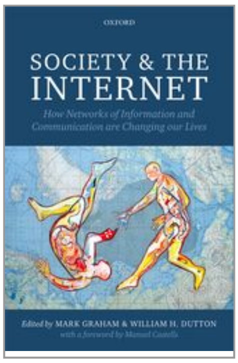

Society and the Internet: How Networks of Information and Communication are Changing Our Lives
Mark Graham and William H. Dutton

Print publication date: 2014
Print ISBN-13: 9780199661992
Published to Oxford Scholarship Online: August 2014
DOI: 10.1093/acprof:oso/9780199661992.001.0001

Next-Generation Content for Next-Generation Networks

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DOI:10.1093/acprof:oso/9780199661992.003.0021

Abstract and Keywords

The Internet promises a very different technological and regulatory future for film and television. As older media are produced for and delivered through the Internet, how might the content be reshaped? The development of cable and satellite networks promised to bring more channels of more diverse programming to households around the world. Internet access to film and television content is similarly enabling more on-demand access to content from anywhere at any time. Will ever-faster broadband networks change what we will view? This chapter takes a systematic historical and economic approach in speculating about how 'super-broadband connectivity' might provide video entertainment unprecedented in its richness and customization for individuals. This example of the application of a multi-disciplinary perspective on the interaction of next generation networks and content shows the potential for reasoning about the future of communication by keeping a firm grounding in the history and economics of communication technologies.

Keywords: broadband, next generation, film, television, video, telecommunications

The Nature of Internet Television

Marshall McLuhan memorably stated that "the medium is the message" (McLuhan 1964: 9), that is, that the nature of the distribution system defines its content. If so, the next generation of the Internet, ultrabroadband at gigabit rates over fiber optic networks, will have an impact on the styles of content. In this chapter I will analyze the types and styles of content most likely to emerge with this new technology of distribution.[1] I will engage in a data-driven analysis of price trends of media consumption, distribution cost, and several other factors. This analysis will determine the historic rate by which media have become more bit-intensive and enriched in terms of sensory signals. Projecting this rate ahead permits us to predict the type of media content of the future.

The question of content is critical for any economic analysis of the viability of an ultra-broadband infrastructure. It is common to rush into talk of technology or rollout strategy without first considering the utility to users. If one builds an oil pipeline one must first be sure that there is an oil supply at one end and demand for it at the other. The economic case for investment in super-broadband must rest on its meeting a demand/price combination that is not satisfied today.

What would super-broadband connectivity be used for? There is no evidence of a major need for significantly more powerful types of email, website browsing, or professional at-home applications beyond basic-quality video. Ultrabroadband provides transmission rates of over 1 Gigabits per second, 50–500 times as fast as typical broadband rates of DSL or cable modem service. To what purpose, then, would many millions of residential users conceivably **(p.320)** want the vastly more powerful connectivity of ultrabroadband? For residential households, the answer to this question has to be video entertainment, broadly defined.

But what kind of video would this be? If one asks even knowledgeable people what types of enhancements to video services a super-powerful Internet pipe would produce, the answers normally include:

- More specialized and “long tail” programs
- More individualized content
- Anytime, anywhere video entertainment
- More user-generated content
- More independent and foreign content
- More interactivity and games

Yet these answers are largely incorrect. Of course, ultrabroadband will be associated with these elements. However, they do not require upgrade to ultrabroadband transmission rates: regular broadband is sufficient. If the economic base of ultra-broadband rests on these applications it will fail as a new medium. Ultra-broadband-capable infrastructure must be supported by different content applications.

And indeed, different generations of television technology have affected content. In the US case, for example, when the first generation of TV was broadcast over a limited amount of spectrum, the number of channels was small and the resolution of its picture was relatively low and nationally standardized. Content was in consequence oriented to the broad center of the taste distribution, often described as the “lowest common denominator.” It was characterized by content that was broad-based, middle of the road, middle-brow, national with some localism added, and an advertising-based economic model. Because audiences were huge due to the limited number of channels, the budget for programming was substantial.

