The Untold Truths about Hybrid Fibre Coaxial (HFC) Technologies

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c-cor

Underpinning Innovative Technology

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About C-COR Broadband

- Established in August 2002 as a result of C-COR Inc.'s global acquisition of the Broadband Networks product division from Royal Philips Electronics. Became 100% Australian owned in 2006.

- The Philips PTS business commenced in 1993/4 as a specialist technologist in Hybrid Fiber Coax (HFC), being a key contributor to the roll-out of cable TV in Australia, primarily with Telstra Corporation.

- Following the completion of the network rollout in 1997, the Company continued to develop into a dynamic sales and marketing organization focused on engineering applications, and supported by a professional customer service and after sales operation.

- More recently, C-COR has focused on extending its reach into emerging digital/optical products and services.

About C-COR Broadband

On 7 April 2006, the local management team exercised a management buy-out and acquired 100% ownership from C-COR Inc. The Company is currently structured across three major lines of business:

- **HFC Network Access:** Production, assembly, repair, and replacement activities for existing HFC networks;

- **Connections:** Distribution of construction and installation products (e.g. cables, connectors, wall plates, taps and passive equipment);

- **Innovation:** Developing new business opportunities, particularly in the digital space (e.g. Coax/Fibre-to-the-Home technology, digital headend signal processing technology, software).

- Each of these lines of business provide engineering and design services, technical support, and after sale services.

Geographic markets

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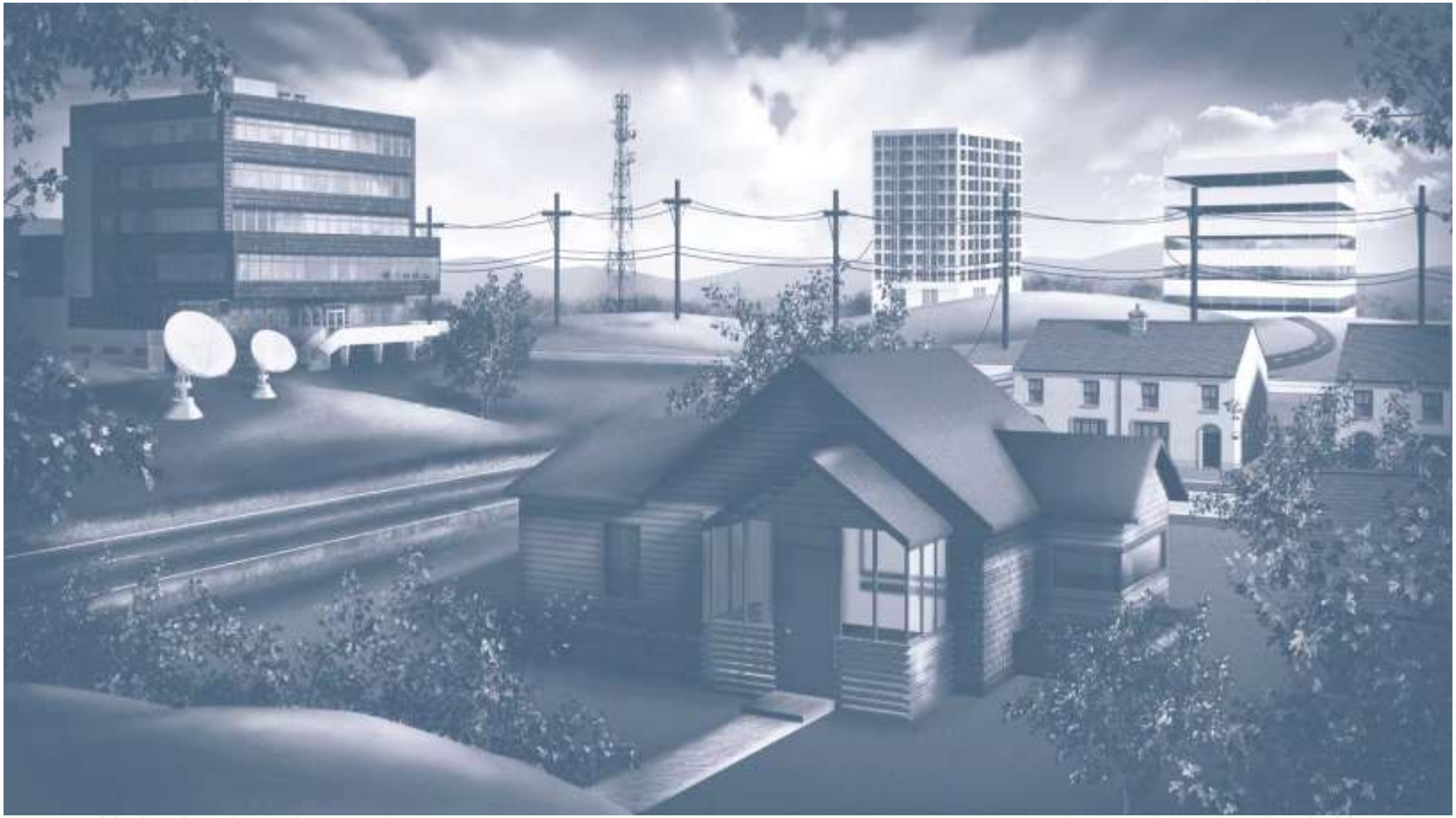
To many of you, HFC CATV is something like this…

Dinosauria…

Jurassic - Cretaceous

A Little History



Source: ARRIS

Humble beginnings

- The roots of Cable started with the development of television (TV) and the TV broadcasting industry between 1946 and 1948. ***
- Note that Jerrold was established in 1948, and C-COR incorporated in 1953.**
- From 1949 to the early 1960s cable systems consisted of tower-mounted antennas with preamplifiers that drove flexible coaxial cable with dispersed vacuum tube amplifiers. *
- By 1975, CATV system technology had matured. HE systems resembled the form, functions, and performance of pre-1995 hybrid fiber coaxial (HFC) cable systems. The CATV hybrid amplifier, now the cornerstone component in modular distribution optical nodes and amplifiers, was well established and Two-way CATV technology was well understood.
- Cable networks have been deployed universally with active reverse path since the inception of HFC in the 1980's ; and with the introduction of the first HFC optical node in 1986, and the installation of HFC networks beginning in the early 1990s, CATV hybrid amplifier performance requirements have steadily increased.

