WHITEPAPER

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The Dash for HEVC

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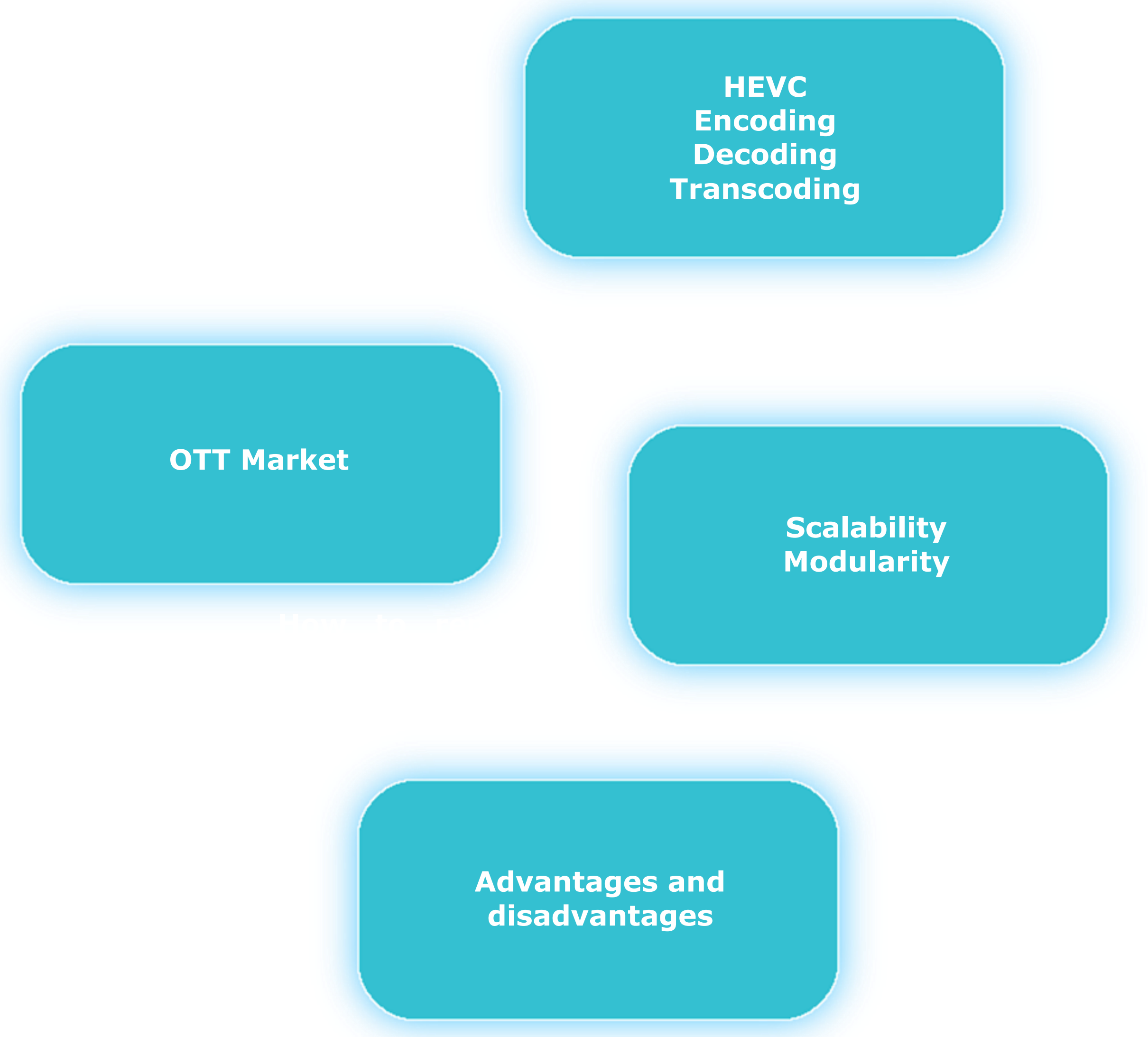
Abstract

This paper discusses HEVC and the various advantages it bring over existing video compression standards in the OTT market.



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Contents

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Introduction

This paper discusses the advantages of the new and upcoming video compression standard H.265, also called HEVC (High Efficiency Video Coding) in the growing OTT (Over-The-Top) market. We examine HEVC from a compression and quality standpoint with emphasis on media contribution, distribution and consumption in the OTT segment. The OTT market itself, is developing in multiple paradigms with the explosion in the growth of video sharing, uploading, downloading, streaming and sharing over the Internet.

