becker MINING SYSTEMS

Collision Avoidance In Mining

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Introduction

What is our Collision Avoidance System (CAS) supposed to do?

- The Becker Multi-Technology CAS is designed to facilitate bi-directional notification and alert messaging against potential collisions between the following targets:

a. PERSON to VEHICLE : A person is warned of stationary or moving vehicles in close proximity.

b. VEHICLE to PERSON : The vehicle operator is warned of persons in close proximity.

c. VEHICLE to VEHICLE : The vehicle operator is warned of other stationary or moving vehicles in close proximity.

Introduction

How is it done?

The Becker COLLISION avoidance recognises that no single detection technology is currently capable of providing all of the required information to predict “dangerous proximity” in a reliable and optimal manner.

Our system is therefore differentiated from others in that it utilizes **multiple detection techniques** concurrently (as appropriate) in order to facilitate

- **System Reliability**
- **System Repeatability**
- **System Comfort.**

Introduction

The Becker CAS system incorporates a collaborative systemic approach as well as novel techniques applied to each independent detector technology such that the failings of existing technologies are circumvented through a plurality of detection and alerting systems

- **System Reliability** :
  By combination of detector redundancy and better systemic decision making based on more available information.
- **System Repeatability** :
  By ensuring best distance measurement accuracies possible under given environmental and installation conditions.
- **System Comfort** :
  By ensuring that the proximity information is conveyed to the vehicle/machine operator and the person/miner in such a manner as to minimize the annoyance factor.

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Technologies

TECHNOLOGY	MERITS	DE-MERITS
UHF RFID - Electric Field	Long Range, Reliable, UG & Surface Suitable, Inexpensive	Lack of Range Accuracy, Susceptible to metallic / dielectric blind spots
EM RFID - Electromagnetic Field	Tight Distance Suitable, Impervious to Large Metallic Obstruction	Relatively Short Range, Larger Equipment, Challenging Hazardous Area deployment
SHF RFID - Radar Ranging (TOF)	Medium Range, High Distance Accuracy, UG & Surface Suitable	Susceptible to multi-path interference, Relatively Expensive
Global Positioning System - GPS	Un-tagged hazard warning functionality, complementary to other technologies	Only surface suitable, Expensive to implement per miner for Vehicle to Personnel CAS
DTIS - Decline Traffic Information System	Productivity Enhancement + Safety Enhancement, Pre-emptive event prevention	Generally only for Vehicle to Vehicle CAS
Video Imaging - Pheripheral Vision Systems (PVS)	Well received by machine operators, Complementary to other technologies	Requires maintenance & cleaning, Driver / Machine Operator Incumbant, Susceptible to environmental dust & humidity
RADAR - Passive RADAR Ranging	Reliable, UG & Surface Suitable, Accurate	Relatively Short Range, Susceptible to metallic / dielectric blind spots (ie: No around coner functionality)
IR CAS - Infrared Detection	Inexpensive, Can integrate with other technologies	Susceptible to environmental conditions (dust & humidity)
LRS - Laser Ranging Systems	Accurate Distance Measurement, Programmable vehicular contouring possible	Expensive, Susceptible to environmental conditions (dust & humidity), Requires regular preventative maintenance
US CAS - Ultrasonic Detection	Extremely Accurate Ranging, Medium Range, Inexpensive	Susceptible to environmental conditions (acoustic noise), Requires regular preventative maintenance

Variable Warning Zones

The specific distances constituting the zone transition thresholds are variable.
Default general values for SLOW moving vehicles (less than 10km/hr) are as indicated:

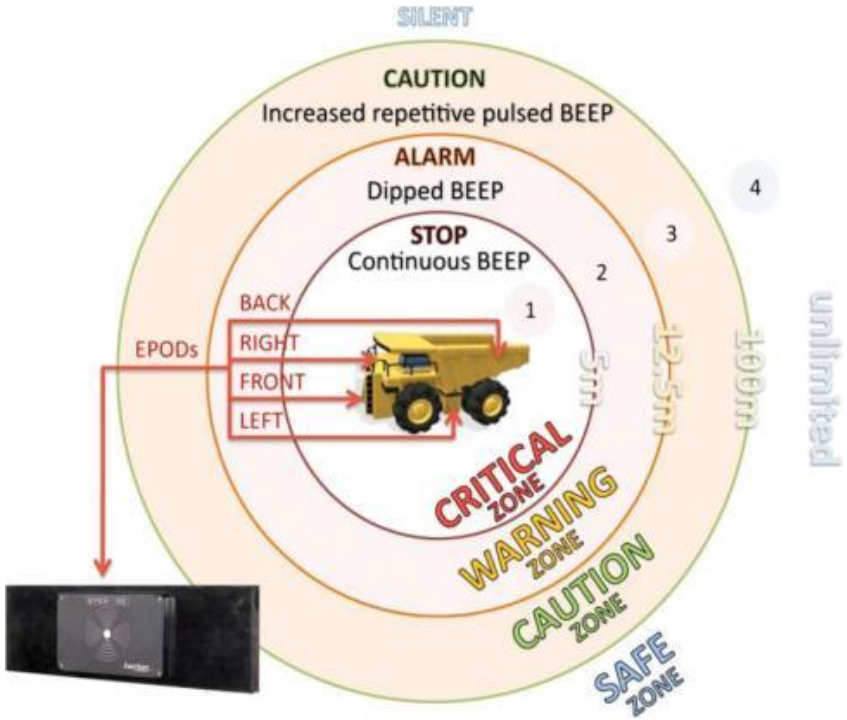
The four PROXIMITY warning zones:

0 to 5m
(1) CRITICAL zone
Forces the vehicle to stop

5 to 12.5m
(2) WARNING zone
Warn the vehicle operator and miners profoundly warning is necessary

12.5 to 100m
(3) CAUTION zone
Gently alert the vehicle operator and nearby miners

