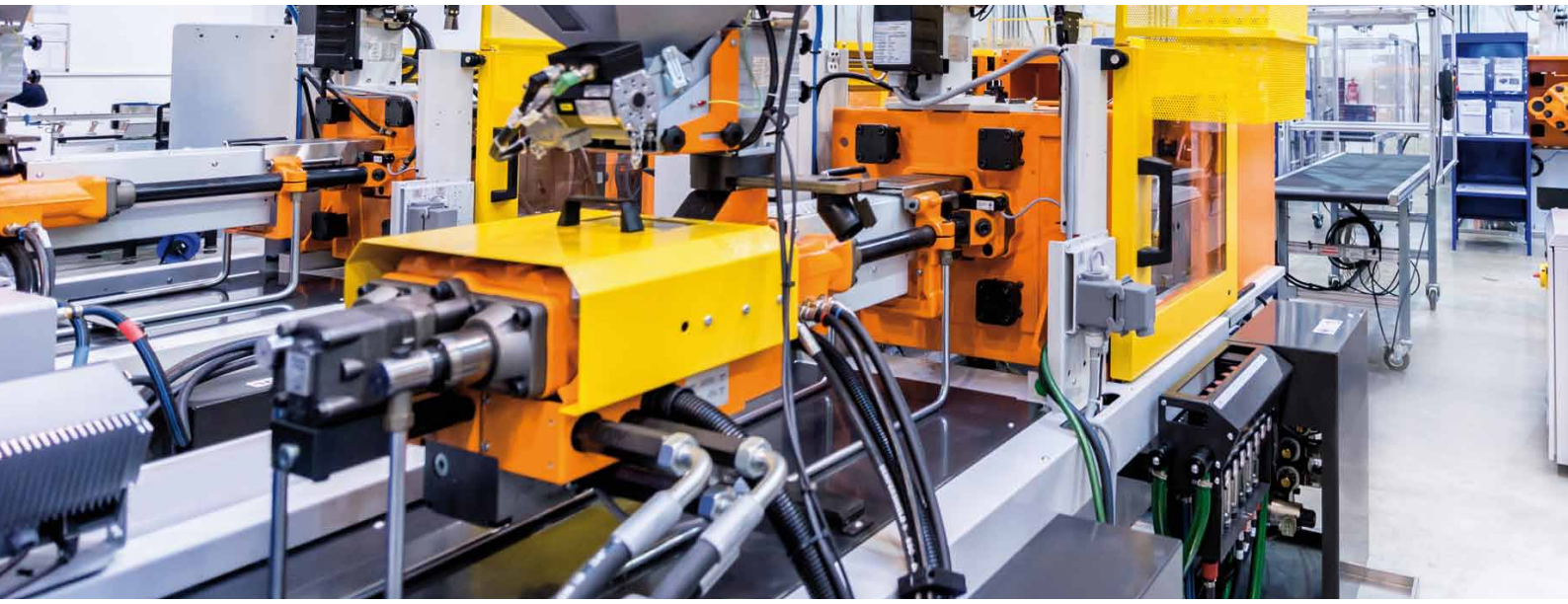
SPRINT ELECTRIC

PRIOCEPT

CASE STUDY

Sprint Electric – Embedded Software Development and IoT Product Design



BACKGROUND

Sprint Electric are an industrial electronics manufacturer. They design, develop and manufacture a range of electronic speed controllers for high power electric motors.

These "motor drive systems" are used to control electric motors across a wide range of industrial applications that include automated production lines, conveyor belts, hoists and cranes, theme park rides, industrial fans and pumps, and any other application of high power electric motors that requires sophisticated control of the motor.

Electronic motor control is a multi-billion dollar market globally, with an estimated 28% of the world's total electricity supply being consumed by electric motors.

Sprint Electric's PL/X series of motor drive systems are solid-state, microcontroller based devices which are fully software configurable. Historically, configuration of these devices has been performed by Sprint Electric's customers via an LCD screen embedded in the front panel of the product, or via proprietary software running on a Windows based laptop computer that is connected to the PL/X device via a serial communications cable.