Compression vs. Quality

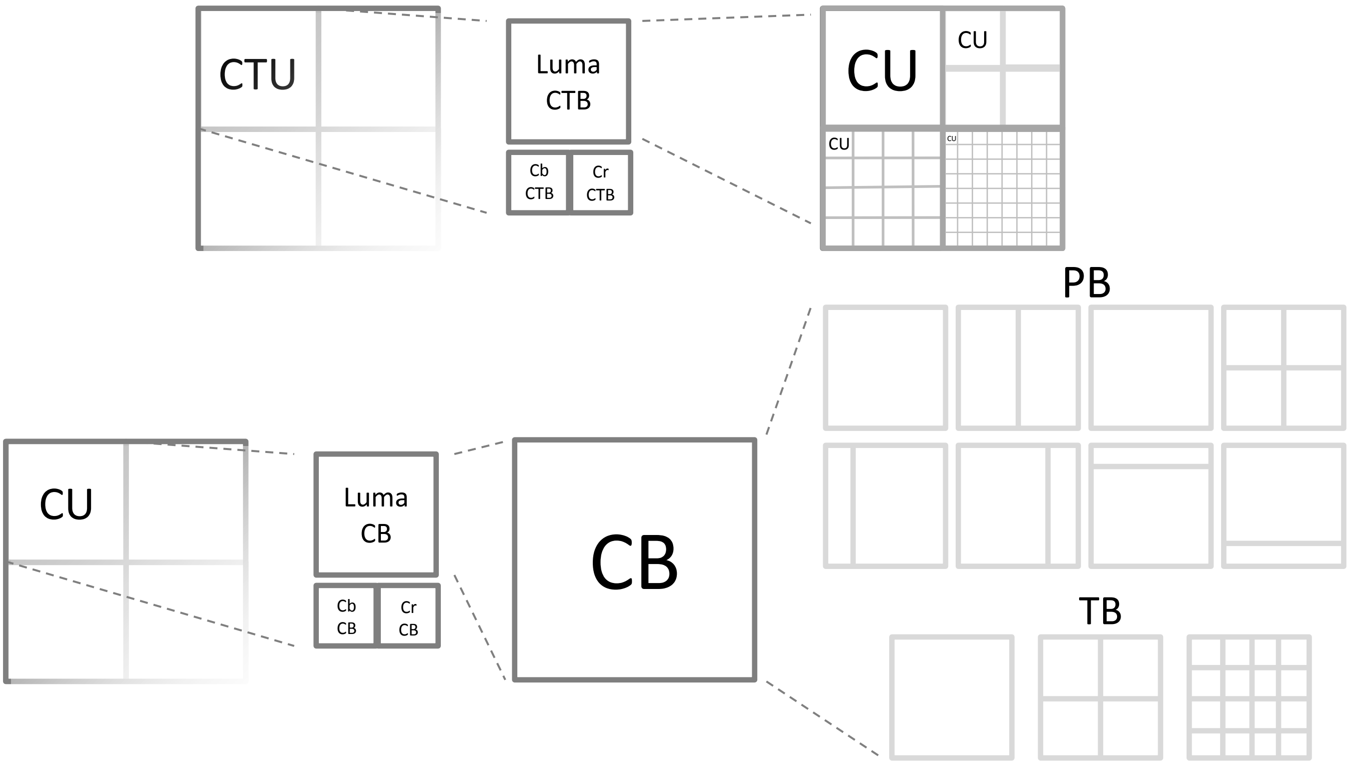

Figure-1: Coding trees and blocks in HEVC (CTU: Coding Tree Unit, CU: Coding Unit, CB: Coding Block, PB: Prediction Block, TB: Transform Block)

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OTT

Recent studies have shown a paradigm shift in the way media is created, distributed (shared/steamed) and consumed by end users. This shift is in many ways fueled by, what the industry now calls OTT services by media hosting sites like YouTube, Hulu, Netflix, etc. that have created a new channel for access to great content that is affordable and easily accessible. User generated content can now be uploaded to a media hosting site and broadcasted, all for free (you only pay for bandwidth usage). OTT has also brought video more closer to the user and made the experience more user centric i.e. any-time, any-where, any-content, any-screen, any-device, with more choice all at the click of button. This convenience of 'any-mode' has resulted in an explosion in global Internet video traffic.