100m +
(4) SAFE zone
No warning is necessary



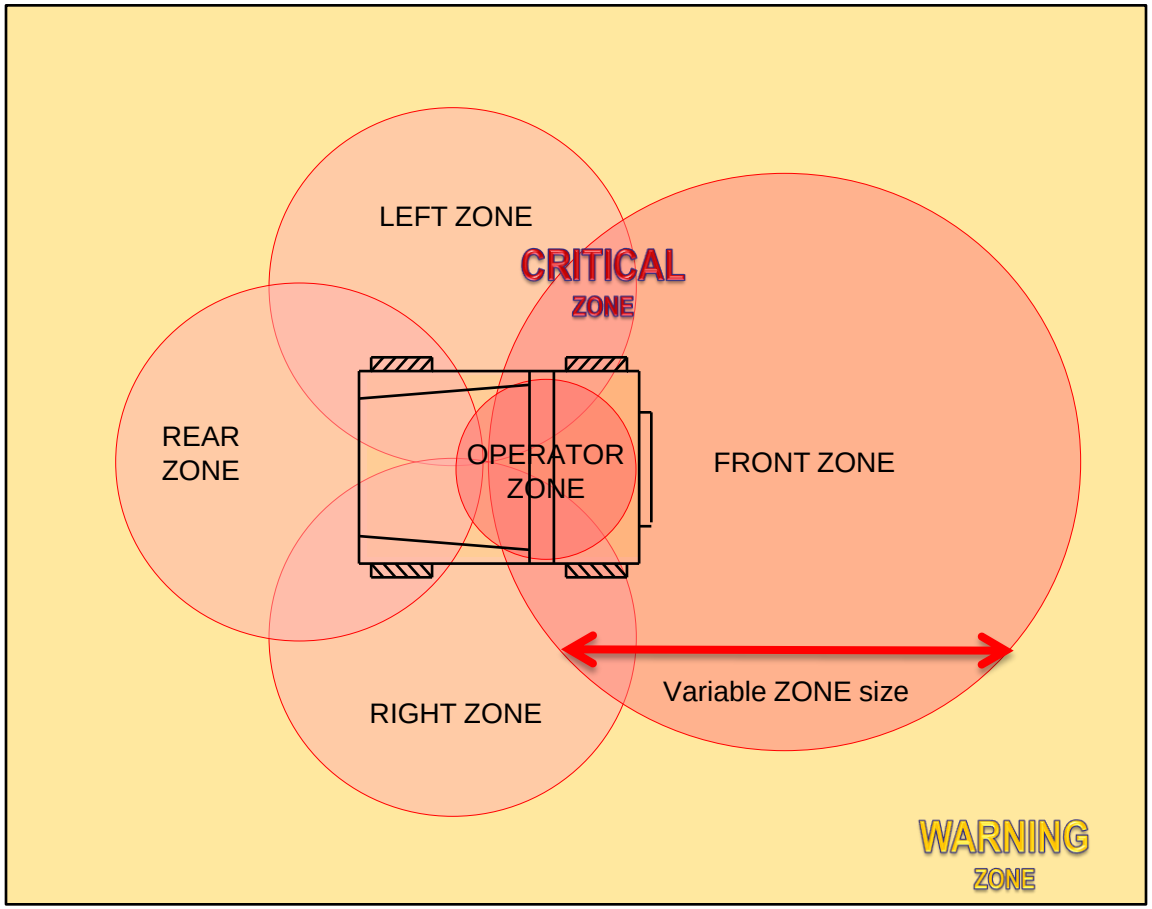
Directionality & Zone Control

Zone Differentiation Capabilities:

Cardinal LED direction indicators

Tri colour green, yellow, red indicating cardinal direction of most urgent potential person collision hazard.

Direction accuracy depends on multiple PODS being installed for discerning direction to target. For example, 4 PODS in front, back, left and right configuration will allow direction indication in 8 directions.



UCAS400 series HMI

7 SEGMENT DISPLAY (rhs)

Indicates 0 to 9 potential collision hazard count for vehicle to vehicle collision hazard types.

7 SEGMENT DISPLAY (lhs)

Indicates 0 to 9 potential collision hazard count for vehicle to personnel collision hazard types.

Cardinal LED direction indicator

Tri colour green, yellow, red indicating cardinal direction of most urgent potential person collision hazard.*

Light Sensor:

Adjusts intensity of LED's on UCAS display to prevent "bright light" distraction in low light operating conditions.

Noise level sensor

Adjusts audio annunciator's volume in response to ambient acoustic noise level automatically.

I-button Interface

Used for driver authentication and protected mode access. Also used for special feature and temporary override facilities.

High intensity Audio Beeper

Driver alert audio sounder. This beeps to alert the driver to an important change of state. The driver can then refer to the OLED display, the audio enunciated message or the in cabin light pipe for details regarding the change of state or imminent collision potential.

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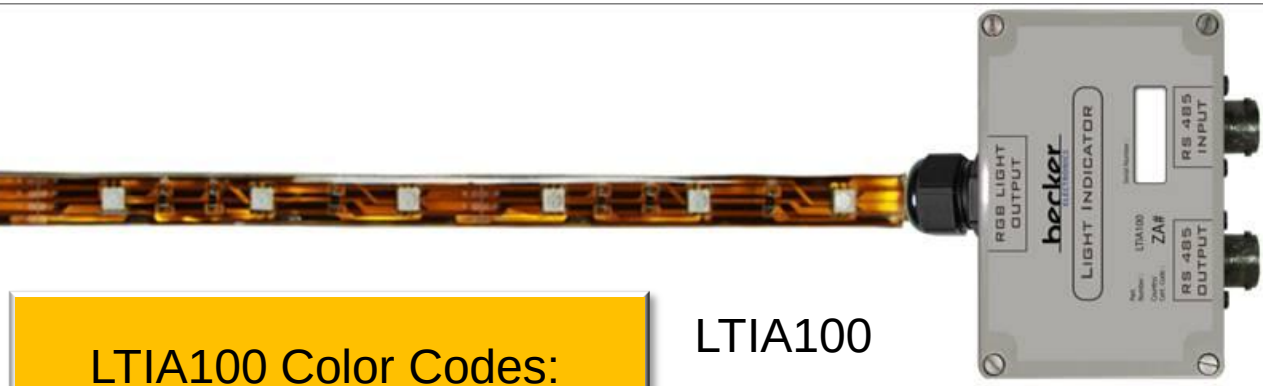
*Note: Direction accuracy depends on multiple PODS being installed for discerning direction to target. For example, 4 PODS in front, back, left and right configuration will allow direction indication in 8 directions.

