

UMTS Forum Report 43

# Two Worlds Connected: Consumer Electronics Meets Mobile Broadband



U M T S  
F o r u m

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## Foreword

### About the UMTS Forum

Mobile broadband is changing the way the world communicates. The UMTS Forum helps all players in this dynamic new value chain understand and profit from the opportunities of 3G/UMTS networks and their Long Term Evolution (LTE).

The UMTS Forum participates actively in the work of the ITU, ETSI, and 3GPP, EC and CEPT as well as other technical and commercial organisations globally. It contributes to the timely licensing and deployment of mobile broadband globally through regular dialogue with regulators and responses to public consultations. A strong promotional voice is maintained via a high-profile presence at conferences, seminars and workshops as well as regular briefings to the media, analyst and other stakeholders.

Membership of the UMTS Forum draws together everyone with an interest in mobile broadband, including network operators, regulators and the manufacturers of network infrastructure and terminal equipment. Since its launch in 1996, The UMTS Forum has been supporting the interests of its membership with a range of studies, reports and other outputs.

Principal focus areas include markets trends, mobile broadband services and applications, key growth markets, spectrum, regulation, technology and implementation. While centred around the promotion of 3GPP technologies and their long-term roadmap, the studies of the Forum nevertheless embrace a range of complementary mobile and wireless access technologies that can deliver broadband multimedia and the personal internet.

### About this report

The report from the UMTS Forum – the first of its kind – investigates the evolving relationship between the mobile communications and consumer electronics (CE) industries.

*Two Worlds Connected: Consumer Electronics Meets Mobile Broadband* was authored for the UMTS Forum by Strategy Analytics, who complemented end-user research with more than 30 in-depth interviews with players across the mobile/CE value chain globally. Companies polled in the study included fixed, mobile and integrated operators, plus wireless technology vendors, consumer electronics manufacturers, media companies and regulators.

The report examines these questions:

- What is the state of the Consumer Electronics industry, and how is it positioned relative to the mobile communications industry?
- What is the impact of CE-focused devices on the mobile industry value chain?
- What is the state of in-home connectivity today?
- How are CE devices likely to be connected and how are the relative merits of air interface standards perceived, as well as the role of regulators?
- What are the respective roles of cloud services and media servers vis-à-vis the consumer environment?
- Which specialised devices, potentially intrinsic to vertical markets, will emerge for the connected consumer?
- What are the barriers and drivers to applications 'horizontalisation' across devices?
- How big is the market, by device type, by geography or by air interface standard, and what are the factors that can impact this forecast?

As well as addressing these questions, the report offers a number of recommendations to all actors in the connected devices value chain. These include mobile operators, chipset and module vendors, telecom system vendors, automotive OEMs and consumer electronics device manufacturers.

Our special thanks go to the team at Strategy Analytics for their extensive work, in particular to Andreas Koehler and Dominique Roussel. I would also like to thank the UMTS Forum Steering Group and study team colleagues for their dedication in the preparation and direction of this report: Bosco Fernandes, Jean-Paul Pallois, Colin Chandler, Guillaume Lebrun, Chris Solbé, Ghislain du Chene and Annika Svensson.



**Jean-Pierre Bienaimé**  
Chairman  
**January 2011**

# 1 Introduction

## 1.1 Objectives

This report was commissioned by the UMTS Forum during 2010 to investigate relationships between the mobile communications and Consumer Electronics (CE) industries. Key issues addressed in the study include:

- What is the state of the Consumer Electronics industry, and how is it positioned relative to the mobile communications industry?
- What is the impact of CE-focused devices on the mobile industry's value chain?
- What is the state of in-home connectivity today?
- How are CE devices likely to be connected and how are the relative merits of air interface standards perceived, as well as the role of regulators?
- What are the respective roles of cloud services and media servers vis-à-vis the consumer environment?
- What specialised devices, potentially intrinsic to vertical markets, will emerge for the connected consumer?
- What are the barriers and drivers to applications "horizontalisation" across devices?
- How big is the market, by device type, by geography or by air interface standard? And what are the factors that can impact this forecast?

## 1.2 Key Messages

Addressing the above questions yields the following brief answers:

- The future growth of the mobile communications and Consumer Electronics industries are intrinsically linked.
  - The largest area for future growth in mobile communications is in CE devices, such as games, e-readers, in-vehicle entertainment, home appliances or healthcare.
  - Mobile broadband will enable the flexible and cost-effective deployment of "always on, anywhere" devices for the consumer.
- By the middle of the decade, non-traditional Consumer Electronics devices (i.e. not phones or data cards), should be the fastest growing mobile broadband device class. There will be at least a billion Consumer Electronics devices directly connected to mobile broadband networks by 2016. This figure could grow significantly, depending on the extent to which actions called for in this report are actually implemented.
  - Though portable devices will represent the major share of these billion devices, more than a third will be designed primarily for in-home use, such as home robots, security or multimedia.
  - The promise of in-car entertainment and telematics will finally be fulfilled by new generation networks, with more than 200 million cars connected to mobile broadband networks by 2016.

- The connected CE device market will be much more fragmented into vertical specialties than has been the handset market, with mobile broadband enabling new classes of devices, such as connected tablets, augmented reality games, robots or telepresence systems.
- Aside from technology, another key enabler will be that operators will firstly, take the lead and “pull CE vendors along” and secondly, continue to develop new business models. There will also be movement away from single-device/single-SIM/single-consumer focussed models, to flexible models bundling devices, users and traffic.
  - Operators will allow more partnerships such as specialised MVNOs for specific applications. Today's examples include e-books and home security.
  - Operators need to drive the unlocking of this opportunity by proactively engaging with potential CE customers and possibly perform roles beyond connectivity. These could include management of technology platform management, parts of the customer experience or acting as a route to market.
- Mobile connected CE devices will be particularly strong in emerging markets, such as Asia and Africa. We expect there to be as many connected CE devices in Africa and the Middle-East as in Western Europe.
- Beyond the more than a billion directly connected CE devices, we expect many more to share connections via Wi-Fi or MiFi.

### **1.3 CE Definition**

What do we include in the definition “Consumer Electronics” for the purposes of this study? In short, we include all devices for which a consumer can be a direct client, namely make a conscious decision to avail him/herself of the services of these devices. The one notable exception is the single largest connected consumer device today: the mobile phone handset.

The definition we have used is extremely broad: it includes all devices that can be found in a home, whether for computing, entertainment, domestic chores, security, home automation, metering or health. These devices can be portable or fixed. In addition, we also include automotive applications, including in-vehicle telemetry and in-vehicle entertainment and communications.

We have explicitly excluded devices which are primarily or exclusively purchased by the enterprise, such as merchandise tracking devices, fleet management systems, or professional computing devices.

Given the diverse range of devices, we have developed a taxonomy of devices, which is somewhat arbitrary but nonetheless facilitates focussed discussion by category, as well as forecasting.

This taxonomy is first and foremost location-based, in terms of where the device will be primarily used. Thus, we have four broad categories:

- In the home
- On the move
- Health
- In the car

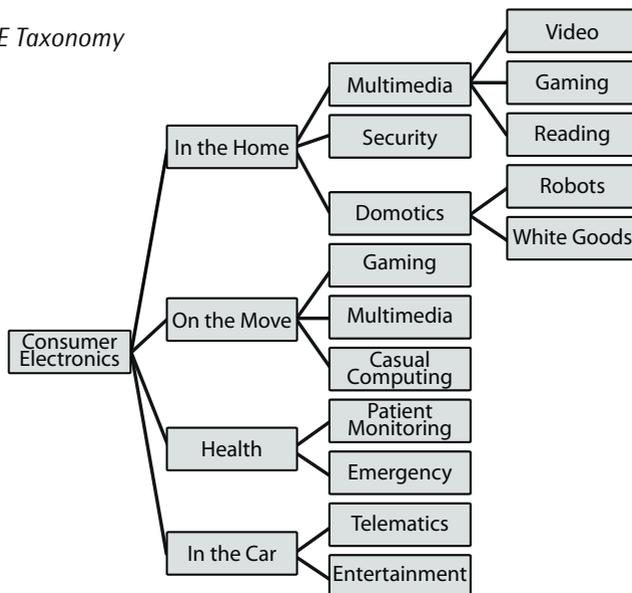
These four categories are broken down into sub-categories, including multimedia, security, domotics, or casual computing.

It goes without saying that portable devices (on the move) may be used in the home or in the car. Conversely, devices in the car are assumed to be embedded and thus are exclusively for use in the car (or at home in the garage!) Devices that are classified as being "in the home" are devices that are primarily used in the home, such as a media jukebox, or a large multimedia display (or TV).

For the sake of clarity, some of the less self-evident categories are defined as follows:

- Security: includes burglary and fire alarm systems which are increasingly linked to a command centre by wireless data to facilitate emergency response and guard against fixed lines being cut.
- Domotics: includes robots and home automation, as well as white goods.
- In-car Telematics: includes driver facing telemetry such as vehicle maintenance and diagnostics, navigation (with off-board component).

Figure 1: CE Taxonomy



## 2 Summary of Research Findings

- There is clearly a need for better communication between different players of the value chain, as there are differing expectations in particular with respect to cost and performance.
  - This study attempts to reflect accurately the views of the industry players interviewed. However there are cases where these views may be founded on imperfect knowledge, particular with respect to technologies that are not yet mature.
- There is no doubt that Consumer Electronics devices are becoming connected, whether by wired or wireless means.
  - Indeed, the CE industry is in flux: there seems to be a sense of “Connect or Perish.”
  - Leaders and new players are pushing connectivity, e.g. Sony, Samsung, Canon and Chinese vendors.
  - There is a strong move towards gaming in the connected world, particularly with the advent of networked gaming.
  - Content players – such as publishers, film makers, software developers or television – are actively seeking to exploit new distribution paths.
- However, the device forecast for LTE or 4G is subject to some uncertainty.
  - Consumer Electronics players will not necessarily wait for cost-effective ubiquitous LTE, since they wish to launch connected devices now or in the near future.
  - Furthermore, the LTE business case is widely expected by operators and other members of the value chain to be “red” until 2015 or later.
  - HSPA+ is proving to be an acceptable or even potent interim solution, at least from the end-user perspective.
  - Nevertheless, with a strong HSPA ecosystem in place and LTE becoming the natural long term mobile broadband choice for most mobile operators, LTE modules will be embedded in many devices. These will include notebooks, ultra-portables, gaming devices and cameras. Furthermore, LTE will feature in cars, mapping devices, MP3 players and e-book readers. Since LTE supports hand-over and roaming to existing mobile networks, all these devices can have ubiquitous mobile broadband coverage from day one.
- Consumer Electronic devices are not the main driver for mobile broadband, at least not in the short-medium term.
  - PC dongles are the first adopter of mobile broadband technology, followed by embedded modules in notebook computers for business, and then by netbooks and smartphones.
  - Some carriers see more potential in using LTE and 4G technologies for leased-line replacement rather than for Consumer Electronics.
  - There is also significant potential in non-traditional CE devices to address a wide range of vertical applications.
    - Some of the leading opportunities include healthcare, video monitoring/surveillance, security and also photography-related verticals such as press, surveying, insurance, real estate or construction.

- Automotive is another major opportunity for mobile broadband, but only embedded car systems and not Personal Navigation Devices (PND).
  - Automotive OEMs are apparently very keen for mobile broadband: however the jury is still out on whether barriers to automotive adoption can be overcome this time. Up until now, automotive OEMs have largely failed to produce a compelling value proposition for in-vehicle telematics or interactive entertainment.
- Unconventional devices still need to meet latency/bandwidth/mobility/cost criteria in order to be successful new entrants or substitutes for existing solutions.
- There is a need for suitable business models to cater for infrequent users who may generate potentially high traffic. This has begun to be addressed, for instance as evidenced by certain pre-paid packages for Apple's iPad.
  - Mobile broadband enabled devices largely support mobile usage.
- In the home, Wi-Fi is the favoured wireless solution
  - To succeed, cellular solutions have to come close to Wi-Fi module cost.
  - Overall, the economics generally favour fixed solutions.
  - Also, fixed-to-mobile substitution is not a driver as mobile cannot win a competition with fixed.
  - Question whether even LTE can support HD video on a large scale.
  - Outside the home, Wi-Fi can aggregate consumer devices to effectively WWAN access.
  - LTE could have a role in serving remote areas without fixed broadband alternatives.
- Cellular connectivity is not necessarily the favoured solution.
  - White goods vendors favour fixed connectivity except for cellular-enabled remote controlling applications.
- On the other hand, CE has the potential to significantly expand the wireless marketplace in various dimensions.
  - New customers, applications, more time connected and more ARPU.
  - "Always on" can be extended to the mobile space ("always connected user experience").
  - SIM cards (which have become synonymous with customer ownership) will remain in mobile phones for many years to come. However they are unlikely to be dominant in many other CE devices in the medium to longer term.
- Emergence of micro SIM, soft SIM and SDR (software-defined radio).
- Possible trend towards embedding at CE source level, i.e. carrier agnostic.

- Mobile operators will almost certainly lose a degree of customer ownership beyond phones.
- An extended period of protocol coexistence is widely expected.
  - 3G has many years left and even 2G will not disappear any time soon.
  - HSPA+ is fast becoming the interim technology of choice.
  - Devices will need to be triple or quadruple-mode, i.e. multiple cellular + Wi-Fi.
  - Least-cost-routing services are likely to be available from operators.
  - WiMAX has little momentum left outside US and emerging markets.
- Likewise, cloud- and server based solutions will coexist.
  - Both solutions with intelligence residing in the device or network will be favoured by vendors and operators in different situations.
  - However, the cloud world appears to have most momentum across the value chain.
    - Content providers in particular are pushing for cloud-based architecture.
    - However, older consumers still want to “own” content and there will be consumer concerns about data security.
- The business model is very much seen by operators and CE vendors as the key or only barrier to mobile broadband enabled CE devices on a large scale.
  - All the players concur that the business model is the key issue but most remain equally unsure about likely outcome or the optimal solution.
  - Operators have grasped need for new business models and tariffs but are still struggling or, at best, testing new value propositions.
  - New tariff models are needed and can include:
    - Pre-paid event-based (e.g. emergency)
    - Data pool shared amongst devices
    - QoS service model, where customers can pay for different levels of service, or an have a lower level of service once a fixed amount of usage has been attained.
  - The operators much prefer connectivity to be built into device, but who will subsidise?
    - This is viewed as a more elegant solution, better to manage diverse traffic needs of different devices.
  - Whilst the business of wholesaling capacity is set to become increasingly important to operators, the circumstances under which this will occur are not yet clearly defined. Amongst the possibilities are:
    - Low traffic devices, which do not generate much revenue, and where the operator may prefer a third-party to manage the customer, and the billing. Examples include alarm systems or e-book readers such as Amazon's Kindle 3G.s

- Vertical market devices, which require specialised knowledge and competencies in which the operator may prefer not to invest. Examples include law and order applications, or logistics.
- Some operators favour letting specialised device vendors be MVNOs – network transparent to users. The most celebrated case to date is Amazon’s Kindle 3G.
- More generally, devices in large volumes using the same, well defined, applications.
- Conversely, applications portability will be a key enabler.
  - Three distinct initiatives are driving app portability, but today’s leading app platform, Apple, is resisting.
  - Though portability should be about promoting platform-agnostic applications, initiatives remain mobile-centric today.
- At this stage, CE players are barely addressing the App Store phenomenon.
  - Sony is currently ahead of its competition with its long-standing goal to leverage its own content, Samsung in planning phase.
  - Operators and vendors largely view CE vendors as out of their depth in the content game.
- Other potential barriers to ubiquitous mobile broadband in Consumer Electronics include:
  - Fragmentation – of device types, of applications, of operating frequencies.
    - In effect, production volumes of any given connected CE device are likely to be significantly smaller than those of most mobile phone models. If one examines the inventory of any consumer electronics shop, it contains thousands of models of CE devices, very few of which attain the same economies of scale in production as do mobile phones.
    - Likewise, aside from the issue of applications portability, the sheer number of applications developed makes it difficult to standardise and thus gain momentum and market share. Open APIs are far from being readily available today.
    - A diverse range of operating frequencies is being assigned to upcoming mobile broadband technologies such as LTE. This increases costs for the modules to be integrated into CE devices which need to cope with many different frequencies.

