INTEROPERABILITY OF SET TOP BOX (STB)

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1. This writeup addresses 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.

2. A little bit of recapitulation is required to understand 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.

3. 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 recipient 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.

4. This is like kindergarten level understanding of addressable broadcast technology under which CATV networks operate.

5. Similarly, in the headend, content is processed, encoded along with decoding instructions, enclosed, i.e. enveloped, in the carrier and pushed into distribution platform.
6. 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.

7. Headends essentially involve content aggregation. Most widely used example is CATV and is depicted as under:-
8. Various entities in Television Video Distribution Platforms are as under:-

Broadcasters (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 channels in 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.
9. 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.

10. 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).

11. 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) decryption to make viewing of encoded program possible by those authorized to view that program.

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

13. Briefly what is involved in encryption and decryption is as under:
14. **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.

15. 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.

16. 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.

17. 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.

18. 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**

19. 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.
20. At the receiving end, the sequence, in that small STB is reversed (sequence of the actions undergone in the headend) as under:-

21. 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.
22. The kernel supports multi threading and multi tasking which allows a STB to execute different sections of a program and different programs simultaneously.

23. 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.

24. 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.

25. 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.

26. 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 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.

27. 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.

28. 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.
29. 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.

30. 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.

31. 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 type
- Output 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

32. 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.

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

34. 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.

35. 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 subscriber want to change the service provider for DTH STBs. However this has been violated by DTH service providers in India.

36. 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

37. 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.

38. 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.

39. 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 ‘interoperability’.

40. 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.

41. Let us examine the circuitry required to impart inter-operability.

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

43. The wished interoperability concept may also work, if configured, as under:-
44. In the above configuration, PCBs part I and II will be integral to STB but tuner and demodulator shall have to be insertible.

45. 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.

46. 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.

47. 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.

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

49. 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**

50. 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.

**Conclusion**

51. Readers of this article would, if understanding various aspects, conclude if desired interoperability is feasible in ‘SASTA aur CHALTAU’ mindset of Indian CATV viewer as well as service providers.