

**TELECOM ADVISORY
SERVICES, LLC**

**HOME PERSONAL NETWORKS AND
NETWORK CAPACITY**

Dr. Raul L. Katz()*

April 21, 2006

(*) The Author would like to acknowledge the contribution of Muayyad Al Chalabi

Contents

1. The future home personal networks
2. Implications on the “public” network
3. Potential Scenarios

Key Messages

1

- The flow of digital information toward, within and from the household, defined as a physical and logical hub, is increasing exponentially

2

- The increase in household network capacity needs is having an exponential impact on “public” network requirements in terms of increased functionality and operating performance

3

- Growth in traffic threatens to deplete the “public” network quality of service unless steps are taken to improve the infrastructure

4

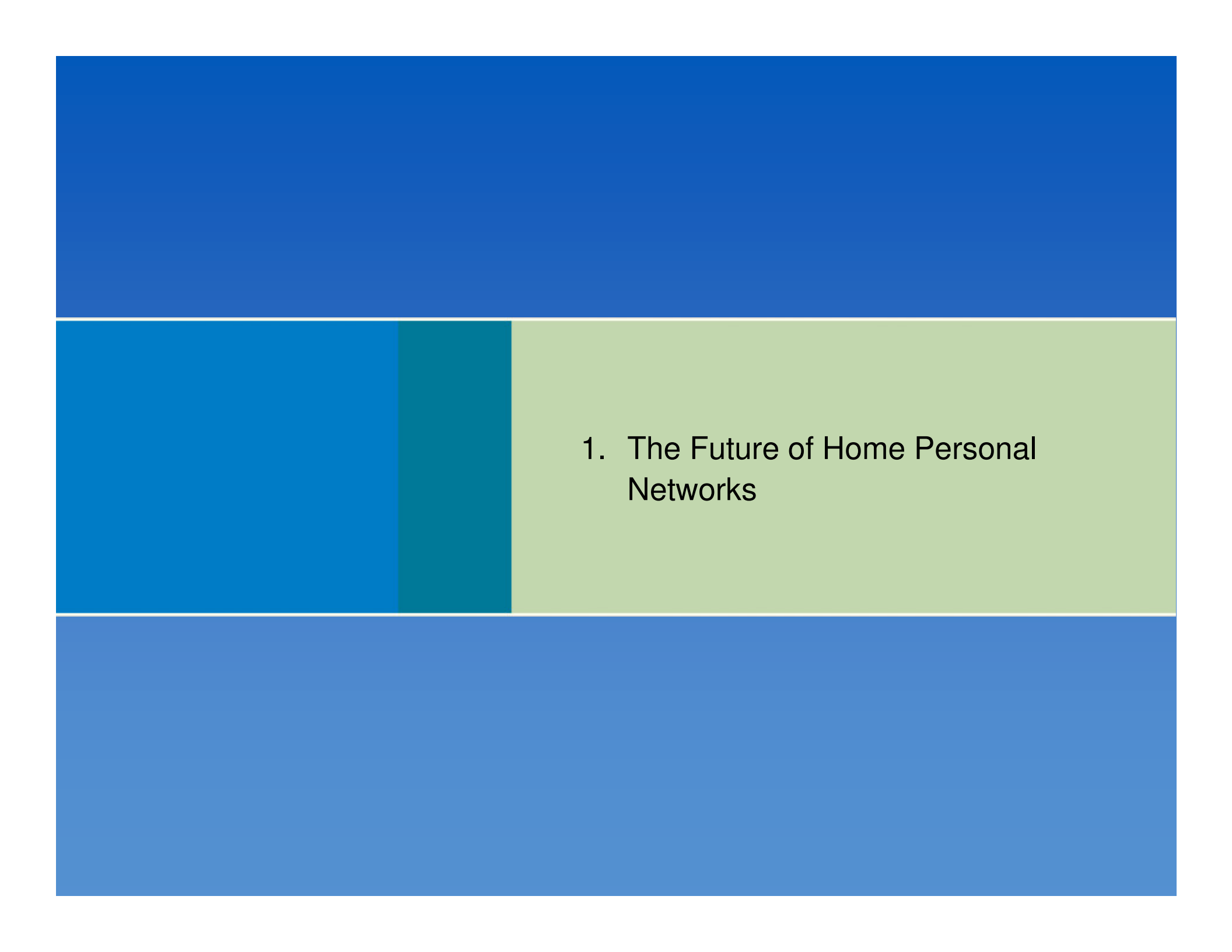
- Finding a solution to the public network challenge will require significant investment with associated market risks

5

- Current industry structure and competitive intensity might have a negative impact on the ability to address the consumer need to upgrade the network

6

- Four potential outcomes: a) Policy driven changes to investment case; b) Winners and losers; c) Hypercompetitive anarchy leading to unmet market needs, d) Industry shake-out resulting from irrational exuberance



1. The Future of Home Personal Networks

The consumer market for information, communication and entertainment services has entered a new stage, challenging the existing network

1.

- Broadband, digital and IP technologies are reaching mass adoption levels

2.

- The household is becoming a multiplatform hub with ethernet gigabit networking speeds

3.

- At the same time, wireless is expanding the physical boundaries of the home extending the network to mobile household members

4.

- These changes are associated with modifications in media and information consumption

5.

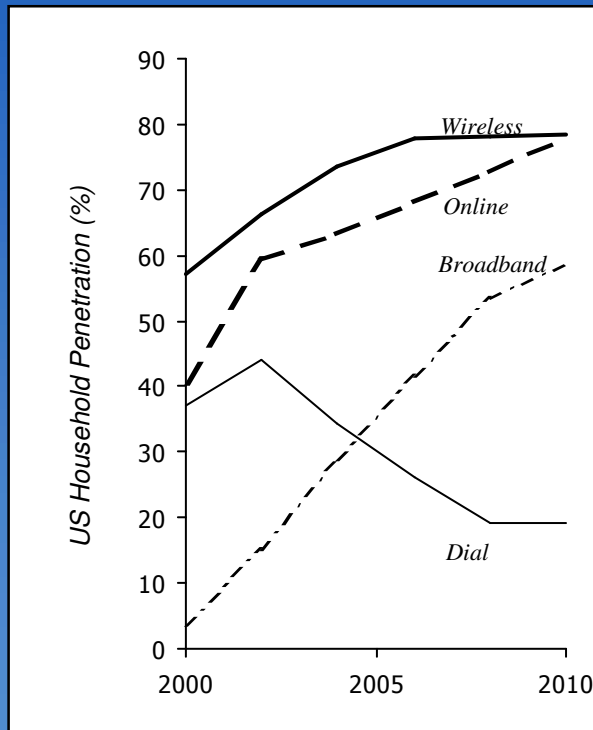
- But consumers are daunted by the technological complexity

6.

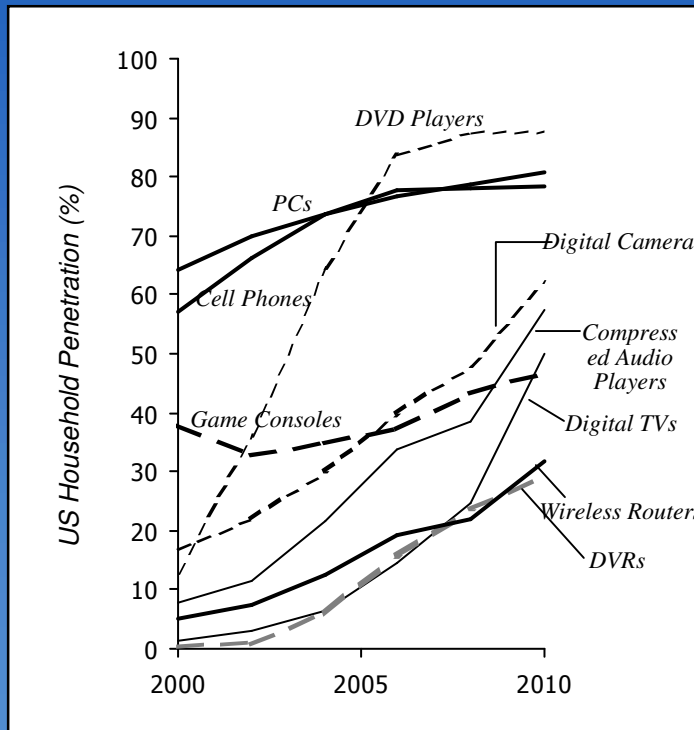
- New architectures could address the complexity in the household, but networking challenges remain

“To the Home”, Broadband, Digital, and IP Technologies Are Reaching Mass Market Adoption Level

