CHALLENGES EXTENDING TEST AUTOMATION FOR VIRTUALIZATION

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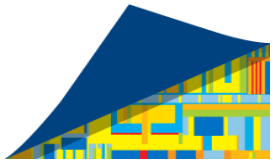

CONTEXT

- Automation essential to manage today's validation workloads
- Focus mainly for Traditional OS validation (Windows, Linux)
- Extending for Virtualization OSes is very different
- In this presentation, the focus is on:
  - Challenges when extending Traditional automation frameworks to support Virtualization OSes
  - Mechanisms useful to overcome them

AGENDA

- Background
- Virtualization Automation Challenges
- Virtualization Automation Design
- Key Points & Experience

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- **Background**
- Virtualization Automation Challenges
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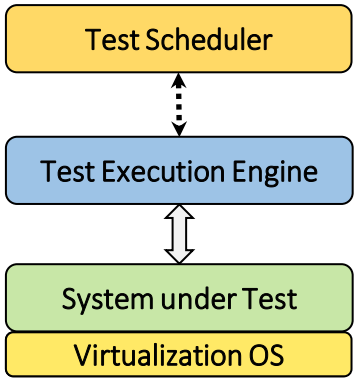
- Key Points & Experience

TEST AUTOMATION FRAMEWORKS

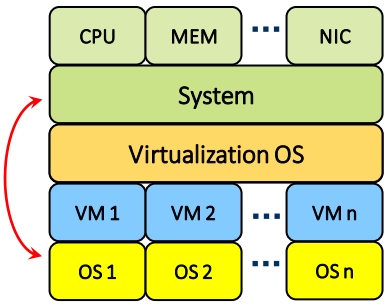
Test Automation Frameworks include 3 components

- **Test Schedulers** trigger test execution
- **Test Execution Engines** run test scripts on SUT
- **System Under Test (SUT)** = System + OS



TRADITIONAL VS. VIRTUALIZATION

- Traditional OS – direct and dedicated control of system hardware
- Virtualization – system hardware is shared
- **System to OS** ratio change from **1:1** to **1:n**
- Automation Frameworks stuck on **1:1**



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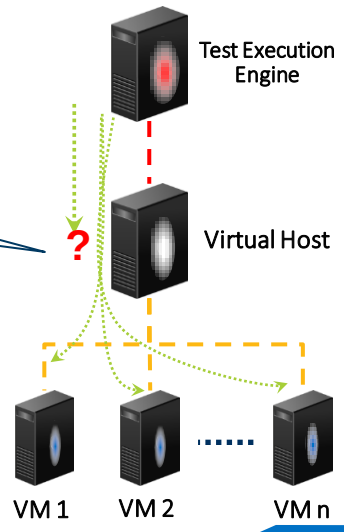
VIRTUALIZATION AUTOMATION: CHALLENGES

- Consider a simple test scenario
- SUT – Virtualization OS

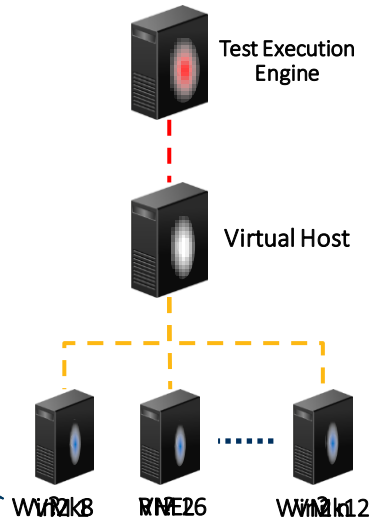
Challenge 1:
How to manage dynamic resources??!!



VIRTUALIZATION AUTOMATION: CHALLENGES

- Test Execution Engines support Windows or Linux
- But what OS are running on the VMs??

