

GTI 5G Sky Office White Paper

The logo consists of the letters 'GTI' in a bold, white, sans-serif font, centered at the bottom of the page. The background of the entire page is a dark blue gradient with a glowing, grid-like pattern that resembles a globe or a network structure, with a bright light source in the center creating a lens flare effect.

GTI

<http://www.gtigroup.org>

GTI 5G Sky Office White Paper



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1. Executive Summary

With the growing popularity of mobile internet, users' usage habits have dramatically changed. The exploration of mobile broadband access capacity significantly stimulates the demand for mobile internet and boosts the growth in mobile data services, which provides an important network access to laptop.

Wideband connectivity by LTE unlock the Sky Office. With the embedded mobile chipset, the laptop is capable to connect the network in anywhere. LTE enables the 1st generation of Sky Office connection. Meanwhile, mobile operators provide special package (e.g. unlimited data plan) for the mobile users and mobile laptop users will not be bothered by the connection charge.

From the beginning, 5G is targeted to support more use cases than smartphone. Sky Office, which leverages 5G connection, is one of the high ranked use cases. During the 5G design, several key features are introduced to enable better support for vertical industries. We can foresee at least several of them will become the key enablers for 5G Sky Office. Network slice can provide a dedicated environment with optimized network parameters for Sky Office use cases including office editing, audio and video conference, online training. To better protect the user data, the edge computing could facilitate the local storage with operators' central management. Further, edge computing can minimize service latency and reduce laptop power consumption because the computing and application server is moved to edge server. 5G low latency connections would enable light fast exchange between server and users, and real time online cooperation will be unlocked at that time.

5G will be commercially launched at 2019 to 2020 by pioneer operators globally on smartphone, CPE and other traditional mobile devices. We could expect 5G Sky Office will come soon after the network is stable.

Laptop PCs are the product of choice for office productivity usage and – more generally - for people to contribute and create. Today these devices are providing increasingly longer battery life, enhanced security in thinner and lighter modern designs. These trends are continuing through ongoing innovation. Cellular connected laptops today already offer always-on, always-connected, seamless roaming and security benefits of avoiding public WiFi hotspots. 5G Sky Office brings the benefits of 5G data speed to these connected PCs for unprecedented convenience, productivity and cloud connectivity anywhere.

2. Abbreviations

ACPC	Always Connected PC
AP	Access Point
CPE	Customer Premise Equipment
eSIM	embedded SIM
iUICC	integration UICC

GNSS Global Navigation Satellite System
KPI Key Performance Index
LTE Long Term Evolution
MIMO Multiple Input Multiple Output
MSC Modern Standby Connected
NSA Non Standalone Access
OTA Over The Air
SA Standalone Access
SoC System on Chip

3. Introduction

This white paper provides an overview of 5G market status, focusing on laptop market and office software support. According to the observation of potential market demand, the concept and objective of sky office are given.

To further study how to support the sky office, several key issues are investigated, covering,

- Laptop architecture roadmap
- Laptop 5G embedded roadmap
- APP user management platform
- eSIM & OTA
- OS on 5G laptop
- 5G test on laptop
- Laptop power consumption

Based on the technical exploration of 5G sky office, several business model analysis is proposed for reference. Finally, to boost the industry, it's proposed to construct a sustainable ecosystem.

Sky office could serve the community and improve the efficiency by leverage the network resource and laptop. Sky office is expected to have a rapid growth in china and many other countries in the near future. In the early phase of 5G commercial deployment, except for the smart phones, multi-type terminals such as laptop is expected to be the key product.

4. 5G Market Status and Requirement

4.1 5G Multi-types terminals Progress

The cellular modem device market, which combines mobile phone and non-handset, is expected to exceed over 2.4 billion units in 2018. The non-handset cellular device is estimated to indicate 15.4% of total cellular devices in 2018 and to expand to higher market share in the future.

In 5G cellular, three types of standards are developed according to the application field.

1. Enhanced Broadband
2. Ultra-Reliable Low Latency Communication

3. Massive Machine Type Communication

According to GSMA report, 182 operators in 78 countries that have launched (limited availability or non-3GPP networks), demonstrated, are testing or trialing, or have been licensed to conduct field trials of 5G-enabling and candidate technologies (up from 154 operators in August 2018). The spread of global activity is shown in Figure 5.1.

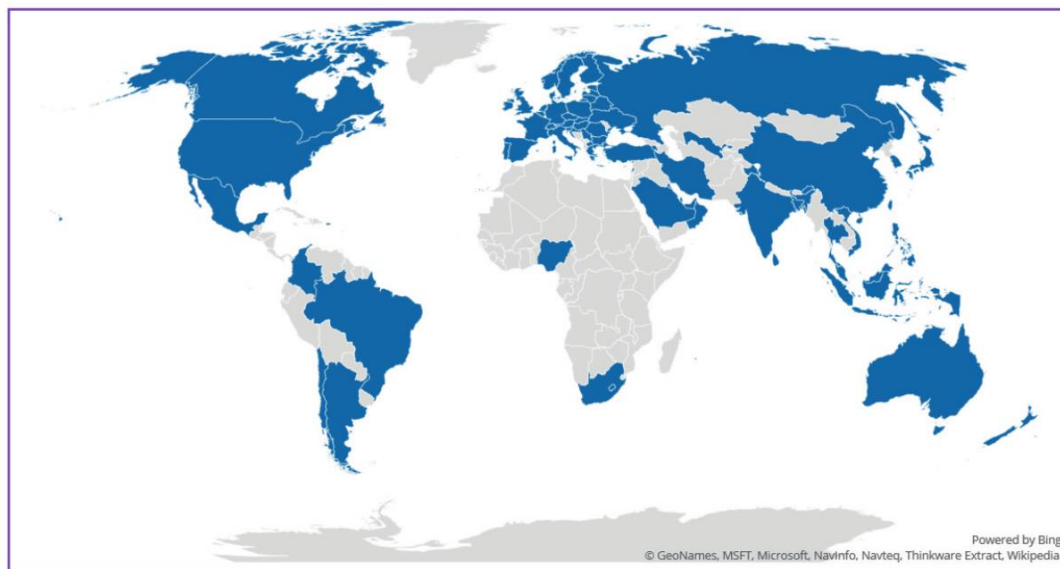


Figure 4.1 Countries with operators investing in 5G

It is expected that 5G devices will be launched in 2019. In North America, Japan and China, Korea, Europe, the transition to 5G will proceed faster than other areas. The mmWave 5G area is initially limited, and it is expected that sub-6GHz 5G will account for a high market share of the total 5G devices.

Table 4-1 The product category of laptop 5G connection

Product category	Description	Key Features
Data card (USB modem)	Cellular modem card/data dongle for PC	<ul style="list-style-type: none"> - USB, PCI interface - Connect to PC
Mobile Router	Portable mobile broadband gateway	<ul style="list-style-type: none"> - Connect to various devices through WiFi - Connect with multiple devices at same time
Cellular tablet	Modem integrated Tablet	<ul style="list-style-type: none"> - The same platform as smart phone, but different form factor
ACPC	Modem integrated Notebook PC	<ul style="list-style-type: none"> - Modem function integrated - better security, remote lock, remote wipe, etc.
Cellular CPE	Cellular based Home Broadband Gateway	<ul style="list-style-type: none"> - High data throughput - Indoor and outdoor type
Cellular Conference call device	Modem integrated conference call device	<ul style="list-style-type: none"> - Modem function integrated - better security, remote lock, etc.,

		- meeting console with touch
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- The cellular data card is the cellular modem card for the PC with USB or PCI (now the USB type is the majority) interface and tablet. Compared to mobile router, it is inexpensive but less convenient. As the low end device. There seems to be a demand for enterprise and industrial uses.
- Mobile router is often recognized by mobile hotspot, or the brand name of the vendor (MiFi , Pocket WiFi , etc.). It connects with the internet by cellular line and with terminal side by WiFi. The difference from the data card is that it can connect to WiFi devices (game machine, etc.), other than PC and tablet, and also connect to multiple terminals at the same time.
- The cellular tablet means slate-type devices of large screen size (e.g. 7.5" or above). The cellular function of tablet is aimed at data communication, and calling function is not essential.
- ACPC will have a built-in modem. The advantage of cellular built-in is that security is strong (remote lock, remote wipe, etc.). ACPC is sold mainly for enterprise in the North American, China and European market. Mobile operator's business model and subsidy strategy will heavily impact ACPC's market growth. In the past, the communication cost has posed a barrier to cellular dissemination. However, the cellular attach ratio may expand depending on the data plan and contract model of a mobile operator.
- CPE is Customer Premise Equipment. Cellular CPE is defined as the fixed broadband modem device with high data throughput modem. 5GCPE will provide much better user experience than 4G/4G.
- Cellular Conference call device will have a built-in modem, touch display console and better security and place in public occasions.

In the non-handset modem market, fixed wireless broadband (cellular CPE), industrial IoT, automotive, ACPC and wearable applications will be the driving force in the market.

In the non-handset cellular devices market, 5G is first adopted for mobile broadband and fixed broadband, then cellular tablet, ACPC and cellular CPE for fixed broadband will be the main application of 5G.

4.2 Laptop development status

In the earlier year laptop development, the Wireless LAN (a.k.a. WLAN, Wi-Fi) played the key role and provided the most services to satisfy the user cases / scenarios in the wireless communication field, for example: the internet access, file sharing peer to peer, image projection...etc.

However, as time goes by, the Wireless LAN can't fulfil the new user scenario and requirement especially for the mobility and security portion.

In the past, if users want to access internet in public area, in most of cases, they will choose the public wireless AP. However, this is a security risk because there are some known hack attacks under those APs due to most of the APs choose open security and some MITM

(man-in-the-middle) threats for the Wireless LAN handshake design limitation. Also Wireless LAN can NOT really provide the seamless connection if the end users go outside the building for outdoor activity so the PC manufacturers start to think about how to improve this.

In the recent years, PC manufacturers adopted more and more WWAN devices (a.k.a. 3G, 4G) onto the platforms to provide the seamless connection user experience and better security...etc. With ACPC, seamless 4G LTE or even 5G connections, fastest throughput ever and even can overtake WLAN (e.g. 4x4 MIMO + 4CA/5CA to have maximum gigabit class throughput via LTE, and realize user experienced gigabit class throughput and maximum dozen gigabit throughput via 5G), receiving emails / instant messages and audio/video call during system standby, DSSA (dual SIM single active) eSIM/iUICC configuration for data roaming cost saving when go abroad...etc. which can make the laptop become a real mobility device and make the sky office concept come true.

