



**INTEGRAL**

Award-winning predictive maintenance system for monitoring critical assets.

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Integral is one of the leading providers of mechanical and electrical maintenance services in the UK, providing a range of maintenance solutions to a large variety of clients. As a major player in the facilities management sector, Integral are always looking to innovate and gain commercial advantage, and so approached us with the concept for their UptimePlus platform in order to make it a reality.

## BACKGROUND

UptimePlus would be the central authority for all asset maintenance data, providing an intelligent system that facilitated the management of key processes and personnel, to ensure maximum uptime of critical assets. The application would provide predictive maintenance, by enabling site managers to view the current statuses and reports across all assets, along with any recommendations the system had generated based on this information.

Integral was announced the winner of the Innovation in Technology & Systems category at the 2014 British Institute of Facilities Management (BIFM) Awards.



## CHALLENGES

One of the key aspects of the system was to establish an accurate mathematical model for predicting equipment failure. This needed to be accurate enough to correctly send engineers on visits sufficiently ahead of time, but also not so sensitive as to cause lots of false alarms.

Additionally, the distributed IoT (Internet of Things) devices collecting various kinds of monitoring data generated a large volume of readings, and as some were installed in locations that had restrictions on connectivity, the method for collecting data from these devices in the field had to be appropriate.

## SOLUTION

We built a web-based management portal to clearly present status information and calendar events, and capture all the asset details and other kinds of data needed for day-to-day management. Complementing this was the vast amount of data harvested from individual monitoring devices deployed on the various Integral customer sites, which included locations such as the Shard, the London Stock Exchange, and the National Grid. Each device would monitor a particular component or location, and many types of physical readings could be collected, including temperature, vibration, infrared, and pH, for use in different environments as appropriate.

Each device was fitted with a GSM card, but supported a range of telephony approaches including LoRa and LTE, so that it could use WiFi, mobile phone networks, or even localised radio, as appropriate for the environment in question. These Internet of Things devices collated data readings and sent either all or a summarised digest, at specified intervals. This allowed adjustment for areas where there was not good connectivity, and allowed fine-tuning to balance system load against the immediacy of the data needed.

We engineered the system to use machine learning methodologies. This was facilitated by velocity-based decay curves, a fine-tuned customised approach to regression analysis, primarily based on Weibull's distribution formula, but modified to achieve the correct outcome. The approach compared collated data against similar profiles and made predictions about the probability of future events (overheating, for example) based on these analyses. Many of our engineering team have a strong background in mathematics and statistics, and so we found this a very enjoyable exercise.

We produced careful test scenarios, monitoring and fine-tuning data collection, and processing with the machine learning approach. Alerts could be programmed to be sent to relevant personnel from the system, upon the occurrence of specified events or thresholds. UptimePlus provided functionality for the scheduling of engineer visits on location at the required intervals to meet regulatory compliance, and ensure the serviceability of the equipment. This solution also provided functionality that enabled inspectors and maintenance personnel to record the findings of their visual assessments.

We also built a separate mobile application for iOS and Android platforms that explained the logic behind the complex maths used for analysis in simple terms, and gave context to how this was applicable to asset maintenance.

## RESULTS

Integral were very happy with the way we worked, and together, we had proven that the concept of technology-assisted predictive maintenance worked extremely well. The predictive maintenance solution UptimePlus presented was ground-breaking in Integral's industry, and in recognition of this, Integral was announced the winner of the Innovation in Technology & Systems category at the 2014 British Institute of Facilities Management (BIFM) Awards.

In addition to creating the system, we also undertook all of the infrastructure design, setup, and maintenance. This included the management of servers for the National Grid, the London Shard, and the London Stock Exchange.



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## Technologies used:



PHP



MYSQL



INFLUX DB



NODEJS



BOOTSTRAP

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PHP | MVC | MySQL | InfluxDB | JavaScript | NodeJS | HTML | CSS | Bootstrap | API | TDD | CI/CD



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