

## GO Net Systems xRF™ Beam Forming Engine

Optimizing WLANs for carrier-grade deployment

Rural - Suburban - Metropolitan Scale

Superior Wi-Fi Performance, Coverage, and Economics



### xRF™ Technology

- First and only multi radio Beam Forming system for 802.11 standard
- Boosts performance & maintains QoS by several factors.
- Reduces susceptibility to noise & hidden nodes.
- Provides true multi-channel operation, with patented multi channel RF filter.
- WiFi certified.

### xRF™ Economy

- Achieves the same level of service with half to quarter devices installed, and sites acquired.
- Cuts your deployment & operating costs by 40%-80%.
- Requires much lesser sites for higher quality of service.

### Overview

While formerly limited to desktop and laptop PC applications, the IEEE 802.11 WLAN standard is now expanding its end-user appeal to include many new applications, including municipal deployments, wireless Digital Subscriber Lines (DSL), Video surveillance and Triple Play services. The use of these applications with WLAN-enabled devices may well revolutionize traditional circuit-switched landline and mobile telecommunications in much the same way that the advent of WLAN revolutionized the wired Ethernet.

However, traditional WLAN infrastructure equipment (originally developed for indoor use) must evolve to meet the challenges that these new applications presents. Maintaining the Quality of Service (QoS) requirements while operating in the 2.4GHz unlicensed band is a huge challenge. As mentioned in numerous recent publications, the 2.4 GHz band now tends to be loaded with interference sources.

GO Net Systems' revolutionary xRF™ technology is currently the world's first access technology, specifically designed to solve the interference, range, and capacity issues that plague current outdoor WLAN deployments in the unlicensed 2.4GHz bandwidth. The xRF™ technology solution noticeably boosts WLAN system performance by combining a unique smart antenna array with powerful Digital Signal Processing (DSP).

### Standard AP Implementation

It is best to review standard WLAN multi-antenna implementation before examining how the xRF™ antenna array functions in GO Net s' products.

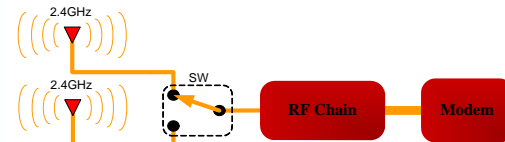


Figure 2 - Standard 802.11 AP Implementation

A WLAN transceiver normally consists of an antenna, an RF chain and a modem. The RF Chain includes reception/transmission (RX/TX) amplifiers and filters. As seen in Figure 2, a standard 802.11 access point (AP) consists of one RF Chain connected to one of two Antennas, an arrangement referred to as antenna selection or antenna diversity. Here, the AP simply uses a switch to select the better of the two antennae when receiving or transmitting packets.

Under this arrangement, only one antenna can be used at a time. Moreover, outdoor tests indicate that when compared with the use of a single antenna, this arrangement results in a relatively low gain of 2 decibels (dB).

### The xRF™ Antenna Array

Until recently, the technology involving the use of smart antenna arrays with DSP processing was almost exclusively employed in military applications, such as anti-jamming radio transceivers and radar/sonar systems. However, its civilian usage included both ultrasound imaging systems and cellular communication infrastructures. With advanced electronic techniques, the integration of antenna arrays in wireless systems is now affordable.

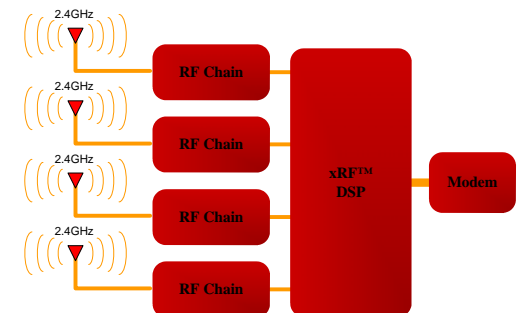


Figure 1 - xRF™ AP Implementation

In contrast to a standard AP, GO Nets' technology uses four antennae with four RF chains, which are combined in the xRF™ DSP. The energy of all four of the antennae is used to receive and transmit WLAN signals.

As it is fully compatible with the IEEE 802.11b/g standard, GO Nets' technology interfaces with any 802.11b or 802.11b/g client – without the need for client modification. Presently, GO Nets' products are WiFi-certified for 802.11b/g and will include 802.11n in the future.

