



# Securing Network Automation

Ivan Pepelnjak (ip@ipSpace.net)

Network Architect

ipSpace.net AG

## Who is Ivan Pepelnjak (@ioshints)

### Past

- Kernel programmer, network OS and web developer
- Sysadmin, database admin, network engineer, CCIE
- Trainer, course developer, curriculum architect
- Team lead, CTO, business owner



### Present

- Network architect, consultant, blogger, webinar and book author

### Focus

- SDN and network automation
- Large-scale data centers, clouds and network virtualization
- Scalable application design
- Core IP routing/MPLS, IPv6, VPN



# What's In It For Me (Why Should I Automate)

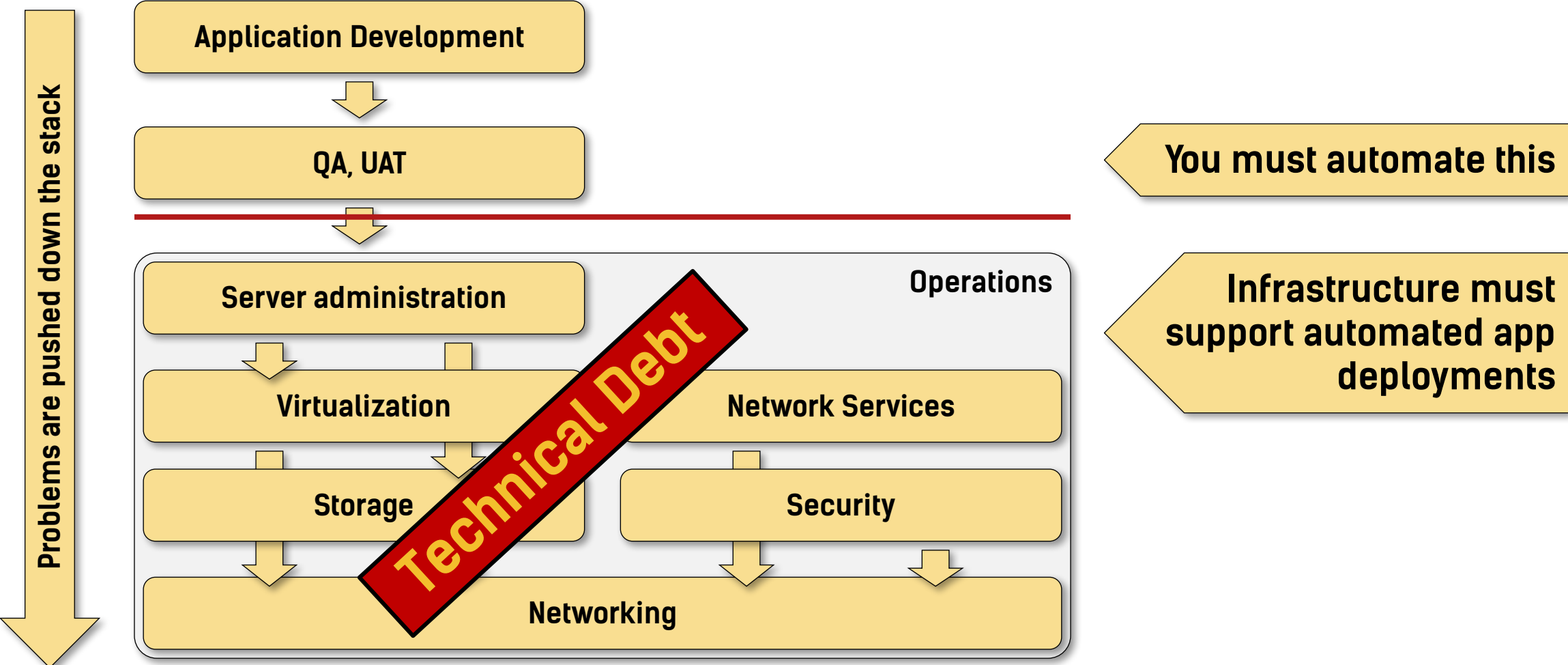
## Sounds Familiar?

