Architecture and Integrated Technologies for Smart Consumer Electronics Systems in Households Environments

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Abstract: This paper introduces the development of modern integrated electronic systems for consumers and their trends towards the implementation of satellite techniques in households environments. Consumer electronics refers to any device containing an electronic circuit board that is intended for everyday use by individuals in flats or residential premises. This encompasses a massive category of electronics that includes cable and satellite television (TV), Internet Protocol TV (IPTV), IP Computers (IPPC), laptops, Bluetooth, ZigBee, Wireless Fidelity (WiFi), Worldwide Interoperability for Microwave Access (WiMAX), Wireless Local Area Network (WLAN), Personal Digital Assistants (PDA), video cameras, surveillance cameras, DVD Players, Internet-enabled home devices, digital clocks, audio devices, microwave ovens, photostat machines, headphones, tablets, smartphones, and many other home products and services.

Key Words: Consumer Electronics, TVIP, IPPC, WiFi, WiMAX, WLAN, HIS, HVAC, HMC, DVB-RCS, UHDTV, ISDN, DECT

1. Introduction

Modern consumer electronics, such as smart TV, IPTV, computers, smartphones, and other home equipment, become the most important consumer devices in our lives. And behind this is a vast world of connected home devices that may together to improve our living conditions. From controlling our homes to unlocking and controlling our cars and monitoring our health advances in connectivity over the past decade have radically reshaped society.

Whether in detached houses or office buildings, comfort standards and the wide scope of application in the management of air conditioning, illumination, and other trades are growing steadily. At the same time, energy efficiency is becoming more and more important. A higher level of comfort and security as well as lower energy consumption can be achieved by using intelligent control and monitoring systems for all consumer electronics products used. However, this means more wiring will be needed to connect sensors and controllers with the controlling and monitoring units, although in the modern age wiring can be substituted by Bluetooth, ZigBee, HiFi, and WLAN networks. The result is more extensive planning and installation work, a higher risk of fire, and rapidly growing costs.

Consumer electronics are growing every day and recent trends in embedded systems are also happening with Internet solutions, so home appliances are talking to each other without human intervention. Consumer appliances are making life simpler with cutting-edge technologies implemented by top electronic companies worldwide, such as Samsung, Google, LG, Sony, Philips, etc. Every technology tinkerer wants to know and use the latest technology gadgets. Therefore, by definition, consumer or home electronics are the devices used in homes and to help homeowners in more comfortable and cost-effective life.

2. Smart Home Systems

Smart home technology generally refers to any suite of devices, applications and systems that can be independently and remotely controlled. When consumers home technology works together in one system, it can also be referred to more loosely as a "connected home". As technology development continues to expand, so will the possibilities for consumer home automation to make life easier and more enjoyable. Smart home or home automation has become more elaborate and affordable in recent years. In fact, it means building on existing, known platforms with modern solutions with the lowest cost to the customer possible. Home automation is a growing industry and a popular trend for homeowners who want the latest technology in their environment. However, it can also be a great new tool for making homes, flats and offices in the building environmentally friendly, using green technology and deploying intelligent touch panels or any other computer in the world to do control and monitor household appliances and their energy consumption.

