

Satellite backhaul for rural small cells



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CONTENTS

- 4 Executive summary
- 5 Section A: Background
 - 5 Introduction
 - 5 Rural coverage - the backhaul challenge
- 6 Section B: Expanding rural connectivity with small cells
 - 6 Big boost for small cells
- 8 Section C: Satellite backhaul for rural small cells
 - 8 Backhaul for small cells – why satellite?
- 10 Section D: Economic modeling case study
- 11 Section E: Conclusion



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For this research, Informa Telecoms & Media conducted an industry-wide survey of 330 communications professionals and conducted 22 individual interviews with representatives from mobile operators.

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Executive summary

Mobile operators around the world are witnessing a surge in data traffic as smartphone use increases, devices become more affordable and network capacity expands. One way in which they are responding to this data explosion is by adopting new, small-cell architectures that can better target underserved areas in developed markets, and extend services into previously unconnected remote and rural areas.

The technology developed for femtocells, the compact home base stations which have already been extensively deployed in many markets as a consumer offering, is now being adapted as a small-cell solution for outdoor metropolitan and rural deployments; an approach which is attracting keen interest from operators and vendors alike.

In a global survey carried out on behalf of iDirect by Informa Telecoms & Media, the use of small cells as a means of providing wireless or mobile access in rural and underserved areas attracted widespread support, with almost half (47%) of respondents favoring small cells in preference to 2G or 3G macrocells.

Out of over 330 senior industry professionals who completed the survey, almost 50% (156) were from operators, with the rest comprising system integrators, hardware and software vendors. The survey results were backed up by means of interviews with selected mobile operators in order to obtain their views first hand. Both the survey and the follow-up research encompassed operators from developed and developing markets.

A key challenge when servicing these new small cells will be the provision of backhaul. Fixed-line backhaul options, such as copper or fiber, are almost certain to prove impractical, inflexible or too costly for use in conjunction with small cells outside highly-developed areas, and the alternatives — such as microwave or satellite, both of which are widely deployed in backhaul networks — are under consideration.

Satellite technology has already proved highly adaptable for mobile backhaul purposes. Modern TDMA-based systems can rapidly deliver the highly-cost-effective, carrier-class, two-way all-IP connectivity with shared bandwidth that is ideally suited to small-cell environments.

When coupled with satellite backhaul, the small-cell approach generated a highly positive response from the survey group, with over 55% expressing an interest in evaluating a solution that combines the two technologies. Both existing users of satellite backhaul and companies without previous experience of the technology responded affirmatively.

Economic modeling carried out by Informa shows that, when used in conjunction with small cells, the business case for satellite backhaul is strongly favorable. Payback can be achieved in as little as two years, and total cost of ownership (TCO) is highly competitive due to significantly reduced capex relative to competing solutions, and opex in line with similar network deployments.

This white paper evaluates the market potential for satellite backhaul when used in conjunction with small cells. In the following pages, key findings from the survey are outlined along with feedback from the operator interviews. Small-cell technologies and their applications are summarized and the performance advantages of satellite backhaul are considered. The key cost benefits of this solution are then outlined in more detail, based on economic modeling and presented in the form of a case study.

Section A: Background

Introduction

Fuelled by the growing public appetite for new services and smart devices, the mobile data boom has placed huge demands on wireless networks, prompting a seismic change in performance and capacity. In the readily-accessible urban centers and populated regions of the world, mobile operators have been willing to invest in new technologies, building out their networks to fulfill the growing demand.

As these markets reach saturation, the next challenge will be to expand data capabilities into regions that are more economically challenging and so have been underserved, whether in the less accessible corners of the developed world or in the unconnected rural areas of the emerging economies.

Evidence of the near-universal demand for mobile data is clear. Between end-2Q10 and end-3Q11, there was a near-doubling of mobile broadband subscriptions worldwide, with significant growth in all of the major regions (see fig. 1). As mobile operators extend their footprint for mobile data services into new, previously untapped markets, mobile data traffic will continue to grow.

More affordable smartphones and the adoption of high-speed data networks by operators are helping to drive up data usage around the world, with strong demand in developed markets and increasing usage in emerging markets.

