

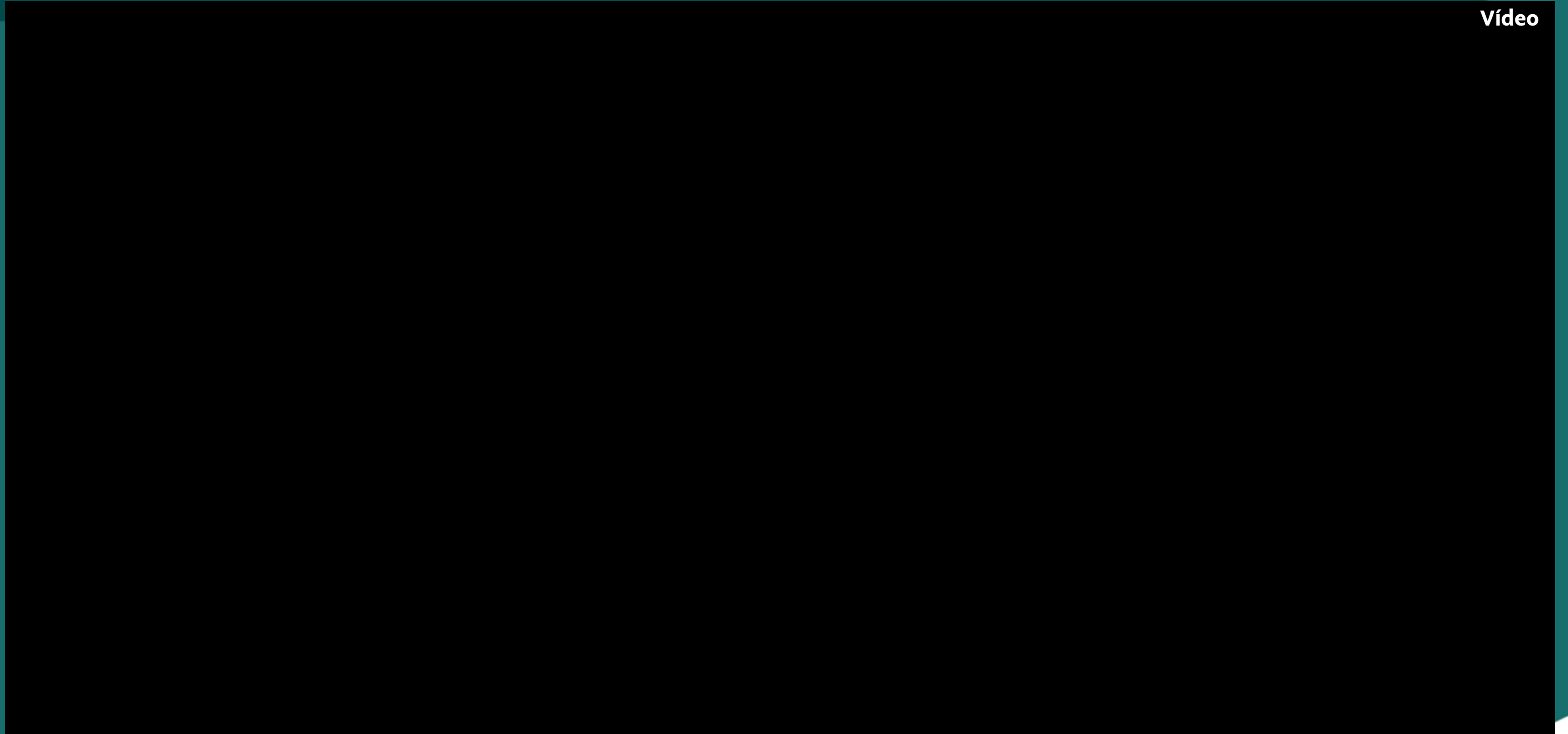
# Conectividade

Workshop – Mission Critical Infrastructure  
February 2025



# CAPANEMA – AUTONOMOUS HAULING

Vídeo



# FROM THE STRATEGY TO PORTFOLIO | VALUE CHAIN AND MISSION-CRITICAL APPS

## VALE'S AMBITIONS



**Benchmark in safety**



**Best in class operator and most reliable**



**Talent driven organization**



**Leader in sustainable mining**



**Reference in creating and sharing value**

## PROGRAMAS DE TRANSFORMAÇÃO DIGITAL INDUSTRIAL



### Autonomous Mine

- Reduce risk and increase efficiency.



### Modern Processing Plant

- Increase productivity and reduce operational risk.



### Optimized Railway

- Efficiency in semi-autonomous operation;
- Productivity of maintenance teams;
- Reduce response time to incidents.



### Connected Port

- Efficiency and safety in the yards, loading, and material transportation.



### Geotechnics & Emergency

- Availability and performance of monitoring systems;
- Reliability of incident response processes.



### Technology Processes

- Aggressive service level agreements;
- Agility and flexibility on delivering;
- Network monetization.

## Challenges

## Opportunities

- Robust connectivity for autonomous systems, transportation and drilling.  
Edge computing for optimization and response time reduction.

