From Standards to Scale: An OEM's Guide to IoT eSIM Success

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YOUR PLAN OF ACTION

- **Do Not Delay:** Although the market is waiting for full ratification of the SGP.32 specification, it is not waiting idly. Developing compliant solutions in preparation for the availability of full certification will ensure a smooth transition once specifications are fully ratified and minimize the time to a certified product, solution, or device.

- **This Is Not Just a Tech Change, but a Business Process Evolution:** Fundamental changes to the manufacturing process mean that developing an Embedded Subscriber Identity Module (eSIM) Internet of Things (IoT) solution must be started now. The solutions will be diverse, with the specific needs of each Original Equipment Manufacturer (OEM) needing to be taken into consideration, and the tailoring process requiring prolonged engagement with expert cellular connectivity partners to provide an optimized solution. Start engaging, start building the understanding, and work out the teething problems sooner, rather than later to hit the ground running once certification becomes available.

- **Understand What You Know, and When You Know It:** At what stage in manufacturing will it be possible to identify the Embedded Universal Integrated Circuit Cards (eUICCs) to be provisioned? How much profile batching can be done within current processes? The availability of information and the flow around provisioning is a key design factor consideration, significantly impacting the scale of automation possibilities. Collaborate with expert providers to determine necessary tweaks.

- **Assign an Evangelist:** Adoption will require early engagement with external collaboration, involving the understanding of a sometimes complex market. Assigning a dedicated eSIM/SGP.32/In-Factory Profile Provisioning (IFPP) point of contact internally will ensure that all teams have a clear source from which to build their understanding, ask questions, and identify challenges and benefits through implementation.

- **Do Not Get Waylaid by Technical Details at This Stage:** eSIM technologies and accompanying standards are simply a delivery mechanism to achieve and manage cellular connectivity. The exact architecture for your needs can be defined in partnership with experts as your adoption journey progresses.

EVOLVING STANDARDS

SGP.32: WHY, WHERE, AND HOW FAST

Currently, eSIM provisioning is a power-hungry process with significant profile management overhead, providing a barrier to entry into cellular for resource-constrained devices and manufacturers that lack the expertise or resources to handle complex rollouts. It is challenging to manufacture with security, and there are not enough turnkey solutions available to ease the way into manufacturing with eSIM. However, the coming ratification of SGP.32 and SGP.41/42 standards will change that.

Chart 1: eSIM SGP.32 Profile Downloads
(Source: ABI Research)
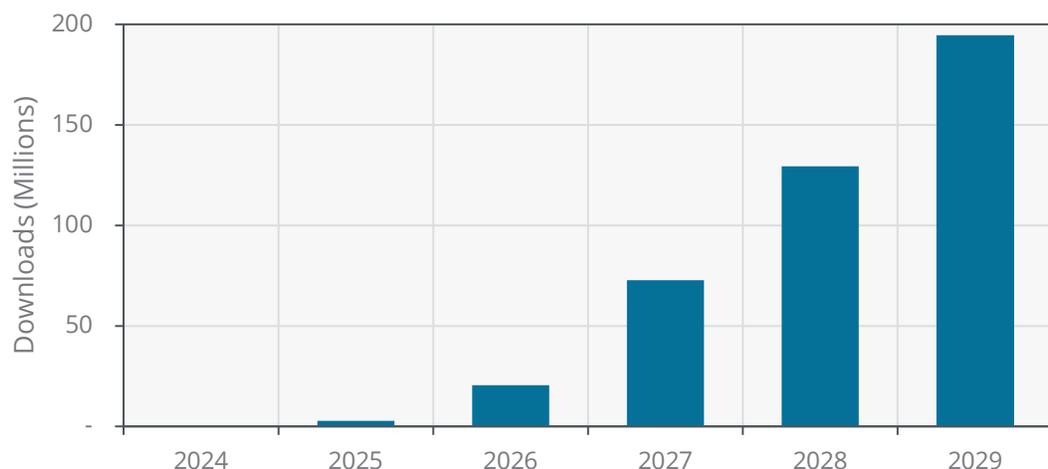
SGP.32 is expected grow rapidly after 2026, with the hunger for a more manageable and flexible way to provision driving adoption. This anticipated growth consists of both of net-new applications such as asset trackers and smart meters and the transition of extant applications currently employing SGP.02. These extant applications primarily arise in the automotive sector, which dominates the Machine-to-Machine (M2M)/IoT category, accounting for 63% of all M2M/IoT shipments in 2023, but this will change as SGP.32 begins to make its mark. While growth of SGP.32 among existing SGP.02 users will present a secondary growth lever, driven by the lack of an established migration path, net-new adopters have no such impediment.

