



# HCK-CI: Enabling CI for Windows guest paravirtualized drivers

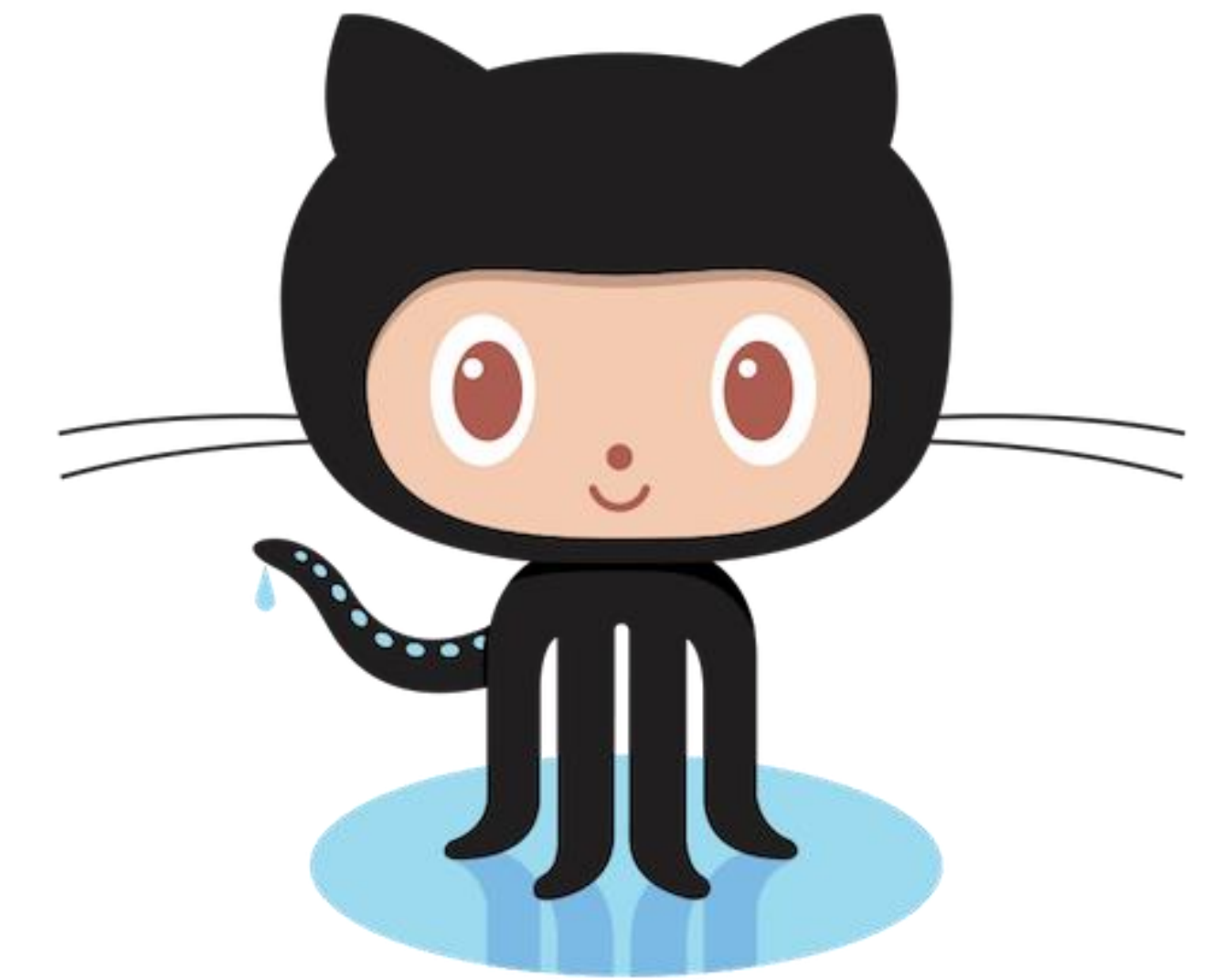
**Kostiantyn Kostyuk - Software engineer, Daynix**

<https://github.com/HCK-CI>



- virtio-win drivers
- Why do we need CI for virtio-win drivers?
- What is WHQL certification and what are HCK\HLK?
- How we can leverage WHQL certification for CI?
- What are the challenges with WHQL certification?
- Automating WHQL certification
- Examples of configuration and usage

- Upstream: <https://github.com/virtio-win/kvm-guest-drivers-windows/>
- Drivers for the major virtio devices:
  - virtio-net
  - virtio-blk, virtio-scsi
  - virtio-balloon, virtio-serial, virtio-vsock, virtio-input, virtio-rng
  - virtio-gpu



# Why do we need CI for virtio-win?

- Enable easy upstream contribution
- We want PRs to pass WHQL certification tests for each driver category
- Not easy to setup and execute

