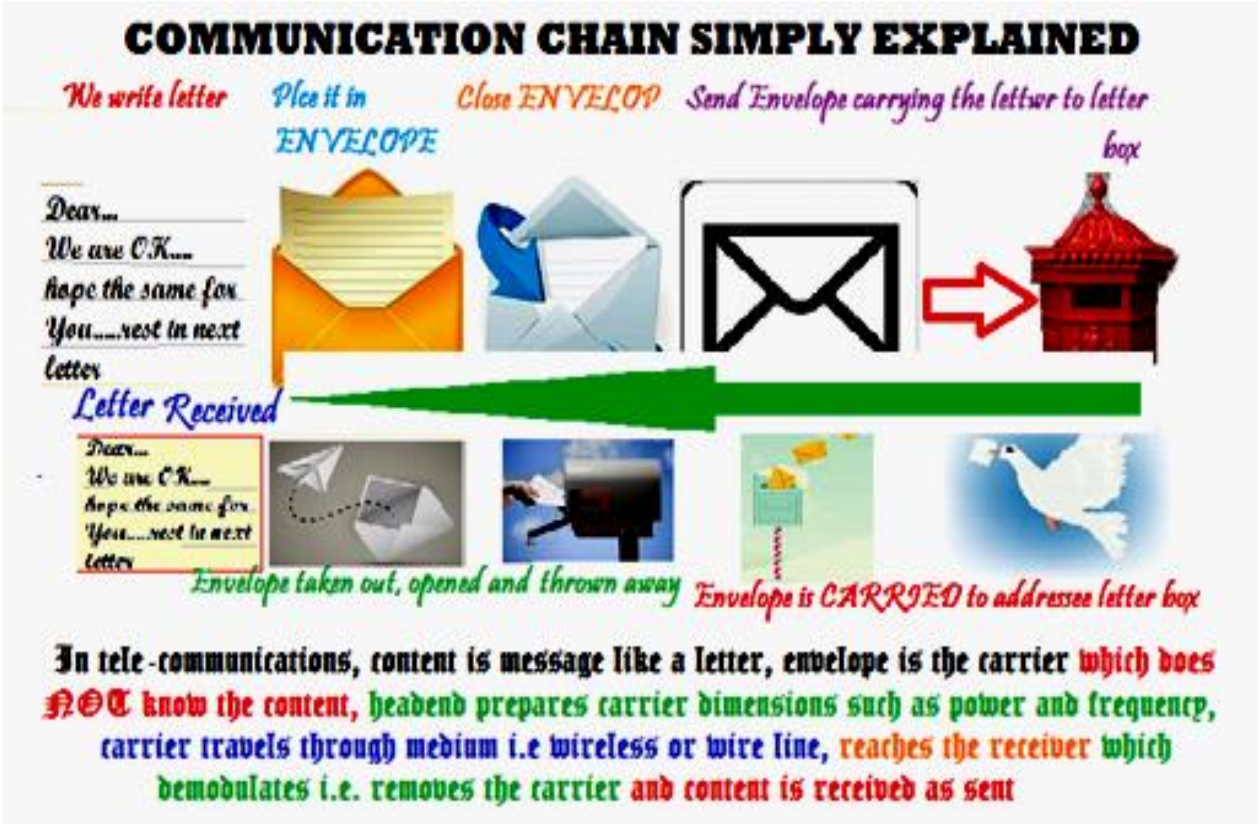
COMMENTS ON TRAI CONSULTATION PAPER No 19/2019

ON INTEROPERABILITY OF SET TOP BOX (STB)

Lt Col VC Khare (Retd) Cable TV industry Observer

A very educative, but lengthy(over 70 pages) for service providers to read, understand and comment, particularly the Cable Operators in immediate contact with the subscribers in the CATV service sector, with QAM, where bulk of Set Top Boxes STBs) are deployed. HITS DPO ultimately uses STB similar to those in CATV but with QAM after downlink. DTT uses OFDM. All these inputs are based upon coaxial cable inputs into STB. TVoIP is insignificant since reckoned a TELCO domain where inputs may be through UTP.

A little bit of re-capitulation is required to comment on this paper ,since expected to be read by not so technically literate people involved in CATV Networking, and others mentally seeking semblance with mobile telephone sets usage environment. To start with, for benefit of CATV segment, an explanation of basic electronic content transmission and reception.



In this schematic, Content is handled similar to a letter, envelope is RF carrier generated in the modulator, Distribution Platform is like the letter box starting at Headend , medium can be wireline or wireless, the envelope carrying the letter, i.e. content reaches the receipient letter box, the Set Top Box (STB) wherein envelope is opened (de-modulation), inside STB, and contents in the envelope retrieved and displayed on TV screen.

Similarly, in the headend, content is processed, encoded along with decoding instructions, enclosed, i.e. enveloped, in the carrier and pushed into distribution plat form.

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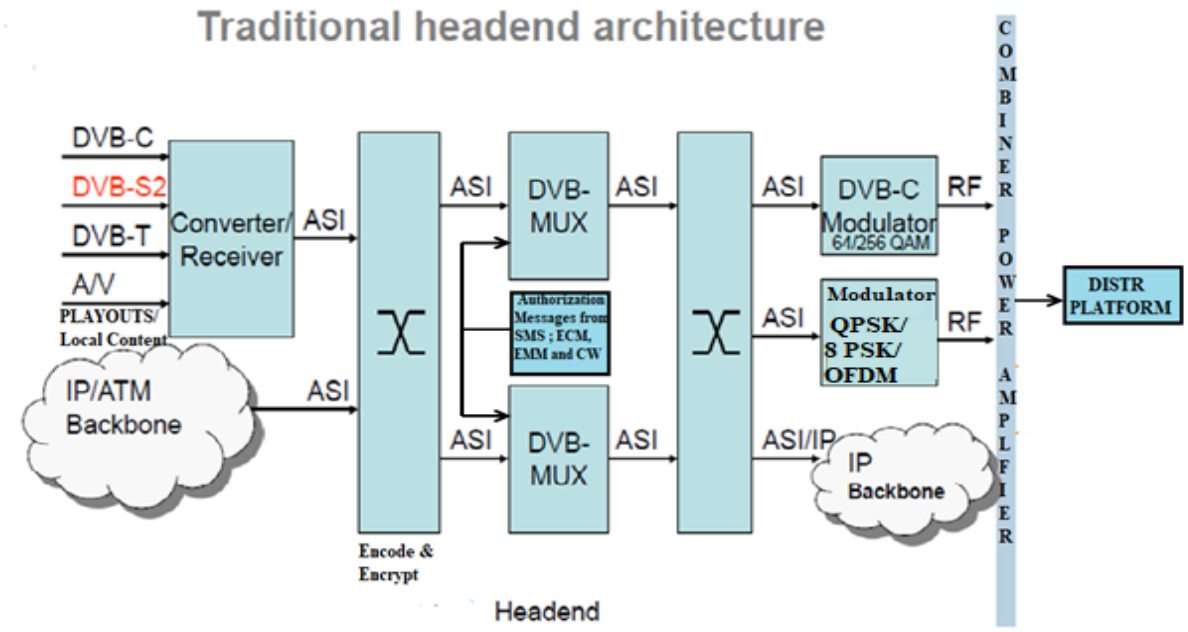
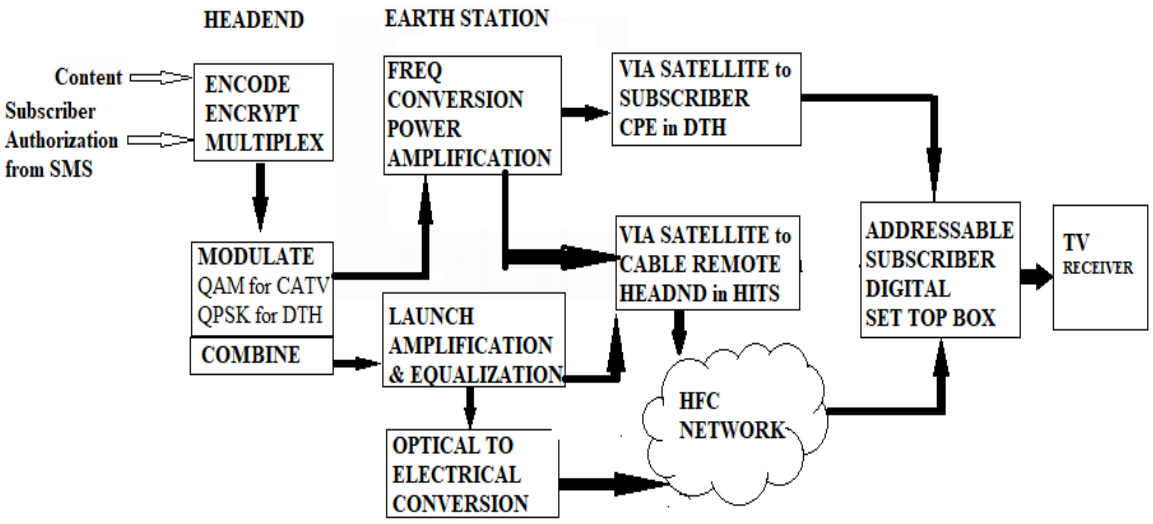


