PREVENT UNINTENDED INTERACTIONS BETWEEN PEOPLE AND ASSETS

CAT® MINESTAR™ DETECT FOR UNDERGROUND

CAT®

KEEP YOUR PEOPLE SAFE

One of the biggest risks to safety in a mining operation is interaction between mobile assets and personnel. The risk exposure in this area is significant, as vehicles and people continually use the same working spaces — intrinsically hazardous environments in which reduced visibility and changes to the operating context are the norm.

Cat® MineStar™ Detect addresses these risks by giving vehicle operators the ability to detect the presence of nearby personnel and vehicles through high-precision proximity awareness and proximity detection systems, giving contextual awareness and warning of proximity hazards well before a threat is posed — even when clear line of sight is restricted.

CAT MINESTAR DETECT FOR UNDERGROUND

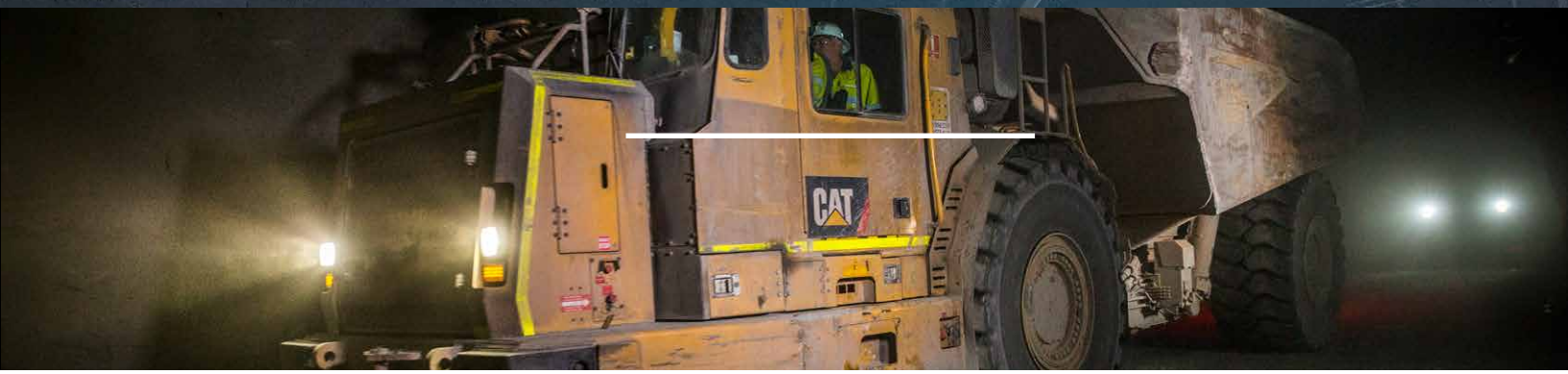
PROXIMITY DETECTION
Enhancing site safety

Detect Proximity Detection uses high-precision proximity detection to keep machine operators and on-foot personnel aware of each other and their positioning in real time. The solution delivers audio, visual and vibration alerts to personnel when proximity limits are breached. Proximity Detection uses high-bandwidth and low-latency technology with peer-to-peer communication independent of network connectivity. The system features intuitive installation with user-friendly configuration and maintenance.

PROXIMITY DETECTION —
FEATURES AND BENEFITS

Detect Proximity Detection is highly configurable, allowing for optimal coverage based on the machine type, regardless of manufacturer. The coverage area is configurable to get the best performance based on the application. Detect Proximity Detection couples a simple, intuitive interface with both audible and visual warnings that enable operators to make informed decisions when moving machines. It alerts the operator when another equipped vehicle or person is in close proximity so they can decide if action needs to be taken to avoid it.

- Configurable for continuous or discrete alarming for people and vehicles (V-V, V-P)
- Minimizes nuisance audible alarms, enabling the operator to focus on the task at hand
- Graphical display for greater levels of operator awareness
- Configurable for directional or non-directional (radial) detection depending on the machine to provide optimal coverage
- Sensory feedback every 300 milliseconds
- System uses visual and audible means to alert operator
- Multiple warning levels help operator assess distance to detected asset
- Overrides other Cat® MineStar™ for underground applications in the event of a high-risk proximity event
- Robust components designed and tested to work in the most rugged applications
- Offboard infrastructure is not required
- Onboard diagnostics monitor system health and alert operator to any issues
- Aligns with elements of the EMESRT Design Philosophy (DP-5) for Machine Operation Controls and the Performance Requirement (PR-5A) for Vehicle Interaction Systems

