GSMA

Network APIs for Manufacturing

An exploration of Use Cases

Contents

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1.0
Executive Summary

Network Application Programming Interfaces (APIs) are expected to grow to a $35B market[1] for Mobile Network Operators in the next five to seven years. Application developers and system integrators can leverage network APIs to create new capabilities and generate additional economic values for the manufacturing industries. GSMA Open Gateway and the CAMARA Project have gained significant momentum since their founding in 2022 and 2021, respectively, in that the key players in the ecosystem, Mobile Network Operators, developers, and channel partners, are contributing to the focus and growth of the initiative and are ramping up their effort to unlock the power of the network for their customers.

In March 2024, the GSMA Connected Manufacturing and Production Community began to explore the opportunity for Network APIs for the Manufacturing and Industrial sector, with a Network APIs for Manufacturing and Aviation workshop hosted by Airbus at the Airbus Leadership University in Toulouse, France. Following that initial activity this white paper was authored to illustrate the potential of

network APIs to enhance manufacturing applications by elaborating several use cases in device provisioning, location service, and connectivity performance.

Network APIs support a wide range of use cases that can significantly enhance manufacturing applications.

1   "Intro to the Network API monetization forecast." STL Partners, April 2024, https://stlpartners.com/tools/intro-network-api-monetisation-forecast/
    Accessed 18 July 2024.

For example:

→ Application credential management APIs streamline the process of securely provisioning and managing device identities, ensuring that only authorised devices can access certain applications.

→ Asset tracking APIs provide real-time visibility into the location and status of equipment and materials, improving inventory management, and reducing downtime.

→ Quality-on-demand (QoD) APIs enable manufacturers to ensure consistent connectivity quality via dynamically requesting a standard of QoS defining priority, data rate, latency, packet loss rate, etc.

→ Finally, network resource booking APIs allow for the efficient allocation and scheduling of network resources, optimising connectivity and performance for critical manufacturing operations.

These use cases demonstrate how network APIs can drive innovation and efficiency in the manufacturing sector, ultimately leading to increased productivity and cost savings.

Standardisation, interoperability, security, and scalability are all essential to the development and adoption of network APIs. We are only at the beginning of this journey, and continuous efforts from all parties to the ecosystem will be required to make this initiative a technological and economic success.

These use cases demonstrate how network APIs can drive innovation and efficiency in the manufacturing sector, ultimately leading to increased productivity and cost savings.

2.0
Introduction

This white paper seeks to illuminate the Open Gateway community and the manufacturing industry on the vast potential of network APIs to fuel industry advancement. It draws from insights gathered during the GSMA Network APIs for Manufacturing and Aviation workshop, held in March 2024 in Toulouse, France. At this diverse gathering, participants explored how specific network APIs could act as catalysts, driving remarkable growth and innovation within the manufacturing and aviation sectors.

As the Mobile Network Operators, industry advances network APIs, it is imperative to highlight the benefits that these developments will bring to various industries, including manufacturing. Leveraging network APIs will enhance industry-specific use cases and create opportunities for new use cases, providing efficiencies, services, and capabilities previously unattainable.