LTIA100



LTIA100 Color Codes:

- White light for "Illumination"
- Green light indicates "Safe to proceed"
- Yellow light indicates "Caution"
- Blue Light indicates "Warning"
- Red light indicates "Stop".

LTIA100

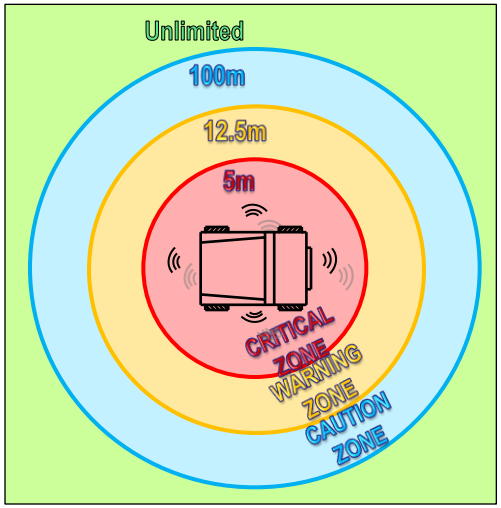
Multicolor light tube indicator.

The LTIA is a 1m long light tube with tri-colour LED's on an adhesive clear flexible tube. The intensity of each LED (Red/ Green/ Blue) can be independently adjusted on the BNET bus by the CAS controller (UCAS400/430) in response to immediate potential collision status immediate.

Any customer colour code can however be facilitated.

CAS Warning Zones:

The four PROXIMITY warning zones:



(0 to 5m) CRITICAL zone: Forces the vehicle to stop

(5 to 12.5m) WARNING zone: Warn the vehicle operator and miners profoundly warning is necessary

(12.5 to 100m) CAUTION zone: Gently alert the vehicle operator and nearby miners

(100m +) (4) SAFE zone: No warning is necessary

Antenna Options

CAS Antennas

Digital POD Antennas

- DPOD400 series (RFID Radar & UHF – External Antenna)
- DPOD600 series (RFID Radar & UHF – Internal Directional Antenna)

Electromagnetic POD Antennas

- EPOD100 series (Number Plate Form Factor Antenna)
- EPOD200 series (Cylinder Form Factor Antenna)

Vehicle Antenna

- RUVA100 series (Omni-directional RFID Radar & UHF Antenna)

DPOD400

The DPOD provides a channel for inter-target communication, such as the exchange of electromagnetic field strength and the exchange of GPS information.

DPOD400 – Digital Point of Detection Antenna

The DPOD430 is provisioned as a separate dual technology point of detection device to enable one omni-directional or, through the use of several DPOD400's, multiple directionally focused UHF and RFID Radar target detection antennas.

Two of the tri-tech collision avoidance technologies are implemented in the DPOD430, with the EPOD facilitating the third. The availability of the dual technology DPOD430 as a stand alone solution allows existing single technology DPOD330 customers an inexpensive upgrade path to dual technology, over only the original single UHF technology.

DPOD 400 – UHF Functionality

- UHF transceiver technology allows the Becker CAS Controller to detect and loosely range 'non-line of sight' vehicle or personnel potential collision targets.
- UHF technology generated range exceeds that of EM by factor 5 and that of RFID Radar by factor 2.
- UHF signal propagates well in the underground mining environment, and navigates past obstructions and around corners. For this reason, the UHF transceiver technology, is utilized for early cautioning of the vehicle operator, as well as for inter-CAS device communication.
- The DPOD430 functions as an own-vehicle transmitting tag, to alert others of the vehicle's presence.
- The DPOD430 is compatible with all existing Becker tags in the mining environment. This ensures that earlier generation tags continues to enjoy further longevity as useful CAS technology.

