
RAVEN
Powering Secure **Autoware.Auto** Deployments
eBook
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Putting Software Developers in Control

The age of fully Autonomous Driving (AD) is quickly becoming a reality, with a number of vendors and industry partnerships already trialing use cases from robotaxis to robodeliveries. Fully Autonomous Drive Systems (ADS) are being realized through:

- Developing new and transformational Electric Vehicles (EV) bespoke to the use case.
- Retrofitting existing vehicles and/or evolved Advanced Driver Assistance Systems (ADAS).

In a world of change, there are no surprises that for both new and retrofitted vehicles there is a need to continually assess and evolve the algorithms, devices, and applications that keep vehicles rolling.

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Tools available today for AD R&D are:

COSTLY

Made up of legacy and proprietary technology, never designed to work together.

INEFFICIENT

Not designed for the petabytes of data that AD generates.

CUMBERSOME

Disparate systems of compute, connectivity, and storage.

COMPLEX

Requires experienced IT staff every time a test vehicle takes to the road.

In this eBook, we will discuss the values of an open architecture platform that overcomes these challenges and puts developers in control of their development environment.

The Open AD Software Ecosystem

Autoware.Auto* is an open community ecosystem that allows developers to develop an understanding of the mechanics of AD and quickly build applications for self-driving. Autoware consists of all the functionality required for autonomous driving (i.e. perception, planning, control) in a modular architecture with crisply defined interfaces and APIs.

In this eBook, we will focus on compute for R&D development of vision systems and accessing physical sensor data for Autoware.Auto application development.

RAVEN (Ruggedized Autonomous Vehicle Networks) is a flexible automotive R&D platform** from Klas, which is highly configurable to meet the R&D needs for Operational Design Domains (ODDs) under consideration by the Autoware community.

We will also go under the hood and discuss in more detail:

1. Open Development Environments: the need for modern and scalable solutions in AD R&D development labs.
2. Connectivity and Security: how to create in-vehicle networks that can be securely extended to the cloud.
3. High-performance compute: the need for scalable compute environments for in-vehicle vision machine learning and training.

* https://www.autoware.org/
** https://www.klasgroup.com/markets/automotive/

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Development Platforms for AD R&D

It's widely understood that AD sensors of lidar and radar generate vast amounts of data, and to run Point Cloud Data (PCD) computations utilized in vision systems is compute-intensive. This implies there is a need for scalable compute systems in the test vehicles.

Raven Overview

RAVEN is an in-vehicle platform that integrates high-performance computing, connectivity, data logging, and storage capabilities in a compact, convenient and consistent form factor. The modular approach allows RAVEN modules such as the high-capacity data logger (TRX D8*) to be mounted on its own to interface with existing Third-Party systems or as part of the RAVEN platform.

RAVEN modules are underpinned by KlasOS Keel**, a secure OS designed for the consistent operation of the R&D platform. Keel provides IT and network professionals with a holistic software environment to configure, manage and automate networking, compute, and storage as a single device.

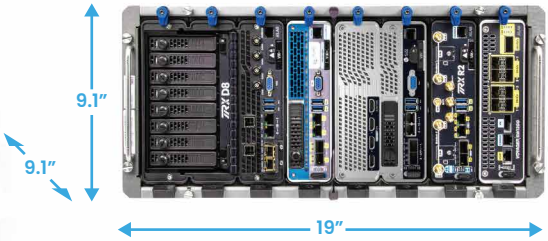

Figure 1: RAVEN - compact form factor.

*https://www.klasgroup.com/markets/automotive/data-logging/
** https://www.klasgroup.com/keel/

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RAVEN provides developers with the foundation to build a scalable R&D platform:

1. High-performance compute: Nvidia Turing (Quadro), Intel Xeon-D processors (up to 32 x cores).
2. Virtualization: Run multiple virtual machines (VM) and Docker containers of Autoware.Auto Agile Development Environments (ADE).
3. Ruggedized: designed for life on the road where shock, vibration and temperature can be extreme.
4. Connectivity: integrated CAN and ethernet network interfaces, separate ethernet switch (1GbE and 10GbE), and cellular compute gateway modules.
5 Storage: up to 240 Terabytes, which is easy to scale by adding additional storage cassettes.

A significant advantage to the virtualization environment on the RAVEN is that multiple software developers and QA engineers can work on a single platform independent of each other. Each user can have their own operating system, networking, storage, and security, as the project demands.

