



## Study Paper on

# Interoperable Set-top-boxes: The Future

### Abstract

#### Background:

Mobiles phones have shown how true freedom for users can be provided through some basic interoperability principles. A mobile user today is able to choose from a range of hand-sets from various manufacturers to suit his taste and budget. He is able to register the handset with any Mobile Service Provider and then roam through-out the world. Today, he can also avail of the “Number Portability” whenever he switches over to a different service provider.

Unlike the mobile phones, the Set-top-boxes (STB) for TVs which started much before the Mobile era are still facing the problem of incompatibility. Every service provider has to give a proprietary box for availing his limited garden-walled services. As the service provider has to bear the upfront cost, he does not hesitate to provide the lowest cost box. Moreover, he has to lock the user in a service plan whereby he can recover the cost of the box over a year or two.

#### The Interoperability phenomenon:

The STB users need to taste the freedom of the mobile phones .What they really need is interoperable STBs (iSTB). With the availability of these STBs in the market, a user can choose a feature loaded iSTB of his/her choice from the market to be used with his new LCD TV. Like all the new age devices, an iSTB will also be an “internet device”. A user can simply plug his new iSTB into an internet connection and access the website of a national “Content Service Provider”. He can then instantly register his iSTB with the Content Service Provider (iCSP) over internet itself. Since the services will be offered on a prepaid basis, he can make the advance payment through the Payment Gateway on the web-site. Alternative modes of payment by the users can also be explored in the interest of the subscribers. The iCSP will provide the user with a unique iSTB-ID which like the Mobile Phone number will allow communication between the iSTBs and other systems across the interoperable Content delivery Network (iCDN). This iSTB-ID can now continue even when the user switches to another iCSP, ensuring continuity of video-mails, video-conference, VoIP calls etc.

Market forces shall, indeed, revolutionize tomorrow's mobile phones with iSTBs integrated in them, proving an ultimate multi-tasking interoperable device, a mobile user can dream of. This mobile iSTB will allow a user to preview any video while on the move in LD (Low Density) resolution over the Next Generation Networks (NGN) . He can even dock his iSTB with any normal SDTV (Standard Definition TV) or HDTV (High Definition TV) to enjoy videos of theatre like quality.

The iSTB will bring about ecology of interoperable players much like the ecology of internet. Like the mobiles (which connect to nearest base-stations), the iSTB will always connect to the nearest interoperable Head-ends (iHE) for accessing the Universal contents. There will be a range of Content and Channel Aggregators who will provide their contents and channels to the iHEs.

A Content Service Provider would be billing all the registered STBs by collecting their daily usage logs. He would be responsible for passing the amount collected from the iSTBs to the designated Revenue Distributor of a region. The Revenue Distributor (iRD) would essentially be a bank which would keep accounts of all the players of this ecology. Every month it will automatically transfer the revenue shares to each ecology player based on the pre-agreed percentages.

The ISTBs will dramatically change the evolution path of the STBs and bring about an incredible paradigm in IPTV service in line with the NGN evolution.

## **The Universal Content Paradigm**

In the interoperability age, "Universal Contents" will reign supreme. These will represent the heritage of each language spoken across the globe and will be preserved for generations to come. The Universal Contents will also include videos, songs; TV shows etc. which were popular when they were introduced and which would be of great interest to people in future too.

Each Content Aggregator will be responsible for aggregating these contents with value additions (such as subtitles, synopsis) so that they can be appreciated by a larger audience. The Content Aggregators will preserve the same in an encrypted form and give the encrypted key to the requesting iSTBs such that only that iSTB can decrypt the content. The public-private key security associated with contents will ensure that although the contents can be distributed in any manner, the decoding can be done only by the authorized iSTBs.

The iSTB can download these Universal contents from any interoperable Head-end through wireline and wireless medium. The Universal contents will thus be truly ubiquitous and available on Anytime, Anywhere basis. The same will be available in LD, SD and HD versions to suite the playing requirements of mobile devices as well as normal or High-Definition TVs. So, a user cans now catch-up on a movie from where he

was viewing at his home, while in a flight or in a Hotel. He can carry his portable iSTB (which indeed could be part of his mobile).

The user never has to ever “own” content. He will just pay the monthly Library fees for Video and Audio contents and access as many titles as he wants. Of course, there will be prime Pay contents which he can use for few days at a time by paying a separate fee.

