

T IoT

**T T-MOBILE
FOR BUSINESS**



T-Mobile® Control Center

Whitepaper

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Introduction

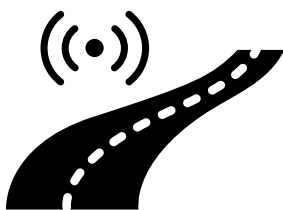
T-Mobile Control Center accelerates business growth by harnessing the power of Internet of Things (IoT) through **custom platforms and flexible solutions**—such as agile activation services, dynamic cost controls, SIM ordering and lifecycle management tools, and the ability to monitor devices and device usage in real-time. Businesses that witnessed 3G and 4G networks transform mobile phones from telecommunication devices into handheld computers must embrace the profound changes being driven by the integration of low-latency, high-capacity of 5G with IoT and other advanced technologies.

T-Mobile Control Center supports 4G LTE, LTE-M, Narrowband IoT (NB-IoT), and 5G Enterprise IoT. These capabilities create significant real-world impact, most notably in managing smart cities, providing robust home security systems, and optimizing fleet management and asset tracking—key business initiatives fully supported by T-Mobile Control Center.

Flexible solutions

T-Mobile Control Center is one of today's most innovative and dynamic IoT management platforms, delivering the scale, flexibility, and speed to market that enables enterprises and their customers to compete in today's rapidly growing marketplace. It utilizes 3GPP 4G LTE, 5G, and IoT-optimized LTE technology to provide **a long-range, efficient power consumption solution** over the licensed cellular spectrum. The IoT for Business solution provides flexible cellular connectivity options, including 4G LTE, LTE-M, LTE NB-IoT, 5G as a radio access network, and open Internet or IPSEC/MPLS-based VPN for connectivity to the enterprise customer's premises.

The Control Center portal and APIs allow customers to **deploy, manage, and monetize their IoT solutions**. They can also view per-device charges, device analytics, device-level triggers and automation, and per-device network connectivity status. The Account Hub portal enables customers to manage their accounts and order Subscriber Identity Modules (SIMs). Customers may also utilize public or private internet Access Point Names (APN), and T-Mobile-provided dynamic/static IP addresses or enterprise-managed IP address assignments.

