplary embodiment of the present invention. Client **66** is a typical desktop personal computer (PC) connected to a keyboard **63K**, a mouse **63K** and a display **63V**. The computing environment may have other peripheral devices, such as, speakers (shown in the figure), mic, cam, printer, and the like, (not shown in the figure). On the desk, there is also a home router **62** connected to the Internet. The home router **62** may provide access to the Internet for client **66** as well as other home devices, such as the user's cellular phone, using Wi-Fi. The home router **62** is also connected to remote KVM console controller **64** via protocols **65w** (e.g., Wi-Fi) or **65e** (e.g., Ethernet cable). Remote KVM console controller **64** is connected to client **66** via protocol **65u**, e.g., USB. Remote KVM console controller **64** is also connected to AFP **630** via protocol **65s**. Protocol **65s** may be USB, RS232, SPI or the like. AFP **630** may be located, as shown in the figure, on top of display **63V**, allowing the user of the remote console to easily access and switch the active host, **10a** or **10b**, by a single keypress on one of the buttons of AFP **630**. As mentioned before, this embodiment configuration is only one possible alternative and many variations of client **66** form-factor, and integration or separations between devices **62**, **64, 66** and **630** are possible in accordance with the present invention.

[0103] Reference is now made to Figure 7. Figure 7 is a simplified block diagram of another embodiment of remote console side. In this embodiment, remote KVM controller **64,** client **66**, and AFP **630**, where integrated into a single remote console client **600** apparatus, that provides a full solution for remote access to the secure peripheral sharing device, e.g., secure KVM switch **20**.

[0104] The remote console subsystem **60** comprises remote console client **600**, the remote console's peripheral devices **63**, **63K**, **63V**, **63M**, and, optionally, also the home router **62**. Cellular AP, shown as well in the figure, may be considered as part of the remote console subsystem **60** but preferably is considered part of the communication infrastructure between the remote console side and the KVM switch side.

[0105] Remote console client **600** may connect to the Internet **40** through, already deployed, home router **62** via wired **65e** or wireless **65w** communication protocol or directly via a cellular communication protocol **65c**, e.g., 3G, 4G or 5G cellular standard, using built-in cellular modem **620**. Cellular modem **620** may be connected to the Internet **40** through a cellular infrastructure, e.g., cellular access point (AP) or cellular base station (BS) deployed as a public infrastructure in proximity to the remote console location, e.g., on one of the rooftops of the buildings in the home's neighborhood. In the case where remote console client **600** is connected to the Internet **40** through home router **62**, the communication services are provided by build-in communication modem **610**. In any case, the data of remote console communication protocol **35** pass through the security/cryptographic unit **640** to provide the mandatory encryption/decryption and the optional authentication with the remote secure KVM switch **20**. Remote console client **600** comprises a remote console processor **660** to perform all necessary tasks to provide the user the ability to work remotely with the active host connected to the remote secure KVM switch **20**. Remote console client **600** may be a thin-client or a zero-client running over a low performance, reduced cost, micro-controller or even non-programable hardware such as ASIC or FPGA. Alternatively, remote console client **600** may be a full capability computing device that can provide, in addition to remote console services to the KVM switch side, some local computing, data processing, gaming, and the like services. Remote console client **600** may be configured to be connected to a keyboard **63K.** Additionally or alternatively, remote console client **600** may have integrated text entry, i.e., keyboard, capabilities. For example, remote console client **600** may have built-in mechanical keyboard, like in a laptop computer, or touch screen keyboard in the case where remote console client **600** is provided by a tablet form-factor.

[0106] Remote console client **600** may be configured to be connected to a mouse **63M** or any other type of pointing device. Additionally or alternatively, remote console client **600** may have integrated pointing device. For example, remote console client **600** may have built-in touch pad for pointing, like in a laptop computer, or touch screen where the finger

touch provides the pointing capabilities, in the case where remote console client **600** is provided by a tablet form-factor.

[0107] Remote console client **600** may be configured to be connected to a display **63V.** Additionally or alternatively, remote console client **600** may have integrated display. For example, remote console client **600** may have built-in display, like in a laptop computer, or touch screen display in the case remote console client **600** is provided by a tablet form-factor.

[0108] The remote console processor **660** receives the video stream from security/cryptographic unit **640** and send the video stream in the proper format to the display. Optionally, remote console processor **660** performs video processing on the video stream. The video processing may be decoding, decompression, format adaptation and the like. Remote console processor **660** may read the DDC or EDID of display **63V** and send it to the secure KVM switch.

[0109] Remote console processor **660** may receive the data from keyboard **63K** and mouse **63M** and send it to the security/cryptographic unit **640**. Optionally, remote console processor **660** may comprise host emulator to emulate a host in front of the peripheral devices such as keyboard, mouse, display or any other peripheral devices. Typically, such a host emulator communicates with a matching device emulator in front of the host in the KVM switch side.

[0110] Security/cryptographic unit **640** is responsible for of security functions of the remote console client **600**. Remote console client **600** may have anti-tampering unit **650**, optionally battery operated, so that any attempt to open the remote console client **600** enclosure will make the device **600** non-functioning as well as erase all sensitive data including the cryptographic keys, firmware, as well as any other sensitive data reside in remote console client **600**.

[0111] To provide trusted authentication, remote console client **600** may comprise biometric sensor **670** to authenticate not only the specific device **600** but also the user, i.e., the identity of the remote console operator. Biometric sensor **670** may be fingerprint reader, eye iris reader, face recognition sensor, or the like. Additionally or alternatively, instead of biometric sensor, other authentication means maybe used. For example, an identification card reader, e.g., CAC reader, smart card, smart dongle, one time password generator, and the like, may be used.

[0112] To select the active host, remote console client **600** may comprise front panel (FP) **632**. FP **632** may comprise push buttons on the front side of the enclosure of remote console client **600**. Additionally or alternatively, active host selection may be done by other means such as a menu over display **63V**, shortcuts assigned to the keyboard **63K**, mouse **63M** gestures, and the like.

[0113] Remote console client **600** may be configured to be connected to an auxiliary peripheral device **63** via any type of peripheral devices communication protocols **25**. Auxiliary peripheral device **63** may be a printer, a camera, a microphone, speakers, a smart card reader, a biometric sensor, an identification device, an external mass storage device, a USB dongle, a mobile terminal, such as, smartphone, and the like.

[0114] The auxiliary peripheral device **63** may be shared between hosts **10** by switching the connection to the active host, a.k.a., switching operation, or by simultaneous working with all hosts, a.k.a., simultaneous use operation. For example, smart cards, biometric sensors, cameras, microphones, printers and the like may be shared or switched. The setup and processing of simultaneous use operation is not in the focus of this document so the details on these embodiments are not provided herein, however the needed modifications are apparent to those skilled in the art.

[0115] The three essential peripherals: keyboard, mouse and display, are almost always operate in switching mode and the peripheral sharing device (or the KVM switch) that provides the switching operation for these essential peripherals, details are provided as a common baseline to be extended, as needed, with additional peripheral devices.

[0116] Reference is now made to Figure 8. Figure 8 is a simplified block diagram to yet another embodiment of the remote console side in accordance with some embodiments of the invention. The remote console subsystem **60** of this embodiment is based on a smartphone **662**. Smartphone **662** is coupled with the KVM switch side via a cellular communication protocol **65c**, e.g., 3G, 4G or 5G cellular standard. The cellular network comprises cellular AP that communicate with smartphone **662** via cellular communication protocol **65c** and, in turn, via remote console communication protocol **35** over the Internet **40** to the secure KVM switch **20**.

[0117] Smartphone **662** is connected to cryptographic add-on device **664**. The cryptographic add-on device may be in the form of a jacket attached to smartphone **662**. In

an exemplary embodiment of the invention, add-on device **664** further comprises a cellular modem to enable add-on device **664** communicate directly via cellular communication protocol **65c** instead of via smartphone **662.** Such a configuration is considered more secure than the previous one but both options can be used depended on the security policy of the operating organization.

[0118] The video stream coming from the active host in the secure KVM switch side is processed (decompressed and decrypted) by Smartphone **662** and/or add-on device **664** and may be presented on the screen of Smartphone **662**. Mouse may be implemented by capturing finger touches on a screen of smartphone **662**. Keyboard may be implemented by virtual keyboard on the screen of smartphone **662**. The mouse and keyboard data encrypted by add-on device **664** and multiplexed to a multiplexed data carried by remote console communication protocol **35.** Active host selection may be provided by soft keys on the screen of smartphone **662** or hardware keys of the smartphone **662**, e.g., the remote console application may use the volume control keys of the smartphone **662** to switch the active host. In an exemplary embodiment of the invention, the smartphone is replaced by a tablet.

[0119] The above remote console subsystem **60** configuration enables the user to operate the active host in the secure KVM switch side on the go (i.e., at mobile condition), however, in many cases, such operation is less comfortable. To provide more comfortable operation with smartphone **662,** a remote console accessory **666** device may be provided. Remote console accessory **666** may be connected to smartphone **662** via remote console communication protocols **65u**, e.g., USB 3.X. Remote console accessory **666** is configured to be connected via standard peripheral devices communication protocols **25** to standard console devices such as display **63V**, mouse **63M** and keyboard **63K**. In an exemplary embodiment of the invention, display is connected via communication protocol **25v**, e.g., HDMI, and mouse and keyboard via communication protocol 25u, e.g., USB.

[0120] In addition, remote console accessory **666** may comprise FP **632** to enable active host selection.

[0121] Remote console communication protocols **65u** multiplexed the video data stream, after decryption, decompression and, optionally, additional video processing by smartphone **662** and/or add-on device **664**, and keyboard, mouse and AFP data from remote console accessory **666.**

[0122] In an exemplary embodiment of the invention, the functions of remote console accessory **666** are integrated into add-on device **664**.

[0123] The attention is shifted back now to the secure KVM switch side. Reference is now made to Figure 9. Figure 9 is a simplified block diagram of another embodiment of the KVM switch side with an ordinary secure KVM switch **20a** and auxiliary remote console adapter **300**.

[0124] The ordinary secure KVM switch **20a** is used alone when no remote console services are required. In order to add remote console function to the ordinary secure KVM switch **20a**, the auxiliary remote console adapter **300** should be added.

[0125] The ordinary secure KVM switch **20a** may be connected, in the regular fashion, directly to console **50** via peripheral devices communication protocols **25**. The connection is performed via one or more ports **26**. If remote console connection is desired, the auxiliary remote console adapter **300** is added to the system. In local mode, switch **302** connect console **50** to KVM switch **20a** so that an ordinary KVM switch operation is performed between console **50** and secure KVM switch **20a** and auxiliary remote console adapter **300** is a dumb transparent mediator between port **26** and console **50.** To enable remote console operation, a switch for remote console mode in UI **304** may set to enable this mode. Additionally or alternatively, enable command to the controller in adaptor processing unit **306** may be provided from dedicated port or organization's local network **74**. From security reason, in some embodiments this command may only be activated by equipment deployed directly on the internal network **74** of the organization. In an exemplary embodiment of the invention, there is a control office or control center that can enable and disable remote access for all or some of the peripheral sharing devices of the organization. For such a setting, the user may call the control center for identification, and the control center operator enables the remote connection, optionally, for a limited duration.

[0126] As soon as the remote KVM switch console mode is enabled, either the remote console side or the KVM switch side may initiate a remote console connection, referred also as a remote console session. Establishing a session may have several types of authentication steps.

[0127] One type of authentication step may involve the identity of hardware devices, referred herein as hardware ID authentication. In hardware ID authentication, a remote console session between only a specific pair of devices may be able to be established. For

example, if an employee has auxiliary remote console adapter **300** with serial number #SN1 in his office, and in his home, a remote console client **600** with serial number #SN2, then one possible security policy may be to allow only connection between device with #SN1 and device with #SN2. Optionally, there is an IT level equipment or IT personal that can enable remote connection with all or some of the KVM switches in the organization. In an exemplary embodiment of the invention, other type of authentication scheme and other type of authentication may be used. For example, personal authentication with biometric sensor, smart card or any other means of personal authentication may be used.

[0128] In an exemplary embodiment of the invention, the authentication process may be two steps authentication or multi-factor authentication or any other type of authentication as defined by the security policy of the operating organization.

[0129] After the remote console session is established, adaptor processing unit **306** switches the connection from local console **50** to remote console **60**. This is done by changing switch **302** state to connect the console port **26** with adaptor processing unit **306.** The active host in this remote console mode is seamlessly get in contact with the remote console **60**. The video stream of the active host is processed by the video unit of adaptor processing unit **306,** encrypted by security/cryptographic unit **308** and sent out using one of three communication link options.

[0130] The first communication link option is communicating using wired modem **312** which is connected, for example similar to the configuration described in Figure 2, via Ethernet port **72**.

[0131] The second communication link option, is communicating using wireless modem **314**. Wireless modem **314** is connected to wireless access point **78** using wireless remote console communication protocols **35w**, such as, Wi-Fi. Wireless access point **78** is connected to organization's local network **74** that, in turn, connected to firewall **76** as in the embodiment described in Figure 2.

[0132] The third communication link option is communicating using cellular modem **316**. Cellular modem **316** is connected a cellular AP, also in some cellular system referred also as a cellular base station (BS), and from the cellular AP the video stream is carried over the cellular infrastructure to the Internet **40.**

[0133] It should be noted that in the same communication link, the remote console communication protocol **35**, all other data needed for establishing the remote console

session is transported. Obviously, remote console communication protocol **35** is typically multiplexed with other types of data communication on the same communication infrastructure.

[0134] To provide the other facilities of the remote console operation the MUX in adaptor processing unit **306** takes care of the keyboard and mouse data that are send from remote console subsystem **60** and after decryption by security/cryptographic unit **308,** this data is adapted to the proper **p**eripheral devices communication protocol **25** and is sent via the switch **302** to port **26**. Active host **10** seamlessly continue to work with the keyboard **63K** and the mouse **63M** of remote console **60** instead of with the local console **50**.

[0135] When an active host switching command is received from remote console **60** to auxiliary remote console adapter **300** via remote console communication protocol **35**, the command is detected, separated and interpreted by mux unit of adaptor processing unit **306** and the controller of adaptor processing unit **306.** The controller sends the selection command to the KVM switch **20a** via port **28.** Port **28** may be an existing AFP input port of KVM switch **20a.**

[0136] Optionally, since auxiliary remote console adapter **300** may comprise a military grade cryptographic unit, it is desired to have anti-tampering unit **318** that erase all keys and sensitive data from auxiliary remote console adapter **300**. In any attempt to open the auxiliary remote console adapter **300** enclosure, lines **319** activate the anti-tampering erase function in security/cryptographic unit **308** and adaptor processing unit **306.** Optionally, erase of any or all keys and sensitive data may be provided by user interface **304**. To eliminate the chance of accidental activation for this function, user interface operations like simultaneous press of several buttons, prolonged presses, sequence of presses, and the like may be used.

[0137] In an exemplary embodiment of the invention, user interface **304** may comprise a push button to restore auxiliary remote console adapter **300** to its default configuration.

[0138] In an exemplary embodiment of the invention, user interface **304** may comprise a push button to reset auxiliary remote console adapter **300**.

[0139] In an exemplary embodiment of the invention, user interface **304** may include indications that indicates that remote console mode is enabled, as well as an indication that the auxiliary remote console adapter **300** is in remote console session.

[0140] Reference is now made to Figure 10. Figure 10 is a simplified block diagram of another embodiment for implementing the KVM switch side of the system. In the embodiment of figure 10 the secured KVM switch **20** of Figure 2 is partitioned to a basic secure KVM switch **20b** and add-on adapter **20c** that extend the KVM switch capabilities to support a remote console **60**. The difference from previous embodiment of figure 9 is that in Figure 9 embodiment ordinary secure KVM switch **20a** was not designed or had any provisions to support remote console subsystem **60** while basic secure KVM switch **20b** was designed to support remote console subsystem **60** with add-on adapter **20c.**

[0141] Add-on adapter **20c** and basic secure KVM switch **20b** are configured to match each other and have a proper interface, i.e., one or more connectors that match and provide all mechanic and electric connectivity properties that are needed to co-work together. The matching form-factor may be an enclosure extension form-factor of the basic secure KVM switch **20b** from one side of the basic secure KVM switch **20b** enclosure or a bay form-factor, wherein add-on adapter **20c** fits inside the bay of basic secure KVM switch **20b**.

