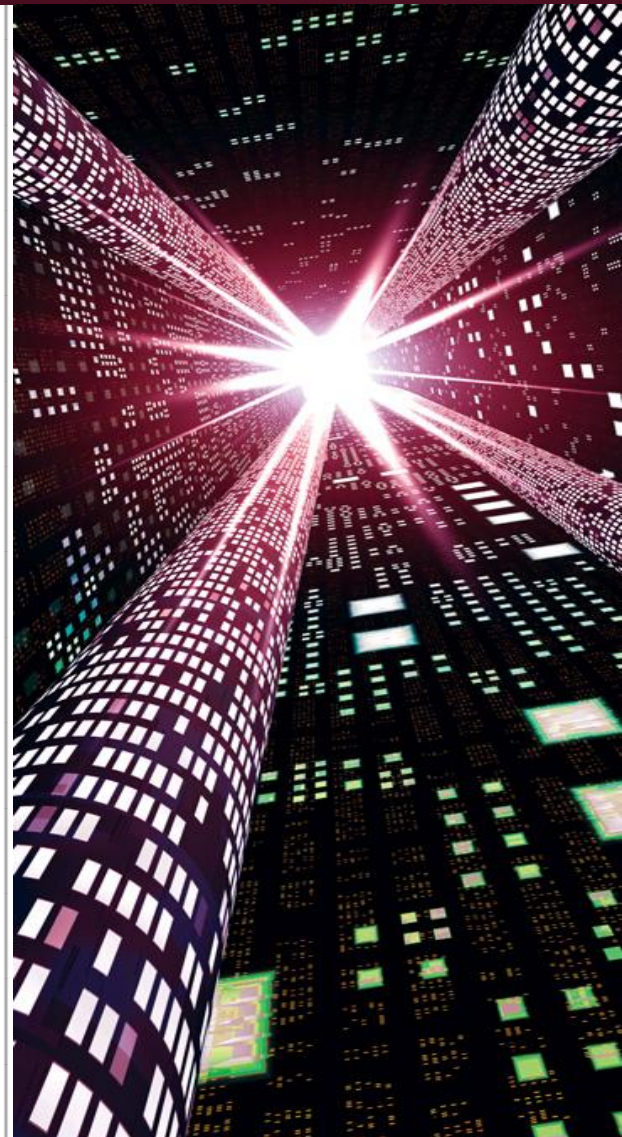


# A Viable Future Model for the Internet

*ATKEARNEY*





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## Executive Summary

The Internet is playing an increasingly important role in the lives of people around the globe and more than ever underpins a significant portion of economic activity. Within its short lifespan it has already delivered huge economic and social benefits in the form of reduced transaction costs, increased competition and lower prices for many goods and services while offering greater access to information and a whole new means of communication, education, information, commerce, political debate and entertainment. Yet this report makes clear that for growth to continue, the next few years must see a realignment of who captures the value and who funds investment in the Internet value chain.

Given its economic and social importance, it is no surprise that the Internet has a political dimension. Most governments and regulatory authorities see wider Internet access as something to be encouraged and promoted; some are considering subsidising services that would not be commercially viable to ensure that 100% of their population have access. Debate has also extended into the question of what constitutes a “level playing field” for competition and the right model to govern consumer and property rights. There is a widespread expectation among policy makers and the wider public that the Internet will continue to function well and support future growth. That expectation will be disappointed without significantly higher levels of investment; however, such investments will not materialise without changes in the economic model.

Recent traffic growth figures and mid-term forecasts for future growth are impressive but raise serious challenges regarding the viability of the current Internet model in the future. Internet traffic delivered via fixed networks is growing at 35% p.a. and via mobile networks at more than 100%, all underpinned by new, more capable devices and new high-bandwidth services unleashed by a fresh wave of innovation. Above all, video content is having a dramatic effect on Internet usage. Yet the Internet risks becoming a victim of its own success as this video traffic, much of it free to the end user, threatens to swamp available network capacity and cause unacceptable levels of congestion for users of all services.

Technology can again provide part of the solution, both in terms of higher capacity networks and greater use of traffic management techniques including compression and caching. This will not be sufficient because of two cumulative effects. First of all, there are limited economic incentives for Online Service (or “Over the Top”) Providers to use network bandwidth efficiently. Secondly, the investment case for such solutions is currently weak, because of a structural disconnect in the Internet value chain.

As this report explains in some detail, those who benefit from higher traffic volumes are those who generate traffic (typically content sites) and those who consume it (typically end users). Those who have to build and operate the networks required to carry these traffic volumes earn almost no revenue from the former group and are often locked into flat rate price schemes with the latter group, continually decreasing because of retail competition. Economists often refer to such “two-sided markets” in terms of virtuous cycles, where each side pays enough for the entire market to grow to everyone’s benefit. Because of the disconnect between sources of revenue and sources of

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cost in the Internet today, however, this two-sided market is simply squeezing value out, undermining future investment and the associated benefits of growth and innovation.

If networks were upgraded to address the forecast capacity needs to 2014 with no new price signals or increase in revenues, we forecast that network operators would see their returns on capital decline by 3 percentage points to around 9% and potentially as low as 7%. This is far below their cost of capital under any normal scenario and incidentally far below the returns enjoyed by the Online Service Providers that are creating demand and generating high traffic volumes.

Maintaining current levels of returns in the telecommunications networks (or “Connectivity” sector) while investing to maintain current network performance in Europe would require additional revenue of €28 billion per annum by 2014 to justify the necessary investments in fixed and mobile networks. This is about 10% of the total telecommunications market today. Considering the backdrop of declining revenues from traditional services (especially voice) and intense competitive and regulatory pressure, raising additional revenue of this order of magnitude will be a challenge. Our analysis, detailed in Section 3 and the Appendix, considers only the incremental investment needed to maintain current performance levels in fixed and mobile networks as traffic levels rise. There is a separate discussion for the longer term about the deployment of fibre to the home (FTTH), which would enable new, even higher bandwidth services. Although, of course, the value chain will also need to provide a sustainable revenue base for this investment.

There are a number of possible options for new models that may rectify the problems described and ensure adequate capacity increase to sustain the correct functioning of the Internet to the benefit of all:

- **Modification of retail pricing schemes:** Increase end user prices, with a likely expansion of volume-dependent pricing to impact heavy users
- **Traffic dependent wholesale charges:** Introduce a reasonable traffic conveyance charge at the wholesale level, which would constitute an increase over current transit pricing but still represent a tiny fraction of the market price for legitimate high-bandwidth content
- **Enhanced quality services over the public internet:** Deploy widespread, standards-based differential quality of service, with commitments of higher performance charged at a premium to Online Service Providers that need and request this; revenues cascade down the value chain, reimbursing those who invest to enable higher service levels
- **Enhanced quality services based on bilateral agreements:** Ensure further evolution of the market (as has already started) via a series of bilateral commercial arrangements operating in parallel to the current Internet model and addressing the needs of high-bandwidth users, freeing up capacity for others

For each of these options, charging models could relate to total traffic (a certain price per gigabyte), to certain types of traffic (based on quality of service needs), or to certain types of providers (based on their business model and willingness to pay). The structure and level of such charges would evolve under regular competitive forces to reach market equilibrium as in other two-sided markets.

Section 4 of this report demonstrates that no single solution can solve all the structural issues. Instead we expect the right answer for the industry to be a hybrid of these different options. Each

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option has its own merits but it is too early to dictate which should succeed and which, if any, should be discarded now. We therefore consider it important that policy makers not restrict the process of innovation and competition by which a more viable commercial model for the Internet emerges.

In our evaluation of the options outlined, we have considered the impact on the wider ecosystem, on those businesses and individuals who use the global reach of the Internet every day to find a market or a community. The only negative impact identified would be for those who offer extensive volumes of free video with no legitimate commercial model—often, though of course not always, pirated content. In our opinion, it is not worth choking the Internet for this.

We have also considered the implications for competition and the correct policy response to each option. On balance, A.T. Kearney would argue that all participants in the Internet value chain should continue to have the flexibility and freedom to devise and test new business models in the market. Imposing any specific option, or forbidding one or more, risks preventing the Internet ecosystem from finding efficient solutions to the current structural problems and therefore hindering customers from enjoying high quality, innovative services. Existing general competition law should be sufficient to deal with any potential anti-competitive behaviour that may arise if players with significant market power in any sector of the Internet value chain attempt to abuse that power in changing economic terms to achieve an unfair advantage.

The future model of the Internet is an area of legitimate policy interest for a range of social and economic matters. Our research suggests that so far too little attention has been paid in the policy debate to the core issue described here: how to fund the required investment while a structural disconnect distorts investment incentives. We hope that this report helps shift the attention. Some recent debate on Internet policy has not been helpful in this regard: for instance, a misguided belief that the Internet—or even fundamental principles of free speech and free enterprise—would suffer from the introduction of more balanced and rational charging and traffic management principles. The opposite is true: without clearer economic incentives, congestion will choke off innovation and usage. It is promising that recent consultation exercises and policy statements in the European Union have shown an appreciation of this point, but the policy discussions are still at an early stage.

In conclusion, this report does not call for new legislative prescriptions, regulatory interventions or taxpayer subsidies to address the immediate pressures. Instead, we recommend that policy makers be supportive of commercial initiatives contributing to investment, innovation and more efficient use of the Internet for the benefit of all sectors of the economy.

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## 1 Introduction

This report analyses an important component of the Internet value chain, the commercial model underpinning network infrastructure and the relationship between Online Service Providers (sometimes known as over-the-top “OTT” players) and Connectivity Providers (primarily telecoms companies but also some firms that specialise in Content Delivery Networks). A.T. Kearney has previously<sup>1</sup> analysed each segment of the value chain and considered the different economics and returns of each segment. Our research demonstrates that the primary beneficiary is the end-consumer while the players within each segment of the value chain have had very different experiences in terms of growth and shareholder returns. The leading Online Service Providers and User Interface manufacturers (hardware and software) have captured significant value while Connectivity Providers and Content Rights owners have seen fewer benefits and even, in some parts of the media industry, value destruction.

At the heart of these differences is the disconnect between traffic (as a key driver of the cost base) and revenues. All forecasts point to a continued rapid growth of traffic, not matched by revenue growth. Given this context, four European telecommunications companies—Deutsche Telekom, France Telecom, Telecom Italia and Telefónica—commissioned A.T. Kearney to conduct an assessment of the viability of the current model of Internet connectivity in terms of performance, economics and policy. We also assessed the investments needed to support expected traffic growth and considered broad options on how the current commercial model may need to evolve, especially with regard to incentives and price signals to enable more efficient use of available network capacity and stimulate further innovation in the delivery of end-user services.

It is important to note that this paper has been produced independently and does not necessarily represent the views of any of the sponsoring companies. The paper is intended to inform ongoing public debate and neither the four operators nor A.T. Kearney can be held responsible for any other use that might be made of it. The analysis is based on a transparent methodology as well as public information sources which are summarised in an appendix for those who wish to review the analysis as part of their own deliberations on this important topic.

In this report, we seek to address five key questions,

- What are the current pressures affecting Internet Connectivity—on technical performance, economics and policy constraints?
- How do these pressures impact the key stakeholders, such as end users, Online Service Providers and Connectivity Providers?
- How should the current commercial model evolve to align incentives and to ensure that the Internet continues to develop in a sustainable and efficient manner?
- How can the value chain accommodate the forecast rise in video usage (i.e., over-the-top video streaming) and the demand for new high-speed access services?
- What are the public policy implications in Europe and globally of changing the model or leaving the status quo intact, especially with regard to the current debate around Net Neutrality?

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<sup>1</sup> A.T. Kearney, Internet Value Chain Economics, 2010



## 2 Overview of the Internet

### 2.1 Description of the Value Chain

A.T. Kearney has previously analysed the Internet Value Chain in which we presented a framework divided into five discrete segments, shown in Exhibit 1.

Exhibit 1 – Internet Value Chain<sup>2</sup>



Source: A.T. Kearney analysis

Throughout the (relatively short) lifespan of the Internet, there have been rapid and ongoing changes in every segment of the value chain. Content Rights owners continue to experiment with commercial models that protect and extend the value of their content. Online Services continue to evolve from the initial free-for-all of the dotcom boom, with powerful players having emerged in many areas, including search, social networking and e-retailing. The enabling technology segment has seen significant growth in innovative service offerings such as cloud computing, content distribution, bespoke and targeted advertising etc. Within the Connectivity segment, the market is extremely competitive, reflected in the continued increase in access speeds and decreasing charges. At the same time the diversity of devices that can be used to access the Internet has grown significantly, allowing users to be connected for longer and access a greater diversity of services from ever more places.

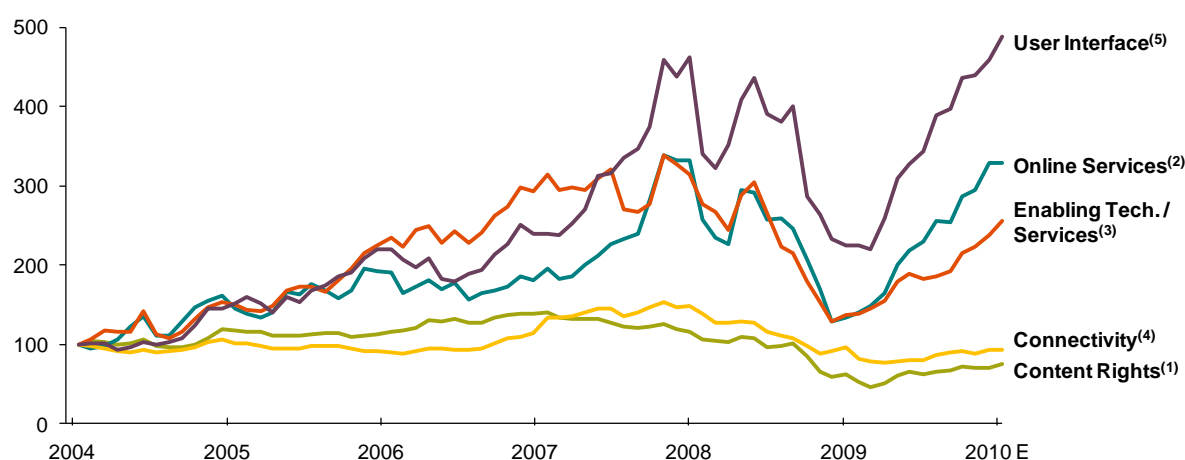
Our research reveals that the imbalance between traffic volumes and revenues also creates significant differences in returns on capital employed for industry players. For example, leading

<sup>2</sup> Company/product names and logos used in this report will often be protected by trade and/or service marks, Please refer to company websites for details.

telecom operators generate returns around 12% (partly due to regulated pricing and high capital intensity) while other key segments such as search, gaming, gambling, and e-Commerce deliver returns of more than 20% and some segments even 30% or more. Our research also demonstrates that revenues for consumer Online Services are growing more than twice as fast as Internet access provision. Of the five main segments, Connectivity and Content Rights players do not appear to have benefited from the growth of the Internet to the extent that the other segments have. Their market capitalisation is the same now as it was five years ago and Exhibit 2 makes clear that this is not simply a feature of the 2008/2009 economic downturn.

## Exhibit 2 – Market Capitalisation by Value Chain Category, 2004-10

- Indexed to Jan. 2004-



(1) Average for Disney, NewsCorp, Time Warner, Warner Music Group, Vivendi & Electronic Arts

(2) Average for Amazon, Google, Yahoo, eBay, Baidu, Expedia & Partygaming

(3) Average for Akamai, CyberAgent, Google, Valueclick, Verisign & WPP

(4) Average for AT&T, Vodafone, NTT, British Telecom, Deutsche Telecom & France Telecom

(5) Average for Microsoft, Apple, Dell, Acer, Nokia & McAfee

Source: Bloomberg, A.T. Kearney analysis

There are many possible reasons for this disparity but, as we explore in this report, the growth of the Internet and consequent growth in traffic carried by Connectivity Providers is not being translated into growth in revenues. We argue that there is a fundamental structural problem with the current commercial model of Internet Connectivity and how it is paid for.

