cable

National Cable & Telecommunications Association
25 Massachusetts Avenue, NW – Suite 100
Washington, DC 20001
(202) 222-2300

www.ncta.com

Neal M. Goldberg
Vice President and General Counsel

(202) 222-2445
(202) 222-2446 Fax

April 13, 2012

Katharine Kaplan
EPA Team Lead
ENERGY STAR Product Development
US Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460
stbs@energystar.gov

Re: ENERGY STAR® Specification for Set-top Boxes Version 4.0

Dear Ms. Kaplan:

On behalf of the National Cable & Telecommunications Association ("NCTA"), I am responding to the Environmental Protection Agency's ("EPA") March 20, 2012 request for comment on ENERGY STAR® Specification for Set-top Boxes Version 4.0 ("ESv4").

Since the adoption of EPA's Energy Star Version 3.0 and 4.0 specifications for set-top boxes, the cable industry has launched new initiatives dedicated to improving the energy efficiency of cable-provided consumer set-top boxes on an aggressive timeline. These new initiatives include (1) the creation of CableLabs - Energy Lab (a specific facility within CableLabs[1] dedicated to improving energy efficiency); (2) focused projects to increase the efficiency of set-top boxes through development of "light sleep" and "deep sleep" set-top box modes that function with U.S. cable system architectures; and (3) cable operator volume procurement commitments for set-top boxes that meet ENERGY STAR standards to move the

---

[1] Cable Television Laboratories or CableLabs, founded in 1988, is the cable industry's R&D consortium playing a role similar to that played by BellLabs for the telephone industry. CableLabs has over 40 cable operator members representing over 80 million customers, predominantly in North American (US and Canada), but also internationally in Europe, Asia, and Central America. Among other things, CableLabs developed common specifications for the cable modem enabling the size and price of such modems to plummet in a short time as they were made available at retail outlets across the country which, in turn, spurred the revolution in broadband access the Nation has experienced in recent years.

marketplace decisively towards more energy-efficient models.   This initiative was welcomed by EPA, among others.[2]

As detailed in the attached Comments, which we recently filed with the Department of Energy in its proceeding looking into the regulation of set-top box energy use,[3] these voluntary energy initiatives are already showing substantial, tangible, and promising results. Cable operators are deploying set-top boxes with "light sleep" capabilities that reduce energy consumption when the set-top box is not in active use, and will be providing "light sleep" software upgrades this fall to compatible set-top box models already in consumer homes. The new CableLabs - Energy Lab is bringing together operators, suppliers, and developers to seek consensus on "deep sleep" solutions that can meet consumer expectations for instant viewing while significantly improving energy efficiency. Set-top boxes with this functionality will be ready for field tests in 2014. After successful field testing of set-top boxes with next generation power management semiconductors, cable operators will begin promoting the deployment of these devices as part of their ongoing efforts to provide functional, reliable, and energy efficient services.[4]

We understand that EPA is tracking this market and revisiting the Version 4.0 requirements before they go into effect to ensure that Version 4.0 requirements align with the evolution of the market and performance of products in this quickly developing product category. We draw to your attention three key aspects in which the current Version 4.0 requirements would not meet those goals.

<u>Limited Allowances for Gateway Functionalities</u>

The ESv4 specifications provide a limited allowance for multi-tuner devices, but there do not appear to be allowances for the functionalities required for gateways designed to serve the many new screens in the home. As detailed in our Comments to DOE, cable operators are using creative and energy-efficient methods for meeting the skyrocketing consumer demand to enjoy cable services anytime, anywhere, on any screen, and often on multiple screens in simultaneous use by the same viewer.[5] Creative, practical, and efficient home networking techniques include connecting set-top boxes with multi-function DLNA-compatible retail devices; MoCA 2.0 networking specifications that support moving devices into and out of low power states in coordination with other devices in the home network; and multiple techniques for delivering

---

[2] *See* Jonathan Make, *Major Cable Operators Target Energy Star 3.0 Devices,* Communications Daily (November 21, 2011) (EPA's Katharine Kaplan called the cable industry initiative an "exciting commitment to deliver greater efficiency to the millions of Americans who rely on cable set-top boxes." She added that the initiative's focus on deployment of boxes that drop to a "true low power sleep mode when not in use offers particular promise for consumer and environmental savings." Ms. Kaplan concluded that "EPA's ENERGY STAR program will look forward to supporting this effort in the ENERGY STAR program's ongoing push for more energy efficient set top boxes of all types.")

[3] Comments of NCTA in Docket No. EERE-2011-BT-NOA-0067 (Department of Energy, March 15, 2012).

[4] *Id*. at 7-13.

[5] *Id*. at 33-37.

services directly in Internet Protocol ("IP") to consumer-owned digital devices like tablets, PCs, smart TVs, and game consoles. The limited allowances that ESv4 provides for tuners do not address the additional functionality that gateway set-top boxes may require, such as transcoding of video formats and changing encryption in order to implement these innovative solutions.

The EPA could better promote the development of innovative, energy-efficient whole home solutions by excluding gateway devices from ESv4 requirements.

Deep Sleep Power Consumption

The ESv4 specifications target a deep sleep level of 3 Watts or 15% of active power consumption (whichever is greater). It is not technically feasible to meet such a target with cable set-top box technology while delivering an acceptable user experience. We are not dismissing various "deep sleep" approaches developed by European satellite or other companies, although we do not believe that the 3 Watt target fairly represents those approaches.[6] But on advanced two-way U.S. cable systems, powering down to that level would not maintain the connectivity to the network necessary for the set-top box to meet operational requirements, or to promote an experience which most consumers would accept. The cable industry is directly engaged in developing a deep sleep solution that is compatible with U.S. cable systems and which could be widely accepted and utilized in consumer homes.[7] CableLabs has assembled multiple working groups to develop specifications for "deep sleep" for next generation semiconductors and hardware, leveraging its unique test laboratory which maintains the wide variety of hardware, software, code drops, and key applications (such as program guides) used in the cable industry.[8] The cable industry, in conjunction with its hardware, applications, security, and set-top box suppliers, and other subject matter experts, has committed to develop specifications during 2012 for next-generation semiconductors to allow parts of the device to operate in a deeply reduced power consumption mode when not in use, while still functioning with system architectures and meeting consumer expectations for quick start-up time. The ESv4 3 Watt target is below the target currently expected to be feasible for cable system architectures and consumer acceptance.

The EPA could better accommodate the development of this practical approach to deep sleep by making deep sleep an optional feature for devices that are being tested to ESv4 efficiency standards.

---

[6] The concept of "Deep Sleep" as such is not discussed in the EU. The Voluntary Industry Agreement to improve energy efficiency of Complex Set Top Boxes (CSTB) within the EU suggests that "the power consumption targets related to standby mode might be variable and dependent on the real functionality requested from the CSTB." Even the recent amendment to the standby regulation (EC)1275/2008 suggests that the new concepts of High and Low Network Availability are not required if "inappropriate for intended use." In any event, the requirement targets for High Networks availability are 12W in 2014 and 8W in 2016.

[7] *Id.* at 7-11.

[8] *Id*. at 16-20.

Deep Sleep Deployment

The ESv4 timeline assumes boxes capable of deep sleep to be in deployment by July of 2013. Moving from a deep sleep specification to deployment requires considerably more time for silicon development, set-top box development, software development, quality assurance, and verification of operational readiness.
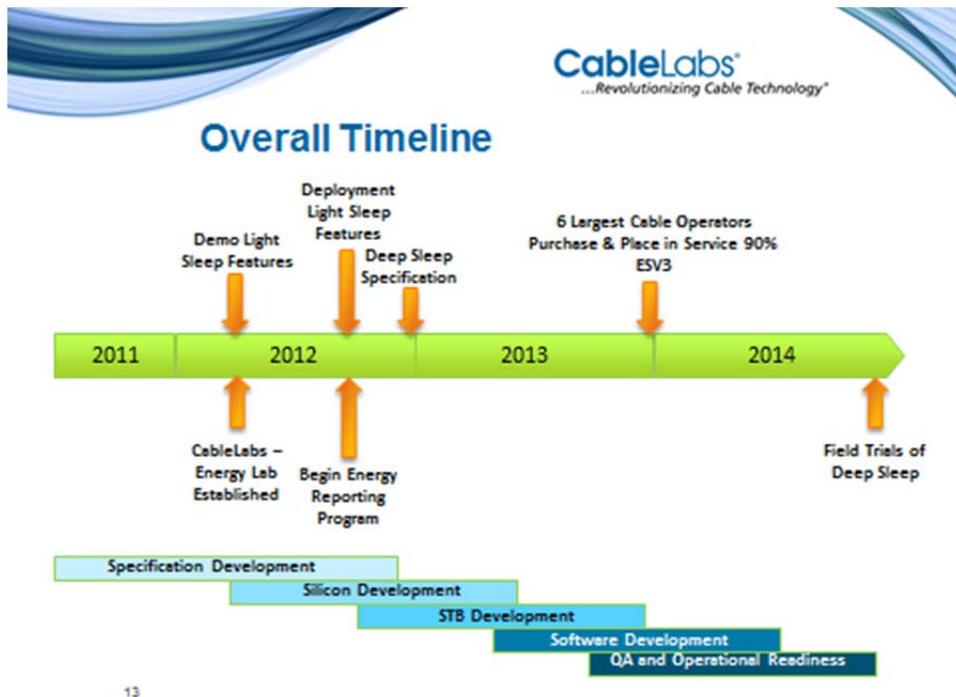
Cable set-top boxes vary from network to network and device to device. They are integrated components of distribution networks that differ significantly in network architectures, transmission protocols, software stacks, conditional access security systems, out-of-band communications channels used for command and control of the set-top box, operating system and processor instruction sets, network control architectures in support of interactivity, and electronic program guide applications and guide metadata formats, among other variables. Even when they are not actively being used to display video, these set-top boxes are receiving more than program guide updates. They are receiving important software updates and navigation information, and receiving and sending other data for diagnostics that vary across networks. Because cable set-top boxes are part of integrated networks that rely upon real-time connectivity and communication, changes required at the set-top box level require changes at the cable headend and network level.[9] Developing and integrating a deep sleep state into these networks takes more time than has been afforded by the ESv4 schedule.

---

[9]   *Id*. at 26-28, App. C.

The cable industry energy initiative is compressing and accelerating these usual cycles, but set-top boxes with functional deep sleep are not expected to be available until December 2014. And, of course, field testing must be successful before broad commercial deployment can begin. Even with the accelerated development and deployment schedule under way through the cable industry initiative, the industry will not be in position to meet many of the ESv4 targets by July 2013.

Recommendations

For the reasons stated above and in the attached Comments, NCTA recommends that the ESv4 specification be adjusted in three ways to accommodate the above concerns:

1. Gateways should be excluded from the scope of set-top boxes that are expected to meet ESv4 standards. This would better promote the development of innovative devices that can provide the resources for tuning, transcoding, re-encryption and other functionalities needed to meet consumer demand to receive services on the wide variety of consumer-owned digital devices. This approach will facilitate the development of energy-efficient whole home solutions which accomplish more with less overall energy consumption.

2. Deep sleep should be an optional feature for devices that are being tested to ESv4 efficiency standards. This would be consistent with the EPA's goal of permitting flexible designs and would better align with the evolution of the market.

3. The schedule for ESv4 should be adjusted to match the development and deployment cycle of "deep sleep" set-top box modes that function with U.S. cable system architectures.

Respectfully submitted,

/s/ Neal M Goldberg

Neal M. Goldberg

Attachment

cc: M. Malinowski

Before the
DEPARTMENT OF ENERGY
Washington, DC

In re	)	
	)	
Energy Conservation Program for	)	Docket No. EERE–2010–BT–DET–0040
Consumer Products and Certain	)	RIN Number 1904-AC52
Commercial and Industrial Equipment:	)	
Proposed Determination of Set-Top Boxes	)	
and Network Equipment as a Covered	)	
Consumer Product, Proposed	)	
Determination	)	

RESPONSE OF
THE NATIONAL CABLE & TELECOMMUNICATIONS ASSOCIATION

William A. Check, Ph.D
Senior Vice President, Science & Technology
and Chief Technology Officer

Andy Scott
Vice President, Engineering

Jim Partridge
Vice President, Industry & Technical Analysis

Rick Chessen
Neal M. Goldberg
Stephanie L. Podey
National Cable & Telecommunications
Association
25 Massachusetts Avenue, N.W. – Suite 100
Washington, D.C. 20001-1431

Paul Glist
Paul Hudson
Adam Shoemaker
Davis Wright Tremaine LLP
1919 Pennsylvania Avenue N.W., Suite 800
Washington, D.C. 20006-3401

March 15, 2012

TABLE OF CONTENTS

In re

Energy Conservation Program for
Consumer Products and Certain
Commercial and Industrial Equipment:
Proposed Determination of Set-Top Boxes
and Network Equipment as a Covered
Consumer Product, Proposed
Determination

Docket No. EERE–2010–BT–DET–0040
RIN Number 1904-AC52

**RESPONSE OF
THE NATIONAL CABLE & TELECOMMUNICATIONS ASSOCIATION**

The National Cable & Telecommunications Association (NCTA)[1] hereby submits its

comments in response to the Request for Information (RFI) released by the Department of

Energy (the Department) in the above-captioned proceeding and to its Preliminary Market and

Technology Assessment ("Preliminary Assessment").[2]

The cable industry fully supports improving the energy efficiency of set-top boxes.

NCTA has previously briefed the Department on steps that the cable industry has taken, long

before this proceeding was launched, to improve energy efficiency in set-top boxes that cable

---

[1] NCTA is the principal trade association for the U.S. cable industry, representing cable operators serving more than 90 percent of the nation's cable television households and more than 200 cable program networks. The cable industry is the nation's largest provider of broadband service, after investing over $185 billion since 1996 to build two-way interactive networks with fiber optic technology. Cable operators also provide state-of-the-art competitive voice service to nearly 25 million customers.

[2] *See Energy Conservation Program: Test Procedure and Energy Conservation Standard for Set-Top Boxes and Network Equipment*, Request for information (RFI) and request for comments; notice of public meeting, 76 Fed. Reg. 78174 (Dec. 16, 2011); Rulemaking Overview and Preliminary Market and Technology Assessment: Energy Efficiency Program for Consumer Products: Set-top Boxes and Network Equipment, Department of Energy (Dec. 11, 2011) ("Preliminary Assessment"). The deadline for comments was extended in Notice of extension of public comment period on Jan. 25, 2012.

operators provide to customers.[3] It has briefed the Department on the launch last year of new

cable industry initiatives dedicated to further improving the energy efficiency of cable-provided

consumer set-top boxes on an aggressive timeline, and to developing advanced cable-enabled

services designed to promote innovative consumer energy conservation measures.[4]

These voluntary efforts are already achieving reduced energy consumption, and further

progress is coming given the tremendous work by major cable operators, vendors, and

CableLabs - Energy Lab to meet voluntary energy efficiency commitments. We are, however,

deeply concerned that the Department's proposed approach on set-top box energy efficiency fails

to reflect the complexity of set-top box operations, the highly varied nature of set-top boxes, and

the wide variety of multichannel video programming distributors' (MVPDs) system architectures

in which these set-top boxes are integrated, and that it may inadvertently thwart the rapid

innovation that characterizes the video industry. As detailed below and in the attached

appendices, the regulatory tools that the Department proposes to bring to bear on set-top boxes

would slow or undermine more promising and rapidly-developing voluntary energy efficiency

efforts and the development of innovative new services and features that would deliver immense

benefit to consumers. Given these concerns, and in light of the significant legal questions

regarding the Department's authority to adopt standards for set-top boxes, the better approach to

achieving the Department's and the industry's energy conservation goals would be to permit

ongoing marketplace developments to proceed without the specter of government regulation.

---

[3] *See Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment: Proposed Determination of Set-Top Boxes and Network Equipment as a Covered Consumer Product*, Proposed Determination, Comments of NCTA (filed Sept. 30, 2011) ("NCTA Comments on Classification").

[4] *See* NCTA, Memorandum for the Record, to the Department of Energy, Dec. 5, 2011, filed as ex parte communication, Docket No. EERE-2010-BT-DET-0040, RIN Number 1904-AC52 ("NCTA Dec. 2011 ex parte").

EXECUTIVE SUMMARY

The cable industry is delivering dramatic increases in energy efficiency. This ambitious undertaking substantially erodes the Department's policy rationale for imposing energy efficiency mandates, as well as the legal underpinnings for any rules it could adopt. Additionally, the potential for any mandates to impede innovation and investment calls into question the wisdom of imposing mandates. As a result, the Department need not – and should not – proceed to the next phase of this proceeding.

The cable industry's energy initiative has already delivered tangible results. Cable operators are deploying set-top boxes with "light sleep" capabilities that reduce energy consumption when the set-top box is not in active use, and will be providing "light sleep" software upgrades this fall to compatible set-top box models already in consumer homes. Light sleep is projected to save 350 million kilowatt hours in the first year alone. Energy-efficient digital transport adapters (DTAs) are already saving 2 billion kWh annually, and those savings are growing. Cable operators are already ahead of schedule in deploying set-top boxes that have "light sleep" capabilities and that meet ENERGY STAR 3.0 energy standards, and they have committed to volume procurement to move the marketplace decisively towards more energy-efficient models.

The new CableLabs - Energy Lab is bringing together operators, suppliers and developers to seek consensus on "deep sleep" solutions that can meet consumer expectations for instant viewing while significantly improving energy efficiency. Set-top boxes with this functionality will be ready for field tests in 2014. CableLabs brings to the task a unique test laboratory that has assembled the wide and rapidly-changing variety of hardware, software, code drops, and key applications used by cable operators nationwide. This environment, created for product certification, interoperability testing, and product development for cable operators and suppliers,

is ideal for development of energy efficiency specifications and test methodologies tailored for "real world" cable systems that can provide a consistent, repeatable, and accurate measurement of energy consumption.

Cable operators are also using creative and energy-efficient methods for meeting the skyrocketing consumer demand to enjoy cable services anytime, anywhere, on any screen, and often on multiple screens in simultaneous use by the same viewer. Creative, practical, and efficient home networking techniques include connecting set-top boxes with multi-function DLNA-compatible retail devices; MoCA 2.0 networking specifications that support moving devices into and out of low power states in coordination with other devices in the home network; and multiple techniques for delivering services directly in Internet Protocol (IP) to consumer-owned digital devices like tablets, PCs, smart TVs, and game consoles.

The Preliminary Assessment is based on inaccurate information and fails to reflect these marketplace realities. It fails to recognize the cable industry's strong and demonstrated business incentives for efficiency. It makes out-of-date assumptions based upon older set-top boxes that have already improved, a "typical" home that is not typical, and inaccurate projections about "business as usual" growth in set-top box energy consumption. NCTA urges the Department to focus instead on what the marketplace is delivering, the early returns from the cable industry's recent energy initiatives, and expert projections that the number of deployed set-top boxes likely will peak and decline as operators shift to IP-based, network-based, and other alternative solutions. *Under the Energy Policy and Conservation Act (EPCA), the Department cannot adopt energy efficiency standards that would not result in significantly better energy conservation than non-regulatory approaches. The savings the cable industry is delivering through the market and through voluntary initiatives promise superior, tailored, practical, effective, and flexible results*

years before any regulation could take effect, which the Department has acknowledged would be 2018 at the earliest.

The Department's regulatory approach to energy efficiency standards for consumer products does not fit the real world of the set-top box marketplace. The Department's usual approach assumes that covered products are commodities that consumers will purchase at a premium price paid back over time through decreases in residential electricity bills. But set-top boxes are not commodities; they vary from network to network and device to device. They are integrated components of distribution networks that differ significantly in network architectures, transmission protocols, software stacks, conditional access security systems, out-of-band communications channels used for command and control of the set-top box, operating system and processor instruction sets, network control architectures in support of interactivity, and electronic program guide applications and guide metadata formats, among other variables. Changes to set-top boxes entail changes in the network, and network costs, that the Department's proposed approach does not take into account. Set-top boxes are not sold to consumers like major appliances priced to pay back through energy-efficiency. They are leased at regulated rates that are based upon cost, depreciation, ongoing maintenance and service, and inventory; bundled with services that include network and programming costs; and returned when consumers change services, switch devices, move, or cancel service. As a result, it is difficult to try to define and develop economic analyses and standards for these products using the Department's traditional tools for regulating consumer products. In fact, set-top boxes are not even "consumer products" that may legally be designated as "covered products" under Section 6292.

The Department's approach to identifying optimal technology is even more ill-suited to the set-top box market. Device design and choice do not lend themselves to one-size-fits-all decisions about what is technically possible or economically justified. Highly-variable private bilateral affiliation agreements between content suppliers and content distributors, and the readiness of content owners to litigate over these rights, affect and limit choices, and often not in the same ways from distributor to distributor. As cable operators evaluate modifications to their service delivery mechanisms, they must each carefully consider the rights under their many individually-negotiated affiliation agreements, and, where necessary, negotiate with individual content owners to assure that they have all necessary rights. As a result, the Department cannot assume that one-size-fits-all efficiency methods, available in theory, can lawfully, technically, and economically be implemented by each and every service provider.

The Department is required by law to protect performance, reliability, and features generally available in covered products; to minimize adverse impact on manufacturers and consumers; and to "promote innovation" and "consider regulatory approaches that reduce burdens and maintain flexibility and freedom of choice for the public."[5] But the Department's standard approach used for consumer products would violate those requirements when applied to set-top boxes. It would stifle innovation by apparently preventing the download of new features to a device – such as integrated social networking or home energy management – unless a cable operator removed some other function from the device or petitioned for a rule change. The Department's suggested design for home networking would stymie superior innovations already being deployed. Its catalog of potential energy efficiency measures does not reflect the realities of this marketplace, and would threaten the use of multimedia gateways, improvements in

---

[5] Improving Regulation and Regulatory Review, Executive Order 13563, 76 Fed. Reg. 3821 (Jan. 21, 2011) ("Executive Order 13563").

display resolution, and future innovations. In the same way that the FCC's mandate that cable

operators include CableCARDs in their set-top boxes led to energy waste and delay in the

deployment of more energy efficient devices, Department regulation would unleash similarly-

unfortunate unintended consequences.

