Université Catholique de Lille 1875

Pass the SALT
Open-source & Security Conference

DesktopRanger Blocks Keystroke Spying: Hardening Windows Desktop Isolation

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Lille, France
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WHO AM I

Igor Korkin, PhD (05.13.19), MEPhI alumni

Academic & Practical security researcher

- Windows & Linux Security · OS Internals · AI-Driven Attacks
- Speaker: Black Hat x3 · ADFSL x7 · IEEE S&P
- Author: 50+ papers · Huawei patent · Monograph
- Scientific Advisor
- Software Developer

AGENDA

- Under Keylogger Attacks
- Keyloggers vs Password Managers
- Windows Desktop vs. High-Privilege Keyloggers
- DesktopRanger: Open-source Project & Testing Results
- Conclusion & Discussion

SENSITIVE INFORMATION

Web Browsing & Communication

Office & Documents

Passwords & Secrets

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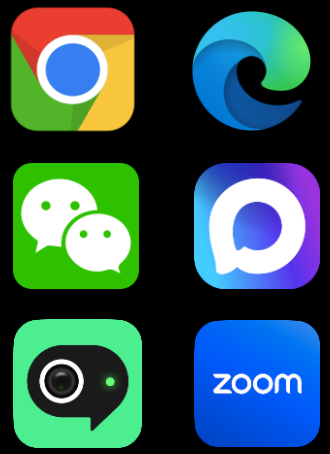
Web Browsing & Communication



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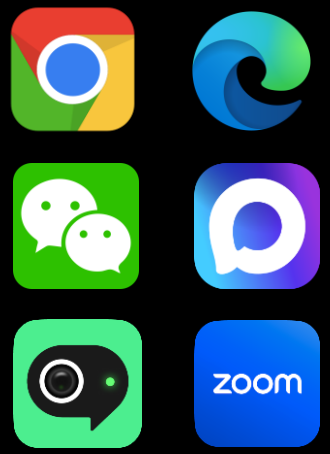

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Keyloggers

KEYLOGGERS = WINAPI-BASED + HIGH-PRIVILEGED

- Software keyloggers
  - User-level keyloggers
    - Based on Windows functions:
      - Hooking-based
      - Polling-based
      - Raw Input
      - Direct Input
    - ETW-based techniques
  - Kernel-level keyloggers

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1 – Top Keyloggers based on WinAPI

WinAPI functions	Malware\Keyspy
SetWindowsHookEx	Snake
	Gurcu
GetAsyncKeyState	WarzoneRAT
	KLogExe
RegisterRawInputDevices GetRawInputData	Rhadamanthys
	RAT (3.3a), APT 31
DirectInput8Create GetDeviceState	EggStreme
	FusionCore

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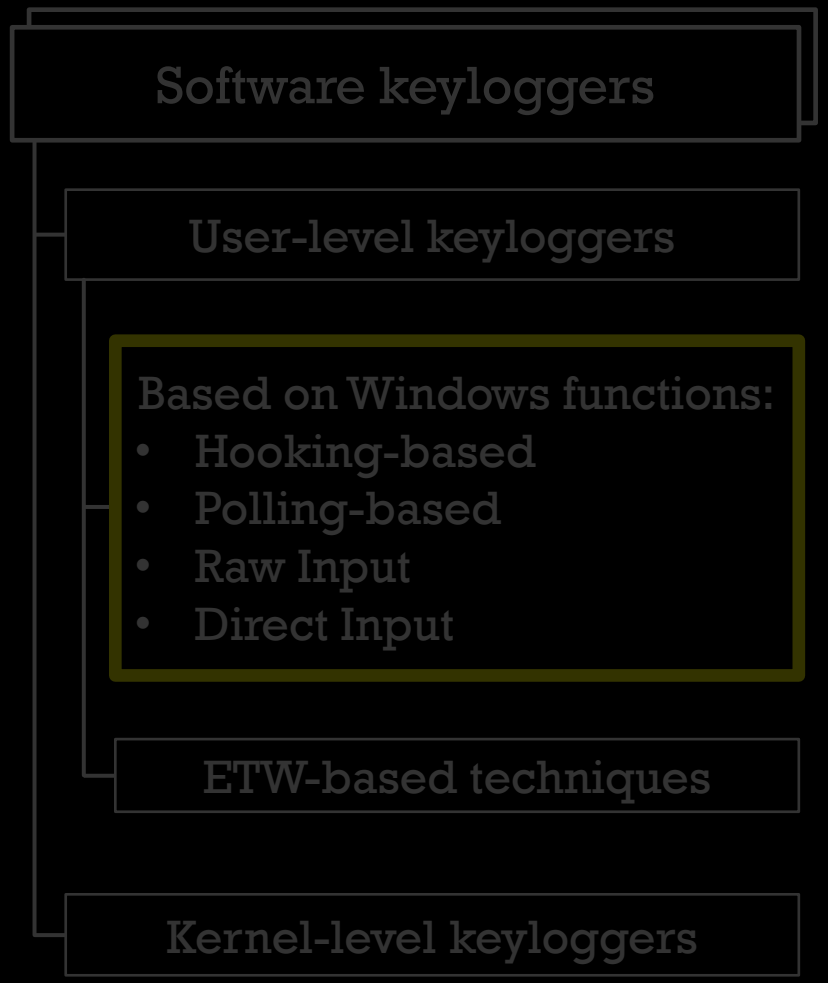

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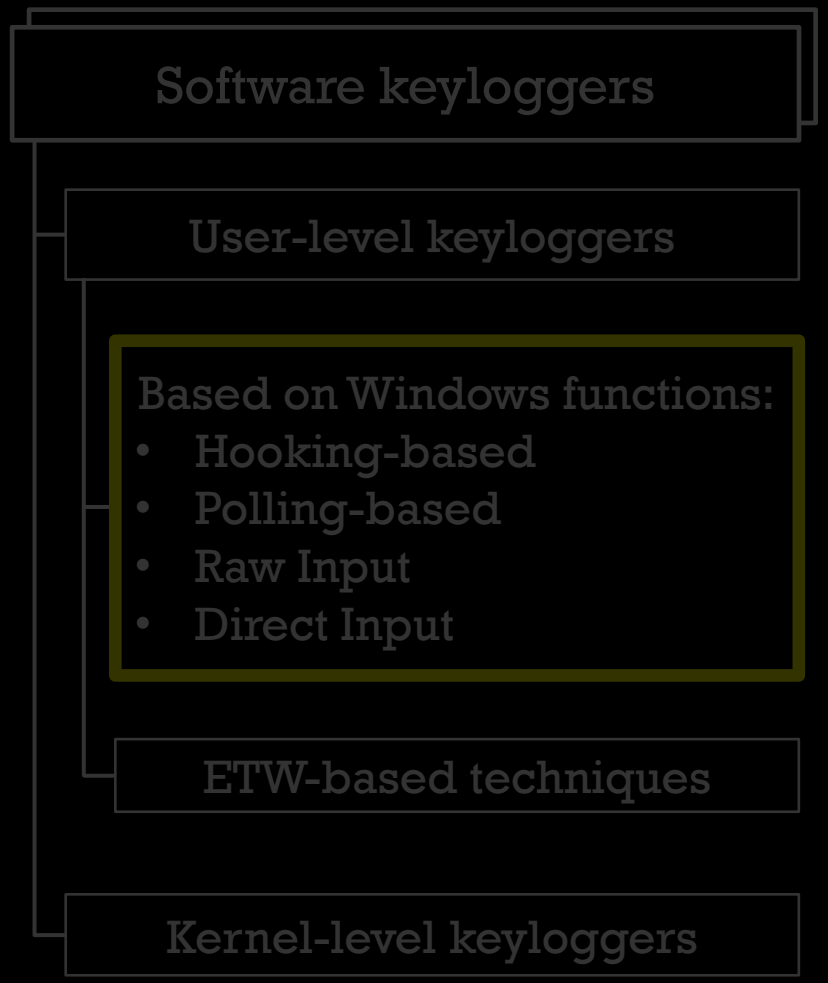

