The forgotten interface: Windows named pipes
Your host

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Introduction To Key Terms

IPC or Inter-Process Communication
• An operating system mechanism that allows processes and applications to manage shared data and communicate
• Categorized as clients and servers, where the client requests data and the server responds to client requests
• Many applications are both clients and servers, as commonly seen in distributed computing
Introduction To Key Terms

Windows Named Pipes

• One of the methods to perform IPC in Microsoft Windows

• One-way or duplex pipe for communication between the pipe server and one or more pipe clients

• Utilizes a unique file system called NPFS (Named Pipe Filesystem)

• Any process can access named pipes, subject to security checks

• All instances of a named pipe share the same pipe name, but each instance has its own buffers and handles
Introduction To Key Terms

Windows Named Pipes

Many configurations and variations:

• Half Duplex or Full Duplex.

• Byte-Oriented or Packet-Oriented.

• Local or Network.

Inter-process communication is not only local!

Named pipes network communication is not encrypted and uses the protocols SMB (port 445) or DCE\RPC (port 135)
Introduction To Key Terms

**RPC or Remote Procedure Call**
- A protocol that allows one program to invoke a service from a program located on another computer

- No need to understand the network's structure\details

- Uses port 135 TCP or UDP

**DCE/RPC or Distributed Computing Environment / Remote Procedure Calls**
- A facility for calling a procedure on a remote as if it were a local procedure call

- To the programmer, a remote call looks like a local call
Introduction To Key Terms

**SMB or Server Message Block**

- An application-layer network protocol providing shared access to files, printers, serial ports etc.

- Mostly used for file sharing
  \192.168.1.1\c$\Users\manager\Documents\
  \fileserver\public\shareddocs

- Also provides an authenticated inter-process communication mechanism

- Uses port number 445 TCP
Introduction To Key Terms

Named and Unnamed \\ anonymous Pipes

Two types of named pipes:
- **Named pipes**: has a specific name, all instances share the name
- **Unnamed \ anonymous pipe**: is not given a name
  - Only used for communication between a child and it’s parent process
  - Always local; they cannot be used for communication over a network
  - Vanishes as soon as it is closed, or one of the process (parent or child) completes execution
  - Actually named pipes with a random name
Connecting To A Named Pipe
Connecting To A Named Pipe

- All pipes placed in the root directory of NPFS
- **Cannot** be mounted within the **normal filesystem**
- Mounted under the special path - `\\.\pipe\{pipe name}`
  - A pipe named "foo" would have a full path name of: `\\.\pipe\foo`
  - Remote connection: `\10.0.0.1\pipe\foo`
- Can be connected to programmatically or with dedicated tools
Connecting To A Named Pipe

**IO Ninja**

- Named pipes (and other communications) Swiss army knife
- [http://tibbo.com/ninja.htm](http://tibbo.com/ninja.htm)
- Free for non-commercial usage 😊
Pipe ACLs And Connection Limitation
Pipe ACLs And Connection Limitation

• Named pipes are implemented by a filesystem driver in Windows NT, npfs.sys, which supports security descriptors.

• Security descriptors are used to control access to named pipes.

• By default, DACL (Discretionary Access Control Lists) permissions are set to everyone using anonymous login (null sessions).

• ACLs can be modified to allow only specific users (same as file ACLs).
Named Pipes have Access Control Lists.
For the following pipe it is permitted to everyone to connect:
Pipe ACLs And Connection Limitation

Named pipes ACLs enumeration
- Using other 3rd party tools
- For example: Beyond Security Pipe Security Editor

An old utility, deprecated

Win32 Pipe Security Editor for Windows NT/2000/XP
http://retired.beyondlogic.org/solutions/pipesec/pipesec.htm
Another limitation of Windows Named Pipes in the **max number of instances** of a pipe.
Enumerating And Scanning For Named Pipes
Named pipes can be enumerated using different testing tools. For locally detecting which named pipes are opened, it is possible to use Sysinternals’ pipelist:

https://download.sysinternals.com/files/PipeList.zip
Enumerating And Scanning For Named Pipes

Named pipes ACLs enumeration using SysInternals’ pipeacl
• enables viewing permission of a certain named pipes:

```cmd
C:\> pipeacl \pipe\lsarpc
```