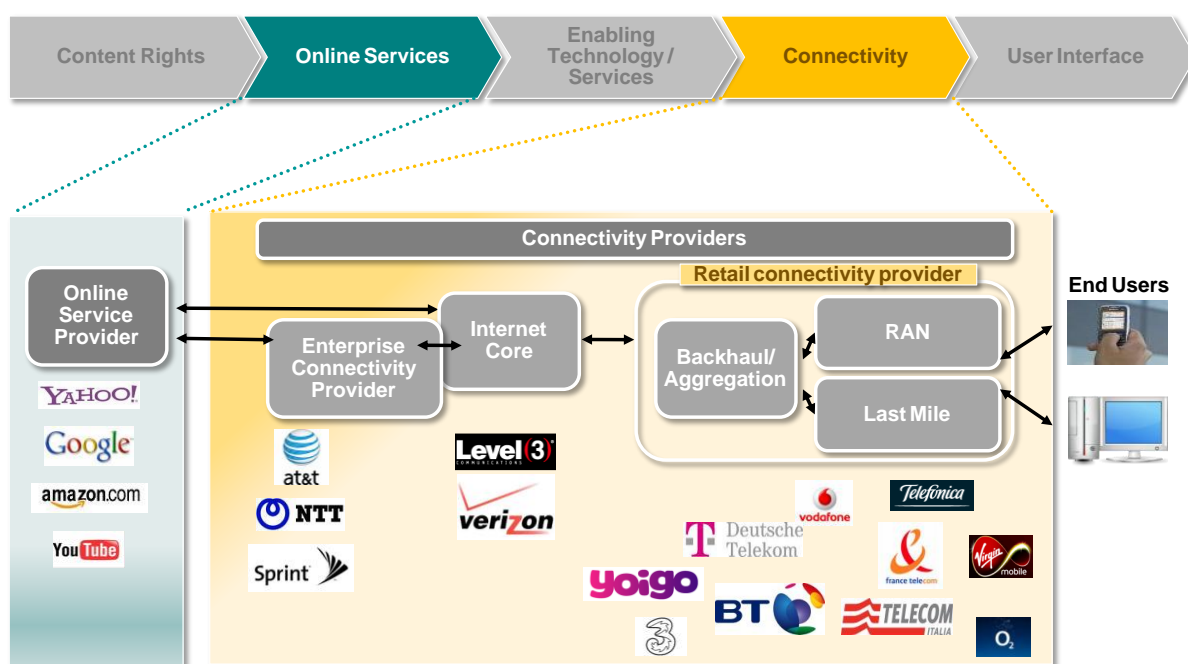
## 2.2 Structure of the Internet

The Internet is an interconnected “network-of-networks” based on open standards and protocols. It originated as a U.S. military network that grew into an academic network linking universities around the world. It took off as a broader service with the invention of the browser and hyper-text linking to provide an easy to use interface. The interconnections allow networks to pass traffic among each other on a “best-effort” basis, that is to say there are no guarantees of how the traffic will be treated or whether it will even reach its ultimate destination. Each participant pays for its own equipment and connection to the network and these charges include a small component to compensate those

who connect the main Internet exchanges.<sup>3</sup> End users pay an Internet access charge, typically bundled with their telephony or TV subscription, to be connected to the Internet. Most Online Service Providers pay a fee to their Connectivity Provider(s) to be connected to the Internet, which is generally based on the bandwidth they require, while the largest ones act as if they were Connectivity Providers in their own right and connect to others via peering agreements. In both cases these charges are generally flat fees, not linked with usage and they form a very small part of their total expenditure/cost structure. In effect, Online Service Providers are paying to connect their services to the network but are not paying for downstream service delivery, particularly to Retail Connectivity Providers since very little, if any, of their payments flow down to other Connectivity Providers in the chain.

For the rest of this report, we adopt network-centric terminology in line with Exhibit 3 to illustrate the key players within the relevant parts of the Internet value chain.

**Exhibit 3: Internet Network Infrastructure**



Source: A.T. Kearney analysis

In this framework the Internet acts as a communications platform, primarily connecting Online Service Providers, who want access to the largest population of potential customers, to end users who want access to the widest selection of services. In performing this function the Internet has been outstandingly successful, rapidly casting aside early “competitors” such as CompuServe, which were offering a similar service within a “walled garden” of fewer users.

<sup>3</sup> A simple analogy would be the cover charge in a restaurant, which does not pay for the food, drink or service to be consumed.

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In microeconomics, this phenomenon is known as a two-sided market—referring to any economic platform that brings together two distinct user groups and where each group exhibits demand economies of scale. In the context of the Internet, Connectivity Providers offer the infrastructure services required to connect two user groups, namely Online Service Providers and end users. The economic concept of two-sided markets achieving optimal pricing structures is well established. A good, non-technical example to illustrate this is the trade-fair—the organiser charges exhibitors for stand space and also charges attendees who visit. The value of the fair to an exhibitor is related to the number of attendees and so exhibitors may expect to pay more to avoid the need for high entry fees. However if exhibitor charges are set too high, some may withdraw and the attraction of the fair to potential attendees declines, which in turn decreases the value of the fair to other exhibitors. The organiser will seek to maximise revenues, taking into account limited floor space and number of visitors that can be accommodated, but always with an eye to the new congress hall in the neighbouring town, which is keen to attract more trade fairs.

All successful providers of two-sided market services must find a pricing balance between the two sides. This balance accounts for the relative value derived by each side and understands that increasing the charges to one side may actually be beneficial to those bearing the increase because it enables more users on the other side to join, increasing the total value enjoyed by all. However, if the pricing balance does not reflect appropriate price signals between the two sides of the market, the model may not be efficient in the long term since all participants in the market are subject to the normal rational economic behaviours and need to make a reasonable return. This is an important consideration when looking at the economics of the Internet value chain, as will be explained further.

### **3 Pressures on the Internet**

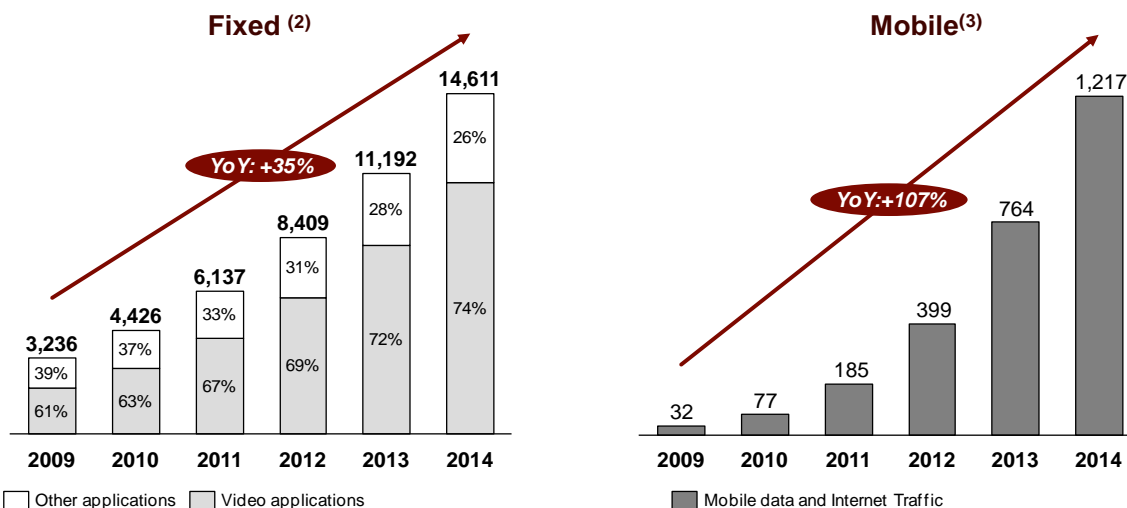
Three major sources of pressure face the Internet: technical performance, economics and policies. These pressures are becoming more evident as the Internet grows to be the critical public infrastructure that underpins a wide range of other important activities such as entertainment, supply chain management, banking and even healthcare and education. The technical robustness of the Internet is closely tied to the sustainability of the underlying commercial model and therefore both are vital to support the growth of current and future economic activity.

#### **3.1 Performance Pressure**

Forecasts of Internet traffic in Europe over the next five years continue to be characterised by exponential growth, both in fixed and mobile at a compound average growth rate of 35% and 107% respectively.

**Exhibit 4: Europe total Internet Traffic Projection (EU 27) <sup>4</sup>**

- PB/month -



(1) Data included for Western, Central and Eastern Europe, for Consumer and Business users  
 (2) Video applications include gaming, file-sharing, video over the internet (i.e. internet video to PC/TV). Other applications include VoIP, business traffic across internet, video communication, web and data  
 (3) Mobile data traffic includes handset-based data traffic, such as text messaging, multimedia messaging, and handset, video services. Mobile Internet traffic is generated by wireless cards for portable computers and handset-based mobile Internet usage  
 Source: Cisco Visual Networking Index, A.T. Kearney analysis

This strong growth is driven by:

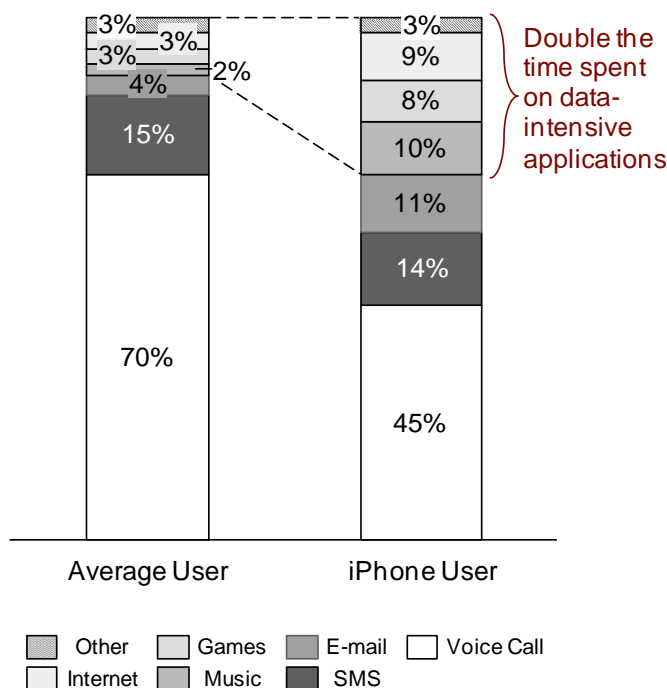
- **Increasing availability of new services** with high-bandwidth requirements, including Internet-TV based services such as Catch-up TV, radio/music streaming services, application and content download services, richer content as part of social networking sites (audio/video) and cloud computing for business services delivery (e.g. SaaS)
- **Increasing penetration of multimedia devices** such as smartphones, set-top boxes, media gateways, Internet connected TVs, connected gaming consoles, enabling new types of high-bandwidth usage
- **Changing usage patterns** supported by flat rate offers and innovation in services and devices, all of which encourage users to spend a greater portion of their day using the Internet (always on, always reachable) to access richer content

A good illustration of these trends is the popular iPhone device, whose users spend almost double the time on data intensive applications as other mobile data users, as shown in exhibit 5.

<sup>4</sup> Cisco VNI traffic forecast for Western Europe, Central and Eastern Europe regions

## Exhibit 5: 2009 Changing Usage Patterns – Average vs. iPhone Users

- Time spent on application/ service-



Source: Apple; Mobile Internet Report Key Themes Final, 2009 Dec, Morgan Stanley; A.T. Kearney analysis

Although the Internet growth has been rapid since its inception, there are some fundamental trends that increase the urgency for change in network service delivery in the near future. Compared to past traffic growth, the Internet today is characterised by the following:

- **Increase in video applications**, which is driving an increase in usage per customer. According to Cisco, the average broadband connection generates 14.9 GB of Internet traffic per month in October 2010, up from 11.4 GB per month in the previous year, an increase of 31%.<sup>5</sup> In the past, traffic growth was driven primarily by the rapid increase in the number of customers.
- **Internet traffic accounts for an increasing proportion of total communications traffic** and now has a major impact on the increase in total traffic carried by telecom network operators. In the past Internet traffic used to be mitigated by lower volume growth rates of traditional services such as voice.
- **Rise in mobile Internet traffic is unprecedented** as the long-awaited adoption of mobile data has been explosive.

Moreover, in the past, Internet traffic was based on many-to-many traffic flows, which were evenly distributed and fairly symmetrical across networks. The connectivity requirements for Internet

<sup>5</sup> Cisco Visual Networking Index: Usage, October 25, 2010

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services were homogenous as the services were largely limited to web browsing, e-mail and file-sharing, all of which were delay-tolerant and resistant to variation in network performance. By contrast, the current Internet is rapidly becoming a “few-to-many” content distribution platform, as shown by the fact that fewer sites account for an ever increasing percentage of total traffic. Google, for example, is ranked 3rd in overall global traffic carried (mainly because of its YouTube service) behind Level 3 and Global Crossing and generates more traffic than the rest of the Tier 1 players such as Sprint and Cogent.<sup>6</sup> As a result, Connectivity Providers today are facing asymmetrical traffic with highly heterogeneous traffic flows that have different performance requirements. The asymmetry in the exchange of traffic between Connectivity Providers and Online Service Providers can reach 1:10 and in some cases even 1:20.<sup>7</sup> At the same time, newer services such as video streaming or unmanaged VoIP are more sensitive to network performance than web browsing or file sharing and require dedicated resources that the best-effort approach may not be able to deliver during times of congestion.

If traffic continues to grow as shown in Exhibit 4, particularly with regard to greater use of video applications, but operators do not have the business case to invest at a similar rate in new capacity, the result will be increasing network congestion at peak times. Voice network congestion manifests itself in the form of blocked calls, but for the Internet the effect is less abrupt, a more progressive degradation of the customer experience. If congestion occurs in a localised area, one of the great attributes of the Internet is its ability to route around such bottlenecks. However, as traffic grows at an aggregate level everywhere, more widespread congestion will occur within operator networks, resulting in:

- Traditional services (e-mail, web-browsing, file downloading) will become progressively slower, although still function
- E-commerce services will become less predictable and reliable and therefore less appealing to end users
- Interactive services such as online gaming, VoIP calls and web-conferencing will stop working effectively, with poor quality or periodic interruptions making them increasingly unusable
- Any sort of streaming service will become unusable at peak times due to frequent interruptions

Such service degradations are clearly frustrating for end users but also affect Online Service Providers who almost certainly lose revenues through lost sales or lost users and the associated loss of advertising. The technical characteristics of different traffic types means that file-sharing traffic, which is more resilient to congestion, effectively crowds-out the more interactive and real-time services that are likely to be the basis of the new more innovative services. In the long-run, Online Service Providers will be less inclined to invest and launch more advanced services if they question their ability to offer a high-quality user experience. Yet they need these advanced services ultimately

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<sup>6</sup>Based on analysis of anonymous ASN (Autonomous System Number) data in the ATLAS Internet Observatory 2009 Report by Arbor Networks

<sup>7</sup>Based on operator interviews

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to generate revenue and to launch new services such as telemedicine, which could have great social and economic benefits, but which rely on high quality connectivity. In economic terms, this illustrates that carrying any traffic not only brings utility, but also has implied opportunity costs.

It is important to repeat that within the best-effort delivery model no allowance is made today for different types of traffic and so applications with specific requirements (round-trip delay, jitter and error-rates, for example) must be treated in the same way as applications that are less sensitive to congestion. When network capacity is abundant relative to traffic, this works fine but in future a mechanism to use limited capacity more efficiently will be needed to deliver adequate service in a predictable way.

Traffic management techniques are increasingly being used to tackle network congestion at peak-hours. Such techniques are used to maximise the use of the “constrained” available capacity and network resources and to use specific actions to limit the impact of the congestion on end users. There are two basic approaches. The first is user-based, where operators allocate the available bandwidth equitably and when necessary limit throughput of heavy users to prevent them from negatively impacting the service of others. Alternatively, operators can manage traffic based on traffic type and minimise delays in applications that are more prone to delays by rate-limiting, or slowing traffic that is more delay-tolerant while continuing to ensure that such services work effectively, albeit taking slightly longer. In both cases, the application of appropriate network management practices can lead to a “win-win” situation where Connectivity Providers optimize network resources and all customers continue to benefit from an effective service. Without traffic management the risk is that all users suffer from a reduced quality of service. While these tactical measures help alleviate some of the main causes of congestion they are only really short-term measures that delay rather than solve the problem. If nothing changes an ever-increasing intensity of traffic management will be needed to help manage congestion.

Technical improvements that improve the capacity and efficiency of the infrastructure and enable operators to squeeze better performance from the network are continually being developed. For example, compression algorithms allow traffic to be transmitted more efficiently and improved application design can minimise the volume of signalling traffic, which can be a particular problem in mobile networks. However, few incentives are currently in place to encourage Online Service Providers to adopt these technical improvements. The performance of network equipment develops similar to Moore’s law for computer processors, enabling faster switching of data in high-end equipment but also improving the cost effectiveness of mid-range equipment, thus delivering greater throughput at similar price points. These incremental improvements, significant though they are in the short term, can only offset a portion of the forecast growth in traffic. What is needed is the right set of economic incentives for a permanent and continual stream of incremental improvements.

A further dimension of performance pressure is the need to continue to enable innovation. The Internet has been a great source of innovation, leading to new business models and the creation of large companies that did not exist 20 years ago, while revolutionising the way many services are delivered to end users. Key attributes contributing to this include:



- 
- Open standards allow both users and service providers to connect and interact seamlessly
  - Ease of use allows anyone with a suitable device to connect to the network and be able to access the full range of content and services
  - A level playing field minimises barriers to entry and initial costs for start-ups, enabling small companies with a good idea to be up and running much sooner and more economically than if they had to establish a more traditional business

It is important that these principles are maintained and protected in the future. However, as the range of services delivered over the Internet continues to grow and diversify, it is also important that the network itself evolves and innovates to support both new services and existing services better. The Connectivity segment is therefore under pressure to streamline the delivery of online services and offer new services such as cloud computing, content distribution, bespoke and targeted advertising, to name a few.

Although the enabling technology platforms may be less visible to end users, considerable innovation has already occurred within the Connectivity segment. The speed and ubiquity of Internet access (fixed, mobile, Wi-Fi) grows relentlessly while access costs have fallen steadily in this highly competitive market. It will become more important that the underlying network infrastructure is able to support more advanced services—for example, HD and 3-D television streaming, telemedicine, full screen online gaming, and B2B services such as telepresence videoconferencing—that will contribute to further innovation and economic growth. This is a question of both the pure capacity to handle the traffic and of the technology used to optimise the delivery of services when today's best-effort protocols are no longer sufficient.

Pressures on the Internet will only increase as traffic continues to grow. The congestion problems will not only diminish customer experience but also limit innovation as Online Service Providers find it more difficult to reach customers and their business models fail to fully exploit their potential. The limitations of the current model could ultimately hinder future innovation of new services for business, entertainment and some critical applications for public services such as e-Health. This will have spill-over effects not only in the Internet ecosystem but also in the economy as a whole.