This white paper will focus on the technical use cases and functionality of network APIs. This will be followed by a second paper in 2025 that will delve into the value and commercial market opportunities that network APIs present for the developer community and service providers, emphasising monetisation strategies and potential market impacts.
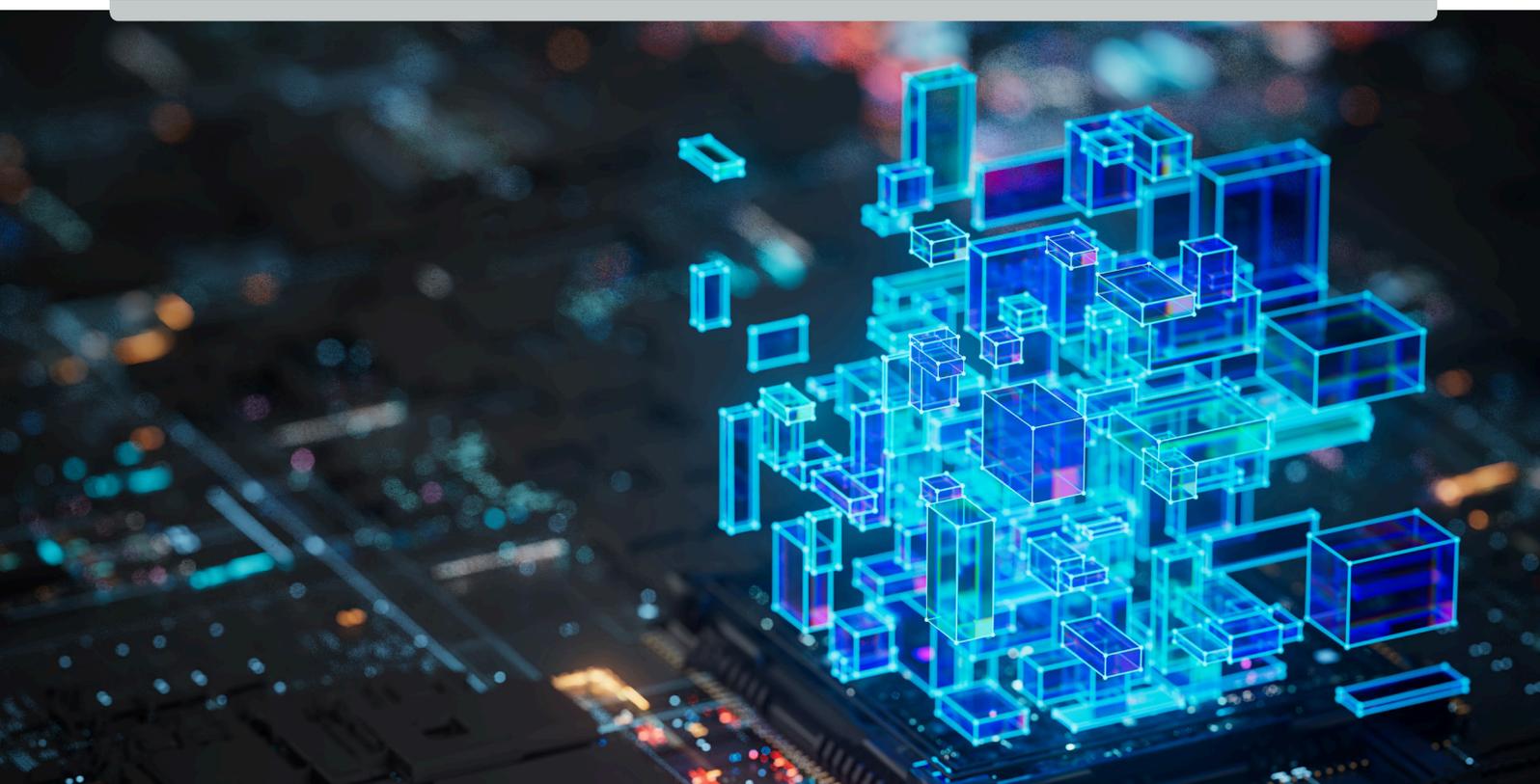
2.1 Objective

The objective of this white paper is to illustrate the role of network APIs and their potential to support the ambitions of manufacturing and industrial enterprises. As the network API ecosystem matures, it is crucial to explore and expand on various use cases to serve as early examples. This whitepaper delves into potential applications of network APIs across a range in the manufacturing spectrum, in order to inspire vendors, application developers, system integrators, and manufacturing customers.

2.2 Scope

The application verticals addressed in this white paper are limited to industrial environments such as factories and worksites, including both indoor and outdoor environments. Several example use cases are elaborated to highlight the manufacturing users' perspective, their pain points, and the value creation from the corresponding network APIs, which not only are essential to the customers but also could prove to be beneficial to network vendors, Mobile Network Operators (MNOs), developers, and ecosystem players such as system integrators.

The network APIs here are described at a conceptual level, and the implementation or source code is left to the future efforts and guided by Open Gateway and CAMARA.

In addition, the commercialisation aspects of network APIs, such as monetisation strategies and pricing models are also beyond the scope of this release but will be addressed in the following release of the series. The focus of this white paper is on 5G network technology, but some network APIs may be available for 4G LTE.

2.3 Stakeholders

GSMA Connected Manufacturing and Production Steering Committee/General Membership

Industry Leaders in Operational Technology, Informational Technology, Communications Service

Service Providers

Device Manufacturers

Industrial Customers and Systems Integrators

Technologists at Large

API Developers

3.0
Background

As a framework for common network APIs, GSMA Open Gateway[2] is paving the way for operators and Network Service Providers to expose and monetise telco capabilities to third-party service providers by transforming mobile networks into programmable Network as a Service (NaaS) platforms, enabling the integration of the network with applications, with frictionless interactions between them.

Launched by the Linux Foundation in collaboration with the GSMA, the CAMARA project is an open-source initiative whose mission is to foster the definition, development, and validation of NaaS APIs. CAMARA has adopted an open-source approach to API definition and reference implementation, using the Apache 2.0 license. This IPR-free spirit is intended to reduce entry barriers for developers, encouraging more use cases which ultimately accelerates industrialisation, and fosters an open and ever-growing community of frontline industry stakeholders, vendors, Communication Service Providers (CSPs),

hyperscalers, solution integrators, and customers.

GSMA Open Gateway and CAMARA have gained significant momentum since their founding in 2022 and 2021, respectively. The ecosystem has transformed with key players contributing to the focus and growth of the initiative. Mobile Network Operators, developers, and channel partners are collaborating to unlock the power of the network, delivering benefits to the entire ecosystem.

2   GSMA Open Gateway, https://www.gsma.com/solutions-and-impact/gsma-open-gateway

In several geographic regions, Mobile Network Operators have proven or begun demonstrating the value of these APIs through commercial launches and proof-of-concepts with Application Service Providers (ASPs), partnership announcements, and commercialisation efforts. The industry is pioneering applicable use cases across various sectors, uncovering new value for businesses. This innovation is taking place in disconnected pockets around the globe, creating a need to bring the ecosystem together to continue to advance. It is critical to invest in raising awareness to all industries, for companies of all sizes and for various stakeholders to extend the breadth of usability.

