SR Telecom
Wireless and Beyond

Point-to-Multipoint: The Rural Fixed Wireless Access Solution of Choice

A Comparison with Fixed GSM

Abstract

Rural markets have traditionally been served by fixed wireless access (FWA) systems such as point-to-multipoint (PMP) radio, which is generally considered a quick and economical way to implement communications infrastructures that link these areas to the rest of the world. FWA is specifically designed to deliver quality, cost-effective services in low-density and scattered rural areas. Global System for Mobile Communications (GSM) remains the world's leading mobile communications technology. Recently, equipment vendors have encouraged GSM operators to use fixed GSM (FGSM) technology to deliver basic telephone service to low- and medium-density rural areas that are not served by landline networks.

Although FGSM may appear to present opportunities for attracting new subscribers by leveraging existing GSM infrastructures, in reality, the advantages this technology provides are limited to the high-density and often narrow corridors already covered by mobile networks. Extending such networks into the countryside in low-density regions is not necessarily a cost-effective solution as the per-subscriber cost of delivering basic telephony substantially increases.

Given the uncertainties of FGSM's evolutionary path, and indeed the lack of support for a cost- effective solution for delivering toll-quality voice and functional Internet access to low-density areas, network planners should carefully consider the advantages and disadvantages of FGSM as a FWA solution.

This white paper reviews PMP/ Wireless Local Loop (WLL) and FGSM, and their respective merits, as they apply to deploying voice and data networks in low-density, rural areas, according to the following criteria:

- Infrastructure
- Network costs
- Social benefits and service mandate

Infrastructure

Compared to a FGSM network, PMP/WLL is operationally less complex and is a more cost-effective method of delivering rural telephony.

While FGSM has some merits, it remains that it is a mobile voice communications network being extended in a context typically served by FWA solutions such as PMP technology. Although FWA is specifically designed to be a direct extension of the landline network, supporting voice and data in a transparent fashion, FGSM adds complexity at different levels of the mobile network – ranging from limiting subscribers' mobility, to number assignations and call type identification, to billing issues. As well, the technical support that an operator requires is different for fixed subscribers as compared to mobile users.

While FWA's mandate has evolved over the years, focusing on its ability to serve the specific needs of low-density rural areas, the same cannot be said of FGSM, where there is no obvious R&D commitment. GSM networks offer a migration path to high data rate applications, although this entails additional costs and requires considerable backbone, capacity and base station upgrades, in order to accommodate the new technologies (GPRS, EDGE and 3G).

The fact remains that in terms of cost, FGSM is not inherently suited to meeting the universal service requirements of a typical rural network. For example, GSM sites consume a great deal more energy than PMP/WLL to serve the same number of subscribers (i.e., 400-500 W per 1000 km^2 site versus 80 W respectively). As a result, these sites cannot survive power outages with off-grid energy solutions such as solar power.

Regarding network management, PMP/WLL is a pure FWA technology that provides a direct connection to existing central office switches, effectively making the PMP/WLL network a direct extension of the wireline network. As well as relying on the public switched telephone network (PSTN) to provide all primary switching functions, the PMP/WLL preserves the advanced features of the PSTN exchange and moreover, allows the use of underutilized switching resources. Compared to an FGSM network, PMP/WLL is operationally less complex and is a more cost-effective method of delivering rural telephony. In fact, an inherent problem associated with using FGSM is that another layer of network management needs to be integrated into an architecture that is already abundantly complex due to the need to handle international roaming. The diverse nature of FGSM service from mobile service can entail additional operational complexity, for example, the requirement for more call centers, technicians, switches, network operations centers, etc. For instance, FGSM customers would undoubtedly expect to receive unlimited local calling at a different rate from prime rate mobile service. This would entail a separate billing system that is not solely based on usage. There is also the question of the PSTN numbering system that would now be required in order to support mobile, as well as fixed subscribers on the same network.

