GWF
GEOSPATIAL WORLD FORUM
CONFERENCE & TECH SHOW

2026, RAI AMSTERDAM

UTILITIES & NETWORKS SUMMIT

GARUDALYTICS
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From Spectrum Chaos to Network Intelligence

Physics-Informed Geospatial Intelligence for Smart Networks & Digital Infrastructure

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GARUDALYTICS PRIVATE LIMITED

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Connectivity Is the New Utility

Smart Cities

1,000+

cities deploying IoT infrastructure globally

Growing Rapidly

5G Expansion

5.9B

5G subscribers expected by 2027

Critical Backbone

IoT Devices

45B+

connected devices by 2030

Network Dependency

"Connectivity is now as essential as power and water — yet our planning tools haven't caught up."

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Visakhapatnam Smart Poles: A Cautionary Tale

HOME / NEWS / CITIES / VISAKHAPATNAM

Smart poles, installed under Smart City Mission-2015, become defunct in Visakhapatnam

People urge authorities to repair and make them available to tourists and visitors; in the new financial year, the poles come under the control of State government and steps will be taken to maintain and use them, says an official

Published - February 18, 2025 12:50 am IST - Visakhapatnam

V. KAMALAKARA RAO

Smart Infra · 6 Min Read

Smart cities of Andhra and Telangana stand as towering examples of mission failure

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Visakhapatnam Smart Poles: A Cautionary Tale

Visakhapatnam, Andhra Pradesh, India

India's Smart City Mission flagship coastal city

~50	Smart Poles Installed
₹15 Cr	Capital Investment
10%	Currently Operational

Root Cause: CAPEX without sustained intelligence — hardware-driven, not intelligence-driven.

What Went Wrong?

Non-Optimized Placement

Poles deployed without proper RF simulation or demand analysis. Location decisions were administrative, not data-driven.

Low Usage → Low Value

Without connectivity optimization, citizens saw no tangible benefit. Adoption was minimal from day one.

No Predictive Maintenance

Reactive-only maintenance model. Equipment degradation went undetected until complete failure.

Environmental Degradation

Coastal humidity, salt air, and heat exposure accelerated hardware failures with no monitoring in place.

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Spectrum Chaos in Urban Environments

Urban density amplifies every wireless challenge, demanding smarter spectrum management.

Why Traditional Geo-Intelligence Struggles to Resolve Spectrum Chaos

Black-Box Predictions

DL models can predict statistically plausible but physically impossible outputs - like negative RSRP or faster-than-light handoffs—due to lack of physical constraints.

Physics Violations

Free-space path loss follows $1/d^2$. Pure ML sees d as just another feature and may predict coverage improvements with distance - violating the inverse-square law entirely.

Spatial Blindness

Standard tabular ML treats lat/lon as scalars. It has no concept of line-of-sight, Fresnel zones or building blockage — all deterministic from geometry and wavelength.

Label Hunger

A new tower site or freshly gazetted smart-city zone has zero drive-test data. Without physics as a prior, the model cannot generalize — a costly blind spot for rollout teams.

The Missing Intelligence Layer

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WE HAVE

GIS & Spatial Data

DEMs, building footprints, land use, road networks

Network Infrastructure Data

Tower locations, fiber routes, cell configurations

Network KPIs & CDRs

Signal logs, user activity, performance metrics

GAP

WE LACK

Physics-Aware Signal Modeling

RF propagation integrated with real 3D environment

Geospatial-AI Fusion

Spatial context embedded in machine learning pipelines

Unified Decision Intelligence

End-to-end optimization from data to action

"The integration of Physics + Space + AI is the missing intelligence layer."

