

WHITE PAPER



Smart Networks for Smart Phones

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Executive Summary

Explosive growth of smart phones and smart devices has exceeded expectations, with more growth to come. Classic macrocellular networks cannot absorb all the new traffic. The mobile operators are moving from providing area coverage to delivering fast mobile data service. Distributed antenna systems (DAS) and picocells will have to be deployed in areas where there will be concentrations of heavy users, such as university campuses, sports venues, and central business districts. NextG Networks® DAS, picocell, and remote radio head installations place antennas close to the users to provide the performance they expect.

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Explosive Market Growth

Smart phones and smart devices have experienced such a fast adoption rate that wireless carriers are scrambling to add capacity. Smart-device users are watching TV clips, sending photos, surfing the Internet, reading email, downloading books, using social networks, and talking, often simultaneously. Network locations hit the hardest are in dense urban areas, on university campuses, and at sports venues such as stadiums and arenas. Of the 50,000-100,000 fans watching a football game, several thousand are typically watching the live game, surfing the Internet for scores, Tweeting, etc. with their smart phones¹.

NextG, as a carrier's carrier, is assisting the wireless network operators' deployment of 4G services and infrastructure by upgrading existing DAS fiber networks to provide additional capacity and deploying new fiber networks to carry future wireless traffic on DAS networks, backhauling picocells, and serving remote radio heads. The addition of 4G networks is not a surprise, as all the carriers have been planning it for years, using either LTE or WiMAX technologies, but the pace of device adoption has been (happily) much faster than anticipated. Cisco shows that a smart phone creates 10 times the traffic of a classic voice-only mobile phone, and a laptop with 4G generates 1,300 times the traffic of a mobile voice phone, as seen in Figure 1. Cisco predicts global mobile traffic will more than double every year until at least 2014 (108% CAGR), and that the US experience will be just as explosive².

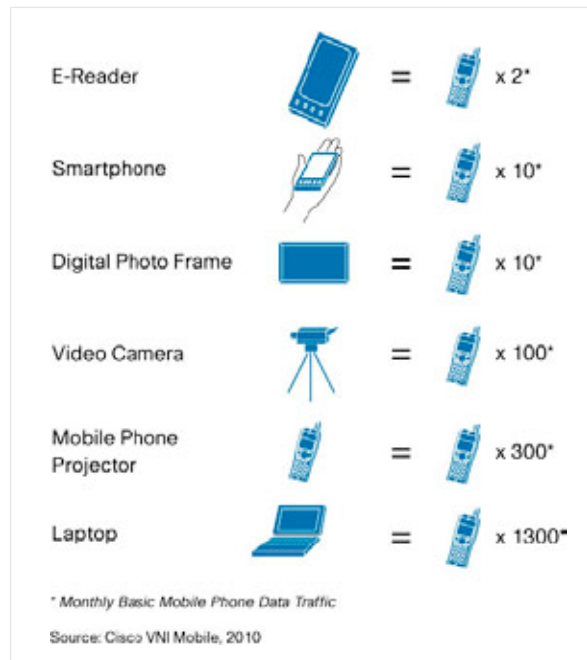


FIGURE 1 • Monthly mobile data traffic relative to a plain voice-only mobile handset³.

¹ "AT&T, Cowboys Ready for 100k Twitterers", NBCDFW.com, blog "Blue Star". Also "AT&T Plans to Improve Wireless Services", Tuscaloosa News, April 10, 2010

² Cisco, "Cisco Visual Networking Index: Forecast and Methodology, 2009-2014", June 2010. North America growth predicted to be 117% CAGR of combined mobile laptop and handset traffic

³ Cisco White Paper, "Hyperconnectivity and the Approaching Zettabyte Era", June 2010.

The mobile industry's CTIA *The Wireless Organization* predicts a 14:1 increase in the number of wireless portable devices sold in the USA by 2014, as shown in Figure 3 below, based on data from Strategy Analytics' market report. The large market increases coming from netbooks, notebooks and mobile internet devices. What is interesting here is not the devices

themselves but the fact that they will all demand increasing wireless bandwidth. Just as an example, smartphones now come with cameras with more megapixels than last year, so the photos taken by the phone's user, and transmitted wirelessly to friends, take much more bandwidth than the year before.

FIGURE 2 • Compound Annual Growth Rate (CAGR) of global mobile device data usage⁴.

