

# IDEA

[Infinitely Diverging Electronic Appliance]

Digital Convergence in a Connected World

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# 1.0 Introduction

## Abstract

*This paper describes the convergence of the digital technology everyday people use every day. The convergence encompasses both hardware and software and is grounded in open standards and protocols which empower a previously un-imagined number of devices to be developed independently yet inter-operate with each other.*

*The "IDEA" is a theoretical point at which all of these devices become one all-encompassing platform which can be expanded indefinitely by adding "hardules" (hardware modules) and "softules" (software modules). Each of these appliances could then act as a node in the distributed network that is the Internet.*

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I will begin by taking a snapshot of the current landscape of the worlds of computing and consumer electronics and attempt to identify trends relating to convergence and communication. I will then attempt to extrapolate these trends to predict where it is we are heading in the world of electronic and computer engineering and what specific obstacles are still to be overcome.

## 2.0 Background

### 2.1 Chaos

The boom in sales of mobile devices like smartphones and PDAs is quite astounding, especially the rate at which they are discarded by consumers and replaced with an entirely separate device which has perhaps one or two features the old one doesn't.

Many homes now have more than one desktop computer which are used to carry out almost identical tasks to each other yet they share only very few of their resources with each other.

We use landline telephones, mobile telephones and Instant messaging to hold real-time conversations with one another.

We have digital TVs, DVD players, set top boxes, CD players, digital radios, portable digital jukeboxes and PVRs yet they barely "talk" to each other at all and they all use separate resources, separate software and separate user interfaces.

All of this is beginning to change.

### 2.2 Current Developments

#### 2.2.1 Media Centre Personal Computers

Apple Computers recently released a very small white box with a CD slot in it and nobody is entirely sure what it's meant to be for. It's a personal computer but it comes with no monitor keyboard or mouse like most Apple computers and doesn't look like any personal computer we've seen before.

Within days of its release the Mac Mini[1] was touted as Apple's attempt to convert Microsoft Windows users to their Mac OS X operating system by providing a smoother and cheaper migration route. Meanwhile people theorised about using it as an in-car computer or storing it on top of the

TV in their living room as a multimedia device acting as the centre of their digital home.

Shortly afterwards, the Open Source Center Stage Project[2] was launched, calling itself The Mac Media Center.

*"Center Stage is an open source project to build a powerful and intuitive media center application for the Apple Macintosh, this project was inspired by the launch of the Mac mini, an ideal Mac to use as part of a home theatre system."*

Also from the Open Source world but on the GNU/Linux platform, the MythTV project[4] enables a desktop PC to be utilised as a PVR, with which you can pause and schedule recordings of live TV.

Microsoft has released Windows XP Media Center Edition[3] and they make no secret what it's meant to be for. Microsoft has a vision of the digital home, using exclusively Microsoft software. XP Media Centre Edition facilitates photos, music, television, movies, and games accessible on either a PC monitor or TV display, all using a single remote control.

### **2.2.2 Consoles**

Currently Sony, Microsoft and Nintendo are all working on new games consoles to be released next year. Sony and Microsoft have been showcasing their products surrounded by a lot of hype. But the games console, too, is morphing into something more, a media centre for the home! Could this be the point at which PCs and games consoles are converging?

Sony announced the Playstation 3[4], dubbing it as a "supercomputer for computer entertainment" with support for music and films and a large, upgradeable hard disk for internal storage. It also demonstrates a strong focus on connectivity with six USB ports, Bluetooth and broadband Internet access, allowing users to access their media over the Internet and make video calls. All of these features coupled with around 4Ghz of processing power make the Playstation 3 much more than a games console.

A particularly interesting aspect to this launch, in relation to the topic of this paper, is the patent relating to the architecture of the Playstation 3 which was filed in the US on 26th September last year. The patent gives insight into the future of the cell processor (developed by IBM and Toshiba), on which the Playstation 3 is based. A diagram shows a multitude of electronic devices with one or more "cells". Interestingly, it shows the inter-connection of all these devices, providing not only communication, but a pooling of processing power of all the "cells", in a kind of distributed computer cluster for the home. Add into the equation a broadband Internet connection and you have a serious implementation of grid computing with far reaching implications.

