Empowering the connected supply chain with eSIM

Global IoT Connectivity
Made Effortless

Pelion

A new technology

With three-quarters of organizations believing that IoT and leveraging advanced data uses are significant to their business's future, finding ways to optimize real-time awareness of the supply chain has never been more vital. A new technology – eSIM – delivers game-changing functionality, agility, and a future-proof solution for device connectivity and data acquisition.

For companies operating in the manufacturing sector, a product's path to the customer can often be convoluted and opaque. Shipping and transport operations have evolved, and intelligent tracking solutions play a pivotal role in the digitalization of logistics. As the industry faces unprecedented challenges, there is an opportunity for manufacturers to double-down and exploit the latest IoT connectivity solutions to achieve greater visibility and automation.

Legacy supply chains struggle to cope with disruption. Often, this is due to a lack of basic information regarding the status of elements along the critical path. For example, a single late or missing component can disrupt an entire production line, and, equally, manufacturers tend to lose "sight" of their products as soon as they roll out the door. Conversely, an increase in visibility can strengthen and protect a critical supply chain. And enhanced visibility, together with additional operational intelligence, offers a platform for automation, creating robust, optimized, and efficient supply chains that mitigate disruption.

Fundamental for a transition from obscure to obvious is the effective connectivity of IoT devices. As the primary source of real-time data, IoT has become manufacturing's go-to resource to inform operational and strategic decision-making and a pivotal contributor to monitoring and optimizing the performance of products and internal operations.

Not all IoT connectivity is, however, created equal. Traditional approaches to provisioning and managing are, at best, inefficient and sub-optimal. And now, with the massive scale required up and down the supply chain, those approaches can quickly fail.

> **// IoT has become manufacturing's go-to resource to inform operational and strategic decision-making //**

IoT/M2M applications

IoT/M2M applications tend to gravitate to one of the three connectivity alternatives: permanent local, flexible localization, or ad hoc roaming. While each model has advantages and drawbacks, there's no one-size-fits-all option. For example, some use-cases work perfectly well permanently linked to one preferred network operator, and this is all they'll ever likely need.

Still, provisioning and activating connectivity remain burdensome, and who's to say that today's operator-ofchoice will remain competitive in terms of access capabilities and usage costs over the extended lifespan of a typical IoT deployment. Additionally, while traditional roaming can accommodate some applications, either because the flexibility is advantageous, the duration is relatively short, or the data quantities are light, it is becoming problematic for specific use-cases. And lastly, it's difficult for roaming tariffs to be competitive compared to a localized connection profile, and data volume capping can occur, although engaging with a commercially savvy MVNO/M2MSP can offset these issues.

Recognizing the gap, the GSMA, the industry body representing the interests of mobile network operators and users worldwide, has defined a solution that, while retaining the crucial pillars of trusted connectivity, completely overhauls those aspects holding back agility and innovation. The result is eSIM. Initially intended to address the M2M use-case, eSIM is also aggressively championed in the consumer space; however, the consumer and M2M use-cases are very different. As a result, the corresponding workflows diverged to deliver two implementation models for eSIM, each optimized of the respective application.

> *// eSIM promises to revolutionize connectivity, making reliable and ubiquitous real-time data acquisition a straightforward reality //*

Focusing on eSIM for M2M/IoT, the GSMA specification aims to improve and optimize every aspect of the managed connectivity life cycle, from manufacturing, through distribution and activation, to operation, and – when appropriate or necessary – swapping providers. For the supply chain generally, and manufacturers more specifically, eSIM promises to revolutionize connectivity, making reliable and ubiquitous real-time data acquisition a straightforward reality.

Manufacturing's back story

Digital transformation within the manufacturing industry has been long hindered by the sometimes competing interest of stakeholders and the multitude of divergent systems, geographic regions, and a complex supply matrix. The same is true for the transportation and logistics sector that services manufacturing and is, in effect, its lifeblood.

