Unlocking the full potential of eSIM for large scale Industrial IoT deployments

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TATA COMMUNICATIONS

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Contents

Since it first emerged as a concept almost 20 years ago, the Internet of Things has become a household term. According to Statista[1], the number of connected devices will triple, from 25.4 billion globally in 2020, to 25.4 billion by 2030. While consumers account for a large share of this number, new IoT applications are continually emerging across multiple sectors. In a recent survey[2], PWC reported that 71% of surveyed manufacturers were already building or testing IoT-based solutions in their operations, as they seek to gain a competitive edge by adopting the Industry 4.0 automated factory model. The modern automobile is packed with sensors, with some capable of generating up to 2 Terabytes[3] of raw data per day which is used by a wide spectrum of cloud-based applications to improve driver safety and convenience. Low-power battery devices are increasingly used by applications from logistics tracking to soil monitoring in agriculture.

This explosive growth of connected devices has highlighted the limitations of the traditional SIM card. As IoT enabled-devices become ever smaller, a separate SIM card is no longer practical. Also, for OEMs targeting global markets, economies of scale demand flexibility when managing connectivity; having to cater for different SIM cards by country or region can seriously impact project viability. During the operational life of an application, connectivity arrangements may change for a number of reasons and,

since many IoT devices are remotely located, a physical SIM-swap can be expensive, resource-hungry, and time-consuming. While this is frustrating for companies with a small number of devices deployed in the field, for those deploying hundreds or thousands of devices, the complexity and cost of dealing with multiple Mobile Network Operators, (MNOs), becomes untenable.

An increasing number of IoT applications, such as logistics and connected automobiles are mobile, crossing national borders, bringing an even more complex set of challenges in terms of interoperability, connectivity, and local connectivity compliance.

The need to manage multiple MNOs also introduces additional complexity such as multiple integrations, on-going administration, different management portals, and APIs. Amalgamating reporting across different MNOs platforms, interfaces, and multiple data feeds also becomes increasingly difficult.

Recognizing these market trends and the limitations of the traditional SIM, the GSMA, a global body representing the interests of mobile network operators worldwide, has defined the concept of the eSIM.

1 https://www.statista.com/statistics/1183457/iot-connected-devices-worldwide/
2 https://www.pwc.com/us/en/services/consulting/technology/emerging-technology/iot-pov.htm
3 https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/unlocking-the-full-life-cycle-value-from-connected-car-data

1. The eSIM

The **eSIM**, or embedded SIM, chip is able to store multiple programmable "profiles," with each "profile" holding the same subscriber-related data as a traditional SIM. The eSIM is normally a SMD, (surface mount device) permanently soldered into the PCB of the IoT device.

The GSMA has defined two separate standards covering eSIM and Remote SIM Provisioning, (RSP) - GSMA SGP.02 for M2M devices, and GSMA SGP.22 for consumer devices.

Due to strong market demand, initial priority was given to the M2M RSP solution, which has three main components:

