BRAEMAC

IN-VEHICLE EMBEDDED TECHNOLOGIES

FOR MINING

intel

innodisk

NEOUSYS TECHNOLOGY

DIGI

xsens

CALIAN

ADLINK LEADING EDGE COMPUTING

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ABOUT BRAEMAC

Braemac is a global leader in the distribution of semiconductor components and electronic systems as well as value-added services. Empowering engineers and developers for over 40 years–Braemac features expert in-house engineers, extensive design-phase support, state-of-the-art distribution, value-add facilities, comprehensive supply chain solutions, and unparalleled customer service. Braemac offers solutions for diverse markets and applications, helping customers streamline development, reduce costs, accelerate time to market, and support long term interoperability.

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FOREWARD

CHALLENGES IN MINING VEHICLE

The future of mining is now. With the industry more focused on digitalization than ever before, automation is quickly revolutionizing the definition of modern mining. As skilled labor becomes increasingly challenging to source and as operational costs rise costs rise, automation in mining vehicles are emerging as game-changers.

Through embedded systems integrated with sensors, radar, LiDAR, cameras, and high-precision location intelligence, mining vehicles are now equipped with the latest technology to collect and process real-time data to enable smarter decision-making. This shift not only reduces the risk of human error but it also boosts productivity by delivering immediate actionable insights.

Enhanced predictive maintenance through AI-edge systems are also assisting operators in mitigating downtime by ensuring equipment consistently remains at peak performance. Implementing automated embedded solutions in industrial vehicles is an efficient way to lower total cost of ownership (TCO), drive greater revenue, and prepare operations for Industry 4.0.

However, as technology evolves, so does the need for stronger cybersecurity. The complexity of integrating legacy operational technology (OT) systems with modern IT networks presents new security vulnerabilities. The future of mining is being defined today, with automation and enhanced cybersecurity driving the industry toward a safer, more efficient, and digitally advanced era.

Technical Resources:

- Lanner - Autonomous Mining Vehicles
- Coast IPC Case Study - Autonomous Mining Trucks

BLOG

4 KEY CONSIDERATIONS WHEN DESIGNING AN IN-VEHICLE EMBEDDED SYSTEMS

Embedded systems play a crucial role in the automotive industry. They drive innovation in engine control, advanced driver-assistance systems (ADAS), engine performance, and many other critical functions. From features such as adaptive cruise control to anti-lock braking systems (ABS), embedded systems power the overall safety and efficiency of modern vehicles. However, for engineers and developers, designing an in-vehicle embedded system is a complex task that requires careful planning and consideration.

What is an In-Vehicle Embedded System?

An in-vehicle embedded system is a specialised computing system integrated directly into a vehicle to control various functions. Unlike general-purpose compute solutions, embedded systems are designed for dedicated tasks, such as traction control, blind spot detection, and electronic control units (ECUs) that manage key vehicle operations. They process real-time data from a variety of onboard sensors, including cameras, LiDAR, and radar.

Key Components of an In-Vehicle Embedded System:

- Embedded software that controls the system's operation and interfaces with sensors, actuators, and vehicle networks.
- ECUs that process inputs from sensors and execute control commands.
- I/O Sensors and Actuators to collect real-time data

Embedded Systems for Mining and Construction

Embedded systems are fundamental in modern mining innovations, ensuring safety, efficiency, and connectivity.

Key Applications:

- Heavy-duty mining trucks and excavators use embedded control systems to optimize fuel efficiency, monitor terrain conditions, and automate operations for improved safety.
- ADAS enhance vehicle maneuverability in hazardous environments.