- Connectivity for sensing and predictive maintenance.

- Modern and scalable connectivity for train dispatch;
- Remote sensing of components, tracks and critical areas;
- Public 4G network for communities.

- Autonomous yard and remote machine operation.
- Sensing and predictive maintenance.

- Last mile network redundancy;
- AI based Edge computing.

- Observability and predictive failure modeling;
- Agile connectivity solutions;
- Tier-based solution catalog.

## Foundation



Edge Computing



AI



Smart Sensors



Cloud

# VALE BRAZIL MINES | MAIN DELIVERIES AND ADOPTIONS IN 2024

## PRIVATE LTE INFRASTRUCTURE



**+60**  
SITES



**+620KM<sup>2</sup>**  
COVERAGE



**8**  
COVERED  
OPERATIONS



**+1.5 GBPS**  
INCREASED  
CAPACITY



**99,9%**  
CURRENT  
AVAILABILITY

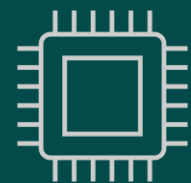


**81**  
RELIABILITY  
ACTIONS

## VALUE DELIVERED



**+60%**  
ADOPTED  
SYSTEMS



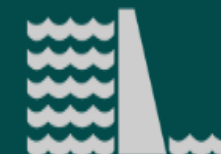
**+2K**  
CONNECTED  
DEVICES



**+380**  
CONNECTED MINING  
EQUIPMENT



**362**  
MONITORED  
CAMERAS



**64**  
GEOTECHNICAL  
STRUCTURES



**+7GB**  
INTERNET LINK  
EXPANSION

## PUBLIC LTE INFRASTRUCTURE



**28**  
COMMUNITIES  
ALONG THE EFC



**+15**  
SITES IN THE  
OPERATIONS

# COMMON FOUNDATION | MINE, RAILROAD AND PORTS



A hybrid, local-distributed architecture in the packet core layer allows a large volume of traffic and end points

