

WHITE PAPER

# Motorola Reach

Achieving highly effective coverage in GSM Networks



# *In a number of countries the volume of wireless connection lines surpass the number of fixed lines.*

## REACH NEW SUBSCRIBERS

Motorola is strongly focused on delivering solutions that will enable service providers to connect the next billion mobile subscribers. We know that with the increasing saturation of mature markets, further growth in the global mobile market will be driven by sales in emerging markets. Currently growth in the number of subscribers in developing countries is twice that in developed markets. In Pakistan alone, between June 2004 and December 2005, subscriber numbers grew by 450%. On the African continent mobiles now account for 75% of all phone connections in 19 of the poorest countries and subscriber growth across Africa is recorded at more than 150% per annum.

Significantly, the rapid adoption of telephony services has been spurred by the liberalization of domestic markets and in a number of countries this has seen the volume of wireless connection lines surpass the number of fixed lines.

Also subscribers in emerging and developed markets now look at mobile communication as a necessity not a luxury. In service driven economies mobile telephony has the potential to increase business productivity considerably. For example tradesmen can call and be contacted by customers via their mobile phone, ensuring optimum use of work time while avoiding unnecessary travel costs and missed job opportunities.



And yet, the proportion of people with mobile phones is still very low - around 5% in India and Sub-Saharan Africa. GSM is forecast to grow from 1.79 Bn subs today to around 2.1Bn by 2010 (Source: WCIS), so there's plenty of room for exponential growth in places like Asia, Africa and South America and there's more than enough momentum in individual demand.

So how can service providers achieve flexible and cost effective mobile network coverage and take advantage of this huge subscriber customer growth potential?

## REACH OUT WITH EFFECTIVE COVERAGE SOLUTIONS

Developing markets are characterized by high cost of capital, low disposable income and low fixed line penetration. Given the volatility of financial markets in some developing economies, service providers often need to deploy extensive coverage at minimum capital costs. Network infrastructure has to deliver cost-effective coverage that minimizes service provider outlays in terms of both capital and operational cost. Solutions also need to allow service providers to have maximum choice and flexibility on where cell sites can be located and where possible take advantage of local resources to keep costs low.

Coverage solutions are not just about provisioning voice services either. Having a combined service offering of voice and data services to protect overall revenue margins has proved an effective strategy for developed market service providers. Having a varied service portfolio is also an equally valid tactic for emerging markets. In fact markets where there is no alternative source of Internet connection, e.g. DSL connections, have shown very strong demand for mobile data connections (even over GPRS) in both urban and rural environments. It is therefore not the case that all the next billion mobile subscribers need is basic voice services. Both emerging and developed market service providers also need to be able to provision data services with effective and scaleable coverage solutions.



## REACH BEYOND THE CHALLENGES

Service providers face a number of key challenges when rolling out their network coverage to subscribers;

- **Radio coverage is the highest cost element of the overall network** – radio network coverage is typically about 70% of the total network build cost (including cell site ancillaries). Therefore even a small percentage reduction in coverage costs can have a correspondingly large reduction on overall network rollout costs.
- **Operational license parameters** – As markets have developed the lower GSM frequency bands, such as GSM 900, which inherently provide a wider coverage, are often fully allocated so that new service providers need to operate their networks in the higher frequencies, such as 1800 which require more cell sites to achieve the same coverage area. Also frequency license agreements from the national regulator often dictate a minimum coverage requirement so that service providers cannot simply build their cell sites where the maximum number of subscribers is likely to be located, e.g. urban areas. Instead service providers often have to commit to a certain level of combined population and geographical coverage. Therefore a requirement is set for wide coverage low density cell sites and data enabled coverage may also be part of this as the market evolves.
- **Service quality (or coverage reliability)** - in theory, the needs of consumers in emerging economies are more 'basic' – with their primary requirement being low-cost service connectivity, Some view points see service availability and quality not featuring as key priorities. Motorola's experience in developing economies has however shown that service quality matters enormously. When subscriber's disposable income is less than US\$10 dollars a month, investment in even a "cheap" mobile service is a far larger financial consideration than it is for someone earning a higher wage - and the expectations of the service are comparatively greater. Subscribers expect handset durability, service availability 24/7 and a service that delivers stable quality voice and data calls – because they're paying out precious money for air time. Therefore solutions that suggest that costs can be cut by reducing service availability, say at peak times, or overall service quality are fundamentally flawed.



- **Quick return on investment delivered by fast network rollout and launch** are also extremely important to a service provider's business success. Solutions that reduce the technical complexity of site installation, assist rapid rollout, and use local content where applicable, are very valuable as they enable reduced overall cost and ensure capital investment is earning revenue quickly.

