MATSING INC.

HOW RF LENS ANTENNAS CAN REVOLUTIONIZE TELECOMMUNICATIONS IN DENSE URBAN, URBAN, SUBURBAN, AND RURAL NETWORKS THROUGH NETWORK CAPACITY EXPANSION

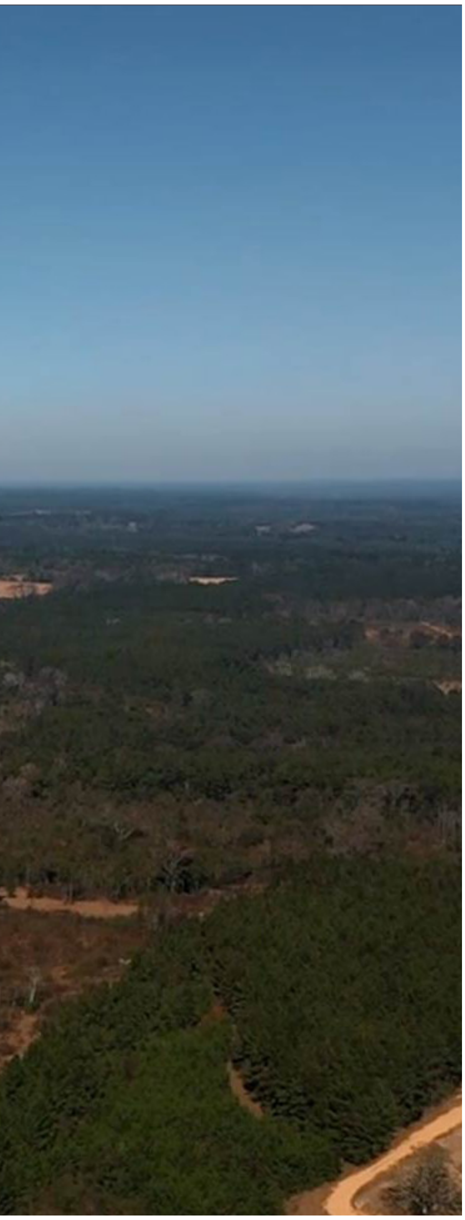
SEPTEMBER 2024

Leveraging modern RF lens antennas to meet the growing telecommunication demands and future-proof network infrastructure

INTRODUCTION

Modern-day RF lens antennas are a fairly recent phenomenon; their use and efficacy in urban networks are not yet widely known. As the telecommunications field grows swiftly, it is essential to focus on technology that best facilitates growth and connectivity, and to ascertain its most efficient implementations.

As the requirement for constant connectivity has grown, fueled by the advent of smartphones and cellular data, it has become a basic human need. The growing requirement of internet access as it relates to "health, education, employment, the arts, gender equality—all things we have the right to enjoy means that Information Technologies...are *inseparable* from the rights themselves." [1]



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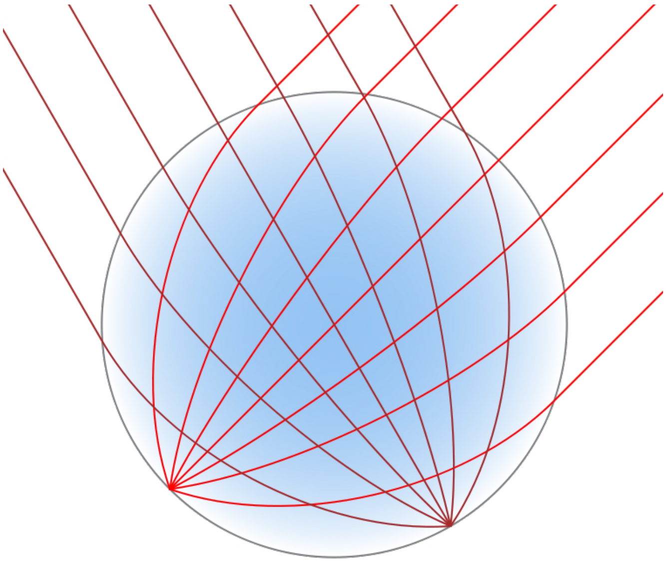
However, the growth in global network infrastructure and capacity has often been unable to keep pace with demand. Providers historically strain to match progress, having to frequently update infrastructure to meet ongoing exigencies. Network providers need a cost-efficient, scalable solution to enhance capacity and preempt future connectivity needs ahead of continuous and geometric growth.