- Increase flexibility while reducing costs
- Faster application deployments
- Compete with public cloud offerings

# How Quickly Can You Deploy Apps?

Dev → Test → Prod

# The Real Culprit



# What Would You Automate?

**Every Well-Defined  
Repeatable Task  
Can Be Automated**



# What Would You Automate?

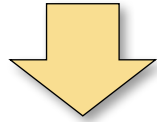
## Common answers:

- Device provisioning
- Service provisioning (= device configurations)
- VLANs
- ACLs
- Firewall rules

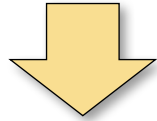
## How about...

- Troubleshooting
- Consistency checks
- Routing adjustments
- Failure remediation

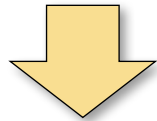
**Automation**



**Repeatability**



**Consistency**

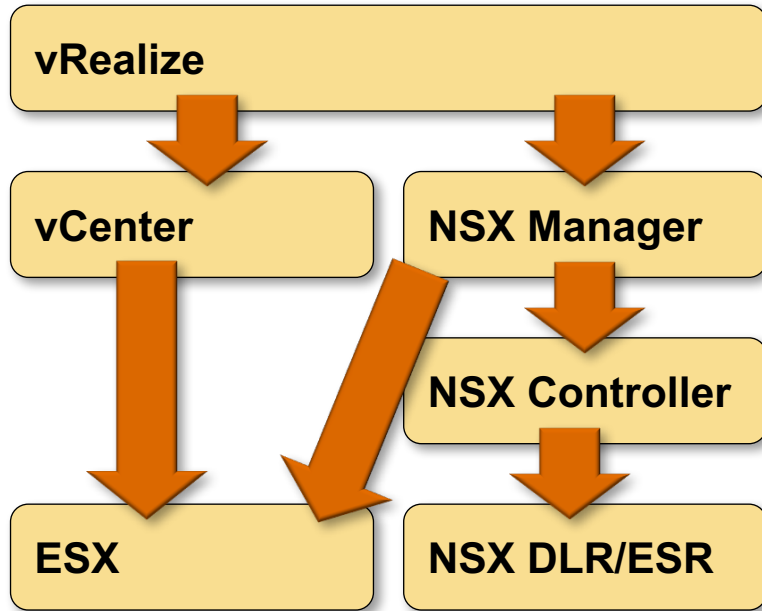


**Validation**

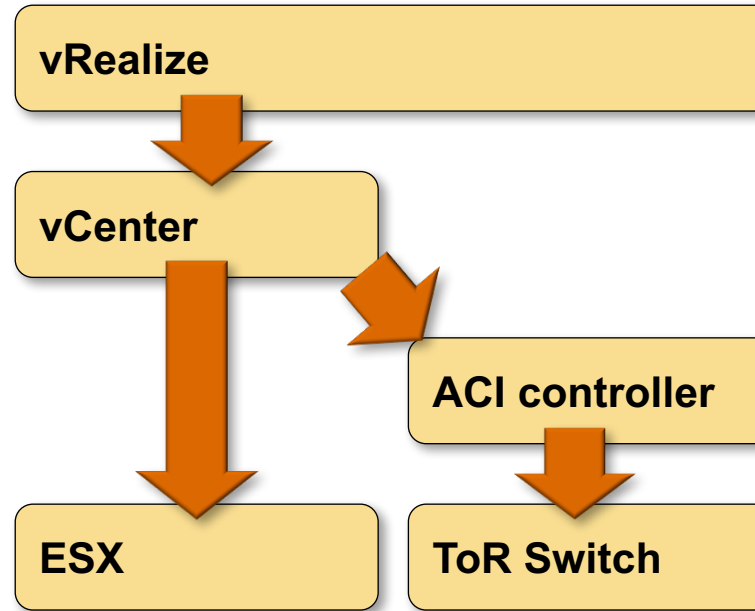
**This is how you sell it**

# Build or Buy?

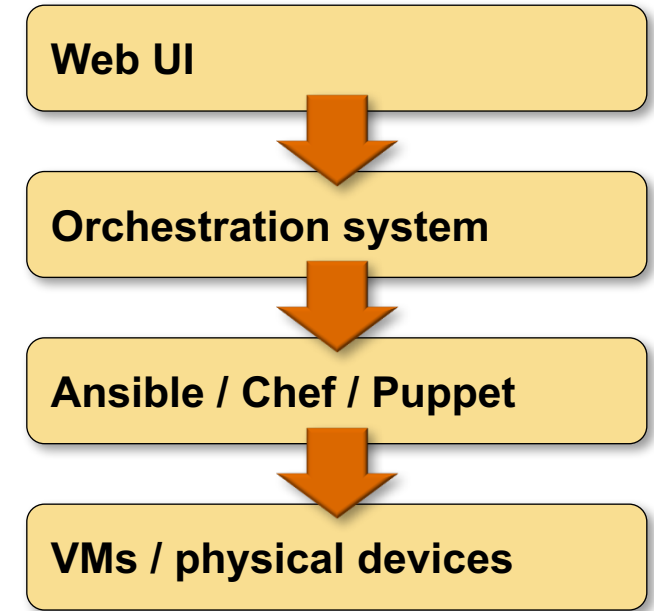
## VMware NSX versus Cisco ACI versus Home-Grown (Ansible)



- Who manages the physical network?
- How do you configure the network services?
- Where's the app deployment?



- Who configures the ACI objects?
- How do you configure them?
- Where's the app deployment?



- Where can I get these components?
- Who will develop all this?

# Build or Buy?

## You'll Have to Build Anyway

## The Interesting Questions

- What do I need?
- How soon do I need it?
- Can I buy what I need?
- How much will that cost?
- How much customization will that require?
- How locked-in will I be?
- How extensible is the product I'm considering?
- Do I have the resources to build it?
- Do I have internal (management) support to build it?
- Can I start small?
- Can I get help (master builders)?
- How long will it take to build it?



