Arthur D Little

Commissioned by EE

The Business Benefits of 4G LTE

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Authors

Joseph Place
place.joseph@adlittle.com
Manager
Arthur D. Little UK

Stuart Keeping
keeping.stuart@adlittle.com
Partner
Arthur D. Little UK

Shinichi Akayama
akayama.shinichi@adlittle.com
Manager
Arthur D. Little Japan

Ansgar Schlautmann
schlautmann.ansgar@adlittle.com
Associate Director
Arthur D. Little Central Europe

Executive Summary

As Information and Communications Technology (ICT) continues to develop, the business world is applying it ever more broadly – and across increasingly diverse applications. Critical to this is the development of mobile communications technology. The latest such technology, 4G LTE ('Fourth Generation – Long Term Evolution'), provides substantial performance improvements over previous mobile technologies, and offers the promise that connectivity will no longer be a barrier to realising the benefits of enterprise mobility.

These improvements in application performance and enterprise mobility can bring a range of benefits:

- Increased sales and improved customer service
- Improvements in products and services
- Productivity gains
  - Personal and team productivity
  - Management effectiveness and innovation
  - Process efficiency and effectiveness
- Direct cost reductions
- Improved employee motivation
- Improved flexibility, agility and decision-making

These benefits are borne out by businesses in countries where 4G LTE is already available. In a survey, commissioned by EE, of organisations using LTE in the United States, 67% have seen increased productivity as a result. Furthermore, 47% have been able to cut costs, 39% say they have won more business and, when asked if 4G has helped their organisations 'innovate and jump the competition', more than three-quarters agree.

Compared with previous mobile network technologies, 4G LTE offers much higher bandwidth (speed of data transfer), lower latency (faster response times from the network) and improved spectrum efficiency (increasing overall network capacity). In practice, this allows:

- More applications to be used on mobile devices, out of the home or office
- Faster or real-time sharing of large files and streaming media
- Near-immediate delivery of time-sensitive data, such as for real-time interaction or transactions

Compared with Wi-Fi, 4G LTE allows:

- Fully-mobile use of applications that require true broadband speeds
- Improved convenience ('ownership' of the mobile connection)
- Security (no need authenticate onto another, possibly public, network)

LTE will deliver improvements in the performance of many existing applications, and make feasible new applications that depend on reliable high-speed or responsive data transfer. Examples include innovative telemedicine applications,

remote monitoring, fully-mobile virtual desktops and high-definition mobile videoconferencing. The improved user experience and practicality of LTE will also hasten uptake of those existing applications that already work on mobile devices – but just not very well. Finally, LTE's high bandwidth can support the rapid set-up of temporary workplaces, as an alternative or backup to fixed broadband connections.

Drawing on interviews with senior executives, together with Arthur D. Little project experience from other countries, this paper sets out to describe some of the real-world benefits that businesses can expect from LTE and explores specific applications in five example verticals: Construction, Healthcare, Retail, Transport and Professional Services.

Based on these findings, the paper defines five general types of business applications or 'use-cases' and explains how their performance can be substantially improved by 4G LTE:

- Large file transfer
- Rapid workplace set-up
- Rich machine to machine and remote monitoring applications
- Videoconferencing, tele-presence and rich media collaboration
- Remote access to business applications

In the UK, there is clear public commitment from the operators to deploy 4G LTE widely, and EE has committed to launch services by late 2012.

Business customers are already anticipating the advantages of 4G. An EE-commissioned survey shows that 94% of IT decision-makers in the UK believe that 4G will be 'an important business tool'. 84% say that they are 'excited by the prospect of introducing 4G' and over 60% hope to deploy 4G 'within six months of its launch.'

UK organisations now need to consider how to exploit the benefits of 4G LTE. They must understand fully how the needs of their users – employees, contractors, suppliers and customers – are evolving, how 4G LTE can support them, and how both revenues and costs can be improved. This understanding should be developed into a full enterprise mobility strategy and business case, which defines how to reconfigure the organisation to capitalise on the promise of advanced mobility.

The Evolution of Business Communications

The three trends of workforce mobility, cloud-based services and the 'consumerisation' of ICT are driving uptake of diverse applications, bringing benefits including increased sales, improved products and services, productivity gains, cost efficiency, employee motivation, flexibility and enterprise agility.

The business environment continues to demand richer communication and collaboration for employees who are increasingly mobile or distributed. Content and services need to be accessible away from the office, and on multiple devices. Businesses are increasingly deploying (or allowing) smartphones and tablets for employee use. Users expect an easy, quick, powerful experience whenever they do anything on these devices – and they want the same in their business lives.

These developments can be summarised in three key trends:

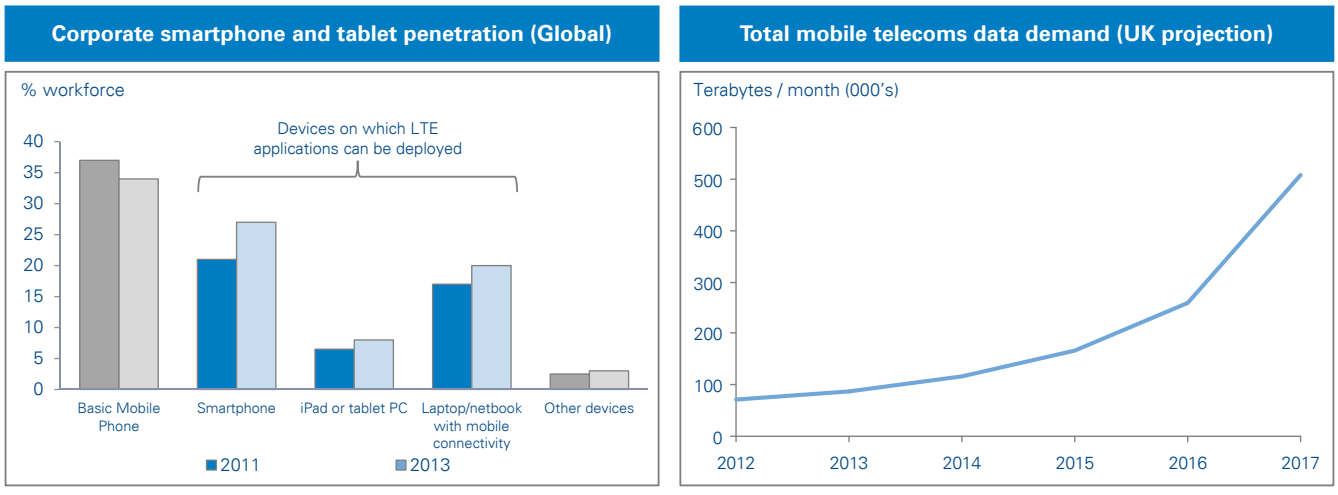
- Increasing mobility and flexibility of the workforce
- Popularity of cloud-based service delivery
- The 'consumerisation' of ICT in organisations

The impact of these trends will see the already dramatic increase in data demand from consumers also reflected in the business world (see Figure 1), driven by a diverse range of business-specific mobile applications.

These high-performance mobility applications will bring a range of benefits:

- **Increased sales and improved customer service:** enhancing sales meetings with richer media, increasing the productivity of a mobile sales force, or simply being more responsive to customers when out of the office.
- **Improvements in product or service (including quality):** incorporating enhanced mobile functionality in products, or improving quality of service provision through faster access to information or media content.
- **Productivity gains:** transforming productivity and flexibility through rich mobile applications for:
  - Personal and team productivity
  - Management effectiveness and innovation
  - Process efficiency and effectiveness

Figure 1: Uptake of devices in business and total UK mobile data projection



Source: Device Penetration: Ovum: Large Enterprise Survey – Corporate Mobility 2011
Data demand: Arthur D. Little analysis

1 Terabyte = 10^6 Megabytes

- **Direct cost reductions:** reducing travel costs, saving office space by increasing teleworking, or saving telecoms equipment or fixed line installation costs.
- **Improved employee motivation:** allowing more effective remote working, reducing wasted time, or improving application functionality.
- **Improved flexibility, agility and decision-making:** providing rapid access and ability to respond to business information, or enabling improved interaction and collaboration.