When it receives a WLAN packet, GO Nets' patented xRF™ DSP implementation detects the packet direction of arrival (DOA) within the first 2μs, and locks the antenna array on the signal. The signal SNR is improved by 6dB with four receiving antennae, which gives the xRF™-enabled device a sensitivity level of up to -102dBm.

As illustrated in Figure 3, the DOA information collected helps to transmit downstream traffic. The xRF™ DSP can transmit packets either directionally (to a specific client) or omnidirectionally. Omni-transmissions are normally used in broadcasts or protection packets, such as CTS-to-self.

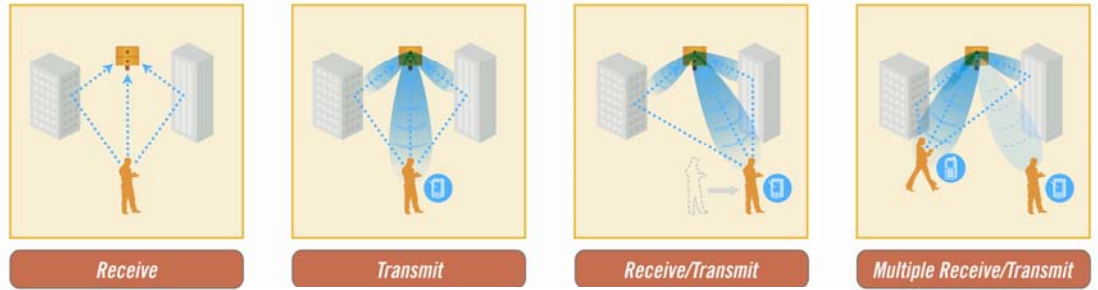


Figure 3 - xRF™ Beam Forming Illustration

## GO Net Systems' xRF™ advantages

- The antenna array transmits in the higher EIRP (up to 42dBm) allowed by the FCC for directional antenna systems.
- The antenna array noticeably decreases interference at the Go Net Systems base station.
- The signal-to-noise [SNR] ratio (in both Uplink & Downlink) is increased for a high array gain and a cleaner signal with fewer reflections.
- The system's susceptibility to hidden nodes is greatly reduced.
- The antenna array produces much lesser air pollution due to its directivity enabling city wide deployment of APs in the dense 2.4Ghz band.

The xRF™ innovative smart antenna design includes MAC enhancements. For example, in the past, the use of conational directional antennae increased the probability of "hidden nodes," which resulted in an overall reduction in network performance. GO has solved this problem by introducing a cross-layer optimized MAC that utilizes the xRF™ hardware's directional/omni transmissions with WLAN protection packets. This represents the industry's first actual cross-layer optimization in the physical layer, the MAC layer, and higher layers.

### Interference Mitigation

Currently, the large number of devices that occupy the 2.4GHz band greatly limits the range and capacity of outdoor WLANs. Even if microwaves, Bluetooth devices, and 2.4GHz cordless phones are not considered, the sheer number of private home access points (APs) and clients is enough to completely block a given 2.4GHz channel.

To compensate for this interference, standard APs simply lower their receiver sensitivity (normally displayed as a "noise floor," below which an AP cannot receive signals). While this achieves the desired result of ignoring distant interference, it also causes the AP to ignore its own far clients, which results in lower range and capacity. Basically, any AP, whose datasheet describes it as having "-100dB receive sensitivity" cannot perform at this sensitivity level in a dense urban environment. In fact, in this type of environment, standard APs often lower their receiver sensitivity to approximately -82dBm or less

Bluetooth devices, 2.4GHz cordless phones, and other non-WLAN signals to make a large percentage air time available.

In addition, its directional antenna pattern automatically ignores a large percentage of the interference. In contrast to a standard omni-AP, which receives a packet with a beam of 360 degrees, GO's WLP product receives one with a beam of 24 degrees, so it ignores 90% of the area (and interference) during reception.

### Differentiating xRF™ from 802.11n

Devices with the soon-to-be-standard IEEE 802.11n specification will use multiple antenna implementation (MIMO), featuring the schematic block design similar to the one shown in Figure 1. Since the main objective of the 802.11n standard is to achieve high indoor bandwidth, it uses many antennae to multiply capacity (for very high rates of OFDM modulations, at short distances and high signal levels). Over 95% of the WiFi chipsets are sold for indoor use, and the 802.11n standard simply fails to address outdoor use.