## 3.2 Economic Pressure

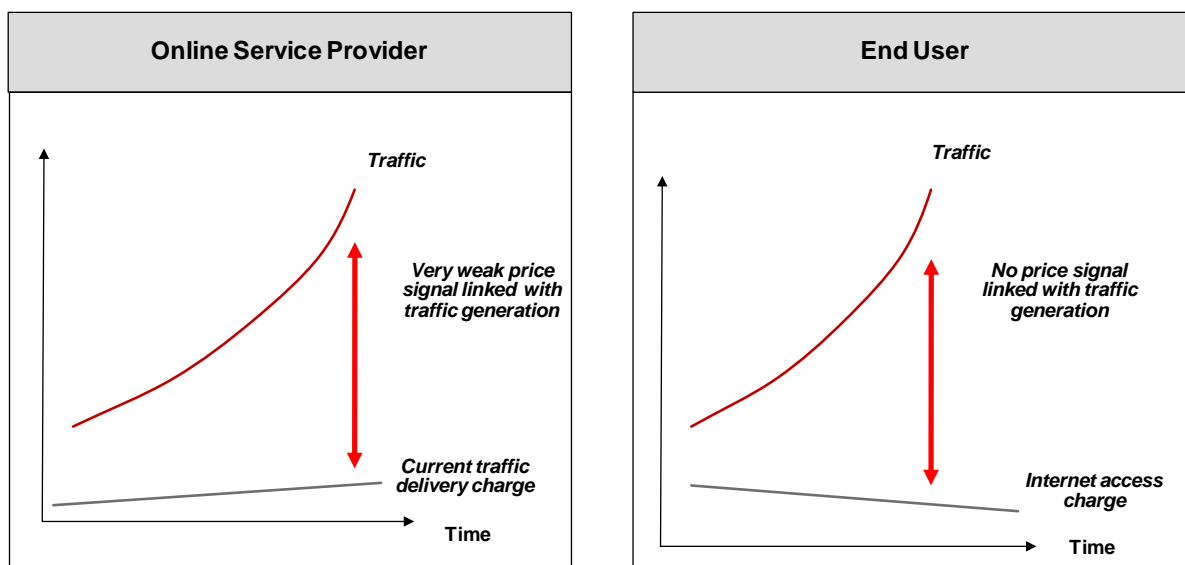
### Structural Problem

A fundamental structural problem exists in terms of who pays for the necessary infrastructure required to sustain the Internet because pricing on both sides of the market is disconnected from network usage. As mentioned earlier, in the vast majority of cases, end users of fixed connections pay a flat monthly fee for as much usage as they need, while mobile users typically choose a tiered usage level. Online Service Providers pay for their access speed to be connected to the Internet, or alternatively connect directly through transit and peering agreements at a much lower unit cost (sometimes zero). In fact, on a per-user basis, traffic per customer is expected to continue to grow, while the average price for a fixed broadband connection (both standalone and in bundles with

other services) is expected to continue declining. (Between 2007 and 2009 the price of the average fixed standalone broadband connection declined by 44%<sup>8</sup>) The result is that operators are faced with an insatiable increase in traffic, which causes a rising cost base that is completely disconnected from revenues. On mobile networks, due to the scarcity of spectrum resource, the trend is moving toward capped data tariffs, for example, a fixed price for 1GB per month and a higher price for 3GB, which at least begins to restore some linkage (albeit weak) between usage and price.

As illustrated in Exhibit 6, the absence of price signals means end users and Online Service Providers have no incentive to manage demand or to optimise the traffic they send or receive; this problem is likely to be exacerbated by the capacity demands of video-intensive applications. Online Service Providers have little incentive to limit traffic because they are only paying for the relatively low backbone network costs and are not paying for access network costs. In fact the misalignment of costs and traffic could actually be an incentive to induce more traffic since their business models and revenues are driven by number of visitors/eyeballs (for instance, advertising based). Furthermore, at times of congestion, a lack of appropriate price signals, combined with the current best-effort delivery approach, incurs opportunity costs not only to the Connectivity Providers but also to the overall value chain if high volume but low value traffic crowds out high value/important traffic.

**Exhibit 6: Price signals in the current Internet model**



Source: AT Kearney analysis

The result of this misalignment between revenue and costs means that when a Connectivity Provider is considering new capacity investments, the return on this investment (i.e. the additional revenues that may follow), is far from clear. Moreover, under the current model, any new capacity built will not resolve the congestion issue but merely delay it as new capacity is rapidly filled by additional traffic as there are no price signals and hence incentives for the users to change their behaviour. This is becoming a pressing issue because, after years where demand often lagged supply, the

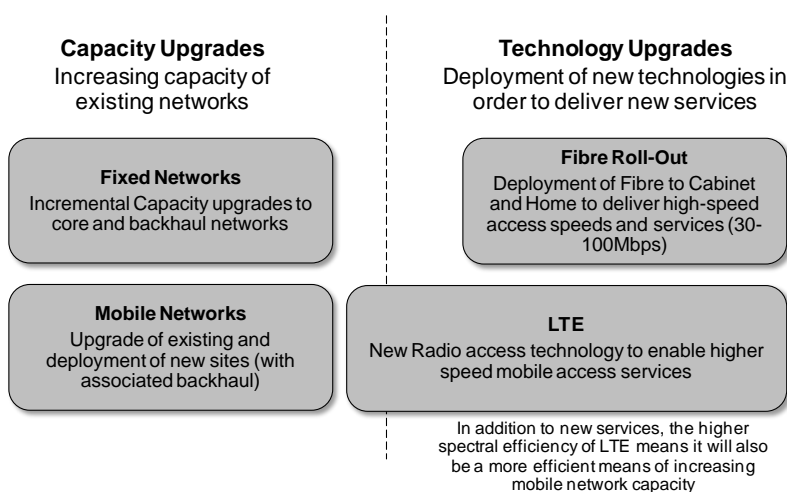
<sup>8</sup> Europe's Digital Competitiveness Report - Volume 1: i2010 — Annual Information Society Report 2009 Benchmarking- i2010: Trends and main achievements, European Commissions

industry—and particularly the mobile segment—is now facing the challenge of managing serious capacity constraints for the first time. Fixing these problems and developing the right pricing signals to promote efficient use of the Internet will require new pricing and commercial models.

### Investment Requirements

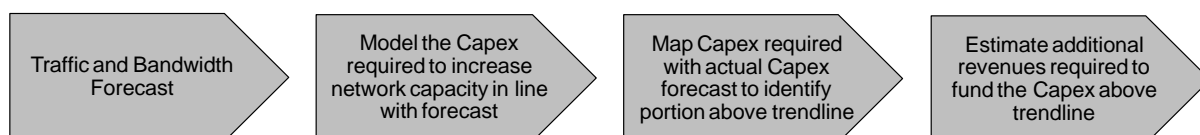
To understand the economic sustainability of the current Internet model, we carried out analysis to estimate the level of capital expenditure (“capex” or investment in ongoing infrastructure expansion) needed to support the forecast traffic growth and assumed that operating expenses (“Opex”) increases proportionately. The investment requirements are broken down between ongoing infrastructure expansion, which is purely traffic driven, and the technology upgrades, specifically fibre and LTE, which will deliver new services and faster access speeds. We have also split the assessment between fixed networks and mobile networks due to the different investment profiles.

#### Exhibit 7: New Network Investments



In the following section we model the expected costs of each of these investments and the potential additional revenue needed to make these investments viable. For fixed and mobile capacity upgrades, and LTE deployment we used the multi-step approach summarised in Exhibit 8. For the fibre roll-out we estimated deployment costs of rolling out fibre according to the EU Commission’s 2020 target. A larger public policy and commercial strategy debate is taking place on the wide-scale deployment of fibre to the home; it is not the intent of this paper to tackle all of these questions.

#### Exhibit 8: Capex and Revenue Modelling Approach

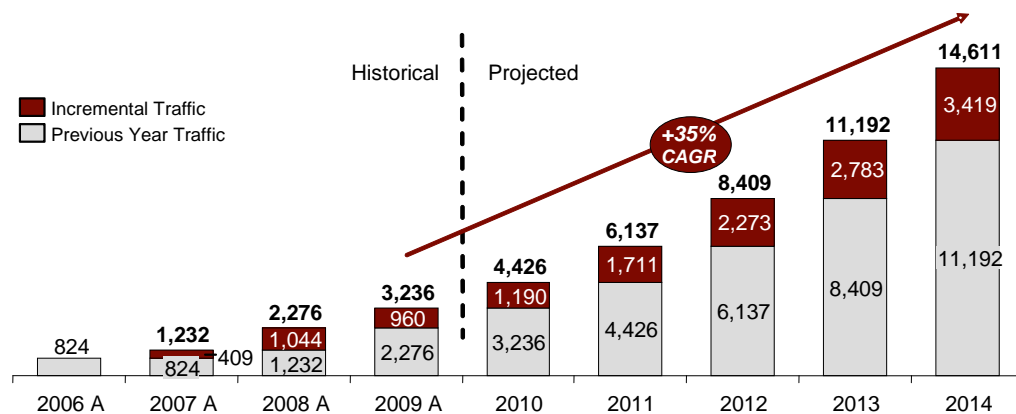


### 3.2.1 Ongoing Traffic Growth in Existing Fixed Networks

Fixed access networks (last mile) have sufficient capacity for today's usage, and therefore traffic increases require mainly investment in aggregation and core network capacity (see Exhibit 3). With much of the traffic growth being driven by video, substituting file-sharing traffic to some extent, capacity or bandwidth requirements may actually outpace the growth in total traffic since it is likely to result in more simultaneous usage versus the more distributed nature of file-sharing traffic. Exhibit 9 shows the estimated traffic growth to 2014, highlighting the incremental capacity required each year.

**Exhibit 9: European Fixed Internet Traffic Growth (EU 27)**

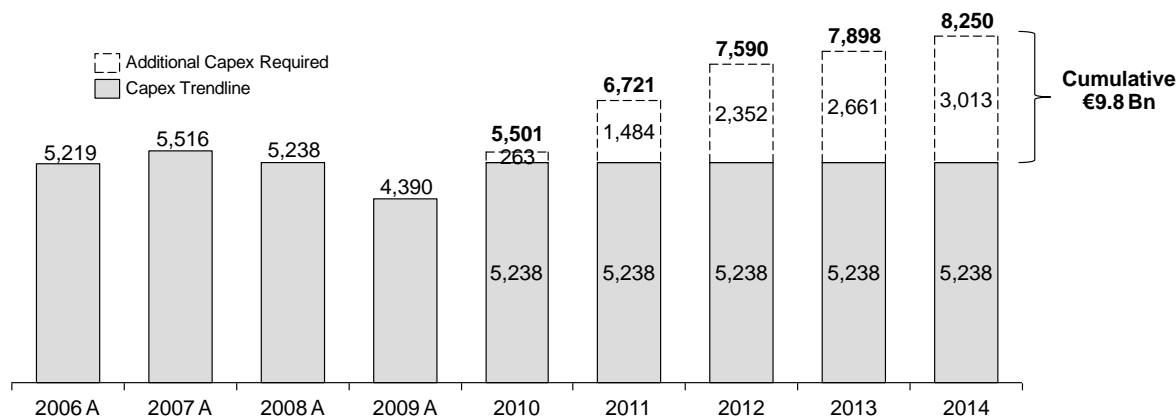
- PB/month-



Source CiscoVNI

The impact of such rapid growth can be clearly seen—in 2014 alone, the incremental growth in traffic is greater than total traffic in 2009. Or in absolute terms, capacity equivalent to the entire Internet today will need to be added in just one year. We modeled the expected cost of building this capacity, based on an estimated historic 20% of operator capex being used for Internet capacity investments (see Appendix for methodology).

**Exhibit 10: Estimated Capex Required to Fund Incremental Capacity for Fixed Internet Networks (EU27) - € million-**



(1) Using an average capex per PB/month from 2008 -2009 and applying 15% cost improvement p.a. thereafter. No new technology considered and quality of services maintained at current level  
 (2) Assuming 20% of total capex has been dedicated to Internet related investments  
 Source: Oppenheimer, A.T. Kearney analysis

Exhibit 10 shows the total capex required to meet the forecast traffic growth and highlights the portion that is above the expected capex plans of the industry. As shown, capex decreased in 2009 compared with previous years in response to the economic crisis and is also reflected in the lower pace of growth in Internet traffic in 2009 shown in Exhibit 9, where traffic grew by less in absolute terms than the previous year (960 PB/month vs 1,044 PB/month in 2008). Investment in Internet related infrastructure is recovering to 2008 levels from 2010 onward according to investor relations statements and industry analysts.

In line with the rapid traffic growth expected, the total capex required rises constantly to 2014 (and beyond), even allowing for 15% year-on-year improvement in the cost/performance of the equipment deployed. However, during this period, fixed operators are generally expected to achieve flat revenues and, based on that expectation, are forecasting flat capex spending plans. As a result the capex required is likely to be only partly funded by current capex plans. Even allowing for a return to capex funding at pre-crisis levels, we estimate that €9.8 billion in additional spending will be needed between 2010 and 2014, with €3 billion alone in 2014, to meet the forecast traffic demand. Importantly, this is not a one-off impact but an ongoing requirement that is likely to keep growing beyond 2014.

Calculating the revenues or contribution margin needed to justify this additional investment is a challenge and one could adopt different methodological approaches. Additional operating costs are implied by such investment (maintenance fees and power, for example) and there is also the question of how to treat common costs for sales, marketing, customer service. For this report, we took our 2009 estimate of fixed capex relative to revenue for Internet Connectivity of 34%<sup>9</sup> and assumed that this (very high level) should not grow even higher. On this basis, additional revenues of around €9 billion per year would be needed by 2014.

<sup>9</sup> In developed markets, the overall average industry capex vs. sales ratio is about 10% incl. both fixed and mobile as well as voice and data. 34% presents a very high capex intensity and is only sustainable for Connectivity Providers if there is matching revenue growth

This increase is obviously significantly above current levels but it is important to view it in the context of other changes. Past investment was driven in part by traffic growth underpinned by increasing penetration and take-up of services that had a matching revenues uplift. Future traffic growth is more driven by an increase in traffic per customer which, with the current pricing structures, does not drive much incremental revenue. In addition, the compounding nature of the exponential growth rates means that in absolute terms the challenge and cost of continually increasing capacity is becoming even more expensive. To date operators have generally used broadband subscriptions as an “add-on” to traditional services and so could cross-subsidise to some extent and use the service as a tool to retain customers who generated higher-margin voice revenues. Increasingly, however, as Internet connectivity service is becoming the core product that represents a greater proportion of an operator’s total revenue, it needs to be self-sustaining. Future investments in Internet infrastructure need to be justified by the returns on that investment.

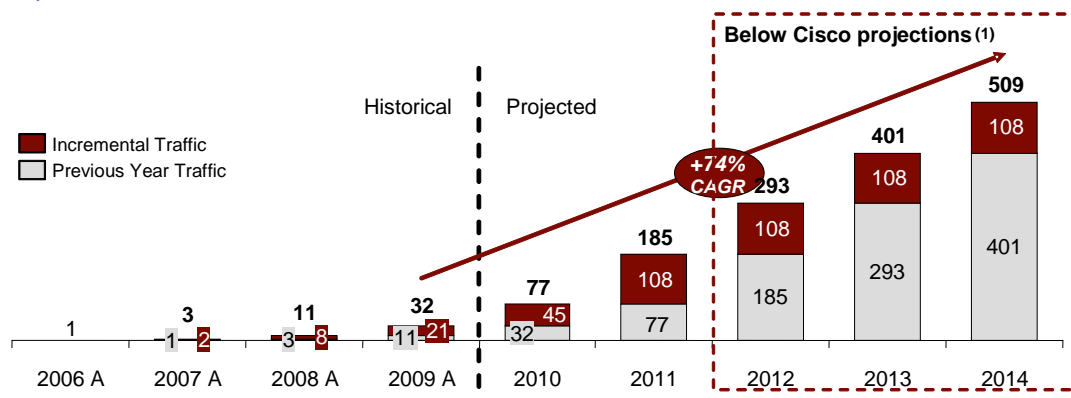
<b>Summary of Findings – Ongoing traffic growth in existing fixed networks</b>	
<b>Expected traffic increase (2010-2014)</b>	11,375 PB/month (35% CAGR)
<b>Expected total capex to convey it (2010-2014)</b>	€ 36 billion
<b>Total capex trendline at current levels (2010-2014)</b>	€ 26 billion
<b>Total incremental capex (2010-2014)</b>	€ 10 billion
<b>Estimated additional annual revenues required in 2014</b>	€ 9 billion

### **3.2.2 Ongoing Traffic Growth in Existing Mobile Networks**

The increase in traffic in mobile networks is even greater than in fixed networks. The forecasts for this are so high in fact that we have modelled a constrained growth scenario, which is lower than that forecast by Cisco VNI, with a constant annual growth in capacity (shown in Exhibit 12). Such a constraint could either come through greater efficiency of applications (for example, more compression), traffic “offloading” (whereby the mobile network tries to use Wi-Fi networks or femtocells as much as possible) or the unsatisfactory outcome of congestion driving users to divert their usage to fixed networks even when mobile access might be more convenient. Nevertheless, this still results in traffic growing 16 fold in the five years between 2009 and 2014, an effective compound annual growth rate of 74%.