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DPOD600 series

The DPOD630 is recommended for large vehicles where omni-directional antennas such as the RUVA, are impractical. The CAT797 dump truck is an example of such a vehicle.

DPOD630 – Digital Point of Detection device

The Digital Point of Detection 630 includes all the same functionality as the DPOD430 from a dual technology provision perspective. It also integrates two high gain integral directional patch antennas into to enclosure to facilitate longer ranges and simpler large vehicle installations.

The first antenna provides a 110 degree UHF detection envelope, with a 20dB front back ratio. The second antenna provides a 130 degree SHF RFID Radar detection envelope with a 24dB front back ratio.

These excellent front back ratios allow the UCAS430 controller to differentiate the cardinal direction of the potential collision risk.

Shuttle Car

EPOD100

The Electromagnetic Point of Detection device is responsible for generating a uniform H-Field for distances of between 1m and 25m surrounding the point of installation on the vehicle.

EPOD100 Functionality

- Achievable range is a variable dependant on vehicle and receiver tag specifics.
- This version is a number plate sized, low profile device, typically installed on the cardinal front, back, left and right sides of the target vehicle.
- Each EPOD100 creates a unique ID EM field within a circular zone around the device.
- The field strength decays exponentially and inversely proportional to the distance cubed.
- The magnetic field (as opposed to electric field) nature of the EPOD system helps to drastically reduce the effects of collocated or in-target-path metallic obstructions.
- The physics of this rapidly decaying field strength, as a function if distance, permit the UCAS system to ascertain distance to target with hitherto unmatched accuracy and repeatability.
- The short duration, low frequency, pulsed nature of the EM field minimise the effects of continuous exposure to EM fields on the vehicle operator.
- It should be noted that the EM fields are only activated in search mode when a potential collision target has been identified by either of the remaining detection mechanisms, such as RFID Radar or UHF proximity detectors.
- The EPOD100 is configured as a simple single connector BNET client device.
- High speed balanced wire communication between the EPODs and the system master controller, such as a UCAS430, ensure that a measurement can be taken from each installed EPOD in less than 30 milliseconds.
- Failsafe mechanisms for simplifying installation and maintenance are included with every EPOD to ensure that the vehicular system quickly achieves and steadily maintains excellent performance.

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EPOD200 & RUVA100

EPOD200 – Electromagnetic Antenna.

- The Electromagnetic Point of Detection 200 is a small form factor version of the EPOD100.
- The EPOD200 is a tubular device with similar functionality to the 100.
- The smaller size of the EPOD200 does incur a range penalty of 65% compared with the EPOD100.
- This type of EM POD is typically recommended for installation conditions where the surface area available for mounting is limited.

RUVA100 - Radar UHF Vehicle Antenna

The RUVA includes an omni-directional UHF antenna and an omni-directional SHF antenna covering both the 2.4GHz & UHF frequency bands.

The Radar/UHF Vehicle Antenna incorporates an both the UHF and the RFID Radar antenna into a single small form factor design.

This antenna has 2 independent Coaxial connections, one for each antenna. The radiation pattern around the RUVA approaches perfect omni-directional symmetry, and allows the DPOD430 to detect and transmit equally in all directions.

Omni-directional coverage for both UHF and SHF frequency bands.
Typically used with the DPOD400.

CAS Vehicle Configuration & Interconnection

All equipment mounted on the vehicle will be interconnected using a proprietary cable interconnect system . This interconnect system is called **BNET** and provides for four different UCAS connector end-termination schemas:

BNET IN

Receives communication and power from previous BNET CAS device.

