# Vision of Personal Broadband

a white paper prepared by the Broadband Working Group

MIT Communications Futures Program (CFP)

Cambridge University Communications Research Network

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- British Telecom
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## Executive Summary

This paper outlines the Broadband Working Group's consensus vision of what a personalized broadband experience should look like for users. Although broadband has already proven to be a popular service, examples from other technologies suggest that if broadband were to "go personal" it could deliver an additional boost of value to users and growth to businesses. Because broadband is not a standalone product, its personalization will require the use of common frameworks across complex industry value chains. The ultimate goal of this work is to develop those frameworks. The vision described in this paper represents the first step of that process: defining what functionality such frameworks will need to support for broadband to make the shift from "high technology" to "my technology."

The paper approaches personal broadband functionality from several angles: first by examining the inconsistencies users commonly experience today, and later by exploring a set of "use cases" describing the more consistent experience that truly personal broadband could offer users. Historically, constraints imposed by the user's location and differences among network providers, access devices, applications, and content have limited a user's ability to experience broadband as a consistent, personalized capability. For example, a user who relies on broadband provided by their employer at work, and a commercial provider at home, typically faces uncertain connectivity when on the road; even when physical connectivity exists, the user's existing provider relationships may not enable access. Alternatively, multiple forms of access may be available, but not visible as a choice to users. That choice can be important in some contexts: for example, a user might rather download a large e-mail attachment over a fast wired connection when available, rather than using a cellular network.

The use cases developed at the end of the paper illustrate scenarios where the decoupling of user location, network provision, access devices, applications or content leads to valuable new functionality for users and opportunities for the businesses that serve them. These range from opportunities to broker the "best" connectivity for a user's needs at any given time and place, to personalization of the broadband experience in situations, such as use of a desktop computer in a home or café, where a single access device or network connection is shared among multiple users.

## Context

The communication industry is going through fundamental change. This change can be attributed to the decoupling of service from its delivery channel and "consumption device" (end user devices designed to deliver and consume information). While this trend has been around for some time, recently it has gained additional momentum in liberalised economies as all information and communication are becoming digital, and access channels, consumption devices as well as entertainment and communication services are proliferating. These new inter-industry dynamics have led to a battle among previously separate markets and industries of media, computing, electronic device manufacturers, and telecommunications.

As different industries try to capture a share of the communication market they put in place mechanisms that allow connectivity to various services. Today "access everywhere" is becoming a reality in many areas of the world. This notion of universal access is led by a strong demand by an increasingly mobile and busy workforce and population with a strong desire to have access to their information, transactional, communication and entertainment services within their context but regardless of their access location. To date, this demand has been met by end users (either organizations or individuals) cobbling together a variety of providers who offer bits and pieces of this "universal access". As these different providers (for example, wired and wireless telephony operators) try to meet this demand, they develop different approaches and networks to offer similar services to the end users. As an example consider the near-future scenario depicted in Figure 1. In this case a number of channels are available to the consumer for his or her most commonly used services such as telephony or Internet access, and where the best solution depends on the particular context of the end user. These services can be provided over a variety

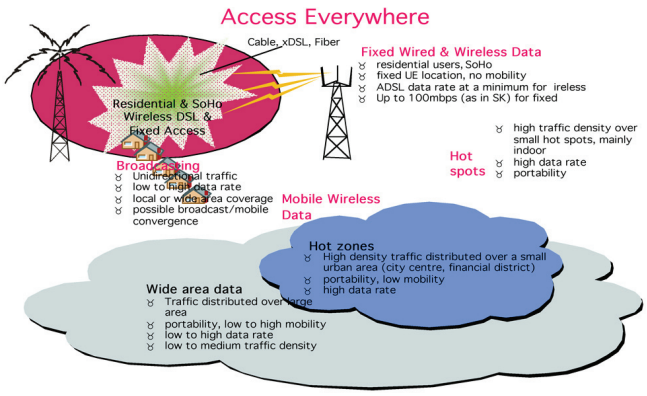


Figure 1: Consumer access options

of fixed channels (e.g., cable, xDSL, or Fiber) as well as a number of wireless channels (e.g., Wi-FiTM, UMTS, or WiMAXTM) with very different characteristics. The differences in characteristics arise from a number of differences in networks including but not limited to:

- Support for mobility
- Coverage (and ability to hand-over application sessions)
- Cost of deployment, upgrades and maintenance (and therefore, price for access)
- Bandwidth (guaranteed, average and peak)
- Quality of service – latency, guaranteed delivery, etc.

