

**CONNECT MORE WITH LESS**

# Baicells Private 5G Empowers Racing Circuits in Brazil

Baicells 5G successful story

September/2023

Baicells Technologies co., Ltd.

**Baicells**

# Part1 Background

## Customers and scenario

# Who is the customer? Deployed country and area?



Mogi Guaçu - State of São Paulo, Brazil



1

### Requirements and pain points?

- Need real-time monitoring the race cars
- Race cars will have over 250mk/h, mobility is requested
- Required throughput per car: 3 cameras HD + Telemetry info. Total 20Mbps(Continuous upload) per car

2

### What problem was solved?

- E2E 5G private network to solve the data transmission
- Low latency and high throughput to satisfy service requirement,
- Fast and Lower cost deployment to Improve the ROI

3

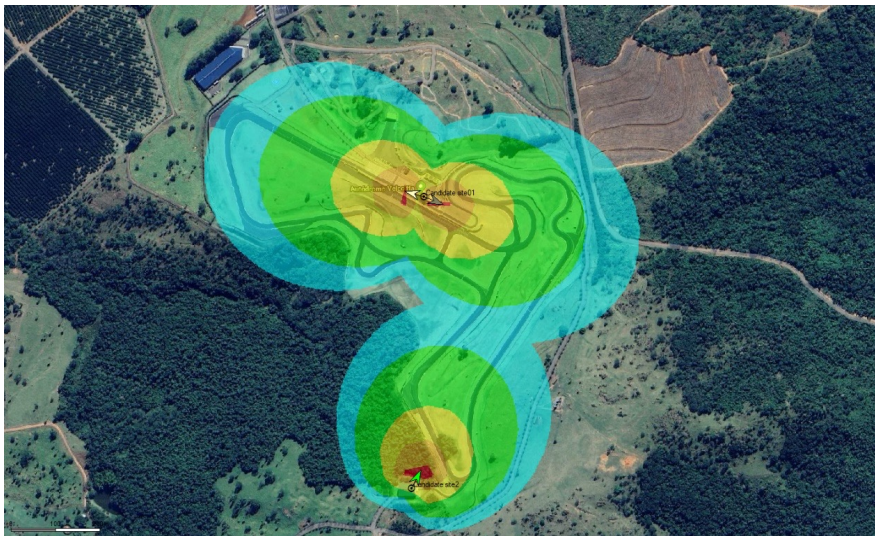
### Application scenarios?

- Car racing track
- Max 8 cars at the same time in the circuit
- Full wireless coverage



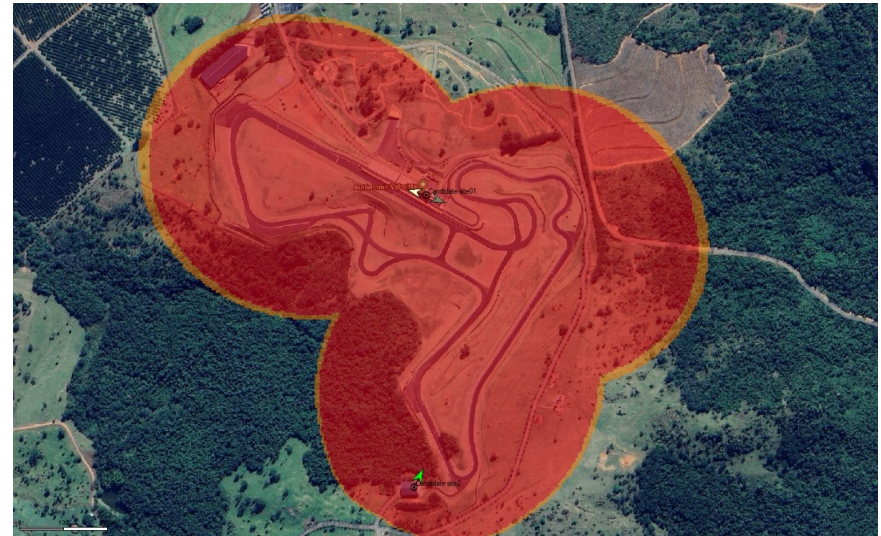
**Autódromo Velo Città**  
Car racing track