build: use recommended codeql suite instead of mustfix one bbfa024

build: Using a common driver cleanup script a3b827a

**Some checks were not successful** [Hide all checks](#)  
1 failing and 5 successful checks

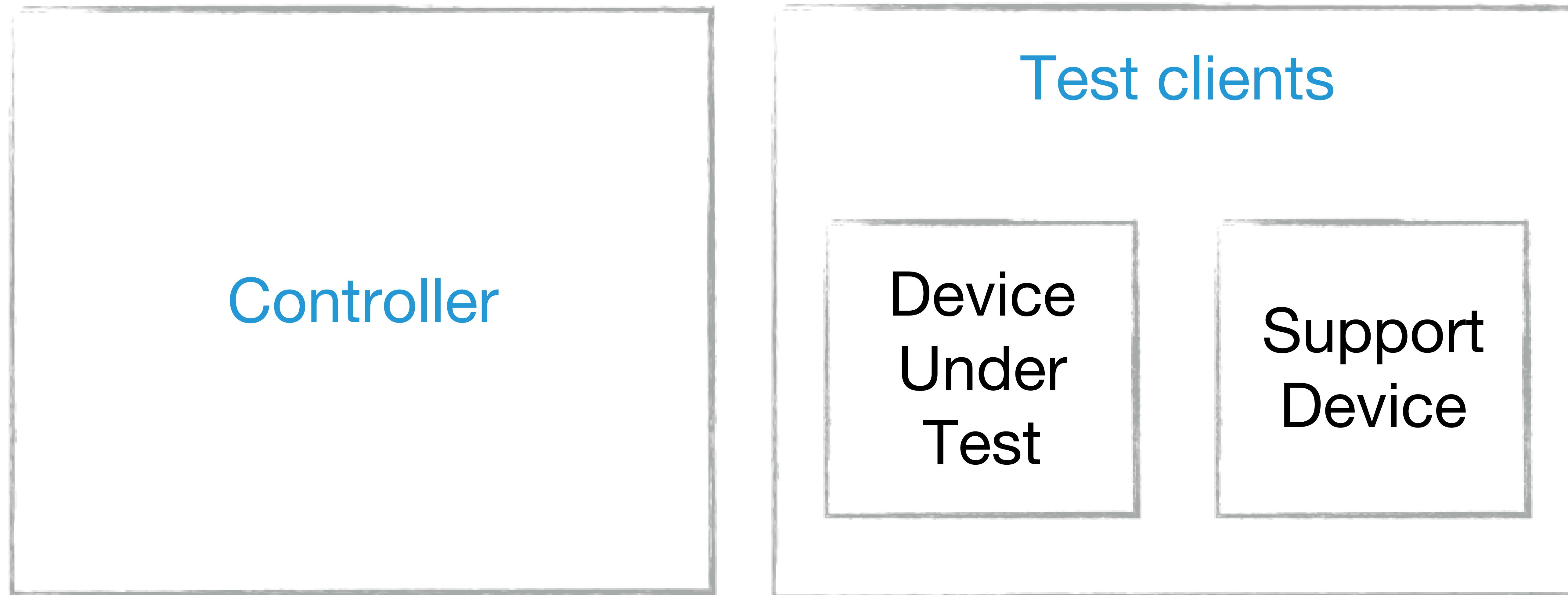
	HCK-CI/viostor-Win2019x64 — 4 tests failed out of 29 tests	<a href="#">Details</a>
	HCK-CI — Build finished.	<a href="#">Details</a>
	HCK-CI/Balloon-Win2019x64 — All tests passed	<a href="#">Details</a>
	HCK-CI/NetKVM-Win2019x64 — All tests passed	<a href="#">Details</a>
	HCK-CI/ivshmem-Win2019x64 — All tests passed	<a href="#">Details</a>
	HCK-CI/ivshmem-Win2019x64 — All tests passed	<a href="#">Details</a>

**This branch has no conflicts with the base branch when rebasing**  
Only those with [write access](#) to this repository can merge pull requests.

# What are WHQL and HLK/HCK?

- Microsoft driver certification
- HLK and HCK are the test kits used for certifications

# VM types



## Device certification

Networking

Storage

USB

Other categories

## System certification

(SVVP for hypervisors)

