

SUPPLY CHAIN SECURITY SOLUTIONS FROM INTEL AND LENOVO: ENSURING DEVICE SECURITY FROM THE FACTORY FLOOR THROUGH END OF LIFE

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Lenovo



With the expansion of data centers, cloud computing, and the Internet of Things, ensuring trust in the supply chain has become more important than ever. A supply chain, based on trusted hardware and standards developed by the Trusted Computing Group, can enhance security for everything from sourcing components to distribution of the final product. This paper describes the incentives for organizations to prioritize supply chain trust and introduces the **Intel® Trusted Device Setup** and **Intel® Transparent Supply Chain** services, which Intel has developed in partnership with Lenovo. It also explains the use of a hardware root of trust to establish a trusted supply chain.

SUPPLY CHAIN SECURITY IS A CONCERN ACROSS THE PUBLIC AND PRIVATE SECTORS.

Federal agencies are concerned about the risks associated with information and communications technology (ICT) products and services that may contain potentially malicious functionality, are counterfeit, or are vulnerable due to poor manufacturing and development practices within the ICT supply chain.

— National Institute of Standards and Technology



INCENTIVES FOR SUPPLY CHAIN TRUST

The use of technology to compromise supply chains is not a new phenomenon; one article in *Supply Chain 24/7* provides a history of supply chain cyberattacks dating back to the Cold War.¹ Before end users even turn on their new equipment, malicious actors have numerous opportunities to disrupt and compromise the supply chain tasked with delivering new devices into end users' hands. Such attacks should concern every company regardless of their size or market focus.

The U.S. government is well aware of the significance of the problem: A paper from the National Institute of Standards and Technology (NIST) states that "Federal agencies are concerned about the risks associated with information and communications technology products and services that may contain potentially malicious functionality, are counterfeit, or are vulnerable due to poor manufacturing and development practices within the ICT supply chain."² In 2015, the U.S. Department of Defense published a three-page interim rule to the Defense Federal Acquisition Regulation Supplement. This interim rule gave government contractors a deadline to implement the requirements of the Special Publication 800-171,³ which NIST published to counteract cybersecurity threats. Section 252.246-7007 of this document, Contractor Counterfeit Electronic Part Detection and Avoidance System, specifically addresses "design, operation, and maintenance of systems to detect and avoid counterfeit electronic parts and suspect counterfeit electronic parts."⁴

The Rise of Remote Work

Companies seeking to secure end-user devices are confronting a new factor in an already fraught equation: the sharp increase in the number of employees working remotely. According to Gallup, the percentage of employed Americans who said they had worked remotely doubled in the spring of 2020 alone—climbing from 31 percent in March to 62 percent in April.⁵ What began as a temporary solution may well become permanent: According

to Gartner, nearly three in four CFOs plan to shift some employees to remote work permanently.⁶ But as the technology to serve those working from anywhere grows more sophisticated, so do the techniques to exploit it. Without the right protection, criminals can tamper with PCs, removing or replacing components—resulting in anything from malfunctioning devices to compromised systems with counterfeit parts.

Today, instances of attacks on supply chains and the use of counterfeit, substituted, or malicious components abound. In a May 2020 brief, Deloitte reported that “4 in 10 manufacturers surveyed indicated that their operations were affected by a cyber incident in the past 12 months.”⁷ According to the brief, the manufacturing industry is one of those most frequently targeted in cyberattacks, with attacks on supply chains having increased just between March and May of this year.



“4 in 10 manufacturers surveyed indicated that their operations were affected by a cyber incident in the past 12 months”

– Deloitte

The diversity of today’s manufacturing, logistics, and inventory environments makes information about a device’s origin and subsequent history especially critical for organizations and end users. In particular, remote deployment and provisioning present both challenges and opportunities for supply chain security: They introduce new vulnerabilities to cyberattacks, but can also decrease service costs and reduce the steps needed to physically track devices. As such, organizations stand to benefit from a trusted supply chain that enables remote deployment and provisioning of end-user devices.

Figure 1 shows vulnerable points in the supply chain and the benefits of adding trustworthy elements.