## 5G RNP(Radio Network Planning) for deployment-3 sites coverage



### RSRP Legend

- Red: SS-RSRP Level (DL) (dBm)  $\geq -70$
- Orange:  $-80 \leq \text{SS-RSRP Level (DL) (dBm)} < -70$
- Yellow:  $-90 \leq \text{SS-RSRP Level (DL) (dBm)} < -80$
- Green:  $-100 \leq \text{SS-RSRP Level (DL) (dBm)} < -90$
- Cyan:  $-105 \leq \text{SS-RSRP Level (DL) (dBm)} < -100$

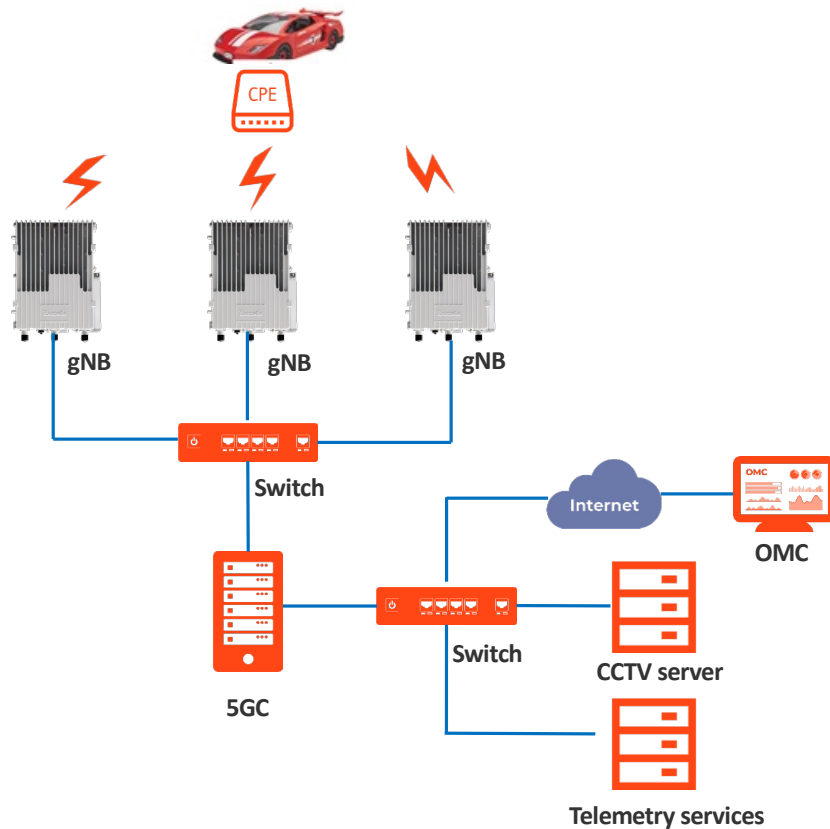


### UL Throughput Legend

- Red: Peak RLC Channel Throughput (UL) (kbps)  $\geq 120,000$
- Orange:  $115,000 \leq \text{Peak RLC Channel Throughput (UL) (kbps)} < 120,000$
- Yellow:  $110,000 \leq \text{Peak RLC Channel Throughput (UL) (kbps)} < 115,000$
- Green:  $105,000 \leq \text{Peak RLC Channel Throughput (UL) (kbps)} < 110,000$
- Cyan:  $100,000 \leq \text{Peak RLC Channel Throughput (UL) (kbps)} < 105,000$
- Blue:  $0 \leq \text{Peak RLC Channel Throughput (UL) (kbps)} < 100,000$

# Part2 Solution and Highlights

## Solution architecture and highlights



### Solution:

- E2E private network: app platform +core + RAN + CPE
- 5G core will be deployed in a central server
- 3 sectors gNB realize the full wireless coverage
- CPE is connected to gNB via wireless frequency
- Max. 8 cars at the same time in the circuit through 5G private network

### Highlights:

- Full seamless wireless coverage
- High integrated network, easy and fast deployment
- 250km/h of the race cars have reliable service for mobility
- Low latency and high UL peak rate is 230Mbps
- Max. 8 cars at the same time in the circuit through 5G private network, Total 20Mbps (Continuous upload) per car



