



## Executive Summary

There is an urgent need for pay TV operators to offer a modern user interface (UI) and to accelerate new service introductions. Consumers demand a new, consistent and easy to navigate experience. Over the top (OTT) operators are meeting that demand with modern interfaces and innovative business models. Their success is compressing Pay TV operator margins and encouraging cord cutting and shaving.

ActiveVideo has introduced CloudTV, a cloud-based approach to delivery of modern user interfaces and other applications. This cloud-based approach supports immediate delivery to all consumer devices and at much lower cost than set-top box-based (STB) solutions. The cloud-based approach eliminates the need to develop device-dependent software and application program interfaces (API) for devices, including several generations of STBs, media hubs, Blue-ray players, connected televisions, game consoles and personal media players. It also eliminates the need to undertake an expensive and time consuming program of replacing first-generation STBs.

ACG Research compared the total cost of ownership (TCO) of the immediate deployment of CloudTV to all consumer devices to a program of upgrading STBs to support a modern user interface. It found an 83 percent TCO savings over five years for CloudTV as compared to the STB replacement program. The analysis also tested the robustness of the TCO findings by performing a number of sensitivity studies. These studies found that the TCO savings of CloudTV are significant and extend well beyond probable operating conditions.

### KEY FINDINGS

ActiveVideo's CloudTV provides rapid introduction of modern UI and UX services and compared to STB solutions has:

- 83% lower TCO over 5 years
- All services deployed at once versus multiyear STB deployment
- 6:1 scaling advantage with increasing number of enabled devices
- 4 to 8 times TCO advantage over a wide range of peak service usage levels
- TCO advantage maintained throughout range of likely STB replacement percentages
- Cost advantage maintained down to 15 sessions per server
- Significant cash flow advantage

## Introduction

The pay TV industry is going through major technology and business model transformations. A shift to All-IP delivery; the need to deliver content to a bevy of new consumer devices such as tablets, smartphones, and connected TVs; and new streaming software/standards (HTML5, H.265) are requiring new network architectures and significant capital expense (CapEx) budgets. These technologies are not just increasing the quality, choice and reach of viewing videos, but are also enabling competition from OTT operators (Netflix, Hulu and Aereo). These players are changing business models, compressing pay TV margins, and encouraging cord cutting and shaving. Another, more subtle consequence of these new viewing options is a shift in consumers' attitudes toward their viewing experiences; they are now starting to demand a new, consistent and easy to navigate experience. This is not an academic exercise. Research studies and anecdotal observation indicate that consumers watch more content, increase their take rates of view on demand (VOD), and are more loyal to a service when presented with a modern interface.

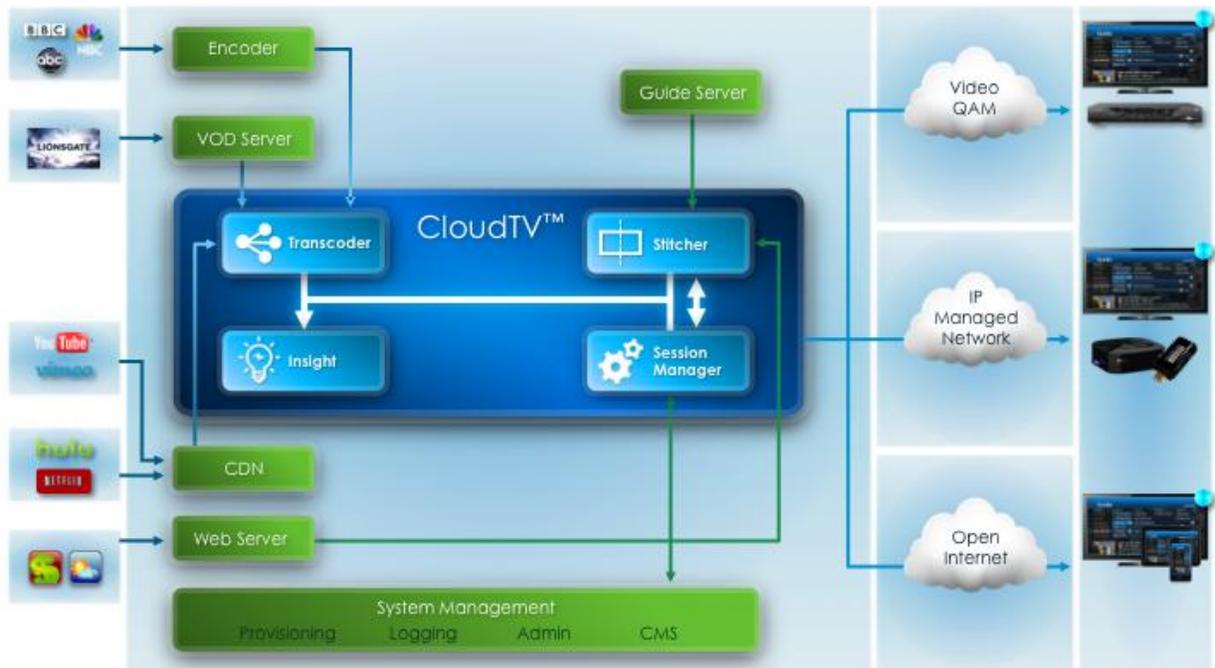
As a result of these trends, there is an urgent need for pay TV operators to offer a modern user interface (UI) and to accelerate new service introduction to meet competitive threats. But these are not easy goals to attain. Operators are constrained by the current STB based guide system that has diverse vendors, multiple generations, and varying capabilities. Additionally, developing, deploying and maintaining new services that are delivered by the STB is a long and complex process that requires multiple code bases and lengthy testing cycles to prevent operational disruptions. In the current economic climate, the prospect of replacing STBs to ensure universal service availability is an unattractive option for many operators.

