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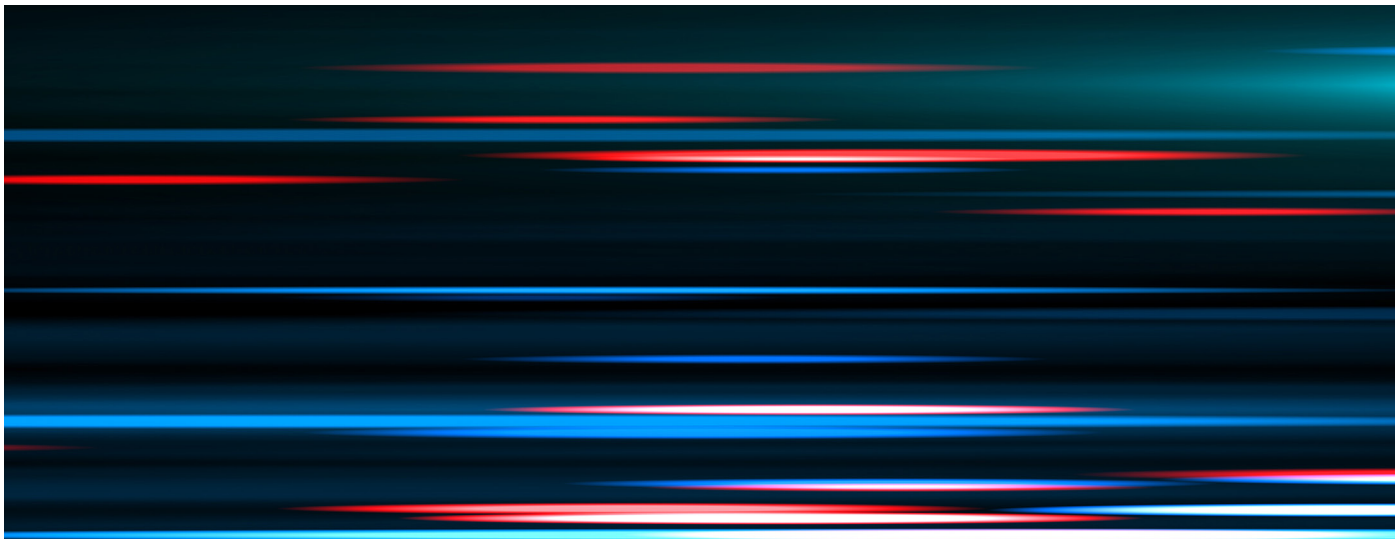


Technical Research Report

PCs or Macs: Which Provide the Best Value and Flexibility for Your Business?

Research shows greater variety, manageability, and supportability, in addition to a lower total cost of ownership (TCO), for PCs in small and medium-sized businesses (SMBs) and in the enterprise.

Executive Summary

When it comes to end-user devices, businesses want to give employees the best user experience possible. In addition, organizations need to consider manageability, supportability, security, and affordability for those devices. The first step in choosing devices lies in selecting the overall ecosystem. For many organizations, that comes down to a choice between PCs based on Windows® or Apple® devices.

Based on extensive research and testing, Prowess has determined Intel® processor–based PCs running Windows to be a better option for most businesses because the Windows PC ecosystem provides several benefits over Apple device–based deployments.

For the devices we compared, the PC option offers:[1]

- Between $650 and $1,249 lower capital expenditure (CapEx)
- Up to 37 percent lower cost for mobile device management (MDM) and essential productivity software
- Between 26 percent and 45 percent lower total cost of ownership (TCO)

In addition, the Windows solution provides:

- More comprehensive compliance and configuration options
- Simpler MDM from a single pane of glass
- Added security capabilities and remote support, even for out-of-band devices, via Intel vPro® technology
- More options for form factors and upgradeability

The Search for Lower Business Costs

In this age of ever-increasing costs and reduced budgets, businesses continuously look for ways to reduce both CapEx and operating expenses (OpEx). Employee devices can make up a significant portion of a company's IT spending in both categories. In addition to their primary PC and/or mobile device, each user requires an initial deployment effort and has ongoing security, support, and maintenance needs. In some cases, the OpEx maintenance and support costs might even outweigh the initial device outlay.

At the same time, businesses understand the need to provide workers with a frictionless experience that simplifies their workflows and increases productivity. Every hour an end user spends manually troubleshooting a problem, installing updates, or struggling to perform a task is an hour removed from accomplishing work that results in revenue for the company. For example, an employee struggling to solve an intermittent Bluetooth® device connection or to identify the cause of dropped Wi-Fi® connections is distracted from being productive at best and blocks critical tasks at worst. That can lead to frustration, wastes valuable hours, and impacts the bottom line for the business.

The same holds true for IT workers: more time spent supporting and troubleshooting PCs results in less time spent on more critical tasks. Every hour an admin spends hand-holding a remote employee through troubleshooting steps is an hour subtracted from business-productivity tasks. This factor is particularly important for enterprise businesses, where the impact is magnified by 1,000 or more users. However, even small or medium-sized businesses (SMBs) need to carefully account for user support and management costs.

PCs Based on Windows® Compared to Apple® Mac® Devices in Business

To minimize costs and reduce overall TCO, businesses need to carefully choose end-user devices that cost less and require less time and labor to deploy, configure, manage, and support. In addition, companies want to purchase devices that deliver a seamless user experience and that can help improve worker productivity.

The primary factor in meeting these goals is the hardware selected for users; namely, PCs based on Windows versus Apple® Mac® devices. These two device options typically have very different up-front costs, require different device-management tools, and require different IT expertise for ongoing support and management.

Currently, Windows PCs are still the overwhelming choice for business users. Recent data from Statista shows the Windows operating system (OS) with a market share of more than 73 percent, compared to about 15 percent for macOS®.[2] Despite that preference, businesses might be considering a switch from PCs to Mac devices in the enterprise.

Which option—PCs or Mac devices—enables a better experience and a lower TCO? To help businesses make a more informed decision, Prowess Consulting performed research and testing comparing the two systems.

PCs Versus Mac Devices for Business: Which Comes Out on Top?

We compared devices in the following categories:

- CapEx for devices and peripherals
- OpEx for deployment, management, and support
- Security considerations
- Upgradeability
- Form factors and user experience

Each of these categories is covered in a separate section below.

Total Cost of Ownership (TCO) Comparisons

For cost comparisons, we selected business PC and Mac options that a company would likely consider or purchase. For example, we selected Windows PCs from one of the top three vendors (Lenovo), based on sales.[3] All the devices are described in more detail in the following sections.

PC Devices Based on Intel® Processors and Windows

For the devices running Windows, we selected two laptops from Lenovo. Both offer flexible form factors and touchscreens.

The first model, a Lenovo® ThinkPad® T14s, is powered by a 12th Generation Intel® Core™ i5 processor and is certified for the Intel® Evo™ platform. The ThinkPad T14s also includes Intel vPro technology, which provides additional security and management capabilities that are important to many businesses. The ThinkPad T14s also comes with Windows 11 Pro, which supports BitLocker® Drive Encryption.

The second model, a Lenovo® Yoga® 7 16-inch 2-in-1, provides a large screen, is also powered by a 12th Generation Intel Core i7 processor, and is also certified for the Intel Evo platform.