Many manufacturers of home automation equipment are providing designs and new smart solutions for the customer's needs. Home Automation is a growing industry and a popular trend for homeowners who want the latest technology. However, it can also be a great new tool for making the house environment more friendly, using green technology and automated solutions. The popularity of home automation or smart home or even the Internet of Things (IoT) has increased in recent years due to much lower cost and simplicity through PC, smartphone, and tablet interface. In such a way, the modern concept of an "Internet Connected House" has grown along with the increased use of Home Automation.
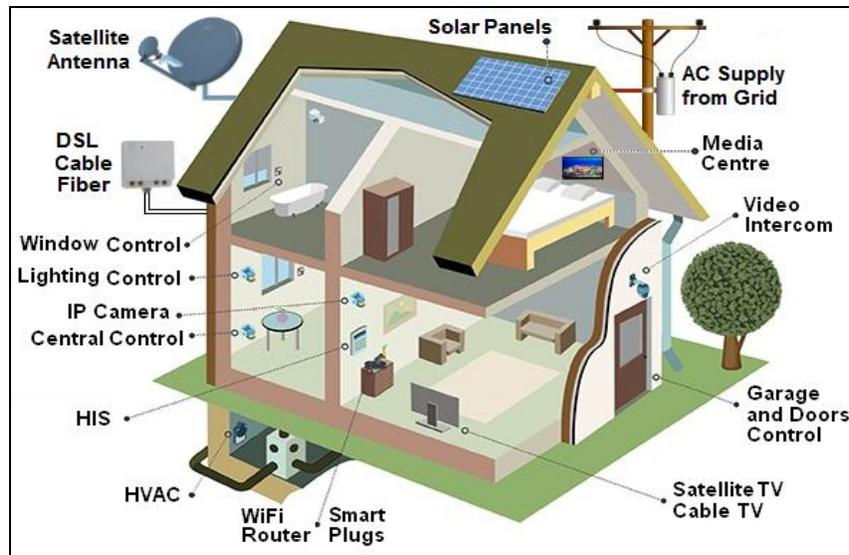
Figure 1. Smart Home Applications

The new smart home solutions are going to integrate electrical, electronic, and communications devices with each other. For instance, these home automation systems can control many home functions, such as Home Entertainment Systems, changing light "scenes" for different events, or reducing the light levels to save on electricity. Lowering shades on one side of the house in the morning and the other side in the afternoon for energy efficiency. In fact,these systems can be connected to resident computers and the Internet for remote monitoring or operation of the system. Namely, modern home and office automation solutions will be able to provide control homes or flats of customers from any Internet location in the World. The homeowner customers may take smart control of their premises Hose Take control of your world with a smart home system via their smar phones, PC, or laptop terminals.

3. Smart Home Applications

As stated, smart home features are designed to make homes more convenient, enough appealing, secure, and energy-efficient, namely all of which are also bonuses when homeowners are trying to sell a house. Sellers who want to move their homes faster may benefit from adding smart features that make their properties more appealing to tech-minded buyers. At this point, automation in any home can include centralized control of all lighting, audio and video distribution, whole house audio, Heating, Ventilation and Air Conditioning HVAC), security systems, gates, door locks, and cameras. These systems can provide improved convenience, comfort, energy efficiency, and security. In **Figure 1** are depicted all main components of smart home applications and features that might catch buyers' attention and help sell someone's home faster:

1. Windows Control – With motorized window automated treatments the householder can easily adjust the amount of daylight in his home to increase comfort, save energy, and protect interiors. Motorized shading, blinders and drapery transforms harsh glare into soft pleasing light enhances privacy while preserving exterior views, reduces solar heat gain, provides ultraviolet protection of expensive furnishings and artwork, and provides the ability to change daytime into night-time for restful sleep with the simple press of a button. Clients and designers have hundreds of window treatment fabric and colour options available to complement any décor.

2. Intelligent House Systems (HIS) – The HIS is designed to make homeowners living easier and more enjoyable. With a tap on the touch control panel or a simple push of a button on a stylish remote control, owners can dim the lights, close the shades, set a comfortable temperature, and cue up favourite movies in the luxury home theater.

3. Climate Control (HVAC) – For example, householder might have floor heaters installed in the bathroom, that are set to begin warming 15 minutes before you wake up each day. They might be set to "warm" the floor for 60 minutes before they automatically shut off. Also, the owner can apply the same technology for towel warmers, and even drawer warmers, so clothes are toasty warm when you get out of the shower.

4. Lighting Control - Lightning can add an extra layer of security, when people are not at home. The homeowner could instruct living room lights to turn on automatically, for instance at 06:45PM every night, so that appears that he to be home, whether he is or not. To avoid a giant carbon footprint, the owner could attach a motion sensor that commands the lights to switch off after 30 minutes if no movement is detected.

Figure 2. Home Media Centre (HMC)

5. Video Intercom - Picture someone sitting in the lounge room at one end of the house, when the house doorbell rings at the other end of your home. Somebody may pick up a palm-sized device, which feeds through a live video stream of the front door. If a householder sees a friend or any invited guest, he presses a button and the door unlocks. If he sees a threatening or unfriendly face, he just calls the police or security.