Both groups have much to gain from the improvements made in SGP.32 specifications— SGP.32 will address many of the current challenges in eSIM provisioning for the IoT and manufacturing space, with consideration for power consumption, device mobility, and ease of management. For net new adopters, SGP.32 enables delivering light profiles for constrained devices. SGP.32 also enables support for devices with limited capabilities, such as no Short Messaging Service (SMS), and supports a broader range of Low-Power Wide Area Network (LPWAN) cellular types.

For some verticals, particularly in long-deployment, low-power use cases, power consumption is a non-negotiable factor and the benefits of methods such as the switch from bootstrap to operational profile via Remote SIM Provisioning (RSP) less impactful. In these instances, the alternative option of IFPP, as standardized in SGP.41/42, will enable eSIM penetration into broader device types and accelerate the adoption of cellular-connected IoT.
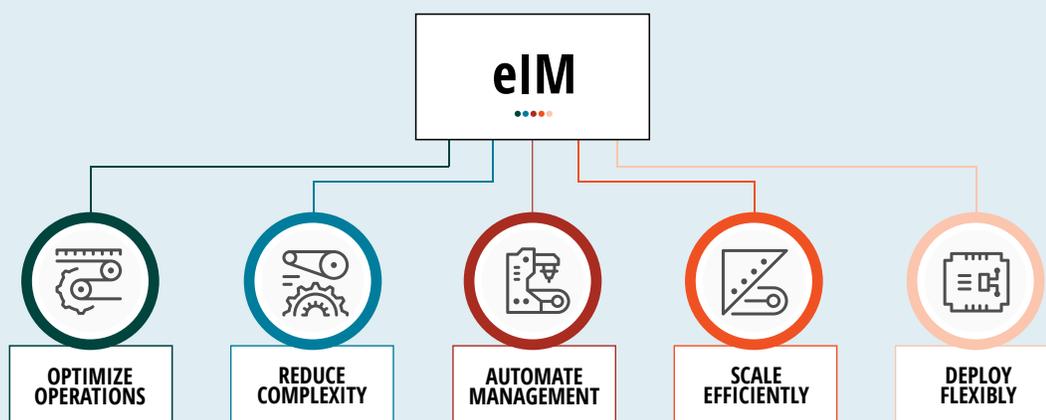
Additionally, profile management processes, although improved from SGP.02 specifications, also remain somewhat complex in the SGP.32 model, requiring relatively long development and implementation periods and significant expertise. However, SGP.32 establishes a conformance and interoperability framework in which Mobile Network Operators (MNOs) & Mobile Virtual Network Operators (MVNOs) can entrust subscriptions to eUICCs, and similarly, OEMs can trust certified servers for these subscriptions on their device. The resulting interoperability lays the foundation for more efficient and scalable provisioning. In essence, SGP.32 is game-changing because it creates the trusted framework to ship cellular connectivity with a digital approach and to decouple connectivity from Subscriber Identity Module (SIM) cards.

eIM EXPLAINED

eSIM IoT Manager (eIM) simplifies the management of large-scale IoT and consumer eSIM fleets. With automated and bulk profile management, providers can optimize operations without major back end infrastructure changes. This reduces complexity, lowers costs, and enables effortless scaling as the IoT ecosystem grows.