4 Steps to Future-Proof Automotive Embedded System Designs

1. Address the Fragmented Technological Landscape

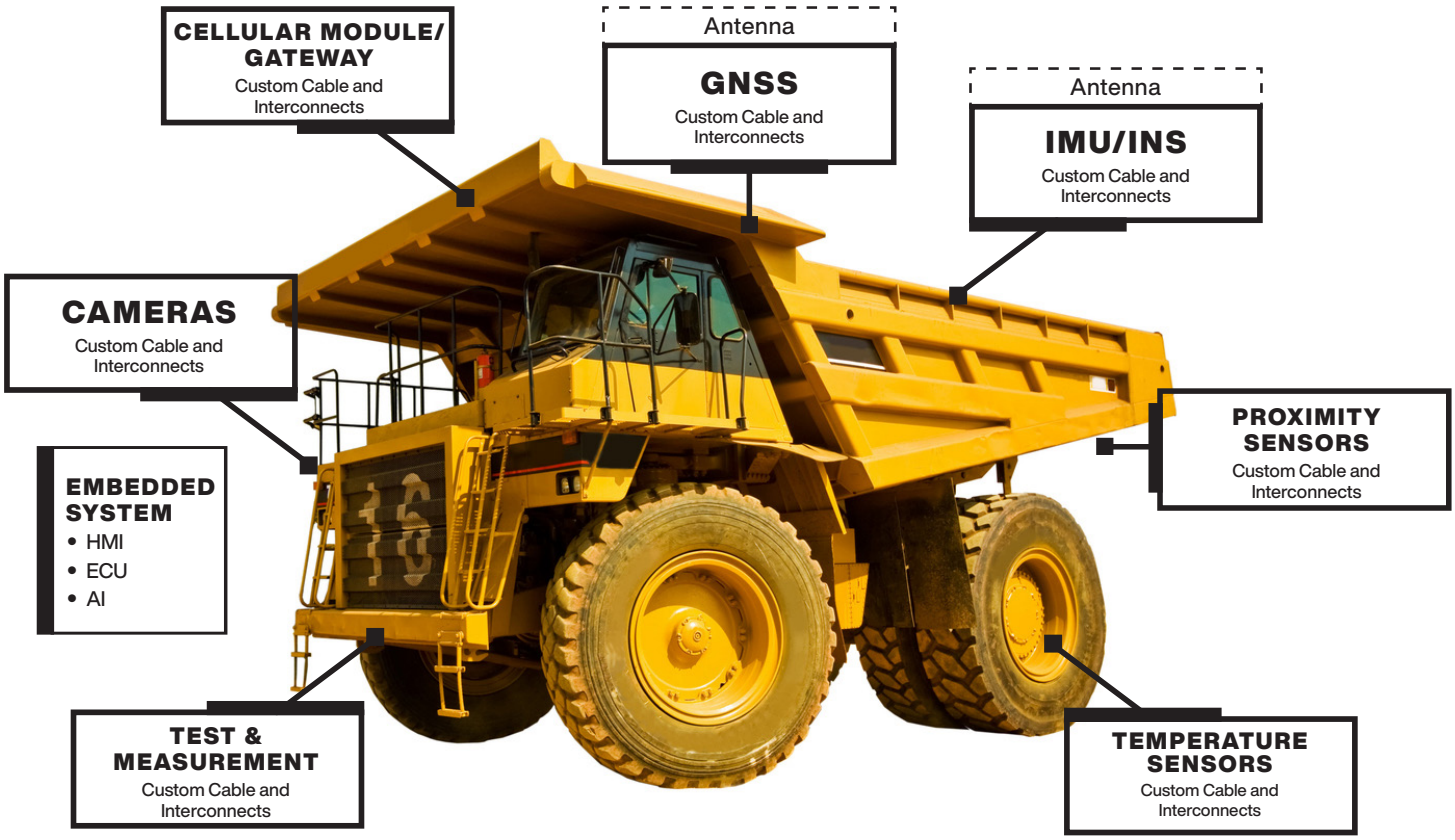
The increasing complexity of ECUs has led to a highly fragmented ecosystem of in-vehicle embedded software and hardware. This fragmentation poses a challenge for system integration, particularly when it comes to real-time responsiveness. Latency in responding to I/O sensors can be a serious safety concern, affecting critical functions such as blind spot monitoring, traction control, and climate control.

BLOG CONTINUED

To enhance safety and performance, modern embedded systems play a crucial role in:

- Onboard data processing to reduce I/O latency for real-time decision-making.
- Streamlining system integration to ensure seamless interaction between sensors, actuators, and the control system.

By reducing response times, automakers can improve the reliability of ADAS and other safety features.



NEXT-GEN MINING VEHICLES ARE EQUIPPED WITH A WIDE RANGE OF ADVANCED TECHNOLOGIES

2. Ensure Scalability and Upgradability

In mining, embedded systems must be scalable and upgradable to keep pace with evolving technology. A rigid system that cannot accommodate new hardware or software improvements risks obsolescence.

By streamlining embedded system designs, manufacturers can:

- Future-proof mining and industrial vehicles for adaptive cruise control, engine performance optimizations, and new sensor integrations.
- Reduce the need for full system overhauls, minimizing downtime and cost.