6. Home Media Centre (HMC) – Today's home entertainment systems have enough possibilities to achieve many tasks and wishes at once. For example, a home media centre system can broadcast a movie and other transmisions with a high-quality picture and sound in one room, while simultaneously allowing a different film to be played in a different room, which scenario is illustrated in **Figure 2.**

7. Central Control – All home automation infrastructures include a signal control system to coordinate between different appliances. More advanced systems have central controls, which allow connecting to any part of the system. In such a way, central controllers can be connected by wire/wireless and are mounted in the wall or wield the specialized remote control or touch panel and communicate with home via infrared (IR) or radiofrequency (RF). Another common and easy way to communicate with smart home is via computer, Internet or smartphone.

8. Garage and Doors Control - With solutions of keyless and remote entry door locks householder will never go out from the house in the dilemma that he left the door not locked. In fact, if the home is equipped with a keyless and remote entry door lock homeowners can use an app on their smartphone to lock the door from wherever they are. Some manufacturers make versions that will also send a text or E-mail to houseowners phones when the door opens. Locks that can be programmed with multiple entry codes also allow the householder to see who comes and goes and when.

9. IP Camera – Wireless Internet Protocol (IP) camera is a type of digital video camera commonly employed for surveillance, which unlike analog Closed Circuit TV (CCTV) cameras, can send and receive data via a computer network and the Internet. In addition, this camera is typically either centralized requiring a central Network Video Recorder (NVR) to handle the recording, video and alarm management or decentralized no NVR needed.

9. Wi-Fi Router – This unit is connecting to the wireless manner all smart equipment, such as smartphones, smart TV, computers, laptops and so on.

10. Satellite/Cable TV – These two TV sets can provide TV programs via cable or satellite Networks. Cable providers offer more flexibility and require less equipment to install, usually a single outlet, coax cable, and set-top box. If the customer lives in a multi-dwelling unit (apartments, town homes, etc.), he can usually install cable without running into any issues. Satellite providers have to install a dish on the outside of your house, and the dish must point in the right direction and be free of debris. On the whole, it's safe to say cable is easier to set up and has fewer technical issues over its lifespan.

11. Lighting Control – Lighting control or automation allows homrowners to control lights remotely and wireless, to energy-efficient Light Emitting Diode (LED) bulbs that can change colour to match your mood and decor, lighting has come a long way. Some smart lights work in tandem with home automation systems to allow you to turn them on or off or even dim them, from an app on a smartphone or tablet.

12. Smart Plugs – This solution is known as Wi-Fi-enabled plugs, which are one of the easiest and most affordable smart home upgrades in smart home plugs to your home. These plugs fit existing outlets and can be controlled from a smartphone app. Plug anything into a smart plug, like lights or a television, and you can turn it on or off remotely, track energy consumption or even create an on-off schedule.
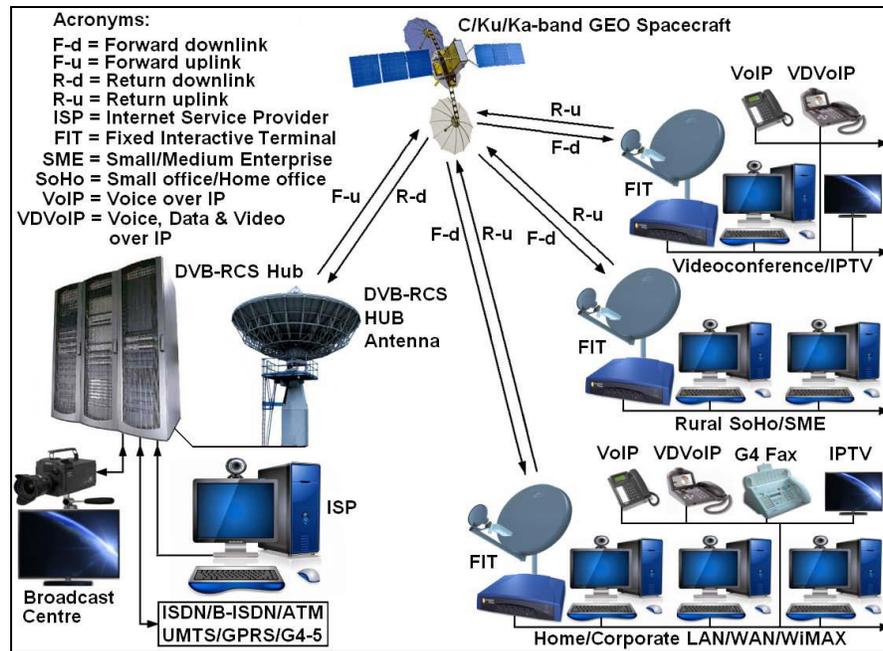
Figure 3. DVB-RCS Satellite Network for Home and Corporate Solutions