[1] https://www.amnestyusa.org/updates/is-internet-access-a-human-right/

THE HISTORY OF LENS TECHNOLOGY

In 1894 Jagadish Chandra Bose, an Indian physicist, was possibly the first to construct lens antennas, using a cylindrical sulfur lens to collimate the microwave beam from a spark oscillator he designed.[2]



Luneburg Lens

Matsing Luneburg Lens Antenna

However, the real development and acceleration of lens antennas occurred during World War II, with the surge in research around microwave technology and transmission, to develop military radar. In 1946, R.K. Luneberg's invention of the Luneberg lens, a critical component in lens antennas, precipitated the conditions that led to the development of modern lens antenna technology. At that time, lenses were made from traditional dielectric materials, which were extremely heavy. This was the main limitation for the widespread use of lens technology, except for special applications such as military.

> "OUR GROUNDBREAKING WORK WITH LUNEBURG LENS ANTENNAS SINCE 2005 HAS CEMENTED OUR STATUS AS A TELECOM LEADER."
>
> - LEO MATYTSINE, EVP & CO-FOUNDER OF MATSING

LUNEBURG'S SOLUTION

$$n = \sqrt{\epsilon_r} = \sqrt{2 - \left(\frac{r}{R}\right)^2},$$

[2] https://books.google.ca/books?id=OLYvAQAAIAAJ&pg=PA55&redir_esc=y#v=onepage&q&f=false

TRANSFORMATION BY MATSING

THE RF LENS ANTENNA

MatSing pioneered the RF lens for base-station antennas. In 2006, the company began developing a new lightweight, low-loss meta-material for RF lens antennas, and by 2008, it had developed and patented the world's first meta-material for lens antennas. This new meta-material was ten times lighter than traditional dielectrics, opening the door for widespread application of lenses in the antenna industry. MatSing also built the world's first lightweight large-size Luneberg lens antenna, not only for base-stations but also for satellite applications.

Subsequently, MatSing has implemented its lens antenna technology in a variety of urban settings, including Coachella, SXSW, presidential inaugurations, and several sports stadiums and arenas.

What sets MatSing antennas apart are their patented meta-materials, which allow the lens antennas to be lightweight while providing multibeam connectivity. This novel approach enables the antennas to be geared towards high performance and capacity. The efficient design allows MatSing's lens antennas to provide broadband coverage, emitting and sustaining multiple beams cleanly while minimizing RF interference, even in settings that traditionally result in disrupted coverage and poor connectivity, such as outdoor events, teeming urban areas, or far-flung rural areas. This means improved coverage with fewer antennas.

These antennas are impeccably compatible with 4G LTE and 5G coverage and are extremely cost-effective as network densification tools.[3]

[3] https://www.businesswire.com/news/home/20230201005410/en/Globe-Telecom-Completes-Successful-Pilot-Deployment-of-MatSing-Lens-Antennas Deployment-of-MatSing-Lens-Antennas

HOW DOES IT WORK?

A LENS ANTENNA WORKS THROUGH REFRACTION, BENDING ELECTROMAGNETIC WAVES THROUGH A LENS.

The RF lens antenna accomplishes this by placing a single radiating element on the surface of a spherical Luneburg lens. This allows a high-gain signal to be transmitted, radiating from the opposite side of the spherical lens. The symmetry of the lens allows multiple radiating elements to be positioned across its surface, creating multiple simultaneous beams from a single antenna.

The antenna delivers multiple, independent, focused high-performance beams. By tightly focusing RF signals, the antenna can target a very precise area without interference in neighboring zones, providing the highest capacity and coverage while being clean and using less power.

Luneburg lenses are typically designed with multiple layers of various dielectric materials, but this material can often be dense and bulky, making it difficult to design lenses large enough for the required capacity. MatSing's lenses are constructed using its own patented metamaterial, allowing for large, lightweight antennas that expand location possibilities for usage and installation.

Moreover, this means fewer antennas can provide the same or better coverage compared to traditional antennas while still using typical line-of-sight locations, resulting in faster and cheaper deployments with record-breaking throughput and data capacity for end users.