# Different kits

## HCK

Windows 7

Windows 8

Windows 8.1

Windows Server 2008R2

Windows Server 2012

Windows Server 2012R2

## HLK

HLK1607

Windows 10, Windows Server 2016

HLK1809

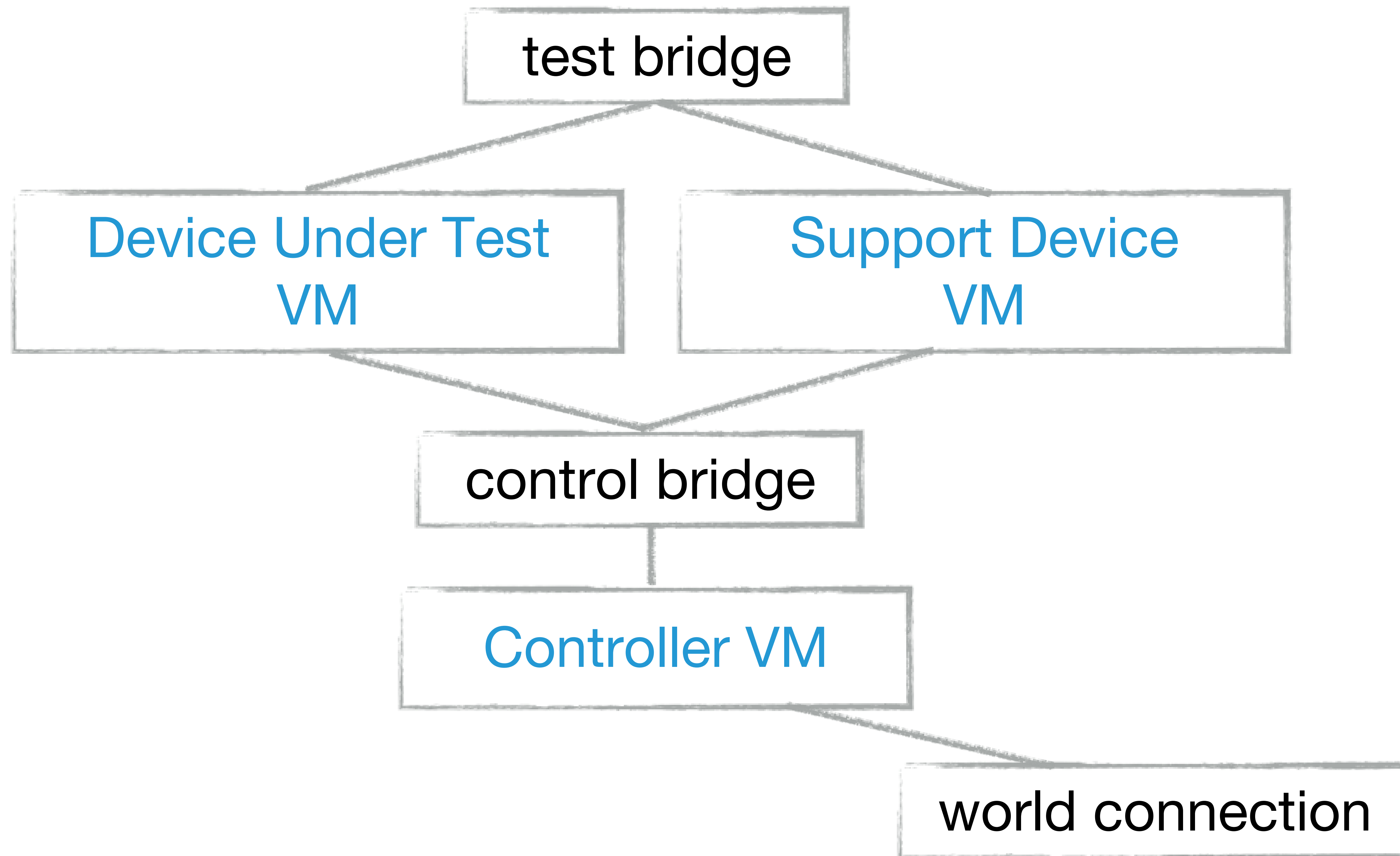
Windows 10, Windows Server 2019

HLK2022

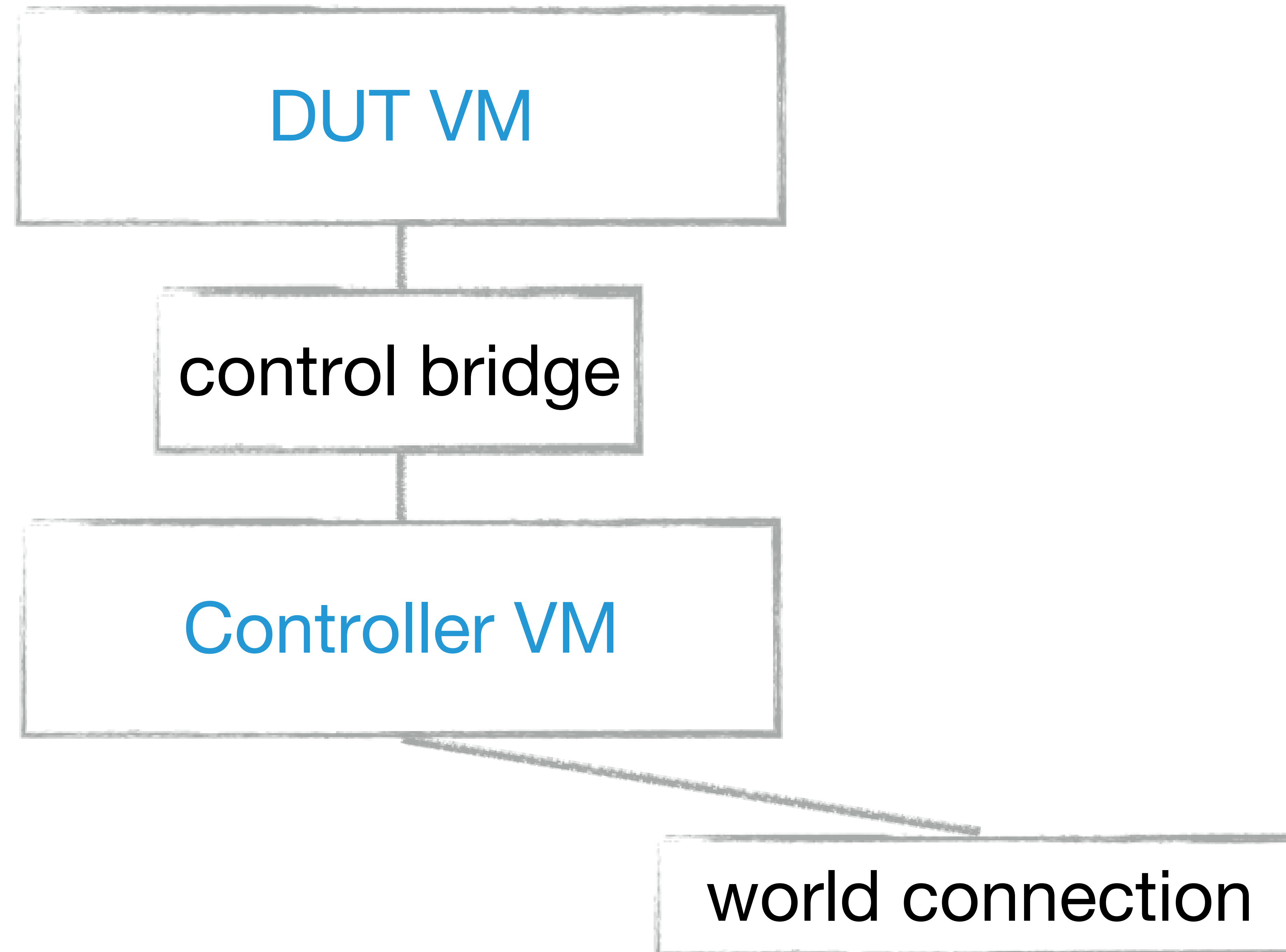
Windows Server 2022



# Sample configuration - network



# Sample configuration - other devices



# What do we need?

- Run certification tests as part of CI process
- Can be used by individual developer
- The ultimate goal - to be used for actual certification

- Used by individual developer
- Orchestrates network and storage for the test
- Runs VMs on top of QEMU-KVM

# What should be automated?

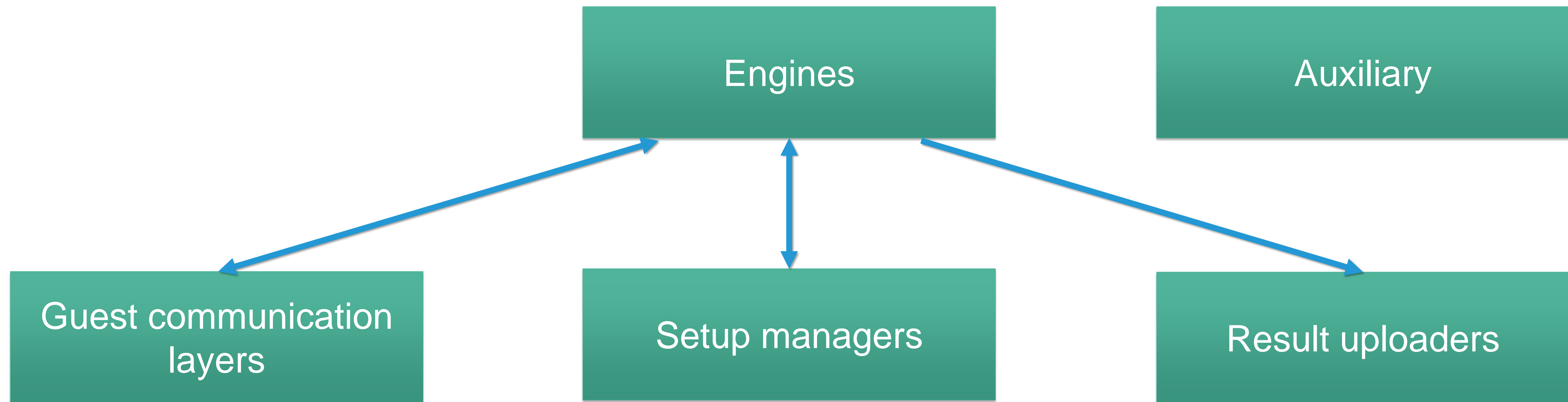
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Guest automation