The Department is required by law not to lessen competition. Any approach that focuses

exclusively on MVPD set-top boxes and not over-the-top (OTT) and other set-top boxes would

distort competition and ignore competitive parity. There are over 200 million OTT and other

video devices that are not provided by MVPDs, most of which operate as set-top boxes but are

less energy-efficient than MVPD-supplied devices. By 2018, many observers, including the

Department, believe these are likely to be an integral part of the "future of TV." It would be

arbitrary – and ultimately counterproductive to the Department's energy efficiency goals – to

ignore them.

I. THE CABLE INDUSTRY'S ENERGY INITIATIVES ARE DELIVERING SWIFT, PRACTICAL, AND EFFECTIVE ENERGY SAVINGS

The cable industry has long been committed to energy efficiency, but it has recently

redoubled its efforts. The energy efficiency of set-top boxes has improved dramatically over the

course of the past decade. And in November 2011, the industry announced a new set of

initiatives and commitments that will improve efficiency even more.

These new initiatives include (1) the creation of CableLabs - Energy Lab (a specific

facility within CableLabs dedicated to improving energy efficiency); (2) focused projects to

increase the efficiency of set-top boxes through development of "light sleep" and "deep sleep"

set-top box modes; and (3) cable operator procurement commitments for set-top boxes that meet

ENERGY STAR standards.   As detailed below, the cable industry's voluntary energy initiatives

are already showing substantial, tangible, and promising results:

- Light sleep is already producing significant energy savings, beginning this year, of 350 million kilowatt hours in the first year.

- Deep sleep, while still in development, is targeted to far more sophisticated power scaling. As we estimated in prior presentations,[6] "deep sleep" could cut total energy consumption by 75% or more, and field tests are planned for 2014.

- In addition, energy-efficient DTAs that consume less than 4 watts each are saving 2 billion kWh annually in place of much higher-powered set-top boxes.[7]

CableLabs - Energy Lab. As of March 2012, CableLabs - Energy Lab has been established and operating at CableLabs' facility in Colorado. Since its founding in 1988, CableLabs has served as the major research and development laboratory for the cable industry. Modeled on Bell Labs, CableLabs has more than 160 employees (including more than 120 technical staff) in addition to large numbers of visiting engineers. Over the decades, it has recreated the wide variety of cable headends in use in North America in order to develop and test products in "real world" environments. It has built 14,000 square feet of lab space dedicated to product certification, interoperability testing, and product development for cable operators and suppliers. CableLabs has a proven history of solving difficult problems in practical, consensus-based ways. It was instrumental in the development of DOCSIS, the standard that brought the Internet from dial-up to broadband, made the modem available at retail, and caused prices to plummet from $500 to less than $50 per modem. CableLabs - Energy Lab project participants include CableLabs personnel and subject matter experts from all major cable operators, chip

---

[6] *See* NCTA Dec. 2011 ex parte, Attachment C, Energy Efficiency in Set-Top Boxes at slide 14.

[7] *See infra* fn. 14 for supporting calculation. Although DTAs are one-way devices, they have become the most commonly deployed set-top box by some operators. The Preliminary Assessment is incorrect in stating that "STBs with only 1-way communication currently represent a relatively small percentage of the market, and are losing market share in favor of 2-way STBs." DTAs represent a large and growing percentage of cable operator set-top box deployments.

manufacturers, and set-top box manufacturers. Additionally, CableLabs often collaborates with government, industry, and research organizations. With its new focus on energy efficiency, it established relations earlier this year with Lawrence Berkeley National Laboratory and the CalPlug program at the University of California at Irvine.

As discussed in more detail in Section II below, CableLabs is uniquely well positioned to address the complex development of sleep functionalities and perform testing for energy efficiency of cable set-top boxes as they operate as integrated parts of highly varied cable networks, software stacks, and guides provided by cable operators. The Energy Lab has four major efforts underway at present: (1) testing "light sleep" in a variety of set-top boxes; (2) engaging multiple working groups in developing specifications for "deep sleep" for next generation semiconductor and hardware; (3) developing a consistent ENERGY STAR-based energy tracking program for new-model set-top boxes; and (4) building a showcase to demonstrate energy savings products and power monitoring capabilities, such as the residential energy management program recently announced by Comcast and Ecofactor to be integrated into Comcast's Xfinity platform.[8] Moving forward, the Energy Lab will also serve as a testing and development facility for developers of energy efficient software and hardware, and products that will help consumers manage their overall residential energy consumption.

"Light sleep." One of the cornerstones of the industry's initiative is a "light sleep" program designed to improve energy efficiency of devices during periods when the customer is not watching or recording video. "Light sleep" generally refers to a lower-power operating condition during extended periods of inactivity, such as shutting down the hard disk drive or turning off video outputs. As part of the industry's initiative, the six largest U.S. cable operators,

---

[8] *See* Kirsten Korosec, *Comcast Taps EcoFactor's Smart Thermostat Tech,* SmartPlanet, Feb. 28, 2012, *available at* http://www.smartplanet.com/blog/intelligent-energy/comcast-taps-ecofactors-smart-thermostat-tech/13590.

serving approximately 85 percent of U.S. cable households, committed to beginning the deployment of "light sleep" options for new model set-top boxes by September 2012. These features will be developed by cable operators for use via the network or through user-selected power management tools.

Some of the largest cable operators already have these "light sleep" deployments underway. In addition, although energy efficiency measures in other industries may typically apply only to new devices, cable operators will begin providing software upgrades this fall to set-top boxes already in consumer homes to enable "light sleep" in models capable of implementing that functionality.

Additionally, CableLabs is completing its first round of testing of the benefits of "light sleep." It estimates that "light sleep" mode reduces energy consumption by approximately 20% or more. CableLabs estimates that there will be more than 10 million set-top boxes capable of light-sleep functionality by the end of 2012. This translates to annual energy savings of about 350 million kilowatt hours in the first year.[9]

The Preliminary Assessment is therefore wrong in asserting that "no pay-TV service provider has initiated a significant power management scheme to date,"[10] and that "[s]ervice providers have made only limited gains in reducing set-top box energy consumption when subscribers are neither watching nor recording video."[11]

"Deep sleep." In addition to its work with "light sleep" mode, the cable industry, in conjunction with its hardware, applications, security, and set-top box suppliers and other subject

---

[9] In addition, Cablevision has deployed approximately 1.5 million HD set-top boxes with "DVR Plus" – a service that allows customers to remotely store digital recordings through the network without the need for a DVR disc in the set-top box. This effectively provides the benefits of "light sleep" by moving functionality into the network.

[10] Preliminary Assessment § 4.6.2.

[11] *Id.* § 4.5.2.

matter experts, is continuing its work to develop a "deep sleep" mode in future generations of semiconductors for new set-top boxes. [12] "Deep sleep" mode would be designed to allow parts of the device to operate in a deeply reduced power consumption mode when not in use, while still functioning with system architectures and meeting consumer expectations for quick start-up time. As part of this effort, the industry will develop specifications during 2012 for next-generation semiconductors. With the cooperation of the multiple suppliers involved in this effort, the cable industry has committed to field trials for set-top boxes with "deep sleep" mode by December 2014.

Procurement Commitments. Another major part of the cable industry's energy initiative is that each of the six largest cable operators, serving approximately 85 percent of U.S. cable households, have committed to purchase new energy efficient set-top boxes. By year-end 2013, at least 90 percent of all of their new set-top boxes purchased and placed in service will meet or exceed ENERGY STAR 3.0 standards. In addition to the benefit of reducing energy usage directly, this commitment by the largest cable operators will assure the manufacturing volume helpful for the transition to energy efficient set-top boxes by all U.S. service providers. Again, cable operators are not waiting until the deadline to implement this commitment. During 2011, the vast majority of the set-top boxes purchased by large cable operators met the ENERGY STAR 2 or 3 standards. This year, Comcast, Time Warner Cable and Cox, for example, are each already deploying HD DVR and other HD set-top boxes that meet ENERGY STAR 3.0 standards.

---

[12] Demand from the largest cable operators is spurring greater energy efficiency development throughout the chain of suppliers of set-top boxes and their components. For example, Broadcom recently announced two new system-on-chip solutions (one for gateways and the other for HD DTAs) that it says can reduce energy consumption up to 65% over a 24-hour period with power-management features that put the devices into "stand-by" mode when not being actively used. *See* Todd Spangler, *Broadcom Chips in for Power-Saving HD DTAs, Web Gateways*, Multichannel News, Mar. 12, 2012, *available at* http://www.multichannel.com/article/481672-Broadcom_Chips_In_For_Power_Saving_HD_DTAs_Web_Gateways.php.
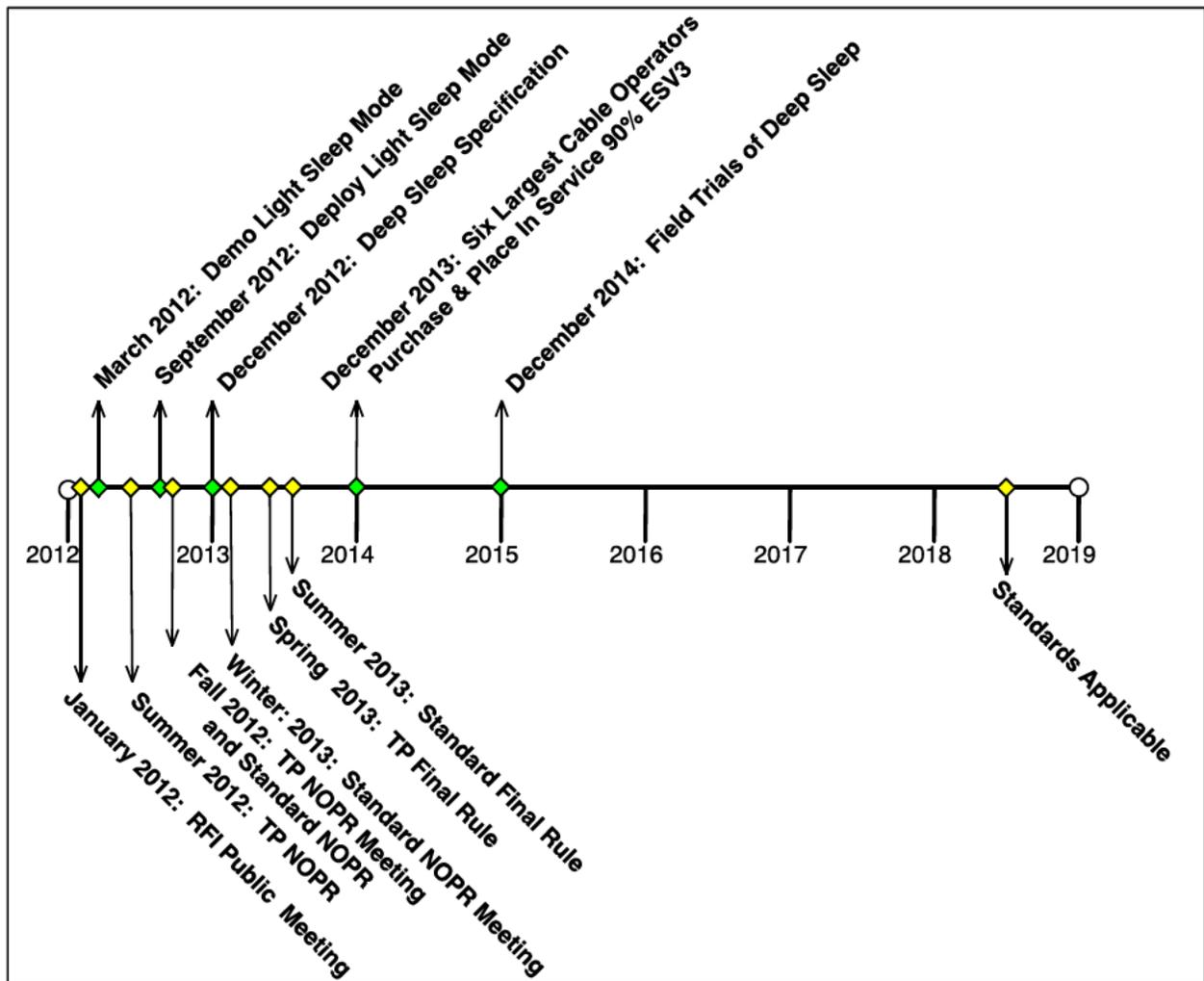
Energy Efficient DTAs. At the beginning of this decade, cable operators were in the early

stages of a transition to all-digital systems, which allows cable operators to use reclaimed

spectrum for more video services and faster broadband over their distribution systems.[13] After a

long regulatory battle to permit use of these energy efficient devices, cable operators offered

energy-efficient DTAs as they transitioned to digital. The more than 27 million DTAs in use

today consume 2 billion less kWh this year than the new model ENERGY STAR HD and SD

set-top boxes that could have been deployed in their place.[14] As more systems go all-digital,

more DTAs are expected to be deployed.

These industry initiatives are adapted to the enormous variation within the industry and

the rapid pace of innovation and change. Even if the Department could find a solution as

tailored, practical, effective, and flexible as the cable industry's initiative, these voluntary

industry initiatives promise results years before any DOE standards could be applied, which the

Department has acknowledged would be in 2018 at the earliest.[15] The chart that follows

compares the timetables for the cable industry energy initiative (with benchmarks above the

timeline) with the timetable for the Department rulemaking (with the relevant benchmarks below

the timeline).

---

[13] In an all-digital system, every analog TV must be connected to a set-top box to display digital programming, and every digital TV must be connected to a set-top box to display encrypted digital programming. Cable's Direct Broadcast Satellite (DBS) and telephone company competitors were already all-digital, and provided fully-featured set-top boxes for each connection.

[14] This calculation assumes that DTAs took the place of approximately 19 million new model SD non-DVR set-top boxes that each use 12.7 watts and 8 million new model HD non-DVR set-top boxes that use 14.6 watts each. Communications Daily reported an estimated 27.2 million DTAs have been deployed as of December 31, 2011. *See* Jonathan Make, *Extent of Analog Cable Subscriptions Debated by NAB, NCTA on Dual Carriage*, Comm. Daily, Mar. 14, 2012, at 6 (citing SNL Kagan).

[15] 42 U.S.C. § 6295(l)(2) (requiring five-year period before new standards may apply). *See* Department of Energy Framework Public Meeting on Set-top Boxes and Network Equipment, Presentation slides, at slide 15.

Timeline markers (above the line):
- March 2012: Demo Light Sleep Mode
- September 2012: Deploy Light Sleep Mode
- December 2012: Deep Sleep Specification
- December 2013: Six Largest Cable Operators Purchase & Place In Service 90% ESV3
- December 2014: Field Trials of Deep Sleep

Timeline years: 2012 2013 2014 2015 2016 2017 2018 2019

Timeline markers (below the line):
- January 2012: RFI Public Meeting
- Summer 2012: TP NOPR
- Fall 2012: TP NOPR Meeting and Standard NOPR
- Winter: 2013: Standard NOPR Meeting
- Spring 2013: TP Final Rule
- Summer 2013: Standard Final Rule
- Standards Applicable

II. THE CABLE INDUSTRY IS BEST POSITIONED TO ADDRESS COMPLEX SLEEP AND TESTING ISSUES IN THE FRAMEWORK OF PRIVATE INDUSTRY COMMITMENTS

The cable industry is able to deliver the substantial energy savings on the expedited timeframe described above because of the significant resources it has invested in the research, development, and testing capabilities of CableLabs, which enables it to tackle complex issues such as power management for set-top boxes as they operate on cable systems.

13

A.   Challenges of Power Management for Set-Top Boxes

Achieving "deep sleep" mode efficiencies in cable set-top boxes presents significantly greater challenges than achieving "light sleep." Set-top boxes operate as integrated parts of complex networks. Even when they are not actively being used to display video, set-top boxes are receiving important software updates and navigation information (such as changes in channel location), populating program guides with the latest programming schedules and descriptions, receiving Emergency Alert System (EAS) messages, and receiving and sending other data for diagnostics, to assure that the service delivers the functionality expected and enjoyed by consumers. These functions require that the set-top box always be ready to meet demands for instant viewing, remote programming, and other functionalities.

Advising a consumer to unplug the set-top box or power the unit down to zero does not work. The Preliminary Assessment is incorrect in stating that when a set-top box is powered down that it takes "two to five minutes to start (or 'boot') up and resume full functionality."[16] In fact, because the set-top box operates as part of an integrated network, shutting off power causes significant harms and can require a much greater recovery period. Specific tests by CableLabs[17] show far more significant problems from powering down a set-top box, including:

- *Lost Guide Data.* If a set-top box is unplugged, the consumer will lose most or all guide data. When the set-top box is later powered on, the user will see the guide populated with "No Data Available" for all program listings for up to a couple of hours, until the set-top box receives updated program information from the network.

---

[16] Preliminary Assessment § 3.8.2.

[17] *See* NCTA Dec. 2011 ex parte at 5, n.15.

- *Lost Recordings.* Set-top boxes equipped with DVR capabilities will not complete their scheduled recordings if they are unplugged.

- *Software Problems.* Set-top boxes require regularly-updated software to implement new features and functions, fix reported bugs, and communicate properly with the network. If a set-top box is unplugged, it will not receive these updates. When powered back on, the set-top box may go into a forced upgrade at boot-up for approximately 40 minutes *before* tuning video or populating a guide.

- *Lost Security Keys.* Each set-top box must remain connected to the network in order to maintain its security relationship with network-based servers. If unplugged for prolonged periods (*e.g.* 3 to 4 weeks) or during an unscheduled security refresh (*e.g.* to renew security in the event of a breach or attack), the set-top box could lose the ability to decrypt content. The user will need to call the cable operator to reset it and will not be able to play most content until this is done.

- *Compromised Incident Response.* Cable operators proactively monitor their networks to determine whether there are outages that must be repaired. If a set-top box is unplugged, it does not answer a ping sent from the network. When there are a number of such set-top boxes in a given service area, operators surmise there is a significant plant issue and take action to remedy it.[18] Investigating such "false positives" slows operators' ability to respond to actual plant issues (such as downed utility poles), causing truck rolls with needless environmental impact and unnecessary operator expense.

---

[18] Proactively monitoring the network via set-top boxes allows outage repairs to take place in the middle of the night, thereby reducing customer impact.

The Preliminary Assessment is also incorrect in suggesting that these problems have already been overcome by "select service providers in Europe." It cites only one example, Sky Broadcasting (BSkyB).[19] As we have previously reported to the Department, the BSkyB set-top box is engineered to operate on one-way satellite systems and is not compatible with – or comparable to – more advanced two-way U.S. cable systems.[20] We are not dismissing various "deep sleep" approaches, whatever their provenance. But until consensus solutions are designed for operation across U.S. cable systems, the problems have not been overcome. This is the very endeavor on which dozens of experts are currently engaged at CableLabs.

B. Set-Top Box Testing Requirements

CableLabs is uniquely situated to perform testing for cable set-top box energy efficiency because it has assembled the equipment and software to effectively recreate the wide variety of cable headends in use in North America.

1. Test Environment Requires Access to Multiple Headends

Today's cable systems vary widely in technology and architecture as a direct result of the industry's technological and structural evolution over the previous five decades. Cable was not designed to a common plan as was the "Bell System." Some cable operators used headends, security, and set-top boxes designed and built by Motorola (formerly General Instrument), while others used equipment designed and built by Cisco (formerly Scientific Atlanta). Their different respective proprietary approaches have been integrated into their equipment, which is therefore

---

[19] Preliminary Assessment § 4.6.2.

[20] The Pace set-top box for BSkyB wakes the chip several times per second to check for broadcast commands from the satellite network. The RFI similarly queries whether a "deep sleep" mode could be designed for U.S. operators in which the set-top box in "deep sleep" would "automatically wake up once every 30 minutes to communicate with the service provider and check for updates." U.S. cable networks use a two-way architecture with individual commands that flow back and forth from the set-top box to the network. In a two-way system, however, it is preferable to design a "deep sleep" mode in which the network has the capability to wake the set-top box on an as-needed basis. *See* NCTA Dec. 2011 ex parte at 5.

not interoperable.[21] Moreover, their design approaches have varied depending on the needs of their customers. General Instrument sought to serve its largest customer's desire for increased channel capacity, lower head-end cost, and centralized set-top box control and authorization. Scientific Atlanta sought to meet its largest customer's desire for two-way interactive services (such as video-on-demand), the ability to add applications and services to the set-top box over time, and local control and authorization.[22]

This diversity of approaches has further diverged, with cable systems upgrading at different times using different digital equipment and software. For example, cable operators have chosen different video-on-demand vendors. Some operators deployed switched digital video ("SDV"), which delivers certain channels only when they are tuned by consumers, while others have not.[23] Cox's Trio guide, Time Warner Cable's Navigator® guide, and Comcast's Xcalibur guide for Hosted Navigation are very different from one another. While these cable systems share some common features, such as MPEG-2 compression and QAM modulation, they have many more distinct proprietary elements: different conditional access, out-of-band communications channels used for command and control of the set-top box, operating system (OS) and processor instruction sets, network control architecture in support of interactivity, and electronic program guide applications and guide metadata formats.

---

[21] Ralph W. Brown, *Tackling the US Cable Set-top Legacy: Middleware in a Sea of Proprietary Systems* at 2 (competing industry equipment suppliers developed proprietary solutions for system architecture, equipment, and set-top boxes, "sufficient to eliminate the possibility that a set-top from one supplier could operate on the network of the other"). Attached as Appendix C hereto.

[22] For the most rural markets, Motorola developed a "Headend in the Sky" ("HITS") platform that enabled smaller cable systems to offer more programming without investing in as much complex equipment at a local headend.

[23] *See Oceanic Time Warner Cable, a Subsidiary of Time Warner Cable, Inc*., Order on Review, File Nos. EB-07-SE-351; EB-07-SE-352, 24 FCC Rcd 8716, 8720-21 ¶ 10 (June 26, 2009) (explaining the technology behind SDV and noting that customers access switched channels "by sending a request, using a remote or program guide, upstream through the use of a set-top box to the hub"). For these systems using SDV, the Preliminary Assessment (at § 4.2.1) is incorrect in asserting that the cable operator "sends every available channel to the STB."

