# Market Structure for Ultrabroadband

**Robert C. ATKINSON** (*)
Columbia Institute for Tele-Information (CITI), New York, USA

***Abstract:*** Investors, operators, policymakers and other stakeholders need to contemplate the likely market structure for ultrabroadband (UBB) in various markets so that they can make effective investment, operational and policy decisions. There will not be a single, universal UBB market structure. Rather, market structures ranging from competition to duopoly and monopoly, including heavily subsidized systems, will be primarily a function of the number of UBB infrastructures that a particular market can sustain. The specific circumstances of each geographic market will therefore largely determine how many UBBs are sustainable and as the circumstances of each market change, market structures will also change. Because of fundamental economic factors such as economies of scale and first mover advantages, the likelihood is that UBB markets will become more concentrated (and not more competitive) than they are today. One of the most important predictors of future UBB market structure will be today's market structure for broadband services: since UBB will generally evolve from existing broadband infrastructures, the broadband past is likely to be the UBB prologue.

***Key words:*** market structure, monopoly, duopoly, competition, infrastructure

## ■ Ultrabroadband (UBB)

Since the dawning of the "broadband era" in the 1990s with the commercial availability of internet services, there has been one constant: the need for ever-increasing speed by customers as new and more demanding devices and applications were adopted by thousands and then millions of customers.

Thus, dial-up internet access at 14.4 and 28.8 kilobits per second (kbps) gave way to 56 and 64 kbps as personal computers equipped with increasingly faster modems proliferated. By the turn of the century, "narrowband" dial-up access had given way to "broadband" access provided over telephone companies' digital subscriber loop (DSL) services and cable

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television companies' cable modem services. These first broadband services generally provided speeds of less than one megabit per second (mbps) that were, nevertheless, an order of magnitude higher than the dial-up narrowband services. These initial broadband services were also asymmetrical, providing significantly higher "download" speeds than "upload" capacity in recognition of the fact that customers were generally consumers of information, primarily downloading increasingly voluminous and complex materials from the worldwide web. These early broadband systems were also relatively low cost, low risk incremental adaptations of existing copper-based telephone and cable television systems.

Current broadband speeds are at least an order of magnitude higher than the first broadband services, with speeds in the range of 5-10 mbps quite common and speeds as high as 100 mbps being offered in some areas. Current broadband access services are becoming more symmetrical, with the upload speeds approaching those of the download speeds in recognition that customers are also becoming information providers, operating web servers and generating significant volumes of information, such as videos. These faster speeds have been achieved in part by substituting fiber optics for some or all of the copper-based systems.

Ultrabroadband (UBB) will provide customers with extraordinarily high speeds: the working definition of UBB is 10 times the top current speed of 100 mbps, or one gigabit per second (1gbps).

The "backbone" of the current internet operates at speeds many times higher than 1 gbps so the immediate challenge posed by the prospect of UBB is not to the core of the network but rather to the "access" links that connect the terminal devices to the core network. Deeper fiber optic penetration and elimination of all but perhaps the very shortest copper-based links will characterize UBB systems. Thus, fiber-to-the home (FTTH) or fiber-to-the curb (FTTC) or possibly to the neighborhood (FTTN) is likely to be the predominant infrastructure architecture for UBB access and, based on experience with current FTTH deployments, UBB access will require extraordinary amounts of capital investment over a number of years. [1]

UBB will obviously support all existing broadband applications. But will UBB speeds (i.e., transmission rates) really be needed? Will the huge

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[1] See, for example, *"UltraBroadband Investment Models"* by Prof. Raul KATZ published elsewhere in this volume of *COMMUNICATIONS & STRATEGIES*.

investment be worth it? One way to answer is to look back at each stage of the development of computers and the internet and think of UBB as just the next turn of the virtuous cycle of new capabilities leading to new applications which justify new capabilities that encourage new applications, and so on. UBB will certainly allow the development of bandwidth-hungry video-based applications (NOAM, 2006). For example, huge two-way three-dimensional high-definition (3D-HD) "televisions" could be used for tele-work, tele-education and tele-medicine in addition to personalized entertainment and gaming. With a number of such displays in millions of homes - perhaps with the costs of the equipment and UBB service subsidized by employers, school systems and health care providers because of the cost-savings they would enjoy - each home would require UBB-level speeds with long connection times, perhaps "always on" 24 hours per day usage.