- Radio spectrum allocation needs to be clarified in short term in many countries where situation is currently unclear.
- Chip prices are a barrier to mobile broadband on CE devices – at least in the short term. As mobile broadband is viewed as being a non-core function of a CE device, Consumer Electronics vendors cannot allocate a large share of the total Bill of Materials (BoM) to the cellular module.
- Some operators claim that cellular equipped devices will only be truly competitive once the total net incremental cost is under \$30. They view their competition as being Wi-Fi, which is already well under \$30 as an add-on functionality.
- Other players such as automotive equipment and white goods vendors require cellular chip-set prices of around \$10.
  - This may appear to be very low, as compared to the price of a car, but it should be noted that the multimedia and communications components of a car are now the key differentiators as well as the main source of profitability. Thus, the cellular chip-set is viewed in the context of a Bill of Materials of no more than a couple of hundred dollars, rather than the total automobile BoM.
  - White Goods vendors are not very enthusiastic about cellular connectivity, in that they believe that smart grid technology using the power line network will more cost-effectively address their requirements. An exception could be China, where White Goods OEMs have formed an alliance to develop standard connectivity using the Chinese TD-SCDMA technology. However it is not clear yet whether this alliance will produce tangible results.
- In terms of LTE, some of its key value proposition elements – managed QoS, low latency – need to be sold to the CE players rather than the consumers who will not understand them. At this point, many major CE players interviewed do not appear to understand the nuances between major wireless communications technologies.
- Connected CE devices worldwide should surpass one billion in 2016.
  - This will represent faster growth than the overall wireless market, and in fact will represent close to half of the wireless market's incremental growth over the period 2010-2011.

## 2.1 *Industry Success Factors*

Though Consumer Electronics will certainly contribute to the growth of Mobile Broadband over the next ten years, this contribution is dependent on several key factors, that will condition the extent to which connected CE devices will either be niche products or rapidly become commonplace around the world.

### *This Isn't the CE Business, Nor Is It the Mobile Business*

Many CE vendors previously failed in the Mobile Business for failing to adapt to a new environment. At the same time, operators and telecoms vendors have to recognise that they are also entering a new space, where ARPU or SAC are perhaps less important than DRM or Content.

### *It's the Economy, Stupid!*

To borrow Bill Clinton's US presidential campaign mantra, business models must take into account the consumer's ability to pay, the very different traffic patterns of CE devices, as well as the economies brought about by the introduction of new technologies such as HSPA or LTE. This applies equally well to in-the-home devices as it does to portable devices, or those that are embedded in the car.

### *Monopolistic Apps and Content Make for Dumb Pipes*

There is no question that Apps and Content have become the levers for value share domination. This has been at the expense of the operators and network vendors, as well as certain handset vendors. However, the current value distribution is probably not sustainable, given needs for investment in infrastructure and in R&D, and given historical consumer resistance to being tied to the same software vendor for too long. There is certainly room for more applications and content portability.

### *If Chips and Modules Aren't Priced for Volume, then Volumes Won't Come*

Until now, data chipsets and modules have been a niche business, catering to business and M2M applications. Suppliers need to change their mindset, in order to serve CE players who need help entering Mobile Broadband, and who can buy volumes sufficient to amortise considerable capital expenditure.

## 2.2 *What is to be Done? Recommendations for Stakeholders*

### *Operators*

This research and interviews carried out across a wide range of players very much affirms the notion that operators need to stimulate the development of mobile enabled CE, rather than expect much drive from CE vendors. Hence operators need to regain their pivotal role in the ecosystem or otherwise the ecosystem may never thrive. Though clearly traffic is linked to the existence of compelling content and applications, at the same time the single biggest critical investment is in the network. Without it, content and applications will remain inaccessible.

Clearly, operator "walled garden" approaches have failed to muster consumer enthusiasm. Thus if operators wish to regain the initiative, it is probably by following exactly the opposite tack: becoming agents of openness – or, in other words, enabling

the federation of devices and content from many different sources.

This approach does not exclude wholesaling of traffic to specialised MVNOs. On the contrary: being the easiest operator to work with, armed with the best customer management systems, for a range of MVNOs can bring a synergistic range of services to the operator's portfolio.

At the same time the key question of who pays for the wireless module demands new collaborative approaches. Modules remain expensive and manufacturers are reluctant to add the cost into the hardware when margins are already very thin. An obvious solution could be for operators and CE vendors to share the investment risk within the framework of service revenue sharing deals. This may also appeal to CE vendors, many of whom are seeking to develop a service revenue business.

In addition CE vendors clearly lack the skills to develop a service business which poses a further opportunity for operators to carry out roles for CE vendors beyond connectivity, e.g. technology platform management, managing parts of the customer experience or acting as a route to market. Here operators could create packaged offers for CE vendors helping them to "mobilise" their devices.

Operators must be motivated to unlock this opportunity by creating value for themselves. Equally, they must prevent other players from seizing the initiative and moulding the opportunity. Otherwise, operators are left stranded in a commoditised and price competitive space, i.e. the dreaded "dumb pipe" scenario.

### ***Chip Vendors and Module Vendors***

The marriage of Consumer Electronics and mobile broadband may be an opportunity for technology vendors to reinvent their roles as key suppliers – and even attempt to move up the value chain.

As previously mentioned, the volumes for any given CE device are unlikely to be as high as for a mobile phone model, so technology vendors may have the opportunity to be volume aggregators for the CE players. Given CE vendors' lack of mobile broadband experience, they should welcome chip and module vendors who offer value-added services. These services could include best-in-class reference designs – that are portable across a CE vendor's worldwide product line -- middleware and Interoperability testing.

In addition, the likely trend towards soft SIMs and embedding at source promotes the idea of module vendors forging partnerships with CE vendors.

Ultimately – and most importantly – chip and module vendors must recognise that this is no longer a niche business: it is one that needs to be served with appropriate services and prices.

### ***Telecoms System Vendors***

System vendors need to align themselves with their paying customers – the operators – to help the network realise its true value and potential.

This means providing the tools for the cloud vision to become a tangible reality to the consumer, ensuring applications portability, and ensuring a seamless experience across different devices, not all of which share the same functions. (e.g. a housecleaning robot versus a smartphone.)

In addition, leading vendors could benefit the market by reducing royalty demands for components such as 3G modules. The cost of these is a key issue in achieving rapid and wide-spread embedding of CE devices with cellular connectivity and ultimately all will benefit from growing the pie.

### ***Automotive OEMs***

Original Equipment Manufacturers (OEMs) need to concede that operators are best placed to operate customer contracts, i.e. OEMs becoming MVNOs does not make much sense.

They need to accept that most customers will not pay subscription charges to OEMs, i.e. any service must be bundled with the vehicle price – and probably beyond the first year. Although SIMs will be in cars once eCall kicks in, most end users will prefer to bring portable devices into the car to consume mobile broadband based apps and services. However, OEMs should work on seamless interoperability, just like using the head unit for hands-free telephony today.

### ***CE Vendors***

As already stated in this report, Consumer Electronics vendors need to “connect or perish.”

However, these vendors cannot simply provide connectivity to their portfolio of devices without first developing a rational ‘embedded strategy.’ In developing this strategy, they need to understand:

- What their users really need,
- How they are likely to connect, when and where,
- To what extent devices need to be directly interoperable or via the ‘cloud’;
- How much users will value various options for connectivity,
- Who will monetise this value, and
- Ultimately, how to reposition from being a vendor of discrete devices to being a valued member of the mobile broadband ecosystem.

### 3 Industry Perceptions

In the course of this project, Strategy Analytics interviewed representatives from more than thirty key links in the value chain, from network operators to chipset vendors, as well as Consumer Electronics vendors and other OEMs.

These were interviewed on a range of topics, including:

- Their expectations for a future connected world, and their company's role in it;
- Their expectations for advanced wireless technologies, in particular LTE or WiMAX;
- Their vision of the business model for connected CE devices;
- The key challenges they are facing on the road towards a connected world.

The respondents' views are summarised in the table below. It should be noted that these are the respondents' own views, and do not necessarily reflect the opinions of Strategy Analytics or the UMTS Forum on future market developments. The views that are summarised in the table below should be interpreted in light of the challenges faced and respondents' tendency to respond conservatively to questions regarding long-term outlook.

The advent of 2G mobile communications represented a sea-change in operator, vendor and consumer attitudes, with such revolutions as global coverage, affordable handsets and tariffs, network competition. This revolution, in essence, took ten years to effect, by which time the socio-economic landscape had changed beyond recognition.

We anticipate the ramp-up to the "Internet of Things" to take less than ten years, but will also likely entail economic and sociological changes at least as radical as those of the first ten years of digital mobile networks.

Indeed, we believe that the key lesson from these interviews is that significant work needs to be undertaken in order to realise the promise of mobile connected broadband CE devices. The major challenge is in federating expectations into a coherent value chain. All players apparently need to learn how to do new things better, most importantly they must learn new ways of working with new or existing value chain partners.

Strategy Analytics also probed respondents on less company-specific questions such as the geographic differences in connected CE deployment, or on the role of regulation and politics.

The views expressed are summarised overleaf:

Table 2: Key interview findings by player type

Players Key Industry Issues	Operators	CE Vendors	Infrastructure & chipsets	Others incl. Auto, White Goods, Media
Connected World Expectations	<ul style="list-style-type: none"> <li>• Main thrust on dongles, notebooks, smartphones, all forms of MIDs</li> <li>• Potential of new devices with cell connectivity may be exaggerated</li> <li>• Exceptions include cameras and vertical apps, especially health</li> <li>• Cloud concept and Pay-per content model will become pervasive</li> </ul>			<ul style="list-style-type: none"> <li>• Early on only premium segments, core services and no embedded SIM in car</li> <li>• Cost too high</li> </ul>
LTE Expectations	<ul style="list-style-type: none"> <li>• *Red business case until 2015 or later</li> <li>• Extended period of protocol coexistence, much current HSPA+ momentum</li> <li>• Clear lead over WiMAX (except emerging markets possibly)</li> <li>• *Always on* concept to transfer from fixed to mobile world (biggest use case in itself)</li> </ul>			
Value Chain & Business Model	<ul style="list-style-type: none"> <li>• Must monetisetraffic better</li> <li>• Larger ops will try innovate, smaller ops looking to device vendors</li> <li>• More open to wholesale</li> </ul>	<ul style="list-style-type: none"> <li>• Not good at doing content and services</li> <li>• Seeking stronger relationships with ops, but still learning to work with them</li> </ul>	<ul style="list-style-type: none"> <li>• Vendor customers back to own R&amp;D</li> <li>• Technology ready, business model only issue</li> <li>• Need play lead role in pushing market</li> </ul>	<ul style="list-style-type: none"> <li>• Media: Have the initiative in all IP world</li> <li>• Auto: Tier1's looking to ops and OEMs to make it happen</li> <li>• Vendors: waiting for lower cost chips</li> </ul>
Key Challenges	<ul style="list-style-type: none"> <li>• *Dumb pipe* scenario</li> <li>• Difficult to innovate with walled garden falling down</li> </ul>	<ul style="list-style-type: none"> <li>• Contract manufacturer competing only on speed, cost and scale</li> <li>• How add value in all IP world?</li> </ul>	<ul style="list-style-type: none"> <li>• Squeezed on cost at bottom of value chain</li> </ul>	<ul style="list-style-type: none"> <li>• Is it worth it? (auto &amp; home apps)</li> <li>• How involved? (Media)</li> </ul>
Geography	<ul style="list-style-type: none"> <li>• Emerging markets are generally behind the curve but there is leapfrog potential for mobile broadband due to lack of fixed infrastructure <ul style="list-style-type: none"> <li>– However, very limited user spending power does impact feasibility for high bandwidth services</li> </ul> </li> <li>• The lack of fixed infrastructure and spending power will generate unique service models <ul style="list-style-type: none"> <li>– E.g. combine DVB STB with SIM card and use TV as screen for Internet via connection with phone</li> </ul> </li> <li>• WiMAX probably best positioned in emerging markets as low cost fixed line substitute</li> <li>• US is a leading market for LTE rollout whereas China is likely held back by competing standards</li> <li>• For suppliers of smart home appliances national markets vary greatly</li> </ul>			
Regulation & Politics	<ul style="list-style-type: none"> <li>• National markets vary greatly in terms of spectrum license situation and some face 4G delays <ul style="list-style-type: none"> <li>– The situation in China faces is downright messy</li> <li>– In South Africa new spectrum may not become available until 2015</li> </ul> </li> <li>• Whilst WiMAX may be a suitable solution for many emerging markets, some operators focused on LTE are concerned about governments favoring WiMAX in part due to heavy lobbying by its vendors</li> <li>• Markets vary greatly in terms of political attitudes towards Smart Grid for home appliances <ul style="list-style-type: none"> <li>– E.g. In Germany political pressure pushing Smart Grid vs. Finland where there is no need</li> </ul> </li> </ul>			

## 4 The State of the Consumer Electronics Industry

### Historically the Consumer Electronics Industry Has Had Difficulty with Mobile

- Many CE players attempted to enter the mobile communications arena, with generally poor results
  - Phillips entered, initially with re-branded Nokia handsets, and then with its own technology, and eventually withdrew.
  - Despite a very strong brand, and significant technology assets, Bosch's handset business was eventually absorbed by Siemens (which itself later saw its handset business taken over by BenQ.)
  - Sony struggled for several years in the mobile handset business, despite an extremely strong brand and reputable domestic cordless phones. It eventually merged with Ericsson to form Sony Ericsson Mobile Communications.
- CE players may have underestimated barriers to entry into the handset business, or in any case were not able to cope with these.
  - The need to sell into the operator channel (as opposed to selling into traditional Consumer Electronics distribution): Indeed, certain CE players attempted to use almost exclusively their own same channels that were used for microwave ovens and clock radios.
  - The need to have network level expertise: although the GSM specification was extremely precise, only players with strong network expertise (such as Nokia) were able to fully translate the network's potential functionality into the handset.
  - The need for economies of scale: Given the enormous costs of entering the market, and the highly segmented nature of the market, it was generally necessary to leverage economies of scale, at least with regard to the technology platform. Most CE players were very quickly behind the curve, with typically only one handset model.
- With non-handset/terminal devices, these barriers may now be lifted, or metaphorically, the playing field may have been levelled. In effect:
  - Clearly the operator channel may not be fundamental to selling connected consumer devices;
  - Network expertise is no longer critical;
  - With similar embedded modules going into different CE devices, all major CE players should be on an even footing, with regard to economies of scale.