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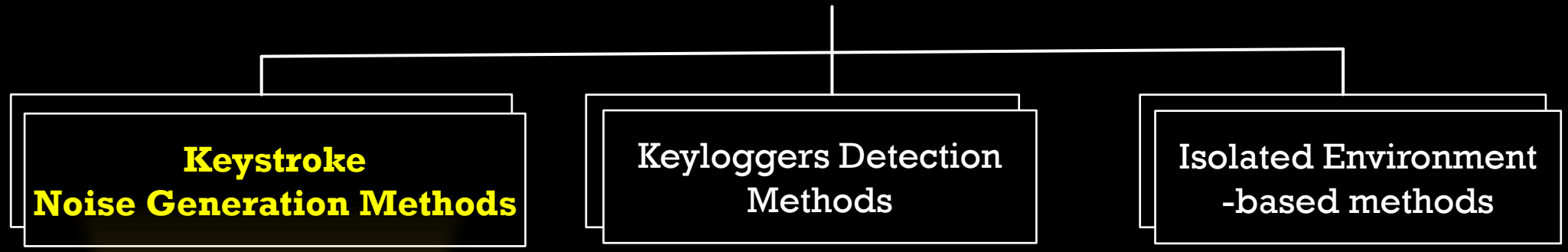
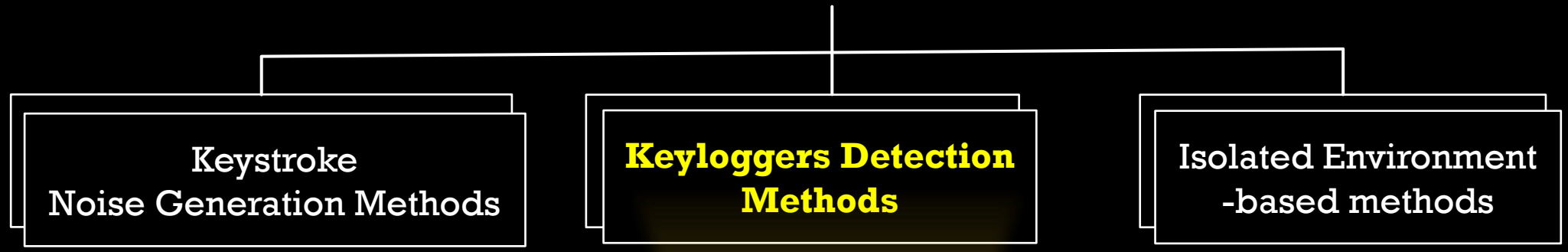
2 – High-privileged attackers

- MATE (Man-At-The-End) — a **highly privileged** local attacker who can **remain in user-mode** and interact with software and OS.
- CheckMATE 2025 @ ACM CCS

FIGHTING KEYLOGGERS



FIGHTING KEYLOGGERS



FIGHTING KEYLOGGERS

- Keystroke Noise Generation Methods
- Keyloggers Detection Methods
- **Isolated Environment -based methods**

FIGHTING KEYLOGGERS

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- Keyloggers Detection Methods
- Isolated Environment -based methods
  - **Windows Desktop Technology**

Password Managers:

KeePass

FIGHTING KEYLOGGERS

Keystroke
Noise Generation Methods

Keyloggers Detection
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Isolated Environment
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Windows Desktop
Technology

Attackers can bypass
protection technologies

FIGHTING KEYLOGGERS

Keystroke
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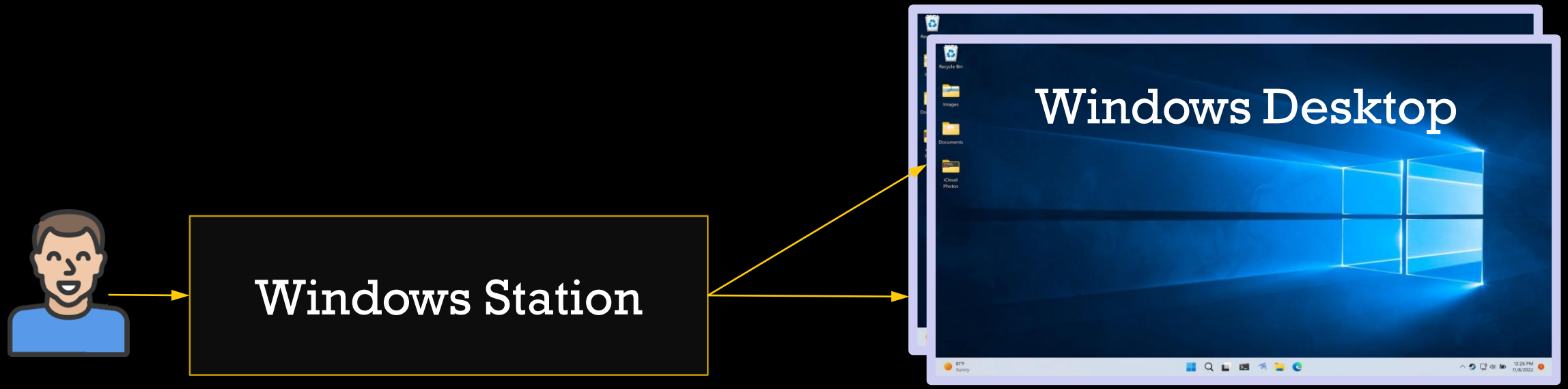
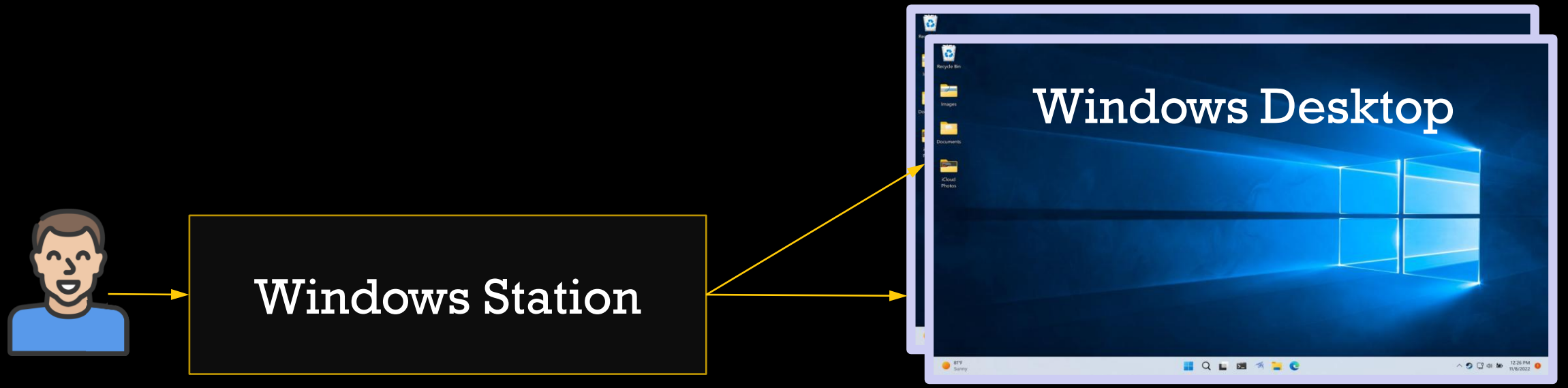
**Desktop
Ranger**

WINDOWS DESKTOP TECHNOLOGY

LOGIN → WINDOWS STATION → WINDOWS DESKTOP



LOGIN → WINDOWS STATION → WINDOWS DESKTOP



- Window station contains one or more desktop objects.

