New Alternatives for PRS Timing

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Symmetricom™

SYNCHRONIZATION BY TELECOM SOLUTIONS

Introduction

The use of GPS technology as a Primary Reference Source (PRS) for telecommunications networks has grown rapidly over the last few years. In fact, GPS is widely touted as the be all and end all PRS technology. In many circumstances, GPS has lived up to its promise and proven to be a reliable, effective, and economical PRS solution.

The growing deployment of ATM and IP equipment at the customer premise for voice/video/data integration represents a significant change in where GPS synchronization systems are deployed. For example, voice over ATM requires the precise level of synchronization that GPS systems provide. However, while central offices are tightly controlled environments and highly similar in nature, no two customer premise facilities are alike. Many end users lease office space with no or limited access to the roof making roof mounted GPS systems impractical.

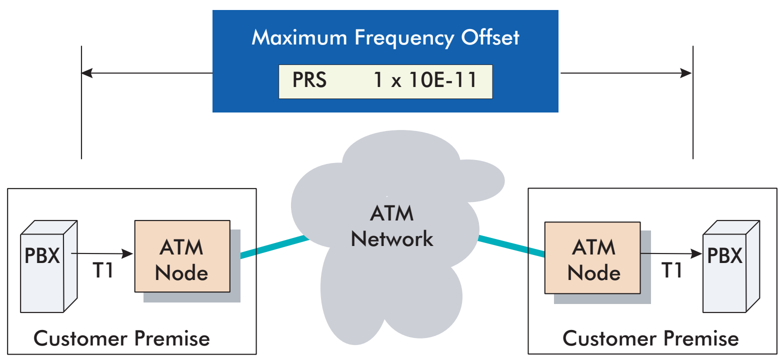


Figure 1. Voice over ATM - the circuit emulation synchronization challenge

As GPS PRS deployment grows, real world experiences are uncovering a number of situations where GPS can not fulfill the universal PRS applicability it once was expected to. The following such situations will be explored in more detail:

1. Urban canyons
2. Leased office buildings
3. High interference zones
4. Human factor

Urban Canyons

Urban canyons are areas of dense building usage where the view to the sky is partially blocked by taller buildings in the adjacent area. In urban canyon environments, limited view to the sky prevents the GPS system from achieving acceptable performance. In many cases, the only definitive way of knowing if

the system will perform is to install (perhaps temporarily) the antenna on the roof and monitor the output for several days, if not weeks. Most organizations view this as an inefficient use of engineering/operations resources.

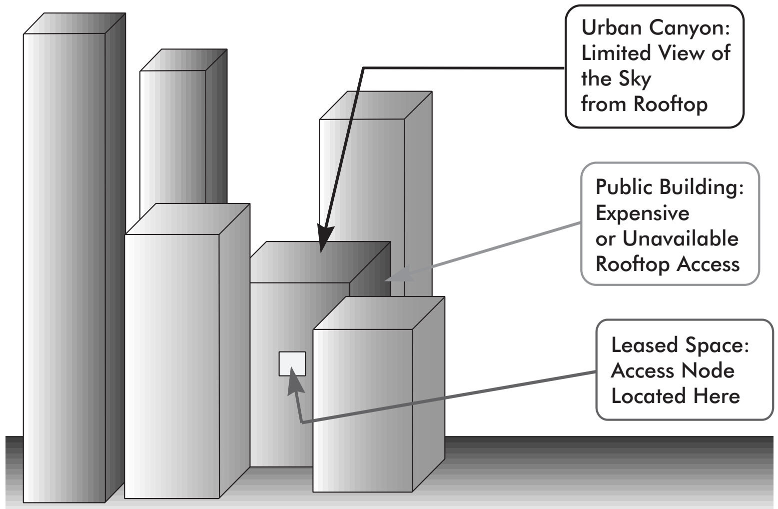


Figure 2. Situations where a roof top GPS antenna is impractical

Leased Office Buildings

Increasingly, central office equipment is installed in buildings not owned by the telecom carrier but rather in leased space within an office building. In some cases, the landlord of the building will not allow access to the roof for mounting the GPS antenna or will charge exorbitant rent for rooftop access.

In other cases, the problem is not with the landlord but with the distance from the shelf equipment to the roof. For example, the leased office space could be on the 5th floor of a 25 story building and the simple act of pulling the antenna cable 20 stories can drive the cost of the installation into the tens of thousands of dollars. In addition, engineering the cable run becomes complex because most GPS systems require amplifiers to boost the signal strength when cable lengths exceed 300 feet. These hidden costs only became clear as GPS systems are installed in large numbers. The problem then is not with sky blockage, but with installation costs driving the overall system cost out of reach.