Drawing on interviews with senior executives from across the value chain, together with project experience and survey data from countries where 4G LTE is already being deployed, this paper describes some of the real-world benefits that businesses can expect. It explores specific applications in five example verticals: Construction, Healthcare, Retail, Transport and Professional Services.

Based on these findings, the paper then outlines five general types of business applications, or 'use-cases', and explains how their performance can be substantially improved by 4G LTE.

What is 4G LTE and What Does it Offer for Organisations?

4G LTE is the fourth major generation of mobile network technology. Its bandwidth, latency and capacity offer the promise that network connectivity will no longer be a barrier to the benefits of high-performance mobile applications. 67% of businesses already using LTE in the United States report increased productivity – with externally-focused departments, such as Sales and Customer Services, benefiting most.

4G LTE is the fourth major generation of mobile network technology, and substantially improves on previous generations in several respects.

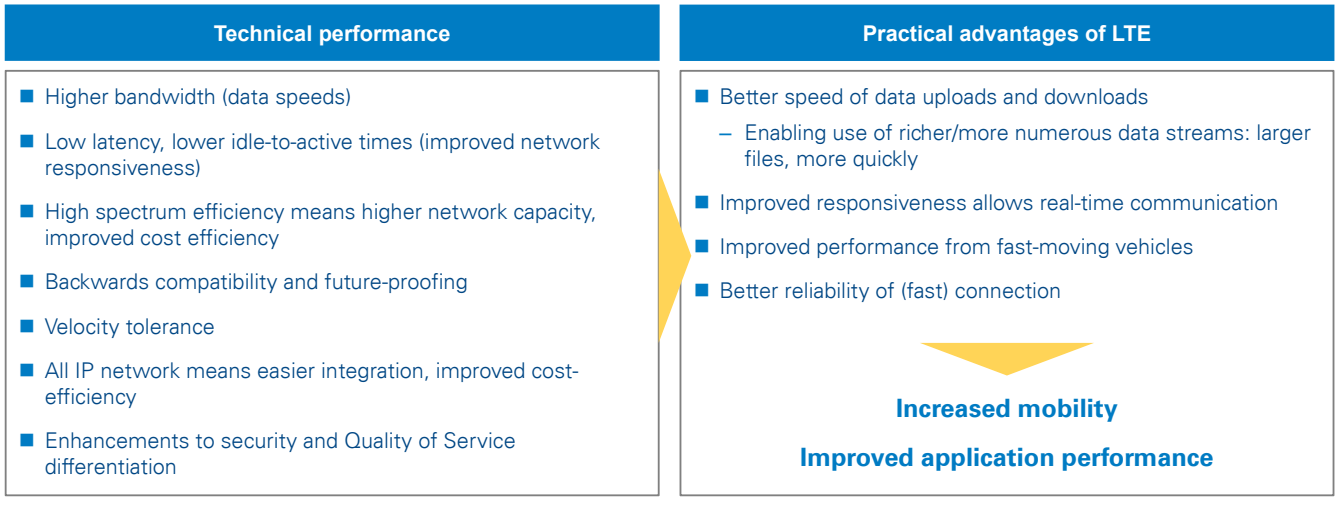
Most significantly, 4G LTE offers:

- **Higher bandwidth** – increasing the speed of data transfer
- **Lower latency** – providing faster response times from the network
- **Improved spectrum efficiency** – which increases overall network capacity

The architecture and efficiency of LTE also make it a more cost-effective network to run. Its Quality of Service (QoS) management capabilities mean that certain applications could be given particular network performance characteristics, providing a more consistently high-quality user experience.

Figure 2 provides an overview of LTE's technical performance advantages over current 3G mobile networks, and what this means in practice for users.

Figure 2: 4G LTE's technical and practical advantages over 3G



Source: Arthur D. Little analysis

4G LTE provides the network performance that many mobile applications need to deliver the benefits described above. A survey of business users in the United States identifies high satisfaction among adopters of 4G LTE and they report a wide range of benefits, as shown in Figure 3[1].

The survey also revealed that Sales (typically one of the most mobility-dependent functions) benefits most from LTE. 57% of respondents selected Sales as the main beneficiary, followed by Customer Services (40%), Operations (39%) and Marketing (28%). Unsurprisingly, the more office-based functions (such as Finance, HR and Legal) benefit least, due to their lower need for mobility.

4G LTE is seen by US businesses as a major trigger for innovation and agility. 76% agree that 4G has helped their organisations 'innovate and jump the competition' and 86% say they get 'more work done on the move'.

Improved speed of access to applications and files, and the ability to work in new locations are the main benefits, according to US users. 'It speeds up daily processes considerably, thus increasing productivity and profit,' stated one retail executive. These are 'traditional' benefits of mobility which have been further enhanced by 4G LTE.

Figure 3: Benefits identified by US businesses using 4G LTE

Source: Arthur D. Little analysis

1 An online survey, commissioned by EE, of 256 US-based senior business decision makers whose firms use 4G LTE

What Applications Benefit Most from 4G LTE?

4G LTE, when compared with 3G, allows more applications to be truly mobile. It provides faster sharing of large files and streaming media and improved performance for latency-sensitive applications, such as real-time videoconferencing or remote desktops. Compared with Wi-Fi, LTE offers full mobility and provides convenient, secure connectivity at true broadband speeds.

Use case characterisation

This paper considers a range of use-cases that demonstrate the benefit from 4G LTE's performance, drawing on experience of organisations that are already using it in other markets. Five main characteristics are important when considering the applicability of 4G LTE to a given use case (Figure 4):

- 'Application breadth' – how many business applications need to be made available?
- 'Degree of mobility' – is use limited to one location, is it nomadic (the user moves between locations, but is generally stationary while using the application) or is it fully mobile?
- 'Richness/data intensity' – what kind and size of data, files, or media are needed for the application?
- 'Responsiveness' – does the application need immediate delivery of data, regardless of the amount of data? For example, real-time voice and video communication and some transaction processes require low network latency.
- 'Application criticality' – what impact will a failure of the application or its communications platform have?

Figure 4: Characterising the use-cases

Application breadth	*Single application*	*Multiple applications*	*Full office / workplace*
Degree of mobility	*Fixed*	*Nomadic*	*Mobile*
Responsiveness	*Little time pressure*	*Quick access*	*Real time*
Richness / data-intensity	*Minimal / basic data*	*Large files*	*Video & multi-stream*
Application criticality	*Important*	*Business-critical*	*Life-critical*

Source: Arthur D. Little analysis

Suitability of different wireless technologies

In broad terms, 3G connections lend themselves to fully-mobile situations, although connection speed and reliability may be limited for certain applications. Wi-Fi, on the other hand, generally offers higher speed (especially with superfast fixed broadband and where the wireless network is private) but at the expense of mobility. Wi-Fi is better suited for static or nomadic situations, such as hot-desking.

Figure 5 (overleaf) summarises the key differences between various mobile technologies and their suitability to meet the needs of each of the use-case characteristics.