A modular approach to embedded system design allows mining operations to adapt to new technological advancements efficiently while maintaining productivity and safety.

3. Overcome Sourcing Challenges and Supply Chain Complexity

It's clear that the role of embedded systems in the automotive industry is expanding. A diverse set of technologies from HMI and automation control/safety to cameras, sensors, and wireless communication. Managing multiple suppliers can be logistically challenging, and increase costs, and lead times.

BLOG CONTINUED

Fortunately, Braemac is a comprehensive distribution resource and manufacturer integration partner with a comprehensive portfolio that includes best-in-class test & measurement solutions for automotive applications.

4. Meeting Certification Standards

Embedded automotive systems must meet safety certifications, industry standards, and vehicle standards. Non-compliance can lead to costly redesigns and regulatory hurdles, impacting the total cost of ownership (TCO).

Developers can simplify compliance processes by leveraging Braemac as a development partner. Braemac's unparalleled industry and technological expertise provides organizations with comprehensive planning and expert guidance that mitigate long-term delays, deliver certification-ready solutions, and reduce total time to market (TTM).

Partnering with Braemac for Embedded System Success

Designing a future-proof in-vehicle embedded system is a complex task, but it doesn't have to be when you make Braemac your chosen distribution partner. Partnering with Braemac gives you access to a robust portfolio of the most cutting-edge solutions available.

Moreover, Braemac is a Subsidiary of the Exponential Technology Group (XTG), a global group of specialty semiconductor suppliers and design engineering services firms. XTG stands alongside Mouser Electronics and TTI IP&E in the TTI, Inc. Family of Specialists (FOS). As a proud member of XTG, Braemac leverages a comprehensive sourcing ecosystem and unparalleled supply chain support to simplify procurement and reduce lead times.

With Braemac's expertise in embedded computing, AI, and connectivity solutions, businesses can confidently navigate the complexities of in-vehicle embedded system design and bring next-generation automotive innovations to market faster and more efficiently.

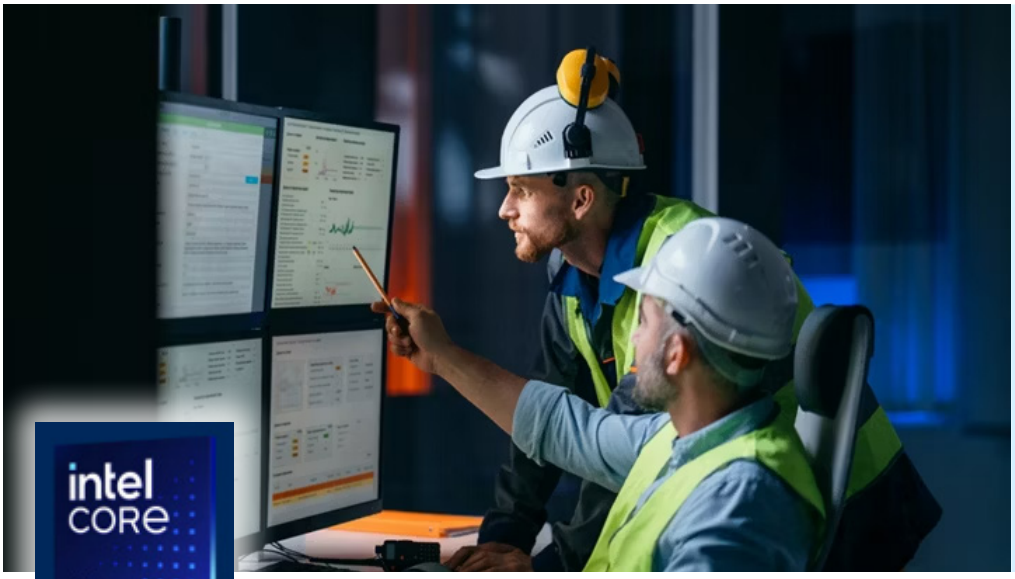
4 Key Considerations When Designing an In-Vehicle Embedded System

TECHNOLOGY 1

EDGE COMPUTING - INTEL

Supercharge AI Vision and Graphics at the Edge

Deploy edge solutions with advanced AI and graphics performance in power-efficient packaging.



Innovate in industry with robotics, industrial PCs, human-machine interfaces and AI-augmented process control

Enhance productivity and safety on shop floors and support advanced Industry 4.0 use cases—including AI vision deployments—while helping to consolidate workloads on easy-to-manage systems in hard-to-reach places. Benefit from cost-efficient platform consolidation, a high number of video streams per device, and detail-rich interfaces.