Guest communication layer

Host Automation: VM and networking  
orchestration

Test manager and reports



- Driver installation (including test certificate)
- HCK\HLK studio control using MS API
  - Orchestration of HCK\HLK setup
  - Running tests
- Filter and playlist application
- Get back the results in a parsed human readable manner and test package

- createpool "NetKVM-pool"
- createproject "NetKVM-Win2022x64"
- createprojecttarget  
"PCI\VEN\_1AF4&DEV\_1000&SUBSYS\_00011AF4&REV\_00\3&267A616A&0&20" "NetKVM-Win2022x64" "CL2"  
"NetKVM-pool"



- `queuetest "bbcc1b46-d0bf-46c8-85b4-2cd62df34a20"`  
`"PCI\VEN_1AF4&DEV_1000&SUBSYS_00011AF4&REV_00\3&267A616A&0&20"` `"NetKVM-Win2022x64"` `"CL2"`  
`"NetKVM-pool"`
- `listtestresults "bbcc1b46-d0bf-46c8-85b4-2cd62df34a20"`  
`"PCI\VEN_1AF4&DEV_1000&SUBSYS_00011AF4&REV_00\3&267A616A&0&20"` `"NetKVM-Win2022x64"` `"CL2"`  
`"NetKVM-pool"`
- `createprojectpackage "NetKVM-Win2022x64" [<package>]`

- Communication between Controller VM and the test manager on the host using WinRM
- Communication between the Controller and Client VMs
- A gateway to toolsHCK

- Creates VMs images with corresponding software
- Orchestrates network and storage for the test
- Creates snapshots that will be used for the tests
- Runs VMs and monitors their status

- Manages test configurations
- Platforms, OSes, devices, HLK / custom test play lists, test black lists, HLK filter
- Orchestrates test setup in HLK studio and run the tests
- Monitors test process

- Result uploading
  - uploading results to DropBox
    - Parsed HLK\HCK results
    - Mini-dump files, if BSOD occurred during the tests' run
    - Symbol and binary files for debugging
  - updates Github pull requests with CI status
- HLK test package

## Server requirements

<b>Processor</b>	12 x vCPUs (minimal)
<b>Memory</b>	14 GB RAM (minimal)
<b>Storage</b>	512 GB (SSD is preferred)
<b>Host OS</b>	Linux based
<b>Internet connection</b>	Recommended

- Project source:
  - AutoHCK
  - toolsHCK
  - HLK-Setup-Scripts
  - extra-software

- JSON – Format
- Global configuration
- Setup managers
- Engines



- Global configuration
  - config.json
  - drivers.json
  - svvp.json

```
{  
  "iso_path": "/home/hck-ci/HCK-Cl/iso",  
  "extra_software": "/home/hck-ci/HCK-Cl/extra-software",  
  "workspace_path": "/home/hck-ci/HCK-Cl/workspace",  
  "ip_segment": "192.168.0.",  
  "id_range": [ 2, 90 ],  
  "winrm_port": "5985",  
  "repository": "virtio-win/kvm-guest-drivers-windows",  
  "toolshck_path": "./toolsHCK.ps1",  
  "studio_username": "Administrator",  
  "studio_password": "*****",  
  "result_uploaders": [ "dropbox" ],  
  "test_engine": "hcktest",  
  "install_engine": "hckinstall",  
  "setupmanager": "qemuhck",  
  "time_out": "9"  
}
```

- Setup managers
  - qemu\_machine.json
  - physhck.json

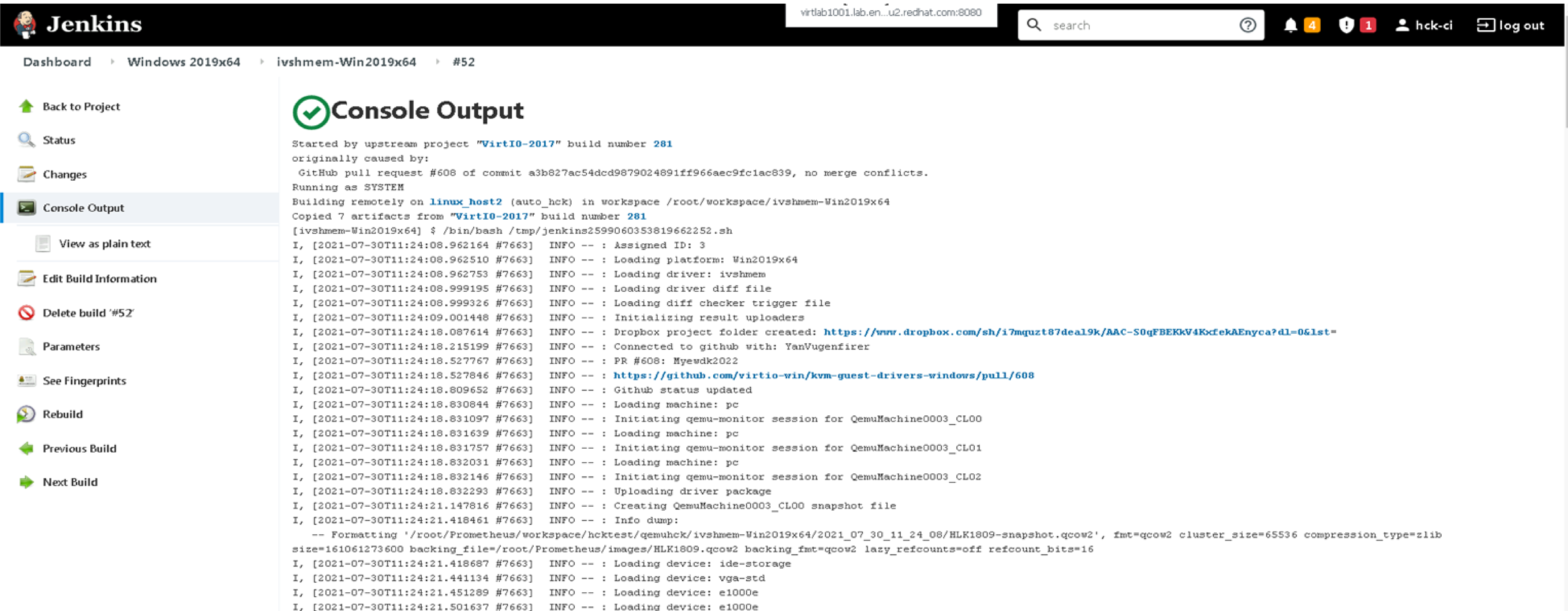
```
[  
  {  
    "name": "PhyWin2016",  
    "st_ip": "10.20.30.40",  
    "kit": "HLK1607"  
  },  
  {  
    "name": "PhyWin2019",  
    "st_ip": "10.20.30.41",  
    "kit": "HLK1809"  
  }  
]
```