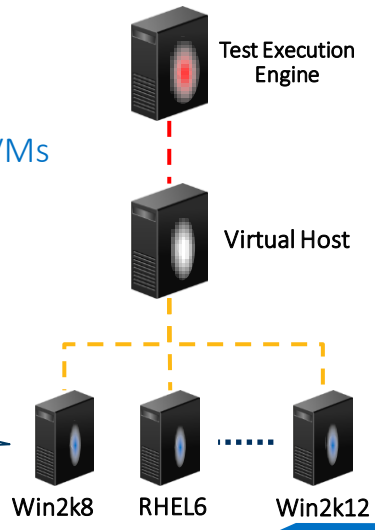
Challenge 2:
Need to support multiple OSes!



VIRTUALIZATION AUTOMATION: CHALLENGES

- Automation uses "Setup-Test-Teardown" per test
- Setup-Teardown times dependent on number of VMs
- Virtualization ≈ 2 * Traditional OS

Challenge 3:
How to manage long setup-teardown times?



VIRTUALIZATION AUTOMATION: CHALLENGES

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- **Virtualization Automation Design**
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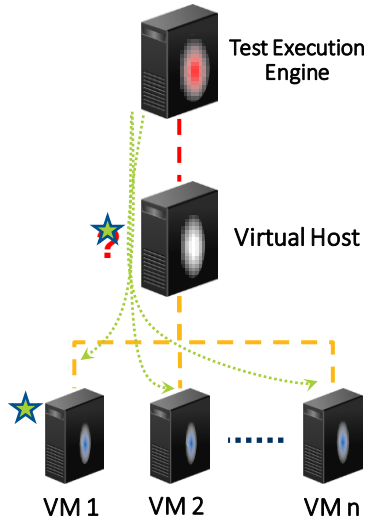
DESIGN: DYNAMIC RESOURCES

Dynamic Resource Management:

- Record systems in a test execution
- **`Pointer`** to control various systems
  - System Table holds key information
- **`Pointer`** helps control test execution correctly
  - Operations executed on system pointed by **`Token`**

Host	OS, Auth, IPAdd, . . .
VM1	OS, Auth, IPAdd, . . .
VM2	OS, Auth, IPAdd, . . .
VM*n*	OS, Auth, IPAdd, . . .



DESIGN: MULTI-OS SUPPORT

- Libraries categorized into 2 types
- Common Libraries:
  - Features common to all OSes – traditional and virtualization
  - E.g. **`SendSystemCommand()`**
- Virtualization Libraries:
  - Virtualization specific features only
  - E.g. **`NewVM()`**

```
Function SendSystemCommand()
  If (systemOS = WINDOWS) Then
    ...
  End If
  If (systemOS = LINUX) Then
    ...
  End If
  If (systemOS = ESX) Then
    ...
  End If
End Function
```

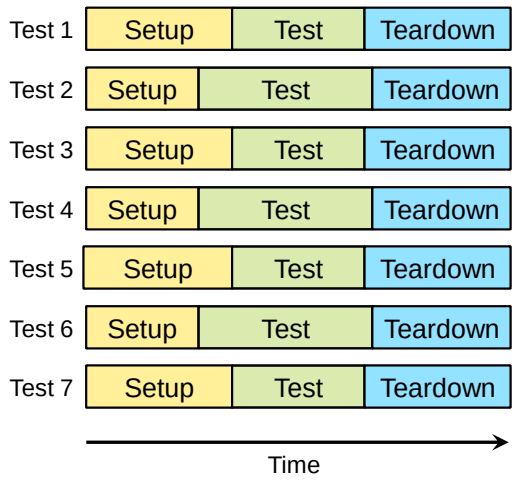
```
Function NewVM()
  If (systemOS = ESX) Then
    ...
  End If
  If (systemOS = Hyper_V) Then
    ...
  End If
  If (systemOS = KVM) Then
    ...
  End If
End Function
```