From Microsoft comes the XBox 360[6], which demonstrates some confusing parallels with its XP Media Center Edition as a media centre for the home with support for music, photos, video, and TV. It seems unlikely that Microsoft can continue to develop two very similar products simultaneously and likely that they will inevitably converge.

### **2.2.3 Mobile clients**

On 25th May Nokia announced a new product to add to its mobile range, but it wasn't a mobile phone. The Nokia 770[7] is described as an Internet Tablet and it resembles a PDA more than a phone, but it isn't quite that either. Even more interestingly, the operating system is based on Debian GNU/Linux and future plans include the implementation of Voice Over IP using the in-built [WiFi?](#) connection. The Nokia 770 comes with a reasonable list of applications for viewing media and even a headphone socket, but it is first and foremost a web browser which fits in your pocket. The primary input device is the familiar stylus pen, it boasts wireless connectivity with WiFi and Bluetooth and seems to be aimed at replacing one of many PCs in the home, one which is used only for web browsing.

Nokia's slightly mysterious product launch echos what seems to be the thinking of Internet giant Google, with rich web-based services like GMail[8]. The idea is that the only user interface you really need is a web browser, therefore making the underlying operating system almost irrelevant providing it has a web browser which supports HTTP and can render DHTML and JavaScript. This is bad news for Microsoft, especially with the open source Mozilla Firefox[9] browser even posing a serious challenge to its ageing Internet Explorer.

Google is keen to make the vast resources of information on the Internet available on the move. It offers a scaled down version of its already minimalistic search engine for the smaller screens of mobile devices and also allows complex queries to be sent by text message with an instant reply, free of charge. These queries can include a request for road directions, sums, conversions, price checking or even a search for a local restaurant, by postcode, with a sea view and a friendly atmosphere!

#### **2.2.4 VoIP**

The Nokia 770 has planned future support for Voice over IP, a method of having voice conversations over the your existing Internet connection with sound quality similar to an ordinary phone. VoIP has potential to be very big in the UK where telecoms are currently dominated mainly by one company. VoIP has been around for quite a while, it's even been made quite popular by the cross platform Skype[10] freeware. Skype offers services called "Skype-In" and "Skype-Out" which offer a connection to the wider telecoms network outside of the Internet, making it a viable software alternative to your telephone.

But recently VoIP has taken another twist. US-based firm Vonage has recently officially launched in the UK with a tempting package offering unlimited UK calls for £9.99 a month for home users and cheap international calls. Their service runs on VoIP but they send you an adapter which you plug into your ADSL connection and can plug your ordinary telephone into. The Vonage service offers everything you'd expect from a phone company, but this time the technology is different. Vonage provides an easy migration route to VoIP and it's this which could finally tip the scale.

#### **2.2.5 Syndicated Content**

Some new buzz words are flying around the Internet like "Podcast", "Blogroll" and "Broadcatching" and little orange buttons are appearing all over the World Wide Web. They all centre around a use of XML called RSS or Really Simple Syndication. RSS enables you to subscribe to a feed of content of some description and be updated whenever something changes.

You can subscribe to multiple live news feeds and aggregate all your news reading to a central location, you can collate a list of weblogs you want to read and have a "blogroll" appear in your news reader which updates whenever a new weblog entry is published. Taking this a step further with the use of "enclosures" you can subscribe to podcasts which are periodical audio broadcasts which can be set to automatically download to your home computer or make their way to your mobile digital music player as they are published.

Another innovation utilising enclosures is Broadcatching. According to Wikipedia[12] Broadcatching *"refers to the use of RSS feeds and BitTorrent peer to peer file sharing as an alternative to distributing multimedia content on the Internet. It is a play on words, in contrast to broadcasting."*

Bittorrent[13] is a Peer to Peer distribution mechanism which allows "swarming" downloads where the more people who connect to the "torrent", the faster it goes. It allows thousands of people to download a file without causing the original publisher huge bandwidth costs. So when Bittorrent is combined with RSS feeds it offers a powerful distribution method for rich media like video, but

doesn't restrict the distribution to huge corporations or organisations. Instead it allows Joe Public to realistically publish his own documentary to the world in a more democratic distribution model.