As an example of differences in characteristics consider that an xDSL channel does not support mobility, has point coverage, and it is very expensive to build (when including the price of laying cable), but is relatively inexpensive to maintain and upgrade with bandwidths ranging from a few hundred thousand bits per second to many million bits per second. xDSL also has Quality of Service (QoS) capabilities for Internet protocol (IP) traffic. In contrast, a GPRS channel supports mobility at speeds of up to 300 Km/hour, is moderately expensive to build (excluding the license cost), operate and upgrade, and has a maximum bandwidth of 128 Kbits/sec with guaranteed QoS for synchronous communication. Clearly, the characteristics between these two networks differ widely, yet in many cases they both can be used to provide the same service depending on the personal context of the user of that service. With the growth and proliferation of these and other similar networks, broadband access to services will become available in a ubiquitous manner in the near future.

It is the increased availability of connectivity choice, however, that raises the potential for "access everywhere" to become "personal", i.e., to become a form of access that is tailored to the needs of the end user depending on the user's context. This type of access is the motivation for defining "personal broadband".

> Personal Broadband (PBB) is defined as a set of capabilities and interfaces that allow users (or their agents) to select the connections that best meet their needs within a particular context.

The rationale for PBB success builds on the observation that many technology-based success stories owe their success, to some significant degree, to the fact that they were "personal".

The personal nature of these services was the key to their success and/or their adoption. The key question then is: Can broadband service become more successful by "going personal"?

Examples of past personal technology successes include mobile telephony, Instant Messaging, VHS (and DVD), Personal Music Players (starting with Sony's Walkman and evolving to Apple's iPodTM), Personal Digital Assistants, Laptop computers, web-based email access and storage and even search engines on the Internet. Each of these technologies enable services that either created new markets or quickly outperformed competition from existing markets and industries by moving away from 'high-technology' and toward 'my-technology'.

For example, globally mobile telephony in 2004 generated more revenue (and had more customers) than its much more established fixed-line counterpart despite its relatively large price differential. As another example consider that despite their typically lower performance and higher cost, in 2004 more laptop computers were sold than desktop machines. DVD (and VHS) sales now account for more than 66% of a movie's total intake. The success of personal music players (iPod accounting for more than 60% of Apple's revenue and profits in 2004) and search engine company Google (the most spectacular IPO in recent memory) provide significant additional insight to the power of personalisation. Similarly, cable and satellite television with expanded (and more personalized) channel availability is now a larger industry than public broadcast television. Other potential candidates for personalization success include program-on-demand (such as VOD) and personal video recorders (such as TiVo). These services customize the consumption of a well-known and already popular service to an individual and fuel the commercial success of those who provide them.

Considering past success and failure stories helps us to identify the common characteristics that define a personal service and help us to determine if broadband is indeed a good candidate for going personal. Successful personal services appear to share a number of common characteristics including:

- They are inherently useful
- They have conducive infrastructure (technology is ready and available for the mass market)
- There is availability of suitable content
- There is availability of suitable consumption devices and user interface, (they are useful and usable where and when you want them)
- They have economically viable business models

Let us consider, as an example, mobile telephony. When first introduced, mobile telephony allowed subscribers to call other subscribers (mobile or fixed) using a familiar consumption device model (the telephone) while they were on the move. This is an inherently useful service as it extends the consumption of a basic service (telecommunication) to a new context. Furthermore, a number of mobile operators (at least outside of the U.S.) were spun off from fixed-line operators who had a ready made and attractive business model to extend their networks to this new mode of consumption.