**NoSQL Borat**

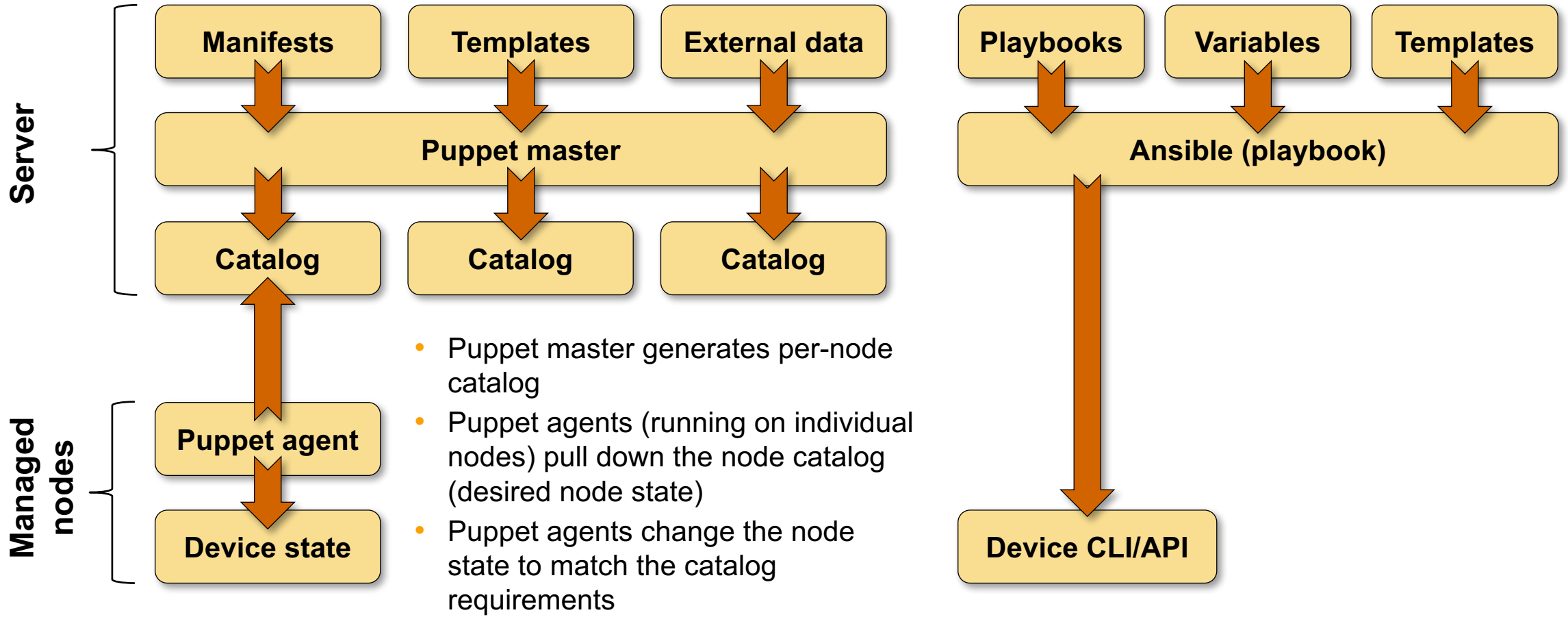
@NoSQLBorat

To make mistake is human. To automatically  
deploy mistake to all of servers is DevOps.