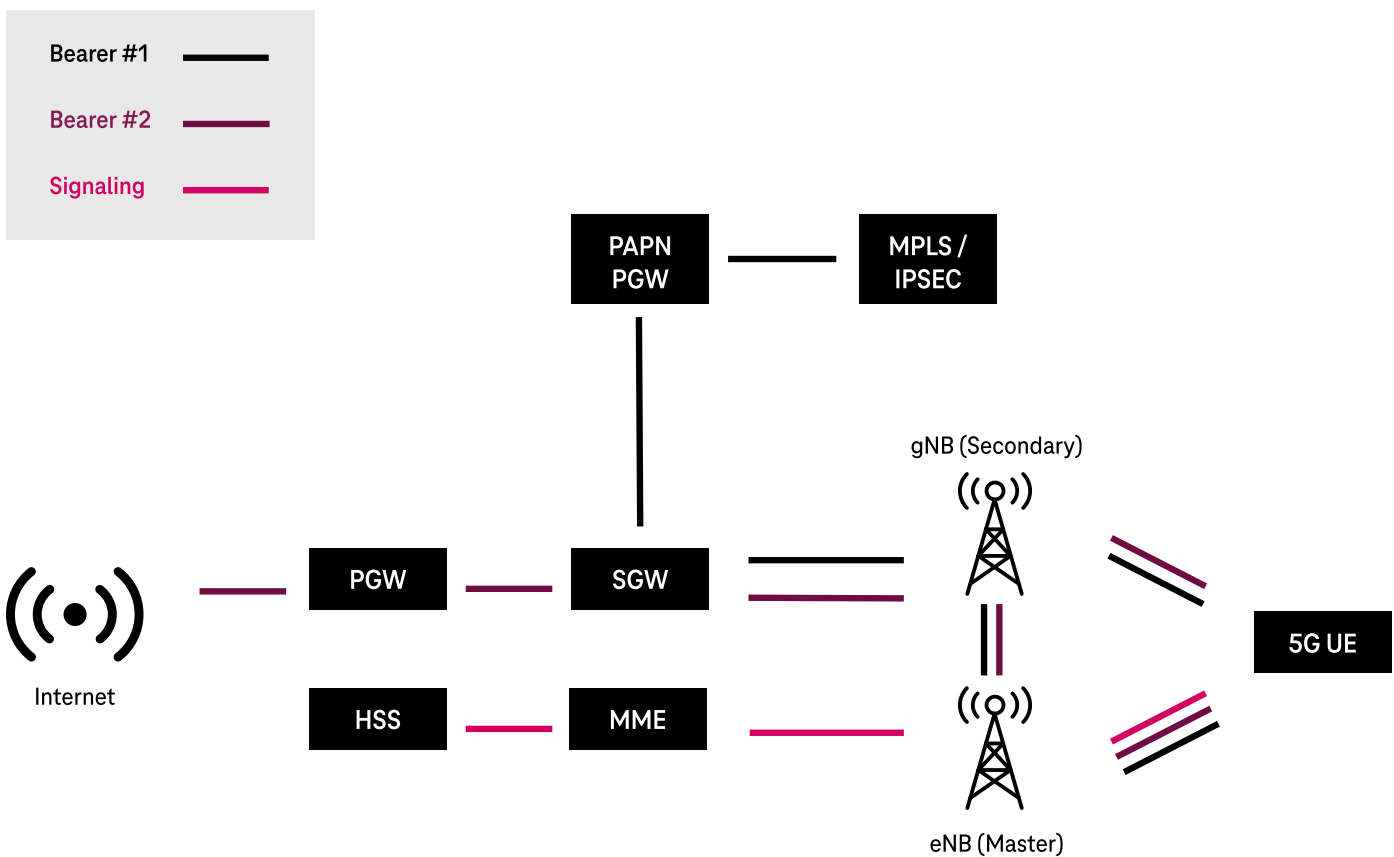


The T-Mobile Control Center supports **domestic and international roaming** in over 100 countries. T-Mobile is continuously enhancing network features and functionality in support of ever-growing IoT use cases and customer needs.

Network capability options

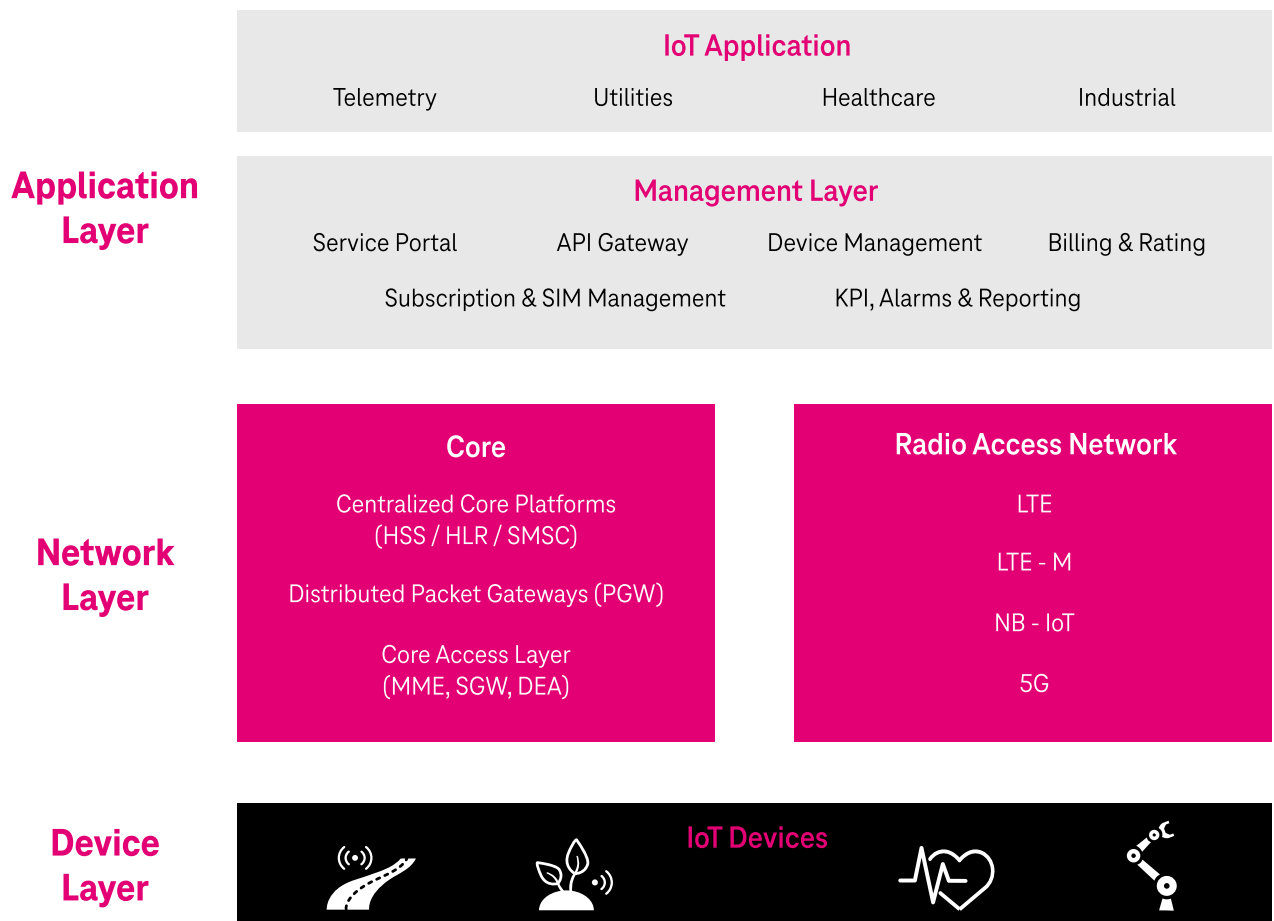
T-Mobile Control Center customers can choose to use the **public (open Internet) APN** to get basic internet access. Dynamic and static IP support options are available for open internet APN customers. This is the default option that is associated with all SIM subscriptions.