The subsequent second TV generation saw the development of cable, satellite, and home video for television. These allowed for the creation of an alternative TV transmission infrastructure. Today, advanced cable TV operates at about 1 Gigahertz. This is about twenty times as much as the typical seven over-the-air terrestrial channels (IDATE 2011). The extra transmission capacity was used first in a horizontal fashion—resulting in more channels employing the traditional technology of analog, 6MHz, one-way TV. Narrowcasting and long-tail content emerged, and new channels included such highly specialized offerings as the Anime Network, the Martial Arts Network, the Baby Network, and the Boating Channel. As audiences fragmented, content budgets dropped even for the bigger channels. Low-cost quiz shows, reality programs, and “talking head” content proliferated. Theatrical films, both recent (for extra pay) and old became a staple. In the 2000s, TV moved to a fully **(p.321)** digital transmission (Seel 2012). This, by itself, did not change very much, but it brought TV much closer to the computer sector, and this ended the next generation of the online TV video medium.

The emerging next TV generation is mostly based on new transmission platforms. Internet TV (representing diverse content) and mobile TV (with ubiquitous availability) are the main components of this generation. The development of these new forms of TV was due in part to the increased transmission capacity on the last-mile access that came with broadband Internet (using the transmission media of DSL over copper phone lines, coaxial cable, fiber lines, and broadband wireless such as LTE). But the main distinguishing aspect of transmission was not so much in its overall increase but in its individualization, that is, the ability of each user to receive communications independently of other users. This is known as “asynchronous” transmission, the opposite of the synchronous broadcast technology. Furthermore, the new type of communication permitted a return channel, that is, it is 2-way, and interpersonal, in other words, social Broadband allows individuals not only to receive but also to create their own content transmission, individually as well as interactively (Smart 2010). Lastly, the cost of transmission of information becomes substantially distance-insensitive, thereby enabling a wider reach of content distribution than in the past.

Thus, the strengthening of transmission rates impacts content distribution and leads to it having much more of the following:

1. More standard TV at different times. Services such as Hulu create free avenues for users to view regular broadcast content online and on-demand.
2. Even more specialized programs for niche audiences than before. Examples might include TV from other countries; specialized feeds (e.g. “The Women’s Field Hockey Channel” from the Olympics); and other types of long tail content.
3. Global aggregation of nationally thin audiences.
4. User-generated content such as that found on YouTube, Daily Motion, etc., even with a lower quality of resolution.
5. Increased downloading of movies. Studios are increasingly considering downloads as part of their traditional release sequence, and some films may even be offered at the top of the sequence. Hindering these efforts, however, are fears of piracy as well as current low download speeds and low picture qualities.

For all the diversity of such individualization, one must understand that it does not require any increase in transmission capacity at the edge of the network in its costly access network segment.

Why is that? Transmission is only one technology dimension underlying new-style TV. A second one is the enhanced storage. This is often overlooked. With powerful and cheap storage, users can access a wide array of video content stored on many locations. The increased storage capacity and **(p.322)** individualization mean that the nature of TV transmission changes. Instead of pumping to individuals hundreds of channels simultaneously, of which only one or two are actually watched at any given time, online TV needs to send out only one or two channels at any given time to the user. This means that the transmission requirement of the end user at the last-mile access segment is actually not particularly high in comparison to the requirements of having hundreds of channels simultaneously transmitted. A household which uses simultaneously VoIP voice service, plus maybe two high definition TV channels, plus some gaming, requires no more than 35 Mbps (Giunta 2006). This is about the rate available already to millions of households. User-generated content and peer-to-peer applications are similarly not reliant on large last-mile access transmission beyond those of regular broadband. Instead, these require storage and a strong core network. Storage is required on both the user end and by intermediaries such as YouTube and DailyMotion. Similarly, online video games do not require ultrabroadband. Even seemingly complex interactive multiplayer games do not use all that much transmission capacity. On average, *Counter Strike* operates at about 40 Kbps. The limiting factor is the processing capacity on the central node, which restricts players' data stream.

Thus, the bandwidth of ultrabroadband—1 Gbps and more—seems excessive for such requirements. What then would one use it for, if at all? Greater bandwidth creates two capabilities: the first is the *widening* of content options. This was discussed and described above. And the second is the *deepening* of content, which is based on the increasing *richness* of content in terms of the bit rate of information supplied per time unit to human sensory receptors.