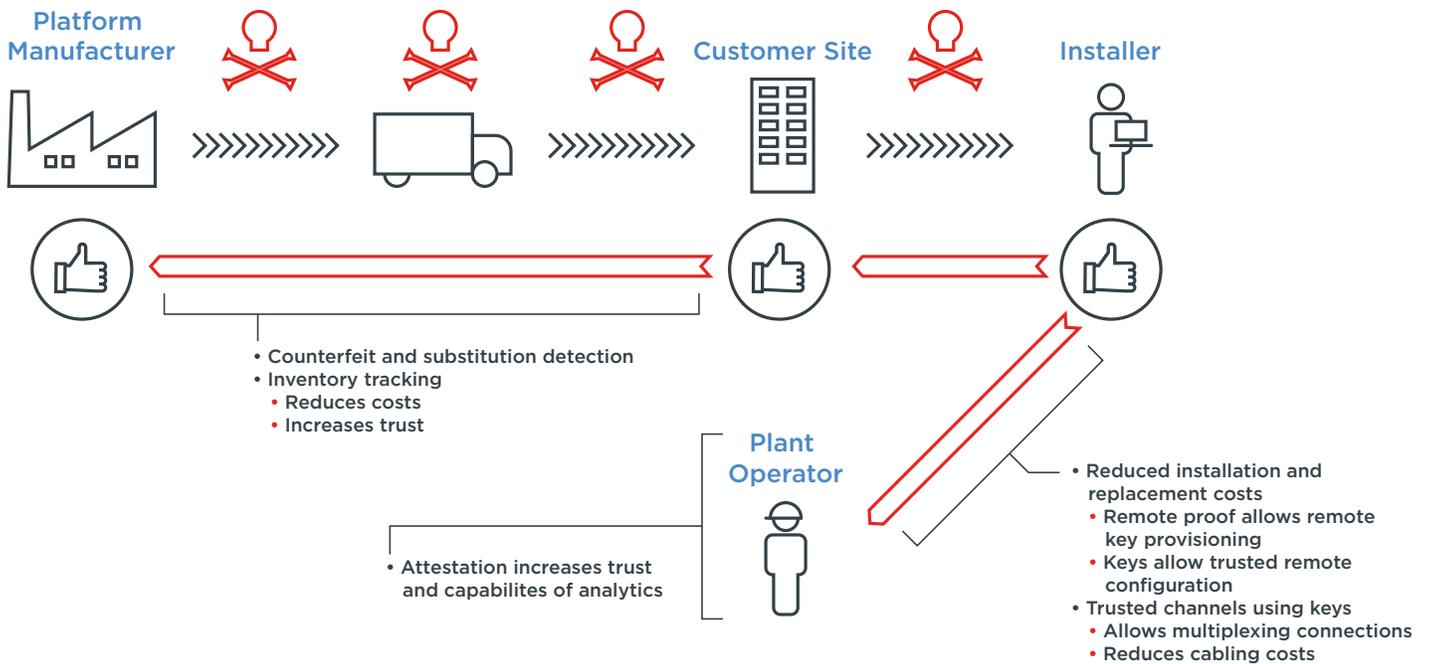


Figure 1: The trusted supply chain value proposition.

How Hackers Monetize Your Data

Cybercriminals can use personal data to do anything from stealing users’ identities to selling their credit card or personal information on the black market. According to anti-malware maker Emsisoft, a “full ID package” containing a user’s name, address, phone, SSN, email, and bank account retails for between USD\$30 and USD\$100.⁸ Consider the scale of the Equifax breach, which exposed the personal information of 147 million consumers,⁹ and you begin

to understand how much money is at stake. Another avenue for monetization is holding a company’s systems hostage until that company pays a ransom. In July of 2020, the GPS maker Garmin reportedly paid a multi-million-dollar ransom after a cyberattack shut down many of its crucial systems and services.¹⁰ Although the techniques and outcomes of these attacks vary, one thing remains constant: the value of users’ data.

THE TRUST SOLUTION

Assurances of a device's origin help establish the foundation for a trusted supply chain. The Trusted Computing Group's initial Trusted Platform Module (TPM) standard defined a hardware root of trust. More recently, Trusted Platform Module 2.0, now the International Organization for Standardization (ISO) standard (ISO 11889),¹¹ created a library specification to describe all the commands and/or features that could be implemented or needed in a variety of platforms, including embedded systems. In the Trusted Platform Module, the Endorsement Key (EK) is a permanent key (with some exceptions) that is uniquely associated with a specific Trusted Platform Module. It provides assertions about the Trusted Platform Module but no assertions about the platform. A Trusted Platform Module EK can certify other TPM and/or platform keys created by the owner or users. In addition, it also has Platform Configuration Registers, Attestation ID Keys, Signature Keys, and Encryption Keys for verifying access and protecting data.