Channel Capacity Growth

Table 1. US CATV System Channel Capacity (1948-2008)		
Year	NTSC Channels	Upper frequency Limit
	#	MHz
1948	3	162 *
1949	5	174 *
1950	8	192 *
1951	12	216 *
1974	35	264
1980	52	378
1988	83	552
1992	91	600
1993	116	750 GA
1995	136	870 GA
2000	158	1002 GA
2008	179	1128
2014		

* - Denotes inclusion of 90MHz for FM radio and other restricted -use frequencies.

GA - Denotes General Availability

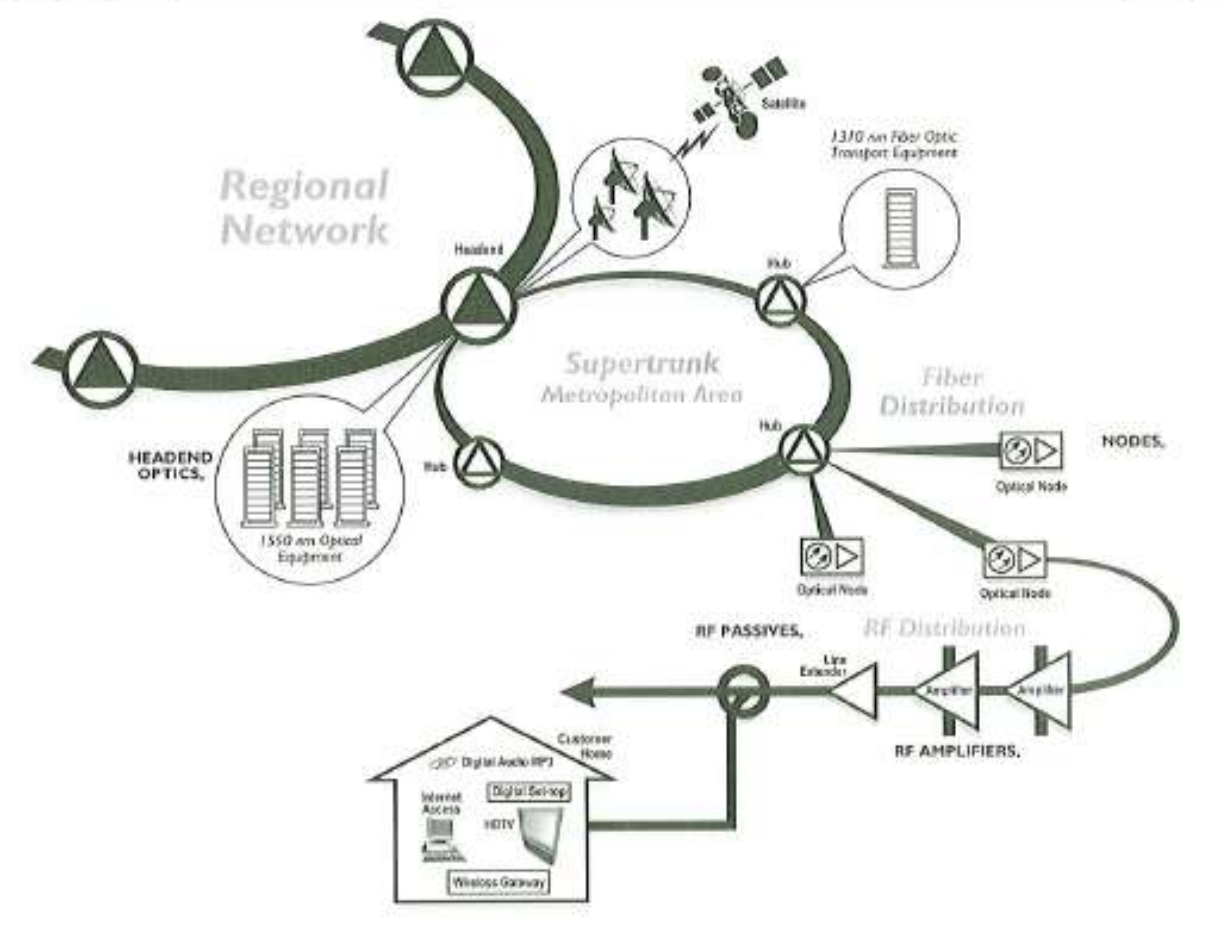
HFC networks actually resemble a high speed interchange……..

‘The transparency and flexibility of the HFC infrastructure allows Cable Operators to quickly adapt their networks to meet the growing needs of consumers with minimal incremental investments’.

The HFC infrastructure can provide service to almost everywhere as it is hybrid of networks.

What do basic HFC networks look like?

HFC Technology Overview
Historical (Classic) perspective



The HFC Network is a broadband RF and optical 2 way signal distribution pipe for voice, video and data from the headend to the home.

Figure 1.