› the eUICC
› the Subscription Management Secure Routing, (SM-SR), subsystem, and
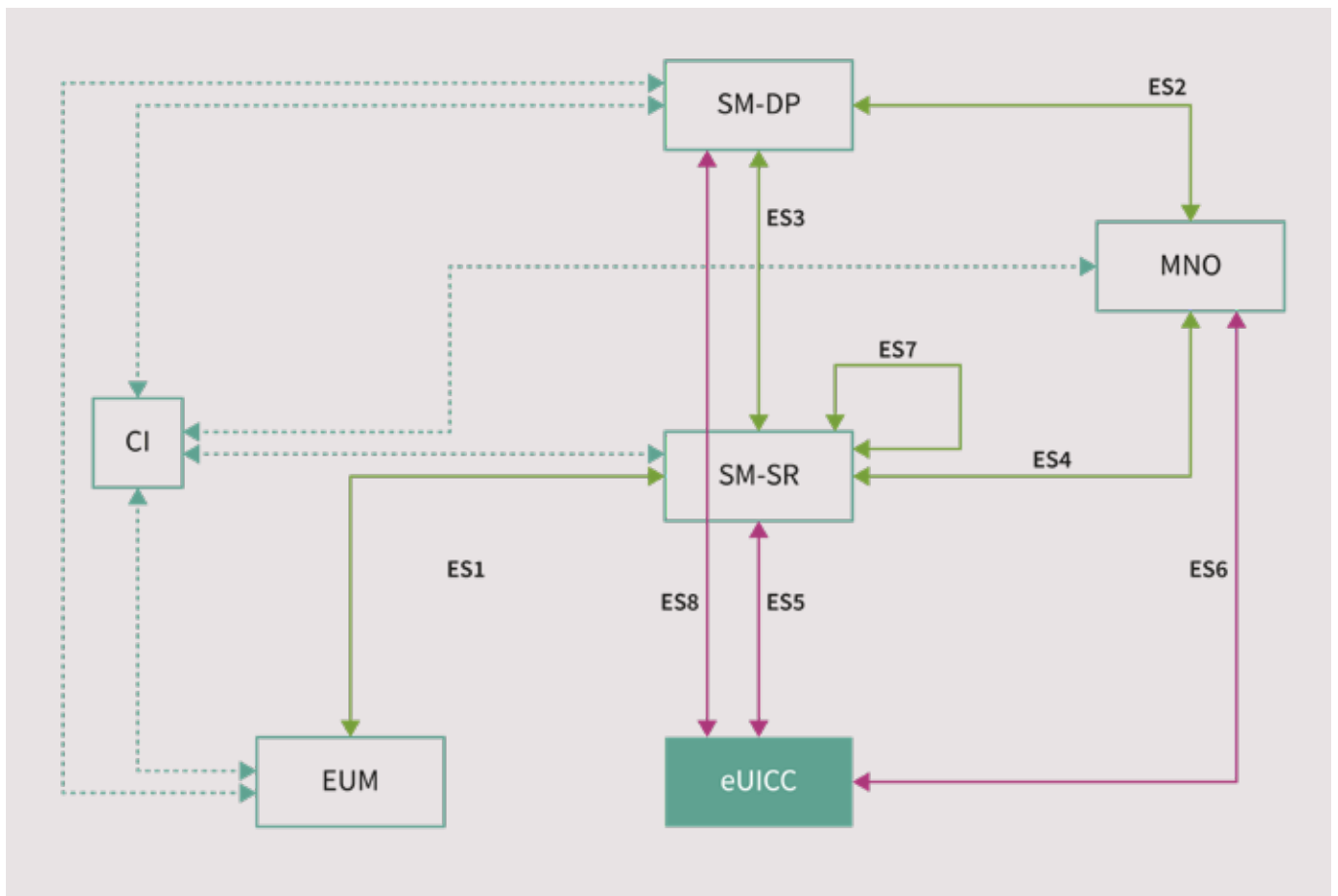› the Subscription Management Data Preparation, (SM-DP), subsystem

Figure 1: The GSMA M2M RSP architecture, Source: GSMA

› The eUICC, or embedded Universal Integrated Circuit Card, forms the core of the eSIM module. The eUICC can hold multiple profiles and eUICC plus profile together deliver the eSIM functionality. Profiles can be downloaded to the eUICC over the air, (OTA), and managed and deleted remotely.
› The SM-DP prepares, stores, and protects the MNO profiles (including the operator credentials) and also downloads and install the Profiles onto the eUICC.

The SM-DP is usually owned by and hosted in the backend systems of an MNO.
› The SM-SR manages the status of Profiles on the eUICC (enable, disable, delete) and secures the communications link between the eUICC and SM-DP over which operator profiles are downloaded. the SM-SR can be owned either by an MNO or a third party and is the only entity that can contact the eUICC for the purpose of subscription management.

This RSP architecture is designed to enable a number of key processes for large-scale users. An implementation of the SM-SR platform would provide a single, aggregated portal enabling the management of all IoT connections and subscriptions globally during the various stages of the product lifecycle, regardless of the connectivity technology or the service provider. Platform users would benefit from a single agreement providing access to dozens of MNOs across the globe instead of dealing with these on an individual basis. An extensive network of connectivity providers could be used as the initial connectivity (known as the 'bootstrap' profile). By applying this pre-integrated bootstrap profile prior to deployment, manufacturers would only need to handle one single agreement and interface, rather than having to deal with many different MNOs and their associated interfaces. The platform could then be used to manage connectivity for the lifecycle of the application, changing MNOs as required or adding more connectivity options to existing agreements for backup, infill, and cost competitiveness.

Remote activation and configuration of IoT devices over-the-air, (OTA), will enable a more automated, secured approach to bring large numbers of devices online.