Design: Test Continuation Mechanism

- Virtualization Setups include:
  - Host Setup
  - Virtual Machine setup
- Teardown is just the reverse of setup
- Setup-teardown times dependent on number of VMs
- Setup-teardown can dominate total test time

Design: Test Continuation Mechanism

- Group tests with similar setups
- Full setup for FIRST test
- Full teardown for LAST test
- Minimal setup-cleanup within tests



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ITE-BERTA TEST AUTOMATION FRAMEWORK

- Built using in-house tools:
  - Integrated Test Environment (ITE)
  - Berta - test-scheduler
- Framework extended to support VMware ESXi
  - Other hypervisor (HyperV, KVM) support planned
- Libraries extended to support Linux
- Libraries support Dynamic Resource Management
- Test Continuation in-progress

PERSONAL EXPERIENCE

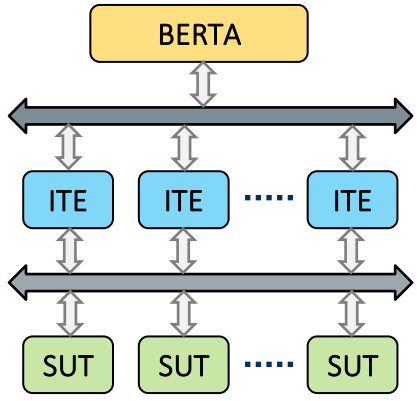
- Three Firsts – Validation, Automation and Virtualization
- Re-using existing framework to create common is possible
- Scripts satisfy dual purpose: Full and Selective Automation
- Script-in-script execution slow; debugging very painful

THANK YOU

BACK-UP SLIDES

ITE-BERTA TEST AUTOMATION FRAMEWORK

- Built using two in-house tools:
  - Integrated Test Environment (ITE)
  - Berta
- ITE:
  - Test Execution Engine
  - Windows OS Validation
- Berta:
  - Test Scheduler
  - Maintains test database (SUT, tests, etc.)
  - Provides metrics, send notification, etc.



CHALLENGES: COMPLEX SETUP-TEARDOWN

	Traditional OS (mins)	Virtualization OS (mins)
Establish connection between SUT and Target	25	25
Add required LUNs	4	(2 min/LUN) 10
Setup VMs (DataStores, VMs, OS, LUNs)	-	(10 min/VM) 50
Setup Time:	29	85
Run Test: (SAN IO for various packet sizes)	30	30
Remove VM Setup (delete DataStores, VMs, etc.)	-	(4 min/VM) 20
Release LUNs, SUT and Target connections	24	(4 min/LUN) 20
Teardown Time:	24	40
Total Test Time:	83	155

DESIGN: DYNAMIC RESOURCE MANAGEMENT

- Implement in two stages:
  - Recording new resources
  - Hand control to correct system (token)
- Extend supports for 3 types of systems:
  - SUT – Initially host
  - PEER – Traffic Partners
  - VM – Test Virtual Machine
- Toggle control to correct system:
  - Token (**controlSystem**) hands control

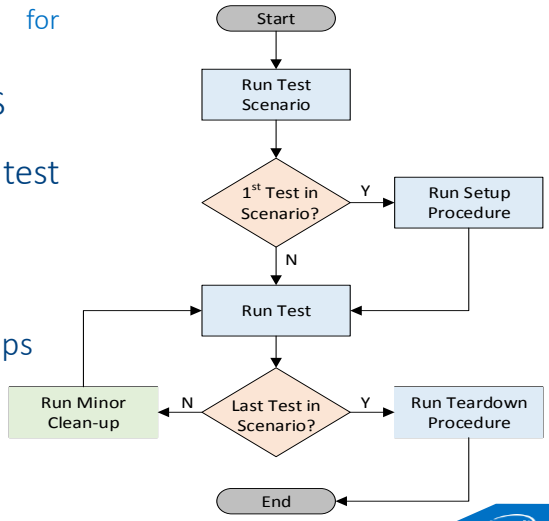
```
Class Class_System
  ...
  '0=Host,1=Peer,2+=VM
  Dim systemSubtype
  Dim systemOS
  Dim mgmtIPAddress
  Dim diskCount
  Dim networkAdapter
  ...
End Class
```

```
'Start IO on peer
controlSystem = PEER
startLANIO()

'Transfer Control to VM1
For system = VM1 To VM
controlSystem = system
'Start FCoE traffic
startSANIO()
```