Intel® Evo™ Platform

To qualify as an Intel Evo device, a device must meet several rigid qualifications, including:

- Consistent responsiveness while on battery power
- System wake-from-sleep in less than one second
- Nine or more hours of real-world battery life
- Fast charging with up to a 4-hour charge in less than 30 minutes
- Wi-Fi® 6 connectivity
- Thunderbolt™ 4 ports[4]
- USB-C charging

Because it is a 2-in-1 device, the Lenovo Yoga offers a flexible form factor for users on the go. It is capable of being used in laptop, tablet, or tent mode, it provides a touchscreen, and it supports handwritten notes with an optional stylus. Because this device is so adaptable, it is particularly appealing to mobile workers, like sales representatives, looking to maximize productivity throughout the workday.

Let's look at a fictional but typical sales rep named Marissa who shuttles between a work office, her home office, and client locations. Marissa might start her day at work, using her Yoga 7 in laptop mode, plugged into an external display. Later, she could pack up her device to go on a sales call. While on a train or in a cab, she can take out the Lenovo device, fold it completely back on itself, hold it vertically like a pad of paper, and use the included stylus to mark up a diagram, sketch out ideas, and add hand-written notes. At the customer site, Marissa can place the device in tent mode and start a Microsoft® PowerPoint® presentation.

Apple® macOS® Devices

For the Apple devices, we looked at current-generation Apple® M1 Pro processor–based Apple® MacBook Pro® laptops. The MacBook Pro provides good performance for business users, but it does not have a touchscreen or stylus support. To match the capabilities provided by the Lenovo Yoga 7, we needed to include an Apple® iPad Air® tablet, because Apple does not provide one device that can offer this combined functionality (see Figure 1).

To replicate the sales rep example above, if Marissa was using Apple devices, she would need to start out her day on a MacBook Pro at the office, and then switch to her iPad to do hand-written notes and sketches. Because she would be using a different device from her MacBook, she would need to rely on wireless syncing to see her changes reflected on the other device. At the customer site, she would need to display her PowerPoint presentation in standard laptop mode, because the MacBook Pro doesn't support tent mode. She could use the iPad for presenting, but the iPad has a smaller screen and no built-in stand.

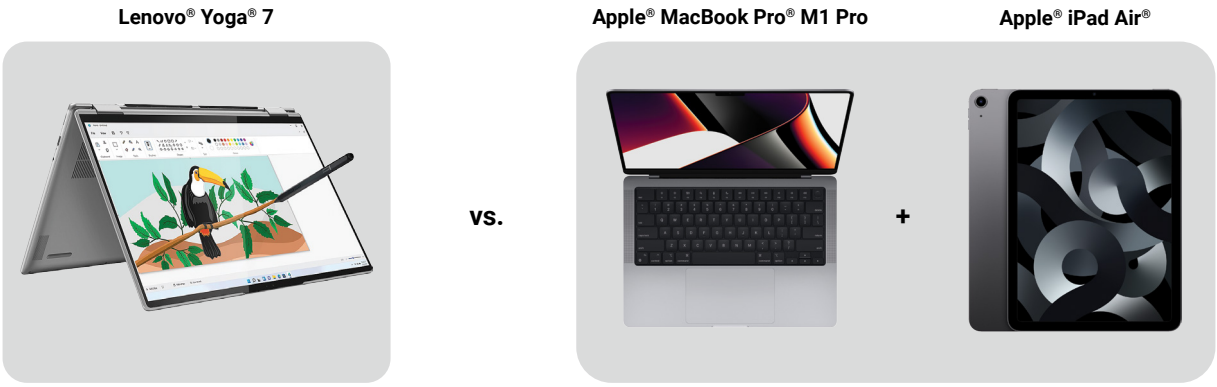


Figure 1 | To get comparable functionality to the Lenovo® Yoga® 7, an Apple user would require two devices

Table 1 summarizes configurations and pricing for the devices compared in this TCO study.[5]

Table 1 | Comparison of tested devices

Device	Lenovo® ThinkPad® T14s Gen 3*	Lenovo® Yoga® 7 161AP7**	Apple® MacBook Pro® M1 Pro***	Apple® iPad Air®
Processor	12th Generation Intel® Core™ i5-1250P processor with Intel vPro® (4 P-cores and 8 E-cores)	12th Generation Intel Core i7-1260P processor (4 P-cores and 8 E-cores)	Apple® M1 Pro with 10-core CPU and 16-core graphics processing unit (GPU)	Apple M1 8-core processor
Memory	16 GB	16 GB	16 GB	8 GB
Storage	1 TB solid-state drive (SSD)	1 TB SSD	1 TB SSD	64 GB
Display	14-inch WUXGA (1920x1200) IPS	16-inch WQXGA (2560x1600) IPS	14.2-inch Liquid Retina® XDR (3024x1964)	10.9 inch (2360x1640)
Price	$1,615.50	$1,349.00	$1,999.00	$599.00
			MacBook Pro + iPad Air: $2,598.00	

* Lenovo ThinkPad T14s pricing obtained 9/6/2022 from the Lenovo online configurator.
** Lenovo Yoga 7 pricing obtained 9/6/2022 from the Best Buy website.
***Apple pricing obtained 7/12/2022 from the Apple website.

In a direct comparison between the Intel processor–based PCs running Windows and the MacBook Pro, PC users would achieve substantial savings:

- Lenovo ThinkPad T14s: **$383.50 per device less** than the MacBook Pro
- Lenovo Yoga 7: **$650.00 per device less** than the MacBook Pro

For an enterprise with 50 users, that adds up to $19,175 in CapEx savings for Lenovo ThinkPad T14s users and $32,500 for Lenovo Yoga 7 users. Extrapolating to an enterprise with 1,000 users, the total CapEx savings would be $383,500 and $650,000, respectively.

But to achieve comparable functionality, the CapEx differences would be even greater. As discussed earlier, users looking for tablet functionality would require two devices—a MacBook Pro and an iPad Air—to achieve equivalent functionality to the Lenovo Yoga 7. Comparing CapEx costs for these two platforms shows significant savings:

- Lenovo Yoga 7: **$1,249.00 per device less** than the MacBook Pro plus iPad Air combination

For an enterprise with 50 users, that adds up to $62,450 in CapEx savings for the Lenovo Yoga. For an enterprise with 1,000 users, the total CapEx savings would be an astounding $1,249,000.

OpEx Costs

For OpEx costs, we focused on device management and productivity software. We didn't include OS costs because both the Windows devices and Apple devices in this study shipped with OS licenses.

In addition, specialized software was excluded because (1) these applications would vary considerably between organizations, and (2) individual application costs would likely be similar across both platforms.

We did include basic productivity software that would typically be needed by all organizations, regardless of size. Productivity suites typically include applications for email, appointments, word processing, presentations, spreadsheets, file management, and collaboration. For the purposes of this study, we elected to use Microsoft 365®, which includes Microsoft® Office productivity apps. We selected Microsoft 365 because, according to a February 2022 study by Statista, Microsoft® Office 365® leads the productivity software space with 48 percent market share.[6]

MDM Software

For testing device management, we selected a popular MDM solution for each platform. For the Apple environment, we chose Jamf®. For the Windows environment, we selected Microsoft Intune®, which is included with several other Microsoft software packages, including Microsoft 365 Business Premium.

OpEx Costs for MDM and Productivity Software

Table 2 shows the combined costs for the MDM solution and productivity suite.