Source: Philips

Key Variables

<u>Key variables to unlock capabilities:</u>

Network Architecture

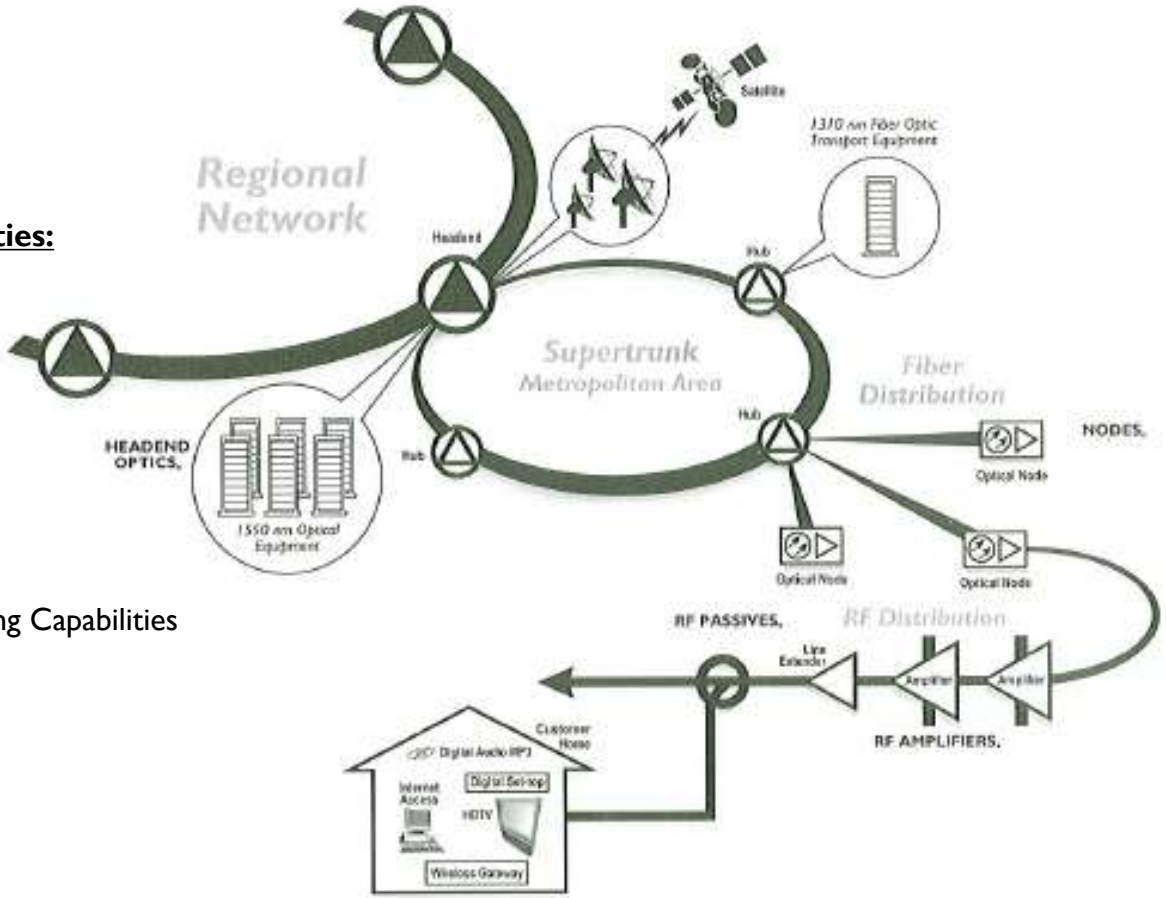
Available RF Bandwidth

Available FO Bandwidth

Modulation Schemes

Analogue and Digital Signal Processing Capabilities

Network Evolution Strategy



HFC Network is broadband RF and optical 2 way signal distribution pipe for voice, video and data from the head end to the premise.

Figure 2.

Source: Philips

Socio-Political Commentary

Senate Select Committee Submission by C-COR 2009

The Challenge

- The objective of the Submission to the Senate Select Committee was to communicate two key insights:

1. How to utilize DOCSIS 3.0 technology as a means of delivering high-bit rate data services to residential and small-medium business customers while leveraging the cable operators' extensive Hybrid Fibre Coax (HFC) Network, Network Access Layer Equipment, Device Activation Systems and Back Offices, *and secondly*;

2. The implications of an emerging technology called RF over Glass (RFoG), an all fibre-to-the-premises (FTTP) solution architecture that lends itself to new access network builds.

Senate Select Committee Submission by C-COR 2009

In the course of the submission, the following statement was made:

"Traditional telecommunications carriers have chosen to evolve their wired networks to either VDSL2 or fibre using either GPON (Gigabit PON) or GePON (Gigabit Ethernet PON) in the belief that these technologies deliver superior access economics to cable technologies".

We set out to challenge this myth and through this process debunk other myths.

And……

"To conclude, the Submission suggested that the current policy mix seems to have caused a dire lack of investment in cable broadband over too many years. Cable broadband is a real alternate fixed broadband asset that can deliver superfast broadband outcomes, simply and economically. It deserves a change in attitude, and it warrants an investment kick start".

Fast and cheap: the HFC solution

On the 29th November 2013 , Phil Dobbie wrote the above headline and the following words in his online column CrossTalk which is produced for Commsday……..

*"**Even the most ardent supporters of a government built fibre network have been struggling with one thing – closing down Telstra's HFC network**. At the NBN:Rebooted forum the ACCC chair Rod Sims said it could have been a different outcome if the regulator had been involved in the decision.*

In this week's program, Kevin Bloch, CTO for Cisco Australia says, with the now ratified standard of Docsis 3.1, HFC networks can deliver 10Gbps download speeds, with 1Gbps upload to the node (somewhat slower for the individual user). It could be delivered with an upgrade over 2-3 years.