In the above schematic, content ,,as received from sources, is digitized (encoded), viewership authorization managed , with coded instructions on how to enable viewing, when received, and, if authorized, to view, modulated, combined and powered to drive the distribution platform to reach the subscriber..



COMMENTS ON TRAI CONSULTATION PAPER No 19/2019

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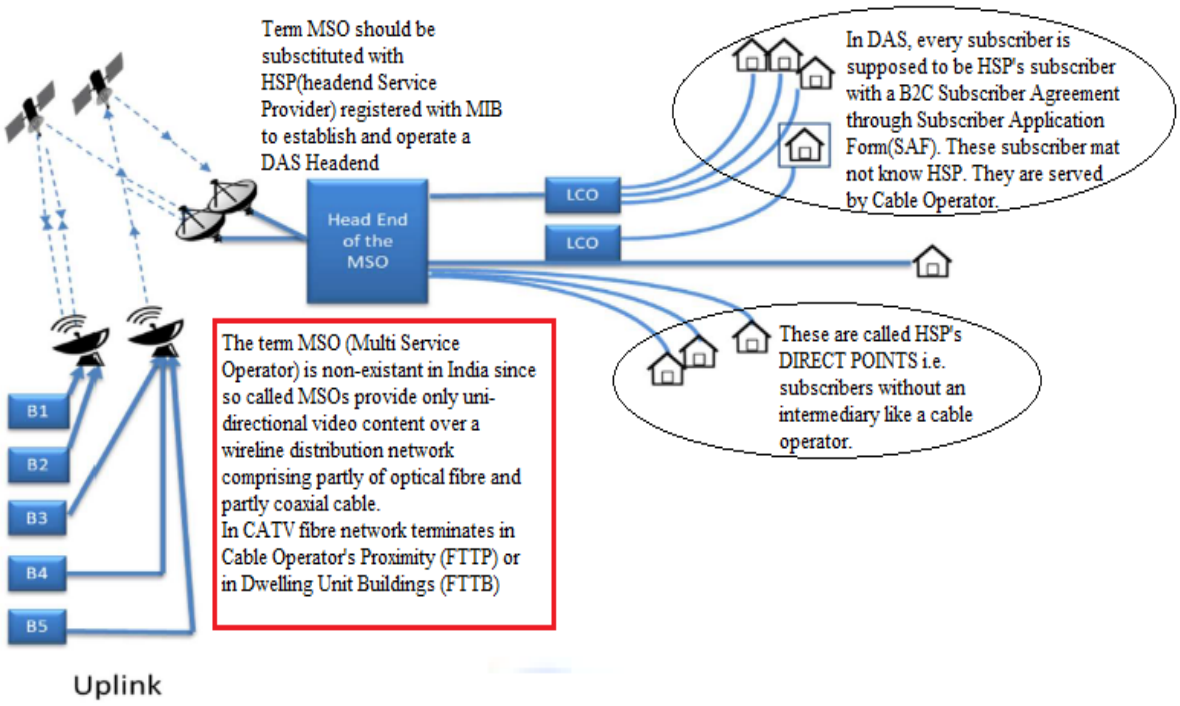
Headends essentially involve content aggregation. Most widely used example is CATV and is depicted as under :-



Various entities in Television Video Distribution Platforms are as under:-

Broadcaster (Including Terrestrial Broadcasters)

Headend Service Provider (including earth station uplinks for HITS and DTH)

IPTV Operator (In this technique, modulation like QAM or QPSK is not used ; system being point to point, bi-directional, addressability is inherent. EoL wireline too is not 75 Ohms for front end)

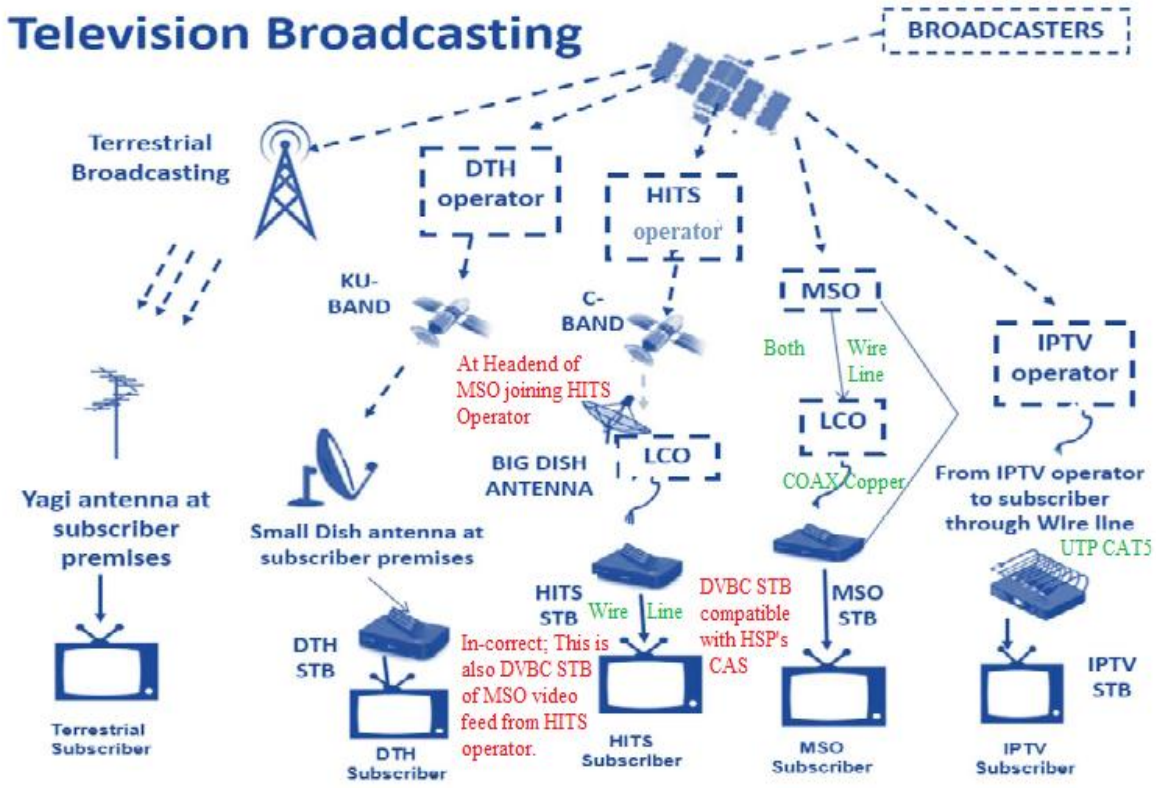
Proliferation , in number of programs being broadcast, and availability of number of RF channelsin the spectrum in use, limited the number of programs in analog mode(one program occupying one channel). Hence digitization was adopted to enhance the compressed programs, per channel, transportation capacity of Delivery Platforms so that Broadcasters granted downlinking permissions could avail eyeball access capability..