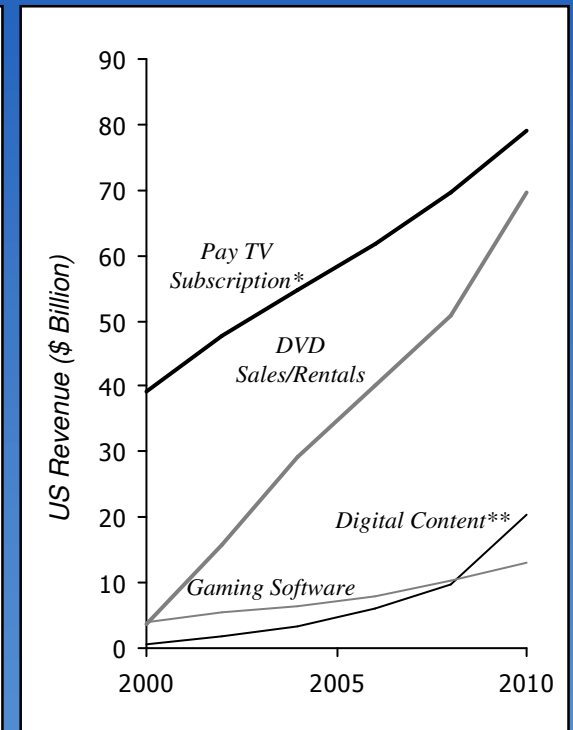
As wireless and broadband connectivity has increased ...



... digital devices have proliferated ...



... creating demand for digital services and content



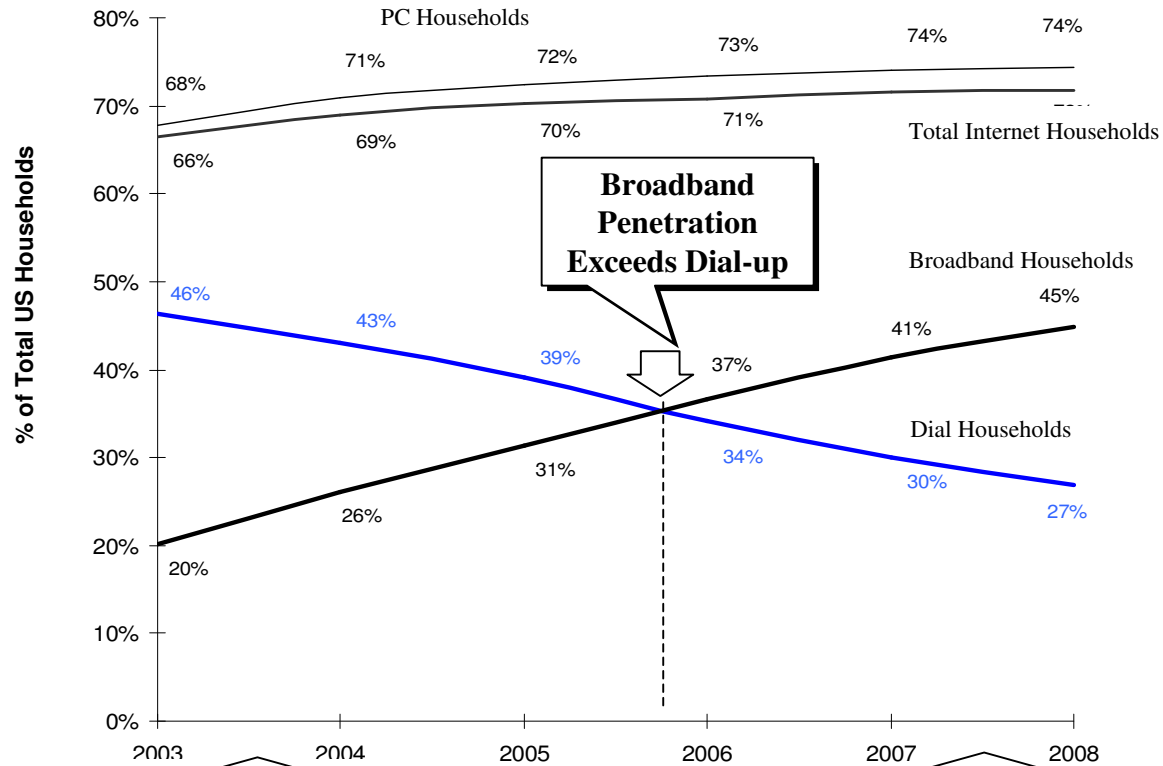
* Cable & Satellite TV

** Online General Content, Online Games, Music Downloads, Personal Video Recorder (PVR) Subscriptions, Ringtones, Video-on Demand

Source: CitiGroup, Deutsche Bank, Forrester Research, IDC, InStat/MDR, Merrill Lynch, Veronis Suhler, Yankee Group

Broadband Adoption Is Crossing Key Thresholds, Driving Unprecedented Demand for Bandwidth

US BROADBAND & PC PENETRATION: 2003-2008 (M)



Source: Yankee Group 2004

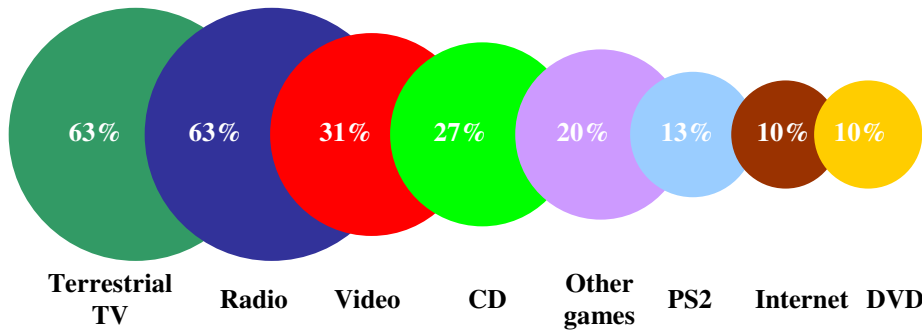
Narrowband Internet: broad reach, long sessions, little multimedia content (voice over IP, rich-media ads, video, content copying), search engines as directories

Broadband Internet: reach headed to ubiquitous, always-on, endless multimedia content, search engines as brokers for media and ads

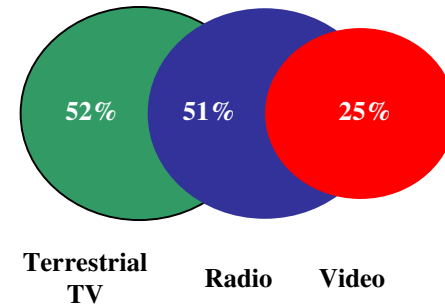
The household is becoming a multi-platform hub