### The Consumer Electronics Industry Has Always Been Linked With Communications

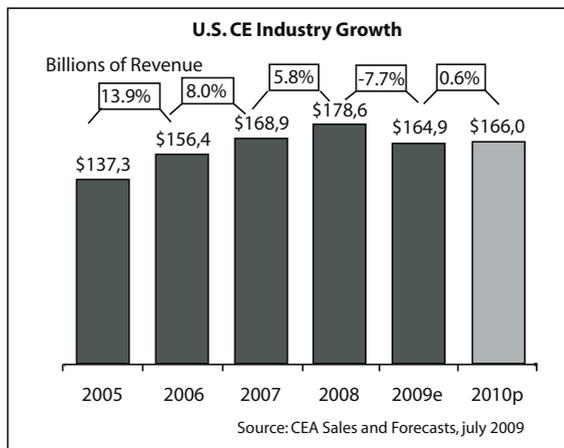
- As an example, in the US, the earliest trade association has evolved from an association focussed on radio's to a general consumer electronics association:
  - 1924: Radio Manufacturers Association
  - 1950: Radio-Television Manufacturers Association

- 1953: Radio-Electronics-Television Manufacturers Association
  - 1957: Electronic Industries Association
  - 1998: Electronic Industries Alliance
  - 1999: Consumer Electronics Association
- In a sense, the CE industry is returning to its roots by connecting hitherto non-connected devices such as cars, by providing two-way connectivity to what were simple receivers such as TVs, and returning to the use of radio waves (as in wirelessly connected digital photo frames).

### The Consumer Electronics Industry Has Faced Severe Pressure in the Last Twenty Years as Evidenced by:

- The disappearance of brands due to competition and consolidation, e.g. Thomson, Zenith.
- The very speedy commoditisation of hardware innovation – the learning curve has enabled dissemination of new consumer electronics products throughout the population, but it has also reduced margins.
- The recent need to differentiate beyond hardware, which has forced CE players to learn new skills, such as software design, and, more recently, software portability.
- The strong competition from communications services for the household budget, which has reduced available funds for discretionary purchases such as consumer electronics.
- Growth well below that of the mobile industry – typically in single digits in the last ten years (as illustrated below for the US Consumer Electronics industry) whereas the mobile industry has much more frequently enjoyed double digit growth.

Figure 2: CE revenues in the US 2005-2010

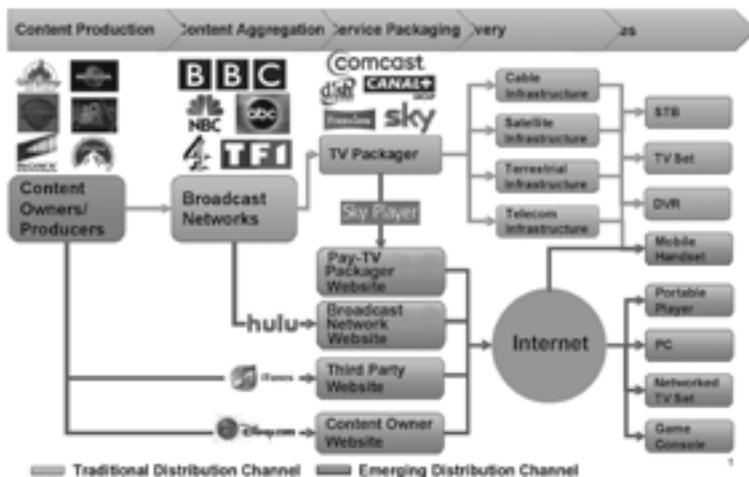


## All Major Consumer Electronics Players Now Going Connected – Not Necessarily Wireless

- Sony views its future as being connected, with the vast majority of devices wireless, and expects the majority to be connected via mobile broadband. On the other hand, Canon is focussed on Wi-Fi. While White Goods giant Bosch is focussed on Smart Grid through powerlines, trend-setter Miele is marketing cellular-ready appliances such as refrigerators.
- Why are Consumer Electronics companies making their video devices connect to the Internet?
  - Established CE companies are facing increasing competition from Chinese companies and hope to increase the value of their devices by connecting them to a digital media ecosystem. At the same time they are trying to gain revenue share from web-provided content
  - This is driven by increasing awareness that consumers are using multiple devices to access web content. (TVs, Media Players, Blu-ray Disc, consoles and mobile devices; E-book Readers, Tablets and MIDs)
  - The theory goes something like this: "More access implies more content implies more devices implies more revenue".

## Traditional and Emerging Distribution Channels for Television Content

Figure 3: Distribution channels for television content



As illustrated in the chart above, television content distribution is now undergoing a revolution as distribution channels multiply:

- Content owners and producers are no longer solely relying on broadcasters to distribute their content. Today they are developing their own websites as well as going to third party websites.
- Broadcasters themselves are developing their own websites.
- The devices on which the content is viewed are proliferating far beyond traditional living room entertainment devices, to mobile handsets, tablets, portable players, games consoles and in-car screens – plus other new CE device sub-categories such as Sony's Dash personal Internet viewer.

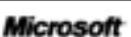
This revolution in the distribution of content has several implications for the mobile industry:

- Significantly increased needs for quality data transport capacity in fixed and mobile networks;
- Increased demand for new devices on which to view this content. Examples of these hitherto non-existent devices include tablets such as Amazon Kindle or Apple iPad, hybrid devices such as Chumby, or household appliances with built-in displays.

There is no question that these new content distribution models will be a major driver of high-speed network build-out and devices capable of displaying content and enabling an interactive experience.

Some key examples of industry players attempting to take advantage of the new content distribution value chain are listed below.

Figure 4: Some of the interested parties in the race to bring OTT video content into the home:

	Connectivity is core to Sony's recovery: BraviaTVs, Blu-Ray Players & PS3 –are all very capable solutions
	Global leader in TVs with strong hopes for connected TV & Blu-ray –currently has the largest number of connectable TVs in the market
	Xbox 360 and more than 25 IPTV operators running the MediaremIPTV solution are the key routes for OTT video content for Microsoft
	2010 will be make or break year for Apple TV. They may utilise their strong digital asset library and even start to produce 'TV's.
	Family of media processors designed to bring Web content and services to the TV. Single chip now optimized with Adobe Flash, to bring visually compelling content like 3-D gaming and video streaming to the TV
	Aims to create a personally relevant Internet experience with a widget-based user experience for TV, integrating popular Yahoo! services as well as content and services from other leading providers
	Browser company which utilise widgets to bring Web content without departing from live TV content.
	Both public and commercial broadcasters support new networked devices to provide Catch-up TV & Web content: Canvas, HbbTV, Sky Player

## 5 CE Devices to be Main Driver for Mobile Broadband in Medium Term

### 5.1 *The Promise of Automotive*

The automotive has been the future gold rush of wireless communications for many years:

- As cars become more reliable, and as the need for speed and performance becomes less pressing (due to environmental concerns) OEMs need to find new ways to add value and differentiate. The car's "head unit" (the electronic device in the centre of the dashboard that manages entertainment and driver information functions such as music, news or navigation) has become a prime battleground for automotive OEMs.
- There has been gradually increasing end-user demand for communications, entertainment, driving assistance and telematics. This growth in demand is partially due to end-user education. In part, it's also due to the emergence of simple user desires for "always-on" connectivity.

But the promise has yet to be fulfilled, due in part to:

- Lack of compelling business models – for instance, purchasers of expensive automobiles have not found it acceptable to be asked to pay a recurring subscription fee in addition.
- Fragmented value chain, as illustrated further below.
- Fragmented technological standards – in particular, between air interface standards, in the car, as well as car operating systems.
- Territorial disputes between OEMs, Tier 1's and Third Parties, namely with respect to customer ownership.

*With the advent of new technologies such as LTE, there is a clear opportunity to finally address automotive needs, but many stakeholders and interests need to be reconciled.*

### **Complex dynamics impact business model development for vehicle-device "connectivity" and "connected" telematics vehicle**

- The Connected Vehicle will be driven by safety telematics and assistance (GPS & cellular). OEMs will focus on cost reduction applications such as software upgrades, diagnostics and CRM, providing leverage into infotainment.
- Vehicle-Device Connectivity being driven by consumer demand for entertainment and communications (Bluetooth and USB) with leverage into navigation, safety/security and other telematics applications.

Understanding the consumer and car maker requirements is critical to any Consumer Electronics or telecommunications vendor wishing to enter this space.

Figure 5: Complex dynamics impact business model development for vehicle-device "connectivity" and "connected" telematics vehicle



### Even a "Simple" Sub-Application such as RTI (Real Time Information) Has Many Variables in Establishing a Business Model

What revenue and pricing models are most logical for road traffic information? The most difficult aspect of the business model for RTI is generating revenues and the cost considerations for any quality RTI solution are considerable.

Table 3: Variables in establishing a business model for RTI (Realtime Traffic Information)

	Subscription	Value add/ Product Push	Advertisement Based	Freemium and Free
OEM Equipped	✓	✓	✓	
System Suppliers includes Aft Market	✓		✓	
PND	✓	✓		✓
Connected PND	✓	✓		
Smartphone (preloaded)		✓		
Navigation and Location Apps	✓		✓	✓
Internet			✓	✓

✓ = Example Available

Established/Likely

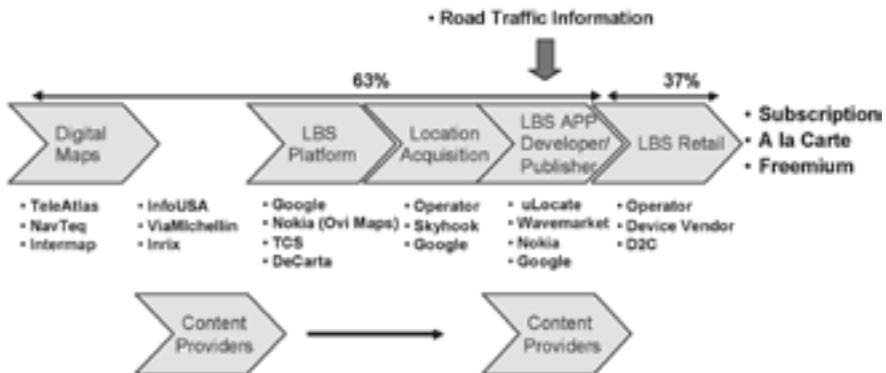
Questionable

Declining/Unlikely

## RTI's Precarious Position in the Value Chain is Typical of Many CE Segments

In terms of the importance of road traffic information in the LBS value chain, RTI is ultimately an application. It is an important application which can heavily influence how one gets from point A to B, but considerably less important than getting from A to B in most cases. With the emergence of free turn-by-turn navigation, the value chain for LBS looks considerably less lucrative to many than it did before. While RTI is content-heavy, the emergence of free turn-by-turn – in some respects – makes content providers little different from LBS App developers.

Figure 6: In-Vehicle Telematics value chain



## 5.2 Healthcare is Equally Complex but Hold Promise

Mobile eHealth – often called mHealth – has been around since 2001, but has now attracted serious momentum and hype. mHealth encompasses the use of mobile telecoms as they are integrated within the health care delivery systems and is part of a movement towards citizen-centred health service delivery.

Significant sums are being invested in supply chain optimisation for suppliers, enterprise IT software (CRM systems), asset tracking, monitoring and proactive maintenance. Moreover, regulation in developed markets such as the Health Insurance Portability and Accountability Act (HIPAA) play a key role in the choice of solution

Cellular has a key part to play in these areas, but is only part of something broader. We are only now getting towards the stage where we can talk about monitoring devices or mobile phones in a user's hand. Rampant mobile phone penetration is the key argument for exponential growth in mHealth, i.e. there are 4.6 billion mobile subscribers globally

However, mobile penetration does not in itself validate the mHealth concept. Many of the commitments are lukewarm, promising to invest in scalable solutions etc. To extract the true value from mHealth, mobile applications will need to be part of a broader set of business processes and mobile ecosystem

What is clear is that the concept of mHealth is related to mBusiness as well as to eHealth and eBusiness:

- eHealth refers to healthcare practice which is supported by electronic processes and communication.
- mHealth is the mobile extension of healthcare applications into the mobile domain and is a subset of eHealth.

eBusiness represents all the technological applications and business processes that enable a healthcare provider to offer a service, including front and back-office systems, essentially the utilisation of information and communication technologies (ICT) in support of all the activities of business.

mBusiness includes the tools required to enable eBusiness applications, such as a mobile application platform (MAP).

Interest in M-Health has increased rapidly over the last year:

- Vodafone has 70 full time staff working on mHealth
- Telefonica now has an mHealth division
- Orange has been working on M-Health applications for 2 to 3 years and has joined the mHealth Alliance
- O2 UK has launched a new division dedicated to mobile healthcare.
- BT Global services has a division working on mHealth
- AT&T considers mHealth to be a future demand driver
- RIM, Nokia and Ericsson have research activities in this area and have deployed services
- The United Nations Foundation considers M-Health to be a major health care innovation in the Developing World.

### **Home Healthcare (Outpatient Communications)**

Home healthcare is primarily aimed at supporting patients at home in order to provide them with a higher quality of living, better access to support services and reduce the cost of medical provision. The main user groups for this application are:

- The elderly
- Patients with chronic diseases
- Patients suffering from mental illness

The growth of these applications will be significant in the developed world, driven by an aging population and an increasing occurrence of chronic diseases such as diabetes and heart disease.

### **Public Healthcare**

This application is mainly confined to the developing world where there is a lack of access to medical care. Machine-to-Machine (M2M) enables health care facilities to be extended to people who could not otherwise afford healthcare or live in areas too remote for medical staff to visit.