Table 2 | Total costs for the MDM solution and productivity suite combined for Apple® and Windows® environments

	Windows® Environment	Apple® Environment
MDM solution per user per year	$0 (Microsoft Intune® included with Microsoft 365® plan)	$156 (Jamf® Business Plan)
Microsoft 365 productivity suite per user per year	$264 (Microsoft 365 Business Premium)[7]	$264 (Microsoft 365 Business Premium)[7]
Total cost per user per year	$264	$420
Total cost for 50 users	$13,200	$21,000 ($7,800 more expensive)
Total cost for 1,000 users	$264,000	$420,000 ($156,000 more expensive)
Savings	**37% lower cost**	

Because it is included in the Microsoft 365 Business Premium subscription offering, Microsoft Intune offers a better value than Jamf Pro. An Apple environment relying on Jamf Pro would need to purchase a separate Microsoft 365 subscription, resulting in a 37 percent lower cost for the Windows users, compared to the Apple users.

TCO for CapEx and OpEx

Combining CapEx and OpEx savings can lead to substantial gains for an organization running Windows, both when comparing basic laptops only and when comparing platforms that support tablet functionality.

Table 3 compares the TCO between the Lenovo ThinkPad T14s and the MacBook Pro. Amortized savings for the ThinkPad over three years can lead to gains of $14,191.50 for an organization with 50 users running Windows, and more than $283,830.00 for a 1,000-seat enterprise. That's a 26 percent savings for the business running Windows, as shown in Table 3.

Table 3 | TCO for a basic-functionality Windows® PC–based environment versus an Apple® device–based environment

	Lenovo® ThinkPad® T14s*	Apple® MacBook Pro®**
Total device cost (first year)	$1,615.50	$1,999.00
Cost per device per year (amortized over three years)	$538.50	$666.33
MDM solution	Microsoft Intune®	Jamf® Business Plan
MDM solution per user per year	$0.00 (included in Microsoft 365® Business Premium plan)	$156.00
Microsoft 365 Business Premium subscription per user per year	$264.00	$264.00
Total yearly cost, amortized over three years	$802.50	$1,086.33
Total yearly cost for 50 users	$40,125.00	$54,316.50 ($14,191.50 more expensive)
Total yearly cost for 1,000 users	$802,500.00	$1,086,330.00 ($283,830 more expensive)
Savings	**26% lower cost**	

* Lenovo ThinkPad T14s pricing obtained 9/6/2022 from the Lenovo online configurator.
** Apple pricing obtained 7/12/2022 from the Apple website.

Table 4 compares the TCO between platforms that support full touchscreen and stylus functionality: a Lenovo Yoga 7 for Windows users and a MacBook Pro plus iPad Air for Apple users. Amortized savings over three years can lead to gains of $28,616.50 for an organization with 50 users running Windows, and more than $572,330.00 for a 1,000-seat enterprise. That's a 45 percent savings for the business running Windows, as shown in Table 4.

Table 4 | TCO for a higher productivity Windows® PC–based environment versus an Apple® device–based environment

	Lenovo® Yoga® 7	Apple® MacBook Pro® + Apple® iPad Air®
Total device cost (first year)	$1,349.00	$2,598.00
Cost per device per year (amortized over three years)	$449.67	$866.00
MDM solution	Microsoft Intune®	Jamf® Business Plan
MDM solution per user per year	$0.00 (included in Microsoft 365® Business Premium plan)	$156.00
Microsoft 365 Business Premium subscription per user per year	$264.00	$264.00
Total yearly cost, amortized over three years	$713.67	$1,286.00
Total yearly cost for 50 users	$35,683.50	$64,300.00 ($28,616.50 more expensive)
Total yearly cost for 1,000 users	$713,670.00	$1,286,000.00 ($572,330.00 more expensive)
Savings	**45% lower cost**	

Comparing Functionality and Ease of Use of MDM Solutions

Device management is a critical factor to consider when choosing between Windows and Apple ecosystems for your business. After all, deploying, securing, and controlling access for remote systems is key for ensuring security and compliance. The choice of MDM can also make or break an end user's experience, depending on how easy it is for a user to get started with a new device and to access all the apps and resources they need out of the box. In summary, the MDM solution needs to be simple to install and use, and it must meet all of the company's needs for enrolling new devices, enforcing compliance, and ensuring strong security.

For MDM testing, we compared the two devices shown in Table 5.

Table 5 | Devices used for MCM testing

Device	Lenovo® ThinkPad® X1 Yoga® Gen 7 14-inch	Apple® MacBook Pro® M1 Pro
Processor	12th Generation Intel® Core™ i7-1270P processor with Intel vPro® (4 P-cores and 8 E-cores)*	Apple® M1 Pro with 10-core CPU and 16-core GPU
Memory	16 GB	16 GB
Storage	512 GB PCIe® Gen4 SSD	1 TB SSD
Display	14.0" WUXGA (1920x1200) IPS with touchscreen	14.2-inch Liquid Retina® XDR (3024x1964)

* Device selected based on availability at the time of testing.

The Lenovo® ThinkPad® X1 Yoga® 2-in-1 is built on the Intel Evo platform with Intel vPro technology and is powered by a 12th Generation Intel Core i7 processor. The MacBook Pro is powered by an Apple M1 Pro processor.

To compare the full experience of Microsoft Intune and Jamf Pro, Prowess engineers deployed both MDM solutions and used them to manage the test devices described in Table 5 (see Figure 2). We created a real-world scenario for testing based on two nearly identical companies: one running Windows devices and one running Apple devices. The organization with Windows used Microsoft Azure® Active Directory®. Both organizations worked with the Microsoft Office suite (included with a Microsoft 365 subscription, as described in the "OpEx Costs" section, earlier).