## Exhibit 12: European Mobile Internet Traffic Growth

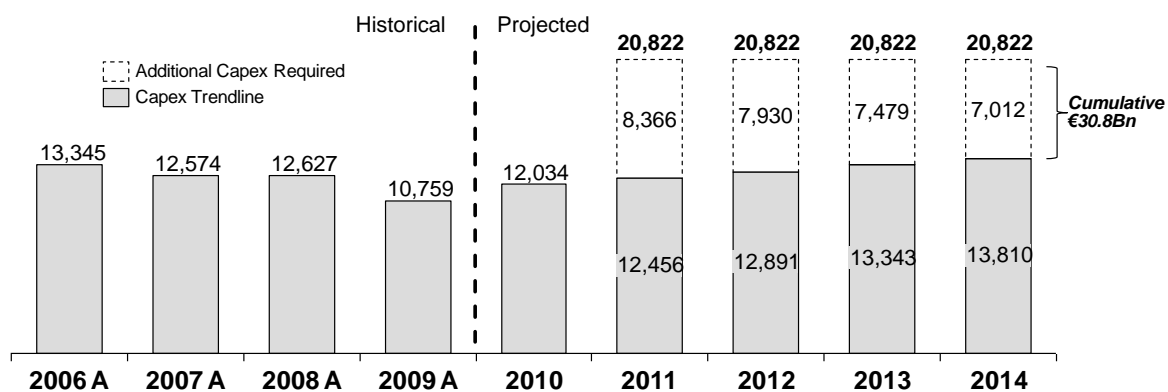
- PB/month -



(1) Constrained scenario with the mobile growth remaining at the 2011 level  
Source: Cisco VNI, Oppenheimer, A.T. Kearney analysis

To separate the effect of traffic growth from new services, we have assumed the demand is met using the current 3G networks. Exhibit 13 shows that the investment required to support our constrained traffic growth scenario is estimated to be €95 billion over five years. Comparing this to the trendline capex based on 3.5% annual growth above historic levels shows that the resulting total capex for 2011 to 2014 is around €31 billion above trend. (See appendix for full methodology)

## Exhibit 13: Estimated Capex Required to Fund Incremental Capacity for Mobile Networks, 3G Only Option, - €m-



(1) The 2006-2010 data CAPEX was derived from Oppenheimer's historical and projected total mobile CAPEX from 2006-2011 by applying the ratio of Network Growth CAPEX over total CAPEX (70%)

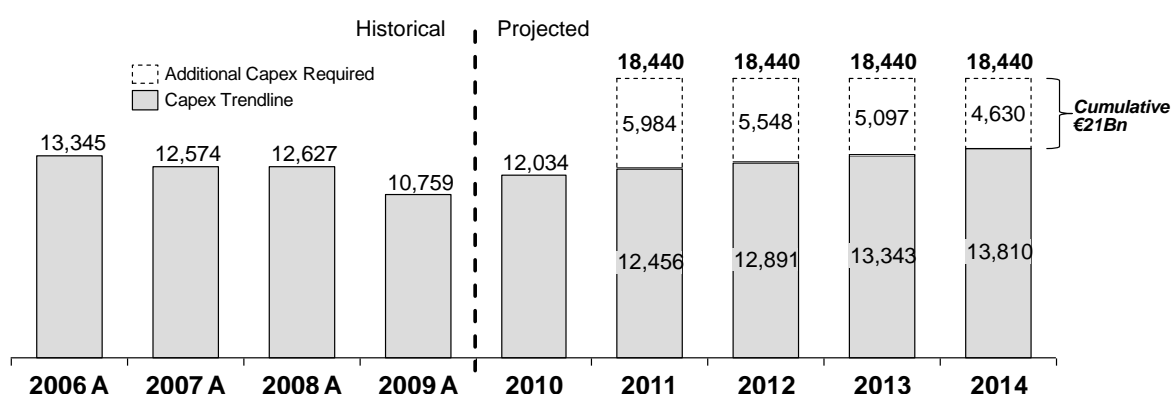
(2) Baseline CAPEX from 2012-2014 was extrapolated using the 2006-2011 CAGR of 3.5%  
Source: Oppenheimer, A.T. Kearney analysis

As in the discussion of fixed capex, this is an ongoing requirement rather than a one-off investment. Maintaining today's 25% ratio of mobile capex to mobile data revenues would imply additional annual revenues of around €28 billion in 2014. This level is much higher than for fixed—although the mix of traffic is still heavily skewed to fixed (which includes Wi-Fi) — due to the need to build additional radio access network capacity and upgrade core and backhaul layers; the fixed scenario assumed adequate capacity in the access network for the near term.

In reality, if the forecast traffic growth materializes, operators are expected to carry a sizeable part of these traffic increases over LTE networks, which is likely to reduce the need to build new cell sites (because of LTE's higher spectral efficiency) and therefore increase capital efficiency.

To evaluate this, we modelled a scenario in which LTE technology is used to carry 13% of mobile data traffic by 2014 and the technology is deployed progressively from 2012 onward. The resulting capex requirement is shown in Exhibit 14.

**Exhibit 14: Estimated Capex Required to Fund Incremental Capacity for Mobile Networks—Hybrid Option, - €m-**



(1) The 2006-2010 data CAPEX was derived from Oppenheimer's historical and projected total mobile CAPEX from 2006-2011 by applying the ratio of Network Growth CAPEX over total CAPEX (70%)  
 (2) Baseline CAPEX from 2012-2014 was extrapolated using the 2006-2011 CAGR of 3.5%  
 Source: Oppenheimer, A.T. Kearney analysis

We estimate the total capex required for the combined 3G and LTE investment is €86 billion between 2010 and 2014 inclusive (note that this is lower than the total capex in the pure 3G scenario noted earlier due to the higher capacity of LTE sites and greater use of existing towers). The exact timing of LTE investments is still to be determined but spreading the total investment over the period shows that by 2014 around €4.6 billion additional capex above the expected trendline will be required. Using the same 25% ratio of mobile capex to mobile data revenues implies additional revenues of €18.5 billion per year in 2014, considerably less than the €28 billion that would be needed to support the same capacity using 3G technology alone.

In the long-run, LTE is a more cost effective means of delivering the extra capacity required. However, upfront investments are required to build a national network and a lag time exists while users upgrade to LTE-enabled devices. During this time it will still be necessary to also invest in 3G. As a result, a capex spike will likely occur as operators invest in LTE launches; over time this evens out.

Beyond 2014, it remains to be seen what effect new services LTE offers will have in the market and specifically in increased mobile traffic. If LTEs higher access speeds prove popular then investment in



LTE will need to increase to meet demand.<sup>10</sup> Our model simply presents the capital efficiency effect of using LTE to meet a low-traffic growth scenario to reduce the potential cost of using 3G technology.

<b>Summary of Findings – Ongoing traffic growth in mobile networks hybrid option</b>	
<b>Expected traffic increase (2010-2014)</b>	477 PB/month (74% CAGR)
<b>Expected total capex to convey it (2010-2014)</b>	€ 86 billion
<b>Total capex trendline at current levels (2010-2014)</b>	€ 65 billion
<b>Total incremental capex (2010-2014)</b>	€ 21 billion
<b>Estimated additional annual revenues required in 2014</b>	€ 19 billion

### 3.2.3 The Case for Fibre

In addition to capital efficiency effects, new access technologies such as fibre-to-the-home (FTTH) and fibre-to-the-cabinet (FTTC) will enable more advanced services and ensure continued innovation and economic growth. Although much of this investment will come after the 2014 timeframe of this report, in the interest of completeness (and comparability to other reports published on broadband) we also reviewed investments required to upgrade to these new fibre based technologies. However, in evaluating options for a viable future model, we do not include the capex requirement for FTTH and FTTC.

In fixed networks, the migration to next generation technologies is a large and important project that will bring additional capex requirements; this has to be analysed as a standalone project. In addition, investment would have to be primarily recovered by additional revenues generated by the new services. We have evaluated a five-year scenario in line with the EU's 2020 fibre rollout target (100% household coverage) by assuming 50% household coverage by 2014 (of which 16% is FTTH with speeds of ~100Mbps). We estimate €116 billion of capex is required for this initial phase. (Another report<sup>11</sup> estimates a total volume of €300 billion in capex to deploy to all households; the second 50% is more expensive because it will be in areas with lower population density.)

Based on our assessment, the investment required to support the forecast traffic growth over existing networks are challenging for Connectivity Providers, even before considering new access technologies. Building the infrastructure will require significant investments and if Connectivity Providers are to make a reasonable return, new revenue will need to be found to justify these investments. It is worth noting that the ever increasing traffic levels are not a technical problem per

<sup>10</sup> For mobile, we have also modelled a scenario where LTE sites are deployed to deliver additional traffic between the scenario modelled above and the unconstrained Cisco VNI traffic forecast, an additional 708 PB / month of capacity by 2014. We have estimated the total additional capex required would be €32 billion, on top of the €84 billion identified above, assuming an 100% LTE roll-out from 2012 and 70% use of existing towers

<sup>11</sup> McKinsey & Co, Fiber: The future of fixed in Europe, FTTH Council Europe Conference, Feb 2010

se: new hardware is being constantly developed to meet the logistical challenge of switching and delivering this traffic. The economic challenge comes when network capacity is not efficiently used and when the required investments are not matched with additional revenues.

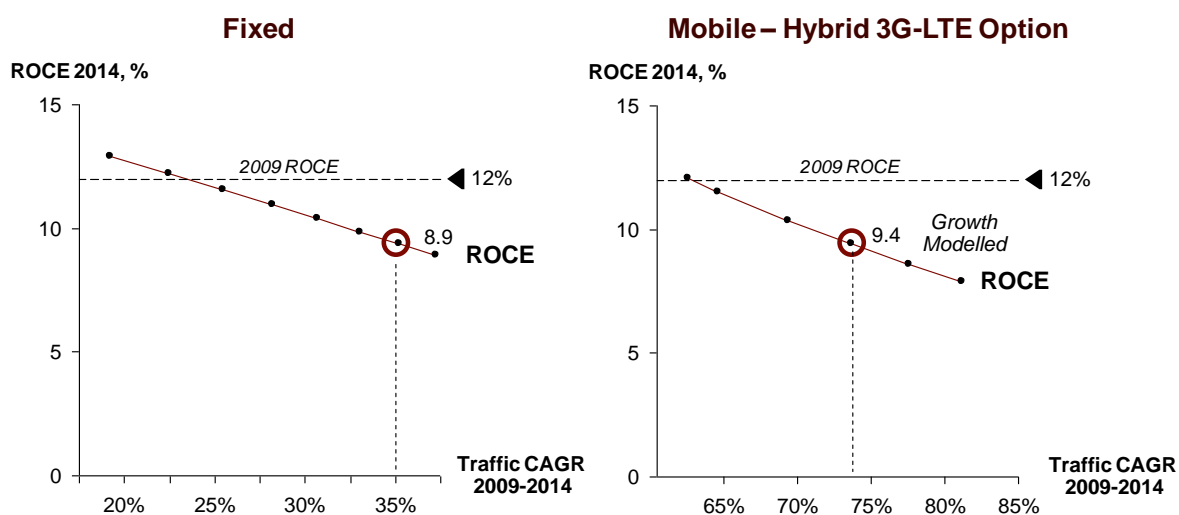
### 3.2.4 Profitability of Investment in New Network Capacity

If operators were to make these investments (to implement the forecast capacity upgrades) without achieving any additional revenue, there would be a significant negative impact on the Return on Capital Employed (ROCE). Obviously the effect will be different on each operator depending on starting position and local market conditions, but such low prospective returns provide no investment incentive.

For fixed operators, if traffic grows at the forecast 35% per year, we estimate that ROCE will decline from around 12% today to 8.9% in 2014. For mobile networks, we assumed a modest increase of 3.5% in revenues as penetration continues to climb and at least a partial linkage exists between traffic and revenues as more operators move to tiered-pricing structures.

Nevertheless, we still estimate a possible reduction in ROCE from around 12% today to around 9.4% for a typical operator if traffic grows at 74% per year as indicated in our model. If traffic growth rates are higher, then the effect on ROCE will be even more dramatic (see Exhibit 14). To put these returns in context, an A.T. Kearney study for the GSMA<sup>12</sup> found that of 11 industries, before the onset of the recent economic downturn, only two industries (wireless communications and power utilities) were earning less than 14%. Inevitably if the returns are not adequate, Connectivity Providers will face increasing pressure from financial markets to delay or reduce investments, implying a subsequent decline in quality of service and innovation.

**Exhibit 14: ROCE Evolution versus Internet Traffic Growth**



(1) Assuming a 34% CAPEX/revenues for Fixed and 25% for mobile  
Source: Cisco VNI, A.T. Kearney Global Cost Benchmark, A.T. Kearney analysis

<sup>12</sup> GSMA, European Mobile Industry Observatory

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### 3.3 Policy Pressure




To date, the Internet value chain has largely been self-governed and free from regulation, other than NRAs encouraging competitive markets in broadband access and in Europe regulating wholesale markets to promote this (for example, via local loop unbundling at fairly low tariffs). As the Internet is playing an ever more important role in communication, there is increasing focus on the commercial and technical architecture, and on content issues such as decency, privacy and piracy. More recently, the emerging debate over “Net Neutrality” both in the United States and in Europe has raised questions about consumer rights and freedoms and the evolving role of the Internet in providing a broad range of services—from blogs, to video services to emergency calls via VoIP. Considering the economic pressure, this ongoing and sometimes heated policy debate has important implications regarding which commercial models are allowed to emerge in the future. This, in turn, could directly affect the viability of the Internet.

Two aspects of the ongoing Net Neutrality debate are particularly pertinent: rules governing traffic management/prioritisation and minimum quality standards for public, best-effort Internet. In a recent consultation exercise, the European Commission sought input on precisely such questions regarding issues of traffic management. The EC’s initial summary of the responses indicates that since the market is still open and competitive, there is no need for policy intervention at this stage as long as all market activities and services offered remain transparent to market participants. In parallel, some national regulators (ARCEP in France, Ofcom in the UK) have been working on these issues. The outcome of ongoing deliberations is still unclear but there is sensitivity to the broader economic challenges discussed above. Debate in the United States has been somewhat more polarised and already the subject of court cases.

Amid the wider policy debate, most commentators agree that Online Service Providers and Connectivity Providers should not be allowed to use market power to distort the market unfairly. At the other end of the spectrum, some people see equal access to the Internet as a basic right and interpret this to mean that price differentials or service differentials are per se wrong. For the interest of the general public, most regulators focus on the economic impact of traffic prioritisation and its transparency to users while maintaining a vigilant eye on socio-political considerations such as privacy and media plurality.

In Table 1, we provide a framework to analyse the different principles discussed under the heading of Net Neutrality and compare the viewpoints among different NRAs.

**Table 1 – Comparison of Views on Net Neutrality: UK vs. France vs. the US**

Principle	Ofcom 	ARCEP 	FCC 
<b>Accessibility</b>	<b>Pro</b> Users have access to all contents, services & applications	<b>Pro</b> Users have access to all contents, services & applications	<b>Pro</b> Users have access to all contents, services & applications
<b>Transparency</b>	<b>Pro</b> Crucial to disclose traffic mgt. practices to key stakeholders including consumers and online service providers	<b>Pro</b> Crucial to disclose traffic mgt. practices to key stakeholders including consumers and online service providers	<b>Pro</b> Crucial to disclose traffic mgt. practices to key stakeholders including consumers and online service providers
<b>Non-Discrimination</b>	<b>Neutral</b> no ex-ante regulation	<b>Pro</b> Not allowed to discriminate against certain content, services or applications	<b>Pro</b> Not allowed to discriminate against certain content, services or applications
<b>Traffic Management</b>	<b>Neutral</b> Only intervene in case of clear abuse	<b>Con</b> Only engage in acceptable traffic management (e.g. spam/virus)	<b>Con</b> Only engage in reasonable traffic management
<b>Differentiation</b>	<b>Open</b> Potentially possible without imposing minimum QoS	<b>Open</b> Potentially possible given minimum QoS	<b>Con</b> No price or quality differentiation

Sources: Eléments de réflexion et premières orientations sur la neutralité de l'internet et des réseaux, ARCEP, May 2010; Comments of the Open Internet coalition - FCC No. 09-93, FCC, Oct 2009; Traffic Management and Net Neutrality, Ofcom, Jun 2010

Whatever policy changes are made, whether to redefine Net Neutrality or to enforce it in new ways to cope with new challenges, it would seem to be in the public interest that such changes do not restrict the ability to tackle the performance and economic pressures on the Internet today. Instead, they should ensure that the openness and competitiveness of the market and the ability to innovate are not jeopardised while also respecting important principles such as the accessibility of content and the right to free expression.

### 3.4 Conclusions

A.T. Kearney is convinced that a major structural problem demands attention from industry stakeholders to maintain the success of the Internet. As outlined in some detail, the increased costs of handling rapidly growing traffic are not matched by additional revenues for a key segment of the value chain: those who operate the networks. Moreover current pricing models do not promote efficient use of existing capacity. The current pressures on the Internet will only increase as traffic continues to grow and Connectivity Providers have to make ever tougher decisions on where to invest and when. With existing limitations, the current model could ultimately hinder future innovation of new services for business, entertainment, communication, and for some mission-critical applications, such as telemedicine, that provide future public services. Therefore, it is crucial to find alternative viable models for the benefit of all stakeholders. This is the focus of the next section.

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## 4 Alternate Commercial Models

To address the structural problems described in the previous section, we have identified four broad options to restore the link between traffic and prices, encourage the efficient use of capacity, and increase funds available to invest in fixed and mobile Internet infrastructure to meet expected traffic growth, while maintaining the fundamental characteristics of an open, competitive and innovative Internet value chain. These options are:

1. Continue with the current commercial model and raise additional revenue required by modifying retail pricing schemes to increase average revenue per user (ARPU)
2. Introduce a data-conveyance charge to be paid by traffic senders based on the total volume of traffic they send, or their peak traffic
3. Develop optional enhanced traffic delivery services over the public Internet in a coordinated manner, with a price premium based on quality of service delivery
4. Develop new services where Connectivity Providers offer Online Service Providers managed services over their networks on a bilateral commercial basis

In this section we describe each option and assess the impact it could have on end users and Online Service Providers and how it could contribute to improving the long-term sustainability of the Internet. To assess the feasibility of each option, the final impact on key stakeholders is evaluated based on the assumption that the full investment required should be funded by each option. However, these four options are not mutually exclusive. After considering each option individually, we consider how they could be combined to achieve the optimal overall improvement.