- Engines
  - hlkinstall.json
- HLK Install
  - studio\_platform.json
  - kit.json
  - iso.json
- HLK Test
  - <platform>.json

```
{
  "name": "Win2022x64",
  "kit": "HLK2022",
  "st_image": "HLK2022.qcow2",
  "clients": {
    "c1": {
      "name": "CL1",
      "cpus": "4",
      "memory": "4G",
      "winrm_port": "4002",
      "image": "HLK2022-C1-Win2022x64.qcow2"
    },
    "c2": {
      "name": "CL2",
      "cpus": "4",
      "memory": "4G",
      "winrm_port": "4003",
      "image": "HLK2022-C2-Win2022x64.qcow2"
    }
  }
}
```

# Optional software - Jenkins

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The screenshot shows the Jenkins web interface. At the top, the Jenkins logo is on the left, and the URL 'virtlab1001.lab.en...u2.redhat.com:8080' is in the center. A search bar and user profile 'hck-ci' are on the right. The breadcrumb trail is 'Dashboard > Windows 2019x64 > ivshmem-Win2019x64 > #52'. The left sidebar contains navigation links: 'Back to Project', 'Status', 'Changes', 'Console Output' (selected), 'View as plain text', 'Edit Build Information', 'Delete build #52', 'Parameters', 'See Fingerprints', 'Rebuild', 'Previous Build', and 'Next Build'. The main content area is titled 'Console Output' with a green checkmark icon. It displays the following text:

```
Started by upstream project "VirtIO-2017" build number 281
originally caused by:
  GitHub pull request #608 of commit a3b827ac54dcd9879024891ff966aec9fciac839, no merge conflicts.
Running as SYSTEM
Building remotely on linux_host2 (auto_hck) in workspace /root/workspace/ivshmem-Win2019x64
Copied 7 artifacts from "VirtIO-2017" build number 281
[ivshmem-Win2019x64] $ /bin/bash /tmp/jenkins2599060353819662252.sh
I, [2021-07-30T11:24:08.962164 #7663] INFO -- : Assigned ID: 3
I, [2021-07-30T11:24:08.962510 #7663] INFO -- : Loading platform: Win2019x64
I, [2021-07-30T11:24:08.962753 #7663] INFO -- : Loading driver: ivshmem
I, [2021-07-30T11:24:08.999195 #7663] INFO -- : Loading driver diff file
I, [2021-07-30T11:24:08.999326 #7663] INFO -- : Loading diff checker trigger file
I, [2021-07-30T11:24:09.001448 #7663] INFO -- : Initializing result uploaders
I, [2021-07-30T11:24:18.087614 #7663] INFO -- : Dropbox project folder created: https://www.dropbox.com/sh/i7mqzt87deal9k/AAC-S0qFBEKkV4KcfekAEnyca?dl=0&list=
I, [2021-07-30T11:24:18.215199 #7663] INFO -- : Connected to github with: YanVugenfirer
I, [2021-07-30T11:24:18.527767 #7663] INFO -- : PR #608: Myewdk2022
I, [2021-07-30T11:24:18.527846 #7663] INFO -- : https://github.com/virtio-win/kvm-guest-drivers-windows/pull/608
I, [2021-07-30T11:24:18.809652 #7663] INFO -- : Github status updated
I, [2021-07-30T11:24:18.830844 #7663] INFO -- : Loading machine: pc
I, [2021-07-30T11:24:18.831097 #7663] INFO -- : Initiating qemu-monitor session for QemuMachine0003_CL00
I, [2021-07-30T11:24:18.831639 #7663] INFO -- : Loading machine: pc
I, [2021-07-30T11:24:18.831757 #7663] INFO -- : Initiating qemu-monitor session for QemuMachine0003_CL01
I, [2021-07-30T11:24:18.832031 #7663] INFO -- : Loading machine: pc
I, [2021-07-30T11:24:18.832146 #7663] INFO -- : Initiating qemu-monitor session for QemuMachine0003_CL02
I, [2021-07-30T11:24:18.832293 #7663] INFO -- : Uploading driver package
I, [2021-07-30T11:24:21.147816 #7663] INFO -- : Creating QemuMachine0003_CL00 snapshot file
I, [2021-07-30T11:24:21.418461 #7663] INFO -- : Info dump:
  -- Formatting '/root/Prometheus/workspace/hcktest/qemuhck/ivshmem-Win2019x64/2021_07_30_11_24_08/HLK1809-snapshot.qcow2', fmt=qcow2 cluster_size=65536 compression_type=zlib
size=161061273600 backing_file=/root/Prometheus/images/HLK1809.qcow2 backing_fmt=qcow2 lazy_refcounts=off refcount_bits=16
I, [2021-07-30T11:24:21.418687 #7663] INFO -- : Loading device: ide-storage
I, [2021-07-30T11:24:21.441134 #7663] INFO -- : Loading device: vga-std
I, [2021-07-30T11:24:21.451289 #7663] INFO -- : Loading device: e1000e
I, [2021-07-30T11:24:21.501637 #7663] INFO -- : Loading device: e1000e
```

# Optional software - Sentry

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**Sentry** konstantin@daynix...