***Telecoms consultant Dermot Cox has been calling for the HFC networks to be maintained and offered as open access to all retail service providers**. He calls their closure the destruction of capital.*

***Malcolm Turnbull commented that it makes no sense to build fibre where HFC already exists, at least in the interim**. So does that mean we can expect it to figure prominently in the forward looking solution for the NBN? And how does it impact Telstra's structural separation undertaking?*

The program also features Mark McDonnell from BBY, Stuart Lee, Group Executive for Telstra Wholesale and Matt Healy, National Executive Industry & Policy at Macquarie Telecom."

Source: Phil Dobbie Podcast

…and further thoughts from Dermot Cox of 'the Consulter'

At the CommsDay Congress, in Melbourne in 2013, Mr Dermot Cox (of the Consulter) noted in his presentation: "…that the ACCC considers cable provides an 'equivalent service' to ADSL2+"

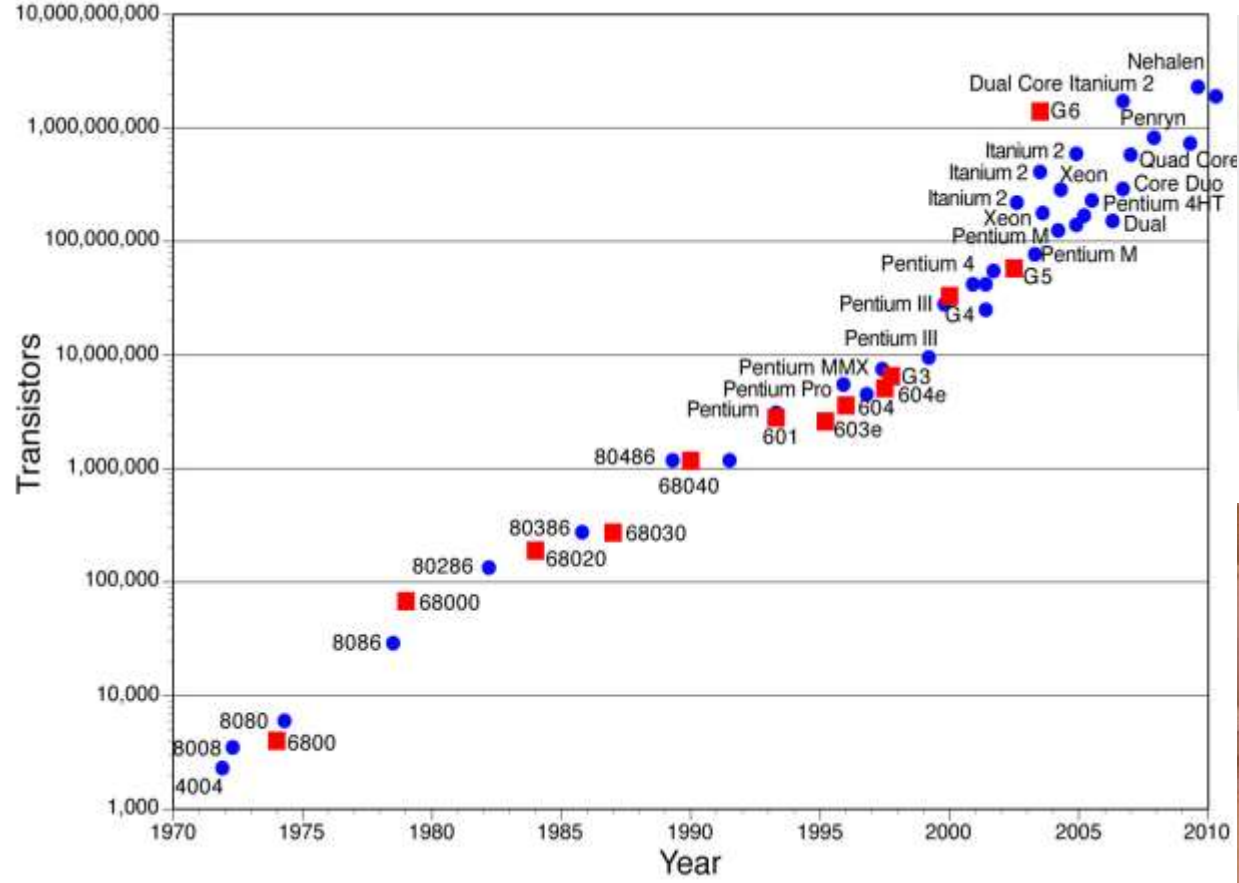
He therefore proposed that the ACCC declare wholesale cable broadband data service under a Part XIC of the Competition and Consumer Act 2010.

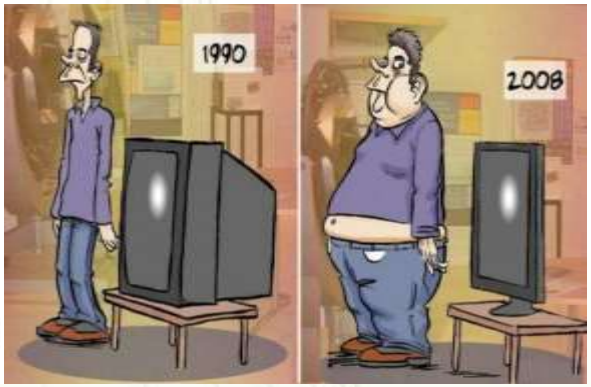
He finished his presentation with the observation:

"The Australian communications industry is in transition and a positive policy adjustment will support Access Seekers in an emerging market for superfast broadband of 100Mbps; a segment that is expected to grow.