The most obvious dimension of increased richness in video media is simply the increase in picture quality. The distinguishing factor between standard and higher definition displays has to do with the number of pixels, which allows a greater level of detail to be displayed. A standard display will possess 525 (or 625, depending on the country). A high-definition display (HDTV) provides twice that number. More advanced are so-called 4K and 8K TV with still more vertical and horizontal lines of pixels, a wider aspect ratio (1:2), more bits per pixel, more frames per second, and much better audio (Sugawara 2008). These new generations of picture quality represent an impressive move forward in the clarity of the moving image. Is such an advance truly necessary? Traditionally, satisfaction levels in video quality have been shortsighted; each generation persuaded itself, and was persuaded by marketers, that it was using a technology that was life-like in video and audio quality. Each generation eventually moved to higher levels of quality and soon wondered how it could have endured the past poor resolution.

The second dimension and driver in media richness is a product of larger screens. As digital displays become flatter than the boxy CRTs, they can become larger, while homes and apartments remain roughly the same size. As a result, people will sit at a wider angle to their screen and its pixels. This **(p.323)** requires sharper pictures, that is, a higher resolution such as 4K and 8K resolution, with a much larger number of pixels.

Three-dimensional displays, as well, will improve on the richness of the media experience. Technically many of its elements are already offered, and technologies that do not require the wearing of special glasses are on their way. Other sensory modalities beyond sight and audition might also find their way to an enriched TV content, such as elements of feel. Vibration is already being set into home-theater seats.

The Economics of Bits

All of the above trends of individualization and increasing richness of experience are interesting to note but have a pronounced technological ring. One is reminded of past scenarios envisioning a helicopter in every garage, electric power too cheap to meter, and other utopian scenarios. If the question is where residential fiber will take video media, the answer is not just technological, but also economic. People will use more bits if their price drops. They will consume these bits by spending more time in the consumption of bits relative to other activities; and they consume more bits per time unit, that is, consume a “richer” medium in sensory terms.

It is necessary to look at the underlying economics. To this end we now turn to bit cost trends. Willingness to pay for media is composed of two elements: the content cost, and the distribution cost.

$$\mathrm{CostofMediaConsumptionP}\,(\mathrm{C}) = \mathrm{CostofDistributionP}(\mathrm{D}) + \mathrm{CostofMediaInformationP}(\mathrm{I})$$

(1)

$$\mathrm{CostofMediaInformationP}(\mathrm{I}) = \mathrm{QuantityofbitsQ}(\mathrm{B})\mathrm{xpriceperbitP}(\mathrm{B})$$

(2)

$$\mathrm{QuantityofbitsQ}(\mathrm{B}) = \mathrm{ConsumptiontimeT}(\mathrm{C})\mathrm{xBitspertimeunit}(\mathrm{BpT})$$

(3)

Substituting, we get

$$\mathrm{P}(\mathrm{C}) = \mathrm{P}(\mathrm{D}) + \mathrm{T}(\mathrm{C})\mathrm{xBpTxP}(\mathrm{B})$$

(4)

We can express this as

$$\mathrm{BpT} = (\mathrm{P}\,(\mathrm{C}) - \mathrm{P}\,(\mathrm{D}))\,/\,(\mathrm{T}\,(\mathrm{C})\,\mathrm{xP}\,(\mathrm{B}))$$

(5)

Equation (5) expresses the bits per time unit of the medium, which is our measure for media richness, as a function of the price of media consumption per unit **(p.324)** of time, the price of distribution per time unit, consumption time, and the price per bit. We now look at these components empirically. To do so we measure the prices and costs for various media, ordered by the time of their introduction, plus a few more years for maturity to be achieved. And this is what we find:

First, the price P(C) which people are willing to pay for entertainment has remained fairly constant over time, adjusted for inflation. It is approximately 0.1 cents per second, or about $3.60 per hour. The rate of decline per year has been merely 0.5 percent. When the cost for individualized consumption is higher than such an amount, people engage in sharing consumption, such as going to film theaters or watching broadcast television as part of a mass audience. When cost drops over time, people shift to individualized consumption for that medium, such as home video or pay TV. They share consumption for the still more expensive, often new, media, until they, too, become affordable (see Figure 20.1).

