

WHITEPAPER

EDGE GATEWAYS: HOW IIoT CAN BENEFIT USERS TODAY AND TOMORROW

Table of Contents

Executive Summary	2
Edge Gateways	3
netIOT Edge: The Potential	4
netIOT Edge: The Product	5
netIOT Edge: Default Functionality	8
Brownfield Applications	10
Greenfield Applications	11
About Hilscher	13

EDGE GATEWAYS: HOW IIoT CAN BENEFIT USERS TODAY AND TOMORROW

Executive Summary

The scope and scale of the Industrial Internet of Things (IIoT) is well beyond recent experience. However, realistic solutions are already available and interest is rapidly growing.

Full-blown IIoT deployments will be based on new automation strategies: field devices will communicate directly with the cloud; concepts such as Artificial Intelligence and “digital twins” will draw users to greater production flexibility and improved asset management; new levels of profitability will be achieved.

Addressing this “full blown” scenario will not happen immediately. Initially, IIoT implementations will be associated with plant upgrades and step improvements. They will use familiar techniques and have to co-exist with current equipment and systems. They will add value without legacy risk.

This Whitepaper outlines IIoT capabilities as they relate to today’s – and tomorrow’s - automation environments. It introduces Hilscher’s netIOT Edge, a powerful new gateway computing platform for bridging IT (Information Technology) and OT (Operations Technology) domains.

netIOT Edge can support familiar “On-Premise” needs today by offering new ways to solve “brownfield” challenges. It can interface with cloud-based services, opening up IIoT to everyone now.

It is also future-proofed in readiness for full-blown IIoT opportunities in the future.

Edge Gateways

Edge gateways are so-called because they sit at the “edge” of networks and they perform a connectivity function. They are similar to the gateways we are familiar with today except that they gather, process and transfer data between the IT (Information Technology) and OT (Operations Technology) sectors.

Edge gateways perform tasks such as data collection, aggregation and even abstraction.

In effect, an edge gateway is a bridge between two domains and that means a good understanding of the technologies used on each side is important.

The diagram below shows the architecture of a full-blown IIoT deployment. Edge gateways sit at the juncture of the OT (Data Generation) and IT (Data Management) layers.