Below, **Figure 2** shows how the Trusted Platform Module provides the hardware root of trust. Its EK certificate and a platform certificate are used to establish the documentation for the platform. The Trusted Platform Module's EK certificate is signed by the TPM vendor. Next, the Platform Manufacturer attaches the Trusted Platform Module to a platform where the Encryption Key is bound to the platform to provide a platform-specific key. The platform certificate created by the platform manufacturer attributes asset information about the platform and the Root of Trust for Measurement (RTM), binding it to the Trusted Platform Module. The value of the measurements is proportional to the trust in the RTM provided by the platform manufacturer. Finally, the supply chain obtains proof of assertions to verify platform and Encryption Key certificate signatures, as well as to verify the EK certificate bound to that platform.

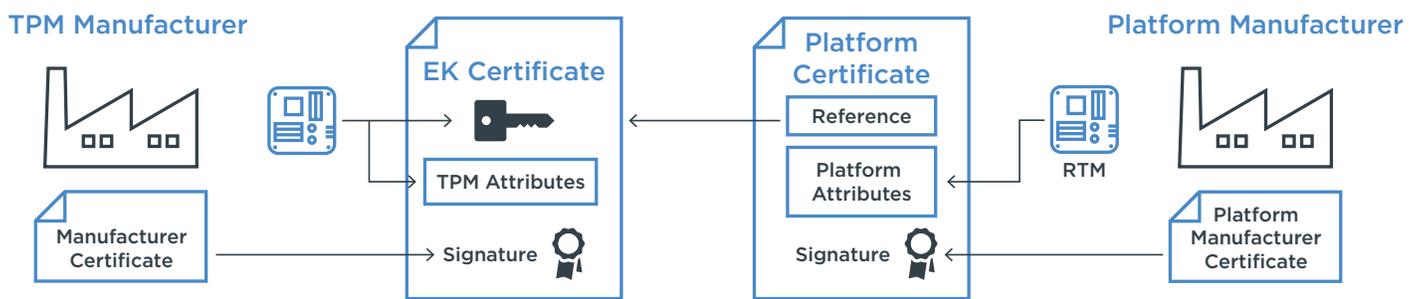


Figure 2: The TPM general architecture transfers keys and certificates to build trust.



IMPLEMENTING A TRUSTED SUPPLY CHAIN

Building on the Trusted Platform Module general architecture, **Figure 3** shows the steps for the documentation for the root of trust, which continues through the supply chain until it gets to the final owner, where an IT expert uses open-source tools to verify platform signatures and EK certificates, as well as conduct other trust-confirming tasks.