The explosive power of OTT will be fully realized when OTT service providers are able to tailor media offerings to end users with new revenue creating 'Over-The – OTT' opportunities like location based media, content and context based advertisements, dynamic advertisement insertion, etc. in additional to traditional revenue generating models such as pay-per view, subscription and online purchases.
The 'any-mode' model is also leading to more challenges in deploying new as well as maintaining existing OTT services. In particular, challenges in streaming content effectively with high compression ratios while still maintaining optimal visual quality. New revenue generating models are forcing technologists to innovate in designing solutions that go beyond just compression and quality.

Over-The-Top

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The Market for OTT

Global market research is forecasting compounded growth in IP traffic. Cisco VNI, 2012 forecasts global IP traffic will grow at a CAGR of 29% from 2011 to 2016 and will surpass the zettabyte threshold by the end of 2016. Of this, global Internet video traffic itself is expected to be 55% of all consumer Internet traffic in 2016, up from 51% in 2011 (Frost & Sullivan estimates that nearly half of global Internet traffic today is video). The sum of all forms of video (TV, Video On Demand [VoD], Internet, and P2P) will be approximately 86% of global consumer traffic by 2016. A growing amount of IP and Internet traffic is originating from non-PC devices and traffic from wireless devices will exceed traffic from wired devices by 2014. Figure-2 illustrates the Global Consumer Internet Video trends, 2011-16 as forecasted by Cisco VNI, 2012. Figure-3 illustrates the Global Consumer Managed IP Traffic by Content Type 2011-16, as forecasted by Cisco VNI, 2012.

ABI Research anticipates more than 1.3 billion online video viewers worldwide. Frost & Sullivan anticipates the market for video transcoding will grow to $630 million by 2017, up from $264 million in fiscal year 2012. Clearly, OTT video will be the dominant traffic type in IP based networks. Add to that, IP based video delivery transmissions by Pay-TV service providers, one can only guess the volume of content that is simply transferred from one end of the network to another. New demands in delivering OTT content are leading to innovations in delivery mechanisms. For example, the market for multi-platform content delivery (broadcast, web, mobile) also known as multi-screen delivery has recently been ranked as the #1 trend in the 'Broadcast Industry Global Trend Index' by Devoncroft's 'The 2012 Big Broadcast Survey'. This has further led to innovations in adaptive bit rate streaming for multi-screen delivery enabling last mile scalability in OTT delivery mechanisms.

OTT service providers and OEMs now need to support content delivery to multiple platforms where each platform may need a different delivery and playback format. Erstwhile support for only Flash, has now led to a need to support devices with Flash players, devices with Silverlight players, iOS devices, Android devices (and its many flavors); And streaming technologies such as Smooth Streaming, HTTP Live Streaming, HTTP Dynamic Streaming, etc. and any device on which a video playback is possible. In other words, a single input stream will now be needed to be transcoded to ~20 output streams of different bitrates and different formats for streaming and playback on any device. That's roughly ~20x more content that needs to be created and stored.

Add to it, the explosion in the number of wireless access devices accessing streaming content via wireless networks (3G/4G LTE), OTT can potentially surpass traditional modes of content delivery and consumption methods. OTT ready devices like Roku and Boxee are further fueling this growth in OTT content delivery.

