An ADLINK Industry White Paper

# Culture of invention leads to IoT success

Andy Penfold, Director of Offering Management


www.adlinktech.com

The Internet of Things (IoT) is the enabler for new types of business model that will increase the bottom line for businesses and improve the range of services they can offer. Edge computing promises near real-time insights and facilitates localised actions that are tuned to the needs of customers. In doing so, businesses can ensure they remain competitive in a rapidly changing world.

According to Markets and Markets, the industrial IoT (IIoT) market alone is expected to grow from $64.0bn to $91.40bn by 2023, a compound annual growth rate of 7.39 percent. Estimates by Accenture indicate that the IIoT could add $14.2tr to the global economy by 2030.

IoT concepts have already created novel business models. For example, real-time status updates from an array of sensors mounted around each jet engine have made it possible to change how those systems are sold. Instead of being bought outright, airline operators subscribe to an ongoing service that guarantees they can be airborne as much as possible. The sensors and the real-time knowledge they deliver ensure the engine suppliers can organise and adjust maintenance schedules to keep the systems in top condition.

There are opportunity costs associated with not embracing IoT strategies. The business advantage of data lies in its timeliness. Data loses value every day that it is not being used. The IoT provides a way for companies to gather and assess data in real time to not just indicate problems in equipment but opportunities that can be pursued.

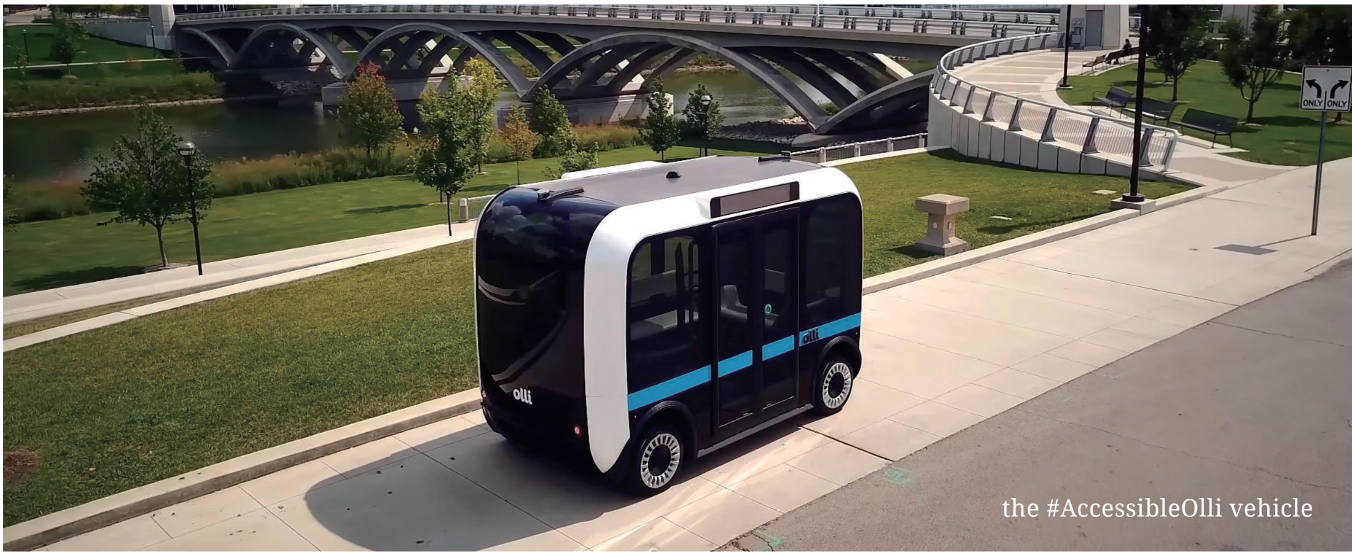
When the IoT works, the results can be highly effective not just as profit centres but to deliver social benefits through smarter cities and infrastructure. The city of Copenhagen in Denmark replaced more than half its street lights with LED technology augmented with IoT functions. Information from an array of sensors feed into a city-wide network so that lights can be controlled dynamically. The lights dim and brighten according to the time of day or night and take account of the natural illumination provided by the moon. Lights will brighten temporarily when sensors detect an approaching pedestrian or cyclist.