M2M allows local individuals to be trained in simple diagnostics and healthcare provision and to be supported by more experienced staff in regional health centres. Examples that illustrate the pent-up demand include:

- Uganda
  - Text to Change’s SMS-based HIV/AIDS awareness quiz led to an increase of nearly 40% in the number of people coming in for free HIV/AIDS testing.
- Philippines
  - TB patients were given mobile phones and called daily with reminder to take their TB medication. Medication completion improved to 90%.
- South Africa
  - Project Masiluleke’s SMS message campaign promoting HIV/AIDS awareness resulted in nearly a tripling of call volume to a local HIV/AIDS helpline.
- Peru
  - Cell-Preven sees health workers using mobile phones to send SMS messages with real-time data on symptoms experienced by clinical trial participants. This enables immediate response to adverse symptoms.
- Australia
  - Medical busses providing eye and ear hospital services and breast cancer screening are using the Telstra Next G (HSPA) network in Australia.

Table 4: Current forms of mHealth

Current Healthcare Picture in Developing World	Global & Demographic Changes	Current Healthcare Picture in Developed World-Future Developing World
<ul style="list-style-type: none"> <li>• Communicable diseases</li> <li>• Lack of immunizations</li> <li>• Lack of safe water sources</li> </ul>	<ul style="list-style-type: none"> <li>• GDP growth increases spending on healthcare</li> <li>• Traditional diseases controlled (TB, smallpox) and new diseases appear (SARS, avian flu)</li> <li>• Aging populations mean increase in death from non-communicable causes</li> <li>• Declining birth rate and climbing life expectancy</li> <li>• Adoption of 'developed country' behaviours</li> </ul>	<ul style="list-style-type: none"> <li>• Shift from 'late stage' treatments to prevention and early detection</li> <li>• Increased focus on health issues of elderly</li> <li>• Continued health worker shortages and distribution inequities</li> <li>• Growing need to support chronic diseases, such as diabetes*, heart conditions, weight problems, cancer, etc.</li> <li>• Need to support "Golden Hour Services" after traumatic events, such as car crashes</li> </ul>

## 5.3 *Emerging Mobile Broadband Use Cases*

### 5.3.1 Miele

In the short term at least, most makers of home appliances (including leading global players Whirlpool and Bosch-Siemens) remain cautious when it comes to equipping their washers and dryers with cellular modules. The idea is far from new and some vendors have been through more than one attempt to successfully launch connected appliances during the past decade. As far as the bulk of product (including budget and mid-range appliances) is concerned, the immediate focus will be on cost saving apps such remote diagnostics.

However, there are also examples of a bright new world of truly connected appliances. Premium vendor Miele is set to soon launch Miele@home, its new system which allows a user to control appliances from an iPhone or relay error messages to a mobile phone or PC. Miele will also launch an iPhone application called InfoControl Plus that gives users full control of all operating Miele appliances at a single glance. According to the vendor, the function is capable of checking on the status of appliances throughout the home by calling up the selected programme, the operating mode or the remaining countdown time. This function also allows kitchen and laundry appliances to be remotely controlled from anywhere around the home. InfoControl Plus is complemented by Miele's InfoService function which can relay error messages and other useful information about Miele appliances to the owner's smart phone, other Internet-enabled mobile phone or a PC – anywhere in the world.



### 5.3.2 Chumby

A well-known example of emerging new connected CE devices is Chumby, designed by Chumby Industries of San Diego. Chumby bridges the gap between IT and CE, enabling consumers to integrate their internet lifestyle into their everyday life. Chumby's operating system and apps library have now been licenced by Sony for the Sony Dash personal Internet viewer.

Chumby sets out to take favourite parts of the Internet and delivers them to the consumer an easy-to-use, always-on, always-fresh format. It is designed to provide a window into Internet life that lives outside the user's desktop and focused on content such as weather, news, celebrity gossip, podcasts, music, and not productivity. Chumby is now being tested in the car, using an LTE mobile broadband link.



### 5.3.3 Mobile Cameras and Camcorders

It is often assumed that devices such as digital cameras are served well enough with Wi-Fi which is becoming very common now. However, only embedded cellular connectivity will create a truly connected device. The user will be able to share images instantly with friends, family or create a safe back-up to the home server, whereas in a Wi-Fi world he or she must first locate and move to a hotspot. There are numerous real life situations such as on the beach or any other outdoor environment where Wi-Fi is not immediately available and possibly not even near.

### 5.3.4 Parrot AR-Drone

French manufacturer Parrot has until now been primarily known as a manufacturer of in-car Bluetooth handset free devices.

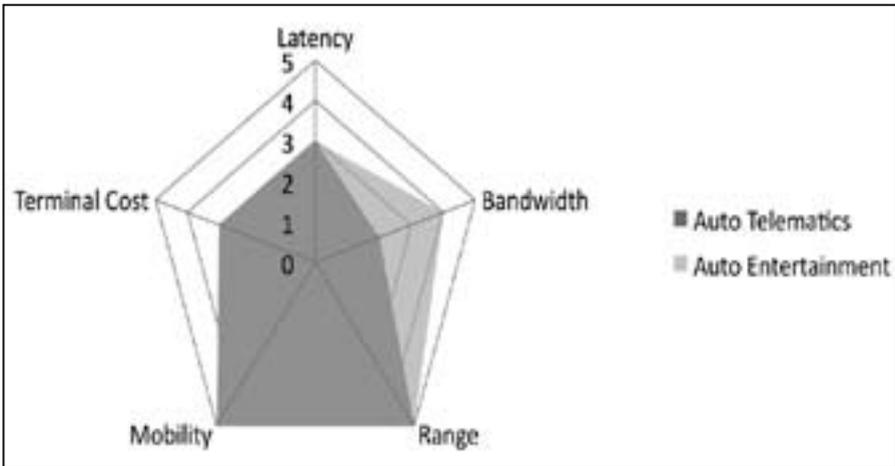
With the AR-Drone, Parrot has bridged the gap between wireless broadband and gaming. The AR-Drone is a four propeller-equipped devices that can be controlled using an iPhone and a Wi-Fi link. The next step could be to pilot the device using the cellular network, where LTE technology with its low-latency performance would be the best candidate.

## 5.4 Value Proposition Requirements of Different Classes of CE Devices

In assessing the relative merits of various technologies, as well as the likely emergence of various classes of Connected CE devices, we have isolated five primary attributes. We have then attempted to measure to what extent each of these five attributes is required for each application. The five attributes we have focussed on are as follows:

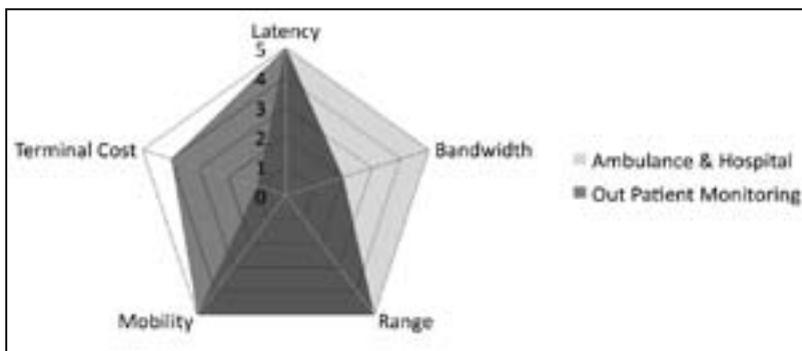
- Latency
- Bandwidth
- Range
- Mobility
- Terminal Cost

Figure 7: Performance Needs of Automotive Devices



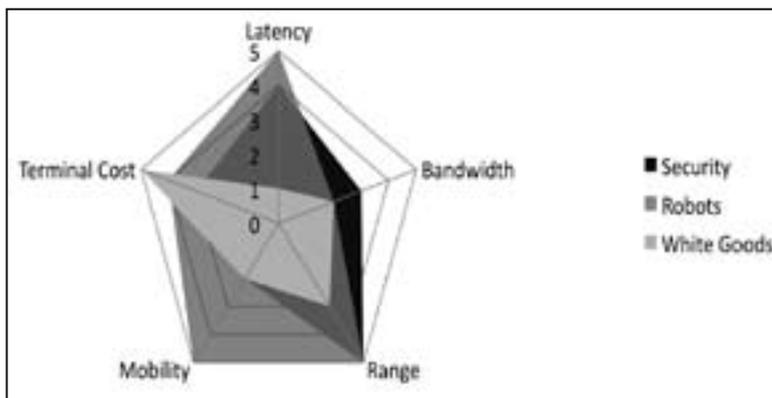
As may be observed above, automotive applications clearly need excellent range and mobility, however terminal cost is of an average sensitivity, and latency is not a major issue. Clearly, bandwidth is a major concern for entertainment applications (for instance movies, or music), whereas it is not a significant issue for telematics applications such as engine diagnostics.

Figure 8: Health Applications Value Proposition Requirements



There is a striking dichotomy in the health sector between out-patient monitoring applications and those related to emergency services. In both cases low latency is needed. However in the case of emergency and remote services, terminal cost is not an issue, whereas high bandwidth is much more of a requisite than it is for out-patient monitoring. Ironically, it is the remote services application – where terminal cost is less of an issue – that is most likely to be driven by developing countries.

Figure 9: Home-Based Applications Value Proposition Requirements



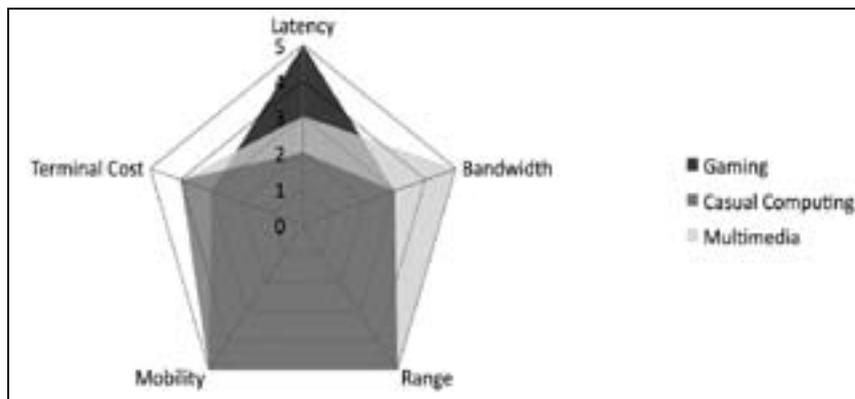
As may be noted above, in Home-Based Applications we have focussed on applications that are exclusive to the home. Many other connected CE devices exist but can also be used outside the home, due to their portable nature. In addition, we have excluded home-baseds

applications which are unlikely to use wireless networks, except in extreme cases, such as television, which is much better served in most cases, through wireline access.

White Goods are clearly a poor fit, a priori, for Mobile Broadband, in the sense that Mobile Broadband attributes such as bandwidth, low latency, or even mobility are of little benefit to White Goods. Aside from the fact that White Goods have little need for mobility (almost by definition, most White Goods are static), White Goods OEMs have stated in interviews that their price sensitivity is extremely high with regard to communications hardware. Thus, most OEMs are examining other connectivity options, such as Power Line Communications, WiFi or Ethernet, with the exception of high-end manufacturer Miele, who have launched a range of cellular-equipped appliances.

Home security is a promising area, in the sense that low latency is required, as well as increasing video bandwidth, as home security more and more often comprises remote video surveillance. New home security installations are increasingly equipped with mobile broadband communications, even in areas with good wireline communications, to avoid the risk of burglars cutting the telephone line.

Figure 10: Portable CE Device Value Proposition Requirements



The most interesting CE devices for mobile broadband are possibly portable devices including gaming devices and "casual computing" devices

Networked gaming has a true requirement for low latency, as well as gentle terminal cost requirements. With respect to multimedia devices (e.g. portable video players) there is a clear need for bandwidth, whilst casual computing devices (see description below) have a more modest set of performance requirements.

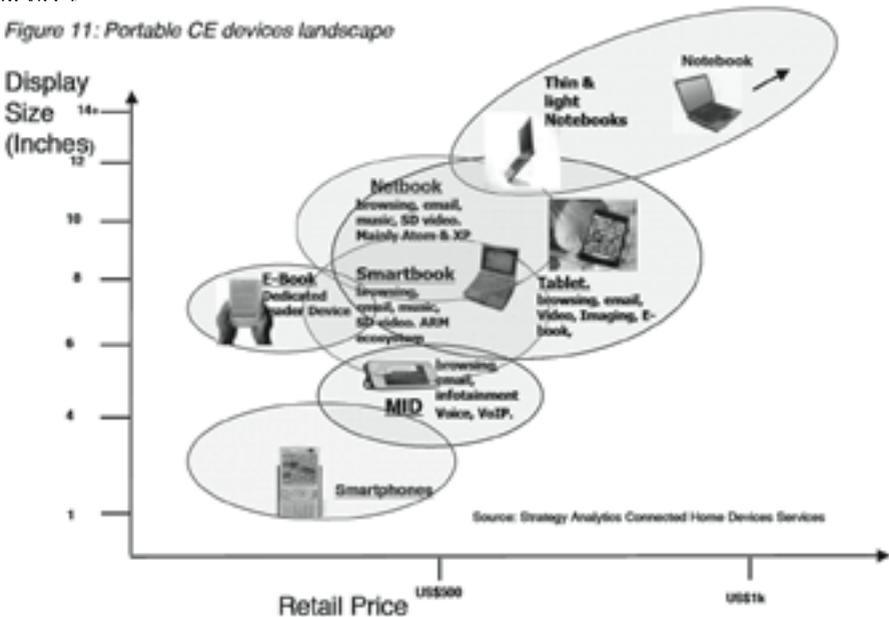
**"Casual Computing" is a recently emerged new class of Consumer Electronics Device**

Over the past five years, we have witnessed the emergence of new CE devices that represent the convergence of Consumer Electronics with computing, connectivity, and multimedia. These devices include:

- Netbooks
- Tablets (e.g. iPad)
- Mobile Internet Devices (MIDs)
- e-Book Readers (e.g. Amazon Kindle)

These devices may share some technologies in common with professional IT solutions. However their application is overwhelmingly consumer: hence their classification as CE devices.

Figure 11: Portable CE devices landscape



## 5.5 The Future of Portable Gaming Devices

Mobile Gaming will this year overtake Mobile Music as the third largest mobile consumer content segment with revenues of \$10.3 billion worldwide. This represents a 12% share of total consumer data revenues generated on mobile handsets. Browsing is set to remain dominant accounting for half of this market, followed by Social Networking.

Today, however, there are no revenues from mobile gaming beyond mobile handsets. While the next generation of devices such as PSP (Portable PlayStation) and Gameboy is widely expected to come with optional cellular connectivity, no firm announcements have yet been made by vendors Sony and Nintendo.

This is against a background of a declining portable game console (PGC) market amidst competition from a new wave of smartphones and e-readers. 3D technology is now the big hope designed to a necessary catalyst to stimulate use of a dedicated PGC device over competing products. It remains to be seen, however, whether the ultimate experience gamers achieve in a 3D game session on a PGC is sufficient to overcome the declining trend in portable gaming devices.

