



openECS

The next generation Engine Control System

THE ENERGY ENGINEERING COMPANY

Mastering future challenges

openECS – The next generation

Engine Control System

Manufacturers of combustion engines face major challenges in the future: Intelligent engine management and condition monitoring set the stage for maximised engine performance. New operating concepts require a flexible integration of engines in a number of plants. To reduce operating costs staff must be optimally supported via automatic data evaluation.

Software is the key to mastering these challenges. The increasing complexity of software, in turn, demands clear development processes with automated part-steps. With **openECS**, AVAT supports you to build-up the necessary know-how in a targeted way and to turn your solutions into practice quickly and safely.

☛ CLOUD SERVICES

Remote services and big data evaluation are important for the future. The ECS architecture is designed with this in mind and our infrastructure is there to ensure rapid start-up.

☛ AVAT SERVICES

Consulting, training, development resources, customization or turnkey solutions. The AVAT team of experienced engine control experts is ready to assist you in any way.

☛ HARDWARE MODULES

The best of two worlds: The combination of an industry standard PLC and AVAT engine technology modules results in a future-proof and highly flexible engine control system.

☛ OPEN CUSTOMER APPLICATION

Whether you develop yourself or buy a ready-tailored AVAT controller. What controls and monitors your engine is delivered in source code. After all, it's your engine and know-how.