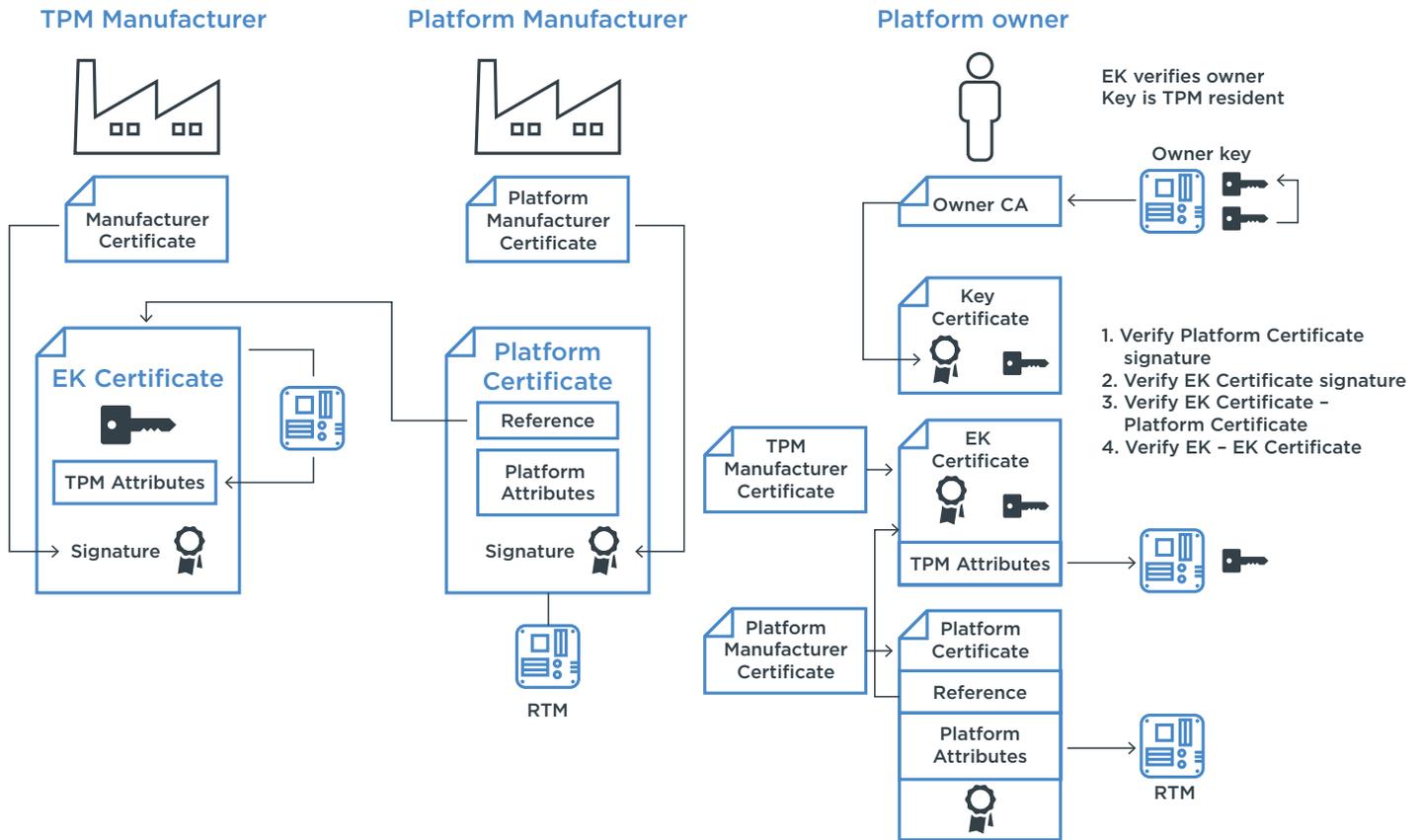


Figure 3: Trusted Supply Chain traceability extends to the platform owner and users.

Based on the previous chain established in the lifecycle of the system, **Figure 4** shows how appliance certificates are generated. Generating the chain of trust starts with the Trusted Platform Module, creating the Encryption Key for each TPM and establishing the hardware root of trust. Next, the platform manufacturer permanently mounts the TPM onto the platform, creates the platform certificate, and binds it to the Encryption Key. A Signing Service provides a platform certificate that cryptographically binds the platform to the EK. Finally, the System Integrator creates an appliance certificate and binds it to the platform certificate. At the end of the process, the end user benefits from the ability to trace the appliance to credible hardware root of trust, establishing technology provider accountability as well as transparency.

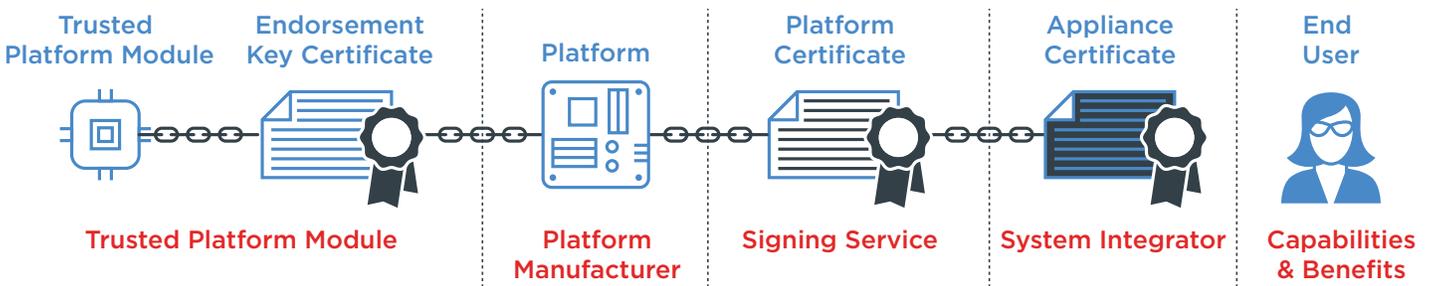


Figure 4: Generating the chain of trust in a typical system touches each stage.