Competition from a variety of devices, including Apple's iPad and a variety of smartphones, will challenge the PGC market and make the desire of separate devices a formidable marketing challenge in a world where device convergence is the rage. Portability and mobility are critical elements for the gaming world. Increasingly, though, these functions are becoming widely available outside of the standalone PGC product set.

Furthermore, conventional thinking about gamers is being challenged, specifically that somewhat more casual gaming often found on social networking sites and accessible by multiple device types would not be of much interest to more serious gamers. This hypothesis is now being rethought, as the growth in casual gaming and mobile gaming continues to show considerable broad acceptance while the PGC market shows signs of stagnation. Other observations include:

- Smartphones are increasing as a percentage of the overall mobile phone market, putting more devices with vast new capabilities into the hands of consumers – many of whom are gamers. These devices are becoming increasingly powerful with both processing and graphical support, and with larger displays making them more suited for supporting games.
- Other devices, such as e-readers (especially the iPad) are beginning to carve out an increasingly large following and with broader functionality which will likely support gaming, both on-line and off-line. The iPad has the potential to be a major disrupter in terms of a platform alternative with enhancements in subsequent releases.
- The sophistication of games on these alternative gaming platforms is increasing and we are beginning to see multiplayer games and other gaming genres surface to take advantage of their potential.
- The emergence of cloud gaming and its longer term support of mobile devices will also have a potential negative impact on dedicated PGC devices as gamers move to a more device-independent environment.

In conclusion, mobile gaming's continued growth (13% CAGR) will further fuel 3G data traffic and also present a key application likely to benefit from 4G technology. However, much of this will be on platforms including smartphones and mobile Internet devices such as tablet PCs, MIDs and e-readers rather than dedicated games devices.

Home-based gaming generates annual revenues of \$50 billion versus \$10 billion from mobile gaming. As such, it will continue to be served largely via fixed line connections such as DSL and cable broadband.

## 6 Technology Issues

### 6.1 *The Future of the SIM card*

In the GSM environment, SIM cards have long been synonymous with customer ownership. In recent years this trend has accelerated for a number of reasons:

- Multiple device ownership, primarily driven by separate devices for home and work;
- Growth in SIM-only plans driven by greater caution in the current recession;
- Rapid growth in the number and type of data devices (USB Modems, cellular routers e.g. MiFi, netbooks, Tablets e.g. iPad and other CE devices);
- Growth in embedded computing (M2M), especially in smart metering and automotive.

#### **The environment for legacy mobile broadband vendors is changing**

New players such as Huawei and ZTE are not the only threat to the existing embedded and external modem OEMs such as Sierra Wireless, Novatel and Option. SimCom, and in future, companies such as Mediatek and Via will threaten the position of incumbents in the mobile computing space. SimCom has now been approved on AT&T's network, and as M2M becomes more mainstream, it is clear that the delineation between mobile computing and M2M module makers will vanish. New devices such as the iPad are taking a custom module approach, not an "off the shelf" module like e-book readers (Nook, Kindle). Further drivers for these changes include overreliance by Sierra Wireless and Novatel on wireless routers (Overdrive, MiFi) and low barriers to entry for competition.

#### **Bigger to Smaller: Birth of the Micro SIM**

One of the major growth areas in recent times has been the micro SIM. Also known as a 3FF (Third Form Factor), it is a standardised SIM card solution developed by the European Telecommunications Standards Institute (ETSI) in collaboration with 3GPP, 3GPP2, SCP, ARIB, GSMA, OMA and other mobile industry bodies. The micro SIM is almost half the size (12 x15 mm) of a regular SIM [also known as 2FF (15x25 mm)], and is designed to fit into devices otherwise too small for a traditional SIM card.

The device manufacturers have consistently put efforts in its device design to pack maximum features and capabilities into minimum space. Furthermore, as every component size in the device design continues to reduce, the SIM cards are also the part of this trend where the device vendors look forward to design the products by moving away from the current bigger form factor 2FF SIM cards to smaller form factor 3FF SIM cards.

Hence, the primary benefit of using this 3FF SIM is to address the internal space limitations in terms of the devices design allowing the device manufacturers to allocate the saved space to other components. The other advantage is that the 3FF card still remains to be backward compatible and is equipped with all the regular SIM Card capabilities. It's similar to the trend where the SD cards have transitioned into micro-SD cards.

Additionally, the smaller size 3FF cards hold significant advantage particularly for the devices and applications in the M2M (machine-to-machine) environment. For example, Lok8u's Num8 GPS device, a wrist watch that is connected to T-Mobile's GSM mobile phone network employs this miniature 3FF card mainly due to the space constraints in the device design where employing a traditional SIM would not have been possible

## Is Apple posing a further threat to operator power?

Apple has been a first-mover in employing the micro SIM card. It is a move that illustrates Apple's commitment towards incorporating newer and aesthetically pleasing design by reducing the component size used in its devices. This ploy has not only provided Apple an edge in differentiating its products, but has also created a marketing buzz amongst consumer and operator communities. Apple also looks to lock-in the customer in its ecosystem, by effectively making it more difficult (at least in the short term) to move between an iPhone and another GSM device.

## What next? From 3FF to the soft SIM or SDR?

Many operators globally have started to adopt 3FF SIM cards, considering the wide range of applications and opportunities it presents with its smaller form factor in M2M space while leveraging the upcoming LTE networks. It also reflects a key trend for handset vendors, where every millimetre of space and every milligram of weight saved in handset design is important.

With the shift towards smaller form factor SIM cards in order to allow for lock-in, smaller devices and improved aesthetics, it is clear that there will be a gradual shift away from larger SIM form factors over time. Clearly SIM cards will remain for many handsets, but several interesting developments are changing the outlook of the SIM market:

- The growth in mobile operators developing M2M Service Platforms, naturally lends itself to elements of provisioning and managing devices, not only in the legacy M2M business, but increasingly in the CE space, as highlighted by Jasper Wireless and AT&T's relationship.
- Global provisioning of SIMs can be managed centrally with various parameters attached to deployment, configuration, service length, tariffs etc.
- The growth in data devices leads naturally to discussions around the price delta at which wireless radios could be embedded at point-of-manufacture. In many cases this could take the form of a soft SIM or software-defined radio (SDR).
- In certain markets (e.g. some healthcare equipment), devices need to be hermetically sealed at source. The only way to manage remote diagnostics and maintenance as well as asset tracking is to embed a radio with a soft SIM at point of manufacture.

## Multiple SIMs unlikely best long term solution.

Clearly the SIM card as a customer touch point is important. Even in the SIM-only market, it is a tangible transaction. However, with the growth in M2M platforms, the way customer profiles are managed across multiple devices and subscriptions will need to be consolidated, and it is questionable whether multiple SIM cards are the logical option.

- In the mid-term, SIM cards will remain for all smartphones and handsets, with a gradual higher-end shift to 3FF.
- Embedded computing (M2M) and CE data devices, will increasingly look to a price delta at which a radio can be integrated at source. This will necessarily be carrier agnostic, although there is much to play for in this space from carriers.
- Soft SIM and SDR will become critical factors when a price delta is reached.

Ultimately, the embedded service platforms that carriers are building now may be ideal for managing subscriptions in future. However, this is not likely to see great

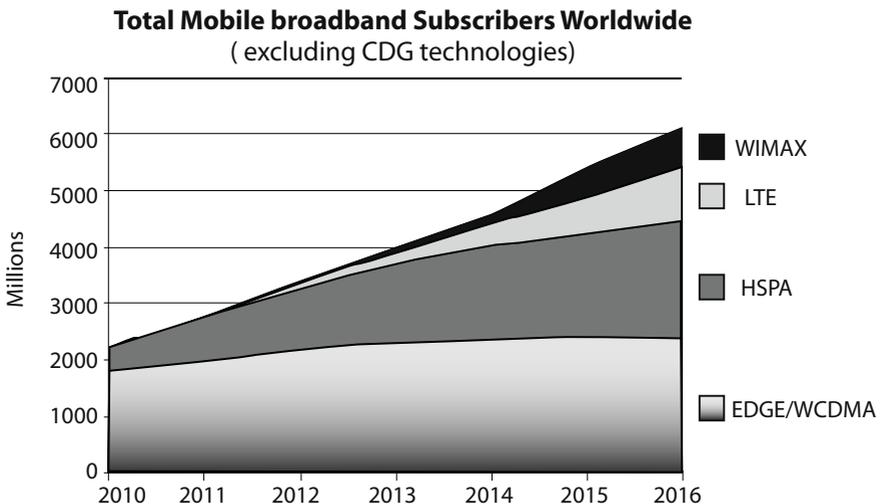
traction before the end of the forecast period, and will first take root in the embedded (M2M) legacy markets as well as dedicated mobile broadband devices.

## 6.2 Protocol Coexistence

The chart below shows the total number of mobile broadband subscriptions (human or machines) worldwide, in the GSM and WiMAX worlds, broken out by major technology family. (As per the UMTS Forum's specification for this study, this analysis excludes CDMA Development Group standards, with the obvious exception of LTE.)

We may note that the HSPA family clearly has momentum for the next five years, showing the most growth, so that by 2016 it should be almost even with EDGE/WCDMA with respect to the number of SIM cards inserted in devices with HSPA capability. By 2016, LTE should have the most momentum, fuelling mobile industry growth through to the end of the decade.

Figure 12: Mobile broadband subscriptions forecast



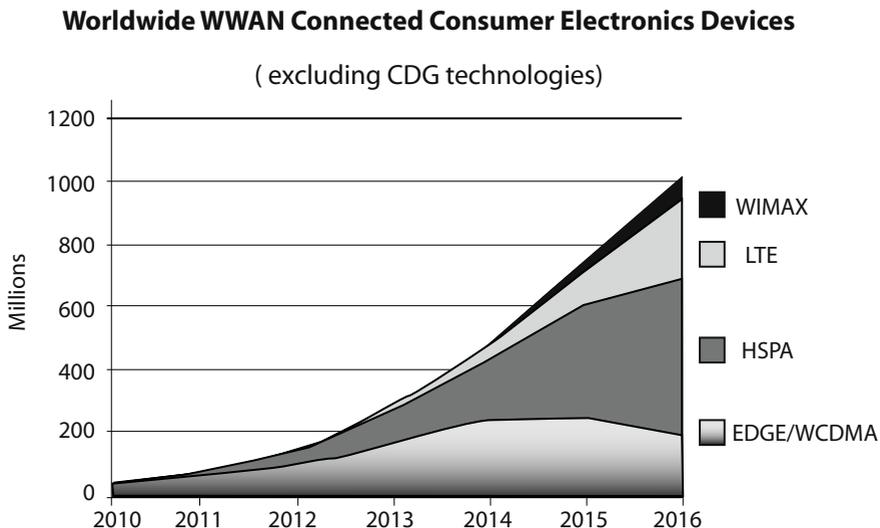
The picture is somewhat different when we focus on connected consumer electronics devices (chart further below.)

In this case we see connected CE devices to a large extent adopting HSPA as the connected CE device market booms, primarily because HSPA should be offering the best cost-performance ratio for the next few years.

Though LTE will make a strong showing towards the end of the forecast period, we do not expect to see much LTE in CE devices before then, in part for cost reasons, and in part because many connected CE devices do not yet really need the performance afforded by the adoption of LTE.

It is very clear that for the next five years – if not ten – there will be several radio standards co-existing to support CE connectivity. And as we will note further on, this co-existence is a fact in most geographic markets.

Figure 13: WWAN CE devices forecast



## 6.3 Cloud versus Server

### 6.3.1 Drivers and barriers for CE to adopt the media server vision

#### Drivers

- Consumers are buying more and more (multimedia) devices, generating significant content
- Some consumers like all their content in one place (server)
- Server offers back-up and virus protection
- Some consumers want to share their content over multiple devices
- An IP based (preferably DLNA Certified) device enables this
- Content would be available to all devices on the IP based home network

#### Barriers

- Extra cost of buying more devices
- Risk of losing all content if the device's local storage fails

- Limited number of DLNA Certified devices in the average consumer home today
- Wi-Fi can be poor quality, impairing video quality in the home
- Many data formats and encryption schemes to cope with
- The hassle of setting up and managing a home network

### **6.3.2 Drivers and barriers for CE to adopt the cloud media vision**

#### ***Drivers***

- Leverages the power and flexibility of the Internet to provide content acquisition and management
- The ability of CE to retrieve online content and services is a potential game changer for manufacturers and content producers
- Lower cost CE, no need for extra intelligence and processing on the devices themselves
- Universal platform that can extend to TVs, Blu-ray Disc players, media servers, gaming consoles, mobile devices and other CE products
- Driving "3-screen" services (also easier set-up and maintenance based on cloud services)

#### ***Barriers***

- Consumers are used to owning content, e.g. CD or DVD
- Consumers are not familiar with cloud based techniques such as virtualisation
- Preferring instead to organise their own content files
- Quality of Service (QoS) depending on broadband speeds available when streaming content from the cloud
- Limited scope for hardware differentiation
- Low intelligence devices means devices can become commodities

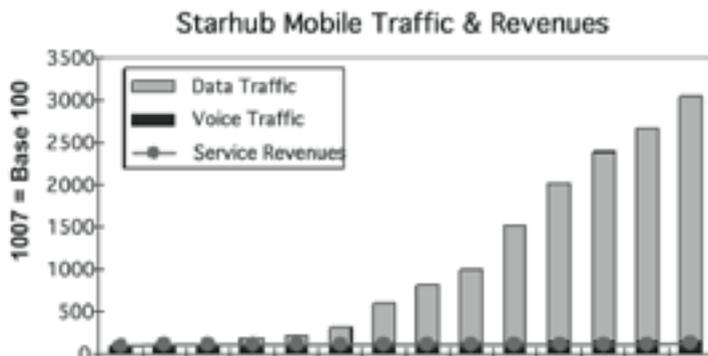
## 7 Economics and Business Model

### 7.1 Operators must find ways to increase traffic revenues

Mobile operators in particular are often considered the primary players in mobile broadband and the development of new digital content delivery and service models. Other key actors – notably device vendors and content providers – tend to look towards the operators to bring the pieces together, to provide the glue and to contribute business and revenue model innovation.

However, a starting point for mobile operators is that they have been facing the challenge of exploding mobile data traffic not being less than matched by revenue growth. For many years previously, mobile data remained behind industry expectations and then-new 3G networks were far below capacity. Other players and industry observers called for flat rate data tariffs to unleash the large anticipated latent user demand. When flat rate tariffs were widely adopted, mobile data usage did go through the roof as expected and networks began to fill up and even experience pockets of congestion.

Figures 14 and 15: Examples of mobile operator traffic and revenue growth



Operators have done a good job at managing that traffic load. CAPEX has not increased as a percentage of service revenues despite the explosion in traffic and OPEX is very much under control too. However, the disparity between traffic growth and revenue growth must be considered since this will either become a problem at some point or operators simply need to think about value creation on their networks in different ways.