BNET OUT

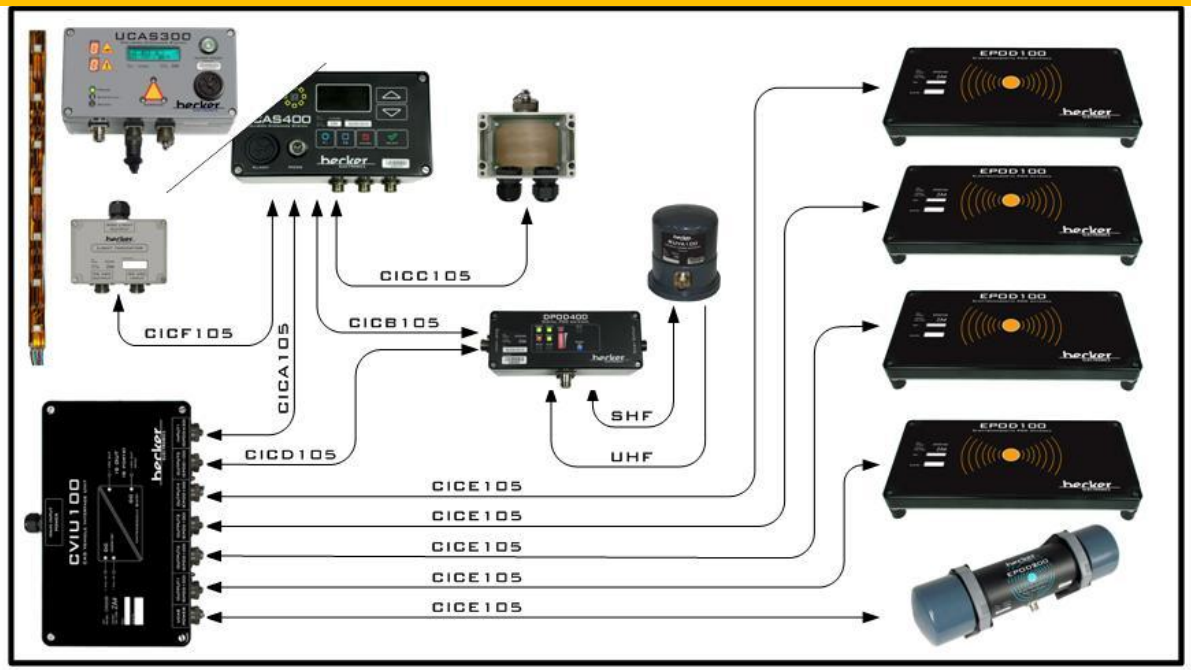
Transmits communication and power to next BNET CAS device.

BNET MASTER

Initiates BNET daisy chain connection to multiple CAS devices in series.

BNET RELAY

Provides potential free relay contacts and open collector GPIO lines. Used for example for stopping vehicles and disabling ignition switches.



UCAS330/ UCAS430
The Collision Avoidance System.

DPOD400
Digital Point of detection (POD) antenna.

EPOD100
Electromagnetic POD Antenna.

RUVA100
Omni-directional ladder antenna.
2.4GHz & UHF frequency bands.

EPOD200
Electromagnetic POD Antenna.

CVIU100
Collision Avoidance System Vehicle Interface Unit.

CTBB100
Vehicle ignition and brake relay in a screw terminal box.

LTIA100
Multicolor light tube indicator.

Collision Avoidance System Cabling

CICA105: CVIU100 to UCAS
CICB105: UCAS to DPOD400
CICC105: UCAS to CTBB100
CICD105: DPOD400 to CVIU100
CICE105: CVIU100 to EPOD
CICF105: UCAS to LTIA100

Personal CAS Equipment

These five appropriate Active RFID technologies with their proceeding personal device reference acronyms, are as follows:

TPT0 : Tag Personnel Type 0 ; Transmits UHF RFID Packets Only, and is self powered by self-contained Lithium Battery. This device interoperates with the **DPOD**

TCT0 : Tag Cap Lamp Type 0 ; Transmits UHF RFID Packets Only, and is powered by external Cap Lamp Battery Power. This device interoperates with the **DPOD**.

TCT1 : Tag Cap Lamp Type 1 ; Transmits and Receives UHF RFID Packets, and is powered by external Cap Lamp Battery Power. This device is also capable of receiving UHF Radiating Cable remote evacuation signals. This device interoperates with the **DPOD**.

TCT2 : Tag Cap Lamp Type 2 ; Provides the exact same functionality as the TCT1, and extends the functionality to include detection of Electromagnetic signals. This device interoperates with the **DPOD** and the **EPOD**.