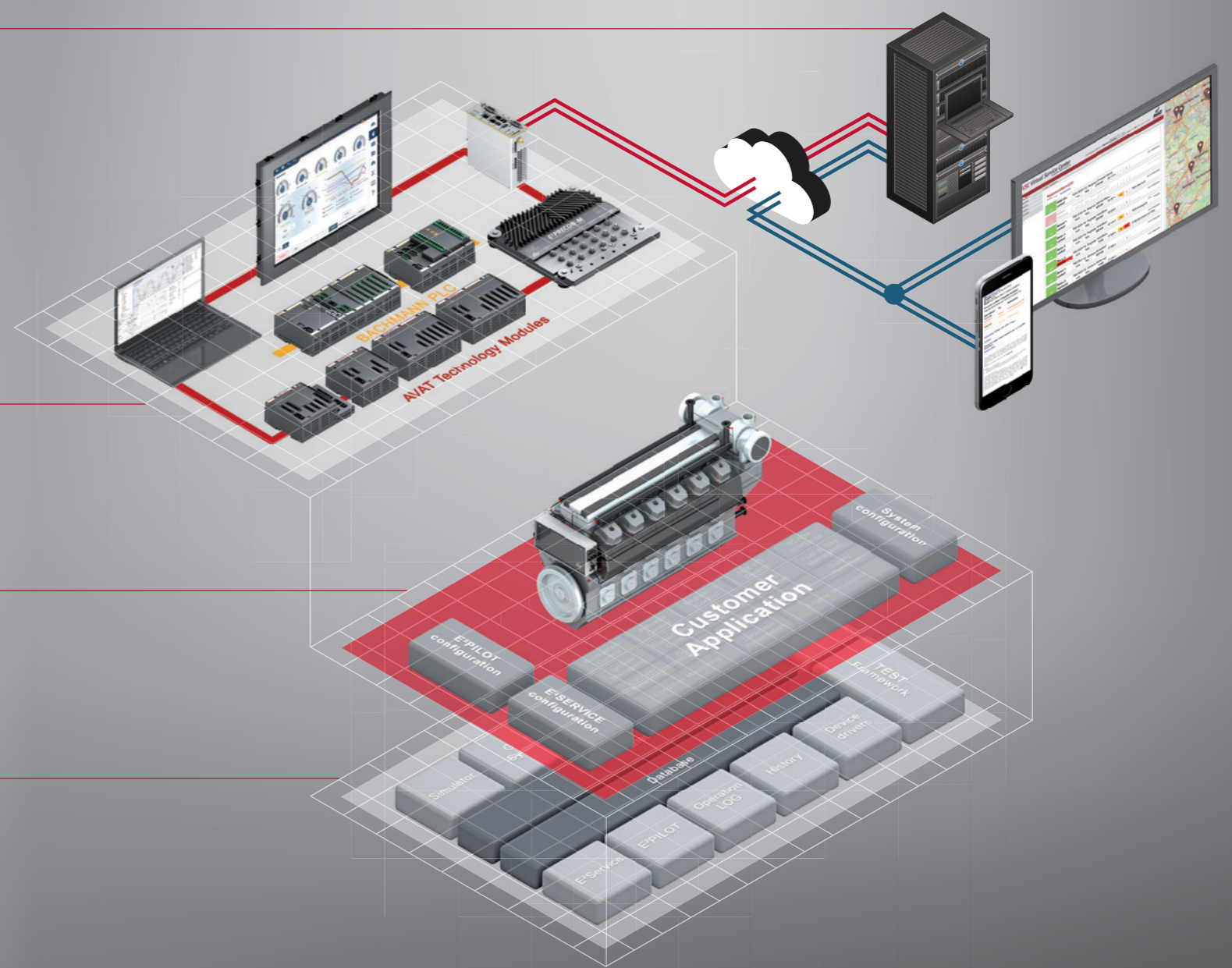
☛ AVAT SOFTWARE PLATFORM

The platform significantly accelerates application development. It makes tools and building blocks available, including test and simulation frameworks.

THE BIG PICTURE: HARDWARE, SOFTWARE, SERVICES AND PROCESSES

What good is a low-price ECS that doesn't do what you want? What use is a development system that doesn't really support your processes? The developers of **openECS** have many years' experience with processes at leading large engine builders. They know themselves how to implement urgent customer requests

with little test-stand time yet still deliver well-tested solutions. **openECS** is more than a collection of high-value hardware and software. Its detailed solutions and tools make it an effective system that developers enjoy using and let them concentrate on adding value for your engine customers.

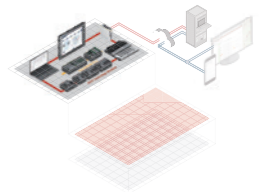


HARDWARE MODULES

A smart combination: Versatile PLC and engine control modules



Why choose between special Engine Control Units and a modular industrial PLC? Exactly this combination gives you a future-proof and highly flexible engine controller. You implement engine, generator and auxiliary control as well as SCADA systems with the same system building blocks. That way you create an integrated system for a complete engine portfolio: from compact 200 kW gas engines to 20 MW dual-fuel marine engines, all sharing the same spare parts and service tools.



AVAT TECHNOLOGY MODULES TURNING A PLC INTO AN ENGINE CONTROLLER

Combustion engines use several sensors and actuators that are not PLC-connectable. This is where the AVAT technology modules serve as specific input and output drivers including special signal processing of high frequency sensor signals.

C-series modules are an optimal mechanical fit to the **Bachmann M1 PLC system** but can still be connected to any PLC or engine controller via standard CAN interfaces.

External devices like ignition systems are integrated via specific AVAT drivers. All modules and devices operate on the “smart sensor” or “smart actuator” principle to deliver processed information but are handled and configured by the PLC. Thus all data can be used by the whole system and displayed on a single user interface.

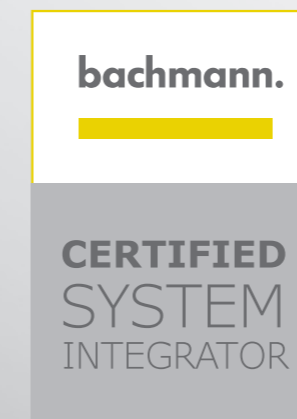
WHY AN INDUSTRIAL PLC?

Modular PLCs can be flexibly applied. A wide range of interfaces make them an ideal control centre for integrating of all types of 3rd party components. Professional development tools specifically for engineers and global, pan-manufacturer programming standards make them the ideal choice for automation tasks.

FOCUS ON THE COMBUSTION

Combustion management is the key to the safe operation of modern high performance gas engines close to their load limit. With combustion control modules characteristic values are available for individual combustion processes, for closed-loop control, balancing, monitoring and service. It couldn't be more direct.