Connecting devices to the internet can be entirely managed remotely via an online portal and eSIM profiles can be changed throughout the product lifecycle.

The GSMA RSP architecture therefore aims to simplify the deployment and management of cellular-enabled IoT devices at scale. Compliant implementations of the SM-SR platform will enable device manufacturers to deliver products capable of worldwide use, rather than needing to develop multiple versions of the same product for various markets. These benefits result in significant economies of scale to the developer, with simplified product management reducing costs and accelerating time to market.

As with any emerging technology, standards are key and the GSMA's work is a fundamental enabler of a global RSP solution. The GSMA has also recognized that successful adoption of the model will require existing MNO business models and relationships to change. The processes described above require significant levels of integration and interoperability between the systems of both MNOs and third parties and the GSMA is encouraging the development of an ecosystem of players and platforms to enable a successful global roll-out.

2. Infineon Technologies and Tata Communications

The collaboration between Infineon Technologies and Tata Communications is a perfect example of how organizations in this ecosystem are combing their expertise and resources to deliver the RSP vision. Designed to deliver end-to-end communication for large-scale IoT deployments, the Infineon-Tata Communications solution provides seamless and secured, pre-integrated network coverage in more than 200 countries and territories.

The OPTIGA™ Connect eSIM for cellular IoT devices is based on Infineon's SLM 97 high-performance security controller and GSM eSIM M2M compliant operating system. Using the eSIM technology provides for worldwide coverage across 2G, 3G, 4G, LTE-M, 5G, and NB-IoT networks.
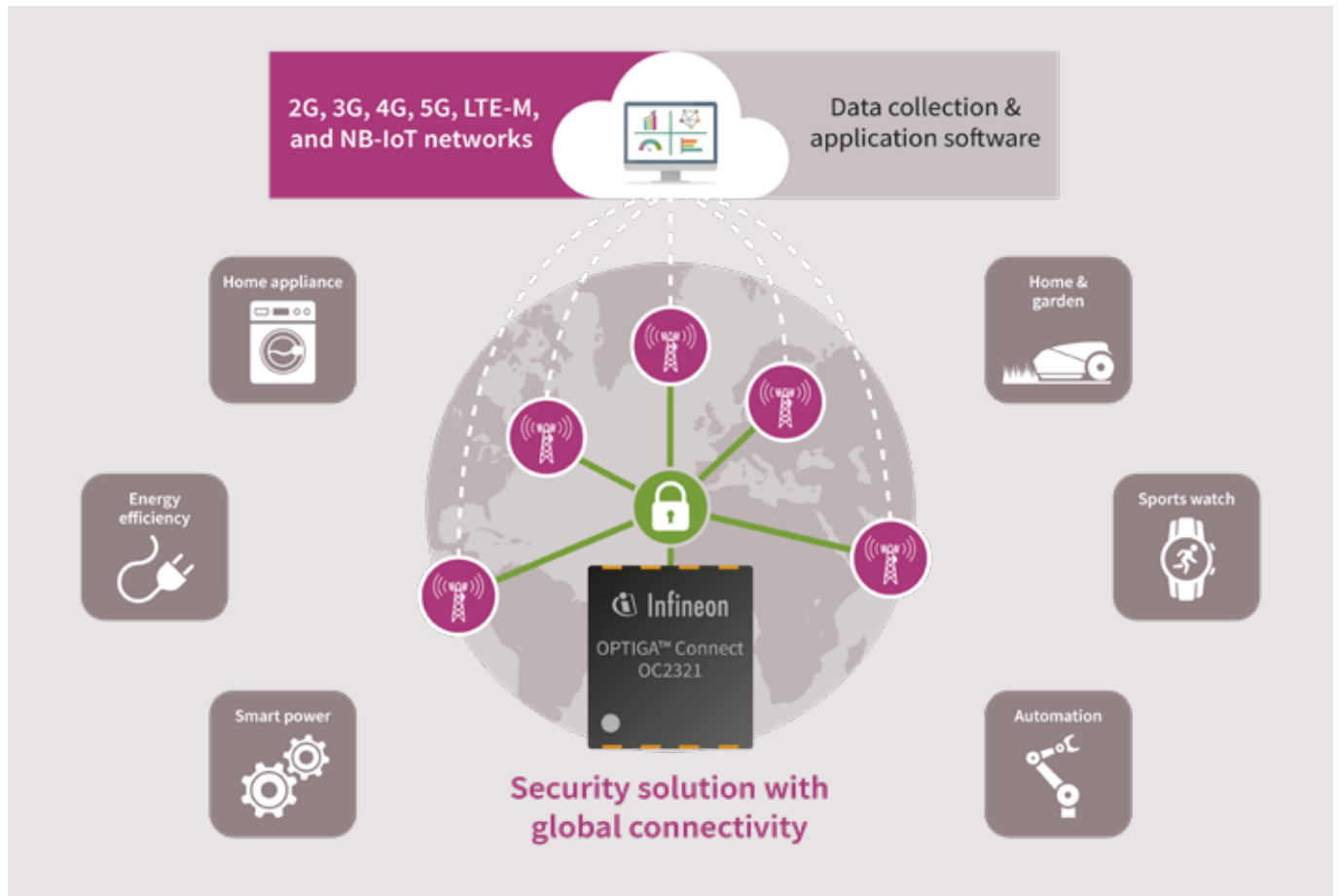