Network Costs

The costs involved in building a network to respond to both current and future market needs is a very good indicator of whether a technology is suitable for a particular application. Figure 1 provides a cost comparison for PMP/WLL and FGSM technologies, based on a scenario in which universal access must be delivered to rural and remote communities considering the following assumptions:

FGSM:

- Frequency: 900 MHz
- 1 site per 40 km
- 1 site has 1 tower, 1 BTS, 1 TRU/TRX, and 1 shelter, in some cases
- Infrastructure average cost per site: US $125,000
- Microwave hop average cost: US $30,000
- No added cost was considered for data applications; only voice services were considered

PMP/WLL:

- PMP/WLL frequencies: 1.5 GHz/300 MHz
- 1 repeater per 70 km
- A mix of wired and wireless subscribers
- An infrastructure average cost of US $1,400 per km for wired subscribers
- Microwave hop average cost: US $25,000
- Voice and data applications were considered

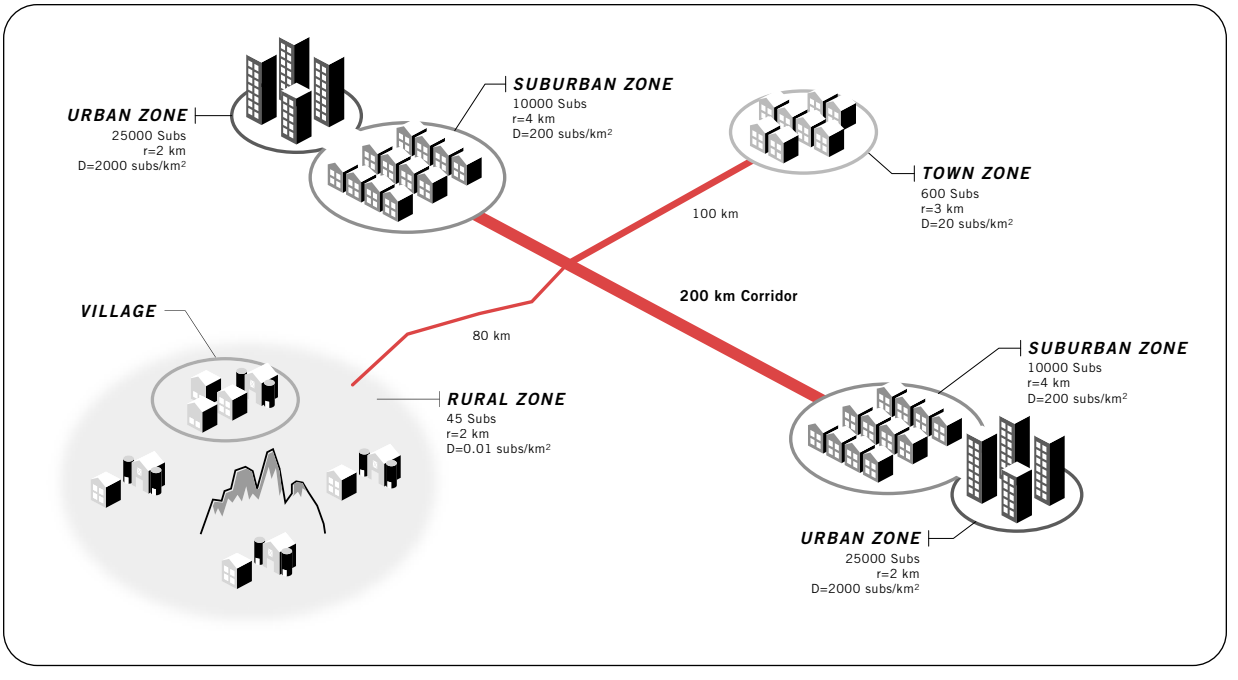

Figure 1: Network Scenario

As illustrated in Figure 1, when a GSM infrastructure has been deployed, an operator using FGSM technology will be able to leverage the existing infrastructure along the 200 km cellular corridor to connect subscribers for as low as US $400 per subscriber. By contrast, the cost of using PMP/WLL technology would be approximately US $800 per subscriber.

However, a critical question to ask is what would happen if you were to move out of the corridor to serve rural and remote communities?

Firstly, to serve a small town that has 600 subscribers with 20 subscribers per km^2, located 100 km from the corridor, the cost using FGSM would rise to US $2,000 per subscriber. However, with PMP/WLL, the cost would remain at US $800 per subscriber, a significant cost saving. Secondly, when serving what might be considered typical areas requiring universal access, for example, a small village with three rural areas with a density of 0.010 subscribers per km^2, the FGSM costs would be very high. That is, up to US $10,000 per subscriber for FGSM, compared with US $1,700 per subscriber for PMP/WLL.(See Figure 2.)