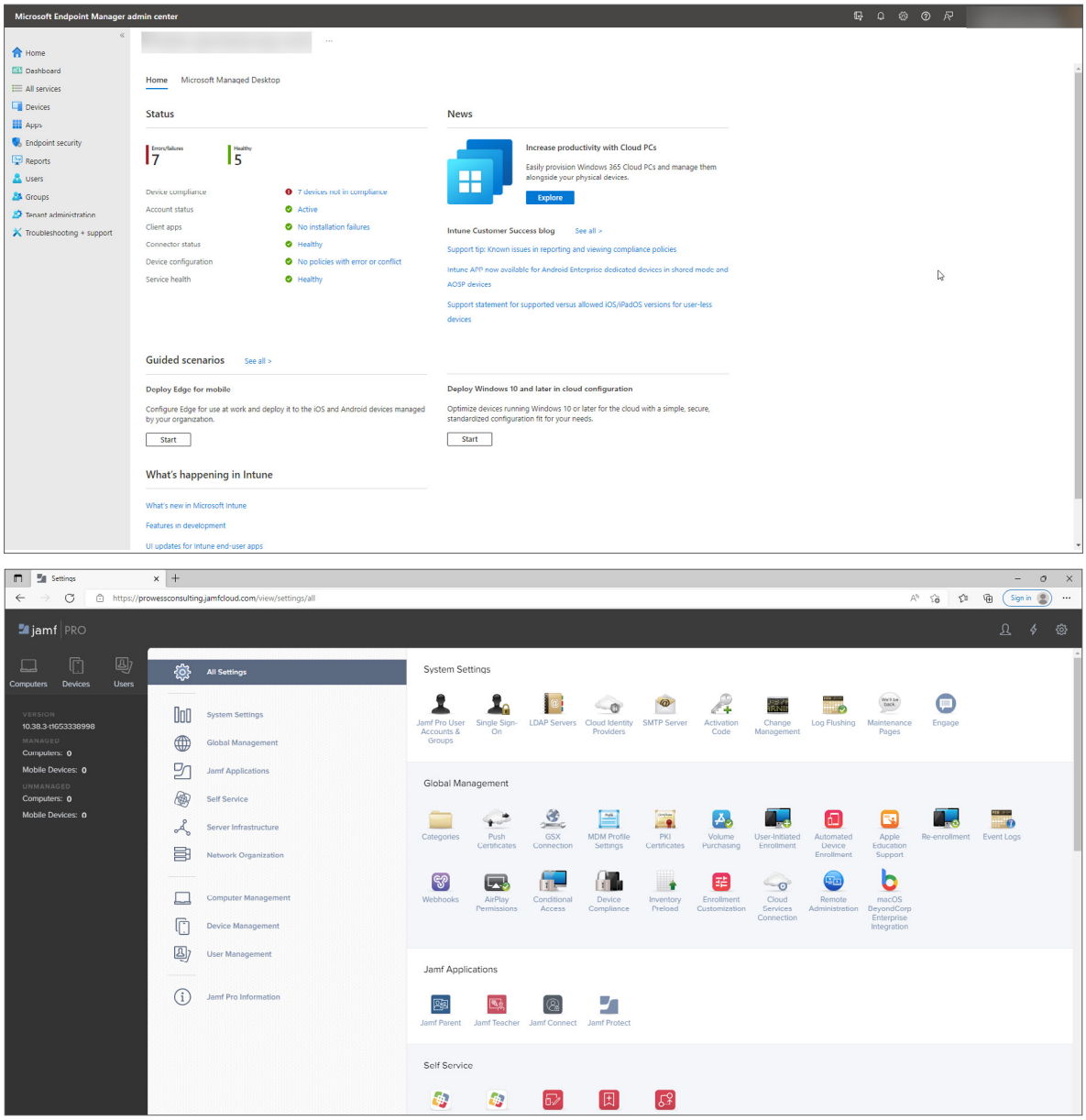


Figure 2 | The Microsoft Intune® and Jamf® Pro user interfaces (UIs) compared

Each business in our scenarios had 50 employees split into human resources (HR), development, manufacturing, sales/marketing, and shipping/receiving groups. Different users and groups were assigned access to different files, applications, and resources, as shown in Table 6. All devices needed to have fully encrypted drives, and all users were required to use multi-factor authentication (MFA).

Table 6 | User and device groups were assigned different default apps and policies for testing

Company User and Device Groups	Applications	Policies
Human resources (HR)	• Microsoft® Office • Intuit® QuickBooks®	• Access to printer 1 • Access to file share 1 & 2 • Disk encryption • DNS: Set to 8.8.8.8 for testing • Password complexity: Set to minimum of 8 characters, history set to 2, must use a capital letter and a number
Development	• Microsoft® Visual Studio®	• Access to printer 1 • Access to file share 1 • Disk encryption • DNS: Set to 8.8.8.8 for testing • Password complexity: Set to minimum of 8 characters, history set to 2, must use a capital letter and a number
Manufacturing	• Microsoft Office	• Access to printer 2 • Access to file share 1 • Disk encryption • DNS: Set to 8.8.8.8 for testing • Password complexity: Set to minimum of 8 characters, history set to 2, must use a capital letter and a number
Sales/marketing	• Microsoft Office • Adobe® Creative Cloud®	• Access to printer 1 • Access to file share 2 • Disk encryption • DNS: Set to 8.8.8.8 for testing • Password complexity: Set to minimum of 8 characters, history set to 2, must use a capital letter and a number
Shipping/receiving	• Adobe® Reader	• Access to printer 2 • Access to file share 1 • Disk encryption • DNS: Set to 8.8.8.8 for testing • Password complexity: Set to minimum of 8 characters, history set to 2, must use a capital letter and a number

Installing and Initial Configuration of MDM Software

Installation was simple and straightforward for both solutions. Both Microsoft Intune and Jamf Pro had simple procedures for creating groups, adding users, and setting policies for users and groups.

We tested by performing the following actions for both Windows devices in Microsoft Intune and Apple devices in Jamf Pro:

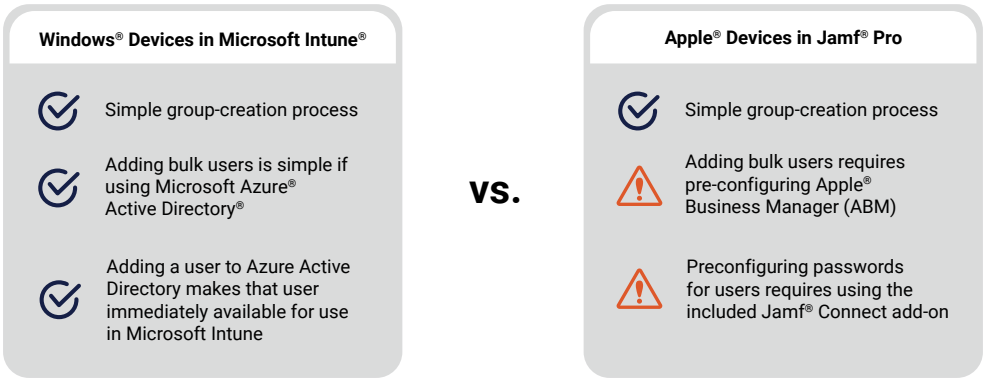
- Set up users and groups
- Created configuration policies
- Created compliance policies
- Created security policies
- Enrolled devices

Our engineers compared the capabilities and ease of use for all tasks. They also investigated IT management and tracking features for both MDM solutions, including locking or wiping remote computers, disabling/enabling features such as Bluetooth or remote desktop, and the ability to remotely access and troubleshoot a device. Finally, our engineers compared the ability to verify and track compliance for each MDM solution.

The following sections describe the findings for each task.

Users and Groups

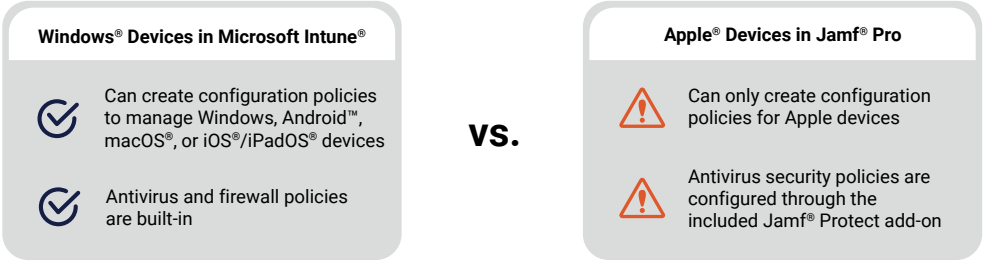
Microsoft Intune provides out-of-the-box ability to batch-add users or import them from cloud-identity services. Jamf Pro requires Apple® Business Manager (ABM) preconfigured in order to create a large number of users. Jamf Pro also requires the included add-on Jamf® Connect tool in order to import users from cloud-identity providers. Without ABM or Jamf Connect, users must be created one at a time, and the user is linked to the device manually after enrollment (unless a Lightweight Directory Access Protocol [LDAP] server is configured, in which case the user can be linked at enrollment).