In 2Q11, mobile data accounted for over 40% of total revenues in Asia Pacific, averaged 30% of service revenues in Western Europe and accounted for almost a quarter of service revenues in Latin America. In North America, one of the fastest-growing markets, data as a proportion of overall mobile service revenues is expected to exceed 50% by 2015.

At the other end of the scale, Africa as a whole has the world's lowest figure for data as a percentage of total revenues at just below 11%, although here too growth has been significant with a 17.5% increase in 2Q11.

However, the figures hide some significant intra-regional disparities. For example, South Africa accounted for 43% of Africa's 10.9 million mobile broadband subscriptions in 2Q11, and although CAGR subscription growth in a number of sub-Saharan countries is expected to be in the order of 15-20% over the next five years, annual ARPU in

many countries is sitting stubbornly at around or below US\$3.

Although data use is growing significantly across all developing markets, their substantially lower base means that these markets will continue to lag well behind the developed economies when it comes to the take-up in data services.

Given both the obstacles and opportunities for growth, fulfilling the pent-up demand in these markets will require technical solutions that are well adapted to the commercial challenges of delivering modern mobile broadband services, encompassing data and voice, to low-density populations in environments that can often be hard to reach.

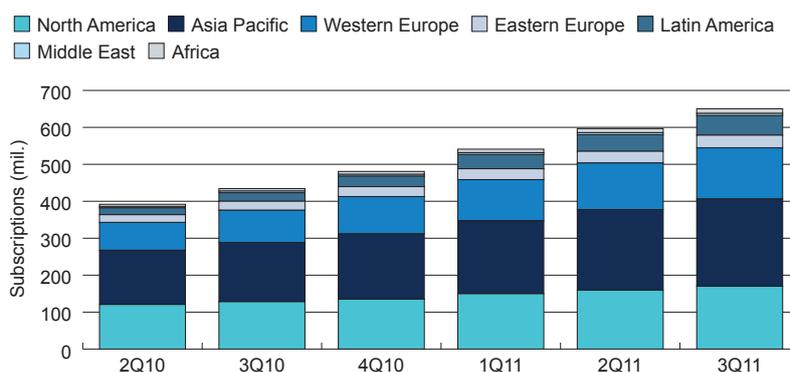
Rural coverage – the backhaul challenge

In their broadest sense, backhaul networks have a critical role to play in providing the all-important link between the end user and the mobile provider's network.

Whether addressing the needs of densely-populated areas with high traffic volumes, gaps in radio coverage in more developed markets, or as yet unconnected remote or rural areas, mobile operators are looking for cost-effective backhaul technologies that will not only provide the much-needed capacity gains, but also support the demands of their evolving networks in terms of flexibility, reach and performance.

In rural coverage areas where pent-up demand for voice and data can often remain largely unfulfilled, rolling out individual backhaul networks is something operators cannot easily do. In most of the African countries for example, rural

Fig. 1: Global, mobile broadband subscription growth, by region, 2Q10-3Q11



Source: Informa Telecoms & Media

populations are very sparsely spread, and capex per capita needs to be several times that which operators have to spend in urban areas.

In addition, rural markets come with lower ARPU yields compared with urban markets, making investment in rural backhaul connectivity doubly challenging. As a result, many operators find it difficult to build a business case to roll out their own backhaul infrastructure.

Sharing infrastructure is one approach which can alter the economics of rural rollouts, potentially improving the operators' business case. Such an approach is being explored for backhaul in some developing markets with the use of fiber, but, outside the major cities and suburban centers, this approach will never be viable on grounds of cost. As a result, alternatives such as microwave and satellite have proved to be — and will continue to be — the only practical solution for backhauling in rural and remote communities.

Section B: Expanding rural connectivity with small cells

Big boost for small cells

At the same time as the evolution of radio-access technologies is helping to fulfill the burgeoning demand for more network bandwidth, the need for greater throughput and capacity is also leading operators to explore new radio access architectures.