The chain of trust process is essential to provide total traceability and an hardware root of trust based on the Trusted Platform Certificate. It enables component-level traceability for platforms and systems to mitigate the risk of counterfeit electronic parts, while conforming to DFARS Supplement 246.870-2. The fact that chain of trust satisfies government regulations for security, which are often more stringent than even large enterprise protocols, reinforces the efficacy of the service. The trusted supply chain also provides an end-user Auto Verify tool that identifies certain system changes from the time of manufacturing to the time of first boot. The “As-Built” data report and Auto Verify tool offers customers confidence in the authenticity of their systems.

Traceability in the supply chain includes platform certificates with component level traceability (supported by an “As-Built” report generated from the factories), a statement of conformance attesting to the authenticity of the system, and a customer web portal that downloads the files with a link to access details to the files and certificates. **Figure 5** shows how the various trust items flow through the Transparent Supply Chain process, from initial generation to the Auto Verify tool.

The Auto Verify tool collects data on all the components in the system, not just the TPM, providing Platform Certificate Validation as well as Direct Platform Components Validation. The components could include a laptop with some drives, memory, processors, and more. The first time the customer powers up their device, the tool checks for any changes in the hardware, comparing what the customer received to what the original design manufacturer (ODM) shipped.

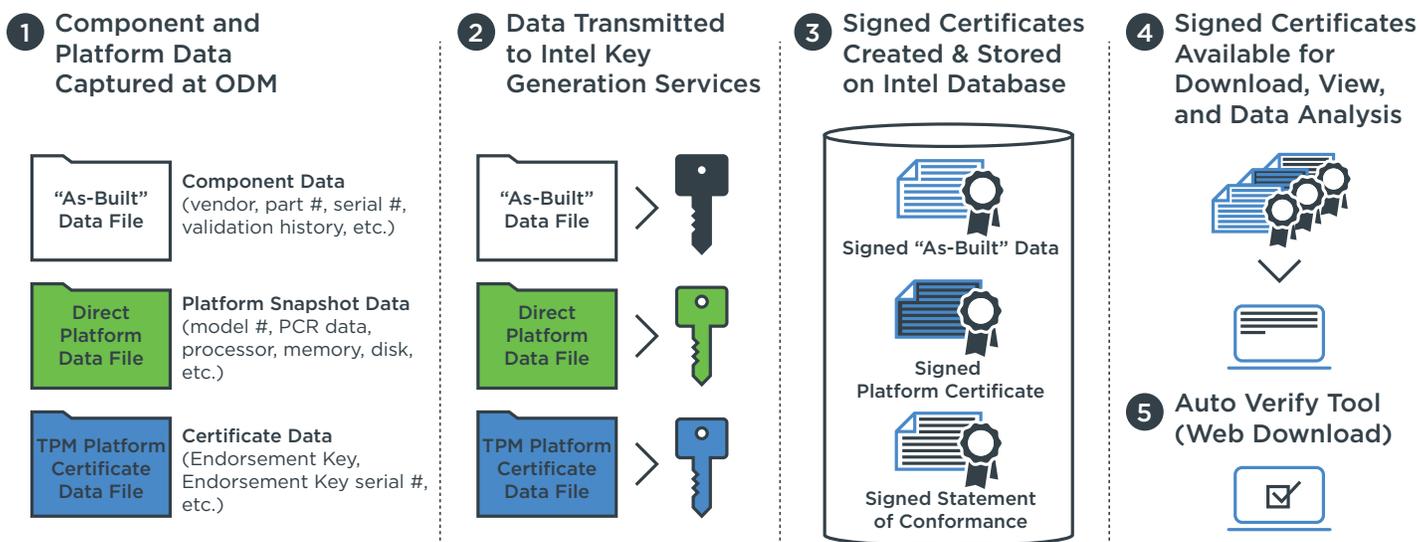


Figure 5: The Trusted Supply Chain process uses the HRoT in the TPM, platform certificates, and other data confirmed by the Auto Verify tool.



System-level traceability is based on a hardware root of trust (HrOT) for each system and starts with the HrOT provided by the Trusted Platform Module on the motherboard. In addition, software tools deployed during manufacturing capture system information and the Trusted Platform Module certificate (including the public EK). A unique X.509 platform certificate for each system is generated and signed using Platform Manufacturer Certificate Authority. This attests that the purchased system is the specific system built by the manufacturer. To aid in the process, the Transparent Supply Chain AutoVerify tool is available for download on Lenovo's TSC web portal. **Figure 6** shows how data from original and as-delivered platform snapshots are identified and displayed.

