

Workstation/End User Device Environment and Trends

Submitted by NASA on behalf of the Core Workstation Category Team
Multiple Award Schedule - Information Technology, NASA SEWP, NIH
NITAAC, US ARMY CHES



3/12/2021

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Preface

This paper was developed to provide U.S. Federal government agencies with insight into the end user computing environment and anticipated trends over the next decade. Development of this white paper began in 2020 by the Core Workstation Category Team (WCT), consisting of principals from the National Aeronautics and Space Administration (NASA), National Institute of Health (NIH), General Services Administration (GSA), and the Department of Defense/Army.

This paper informs Federal agencies about the Government-wide Strategic Solutions (GSS) for Desktops and Laptops initiative for which technical standards that define end user computing solutions have been developed and refreshed annually over the past seven years. The trends and assessments highlighted in this paper will enable agencies to shape their specific workstation requirements, price negotiations, terms and conditions, and other acquisition considerations. The overall intent is that these insights will guide Federal agencies on hardware technology acquisitions in alignment with the U.S. Federal Government Category Management IT Hardware Plan.

Overview

As part of the Office of Management and Budget (OMB) Federal Strategic Sourcing Initiative (FSSI), WCT was established in 2013 to develop a framework and strategy to reduce costs and increase value through the application of strategic sourcing principles. The Team, led by the National Aeronautics and Space Administration (NASA) with participation by over twenty-five federal agencies, identified desktop and laptop (now referred to as notebook) configurations that met the requirements of the federal government for approximately 80% of systems purchased and incorporated best practices in spend management.

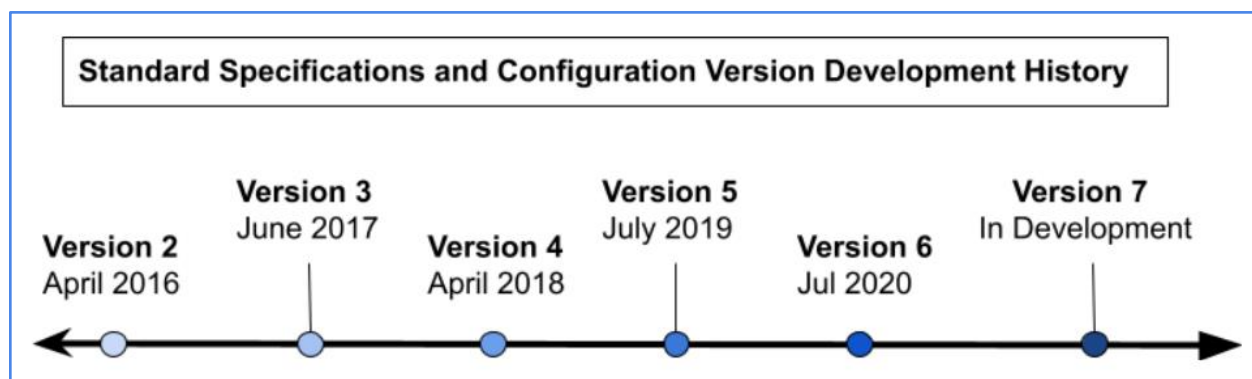
In October 2015, OMB issued M-16-02: Category Management Policy 15-1: Improving the Acquisition and Management of Common Information Technology: Laptops and Desktops¹. This policy mandates the use of Government-wide Strategic Solutions (GSS) for federal agencies to fulfill the bulk of their desktop and laptop requirements. The GSS for Desktops and Laptops is offered through the following acquisition vehicles: NASA Solutions for Enterprise-Wide Procurement (SEWP), the NIH Information Technology Acquisition and Assessment Center (NITAAC)'s Chief Information Officer (CIO)-Commodity and Solutions (CS), GSA's Multiple Award Schedule - Information Technology Category, and through the U.S. Army Computer Hardware Enterprise Software and Solutions (CHESS). NASA worked collectively with implementation partners from the General Services Administration (GSA) and the National Institutes of Health (NIH) to develop a deployment strategy for the GSS initiative. This group became known as the Core WCT.

The Core WCT collaborated across Best-In-Class (BIC) acquisition vehicles to ensure government-wide customer requirements and industry trends were/are considered as the systems are refreshed. The system specifications and terms and conditions, which drive value for the federal customer, are refreshed annually. As part of this process, the Core WCT gathered agency requirements, met with leading original equipment manufacturers (OEM) of workstations and processors, and employed industry technology advisory and research services to equip the team with a balanced, comprehensive view essential for selecting highly relevant and valuable specifications each subsequent year.

The GSS pilot program systems were implemented for purchase in 2015. The GSS systems follow terms and conditions agreed upon by the Core WCT to include Electronic Product Environmental Assessment Tool (EPEAT), Energy Star, Section 508, and Trade Act Agreement Compliant, 45 days or less delivery, and extended warranty options to ensure alignment and compliance. An annual, comprehensive refresh process was established to allow agencies to provide updates on requirements and collect industry inputs on trends, directions, and feedback.

¹ Category Management Policy 15-1: Improving the Acquisition and Management of Common Information Technology: Laptops and Desktops Download PDF. Questions and Answers-OMB Policy Memo-Laptop and Desktop. [Linked PDF](#).

System history is as follows²:



GSS Version 6 systems became available July 2020. Prior versions remain offered until they reach end of life or are no longer available from the manufacturer. GSS Version 6 systems are offered in the following categories:

GSS Version 6 System Categories			
Desktops	Notebooks	Tablets	Thin/Zero Clients
<ul style="list-style-type: none">• Small Form Factor (including Mini/Micro)• Desktop (Mini Towers and Towers)• Integrated/All-In-One	<ul style="list-style-type: none">• Lightweight (including 360-degree foldable and Two-In-One)• Notebook• Performance	<ul style="list-style-type: none">• Slate• 2 in 1• Convertibles	<ul style="list-style-type: none">• Mobile• Desktop

These robust GSS Version 6 systems offer many options to meet customer needs, including enabled security, upgraded memory/storage, imaging, docking stations, warehousing, asset tagging, and more.

² IT Hardware: Governmentwide Strategic Solutions (GSS) for Desktop and Laptops. Acquisition Gateway: Technical Specifications and Versions. [Linked Resource](#).