- **Windows desktop** contains windows, menus and **System Message Queue** shared among all apps running on the same desktop

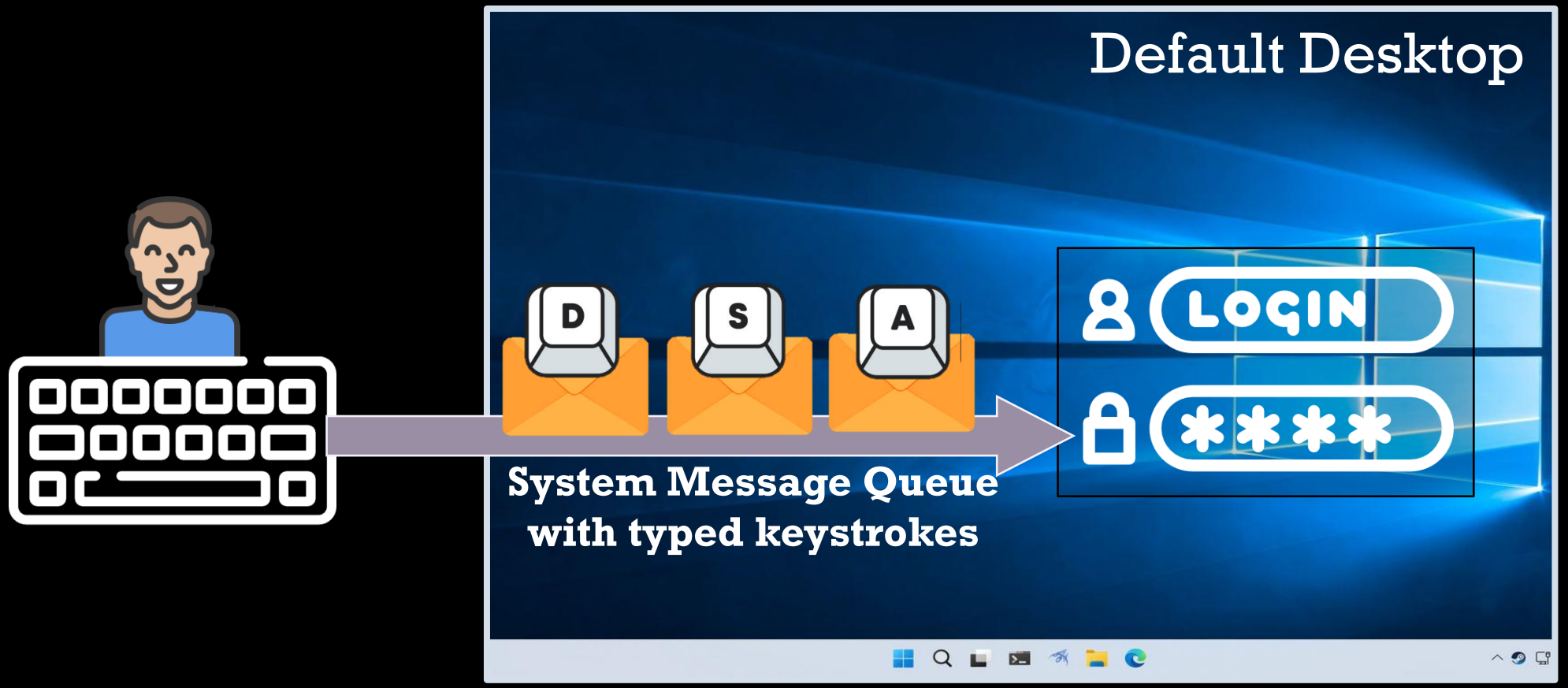
Station and Desktops are securable OS objects with access-rights

Access-rights:

- Create a desktop
- Enumerate desktops
- Read attributes
- etc

- Create windows
- Install hooks
- Read desktop's objects
- etc

SAME DESKTOP = NO ISOLATION



A. Sensitive App is running on the Default Desktop

B. Keyspy gets keystrokes by reading System Queue shared among all apps running on the same desktop

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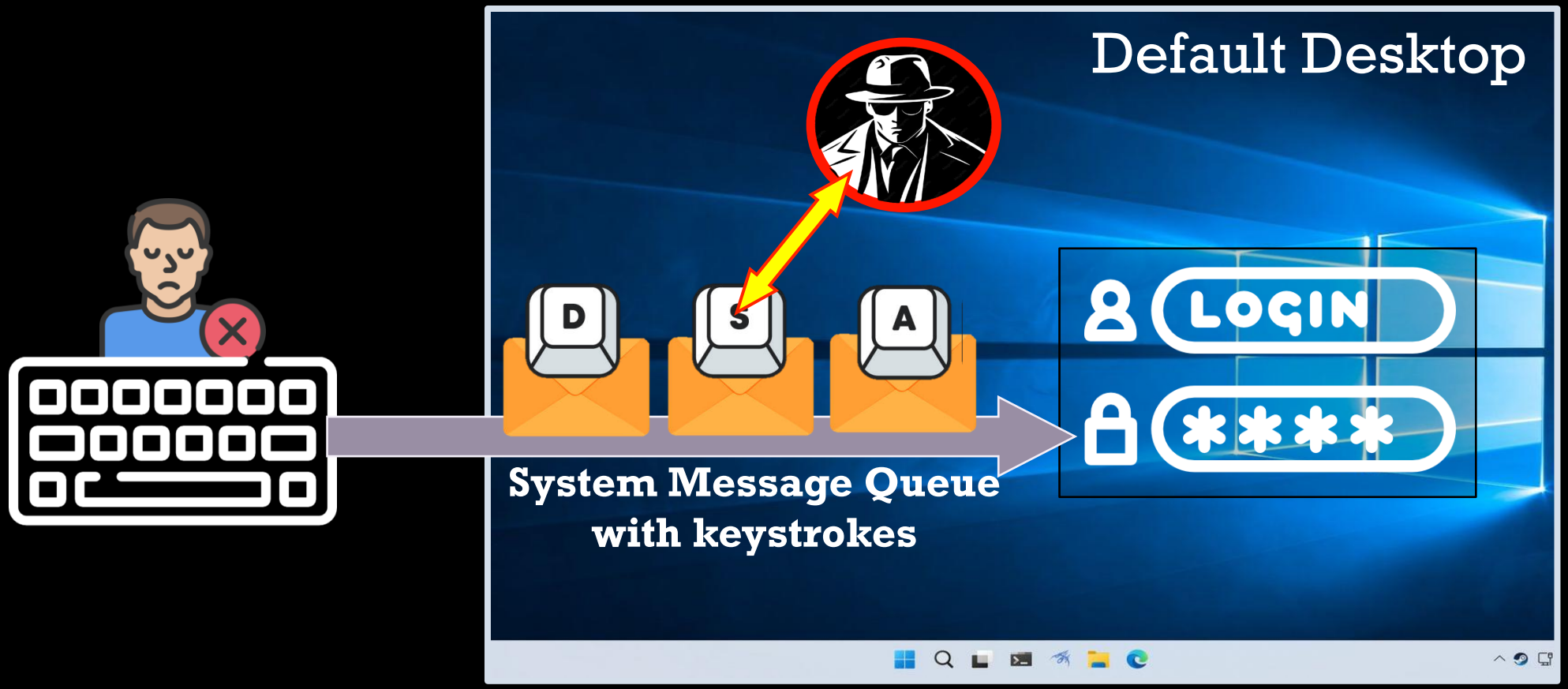