Due to consolidation in the cable industry, there can even be considerable variation among systems owned by the same company. Cable operators that were once in the top ten – TCI, MediaOne, Adelphia, Century and Marcus – have been acquired (sometimes in parts) by other operators, leaving the owners today with a wide variety of system architectures and technologies within single companies.[24] Today's cable systems thus encompass "a set of legacy digital video delivery systems that have a huge installed base of tens of millions of digital cable set top boxes," and system technology that "spans over a decade of technology advances resulting in a broad range of set-top capability and performance."[25] There are more than 7,000 cable headends in the United States with countless permutations of hardware and software designs. Accordingly, set-top boxes continue to have significant "variations on processor, memory, graphics and video processing capabilities that occurred over ten years of set-top technology development."[26]

2. CableLabs Testing Facility

CableLabs has built and maintained a laboratory where devices can be tested against this wide variety of cable implementations. It maintains not only legacy and current hardware, but the current software, code drops, and key applications (such as program guides) which cable operators change frequently. This environment, created for product certification, interoperability testing, and product development for cable operators and suppliers, is now ideal for development

---

[24] *Compare, e.g. Fifth Annual Report*, 13 FCC Rcd 24284, 24422, Table C-3 ("1998 MVPD Horizontal Concentration Nationwide") with *Annual Assessment in the Status of Competition in Markets for the Delivery of Video Programming Services*, 24 FCC Rcd 542, 556 (2009), Table 2 ("Top MSOs' Basic Cable Subscribers – Year End 2004 to June 2006"); *id.* at 687, Table B-3. While the number of operators decreased, between 1990 and 2012, the number of customers served by the industry increased by 55% (from 50,000,000 total basic subscribers to 77,655,000). Television & Cable Factbook No. 80, Cable Vol. at F-1 (Table, "Estimated Growth of the Cable Industry") (Warren 2012).

[25] Brown, *Tackling the US Cable Set-top Legacy: Middleware in a Sea of Proprietary Systems* at 1.

[26] *Id.* at 6.

of energy efficiency specifications and test methodologies tailored for "real world" cable systems.

The CableLabs infrastructure is unique in that it enables controlled and repeatable testing in as realistic an environment as technically feasible. Closed network testing in this environment enables an accurate assessment of the various network configurations, including conditional access, channel lineup, control signal network (DAVIC, DC-II, or DSG), the guides in use, and set-top box operation. This realistic testing environment enables consistent, repeatable, and accurate measurement of energy consumption in various set-top boxes and network configurations.

By contrast, testing in a home on live plant – an option under consideration in the Preliminary Assessment –would not provide access to test signals from the wide variety of headends or produce repeatable results. Conceivably, testing in homes might serve as a supplement to lab testing, but it would be problematic to integrate such testing into a normal product development and acquisition cycle. In general, cable operators do not encourage non-certified or development equipment to be attached by consumers to live plant, because the network is a shared facility. Products are normally tested and certified in a lab environment before they are ordered and manufactured in quantity.

3.   CableLabs Test Method

The energy efficiency of set-top boxes should be tested as shipped and as normally installed for the end-user. Testing should be carried out in controlled, repeatable conditions, such as the CableLabs test facility. CableLabs is currently engaged in developing a test methodology designed to emulate "real world" viewing habits.

As part of that effort, CableLabs is reviewing the potential test methodologies suggested in the RFI, current draft CEA testing spec CEA-2043, IEC-62087, and is working with subject

matter experts on the development of an appropriate test methodology. At present, existing draft and IEC specifications are not adequately tailored to serve as a test methodology for "real world" cable systems or for cable power management states. CableLabs is consulting with several stakeholders to design a test methodology appropriate for cable set-top boxes while also accounting for the testing needs of set-top boxes used on other platforms.

The cable industry is committed to developing a test method that allows tracking of set-top energy efficiency in as realistic an environment as technically feasible. CableLabs is uniquely positioned to meet this goal. By contrast, the Department's efforts to conduct testing in private homes on live plant that it does not control, or to recreate the wide variety of headends, networks, and constantly-changing software stacks and guides, is impractical and would not achieve its desired results. Allowing the industry to bring its unique resources to bear will achieve realistic energy efficiency measures in a practical and efficient manner.

III. THE DEPARTMENT'S REGULATORY APPROACH DOES NOT FIT THE SET-TOP MARKETPLACE

At the Department's public meeting on January 26, 2012, it was widely acknowledged that set-top boxes and the marketplace in which they are sold and distributed are very different from the other appliances for which the Department has previously adopted energy efficiency standards.[27] Parties emphasized that set-top boxes change much faster than other regulated appliances, and that the already-underway energy efficiency initiatives are delivering solutions faster than could Department standards. As a result, the traditional regulatory approach and analytical and measuring tools that the Department has used in prior proceedings are not suited to its consideration of set-top boxes.

---

[27] January 26, 2012 Framework Public Meeting on Set-top Boxes and Network Equipment, Court Reporter Transcript ("Public Meeting Transcript") at 121-122.

A. Mandated Efficiency Standards Are Not Economically Justified Given Marketplace Developments and the Incentives of Network Service Providers to Improve Efficiency

NCTA was disappointed that the Preliminary Assessment repeats the erroneous premise that cable operators and their equipment suppliers lack incentives to conserve energy. The cable industry's public commitments and achievements tell a different story, one which the Preliminary Assessment largely ignores. Cable operators pursue energy efficiencies in delivering cable services because energy efficiency aligns with the key objectives for the business. Cable operators own and maintain tens of millions of devices in consumer homes. If these devices fail, it means customer dissatisfaction, expensive customer service calls, and additional cable truck rolls. In a marketplace with formidable competitors that are constantly vying with one another for subscribers, cable operators are eager to avoid these consequences and therefore embrace energy efficiency.

Lower power consumption generally means less heat and lower operating temperatures for devices, which translates into lower component failure rates and fewer service calls from failed equipment. Likewise, cable operators favor the integration of components onto "systems on a chip" to reduce component count, which means both lower failure rates and lower energy consumption. With generational chip changes, lower energy consumption need not mean lower performance. They can also provide increased processing horsepower which allows them to run better applications and user interfaces for consumers. Lower power usage is well aligned with the cable industry's business incentives: better total cost of ownership (including purchase, maintenance, and repair), fewer trouble calls, and better performance in a competitive marketplace.

The best evidence of the cable industry's incentives to reduce set-top box energy consumption is found in its recent track record in reducing set-top box energy consumption and

commitments to pursue further energy conservation measures over the next few years. These

voluntary cable industry efforts make Department standards not only unnecessary, but unjustified

by law. In evaluating whether, under Section 6295(o)(2)(B), the benefits of any proposed

efficiency standard exceeds its burdens, "savings likely to result *directly* from the imposition of

the standard" must be superior to the savings expected from non-regulatory approaches.[28] By

law, the net present value of the estimated energy savings that would result beginning in 2018 as

a result of any mandatory DOE standards must be measured against the estimated usage that

would otherwise occur in 2018 and beyond *after these voluntary initiatives and market changes*

have been factored into the equation.[29] The Department's current proposed analytical

framework would not enable it to meet this requirement.

As an initial matter, the Department is starting from a mistaken baseline. The NRDC

report, on which the Preliminary Assessment relies, was based upon set-top boxes in circulation

in early 2010.[30] As we have previously demonstrated, and as the Department seems to agree,

efficiency has improved dramatically since then.[31] Second, the NRDC report assumes a

"typical" home has one HD DVR and one HD non-DVR, but such a home is not typical.[32]

Third, NRDC presents a chart claiming that "business as usual" would require at least four more

---

[28] 42 U.S.C. § 6295(o)(2)(B)(i)(III).

[29] This point is illustrated in a study of television regulation by the California Energy Commission, in which the authors demonstrate that energy savings must be discounted by the energy savings delivered through improved technology incorporated in each successive model of television. C. Paul Wazzan & Dawn E. Eash, *A Review of the 2011 and 2013 Digital Television Energy Efficiency Regulations Developed and Adopted by the California Energy Commission*, Cal. J. of Pol. & Pol'y, Vol. 3, Iss. 1, at 12. The Department seeks to apply a similar energy savings analysis to set-top boxes, and must also account for how rapidly marketplace and technology developments are themselves delivering the energy savings that may no longer be attributed to proposed standards.

[30] As the Preliminary Assessment notes, the set-top boxes measured by the NRDC study were those in circulation in early 2010 and their energy usage is not representative of current models. Preliminary Assessment § 4.5.2.

[31] *See* NCTA Dec. 2011 ex parte at 4. The Preliminary Assessment also acknowledges that the EPA's study of current set-top box efficiency for ENERGY STAR-qualified set-top boxes, which represent the vast majority of set-top boxes now being deployed, shows that "[o]n average, these models are consuming significantly less power than the average models in [the NRDC study], especially for HD-DVR models." Preliminary Assessment § 4.5.2.

[32] *See* NCTA Dec. 2011 ex parte at 5; NCTA Comments on Classification at 16-17.

500 megawatt power plants to power set-top boxes.[33] The NRDC chart is unsupported and does not mesh with the current state of technology, the pace of energy reduction, or expert projections that indicate that the number of deployed set-top boxes likely will peak and begin to decline as operators shift to IP-based, network-based, or other alternatives.[34]

Finally, the NRDC report overstates the role of the set-top box in overall household energy use. While we do not diminish the importance of energy efficiency in set-top boxes, some perspective is appropriate. The total energy in use by set-top boxes is dwarfed by virtually everything else in the home, such as heating, air conditioning, and appliances:[35]

kWh per Month

Total Household 958.00	Total Household 958.00	Total Household 958.00
Heating and Cooling 440.68	All Appliances 124.54	Average Cable STB 12.5

---
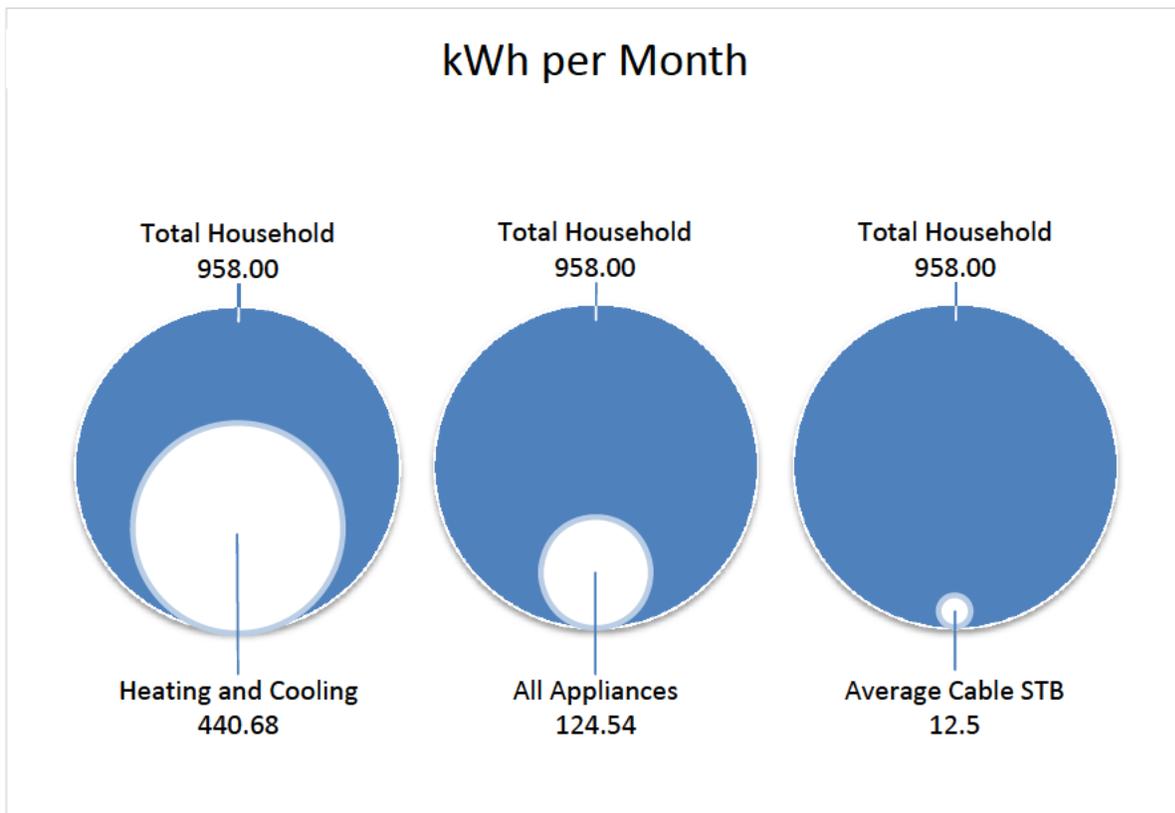
[33] Natural Resources Defense Council, *Better Viewing, Lower Energy Bills, and Less Pollution: Improving the Efficiency of Television Set-Top Boxes* (June 2011) at 5.

[34] *See, e.g.,* Ian Olgeirson, *Cable Set-Top Forecast: Industry's Move to IP Video Impacts Projections*, SNL Kagan, Sept. 16, 2011.

[35] Household energy use from U.S. Energy Information Administration, *Frequently Asked Questions: How much electricity does an American home use?, available at* http://205.254.135.24/tools/faqs/faq.cfm?id=97&t=3 (last

To accurately calculate potential energy savings that could be achieved as a result of a government mandate beginning in 2018, the non-regulation baseline must use the expected efficiency of models in the future, and not outdated data from the past. The analysis would have to accurately predict and reflect device designs as they will have evolved by 2018, and then on an ongoing basis for years thereafter. It is unrealistic to expect that the Department can accurately project energy savings in such a rapidly changing technology-driven marketplace over a 30-year period from 2018 to 2048 to justify proposed rules. Thirty years from now, set-top boxes as they are defined today may not even exist. Today's methods of video delivery may have been entirely replaced by IP, which in turn may have been replaced by something else.

Given marketplace realities, the Department cannot conclude that the "savings likely to result *directly* from the imposition of the standard" can practically be superior to the savings the industry is working to deploy well before that time.

B.   The Department Is Ignoring Network Variation

Set-top boxes are different from the appliances previously regulated by the Department because they are components of a complex network of electronics, software, and distribution infrastructure that varies not just from provider to provider, but often from cable system to cable system. There are more than 850 cable operators operating more than 7000 headends. Though

---

visited Mar. 10, 2012) (total 2010 household electricity use average of 958 kWh per month 2010); U.S. Energy Information Administration, *Table 5.3. Average Retail Price of Electricity to Ultimate Customers: Total by End-Use Sector, 1997 through December 2011*, *available at* http://205.254.135.24/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_3 (last visited Mar. 10, 2012) (average 2010 electricity cost 11.54 cents per kWh); ENERGY STAR, *Save Energy at Home, Energy Use*, *available at* http://www.energystar.gov/index.cfm?c=products.pr_save_energy_at_home (last visited Mar. 10, 2012) (heating and cooling accounting for 46% of total household distribution); Bryan Urban, Verena Tiefenbeck & Kurt Roth, *Energy Consumption of Consumer Electronics in U.S. Homes in 2010, Final Report to the Consumer Electronics Association (CEA)*, Fraunhofer Center for Sustainable Energy Systems at 90 (Dec. 2011), *available at* http://www.ce.org/PDF/Energy-Consumption-of-CE-inUSHomes-2010.pdf ("2011 CEA Report") (Average cable set-top box energy use circa 2010: 150 kWh/year).

six cable operators now provide service to approximately 85% of cable subscribers, they operate

systems with often substantial diversity in their networks and set-top boxes. There is not only

substantial variation among these six operators, but also within their companies as well. And

each of these separate ecosystems is far from static. System architectures and networks are

constantly in flux. Such changes further complicate attempts to categorize set-top box products

based on features or functionality, as the Department has been exploring in this proceeding.

Variation is even greater when other types of video service providers are considered.

Four of the eight largest MVPDs are telephone companies and DBS providers.[36] Dozens of

telephone companies, utilities, wireless providers, and other types of providers offer video

services, with varying implementations. Verizon's FiOS set-top boxes and plant are similar to

cable's, but add a separate Optical Network Terminal ("ONT") at the customer's premises

powered by the customer's residential current. AT&T transmits using managed Internet Protocol

over Discrete Multi Tone (DMT) modulation rather than MPEG over Quadrature Amplitude

Modulation (QAM) used by Verizon and traditional cable operators.[37] DBS systems rely on one-

way communication from satellites, and use low noise block-downconverters (LNBs) associated

with the satellite dish that are powered by the customer's electricity.[38]

---

[36] *See* Preliminary Assessment Table 3.5.1.

[37] The Preliminary Assessment (at § 4.2.3) incorrectly states that all so-called IPTV providers "provide[] television via the Internet." AT&T's U-verse is not delivered "over the Internet." U-verse utilizes Internet Protocol, but its video content is carried over AT&T's managed network rather than the public Internet. *See, e.g.*, What Is IPTV?, AT&T, http://www.att.com/Common/merger/files/pdf/IPTV_background.pdf (last visited Feb. 2, 2012) ("Watching U-verse TV is different than streaming videos over the public Internet. With U-verse TV, programming is carried over our managed network, which allows us to control video quality and the reliability of your service. Best-effort Internet video can be subject to delays due to lower bandwidth, high traffic or poor connection quality."); Comments of AT&T Inc., *In re Preserving the Open Internet; Broadband Industry Practices*, GN Docket No. 09-191; WC Docket No. 07-52, at 72 (Jan. 14, 2010) (describing AT&T's U-verse video service as a "*non*-Internet-based IPTV service[]") (emphasis in original).

[38] The power consumed by companion devices such as ONTs and LNBs should be included in the power consumption calculations of the associated set-top boxes since they use the consumer's electricity and must be taken with the set-top box.

In sum, not only do "set-top boxes" vary considerably by type of network, but there is also enormous deeply-rooted variation within those networks. The Department should account for these differences in considering the appropriate treatment of each set-top box "product."

C. The Department Is Ignoring Network Costs

EPCA requires the Department to consider standards based upon the maximum improvement in energy efficiency that is technologically feasible and economically justified.[39] The technical analysis and economic justification for changes in set-top boxes, however, requires far more than the analysis the Department has proposed because, unlike appliances, set-top boxes are highly integrated network devices. The Preliminary Assessment suggests that "[t]he cost to change the network infrastructure is potentially very large, and requires a long planning horizon," but that "[c]hanges to the set-top box are likely relatively low cost and easier to achieve than those to the existing network infrastructure."[40] The second part of the statement is incorrect because the first part is true: changes to set-top boxes typically necessitate changes to network infrastructure, and the costs of doing so are usually significant.

As described above, cable set-top boxes are part of integrated networks that rely upon real-time connectivity and communication. Because of that relationship, changes required at the set-top box level require changes at the headend and network level. For example, a set-top box can be equipped with the capability of retrieving from the network past episodes of popular television shows on an on-demand basis rather than relying upon a local DVR. But including that capability in the set-top box does nothing unless the cable operator invests in the on-demand servers and negotiates the rights with content providers to offer that option. Redesigning the set-top box requires significant network investment to make the system operate as a whole.

---

[39] 42 U.S.C. § 6295(o)(2)(A).

[40] Preliminary Assessment § 4.6.

The same is true for energy efficiency. Existing cable network architectures are the product of the diverse design needs of the many owners who built those systems. We have explained that set-top boxes cannot lose a connection to the network without losing critical data, network updates, and entitlements. Part of the reason is that systems were designed around narrow out-of-band control channels through which data must be continually fed in order to keep millions of set-top boxes up to date. The set-top boxes must remain connected to receive that narrow data stream.

As an alternative for control signaling, some systems use DOCSIS Set-top Gateway (DSG), which provides greater bandwidth. But to use DSG, the network itself has to be changed and all legacy devices on that plant need to be changed to DSG before the system can redesign network updates exclusively around DSG. Similar issues arise with architectures in support of new forms of guides. For example, Comcast's next-generation Xfinity TV experience, which is currently undergoing trials in Augusta, Georgia, features an enhanced program guide that is hosted from the network rather than resident in the set-top box.[41] Moving guide data back into the network can conserve set-top box resources, but hosted navigation in the network is very expensive due to costs of network hosting equipment and bandwidth. Changing the set-top box to gain some measure of efficiency carries a cost to the network and to the headend.

Middleware provides another illustration. Because the native languages of set-top boxes and headends were not built for interoperability, applications written to one platform do not automatically work on another. To surmount this challenge, the cable industry created the Java-

---

[41] *See* Meg James, *Comcast Chief Brian Roberts Unveils Next Generation Xfinity TV System*, L.A. Times, June 16, 2011, *available at* http://latimesblogs.latimes.com/entertainmentnewsbuzz/2011/06/comcast-chief-brian-roberts-unveils-faster-xfinity-tv-system- html; Press Release, *Comcast Corp., Comcast Chairman and CEO Brian L. Roberts to Unveil Next Generation Television Experience and New Generation Television Experience and New Broadband Speeds*, June 14, 2011, *available at* http://www.comcast.com/About/PressRelease/PressReleaseDetail.ashx?PRID=1097.

based OpenCable Application Platform (OCAP) as a middleware layer between the native code of set-top box hardware and applications intended for wide dissemination. Today, some major cable operators are using OCAP applications to put certain DVRs into "light sleep" when they are not being actively used for viewing or recording, but achieving that result comes with a cost. Specifically, at the set-top box level, the OCAP stack requires larger memory and processing power than older equipment. And OCAP also requires substantial network and headend investment.[42] Moreover, not all systems support OCAP, and even OCAP systems continue to serve millions of set-top boxes that still speak only native code. So deploying comparable protocols in such systems would require, at a minimum, the development of support at the headend for new applications for the native code in each set of set-top boxes used in that system.

The problem is even more challenging for "deep sleep" solutions and the ability of set-top boxes to reduce power consumption, be awakened by the wide area network or the local area network, and to channel critical data, network updates, firmware updates, and entitlements to each set-top box in new ways. These all require changes in the network.

The Department offers no method for factoring in the recovery of the cost of network changes incurred as a result of a mandatory energy standard.

D. The Department Is Ignoring Programming Rights

The technologically "possible" choice of device designs may also be affected by the requirements of content owners. Content suppliers license their content for distribution on MVPD platforms through complex and highly variable private bilateral affiliation agreements that define required content protection measures, restrictions on the types of devices that can receive the content, and many other terms. A content provider may be willing to make

---

[42] For example, one cable operator alone invested over $100 million in software to implement OCAP on both the network and in the set-top box. This does not even account for costs of hardware-like application servers to be able to communicate with the set-top box correctly.

programming available to MVPDs or others based on distribution paths and security particular to

that distributor. If a particular distributor does not agree or cannot deliver terms sought by the

content owner, the content owner can refuse to provide content to that distributor and rely instead

on alternative distributors, such as competing MVPDs or over-the-top platforms.