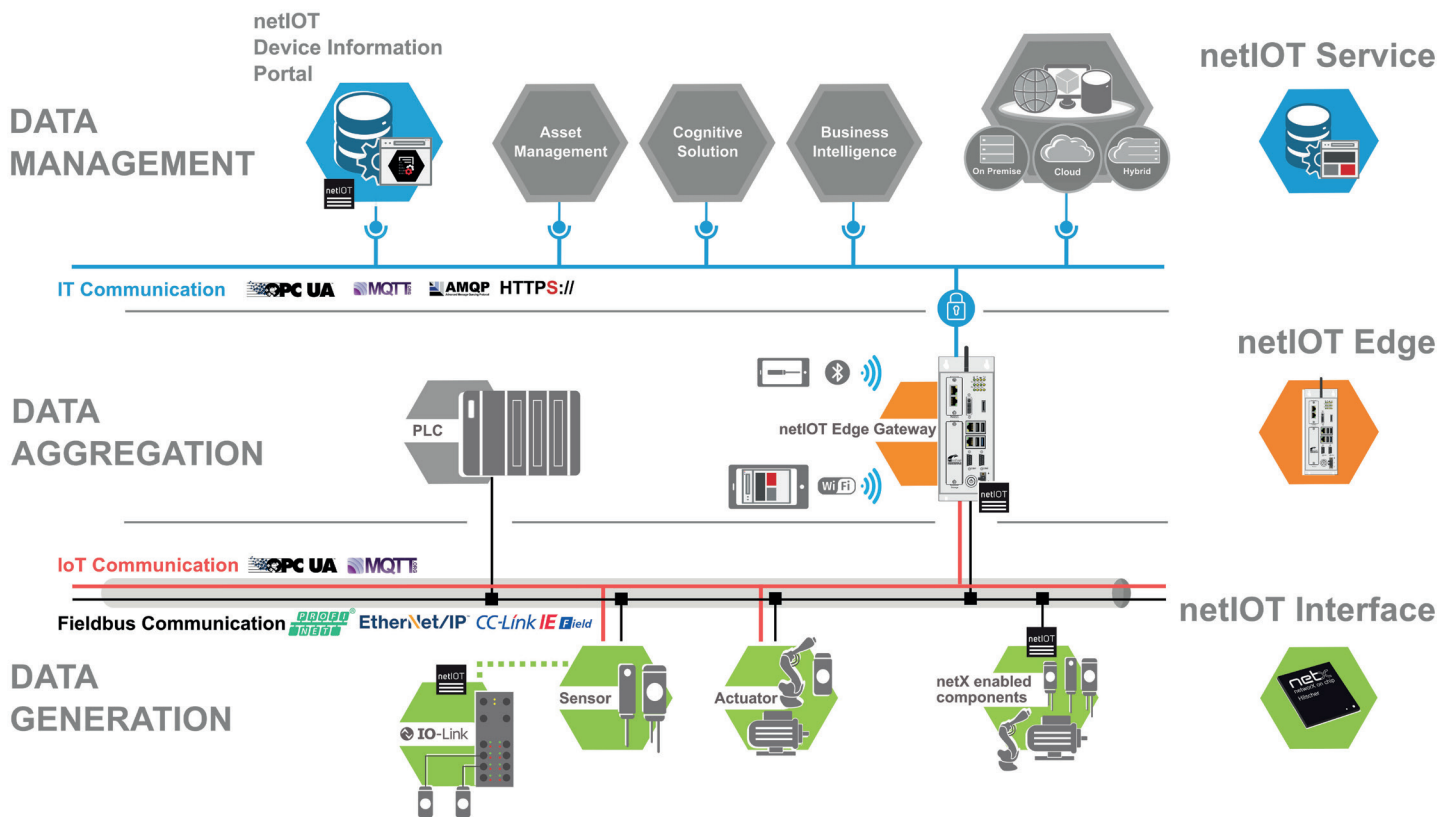


Figure 1: Hilscher's IIoT architecture vision

Techniques and protocols are already available for “crossing the edge”. Some are IT-based, e.g. HTTP and web services. In the automation world, the hard real-time benefits of protocols like PROFINET and EtherNet/IP will ensure they remain favored networking options.

OPC UA is a technology that can exist on both sides of the divide. A recent arrival to IIoT is the MQTT protocol, actually devised 20 years ago as a lean and efficient way of transmitting data over long distances for SCADA. Both MQTT and OPC UA will be de facto standards for IIoT.

A less familiar - but potential - IIoT protocol standard is AMQP. This is similar to MQTT but has yet to be strongly positioned. Various vendors are supplying cloud-based services in support of the Data Manage-

ment layers, for functions such as MES and ERP.

An edge gateway must be able to deal with all of these needs, while interfacing with the established automation networks from where data is aggregated. It has to deal with emerging cloud-based services and remote applications such as analytics, artificial intelligence and virtual modelling concepts such as “digital twins”.

Recognizing the importance of upgrading brownfield sites, it must also support more traditional data gathering functions e.g. SCADA, visualization, preventative maintenance, etc.

netIOT Edge: The Potential

netIOT Edge is capable of delivering a flexible and versatile solution that offers unprecedented – sometimes disruptive – opportunities for adding value to plants today at little or no risk to existing systems.

netIOT Edge is more than a simple “gateway.” It is an independent computing platform capable not only of conventional gateway tasks but also of acquiring, processing, storing and analysing data locally, as well as interfacing that data to cloud-based systems.

Essentially, netIOT Edge offers a way to support traditional data gathering applications (e.g. historian, visualization, SCADA etc.) while opening up a plant to the full potential of Industrial IoT.

It’s “disruptive” in that it can be employed in both traditional and futuristic roles. It can be a passive device that simply listens to traffic on a network, or it can be an active device handling complex functions such as rule-based decision making.

netIOT Edge is based on open standards that free users from proprietary solutions tied to vendor-specific control systems. For plants where programming skills have been lost, or where equipment is “closed” to reconfiguration, or it’s costly to reprogram, netIOT Edge provides an easy way to gain access to what is really going on in a production line. Many functions can be user-chosen based on third-party applications.



*Figure 2: netIOT Edge
"On-Premise" gateway*

netIOT Edge: The Product

netIOT Edge is Hilscher's answer to the edge gateway challenge. Below is an illustration of its software architecture.