**+700K**  
CONNECTED  
USERS/DEVICES

**~1200**  
RADIO BASE  
STATIONS  
(eNodeBs)

**~300Gb**  
DATA TRAFFIC

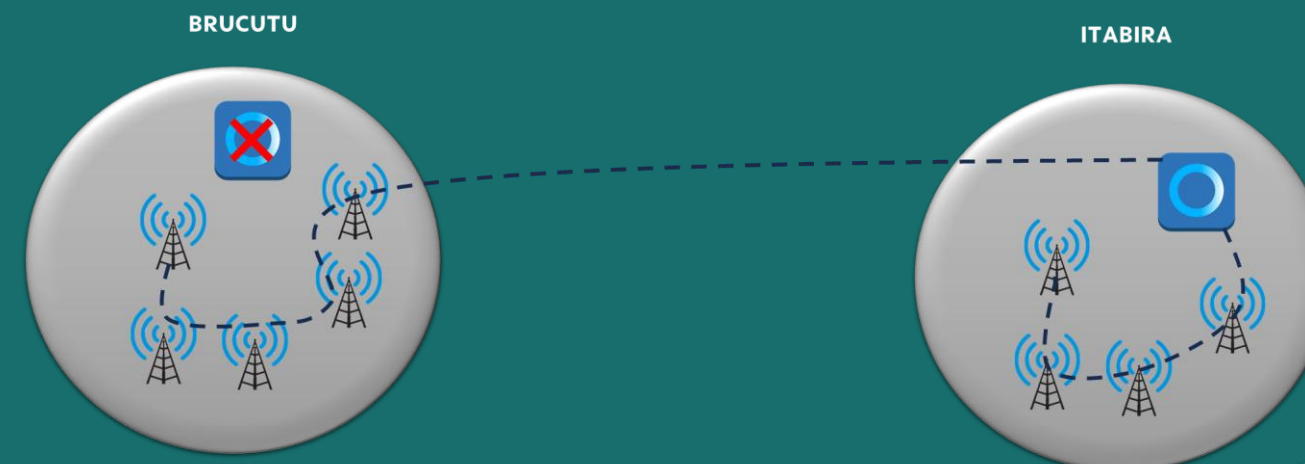
The architecture provides

LOWER  
LATENCY

HIGHER  
SECURITY

SCALABILITY  
OF NEW SITES

MME Pool setup is in progress to allow inter site redundancy

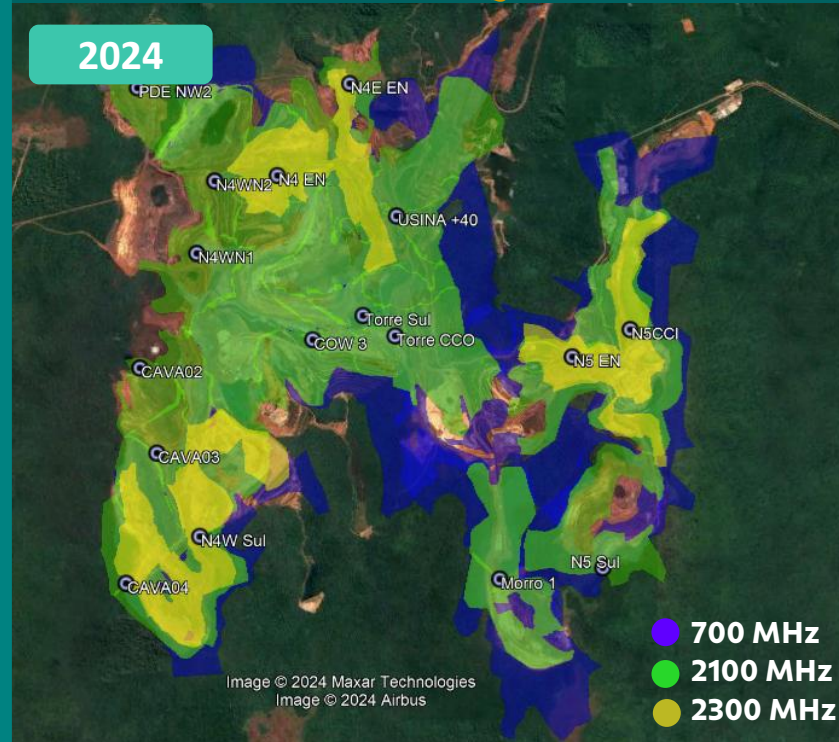


# NORTH CORRIDOR \$\$ – CARAJAS AND S11D | FULL MULTI-FREQUENCY COVERAGE

## COVERAGE EVOLUTION – CARAJÁS

**+1.4 GBPS capacity**  
**259KM<sup>2</sup> coverage**  
**97,69% availability\***

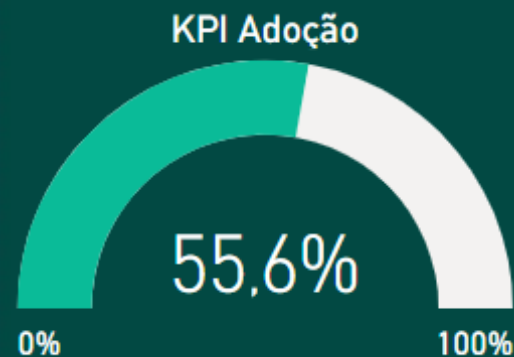
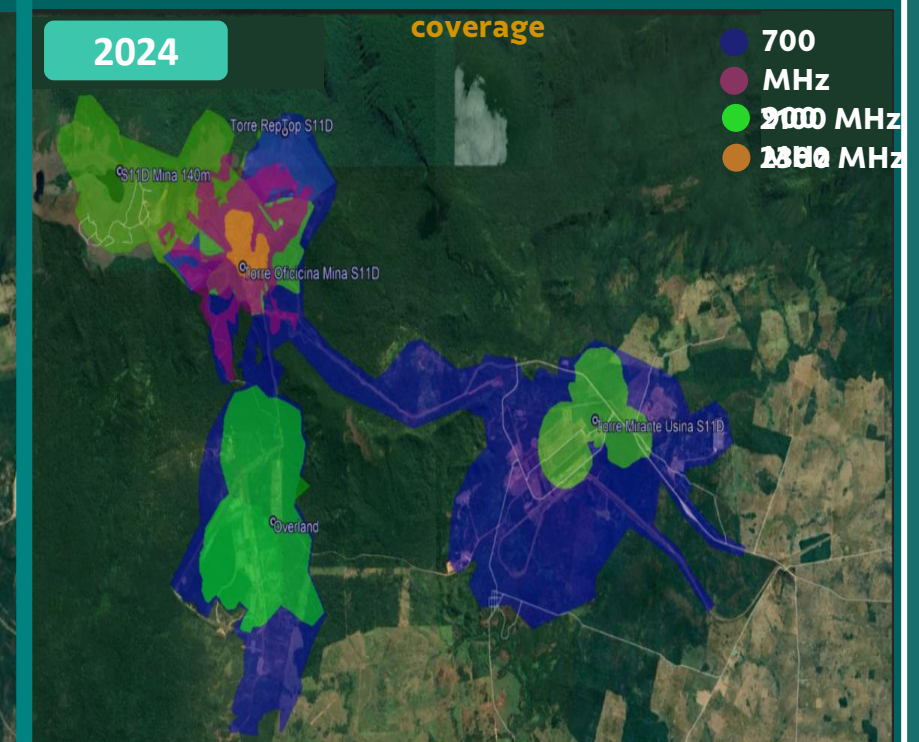
**+1.7 GBPS capacity**  
**348KM<sup>2</sup> +34,36% coverage**  
**98,93% availability\***