This whitepaper aims to engage and prepare the manufacturing industry on how network APIs can transform applications across their business functions.

It is critical to invest in raising awareness to all industries, for companies of all sizes and for various stakeholders to extend the breadth of usability

4.0
Network API Domains and Opportunities

This section starts with a review of mobile network types and network domains and API types.

4.1 Network API Domains and Types

There are a variety of mobile wireless network solution deployment options, including public, private, mobile-private, and neutral-host networks. These can be operated by Mobile network operators (MNOs), resellers (MVNOs), Network Service Providers or other organisations. In the context of manufacturing, the relevant types of mobile networks are likely to be private, neutral-host, and possibly mobile-private. For a comprehensive list of potential Non-public Network (NPN)

configurations and their development within the 3GPP, please refer to GSMA's Private 5G Industrial Network for further insights.[3]

Hundreds, if not more APIs are available for network solution providers to adopt and support a wide range of functionalities. This section reviews the types and domains of these APIs to provide context for Section 5, which explores the demand for network APIs from the manufacturing communities.

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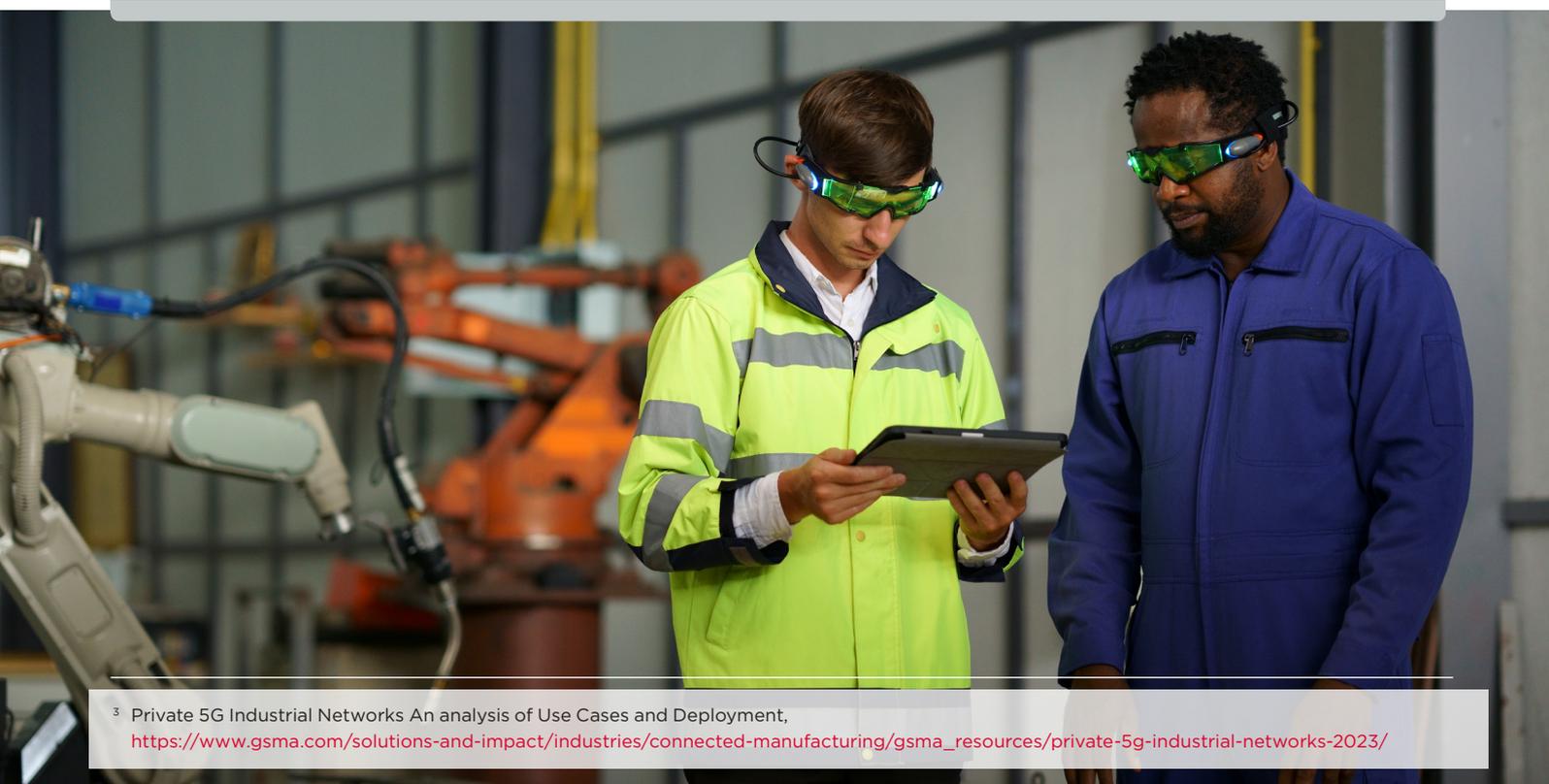
³ Private 5G Industrial Networks An analysis of Use Cases and Deployment,
   https://www.gsma.com/solutions-and-impact/industries/connected-manufacturing/gsma_resources/private-5g-industrial-networks-2023/

