

PUERTO RICO'S SHOWCASE WIRELESS NETWORK TEACHES MANY LESSONS

Introduction: Imagine a government network covering approximately 3,000 square miles – connecting universities, public schools, fire stations, police stations, county offices, city halls, legislature, public housing, courts, public libraries...even the Governor's office. What if you also knew that this network was to be implemented using public, *unlicensed* wireless frequencies? "Absurd!" you may say... Unlicensed wireless frequencies are open for public use by anyone. No network of such scale would risk operating in such public frequencies. Nevertheless, this is exactly what the government of this Caribbean island located just 2 hours from the US mainland has done.

Who would plan such an ambitious network? Puerto Rico - now the proud home of this world-class network – called www.puertorico.pr. This network emerged from a vision and quickly developed into the world's largest public service wireless broadband network in operation today.

But what were the driving factors behind this program? What lessons can be learned from (a) how the government approached the program, and (b) how the program was executed to take advantage of public frequencies, but avoid their pitfalls? *Was it the goal to become the largest public frequency wireless network in the world?* Not at all... in fact the network's underlying vision was pragmatic and precise:

1. To extend government services to all citizens of Puerto Rico, regardless of whether they were in major cities or outlying locations.
2. To create an advanced infrastructure that can fuel further economic development.
3. To use that infrastructure to assist local businesses and attract foreign investment.
4. To use advanced technologies as a catalyst for partnerships between the public and private sector.

Statistics on the Network: The main island of Puerto Rico is roughly 100 miles long and 30 miles wide – approximately 3,000 sq. mi. The wireless network is a hierarchy of three layers:

1. OC-3 (155Mbps) backbone, stretching across the length of the main island
2. Series of DS-3 (45Mbps) links, connecting towns and cities to the backbone
3. Multiple *star* networks within each city and town, using Solectek's *SkyWay* family of products

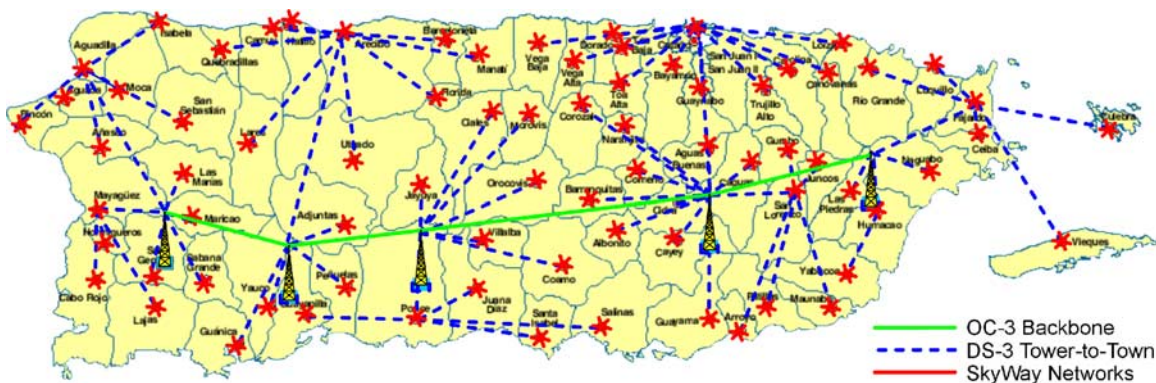


Figure 1: Puerto Rico's Wireless Network

This entire network is anchored by terminating the OC-3 backbone at a central server center, located in the Minillas government complex, in San Juan. While it is the OC-3 and DS-3 links that help form the network's *skeleton* (see Figure 1), it is Solectek's SkyWay-Net bridge/routers that complete the *last mile* of this end-to-end wireless network at 11 Mbps. Unlike the skeletal, high speed links, the SkyWay bridge/routers are *multipoint networks*, encompassing numerous units in each community.