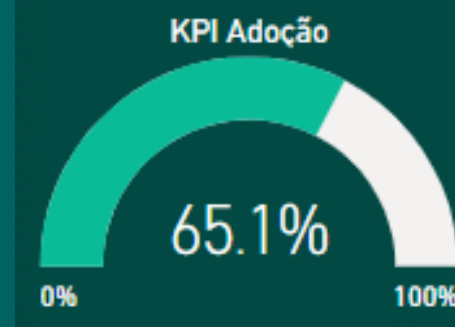
## COVERAGE EVOLUTION – SERRA SUL

**333 MBPS capacity**  
**52KM<sup>2</sup> coverage**  
**97,31% availability\***

**608 MBPS capacity**  
**122KM<sup>2</sup> +134,62% coverage**  
**99,22% availability\***



APPLICATION	ENDPOINTS	Adoption KPI
CAMINHÃO AUTÔNOMO	14	100,0%
DETECÇÃO DE FADIGA E SONOLÊNCIA	2	100,0%
DRILLING MANAGER	3	100,0%
PERFURATRIZ AUTÔNOMA	8	100,0%
SHOVEL METRICS	7	100,0%
RELIGADORES DE ENERGIA REDEL	27	90,0%
MODULAR MINING [DESPACHO]	46	86,8%
DYNAMOX	136	83,4%
SIM CARDS LIDERANÇAS	85	77,3%
INSTRUMENTAÇÃO CONVENCIONAL	12	75,0%
VÍDEO ANALYTICS - SVA	3	60,0%
PTS DIGITAL	15	50,0%
RADAR	3	37,5%
ENERGIA ZERO	30	15,0%
<b>TOTAL</b>	<b>391</b>	<b>55,6%</b>



APPLICATION	ENDPOINTS	Adoption KPI
VÍDEO ANALYTICS - SVA	3	100,0%
OPTALERT	37	94,9%
ENERGIA ZERO	31	83,8%
MEMs	43	81,1%
MINESTAR [DESPACHO]	95	68,3%
SENSOR DE PROXIMIDADE DE VEÍCULOS	356	67,9%
DYNAMOX	50	50,0%
<b>TOTAL</b>	<b>615</b>	<b>65,1%</b>

# BRUCUTU AUTONOMOUS MINE | AGILE AND FULL OFF-GRID COW

**Innovative Product:** LTE and Starlink backhaul integration.

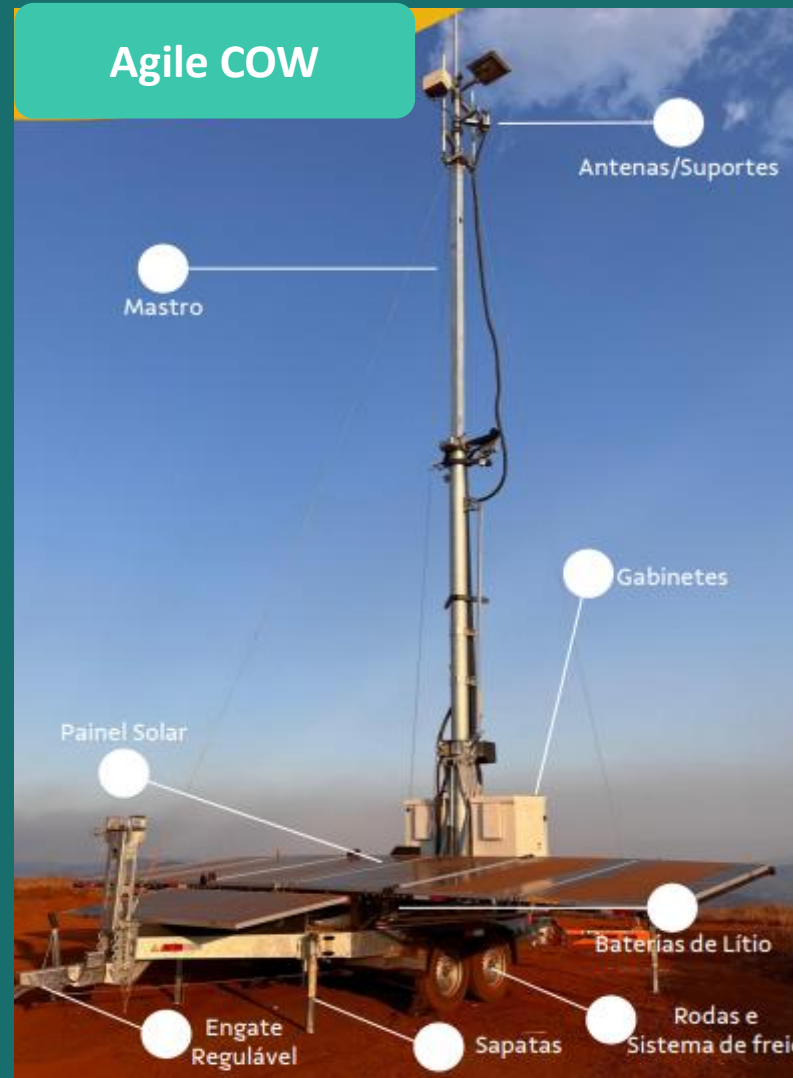
**Agility:** LTE coverage enabled in **7 business days.**