Figure 5: Applicability and performance of wireless technologies

		2G (GSM/GPRS)	3G (HSPA, HSPA+)	Wi-Fi (with fibre)	4G LTE
Applicability	Application breadth				
	Degree of mobility				
	Responsiveness				
	Richness / data-intensity				
	Application criticality				
	Device type	Feature phone, smartphone	Tablet, smartphone	PC/laptop, tablet, smartphone	PC/laptop, tablet, smartphone
Performance (typical measured)	Download speed (Mbps)	0.01 – 0.13	1 – 5	20 – 30	10 – 40
	Upload speed (Mbps)	0.008 – 0.13	0.2 – 0.5	2 – 10	1 – 15
	Latency (ms)	300– 700 (GPRS)	100 – 200	10 – 20	50 – 150

Sources: PCMag.com, LTEworld.org, mobile-phones-uk.org.uk, ISPreview, 3G Americas/RYSAVY Research, Agilent technologies, TeliaSonera, Verizon, AT&T, EE, Arthur D. Little analysis. Note: performance statistics are typical or average measured figures – not theoretical maximum/minimum

4G LTE potentially offers the 'best of both worlds' and has intrinsic advantages across all dimensions. The practical advantages of 4G LTE over 3G and Wi-Fi can be summarised as follows:

Practical advantages of 4G LTE over other wireless technologies	
Compared with 3G	Compared with Wi-Fi
■ More applications to be used on mobile devices, out of the home or office	■ Fully-mobile use of applications requiring true broadband speeds
■ Faster or real-time sharing of large files and streaming media	■ Improved convenience ('ownership' of the mobile connection)
■ Near-immediate delivery of time-sensitive data, such as for real-time interaction or transactions	■ Security (no need authenticate onto another, possibly public, network)

Relevance of LTE to business applications

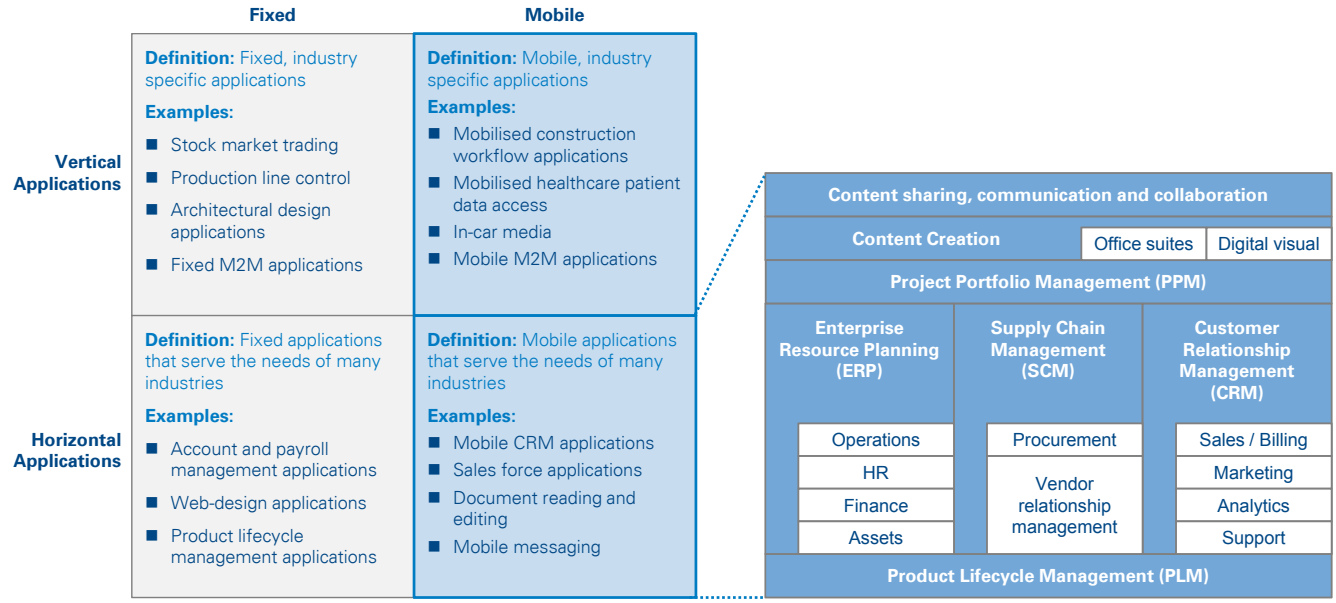
Industry executives draw a clear distinction between applications that are 'horizontal' and those that are 'vertical'.

- **Horizontal applications**, such as email or sales force automation, are used across different industry sectors.
- **Vertical applications** are specific to a particular industry sector, such as parcel tracking in Logistics or patient monitoring in Healthcare.

Drawing from a paper published by Arthur D. Little with Orange Business Services in early 2012, Figure 6 (overleaf) shows how enterprise applications can be described in terms of their level of mobility and the extent to which they are vertical-specific.

There are major differences in the nature and requirements of many applications. Considering horizontal applications first, Figure 7 (overleaf) considers the characteristics of a range of such applications, to identify those for which LTE is likely to have the greatest impact.

Figure 6: Enterprise applications including horizontal application model



Sources: Arthur D. Little analysis; horizontal enterprise application model based on Gartner

Figure 7: Relevance of LTE to selected horizontal enterprise applications

	Description	Appln. breadth	Degree of mobility	Respons-iveness	Richness/ data intensity	Appln. criticality
Content sharing, communication and collaboration	Management and sharing of company content, tools to assist collaboration and project delivery, and services to allow rich communication	◕	●	●	●	◕
Customer Relationship Management (CRM)	Software to organise interactions with customers as well as sales and marketing efforts – including sales support tools: presentations, media files etc	◑	◕	◕	◑	◕
Project Portfolio Management (PPM)	Systems for project or programme managers – including associated documentation	◑	◕	◑	◑	◑
Content creation	Facilitates the production of documents and rich content – including taking photos, videos etc	◑	◑	◑	●	◑
Supply Chain Management (SCM)	Systems to manage procurement and vendor relationships, as well as optimise the product flow through to the customer	◑	◑	◑	◑	◑
Enterprise Resource Planning (ERP)	Set of applications for management of a broad range of internal resources and administrative processes	◑	◔	◑	◔	◑
Product Lifecycle Management (PLM)	Manages manufacture or development of products through to disposal	◑	◔	◑	◔	◑

Increasing relevance of LTE

Sources: Arthur D. Little analysis

LTE's advantages are of greatest relevance to applications for personal communication and collaboration, CRM and project management. These are more data-rich and mobile-centric applications – heavily used by staff in Sales, Customer Service and Field Operations, bearing out the survey findings discussed earlier.

Vertical applications are highly varied, and are typically bespoke or highly customised to industry-specific processes. They are used to address underlying industry drivers such as: improving health outcomes in the healthcare sector; improving journey reliability or the passenger experience in the transport sector; and managing tight margins or optimising marketing in the retail sector.

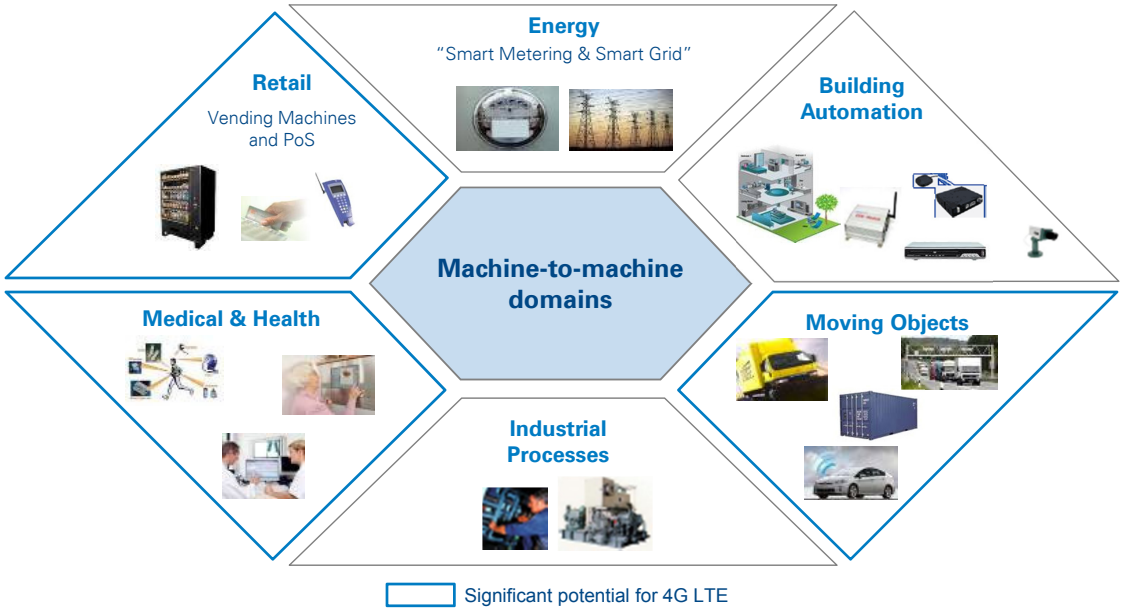
One emerging category of vertical applications covers communication between devices and machines, or from remote machines to a central hub of people, rather than between humans. Arthur D. Little categorises this machine-to-machine (M2M) world in six key domains, as shown in Figure 8.