Market Definition

The market is defined by the industry offerings of end-user computing devices:

Form Factors and Types			
Notebook PCs: Product screen size is 14 inches or larger, with a clamshell or convertible form factor and various configurations: <ul style="list-style-type: none">○ Hybrid: Convertible, detachable and fold-over designs○ Clamshell: A traditional design with a display folding onto a hinge or a fixed keyboard	Ultramobile Premium (UMP): The display size of this form factor is typically between seven and 14 inches, with a weight typically less than 1.6 kg. These products come in three form factors:	Tablets: A completely open, slate-style design with touchscreen shipped without dock or keyboard	Desktop PC: Desk-based system of various form factors (including towers, small form factors and all-in-ones) and configurations. Thin-client terminals and technical workstations are typically similar to the base market segments except typically provide more “edge-dwelling” capability therefore appealing to a smaller, yet important market segment. The primary providers of these classes of products are typically similar, and many of the same criteria may apply when specifying and procuring those devices.

Key Findings

The Core WCT considers the following findings when refreshing the GSS specifications each year. This process includes continuous agency customer engagement and OEM/Industry outreach.

- **Lifecycle:**
 - Improvements in overall device reliability may make infrastructure and operation (I&O) leaders reluctant to replace aging devices that continue to function well, increasing the likelihood that these devices will exceed their remaining life span and no longer support users' needs.
 - I&O leaders are faced with a more rapidly evolving software and security environment, which may shorten the useful life of devices.

- Many organizations employ workers with a variety of work styles and device needs, making it difficult for I&O leaders to address all of their requirements with a single blanket policy.
- A four-year life cycle for desktop PCs has been the best practice for at least the last decade. However, many enterprises have found that they can extend the life of their PCs with little operational impact.
- Reliability is seldom the driver for replacement of desktop hardware, and at the end of four years, the annualized failure rate (AFR) is still in the mid-single digits.
- Government and Education continue to hold notebooks much longer (due to budget constraints) and more importantly, to the compromise of business objectives.
- **Maintenance:** Consumer notebooks can experience failure rates that are as much as 50% higher than the failure rates for enterprise-class notebooks. Savings from lower initial capital costs can be consumed rapidly by higher repair rates and/or more rapid replacement cycles.
- **Supply Chain Risk Management (SCRM):** Recognized as a critical element of any comprehensive cybersecurity capability. While federal agencies seek SCRM support as a requirement, most agencies and suppliers are not yet sufficiently organized and prepared to check compliance after contract award and most are not able to address non-compliance if and when a supplier change is necessary.
- **Pricing:** Knowing what the “best” price is for a specific device is problematic at best even in the commercial marketplace as suppliers maintain very sophisticated pricing algorithms that widely fluctuate based upon features, delivery times, time of year, the supplier’s current performance, and specifics about the customer. Therefore, despite the publishing of fee schedules and tiered pricing, price is negotiable, yet few federal agencies aggressively go so far as to negotiate the absolute best price possible.
- **Terms & Conditions:** An essential component of the Core WCT has been incorporating similar Federal Acquisition Regulation (FAR) and other common terms and conditions into its respective contract vehicles. This has assisted in ensuring baseline pricing across the participating contract vehicles. However, OEMs use resellers to provide indirect sales and product support, some OEMs maintain direct interaction with customers, particularly large enterprises to negotiate specific pricing, terms and conditions.

Key Attribute Considerations

These attributes are considered in the market definition.

- **Portability Scale:** Size, Weight, Connectivity, Power Requirements/Battery Life
- **Expandability:** Tools, Interface, Input Methods, input/output (I/O) Speeds, I/O Ports
- **Brand Strength:** Awareness, Market Share, Technology/Innovation, Price Premium, Loyalty, Buyer Consideration
- **Applications:** Integration of Store, Quantity, Quality, Sophistication of Applications, operating system (OS)
- **Versatility:** Screen Resolution, central processing unit (CPU) Power, CPU Efficiency, Memory Size, Memory Speed, Touchscreens, Detachable Screens (Convertible)

Trends

Product Trends

Docking Station (Port Replicator)

- **Docking stations** enable workstations and end user products to function like or better than a desktop device regardless of location. Key functions include:
 - Type of Connectivity/Ports: Consolidation down to universal serial bus (USB) 4.0 in 2021/2022
 - Anything requiring a wired connection:
 - Peripheral Connectivity – keyboard, monitor
 - Bluetooth – and alternatives that are less protocol-heavy and therefore higher-performing.
 - Power – via USB-C or wireless
 - A stand for tablets, smartphones
 - Auto-recognition of available services for user selection with docking stations technically enabling power control (on/off switch) and regeneration of signals.
- Industry will struggle to get to a standard keyboard and stand for tablets

Processor Architecture

- Leading-edge semiconductor manufacturing and packaging technology in CPU, graphics processing unit (GPU) and memory make it possible to build ultra-mobile personal computers (PC) with advanced features under low power consumption.
- Premium ultra-mobile is accelerating to displace the mainstream of mobile PCs platforms. But, traditional notebooks vendors are repositioning the market by bundling advanced features and components for specific markets, such as the enterprise, workstation and gaming, and will replace part of the desktop PC market for work-from-home users.
- In the next five years we expect to see more diversification in processor choice.
- COVID-19 has accelerated the migration of platforms to premium ultra-mobile, and will impact mobile PC features in two ways:
 - Ultramobile Premiums may benefit from work-from-home and remote education and dominate as the mainstream platform of mobile PCs after 2020. High performance (advanced CPU with embedded GPU, high-capacity solid-state memory), high-speed wireless connectivity (Wi-Fi 802.11ax, Bluetooth 5 and 5G cellular) will drive the feature evolution as the mainstream of mobile PC platforms.
 - Traditional notebooks will reposition their aim to high-performance markets in the enterprise, workstation, and gaming fields. It will bundle advanced features and components with its larger space at acceptable prices. Discrete GPU, high-speed wired connectivity (USB4.0 in Type-C), and speedy refresh-rate displays will be the key features to distinguish.

Device Architecture

Desktop

- “Device agnostic” moves center stage yet does not mean that one device should do everything. It does mean that all devices are unified seamlessly, enabling the user to access the same business processes, tools, applications, and services across multiple devices without having to know device-specific usage techniques.
- The new desktop is either very, very powerful and places little to no dependence upon external services to perform while portable devices become “thinner” (e.g., shrink in size), mount to a docking station, and are used like a desktop.
- High-performance devices are most often replaced every two-years to provide workers with the latest technology.