## **One iSTB for multi-purposes**

Like the ubiquitous PC, the iSTB will become network agnostic. The same Universal contents can be accessed irrespective of the networks which the iSTB is connected to. Like the PC, only an appropriate “network adaptor” may be needed for connecting to a specific network. Alternatively, the iSTBs can be equipped with different plug-in modules supporting different interfaces. The iSTB can be connected to several networks at the same time and thus be able to access contents simultaneously from several Head-ends.

In today’s world, a user would like to have a single device connected to his TV and avoid the mess of multiple devices with multiple cables and multiple remotes. A single iSTB should obviate other devices for Music, Radio, DVD, Games etc. A common user-interface controllable through a single remote would give the much sought relief.

Like the PC, the iSTB should be able to operate even in a stand-alone way without being connected to any network. The user should always be able to play the audio/video contents stored in the internal mass storage of the iSTB. Apart from this, he should be able to play the contents stored/archived in externally attached USB/SATA drives. The iSTB should also function as a DVD player with the attachment of a DVD drive.

It shall be possible to use the iSTB even in remotest places across the globe with the weakest of intermittent internet connection. The internet connection, even if it is of low speed and unreliable, would be helpful in intermittently conveying the usage records to the Content Service Provider. The internet connection would also be required for fetching of the “keys” required for decryption the Universal Contents most of which will always be in the encrypted state. Once the keys are fetched, it would be possible to play the content even without using an internet connection. The iSTB will provide up to 24 hours of “play-time” even without depositing of the usage log. This flexibility will allow iSTB to be used on-the-move, with wireless internet connectivity available sporadically.

It will be now possible for a user to buy DVDs at rock bottom prices from road-side vendors with a selection from all the popular titles in the Universal Contents. For playing these encrypted contents, an iSTB will have to fetch the corresponding “key” through the CSP. Accounting will occur in the iSTB for each playing of these Universal Contents. Thus a Content Aggregator will earn more revenues with his contents being freely distributed through DVD duplicators and users copying them through their USB sticks.

iSTB will always be provided with an Ethernet port allowing connection to an internet, and broadband networks of different Head-ends through ADSL modems.. The Ethernet port can be used with a Cable-modem for fetching contents over the coaxial cable and also for connections to Fibre-to-kerb or Fibre-to-home networks, providing upto 100 Mbits bandwidth from the Head-end. An iSTB can also be connected to a wireless networks such as WiFi or WiMax through a modem connected to its USB or Ethernet port. As the iSTB can be simultaneously connected to more than one Head-end, seamless roaming would be possible between wireless networks.

Besides this, an iSTB can be simultaneously connected to one or more traditional broadcast medium using add-on tuners. By adding a DVB-C tuner, it will be able to get digital channels from a coaxial cable. Similarly, with a DVB-S and DVB-T tuner, it will be able to get digital channels from a satellite and terrestrial transmission respectively. Using DVB-H tuner, it will be able to get LD resolution channels for mobile applications. The TV channels can be got through even an existing service provider by using his Conditional Access system for decrypting the channels (either with a DVB-CI, or a soft-client).

Even in remote areas with weak, unreliable internet connection it will be possible for an iSTB to get channel related contents. The encrypted channels would require fetching of the decryption keys as and when required. Thus, the Content Service provider will be able to account for the usage of all the channels, and even the specially designated Pay Programs within it.

In these remote areas, it is even possible to request contents to be delivered through the broadcast medium itself. The request would be sent by an iSTB to the Broadcast Head-end over the internet connection. The requested contents will be queued up by the broadcast head-end on a priority basis for simultaneous delivery to all the requesting users. Repeated broadcasts can be done for the same contents to eliminate all the errors which might occur in reception.

Thus, a first-day-first-show movie (a Pay Content) can be delivered to all the iSTBs, even those in the remotest areas. Now each member of a family can have the convenience of watching the same at their convenience within the allotted days for viewing. It will be possible for the same movie to be seen in HD or SD resolution depending on the TV. This will then constitute the biggest box-office in which on the very opening day itself, a producer may be able to get back an appreciable cost of the movie.

## **Ease in Sharing of Contents**

The iSTB ecology segregates content charging from content distribution. In fact, it allows the contents to be charged in a uniform way, irrespective of the manner in which it was collected. The charging happens only when the content is played, and is proportional to the viewing time, for Library contents. A Pay content will get charged for when it gets

viewed for the first time in an iSTB. The Pay content will get charged again (according to the rate prevailing at that time) once the rental period is over upon its replay.