4G LTE has applications in all of these domains, but three domains (shaded) stand out as being particularly well-suited to exploit the richness of data and rapidity of access which LTE can provide:

- The **Moving Objects** domain includes streaming media in cars and public transport, fleet and freight management applications and data-rich telemetry.
- The **Retail** domain includes examples such as point-of-sale and stock control applications, automated kiosks, media distribution and digital signage.
- The **Medical & Health** domain includes remote monitoring and diagnostics, support for assisted living and, in the broader area of security, video surveillance.

Case studies for machine-to-machine and other vertical applications are considered in more detail later in this paper, which further explores five example sectors: Construction, Transport, Healthcare, Retail and Professional Services.

Figure 8: Machine-to-machine ecosystems and LTE applicability



Sources: Arthur D. Little analysis

Where Has 4G LTE Been Rolled Out and What are the Lessons?

First launched in Scandinavia in 2009, 4G LTE is expected to be available in 59 countries by the end of 2012. Experience in markets where 4G LTE has been launched suggests that widespread adoption by businesses requires five essential 'enablers': device availability and choice; reasonable pricing; clear awareness of LTE's capabilities; applications that use its capabilities; and widespread network coverage. These are, or will soon be, in place in the UK.

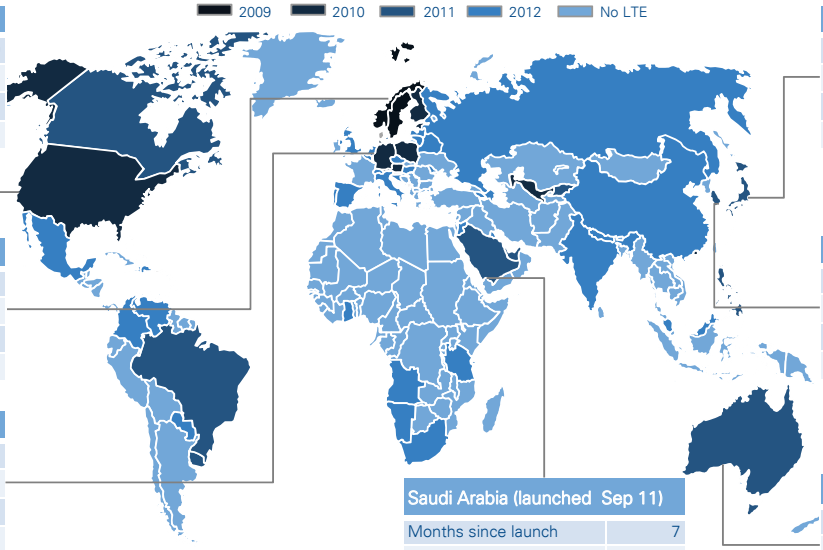
4G LTE was first launched in Norway and Sweden in 2009, followed by ten further countries in 2010. Roll-out is expected to have begun in 59 countries by the end of 2012, as shown in Figure 9.

Early uptake in Norway and Sweden was hindered by poor availability of compatible devices and initially limited coverage, and 4G LTE was priced at a significant premium. By the time 4G LTE services were launched in other countries (such as South Korea, Japan and the United States), more devices were available and pricing was more competitive. Some operators are even pricing 4G LTE lower than equivalent 3G packages to encourage rapid adoption. In Japan, for instance, on some data plans NTT Docomo charges around 16% less per month for the same data allowance on 4G than it charges on 3G.

Widespread network coverage is crucial. In South Korea, where almost 100% coverage was in place within 9 months, 4G LTE penetration had reached 18% of subscribers just two years after launch. This is a much faster take-up rate than in countries where coverage has been more limited, such as Japan and the US.

In the countries surveyed for this paper, no 4G LTE-*only* applications can yet be identified. These are unlikely to be created until coverage and uptake is widespread. However, many existing enterprise applications can take, and are taking, advantage of LTE. In Japan, NTT Docomo is primarily using its business 4G LTE service to drive uptake of business-focused tablet devices for mobile access to project management and sales support applications and the internet.

Figure 9: Latest 4G LTE deployment, and uptake status in selected lead countries



USA (launched Sep 10)	
Months since launch	19
Subscriptions (M)	10.1
Penetration	3%
Coverage	75%

Sweden (launched Dec 09)	
Months since launch	29
Subscriptions (M)	0.16
Penetration	1.4%
Coverage	61%

Germany (launched Dec 10)	
Months since launch	16
Subscriptions (M)	0.18
Penetration	0.2%
Coverage	95%

Japan (launched Dec 10)	
Months since launch	20
Subscriptions (M)	5
Penetration	3.9%
Coverage	70%

S. Korea (launched Jul 11)	
Months since launch	14
Subscriptions (M)	9.4
Penetration	17.9%
Coverage	100%

Saudi Arabia (launched Sep 11)	
Months since launch	7
Subscriptions (M)	0.01
Penetration	0.02%
Coverage	65%

Australia (launched Sep 11)	
Months since launch	8
Subscriptions (M)	0.3
Penetration	1.2%
Coverage	40%

'Months since launch' on the date at which the data were collected. Penetration as % of mobile subscribers; coverage as % of total population; Saudi expects 65% LTE coverage by end of 2012. Source: Operators; Informa; International Telecommunication Union; Global mobile Suppliers Association; Arthur D. Little Analysis

A wider choice of devices is now becoming available and will be increasingly attractive to businesses, particularly as lower price-point devices arrive using the UK's chosen LTE frequencies and if early concerns over battery life are addressed. There are LTE versions of handsets such as the Apple iPhone 5, Samsung Galaxy S3 and HTC One XL. The Global mobile Suppliers Association (GSA) reports that 347 LTE-enabled devices were available as of April 2012, examples of which can be seen in Figure 10.

Many of these devices are primarily aimed at consumers but are increasingly being used in the workplace and will often belong to employees themselves. This trend, sometimes referred to as 'bring-your-own-device', or BYOD, has led Samsung to produce a version of its Galaxy S3 smartphone aimed at corporate use. It incorporates business features such as enhanced security, improved Virtual Private Network (VPN) connectivity and enhanced collaboration and calendaring.

For business customers, there is evidence to suggest that modest adoption of 4G LTE also results from low awareness of the benefits it can bring. With plenty of examples now emerging around the world, UK businesses appear to be very aware of 4G LTE and its potential impact. An EE-commissioned survey[2] shows that 94% of IT decision-makers think that '4G will be an important business tool' and 84% say they are 'excited by the prospect of introducing 4G'. Over 60% hope to deploy 4G within six months of its launch.

So, experience from countries where LTE has already been deployed clearly shows that widespread uptake of 4G LTE in the UK will be dependent upon a number of vital 'enablers':

1. **Broad choice and availability of LTE-enabled devices**
2. **Extensive network coverage**
3. **Reasonable and attractive pricing**
4. **Awareness of LTE's performance and applicability**
5. **Applications that capitalise on the capabilities of 4G LTE**

In the UK, there is clear public commitment from the operators to deploy 4G LTE widely and plans are already announced by EE to launch services by late 2012. A reasonable range of devices is already available internationally which can be deployed in the UK and this will develop rapidly. Above all, as the research shows, business customers are already anticipating the availability of 4G LTE.

The main enablers of uptake in the UK appear to be falling into place.

Figure 10: Examples of 4G LTE devices currently available in other markets

Sources: Verizon, Huawei, ZTE, Apple, Nokia, Sony, Fujitsu, Amazon, BMW

2 An online survey, commissioned by EE, of 1,019 UK-based senior business decision makers

What Business Benefits Can be Seen from 4G LTE in Other Markets?

47% of early LTE adopters report resultant cost savings, and 39% report increased sales. The creative, hotel and leisure, healthcare, IT and automotive and transport industries have benefited most widely.