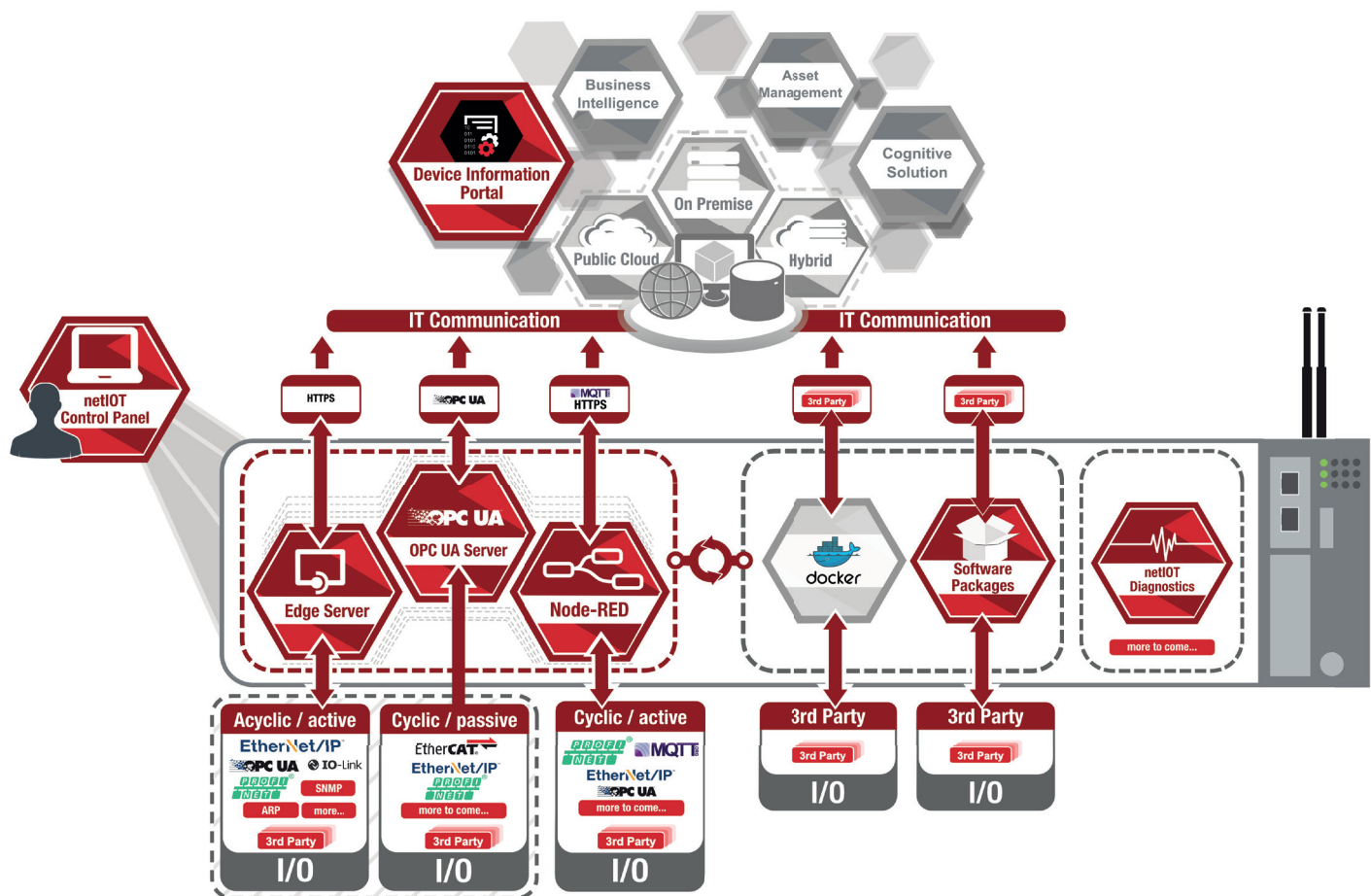


Figure 3: netIOT Edge software architecture

Hardware-wise, it has two processors – a powerful netX ASIC with processor running an embedded Operating System (OS with protocol stacks to support the automation connectivity), and a separate x86-based processor for handling the IT-oriented functions, running Linux. Linux is the world's most widely used open-source operating system and is at the heart of millions of applications in all industries, including manufacturing automation and enterprise management. (For more on netX, see "Hilscher's Pedigree" on the last page of this Whitepaper.)