% penetration by type of room

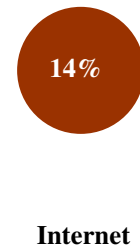
Children's (10-14) bedroom



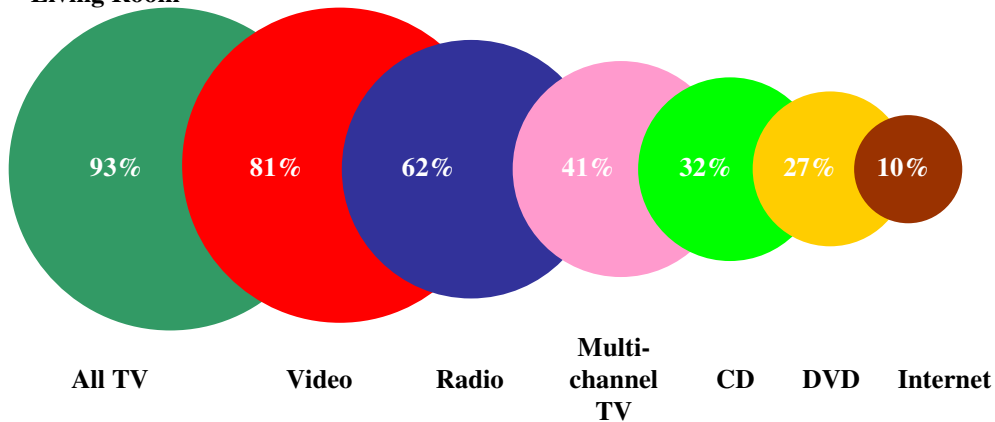
Adult's bedroom



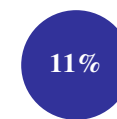
Study



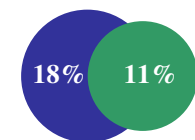
Living Room



Dining room



Kitchen



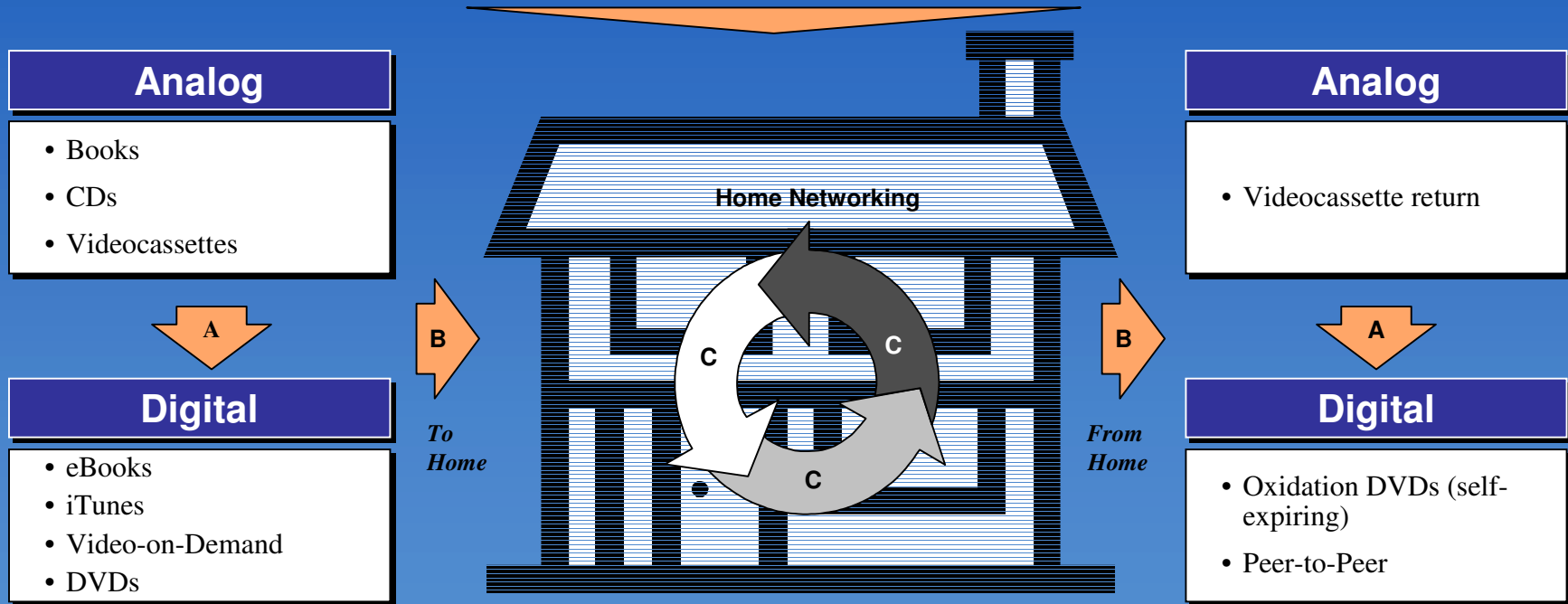
Source: Daily Life Survey, BBC – "Building Public Value"

Note: Only includes technologies with at least 10% 'room penetration' shown

The multi-platform hub is supporting information flowing to, within and from the household

3 Content Distribution Vectors

- A. Analog flow to digital flow
- B. Increased velocity to and from the home
- C. Increased velocity within the home

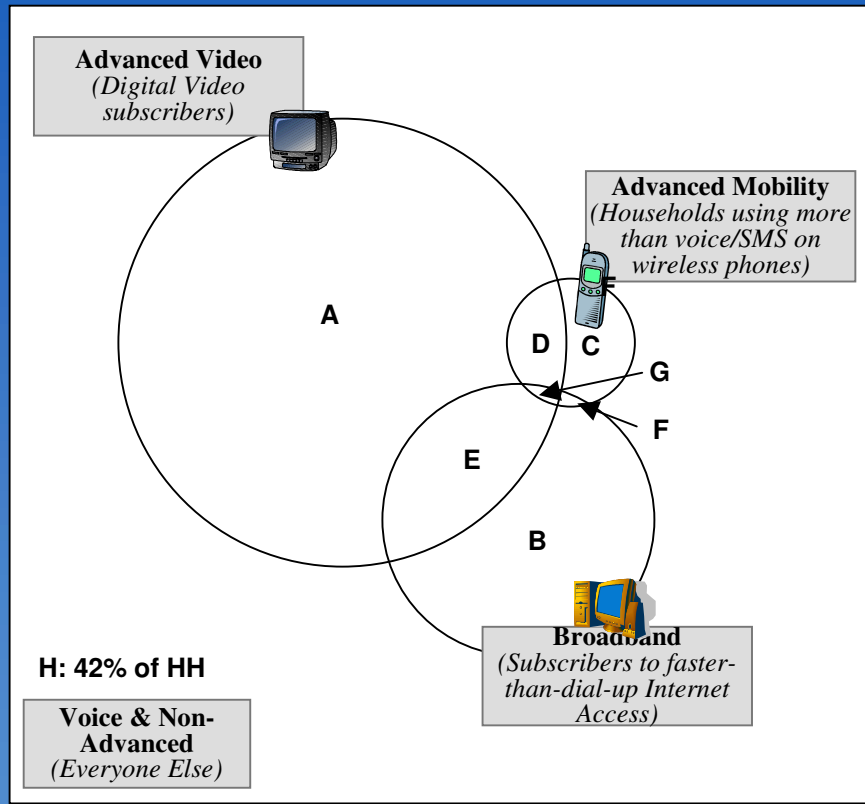


Stimulating traffic within the home will significantly drive traffic in and out of the home - 40% of U.S. Broadband Households have home networking while 18% of total PC households have home networking

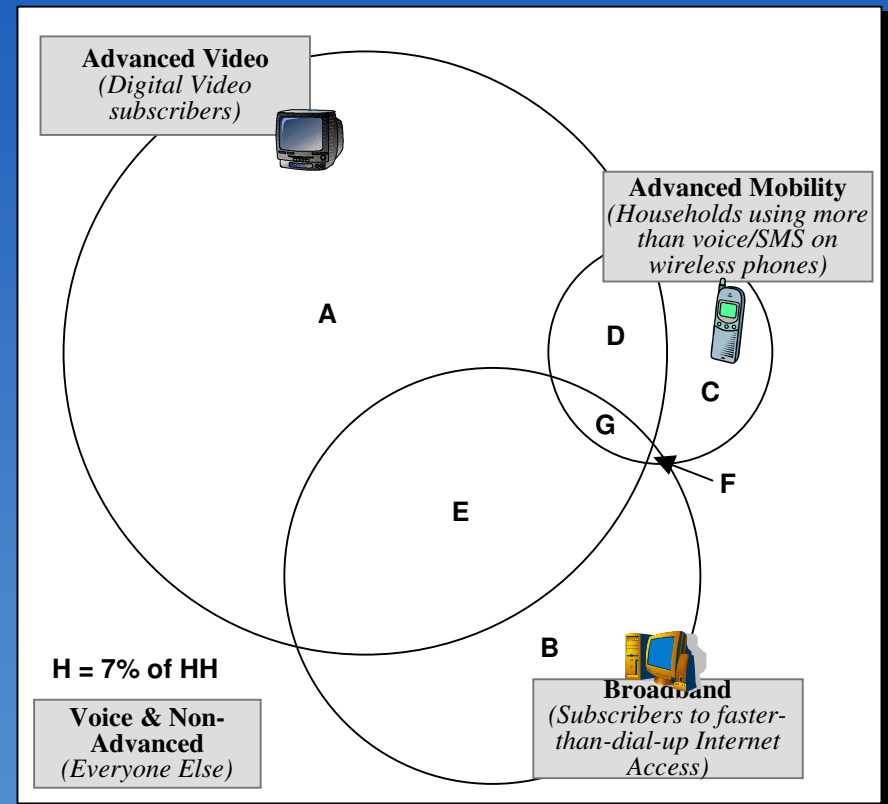
Source: CTAM,

A forward looking perspective also points to a growing overlap between wireless and wireline access of information

2003



2008

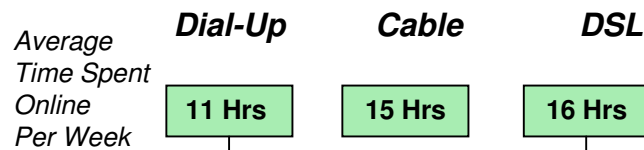


Note: Bubble areas proportional to advanced segment sizes. Overlay areas roughly indicative of households purchasing more than one service

Source: ADVENTIS

Changes in the US household network are driving modifications in the behavior of media consumption