Copenhagen

The water utility in Houston, Texas found it was losing as much as 15 billion gallons of water a year through leaking pipes – close to 15 percent of the total supply. Embedding sensors and smart pipes in the network made it possible to regulate the flow of water and reduce the amount lost where the electronics identified a leak.

A partnership between IBM, CTA Foundation and Local Motors that uses edge-computing capabilities developed by ADLINK aims to bring transportation to people who find mobility difficult. When it stops to pick up a passenger to convey them to their destination, the #AccessibleOlli vehicle has the local intelligence to direct visually impaired users to an empty seat. ADLINK's IoT technology also helps keep field generators running smoothly in Puerto Rico.

In the supply chain, the IIoT is enabling novel production techniques and improved distribution. It facilitates customisation of a wide range of products at the point of manufacture. RFID and barcode technology tells production machinery the steps they require for that order. There is no need to waste money on producing batches of variants that may need to be sold at a discount because there are not enough customers. Each customer receives precisely what they want. And through IoT-enabled distribution networks, they receive real-time updates on when their products will be delivered.



the #AccessibleOlli vehicle

Though the IoT is capable of delivering success, implementing a solution effectively can be difficult and costly. A fully deployed IoT solution requires significant upfront investment because of the large number of sensors and network gateways that need to be installed and commissioned before services can start running. The solution must not just be functional but also deliver on key metrics such as security and reliability. With such stringent demands, the success rate for early adopters has been comparatively low. A 2016 study conducted by Cisco found the success rate for an IoT project was just 26 percent.

Research by McKinsey found pilot projects frequently went no further: just 30 percent of those surveyed were starting to scale to enterprise-wide deployment. The pilots themselves were often lengthy endeavours. Of those organisations surveyed, 84 percent of companies were stuck in pilot mode for more than a year. For 28 percent, the pilot was still running after two years.

However, pilot projects do convey important information for the organisation. According to McKinsey, 64 percent of the decision-makers surveyed agreed they learned even from stalled or failed IoT initiatives and those experiences have helped accelerate their organisations' subsequent investment in IoT projects. Many of those who have been successful did not try to manage the projects alone: they engaged the IoT partner ecosystem at every stage of the implementation plan. Working with partners is a key factor in IoT success but there are many other contributors.