The eIM is an essential part of the streamlined architecture defined by the new GSMA IoT eSIM specifications (SGP.32) that manage eUICCs and facilitate profile downloads. A key advantage of the eIM solution is its ability to extend cellular connectivity to a new generation of LPWAN IoT devices, expanding its reach and impact. It also allows manufacturers to combine the eIM with IFPP for seamless device connection. Flexible eIM deployment options allow manufacturers to tailor a solution to their needs with optional SAS-SM and the choice of hosted, on-premises, as-a-Service or software licensing contracts—meaning there are eIM solutions to suit everyone.


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                          eIM

OPTIMIZE      REDUCE        AUTOMATE      SCALE         DEPLOY
OPERATIONS    COMPLEXITY    MANAGEMENT    EFFICIENTLY   FLEXIBLY
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UNIFYING IFPP

IFPP, building on the trust established via compliance to SGP.32, provides OEMs with an interoperable approach for a specific profile provisioned early in the manufacturing process, preventing the need for power-hungry in-field provisioning and prolonging the in-field deployment of low-power devices.

SGP.41/42 is the oncoming standardization for this approach, providing a critical harmonization for the ecosystem and easing the path to adoption. Manufacturing processes are truly unique to the industry one operates in, but these new specifications liberate manufacturers from the restriction of only using certified and secure manufacturing facilities in the direct injection of cellular connectivity into the device.

SGP.41/42 will be a framework designed with a significant focus on manufacturers—the streamlined batch provisioning of IFPP profiles alleviates bottlenecks in production and accelerates time to market for manufacturers. Building on SGP.32, an OEM can securely install eSIM and provisioning capability during manufacture, not bound by the MNO/MVNO process, with a reduced requirement for Stock Keeping Units (SKUs). With pre-configuration achieved in a standardized method at the point of manufacturing, device makers can guarantee a faultless customer experience with streamlined activation of out-of-the-box connectivity, at a lower price point.

BRING YOUR OWN CONNECTIVITY & PROVISIONING FLOW

Standardization is a critical component of the IFPP proposition—current solutions are fractured and proprietary, with tight coupling between the SIM or eSIM and the MNO provisioning, impeding scalability and creating unpredictability through rigid dependency. Standardization improves interoperability and a "generic part," opening up the ecosystem to provide customers with more choice, resulting in a "bring your own connectivity" environment, empowering manufacturers to provision the device in a way that is tailored for their production flow, the destination market of the device, and the ability to serve more customers.

IFPP "batch mode," where applicable (see case study) empowers the manufacturer to provision devices without connectivity to the MNO, creating a more resilient provisioning process with fewer dependencies and ensuring profiles can be pre-prepared at will to enable whatever provisioning flow is most suitable for a specific manufacturing process.

For RSP users, implementation allows ultimate flexibility in managing local requirements, including the ability to re-provision with local MNOs in regions, disallowing permanent roaming. As a result, it does not matter where a device is ultimately deployed, allowing regionally-agnostic management during the manufacturing stage.

For automotive manufacturers, in particular, the ability to test cellular connectivity and connected features in the country of manufacture is critical during the highly regulated quality control stage, and there is a great ongoing need to "own" the connectivity over the lifetime of the vehicle or provide this capacity to customers. Standardized RSP implementation allows freedom of choice over the long term, providing ongoing customer support options throughout changes to local networks.

Many automotive manufacturers will operate dual eSIMs, with one being reserved for manufacturer needs such as emergency services and telematics, and the other for establishing consumer-facing services. Both will need to be rigorously tested with flexibility to accommodate local options once delivered to the customer. This also improves the capacity to maintain long-term management services, with the ability to re-provision devices where customer movement (e.g., within the European Union (EU), where customers may move to other countries and keep their cars) and changes to networks may otherwise inhibit Over-the-Air (OTA) firmware updates.

Overall, the dual ratification of SGP.32 and SGP.41/42 is beckoning manufacturers toward a new way to create within a more flexible and empowered eSIM ecosystem, with manufacturers having full choice of how to implement standardized, interoperable approaches.