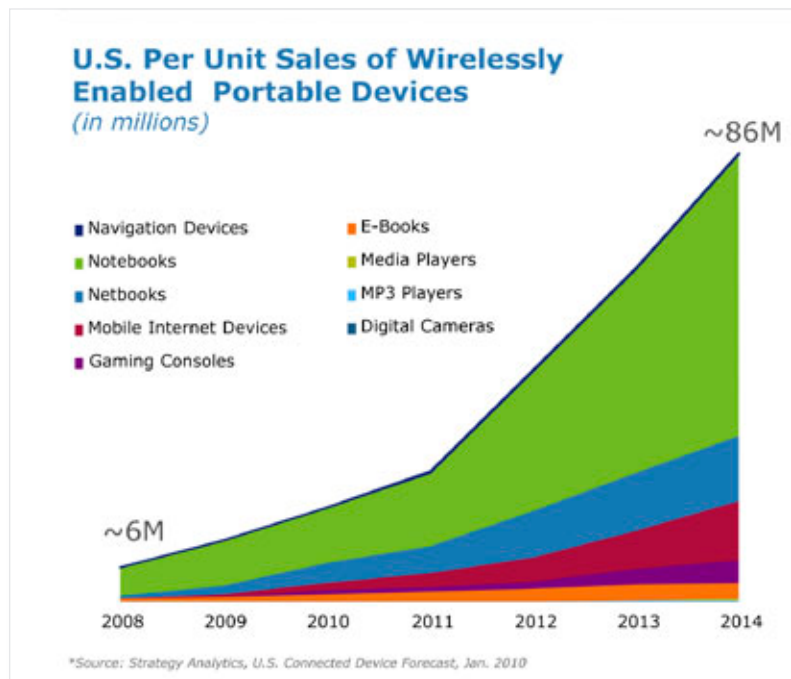
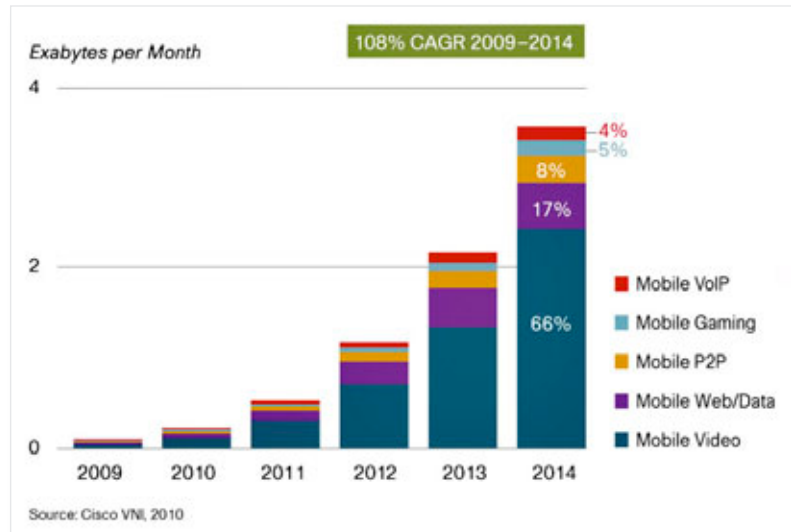


FIGURE 3 • US per Unit Sales of Wirelessly enabled Portable Devices⁵

⁴ Ibid.

⁵ "United States: Leading the Mobile Broadband Revolution", Ralph de la Vega Chairman, CTIA Board of Directors, March 2010, quoting Strategy Analytics, www.strategyanalytics.com

Shorter Distances Deliver Higher Speeds

Distance matters. A 4G mobile device operates faster when it is closer to the 4G cell site, whether it is DAS, macrocell or a 4G remote radio head. The Figure 4 below shows Nokia Siemens measurements of data throughput and they demonstrate that throughput will quickly drop by half and then, at greater distances from the 4G cell site, by a factor of 10 or more. So, for example, a 4 megabyte photo will take a couple seconds to send to a friend if the user is next to the cell site and might take several minutes to send further away from the site.

A weak signal at a long distance from the cell site may force the sender to stand still in one place while sending that photo, or risk a dropped call.

Throughput is shared by all the users in a sector, typically the beam of RF from the cell site antennas. A large macrocell might have tens of simultaneous users. Motorola illustrates in Figure 5 how one sector with 8 users at different distances from the cell site, experience connection speeds that range from 0.4 to 8.0 Mbps, a 20:1 ratio in performance seen by the user.