Given these challenges, ActiveVideo designed a solution that uses a different approach. Instead of having guide/user interface functionality in the STB, ActiveVideo moved this functionality to the cloud. By using a cloud-based approach, CloudTV enables rapid, cost effective, and scalable introduction of a modern UI (and other applications) that bypasses the cost, scale and operational difficulties of STB based guide systems.

The cost and service acceleration advantages of CloudTV are demonstrated by comparing the CloudTV solution to the present mode of operations (PMO) of STB based UI and applications.

## CloudTV Solution

Figure 1 shows an overview of the CloudTV solution.



**Figure 1 – Overview of CloudTV Architecture**

Upstream action requests are received and processed in the CloudTV Core platform. The UI is updated, rendered and stitched with video into a standard MPEG2/H.264 bit stream. CloudTV supports both cable (QAM and DOCSIS) and IP (DSL, PON, and Ethernet) networks. Support for device connections includes an ultra-thin client solution that provides a uniform, advanced TV experience to first-generation digital set-top boxes and many other devices. A hybrid client solution is provided for robust set-top boxes and other devices that combine network processing and device-based functionality, such as advanced graphics rendering.

The CloudTV Core also provides services for ingesting, transcoding and storing of media content. CloudTV supports HTML5 web applications, many media sources, and other video services.

### PMO: Set-Top Box Solution

The present mode of operations is defined as a set-top box-based solution. Electronic Program Guide (EPG) and other advanced UIs (VOD/Navigation) are provided by replacing first-generation set-top boxes with set-top boxes capable of rendering advanced UIs. Under the PMO other devices capable of rendering advanced UIs must be supported on a case-by-case basis by the operator.

### TCO Analysis

The total cost of ownership (TCO) of deploying, operating and maintaining the CloudTV solution is compared to the cost of replacing first-generation digital set-top boxes with set-top boxes capable of

supporting advanced UIs (PMO solution). Although all CapEx and operation expense (OpEx) cost items are analyzed for the CloudTV solution only CapEx items are analyzed for the PMO. This provides the PMO with a best-case comparison.

Table 1 lists the CapEx and OpEx items that are included in the two solutions.

Expense Category	CloudTV	PMO
<b>CapEx</b>	Server	Set-Top Box
	Engineer, Furnish, & Install (EF&I)	Truck-Roll (Install Set-top Box)
	Network Upgrade	Application Development
	Application Development	
<b>OpEx</b>	Network Care	N/A
	Floor Space	
	Power	
	Cooling	

**Table 1 – Cost Items Included in Analysis**

The primary CloudTV CapEx item is the cost of CloudTV Stitcher, the servers. The Stitcher executes and renders HTML5 applications and generates MPEG-2 and H2.64 compliant streams on a per-client basis. The network upgrade cost item is the cost required to add access network capacity to accommodate communications between the set-top boxes and the CloudTV Core. In most cases existing network capacity will accommodate the additional capacity required to support CloudTV. Cable networks (QAM or DOCSIS) are upgraded by splitting the service groups. For example, a 1,000 device service group might be split into two 500 device service groups. IP networks are upgraded by adding additional backhaul capacity at the access node. For example, a 1 Gbps Ethernet port might be added to the DSLAM and to the pre-aggregation router.