Briefly, here's what netIOT Edge offers:

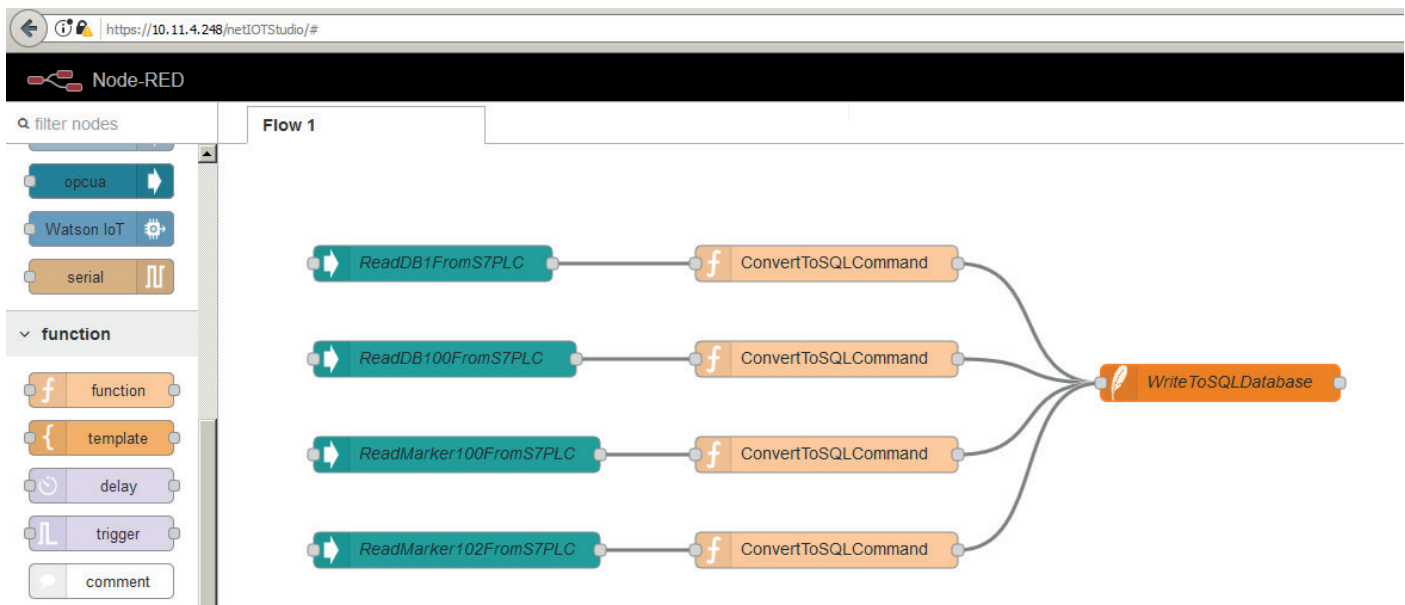
- Isolation of the automation-facing network, helping protect it from outside attack. netIOT Edge Gateway is among the first devices of its kind to be submitted for IEC 62443 certification.
- Plenty of choice for running third party software applications locally in the IT-facing core. Options include SCADA, polling and analytics. Third-party add-ons supporting Artificial Intelligence and other Cognitive applications can also be run.
- Collection of additional data from a real-time time Ethernet network with netIOT Edge making non-visible data available for smart applications.
- Node-RED configuration. Node-RED is an open-source, visual wiring tool for the Internet of Things. It enables users to easily configure the data flow and processing functions. There's more about Node-RED below.

netIOT Edge can also support IIoT stacks for customer-specific applications.

Node-RED: Drag and Drop Flow Control

Node-RED is a browser-based editor that makes it easy to wire together data flows using graphical blocks called “nodes.” “Drag, drop and click” are used to build the flows.

The Node-RED project is “open-source” and supported widely by the IT industry. Flow functions are created by selecting “nodes” from a user library, dragging them into position on a screen, and then click-connecting them (see diagrams).