With the proliferation of browser-based web applications, tablets and mobile apps, and the internet-enabling of industrial devices to allow real-time remote monitoring and control ("Internet of Things" or "IoT"), Sprint Electric identified the need to develop a new architecture for their PL/X devices that would allow them to incorporate modern web, mobile and internet based features into their products.

As a result, Sprint Electric engaged with Priocept to help them with product and technical strategy for the next generation of PL/X devices, and to deliver a combination of hardware design and software development services to help bring the new products to market.

PRODUCT CONCEPT

Priocept identified a need for the next generation of PL/X motor drive systems to deliver the following new features:

- **Web-based configuration and control** – Based on an embedded web server running on the PL/X hardware, this would allow all interaction with the product to be via any computer or mobile device that was capable of running a web browser, eliminating the need for proprietary software installation and support.
- **Wireless connectivity** – Aside from the convenience offered by eliminating cables between a user's laptop and the PL/X device, "arm's length" connectivity via a wireless link would provide additional safety benefits when dealing with high voltage electrical systems.
- **Mobile app** – This would allow a richer experience when configuring a PL/X device from a mobile phone or tablet, that was not limited by the capabilities of a web-based user interface. Android was chosen as the preferred mobile platform due to its broad hardware support and the ability to embed it into custom hardware using off-the-shelf Android hardware modules, in addition to supporting a wide range of consumer-grade mobile devices.
- **IoT functionality** – This would allow each PL/X device to establish a permanent connection to the internet, to allow remote configuration and monitoring and avoid the need to perform device configuration and maintenance "in the field".

Having assisted Sprint Electric with developing a high level product strategy and identifying the features required for the next generation product, Priocept was tasked with designing and developing a technical platform that would deliver on the new strategy.

Figure 1: Existing range of PL/X products and new Variscite hardware upgrade board

SOLUTION ARCHITECTURE

A new architecture was developed which encompassed both the hardware and software components of the new PL/X product. This compromised of the following components:

- **Hardware Platform** – This has been designed both as a "daughterboard" hardware device that can be plugged into legacy PL/X devices, and as a fully integrated solution for new hardware designs. This new hardware platform supports all the new software features on a single device. It includes an ARM based System-on-Module ("SOM") running a custom built Yocto embedded Linux distribution, networking hardware that can operate as both a Wi-Fi server or Wi-Fi client to provide a range of connectivity options to the user, and various interfaces for integration with the core PL/X hardware including UART, RS232 and a proprietary high speed logic interface. Flash storage is also incorporated to allow upgradeable firmware, configuration storage and data logging. Early prototyping was performed using a range of Raspberry Pi devices, which were subsequently replaced with hardware supplied by Variscite as this was deemed more suitable than Raspberry Pi for a high volume, production-grade design.

- **Web Configuration App** – This is a custom web application developed using Vaadin running on the Spring Boot framework for Java. It provides the facility to configure or monitor a PL/X device using only a web browser and a Wi-Fi connection. Contentful is used to manage application labelling and embedded documentation.

- **Internet Telemetry Service** – This software runs alongside the Web Configuration App on the same hardware. It provides real-time monitoring of the state of the PL/X device and streams data to the "IoT Core" product that is part of Google Cloud Platform (GCP). IoT Core provides a framework for building secure and highly available IoT infrastructure that is operated by Google, with zero upfront cost and a simple pay-per-use charging model.

- **Datawarehousing and Analytics** – Data that is received by the IoT Core framework is then fed via GCP's message queuing service (Pub/Sub) into BigQuery, a fully managed data warehousing solution that provides querying and analytics on virtually unlimited volumes of data.