[0142] Console device **30K**, **30M** and **30V** as well as hosts **10a** and **10b** are connected directly to the secure KVM switch **20b** in similar to the way shown in Figure 2. The KM unit **202**, the video unit **212**, UI **228,** Ethernet type remote console port **226**, and controller **220** are also similar to the ones described in secure KVM switch **20** of Figure 2 and they are configured to have the capabilities needed to connect to a remote console **60**.

[0143] Similar to, mux **222** and security **224** of secure KVM switch **20** shown in Figure 2 and to security / cryptographic unit **308** and adaptor processing unit **306** of auxiliary remote console adapter **300** shown in Figure 9, processing unit **406** of add-on adapter **20c** provides all the remote console functions describe in the units specified hereinabove. Similarly, user interface **404** and anti-tampering **418** provide similar functions as user interface **304** and anti-tampering **318** in Figure 9.

[0144] In addition to the functions described hereinabove, Add-on adapter **20c** comprises port **432** that is configured to enable tunnelling of additional information or to securely connect additional devices between the KVM switch side and the remote console side. Furthermore, add-on adapter **20c** comprises port **442** for key management of cryptographic unit of processing unit **406**.

[0145] In a typical office of many organizations, the office wall **70** comprises only two Ethernet sockets, the first Ethernet socket is for an unclassified (black) network **72**, and the

second Ethernet socket is for a classified (red) network **73**. Secure KVM switch **20b** in Figure 10 support two hosts: **10a** and **10b**. The classified host **10a** is connected directly to Ethernet socket for the classified (red) network **73**. If we connect host **10b** to the Ethernet sockets for the unclassified (black) network **72,** and want to have also a connection to the remote console **60** we would need another Ethernet socket in the office wall or need to deploy additional Ethernet router in the office. To avoid this additional infrastructure requirement, add-on adapter **20c** comprises port **422**, e.g., Ethernet socket, that is connected to a built-in internal MUX **424**. MUX **424** may be Ethernet router, Ethernet switch, hub or any circuitry that aggregate the communication from processing unit **406** and port **422** to remote console port **226**. Remote console port **226** communicate with the non-classified network of the organization and, in turn, further connected to the Internet **40** and to remote console **60**. Having MUX **424** in Add-on adapter **20c** enables connecting host **10b** to port **422** as shown in the figure, so that host **10b** may be connected to the internet while the KVM switch (**20b** and **20c**) simultaneously may be connected to the remote console **60** through the same Ethernet communication protocol via the unclassified (black) network **72**.

[0146] Reference is now made to Figure 11. Figure 11 is a conceptual simplified flow diagram of the method **500** implemented by the KVM switch side and remote console side devices. In the Figure, the steps performed in the remote console side are shown in the right side of the figure and the steps performed in the KVM switch side are shown in the left side of the figure. The method starts when in any of the sides a triggered to start remote console session is received. This can be by enabling the remote console mode to the KVM switch, i.e., **20**, **20a+300**, **20b+20c**, or initiating a remote console session by the user in the console side devices, i.e., **60**, **64**, **66**, **600**, **660**, **662**, **664**, **666**. If the trigger starts in the remote console side, step **512** triggers step **510** in the KVM switch side, and vice versa, if the trigger starts in the KVM switch side, step **510** triggers step **512** in the remote console side. When all security conditions are met, i.e., the KVM switch is allowed to enter remote console mode, the console side is active and request to work with the KVM switch and all authentication processes are accomplished, remote console session is imitated, the method **500** progress to steps **520**, **530** and **540** in the KVM switch side and to steps **522**, **532** and **542** in remote console side. Steps **520**, **530** and **540** are running concurrently and in infinite loop as indicated by the circular arrows in the figure. Similarly, steps **522**, **532** and **542** are

running concurrently and in infinite loop as well. The execution of these steps is stopped when a request for closing the remote session is received in any of the sides. For example, a closing request may occur in the KVM switch side when the session duration is expired. A closing request may occur in the remote console side when the user of the remote console finish his work on the remote console. Many other events may trigger a session closing request, for example, if a monitoring subsystem suspect a malicious activity or if the console user do not use the console for a predefined period, a remote console session closing request may be triggered.

[0147] During active session, step **520** receives the video stream (or, in general, the one or more video streams, if more than a single display is supported) from the active host, e.g., **10a** or **10b**, via peripheral devices communication protocols **25,** or in specific, peripheral devices communication protocols **25v**. For example, peripheral devices communication protocols **25v** may be HDMI. To provide lower delay in the transport of the video stream, the video stream may be compressed, optionally sliced to packets, e.g., IP packets, and then encrypted and send to remote console via remote console communication protocol **35**. This video stream is received by step **522** and then decrypted, decompressed and adapted to the remote console display format, e.g., back to HDMI, or alternatively converted to DVI. The video stream output of step **522** is sent to display **63V** via peripheral devices communication protocols **25,** or in specific, peripheral devices communication protocols **25v**.

[0148] During active session, step **532** receives data from keyboard **63K** and mouse **63M** or any other text entry devices and pointing devices reside in the remote console side, encrypt this data and multiplexed and send this data via the remote console communication protocol **35**. In step **530** this data demultiplexed, decrypt and send in the proper format, e.g., as USB HID device over a USB bus, to the active host.

[0149] During active session, step **542** receives active host switching command initiated using AFP **630**, FP **632** or any other means used by the remote console devices, encrypt this data and multiplexed and send this data via the remote console communication protocol **35**. In step **540** this data demultiplexed, decrypt and processed by the proper controller in the KVM switch side and then switch the active host as commanded.

[0150] In an exemplary embodiment of the invention, method **500** for providing a remote console subsystem **60** to a secure peripheral sharing device **20** is disclosed. The secure peripheral sharing device comprises: a plurality of ports to be configured to be connected to

a plurality of hosts **10**; a port to be configured to be connected to a console **50** comprising at least a first keyboard **30K**, a first mouse **30M** and a first display **30V**; and a remote console port **22** configured to be coupled to a remote console subsystem. The remote console subsystem **60** comprises: a port configured to be coupled to a secure peripheral sharing device **20**; and a remote console comprising at least a second keyboard **63K**, a second mouse **63M** and a second display **63V**.

[0151] The method **500** comprises the step of:

- receiving requests for open new remote console sessions and upon such request open a remote console session in both the side of the secure peripheral sharing device and the remote console subsystem **(510, 512)**,
- as long as the remote session is active, continuously perform the steps of:
  - receiving video stream from the active host and transferring the video stream to the second display **(520, 522)**
  - receiving a keyboard and mouse data from the second keyboard and the second mouse and transferring the keyboard and mouse data to the active host **(530, 532)**, and
  - upon receiving active host switching commands from a user, switching the active host **(540, 542)**,
- receiving requests for close remote console sessions and upon such request close the remote console session and resume working of active host with the console **(550, 552)**.

[0152] While this high-level flowchart describes the basic flow of the remote console operation, it would be apparent to those skilled in the art to how to make modifications and additional steps, such as, to support additional peripheral devices in the remote console, to provide additional means of security, to convert formats as needed, to accelerate system latencies, and the like.

[0153] The delay between user action on the console and the response might become an issue if the delay in remote console communication protocol **35** becomes higher than few hundreds of milliseconds. To reduce this latency, several measures may be taken: (a) reducing video bandwidth by lower the video quality, (b) reducing video bandwidth by higher rate of video compression, (c) reducing the latency of processing elements such as

video compression, video decompression, encryption/decryption and the like, (d) reducing the latency of communication by reducing the number of communication device in the link, and (e) reducing the latency of communication by having higher quality communication links, higher quality of service (QoS) links, and low latency communication links, for example using 5G cellular network in both the remote console side and the KVM switch side.

[0154] In an exemplary embodiment of the invention, other means are used to improve the latency, for example, various technics of processing the mouse data such as to predict its future location, to manipulate click time and the like may be used. In addition, remote console software might be installed in the hosts to provide deeper understanding and processing of the video stream. For example, this software might give priority to the active window, priority to parts in the video frame that are updating text entry information, active area that are affected by mouse hover or mouse clicks, and the like. This software might communicate with a remote console side software via another side channel that is multiplexed on the keyboard and mouse USB connection.

[0155] While the above embodiments teach remote console using a KVM device reside in the organization premises, there are many organizations that are not using KVM at offices and their work from home solution is a software-based remote desktop solution that is illustrated in Figure 12. Figure 12 is a simplified block diagram of a remote desktop system. System **700** comprises a plurality of users **702** working at home, or anywhere out of their offices, using client-side host **710**. Client host **710** may be desktop computer, laptop computer, notebook computer, tablet, PDA, smartphone, thick/thin/zero client or any other computing system with UI the user can use for accessing remote host. client-side host **710** may have console **720** for interaction between the user and the host. A typical console for desktop computer may be a keyboard, a mouse (or any other pointing device) and display. In some embodiments, part of the console is integrated into the client-side host **710**, e.g., the keyboard in a laptop computer. In other examples, the full console is integrated in the client-side host **710**, e.g., a smartphone comprising a display, a keyboard and a pointing device where all these console devices are integrated into the smartphone and implemented over the touch screen display element. Many hybrid configurations of console **720** and host **710** may exist in practice. For example, a docking station may connect to typical desktop environment console devices, such as, a keyboard, a mouse and a desktop display to a

smartphone that already comprises integrated console in order to improve the user interface productivity.

[0156] Client-side host **710** comprises client-side remote desktop software **730**. The client-side remote desktop software **730** captures the mouse and the keyboard (or in general, the user inputs) data from client-side host **710** and sends these inputs to a server-side host **750**. The server-side host **750** comprises server-side remote desktop software **760** that receive the user inputs data and use the user input data to control server-side host **750** as if it was controlled by a user which is operating a local console. The display (or in general the user output) of server-side host **750** are sent by server-side remote desktop software **760**, in turn, to the client side.

[0157] In an exemplary embodiment of the invention, user input may further comprise audio input (for example from a microphone), video stream (for example from video camera - cam), other data from console input device (e.g., biometric authentication sensors), and the like

[0158] The communication between client-side remote desktop software **730** and server-side remote desktop software **760** is provided by a remote desktop protocol (RDP). Many versions of Remote Desktop Protocols exit and they may communicate over many types of communication links **740**. For example, one of the most prominent remote desktop solutions in the market is Microsoft solution wherein the client-side remote desktop software **730** is referred as "remote desktop connection" or "terminal services client", the server-side remote desktop software **760** is referred as "remote desktop server (RDS)" and the communication protocol is referred as "Remote Desktop Protocol". Note that the "Microsoft remote desktop protocol" is a specific type of the general term RDP for the protocol and unless specifically mentioned in the document the term remote desktop protocol (RDP) is referred to any protocol for remote desktop solution. For example, RDP may mean, (1) Apple Remote Desktop Protocol (ARD) – by Apple, (2) Independent Computing Architecture (ICA) – by Citrix Systems, (3) Appliance Link Protocol (ALP) – by Sun Microsystems, (4) HP Remote Graphics Software (RGS) – by Hewlett-Packard, (5) Remote Desktop Protocol (RDP) – by Microsoft, and the like.

[0159] The RDP protocol may communicate over many variants of communication links **740**, the most common is IP protocol over Ethernet. Microsoft's RDP is typically run over IP and the server-side remote desktop software **760** listens on TCP port 3389 and UDP port

3389. Other communication links like optical and wireless communication links may be used as well.

[0160] Regarding the remote desktop software 730 and 760, there is also many software available in the market such as freeRDP, rdesktop, LogMeIn, Anydesk, Apple remote desktop, GoToMyPC and XenApp from Citrix, PCanywhere, xrdb, and many more.

[0161] It should be mentioned that remote desktop solution provides a good way for cross platform operation so while the server-side remote desktop software **760** may run for example on Linux, the client-side remote desktop software **730** may run, for example, on Microsoft Windows. The above listed software may enable to run remotely (and sometimes also locally) software of almost any computing platform using any other computer platform.

[0162] Remote desktop solutions are also known as "desktop virtualization". Remote desktop solutions are usually used in combination with another virtualization concept of virtual machines or hosts farms **770**. A plurality of virtual hosts **780** instances may reside inside virtualization machines/farms 670 sharing the same hardware to create a plurality of virtual host **780**. Each virtual host **780** can have a server-side remote desktop software **760V** that runs an instance of the server-side remote desktop software **760**.

[0163] User **702** of client side-remote desktop software **730** may access (and operate) a host **750** located remotely in his office using a data path that starts from the Internet **40**, through firewall **76** that communicate with organization network **742** (e.g., a local network) and ends in the server-side host **750**. Similarly, user **702** may access (and operate) a host located in a computing center on the cloud, i.e., host **750** that resides in cloud computing center and connected to the internet through cloud computing center network **744**. Furthermore, user **702** may access a virtual host instantiates **780** on a virtualization machines/farm **770**. Virtual host instantiates **780** may reside either on the organization network **742** or the cloud computing center network **744**.

[0164] While this remote desktop solution is very convenient and flexible, such remote desktop solutions are known to have cyber security vulnerabilities, while some can be addressed using software means (such as firewalls, authentication, DMZ zones, and other cyber security tools that may be customized for remote desktop software solution, software based cyber security measures are generally not secure enough to many organizations. Furthermore, in some cases the organization would like to give access to hosts that reside on isolated network, i.e., network that is not connected to the internet for workers at home

or on-the-move. A solution for more secure access to such hosts, without using a KVM as disclosed above, is disclosed next.

[0165] Figure 13 is a conceptual remote desktop solution system 800 using a remote desktop isolator **810**. As in previous case, user **702** may access (and operate) host **750** located in his office or elsewhere in the organization premises and connected to organization network **742**. In some embodiment, network **742** is isolated and not connected to the Internet **40**. Whenever the organization network is isolated network, i.e., not connected to the Internet **40,** there is no other way to support remote desktop solution other than using remote desktop isolator **810**. Remote desktop isolator **810** is a device that securely bridge between the internet **40** and organization network **742** for remote desktop access solution. Remote desktop isolator **810** is more cyber secure solution and the isolator mission is to allow cyber secure use of remote desktop access to host **750**.

[0166] In an exemplary embodiment of the invention, a firewall **76** is provided between internet **40** and organization network **742**, however, in this case, firewall **76** may block the access of remote desktop services and if remote desktop services are provided, they will be performed only through remote desktop isolator **810**. It should be noted that having a firewall reduce the cyber security of the organization and typically such solution would be selected for less classified networks.

[0167] Remote desktop isolator **810** comprises three major zones, or layers: client-side desktop isolator layer **820**, isolator layer **830** and server-side desktop isolator layer **840**. Client-side desktop isolator layer **820** is connected to the client-side host **710** via communication link that provide RDP communication services with the client-side remote desktop software. For example, client-side desktop isolator may comprise Ethernet port that is connected to Ethernet network that is connected to the Internet **40**. Client-side desktop isolator layer **820** may comprises processor and software (or firmware) that run server-side remote desktop software that act as a remote desktop server proxy for the client-side remote desktop software **730** that user **702** interacts with. In an exemplary embodiment of the invention, the RDP communication on the Internet 40 is protected by encrypted communication tunnels, e.g., a Virtual Private Network (VPN) using SSL, SSH or the like.

[0168] server-side desktop isolator layer **840** is connected to the server-side host **750** via communication link that provide RDP communication services with the client-side remote desktop software. For example, client-side desktop isolator comprises Ethernet port that is

connected to Ethernet network that is part of the organization network **742**. Server-side desktop isolator layer **840** may comprise processor and software (or firmware) that run client-side remote desktop software that act as a remote desktop server proxy for the server-side remote desktop software **760**. In an exemplary embodiment of the invention, the RDP communication over the organization network is protected encrypted communication tunnels e.g., Virtual Private Network (VPN) by using SSL, SSH or the like.