The possibly biggest threat to operators, on the other hand, may come from the so-called over-the-top digital (OTT) content providers. Operators wholesale their networks to this new breed of Internet companies as part of a balanced retail/wholesale strategy, to fill their networks and attracting new users to the networks.

Whilst OTT does not threaten to replace services that are core to the telco operators business, such as Voice, Messaging and Data, there is a valid threat that in future customers will develop closer relationships with these players than with the network operator who will then face the often cited "dumb pipe scenario". Here the commoditisation of services would accelerate and operator revenues under even more pressure. This in turn could potentially impact operators' ability to invest in LTE networks.

Probably the most popular strategy option for operators in this situation is that of "smart pipe" provider. This strategy is focussed on partnering with Internet companies to avoid competing with them and entering into a potentially losing battle. Operators do possess many assets and strengths they are bringing to the party, in particular the entire sphere of network management including infrastructure operations, subscriber management and the actual customer databases that can be of great value to third party content and service providers.

### **Early Stage Market: Pricing and fair use policies to manage traffic**

In European mobile broadband pricing there are now only few plans left with no usage limit. Usage caps have become a favoured solution over hitting customers with overage charges. The ratio in favour of overage charges versus usage caps decreased from 70:30 in mid-2008 to 55:45 in 2010 where in most cases operators now apply speed reduction if the agreed cap is breached. Though some speed reductions are threats only in reality and operators are generally sensitive to keep high usage customers satisfied.

T-Mobile recently suggested that average usage levels have stagnated due to fair use policy, and that strong customer satisfaction on mobile broadband was due to not overpromising on speed, offering a good network and not even talking about overage charges.

However, going forward differentiated pricing is likely to become the most preferred solution deployed by operators.

## **7.2 New and Evolving Business Models**

### **Tariffs are the key catalyst for service growth**

Tariff innovation will be a key element in driving adoption of mobile broadband services with operators needing to balance the need of appealing to users' wallets without compromising network performance and profits. Price differentiation is a tool as operators have priced services to attract consumer volumes without undermining revenues in the business market. Recent pricing developments include:

- Prepaid services and daily or weekly plans, which will make services affordable for more casual users without having to reduce average revenues per megabyte;
- Homezone plans, which offer a large bundle of data for use at home (or through the cell site covering the home) but more expensive services in the wide area. These have been used effectively in a number of markets such as Portugal and Germany to target landline replacement business, while maintaining a wide-area price point that would not appeal much to a user wanting to consume much data outside the home;
- Peak/off-peak plans, which have a similar effect to homezone plans in making off-peak use more affordable without cannibalising peak (which are business revenues to a large degree);
- Hybrid fixed/mobile broadband plans that bundle at-home DSL use with wide-area 3G data allocations;
- Family offers that allow users to bundle more than one modem into a single plan.

In addition there is now a strong focus on what makes most sense to consumer, such as which brand and sub-brands have best traction, to whom consumers naturally look to for service, whether consumers want service as part of a bundle, whether "pay as you need" service make sense rather than "off-hours", or whether access should best be transparently included with a device purchase or content purchase. This question also relates to who will own billing and customer care and is best placed to provide ease of use and customer satisfaction.

In principle there are three options in the main triangle of player relationships, i.e. the lead can be assumed by the operator, device vendor or content/media companies.

Table 5: Principle partnership models

Operator Lead	Device Vendor Lead	Content/Web 2.0 partner
<ul style="list-style-type: none"> <li>• Build on presence, multiscreen, in-home VAS building on home gateway with integrated femto</li> </ul>	<ul style="list-style-type: none"> <li>• Build on device centric brand experience and/or excellent user interface</li> <li>• Could offer introductory service bucket/period with device purchase</li> </ul>	<ul style="list-style-type: none"> <li>• Focus on extension of online/content extension to multiscreens</li> <li>• Access could be bundled in content price</li> </ul>

Verizon's Open Development Initiative provides an example of a flexible operator approach to the challenges of trying to establish mutually successful partnership with other players for the benefit of mobile broadband development.

## Managing the Mobile Broadband Ecosystem: Verizon's Open Development Initiative

Figure 16: Example of a leading operator's approach

<b>Retail Model:</b> Device developer responsible for all sales & customer support. VZW will activate devices and provide data plan	<b>Wholesale Model:</b> Device developer buys wholesale capacity and builds own plans. Device developer "owns" the customer.	<b>Custom Model:</b> VZW sees need for flexibility –a 3rd way (e.g. charge device partner retail rates for device sold with free data)									
<table border="1"> <tr> <td data-bbox="115 391 213 560"> <b>Integrated PDA</b>              • Construction            • Government         </td> <td data-bbox="216 391 314 560"> <b>Digital Camera</b>              • Journalists            • Insurance Companies         </td> <td data-bbox="316 391 408 560"> <b>Gaming Device</b>              • Young Adults            • Parents         </td> </tr> </table>	<b>Integrated PDA</b>  • Construction • Government	<b>Digital Camera</b>  • Journalists • Insurance Companies	<b>Gaming Device</b>  • Young Adults • Parents	<table border="1"> <tr> <td data-bbox="416 391 515 560"> <b>Fleet Management</b>              • Construction            • Government         </td> <td data-bbox="517 391 616 560"> <b>Home Security</b>              • Homes            • Businesses         </td> <td data-bbox="618 391 716 560"> <b>Marketing</b>              • Public Utilities            • Vending         </td> </tr> </table>	<b>Fleet Management</b>  • Construction • Government	<b>Home Security</b>  • Homes • Businesses	<b>Marketing</b>  • Public Utilities • Vending	<table border="1"> <tr> <td data-bbox="711 391 809 560"> <b>Health Monitoring</b>              • Sensors            • Patients         </td> <td data-bbox="812 391 910 560"> <b>Vehicle Tracking</b>              • Consumers            • Manufacturers         </td> <td data-bbox="912 391 1000 560"> <b>Digital Music</b>              • Mobile            • Fixed         </td> </tr> </table>	<b>Health Monitoring</b>  • Sensors • Patients	<b>Vehicle Tracking</b>  • Consumers • Manufacturers	<b>Digital Music</b>  • Mobile • Fixed
<b>Integrated PDA</b>  • Construction • Government	<b>Digital Camera</b>  • Journalists • Insurance Companies	<b>Gaming Device</b>  • Young Adults • Parents									
<b>Fleet Management</b>  • Construction • Government	<b>Home Security</b>  • Homes • Businesses	<b>Marketing</b>  • Public Utilities • Vending									
<b>Health Monitoring</b>  • Sensors • Patients	<b>Vehicle Tracking</b>  • Consumers • Manufacturers	<b>Digital Music</b>  • Mobile • Fixed									

### The Ecosystem Takes Centre Stage: Partnerships Essential

One of the most important differences between the early stage development of 3G and what we have been seeing with the development of LTE is the realization that growth and success are all about the ecosystem

A number of examples of efforts to develop the LTE ecosystem include:

- Joint Innovation Lab - Verizon Wireless, Vodafone, China Mobile, and Softbank (Japan) formed a venture for to support developers in the creation of mobile applications that can operate seamlessly across multiple operating systems through development of a software platform.
- 4G Venture Forum - Verizon Wireless, jointly with its infrastructure vendors, formed a group that involves several venture capital firms in identifying areas for innovation to accelerate innovation for services that will utilize LTE networks.
- Ng Connect Program - Alcatel Lucent began this program in February 2009 to bring together a range of partner companies in device, content and applications to stimulate innovation for services and new device types to run on LTE and other high-speed networks, and to provide opportunities to test out solutions in laboratories to identify issues and support integration. The program is organised around five key areas: consumer media and entertainment, enterprise collaboration and e-healthcare, automotive connectivity, digital signage and computing experience.

### The wireless business model is critical

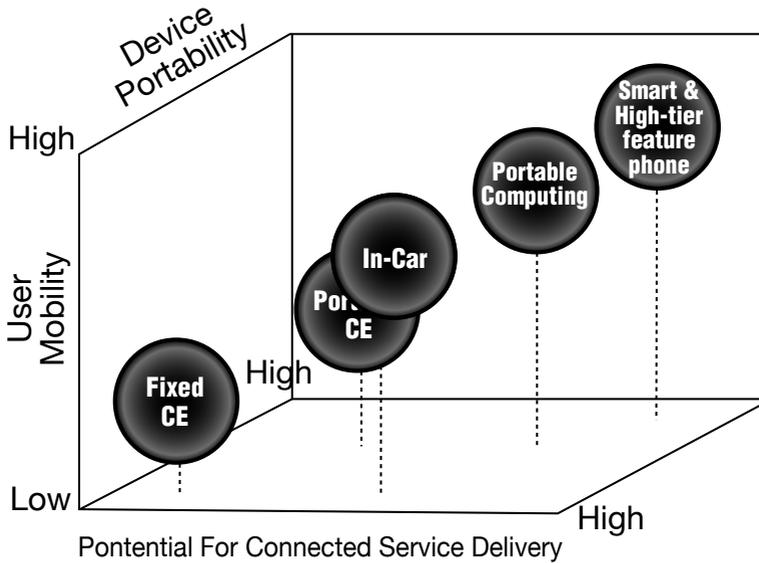
As with Amazon's Kindle, a transparent business model where wireless costs are embedded in the device price (or the cost of content/applications) is the most consumer friendly option. It's a model that will likely be found in most of the future emerging device scenarios we envision.

It is likely to become more difficult for consumers to digest the value in devices using pay as you go or subscription models

The potential in these business models of course rests in the appeal of the content they want to download and the need to access it while mobile

Defining where a device sits across the portability/mobility matrix will largely determine the type of and level of pricing that wireless can seek to monetize on these new devices.

Figure 17: Portability and mobility in the context of business models



## 8 The Regulatory Position

### Most regulators are likely to adopt a hands-off approach:

- Let the market develop freely as much as possible;
- Intent in not to influence the market either not even through thought leadership;
- In the US at least, mobile operators are free to try and deliver any service including multi-channel TV should they wish to.

It can be expected that most regulators in Western and developed markets will adopt a fairly hands-off approach to mobile broadband, embedded devices and LTE. Led by the FCC of the US and Ofcom in the UK, it is generally felt that the market is best left to develop with as little intervention as possible. The regulator will step in to prevent collusive behaviour and anti-competitive practices by dominant players. However, this study has not found any signs that the advent of mobile broadband and LTE networks will require any particular regulatory measures.

Spectrum allocation is the key area where regulators get active and where they can and will to an extent influence the development of next generation networks and services:

- The European Commission proposes allocating the European digital dividend spectrum for Mobile Broadband by January 2013.
- Significant differences exist between countries in terms of when new spectrum becomes available and how it can be used.
- Some countries including the UK are set to face delays in auctioning new spectrum. This involves debates on how spectrum can be used especially in the context of incumbents versus newer operators.
- In the US operators are free to use spectrum in any way they like whereas other markets may see limitations and conditions put in place as was with 2G and 3G.
- In some markets regulators (or rather government) could influence the market by favouring one technology (and even players) over others. In this context, common are practices of technology vendors in particular actively lobbying governments and their relevant departments by promising certain levels of technology and service penetration.

Furthermore, no evidence was found that regulatory bodies could decide to limit or exclude certain devices from being WWAN connected on the grounds of potential privacy issues.

However, spectrum harmonisation could become a critical issue where regulator policy could and would affect the development of mobile broadband. Specifically, harmonising spectrum could hinder market development as players would find it costly – and in some cases uneconomical – to support a large variety of spectrum bands.

In conclusion, the above issue represents the key area where regulation influences the emergence of connected CE devices.

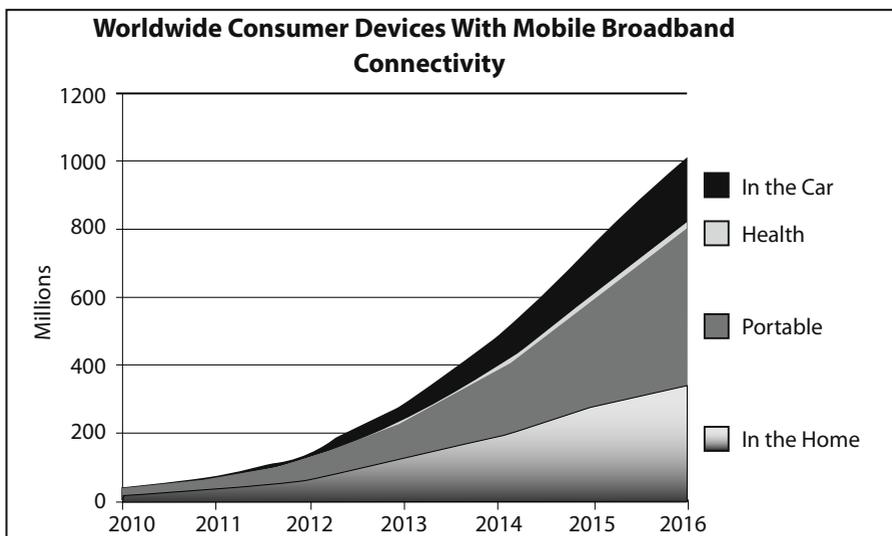
## 9 Forecasts

### Top Line Projections

- Connected CE Devices worldwide should attain over 1 billion in 2016
- Faster growth than the overall wireless market
- Devices for pedestrians on the move will represent the lion's share of these devices
- LTE CE Devices could number 250 million
- Nearly a quarter of all LTE devices in 2016

As noted above, worldwide connected consumer devices could well exceed 1 Billion by the year 2016

Figure 18: Global forecast CE devices with mobile broadband connectivity



Currently, the market is in the early stages of mobile data adoption, and enterprises, vertical markets, and consumers are beginning to understand the benefits of mobile broadband data and the freedom it offers.

Network stability, higher data rates, improved backhaul and the migration to LTE will all serve as factors in improving the user experience.

But the flipside is the burgeoning device market.