- **E^oPRECON** computes IMEP, peak pressure, heat release, combustion timings and even NOx estimation in real time from cylinder pressure signals.
- **E^oKNOCKCON** reliably detects knocking and misfiring from common piezo-type knock sensors.



openECS uses components of the **Bachmann M1 system**. The compact modules save space in control cabinets and are marine-certified for use on ships. In the framework of a strategic partnership AVAT and Bachmann work together on innovative solutions that push the boundaries of traditional PLCs.

CORE BUSINESS ENGINE CONTROL

The basis of every engine controller is the regulation of speed, power and mixture. Today's demands for control performance require well-tuned, multivariable controllers.

- **E^oCORE** contains actuator drivers for mixer, throttle and wastegate positioners and can independently regulate rpm, power, charge-air pressure and air/fuel ratio on gas engines.

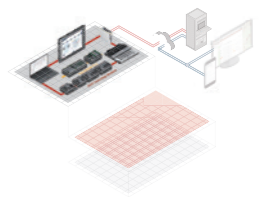
USER INTERFACES

Setup, tune and analyse your AVAT powered engines



The operating terminal is where your customers get in touch with your engine. So have it best presented with an up-to-date graphical user interface in your corporate design. Our visualisations

E²PILOT and **E²SERVICE** let all users interact efficiently with the engine. Ergonomically structured displays, tooltips and integrated documentation facilitate precise, confident working with **openECS**. No matter whether you work on site, assist remotely via an internet connection or analyze recorded data in detail. Your service personnel is doing a good job – our mission is to support them in the best way.



VISUALISATION THE WINDOW TO THE ENGINE



E²PILOT OPERATOR INTERFACE

The multi-touch user interface offers the convenience users are expecting nowadays from tablet or smartphone apps.

- A quick glance at the cockpit screen shows the current engine status.
- Intuitive test functions support minor troubleshooting or maintenance tasks.
- The operation log displays pending alarms and delivers a detailed overview of past events.
- Configurable trends provide a better understanding about the engine's operation.



E²SERVICE TOOL FOR PROFESSIONALS

E²SERVICE, on the other hand, is a tool for ambitious service technicians. The displays are configured for maximum time saving during typical tasks such as commissioning, controller adjustment, fault finding and maintenance.

- The operation log includes context information, filters, jump and search functions.
- Parameter screens include an inline help function as well as save, restore and compare features.
- Comprehensive combustion diagnostics show precisely what is going on in the individual cylinders.

