MAPPING A COST EFFICIENT TRANSITION TO CONVERGED SERVICES: BUSINESS MODELING TOOLS AND OUTCOMES TO GUIDE A PATH TO IP VIDEO

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ARRIS

ABSTRACT

ARRIS has developed a comprehensive cable operator business modeling tool with over 300 input variables that can assist the operator in selecting a low risk, economical transition plan to an IP-enabled converged network. Through tailoring of the inputs and evaluating the various service, network and component choices along with review of their current competitors' offerings, operators can evaluate if they should;

- *First deploy reliable converged in home services or TV anywhere services*
- *Delay or accelerate their IPTV initiatives in response to market pressure*
- *Reclaim bandwidth with DTAs or deploy SDV*

In addition, the model can quantify effects of operational improvements from deploying a single network for all services and potential new revenue streams. The tradeoffs between sophisticated set top box deployments versus enabling increasing amounts of consumer-purchased equipment in their networks can also be evaluated. In a separate paper from ARRIS we will also be looking at the bandwidth transitions and traffic engineering associated with the support of all services during the transition to a converged services network.

INTRODUCTION

Operators today are faced with updating their service offering both in the quality of service and the diversity of service to meet the ever increasing competitive offers from Telco, Satellite and Over the top service providers. Cable Operators have been presented many options to achieve the endpoint of a robust network offering an attractive range of converged services. Each operator also has their own unique network built up over the years and faces unique local market dynamics in terms of competition and consumer expectations. This wide array of variables makes selecting the most economical path pure guess work in the absence of a modeling tool. A modeling tool can significantly reduce the range of variables by identifying the key variables and thereby improve the operators' decision process.

Background on Transition to IP Video Services

Multiple System Operators (MSOs) are beginning to plan and deploy architectures which will ultimately be used to expand the range of Video services delivered to their subscriber base to include video over IP to non-settop boxes within the home and eventually to all video devices. In general, subscribers will experience IP Video as a delivery system that permits them to steer video over their home IP network to any video-enabled device including: IP STBs, connected TVs, handheld devices (like smartphones or tablets), and PCs.

Why the IPTV Transition is Needed

The video entertainment marketplace is changing rapidly. The traditional business model of user content subscriptions combined with leased settop boxes augmented by local ad sales is facing competition. New entrants are competing for both user subscription fees and advertisers' dollars. New consumer electronic equipment such as connected TVs and tablets are changing the consumer's expectations for video services and potentially reducing the MSO's brand presence to just another app on the screen. The average consumer is beginning to explore new ways of accessing video content that only a few years ago were not available.

For CATV MSOs to retain their position as the premier way to access and experience the best video content, the traditional CATV network needs to change. The new devices sweeping the CE market support OTT (over the Top) internet providers at least as well if not better than the MSOs' services. The MSOs need to alter and augment their networks to deliver content to these new devices as well as find ways to expand the offerings they make available directly to compete with the offerings of telcos and satellite providers.

As ARRIS evaluated how to best to support the industry as it confronts these sweeping market changes, we found that the questions posed by this monumental shift in market and technology in the video industry touched many facets of planning and implementation. While most operators' networks share basic technologies and architectures, the actual networks implemented by each operator, and sometimes by each region within larger operators, vary widely. So, a solution evaluated from one set of starting assumptions could be completely invalid for another set of starting assumptions.

We also found that the range of possible transition paths was wide with proprietary and non-proprietary solutions being proposed. Some vendors suggested separate overlay networks, while others proposed transition strategies reshaping current networks in various ways.

Finally, the relative importance of various other factors, such as the coming availability of connected TVs for example, has been hotly debated because there was not a simple way to compare the various scenarios objectively and evaluate their relative merits.

GOALS OF THE MODEL

After analyzing the above problems, we decided to build a model that we could use internally and while working with our customers to efficiently evaluate and understand the tradeoffs between the many paths available to the industry.

The model's goals were:

- Provide a structured set of input factors that could be tailored to represent various network configurations including analog and digital channels, SDV if deployed, and DTAs if deployed;
- Evaluate a transition strategy to IP Video comparing different industry proposals with the default option of no significant change;
- Allow various options to be explored such as adoption of IP devices in lieu of standard STBs, or deployment of streaming solutions to generic IP devices such as tablets;
- Evaluate deployment of Network-based DVR and Network-based Time Shift Buffered TV;
- Allow costs to be calculated and compared for various options, including both capital estimates and operational costs estimates;
- Allow revenue estimations, including subscriptions, and ad revenues, that reflect the latest analysts' projections;

All of the above goals were a formidable set, so some simplifying assumptions were made.

