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Multi-Beam Antennas: Increased Capacity, Enhanced Spectral Efficiency

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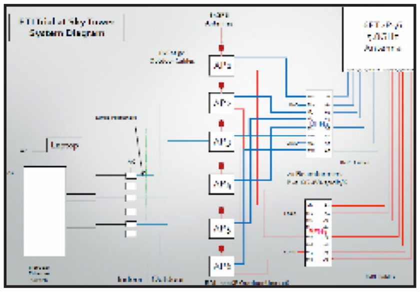


22: Feature Article

Multi-Beam Antennas: Increased Wireless Capacity with Enhanced Spectral Efficiency

By John Howard and Steve Jalil

Multi-beam antennas provide increased wireless capacity with enhanced spectral efficiency. Typically, wireless providers use three sectors in a 360° coverage area. With multibeam antenna systems, spectrum and capacity are multiplied. In this paper, a 5GHz, 6-dual polarized beam system is presented. The system covers 90 degrees in the azimuth and was deployed at the Sky Tower in Auckland, New Zealand. Live data was gathered at street level and presented.

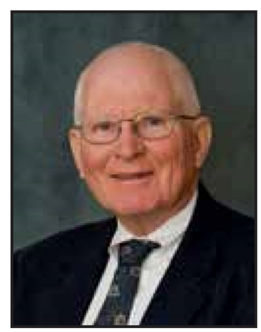
ETI has designed as many as 32 dual polarized beams within 120° coverage, providing 96 sectors in 360°. The benefits of such a system are higher data throughput, higher customer capacity, increased spectral efficiency, and reduced number of cell sites versus traditional antennas. With the use of multiplexers, several frequency channels can be merged and transmitted into a single beam producing a multi-channel sector. For every channel that is transmitted into the beam, an increase in capacity and throughput factor is obtained.

16: Featured Products

Featuring Ducommun, Analog Devices, LadyBug Technologies, Micro Lambda Wireless, National Instruments, and more.

30: Product Highlights

Showcasing SGMC Microwave, Passive Plus, Marki Microwave, Herotek, Coilcraft, Rohde & Schwarz, and more.



6: Editorial

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Introduction

ET Industries has been in production of 5G Antenna Systems since 2006. The antenna systems of the 2006 production covering the CBRS band are shown in figures 1 and 2. The system has a total of 48 beams in 360 degrees. Frequency was repeated three times per 90

Fig. 1 • 2006, 3.5GHz, 5G phased array antenna.

Fig. 2 • 2006, 3.5GHz, 5G beamforming network.

degrees thus providing 12 times higher spectral capacity from a single cell.

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In this paper, a 6-dual polarized beam system is presented. The system covers 90 degrees in the azimuth and was deployed at the Sky Tower in Auckland, New Zealand.

Deployment

The architecture of the ETI 5G Antenna System deployed at the Sky Tower in Auckland, NZ is detailed in figure 3. The system deployment consisted of six MIMO access points interfaced with two beamforming networks, one per polarization. The 5 GHz phased array had a 128-element geometry per polarization. The 5G antenna system provided a radiation pattern of six dual polarized beams in a 90-degree azimuth footprint.

Results

Measurements were taken at street level in the city of Auckland up to 10 km from the transmission point. Speeds of 200Mbps per 20MHz channel per beam were witnessed. Modulations of 256QAM were produced in the field. This resulted in 1.2Gbps aggregate from one antenna across the 90-degree azimuth coverage. The Smart MIMO Switching capabilities of the system were also witnessed. The links automatically changed from MIMO-A (Diversity) to MIMO-B (Multiple Streams) based on link conditions to increase efficiency, link stability, as well as increased data capacity.

During the deployment, ETI repeated the same frequency on beams 3 and 8, essentially doubling this channel's speed. Simultaneous readings at the same channel were taken demonstrating no interference and a substantial increase of capacity by repeating the channel. See figure 6 for frequency reuse of beams 3 and 8 carrying the same channel.