The terms of these affiliation agreements impact an MVPD's choices regarding the

devices to use in customers' homes. For example, several cable operators recently began to

enable their customers to watch content on iPads within their home without an additional set-top

box, and plan to make that function available to additional devices in the near future. However,

one of the largest content owners, Viacom, sued Time Warner Cable alleging that the parties'

affiliation agreement did not permit this arrangement.[43] Similarly, Cablevision was sued by

numerous broadcasters and studios when it launched a "remote storage" DVR ("RS-DVR"),

which allowed customers to obtain DVR functionality through the network without having a

physical DVR present in their home. The RS-DVR delivers individually-recorded content from

network-based DVRs for television display.[44] The copyright issues raised by this solution are

not completely resolved.[45] The U.S. Solicitor General recommended that the Supreme Court not

try to resolve the issues until they were developed through more litigation with other parties and

---

[43] *Viacom International, Inc. v. Time Warner Cable*, No. 11-civ-2387 (S.D.N.Y.).

[44] *See* About DVR Plus, Optimum.net, http://optimum.custhelp.com/app/answers/detail/a_id/2580/~/about-dvr-plus (explaining features and availability of the RS-DVR product, known as "DVR Plus," and noting that "[t]he DVR Plus service is similar to our traditional DVR for iO service however, the programs you recorded are stored on Cablevision's remote servers instead of storing the programs on the hard drive within the DVR cable box"); Optimum Link, Optimum.net, http://www.optimum net/optimumlink ("With Optimum Link, what you have on your computer can now be seen on your TV including videos, pictures, music and more."); Jeff Baumgartner, *Cablevision's Network DVR Debuts in the Bronx,* Light Reading Cable, Jan. 24, 2011, http://www.lightreading.com/document.asp?doc_id=203480&site=lr_cable (stating that, with DVR Plus, "all content is stored on, and played back from, the MSO's cloud-based storage banks").

[45] A federal district court ruled that Cablevision's RS-DVR was not authorized by its agreements and thus violated the Copyright Act as infringement. *Twentieth Century Fox Film Corp. v. Cablevision Systems Corp.*, 478 F.Supp.2d 607 (S.D.N.Y. 2007). Although the Second Circuit Court of Appeals reversed that decision, it did so on only some of the potential claims. *Cartoon Network LP v. CSC Holdings, Inc.*, 536 F.3d 121 (2nd Cir. 2008).

in other circuits.[46] This understandably places a cautionary flag over deployments of such technology by others.

These legal and technical considerations help explain why, as the Preliminary Assessment observes, MVPDs do not give customers unlimited choices in the types of set-top boxes they use or in the customization of service presentation.[47] Set-top boxes are part of a complex distribution system that enforces rights in content and distribution, and that is subject to a pervasive regulatory and legal regime. These same factors affect and limit the ability to redesign set-top boxes for energy efficiency.

Device design does not lend itself to one-size-fits-all decisions about what is technically possible or economically justified, because the use of devices is affected by individually-negotiated agreements among multiple distributors and multiple content providers. As MVPDs continue to consider modifications to their service delivery mechanisms, they must each carefully consider the rights under their many individually-negotiated affiliation agreements, and, where necessary, negotiate with individual content owners to assure that they have all necessary rights. The Department cannot assume that one-size-fits-all improved efficiency methods available in theory can actually lawfully, technically, and economically be implemented by each and every service provider.

---

[46] *See* Solicitor General Brief on RS-DVR, Scribd.com, http://www.scribd.com/doc/15932800/Solicitor-General-Brief-on-RSDVR ("The Second Circuit's decision, however, is unlikely to be the last appellate ruling to address these issues.").

[47] Preliminary Assessment § 3.8.2 ("Customers have limited choice of what type of STB their service provider deploys to their home. In addition, the middleware installed by the service provider often gives little to no options for customization (*e.g.*, view options, channel filtering, etc.).").

IV.   DEPARTMENT REGULATIONS WOULD THWART INNOVATION

As explained by NCTA and others at the Department's public meeting, application of the Department's standard appliance rulemaking approach to set-top box regulation would pose a grave risk to innovation.

EPCA prohibits DOE from adopting energy standards that would take away any "performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as those generally available in the United States at the time of the Secretary's finding."[48] The Administration has directed that its agencies avoid impeding such future features and innovation as well. Executive Order 13563 commits federal agencies to "promote innovation" and "consider regulatory approaches that reduce burdens and maintain flexibility and freedom of choice for the public."[49] The Administration has also directed that any new regulation should take into account the evolving nature of emerging technologies and should promote innovation.[50]

A.   Department Rules Would Impede Software Upgrades

The Department is proceeding down a path to classify set-top boxes into various product classes and then set testing and energy efficiency standards for each. The impact of this approach on feature and device innovation was made apparent at the January 26, 2012 public meeting. NCTA counsel asked how standards would be applied as new features were

---

[48] 42 U.S.C. § 6295(o)(4). ("The Secretary may not prescribe an amended or new standard under this section if the Secretary finds (and publishes such finding) that interested persons have established by a preponderance of the evidence that the standard is likely to result in the unavailability in the United States in any covered product type (or class) of performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as those generally available in the United States at the time of the Secretary's finding. The failure of some types (or classes) to meet this criterion shall not affect the Secretary's determination of whether to prescribe a standard for other types (or classes).").

[49] Improving Regulation and Regulatory Review, Executive Order 13563, 76 Fed. Reg. 3821 (Jan. 21, 2011).

[50] Memorandum for the Heads of Executive Departments and Agencies, Office of Science and Technology Policy, United States Trade Representative, Office of Information and Regulatory Affairs (Mar. 11, 2011).

downloaded to set-top boxes that were subject to energy-use limits and consumers began to use them. The representative of the Northwest Energy Efficiency Alliance – presumably speaking from experience with Department regulation – said that the answer was to remove some other function from the device or petition for a rule change:

> You have to agree on what capability the box has before you can use it . . . . I know that it has some functionalities that you can then use and change in the future, but you have two choices based on what I've seen in the past. You either adjust the energy consumption of the whole thing so that you stay within the existing limit of that class as you change it, or you can petition to DOE to make it a new class, and you can petition to test it under a different regime and represent its energy use.[51]

This approach is anti-innovation and anti-investment, and the Department must reject it. The cable industry has invested more than $185 billion in facilities and equipment since 1996 to build interactive broadband networks that are available to 93 percent of all U.S. households, or about 122 million homes. It uses that infrastructure to update set-top boxes, download new guides, add social networking and caller-ID on TV, and integrate new applications like managing home alarm systems and home energy management systems. Requiring a Department rulemaking or waiver before launching new consumer applications would hardly be conducive to rapid innovation, conservation,[52] or home energy management.

---

[51] Public Meeting Transcript at 106-107.

[52] Having a set-top box prematurely rendered obsolete consumes more energy in manufacturing. Scientists have estimated that 80% of the lifetime environmental impact of an electronics device is caused by its manufacture. For example, Executive Vice President Jill Vaske of Redemtech, an information technology asset recovery company that is providing refurbished PCs to subscribers of Connect to Compete, has explained that "[c]omputer re-use dramatically cuts e-waste because 80 percent of the environmental impact from a PC arises from its manufacture." *Redemtech Says Refurbished PCs for Broadband for the Poor Cut E-Waste*, Green Electronics Daily, Feb. 28, 2012, at 3. *See also* Eric Williams, *Energy Intensity of Computer Manufacturing: Hybrid Assessment Combining Process and Economic Input-Output Methods*, 38 Envtl. Sci. & Tech. 6166 (Nov. 15, 2004), *available at* http://www.cs.ucsb.edu/~chong/290N/Williams.pdf ("In contrast with many home appliances, life cycle energy use of a computer is dominated by production (81%) as opposed to operation (19%)"); J. Quariguasi Frota Neto & Jacqueline M. Bloemhof-Ruwaard, *The Environmental Gains of Remanufacturing: Evidence from the Computer and Mobile Industry*, ERIM Report Series Reference No. ERS-2009-024-LIS at 8-9 (May 11, 2009), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1410467 (stating that "[c]ontrary to most of the other electric appliances, the highest environmental burden of computers is due to the production phase," and listing prior studies that generated similar conclusions).

B.   Department Rules Would Impede Multi-room and Home Networking

A similar hazard to innovation is the Department's apparent view that it can design the optimal home networking technology.

The Preliminary Assessment discusses, as one of the two key "primary energy savings opportunities," shifting to a whole-home solution powered by "thin clients." The Preliminary Assessment describes a very specific view of what a whole home solution should be: one in which a primary set-top box provides the tuners, recording, and networking capability to a set of dedicated thin clients that have no independent connectivity to the network. The Preliminary Assessment acknowledges that cable set-top boxes can be used as a way to connect secondary TVs to cable, but states that this is "an expensive way to connect,"[53] and seems to state that its version of thin client is best.[54] There is no basis for this conclusion. As we will explain, that analysis has not considered the consequences to the consumer, the impact on the primary set-top box, or the rapid development of far superior methods for delivering a whole home experience.

The Department cannot realistically be expected to predict the optimal whole-home experience or the most appropriate solution for the needs of particular households. Consumers often want functionalities on multiple televisions that require network connectivity. For example, in order to address consumer demand for the availability of content "any time," cable operators have placed tens of thousands of viewing choices onto on-demand servers. Comcast features 8,000 on-demand shows and movies in high definition alone, while Time Warner Cable customers can choose from more than 10,000 on-demand titles available at any time.[55] Cable

---

[53] Preliminary Assessment § 3.2.

[54] *Id.* § 4.6.3.

[55] *See, e.g.*, High-Definition (HD) from Comcast, Comcast.com, http://www.comcast.com/Corporate/Learn/DigitalCable/HD html (noting that "[w]ith HD from XFINITY, you get the best HD experience anytime, anywhere, with stunning HD picture quality and 8,000 HD On Demand TV shows and movies"); Comcast Video Services, Comcast.com,

operator guides are increasingly incorporating applications, social networks, and recommendation engines. Consumers cannot enjoy any of these features without connectivity to the network.

It is one thing to connect a client set-top box to the living room DVR and play back a recording from the bedroom. This is done today with "multi-room DVR" clients, and through new DLNA approaches we discuss below. But it is quite another to require the living room set-top box to provide all of the resources needed for tuning every client in the home and providing all network connectivity. Under this approach, living room set-top boxes that today have two tuners will need many more video tuners and more processing power. This gateway and the home networking technology would need to be awakened when someone in the bedroom wants to check the program listings, watch a movie on-demand, or check a traffic or weather application.

This may be one viable approach for some whole home solutions, but there is no one-size-fits-all solution for all customers. Cable operators serve a wide variety of customers, and many do not have or want a home network. In fact, for customers who are satisfied with one-way content delivered downstream to the second television, cable DTAs are a very effective solution. At less than 4 watts, they are energy efficient and do not rely on a multi-tuner gateway.

For consumers who have or want home video networks, there are already more flexible approaches, and more will surely be available in the future. The Digital Living Network Alliance (DLNA) is one place where companies such as Comcast, Time Warner Cable, Sony, Samsung, Panasonic and others are reaching agreements on how to make home networking

http://www.comcast.com/MediaLibrary/1/1/About/PressRoom/Documents/ProductsAndServices/video.pdf (last visited Mar. 8, 2012) (describing On Demand and HD VOD services); Home Theater Anytime (On Demand), TimeWarnerCable.com, http://www.timewarnercable.com/east/learn/cable/ondemand ("Welcome to a world of Instant Entertainment. Where more than 10,000 hit movies and shows are already on your TV, just waiting for you to watch them. Exactly what you want, the instant you want it. That's On Demand. That's the Power of You.").

approaches work. The DLNA Commercial Video Profile (CVP) specifications allow recorded

cable content to be shared within home networks with a variety of retail devices.[56] Successful

interoperability testing has demonstrated the ease with which the set-top boxes can share

premium content with retail TVs, game consoles, PCs, and mobile devices across the home

network – all without a set-top box next to those retail devices. [57] Industry participants are

continuing the work needed for handling live content and interactive features over the home

network, as part of DLNA specifications.

Multimedia over Coax Alliance (MoCA) is another approach to home networking.[58]

MoCA develops specifications for the transport of digital entertainment and information content

over in-home coaxial cable.[59] Cox's Trio Guide is designed for compatibility with MoCA and

DLNA and allows retail devices in the home to find, retrieve, play, pause, fast-forward and

rewind recorded content stored on a Cox DVR.[60] MoCA is being widely deployed by major

service providers across the cable, telephone, and satellite sectors. "Plug and play" MoCA-based

---

[56] *See* Press Release, DLNA, *DLNA Advances Playback of Commercial Video Across DLNA Certified® Products*, May 23, 2011, *available at* https://members.dlna.org/news/pr/view?item_key=91b712addabcc5ff9ba8338bb988ef83d5ccfe46 (announcing the release of new Interoperability Guidelines for the playback of high-quality, premium commercial video, developed in conjunction with global cable, satellite and telecommunications service providers).

[57] *See CableLabs® Tru2way® Home Networking Interop Demonstrates Premium Content Sharing among Home Network Devices*, SPECS News & Technology from CableLabs, Jan.-Apr. 2011, *available at* http://www.cablelabs.com/news/newsletter/SPECS/JanApr_2011/story5 html (describing multi-vendor, multi-device demonstrations of sharing premium DVR content over a home network among multiple tru2way set-top boxes and DLNA devices, such as connected TVs, game consoles, and PCs).

[58] *See, e.g.,* Multimedia over Coax Alliance, http://www mocalliance.org; Letter from Tom Lookabaugh, Entropic Communications, to the FCC, July 13, 2010, filed as ex parte communication, CS Docket No. 97-80.

[59] *See* MoCA Brochure 2011, *The Standard for Home Entertainment Networking*, Multimedia over Coax Alliance, *available at* http://www mocalliance.org/marketing/brochure/MoCA_Brochure_2011.pdf.

[60] *See* Letter from Michael Powell, NCTA, to the Federal Communications Commission, July 7, 2011, filed as ex parte communication, MB Docket No. 10-91; CS Docket No. 97-80; MB Docket No. 07-269 at 6 (describing cable operators' innovations in using standards-based home networking technologies).

components are available at retail.[61] The second generation of the specification, MoCA 2.0,

supports multiple power states, allowing a MoCA device, under the control of its host processor,

to move into and out of low-power states in coordination with the other devices in the network.

By doing so, MoCA 2.0 reduces the energy consumption of the MoCA-based home network as

well as enables significantly lower energy consumption of all devices – such as gateways, media

servers, IP set-top boxes, and MoCA Wi-Fi extenders – connected to that network.

Cable operators are also delivering services in far more innovative ways than the

stripped-down thin client envisioned by the Department. Cable operators are enabling

increasingly more consumer-owned devices to connect to cable services directly in IP.

Consumers can access cable on their portable tablets that need no set-top box, thin or otherwise.

Time Warner Cable's TWCable TV™ for iPad® allows subscribers to view VOD and

subscription linear channels on an iPad.[62] Comcast's AnyPlay device plugs into a Wi-Fi router

and transcodes MPEG-2 television into MPEG-4 IP streams for viewing on the local home

network on tablets throughout the home.[63] Consumers can access video programming from

cable operators on their personal computer using implementations of "TV Everywhere," with no

set-top box. One such implementation, Comcast's Xfinity TV Online service, offers full-length

programming from nearly 30 content providers, including premium cable channels like HBO,

Starz, and Cinemax.[64] Consumers can access cable programming through their Microsoft Xbox

---

[61] Among retail MoCA products available today are TiVo Premiere Elite with built-in MoCA. Other product categories include routers, set-top boxes, Ethernet-to-coax bridges, optical network terminals and cable modems.

[62] *See* TWCable TV for iPad on the iTunes App Store, *available at* http://itunes.apple.com/us/app/twcable-tv/id420455839?mt=8.

[63] *See* Lance Whitney, *Comcast AnyPlay Will Stream Live TV to Your iPad*, CNET News, Jan. 11, 2012, *available at* http://news.cnet.com/8301-1023_3-57357067-93/comcast-anyplay-will-stream-live-tv-to-your-ipad/; Darren Murph, *Comcast Lights Up AnyPlay for In-Home Live TV iPad Streaming, Xoom Support 'Coming Soon*,' Engadget, Jan. 10, 2012, *available at* http://www.engadget.com/2012/01/10/comcast-anyplay-ipad-app-xfinity-tv-launch-xoom-soon-ces-2012/ (describing AnyPlay and noting that "more markets are planned for the coming months").

[64] *See, e.g.,* Xfinity TV Home Page at http://xfinitytv.comcast net/ (last visited Feb. 23, 2012).

game console, again with no set-top box.[65]   This spring Samsung will release a Smart TV that can access cable services as a clickable screen icon displayed side-by-side with other services, without any set-top box.[66] Sony, Panasonic, and LG plan to release similar TVs beginning later this year.[67] These rapidly evolving innovations are enabling consumers to enjoy content around the home on retail devices which (more often than not) have wired or wireless network connectivity to the Internet, but do not need a set-top box, thin client or otherwise.

The cable industry is meeting rapidly expanding customer demand for access to services anytime, anywhere, on any screen, and often on multiple screens in simultaneous use by the same viewer.[68] It is doing so in highly creative energy-efficient ways that are improving energy efficiency on a whole home basis while meeting skyrocketing consumer demand. Regulations that limit energy use based upon a one-size-fits-all "thin client" approach would stifle MVPDs' ability to continue their otherwise ongoing efforts to deliver video programming to a proliferation of home devices using a wide variety of innovative energy-savings techniques.

---

[65] *See* Liana B. Baker, *Microsoft Reaches 40 Content Deals for Xbox*, Reuters, Oct. 5, 2011, *available at* http://www.reuters.com/article/2011/10/05/us-microsoft-idUSTRE7945E920111005; Barbara Ortutay, *Microsoft Brings TV to Xbox 360*, USA Today, Oct. 5, 2011, *available at* http://www.usatoday.com/tech/news/story/2011-10-05/xbox-tv-on-demand/50670406/1; Cliff Edwards, Alex Sherman & Dina Bass, *Microsoft Is Said to Add Comcast, Verizon Pay TV to Xbox Live*, Bloomberg News, Sept. 29, 2011, *available at* http://www.bloomberg.com/news/2011-09-29/microsoft-is-said-to-plan-xbox-live-expansion-with-comcast-pay-tv-service.html.

[66] *See* Todd Spangler, *CES: Samsung Plugs into PayTV Services*, Multichannel News, Jan. 11, 2012, *available at* http://www.multichannel.com/article/478999-CES_Samsung_Plugs_Into_Pay_TV_Services.php; *see also* Daniel Cooper, *Samsung 2012 SmartTVs Will Access DirecTV Without a Set Top Box, Minimalists Rejoice*, Engadget, Jan. 10, 2012, *available at* http://www.engadget.com/2012/01/10/samsung-smart-tv-directv-without-stb (attaching press release indicating spring 2012 release date).

[67] *See* News Release, LG Electronics USA, Inc., *LG Electronics and Verizon Collaborate to Offer FiOS TV App On LG's Smart TV Platform*, Jan. 11, 2012, *available at* http://www.prnewswire.com/news-releases/lg-electronics-and-verizon-collaborate-to-offer-fios-tv-app-on-lgs-smart-tv-platform-137086198.html; Jeff Baumgartner, *FiOS: Look, Ma, No Set-Top!*, Light Reading Cable, Jan. 11, 2012, *available at* http://www.lightreading.com/document.asp?doc_id=216287&site=lr_cable ("A new deal will let Verizon Communications Inc. … stream a bunch of video-on-demand (VoD) titles and a limited number of live TV channels to LG Electronics Inc. … Smart TVs and Blu-ray players later this year – all without a set-top box.").

[68] *See* Stuart Elliot, *Shazam Ties Into the Sounds of Super Bowl Spots*, N.Y. Times, Feb. 2, 2012, *available at* http://mediadecoder.blogs.nytimes.com/2012/02/02/shazam-ties-into-the-sounds-of-super-bowl-spots/.

C. Department Rules Would Impede Improvements in Display Resolution

Innovation is also threatened by what may seem like routine definitional questions but which could bring a sudden halt to new services. For example, the Department asks if it should define HD as "any resolution greater than 720p."[69] If by doing so the Department would effectively set a ceiling on processing power, it could bring a halt to display resolutions that are just now emerging. At CES 2012, Sharp exhibited an 8K television, and LG exhibited a 4K and a 4K 3D television. If programming in such high resolution gains in popularity, we should expect set-top box processing power to change. If Department rules stand as a barrier, it will have frustrated yet another innovation, when it is legally required not to reduce the functionalities available to consumers.[70]

D. The Energy Costs and Lessons of the FCC's Integration Ban

The cable industry has recent painful experience in witnessing the unintended consequences of regulation of set-top boxes. The CableCARD, on which the Department solicits information, stands as an important cautionary tale of how regulations can frustrate both innovation and energy efficiency.

Since July 2007, cable operators have been required by the FCC's "integration ban" to include a separate security module, called a CableCARD, in each new leased set-top box that they place into service, in the same way that CableCARDs are used in some retail devices.[71] Cable operators vigorously objected to this unnecessary rule as inefficient, because most leased

---

[69] RFI at 12.

[70] 42 U.S.C. § 6295(o)(4) ("The Secretary may not prescribe an amended or new standard under this section if the Secretary finds (and publishes such finding) that interested persons have established by a preponderance of the evidence that the standard is likely to result in the unavailability in the United States in any covered product type (or class) of performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as those generally available in the United States at the time of the Secretary's finding. The failure of some types (or classes) to meet this criterion shall not affect the Secretary's determination of whether to prescribe a standard for other types (or classes).").