AUDIENCE BEHAVIOR CHANGES WITH ADOPTION OF BROADBAND



Broadband users spend approximately 5 more hours online than dial-up users

After upgrading to high-speed consumers spend more time online doing the following activities:



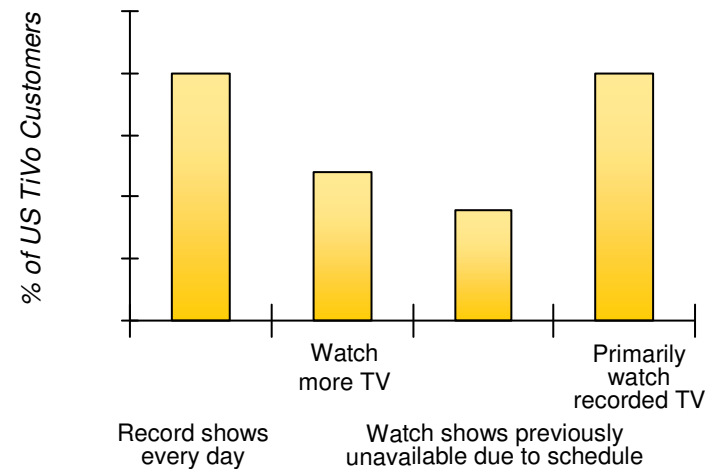
On average they also spend approximately 5 hours less per week watching TV

Source: ADVENTIS Survey of 400 consumers

USERS ARE BEGINNING TO SELECT THE TIME AT WHICH THEY CONSUME CONTENT

Consumers with TiVo show high usage levels and loyalty

- TiVo users spend only ~26% of total time watching “live” TV
- 70% of TiVo users record shows every day rather than watch them live
- Among TiVo customers, 90% claim their propensity to channel surf fell considerably



Source: TiVo US Customer Survey

Audience Behavior is changing toward a paradigm that could be described as consume “what I want, when I want it”

Research in the UK also indicates that broadband is already cannibalizing traditional television

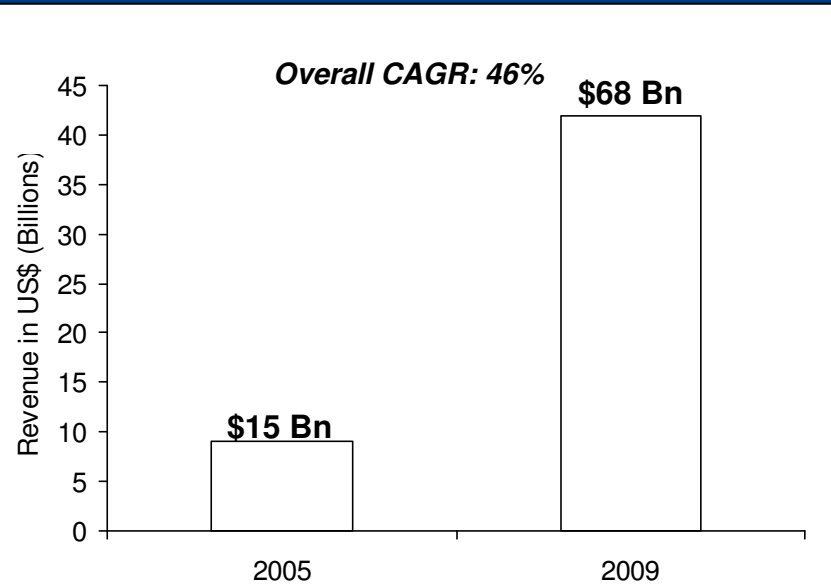
UK: Weekly Media Consumption

Medium	Narrowband Users	Broadband Users
Television	23.2 hs./week	21.1 hs/week
Radio	9.4 hs./week	9.8 hs./week
Internet	4.0 hs./week	6.1 hs./week
Newspapers	1.9 hs./week	1.6 hs./week
Magazines	0.7 hs./week	0.8 hs./week

Source: UK Internet Advertising Bureau, 2005

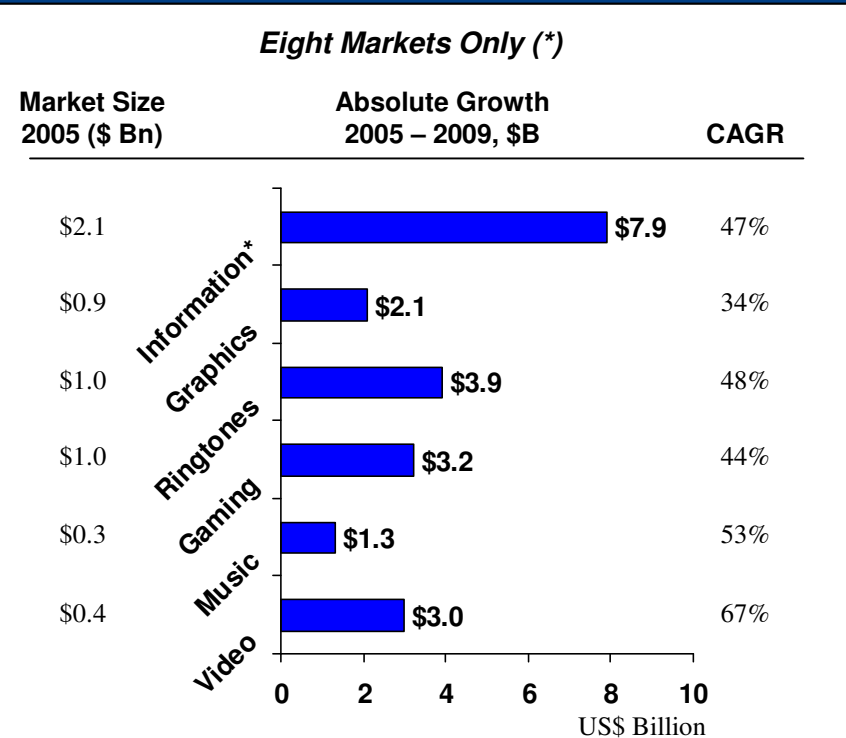
Furthermore, mobility will trigger a new round of media consumption

The Global Mobile Media Market Is Expected To Grow To \$68B By 2009



Source: Yankee Group Data

Sophisticated Content Genres (Music & Video) Are Expected To Be The Fastest Growing



* Includes: media driven interaction such as voting, polling, & trivia; premium chat & dating services; non voice directory services; access to personal information (e.g. calendar); together with news, sports, financial etc.

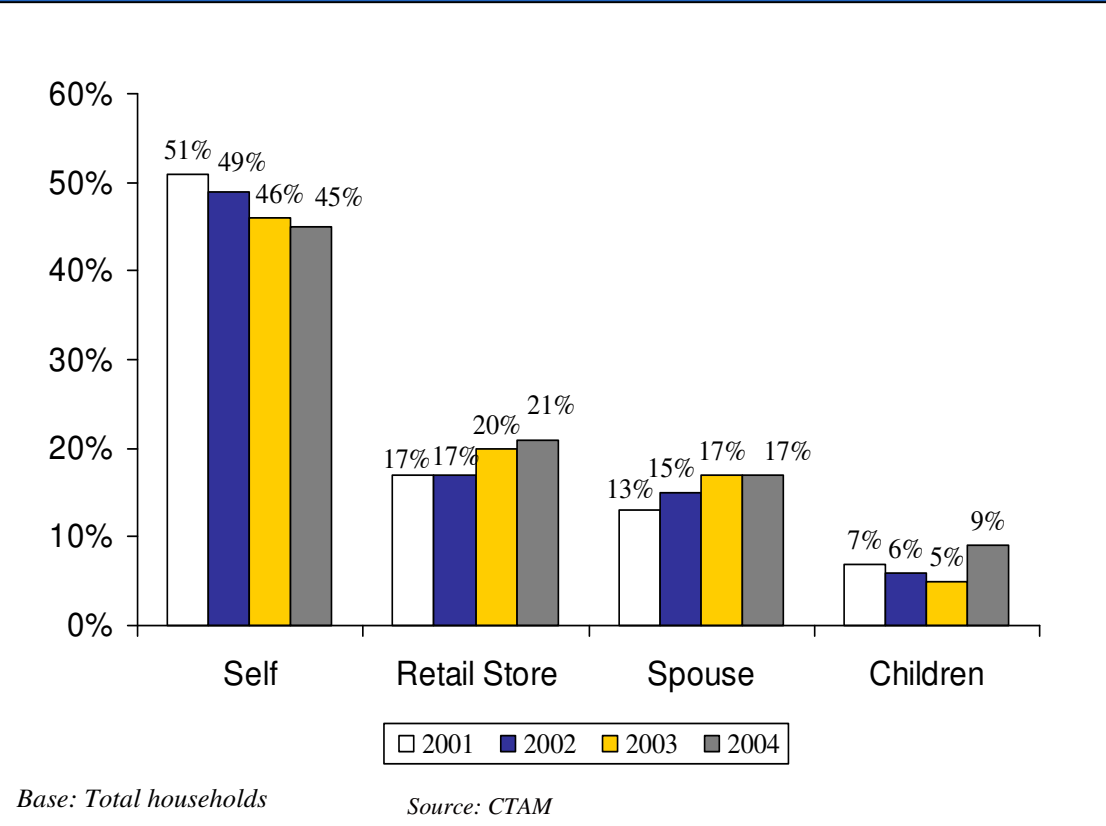
* 8 markets: USA, UK, Italy, Spain, China, India, Russia, Brazil. The gap between the global and eight target market revenue forecast can be attributed to large markets such as Japan, Korea, France, and Germany