What drives demand for Broadband Bandwidth?

Technology – Something about "Moore's Law"





Source: ARRIS

Bandwidth Growth – How Long ?

1990 decade — Letter to Email

2000 decade — Music, Pictures online

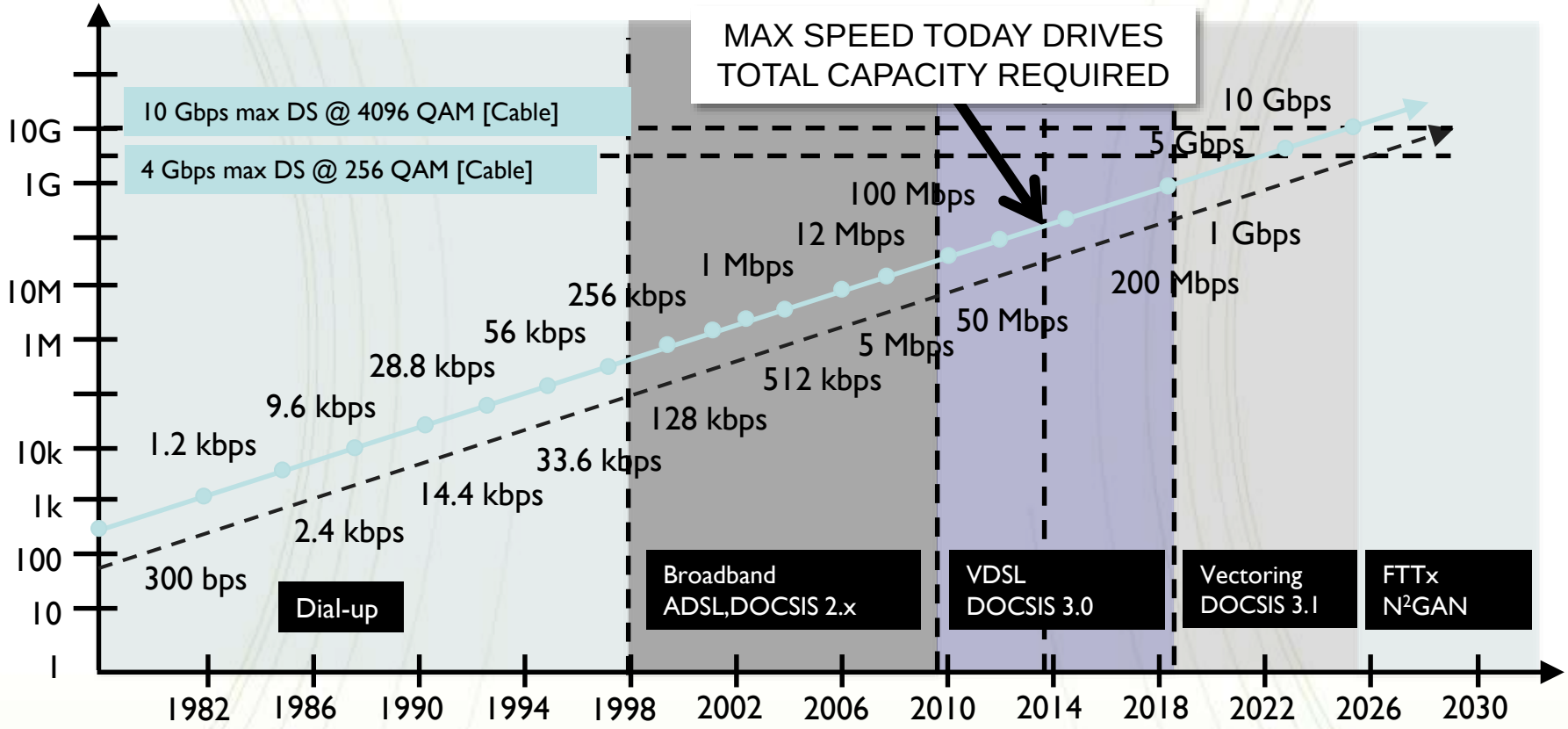
2010 decade — Streaming Video, Multiscreen,

2020 decade — Immersive Video, Holographic, M2M

Source: ARRIS

Broadband Growth Continues…

Billboard Consumer Speeds



Source: ARRIS

HFC upward curve twisters

- Increase Pipe Size to the Home

AND/ OR

- Reduce Number of Homes Per Pipe Size

HFC upward curve twisters

- A. RF Modulation Scheme Increase (bit/Hertz)

  PAL, QPSK, 16QAM, 32QAM, 64QAM, 256QAM, 512QAM, 1024QAM, 4KQAM, 8KQAM, 16KQAM

- B. Optical Modulation schemes Increase (Hertz/nm)

  1,4, 8, 16, 32, 64

- C. Plant Segmentation (less users/uplink)

  1, 1x2, 1x4, FTTA, 42/54, 65/85 Mhz, 85/105 Mhz, 200 Mhz+

- D. RF bandwidth Increase (more users/downlink)

