CloudRAN.ai

Private 5G for Mining & Remote Operations

Dedicated wireless connectivity for remote equipment, mobile assets, high-uplink video, worker safety, and field operations

Mining sites are becoming more connected, automated, and data-driven.

Haul trucks, drilling equipment, cameras, sensors, field teams, control rooms, safety systems, and autonomous machinery increasingly depend on reliable communications across wide, remote, and constantly changing environments.

Where Wi-Fi, public cellular, and fixed infrastructure cannot fully support these operational requirements, Private 5G provides a dedicated wireless layer designed around the mine’ s coverage, mobility, performance, security, and control needs.

Built for surface mines, remote industrial sites, processing facilities, and connected mining operations.

Deployment-ready Private 4G/5G infrastructure

for mining operators, contractors, service providers, system integrators, equipment manufacturers, and technology partners.

02 THE MINING CONNECTIVITY GAP

Mining operations are becoming more remote, automated, and data-driven

Modern mining operations increasingly depend on continuous data exchange between people, vehicles, machines, cameras, sensors, control rooms, and operational platforms.

A connected mining site may need to support:

- Remotely operated haul trucks and heavy equipment
- Environmental and geotechnical sensors
- Autonomous and semi-autonomous vehicles
- Tablets, handheld terminals, and maintenance tools
- Vehicle-mounted multi-camera systems
- Worker safety and location systems
- Driver and operator fatigue monitoring
- Push-to-talk, video, data, and emergency communications
- Equipment telemetry and condition monitoring
- Fleet management and dispatch platforms
- Drones and mobile inspection systems
- Edge analytics and AI-assisted operational systems

Connectivity in these environments affects more than workforce productivity. It can influence equipment availability, situational awareness, worker exposure, operational continuity, and the ability to introduce remote or autonomous workflows.

Why this matters

- When latency is unstable, remote-control workflows become harder to operate safely and confidently.
- When uplink capacity is insufficient, multi-camera video, inspection, and safety monitoring can degrade.
- When coverage cannot adapt, changing haul routes and operating zones create connectivity gaps.
- When communication traffic is best-effort, operational teams may lose priority when the network is under pressure.

Private 5G helps address this gap by giving mining operators a dedicated wireless layer designed around the site's equipment, workflows, risks, and production priorities.

The challenge

Mining teams often need wireless networks that can support:

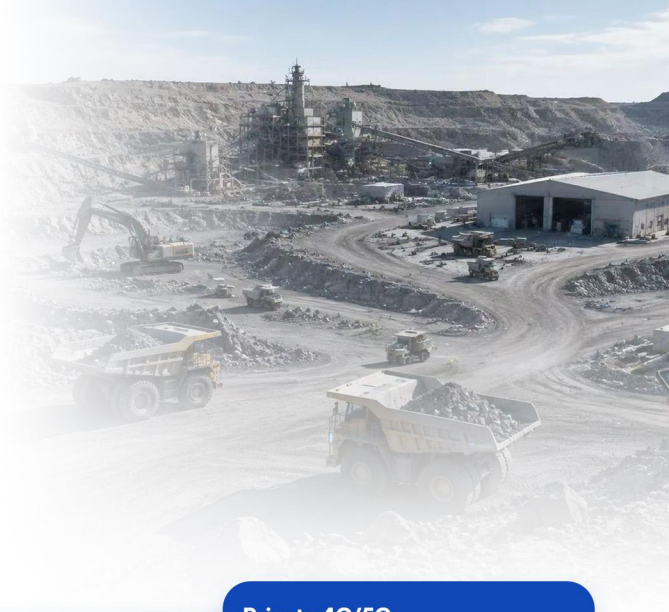
- Wide-area coverage across large and irregular sites
- Mobility for haul trucks, service vehicles, machinery, and field teams
- Low and stable latency for remote-control workflows
- Strong uplink capacity for simultaneous camera feeds
- Flexible coverage as haul roads and operating zones change
- Secure connectivity for operational devices and applications
- Local traffic handling for responsive on-site systems
- Priority communications during incidents or network congestion
- Centralized monitoring across remote infrastructure
- A practical path from one use case to a larger production deployment

Traditional connectivity options still play valuable roles. Wi-Fi can support offices, workshops, and defined indoor areas. Public cellular networks provide useful wide-area mobility where coverage is available. Fixed networks remain important for stationary infrastructure.

However, many mining use cases require a level of site-specific coverage, mobility, uplink performance, traffic control, and operational ownership that these options may not provide alone.