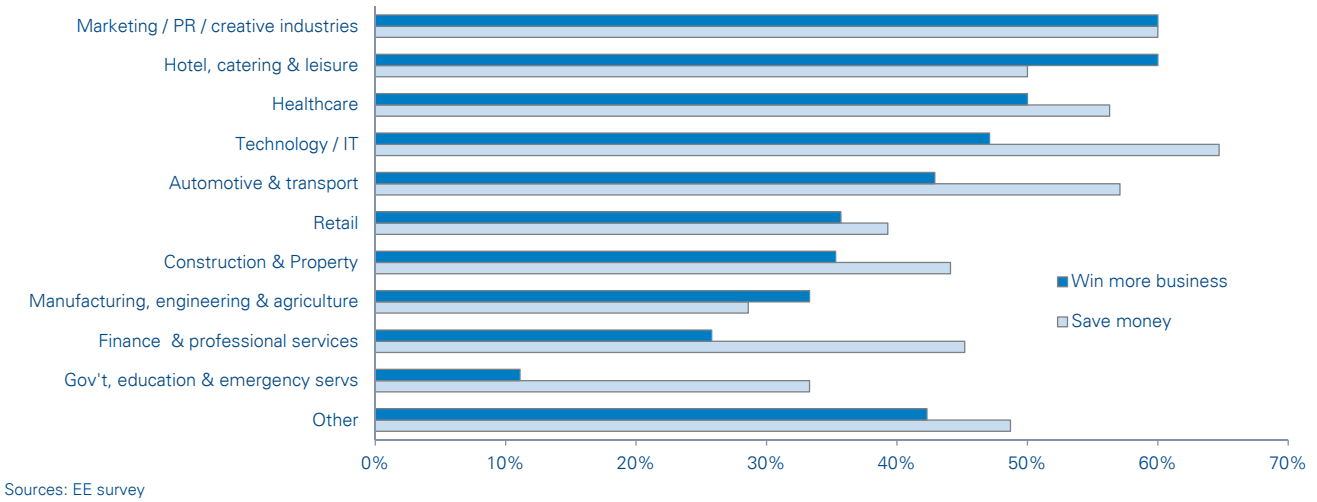
Businesses can capitalise on 4G LTE for a wide set of applications, some of which are purely 'horizontal' while others are highly sector-specific, addressing needs unique to the industry. In the United States, 47% of LTE users report identifiable cost savings and 39% report increased sales. Figure 11 shows how these numbers vary by industry sector.

Businesses in creative industries and the leisure sector, in particular, point to increased sales. Almost 60% of 4G LTE adopters in these sectors claim that 4G LTE has helped them win more business. Cost saving is cited by businesses across all sectors, but is particularly evident in technology/IT, transport, healthcare and in creative industries.

This paper now considers five selected vertical sectors, drawing on a wide range of interviews, survey data and Arthur D. Little's project experience. It highlights some of the main business drivers of mobile applications and shows a range of real-world cases where 4G LTE is already being seen to deliver benefits.

Figure 11: Business Impact of 4G LTE for US adopters

Has 4G helped your business to win more business or save money?



Sources: EE survey

Vertical: Construction

The inherent project complexity and need for temporary work locations in the Construction industry mean that fast mobile applications can greatly improve productivity, agility and cost-effectiveness – through direct expense reduction and faster project completion.

Interviews with senior executives in the construction industry identified three main drivers of mobility:

- **Complexity, difficulty and scale** of projects in the industry.
- **Efficiency:** optimisation of operations, through improved on-site efficiency and resource allocation.
- **Location:** operating from temporary or semi-permanent premises on sites that often have few amenities.

These mean the industry includes some of the most demanding 4G LTE users, owing to its need for both mobility and rich information. 77% of construction executives surveyed say they use 4G mobile devices to enable working in new locations. Tablet devices are the most commonly used mobile device on many construction sites and are seen by many as 'revolutionising the industry'. For example, the larger form factor is used to display detailed schedules, plans and diagrams, while being truly mobile. One CIO said 'We can write up contracts or change anything via mobile. We are almost entirely mobile these days. Most of us have no need to go back to base.'

Three main use-cases stand out:

- Connected site office
  - The high bandwidth of LTE allows multiple employees to connect their devices, either directly or through a Wi-Fi hub connected by LTE. This enables full use of all enterprise applications without returning to a main office, while avoiding the cost of fitting temporary fixed broadband to the site. One US construction firm interviewed uses this approach to provide a fully-functional connected office on site, for the duration of its projects.
- Site security
  - 4G-connected video surveillance, using LTE cameras and cloud storage, brings high-resolution video in real-time without needing to install a fixed line or store video feeds on-site. LTE's upload speeds are a key improvement here over 3G. One company described how it uses centrally-located security personnel to review the feeds remotely, complementing local staff. Another uses helmet-mounted HD cameras to relay video information back to colleagues, using LTE.
- Mobile applications for workflow management
  - Applications for managing any aspect of a construction project using a mobile device – often a tablet – from the construction site itself. Many interviewees highlighted the value of LTE's responsiveness in improving the experience of these applications, and its high bandwidth in making transfer of large data files and images much more practical. 71% of construction executives surveyed said that such applications helped increase their productivity. The case study provides further details.

Construction case example: Mobile applications for on-site management

A construction company uses web-based applications to provide access to Building Information Models (BIM) in the field. Supply chain-wide material management, percentage of work complete, and quality inspection data are delivered back to base for a near real-time view of field activities. The company found the overall efficiency improvements of using one application so great that it reduced typical cycle times (project start to finish) by as much as 30%, saving over $1000 per day.

In some cases, visual images such as photos and 3D CAD graphics are transferred. Builders can view 3D graphics with 360 degree rotational view, add notes and comments on the graphics, and exchange the files with office-based colleagues on their mobile devices.

Another cloud-based service allows superintendents, trades and managers to access and respond to role-specific information on site, such as work requests and quotations, schedules, payments, purchase orders, bid management, and notifications. Typical savings per bid conducted through the platform were $500-1800.

Vertical: Healthcare

The healthcare industry is an enthusiastic adopter of mobile technology, using media-rich applications to implement effective mobile health interventions that improve service delivery, cut costs, share intelligence and information, and improve provider productivity.

The picture that emerges from interviews with the healthcare industry is one of enthusiastic and innovative use of mobility applications. This is primarily due to three major trends driving mobile technology:

- More **outcome-driven health policy** driving greater focus on **preventive health.**
- More **choice and information for the patient**, with the ability to select the healthcare provider and have greater access to both provider performance and health- and wellness-related information.
- **The emergence of mHealth:** healthcare using mobile devices that support outpatient care, manage chronic diseases, allow the elderly to retain their independence longer and manage costs.

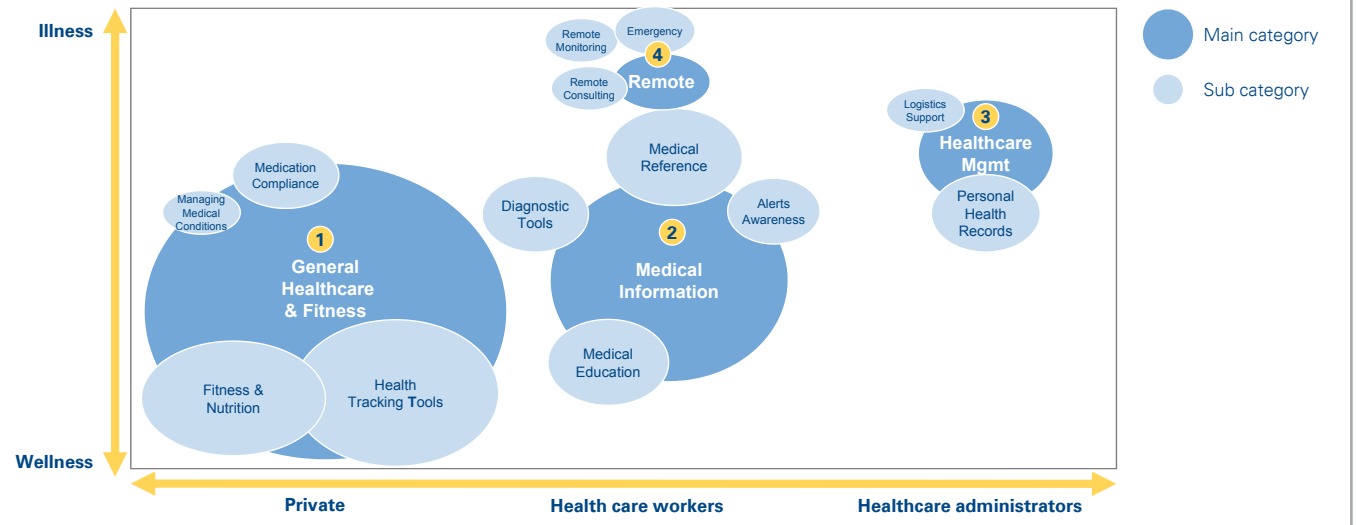
mHealth encompasses a diverse set of applications, which Arthur D. Little categorises into four main areas (Figure 12).

