Securing Devices

AP Cybersecurity

Device Vulnerabilities and Attacks

A **device** is any computer - a server, a personal laptop, a smartphone, or an **embedded computer** 嵌入式计算机 built into a machine. Everyday devices with embedded computers are called **Internet of Things (IoT)** 物联网 devices, and they run everything from water pumps to washing machines.

The four classes of device, and why the class matters

Class	What it is	Security consequence
servers	shared machines running services for many users	the highest-value target; one compromise reaches everyone
personal computers	desktops and laptops	general purpose, so they run anything the user installs
handheld computers 手持计算机 (also called mobile computers or information appliances)	smaller than a PC and running on **battery power** — smartphones, tablets, smart watches and other **wearable technology**	easily lost or stolen, and often carried across untrusted networks
embedded computers	a computer that is **part of a machine** — a car's engine controller, a thermostat, a medical pump	has a **specialised instruction set** for interfacing with its components, and **tends to be slower, cheaper and to have minimal storage**, so security features are often left out and updates are rare

That last row is the reason embedded and IoT devices appear so often in attack scenarios: the constraints that make them cheap are the same constraints that make them hard to defend.

The main threat to a device is **malware** 恶意软件 - malicious software. Learn the types:

- **Virus** 病毒 - must be activated by a user opening a file.
- **Worm** 蠕虫 - spreads by itself, with no human action.

- **Trojan** 木马 - hides inside software that looks safe; a **remote access trojan (RAT)** 远程访问木马 gives the adversary remote control.
- **Ransomware** 勒索软件 - encrypts your files and demands payment for the key.
- **Spyware** 间谍软件 - secretly tracks what you do.
- **Keylogger** 键盘记录器 - records every keystroke to steal passwords.
- **Logic bomb** 逻辑炸弹 - triggers only when a condition is met (a date, a version).
- **Rootkit** - deeply hides in the operating system and can even make itself invisible.

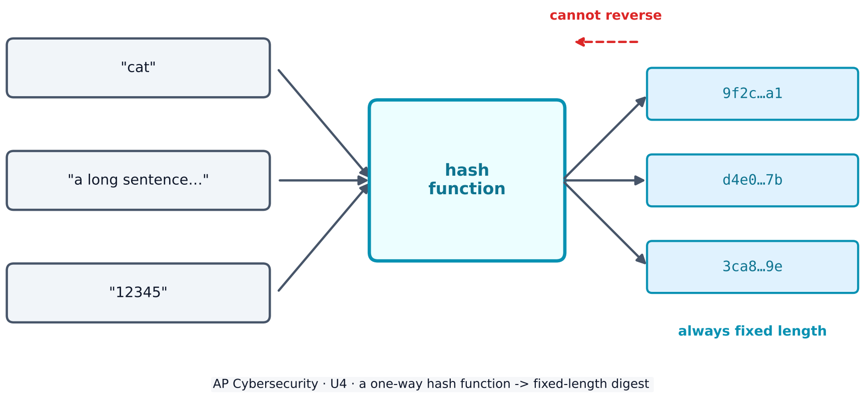
Most malware is a file, but **fileless malware** 无文件恶意软件 is different: it lives only in **RAM** 内存 and abuses legitimate programs already on the device, leaving no file for a scanner to find.

Adversaries exploit **unpatched software** 未打补丁的软件, weak passwords, unprotected **BIOS/UEFI** startup settings, and open ports. We rate device risk by the value and criticality of the device - a hospital's unpatched email server is **high** risk, while an employee's laptop with one unused open port is **low**.

Authentication

A fingerprint scanner: biometric authentication checks something you ARE, which is much harder for an attacker to steal or guess than a password

To store passwords safely, systems use a **cryptographic hash function** 密码散列函数 - a one-way maths algorithm that turns any input into a fixed-length string called a **hash** 散列值 (or digest). Hashes have three vital properties: they are **collision resistant** 抗碰撞 (hard to find two inputs with the same output), have **pre-image resistance** 抗原像 (you cannot work backwards to the input), and are **repeatable** (the same input always gives the same hash).