While the advances in radio access provided by HSPA+ and LTE can offer greater efficiency and capacity, small-cell technologies such as femtocells, picocells or metrocells can provide a low-cost and flexible alternative to the traditional

Fig. 2: Femtocell deployment segmentation, 1Q12

Target group	Number of deployments	Examples
Consumer	20	Vodafone UK, AT&T, Cosmote
Enterprise	6	T-Mobile UK, Network Norway, Orange France
Consumer and Enterprise	6	Vodafone NZ, Verizon Wireless, Sprint
Public	3	Vodafone Qatar, SK Telecom, TOT Thailand
Rural	1	Softbank (using satellite backhaul)

Source: Informa Telecoms & Media

macro network model. Small-cell technologies have the combined benefits of expanding mobile broadband coverage in developed markets by extending 3G/4G networks to previously un-served rural and remote areas, and of supporting new growth opportunities in similarly underserved or rural areas in developing markets.

Mobile operators are realizing that the typically lower cost of small cells is a natural fit for geographies with a low population density and fewer revenue opportunities that have traditionally been covered using very large macrocells, mounted on high towers, which are expensive to deploy, maintain and support.

The size of these macrocells will in most cases be disproportionate to coverage or traffic demands, particularly where rural mobile coverage is driven by regulation in the form of a Universal Service Obligation, under which an operator may be required by law to cover a certain geographical area or percentage of the population. Even where requirements may not be as stringent, operators have up to now had no choice but to provide blanket coverage in order to reach small pockets of potential subscribers in underpopulated areas.

Due to their ability to provide highly-targeted coverage, small cells are

particularly appropriate in instances where USO requirements are defined by the regulator in terms of population coverage, as in the majority of cases, rather than by geography.

Whereas previously an operator would probably have had to accept that such a deployment will be loss-making, by using small-cell technology not only can operators cost-effectively meet these obligations and requirements and serve smaller areas such as remote villages, they can now do so and be profitable at the same time.

Consumer femtocells have already been extensively rolled out by a number of operators in North America, Europe and Asia Pacific (see fig. 2). They are being adopted as a key differentiator in order to improve coverage and offload data traffic from the macro network, so providing a better customer experience while also freeing up network capacity. Now that these operators are familiar with small-cell technology and comfortable with how it works, many are planning to extend the use of small cells into both urban and rural environments.

To support these plans, a new generation of outdoor-grade rural femtocells have been developed that can cost-effectively cover a small public area, town or village, potentially offering significant

price savings over macrocells and creating a more attractive financial model to cover these types of areas.

Among the operators planning these small cell-deployments is Vodafone Group, which has rolled out consumer femtocells across many of its markets, and is planning to extend its use of small cells into outdoor networks. Network Norway, a pioneer of femtocells in the enterprise market, is also studying the business case for rural small cells, while Japan's Softbank is already deploying a network of outdoor rural femtocells using satellite for backhaul; the operator says it can deploy a new small cell site in just three days.

Although still at a relatively early phase of their development, industry awareness of the potential benefits of small cells is already high. In a survey of over 330 industry professionals carried out by Informa, small cells were judged to be the most suitable technology for providing mobile or broadband access in remote or underserved areas by over 40% of respondents (see fig. 3).

Whereas just over 51% said they would currently still support a macrocell solution, in the longer term over three-quarters of respondents believed that small cells would be important or very important in connecting the world's next billion subscribers, while a further 11% considered them to be critical.

The key advantages of small cells over macrocells were judged to be their low hardware costs and suitability to better target coverage for infill and for rural areas, both features that single them out as an alternative to macrocell deployments.

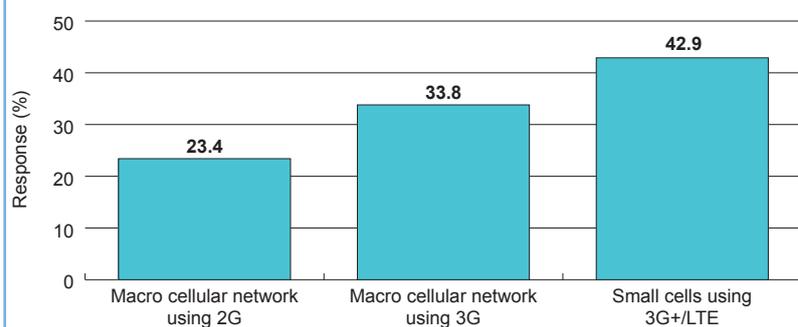
Unlike macrocells and alternative small-cell technologies, such as picocells which can be proprietary in nature and costly to configure and commission, femtocells benefit from a common, open-standards-based architecture, with industry-defined interfaces and functionalities. The self-install and self-organizing (SON) capabilities developed for domestic femtocells are also being extended to cover deployments in public areas, enterprises and rural environments.