- Operational expenses were at least partially calculated as a percentage of revenues
- Four scenarios were chosen as the most likely:
    - Transition from today directly to an All-IP network,

- Transition from today to an model with IP only in the home,
- Transition from today to mixed model that uses both MPEG and IP in the HFC network and IP in the home,
- and finally a scenario that leaves the current network in place and only adds incremental services over IP.

STRUCTURE OF MODEL

The model was implemented within Excel™ to take advantage of its portability to multiple computing platforms, and facilities for generating graphical output. The model was configured to accept a set of network starting conditions, and a set of assumptions about future network trends. An example of this part of the model is that it can accept a current channel lineup with analog, SD and HD channels delivered by broadcast and/or SDV. The user then selects the behavior of this channel lineup over the simulation period, i.e. will the analog channels decrease each year, will the SD channels increase or remain constant, similarly the HD channels.

	Y-Y Growt	Year 0	Year 1	Year 2
System Bandsplit		750/42	750/42	750/42
Analog Channels		70	70	70
Total Linear SD Program Streams	1%	365	369	373
Total Linear HD Program Streams	2%	200	204	209
Broadcast SD Program Streams	-10%	65	59	54
Broadcast HD Program Streams	-10%	30	27	25
SDV SD Programs		300	310	319
SDV HD Programs		170	177	184
SDV 3DHD Programs	5%	5	6	7

Figure 1 - Portion of Channel Lineup

Also set as inputs to the model are cost estimates for equipment and operations as well as revenue estimates from subscriptions and other sources, such as advertising.

The inputs described above were then applied to the set of scenarios listed above. Each scenario began with the same starting conditions and applied the specified growth curves. Within the model, network bandwidth was evaluated periodically as the growth curves played out and necessary node splits and frequency upgrades were added in to ensure that the scenario remained realistic.

The model provides graphs and charts to communicate the results. Results are generated for each scenario showing capital and operational investments as well as the network bandwidth allocation that is predicted by the model. The model also adds in the estimated revenue figures to reach an estimate of the free cash flow for each option.

IPTV Transition Scenarios Modeled

Four scenarios were selected for inclusion in the model:

- No Change,
- Hybrid Home,
- IP Transitional,
- All-IP.

For all scenarios there are some common parameters, such as the STB replacement rate. The STB replacement rate models the normal churn and breakage of subscriber devices and may also adjusted upwards to model a deliberate increase in STB upgrades to speed IP video. For the examples shown, a gradual replacement rate of 10% per year was used. To ensure fair comparisons, all scenarios also provide the same set of services such as VoD, and DVR, HSD and voice, as well as following the same set of service growth curves.

<u>No Change</u>

The No Change model assumes that the MSO does not actively pursue folding IP technology into their network. The STB replacement activity still runs, but new boxes only provide MPEG4 as an added capability.

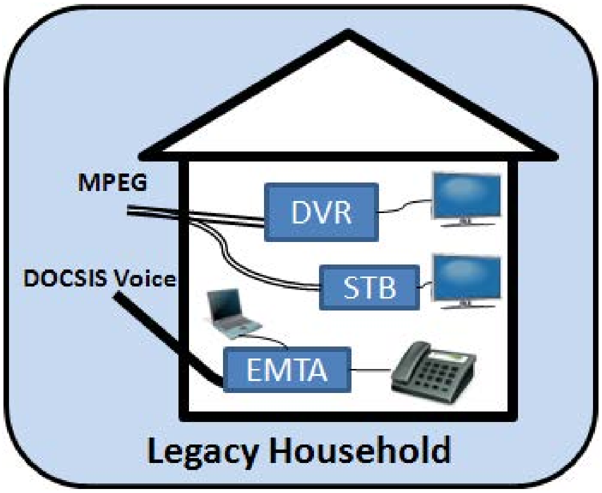


Figure 2 - Legacy Household

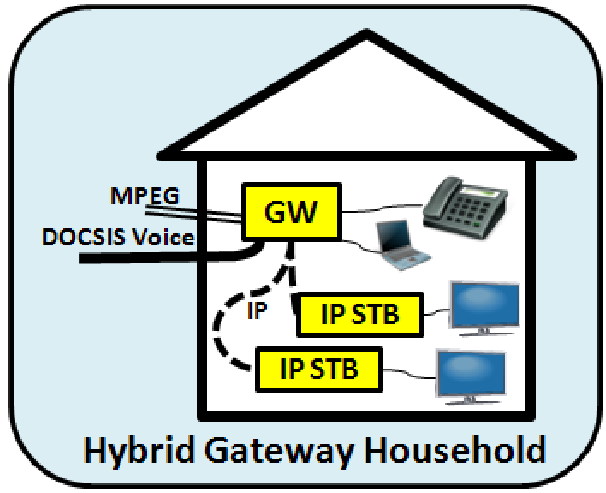


Figure 3 - Hybrid Gateway Household

The model assumes by default that some form of DVR is provided by at least one of the new boxes in the home – so one box is a higher price than the others. Alternatively, it can be set up to model a single type of box deployed in the home.