DESIGN: TEST CONTINUATION MECHANISM

- Need to reduce setup-teardown times for virtualization testing!
  - Takes 2x Time versus Traditional OS
- Test Continuation helps reduce test times for test groups
- The Idea involves:
  - Classify/Group tests with similar setups
  - Full setup for FIRST test
  - Minimal clean-up within group
  - Full teardown for LAST test



OTHER SLIDES

CONTEXT

- Automation been mainly focused for Traditional OSes (Windows, Linux)
- Extending automation for Virtualization OSes/Hypervisors is very different
- In this presentation, we present:
  - Challenges with extending automated validation for virtualization OSes
  - Mechanisms used to overcome them
- We present our internal ITE-Berta Automation Framework used to:
  - Extend a Windows-only automation framework to support Virtualization Hypervisors (VMware)

STORAGE NETWORKING

- Involves Storage Area Networks (SAN)
- SANs are dedicated networks to access consolidated data storage
  - **Initiators** are servers initiating RD/WR data requests
  - **Targets** are data storage devices that service these requests
  - **LUNs** are data storage hard-drive (logical unit numbers)
- Protocols include Fiber Channel (FC), iSCSI, FC over Ethernet (FCoE)

ITE-BERTA Test Automation Framework

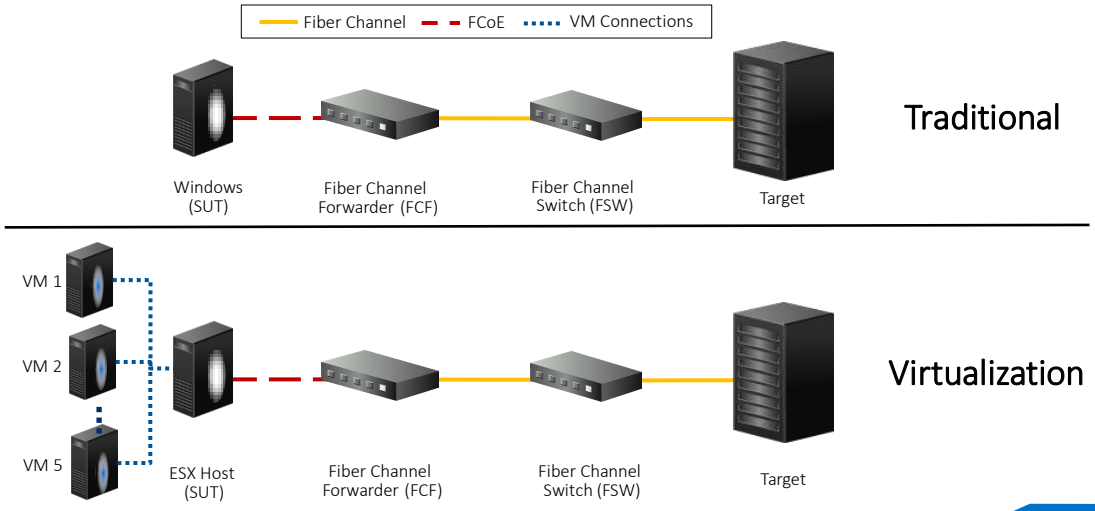
- No-Touch Automation Solution
  - Monitors for new component and project builds
  - Triggers BAT testing on new builds
  - Triggers Regression testing on BAT-certified builds
  - Notifies key stakeholders