Assuming that we have correctly identified the characteristics of a successful personal service, and assuming that broadband will benefit from "going personal", we can now consider the vision of PBB in light of the above-mentioned characteristics.

## Personal Broadband Vision

We should point out that most if not all of the past success stories in personal services were application specific (in the case of mobile telephony it was voice followed by messaging). Broadband, on the other hand, is an infrastructure service; therefore, at first it is not clear how such a service can become personal, as it is not tied to any specific application or consumption device. We note that the definition of PBB provided earlier allows it to be independent of any particular access without precluding any service.

As defined, PBB enhances the personal nature of applications and services that are accessed through it, and by doing so PBB extends the virtuous cycle of broadband investment and adoption. Therefore, while the services accessed via PBB will have or utilize all five characteristics of personal services identified earlier, specific PBB access may only have some of them. Specifically, PBB must be based on a solid infrastructure (realizing the "access everywhere" goal) with an appropriate business model (PBB access providers must be financially successful to provide on-going services) offering an inherently useful service (e.g. "best access" to remote information). These characteristics allow PBB to offer a suitable infrastructure capable of supporting a wide variety of services including:

- Personal Services: User selected (subscribed or ad hoc) services usable by an individual user. The list of personal services is kept by the "network" and maybe managed and altered by the user, or the network.

- Group or Team Services: Services aimed for usage by a defined group such as secretary functionality. An administrator creates a team. He or she also manages the group membership (addition, deletion, and alteration of group members and their access rights) and configures the service.
- Enterprise Services: Services aimed at enterprise customers with higher security and trust models than those for groups.
- Network Services: Traditional (i.e., PSTN-like) services defined by the network as well as new services such as those enabled by IP Multimedia Subsystem (IMS).
- Vertical Services: Specific services targeted at particular segments or applications (such as on-demand-video or commercial inventory and ordering applications). Such services may also utilize dedicated networks and consumption devices.

Figure 2 illustrates the key ingredients of the PBB vision. In this figure a communication service is decomposed into consumption, services & applications, and channel ingredients. Since one goal of PBB is to provide "best access" to a range of applications running on a range of devices and accessed through a number of networks, flexible access for PBB is of core importance. PBB must be open to, and in fact encourage and support, diversity in each of these areas. The implementation of PBB requires a number of key functionalities to support any user on any device accessing any application via any access method or network (assuming suitability of context and appropriate authentication, authorization and accounting). Therefore, the PBB vision includes the set of functionalities, which allow a user of communication services to access those services in an optimal manner via any network on any device.

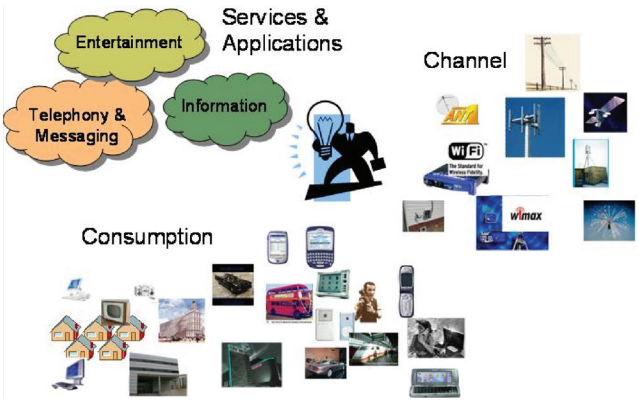


Figure 2: Key ingredients of the PBB vision

The illustration of PBB ingredients, as depicted in Figure 2, allows various access technologies, applications, and devices to be integrated within a common framework. This implies a framework to solve problems of interoperability among diverse technologies; however, the vision is incomplete unless it puts users (possibly via their agents) at the center and allows them their choice of connectivity. The choice must be explicitly supported by PBB and embedded within its architecture. The functions required for this explicit support and an appropriate architecture will be addressed in the next phase of PBB.