If SDV is enabled, the model evaluates the probability of simulcasting SDV programs in MPEG2 and MPEG4 and allows MPEG4 simulcast when the predicted channel usage is less for the mixed MPEG4 and MPEG2 program delivery than for video delivery using only MPEG2.

Hybrid Gateway

The Hybrid Gateway model assumes that old STBs are replaced with headless Media Gateways, not capable of directly feeding a television, and IP STBs, but no video traffic is placed over DOCSIS until the transition is complete. The model assumes that the Hybrid GW has a cable card, but no DRM expenses are included until the legacy units are all replaced and traffic moves to DOCSIS. The Media Gateway replaces the cable modem and/or EMTA for the household.

The Hybrid Gateway model also allows MPEG4 simulcast with SDV scenarios when it is more efficient.

IP Transitional

The IP Transitional Model assumes that STBs are replaced with headless Media Gateways and IP STBs. The Media GW also replaces the cable modem and/or EMTA. The Media GW is capable of accessing video program content from either DOCSIS or traditional MPEG channels. These units are deployed with CableCards, but are also capable of supporting IP DRMs. The model moves all Video on Demand traffic to DOCSIS using new CAS/DRM, but assumes that linear program delivery does not move to DOCSIS until the last of the legacy units are removed.

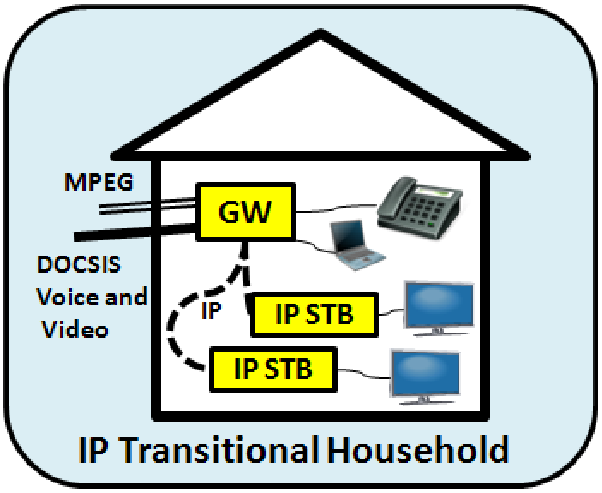


Figure 4 - IP Transitional Household

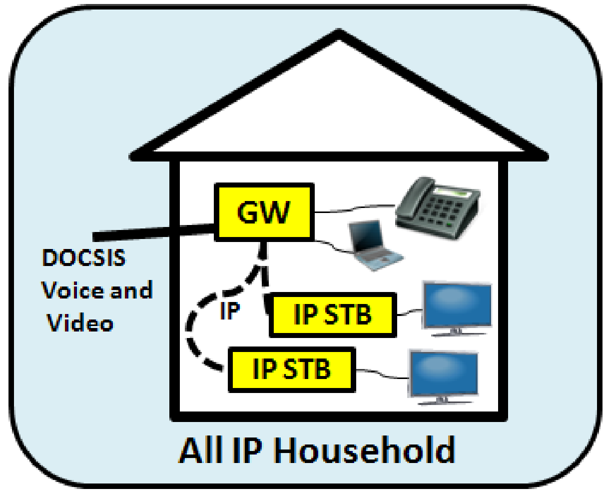


Figure 5 - All-IP Household

The model also assumes the opportunistic use of DOCSIS and MPEG4 when SDV is enabled. The model evaluates the probability of simulcasting SDV programs in MPEG2 and DOCSIS/MPEG4 and allows DOCSIS/MPEG4 simulcast with MPEG2 when the predicted channel usage is less for the mixed MPEG4 and MPEG2 program delivery than for video delivery using only MPEG2.

All-IP

The All-IP model assumes that as STBs are replaced, the MSO provides a new IP Gateway and IP STBs for that household. The IP Gateway is assumed to be headless, not capable of directly feeding a television, and providing HSD and telephone service. The IP GW also replaces the cable modem and EMTA in the household.