Additionally, there's often been a disconnect between the input and output sides of manufacturing. While some organizations have implemented finely-tuned just-in-time delivery systems by tightly integrating with their supply partners, they are just as likely to have little to no control or visibility of their finished product. If Manufacturer A is merely one part of a complex supply chain, the trickledown effects of inefficiency or lack of coordination can be significant. A case in point is the impact of semiconductor shortages on the automotive, consumer electronics, and household appliance sectors.

Taking one of these examples – automotive – further demonstrates the domino effect of supply chain interruption: production delays mean fewer vehicles are reaching customers, impacting delivering to rental car companies, reducing available and rising prices, negatively affecting the travel and tourism industries.

One size does not fit all

And it is essential to appreciate that manufacturing is not a single use-case that is easily defined and addressed with a one-size-fits-all solution. Indeed, manufacturing is a broad tent, with many nuanced and subtle uses for IoT, including manufacturers seeking and striving to:

- Optimize the upstream supply chain
- Enhance internal processes and procedures
- Perfect product design
- Improve downstream warehousing, shipping, and order fulfillment
- Gain post-sales insights that will inform future product development
- Deliver connected products to a global market
- Exploit connectivity to create new market segments

In a recent survey conducted by the IMechE, 74% of respondents declared IoT and the understanding of advanced data to be significant to the future of their businesses. And the Economist Intelligent Unit, in their most recent edition of the IoT Business Index – a state-of-the-nation report conducted every three years – found that the manufacturing sector ranked high, often Top 3 or better, in many categories of IoT adoption and exploitation. These include intent to use (both for internal operations and in products), future investment, and as a strategic enabler.

Increasingly, IoT is exerting its influence. To varying degrees and depending upon manufacturer and product – IoT is becoming mission-critical before, during, and after the product manufacturing process.

// Manufacturing is a broad tent, with many nuanced and subtle uses for IoT //

IoT's role in product and process improvement

One path emerging for businesses seeking to advance new and better products is integrating IoT data directly in the strategic planning cycle. Increasingly, organizations are embedding connected sensors in products to gain hitherto unknown insights into buyer behaviors and usage patterns.

Often, the impetus for real-world, real-time data comes from multiple parts of the organization simultaneously. For example, the engineering and production teams seeking to make products more reliable will recognize the value of adding sensors and analytics. On the R&D and product management side, advanced analytics helps drive product enhancements and new product development. And finally, building an accurate analytic capability that monitors critical operational, sales, and financial performance indicators has full-circle benefits for shipment and component forecasting, leading directly to improved bottom-line performance.

Early engagements have proven that it's essential to prioritize IoT projects that can demonstrate a clear and immediate business value; indeed, connectivity is not the answer to every question. However, as IoT becomes simpler to use and manage, it is becoming a tool that can more easily be employed and leveraged. IoT-powered digital transformation is increasingly finding resonance with virtually every industry sector, from agriculture and automotive to energy and infrastructure. Manufacturing is no different, and the data collected from sensors establishes a knowledge bank about how specific products perform in certain circumstances.

This transformation is facilitated by identifying high-value IoT use cases that help target and justify investments and the required capabilities.

A note of caution, for this innovative approach to flourish, it's vital to strengthen bonds to traditional IT platforms and genuinely seek to integrate the new IoT-derived data layer with legacy data systems, including ERP and CRM.

> **// IoT-powered digital transformation is increasingly finding resonance with virtually every industry sector //**

IoT's role in the supply chain

A prominent and, it might be said, obvious area for deploying IoT is in the upstream and inbound supply chain. As a result, early adopters of IoT have seen benefits in areas as diverse as data management and analysis, inventory optimization, and asset and energy management. Indeed, lowering the cost base – through improved visibility and data analysis – has come hand-in-hand with a corresponding innovation in operational processes and employee productivity.