A system's range for outdoor deployment in the US is determined by its ability to receive the lowest 802.11 modulation, which is CCK 1Mbps. Since 802.11n only handles OFDM modulations, an 802.11n device receives a 1Mbps packet with a single antenna, just as the older 802.11b devices did. This is true for all CCK/DSS modulations used for 1,2,5.5 and 11Mbps rates. Even when a 802.11n device receives a 6Mbps packet with OFDM modulation, its performance will still be below that of the xRF™, since it fails to use multiple antennae to detect low signal levels of incoming packets, and was not designed to increase overall range.

Although 802.11n devices, operating at close range, have higher capacity (since the standard allows for higher bit rates), their single transmission antenna continues to limit them to 802.11b/g device performance levels.

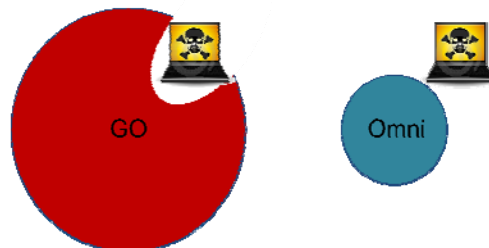


Figure 4 - xRF™ range reduction per direction compared to Omni in interference scenario

Different than conventional APs, GO xRF™ selectively fits the optimal sensitivity per direction therefore instead of lowering the whole 120 or 360deg sensitivity to the minimum it only cancels out portions of that space that are interfered. GO Nets' xRF™ technology can combat interference with its directional correlators and omni-directional antenna pattern. Its directional correlators distinguish WLAN signals from

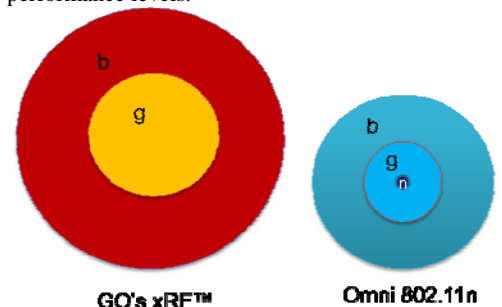


Figure 5 - xRF™ vs. 802.11n coverage

### Multi channel xRF™

While it is widely known that the 2.4GHz band can support up to three non-overlapping channels, a lesser known fact is that when two WLAN devices operate in close proximity, their non-overlapping channels severely interfere with one another. These cross-channel interferences are due to the following factors:

- A device transmitting in channel 1 in an EIRP of approximately 40dBm also transmits at approximately -30dBm in channel 6 and at approximately -40dBm in Channel 11. This residual energy is part of the CCK/OFDM spectral mask illustrated in Figure 4. The energy transmitted by a channel to non-overlapping channels is quite significant, since those channels receive signals at levels of approximately -100dBm.
- A WLAN modem receiving chain normally consists of at least one Low Noise Amplifier (LNA) that operates within the entire 2.4GHz band, before bending pass filtering to the operating channel. The received signal distortion results from the WLAN's attempt to amplify: (a) the strong interference in a non-overlapping channel and (b) a weak requested signal.

Formerly, large, expansive cavity filters limited every AP to a specific channel and frequency so that multiple APs could operate on the same mast. Changing the frequency entailed purchasing a new filter and physically installing it on the mast.