## 5G gNB spec



### 5G Aurora243 2x10W gNB

#### Highlights:

- All-in-one and high-integrated, portable and 0 footprint
- Outdoor 5G integrated gNB (CU+DU+RU)
- support AC/DC input;
- 600 RRC connected users;
- Peak rate (up to) DL 850 Mbps, UL 330 Mbps
- Modulation: DL:256QAM; UL:256QAM

Model	Aurora243 2x10W outdoor gNB
Frequency band	n78H(3600Mhz-3800Mhz)
Bandwidth	100 MHz
Carries	single carrier
Synchronization	GPS
Max Output Power	40 dBm / channel x 2 channels
Antenna	External high gain antenna
Antenna port	2T2R
RF connector type	N-Type connector
Data interface	1 optical (SFP+) and 1 RJ-45 Ethernet interface (1 GE)
Power supply	90VAC to 264VAC, 47Hz to 63Hz or -40VDC to -57VDC, nominal -48VDC
Power consumption	Maximum 150W
Dimension	13.1 x 9.4 x 4.3 inches 333 X 240 X 109 millimeters
Weight	18.7lbs / 8.5kg
Installation	Pole or wall mount
Ingress Protection Rating	IP65
MTBF	≥ 150000 hours
MTTR	≤ 1 hour
Temperature	-40° F to 149° F / -40° C to 65° C
Humidity	2% to 95%

## 5G lite 5GC spec



### Introduction

- Baicells 5G Core (BaiCore) provides a carrier-class virtualized solution for Communication Service Providers (CSP)
- The BaiCore is a complete 5G core solution, and this consolidated solution is comprised of 3GPP-compliant AMF, SMF, UPF and UDN network functions.
- These functions are no longer tied to vendor proprietary hardware and instead are virtualized on Commercial Off-The-Shelf (COTS) x86 servers.

### Highlights

- Flexible deployed on cloud or server
- Support VoNR and traffic service
- External connection to OMC, Boss billing, centralized management.
- Support QoS service control to realize different services.
- Support mobility management function.
- Follow the general standards of the 3GPP protocol and support the access of other RAN devices.
- Support dynamic IP allocation, static IP allocation and IP allocation using external DHCP server for UE.



## 5G CPE spec



### High Speed Smart 5G router

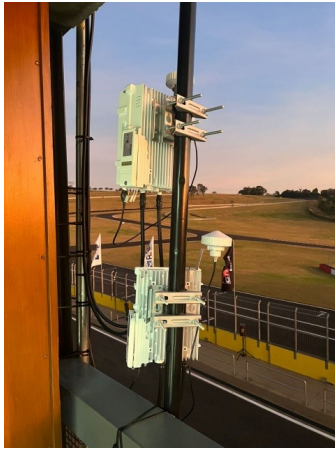
#### Highlights:

- Low cost industrial 5G Router
- Global 5G/4G/3G cellular connections
- Cutting-edge 5G 3GPP Release 16 cellular interface
- Supports Ethernet, Wi-Fi and 5G/4G internet with auto-failover
- 1 x RS232/RS485 ports for connection to industrial/legacy devices
- Fully programmable Operating System with a well-documented SDK
- Multiple VPN options available including DMVPN, IPsec, L2TP + more...
- Robust metal enclosure with small footprint – DIN-rail + wall mount options

<b>Model</b>	ER5020
<b>Mode</b>	5G/4G/3G
<b>Channel Bandwidth</b>	100MHz
<b>Multiplexing</b>	2x2MIMO
<b>Frequency Bands</b>	5G: NR SA/NSA: n1/n2/n3/n5/n7/n8/n12/n13/n14/n20/n25/ n26/n28/n29/n30/n38/n40/n41/n48/n66/ n71/n75/n76/n77/n78/n79 4G/3G
<b>Peak Rate</b>	5G: Up to 867 Mbps 2.4G: Up to 300 Mbps
<b>Antenna</b>	4 (ANT0 + ANT1 + ANT2 + ANT3)
<b>WLAN</b>	IEEE 802.11b/g/n/ac
<b>ETH LAN Port</b>	4 (ANT0 + ANT1 + ANT2 + ANT3)
<b>USIM</b>	2 x Mini SIM (2FF)
<b>Power Supply</b>	12 ~ 36 VDC
<b>IP Protection Rating</b>	IP30
<b>Dimensions (HxWxD)</b>	136*115*32 mm
<b>Weight</b>	475g
<b>Temperature</b>	-40 ~ +85°C
<b>Humidity</b>	5%~95%