Also considered important by the survey respondents was the ability of small cells to support a flexible choice of backhaul options including microwave and satellite.

The survey showed that among operators, the key considerations when making their selection of a rural backhaul technology were on-going operational and capacity costs along with the capital outlay on hardware and deployment. These factors were considered to even outweigh the range and reliability of the chosen technology (see fig. 4).

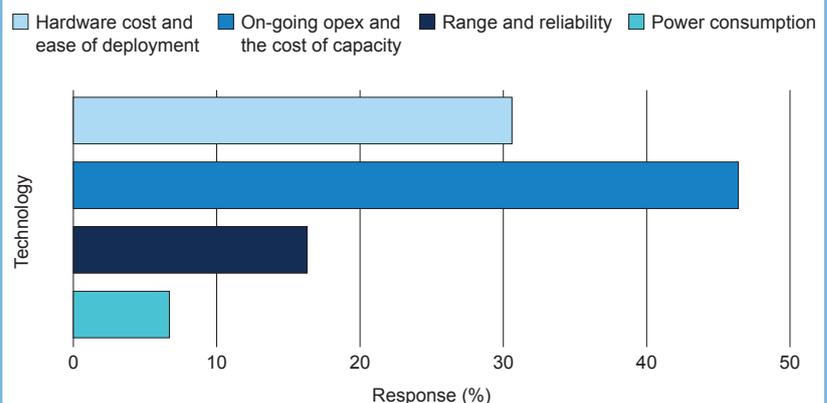
Those with experience of satellite backhaul acknowledged the significant advantages that it could provide over competing technologies in extending services to previously un-served rural communities; a view backed up by primary research conducted with mobile operators

Fig. 3: What is the best technology for providing wireless/mobile access in rural and underserved areas?



Source: Informa Telecoms & Media

Fig. 4: Mobile operators' major consideration in the choice of backhaul technology for remote locations



Source: Informa Telecoms & Media

across several regions including Eastern Europe, Africa, Latin America and Asia Pacific.

The operators agree that backhaul is the most costly and critical component affecting the provision of rural services, and that the need to fulfill coverage obligations or to meet a social responsibility towards previously unconnected populations often conflicts with commercial concerns. Nevertheless, a large proportion of those operators interviewed recognized that extending coverage into previously uncharted or marginalized areas could also provide a competitive advantage.

In this regard, the choice of backhaul has a key role to play, and satellite has advantages over competing technologies in being quicker and more convenient to deploy and often more economic when extending service into territories that are otherwise difficult to reach.

As one East African mobile operator serving rural areas and villages around the country's major cities observed, the use of satellite backhaul has allowed it to quickly and economically penetrate an area with strong and effective coverage beyond the reach of its microwave backbone. "The decision to deploy VSATs in remote sites gave our company a competitive advantage by being the pioneering operator to roll out network coverage in those areas," it said.

Other mobile operators are planning to supplement their 2G voice offering with data by using satellite backhaul. A major Latin American operator is evaluating satellite backhaul for its 3G rollout with the plan to deliver high-quality data and voice broadband services,

saying that capex for alternative technologies in that part of the country would be "very high".

Even in current network architectures, therefore, the perceived high cost of satellite capacity, which some operators say has been a barrier to their adopting the technology, need not render it uncompetitive. What is more, in the survey a high proportion of those operators with limited or no experience of satellite systems admitted to being unfamiliar with the technology.

Existing users of satellite backhaul accounted for 42% of mobile operators responding to the survey. They valued advantages such as the virtually unlimited coverage that satellite provides, its ease of installation, sustained service quality and ability to operate independently of terrestrial networks.

The survey also showed that these operators regarded the capability to share satellite capacity as a key benefit, a feature that could prove highly significant in terms of reducing opex in small-cell deployments where backhaul capacity can be shared between multiple end-user sites (see fig. 5).