All video distribution to All-IP households is over DOCSIS bonded channels. The model assumes that the modem in the GW is capable of handling a large enough bonding group for good bandwidth efficiency. For most simulations, the video bonding group was found to require less than 14 channels. Video on Demand is assumed to be sent unicast, while linear channel viewing that is not N-DVR (Network Digital Video Recording) or N-TSB (Network Time Shift Buffer) is assumed to be multicast.

Since all programs are now being carried over IP, new CAS/DRM costs are added, and CableCards are not included in the IP GW cost, though residual maintenance fees are still included to support the legacy boxes until they are all replaced. The IP GW is headless and replaces the CM and/or EMTA.

DATA FOR MODEL

The data used to construct the model came from many sources. The cost projections for system components were based on our internal estimates as well as an evaluation of the overall marketplace. Similarly the operational expenses were derived partially from other operational studies ARRIS has sponsored as well as from industry publications.

For the revenue estimates, industry studies were consulted to estimate the operational expenses as a percentage of the revenues. Other operational expenses were estimated based on industry studies and internal experience.

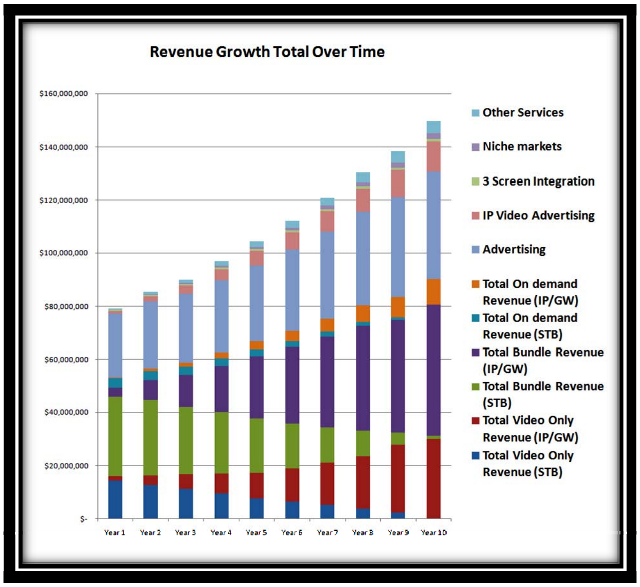


Figure 6 - Example Revenue Projection

The SDV model was developed from a study of actual user channel change behavior. The High Speed Data model is based on historical experience and trends.

The model has been shown to various industry experts for confirmation that its basic assumptions are reasonable and that its predictions are generally in accord with other models.

SOME RESULTS FROM MODEL

Sample analysis

A sample analysis was done as an example for this paper. It uses a starting network that has deployed SDV and has a section of analog channels. The channel lineup is slowly shifting to add more HD channels over the transition period. At the end of the transition period, analog channels are also reduced. The No Change scenario keeps the digital MPEG broadcast channels through the transition, but the other scenarios taper off the MPEG broadcast channels under the assumption that the MSO would be trying to motivate their customers to move to the newer technology.

In all scenarios, the network also supports non-STB devices with unicast streaming over DOCSIS. DVR services are being provided through traditional DVR STBs and Gateways.

The transition path replaces 10% of the STBs each year.