The key questions any new model needs to address and therefore on which they should be evaluated, are as follows:

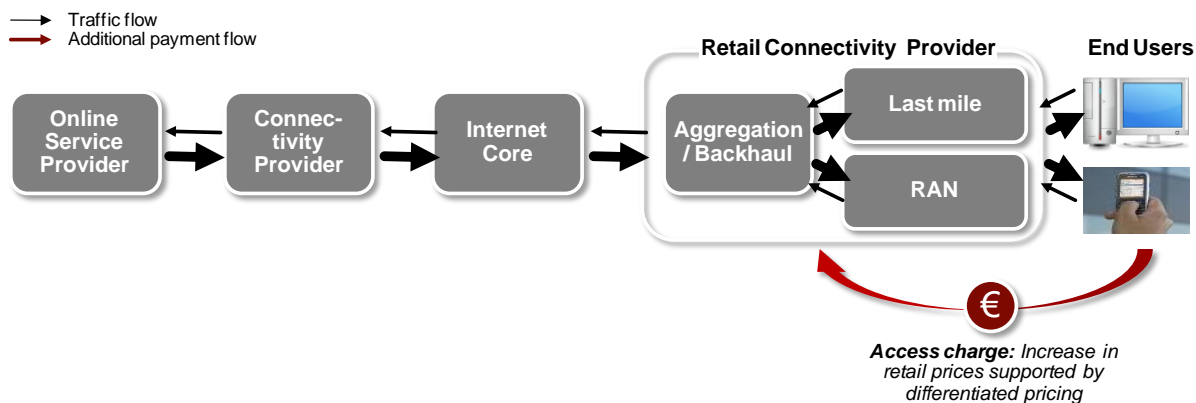
- Does the model improve overall economic efficiency?
- Could the model influence end-users' behaviour (such as increasing/decreasing usage and penetration)?
- Could the model affect Online Service Providers' behaviour (for example, increasing/decreasing entry barriers, innovation and content accessibility or increasing prices excessively)?
- Does the model ensure the Internet value chain remains open and competitive?
- Does the model encourage more efficient use of available network capacity?
- How feasible is it to implement the model and what is the wider impact on key stakeholders?

### 4.1 Modification of Retail Pricing Schemes

The most straightforward option would be to adjust the retail price model to increase revenues raised but also offer a wider set of tariffs based on traffic volume, traffic type or time of day. In this option, almost all network costs continue to be paid by end users while Online Service Providers continue to pay their Connectivity Provider for standard Internet access—that is, connecting their hosting infrastructure to the nearest Internet exchange (tariffs here are usually very low). The bluntest approach would be a simple across the board price increase. However, this would not address the disconnect between usage and price paid since someone using a fixed broadband

connection to download movies or watch streaming TV for 12 hours a day would pay the same as someone using their connection for basic web-browsing or to check email.

### Exhibit 15 – Option 1: Modification of Retail Pricing Schemes



To move away from flat-rate “unlimited usage” charging, more differentiated tariffs could be developed. As is becoming more common on mobile tariffs, the monthly fee would be partly based on download bands/caps, for example, 1GB per month and a higher price for 5GB or 10GB. Some fixed operators have started to include usage caps in their tariffs at the high end, but this principle could be expanded to include a broader range of tariffs, perhaps including a “light-user” option that allows basic Internet access but has a surcharge for traffic such as streaming or file sharing. This would encourage customers to consider their usage and ensure that the actual costs incurred by traffic are reflected in the pricing mechanism.

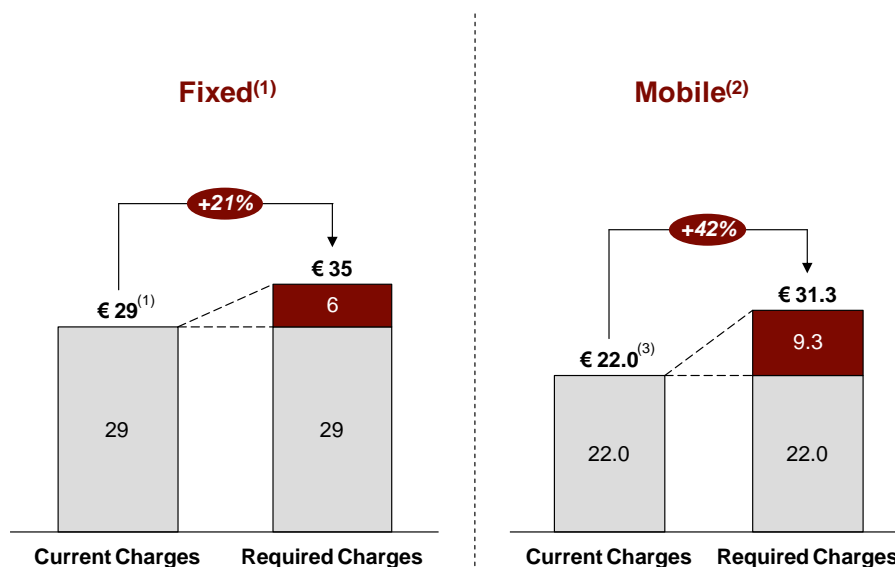
A further refinement would be to launch services based on the differentiation of tariffs. Vodafone has launched a mobile broadband tariff in Spain that introduces a time-of-day element, for example, off-peak usage not counting toward traffic caps, or possible voluntary throttling during periods of congestion in return for lower monthly fees. Traffic carried at off-peak periods has less impact on Connectivity Providers’ investment profile and so could be offered at lower rates. These would also enable Connectivity Providers to offer low “entry-level” tariffs to promote increased penetration and mitigate the effect of price rises on penetration.

### Implementation challenges

On the technical level there would be little change—all traffic would still be subject to best-effort delivery with traffic management likely still required at peak times. The biggest challenge would be achieving the average price increases needed in highly competitive markets. Price increases would also need to be reflected in wholesale bitstream pricing to ensure the full pricing model remains consistent. For usage-based tariffs, the problem is that end users often do not have full control or awareness of the actual traffic they are downloading. Software updates tend to download in the background automatically; animated adverts are not actively requested; compression and encoding techniques for video are important variables determining traffic volumes but are not visible to end users. So although a price signal exists, customers may not be sufficiently well informed to be able to respond to it without suitable mechanisms to inform them about traffic consumption. There is also the legal difficulty of charging end users for traffic they receive but did not ask for (for example, animated pop-ups or automatic software updates).

## Standalone evaluation

### Exhibit 16 – European Average Broadband Access Service Charge, Based on 2009 Price Level - € per month -



(1) Excluding line rental, Europe's Digital Competitiveness Report - Volume 1: i2010 — Annual Information Society Report 2009 Benchmarking- i2010: Trends and main achievements, European Commissions

(2) For Mobile, the increase is based on the estimated total number of smartphone/ data dongle subscribers in EU 27 in 2014

(3) Mobile Broadband ARPU in Europe 2007-2010, Analysys Mason

Source: Comparative international pricing 2009, Ofcom; Mobile Phone Service Prices 2009, International Comparison, Ficora, 2009; Comscore - March 2010; US Mobile Broadband 2010–2014 Forecast: Consumers Join Business Users to Spur Growth, IDC 2010; A.T. Kearney analysis

By way of illustration, if this option were applied in isolation, we estimate that fixed broadband access charges would need to rise by an average €6 per month by 2014 in order to deliver the €9 billion additional revenues identified in section 1 to support future traffic growth. This equates to a 21% increase in the average fixed broadband access charge from €29<sup>13</sup> per month to €35. For mobile, an increase of €9 in ARPUs of smartphone and data dongle users would be needed.

Such price increases are unlikely to be achievable in the current highly competitive fixed and mobile markets, thus congestion is likely to continue or worsen. In addition, substantial price changes in a flat tariff structure will be difficult to achieve in the short term, and increases are counter to the general trend and potentially risk pricing some people out of the market. Taking fixed network pricing as an example, based on an elasticity of demand of -0.43<sup>14</sup> (that is, a price elasticity of demand of -0.43 means that a 1% increase in price leads to a 0.43% reduction in demand), the penetration in 2014 would be around 5 percentage points lower than it would have been with no price rise. (Note, this does not imply that consumers cancel subscriptions, but that potential new users choose not to subscribe and fewer users pay for both a fixed and a mobile broadband connection. Alternatively some users might choose to reduce their consumption of high bandwidth services which in aggregate could slow the need to upgrade capacity). However, because such large

<sup>13</sup> Europe's Digital Competitiveness Report - Volume 1: i2010 — Annual Information Society Report 2009 Benchmarking- i2010: Trends and main achievements, European Commissions

<sup>14</sup>Price and Income Elasticity of Demand for Broadband Subscriptions: A Cross-Sectional Model of OECD Countries, SPC Network.

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price increases are unlikely to occur, in practice more moderate price increases could be combined with greater use of traffic management techniques to achieve an outcome that still provides an acceptable user experience.

### **Impact on the Internet value chain**

This alternative maintains the current model whereby end users fund most of the network. With more flexible price schemes there could be benefits for users—both light-users who get more affordable tariffs and heavy users who could enjoy a less congested service at a higher price. However, this model does not introduce a price signal to Online Service Providers, nor to users unless a stronger traffic-dependent element is introduced in retail tariffs. Therefore, it is unlikely to have a major effect on the efficient use of the network, just a fairer distribution of the costs among end users. Over time, equilibrium occurs to ensure that appropriate capacity upgrades are financed, but there might well be geographic disparities as some markets more easily absorb price increases than others.

However implemented, the overall increase in average retail tariffs will almost certainly have a negative effect on penetration and/or usage. This is the only significant policy challenge, since it runs counter to the promotion of universal broadband access. In addition to the obvious disadvantages for users unable to afford Internet access, Online Service Providers also suffer as they are unable to reach a portion of the potential market and so lose potential customers and revenue opportunities. As differentiated and light-user tariffs become more established, Online Service Providers would need to modify their approach by introducing lower bandwidth versions of their services to attract price-sensitive customers, similar to low-graphics versions of services targeted to today's mobile users. Providers wishing to launch high-bandwidth services targeted at lower-income user groups would have to reconsider their business models. On the other hand, there are still advantages to the wider value chain versus a scenario of low investment and increasing congestion: higher bandwidth/higher quality of service dependent applications could be successfully launched, supporting innovation.

### **Summary**

The modified retail pricing scheme option is conceptually straightforward to implement as it does not require structural change but just the creation of new price plans (and the IT and billing support to enable these). However, it does introduce some challenging questions with potential legal implications around how users can avoid paying to receive traffic they did not request (such as pop-ups and video ads on webpages) and whether they really have the ability to control the traffic they consume. This option could negatively change users' behaviour, reduce penetration and the uptake of new services; this depends on price elasticity of demand over time.

In reality, it would be challenging for Connectivity Providers to raise prices to this extent in competitive markets. Any retail price increases would need to be based on actual increased costs and, where applicable, implemented at the wholesale level also. The market for broadband services



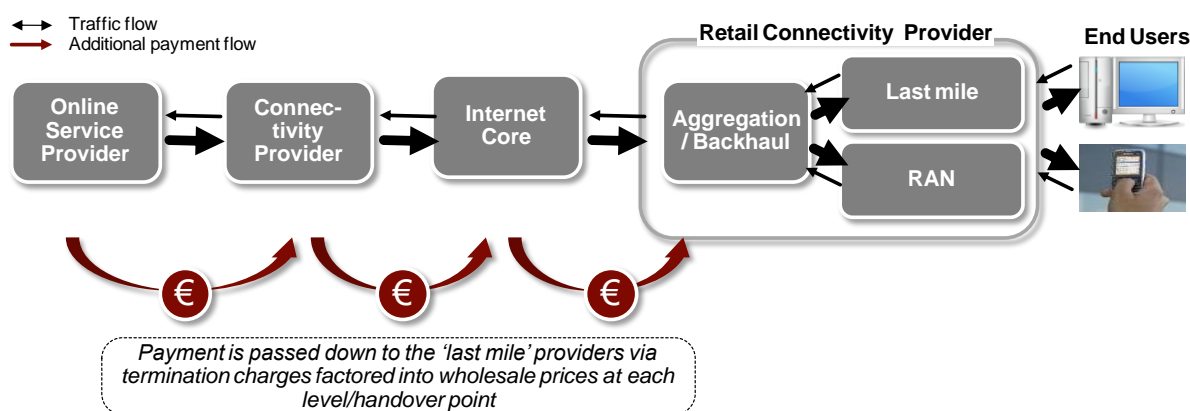
is so competitive in most European countries that prices have been declining rapidly. While there is room to introduce more volume-dependent pricing and thus address part of the structural problem, price increases for end users are unlikely to be the sole remedy to ensure a more sustainable model.

Summary of Findings – option 1 Modification of Retail Pricing Schemes	
Estimated required increase in fixed ARPU	€ 6/ month (+21%)
Estimated required increase in mobile data ARPU	€ 9/ month (+42%)

#### 4.2 Traffic Dependent Charges for All Traffic

The second option we have assessed is radically different, focussing on Online Service Providers and the fees they could potentially pay toward the cost of the infrastructure. Many leading Online Service Providers are increasingly using the Internet as a content distribution network to generate revenues (either from the user directly as subscription or download fees, or via advertising) but are contributing little to the cost of the infrastructure. Consequently, they have limited incentive to use the infrastructure in an efficient way since to them it is a largely free resource.

Exhibit 17 – Option 2: Traffic Dependent Charges for All Traffic



In this option, traffic senders (Connectivity Providers and Online Service Providers) pay the receiving network for onward delivery of traffic, with charges being traffic-based. As the main source of the traffic load, Online Service Providers pay for the traffic sent into the network and most of that payment is passed down to the Retail Connectivity Providers. It is too early to say how the actual level of charges would be determined, whether they would be based on traffic volumes or peak usage, or how they would evolve over time. In practice, pricing would most likely start with Access Network Providers setting a fee for incoming traffic, followed by upstream networks charging this onto their fees until it reaches the Online Service Provider originating the traffic. A mechanism would have to be in place to prevent smaller networks fraudulently initiating inbound traffic to generate revenue.

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An alternative way of implementing this option could be to move from the current free peering agreements to “paid-peering” once the asymmetry of traffic goes above a threshold (for example, 1:2). Such clauses are already part of private peering agreements but, based on discussions within the industry, we believe these are not strictly enforced. As a result, large Online Service Providers are allowed to inject large volumes of traffic at such points with effectively zero marginal cost. This is within the rules but certainly not the original intent of peering, which was designed as the mutually beneficial exchange of traffic between carriers whereby each carrier covered its own costs and these costs were roughly symmetrical.

The key feature of this model is that Online Service Providers pay substantially more than they do today for connectivity, based on the traffic they send, giving them a clear incentive to optimise traffic to the full extent. The access infrastructure is still heavily funded by consumer revenues (at or near today’s prices) which encourage correct pricing for different access networks relative to each other (fixed vs. mobile vs. Wi-Fi and even versus broadcast networks for TV content distribution).

### **Implementation challenges**

Two key challenges would need to be addressed to implement this model. First is the need for common agreement among all stakeholders on the principle of charging for traffic delivery, which would be a major change to the current model. If an operator takes a unilateral stance, there is a significant chance that some Online Service Providers will leverage their market franchise and restrict access to their content (just as some disputes over cable TV fees in the UK or the United States have led to blank screens at times). By discriminating between Connectivity Providers they could induce users to leave a Connectivity Provider with a high traffic dependent charge. The second challenge is to arrive at and maintain a reasonable and transparent price level that is sufficient to enhance the efficient use of available capacity and to cover costs incurred—which might well evolve over time.

Consequently, a more coordinated approach is probably required where all Retail Connectivity Providers in a market set similar charging schemes and so Online Service Providers wanting to serve that market have to pay and adjust their commercial models to cover the higher costs—doing so, for example, with higher advertising fees or subscriptions. The most effective method, but also toughest to achieve in practice, would be a universal structure agreed by all Connectivity Providers at the national or regional levels, and implemented across the Internet (but with actual price levels varying between networks to reflect healthy competitive dynamics). This would certainly take a long time to negotiate and regulatory authorities would need to be satisfied that the public interest was being well served (such coordinated efforts are common in other aspects of the Internet and in other communication services, for instance, in devising technical standards, interoperability and numbering).

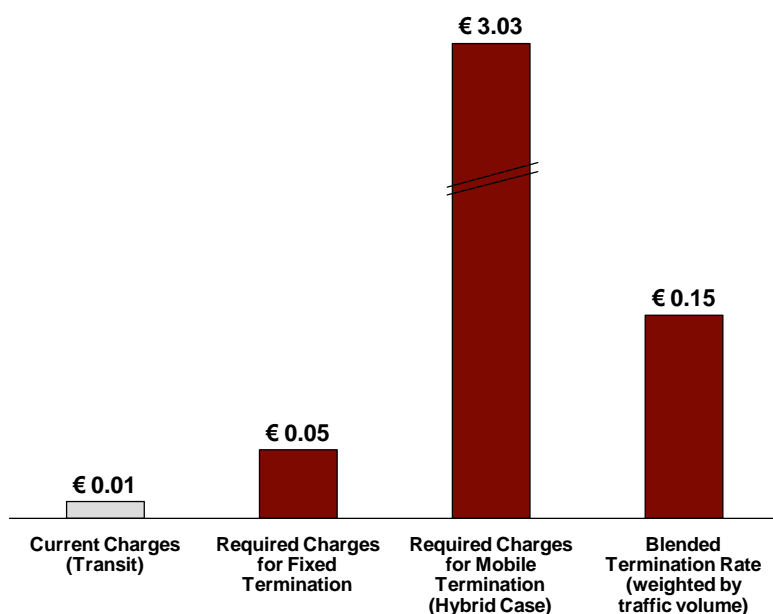
Other technical aspects of traffic delivery remain as they are today, based on best-effort traffic delivery and with no prioritisation of traffic by type or destination.