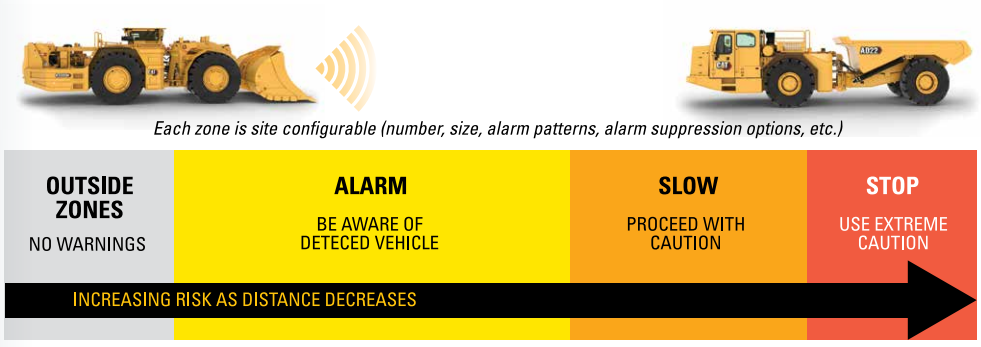


PROXIMITY DETECTION — FUNCTIONALITY

Proximity detection is a simple system that offers vehicle-to-vehicle and pedestrian-to-vehicle functionality. Once configured, each Detect deployment operates independent of any infrastructure, so it can operate virtually anywhere that vehicles and personnel are equipped with the required hardware products.

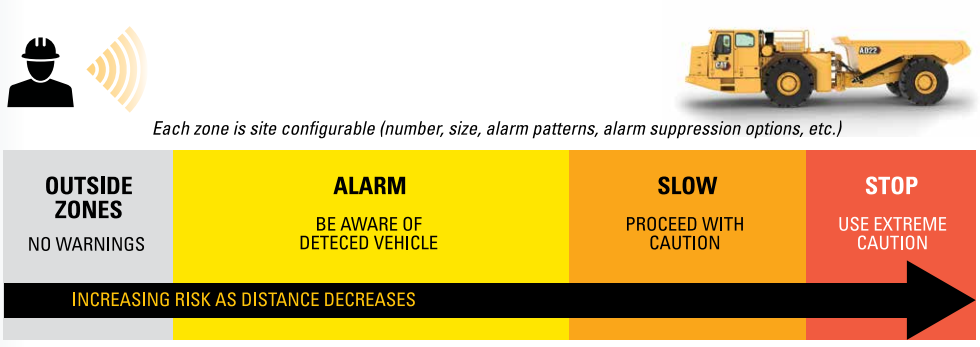
VEHICLE-TO-VEHICLE PROXIMITY DETECTION

Vehicle-to-vehicle proximity detection is achieved by fitting each vehicle with one or more MineStar for underground sensory nodes that communicate with sensory nodes on other vehicles. The distance between vehicles is calculated and communicated to the onboard cabin display, which provides warnings to the operator if another vehicle is too close.



PEDESTRIAN-TO-VEHICLE PROXIMITY DETECTION.

Pedestrian-to-vehicle proximity detection is achieved by providing all ground-based mine personnel with a Detect Personal Node. The Personal Node communicates with vehicle-mounted Nodes and triggers visible and audible warnings to the pedestrian and the vehicle operator if the vehicle and pedestrian are both within predefined detection zones.



PROXIMITY DETECTION —
CONFIGURATION

Detect configuration is performed remotely via a proprietary or internal management web platform. This remote option makes it possible for you to choose the specific machine configuration that provides the best coverage for your application. Currently, up to four zones can be configured around a vehicle or pedestrian.