4. Home Interactive Satellite Internet and Broadcasting

The Digital Video Broadcasting-Return Channel via Satellite (DVB-RCS) is modern satellite Internet and broadcasting system, which can be implemented in smart homes, building, and cities, which network is shown in **Figure 3.** This network is connecting Internet facilities of Internet Service Provider (ISP) and broadcasting contents via DVB-RCS Hub and antenna with Very Small Aperture Terminals (VSAT) or Fixed Interactive Terminals (FIT) via Geostationary Earth Orbit (GEO) satellites at C, Ku and Ka-bands.

Depending on Hub capacity, DVB-RCS network can connect from 10 up to 1000 VSAT units, and each VSAT can connect up to 100 PC, IPTV, or other consumer equipment in homes, corporate offices, rural Small office/Home office (SoHo), and Small/Medium Enterprises (SME) in Local Area Networks (LAN), Wide Area Networks (WAN), WiMAX and WiFi. Thus, home offices can be connected to the Integrated Services Digital Network/Broadcasting (ISDN/B), ISDN, Asynchronous Transfer Mode (ATM), Universal Mobile Telecommunications System (UMTS), General Packet Radio Service (GPRS), and Cellular G4/G5.

Home VSAT configuration consists of indoor satellite transceiver (FIT) and outdoor dish antenna, which can be installed on the home or building roof. For instance, the VSAT interactive (satellite receiver and transmitter) unit can usually connect in-home LAN configuration the following service: Internet, IPTV, Videoconference, Voice over IP (VoIP) telephones, videophones, Voice, Data and Video over IP (VDVoIP), FAX machines, video cameras, and other equipment.

5. Smart Home Satellite Broadband Office

New satellite technologies and technique are modern solutions for implementation in modern home office and entertainment rooms. The main home units are DVB-RCS satellite interactive dish antenna and IP VSAT transceiver (receiver and transmitter). The satellite antenna is connected via GEO or other types of satellites to the DVB-RCS Hub with the gound antenna.

Interactive VSAT remote modem station is the brain of a modern home-consuming electronic system that is connecting much equipment for serving in-home office or in entertainment rooms. This VSAT is Advantech IP terminal that Provides higher forward link capacity, higher IP throughput, Single Channel Per Carrier (SCPC) transmit capability in point-to-multipoint networks and wider IF frequency range. The terminal has been designed with all key IP features to fulfil all the needs of an enterprise, offices, and homes via cable, Digital Subscriber Line (DSL), or WiFi connections.

The attractive design and small form-factor makes it ideal as a cost-effective, desktop high-speed solution, such as: receive up to 200 Mb/s (Hub to VSAT) with the Ethernet throughput up to 100 Mb/s; up to 9.5 Mb/s transmit (VSAT to Hub) in Time Division Multiple Access (TDMA) mode; and up to 20 Mb/s transmit in SCPC mode for point-to-multipoint networks.
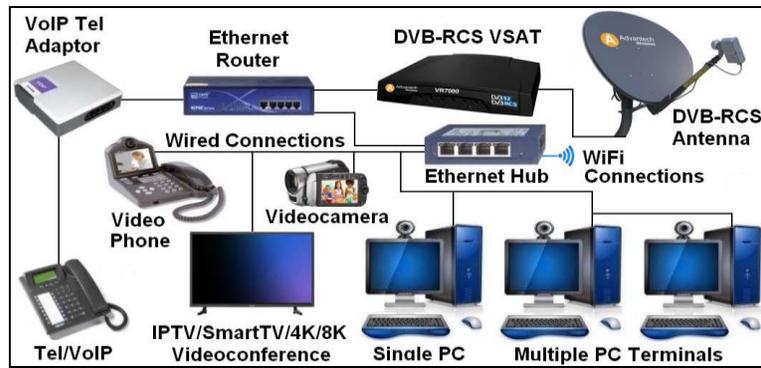
Figure 4. DVB-RCS Satellite LAN for Home Office and Entertainment Room