- Revision: 1
- Reserved: 0
- Control : 8004
- Owner: BUILTIN\Administrators (S-1-5-32-544)
- Group: SYSTEM (S-1-5-18)
- Sacl: Not present
- Dacl: 3 aces
  - (A) (00) 001f01ff : BUILTIN\Administrators (S-1-5-32-544)
  - (A) (00) 0012019b : Anonymous (S-1-5-7)
  - (A) (00) 0012019b : Everyone (S-1-1-0)

[www.securityfocus.com/tools/2629](http://www.securityfocus.com/tools/2629)
Enumerating And Scanning For Named Pipes

Forgotten Metasploit module called **Pipe auditor** enumerate **remotely** accessible named pipes, over SMB (**Pipe_Auditor**) or RPC (**Pipe_dcerpc_auditor**)
Sniffing Named Pipes Content
**Sniffing Named Pipes Content**

**IO Ninja** also enables sniffing and monitoring traffic of a chosen named pipe:

http://tibbo.com/ninja.html
Fuzzing
Named Pipes
Fuzzing

- **Fuzzing** or **fuzz testing** is an **automated software testing** technique that involves providing **invalid, unexpected, or random data** as inputs to a computer program.

- Done with **fuzzers** – automatic fuzzing tools

- The program is then **monitored** for exceptions such as crashes and potential RCEs.

- Typically, fuzzers are used to test programs that take structured inputs.
Fuzzing

Two types of fuzzing approaches:

**Dumb (“Black Box”)**
- Go over all possible inputs without understanding the expected ones (sometimes implemented using random data)
- Simple to implement, sometimes impossible to execute using the sequential approach

**Smart (“White Box”)**
- Understand the expected input and fuzz along the edges (mix expected data template with random values)
  - Smart data generation
- Harder to implement, more code coverage
Fuzzing Named Pipes

Windows IPC Fuzzing - dump-fuzzing named pipes script

Exploitation And Impact
Exploitation And Impact

• Many pieces of software work with hidden and/or undocumented APIs

• The forgotten nature of named pipes leave an uncharted territory of socket-like interfaces that can contain vulnerabilities

• If software reads data from the named pipe without any validation of the content, the attacker might trigger Buffer Overflow leading to Denial of Service of the software and even Remote Code Execution
Exploitation And Impact

• If named pipe ACLs allow remote access, **remote DoS or RCE** can be triggered

• Research of the cause behind the crash will allow the attacker to facilitate it as a **zero day vulnerability**

• Could be used to spread a malware in an internal network, as recently seen in the WannaCry ransomware campaign

GAME OVER
Case study: qBittorrent & SugarSync
qBittorrent & SugarSync case study

qBittorrent
• a cross-platform client for the BitTorrent protocol
• Free and open-source, released under the GPLv2
• Written in C++

SugarSync
• A cloud service that enables active synchronization of files across computers and other devices
• Used for file backup, access, syncing, and sharing
• Supports variety of operating systems, such as Android, iOS, Mac OS X, and Windows devices
Exploitation And Impact

Both application use **QT framework**:
- A cross-platform application development framework for desktop, embedded and mobile. Supports multiple platforms and operating systems

- Both applications use the `qtsingleapp` functionality which is responsible for writing temp files

- By **fuzzing** the named pipe both locally and remotely, we managed to **remotely crash the programs**
Demo
Mitigation And Defense
Mitigation And Defense

Developers point of view

Know the risk!

• When creating a named pipe, set a secured ACL to allow only authorized connections to the named pipes

• Follow the least privilege approach
  o Giving a user account only those privileges which are essential to perform its intended function

• If possible, limit the maximum number of instances of a named pipe, thus effectively limiting the number of simultaneous connections
Mitigation And Defense

**Users' 3rd party software clients point of view**

Know the risk!

- Block all unnecessary SMB and RPC services (ports 135 and 445), especially over WAN/Internet
- Segment the network according to security best practices
- Always install the latest software security patches
Mitigation And Defense

**Hackers’ point of view**

Know the opportunity!

- Well… Hack
- Explore remotely accessible named pipes and test for RCE and DoS whenever seeing open SMB or RPC ports
- Have fun! 😊
Closing remarks

- Windows named pipes are a forgotten, remotely accessible, socket-like interface

- A whole, newly rediscovered, potential world of local and remote vulnerabilities – increased attack surface

- Don’t ignore named pipes in Windows desktop applications

Stay safe
Thank you

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