UBB access services may create a new type of bottleneck, the reverse of the common situation where the access link is the traffic bottleneck and the core backbone network has enough capacity: will the core have enough bandwidth to handle a veritable tidal wave of volume, once thousands and then millions of consumers establish always-on two-way connections at UBB speeds?

## ■ UBB market structure

It is not too early for investors, policy-makers, service providers and customers to be considering the sort of market structures that are likely to result from the evolution of telecommunications networks to widespread ultrabroadband capability. By considering the possible market structures and their respective benefits and problems sooner rather than later, these critical stakeholders might make more optimal investment, policy, operational and consumption decisions, leading to faster, less costly and more effective deployment of UBB. Stated differently, the risk of UBB can be reduced at least to some extent by early consideration and resolution of market structure issues and any reduction of the risk can pay substantial dividends in terms of lower financial costs, an earlier, more robust deployment of UBB and the beneficial impact on UBB-induced economic and social activity.

So, the broad question is: *Should We Expect Multiple, Competitive UBB Access Infrastructures… or Regulated Monopoly Utilities? or Something Else?*

And the short answer to this question is: *all of the above!*

The longer answer is that we should expect and be prepared for a wide variety of market structures that will reflect the wide variety of circumstances in each UBB market. It is unlikely that there will be one market structure that is optimal in every UBB access market and, instead, there will inevitably be a range of market structures that flow from the wide range of market circumstances. Broadly, at one end of this range will be a few markets that are large enough and dense enough to support several competing UBB access infrastructures. At the other end of the range will be markets that cannot support any UBB access infrastructure at all, at least without some sort of direct or indirect subsidy. As discussed in this paper, most markets will fall between the extremes of many and zero, with one or two ubiquitous UBB access infrastructures the most common number of systems, at least in North America.

UBB access systems will not be deployed on a clean slate in markets where broadband infrastructure exists today. Rather, just as current low capacity broadband infrastructures evolved from the traditional fixed telephone, cable TV and mobile telephone services, "ultra" broadband will generally evolve from today's broadband. Thus, current broadband's past is likely to be UBB's prologue.

The "boom and bust" of the telecom and dot.com industries at the beginning of the 21st century are a significant part of the past upon which UBB will be built. CITI's annual evaluation of the "State of Telecom" has concluded that the "boom-bust" cyclicality is likely to repeat in the future. [2] There will be new booms as new technologies and applications create business opportunities that attract investors and new service providers. But the booms will become a bust in many markets because equilibrium for telecom networks (particularly for access networks) is not generally infrastructure competition but infrastructure oligopoly or even monopoly. This is because infrastructure operators must eventually cover their fixed costs and, in markets where there are numerous competing infrastructures,

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[2] "Fundamental instability: Why telecom is becoming a cyclical and oligopolistic industry", Eli M. NOAM, *Information Economics and Policy*, Volume 18, Issue 3, September 2006, at 272-284.

operators will have to do one of two things: collude to maintain prices (and risk catastrophic anti-trust enforcement by governments) or engage in fierce price competition until the number of infrastructure operators is rationalized to suit the circumstances of each market. (Once costs are sunk, competition will drive prices toward the very low incremental costs and below average costs.)

This is not a preference or policy recommendation, but a forecast based on business fundamentals of high up-front costs, commoditization of services and competition driving prices to marginal costs.