4G LTE has the biggest impact on categories 3 and 4: **remote care** and **healthcare management**, since these typically involve significant interactivity between patients and different actors in the industry.

The other categories include a range of applications in **wellness and consumer healthcare**. These enable patients to be more involved in tracking their own conditions and managing their own well-being. 4G LTE allows transmission of richer information and media but, in most cases, applications are currently engineered specifically not to require this level of connectivity.

The US survey commissioned by EE shows that healthcare respondents are far more likely than most other sectors to use cloud content and services, and to use videoconferencing and related applications. They are especially likely to use 4G to work in new locations and to deliver customer services – which many believe significantly improves customer satisfaction and promotes innovation. 4G is likely to find widespread use in supporting sales and marketing, for example by medical device companies, especially in hard-to-access or rural areas.

Figure 12: Categories of mHealth



Source: Arthur D. Little analysis

Overall, 56% of the healthcare organisations surveyed say that 4G has saved them money and 50% that is has helped them win more business. These numbers are far higher than the average across all sectors.

It is clear, however, that the main barriers to uptake of mHealth are typically not technical. In Europe they relate primarily to patient privacy/data integrity, doctors' reluctance to prescribe such solutions, regulatory issues and structural barriers to implementation and funding.

Three main use-cases, two in the 'remote' category and one in healthcare management, were highlighted from executive interviews and Arthur D. Little projects, as follows:

- Remote healthcare/telemedicine
  - Using enhanced connectivity to facilitate innovations in healthcare. This includes remote consultations, diagnosis and follow-up, as well as real-time therapeutic interventions. A specific example is 'telecare'-remote care and monitoring for disabled people and the elderly. Projects in Scotland suggest a 25% reduction in care costs is possible[3], through improved outcomes and from time and cost savings for both patients and healthcare providers. LTE provides security of data and resilient service that is critical for remote real time diagnostics. The first case study describes one example.
- Bringing the hospital to the ambulance
  - Connecting emergency vehicles to hospitals to get expert diagnosis en-route, reducing treatment times. The second case study provides an example of an ambulance equipped to provide stroke treatment remotely.
- Healthcare management
  - Healthcare workers or administrators get patient health records and data (including files such as MRIs or CT scans) quickly wherever they are. Mobile workers, such as health visitors or paramedics, benefit most clearly. Companies interviewed estimate 20-30% of administrative time can be saved by providing healthcare workers with remote access to patient files.

3 Scottish Parliament Archive, Finance committee inquiry into preventative spending: submission from Age Scotland

Healthcare case example 1: Remote healthcare/telemedicine

One US hospital uses telemedicine to provide acute care in an underserved city neighbourhood. Broadband coverage in the neighbourhood is limited, so the team uses 4G to connect their telemedicine devices in patient homes or local clinics.

Videoconferencing is used by hospital-based doctors to deliver information and guidance to the patient and clinic staff. It is also used to conduct check-ups or rapid diagnoses when complications arise – one example being peripheral oedema (leg swelling) in heart patients.

LTE's high bandwidth ensures smooth, real-time transfers of large documents, images and video. The team frequently shares angiograms – requiring very fine resolution – with healthcare providers in the community to brief them on specific diagnoses. The telemedicine device also allows attachment of peripherals such as weight scales or pressure cuffs that are regularly used in patient consultation.

The increased reach of the hospital brings high-quality care to people who would not usually have visited the hospital. It reduces the travel needed for patients to receive care, and the costs for healthcare providers to set up permanent clinics closer to the neighbourhood.

The team has also seen benefits from improved training and retention of clinic staff, by involving them in a geographically broader team.

Healthcare case example 2: Bringing the hospital to the ambulance

In Germany, one city hospital is trialling a 4G LTE-enabled ambulance, aimed at improving survival of stroke patients. Strokes account for nearly 3% of ambulance transport in the city. The vehicle is equipped with a portable CT scanner and on-board operators can perform scans on patients, transmitting images to nearby hospitals/clinics and receiving instructions for immediate treatment.

Data transfer speed is essential, given the high resolution of CT images. A range of wireless technologies were tested to find the best available solution. 4G LTE has been found to offer the best overall performance, particularly in rural areas (where LTE was first rolled out in Germany and where ambulance journey times are longer). LTE's high velocity tolerance minimises connectivity interruption on fast moving vehicles.

The trial saw a reduction in median time from alarm to therapy decision by 54%. This real-time diagnosis and treatment in transit is expected to substantially improve stroke survival rates and also reduce the time needed in hospitals to treat stroke patients.

Vertical: Retail

In Retail, 4G LTE is being used to improve marketing and customer service, provide in-store connectivity, and to increase speed to market and flexibility. It is also being used in new store formats, especially distributed or 'pop-up' stores and retail kiosks. Retailers and their supply chains can use fast mobile applications to respond to the continuing pressure for operational efficiency and B2B sales effectiveness.

The key drivers of mobile technology in the retail industry are:

- **Online and mobile commerce:** the internet has rapidly changed consumption habits, increased competition and provided new ways to reach consumers – increasingly over mobile devices.
- **Multi-channel customer management:** customers expect ever more convenience, to pick and choose sales and product delivery channels, and to have similar experience across the channels.
- **Targeted marketing and sales:** improving effectiveness by tailoring communications to specific segments and engaging individuals directly, providing relevant and timely information. This requires ubiquitous, high-quality connectivity and the ability to collect and process huge quantities of customer data.
- **Demand for efficiency:** competitive pressures drive a continuous need for improved operational efficiency – through service improvement, optimising supply chains and logistics, inventory control and quality management.

EE's US survey suggests that the retail sector has been comparatively slow to adopt the breadth of 4G LTE services, primarily using it for faster internet access and some videoconferencing. Retailers are less likely to use cloud services and horizontal business applications. However, 36% of retail industry respondents – close to the average for the whole survey – say that 4G has helped them to 'win more business'.

Interviews with executives in the sector highlight four main retail-specific use-cases, some of which depend on other parts of a complex ecosystem:

- Digital signage
  - 4G-enabled smart displays can be deployed or moved easily, enabling up-to-date content to be rapidly distributed and updated. More advanced forms of advertising are emerging, such as customer-profiled advertising with face recognition, which is in the pipeline of one Japanese retailer. These will be more reliant on the faster connection provided by LTE.
- Connecting distributed stores
  - Providing smaller stores, 'pop-up shops' and kiosks with point-of-sale systems and store-based internet access (for customers or staff). 4G LTE can be used as a primary network connection for a small retail location to support a range of applications. One US firm already offers a 4G-connected kiosk to stores offering two-way video sessions between customers and support teams.
- In-store marketing
  - Using LTE to ensure that shoppers in-store can be targeted rapidly with rich, engaging and often location-specific content. In the UK, M&S is investing in Wi-Fi, to encourage customers to browse the full range of stock on their smartphones or on tablets provided to store staff. 4G LTE provides an alternative to store-provided Wi-Fi, especially for smaller or temporary stores, and avoids the need for customers to find and log into the store Wi-Fi.
- Sales support in the retail supply chain
  - Due to the highly distributed nature of retail, businesses in the supply chain can benefit significantly from the ability of 4G LTE to provide mobile sales support applications. One company interviewed gives its sales and distribution teams virtually instant access to in-depth and up-to-date information on tens of thousands of products. This dramatically enhances their ability to respond quickly to customer needs and reduce buying cycle times, giving the company a much-needed competitive edge.