The inclusion of choice, as depicted in Figure 3, emphasizes the range and importance in the vision of personal broadband and its usefulness and value across multiple user contexts throughout their day.

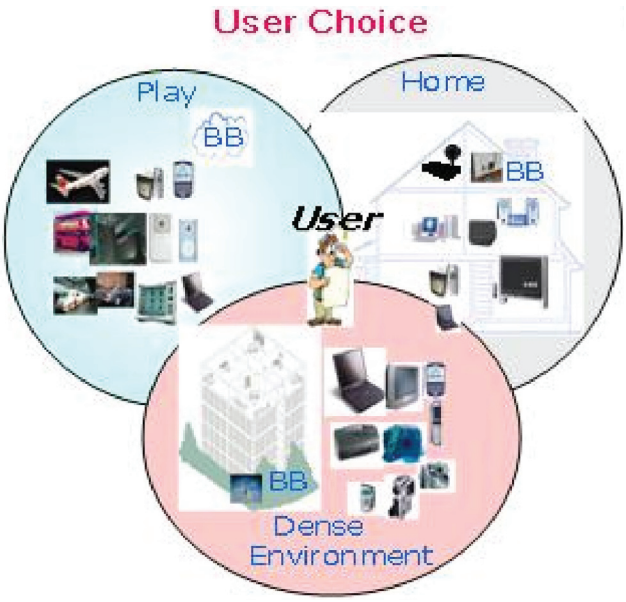


Figure 3: The value of user choice

Fulfilling the vision of PBB depends largely on personal applications that use this infrastructure and how they are used by the end users. These users go through a process that leads the applications and the infrastructure that supports them to first be adopted, then adapted to, and finally absorbed into their daily lives. This process defines a progression signalling when broadband has been personalised. There are, however, a number of technology and business barriers to overcome before this process can happen. Some of the dimensions and trade-offs of these barriers are indicated in Figure 4, but their detailed definitions and approaches to overcoming them are the topic of a future paper.

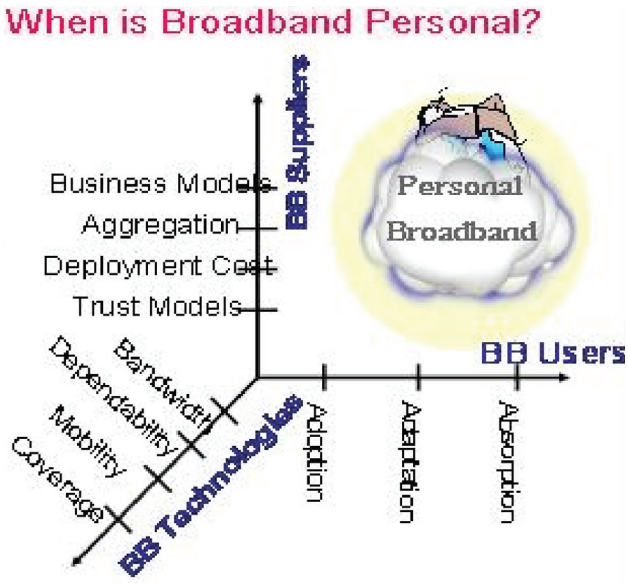


Figure 4: Barriers to PBB adoption

## Sample Use Cases and New Possibilities

Ultimately, the PBB Vision translated to daily life is where we will find value for users and new opportunities for providers of services. Here are a few scenarios illustrating what PBB might grow up to be:

*Being best connected* — A sales representative is travelling to a client meeting and realizes that he has forgotten to bring a copy of his presentation with him. Using his multimodal advanced cellular device he select the "best" connectivity method from the available connection options. Since he needs to download a large document containing confidential material, he selects a secure network with sufficient bandwidth. Since his company pays for the connectivity, the cost of that connectivity is not as important in his selection as performance. The sales representative is able to quickly download his presentation because his access device can choose the network provider that best meets his need.