Another way to consider how UBB market structures may evolve is to consider the historic evolution of market structures for other critical or networked infrastructures, such as water, electricity, telephone, air transport or railways. The market structures associated with these industries have, broadly, included unregulated private monopolies, regulated private monopolies, unregulated competition, government ownership and operation, public-private partnerships, and various degrees of "regulated competition." However, the more usual market structures in most countries have been toward the last items on the list because fundamental economics (high capital intensity, scale economies, commoditization, price competition) lead to consolidation and public policy abhors unregulated private "utilities," particularly if the utility is a monopoly.

Ultrabroadband presents even greater competitive and policy challenges simply because it is likely to be substantially more expensive to deploy than current broadband systems. DSL and cable modem services are essentially incremental cost add-ons to previously deployed telephone and cable TV systems. By contrast, UBB will generally require a fiber-to-the-home or at least fiber-to-the-neighborhood deployment, which is effectively an over-build of existing copper or coaxial cable plant and only justified economically by the advanced and yet-to-be-developed services (such as two-way, three dimensional high definition television) that cannot be provided over the existing telephone or cable TV plant.

## ■ How many UBB infrastructures are sustainable?

The critical determinant of the market structure of UBB will be the number of UBB access infrastructures that can be sustained economically within a relevant geographic market. If the market can sustain multiple (more than

two) UBBs, the market structure will be one of competition. Of course, if the market can sustain only one system, the market structure (by definition) will be a monopoly. If the market can sustain two UBBs, the market will be a duopoly, which may or may not be competitive, depending largely on the business decisions and tactics of the two market participants. And if the market cannot sustain even one UBB access infrastructure, the market structure will be unserved or with one heavily subsidized provider.

And subsidies may not even be enough of an incentive to induce private companies to deploy ultrabroadband in some very unfavorable (i.e., barely inhabited) geographic markets. In such areas, government *may* be the UBB builder, even operator, as a last resort

After an era where governments around the world attempted to create competitive telephone markets and in many cases failed, this history raises some fundamental questions: should government try to create an environment that can economically sustain multiple, competitive UBB access networks? (And if so, what lessons learned from attempts to foster telephone competition are relevant and what should be done differently?) Or, should governments accept the notion that a non-competitive UBB market is either inevitable or even desirable and develop policies for such a market structure? Because the competitive circumstances of each geographic market are likely to be different, many governments will have to deal with both situations: competition in some markets, monopoly in others and a great deal of unpredictability in the rest.

## ■ Is there a business case for multiple UBB access infrastructures?

Other authors in this journal provide analyses regarding the business case for UBB. [3] It seems clear from these contributions that the economic viability of the UBB business case will be highly dependent on the *changing*, *specific circumstances* of each market.

For UBB access infrastructure, the revenue side of the business case will be sensitive to local factors, such as:

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[3] See KATZ, note 1, *supra*, and other papers in this volume of *COMMUNICATIONS & STRATEGIES*.

- How large is the overall revenue opportunity in the local market, over time?
- What portion of the total UBB revenue opportunity will be retained by the access infrastructure operator and how much will flow through to upstream UBB network operators and to unaffiliated applications providers?
- How many UBB access competitors will there be in the local market area and what portion of the available access infrastructure revenue will each competitor capture?

The cost side of the UBB access business case will be equally sensitive to the local circumstances of each market. For example:

- User density and market topography will largely determine the economically optimal technology to serve the market.
- The availability and cost of rights-of-way for cable-based infrastructure and the availability and cost of antennae sites for wireless systems are major cost components.
- Is UBB a low-cost incremental upgrade to an existing broadband infrastructure or an expensive "greenfield" or over-build deployment?