Our **Private APN (PAPN)** provides customers with a private connection to their internal network, which they can fully control and customize to their preferences. PAPN customers gain access only to specific applications or data that their network team allows. T-Mobile assigns a dedicated APN name with a particular IP address range for each customer. The private APN does not have direct internet access and routes traffic to the customer's premises network gateway. This option is ideal for users with sensitive information and who want to protect their devices from unfettered access, especially in cases like electric vehicle charging stations or connected cars.



How the technology works

T-Mobile offers network technologies that fit the unique needs of enterprises—regardless of size or industry—and their customers by connecting NB-IoT, Cat-M, and LTE CAT 1+ to America’s largest and fastest 5G network. With this range of network connectivity, T-Mobile Control Center can provide connection management capabilities to **fully manage underlying networks**. T-Mobile Control Center supports Voice over LTE (VoLTE) and SMS messaging services including SMS over IMS, and SMS over NAS.



Packet core

IoT traffic is served by geographically distributed and highly reliable T-Mobile packet core infrastructure. The **distributed core deployment** takes the network closer to where data is processed rather than forcing long-haul data to transport over a distributed network infrastructure.

The IoT core layer consists of EPC network elements such as Mobility Management Entity (MME), Serving Gateway (SGW), Packet Network Data Gateway (PGW), and Diameter Edge Agent (DEA). The core is **highly reliable and available with no single point of failure**, including intra and inter-site redundancy and failover and recovery of critical systems.

MMEs handle several essential tasks, including authenticating and authorizing subscribers via the HSS, and tracking registered devices on the network.

The SGWs handle numerous tasks, like routing packets between the serving eNB and the selected PGW, serving as a mobility anchor point during handover between eNBs, and replicating user-data traffic for a Lawful Intercept request. Similarly, PGWs are deployed in a distributed manner to minimize end-to-end packet delay and serve as an anchor point for network mobility and policy enforcement.

The SGWs and PGWs are strategically deployed across the network to provide carrier-class resilience and availability to ensure client communications are operational. The distributed PGW deployment across the network makes it possible to bring the network edges closer to the customer premises, enabling T-Mobile to offload the traffic at PGW sites and bring applications and computing resources closer to the customers.