Get the performance you need—with integrated AI and graphics

Intel Core Ultra 7 processor 265H is up to

5.8x

faster than NVidia Jetson AGX Orin 64GB in media performance.[4]

Intel Core Ultra 7 processor 265H is up to

8.2x

better than NVIDIA® Jetson AGX Orin 64GB in performance per watt per dollar.[4]

Intel Core Ultra 7 processor 265H is up to

3.4x

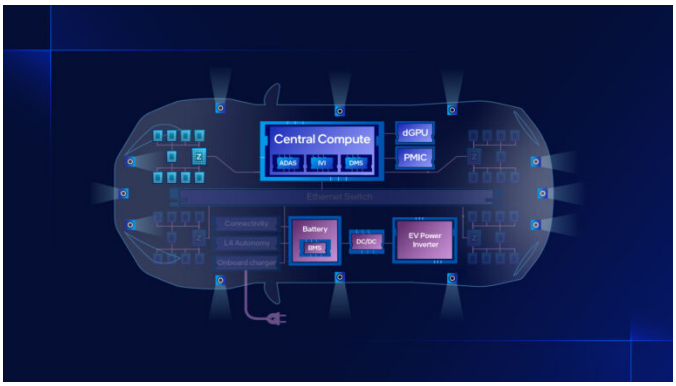
faster than NVIDIA® Jetson AGX Orin 64GB in video analytics end-to-end workload media + AI inference performance.[4]

Intel's Whole-Vehicle Approach to Boost Automakers Profits

Intel utilizes a holistic, system-level strategy to address a wide range of cost challenges.

Rather than simply building better individual components (which they do), Intel delivers system wide benefits by integrating three key elements: software defined in-cabin compute, intelligent energy management, and data-center-like workload management. This combination delivers a multiplier effect over trying to optimize individual design aspects.

The Intel approach looks at the vehicle systems as a "whole" and allows for the seamless movement of workloads between software-defined central compute systems and software-defined



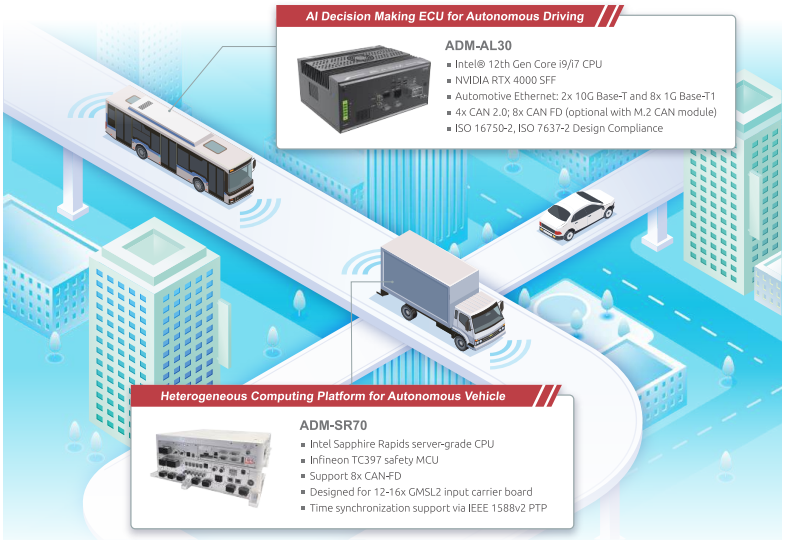
zonal compute subsystems, ensuring maximum flexibility, optimal cost and performance with significant energy efficiency benefits. Read the whole article here.

TECHNOLOGY 1

EDGE COMPUTING - ADLINK TECHNOLOGY

Edge-AI Computers for Autonomous Vehicles

The ADLINK ECU delivers the power and AI acceleration needed to process data from multiple sensors, including LiDARs, radars, and cameras. ADLINK is committed to providing AI-accelerated computing systems that enable real-time processing in commercial autonomous vehicles like freight trucks, shuttle buses, taxis, and even heavy-duty vehicles like mining trucks.



Automotive-grade Quality

ADLINK hosts a specialized production line meticulously designed for automotive products, following IATF-16949 and ISO 26262 standards.

Collaborative Alliance

SoC partners：Intel, NVIDIA, NXP, TI, RENESAS, Qualcomm

Innovative Design Capability

ADLINK complies with both ISO 7637 and ISO 16750 standards. Our automotive products are specifically made with redundant power supplies and anti-shock vibration features.