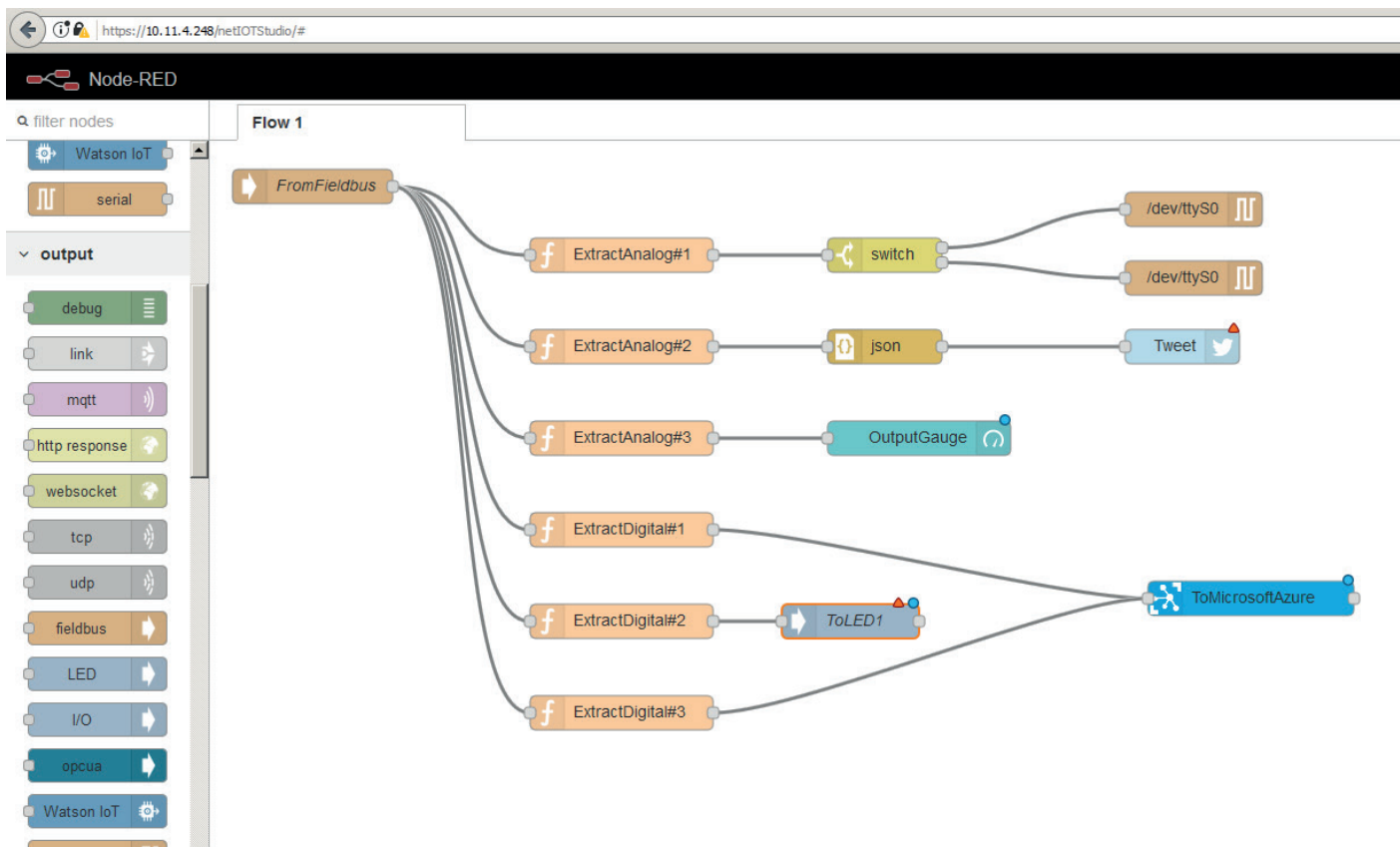


Figure 4a and b: Node-RED configuration screens showing how data sources, functions and destinations are selected and linked graphically

“Nodes” range from basic READ and WRITE to advanced rule-based decision-making. Relevant to the automation industries are nodes such as serial communications, MQTT protocol conversion, and TCP/UDP communications.

Currently Node-RED has over 800 “nodes” in its online library. This total is growing rapidly as the global user community contributes to the repository. Hilscher has contributed by developing an OPC UA node and a node for the Siemens S7 PLC.

All nodes in the global repository are freely available to any netIoT Edge user. Many common automation nodes are pre-installed in netIoT Edge on shipment. Other nodes can be downloaded as required. With Node-RED the user has access to rich and powerful functionality that can be configured by almost anyone.

Docker: Run Any Software Locally

Docker, the world’s leading software “container” platform, is shipped ready-to-use with netIoT Edge. It allows third-party software applications to be run safely and securely.

Docker is supported by an open-source developer community. Everything required to make a piece of software run is packaged into an isolated container. Containers do not bundle a full operating system, only the libraries and settings required to make the software work. This makes for efficient, lightweight, self-contained systems that guarantee software runs the same, regardless of where it’s deployed.

Containers enhance security since applications are isolated from each other and netIOT Edge's Linux host system.

Docker aids collaborating on code with co-workers. Docker can run and manage apps side-by-side to get better compute density. Docker enables new features to be deployed fast and with confidence. It opens opportunities for making netIOT Edge a powerful partner in an IIoT architecture.