[0169] Between client-side desktop isolator layer **820** and server-side desktop isolator layer **840** there is an isolation layer **830** that contains special hardware to enforce that only valid information flow will be transferred between client-side remote desktop software **730** and server-side remote desktop software **760**. A more detailed view of the isolator layers will be disclosed next.

[0170] Figure 14 is a conceptual block of the remote desktop isolator **810**. remote desktop isolator **810** comprises client-side interface **822** that communicate RDP using communication link **740C**. the interface may be Ethernet, Optical link or any link that is used to connect devices and hosts to a network. The client-side interface **822** should be able to connect via the communication link **740C** to the client-side host **710**. Client-side interface **822** is internally connected to a client-side isolator processor **824**. The client-side isolator processor **824** may be any processor, host, circuitry, FPGA, or computer that is able to perform the function of a client-side remote desktop isolator software. In an exemplary embodiment of the invention, the client-side isolator processor **824** may be implemented by a standard X86 microprocessor architecture and running Microsoft windows operating system, or may be ARM based architecture running Linux operating system or the like. The processor architecture may be associated to think/think/zero client architectures. The client-side isolator processor **824** execute the client-side remote desktop isolator software **826**. The **client-side** remote desktop isolator software **826** may act as a proxy for **server-side** version of a remote desktop software. This software may be a special version of an off-the-shelf software, such as remote desktop server (RDS) from Microsoft, or any other server-side version of remote desktop software, from Apple, Citrix, HP, or the like. It should be noted that the client-side remote desktop software **730** should be compatible with the client-side remote desktop isolator software **826**. In an exemplary embodiment of the invention, a customized version of client-side remote desktop isolator software **826** and/or client-side remote desktop software **730** may be used. In an exemplary embodiment of the invention,

the client-side remote desktop isolator software **826** is the sole executable software of client-side isolator processor **824** and the code is stored in read-only memory so that hacking the processor with malicious code is almost impossible.

[0171] client-side remote desktop isolator software **826** act as proxy (or emulator) for the server-side remote desktop software **760**, and as such it receives the keyboard and mouse (KM) data from client-side remote desktop software **730** than send the KM data to server-side remote desktop software **760**. Sending the KM data is performed through the client-side channels drivers **828**, and specifically the KM channel that is sending the data to the KM unidirectional isolator **834** that is part of the isolation layer **830** of remote desktop isolator **810**.

[0172] KM unidirectional isolator **834** enforce unidirectional communication so that only KM data can be passed from the client side to the server side. In an exemplary embodiment of the invention, additional monitoring processing is performed to check that no suspicious malicious KM data is transferred over the KM channel. The KM data is passed to server-side channels drivers **848** which pass the KM data to server-side remote desktop isolator software **846** that executes on server-side isolator processor **844** that reside on the server-side isolation layer **840** of remote desktop isolator **810**. It should be noted that the two processors **824** and **844** are completely independent and isolated from each other and other then passing RDP data between sides they can not communicate or share any data.

[0173] In addition, remote desktop isolator **810** comprises server-side interface **842** that communicate RDP using communication link **740S**.The interface may be Ethernet, Optical link or any link that is used to connect devices and hosts to a network. The server-side interface **842** is able to connect via the communication link **740S** to the server-side host **750**. Server-side interface **842** is internally connected to a server-side isolator processor **844**. The server-side isolator processor **844** may be any processor, circuitry, FPGA, host or computer that is able to run a server-side remote desktop isolator software **846**. In an exemplary embodiment of the invention, the server-side isolator processor **844** may be implemented by a standard X86 microprocessor architecture and running Microsoft windows operating system, or may be ARM based architecture running Linux operating system or the like. The processor architecture may be associated to think/think/zero client architectures. The server-side isolator processor **844** may execute the server-side remote desktop isolator software **846**. The **server-side** remote desktop isolator software **846** may act as a proxy or emulator

for **client-side** version of a remote desktop software **730**. This software may be a special version of an off-the-shelf software, such as remote desktop connection from Microsoft, or any other client-side version of remote desktop software, from Apple, Citrix, HP, or the like. It should be noted that the server-side remote desktop software **760** should be compatible with the server-side remote desktop isolator software **846**. In an exemplary embodiment of the invention, a customized server-side remote desktop software **760** and/or server-side remote desktop isolator software **846** may be used. In an exemplary embodiment of the invention, the client-side remote desktop isolator software **846** is the sole executable software of server-side isolator processor 844 and the code is stored in read-only memory so that hacking the processor with malicious code is almost impossible.

[0174] Server-side remote desktop isolator software **846** act as proxy (or emulator) for the client-side remote desktop software **730**, and as such it receives the display data from server-side remote desktop software **760** than send this data (may be just a video stream) to client-side remote desktop software **730**. Sending the display data is enabled using the server-side channels drivers **848**. The display data in remote desktop systems can be represented in two ways: (1) descriptive data of the desktop objects on the display, like, windows frames, icons, menu, etc., hereinafter a "native desktop data", or (2) a video stream. When native desktop data is provided, the client-side remote desktop software **730** redraws the display in accordance with the native desktop data information and when a video stream version is provided the client-side remote desktop software **730** project the video stream on the display. While sending native desktop data may demand less bandwidth from the communication link and make in some cases the synchronization between KM data and display data easier, it is less secure and more complex to handle in the remote desktop isolator **810**. Both cases might be supported, and since, for example, a window in the desktop might contain a video stream any RDP solution can support using video stream for the full desktop, i.e., the display is represented as a video stream covering all desktop area. In an exemplary embodiment of the invention, the remote desktop isolator **810** may convert native desktop data to video stream and enforce the system to work in a more secure full screen video mode for the display data. In any of the cases, the display data is transferred from server-side remote desktop isolator software **846** to server-side channels drivers **848**. Server-side channels drivers **848** may convert the video stream format from IP video stream to more native unidirectional video format, such as, HDMI, DisplayPort, or the like, or even

to analog video format in order to prevent any hidden data transfer between the server-side host **750** and client-side host **710**. Similarly, the video conversion may be done inside the isolator layer **830** of remote desktop isolator **810**.

[0175] The display data, in any of the possible formats, is transferred to display/video unidirectional isolator **832** and through the client-side channels drivers **828** to client-side remote desktop isolator software **826**. The display data may convert the video format back to original or to another format on the isolator layer, the channel driver or the software. From software **826** the display data is sent to the client side-remote desktop software **730** which take care to send it to user **702** display on console **720**.

[0176] display/video unidirectional isolator **832** enforce unidirectional communication so that only display data can be passed from the server side to the client side. In an exemplary embodiment of the invention, additional monitoring processing is performed to check that no malicious display data is getting over this channel. It should be noted that processor **844** are completely independent and isolated from processor **824.** Optionally, each of the processors communicates in different RDP protocol.

[0177] In addition to the KM data and the display data, in some of the remote desktop systems other input or output devices may be supported. For example, user **702** might have the ability to receive audio streams (mono or stereo) from server-side host **750**. In this case, audio unidirectional isolator **836** may transfer unidirectional digital or analog audio that originated from server-side remote desktop software **760**, pass through server-side desktop isolator layer **840** and then the isolator transfers the secured audio data to client-side desktop isolation layer **820**. Additionally or alternatively, the audio stream may be handled inside the display data video stream.

[0178] Other audio devices, like Microphone, may be supported as well by the system. Mic audio data direction and the unidirectional data flow enforcement is reversed in this case. special MIC unidirectional isolator **836** may be provided for this services in isolator layer **830**.

[0179] The remote desktop isolator **810** may also support a video camera (i.e., a cam) in the client side, in this case the video stream is handled similarly by the remote desktop isolator 810 where the security and unidirectional enforcement is provided by cam unidirectional isolator **836**.

[0180] One important issue for cyber security in such remote desktop systems is the authentication of user **702**. Since the client-side host is not inside organization promises, it is important to authenticate the user. In an exemplary embodiment of the invention, a biometric sensor is used to authenticate user **702**. The authentication data is either forward to the remote desktop isolator **810** and the authentication is made there, preferably on the server-side desktop isolator layer **840** or the authentication data is transferred through the remote desktop isolator **810** to the server-side host **750** and user **702** is authenticated there. In any case, the RDP session is not active before there is full authentication of user **702** to the system.

[0181] Another important issue is the RDP data passing through the Internet 40. To prevent any data eavesdropping, all RDP data passing through the communication links **740** are encrypted using virtual private network (VPN) solution or the like.

[0182] While the remote desktop isolator **810** of figure 13 may be located in the office of the worker, where the client-side ethernet port of the isolator is connected to non-classified network (e.g., the internet 40) port and the server-side ethernet port of the isolator connected to the classified (preferably isolated) network. Many other deployment options and system configuration of for the remote desktop isolator are possible.

[0183] For example, many remote desktop isolators **810** may be deployed in central location in the organization and they may be associated statically or dynamically with server-side hosts located in the offices of the workers. Alternatively, many virtual hosts **780** instances may be dynamically initiated over virtualization machines/farm **770**. These virtual hosts **780** are loaded with server-side remote desktop software **760V** that are dynamically assigned to desktop isolator **810**. The user **702** may connect or authenticate to one of the remote desktop isolators **810** and get access to one of the virtual hosts **780**.

[0184] Figure 15 is a block diagram presenting several deployment options for remote desktop systems incorporating remote desktop isolators. On the left side of the figure there are two types of deployment for organization with isolated organization network **742**. In the bottom side of the figure, the client-side port **822** of remote desktop isolator **810A** is connected directly to the internet **40**. This can be through unclassified network with a router connected to the internet or even direct wireless connection through cellular network such as 5G network that provide low latency and sufficient data bandwidth. In an exemplary embodiment of the invention, the client-side host **710** may be connected to 5G cellular

network as well. The server-side of remote desktop isolator **810A** is connected to server-side host **750**. Server-side host **750** is connected to the organization network **742** with one communication link, e.g., Ethernet, while with another separate communication link, host 750 is connected to server-side interface **842** of remote desktop isolator **810A**. this communication link might be another communication link type, such as USB or the like. In an exemplary embodiment of the invention, remote desktop isolator **810A** is small form-factor low-cost device designed to be deployed in proximity to a desktop computer (e.g., host **750**) in the office of the worker of the organization. The managing and control of remote desktop isolator **810A** may be done by software running on the near-by host **750**.

[0185] In the top left side of the figure, there is a central deployment of remote desktop system for organization with isolated organization network **742**. The organization have a central computing facility **770** with high performance host computer or computer farm that can instantiate and initiate a plurality of server-side hosts **780** each with server-side remote desktop software **760V**. The hosts **780** can access internal resources through organization network **742**. The server-side port of a remote desktop multi-session isolator **810M** is also connected to the organization network. The client-side port of the remote desktop multi-session isolator **810M** is connected to the Internet **40**. remote desktop multi-session isolator **810M** may support simultaneously a plurality of RDP sessions with a plurality of instances of server-side hosts **780**. Remote desktop multi-session isolator **810M** may comprises multiple replicates of the remote desktop isolator **810** shown in Figure 14. Alternatively, remote desktop multi-session isolator 810M may be designed to share some hardware, for example, processors **824** and **844** may run each multiple instances of client-side remote desktop isolator software **826** and server-side remote desktop isolator software **846** respectively. Remote desktop multi-session isolator **810M** may be managed and control from a single management software that may enable of disable each session, take care for association between server-side hosts **780** and isolators instances in remote desktop multi-session isolator **810M** as well as users **702** authentication. In an exemplary embodiment of the invention, this management software is operated and monitored by manually human operator to enhance the security of the system.

[0186] On the right side of figure 15 there are two deployments of the remote desktop system over host infrastructure on a general cloud-based services. In the bottom side of the picture a single server-side host **750** is connected to the cloud computer center network **744**

and to the server-side port **842** of remote desktop isolator **810**. Client-side port **822** of this isolator is connected to the cloud computer center network **744**. In this configuration user **702** have an option to open an RDP session through the isolator, however, in addition, without any restriction on the firewall **76** or the server-side host **750** a less secure direct RDP session to server-side host **750** may also be opened by user **702**. Note that since both ports of the remote desktop isolator are essentially connected to the same network the isolator may be exploit to the same cyber security attack from both the client-side port and the server-side port so that this configuration is inherently less secure.

[0187] The right top side show more realistic deployment of remote desktop system with isolator on the cloud. In this configuration the organization lease computing services from the cloud services provider that have a central computing facility **770**. The facility may instantiate server-side hosts **780** with server-side remote desktop software **760V**. The cloud computing service provider also deployed remote desktop multi-session isolator **810M** to enable RDP session from user **702** to the server-side remote desktop software **760V**. While the client-side remote desktop software **730** may be access the client-side port of remote desktop multi-session isolator **810M** from the cloud computing center network **744** through the general-purpose firewall **76**, the server-side remote desktop software **760V** may contact the server-side port of remote desktop multi-session isolator **810M** only through a second firewall **976**. Firewall **976** allow communication only between server-side remote desktop software **760V** and the remote desktop multi-session isolator **810M** as well as restrict the communication only for RDP data, hence create a more secure remote desktop solution then the one without the remote desktop isolator as presented in Figure 12. This configuration is somewhat less secure than the configuration of the organization isolated network presented on the top-left of the figure but still can be used for organization that do not have isolated networks.

[0188] It should be understood that other configurations of deploying the remote desktop isolator are possible as well as combining the isolators with other known in the art software security tools and/or hardware security tools is also covered by this invention.

[0189] It is to be understood that the invention is not necessarily limited in its application to the details of the exemplary cyber security configurations set forth in the following

description and/or illustrated in the drawings is capable of embodied in other embodiments or of being practiced or carried out in various types of devices.

[0190] It is to be understood that the invention is not necessarily limited in its application to the details of the exemplary cyber security cable set forth in the following description and/or illustrated in the drawings is capable of embodied in other embodiments or of being practiced or carried out in various types of devices.

[0191] It is expected that during the life of a patent maturing from this application many relevant client types, peripheral devices, and communication protocols will be developed and the scope of the invention intended to include all such new technologies *a priori*.

[0192] The terms "comprises", "comprising", "includes", "including", "having" and their conjugates mean "including but not limited to".

[0193] As used herein, the singular form "a", "an" and "the" include plural references unless the context clearly dictates otherwise.

[0194] It is appreciated that certain features of the invention, which are for clarity, described in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the invention, which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable subcombination or as suitable in any other described embodiment of the invention. Certain features described in the context of various embodiments are not to be considered essential features of those embodiments, unless the embodiment is inoperative without those elements.

[0195] Although the invention has been described in conjunction with specific embodiments thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, it is intended to embrace all such alternatives, modifications and variations that fall within the spirit and broad scope of the appended claims.

CLAIMS

What is claimed is:

1.A computing system comprising:
- a plurality of hosts;
- a console comprising at least a first keyboard, a first mouse and a first display;
- a secure peripheral sharing device; and
- a remote console subsystem comprising at least a second keyboard, a second mouse and a second display,
wherein the secure peripheral sharing device is configured to be connected to the console and the plurality of hosts, the peripheral sharing device is configured to be coupled to the remote console subsystem that is located away from the peripheral sharing device, and wherein the secure peripheral sharing device is configured to connect or couple between either the console or the remote console subsystem and an active host of the plurality of hosts, and wherein the peripheral sharing device is configured to switch any one of the plurality of host to become the active host, and wherein a video stream from the active host is transferred to either the first display or the second display, and a keyboard and mouse data is transferred to the active host from either the first keyboard and the first mouse or the second keyboard and the second mouse.

2. The computing system of claim 1, wherein the peripheral device is a secure KVM switch.

3. The computing system of claim 1, wherein at least one peripheral device in the console or the remote console is shared using simultaneous use operation.

4. The computing system of claim 1, wherein at least one peripheral device in the console or the remote console is at least on of or any combination of: a biometric sensor, an identification device, a printer, an audio device, a camera, an external mass storage device, a USB dongle, a phone, and a smartphone.

5. The computing system of claim 1, wherein the connection between the secure peripheral sharing device and the console, and the connection between the remote

console subsystem and the remote console is provided by peripheral devices communication protocols, and peripheral devices communication protocols comprises at least one of or any combination of: USB, SPI, I2C, SCSI, FC, IDE, ATA, Firewire, Ethernet, Thunderbolt, InfiniBand, VGA, DVI, HDMI, DisplayPort Wi-Fi, Bluetooth, and Zigbee.