Autonomous Electrical Bus

ADLINK and TIER IV collaborated in Japan and have so far completed over two dozen trials for that market. Japan is relatively stringent in its AV regulatory approvals, and this, combined with factors such as dense population, harsh weather, and narrow, congested roads, makes for a particularly difficult test environment. Progressing from Level 3 to Level 4 can take up to four years in some regions. Successful trials in Japan should bode particularly well for other efforts globally.

Watch Video ›

TECHNOLOGY 1

EDGE COMPUTING - NEOUSYS TECHNOLOGY

Industrial Autonomous Mining Vehicles with a Trusted AI Platform

Engineered to operate in extreme or hazardous environments, industrial vehicles are utilized in a broad range of industries, such as mining, agricultire, military, logistics, utility, and more. When integrated with reliable embedded computers, Neousys enables designs that are capable of data collection, communication, control, and video processing for automation applications. Implementing modern edge AI systems with GPU-aided devices into vehicles enable intelligent decision-making and enhancing both safety and operations efficiency.

SEMIL-1700 Series

POC-465AWP

Nuvo-2610VTC Series

SEMIL-1700GC Series

Environmental

- IP67 water/ dustproof GPU computer
- Extreme rugged computers for extra volatile environmental conditions
- Shock and vibration proof for in-vehicle use
- True -25°C up to 70°C wide-temperature operations for harsh, volatile environments
- Patented Cassette design for segregating thermal/ electrical interference
- Tri-axis tested patented damping bracket to withstand shock and vibration conditions
- Ultra-compact VTC systems to fit into tight spaces

Connectivity/Expandability

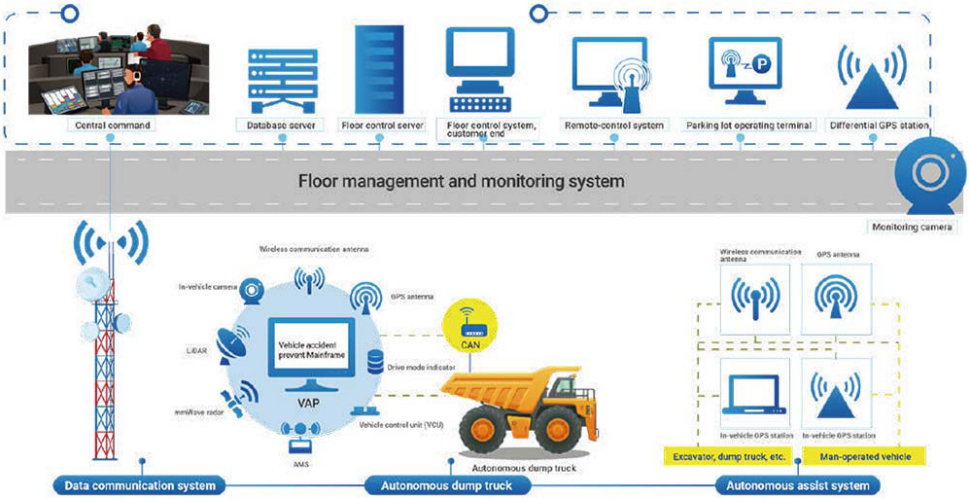
- PoE+ connectivity for GigE cameras
- USB3.1 Gen1/ Gen2 connectivity for USB cameras
- Connection ports with screw-lock for rugged connectivity
- WiFi 6/ WiFi 5/ 5G/ 4G wireless communication, expansion via mini-PCIe module

Electrical

- Patented SuperCAP UPS to counteract unforeseen power interruptions
- Wide-range DC input
- Configurable intelligent ignition power control

Inference Processing Power

- Support up to dual NVIDIA® RTX 30/20 series graphics cards
- Support up to NVIDIA® RTX 30/20 series graphics card
- Support up to NVIDIA® Tesla/ Quadro inference accelerators



TECHNOLOGY 1

EDGE COMPUTING - INNODISK

Traversing the Toughest Roads

Vehicles operate in just about any environment imaginable, which means any system onboard has to withstand the stress induced by changes in temperature and other rough conditions. Another challenge is electromagnetic interference both from the environment and from other onboard systems, as well as unstable power supply.