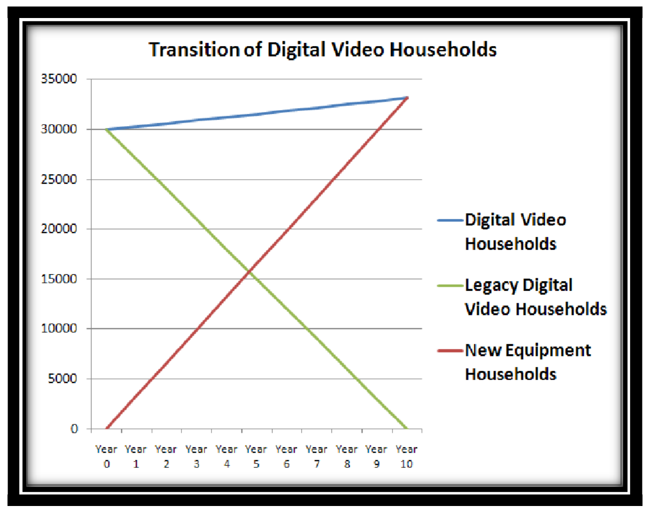
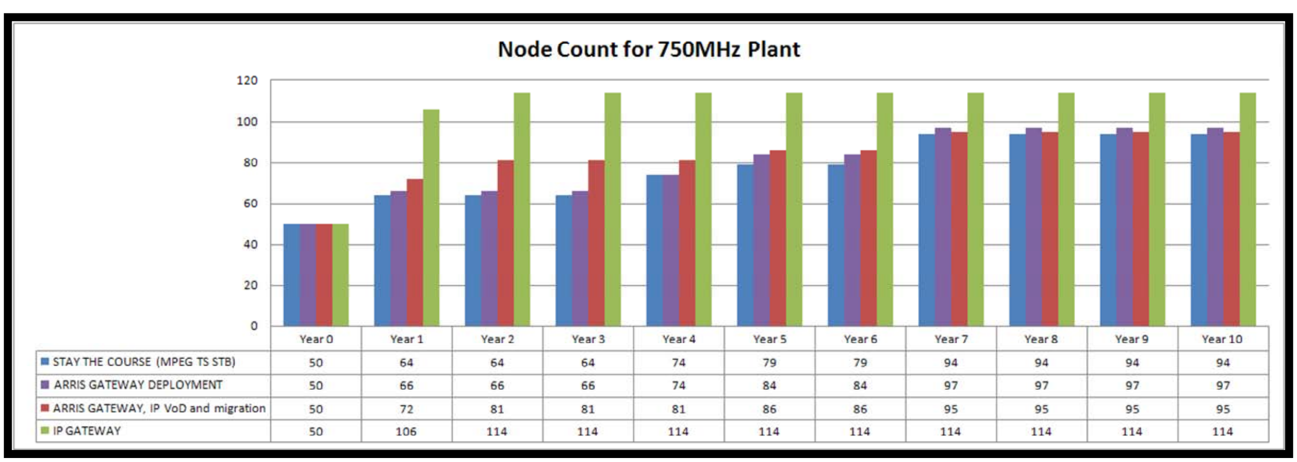


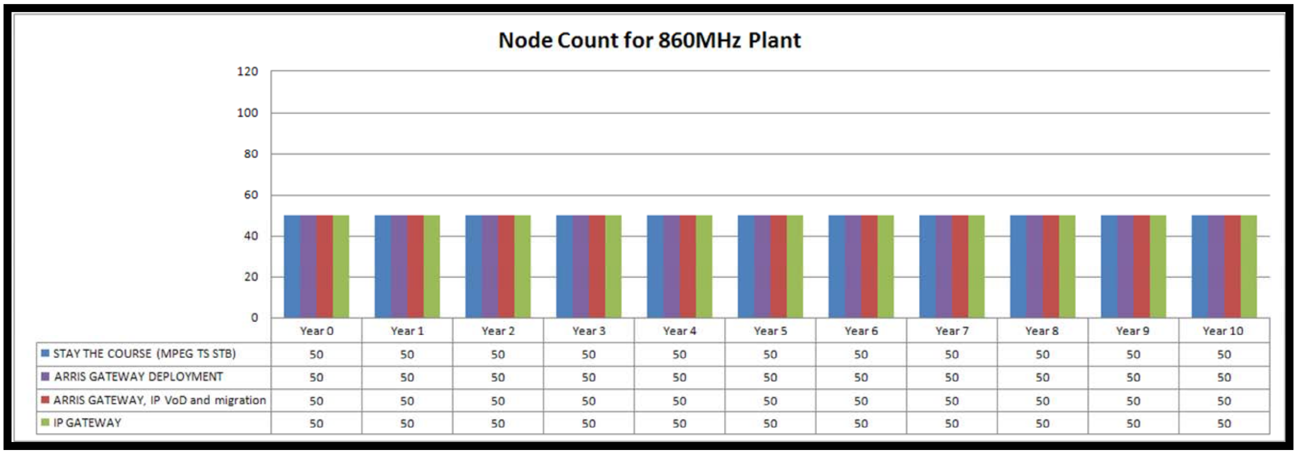
Figure 8 - Transition of Digital Video Households

The model computes bandwidth utilization for each scenario and automatically simulates node splits to ensure that each



	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
STAY THE COURSE (MPEG TS STB)	50	64	64	64	74	79	79	94	94	94	94
ARRIS GATEWAY DEPLOYMENT	50	66	66	66	74	84	84	97	97	97	97
ARRIS GATEWAY, IP VoD and migration	50	72	81	81	81	86	86	95	95	95	95
IP GATEWAY	50	106	114	114	114	114	114	114	114	114	114

Figure 7 - Example Node Calculations - 750MHz Plant



	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
STAY THE COURSE (MPEG TS STB)	50	50	50	50	50	50	50	50	50	50	50
ARRIS GATEWAY DEPLOYMENT	50	50	50	50	50	50	50	50	50	50	50
ARRIS GATEWAY, IP VoD and migration	50	50	50	50	50	50	50	50	50	50	50
IP GATEWAY	50	50	50	50	50	50	50	50	50	50	50

Figure 9 - Example Node Calculations for 860MHz Plant

service group remains within pre-defined channel limitations. The graphs below compare node splits required for a 750MHx plant with an 850 MHz plant with all other variables held constant.