6. The computing system of claim 1, wherein the coupling between the secure peripheral sharing device and the remote console subsystem is provided by remote console communication protocols, and the remote console communication protocols comprises at least one of or any combination of: Ethernet, SDH, SONET, OTN, FC, InfiniBand, USB, Firewire, Thunderbolt, GSM; CDMA, LTE, 3G; 4G; 5G, TCP/IP, UDP, FTP, HTTP, and SNMP.

7. The computing system of claim 6, wherein the remote console communication protocol transfers video stream, the keyboard and mouse data, and active host selection commands.

8. The computing system of claim 6, wherein the remote console communication protocol further transfers: additional video streams, session control and authentication data, and data of additional peripheral devices.

9. The computing system of claim 1, wherein the communication between the remote console subsystem and the secure peripheral sharing device is encrypted.

10. The computing system of claim 1, wherein the secure peripheral sharing device comprises a security unit that perform at least one or any combination of (a) encrypt data sent to the remote console subsystem, (b) decrypt data received from the remote console subsystem, and (c) authenticate the remote console subsystem.

11. The computing system of claim 10, wherein an authentication procedure is performed between secure peripheral sharing device and remote console subsystem, and the authentication procedure comprises at least one of or any combination of: (a) Hardware ID authentication, (b) biometric authentication, (c) smart card authentication, (d) password authentication, (e) one time password authentication, and (f) multi-factor authentication.

12. The computing system of claim 1, wherein the secure peripheral sharing device communicates with the remote console subsystem using at least one of: (a) Ethernet modem, (b) Wi-Fi modem, and (c) 5G cellular modem.

13. The computing system of claim 1, wherein the paths between peripheral devices and hosts in the system comprises device emulators and host emulators.

14. The computing system of claim 1, wherein the video processing between hosts and displays comprises at least one of or any combination of: (a) compression, (b) decompression, (c) packetizing, (d) video format conversion, and (e) display EDID emulation.

15. The computing system of claim 1, wherein the remote console subsystem comprises at least one of: (a) desktop computer, (b) laptop computer, (c) notebook computer, (d) tablet, (e) PDA, (f) smartphone, and (g) thick, thin or zero client.

16. The computing system of claim 1, wherein the remote console subsystem comprises front panel or auxiliary front panel to receive active host selection commands from these panels.

17. The computing system of claim 1, wherein the secure peripheral sharing device comprises of ordinary secure KVM switch and auxiliary remote console adapter.

18. The computing system of claim 1, wherein the secure peripheral sharing device comprises of basic secure KVM switch and add-on adapter, wherein matching form-factor between basic secure KVM switch and add-on adapter is extension form-factor or bay form-factor.

19. The computing system of claim 1, wherein the secure peripheral sharing device or the remote console subsystem comprises anti-tampering circuitries.

20. The computing system of claim 1, wherein the secure peripheral sharing device is configured to receive enable remote console operation mode from control center.

21. The computing system of claim 1, wherein the secure peripheral sharing device comprises Ethernet switch to aggregate communication from first Ethernet port and remote console communication to a second Ethernet port.

22. A secure peripheral sharing device comprising:
- a plurality of ports to be configured to be connected to a plurality of hosts; and
- a port to be configured to be connected to a console comprising at least a first keyboard, a first mouse and a first display; and
- a remote console port configured to be coupled to a remote console subsystem comprising at least a second keyboard, a second mouse and a second display,
wherein the remote console subsystem is located away from the peripheral sharing device, and wherein the peripheral sharing device is configured to connect or couple between either the console or the remote console subsystem and an active host of the plurality of hosts, and wherein the peripheral sharing device is configured to switch between any one of the plurality of hosts to become the active host.

23. The secure peripheral sharing device of claim 22, wherein the secure peripheral sharing device is a secure KVM switch.

24. The secure peripheral sharing device of claim 22, wherein at least one peripheral device in the console or the remote console subsystem is shared using simultaneous use operation.

25. The secure peripheral sharing device of claim 22, wherein at least one peripheral device in the console or the remote console is at least on of or any combination of: a biometric sensor, an identification device, a printer, an audio device, a camera, an external mass storage device, a USB dongle, a phone, and a smartphone.

26. The secure peripheral sharing device of claim 22, wherein the connection between the secure peripheral sharing device and the console, and the connection between the remote console subsystem and the remote console is provided by peripheral devices communication protocols, and peripheral devices communication protocols comprises at least one of or any combination of: USB, SPI, I2C, SCSI, FC, IDE, ATA, Firewire,

Ethernet, Thunderbolt, InfiniBand, VGA, DVI, HDMI, DisplayPort Wi-Fi, Bluetooth, and Zigbee.

27. The secure peripheral sharing device of claim 22, wherein the coupling between the secure peripheral sharing device and the remote console subsystem is provided by remote console communication protocols, and the remote console communication protocols comprises at least one of or any combination of: Ethernet, SDH, SONET, OTN, FC, InfiniBand, USB, Firewire, Thunderbolt, GSM; CDMA, LTE, 3G; 4G; 5G, TCP/IP, UDP, FTP, HTTP, and SNMP.

28. The secure peripheral sharing device of claim 27, wherein the remote console communication protocol transfers video stream, the keyboard and mouse data, and active host selection commands.

29. The secure peripheral sharing device of claim 27, wherein the remote console communication protocol further transfers: additional video streams, session control and authentication data, and data of additional peripheral devices.

30. The secure peripheral sharing device of claim 22, wherein the communication between the remote console subsystem and the secure peripheral sharing device is encrypted.

31. The secure peripheral sharing device of claim 22, wherein the secure peripheral sharing device comprises a security unit that perform at least one or any combination of (a) encrypt data sent to the remote console subsystem, (b) decrypt data received from the remote console subsystem, and (c) authenticate the remote console subsystem.

32. The secure peripheral sharing device of claim 31, wherein an authentication procedure is performed between secure peripheral sharing device and remote console subsystem, and the authentication procedure comprises at least one of or any combination of: (a) Hardware ID authentication, (b) biometric authentication, (c) smart card authentication, (d) password authentication, (e) one time password authentication, and (f) multi-factor authentication.

33. The secure peripheral sharing device of claim 22, wherein the secure peripheral sharing device communicates with the remote console subsystem using at least one of: (a) Ethernet modem, (b) Wi-Fi modem, and (c) 5G cellular modem.

34. The secure peripheral sharing device of claim 22, wherein secure peripheral sharing device comprises device emulators and host emulator for peripheral devices.

35. The secure peripheral sharing device of claim 22, wherein the video processing between the hosts and the displays comprises at least one of or any combination of: (a) compression, (b) decompression, (c) packetizing, (d) video format conversion, and (e) display EDID emulation.

36. The secure peripheral sharing device of claim 22, wherein the remote console subsystem comprises at least one of: (a) a desktop computer, (b) a laptop computer, (c) a notebook computer, (d) a tablet, (e) a PDA, (f) a smartphone, and (g) a thick, a thin or a zero client.

37. The secure peripheral sharing device of claim 22, wherein the remote console subsystem comprises front panel or auxiliary front panel to receive active host selection commands from these panels.

38. The secure peripheral sharing device of claim 22, wherein the secure peripheral sharing device comprises of ordinary secure KVM switch and auxiliary remote console adapter.

39. The secure peripheral sharing device of claim 22, wherein the secure peripheral sharing device comprises of basic secure KVM switch and add-on adapter, wherein matching form-factor between basic secure KVM switch and add-on adapter is extension form-factor or bay form-factor.

40. The secure peripheral sharing device of claim 22, wherein the secure peripheral sharing device comprises anti-tampering circuitries.

41. The secure peripheral sharing device of claim 22, wherein the secure peripheral sharing device is configured to receive enable remote console operation mode from control center.

42. The secure peripheral sharing device of claim 22, wherein the secure peripheral sharing device comprises Ethernet switch to aggregate communication from first Ethernet port and remote console communication to a second Ethernet port.

43. A remote console subsystem comprising:
- a port configured to be coupled to a secure peripheral sharing device; and
- a remote console,
wherein, the secure peripheral sharing device is configured to be connected to a plurality of hosts, and to a console comprising at least a first keyboard, a first mouse and a first display, the remote console comprising at least a second keyboard, a second mouse and a second display, the remote console subsystem is located away from the peripheral sharing device, the peripheral sharing device is configured to connect or couple between either the console or the remote console and an active host of the plurality of hosts, and condition upon a switching command from the remote console subsystem, the peripheral sharing device is configured to switch any one of the plurality of hosts to become the active host.

44. The remote console subsystem of claim 43, wherein the secure peripheral sharing device is a secure KVM switch.

45. The remote console subsystem 1, wherein at least one peripheral device in the console or the remote console is shared using simultaneous use operation.

46. The remote console subsystem 1, wherein at least one peripheral device in the console or the remote console is at least on of or any combination of: a biometric sensor, an identification device, a printer, an audio device, a camera, an external mass storage device, a USB dongle, a phone, and a smartphone.

47. The remote console subsystem of claim 43, wherein the connection between the secure peripheral sharing device and the console, and the connection between the remote console subsystem and the remote console is provided by peripheral devices communication protocols, and peripheral devices communication protocols comprises at least one of or any combination of: USB, SPI, I2C, SCSI, FC, IDE, ATA, Firewire,

Ethernet, Thunderbolt, InfiniBand, VGA, DVI, HDMI, DisplayPort Wi-Fi, Bluetooth, and Zigbee.

48. The remote console subsystem of claim 43, wherein the coupling between the secure peripheral sharing device and the remote console subsystem is provided by remote console communication protocols, and the remote console communication protocols comprises at least one of or any combination of: Ethernet, SDH, SONET, OTN, FC, InfiniBand, USB, Firewire, Thunderbolt, GSM; CDMA, LTE, 3G; 4G; 5G, TCP/IP, UDP, FTP, HTTP, and SNMP.

49. The remote console subsystem of claim 48, wherein the remote console communication protocol transfers video stream, the keyboard and mouse data, and active host selection commands.

50. The remote console subsystem of claim 48, wherein the remote console communication protocol further transfers: additional video streams, session control and authentication data, and data of additional peripheral devices.

51. The remote console subsystem of claim 43, wherein the communication between the remote console subsystem and the secure peripheral sharing device is encrypted.

52. The remote console subsystem of claim 43, wherein the remote console subsystem comprises a security unit that perform at least one or any combination of (a) encrypt data sent from the remote console subsystem, (b) decrypt data received to the remote console subsystem, and (c) authenticate the secure peripheral sharing device.

53. The remote console subsystem of claim 43, wherein an authentication procedure is performed between secure peripheral sharing device and remote console subsystem, and the authentication procedure comprises at least one of or any combination of: (a) Hardware ID authentication, (b) biometric authentication, (c) smart card authentication, (d) password authentication, (e) one time password authentication, and (f) multi-factor authentication.

54. The remote console subsystem of claim 43, wherein the remote console subsystem communicates with the secure peripheral sharing device using at least one of: (a) Ethernet modem, (b) Wi-Fi modem, and (c) 5G cellular modem.

55. The remote console subsystem of claim 43, wherein remote console subsystem comprises host emulators configured to communicate with device emulators for any one of the peripheral devices of the remote console subsystem.

56. The remote console subsystem of claim 43, wherein the video processing between the hosts and the displays comprises at least one of or any combination of: (a) compression, (b) decompression, (c) packetizing, (d) video format conversion, and (e) display EDID emulation.

57. The remote console subsystem of claim 43, wherein the remote console subsystem comprises at least one of: (a) a desktop computer, (b) a laptop computer, (c) a notebook computer, (d) a tablet, (e) a PDA, (f) a smartphone, and (g) a thick, a thin or a zero client.

58. The remote console subsystem of claim 43, wherein the remote console subsystem comprises front panel or auxiliary front panel to receive active host selection commands from these panels.

59. The remote console subsystem of claim 43, wherein the remote console subsystem comprises anti-tampering circuitries.

60. The remote console subsystem of claim 43, wherein the remote console subsystem comprises a smartphone and remote console accessory.

61. A method for providing a remote console capability to a secure peripheral sharing device using a remote console subsystem,
the secure peripheral sharing device comprises:
- a plurality of ports to be configured to be connected to a plurality of hosts;
- a port to be configured to be connected to a console comprising at least a first keyboard, a first mouse and a first display; and
- a remote console port configured to be coupled to a remote console system,
the remote console subsystem comprises:
- a port configured to be coupled to a secure peripheral sharing device; and

- a remote console comprising at least a second keyboard, a second mouse and a second display,
the method comprises the step of:
- receiving requests for open new remote console sessions and upon such a request, open a remote console session in both the side of the secure peripheral sharing device and the side of the remote console subsystem,
- as long as the remote session is active, perform continuously in both the side of the secure peripheral sharing device and the side of the remote console subsystem, the steps of:
-- receiving video stream from the active host and transferring the video stream to the second display;
-- receiving a keyboard and mouse data from the second keyboard and the second mouse and transferring the keyboard and mouse data to the active host; and
-- upon receiving active host switching commands from a user, switching the active host,
- receiving requests for close remote console sessions and upon such request, close the remote console session and resume working of active host with the console.

62. The method of claim 61, wherein the secure peripheral sharing device is a secure KVM switch.

63. The method of claim 61, wherein at least one peripheral device in the console or the remote console is shared using simultaneous use operation.

64. The method of claim 61, wherein at least one peripheral device in the console or the remote console is at least on of or any combination of: a biometric sensor, an identification device, a printer, an audio device, a camera, an external mass storage device, a USB dongle, a phone, and a smartphone.

65. The method of claim 61, wherein the connection between the secure peripheral sharing device and the console, and the connection between the remote console subsystem and the remote console is provided by peripheral devices communication protocols, and peripheral devices communication protocols comprises at least one of or any combination of: USB, SPI, I2C, SCSI, FC, IDE, ATA, Firewire, Ethernet,

Thunderbolt, InfiniBand, VGA, DVI, HDMI, DisplayPort Wi-Fi, Bluetooth, and Zigbee.

66. The method of claim 61, wherein the coupling between the secure peripheral sharing device and the remote console subsystem is provided by remote console communication protocols, and the remote console communication protocols comprises at least one of or any combination of: Ethernet, SDH, SONET, OTN, FC, InfiniBand, USB, Firewire, Thunderbolt, GSM; CDMA, LTE, 3G; 4G; 5G, TCP/IP, UDP, FTP, HTTP, and SNMP.

67. The method of claim 66, wherein the remote console communication protocol transfers video stream, the keyboard and mouse data, and active host selection commands.

68. The method of claim 61, wherein the method is further comprising the steps of transferring additional video streams to additional displays in the remote console subsystem, transferring remote console session control data, transferring data from or to additional peripheral devices.

69. The method of claim 61, wherein the method is further comprising the steps of encrypting of the communication between the remote console subsystem and the secure peripheral sharing device.

70. The method of claim 61, wherein the method is further comprising the steps of authentication between secure peripheral sharing device and remote console subsystem.

71. The method of claim 70, wherein the authentication step comprises at least one of or any combination of: (a) Hardware ID authentication, (b) biometric authentication, (c) smart card authentication, (d) password authentication, (e) one time password authentication, and (f) multi-factor authentication.

72. The method of claim 61, wherein the steps of transferring data are using at least one of: (a) Ethernet modem, (b) Wi-Fi modem, and (c) 5G cellular modem.

73. The method of claim 61, wherein the method is further comprising the steps of emulating host in front of peripheral devices and emulating peripheral devices in front of hosts.

74. The method of claim 61, wherein the method is further comprising at least one of or any combination of the steps of: (a) video compression, (b) video decompression, (c) video packetizing, (d) video format conversion, and (e) display EDID emulation.

75. The method of claim 61, wherein the remote console subsystem comprises at least one of: (a) desktop computer, (b) laptop computer, (c) notebook computer, (d) tablet, (e) PDA, (f) smartphone, and (g) thick, thin or zero client.