Obviously as a result of these issues a strong focus for service providers considering network rollout is to reduce the number of overall cell sites required without impacting quality service provision, especially when implementing wide area coverage. Though the number of sites required for initial coverage is dependent on a range of factors, such as which spectrum is allocated by the regulator and license regulations on coverage, the impact of choosing solutions that deliver high performance coverage; that reduce the number of sites required and positively influence the overall cost of mobile network implementation is critical.

## IMPORTANCE OF LINK BALANCE WHEN SETTING UP COVERAGE

Generally in areas of high subscriber density, such as urban environments, the number of sites required is dependent on the capacity requirements. However where subscriber densities are low, such as in rural environments, the required quantity of sites is driven by the link budget between the cell site and the handset.

The link budget describes the maximum amount of signal extension or attenuation that can be tolerated while maintaining a communication link between the transmitting and receiving devices during a mobile call. If the link budget can be extended this can improve call performance over a wider range as RF signal loss is reduced, increasing the probability of good signal acquisition by the receiving device and for the mobile handset considerable improvements in battery life.

## MOTOROLA REACH HIGH PERFORMING GSM COVERAGE SOLUTIONS

Motorola's Reach solutions for GSM deliver low entry cost scalable solutions to build out coverage for both voice and data service delivery. There are a number of key elements to the Motorola Reach solutions that specifically target coverage and link budget improvement:



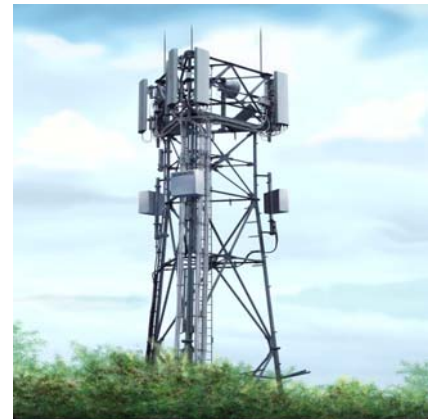
### **Reach Trio and the rest of the Reach BTS family**

Motorola Reach Trio is a high power base station configuration that enables tri-sector wide area coverage delivery, particularly effective for fast rollout in rural or lower population subscriber density areas. It has a minimum footprint based on a Horizon II mini / micro combination delivering a macro type performance. Typical configurations could be 20W 2/2/2 or high power 63W 1/1/1 in 900MHz.

Motorola's overall range of flexible high power output BTS in macro, mini and micro formats provide increased deployment flexibility. Motorola's Horizon II basestations address issues, such as achieving lower cost-per-subscriber, serving both dense and sparsely-populated areas, and maintaining consistent service quality. Reduced power consumption (up to 15% improvement on previous generation) and lower maintenance requirements, due to fewer field replaceable units are just two of the features that result in sustained lower operating costs. All Horizon II basestations are data capable including support of EDGE.

### **Tower Mounted Small Basestations**

Mounting small basestations close to an RF antenna at the cell site location can improve mobile service performance by eliminating RF cable losses. The minimization of cable losses can also mean that Tower Mounted Amplifiers (TMA) can be avoided and hence reduce site installation CapEx. Furthermore, the resulting improvement in both the uplink and downlink paths extends the link budget, thus potentially reducing the number of sites required for coverage.



In the Motorola BTS portfolio, this requirement can be met using the Motorola Reach Trio configuration deployed for example in a 2/2/2. Motorola's high power micro is ideal for this type of deployment as its compact nature facilitates mounting on the antenna tower.

Alternatively remote RF heads can be used to minimize cable losses; however, the cost of deploying such RF heads may be prohibitive, due to the high RF power amplification requirements in coverage applications.



### **Tower Mounted Amplifiers (TMA)**

TMA's enhance the basestation receiver performance by reducing the effects of antenna cable loss. The resulting improvement in the uplink path extends the link budget and hence increases the cell coverage area. Nonetheless when using TMA's careful consideration needs to be given to the cell site design because certain RF characteristics can counteract the benefit and therefore overall coverage performance.

### **Adaptive Multi-Rate (AMR)**

AMR employs speech codecs which are more resilient to interference and can enable an improvement in cell coverage area by as much as 27%<sup>1</sup>. AMR associated improvements in cell coverage are achieved in environments where interference is the limiting factor. There will also need to be a high penetration of AMR capable mobile devices to realize the cell coverage gains.

### **Multi sector – 6 sector**

Multi sector high gain antenna configurations can achieve about 2dB improvement in the link budget. The resulting coverage improvements can yield up to 20% reduction in the number of sites required. Multi sector benefits, especially the higher sector configurations, will need to be balanced against potential increase in site installation costs due to the increase in the number of antennas required at the site. The resulting increase in tower loading may necessitate the use of more expensive antenna masts.