Types of Mobile Networks

NETWORK TYPE	CHARACTERISTICS
PLMN	Public Land Mobile Network, a wireless communication network, designed for use by mobile consumers and typically offered by a specific operator in a specific country.
PCN	Private Cellular Network, sometimes called Dedicated or On-Site Network, is a dedicated mobile network (4G or 5G today) that provides dedicated coverage for a specific geographic area, organization, or use case.
MPN	Mobile Private Network, a type of mobile network that leverages the coverage of public mobile networks but provides a secure data connection for enterprises or organisations. It can be a slice of Public Land Mobile Network (PLMN).
NHN	Neutral Host Network, a shared and collaborative radio network by more than one provider. Sharing can take the form of Multi-Operator Core Network (MOCN) or Multiple Operator Radio Access Network (MORAN), depending which domain(s) of a network is shared.

4.1.1 Network API Domains

Being an end-to-end communication system, 4G or 5G mobile networks can be roughly divided into three main domains, namely radio access network (RAN), core network, packet data network (PDN), and in recent years,

multi-access edge compute (MEC). Quality of Service (QoS) flows and network slices traverse several domains to provide the desired SLAs and isolation.

Network domains and flows.
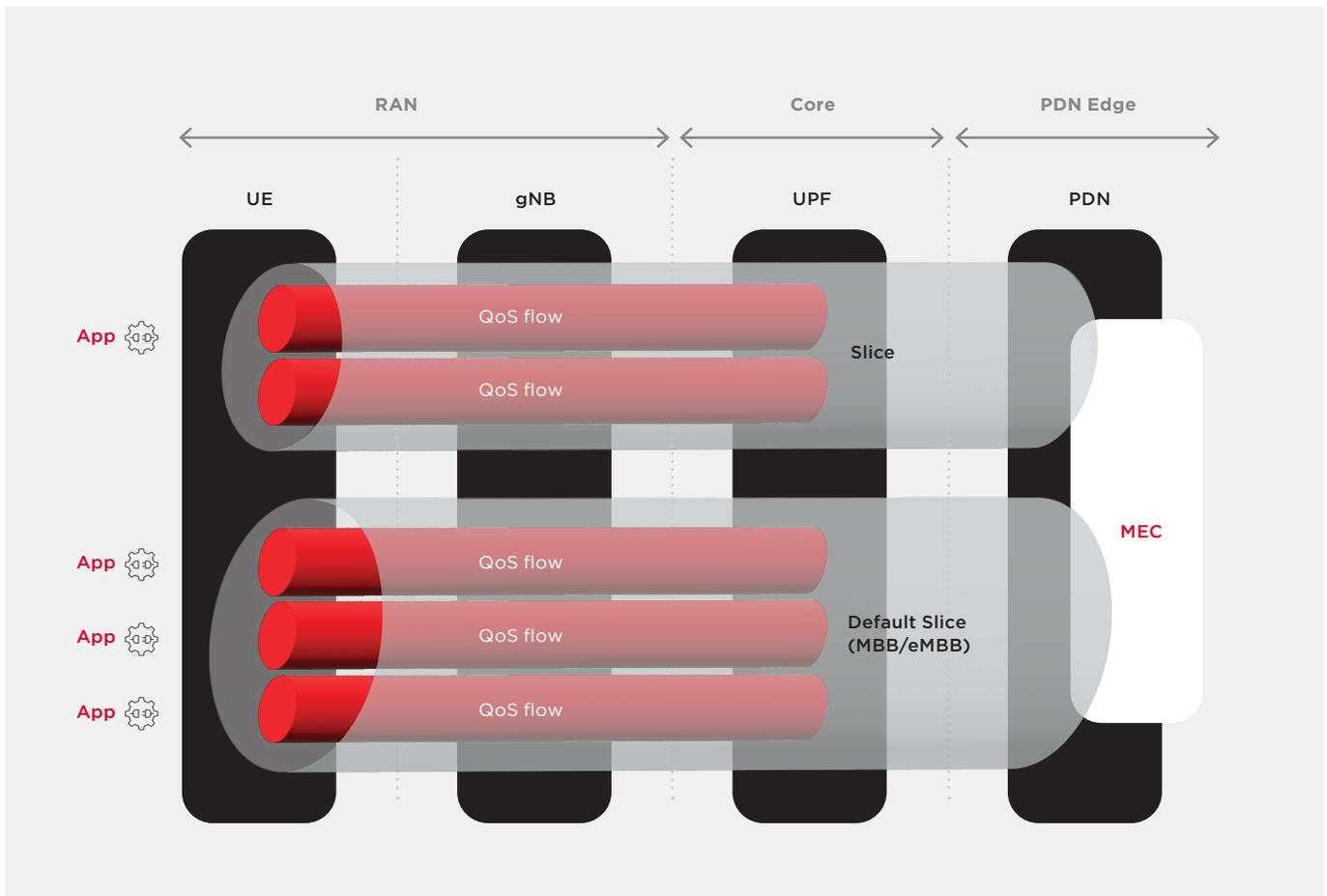
Mobile networks employ a multitude of APIs for configuring, monitoring, and controlling their operations. Some APIs can be clearly categorised as device, RAN, core network, etc., but frequently they involve multiple parts of the end-to-end connection, e.g., network slicing. Today, APIs are also available for certain Over-The-Top (OTT) and edge computing services.