Applications

- Rugged Computers
- Onboard surveillance systems
- Vehicle computers

Featured Technologies:

Flash Storage

DRAM Modules

Enhanced Thermal Sensing

Extreme temperatures and constant thermal cycling can cause damage and severely reduce product lifespan. Innodisk in-vehicle products are tested and certified for operations in temperatures ranging from -40°C to 85°C. With integrated thermal sensors, Innodisk SSD can detect temperature spikes and efficiently throttle performance to avoid overheating.

Engineered for Extreme Environments

In compliance with US MIL-STD-810G, Innodisk solutions are certified to withstand shock and vibration during operation in the most extreme environments. Conformal coating is available for all modules ensuring protection from dust, dirt, and humidity.

Unmatched Power Stability

Innodisk in-vehicle solutions comply with E-Mark (EU), SAE J1113 (US), and ISO 7637-2 standards, ensuring that modules are unaffected by electromagnetic interference. Due to often unstable power supply, onboard systems are at risk of data loss. To mitigate this, Innodisk utilizes a combination of firmware and hardware technology to protect data.

TECHNOLOGY 2

CONNECTIVITY - DIGI

High Performance Cellular Router with Dual Redundant Communications for Complex Transit & Transportation Systems

- 5G platform: future-built with powerful quad-core processor
- Segmented private and public data communication across 5G NR Sub-6 GHz, 4G LTE-Advanced Pro and 4G LTE-Advanced modems
- FirstNet Trusted™ and Verizon Frontline support for primary responder communication
- Meets U.S. government FIPS 140-2 cybersecurity standard
- Wired Gigabit Ethernet (4-port) for onboard systems
- Video and vehicle data offload over Wi-Fi 6 4x4 backhaul, with passenger Wi-Fi over Wi-Fi 6 2x2 access point

Digi TX64 application example

Major Oil and Gas Operation Monitors Edge IoT Devices with Digi Remote Manager

As a division of one of the largest oil and gas production companies globally, one Digi oil and gas customer has contributed to tripling the larger organization's resource portfolio over the past ten years. The global organization now features approximately 40,000 active oil and natural gas sites across North America.

Understandably, this Digi customer has a mission-critical requirement to monitor remote sites and gather device data and readings through their SCADA process control system, while maintaining the highest levels of network and data security. With so many remote locales, this can be a challenging proposition. Read the whole article here.

TECHNOLOGY 2

CONNECTIVITY - ADLINK

ARM-Based Vehicle Gateway for Fleet Management

- i.MX 8M Plus SoC with 9-36v power input, MCU ignition control
- Wide operating temperature range: -40°C to 85°C
- Palm sized design: 131mm x 110.5mm x 40mm
- 1x HDC(DB26) with 2x CAN, audio, Mic-in, 2x RS232
- 2x 10/100/1000 Mbps ethernet ports, RJ45
- Capable with 1x WiFi6 and 1x LTE/5G M.2 module
- E-Mark(12V/24V) design compliance
- ISO-7637-2 automotive certification

Wide Temperature Range:

With an operating temperature range of -40°C to 85°C, the ADM-IM10 is engineered to withstand even the harshest environmental conditions, ensuring reliable performance in any scenario.

Multiple Sensors Connections:

Equipped with 2x RJ45, 2x RS-232 COM, 2x DI/DO, 1x Mic-in, 1x Line-out, and 2x CAN Bus, the ADM-IM10 enables seamless integration with a variety of sensors, allowing for comprehensive data collection and analysis.