Currently, innovation in laptops is focused around the following areas:

1. Portability. Laptops give you the components of a desktop computer packed into a portable unit that you can take anywhere. Working on the move, away from the office or at a different desk is a lot more convenient when using a laptop than a desktop. However, in terms of size and weight, tablets offer even more portability than laptops. If you can live without a physical keyboard or have a Bluetooth keyboard paired and have all the apps you need to work, then a tablet device can be even more convenient than a laptop.
2. Battery life. Portability for laptops comes at a price -- Can't work forever without finding a power outlet at some point. Laptops can now boast similar battery performance to tablets, with many higher-end laptops offering a 12-hour battery life. Battery life can vary substantially depending on the specification and design of the laptop working with, but it's an essential point to consider when comparing laptops with desktops and tablets. An extended battery life is an advantage on a laptop, while a limited battery life is a definite disadvantage.
3. Connectivity activation.
 - 1) WiFi defects. In real-world applications, wireless networking is significantly slower than wired networking when transferring files over a local area network. The problem becomes even more acute if you have a busy network or if your signal strength is weaker than optimal. Public wireless APs pose a certain risk because there are some known hacking attacks under these public APs, which poses a threat to us.
 - 2) Complicated to get a SIM card and activate, and purchase subsequent data plans. Use the SIM card to connect the network, users cannot directly manage and maintain WiFi and mobile cellular networks through the device itself to more easily activate their network packets. This series of operations is more complicated and inconvenient for users.
4. Data plan purchase. if not activate the network, working outside is like an island and cannot communicate with the outside world. The broadband traffic generated by surfing the Internet through a laptop is much larger than that of a phone. Downloading applications, logging in to the web, browsing videos, games, etc. The high-traffic package costs are unbearable for users. Users prefer to look for WiFi hotspots and are reluctant to purchase data traffic via a SIM card configured by the machine, which makes this feature not widely accepted by users.

5. Connection speed and service latency. The current cellular network speed can only meet the basic use cases in professional scenarios. Still far away from the needs on live video meeting, cloud storage and access, collaboration, etc. In the future, we should download movies or office should have faster speed.
6. Wake time. The laptop that has been idle for some time, either left on a desk at work during lunch or picked back up after an overnight rest, should be able to turn on the display and accept user input the moment a keyboard button is pressed or a wake button on the device is pushed. Most modern machines default to entering a sleep state after a small amount of time (in the 30-90minute range) and then a deeper state of hibernation after a couple of hours. This allows current architectures to save valuable battery during extended periods of non-use. As a result, it can take from 20-60 seconds for the machine to become responsive for authentication or user input, depending on the hardware configuration, memory capacity, and storage devices in use. Always Connected PCs do not hibernate; instead, they just turn on instantly even after hours of being on standby.

4.3 US carriers Sky Office Status

US carrier Verizon is offering \$45 monthly business unlimited 4G LTE with 2-year contract to business owner who has a connected device such as one of ACPC laptops. In its 2Q 2018 annual report, Verizon noted that their retail postpaid connections per account increased 2.3% as of June 30, 2018 compared to June 30, 2017. The increase is primarily due to an increase in Internet devices, including tablets and other connected devices, which represented 19% of its 111 million retail postpaid connection base as of June 30, 2018 compared to 18% as of June 30, 2017. The increase in Internet devices is primarily driven by other connected devices, primarily wearables. According to Sprint 2Q 2018 financial report, the total connected device subscribers is 13.39 million by June 30, 2018, which is 1.5% increase compared to June 30, 2017. The connected device represents 24.5% of total wireless subscribers.

US Carrier AT&T reported in its 2Q 2018 financial that at June 30, 2018, they served 57.7 million subscribers, an increase of 25.0% from the prior year. Connected devices increased 29.0% from the prior year. Connected devices include the connected car business and other data centric devices that connect to the network and rely on embedded computing systems and/or software, commonly known as IoT.

US Carrier T-Mobile reported in its 2Q 2018 financial that at June 30, 2018, they served 40 million branded postpaid subscribers, an increase of 11% from the prior year. Connected devices increased 32% from the prior year, primarily from the Apple Watch.

The overall US cellular market shows a continuous growth in the connected device segment from all four major carriers. Apple Watch and other IoT devices are the driving force behind this growth. Even though their financial reports do not separate ACPC line item out, we could foresee more and more connected devices, including ACPC, would be sold if they are designed and marketed properly.

4.4 Sky Office Software dev status

All software, including the OS, requires regular upgrades and updates. Most data require sync

between the PC and the cloud. The 5G path bridges apps and services in no time as long as we have up-to-date 5G device firmware/driver and 5G network. People can work anywhere and ACPC is one choice of device to achieve that. Users can sync emails, update calendars, create and consume documents and information, real-time collaborate with many users, and do more from any location and on any ACPC device. In the sky office environment, there are next to no limits on how, where, when, and with whom work is done whenever the 5G path is presented.

All below chapter are discussed take Windows as an example; but Sky office not limited to Microsoft windows OS; all other suitable OS or software should be considered;

From first generation of ACPC, we spot that Microsoft Windows 10 is the dominated OS pre-installed. The cloud-based Microsoft Office 365 is available to be bought and downloaded from the Microsoft Store app, in addition to the free app such as Mail, Messaging, Microsoft Edge, OneDrive and other productivity Apps. On the other hand, Google is not slowing down its own office platform development. One app at a time, starting with Gmail, Chat, Calendars, Spreadsheets, Docs, Presentations, Drive, and Sites, Google Apps suite is continuously expanding.

Office 365 is a line of subscription services offered by Microsoft, as part of the Microsoft Office product line. The brand encompasses plans that allow use of the Microsoft Office software suite over the life of the subscription, as well as cloud-based software as a service products for business environments, such as hosted Exchange Server, Skype for Business Server, and SharePoint among others. All Office 365 plans include automatic updates to their respective software at no additional charge, as opposed to conventional licenses for these programs—where new versions require purchase of a new license. Microsoft 365 is an intelligent solution that is a productivity software suite for business users, SMB and business users, and educators. Enable everyone to work collaboratively, creatively, and safely.

Outlook

The email service, task management, calendar application, and contacts manager included with business and enterprise Office 365 subscriptions are under the Outlook on the web brand. It includes Outlook Mail, Outlook Calendar, Outlook People, and Outlook Tasks.

Microsoft introduced an email feature called Clutter with Office 365. Clutter remembers user's preferences as it comes to the relevance and importance of emails. It analyses user's pattern of behavior about email topics, if user keeps ignoring emails about a certain topic, Clutter moves those emails to a folder with the same name in Outlook. Users can enable and disable this feature by logging on to Office 365 portal.

Hosted services

Business and enterprise-oriented plans for Office 365 offer access to cloud-hosted versions of Office's server platforms on a software as a service basis, including Exchange, Skype for Business, SharePoint, and the browser-based Office Web Apps suite. Through SharePoint's OneDrive for Business functionality (formerly known as SharePoint My Sites and SkyDrive Pro, and distinct from the consumer-oriented OneDrive service), each user also receives 1 TB of online storage. Certain plans also include unlimited personal cloud storage per user.

In lieu of Microsoft's enterprise software, Home plans for Office 365 include premium enhancements for Microsoft's consumer-level online services, including 1 terabyte of OneDrive storage for each user, along with 60 minutes of phone calls per month on the

Microsoft-owned Skype VoIP service.

Office applications

Some plans for Office 365 also include access to the current versions of the Office desktop applications for both Windows (Office 2016) and OS X (Office for Mac 2016) for the period of the subscription. In the case of Office 2016 on Windows, it is installed using a "click-to-run" system which allows users to begin using the applications almost instantaneously while files are streamed in the background. Updates to the software are installed automatically, covering both security updates and major new versions of Office. If an Office 365 subscription lapses, the applications enter a read-only mode where editing functionality is disabled. Full functionality is restored once a new subscription is purchased and activated.

Access to the Office Mobile apps for Android and iOS devices (including both smartphones and tablets) were originally limited to Office 365 subscribers but basic editing and document creation has since been made free for personal use. However, Office 365 is still required to unlock certain advanced editing features, use the apps on devices with screens larger than 10.1 inches, or to use the apps for business use. Outlook Groups was also made available as an app on Windows 10 Mobile.

Collaboration tools

Office 365 includes several productivity applications that are designed to cover collaboration needs at the organizational, departmental and team levels. Currently, the list of collaboration tools includes OneDrive for Business, SharePoint Online, Microsoft Teams, Yammer, Skype for Business, Outlook Online and Delve boards. The wide choice of tools is the source of ongoing debates about the purpose of each tool and their optimal application in real business life. There are several approaches to defining the role of Office 365 collaboration tools in an organization. Key aspects that influence the choice of a certain tool are particular communication needs, team size, project specifics, as well as employees' preferences. According to the use case approach, each collaboration tool suits a particular collaboration scenario. SharePoint Online often serves as a platform for corporate intranets and portals the same way as SharePoint On-Premises does. At the same time, SharePoint Online comes not only with team sites but also with communication sites and hub sites (Office 365 First Release customers will be able to try them out in the first half of 2018). Microsoft Teams enable collaboration channels for public or private communication, as well as voice and video conferences. Outlook Online hosts email-based collaboration. Yammer serves for communication with business users outside of an organization and enables forum-like enterprise-wide and team communication. Skype for Business supports instant messaging, VoIP, audio, video and web conferencing. As for Delve boards, they allow creating boards to group together and share related documents. Additionally, there are Office 365 Groups that represent rather a technological capability within the suite than a tool apart. Office 365 Groups allow creating separate collaboration spaces in other Office 365 tools. An Office 365 Group can be organized in Outlook, SharePoint Online, Yammer, Microsoft Teams and other collaboration tools to diversify the native collaboration capabilities of these applications. For example, if a team collaborates in a Group in Yammer, its members automatically get a team calendar, a shared Outlook inbox, a Shared Point library, a Shared Point team site, a shared OneNote notebook and Planner.

Updates

The Office 365 platform uses a rolling release model; updates to the online components of the

service are provided once per quarter. On launch, the 2010 versions of server components were used with Office 365. These services were automatically upgraded to their Office 2013 counterparts upon its release in February 2013. With the introduction of Office 2013, Office division head Kurt DelBene stated that minor and incremental updates to the Office desktop software would be provided on a similarly periodic basis to all Office 365 users by means of the streaming system, as opposed to the three-year cycle for major releases of Office that had been used in the past.

Office 365 Education

Empower educators to unlock creativity, promote teamwork, and provide experience in a single, affordable solution built for education.