Figure-2

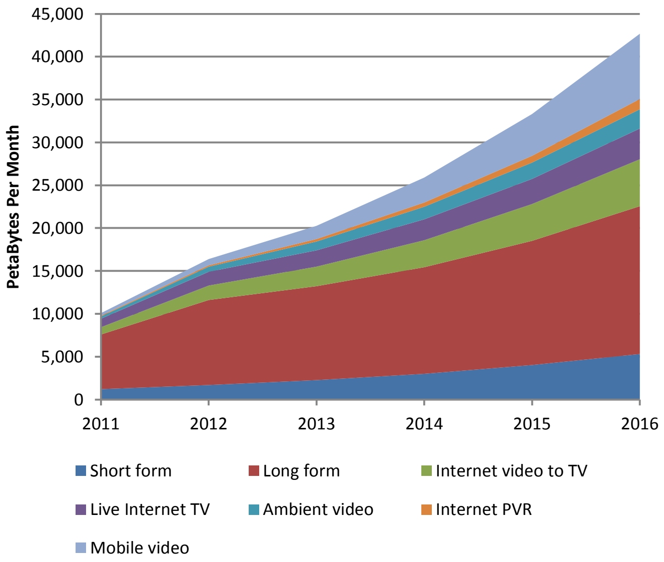
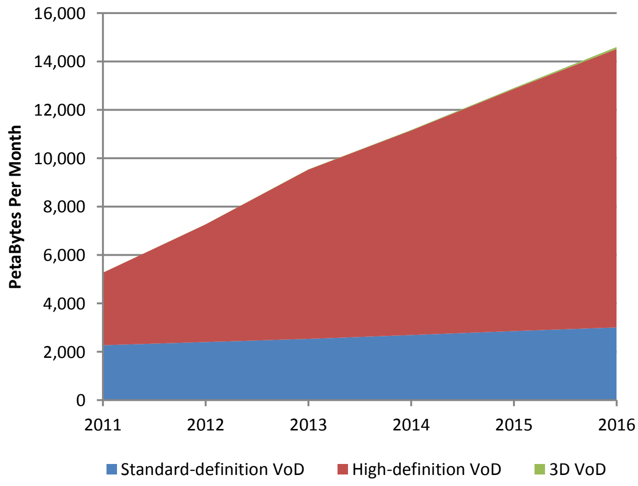


Figure-3



An OTT Flow

Figure-4 illustrates an end to end media OTT flow as agnostic to the content format and compression technology used. Different OTT flows have different quality, compression and storage requirements. However, high stream density and high file density in CDN are primary drivers for delivering more content with a marginal increase in cost.

OTT contribution nodes have access to pre-created/pre-recorded content to send to a consumer node via a distribution node. Contribution nodes include storage servers or media servers in a public/private cloud. An OTT distributor node typically only transports media, with or without a change in the quality/compression ratio of the media itself and include network switches, network routers, local headends, set-top box, residential/home gateway, DSL CPE, Wi-Fi router/access points, base-stations, etc. An OTT consumer node consumes media by displaying it for viewing purposes. Consumers include nodes such as, network enabled digital televisions, handheld mobile devices (smartphones, tablets, etc.), PCs/laptops, etc.
Table-1 lists the various processing requirements within each of the above categories of nodes.

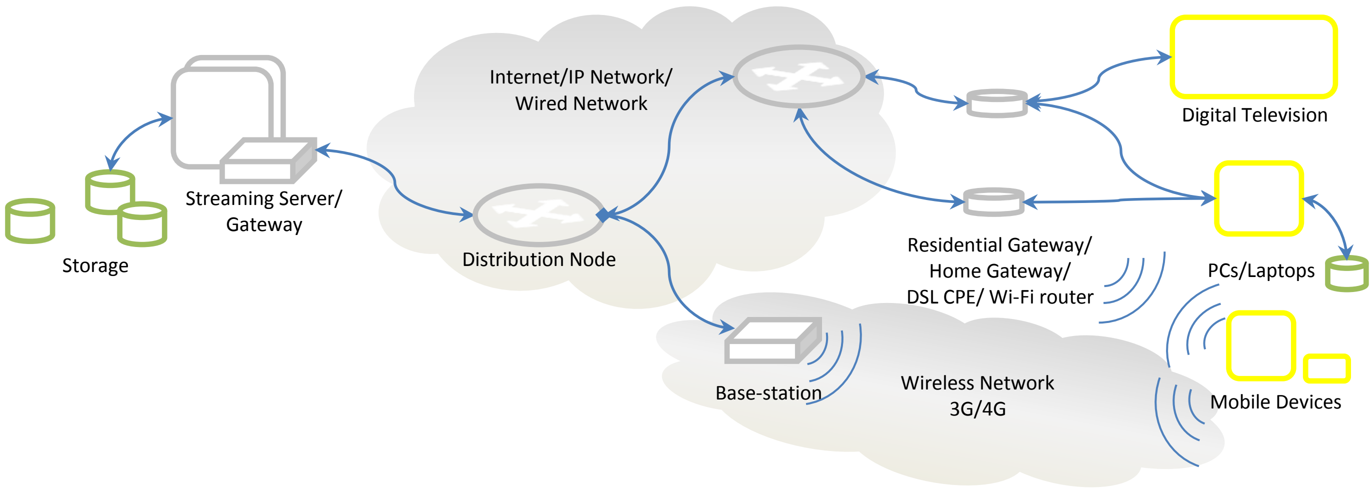


Figure-4: OTT Media Flows

Table-1

	Encoding	Transcoding	Decoding
OTT Contributor Node	✓	✓	
OTT Distributor Node		✓	
OTT Consumer Node			✓