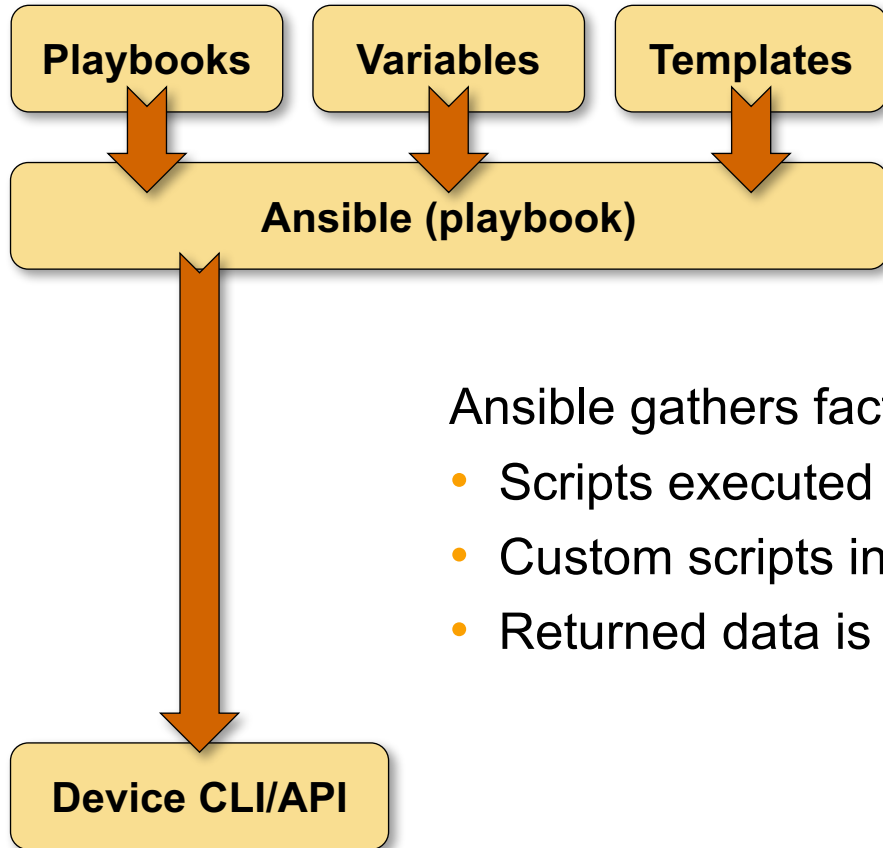
# Security Aspects



## Example: Puppet or Chef versus Ansible



## Sidetrack: Ansible Vulnerabilities



Ansible gathers facts from managed devices

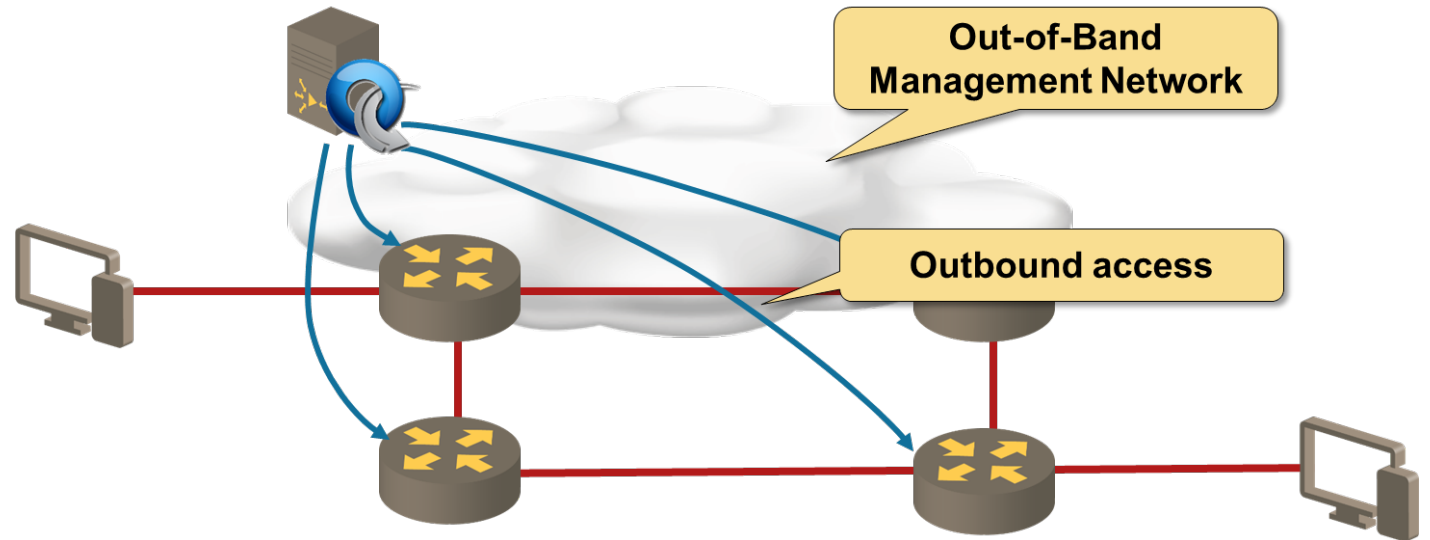
- Scripts executed on managed devices → data injection opportunity
- Custom scripts included in fact gathering → more data injection
- Returned data is not properly quoted/parsed → privilege escalation

**Not applicable to most network devices (no fact gathering, no custom scripts)**

# Solutions

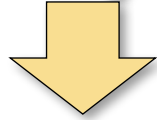
## The Usual

- Out-of-band management
- Management network/VRF
- Limit access to management hosts
- SSH-based access
- Use SSH keys
- Role-based access control (commit scripts)

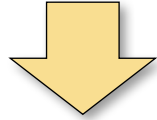


No different from traditional network management systems

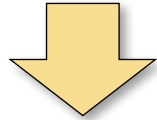
**Read-Only Access**



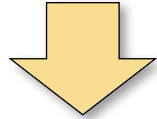
**Device Provisioning**



**Service Provisioning**



**Traffic Rerouting**



**Real-Time and Data Plane**

**This is how you start**

# Reliability Aspects

# Shall We Program the Network?

Keep in mind

- Network is your most critical infrastructure
- Treat network programming like any other critical application

You need

- Programming skills
- Deep understanding of the desired network behavior
- Tools, processes and procedures
- Test environment and QA
- Deployment procedures



**NoSQL Borat**  
@NoSQLBorat



To make mistake is human. To automatically deploy mistake to all of servers is DevOps.

Applies equally well to home-grown automation or vendor SDN solution

# Principles

Trust is good but control is better

- Don't trust input data
- Don't trust device state
- Assert your assumptions
- Fail on unexpected results (device-supported rollback helps)

Validate successful deployment

- Execute **show** commands after configuration change
- Check actual device state, neighbors...
- Fail (or report error) on mismatch



# Test, Test, Test ... and Test Some More

## Unit tests

- Test every single component with valid and all possible invalid inputs

## Functional/integration tests

- Does the automation solution generate the desired configurations?
- Use mockups (check executed commands, return pre-collected printouts)

## Continuous Integration

- Generate a test lab and execute tests after every committed change
- Virtual lab for quick checks, physical gear for pre-deployment tests
- Your vendor doesn't want to give you device VMs? Change the vendor!