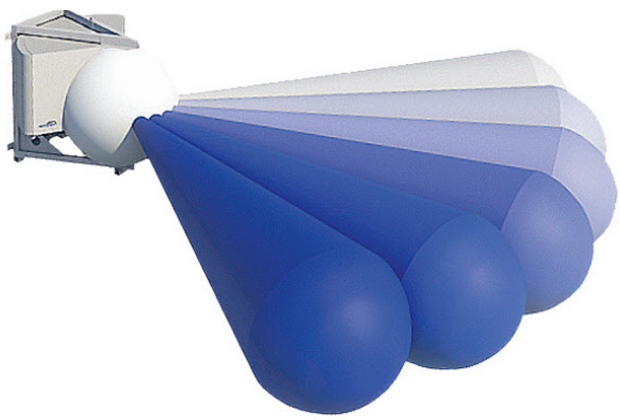


FIGURE 1.0 – LARGE SPHERE SIX BEAM LENS ANTENNA

"THE ANTENNA DELIVERS MULTIPLE, INDEPENDENT, FOCUSED HIGH-PERFORMANCE BEAMS."

MatSing lens antennas provide a dedicated beam to a group of UEs (user equipment) located in a specific geographic area. Each beam is fed through a dedicated radio unit to ensure network service.

Extremely high data demand by cell phones and IOT devices requires more and more network resources with a limited available spectrum. Lens antennas are a spectrum multiplier.

High isolation between beams, reduced side lobes and back lobes help achieve the least overlap between beams, which results in higher SINR (signal to interference and noise ratio). Higher SINR values help obtain higher throughput values. High gain and narrow vertical beamwidth make lens antennas a unique solution to build supercells.

Network coverage and capacity have always been the focus of wireless operators to cover more pops and provide a higher throughput speed to the end user. Lens antennas generate 95% of the energy in the target coverage area with a sector power ratio (SPR) of below 5%.

$SPR_{(\%)} = [P_{undesired} / P_{desired}] \times 100$

Lens antennas are being used by mobile operators both in mobile and fixed wireless access network to provide coverage and capacity.

Lens antennas are multiband and equipped with Remote Electrical Tilt AISG 2.0, offering a broad deployment range based on customer needs.

AREAS OF LENS ANTENNA APPLICATION

Lens antennas have critical applications in a variety of locations and contexts. These are divided mainly by coverage area and density. Each of these use cases has been tested and found to improve network KPIs and exceed performance and coverage criteria.

The testing methodology is threefold:

1. DRIVE TESTS

This consists of testing network coverage by testers driving in or around the coverage area and monitoring connectivity and speeds.

2. USER DATA

This is collected directly through user feedback and the connectivity performance on UEs in the location of antenna coverage.

3. NETWORK GUI

This is information obtained through the operations support system (OSS), which provides data KPIs and allows operators to examine antenna performance.

The aggregation of all this information and feedback is what's used to gauge whether or not the required benchmarks are being met.

APPLICATIONS

APPLICATION 1: VENUES & SMALL CELLS

CASE 1 – CULTURAL FESTIVAL (CEBU, PHILIPPINES, 2023)

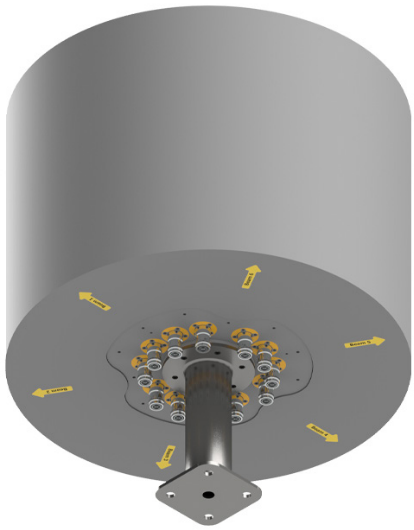
The trial was conducted by a major telecom provider in the Philippines. The antenna deployed was a C.A.L.F. (COW at Less Footprint, where a COW is Cell on Wheels, i.e. a portable network solution), to provide service to a large cultural festival at an outdoor sports complex.