Configuration Policies

Both Microsoft Intune and Jamf Pro make it easy to set up and apply configuration policies, although Microsoft Intune has a broader selection of policies to choose from.

Microsoft Intune enables IT admins to use one tool to manage devices running the most common operating systems—Jamf does not. While Microsoft Intune works for Windows, Android™, macOS, and iOS®/iPadOS® devices, Jamf Pro only works with macOS and iOS/iPadOS devices. In addition, Microsoft Intune has security (antivirus/firewall) policies built-in, whereas Jamf Pro requires using the Jamf® Protect add-on (included with the Jamf Business plan).



Compliance Policies

Both MDM solutions offered similar functionality and ease of use, with one exception. Enabling disk encryption was less intuitive in Jamf Pro because the solution required first configuring encryption from the main **Settings**, **Computer Management** screen, which wasn't clearly documented. Prior to taking that step, the FileVault® policy screen did not show any options in the drop-down list for disk-encryption configuration, as shown in Figure 3. After enabling encryption in the **Settings** menu and returning to the policy setting, the drop-down list was propagated, and the policy could be configured.

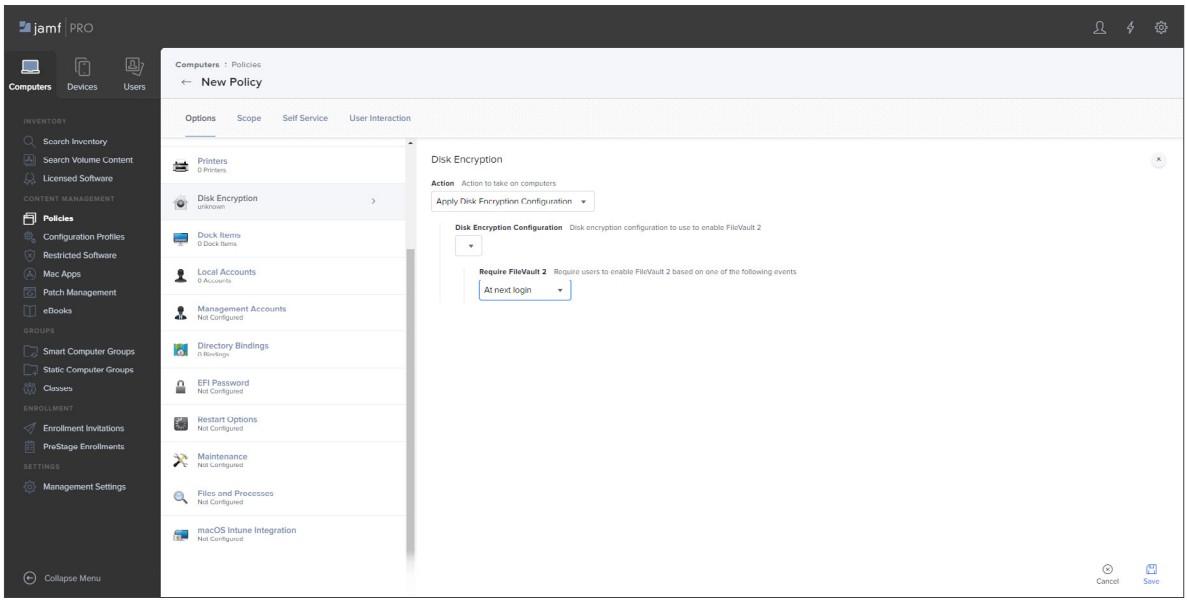
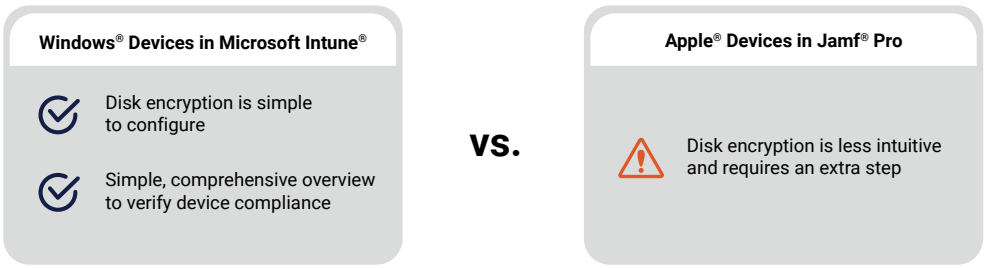


Figure 3 | The **Disk Encryption** policy drop-down menu in Jamf® Pro was blank until encryption was separately configured from the **Settings**, **Computer Management**, **Disk Encryption** section

Note that there are no compliance policies specifically for mobile devices in Jamf Pro because iOS and iPadOS devices are already essentially walled off by default.

Microsoft Intune also makes it easier to verify compliance for devices within the user interface (UI), as shown in Figure 4.



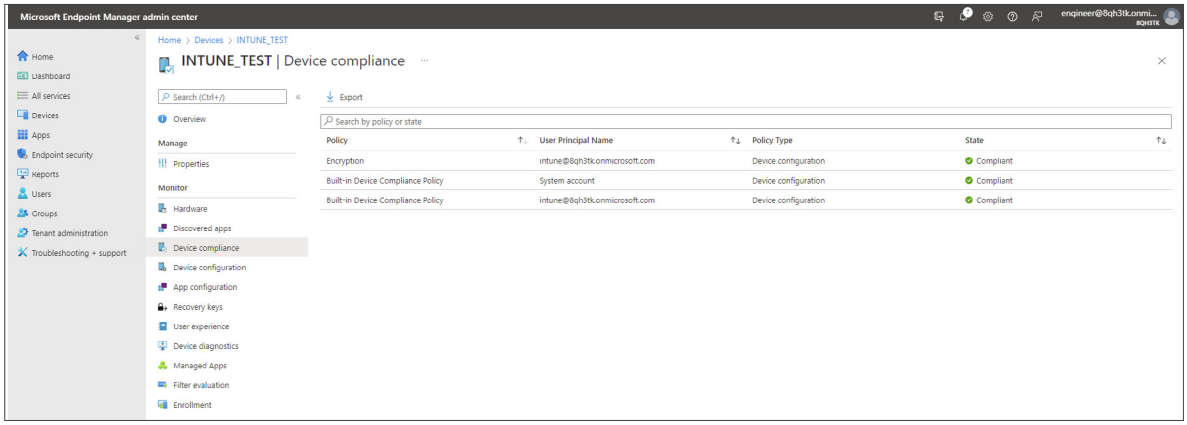
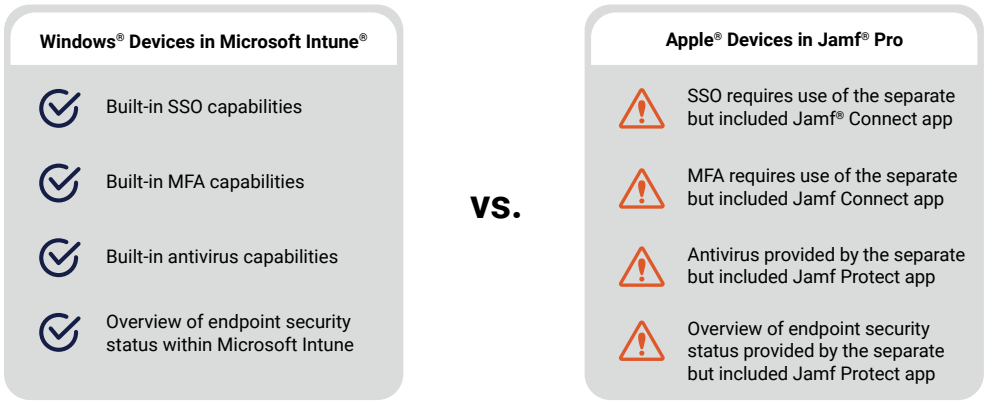


Figure 4 | Microsoft Intune® makes it easy to see compliance status at a glance

Creating Security Policies

Jamf Pro does not include many security features in the core application, aside from remote lock/wipe and setting password requirements, but the app does provide additional functionality in the included Jamf Protect and Jamf Connect add-ons. Jamf Connect is required to configure single sign-on (SSO) and multi-factor authentication (MFA). Jamf Protect provides antivirus protection and monitoring.