Here comes HEVC…

H.265 (or popularly known as HEVC), at the time of writing this paper, is a draft under joint development by the ISO/IEC Moving Picture Experts Group (MPEG) and ITU-T Video Coding Experts Group (VCEG). HEVC is said to ***improve video quality*** and double the ***data compression ratio*** compared to its preceding standard H.264, and can support resolutions up to 8K Ultra High Definition (7680 x 4320). The standard is expected to be ratified in January 2013.

HEVC has the potential to be nearly twice as efficient as H.264 in compression. Initial estimates of Ittiam's HEVC encoder show up to 30% - 50% compression efficiency over standard H.264 encoders. Greater compression IS the need of the hour. For OTT contributors, to be able to encode higher resolution content for streaming and/or storing and also transcoding existing non HEVC content to HEVC to stream out to HEVC compatible decoders. For OTT distributors, to be able to transport content with faster throughput at the same network bandwidth. For OTT consumers, to be able to watch their favorite videos at higher resolutions at better quality without paying more for bandwidth and also in storing more downloaded

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content in the same memory capacity. In addition, user generated content encoded in HEVC format will utilize lower bandwidth for uploading than when encoded in H.264/MPEG-2 formats.

As with any new technology, HEVC will have to compete with incumbent compression standards like MPEG-2 and H.264 which are today widely used, well established and more importantly well understood in contribution and distribution applications. In addition, mobile device codecs like VP8/WebM that are license/royalty free also pose a threat to the adoption of HEVC on mobile devices.

HEVC goes beyond just compression and quality. With complimentary streaming technologies like MPEG-DASH, HLS, Smooth Streaming – HEVC promises to bring more than just compression and quality. The exponential growth in user generated content and with multiple multicore processor variations flooding the embedded market, it is just a matter of time when the demand for a software codec will be needed for ease of porting across platforms and deploying on wide ranging devices. More streaming content is all going to be adaptive giving rise to the need for real-time adaptive bit rate encoding, transcoding and decoding of such content.