However, consumers are overwhelmed by the complexity of multi-platform systems integration

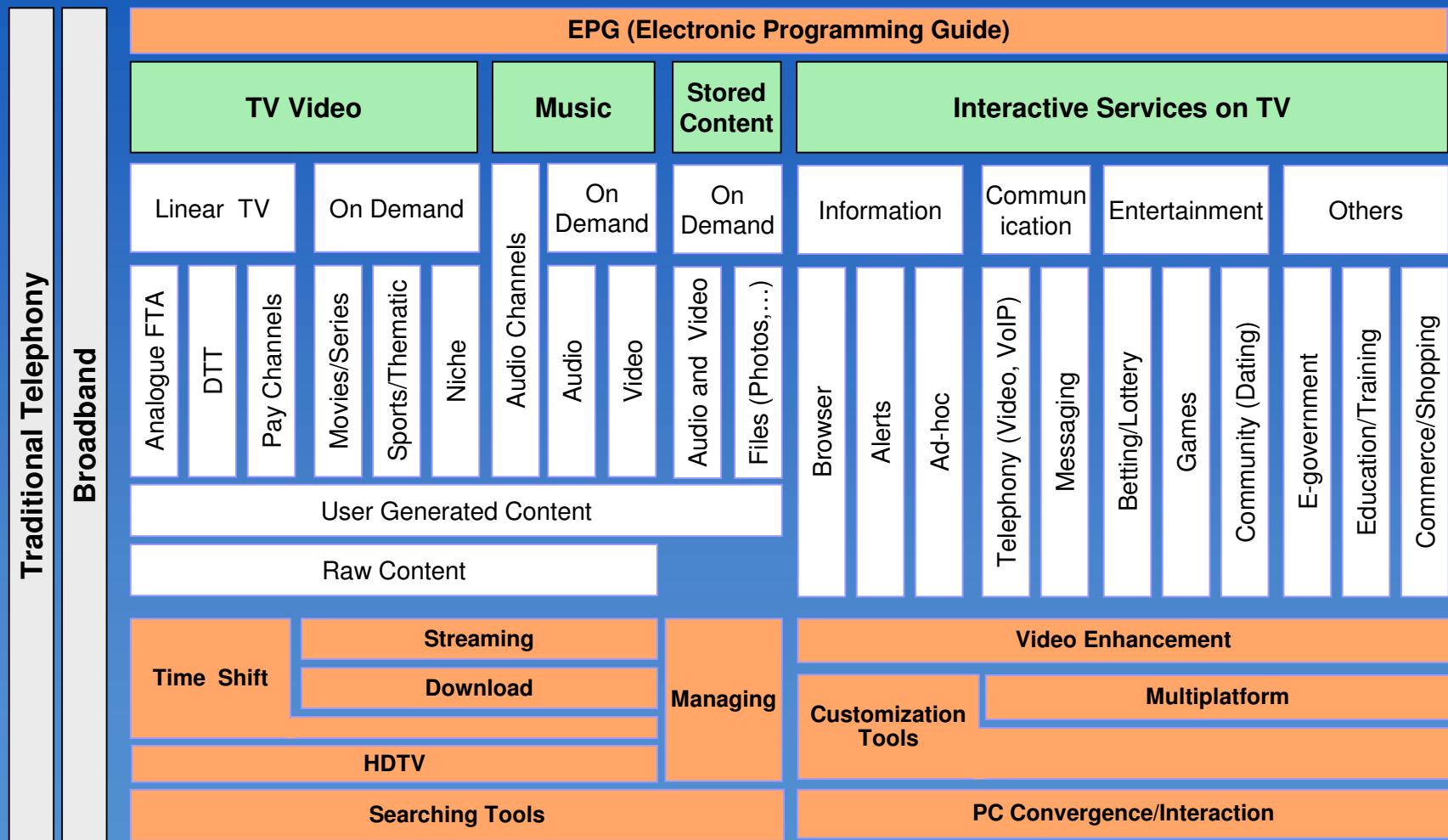
Key Observations

- Home technology devices are becoming increasingly digital, broadband, wireless, sophisticated and complex
- Consumers are confused by the large number of devices and frequently lack a full understanding of the features and interoperability
- Many in-home devices are not being made full use of or have been installed in a sub-optimal way
- These factors all create a poor customer experience for any service relying on in-home devices
- Consumers are depending more on the retail store or a family member for installation

Example: Entertainment Equipment Installations



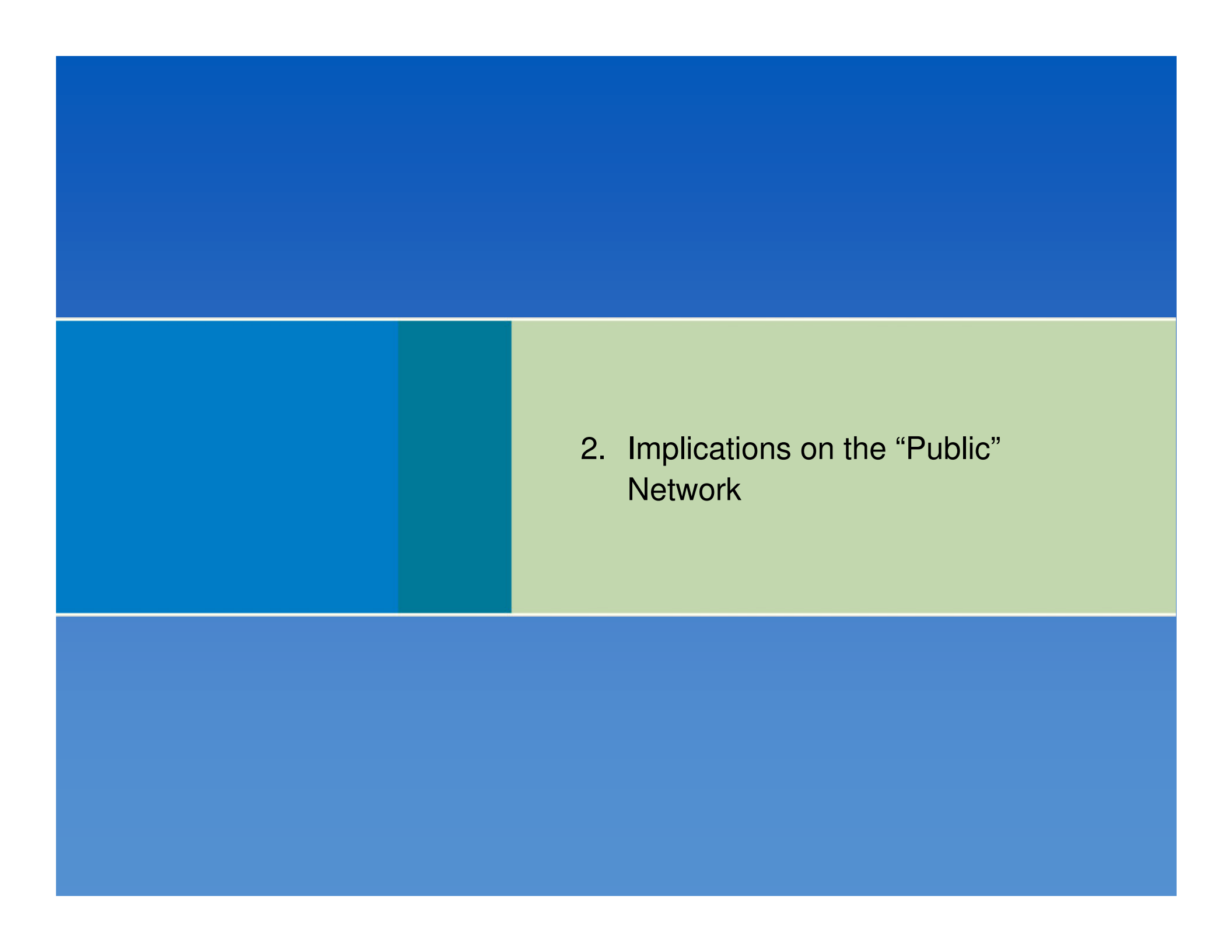
A functional architecture of services will bring some order to the multiplicity of platforms



■ Content and Services Categories
■ SubLayers of the Offer

But at the end of the day, new functional/platform requirements will put pressure on the network

- What is the ultimate capacity requirement?
 - Three to five simultaneous HDTV channels (linear and time-shifted on-demand)
 - Videoconferencing
 - Other data and voice
- Are we moving to a new definition of “busy hour” (Multi-hour busy period)?
 - New patterns of media consumption could unclog the prime time
 - Telecommuting could “smooth out” the peaks, but eliminate the “valleys”
 - Always on puts additional pressure on the network
 - Machine-to-machine communications; backup of digitally stored data, continuous video monitoring
- The multiplicity of applications riding on the network will require building intelligence in the middle layer
 - Security
 - High transaction databases
 - Middleware and APIs
 - Software
 - Network protocols and signaling



2. Implications on the “Public”
Network

The increase in home networking requirements will have a significant impact in the future of the “public” network

1.