Laptop/Ultra-mobile

- Lifecycle of 3 years for traveling workers vs. 4+ years for day extender notebooks that stay in docking station nearly full-time
- Inherent portability, the casing, and embedded mechanicals (e.g., keyboard, mouse) continue to fail much earlier than on desktops or devices that are not often moved
- Displays are thin and multiple, providing a multi-monitor view similar to what is used today in a workspace.
- Standalone devices will have more than 8 cores (including non-CPU cores), even more powerful graphics to enable 3D imaging of inherently 2 dimensional views when applications can be appropriately enhanced.

Tablet

- The tablet sees a shorter average lifespan than laptops/notebooks due to the nature of their use (e.g., shop floor, “in the field”, heavy manufacturing, construction).
- Augmented Reality (AR) positions Tablets and Smartphones as the Human-Machine interface aggregators “in-theater”, connected back to Cloud-based services that enable delivery of an AR user experience or a platform to engineer 508 Compliance with, the latter of which when standard monitor and keyboard are not acceptable.
- Wireless charging becoming standard
- Displays thinner and more flexible
- Additional device attribute changes:
 - Screen Size
 - Screen Resolution
 - Screen Coating
 - Operating System
 - Weight
 - CPU
 - Cellular (e.g., 5G)
 - Keyboard options
 - Form Factor and flexibility

Thin-Client Devices

- Useful life runs between 6 years and 8 years
- Dedicated devices leverage network or Cloud-based I/O, storage, user interface (U/I), and communication services.
- Dedicated alternative to PC whether that be a desktop or a laptop.
- Enables the user to function “Device Agnostic”.
- Remains a functional equivalent to a tablet or similarly mobile device yet is physically dedicated.
- Human – Machine Interface to a virtual desktop infrastructure (VDI) environment.
- Most ruggedized and durable as it has very few “moving” parts that require admin support to ensure their operation.
- Device problems that cannot be resolved with a hard boot, continue to be resolved with device replacement (e.g., overnight drop ship).

Technology Upgrades

- By 2025, 60% of I&O leaders will drive business innovation using disruptive technologies, up from less than 5% in 2019.
- By 2030, improvements in semiconductor performance will result from innovations in chip architecture, heterogeneous integration via advanced packaging, and software, as well as the advent of new compute technologies into practical use. Product managers should monitor and exploit these improvements.
- By 2030, semiconductor process technology will no longer be a relevant factor in driving microprocessor performance enhancements.
- By 2030, 90% of all integrated circuits (ICs) will use some form of heterogeneous integration, up from less than 5% in 2020.
- New computing architectures will drive next-generation memory usage from \$0.5 billion in 2019 to nearly \$11.1 billion by 2030.
- Through 2030, quantum computing will drive innovation in qubit manufacturing techniques.
- Design for constant change.

User Interface

- Refinements in human-to-machine Interface streamline device interaction, especially using voice recognition and touch.
- Demand continues to outweigh delivery of high-quality multimodal Human-Machine Interfaces (HMI).
- Emerging HMIs (primarily speech, gesture, vision) are increasingly important as they improve the user experience but may pose security challenges.
- The emerging HMI Impact Timeline centers on:
 - Near Term (<1 year): Virtual Assistants
 - Mid Term (1 to 6 years): Gaze, Gesture, Motion
 - Long Term (6+ years): conversational UI, Myoelectric, Brain-Computer Interface

- There is a progressive shift aware from technology-aware humans to human-aware technologies (aka, emphatic technologies).
- Improved algorithms and artificial intelligence (AI) enable new user experiences.
- Increasing numbers of interaction modes and technologies.

Form Factor/Device Shape, Size, Weight

- Enterprise-grade tablets generally have stronger casing materials (such as aluminum, magnesium or high-strength carbon fiber) and often also include reinforced glass, reducing the likelihood of case or screen breaks as well as improved cooling, higher quality components (e.g., memory, SSD, fans).
- Mainstream consumer- or enterprise-grade non-ruggedized tablets used inappropriately in extreme environments (with heat, cold, vibration, dust or moisture) will experience shorter life cycles. External protective cases don't endow ruggedness because they mask less robust electronics.
- Common cross-industry wearable use cases which can be broken down into the following four categories:
 - Hands-free workflow. This enables employees to perform job functions while their hands are occupied with another task, or unusable due to gloves or other protective equipment. Workers use smartwatches or other body scanners for alerting to perform a task or scanning items as needed. Gartner also sees use of augmented reality overlay on the display of glasses or other head-mounted displays (HMD), where a worker sees step-by-step instructions on how to perform a task via a displayed checklist.
 - Remote expert guidance. Through smart glasses, workers share hands-free video of what they are working on with an expert in a remote location, who offers guidance on the next steps. Experts can be located in a contact center via a PC or connected elsewhere via tablet or smartphone. The expert uses voice, video markers, or instructional images for the workers to view through smart glasses.
 - Health and safety monitoring. Workers wear sensors to improve their safety, monitor their health in strenuous situations and send alerts with their location information to summon help during an emergency. Sensors worn at the waist can detect improper posture that may lead to injury when lifting heavy items. Other sensors can track heart rate, skin temperature, respiration, drowsiness and stress levels.
 - Immersive technology for worker training. Workers wear HMDs to learn procedures or practice scenarios in a simulated or augmented environment. They may control the simulation via handheld user interfaces, gesture devices, eye tracking and/or voice.

Mobile Technologies

Besides that which is already addressed in other sections of this paper, demands for expanded functionality will drive the use of Cloud to provide more OS functionality to enable the device to remain small.

Managed Services vs. Ownership (“X as a Service”)

- **Managed Services Scope:** With end-user computing groups converging into digital workplace teams that support mobile workforces accessing cloud services across endpoints, new demands for managed services emerge as employee location is no longer necessarily associated with enterprise headquarters or even campus-based.
- **The New Buyer:** “Device agnosticity” promotes greater support and funding for bring your own device (BYOD) as enterprises seek to reduce acquisition cost of infrastructure to employees. In response, suppliers modify their marketing, product delivery, and support models as the “buyer” is increasingly not only the enterprise, but the end-user as well.

Security

- By 2023, 50% of organizations will have mobile threat defense (MTD) in place, growing from fewer than 20% of organizations in 2020.
- Large-scale MTD adoption limited to regulated and high-security verticals. For mainstream organizations, countering malicious mobile threats is still a lower priority than more mundane data leakage risks. In the absence of spectacular mobile breaches, low visibility of mobile attacks leads to continued low perception of mobile risk.