- Projects
- Issues**
- Performance
- Releases
- User Feedback
- Alerts
- Discover
- Dashboards
- Activity
- Stats
- Settings

**ruby**

x v

All Environments

v

Last 14 days

v

## Issues

All Unresolved **2** For Review Ignored Saved Searches v

is:unresolved

x +

Sort by: Last Seen v

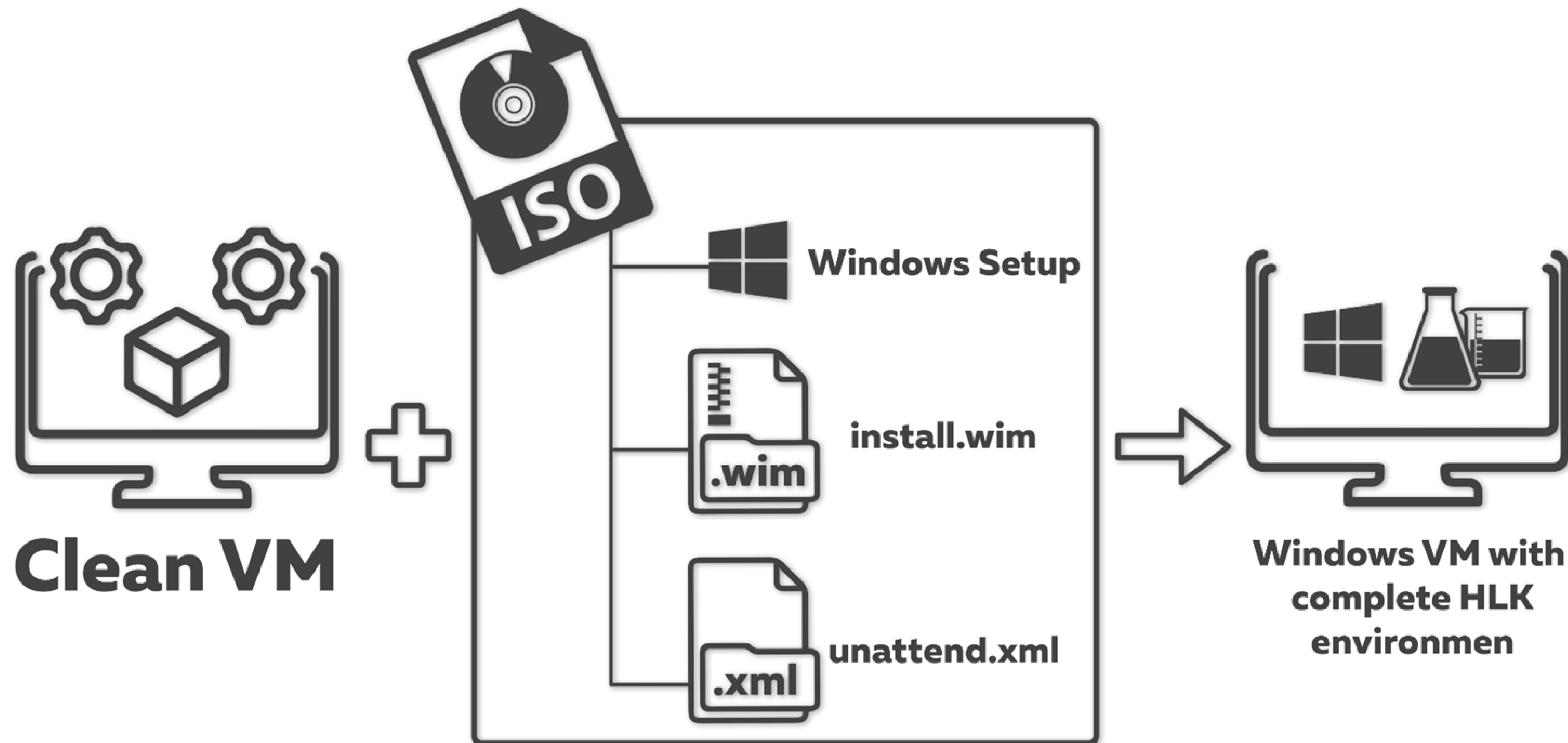
	GRAPH:	24h 14d	EVENTS	USERS	ASSIGNEE
<input type="checkbox"/> <b>@project.close</b> <small>RUBY-M 1wk ago   3wk old</small>	-----		1	0	v
<input type="checkbox"/> <b>Errno::EACCES</b> lib/project.rb in init_workspace Permission denied @ dir_s_mkdir - /data/user/auto_hck/workspace/hcktest <small>RUBY-Q 1wk ago   1wk old</small>	-----		1	0	v

Showing 2 of 2 issues

< >

# Image installation

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```
ruby ./bin/auto_hck install -p Win10_2004x86
```

# Running sample test

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```
I, [2021-08-25T00:15:36.465688 #22317] INFO -- : >>> Currently running: DF - Sleep with IO During (Reliability) [00:45:00]
I, [2021-08-25T00:20:27.038361 #22317] INFO -- : Applying filters on finished tests
I, [2021-08-25T00:21:20.460527 #22317] INFO -- : Github status updated
I, [2021-08-25T00:21:21.437649 #22317] INFO -- : Passed: DF - Sleep with IO During (Reliability)
I, [2021-08-25T00:21:21.437788 #22317] INFO -- : Test information page: https://docs.microsoft.com/en-us/windows-hardware/test/hlk/testref/9d87d997-f451-4a3d-852c-90367d4d3864
I, [2021-08-25T00:21:24.146337 #22317] INFO -- : Test archive successfully created
I, [2021-08-25T00:21:27.520875 #22317] INFO -- : Tests results logs updated via the result uploader
I, [2021-08-25T00:21:28.917326 #22317] INFO -- : Test archive uploaded via the result uploader
I, [2021-08-25T00:21:28.917598 #22317] INFO -- : <<< Passed: 20 | Failed: 0 | InQueue: 2
I, [2021-08-25T00:21:38.928046 #22317] INFO -- : Adding to queue: DF - Reinstall with IO Before and After (Reliability) [01:30:00]
I, [2021-08-25T00:21:48.070334 #22317] INFO -- : >>> Currently running: DF - Reinstall with IO Before and After (Reliability) [01:30:00]
I, [2021-08-25T00:38:25.438541 #22317] INFO -- : Applying filters on finished tests
I, [2021-08-25T00:39:17.476092 #22317] INFO -- : Github status updated
I, [2021-08-25T00:39:18.567195 #22317] INFO -- : Passed: DF - Reinstall with IO Before and After (Reliability)
I, [2021-08-25T00:39:18.567345 #22317] INFO -- : Test information page: https://docs.microsoft.com/en-us/windows-hardware/test/hlk/testref/8dd417ab-e523-4bf0-a971-7c27d99ff5b2
I, [2021-08-25T00:39:22.503789 #22317] INFO -- : Test archive successfully created
I, [2021-08-25T00:39:27.018756 #22317] INFO -- : Tests results logs updated via the result uploader
I, [2021-08-25T00:39:28.263472 #22317] INFO -- : Test archive uploaded via the result uploader
I, [2021-08-25T00:39:28.263768 #22317] INFO -- : <<< Passed: 21 | Failed: 0 | InQueue: 1
I, [2021-08-25T00:39:38.274602 #22317] INFO -- : Adding to queue: DF - Reboot Restart with IO During (Reliability) [05:00:00]
I, [2021-08-25T00:39:47.754999 #22317] INFO -- : >>> Currently running: DF - Reboot Restart with IO During (Reliability) [05:00:00]
```

```
ruby ./bin/auto_hck test \  
  --platform Win2019x64 --drivers ivshmem \  
  --driver-path "${HOME}/workspace/ivshmem-Win2019x64-build"
```