IoT enables new insight into supply and inventory levels; both are critical to maintaining production efficiency and avoiding insufficient – or costly surplus – component quantities. In addition to specific, real-time quantity and location data, IoT adds a complementary layer of condition information, vital to industries involving manufacturing products created from perishable or fragile elements. And just as with any modern industrial setting, IoT delivers significant advances in process automation and preventative maintenance of the production line. Equally, environmental monitoring, health and safety monitoring and compliance, and fleet management are all areas where IoT is impacting how manufacturers positively do business.

None of this is, in isolation, particularly newsworthy or groundbreaking. Yet, for any business transitioning from start-up and innovation to mainstream, the need to proactively confront and optimize the upstream supply chain is as common as it is necessary. And IoT, in its many and varied guises, is opening new avenues for efficiencies and streamlining.

IoT's role in connected products

IoT opens lots of new doors for the manufacturing process – how, when, and why – but the area that's seeing some of the most exciting development is the area of connected products. Embedding connectivity into products, large and small, overtly or covertly, empowers manufacturers with real-world insights and streamlines how they address the global market.

Broadly, connected products fall into two categories, where the connectivity is evident, required, and fundamental to the product's core functionality, or where it's subtle, optional, or secondary. For the former, IoT is often the only reason these products exist; without the ubiquitous connectivity that enables data delivery and analysis, the product or service doesn't work; there wouldn't be a product (think: smart utility meters). While, for the latter, connected products help inform both potential enhancements and possible future developments. For example, data analysis might indicate marked variance in actual usage relative to the original design intent. As much as organizations would like to believe that they're delivering a product that addresses their target market, real-world data analysis could indicate that small – or possibly large – changes would indeed make their products perfect from the customer's perspective.

> *// embedding connectivity into products, large and small, overtly or covertly, empowers manufacturers with real-world insights //*

Despite their divergent business models, what combines both categories of connected products is the need to streamline the connectivity management process.

Global reach can be vital for a manufacturer to succeed; the economies of scale of new markets maximize their R&D outlay. Yet, no one network operator can provide genuinely global connectivity, meaning manufacturers that want to deliver their product globally must contract with multiple operators and manage operator- and location-specific SIM cards. Furthermore, these manufacturers must create and maintain separate product lines for each network access requirement to accommodate the different SIM cards, even though the underlying device itself is the same. Simultaneously managing multiple SKUs creates costly inefficiencies in management, production runs, sales forecasting, and inventory management. This situation fragments the supply chain, and the inefficiency can negatively impact engineering, production, quality, finance, and operational departments.

eSIM: What is it?

A conventional cellular connectivity solution requires users to provision, stock, and ship various SIM cards based on every combination of regional or network access requirements. The SIM, more technically known as the Universal Integrated Circuit Card (UICC), is a legacy of the cellular's consumer-based heritage; however, it's often ill-suited to IoT and Machine-to-Machine (M2M) applications.

However, Remote SIM Provisioning (RSP) is a service that delivers replaceable network access profiles to a SIM card. RSP gives users the ability to securely download, attach, enable, and disable profiles remotely. eSIM is the user-friendly term for RSP, with the two terms often used interchangeably. Regardless, they describe the various components, including RSP-capable SIM hardware (an eUICC), eSIM profiles, and the different RSP platform functions that facilitate the remote provisioning of SIM profiles. One of the primary design goals for eSIM was to create a reference architecture that would promote broad interoperability and solution longevity.

The result is a capability that streamlines the logistics required to support a large-scale connectivity solution, future-proofs network choice, and – when combined with a fully-managed eSIM-as-a-Service offering – abstracts all the complexity necessary to enable and deliver these operational benefits. In addition, consolidating to fewer SIMs – potentially just one – means that the job of onboarding new connectivity just became so much easier, more cost-effective, and far more responsive. No longer do connectivity users have to obtain specific SIMs with just the right operational profile and form-factor combinations.

eSIM: What is it?