1. Everything needed to get started

A new Microsoft 365 Education device license includes Windows, Intune for Education, and Office 365 Education.

2. Unlock creativity in each student

Spark creativity, collaboration, and problem solving with immersive and engaging apps. Bring ideas to life in 3D and data visualization tools.

3. Promote teamwork

Collaborate and save educators time with a single hub for classes and teams. Connect with others and co-author in real time. Meet the needs of individual students with a universal toolkit to connect, share and communicate in class and out.

Microsoft 365 Enterprise

Microsoft 365 brings together Office 365, Windows 10, and Enterprise Mobility + Security. It delivers a solution to empower employees to be creative and work together, securely. Use AI-powered tools to create high-quality content that stands out, from impressive slides to animated 3D models and immersive mixed reality experiences. Turn an ever-growing mass of data into actionable insights to transform organization. Find people and access the required information without leaving the flow of work. Work naturally across devices. Go from thought to content effortlessly on any device through more natural ways of working with voice, touch and pen. Stay connected and organized on the go. Connect and collaborate wherever go. Outlook for iOS and Android brings email, calendar, contacts and documents securely together, so can share files, coordinate schedules and book meetings.

Synergy Research Group recently took a look at the cloud market share for the first quarter of 2018 and found that revenues had outpaced those of the same year-ago quarter by a significant margin, 51%. Cloud infrastructure describes services typically used by businesses to run IT workloads in the cloud, namely infrastructure as a service (IaaS), platform as a service (PaaS) and hosted private cloud. In total, the market research firm estimated that sales are nearing \$15 billion per quarter. Among public cloud providers, the top five took nearly three quarters of the market.

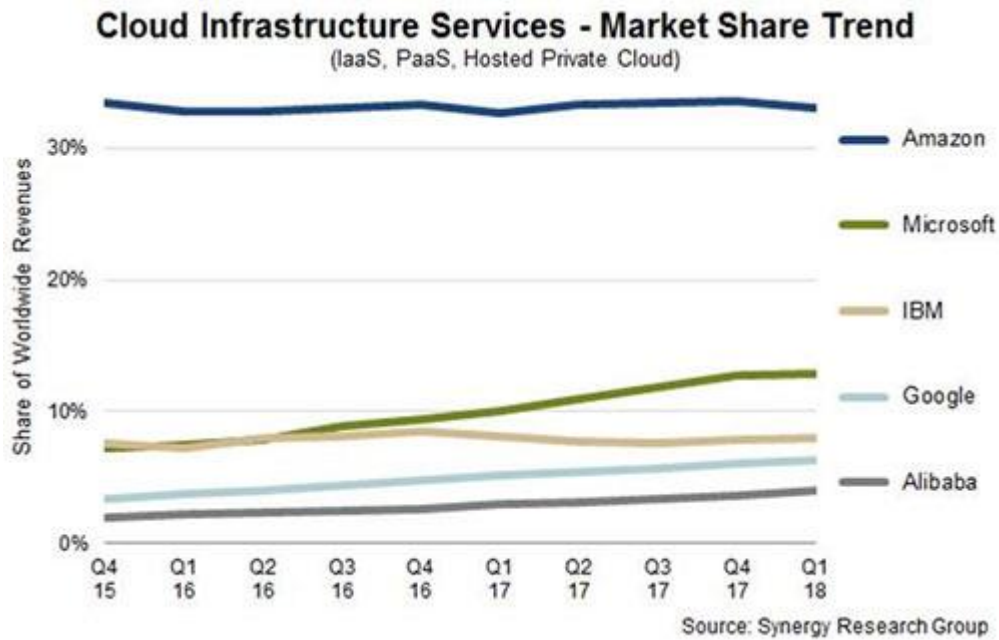


Figure 4.4 Cloud Service Provider Market Share

Amazon Web Services dominates with the largest cloud market share. AWS alone commanded 33 percent of the market during the first quarter of 2018. Amazon generated over \$5.4 billion in cloud sales during the period, a 49 percent over-over-year. Microsoft Azure took second place, with 13 percent of the market, according to Synergy's data.

Gartner recently forecast that sales of worldwide public cloud services will surpass \$186 billion in 2018 compared to \$153.5 billion last year. In 2021, that figure is expected to nearly double to a whopping \$302.5 billion. With the booming cloud services over the next few years, this could spell good news for the 5G ACPC and the 5G network.

Microsoft Azure

Microsoft Azure is an open, flexible, enterprise-grade cloud computing platform. The advantages of Microsoft Azure is as below:

1. Productive

Use any tool, language, or framework. Quickly turn ideas into solutions to get up and running fast—just bring your code. Work with best-in-class development tools for PC or Mac to increase your productivity. Get mobile apps into the hands of users faster by streamlining the mobile development lifecycle with Visual Studio App Center.

Choose from more than 100 services. Engage users in richer ways by building native mobile apps, responsive web apps, or next-generation experiences like bots and mixed reality. Quickly solve the toughest challenges and get your app up and running with minimal effort through seamless integration with the Visual Studio family of tools and more than 100 turn-key Azure services.

Manage apps, services, and resources faster. Manage applications no matter how large or complex. Use the management tools you feel most comfortable with, including the Azure portal, Power Shell, BASH, or REST APIs.

Accelerate application delivery with DevOps and agile practices .Focus on your app, iterate

quickly, and deliver software faster with an end-to-end cloud development platform that has DevOps built in.

2. Hybrid

Build solutions on the platform that's hybrid by design. Create a truly consistent experience across your hybrid cloud using comprehensive Azure cloud capabilities. Reduce complexity and risk with the platform, tools, and services designed to work together across your on-premises and cloud environments. Build and deploy your applications consistently, seamlessly manage data, enable anywhere access with single sign-on, and deliver integrated security and management across on-premises and the cloud.

Develop modern apps across hybrid environments. Provide cloud capabilities to on-premises infrastructure by running Azure services in your datacenter to build, test, and deploy applications the same way anywhere across your hybrid environment. Address latency and connectivity requirements for edge and disconnected solutions. Develop applications once and deploy in Azure or on-premises to meet regulatory and policy requirements. Update and extend legacy applications with modern Azure services on-premises.

Unify your DevOps. Use Azure DevOps to enable agile development and consistent software delivery across your hybrid cloud by adopting the same continuous integration and continuous delivery pipeline between on-premises and the cloud.

Seamlessly distribute, manage, and analyze data. Manage your data and analytics consistently across your on-premises environment and the cloud, whether your data is stored in SQL Server, MySQL, PostgreSQL, or NoSQL. With Azure SQL Database Managed Instance, easily move your SQL workloads to the cloud and back again—with no code changes—regardless of what SQL database management system you're currently running. Azure services like Azure Data Factory enable new cloud analytics scenarios while maintaining data in your existing on-premises environments.

One identity, access anywhere. Connect your on-premises Active Directory solutions to the cloud with Azure Active Directory and have one identity and access management strategy across your hybrid environment.

Integrate security and management. Monitor, secure, and manage your hybrid cloud with the broadest built-in security and management capabilities. Get a unified view of security for all your workloads across on-premises, Azure, and other clouds, in one Azure Security Center dashboard. With Azure Monitor, collect and analyze data to enable proactive insights and troubleshooting through a common view. Easily integrate alerts from System Center Operations Manager into Azure services.

3. Intelligent

Develop breakthrough apps with built-in intelligence. Take advantage of a comprehensive set of services, infrastructure, and tools to build AI-powered experiences. Build bots that naturally interact with users and built-in advanced analytics tools to make faster predictions.

Build and deploy custom AI models at scale. Work across teams to build, test, and manage different versions of your models in production with Azure Data bricks and Azure Machine Learning.

Expand your possibilities with an open platform. Use your existing skills and the tools you love to build any application—using any data source, operating system, and device. Azure supports a range of deployment options, popular stacks and languages, and a comprehensive set of data

engines, such as PostgreSQL, MySQL, MongoDB, Hadoop, and Apache Spark.

4. Trusted

More certifications than any other cloud provider. Microsoft leads the industry in establishing clear security and privacy requirements and then consistently meeting these requirements. Azure meets a broad set of international and industry-specific compliance standards, as well as country-specific standards. Rigorous third-party audits verify Azure's adherence to the strict security controls these standards mandate.

Strengthen your security posture with Azure. Azure protects business assets while reducing security costs and complexity. Built-in security controls and intelligence help you easily identify and respond to threats and security gaps, allowing your organization to rapidly improve your security posture.

Citrix on Azure

Citrix Virtual Desktops Essentials Service is the name of the new Citrix Cloud service designed specifically for managing and delivering Windows 10 Enterprise virtual desktops on Azure. This new service harnesses the power of Citrix Virtual Apps and Desktops to simplify Windows 10 Enterprise migration, expedite Windows 10 Enterprise on Azure deployment and streamline on-going management at-scale while delivering a rich user experience. Citrix Virtual Desktops Essentials will be available exclusively in the Azure Marketplace giving Citrix and Microsoft customers a single transactional interface to manage the new Citrix Cloud service and Azure infrastructure side-by-side.

Citrix Virtual Desktops Essentials Service includes all the respective Citrix Virtual Apps and Desktops management components (Citrix Studio, Director, Delivery Controller, and SQL Server) and the underlying Microsoft Operating System and Azure infrastructure for those components. Citrix Virtual Desktops Essentials Service also includes 1GB of Citrix Gateway Service data transfer per user per month. By providing instant access to all the core Citrix Virtual Apps and Desktops management components, users can quickly provision and manage hundreds or thousands of Windows 10 Enterprise virtual desktops from Azure.

5. 5G Sky Office Concept and Objective

5.1 5G Sky Office concept: 5G Laptop +5G Network+ Cloud service

The concept of 5G Sky Office system is shown in figure 5.1. The system consists of laptops, network and cloud. In aspect of networks, network slicing will provide customized logical service to ensure the communication and safety for the online office if need.

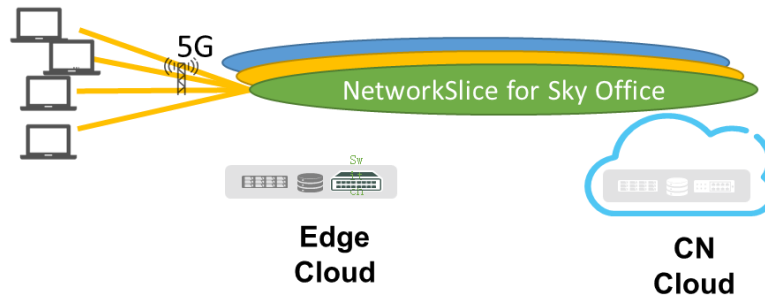


Figure 5.1 The Concept of 5G Sky Office

The Sky Office system applies the framework structure of cloud-network-terminal. The terminal includes chipsets, laptops with antennas, as is shown in figure 5.2. Two alternatives to integrate the 5G chipset into the Sky Office laptop is CoB (Chip on-Board) or separate 5G modules. Either of them can enable the 5G connection to the cloud for computing and storage, which is expected to be more power consumption efficient, and with higher transmission data rate in both DL and UL.