- The current public network is under stress from changes in consumer behavior and disruptive business models

2.

- Therefore, investments are required now in order to address degradation in quality of service

3.

- Beyond the investments currently required, carriers will have to address the future needs for network performance resulting from new applications

4.

- However, at this point it will critical to ascertain what those future needs for speed are going to be given the sensitivity of the investment return to this variable

5.

- While investments at the metro and long-haul level are feasible, the speed enhancement at the access level is fraught with market risk

6.

- In this context, it is not out of the question to consider an outcome where user needs might not be met (or user adoption may not materialize at the expected levels)

The current public network is under stress from changes in consumer behavior and disruptive business models

- Users of current-generation broadband (DSL, cable modems, <1Mbps) generate ~10x traffic of narrowband (56kbps)
- Outdated peering and carrier interconnect models enable 'tragedy of commons' exploitation of shared resources: Spam, 'peer-peer' content copying
- Arbitrage on call termination fees and revenues enables VoIP at lower prices than either CLEC- or ILEC-provided services

Growth in Traffic Threatens to Deplete Internet Quality of Service Unless Steps are Taken to Encourage Investments in Infrastructure

Key Trends Impacting The Public Internet

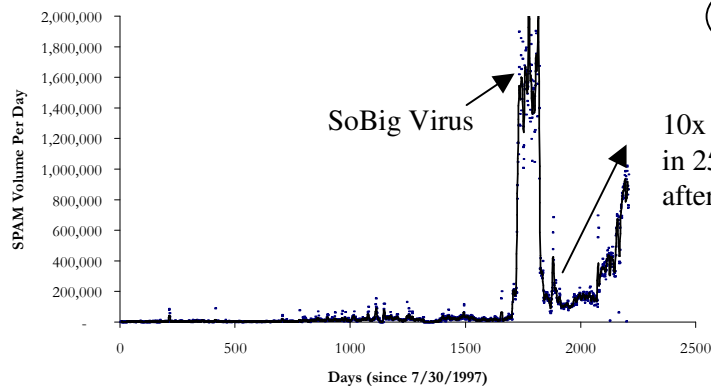
RAMPANT FREE RIDING

- P2P traffic (e.g. Kazaa, Bit Torrent) driving network over 30% of overall Internet usage (60%-80% in consumer ISP networks)
- VoIP P2P clients (e.g. Skype) and line-side players (e.g. Vonage) threatening carrier revenue streams

PROLIFERATION OF MALWARE

- Spam accounts for 60% to 80% of email traffic – projected to rise to 100:1 per ‘normal’ email
- Worms, denial of service and other attacks degrading service and threatening network availability
- Continual background probe and infection attempts – which cannot be traced to their source
- Exponential growth in vulnerabilities
- Growing infectivity rates (I.e. attacks affect a larger number of hosts, faster)

SPAM Volume per Day



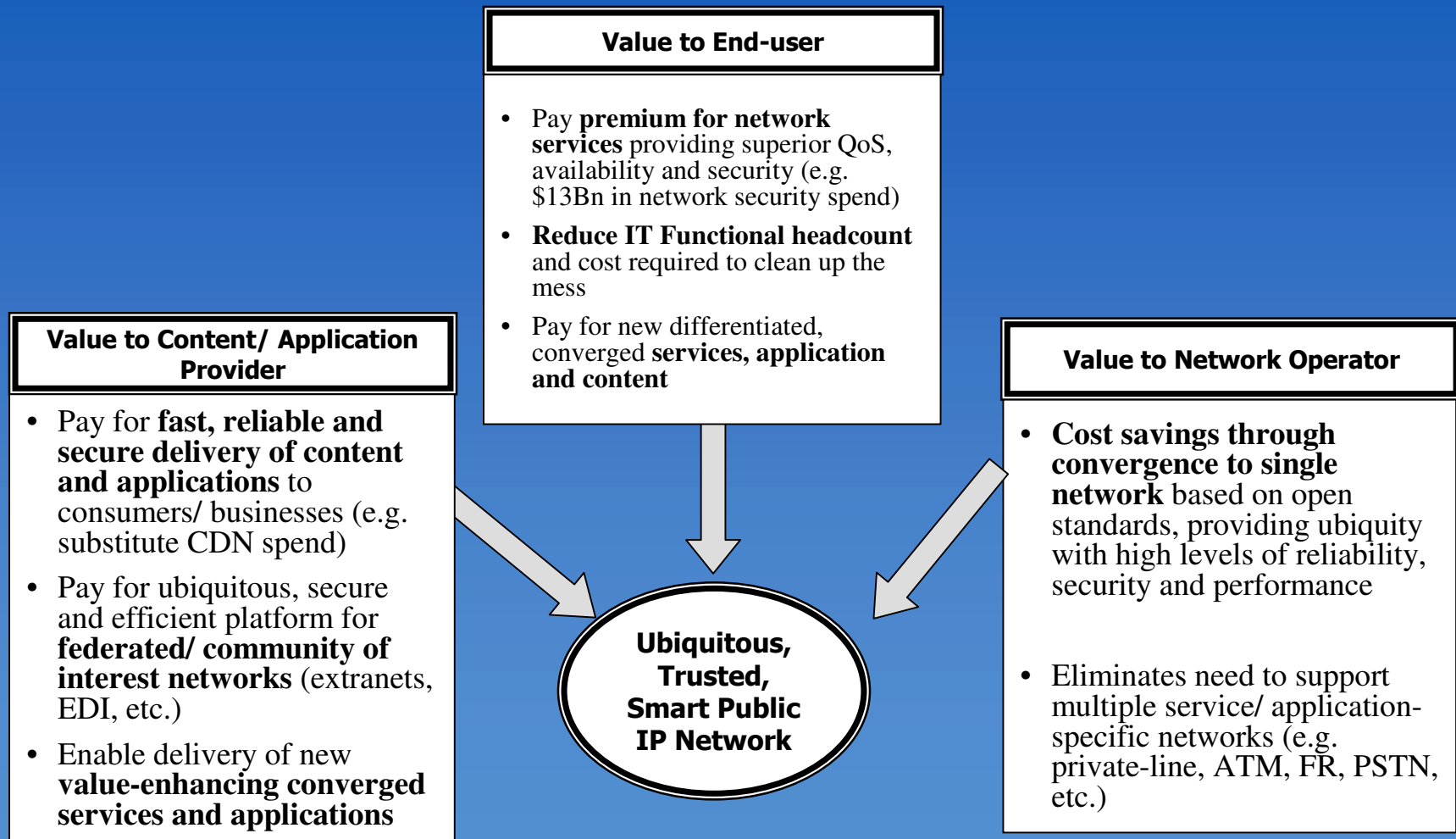
IMPLICATIONS FOR CARRIERS

- Heavy users of the network are not accountable to supporting and investing in network infrastructure
- Malicious users of the network are able to avoid accountability -- easy to conceal identify
- End-user trust in the network is being eroded
- **Network operators are left carrying the burden ...**
 - Invest in capacity for actual load, plus abuse
 - Invest in safeguards (which are increasingly ineffective)

* Geoff Huston, Internet Architecture Board, July 2004

A Ubiquitous, Trusted And Smart Public IP Network Would address some of the more immediate needs