THE ROAD TO ADOPTION: REAPING THE BENEFITS AND AVOIDING THE HURDLES

SIMPLIFY & ACCELERATE CERTIFICATION

The numerous benefits of IFPP make the drive to adoption clear, but there will naturally be challenges to implementation. The IoT is a particularly diverse space, and standards must be interpreted into a tailored implementation. Cultivate partnerships to develop and execute practicable models, and begin building relationships now to be among the leaders of the wave of post-standard ratification adoption.

Prior to standardization, proprietary pre-certification approaches will be implemented, and it is important that these approaches remain faithful to the eventual technical specification to prevent a fractured ecosystem with poor interoperability. Kigen's leadership in this space, with extensive investment in education and centralized guidance, will help keep the ecosystem unified, while awaiting ratification. This thought leadership and repository of materials covering technical information through to business process explanations and detailed customer use cases will also support the full rollout with detailed, pragmatic advice suitable to facilitate the entry of manufacturers inexperienced in this space, enabling greenfield growth.

Security is a frequent concern for new technology integrations, but this is minimally impactful to IFPP. Building on RSP defined in SGP.32 for IoT eSIMs, IFPP offers the opportunity for simplified security management, as devices may be associated with known profiles, preventing the subversion of a device through the misapplication of a SIM profile.

Certification is a necessary component to a new integration. If each component of a design is created from scratch, each must be certified, creating a minimum lead time of around 9 months before new devices can be brought to the market. The process of developing and certifying a full new solution or product is outlined in Chart 2, detailing the necessary prerequisites and workflows involved.
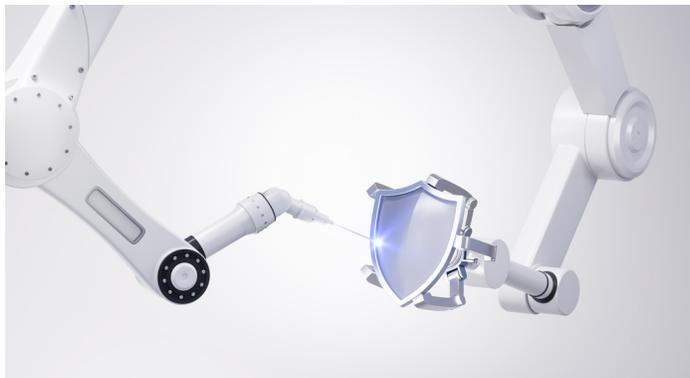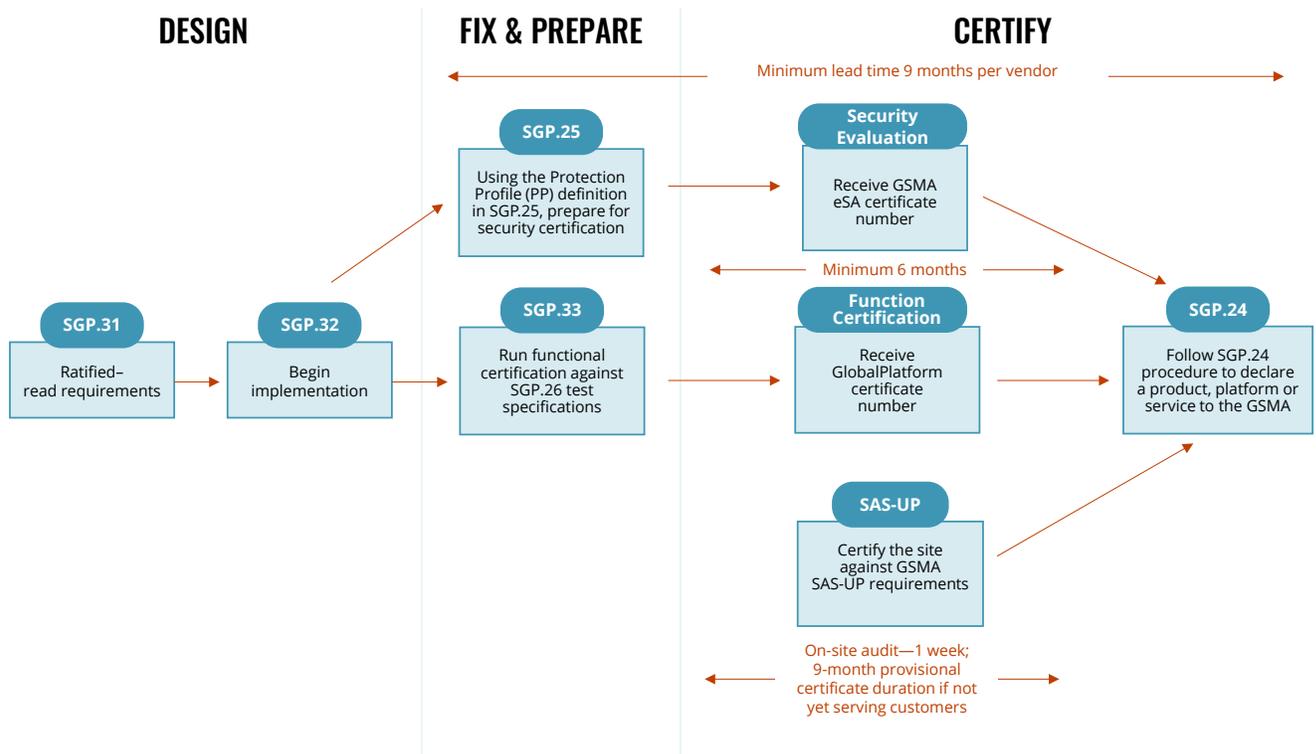
Chart 2: SGP.32 From-Scratch Certification Process
(Source: ABI Research)