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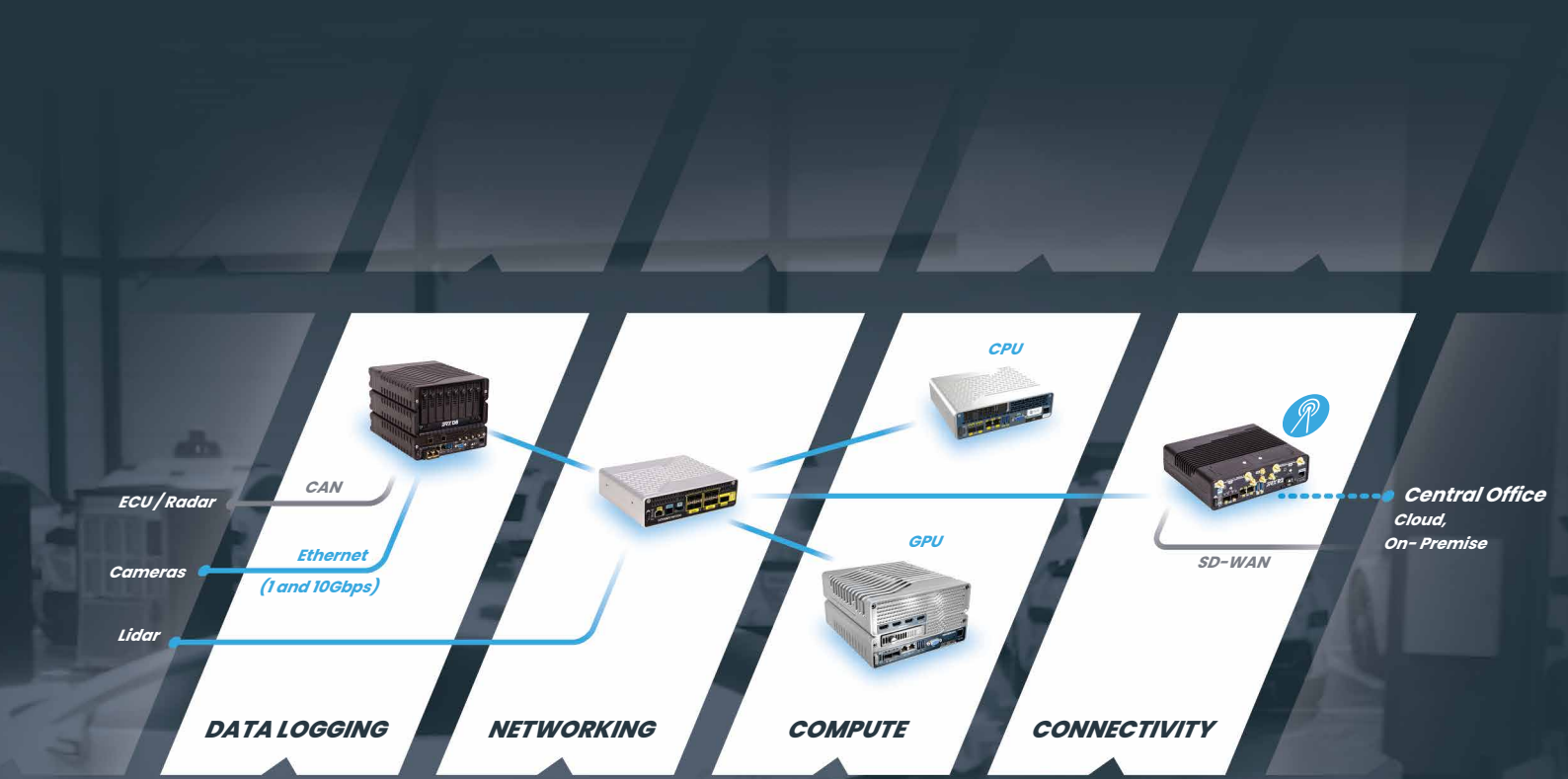

Figure 2: RAVEN modular architecture.