76. The method of claim 61, wherein the remote console subsystem comprises front panel or auxiliary front panel to receive active host selection commands from these panels.

77. The method of claim 61, wherein the method is further comprising the step of enabling remote console operation mode from control center.

FIG. 1

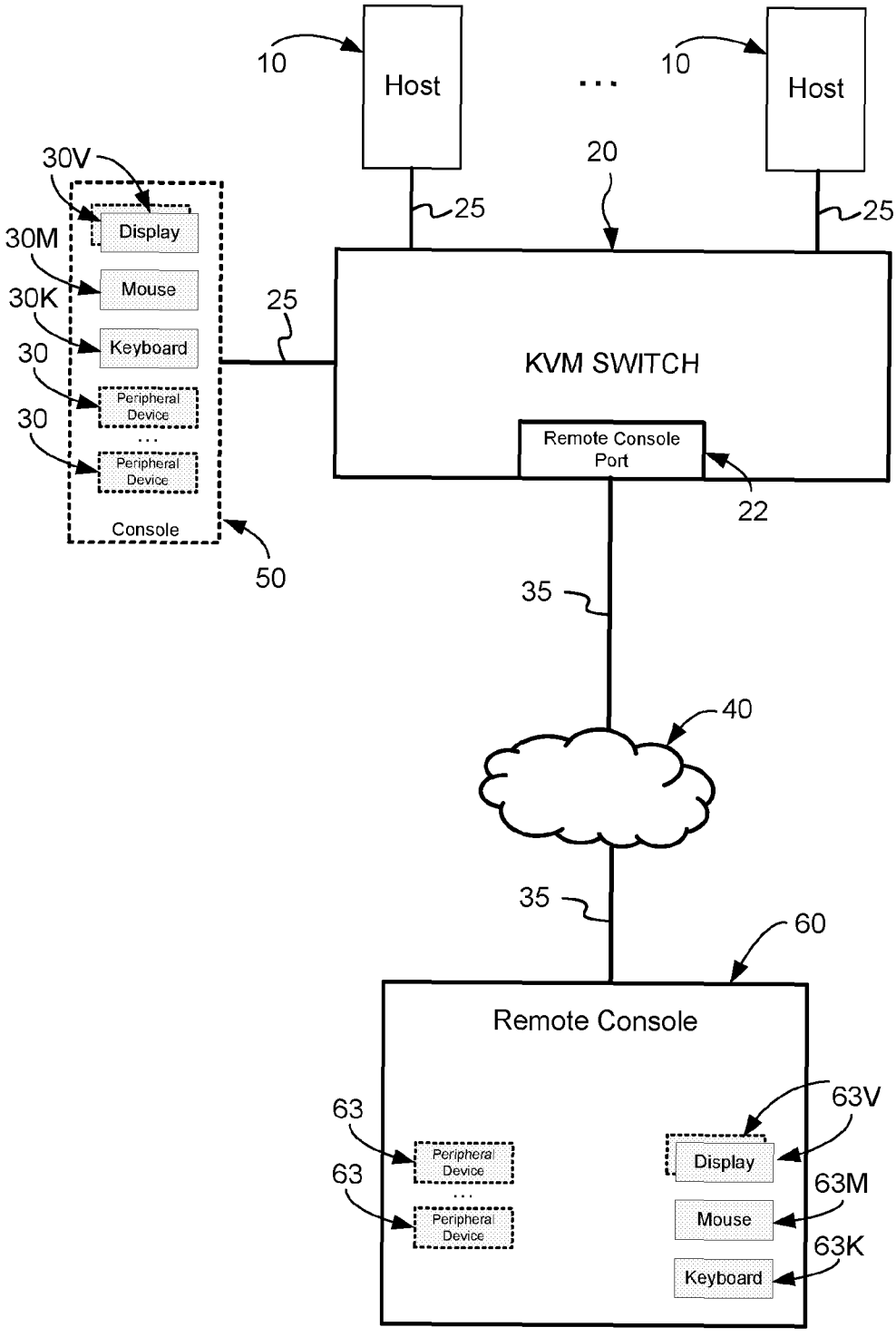
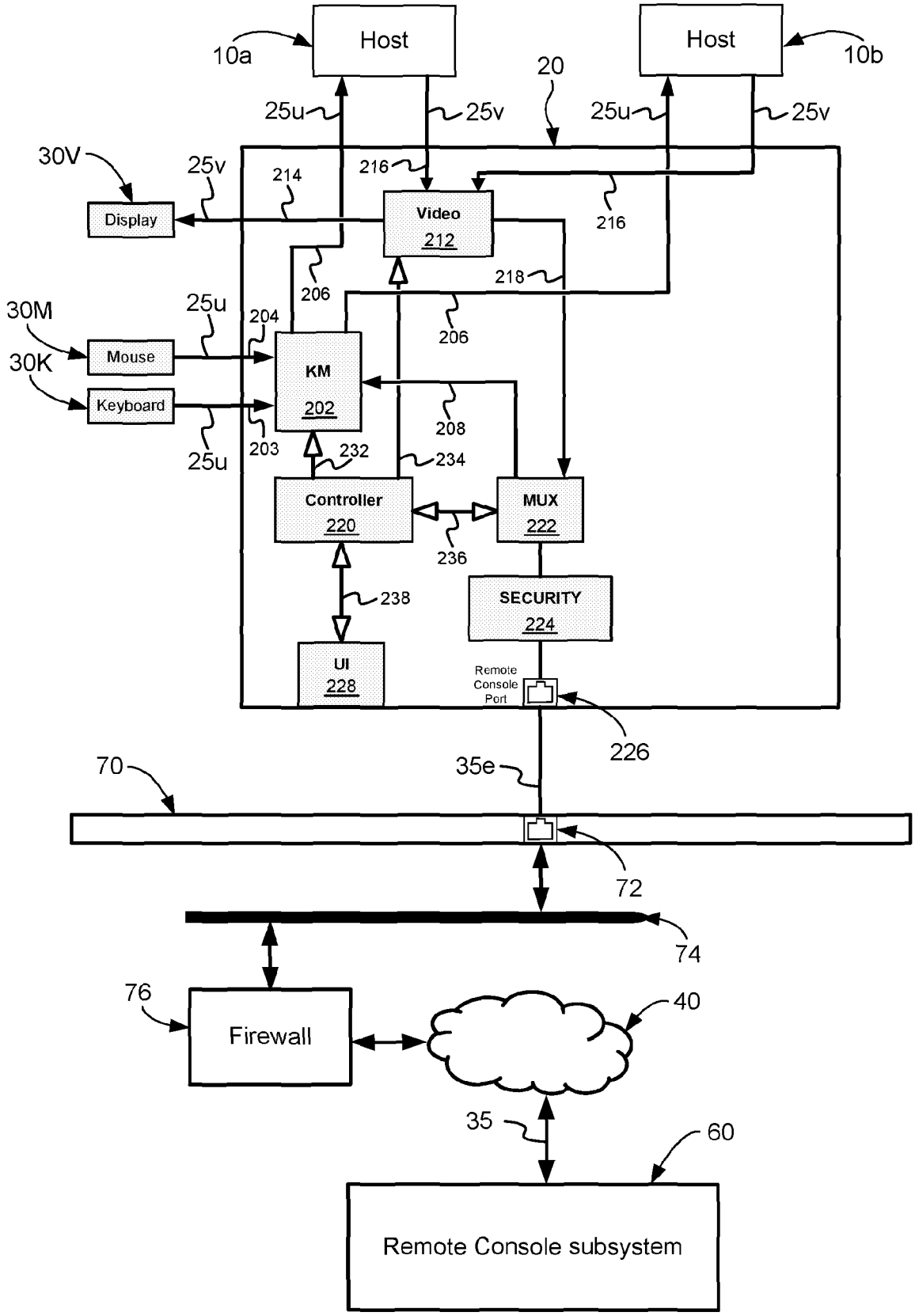

10
Host
10
Host
20
25
25
25
30V
Display
30M
Mouse
30K
Keyboard
30
Peripheral Device
30
Peripheral Device
Console
50
KVM SWITCH
Remote Console Port
22
35
40
35
60
Remote Console
63
Peripheral Device
63
Peripheral Device
63V
Display
63M
Mouse
63K
Keyboard

FIG. 2


Host
Host
10a
10b
20
25u
25v
25u
25v
30V
25v
214
216
Display
Video
212
216
206
218
30M
25u
204
206
30K
Mouse
KM
202
Keyboard
208
203
232
234
25u
Controller
220
MUX
222
236
238
SECURITY
224
UI
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Console
Port
226
70
35e
72
74
76
Firewall
40
35
60
Remote Console subsystem

FIG. 3

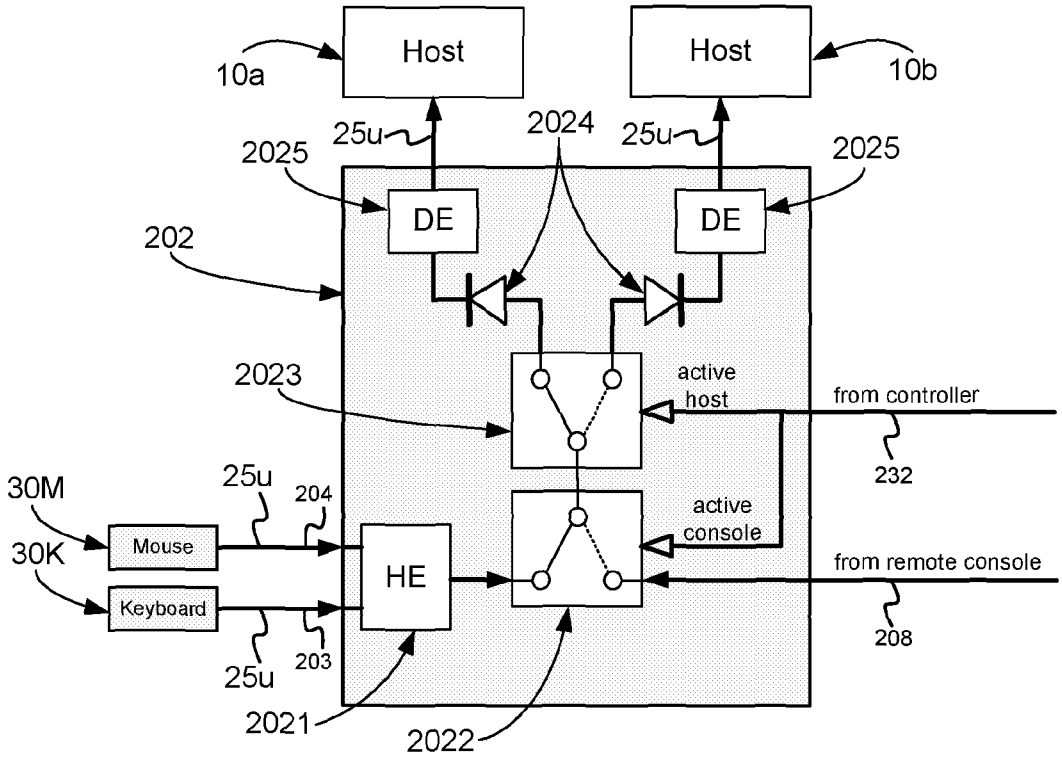

Host
Host
10a
10b
25u
2024
25u
2025
2025
DE
DE
202
2023
active host
from controller
232
30M
25u
204
active console
30K
Mouse
HE
from remote console
Keyboard
208
25u
203
2021
2022

FIG. 4

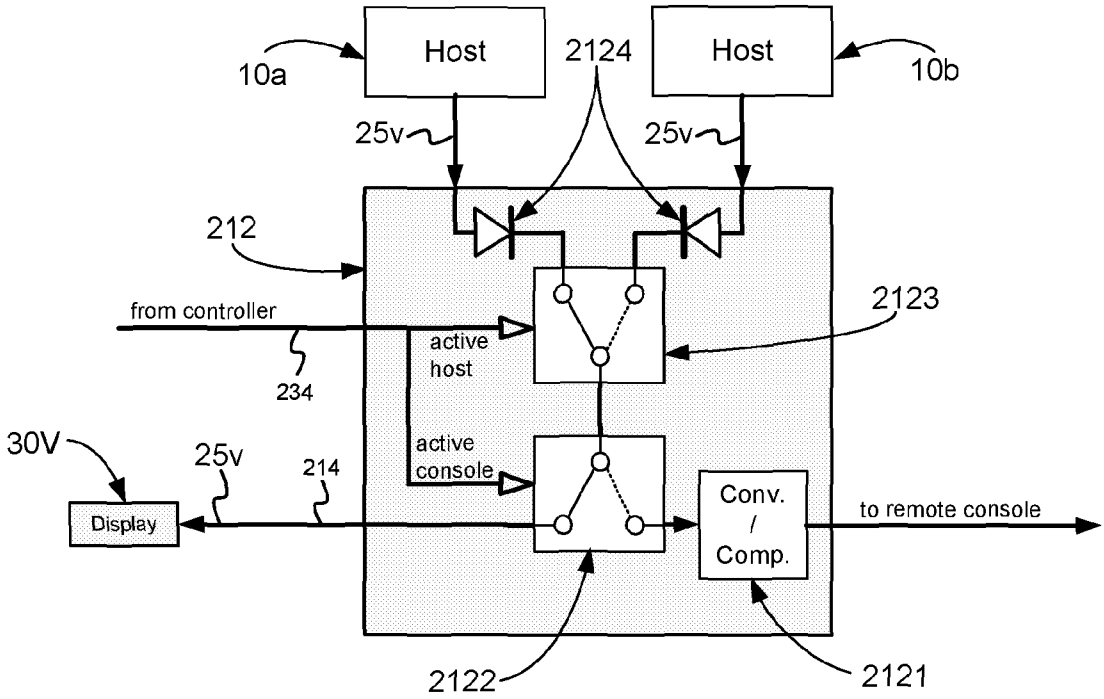

Host
2124
Host
10a
10b
25v
25v
212
2123
from controller
active host
234
30V
active console
25v
214
Conv. / Comp.
Display
to remote console
2122
2121

FIG. 5

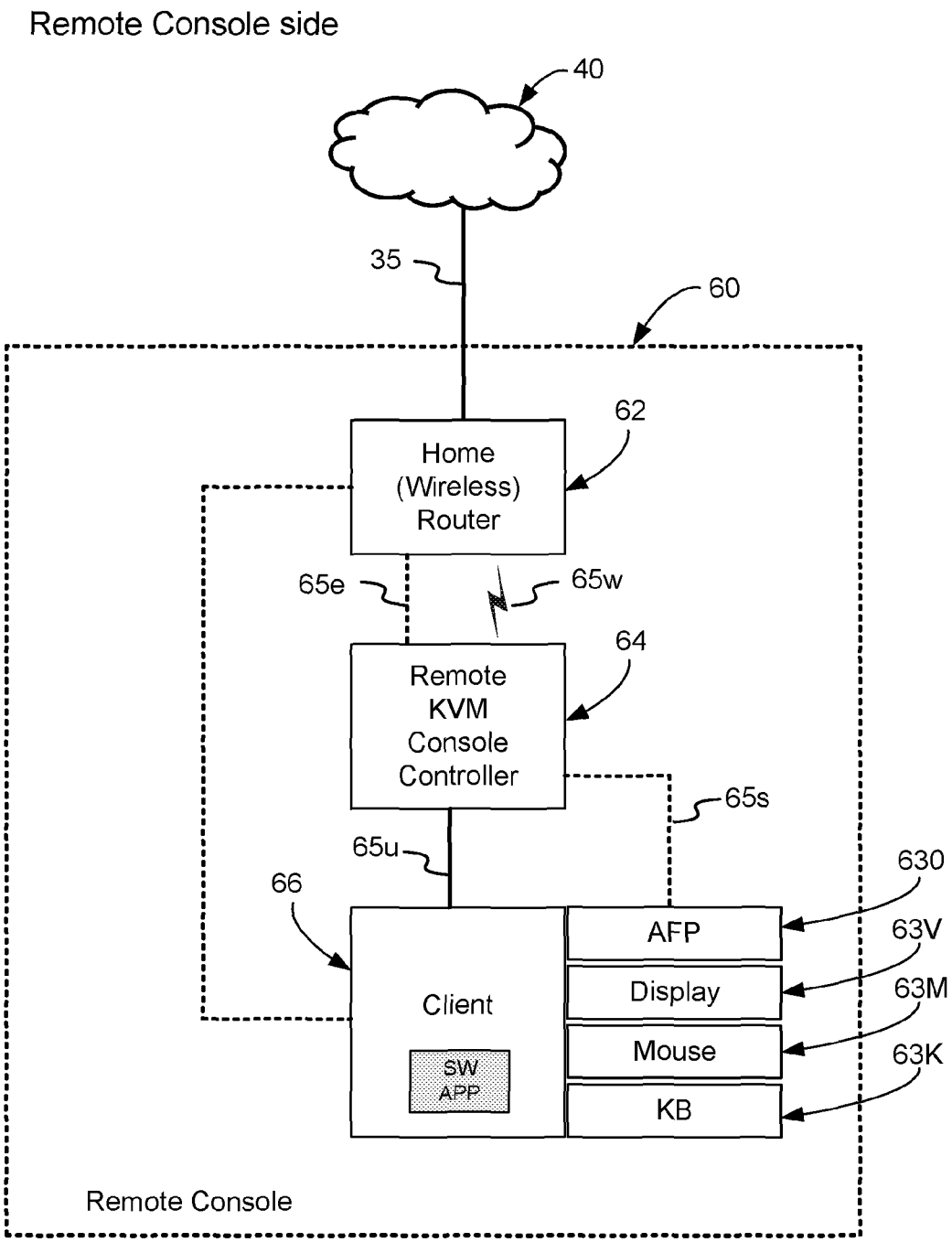

Remote Console side
40
35
60
62
Home
(Wireless)
Router
65e
65w
64
Remote
KVM
Console
Controller
65s
65u
66
630
AFP
63V
Display
63M
Client
Mouse
63K
SW
APP
KB
Remote Console