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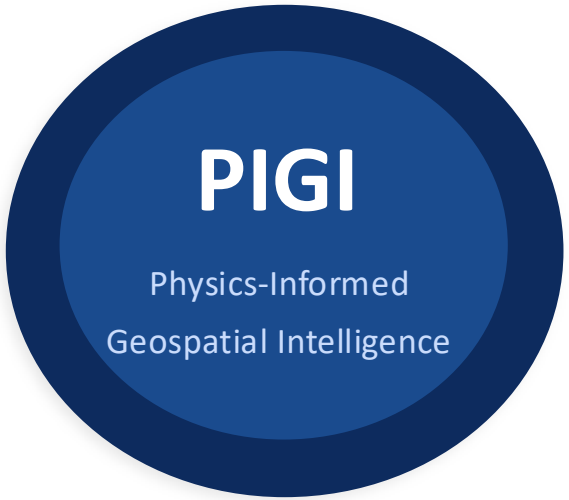
Physics-Informed Geospatial Intelligence (PIGI)

Physics-Based RF Modeling

Real-world signal propagation using path loss, diffraction, scattering & reflection



Geospatial Context Awareness

DEM, DSM, building footprints, land use — geography shapes every decision

AI-Driven Optimization

Machine learning that learns from network KPIs to predict and optimize coverage

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Integrated Intelligence Pipeline

1

DATA INGESTION

GIS, CDR,
KPIs, Imagery

2

RF PHYSICS MODELING

Path loss,
Diffraction,
Scattering

3

GEO-AI LEARNING

Coverage
prediction,
Gap detection

4

OPTIMIZATION ENGINE

Site selection,
Deployment
strategy

5

DECISION MAPS

Signal maps,
Risk zones,
Action plans

"AI guided by physics, grounded in geography — the foundation for intelligent infrastructure planning."

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Physics - Driven Layer: How Signals Behave in the Real World

Path Loss

$$L = 20\log(d) + 20\log(f) + K$$

Signal power diminishes as distance and frequency increase. The bedrock of all coverage calculations.

Reflection

$$\theta_i = \theta_r \quad \text{(Snell's Law)}$$

Signals bounce off hard surfaces — buildings, roads, water — creating multipath propagation effects.

Diffraction

$$\lambda/d > 1 \quad \text{(Huygens Principle)}$$

Signals bend around building edges and terrain obstacles, extending coverage into shadow zones.

Scattering

$$\sigma = f(\text{surface roughness})$$

Irregular surfaces scatter signal energy in multiple directions, contributing to interference floors.

Physics-based modeling ensures our AI predictions are constrained by the laws of electromagnetics — not just statistical patterns.

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Geospatial-Driven Layer: Geography Defines Signal Behavior

Land Use Data

Classifies urban, suburban, and rural zones — each with distinct propagation characteristics and demand profiles.