**Fleet management** operation enabled

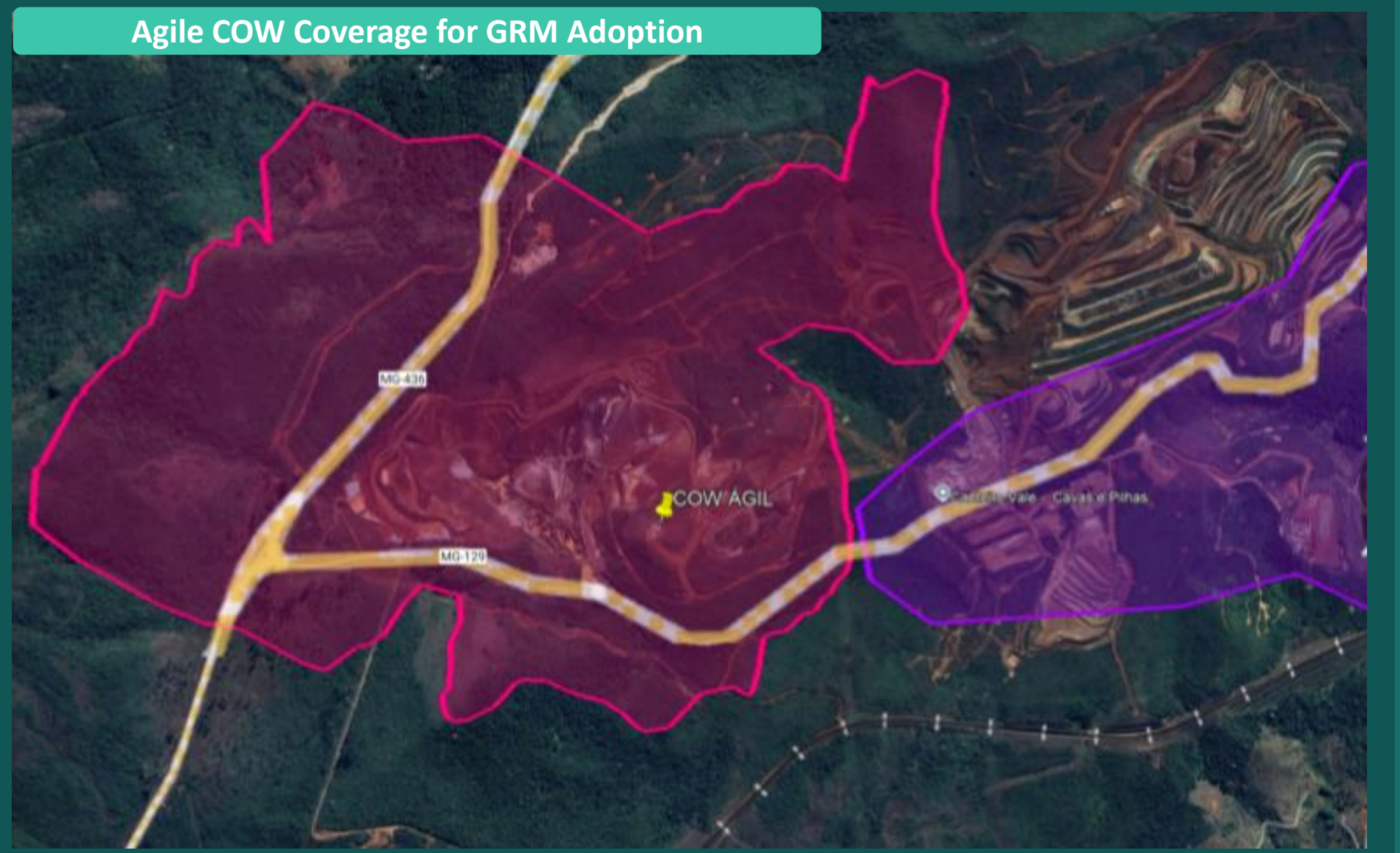
**Performance:** **99.9% network availability** over ~90 active days.

**Off-grid:** Uses only solar panels and battery, **with 3 days of autonomy without sunlight.**

**Sustainable:** Uses solar energy, eliminating the need of diesel generators.



Network Availability	
Month	Connection Availability ⓘ
2025-01	99.9%
2024-12	99.9%
2024-11	99.9%
2024-10	99.9%



## MISSION CRITICAL | FINAL REMARKS ... FOR DEBATE



- In a constantly changing mining environment... How can we build an infrastructure that is both robust and agile?
- How can we balance both cellular and satellite networks to maximize availability and performance in critical operations? There will be a tipping point between the two technologies?
- How much Intelligence in the edge could reduce overall investments in network infrastructure?
- How can we enhance the use of AI at industrial networks? Can we go beyond ...?



# Mine of the Future

Building a more sustainable and smart mining



1,761M  
0  
4,885K  
04-182%

MAXIMUM POWER 20141  
7515-2023-0205-1183-961  
01X-07T

57%

58%

# VALE AMBITIONS | MINE OF THE FUTURE



## Benchmark in safety

We cannot let our guard down. We must achieve zero fatalities and transformed lives.

- Operational safety
- Risk management
- Dam safety and decharacterization



## Best in class operator and most reliable

Achieve production volume and competitive costs consistently, with efficiency and safety.