The configuration included an emergency cabinet with RRU, BBU, batteries, rectifier, and storage facility. The antenna included with the emergency cabinet was replaced with a MatSing light pole antenna, MS-LP-6-H2, providing 360° mid-band coverage in L2100 & L1800. The site was deployed with two sectors and integrated using Starlink satellite or FTTH internet service as backhaul. The antenna was placed at a 5-meter height from the ground, with the audience about 100 meters away from the antenna. Attendance was 1,000+ people.

RESULTS

Several functionality tests were performed throughout the duration of the festival, including VoLTE voice call (including setup time), speed tests, CSFB (circuit-switched fall back), and evaluating a variety of OSS KPIs.

The telecommunications provider that conducted the trial sees an opportunity for using the antennas & emergency cabinet as a solution for various deployment scenarios, including:



MS-LP-6-H2

- Special events at locations that are not frequently used, as the location would have low investment benefit in terms of installing permanent infrastructure
- Disaster relief, as regular communications may be disrupted and the lens antennas are convenient for quick deployment
- Displacement of basic service, wherein a short-term solution may be required.

The provider also concluded that C.A.L.F. deployment would be a better implementation, both in terms of cost and time to deployment. They have purchased MatSing MS-LP-6-H2 for small-cell deployment in downtown & urban locations and continue to grow their small cell network with MatSing products.

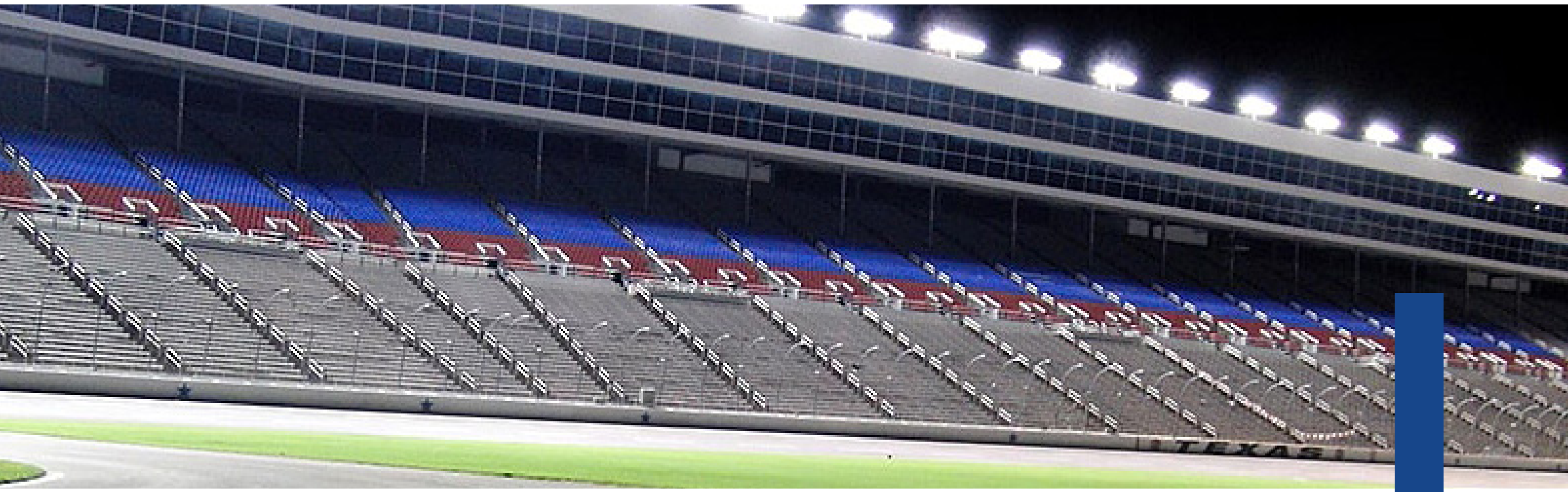
APPLICATION 1: VENUES & SMALL CELLS

CASE 2 – MOTOR SPEEDWAY EVENT (TEXAS, USA, 2015)

The trial was conducted over two days by a major North American telecom provider, during an auto racing event. The provider deployed a MS-12.6DB180, with 12 beams in mid band (2100 MHz) and 6 beams in low band (700 MHz), using one MatSing antenna on a C.O.L.T. (Cell on Light Truck).