Device Management

- Unified endpoint management tools are required to leverage the full set of management controls available in Windows and other platforms.
- By 2023, 40% of frontline workers will use wearables as their primary computer devices, which is an increase from fewer than 10% in 2019.
- By 2024, the adoption of Windows 10, Google Chrome OS and Apple macOS will drive the need for a combined endpoint management console in more than 70% of organizations.
- By 2024, the average enterprise wearable deployment will have grown by a factor of 10x from fewer than 100 devices in 2019.
- Endpoint analytics will improve transparency into the IT estate, provide an objective view of user experience and enable frictionless authentication.
- Embrace lighter-weight forms of device management that focus on apps and data, rather than on controlling and restricting device behaviors.

Supply Chain Risk Management (SCRM)

- **Awareness**
 - SCRM program growth and health is driven by publicly known SCRM violations that cause moderate to material damage to the enterprise.
 - Government brandishes suppliers for failing SCRM compliance, yet softens on their “get well” effort.

- **Policies**

- Policies for embody all suppliers including those back to raw material and/or component providers.
- Multimodal: More mature enterprises implement policy that is multi-modal in approach: key suppliers are given rigorous audits while the rest are given ad hoc checks.
- Penalty Box: Suppliers not passing will be sidelined to the “penalty box” for a predetermined “time-out” while they will resolve all discrepancies and are able to pass a compliance check.
- Policy is translated into requirements and implemented as no-negotiable terms and conditions in contracts.

- **Practices**

- Broadly adopted by the CISO
- Federal continues to forge SCRM requirements, evaluations, compliance validations, and driven by policy
- Incremental expansion and/or refinement in policy forces enterprises to implement “good enough” SCRM, except when required by customers and suppliers.
- As trust in suppliers weakens (and a shared service desires to manage the clearing of suppliers, public agencies will struggle to validate that their initial purchases comply with government (or their own) SCRM policy, causing delays in deployment and in repairs (as parts need to pass a SCRM check as well).
- Suppliers will struggle to be removed from centrally managed “blacklists.”
- Replacement suppliers pop-up to serve as blacklisted suppliers depart.
- Suppliers build out SCRM compliance capabilities for customers in an effort to reduce time and cost of sale.

- **Tools**

- Practices and policies (e.g., compliance checking) are automated in core business processes.
- To achieve productivity and targeted output, ongoing monitoring and scoring to ensure continued compliance is automated in core systems delivered by the core system developer or by add-on modules.
- The ability to isolate devices that have been discovered to not be SCRM compliant will be common.
- SCRM compliance reporting, ensuring enforcement compliance, and escalation processes are fully automated to remove the uncertainty of manual practices and methods.
- Strategic and risk checks based upon potential risk type (e.g., lightning, snowball, tsunami) between buyer and supplier (e.g., impact and chance) is baseline triage completed prior to any dialog.

Commercial/Industry Trends

- **OEM Support:** Move to accept OEM images, embrace faster updates, broader user support for piloting new OS versions faster, delivered by the vendor under customer policy.

- **Hyperautomation:** Focuses on task, process and organizational automation using a range of tools. A hyperautomated future state can be achieved only through hyperagile working practices and tools. Hyperautomation refers to the combination of multiple machine-learning, packaged software and automation tools to deliver work.
- **Multiexperience:** Through 2028, the user experience will undergo a significant shift in how users perceive the digital world and how they interact with it. Conversational platforms are changing the way people interact with the digital world. Virtual reality, augmented reality and mixed reality are changing the way people perceive the digital world. This combined shift in both perception and interaction models leads to the future multisensory, multidevice, multitouchpoint experience.
- **Human Augmentation:** Explores how technology can be used to deliver cognitive and physical enhancements as an integral part of the human experience. Instead of computers and applications being something outside the normal human experience, they become a natural — and sometimes necessary — part of the day-to-day human experience. Human augmentation also includes bioengineering factors that go beyond exploitation of computers and applications.
- **Transparency and Traceability:** Applying technologies and best practices to build systems that support digital ethics and privacy goals and generate trust. The transparency and traceability trend is an essential foundation for digital ethics and is a key element of a strategy to establish customer trust. In 2020, an increasingly important aspect of transparency and traceability is explainable AI, which is evolving into responsible AI.
- **Empowered Edge:** In edge computing, information processing and content collection and delivery are placed closer to the sources, repositories and users of this information. The empowered edge drives greater compute power, storage and sensors into the physical world, creating new digital business opportunities.
- **Distributed Cloud:** A distributed cloud refers to the distribution of public cloud services to different locations outside the cloud provider's data centers, while the originating public cloud provider assumes responsibility for the operation, governance, maintenance and updates. This represents a significant shift from the centralized model of most public cloud services and will lead to a new era in cloud computing.
- **Autonomous Things:** Using AI to automate functions in physical devices, software or services is enabling the creation of autonomous things such as advanced robots, drones and autonomous vehicles. Intelligent things create opportunities in sectors and industries such as retail, where robots are acting as baristas and store greeters, and in farming, where self-driving tractors, robots and drones could increase farm yields and efficiencies. Existing things will become intelligent and autonomous, potentially delivering the power of AI-enabled systems everywhere, including the home and medical facilities.
- **“Practical” Blockchain:** Practical blockchain solutions implement a subset of the full blockchain stack and can achieve operational efficiency and reduce technical and business friction, but they lack truly decentralized trust models. They may enhance sharing of information among known entities and improve opportunities for tracking and tracing physical and digital assets.
- **AI security:** Through 2025, AI (especially machine-learning) will be applied to virtually every piece of software and every service and device. At the same time, there will be a massive increase in potential points of attack with the edge computing, cloud computing, microservices and highly connected systems in smart spaces.

Federal Government Trends

- The pandemic and digital workforce transformation drivers impact the way in which end-user computing devices are configured and provisioned.
- Mobility and Remote Workforce Expansion: Peripherals, Accessories: With an increasingly mobile workforce and proven remote work success, we anticipate more remote access requirements for the federal workforce. We see lightweight portable devices and accessories such as large monitors increase in use. There is a trend for the mobile workforce to replicate the office environment at home.
- BYOD: Agencies continue to develop policies addressing the use of personal devices to access agency resources.
- Connectivity: The federal government will likely follow industry trends, e.g., 5G.
- Thin-client and/or virtual environment: Adoption will likely lag behind agency cloud adoption. After agencies transition to the cloud, we anticipate a larger quantity of Thin-client devices being acquired.