To illustrate how specific historic, market and technology circumstances shape the deployment business case for today's advanced broadband (essentially the precursor of UBB), consider the following statement by Tom Gerke, the CEO of Embarq, an American rural telephone company that resells satellite television service:

> "We haven't seen a business case that justifies some of the investments that Verizon and AT&T have made because of the geography and our particular markets," he said. "We're offering 10-Meg service, and we continue to make sure we have the bandwidth that is necessary for HSI [high-speed internet]. We also see a lot of non-linear entertainment coming in the future. We have our new portal we migrated to that includes our video store with 5000 movies, 5000 music videos and 1000 television episodes that our customers can pull down over the 10-Meg pipe. There is a newer generation of customers that wants to see something when they want to see it." [4]

[4] "New CEO Gerke vows to build on Embarq's innovations," *Telephony Online*, Mar 3, 2008, http://telephonyonline.com/independent/news/embarq-gerke-ceo-0303/

## ■ The broadband past may be ultrabroadband prologue

In many if not most markets, UBB will be the evolutionary successor to the current broadband infrastructure. Therefore, the current market structure is likely to be a major and perhaps decisive factor in the structure of UBB in each market.

In those markets currently served by a broadband infrastructure, most have either one or two ubiquitous wired infrastructures (telephone-based only or telephone and cable TV- based) and a number of less ubiquitous (niche) wired systems (such as CLECs') and wireless broadband networks. [5] Markets with one ubiquitous wired infrastructure and various wireless and niche networks can be thought of as having "1.5" broadband infrastructures while markets with two ubiquitous wired networks plus the niche and wireless systems can be classified as "2.5" markets. [6]

1.5 markets typically have less competition, which means the likelihood of greater profits or less risk, so that broadband investments in such markets are easier to finance. But less competition generally means less dynamism and less innovation that, in turn, invites more regulation by government, particularly with respect to "open access" or "network neutrality" issues.

By contrast, 2.5 markets have more infrastructure competition, which results in greater volatility, more innovation, lower consumer prices and significantly higher investor risk. The greater risk has the potential for encouraging the two wired infrastructure operators to engage in oligopolistic or even collusive behavior to share the market opportunity rather than compete for it. Governments, in such instances, normally try to detect and prohibit such collusive, anti-competition behavior.

In markets that prove to have insufficient infrastructure profits to sustain 2.5 infrastructures, both of the ubiquitous network operators will need additional revenues (and profits) or one is likely to fail, resulting in a 1.5 market. Government can provide the additional revenue needed to sustain

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5 It should be noted that "wireless" broadband services are generally "wireless" for only the last link to the user.

6 For further discussion of 1.5 versus 2.5 infrastructures, see: "Interview with Prof. Eli NOAM," *COMMUNICATIONS & STRATEGIES*, no. 60, 4th quarter 2005 at 150. http://www.idate.fr/fic/revue_telech/135/CS60%20Interview%20NOAM.pdf;
"Broadbandwagons at the Crossroad" by Eli NOAM, FT (*Financial Times*) Online, March 6, 2006, http://www.ft.com/cms/s/2/d8b9c834-ad2d-11da-9643-0000779e2340.html

2.5 infrastructures directly, through subsidy programs, or indirectly, by permitting the infrastructure operators to earn additional revenues by, for example, offering content services. Of course, the latter approach then raises network neutrality concerns and the dilemma of whether government should require neutrality and risk crippling essential infrastructures or allow non-neutral behavior and risk crippling diversity of content.

With respect to wireless UBB, it is generally assumed at the present that wireless technologies will not be capable of providing UBB speeds ubiquitously in most markets. Thus, it is likely that wireless will continue to be part of the 0.5 that tend to be adjuncts to and not competitors of ubiquitous fiber optic-based infrastructures. [7] With that assumption in mind, current fiber-rich infrastructures being utilized or deployed today (fiber to the neighborhood or better) for current broadband services provide the broadband operators with a substantial lower risk head start-business case advantage over future UBB start-ups. These advantages include:

- economies of scale and incremental cost upgrades to establish UBB versus the start-up's "greenfield" costs (unless the new entrant can utilize a yet-to-be developed new technology - probably wireless based - which has substantial cost advantages over the incumbent's incremental costs at lower volumes);
- a substantial existing, installed customer base and revenue stream that can be migrated to UBB service versus the start-up's substantial customer acquisition costs and time required by a new entrant to establish a critical mass of customers and revenue; and,
- the resulting strong cash flow and net income that reduces financing costs and risk versus a start-up's riskier business case and more expensive financing.