# The invention culture

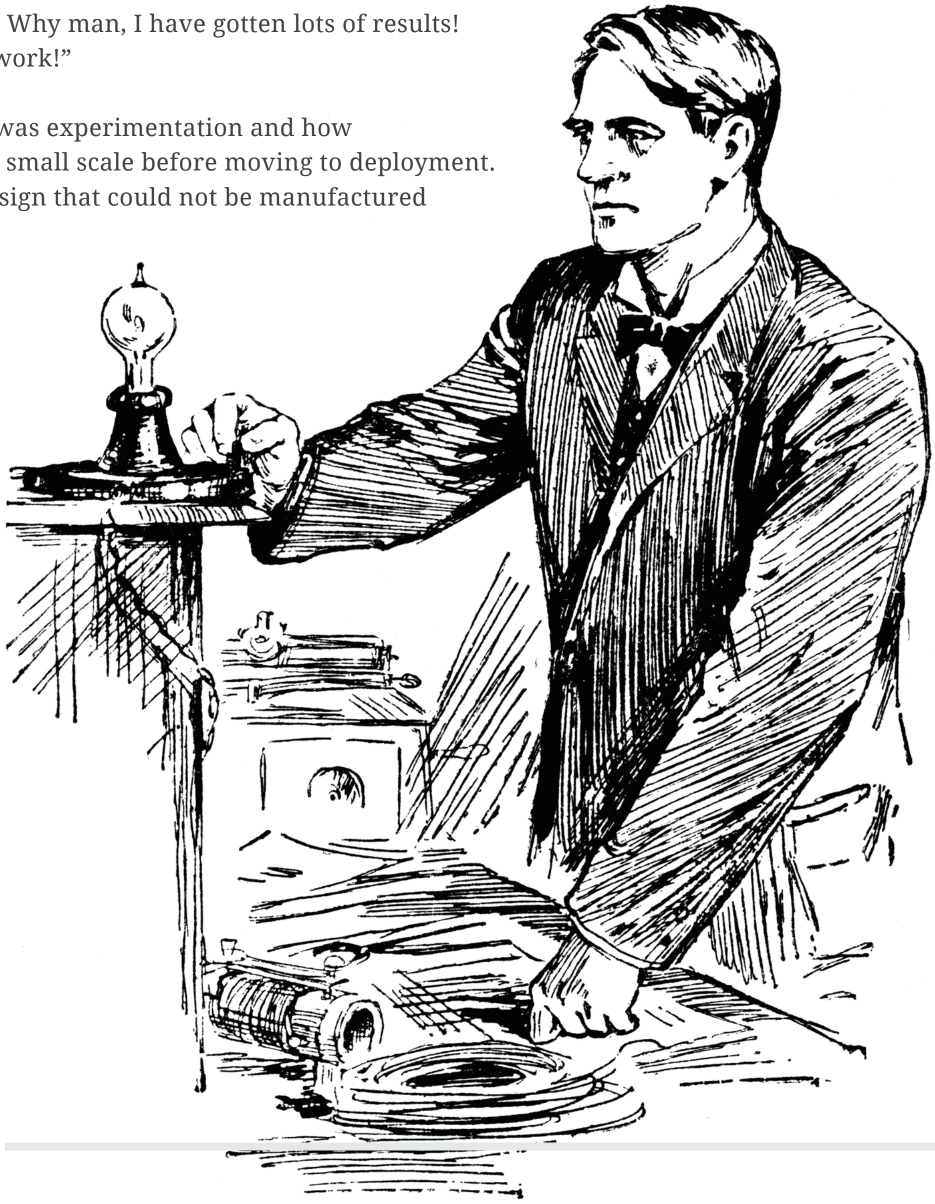
Continued success in business requires the balancing of a number of factors, some of which can often seem contradictory. Successful organisations want to be able to keep pursuing proven strategies. But to remain competitive, organisations have to embrace change and innovate to maintain market-leading positions.
The IoT is now seen to be a leading candidate for advancing innovation. But as with any innovation, working with the IoT involves risk. For every innovation that results in an improvement to the bottom line there are many ideas that fail to deliver. The key is to minimise the costs of failures and learn as much as possible from them to help drive the innovation that will deliver a successful deployment.

The path taken by inventors demonstrates how innovation often results not from one bright idea but from the exploration of many different options. There are important lessons in each of them. A failed experiment is as important as one that is successful because it demonstrates what attributes the final implementation should avoid.

Thomas Edison's pursuit of the electric light bulb and chemical batteries took many different paths before he settled on designs that could work in mass production. Friend and associate Walter Mallory once remarked on the 9000 experiments Edison claimed to have run on different formulations for his batteries. His judgment getting the better of him, Mallory said: "Isn't it a shame that with the tremendous amount of work you have done you haven't been able to get any results?"

Edison had an immediate answer: "Results! Why man, I have gotten lots of results! I know several thousand things that won't work!"

The key to Edison's success with invention was experimentation and how important it is to experiment at a relatively small scale before moving to deployment. He had no wish to rush to market with a design that could not be manufactured cost-effectively or would not work at scale.



"Results! Why man,
I have gotten lots of results!
I know several thousand things
that won't work!"
Thomas Edison

Low-risk experimentation is as important in IT as it has been in mechanical and electrical inventions. Eager to take advantage of rapid advancements in hardware made possible by integrated circuits, Bell Labs pulled together a team of experts from its own ranks and commercial sponsors to build a novel operating system, Multics. Though it was not clear how the technology would work, the team had a clear objective: to build an operating system with a specific set of features. But the large-scale, expensive project was a failure. Not far from the team at Bell Labs, another much smaller group was experimenting with both languages and operating system design. They gave it the name Unix in a nod to the much smaller scale of the work. While the Multics team was writing error-recovery code for a system that would never go to market, the Unix developers were able to create technologies that were more robust in use.