[71] 47 C.F.R. § 1204(a)(1) (second sentence).

set-top boxes already spoke the security language of the headend, and redesigning leased set-top boxes added cost but no functionality to the device. CableCARDs consume power, require additional heat dissipation, and operate even when they are not actively decrypting video content because they must constantly process network messages and updates. Given the EPA allowance for CableCARDs of 15 kWh, the 32 million CableCARDs that cable operators have deployed inside their leased set-top boxes account for more than 480 million wasted kWh/year.[72]

This FCC rule adversely impacted innovation and energy conservation, and delayed the deployment of energy-efficient DTAs for nearly two years. The cable industry and its vendors had to go through an arduous waiver process and then a rulemaking process to change the rule and allow the deployment of low-wattage DTAs. The sobering lesson from this FCC mandate is that government regulations along the lines of what the Department is contemplating can have significant unintended effects on future innovation in the video marketplace.[73]

* * * *

The Department should avoid imposing standards in this proceeding that would inhibit innovation or the delivery of new features or services to consumers. A market-driven approach to cable technology has produced growth in jobs, in energy-saving telecommuting, in telemedicine, in broadband and Internet services, in choice and savings in voice services, in content and applications, and in new opportunities for future innovators – the kind of innovation

---

[72] The Department's Preliminary Assessment includes some mistakes regarding the specifics of CableCARD technology. It states that "[t]he initial implementation of CableCARD did not … support electronic program guide, video-on-demand or pay-per-view features. As a result, although all cable set-top boxes must have CableCARD, the majority of cable service providers also utilize additional proprietary security protocols to enable 2-way communication functionality such as video-on-demand." Preliminary Assessment §§ 3.11.2, 4.4.5. In fact, CableCARDs do support two-way services such as video on demand (VOD). This is how most leased set-top boxes operate today. However, most retail devices that use CableCARDs were not designed to support two-way services.

[73] This FCC regulatory framework could get worse. As the Preliminary Assessment notes, the FCC has taken comment on proposals to require all MVPDs to pass all video services through a standard "AllVid" set-top box that would include only basic functionality and would be connected to a separate retail or leased set-top box or other device. The FCC proposal would not only add additional devices to the home, it could limit and freeze the technology in ways that complicate or frustrate MVPDs' ability to improve energy efficiency.

funded by private capital that the Administration has been seeking to stimulate.[74] The same

approach can produce energy efficiency benefits. The interests of energy conservation will be

far better served if the Department does not attempt to impose *a priori* assumptions or artificial

design constraints on a rapidly evolving technology market.

V. RESPONSE TO OTHER DEPARTMENT ISSUES

With this background as context, we address below the remaining issues raised by the

RFI and the Preliminary Assessment: product classifications, scope of testing, errors in the

Department's energy efficiency suggestions, and set-top box pricing.

A. Product Classifications

The RFI asks whether ENERGY STAR classifications can serve as a starting point for its

classification of products. EPA has six separate base types (cable, satellite, IPTV, DTA,

terrestrial, and thin client), and 10 different allowances (Advanced Video Processing,

CableCARD, DVR, DOCSIS modem, HD, home network interface, multi-room, multi-stream,

removable media player, and removable media recorder).[75] The Department states that it cannot

follow the EPA model of creating allowances above a base standard for additional features or

functionalities, and that it would instead manage such variation by creating separate product

classes with a standard and testing procedure for each. This approach would result in hundreds

or even thousands of product classes. DTAs may lack many of these functionalities, and only the

cable set-top boxes have CableCARDs. But even if the other four base types were each divided

---

[74] *See* NCTA Comments on Classification at 21.

[75] The RFI asks whether it is necessary to classify cable DTAs separately from other cable devices as does
ENERGY STAR, or whether the DTA classification is unnecessary because DTAs "are becoming less common."
The RFI is incorrect in suggesting that DTAs are used only with analog televisions. DTAs may also be used to
decrypt programming to make it viewable on digital TVs, and so are likely to remain in use for years to come. DTA
deployment has been increasing, rather than decreasing, in recent years.

into product classes based on whether they have each of the other nine functions, that would equate to more than 2000 product classes.[76]

But as we described above, set-top boxes can also vary depending on MVPD network, software stack, and guide provided by the MVPD, among other variables. Two cable operators may buy set-top boxes from the same manufacturer, but with different software, guides, and other features. Such set-top boxes are not interoperable or necessarily the same product.

This is just the beginning. Advanced Video Processing can entail a variety of functions, including decoding of new formats, such as High Efficiency Video Coding (HEVC), Multi-View Coding (MVC), Scalable Video Coding (SVC), encoding of video into one of these formats, transcoding from one format to another, adaptable bit-rate packaging, etc. In addition, the number of concurrent video streams that can be processed at different resolutions and formats introduces more variation in this functionality. Actual energy consumption depends on which features are implemented at what levels of concurrency and which are active at any point in time. Multiple products may need to be defined to reflect different variations of Advanced Video Processing.

Another variable is the number and type of tuners. While the EPA standard has a multi-stream allowance for set-top boxes with two tuners, a gateway – of the sort the Department wishes to encourage – has six or more. ENERGY STAR does not provide a sufficient allowance for the tuners required in a gateway. Even if it did, gateways may vary by the networks and services of individual MVPDs.[77]

---

[76] Because each of the 9 features would be either present or not, there would be 2^9 or 512 possible combinations for each of the four base types. $4*2^9 = 2048$.

[77] For example, there is variation in the amount of processing power required by a gateway depending on whether the operator seeks to support the ability of the gateway to transcode on the fly to devices inside the home, or perform that function within the network. An operator's preference depends upon the topology of its network. *See Media*

And the Department is considering standards for 2018. In today's rapidly changing

environment, no one can predict the precise suite of new features and services that innovation

(including by cable's competitors) may be able to deliver in the future, or which of those features

and services consumers may come to demand, or the amount of energy that those features and

services will require. We can only predict confidently that change will continue to occur except

to the extent that regulation blocks it. Predictions are particularly difficult given that innovations

from one person or company build off of innovations of others, and consumers often end up

using new features in ways that even its inventors did not imagine. For example, the

introduction of the DVR has significantly altered TV viewing behavior.[78] The introduction of

broadband Internet access has enabled video delivery over the Internet to a broad range of

devices, further altering consumer video consumption. It has altered the TV viewing experience,

so that, for example, television viewing is accompanied by second screens for one or more

viewers in the room, and Super Bowl programming is synchronized with those multiple

companion screens. The only reasonable prediction that can be made is that there will be

increasing competition to offer more and better forms of entertainment directly to consumers.

But it is impossible for the Department to confidently project a comprehensive and appropriate

product classification regime today for 2018 and beyond. And, even if it could, any such regime

---

Gateways Take Hold As Path to Future in Cable, ScreenPlays, Nov. 10, 2010, *available at* http://www.screenplaysmag.com/2010/11/17/media-gateways-take-hold-as-path-to-future-in-cable-2/.

[78] *See, e.g.*, Pat McDonough, *As TV Screens Grow, So Does U.S. DVR Usage*, NielsenWire Blog, Feb. 29, 2012, *available at* http://blog.nielsen.com/nielsenwire/media_entertainment/as-tv-screens-grow-so-does-u-s-dvr-usage/ (explaining results of recent Nielsen study on viewing trends and DVR usage, and stating that "[a]mong the three major devices connected to our TVs (video game consoles, DVRs and DVD players), DVRs account for the greatest percentage of Americans' watching time"); Bill Carter and Brian Stelter, *DVRs and Streaming Prompt a Shift in the Top-Rated TV Shows*, N.Y. Times, Mar. 4, 2012, *available at* http://www.nytimes.com/2012/03/05/business/media/dvrs-and-streaming-prompt-a-shift-in-the-top-rated-tv-shows.html (explaining that, once DVR playback is factored into the results, the rankings of top-rated television programs often change dramatically, especially among coveted demographics).

based upon hundreds of different product classes would also confuse consumers and make the task for manufacturers, MVPDs, and test facilities administratively burdensome.[79]

B.   Scope of Devices for Testing

Today, we would define a set-top box as any non-gateway device whose function is to receive digital video signals delivered by a network, to optionally decrypt or descramble these signals, and to deliver them for display to a single residential consumer display and/or recording device. Virtually any device that has a display or is connected to a display and has some form of network connectivity can effectively become a set-top box by providing the ability to navigate, select, and display video content. Thus, devices that once were not set-top boxes, such as gaming consoles, personal computers and other household electronics, are becoming set-top boxes. In addition, third parties are manufacturing new types of "over the top" set-top (OTT) boxes, such as Roku, Boxee, and Apple.

The Preliminary Assessment suggests that OTT set-top boxes are not within the "focus" of this proceeding.[80] Any approach that focuses exclusively on MVPD set-top boxes and not over-the-top set-top boxes would distort competition and ignore competitive parity, but it would also not reflect energy conservation priorities. Contrary to an assumption made in the Preliminary Assessment that OTT devices are more energy-efficient than MVPD set-top boxes, MVPD set-top boxes compare quite favorably to the many other forms of video systems. OTT devices rely on other power-consuming devices within the home, such as broadband modems, wireless routers, computers, and external speakers. When all of the components for viewing are included, some OTT devices use more power, even several times more power, than a typical cable set-top box. For example, a consumer watching video on a broadband-enabled Sony

---

[79] *See* Public Meeting Transcript at 114, 121.

[80] *See* Preliminary Assessment § 3.9 ("OTT hosts are not the focus of this assessment.").
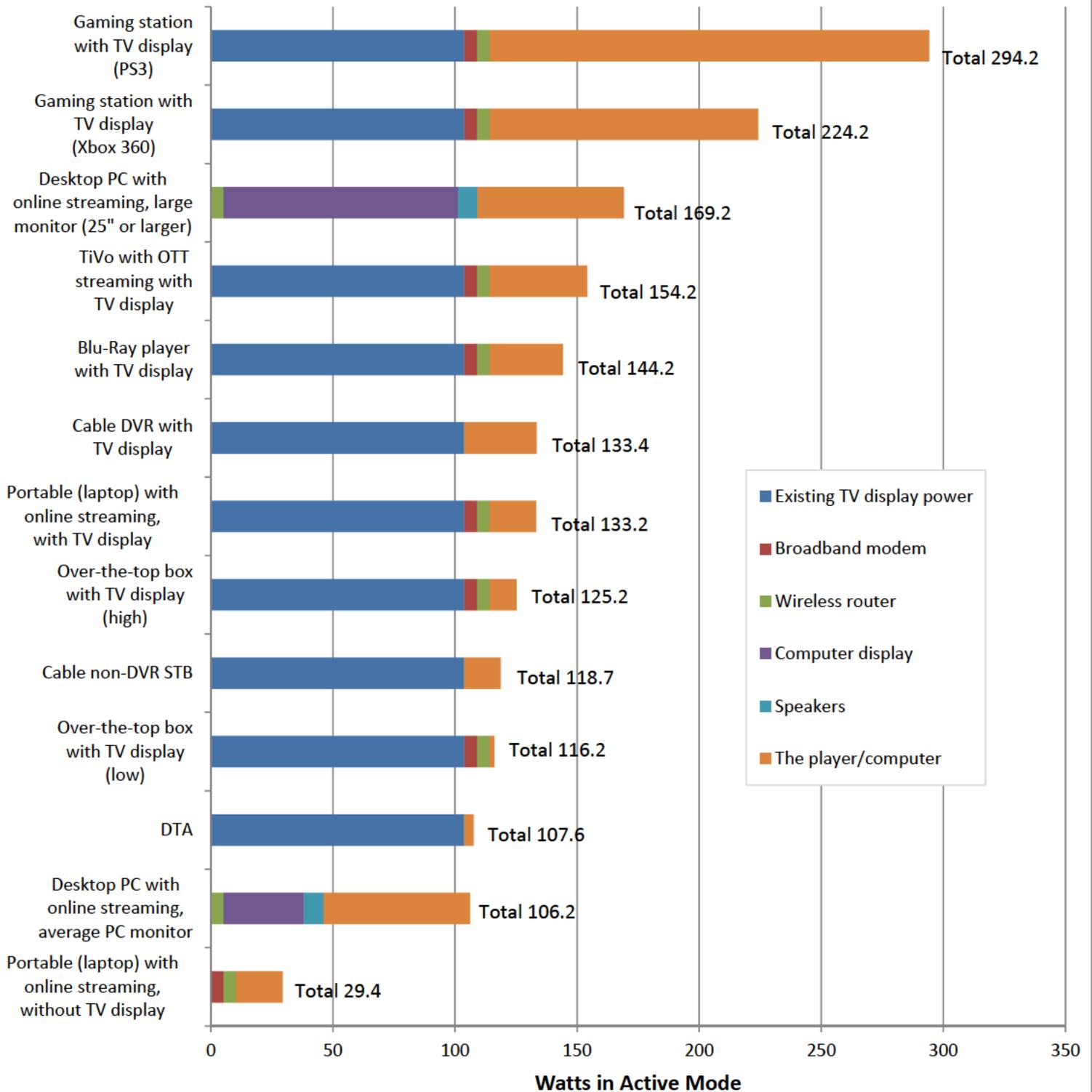
PlayStation 3 game console consumes 294 watts: 180 watts for the game console, 5 watts for the broadband modem, 5 watts for a wireless router, and 104 watts for the average television.[81] This compares to 134 watts using a cable DVR and average TV (29.6+104), and 119 watts using a cable HD non-DVR and TV (14.9+104).[82] A comparison of cable set-top boxes to various OTT options is provided in the following table:[83]

---

[81] Bryan Urban, Verena Tiefenbeck & Kurt Roth, *Energy Consumption of Consumer Electronics in U.S. Homes in 2010, Final Report to the Consumer Electronics Association (CEA)*, Fraunhofer Center for Sustainable Energy Systems (Dec. 2011), *available at* http://www.ce.org/PDF/Energy-Consumption-of-CE-inUSHomes-2010.pdf ("2011 CEA Report") at 106 (PS3 playing HD: 148-180w), 70 (broadband modem: 5.2w; wireless router: 5.2w).

[82] *Id.* at 90 (Cable non-DVR set-top box: 14.9w average in active mode; Cable DVR: 29.6 W average in active mode), 97 (Television: varies widely by display technology, screen size, and year of manufacture. The average TV is 29.1" diagonal and 6.2 years old. The average primary TV is larger, at 38" diagonal, and used more frequently than older, smaller ones.), 101 (The average TV uses 103.8 W in active mode. The average primary TV uses 133 W in active mode.). A typical 2011 DTA uses 3.85 W in active mode. *See* NCTA Comments on Classification at 3.

[83] 2011 CEA Report at 87 (TiVo: 27-40w), 28 (Blu-Ray: active mode 30w), 31 (desktop computer: active mode 60w), 39 (portable computer: active mode 19w), 48 (average two-speaker system: 8w), 106 (average 18"computer display: 33w in active mode; Xbox 360 playing HD: 110-126w). Apple TV reports 2.08w streaming HD. *See* http://www.apple.com/environment/reports/docs/AppleTV_Product_Environmental_Report_20110323.pdf. Roku advertises less than 2w when streaming video. *See* http://www.roku.com/rokuproducts. A consumer reported Boxee using 11w when streaming video at http://forums.boxee.tv/showthread.php?t=22177.

Energy Consumption in Active Mode

Horizontal bar chart showing "Watts in Active Mode" (x-axis, 0 to 350) for various devices:

Device	Total
Gaming station with TV display (PS3)	Total 294.2
Gaming station with TV display (Xbox 360)	Total 224.2
Desktop PC with online streaming, large monitor (25" or larger)	Total 169.2
TiVo with OTT streaming with TV display	Total 154.2
Blu-Ray player with TV display	Total 144.2
Cable DVR with TV display	Total 133.4
Portable (laptop) with online streaming, with TV display	Total 133.2
Over-the-top box with TV display (high)	Total 125.2
Cable non-DVR STB	Total 118.7
Over-the-top box with TV display (low)	Total 116.2
DTA	Total 107.6
Desktop PC with online streaming, average PC monitor	Total 106.2
Portable (laptop) with online streaming, without TV display	Total 29.4

Legend:
- Existing TV display power
- Broadband modem
- Wireless router
- Computer display
- Speakers
- The player/computer

Source: 2011 CEA Report and other sources. See footnotes 81-83.

There are a significant number of these devices in the U.S. At year-end 2011, there were

19.88 million PS3s,[84] 33.05 million Xbox 360s,[85] and 40 million Blu-Ray players.[86] As of 2010,

there were 101 million Desktop PCs.[87] All of these can operate as set-top boxes.

Some OTT services are designed to encourage consumers to watch more video, or to use

computers for interaction while viewing a video on a television, which result in increased overall

power usage. Many are delivering services similar to some of those offered by MVPDs. The

Preliminary Assessment speculates that these devices are hindered by "lack of content,"[88] but

OTT providers have negotiated agreements with an ever-expanding list of major content

providers, including professional sports leagues (MLB, NBA, NHL, MLS),[89] networks (NBC,

Disney/ABC, CBS, Fox, HBO, ESPN),[90] and studios (20th Century Fox, DreamWorks Animation

---

[84] *See* USA Yearly Chart (2011), VGChartz.com, *available at* http://www.vgchartz.com/yearly/2011/USA/ (last visited Mar. 9, 2012) (ranking top-selling game consoles in 2011 and listing all-time sales totals for each in "USA Hardware by Platform" chart on sidebar).

[85] *See id.*

[86] *See* News Release, *DEG's Year-End 2011 Home Entertainment Report*, Digital Entertainment Group, Jan. 10, 2012, *available at* http://www.degonline.org/pressreleases/2012/DEG_year_end_2011.pdf ("Total Blu-ray penetration in 2011 jumped 38 percent (including BD set-top boxes, PS3s and HTiBs) with total household penetration of all Blu-ray compatible devices now at nearly 40 million U.S. homes.").

[87] *See* 2011 CEA Report at 30 (stating that, "[a]ccording to the CE Usage Survey [CEA-funded survey of 1,000 demographically representative U.S. households performed in October 2010], the installed base of desktop computers is 101 million units").

[88] Preliminary Assessment § 3.9.

[89] *See, e.g.*, MLB.TV Devices, MLB.com, *available at* http://mlb.mlb.com/mlb/subscriptions/index.jsp?content=products&c_id=mlb (last visited Mar. 8, 2012) (listing devices upon which Major League Baseball's MLB.TV subscription service, which streams live HD-quality baseball games, is available); Watch Live NBA Games on Your Apple TV, NBA.com, *available at* https://account.nba.com/appletv (last visited Mar. 8, 2012) (noting features and pricing options for streaming service on Apple TV device); Stay Connected to Live Hockey, NHL.com GameCenter, *available at* http://gamecenter nhl.com/nhlgc/cdsignup.jsp (last visited Mar. 8, 2012) (listing devices upon which the National Hockey League's GameCenter LIVE streaming service is available); MLS LIVE, MLSSoccer.com, *available at* http://live mlssoccer.com/mlsmdl/ (last visited Mar. 8, 2012) (promoting "[o]ne subscription access on computer, iPhone, iPad, Roku, and Panasonic," as well as "integration with Apple TV").

[90] *See, e.g.*, About Hulu, Hulu.com, *available at* http://www hulu.com/about (last visited Mar. 8, 2012) (explaining that "Hulu brings together a large selection of videos from over 350 content companies, including FOX, NBCUniversal, ABC, The CW, Univision, Criterion, A&E Networks, Lionsgate, Endemol, MGM, MTV Networks, Comedy Central, National Geographic, Digital Rights Group, Paramount, Sony Pictures, Warner Bros., TED and more."); *Netflix, CBS Sign 2-Year Content-Streaming Deal*, Bloomberg Businessweek, Feb. 22, 2011, *available at* http://www.businessweek.com/ap/financialnews/D9LI1K6G3.htm (describing a "two-year licensing agreement that

SKG, Inc.).[91] Some OTT services are also being designed to offer recording functionality, with

increased power consumption. By 2018 and beyond, many predict that OTT set-top boxes will

be far more widely deployed than today, and may increasingly be used to deliver services similar

to those offered by MVPDs.[92] But while the Preliminary Assessment agrees that these devices

will likely be an integral part of the "future of TV,"[93] it does not suggest including them in any

Department regulation of set-top boxes.

The EPA treats OTT devices as set-top boxes under the ENERGY STAR program, and

they should similarly be considered by the Department to the extent that set-top boxes are

---

will let users of Netflix's online streaming service watch certain shows from the CBS library, including 'Medium,' 'Frasier' and 'Cheers'"); It's HBO. Wherever You Go, HBOGo.com, *available at* http://www hbogo.com/#devices/ (last visited Mar. 8, 2012) (listing devices such as iPad, iPhone, Android phones, Roku, and Samsung televisions that feature HBO's HBO GO streaming service); Brian Stelter, *An ESPN Channel to Stream Through Xbox 360 Console*, N.Y. Times, June 14, 2010, *available at* http://www.nytimes.com/2010/06/15/business/media/15espn.html (stating that "[a]ccess to ESPN's broadband sports network, known as ESPN3, will be free for premium subscribers to Xbox's membership service, which is called Xbox Live").

[91] *See* Ben Fritz & Dawn C. Chmielewski, *Rivals Amazon.com and Netflix Add Studio Partners*, L.A. Times, Sept. 27, 2011, *available at* http://articles.latimes.com/2011/sep/27/business/la-fi-ct-amazon-netflix-20110927 (describing Amazon.com's streaming video deal with 20th Century Fox and Netflix's deal with DreamWorks Animation SKG Inc.); Laura Sydell, *Amazon Expands Streaming With Viacom Deal*, NPR.org, Feb. 8, 2012, *available at* http://www npr.org/2012/02/08/146593298/amazon-expands-streaming-with-viacom-deal (noting that a new Amazon deal for streaming video from Viacom includes "Paramount movies, as well as shows from Comedy Central, Nickelodeon, MTV and more"); Brian Womack, *YouTube Forges Deal With Disney for Movie Rentals on Service*, Bloomberg.com, Nov. 23, 2011, *available at* http://www.bloomberg.com/news/2011-11-23/youtube-forges-deal-with-disney-to-show-movies-for-rent-on-site.html ("Google Inc. (GOOG)'s YouTube announced a deal with Walt Disney Co. (DIS) to offer rentals of the studio's movies, letting U.S. and Canadian users watch such films as 'Cars 2' and 'Pirates of the Caribbean: On Stranger Tides.'").

[92] *See, e.g.*, *Consumers of All Ages Are Going Over-The-Top*, Accenture (2011) at 4, *available at* http://www.accenture.com/SiteCollectionDocuments/PDF/Accenture_Communications_Media_Entertainment_Video-Over-Internet_Consumer_Usage_Survey.pdf ("This is a trend that's been growing in the marketplace, and our research confirms it. The consumers participating in the Accenture Video-Over-Internet Usage Survey are certainly still watching traditional, passive, linear TV, but they're also accessing and viewing content over an amazing range of other devices and using other means to interact with content and people during the viewing experience."); Michael Humphrey, *Good News, Google And Apple TV: Studies Find Internet-TV Trends 'Irreversible,'* Forbes, Feb. 15, 2012, *available at* http://www forbes.com/sites/michaelhumphrey/2012/02/15/good-news-google-and-apple-tv-studies-find-internet-tv-trends-irreversible/ (citing a large recent study by Boston-based research firm Chadwick Martin Bailey that confirms that "a wide-ranging consumer base wants more of their television OTT (over-the-top), meaning anytime, anywhere on multiple devices").