SNAPSHOT – A CLEVER IDEA

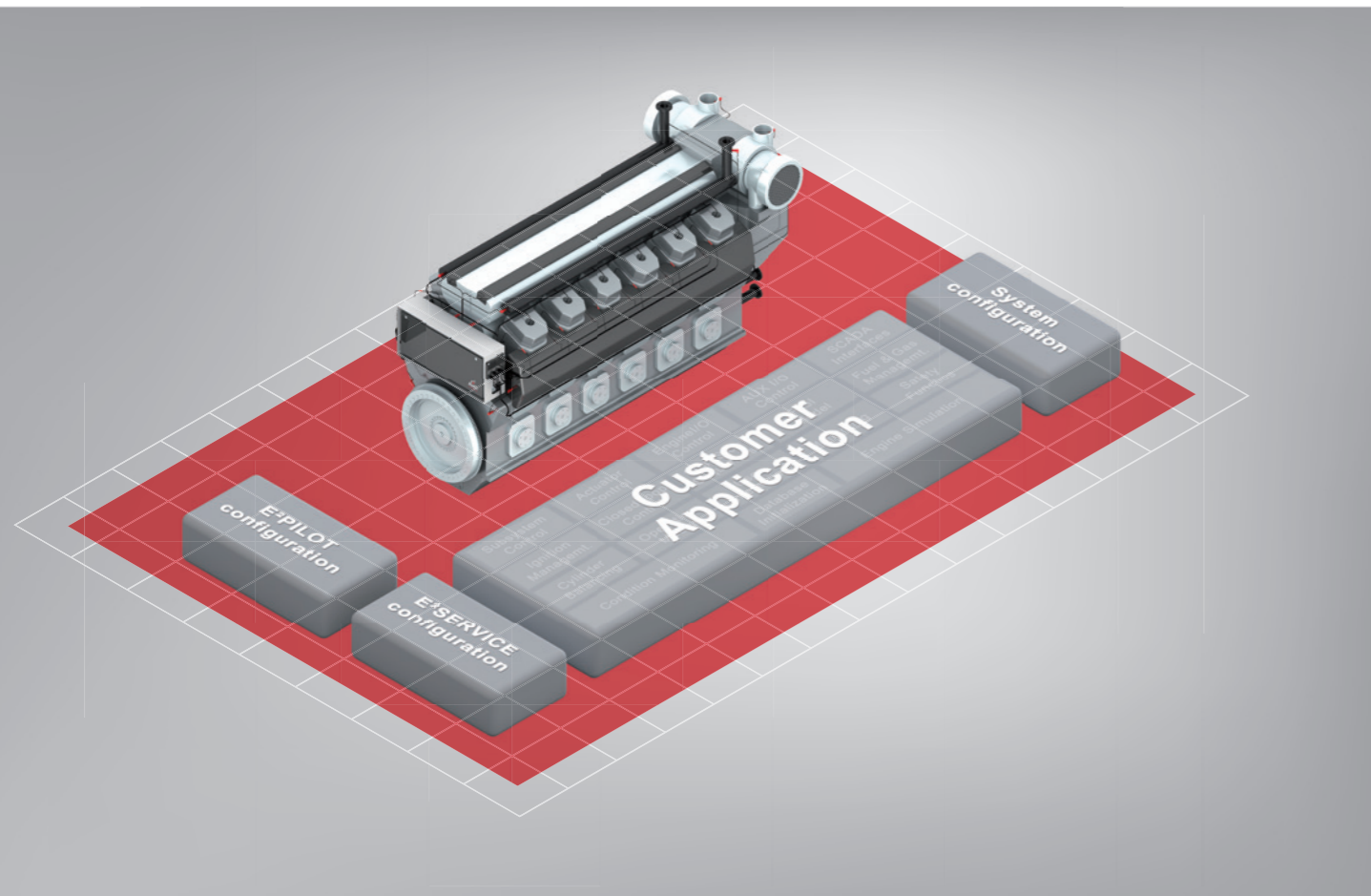
With a single touch an operator on site creates a copy of the current engine status, sends it automatically to the remote service center and requests assistance. The supporter opens the Snapshot with the **E²SERVICE** tool. Seeing the engine's complete setup and operating behavior he can quickly recommend countermeasures. A small detail making remote support much easier.

"In the past I spent a lot of time getting at the operation data of the engine. With the snapshot function I receive all the information I need already together with the support request. After that, finding the solution of the issue is usually just a matter of minutes."

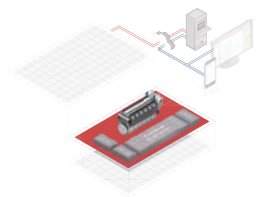
T.Gillmeister, Technical support

OPEN CUSTOMER APPLICATION

Your application software managing engine and periphery



You determine how your engine should behave. In the open customer application everything comes together. It contains all the controllers, sequences and functions that control and monitor the behaviour of the engine or its periphery. You have full access to the source code of this layer and can thus see and change all the details yourself. AVAT delivers either a standard engine control template or a finished application tailored to your needs, which your developers can further evolve. In that way you start at a high level and systematically expand your own know-how.



HOW WILL YOUR ECS LOOK IN 5 YEARS TIME?