Example Test-Case Scenario

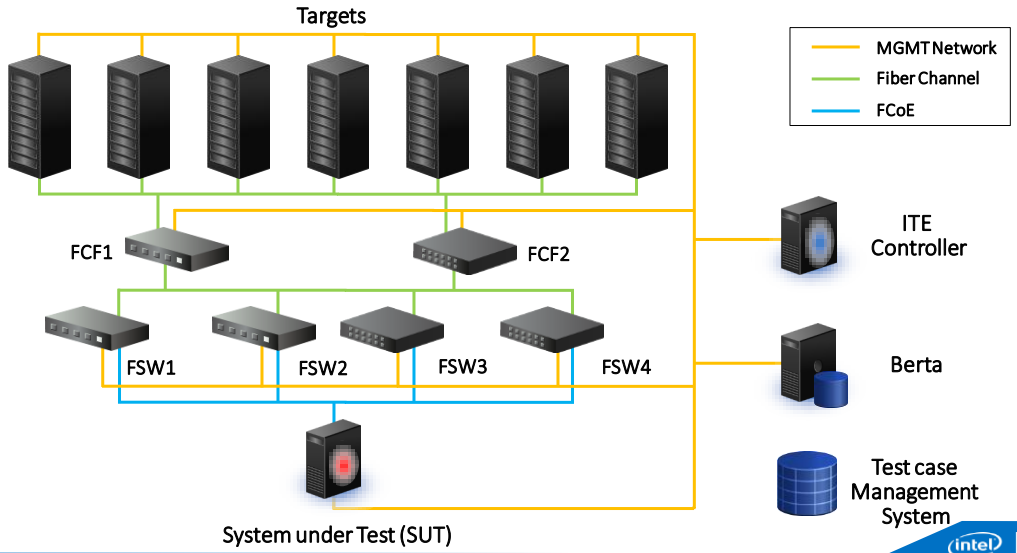
- Comparing Setup, Runtime, Teardown for Traditional vs. Virtualization

Traditional OS	Virtualization OS
Setup SUT and Target (FCF-FSW setup)	
Add 1 LUN of required size	Add 5 LUNs of required size
n/a	Create a DataStore on the LUNs
n/a	Create 5 VMs with Windows/Linux OSes
n/a	Attach a LUN to each VM
Run traffic between SUT and Target	Run traffic between VMs and Target
Clean-up Setup	

EXAMPLE TEST-CASE SCENARIO



AUTOMATION INFRASTRUCTURE SETUP



VIRTUALIZATION AUTOMATION: CHALLENGES

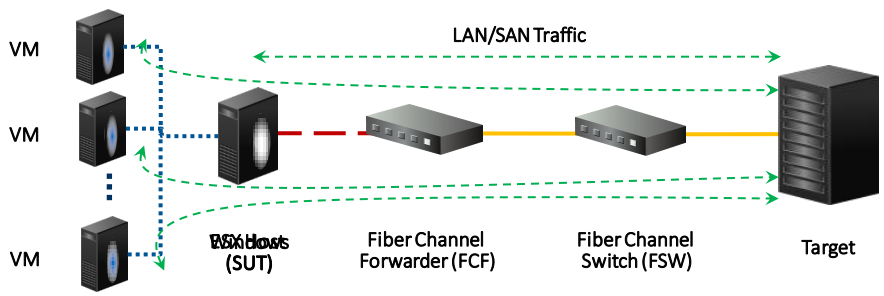
- Virtualization OSes or Hosts allow VMs to work independently
- Virtualization OS validation involves both Host and VM testing
- The main challenges:

STATIC RESOURCE MANAGEMENT

SINGLE OS SUPPORT

COMPLEX AND TIME-CONSUMING SETUP AND TEARDOWN

EXAMPLE TEST SCENARIO



Virtualization Traditional

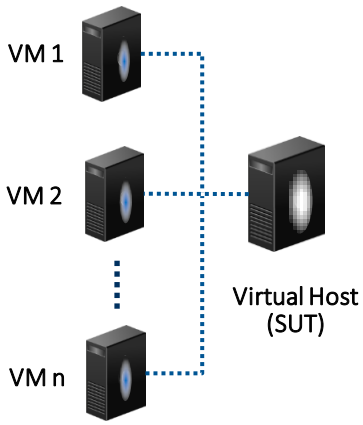
CHALLENGES: STATIC RESOURCE MANAGEMENT

- Test execution engines use STATIC resource management
  - Resources selected before tests
  - Resources cannot change within tests
  - No communication-control with new resources
- Problems for Virtualization
  - VMs are virtual test resources (SUTs)
  - VMs created within tests
  - Need to communicate with VMs within tests

CHALLENGES: STATIC RESOURCE MANAGEMENT

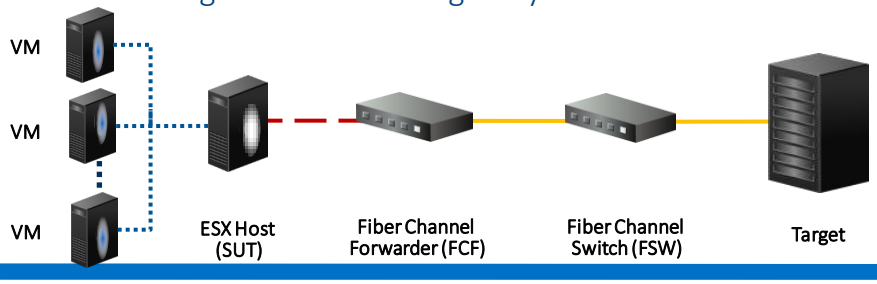
Example:

- Before VMs, SUT → ESXi HOST
- Later, VMs become the SUT (Host becomes manager)
- Run IO to-from the VMs
- Test execution engine cannot manage a system that it is not aware of!



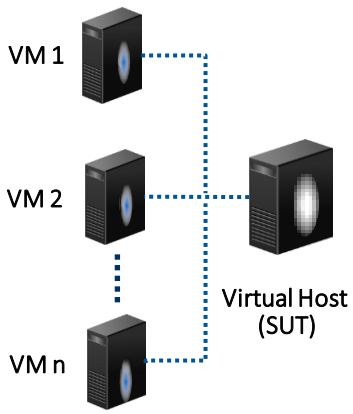
CHALLENGES: STATIC RESOURCE MANAGEMENT

- Example Test Scenario:
  - Before VMs, SUT → ESXi HOST
  - Later, VMs become the SUT (Host becomes manager)
  - Test requires running IO between the VMs and Target
  - Test execution engine cannot manage a system that it is not aware of!



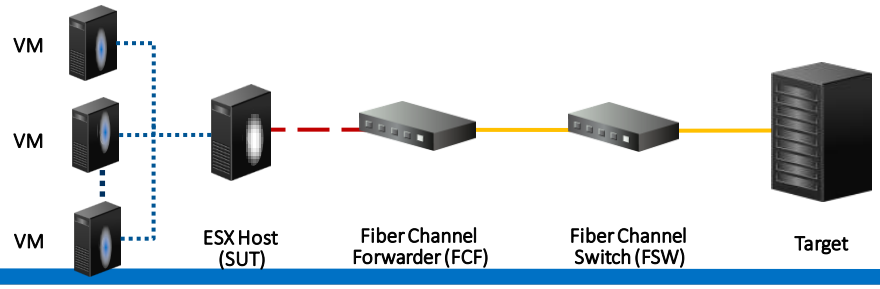
CHALLENGES: SINGLE OS SUPPORT

- Test Execution Engines typically support one OS
  - Most support either Windows or Linux
  - However, VMs created can run either Windows or Linux OS
    - Need to communicate-control with all VMs to complete test (start IO)
- Need to extend support for multiple OSes
  - Need to add support for Windows, Linux, ESXi
  - Complicated feature – Compiler support and/or Library support?