### **4x Diversity / High power mode**

4 branch receive diversity feature combines signals from 4 receive antennas to achieve gains of 4-5dB in the uplink signal path. In order to fully exploit these uplink gains from 4-branch receive diversity, transceivers are configured in high power mode which delivers up to 4dB improvement in the downlink transmit power. The combination of High Power mode and 4-branch receive diversity can deliver up to 50% reduction in the number of cell sites required.

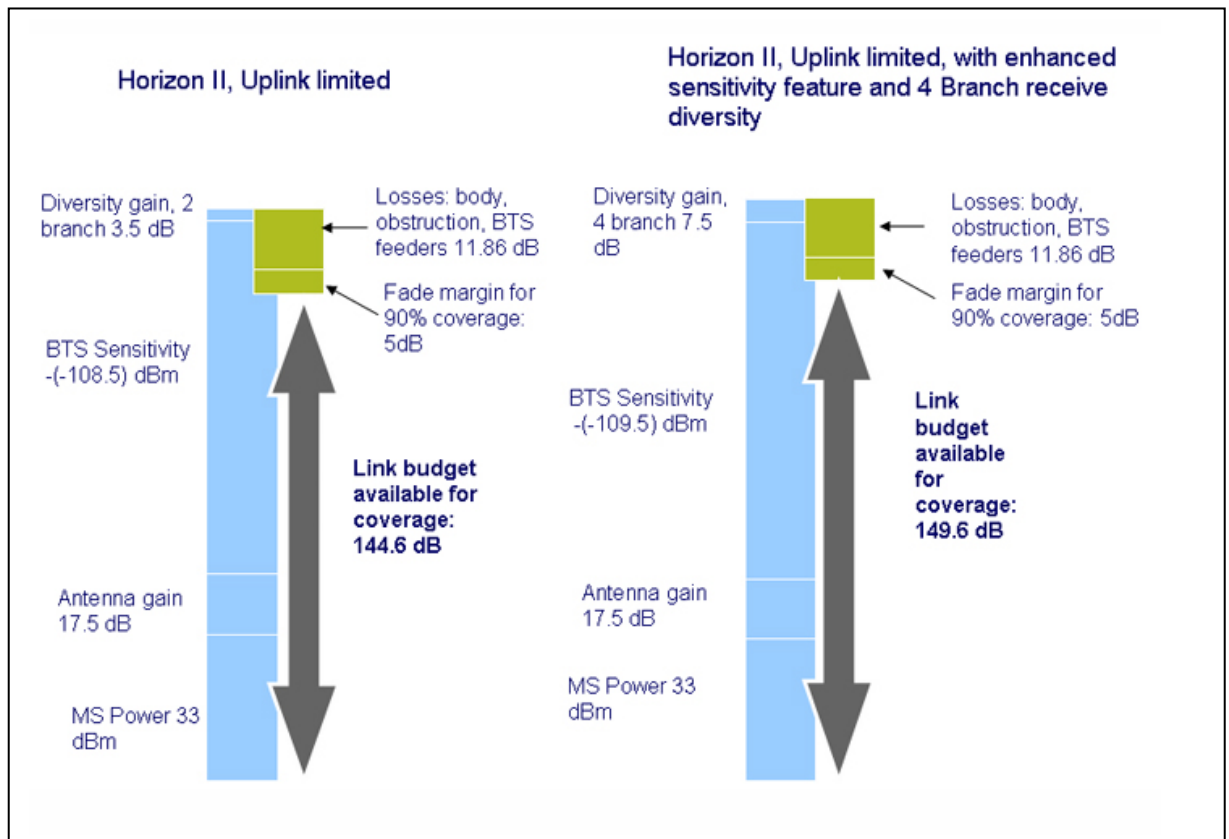
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<sup>1</sup> See Motorola BSS Equipment Planning (Document Ref. 68P02900W21-P)



Potential increases in site installation costs, due to the doubling in the number of antennas required at the site, need to be considered and again tower loading may necessitate the use of more robust antenna masts.

### 4 Branch Diversity and Coverage



**4 Branch Diversity with enhanced Sensitivity feature can save 50% of sites required in rural deployments. In practice, savings of 15-20% of sites required are achievable.**



### **Extended Range Cell (ERC)**

Where RF propagation conditions are favorable, the extended range cell feature permits cell ranges of up to 120km (GSM 900Mhz). This feature can therefore be effective for extending voice and data service coverage and thereby reducing the required number of cell sites.

This feature is enabled by permitting timing advances for the mobile handset transmission of more than 63 bit periods. As the Figure below indicates, this increased timing advance requirement has the effect of reducing the traffic carrying timeslot capacity of the transceiver.

Maximum benefits of ERC can only be realized where RF propagation conditions are favorable e.g. coastal or open rural areas.