Microsoft Intune includes Microsoft® Defender for Endpoint by default for both Windows and Apple devices. In addition, Microsoft Intune can work with any third-party antivirus solution that is registered with Windows Security Center. Microsoft Intune also includes a full overview of the security state of all devices, as shown in Figure 5. Jamf Pro provides similar functionality, but only from the separate Jamf Protect tool.



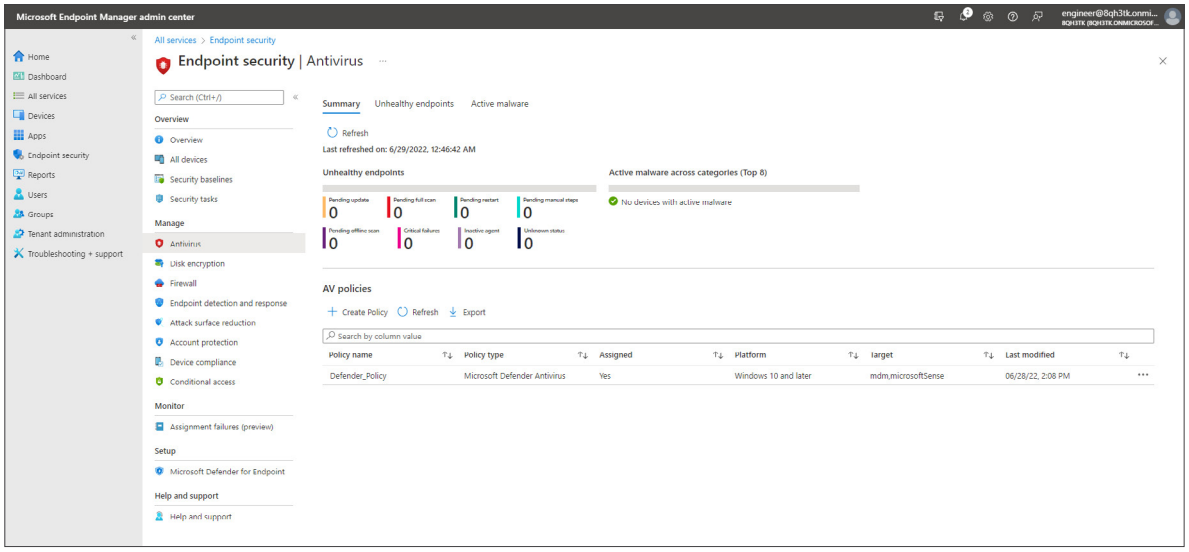


Figure 5 | Microsoft Intune® provides an overview of endpoint security directly in the MDM application

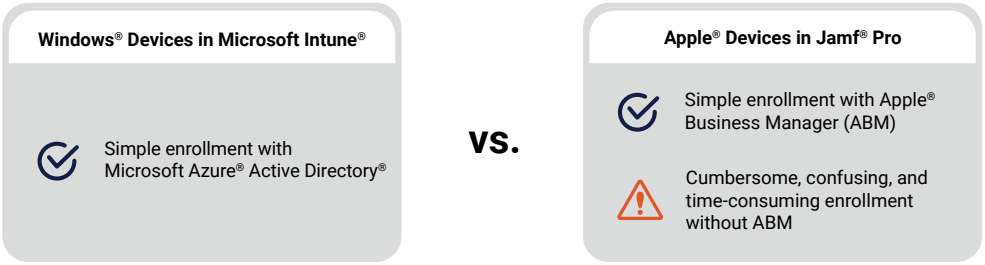
Enrolling Devices

Enrollment is straightforward and simple for both Windows device– and Apple device–based environments when Azure Active Directory is used with Microsoft Intune and ABM is used with Jamf Pro.

ABM is a web-based portal from Apple that helps organizations deploy Apple devices and distribute books and software. ABM provides automated device enrollment for Jamf Pro and can connect to Azure Active Directory to provide federated authentication.

If a business is not using ABM, the process is more complicated and confusing. Administrators need to create a push certificate, download the file to the admin machine, rename the resulting .plist file to a .txt file, upload the file to the Apple push-certificate portal, create and download a certificate, and then upload that certificate in Jamf Pro. Then, on the end user device, an administrator enrolls the device by entering a URL in Safari®, logging in with administrator credentials, and then creating and downloading an MDM file. To complete enrollment, a user needs to be assigned to the device in Jamf Pro.

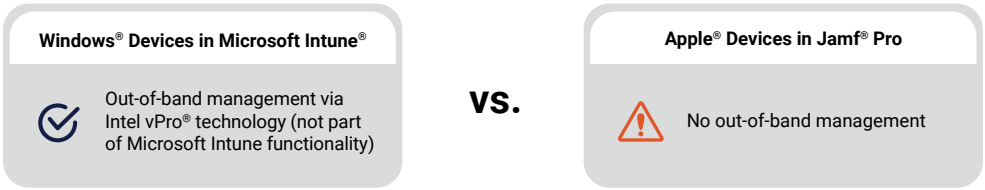
For Windows devices, once the MDM user scope is configured in Azure Active Directory, users are automatically enrolled when they sign in from their devices using their Azure Active Directory account credentials.



Managing Devices

Management functionality is comparable between Microsoft Intune and Jamf Pro. Both solutions include the ability to remotely lock or wipe compromised, lost, or stolen computers, install updates, unlock user accounts, collect diagnostics, and more.

On the Windows side, additional management functionality is available through Intel vPro technology, but this is not part of the MDM solution. Intel vPro security and out-of-band management capabilities are described in a separate section below.



Overall Observations

Both systems offered extensive feature sets for managing devices. While Jamf Pro has a cleaner, simpler UI, Microsoft Intune offers the ability to drill deeper into configurations for setting policies. Microsoft Intune also integrates natively with Azure Active Directory and includes security features within the base product. Jamf Pro offers security and federation capabilities through separate add-on products. While these add-ons are included with the Jamf Business plan we tested, the tools must be accessed separately from Jamf Pro. With Microsoft Intune, the comparable feature set is available from a single pane of glass.

Cost is also a consideration when comparing solutions. For a business that already relies on Microsoft 365 for Microsoft Office apps and other tools, the Windows solution is a better value. This is because Microsoft Intune is available with Microsoft 365 Business Premium (and other subscription offerings) at no additional cost.