In addition to the installed base of established devices such as notebooks, new devices such as Netbooks, MIDs, PNDs (personal navigation devices), e-Book readers and media tablets such as the iPad will all dramatically increase the number and type of devices wanting to access the cellular data network

Moreover, growth in traditional low bit rate M2M traffic will increase as more objects become connected to the network

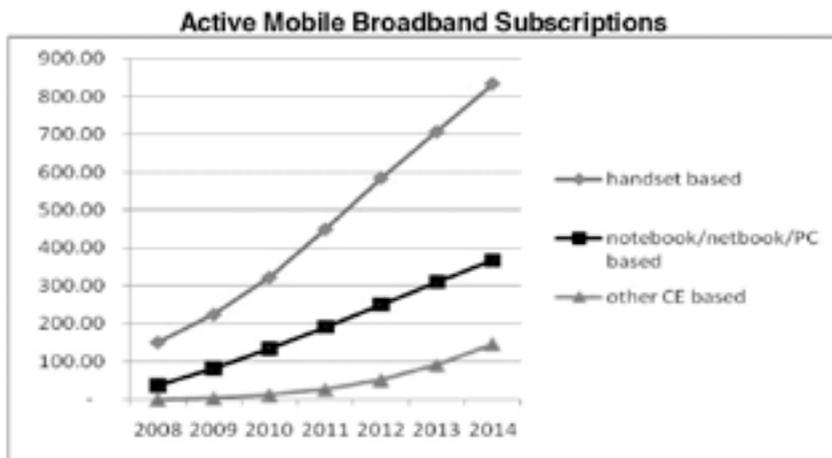
### Market for mobile broadband showing strong growth

Wireless data revenue is growing at high year-over-year rates in developed markets

Annual global smartphone sales growth is of approximately 28% in 2010, while mobile broadband card sales will have grown 43% in 2010. Growth should be even steeper in 2011, with smartphone sales achieving over 50% growth and broadband card sales maintaining a rate of growth over 40%. The real story is that towards the middle of the decade, non-traditional Consumer Electronics devices (namely NOT phones or data cards), should be the fastest growing mobile broadband device class.

The chart below shows active mobile broadband subscriptions. "Active" only includes those devices whose users have deliberately signed up for a mobile broadband line rental. Of course, these users are but a fraction of the users who are on mobile broadband networks without being aware of it.

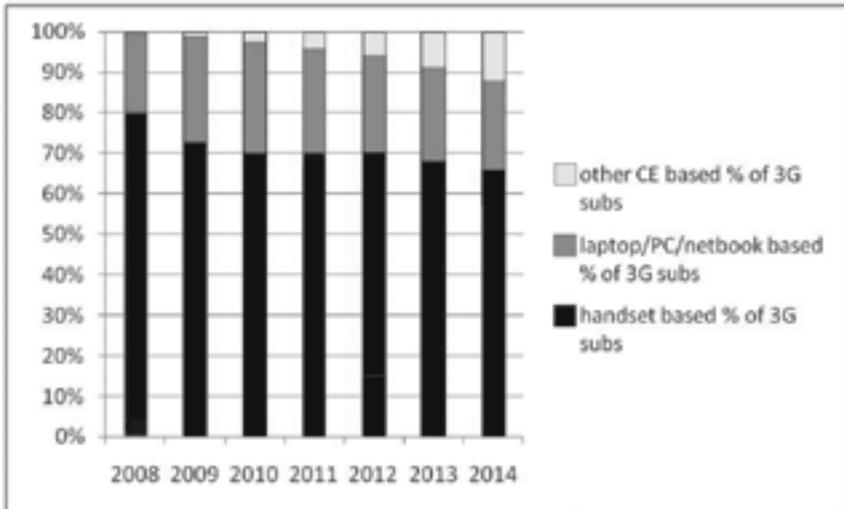
Figure 19: Mobile broadband subscription forecast



Mobile connectivity, while growing rapidly, has lagged performance gains in core computer technology, potentially leading to pent-up demand for more robust mobile connectivity in the form of mobile broadband-enabled notebooks, netbooks and increasingly sophisticated smartphones.

With so many different applications appealing to a wide range of users, smartphones continue to increase their penetration in a variety of mostly developed markets.

Figure 20: Breakdown of CE devices with active 3G connectivity



### Still Low data Penetration Today

Even in developed markets where voice penetration is extremely high, data card and smartphone penetration is relatively low

As Figure 20 on the previous page shows, mobile datacard (embedded and external) subscribers are relatively modest at 28.6% globally in 2010 (as a percentage of overall wireless data subs)

Today the number of active broadband subscribers is still modest at just below 10% of all wireless subscribers.

### Emerging Markets a Long Term Mobile Broadband Growth Driver

While the bulk of growth in mobile broadband data will occur in developed economies in the short term, demand in emerging markets will become a strong growth driver over the long term.

In terms of USB modem sales, Europe has been the most aggressive market by far. Yet with over half the world population possessing mobile phones, the current scope and potential of the larger mobile market becomes clear

Growth will be driven by several factors:

Rapid wireless subscriber growth in the developing markets: China, India, Latin America, and Eastern Europe are experiencing high subscriber net additions and ARPU growth. Data services are in their nascent stages for these markets. In the poorest of nations, lack of traditional infrastructure opens the door to unique opportunities for mobile data usage.

Developing markets are likely to use more wireless data as a primary means of connectivity. Poor landline infrastructure and rapid mobile growth will drive mobile data adoption.

However encouraging, basic penetration only tells part of the story. In the developing world, some carriers have overall ARPU as low as \$4. Yet users own cell phones despite a lack of running water or electricity

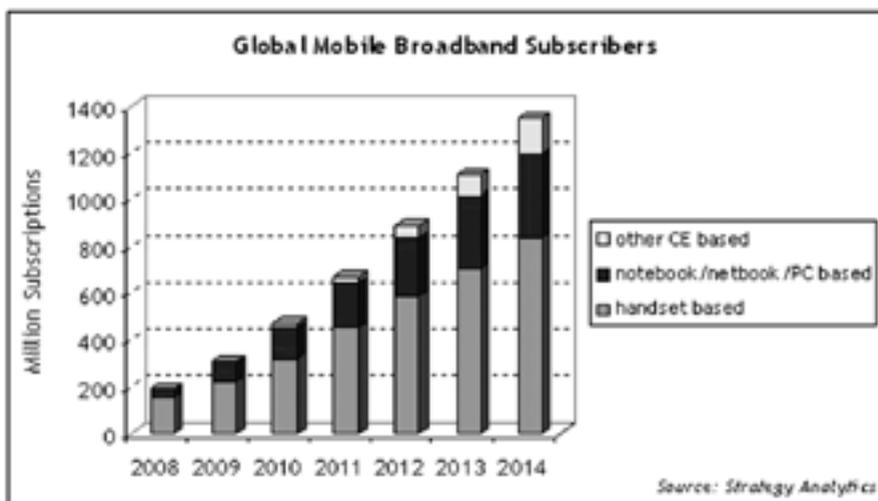
These subscribers will increase their mobile spending as their incomes rise and the breadth of value-added services provided by carriers expands

At the same time, they will likely begin to use the non-voice characteristics of their phones and become data customers.

### Mobile Broadband Forecast by Device Class

Smartphones and the notebook/netbook categories will continue to dominate mobile broadband, at least in terms of active users (namely users who have made a deliberate decision to avail themselves of mobile broadband services.)

Figure 21: Active Mobile broadband subscribers by device type



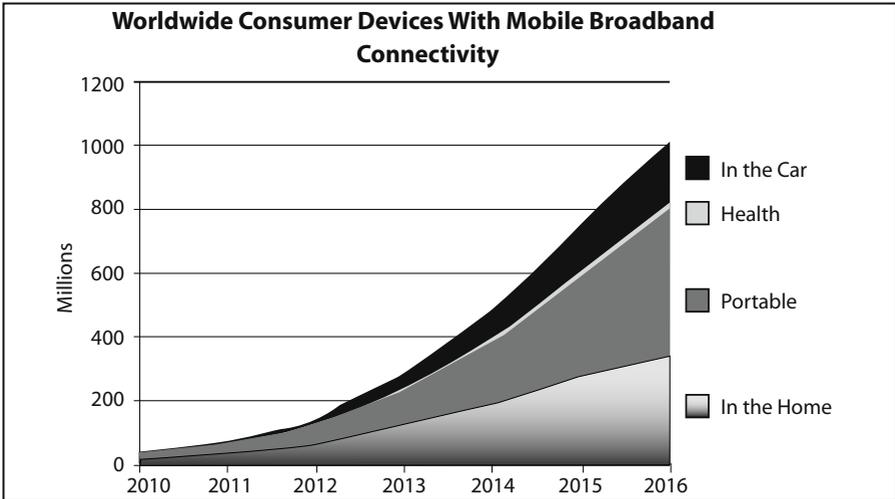
### Portable CE Apps Drive the Market

Though portable Consumer Electronics devices are the largest category of CE devices with WWAN connectivity, devices designed for in the home use are not far behind.

The category that will have difficulty emerging is that of Health, primarily due to budgetary issues.

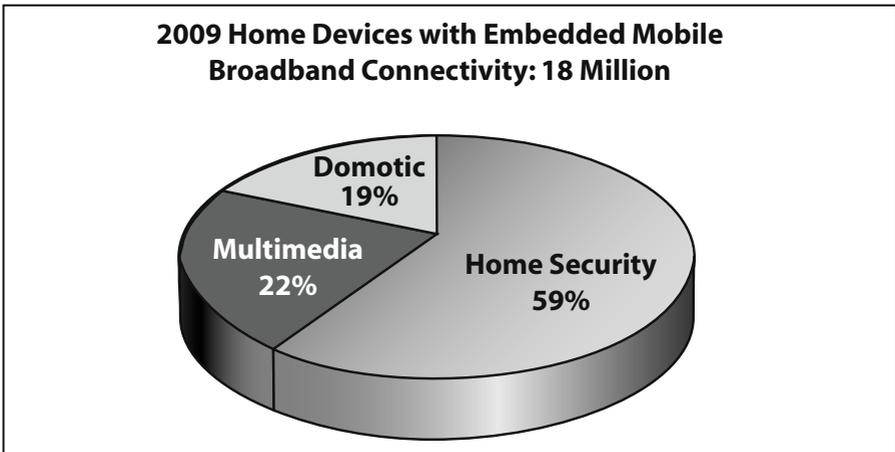
Portable consumer applications are fairly well known, and their growth is well documented. The really interesting story is that of in-the-home devices, which will grow significantly, whilst changing their mix of types of devices.

Figure 22: Connected CE devices by type/category



As illustrated below, the 2009 market for in-the-home devices with mobile broadband connectivity is dominated by security devices, typically alarm systems with remote video surveillance. Domotics and multimedia share the remaining 40% of a modest 18 Million unit installed base.

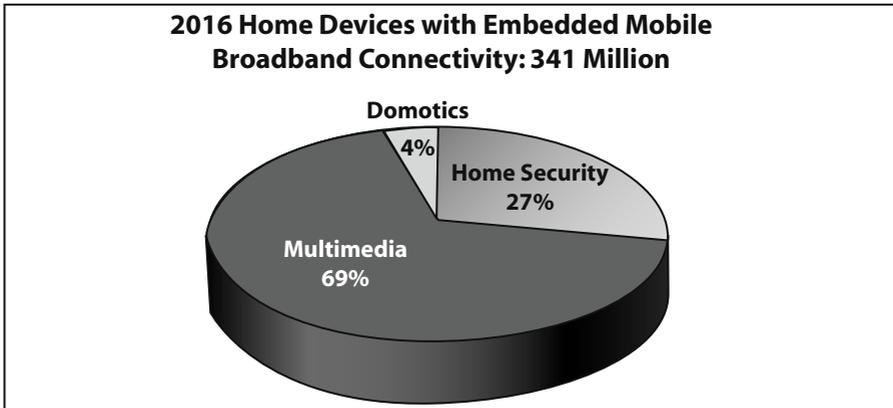
Figure 23: Home CE devices with embedded connectivity by type in 2009



By 2016, we expect the home device market to have mushroomed, to attain an installed base of 341 Million units.

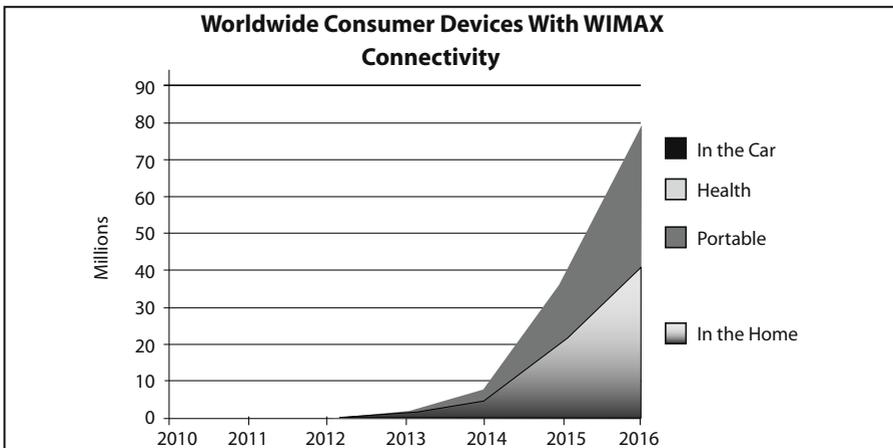
Mobile broadband-connected multimedia will by now represent 69% of the installed base. Though domotics will have seen healthy growth, given the relatively weak usage case for mobile broadband-connected domotics, its growth will have been slower than that of either multimedia or security.

Figure 24: Home CE devices with embedded connectivity by type in 2016



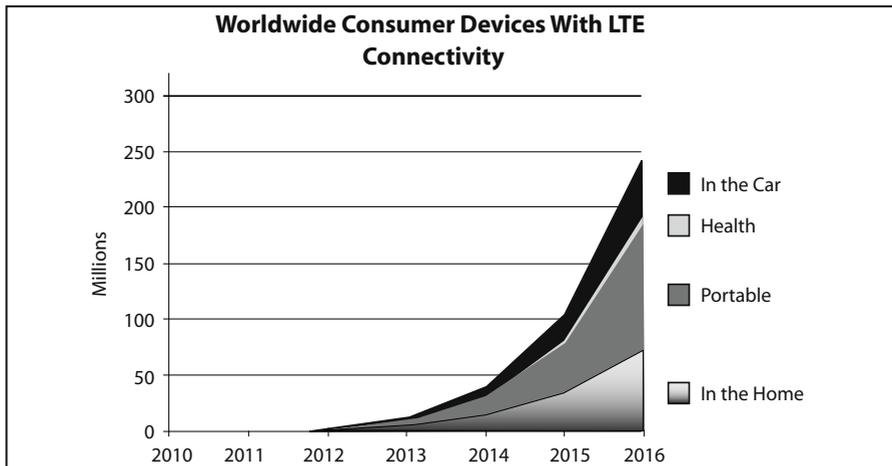
Given the performance of WiMAX, and its limited deployment, we do not expect significant use of WiMAX for either automotive or health applications.