A hash function turns any input into a fixed-length digest, and cannot be reversed

Real hash functions have names. The **Secure Hash Algorithm (SHA)** family – SHA-256 and SHA-512 – is today's standard. Adversaries attack a hash function by trying to **force a collision** (two different inputs with the same hash); once an efficient collision attack exists, that function is **deprecated** 弃用 (retired from secure use). **MD5** and **SHA-1** are the classic deprecated examples – never rely on them to protect data today.

A service never stores your plaintext password. It stores the **hash**; when you log in, it hashes what you typed and compares. To stop two identical passwords producing identical hashes, a few random bits called **salt** 盐值 are added before hashing, so every stored hash is unique.

Worked example. Two users both choose the password `sunshine`. Without salt, both stored hashes would be identical, so cracking one instantly cracks the other. Give each user a unique salt - say `x7` and `q2` - and the service hashes `sunshinex7` and `sunshineq2` instead. The two stored hashes now look completely different, so the adversary must attack each account separately. This is why a stolen hash database is far less dangerous when the hashes are salted.

Adversaries fight back with **password attacks**. **Online** attacks guess against a live login; **offline** attacks steal the hash database and crack it on their own machine (which bypasses any account-lockout protection). Techniques include:

- **brute force** 暴力破解 - an automated tool tries *every* possible password in turn; guaranteed to work eventually, but slow, and it grows explosively with password length.

- a **dictionary attack** 字典攻击 - the tool tries a list of common words and known passwords first, because most people pick guessable ones.
- **password spraying** 密码喷洒 - one common password against many accounts (this dodges lockout, which counts failures per account).
- **credential stuffing** 撞库 - reusing stolen or default credentials, exploiting that people reuse passwords across sites.
- a **rainbow table** 彩虹表 - a precomputed table of passwords and their hashes, sorted by hash, so a captured hash can be looked up instead of recomputed.

Password policy settings

An administrator hardens accounts by **configuring login settings** - and the exam expects you to name them and say what each defends against:

Setting	What it does	The attack it slows
complexity 复杂度	require a character from each set (upper, lower, digit, special)	brute force / dictionary
minimum length 最小长度	require N characters - length matters more than anything	brute force (grows exponentially)
maximum age 最长有效期	force a change every ~90-120 days	limits how long a stolen password is useful
password history 密码历史	store the last 5-10 hashes, block reuse	stops recycling an old (possibly leaked) password
lockout 锁定	lock the account after 3-5 wrong tries	brute force / online guessing

One subtlety worth a mark: some national standards now advise **against** forced expiry, because regular changes push users into predictable patterns like `PasswordFall2028`. A **password manager** 密码管理器 solves the real problem - it generates and stores a long, unique password per site, so none is ever reused or guessable.

Authentication factors prove who you are, and fall into categories: something you **know** (a password), something you **have** (a token or phone), something you **are** (a **biometric** 生物特征 like a fingerprint or retina scan), and somewhere you **are** (a location factor). Using two or more is **multifactor authentication (MFA)** 多因素身份验证 - far stronger than a password alone.

A hardware security key proves who you are with something you physically hold — a strong second factor

Removable media, and the autorun problem

An adversary can load malware onto an **external drive** — a USB stick, a portable disc — and leave it where someone will pick it up. If **autorun** 自动运行 is enabled, the device runs a program from that drive **the moment it is inserted**, with no click required, so the malware executes before the user has decided to trust anything.