Laptop + 5G Module + Software + Cloud

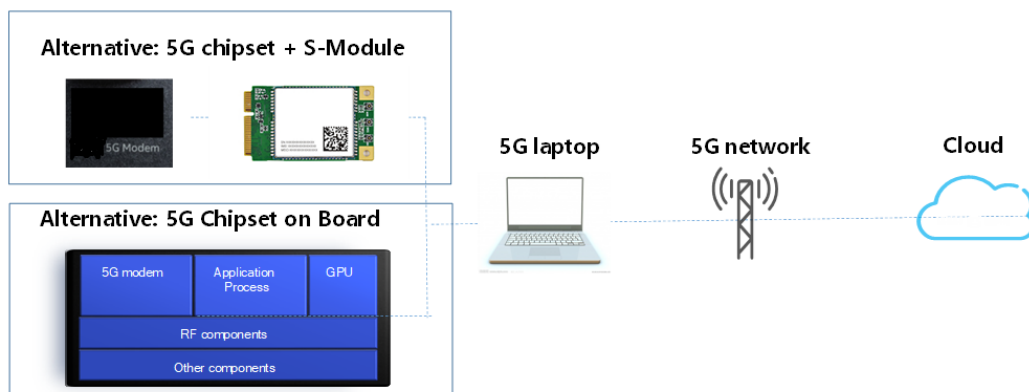


Figure 5.2 the Frame Structure of Sky Office

5G Sky Office requires an eco-system, which needs operators, chipset vendors, e-SIM vendors, OEM vendors, software vendors and module vendors. The work of participants is suggested below.

Operators:

- Setting up the platform for cooperation
- Discussing technical issues such as network slice and S-module for the system
- Evaluating the telecommunication performance of the 5G laptop
- Developing subscriber management system
- Facilitating the devices for the business & service demonstration/ friendly user test

Chipset Vendors:

- Providing the 5G chipsets or SoC solution for OEM vendors as required, etc.
- Preparing the firmware which is required for the hardware and software

Module Vendors:

- Providing the 5G Modules as required, etc.

e-SIM Vendors:

- Providing the e-SIM as required, etc.

OEM Vendors:

- Providing the 5G laptop/ 2-in- 1s as required, etc.

Software & Cloud Vendors:

- Providing the office OS and software and cloud service as required, etc.

5.2 Objective of Sky Office:

The features of 5G such as high data rate, low latency, safety will bring an opportunity for innovation of office. AT the same time, 5G makes it possible to office anytime, anywhere, e.g. keep online on the high speed train with the 350-500km/h speed. Laptops with 5G modules will synchronize with cloud, and achieve some user cases such as file management in cloud, cloud coordination, remote HD meetings, upgrading normal PC + high end display to work station and so on. The application scenarios are shown in Figure 5.3.



Figure 5.3 the Application Scenarios

Also, unlimited data plan from the operators will become the main trend to stimulate the usage of 5G laptop.

The objectives of Sky Office are shown as below.

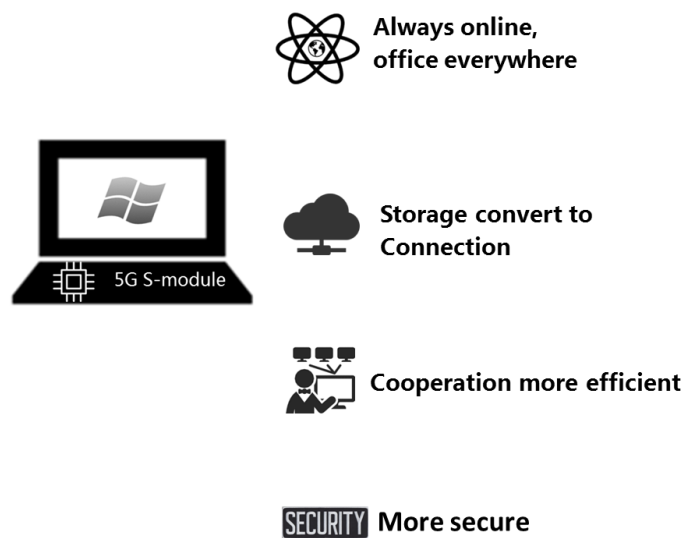


Figure 5.4 the Objective of Sky Office

6. Technical Exploration for 5G Sky Office

6.1 Laptop architecture Roadmap

Laptop is most and foremost an office productivity system which requires uncompromised performance with the ability to run software application without a compatibility concern. Users should not even to think about whether a particular software can be ran on a given laptop as long as it is a windows based software regardless when the software was published. The laptop should also support wide range of peripherals, such as monitor, keyboard, mouse, docking solutions, USB sticks, SD cards, USB hubs, etc. regardless of the brand and model of those peripherals.

Laptop manufacture should offer a wide range of products with different performance and configuration along with different price point to satisfy the nature of different work demand. The product line up should include different type of CPU which provides different processing performance level, different size of memory, different type or size of storage, different screen size and resolution, etc.; backward compatibility is also an import aspect to address since there are so many mature software products on the market, especially for general IT management tools and Domain service related security & management tools.

If enterprises have managed laptop solution needs, the laptop offers should include commercial level security solution to ensure the system within the company network is remote manageable to push necessary patches, updates and to ensure the laptop can be securely locked and erased to protect company's assets.

Given connectivity is a must to have requirement to support modern workplace, all laptops should include WIFI, optionally to support WWAN and Ethernet LAN.

The thinner and lighter as the trend of the laptop, it will let users more easily hand carry with better mobility; with this trend; go to network everywhere will be as mandatory requirement, then LTE and 5G will take more flexible for users and change their life;

At the same time thinner and lighter laptop will also take some design challenge, like much more difficult to design long battery life, much more difficult for thermal design, with higher performance; today, we have kinds of architectures in the market, typically like X86 architecture; also has some ARM with windows architecture.

6.2 Laptop 5G embedded Module Roadmap

With the development of communication industry, more and more WWAN function implement on PC, especially when 5G coming; and more and more communication types introduced on PC with 5G higher data rate and low latency and massive IOT APP; so, below content will state some general 5G embedded module requirement on 5G. Since 5G module has very high speed, it will be suitable for PC and laptop sky office application.

6.2.1 Location ability

PC WWAN network data transfer can be met by 5G NR, LTE, 3G, but still it needs navigation function to fit into thinner and lighter PC ; so GNSS features are mandatory for PC; since PC also needs to be integrated into 5G embedded module; generally 5G modules for PC will support GNSS and fulfill this requirement.

6.2.2 Network architecture requirement for 5G

5G NR has two network architectures: NSA (Non-stand-alone), SA (Stand-alone); 5G embedded module should support operators both NSA and SA network to make sure 5G and 4G network switch smoothly; especially when 5G early transition stage from 4G; Further 5G embedded should follow operators' popular network architecture; Below are current progress of network architecture;

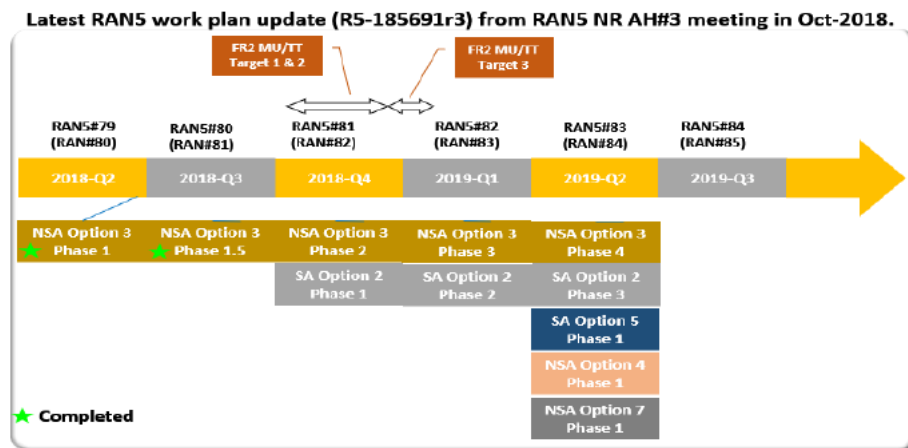


Figure 6.1 The Objective of Sky Office

WWAN modules are standardized according to the latest M.2 standard. This standard defines the module's dimensions and the electrical pin/signal definition follow the PCI SIG standard (PCIe M.2 specification rev 1.1). M.2 modules offer benefits in terms of interoperability, supply chain flexibility, also optimizing certification/type approval efforts and OEM portfolio level product development investments.

	Connector Key	Type	Add-in Card Height Options	Module Key	
Socket	2	B, C	3042	S1, D1, S3, D3, D4	B, C
WWAN/Other		B, C	2242	S1, D1, S3, D3, D4	B, C

The LGA modules are soldered on the board and are another option. These modules are not standardized in terms of dimensions and electrical connections and will vary from vendor to vendor.

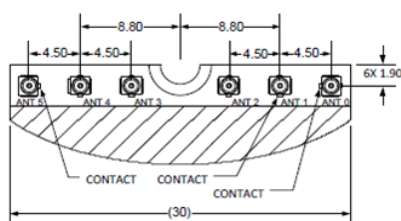
6.2.3 Antenna Design

5G embedded module has specify antenna ports for RF performance enhancement;

Need follow PCI SIG Spec;

In this chapter we define expectation of antenna ports on 5G M.2 module;

It's better LTE and Sub6G share the same antenna port with 4 ports; please see pictures below:



Antenna	Interface
0	WWAN Main
1	TBD
2	WWAN MIMO 1/ GNSS L5
3	WWAN MIMO 2
4	TBD
5	WWAN Aux/ GNSS L1

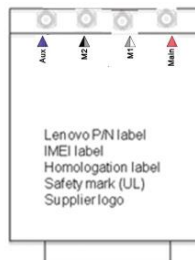


Figure 6.2 antenna connector

The antenna could be connected to the module by RF seat and RF connector cable,

Here we will also describe 5G NR mmWave interface generally.

Mm Wave RF Array(including RF components and Antenna Array) should be easy connect to the 5G M.2 module or CoB; cable is recommend;

Mm Wave RF Array(including RF components and Antenna Array) power supply/signal control recommend come from 5G module or CoB;

Mm Wave RF Array(including RF components and Antenna Array) max power consumption should be as lower as possible.