Almost as highly valued in terms of technical features were those that most closely align with the broader network trends concerning mobile operators, such as support for the migration of operator networks towards full-IP and greater broadband speeds, carrier-class services and bandwidth management with flexible QoS.

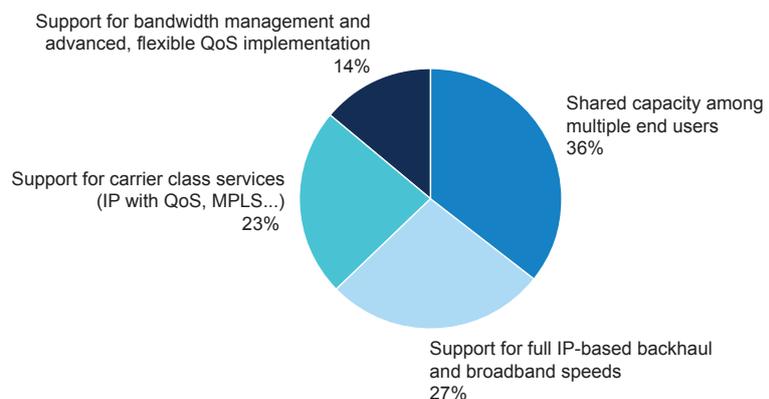
Aspects such as latency or the impact of adverse weather conditions feature well down the operators' list of concerns, suggesting that recent advances in satellite technology have addressed some of the perceived performance issues traditionally associated with satellite systems.

Section C: Satellite backhaul for rural small cells

Backhaul for small cells – why satellite?

Backhauling for small cells, whether in an urban or rural environment, is expected to be challenging. In remote areas, cost will be an overriding consideration for operators, but performance will also be a key factor.

Fig. 5: What do you consider are the key technical features of satellite backhaul?



Note: Existing users of satellite backhaul
Source: Informa Telecoms & Media

Fiber and copper are unlikely to have the necessary reach, and will almost certainly be uneconomic to deploy. Microwave will serve in certain circumstances, for example, where a straightforward point-to-point link is required. However, build costs will inevitably multiply where multiple hops are required, such as in a more dispersed small-cell deployment.

Satellite backhaul, on the other hand, is a technology well-suited to address this area. Bandwidth costs, which are perceived to challenge the business case for satellite backhaul in some environments, are likely to be highly competitive, particularly when rural deployments are large enough to introduce economies of scale.

Crucially, modern satellite systems can boast a range of features that make them commercially and technically well-suited for use as a backhaul solution in femtocell or other small-cell deployments.

The capability to operate independently of terrestrial networks ensures ease of installation and means that services can be up and running in far shorter time, while overcoming the challenges of distance and terrain can be accomplished with a degree of ease that alternative technologies are unable to match. The effectively unlimited coverage area achievable with satellite also means that multiple end users, or multiple small-cell sites, within any given area covered by the satellite footprint, can share the available bandwidth.

Advances in satellite technology over the last decade have largely overcome issues of data speed and

latency, so that today's IP-over-satellite systems can deliver two-way IP connectivity that is fast and reliable. Modern satellite systems are also largely immune to the effects of adverse weather conditions, delivering high levels of availability and resilience.

Also critical when using satellite to backhaul small-cell deployments has been the move from Single-Channel-Per-Carrier (SCPC) satellite systems to those using Time Division Multiple Access (TDMA). This is because the ability to share a pool of bandwidth cost-effectively becomes extremely important when a large number of sites are connected by satellite. While SCPC was the primary technology when satellite was used for large trunking links for backhaul, it is no longer cost-effective for connecting large numbers of small cells as the bandwidth will be too expensive.