  450, 550, 750, 860, 1000, 1200Mhz, 2000Mhz+

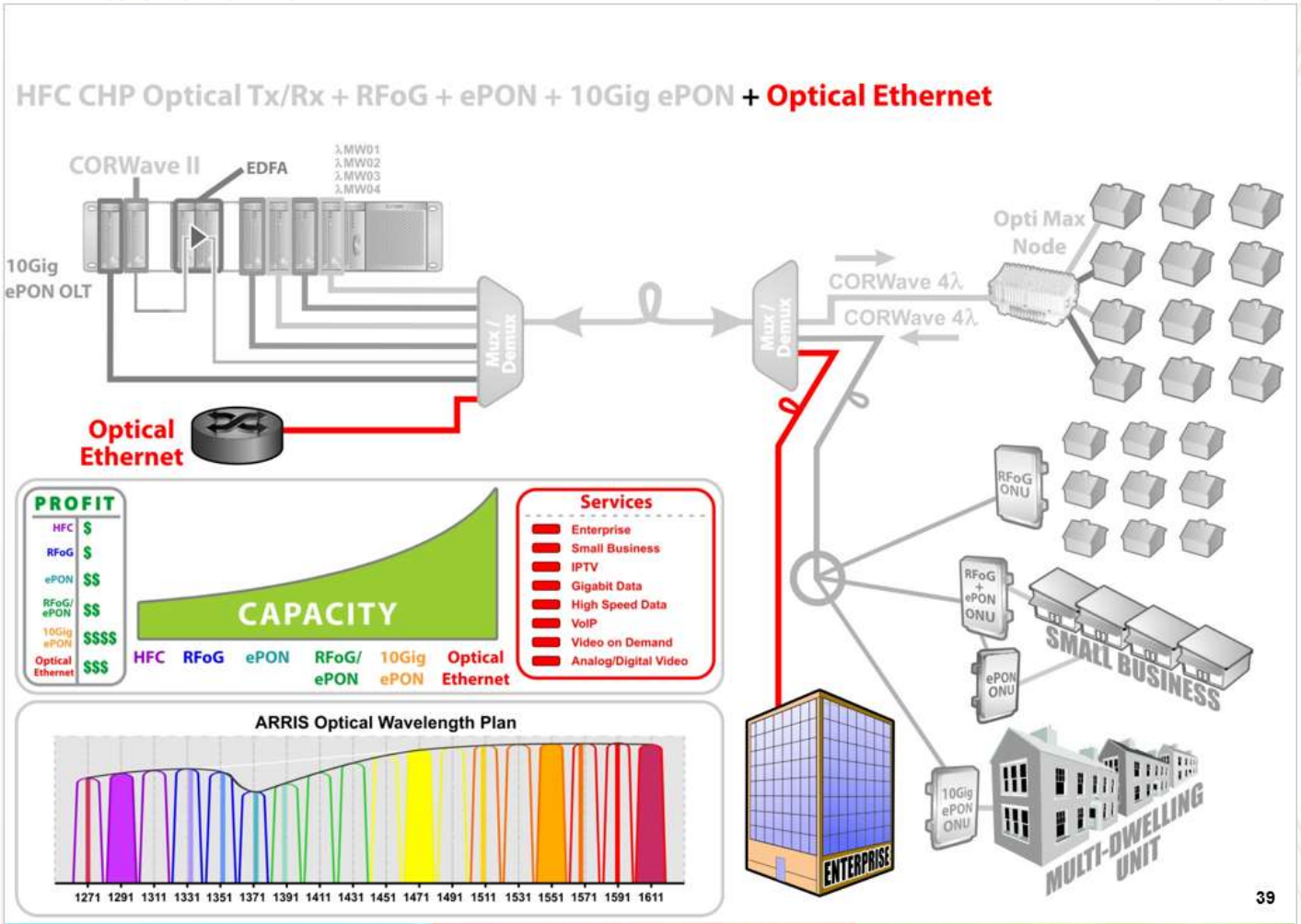
- E. HFC – as Hybrid of FO & COAX Access Networks

  COAX, RFOG, EPON, GPON, Optical Ethernet,

Total balance: A+B+(C & D)+E = More bits/home

HFC today – Hybrid of FO & COAX Access Networks

Evolution rather than expensive Revolution

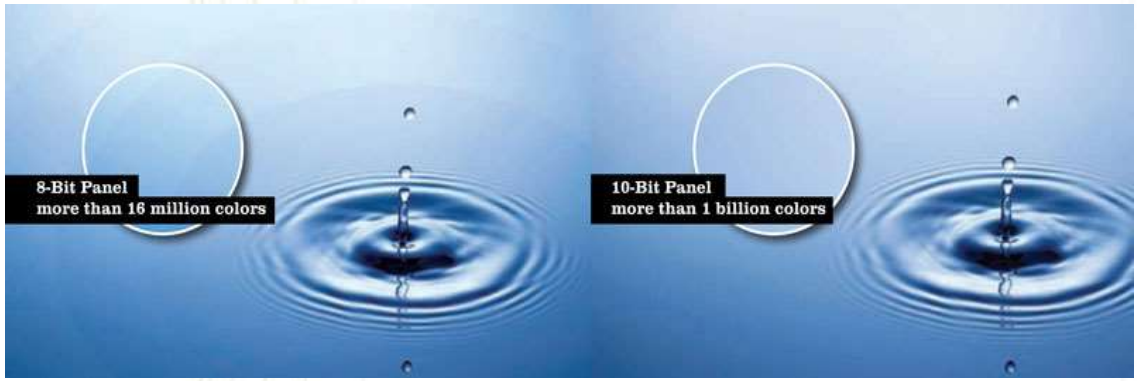


User Demand Drivers

- *Video Evolution*
- *More Customer Choices*

Ultra High Definition

- 4 x resolution of 1080 HD = 4 x bandwidth
- Higher frame rates
- Increased color space and color resolution



- Consumer electronics will drive UltraHD TVs into market
  - Ultra HD TV retail prices are dropping fast
- UltraHD is a going to be an industry focus over next decade
  - Programming, head-end, network, CPE , CE . . .

"Industry consensus is that UltraHD is on the way and will not be the flop that 3D TV has been so far. [Question is] how fast will programming develop . . ."