TECHNOLOGY 3

NAVIGATION AND POSITIONING - CALIAN

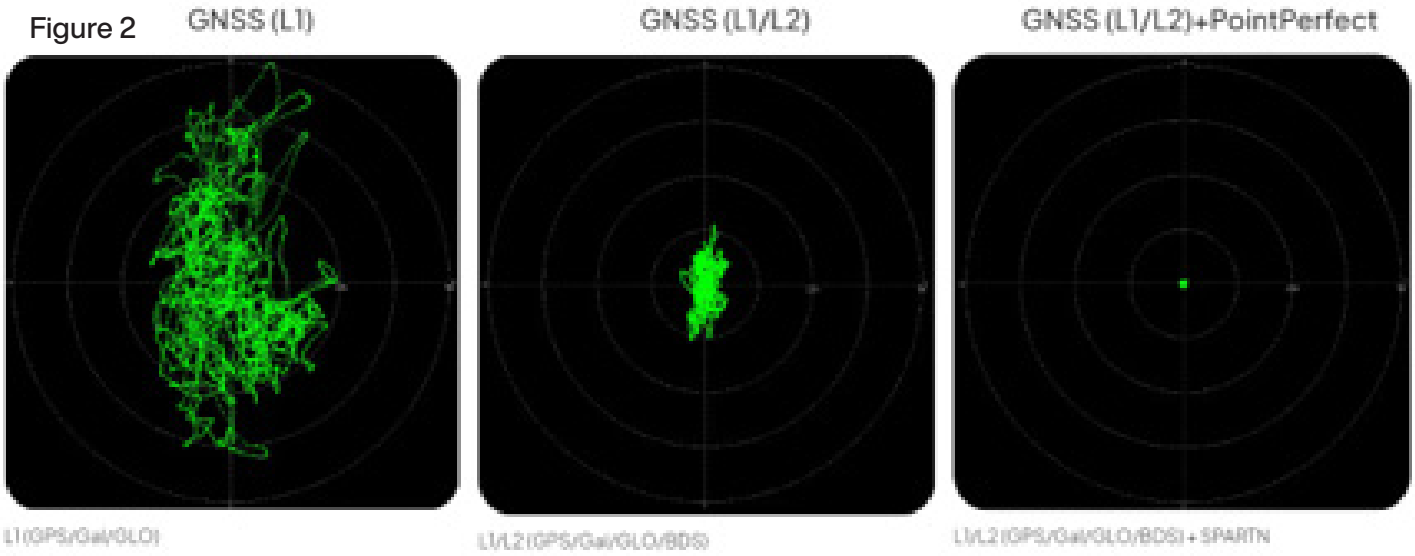
Integrated Smart GNSS Antenna: A High-Performance Antenna with a High-End Receiver

The TW5390 is a feature-rich Augmented Smart GNSS receiver (Figure 1) that enables results detailed in the 5m radius scatter plots (Figure 2).

Figure 1

TW5390 Smart GNSS Antenna with IP-Network/L-Band Corrections and IMU

Figure 2



Calian Antenna Enhances the Performance of the OxTS Advanced Driver Assistance System (ADAS)

The AB Dynamics LaunchPad is a pilotable platform designed to carry Vulnerable Road User (VRU) targets, such as pedestrian, cyclist, and moped dummies, for ADAS development and testing. The LaunchPad50 chassis, designed with a high-strength aluminium, is robust enough to cope with being repeatedly driven over by a large test vehicle, including SUVs. Read more here.

AB Dynamics LaunchPad50

TECHNOLOGY 3

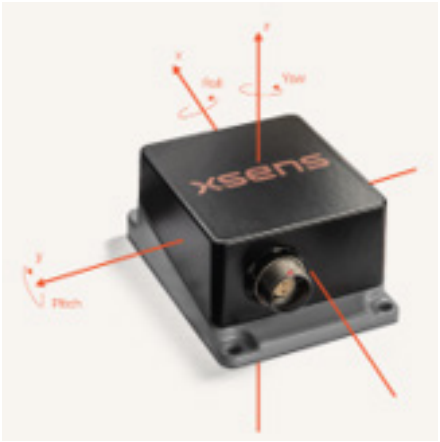
NAVIGATION AND POSITIONING - XSENS

Indispensable IMU Solutions for Mining Vehicles

Xsens MTi sensor modules deliver functionality range from inertial measurement units (IMU), vertical reference units (VRU), and attitude and heading reference systems (AHRS) to fully integrated GNSS/INS (Global Navigation Satellite System/Inertial Navigation System).

Their vibration and shock-rejecting signal pipeline ensures accurate measurements even in extreme vibration conditions, supported by analog filtering.

MTi sensor modules have rugged and reliable MIL-standard IP68 housing that is resistant to temperature extremes, humidity, salt spray, sand, dust, and electromagnetic interference.