A user can now collect contents of his choice from various iSTBs in his USB stick for playing with his iSTB. Before playing the, iSTB will fetch new keys for all the new contents and will account for them subsequently in the normal manner.

Like a PVR, iSTB will allow channels to be recorded in an external storage. However, unlike a PVR, these recording will remain encrypted. The encrypted keys for the programs are stored along with the contents so that the same can be played back on the same iSTB without requiring re-fetching of the keys. This provides a guarantee against the unlikely event of the keys for the archived channel program being discarded by a Channel Aggregator.

A user can now transfer a Universal content or a clip to another iSTB, through an email or even a SMS, since all that needs to be sent is just the ID of the content, and the start and end timing. The receiving STB will fetch the Universal content from its Head-end and play only the specified section of the content. In case the desired content is not available on a Head-end, the same will get fetched from the sending iSTB. Thus people can freely send their viewing recommendations to each other. These, however, will be fetched and charged only when a receiving person decides to view them.

## **Future Proof Features**

An iSTB would allow the user to have a unified common way of handling all contents and channels. Like the PCs, the iSTBs will have a common human-interface with interoperable remotes so that a user will feel at home with any iSTB. Unlike PCs, however, an iSTB will be “grandma friendly”. It will follow the philosophy of “keeping simple things simple and tough possible”. Needless to say simple features of TV browsing, video playing etc. will not be compromised for the sake of more versatile features.

iSTB will allow VCR features to be used while playing any content including channels. Thus, it will be possible to Pause a Live channel and even Rewind through it. Any video can be played in slow motion and even stepped through frame-by-frame. Thus, instant slow-motion replays can be created in live channels. It would even be possible to shuttle between two Live channels, such that one doesn't miss out any portion of interest while fast forwarding through the rest.

The iSTB will provide a flexible configuration option whereby he can set the primary and secondary language he is interested in. Channels and contents corresponding to only these languages will be shown to avoid the clutter. The user will also be able to configure the Censorship level such that content belonging to stricter censoring will not be displayed.

An iSTB will also provide a slot for temporary insertion of a Smart Card. This Smart Card can be a credit card for making Payments or a Citizen Card for authentication of a user and secure logins.

Although iSTB will initially handle the Universal Audio and Video contents, it need not be restricted to it. iSTB can handle the Web Audio and Video contents through a web-browser in a manner akin to the PC. The iSTB can also act as a “Media Organizer” allowing a user to organize his personal contents in one place. iSTB will also be able to handle other types of contents such as Electronic Books and Video Games and provide them on a Pay or Library basis.

## **A new Channel Paradigm**

Channels will also be part of Universal Contents, and their programs would be available on Anytime, Anywhere basis. Like the Content Aggregators, the Channel Aggregators will release their channels in an encrypted form to all the Head-ends. They will give the encrypted keys for decrypting these channels, separately to each iSTB. The encrypted keys will allow only the specific iSTB to decode the channels. The Channel Aggregator will be changing the keys everyday for ultimate security. The user, however, will not be inconvenienced during channel browsing, as the iSTB will automatically fetch the key every-day in advance in accordance with the configured settings.

Billing of Channels will occur based on the actual viewing, rather than fetching of channel data or keys as done in the case of other Universal contents.. The Channel Aggregator can designate a channel to be a Pay channel or a Library Channel. A user will not have to worry about deciding which Pay channels to activate every month (a Herculean task). He can browse through all the channels as per his convenience with a Pay channel being charged for the month, only if he watches it for more than a few minutes at a time. The Library channels will share the Library fees in proportion to their viewing time.

Electronic Program Guide (iEPG) would perhaps be the most versatile feature of the iSTB in allowing unparalleled control in viewing of channel programs. These versatile iEPGs will be fetched as content (XML) from the Head-end Servers and would be kept timely updated. The EPGs will be available for separate channels and even for separate categories of programs such as movies, talk-shows, reality-shows, soap-operas, science programs etc. Thus a person will be well informed about all the shows of his interest displayed channel wise.