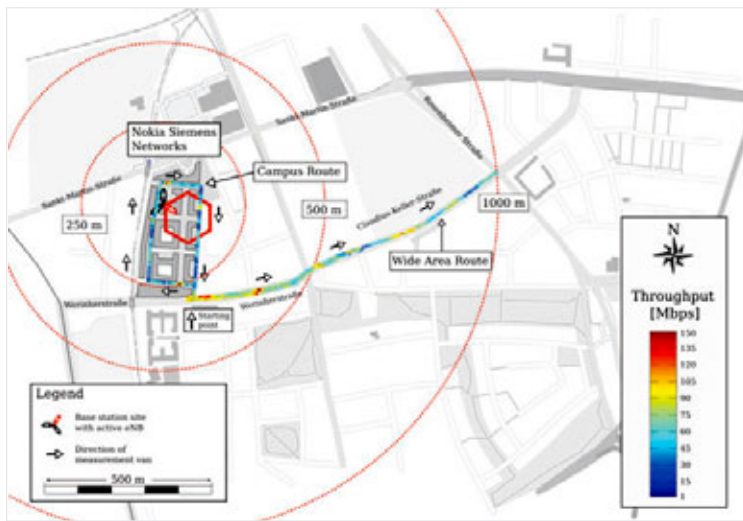
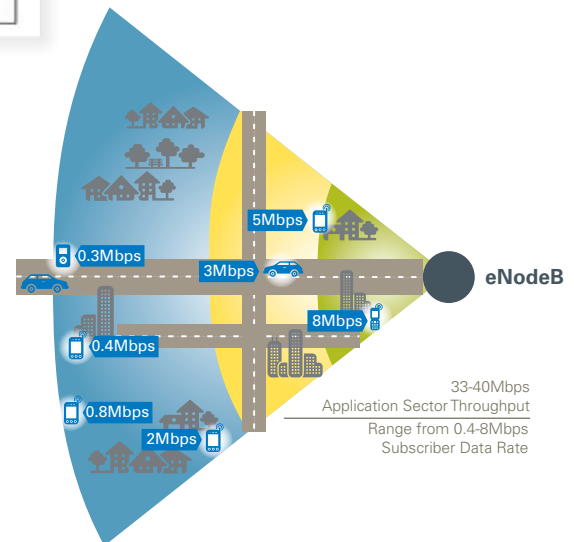


FIGURE 4 • Data rates along campus and wide area routes in Munich, Germany⁶.

FIGURE 5 • Snapshot example of instantaneous sector throughput (aggregate capacity of several subscribers)⁷.



⁶ Siemens, "LTE Performance for Initial Deployments", 2009

⁷ Motorola, "Realistic LTE Performance", 2009

NextG's DAS Solution

NextG Networks' DAS solution is very efficient as a 4G network because each site has a smaller footprint than a macro cell. Examples of NextG installations in residential and business districts are in Figure 6 below. The small DAS footprint means:

- The smart device is closer to the 4G antenna, which are approximately 30-40 feet above the sidewalk and street
- A smaller area served, i.e., fewer users share the signal, giving each user higher quality service
- The RF power transmitted is reduced, which prolongs the mobile device battery life
- The device can run at full speed, and so video clips are displayed smoothly, i.e., with no jerky pictures
- The speed at which a device can transmit or receive is 10 or 20 times greater on a nearby DAS connection than when the device is connected over a greater distance to a macro cell site
- The DAS has good spectral efficiency in low traffic areas
- Easy adjustment to traffic evolution by reconfiguring only at the central hub site
- The fiber-fed network has virtually unlimited bandwidth between the DAS remote, or remote heads, and the central hub
- Installation on public right-of-way is faster and far easier than on private buildings
- More aesthetically pleasing than large macro-cell towers

Notice that in the installations in Figure 6, the DAS antenna is approximately 30-40 feet above the sidewalk and street. The classic macrocell is placed on top of tall buildings, or a huge tower, and may be 100-200 feet above ground, placing it far away from the user walking on the sidewalk or in the store.

Traditional macro-cell sites are able to provide 4G service by adding 4G electronics, but they will be unable to cope with the high traffic demands where there is a concentration of smart-device users within a sector. By comparison, the 10X-to-20X speeds offered by DAS sites closer to the user make it the ideal technology to supplement traditional macro-cell sites. Refer back to Figure 5 and imagine all the users are close to the antenna and all want multi-megabit service.