In our Applications section below you'll find a few examples of how Docker, combined with Node-RED and the Linux-based netX kernels, deliver a high-value proposition for netIOT Edge in IIoT applications.

netIOT Edge Default Functionality

In netIOT Edge, Hilscher's netX ASICs and Intel x86 CPUs, together with Linux, Node-RED and Docker combination, create a computing platform optimized for IIoT. Powerful new concepts complement traditional functionality to offer opportunities for the gathering, distribution and processing of data.

Here's a summary of what's possible:

Functionality Available by Default	Typical Use Cases
Traditional	Serial communications; Connecting an ASCII scanner; Connecting an RFID reader; Serial devices with proprietary protocols; Replication of Modbus RTU master / slave communications protocol.
Ethernet-based	Connectionless (UDP) data transmissions over an IP network; Listening on and sending over any port number; Simple data exchange; IP-to-serial converter; Data transmission to a data logger. Connection-oriented (TCP/IP) data transmissions over IP networks; Meshing devices; Connecting IO; Exchanging data with PC; Connection of printer.
Web-based	Bi-directional transmission of dynamic data between web browser and Node-RED web pages; Dynamization of web content via Node-RED; Feeding Node-RED with data from user inputs fields on web pages; Filling simple web pages with dynamic content with some interactivity via Node-RED.
MQTT Communications (Embedded Mosquitto running under Linux)	MQTT broker for monitoring subscribed MQTT messages; MQTT client for sending data to any MQTT devices; Bidirectional connectivity to MQTT supporting devices; Transmitting IoT data between Field and Cloud; Data transfer and distribution through IP channels such as Ethernet LAN / Wifi / LAN Fieldbus.

OPC UA Communications	OPC UA client cyclic polling; Data transfer from and to end devices (e.g. field sensors) supporting the nano and micro profiles. OPC UA Server support is coming soon.
Modbus Communications	Modbus TCP/RTU Client; Connecting to Modbus TCP supporting PLCs, RTU converters and analog/digital I/O; Cyclic reading of data.
SIMATIC S7 PLC communications	Read and write services for visualization; Long time recording of data; Writing data triggered by user inputs via Node-RED.
Local Graphing	Displaying Node-RED data in graphs or charts on local web pages (dashboards); Multiple dashboards; Simple web visualization; Transmission of status information; Historical data.
Local Database (SQLite)	Reading/writing of data in accordance with https://sqlite.org/lang.html ; Long term recording of process data on SD card; File output size effectively unlimited.
Programming via Javascript	Adding semantic information before forwarding data to Cloud; Conversion of data formats; Building complex state machines and sequences; Arithmetic functions.
Third Party Applications	
Docker-supported	Using Docker, it is possible to run applications such as SCADA, polling and analytics, or set up rule-based decision routines for data processing and analytics at the edge. Low latency response times are a big advantage.
SCADA-specific (Collaboration with Inductive Automation and Cirrus Link Solutions – see more below)	Customized client for Inductive Automation's Ignition SCADA platform; Compliant with Cirrus Links Solutions' Sparkplug specification; Sends topic-based messages to Ignition via MQTT for visualization, data analysis, device status, and MES/IIoT applications.
Customized Applications	
Cloud-specific	Bidirectional transmissions of Node-RED data to and from cloud solutions such as IBM Bluemix (e.g. Watson), Microsoft Azure, SAP.

Brown field Applications: How netIOT Edge Supports Real World Needs Today

Automation systems can range from highly flexible networks managed by skilled engineers who can “make things happen”, to fixed installations that are impossible to change without great expense or delay. The pressure to “do better” is immense and constant yet staffing levels are under continuous review and skills are slowly disappearing as generations of personnel retire or are laid off.

netIOT Edge can be a solution to these challenges. Considerable flexibility is on offer and costs can be much lower.

Here are a few ways netIOT Edge can enhance brownfield sites. They are based on actual use cases:

- **Direct polling:** netIOT Edge is used to poll the PLC and pull data from it into local memory. This can be done over an existing network or - for increased security – via an independent Ethernet connection from the netIOT Edge gateway to the PLC. Once data is in netIOT Edge it can be used locally (e.g. a database application) or streamed to the cloud.
- **Active mode:** netIOT Edge becomes a part of the PLC’s automation network as a slave device, and the PLC pushes data to it. It’s a fixed solution that can be alarm/event driven. Like Direct Polling, it takes up bandwidth (though not as much). Once data is in netIOT Edge it can be used locally or distributed in the usual way.
- **Passive mode** (or P-mode): This is Hilscher’s name for the so-called “promiscuous” mode commonly referenced by IT experts. Passive mode enables netIOT Edge to sit unnoticed on a network, monitoring any or all activity. Selected events or data streams are extracted and delivered to local storage for further processing. P-mode can only READ data; it cannot WRITE to the network so it is a secure method of monitoring what happens without interfering with operations.