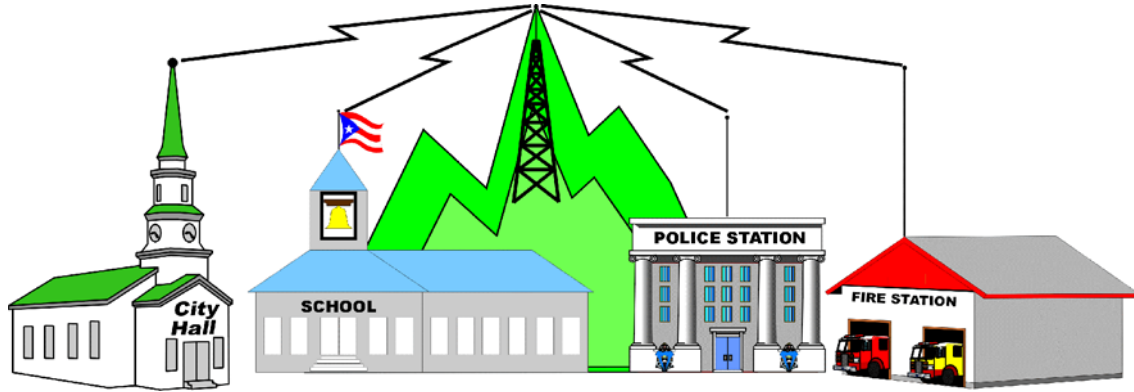


Figure 2: SkyWay Town-Level Networks

From the town level, over 1,000 SkyWay bridge/routers distribute *last mile* connections to schools, government offices, fire & police stations, etc., (see Figure 2). The SkyWay units reach 130 communities – and form the world’s largest public wireless network.

The Network’s Financial Drivers: At the conclusion of this phase, there was no doubt as to the overall cost savings that the government and people of Puerto Rico will enjoy. Solectek then conducted a comparative study of how other Caribbean nations would far in a similar nationwide project of this scale. Table 1 summarizes the financial comparison for the region - notwithstanding each government has its own scale, timetable, and priorities. What is unmistakable is how quickly a cost-savings network can be deployed using broadband wireless technologies. When examining network strategies, the costs to deploy traditional wireline connections compared to wireless network systems shows the following conclusions:

1. Wireline connections cannot reach most remote locations.
2. Wireline connections can take *years* to reach the required coverage.
3. Dial-up/leased lines costs require both *installation fees* and *monthly access fees*.

Table 1: Caribbean Region Leased Line versus Wireless Network Systems Costs

Average Caribbean Region Leased Line Costs		Estimated Wireless Project Costs	
Average installation cost per connection	\$3,000	Estimated total cost of wireless network, including installation	<i>Under \$25,000,000</i>
Number of connections in network	3,000		
<i>Total Installation Costs</i>	<i>\$9,000,000</i>		
Estimated monthly cost per connection	\$800	Monthly cost per connection	N/A
Number of connections	3,000	Number of connections	N/A
Estimated total monthly costs	\$2,400,000	Total monthly costs	N/A
<i>Estimated Total Yearly Costs</i>	<i>\$28,800,000</i>	<i>Total Yearly Costs</i>	<i>N/A</i>
<i>Leased Line Costs for 1st Year</i>	<i>\$37,800,000</i>	<i>Estimated wireless costs for 1st Year</i>	<i>Under \$25,000,000</i>
Leased line costs for 2 nd Year	\$28,800,000	Wireless costs for 2 nd Year	\$0
Leased line costs for 3 rd Year	\$28,800,000	Wireless costs for 3 rd Year	\$0
Leased line costs continue for years until service is terminated		Wireless costs are initial investment only <i>i.e. no monthly charges</i>	
Note: Maintenance costs were not calculated into either side of these figures.			
Note: Cost figures for leased lines vary from country to country; costs, fees and tariffs are not included.			

The Network's Technology Drivers: Having established that 1) wireless is installable almost anywhere, 2) speed of deployment, and 3) financial savings made high-speed wireless networks a smart choice, some questions remain:

- Why did the government of Puerto Rico select the unlicensed frequency band for its inner-city networks?
- Why did the government choose Solectek's 2.4 GHz/ 11 Mbps wireless bridge/routers?

At first glance, it may seem the decision to operate a government services network in a public frequency contradicts popular logic. But the Puerto Rican government asked itself two questions early in the planning stages of this program: (1) Why are public frequency bands long been cited as being fit only for small private networks - not for use by service providers? (2) Have any equipment suppliers addressed these age-old concerns? The government's planning committee was determined to answer these questions.

(1) *The Myths of Unlicensed Frequencies:* The use of public frequencies for outdoor wireless networks, especially the 2.4GHz band, is often misunderstood - largely due to several popular (mis)beliefs:

Myth 1: This frequency band is also being used by everything from microwave ovens, household cordless phones, and indoor wireless laptops and desktops.

Myth 2: This frequency band is already popular with operators of private outdoor networks and any service provider would be vulnerable to unpredictable levels of interference. Any semblance of quality of service (QoS) features would be impossible to deliver.

Myth 3: Many wireless networks operating in this band have reported dwindling throughput as their network became loaded with traffic.

These issues combine to present the unlicensed frequency band as a chaotic, unpredictable, ungovernable environment.

Now – the Facts of Unlicensed Frequencies:

Fact 1: The 2.4GHz band is regulated by government bodies throughout the world. While its use may be largely unlicensed, outdoor wireless equipment is closely tested by government laboratories to ensure it does not conflict with indoor wireless applications, or with each other. Severe penalties are levied on suppliers and installers who do not comply.