## 3.0 Ideas for the home

### 3.1 Entertainment

In a previous section we saw that personal computers are merging with games consoles to become a media centre for the home. Devices which are on the horizon will cater for pictures, music, films, TV, radio and much more in a single unit.

Published Media can be split into three categories:

1. Live Broadcast - live events like sporting events or lottery draws can be watched in real time.
2. Syndicated Content - a series of recorded events or thoughts can be distributed over a period of time and optionally be continually updated. For example, episodes of soap operas or a personal weblog.
3. Archived Media - photo albums, film, books or music collections.

The vast majority of media falls under one of the latter two categories, yet syndicated content and one-off film showings are currently broadcast as if they were live events. Internet distribution models represent a shift to a more on-demand model of media consumption where the viewer watches what they want when they want. Even live events could be viewed at a later date if this better meets the convenience of the viewer.

Strict TV schedules could be restricted only to live events as all other content is viewed as and when the viewer decides, at any point after its publishing date. This idea has been exercised to a certain extent with the BBC's "Listen Again"[14] service for radio programmes and through PVR solutions like Sky Plus[15] but it has the potential to go much further. Currently the most significant obstacle is the bandwidth needed for the broadcast of live events over the Internet. With archived media, peer to peer distribution models mean this isn't an issue, but for the time being live broadcasts could be received via DVB[16] as a secondary network interface to the same device.

At its most basic level, multimedia can be categorised as combinations of text, sound and images varying in different ways over time. All of these mediums can be stored in a digital format and manipulated and viewed using a computer. Current trends seem to point towards a single, central appliance in the home which sends, receives and stores this data. If there is to be a single point of storage, access can be provided from multiple input and output devices throughout the home and even over long distances via the Internet.

There are obstacles which complicate matters slightly - for example, the number of competing digital formats for sound, video, images and documents is bewildering. It is common for a desktop PC to have three, four or more different applications installed simply to play different video formats available on the web. In order for the Internet to become the dominant distribution method, a set of open, standard formats must be settled upon to avoid unnecessary complexity for the end user. Perhaps even a single hybrid format which can contain certain combinations of text, images and sound could be utilised where the user decides how they "view" the content. This would be a boon for accessibility (subtitles for the deaf for example) but represents significant technical obstacles like complicated compression algorithms.

## 3.2 Communication

As was mentioned in the previous section, we use a variety of different methods to communicate using electronic devices. Below is an overview of ways in which people communicate over the Internet using Social Software or "Groupware".

	synchronous	asynchronous
multi-directional	Instant Messaging Chat Rooms Videoconferencing VoIP	Email SMS Collaborative Writing Shared Calendar/Schedule Shared Address Book Newsgroup Forum
uni-directional		Web Pages Blogs News Feed Podcast Broadcasting

I have categorised the methods of communication above into multi-directional or uni-directional and synchronous or asynchronous. You will notice that many methods of communication are very similar. Mailing lists, newsgroups and forums (Bulletin Board Systems) all fulfill a very similar function yet rarely work together. Equally, Instant Messaging and Chat Rooms fulfill similar tasks but are offered as distinct services.

In a similar way to media, communication methods may be generalised into combinations of text, sound and pictures which vary differently over time. The uni-directional methods of communication fall more into the realm of entertainment and broadcast media covered earlier, but perhaps the multi-directional methods could also converge into a single service. This service could feature different layers of richness of content and time-scale, decided upon by the user and dependent on their convenience, environment and available bandwidth at any one time. A single mobile device could be capable of a variety of functions ranging from full video conferencing to short, asynchronous text messages.

With 3G phones on the high street, this is already becoming a reality. But the integrated service has yet to make its way into the home setting where the land line telephone and email are still very distinct services for most people. It seems inefficient to use your mobile telephone to connect to a 3G network to make a phone call, when you may already have a wireless access point in the home connected to a broadband Internet connection, albeit using different technology, but a greater bandwidth. This will be covered further in section 5.0.

Given that a household may in the future use a central computer for entertainment, this computer could also be used for communication including email, VoIP and video conferencing over the Internet. A video call could come in via the central computer, but be taken on a screen in any room of the house.

The same central computer in the home could store your emails, text messages, voicemail, calendar, address book and all your correspondence and be accessed remotely wherever an Internet connection is available.