Radio Access Network

The T-Mobile Radio Access Network (RAN) provides access links between the IoT devices and the Evolved Packet Core (EPC) components supporting the IoT traffic. The RAN provides a full suite of LTE and 5G NR capabilities, ranging from NB-IoT, Cat-M, and Cat 1+. This range of capabilities is tailored to all types of client applications, from very low bandwidth and battery-operated devices designed to run for many years to high-bandwidth consumption devices for activities such as video streaming.

	NB-IoT	Cat-M	Cat-1+	5G
Use Cases	Smart parking, smart metering, etc.	Fleet mgmt, regulated smart metering, wearables, etc.	Larger data volume UCs like LTE	Autonomous Driving, Robotics, VR/AR, Traffic Control
Data Volume	Kilobytes	Megabytes	Gigabytes	Gigabytes
Data Transfer	DL: max 250 kbps (avg 21 kbps) UL: max 250 kbps (avg 30 kbps)	DL: max 1 mbps (avg 375 kbps) UL: max 1 mbps (avg 300 kbps)	DL: max 10 mbps to 300 mbps UL: 5 mbps to 50 mbps (For 20 MHz channel)	DL: higher than 100 mbps UL: higher than 50 mbps (User experience)
Latency	< 10 sec	< 1 sec	< 50 msec	< 30 msec
Mobility	Cell reselection	Handover	Handover	Handover
Indoor Coverage	Maximum indoor coverage possibility (+20dB)	Very good indoor coverage possibility (+15dB)	Similar coverage possibility as GSM (+0dB)	Similar coverage possibility as GSM (+0dB)
Voice / SMS	No Voice support SMS supported	No Voice support SMS supported	VoLTE supported SMS supported	VoLTE supported SMS supported
Battery Lifetime	Up to ~ 10 years	Very long (5 years)	N/A	N/A