[93] Preliminary Assessment § 4.7.1. In some places the Preliminary Assessment attributes a decline in viewership to decisions by consumers to streaming online content only rather than pay TV. Preliminary Assessment §§ 3.3, 3.9. It is not clear that this accounts for such a decline. The authority cited by the Department focuses on declines in the new housing market and competition with other pay TV providers, rather than cord-cutting. Elsewhere in the Preliminary Assessment, the Department states that OTT streaming serves as a supplement rather than a replacement service. Preliminary Assessment § 4.5.2.

classified as covered products. It would be arbitrary to exclude OTT devices.[94] Emerging

competition from OTTs is a rapidly growing force in the set-top box market. Exclusion of OTT

set-top boxes would impair the coherence of an overall energy policy for set-top boxes and skew

and reduce competition and innovation in the video services marketplace. Such exclusion would

therefore contravene the Department's statutory obligation "to consider the impact of any

lessening of competition."

It would be similarly unwarranted to exclude "stand-alone DVRs" from a standards

regime applied to other set-top boxes. As the Preliminary Assessment concedes, TiVo devices

using CableCARDs are "generally considered a cable set-top box."[95] TiVos decrypt MVPD

content with a CableCARD just as leased cable DVRs do. They are functionally and technically

very similar to the DVRs deployed by MVPDs, and in some cases MVPDs themselves are

deploying DVRs built by TiVo.

C.   Errors in Department's Suggested Energy-Savings Strategies

The Department offers a table of supposed possible energy efficiency solutions which is

neither substantiated nor grounded in the reality of the set-top box market. It states:

Table 4.6.1   Energy-Saving Strategies for set-top boxes

No.	Name	Explanation	Savings	Difficulty
1	Power management	Switch off components when not actually required, including hard disk, image	High	Moderate

---

[94] 42 U.S.C. § 6295(o)(2)(B)(i)(V), (VII). The Department must obtain the Attorney General's opinion on competitive impact. *See id.* and *id.* at § 6295(0)(2)(B)(ii). The Attorney General's eventual opinion, however, does not lessen the Department's need to consider competitive impact at this stage, because the Department has an independent obligation to consider any relevant factor presented by the circumstances. 42 U.S.C. § 6295(o)(2)(B)(i)(VII).

[95] Preliminary Assessment § 3.10.

		processing chips, and multiple tuners		
2	Utilize multi- room technology	Shifting to whole-home solutions that include a main box connected to the primary TV with either TVs specially-designed to access the video content stored on the main box or low-power thin client set-top boxes that serve the same function	High	Low
3	More efficient components	Install switch-mode power supply and more efficient chips for image conversion	Moderate	Moderate
4	Reduce disk energy use	Install more efficient disk designs, switch to flash memory, or store content at a remote server	Moderate	Moderate
5	Lower clock speeds on chips	Reduce processing speed to minimum speed for type of image transmitted	Low	Low
6	Consolidate boxes	Some homes use two or more boxes to provide signals to several televisions	High	Moderate
7	Relax security requirements	Service provider currently restricts ability of box to enter low power modes to guard against hackers and to protect content	Moderate	High
8	Allow user to set functionality	Through a control panel, the user could modify settings to more precisely match his needs, possibly resulting in even greater energy savings	Low	Moderate

This table was largely copied from a short chapter in a 2007 publication about the so-

called "principal-agent problem" as it relates to strategies for improving energy efficiency in set-

top boxes.[96] Under this theory, energy efficiency is stymied because most set-top boxes are built

to the desired specifications of the service providers that lease them, without regard for energy

efficiency since the service provider does not pay the electricity bill of the end user customer

who uses the device. The Preliminary Assessment declares that this "situation is potentially the

most significant barrier to reducing the national energy consumption of STBs in the U.S."[97] We

disagree. As we have demonstrated above, cable operators do have an incentive to use energy

efficient set-top boxes, which is why the industry has devoted substantial resources that have already

resulted in dramatic improvements in energy efficiency even as set-top boxes are being called upon

to deliver more and more functionality. Ironically, the very source from which the Department

obtained the above chart acknowledges a fact that illustrates that the "principal-agent" dynamic is not

a significant factor in set-top box energy usage. The author states that the "average energy use of

[retail set-top boxes] is likely the same" as a set-top box leased by service providers.[98] If so, then the

principal-agent dynamic is not reducing energy efficiency, because, if it were, then the set-top boxes

marketed for retail consumption would feature energy savings, and they do not. Instead, the energy

usage of set-top boxes is driven by the factors that we have described herein. Moreover, the DOE's

source also explains another reason why government-mandated standards are likely to fail: "The

technologies are evolving rapidly, however, and it is not clear if a regulation will be able to keep up

with new features and functionalities."[99]

The above chart is also wrong in its specifics, which were apparently compiled from

presentations at a workshop in Paris five years ago. The source provides no attribution for its

---

[96] Preliminary Assessment, Table 4.6.1.

[97] Preliminary Assessment § 3.8.1.

[98] *Set-Top Boxes: Energy Use Affected by the Principal-Agent Problem in the United States*. In Mind the Gap: Quantifying Principal-Agent Problems in Energy Efficiency. Paris, France: IEA Publications, at 145 (2007).

[99] *Id.* at 148.

ideas, or any explanation or evidence in support of its theorized conclusions. We briefly address each below.

Measure 1: We agree that savings are high, but there is no basis to claim that the degree of difficulty is moderate. Even for "light sleep," there is a need to change consumer expectations (e.g., loss of buffering when the viewer tunes in late to a show and cannot rewind), and there may be a need to incur substantial network costs and/or write new network applications to the applicable code in each device.[100]

Measures 2, 6: There is no basis for claiming that the degree of difficulty is low or moderate. It has taken years to get to a solution that allows cable service to appear as an app on tablets, smart TVs, and other devices, with considerable investment in development, networks, and business-to-business relationships. DLNA has taken years to work out. It is also not a low or moderate effort to change consumer behavior.[101]

Measure 3: Even if semiconductor costs are declining generally, the addition of functionalities adds cost to the bill of materials. Power management for "deep sleep" requires many network changes, and the Department does not have the tools in place for accounting for these costs.[102]

Measure 4: Flash memory is currently too costly for widespread use as a set-top box solution. Many cable operators do centralize certain programming sources, like video on demand, but moving to a "remote server" requires each MVPD to consider the rights under their many individually-negotiated affiliation agreements, and, where necessary, negotiate with individual content owners to assure that they have all necessary rights to offer content on an on-

---

[100] *See supra*, pp. 9-10, 26-28.

[101] *See supra,* pp. 35-38.

[102] *See supra,* pp. 10-11, 26-28.

demand basis. Deployment of the RS-DVR carries legal uncertainty. Hosted navigation also entails considerable network expense.[103]

Measure 5: This is a very small element of power scaling on the chip, which the cable industry is working on for "deep sleep" across multiple chip sectors. This work involves a major specification development effort to find a common approach that works for network, chip, guide, software, hardware, conditional access and security parties. The result would entail network and other costs that the department has ignored.[104]

Measure 7: It is a fundamental requirement in affiliation agreements to protect commercial content across the distribution ecosystem. Content protection is also required by the compliance and robustness rules in licenses for patented technology used in security and video interfaces. Cable operators may not simply "relax security." Such relaxation would also invite more piracy, and as a consequence content would be at risk of not being licensed by content providers for distribution to consumers on such compromised platforms.[105]

Measure 8: This is essentially the same approach as measure 5, but requires a great deal of education of and effort by individual consumers. A cable operator would also need to incur all of the network costs, plus employee time to help customers deal with these settings.[106]

---

[103] *See supra*, pp. 29-31.

[104] *See supra*, pp. 26-28.

[105] *See supra*, pp. 29-31. President Obama and the current Administration have emphasized the need to protect commercial content from theft on several occasions. *See, e.g.*, President Barack Obama, Remarks by the President at the Export-Import Bank's Annual Conference (Mar. 11, 2010), *available at* http://www.whitehouse.gov/the-press-office/remarks-president-export-import-banks-annual-conference ("[W]e're going to aggressively protect our intellectual property. Our single greatest asset is the innovation and the ingenuity and creativity of the American people. It is essential to our prosperity and it will only become more so in this century.").

[106] *See supra*, pp. 26-28.

D.   Set-Top Box Pricing

The economic analysis that the Department has traditionally used for white goods is ill-suited for the market in which set-top boxes are purchased and distributed. Previously, the Department has considered the increased cost paid by the consumer for the covered product and calculated the point at which the consumer would recoup that extra cost through lower energy bills. MVPDs do not simply apply a "markup" to set-top boxes and sell them, as with other appliances the Department has regulated. Under FCC rate regulations, stand-alone set-top box lease rates include cost, ongoing maintenance and service, and inventory, among other elements. But set-top boxes are often included in bundles with services, which also cover network and programming costs. (This model is also common for satellite providers, which are not subject to FCC rate regulation.) Set-top boxes are leased, and consumers may return them if they want to switch to a different type of devices, move, or cancel service. Previously-deployed devices may be redeployed to a new customer. Set-top boxes may change features and functionalities while in the field through software updates. Individual consumers do not typically make the decision about which model to purchase, nor are the economics of this market comparable to a consumer's purchase of commodity white goods at a premium paid back through decreases in residential electricity bills.

CONCLUSION

The cable industry's ambitious energy initiative is already delivering dramatic results, demonstrating its continuing commitment to deliver innovative energy efficiency solutions as well as compelling consumer services. The technological innovation in this market and the savings the cable industry is delivering through its voluntary initiative promise superior, tailored, practical, effective, and flexible results years before any Department standard could take effect. This erodes the Department's policy rationale for imposing energy efficiency mandates and, as

we detail in prior submissions and in Appendix A, it removes the legal underpinnings for any rules it may adopt. By contrast, Department mandates pose a serious threat to the very innovation and investment that the Department is charged to protect. The Department should halt its efforts to impose energy efficiency mandates on this dynamic industry.

Respectfully submitted,

/s/ Neal M. Goldberg

William A. Check, Ph.D
Senior Vice President, Science & Technology
and Chief Technology Officer

Andy Scott
Vice President, Engineering

Jim Partridge
Vice President, Industry & Technical Analysis

Rick Chessen
Neal M. Goldberg
Stephanie L. Podey
National Cable & Telecommunications
Association
25 Massachusetts Avenue, N.W. – Suite 100
Washington, D.C. 20001-1431

Paul Glist
Paul Hudson
Adam Shoemaker
Davis Wright Tremaine LLP
1919 Pennsylvania Avenue N.W., Suite 800
Washington, D.C. 20006-3401

March 15, 2012

APPENDIX A

LEGAL FAILINGS OF THE DEPARTMENT'S APPROACH

The Department does not have the legal basis for imposing new government standards on set-top boxes as if they were consumer appliances.

I.   DOE STANDARDS WOULD NOT RESULT IN SIGNIFICANTLY BETTER ENERGY CONSERVATION THAN NON-REGULATORY APPROACHES

Under EPCA, the Department is not to adopt energy efficiency standards if they would not result in significantly better energy conservation than non-regulatory approaches.[1] With leadership from the cable industry, the video marketplace is delivering dramatic increases in energy efficiency. Cable operators are already deploying "light sleep," developing testing methods and "deep sleep" solutions, using ENERGY STAR 3.0 set-top boxes and committing to volume procurement of more to move the market. Cable operators have also been meeting skyrocketing consumer demand to enjoy cable services on more digital screens by using energy-efficient DTAs, deploying more innovative and efficient home networking techniques than those imagined by the Department, and pursuing creative techniques for delivering services directly to consumer-owned digital devices.

The Preliminary Assessment's proposed analysis of benefits of regulation does not reflect the industry. The Department is starting from an erroneous baseline. It is looking at set-top boxes in circulation in early 2010 that have already improved dramatically. It is looking at a "typical" home that is not typical. It is citing incorrect projections about "business as usual" contradicted on all fronts by actual business incentives, what the market is delivering, early returns from the voluntary initiative, and expert projections that the number of deployed set-top

---

[1] 42 U.S.C. § 6295(o)(3)(B); 10 C.F.R. Ch. 11, Appendix A to Subpart C of Part 430—Procedures, Interpretations and Policies for Consideration of New or Revised Conservation Standards for Consumer Products, Objectives, Objective 5(e)(3)(D); *Cf. id.* at Objective 1(e); *id*. at 4, Process for Developing Efficiency Standards and Factors to be Considered, Factor (d)(5)(viii).

boxes likely will peak and soon decline as operators shift to alternative approaches that

revolutionize set-top boxes or eliminate them entirely. The net present value of the estimated

energy savings that would result beginning in 2018 must be measured against the estimated

usage that would otherwise occur in 2018 and beyond after these voluntary initiatives and market

changes have been factored into the equation. But the Department has not grounded its

Preliminary Assessment in the market as it exists today, let alone where it will be in 2018. And

it would be fiction to try, as proposed, to measure energy savings in this dynamic technology

market over a 30 year period from 2018 to 2048.[2]

Under EPCA, the benefits of any proposed efficiency standard must exceed its burdens.[3]

The Department cannot conclude that the "savings likely to result *directly* from the imposition of

the standard" can practically be superior to the savings the industry is delivering through the

market and through voluntary industry initiatives that promise tailored, practical, effective, and

flexible results years before any regulation could take effect. The cable industry is far more

likely to achieve, more quickly and effectively, the dual goals of energy conservation and

delivery of innovative services and devices through natural business drivers, voluntary efforts,

and market forces promoting product efficiency.

---

[2] The Preliminary Assessment includes a similarly problematic approach for estimating future benefits of emissions reductions. Preliminary Assessment §§ 2.15, 2.16. We agree that both SO_2 and NOx are subject to cap-and-trade regimes and, as a result, reduced emissions from one source generally do not produce a reduction in overall emissions levels. But we note that while the interagency group has valiantly tried to quantify the economic benefits of each ton of avoided CO_2 emissions, the "social cost of carbon" estimates vary so widely (from a low of $4.9 to a high of $67.6 per-ton) that even if discounted for estimated domestic effect they are virtually useless for the cost-benefit analysis required by Executive Orders 12866 and 13563. Given the questionable reliability of the resulting estimates of monetary benefit, they should be given minimal weight. We also note that EPA is currently engaged in developing Hg emissions standards, so it is unknown what mechanism EPA might employ regarding Hg emissions, what types of sources would be regulated (and therefore, whether any resulting cap would apply to the devices under consideration here), when regulations would be implemented, and what magnitude of reduction might result from such regulations.

[3] 42 U.S.C. § 6295(o)(2)(B).

II. THE DEPARTMENT'S ASSESSMENT APPROACH IS MISMATCHED TO THE SET-TOP BOX MARKET

The Department's standard approach for assessing technological feasibility and economic impact of an energy efficiency standard for a consumer product does not fit the set-top box market. The Department's approach assumes that covered products are commodities that consumers will purchase at a price premium to be recovered over time through decreases in residential electricity bills.

Set-top boxes are not commodities. They are deeply integrated into distribution networks with differences in network architectures, transmission protocol, software stack, conditional access, out-of-band communications channels used for command and control of the set-top box, operating system and processor instruction set, network control architecture in support of interactivity, and electronic program guide applications and guide metadata formats, among other variables. These different devices are not even the same product. Changes to set-top boxes entail changes in the network and network costs that the Department's proposed approach simply ignores.

The Department's normal "max-tech" approach to identifying optimal technology is even more ill-suited to the set-top box market. Device design and choice does not lend itself to one-size-fits-all decisions about what is technically possible or economically feasible. Highly variable private bilateral affiliation agreements between content suppliers and content distributors, and the readiness of content owners to litigate over these rights, limit choices. As MVPDs evaluate modifications to their service delivery mechanisms, they must each carefully consider the rights under their many individually-negotiated affiliation agreements, and, where necessary, negotiate with individual content owners to assure that they have all necessary rights. The Department cannot assume that one-size-fits-all improved efficiency methods available in

theory can lawfully, technically, and economically be implemented by each and every service provider.

III.   THE DEPARTMENT'S APPROACH WOULD SACRIFICE THE FUNCTIONALITY, PERFORMANCE AND INNOVATION IT IS REQUIRED TO PROTECT

The Department is required to protect performance, reliability, and features generally available in covered products; to minimize adverse impact on manufacturers and consumers; and to "promote innovation" and "consider regulatory approaches that reduce burdens and maintain flexibility and freedom of choice for the public."[4] But as it proposes to apply the approach developed for consumer products to set-top boxes, the Department would violate those obligations.

It was suggested at the Department's public workshop that, under the standard Department approach, a cable operator could not download new features (as it does today to offer innovative services) unless it removed some other function or petitioned for a rule change. The Department would stand as a barrier to new guides, the integration of social networking, and engaging set-top boxes in offering home alarm services and home energy management systems.

The Department's apparent view that it can design a single, optimal whole home solution would also frustrate innovation. The industry today delivers multiple, far more creative, practical, and efficient home networking techniques. These include multi-room DVR, DLNA approaches for connecting set-top boxes with multi-function retail devices on the home network; and MoCA home networking approaches that allow devices to move into and out of low power states in coordination with other devices in the home network. A wide variety of methods enable

---

[4] 42 U.S.C. § 6295(o)(4); 10 C.F.R. Ch. 11, Appendix A to Subpart C of Part 430—Procedures, Interpretations and Policies for Consideration of New or Revised Conservation Standards for Consumer Products, Objectives, Objective 5(e)(3)(E); Improving Regulation and Regulatory Review, Executive Order 13563, 76 Fed. Reg. 3821 (Jan. 21, 2011).

more and more consumer-owned devices (tablets, PCs, smart televisions) to connect to cable

services directly in IP, meeting the rapidly expanding customer demand for access to services

anytime, anywhere, on any screen, and often on multiple screens in simultaneous use by the

same viewer.

The Department's catalogue of potential energy efficiency measures does not match the

realities of this market. It would threaten current functionalities, the use of multimedia

gateways, improvements in display resolution, and future innovations. In the same way that

FCC integration ban mandates led to more than 480 million wasted kilowatt hours each year, and

delayed by two years the deployment of more energy efficient DTAs, Department regulation

would create a similar set of unintended consequences.

To prescribe energy efficiency standards for set-top boxes as though they were standard

consumer appliances risks derailing cable's long history of innovation and its demonstrated

creativity in conserving energy.

IV.   THE DEPARTMENT SHOULD NOT REGULATE SET-TOP BOXES AS CONSUMER PRODUCTS

The Department's approach to economic feasibility assumes that consumers will

purchase energy-efficient commodity products at a premium paid back through decreases in

residential electricity bills. This approach to economic justification does not fit the set-top box

market.

Department regulation could not provide any meaningful price signal or payback

mechanism. Set-top boxes are not sold to consumers with a "markup." They are tailored to

specific systems and leased to consumers at regulated rates based upon cost, depreciation,

ongoing maintenance and service, and inventory. They are often included in pricing bundles that

include network and programming costs. Consumers may return them if they change services,

switch devices, move, or cancel service. This is not comparable to the sale to consumers of

appliances priced for pay back through energy-efficiency. Set-top boxes therefore are not

"consumer products" that may legally be placed within the scope of Department energy

efficiency standards setting.

V.   THE DEPARTMENT'S FOCUS ON SET-TOP BOXES PROVIDED BY MVPDS IS ARBITRARY

The Preliminary Assessment proposes to exclude over-the-top set-top boxes from the

"focus" of this proceeding, and to concentrate instead on MVPDs. There are over 200 million

other video devices, most of which operate as set-top boxes but are less energy-efficient than

new cable set-top boxes. By 2018, many observers, including the Department, believe these

other set-top boxes are likely to be an integral part of the "future of TV." It would be arbitrary

and would distort competition to exclude them from the focus of this proceeding.

APPENDIX B

SUMMARY AND INDEX OF RESPONSES TO SPECIFIC RFI QUESTIONS

A.   Energy Conservation Standard

1.   Product Classes

Question: Should Cable DTA be a factor in defining a product class? DOE believes this is used for older analog televisions (TVs), which are becoming less common as consumers switch to digital TVs.

Response: Cable DTAs are also used with digital TVs, and the number of DTAs deployed by cable operators is increasing. See page 12 and footnote 75.

Question: How should tuner types be categorized? Are there significant energy differences between analog and digital tuners?

Response: Accommodation should be made for the fact that devices may increasingly have more than two tuners. Existing set-top boxes have three, four, five, and six tuners, and other options may be introduced in the future. See page 42.

Question: Should streaming STBs (e.g., streaming video from a web-based service) be distinguished from service provider IPTV STBs? What, if any, differences are there between those types of STBs? Is the term ''video signals'' sufficient for including streaming STBs in the potential IPTV product classes?

Response: Streaming set-top boxes and other over-the-top set-top-boxes should not be excluded from the focus of this proceeding. See Section V.B.

Question: Should there be additional features defined due to significant differences in functionality (i.e., performance related feature) that affect energy consumption? Note that for ENERGY STAR, Cable DTA and Cable are two separate definitions despite the fact that they both use cable as the transmission medium.

Response: Yes. There is more variation in set-top boxes features than is defined in the ENERGY STAR program. Because ENERGY STAR is voluntary, manufacturers can still build different types of new set-top boxes not covered by existing ENERGY STAR standards, such as ARRIS' six-tuner home gateway. See Sections III.B, V.A.

Question: Is the Cable STB definition sufficient to include stand-alone DVRs (which include a CableCARD slot to interface with an existing service provider) generally purchased through retail? Should a separate product class exist for stand-alone DVRs?

Response: Stand-alone DVRs should be included. See page 48.

Question: Should the Cable STB definition include CableCARD and DOCSIS functionality?

Response: Yes. At this time, cable operators continue to be required by law to include CableCARDs in most new set-top boxes. Some cable operators use DOCSIS in set-top boxes, among other ways, for DOCSIS Set-top Gateway (DSG) used for out-of-band communications channels used for command and control of the set-top box. See Sections III.C and IV.D.