(www.Spacenews.Com)

Source: ARRIS

HEVC Applications

- Multiscreen ABR
  - Ready availability of SW decoders on PC/tablets/smartphones
  - Higher quality video on restricted bandwidth
  - Mobile network efficiency (4G)

- IPTV over DSL
  - Extends network reach at the edge
  - Requires new STBs – but can be launched as overlay
    - Initial STBs and Gateways available around mid-2014

- UltraHD
  - Early deployments will be file-based for VOD
  - Live launches late 2014 and beyond
    - Real-time 4Kp50/60 platforms available for trials in 2014
  - Many operators looking to use 10-bit color space (4:2:0 10-bit)

Source: ARRIS

Multiscreen User Experiences

CUTTING EDGE
features and designs that excite and delight
2nd screen experiences

PERSONALIZED
helping to build a 1–1 relationship with the user

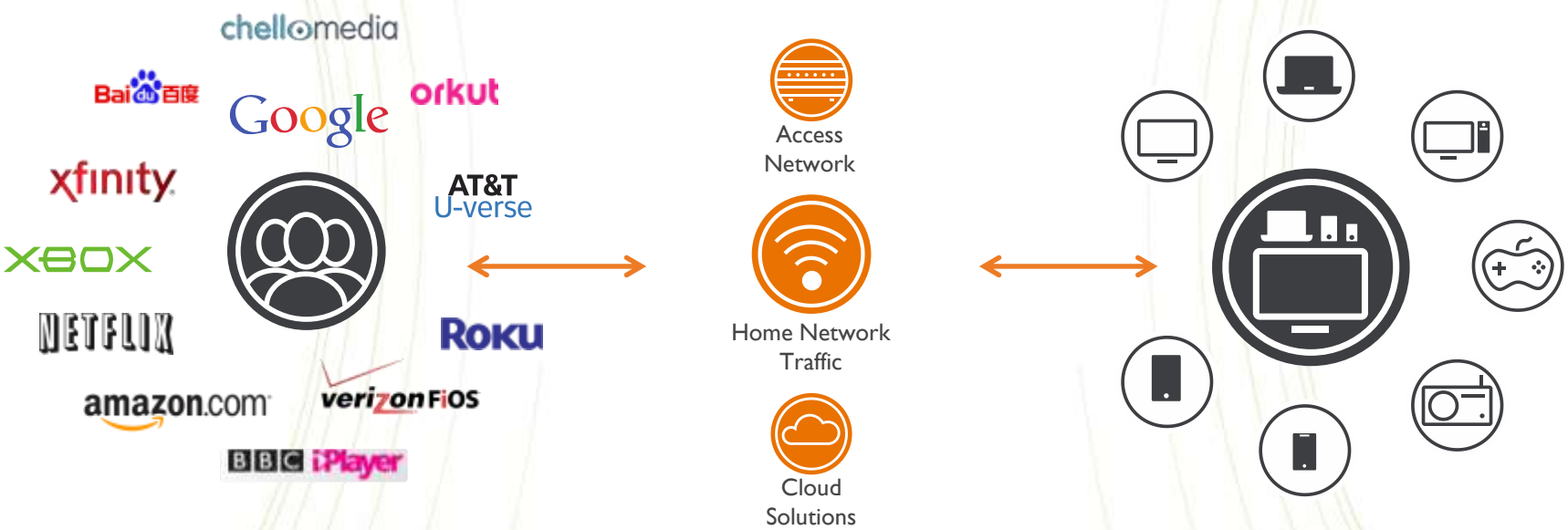
MULTISCREEN
content discovery + consumption on the device of choice
Single platform

BUILT FOR BUSINESS
more ways to sell and satisfy
Faster to market

Courtesy ARRIS Enterprises, Inc.
Proprietary & Confidential

Market trends impacting the home

ENTERTAINMENT REDEFINED	INCREASED HOME NETWORK DEMANDS	GROWING DEVICE POPULATION WITHIN THE HOME



CREATING A "CHALLENGED" CONSUMER EXPERIENCE

Courtesy ARRIS CONFIDENTIAL
JAN 2014

HFC Solutions…….

- Continuation of the Network Architecture Evolution

- Hardware and software innovation

- User experience enhancement and interface simplification

- Multi-network unification within the same platform.

Outcome 1:

Competitive solutions for data throughput enhancements already exist for HFC to satisfy typical household demand to Y2026

Node Upgrades:

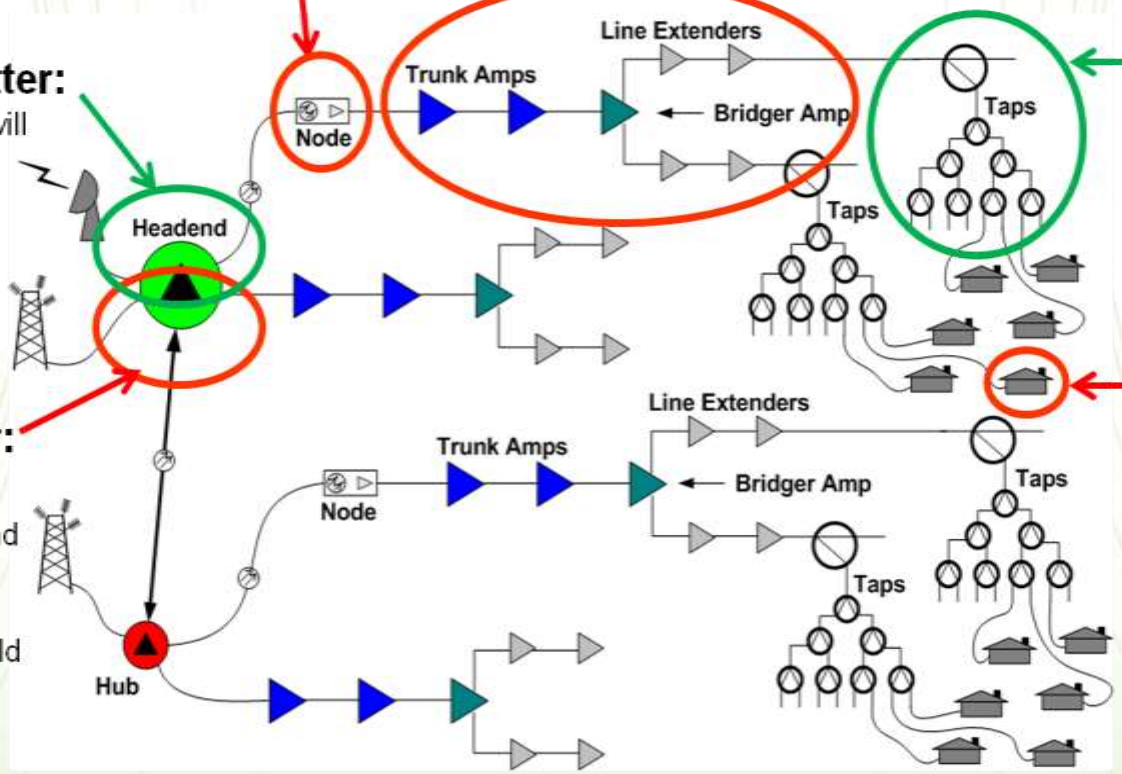
- **Optical Side (using analog return)**
  - FP 200 MHz Tx: will need to be replaced
  - DFB 200 MHz Tx: will work
  - 42 MHz Digital Return: will have to be replaced
- **RF Side**
  - same handling as Amp

Amplifiers:

- Best Case: Replace the Diplexer Filters with a pluggable filter swap (this may not be field swappable)
- Worst Case: Replace the Amp housing because there is not pluggable filter or amp that fits into existing housing

Optical Transmitter:

- Optical Transmitters will work



Passives:

- Mid-split and High-split leverages existing Passives

House:

- Mid-split will require change of a home amp
- OOB STB communications may be impacted with High-Split

Optical Receiver:

- Analog receivers support up 200 MHz and would not need to be replaced
- Digital Receivers would have to be replaced

Outcome 2:

2 sets of modern DOCSIS3.1 CMTS (eg.ARRIS E6000)

(1 single rack) can serve 162,800 Cable modems (Homes) today.

Courtesy ARRIS

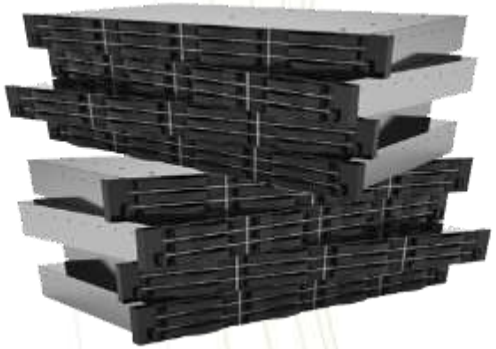
Outcome 3:

CCAP = Capacity Augmentation Made Simple

With CCAP…

vs.

Dedicated boxes for CMTS, VoD, SDV…



Add "and" change capacity allocation via software upgrades

Add capacity via new hardware and re-cabling

Outcome 4:

Simplify the User Connected Experience

- Connecting devices in the home
- Enabling content sharing
- Unifying & enhancing the consumer experience

- Gateway is the unification device for cloud and screen
- STB - low cost point to move with the changing graphics and screen services
- New Digital Life Applications driving new ARPU opportunities

Outcome 5:

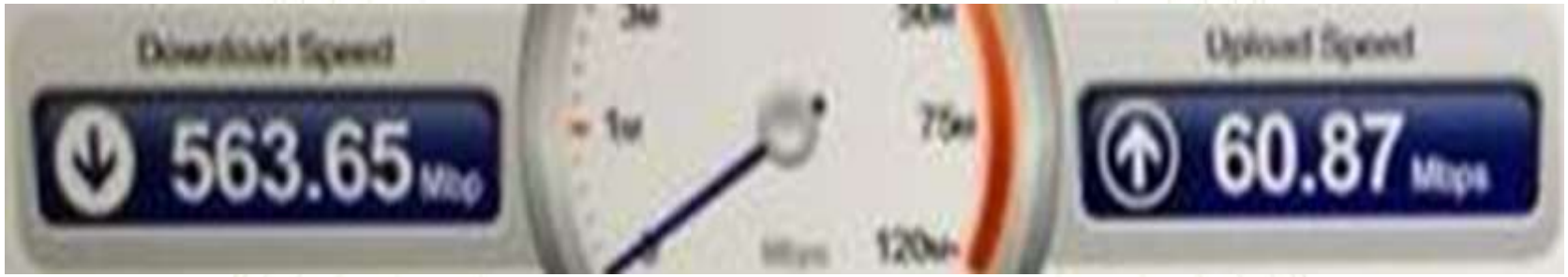
New Home Gateway

Headed and Headless Gateway replaces the traditional STB
Becomes a Home Service Platform not just a Video Decoder

- High Bandwidth WAN interface – 1Gbs
- Cloud to Ground
- High MIPS CPU for Home Services
- Unified Home Networking Platform
- Gateway to Multiscreen devices
- Connection to new IP STB client devices
- Enabler of the all Wi-Fi Home Network

HFC

‘Science Fiction to Reality…In incremental Steps…’



Thank You