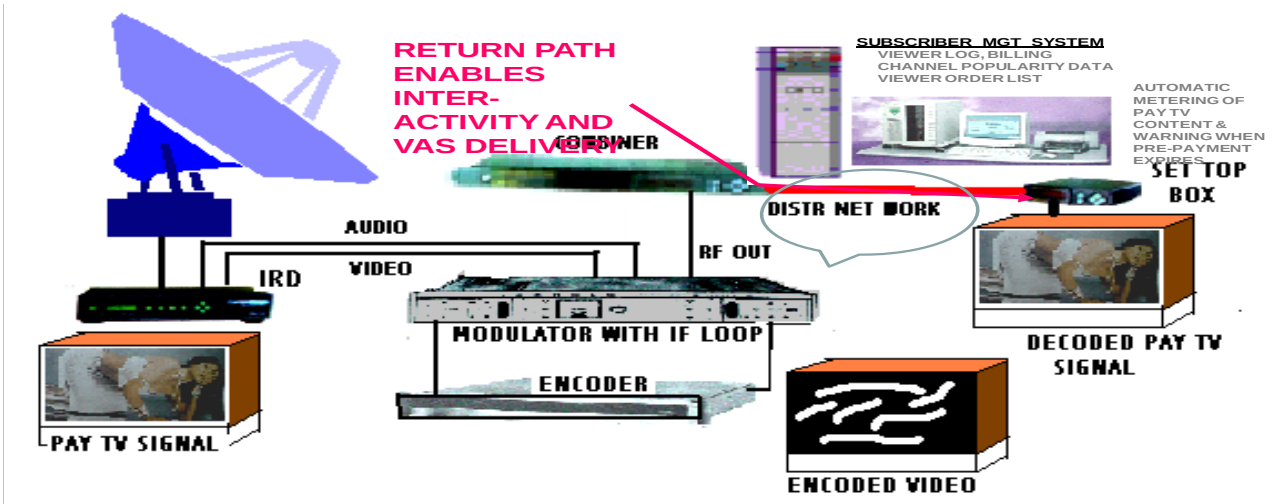
Protection of PAY content, and levying charges for its viewing, by broadcasters prompted use of conditional access (CA i.e. facility to enable or disable viewing of content remotely and selectively from the headend) involving encryption, i.e. scrambling and Subscriber Authorization through incorporation of CAS(Conditional Access System) and Subscriber Authorization System.

COMMENTS ON TRAI CONSULTATION PAPER No 19/2019

ON INTEROPERABILITY OF SET TOP BOX (STB)

Lt Col VC Khare (Retd) Cable TV industry Observer





SCHEMATIC SHOWING CONDITIONAL ACCESS SYSTEM PRINCIPLE

COMMENTS ON TRAI CONSULTATION PAPER No 19/2019

ON INTEROPERABILITY OF SET TOP BOX (STB)

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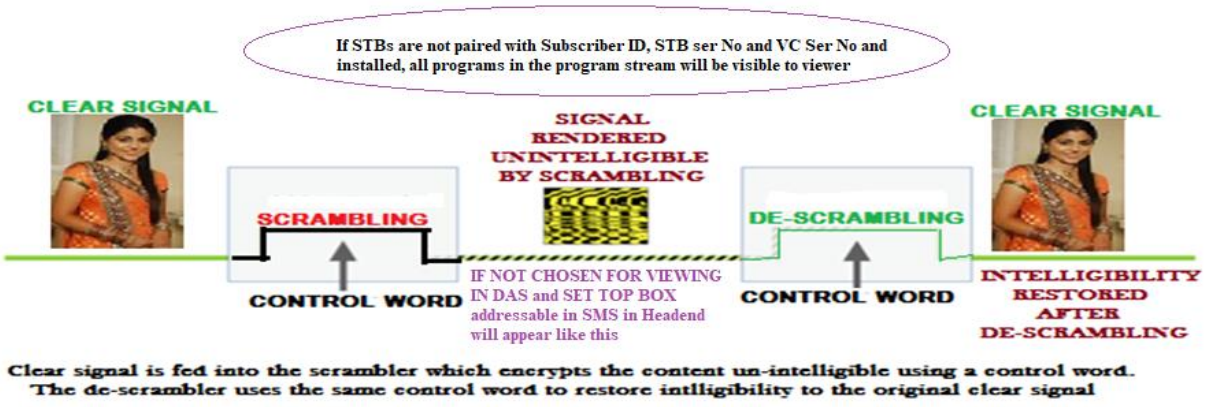
PAY TV content broadcasters wanted only those subscribers to watch the content who were willing to pay for the content. Hence content was scrambled,(i.e. some parameters disturbed to enable clear viewing when received), unless so instructed in the receiving STB.

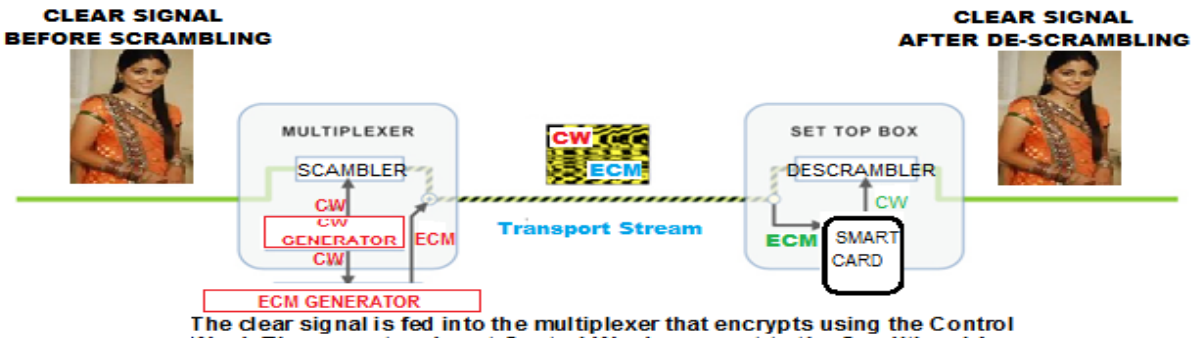
Scrambling, basically implies deliberate electronic disturbance in digital sequential description of the encoded signal so that content is rendered un-intelligible to watch, unless that deliberate disturbance is restored electronically. This action is called DE-SCRAMBLING and is achieved through use of a control word (CW)



Such content protection envisaged (a) digitization of content i.e. encoding (since digital content makes addressability easy) (b) encryption i.e. making viewing un-intelligible for viewers not authorized to watch such content and (c) de-cryption to make viewing of encoded program possible by those authorized to view that program..

In DAS, however, all programs have been mandated to be digitized and encrypted. Hence authorization would be required even for Free to Viewer content.