An eSIM profile holds a device's unique identity. It matches the customer's subscription agreement with a specific network operator, and enabling an eSIM profile on the eUICC SIM grants it access to the operator's network. Crucially, an eSIM profile is replaceable, with a new profile provisioned on an eUICC SIM using the Remote SIM Provisioning process. eSIM profiles broadly fall into two category types: an initial activation – or "Bootstrap" profile – and one and possibly more operational profiles.

When used as the base eSIM profile preconfigured to an eUICC SIM, the Bootstrap profile serves two purposes. Firstly, it facilitates global network access for the provisioning of Operational profiles to the eUICC SIM. Secondly, it acts as the fallback option enabling international roaming to a broad network of operator partners should access defined by the Operational profile no longer be available. Once the Bootstrap profile has enabled initial network access, customers will typically download an Operational profile customized for local access and avoid potential roaming restrictions or costly charges. Users considering eSIM should note that while more than one Operational profile can be downloaded to and stored on the eUICC, only one can be active at any one time.

*// **Manufacturing is a broad tent, with many nuanced and subtle uses for IoT //***

eSIM: What is it?

Encapsulating and combining the various ecosystem functions needed to support the RSP process is Platform Management; this includes eSIM profile generation and personalization, secure profile storage and transport, and profile provisioning actions such as download, install, enable, disable, and delete.

Platform Management involves orchestrating several entities – MNOs, eUICC Manufacturers, and eSIM SM-DP and SM-SR service providers. The SM-DP (Subscription Manager Data Preparation) and SM-SR (Subscription Manager Secure Routing) services are crucial elements of the RSP ecosystem. The SM-DP securely prepares eSIM profiles and stores them awaiting provisioning to eUICCs; preparation includes encrypting profiles using digital certificates. Typically implemented as a discrete service, the SM-SR performs the actual over-the-air secure transmission of profiles.

The eUICC – with its dedicated operating system and read/write capabilities – is vital to the remote provisioning process.

Provided they support the GSMA's standardized eSIM/RSP capability, the term applies equally to removable and fixed form-factors. And eUICCs are available in all the usual form-factors: removable triple-cut (also known as 2FF, 3FF, and 4FF) and the fixed, surface-mounted option (MFF2 or QFN8).

Indeed, the emergence of eSIM has given a new lease of life to the fixed, non-removable SIM. Integrated during manufacturing by soldering the chip directly onto the circuit board, this type of SIM is virtually impossible – certainly impractical – to remove or tamper with without causing significant damage. Thus, its usefulness was limited and only applicable to shorter life use-case or those where network access flexibility was never needed or possible. However, the fixed option, empowered with eSIM, enables manufacturers to create smaller, longer life, and more hardened and agile connected products.

Solving challenges for manufacturers

Clearly, with most organizations pivoting to IoT as the primary source of advanced data, it's vital to deliver this connectivity as efficiently and effectively as possible.