Figure 2: Infineon's OPTIGA Connect eSIM offers a variety of connectivity options

Connectivity comes via the Tata Communications MOVE™ platform. Described as the world's first truly global-local mobile network, Tata Communications MOVE™ provides global, network independent, cross-border, cellular connectivity through access to ~600 mobile networks across 200+ countries and territories on a 'carrier agnostic' basis. Data traffic is broken out to the nearest regional point-of-presence (PoP), to enable optimum international traffic routing and access to applications in the cloud. Pre-integrated interconnection with major cloud providers enables the secured routing of traffic over private networks.

There are several benefits associated with the Tata Communications MOVE™ platform, including simplicity and ease of implementation. Tata Communication MOVE™ management portal allows companies to plug in their existing agreements, enabling management of existing and new connections using a single integrated portal for all their IoT connectivity management, regardless of the connectivity technology or the service provider. This means that companies can onboard their own connectivity agreements, with a minimum of disruption. The platform delivers intelligent connectivity with a single overview

of the entire connected asset base – something that would be impossible with disparate providers. By using intelligent network selection based on a defined set of rules addressing a combination of network availability, signal strength and quality of service (QoS),

Tata Communications MOVE™ can seamlessly switch connectivity between network providers to offer the best possible connectivity outcome for each use case or location.
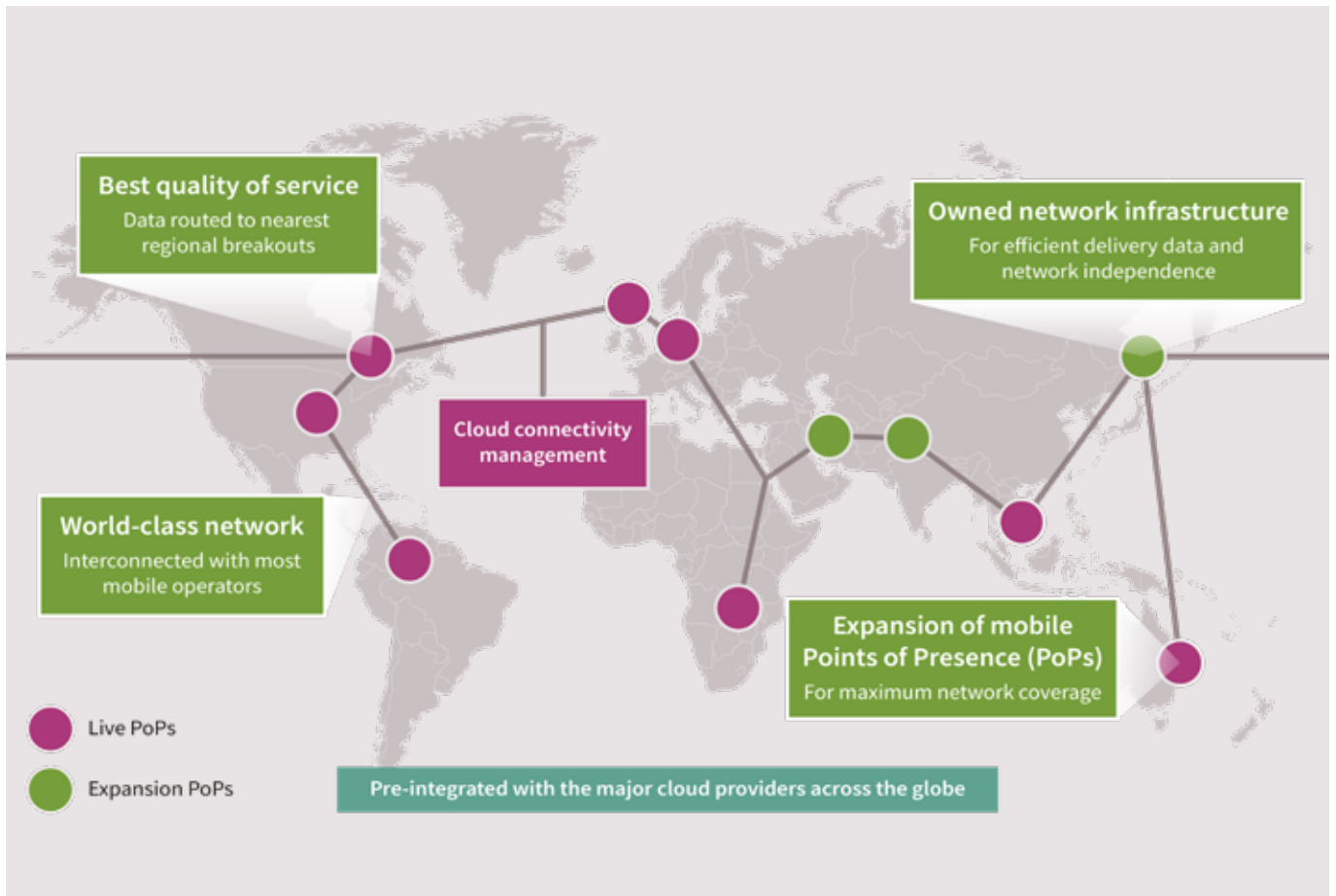