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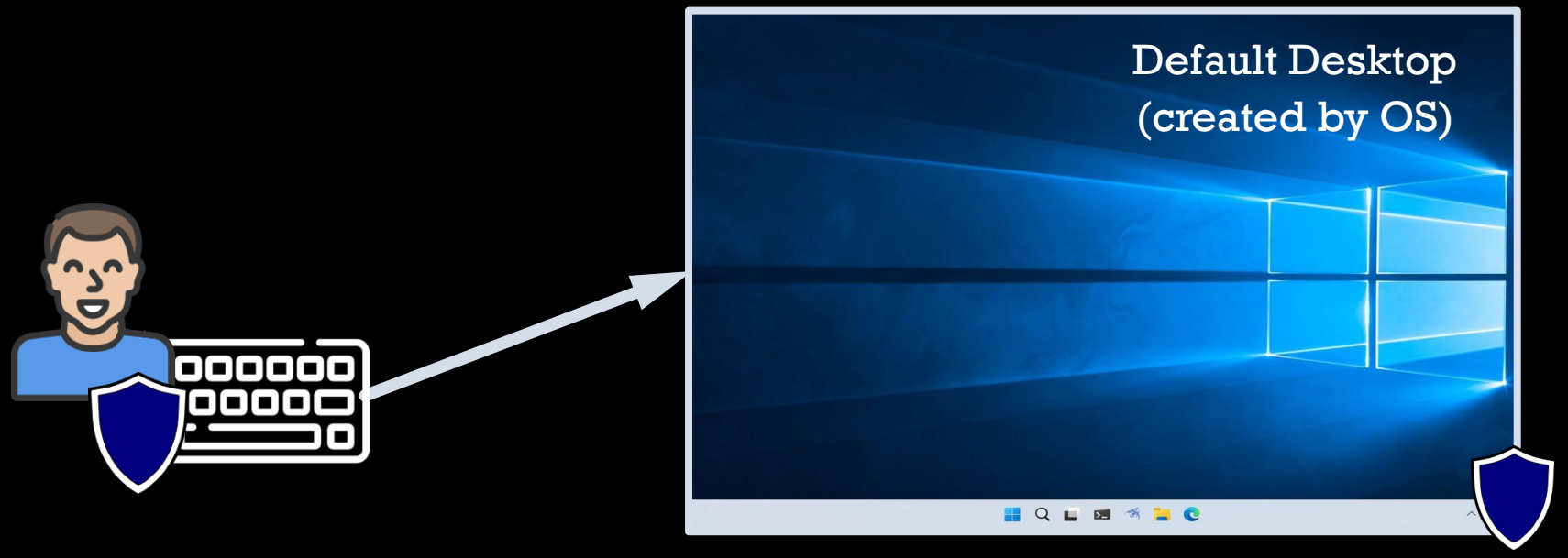
How to get an isolated message queue ??

Let's create a new Desktop!!

WINDOWS DESKTOP AS A SECURE OBJECT



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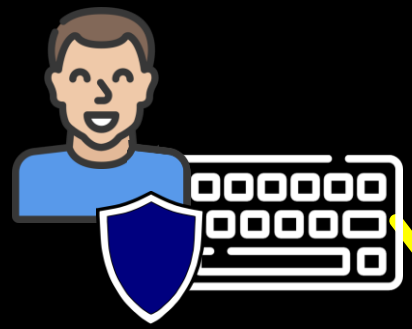
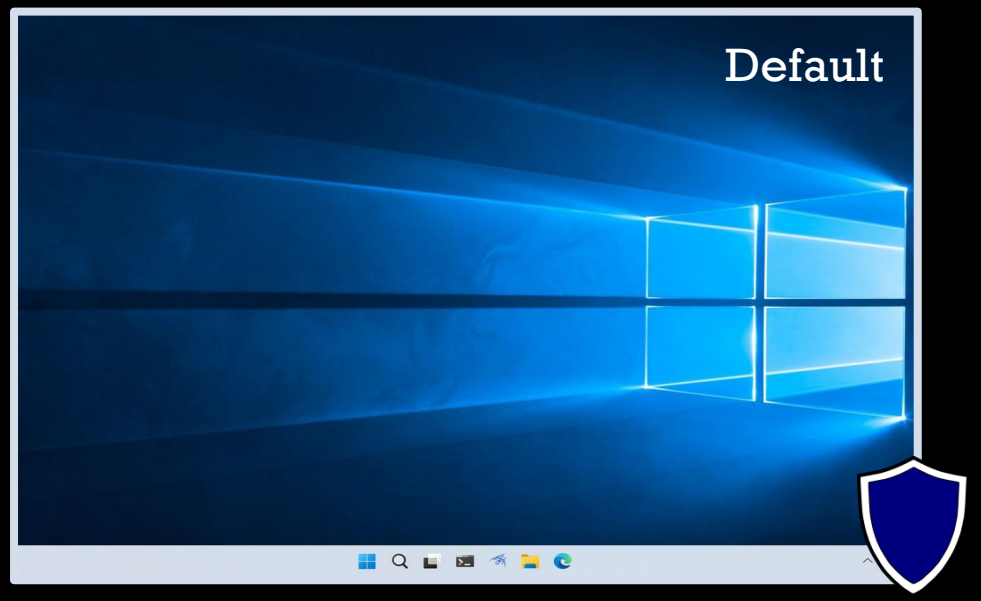
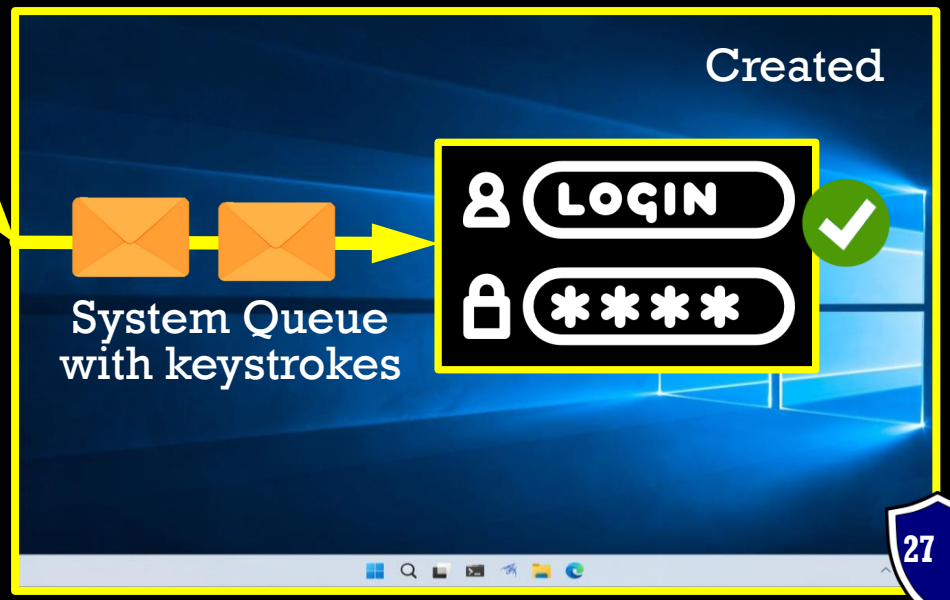