Thus, the left hand of equation (5) above shows almost no upward or downward trend for a century for consumers' payment for media per time unit, adjusted for inflation, even though several components of media cost have declined considerably. The price per second is about 0.073 cents. The growth rate is almost flat, at 0.08 of one percent.[2]

(p.325)

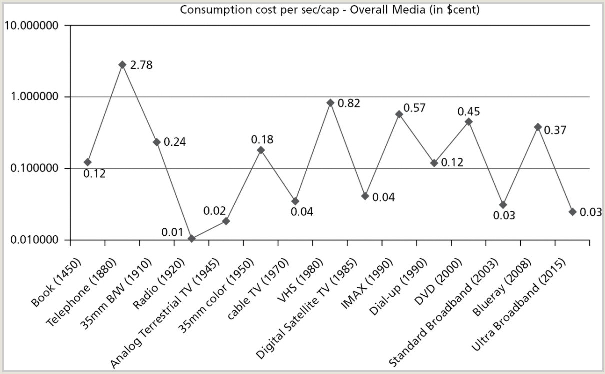


Figure 20.1 Media consumption cost per second, per capita[3]

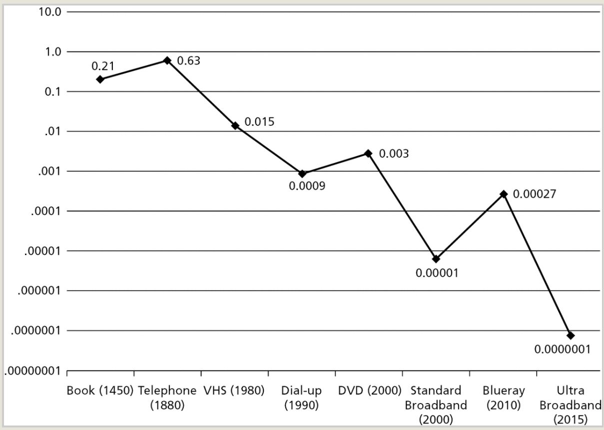


Figure 20.2 Distribution cost per Mbit/capita (individualized channels)[4]

Of the right-hand elements of equation (5), the price of distribution P(D), as measured in the price of transmission of bits per second, has declined enormously over time, at a rate of almost 10 per cent (9.68%) per year since 1880 (see Figure 20.2). With this cost component dropping rapidly, and with the willingness to pay per media time unit stable (P(C)), the component of payment for the information itself (P(I)) has been able to rise. This consumption could rise both in terms of time units (T(C)) and in the consumption of bits per time unit BpT. The former has not risen much, given the reality of work, transportation, sleep, and other time-consuming necessities of life. According to studies such as those by the media investment bank Veronis Suhler Stevenson, media consumption is 9.67 hours per day, or about 3, 530 hours per year (Stevenson 2007a). This includes multitasking with other media and other activities. It is hard to imagine how much extra time could be allocated to media consumption. Indeed, in one year, 2006, that number even declined slightly according to the US Census (Stevenson 2007b). Over the past decades, media consumption time has risen only modestly—15 percent over the past three decades, for an annual compound growth rate of 0.47 percent—even though its composition has changed.

(p.326)

Meanwhile, the price per bit has declined sharply, by an 8 percent compounded annual growth rate, as can be seen in Figure 20.3. If we put these elements together, we observe that what has risen, then, is not the time units of media consumption but their quantity per time unit, in terms of bits. Media enrichment can be calculated by equation (5):