Potential Sources of Value From 'Smart Pipes'/ Trusted Network



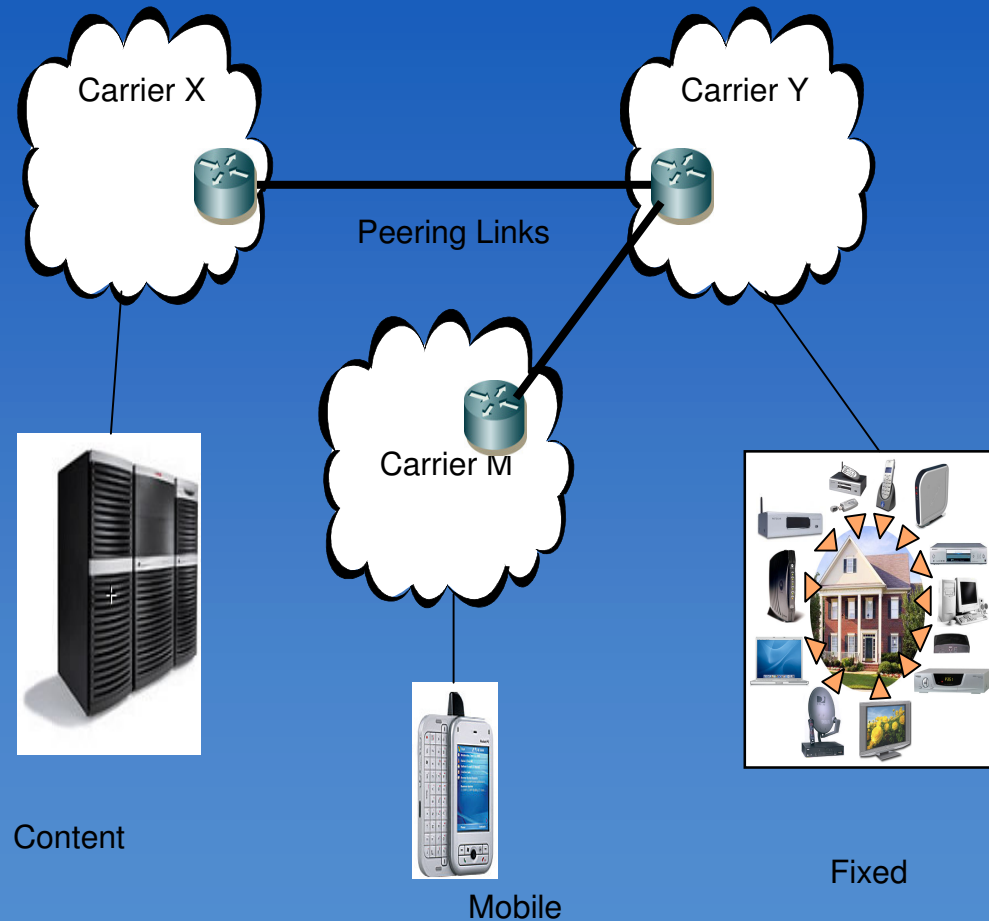
Multiple Initiatives Underway Could, at least partially, support the goal of addressing some of the performance problems

<i>Initiative</i>	<i>Overview</i>
The Infranet Initiative/ IP Sphere	<ul style="list-style-type: none">• Juniper initiated, carrier driven open forum – strong support from BT, DT• The initiative has three primary goals:<ul style="list-style-type: none">- Define a new overall IP infrastructure, where the best-effort Internet is presented as a ‘tunnel’ alongside more robust services- Support interconnection for any network service with clearly defined business models, and mechanisms for revenue settlement and SLA accountability- Ensure network users can access only the presented services, and not the underlying infrastructure itself, to heighten reliability and integrity
Vendor-Specific Approaches	<ul style="list-style-type: none">• Individual vendors provide own vision for NGN addressing security, availability and business model issues• Current focus of most vendors is on converged Service Delivery Platforms to provide integrated technologies to enable service provider control of the network at the application and user level over common IP network• For example, Cisco vision/ architecture for Next-Gen IP networks focusing on Service Exchange Framework
Internet2	<ul style="list-style-type: none">• Consortium led by 207 universities working in partnership with industry and government to “develop and deploy advanced network applications and technologies, accelerating the creation of tomorrow's Internet”• The primary goals of Internet2 are to create a leading edge network capability for the national research community, and ensure the rapid transfer of new network services and applications to the broader Internet community.

However, emerging content distribution patterns are creating new business model challenges to the “network”

NET NEUTRALITY DISCUSSION

- Proponents of Net Neutrality argue that content and end-users should not be obstructed from accessing any content and information.
- Carriers argue that Connectivity between Content Providers and users should be based on business models.
- Carrier Y is building “Broadband” infrastructure and requires ROI for investment, The options of charging for content distribution are:
 - Charge consumers (mobile and fixed)
 - Charge Carrier X: Since Carrier X is charging the content Provider for Internet access
 - Charge the Content Provider additional charges



Going forward, the combination of “public” network providers will have to address the future throughput challenge

- Question 1: What is the near and medium term need for speed to accommodate consumer needs?
- Question 2: Are providers planning to support those requirements?
- Question 3: Are there any risks of the requirements for speed not being met?

It is hard to envision that users might need speeds beyond 50 Mbps

- Near Term

- 1 HDTV: 7 Mbps
- 2 TVs (Analog): 6 Mbps
- Data: 1.5 Mbps
- Voice: 100 Kbps (*)
- **Total: 14.6 Mbps**

- Medium Term

- 3 HDTVs: 24 Mbps
- Data: 10 Mbps
- Voice: 100 Kbps (*)
- Videoconferencing: 384 Kbps
- Other (Machine-to-Machine): 1 Mbps
- **Total: 25.484 Mbps**

() Voice with compression is around 8 Kbps continuous stream*

Plans to increase throughput need to be evaluated by looking at the three elements of the network topology

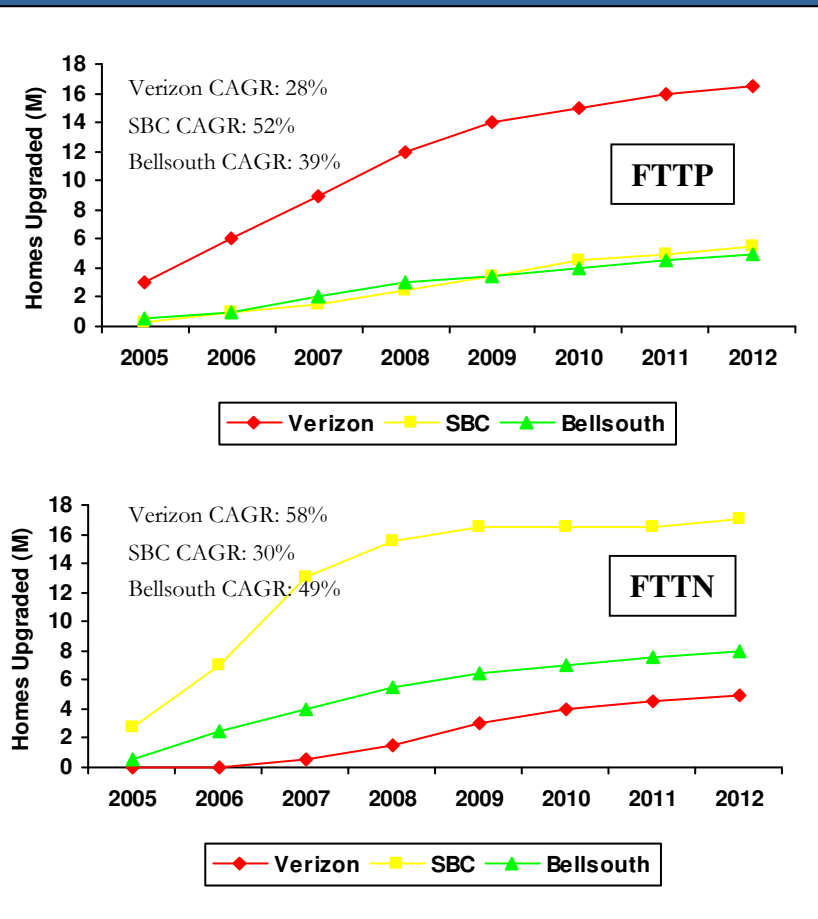
ACCESS	<ul style="list-style-type: none"> • Telco wireline; FTTX where X is home, node or curb) • Cable • Wireless (based on new spectrum auction) 	<ul style="list-style-type: none"> • Today: 10 Mbps • Mid-Term: 100 Mbps • Long Term: 1 Gbps
METRO	<ul style="list-style-type: none"> • Wireline – fiber based, IP and Optical networks • Wireless – some-point-to-point backhaul • Multiple competitors (Telco, CLEC, Cable) 	<ul style="list-style-type: none"> • 10 Gbps Ethernet
LONG HAUL	<ul style="list-style-type: none"> • Wireline – fiber based, IP and smart optical networks • Multiple providers/competitors 	<ul style="list-style-type: none"> • 40-100 Gbps