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Appendix

GSS VERSION 6.0 SPECIFICATIONS as of 5/27/2020

TERMS AND CONDITIONS FOR ALL SYSTEMS:	Revised MINIMUM STANDARD
EPEAT:	EPEAT any level (based on 2018 standards)
Energy Star Compliant:	Compliant
TAA Compliant:	Compliant
Section 508 Compliant:	Compliant
Delivery Time (Days):	45 Calendar days After Receipt of Order (ARO) or less
3 year Standard Manufacturer Warranty (with options for 4, 5 year):	3 year standard warranty includes wearable items such as keyboard and battery in laptops & "Keep Your Hard Drive (KYHD)". Warranty options for 4 and 5 years do not cover wearable items.
SYSTEM	
LIGHTWEIGHT NOTEBOOK (including 360 degree foldable and Two-In-One Notebooks)	
CPU: Salient processor and platform characteristics:	CPU must be latest generation processor technology. <ul style="list-style-type: none"> - NIST SP800-147 compliant, Tamper Resistant UEFI 2.6 or later with Secure Boot functionality - Support Hardware-rooted trust platform and Hardware Security Test Interface (HSTI) Specification - CPU Virtualization Extensions w/ Second Level Address Translation (SLAT) support - CPU Input/output Memory Management Unit (IOMMU)
O/S:	Windows 10 Pro 64
RAM:	8GB
Hard Drive:	256GB SSD
Graphics:	Integrated HD graphics with dual monitor support
Display Size:	11" or larger
Display Resolution:	(1920x1080), FHD, Anti-glare where available
Sound:	Stereo Output
Speakers:	Integrated Stereo (Built-in Stereo Speakers)
Keyboard:	ANSI or ISO Standard Keyboard
Webcam:	Integrated
Microphone:	Integrated
Bluetooth:	Bluetooth 4.2 +, Integrated
Network Interface:	Gigabit Ethernet (network adapter/dongle is acceptable) / Wireless

Ports:	2 Ports- USB (USB 3.0 or later) at a Min (1 Type A and 1 Type C)
Expansion Slots:	Locking Cable Slot
Weight (includes battery):	3.5 pounds or less
Platform Integrity:	TPM Version 2.0
OPTIONS: The following options MUST be priced and quoted if available.	
Optional Docking Station:	Powered Docking Station (Snap-in-dock, single cable dock with USB or USB-C). Minimum 2 USB 3 ports with dual digital video output.
Optional Smart Card Reader:	Integrated or External FIPS-201 Approved OR ISO 7816 supported Smart Card Reader
Optional keyboard:	USB or wireless compatible with docking stations
Optional mouse:	USB or wireless compatible with docking stations
Optional Touchscreen:	Touchscreen capability
Optional Monitor:	23.8 inch viewable; must be compatible with optional docking station offered.
Optional Speakers:	Stereo speakers
Optional Optical drive:	External DVD RW
Optional Security-enabled features:	Webcam, microphone and Bluetooth not provided or disabled at BIOS; no optical drive
Optional Hard Drive upgrade:	Larger SSD
Optional Memory upgrade:	Upgrade to 16 GB or more
Optional Warranty:	Extend standard manufacturer base warranty to 4 years
Optional Warranty:	Extend standard manufacturer base warranty to 5 years
Any one or more of the following options MAY be priced and quoted.	
Optional Imaging - pre-supplied:	Ship with customer previously supplied and approved image
Optional Imaging - image provided with order:	Ship with customer supplied image at the time of the order
Optional Asset tagging:	Tag assets before shipping
Optional Warehousing:	Store assets
Optional Graphics Card:	Discrete graphics card
Optional Alternative CPU:	Must meet or exceed base CPU specs
Optional CPU w/Remote Desktop Management Support:	Processor and chipset support for 1. Trusted/secure execution environment and 2. PKI secure remote power up/down/reset
Optional Screen Protector:	Protect screen
Optional Laptop Carrying Case:	Laptop carrying case
Optional Monitor:	22 inch or larger; must be compatible with optional docking station offered.
Optional Backlit Keyboard:	Integrated backlit keyboard
Optional USB Keyboard Light:	USB plug-in keyboard light
Optional Power Adapter upgrade:	Upgraded OEM AC Power Adapter

NOTEBOOK	
CPU: Salient processor and platform characteristics:	CPU must be latest generation processor technology. - NIST SP800-147 compliant, Tamper Resistant UEFI 2.6 or later with Secure Boot functionality - Support Hardware-rooted trust platform and Hardware Security Test Interface (HSTI) Specification - CPU Virtualization Extensions w/ Second Level Address Translation (SLAT) support - CPU Input/output Memory Management Unit (IOMMU)
O/S:	Windows 10 Pro 64
RAM:	8 GB RAM
Hard Drive:	256GB SSD
Graphics:	Integrated HD graphics with dual monitor support
Display Size:	13 inches or larger
Display Resolution:	1920x1080 Anti-glare
Sound:	Stereo output
Speakers:	Integrated stereo (built-in stereo speakers)
Keyboard:	ANSI or ISO standard keyboard
Webcam:	Integrated
Microphone:	Integrated
Bluetooth:	Bluetooth 4.2 +, Integrated
Network Interface:	Gigabit ethernet/wireless
Ports:	3 Ports- USB (USB 3.0 or later) at a Min (1 Type A and 1 Type C)
Expansion Slots:	Locking cable slot
Weight (includes battery):	5 pounds or less
Platform Integrity:	TPM Version 2.0
OPTIONS: The following options MUST be priced and quoted if available	
Optional Docking Station:	Powered Docking Station (Snap-in-dock, single cable dock with USB or USB-C). Minimum 2 USB 3 ports with dual digital video output.
Optional Smart Card Reader:	Integrated or External FIPS-201 Approved OR ISO 7816 supported Smart Card Reader
Optional keyboard:	USB or wireless compatible with docking stations
Optional mouse:	USB or wireless compatible with docking stations
Optional Monitor:	23.8 inch viewable; must be compatible with optional docking station offered.
Optional Speakers:	Stereo speakers
Optional Optical drive:	Integrated or external DVD RW