Retail case examples: Connectivity for distributed stores

A US fuel station chain has replaced fixed broadband lines with 4G LTE, for all of its locations where 4G is available. LTE's high bandwidth allows the chain to run all its applications reliably on a standard platform. These applications include systems for point-of-sale (POS) and inventory control, connected to a centralised back office, and a cloud-based timekeeping system. The LTE connection is also used to run a VOIP telephone system, and to connect company-owned ATMs on-site.

The company used 4G to replace fixed broadband and two phone lines in each of its stations; it also pooled data plans across its operations. This saves on, and improves the predictability of, its overall telecoms costs. It also reduces the complexity of managing around a hundred broadband lines from several providers.

An operator of retail kiosks uses 4G LTE to 'bring its own connection' to its 'nomadic' mall and supermarket locations. 4G replaces the previous cumbersome installation of broadband, and is used to connect laptops, VOIP phones and all POS equipment.

A third retailer was faced with several weeks' delay in the launch of a large new store, due to a delayed fixed broadband installation. Using a 4G-connected router as an interim solution, the store's entire POS system and payment card processing was connected over the high capacity 4G network. The store launched on time, avoiding tens of thousands of dollars in losses. Following eventual installation of the broadband line, 4G is now used as the store's backup connection.

Vertical: Automotive and Transport

4G LTE will be a key technology in providing consumers with in-car media and connectivity on public transport. Automotive and Transport LTE adopters report strong sales increases and cost reductions, especially through improved operations. 4G LTE could be a game-changer in certain market niches such as connected cars, though in some cases it will require standards to emerge.

Interviews with senior executives and Arthur D. Little project work highlight three key drivers of mobile technology for automotive companies and public transport organisations:

- **Connected vehicles:** communications and connected devices in cars and public transport, delivering entertainment and information, and improving in-car control, monitoring and telematics.
- **Integration of urban transport systems** to improve efficiency and convenience across different modes of transport (e.g. better planning, inter-operability and use of smart transport cards).
- **Improved information delivery:** development of an application ecosystem providing real-time updates on the transport network, such as traffic alerts and journey planning.

4G LTE is likely to be a game-changer in some markets but may be slow to market while new standards emerge. The US survey commissioned by EE reveals broad use of 4G LTE by the automotive and transport industry. 57% of such businesses say that 4G has saved them money, and 43% say that it has helped them win more business. These figures are among the highest in the survey. Operations functions are, by some margin, the biggest current users of 4G LTE. Rapid file transfer is particularly prominent among applications – for example sharing of technical documentation, project plans, diagrams and photographs.

These are typical 'horizontal' type applications that improve business operations. However, the larger medium-term impact is likely to be in two main use-cases emerging in automotive and transport:

- In-car media
  - Several manufacturers are preparing LTE-connected cars for full series production. These will support multiple applications such as streaming media or business application via an in-car hot-spot, real-time updates for navigation systems, and richer location-based content. The case study provides a specific example.
- Connected public transport
  - Organisations are using 4G LTE directly or as backhaul to connect both consumer-facing services – such as Wi-Fi provision, on-board 'infotainment' and VOD services – and technically-oriented services such as asset management and remote condition monitoring.

Other connected vehicle applications will also be provided over 4G LTE, although they may not explicitly require its high performance. These include telemetry applications such as monitoring of the vehicle's performance, driver monitoring for insurance purposes, routine maintenance and emergency services (such as the e-call initiative). In the longer-run, 4G LTE is likely to become a platform for a wide range of services, future-proofing investment in in-car technology.

Automotive and Transport case examples: In-car media

BMW is one example of a manufacturer that is beginning to use 4G LTE for in-car connectivity. The first product enhancement, expected to be released in November 2012, will be an in-car LTE mobile hotspot. This removable device provides Wi-Fi connectivity to any car passengers. The device connects to the vehicle aerial when plugged into the car, improving reception, and can operate for 30 minutes when removed from the car. The device is backward-compatible, able to plug into older vehicles with little adaptation.

The hotspot is essentially a stand-alone product. However, BMW also plans to replace its vehicle-integrated 3G SIM-cards with 4G LTE SIMs for its 'ConnectedDrive' navigation and media system. The capabilities of LTE will be used to improve the performance of its cloud-based media streaming and new 3D navigation tools, and will enable further advanced services in future.

LTE-enablement supports BMW's innovative brand image, positioning the company at the forefront of the evolution of mobile technology. The LTE hotspot enhances BMW's customer proposition in its premium car segment, allowing business travellers to use the car as a mobile office and passengers to access entertainment in the car with any Wi-Fi enabled device. It also 'future-proofs' vehicles, with inclusion of LTE in vehicles allowing BMW to introduce new services on a common communications platform.

Vertical: Professional Services

4G LTE improves productivity and collaboration in the Professional Services industry, by supporting the inherent flexibility, mobility, security and rich information transfer required. This will drive improved responsiveness, both in sales and in the delivery of projects and content.

Mobile communications requirements in the professional services industries are driven by the following key business drivers:

- **Networked, and often global, firms with a competitive premium on information efficiency:** workers in professional services drive value primarily through their own and their firm's knowledge base; companies must continually develop their internal and external networks and bring them to bear to improve project sales and execution.
- **'Always on' mobile, flexible workforce:** increase in working away from the office, driven by the multi-location demands of the job, while travelling or at client sites.
- **Brand and customer influences:** the need to portray a cutting-edge, innovative image to customers and work with the technology used by their (often technically-advanced) clients.

The impact of 4G LTE in the professional services industries

For these reasons, professional services workers tend to be 'power-users' of communication applications, although EE's US survey suggests professional services firms have not yet embraced 4G LTE to the same extent as other industries. Nevertheless, the picture is consistent with the cross-sector situation, with good use of core productivity applications and services. 45% of companies say 4G LTE has helped them save money. Mobile hotspot devices are especially popular with the industry, with 45% of respondents using one.

Interviews highlighted two main use-cases in professional services, as follows:

- 'Mobile war room'
  - Setting up a workspace at a client site. One M&A lawyer uses an LTE wireless hub to set up a securely-connected work room for her entire team at client sites – usually investment banks – removing the need to authenticate onto the client's network. A second lawyer interviewed uses an LTE dongle to connect from the courtroom: 'If something is forgotten or unexpectedly needed we can access it in almost real time, in court, rather than have someone race the 10 miles downtown. Or usually we just went without the document or evidence.'
- Knowledge sharing
  - Improving project productivity and sales effectiveness by transferring and working on documents, including media-rich files, on the go. Involving geographically-distributed experts in both internal and client meetings – using web-conferencing, videoconferencing and collaboration platforms on mobile devices.

Professional Services case examples: Mobile unified communications

A medium-sized financial services company implemented a unified communications platform, which included videoconferencing on any connected device.

Half of the company's employees spend over 40% of their time out of the office. They had used 3G-connected tablets to participate in internal videoconferences, but the experience tended to be unsatisfactory, with 'jumpy' visuals and often poor sound quality. The quality was also considered insufficiently professional to use with customers. The company is now introducing 4G iPads, which provide a far higher-quality, smoother videoconferencing experience.

The company believes mobile videoconferencing improves the quality of communication and teamwork, both internally and when working with clients. 'Emotions are the best indicator of project health,' says the manager in charge of enterprise services, 'and are easier to interpret in a videoconference'. It also helps to overcome language barriers, for instance as facial expressions reveal colleagues' levels of comprehension.

Critically for a knowledge-driven services firm, experts are more easily accessible and can be brought into a client conference more easily, even when out of the office. These aspects all contribute to improved client service overall.

What are the Main Use-Cases That Benefit from 4G LTE?