Briefly what is involved in encryption and decryption is as under :



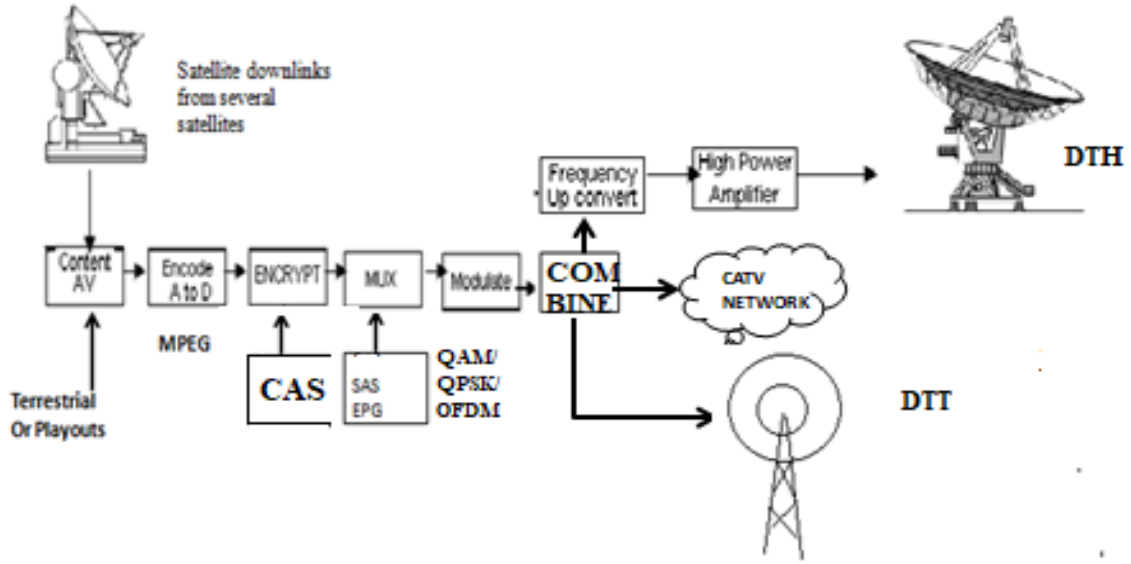
The clear signal is fed into the multiplexer that encrypts using the Control Word. The current and next Control Words are sent to the Conditional Access system ECM encryptor which will create an encrypted ECM containing the current and next Control Words. The ECM is then returned to the multiplexer that inserts it into the transport stream.

COMMENTS ON TRAI CONSULTATION PAPER No 19/2019

ON INTEROPERABILITY OF SET TOP BOX (STB)

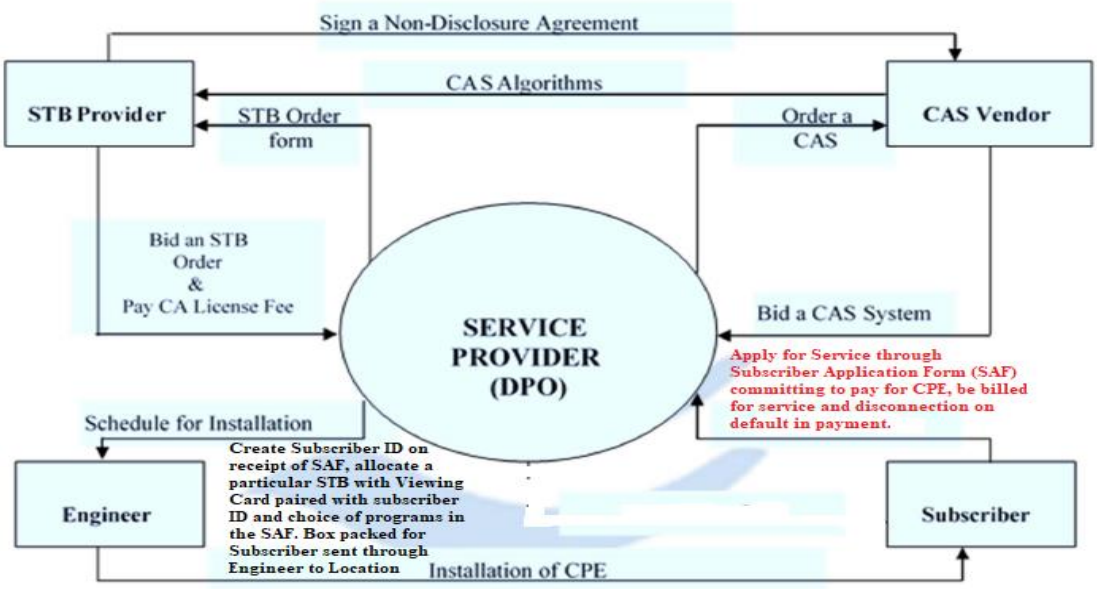
Lt Col VC Khare (Retd) Cable TV industry Observer

Digital Addressable System :Headend content processing is easier to understand from the architecture, generally, in use : Thus sequence of actions in video program processing in a digital headend is 1.turnaround, 2.encoding, 3.encryption, 4.viewing authorization message insertion, 5.multiplexing, 6.modulation, 7.combining and , purposing (RF signal level equalization, power amplification and Electrical to Optical, E2O, conversion for CATV) for driving the distribution platform. For DTH combined content stream is fed into frequency conversion and power amplification for beaming into the satellite in Ku Band. In case of HITS too power amplification is required to point the beam to the satellite. In case of OTT, the stream is terrestrially broadcasted by a High Power Transmitter.



Video content is of two types; (a) PAY, where Headend Service Provider(HSP) has to pay to the Broadcaster for subscriber watching the content after realizing payment for such content from the viewer, and (b) where neither any payment is to made by HSP to the broadcaster nor is any payment realized from the viewer by the HSP. This excludes Network Capacity Fee charged from subscribers.

CAS vendors develop the scrambling algorithm for their proprietary content protection, which is got embedded in the decryption chip. Upon seeking order from HSP to provide content protection, against upfront software price and annual royalties based upon number of subscribers , they advise chip manufacture to supply chip[s to STB manufacturer containing algorithms. The STB manufacturer supplies STBs to DPO for use in the Headend. At this stage EPG for the DPO is also loaded into the STBs being delivered. Once installed, EPG upgrades are possible from the headend through out of band transmissions whenever STB is powered ON.



Subscribers exercise choice of programs through an application form, SAF(Subscriber Application Form) , to the HSP wherein the subscriber ID is created linked with platform service provider, STB allocated for a subscriber paired with Subscriber ID duly authorized for viewing initial choice of subscriber(which can be changed subsequently through the customer care) and sent to technician for installation. Upon installation the service is activated to start billing.

CATV and HITS use frequency range 47-862 MHz at input terminal of STB, DTH uses 950 – 2150 MHz and DTT 510- 560 MHz . Hence inputs at the tuners have to correspond to these frequency ranges. OTT so far

is not encrypted and hence does not conform to DAS as enacted. In Digital transmission, depending upon compression ratio, 10-24 programs can be compressed in one RF channel bandwidth.

SET TOP BOX

Set Top Box, which is also referred as **STB,** is .a digital device which connects between signal source (CATV coaxial drop or DTH coaxial cable from the LNB or coaxial cable from yagi antenna receiving DTT)and television set and used to select different TV encrypted and addressable programs carried in RF channels compatible with tuners TV receivers, as per user choice of viewer, is called **set top box**. Connecting cable carries signals consisting of different broadcast video programs from Headend Service Providers (HSP) with DPO CATV or DTH across the globe. With the help of built in tuning circuit, set top box selects one program out of many multiplexed among each of these received channels.