The 860MHz plant obviates the need for any node splits for this example configuration. At first, this may seem counter-intuitive because the number of additional channels provided by an 860MHz upgrade does not double the available channels, while the node splits required in a 750MHz plant equate roughly to a doubling of nodes. The answer understood after considering the next diagram.

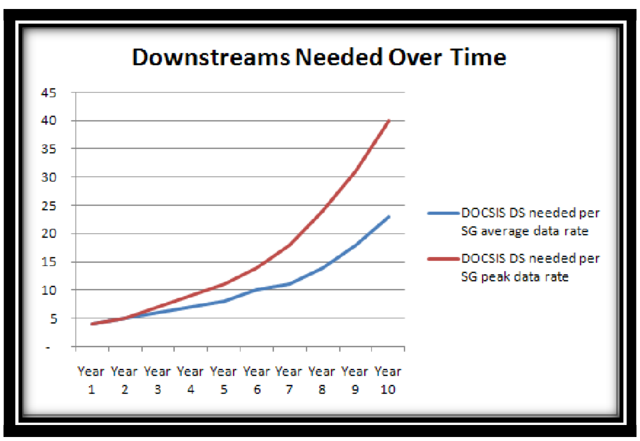
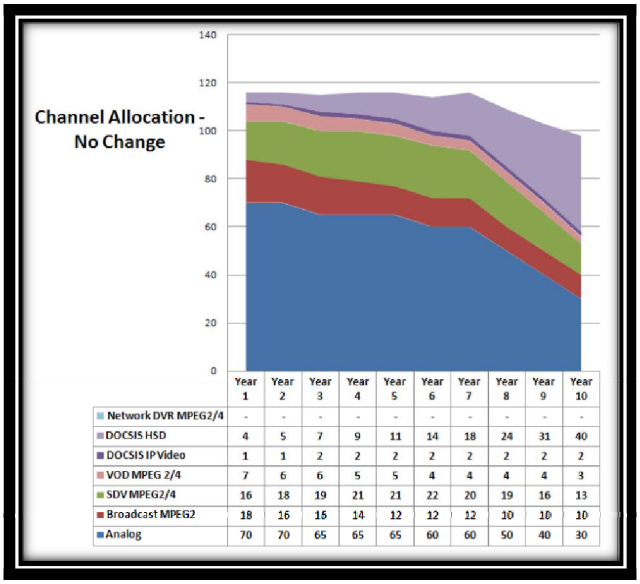


Figure 10 - Comparison of DOCSIS Peak and Average Downstream Requirements

The amount of true narrowcast bandwidth in these networks that varies with the size of the node is quite a small percentage, just SDV and VoD. Broadcast analog and digital video are easily understood as a constant in the bandwidth allocation per node. In most current HFC networks, DOCSIS High Speed Data is considered a narrowcast service with bandwidth expectations that parallel the node size. but Figure 10 shows that expectation is no longer true with projected increases in DOCSIS peak rates and average consumption. From a bandwidth perspective, while the other services scale with node size, DOCSIS HSD becomes invariant to the size of the node as the promised peak speed increases. Even if there are not enough users on that node to fill the DOCSIS downstream on average, the channels are required to ensure that the promised advertised speed is available at any instantaneous time. The headend resources may be shared among several nodes, to make more efficient use of the overall downstream channel group, but each node must have enough bandwidth to satisfy the premium user's speed tests.

The next diagram illustrates the bandwidth usage in a typical node as the transition progresses in a No Change, or Stay the Course, scenario.