Types of Mobile Networks

API DOMAIN	API EXAMPLES
Device: User Equipment (UE) device-specific APIs from the network side	➜ Device management (IDs, verification, authentication) ➜ Device status ➜ Device location (tracking, geofencing, etc.) ➜ Device diagnostics ➜ Connectivity management
RAN: APIs for the radio access network	➜ RAN performance KPIs ➜ Discontinuous Reception, of a UE (DRX)
Core Network: information and control on the core network	➜ Event monitoring ➜ Core network resource control ➜ Network analytics ➜ Charging APIs
UE-RAN-Core: from UE to the core network	➜ Voice call-related APIs ➜ Session QoS control ➜ PDN connection status
UE-RAN-Core-PDN: from UE to packet data network	➜ Network slicing APIs
OTT: APIs related to over-the-top services	➜ WebRTC routing setup ➜ Group messaging
Edge: APIs related to edge computing	➜ Edge computing resource discovery ➜ Edge computing service profile

4.1.2   Network API Types

Network APIs can be divided into two types, information and control. The first type only retrieves information about the network or devices and does not alter how the network or device operates, therefore deemed relatively low-risk to the network. The control type, however, does change the operation of the network or the devices, and extra care must be taken to safeguard the network and avoid unintended consequences.

Types of Mobile Networks

API TYPE	CHARACTERISTICS
Information	The type of APIs that only retrieve information from the network and present lower risk to the network's operation and services
Control	The type of APIs that change the configuration or operation of the network and devices and present a higher risk to the network and services

5.0
Manufacturing Use Cases

With the focus on the manufacturing vertical, from our initial workshop and subsequent efforts, we have identified and documented four initial use cases, which will be prioritised via the Open Gateway project. We understand that future demands may introduce additional features that can be supported by network APIs. The GSMA Connected Manufacturing and Production community is actively looking and open to feedback and will act as a bridge for the Manufacturing and Industrial sector's requirements to the Open Gateway project. Potential industrial and manufacturing customers can discover the relevant network APIs through their communication service providers, system integrators, and/or application developers when they become supported by MNO or Service provider.

5.1   Network API Use Case Examples in Manufacturing

For each use case in the table below, the perspectives from both the manufacturing customers and the network owners or operators are discussed. Please note that the proposed changes to the current API Types aim to provide additional information beyond what is currently available to support the use cases identified.

CATEGORY	API TYPE	USE CASE
Service	Control	Application credential management
Service	Information	Asset tracking
Performance	Control	Quality on Demand (QoD)
Performance	Control	Network resource booking

5.2 Service: Application Credential Management

When a visitor, be it a person, an equipment, or a vessel, enters a manufacturing or service area, they may need to access some of the services and APIs offered by the local network in that area, in addition to connectivity. This is not satisfied by traditional roaming over public networks in which the visited network simply provides wireless connectivity, and the services are typically provided by the home network. A visiting device must be authenticated and activated on a local mobile network (private or public) quickly so that services such as asset tracking, geofencing, QoD, etc. can be provided to that device.

This credential management API provides the customer an easy and possibly automated way of getting a device provisioned and activated on a network, thereby granting access to the services provided by the network.

Value Generation and High-Level Description of API

USE CASE	APPLICATION CREDENTIAL MANAGEMENT
Potential Customers	→ Ports → Airports → Prioritisation for remote captain steering ship when arriving into a port → Factories and their visitors → Manufacturers that have multiple sites using different private networks → Flights arriving at airports to offload data → Aircraft OEM
Customer Pain Points	→ Marine pilots need to board incoming vessels to guide it in the harbour, impacting time, safety, cost, and space → Employee or equipment traveling to multiple work locations with different networks and needing local information and services → IoT smart tools not capable of supporting SIM lifecycle management → Access to application is restricted from traditional roaming → Only unprioritised access is available → Network/application provider unable to deliver additional use cases to roaming devices → Each vehicle, vessel, or aircraft may have too many networks to register to have service agreements