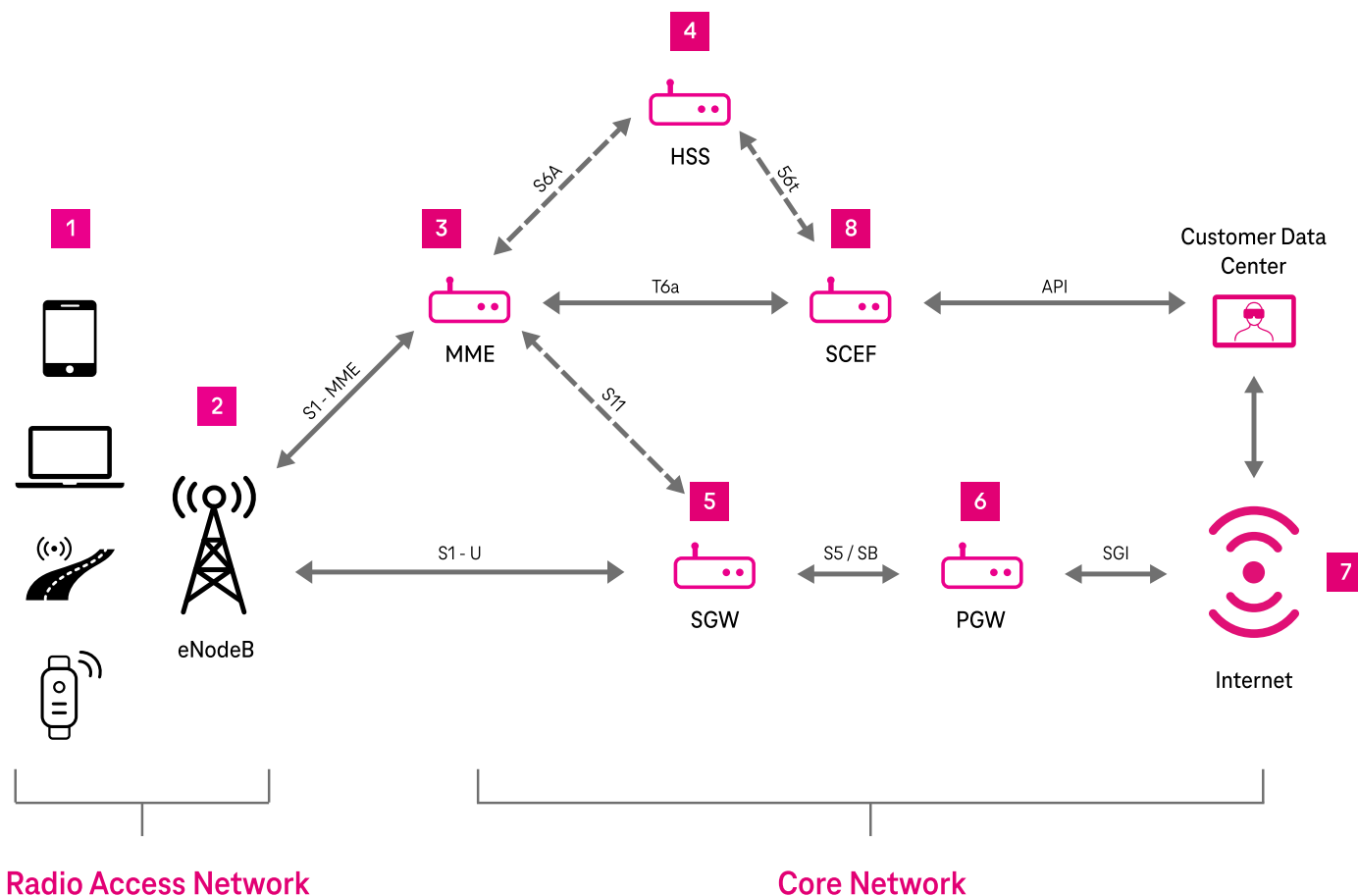
IoT call flows

After successful authentication with the Home Subscriber Server (HSS), the IoT device initiates the attach procedure and establishes the Non-Access Stratum (NAS) session. The eNB uses the PLMN to assign the IoT UE to the MME. The MME performs a domain name system query to obtain an ordered list of SGWs and PGWs based on TAC and APN information. For NB-IoT NIDD, the MME establishes the T6a interface towards the Service Capability Exposure Function (SCEF) after checking if the requested APN has the index of “Invoke SCEF Selection.”

The MME sends a Create Session Request (CSR) to a selected SGW and PGW. Upon receiving a successful CSR response, a default PDN is established between

the UE and PGW, and the UE can send and receive traffic. For NB-IoT NIDD, the MME sends a “create SCEF connection request” to the SCEF and establishes a PDN connection between the UE and the SCEF.

The NB-IoT PDN connections utilize the data packet transmission in the control plane via Non-Access Stratum (NAS). The IP-type NB-IoT PDN connections use NAS in conjunction with the S11-U interface based on the UE request during the attach procedure. In the current implementation, the non-IP type PDN traffic is only supported via T6a and SCEF.