CloudTV OpEx is associated with operating and maintaining the CloudTV Core equipment. Network care includes the cost to maintain and repair the CloudTV Core equipment as well as to license the CloudTV software. No OpEx is assigned to the PMO. Table 2 itemizes the modeling assumptions used in the base-case analysis.

Assumption	Value
Number of Enabled Devices	5 Million
Study Period	5 Years
Peak Service Usage (PSU) as a Percentage of Enabled Devices	5% <sup>1</sup>
Service Group Size	1,000 Devices
Session per Server Blade	500
Cost of Set-Top Box	\$100
CapEx: Is in First Year Only	
Network Upgrade Expense Is for Cable System (QAM or DOCSIS)	
Percentage of Service Groups that Must Be Upgraded	19%
Percentage of Set-Top Boxes to Be Replaced	60%
CapEx to Split a Cable Plant Service Group	\$4,000
CapEx to Add an Additional Gigabit Port to a DSLAM	\$1,500
Cost to Install a Set-Top Box	\$100
Percentage of Replaced Set-Top Boxes that Must Be Installed by Operator	30%
Annual Cost of Floor Space in POP	\$500/sq. ft.
Cost of Electric Power	\$0.12/KWH

**Table 2 – TCO Study Assumptions for Base Case**

The most important cost drivers include the number of enabled devices, peak service usage, percentage of STBs replaced over the five-year study period, the size of the service group and the number of advanced UI sessions handled per server blade. Sensitivity studies are presented for each of these cost drivers. The cost of the set-top boxes accounts for nearly all of the TCO of the PMO. Its cost is set at \$100, which is at the low end of unit costs. This is done to provide a conservative estimate of cost advantage of CloudTV.

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<sup>1</sup> Peak service usage is the percentage of enabled devices that are active during the period of peak usage. According to the Nielsen Company the peak usage period is at the top of the hour during prime viewing time and has four minute duration. Thirteen percent of enabled devices are active during this period and have a ½ minute session time. This implies peak service usage of 3.25 percent. ACG Research’s discussions with operators confirm this value. The base case PSU value is set at 5 percent to provide a conservative estimate of the TCO advantage of CloudTV.

## TCO Results

Table 3 summarizes the TCO comparison for the base case.

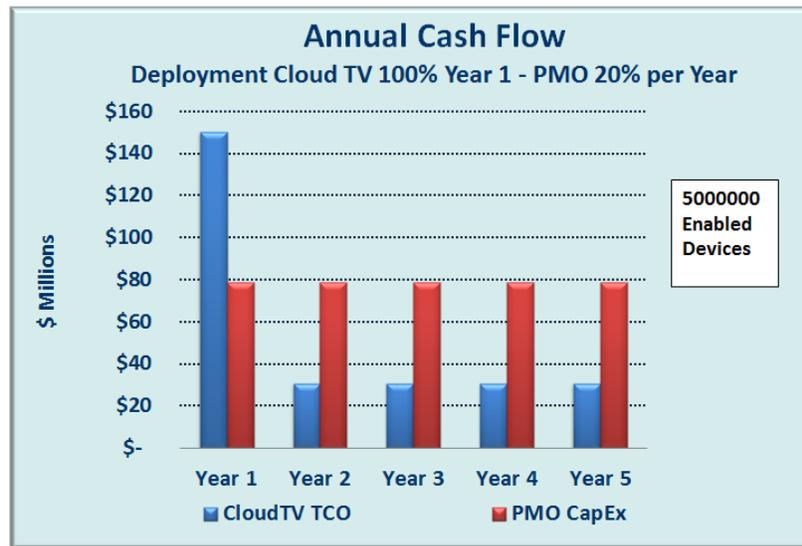
CapEx	CloudTV	PMO	Savings Compared to PMO	Percentage Savings
Hardware Cost	\$ 5,000,000	\$ 301,200,000	\$ (296,200,000)	-98%
EF&I	\$ 582,500	\$ 90,000,000	\$ (89,417,500)	-99%
Network Upgrade	\$ 3,864,914		\$ 3,864,914	N/A
Application Development Cost	\$ 500,000	\$ 2,000,000	\$ (1,500,000)	-75%
Cumulative CapEx	\$ 9,947,414	\$ 393,200,000	\$ (383,252,586)	-97%
Operating Expenses	CloudTV	PMO	Savings Compared to PMO	Percentage Savings
Network Care	\$ 50,750,000			
Floor Space Cost	\$ 488,333			
Power Cost	\$ 2,310,012			
Cooling Cost	\$ 1,686,309			
Cumulative OpEx	\$ 55,234,654	\$ -	\$ 55,234,654	N/A
Cumulative TCO (CapEx+ OpEx)	\$ 65,182,068	\$ 393,200,000	\$ (328,017,932)	-83%