Question: Does CableCARD functionality consume energy when a CableCARD is installed but not used, or does it also have to be in use? DOE believes this feature only applies if it is actively decrypting video content during testing.

Response: A CableCARD consumes energy even when it is not actively decrypting video content. The CableCARD must process conditional access network messages, including entitlement updates and software updates, at all times. See page 39.

Question: Should the Advanced Video Processing feature encompass both encoding and decoding of video content? Would encoding or transcoding require more hardware and energy consumption compared to decoding? Does the presence of Advanced Video Processing significantly affect power consumption when viewing MPEG–2 or analog video?

Response: Multiple products may need to be defined to reflect different variations of Advanced Video Processing. See Section V.A, page 41.

Question: Can Advanced Video Processing and High Definition be combined into a single functionality?

Response: No. See page 41.

Question: Is it sufficient to define HD as any resolution greater than 720p? Should there be a separate definition for even higher video resolutions?

Response: No, for purposes of product classification, HD should not be defined as any resolution "greater than" 720p or any other particular measure. Resolution will continue to increase over time, and product classifications should not have open-ended definitions that could impede future innovations. See Section IV.C.

Question: Does the capability for multi-room increase the energy consumption of the STB when only one output is connected?

Response: Testing is not complete at this time. See Section IV.B for discussion of home networking.

Question: Does the capability for multi-stream increase the energy consumption of the STB when only one stream is being accessed?

Response: Testing is not complete at this time.

Question: None of the currently qualified ENERGY STAR products take credit for Removable Media Player or Recording. Are there STBs that currently implement removable media support? Does the presence of this feature increase the energy consumption when not in use (e.g. when the STB is accessing live TV content)?

Response: Current models of cable set-top boxes deployed by U.S. operators do not include removable media players or recorders.

Question: DOE further requests that interested parties comment on whether there are any features that would impact some potential product classes of STBs and network equipment differently than others? For example, would DVR functionality tend to increase the energy consumption of satellite STBs and cable STBs similarly?

Response: Yes, set-top boxes vary depending on MVPD network, software stack, and guide provided by the MVPD, among other variables. See *e.g.* Sections III.B, III.C, V.A.

Question: Lastly, should DOE consider any other additional features that currently exist or are in development that would significantly affect consumer behavior and/or STB energy consumption (e.g., 3D video processing, ultra high definition)?

Response: Yes. See page 38 and Part IV.

2.   Low Power Sleep Mode

Question: DOE seeks feedback from interested parties on methodologies that reduce STB energy consumption when not performing a primary function. As an example, a STB could enter a "deep sleep" mode during off-peak hours (such as the middle of the night) and automatically wake up once every 30 minutes to communicate with the service provider and check for updates. At other times, the device would remain in a "light sleep" mode when not in use and not require a long wake-up time.

Response: See Sections I and II.A, and footnote 20. Rather than have devices automatically wake up periodically, in a two-way system, however, it could be preferable to design a "deep sleep" mode in which the network would instead wake the box on an as-needed basis.

3.   Multi-room Setups

Question: DOE is seeking market data on how prevalent multiple STBs are in current homes. For example, how many homes use two STBs? How many homes use three STBs?

Response: See Section IV.B.

Question: How much more power does a multi-room STB use compared to a thin-client device? How much more power does a multi-room STB use compared to a STB without multi-room capability? Are generic thin-client STBs capable of connecting to any multi-room STB, or will only specific models of thin-clients work with a given multi-room STB?

Response: See Section IV.B.

B.   Test Procedures

1.   Impact of Service Provider Software

Question: What impact does the service provider software have on energy consumption?

Response: Software is part of the complex, interrelated ecosystem of each MVPD system's unique architecture. Set-top box energy consumption can vary based upon these varied implementations. See Sections III.B, III.C, IV.A, and V.A.

Question: How does service provider software impact idle or sleep behavior?

Response: Software can affect whether and when sleep functions are available and activated, and thus varies by MVPD system. See Sections I, II.A., and III.C.

Question: How does such software affect any other energy saving features?

Response: Software is part of the complex, interrelated ecosystem of each MVPD system's unique architecture. Set-top box energy consumption can vary based upon these varied implementations. See Sections III.B, III.C, IV.A, and V.A.

Question: For cable STBs, will there be different energy consumption of a generic STB with CableCARD accessing the digital programming of a service provider versus a programmed device with full two-way communication with the service provider.

Response: This question appears to be based upon a misunderstanding of CableCARDs. CableCARDs *do* support two-way services, and most new cable-operator deployed leased set-top boxes include CableCARDs and support the use of two-way services. However, most retail devices that use CableCARDs were not designed to support two-way services. See page 39, footnote 72.

2. Live Network Testing

Question: How will STB behavior compare between closed network testing and live network testing?

Response: See Section II.B. Closed network testing at CableLabs enables an accurate assessment of the network configuration that enables consistent, repeatable, and accurate measurement of energy consumption. Testing in the home would not provide access to the wide variety of headends or repeatable results.

Question: How will STBs with subscription service be affected by geographic location and time of day?

Response: Cable systems generally align with franchise boundaries. Conditional access systems, channel lineups, out-of-band communication networks, and set-top boxes may vary by system. Consumer usage patterns will vary with time of day. See Section III.B.

Question: How will energy usage of the STB be affected by the subscription package selected?

Response: We cannot conclusively answer this question at this time. To the extent that some subscription packages may correlate to increased viewing and recording, they may also thereby correlate to increased energy usage. We cannot project the full range of subscription packages that may be available by 2018. See Sections III.B and III.D.

Question: Are there any obstacles with service providers providing head-end equipment to labs for testing STBs?

Response: Yes. CableLabs has created a unique testing environment. See Section II.B.

Question: Are there any additional factors that should be considered when deciding between closed network and live network testing methods?

Response: See Section II.B.

Question: Are there other potential test setups that should be considered?

Response: Testing in homes might serve as a supplement to lab testing, but it is problematic to integrate such testing into the normal product development and acquisition cycle. See Section II.B.2.

3. Video Source

Question: How much modification do service providers make to content providers' signals? Does a specific channel use similar frame rates, encoding, and bit rates across different service providers or locations? DOE does not wish for service providers to lower the quality of video in order to meet potential energy standards.

Response: Signals are demodulated and remodulated. Compression may vary in QAM. New requirements call for adjusting sound levels. IP-based delivery use a variety of approaches and may include Adaptive Bit Rate (ABR) transport that can affect bit rate and picture quality. NCTA agrees that the Department should avoid any regulations that would result in decreased quality of video. See Sections III.B and IV.

Question: For a given service provider, are there any regional differences in video format? For example, would an HD broadcast of a specific channel be delivered at an identical video format across all geographic locations?

Response: Among cable operators, there are differences in signal origin. Some cable operators receive signals directly from the content provider, while others receive signals from Headend-In-The-Sky (HITS) which packages a number of program channels on behalf of a number of smaller cable operators. As a result there may be variation in the signals geographically. See Section III.B.

Question: How much variance in energy consumption would be expected based on the video content? Would sports content (more dynamic) have significant differences in energy consumption compared to news content (more static)?

Response: Testing is not complete at this time.

Question: Is it possible to determine or measure the frame rate, bit rate, and video format being received by the STB? If so, how is this done?

Response: Yes, these can be measured at signal distribution from the cable headend. See Section II.B.

Question: If labs are able to test with a controlled video source, what parameters most impact energy consumption? DOE has identified resolution, format, frame rate, and bit rate. Are these sufficient, or are there other parameters that should be specified? Are any of these parameters irrelevant to energy consumption?

Response: Testing is not complete at this time.

4. Digital Video Recorder Testing

Question: The ENERGY STAR test procedure specifies that live TV testing includes pausing (5% of test time), fast forward (10% of test time), and rewind (10% of test time), and watching video for the remaining 75% of the time. It also specifies energy consumption for recording and playing back stored video. DOE believes that energy consumption may depend on the order that these operations are performed as well as the number of transitions between modes. Additionally, DVR STBs usually have multiple speeds for fast forwarding and rewinding that may impact energy usage. DOE is considering that each DVR operation mode be measured in a separate test for fixed test time durations. For example, the tester could measure power for 5 minutes while rewinding video, measure power for 5 minutes while playing video, and measure power for 5 minutes while fast-forwarding video. The weighting for energy consumption can be incorporated into the final efficiency metric. DOE is also considering including multiple speeds for fast- forward and rewind for testing. DOE seeks feedback from interested parties on handling DVR testing.

Response: Testing is not complete at this time.

5. Low Noise Block Power Consumption

The power consumed by companion devices such as Optical Network Terminals and Low Noise Block-downconverters should be included in the power consumption calculations of their associated set-top boxes since they use the consumer's electricity and must be taken with the set-top box. See page 25, footnote 38.

Additional Questions Posed at January 26 Public Meeting

Question: What design limitations are imposed on STBs by the cable, satellite, terrestrial, or internet infrastructure? How might this affect STB behavior/usage profiles? How might this affect STB energy consumption?

Response: Design options may be limited and affected, among other factors, by the technical implementation of each MVPD's hardware and software configurations; by their obligations to content owners under their affiliation agreements; and by FCC regulatory requirements.   These variations in services and features may affect consumer usage patterns. See Sections III.B, III.C, III.D.

Question: DOE welcomes comment on markup approaches for developing estimates of manufacturer selling prices.

Response: The Department's traditional markup approach does not fit this market since consumers lease set-top boxes from service providers that combine software and other functionality with the devices, and because some service provider set-top box rates are subject to rate regulation while others include set-top boxes within their rates for services. See Section V.D for discussion of set-top box pricing.

Question: DOE welcomes comment on the approach to determining the relationship between manufacturer selling price and set-top box efficiency.

Response: See Section V.D for discussion of set-top box pricing.

Question: DOE welcomes comment from interested parties on the best methodology for scaling from the representative product classes to the remaining product classes, including the proposed methodology of assigning specific power requirements for additional features, similar to ENERGY STAR allowances.

Response: Given the number of potential product classifications under this approach, and the variety of set-top boxes that exist or could exist by 2018, it is not clear on what basis "representative product classes" would be identified. See Section V.A for discussion of product classification.

Question: DOE welcomes comment on whether there are outside regulatory changes that DOE should consider in its engineering analysis of set-top boxes.

Response: See Section III.D (cable operator set-top boxes are subject to pervasive regulation) and Section IV.D, footnote 73.

Question: DOE welcomes comment on other end-use issues that could impact the energy use analysis.

Response: See generally Sections III and IV.

Question: DOE welcomes feedback and data on how to properly address equipment price markups for set-top boxes. Specifically, DOE welcomes comments on how to apply the mark-up analysis to set-up boxes given that set-top boxes are often leased, as opposed to sold, to

consumers. How much of service fees charged to customers should be allocated to the lease of set-top boxes?

Response: See Section V.D for discussion of set-top box pricing.

Question: What changes to network infrastructure would be necessary for STB efficiency design options? What would be the cost of these changes? Would service providers pass these costs onto consumers in the form of increased fees?

Response: See Section III.C. Increased costs would be borne by subscribers through higher service fees.

Question: DOE welcomes input on the proposed approaches for estimating discount rates for consumers of set-top boxes covered under this rulemaking.

Response: Consumers typically do not purchase set-top boxes. See Section V.D for discussion of set-top box pricing.

Question: DOE welcomes comment and data on appropriate set-top lifetimes. DOE also welcomes comment on how returns and refurbishments impact total set-top lifetimes.

Response: See Section V.D (consumers may return devices to switch services or providers, and operators may re-deploy set-top boxes to different customers) and footnote 52 (refurbishing and avoiding premature obsolescence are economically and environmentally beneficial).

Question: DOE welcomes recommendations on data sources for shipments of STBs by different product classes and long-term trends in STB shipments.

Response: As noted in footnotes 14 and 34, SNL Kagan collects and analyzes relevant industry data.

Question: DOE welcomes comment on how any standard for STBs might impact shipments of these STBs, as well as interactions between various STB product classes. DOE also invites information about market-pull programs that promote the adoption of more-efficient STBs.

Response: See Section I for discussion of cable operator incentives to improve the energy efficiency of set-top boxes and the results of their ongoing efforts.

APPENDIX C

Ralph W. Brown, *Tackling the US Cable Set-top Legacy: Middleware in a Sea of Proprietary Systems*

Tackling the US Cable Set-top Legacy:
Middleware in a Sea of Proprietary Systems

Ralph W. Brown, *Member*, IEEE

Abstract — *US cable operators moved into the world of digital video in the late 1990s taking the expedient proprietary systems approach. While this enabled them to get to market relatively quickly, it put in place a set of legacy digital video delivery systems that have a huge installed base of tens of millions of digital cable set-top boxes. This installed base spans over a decade of technology advances resulting in a broad range of set-top capability and performance. Legal and regulatory mandates, as well business imperatives, have given rise to multi-vendor interoperable solutions in this space. Middleware is a critical component of these solutions. This paper will summarize two of the key middleware alternatives in US cable today, their capabilities, limitations, technical challenges and future opportunities.*

Index Terms — Interactive Television, Middleware, Digital Cable Systems.

I. INTRODUCTION

With the development of digital video encoding techniques and their standardization through the Motion Pictures Expert Group (MPEG) in the early 1990s the interest in deploying digital video services grew within the cable industry. The increased spectral efficiency of compressed digital video (enabling the 500 channel universe), together with the increased security enabled via digital cryptography and the ability to efficiently switch digital video signals, opened up a wealth of new opportunities and service offerings for the cable industry.

Two primary solutions providers for digital cable video delivery systems in North America resulted as direct outgrowth from the dominant analog cable video delivery system providers at that time. These solutions providers were General Instruments (GI, subsequently purchased by Motorola) and Scientific Atlanta (SA, subsequently purchased by Cisco). They each designed digital video delivery systems that were most appropriate for their respective largest customers. In the case of GI their largest customer was Tele-Communications, Inc. (TCI) and in the case of SA their largest customer was Time Warner Cable (TWC). TWC had made a concerted effort to acquire and build cable systems that were upgraded to provide higher bandwidth and two-way communications. These cable systems were clustered in and around major metropolitan areas. TCI on the other hand was made up of largely rural systems that had limited bandwidth and in some instances did not provide two-way communications.

The objectives for TCI in deploying digital video systems were largely on a lower cost alternative to provide increased broadcast channel capacity serving their more distributed smaller systems. Consequently, GI designed a system that enabled a centralized, national control system and low cost distributed head-ends. Figure 1 shows a high-level block diagram of the early GI system architecture.
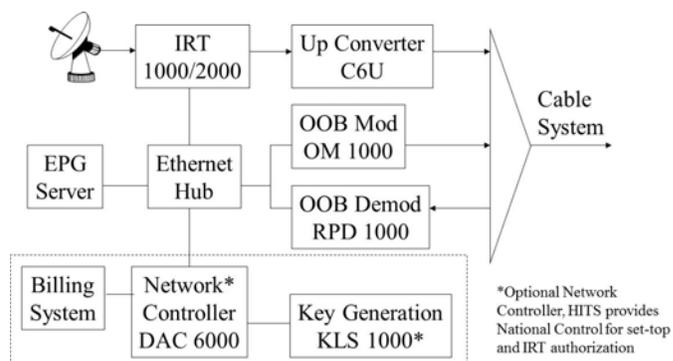

Fig. 1. – Early GI System Architecture

Shown in this diagram are the major system components of the GI system. The Integrated Receiver Transmitter (IRT) received, demodulated and decrypted the satellite Quadrature Phase-Shift Keying (QPSK) transmission of the digital video signal and associated control information. It then re-encrypted, and modulated using Quadrature Amplitude Modulation (QAM) the digital video signal at an intermediate frequency. The IRT also stripped out the control signals from the satellite appropriate for that specific cable system for distribution on the Out-of-Band communications channel. The C6U up-converter placed the QAM signal at the proper frequency for distribution on the cable plant. The OM 1000 Out-of-Band (OOB) Modulator generated the QPSK signal for transmission to the receiving set-tops in the home. The Return Path Demodulator (RPD) demodulated the QPSK signal transmitted from the set-top to the head-end. Combined these form a two-way OOB communications channel for set-top command and control.

The Electronic Program Guide (EPG) server provided the proprietary EPG data stream that was also transmitted via the OOB channel to the receiving set-tops. For those systems where local control was required, a Digital Access Control (DAC) server could be used in place of the national control

signal received from the satellite. This also involved a Key List Server (KLS) for generation of the encryption keys used by the DigiCipher™ conditional access (CA) system.

The objectives for TWC in deploying digital video systems grew out of their experiences with the Orlando Full Service Network™ (FSN) [1,2,3] focused on Video-on-Demand (VoD) and interactive services. In March of 1996 TWC issued the initial Pegasus Request For Proposal (RFP) based on this experience and detailing the type of system they envisioned [4]. SA was the primary supplier selected through the RFP process and they designed a system based around the interactive TV standards that were evolving at the time, in particular the Digital Audio Visual Council™ (DAVIC) specifications and the MPEG Digital Storage Media Command And Control (DSM-CC) [5]. Figure 2 below shows a high-level block diagram of the early SA system architecture.
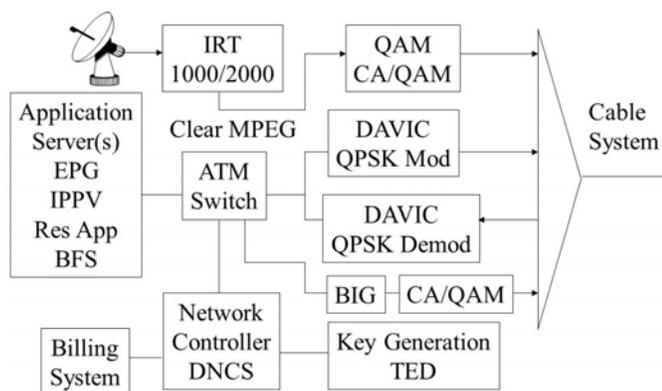
Fig. 2. – Early SA System Architecture

Shown in this diagram are the major system components of the SA system. Since much of the desired cable programming was distributed via satellite using the GI system, an IRT would often be used to receive these signals. However, since the SA system made use of a different CA methodology, the clear MPEG signal was tapped from the IRT and passed to the SA CA/QAM for encryption and QAM modulation. The CA/QAM was also capable of transmitting on the desired frequency eliminating the need for an up-converter. The OOB communications channel was established using the DAVIC based QPSK modulators and demodulators. The Broadband Interactive Gateway (BIG) generated object carousels and Broadcast File Systems (BFS) to transport system and application specific data files. A local Digital Network Control System (DNCS) managed the overall network and set-tops. The key generation for the SA PowerKey™ CA system was provided by the Transport Encryption Device (TED).

II. PROPRIETARY DIGITAL VIDEO SYSTEMS

The respective design objectives resulted in proprietary systems that had different system architectures and network configurations, as well as different Conditional Access (CA)

systems, as described above.

Despite these different design goals there were also a significant number of common elements:

- Both systems used MPEG-2 video compression and Dolby® AC-3 audio compression [6,7].
- Both systems have added support for MPEG-4/AVC in the intervening years [8].
- Both systems used QAM modulation for transmission of MPEG-2 transport streams carrying the audio/video signal [9].
- Both systems used variants of Data Encryption Standard (DES-64) [10] encryption as the working cipher for their CA systems and in particular both were capable of supporting the SCTE 52 2008 DES-CBC variant [11].
- Both systems used a common Service Information format to communicate channel line-up information [12].

However, because of the different design goals there were many proprietary components remaining in each system.

The proprietary aspects of the two systems largely lay in following areas:

- The Conditional Access (CA) system (DigiCipher™ II in the case of GI and PowerKey™ in the case of SA) used to control subscriber entitlements and manage access to digital channels.
- Their out-of-band (OOB) communications channels used for command and control of the set-top box:
  - GI's system implemented the DigiCipher II OOB utilizing an MPEG structure for transporting OOB messaging downstream, standardized as ANSI/SCTE 55-1 2009 [13]. The GI OOB channel provided 2Mbps downstream bandwidth and 256Kbps upstream bandwidth through an aloha, polled communication protocol.
  - SA's system implemented a DAVIC based OOB utilizing an ATM/IP structure for transporting OOB messaging downstream, standardized as ANSI/SCTE 55-2 2009 [14]. The SA OOB channel provided 1.5 Mbps bandwidth in both the downstream and upstream using a real-time, two-way protocol.
- Operating system (OS) and processor instruction set:
  - GI's system initially implemented a proprietary kernel on a Motorola 6800 processor instruction set.
  - SA's system initially implemented the PowerTV™ OS on a Sun SPARC™ processor instruction set.
  - Subsequently, other OS (e.g. Linux) and processor instruction sets (e.g. MIPS) have been introduced by both system providers.
- Network control architecture in support of interactive applications, such as VoD and Switched Digital Video (SDV):

- GI's network control architecture lacked the concept of an interactive session manager, requiring third-parties to provide this component when integrating session based services, such as VoD.
- SA's network control architecture implemented an interactive session manager, supporting DSM-CC User-to-Network commands for support of dynamic MPEG transport sessions.

- Electronic Program Guide (EPG) application and EPG metadata format.

These differences were sufficient to eliminate the possibility that a set-top from one supplier could operate on the network of the other. Each had licensed their proprietary set-top technologies to third-parties, however, set-tops from these third-party suppliers never developed into significant market largely due to the license terms involved. Consequently, once a cable operator had selected a system provider, the choice of set-top and a significant amount of the additional network equipment (e.g. OOB modulator/demodulators, QAM modulators, etc.) was limited to that supplier. Further, applications developed for one system could not be deployed on the other.

Integration of interactive service components, such as a VoD application and corresponding video streaming servers, required tight integration with either GI or SA's network. This resulted in pair-wise integrations between VoD vendors, set-top applications vendors, and the digital video systems providers. The net result being higher system costs with corresponding longer time to market for new services and applications.

III. OPENCABLE™ AND TRU2WAY®

In September of 1997 CableLabs® launched the OpenCable program [15], which was subsequently given the retail brand of tru2way®. The objective of the OpenCable program was to enable third-party manufacturers to develop terminal equipment (set-tops, personal digital video recorders, or integrated digital televisions) for these proprietary systems without the need for a technology license from one or both of the two dominant proprietary digital video systems provider.