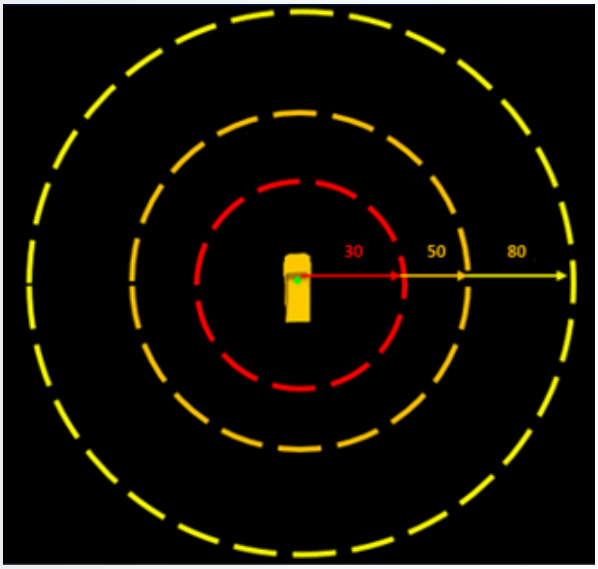
VEHICLE-TO-VEHICLE PROXIMITY DETECTION

Predefined zones enable detected vehicles and/or pedestrians to be categorized and trigger visual and audible warnings to operators.

- Up to four zones can be configured around a vehicle or pedestrian: ALERT, ALARM, SLOW and STOP representing the lowest to highest risk due to an approaching vehicle or pedestrian.
- For a vehicle, the outer perimeters for ALARM, SLOW, and STOP are 80, 50 and 30 meters — but the sizes may differ per site requirements.
- For a pedestrian, the outer perimeters for ALERT, ALARM, SLOW and STOP are typically 20, 15, 10 and 5 meters — but the sizes may differ per site requirements.

Each zone is defined as a circle around the vehicle. A fourth ALERT zone is available if configured. The vehicle icon at the center of the zone represents your vehicle. The System Administrator will configure zone sizes. Zones measure radially out from each Node.

The onboard display can be configured to display different alarms for different proximity events. An audible warning activates when a vehicle or pedestrian is detected within one of the pre-set detection zones. The management platform allows for configuration of audible warnings to meet specific site requirements. An audible warning continues to sound until muted by the operator or the detected vehicle or pedestrian exits the lowest-risk detection zone. If the operator mutes the audible warning, the visible warning remains.

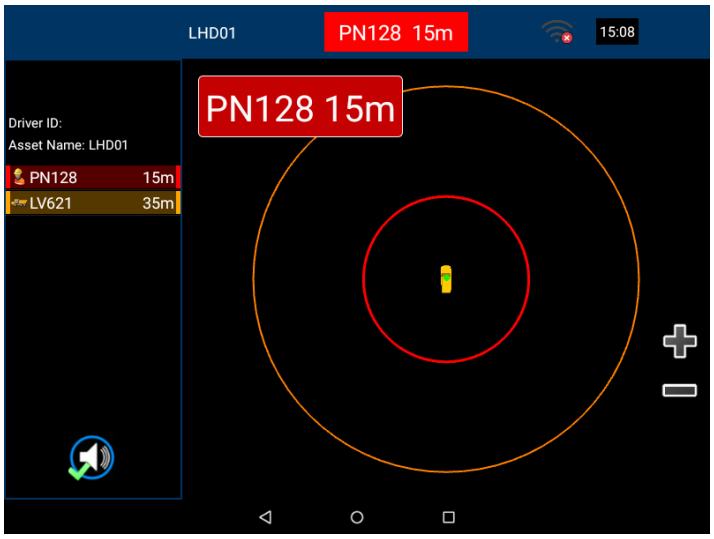


Zone/Function	Radius (m)	Show static zone circles	Audio alarm	Repeat alarm
ALERT	Disabled	N/A	N/A	N/A
ALARM	80	No	No beep	No
SLOW	50	No	Single beep	No
STOP	30	No	2 beeps per second	Yes

Detect allows for two different types of detection, depending on the number of sensory Nodes fitted on a vehicle. The detection type influences how an operator interprets a proximity alarm. In standard implementations, the two detection types are:

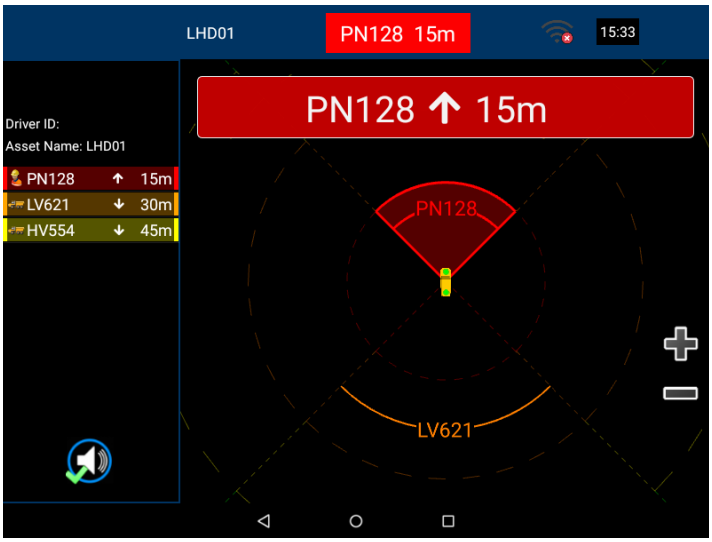
» Radial detection

» Directional detection



Radial Detection

Where one sensory Node is installed on a vehicle, a warning triggers when a vehicle or pedestrian is detected entering a detection zone from any direction.



Directional Detection

Two Nodes installed in a vehicle with a Vehicle PC provide directional detection. Detect provides additional indication as to whether an object is located at the front or rear of a vehicle.

In-Vehicle Detection (IVD)

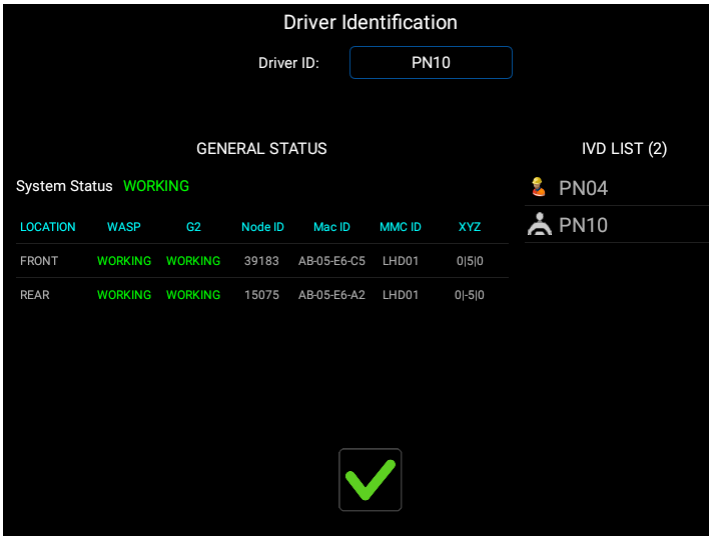
In-Vehicle-Detection is when a pedestrian wearing a Detect Personal Node enters a vehicle equipped with MineStar sensory nodes, disabling the Personal Node's proximity trigger alarms.

The user activates IVD mode to confirm that they are inside a vehicle as either the operator or a passenger. IVD mode may be automatic or manual depending on site policies

For auto-IVD, IVD is activated automatically as you enter the vehicle. The Personal Node beeps and flashes for 20 seconds when it's in an IVD zone, then automatically enters IVD. If you leave the IVD zone, it instantly leaves IVD and returns to normal functionality. An IVD zone is typically configured to be a 1-5m diameter ring around the vehicle.

For manual IVD, the wearer of a MineStar Personal Node presses the "acknowledge" button on top of the device twice within 1.5 seconds. This changes the LED indicator lights to solid and any IVD audible alarm will mute. IVD mode is automatically deactivated when exiting the vehicle.

An IVD list is displayed on the in-cab display (if equipped) to visually present who is in the vehicle.