FIG. 6

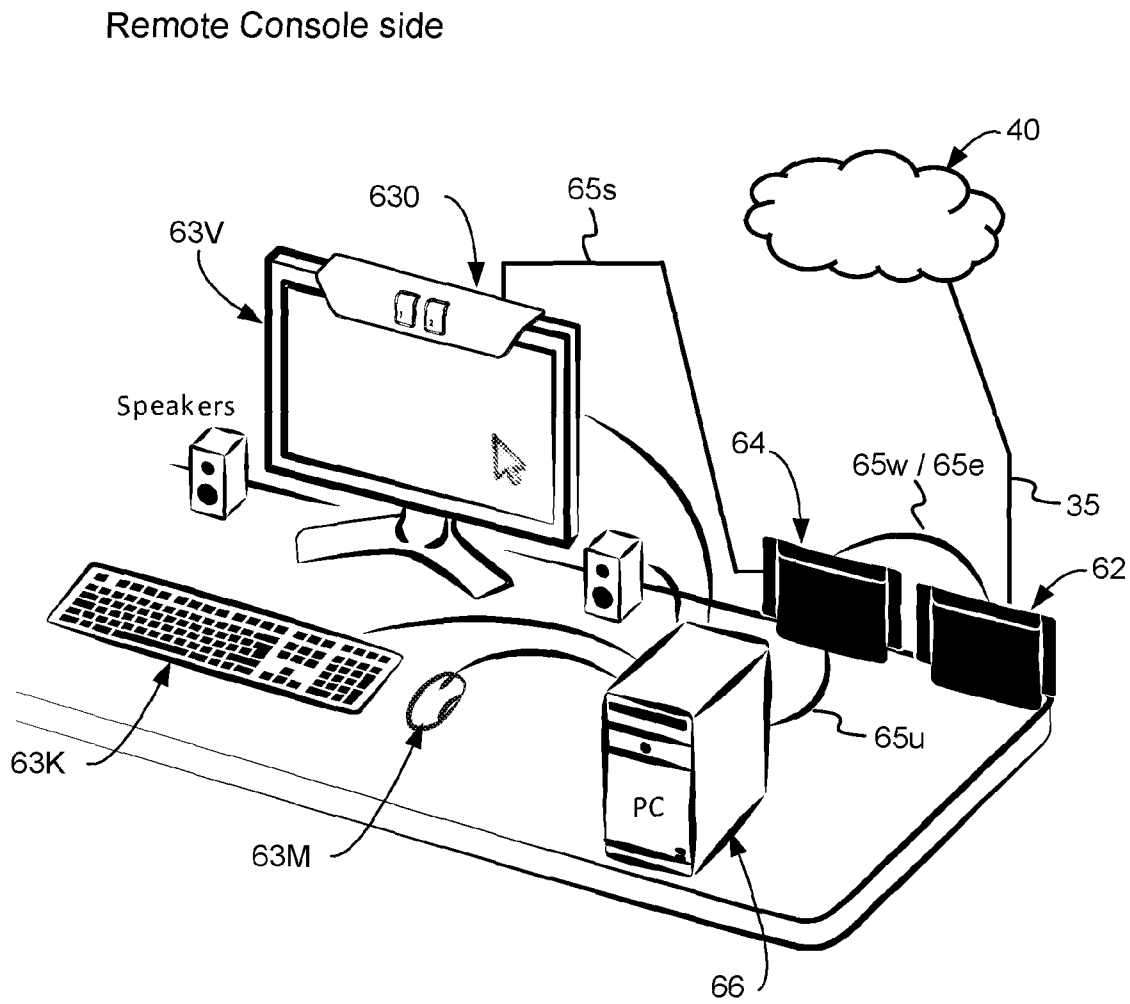

Remote Console side
40
630
65s
63V
Speakers
64
65w / 65e
35
62
65u
63K
63M
PC
66

FIG. 7

Remote Console side

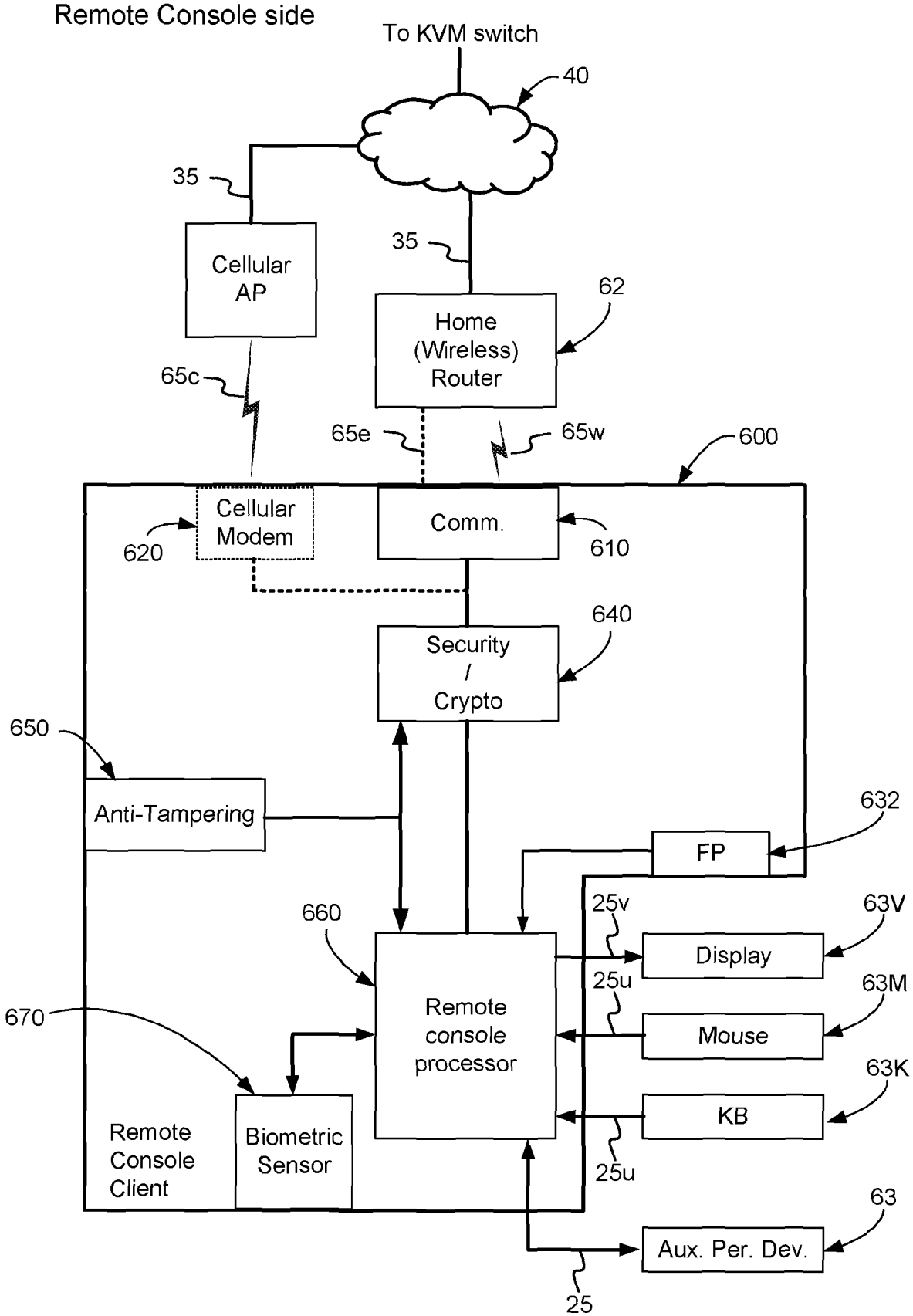
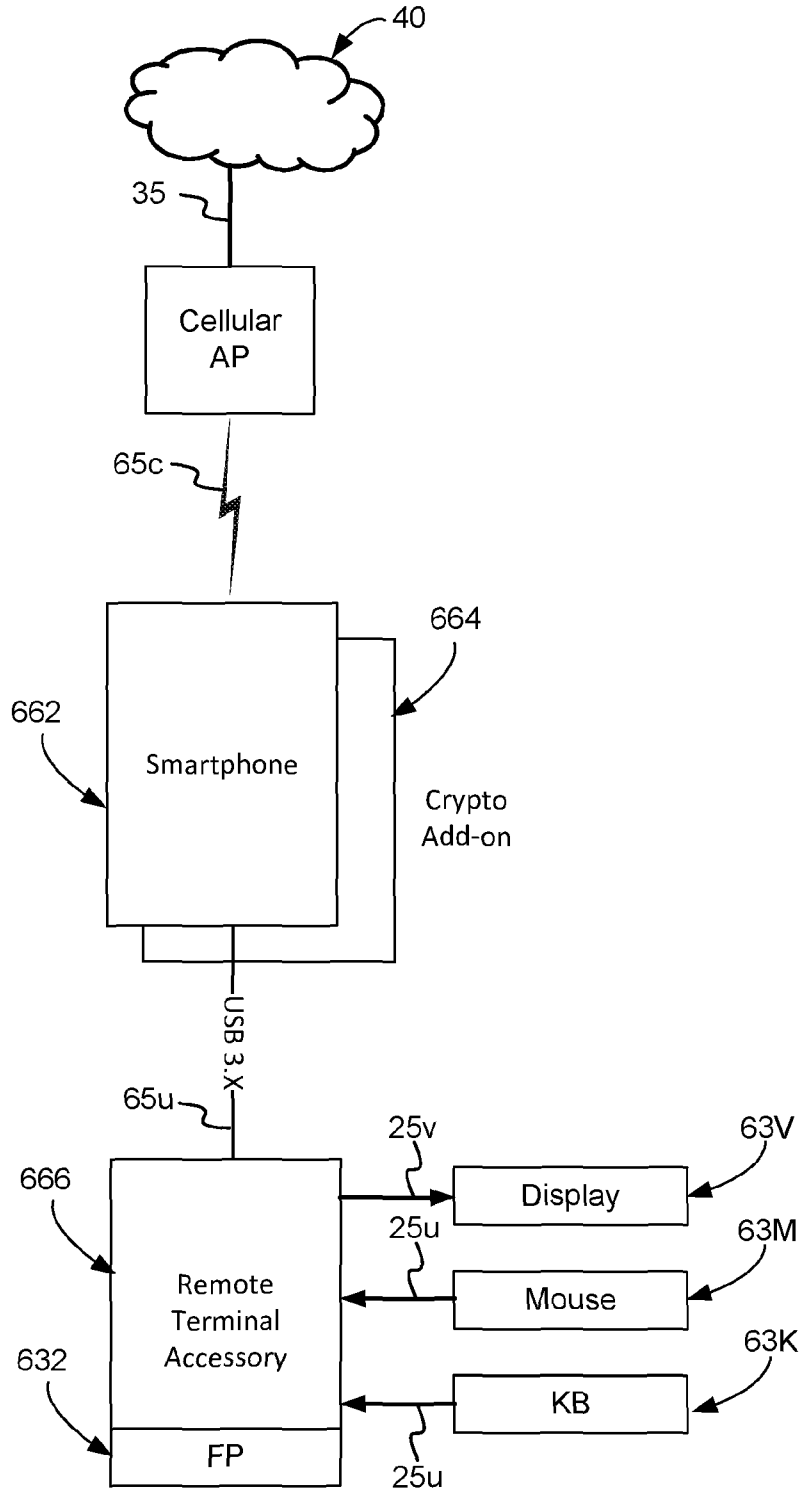


FIG. 8

Cellular phone based Remote console side



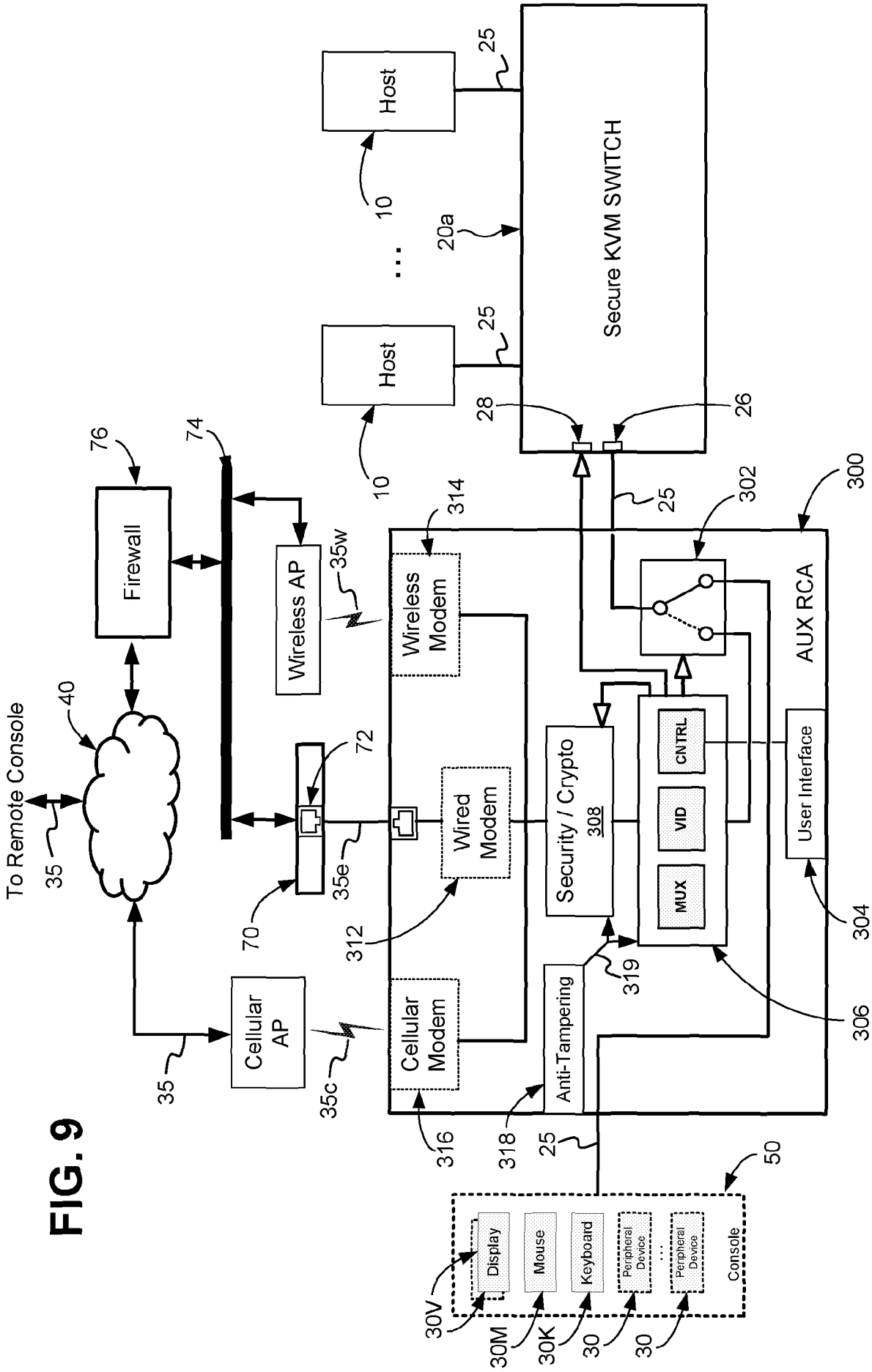

Host
25
Secure KVM SWITCH
10
20a
Host
25
28
26
10
314
25
302
300
76
Firewall
74
Wireless AP
35w
Wireless Modem
AUX RCA
40
72
Wired Modem
Security / Crypto 308
CNTRL
VID
MUX
User Interface
To Remote Console
35
70
312
35e
304
Cellular AP
Cellular Modem
Anti-Tampering
319
306
35
35c
316
318
25
50
Console
Display
Mouse
Keyboard
Peripheral Device
Peripheral Device
30V
30M
30K
30
30