| DESIGN | FIX & PREPARE | CERTIFY |

Minimum lead time 9 months per vendor

SGP.25
Using the Protection Profile (PP) definition in SGP.25, prepare for security certification

Security Evaluation
Receive GSMA eSA certificate number

Minimum 6 months

SGP.31
Ratified– read requirements

SGP.32
Begin implementation

SGP.33
Run functional certification against SGP.26 test specifications

Function Certification
Receive GlobalPlatform certificate number

SGP.24
Follow SGP.24 procedure to declare a product, platform or service to the GSMA

SAS-UP
Certify the site against GSMA SAS-UP requirements

On-site audit—1 week; 9-month provisional certificate duration if not yet serving customers

However, there is no need to reinvent the wheel. This lead time is compressed and the process streamlined with the Secure with Kigen program; modules are already available with tried and tested interoperability to prevent delays in device certification. This modular approach limits the time between ratification and product delivery by focusing only on the components affected by RSP—namely eUICC and IoT Profile Assistant (IPA) implementations—with Kigen's IPA in eUICC (IPAe) approach ensuring that modules are already certified for cellular connectivity.

It is critical to begin the process of IFPP adaptation early, as integration requires changes to business processes and manufacturing flows, with the SIM provisioning stage moving earlier in the chain. However, the availability of existing modular solutions in an ecosystem with expert partners makes this a supported and efficient process.
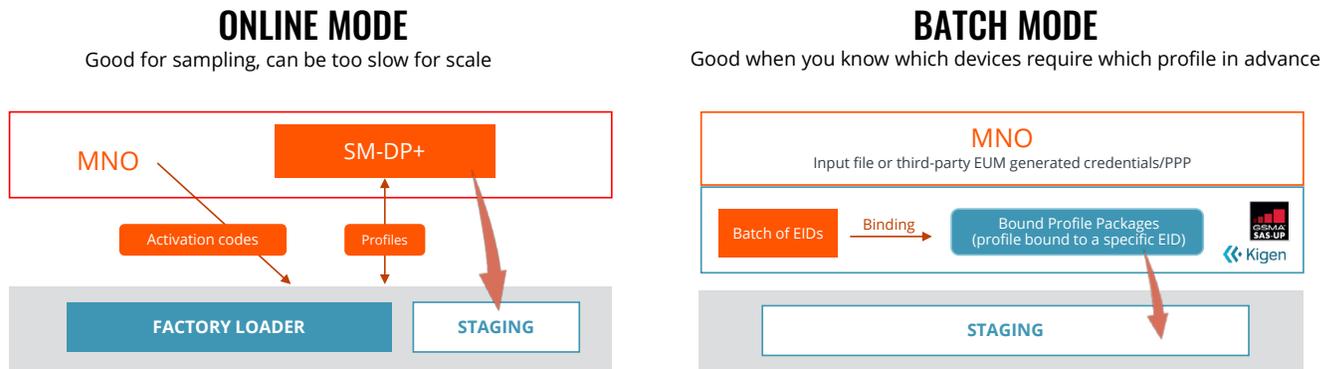
HYPER-SPEED SCALING WITH AUTOMATION

The security of the eSIM is the main factor that determines the manufacturing and information exchange processes that the cellular connectivity providers and manufacturers follow to maximize security and protect customers and enterprise business data. The streamlined approach of IFPP leads to reduced deployment and management overheads for MNOs and MVNOs servicing IoT customers, being simpler and quicker to deploy and lending itself to easier automation to further reduce the cost per new customer acquired. Reduced complexity lessens the customer support load, while the ability to provide profiles in batched transactions creates fewer pulls from the network, making availability easier to manage.

Equally, customers can benefit from increased automation potential, with more "known quantities" as pre-provisioned SIMs allow for more organized and pre-planned device deployment—of particular importance in manufacturing markets that may have very large numbers of devices to manage and logistical challenges to overcome. Automated provisioning management would further reduce manufacturing time, reducing management overheads and allowing reliable application of production changes in an instant.