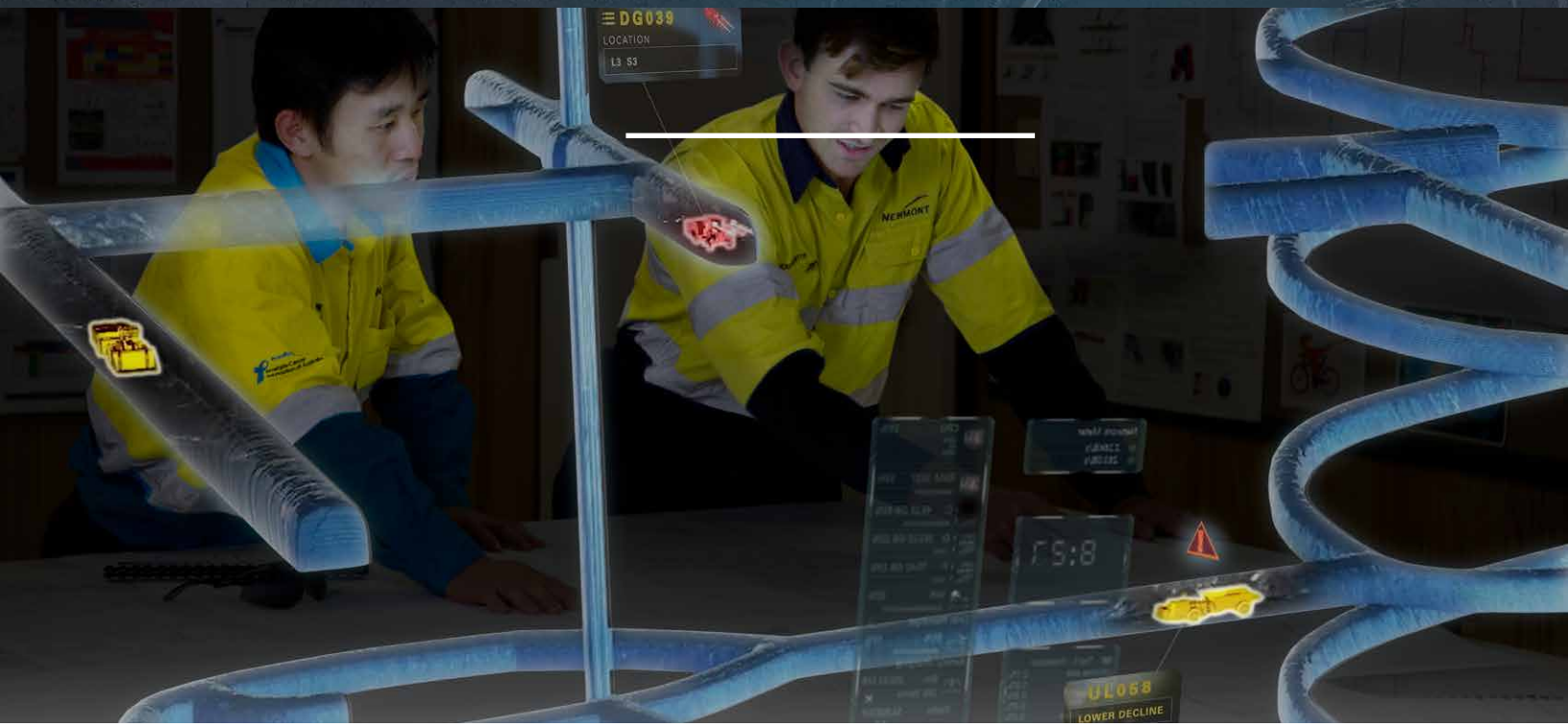
PROXIMITY AWARENESS & ASSET TRACKING

Protect your operators by providing real-time information

The Detect Proximity Awareness System (PAS) is a high-precision positioning system that tracks Detect-equipped machines, light vehicles and personnel, allowing operators to view other asset locations within a mine.

The Detect PAS uses the same onboard hardware as Detect Proximity Detection and is integrated with MineStar for underground's Wi-Fi network. While Proximity Detection alerts the equipment operator if another asset is detected around the machine during operation, Proximity Awareness is active at all times (Wi-Fi dependent), providing complete operational coverage.

Proximity Awareness is powered by MineStar's sensory and network hardware, harnessing the power of WASP™ (Wireless Ad-Hoc System for Positioning) — the world's most accurate, sub-meter, real-time 3D tracking technology.



PROXIMITY AWARENESS & ASSET TRACKING —
FEATURES & BENEFITS

When used in conjunction with Detect Proximity Detection, Proximity Awareness provides added protection. PAS has been developed to give unprecedented vision and knowledge of the movement and location of assets within an underground mine environment. The dynamic 3D mine view on the in-cab display provides underground operators with the right contextual information on other traffic and personnel movements underground, enabling a safer, more efficient operation. The onboard display shows a mine map indicating the machine's position in relation to others nearby. The interface allows operators to rotate and zoom in on areas of interest using touchscreen functionality.

With better site awareness, operators can run their equipment with more confidence. Also, cycle times can improve when operators know that loading and dump areas are clear as they get ready to pull away, allowing them to work more smoothly and efficiently.