This is not to say that start-up UBB access operators will not have their own competitive advantages, such as:

- using a single, up-to-date and probably low cost technology versus the broadband incumbent's complex combination of technologies from various eras;
- a new, up-to-date labor force scaled to its operations;

[7] WiMAX, for example, is currently expected to provide a 40 mbps per channel shared among a number of users, with each user generally getting 1-5 mbps. The next generation of WiMAX is expected to have 300 mbps, again shared among numerous users, and even though each user would get proportionately higher speeds none would get UBB speeds. See, WiMAX Forum, Frequently Asked Questions, at http://www.wimaxforum.org/technology/faq/

- being more nimble than the broadband incumbent in responding to opportunities and market requirements;
- being aggressive and innovative since they have no customers or revenue streams protect; and,
- fewer government-imposed service obligations and regulatory constraints.

The competitive advantages and disadvantages of broadband incumbents and new entrants are similar to those of the incumbent local telephone companies and the new entrant Competitive Local Exchange Carriers (CLECs) in the 1990s. The lesson learned from that earlier competitive era is that the systemic and scale advantages enjoyed by incumbents often (but not always) eventually outweigh the benefits of being a new entrant, particularly one attempting to compete as a ubiquitous service provider rather than as a "niche" service provider. [8] Thus, the CLECs that have survived and even prospered are generally those which focused on "niche" markets, such as serving targeted sectors of the business community in concentrated geographic areas [9], while those who attempted to compete broadly with the incumbents have almost universally failed.

This lesson implies that it will be equally difficult for new entrants to challenge broadband incumbents in establishing a greenfields, ubiquitous UBB access infrastructure. [10] And this, in turn, means that markets that currently have 1.5 fiber-rich broadband infrastructures are very likely to have 1.5 UBB infrastructures. Similarly, markets that currently have 2.5 fiber-rich broadband infrastructures *may* become 2.5 UBB markets.

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[8] Cellular telephone has become a very effective competitor to wireline telephone service because cellular was able to mature and achieve economies of scale as a premium, mobile service that did not initially compete with landline telephone service.

[9] See, for example, FiberNet Telecom Group, http://www.ftgx.com, and Time Warner Telecommunications, http://www.twtelecom.com/, in the United States or COLT Telecom Group, http://www.colt.net/UK-en/index.htm, in Europe.

[10] Because wired broadband service does not compete with a wireless service if the consumer requires mobility, wireless broadband services are likely to mature and achieve economies of scale. But it is unlikely that highest speed wireless broadband will be competitive as an "always on" 1 gbps UBB service.

However, it is unlikely that a 1.5 will become a 2.5 [11] or that a 2.5 will become a 3.0 or 3.5. [12]

There will also be a reasonable likelihood that some 2.5 broadband markets could become 1.5 UBB markets if one ubiquitous broadband operator is unable to make the transition to UBB or if the market is not able to sustain 2.5 UBB access operators. Also, in markets that cannot support even one broadband infrastructure today without subsidies, it is likely that such markets will not support more than one subsidized UBB access infrastructure in the future.

## ■ When does government intervene in market structure?

The preceding discussion implies that there will be a substantial governmental role in UBB in two areas. First, with respect to UBB access deployment, government can take steps that will encourage a quicker and broader initial deployment of UBBs in most markets. Second, for the same reasons that governments have generally regulated telephone and broadband access (i.e., lack of competition and the essential nature of the service), governments might decide to regulate some aspects of how UBB access services are offered. However, these two government roles might be contradictory: for example, the prospect of usage regulation may discourage UBB deployment but the prospect of an unregulated monopoly with respect to an essential infrastructure is probably unacceptable to most governments. Reconciling contradictory roles will be a challenge for every government and it is likely that different governments will choose to emphasize different roles and perhaps change the emphasis over time.