Road Networks

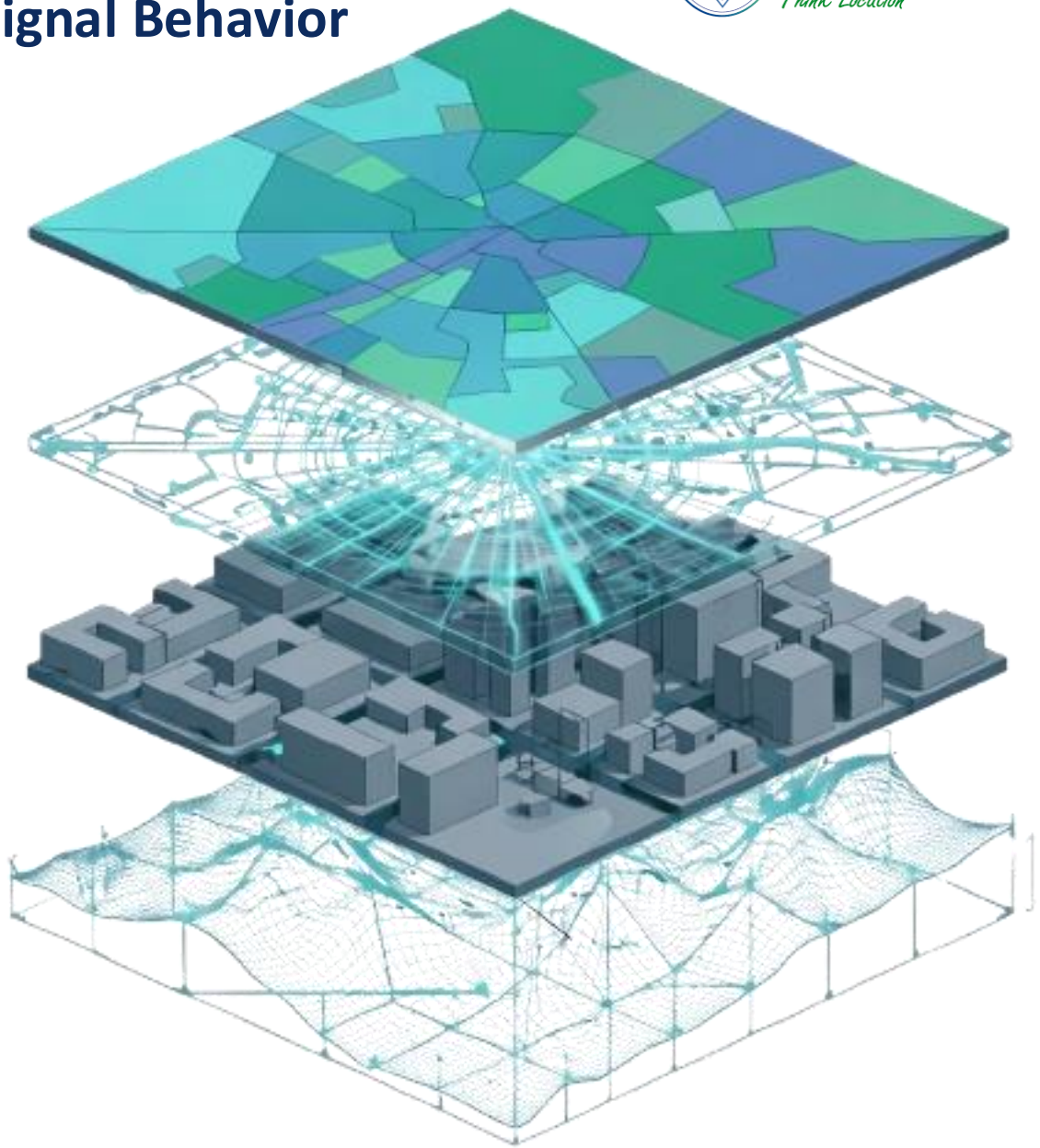
Infrastructure corridors define mobility patterns, demand concentrations, and deployment access routes.

Building Footprints

3D building data determines signal blockage, reflections, and the urban canyon effect on network coverage.

DEM / DSM

Digital Elevation and Surface Models capture terrain height and building canopy — essential for RF propagation accuracy.



Stacked Geospatial Data Layers

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AI-Driven layer: That Learns from Geography & Network Behavior