Subsystem Control	Actuator Control	Engine I/O Control	AUX I/O Control	SCADA interfaces
Ignition Managemt.	Closed-loop Control	Start/Stop Sequences	Fuel Mode	Fuel & Gas Managemt.
Cylinder Balancing	Operation modes	User Interaction	Monitoring	Safety Functions
Condition Monitoring	Database Initialization	Engine Simulation		

Roadmaps change, especially in times when technologies are being established or when competition is fierce. Development is never complete, whether it's raising engine performance, complying with new limits, further developing condition monitoring or simply achieving new customer requests. **openECS** grows according to need and via the clear division of data and functions projects do not interfere with each other. A good thing, that the decisions you make today do not limit your scope of action in the future.

PROGRAMMING IN 3 STEPS

1. Application Database

With **openECS** data are at the centre of things. Data points addresses, units, texts and all monitoring functions are centrally configured with the AVAT PLC configuration tool. All functions access the same data source and you always keep your overview.

2. Application Code

Programming relies on the widely accepted, pan-manufacturer PLC Standard IEC 61131-3. It defines several programming languages especially made for engineers of automation systems. In conjunction, **openECS** employs the proven development environment of the **Bachmann M1 system**. Configuration tools, editors, compilers and debuggers are integrated and work together perfectly. Optionally, code generated from MATLAB/SIMULINK can be embedded.

3. User Interface Configuration

The visualisation pages are configured directly in **E²SERVICE**. You import all the data points and their properties from the database with a single mouse click. In this way you guarantee that every-thing fits together. The pages are assembled from growing library of smart GUI element.

E²SERVICE and **E²PILOT** take care of everything else automatically.

SIMULATION

Test-stand time is far too expensive to use it for testing software functions in detail. Simulations are a means of relieving these bottlenecks. **openECS** supports various forms of simulation:

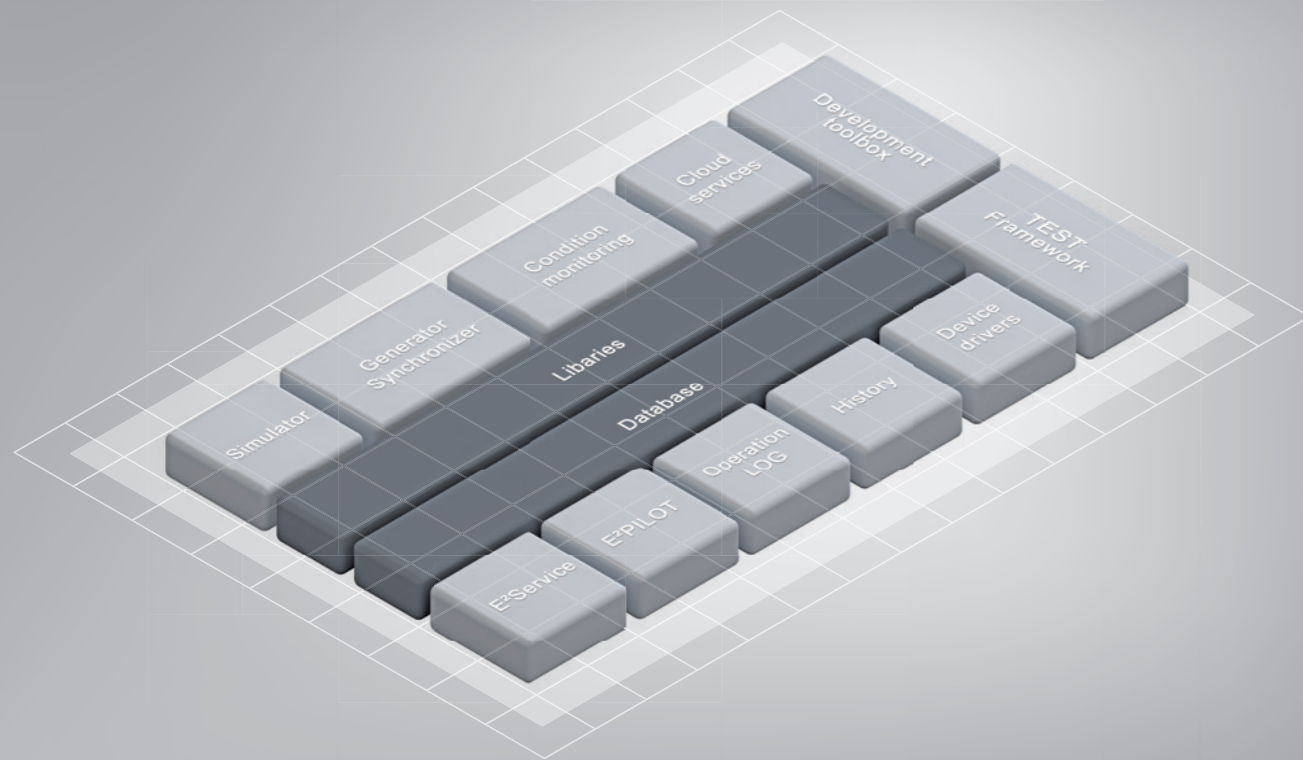
- Software-in-the-Loop (SiL) is the method of choice for testing governing strategies based on detailed engine models.
- Hardware-in-the-Loop (HiL) simulators are best for the verification of the overall system.
- Model-on-the-Target (MoT) is a special feature of **openECS**: An engine-plant model runs directly on the controller.