- Production
- Financial discipline
- Priority projects
- Critical licenses
- Productivity



## Talent driven organization

The best company to work for and grow in, respecting diversity and promoting inclusion.

- Cultural transformation
- Diversity and inclusion
- Talent attraction and retention
- Technical development of people



## Leader in sustainable mining

Foster low-carbon emission solutions focused on the customer and promote sustainable mining.

- Brumadinho reparations
- Mariana reparation agreement
- Human rights
- Energy transition
- Community relations



## Reference in creating and sharing value


Be the best option for clients, investors, and partners, contributing to the development of workers and communities.


- Mega Hubs
- Premium capture
- Agglomerated production (briquettes and pellets)
- Innovation
- Vale's reputation


## Vale 2030:


A trusted partner with the most competitive and resilient portfolio





 Cultivating institutional relationships


 Generating a positive impact for people and nature


 Ensuring greater trust through increased transparency


 Delivering a high quality, and flexible iron ore portfolio

 Focusing on customer-oriented solutions

 Accelerating copper growth

 Reference in safety and operational excellence

 Securing competitiveness through a talent-driven and agile company

 Fostering innovation and digital solutions

# MINE OF THE FUTURE | STRATEGIC FRAMEWORK – VALE 100

 We exist to improve lives and transform the future. Together.

## ► Strategy

Promote **sustainable mining**, contributing to our license to operate.

Foster **low-carbon solutions** centered on the customer, focusing on high-quality products and capturing green premiums.

Ensure **efficient capital allocation** to support the growth agenda while maintaining attractive shareholder returns and a healthy balance sheet in any scenario.

## Environment

- **Industry cycles will continue**, with the energy transition providing a boost in demand.
- **The energy transition will be asynchronous and unequal** across sectors and geographies.
- **China will be a less reliable** driver of commodity growth.
- High **geopolitical volatility** will become the 'new normal.'
- **Mineral supply will become** increasingly challenging.
- **Technology will be essential** to make mining safer and more sustainable.
- **Talent will be scarce.**

## Business

### Growth Platforms



### Emerging Opportunities

### Business Adjacencies



## Levers

-  **Safety**
-  **VPS**
-  **People**
-  **Innovation**
-  **Sustainability**

## Ambitions

### A company recognized for being:

-  A benchmark in safety
-  The best in class operator and the most reliable
-  A talent driven organization
-  A leader in sustainable mining
-  A reference in creating and sharing value

Source: Marketing and Strategy

# MINE OF THE FUTURE | AXES

For more integrated and efficient mining, five key action areas will combine efforts to generate social and environmental value:

## Future Workforce



How can we ensure our teams are prepared for rapid technological and market changes while also meeting employee well-being and development needs?

## Advanced and Connected Operations



How can we increase the accuracy and efficiency of our activities, improve product quality, and make our processes more connected?

## Zero Tailings, Waste, and Carbon



How can we develop techniques to drive CO<sub>2</sub> reduction and offset emissions while also achieving zero tailings in operations?

## Minimally Invasive Mines



How can we explore the full potential of our mines with the smallest possible environmental footprint?

## Value Sharing



How can we make value generation for the community and other stakeholders tangible throughout the entire lifecycle of the operation?

# MINE OF THE FUTURE | PRELIMINARY OPPORTUNITIES AND CHALLENGES



## Advanced and Connected Operations

- Assurance of Coverage and Connectivity Quality;
- Integration of the Entire Value Chain;
- Traceability (Quality);
- Greater Adherence to Plans;
- Automation of processes from mine to plant;
- Shorter Lead Time and Waste Reduction.



## Zero Tailings, Waste, and Carbon

- Reprocessing of MFe stockpiles and dams;
- Utilization of Waste Rock and Tailings as By-products;
- Mine and Plant Planning with a Lower GHG Footprint;
- CO2 Capture from waste rocks.



## Workforce of the Future

- Lack of new professionals in the mining sector;
- Attraction and retention of talent with digital and environmental skills;
- Continuous reskilling to keep up with technological innovations;
- Use of technologies to enhance training programs.



## Value Sharing

- Territory Management;
- Progressive Mine Closure;
- Vendors Development;
- Promotion of the local economy;
- Integration of sustainable growth with value generation for stakeholders.



## Minimally Invasive Mines

- Non-invasive drilling;
- Reduction of production areas;
- More selective mining;
- Reduction of waste rock movement;
- Mining near sensitive and urban structures;
- Social license to operate.