This IP satellite modem can support the following applications, Internet/Intranet Access, Email, File Transfer, VoIP, VDVoIP, Video Streaming, Backup Services, Private Networking, Video-On-Demand, Distance Learning, Multicasting, IPTV and other broadband solutions.

As shown in **Figure 4**, the VSAT modem is connecting all Internet and broadband consumer equipment via Ethernet Router, VoIP Tel Adaptor and wired or wireless (Wi-Fi) Ethernet Hub. The VoIP Tel Adaptor is connecting via wire Tel and VoIP Tel sets, while Ethernet Hub is connecting all single and multiple PC terminals, IPTV, Smart TV, Videoconference and another kind of TV terminals via cables or Wi-Fi points.

1.Internet Protocol television (IPTV) – This is the process of broadcasting or delivering televised content to end-user computing devices over Internet Protocols (IP) networks. This is in contrast to delivery through traditional terrestrial, satellite, and cable television formats. Unlike downloaded media, IPTV offers the ability to stream the source media continuously. As a result, a client media player can begin playing the content, such as a TV channel almost immediately, which is known as streaming media.

2. Smart Television (Smart TV) – It is a TV that provides interactive features similar to those involved in Internet or Web services on PC. This includes the ability to search for the video or interact with the television in other ways. This can be done through a set-top box or through internal technology in the television, such as an operating system that commands and controls these interactive features.

3. Ultra High Definition (UHDTV) – This modern TV format provides new generations of UHDTV for home or mobile consumers, such as 4K and 8K. The first 4K UHDTV standard was originally designed to describe digital cinema, which provides 4096 pixels long by 2160 pixels wide, for a total of 8,847,360 pixels of picture resolution. The second 8K TV or UHDTV2 standard is in the development phase, which has to provide 7680 pixels long by 4329 pixels wide, for a total of 33,177,600 pixels.

6. New Implemented 4K Ultra HDTV

The 4K Ultra HDTV (UHDTV) is Ultra HD formats, which new 4 Sony producers for households and other customers is shown are **Figure 5.** Unfortunately, a common misnomer arises when describing 4K terms has to be clear up in case of any further confusion. In fact, the standalone term "4K" was originally used to describe digital cinema (4096×2160 px). Since digital cinema resolution is not available in a consumer home television, the term "Ultra HD" (3840×2160 px) and "4K UHDTV" (4096x2160) were invented. It has to be noticed that the slight reduction in 4K Ultra HD resolutions is to achieve a 16×9 aspect ratio.

Figure 5. 4K UHDTV – Product of Sony Manufacturer

Figure 6. 8K UHDTV – Prototype of Sharp Manufacturer

The advantage of the 4K Ultra HD gives exactly four times the resolution of Full HDTV, which produces a magnificent image when viewed in person. The consumers will be doing themselves a great injustice if they try to gauge the clarity of a 4K Ultra HDTV screen using their computer or current Full HDTV, so they will not experience anything near the actual quality of 4K Ultra HDTV.

In the first stage of development, 4K Ultra HDTV displays are available today from several manufacturers, including: Sony, Samsung, and Seiki. Other TV producers, like Sharp, Toshiba, TCL, and HiSense will begin offering 4K Ultra HDTV's toward the end of 2013.

The second round of 4K HDTV in 2014 are hitting the market, and at much lower prices than they were last year. Plus, they are coming from big-name vendors like Sony, Samsung, and LG.

Now that there are 4K HDTV displays in the mid-four figure range, still too dear for most of the future customers, but not unlike what big-screen plasma TVs cost in, say, 2005 it is more realistic to look at them now, even if they are still too expensive for most of the customers today.