Connectivity management platform

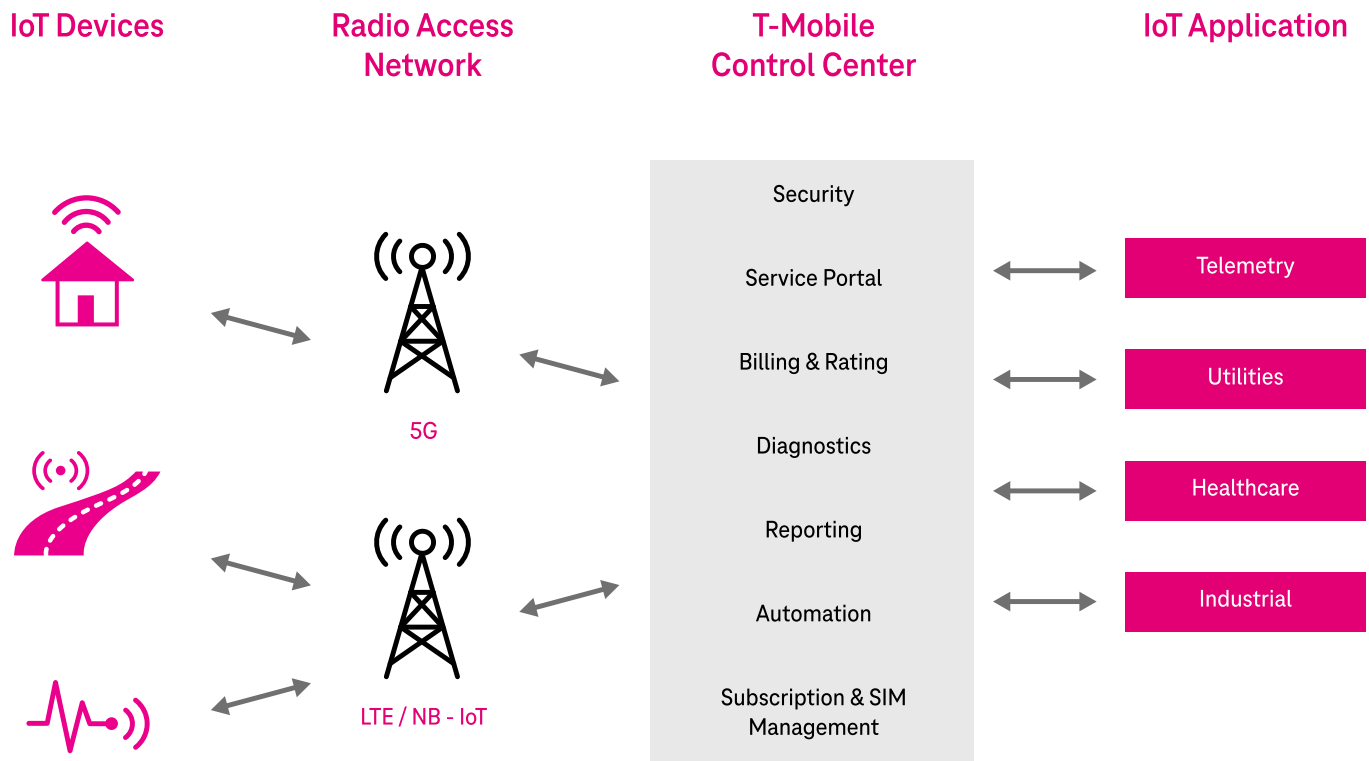
T-Mobile provides T-Mobile Control Center, a connectivity management platform based on Cisco's cloud-based platform to Enterprise, Small-Medium Business, State, Local, and Education IoT customers. This platform allows IoT customers to **analyze device connectivity**—i.e. it equips customers with diagnostic tools so they are enabled to self-provision, configure, administer, automate, and monitor data usage and billing.

Customers can manage the entire lifecycle of their IoT solution through T-Mobile Control Center. Starting with SIM ordering, zero-touch provisioning allows for **easy deployment of your IoT solution**. SIMs come in a Test Ready state, ready to connect to the network. Through automation they move to an activated/billable state. The ability to manage the SIM state can be fully automated moving a device from activated to deactivated and back again, based on your custom business requirements. Finally, when a device reaches the end of its useful life it can be retired.

The management platform diagnostics feature enables customers to analyze any device's connectivity and identify any provisioning, SIM/device, or network connection issues. T-Mobile Control Center Spotlight tool offers more advanced diagnostic features, enabling users to monitor device activity in real-time.

Spotlight allows customers to view the history and timeline of significant events and activities and view available APNs, network registrations, and session details. Additionally, customers can view their billing invoices and usage per SIM for each billing cycle via the connectivity management platform.

Automation Engine allows customers to **build custom rules** that give them the ability to go beyond just constantly monitoring service. For large-scale deployments of thousands or tens of thousands of devices, the ability to create customized rules that handle day-to-day tasks and integrate them with existing business processes is critical.



T-Mobile Control Center features

Diagnostics/spotlight:

Allows users to see what's happening with a device in real time and to analyze historical behavior. These applications are extremely valuable for troubleshooting device issues during development and in production.

Automation rules:

Allows users to trigger automated changes to SIMs when certain thresholds are met, i.e., SIM State change.

Analytics:

Allows users to view service and usage analytics such as view session details, usage per device, and average usage per device.

Standard reports:

Allows users to view billing and invoicing, subscription history (weekly/monthly subscribers, daily subscribers/activations).

Audit trails:

Shows the history log of users and changes made to subscriptions.

IMEI change detection:

The IMEI change rule allows users to act when the network returns an unexpected device IMEI value.