Today, derivatives of Unix run most the world's computer servers and power a multitude of embedded systems. The C language and its object-oriented successor C++ is the one most commonly used for writing programs that control real-time embedded systems in the IoT and IIoT. The Unix team embraced failure as a way to learn from mistakes and fix those mistakes quickly. This spirit of experimentation and invention is required in the new generation of computer-enabled systems that will drive the IoT and IIoT forward. It keeps the cost of failure down without hiding the benefits of what failures can teach us and, in doing so, maximise the return on investment when the final system is deployed.

# Faster invention through digital experiments

When a team develops an idea, its members will naturally make assumptions about why they think it should succeed. It is easy for those initial assumptions to be wrong – if not at a broad level, at least in detail. Experimentation can quickly identify which details need changing or ideas should be fleshed out. In many cases, options that will be expensive to deploy can be ruled out because the data they provide does not provide a significant ROI compared to simpler, more expedient technologies and devices.

Experimentation can answer the many questions that need to be tackled before any mass IoT deployment. For example, for a system that needs measurement of physical properties such as temperature and location, how accurate and reliable do those readings need to be? Can some be missed? What are the sources of error and what tolerances are acceptable? Is an audit trail essential to ensure the product or system has not been tampered with?

There are also questions about attributes of the system that do not affect functionality but which are vital for successful implementation. For example, what is an acceptable level of security for each of the different devices in the system? A thermostat might be considered a low-level risk in any system. But as part of a larger network, such devices can be weak links in terms of security and may need additional safeguards. Early testing can determine whether data needs to be encrypted at the point of capture or whether less-sensitive data need only be protected once it has passed through a gateway, reading for relay to a cloud server.

Experimentation can answer higher-level questions about ROI and not just technological capability. Will the project, if deployed, deliver value? An initial concept may seem productive when mapped out on a whiteboard or presentation but as the project develops, customers may report they see other applications that are more valuable to them. Often, these changes will involve modifications to the technological platform or software used to deliver status updates. For example, an initial survey of customers may indicate the need for a direct API to a database to pull information in real time. But some functions may prove to be just as effective with daily updates provided by email or a similar push application – and therefore much cheaper to deploy at scale.

There are practical management concerns. Can you be sure different groups within the organisation will cooperate with the project? They may have valid reasons for denying real-time access to databases for legal reasons. Personal data in the EU needs to be safeguarded. Similarly, health-related data in the US is covered by stringent legislation.

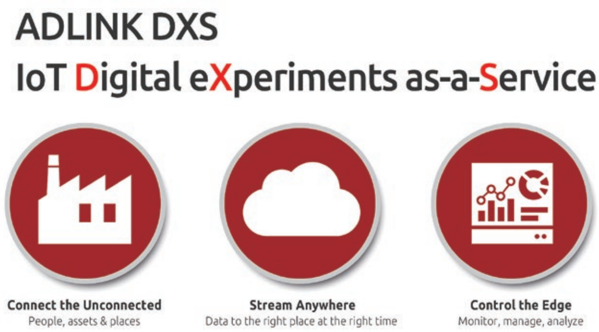
If groups cannot comply with the original design, the system architecture can be changed to work around the issue. For example, systems that track deliveries may not record and relay driver information or customer information – this data is passed through a different system that is known to be GDPR compliant. Instead, the delivery addresses are anonymised and possibly recorded at a coarse level of resolution to make it hard to identify specific destinations from the delivery tracker network.

The technological landscape of the IoT involves many choices. What is the right wireless network for a particular application? Delivery and distribution applications may use cellular communications or a low-power wide-area network (LPWAN) solution such as Sigfox or LoRA, each with its own cost and service quality parameters. Inside a factory, implementers may want to use Bluetooth delivered through luminaires that are connected using Power-over-Ethernet. But another solution based on 6LowPAN may be more appropriate if direct IP addressing to each device is required. Experiments can determine whether such direct addressing is required or whether gateways can perform the task of mapping between protocols. In many cases, existing sensors will already be in place that may use older protocols such as Zigbee. An important process is to determine how well IoT gateways can communicate with both legacy and freshly installed sensor nodes as well as traditional industrial computers and SCADA systems.