High Interference Zones

High interference zones are areas where signals from other over-the-air communications technologies like AM/FM radio, TV, and microwave radio interfere with or jam the GPS signal. In some cases, moving the antenna away from the interfering signals to another location on the roof, or shielding the antenna from the interfering signals, will solve the problem. In other cases, the interference is just too great to be overcome. Similar to the urban canyon situation, the only definitive way of knowing if the system will perform is to install it and do real time troubleshooting as necessary.

Human Factors

Prior to the use of GPS technology, synchronization systems were installed entirely within the central office and fell under the domain of the inside plant personnel. However, the roof mounted GPS antenna falls outside the domain of inside plant, yet is not considered outside plant either. This hybrid nature of GPS systems is difficult for some telecom carriers to deal with. In addition, coordinating the inside and outside plant installation can become quite involved including such factors as the cable run and conduit placement, lightning protection engineering, and antenna placement planning. Safety issues are also a major concern when personnel are working on rooftops. The combination of these human factors issues has forced some carriers to cut back their deployment plans for GPS PRS systems. Unfortunately, the only alternative is do without or use cesium PRS systems, the area we will explore next.

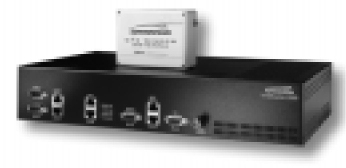
Current PRS Alternatives

Up till now, the only practical alternatives to GPS PRS systems have been to use cesium clocks or to do without. In fact, cesium was used almost exclusively prior to the invention of GPS technology. The high cost of cesium clocks meant that, in most networks, a single PRS was used with sync signals transported throughout the network over T1 lines in a hierarchical architecture. SONET rings changed the network architecture (see Symmetricom's application note Synchronizing the Rings and Chains of SONET for full details) requiring the use of more PRS systems in the network to ensure the integrity of the network. This is known as Local Primary Reference, or LPR, for short. GPS systems filled the LPR need created by SONET deployment with the notable exceptions previously discussed.

The following is a summary of the main limitations to using cesium in typical telecom networks and in particular for LPR applications:

- High cost (range from $30,000 to $70,000 per clock)
- Limited life (3-7 years)
- Provides only frequency synchronization (no Time of Day output)
- Calibration required (difficult and expensive)

The bottom line is that cesium continues to have valid application in telecom networks. Examples include emergency restoration, and as a test reference source. Cesium is practical to deploy in most networks but in only very limited numbers.



New Alternatives

GPS is a relatively young technology, but it does have widespread applicability across several industries. This means that technical advancements are being made exponentially, and manufacturing economies of scale are continuously reducing costs. Major advancements in 4 key subsystem technologies are being combined to allow for advancements in GPS PRS systems which will reduce hardware costs and dramatically cut the cost of antenna installation. This is accomplished by installing the antenna within the building in a window which has a partial view to the sky. The 4 key advancements which we explore in more detail below are:

1. Sophisticated holdover techniques
2. Improved local oscillator technology
3. Miniaturized GPS antenna technology
4. Advanced GPS receiver electronics and software

Technological Advancements

Sophisticated Holdover Techniques

Most current GPS systems let their local oscillators free run when the system can not lock on GPS signals. This means the output signal immediately begins to degrade according to the characteristics of the oscillator. Stratum 1 PRS performance is maintained by these systems from as little as 15 minutes to as much as 6 hours. The length of time the system can maintain PRS performance is called holdover time, and the system is commonly referred to as being in holdover. New holdover algorithms are now available which can predict the GPS input value based on past performance history when GPS signals are lost. These systems continue to steer the local oscillator based on the predicted GPS value, keeping the oscillator on frequency and meeting PRS performance for extended holdover times (up to 24 hours for higher quality local oscillators).

The next generation of clock engines now becoming available, include other commonly available sources of synchronization (for example, remote oscillators and T1 span lines) in an adaptive ensembling arrangement. Combined with prediction software, these clock engines extend PRS performance to 72 hours when GPS signals are lost. Extending holdover times means designers and network planners can anticipate frequent GPS outages and engineer systems which can be placed in hostile GPS environments, like the urban canyon, while still meeting PRS performance requirements.