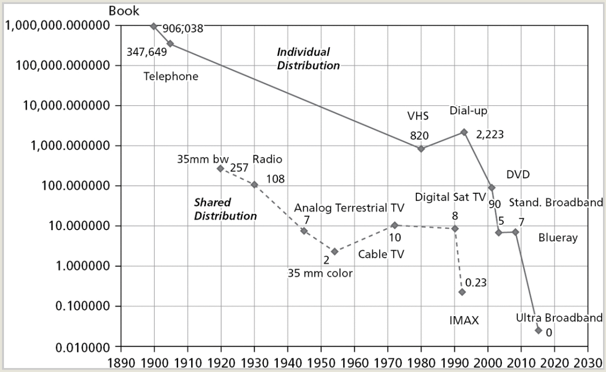


Figure 20.3 Consumption cost per Gbit/cap[5]

$$\mathrm{BpT} = (\mathrm{P}(\mathrm{C}) - \mathrm{P}(\mathrm{D})) / (\mathrm{T}(\mathrm{C})\, \mathrm{xP}(\mathrm{B}))$$

(5)

We can express the changes logarithmically:

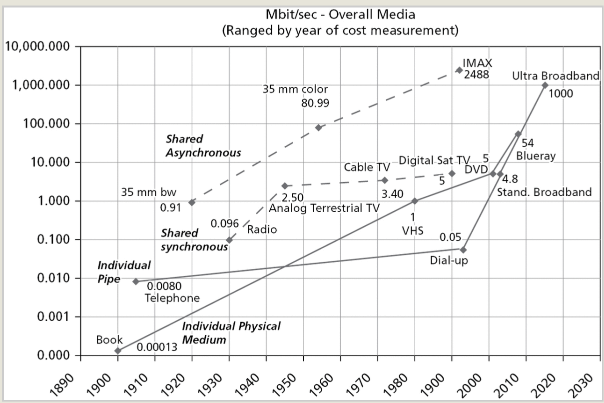
$$\begin{aligned}\mathrm{InBpT} &= \mathrm{In}\,[\mathrm{P}(\mathrm{C}) - \mathrm{P}(\mathrm{D})] - \mathrm{InT}(\mathrm{C}) - \mathrm{InP}(\mathrm{B}) \\ &= -2.15 - .47 - (-8.0) = 5.38\end{aligned}$$

(6)

Thus, the consumption of bits per time unit of media use has risen, by this calculation, by a 5.38 percent compound annual growth rate. This relationship is roughly confirmed by the directly measured empirical trend, as shown in Figure 20.4 which exhibits a compound growth rate of 8 percent.

We can be more specific. Our data shows that the bit richness of print (books), once the dominant medium, was .00013 Mbit per second of consumption. Radio's bit rate was typically about 0.096 Mbps. Standard analog television required about 2.5 Mbps. HDTV is 19.6 Mbps. The next generations of TV **(p. 327)**

display, 2K and 4K, have compressed bitrate needs of about 180 Mbps and 640 Mbps respectively. In each of these generations, visual imagery becomes more pronounced. In the print medium, a relatively few content bits are carefully crafted by the author, and the reader supplies the imagination process which enriches the experience. As the bit rate for a medium grows,



the visual imagery that is supplied by the medium rises. The growth rate of this enrichment, as measured above, is about 8 percent per year. In the process, the sensory content of a medium keeps rising. It becomes ever more realistic, approaching reality with its sounds and images.

Implications for Content

Figure 20.4 Transmission rates of different media[6]

What kind of television will such enrichment in terms of bits yield? There is no need to engage in futuristic imagining of the nature of content. Instead, we can follow the trends of media in the past. And here one can observe the following path. The basic dynamics of a new medium are that when it is first introduced it tends to be relatively expensive, and in that period of high cost **(p.328)** it is mainly consumed by elite users individually or in small groups. Soon the medium leads to the creation of a system of mass shared usage, which lowers the cost for each individual user, defrays the high fixed cost over multiple users, and enables the creation of high-cost productions of content. Examples include theater plays, public concerts, and operas, all of which moved from high-priced individualized consumption to low-cost shared consumption through shared distribution technologies of large halls, film theaters, broadcast TV, and cable and satellite distribution. At this stage, consumption is by necessity synchronous, that is, hundreds or even millions of users share the content simultaneously. But this is not the end of the story. In time, content and distribution costs decline still further and eventually move to a range that is affordable for ordinary individuals (see Figure 20.5). Once this occurs, the medium starts to become individualized and asynchronous again.