Two controls answer this, and the exam wants both named:

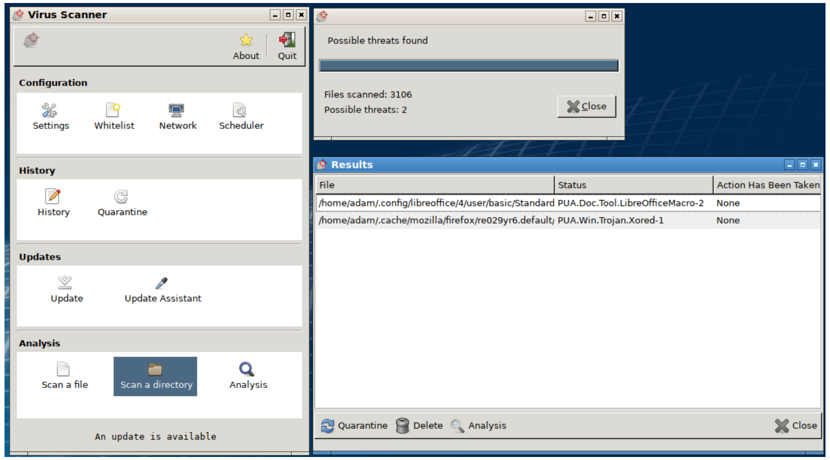
- **Disable autorun**, so inserting a drive never runs anything by itself.
- **Prohibit users from connecting external drives or media** at all — enforced by policy and by a technical control that blocks the USB ports — which is why so many secure environments physically or logically disable them.

Protecting Devices

Managerial controls set the rules: an **acceptable use policy** 可接受使用政策 lists what users may and may not do, a **password policy** sets length and reuse rules, and a **software installation policy** controls what can be installed.

Technical controls do the work. **Anti-malware software** 反恶意软件 keeps a database of malware **signatures** and quarantines any file that matches. Keeping the operating system and applications **updated** - installing each **patch** 补丁 - closes known holes before adversaries can use them. A **host-based firewall** 主机防火墙

controls traffic in and out of one single device, blocking ports and services it does not need.



Anti-malware software scans files against a signature database and quarantines any matches — this scan has flagged two threats

Detecting Attacks on Devices

Devices log logins, file changes, and processes, and these logs reveal an **indicator of compromise (IoC)** 入侵指标 - evidence that an adversary got in. **Host-based** IoCs show up as unexpected processes or changed settings; **file-based** IoCs are files whose hash matches known malware; **behaviour-based** IoCs are things like many failed logins or unusual login times.

Choosing a detection method means weighing **performance** (signature-based is lighter, better for weak devices), **cost** (an **endpoint detection and response (EDR)** 端点检测与响应 service is powerful but expensive), and how sensitive the device is. Reading **authentication logs** exposes password attacks: many wrong passwords for one user signals a guessing attack; many users failing from one IP signals **password spraying**; a burst of default credentials signals **credential stuffing**. Offline attacks, though, cannot be detected - they happen on the adversary's own computer.

Speed is itself a security factor. **Signature-based** detection compares what it sees against a list of known-bad patterns, so it is **faster** than **anomaly-based** detection, which must first learn what normal looks like and then measure every event against that model. Anomaly-based detection catches attacks that have no signature yet, but it costs far more processing power — and on a device that lacks it, the effect compounds: the detection runs slowly, the device degrades, and the method ends up not being implemented effectively at all.

Exam tips

- Know each **malware type by its defining trait**: a worm self-spreads, a virus needs a user, ransomware encrypts for money, a RAT gives remote control, a rootkit hides.
- A hash is **one-way and fixed-length**; **salt** makes identical passwords hash differently. Never say a service "stores the password" - it stores the **salted hash**.
- Name real algorithms: **SHA-256/SHA-512** are current; **MD5** and **SHA-1** are **deprecated** because efficient collision attacks exist.
- Match the password attack to its log signature: one user + many wrong passwords = guessing; many users + one IP = **spraying**; default credentials = **stuffing**.
- Sort authentication factors into **know / have / are / where**, and remember **MFA** combines two or more - a fingerprint plus a password, not two passwords.
- **Offline password attacks cannot be detected** because the cracking happens on the adversary's machine - a favourite exam "gotcha".