In order to accomplish this goal it was necessary to isolate the proprietary system specific aspects of these systems into separable components. The systems specific aspects fell into two general categories:

- Hardware – These included, the core hardware components of the CA system (working cipher and key hierarchy) and the key components of the OOB communications network (e.g. forward error correction and MAC layer processing)
- Software – These included, Operating System (OS) and applications (both MSO specific and potentially third-

party applications)

The OpenCable program involved isolating these system specific hardware and software components to enable third-party device (set-top or DTV) providers to build devices that could be integrated into these proprietary systems at the point of deployment. Ideally, these devices could be purchased at retail by the consumer, taken home and with the appropriate system specific components be connected to the proprietary cable system and function in exactly the same way as a proprietary set-top box from the system provider.

In order to meet the OpenCable objectives, a number of interfaces needed to be specified and standardized. Figure 3 provides a block diagram identifying the key interfaces in the tru2way architecture.
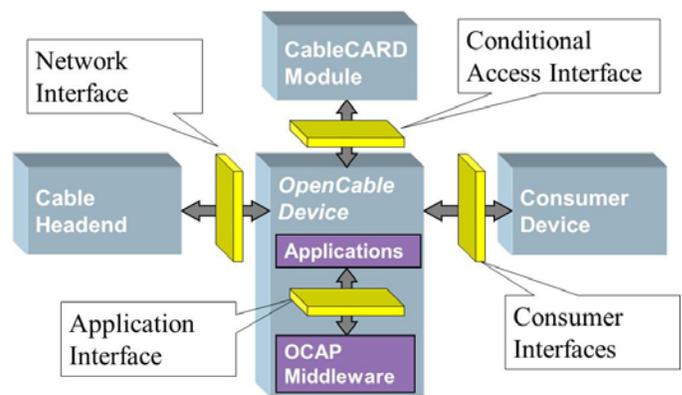

Fig. 3 – OpenCable/tru2way Interface Diagram

The four interfaces specified by OpenCable:

- The Network Interface – This is the interface that connects to the cable network at the consumer's home and is specified as part of the OpenCable Host Specification.
- The Consumer Interfaces – These are the interfaces that connect to the consumer's TV or other entertainment devices (e.g. HDMI, component analog, composite analog, etc.) and are also specified as part of the OpenCable Host Specification.
- The Conditional Access Interface – This is the interface to the system specific CA and OOB channel and is specified in the CableCARD™ Specifications.
- The Application Interface – These are the Application Program Interfaces (APIs) that applications use to perform the desired functions using the Host and CableCARD components and is specified by the Open Cable Application Platform (OCAP) specification.

In this architecture, an OpenCable Host device is enabled to function on the cable network by providing a hardware component, the CableCARD, which is specific to the proprietary system deployed in that cable network.

Originally, this would be either a GI or SA CableCARD; however other CA systems, such as NDS and Conax, have been added to this list over time. The CableCARD cryptographically binds to the Host for security and copy protection purposes and instructs the Host how to acquire the OOB communications channel, register on the network, and receive the OOB command and control signals appropriate for the CA system. The Host is then able to acquire the list of applications, for example the EPG, that are supported on the cable system, securely download them if necessary, and begin execution.

While these four interfaces are easily identified, the details of how these specific interfaces were achieved are much more complex.

A. Isolating Hardware Aspects

As mentioned above there were two system specific hardware aspects that needed to be addressed, the proprietary CA System, typically involving proprietary, tamper-resistant cryptographic silicon, and the proprietary OOB communications channels. The CableCARD is the hardware module in the OpenCable/tru2way system that achieves this isolation through a physical encapsulation of the cryptographic CA component and some portions of the OOB communications channel. The CableCARD by necessity had to be a separable or removable module that could be delivered independently from the Host device. In practice, the CableCARD is provided by the local cable operator.

There were two alternatives that were considered for this hardware module, based on two parts originally defined in the EIA-679, the National Renewable Security Standard and initially adopted in September 1998 [16]. Part A of that standard uses the ISO/IEC 7810 Smart Card interface and form factor. Part B of that standard uses the computer industry PCMCIA card interface and form factor. Further, the EIA-679 standard was derived from the DVB Common Interface (DVB-CI) [17].

Of these two options, the ISO/IEC Smart Card form factor was rejected due to the limited bandwidth of the interface and lack of the ability to extend the interface to support the proprietary OOB channels used in the then deployed digital cable systems. The PCMCIA form factor supported the necessary bandwidth and also had unused interface pins that could be used to extend the interface to address the proprietary OOB channels. Further, the PCMCIA interface supported a personality protocol that allowed the host device to recognize different pin-outs and adapt appropriately. Consequently, Part B of the EIA-679 standard was ultimately adapted for use in the OpenCable architecture.

The only commonality the two proprietary OOB channels had was the use of QPSK modulation; they differed in the frequency band and bandwidth, the Forward Error Correction (FEC), the framing, and the transport protocol used. Consequently, the QPSK front-end (modulation and demodulation) was placed in the OpenCable Host and all of the higher layers of the proprietary OOB communications protocol stack were placed in the CableCARD. Raw QPSK symbols and their timing passed across the PCMCIA interface through the use of redefined pins in the physical interface. The CableCARD is responsible for instructing the Host what mode of operation the system requires.

While this approach was sufficient to simply isolate the proprietary OOB channels, it did not address the proprietary hardware components in the head-end, the OOB modulators and demodulators, nor the limited bandwidth available on these proprietary OOB channels. In order to isolate this particular hardware aspect the logical choice was to migrate the proprietary messaging carried on these proprietary OOB channels to a standard two-way communications channel, such as Data-Over-Cable Service Interface Specification (DOCSIS®). This was accomplished through the DOCSIS Set-top Gateway (DSG) with the appropriate modifications to the CableCARD [18]. Since DOCSIS provides an efficient two-way IP connection for devices, the DSG specification focused on extending the DOCSIS specification to perform two key functions:

- Encapsulate the downstream proprietary messaging in an IP transport using a broadcast or multicast transmission so that all set-tops could access it concurrently.
- Provide a one-way mode of operation so that the set-top could continue to function in a one-way mode in cases of network disruption.

In addition, DSG provides higher bandwidth than either of the proprietary OOB channels. DOCSIS 2.0 supports 40 Mbps downstream and 30 Mbps upstream. This enables rich media applications on OpenCable Host devices requiring greater bandwidth.

EIA-679 Part B only permitted the decryption and processing of a single MPEG Multi-Program Transport Stream (MPTS), equivalent to a single set-top tuner. The original CableCARD specification followed this model with single stream mode, or S-Mode, of operation. As Digital Video Recorders (DVRs), picture-in-picture, and other multi-tuner features were developed, it was realized that the original S-Mode CableCARD had inadequate bandwidth for these features. It would require multiple S-Mode CableCARDs to provide this capability and could not grow to support multi-tuner gateway scenarios. Subsequently, the M-Mode (or Multi-stream mode) CableCARD specification was developed and has its origin in SCTE 28 [19]. M-Mode provides the higher transport data throughput rates that are required to support features, such as multiple-tuner Hosts, Hosts with DVRs, and Hosts with picture-in-picture capability.

Successfully isolating the hardware specific aspects represented only half of the challenge. It was also necessary to isolate the software aspects.

B. Isolating Software Aspects

In September of 1999 CableLabs issued a Software Request For Proposals (RFP) [20] soliciting proposals for a middleware solution enabling application independence from the underlying hardware and operating system of the set-top terminal device. Ultimately, the cable industry chose a middleware solution based on the Digital Video Broadcast (DVB) Multimedia Home Platform (MHP), a Java™ based middleware solution [21]. The industry requirements that led to this decision were the desire for the cable industry to programmatically define the customer user interface (UI) and to remain independent of the underlying hardware and operating system. Other declarative formats, such as HTML and JavaScript, were considered, but deemed insufficiently flexible to meet the cable industry's requirements. At this time Java was the most broadly adopted virtual machine implementation and a logical choice. Coincidently, Sun had proposed Java as a technology for use in the TWC FSN, though it was not selected at that time.

The DVB-MHP specification was designed for the European market and was focused on broadcast applications (also known as bound applications). Bound applications are transmitted along with the audio/video program stream and execute only in the context of that program. Once a new program stream is acquired, the application terminates and potentially a new application bound to the new program stream is loaded and executed. Cable operators had applications, such as EPGs or VoD client applications, which were not bound to a single program stream (un-bound applications) and must continue to execute across the context of multiple program streams. Consequently, it was necessary to make several modifications and extensions to the MHP specification in order to meet North American cable operators' requirements. These modifications and extensions included:

- Support for un-bound applications that persisted across channel changes.
- With the introduction of un-bound applications a greater need to manage resource conflicts among applications and application lifecycle, this capability was defined by a monitor application that accessed a well-defined set of privileged APIs.
- A different set of System Information (SI) APIs to address the differences between North American and European SI models.
- A set of POD/CableCARD APIs to provide a software interface to the POD/CableCARD.
- A specific set of hardware capabilities (e.g. graphics display pixel depth, graphics planes, and resolution,

mandatory remote control input keys and input handling, output port control, etc.).
- OpenCable also defined several device profiles to support both set-top box and integrated DTV implementations.

The result of these modifications and extensions is the OpenCable Application Platform (OCAP) specification [22] shown in figure 4 below.
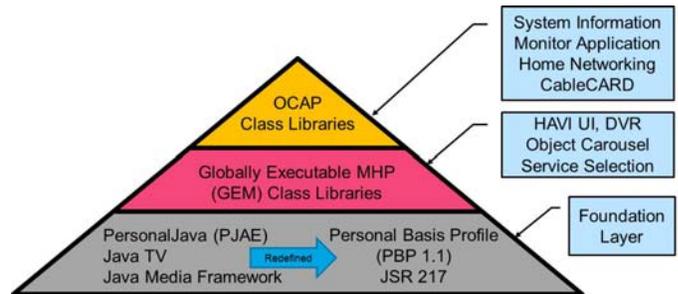

Fig. 4 - OCAP Stack Components

This figure shows the layers of the OCAP stack. The foundation layer of OCAP was originally based on Sun Microsystem's PersonalJava Application Environment (PJAE) Specification Version 1.2a with the inclusion of the Java TV class library for basic TV tuning or service selection functions and the Java Media Framework (JMF) class library for media processing functions. Over the years Sun went through a process of redefining the Java platform profiles and the Personal Basis Profile (PBP) 1.1 emerged as the Java platform used in the foundation layer. The application of Java technology to other television standards throughout the world led to the definition of a core set of MHP APIs known as the Globally Executable MHP (GEM) standard [23]. GEM is incorporated into ATSC ACAP [24], ARIB [25], and Blu-ray Disc Java (BD-J) [26] the more widely adopted standards shown in figure 5 below. The GEM layer provides basic service selection functions, object carousel for broadcast data services, Home Audio Video Interoperability (HAVi) User Interface (UI) class libraries for light weight UI widgets suitable for TV display, and basic DVR functions, in addition to incorporating Java TV and JMF. The final layer of OCAP included the OCAP class libraries addressing the features identified above.
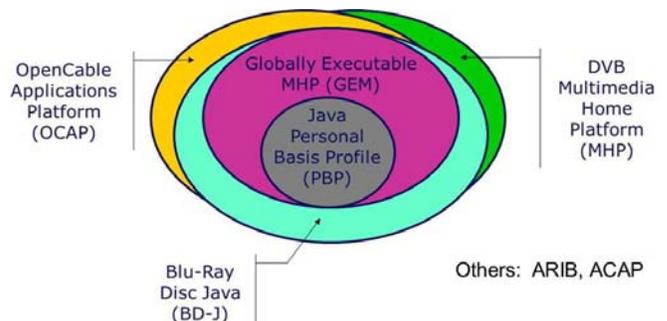

Fig. 5. Java Based Middleware Standards

During the development of the tru2way platform, cable operators began to deploy proprietary network switching equipment to enable VoD and SDV services and applications. The proprietary nature of these systems was tied to the underlying proprietary digital video delivery systems. The Java platform enabled the development of navigation applications that could encompass these system specific proprietary VoD and SDV systems without the need to overhaul the network equipment and systems.

In the intervening period since the original definition of OCAP, two major extensions to the OCAP specification have been defined to address Digital Video Recorder (DVR) [27,28] functionality and home networking functionality [29,30,31,32,33,34]. The ability to expand the core functionality of OCAP has enabled it to address expanding requirements of the cable industry.

The resulting middleware platform has enabled cable operators to develop a broad range of navigation and EPG applications, supporting VoD, Multi-room DVR, SDV, advanced content search and other compelling features. These applications are fully decoupled from the underlying platform, including the system specific layers, enabling the integration of new hardware platforms. Competition among set-top suppliers has reduced cost and increased performance, yielding benefits to the subscriber.

While the tru2way specifications addressed technology going forward it did not scale in a backward compatible manner to the large number of deployed set-tops. A different middleware approach was called for to address this installed base of less capable set-tops.

IV. ENHANCED TELEVISION BINARY INTERCHANGE FORMAT (EBIF)

On July 1, 2007 the largest cable operators in the US began deployment of CableCARD/OCAP set-tops. Prior to this point, the cable industry had deployed over 58 million proprietary set-tops that largely lacked the memory and processor capability to support the full OCAP software stack. These millions of set-tops represented a significant opportunity for interactive applications that required less full-fledged capabilities.

To address this large installed base of proprietary set-tops CableLabs introduced the Enhanced Television (ETV) specifications in April 2005 [35,36]. The ETV specifications defined an application signaling message format and a declarative content format known as Enhanced TV Binary Interchange Format (EBIF). The implementation of the ETV specification is through an ETV User Agent (UA) that can be implemented both natively on the older proprietary set-tops and as an OCAP application on the newer generation of set-tops being deployed as of July 2007.
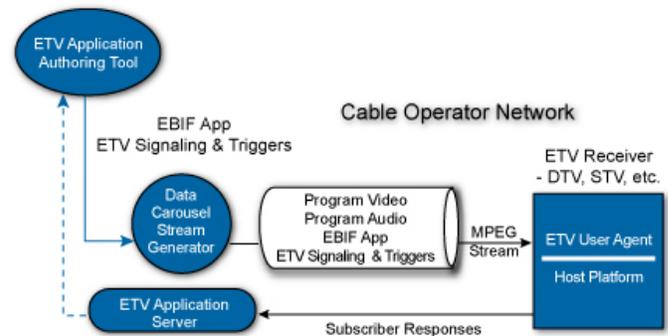

Fig. 6 - ETV Network Architecture

The primary design point for ETV was to support the broadest range of cable set-tops. For GI this included the DCT2000 onward and for SA the Explorer 2000 onward. Another design point was support for bound applications designed to enhance the broadcast television programming. Because of these design objectives EBIF is focused on a constrained set of application functionality unlike the generalized programming environment of tru2way.

Due to variations on processor, memory, graphics and video processing capabilities that occurred across over ten years of set-top technology development, the EBIF specifications define three profiles: baseline, full, and advanced. Baseline is the most limited. Full is a proper superset of Baseline and Advanced is a proper superset of Full. This enables ETV applications to adapt to the underlying capabilities of the set-top platform on which the UA is executing. Some examples of the set-top limitations include graphics resolution, pixel depth, and the capabilities of the OOB channel.

The EBIF specification contains a well defined set of widgets for the creation of applications. These include Buttons, Collections, Containers, Forms, Images, Text, Rectangles, Text Input, Timers, and Video. Applications are also implemented through action tables that provide a sequence of actions to be performed to complete a procedural function. These widget resources and actions are compiled through an ETV Application Authoring Tool which generates EBIF binary objects. These are then multiplexed with the program audio/video signal and ETV signaling/triggers to manage the life-cycle of the applications at the appropriate points in time.

Figure 6 shows a high-level diagram of the ETV architecture. ETV applications are created using an ETV Application Authoring Tool which generates an EBIF binary that constitutes the application and associated ETV signaling. The EBIF binary is placed in a data carousel for cyclic playback to ensure complete capture by the ETV UA. This data carousel and the associated signaling are multiplexed together into an MPEG program streams along with the program audio and video streams. User generated input or

responses can be sent to an ETV Application Server in the cable operator's network for aggregation or other processing. In this way, responses to voting/polling applications or request for information (RFI) applications can be processed and subsequently fulfilled. One of the major application areas being addressed through the use of EBIF is advanced advertising, including targeted ads, RFIs, and user initiated (telescoping to long form VoD advertising).

V. CONCLUSION

While proprietary systems did enable faster time to market for the cable industry, in a competitive Multi-Video Program Distributor marketplace, single vendor solutions limit innovation and time to market of new services. Middleware is a necessary component to enable both competitive suppliers of technology and a broader application development community. Hardware and software solutions are required to isolate both existing proprietary hardware and software systems. In the cable industry, tru2way and ETV provide the middleware solutions.

ACKNOWLEDGMENTS

REFERENCES

[1] Louis D. Williamson, "FSN Technology," Proceedings: Society of Cable Television Engineers 1995 Conference on Emerging Technologies, Jan. 4-6, 1995, Orlando, FL, pp. 27-35.
[2] Michael B. Adams, "MPEG and ATM in the Full Service Network," Proceedings: Society of Cable Television Engineers 1995 Conference on Emerging Technologies, Jan. 4-6, 1995, Orlando, FL, pp. 13-26.
[3] Ralph Brown and John Callahan, "Software Architecture for Broadband CATV Interactive Systems," NCTA Cable '95 Proceedings, Dallas, TX, May 1995.
[4] PEGASUS PROGRAM, Request For Proposal and Functional Requirements Specification, V1.0, Time Warner Cable - Engineering & Technology, March 6, 1996.
[5] ISO/IEC 13818-6:1998 - Information technology -- Generic coding of moving pictures and associated audio information - Part 6: Extensions for DSM-CC.
[6] ISO/IEC 13818-2, 2000: Information technology—Generic coding of moving pictures and associated audio (MPEG): Video.
[7] ATSC Digital Audio Compression Standard (AC-3, E-AC-3), Revision B.
[8] ISO/IEC 14496-10:2005: Information technology - Coding of audio-visual objects - Part 10: Advanced Video Coding.
[9] ISO/IEC 13818-1, 2000: Information technology—Generic coding of moving pictures and associated audio (MPEG): Systems.
[10] Federal Information Processing Standards Publication (FIPS PUB) 46-3, Data Encryption Standard.
[11] ANSI/SCTE 52 2008, Data Encryption Standard – Cipher Block Chaining Packet Encryption Specification.
[12] ANSI/SCTE 65 2008, Service Information Delivered Out-Of-Band For Digital Cable Television.
[13] ANSI/SCTE 55-1 2002, Digital Broadband Delivery System: Out Of Band Transport Part 1: Mode A.
[14] [ANSI/SCTE 55-2 2002, Digital Broadband Delivery System: Out Of Band Transport Part 2: Mode B.
[15] CableLabs Press Release, "Cable Industry Creates 'OpenCable™' Goal is Interoperable Set-top Boxes", September 4, 1997.

[16] CEA-679-C Part B, National Renewable Security Standard (July 2005). A joint work of NCTA and CEMA Technology and Standards.
[17] EN 50221-1997, EN 50221: "Common interface specification for conditional access and other digital video broadcasting decoder applications".
[18] DOCSIS Set-top Gateway (DSG) Interface Specification, CM-SP-DSG-I15-100611, June 11, 2010, Cable Television Laboratories, Inc.
[19] ANSI/SCTE 28 2007, HOST-POD Interface Standard
[20] OpenCable™ Software Request For Proposals, OC-RFP-990914, September 14, 1999, Cable Television Laboratories, Inc.
[21] DVB Multimedia Home Platform 1.1.3, DVB-MHP 1.1.3, ETSI TS 102 812 V1.3.1 (2007-03), Blue book A068r3.
[22] OpenCable Application Platform Specifications, OC-SP-OCAP1.1.3-100603, June 3, 2010, Cable Television Laboratories, Inc.
[23] DVB Globally Executable MHP version 1.0.2, (GEM 1.0.2), ETSI TS 102 819 V1.3.1 (2005-10).
[24] Advanced Common Application Platform (ACAP), ATSC Document A/101A, February 12, 2009.
[25] Application Execution Engine Platform For Digital Broad Casting, ARIB STD-B23, Version 1.1, Association of Radio Industries and Businesses, February 5, 2004.
[26] System Description, Blu-ray Disc Read-Only Format, Part 3-2: BD-J Specifications, version 2.4. Blu-ray Disc Association, 2009.
[27] Host 2.0 DVR Extension, OC-SP-HOST2-DVREXT-I01-050502, May 2, 2005, Cable Television Laboratories, Inc.
[28] OCAP Digital Video Recorder (DVR), OC-SP-OCAP-DVR-I06-100603, June 3, 2010, Cable Television Laboratories, Inc.
[29] OpenCable Host Home Networking Extension 2.0, OC-SP-HOST-HN2.0-I04-100507, May 7, 2010, Cable Television Laboratories, Inc.
[30] Home Networking Protocol 2.0, OC-SP-HNP2.0-I03-100603, June 3, 2010, Cable Television Laboratories, Inc.
[31] Reserved Services Domain Protocols Specification, OC-SP-RSD-PROT-I01-080828, August 28, 2008, Cable Television Laboratories, Inc.
[32] Reserved Services Domain Technology Specification, OC-SP-RSD-TECH-I01-080630, June 30, 2008, Cable Television Laboratories, Inc.
[33] OCAP Home Networking Extension, OC-SP-OCAP-HNEXT-I05-100603, June 3, 2010, Cable Television Laboratories, Inc.
[34] Home Networking Security Specification, OC-SP-HN-SEC-I01-091217, December 17, 2009, Cable Television Laboratories, Inc.
[35] Enhanced TV Application Messaging Protocol 1.0, OC-SP-ETV-AM1.0-I05-091125, November 25, 2009, Cable Television Laboratories, Inc.
[36] Enhanced TV Binary Interchange Format 1.0, OC-SP-ETV-BIF1.0-I05-091125, November 25, 2009, Cable Television Laboratories, Inc.

BIOGRAPHY

Ralph W. Brown (M'76) has a Bachelors Degree in Electrical Engineering, Summa Cum Laude, from North Carolina State University and a Master's Degree Electrical Engineering from Massachusetts Institute of Technology, where his thesis was in the area of speech recognition. He is a member of IEEE and SCTE. He is currently Chief Technology Officer at Cable Television Laboratories, Inc. and he was previously employed by @Home Networks, Time Warner Cable, and Bell Laboratories.