The site also included 6 sectors of 1900 MHz on a separate antenna, and utilized 500M microwave backhaul. Event attendance was approximately 154,000.

Day 1 was the warm up race, and day 2 was the actual race. Data was collected from 6 a.m.-11 p.m. each day.



RESULTS

- RRC connection attempts increased 58% during peak hour on race day (day 2)
- RRC connection failures decreased from 3.5% to 0.63% during peak hour on race day.
- Overall throughput improved – prior to MatSing deployment, in 2014, at peak hour with 40 connected users, throughput speeds were <2M. After deployment, with the same variables, throughput speeds increased to >4M

The antenna performed above expectations and enhanced accessibility, retainability, and capacity within the stadium, and it provided cleaner RF.

The provider has adopted MatSing as a solution for special events, in DAS (distributed antenna systems) deployments at large venues, and in their macro network.

APPLICATION 2: MACROS

CASE 1 – COLOMBIA (2022)

The trial was conducted by a mobile network operator serving several countries in Latin America through its subsidiaries. The antennas were deployed at two sites: Site 1 and Site 2.

Site 1 consisted of two deployment scenarios:

Scenario 1
6-sector site with 3 conventional antennas and a new MatSing MS-MBA-3-H4 with 3 beams in the mid band.

Scenario 2
5-sector site with 2 conventional antennas and the MatSing MS-MBA-3-H4.

Site 2 was upgraded from 3 sectors in conventional multi-band antennas to 5 sectors, including 2 conventional antennas along with the MatSing MS-MBA-3-H4.

RESULTS

Site 1

- Downlink (DL) & uplink (UL) data volume improved by 60%
- Connected RRC users increased by 75%.
- Improved L2600 carrier coverage levels were observed in the drive test.
- Sustained VoLTE calls over 100% of the route.

Site 2

- Data volume improved by 15.6% in DL and 6% in UL
- User throughput improved 141% in DL at peak time

The trial results exceeded expectations despite a high load at site in the sector serving multiple apartment complexes.

The provider adopted MatSing as an approved vendor and aimed to deploy throughout Latin America under its subsidiaries.

APPLICATION 2: MACROS

CASE 2 – HIGH-DENSITY URBAN MACRO NETWORK (MINDORO ISLAND, PHILIPPINES, 2022)

The trial was conducted by a major telecom provider in the Philippines, with a deployment at two sites: Site 1 and Site 2, using MS-MBA-3.2-H4-L4 with 3 beams in the mid bands (L1800MHz/ L2100 MHz) and 2 beams in low bands (L700MHz).

The MatSing antennas were installed at the same height and mechanical tilt as existing antennas, with the same power settings.

RESULTS

Comparative testing showed that MatSing lens antennas provided better results and significant signal improvements, which was reinforced by customer testimonials.

- The average download user throughput increased 7.92x in comparison to conventional antennas and 2.98x compared to competitive antennas
- The traffic volume increased 2.17x compared to conventional antennas and 3.1x compared to competitive antennas
- Coverage improved 1.36x compared to conventional antennas and 8.36x compared to competitive antennas
- Connection quality was improved 1.09x compared to conventional antennas and 2.67x compared to competitive antennas
- The client overwhelmingly reduced the competition gap in DL and outranked their main competitor in UL

The provider identified opportunities for MS-MBA-3.2-H4-L4 deployment in various scenarios, including:

- Replacement to new site build if the potential site is within the minimum site distance
- Replacement to new site build if the potential site has site acquisition issues
- Deployment to existing site(s) with LTE low and mid band congestion
- Outdoor deployment, serving indoor coverage and sites in venues and large areas

The provider now uses MatSing antennas as part of its solution, in the given deployment scenarios, in order to address congestion, expand coverage, and improve quality.

APPLICATION 2: MACROS

CASE 3 – RURAL SUPER CELL (NIGERIA, 2020)

The trial was conducted by an American multinational technology conglomerate working on expanding their services globally. It includes the results of prototyping a “SuperCell,” a large-area coverage solution that leverages towers up to 250 meters high and high-gain, narrow-sectored antennas to increase data coverage range and capacity.