Optional Security-enabled features:	Webcam, microphone and Bluetooth not provided or disabled at BIOS; no optical drive; network default to wired
Optional Hard Drive upgrade:	Larger SSD
Optional Memory upgrade:	Upgrade to 16 GB or more
Optional Warranty:	Extend standard manufacturer base warranty to 4 years
Optional Warranty:	Extend standard manufacturer base warranty to 5 years
Any one or more of the following options MAY be priced and quoted.	
Optional Imaging - pre-supplied:	Ship with customer previously supplied and approved image
Optional Imaging - image provided with order:	Ship with customer supplied image at the time of the order
Optional Asset tagging:	Tag assets before shipping
Optional Warehousing:	Store assets
Optional Graphics Card:	Discrete graphics card
Optional Alternative CPU:	Must meet or exceed base CPU specs
Optional CPU w/Remote Desktop Management Support:	Processor and chipset support for 1. Trusted/secure execution environment and 2. PKI secure remote power up/down/reset
Optional Touchscreen:	Touchscreen capability
Optional Screen Protector:	Protect screen
Optional Laptop Carrying Case:	Laptop carrying case
Optional Monitor:	22 inch or larger; must be compatible with optional docking station offered.
Optional Backlit Keyboard:	Integrated backlit keyboard
Optional USB Keyboard Light:	USB keyboard light
Optional Power Adapter upgrade:	Upgraded OEM AC Power Adapter
PERFORMANCE NOTEBOOK	
CPU: Salient processor and platform characteristics:	CPU must be latest generation processor technology. - NIST SP800-147 compliant, Tamper Resistant UEFI 2.6 or later with Secure Boot functionality - Support Hardware-rooted trust platform and Hardware Security Test Interface (HSTI) Specification - CPU Virtualization Extensions w/ Second Level Address Translation (SLAT) support - CPU Input/output Memory Management Unit (IOMMU)
O/S:	Windows 10 Pro 64
RAM:	16GB
Hard Drive:	512GB SSD
Graphics:	Integrated HD graphics with dual monitor support
Display Size:	14 inches or larger

Display Resolution:	1920x1080 Anti-glare
Sound:	Stereo Output
Speakers:	Integrated Stereo (Built-in Stereo Speakers)
Optical Drive:	Integrated or external DVD RW. DVD with all applicable hardware drivers, both 32Bit and 64Bit where available
Keyboard:	ANSI or ISO Standard Keyboard
Webcam:	Integrated
Microphone:	Integrated
Bluetooth:	Bluetooth 4.2 +, Integrated
Network Interface:	Gigabit Ethernet / Wireless
Ports:	3 Ports- USB (USB 3.0 or later) at a Min (1 Type A and 1 Type C)
Expansion Slots:	Locking cable slot
Platform Integrity:	TPM Version 2.0
OPTIONS: The following options MUST be priced and quoted if available	
Optional Docking Station:	Powered Docking Station (Snap-in-dock, single cable dock with USB or USB-C). Minimum 2 USB 3 ports with dual digital video output.
Optional keyboard:	USB or wireless compatible with docking stations
Optional mouse:	USB or wireless compatible with docking stations
Optional Monitor:	23.8 inch viewable; must be compatible with optional docking station offered.
Optional Speakers:	Stereo speakers
Optional Security-enabled features:	Webcam, microphone and Bluetooth not provided or disabled at BIOS; no optical drive; network default to wired
Optional Smart Card Reader:	Integrated or External FIPS-201 Approved OR ISO 7816 supported Smart Card Reader
Optional Hard Drive upgrade:	Larger SSD
Optional Memory upgrade:	Upgrade to 32 GB or more
Optional Graphics Card:	Discrete graphics card
Optional Warranty:	Extend standard manufacturer base warranty to 4 years
Optional Warranty:	Extend standard manufacturer base warranty to 5 years
Any one or more of the following options MAY be priced and quoted.	
Optional Imaging - pre-supplied:	Ship with customer previously supplied and approved image
Optional Imaging - image provided with order:	Ship with customer supplied image at the time of the order
Optional Asset tagging:	Tag assets before shipping
Optional Warehousing:	Store assets
Optional Alternative CPU:	Must meet or exceed base CPU specs

Optional CPU w/Remote Desktop Management Support:	Processor and chipset support for 1. Trusted/secure execution environment and 2. PKI secure remote power up/down/reset
Optional Touchscreen:	Touchscreen capability
Optional Screen Protector:	Protect screen
Optional Laptop Carrying Case:	Laptop carrying case
Optional Monitor:	22 inch or larger; must be compatible with optional docking station offered.
Optional Backlit Keyboard:	Integrated backlit keyboard
Optional USB Keyboard Light:	USB keyboard light
Optional Power Adapter upgrade:	Upgraded OEM AC Power Adapter
DESKTOP SMALL FORM FACTOR (including Mini/Micro Desktops)	
CPU: Salient processor and platform characteristics:	CPU must be latest generation processor technology. - NIST SP800-147 compliant, Tamper Resistant UEFI 2.6 or later with Secure Boot functionality - Support Hardware-rooted trust platform and Hardware Security Test Interface (HSTI) Specification - CPU Virtualization Extensions w/ Second Level Address Translation (SLAT) support - CPU Input/output Memory Management Unit (IOMMU)
O/S:	Windows 10 Pro 64
RAM:	8GB
Hard Drive:	256 GB SSD
Display/Graphics:	Integrated HD Graphics w/ Dual Monitor Support
Sound:	Stereo output
Speakers:	Integrated headphone and stereo speaker jacks or via splitter
Mouse:	USB or wireless optical mouse with scroll
Keyboard:	USB or wireless keyboard (ANSI/ISO w/card reader)
Network Interface:	Gigabit ethernet or wireless
Ports:	4 USB ports (USB 3.0 or later) (at least 1 Type A and 1 Type C), support for dual monitors
Expansion Slots:	1 slots available (PCI, PCIe, or m2)
Platform Integrity:	TPM Version 2.0
OPTIONS: The following options MUST be priced and quoted if available	
Optional Monitor:	23.8 inch viewable
Optional speakers:	Stereo speakers
Optional Graphics Card upgrade:	Discrete graphics card
Optional Security-enabled features:	Webcam, microphone and Bluetooth not provided or disabled at BIOS; no optical drive