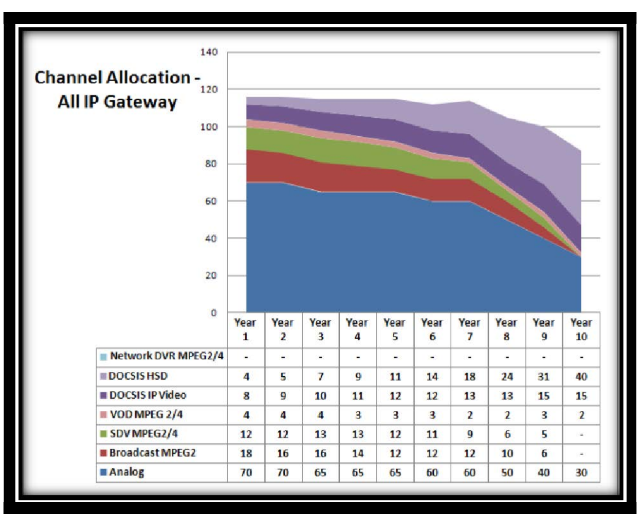


	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Network DVR MPEG2/4	-	-	-	-	-	-	-	-	-	-
DOCSIS HSD	4	5	7	9	11	14	18	24	31	40
DOCSIS IP Video	1	1	2	2	2	2	2	2	2	2
VOD MPEG 2/4	7	6	6	5	5	4	4	4	4	3
SDV MPEG2/4	16	18	19	21	21	22	20	19	16	13
Broadcast MPEG2	18	16	16	14	12	12	12	10	10	10
Analog	70	70	65	65	65	60	60	50	40	30

Figure 11 - Channel Allocation - No Change

The two bottommost wedges show a progression where analog channels decrease with time, but the digital broadcast channels remain, perhaps reflecting renegotiation of analog carriage agreements to migrate into the digital tier, and other channels moving to the SDV tier. The next bar up shows SDV that moves with time from all MPEG2 to mixed codecs then to all MPEG4.

The diagram below provides a view of the All IP scenario from the same starting point as the previous scenario.



	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Network DVR MPEG2/4	-	-	-	-	-	-	-	-	-	-
DOCSIS HSD	4	5	7	9	11	14	18	24	31	40
DOCSIS IP Video	8	9	10	11	12	12	13	13	15	15
VOD MPEG 2/4	4	4	4	3	3	3	2	2	3	2
SDV MPEG2/4	12	12	13	13	12	11	9	6	5	-
Broadcast MPEG2	18	16	16	14	12	12	12	10	6	-
Analog	70	70	65	65	65	60	60	50	40	30

Figure 12 - Channel Allocation - All IP

Notice for both scenarios the DOCSIS HSD bar on the top is the same width due to the Peak rate issue discussed earlier. In the All IP diagram the second band from the top shows the bandwidth used for IP video. Also the third band from the bottom shows the SDV tier which continually shrinks in this scenario as subscribers migrate to IP.

General Observations

The model of the various scenarios yielded results that allow a number of general observations. One general observation is that the exact transition mode deployed does not appreciably affect the overall cash flow analysis. The magnitude of operational expenses with their recurrence every year far outweighs the one-time capital expenditures for any model. The most significant factor coming out of a transition is that the operator is changing their network to accommodate new services that also introduce new revenue streams, or reduce their operational expenses. In this case since a portion of the opex is derived from the revenues, the larger revenue slice is partially offset by increased operational expenses, but the new revenues enabled by IP Video technology, such as increased personalized advertising, can result in a net positive business case.

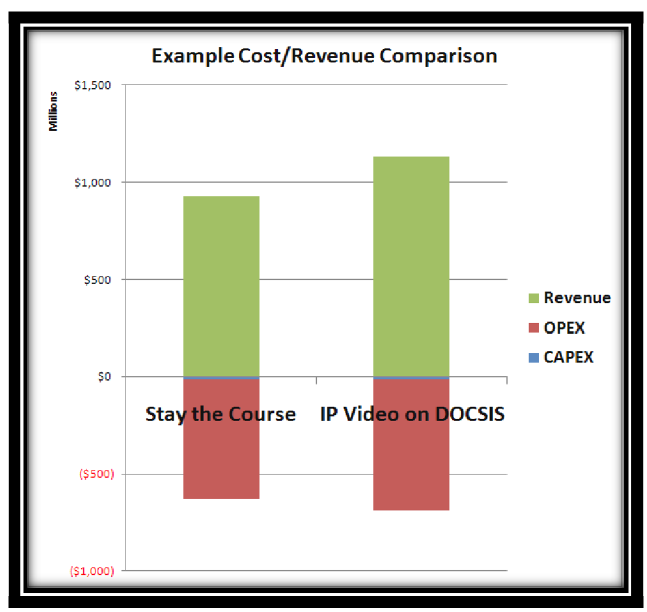


Figure 13 - Example Cost - Revenue Comparison

Another general observation, that in retrospective may seem obvious, is that any cost or income that is calculated on a per subscriber basis will be significant. For example, over 75% of the capital expenditures are CPE related for most models, regardless of the transition path taken simply due to the volume of equipment required. Additional revenue streams from subscribers can be individually small, but collectively can make a real difference in the overall cash flow.