**Table 3 – Base Case TCO Results Comparison**

The CloudTV solution has 83 percent lower TCO than the PMO. Network care expense, which includes the annual license fee for CloudTV software, accounts for the majority of the cost of CloudTV and set-top box cost accounts for nearly all of the cost of the PMO.

PMO EF&I cost is due to those STB replacements that require onsite installation by the operator (truck-rolls). CloudTV network upgrade cost is the cost to add bandwidth capacity within the service groups. Bandwidth capacity is added by splitting the service groups. Application development cost is higher for the PMO than CloudTV. Developing a new application/guide for the PMO requires more work than does CloudTV. The operator must support multiple STB types, and each type requires porting and regression testing.

Figure 2 shows a cash-flow comparison over five years where CloudTV service is deployed to all five million devices in the first year and set-top boxes are replaced uniformly over five years.<sup>2</sup>



**Figure 2 – Annual Cash Flow Comparison, Base Case**

The cash-flow analysis shows an overwhelming advantage to the CloudTV solution. The five-year CloudTV TCO is significantly less than the annual PMO cash flow. The chart also shows that Cloud TV start-up costs are equal to about one-half of annual OpEx. CloudTV, furthermore, delivers the benefits of advanced UIs to all 15 million enabled devices in the first year; the PMO does not reach 100 percent coverage until the fifth year.

### ***Scaling Comparisons and Sensitivity Analyses***

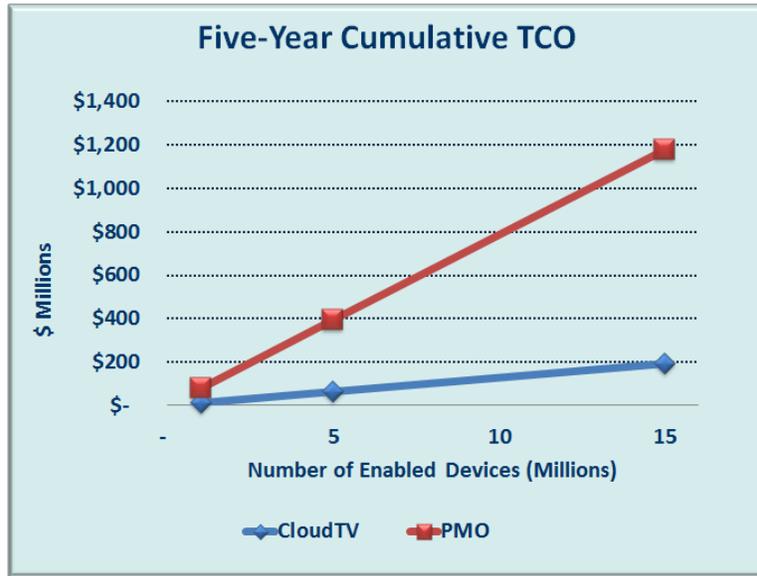
CloudTV maintains its cost advantage over the PMO under a wide range of possible and even extreme planning assumptions. The analyses explore the robustness of the CloudTV cost advantage subject to variation in:

- Number of Devices: Does CloudTV cost effectively scale as the number of enabled devices increases?
- Type of Network: Are CloudTV networking costs manageable for cable QAM and DOCSIS systems as well as IP access networks?
- Peak Service Usage: Does CloudTV cost effectively scale as the peak service usage increases?
- Percentage of STBs replaced over the five-year study period: Does CloudTV maintain a TCO advantage over the entire range of likely STB replacement scenarios?
- Service Group Size: Are CloudTV economics robust to variations in service group size?
- Sessions per Server: Does CloudTV remain economically attractive as more compute-intensive sessions reduce the number of simultaneous sessions that can be hosted on a server blade?