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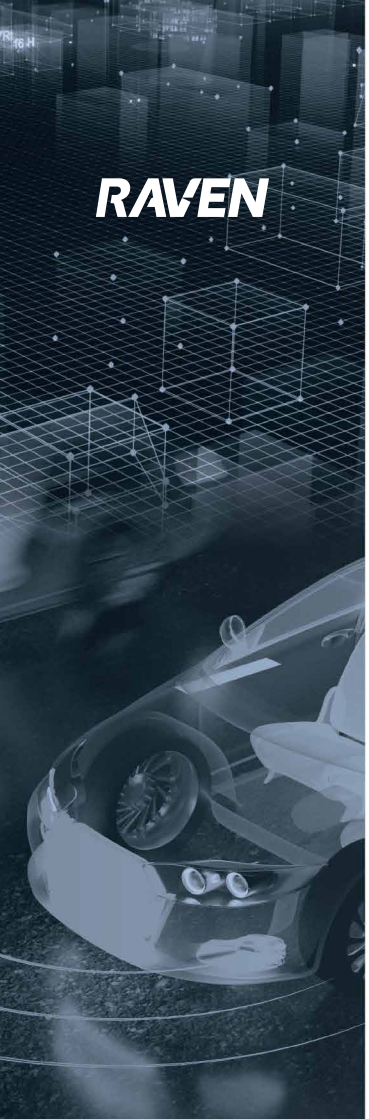

Open and Agile Development Environments

A core component of the Autoware.Auto architecture is the meta-operating system known as Robotic Operating System (ROS2) and the integrated communication layer Data Distribution Service (DDS) middleware, a type of virtual messaging bus. This allows developers to quickly and seamlessly access vehicle data for use in the application under development.

Supporting Agile Development Environments (ADE)

With RAVEN, developers can instantiate multiple ADE with ROS2/DDS that are seamlessly interconnected with the vehicle's IP network of sensors and cameras, radars and ECUs on the CAN bus.

With RAVEN's KlasOS virtualization layer, AD developers can logically segment the development environment into multiple subnetworks e.g. Sensing, Perception, Planning, and Actuation.
RAVEN's rich set of physical network interfaces - ethernet (1 and 10GbE), CAN-FD, and cellular are complemented by the capability to create a Software-Defined Wide Area Networking (SD-WAN).

The KlasOS SD-WAN allows developers to securely extend in-vehicle networks to the cloud over a cellular network. This facilitates developers with the opportunity to run multiple domains of ROS core in-vehicle that can securely communicate with ROS nodes outside of the vehicle.

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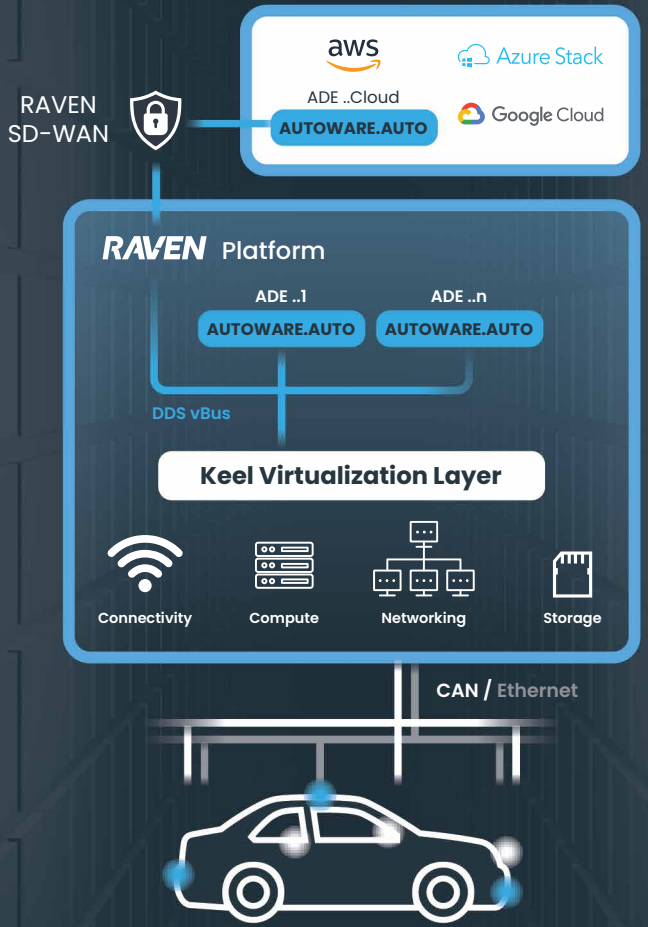

Figure 3: Example R&D deployment architecture.

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Securing remote access to ROS2 from the cloud

By using RAVEN and the Keel SD-WAN, developers can reduce the risk of cyber security threats in their ADE. The Keel SD-WAN headend VM runs inside the Virtual Private Cloud (VPC), on the private network that seamlessly connects with the RAVEN platform. The result is faster deployment times without the complexity of managing cloud-generated digital certificates in each test vehicle.

Extending the in-vehicle DDS bus to the VPC private network

The Keel SD-WAN headend requires minimal configuration and management effort and can be integrated into an existing enterprise's Public Key Infrastructure (PKI).