Optional Smart Card Reader:	Integrated or External FIPS-201 Approved OR ISO 7816 supported Smart Card Reader
Optional Optical drive:	Integrated or external DVD RW
Optional Disk drive (primary):	Larger SSD
Optional Memory upgrade:	Upgrade to 16 GB or more
Optional Warranty:	Extend standard manufacturer base warranty to 4 years
Optional Warranty:	Extend standard manufacturer base warranty to 5 years
Optional Webcam	Webcam
Any one or more of the following options MAY be priced and quoted.	
Optional Imaging - pre-supplied:	Ship with customer previously supplied and approved image
Optional Imaging - image provided with order:	Ship with customer supplied image at the time of the order
Optional Asset tagging:	Tag assets before shipping
Optional Warehousing:	Store assets
Optional Alternative CPU:	Must meet or exceed base CPU specs
Optional CPU w/Remote Desktop Management Support:	Processor and chipset support for 1. Trusted/secure execution environment and 2. PKI secure remote power up/down/reset
Optional Monitor:	22 inch or larger
Optional Drives & Carriages:	Removable carriage drive
Optional KVM Switch:	Digital KVM switch (Connect min 2 systems)
DESKTOP (Mini Towers and Towers)	
CPU: Salient processor and platform characteristics:	CPU must be latest generation processor technology. - NIST SP800-147 compliant, Tamper Resistant UEFI 2.6 or later with Secure Boot functionality - Support Hardware-rooted trust platform and Hardware Security Test Interface (HSTI) Specification - CPU Virtualization Extensions w/ Second Level Address Translation (SLAT) support - CPU Input/output Memory Management Unit (IOMMU)
O/S:	Windows 10 Pro 64
RAM:	16GB
Hard Drive:	512 GB SSD
Display/Graphics:	Integrated HD graphics with dual monitor support and a slot available for a discrete card
Sound:	Stereo output
Speakers:	Integrated headphone and stereo speaker jacks or via splitter
Optical Drive:	Not required
Mouse:	USB or wireless optical mouse with scroll

Keyboard:	USB or wireless keyboard (ANSI/ISO w/card reader)
Network Interface:	Gigabit ethernet or wireless
Ports:	4 USB ports (USB 3.0 or later) (at least 1 Type A and 1 Type C), support for dual monitors
Expansion Slots:	2 PCI Slots available (PCI and/or PCIe)
Platform Integrity:	TPM Version 2.0
OPTIONS: The following options MUST be priced and quoted if available	
Optional Monitor:	23.8 inch viewable; must be compatible with optional docking station offered.
Optional speakers:	Stereo speakers
Optional Graphics Card upgrade:	Discrete graphics card
Optional Security-enabled features:	Webcam, microphone and Bluetooth not provided or disabled at BIOS; no optical drive
Optional Smart Card Reader:	Integrated or External FIPS-201 Approved OR ISO 7816 supported Smart Card Reader
Optional Optical drive:	Internal or External DVD RW
Optional Disk drive (primary):	Larger SSD
Optional Memory upgrade:	Upgrade up to 32 GB or more
Optional Warranty:	Extend standard manufacturer base warranty to 4 years
Optional Warranty:	Extend standard manufacturer base warranty to 5 years
Optional Webcam	Webcam
Any one or more of the following options MAY be priced and quoted.	
Optional Imaging - pre-supplied:	Ship with customer previously supplied and approved image
Optional Imaging - image provided with order:	Ship with customer supplied image at the time of the order
Optional Asset tagging:	Tag assets before shipping
Optional Warehousing:	Store assets
Optional Alternative CPU:	Must meet or exceed base CPU specs
Optional CPU w/Remote Desktop Management Support:	Processor and chipset support for 1. Trusted/secure execution environment and 2. PKI secure remote power up/down/reset
Optional Monitor:	22 inch or larger
Optional Drives & Carriages:	Removable carriage drive
Optional KVM Switch:	Digital KVM switch (Connect min 2 systems)
INTEGRATED (ALL-IN-ONE) (Computing hardware and display are integrated into a single housing)	

CPU: Salient processor and platform characteristics:	CPU must be latest generation processor technology. - NIST SP800-147 compliant, Tamper Resistant UEFI 2.6 or later with Secure Boot functionality - Support Hardware-rooted trust platform and Hardware Security Test Interface (HSTI) Specification - CPU Virtualization Extensions w/ Second Level Address Translation (SLAT) support - CPU Input/output Memory Management Unit (IOMMU)
O/S:	Windows 10 Pro 64
RAM:	16 GB
Hard Drive:	256 GB SSD, NVMe over M.2 (4GB/s or greater)
Display/Graphics:	Integrated HD Graphics or Discrete Graphics Card w/ Dual Monitor Support
Display Size:	21.5" or larger
Display Resolution:	1920 x 1080 (FHD)
Sound:	Stereo output
Speakers/Microphone:	Analog microphone audio input, and stereo analog line level audio output. (Headphone/Microphone Combo Port is acceptable)
Mouse:	USB or wireless optical mouse with scroll
Keyboard:	USB or wireless keyboard (ANSI/ISO w/card reader)
Network Interface:	Gigabit ethernet or wireless
Ports:	4 USB ports (USB 3.0 or later) (at least 1 Type A and 1 Type C), support for dual monitors
Expansion Slots:	N/A
Platform Integrity:	TPM Version 2.0
OPTIONS: The following options MUST be priced and quoted if available	
Optional Monitor:	23.8 inch viewable; must be compatible with optional docking station offered.
Optional speakers:	Stereo speakers
Optional Graphics Card upgrade:	Discrete graphics card
Optional Security-enabled features:	Webcam, microphone and Bluetooth not provided or disabled at BIOS; no optical drive
Optional Smart Card Reader:	Integrated or External FIPS-201 Approved OR ISO 7816 supported Smart Card Reader
Optional Optical drive:	Integrated or external DVD RW
Optional Disk drive (primary):	Larger SSD
Optional Memory upgrade:	Upgrade to 32 GB or more
Optional Warranty:	Extend standard manufacturer base warranty to 4 years
Optional Warranty:	Extend standard manufacturer base warranty to 5 years
Optional Webcam	Webcam
Any one or more of the following options MAY be priced and quoted.	