<sup>2</sup> The analysis assumes that only 60 percent of all set-top boxes must be upgraded to support advanced UIs.

### Number of Devices

Figure 3 shows the TCO comparison as the number of enabled devices increases.

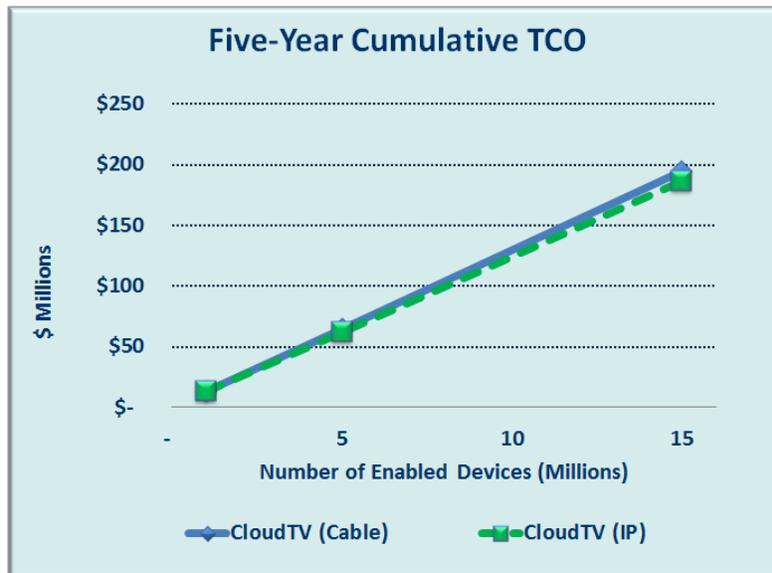


**Figure 3 – Sensitivity to Number of Enabled Devices**

In this sensitivity study all input variables are held at their base-case values, and the number of devices is varied from 1 million to 15 million. The figure shows that CloudTV scales much better than the PMO. The slope of the PMO line is much steeper than that of the CloudTV solution.

### Type of Network

Figure 4 compares TCO for cable networks (QAM or DOCSIS) and IP (DSLAM or PON) networks.

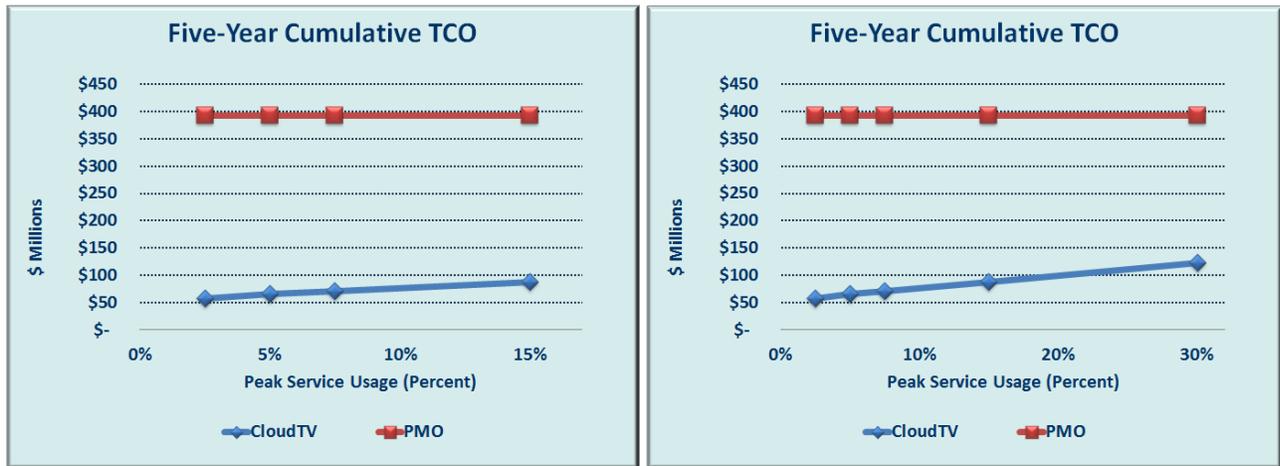


**Figure 4 – Cable versus IP Access Networks**

The figure shows a very slight cost advantage to IP network deployments over cable networks. The cost advantage is attributable to the use of Ethernet technology by the IP network. Ethernet technology has very low unit costs because of the very high manufacturing scale of this ubiquitous technology.