A. Password manager: creates a new desktop and relaunches its app on it
B. A desktop created with default SD inherits the creator's DACL

Password Managers:

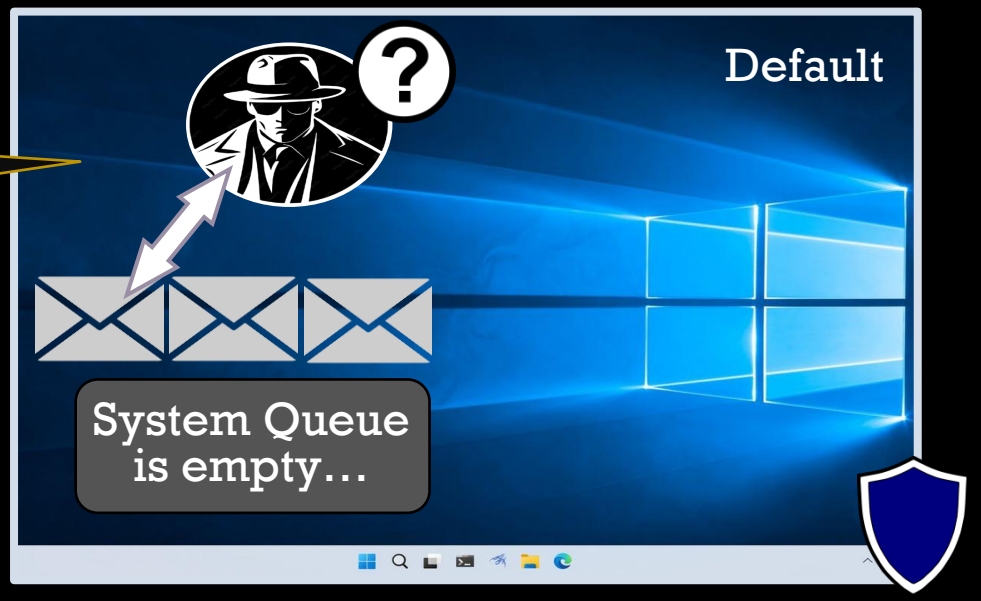
KeePass 1Password VeraCrypt



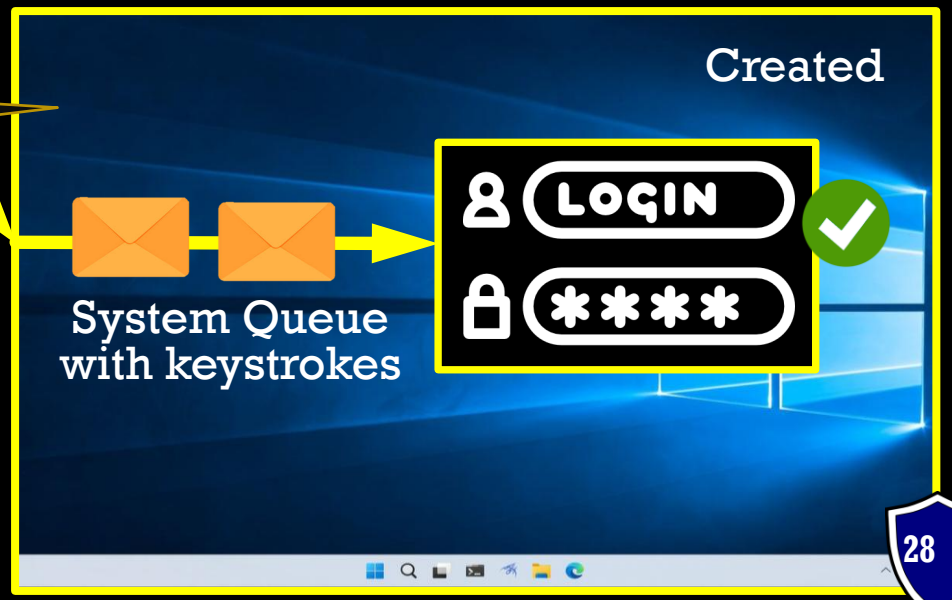


WINDOWS DESKTOP AS A SECURE OBJECT

A. Keylogger from Default Desktop cannot get any keystrokes typed on newly created Desktop



B. New Desktop has its own **isolated** System Msg Queue



Password Managers:

KeePass 1Password VeraCrypt

Can 2nd Desktop be infected?

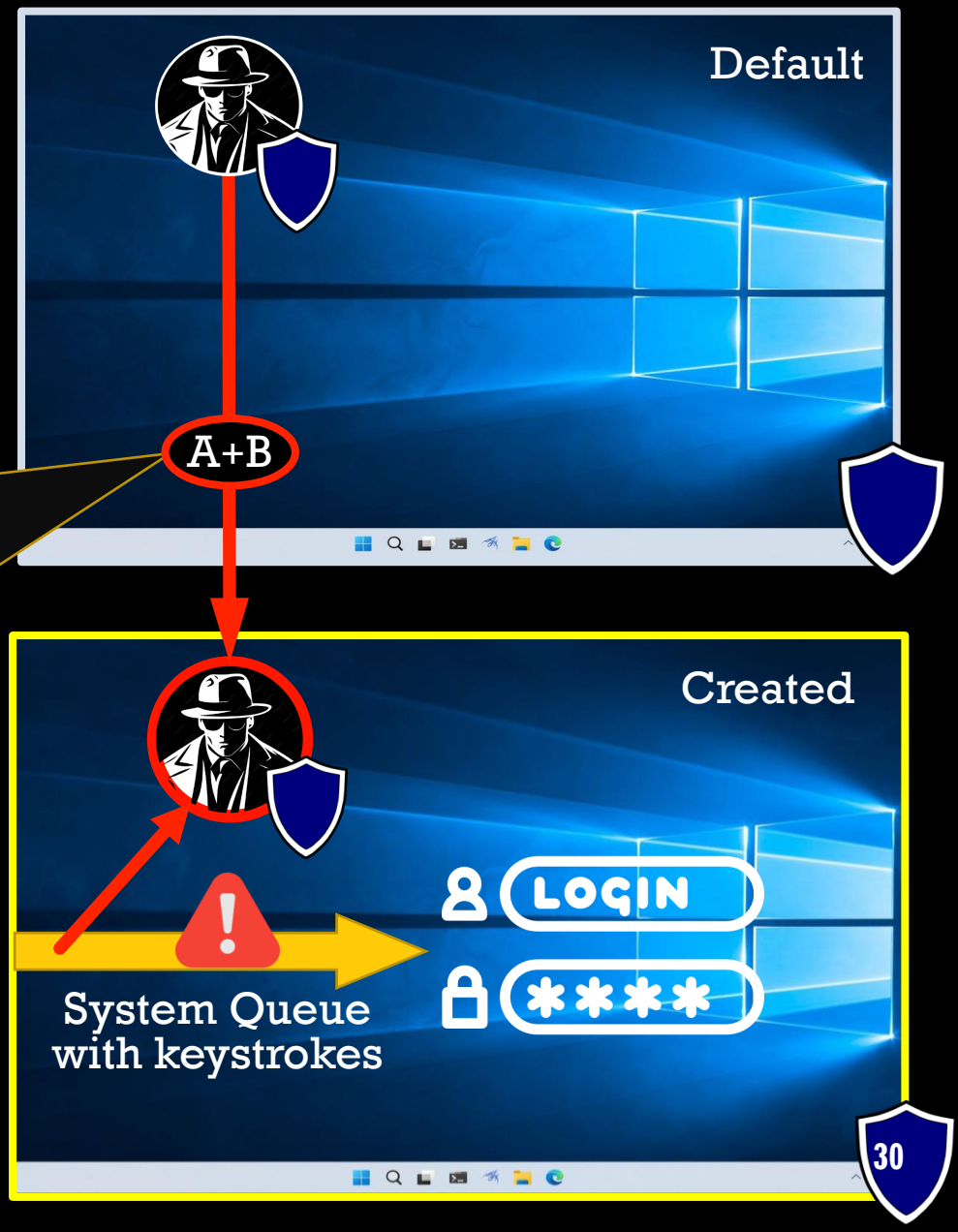
Yes, it can be infected 😮

2ND DESKTOP = NO ISOLATION

Attacker using the same user privilege can infect all the desktops:

Steps	WinAPI
A. Getting a list of all desktops	EnumDesktops
B. Launching its own app on each of desktop	OpenDesktop(name)

→ Now attacker can read all the keystrokes



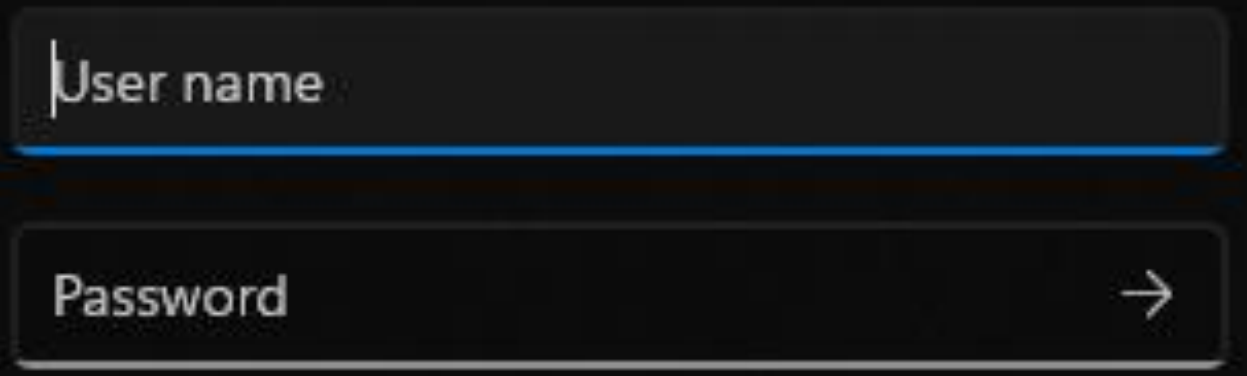
Keyloggers against KeePass Manager:

KeepassKeylogger shows that Master Password can be easily keylogged from "Secure desktop“

https://github.com/adenkiewicz/KeepassKeylogger

Winlogon desktop seems protected……

Actually, it can be infected too 😨



WINLOGON DESKTOP = NO ISOLATION

A. User-privileged keylogger cannot access Winlogon

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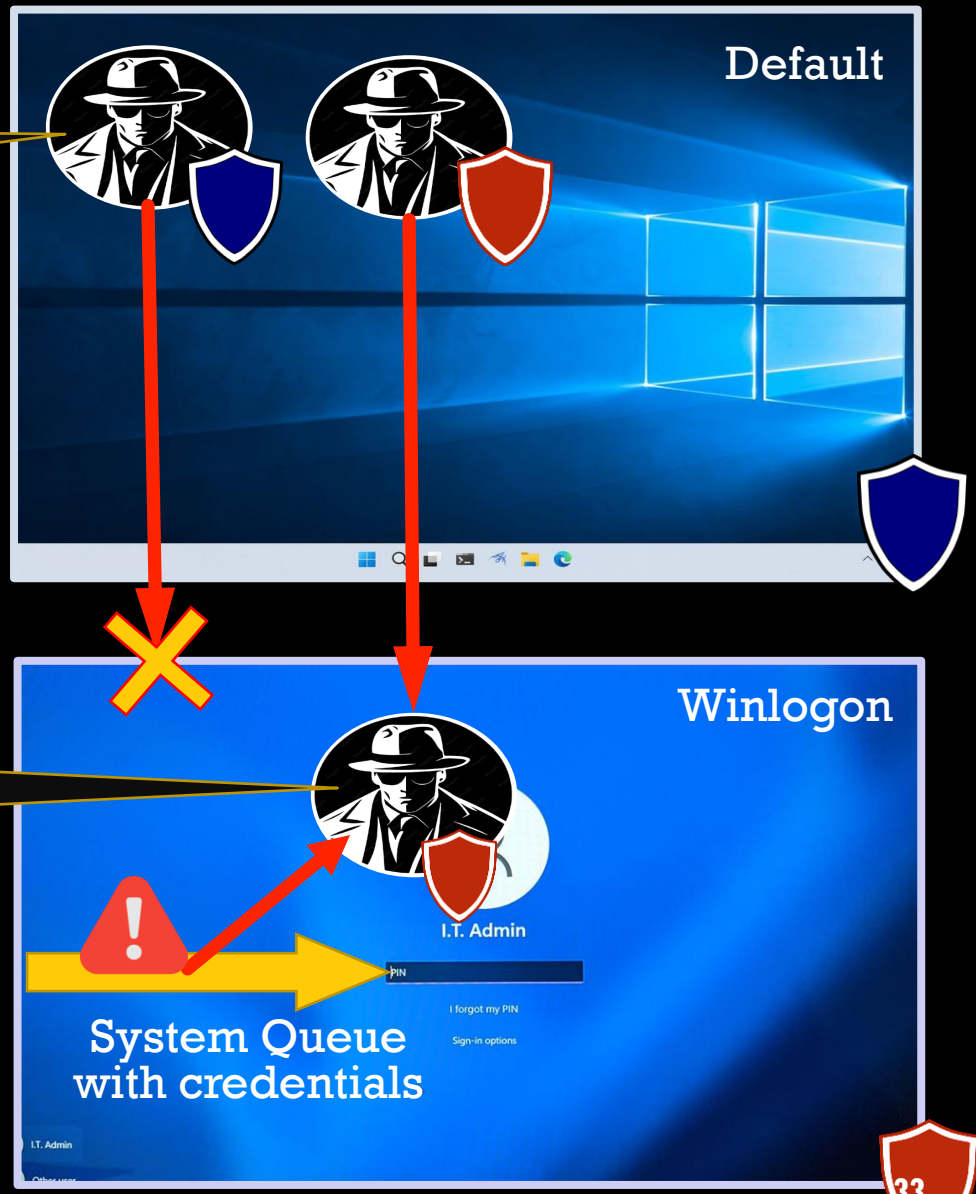


B. High-privileged keylogger can get access to Winlogon Desktop (e.g. via PsExec)

Keyloggers against Winlogon:

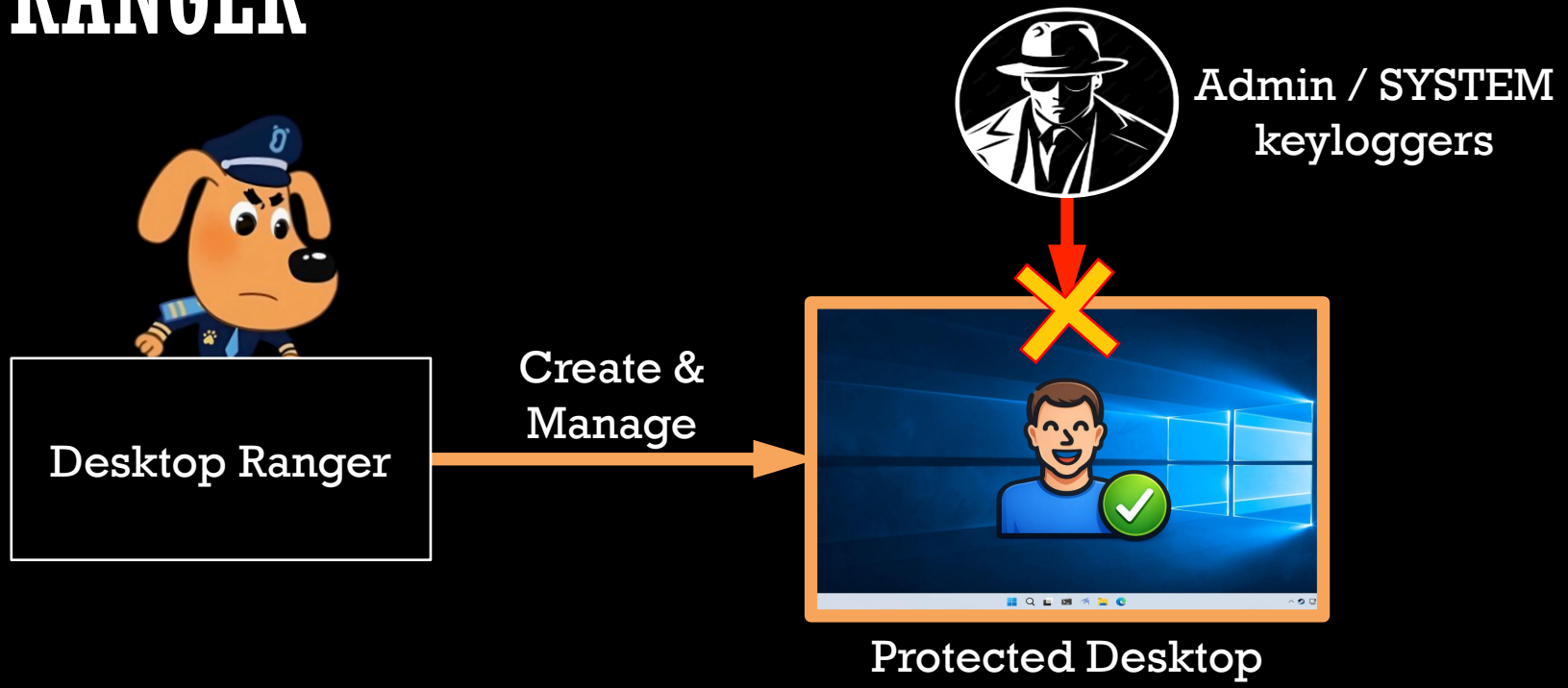
1. AdvanceLogger
2. AlmightyKeyLogger

https://github.com/Daniel-Ayz/AdvancedTopicsInMalware/tree/main/AlmightyKeyLogger
https://github.com/yuval2017/AdvanceLogger

Is possible to create a Desktop protected from high-privileged keyloggers?

Actually, yes

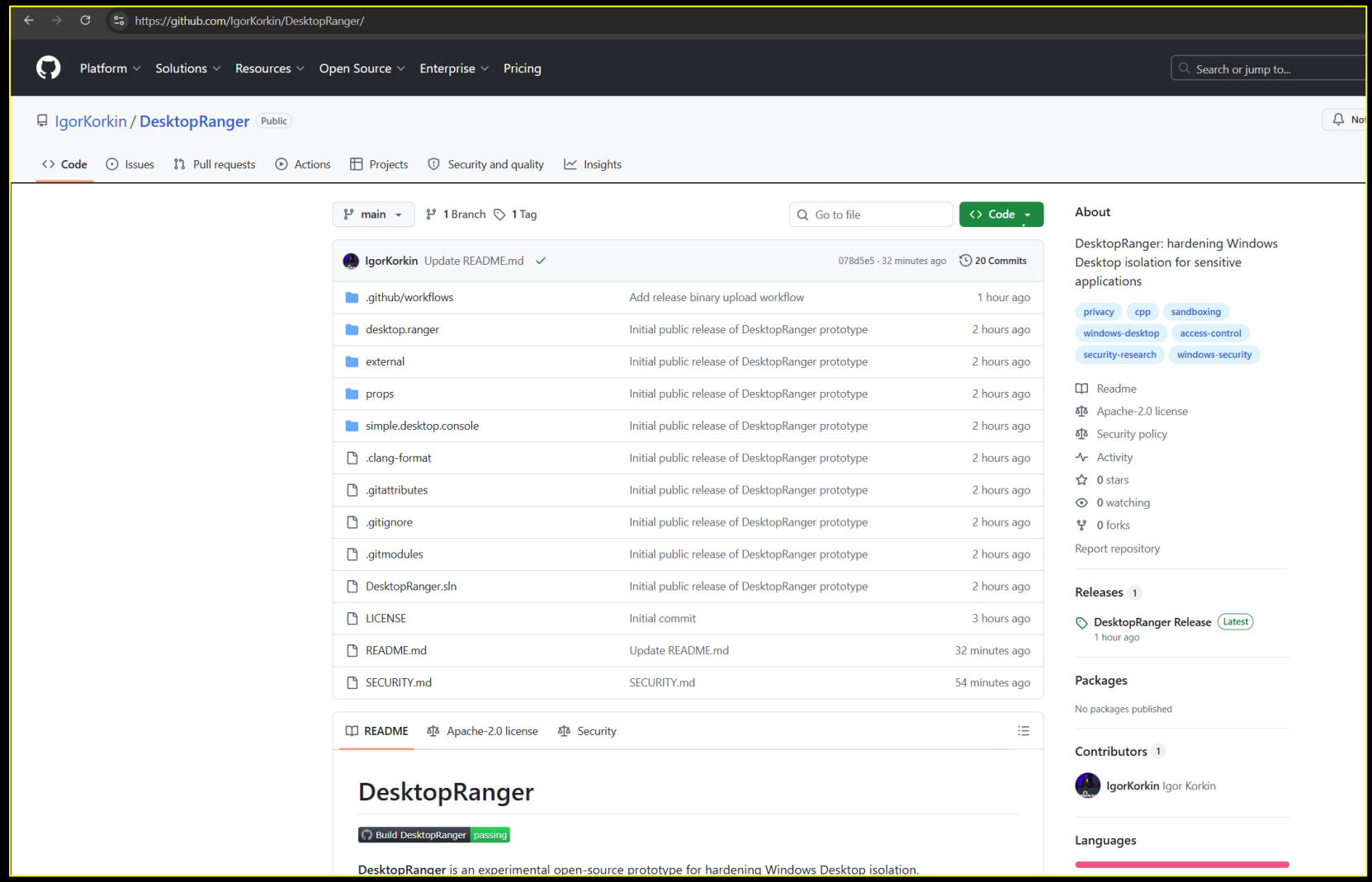
DESKTOP RANGER



- User-mode utility to create a secret desktop for private work
- Blocks attempts to enumerate, open, or attach to the protected desktop.
- Protects against high-privilege user-mode keyloggers.
- WinAPI + WIL / C++26 / ~2500 SLOC / Windows 11 26H1

DesktopRanger: Open-source repository

- Public repo: https://github.com/IgorKorkin/DesktopRanger



Step 1 – Create a desktop with an empty DACL

```
CreateDesktopW(RandomName, "D:P")
```

`"D:P"` – protected empty DACL: no ACEs, no inherited access

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`CreateDesktopW(RandomName, "D:P")`

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WinAPI	Result
EnumDesktops	RandomName is not returned
OpenDesktop	Access denied
CreateProcess(RandomName)	Access denied