TCT3 : Tag Cap Lamp Type 3 ; Provides the exact same functionality as the TCT2, and extends the functionality to include RFID Radar. This device interoperates with the **DPOD** the **EPOD** and the **RPOD**.

Installation Examples

The images below are from an LHD at Xstrata Kroondaal. This site has been the trial site for Becker' Tri Technology solutions.

EPOD/RPOD's installed near the scoop. The EPOD signal is not affected by the scoop position.

EPOD/RPOD's installed on rear of vehicle in a protected position.

Pantha Software Suite

Pantha Software Suite is the evolution of the original CATS standalone application, consisting of applications that bind various Becker Systems together :

- Tagging & Tracking - ATR, IPICO, Wireless devices (WRAP)
- Leaky Feeder Diagnostics (RBDA)
- Remote Evacuation Signaling (RESS)
- Collision Avoidance (CAS)
- Wireless Router (WRAP)
- and more…

The Pantha Suite

- Primary Sub-systems
  - Communication Services
  - Database Services
  - Automation Services
  - Web Services
- System Tools
  - Pantha Administration
  - Pantha View Terminal

Tagging & Tracking

System Components

- Pantha Suite
- Passive and/or Active Tags
- Tag Readers
- Server Machine
- Backbone Infrastructure

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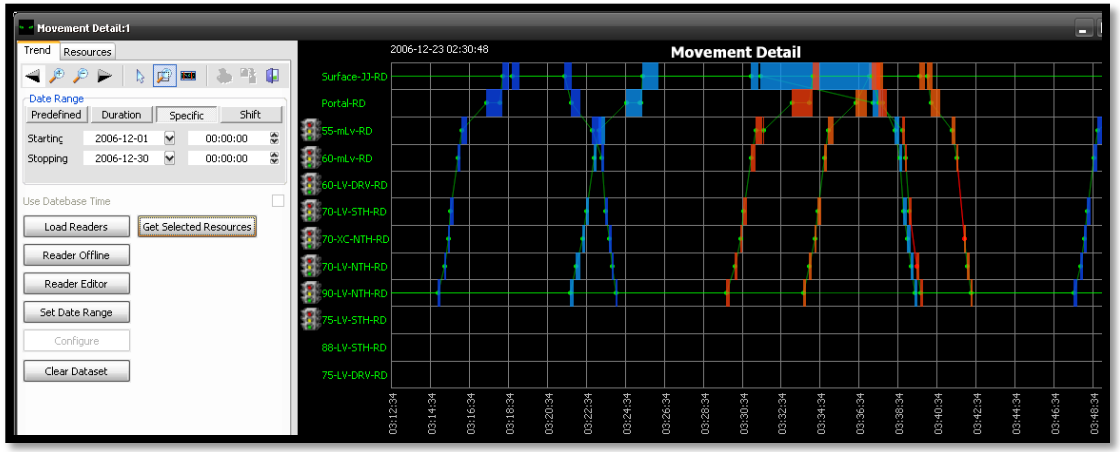
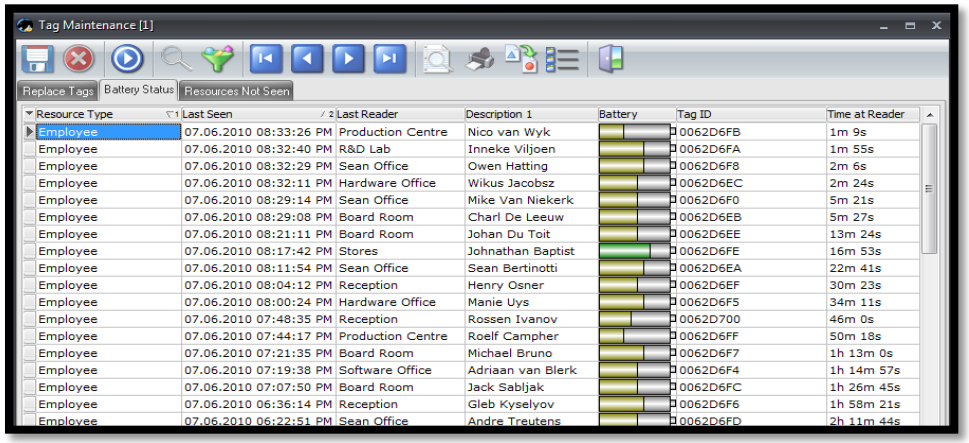
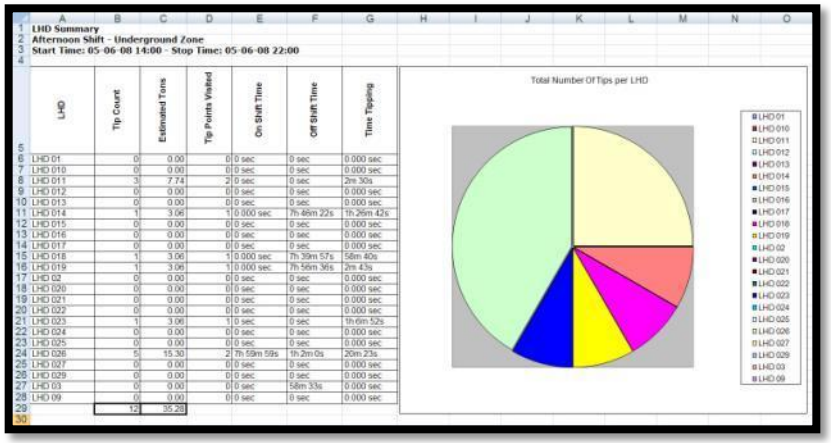
Tracking & Tagging