As Canadian scholars advised the Canadian government with respect to broadband deployment:

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[11] It will be difficult to establish a UBB infrastructure based on cable television in countries that do not have robust cable TV systems today since so much of the market opportunity for video services has been captured by direct broadcast satellite (DBS) and the DBS operators have the economies of scale and the other advantages of incumbents in the video business.

[12] It is possible that a UBB operator that is successful in one geographic market could enter adjacent geographic markets as a competitor and transfer the economies it enjoyed in the original market to the adjacent market. The result could be 2.5 UBB infrastructures where there had been 1.5, or 3.5 where there had been 2.5. The question is how many UBB infrastructures are sustainable in the adjacent markets: will the 3.5 revert, over time, to 2.5 or the 2.5 to 1.5?

> "In the case of broadband deployment, if a project does not generate investment because it does not represent a sound financial business case to a carrier, government intervention can be justified if the expenditures are outweighed by the broader socio-economic benefits." [13]

The Canadian report [14] suggested that governments are likely to have three broad roles with respect to initial broadband (and presumably UBB) deployment:

- Little or no involvement in communities that can be, or are, served by market forces. These will generally be the largest and densest urban markets where costs are relatively low due to the density and the large number of businesses and consumers generate enough revenue to make at least one UBB self-sustaining.
- Improving the business case so that at least one UBB can become self-sustaining.
- Permanent support in communities where UBB cannot become self-sustaining and will require financial support.

The most difficult and delicate involvement by government will be with respect to the second case: improving the UBB business case - and thereby encouraging multiple UBBs in some markets and at least one in others - by addressing both the revenue and the cost sides of the business case. Delicacy will be required because government, investors and operators will want to avoid the mistakes made when many governments encouraged "too much" local telephone competition, with one result being too many so-called Competitive Local Exchange Carriers (CLECs) in many markets. The result was a CLEC boom, a bust and greater entrenchment of the traditional telephone monopoly…exactly opposite from the intended result.

There are two types of UBB market failure that some governments will have to deal with. The first case is where no private company will deploy a UBB access infrastructure in a particular market because the private business case does not work despite government efforts to increase a prospective operator's revenues and reduce its' costs. In such cases, government has usually done one of two things with respect to a critical

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13 Readiness Framework and Sustainability Model for Broadband, Carleton University and Strategic Networks Group for Industry Canada and Government of Ontario, March 2005; see, http://broadband.gc.ca/pub/program/case_studies/carleton/carleton_en.pdf

14 *Ibid.*

infrastructure: either subsidize a private company's deployment and operation or build and operate the infrastructure directly.

The other market failure will occur where one or more UBB infrastructures are deployed but they are not economically sustainable. If there is only one UBB in a market and it is failing, does government subsidize it or allow it to fail and have its assets acquired at a fraction of their costs by another company? Where there are two or more UBBs and all are failing, does government allow them to merge and consolidate? Or does government allow the weakest UBB operator to fail? A failure could lead to a consolidation or a serial bankruptcy where the failed UBB operator's assets are purchased out of bankruptcy, creating a low cost supplier that bankrupts the previously "healthy" operator. In all of these scenarios, will the failing company provide adequate service and will other social and policy goals be served?

Recently, perhaps in recognition of the difficult business case for UBB, a number of policy-makers have been considering whether they should be promoting "infrastructure sharing" to encourage broadband deployment with a degree of retail service competition while minimizing the risk of market failures. Like consolidation, infrastructure sharing allows operators to capture some economies of scale, which might make the operators more economically viable. As a briefing paper prepared for a recent ITU meeting observed:

> "The single biggest reason to adopt sharing is to lower the cost of deploying broadband networks to achieve widespread and affordable access… For developed countries, infrastructure sharing promises to play an important role in the move to FTTx access…" [15]

The telephone industry in the United States and a few other countries was initially very competitive in the late 19th and early 20th centuries but the number of competitors was unsustainable and the industry consolidated into local monopolies. In other countries, the government simply extended the postal monopoly into telephone services. Monopoly telephone "utilities" were the universal result. Will history be repeated in the broadband-UBB era?