*Find me a printer* — A mobile user is visiting at a corporate office and wants to print a document. She needs to find a local printer and be granted access. However, her selection of the printer cannot be based on network identity, typically the user's home office location. PBB allows the user to locate a local resource with the desired attributes nearest her current location. By decoupling her device from a logical network identity, location, and a network provider, PBB allows the user to discover any networked device within her proximity.

*On the road with 'my' music or video library* — With the advent of personal entertainment devices such as Apple's iPod or Sony's PSP, users can increasingly take their music, games, and videos with them. Although the portability of these electronic libraries has increased, a user's content can easily exceed local storage limits and updates by trusted third parties can be delayed or restricted by available connectivity. PBB eliminates this dependency between a user's content and their access location. For example, roaming users can get "outside-in" access to their complete libraries of music, games, and videos, including recent updates from other trusted parties such as family or friends. Users can always have the latest updates for their own enjoyment or show & tell with friends.

*Mobile Office* — A knowledge worker is expecting an important call from a client. However, she also wants to have lunch with a good friend who is rarely in town. Since PBB enables common network identification for all forms of communications technology (wireline, wireless, Voice over Internet Protocol, etc.) wherever they are, the worker need not worry about her client contacting her at her office while she's out. Instead, the worker can simply connect to her office via a secure PBB connection. She has a virtual presence in her office as well as access to all corporate network services. Phone calls to her desk are automatically forwarded to her PBB device and she has full access to the same records and resources available in her office. By managing the correlation between a common network identifier and a device, PBB allows the worker to maintain the same level of connectedness regardless of her location.

*Personalizing shared connections* — A user arranges for home broadband service so his family can access the Internet for school and personal interests. This user sometimes works from home and uses the same network as his family. On these occasions, he needs better connectivity in order to properly support his synchronous communication needs such as voice, collaboration and video. PBB allows him to control and manage dynamic upgrades to his connectivity through his company's IT account while maintaining an independent service level for his family's personal use.

This concept could also be extended to the retail world: A user purchases a video iPod and attempts to download videos from iTunes while at home. Since she uses her home Internet connection infrequently, she only buys a minimal level of connectivity from her Internet provider. Unfortunately, this low level of connectivity results in lengthy delays when she attempt to download videos for her iPod. The user does not want to upgrade her Internet connectivity plan, but she would happily pay to increase her connectivity on

a per video basis. Recognizing this, Apple offers two prices for each video. The lower price option provides best effort delivery, where speed is constrained by the user's agreement with her Internet provider. The higher price option arranges for a download rate that exceeds the user's contracted rate for the duration of the download. Apple's higher price incorporates the cost of upgrading the user's connectivity to a higher capacity rate when needed. The user's connectivity rate is no longer dependent on her relationship with her network provider.

These use cases build on each other to illustrate progressively more complex scenarios. The first case, "Being best connected", shows how users can choose the "best" available access based on their specific needs at the time. "Find me a printer" assumes a "best" connection and adds dynamic access to devices that become local as the user's location changes. "On the road with my music" illustrates consistent remote access to personalized sources of information. The "Mobile Office" example adds bi-directional connectivity and virtual presence, making a user available to others even when they are away from a specified location – a form of "being best connected" but in reverse. The final case adds the concept of dynamic personalized access based on the preferences of multiple users of shared devices or network connections.

## Summary and Next Steps

In this paper we have described a vision of a future in which connectivity is moved from fixed locations to individuals based on their personal preferences. Personal Broadband offers capabilities that not only provide pervasive connectivity, but also seamless services amid a sea of providers and user devices. Table 1 provides a summary of the attributes, capabilities and interfaces described by the PBB Vision. Some of these attributes and capabilities are becoming available today while others will take longer to realise. To date there has been considerable discussion, but not yet agreement, on the architectures of networks and services required to fulfill this vision.