FIG. 9

FIG. 10

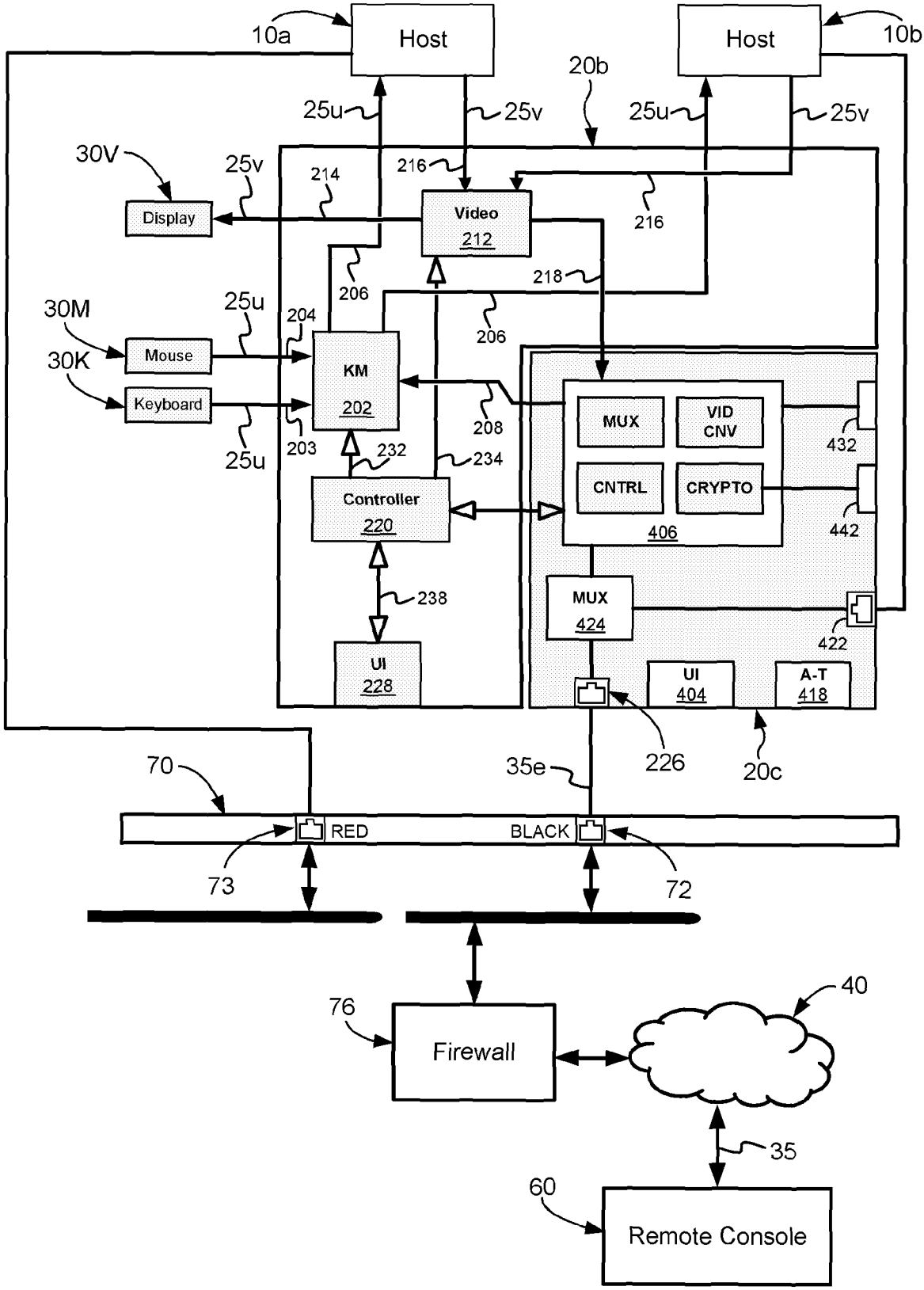

10a
Host
Host
10b
20b
25u
25v
25u
25v
30V
25v
214
216
Display
Video
212
216
206
218
30M
25u
204
206
30K
Mouse
KM
202
Keyboard
208
MUX
VID
CNV
432
203
232
234
25u
CNTRL
CRYPTO
Controller
220
406
442
238
MUX
424
422
UI
228
UI
404
A-T
418
226
20c
70
35e
RED
BLACK
73
72
40
76
Firewall
35
60
Remote Console

FIG. 11

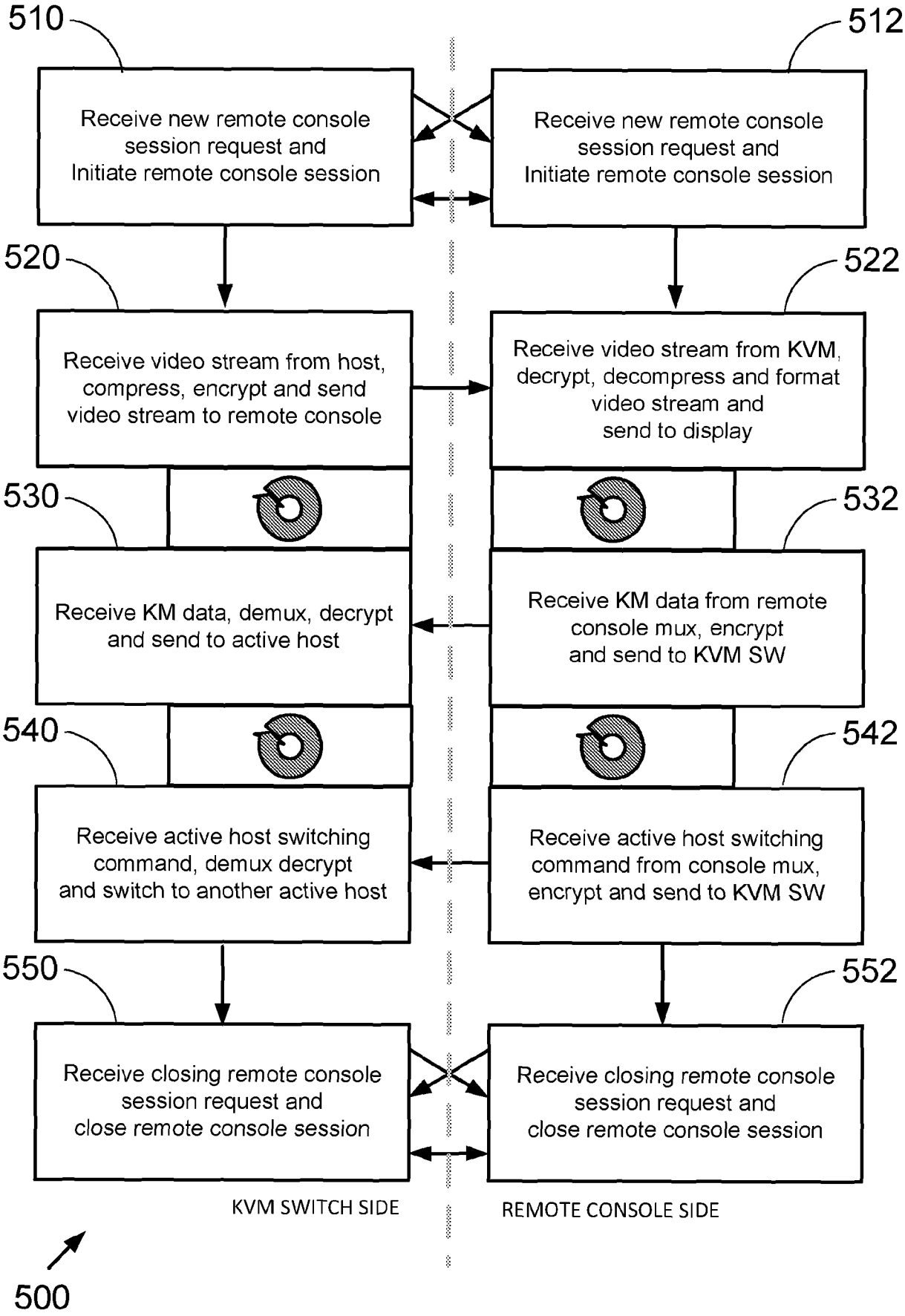

510
512
Receive new remote console session request and Initiate remote console session
Receive new remote console session request and Initiate remote console session
520
522
Receive video stream from host, compress, encrypt and send video stream to remote console
Receive video stream from KVM, decrypt, decompress and format video stream and send to display
530
532
Receive KM data, demux, decrypt and send to active host
Receive KM data from remote console mux, encrypt and send to KVM SW
540
542
Receive active host switching command, demux decrypt and switch to another active host
Receive active host switching command from console mux, encrypt and send to KVM SW
550
552
Receive closing remote console session request and close remote console session
Receive closing remote console session request and close remote console session
KVM SWITCH SIDE
REMOTE CONSOLE SIDE
500

FIG. 12

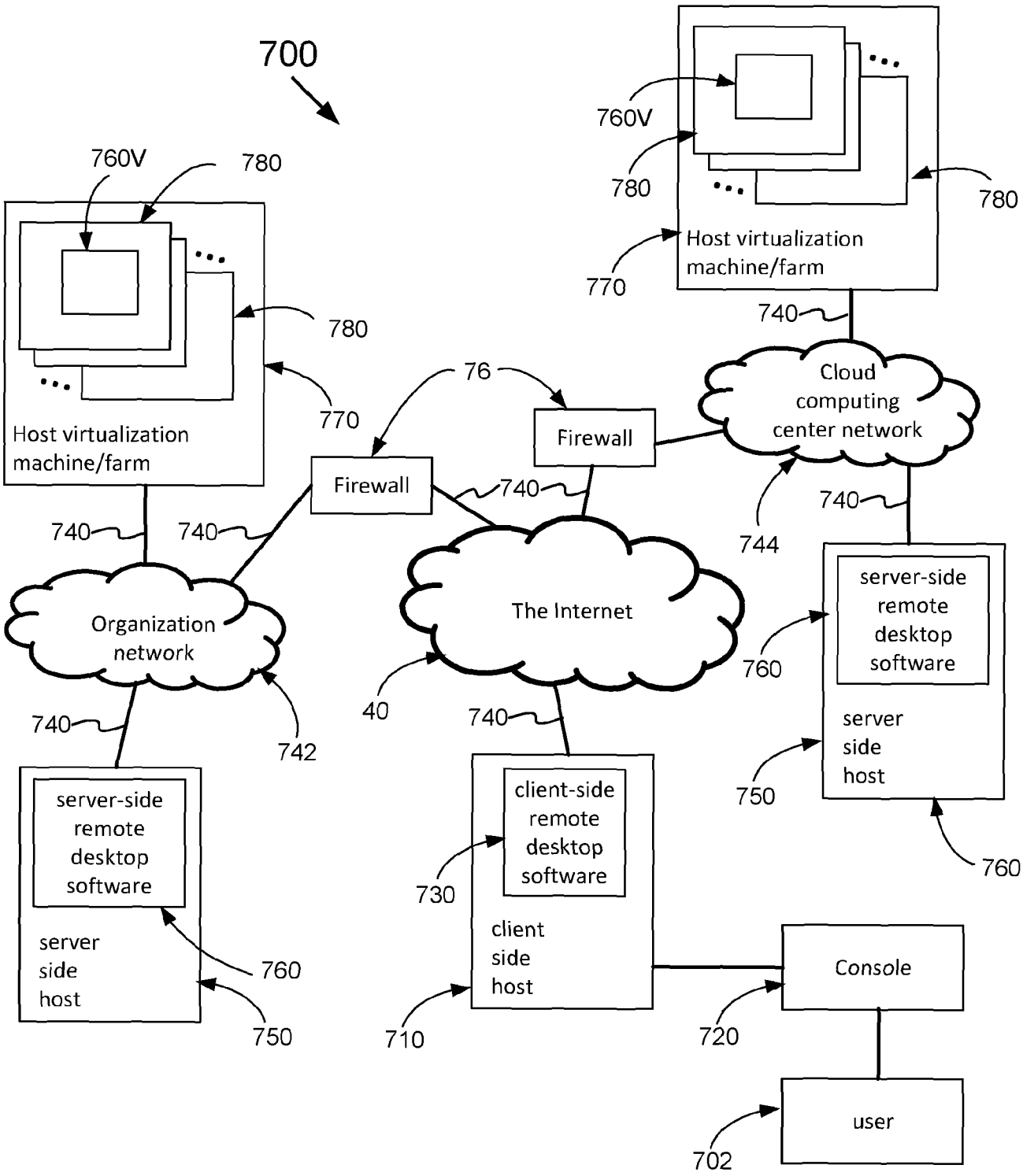

700
760V
780
780
770
Host virtualization machine/farm
740
Cloud computing center network
76
Firewall
Firewall
740
740
740
744
740
Organization network
The Internet
server-side remote desktop software
760
server side host
750
760
40
740
742
740
server-side remote desktop software
server side host
760
750
client-side remote desktop software
730
client side host
710
Console
720
user
702