Peak Service Usage (PSU)

Figure 5 compares TCO over a wide range of PSU values.

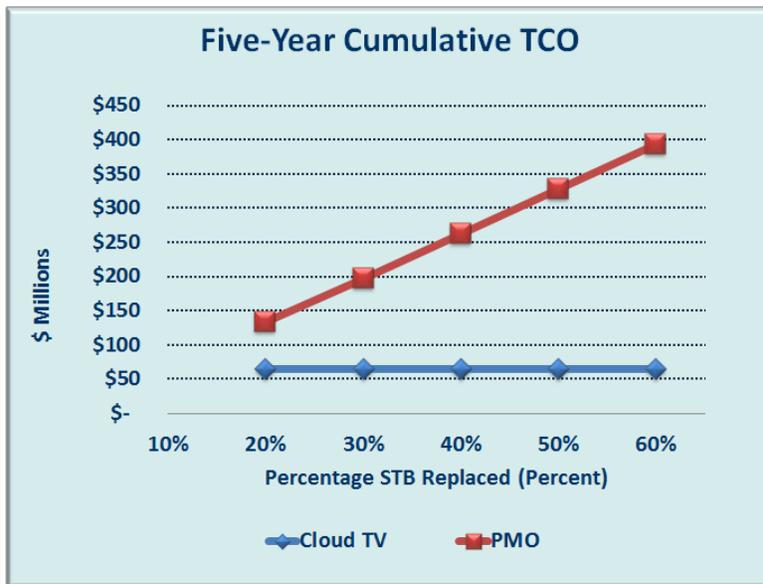


**Figure 5 – Sensitivity to Peak Service Usage**

The figure shows that CloudTV maintains a large cost advantage over the PMO solution over a wide range of peak service levels. ACG Research estimates that actual peak service usage ranges between 2.5 percent and 7.5 percent with the median level at 5 percent. However, CloudTV maintains nearly a 4:1 cost advantage over the PMO even at 30 percent PSU, which is six times the median level. CloudTV has 28 percent lower TCO than the PMO even with 100 percent PSU.

Percentage of STBs Replaced

Installation of CloudTV immediately provides a modern UI to all enabled devices. Under the PMO, however, the operator must make tradeoff analyses of the benefit of providing a modern UI to each STB type versus the cost of replacing the STB. Figure 6 compares the five-year TCO of CloudTV and the PMO over a likely range of STB replacement percentages.

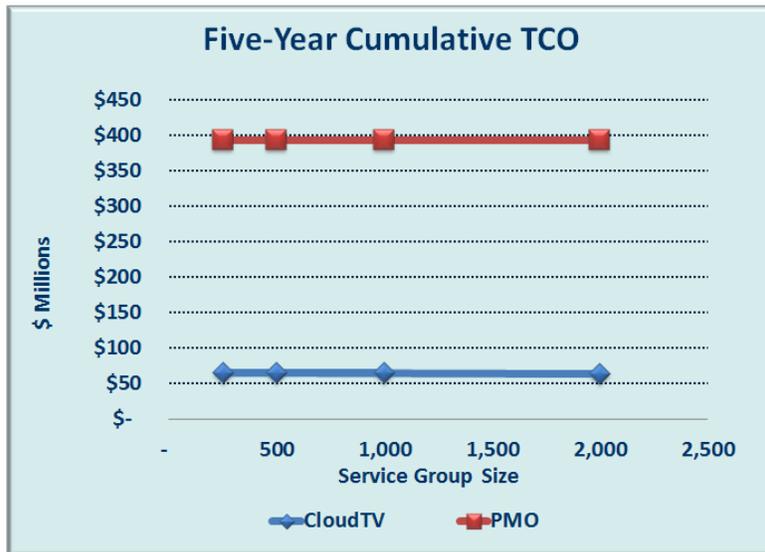


**Figure 6 – Sensitivity to Percentage STB Replaced**

CloudTV maintains a significant TCO advantage throughout the range of likely STB replacement percentages over the five-year study period (51 percent TCO savings to 83 percent TCO savings.) Also, CloudTV delivers the benefits of a modern UI to all devices immediately; benefits are phased in over five years (if at all) under the PMO.