COMMENTS ON TRAI CONSULTATION PAPER No 19/2019

ON INTEROPERABILITY OF SET TOP BOX (STB)

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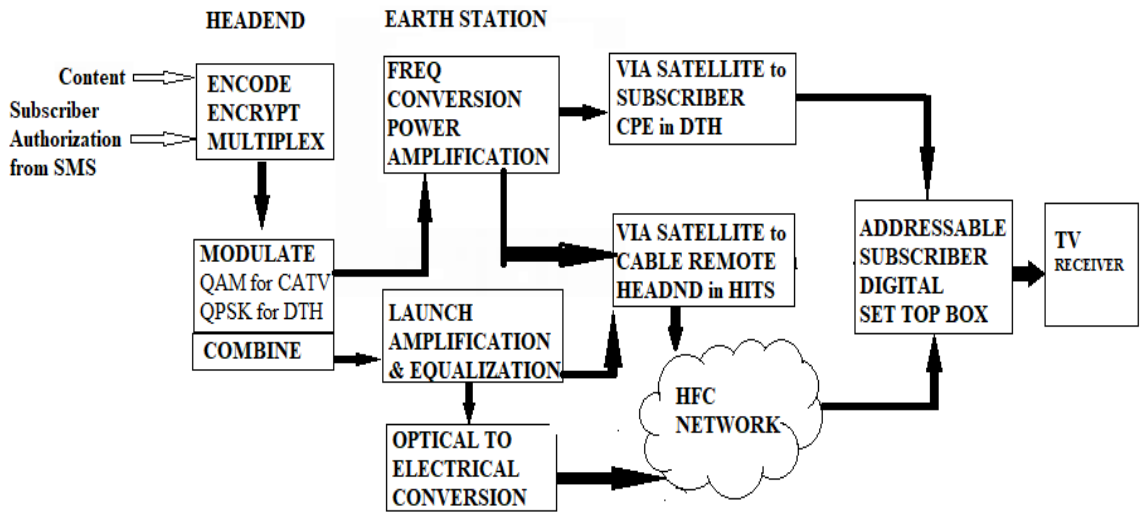
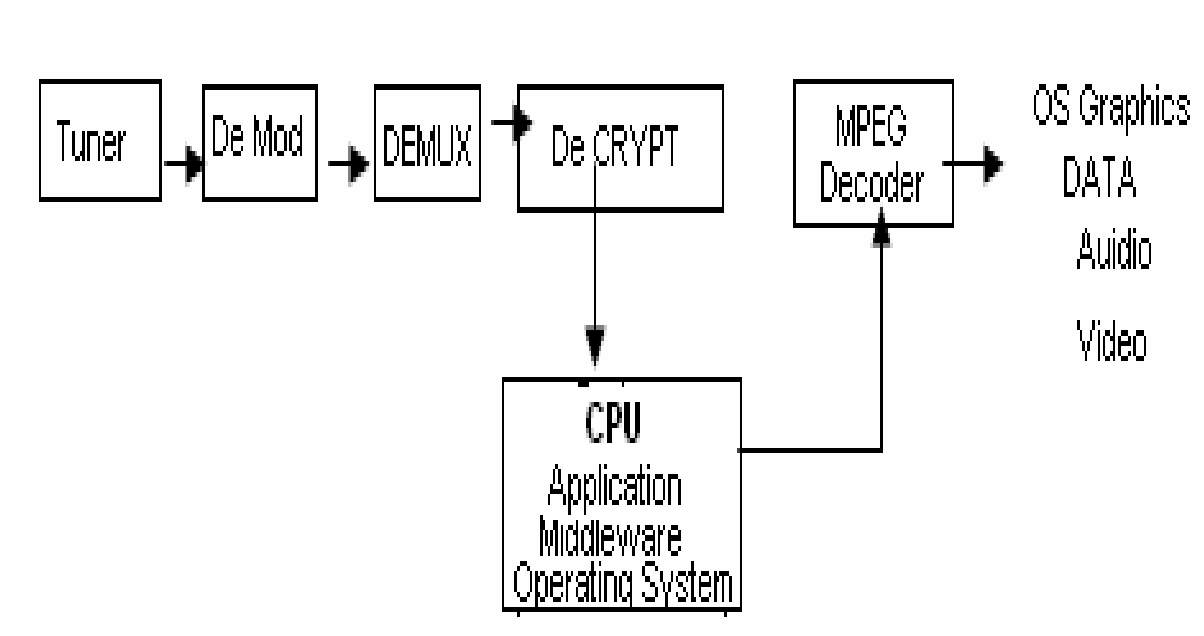


At the receiving end, the sequence, in that small STB is reversed (sequence of the actions undergone in the headend) as under:-



An operating system is the most important piece of software in a STB. An OS is a suite of programs which talks to the STB hardware and manages their functions such as scheduling

real time tasks, managing limited memory resources, etc. A STB OS is arranged in layers with each layer adding new capability. At the heart of any STB OS is the "**Kernel**" layer, which is stored in ROM. Once the STB is powered up, the kernel will be loaded first and remains in memory until the STB is powered down again. Typically the kernel is responsible for managing memory resources, real time applications and high-speed data transmission.

The kernel supports multi threading and multi tasking which allows a STB to execute different sections of a program and different programs simultaneously.

In addition to the kernel, a STB needs a 'loader' to enable the TV operator to upgrade 'resident applications' or download 'OS patches' to STB.

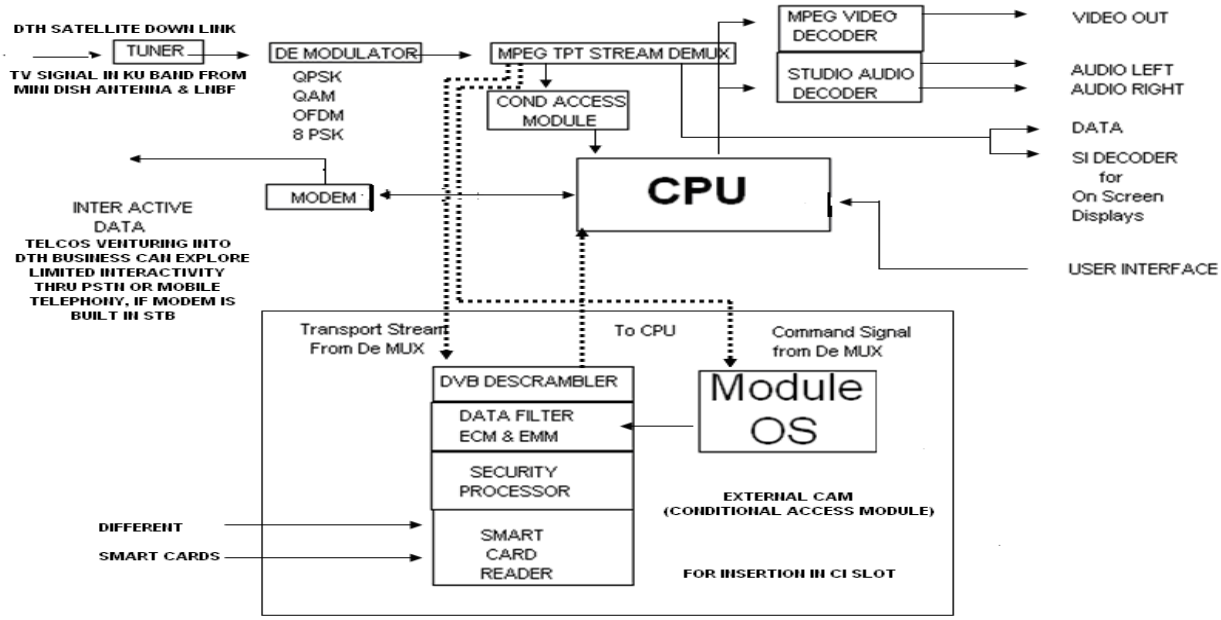
STB OS needs to incorporate a set of Application Programs Interfaces

(APIs) which are used by the programmers to write high-level applications for a specific API. AN API is basically a set of building blocks used by software developers to write programs that are specific to a particular STB OS environment.