Finally, as mentioned earlier, Microsoft Intune is capable of managing Windows, Apple, and Android devices (Figure 6), whereas Jamf Pro is limited to managing Apple devices.

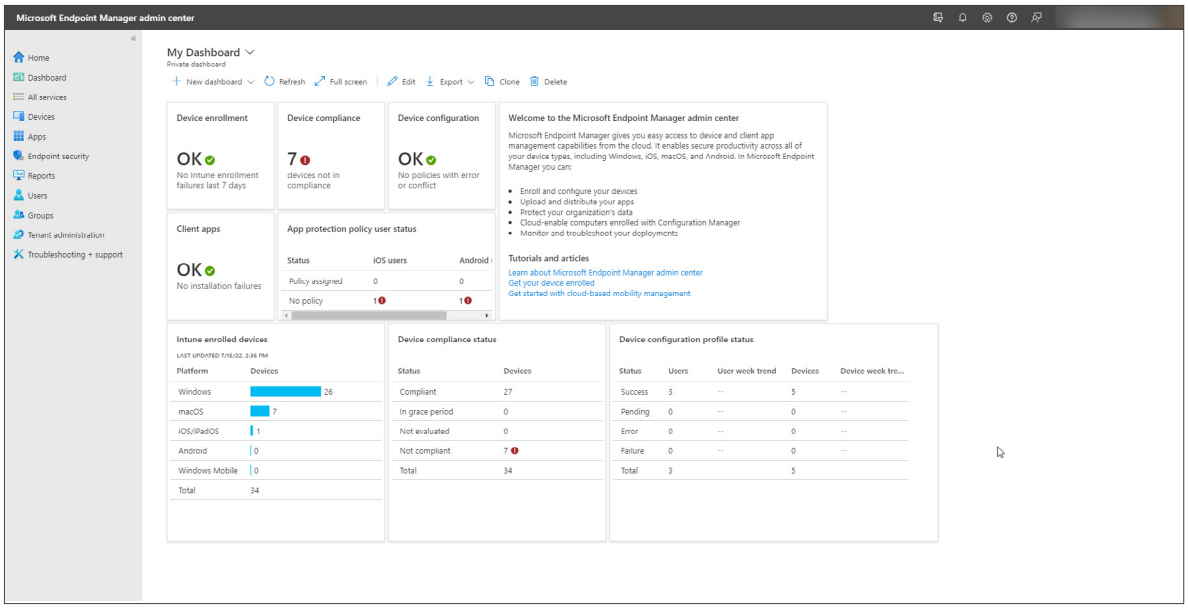


Figure 6 | Microsoft Intune® lets you manage Windows®, Apple®, and Android™ devices from a single interface

Other Considerations for Choosing Between Windows and Apple Devices

Businesses need to look beyond cost and MDM solutions when choosing between Windows and Apple devices. The following sections present findings of our research into several other areas organizations should take into consideration, including ongoing support and maintenance, threat vulnerability and overall security, upgradeability, and overall experience for users and IT admins.

Ongoing Support, Maintenance, and Updates

Many repairs can be done in-house quickly and cheaply with many PCs. This is not the case with Mac devices, where even the simplest issues could require sending the device out for specialized repair or asking a remote user to bring their device to an Apple Store® for support, assuming there is a store in the user's local region.

Business PCs like the Lenovo devices we tested include support for Intel vPro technology, which includes security, management, and support benefits. For example, Intel vPro technology includes secure remote access capabilities, including keyboard/video/mouse (KVM) over IP and out-of-band management, via Intel® Active Management Technology (Intel® AMT) and Intel® Endpoint Management Assistant (Intel® EMA). These technologies let IT personnel more easily resolve remote issues, even if the operating system is unresponsive. By remotely accessing, troubleshooting, and repairing PCs, organizations can significantly reduce the length and severity of support calls and reduce the need to perform remote visits or have users send devices in for repair. As a result, businesses equipped with devices that include Intel vPro can help reduce costs from:

- Less IT/help-desk support time
- Fewer third-party support calls
- Less downtime for users

Apple devices do not have equivalent technology for remote, out-of-band access, which means users of those devices must resort to in-person options for anything beyond a simple support call.

Threat Vulnerability and Security

Security is always a priority for enterprise organizations. Aside from downtime, a breach could result in loss of sensitive company, customer, or worker data. There is an impression that Apple devices are inherently safer because historically there have been fewer attacks on macOS compared to Windows. However, recent data shows that cybercriminals are increasingly focusing their attention on macOS. Specific threats focused on macOS show the potential for increased attacks. For example, macOS-focused malware exploded in the third quarter of 2020 by 420 percent, due to EvilQuest ransomware.[8]

In addition, a recent Malwarebytes® State of Malware Report states that Mac detections for businesses (versus consumers) increased 31 percent in 2020, while Windows detections for business dropped 24 percent in the same period.[9]

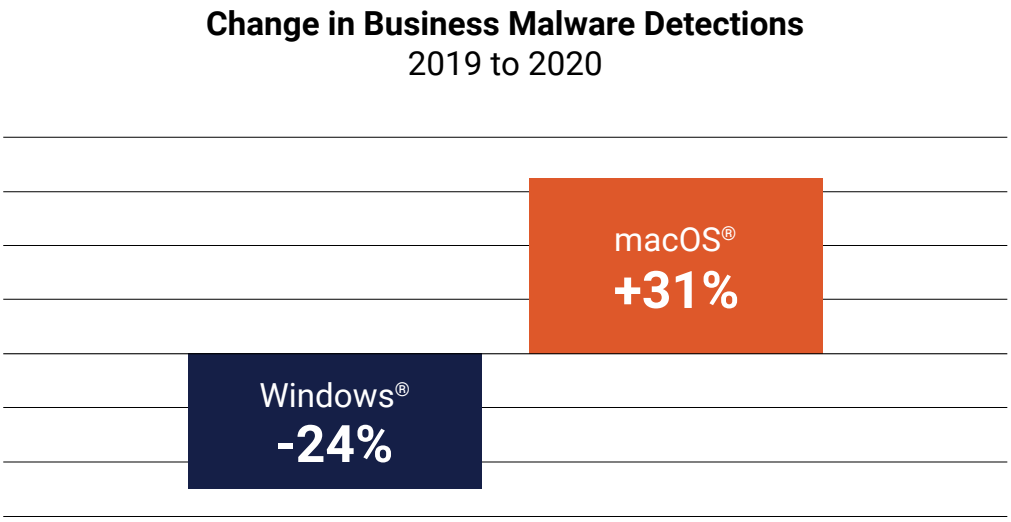


Figure 7 | Change in business malware detections from 2019 to 2020[9]

Note that attacks like these wax and wane for both platforms over time. In response to growing threats, both PCs and Mac devices include several built-in security features. For example, both provide options for full disk encryption to help protect sensitive data, with Windows 10 and Windows 11 Pro devices relying on BitLocker Drive Encryption.

As stated earlier, the PC devices for business that we tested also included Intel vPro technology, which adds several hardware-based security features. For example, Intel® Hardware Shield delivers integrated hardware-based PC protection, which includes below-the-OS security, application and data protection, and advanced threat detection.

Upgradability

Replacing or upgrading basic components is a time-tested way to extend the life of a computer for lower lifecycle-management costs.