6.2.4 How the 5G module and PC connect to each other

For the connection of the PC and the 5G module, the LGA module will be soldered to the motherboard directly, while the M.2 module could be inserted into the laptop motherboard, via the matching board to board connector.

For the connection of antenna and SIM card to the module:

SIM card could be mounted to the motherboard, it could be set into the SIM slot, or we could do eSIM for Sky office application.

6.2.5 Temperature and Humidity requirement

This is a general requirement for both LGA and M.2 5G modules for the laptop and PC.

Below are recommend condition:

State support for relative humidity:

- Operating: 8% to 95%,

maximum wet-bulb temperature : 23°C (73°F)

- Storage: 5% to 95%

maximum wet-bulb temperature : 27°C (81°F)

State operating temperature range specification (-25 deg C - +75 deg C)

Below are minimum requirement;

Normal Operating Temperature:	-10°C ~+55°C (M.2 standard)
Extension Operating Temperature:	-20°C ~+70°C
Storage Temperature:	-40°C ~+85°C

Table 6-1 Operating Temperature

The 5G module power consumption will be bigger than LTE module. We recommend to have heat dissipation holes as in the following figure to avoid module overheating in the 5G network.

6.3 APP User log in Interface Management

At present, there is no unified application and service on the laptop for identity authentication, data traffic purchase, payment and inquiry, so we need a unified user management platform. The client-side application of this platform should be pre-installed in the laptop/desktop computer, responsible for managing the connection between user terminal and platform server. The platform must be tested and certified to ensure compatibility and stability.

The connection management platform should have the following basic capabilities:

- 1) User authentication
- 2) Support users to select different online data package products
- 3) Support online payment
- 4) User purchase history browsing
- 5) Traffic usage check
- 6) Multi-APN management (requires Modem to support multiple PDPs)

7) Support future function expansion

Identity management is a core component of any complete security solution. Whether through a native identity and access management (IAM) solution or integration with existing IAM infrastructure, solution must facilitate secure authentication across all cloud apps. This includes simple provisioning of accounts, a streamlined user experience with single sign-on. Multi-factor authentication, for example, requires a user's password and access to a physical token in order to allow a login. The solution needs to recognize the ACPC device as new device and take user through additional authentication steps in order to validate user identity and enable productive mobile work environment.

Below are the typically and an example from windows presentative; but this chapter not only limited to Windows APP example:

Connection Management Application

Mobile Plans is the program in Windows 10, version 1803 and later that enables mobile operators (MOs) and other service providers to sell plans to end users.

Some Windows 10 PCs come with an embedded SIM (eSIM). With an eSIM, end users can get online using cellular data whenever they have a cellular signal—just like they can with their mobile phone.

If the PC has an eSIM, end users might be able to add the device to their current mobile account by using the Mobile Plans app in Windows 10. This lets users manage their mobile devices and bill from one place, and they don't need to get a SIM card from the mobile operator. If the mobile operator doesn't offer plans through the Mobile Plans app, users can sign up with a new mobile operator through the app to buy a plan and get connected in more places.

If the PC doesn't have an eSIM, end users can still use the Mobile Plans app if they have a SIM card from a supported mobile operator.

The Mobile Plans app helps users add their PC to a new or existing mobile operator account. After doing this, users can get online with cellular data on the PC. They can pay for cellular data using the same mobile account and bill they have today.

If the current mobile operator isn't found or doesn't offer plans in current area, users can sign up with a new mobile operator. When they do this, they'll get a new mobile account with that mobile operator.

Mobile Plans enables end users to perform the following:

- Install and activate an eSIM profile.
- Activate a device on a mobile operator subscription with either prepaid (PAYG) or postpaid plans.

- Top up prepaid subscriptions when out of data and the only connectivity available is mobile connectivity.

Depending upon the detailed implementation of the mobile operator, data package payment can be made through multiple ways such as Credit cards, PayPal, Alipay and WeChat pay.

Once the mobile operator has implemented their Mobile Plans integration working with Microsoft, after the user inserts a physical SIM issue by the operator, or an esim with profile downloaded, data balance can be shown in real time in the network flyout to easily tell users how much data is still left, and when the data plan will expire.

The network flyout contains the following elements:

1. Connect with a data plan
This launches the Mobile Plans app.
2. View my account
Behaves based on the Windows COSA configuration
3. Balance information
Shows the balance available.

The following image shows these network flyout elements. Connect with a data plan corresponds with A, View my account corresponds with B, and Balance information corresponds with C.

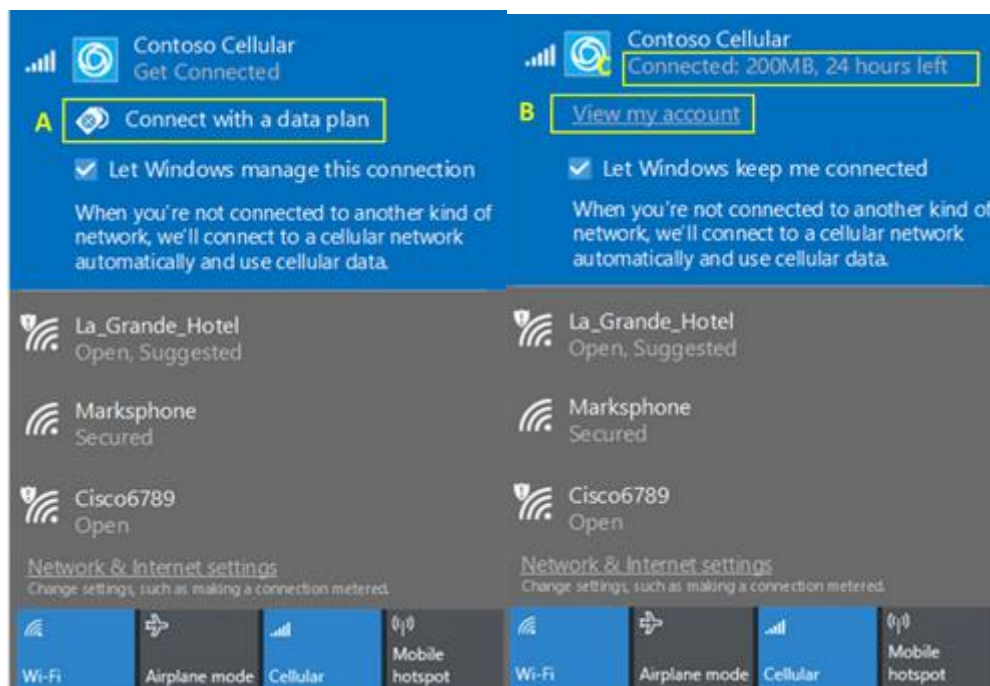


Figure 6.3 Multiple PDP Context Management

A Packet Data Protocol (PDP) context offers a packet data connection over which a device and the mobile network can exchange IP packets. As per 3GPP standards, a device can have more than one PDP context activated at a time. In Windows 8.1 and Windows 10, multiple PDP contexts are supported and enables apps to communicate over special PDP contexts to the mobile networks along with the internet PDP context that was supported in Windows 8. Developers can use this feature to create differentiated experiences and innovative services on Windows. Developers can also partner with app developers to develop great quality VOIP and video streaming experiences for their customers.

Here's a figure that shows how multiple PDP context works in Windows 8.1 and Windows 10:

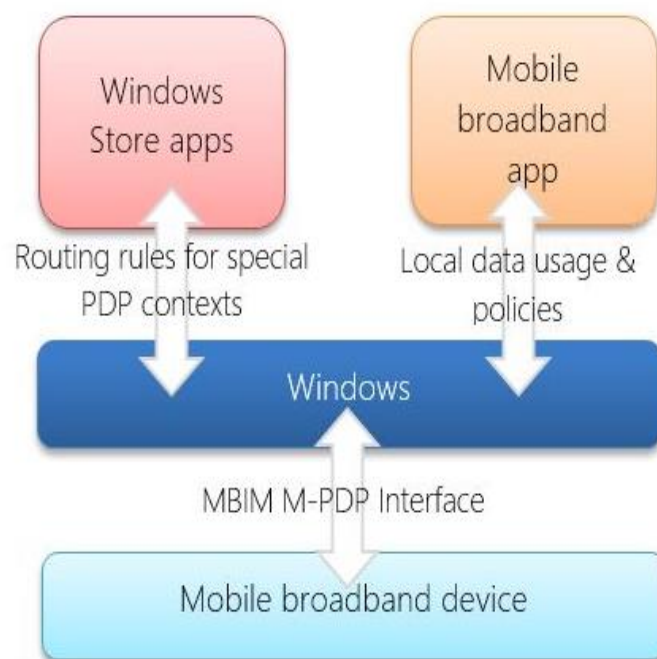


Figure 6.4 how multiple PDP context works in Windows 8.1 and Windows 10

6.4 eSIM& OTA for SIM

6.4.1 Why eSIM

eSIM is a global specification by the GSMA which enables remote SIM provisioning of any mobile device. eSIM can provides Many benefits .also, IUICC maybe further products possibility; same function as eSIM; below chapter description also apply for iUICC;

- **For the device end user**, eSIM enables simplified management of subscriptions and connections. End users will no longer have to manage several SIM cards.
- **For organizations**, eSIM enables remote management of subscriptions. This is a significant benefit where devices are not managed by the end user or are not be readily accessible (for example due to operational scale, making individual device management cost prohibitive).

This enables pioneering categories of connected devices:

- **For distributors**, simplified logistics are possible, customization for specific operators or regions may be reduced:
- **Operators** will have simpler means to expand their businesses into emerging markets, for example, automotive, wearables and consumer electronics. SIM card distribution costs will be eliminated, and eSIMs will enable new distribution models for devices and for marketing of subscriptions:
- **Device Manufacturers**, can exploit the reduced space within their products to make smaller devices. Their products could also be made more tolerant to environmental factors such as dampness, temperature and vibration as they can be hermetically (completely airtight) sealed. Manufacturers can also leverage eSIMs to optimize supply chain processes.

