Enhanced mobile infrastructure is often a requirement for major events ranging from the Olympics or World Cup to concerts and festivals. The nature of these events presents specific mobile network challenges such as massive crowds, the temporary nature of the event, and the short timeframe allowed for deployment.

This paper discusses the requirements event-driven mobile systems along with strategies and best practices for deploying systems that deliver high capacity for large crowds while offering long-term value for wireless service providers and event venue management.

**Event communications requirements**

It is relatively easy to provide cellular coverage in an enclosed space like a stadium or arena, but the real challenge at big events is to provide enough network capacity to huge crowds of people who are using their mobile devices to send photos, access the Internet, or transmit video simultaneously. The temporary demands on the network can be staggering. In the 2009 Final Four basketball tournament, for example, Verizon reported a 400 percent spike in network usage, while AT&T reported traffic 14 times normal cellular activity during the 2008 Super Bowl.

Putting up one large antenna won’t deliver enough performance in these situations. Rather, the coverage and capacity must be focused to each seating section. This means that the wireless solution designs may need to be heavily sectorized to deliver defined capacity to each group of seats and other service areas.

Another requirement is that the design should minimize soft hand-off (SHO) from signals bleeding from one sector into another. As a result, the solution must be designed to accurately target the signal so as not to create overlap between sectors, or create isolation.

Venue operators must also decide whether the coverage and capacity enhancement is intended to be permanent (as in a sports stadium) or temporary (such as for one of the venues at the 2008 Democratic National Convention in Denver). Another issue is the number of wireless service providers who will receive service on the system. These requirements will impact the design of the system as well.
Alternative deployment strategies

In smaller venues it is possible to get away with one or two sectors of RF being repeated from the macro network and antennas at opposite ends of the facility. This method is known as “spray and pray” in the industry because it floods the facility with a signal without attempting to meet the needs of any particular part of the facility. Quality of service will vary widely in different parts of the building under this scenario, and visitors located midway between the two antennas will experience SHO, failed call attempts, slow data, and dropped calls. In addition, this approach does not provide adequate capacity for all spectators during periods of high usage, such as major plays or ceremonies where many people are snapping and e-mailing photos.

A better strategy is to divide the facility into sectors, and then use a distributed antenna system (DAS) to provide focused coverage and capacity to each sector. Stadiums and arenas naturally lend themselves to this approach because they are already divided into seating sections – these can serve as a guide for sectorization (Figure 1).

In addition to sectorizing, it is possible to deploy the DAS itself in four specific configurations:

- **High power, shared amplifiers** – Using fewer, high-powered remote amplifiers and antennas, it is possible to cover the stadium. Shared amplifiers allow more than one service provider to share the cost and capacity of the amplifier portion of the deployment. This approach is best when the facility does not need to be heavily sectorized and the issue is more about coverage than capacity. The trade-off is that with shared amplifiers, each carrier will have to share the amplifiers’ capacity.

- **High power, discrete amplifiers** – Again using just a few antennas, this scenario uses dedicated amplifiers for each service provider. This scenario is needed when service providers want dedicated capacity and want to take on the responsibility of monitoring and maintaining their portion of the system.

- **Low power, shared amplifiers** – When the facility needs a lot of sectors to provide adequate capacity for guests, it is better to use low-power antennas. These antennas can be aimed to deliver coverage and capacity with considerable precision so as to minimize SHO and inter-cell interference. The shared amplifiers are adequate and save costs for operators if each operator does not require a very high level of overall capacity.

- **Low power, discrete amplifiers** – This scenario offers high precision in terms of coverage with dedicated capacity for each operator.

Along with cellular systems, some stadium owners are adding an 802.11 Wi-Fi network and recommending that visitors use the Wi-Fi network for data applications. This is another way to offload network demand and create an alternate source of capacity for data applications. But it is not an approach that will be appreciated by 4G users who just purchased spiffy new phones with high promised data rates.
Best practices for meeting event requirements

With so many requirements and options to consider, what is the best way to approach deployment of a wireless system for a major event? There are several steps to take:

- Understand the level of data throughput needed, and how the system will need to handle a given number of handsets/devices.
- Decide whether the deployment is to be permanent or temporary. Some venues need a high level of service permanently, while others will deploy coverage and capacity for a particular event and then scale down the in-building deployment when the event (i.e., the Olympics, Super Bowl, or a major convention) is over. On the other hand, some venues deploy a certain level of capacity and coverage initially and then expand it over time to include other parts of the venue (back-of-house areas, for example). Active systems that use thin cabling and active electronics are relatively easy to re-deploy; passive systems based on heavy coaxial cabling were never designed to be re-deployed.
- Choose an architecture that matches the flexibility and scalability needs of the project. For example, passive systems using heavy coaxial cabling are suitable for projects where coverage and capacity will be deployed permanently, while active systems that use a hub-and-spoke architecture are easier to scale up or down if the venue will require changes.
- Select a deployment scenario that addresses the capacity and maintenance needs of each operator on the system.

Business models

Once the project’s requirements are understood, the host venue or event manager must identify the best business model. The project will involve the facility, the wireless service providers, and perhaps a “neutral host” provider who builds the system and then leases it to operators. The facility may charge operators or host providers for access to its facilities, but there are deployment and maintenance issues to consider as well. There are advantages and disadvantages to each approach.

In the service provider-driven model, each service provider typically deploys its own DAS and pays for the deployment. The service provider can then use the system with little or no lease fees to the venue management. In some cases, two or more service providers may form a consortium to share deployment costs. This approach requires the service provider to maintain the system itself, so the venue is not involved.

- In the venue-driven model, the venue itself deploys the DAS and leases access to it to each desired service provider. The advantage to this is that it creates a fatter revenue stream for the venue, but it also means that the venue is responsible for the system’s upkeep and performance.
- In the neutral-host model, a third party deploys the DAS and then manages collection of access fees from the service providers while making lease payments to the venue for use of the facilities. Like the service provider-driven model, this minimizes the venue’s direct involvement in deployment and maintenance of the DAS, but it also reduces the revenue stream that the venue would realize. Typically, the project timeline increases as the number of involved parties increases. It is important to clearly define roles and responsibilities and have a crisp understanding of who has decision-making authority on priority matters.
- As more and more people actively use their mobile phones at live sports and entertainment events, facilities management and service providers must find ways to deliver better wireless coverage, data throughput, and capacity. In-building DAS solutions using active electronics are an excellent way to satisfy this requirement.