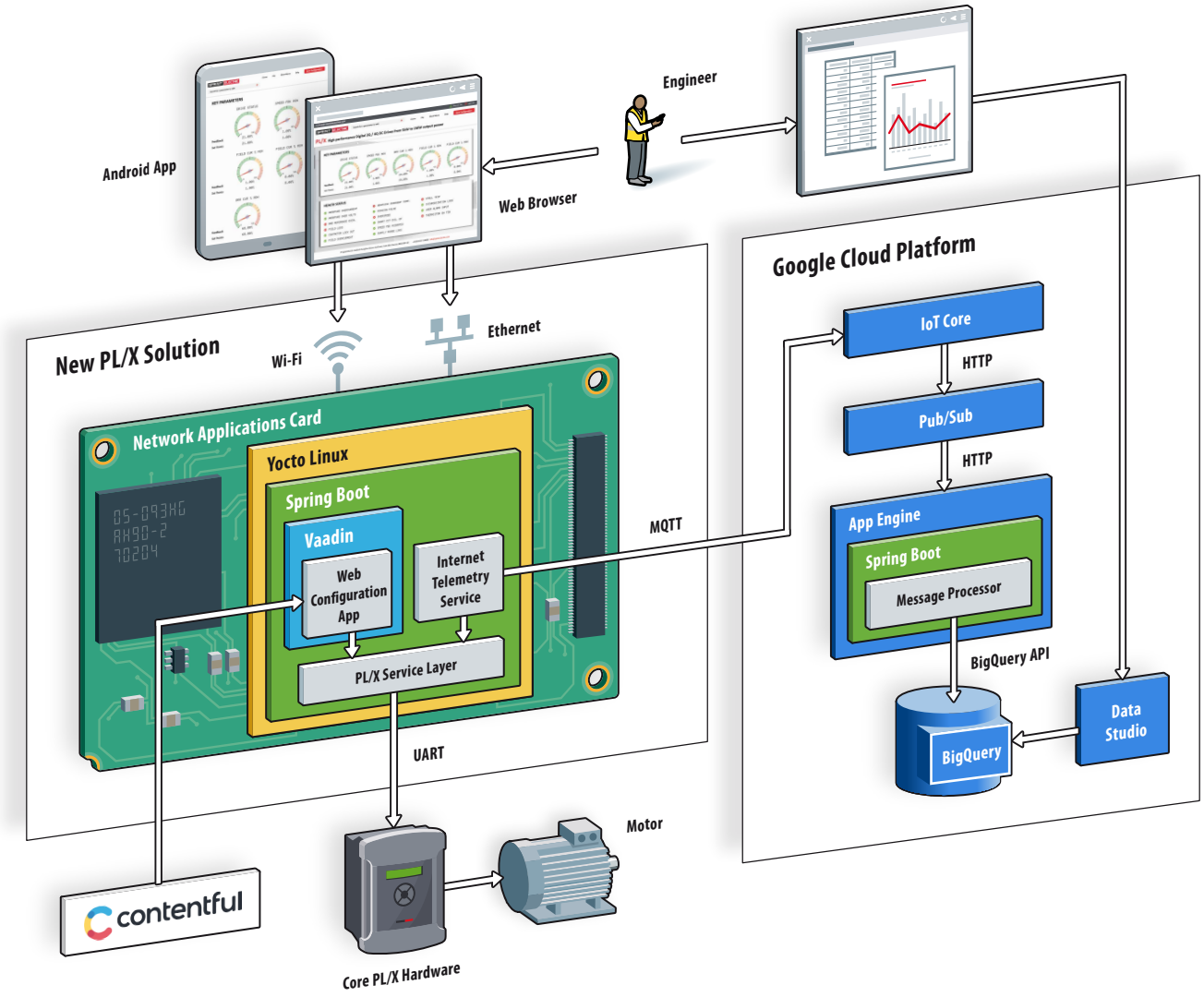


Figure 2: New PL/X architecture for adding web, mobile and IoT capabilities to the PL/X product range

PRODUCT FEATURES

The Web Configuration App (WCA) provides the following key features:

- **Diagrammatic editing** – Configuration parameters are mapped to editable (clickable and zoomable) block diagrams which provide an intuitive and familiar interface for users to view and edit configuration data. Parameter values are automatically constrained to support the user in setting values within valid thresholds.
- **Real-time feedback** – Key parameter values update in real-time to show the difference between the commanded parameter values set by an engineer versus the actual values achieved by the motor drive system. This allows engineers to optimise and fine-tune the motor control parameters and logic.
- **Quick search** – Individual parameters can be searched by their name or parameter number to allow users to quickly find and update values, across a range of more than 1,000 configuration parameters.
- **Wireless connectivity** – The WCA offers wired (Ethernet) and wireless (Wi-Fi) connectivity with the option to connect to existing networks or to establish a new Wi-Fi or ad-hoc wired network. Network settings are completely configurable within the WCA interface.
- **Backup/restore** – Users can take a complete backup of all configuration data for a given PL/X. This can then be used as a baseline to restore elsewhere, which saves engineers considerable time when configuring multiple PL/X devices.
- **Firmware upload** – Firmware updates can be installed through the Firmware Upload feature to ensure that customers can benefit from continual improvements to both the WCA software and the core PL/X firmware, as soon as they are released by Priocept or Sprint Electric.