03 PRIVATE 5G VS WI-FI VS PUBLIC NETWORKS

Different mining workflows require different connectivity models



Wi-Fi, public cellular networks, fixed infrastructure, and Private 5G can all contribute to a mining connectivity strategy. The question is not which technology is universally better. The question is which model fits each operational requirement.

Operational fit at a glance

Requirement	Wi-Fi	Public 4G/5G
Control over coverage design	Enterprise-controlled but generally site-limited	Operator-controlled
Mobility across large	Variable	Strong where service is available
Remote equipment control	Possible in defined environments	Operator and service dependent
High-uplink multi-camera video	Variable	Capacity and coverage dependent
Local traffic and edge processing	Possible	Usually service dependent
Traffic prioritization and QoS	Limited or implementation dependent	Operator controlled
Secure device onboarding	Enterprise dependent	Operator managed
Coverage across changing terrain	May require dense access-point infrastructure	Dependent on operator coverage
Mission-critical communications	Application dependent	Service dependent
Operational ownership	Enterprise managed	Operator managed

Private 4G/5G

- Designed around the mining site
- Engineered for the required routes and zones
- Designed around the application requirement
- Uplink can be planned for the use case
- Local breakout and edge-ready options
- Enterprise-defined and configurable
- SIM-based, policy-controlled access
- Can be planned and adjusted around operations
- Integrated MCX upgrade path available
- Enterprise or managed-service model

Simple framing

Wi-Fi

Wi-Fi remains useful for offices, workshops, warehouses, processing buildings, and controlled areas. It can become more difficult to scale across large outdoor footprints, moving vehicles, irregular terrain, and latency-sensitive workflows.

Public 4G/5G

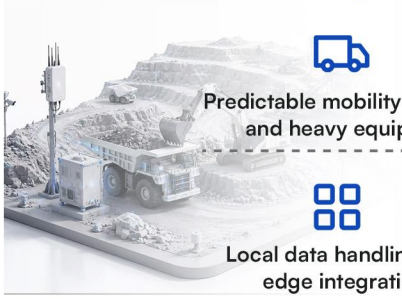
Public cellular networks provide broad mobility and can be valuable for general field connectivity. However, the operator controls coverage, traffic policy, capacity, service behavior, and upgrade priorities.

Private 4G/5G

Private 4G/5G gives the mining operator a dedicated network designed around its own operating zones, users, vehicles, devices, applications, and service priorities.

When Private 5G becomes relevant

Private 5G becomes especially relevant when a mining operation needs:



- Predictable mobility for trucks and heavy equipment
- Stable, low-latency remote control
- Strong uplink for vehicle-mounted video
- Coverage aligned with changing operating zones
- Local data handling and edge integration
- Secure separation for operational traffic
- Priority communications for field and safety teams
- A repeatable network model that can expand across the site

04 MINING USE CASES

Private 5G is strongest where connectivity affects safety, visibility, and production

Mining connectivity is not simply about providing internet access across a remote site.

It supports mobile equipment, remote operations, worker coordination, operational video, safety systems, and the data flows required for increasingly automated mining environments.

Common use cases

1 **Remote-controlled equipment**

Low-latency connectivity between remote operators, vehicle-control systems, cameras, and mobile equipment.

2 **Multi-camera video**

High-uplink connectivity for forward, rear, side, blind-spot, cabin, and equipment-status camera feeds.

3 **Autonomous and semi-autonomous vehicles**

Mobility and operational data exchange for haul trucks, service vehicles, drills, loaders, and other connected machinery.

4 **Worker safety and fatigue monitoring**

Reliable transmission of video, alerts, wearable data, and safety information to operational teams.

5 **Fleet management and dispatch**

Real-time connectivity for vehicle location, scheduling, utilization, route management, and production coordination.

6 **Equipment telemetry and predictive maintenance**

Connectivity for condition monitoring, diagnostics, sensor data, maintenance tools, and equipment-health platforms.

7 **Drones and remote inspection**

Wireless support for aerial inspection, surveying, stockpile monitoring, site mapping, and visual assessment.

8 **Environmental monitoring**

Connected sensors for air quality, dust, vibration, temperature, water, slope stability, and site conditions.

9 **Edge analytics and AI-assisted operations**

ocal data flows supporting video analytics, fatigue detection, dispatch optimization, equipment monitoring, and future AI applications.

10 **Mission-critical communications**

Prioritized push-to-talk, video, data, alerts, and incident coordination for field teams, control rooms, maintenance crews, and safety personnel.