- Allows machine operators to see locations of nearby machines and personnel in a map view on the in-cab display.
- Touchscreen functionality for zooming and target viewing.
- Asset lock that dynamically follows a machine, displaying a 100m diameter viewing radius.
- Asset search and locate.
- Safely monitors the movements of assets around areas of interest, including Declines, Production Levels, Crusher Tipples, Ore Passes and Stockpiles, Workshops, Refuge Chambers and any other location with installed MineStar network infrastructure.
- Reduces traffic congestion for increased safety and to reduce truck load and idle times.
- Enables insight into vehicle locations on major access ways (declines and major haul routes), significantly reducing the number of times haul vehicles need to stop for light vehicles or other low-priority assets.
- Monitors the movement of load and haul activities, adding greater consistency in material handling and grade control.
- Dynamically instructs operators to perform specific tasks based on their proximity to particular areas such as fuel bays and park-up locations.
- Locates idle or parked-up equipment throughout the mine, significantly reducing search times at shift changes. Locating particular assets will also help reduce maintenance cycles.

PROXIMITY AWARENESS & ASSET TRACKING — FUNCTIONALITY

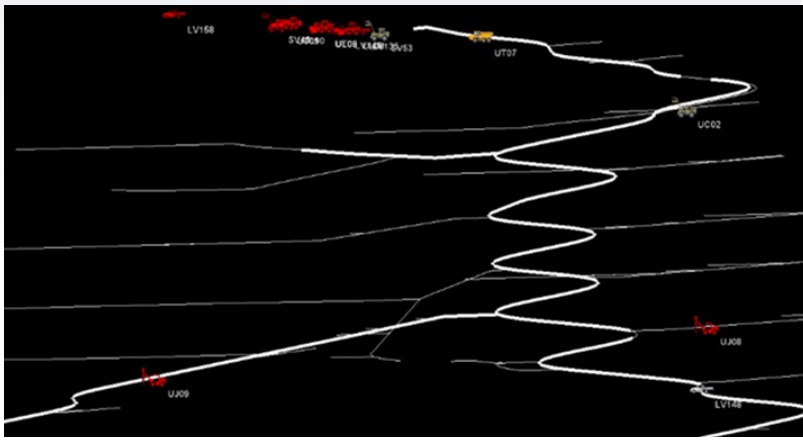
The Proximity Awareness System can be configured based on the needs of your site and fleet. PAS provides functionality for both office and onboard applications.

OFFICE FUNCTIONALITY

Minestar Proximity Awareness and Asset Tracking is powered by MineStar's network hardware, harnessing the power of WASP. MineStar Proximity Awareness and Asset Tracking has been developed to give unprecedented vision and knowledge of the movement and location of assets within an underground mine environment.

The TAGBOARD system is an optional feature that improves site access control, visibility and safety by providing alerts when people and machines enter unauthorized zones. These events are organised graphically on digital displays to create a TAGBOARD. TAGBOARD can be configured to display visual alerts depending on a list of configurable violations.

By using TAGBOARD, mine personnel can visualize the location of assets, display alarm conditions and entry/exit events in a single intuitive, easy-to-read interface. TAGBOARD is capable of raising visual alarms in the event of violations — these are represented on TAGBOARD as different icons displayed next to the asset or personnel.



ONBOARD FUNCTIONALITY

The in-cab display gives remote control operators, shift bosses or truck drivers an unprecedented window of visualisation into the whole mine operation. The dynamic 3D mine view provides operators with the right contextual information on other traffic and personnel movements underground, enabling a safer, more efficient operation. The interface allows operators to rotate and zoom in on areas of interest using touchscreen functionality.

DETECT COMPONENTS & SPECIFICATIONS

Rugged components backed by unmatched global support

For more than 25 years, Caterpillar has been providing electronic components and systems for your mining and earthmoving applications — real-world technology solutions that enhance the value of Cat products, making you more productive and profitable

Detect for underground includes both onboard and off-board components that have been developed specifically to withstand harsh mining environments. Individual components are heavily validated, and systems are integrated and tested at our Burnie proving grounds to ensure reliability and performance of hardware on machines underground.

These components — like all Cat machines, technologies and solutions — are supported by the Cat dealer network. Wherever you are in the world, your Cat dealer is ready to assist you with knowledgeable support and technology systems that enhance site performance and safety.

COMPONENTS

Onboard

DISPLAY

The high-resolution display provides operators with vital information at a glance, enabling the user to switch between screens and configure, monitor or view system data. The touchscreen display is designed for reliable performance in extreme operating conditions. Built to withstand shock and vibration, it is also sealed against dust and moisture. A single display can be used for Proximity Awareness, Proximity Detection and Fleet.