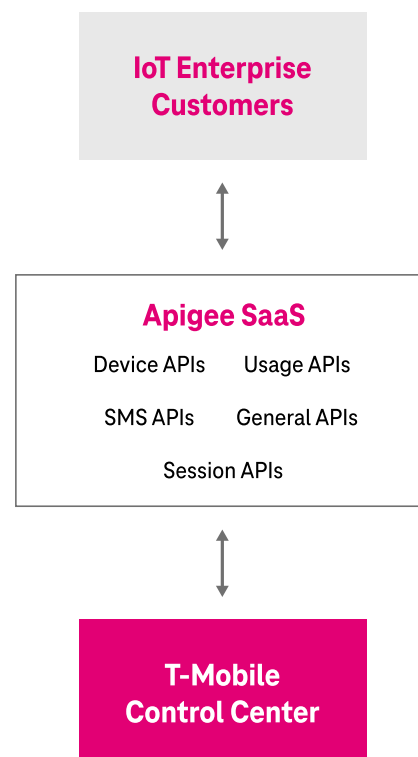
Knowledge base:

Provides comprehensive online user guide.

APIs

Security is top of mind at T-Mobile. We have developed protocols that exceed industry standards to ensure that our customers' connection and data are safe. Customers will be provided documentation on the T-Mobile API Access Process (TAAP) and APIs and will also be onboarded to the [T-Mobile developer site](#) for detailed documentation.

T-Mobile uses an Apigee API Gateway (SaaS) as an API overlay for added security. Apigee is a platform for developing and managing APIs that provides security, rate limiting, quotas, analytics, and more by fronting services with a proxy layer. Customers will be onboarded to Apigee to use T-Mobile Control Center APIs.



SIM

The **Subscriber Identity Module (SIM)** is a piece of hardware that stores the user's identity and the related security keys that are used to authenticate users on the mobile wireless network and validate the device. T-Mobile Enterprise IoT supports a portfolio of consumer and industrial-grade SIM Cards. These include traditional removable form factors such as Mini-SIM (2FF), Micro-SIM (3FF), and Nano-SIM (4FF), triple punch (2FF/3FF/4FF) as well as embedded SIM (eUICC) with the MFF2 form factor.

The long-term goal of T-Mobile is to support eSIM according to GSMA specifications for "Remote Provisioning Architecture for Embedded UICC Technical Specification," which is critical for a higher level of interoperability among operators and provisioning systems and device manufacturers.

An **eSIM (Embedded SIM)** or an **eUICC (Embedded Universal Integrated Circuit Card)** works with any operator subscription in any part of the world, supports multiple subscriptions, and can be programmed to change subscriptions, as required, with an (Over-the-Air) OTA update. The eSIM is a significant shift in managing cellular connectivity because it lets you change service providers without swapping out the SIM or having any other physical access to the device. Remote provisioning capabilities, enabled by eUICC technology, can be added to any SIM form factor (2FF, 3FF, 4FF, MFF2) and can be used in any operating environment, from automotive and industrial to consumer.



Device/module chipset certification

T-Mobile requires all new non-stock IoT Modules and IoT End Devices to complete the Network Certification process to be T-Mobile certified and approved. This process ensures IoT Modules and IoT End Devices (that are non-stocked) meet the performance criteria for T-Mobile Network Technology deployments by engaging with the T-Mobile Device Technology and Quality Assurance organization for Network Certification.

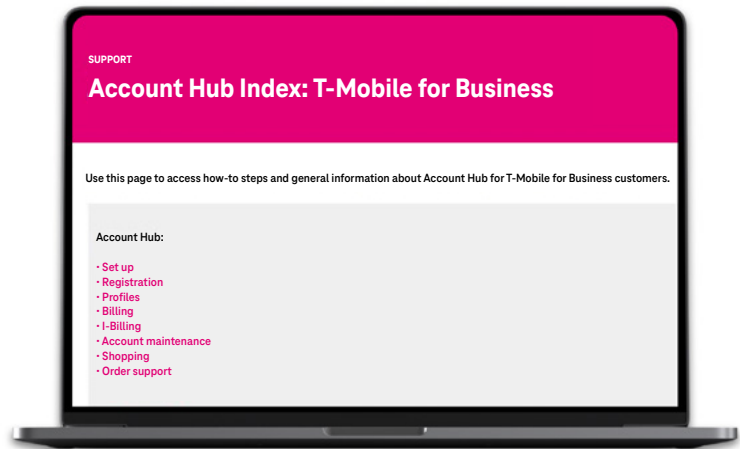
Operation support

The IoT Business Account Management (BAM) team supports the onboarding and training of IoT Enterprise customers and provides post-onboarding assistance with the connectivity, network issues, and triage of the platform.