Chart 3: Online Versus Batch Mode—Two IFPP Options
(Source: ABI Research)

ONLINE MODE
Good for sampling, can be too slow for scale

BATCH MODE
Good when you know which devices require which profile in advance

This is particularly true in implementations using "batch mode," as opposed to "online mode." In this model, the profiles may be requested from a pre-prepared pool via an API such as Kigen Pulse, available as part of Kigen eIM and IoT eSIM RSP solutions. Rather than requiring singular transactions of profiles and activation codes, a full input file of credentials is provided by the MNO/MVNO to the management tool, accelerating the provisioning process and allowing automation through API requests.

The simplicity of this approach provides a low barrier for entry for designing complementary solutions such as Artificial Intelligence (AI) management, providing compound benefits to manufacturers and MNOs/MVNOs looking to drastically simplify their operations and enable scalability. Early adoption of these standards, with solutions built for long-term automation potential, presents an upfront investment, which will drastically smooth the path to growth.

Although more complex than IFPP, SGP.32 will foster an ecosystem of similar tools, with the flexibility of RSP being best utilized through automated tools that remove the pain of management. Many will seek to implement IFPP in a combined SGP.32 & SGP.42 model, so all good automation tools should seamlessly integrate into hybrid approaches with centralized, simplified management.

This ecosystem is already growing quickly. Kigen is partnering with a variety of players looking to take advantage of this new way to create and connect for the IoT across a range of use cases; two examples of which we will investigate in detail.

SPECS TO SOLUTIONS: REAL-WORLD USE CASES

Supplied by Kigen

ACCELERATING ADVANCED SMART METERING WITH KIGEN'S eSIM FOR IoT AUTOMATION

THE CUSTOMER

A global leader in energy and water resource management, the customer manufactures next-generation cellular smart meters for multiple electricity and gas providers, including municipalities, cooperatives, and regional utilities, supporting deployments from initial rollout to scaling up to 100,000 units. eSIM serves as the foundation in its vision of a resilient and intelligent grid, backed by industry-leading standards and warranties, and with water and gas meters designed for up to a 20-year asset life and extreme climate adaptability.