These use cases translate into the following possible scenarios:

- netIOT Edge can be a master for polling devices.
- netIOT Edge can be a slave collecting data passing between the PLC and its I/O.
- netIOT Edge can read/write data to and from the controller.
- netIOT Edge can be a slave and have the controller push event driven data to it.
- netIOT Edge can be an “invisible” slave reading (only) data passing between the controller and its I/O.
- netIOT Edge can poll data and read data off the I/O network simultaneously.

SCADA Collaboration: Hilscher has formed an agreement with two other companies – Cirrus Link Solutions and Inductive Automation – to jointly market a fresh approach to SCADA using netIOT Edge.

Normally, data sent to a SCADA application is “raw” data. Cirrus Link Solutions’ Sparkplug specification adds context and semantics to the data stream, turning it into meaningful information (tagged, parameterized, etc.). Anyone in the enterprise with access to a SCADA terminal can see exactly what is happening with the data points they are interested in.

With Inductive Automation’s Ignition, displays can be built in minutes as no programming skills are needed. Ignition is highly scalable and can meet virtually any size of automation or enterprise need.

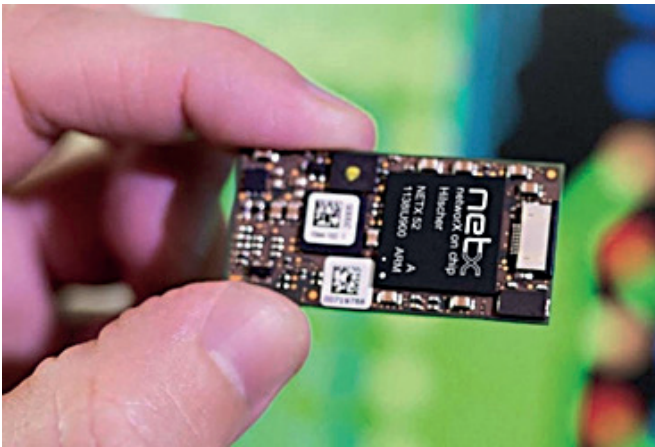
Greenfield Applications: How netIOT Edge Gateway Can Support Real World Needs Tomorrow

In parallel with the aspirations of individual OT and IT companies, many collaborative efforts are underway. In Germany, the Platform Industrie 4.0 project is working to realize its strategic vision for the future of manufacturing. In North America, the Industrial Internet Consortium is creating specifications and definitions for IIoT connectivity, and organizing testbeds for IIoT deployment.

It's not clear where their efforts will take us. Major industrial suppliers meanwhile are developing initiatives of their own, while IT vendors such as IBM, Microsoft and SAP (among others) have identified the industrial space as a key new market.

Hilscher is close to all of these players and is playing a direct role in the Industrial Internet Consortium and the Platform Industrie 4.0 projects. Recently Hilscher joined the TSN (Time-Sensitive Networking) initiative which aims to bring a level of standardization to real-time Industrial Ethernet protocols. Although not directly related to IIoT, TSN is seen as an important part of next generation automation systems.

netIOT Edge and in particular the netX ASIC are attracting interest in all these cases. netIOT Edge is already being used in testbed implementations.



Hilscher's IIoT strategy includes another important component for true IIoT functionality. The netIOT Interface module (pictured) and the new netX 90 ASIC are designed specifically to be embedded into low cost field devices. netIOT Interface incorporates Hilscher's netX ASIC and currently includes on-board support for both OPC UA and MQTT.

This means that field devices will be able to communicate directly with netIOT Edge, sending data from the field through an automation network for local processing, and then onwards into the cloud.

Figure 5: netIOT Interface - an embedded module for building IIoT-ready smarter sensors

Smarter field devices will deliver data that once was considered unwanted. For example, an encoder might transmit temperature and vibration data along with motion control information. This added data will enable better monitoring of field devices and lead to improved asset management.

With netIOT Interface and netIOT Edge, the ideal IIoT architecture becomes fully realizable.

Hilscher's Pedigree

Hilscher is among a handful of companies dedicated to “connectivity”. We have in-depth knowledge of automation networks. We know how to interface them, and how to transfer data between them.