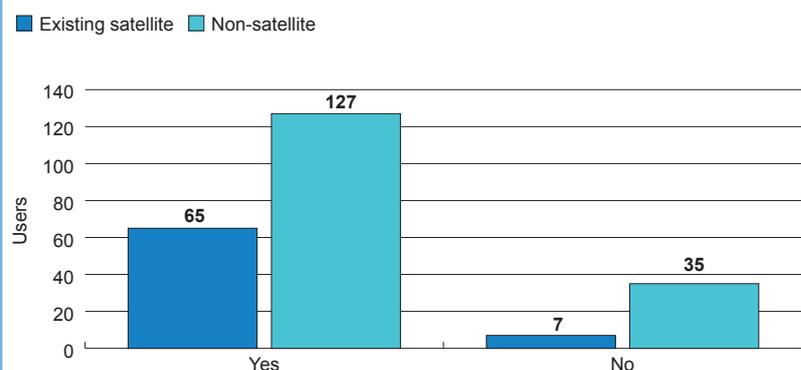
Modern TDMA-based satellite solutions in combination with small-cell technology can now provide a new cost-effective way to reach the edge of the network, allowing more efficient and

economical shared transmission and making modern TDMA satellite systems ideally suited to support widely-dispersed populations in remote areas. As TDMA has matured, it has also acquired additional load-sharing and congestion-management features that allow more efficient use of the available bandwidth than with the previous generation of satellite systems.

TDMA networks also allow the satellite provider to offer flexible bandwidth options to suit an operator's capacity requirements and keep costs under control. Today's satellite technology can deliver operators' minimum data rates and above at a cost that is price-competitive with alternatives such as microwave.

Lastly, and most importantly, the combination of small-cell technology and satellite mobile backhaul is clearly appealing to operators. In the survey, an overwhelming proportion (90%) of existing satellite backhaul users said they would be interested in evaluating such a solution and, significantly, so did the majority (78%) of non-satellite users (see fig. 6).

Fig. 6: Would you consider evaluating a solution that used outdoor femtocell/small-cell technology and all-IP based satellite backhaul for remote and rural coverage?



Note: Sample size: 234
Source: Informa Telecoms & Media

Section D: Economic modeling case study

In order to assess the business potential of rural small cells combined with satellite backhaul, Informa has used its Network Economics Tool to calculate the financial viability of such a deployment scenario under specific circumstances. This economic model is used to estimate whether the financial benefits of femtocells and satellite backhaul are strong enough to generate new business potential and organic growth in rural areas of developed markets.

In order to achieve this, the rural part of a network in the UK was modeled. Such a developed market makes the business case for rural connectivity difficult given the expensive nature of both macrocells and backhaul expansion, and the application of rural femtocells and satellite backhaul provides a positive business case for more aggressive rural expansion. The network was assumed to be HSPA+, similar to other parts of the UK, while the modeling period was set to 2013 until 2017.

The following economic analysis presented calculates the business case for rural networks only. Other parts of the network are not taken into account in order to assess the financial viability and profitability of these rural “islands” of connectivity given the new cost parameters brought forward by femtocells and satellite backhaul. This modeling process is similar to the network planning and dimensioning mobile operators perform when assessing new investments in the network, whether these are new technologies or a more aggressive rollout for existing networks.

The scenario modeled here calculates the business case of expanding the

network more aggressively in rural areas, something that operators may not be willing to undertake given existing high costs of macrocells and traditional backhaul. Several major input parameters were used for this particular scenario of economic modeling (see fig. 7).

In short, rural areas in the UK are modeled where subscriber coverage increases from 70% to 80% solely driven by rural femtocells combined with satellite backhaul. Calculating the network Total Cost of Ownership (TCO) per site for this particular scenario (see fig. 8) found that, as

expected, network opex dominates the TCO as the number of rural small-cell sites is in the order of 15,000. The capex for these cell sites is minimal since small cells are cost-efficient and capex is usually depreciated for a fixed period — five years in this model. On the other hand, opex costs — and satellite backhaul leasing costs — amount to a much higher number, which is similar to any other network deployment.