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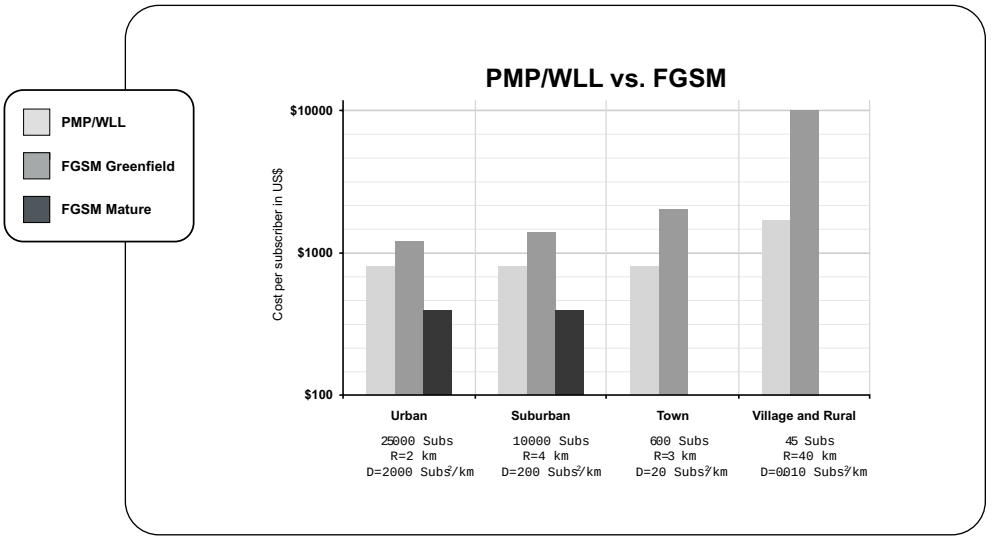
If one were to examine this issue from another perspective, the cost advantage of FGSM compared to PMP/WLL lies in using low-cost legacy GSM terminals. However, this assumption does not take into account the cost of Base Transmission Stations (BTSs).

Here again, FGSM offers an attractive cost structure for easily accessible subscribers. However, in terms of BTSs, the costs are very high compared to PMP. That is, to serve 400 users at 70mE per user, a FGSM BTS costs US $150,000, while the cost is one third of that for PMP. The implications of this are clear. Firstly, the short-term gain of having new subscribers within the corridors is offset by the long-term pain of coping with growing demand for voice channels. Secondly, for mobile applications, the revenues justify the high cost of the BTSs. However, in a rural environment, where the revenues are much lower due to fixed service tariffs and low densities, the operator must assume these high costs in order to reap the rewards.

Indeed, the long-term costs associated with FGSM technology could be significant when one considers the pending advances in GSM technology to support the transmission of data-rich applications, which are fundamental to any long-term subscriber base growth strategy. For example, it costs US $10,000 to US $20,000 per site to install GPRS data modules to support data applications which, incidentally, results in lower coverage of a macro cell, beyond the current 9.6 kbps of 2G digital services. Also, support for 3G data applications will require a substantial network upgrade. This will involve a significant change to the backhaul since capacity will need to be doubled, and the installed BTS base will require a complete forklift changeout.

The PMP configuration and the cost structure of the equipment make the PMP/WLL technology more suitable than FGSM when there is a need to effectively respond to the present and future needs of rural and remote communities for voice and data applications. The primary argument in favour of FGSM technology is the low capital investment in network infrastructure per subscriber. However, this argument also creates misconceptions about FGSM as it relates to the delivery of universal services to rural and remote communities where low densities are a given and there is a lack of infrastructure.



Social Benefits and Service Mandate

As mentioned in the "Final Report of ITU-D Focus Group 7 2001: New technologies for rural applications", rural and remote areas are often characterized by a lower than average level of education, a lower income than urban areas, insufficient medical support and a lack of government services. One of the basic drivers for expanding telecommunications services in these areas is to trigger and sustain economic development and improve the quality of life.