Account Hub

The Account Hub is a customer-facing portal that allows users to order new connectivity services, manage their accounts and users, and view their traffic and billing information. IoT customers with access to T-Mobile Control Center will also have access to Account Hub.

Administrators can create roles and permissions with access levels to fit the needs of their organization.



Account Hub	T-Mobile Control Center
Dashboard View	Diagnostics
Account PIN Update	Basic SIM Lifecycle Management
IoT User Management	Rate Plan Management
SIM Ordering	Standard Enterprise Reports & Analytics
Account PIN Update	Basic SIM Lifecycle Management
Billing & Payments	Essential Automation

Inseego

T-Mobile partners with Inseego to provide state and local government customers a **regulation-compliant account management portal**. The list below summarizes Inseego portal functionalities:

- Ability to submit new activation and upgrade orders through a secure portal.
- Customized pricing per customer.
- Order status notifications via email.
- Account info (billing, billed usage, unbilled usage, etc.).
- Plan and device management (account changes, SIM changes, etc.).
- Online and downloadable reports.

Use cases

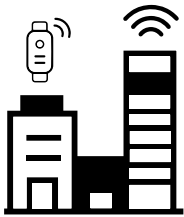
With T-Mobile Control Center, use cases range from low costs and low-power consumption to deep indoor coverage that will proliferate into numerous business implications.

Organizations can take advantage of our integrated portal, backend self-serve tools, and our accelerated launch plan to go to market quickly.

The powerful capabilities of T-Mobile Control Center provide visibility and control for organizations and their customers to **launch, scale, and manage IoT deployments of any size.**

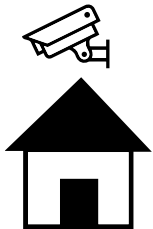
The robust T-Mobile Control Center platform offers **unprecedented flexibility** by accommodating massive to critical IoT applications across various vertical use cases. Customers can choose from multiple network service types and devices and use various billing models such as recurring, upfront annual, individual, pooled, location, or time-based. Customers can also determine how and when devices are provisioned within the device lifecycle.

Organizations can **reduce costs and prevent overages** with real-time usage monitoring, diagnostics, and self-support features that automate connectivity management and troubleshooting and reduce manual processes.



Smart cities:

Whether it's smart street lighting or complex public safety systems or anything in between, we have a platform and network optimized for IoT.



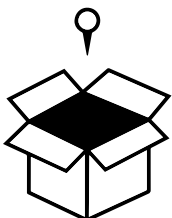
Home security and automation:

Create robust solutions for homes of the future by connecting devices, sensors, controllers, security cameras, and almost any type of device for making a home a better and safer place to live.



Fleet management:

Your customers can manage, locate, and monitor their vehicles and fleets on the T-Mobile nationwide network.



Asset tracking:

Enterprises can monitor and track assets in near-real time to improve efficiency, optimize logistics, and gain deeper insights into their operations. Customers are using the T-Mobile NB-IoT network to improve loss prevention, item-level monitoring, and cold-chain monitoring.

Coverage map

Coverage map description	URL
5G/LTE coverage	https://www.tmobile.com/coverage/coverage-map
NB coverage	https://www.t-mobile.com/business/iot/nb-iot-coverage-map



5G: Capable device required; coverage not available in some areas. Some uses may require certain plan or feature; see T-Mobile.com. Fastest based on median, overall combined 5G speeds according to analysis by Ookla® of Speedtest Intelligence® data 5G download speeds for Q4 2021. Ookla trademarks used under license and reprinted with permission. T-Mobile, the T logo, Magenta, and the magenta color are registered trademarks of Deutsche Telekom AG. © 2022 T-Mobile USA, Inc.