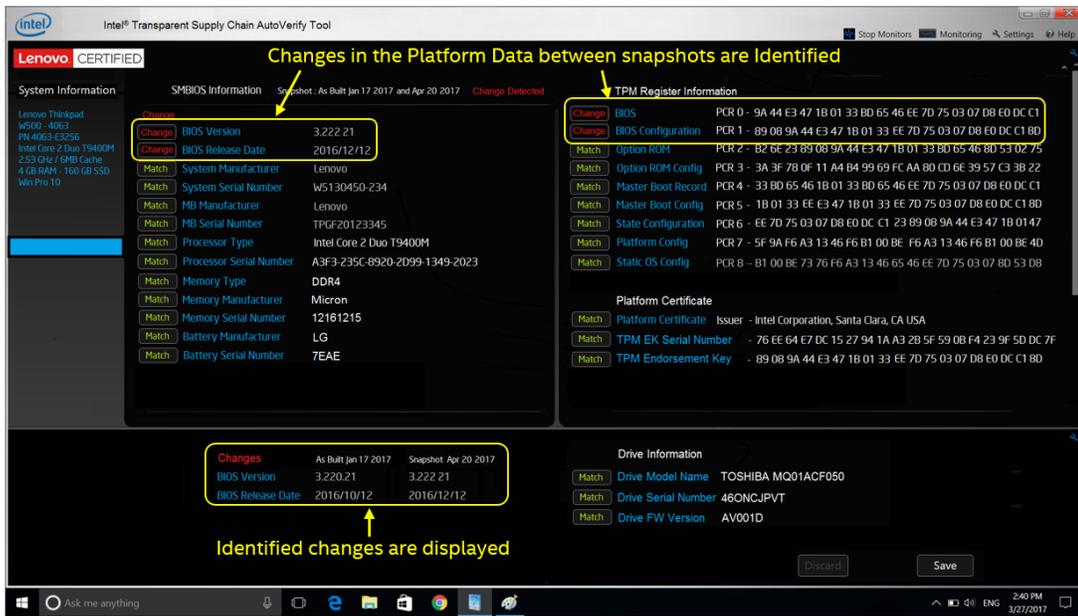
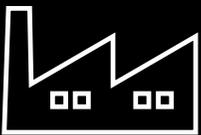


Figure 6: The Auto Verify tool communicates identified changes and other crucial data to the end-user certificates.

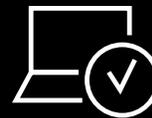
Protect devices...



from the point of manufacture...



and during transport...



until they're on-site with the end user

Steps to Establishing Supply Chain Trust

1. **Immediately:** Evaluate your company's supply chain for its IT components.
2. **Within the next three months:** Identify IT components that have supply chain risk and determine if there is an opportunity to incorporate the TSC.
3. **Within the next six months:** Implement a secure supply chain based upon the TPM.
4. **For future purchases:** Consider platforms that incorporate Lenovo models with the Intel® Transparent Supply Chain Certification Tools for TPM 2.0 Support.

INTRODUCING INTEL® TRUSTED DEVICE SETUP AND INTEL® TRANSPARENT SUPPLY CHAIN

In this evolving threat landscape, Lenovo ThinkShield secures companies' critical data and business technologies with comprehensive, end-to-end protection. Taking a "security by design" approach to the entire product lifecycle, Lenovo ThinkShield offers four primary focus areas:

- **Device Protection:** Includes Trusted Device Setup and Transparent Supply Chain
- **Built-in Platform Security:** Includes self-healing BIOS and Trusted Supplier program
- **Security Management:** Includes integrated system management solutions for deploying, monitoring, and reporting for IT assets
- **Threat and Data Protection:** Includes endpoint protection with capabilities like Ransomware Rollback and integration with Microsoft Defender

The following section focuses on two services that fall under the Device Protection category: Trusted Device Setup and Transparent Supply Chain.