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## Standalone evaluation

In 2014 total European fixed traffic is forecast to be 14,600 PB/ month. In order to raise the €9 billion additional revenue identified in Section 1, a charge of €0.05 per GB would be required. A similar calculation for mobile, based on our constrained growth case with a combination of 3G and LTE shows that a charge of €3.03 per GB would be needed to raise the required additional mobile revenues.

**Exhibit 18 – Current Transit Charges vs. Traffic dependent Charges <sup>(1)</sup>**  
- € /GB-

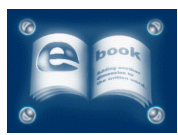





(1) Assuming current transit charge of €4/Mbps per month  
Source: Cisco VNI, DrPeering

The tariff of €0.05/GB on fixed networks is similar to the fee charged for private content delivery services which start at around €0.11/GB and go down to around €0.03/GB for Online Service Providers with high volumes. On the mobile side, €3/GB is similar to the current retail pricing for 1GB/ month tariff. The large difference between Fixed and Mobile traffic pricing also reflects the fact that increasing Mobile Capacity has a much higher variable element via the cost of new sites, new towers etc. In fixed networks, additional capacity can be added at lower marginal costs. It also reflects that mobile network capacity must be added right through the network, including the expensive radio link, whereas we assume that at least in the medium term the copper “last mile” of fixed networks can handle the envisaged traffic growth.

It is difficult to gauge the reaction of Online Service Providers to such a charge across all of their traffic volumes. Clearly a portion of traffic would no longer be economical and so likely withdrawn or moved to a paid-for model (a natural reaction to a price signal). We did not include an assumption for such elasticity of supply in our traffic and capex modelling but it would likely have an impact on closing the gap too. Exhibit 19 shows that in practice a charge of this level should be acceptable to deliver revenue-generating content to the end user over a fixed network based on charges of €0.05/GB.

**Exhibit 19 – Price Impact of the New Model for Online Content on Fixed Networks**

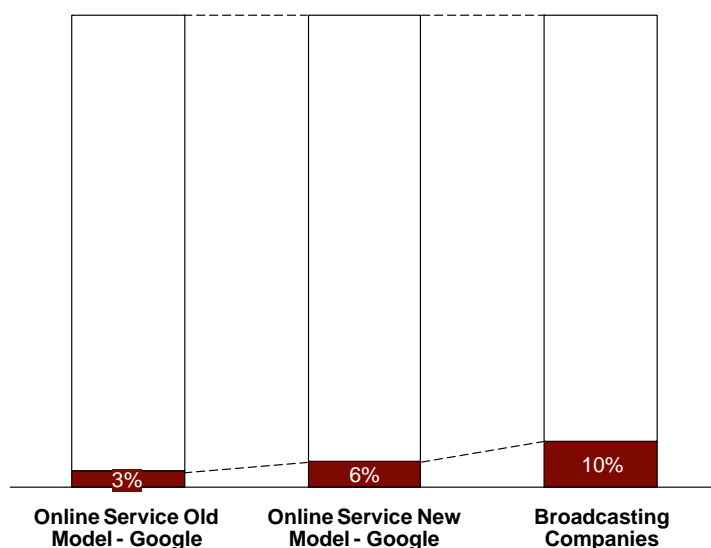
	<ul style="list-style-type: none"> <li>■ <b>1000 digital books</b></li> <li>• 1000 digital books represent approximately 1 GB</li> <li>• Additional costs: € 0.05</li> </ul>	<div style="border-left: 1px solid black; border-right: 1px solid black; border-bottom: 1px solid black; padding: 10px;"> <p>Low delivery cost relative to value of the product downloaded</p> </div>
	<ul style="list-style-type: none"> <li>■ <b>A Music Album</b></li> <li>• 74 minutes music album represents approximately 780 MB</li> <li>• Additional costs : € 0.04</li> </ul>	
	<ul style="list-style-type: none"> <li>■ <b>A movie</b></li> <li>• Downloading a movie represents approximately 1.5 GB</li> <li>• Additional costs : € 0.08</li> </ul>	
	<ul style="list-style-type: none"> <li>■ <b>A HD movie</b></li> <li>• Downloading a movie represents approximately 3 GB</li> <li>• Additional costs : € 0.15</li> </ul>	

Source: A.T. Kearney analysis

The situation for mobile networks would be more challenging and the charge of €3.03/GB would seem problematic for the examples shown in Exhibit 19 (reflecting the underlying economic fact that mobile networks are not the best medium for mass downloading of certain content, such as HD videos). For such revenue-generating content, mobile operators are already striking revenue sharing agreements with Online Service Providers to cover their costs while making such content more widely available. For other content, Online Service Providers will require a convenient means to identify that a user is on a mobile network in order to agree to pay more for traffic being sent to a mobile user than to a fixed user. They could then send lower resolution images or simplified versions of webpages to reduce costs. In principle, however, it will be the user’s choice to access from a fixed or mobile device and Online Service Providers have no control over it.

An alternative is to compare this fee to typical fees paid by today’s broadcasters for content delivery. Exhibit 20 shows that broadcast service fees for a large broadcaster are typically around 10% of revenues. By this measure, an Online Service Provider such as Google would be paying less than this, but still double what they currently pay.

**Exhibit 20 – Comparison of Service Delivery Costs: Online Service vs. Broadcasting <sup>(1)(2)</sup>**  
**- Cost as % of revenue, 2009, Based on €0.05/GB delivery cost on fixed networks -**



(1) Estimated based on Google bandwidth and traffic volume in 2009 i.e. ~ 5.2% of total internet traffic globally

(2) 2009 weighted average broadcasting cost of ITV, BSKyB, TF1 and Canal Plus

Source: 2010 Financial Tables – Google Investors Relations: company annual reports; Estimating Google’s US Consumer Internet Usage & Cost, Cleland Scott; Cisco Visual Networking Index: Forecast and Methodology 2009-2014; Arbor Networks; A.T. Kearney analysis

The Google example obviously combines their revenues from search and the traffic of YouTube. Free video sites in general may find the conveyance charges are a strong incentive to develop more efficient traffic delivery (better compression techniques). But in extreme cases the costs may be prohibitive (on top of their already significant hardware, storage and data centre costs) and they would either consider reducing the content they make available or create a stronger link to revenue. This latter point is arguably an intended consequence of focusing network usage on traffic for which people are willing to pay to receive.

Increased transparency will be needed to prevent an Online Service Provider paying the higher price for traffic that may not be going to a mobile network. A blended rate would be hard to implement since traffic to a fixed network would be generating a premium over the €0.05 required; the difference would need to be redistributed to mobile networks if it is to have the desired impact rather than just rewarding fixed operators. As a first step, the most workable plan would be to implement the fixed charge of €0.05 for all traffic and leave mobile operators to recover the shortfall from the end user through higher retail prices (essentially, combining option 2 with option 1).

Finally, if the traffic conveyance fee were also applied to consumers sending or uploading very large volumes of traffic, content which is illegally distributed and typically shared for free would become more costly, while legal distribution services would continue and may see an increase in business that would offset additional fees they have to pay.

**Impact on the Internet value chain**

The key benefit of option 2 is that it establishes a clear price signal for Online Service Providers to take responsibility for the traffic they send over the Internet. Online Service Providers would be forced to consider the value of the traffic they send. If it is deemed “valuable” in the sense that it

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contributes to their revenue because either the end user or advertisers are willing to pay for it, then it would be worthwhile to send. It would strengthen the link between Connectivity Providers' revenues and the traffic they carry, making the model sustainable in the longer-term regardless of how traffic growth evolves.

For individuals operating blogs or small businesses operating their own websites, we estimate that Internet access charges would need to increase by around €3 per month to cover the costs of 60GB of traffic. This compares favourably to other costs such as a typical website hosting service cost of around €10 per month. As such, this option neither harms the flow of information or commerce, nor jeopardises the participation of smaller organisations in the benefits of the Internet value chain.

In fact, by increasing the proportion of revenues raised from Online Service Providers it enables affordable end-user prices and network investment, promoting growth in usage in line with the two-sided market concept outlined in section 1.4. Unlike option 1, increased penetration and consumers unconcerned by usage caps or traffic related fees, means they are more likely to use the services of Online Service Providers and so increase the potential customer base. Clearly equilibrium would need to be established here too.

There is a real possibility in this scenario that Online Service Providers with a strong market franchise may be able to frustrate traffic-dependent charging by withholding their content or services from some networks. In extreme cases, competition authorities would likely be asked to review whether this is a legitimate negotiation tactic or an inappropriate use of market power. The risk that a Connectivity Provider would charge excessive amounts for conveyance seems far less likely given the current inability to enforce peering agreement terms and the generally competitive nature of the market, but clearly this would be a factor in any future regulatory assessments of wholesale markets.

Further, by establishing an "economic value" for traffic carried, this option discourages traffic that increases network congestion without raising revenues for any value chain player. This should have the greatest impact on pirated content and would therefore have a positive effect for the content players within the value chain, both the Content Rights owners and those Online Service Providers with legitimate business models who would face a more level playing field. Ultimately, it increases economic utility and promotes efficient use of available capacity.

## **Summary**

The challenges in introducing traffic dependent charges are mainly around implementation: achieving sufficient alignment that the model could be sustained and charges negotiated at a level that makes this option effective. Although this option implies a cost to Online Service Providers, it also helps them monetise their new and more innovative services and applications (mainly video driven). Clearly, a better infrastructure will allow improved distribution of content and a better user experience. To use the network in a more efficient way will also reduce congestion significantly. In policy terms, moving some free video content to paid-for content would likely face a mixed response: concern over accessibility (although our examples indicate that charges on fixed networks should not distort this) but support for restrictions on piracy that undermine legitimate content businesses.

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Although some complex negotiations will be necessary to implement this solution, from a policy perspective these are familiar issues and could be handled within the current regulatory and anti-trust frameworks.

Summary of Findings – option 2 Traffic Dependent Charges for All Traffic	
Estimated required charges on fixed networks	€ 0.05/GB
Estimated required charges on mobile networks	€ 3.03/GB

### 4.3 Enhanced Quality Services over the Public Internet

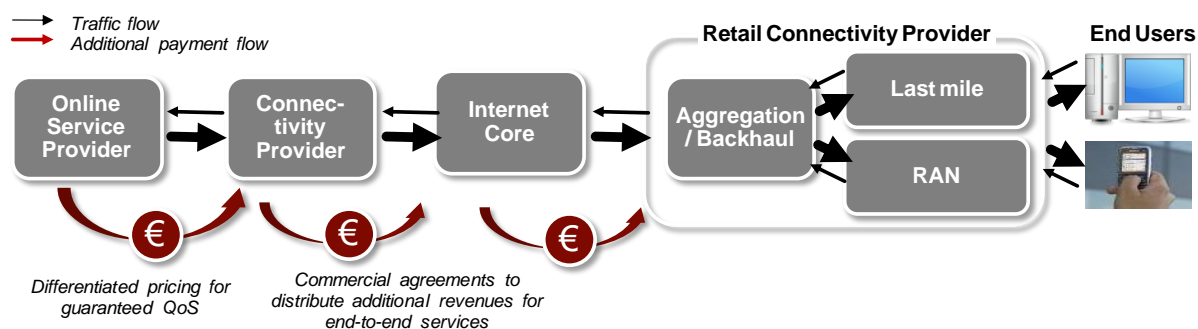
In the third option, best-effort traffic delivery remains the same with no additional charges but Connectivity Providers charge additional fees for enhanced or premium services. These could be in the form of different quality of service (QoS) offerings for different traffic types (video, gaming or voice, for example) or prioritisation of other traffic for specific content types as selected by the Online Service Provider that commissions and pays for such services.

Quality of service is the ability to establish a different priority for traffic from different applications, users, or data flows, or to guarantee a certain level of performance to a specific data flow. Quality of service guarantees are particularly important at times of congestion, especially for real-time streaming of multimedia applications such as online games, voice over IP and IPTV.

Online Service Providers would pay their Connectivity Provider additional fees for traffic delivered with premium service levels, and the Connectivity Provider then pays a premium to the other Connectivity Providers in the chain as shown in Exhibit 21. In this way, additional fees for premium traffic cascade down to the Retail Connectivity Provider who bears the greatest investment burden to make premium QoS succeed.

These services would be “end-to-end” across the Internet in a coordinated way, that is, offered by all participating parties with full support across different networks. Clearly a critical mass of providers would need to participate to make such a service workable and to cover a high proportion of end users. Once established, the remaining Connectivity Providers would likely choose to offer enhanced services too, driven by local competitive forces and to take advantage of established standards.

Exhibit 21 – Option 3: Enhanced Quality Services over the Public Internet



### Implementation challenges

Importantly, by using the public Internet as the delivery medium, all parties in the chain need to agree and support a set of common delivery standards in order for it to work effectively. Standards of service must be defined and agreed upon by all participating Connectivity Providers in a consensus driven manner, although actual commercial agreements for the interchange of traffic would remain on a bilateral basis, similar to today's transit and peering agreements. Suitable wholesale billing arrangements would also need to be developed, and mobile networks would need to consider how to deliver the enhanced services and the technical implications, especially in legacy 3G networks.

The technology to deliver this option exists today. The challenge, however, is using it as part of the public Internet infrastructure, particularly in finding common agreement on service levels to be offered and setting up inter-working arrangements (technical and commercial) to make it function on a consistent basis across multiple networks to justify a premium price. Multiple service levels have already been defined in current Internet protocols, so the most acute task would be to set up a process to select the quality levels and then run the required testing and network synchronisation procedures.

Clearly the "value" of the higher-quality services, (and so potential price that could be charged) is directly dependent on there being a discernible difference in performance versus best-effort delivery. Although Connectivity Providers may appear to have an incentive to degrade best-effort services to increase revenue from the enhanced service, we do not believe this is likely to occur due to the stiff competition and operators' interest in retaining overall market share in the retail market. Such a short-sighted move would lead to millions of regular-service-level customers becoming dissatisfied and switching to other Connectivity Providers. Therefore, as long as there is a competitive market in retail broadband access, competitive forces would continue to determine the quality of best-effort Internet service and the market will determine an appropriate balance. Many regulatory authorities are focusing on the quality of best-effort Internet services and promoting transparency on performance levels to support a competitive market.



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## Standalone evaluation

The commercial value of these services is directly related to the improvement they offer over the future best-effort delivery. Clearly if an Online Service Provider is able to provide a satisfactory service to their customers using best-effort delivery they are unlikely to pay extra for enhanced traffic delivery services. However if congestion is disrupting their service delivery in a way that affects their own revenues, they will be more willing to pay a premium. For example, a VoD provider could easily lose customers if its streaming service is frequently interrupted and hence is likely to pay for guaranteed quality of service. Advertising-funded services may pay for enhanced service if it improves the user experience (faster search, richer content) and so helps attract more viewers/users from competitors.

IP network designers face a trade-off between investing in increasing transmission and switching capacity, and investing in management systems to differentiate traffic classes. For most of the past years, while the Internet was only fixed and its services delay-insensitive, the balance was tilted towards investments in capacity. However, the intrinsic capacity limitations of mobile broadband access and the rise of demand of high-bandwidth and real time services are tilting the balance the other way now. Quantifying the demand for these premium services is difficult given we are considering content and delivery services that do not currently exist. However, the growth of CDN services to date (reflected in the rapid growth of the major CDN players. Akamai's revenues, for example, have grown fourfold over the past 5 years<sup>15</sup>) already indicates a willingness for Online Service Providers to pay for services that deliver traffic faster and more reliably to end users. We expect providers of video-over-Internet and gaming services to have the highest propensity to pay for enhanced delivery and we estimate the value of the European market for these services will be around €42 billion<sup>16</sup> by 2014. If they were prepared to pay around 10-15% in delivery costs (i.e. at least the 10% broadcasters currently pay for satellite and terrestrial broadcast distribution), this would suggest demand of around €4-6 billion per year for these services. Other types of Online Service Providers that sell real time services may also be willing to pay, which may increase the value, although their traffic volumes will be an order of magnitude lower.

## Impact on the Internet Value Chain

Once established, this option offers Online Service Providers new service delivery options which would be standards-based and so available to all globally as easily as best-effort services are available today. This would enable a provider in one country to offer enhanced services directly to users in new markets without the obstacle of having to setup agreements with local Connectivity Providers to deliver the enhanced service. By doing so, it opens new opportunities for Online Service Providers to launch more advanced services that may not be viable in the current best-effort model. There is clear benefit for end users who will have access to services that would not otherwise be available, such as HD, 3D on-demand movie services or improved online gaming.

By maintaining the best-effort Internet service at existing price points this option also helps sustain the continued increase in Internet access to a broad population and promotes usage, with the

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<sup>15</sup> Wedbush Equity Research, Sep 2010

<sup>16</sup> Internet Value Chain Economics, 2010, A.T. Kearney

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positive aspects for Online Service Providers already mentioned in option 2. It also ensures that all those currently making their content available for free, from blogs to small businesses to public services, would continue to do so without the disruption that would arise if the best-effort Internet became too congested with high-bandwidth commercial services. There could of course be opposition to the idea of a “two-class” Internet, but this would really be a choice for the Online Service Provider, which is already making a series of economic trade-offs about its technology investments or go-to-market strategy (and some of which are already choosing to bypass public Internet infrastructure in search of better performance). For the end user the question of how the traffic is delivered would remain immaterial and they would focus instead on the quality of the overall service they receive relative to the price paid.

### **Summary**

This option should be considered as complementary to today’s best-effort Internet, not a replacement. There is complexity and cost involved in setting up the new services and billing arrangements in a co-ordinated way but this should be feasible in the medium term.