Pantha screenshots allow unlimited options for displaying Tracking information and system maintenance/performance data.





Resource Type	Last Seen	Last Reader	Description 1	Battery	Tag ID	Time at Reader
Employee	07.06.2010 08:33:26 PM	Production Centre	Nico van Wyk		0062D6FB	1m 9s
Employee	07.06.2010 08:32:40 PM	R&D Lab	Inneke Viljoen		0062D6FA	1m 55s
Employee	07.06.2010 08:32:29 PM	Sean Office	Owen Hatting		0062D6F8	2m 6s
Employee	07.06.2010 08:32:11 PM	Hardware Office	Wikus Jacobsz		0062D6EC	2m 24s
Employee	07.06.2010 08:29:14 PM	Sean Office	Mike Van Niekerk		0062D6F0	5m 21s
Employee	07.06.2010 08:29:08 PM	Board Room	Charl De Leeuw		0062D6EB	5m 27s
Employee	07.06.2010 08:21:11 PM	Board Room	Johan Du Toit		0062D6EE	13m 24s
Employee	07.06.2010 08:17:42 PM	Stores	Johnathan Baptist		0062D6FE	16m 53s
Employee	07.06.2010 08:11:54 PM	Sean Office	Sean Bertinotti		0062D6EA	22m 41s
Employee	07.06.2010 08:04:12 PM	Reception	Henry Osner		0062D6EF	30m 23s
Employee	07.06.2010 08:00:24 PM	Hardware Office	Manie Uys		0062D6F5	34m 11s
Employee	07.06.2010 07:48:35 PM	Reception	Rossen Ivanov		0062D700	46m 0s
Employee	07.06.2010 07:44:17 PM	Production Centre	Roelf Campher		0062D6FF	50m 18s
Employee	07.06.2010 07:21:35 PM	Board Room	Michael Bruno		0062D6F7	1h 13m 0s
Employee	07.06.2010 07:19:38 PM	Software Office	Adriaan van Blerk		0062D6F4	1h 14m 57s
Employee	07.06.2010 07:07:50 PM	Board Room	Jack Sabljak		0062D6FC	1h 26m 45s
Employee	07.06.2010 06:36:14 PM	Reception	Gleb Kyselyov		0062D6F6	1h 58m 21s
Employee	07.06.2010 06:22:51 PM	Sean Office	Andre Treutens		0062D6FD	2h 11m 44s



End of Presentation

Thank you
for your time
&
attention

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