# Running sample test

Windows Hardware Lab Kit Help | Configuration | Connect | About

ivshmem-Win2019x64

Project Selection **Tests** Results Package

Run Selected View Details Load Playlist Save Selected As Playlist View By Bring...

<input type="checkbox"/>	Status	Test Name	Type	Length	Target	Machine(s)
<input type="checkbox"/>		DF - PNP Rebalance Request N...	⚙️	03m	IVSHMEM Devic	CL1
<input type="checkbox"/>	✓	DF - PNP Rebalance Request N...	⚙️	08m	IVSHMEM Devic	CL1
<input type="checkbox"/>		DF - PNP Remove Device Test (I...	⚙️	03m	IVSHMEM Devic	CL1
<input type="checkbox"/>	✓	DF - PNP Remove Device Test (I...	⚙️	08m	IVSHMEM Devic	CL1
<input type="checkbox"/>		DF - PNP Stop (Rebalance) Dev...	⚙️	03m	IVSHMEM Devic	CL1
<input type="checkbox"/>	✓	DF - PNP Stop (Rebalance) Dev...	⚙️	08m	IVSHMEM Devic	CL1
<input type="checkbox"/>		DF - PNP Surprise Remove Dev...	⚙️	03m	IVSHMEM Devic	CL1
<input type="checkbox"/>	✓	DF - PNP Surprise Remove Dev...	⚙️	08m	IVSHMEM Devic	CL1
<input type="checkbox"/>	✓	DF - Reboot restart with IO bef...	⚙️	04m	IVSHMEM Devic	CL1
<input type="checkbox"/>		DF - Reboot Restart with IO Du...	⚙️	10m	IVSHMEM Devic	CL1
<input checked="" type="checkbox"/>	🔄	DF - Reboot Restart with IO Du...	⚙️	05h 00m	IVSHMEM Devic	CL1
<input type="checkbox"/>		DF - Reinstall with IO Before an...	⚙️	10m	IVSHMEM Devic	CL1
<input type="checkbox"/>	✓	DF - Reinstall with IO Before an...	⚙️	01h 30m	IVSHMEM Devic	CL1
<input type="checkbox"/>	✓	DF - SimpleIO stress test with I...	⚙️	02m	IVSHMEM Devic	CL1
<input type="checkbox"/>		DF - Sleep and PNP (disable an...	⚙️	05m	IVSHMEM Devic	CL1
<input type="checkbox"/>	✓	DF - Sleep and PNP (disable an...	⚙️	45m	IVSHMEM Devic	CL1
<input type="checkbox"/>		DF - Sleep with IO Before and A...	⚙️	04m	IVSHMEM Devic	CL1
<input type="checkbox"/>		DF - Sleep with IO During (Dev...	⚙️	05m	IVSHMEM Devic	CL1
<input type="checkbox"/>	✓	DF - Sleep with IO During (Reli...	⚙️	45m	IVSHMEM Devic	CL1
<input type="checkbox"/>	✓	HyperVisor Code Integrity Reac...	⚙️	10m	IVSHMEM Devic	CL1
<input type="checkbox"/>	✓	Operate In Server Core Test		05m	IVSHMEM Devic	CL1
<input type="checkbox"/>	✓	Static Tools Logo Test		05m	IVSHMEM Devic	CL1
<input type="checkbox"/>	✓	TDI filters and LSPs are not allo...		01m	IVSHMEM Devic	CL1
<input type="checkbox"/>		Wdf - Check Kmdf Function Tab...	⚙️	01m	IVSHMEM Devic	CL1

DF - Reboot Restart with IO During (Reliability)

22  24

Run Test

ivshmem-Win2019x64  
Database Project

- Targets
  - IVSHMEM Device
- OS Platforms
- Product Types
- Test Status
- Machine Status 🌐