> CloudRAN.AI Integrated MCX can connect mission-critical applications with the Private 5G Core and RAN so operational communications receive network-aware priority, QoS, and policy treatment when required.
> **Explore Integrated MCX for Private 5G.**

Example environments

Private 5G can be evaluated across:

- Open-pit and surface mining operations
- Underground mine environments
- Haul roads and loading zones
- Processing and materials-handling facilities
- Maintenance yards and workshops
- Remote command and control centres
- Stockpile and storage areas
- Industrial rail and conveyor systems
- Exploration and temporary operating sites
- Energy and utility infrastructure supporting mine operations

A good Private 5G opportunity usually starts with a practical question

Is connectivity limiting remote operations, equipment mobility, safety monitoring, operational visibility, or the ability to scale automation?

If the answer is yes, Private 5G may be worth evaluating.

05 FROM PILOT TO PRODUCTION

What makes Private 5G work in a mining environment?

Many private network initiatives begin as pilots.
The challenge is moving from a controlled demonstration to a network that performs across real terrain, operating shifts, moving equipment, changing work zones, and production-critical workflows.

For mining, a successful rollout depends on more than radio performance. It requires a clearly defined use case, realistic coverage planning, application-aware traffic design, integration with mining systems, and an operating model that can be maintained in the field.

Five things that matter

1 A clearly defined operational use case

The project should begin with a real mining requirement, such as:

- Unstable connectivity for remote-controlled equipment
- Insufficient uplink for multi-camera video
- Coverage gaps along a haul route
- Limited visibility into mobile equipment
- Weak communications across remote work zones
- The need to reduce personnel exposure in hazardous areas
- A requirement for prioritized field and incident communications

A focused use case makes it easier to define technical requirements and measure whether the deployment creates operational value.

2 Coverage planning for real terrain

Mining sites are dynamic radio environments.
Planning should account for:

- Pit geometry and elevation changes
- Haul roads and vehicle routes
- Excavation, loading, and dumping areas
- Terrain obstruction and shadowing
- Moving machinery and temporary infrastructure
- Surface, underground, or mixed environments
- Backhaul and power availability
- Future changes to operating zones
- Antenna placement, mounting, and environmental protection
- Coverage overlap and mobility between cells

The network must follow the operation as it changes.

3 Application-aware performance

Mining applications may have very different traffic profiles.
Remote control requires low latency/jitter, multi-cameras strain uplink, sensors must stay available despite low data, and field communications take priority in emergencies.
Performance planning should consider:

- Uplink and downlink requirements
- Latency and jitter
- Camera quantity and video quality
- Device density
- Mobility and handover
- QoS and traffic priority
- Local breakout and edge processing
- Availability and operational resilience

4 Integration with mining operations

Private 5G becomes more valuable when it connects with the systems already used by the mine.
These may include:

- Fleet management and dispatch
- Remote-control platforms
- Video management systems
- Equipment telemetry
- Fatigue-detection and safety platforms
- Asset and personnel tracking
- Environmental monitoring
- Edge-computing and AI platforms
- Maintenance and operations systems
- Alarm and incident-management tools
- MCX applications and legacy radio environments
- OSS and centralized network management

5 A right-sized, manageable architecture

The best starting point is rarely a site-wide transformation from day one.
A practical model should allow the operator to begin with one route, zone, vehicle group, video workflow, or safety requirement and expand after the technology and operational value are validated.
The network should also be straightforward to deploy, monitor, troubleshoot, update, and support across a remote industrial environment.

A faster path to mining demonstrations, trials, and focused proof-of-concepts

For many mining operators, contractors, equipment providers, and system integrators, the first step is not a complete production network. The first step is validating a defined use case under realistic operating conditions.

That is where a Private 5G Starter Kit can help.

What is a Private 5G Starter Kit?

A Private 5G Starter Kit is a compact, integrated environment designed to reduce the time and complexity required to begin evaluating private network capabilities.

For mining, it can support:

- Remote-equipment demonstrations
- Edge and local-breakout demonstrations
- Vehicle-mounted CPE validation
- Push-to-talk, video, and data communication tests
- Camera and uplink testing
- Partner-led mining demonstrations
- Low-latency application trials
- Equipment OEM and application integration
- Tablet, handheld, gateway, and sensor testing
- Mobility validation across a defined route
- Training and technical validation

A Starter Kit is not a substitute for full site engineering. It provides a controlled starting point for proving devices, workflows, integrations, and performance requirements before a larger rollout is designed.