6.4.2 Remote SIM Provisioning

The GSMA Remote SIM Provisioning is organized around four elements: the SM-DP+ (Subscription Manager - Data Preparation +), the SM-DS (Subscription Manager - Discovery Server), the LPA (Local Profile Assistant) and the eUICC. With Remote SIM Provisioning, there is an embedded SIM, which may be soldered inside the laptop, that can accommodate multiple SIM Profiles. See the architecture of Remote SIM Provisioning. Below architecture are applied for both embedded SIM and reprogrammable eSIM type, which has capacity of profile OTA write and control;

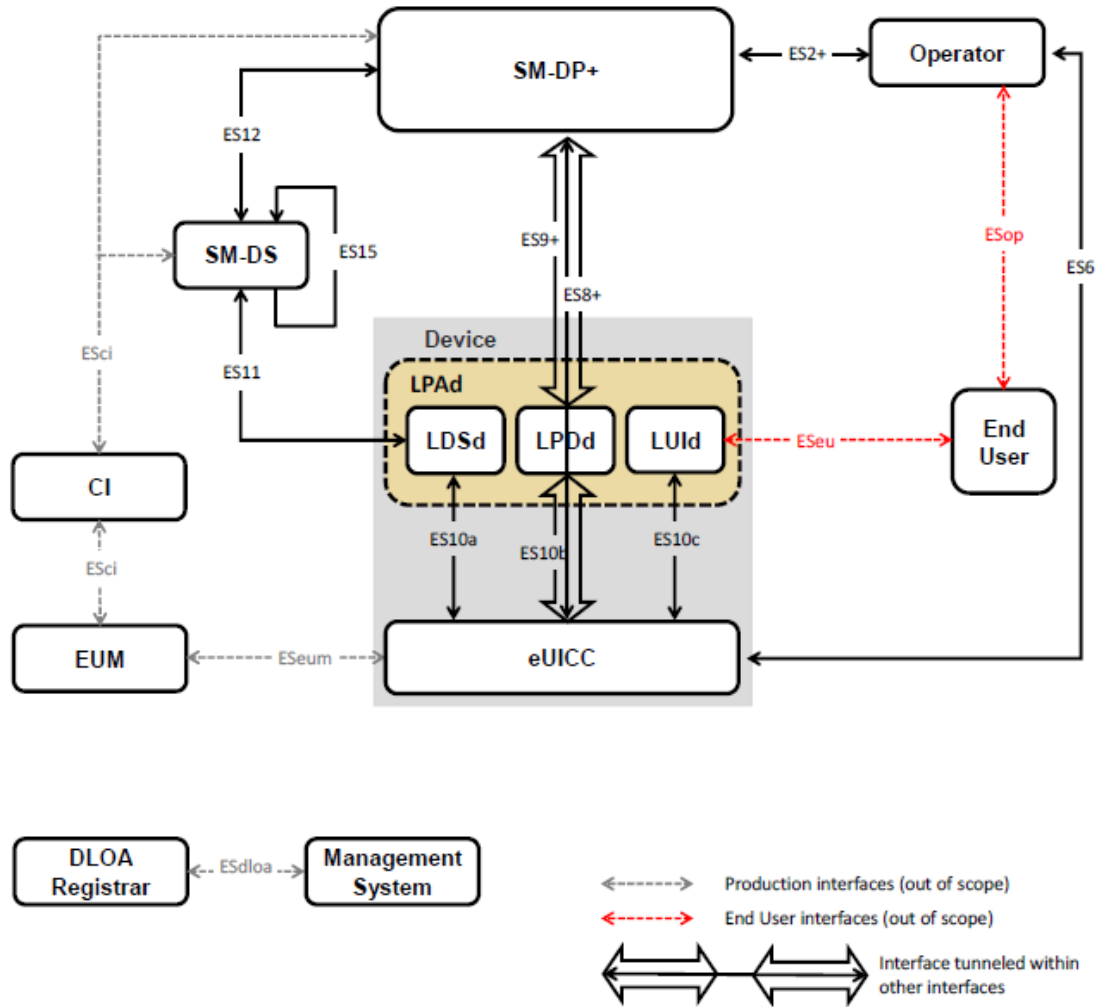


Figure 6.5 Remote SIM Provisioning System, LPA in the Device

Remote provisioning means devices can be much easier to extend mobile connectivity. It has been successfully applied in the fields of connected PC, tablets, smart watches, fitness bands, portable health systems and various other devices even the wireless module. The wireless module with eSIM can help OEM achieve one-time design and global deployment.

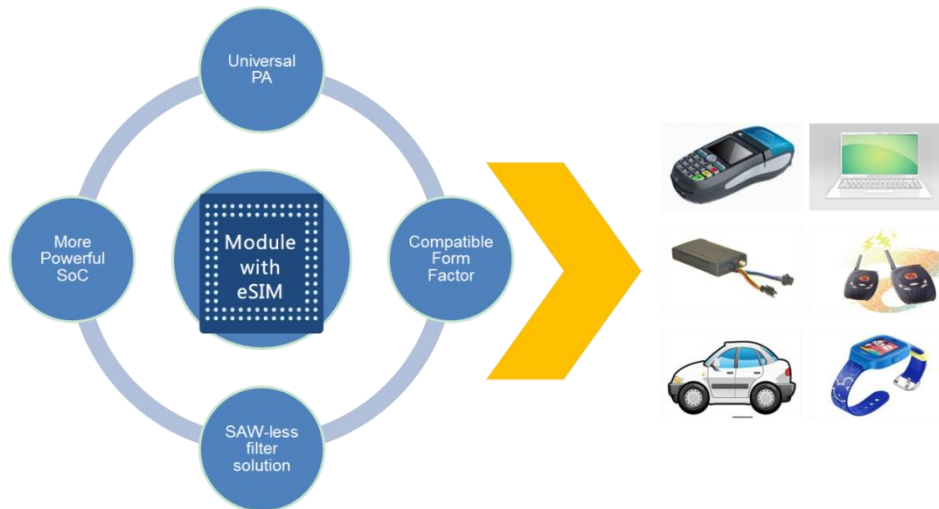


Figure 6.6 module with esim

6.4.3 Certificates of the RSP system

A Certificate Issuer issues certificates for Remote SIM Provisioning system entities and acts as a trusted root for the purpose of authentication of the entities of the system.

The following certificates SHALL be signed and issued by a GSMA CI:

- GSMA CI Certificate (CERT.CI.ECDSA)
- EUM Certificates (CERT.EUM.ECDSA)
- SM-DP+ Certificate (CERT.DPauth.ECDSA and CERT.DPpb.ECDSA)
- SM-DP+ TLS Certificate (CERT.DP.TLS)
- SM-DS Certificate (CERT.DSauth.ECDSA)
- SM-DS TLS Certificate (CERT.DS.TLS)

The following certificate SHALL be signed and issued by the EUM:

- eUICC Certificate (CERT.EUICC.ECDSA)

Currently most of the operators use the certificates was signed and issued by GSMA CI . but for some strategy reason. Some operators choose to use self-issued certificates .

6.4.4 User experience with eSIM

Below content take example with Windows eSIM scenario but this chapter not only limited to Windows; other types of similar scenario also should be considered;

6.4.4.1 eSIM for Windows - feature details

An eSIM lets users connect to the Internet over a cellular data connection. With an eSIM, don't need to get a SIM card from mobile operator, and users can quickly switch data plans.

The following content will show the basic flows to activate and manage eSIM on Windows PC.

6.4.4.2 To see if your PC has an eSIM

1. Select the Start button, then select Settings >Network & Internet >Cellular .
2. On the Cellular screen, look for a link near the bottom of the page that says Manage eSIM profiles. If that link appears, the PC has an eSIM.

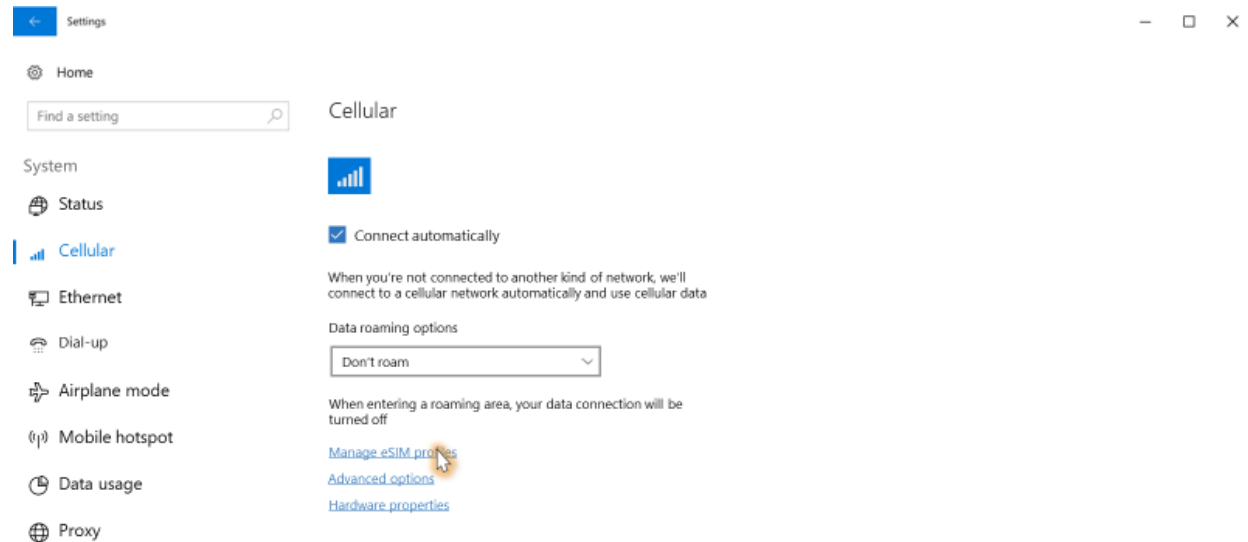


Figure 6.7 Manage eSIM profiles

6.4.4.3 To add an eSIM profile

Users will need to add an eSIM profile to get an Internet connection using cellular data.

1. Select the Start button, then select Settings >Network & Internet >Cellular >Manage eSIM profiles.
2. Under eSIM profiles, select Add a new profile.
3. To search for available profiles or use an activation code which have from mobile operator, do one of the following:
 - Search for available profiles
 - a. Select Search for available profiles>Next.
 - b. When a profile users want to use is found, select Download.
 - c. Enter the confirmation code from mobile operator in the corresponding box, then select Download.
 - d. After the profile is downloaded and installed, select continue to find other profiles users might want and then repeat the previous steps.
 - e. Select Close when users downloaded the profiles.

- Use an activation code which have from mobile operator
 - a. Select Let me enter an activation code I have from my mobile operator>Next.
 - b. If users have a QR code to scan for the activation code, choose which camera to use on the PC, and then scan the QR code.
 - c. The activation code should appear in the corresponding Activation code box. Select Next.
 - d. For the dialog box that asks Do you want to download this profile?, enter the confirmation code from mobile operator into the corresponding box, and then select Download.
 - e. Select Close.
4. Optional: To give the profile a friendly name (for example, Work or Personal) to help users remember it, select the profile, select Edit name, type a name, and then select Save.