USE CASE	APPLICATION CREDENTIAL MANAGEMENT
API Short Description	This API allows the requester to obtain a credential for a device to access to a private or public network and more advanced services
Applicable Network APIs	A new API is needed for device credential and/or SIM lifecycle management
API Type(s)	REST (POST/GET)
Adjustments Required	Application credential management API is of the control type, and it changes the behaviour of the network and the services. For security reasons, a separate APN/DNN and application server may be needed for visiting devices.
Input Parameters	→ Device/vehicle/vessel/aircraft owner → Device ID (ICCID for SIM, eSIM, and iSIM) for private or public network → Optional: [IMEI] → Requested area identifier (port/airport/other) → Device/UE capabilities (radio: bands, bandwidths UL/DL, MIMO, baseband parameters, SA/NSA, max throughput, etc.) → Requested time window
Output Parameters	→ Credentials (optionally with service capabilities - IP address, URL of default endpoint(s) DNN/APN) → Granted time window

5.3 Service: Asset Tracking

Given the diverse layouts, sizes, and environmental conditions — ranging from indoor to outdoor sites — of production and industrial manufacturing facilities, it's crucial to be able to locate and identify assets accurately. This capability also needs to be scalable to accommodate future growth.

Industrial and service customers frequently need to locate their assets, tools, materials, and products. While a User Equipment (UE) may potentially have the ability to find its own location, such as a smartphone using GPS outdoors, both 4G and 5G networks have the ability to locate the UE to a certain precision using fingerprints, proximity, and triangulation/trilateration principles. The combination of both positioning techniques ensures better device reach and lowers the risk of fraud.

A UE can be located from the network based on a variety of information and measurements from the cell radios, such as cell ID, Downlink angle of departure (DL-AoD) , Uplink angle of arrival (UL-AoA), Observed time difference of arrival (OTDoA), Uplink time difference of arrival (UL-TDoA), and Round-trip time (RTT), etc. that can work both indoors and outdoors. The Location Management Function (LMF) in 5G networks is responsible for computing the position of UE based on positioning measurements and assistance information.

Additionally, zoning and access restrictions ensure that only authorised personnel can access specific areas within a facility, enhancing security and compliance with safety regulations. Geofencing creates a virtual perimeter around a geographic area, improving the accuracy of alerts and reducing alert fatigue. By integrating zoning, access restrictions, and geofencing with 4G and 5G networks, companies can achieve precise location tracking and enhance overall security and operational efficiency.

The Asset Tracking API provides the customers the location information from the network.

Value Generation and High-Level Description of API

USE CASE	ASSET TRACKING
Potential Customers	→ Manufacturers using smart tools → Regulators for manufacturing of explosive products → Warehouse management needing to know the movement of people → Logistics → Healthcare providers → MRO (maintenance, repair, and overhaul) suppliers → Taxi service providers → Autonomous vehicles operators
Customer Pain Points	→ High cost of assets - "I need to locate my tools" → Need for identifying the locations of hazardous products → Inability to locate product or tools (Loss of production, increased risk and production time)
Value for the Customers	→ Cost saving → Reduced risk → Being able to locate an asset while it is offline ("last known location") → Device location that is critical to efficient production (increased productivity)
API Short Description	Process automation needs to know the location of a configurable item, on public or private networks to a high accuracy. The manufacturer will use this API to query the network to obtain the Configuration Item's (CI) spatial parameters. The current Location Retrieval API is accurate to a max of 800 meters and down to 10s of meters, where in manufacturing the typical need is <10m or better, with some being in the centimetre range.
Applicable Network APIs	Location retrieval (existing network location API), to be augmented with height and additional information on orientation and movement.
API Type(s)	1. REST (POST/GET) 2. Pub/Sub Both need to be multi-ID capable[†]
Adjustments Required	New output fields to be added: 1. Orientation 2. Direction of travel (if moving) 3. Speed of travel (if moving) 4. Acceleration (positive or negative or zero) 5. Time stamp of the response 6. Level of accuracy/confidence 7. ICCID[†] of item being requested (this should match the query ID) Asset tracking API is of the information type, and it does not change the behaviour of the network.

USE CASE	ASSET TRACKING
Input Parameters	For the two types of API suggested, 1. REST POST/GET: ➜ Provide an ICCID, or a list of ICCIDs†, that the network knows 2. PUB/SUB: ➜ Provide an ICCID, or a list of ICCIDs†, that the network knows, and an update frequency required
Output Parameters	➜ Location in 3D (x, y, z) - Required ➜ Time stamp - Required ➜ Level of accuracy/confidence - Required ➜ ICCID – Required ➜ Orientation (pitch, tilt, azimuth) - Optional ➜ Direction (vector) - Optional ➜ Speed - Optional ➜ Acceleration - Optional
Notes	† The customer needs to be able to make a call with a request for a list of ICCIDs that would accordingly return a list of outputs. This is important for managing constellations of drones or Advanced Vertical Robotics (AVRs). ‡ ICCID is linked to the IMSI and possibly IMEI by the network operator, but both IMSI (eSIM update by operator) and IMEI (device) can change over time. How an ICCID is linked to the customer Configuration Item (CI) ID - could be part of the provisioning / deprovisioning process, or the sole responsibility of the customer. From the Configuration Management Database (CMDB) point of view, each CI has its properties with attributes. This is a user responsibility rather than a network responsibility.