Despite intermodal competition in the access network, it is difficult to envision throughput speeds reaching 100 Mbps in the mid-term

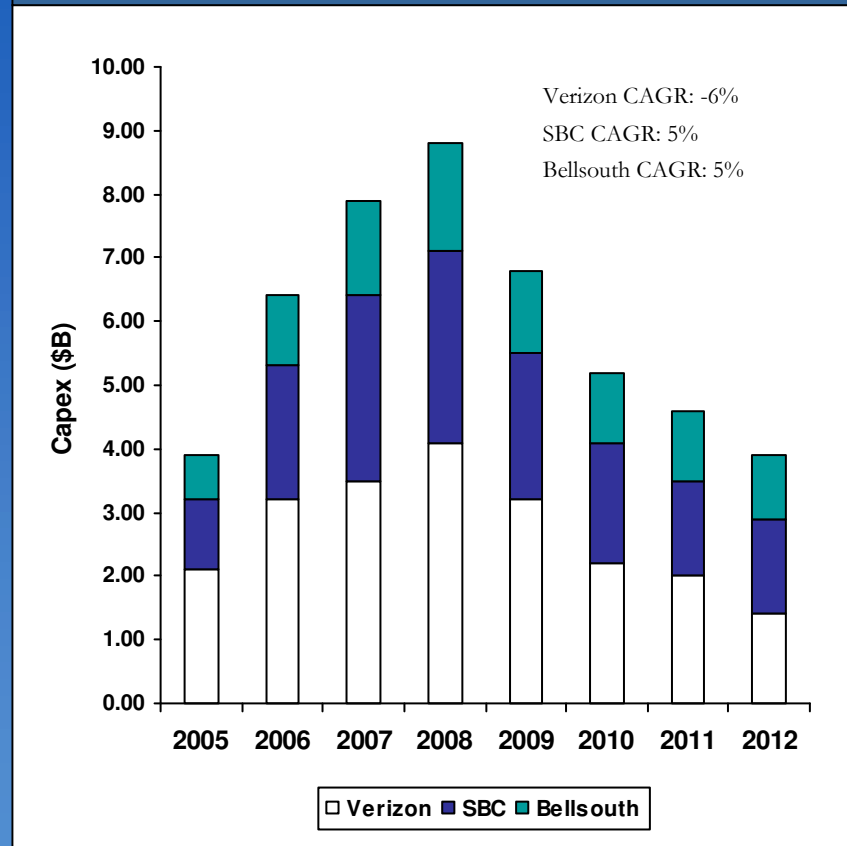
- Few players are planning to deploy FTTH, which could deliver in excess of 100 Mbps
 - Verizon is the only US carrier planning to deploy FTTH on a household shared basis, which could deliver almost unlimited speeds; however, given the number of households shared (64), one could not expect reaching 1Gbps before 10 years
 - On the other hand, at&t, BLS, and most European carriers are planning FTTC which, by delivering up to 100 Mbps, are well within the current consumer capacity needs
- Cable TV players have already defined a technological approach capable of delivering up to 100 Mbps
 - Architecture enhancements comprise bonding of multiple channels (DOCSIS 3.0)
 - With additional deployment of Ethernet switches for each household, it could reach 1 Gbps, but not before 2015
- Wireless players (e.g. Sprint Nextel) are also considering deploying broadband access platforms, although the envisioned speed in this case would be in the 1 to 10 Mbps

In order to deploy these networks, Carriers Are Making Significant Investments to Upgrade their Networks

FTTP and FTTN Consumer Home Upgrades



Capex Investment for Consumer Home Upgrades



In addition to the telcos, the cable TV operators are planning to invest \$60 billion to upgrade their networks

This amount of investment implies a huge investment risk at the access level, which could result in limited deployment

- 1) In a net neutral environment, the ability of carriers to monetize these investments is severely limited
- 2) Even under non net neutral conditions, the limits that telcos could experience in capturing share of the video distribution market (6-10%) with a cost per sub of approximately \$1,500 could push the payback to 9-10 years
- 3) Under these conditions, carriers are logically opting for “success-based” deployment strategies (pay as you go) which could result in a potential “digital divide”
- 4) On the other hand, given that costs at the metro and long-haul level are only 30% of the total, the investment risk is much smaller and we expect network providers to go through with their plans

The requirements for network intelligence will be at the core of competitive dynamics, with potentially negative outcomes

- Key issue: intelligence at the core (IMS) or at the edge (treating each application discretely)?
- Key players: Telcos/Equipment vendors/ITU vs. Application providers (Google)
- Potential outcome: limited IMS-like solution that would put limits on network capacity (maybe delivering up to 20Mbps) and services limited to dumb pipe provisioning



3. Potential Scenarios

Given the changes in consumption patterns of media and communications and the issues surrounding the performance of the public network, four potential outcomes have been defined

1.

- The regulator steps in and implements policies that modify some of the parameters of the investment case (telcos win, cable loses)

2.

- Cable TV industry implements an IMS-like solution which allows it to be the network provider of choice in the consumer market (Cable wins, telcos lose)

3.

- Intermodal competition results in a stalemate where, concerned about market risk, network providers slow down their investment plans and consumers might not have all their needs met

4.

- Irrational exuberance drives “fallacy of composition” investment assumptions leading to industry shake-out and delay in meeting consumer needs

Scenario 1: Policy Driven Changes to the Telco Investment Case

- Telcos argument:
 - Internet architecture has fatal flaws today – without our engagement this engine of economic growth may disintegrate
 - Without our investment \$, the result will be “walled gardens for the affluent”
 - We need fair regulation to achieve returns and be a countervailing force vs. cable!
- Public Policy Changes:
 - Subsidization of broadband deployment
 - Complete abdication of network neutrality argument
- Telcos allowed to monetize their network investment
- IMS becomes the dominant middle layer paradigm, supported by equipment manufacturers (e.g. Lucent/Alcatel)
- Telcos push full pace forward with broadband deployment plans
- However, the question remains as to whether expected video market share does not match business case assumptions (6% vs. 20%)

Scenario 2: Cable wins and Telco loses

- Cable TV pushes forward with investment to upgrade network speeds to 100 Mbps
- Cable TV succeeds in implementing an IMS-like solution that allows them to become the “smart-pipe” of choice to the consumer market
- Cable TV succeeds in adding a wireless component to their quad-play through either partnership or acquisition
- Telcos cannot succeed in gaining large enough share to justify success-based roll out, cannot generate enough opex savings and retrench in their fiber deployment plans

Scenario 3: Systemic slowdown of investment resulting in unmet user needs

- Limited changes in regulatory framework leads to competitive stalemate
 - Telcos pursue “success-based” deployment leading to limited roll-out
 - New entrants (e.g. Google) continue to push for application specific intelligence at the edge of the network
 - Cable TV cannot craft an IMS-like platform
- Likely solution: small speed increment reaching 20 Mbps and services limited to dumb-pipe provisioning
- Consumers cannot meet their needs for network performance and might retrench from considering a unified platform and continue to rely on discrete, redundant networks

Scenario 4: Industry shake-out

- Lured by potential capture of share of the content distribution market (\$55B), all players continue with their planned investments
- Irrational exuberance is enhanced by displacement effect of wireless auctions which open up over 200 Mhz and stimulate entry of new players
- Investor irrational exuberance leads to a fallacy of composition and overcapacity of redundant networks
- No new player meets minimum efficient market share needed to recoup their capital investment (for reference, it took 10 years under better conditions for DBS to capture 13% of the market)
- Telcos find that cost savings due to fiber deployment are difficult to achieve because of “success-based” and legacy issues
- Irrational consumer pricing emerges as the only way new entrants can capture share (15%-20% over cable TV)
- DBS loses large market share to new entrants and cable TV
- Content providers enforce pricing squeeze to new entrants due to their diseconomies of scale in program acquisition (15% penalty)
- Industry shake-out leading to new round of consolidation:
 - Telcos: low video revenues, limited operational savings, high voice erosion due to VoIP
 - Satellite: low subscriber growth, no revenue replacement
 - Cable TV: subscriber loss, albeit very moderate, ARPU impact in case of price war
 - Content insurgents bring further market disruption

**TELECOM ADVISORY
SERVICES, LLC**

For further information please contact:

Raul Katz, raul.katz@teleadvs.com, (845) 868-1653

TELECOM ADVISORY SERVICES LLC
182 Stissing Road
Stanfordville, New York 12581 USA