"When developing ECS we always take care for the engine-plant model, too. Every controller is capable of running in the MoT mode. That way not only developers can effectively conduct tests. MoT has also become indispensable for training courses, customer acceptance tests and documentation."

Klaus Schmid, Head of ECS development

AVAT SOFTWARE PLATFORM

Build your benefits on our firm foundations



With its proven tools and software modules, the AVAT software platform is a solid basis for your applications. You make rapid progress because we have already taken care of many details. And we are constantly developing the platform to support new technologies and state-of-the-art development tools, or to integrate further devices. In all this our goal is to add value for your **openECS** developers – their feedback determines our priorities.

IT'S ALL ABOUT DATA – OPEN ECS DEVELOPMENT IS DIFFERENT

With **openECS** the data are at the center of things. You notice this from the fact that once **openECS** is configured you can forget about a lot of interfacing aspects. Information arrives automatically where it is needed: in the operation log, in the history, in the visualisation, in the connected SCADA system or on the cloud server. All functions access the same data and even the external interface documentation is automatically generated. Everything from a single source – lean and efficient.



THE BACKBONE OF THE SYSTEM

The platform makes tools and building blocks available which significantly accelerate application development:

- Libraries of engine-typical functions (e.g. balancers, speed/load/mixture controls)
- The simulator toolbox contains building blocks for Model-on-the-target (MoT) simulations as well as interfaces supporting HiL and SiL simulators.
- Generator/Synchronizer integrates generator and grid measurements into the **openECS**. A library with standard generator protection functions is included.
- Condition monitoring functions work directly on the database, either on-system or offline in the cloud.
- Cloud services: establishing time-controlled or event-triggered transmission of encrypted data packets to a cloud server is just a matter of a few lines of code.
- The **E²SERVICE** and **E²PILOT** packages include application templates and a set of smart GUI elements.
- The Diagnosis suite consists of a well-structured operation log, automatic history recording in the background and the appropriate user interfaces.
- A growing set of specific device drivers make the integration of AVAT technology modules or 3rd party units such as ignition systems rapid and straightforward.

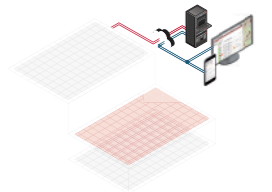
FOCUS ON THE DEVELOPMENT PROCESSES

The development tools are equipped with interfaces for integrating external tools for source code management, ticketing or test frameworks. We expressly recommend the use of such established collaboration tools for the improvement of processes and the assurance of the software's quality. Typically, during certification processes the use of such tools is explicitly required.

Moreover, the development toolbox contains add-ons such as templates, automated code checks, documentation interfaces and translation tools. This avoids structural errors and duplication of work. As with the test framework, which our developers use to test software – largely automatically. We will be glad to show you how these tools can work for you.