5.4 Performance: Quality on Demand

Quality on Demand (QoD) allows the user, in an ad hoc manner, to request a network service of a defined QoS level, typically specified by service type (Non- Guaranteed Bit Rate (nGBR), GBR, delay-critical GBR), priority level, minimum uplink and downlink data rates, packet delay budget, packet error rate upper bound, data burst volume, and averaging window, etc. Here we look at it from the manufacturing customers' perspective, especially in the context of private networks.

Since the QoD API has been under development by CAMARA[4] since 2021 and is offered by several operators, either commercially or for developers, we will skip the specifics of the API here.

Value Generation and High-Level Description of API

USE CASE	QUALITY ON DEMAND (QOD)
Potential Customers	Manufacturing and logistics verticals → Manufacturing, oil & gas, OT managers → Warehouses → Venue operators → Drone operators → Airports → Automotive manufacturers and operators → Public transport operators → Hospitals
Customer Pain Points	→ Getting differentiated service SLAs for different applications (e.g., computer vision and video surveillance require high uplink speeds) → The desired network slice is not available on the private or NHN network → The device is not capable of end-to-end network slicing → The network is not capable of end-to-end network slicing
Value for the Customers	→ A level of guarantee that a specific application would work satisfactorily → Supporting multiple applications on the same network → Realising the benefits of private networks → Efficient and optimised use of radio/network resources
Applicable Network APIs	QoD API has been under development by CAMARA for requesting a desired QoS level.

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4 CAMARA project QoD API. https://github.com/camaraproject/QualityOnDemand/blob/release-0.10.1/code/API_definitions/qod-api.yaml

5.5 Performance: Network Resource Booking

Network resource booking is a relative long-term reservation of resources ahead of anticipated utilisation period. This is in contrast to dynamic on-demand allocation of network resources.

Network Resource Booking has started development recently in the "Dedicated Networks" and the "Network Slice Booking" CAMARA repositories.

Value Generation and High-Level Description of API

USE CASE	NETWORK RESOURCE BOOKING
Potential Customers	→ Event planners → Sports venues → Operators of drones over flight corridors → Enterprise OT/IT managers → Manufacturing, oil & gas, and other vertical industries → Airport, automotive and/or public transport operators → Hospitals
Customer Pain Points	→ Different applications require different SLAs (QA video, AGV, AMR, voice, PTT/PTX, etc.) → Challenges in managing compliance (confidentiality, security, SLAs) → Only fixed service levels are available → Resources are blocked even when unused → Only best-effort service is available, not being able to meet the demands → Suffering from congestion → Permanent network slicing may not be cost effective for some cases
Value for the Customers	→ Better utilisation of network assets by SLA provisioning → Network service differentiation for different applications → Improved cost-benefit over adding network resources → Improved service level and mission criticality → Shortened deployment time for new applications → Access to customised services as per SLA → Access to QoD services → Paying for service only when needed → Efficiency in SLA maintenance

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USE CASE	NETWORK RESOURCE BOOKING
API Short Description	A new Network Resource Booking API is used to reserve a set of network and radio resources for a specific application for a group of devices. Executed in the Operations Support System (OSS)/ Business Support System (BSS), the network resources reserved are persistent over a certain period of time, in contrast to the QoD API, which is short-term, on-demand, for a single device and takes immediate effect. A new Device Connect API allows the designated devices to use the network resources after their booking.
Applicable Network APIs	A new Network Resource Booking API for reserving network resources and radio capacity for a group of devices. A new Device Connect API allows the devices to use the network resources.
API Type(s)	REST (POST/GET) Multi-ID capable†
Adjustments Required	SLA (5QI[5] value and additional requirements). For non-standard SLA, specify radio resources in resource block (RB), backhaul bandwidth, etc. Number of devices or application instances to be supported Locations Start time Time duration Request name or ID
Output Parameters	→ Request name or ID → Confirmation or error information (error in request, insufficient resources, too many devices or instances, etc.) → Outputs from the new Device Connect API
Notes	† The customer needs to be able to make a call with a request for a list of ICCIDs that would accordingly return a list of outputs. This is important for managing constellations of drones or Advanced Vertical Robotics (AVRs).

[5] 5QI is a parameter that defines the level of QoS for different services in 5G networks.

6.0
Conclusion and Next Steps

Network APIs are expected to grow to a $35B market for Mobile Network Operators in the next five to seven years. GSMA Open Gateway and the CAMARA Project have gained significant momentum since their founding in 2022 and 2021, respectively. This paper documents an initial exploration of how Network APIs can create value and new capabilities for manufacturers.

In the last two years, Mobile Network Operators, developers, and channel partners have been ramping up their effort to unlock the power of the network, demonstrating and delivering benefits to the entire ecosystem. Standardisation, interoperability, security, and scalability are all essential to the adoption, development, and their applications of network APIs, and continuous efforts from all parties to the ecosystem will be required.

This paper aims to highlight the opportunities for exposing network features and services to the manufacturing sector via Network APIs, benefiting the entire ecosystem, including developers, service providers, and enterprises, and encouraging further exploration and innovation for the industry.

Drawing from the GSMA Network APIs for Manufacturing and Aviation workshop in March 2024, this white paper elaborates on four initial technical use cases of network API for manufacturing in device provisioning, location service, and connectivity performance, from the perspectives of both the customers and the network operators.