WinAPI	Result
SwitchDesktop/CloseDesktop	☑
CreateProcess	see Step 2

Step 2 – Temporarily allow access in a secure way to run the app

1. Window Station: Revoke WINSTA_ENUMDESKTOPS
2. SetDesktopSD(“allow access”)
3. CreateProcess(UserApp) & Wait App initialization
4. SetDesktopSD(“restrict access”)
5. Restore WINSTA_ENUMDESKTOPS

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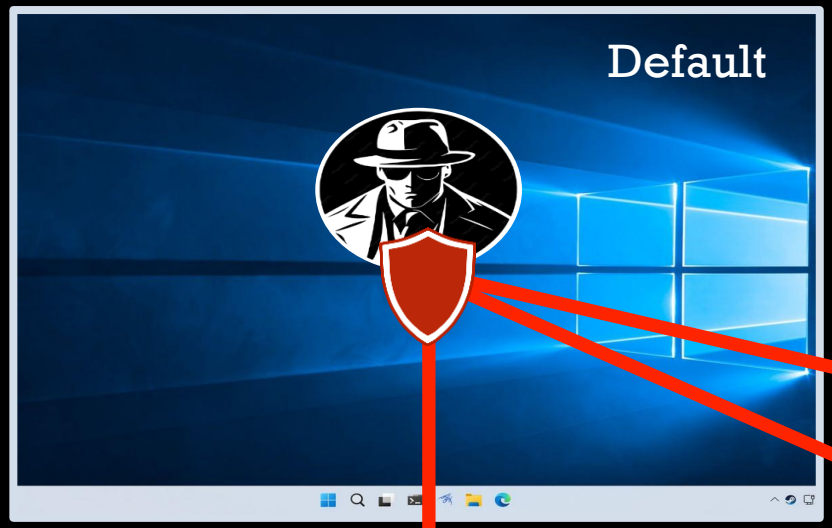
WinAPI	Result
EnumDesktops	Empty list (Step 1)
OpenDesktop(name)	name is random + not enumerable

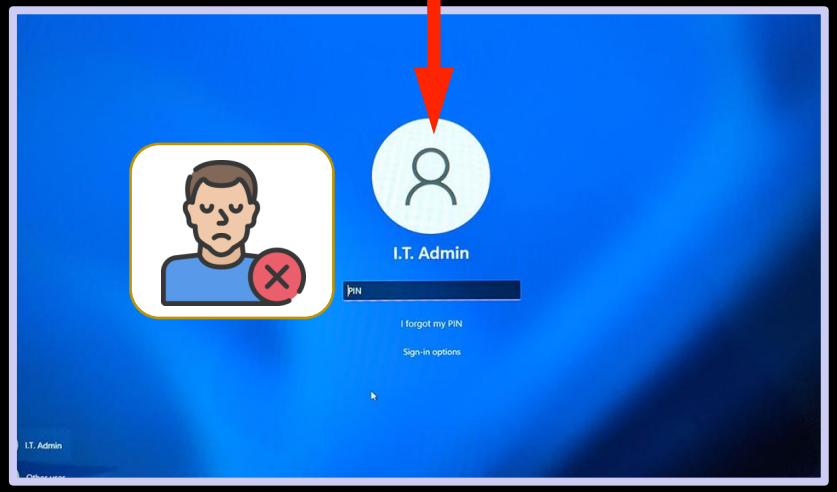
WinAPI	Result
CreateProcess	☑

TESTING SCENARIO

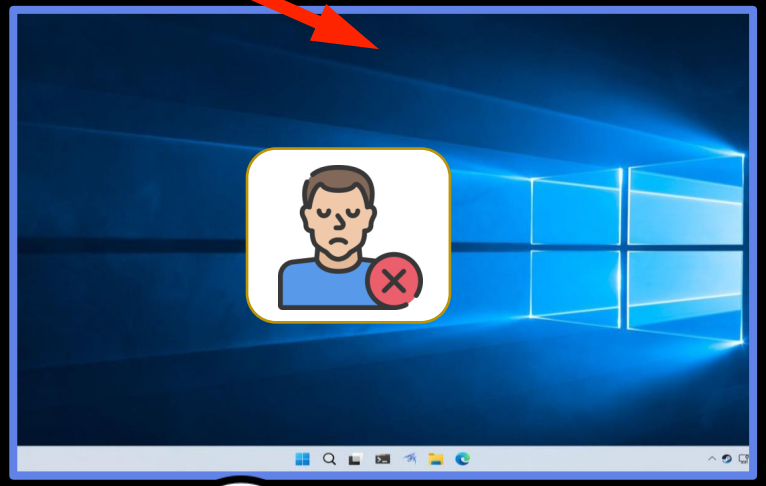
Experimental Keylogger:

1. WinAPI + WIL / C++26 / ~3000 SLOC
2. Implements 4 key intercepting techniques
3. Running with SYSTEM privileges
4. Monitoring desktops entities
5. vs Winlogon, KeePass & DesktopRanger





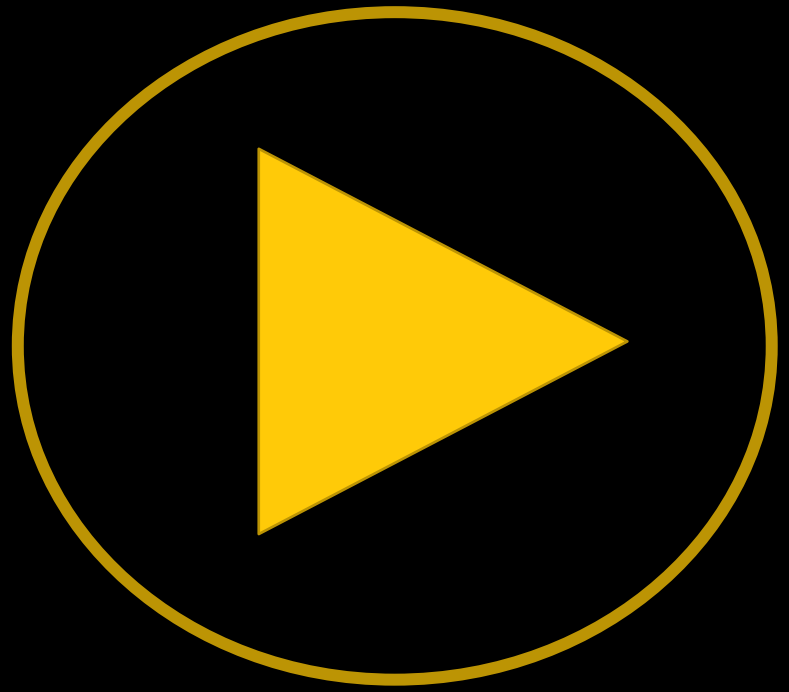
Winlogon



KeePass

Desktop Ranger

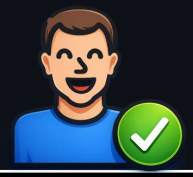
Demo: Advanced Keylogger vs Security Tools



The online version is here – https://igorkorkin.github.io/

PROTECTION AGAINST HIGH-PRIVILEGE KEYLOGGERS

Testing Results:

		KeePass	Winlogon	Desktop Ranger 
	Default User	⛔	☑	☑
	Admin (via UAC)	⛔	☑	☑
	System (via PsExec)	⛔	⛔	☑
	Launch users apps	⛔	⛔	☑

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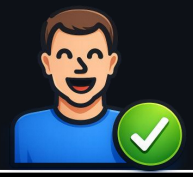	Launch users apps	⛔	⛔	☑

THANK YOU

- Igor Korkin
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- github.com/IgorKorkin/DesktopRanger