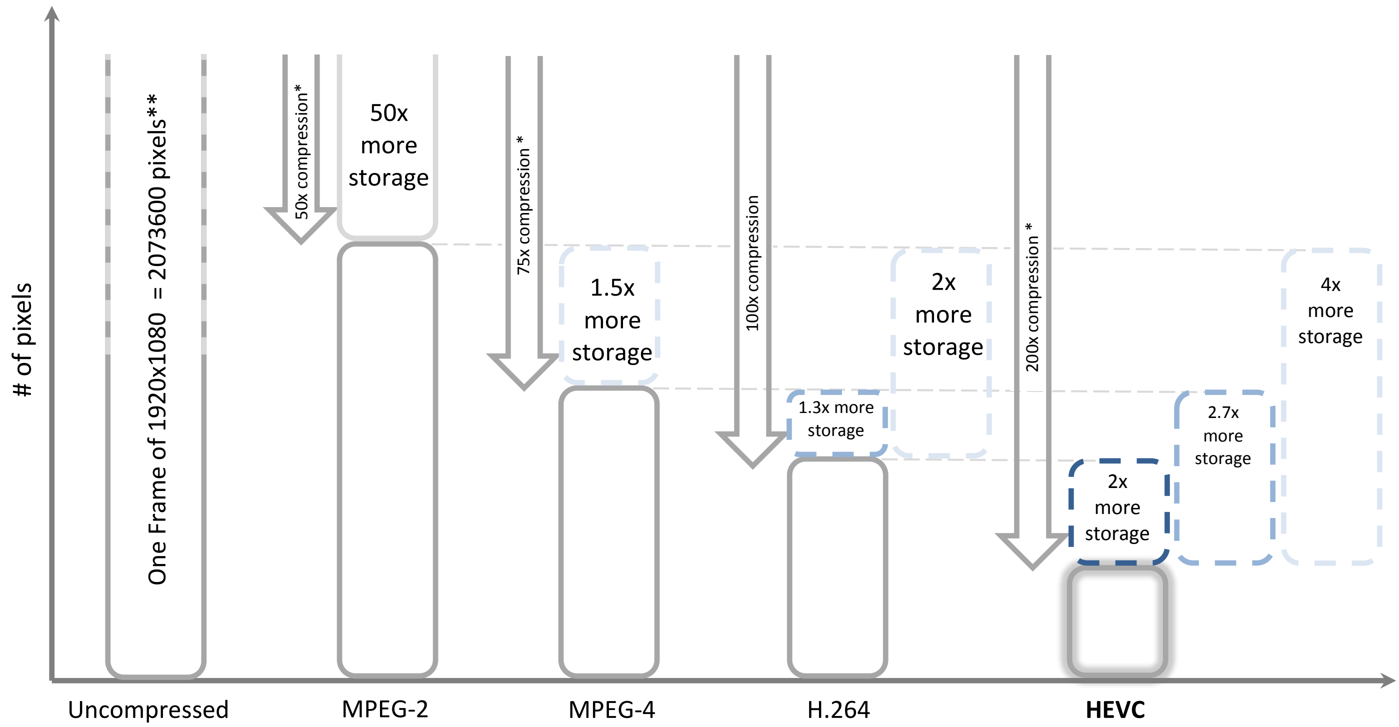


Figure-4: Compression Ratios

* Maximum possible compression. ** One Frame of 1920x1080 = 2073600 pixels

The Ittiam Codec Design Methodology

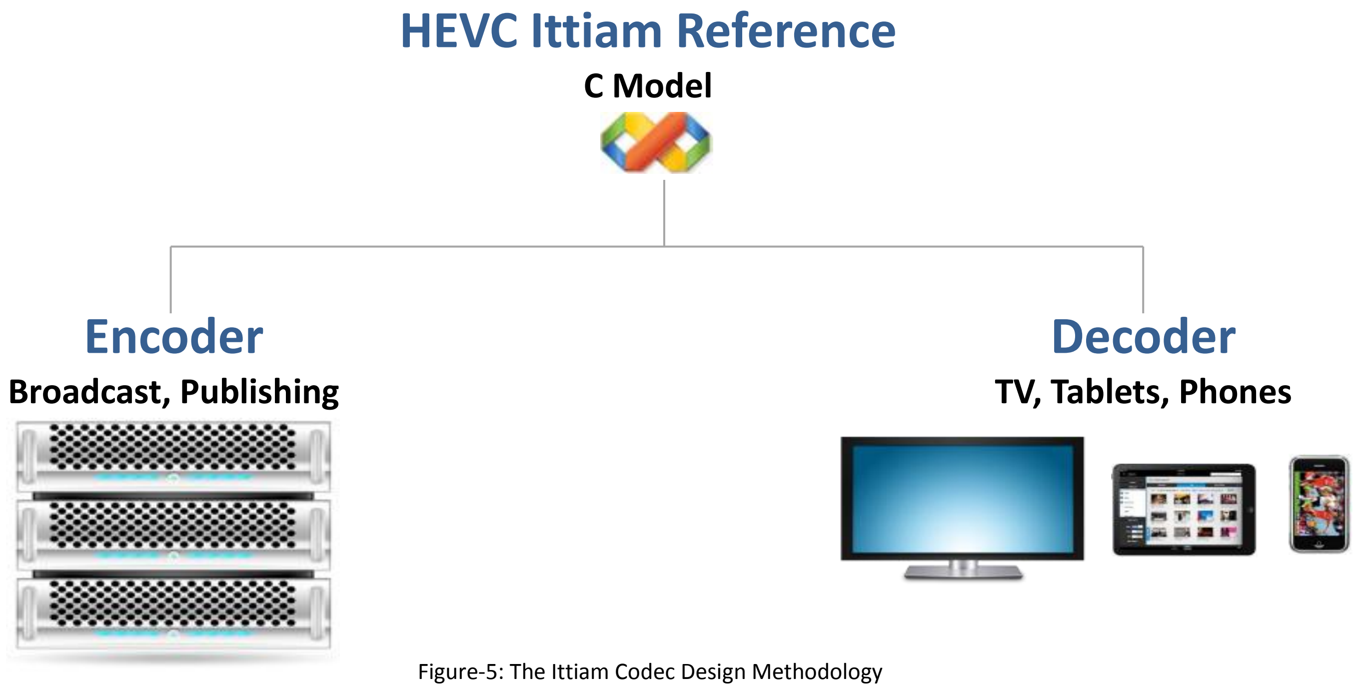


Figure-5: The Ittiam Codec Design Methodology

What can I do with a HEVC decoder?