Best quality of service
Data routed to nearest regional breakouts

Owned network infrastructure
For efficient delivery data and network independence

Cloud connectivity management

World-class network
Interconnected with most mobile operators

Expansion of mobile Points of Presence (PoPs)
For maximum network coverage

Live PoPs

Expansion PoPs

Pre-integrated with the major cloud providers across the globe

Figure 3: Tata Communications MOVE™ platform is the world's first truly global-local mobile network

Infineon and Tata Communications have developed several reference designs that will be made available to IoT device manufacturers, further speeding up and simplifying product development, prototyping, and deployment.

3. Conclusion

The partnership between Infineon and Tata Communications offers the market a turnkey solution allowing easy, secured and cost-optimized deployment and management of cellular-enabled IoT devices at scale. Fully compliant with the GSMA SGP.02 specification, this solution offers global cellular network coverage (2G, 3G, 4G, 5G, CAT-M, NB-IoT and other LTE services) spanning ~600 networks across 200 countries and territories. With end-to-end connectivity management extending from design through manufacture to deployment customers benefit from significantly reduced complexity, simplified control, and full visibility into IoT devices.

4. Case Study: Logistics – eSIM solution for global asset tracking

Technology solutions deployed in the logistics sector are constantly evolving in response to ever changing economic, geo-political and regulatory environments. Asset tracking solutions in this sector face a number of unique challenges, including:

› Solutions must monitor an increasingly broad range of range of environmental parameters, including temperature, humidity, light exposure, and damage impact. This requires more integrated, robust, and reliable components adding more cost to the overall solution and increasing power usage
› As most tracking devices are battery operated, battery lifetimes are critical to the reliable operation of the solution
› Traditional mobile networks are not designed to support the specific needs of asset tracking solutions. Monitoring tools are restricted to access by MNO internal customer care teams and are usually not available to 3rd parties and SIM customization options are limited
› Additionally, international roaming options are limited, with only a limited set of predefined offers, which severely restrict flexibility

A global logistics company operating across Europe, the USA, Asia-Pacific and Latin America were operating a solution based upon a battery-powered asset tracking device which supported two different cellular connectivity frequencies. The company were working with a single, Tier 1, MNO partner, to hold stock keeping units (SKUs) to a minimum, for global coverage.