FIG. 13

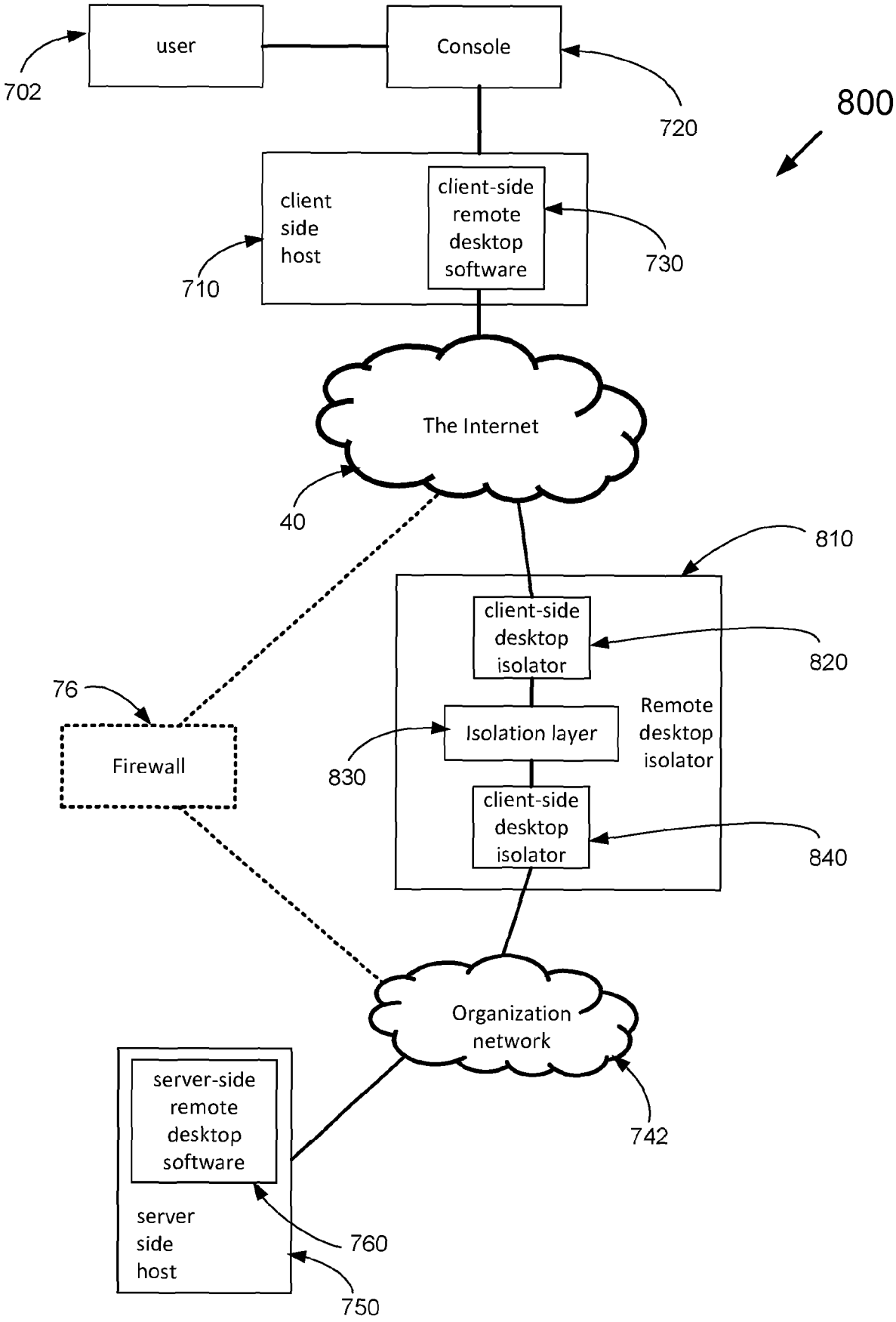

user
Console
702
720
800
client
side
host
client-side
remote
desktop
software
710
730
The Internet
40
810
client-side
desktop
isolator
820
76
Firewall
Isolation layer
Remote
desktop
isolator
830
client-side
desktop
isolator
840
Organization
network
742
server-side
remote
desktop
software
server
side
host
760
750

FIG. 14

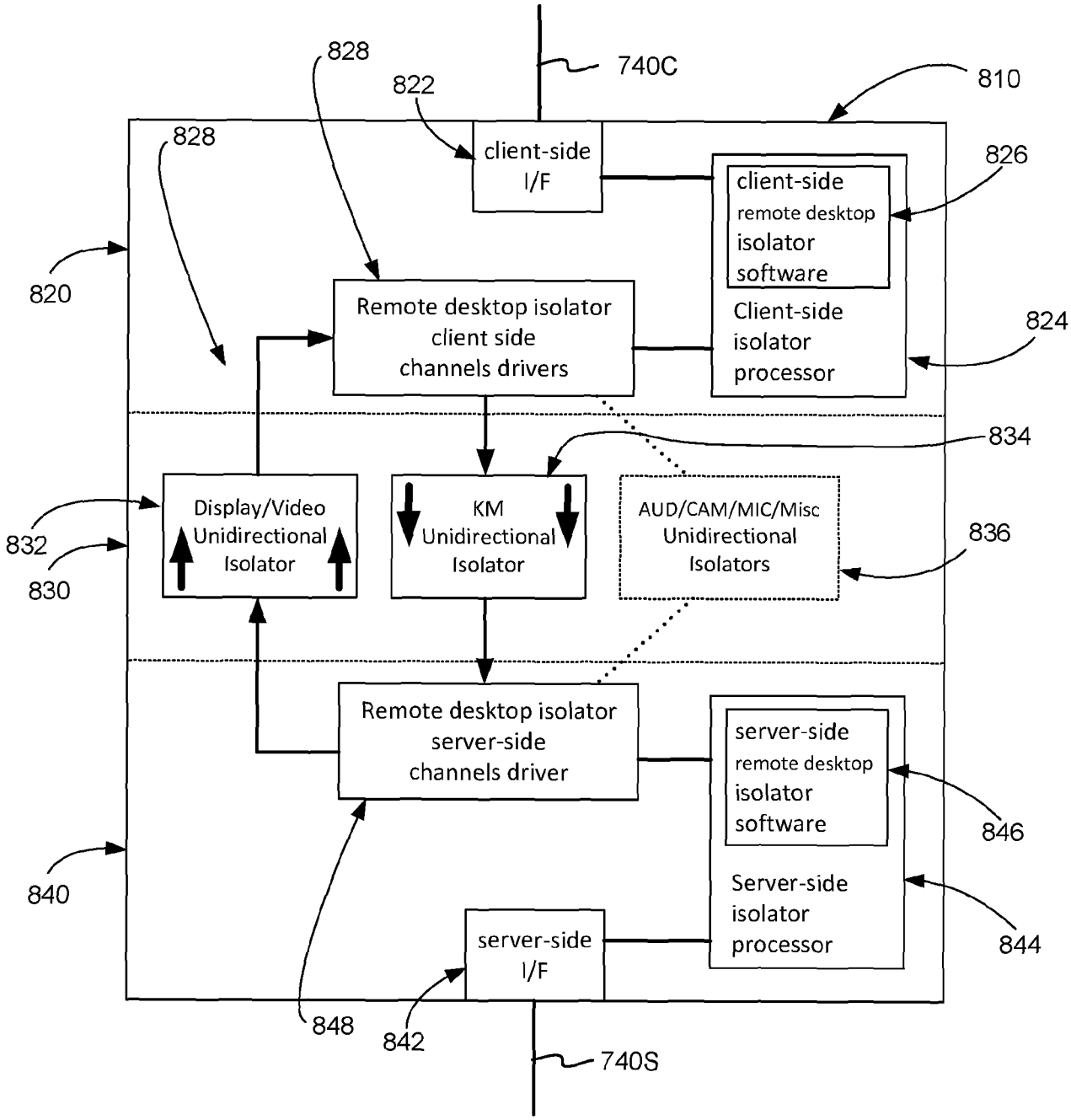
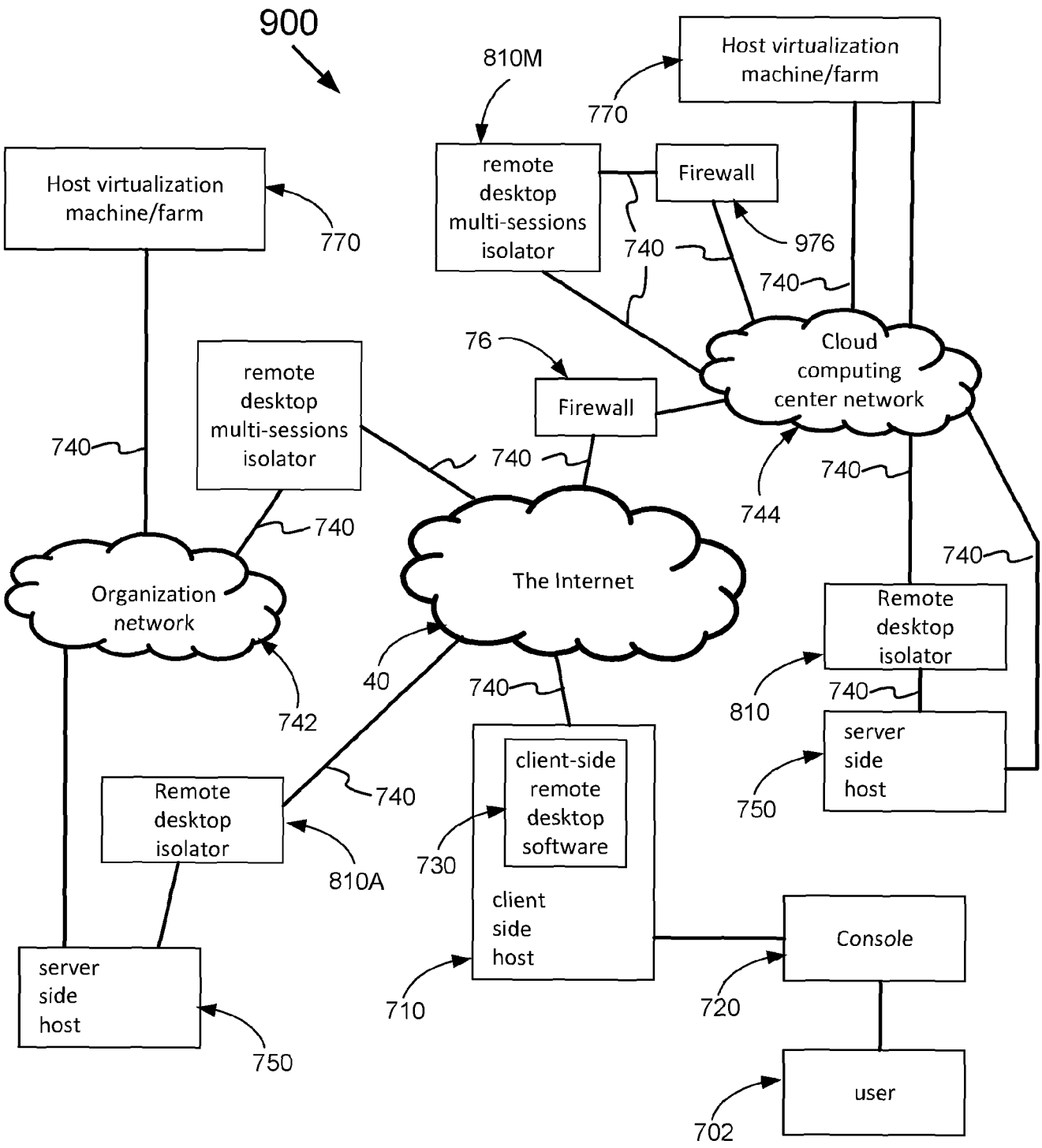

828
822
740C
810
828
client-side I/F
826
client-side remote desktop isolator software
820
Remote desktop isolator client side channels drivers
Client-side isolator processor
824
834
Display/Video Unidirectional Isolator
KM Unidirectional Isolator
AUD/CAM/MIC/Misc Unidirectional Isolators
832
830
836
Remote desktop isolator server-side channels driver
server-side remote desktop isolator software
846
840
Server-side isolator processor
844
server-side I/F
848
842
740S

FIG. 15


900
810M
770
Host virtualization machine/farm
Host virtualization machine/farm
770
remote desktop multi-sessions isolator
Firewall
740
976
740
76
Firewall
Cloud computing center network
remote desktop multi-sessions isolator
740
740
740
744
740
740
Organization network
The Internet
Remote desktop isolator
40
740
742
740
810
740
server side host
client-side remote desktop software
Remote desktop isolator
740
730
750
810A
client side host
Console
server side host
710
720
750
user
702

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2023/053080

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - INV. - G06F 13/40; G06F 3/02 (2023.01)
ADD. - G06F 13/10; G06F 21/83 (2023.01)

CPC - INV. - G06F 13/4022; G06F 3/02 (2023.05)

ADD. - G06F 13/10; G06F 21/83; G09G 2370/24 (2023.05)

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)
See Search History document

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

Electronic database consulted during the international search (name of database and, where practicable, search terms used)
See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/0100652 A1 (LIN et al.) 22 April 2010 (22.04.2010) entire document	1-7, 13, 22-28, 34, 43-49, 55
---		---
Y		8-12, 14-21, 29-33, 35-42, 50-54, 56-60
Y	WO 2021/245644 A1 (HIGH SEC LABS LTD.) 09 December 2021 (09.12.2021) entire document	8-11, 16-18, 29-32, 37-39, 50-52, 58
Y	US 2020/0125771 A1 (HIGH SEC LABS LTD.) 23 April 2020 (23.04.2020) entire document	11, 14, 32, 35, 53, 56
Y	US 2014/0019652 A1 (SOFFER) 16 January 2014 (16.01.2014) entire document	12, 15, 19, 33, 36, 40, 54, 57, 59, 60
Y	US 2013/0159391 A1 (LIN et al.) 20 June 2013 (20.06.2013) entire document	20, 41
Y	US 2015/0003464 A1 (HUAWEI TECHNOLOGIES CO., LTD.) 01 January 2015 (01.01.2015) entire document	21, 42
A	BLACK BOX CORPORATION et al. "Secure Analogue and Digital KVM Switches." (2010) Retrieved on 21 July 2023 (21.07.2023) from <http://www.commoncriteriaportal.org/files/epfiles/t265_st.pdf> entire document	1-60
A	US 2005/0010696 A1 (EMERSON et al.) 13 January 2005 (13.01.2005) entire document	1-60

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"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)
"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
"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
"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
"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
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 July 2023	AUG 30 2023
Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	Authorized officer Taina Matos Telephone No. PCT Helpdesk: 571-272-4300

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2023/053080

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2005/0283563 A1 (LOU *et al.*) 22 December 2005 (22.12.2005) entire document	1-60

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2023/053080

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See extra sheet(s).

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-60

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2023/053080

Continued from Box No. III Observations where unity of invention is lacking

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claims 1-60, is drawn to a computing system comprising: a plurality of hosts; a console comprising at least a first keyboard, a first mouse and a first display; a secure peripheral sharing device.

Group II, claims 61-77, is drawn to a method for providing a remote console capability to a secure peripheral sharing device using a remote console subsystem, the method comprises the step of: receiving requests for open new remote console sessions.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the special technical feature of the Group I invention: the peripheral sharing device is configured to be coupled to the remote console subsystem that is located away from the peripheral sharing device, and wherein the secure peripheral sharing device is configured to connect or couple between either the console or the remote console subsystem and an active host of the plurality of hosts, and wherein the peripheral sharing device is configured to switch any one of the plurality of host to become the active host, and wherein a video stream from the active host is transferred to either the first display or the second display, and a keyboard and mouse data is transferred to the active host from either the first keyboard and the first mouse or the second keyboard and the second mouse as claimed therein is not present in the invention of Group II. The special technical feature of the Group II invention: the method comprises the step of: receiving requests for open new remote console sessions and upon such a request, open a remote console session in both the side of the secure peripheral sharing device and the side of the remote console subsystem, as long as the remote session is active, perform continuously in both the side of the secure peripheral sharing device and the side of the remote console subsystem, the steps of: - receiving video stream from the active host and transferring the video stream to the second display; - receiving a keyboard and mouse data from the second keyboard and the second mouse and transferring the keyboard and mouse data to the active host; and - upon receiving active host switching commands from a user, switching the active host, receiving requests for close remote console sessions and upon such request, close the remote console session and resume working of active host with the console as claimed therein is not present in the invention of Group I.

Groups I and II lack unity of invention because even though the inventions of these groups require the technical feature of a secure peripheral sharing device comprises: a plurality of ports to be configured to be connected to a plurality of hosts; a port to be configured to be connected to a console comprising at least a first keyboard, a first mouse and a first display; and a remote console port configured to be coupled to a remote console system, the remote console subsystem comprises: a port configured to be coupled to a secure peripheral sharing device; and a remote console comprising at least a second keyboard, a second mouse and a second display, this technical feature is not a special technical feature as it does not make a contribution over the prior art.

Specifically, WO 2021/245644 A1 to HIGH SEC LABS LTD. teaches a secure peripheral sharing device comprises: a plurality of ports to be configured to be connected to a plurality of hosts; a port to be configured to be connected to a console comprising at least a first keyboard, a first mouse and a first display; and a remote console port configured to be coupled to a remote console system, the remote console subsystem comprises: a port configured to be coupled to a secure peripheral sharing device; and a remote console comprising at least a second keyboard, a second mouse and a second display (Paras. [0042-0049]).

Since none of the special technical features of the Group I or II inventions are found in more than one of the inventions, unity of invention is lacking.