Many PCs allow simple expansion or replacement of DRAM DIMMs as a way to expand memory. Similarly, internal SSDs can often be replaced with larger capacity and/or faster drives when needed. For example, the Lenovo ThinkPad X1 Yoga used in our testing allows for M.2 SSD replacements or upgrades. IT pros can choose replacement components from a wide array of third-party options at a variety of price points.

Businesses looking for maximum flexibility can even purchase a Framework laptop. These devices, built with 12th Generation Intel Core processors and Windows 11, are specifically constructed to allow users to easily upgrade, customize, and repair as needed.

The latest MacBook Pro devices have integrated memory and storage that can't be upgraded after purchase, which means companies will need to completely replace the laptop when a simple memory or storage upgrade would suffice. In addition, many PCs offer more up-front configuration options to choose from. Apple typically offers only a few options for memory and storage.

User and IT Experience

The end-user experience is another factor that—although difficult to quantify—can make a difference to company productivity. When users have devices that provide an enjoyable experience and that adapt to their workflows, they are enabled to perform better.

There is an enormous range of form factors available for Windows PCs on the market today. Businesses can purchase laptops with screens that fold 180-degrees, or that completely detach or flip back into tablet mode. They can choose devices with standard or high-resolution displays, with or without touchscreens. And PCs are available in a wide array of colors, weights, sizes, materials, port-counts, performance levels, and price points.

MacBook Pro devices, in contrast, are available only in a standard laptop form factor with limited screen angles, no touchscreens, and only two colors.

Businesses that are weighing whether to transition from PCs to Mac devices also need to take into account several other factors that can impact the bottom line:

- Most enterprise businesses are currently PC-based. Incorporating Mac devices into an existing PC environment increases complexity for managing and supporting user systems.
- Apple studies tout ease of use for Mac users; but PC users switching to Mac devices will still have a large learning curve that could result in lower productivity.
- Some innovative features on PCs, like Windows Hello®, are not supported on Mac devices, which have fingerprint readers but no facial recognition.
- Many businesses rely on commercial applications and proprietary software that does not run on macOS. To use these apps, companies would need to add virtualization to run Windows on Macs, which in turn increases complexity and adds cost for virtualization software and additional OS licenses. Additionally, some Windows software licenses might not extend to macOS, which would require additional application licenses.
- Having both PCs and Mac devices adds complexity for IT management and support staff. Companies will likely need specialized technicians for MacBook repairs, or they will need to spend more to send MacBook devices off site for repairs. Also, it's far more common for IT professionals to be proficient in Windows PC–based management tools than tools for supporting Mac devices. As a result, a business that adds or switches to Apple devices would likely need to retrain its IT staff or hire additional staff for Mac device management and support.

Overall Findings

Based on research and testing, Prowess determined that for most businesses, Windows PCs would be a more affordable option to purchase, manage, and support, compared to Apple devices. In addition to more comprehensive options for remote support and MDM compliance, our testing and analysis found the following benefits for a business based on Windows devices, compared to one based on Apple devices:

- Up to $600 lower CapEx cost
- Up to 37 percent lower cost for MDM and essential productivity software
- Up to 45 percent lower TCO

In addition, the Windows solution delivers the following advantages over the Apple option:

- More comprehensive compliance and configuration options
- Simpler MDM from a single pane of glass
- Added security and remote support, even for out-of-band devices, via Intel vPro technology
- More options for form factors and upgradeability

When choosing between Windows and Apple devices, it's important to look beyond initial device costs. Based on our research and testing, we find Windows devices to be a better overall option for most businesses, based on total cost, management, support, security, and flexibility.

Appendix

Table 7 provides details on the devices used in our testing and TCO comparisons.

Table 7 | Device SKUs and configuration details

Device	Lenovo® ThinkPad® T14s Gen 3	Lenovo® Yoga® 7	Lenovo® ThinkPad® X1 Yoga® Gen 7 14-inch	Apple® MacBook Pro®	Apple® iPad Air®
Processor	12th Generation Intel® Core™ i5-1250P processor with Intel vPro® (E-core max 3.30 GHz, P-core max 4.40 GHz with Intel® Turbo Boost Technology, 12 cores, 16 threads, 12 MB cache)	12th Generation Intel Core i7-1260P processor (E-core max 3.40 GHz, P-core max 4.70 GHz with Intel Turbo Boost Technology, 12 cores, 16 threads, 18 MB cache)	12th Generation Intel Core i7-1270P processor with Intel vPro (E-core max 3.50 GHz, P-core max 4.80 GHz with Intel Turbo Boost Technology, 12 cores [4 P-cores, 8 E-cores], 16 threads, 18 MB cache)	Apple® M1 Pro with 10-core CPU and 16-core GPU	Apple M1 8-core processor
Memory	16 GB LPDDR5 4,800 MHz	16 GB LPDDR5 4,800 MHz	16 GB LPDDR5 5,200 MHz	16 GB unified memory 256-bit LPDDR5-6400 SDRAM	8 GB 4,266 MT/s LPDDR4X SDRAM
Storage	1 TB PCIe® Gen 4 SSD	1 TB PCIe Gen 4 SSD	512 GB PCIe Gen 4 SSD	1 TB SSD	64 GB
Display	14-inch WUXGA (1920x1200) IPS, anti-glare, touchscreen, 300 nits	16-inch WQXGA (2560x1600) IPS, glossy, touchscreen, 400 nits	14-inch WUXGA (1920x1200) IPS, anti-reflective, anti-smudge, touchscreen, low power, 400 nits	14.2-inch Liquid Retina® XDR (3024x1964 native resolution at 254 pixels per inch)	10.9-inch (2360x1640)

[1] See Tables 3 and 4 for TCO calculations and the appendix for device details.

[2] Statista. "Global market share held by operating systems for desktop PCs, from January 2013 to December 2021." February 2022. www.statista.com/statistics/218089/global-market-share-of-windows-7/.

[3] Gartner. "Gartner Says Worldwide PC Shipments Declined 5% in Fourth Quarter of 2021 but Grew Nearly 10% for the Year." January 2022. www.gartner.com/en/newsroom/press-releases/2022-01-12-gartner-says-worldwide-pc-shipments-declined-5-percent-in-fourth-quarter-of-2021-but-grew-nearly-10-percent-for-the-year.

[4] Thunderbolt performance will vary depending on the specific hardware and software used. Must use a Thunderbolt-enabled device.

[5] Pricing comparisons do not include stylus devices because those are optional accessories for both the Lenovo® and Apple® iPad Air® tablets examined in this study.

[6] Statista. "Market share of major office productivity software worldwide as of February 2022." February 2022. www.statista.com/statistics/983299/worldwide-market-share-of-office-productivity-software/.

[7] Other plans are available for Windows and Apple device business and enterprise users. For more information, see: Microsoft. "Reimagine productivty with Microsoft 365 and Microsoft Teams." www.microsoft.com/en-us/microsoft-365/business/compare-all-microsoft-365-business-products.

[8] McAfee. "McAfee Sees COVID-19-Themed Threats and Powershell Malware Continue to Surge." April 2021. ir.mcafee.com/news-releases/news-release-details/mcafee-sees-covid-19-themed-threats-and-powershell-malware.

[9] Malwarebytes. "2021 State of Malware Report." 2021. www.malwarebytes.com/resources/files/2021/04/mwb_stateofmalware2021_exec-summary_with-cta_final.pdf.

The analysis in this document was done by Prowess Consulting and commissioned by Intel.