# Running sample test

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```
Administrator: C:\Windows\system32\cmd.exe
C:\Windows\SYSTEM32\cmd.exe
WDTF_TARGETS      :      Target: IVSHMEM Device PCI\VEN_1AF4&DEV_1110&SUBSYS_11001AF4&REV_01\3&13C0B0C5&0&20
WDTF_TARGETS      :      - GetInterfacesIfExist("SimpleIOStressProc")
WDTF_SIMPLE_IO    :      - For Target:IVSHMEM Device PCI\VEN_1AF4&DEV_1110&SUBSYS_11001AF4&REV_01\3&13C0B0C5&0&20  n
o Simple IO Interface was found.
WDTF_SIMPLE_IO_ANY  :      - The Generic Any SimpleIO plugin will be used to generate IO for Target: IVSHMEM Device PCI\
VEN_1AF4&DEV_1110&SUBSYS_11001AF4&REV_01\3&13C0B0C5&0&20
WDTF_SIMPLE_IO    :      - For Target:IVSHMEM Device PCI\VEN_1AF4&DEV_1110&SUBSYS_11001AF4&REV_01\3&13C0B0C5&0&20  W
DTF will use the ANY Simple IO Interface.
WDTF_TARGETS      :      Target: IVSHMEM Device PCI\VEN_1AF4&DEV_1110&SUBSYS_11001AF4&REV_01\3&13C0B0C5&0&20
WDTF_SYSTEM       :      - Have restarted. Context = WDTF_RebootRestart
WDTF_SYSTEM       :      Data  UUIDString = 535b6ff4-2211-43d2-8389-96328a564a12
WDTF_SYSTEM       :      TestName = DF - Reboot Restart with IO During (Reliability)
Telemetry: Registering trace logging.
Telemetry trace logging registration status: 0x0
Telemetry trace logging initialization status: True
WDTF_SIMPLEIO_STRESS_PROC : - StartAsync(IVSHMEM Device PCI\VEN_1AF4&DEV_1110&SUBSYS_11001AF4&REV_01\3&13C0B0C5&0&20 )
WDTF_SUPPORT      :      - WaitForMinutes : 1
WDTF_SIMPLE_IO    :      INFO : - For Target:IVSHMEM Device PCI\VEN_1AF4&DEV_1110&SUBSYS_11001AF4&REV_01\3&13C0B0C5
&0&20  no Simple IO Interface was found.
WDTF_SIMPLE_IO_ANY  :      - The Generic Any SimpleIO plugin will be used to generate IO for Target: IVSHMEM Device PCI\
VEN_1AF4&DEV_1110&SUBSYS_11001AF4&REV_01\3&13C0B0C5&0&20
WDTF_SIMPLE_IO    :      INFO : - For Target:IVSHMEM Device PCI\VEN_1AF4&DEV_1110&SUBSYS_11001AF4&REV_01\3&13C0B0C5
&0&20  WDTF will use the ANY Simple IO Interface.
WDTF_SIMPLE_IO    :      INFO : - Open(IVSHMEM Device PCI\VEN_1AF4&DEV_1110&SUBSYS_11001AF4&REV_01\3&13C0B0C5&0&20
) Try count 1
WDTF_SIMPLE_IO    :      INFO : - PerformIO(IVSHMEM Device PCI\VEN_1AF4&DEV_1110&SUBSYS_11001AF4&REV_01\3&13C0B0C5&
0&20 ) Count 1
```

# Projects using HCK-CI

## virtio-win CI

sameehj added some commits on Aug 22

- NetKVM: List: Add empty list method ... 3bf3a03
- NetKVM: CX: Extend SendControlMessage bufs > 2 ... f354529

sameehj force-pushed the sameehj:netkvm\_cx branch from ba9370e to f354529 18 hours ago

Add more commits by pushing to the `netkvm_cx` branch on `sameehj/kvm-guest-drivers-windows`.

**Some checks haven't completed yet** [Hide all checks](#)  
4 pending and 2 successful checks

- HCK-CI/NetKVM-Win10\_1703x64 Pending — Running tests (11/58): 0 tests f... [Details](#)
- HCK-CI/NetKVM-Win10\_1703x86 Pending — Running tests (10/56): 0 tests f... [Details](#)
- HCK-CI/NetKVM-Win10\_1809x64 Pending — Running tests (35/58): 4 tests f... [Details](#)
- HCK-CI/NetKVM-Win81x64 Pending — Running tests (14/79): 0 tests failed [Details](#)
- HCK-CI — Build finished.
- This branch has no conflicts with the base branch when rebasing**  
Rebase and merge can be performed automatically.

## OpenVPN CI

[Open](#) **buildtap.py: Allow to use environment variable for paths #145**  
kostyanf14 wants to merge 1 commit into `OpenVPN:master` from `kostyanf14:fix_3`

- buildtap.py: Allow to use environment variable for paths ... 886137c

cron2 assigned **mattock** yesterday

Add more commits by pushing to the `fix_3` branch on `kostyanf14/tap-windows6`.

**Some checks haven't completed yet** [Hide all checks](#)  
1 pending and 2 successful checks

- HCK-CI/openvpn-Win2019x64 Pending — Running tests (58/58): 2 tests failed [Details](#)
- HCK-CI — Build finished. [Details](#)
- continuous-integration/appveyor/pr — AppVeyor build succeeded [Details](#)
- This branch has no conflicts with the base branch**  
Only those with [write access](#) to this repository can merge pull requests.

- Running as upstream CI for several projects
- Modular architecture allowing adding support for other hypervisors or bare metal support (vDPA on Windows)
- Support for automating SVVP (hypervisor) certification tests
- Integration with GitHub (modularity allowing integration with other services)
- Integration with DropBox to upload the results
- Parsing the results so they can be viewed by people without installation of HLK\HCK Studio

- Adding support for other hypervisors
- Adding support for additional results' storage

# Q&A

[konstantin@daynix.com](mailto:konstantin@daynix.com)

- HCK-CI Framework source:
  - <https://github.com/HCK-CI/AutoHCK>
  - <https://github.com/HCK-CI/toolsHCK>
  - <https://github.com/HCK-CI/HLK-Setup-Scripts>
  - <https://github.com/HCK-CI/extra-software>
- virtio-win drivers source code (upstream CI):
  - <https://github.com/virtio-win/kvm-guest-drivers-windows>
- OpenVPN TAP-Windows driver source code (upstream CI):
  - <https://github.com/OpenVPN/tap-windows6>





- Windows Unattended Setup:
  - <https://docs.microsoft.com/en-us/windows-hardware/manufacture/desktop/automate-windows-setup>
  - <https://docs.microsoft.com/en-us/windows-hardware/manufacture/desktop/update-windows-settings-and-scripts-create-your-own-answer-file-sxs>
- HLK Test Reference
  - <https://docs.microsoft.com/en-us/windows-hardware/test/hlk/testref/hardware-lab-kit-test-reference>

# Links – related presentations

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- KVM Forum 2012 WHQL Process for Windows Drivers and What the Community Can Learn From It - Yan Vugenfirer, Daynix :
  - <https://www.linux-kvm.org/images/8/82/2012-forum-WHQLAndTheCommunity.pdf>
- HLK Test Reference
  - <https://www.slideshare.net/YanVugenfirer/virt-hck-kvmforum2013>





# KVM FORUM