A **resident application** is a program, or a number of programs, that are built into the memory of the STB. The STB also requires 'drivers' to control the various hardware devices. Every hardware component in the STB must have a driver.

A **driver** is a program that translates commands from the TV viewer to a format that is recognizable by the hardware device.

Middleware is a bridge between the OS and the 'subscriber applications' It represents the



COMMENTS ON TRAI CONSULTATION PAPER No 19/2019

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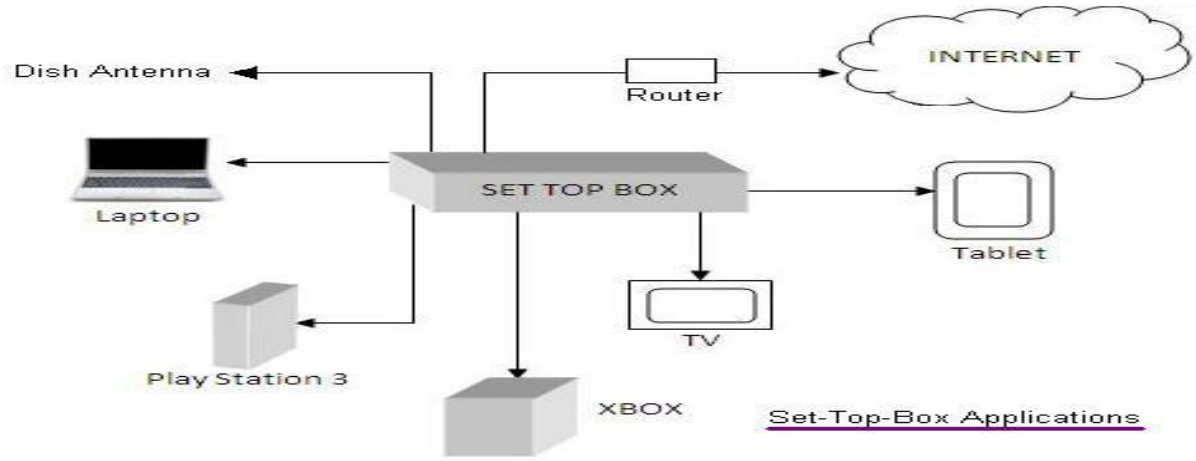
logical abstraction of the middle and upper layers of the communication software stack used in set top software and communication system. Middleware is used to isolate set top application programs from the details of the underlying hardware and network components.

The main function, that set-top boxes enable, is to provide subscriber management based viewing functions. Pay TV content is normally encrypted or scrambled to stop customers getting all content for free. The STB device decrypts the content it receives against 'entitlements' from the headend operator, based on the customer's choice and subscriptions.

A bonus function that STBs provide to operators is managing the order and appearance of the programme guide. This adds significant value to programs for their position in the programme guide (and/or channel number). Interactivity and value added services are also sale-able features.

It may be noted that DVB Conditional Access (DVB-CA) ensures authorized viewing and content protection for programs during transport in a network. It does NOT guarantee protection after scrambling in the STB except by way of binding terms and conditions. There are anti-piracy safeguards practiced by way of terms and conditions in provision of services and consequences on detection of piracy.

Set top boxes are used for not one but for many applications. Its functionality includes digital satellite receiver, digital cable receiver, digital terrestrial receiver and digital IP TV. As shown in figure next generation set top boxes can be connected with many home devices/equipments such as tablet, PS3 play station, laptop, TV, XBOX video game console unit and so on.



COMMENTS ON TRAI CONSULTATION PAPER No 19/2019

ON INTEROPERABILITY OF SET TOP BOX (STB)

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Typical connectorization at back panel of Set Top Box

Following set top box connectors would exist on every STB :-

- input with 75 ohm connector of female typeOutput video 1 x RCA type
- Output audio 2 x RCA type
- RF output, 75 Ohm male connector
- USB port

- SCART connector for OS updates etc

STBs support, by design and manufacture, DVB-S, DVB –C or DVB-T Systems

• QPSK or QAM or 8 PSK modulation
• C/N ratio and symbol rate is compliant to DVB-S. DVB-C or DVB-T standards
• Input level per carrier is about -65dBm(Min) and -25dBm(Max)
• supports PAL-B for VHF and PAL-G for UHF in the modulation
• may support RF output channel as VHF 3/4 OR Agile/UHF for TV sets without AV output or for recording on domestic devices.

Indian standards exist for STBs for CATV, DTH and IPTV.

Millions of STBs have been paid for and deployed in India in viewer homes. They use proprietary encryption algorithm (Common Scrambling Algorithm) as per DVB standards. Rightly so, because PAY TV broadcasters do not want people to access their content easily and defeat their purpose of making their content viewing against payments.

Most STBs have CAS embedded in the processor chip soldered on the circuit board inside the STB. That means that STB will work only with those transport streams which have used encryption compatible with what is embedded. Provision was made to provide a common interface (CI)slot for inserting a common access module should the subscribe want to change the service provider for DTH STBs. However this has been violated by DTH service providers in India.

Thus, if a subscriber wishes to change the service provider, the STB too has to be changed since conditional access encryptions may not be NOT interoperable to descramble the content for viewing.

Interoperability

A STB is said to be **interoperable** if it can receive any video distribution service from any other service provider also. It is possible to have such an interoperable STB. By design an inter-operable STB can be configured to access video from any source (CATV, DTH, DTT or TVoIP) with higher costs and establishment of facilitation centres to achieve the same. It may not be as simple as buying a mobile hand set and just inserting a SIM card for it to enable viewing.

TRAI had, earlier, envisaged commercial inter-operability, wherein service provider was expected to provide STB against a non-interest bearing refundable security deposit to be refunded, if STB was returned in working condition. Use of STB was to be charged on a rental basis. This would have enabled a subscriber migrating from one service provider to another by returning the STB from existing service provider, taking the refund of security deposit, taking another STB from the new service provider on similar terms and avail service.

Without detailed knowledge of the preceding details, many people have resorted to **comparison with mobile handsets,** wherein one can buy any handset, insert a SIM card of any other service provider and start using the service. This concept has been termed **'inter-operability'**.

Such wishes, perhaps, overlooked :-

(a) Mobile telephony is provided by TELCOS who only render connectivity and not content security.(b) TELCO services are from one point to another and session based. The service is charged on usage basis.

(b) TELCOS basically provide voice and data communication which does not envisage piracy because such a content has no business value.