Figure 6.8 Add an eSIM profile

6.4.4.4 To connect to cellular data using an eSIM profile

1. Select the Start button, then select Settings >Network & Internet >Cellular >Manage eSIM profiles.
2. Under eSIM profiles, select the profile, and then select Use.

3. Select Yes for This will use cellular data from your data plan and may incur charges. Do you want to continue?

Users will be connected to a cellular data network and ready to go.

6.4.4.5 Add an eSIM profile

If have more than one profile installed on PC, users can switch between profiles to use a different data plans.

1. Select the Start button, then select Settings >Network & Internet >Cellular >Manage eSIM profiles.
2. Under eSIM profiles, select the profile to stop using, and then select Stop using.
3. Select Yes for You'll be disconnected from this cellular network. Continue?
4. Select the different profiles users want to use, then select Use.

6.4.4.6 To delete a profile

If users don't want to use a profile anymore, can delete it from PC. If users delete the profile and want to add it again later, need to download the profile again and might need to contact mobile operator.

1. Select the Start button, then select Settings >Network & Internet >Cellular >Manage eSIM profiles.
2. Under eSIM profiles, select the profile to delete, and then select Delete.
3. At the prompt that the profile will be permanently deleted, select Yes.

6.5 OS on 5G Laptop

For 5G NR 3 key factors:

eMBB: enhanced Mobile Broad Band; with extreme data throughput; Gigabytes data in a second, then UHD screens, 3D videos such required can be met by 5G with real time;

uRLLC: Ultra-Reliable and low latency communication; Industry automation with Ultra-Reliable will be more and more popular;

mMTC: Massive Machine Type Communication; Smart building/city etc

Above plenty of outburst new Application will takes SW type and electric consumer products use type change in OS; for example 5G Sky office;

Laptop 5G Sky Office

Always online office everywhere with high speed data throughput;

Cloud storage and real time data transfer with local laptop;

5G make cloud based mobile office come true;

OS integration with cloud service as mandatory;

OS will take more calculation work loading than before;

Below take windows as an example, but this chapter not only limited to windows; other OS also

should be considered;

Windows 10

Windows 10 allows users to scroll through time to find documents and websites. Most of users are familiar with touchscreens on the phones, and now users can have a touchscreen on a new Windows 10 computer. It is easy to zoom in, zoom out, quickly scroll, and sign documents. Windows 10 let users free up time and hands by talking to the computer. Focus assist allows to have a distraction-free work space. Windows Hello allows users to utilize faces or fingerprint to securely and instantly unlock the computer.

The Windows device comes with built-in security features, including firewall and internet protections to help safeguard against viruses, malware, and ransomware. Ongoing security updates protect the system against the latest threats. Users can use Windows Defender to detect ransomware attacks and, with an Office 365 subscription, restore the files with a click. Connect the family's Microsoft accounts and use Windows settings to help keep kids safe. Windows 10 helps to manage screen time, limit access to mature content, and control online purchases.

Windows 10 has the apps to get in touch with the creative side. The Photos app automatically organizes and tags the photos. Searching for photos is easy and fun. Windows 10 gives users everything to create, remix, and share in 3D. It's a great way to add some impact to an email or PowerPoint.

Windows 10 has apps and features to help get more done with less hassle. With a digital pen, users can write out a headline, add bullet points, design your slides with a pen—then easily convert them into a polished PowerPoint presentation. With features like Line Focus and an easy to use offline dictionary, Microsoft Edge now has even more ways to help improve reading and focus.

Windows 10 comes with fun and function built in. Get the game on in the real or virtual world with Windows 10. Play in 4K, reap the rewards of Game Mode and DirectX 12 performance, and strut the stuff with built-in Mixer broadcasting. Whether users have a disability, a personal preference, or a unique work style, Windows adapts to them.

Windows 10 Update

To help keep all Windows 10 systems secure and to provide the latest features and improvements, the Windows 10 Update Assistant downloads and starts the installation of the latest version of Windows 10. The Windows 10 Update Assistant will be deployed to Windows 10 PCs that have not yet had the latest update installed.

Feature updates

With Windows 10, Microsoft will package new features into feature updates that can be deployed using existing management tools. Because feature updates are delivered more frequently than with previous Windows releases changes will be in bite-sized chunks rather than all at once and end user readiness time much shorter.

6.6 5G Test on Laptop

For 5G NR that provides eMBB with extreme data throughput, uRLLC with ultra low latency performance, it also introduces many new technical challenges for laptop devices. Therefore, it is important for device manufacturers to validate the 5G NR integration in different aspects to guarantee the KPIs (key performance index) are met.

KPIs for Laptop

- Antenna performance
The antennas' covering bands are extending and now 4x4 DL MIMO is mandatory for several FR1 bands defined by 3GPP rel.15 and carriers.
UE manufacturers need to make sure the passive/active antenna performance is fine tuned with acceptable gain.
- Over the air radio performance
To meet carriers' acceptance level for good signal transmission and reception.
Validate the TRP/TIS, MIMO throughput
- Data throughput in different RATs (radio access technologies)
To verify the maximum throughput in LAB facility conductively to be sure the SW/FW running on the device is working properly.
- Field testing for interoperability check
To make sure the network settings are complied with different carrier expectations
Tests like handover, data connection, A-GNSS shall be verified.
- eSIM validation
- UI function
The SW running on the device sometimes might not working well, for the settings related to cellular need to be verified, for example the auto APN data base stored in MSFT windows, airplane modes, GNSS functions.

System Validation

- System stability check
To guarantee that the cellular function is robust and stable, stress data connection tests shall be performed, such as overnight Youtube running, UE system sleep/restart repeatedly.
- System power consumption with the 5G NR radio
To meet ACPC and MSC (modern standby connected) requirements.
Battery life is key for commercial users and hence cellular functions power drain has to be measured and optimized.
Idle and active power consumption shall both be checked.
- System thermal consideration while 5G NR is operating
To meet system and radio card thermal limitation that the end users can have good experience and good cellular performance.
- SAR validation
DC (dual connectivity) or inter-band UL CA mode condition
- Other regulatory tests for each country

- Self-interference check
 - To make sure the UE won't interfere with other electronic devices or safety regulations.
 - To make sure the radio operation doesn't interfere or be interfered by other device functions. So the manufacture need to make sure the function/performance is still fined while multi-function operation (for example, when the panel is set to high resolution mode, it should not interfere the radios).

6.7 Laptop performance and power consumption

A connected Sky Office PC needs to deliver performance and battery life. Both performance and battery life requirements must be assessed while keeping in mind how such products are will be used in reality.

For performance this means using benchmarks that space across the use PC user cases, such as:

Table 6-2 PC user cases

Category	Metric
Productivity (Important for Sky Office)	Sysmark 14 SE
Responsiveness	SPECInt_2006 ST
MT Compute	SPECInt_2006 Rate MT
AI	INT 8 TOPS
Graphics	3D Mark 11

It is to be noted that the PC market consists of different performance the price point tiers.

For Battery Life the same logic applies. The approach to assess the battery life must be based the full system and with a usages mix that reflects how the Sky office Connected PC is used in real daily life. Optimizing for battery life is critical, yet should never be at the cost of performance and compatibility to ensure user's workflows remain seamless and smooth.

- Need have enough range to accommodate different type of laptop with different configurations.
- This document defines operation modes and test methods for laptop power consumption. The power consumption should be extrapolated from complicated user scenarios. The basic scenarios definition should base on user active experience. According to battery capacity and the power consumption of each scenario and the weighting given of each basic scenario to estimate the laptop standby time and user active time. The basic scenarios and each basic scenario weighting given defined in Table 7-1. The display backlight also be defined in the table. Test environment lighting should be typical office conditions. Audio volume should be set to the middle of the available range. RF Power level setting (0dBm?) and CA configuration under each scenario need TBD.

Table 6-3 basic scenarios

Scenario	Weighting Given	Equipment connetion
----------	-----------------	---------------------

		WWAN connection	WiFi connection
Desk ideal	TBD	TBD	TBD
Browser	TBD	TBD	TBD
Office	TBD	TBD	TBD
Video	TBD	TBD	TBD
Skype audio call	TBD	TBD	TBD
Skype video call	TBD	TBD	TBD
A. Estimate user time(100% backlight on)	TBD	TBD	TBD
B. Estimate user time(60% time backlight on and 40% time backlight off)	TBD	TBD	TBD
C. Local video play(1080P)	TBD	TBD	TBD

6.8 EDGE computing

Edge computing as an evolution of cloud computing brings application hosting from centralized data centers down to the network edge, closer to consumers and the data generated by applications. Edge computing is acknowledged as one of the key pillars for meeting Key Performance Indicators (KPIs) of 5G, especially as far as low latency and bandwidth efficiency are concerned. ETSI ISG MEC (Industry Specification Group for Multi-access Edge Computing) is the home of technical standards for edge computing.

As systems and workloads that once run primarily in local hardware equipment like PC or laptop are now coexisting in the cloud, MEC is envisaged to play an important role in the way 5G penetrates enterprise connectivity and is used to support enterprise applications. Industry sectors such as healthcare, government institutions and fleet management are expected to benefit from MEC-based 5G applications as doing this computing closer to the edge of the network lets organizations analyze important data in near real-time, and optimize the performance for high bandwidth services.

MEC characteristics include:

- Proximity
MEC can be flexibly deployed in different locations like near the Base Station or the source of amounts of data, steering the processed data towards the targeted MEC applications.
- Ultra-low latency

For mission critical IoT services and ACPC and MSC requirements, there is the concept of URLLC (Ultra Reliable Low Latency Communications) that can be enabled by local processing in the Edge Cloud supported by the 5G architecture.

- High bandwidth
Bringing computation to the network's edge minimizes the amount of long-distance communication and provide high bandwidth as significant data gets consumed by the edge.
- Virtualization
Adding virtualization to MEC, as ETSI points out, also allows the "capability for an application to discover applications and services available on other hosts, and to direct requests and data to one or more hosts." Virtualization plays a critical role in the speed of data transmittance. And the edge requires lighter virtualization solutions than the virtual machine-based technology we currently have in cloud data center.

When MEC is utilized for cloud office together with central cloud, the computing, storage, connectivity can be integrated together to provide end-to-end network and business capability effectively. An enterprise-oriented office network should not only have the ability to connect and forward by traditional equipment, but also have the real-time processing ability for corresponding business data, and realize more reasonable service logic for data distribution by cloud computing. The intelligent features of MEC nodes, such as flexible forwarding of local traffic, real-time business processing and multi-protocol interworking conversion, can provide diversified choices for the office scenario. MEC has inherent advantages in improving users' real-time experience, providing differentiated services and sharing the load of cloud computing.