Intel® Trusted Device Setup

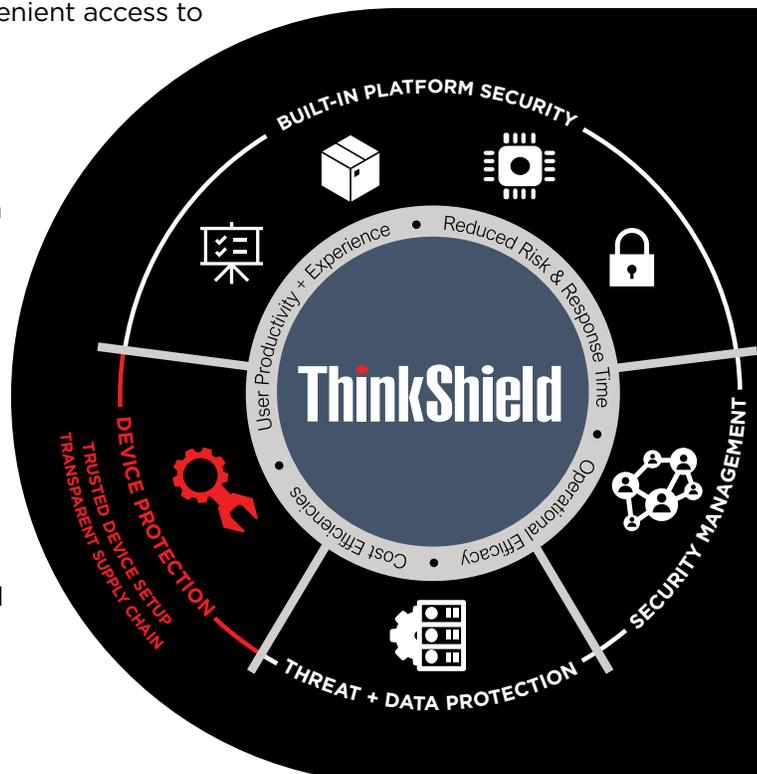
For devices with the Intel® Core™ vPro® platform, Trusted Device Setup seals software at the point of manufacturing, enabling companies to ship boot-ready devices directly to employees. **Preload verification** helps protect against ever-evolving security threats and minimizes the risk of tampering before devices are in end users' hands. A **certificate-based comparison** tests the integrity of the OS, while **BIOS and drive locks** protect against chassis intrusion.

Intel® Transparent Supply Chain

Intel® Transparent Supply Chain brings Lenovo security into the transport and delivery cycle with a documented, auditable supply chain security program that enables traceability of all purchases at the component and system level. A **trusted supplier guarantee** ensures that all suppliers adhere to Lenovo's strict manufacturing standards and pass quarterly compliance and security assessments, while an **Auto Verify tool** identifies certain system changes from the time of manufacturing to the time of first boot. **The Customer Web Portal** allows convenient access to signed files verifying integrity, such as:

- A signed **platform certificate** that links to a Trusted Platform Module (TPM) on the device's motherboard
- **"As-Built" data reports** that provide users with information on key system components (such as the manufacturer, part number, batch number, and distributor)
- **A statement of conformance**, signed by Intel, that guarantees the authenticity of the systems

With these two services from Lenovo and Intel, companies can ensure device protection through transport and delivery, minimize the risk of tampering throughout the supply chain, reduce the chance of receiving counterfeit electronic parts, and keep company data secure.



CONCLUSION

Product tampering and unauthorized substitutions can occur anywhere in the supply chain. Intel and Lenovo have introduced two services to enhance end-to-end device security: Intel® Trusted Device Setup and Intel® Transparent Supply Chain. With a trusted supply chain in place, companies can reduce the risk of supply chain tampering and minimize the chance of receiving counterfeit parts—ultimately protecting valuable company data. This paper explored the mechanics underpinning these services: namely, a trusted supply chain (based on a hardware Root of Trust established by using the Trusted Computing Group's Trusted Platform Module standard) and an Auto-Verify tool (which provides traceability, accountability, assurance, and security to the user) to establish trust in the supply chain and mitigate the potential for cyberattacks due to supply chain tampering.

ThinkShield. Smarter security from manufacture to first boot.

Talk to your Lenovo representative to see how Trusted Device Setup, Transparent Supply Chain, and ThinkShield solutions can protect your sensitive data.

Learn more at www.lenovo.com/ThinkShield



ABOUT THE AUTHOR

Tom Dodson has been in the Supply Chain Security field for the past 24 years working with component suppliers and system manufacturers to ensure a secure and healthy supply chain has been established. Over the last five years, Tom has developed a set of Trusted Supply Chain Policies and Procedures, working with NIST and TCG to establish standards that can be used across the industry.

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