Improved Local Oscillator Technology

In GPS PRS systems, local quartz or rubidium oscillators, which are typically the largest single cost component of the system, are kept on frequency by GPS while the system is tracking, or locked, to GPS signals. When GPS signals cannot be tracked, the system goes into holdover and must rely on the local oscillator to generate its outputs. Local oscillator technology in current GPS PRS systems continue to provide PRS quality outputs for short periods of time while in holdover. New advancements in quartz and rubidium oscillators have improved holdover performance duration, all while reducing costs. The improved local oscillator technology is combined with extended holdover software to push GPS systems to perform in increasingly hostile environments.

Miniaturization Of GPS Antennas

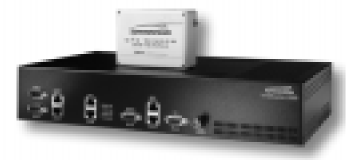
GPS antennas are undergoing their own performance improvement and cost reduction revolution. Advancements in miniaturization are also key. The new generation of high performance GPS antennas are about the size of a cellular phone antenna, making easy to install window mounted GPS antennas possible for the first time.

Advanced GPS Receiver Electronics And Software

The current generation of GPS PRS receivers must have a view to four or more satellites in order to lock, and are designed to expect to see four or more satellites for the vast majority of the time. New receiver technology and software is now available which can lock on a single satellite and are programmed to expect to see zero satellites up to 50% of the time without negative performance impact.

Introducing Timesource 2500

The TimeSource 2500 from Symmetricom is the first PRS offering which effectively combines the new oscillator, antenna, receiver and holdover technologies in a single product. By combining these technologies, the TimeSource 2500 works inside the office environment, with the antenna mounted in a window or through a small hole bored through a wall, as illustrated in figure #3 below. Through the window or wall antenna mounting solves the high cost and human factor issues of rooftop mounted antenna installations while single satellite tracking allows for use in urban canyons and high interference zones. For detailed product information, the TimeSource 2500 data sheet can be viewed on Symmetricom's web page at www.symmetricom.com.



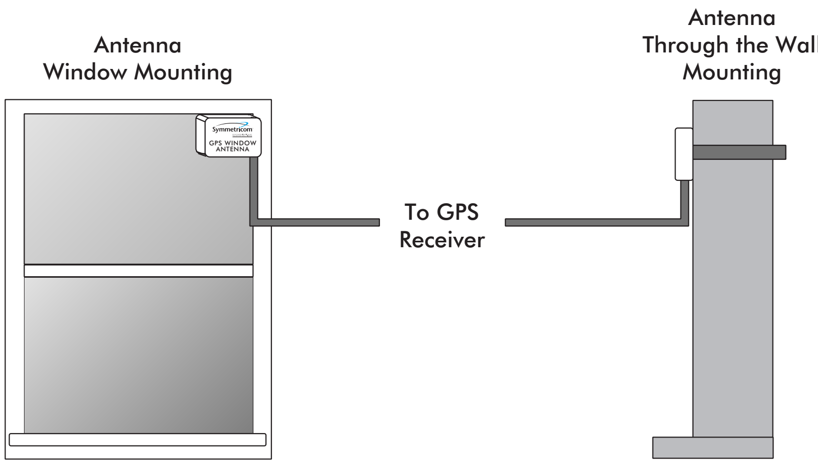


Figure 3. Minimizing the cost of antenna installations

Summary

Rapidly growing demand for higher and higher speed data delivered closer and closer to the end user is pushing precise synchronization from the network backbone into the network edge and onto the customer premise. Synchronization systems must evolve to meet these needs. GPS PRS products must be designed which can be easily and inexpensively integrated into all types of telecom environments. The TimeSource 2500 answers the challenges of the evolving network.

The TimeSource 2500 is the most recent development from Symmetricom, the worldwide leader in synchronization who produced the first Building Integrated Timing Supply (BITS) clock and innovated the use of rubidium oscillators for telecom applications. Significantly, the TimeSource 2500 is the first GPS system which meets PRS specifications without the use of a roof mounted antenna.

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Symmetricom
2300 Orchard Parkway
San Jose, CA 95131, USA
tel: 408-433-0910
fax: 408-428-7897
e-mail: sync@telecom.com
http://www.symmetricom.com

Symmetricom Europe
2 The Billings
Walnut Tree Close
Guildford, Surrey
GU1 4UL, England
tel: 44-1483-510300
fax: 44-1483-510319