For starters, play a HEVC video file on a hand-held device. An **HEVC decoder** is of much lower complexity than its counterpart encoder. This further simplifies the decoder design to execute on low powered hand-held devices making it the codec of choice for decoding video streaming over low bandwidth wireless connections.

Ittiam's HEVC decoder designed for optimal performance on ARM based processors is expected to have an average complexity of 1.4x times (including memory fetches and CPU utilization) than that of a H.264 decoder. Hence a mid-end to high-end hand-held device will still be able to decode the same video file encoded in HEVC format with minimal impact on device resources.

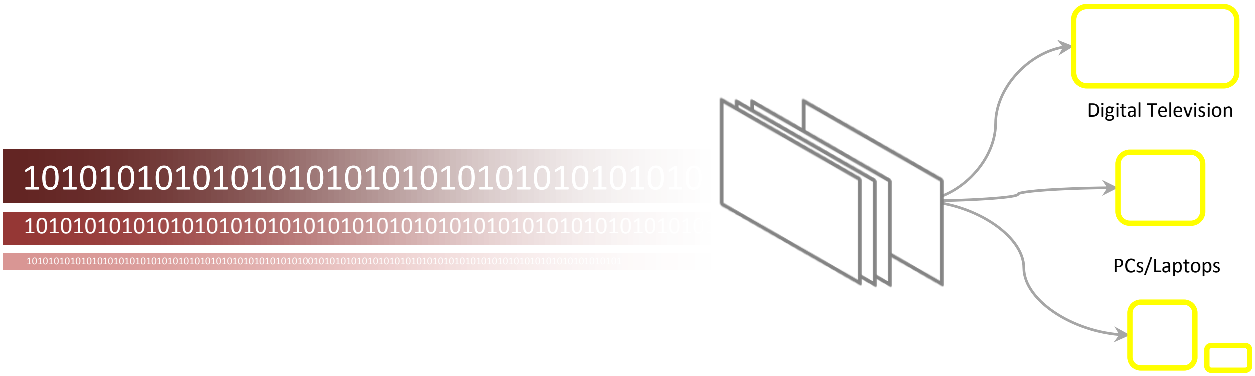


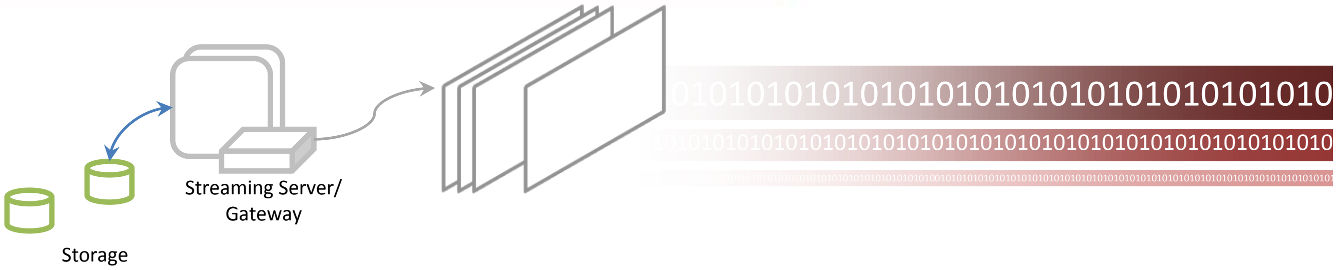
Figure-6: HEVC Decoding

Nov 2012 Evaluation Codec	April 2013 Universal Decoder	Only 1.4x as complex as H.264	x86 & ARM based platforms

But there is NO HEVC content out there?

And that’s why you need a **HEVC Encoder and Transcoder**. A H.264 to HEVC (or MPEG-2 to HEVC) transcoder will transcode all your H.264 (or MPEG-2) content into HEVC format, saving valuable storage space for a cloud based service. A real-time transcoder will transcode, in real-time, for streaming out to users on demand. New user generated content, can be encoded in HEVC for uploading, saving both bandwidth and cost.