We are unique in having our own family of ASICs – the netX range. These ASICs support our entire product portfolio. They have evolved over more than 20 years and today are positioned as the most advanced available anywhere.



Device Information Portal (DI Portal): “Digital Twins,” Asset Management systems and similar functions will require comprehensive knowledge of a plant and its hardware. This information exists in the form of Device Description files that are generated and maintained by individual device vendors. Currently, there is no single reliable resource where up-to-date data can be accessed automatically over the web. Hilscher recognizes this market gap and is developing the DI Portal in collaboration with other vendors and users. The DI Portal will give immediate on-line access to any system requesting the information.

With our long history in communications and connectivity, Hilscher is uniquely suited to understand how to acquire and move data between industrial networks and the cloud. Our installed base and engineering research have allowed us to see deeply into IoT processes and solutions, and address their needs. We are collaborating with IT majors, who in IIoT terms hold many of the aces. They are the key drivers for greater IIoT use.

A single, reliable source of device information is a “must have” for IIoT. As part of our netIIoT Service offering, and in the spirit of collaboration, Hilscher is launching a Device Information Portal to meet this need. (See box at left).

Whether greenfield or brownfield sites, we expect many IIoT deployments to be a series of steps that enable users to gain experience. This will let users adjust their strategies accordingly while reaping short term benefits in terms of productivity and profitability.

Longer term, IIoT will lead us in directions that we cannot imagine today, resulting in true OT and IT convergence.



Hilscher's netX family is based on ARM technology and optimized for connectivity in automation networks such as PROFINET, PROFIBUS, EtherNet/IP, EtherCAT, etc., in both slave and master modes. Protocol stacks are supported in firmware so changes are simple and quick. We offer over 20 protocols in a range of form factors that include embedded modules for IIoT-enabled low-cost field devices such as sensors. Newer netX types such as netX 90 and netX4000 are designed to bring OT and IT domains together securely and reliably.

Useful Links:

- Hilscher Web Site: <https://www.hilscher.com>
- netIIoT Web Site and Blog: <https://www.netiiot.com/>
- Device Information Portal: <https://www.netiiot.com/netiiot/netiiot-device-information-portal/>
- Node-RED: <https://nodered.org/>
- Docker: <https://www.docker.com/>

Contact

Headquarters

Germany
Hilscher Gesellschaft für
Systemautomation mbH
Rheinstrasse 15
65795 Hattersheim

Phone: +49 (0) 6190 9907-0
Fax: +49 (0) 6190 9907-50
E-Mail: info@hilscher.com

Support
Phone: +49 (0) 6190 9907-99
E-Mail: de.support@hilscher.com

Subsidiaries

China

Hilscher Systemautomation (Shanghai) Co. Ltd.
200010 Shanghai
Phone: +86 (0) 21-6355-5161
E-Mail: info@hilscher.cn

Support
Phone: +86 (0) 21-6355-5161
E-Mail: cn.support@hilscher.com

France

Hilscher France S.a.r.l.
69500 Bron
Phone: +33 (0) 4 72 37 98 40
E-Mail: info@hilscher.fr

Support
Phone: +33 (0) 4 72 37 98 40
E-Mail: fr.support@hilscher.com

India

Hilscher India Pvt. Ltd.
New Delhi - 110 065
Phone: +91 11 26915430
E-Mail: info@hilscher.in

Italy

Hilscher Italia S.r.l.
20090 Vimodrone (MI)
Phone: +39 02 25007068
E-Mail: info@hilscher.it

Support
Phone: +39 02 25007068
E-Mail: it.support@hilscher.com

Japan

Hilscher Japan KK
Tokyo, 160-0022
Phone: +81 (0) 3-5362-0521
E-Mail: info@hilscher.jp

Support
Phone: +81 (0) 3-5362-0521
E-Mail: jp.support@hilscher.com

Korea

Hilscher Korea Inc.
Seongnam, Gyeonggi, 463-400
Phone: +82 (0) 31-789-3715
E-Mail: info@hilscher.kr

Switzerland

Hilscher Swiss GmbH
4500 Solothurn
Phone: +41 (0) 32 623 6633
E-Mail: info@hilscher.ch

Support
Phone: +49 (0) 6190 9907-99
E-Mail: ch.support@hilscher.com

USA

Hilscher North America, Inc. Lisle, IL 60532
Phone: +1 630-505-5301
E-Mail: info@hilscher.us

Support
Phone: +1 630-505-5301
E-Mail: us.support@hilscher.com