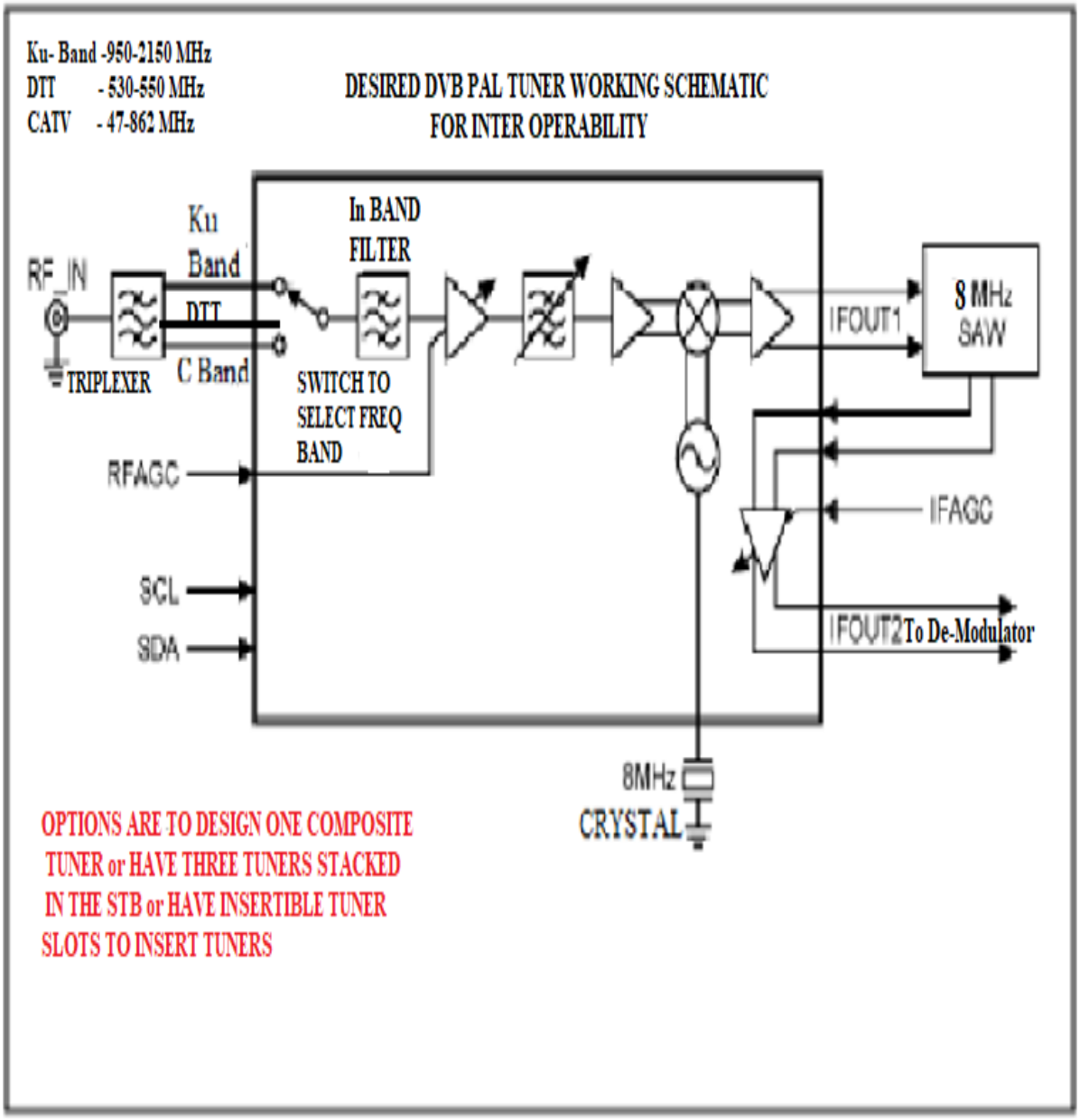
(c) In case of video delivery platforms, some content(PAY TV) is provided against payment. Hence it involves authorized viewing against charges to be levied and billed.

(d) STBs are like mini-computers, unlike hand sets which are simpler.

(e)TELCOs use one frequency brand for transmission whereas video DPOs use different Radio Frequency bands to which the tuner in the STB has to be compatible.

Let us examine the circuitary required to impart inter-operability.

Tuner



COMMENTS ON TRAI CONSULTATION PAPER No 19/2019

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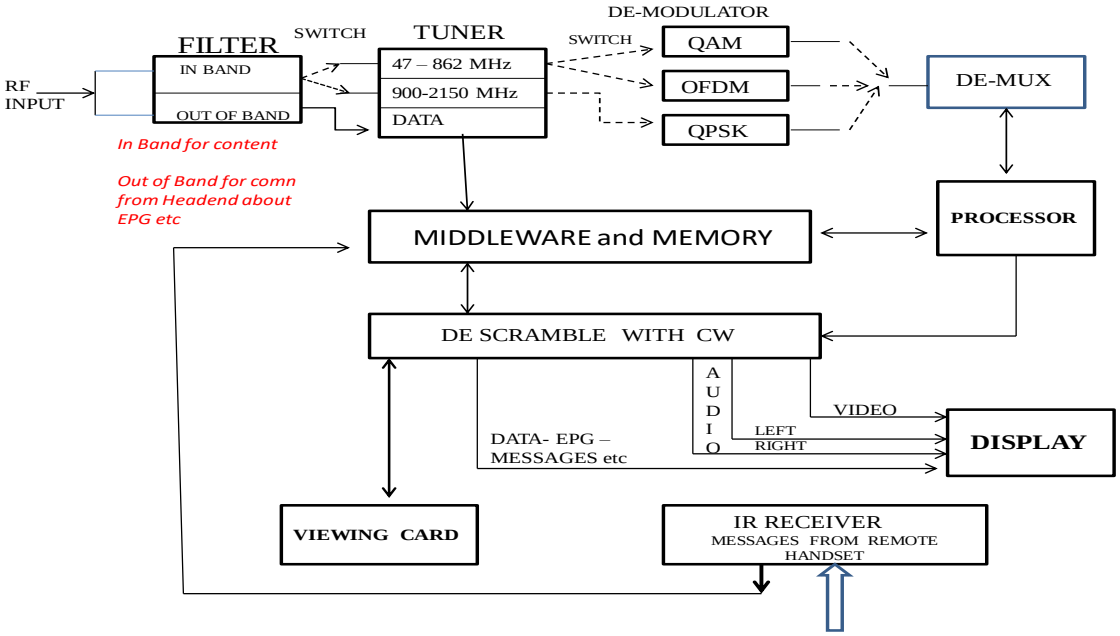
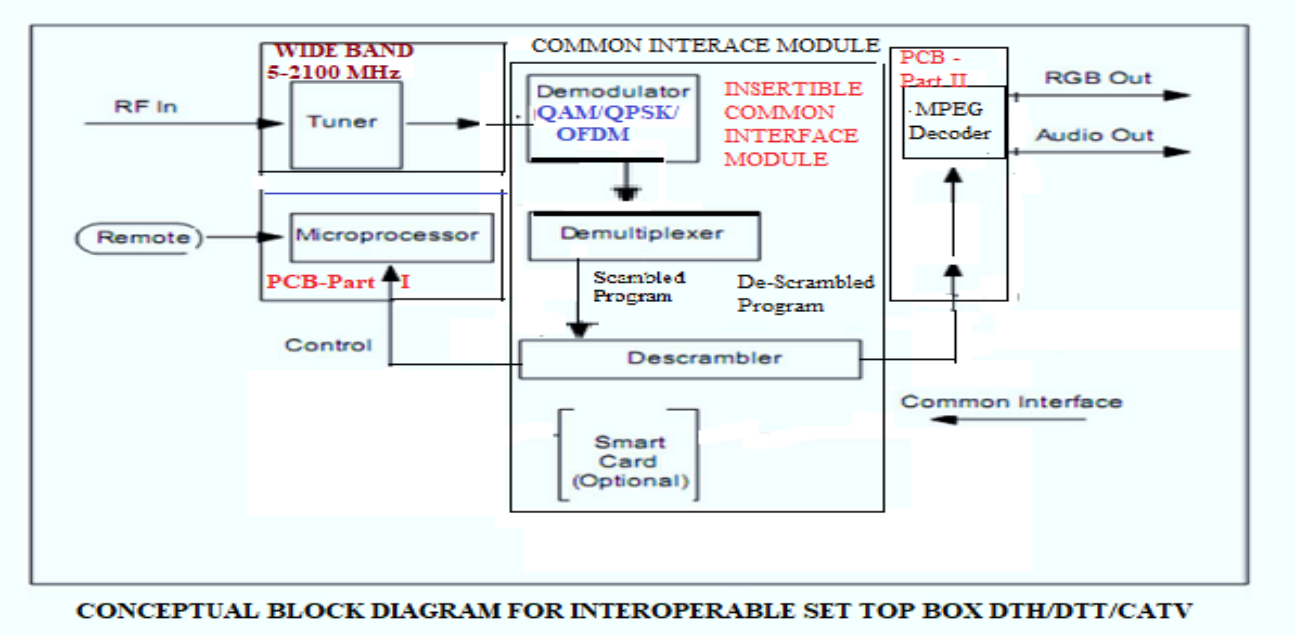
Demodulator to address different modulations used in services (CATV, DTH and DTT)



The wished inter-operability concept may also work, if configured, as under :-



CONCEPTUAL BLOCK DIAGRAM FOR INTEROPERABLE SET TOP BOX DTH/DTT/CATV

COMMENTS ON TRAI CONSULTATION PAPER No 19/2019

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In the above configuration, PCBs part I and II will be integral to STB but tuner and demodulator shall have to be insertible.