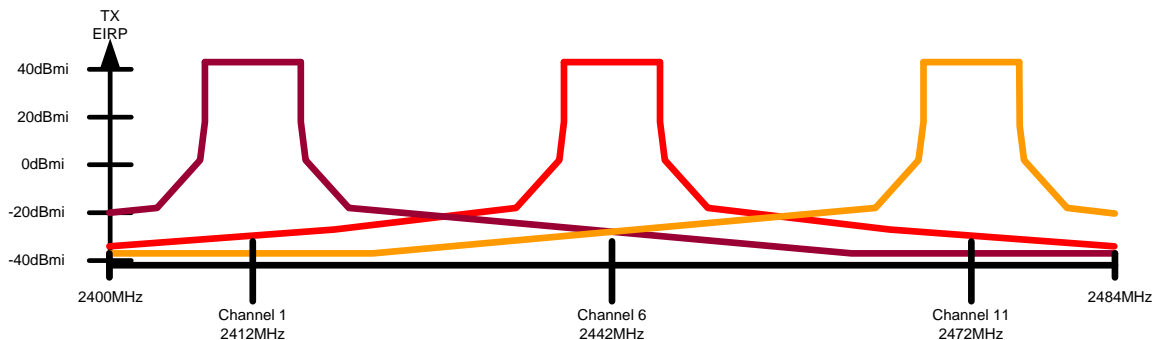


Figure 4 - North American Non-overlapping Channels

Currently, Go Networks' WLS products constitute the only APs on the market in which a multiple, independent xRF™ 2.4 GHz radio can operate in a single box with integrated antennae to increase capacity in a multi-channel operation. GO has a registered patent on its unique implementation of the tunable high quality RF filter.

### Performance Benefits

While Link Budget calculations for RF systems may be useful in calculating a system's range (and throughput for a given range) in isolated areas, where an AP is the only system operating in the 2.4GHz band for miles around, those calculations do not reflect the reality of large city environments for the following reasons:

- Lamp posts, trees, and other obstructions all affect loss, making the accurate estimation of street-level coverage a huge challenge, even with the most sophisticated RF planning tools.
- The fact that the 2.4GHz band is unlicensed makes it hard to predict interference levels in a given area, especially since receiver sensitivity is dynamic. (Interference desensitizes WLAN APs.)
- Standard WiFi modems were designed for indoor use, and cannot adequately decode packets with large delay spreads. Although the xRF™ can somewhat overcome this obstacle, overall performance largely remains client-dependent.
- Since only three non-overlapping channels can work in parallel in an area covered by the 2.4GHz band, an AP must share its air time with neighboring networks, resulting in decreased system capacity. For all of the above reasons, an actual comparison test is superior to any Link Budget calculation in a large city environment.

### Executive Summary

The xRF™ technology by Go Net Systems is an innovative implementation of beam forming smart antenna solution for outdoor WiFi systems. In GO's MBW family of products a beam is created every packet toward the user being served, in contrary to omni systems which transmits and receives from all directions evenly. As such the main benefits of the beamforming system are:

- 4) **Higher antenna and array gain**, xRF™ systems have antenna gain of 14-17dBi compared to less than 8dBi for standard omni radios. This fact together with the additional diversity gain provides **x2 range and capacity advantage**. The x2 range translates to **one fourth of the systems and sites required** to cover the same area (Area =  $\pi * R^2$ ).
- 5) **Transmit power** - Certifications allow beamforming system to transmit higher power, for example in FCC environment xRF™ system is allowed to transmit more than 43dBm compared to 36dBm to standard radios, these extra 7dB is more than 4 times the power, and translates to significant extra range and capacity.

- 1) **Interference mitigation** - while in Omni systems interferer is received with same gain as the user's signal itself. In Beamforming interferer from the side lobes is received in average 20dB (1%) the power of the user's signal, and as such increasing significantly the system's interference immunity.
- 2) **Inter-cell interference** - due to the directivity of the transmissions, each AP is polluting the air much less than regular APs transmitting to all directions. In the 2.4GHz band only 3 non-overlapping channels exist, and as such dense deployments of standard radios significantly reduces the total system capacity due to interference between adjacent cells.
- 3) **Resistance to fading** - One of the major issues limiting the performance of outdoor WiFi is the fading phenomena in urban areas where signals reflected from buildings and objects are combined destructively and degrades significantly the signal quality. BeamForming systems are resistant to fading and provide advantage of 5-8dB extra gain in such environments.



## About GO Net Systems

GO Net Systems provides cost-effective carrier-class Mobile Broadband Wireless (MBW) solutions for rural, suburban and metropolitan scale deployments based on 802.11 (Wi-Fi) standards. GO Net Systems' MBW solutions comprise products and services aimed at delivering superior wireless performance, coverage, and economics for service providers, mobile operators and municipalities worldwide. With GO Net Systems' innovative xRF™ adaptive beamforming smart antenna technology coupled with highly-scalable broadband architectures, wireless networking infrastructure requirements can be reduced delivering immediate upfront CAPEX and recurring OPEX savings. And with GO Net Systems' comprehensive design and deployment services, customers can deploy wireless IP networks of any size with ease and confidence.