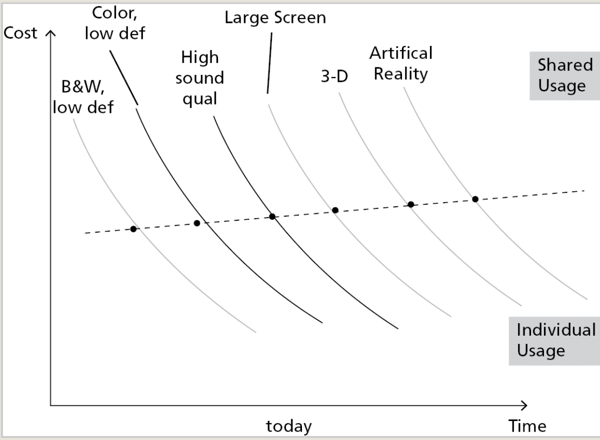


Figure 20.5 Trends of media prices and usage patterns (schematic)

Therefore, by looking at the present use of shared media, and assuming a certain rate of price decline per bit, we can predict the future of individualized media usage and its timing. It allows us to predict the next individual content type and medium by looking at existing shared communications styles.

The nature of a medium affects its content. When visual images could not be easily stored and transmitted, before film, the major medium was print. The print medium generated extraordinarily subtle works—novels, poems, all aimed at creating images in the imagination—using the compressed, bit-parsimonious technology of the written word. The human mind had to **(p.329)** supply much of the processing and imagination. Film changed this. It explicitly filled in the visual details. Early film was probably the most unsubtle form of mass media expression ever. The less expensive bits are, the more visual the medium becomes. The less expensive the visual aspects are, the more they dominate. A weaker capacity for visuals favors story line, character development, and dialog. With no sound, the early film medium relied primarily on action, painted in the broad strokes of slapstick comedy, simplistic plots, and uncomplicated characters. But still, the film medium could present visual tableaus that had not existed before and which quickly outperformed the visual capabilities of the acting stage. Thus, within the following ten years of the new medium, new genres appeared in film, and new forms of expression were pioneered. The genres of science fiction (*A Trip to the Moon*, 1902), Western adventure (*The Great Train Robbery*, 1903), and voyeur content (*The Gay Shoe Clerk*, 1905). Without sound, these were heavily visual and physical. The first feature-length film with sound and embedded dialog came in 1927 with *The Jazz Singer*, and this advance soon enabled more subtle films with dialogue, ideas, and wit.

Two decades later, with the emergence of television with its black-and-white, low-resolution visual content, theatrical film was prompted to upgrade its technology and content. Color and wide-screen Cinemascope became standard. Sound improved enormously. Higher-quality 70mm film was introduced, allowing filmmakers greater ability to include fast-moving action, fine detail, close-ups, and convincing special effects. In content terms, theatrical films included themes of sex and violence, and provided spectacles with huge supporting casts and special effects. These films dominated worldwide. In contrast, Europeans had much lower budgets for advanced visuals, and so they shot black-and-white films with a greater portion of dialogue and character development, and much less in the way of action or special effects. Intellectually interesting, but not visually flashy, such films were more like books on screen.

In the 1980s, computer animation began to emerge. In time, stars' faces were superimposed on others' bodies, and computer-generated characters were on the verge of substituting for human actors.

The combination of computer animation (especially in video games) and 3-D displays will create a new entertainment approaching total sensory captivation. This new entertainment would allow for user participation and some user control. Imagine dazzling computer-generated special effects. Add virtual reality and game elements. Imagine the avatars and participation in virtual worlds. A total immersion becomes possible, in which viewers become participants, inserting themselves with undivided attention into the action, in the center or on the sidelines, *Zelig*-like. This is where new content creators will go.

(p.330) Implications for the Content Business

Now that we have a better idea of what ultra-broadband content will look like, the question is, who would supply it? To produce such content is expensive, and it will be scarce in its early phases. It requires creativity, many programmers, visual artists, special effects experience, performance testing, and constantly improved versions. This type of content exhibits strong economies of scale on the production side and network externalities on the demand side. Providers positioned to take best advantage of these factors are characterized by large budgets; ability to diversify risk and distribute over multiple platforms; strong branding; access to large audiences; and an ability to coordinate specialized inputs. Premium content then will be supplied by large and complex providers. Long-tail content, on the other hand, can be readily produced by just about anyone with a broadband connection. This means that there will rarely be sustained profit in it. There will be room for experimental developers for such content, and should it prove successful these suppliers will likely be acquired by the larger players. Other content is likely to be developed through interactive communities of individual non-commercial developers, or through a multiplicity of small specialist commercial firms coordinated by large integrators.