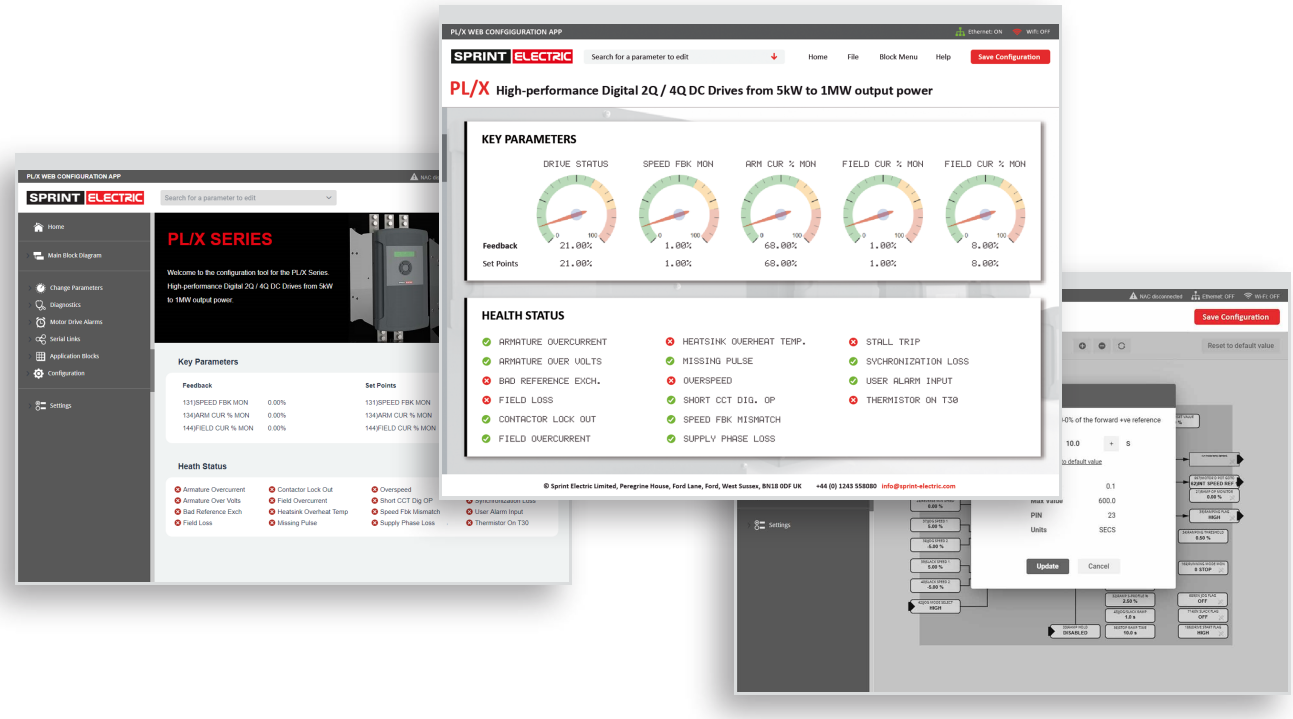


Figure 3: Web Configuration App screenshots

CONCLUSION

By combining the latest hardware and software technologies, including low cost System-on-Module hardware, embedded Linux, Internet-of-Things frameworks, modern web application frameworks and cloud infrastructure from Google Cloud Platform, Sprint Electric and Priocept have been able to evolve and dramatically improve the existing range of PL/X industrial electronics products. This has all been possible using a retrofit architecture, thereby extending the life of many thousands of devices that are already in the field rather than making them obsolete, and avoiding the need for a large scale R&D project to completely redesign or replace Sprint Electric's existing line of products.

The modern hardware platform and embedded software development framework, plus IoT and cloud infrastructure technologies that have been introduced into the product architecture, will provide a foundation for virtually unlimited future innovation of Sprint Electric's range of products.

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