eSIM offers that solution. It simplifies the fabrication, procurement, logistics, and provisioning of SIM profiles to devices. eSIM delivers a seamless path for lifelong network access and tariff optimization, ensuring network access regardless of location. Additionally, eSIM empowers future-proof interoperability, portability, and agility. eSIM offers a single, unified way forward for provisioning and managing network access profiles.
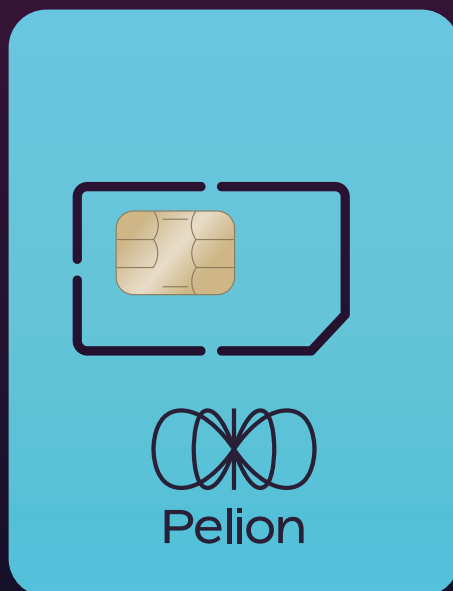
How eSIM optimizes IoT for the manufacturing process
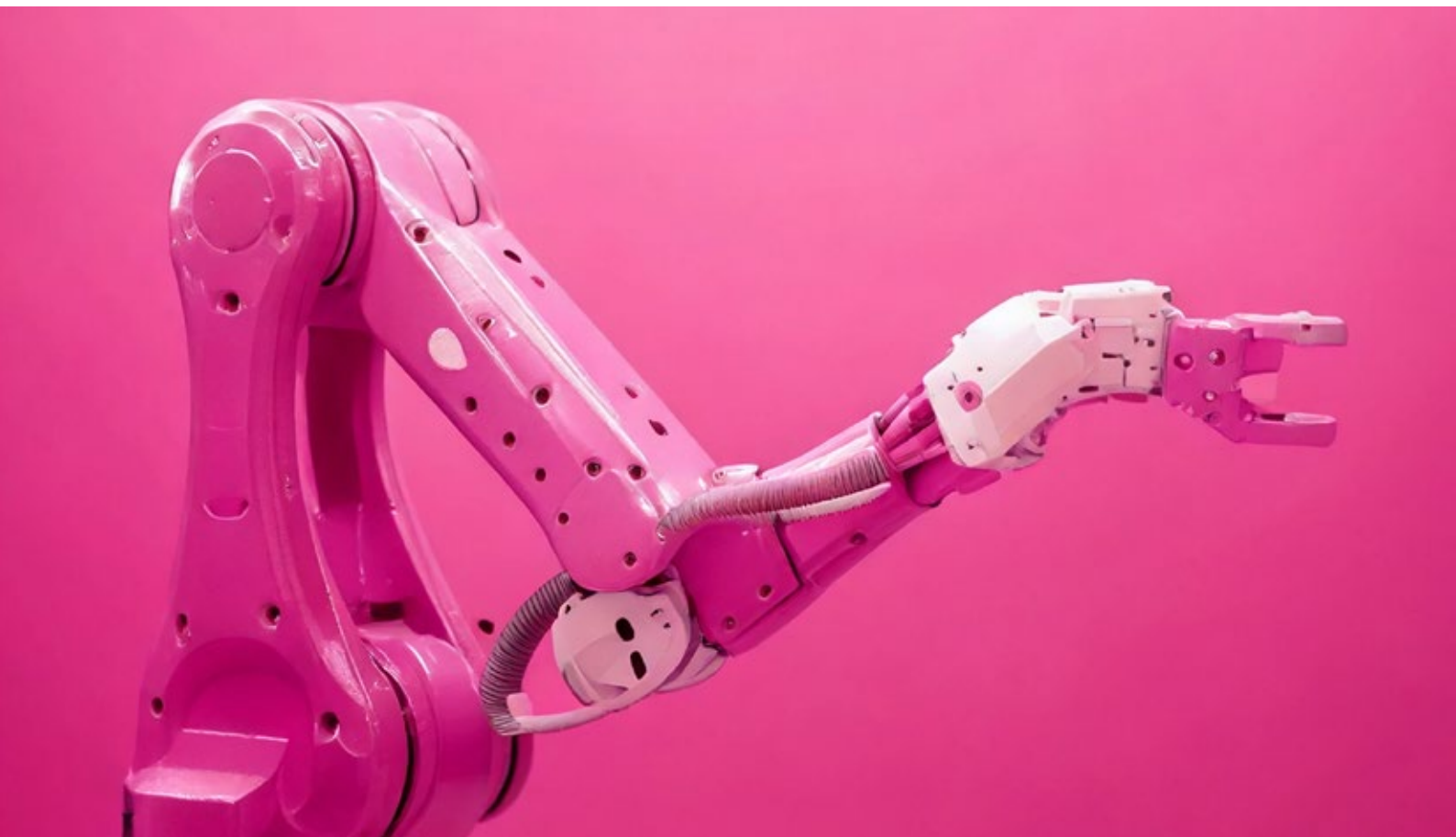
Typically, the manufacturing process draws on a complex mosaic of inputs and sources. It's very much product-dependent, but there could be thousands, even millions of individual components; a Boeing 777 is said to have 3 million parts supplied by 500 different sub-contractors. Conversely, even the most straightforward products, requiring just a few essential elements, often source from geographically dispersed suppliers. Already, IoT has played a part in improving the efficiency of this supply chain; however, traditional connectivity management can only do so much and go so far before the limitations and overheads neutralize the gains.