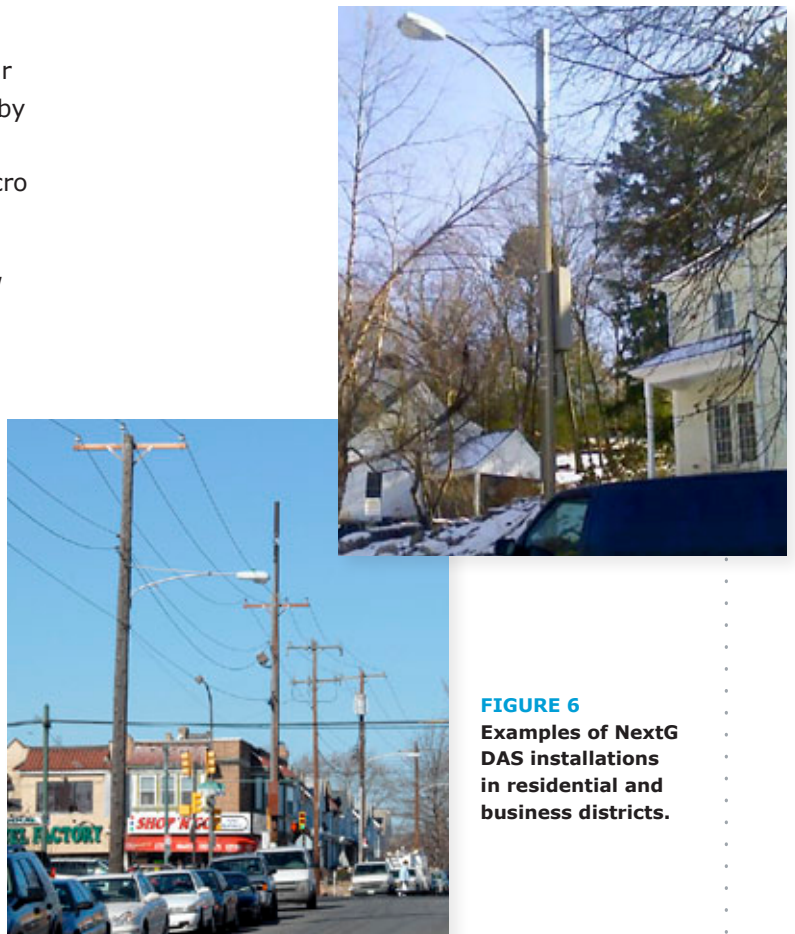


FIGURE 6
Examples of NextG
DAS installations
in residential and
business districts.

Central Business District

Smart devices are getting smarter, and NextG is helping carriers roll out smart networks to support them. An operator asked NextG to install DAS nodes in the dense urban, high-traffic urban areas and the operator installed macro-cells in the low-traffic suburban areas. The predicted traffic supported is shown in Figure 7, where black, red & yellow colors are high traffic and the blue is low traffic.

Another factor when close to a DAS site is the radiated RF power the mobile device has to generate to be connected. It is greatly reduced when close to the site, which prolongs battery life. It also means the user holding the device to their head is subjected to less RF energy, a factor that is a concern to some mobile users.

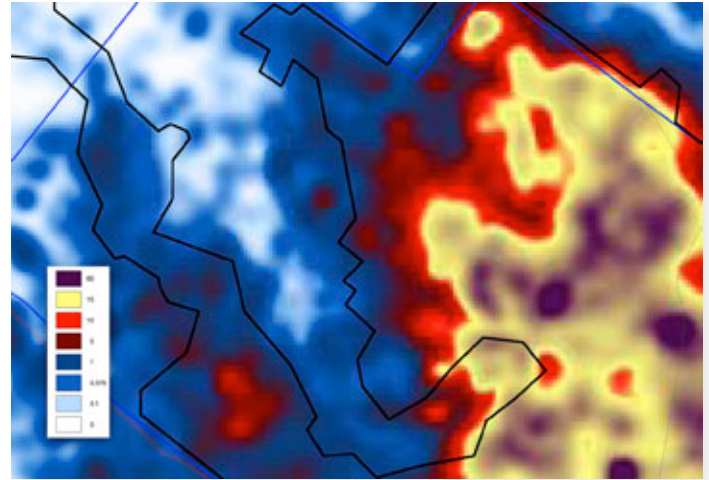


FIGURE 7 • Traffic prediction plot with a DAS network delivering high traffic (black, red & yellow) and complementing the macrocell network in the low traffic area (blue).