Universal service and access to the Internet are two key goals for regulators of the public telecommunications network. Therefore, any discussion of competitive service delivery technologies and infrastructure needs to take these goals into account.

The quality of voice service is critical when delivering services to the rural market. The voice coding at 64 kbps pulse code modulation (PCM) or 32 kbps adaptive differential pulse code modulation (ADPCM) allows PMP/WLL to provide a higher quality of voice, compared to FGSM where the voice coding at 8 or 13 kbps implies a lower quality of voice service.[1]

[1] Mean Opinion Scores: **3-4** for GSM; **4-5** for PMP/WLL according to Wong W T et al: 'Low rate speech coding for telecommunications', BT Tecnol J, 14, No 1, pp 28-44 (January 1996).

The requirement for "functional" access to the Internet has become a basic expectation of many rural operators. Basic telephone service subscribers expect to have dial-up access at 56 kbps. However, cellular-based Internet connections do not normally exceed 14.4 kbps. At this speed surfing the web is not an easy task.

Beyond basic Internet and value-added voice services, rural communities are also demanding other high-data rate applications, such as telemedicine and e-learning. PMP/WLL supports these services, as this technology is essentially an extension of the wireline network.

A more serious barrier to universal service is the inherent cost structure of FGSM, which was previously described. Clearly, the FGSM model is designed to bring service to subscribers located within a certain distance of the service cell.

However, it is important to note that extending service beyond this area is prohibitively expensive, mainly because the infrastructure must serve the entire extended service area, even if there are few subscribers. By contrast, a PMP/WLL infrastructure can scale up cost-effectively to meet the needs of a few or many subscribers. For example, an extension of a network to reach scattered and obstructed users in a rural area may cost approximately US $6,000 per subscriber, using FGSM, and about US $1,700 per subscriber using PMP/WLL.

Summary

While PMP/WLL technology allows for targeting individual subscribers and is, therefore, user-oriented, the FGSM solution focuses on a geographic cell and could leave many pockets with poor coverage.

For two decades, PMP/WLL has been a proven, cost-effective solution for providing connectivity to low-density, rural areas. Part of its strength lies in the fact that it is specifically designed and developed to cost-effectively address the needs of the operators in those areas, while providing toll-quality voice and functional Internet access to users. Specializing in this area has allowed vendors to develop a product that can support both current and future applications, as well as contribute to the positive economic outcome of such projects.

When compared to PMP/WLL:

- FGSM cannot deliver toll-quality voice
- There is not, to our knowledge, any current R&D initiatives that are focused on evolving the FGSM network for fixed applications
- Network costs are very high when services have to be delivered to rural and remote areas
- While PMP/WLL technology allows for targeting individual subscribers and is, therefore, user-oriented, the FGSM solution focuses on a geographic cell and could leave many pockets with poor coverage.

SR Telecom's extensive experience in delivering cost-effective, wireless access systems that deliver toll-quality voice and functional Internet service, has taught us to design and engineer systems with real fixed network applications in mind. That way, you can be sure of outstanding quality and cost-effective performance… both now and far into the future.

For more than 20 years, SR Telecom has been a world leader and innovator in point-to-multipoint fixed wireless access solutions, including equipment, network planning, project management, installation and maintenance services. Its products are among the most advanced and reliable PMP wireless telecommunications systems available today. Serving telecommunications operators in over 110 countries, our fixed wireless solutions provide high-quality voice and data for applications ranging from carrier class telephone service to high speed Internet access.

Acronym Glossary

3G:	Third Generation's application
ADPCM:	Adaptive Differential Pulse Code Modulation
BTS:	Base Terminal Station
EDGE:	Enhanced Data Rates for Global Systems for Mobile Communications Evolution
FGSM:	Fixed Global System for Mobile communications
FWA:	Fixed Wireless Access
GPRS:	General Packet Radio Service
GSM:	Global System for Mobile communications
PMP:	Point-to-Multipoint
PSTN:	Public Switched Telephone Network
R&D:	Research and Development
TRU:	Transceiver Unit
TRX:	Transceiver / Receiver
WLL:	Wireless Local Loop

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