A user will be able to browse through upcoming programs for at least a week ahead. He will get enough further information on any program through clickable multimedia information and links to web-site contents. He can then choose to have any upcoming program recorded by just clicking on it. He would never have to worry about any potential timing clash or power failure preventing the recordings. The iSTB will use the Net PVR features of the iHead-end transparently in order to guarantee proper recordings.

A user perhaps will not bother about the forthcoming programs as he will now be able to travel backwards in the EPG and click on any program as if it was a Video-on-Demand program. This would be possible through the Time-shift-TV (TSTV) feature of the Head-end, whereby recordings for each channel would be available for at least a week back. While watching a TSTV program the user will be able to fast forward which couldn't have been done if the program was watched live. It sounds more appropriate to say that majority of people will watch live channels for actual live events such as sports, news etc. and like to catch up with other programs as and when they have time. The Prime time problem will thus disappear.

The attractive TSTV feature will be remunerative for the channels too as they will share an extra TSTV Library fee on the basis of time percentage viewing of their programs.

Channels will be able to earn more by designating any special program as a Pay program in the iEPG. This will then require the user to consent to paying an extra amount if he chooses to watch the program. However, on a normal playing of the channel, the Pay program will simply blank out if the user does not give a separate consent thereby preventing excess billing.

Channel programs can now become "participative programs" through iVoting feature of the iSTBs. So now, in a live program, the host can ask the audience to rate the contestants by pressing a button on his computer. This will cause the voting trigger message to be sent via the Channel Aggregator to all the Head-ends and finally to all the iSTBs watching that channel. The iSTBs will then display a Voting dialog box for the specified voting duration. The user responses will be collected and collated by the Content Service Providers and then forwarded to the Channel Aggregator. The Channel Aggregator will further collate all the responses and forward the result to designated host so that he can announce the results immediately.

In the same manner, it would be possible for a channel to conduct an "Instant TRP". In this case the Instant TRP trigger will cause each of the iSTB displaying that channel, to send its information automatically without user intervention. This will become an ideal vehicle for judging a popularity of a program and deciding on the Spot Ad rates.

Like the "on-line voting" during a Live program, it is possible to conduct an "off-line voting" during a recorded program which would be telecast later. In this case, the trigger for voting would be embedded in the data of the channel itself. It will have the additional information of the expiry date of the voting. This would enable the iSTB to show the Voting dialog box whenever the program is played so long as the date has not expired. The collated votes are delivered to the Channel Aggregator who can then give the final results of the voting before the recording of the next episode of the program.

A small charge for each Vote will ensure seriousness of the users and give some more revenues to the concerned channel program. However, the channel will have to pay an agreed amount for conducting each Instant TRP. As such, daily TRPs and usage statistics

will be available from the Content Service Providers based on the daily usage Logs sent by the iSTBs.

The iSTB will have potentially hundreds to thousands of individual channels and contents in different categories. It would be too tedious for a user to browse through the entire list. This exercise will, however, be eliminated by allowing a user to dynamically see a filtered list by typing just a few letters in a manner similar to that of finding a name in the contact list of a mobile phone. The iSTB remote will facilitate searching through lists in different languages through a multilingual keypad either provided directly on the remote or on-the-screen. Unlike Google searches, a search string can consist of only few letters of a word with spaces marking the boundary of the words. This specially becomes very useful for multilingual typing where one may not be sure of the proper spelling of a word.

Needless to say, the above features will co-exist with other useful features such as VoIP telephony, Video Conferencing and streaming of Private Video Channels.

## **Ad Experience Redefined**

Spot Ads will no longer be troublesome intrusions during TV watching, forcing people to move to another channel. They will now be welcome, as they will now be targeted based on the interest of the iSTB user. The user can specify in his iSTB, the categories of Spot Ads he is interested within each of his selected languages. The Spot Ads will be filtered even based on the Censor ship level which he has selected. Despite this, if he gets some annoying ads, he can ban them from subsequent display.

The Spot Ads will be shown during the designated Ad interval in a channel. The iSTB will fit in randomly selected Spot Ads (conforming to the user selected categories) within the Ad interval in a seamless manner. A Channel Aggregator can indicate that he wouldn't like the embedded Ads in the Channel to be replaced during Live watching. This way, he can continue earning from the embedded Ads in the existing manner while earning extra amount when a recorded content gets played back with the targeted Spot Ads. In fact, a channel need not bother about embedding any Ad itself and just designate Ad intervals during its programs.