However there are two limitations of this option. Firstly it does not establish a strong price signal for best-effort traffic on either side of the market so the structural problem is not fully addressed. However if the most bandwidth intensive applications/services can be more efficiently distributed, this will help reduce potential congestion of best-effort Internet traffic which is in everyone’s interest. Secondly, the concept of prioritising some traffic over others, even in a transparent manner, contravenes some of the stricter interpretations of Net Neutrality proposed by some interest groups and its implementation could lead to an extended period of debate. Assurance by regulators that such an approach is encouraged under an open Internet policy would give regulatory certainty for operators who wish to advance with this model.

Although this option is based on open standards that all Connectivity Providers would need to adhere to, the pricing and inter-Provider agreements would all be based on normal commercial agreements. In fact, precisely because all services are standards based, the market would be particularly transparent and efficient (as it is for transit services today) in finding the right market pricing for the new services and indeed varying these over time as demand for higher quality services almost certainly grows. This option should therefore not pose any regulatory challenges as long as the concept is clearly explained.

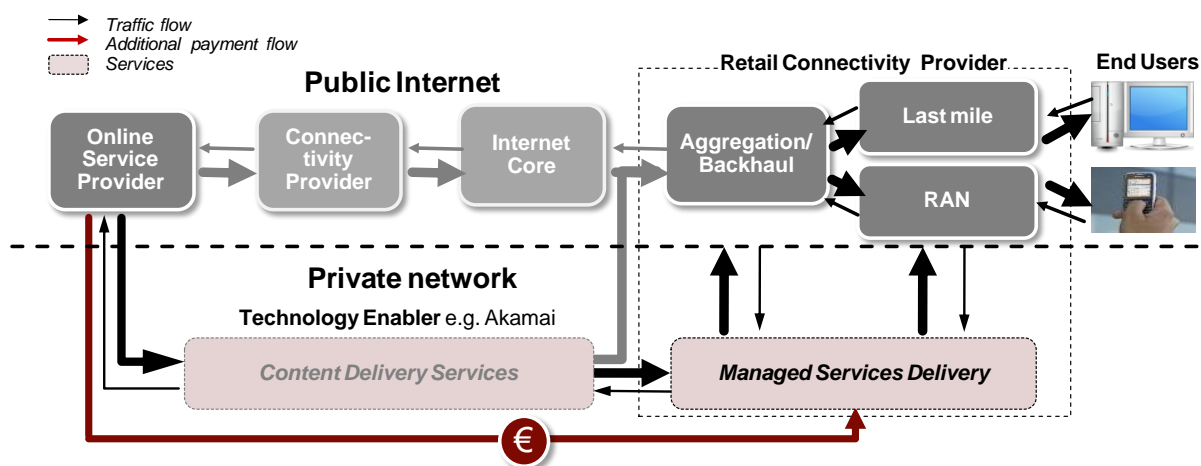
#### **4.4 Enhanced Quality Services Based on Bilateral Agreements**

In our fourth option, enhanced traffic delivery services are offered on a bilateral basis by Retail Connectivity Providers to Online Service Providers to improve and differentiate delivery over their access networks. Such services could be bundled with hosting/caching services as part of integrated “managed services” and would be a natural extension of the growth in content delivery services that currently seek to address congestion in the core network layer. In practice, alliances may form (as they have in the Managed VPN/MPLS services area) between groups of Retail Connectivity Providers and CDN operators to offer services with broader reach and a stronger proposition to the Online

Service Providers, who would probably prefer to avoid having to strike bilateral agreements with every Retail Connectivity Provider in each target market.

These enhanced services would be part of the Connectivity Providers' service offering (both retail and wholesale) and could be customised and tailored to address local demands and needs. They could include exclusive content such as IPTV and VoD services or higher speed delivery of public content to the end user.

### Exhibit 22 – Option 4: Enhanced Quality Services Based on Bilateral Agreements



#### Implementation challenges

In contrast to Option 3, this option is based on bilateral agreements for enhanced services using dedicated network resources. The best-effort public Internet remains as it is today using current core infrastructure, but in addition, Online Service Providers make commercial agreements with Retail Connectivity Providers on a bilateral basis, or content delivery networks act as aggregators and then offer 'end-to-end' packages to Online Service Providers. Retail Connectivity Providers need to be able to offer QoS guarantees within their own networks, not visible to the public Internet, which many are already doing to deliver IPTV services as part of service bundles to retail end users. Mobile networks could develop bespoke services that enable Online Service Providers to tailor services and applications to mobile users or adapt other services to better suit the technical limitations of mobile networks.

#### Standalone evaluation

This option offers the widest potential for Connectivity Providers to quickly develop innovative services that complement the needs of new online services, without needing to coordinate with the whole industry on technical or commercial standards. The potential opportunity is similar to option 3 (estimated annual revenues of around €4-6 billion by 2014) but the increased flexibility and diversity of services may result in Connectivity Providers being able to meet more closely the needs of Online Service Providers and in so doing, raise more revenues. By avoiding the need for the consensus required in Option 3, innovative Connectivity Providers will be able to launch new services more quickly and potentially extract more of the added value and a better return for their innovation and

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investment. There would also be no restrictions on how services evolve or what new services may emerge in future given that the public Internet continues to develop as it has done so far.

Providers of CDN services have been growing rapidly in recent years as Online Service Providers seek to improve the delivery of their content but CDNs are not able to improve delivery over the access networks. To date the access networks have not been a limitation but with the expected increase in high-bandwidth services, especially video services, this is becoming a more important requirement. This option opens up the possibility and the potential revenue opportunity that incentivises Connectivity Providers to invest in the necessary infrastructure in the access networks to deliver the services. In fact there are already examples of such enhanced services today,

- **BT Content Connect.** A service recently launched by BT aimed at video content service providers allows them to pay to have content cached closer to the end user in order to improve the quality of delivery and the user experience and to avoid congestion
- **Telstra.** The company makes public that it hosts certain content on its network (YouTube) and that accessing such content does not count toward end-user traffic download limits. This is a move toward differentiating access services on more than basic performance.
- **Managed IPTV services.** Many operators now bundle IPTV services as part of the broadband access package, generally under their own brand, which are delivered over the access network using traffic prioritisation/reserved bandwidth.

As in Option 3, the quality of best-effort services is expected to be maintained at acceptable levels driven by competitive forces, although in option 4 the bilateral deals would mean Retail Connectivity Providers will be better able to differentiate their offerings and so would be competing on more than pure price and quality of service.

### **Impact on the Internet value chain**

This option would benefit Online Service Providers who will be offered enhanced services on commercial terms that make it possible for them to launch new services in a similar way to option 3 but almost certainly in a quicker and more flexible manner. The price for this is the management cost of setting up many bilateral agreements. Initially, this might appear to be a barrier to entry for smaller Online Service Providers but we expect that CDN providers would develop offerings for smaller players, acting as aggregators or resellers of CDN capacity. In fact, it seems likely that a vibrant competitive market would develop for such services, where new business models and new entrants could quickly establish themselves.

Regulators would naturally wish to scrutinise elements of the market under this option. They would need to ensure that a less standards-based approach does not allow a small number of global providers to erect barriers to switching that could restrict long-term choice and competition. Where Connectivity Providers choose to bundle non-network services with network services in the retail market, they would at times be asked to demonstrate that they are not unduly discriminating against competitors. Yet none of these issues is new and existing regulatory and anti-trust frameworks should continue to be sufficient to prevent abuse. Recent commentary by the UK government, for instance, has been supportive of the evolution of the Internet in this way as long as

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transparency is maintained and the same commercial offers are made available to all market participants in a non-discriminatory fashion.

This option would enhance the end-user experience in two ways. Firstly, they would enjoy better quality when using Online Service Providers' high performance services. Secondly, their best-effort services would be less prone to congestion as the main sources of congestion that may degrade quality would have been taken out of the public Internet. The same applies for organisations offering their content for free, as discussed in option 3.

### **Summary**

This option should be considered as complementary to the best-effort Internet services currently offered. It has an obvious commercial appeal in that future investments are based on Online Service Providers' willingness to pay for the services offered and successful services will attract more investment. By providing an alternative to the best-effort public Internet, it ensures the sustainability of traffic delivery services. When combined with CDN services, this option offers a high-speed private infrastructure for those willing to pay, while the best-effort infrastructure remains for all other traffic and is preserved from worsening congestion, although as with option 3, the price signal is still absent in that part of the market. Above all, this option has the advantage of speed: it would take less coordination and planning to implement it and thus quickly begin to address the structural problem in the Internet value chain.

Provided these services are open to all potential market participants on fair terms, the key policy issue would be ensuring transparency and competitiveness in the Connectivity market. As in option 3, some interest groups would consider this diversity of provision and differentiation of service levels to be against their strict interpretation of net neutrality principles. However, a counter-argument is that one cannot prevent commercial organisations from agreeing to bilateral commercial terms as long as they are transparent and non-discriminatory.

## **4.5 Summary Evaluation of Options**

The four broad options are all possible solutions to address the structural problem of the current Internet model and all merit further exploration. As described in Table 2, each can only resolve part of the structural issues (for example, incentives, pricing signals, traffic optimisation, future sustainable investment funding, and openness of the model) and none of them on its own offers a silver bullet in terms of a viable long-term resolution of all the pressures discussed in section 2.

**Table 2 – Evaluation of Options for the Viable Internet Model**

Key Dimensions	1. Modification of Retail Pricing Schemes	2. Traffic Dependent Charges for All Traffic	3. Enhanced Quality Services over the Public Internet	4. Enhanced Quality Services Based On Bilateral Agreements
Does it improve the overall economic efficiency?	No	Partly – price signal linked with traffic but no differentiation in terms of type of traffic	Yes - since prioritisation reflects willingness to pay overall utility and welfare is maximised	Partly – Crowding out is prevented through channelling of QoS on separate networks. Provisioning of best effort services remains relatively inefficient
Does it influence/ change users' behaviour (i.e. increasing/decreasing usage and penetration)?	Yes –may reduce penetration and uptake depending on price elasticity of the demand and market maturity	Partly – no immediate impact but in practice, Online Service Providers may pass on the increased costs to End-Users through price increases or through increased exposure to advertisement. Bandwidth "hungry" services would have to pay more and therefore become less attractive	Partly – no effect on penetration and the overall usage may increase driven by the potential demand for paid-for services. No change or potentially decrease of usage for public or less valuable content.	Possible – availability of new services though users may have to change connectivity provider and pay more to get access to premium content.
Does it affect Online Service Providers' behaviour (e.g. increasing/decreasing innovation and content accessibility or increasing prices excessively?)	No – no major change to current situation; however, the reduction in penetration may potentially affect new service development negatively	Yes – charges directly related to traffic sent. Need to address traffic efficiency issues. Higher potential growth and innovation than just using Option 1	Yes – Possibility of delivering new services with QoS requirements and hence creating potential new revenue stream. Voluntarily pay more for certain traffic but does not address free-riding on best-effort service levels	Yes – Possibility of delivering new services with QoS requirements and hence creating potential new revenue stream. Stronger incentive to voluntarily pay more but channelled to private networks rather than public. Potentially more innovation and increased retail prices for services (as compared to Option 1 and 2, but the same as 3)
Does it ensure the market remains open and competitive?	Yes – no change to current situation	Yes – no major change to current situation since charges would be transparent and applicable to all without discrimination	Yes – no change to current situation since best effort Internet remains	Partly – as long as the market remain competitive and services are transparent and available to all type of players
Does it encourage more efficient use of the available network capacity?	No – same structural problems as today	Yes – clear price signal linked to traffic, especially to heavy traffic users	Partly – does not directly address root cause of congestion but provides an alternative path for those willing to pay	Partly – quality sensitive content is likely to be transported over private infrastructures. Problem of best effort remains.
How feasible is it to implement the model?	No structural issues but challenge to actually implement price rises in such competitive market	Requires a high degree of consensus (which is unlikely) or potential regulatory intervention	Requires cross-operator co-operation to support traffic delivery at QoS and also charging/ revenue sharing	Already happening to some degree in certain markets

**Option 1: Modification of Retail Pricing Schemes.** This is a default option if no decisions are made on creating alternatives. It helps raise additional revenues but does not address the structural problem and may have negative consequences on take-up and usage, with consequent impacts for Online Service Providers in terms of smaller target audiences.

**Option 2: Traffic Dependent Charges for All Traffic.** This establishes the necessary price signal most strongly. The challenge here is in the feasibility of implementing such a solution on a regional or global basis and the potential impact in terms of some Online Service Providers withdrawing content that cannot be monetised. By avoiding putting additional cost on the end user this option promotes wider Internet penetration and usage, which should be to the benefit of Online Service Providers too.

**Option 3: Enhanced Quality Services over the Public Internet.** This brings new functionality to the Internet and increases revenues from those who choose to use it; it does not fully address the underlying structural problem of growing best-effort traffic. Here too there is a complex timing challenge in terms of coordinating the implementation and some uncertainty over how much revenue such services would raise. The enhanced services would encourage innovation and investment in new Online Services which exploit their potential in ways not possible over the best-effort Internet today.

**Option 4: Enhanced Quality Services Based on Bilateral Agreements.** This is perhaps the most practical option in terms of short-term implementation and is also one of the default options if no decisions are made on creating alternatives. It does not completely address the structural problem for the best-effort service either, but it does provide a workable alternative service that could be

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used to continue to drive innovation and support the needs of new services yet to be launched for which best-effort delivery is not sufficient and for which revenues could be raised. This option would promote innovation in Online Services and also allow Connectivity Providers to experiment with new service offerings.

Considering this assessment, it seems that the most desirable way forward will be a hybrid solution that involves a partial implementation of several of the models described in this paper:

- Option 1 could be pursued in combination with any of the other options as the two-sided market finds the right equilibrium to fund investment
- Options 2 and 3 could be complementary, with some Online Service Providers paying a fee for best-effort delivery and others paying a premium for enhanced QoS delivery
- On the same basis, Options 2 and 4 could be complementary, with the business case for an Online Service Provider to make bilateral CDN-like arrangements strengthened if best-effort delivery also has a modest charge

Options 3 and 4 could directly compete with each other, both being means of achieving higher quality of traffic delivery but the difference being in whether this is in a coordinated way via the public infrastructure or via bilateral agreements and the use of private infrastructure/managed services. Technically they could co-exist and the competition to offer cost-effective enhanced services could actually provide healthy competition that drives both forward.

For each option, there are different policy concerns. For option 1, there is the telecoms policy objective to promote penetration and widen access to the high speed Internet and therefore any increase in retail tariffs would need to be thoroughly considered and implemented in a way that does not exclude those unable to afford higher prices. In addition, there is also the potential legal complication of applying charges related to traffic not requested by end users.

The traffic dependent charge proposed in Option 2 may raise concerns for the viability of less well-funded Online Service Providers used to very low connectivity fees. However, based on our assessment, it should be affordable for both sides of the market and also support tackling the piracy issue. Options 3 and 4 are likely to be somewhat contentious at first since they introduce differentiated services where currently there is only best-effort, although it should be noted that currently option 4 is generally considered to be outside of the public Internet and so classed and regulated as a private managed service by regulatory bodies. When set against the “do nothing” alternative of worsening congestion and unusable services, however, it is difficult to argue that these options are damaging to the founding principles of the Internet, which was designed first and foremost to be resilient in maintaining communication flows.

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## 5 Conclusions

This study demonstrates that there are clear structural problems in the current Internet economic model making it increasingly inefficient and ultimately unsustainable as traffic growth continues, usage patterns evolve and new applications are developed. For the Internet ecosystem to fully develop its potential there is an increasing need to find solutions to the current structural problems.

Two main problems have been identified:

- Few economic incentives exist for Online Service Providers to use network bandwidth efficiently. In particular, the massive growth of video usage and its inefficient management by standard Internet routing procedures places excessive pressure on network capacity. The resulting congestion leads to high opportunity costs for innovative online applications and content. Network optimisation/traffic management approaches are necessary but not sufficient in the medium term to overcome the structural problems and to ensure the viability of the Internet.
- Networks have not been able to monetise this traffic growth and if no new incentives are created to encourage network operators to invest, growing congestion problems will diminish the customer experience and limit innovation. Online Service Providers will find it increasingly difficult to ensure a satisfactory customer experience and their business models will be unable to exploit their potential. This will have implications not only for the Internet ecosystem but also for the economy as a whole.

Customers benefit from access to a wide variety of content, while Online Service Providers benefit from access to a large population of end users. Network operators provide the platform for this relationship and must find an efficient pricing balance between the two sides, taking into account the relative value derived by each and providing appropriate price signals for both sides of the market to establish sustainable long-term business models. The two-sided market concept has proven successful and sustainable in multiple other industries.

Four options of alternative Internet economic models have been explored in this study. If combined in the right way, these options have the potential to promote more efficient use of a common infrastructure while “incentivising” network operators to continue investing for the benefit of all. Therefore, all four options should be further explored and we expect elements from each to play a role in the future evolution of the Internet as a two-sided market.

The choice of the preferred commercial solution or mix of solutions will be different for different players depending on their position on the Internet value chain and their specific market situation. None of the solutions should be a priori excluded, provided each is implemented transparently and is consistent with competition law. Market players have the obligation to find a new equilibrium to the benefit of the Internet ecosystem and society at large. There clearly is the potential for new win-win solutions, and for all parties to gain.



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A.T. Kearney would argue that all participants in the Internet value chain should continue to have the flexibility and freedom to devise and test new business models to allow market forces to establish a new sustainable equilibrium. Imposing any specific option, or forbidding one or more of them, risks preventing the Internet ecosystem from finding efficient solutions to the current structural problems and therefore would prevent customers from enjoying high quality and innovative new services. Existing general competition law should be sufficient to deal with any potential anti-competitive behaviour that may arise in open and developed markets. This report therefore does not see a need for new legislative prescriptions or regulatory interventions. Policy makers globally should be supportive of commercial initiatives contributing to investment, innovation and more efficient use of the Internet for the benefit of all.