## Part3 Implement and Testing Result

## On-site Installation



Site1-gNB1&gNB2



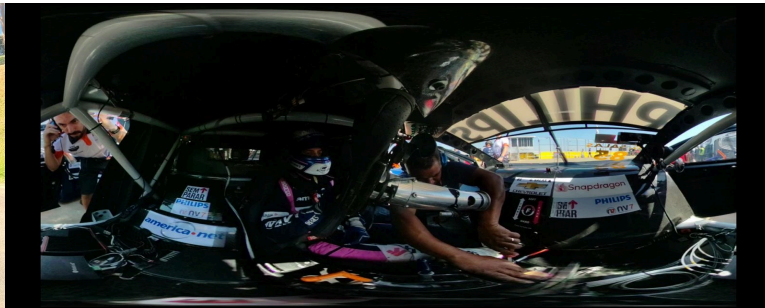
Site1-gNB1 &gNB2 Antenna



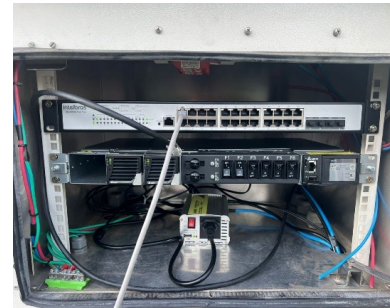
Site2-gNB3&Antenna



CPE



Race car