THE CHALLENGE

Traditional SIM supply and logistics can cause production delays of up to 6 weeks, impacting smart meter production and provisioning personalized for the utilities served. The customer required:

- A 15+ year eUICC lifetime with enhanced software endurance.
- Durable materials resistant to harsh environments, moisture, and corrosion.
- Power-efficient designs for battery-operated metering.
- Support for private and public networks with autonomous connectivity switching.

Alongside the technical demands of long-lasting IoT environments, the customer must operate a streamlined production environment, provisioning each batch for its utility customers per their requirements.

BUILDING BLOCKS OF SUCCESS

Kigen's eSIM technology streamlined smart meter production through:

1. **Kigen's Consumer eSIM Operating System (OS) eUICC with IPAe:**

   Industry's most compact eSIM OS with SGP.32-ready IoT features with failover logic to avoid any data loss of remote assets.

   Proven performance in public and private network utility environments.

   World's first GSMA Security Accreditation Scheme for Subscription Management (SAS-SM)-certified infrastructure for SGP.32, delivering firewalling to end devices.

   Seamless MNO profile access and integration with production processes via APIs via Kigen Pulse.

2. **In-Factory Profile Provisioning:**

   Fully automated RSP with secure profile packaging and real-time factory integration.

   Reduction in provisioning time from 6 weeks to under 10 minutes.

   Future-proofed for GSMA's SGP.4x standards.

"SGP.32 transactions will be driven by new IoT applications, including asset tracking and smart metering (particularly within the domains of water and gas)."
—ABI Research, Understanding the eSIM SGP.32 Timeline and Opportunity, 2024

THE SOLUTION

Kigen eSIM OS and eIM solution simplifies smart meter production with automation, eliminating provisioning delays in standard SIM supply through secure digital delivery and the ability to bulk and batch manage RSP profile operations. By integrating the secure Kigen eSIM OS, automated profile provisioning and forward compatibility to potential SGP.4x developments, the customer can streamline provisioning at a late stage of their manufacturing, personalizing as required, and defined by the deployment schedules of utilities.

KEY BENEFITS

Automation: Reduced provisioning time from weeks to minutes, accelerating production.

Endurance & Durability: Smart meters operate for 15+ years in extreme conditions.

Flexibility: Support for private/public networks with failover connectivity.

Scalability: API integration ensures seamless factory-scale expansion.

Compliance: GSMA SGP.32 adherence for interoperability and security.

LOOKING AHEAD

By adopting Kigen's eSIM automation, the customer future-proofs smart meter production, ensuring rapid deployment, enhanced reliability, and seamless connectivity management. This collaboration underscores the impact of automated eSIM provisioning in critical infrastructure applications.

FRICTIONLESS PROVISIONING FOR WEARABLE MANUFACTURERS WITH KIGEN IFPP

THE CUSTOMER

A global leader in connected products, the customer manages a vertically-integrated business model, managing all stages of product development from concept to mass production of shelf-ready units to maintain a high level of quality. A top consumer brand, the customer is developing its next-generation Integrated SIM (iSIM)-connected wearable.

THE CHALLENGE

Deploying IoT devices at scale presents logistical challenges, particularly in ensuring seamless, region-specific connectivity or "best-fit connectivity" with fallback options in case of disruptions. Traditional methods prevalent in physical SIMs add complexity and cost, and are not suited for soldered or integrated SIMs. Managing different SKUs for various regions further complicates logistics and increases the Total Cost of Ownership (TCO). Furthermore, the compact and resource-constrained wearables require out-of-the-box functionality delivered through Kigen iSIM to meet consumers' high expectations.

BUILDING BLOCKS OF SUCCESS

Kigen iSIM OS and Kigen iSIM Secure Package bring the IFPP capability, allowing secure pre-loading of required profiles during manufacturing. This eliminates the need for physical SIMs and manual setup, streamlining production and reducing complexity. IFPP enables manufacturers to tailor devices for different regions without multiple SKUs, cutting logistical overhead.