Network coverage with this approach was unreliable and even non-existent in some regions where the MNO had no local presence of its own. In some countries such as Brazil, where permanent roaming is not permitted, a separate SIM was often required to access connectivity from local MNOs. Additionally, the relationship with the Tier 1 MNO did not allow the logistics company to access preferential rates that they had negotiated in certain countries. This brought further cost and complexity, with the company either incurring higher charges or the inconvenience of managing another local MNO contract.

Working with Infineon, the company migrated to a combination of an OPTIGA™ Connect eSIM and Tata Communications MOVE™ platform. The traditional SIM card in the asset tracking device was replaced by a soldered eSIM resulting in a much more reliable and robust solution for their devices, which operate in harsh environment with vibrations and under extreme temperatures. The eSIM also enabled the optimization of the logistics process, with the Infineon eSIM OC2321 replacing the multiple SIM batches of the previous solution, giving a single SKU.

The Tata Communications MOVE™ platform brought extensive coverage and the ability to access pre-negotiated rates with ~600 MNOs in 200+ countries and territories. Pre-embedded cellular credentials eliminated the need for complete downloads of new credentials, simplifying regional deployment and cross-border roaming, at the same time contributing to extended battery life. Configurable business rules allow the automation of routing data into the cloud-based application based on the company's specific eco-system in any given region.

This case study illustrates the comprehensive benefit that can be gained by logistics companies when using Tata Communications MOVE™ in conjunction with Infineon Optiga™, including:

Network agnostics global connectivity
› Visibility and control of services
› Simple network integration, using APIs
Secured, Versatile, Scalable and Reliable connectivity to accommodate evolving applications

5. Case Study: Energy Management – eSIM for Smart Grid Solutions

As climate change becomes a growing concern around the world the, the demand for renewable energy as an alternative to fossil fuels is growing. The International Energy Agency reported[4] that in, 2020, renewables accounted for 11.9% of total OECD primary energy supply, a new high. Most existing power grids, however, are over 50 years old and based on large, centralized power stations, with energy flowing in one direction, from the grid to the consumer. As the use of power from renewable sources grows, more energy is being generated locally, with solar panels for example, and energy flows are becoming multi-directional.

The growth of renewable energy is therefore driving the emergence of a smarter energy system, one which maximizes the use of alternative energy sources while keeping infrastructure costs down.

Smart grids are electricity networks which enable a two-way flow of electricity and data, leveraging digital communications technology to pro-actively detect and react to changes in usage patterns and also to issues arising within the network. Stakeholders in the electricity market can use the information and data available from smart grids to optimize the grid and build new capacities and services in response to changing demand profiles. These capabilities are also seen as essential to support the growth of the electric vehicle (EV) market and consequent demand for charging points.