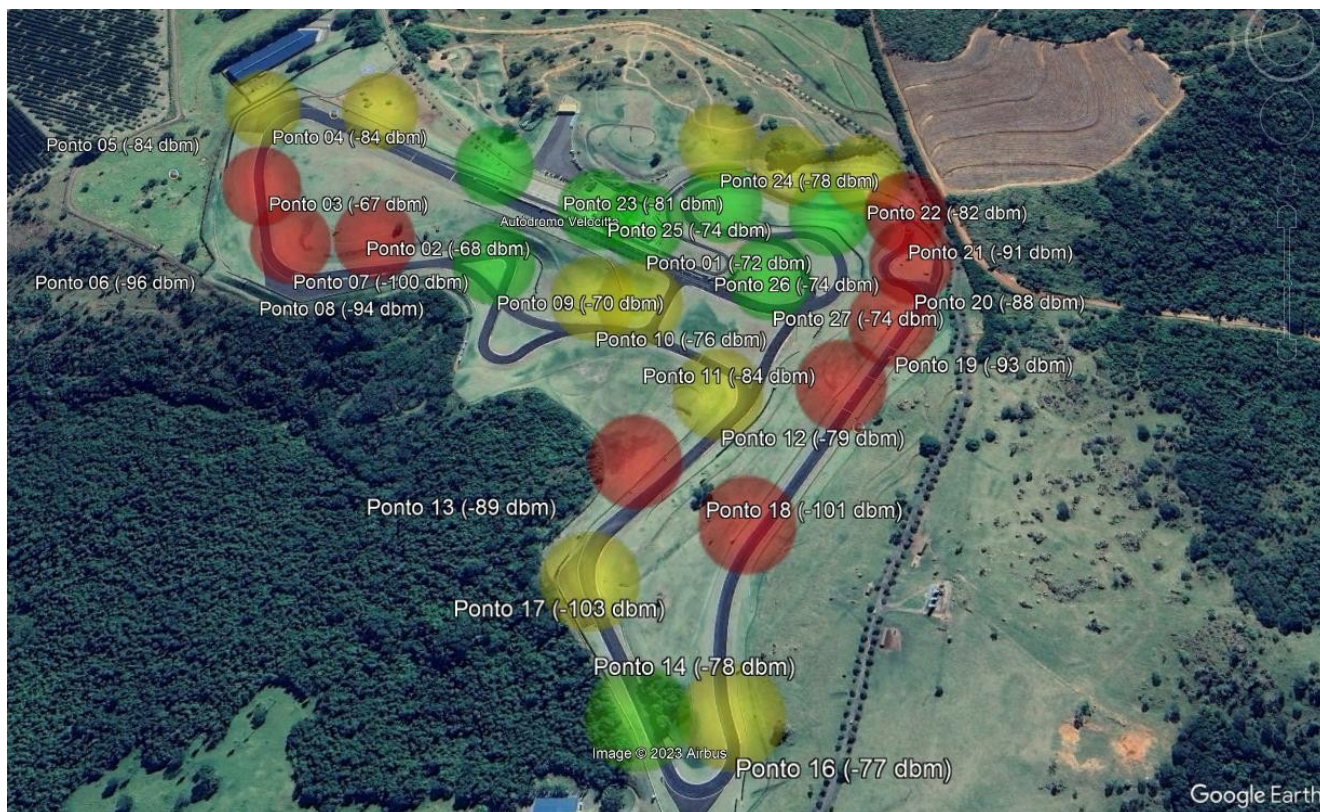
5G core



APP platform



## Coverage test – full coverage of the race track



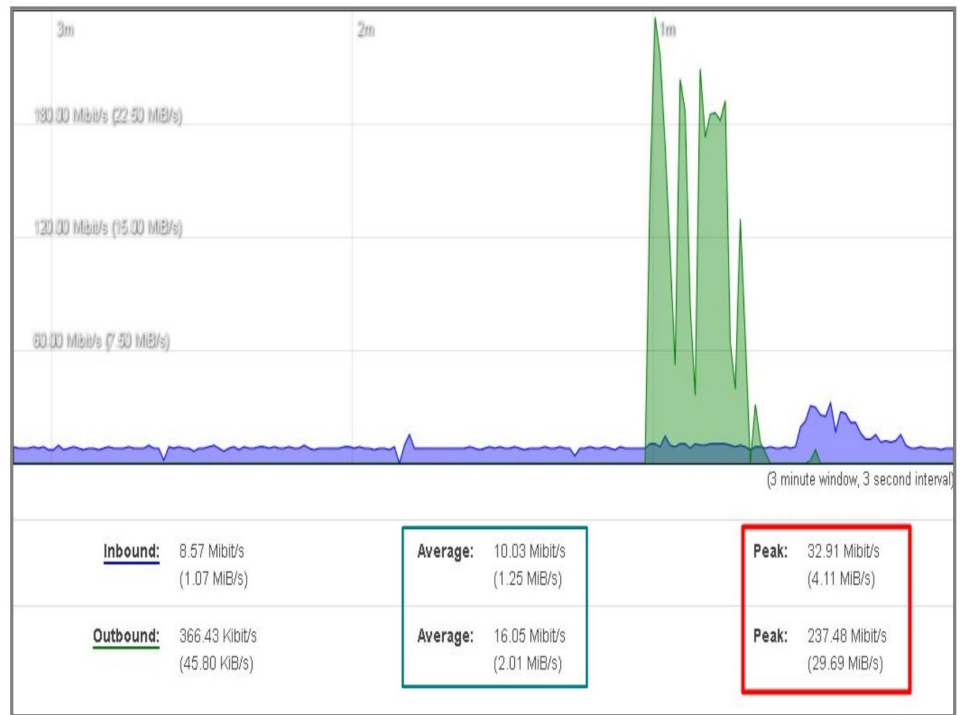
Equipment used: Baicells gNB Aurora 243 – 2x10w + 5GC +CPE GX3000