Tuner receives all content enveloped in the input frequency range from the wireless or wireline medium, demodulates the channel selected in the remote handset, feeding all programs compressed into that RF channel. If a wide-band tuner, 5-2100 MHz, is developed, it can be permanently mounted inside the STB.

PCBs Part I and Part II can be fixed in the STB, Common Interface Module for different CAS algorithms, can be inserted into slots prepared.

But these changes would not be feasible at hands of users. Such conversions/adaptations will be feasible at service centres or by trained visiting technicians.

Another issue will pose problem of disposal of replaced parts or compensation therefor...

Since TELCOs are also entering DTH business, their STBs may also contain some form of modem to allow it to send and receive interactive data through POTS or connecting mobile telephones

Open Architecture

Interoperability implies open architecture.

Architecture can be considered to be **"Open"** if the functionality of each and every block in that architecture is available in the public domain in the form of published design descriptions or recognized standards. The technique could be regarded "Open" if the IPR (Intellectual Property Rights) and the technical information needed to implement, compliant products is available under fair, reasonable and non-discriminatory (FRND) terms. IPR holders are generally required to accept the FRND terms set by the recognized international bodies.

Answers to Questions in the Consultation Paper

Q1. In view of the implications of non-interoperability, is it desirable to have inter-operability of STBs? Please provide reasoning for your comment.

The two terms have implications in terms of feasibility, availability and affordability. This talk of inter-operability stems from un-informed mindsets comparing a content predominant service with one (data + voice) where content/security protection is of no concern.

Technically inter-operable box can be constructed in a hobbyist domain. But its cost will rise at least three times, if the preceding text is read and understood.

Availability will emerge if the need felt is acute and unavoidable.

Affordability, the decision making trait, in the price conscious Indian market is NOT likely to be in favour.

Q2. Looking at the similar structure of STB in cable and DTH segment, with difference only in the channel modulation and frequency range,would it be
desirable to have universal interoperability i.e. same STB to be usable on both DTH or Cable platform? Or should there be a policy/regulation to implement interoperability only within a

platform, i.e. within the DTH network and within the Cable TV segment? Please provide your comment with detailed justifications.

If interoperability within a platform was desired separately in DTH segment, the enforcement mechanism should have prosecuted service providers seeding boxes without mandated Common Interface(CI)slot in their STBs, as laid down in the Indian Standards.

For the Cable Platform CI slot can be mandated now, or else commercial interoperability adopted through Regulations.

Q3. Should interoperable STBs be made available through open market only to exploit benefits of commoditization of the device? Please elaborate.

Yes ! If interoperability is enforced with insertible tuners, Conditional Access Module and demodulators.

Q4. Do you think that introducing STB interoperability is absolutely necessary with a view to reduce environmental impact caused by e-waste generated by non-interoperability of STBs?

No

Q5. Is non-interoperability of STBs proving to be a hindrance in perfect competition in distribution of broadcasting services? Give your comments with justification.

No ! millions of STBs are already deployed. These devices are an interface with the domestic TV receiver and hence to be used in static configuration. Residential group viewing environment does not dictate need for inter-operability.

The situation may arise, in case of DTH subscriber re-locating residence with STB without the CI slot, because proximity service representative like a cable operator is non-existent. It involves transportation to new location, calling a technician to install and restore service. If such a location is in remote area, facility may not be available.

For Cable TV, such migration was not envisaged. CATV STBs do not have a CI slot by mandate.. In any case CATV subscriber relocating and approaching cable operator in new location is likely to get service without hassles.

Hence lack of inter-operability is NOT considered a hindrance in distribution.

A simple solution to overcome all issues related with this topic is to mandate provision of CPE by DPO against a refundable non-interest bearing security deposit to be encashed when retuning the CPE in working condition. This in simple terms is commercial interoperability.

Q6. How interoperability of STBs can be implemented in Indian markets in view of the discussion in Chapter III? Are there any software based solution(s) that can enable interoperability without compromising content security? If yes, please provide details.

COMMENTS ON TRAI CONSULTATION PAPER No 19/2019

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Contents of chapter III do not seem feasible at hands of common man being able to use the CPE by just inserting a SIM card like practice for Mobile handsets. Not many viewers want interoperability at additional costs and hassles.

Q7. Please comment on the timelines for the development of eco-system to deploy interoperable STBs for your recommended/ suggested solution.

First of all feasibility trials have to be conducted. Next standards have to be drafted for manufacturers to undertake such an initiative. Then production, marketing and service environment shall have to be established. This may take 3-5 years..

Q8. Do you agree that software-based solutions to provide interoperability of STBs would be more efficient, reduce cost of STB, adaptable and easy to implement than the hardware-based solutions? If so, do you agree ETSI GS ECI 001 (01-06) standards can be adopted as an option for STB interoperability? Give your comments with reasons and justifications.

No !

Q9. Given that most of the STB interoperability solutions become feasible through a common agency defined as Trusted Authority, please suggest the structure of the Trusted Authority. Should the trusted authority be an Industry led body or a statutory agency to carry out the mandate? Provide detailed comments/ suggestion on the certification procedure?

Common agency may lead to monopoly and is not desirable in prevalent environment in the country.

Q10. What precaution should be taken at planning stage to smoothly adopt solution for interoperability of STBs in Indian market? Do you envisage a need for trial run/pilot deployment? If so, kindly provide detailed comments.

Being misled by some myth, like comparison with SIM card based similarity in Mobile Handsets environment, it appears that the Authority wants to proceed with un-implementable endeavour. Should that be so, both possible pilots(with stacked tuners and de-modulators and CI Module and the other one with insertible tuner, demodulator and CA Module) should be got assembled and market tested. This will be particular focus on ease of execution

Q11. Interoperability is expected to commoditize STBs. Do you agree that introducing white label STB will create more competitions and enhance service offerings from operator? As such, in your opinion what cost reductions do you foresee by implementation of interoperability of STBs?

White lable STBs sound attractive. How will these be customized on change of service providers at the viewer end? Interoperable STBs will only add to cost for provision of flexibility. No cost reduction is foreseen.

Q.12 Is there any way by which interoperability of set-top box can be implemented for existing set top boxes also? Give your suggestions with justification including technical and commercial methodology?

Simple !

Lt Col VC Khare (Retd) Cable TV industry Observer

Just get encryption requirement repealed in DAS. Just use digitization to increase the volume handling capacity of networks ar satellite transponders to provide eye-ball access for several broadcasters granted downlink permissions and registration with MIB. Then the STBs will remain addressable to act only as D2A converters.

Q13. Any other issues which you may like to raise related to interoperability of STBs.

Mandating wishful thinking through gazette notifications seems easy.

Where is the enforcement mechanism with the Authority ?

CI slot for DTH STBs is mandated. This is grossly violated by existing DTH Service providers and is admitted as a fact by the Authority too. But has any service provider been prosecuted ? If such is the past, with envisaged inter-operability in that sector, how can endeavour under consultation be expected to succeed ?