One key area where eSIM complements and extends IoT's already impressive contribution is that of inventory management. Recent macro events have shown the world that finely tuned supply chains built around a paradigm of just-in-time delivery and wafer-thin margins can be fragile and lack the necessary degree of robustness. Often the vital ingredient missing was real-time data. Influences include conventional IoT devices being difficult to integrate at a sufficiently granular level in the supply chain, combining with the inflexibility of the manual SIM profile provisioning process.

// Now, with eSIM, we see IoT gaining a much broader appeal //

The MFF2/QFN8 format of fixed, non-removable SIM chipset could facilitate IoT much further down the value stack; however, only when combined with eSIM as the key enabling technology. eSIM gives the necessary agility and longevity to make these solutions feasible. Furthermore, without the deployment flexibility guaranteed by eSIM, manufacturers and their suppliers lacked the confidence to invest heavily in innovation at the low-end. Because this form-factor delivers savings in size (80% reduction) and unit cost (between 30-50% reduction), the use of an eSIM-powered fixed chipset enables smaller, lighter, cheaper, vibration-tolerant, and environmentally hardened devices.

Now, with eSIM, we see IoT gaining a much broader appeal. Having low-cost sensors more widely integrated into all manner of upstream supply chain logistics that handle the various components, ingredients, and elements translates into a significantly more granular view of inventory status, so, whether it's intelligent foodstuff packaging - required by supermarkets in their thousands, the safe transport of bulk liquids across continents - policing geo-fenced dangerous routes, or international cargo tracking - periodically switching networks to send status updates; eSIM's agility that makes the difference.

In addition to the robustness of the inbound supply chain, sustainability is another area driving the need for increased awareness, transparency, and connected intelligence. Greater horizontal use of IoT data, in association with deeper vertical deployment, means that logistics can be substantially more efficient, reducing waste and carbon footprint. For example, in 2019, the U.S. Environmental Protection Agency reported that, at 23%, manufacturing was of the top three contributors to greenhouse gas emissions worldwide. However, this figure only represents direct emissions. And given manufacturing's sizable reliance upon the other two big emitters – electricity generation and transportation – every effort made, every advancement exploited, to reduce this impact.

IoT and, in particular, eSIM-powered connectivity represents game-changing innovation to facilitate the necessary emissions reductions.

How eSIM further enables IoT for manufacturers operating in global markets

Manufacturers operate more profitably when they can address large markets; the opportunity to sell large volumes of devices worldwide allows them to amortize their R&D costs across a broader customer base.

A conventional SIM strategy that permanently defines the network access profile onto a SIM at manufacturing is problematic for OEMs seeking to address global markets. In this model, the onus is on the manufacturer to precisely and proactively architect the IoT connectivity provisioning logistics for every market they wish to address.