INPUTS

CDR Data
Call Detail Records, mobility patterns

Network KPIs
RSRP, RSSI, throughput, latency

3D Urban Models
Building heights, urban morphology

RF Simulation Data
Physics-computed signal propagation

GeoAI Model

Physics-Informed
Spatial Machine Learning

PINNs · GNNs · Spatial CV

OUTPUTS

RSRP / SINR / RSSI
Predicted signal quality maps

Coverage Gap Maps
Spatial identification of weak zones

Optimal Site Locations
AI-ranked deployment candidates

Interference Zones
Predicted interference hotspots

Reimagining Visakhapatnam with PIGI

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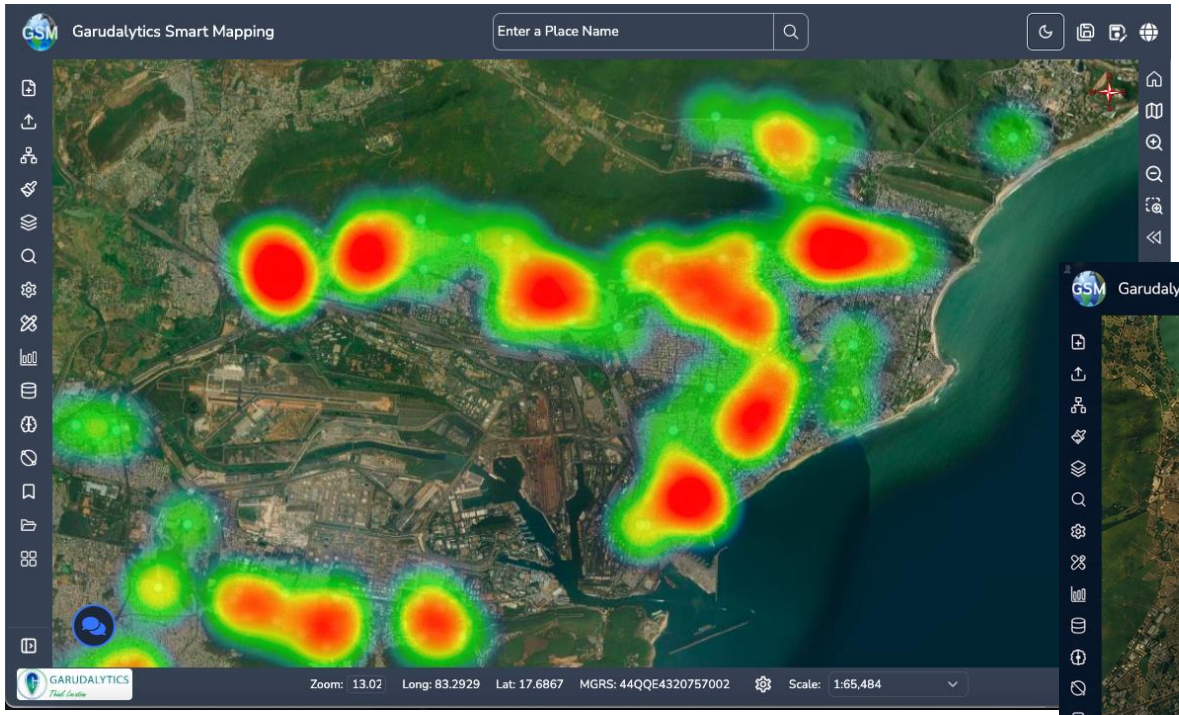
WITHOUT PIGI (What Happened)		WITH PIGI (What Should Happen)
✗ Deploy first, analyze never		✓ Simulate first, deploy confidently
✗ Administrative placement logic		✓ Demand-aware, RF-optimized placement
✗ No RF simulation pre-deployment	VS	✓ Full pre-deployment RF simulation
✗ Reactive maintenance only		✓ Predictive maintenance from day one
✗ No digital twin or monitoring		✓ Live digital twin + real-time monitoring

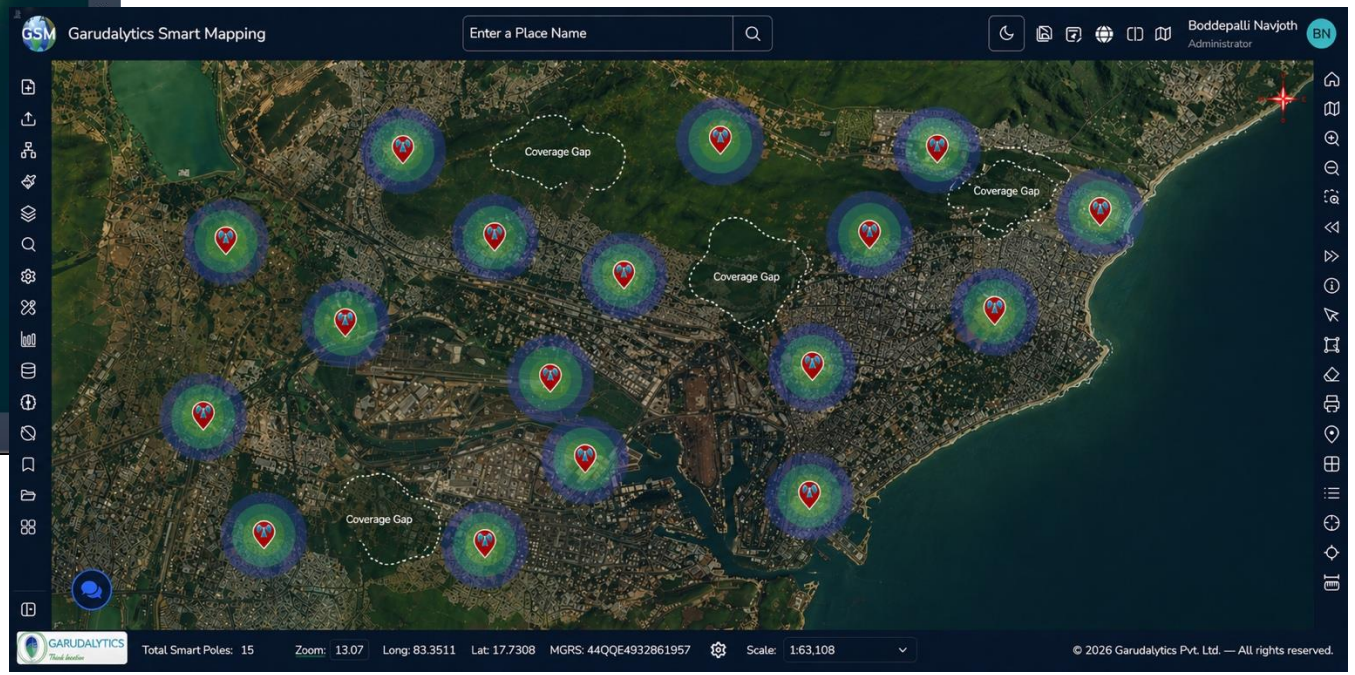
PIGI Principle: "Build before you build" — simulation-first, deployment with confidence.