Source: Vale

# NOKIA COGNITIVE DIGITAL MINE (CDM)

## Intelligence to enhance mine operations and increase agility

Industrial real-time AI platform for faster, predictive and better decisions to boost mine resource planning, asset usage, scheduling, and operation safety

### 1. Sense

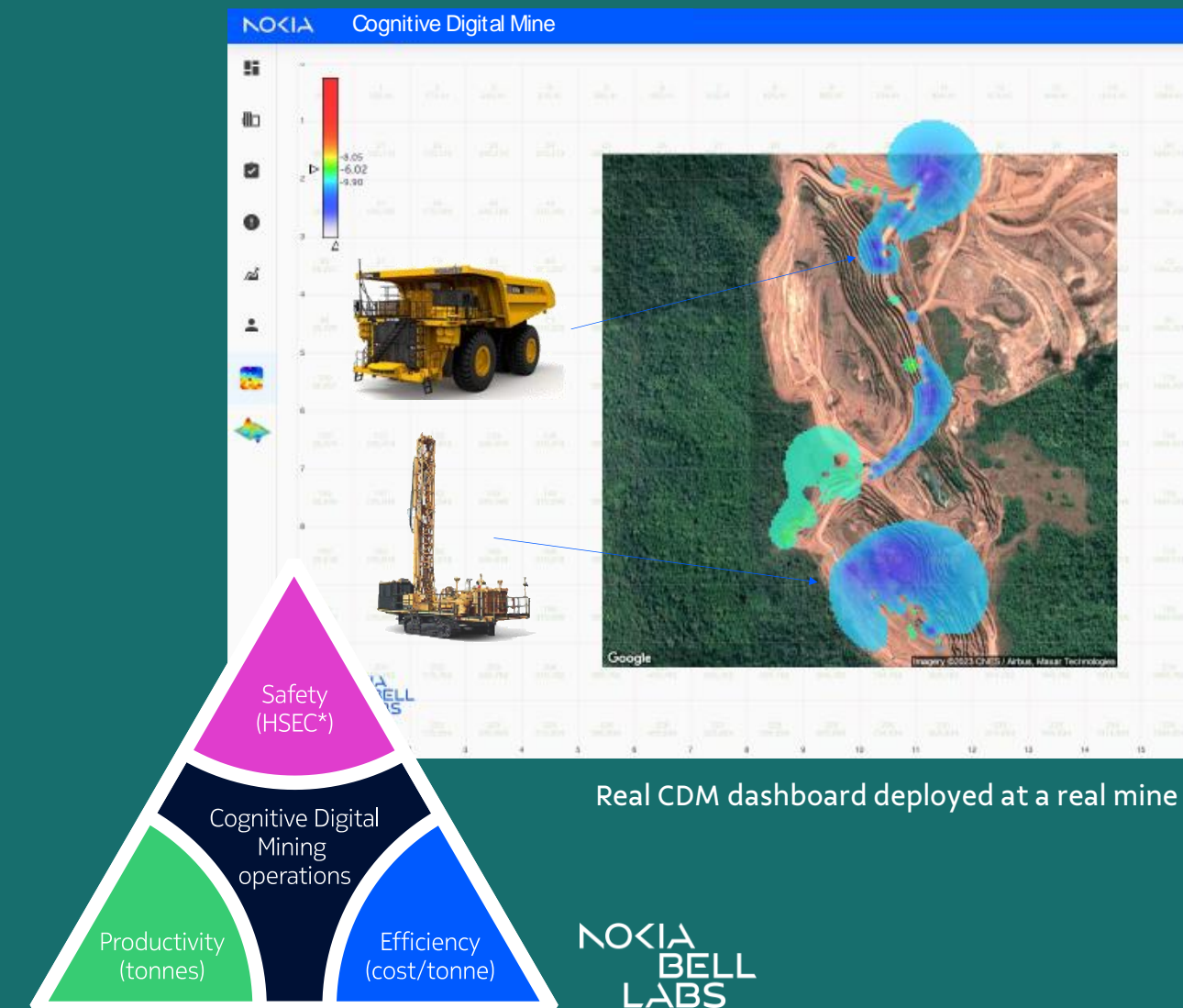
Autonomously learn the implications of monitored performance KPIs and impact on business goals

### 2. Think

Provide retroactive and predictive Insights across horizontal operations and vertical performance goals