## Post-Deployment Tests

Compare actual and expected network state

- HSRP/VRRP/OSPF/BGP/EIGRP neighbors
- Number of prefixes received from each neighbor
- Traffic statistics (need baseline and anomaly detector)

Perform connectivity tests

- Is the traffic flowing where I expect it to flow?
- Are ACLs or firewall rules working as expected?

Use post-deployment tests for continuous network validation

## Gaining the Trust

### Read-only access

- Non-intrusive solutions that add immediate value
- API access or topology collection/extraction (example: BGP)
- Leverage end-to-end visibility (usually ignored by NMS)

### Configuration generation (templates)

- Cut-and-paste
- Verify-and-deploy (use **check** mode with Ansible)
- Automatic deploys in maintenance windows
- Automatic real-time deploys

### More extensive programming

- Control-plane interactions (BGP, RTBH, BGP FlowSpec)
- Read-write API access (example: DirectFlow)

**Hint: Get management buy-in and professional programmers**

# Takeaway

# You'll Be Developing Software No Matter What

## Get used to it

- The only way to get agile is to automate deployments
- The only way to automate deployments is to buy or build automation solutions
- Don't trust vendors (or their solutions)
- You don't have to become programmer
- You **MUST** think about **SYSTEMS** and **PROCESSES**

” The real tiger is never a match for the paper one, unless actual use is wanted.

Mythical Man-Month (Frederick P. Brooks, 1975)

# You'll Be Developing Software No Matter What

## Getting there

- Build a prototype to prove the concept
- Get management buy-in
- Get senior software developer(s) in your team
- Get a few programmers
- Cross-pollinate ;)

” In most projects, the first system built is barely usable

” The only question is whether to plan in advance to build a throwaway, or to promise to deliver the throwaway to customers.

Mythical Man-Month (Frederick P. Brooks, 1975)

## Gartner on Shiny New Object Syndrome

[...] address the following questions before introducing any new technology:

- Can the root issue be addressed via a policy or process change?
- If we wait a year, will this become a commoditized capability from established providers (or my existing providers)?
- Do we have existing network, security, or management capabilities that can address the bulk (i.e., 85%) of the technological requirements?
- Do we have the right process and staff expertise to properly leverage the new technology?