The actual measurements are too numerous to present herein, but representative measurements are shown in Tables 1 and 2. Table 1 consists of the readings in beam mode 3 and table 2 of beam mode 1. RF 1 and RF 2 are the two paths for the dual polarization in downlink and uplink. During the trial different measurements at

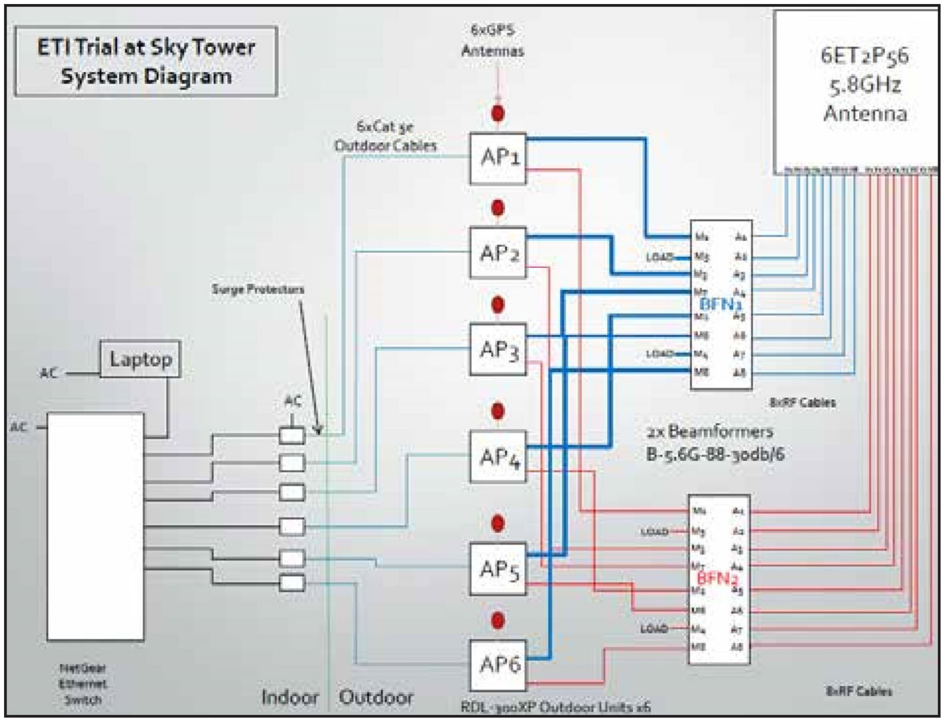

Fig. 3 • 5GHz system diagram deployed at Sky Tower.

different distances were gathered as follows: received signal strength (RSSI), Signal-to-noise and distortion ratio (SINADR), data rates in Mb/s and MIMO for both uplink and downlink.

Some areas where there is MIMO-A is because of non-optimized street level positions of the subscriber module. This in turn decreased the link efficiency.

Fig.4 • Point of Transmission from Skytower.

