

Mountaineer Case Study

.NET Micro Framework in practice

Smart Interface to Combined Heat and Power Plants of 2G Energy AG



Local access, remote monitoring and remote control

2G Drives GmbH in Heek, Germany is the research and development division of the 2G Energy group. This group produces and distributes combined heat and power plants (CHP) in the power range of 20 to 2000 kW, based on gas engines. A CHP allows for the production of electricity and useful heat at the same time. For optimization purposes, a number of control parameters need to be set up, e.g., ignition timing or the air fuel ratio.

These parameters must be accessible to maintenance engineers, both locally at the CHP as well as over the Internet, to allow for remote optimization of the device while it is running. In addition, characteristic data is logged so that the facility's efficiency can be analyzed continuously. Error states are sent to the 2G support center automatically.

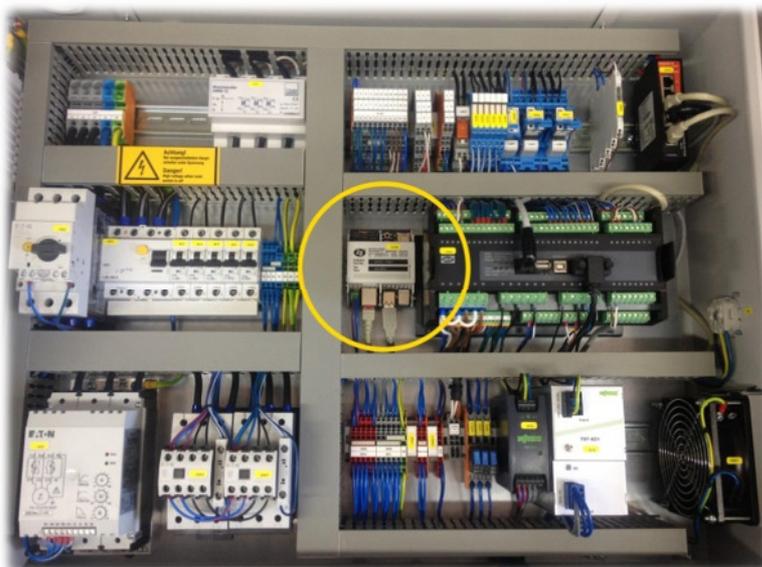
Challenges

The desired solution should be useable for all CHP models produced by 2G. For small models in particular like the G-BOX20 shown at the left low hardware costs, license costs and development costs are a primary goal. For all models the same gateway software should be useable. In the future if the electronics need to be replaced, migration of the software must be possible at low cost (hardware inde-

pendence, investment protection). Moreover, foreseeable future requirements such as remote software updates or the integration into virtual power plants should be allowed for.

Requirements

A smart gateway was required that can fit onto a DIN Rail in a control cabinet (see right side). Required interfaces are Ethernet for remote access, USB Host and SD-Card for storing larger amounts of data and Modbus for connecting to the PLC. Access to the gateway should be done such that future modifications of the hardware can be done without costly adaptations of the application software. In addition a battery-backed real-time clock is integrated into the solution. For Internet access, SSL should be allowed for. Performance and hardware resources of the smart gateway should be chosen so that they can relieve the PLC e.g. by processing and bundling the raw data from the PLC. Programming of the gateway should be possible using modern programming tools.



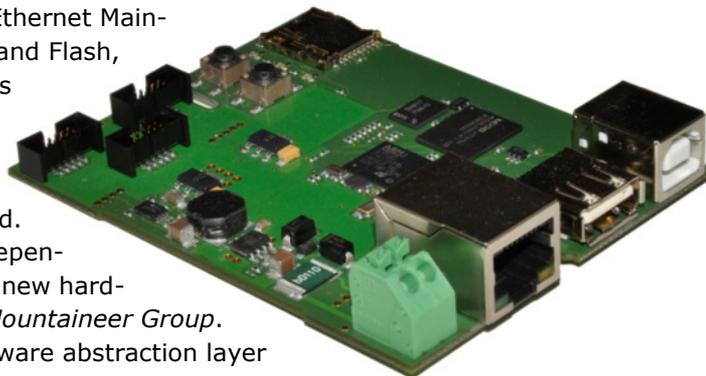


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Solution

2G Drives decided to have a variant of the Mountaineer Ethernet Main-board designed and produced, which adds external RAM and Flash, an SD Card slot, and a USB Host interface. The board was designed by *CSA Engineering*, a member of the *Mountaineer Group*. A suitable STM32F4 microcontroller model was chosen. For the software platform the .NET Micro Framework (NETMF) was selected. NETMF's hardware abstraction layer allows hardware-independent access to peripherals. NETMF 4.3 was ported to the new hardware by *Oberon microsystems*, another member of the *Mountaineer Group*. Oberon added the required additional drivers to the hardware abstraction layer firmware.



Software for maintenance and remote access

2G Drives implemented its own software stack for the Modbus protocol for accessing the PLC that controls the motor. This stack is completely written in C# and fully portable. This allows for directly reading out of the logged data without a separate hardware adapter. Logged data is directly buffered locally to the .NET board which then can be sent over the Ethernet interface to the support center, as well as alarms when critical conditions are detected. Transmission of the data occurs independently of the motor control tasks of the PLC.

.NET Micro Framework

The .NET Micro Framework is the smallest member of the .NET platform family specifically designed for microcontrollers. It does not need a separate operating system ("bootable runtime") and can be programmed conveniently from Microsoft's Visual Studio development environment – including symbolic debugging. Thanks to this tool it has made for far easier debugging, even of the Modbus protocol implementation of third-party components. NETMF allows the use of Visual Studio, .NET and C# from microcontrollers all the way to cloud servers, and thus enables more effective use of available personnel and know-how. The .NET Micro Framework is licensed under the Apache 2.0 open source license.

2G Energy AG

2G is one of the leading suppliers of cogeneration (CHP) and consequently has specialized in high efficiency systems for natural gas and biogas in the power range of 20 to 2.000 kW electrical power. 2G serves a wide range of customers from farmers to industrial clients, municipalities, real estate industry up to big utility companies. Their products and developments have produced a multitude of satisfied clients in more than 20 countries.

2G: www.2-g.com 2G Drives: <http://www.2-g.de/2g-drives-gmbh-1>

Mountaineer Group

The *Mountaineer Group* is an international cooperation of independent companies that offer engineering services in the innovation domain. Their focus is on demanding embedded systems and their integration into the Internet ("Internet of Things").

Mountaineer:

- www.mountaineer.org/mountaineer-group
- www.mountaineer-boards.com/engineering-services

.NET Micro Framework:

- www.mountaineer.org/netmf-for-stm32
- netmf4stm32.codeplex.com