Hollywood studios already spend heavily on premium content. For *Terminator 3* (2003), $20 million was spent on computer-generated special effects alone. In the same year, the *Attack of the Clones* listed 572 technicians (Epstein 2005). Premium ultrabroadband content is likely to be still more expensive. Is there really a demand to justify it? The answer would appear to be yes, given the ever-rising levels of stimulation that media consumers seem to require. In terms of global demand, if 100 million households use such content for two hours per week at $5, the annual revenue generated is $52 billion, with maybe half going to distribution and to content production respectively.

The globalization of media will also be affected. Contributing elements are 1) the price of international transmission is dropping rapidly, 2) Internet penetrations are increasing rapidly, and 3) ultrabroadband content has economies of scale. US firms are likely to play a major role in such content. They are early entrants, with large domestic audiences, leading software and hardware suppliers, access to risk capital, global talent, and established distribution channels.

Conclusions

To summarize, we find that:

1. Individualizations of content style—of space and time, of consumption mode, or of source—do not require ultra-broadband on the user level. **(p. 331)** Storage and transmission are substitutes for one another. In fact, as storage becomes less expensive, it requires less transmission than in the past. For regular quality TV, to enable more content diversity, the proper approach would be to store more programs and make access and download possible. Synchronous channels make sense only for large audiences or live-critical content—such as sports events.
2. The price people have been willing to pay for media entertainment per time unit has been fairly steady over a century, adjusted for inflation, at about 4.4 cents per minute.

3. The price of distribution of content has been dropping at a compound rate of 8 percent.
4. The bit quantity of media content has risen at a steady clip, at the rate of about 5.5 to 8 percent per year.
5. This enrichment of media content leads to genres and styles that are individualized, immersive, and often interactive.
6. For the first time, entertainment at home will be technically superior to that in a shared communal environment.
7. It is only a matter of time, given the trends of steady enrichment of media content in terms of signals, until media content will be richer in sensory terms than real life.

Thus, should technology continue to influence content as it has, we can look forward to ultra-broadband content that is highly individualized, customizable, and of unprecedented sensory richness. Ultra-broadband pipes will require appropriate ultra-content in order to be economically viable. Yet to realize these new content forms and genres will take time and creativity, trial and error. The implication for the infrastructure providers is that to fill their pipes with users, they must help to develop ultra-broadband content. If they do not support new content creation, or if they restrict access, they will find that they have created a theater with nobody ready to perform. This interaction of new generation infrastructure networks with new generation content leaves much room for entrepreneurship, innovation, and originality. And it provides the analysts of media with important new topics of study on the nature of culture, entertainment, and news in the next electronic environment.

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Notes:

(1) An earlier version of this article appeared as Noam, E. (2008). “If Fiber is the Medium, What is the Message? Next-Generation Content for Next Generation Networks, ” *Communication & Strategies*, special volume: 19–34.

(2) Here and subsequently, the estimated OLS regressions are lnY = a +blnt + u, where t is time.

(3) We identified the historical prices for different mediums per media unit (e.g. price for one book, record, DVD, etc.), or per monthly subscription rates, plus cost of time if the medium incorporates advertising. Historical prices are adjusted for inflation to 2008 dollar equivalents. We divide by the time spent with each medium or media product. We arrange the media by their time of appearance as a consumption item.

(4) The distribution cost per media product is divided by the Mbit per unit of each media.

(5) The cost per second (see Figure 20.1) is divided by the Mbit/sec transmission rate.

(6) Rates of data transmission for telephone, dial-up Internet, DSL, Broadband, etc. from http://en.wikipedia.org/wiki/Bitrate (accessed 7 April, 2013). For

traditional media, bandwidth is calculated by the number of bit equivalents of the information per second.