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[15] "What Do We Mean by 6 Degrees of Sharing?", discussion Paper for the 8th ITU Global Symposium for Regulators (GSR08), Feb. 2008 at 3.
http://www.itu.int/ITU-D/treg/Events/Seminars/GSR/GSR08/discussion_papers/Overview_Final_web.pdf

If multiple UBBs are not economically sustainable, infrastructure sharing or consolidation may well produce a UBB access utility in the same way that telephone utilities were formed over 100 years ago. A monopoly infrastructure would allow the UBB access operator to capture economies of scale and reduce investor risk, potentially leading to lower prices and more widely available UBB services, sooner. But, because of the monopoly nature of such a utility and the role that government played in its formation, it is likely that government will require the UBB utility to share the scale economies costs with consumers just as telephone utilities were required to do. This could be accomplished by traditional rate regulation or through other mechanisms such as structural separation where, for example, the access monopoly does not have retail customers but only provides access connections to UBB service providers. With structural separation, a UBB utility would minimize access infrastructure competition without sacrificing retail application/service competition if the market power of the access monopoly is separated from content or other competitive adjacent markets. [16]

Finally, if all else fails, what will government do to ensure the availability of UBB in the markets that will not sustain a private UBB? In markets with broadband service, the simplest action would be for government to subsidize incumbent broadband operator(s) to upgrade to UBB capability. But in those markets without broadband service, it may be quicker and less expensive for government to build (probably through contracted construction) and even operate (perhaps through a contractor) the ubiquitous UBB access network in the same way that governments built the first telephone systems in many countries. Presumably, competition for government construction contracts will result in lower initial costs and then government could then auction the UBB access infrastructure to the highest bidding (qualified) operator. Since the UBB infrastructure would be a monopoly, the auction could require the operator to be a wholesale utility that only supplies capacity to retail service providers. Any loss incurred by the government in the auction would be a one-time infrastructure subsidy (like building a highway and road system).

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[16] A current model for this sort of arrangement would be the "Openreach" approach adopted in the United Kingdom in which BT's access infrastructure has been functionally separated from its competitive services, with the access operator obligated to treat all competitors equally. http://www.openreach.co.uk/orpg/home/home.do

## ■ Some conclusions

First, initial UBB access market structures are likely to be similar to current broadband market structures: where there are multiple ubiquitous broadband infrastructures ("2.5" or more), there will probably be multiple UBB infrastructures; where there is one ubiquitous broadband infrastructure ("1.5" or less), there will be one UBB infrastructure; and where there is no broadband, there will be no UBB without substantial government subsidy.

Second, UBB market structures will evolve over time (probably decades) in response to changes in business, technology and market conditions as well as changes in public policy. In the absence of a new technology that makes today's fiber optics obsolete, the tendency will be for fewer UBB access infrastructures and therefore less competition and more regulation. In marginal markets, a public utility model may be attractive.

Third, there is no single market structure that will be optimal in every market, for all time. Circumstances, including technology, public policy and consumer demands, will change, sometimes dramatically and rapidly. Therefore, operators, investors and governments will need to be adept at adapting to changing circumstances.

Four, because of political and social considerations, governments will intervene in UBB. Whether and how UBB infrastructure operators are permitted to provide content services and how they treat unaffiliated content providers (questions that affect how much of the value chain can be retained by infrastructure operators) will be an area of constant concern to all stakeholders. It is also likely that government will intervene in some fashion where the UBB access market is not clearly competitive because public policy will not tolerate unfettered monopoly, a lazy and non-competitive duopoly or "second class" UBB infrastructures.

Overall, the development path of UBB at the beginning of the 21$^{st}$ century may be remarkably similar to the development path taken by telephone service at the beginning of the 20$^{th}$ century because the fundamental economics and public policy factors are remarkably similar.