Consolidating to fewer SIMs – potentially just the one eSIM – means that the job of onboarding new connectivity just became so much easier, more cost-effective, and far more responsive. No longer do manufacturers have to source and integrate multiple SIMs with just the right combinations of network access profile and form-factor. For device OEMs servicing a global market, the transition from multiple to a single stock-keeping unit (SKU) delivers rapid and genuine manufacturing and logistical advantages. eSIM removes the need to design, make, stock, ship, track, repair, or replace numerous variations of what is effectively the same device. eSIM powers a simplified manufacturing process, making it easier to manage and reduce cost and complexities.

The manufacturing and distribution agility enabled by eSIM reduces barriers of entry to worldwide markets for device manufacturers. Entering new geography no longer requires a new product and new inventory. Instead, as a manufacturer decides to target a new territory, existing products can immediately be deployed in that region.

Additionally, leveraging eSIM means that one distribution model can apply across many borders and use-cases. Instead of contracting with region-specific distributors or resellers, a manufacturer can supply a global distributor or major chain, ultimately saving costs by limiting the distribution channels used and increasing the average deal size.

// One distribution model can apply across many borders and use-cases //

Again, the reality of eSIM-power connectivity allows device OEMs to realistically consider a transition away from removable form-factor chipset in favor of the fixed option. The physical and logical advantages delivered by eSIM also enable the OEM to concentrate their finite resources on product innovation, including improving packaging, environmental robustness, and future-proofing cellular connectivity capabilities.

Facilitating longer lifetimes – enabled by eSIM's agility – means that an individual device's deployment may span multiple generations of technology, from 2G to 5G and beyond. Ditto, this longer life improves return on the R&D investment and overall total cost of ownership.

Summary

Fundamentally, eSIM gives more flexibility and more choices for connectivity. In short, users can streamline the entire connectivity onboarding process and have complete freedom to change a device's network access later in its life cycle, regardless of its location.

eSIM optimizes the fabrication and provisioning process, reduces costs, improves agility, and delivers an ability to react to market demands quickly. eSIM improves and optimizes every aspect of the connectivity life cycle. Whether pre-deployment and post-deployment – from fabrication, distribution and activation, to operation, and – when appropriate or necessary – swapping, eSIM delivers. It features a flexible, standardized ecosystem that mandates multi-entity portability and flexibility.

For manufacturers, servicing their key markets and customers is the core business objective; eSIM provides them with a future-proofing technology that outsources the risk and burden of implementing all-important game-changing IoT capabilities.

> **// eSIM optimizes the fabrication and provisioning process, reduces costs, improves agility, and delivers an ability to react to market demands quickly //**

Pelion's managed eSIM-as-a-service

The value of Pelion is that we accelerate speed to market. As a result, organizations get all the eSIM benefits in days, rather than investing months or even years mastering the technology and building multiple relationships up and down the service stack. Correspondingly, Pelion enables companies to reap eSIM's benefits without diverting precious, finite resources into becoming experts on the labyrinthine global MNO landscape.

When utilizing Pelion's managed eSIM-as-a-Service offering, customers benefit from a single vendor managing numerous complex relationships, all within an agreed regulatory framework. In addition, Pelion's approach to integrating strategic technologies translates into establishing and building functional relationships more quickly, giving customers ready access to eSIM's diverse range of capabilities. For manufacturing organizations considering ways to future-proof an IoT/M2M rollout globally, robust security, proven identity, cross-vendor interoperability, service portability, and solution longevity are vital capabilities.

As such, Pelion confidently proposes its fully managed eSIM-as-a-Service offering to truly future-proof IoT/M2M connectivity with a fully managed and standards-based implementation that guarantees complete interoperability and flexibility.

> *// eSIM optimizes the fabrication and provisioning process, reduces costs, improves agility, and delivers an ability to react to market demands quickly //*

[i] IMechE Professional Engineering: The Internet of Things in 2020
[ii] The Economist Intelligence Unit: The IoT Business Index 2020
[iii] United States Environmental Protection Agency: Sources of Greenhouse Gas Emissions

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