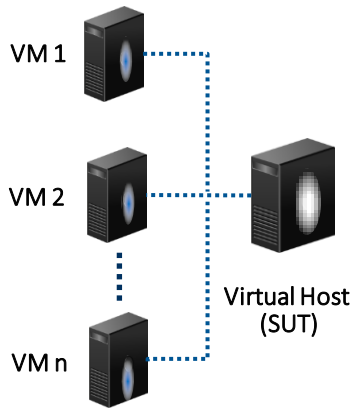
CHALLENGES: COMPLEX SETUP-TEARDOWN

- Setup and Teardown occurs for each test in automation
- Setup/Teardown is complex and time-consuming for virtualization
  - Setup/Remove Host, VMs, etc.
- Directly dependent on number of VMs



CHALLENGES: COMPLEX SETUP-TEARDOWN

- Setup/Teardown for each test in automation
- Directly dependent on number of VMs
- Traditional vs. Virtualization (on-average):
  - Setup takes 3x longer
  - Teardown takes 2x longer
  - Total test time 2x longer for virtualization



In current form, Virtualization Automation would require 2x hardware to run similar number of tests in the same time as Traditional Automation

CHALLENGES: COMPLEX SETUP-TEARDOWN

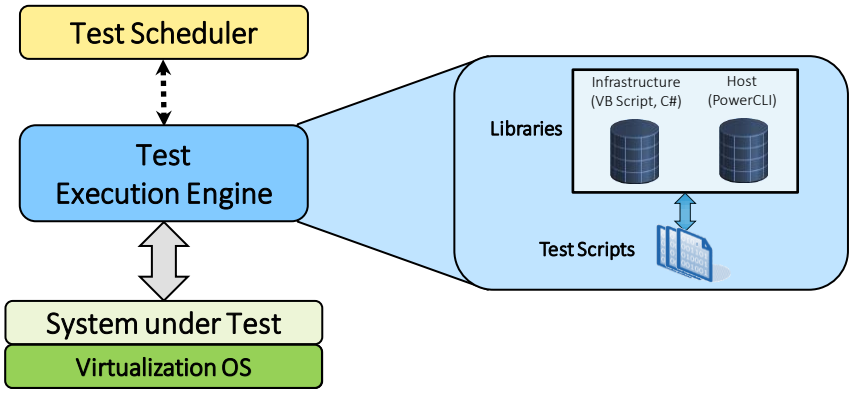
- Traditional vs. Virtualization Times (on-average):
  - Setup takes ~3x longer
  - Teardown takes ~2x longer
- Total test time ~2x longer for virtualization

In current form, Virtualization Automation would require 2x hardware to run similar number of tests in the same time as Traditional Automation

VIRTUALIZATION AUTOMATION: DESIGN

PowerCLI	C# Wrapper	Hybrid
PowerCLI for infrastructure	Existing C#, VB for infrastructure	Existing C#, VB for infrastructure
PowerCLI for all Host Ops	PowerCLI in C# for Host Ops	PowerCLI in VB for Host Ops
PowerCLI for all tests	VB for tests	VB for tests
Native ESX support	Leverage existing framework	Leverage existing framework
Lower Maintenance		
Specific to ESX Virtualization	Double wrapping of ESX cmdlets	PowerCLI execution slower
Re-invents a new framework	Higher Maintenance	PowerCLI debugging painful
		High Maintenance

VIRTUALIZATION AUTOMATION: DESIGN



SUMMARY

- Extending automation for virtualization has challenges:
  - Static resource management
  - Single OS support
  - Long setup and teardown times
- We presented mechanisms that support:
  - Automation for both traditional and virtualization OSes
  - Dynamic resource management
  - Multiple traditional and virtualization OSes
  - Test Continuation Mechanism (to reduce setup-teardown times)