Practical benefits

A well-designed Starter Kit can help mining teams and partners:

- Shorten the path from interest to demonstration
- Reduce initial integration complexity
- Validate mining devices earlier
- Test uplink, latency, and mobility requirements
- Evaluate one operational zone before expanding
- Demonstrate the solution to mine operators and stakeholders
- Build a repeatable deployment model
- Identify integration requirements before production rollout
- Move into detailed site planning with better information

Best-fit questions

A Starter Kit is particularly useful when the project needs to answer questions such as:

- Can Private 5G support this remote-control workflow?
- Can several camera feeds operate without affecting control traffic?
- Can the selected CPE connect the vehicle’ s existing systems?
- Can we validate mobility along a representative haul route?
- Can local breakout improve application responsiveness?
- Can operational communications receive priority during congestion?
- Can the solution integrate with the mine’ s existing platforms?
- What would be required to move from one pilot zone to production?

07 HOW CLOUDRAN.AI HELPS

Deployment-ready Private 4G/5G infrastructure for mining and remote operations

CloudRAN.AI provides Private 4G/5G solutions designed for real industrial and operational environments.

For mining, the focus is practical: helping operators, contractors, service providers, equipment manufacturers, system integrators, and partners move from use-case evaluation to field validation and from focused pilots to repeatable production deployments.

CloudRAN.AI value pillars

Fast to deploy

Compact, integrated network architecture can reduce the number of components, simplify site installation, and shorten the path to an operational network.

Designed for mobility

Private RAN, vehicle-mounted CPEs, and mobility support can connect trucks, equipment, workers, cameras, and operational devices across multiple coverage areas.

Built for uplink-heavy operations

The network can be designed around multi-camera video, equipment telemetry, safety monitoring, and other field-to-control-centre data flows.

Edge-ready and responsive

Private 5G Core and local-breakout options can keep latency-sensitive traffic closer to remote-control, monitoring, and operational systems.

Secure and manageable

SIM-based access, traffic policies, centralized monitoring, and lifecycle management provide greater control over operational connectivity.

Mission-critical communications ready

CloudRAN.AI Integrated MCX provides an upgrade path for network-prioritized push-to-talk, video, and data, with options for QoS, policy control, and legacy interworking.

Proof in practice: Smart mining in Ordos

At a large open-pit coal mine in Ordos, China, CloudRAN.AI Private 5G supported remote-controlled mining trucks, vehicle-mounted multi-camera feeds, fatigue monitoring, equipment connectivity, and broader smart-mining workflows.

The approximately 6.25 km² deployment reported:

- Remote-control latency reduced from 50—100 ms to 5—15 ms
- Available bandwidth increased from 10—50 Mbps to 500 Mbps—1 Gbps
- Connected-device capacity expanded from 50—100 to 500—1,000
- Safety-monitoring accuracy increased from 70—80% to 95—98%
- A reported productivity improvement of 30—40%

These results demonstrate the combined importance of latency, uplink capacity, mobility, coverage flexibility, and operational visibility. Actual performance and outcomes will vary according to spectrum, terrain, architecture, devices, applications, and operating conditions.

Read the full Ordos smart-mining case study.

A practical Private 5G architecture for connected mining operations

A mining Private 5G deployment typically connects vehicles, field equipment, cameras, workers, radio infrastructure, the 5G Core, operational tools, and mining applications.

Example structure

Mining devices and assets

- Haul trucks and service vehicles
- Drills, loaders, excavators, and mobile machinery
- Vehicle-mounted cameras
- CPEs and industrial gateways
- Tablets and handheld terminals
- Wearables and safety devices
- Drones and inspection systems
- Environmental and geotechnical sensors
- Communication devices

CloudRAN.AI Private 4G/5G RAN

- Indoor, outdoor, and all-in-one base-station options
- Coverage designed around mining routes and operating zones
- Mobility across multiple coverage areas
- Flexible deployment for changing terrain
- Integrated or external antenna options

Private 5G Core and local connectivity

- Device authentication and session management
- Local breakout
- Traffic policy and QoS
- Edge-ready connectivity
- Secure operational traffic
- Integration with enterprise or customer-approved infrastructure

Network operations and communications

- Centralized monitoring
- Configuration and lifecycle management
- Remote support and diagnostics
- Performance and alarm visibility
- Mission-critical push-to-talk, video, and data
- Legacy communication interworking where required

Mining and enterprise applications

- Remote vehicle and equipment control
- Fleet management and dispatch
- Video management and analytics
- Fatigue and safety monitoring
- Equipment telemetry
- Predictive maintenance
- Asset and personnel tracking
- Environmental monitoring
- Edge AI and operational analytics
- Incident and emergency coordination

Integration-ready by design

CloudRAN.AI can support partner-led deployment discussions around:

- Mining vehicle and equipment integration
- CPE and gateway selection
- Camera and video-platform integration
- Private 5G Core and local breakout
- Edge-computing platforms
- Fleet and dispatch systems
- Safety and monitoring platforms
- OSS and network-management integration
- MCX applications and legacy radio interoperability
- AI-assisted RF planning through Megrez
- Enterprise security and identity requirements

The goal

The goal is to create a controlled and repeatable connectivity foundation—

one that supports safer field operations, stronger visibility, increased automation, and a practical path from connected equipment to AI-ready mining.