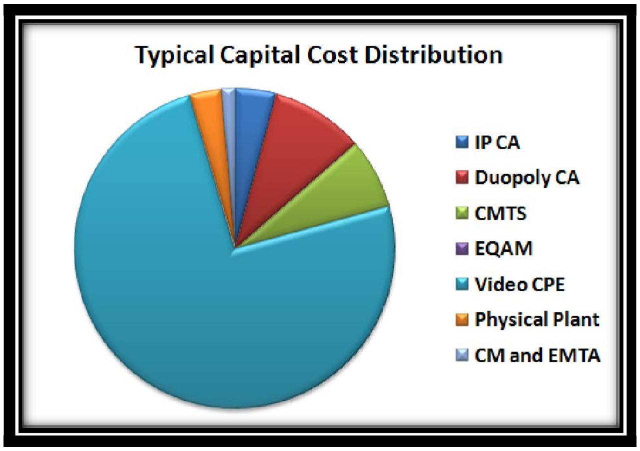


Figure 14 - Example Capital Cost Distribution

Sensitivity analysis for N-DVR

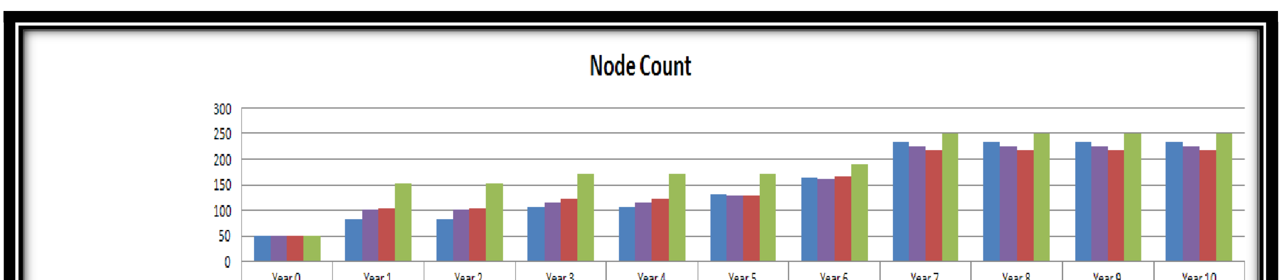
As another example, a network-based DVR deployment was added to the previous example. This technology is under evaluation for both MPEG-based architectures as well as IP-based architectures. This example analysis uses MPEG transport of N-DVR streams for the No Change scenario and the Hybrid Gateway scenario. IP over DOCSIS transport is used for the All-IP and IP transitional scenarios.

There are two possibilities for N-DVR deployment. An MSO could offer these new capabilities to only subscribers receiving new equipment, or they could offer it to all their subscribers. If an MSO has already deployed DVR technology within their network, it would make sense to allow the deployed DVRs to perform their designed function until they have to be replaced. This approach makes efficient use of that sunk capital, using it to allow the bandwidth increases due to N-DVR to grow gradually, minimizing network disruptions. On this theory in this example, newly deployed MPEG STBs or GWs utilize network DVRs while legacy equipment does not.

The N-DVR usage rate in this simulation is taken from ARRIS MOXI experiences regarding the use and frequency of DVR recordings. The bandwidth model has had normal DVR recording rates subtracted from the SDV demand totals, and average playback rates added in as unicast traffic.

The following graph shows the node count changes required to support N-DVR as it gradually rolls out with the STB replacements. The presence of additional unicast traffic forces additional node splits as compared to the model without N-DVR.

While the CPE costs decreased by an average of 14% compared to the original model, that decrease was offset by the increased nodes



	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
STAY THE COURSE (MPEG TS STB)	50	83	83	108	108	131	164	233	233	233	233
ARRIS GATEWAY DEPLOYMENT	50	101	101	115	115	129	162	227	227	227	227
ARRIS GATEWAY, IP VoD and migration	50	105	105	123	123	128	165	217	217	217	217
IP GATEWAY	50	153	153	173	173	173	191	249	249	249	249

Figure 15 - Example Node calculations for N-DVR Deployment

splits and increased headend equipment needed to provide the additional downstream channels. There were no changes made to the operational costs assumed, and perhaps additional saving might be found there, but published information was not found to substantiate that assumption.

CONCLUSIONS

In conclusion, this paper introduces a comprehensive business model built to examine and quantify the many factors that can affect an MSO's evaluation of the plethora of IP Video options. It does not attempt to evaluate every possible option, but concentrates on factors that are frequently under discussion in the industry currently.