The numerous ways in which early experimentation can inform the development of IoT implementations is clear. But how can the concept be put into practice? Any development team focused on small-scale experiments that tries to integrate disparate IoT devices and services will face just as big an integration challenge as a much larger pilot project – and the pilot project's team will be better resourced. In principle, that larger team could achieve integration more quickly, albeit at much greater expense. What is required is a readymade platform that supports experimentation through plug-and-play substitution of components both at the hardware and software level. The platform needs to offer customers a safe space that makes it possible to get results fast, whether they are successes or failures.

A platform that is offered as a subscription can provide all the relevant hardware, software and services required for a variety of projects and experiments that are run simultaneously in a manner that minimises risk for the user. The key to the ability to deploy such a subscription-based offering is a platform that understands the many different protocols and data-access technologies that can form an IoT implementation. The platform lets users connect disparate devices and computers using their native protocols and feed into an IoT backbone. Additional sensor functions can be handled through the small-scale temporary installation of pre-validated sensors and pre-configured edge devices that are connected to enterprise assets. As pre-configured devices, integration does not need additional programming. The data flows into a common stream from which back-end services can pull insights and deliver real-time knowledge to users and customers with access to the experiment.

Such back-end services can securely transform and move data supplied by any device connected to the platform and provide a set of integrated services for endpoint monitoring, device management, visualisation, analytics and security. A two-way flow of information makes it possible to create intelligent devices quickly that can react to change and the world around them.



A service that provides edge hardware, real-time data streaming software and secure management microservices provides the basis for simplifying IoT integration and so get multiple experiments off the ground quickly. A modular architecture that is device-, software- and cloud service-vendor neutral makes it possible to swap components in and out and move data easily as the engineering team discovers which course it should pursue while each experiment is running. In doing so, the platform allows for innovation and for investment to be deployed where it is seen to matter. The result is reduced risk through the ability to start small and move fast, and gain the right knowledge to support migration of the most successful implementation to large-scale deployment.

Such an approach is already working in a number of situations. In one case, monitoring systems were incorporated into the air-conditioning systems employed in a factory. The compressors in particular are located in a secured area and are difficult to access, making a traditional inspection regime impractical. Failures in the systems have shut down the factory for days at a time, leading to more than $1m in lost production. The incorporation of real-time asset monitoring and anomaly detection systems able to email service personnel with early warnings of problems proved to be the most cost-effective implementation. Since deployment, the anomaly detection has prevented at least two failures.

In the agricultural sector, experiments have shown how multiple proprietary systems used for milking, feeding and assessing the health of cows can be integrated into one complex monitoring system. Traditionally, it has been difficult to normalise the data from each of the processes and share it with farmers, vendor partners and buyers. Evaluation of different techniques for secure and interoperable real-time data sharing made it possible to determine the best approach to be used for deployment. The resulting system can quickly identify the sources of quality issues in milk production and perform automatic discovery of new machines as the network expands, which reduces ongoing commissioning costs.

Similar work in the distribution sector has resulted in systems that match the hardware and software to the specific needs of the user. In one case, the solution employed smart cameras to capture and process barcode images on packages as they move between robots and human operators across a conveyor system. Local analytics enables real-time determination of where each package needs to go next, streaming data to sorting machines and triggering alerts if a package is in the wrong place. The resulting solution improves destination accuracy by 5 percent.

# Conclusion: a clearer path to innovative IoT

When implemented in a manner that satisfies stakeholders and which takes account of the capabilities and limitations of individual technologies, the IoT can deliver cost savings and increased business value. As early adopters have found, deployment of IoT technologies can be difficult and slow to roll out, particularly if decisions were taken on architecture and implementation were based on assumptions that turned out to be incorrect.

Any distributed system is a complex endeavour. Because it can involve many stakeholders and components as a system of systems the IoT potentially raises complexity to another level. However, a divide-and-conquer strategy that uses early experimentation to let implementers gain knowledge as quickly as possible provides a way to cut out many of the obstacles to success. Small-scale experiments enabled by a service that provides a wide variety of IoT technologies and devices that are known to work together streamline the learning process. In doing so, they make it much easier for organisations to move from the whiteboard stage to full deployment and not get stuck in development hell. The implementation of IoT solutions can take many directions, but a commitment to experimentation steers a clear path to successful IoT initiatives.