Source: <http://blogs.gartner.com/andrew-lerner/2015/01/15/netsecdirtydozen/>

# Vote with Your Wallet

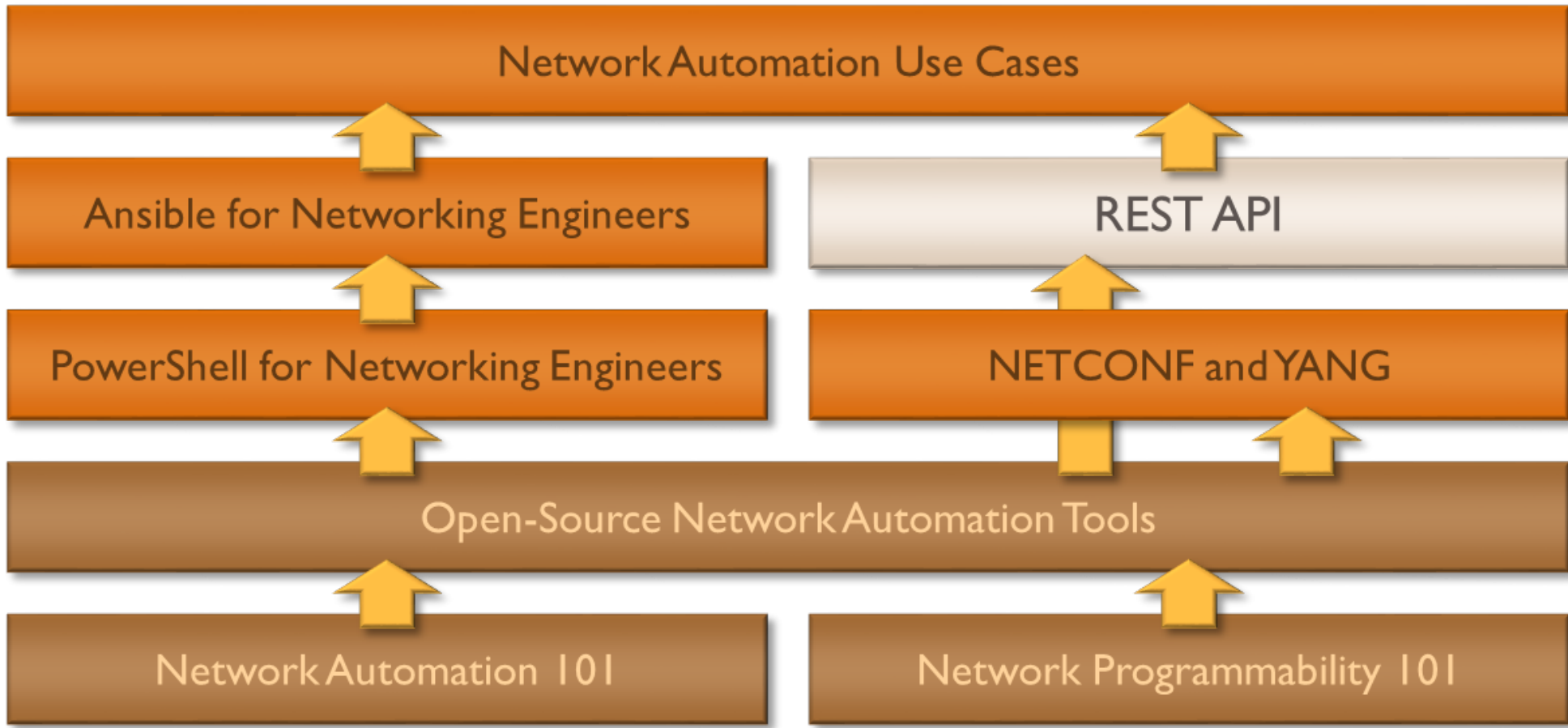


## What Should You Ask For?

- Programmable interface (API)
- Structured operational data (in JSON or XML format)
- Device configuration in structured (JSON/XML) format
- Atomic configuration changes (candidate configuration + commit/rollback)
- Configuration rollback
- Configuration replace
- Contextual configuration diff
- Support for industry-standard models (IETF and OpenConfig)
- Feature parity (API to CLI)

More @ <http://blog.ipSpace.net/2016/10/network-automation-rfp-requirements.html>

# Network Automation Track



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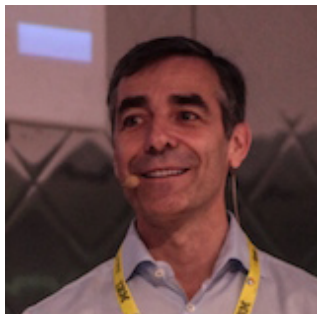
Course starting in

**September 2017**

# Building Network Automation Solutions

6 week advanced interactive online course

- High-intensity online course
- Hands-on experience developing automation solutions
- 6-week course spread across 2 months
- Live online discussions and guest speaker sessions
- Design and coding assignments



More information @ [automation.ipSpace.net](http://automation.ipSpace.net)



A young child stands in the center of a large-scale floor installation. The floor is covered with a large, stylized map of Europe, with the word 'London' clearly visible. The map is drawn in black lines on a light-colored tiled floor. Scattered around the map are various pieces of network equipment, including two black server-like devices with numerous colorful cables (red, blue, yellow, green) plugged into them. The child is wearing a white t-shirt with red sleeves and dark pants. The overall scene suggests a hands-on learning activity or a project related to networking or geography.

Questions?

Send them to [ip@ipSpace.net](mailto:ip@ipSpace.net) or [@ioshints](https://twitter.com/ioshints)