Ittiam’s HEVC encoder promises 30% - 50% compression for interlaced video and 35% - 40% compression for progressive video. Subjective quality evaluations show improved visual quality.



Nov 2012 Evaluation Codec	April 2013 Fully Compliant Encoder	Multicore Scalable & Modular Design	4x more complex than Decoder

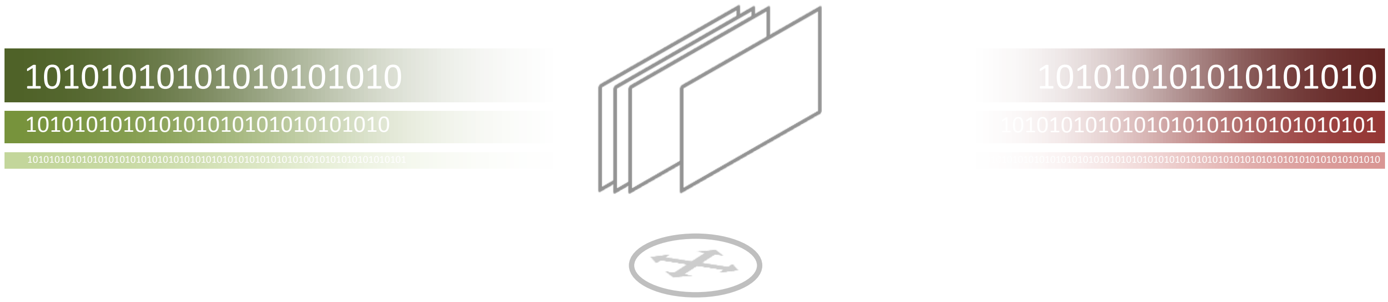


Figure-8: Any to HEVC Transcoding

Who needs accelerators anyway?

All codecs do. Specialized accelerators, either hardwired or DSP blocks, that accelerate certain signal processing intensive functions in the encoder and decoder will not only accelerate the playback and recording of video, it will also allow for; 1) higher density encodes at the same price point, 2) transcode for optimal bit rates, 3) decode higher resolution video.

However, accelerator based HEVC codecs will be available much later in the HEVC standards adoption. Pure software, multi-core based HEVC codecs will first hit the market and prevail until the complexities of the codec are fully understood and use cases well defined. Integration with chipset vendors are already in progress to compete with upcoming optimized solutions to serve as an additional offering to their suite of supported codecs.

Ittiam's HEVC codecs are software codecs that have been designed to be modular so as to identify critical processing functions in the codec that can execute in a multi-core processor while at the same time being scalable across cores. Different modules are designed to be core agnostic and hence processing functions can scale from 4-core to n-core seamlessly.

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Conclusion

Large scale adoption of HEVC is yet to be seen and without doubt will take at least 5-6 years for adoption across all media and entertainment segments. Challenges in OTT services are forcing service providers to look at adopting compression standards, like HEVC, to aid in high density storage and streaming of content. Those broadcast segments with a high upgrade cost (existing MPEG-2 or H.264 based equipment) also stand to gain from an upgrade to HEVC. The ability to pack more streams per subscriber while providing a better quality of service is a huge advantage from a revenue per user point of view. With announcements from Digital Television manufacturers that support 4K – or Ultra HD – it is only a matter of time when end users will be looking for 4K resolution content. The spike in bandwidth consumption of a 4K video can only be managed with the use of a codec that providers greater levels of compression.

The biggest gainers from HEVC based technology will be end users. Enhanced user experience, streaming media in ‘any-mode’ with minimal additional $ spend is a highly attractive bargain. What needs to be seen is what innovative use cases will trigger the initial adoption of HEVC. For MPEG-2, it was offline content storage in CDs and DVDs, due to the advantage of a higher compression ratio that MPEG-2 brings over uncompressed video. For H.264, it was the online content streaming and sharing, due to the ability to stream CBR and VBR content over an IP network.

Ittiam’s HEVC encoders and decoders are in pace with the standardization of the codec. Moreover, our software codecs are ready for initial deployments in cloud based video services and infrastructure, OEM’s equipment and hand-held mobile devices. Ittiam’s experience in video codec implementations across multiple architectures and processor generations, across multicore processor variants, and best in class software development practices demonstrates our unique position among software vendors for a market ready HEVC codec.

HEVC is here and the time for HEVC is now.

Disclaimer