How to evaluate a Private 5G opportunity in mining

Private 5G should be evaluated through both operational and technical questions.

Use case

- What operational problem are we trying to solve?
- Is the priority remote control, video, vehicle mobility, worker safety, field communications, telemetry, or automation?
- Is the existing network limiting responsiveness, visibility, coverage, or scale?
- Which workflow creates the clearest operational value if improved?
- Does the application require guaranteed priority or only general connectivity?

Site environment

- Is the operation open-pit, underground, processing-focused, or mixed?
- How large is the target coverage area?
- How does the terrain change over time?
- Where are the haul roads, loading zones, maintenance areas, and command locations?
- Are coverage requirements temporary, permanent, or frequently changing?
- What power and backhaul infrastructure is available?
- What environmental, mounting, and protection requirements apply?

Devices and traffic

- Which vehicles, machines, cameras, sensors, and user devices need to connect?
- Are the devices natively 5G-enabled, or will they require CPEs and gateways?
- How many simultaneous camera feeds are required?
- What are the uplink, latency, jitter, and availability requirements?
- How quickly are vehicles moving between coverage areas?
- Does traffic need to remain local to the mine?
- Which applications require QoS or priority?

Operations and communications

- Who will operate and support the network?
- Is centralized or remote monitoring required?
- How will alarms, incidents, and maintenance workflows be handled?
- Are mission-critical push-to-talk, video, or data services required?
- Does the site need interoperability with TETRA, DMR, or another legacy communication environment?
- What cybersecurity, identity, and data-control requirements apply?

Deployment path

- Is the first phase a demo, testbed, field pilot, or production deployment?
- Which route, zone, vehicle group, or workflow should be validated first?
- What is the target timeline?
- What does success look like?
- Which results must be demonstrated before the network expands?
- What additional infrastructure would be required for production scale?

Recommended first step

Begin with one operationally meaningful use case and a realistic deployment environment.

A pilot should not try to demonstrate every possible mining application. It should prove whether Private 5G can solve one clearly defined operational problem better than the current connectivity model.

Strong starting points can include:

- Multi-camera uplink from one remotely operated vehicle
- Remote control across a defined route or operating zone
- Vehicle-mounted CPE and equipment integration
- Safety and fatigue-monitoring video
- Coverage and mobility testing along a haul route
- Field communications across one work area
- Environmental or equipment-monitoring sensors
- A partner-led mining demonstration using a Starter Kit

10

Ready to explore Private 5G for mining and remote operations?

Private 5G is becoming a practical option for mining operators, contractors, service providers, system integrators, equipment manufacturers, and technology partners that need more control over operational connectivity.

Whether you are evaluating remote-controlled equipment, improving multi-camera visibility, connecting a mobile fleet, planning an automation initiative, or introducing mission-critical communications, CloudRAN.AI can help identify a practical starting point.

Talk to us about

- Private 5G opportunity assessment for mining
- Open-pit, underground, and remote-site coverage
- Remote-control latency and mobility requirements
- Multi-camera uplink and video validation
- Vehicle-mounted CPE and equipment connectivity
- Starter Kit demonstrations and proof-of-concepts
- Local breakout and edge integration
- Fleet, safety, video, and telemetry platforms
- AI-assisted network planning
- Integrated MCX for push-to-talk, video, and data
- Legacy communication interoperability
- Moving from one pilot zone to production rollout
- Partner-ready mining architectures

Choose the conversation that moves your Private 5G evaluation forward

Request a technical briefing | Book a Starter Kit demonstration | Discuss a mining use case | Contact CloudRAN.AI

CloudRAN.ai

contact@cloud-ran.ai

Deployment-ready Private 4G/5G infrastructure for real mining and remote operating environments

A practical starting point. A focused use case. A clear path from field validation to production.

About CloudRAN.AI

CloudRAN.AI, a Cloudnet.ai company, provides deployment-ready Private 4G/5G infrastructure for enterprise, industrial, operator, mining, and partner environments.

Our portfolio combines integrated RAN infrastructure, Private 5G Core, CPE, centralized network management, compact Starter Kits, AI-assisted planning, and mission-critical communications.

CloudRAN.AI solutions are designed to help teams reduce rollout complexity, validate operational use cases faster, and deliver controlled, production-ready connectivity for real-world environments.

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