CLOUD SERVICES

Central Data Management in the Virtual Service Center (VSC)



Your developers seek continuous feedback regarding the engine operation in the field. Your service technicians prefer online connections to the plants rather than wasting their precious time on the road. Your customers expect to have full access to their installations – and maximum privacy at the same time. You manage all that in one system.

Welcome to the Virtual Service Center.

CLOUD SERVICES PREPARED FOR BIG DATA

In the future, engine builders will acquire far more data from their plants in operation. Automatic feedback regarding engine use and occurring failures will be opening new paths to product optimization and better deployment of resources. Complex functions which rely strongly on experience data, like condition monitoring and automatic diagnostic systems will be relocated from the engine controller to a central server.

With **openECS** cloud services, you can start straight away. For direct remote access to the controllers, pre-configured VPN routers create a secured communication tunnel from the plant to a secure rendezvous server. The platform software modules take over the time-controlled or event-triggered transmission of encrypted data packets to the central server. There, they are processed further. Comprehensive management of access rights enables multi-client capability with selective user-specific rights.



MAINTENANCE OPTIMISATION

The VSC keeps the service personnel informed of the current status of all engines assigned to them. Irrespective of their location technicians can check operating data directly via a web browser at a PC work station and on a smartphone or tablet.

- The VSC cockpit provides an overview of all engines' output power and status as well as accumulated data for groups of engines.
- The alarm monitor informs about pending alarms, responsible staff members and actual job status.
- The service monitor displays operating hours, indications of service intervals and forecasts.

REDUCED DOWNTIMES

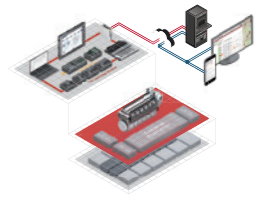
With the Virtual Service Center you gain an efficient tool to minimise engine downtimes. The **openECS** alarm management communicates status information constantly to the VSC. In the case of alarms an email with the most important details is sent directly to the smartphone of the technician on duty. Using **E²SERVICE** via a secured communication channel the technician gets instant access to all operation data, solves the issue remotely or plans a service mission.

AVAT SERVICES

Services and Support – share the AVAT experience



Simultaneous engineering in international projects is our daily business, because setting up a new engine control system involves many activities from the first design to production rollout. For more than 25 years AVAT has partnered major OEMs of gas and DF engines for both R&D and commercial applications. With AVAT, you benefit from day one from the support of specialists with practical experience who will accompany you until your engine controller is up and running. In time, in budget.



EXTEND YOUR DEVELOPMENT RESSOURCES

For the development of your own engine control system you decide what you do yourself or which of AVAT's services you wish to buy-in. Use our specialists as your advisers for a rapid introduction to new technologies or have your software developed directly at AVAT so that you progress faster in large projects. Right up to turnkey solutions from the specification to the acceptance test on the running engine.

Professional development tools and the well-structured architecture of **openECS** enable real collaboration between the engine OEM and AVAT. In this way you can concentrate on the further development of your control algorithms while AVAT takes over quality control for series releases according to clearly-defined preconditions. The underlying question is always: which option will be faster and more economic?



AVAT ACADEMY TRAININGS

In our training courses we impart practical know-how to your developers so that they can quickly get started with new technologies, including:

- Advanced PLC programming
- Development tools and processes
- **openECS** software platform
- Avanced Control and monitoring concepts on gas and DF engines
- Closed-loop combustion control
- Use of simulation techniques



ELECTRICAL ENGINEERING

With more than 8.000 customer-specific Engine Control Systems designed and produced, we are sure to find the best solution for your project:

- Electrical engineering, wiring diagrams, choice of components
- Mechanical design of on-engine panels
- Prototype or series production of switchboards and control panels
- Customer-specific product branding



HOTLINE SUPPORT

Our engineers and technicians with long gas engine experience are ready to assist you in any phase of your empire product life cycle:

- Test bed and commissioning assistance (on site or remote)
- Hotline support
- Spare part handling and obsolescence management



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