Map-Driven Decisions & Long-Term Intelligence

Signal Strength Maps



Coverage Gap Identification



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From Reactive Infrastructure to Predictive, Self-Optimizing Networks

Physics-Guided AI

Every prediction constrained by the laws of electromagnetics. No more black-box deployments.

Geospatially Aware

Decisions rooted in real terrain, real buildings, real geography — not lab-bench assumptions.

Predictive by Design

Infrastructure that anticipates failures, optimizes itself, and adapts to urban evolution.

About Product **GSM**

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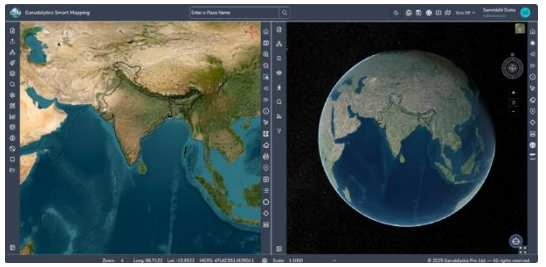
- User / Admin Console
- Voice Commands
- Geo Data Lake
- SaaS Model
- Secure Access
- No-Code UI
- Cloud Scalable
- Data Interoperability
- 50+ GeoAI Tools
- Multilingual



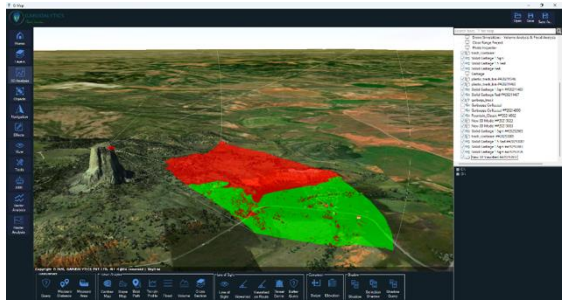
About Product **G-mAP**

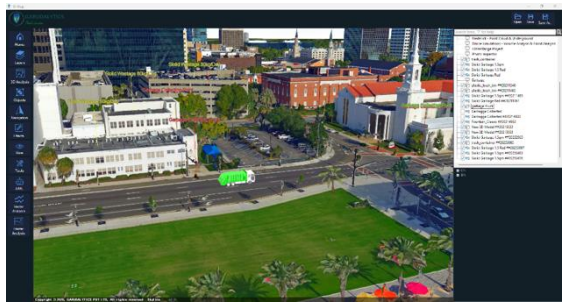
Advanced 3D Geo-Analysis

Interactive Animation

Built-In AI/ML Intelligence

AR/VR-Enabled Terrain Exploration





About Product **G-Field**

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Seamless Data Collection

Offline Capabilities

Domain Specific Schemas

Team Collaboration

Cross-Platform

Easy Configuration

Thank You