The next steps to develop the underpinnings of the PBB Vision include identifying the barriers to the creation of PBB and the steps needed to resolve and remove those barriers. We envision three broad categories that need to be addressed:

1. Supplier-side business issues: the barriers in this group include trust models among various providers (commercial, non-commercial and ad-hoc), risk management by the providers, economic viability of deploying such capabilities, appropriate business models for the identi-

Table 1. Personal Broadband will be realised through complementary devices, core and access networks, applications and content, and the required supporting infrastructure working in concert.

| Capabilities | Attributes | Interfaces |
|---|---|---|
| Ubiquitous: available "everywhere" and "always-on" | Focused on providing the most suitable connection as defined by the user | Open to applications and devices |
| Provides options to users to choose from among multiple providers | Enhances the personal nature of applications and content accessed through it | No particular device or application is assumed |
| Provides flexible treatment of user's information (e.g., their identities or how much of their profile information is to be "passed-on") | Compatible with commercial and non-commercial access service relations which can be long or short-lived (ad hoc) | Focused on layers 1 to 3 of ISO stack (Physical, Data Link, and Network) |
| Maintains the integrity of content as it passes through the network | Compatible with existing investments | Defined to support higher level functionality required for realisation of PBB |
| Provides dependable (trustworthy) access to applications and content from any device | Can be realised as a service, or offered as a product, by one or more service providers | Allows for explicit passing of contextual information from user to application and vice versa |

fied players including roaming agreements with flexible value exchange, and the role of aggregation.

2. Technical issues: the barriers in this group include the availability of the appropriate supporting infrastructure (always on, bandwidth, latency, coverage, and support for mobile or nomadic use), scalability and dependability of proposed interfaces and functions, and security and privacy concerns of the value-chain participants from users to sourcing suppliers. Furthermore, as mentioned previously, a suitable technical architecture needs to be developed for PBB based on the vision and its associated business architecture. This technical architecture, although focused on layers 1 to 3 within our work, will need to properly identify, address and support dependencies to higher layer functionality including support for both synchronous and asynchronous services as well as simple and composite services. Examples for such dependencies are identity management, context processing, access network selection and QoS detection and provisioning.
3. Demand issues: what applications and devices will drive the demand so that PBB is developed and adopted? What form will the adaptation of users' lives take to the availability of PBB, and what will cause PBB to become absorbed so that it is only noticed by the users when it is absent, much like the previous absorption of telephony services?

We will describe these barriers and develop a proposal for their removal in a follow-on paper for the Personal Broadband Vision.

## Acknowledgments

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## Appendix

**About the BBWG and CFP**

The goal of the Broadband Working Group (BBWG) within the Communication Futures Programme (CFP) is to promote the virtuous cycle of growing Internet usage and further investments in broadband access. The goal of the group is based on the observation that if there is growth in Internet usage then that would justify future investment in the network, which leads to the creation of innovative (and possibly bandwidth-hungry) applications and services which in turn leads to growth in the usage and so on. The approach of the group is to develop white papers identifying the barriers to the above-mentioned virtuous cycle via consensus among stakeholders across the broadband value chain. The activities of the group are driven by "small-group" teams focusing on articulating specific problems and/or approaches to solutions followed by agreement of the entire working group. The group demonstrates consensus via short white papers (such as this one) and disseminates these papers to policy and executive audiences who impact the industry.

**Why write this paper?**

The contribution of the BBWG can be categorised into two groups; first, there are activities, which try to ensure that the existing (or predicted) paths for growth result in a virtuous cycle. This group of activities concentrates on the economic viability of investing in infrastructure of broadband and tries to determine how a virtuous cycle can be formed. Personal Broadband (PBB), on the other hand, belongs to a second category of activities, those that extend the existing notion of broadband to include new context and usage. By adding new context and use-cases it is hoped that there will be positive economic impact so that the virtuous cycle can be extended. Therefore, the nature of PBB is to define and create new opportunities and not solve specific issues. As such it has been decided that PBB can benefit from a vision and definition so that its creation can be turned into a series of actionable tasks. This paper attempts to define the vision of PBB without going into the details of what steps are required to create it.