7. Newcomer 8K Ultra HDTV

The last developed 8K Ultra HDTV is the second of the two Ultra HDTV formats, featuring a 7680×4320 px resolution, which is exactly 16 times the resolution of Full HD or 4K UHDTV. The design of the 8K UHDTV prototype of Sharp producer for households and other customers is illustrated in **Figure 6**.

The new television standard is the largest UHDTV resolution to exist in digital television and digital cinematography. It refers to the horizontal resolution of these formats, which are all on the order of 8,000 pixels, forming the total image dimensions (7680x4320). In such a way, this standard provides a display resolution that may eventually be the successor to current 4K resolutions. Today, the 4K standard is speculated to become a mainstream standard in televisions by 2017. One advantage of high-resolution displays such as 8K is to have each pixel be indistinguishable from another to the human eye, at a certain distance away. On an 8K screen-sized 52", this effect would be achieved in a distance of 20" from the screen, and on a 92" screen at 3' away.

Another practical purpose of this resolution is in combination with a cropping technique used in film editing. This allows filmmakers to film in a high resolution such as 8K, with a wide lens, or at a farther distance from a potentially dangerous subject, intending to zoom and crop digitally in post-production, a portion of the original image to match a smaller resolution such as the current industry standard for High-definition televisions (1080p, 720p and 480p).

Few film cameras have the capability to film in 8K, with innovators NHK being one of the only companies to have created a small broadcasting camera with an 8K image sensor. Sony and Red Digital Cinema Camera Company are both working to bring larger 8K sensors in more of their cameras in the coming years. Although 8K will not be a mainstream resolution anytime soon, the major reason filmmakers are pushing for 8K cameras is to get better 4K footage. Through a process called down sampling, however, using a larger 8K image down sampled to 4K could create a sharper picture with richer colors than a 4K camera would be able to achieve on its own with a smaller sensor.

Therefore, the 8K Ultra HD technology is still largely experimental at this point, with only one 8K Ultra HDTV being featured at CES 2013 by Sharp. Having seen this resolution in person, it is possible to conclude that the astounding video quality cannot be described with words, nor can a still photograph accurately represent the sheer awesomeness of this video resolution. When 8K Ultra HD is combined with 22.2 surround sound, NHK advocates this as Super Hi-Vision**.**
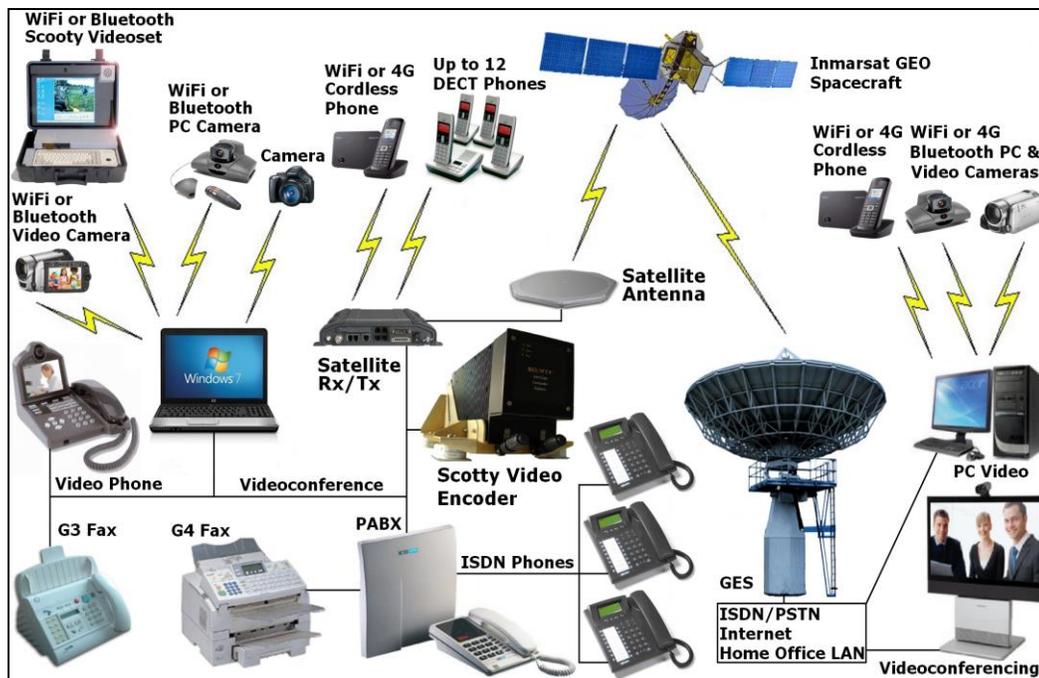
Figure 7. Package of Inmarsat Broadband Transceiver and Video Encoder