NODES

The onboard Node is a vehicle-mounted, low-power, high-precision positioning and proximity detection device specifically designed for harsh mining environments. Mobile Nodes integrate with in-cab display devices for audible and visual alerts and location visualization. All Minestar for Underground Nodes use CSIRO's WASP WiFi system, including Time of Arrival (ToA) techniques for accurate ranging and operating in two frequency bands: 5.8 GHz for WASP and 2.4 GHz for data communications. The Mobile Node is powered by the vehicle's DC power system. Multiple Mobile Nodes can be mounted on a single vehicle to improve accuracy and provide redundancy.

POWER DISTRIBUTION UNIT

The Power Distribution and Protection Unit (PDPU) is a vehicle-mounted voltage conditioning unit used to distribute vehicle power to devices such as Mobile Nodes and the display device in the cab.

Off-Board

PERSONNEL DEVICES

The Minestar Personal Node is a battery-powered tracking and proximity detection device, worn by personnel and specifically designed for harsh mining environments. Personal Nodes provide combined positioning, proximity awareness and proximity detection for personnel. The Personal Node has a simple physical user interface with no on/off switch. The device automatically turns off when placed in the charging dock and turns on when removed. The device includes over-the-air configuration and firmware upgrades, with no cables required for either charging or configuration of alarms.

WIRELESS RADIO

The MineStar for Underground Wi-Fi WASP wireless radio is an agnostic 802.11 n radio with an integrated WASP tracking module. The Wi-Fi WASP radio throughput peak is 100mb/s airtime with 1 Gigabit backhaul via Ethernet connection. Radios can be daisy-chained up to 1km from a backbone fiber connection using a CAT 5E Ethernet cable. The MineStar for Underground Wi-Fi WASP network provides mines the capability for underground connectivity, no matter the application.

WIRELESS RADIO BRIDGE

The Minestar Wi-Fi WASP Bridge operates by receiving WASP tracking signals from a Detect-connected machine or personnel device and onward transmits it to an existing Wi-Fi network (2.4 GHz) for backhaul. The Wi-Fi WASP bridge is connected to a third-party Access Point via CAT 5E Ethernet or wirelessly via 2.8 GHz Wi-Fi.

SPECIFICATIONS

Touchscreen Display	
Display screen	4:3 aspect ratio. 8-inch diagonal; 162 mm x 121.5 mm. Resolution: 800 x 600; dot pitch: 0.0675 mm x 0.2025 mm; 50 Hz Refresh rate. Brightness: 250 nit typical, designed for underground use. (1 nit = 1 Cd/m2). Touch Screen: 5-wire resistive on 1.8 mm glass and with surface protection film.
Processor	Intel® Atom™ E3845 1.91 GHz. 4GB DDR3L 1333 RAM
Wireless LAN	Two Silex Industrial Wi-Fi IEE 802.11 b/g/n (2.4GHz) modules with MIMO technology.
Storage	32 GB Wide Temperature MLC SSD with wear levelling
Electrical input	8 Vdc to 40 Vdc
Interfaces	One 10/100 Base-T LAN port Three RS-232 ports One Composite Video Capture: NTSC, PAL-B, PAL-D, PAL-G, PAL-I, PAL-K Two CAN bus
Operating temperature	-40°C to +75°C
Humidity	0% to 95% RH, non-condensing.
Dimensions	220 x 193 x 55 mm
Weight	1.5kg (with UPS fitted)
Ingress protection	IP65
Standards/Compliance	

Onboard Node	
Input Voltage	10 Vdc to 53 Vdc
Dimensions	110 x 75 x 67 mm including connector, excluding bracket
Weight	440 g excluding bracket; 670 g including bracket; 800 g shipping weight
Operating temp	-25° C to 70° C
Humidity	5% to 85% (non-condensing)
Ingress protection	IP66
Communication interfaces	802.11b Wi-Fi, RS232, 2xDig IO, 5.8 GHz WAS
Connectors	8 pin Deutsch
Standards/Compliance	AS/NZS 4268:2012 AS/NZS 60950-1: 2005+A1:2009+A2:2013