Consider the trend that operator network is evolving to virtualization technology, cloud data center represented by computing-storage resources gradually extends from backbone network to metropolitan network and even access network, as shown in following figure. The core data center deployed in the highest position mainly carries the functions of control plane nodes, such as network choreographer, core network control etc., while the edge cloud introduces network side multi-access edge computing, CDN that with more business attributes.

In an enterprise, data communication is often needed among headquarters and branches, including order, production and construction data. Conventional solutions have typically been to establish dedicated lines, which is expensive and requires branches to have complex infrastructure, including routers, WAN path controllers, WAN optimizers, firewalls, and other components. This adds purchase and maintenance cost. Nowadays, emerging services such as VoIP, video conference, streaming media, virtual applications and virtual desktop office, all require low latency, high bandwidth, and higher requirements for physical link.

Using EDGE computing gateway as the enterprise network gateway, can deploy a series application to provide private network services for cloud office, support information management, data security, real-time and reliable data transmission, improve office efficiency, and realize VPN gateway, network probe, data acquisition and other functions. In the meantime, PC device power consumption can be reduced because of less local computing.

7. Business model and Analysis

7.1 5G Sky Office traffic model analysis

As time goes by, the demand for Ethernet in industries such as business and education has gradually increased and due to the maintenance cost, the difficulty of deployment, device mobility and other reasons gradually turned to wireless LAN. With the concept of 5G cloud office appearance, the terminal device synchronizes with the cloud in real time through the integrated 5G communication module and cooperates with peripheral hardware support. There are three large-scale application scenarios:

7.1.1 Cloud Storage

Putting corporate documents in the cloud or share-points is becoming more and more popular. With the introduction of the 5G cloud office concept, it is possible to work anywhere while making modifications on the same file. Cloud storage are based on 5G technology and the office files are synchronized with the cloud in real time so they are not limited to fixed office equipment and can be acquired and operated anytime, anywhere. The specific application mode of cloud storage shown in Figure 5-1.

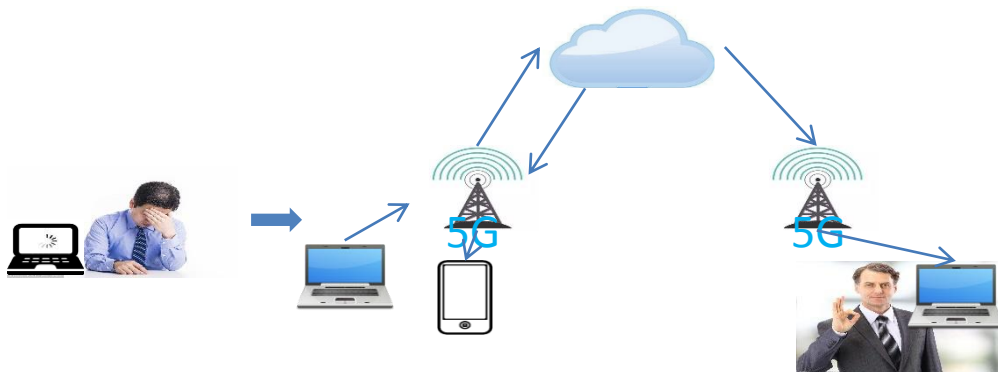


Table 7-1 Schematic for Cloud Storage

At this stage, due to the limitation of network speed, the time taken for uploading and downloading in the cloud is too long causing the bad user experience. By introducing the higher data rate of 5G communication technology to convert the local storage to the cloud, it can reduce the requirements for local hard drives of office equipment or even do not need to use hard drives. On notebooks, mobile phones, PC...etc. if user sets "My Cloud" in the office equipment and other office equipment to replace the "My Computer" function in the existing office, office equipment preparation direction can be moved to lower power, lower cost...etc.

Furthermore, such as:

- (1) Cloud storage can provide a better solution for employees to go out or after work with quicker synchronization resources through mobile phones. The faster upload after processing can greatly improve the work efficiency, for example.
- (2) Providing a reliable, convenient and efficient solution for the information security and confidentiality work of cross-border travellers. In order to prevent information leakage during

business trips abroad, generally the completely secured notebook should be provide. At present, the existing solution is to copy and work through the U disk. If the 5G cloud office system is used, it is more convenient and efficient to use the cloud to synchronize data in time after the person arrives on the business trip.

7.1.2 Cloud collaboration

Collaborative office and development of multiple people and multiple locations has become a trend. 5G low latency technology can realize the fast wireless transmission of large files, reducing the delay of collaborative office and development and improving cooperation efficiency.

As shown in Figure 5-2, when multiple people edit the same document from different terminal devices at the same time, collaborative office software such as office365, Tencent documents...etc. will update the input of many people in real time and display the editor. The information can be view through the icons on the page when there are different opinions for the editor's input. When the call is initiate for discussion or when multiple members of the project team are developing at the same time, it can be based on 5G communication technology. Real-time updates and communication can greatly improve work efficiency and timely avoid possible code problems.

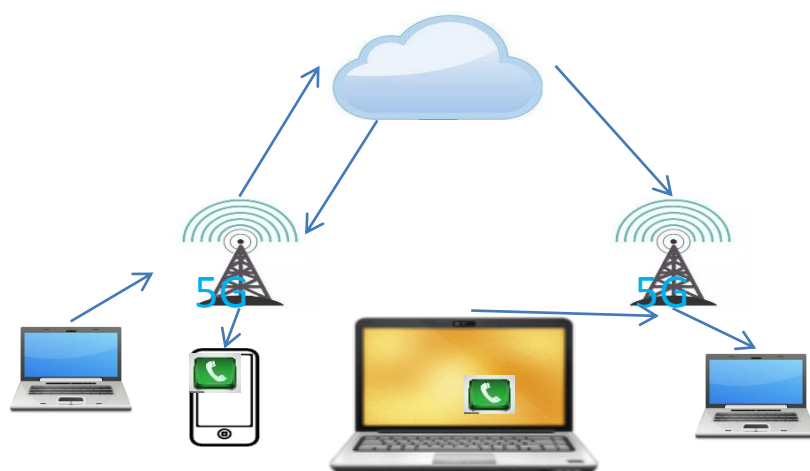


Table 7-2 Schematic for Cloud Synergy

7.1.3 High-definition video conferencing

As shown in Figure 5-3, high-definition remote conferences are implemented base on peripherals such as VR, microphone, and TV. Bandwidth and low latency support multi-user concurrent simulation conference scenarios, enabling the main venue, mobile phone, notebook, VR Glasses and other devices can provide or receive meeting materials in real time, view HD conference videos and make communication more smoothly.

7.2 Business Mode Analysis

For a long time, traditional localized office software has been the first choice of collaborations for working. Nowadays, this situation has begun to change as most of the new office softwares being upgraded or installed are cloud deployed.

Keeping collaboration services on-premises will lead to cost increase, reduced functionality and obstacles in the way of higher working efficiency.

The popularity of mobile working APPs have also added to people's preference to new ways of working that cloud office capabilities can support. Cloud office suites provide platforms for mobile working and videoconferencing, and help users to sync email, organize and assign tasks, share files, chat about what they're working on, and get updates on progress.

Cloud-based innovative features include content visualization and discovery, virtual personal assistance, "smart" inboxes and "unlimited" storage. Based on cloud computing, cloud working provides users with the best experience and the most economical working platform. 5G ACPC and 5G network are the core drivers of such development.

The 5G-based cloud office system mainly offers mobile office services, including providing soft and hard ware services and cloud services through operators' internet connection. Earning points cover the cost of 5G flow and slicing, cost of terminals, cost of software subscription, cloud computing, etc. A sum of money to compensate for the cost increase of users resulted from 5G S-Modules and 5G expenses should be taken into consideration. In early commercialization, the 5G S-Module would cost over 500RMB but the price will further decline as the market stabilizes. Cloud office system shares cooperative partnership with the third-party enterprise service-suppliers and hardware manufacturers. By providing software system, hardware equipments, cloud sources and user traffic, cloud office system create values for its partners.

The commercialization mode can be categorized in 3 types: pay-on-demand, pay-on-order and pay-on-data flow.

- Pay-on-demand: Pin down the project to develop according to users' need, develop products that cater to enterprises' need and realize the function of the cloud office system of the next generation by internet.
- Pay-on-order: This charging mode is mainly based on the number of enterprise users and aims at small-and-medium sized companies.
- Pay-on-flow, CPU or authorization: This charging mode should have a clear picture of enterprises' IT expenditure and curb the cost according to their traffic.
- Multiple APN enable business models, applying different business models to different APNs/Data Connections.

What's more, considering the combination of network flow with content, cloud office system can also forge partnerships with content providers through operators and laptop producers to offer more content services with specific APN.

8. Ecosystem Construction

The cloud office is your day-to-day in the cloud. It's a new platform for email and documents and messaging and calendaring, but more than that, it's connectivity; it's collaboration; it's centralization; it's having choices about where, when and how you work.

It's difficult to separate the cloud office from cloud office system, the most widely used being Microsoft Office 365 and Google G Suite, because while the systems provide the cloud-based infrastructure, by doing so they make this new way of collaborated work possible.

Cloud (software, platforms, and infrastructure), Industrial IoT (IIoT), and Mobile Edge Computing (MEC) represent three powerful technologies that are driving substantial innovation within Information and communications technology (ICT). Cloud computing technology and the "as a service" business model is transforming Services, Platforms, and Infrastructure (SPI) for the entire ICT ecosystem (data centers, storage providers, CDN providers, wireless broadband service providers) as well as enterprise across virtually every industry vertical.

The ACPC hardware component involves case (rugged option), touch/pen/vision/speech enabled display, cameras, local storage, local memory, local generic computing resource of CPU/GPU, 5G S-Module, other universal short-range wireless such as Wi-Fi, Bluetooth, and many other sensors (audio, light, location, mobility, solar power, etc.). On top of these hardware components, we will need fully updatable software to support each of these lower layer entities via well-defined standard based interfaces.

Now the ACPC is powered up, connected, truly the sky is the limit with all the interesting capability from the rest of ICT ecosystem. Content is massively and intelligently synced and big data is mined across multiple 5G paths, which connecting every human being and many things assisting us and entire society at all time.

Are we ready for an ACPC? Windows version or macOS version? Global roaming enabled without a physical SIM card or with dual SIMs dual standby?