### 3.3 Home Automation

Once the idea of having a central home computer is established, there are further implications for a digital home. There are many remaining unconnected electronic (and electrical) devices left in a house. These are used for tasks such as lighting, heating, washing, cooking, cooling, security etc.

IPv6[17] is the "next generation" protocol designed by the IETF to replace the current version Internet Protocol, IP Version 4 ("IPv4"). It introduces such a large number of Internet addresses that it gives scope for literally any electronic device to be connected to a network and even the Internet.

If the microwave and TV suddenly learnt to talk TCP/IP, a message could pop up on your screen when the chicken finishes defrosting in the kitchen. You could literally log into your house from work and check you'd turned the lights off, monitor the CCTV in the back yard, or turn the heating on in the lounge so it would be nice and warm when you came home on a cold day.

It also gives the potential for a much more economic and efficient home. A central computer could make suggestions on how to use energy more efficiently. It could be that 10% of your electric bill comes from a light you leave on all night which doesn't need to be on at all!

This isn't science fiction; most of the technology already exists, it's just a case of putting it all together.

### 4.0 Ideas for the community

The real beauty of the Internet comes to light when you take each home as a node of the wider community.

Human beings are very social animals and we interact with many different groups of people. Be it in a place of learning, a place of work or simply groups with similar interests. Using the Internet they can have discussions and collaborate on projects in a common, virtual space.

*"The web is more a social creation than a technical one. I designed it for a social effect to help people work together and not as a technical toy. The ultimate goal of the Web is to support and improve our weblike existence in the world. We clump into families, associations, and companies. We develop trust across the miles and distrust around the corner."*

--Tim Berners-Lee, Weaving The Web

If you were to take the central computer for the home as discussed above and put it in a large organisation with more people in it, say a school, it has even greater benefits. There's already a great deal of web based software available for schools such as Course Management Systems (e.g. Moodle [18]), Library systems (e.g. Koha[19]), Administrative Systems (e.g. SchoolTool[20]) and more general software like Content Management Systems (e.g. Drupal[21]).

A student can log into their school account from home, submit their homework, renew a library book, check their timetable and interact with their peers.

For other organisations, CSCW (Computer-Supported Cooperative Work) utilises groupware and collaborative software to get work done. A simple example would be a Wiki[22] - a web site where anyone can edit the content. Such systems have problems associated with them which are often social rather than technical, the well known Commons Problem[23] for example.

Internet access in public places is becoming popular with a large number of "wireless hotspots" in restaurants and trains where you can connect with a compatible wireless device. Taking this to

another level, pilot projects are in place where a "wireless mesh" is installed over a large area, say a village or town. Wireless meshes are mostly used in areas which can't get broadband through traditional channels - some are commercial but others are entirely community run. But a high speed wireless connection has benefits in any area.

If each home in a community had a powerful central computer with high speed wireless connectivity to all the other homes in the local community, it opens up great potential for social interaction on a more local scale. Broadcastng, visited earlier, is a democratic video publishing model which would enable a local football team to release videos of all its games to people in the community or a local Priest to distribute his sermons in full video to members of the parish who are too sick or busy to make it to church - bringing a new light to local TV.

Greater communication and interaction on a local level would do a lot to increase a sense of community which up until now has been widely regarded to have been diminished by technology rather than enhanced by it. If it's free to talk to someone living on a neighbouring estate using VoIP you're probably more likely to do it!

## 5.0 Ideas on the move

### 5.1 Infinitely Diverging



As this is a paper on convergence, I'm sure you can guess what the picture above is demonstrating. These are just a few of thousands of digital hand-held devices with striking similarities which all carry out different tasks. Mobile phones are becoming indistinguishable from PDAs and hard disk based digital music players like the iconic iPod are evolving into a device which also plays video and stores your photo album. It's only a matter of time until a device hits the shelves which takes on all of these tasks with equal success and delivers them in a single package with a simple user interface. That may be a touch sensitive screen, a keypad or even a virtual interface projected onto a flat surface.

But in order to keep up with consumer demand, the device itself must not be replaced with another when a new feature becomes popular, but be upgradeable. Upgrade fatigue with mobile devices is starting to show itself with some companies now offering a stripped down simple phone which carries out just one task and does it well. This is a knee-jerk reaction from the consumer in a market where your purchase is obsolete the day after you buy it!