Service Group Size

Figure 7 compares TCO for a wide range of service group sizes.

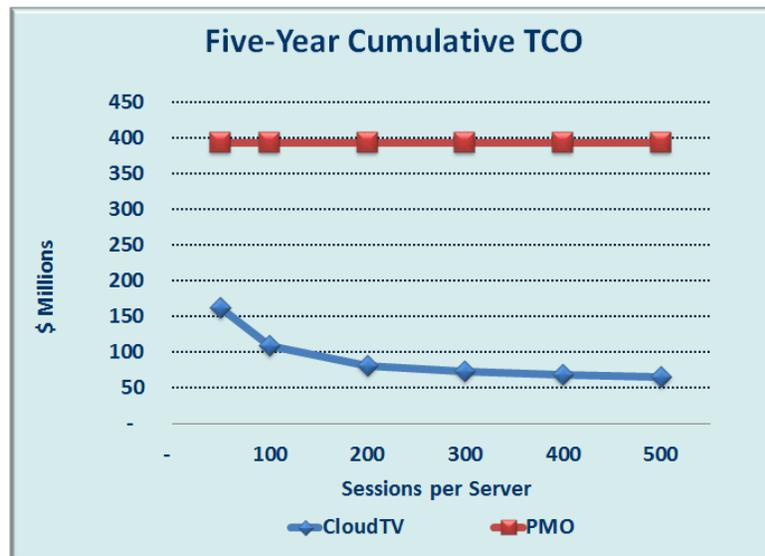


**Figure 7 – Sensitivity to Service Group Size**

Neither solution is sensitive to service group size. This may seem counter intuitive in the CloudTV case. Though larger service groups drive up CloudTV network capacity requirements the cost of adding capacity through service group splitting is offset by the smaller number of large versus small service groups for any fixed network size.

## Sessions per Server

It is likely that increasingly sophisticated advanced UIs will drive the number of sessions per server below the current rate of 500 sessions per CloudTV server. Figure 8 explores the sensitivity of CloudTV TCO to declining sessions per server values.



**Figure 8 – Sensitivity to Sessions per Server**

The figure shows that the large TCO advantage of CloudTV is maintained even at sessions per server values as low as 50. CloudTV TCO does not equal that of the PMO until sessions per server equals 15.

## Conclusion

Consumers demand a new, consistent and easy to navigate user experience. OTT operators are responding to that demand by offering modern and innovative user interfaces. They also are changing business models, compressing margins, and encouraging cord cutting and shaving. As a result there is an urgent need for pay TV operators to offer a modern user interface and to accelerate new service introductions to meet these competitive threats.

CloudTV is ActiveVideo’s cloud-based approach to delivering a modern UI. CloudTV provides a much more rapid, less costly, and more scalable solution than the present mode of operations that uses STB based functionality. CloudTV provides immediate delivery of a modern UI to all devices versus a multiyear deployment program and device-dependent UIs of STB based solutions. The TCO study found that CloudTV has 83 percent lower TCO over five years than the STB based solution. The TCO results were found to be robust when subjected to a wide range of sensitivity studies. Specifically:

- CloudTV scales with increasing numbers of enabled devices at a 6:1 advantage over the STB based solution.
- TCO advantage of CloudTV is sustained across all types of cable (QAM and DOCSIS) and IP (DSLAM, PON, and Ethernet) network types.
- CloudTV maintains a significant TCO advantage across all possible peak service usage levels from 0 percent to 100 percent.

- CloudTV maintains a significant TCO advantage throughout the range of likely STB replacement percentages.
- CloudTV economics are unaffected by the service group size.
- CloudTV maintains a TCO advantage from the nominal sessions per server level of 500 down to 15 sessions per server, which is well below expected performance ratings.

The ability of CloudTV to deliver a modern UI immediately and at much lower cost than STB based solutions provides pay TV operators with the competitive advantages needed to sustain their businesses. Customers' loyalty is strengthened by rapidly meeting consumers' demand for a new, consistent and easy to navigate experience. This strengthens pay TV operators' business strategies because perceived service values increase over the lifetime of an account (five-year accounts have higher value than three-month accounts.) Finally, cloud-based services can be deployed and modified more rapidly than STB based solutions. This high service velocity also strengthens operators' business strategies by making them more agile and responsive to consumers' changing demands.

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