Fact 2: Much like crosstalk on wireline networks, interference has largely been due to poorly designed or installed networks. In nearly 12 years of delivering wireless solutions, Solectek has not encountered situations that could not be remedied by proper site installation.

Fact 3: Poor throughput over outdoor 2.4GHz networks has largely stemmed from suppliers trying to extend *indoor* wireless design concepts to *outdoor* wide area networks. Chief amongst these culprits is the practice of citing "compliance with IEEE 802.11(b) specifications" - when in fact such compliance means the supplier allows equipment to fight for the available bandwidth [a process called contention; typically using rules called CSMA¹]. While such rules can apply to laptops roaming inside a building, they cripple the network's efficiency when applied outdoors.

(2) *Solectek's Family of SkyWay Products:* Solectek's focus on wireless networking has always been the outdoor wide area network [WAN]. The SkyWay family of products is specifically designed to address the myths and concerns of service providers. SkyWay products comply with and exceed 802.11(b) transmission and interference specifications, but **do not** adopt CSMA to share capacity. Instead, capacity is *managed* by adapting to changing wireless traffic patterns.

¹ CSMA= Carrier Sense Multiple Access. A set of rules used to share a common pool of capacity by seizing it when it is perceived to be unused. See Solectek's "Design Considerations For 2.4 GHz Wire information on this topic.

Where interference levels are high, the SkyWay products can be tuned to any one of eleven secured channels, where most other equipment offers only six.

SkyWay receiver sensitivity is such that wireless links reaching 30 miles [48 km] maintain twice as high a throughput as any other equipment in the 2.4 GHz band.

Even the equipment itself is protected in a sealed, waterproof, airtight enclosure. Solectek delivered the first NEMA-class bridge/router on the market – and that means *reliable* – enough to withstand any harsh weather. Given the islands' famous "El Yunque" Tropical hurricanes and highly-corrosive salt spray from the ocean, the entire bridge/router and wireless radio are secure inside a single unit; not much larger than a laptop computer.

All these features combine to give the government of Puerto Rico control over its network, and rugged performance to guarantee its services.

Now The Benefits of Good Planning Can Be Enjoyed: Once installed and operational, the wireless network made a dramatic difference in productivity levels throughout Puerto Rico. No place is this more evident than in the government offices. Transferring information electronically not only saved time; it also saved money. Productivity continues to increase, e.g., the cost of notifying all of the courthouse, city halls, and government offices via regular mail was costly and time consuming. Initial estimates for using e-mail verses regular mail, courier service, etc., saved \$19 for every letter sent via e-mail. What took days – could be done in seconds. What cost hundreds of dollars to send -now only a few pennies. Less time and less money... more opportunity and productivity!

A Government Network & More: Having set the foundation for an advanced public service network, the government pressed on with its vision to do more. Its rallying cry was to use *www.puertorico.pr network* as a catalyst to "bridge the digital divide." The network is helping to bring the island together. For example, three communities: Vieques, Culebra, and Castaner were virtually isolated from the rest of the island. Because of their isolation, they did not have local government offices, libraries, and services normally afforded to communities. Thanks to world's largest wireless public services network – these communities now have access to all of these.

Betting on Puerto Rico's Future Leaders: Nowhere is the government's vision more far reaching than into the schools across Puerto Rico. Teachers and students alike are now being connected to the Internet and enjoy fast network access right in their classroom. Having rapid access to the Internet, e-mail and centralized servers in the classroom means they have a world of educational and research tools – right at their fingertips. Having hands-on experience with state-of-the-art technology now empowers the children – the leaders of the future generation. Solectek Corporation has participated in the planning, design and implementation of wireless wide area public service networks for over twelve years - at all levels of local, regional, state and federal governments. This has afforded Solectek the satisfaction of seeing the most advanced technologies harnessed for public good. But it has also allowed Solectek to develop product features that best serve such networks. Listening to customers' needs and adapting wireless networking technologies to meet them - is Solectek's business focus.

Solectek Corporation, headquartered in San Diego, California, designs, manufactures and markets a full line of wireless interconnectivity products. Through technical innovation and steady revenue growth, Solectek has become a recognized leader in the wireless LAN/WAN connectivity market and the industry market leader in wireless bridges. Founded in 1989, Solectek has over 4,000 installations worldwide. The Solectek product line of wireless bridges and routers is the most flexible, reliable and secure in the industry. For more information on Solectek wireless products & services, contact Solectek's Marketing Communications at (858) 450-1220 or visit us on the web at www.solectek.com.

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