THE SOLUTION

Kigen's IFPP has successfully provisioned iSIM-enabled wearables with digital profile delivery for a major U.S. operator, along with Skylo's Non-Terrestrial-Network (NTN) connectivity, offering satellite IoT connectivity as an alternative. Due to automation, digital profile delivery takes only minutes, removing bottlenecks typically presented by provisioning and testing stages for cellular provisioned goods. The compound benefit of Bill of Materials (BOM) reduction, streamlined sourcing, and removal of the contractual access to traditional SIM supply saves weeks to months in product development timelines. Kigen iSIM Secure Package delivery also meets the stringent security assurances and requirements that support the manufacturer in expanding its footprint.

KEY BENEFITS

Adopting Kigen's IFPP reduces production costs and accelerates time to market. Pre-loading SIM profiles simplifies manufacturing, while remote provisioning allows seamless connectivity management across regions. Automated profile delivery enhances scalability, ensuring a cost-effective and agile IoT deployment approach.

LOOKING AHEAD

Kigen's IFPP and eSIM technologies future-proof IoT operations with secure, scalable global connectivity. The successful provisioning of iSIM-enabled wearables and integration with Skylo's NTN highlight the transformative potential of digital profile delivery, enabling faster deployments, lower costs, and streamlined logistics. This presents a leading-edge case with the same digital secure delivery available for customers in all growing IoT markets with eSIM.

DO NOT DELAY THE CONVERSATION

There are powerful evolutions of the IoT eSIM ecosystem on the way, with the ratification of SGP.32, SGP.41, and SGP.42 creating an opportunity for broader and more creative collaboration, unbound by the restrictions of proprietary interoperability. OEMs and MNOs looking to lead in this market have much to consider, but there is no need to do it alone— expert providers such as Kigen provide the optimum opportunity to jump in with pre-certified modules, key guidance, and the ability to tailor solutions to multivariate IoT needs. ABI Research's key recommendation is this:

Align with Standards Now to Future-Proof for Certification: Start exploring, understanding, and relationship building now. The IoT cellular connectivity market is quickly evolving and SGP.32 will be the foundation from which cellular-enabled IoT device adoption accelerates across myriad device types and verticals. OEMs that embrace and begin implementing pre-certified solutions that comply with SGP.32 will be in a leading position to capture the earliest stages of the IoT growth wave. Certification can be achieved later, with many of the building blocks readily available today. Adopting compliant solutions early and designing with the use of Kigen's pre-certified modules in mind will ensure continued market relevance through this evolution and significantly reduce certification time to market. Given the fact that in the cellular market, technology has been historically driven by standards, it is imperative to align to develop with the IoT eSIM future in mind. At last, device makers and enterprises can take advantage of the freedom to steer their destiny-aligning choices in security, connectivity, and manufacturing for next-generation products.
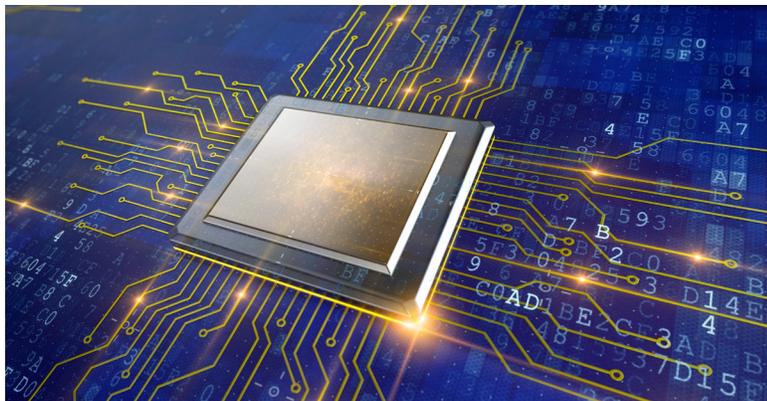
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