### Legend

- gNB1 coverage
- gNB2 coverage
- gNB3 coverage

## KPI performance- latency & throughput & streaming consumption

← Ping			
8.8.8.8	PING		
De 8.8.8.8	Sequência 109, tamanho 64 bytes, ttl 57	51 ms	
De 8.8.8.8	Sequência 110, tamanho 64 bytes, ttl 57	56 ms	
De 8.8.8.8	Sequência 111, tamanho 64 bytes, ttl 57	43 ms	
De 8.8.8.8	Sequência 112, tamanho 64 bytes, ttl 57	67 ms	
De 8.8.8.8	Sequência 113, tamanho 64 bytes, ttl 57	95 ms	
De 8.8.8.8	Sequência 114, tamanho 64 bytes, ttl 57	107 ms	
De 8.8.8.8	Sequência 115, tamanho 64 bytes, ttl 57	57 ms	
De 8.8.8.8	Sequência 116, tamanho 64 bytes, ttl 57	48 ms	
De 8.8.8.8	Sequência 117, tamanho 64 bytes, ttl 57	38 ms	



01 Handover low latency

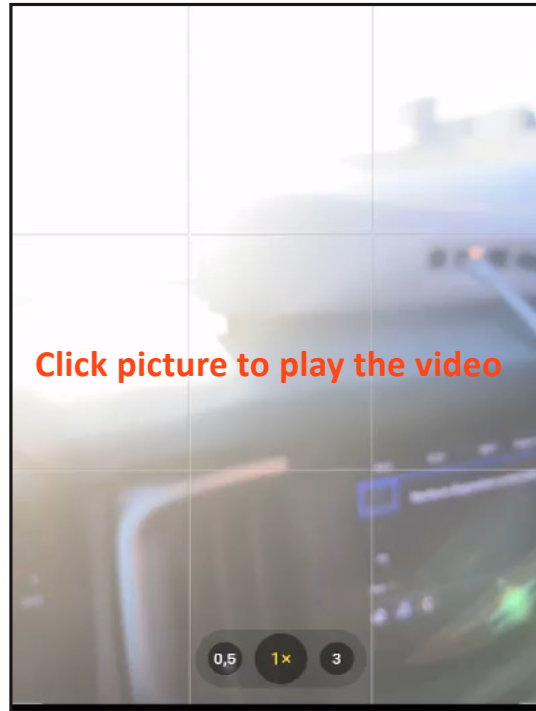
02 Speed test

03 Average streaming consumption 10.03Mbps per car, total is 8 cars

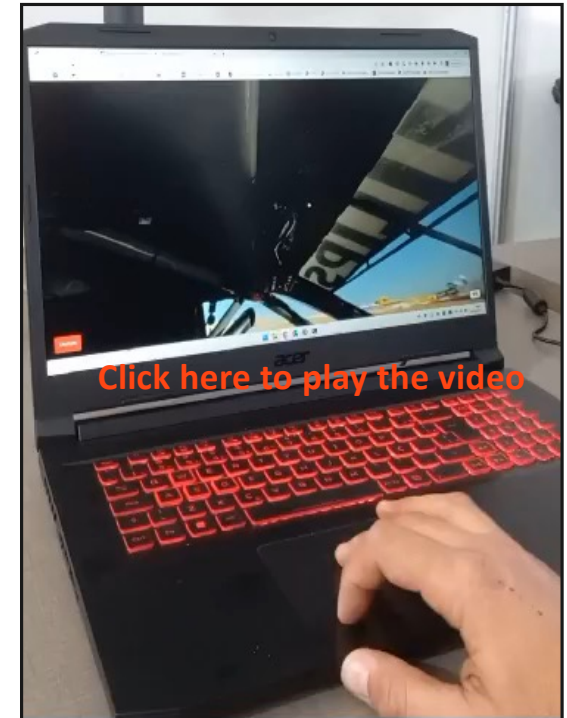
## On-site excellent experience test



**Live broadcast**



**Drive tests(click to play the video)**  
**(30 km/hour)**



**Onboard 360° Camera – real time**  
**(248 km/hour)**



## Innovation 5G Project Award



Baicells won the most innovation 5G project award of the year in Brazil for MPN (Mobile Private Networks) on Sep. 1th,2023. using Baicells E2E solution in racing circuit. integration Baicells 5G Core and 5G Aurora 243 gNB n78H and 5G CPE, connecting race cards until 248 km/ hour.



# THANK YOU

[www.baicells.com](http://www.baicells.com)