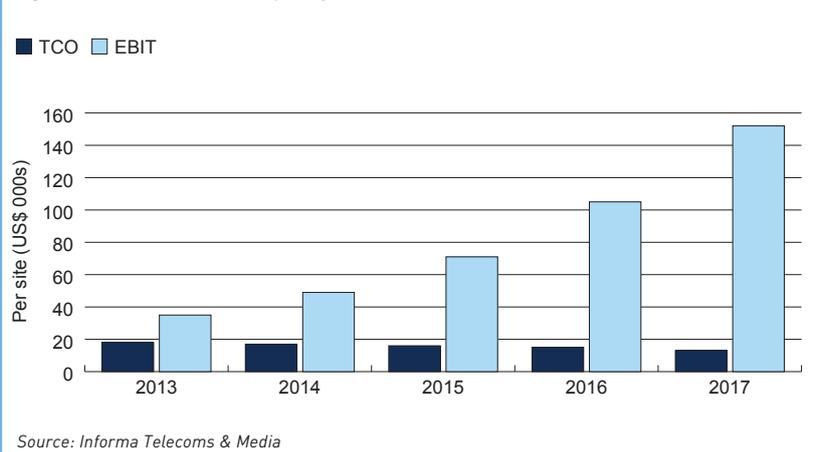
However, when analyzed in terms of the entire 15,000 cell sites, the investment potential and profitability of satellite backhaul with rural

Fig. 7: Economic modeling input parameters

Parameter	Value
Country	United Kingdom
Area (geotype)	Rural
Air interface	HSPA+
Forecast period	2013 until 2017
Coverage (start year: 2012)	70% (subscriber coverage)
Coverage (end year: 2016)	80% (subscriber coverage)
Satellite backhaul capex per link (US\$)	4,000
Satellite backhaul opex (per Mbps)	1,500 per month
Rural femtocell capex (US\$)	10,000 (including site costs, installation)
Rural femtocell opex (US\$)	200 per month (utilities, maintenance)
Rural subscriber ARPU (US\$)	Varies from 2 to 20 according to device

Note: Spectrum, subscriber and marketing costs are excluded from calculations.
Source: Informa Telecoms & Media

Fig. 8: TCO and EBIT analysis per site



femtocells is clearer, as the financial metrics show (see fig. 9).

Despite having high opex requirements, satellite backhaul provides payback in two years and other financial metrics are also very positive. Also, this modeling example has assumed that all rural sites are backhauled over satellite when only a proportion of these will be addressable in developed markets. When fewer sites are considered, capex is less intensive, so making the total TCO required for rolling out small cells in unreachable areas lower and the decision to deploy easier. Moreover, while developed markets are saturated, rural areas can provide the necessary organic growth to sustain revenues and profitability, and these areas may only be reachable through satellite backhaul.

Section E: Conclusion

Both developed and emerging mobile markets are seeing a huge surge in demand for data services. In the more saturated markets where networks are reaching full capacity, operators are keen to develop more granular coverage that can target traffic hotspots better and fill in areas where coverage has previously been lacking.

Fig. 9: Economic modeling results

Financial metric	Value
Internal Rate of Return (IRR)	33.6%
Net Present Value (NPV)	US\$2.29 billion
Discounted payback	2015
<i>Source: Informa Telecoms & Media</i>	

At the same time, attention is turning to rural and underserved areas, where the wider availability of low-cost smartphones and advances in mobile networks are also driving up levels of data consumption. In these challenging markets, mobile operators are looking for cost-effective ways to extend their reach to a population that increasingly demands services on a par with those offered in the more intensively-developed urban and suburban centers.

In order to provide profitable services to these more remote populations, a more radical approach than the traditional macro-cellular model is clearly required. As a result, the industry is turning to small cells based on commercially-proven, standards-compliant femtocell technology, which are proving to be tailor-made for these environments by virtue of their ability to be targeted, quick and trouble-free to install — and, above all, cost-effective.

Microwave and satellite have traditionally served as backhaul for

remote locations where the rollout of fixed-line or fiber is uneconomic. The advent of small cells changes the dynamic and poses new demands for the backhaul network, requiring a solution that can be quickly deployed and is adaptable to these new network architectures, but that still meets the key performance criteria demanded of mobile broadband services.

The development of flexible, affordable and efficient carrier-grade satellite backhaul ideally meets the demands of this new generation of small cells. Modern satellite systems can provide an affordable bandwidth pool serving large-scale, small-cell deployments in areas that are hard to reach, with a greater degree of flexibility and ease of deployment than competing technologies, including microwave, can offer.

In addition to being technically well-suited, the economic case for satellite backhaul reinforces its strong potential as a profitable, low-cost solution for small-cell deployments, whether in developed or developing markets.

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