To remedy this problem, a mobile device must be infinitely diverging rather than permanently outdated. You should be able to purchase an add-on module for your mobile device which adds a



new feature without ruining its form factor and appearance. This "hardule" should automatically inject its own drivers and software ("softule") into the core of the device in a zero-configuration upgrade. You should be able to upgrade processing power as easily as you can upgrade the volatile and non-volatile memory and even change its appearance with click-on shells.

In order for this to happen, a common platform must emerge which allows many manufacturers to make compatible devices which allow very easy upgrades which maintain a consistent physical appearance while meeting different consumer tastes. This is enough of an engineering and design problem to be considered a serious obstacle, but not one which can not be overcome.

## **5.2 Mobile Connectivity**

For a mobile device to reach its full potential it must have maximum connectivity at all times. This means that it should automatically detect networks it can connect to via different technologies and negotiate authentication, without user intervention as far as possible. The different technologies include a wide radio spectrum from from hundreds of Mhz (TV) to 6Ghz (Wifi). Bluetooth, GPRS, 3G, Wifi, Wimax and even near field communication and Infra-red.

In around 5-10 years all of this could change with the introduction of Cognitive Radio[24]. A mobile device could have the ability to sense the world around it and learn from experience, adjusting its RF characteristics and performance in real time according to the "Interference Temperature" (so called by the FCC). Suddenly staying connected would become a lot more trivial, even while travelling at high speeds.

In the more short term, radio scientists have successfully maintained a VoIP conversation in a microlight at 2,000 feet, flying above the Wireless Mesh run by South Witham Broadband, demonstrating the potential of WiFi for mobile applications over large areas. During the research for this paper I've personally spoken to the non-profit group responsible for this community-run wireless mesh and their enthusiasm about its effect on the community speaks volumes about its potential on a local level.

## **6.0 Wider Implications**

In this paper I have focused on the home and the community as these are my main areas of interest. However, all of this technology has equal potential in the business arena. Project Management, Customer Relationship Management, Accounting, Content Management and a whole array of multimedia groupware is already having a huge impact on mobile workers and business as a whole.

Additionally, the potential in sales of media and telecommunications over the Internet and all of the related hardware is huge. Although the music and film industries may be traditionally over-cautious of new technology (remember how the recordable cassette and video recorders were going to be the end of the music and film industries?), they will eventually catch on as the consumer drags them forward. At the moment, any mention of "Peer to peer technology" sends chills down the spine of big media executives, but with a little more research I think they will discover a rich new platform which increases and diversifies their revenue rather than damages it.

## **7.0 Conclusion**

Current developments seem to point towards the convergence of digital media and communications into a central appliance in the home, shared by a large organisation or travelling around in your pocket. Data is fast becoming as essential to modern day living as gas, water and electricity. The

Internet first managed to create a global village, but has yet to show its full impact on more geographically local communities.

The mantra for the information age seems to be "Virtually centralised, physically distributed" as all devices ultimately connect to each other but are controlled through a virtually centralised and universally accessible system. The gadget in your pocket will talk to the server in your house to access your address book, calendar and archived media and the microwave could well talk to the TV.

Synchronous and asynchronous text, voice and video communications will become less distinct and wireless technologies will merge together. Staying connected all the time will be realistic, even as you travel around in remote rural areas. Wireless networks will be adaptive and self-healing and require little user intervention.

Publishing will be a more distributed and democratic affair, even through mediums which have traditionally been limited to large organisations, like TV. Anyone will be able to start a weblog, radio station or even a TV station and a much more diverse range of interests will be satisfied as a result.

In order for much of this to happen, developments must be based on widely accepted open standards which encourage competition and innovation. Many obstacles must be overcome. From the one side, infrastructure must be improved to allow greater bandwidth over a wider area and more versatility, and on the other greater compression methods need to be created to squeeze as much data through the infrastructure as possible.

Finally, if Sony's patent filings are anything to go by, the connected devices of the future won't just share data but processing power as well. The biggest supercomputer on earth could well be owned by Joe and Joanne Bloggs with their fridge and little Joe Junior with the portable computer he takes to school.

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