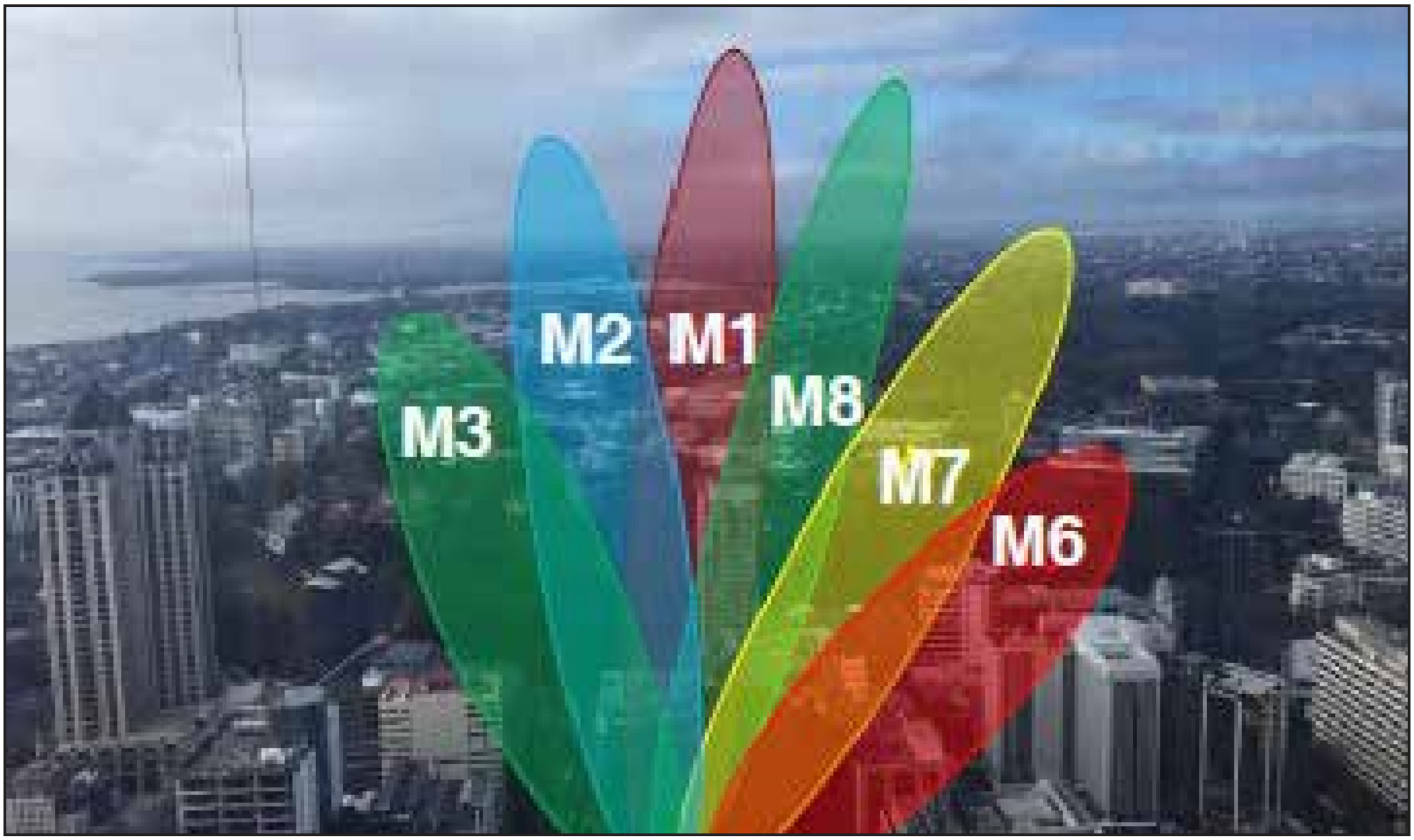

Fig. 5 • View from behind the 21 dB gain antenna system. 6 beams, M3 (left outermost beam), M2, M1, M8, M7 and M6 (right outermost beam).

Fig. 6 • Repeated channels beams M3 and M8.

Fig.7 • Street level reading, in the distance the Sky Tower where the ETI multibeam antenna is transmitting.

Proper planning and optimization of the subscriber modules' position will allow for MIMO-B links everywhere.

Conclusion

Traditional 360° cells sites are divided into three sectors. With the multi-beam antenna system, spectrum and capacity can be multiplied. The benefit of such a system is higher data throughput, higher customer capacity and increased spectral efficiency. The beam crossing can be designed to cross between 3 to 10 dB with side lobe levels of 25dB. As the number of beams increases, so does the capacity and throughput. With the use of multiplexers, multi-channel sectors can be created to further enhance the benefits of the system. The multi-beam antenna system is clearly the solution to the ever-growing demand of data usage and network capacity for the finite amount of spectrum.

Location	RSSI (dBm)				SINADR (dB)				Data Rate (Mb/s)		MIMO		Distance (km)
	RF 1 DL	RF 2 DL	RF 1 UL	RF 2 UL	RF 1 DL	RF 2 DL	RF 1 UL	RF 2 UL	DL	UL	DL	UL	
Gladstone Park	-71	-69	-66	-62	21	21	22	21	72	108	B	B	2.1
Michael Joseph Savage Memorial	-76	-74	-75	-73	15	17	18	18	72	72	B	B	5.7
Achille's Point	-80	-78	-79	-77	16	16	14	14	48	48	B	B	9.1

Table 1 • Beam mode 3 street level results.

Location	RSSI (dBm)				SINADR (dB)				Data Rate (Mb/s)		MIMO		Distance (km)
	RF 1 DL	RF 2 DL	RF 1 UL	RF 2 UL	RF 1 DL	RF 2 DL	RF 1 UL	RF 2 UL	DL	UL	DL	UL	
Birdwood Crescent	-61	-58	-61	-57	21	24	20	21	108	96	B	B	2.0
Burwood Crescent	-74	-70	-69	-65	20	23	19	21	96	96	B	B	3.52
Victoria Ave School	-72	-68	-72	-65	19	22	12	12	96	18	B	A	3.76
Walton St.	-75	-72	-75	-71	17	19	15	17	72	72	B	B	4.1
82 Upland Rd.	-76	-75	-79	-73	18	18	16	17	72	36	B	A	5.1
53 Upland Rd.	-79	-74	-78	-71	18	18	19	19	48	48	A	A	5.32
20 Waiatarua Rd.	-80	-83	-80	-79	16	16	14	14	48	36	B	A	6.25
Mt. Wellington	-84	-80	-83	-78	12	12	13	14	24	36	A	A	9.04

Table 2 • Beam mode 1 street level results.

About the Authors

John Howard and Steve Jalil are with Electromagnetics Technologies Industries, Boonton, New Jersey.

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