The Keel SD-WAN headend overcomes the challenge of working with multiple cloud networks and in-vehicle subnetworks by supporting configurable:

- IP routing
- IP access list rules
- Network Address Translation (NAT) and Port Forwarding

With simple NAT/Port rule assignments in the headend, developers can map between the VPC private network and in-vehicle networks. However, for the security conscious, ROS2 Core and Nodes can be assigned dedicated ports in their configuration.

With two simple headend commands, the ROS2 node in the cloud can securely communicate with the target node in the vehicle:

1. access-list 101 permit tcp any host {IP_VM 2} eq 11311
2. ip nat outside source list 101 {IP_VM 1} port 11311

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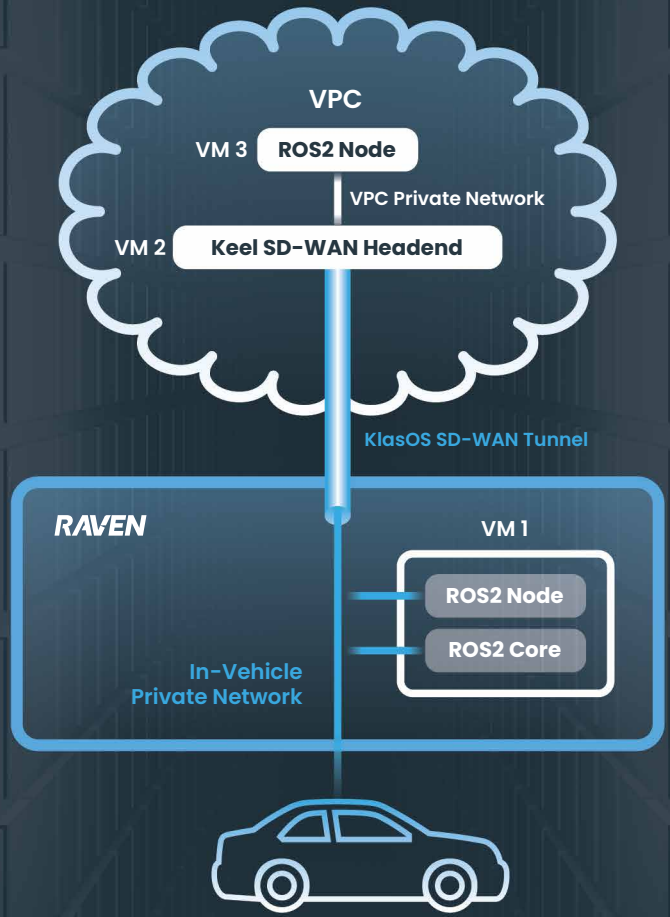

Figure 4: KlasOS securely bridges private cloud networks with test vehicle development environments.

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Compute for Perception, Decision and Planning

With a successful running deployment of the ROS2/DDS communication framework, developers can now build applications that serve the needs for Perception, Decision, and Planning (referred to as the Computing module in the Autoware architecture).

Scalable compute power

RAVEN enables developers to easily capture and store data from cameras, lidar and radar. However, both the GPU and data logger modules support 2x10Gbps ethernet interfaces for high-speed access to the stored data.

Developers can leverage the high-performance GPU compute module to implement machine learning based on deep learning frameworks in real-time.

Developers can easily create multiple unique VMs on RAVEN, underpinned by the ROS2/DDS framework:

For example, developers can easily create multiple unique VMs on RAVEN are gets underpinned by the ROS2/DDS framework:

- Point Cloud Library*: use the PCL framework to filter and stitch 3D maps for planning.
- Deep Learning Framework: leverage the Caffe** framework to easily switch between CPU and GPU on the RAVEN for decision making.
- Annotation: leverage OpenCV*** to create vision libraries for planning and decision making exercises.

* https://pointclouds.org/about/
** https://caffe.berkeleyvision.org/
*** https://opencv.org/about/

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Scalable and Modular Solutions

Klas has over 30 years of experience in delivering combined hardware and software solutions. To continually exceed our customer's expectations, we have developed a genuinely modular hardware architecture. Customers gain the agility to support everything in one box, from cellular and GPS to the Controller Area Network (CAN) vehicle bus standard, in different types and sizes of computing and storage.

In parallel, Klas has evolved its operating system (KlasOS), which significantly simplifies the hardware's operation and management. Through streamlined command-line instructions, users of Klas products can turn up a secure edge deployment in minutes.