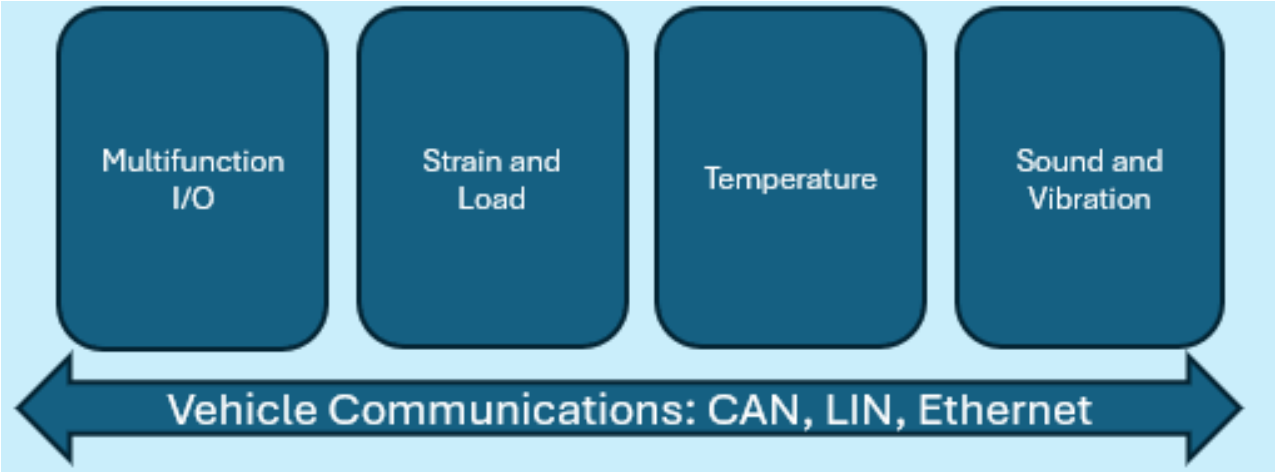


Robotic Mining Competition for NASA Mars Mission

NASA aims to send humans to Mars in the 2030s. Such a mission would require a 16-month stay on the Red Planet and 18 months of total travel time, To maximize in-situ resource utilization, NASA plans to deploy an armada of robotic precursers to prepare for human arrival. These autonomous systems will mine the Martian regolith for various uses, including structures, water reclaimation, and fuel production. NASA hosts the annual Robotic Mining Competition (RMC) at the Kennedy Space Center, which Virginia Tech has consecutively attended for the past eight years. Read more here.

TECHNOLOGY 4

DATA LOGGING AND CONDITION MONITORING - NI



Key Features of the Vehicle Physical Measurement Bundles

Precise Sensors

Pick from more than 70 high-quality C Series I/O modules with built-in sensor- or signal-specific conditioning. Mix and match to build an accurate and repeatable system that meets any needs.

System Scalability

Expand and distribute your system with Ethernet-compatible CompactDAQ chassis to take µs-synchronized s across multiple chassis and in distributed setups.

Develop or Don't

Develop a custom data-logging application with .NET, C#, Python, or LabVIEW Full or use FlexLogger™ application software to quickly configure your system and log and view data.

TECHNOLOGY 4

DATA LOGGING AND CONDITION MONITORING - NI

Monitoring the Main Gearbox of a Bucket-Wheel Excavator Using CompactRIO

"We chose CompactRIO because of its resistance to shock and vibration, and its ability to operate in a wide temperature range. In addition, the system ensures failure-free operation with custom diagnostics tasks."

- Paweł Pawlik, AGH University of Science and Technology, Faculty of Mechanical Engineering, Department of Mechanics and Vibroacoustics. Read the whole article here.

Oil Well Fracture Pump Monitoring and Analysis Using LabVIEW and NI RIO Technology

"LabVIEW has made the software development side much quicker. What most C programmers take two years to do, we can accomplish in a couple of months. We can use that time savings to get to market quicker and capitalize on our competitors' lag time." – Robert Stewart, CEO Lime Instruments, LLC. Read the whole article here.

SMART PARTNERSHIPS, SMARTER MINING

Braemac Powers the Future of Automation

Braemac is your ideal partner in navigating the future of mining automation. Partnerships with industry-leading technologies—from edge computing to advanced sensors and test and measurement devices—we bring the best of the latest innovations to your mining operations.

We are a comprehensive resource offering everything mining developers need, from sourcing to manufacturing integration and beyond. Our robust portfolio includes best-in-class automated solutions, including control and safety solutions, cameras, sensors, IMU/INS, wireless communication, and test & measurement solutions.

Partnering with Braemac means more than just access to cutting-edge technology—it's an investment in a trusted ally who truly understands your unique needs and is dedicated to optimizing your mining operations for the future.

Technical References:

Accenture Industry Q&A on Autonomous Operations

Chipatronic Gives Mining Vehicles Eyes Everywhere

Tosibox OT Network for Enhanced Cybersecurity

Mining Vehicles and Service Trucks from Plantman

QUESTIONS?

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