Five broad types of use-case can be defined, based on the findings from customer interviews and survey results. Each shares characteristics which mean that their performance can be substantially improved by the specific capabilities of 4G LTE.

Our research and interviews have uncovered many examples where businesses are benefiting from LTE's improved performance. This section brings together these insights to define five 4G LTE use-case types – each of which has characteristics and performance requirements which can be met or enhanced by 4G LTE.

Use-case type 1: large file transfer

Downloading or uploading large files when on the go, from a mobile device. An increasingly common form of this is to use cloud-based storage. File transfer rates are the critical factor.

- 47% of survey respondents in the US are using 4G LTE to download large documents on the move.
- 39% are using it to access files from the cloud.
- 38% download high resolution videos and presentations to show clients.

Use-case type 2: rapid workplace set-up

The establishment of a temporary or semi-permanent workplace by providing 4G LTE instead of a fixed broadband connection. This often supports multiple users via an LTE-connected Wi-Fi hub, and is especially relevant in situations where fixed broadband is impractical, slow or expensive to install. 4G LTE brings fully mobile data transfer speeds into the range currently occupied by fixed broadband.

- Average download speeds for ADSL2+ (still the most widespread fixed broadband technology) are 7–10 Mbps, below the speeds of 10–40Mbps available with 4G LTE.
- 36% of the US survey respondents use LTE with a Wi-Fi router, more than use LTE tablets or dongles.

Use-case type 3: rich machine to machine and remote monitoring applications

A wide range of machine to machine applications provide monitoring or remote automation. This increasingly involves transmission of rich media such as video or multiple, always-on data streams. It is especially relevant to moving objects, where Wi-Fi or fixed broadband are not feasible.

- 4G LTE can transform many M2M applications, notably mobile video-based monitoring and delivering real-time media to mobile or nomadic devices.
- M2M market projections range from 200 million to several billion connected devices by 2015, and many of these will benefit from the improved capabilities of LTE.

Use-case type 4: videoconferencing, tele-presence and rich media collaboration

Mobile device access to a wide range of real-time streaming, video-based and/or interactive collaboration platforms (e.g. as part of a unified communications solution). The high speed and low latency of LTE makes enterprise videoconferencing over mobile networks feasible, although behavioural barriers remain.

- 35% of the US survey respondents use their 4G LTE devices to communicate with colleagues using video conferences calls / collaboration software.
- 23% said they communicate with customers using HD video calls.

Use-case type 5: remote access to business applications

Access to enterprise applications on a mobile device, increasingly delivered from public or private cloud-based platforms. The use-case covers anything from single browser-based services through to complete desktop virtualisation.

- 40% of the US survey respondents use office-based desktop applications while on the move via VPN.
- A recent equipment vendor survey highlights the need for constant connectivity and poor response times as two of the main barriers to uptake of cloud-based applications.

Figure 13 (overleaf) summarises each of the use-case types and the advantages LTE can bring to each.

Figure 13: Use-case types and advantages of LTE

Use case type	Example use-cases (industry)	Incremental benefit of LTE	Advantages of LTE
1. Large file transfer	**Bringing the hospital to the ambulance** (healthcare) **Knowledge sharing** (professional services and others) **Media transfer** (e.g. creative industries, journalism, engineering) **Sales support** (all industries) **Horizontal applications** e.g. Sharepoint, Dropbox for Teams (all industries)		■ High bandwidth allows fast file transfer ■ Mobility (fixed broadband unable to support fully mobile access)
2. Rapid workplace set-up	**Connected site office** (construction) **Mobile war room** (professional services) **Connecting distributed stores** (retail) **Connected public transport** (transport)		■ High bandwidth supports multiple connections ■ Convenience ■ Security (esp. vs. public Wi-Fi)
3. Rich machine to machine and remote monitoring applications	**Site security** (construction and others) **Smart home and assisted living** (healthcare and social care) **Digital signage** (retail) **Remote monitoring** (many industries)		■ High bandwidth and low latency allow real-time data transfer ■ Security (esp. vs. third-party Wi-Fi)
4. Video-conferencing, tele-presence and rich media collaboration	**Remote healthcare/telemedicine** (healthcare) **In-car media** (automotive) **Knowledge sharing** (professional services and others) **Horizontal communication platforms** e.g. Skype, WebEx, Adobe Connect, Google Hangouts (all industries)		■ High bandwidth (especially upload speeds) and low latency allow real-time communication ■ Mobility
5. Remote access to business applications	**Mobile applications for workflow management** (construction, others) **Healthcare management** (healthcare) **Sales support in the retail supply chain** (retail, others) **Horizontal applications e.g. CRM, PPM, ERP** (all industries)		■ Reliable Quality of Service: high bandwidth, low latency and high network capacity ■ Mobility ■ Security (esp. vs. public Wi-Fi)

The Way Forward for UK Businesses

This paper has discussed a number of ways in which 4G LTE is making feasible applications and use-cases that require reliable high-speed mobile data. LTE will also help applications that already work reasonably well on mobile devices, improving their performance, practicality and responsiveness.

Businesses in the UK report high awareness of 4G's potential, and enthusiasm for adopting it. They are right to be open to the opportunities. The 4G LTE-enabled applications described can deliver a wide range of benefits to the organisation: increased sales and improved customer service; improvements in products or services; productivity gains; direct cost reduction; improved employee motivation; greater flexibility and agility; and faster business decision-making.

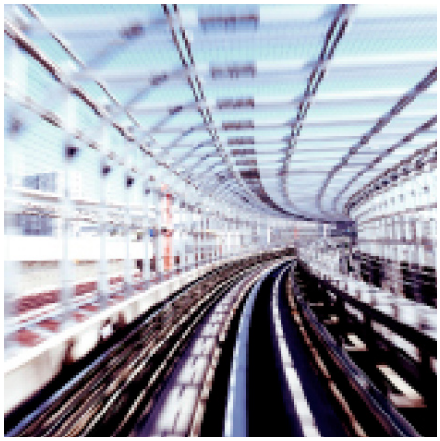
Belief in these benefits is widespread, with 84% of US LTE users saying that, now that they have used it, they believe '4G is an important business tool'.

UK organisations now need to consider how to exploit these applications. They must understand fully how the needs of their users – employees, contractors, suppliers and customers – are evolving, how 4G LTE can support them, and how both revenues and costs can be improved. They need to consider not only what LTE can do to further mobilise their existing applications, but also new applications that could be enabled.

Finally, the costs of implementation of these applications must be understood: for instance for new devices, systems integration, connectivity, application licencing and training.

This understanding should be developed into a full enterprise mobility strategy, with a clear business case, which defines how to reconfigure the organisation to capitalise on the promise of advanced mobility.

4G LTE is arriving – the time to act is now.



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Contacts

If you would like more information or to arrange an informal discussion on the issues raised here and how they affect your business, please contact:

Austria
Karim Taga
taga.karim@adlittle.com

Belgium
Jean Fisch
fisch.jean@adlittle.com

China
Jian Xu
xu.jian@adlittle.com

Czech Republic
Dean Brabec
brabec.dean@adlittle.com

France
Didier Levy
levy.didier@adlittle.com

Germany
Michael Opitz
opitz.michael@adlittle.com

Italy
Giancarlo Agresti
agresti.giancarlo@adlittle.com

India
Srini Srinivasan
srinivasan.srini@adlittle.com

Japan
Yoshikazu Matsuoka
matsuoka.yoshikazu@adlittle.com

Korea
Daesoon Hong
hong.daesoon@adlittle.com

Malaysia & Singapore
Thomas Kuruvilla
kuruvilla.thomas@adlittle.com

Middle East
Thomas Kuruvilla
kuruvilla.thomas@adlittle.com

Nordic Countries
Bo Lenerius
lenerius.bo@adlittle.com

The Netherlands
Martijn Eikelenboom
eikelenboom.martijn@adlittle.com

Spain
Carlos Abad
abad.carlos@adlittle.com

Switzerland
Karim Taga
taga.karim@adlittle.com

UK
Stuart Keeping
keeping.stuart@adlittle.com

USA
John W. Brennan
brennan.john@adlittle.com