Power Distribution	
Input Voltage	12 Vdc or 24 Vdc
Dimensions	320 x 100 x 106 mm enclosure only with blanking plugs
Weight	1.3 kg without bracket, 3.3 kg with bracket, 4.9 kg shipping weight
Operating temp	-25 °C to 60 °C
Humidity	10 % to 90 % RH (non-condensing)
Ingress protection	IP55 when used ports sealed with connectors and unused ports with supplied dust caps
Communication interfaces	
Connectors	1x 2-pin Deutsch, 4x 8-pin Deutsch
Standards/Compliance	

DETECT COMPONENTS & SPECIFICATIONS

SPECIFICATIONS — ONBOARD

WASP AP	
Input Voltage	12-55 Vdc (operating range)
Dimensions	245 x 211 x 61 mm without bracket or antennas
Weight	1.28 kg Access Point only; 1.6 kg SS bracket with screws, 166 g per antenna
Operating temp	-25 °C to 70 °C
Humidity	10 % to 90 % RH (non-condensing)
Ingress protection	IP66 when used ports sealed with connectors and unused ports with supplied dust caps
RF interfaces	2.4 GHz Wi-Fi Range: 2412 MHz to 2472 MHz Channels: Configurable selection 1 to 11 Tx Output Level: +19 dBm Modulation: 802.11b, DSSS (DBPSK, DQPSK, CCK); 802.11g/n, OFDM (BPSK, QPSK, 16QAM, 64QAM) Antenna: 2x External, Type N Coaxial 5.8 GHz WASP Range: 5725 MHz to 5850 MHz Channels: 1 to 6 overlapping channels Channel bandwidth: 18.8 MHz Tx Output Level (Peak): +18.7 dBm EIRP Modulation: QPSK Antenna: 1x External, N-Type Coaxial
Connectors	Power: 2-pin, Holin, M12 female Ethernet: 8-pin, M12/X Coded, female
Standards/Compliance	EMC: AS/NZS CISPR 32:2015 Class B

Off-board Bridge Node	
Input Voltage	12-55Vdc (operating range)
Dimensions	110 x 73 x 57 mm (enclosure only), 173 mm x 25mm dia. (antenna)
Weight	830 g with bracket, 1162 g with bracket and two antenna.
Operating temp	-25 °C to 50 °C
Humidity	10 % to 90 % RH (non-condensing)
Ingress protection	IP66 when used ports sealed with connectors and unused ports with supplied dust caps
RF interfaces	2.4 GHz Wi-Fi: 2412 MHz to 2472 MHz Channels: Configurable selection 1 to 13 Tx Output Level: +19 dBm Modulation: 802.11b, DSSS (DBPSK, DQPSK, CCK); 802.11g/n, OFDM (BPSK, QPSK, 16QAM, 64QAM) Antenna: 1x External, N-Type Coaxial 5.8 GHz WASP: 5725 MHz to 5825 MHz Channels: 1 to 6 overlapping channels Channel bandwidth: 18.8 MHz Tx Output Level (Peak): +18.7 dBm EIRP Modulation: QPSK Antenna: 1x External, N-Type Coaxial
Connectors	Power: 2-pin, Holin, female Ethernet: 8-pin, M12/A Coded, female (reserved) RF: N-Type, female
Standards/Compliance	AS/NZS 60950.1:2015

SPECIFICATIONS — OFF-BOARD

Personal Node	
Charge Time	Up to 6 hours, depending on existing charge state
Operating Time	> 18 hours for a new and fully charged battery at approximately 20°C
Dimensions	154 x 75 x 49 mm
Weight	0.56 kg (including standard belt loop)
Operating temp	-25 °C to 50 °C
Humidity	5% to 95% (non-condensing)
Ingress protection	IP66/67
RF interfaces	2.4 GHz Wireless Mesh: 2402 MHz to 2482 MHz Channels: Configurable selection 1 to 13 (default channel 11) Tx Output Level: +18 dBm @ UFL connector Modulation: 802.11b (DBPSK-2) Antenna: Internal, 2.2 dB gain 5.8 GHz WASP: 5725 MHz to 5825 MHz Channels: 1 to 6 overlapping channels Channel bandwidth: 18.8 MHz Tx Output Level (Peak): +20.23 dBm EIRP Modulation: QPSK Antenna: Internal
Connectors	Power: 2-pin, Holin, M12 female Ethernet: 8-pin, M12/X Coded, female
Standards/Compliance	EMC: AS/NZS CISPR 32:2015 Class B