**Motorola Leadership cell radius of up to 120 KM**

### **Effective planning and optimization**

Network services and deployment - Motorola offers considerable experience in network design, rollout and optimization across developed and emerging economies. Motorola considers the overall service performance – we have delivered leadership in multi-vendor optimization across the RAN network but also in E2E data service optimization where throughput issues can surface in either the RAN or the Core network elements.



## CREATIVE STRATEGY SOLUTIONS TO ASSIST SERVICE COVERAGE

Facilitating solutions that assist service providers with easier coverage rollout, making it more cost effective or driving subscriber take-up are also important aspects of the coverage discussion. Motorola is driving a number of strategies in terms of localized solutions, alternative power for cell sites and service facilitators for lower income subscribers in emerging markets

### Localized Solutions

Motorola is working hard to bring the cost benefits of localized solutions into its overall GSM solutions proposition. Motorola Reach Strongbox is a good example of this. The background for the solution was the need from the Indian Market to have a basic cost effective outdoor enclosure. Working with the local operations of an international engineering company the Motorola Reach Strongbox specification has been created. Once commercially launched the specification will be evolved further for other markets, for example China where the temperature range requirements are different, again using in country support.



**Motorola Reach Strong-box is an example of a local sourcing approach**



### Flexible power options

Utilizing the full range of modern methods for powering cell sites increases the flexibility that service providers have on where the cell site is located and provides sustainable cost effective power sources for the site. Issues, such as high grid connection costs and the unreliability of commercial power mean that well designed alternatives with battery backup, diesel/bio-diesel, LPG, solar and wind are all flexible options. It is worth noting that in some markets a high proportion of sites are autonomously powered from a generator. This drives the business case for highly fuel efficient cell site solutions. The combination of solar and wind is very promising, an integrated design of renewable power could enable the system to charge reserve batteries and also provide active power to drive the cell site during daylight hours.



### Transmission options

Motorola can offer a range of transmission backhaul options for cellular networks depending on local requirements including Motorola Canopy™, microwave and IP satellite. The very cost effective Motorola Canopy solution has now been deployed as GSM backhaul and tested successfully. Motorola Canopy backhaul solution can support point to point transmission with capacity equivalent to 4 E1 connections. It can provide cost savings of up to 30% for the service provider compared to traditional microwave PDH based transmission.



# *The Motorola C113 has all the features you can depend on, without putting a dent in your wallet*



## **Shared networks and roaming**

One option for service providers looking to minimize rollout costs in the early days of subscriber development is to do rollout on a regional basis and then have corresponding network sharing agreements with a service provider strong in another regional area of the relevant country or market. This sharing can perhaps be most practically done with a roaming agreement so that subscribers experience extended coverage but are still billed through a single service provider.

Roaming agreements can also be useful for capturing valuable international call revenues for users such as business and tourist travelers coming into the country.

## **Getting the handset right for emerging market growth**

Durable low cost handsets which do not require subsidy by the service provider to meet emerging market subscriber price points are extremely important particularly for lower income economies. For the last two years Motorola has successfully won the contract with the GSM Association to manufacture a range of low cost devices. The 2006 contract for robust sub-\$30 handsets meets the specific needs of emerging markets, such as longer battery life.

## **Spreading the use of mobile communication**

In India and Africa, Motorola has entered an agreement with SharedPhone™, a company that supplies a SIM card that allows a subscriber's personal mobile phone to be used as a payphone – this enables people who cannot afford the entry level cost of having their own mobile and subscriber service the opportunity to still have access to mobile communications to contact family, friends and work opportunities. It also enables the person who owns the SIM card to add up to US\$700 to his or her monthly income. The SIM card enables the owner of the phone to allocate agreed airtime to the person wanting to make a call and then automatically cuts off the call when the airtime expires. The owner of the phone makes a profit on each call made in this way. Over 500,000 Motorola handsets have been shipped to date with this feature enabled, with Motorola and Shared Phone™ doing joint promotion campaigns in several key African markets and India.



## Spreading use of mobile communications



**Motorola and SharedPhone...working across Africa**

### SUBSCRIBER GROWTH

Once mobile service coverage is launched and the service provider starts to get established in the market - attention will soon turn to increasing network capacity so that increasing numbers of subscribers can be managed and supported. Please refer to Motorola's Reach paper – Voice Capacity in GSM networks for further information on Motorola's GSM capacity solutions.



## SUMMARY

Motorola continues its GSM solutions strategy to support both developed and emerging market growth. With the strong combination of the Motorola Reach platform and software solutions, service providers can achieve major reduction in the number of cell sites required to deliver competitive yet quality mobile service coverage.





**Motorola, Inc.**

[www.motorola.com/networkoperators](http://www.motorola.com/networkoperators)

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