Figure 25: Forecast CE devices with WiMAX connectivity



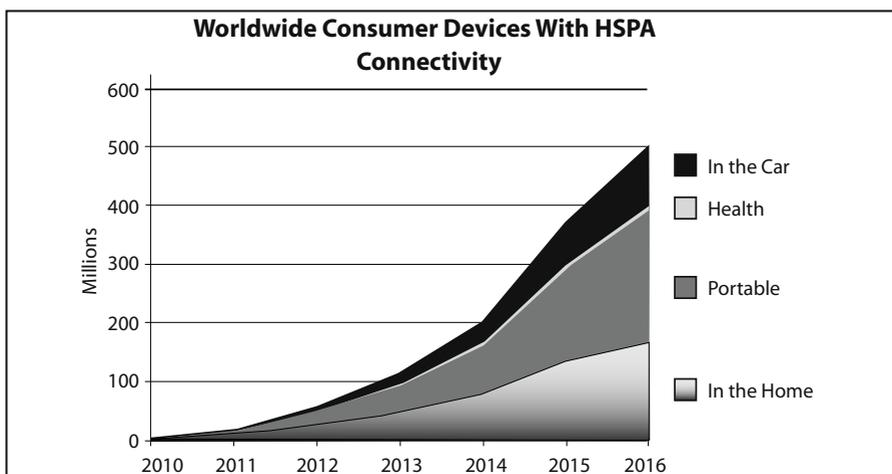
LTE will be driven first by portable devices, and then very quickly by in-the-home devices, with automotive applications showing strong growth as of 2015.

Figure 26: Forecast CE devices with LTE connectivity



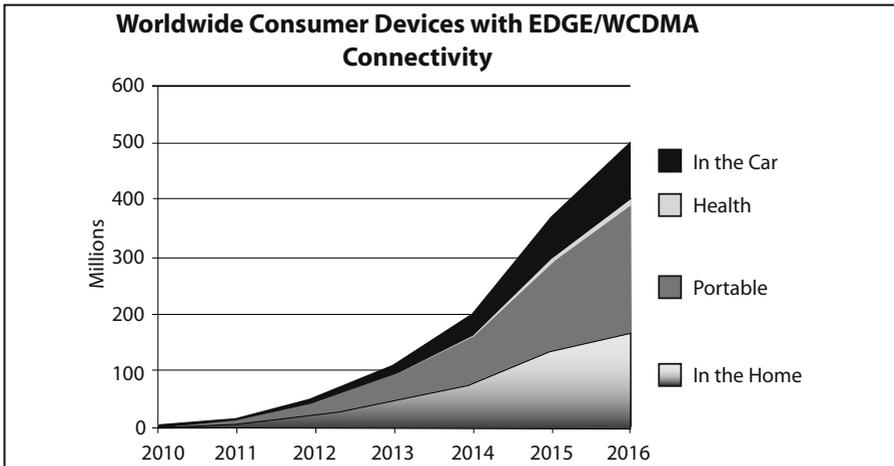
HSPA will be the workhorse technology for the forecast period, particularly for in-the-home and in-the-car applications, where its performance and its maturity will be strong assets.

Figure 27: Forecast CE devices with HSPA connectivity



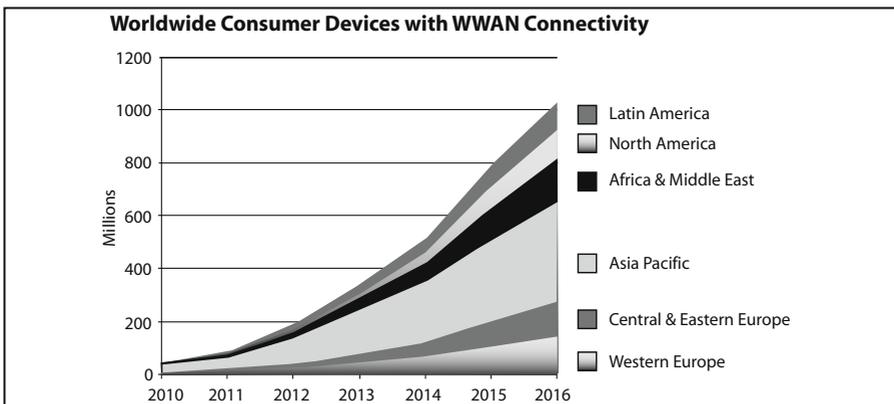
Finally EDGE & WCDMA will also play major roles in the forecast period, particularly in regions late to deploy LTE and/or HSPA.

Figure 28: Forecast CE devices with EDGE/WCDMA connectivity



If we examine regional markets, clearly Asia-Pacific will be the largest market, with an installed base representing close to 40% of the world market in 2016.

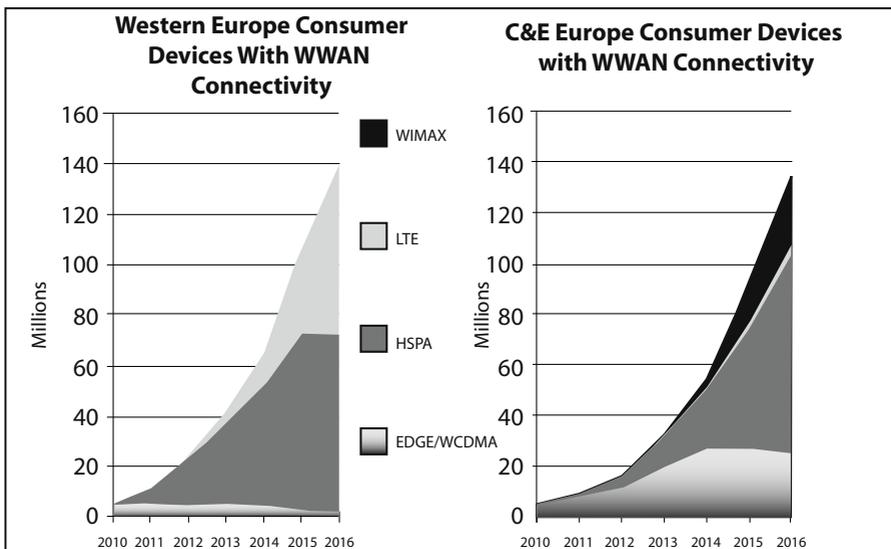
Figure 29: Forecast CE devices with WWAN connectivity



Due to the lack of a wireline infrastructure, we anticipate the African market to be as big as Western Europe's. (NB: Our data does not include CDMA lines, thus the Americas are certainly under-represented.)

Western and Eastern Europe will be a study in contrasts, as illustrated below:

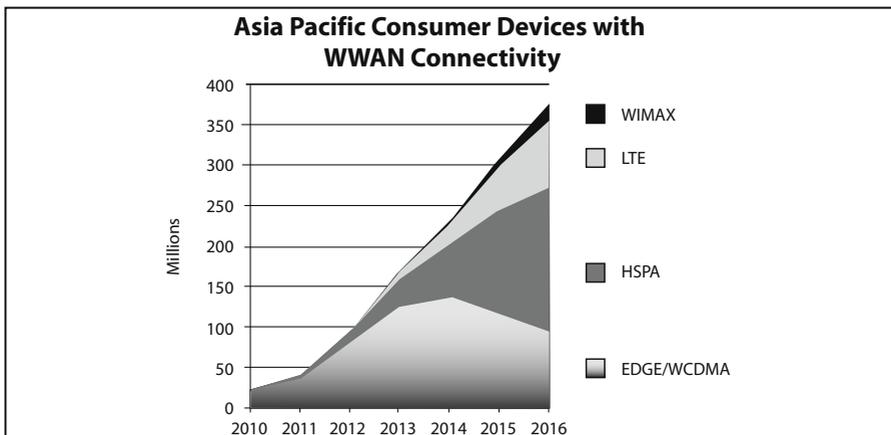
Figures 30 and 31: Forecast CE devices with WWAN connectivity WE and CEE



We anticipate that HSPA and then LTE will be the technologies of choice in Western Europe, whereas Central & Eastern Europe will employ EDGE & WCDMA for a longer period and in fact may deploy WiMAX solutions faster than LTE.

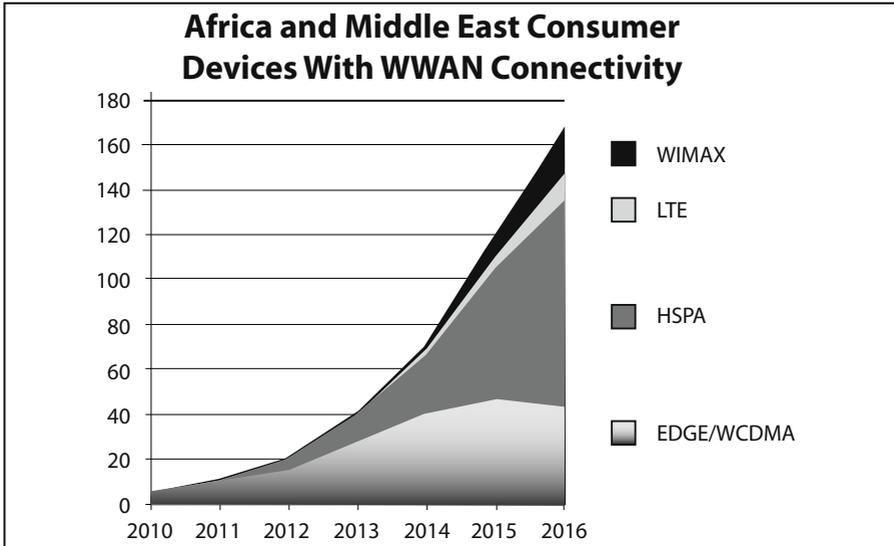
As previously mentioned, Asia-Pacific will be the world's biggest market, but with a diversity of technologies.

Figure 32: Forecast CE devices with WWAN connectivity in APAC



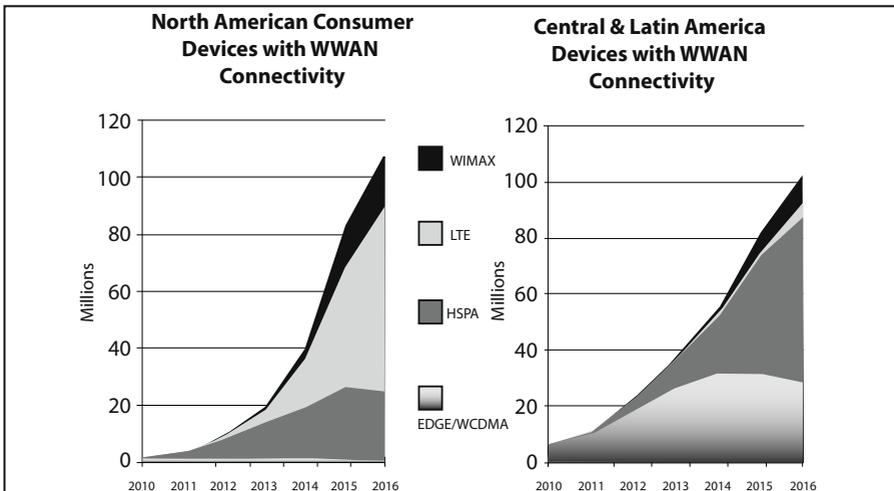
growth during the forecast period, as mobile broadband solutions make up for non-existent wireline. However, the mix of applications will no doubt be different, with less multimedia, and more domotics.

Figure 33: Forecast CE devices with WWAN connectivity in ME&A



Finally, the America's will show similar growth but with different technology mixes.

Figures 34 and 35: Forecast CE devices with WWAN connectivity in NA and CALA



## Study Approach

Strategy Analytics (SA) has applied a standard three-phased project methodology that involved:

- Mobilising the knowledge bases maintained by ongoing research by SA's Global Wireless, Tariff and Revenue Strategies, Digital Consumer, Global Automotive and User Experience Practices
- Secondary data from SA's in-house database, external sources
- Interviews with industry players from across the wider spectrum and globally

*Table 1: List of Companies Interviewed By Type of Player*

<b>Operators</b>	<b>CE Vendors</b>	<b>Technology Vendors</b>	<b>Other Players</b>
AT&T	Archos	Alcatel-Lucent	Bertelsmann
China Mobile	Bosch-Siemens	Ericsson	Delphi
DTAG	Chumby	Huawei	FCC
FT/Orange	Lenovo	Infineon	Garmin
Korean Telecom	Parrot	Nokia-Siemens	Ofcom
NTT	Samsung	Qualcomm	PSA
Reliance	Sony	Sierra Wireless (Wavecom)	TeleAtlas
Telefonica	Whirlpool	Texas Instruments	
Verizon		ZTE	
Vodacom			

## Glossary

API	Application Programming Interface
App Store	Originally a service for the iPhone, iPod Touch and iPad created by Apple which allows users to browse and download applications from the iTunes Store that were developed and published through Apple. These "apps" are available either free or at a cost and can be downloaded directly to target device, or downloaded onto a computer via iTunes. After the success of Apple's App Store, and the launch of similar services by its competitors, the term "app store" has been used to refer to any similar service for mobile devices. However, Apple claims "App Store" as a trademark.
Capex	Capital expenditure
CDMA	Code Division Multiple Access
CE	Consumer Electronics
CRM	Customer Relations Management
DLNA	Digital Living Network Alliance, a non-profit collaborative trade organization comprising more than 250 member companies in the mobile, consumer electronics, PC, and service provider industries.
Domotics	Home automation, i.e. the residential extension of "building automation" including centralized control of lighting, HVAC (heating, ventilation and air conditioning), appliances, and other systems, to provide improved convenience, comfort, energy efficiency and security.
EBR	e-Book Reader
Femtocell	A small cellular base station, typically designed for use in a home or small business.
HD	High Definition
HIPAA	Health Insurance Portability and Accountability Act was enacted by US congress in 1996.
HSPA+	Also known as Evolved High Speed Packet Access, a wireless broadband standard as defined in 3GPP (3rd Generation Partnership Project) Release 7
LBS	Location-Based Services
LTE	Long Term Evolution, the last step in development of 3G mobile broadband systems, before the eventual arrival of "true" 4G systems (IMT-Advanced).
M&A	Mergers Et Acquisitions
MID	Mobile Internet Device
MVNO	Mobile Virtual Network Operator, a company that provides mobile phone services but does not have its own licensed frequency allocation of radio spectrum, nor does it necessarily have all infrastructure required to provide mobile telephone service.

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Opex	Operational expenditure
OTT	Over-The-Top, i.e. delivery of video content and applications over an alternative means than the main video delivery infrastructure e.g. live video delivery through digital terrestrial and accessing content or applications through the Internet.
QoS	Quality of Service
Smart Grid	Overlays the electricity distribution grid with an information and net metering system. A smart grid delivers electricity from suppliers to consumers using digital technology with two-way communications to control appliances at consumers' homes to save energy, reduce cost and increase reliability and transparency.
TD-SCDMA	Time Division Synchronous Code Division Multiple Access is an air interface found in UMTS mobile telecommunications networks in China as an alternative to W-CDMA.
Tier 1	Automotive industry term meaning Tier 1 Supplier of vehicle equipment such as radio and navigation systems. Leading examples include Bosch and Delphi.
Web 2.0	Web applications that facilitate interactive information sharing, interoperability, user-centred design and collaboration on the World Wide Web. Examples of Web 2.0 include social-networking sites, blogs, wikis, video-sharing sites, hosted services, web applications, mash-ups (a web page or application that uses and combines data, presentation or functionality from two or more sources to create new services).
WiMAX	Worldwide Interoperability for Microwave Access: a telecommunications protocol that provides fixed and fully mobile internet access.



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