A user can allow the Spot Ads to be played during natural pauses such as that during fetching of a new content. He can also allow Spot Ads to be played with the sound muted by default during a pause in a video or during idling.

The Spot Ads will be in increments of 15 seconds, and normally up to a minute in length. They will be released by a Content Aggregator on behalf of the Advertiser. The Advertiser will have to pay in proportion to the actual viewings of the Spot Ads. The Content Aggregator can though monitor the usage of the Ads everyday and ask the Head-ends to stop the Spot Ad when it reaches its budget limit. The Content Aggregator can

also inject the Spot Ads only in the Head-ends catering to the audience the Spot Ad is interested in. The Spot Ads will be more effective for the Advertisers too.

A Spot Ad can always show a link to a Pull Ad. This Pull Ad will generally be a longer Ad, giving a comprehensive video demonstration of the product or an event. Thus, an interested user can go into as much depth of an advertisement as he is interested in. The links for Pull Ads can be embedded during playing of other contents/channels. They can also be part of the strip ads, accompanying a web-page. Thus the advertiser now has the means of separating the Push mechanism for catching user's attention from the comprehensive information needed by a user for decision making.

The Content Aggregator will again be responsible for releasing the Pull Ads in the manner of the Spot Ads. Unlike the Spot Ads, the charging on the Pull Ads will be based on just the size of the Ads and the number of iSTBs which have watched it, rather than number of viewings within each iSTB. Thus the Advertiser, wouldn't have to worry about a run-away budget in case users are viewing their Pull Ads for a long time for decision making.

The user can, of course, treat the Pull Ads as Universal Contents in their own rights and like the Yellow Pages, search for more information on the products or events he is interested in. No advertiser can now afford not to have the Pull Ad for any of his product. – he can, of course, save on the cost involved in demonstrating the product in the show-rooms.

## **Universal Content Locator (UCL)**

Like the Universal Resource Locator (URL) on the Internet, it now makes sense to have a Universal Content Locator (UCL) too, for all the Universal Contents. A UCL will show up as a clickable Hyperlink on a web-page, or documents. Unlike the URL, the UCL will identify only the Universal Content and not its location on any server. Unlike the URL, the UCL would also be usable for file naming providing tremendous convenience.

The UCL, will have a unique preamble at the beginning (“iC” for interoperable Contents), allowing it to be detected in any context by a browser (like the URL). It will then have a few letters depicting the type of contents: Video/Audio, Contents/Channels and Ads/Spot-Ads etc. It will then be followed by a unique numeric ID for the Content/Channel Aggregator and then by a three letter mnemonic of the primary language of the content and then the serial number of the content/channel.

In the case of a recorded program from a channel, there will be a date-time (GMT) and duration suffixed to the UCL of the Channel. This would uniquely define the portion of the channel to be played.

A user can now browse through movie reviews on the IMDB web-site and then click on a UCL hyper-link to watch the movie in full HD resolution. He can click on a UCL

mentioned on a social-website and immediately watch the referred Channel Program. He can use the Google search to get a listing of all the title of programs/movies featuring his favourite actors and then he can click on an embedded UCL to see the program (it could be a movie or a channel program).

A UCL will also have tags at the end (starting with a hyphen character), identifying some of the important attributes of the contents, which needs to be gleaned even before looking inside any of its file. These tags can be the Censorship tag, the Spot Ad category tag and a tag for indicating the non-encrypted content (by default they are encrypted). The serial number of content would be different for different prefixes but will not be affected by the tags, providing convenience in subsequent changing of the tags.

The UCL being a text-string compatible with the file naming conventions would allow the content to be conveniently copied on a disk, USB or a CD with the file name being the same as that of the UCL while the extension can be the same as that of the content such as .MPG, .264 or .MP3. The same UCL will be associated with more than one file with different extensions. The primary file will be the .XML file which will give information about all the other files which are present. It will also give information about the other related UCLs for the versions of the same content in other resolutions (LD/SD/HD). A “.KEY” will be used by an iSTB for keeping the encrypted key corresponding to an UCL.

For a long-time TV has been labeled as an “Idiot-box”. It indeed made a person scatter-minded with mindless surfing of channels. TV medium should not any longer be the opium for the masses. UCLs will bring about a new ecology of interoperable world-wide contents. The TV medium will now become the source of mental nourishment and wisdom.

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