DAS Adjusts to Traffic

DAS networks have the advantage of flexibility, adjusting to changing traffic patterns as usage changes. In a classic macro-cell arrangement, an evolution of traffic that increases between macro sites, the operator has to find a new building or tower in the center of the area. This is sketched in the top of Figure 8 below. If, instead, the network is a cluster of DAS nodes, with four DAS nodes per sector broadcasting the same signal (called simulcasting), as in the bottom of Figure 8, it is easy to adjust the traffic. All that is needed to create a new sector in the middle, using three nodes per sector for four sectors, is some re-cabling at the base transmitter station. It is a simple, inexpensive maintenance task. With all the new smart devices creating a difficult traffic prediction situation, making DAS adjustments amounts to a considerable savings in the total cost of ownership over the life of the network.

Simulcasting is a very efficient use of limited spectrum. The DAS nodes in Figure 8 can be

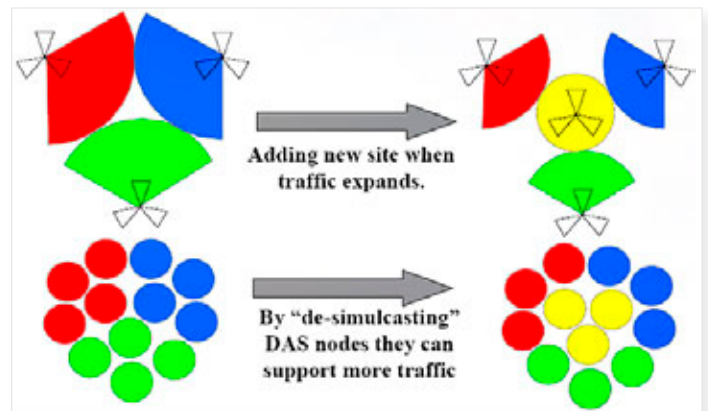


FIGURE 8 • DAS sites are easy to reduce simulcast for changing traffic patterns.

connected using a large number of variations to meet traffic needs. Simulcasting can be every other node instead of clusters, or the clusters can be different numbers of nodes. A cluster can be as small as one DAS site outside the coffee shop, giving every user inside the coffee shop megabits of service.

University Campus DAS Network and In-Building Systems

DAS systems can go inside buildings as well. Many universities are already adding in-building systems to supplement outdoor DAS. The problem is that the building walls significantly reduce signal strength. The advantage of an in-building system is that it restores signal strength, brings the network antenna closer to the users' devices and can serve large concentrations of users. NextG's in-building DAS networks support multiple operators, avoiding the one-antenna-per-operator problem that landlords abhor.

Universities are asking NextG to add indoor and outdoor DAS systems to support the smart devices in dorm rooms, lecture halls and sports venues. As an example of a stadium, NextG measured the existing mobile signal level around the outside perimeter. In Figure 9, the small blue dots are where measurements showed good signal levels and the red, yellow and purple dots show poor signal levels.

To support tens of thousands of fans inside the stadium, NextG designed a DAS system with many sites, one for each small section of seats. The predicted signal levels are shown looking down on one level of seating in Figure 10 below, where purple and red are excellent signal levels and the green is poor signal levels, i.e. only outside the stadium.



FIGURE 9 • Measuring signal strength outdoors to determine where to improve performance.

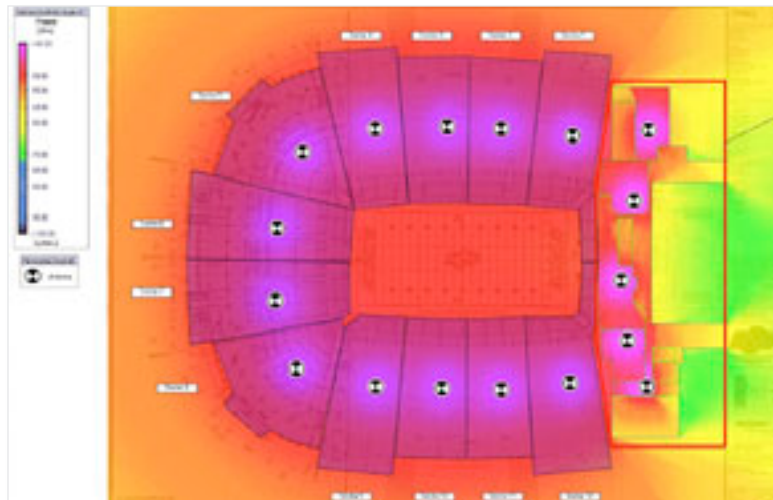


FIGURE 10 • 4G DAS network predicted coverage for the football stadium seating area and end zone building. The black and white dots represent DAS nodes and in the predicted coverage, red and purple end of spectrum is a strong signal, green is poorer). Heavy coverage requirements create the need for extra DAS units to provide capacity.