### Wireless

- Wireless Network Standards: IEEE 802.11a/b/g
- Radio Interfaces:
  - Dual Simultaneous Access: 802.11b/g interface
  - Mesh: 802.11a interface
- Frequency bands: 2.412-2.472, 5.470-5.725, 5.725-5.825 GHz
- xRF™ smart antenna technology
- Antennas:
  - Internal Sector Directional 2.4GHz antennas
    - ETSI : 120° Horizontal 40° Vertical 14 dBi
    - FCC : 120° Horizontal 27° Vertical 17 dBi
  - 5GHz antenna: RP-TNC connector for multiple antenna options
- Modulation:
  - 802.11b – DSSS (DBPSK, DQPSK, CCK):
  - 802.11a/g – OFDM (BPSK, QPSK, 16-QAM, 64-QAM)
- Tx Power (typical EIRP)
  - ETSI: 20 dBm @ 2.4GHz, 30dBm @ 5GHz
  - FCC: 40 dBm @ 2.4GHz, 30dBm @ 5GHz
  - MII: 27 dBm @ 2.4GHz, 30dBm @ 5GHz
- Rx Sensitivity (FCC):
  - 802.11b: -102 dBm @ 1 Mbps, -99 dBm @ 2 Mbps, -95 dBm @ 5.5 Mbps, -89 dBm @ 11 Mbps
  - 802.11g: -96 dBm @ 6 Mbps, -94 dBm @ 9 Mbps, -92 dBm @ 12 Mbps, -90 dBm @ 18 Mbps, -88 dBm @ 24 Mbps, -86 dBm @ 36 Mbps, -82 dBm @ 48 Mbps, -80 dBm @ 54 Mbps
  - 802.11a: -92 dBm @ 6 Mbps, -91 dBm @ 9 Mbps, -91 dBm @ 12 Mbps, -89 dBm @ 18 Mbps, -87 dBm @ 24 Mbps, -84 dBm @ 36 Mbps, -80 dBm @ 48 Mbps, -77 dBm @ 54 Mbps

### Networking

- 802.11s draft compatible meshing
- Multiple ESSIDs' & BSSIDs'
- QoS, traffic classification
- WME
- 802.11q VLAN
- Layer 2, 3 support
- DHCP Client

### Management

- GO Net Systems private, standard MIBs
- Local CLI via serial port
- Remote configuration upload/download
- SNMP v2 (NMS)
- Telnet/SSH CLI (configuration, statistics and alarms)
- (remote initial IP configuration) DHCP client
- Remote software upgrade
- FTP, TFTP, Web

### Authentication & Security

- WPA/WPA2 (WPA-PSK, WPA-EAP)
- WEP 40/128 bit encryption
- MAC filtering
- Standard RADIUS server interface
- AES Mesh encryption

### Interfaces

- IP67 Weatherproof RJ-45 100Base-T Ethernet with auto cross over
- IP67 Weatherproof RJ-45 Serial port (configurations)

### Hardware

- Dimensions: 40 x 60 x 7 cm, 15.7 x 23.6 x 2.7 in (W x H x D)
- Weight: 7.6 kg, 16.75 lbs
- Power input: -48VDC
- Operating Temperature: -40° to 55°C, -40° to 131°F
- Storage Temperature: -40° to 60°C, -40° to 140°F
- Operating relative humidity (non-condensing): 15% - 100%
- Non-operating relative humidity (non-condensing): 5% - 95%
- Supplied Accessories:
  - Base Station power supply (AC to DC, -48 VDC, 48W)
  - Pole mounting kit

### Standards Compliance

- Xin Bu Wu [2002] #353
- EMC Standards
  - US: FCC Part 15.107 and 15.109
  - Europe: EN 301.489-1 and -17
- EMI and Susceptibility (Class B)
  - US: FCC Part 15.107 and 15.109
  - Europe: EN 301.489-1 and -17
- Safety
  - US, Canada: UL 1950
  - US, Canada: UL 60950-1
  - Europe: EN 60950-1
- Environmental
  - Wind survivability: >165 mph (Up to 100 mph sustaining, up to 165 mph gusts)
  - Europe: EN 300.019-2-4 class 4.1 and EN 300.019-2-2 class 2.3



### Ordering Information

Part Number	Item
MBW-WLS-2100M/E/F	WLAN Micro Base Station
MBW-WLS-1100M/E/F	WLAN Pico Base Station
MBW-WLS-510M/E/F	WLAN Femto Base Station
M	MII China certification
F	FCC certification
E	ETSI certification

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