In each of the four use cases described, existing network APIs have already been defined but a closer review indicates that the Network APIs for application credential management, asset tracking, and network resource booking use cases need to be extended or combined in order to satisfy the needs of manufacturing customers.

While this paper is intended to start the discussion on the role of network APIs for manufacturing, we recognise that there is more to be done to develop the opportunity. The paper covers just four use cases from a long list identified in the March 2024 workshop, it does not touch on any business processes, assess commercial or legal considerations (for accessing data for example), investigate private network integration considerations or attempt to quantify the value of the network API in each scenario.

The following next steps are recommended:

→ The white paper is reviewed by the Open Gateway project members to assess the use case to identify potential API development opportunities.
→ The Connected Manufacturing and Production community prepare a second paper that considers

  – Business and commercial process considerations
  – Network APIs in 5G private network infrastructures
  – Value generation through existing API deployment examples in manufacturing or adjacent industries
  – Additional use cases and/or deployed case studies

Any organisation wishing to participate in the discussion about network APIs for manufacturing or contribute to the next white paper, please contact manufacturing@gsma.com.

7.0
Acronyms and Terminology

ABBREVIATION / TERMINOLOGY	DEFINITION
5GC	5G Core (network)
5QI	5G QoS Identifier. 5G-equivalent of QCI
AGV	Automated guided vehicle
AMR	Autonomous Mobile Robots
AoA	Angle-of-Arrival. The direction of reception
AoD	Angle-of-Departure. The direction of transmission
APN	Access Point Name, the gateway between an LTE network and another network
ASP	Application Service Provider. Providers of application software, generally through the web, providing software as a service
AVR	Advanced Vertical Robotics
BSS	Business Support System, for order capture, customer relationship management, telecommunications billing
CAMARA	Initiated in 2021, CAMARA is a Linux Foundation open-source project that defines, develops, and tests APIs for telco networks
CI	Configuration Item: item or aggregation of hardware, software, or both, that is designated for configuration management and treated as a single entity in the configuration management process
CMDB	Configuration Management Database: a database used by an organisation to store information about hardware and software assets (CIs)
CSP	Communication Service Provider
DL	Downlink. The direction from the cell toward the UE
DNN	Data Network Name, 5G counterpart of APN that identifies the data network for a network slice

ABBREVIATION / TERMINOLOGY	DEFINITION
eSIM	Embedded SIM. A SIM chip that is directly soldered onto the UE hardware
gNB	(5G) G-Node B. 5G cell radios
GBR	Guaranteed Bit Rate
ICCID	Integrated Circuit Card ID: a unique 18-22-bit identification of a SIM card
IMEI	International Mobile Equipment Identity, is a numeric identifier, usually unique, for mobile phone, as well as some satellite phone devices
IMSI	International Mobile Subscriber Identity is a number that uniquely identifies every user of a cellular network. IMSI has implications in identification/authentication and roaming
IIoT	Industrial IoT
IoT	Internet-of-Things
iSIM	Integrated SIM. SIM card functionality built into the secure enclave of a processor
KPI	Key Performance Indicator
LMF	(5G) Location Management Function
MEC	Mobile/Multi-access Edge Computing
MIMO	Multiple-Input Multiple Output. Antenna array for diversity and/or spatial multiplexing
MPN	Mobile Private Network
MNO	Mobile Network Operator
MVNO	Mobile Virtual Network Operator
MOCN	Multi-Operator Core Network
MORAN	Multiple Operator Radio Access Network
MRO	Maintenance, Repair, and Overhaul
NaaS	Network-as-a-Service. A service model that allows customers to operate their own networks without maintaining the network infrastructure
NPN	Non-Public Network

ABBREVIATION / TERMINOLOGY	DEFINITION
NSA	Non-Standalone. A version of 5G transitioning from 4G
OSS	Operations Support System, for order management, network inventory management, network operations
OTT	Over-the-Top. Application(s) over the IP network provided by mobile networks
PCN	Private Cellular Network
PDN	Packet Data Network
PLMN	Public Land Mobile Network
PTT	Push to Talk
PTX	Push to X
QCI	QoS Class Identifier. A 4G identifier defining the quality of packet communication service
QoD	Quality on Demand
QoS	Quality of Service. A description of the overall performance of a communication service, typically characterised by bit rates, priority level, delay budget, packet error rate, jitter, etc.
RAN	Radio Access Network. Includes cell site network and UEs
RTT	Round-Trip Time
SA	Standalone. 5G mobile network on its own
SIM	Subscriber Identity Module. An IC (Integrated Circuit) for storing IMSI and related keys securely
SLA	Service Level Agreement
TDoA	Time Difference of Arrival
UE	User Equipment. The user-end device of the mobile network
UL	Uplink. The direction from the UE toward the cell
UPF	User Plane Function. The fundamental component in the 5G core that handles data-plane traffic
URSP	User equipment Route Selection Policy. A 5G feature on the UE to support multiple slices/applications.

8.0
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