Optional Imaging - pre-supplied:	Ship with customer previously supplied and approved image
Optional Imaging - image provided with order:	Ship with customer supplied image at the time of the order
Optional Asset tagging:	Tag assets before shipping
Optional Warehousing:	Store assets
Optional Alternative CPU:	Must meet or exceed base CPU specs
Optional CPU w/Remote Desktop Management Support:	Processor and chipset support for 1. Trusted/secure execution environment and 2. PKI secure remote power up/down/reset
Optional Monitor:	22 inch or larger
Optional Drives & Carriages:	Removable carriage drive
Optional KVM Switch:	Digital KVM switch (Connect min 2 systems)
PERFORMANCE DESKTOP (Mini Towers and Towers)	
CPU: Salient processor and platform characteristics:	CPU must be latest generation processor technology. - NIST SP800-147 compliant, Tamper Resistant UEFI 2.6 or later with Secure Boot functionality - Support Hardware-rooted trust platform and Hardware Security Test Interface (HSTI) Specification - CPU Virtualization Extensions w/ Second Level Address Translation (SLAT) support - CPU Input/output Memory Management Unit (IOMMU)
O/S:	Windows 10 Pro 64
RAM:	32GB
Hard Drive:	256 GB Solid-State (SSD) and a 1TB (HDD or SSD)
Display/Graphics:	Discrete graphics card
Sound:	Stereo output
Speakers:	Integrated headphone and stereo speaker jacks or via splitter
Optical Drive:	DVD RW
Mouse:	USB or wireless optical mouse with scroll
Keyboard:	USB or wireless keyboard (ANSI/ISO w/card reader)
Network Interface:	Gigabit ethernet or wireless
Ports:	6 USB ports (USB 3.0 or later) (at least 1 Type A and 1 Type C), support for dual monitors
Expansion Slots:	2 PCI Slots available (PCI and/or PCIe)
Platform Integrity:	TPM Version 2.0
OPTIONS: The following options MUST be priced and quoted if available	
Optional Monitor:	23.8 inch viewable; must be compatible with optional docking station offered.

Optional speakers:	Stereo speakers
Optional Security-enabled features:	Webcam, microphone and Bluetooth not provided or disabled at BIOS; no optical drive; network default to wired
Optional Smart Card Reader:	Integrated or External FIPS-201 Approved OR ISO 7816 supported Smart Card Reader
Optional Disk drive (primary):	Larger SSD
Optional Memory upgrade:	Upgrade to 64 GB or more
Optional Warranty:	Extend standard manufacturer base warranty to 4 years
Optional Warranty:	Extend standard manufacturer base warranty to 5 years
Optional Webcam	Webcam
Any one or more of the following options MAY be priced and quoted.	
Optional Imaging - pre-supplied:	Ship with customer previously supplied and approved image
Optional Imaging - image provided with order:	Ship with customer supplied image at the time of the order
Optional Asset tagging:	Tag assets before shipping
Optional Warehousing:	Store assets
Optional Graphics Card:	Integrated HD graphics with dual monitor support
Optional Alternative CPU:	Must meet or exceed base CPU specs
Optional CPU w/Remote Desktop Management Support:	Processor and chipset support for 1. Trusted/secure execution environment and 2. PKI secure remote power up/down/reset
Optional Monitor:	22 inch or larger
Optional Drives & Carriages:	Removable carriage drive
Optional KVM Switch:	Digital KVM switch (Connect min 2 systems)
TABLET	
CPU: Salient processor and platform characteristics:	CPU must be latest generation processor technology. - NIST SP800-147 compliant, Tamper Resistant UEFI 2.6 or later with Secure Boot functionality - Support Hardware-rooted trust platform and Hardware Security Test Interface (HSTI) Specification - CPU Virtualization Extensions w/ Second Level Address Translation (SLAT) support - CPU Input/output Memory Management Unit (IOMMU)
O/S:	Windows 10 Pro 64
RAM:	8GB
Hard Drive:	128GB
Graphics:	Integrated HD graphics
Display Size:	9" minimum
Display Resolution:	1920x1080

Touchscreen	Yes
Sound:	Stereo output
Speakers:	Integrated Stereo (Built-in Stereo Speakers)
Webcam:	Front and rear facing
Microphone:	Integrated
Bluetooth:	Bluetooth 4.2 +, Integrated
Network Interface:	Wi-Fi mandatory, Cellular (4G) optional
Ports:	2 USB Ports including 1 type C
Weight:	2.2 pounds maximum
Platform Integrity:	TPM Version 2.0
OPTIONS: The following options MUST be priced and quoted if available	
Optional Keyboard:	Detachable ANSI or ISO keyboard
Optional Warranty:	Extend standard manufacturer base warranty to 4 years
Optional Warranty:	Extend standard manufacturer base warranty to 5 years
Optional Smart Card Reader:	Integrated or External FIPS-201 Approved OR ISO 7816 supported Smart Card Reader
Any one or more of the following options MAY be priced and quoted.	
Optional Asset tagging:	Tag assets before shipping
Optional Warehousing:	Store assets
Optional Input Device:	Stylus
Optional Carrying Case:	Carrying case
Optional Screen Protector:	Screen protector
Optional Stand:	Stand compatible w/Tablet offered
Optional Slot:	Memory Card Support
Optional Alternative CPU:	Must meet or exceed base CPU specs
Optional CPU w/Remote Desktop Management Support:	Processor and chipset support for 1. Trusted/secure execution environment and 2. PKI secure remote power up/down/reset
Optional Power Adapter upgrade:	Upgraded OEM AC Power Adapter
Thin Client / Zero Client Computer	
Operating System (thin client)	Varies based on virtual machine solution
Kernel Services (zero client)	Kernel that provides networking protocol services between the device and host server to include display, keyboard/mouse inputs, and audio services
BIOS (thin client)	NIST SP 800-147 Compliance
Installed RAM (thin client)	8GB
Installed RAM (zero client)	512MB
Number of Independent Displays Supported	Two
Display Interface Type	Digital Video Interface (DVI) or DisplayPort (Version 1.2 or higher) interfaces

Audio Support	Analog microphone audio input, and stereo analog line level audio output. Headphone/Microphone Combo Ports are acceptable
Network Interface	IEEE 802.3ab 1000 Mbit/s with a physical layer 1000BASE-T connection
USB Ports	Four externally accessible Universal Serial Bus (USB 2.0 or USB 3.0) ports
Keyboard:	Section 508 compliant 104-key QWERTY keyboard
Smart Card Reader:	FIPS-201 and ISO/IEC 7816 compliant (integrated in keyboard)
Mouse	Optical mouse with two buttons and scroll wheel
OPTIONS: The following options MUST be priced and quoted if available	
Optional Asset tagging:	Tag assets before shipping
Optional Warehousing:	Store assets
Optional Monitor	22 inch FHD or larger/better
Optional Slot:	Memory Card Support
Optional Warranty:	Extend standard manufacturer base warranty to 4 years
Optional Warranty:	Extend standard manufacturer base warranty to 5 years
Optional Management Suite	Compatible with environment/device
Optional VDI Broker Support	Support Customer's environment
Optional Storage	SSD 128G