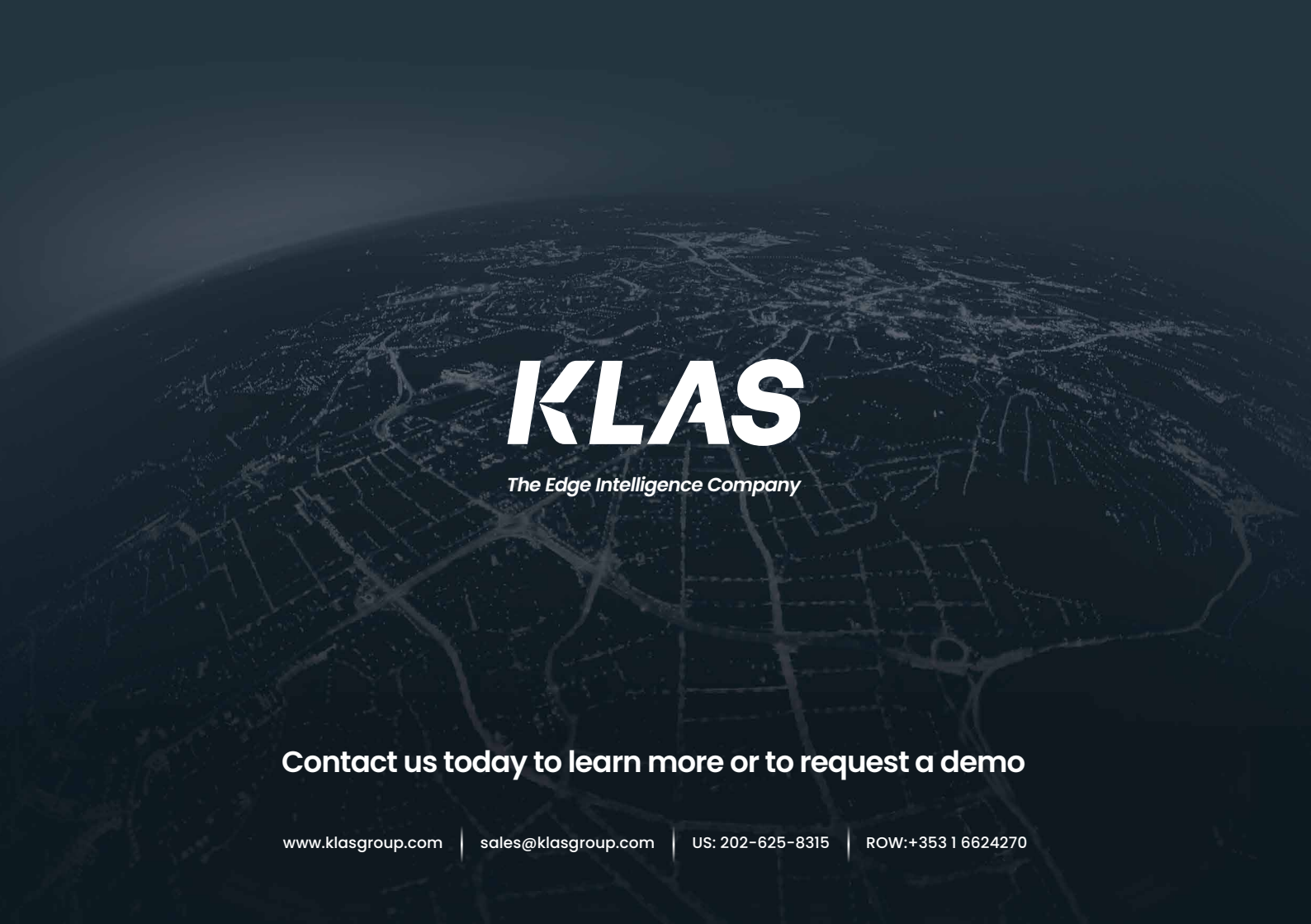
KlasOS Keel is an x86-focused operating system with a lightweight hypervisor and a range of networking features. Keel allows applications to be hosted locally in virtual machines or containers, allowing your system to make decisions based on information from locally connected devices such as video streams, vehicle management systems, and environmental sensors.

Furthermore, the Klas product lines come with an extended software framework that offers:

- Software-Defined Networking
- SD-WAN Management
- Inventory Management
- Performance Monitoring
- Automation (Ansible)

The Klas extended software framework facilitates enterprises with the base cybersecurity framework that encompasses Identification, Protection, Detection, Respond and Recover as outlined by NIST1. Klas switch modules are independently certified as NIAP compliant.

https://www.nist.gov/cyberframework



Contact us today to learn more or to request a demo

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