Many rural communities still have little to no cellular internet access because traditional macro technologies that deliver connectivity to urban areas are not economically feasible for remote communities, especially in lower-middle-income countries. The SuperCell is designed to be a cost-effective & reliable alternative to traditional connectivity technologies, specially geared towards rural connectivity.

RESULTS

- One SuperCell could replace 15-20 traditional macros, or hundreds of small cells, providing coverage to the same number of customers
- A network of SuperCells could be deployed at more than 33% lower overall total cost of ownership (TCO) compared to a macro network
- Given the coverage gap, infrastructure needs, and topography of sub-Saharan Africa, this region has potential for high impact by SuperCell

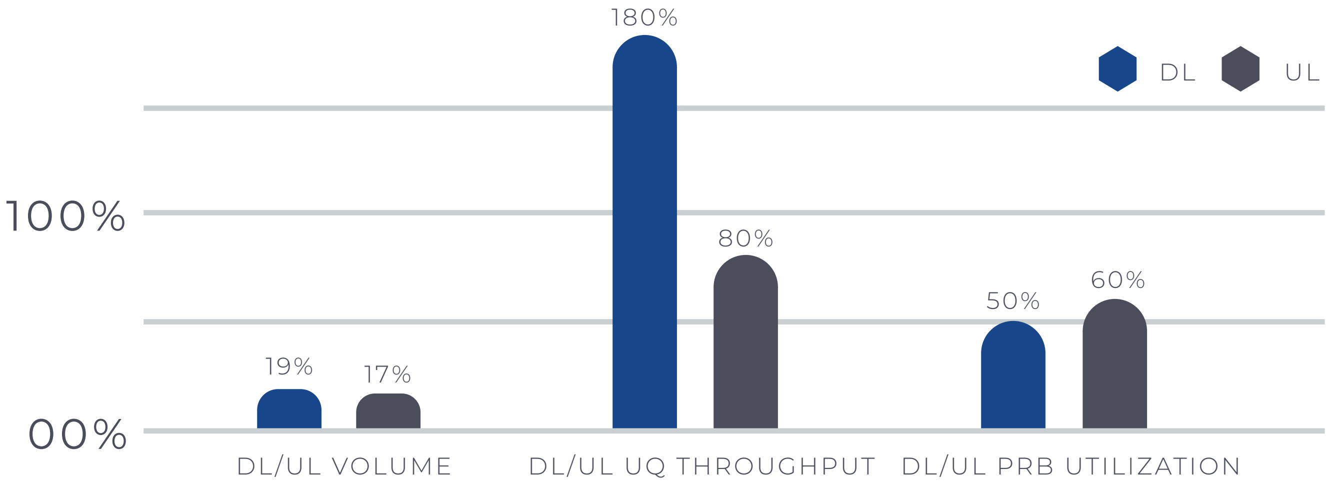
APPLICATION 2: MACROS

CASE 4 - WASHINGTON D.C. (2017)

The trial was conducted by a major American mobile network provider in the U.S., with deployments at one site. One sector was upgraded with a MatSing MS-MBA-8 3-beam antenna, replacing one dual-band antenna integrated radio in the mid band (1900 MHz & 2100 MHz).

RESULTS

- VoLTE performances remained stable
- DL/UL volume increased (DL increased by around 19% and UL by about 17%)
- DL/UL UE throughput improved (DL by 180% and UL by 80%)
- DL and UL PRB utilization improved (DL by 50% and UL by 60%)
- Slight improvement in RSRP according to the drive test



CONCLUSION

"PROVIDERS THAT HARNESS LENS TECHNOLOGY WILL ECLIPSE THEIR COMPETITORS"

Lens antennas offer a variety of applications and use cases for telecommunications providers around the world. The quality, capacity, and signal integrity are all greatly improved by the use of lens antennas, whether as an additional integration into an existing network or as a replacement to traditional technology.

The antennas offer a myriad of opportunities for strengthening connectivity across the globe, including in far-flung regions and communities, at a fraction of the cost of conventional network infrastructure and with increased mobility.

Legacy systems need to be continuously updated before they become too unwieldy and costly to operate and for increased agility. Lens antennas provide a window to do that. The providers that harness this technology will eclipse their competitors and be able to provide a service to customers that far outshines other suppliers on the market.

MATSING

LENS TECHNOLOGY ENABLED

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THANK YOU!

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