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## Appendix

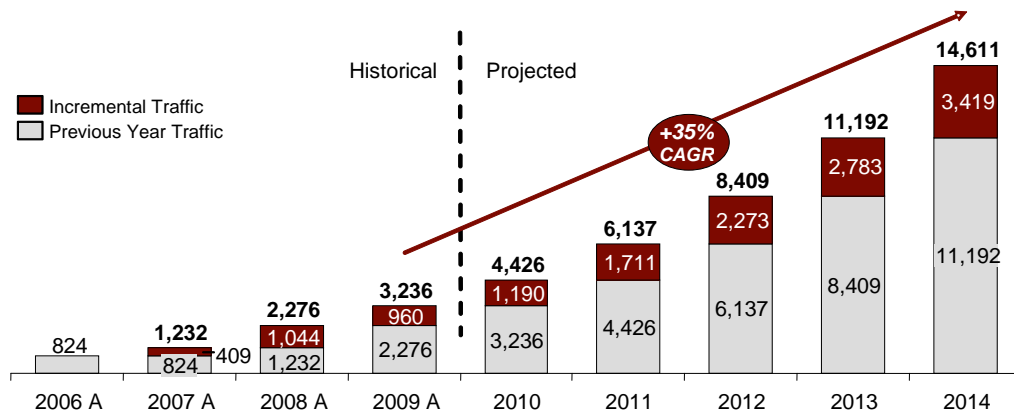
### Report Methodology

#### Methodology for Capex Model for Ongoing Traffic Growth in Existing Networks

##### Fixed

Our approach starts with the Cisco VNI traffic forecast for Western, Central and Eastern Europe, shown in Exhibit 23 below.

Exhibit 23 – Fixed European Traffic (PB/month)

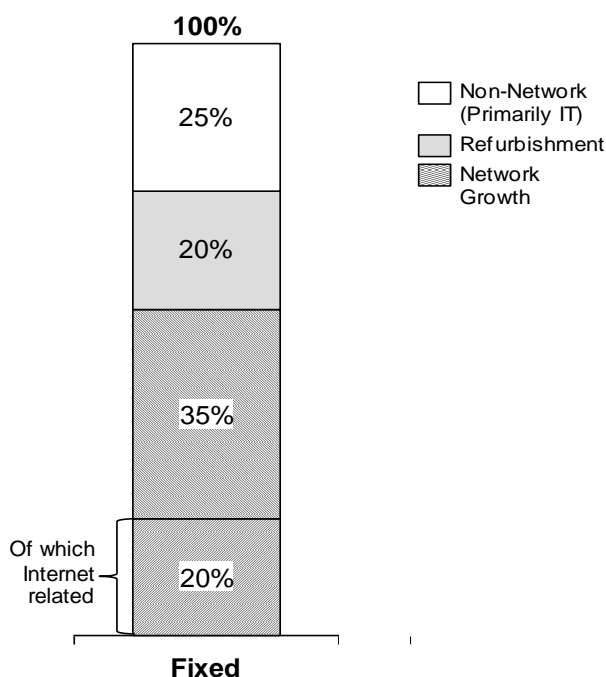


Source: CiscoVNI

Based on our Global Cost Benchmark studies and industry interviews at various European operators, we estimate that around 20% of fixed telco capex is used to expand Internet network capacity. Of the other 80%, 25% is typically for IT investments, 20% for network renewal and compliance, and the remaining 35% is investment in network growth in other services e.g. MPLS, WAN etc. However, in reality, it is difficult to split network investment definitively since much backbone infrastructure is shared between Internet and other services and many network investments are driven by both renewal and capacity needs. For particular operators the breakdown could be very different and also a function of the size of their Internet services business relative to other services.

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## Exhibit 24 – Typical Breakdown of Capex (based on 2009 data) for Fixed Connectivity Providers



(1) Based on 2009 data from a selection of European fixed operators  
Source: A.T. Kearney Global Cost Benchmark; Company financials

For fixed European Internet traffic, the CAGR 2009—2014 is forecasted to be 35%, reaching 14,611PB/month in 2014 (as shown in Exhibit 23).

Using the capex ratio and applying to industry total capex figures, we have calculated an “average cost per PB added” based on historical data which lead to €3.1 Mn/PB per month in 2014. We then used this to calculate the capex required to fund future traffic growth, based on the following assumptions:

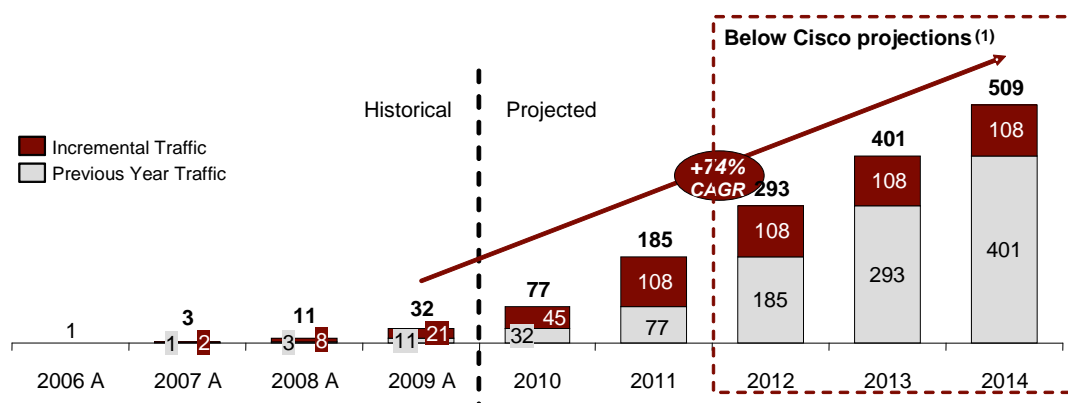
- The growth assumes a similar traffic profile to today and no change in traffic type. The shift towards a higher proportion of video streaming applications in particular may necessitate an increased investment if quality is to be maintained at today’s levels since it is more demanding, but to be conservative we have not included this in our model
- The capex allocated to “network growth” projects is funding the additional traffic (i.e. if no growth, only maintenance capex is required) and in-year capex funds each year’s traffic growth. In reality there will be some lag or use of “spare capacity buffers” and considerable year to year variations in capex, but the long term trend will hold.
- A 15% cost improvement in the unit cost of capacity each year is assumed
- Average cost of PB is not strictly the correct unit; it is the growth rate that is important. The approach works by assuming that capacity added correlates with total traffic increase.

We used these assumptions and calculations to model the capex required to meet the traffic forecast and then mapped this against the trendline capex and the results are shown in Section 3.2.1.

## Mobile

For mobile we take a slightly different approach based on calculations of the number and cost of the additional sites required to meet the forecast traffic demand.

### Exhibit 25 – Mobile European Traffic (PB/month)



(1) Constrained scenario with the mobile growth remaining at the 2011 level  
Source: Cisco VNI, Oppenheimer, A.T. Kearney analysis

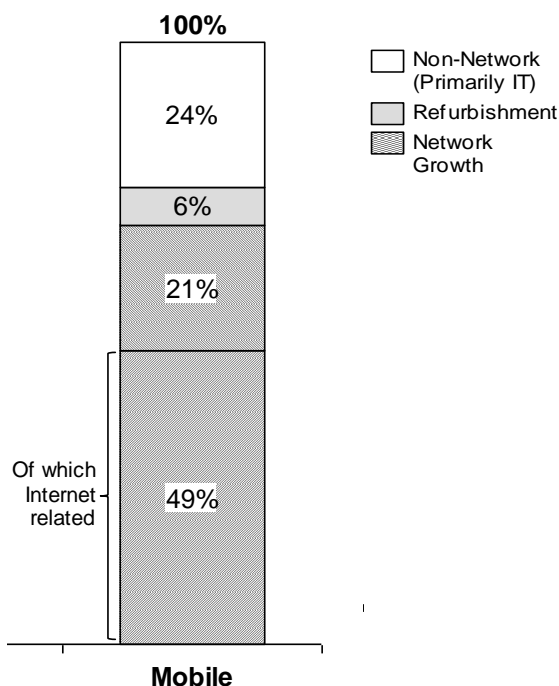
In modelling the mobile capex required, we used a constrained growth scenario from 2012 onwards, assuming constant capex at the same level for following years (without LTE, it is hard to envisage the level of forecast traffic growth being feasible) which constrains growth so traffic is less than half the Cisco forecast for 2014.

For the 3G only scenario in section 3.2.2, we have modelled the number of sites required to deliver the incremental capacity, based on a typical average monthly site capacity of 0.7 TB/Month (from our experience of typical site loading and certainly below the theoretical capacity of a site).

We then modelled the cost of these sites based on 50% new sites (so civil works, site rental etc required), and 50% existing (only a new Node B required). This equates to around 410,000 new sites across Europe, at an effective cost of €192 Mn/PB per month of incremental capacity added, including backhaul and aggregation investments.

We have then calculated the capex for these sites. The 2006-2010 data capex was derived from Oppenheimer's historical and projected total mobile capex from 2006-2011 by estimating that around 50% of total Telco capex is used to expand mobile Internet network capacity. As shown in Exhibit 26 below, of the remaining 50%, 24% is typically for IT investments, 6% for network renewal and compliance, and the remaining 21% is network growth investment in other services.

**Exhibit 26 – Typical Breakdown of Capex (based on 2009 data) for Mobile Connectivity Providers**



(1) Based on 2009 data from a selection of European mobile operators  
 Source: A.T. Kearney Global Cost Benchmark; Company financials

We assumed a 3.5% growth in trend capex to match forecast growth in revenues. The difference is then the additional capex required to be funded.

Consistent with ongoing capex rather than a one-off investment, we have calculated additional revenues required based on maintaining a 25% capex/revenue ratio (based on European mobile data capex and revenues in 2010).

As explained in Section 3.2.2, if this level of traffic growth materialises, operators will seek to deploy LTE earlier as it is a more cost effective means of deploying such large capacity. We modelled a hybrid solution where 13% of mobile traffic is carried on LTE networks in 2014. This reduces the number of 3G sites required and replaces them with a lower number of LTE sites. We assume that 70% of LTE sites will be on existing towers and 30% will be greenfield sites. For core network we made an allowance for transmission upgrade costs in the cost per site.

**Methodology for case for fibre**

In section 3.2.3 we estimated the capex requirement of rolling out FTTH and FTTC networks. In calculating the required capex and subsequent revenue funding, the following assumptions were taken:

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- Considering the competition and policy pressures facing the Connectivity Providers, the capex model was developed to be aligned with the EU 2020 fibre roll-out target (100% household coverage via FTTC) assuming 50% household coverage by 2014.
  - We differentiated the deployment costs between Urban and Suburban areas. To achieve 50% of household coverage, we assume 100% coverage in Urban and a percentage of coverage in Suburban for each EU 27 country based on the distribution of the households in each country.
  - We assumed no coverage in rural area for economic considerations to be conservative.
  - We also assumed 2:1 FTTC to FTTH ratio as an interim step to achieving the EU target for both urban and suburban areas; and capex per household ranges between €350-€2,000 for FTTC and €1,000-€4,000 for FTTH.
  - For opex we assumed the upgrade is opex neutral because copper still needs to be maintained in the medium term.
  - For core network, we included an allowance (10% of the total investment) for backhaul and Connectivity Provider backbone to cover additional traffic generated.

This gives a capex requirement of €116 billion for the EU 27 countries.

## Glossary

Terminology	Definition
<b>ARCEP (The Autorité de Régulation des Communications Électroniques et des Postes)</b>	Independent French agency in charge of regulating telecommunications in France. It can be compared with United States Federal Communications Commission (FCC).
<b>Backhaul</b>	A specific network function which connects core switching nodes to the many physical sites that make up the "edge" of the hierarchical network (e.g. Mobile base station sites or fixed network local-exchanges)
<b>Bandwidth</b>	A measure of data transmission speed, expressed in bits/second or multiples of it (kilobits/s, megabits/s etc.)
<b>Best Effort Internet</b>	Principle that on the internet there are no service guarantees for content delivery (as opposed to private/managed network services). On the internet good-faith efforts will be made to achieve the best result in service delivery depending on the traffic load.
<b>Bit-Torrent</b>	A popular peer-to-peer file sharing protocol used for distributing large amounts of data.
<b>Broadband</b>	A high data rate, always-on connection to the internet. E.g., ADSL, cable and 3G internet access.
<b>CDN (Content Distribution Network)</b>	A system of computers containing copies of data, placed at various points in a network, so as to maximize bandwidth from clients throughout the network. A client accesses a copy of the data near to the client, as opposed to all clients accessing the same central server, so as to avoid bottlenecks near that server.
<b>Connectivity Providers</b>	Any of the network operators offering internet connectivity services, whether wholesale services to other telecom operators, retail services to consumers or business orientated services to enterprises
<b>Content Rights Owners</b>	The legal owners of proprietary content, including companies such as Time Warner, ABC or NBC Universal
<b>Differentiated Services</b>	On private networks, telcos may offer a variety of data delivery services tailored to different types of traffic. From technical perspective these could also be offered over the public internet if there was commercial agreement between all operators involved
<b>E-Commerce</b>	The buying and selling of products or services over electronic systems such as the Internet and other computer networks.
<b>Enabling Technology / Services</b>	Companies providing various supporting services that aid the entire value chain, such as enabling online transactions, providing online advertising solutions and providing support technology. E.g. Paypal, Nielsen and Akamai
<b>FCC (The Federal Communication Commission)</b>	Independent agency of the United States government in charge of regulating telecommunications, including broadband, competition, the spectrum, the media, public safety and homeland security.
<b>FTTC/ FTTH</b>	Fibre to the Cabinet/ Fibre to the Home - these are variations of fibre deployment which use fibre infrastructure rather than copper in the last mile to increase the bandwidth offered to end consumers
<b>GB (Gigabit)</b>	Multiple of the unit 'bit' for digital information. 1 gigabit = 10,000,000,000 bits.
<b>Internet Core (or backbone)</b>	Refers to the principal data routes and infrastructure connecting large, strategically interconnected networks and core routers in the Internet
<b>IPTV (Internet Protocol television)</b>	See: Video over Internet
<b>ISP (Internet Service Provider)</b>	See: Connectivity Provider
<b>Last Mile (or Fixed Access network)</b>	The last mile is the communications link, which connects subscribers to their service provider's network infrastructure. Access network technologies include DSL, cable, fibre optics for fixed; GSM, UMTS and LTE for mobile
<b>Network congestion</b>	Occurs when a link or node has excess traffic, causing impairment to network connection. Typical effects include queuing delay, packet loss or the blocking of new connections.
<b>NRA's (National Regulatory Authorities)</b>	Implement the regulatory framework for sections of public service and economy, laid down in EU and national law.
<b>Ofcom (The Office of Communications)</b>	The independent telecommunications regulator and competition authority for the communication industries in the United Kingdom.

## Glossary

Terminology	Definition
<b>Online Service Provider</b>	Any provider of internet based content or end-user service, including news websites, social networking sites, internet retailers, online gaming, Internet TV, messenger/communications services etc
<b>Over-The-Top (OTT)</b>	A variation of name used to refer to the services offered by Online Service Providers. It refers to the fact that hte services are offered over the internet infrastructure.
<b>Peer-to-Peer (P2P)</b>	Distributed application architecture that partitions tasks or work loads between peers, rather than using a centralized server.
<b>Petabyte (PB)</b>	A unit of information equal to one quadrillion bytes (B). 1 PB = 1,000,000,000,000,000 B
<b>Quality of Service (QoS)</b>	The name given to the variety of services which can be offered over private networks which are differentiated from 'best-effort'. Different services can have different characteristics such as low latency, low jitter, high-priority. There are a number of different protocols used to deliver such services, e.g. MPLS
<b>Software as a Service (SaaS)</b>	Software applications provided to users as a service and paid for based on a usage or rental basis, rather than the more traditional model of a user buying a license outright and then having to run it on their own infrastructure and support it themselves.
<b>Streaming</b>	Data is constantly received by and presented to an end-user while being delivered by a streaming provider, as opposed to download and store.
<b>TCP (Transmission Control Protocol)</b>	One of the core protocols of the Internet Protocol Suite. TCP is one of the two original components of the suite, complementing the Internet Protocol (IP), and therefore the entire suite is commonly referred to as TCP/IP.
<b>Telemedicine</b>	Application of clinical medicine where medical information is transferred through interactive audiovisual media for the purpose of consulting, and sometimes remote medical procedures or examinations.
<b>Throttling</b>	A technique employed in communications networks to manage network traffic and minimize congestion. For example, a server might limit, or throttle, the rate at which it accepts data, in order to avoid overloading its processing capacity.
<b>Traffic Management</b>	The activity of taking specific actions in response to congestion on particular links (i.e. Traffic exceeds capacity at a given moment) when it occurs. This will generally take the form of a set of policies which are implemented on routers to determine how they should respond (re-routing, discarding certain traffic etc)
<b>User Interface Providers</b>	Companies providing devices or applications which end-users then use to access internet based content and services. A PC and browser is the obvious user interface but there are also a whole range of others including mobile phones, connected TVs, games consoles. Providers include companies such as Dell, Nokia, Microsoft or Mozilla
<b>Video over Internet</b>	Video driven content delivered via Internet to PC or TV, instead of a traditional radio frequency broadcast. This includes catch-up TV, VoD and live television and excludes contents delivered through managed services such as IPTV
<b>VoD (Video-on-Demand)</b>	Systems which allow users to select and watch/listen to video or audio content whenever they choose to.
<b>VoIP (Voice over Internet Protocol)</b>	Transmission technologies for delivery of voice communications and multimedia sessions over Internet Protocol (IP) networks, such as the Internet.



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