### 3. Act

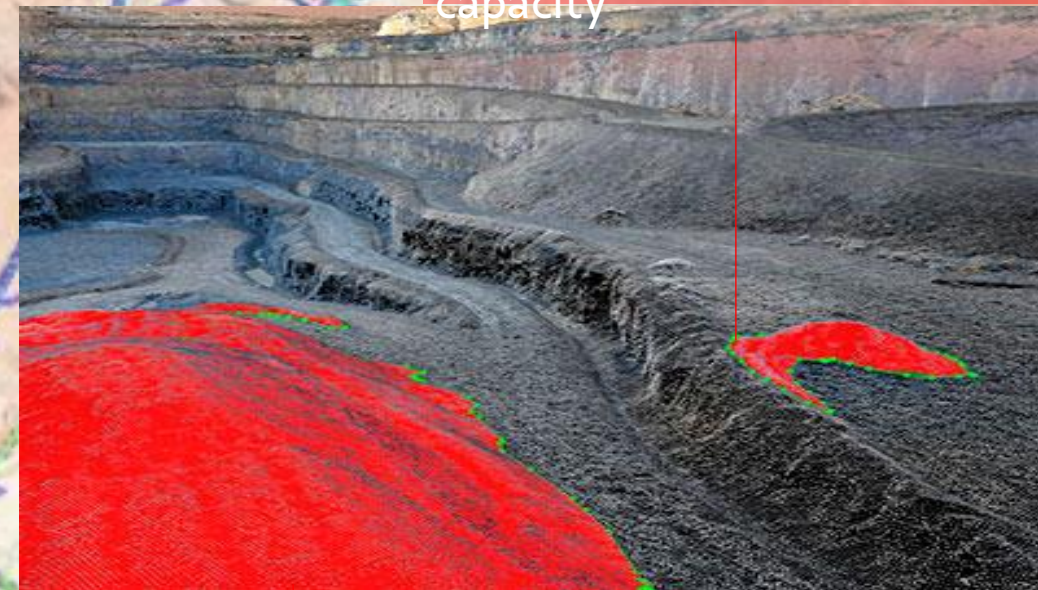
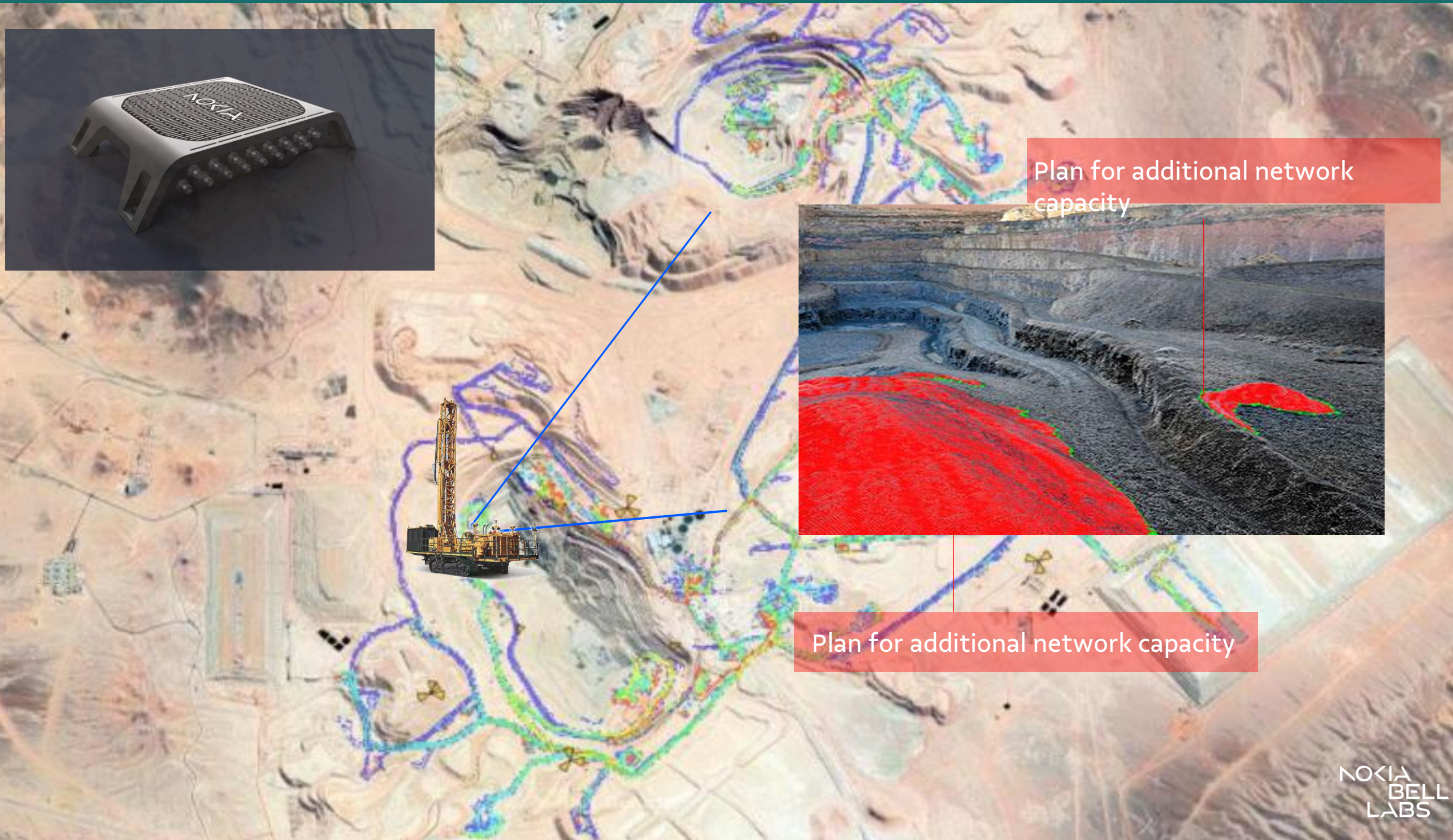
Provide actionable intelligence to optimize operation, resource allocation across mine operations leveraging generative AI



Real CDM dashboard deployed at a real mine

NOKIA  
BELL  
LABS

# REFINED PERSPECTIVE | SMART OPERATIONS







**Thank You!**

Foto: Ricardo Teles