Upgrading a DAS Network to 4G

NextG has always deployed fiber-fed DAS networks that are technology and frequency-agnostic. NextG worked closely with carriers, equipment manufacturers and antenna manufacturers in anticipation of 4G network deployments in the AWS band (2100 MHz), the former TV band (700 MHz) and at 2.4 GHz. Carriers are deploying LTE or WiMAX with 4G services in these bands, depending on their local licensed frequency. The result has been a cost-efficient upgrade path.

The fiber feeding the DAS nodes has virtually unlimited bandwidth, so as traffic grows beyond the initial design, additional DAS nodes can be added and the fiber will support the extra bandwidth. The same fiber can be used to support new frequency bands, as they become available to the industry or as the operator obtains new licenses.

In many locations, NextG teams are able to perform the upgrade as a maintenance task. When this is done, the cost is approximately one-quarter the cost of a new overlay, which would require installing new fiber, securing construction permits, constructing utility poles, controlling vehicle traffic, and many other costs associated with new deployments. A maintenance task may be as simple as adding electronics at the central hub and doing some re-cabling there, or, at most, replacing remote electronics with new modules and/or antennas.

Even when a new DAS network is needed as an overlay where a macrocellular network was previously adequate, the DAS units are mounted in the public right-of-way, saving considerable time, cost and effort by avoiding lease agreements with local landlords for building-mounted sites and possibly reinforcing a roof to support the extra weight of additional equipment. Installations in the public right-of-way are designed to meet strict utility safety and construction standards, and every installation follows local permit processes. NextG is registered as a carrier in most states, either as a CLEC or similar entity, which gives NextG access to the public right-of-way.

4G DAS deployments in central business districts provide the strongest signals at street level, for pedestrians and vehicles, and strong signals in the first couple floors of the high-rise buildings, which are often retail stores with high pedestrian traffic usage.

4G Remotes

The industry is developing products that will take the digital processing that occurs today at the central hub and push it out to small remote radio head units. These remote heads are small boxes of electronics, fed from the central hub by fiber strands. To the consumer, these remote radio heads will look no different than DAS remotes when mounted in the public right of way. To the operator, these fiber-fed remote heads have all the advantages of DAS networks. NextG is working closely with manufacturers of remote radio heads and with operators to develop and test units that are easy to install and maintain in the public way, just like DAS.

Conclusion

The continuing increase in device speeds, explosive growth in high-speed mobile applications, and the runaway success of consumer mobile devices, will continue to require orders-of-magnitude improvement in network capacity.

The advantages of fiber to multiple small remotes for 4G are:

- The smart device is closer to the antenna
- Fewer users share the signal, giving each user better service
- The device can run at full speed, and so video clips are displayed smoothly, i.e., with no jerky pictures
- The speed at which a device can transmit or receive is 10 or 20 times greater
- The DAS has good spectral efficiency in low traffic areas
- The RF power transmitted is reduced
- Easy adjustment to traffic evolution by reconfiguring at the central hub site
- The fiber-fed network has virtually unlimited bandwidth between the remotes and the central hub
- Installation on public right-of-way is far easier than on private buildings

About NextG Networks

NextG Networks is a leader in outdoor DAS systems, using fiber-fed distributed antenna systems to operate carrier-class wireless networks. With its proprietary fiber-optic architecture and expertise in public way access, NextG designs, permits, builds, operates, and manages DAS systems. NextG's DAS systems are protocol-neutral, enabling them to support multiple wireless carriers, services, and technologies. NextG provides RF transport and backhaul services to wireless service providers over discrete, multi-frequency, scalable networks that improve wireless service coverage, capacity and performance. Main offices in Silicon Valley, California, NextG operates wholly-owned regional subsidiaries throughout the United States.

For information, visit NextG Networks online at www.nextgnetworks.net.



NextG Networks®

890 Tasman Drive
Milpitas, CA 95035-7439 USA
Tel 408.468.5400
Fax 408.434.6285
Email info@nextgnetworks.net

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