The 8K Ultra HD system is still at least several years away from the living room of future consumers. Three main obstacles must be overcome to bring this resolution to the mainstream: Storage, Bandwidth, and Content. Thus, similar to the previous standards, various 8K Ultra HD products are being designed, such as the AH-4800 camera by Astro Design, capable of recording 8K resolution and other relaying products.

8. Integrated Satellite Broadband and Scotty Video Encoder

The video communications platform via Inmarsat GEO satellites known as "Scotty Computer System (SCS)" from Scotty can provide special service specialized in beyond line of site audio, video, PC/Laptop, PABX interface, Integrated Services Digital Network (ISDN) solutions and data for households and other customers, which network is shown in **Figure 7**. This system has been designed for multiple beyond Line of Sight (LoS) mobile applications such as videoconference, video surveillance, and fleet tracking.

The Scotty system consists of a high-resolution day and night vision gimbals, which provides the video signal, the SCS that encodes the video into an H.264 data stream (up to four video inputs are possible), and an operator console to control the system and display the receiving video from the ground. A cabin interface can be connecting to headsets or the mobiles intercom system via Bluetooth, Wi-Fi, and Digital Enhanced Cordless Telecommunications (DECT), and a docking stations for encryption devices are available.

The SCS equipment supports additional external NTSC or PAL composite video inputs, audio inputs, and an external audio and composite video output utilizing an easy-to-use software audio/video switching matrix and audio mixer. However, this makes using external video and audio sources very simple, and sources can be hot switched during the video communications session. This system supports multiple video monitors, which can be used to have multiple observers in-home or buildings. The built-in video recording capability enables users to record high resolution (up to 62.5 Mb/s 1080p resolution in MPEG-4 format) video and audio from any of the sources or ongoing video communication and, either forward the file or save it to a removable drive. Many home intertaitment devices integrated with SCS modem provide the following service:

- Data transfer (ISDN or IP) to the receiving side - Transmitter (Tx) and Receiver (Rx);
- Channel bundling for higher data rates (virtual CAPI over LAN);
- Live video transmission with n x 64 Kb/s (up to 256 Kb/s) into the ISDN network up to 432 Kb/s;
- H.320/H.323 video conferencing and H.264 (MPEG 4 –AVC10) video coding for live transmissions;
- MPEG 4 video recording selectable between 250 Kb/s up to 5 Mb/s (resolution FD1 with 720 x 576 pixels) and store & forward data transmission; and
- Implementation and presentation of command-and-control components.

Furthermore, because the SCS unit includes a Windows PC, it can be used as a data work station and an onboard communication hub. In combination with other Scotty mobile units, it is also compatible to military standard encryption equipment.

9. Conclusion

In this paper are present just a few of the many examples of how self-service tools for the smart homes have made customer service more digital. The smart home concept is offering different integrated possibilities in the establishment of context-aware home and office spaces able to take intelligent decisions and respond autonomously according to the environmental situation at any moment. Artificial and digital intelligence provides ad hoc concepts and techniques that support this view from a computational perspective. However, research on smart homes and offices has traditionally prioritized the Internet of Things (IoT) network and intelligent hardware-based solutions.

Smart homes are more than technical innovation and hardware solutions. Smart homes are the first need of a modern person in rooms where household members spend a significant part of their lives and therefore they should contribute as much as possible to maintaining their health. This should especially include maintaining psychological health and relaxation. In the current digital and technology age, everyone feels the pressure of the flow of information, which can lead to discomfort, stress, and even illness. To process such a flow, choose only the most necessary and most interesting for a person in a home environment, which is the basic task of information and suitable smart home systems.

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