Markets+Markets, a global market research company, predicts[5] that the smart grid market will be worth $103.4 billion by 2026, representing a compound annual growth rate of 19.1% over five years.
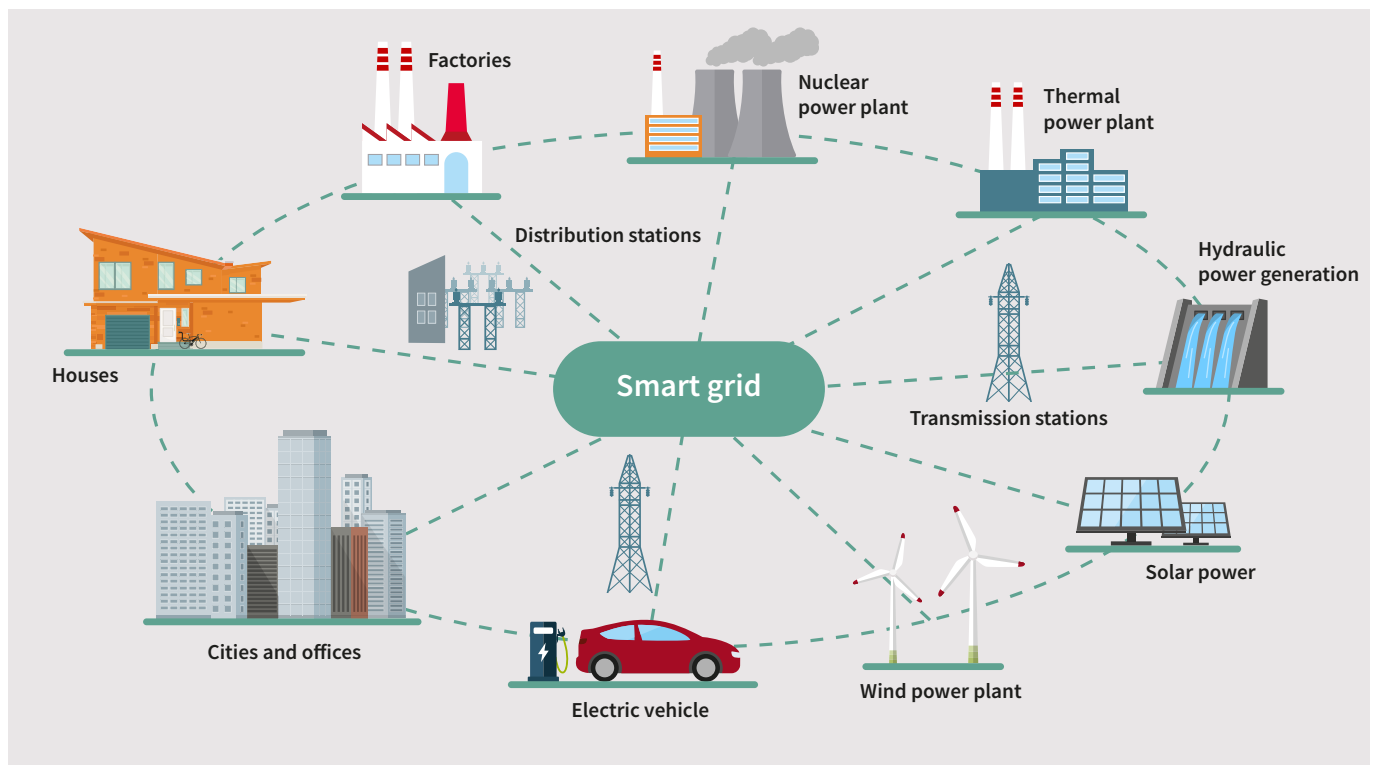

Figure 4: Smart Grid Overview, Source: IEEE.org

4 https://www.iea.org/reports/renewables-information-overview/supply
5 https://www.marketsandmarkets.com/Market-Reports/smart-grid-market-208777577.html

Smart metering is widely regarded as the cornerstone for future smart grids and is currently being deployed in many countries. Smart meters are essentially IoT devices which measure and transmit data on electricity, water, and gas consumption. As with any IoT device, a smart meter requires connectivity to get its data back to the cloud and, also as with any IoT device, various connectivity options exist. Smart grid networks are usually organized hierarchically with two or three layers. Core grid assets are connected with high performance broadband networks and, at the edge of this core network, gateways, often located in substations, concentrate data from smart meters in their region. The communication requirements for this "last mile," between the concentrator and the smart meter, are very similar to many other IoT applications:

› Smart meters transmit relatively low amounts of data at irregular intervals
› Smart meter deployments, due to their scale are sensitive to network costs
› Size is often a constraint and, particularly with gas and water meters, devices tend to be battery operated, requiring low-power operation

While various options such as Power Line Communications, (PLC) or proprietary RF solutions are possible, standardization benefits meter manufacturers as they scale up production. Many smart meter deployments use cellular networks as a practical connectivity option and, for smart meter manufacturers targeting global markets, eSIM technology unlocks the benefits described in this paper.

The OPTIGA™ Connect IoT eSIM, combined with the Tata Communications MOVE™ platform offers a single SKU solution to deliver secured global cellular connectivity. When combined with the considerable benefits of remote management and small form factor, the solution is well-positioned to effectively address the challenges posed by smart metering deployments, offering:

› Network agnostic connectivity - the smart meter can be deployed without the need for multiple connectivity agreements in any particular country – also reduces SKUs.
› Tata Communications MOVE™ enables inter-operability across eSIM vendors and networks, via its eSIM Hub.
› Dynamic switching, where one network is suffering from quality issues, the platform can dynamically switch to a different network.
› Ease of platform integration vias APIs with 3rd party enterprise management applications, such as ERP and SCM systems.
› Usage can be tracked and invoiced on a group of meters, so more flexible commercial model.
› Ability to track not just the meters, but other elements within the smart grid network for a more comprehensive view.
› Ruggedized and solderable eSIM HW preventing theft, corrosion, and bad electrical contact.
› Highest security level, Common Criteria certified.
› Best Performance vs Power ratio.

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