Automated Configuration Management

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Microsoft

Why the need for Configuration Management Automation?

- As a Network Scales:
  - So does complexity
  - Manual configuration becomes impractical and unreliable
  - Increasing number of devices and roles
  - Networking staff become specialized in a limited space
- Automation forces consistency
- Consistency reduces complexity
- Humans make mistakes or may choose to not follow rules

Network at Microsoft

- Networking Environment at Microsoft:
  - Multiple hardware vendors
  - 77 device roles
  - Tens of thousands of network devices
  - Over 30 million lines of configurations
- This scale would not be possible without automation.
- Most tools and process developed for deployments or monitoring.

Why is Service Management important?

- Improves reliability of our services and avoids data loss
  - Great for users!
- Reduces cost
  - Allows us to scale headcount sub-linearly with network growth
- Improves time to market
  - Better customer experience and faster turnaround

Introducing Standard Enforcement Scripts

- Service Management system used by Microsoft's Global Networking Services
- Initial deployment
  - Core and backend networks
- Inspired by others in Microsoft
  - Windows Azure Fabric and Autopilot
- Follows "Lights Out" management principles

Improvements we've seen with SES

	Before	After
Router Rollout	2-3 days	30 seconds
	2-3 engineers	1 engineer
	10-20% Errors	0%
Bill of Wrongs	~4-6/mon	~0/month
Change Velocity	~50 a month	~1000/month

Principles: deployment

- Deployment is declarative
  - Describe the desired state and SES will figure out how to get there
- Everything on the Network should come through SES
  - No manual changes or other systems
- There should never be any end-user downtime during deployments

Principles: repair

- Bake repair into the application design
  - Hardware failure is guaranteed and should never require urgent human intervention
- Repair should remove urgency from issues
  - You shouldn’t have to completely understand all issues to keep the system running
  - Reporting is key
- Keep repair simple – use as few hammers as possible
  - Example: minimal set of transformations to bring system into compliance with design rule

Principles: alarming

- Alarming is required in some scenarios
  - Drive for non-urgent reporting when possible
- The same instrumentation and brain should be used for alarming and repair
  - Triggers for alarm are aware of repairs
  - Can move to repair in some cases

Principles: development lifecycle

- Management is baked into the software development lifecycle (SDLC)
  - All assets live in the source control system
  - All environments from dev box, through labs to production are deployed, monitored and repaired in the same way
- Code and test deployment, repair, alarming as part of coding cycle

Principles: safety

- SES provides a safety net
  - Human error should not be able to affect site availability
  - The system won’t let buggy code go out
  - The system won’t allow an operator to harm the system

Principles: standardization

- Standardize on small list of SKUs, network configurations, etc
  - Hardware is fungible
- Don’t micro-optimize

Standard Enforcement Scripts (SES)

Motivation

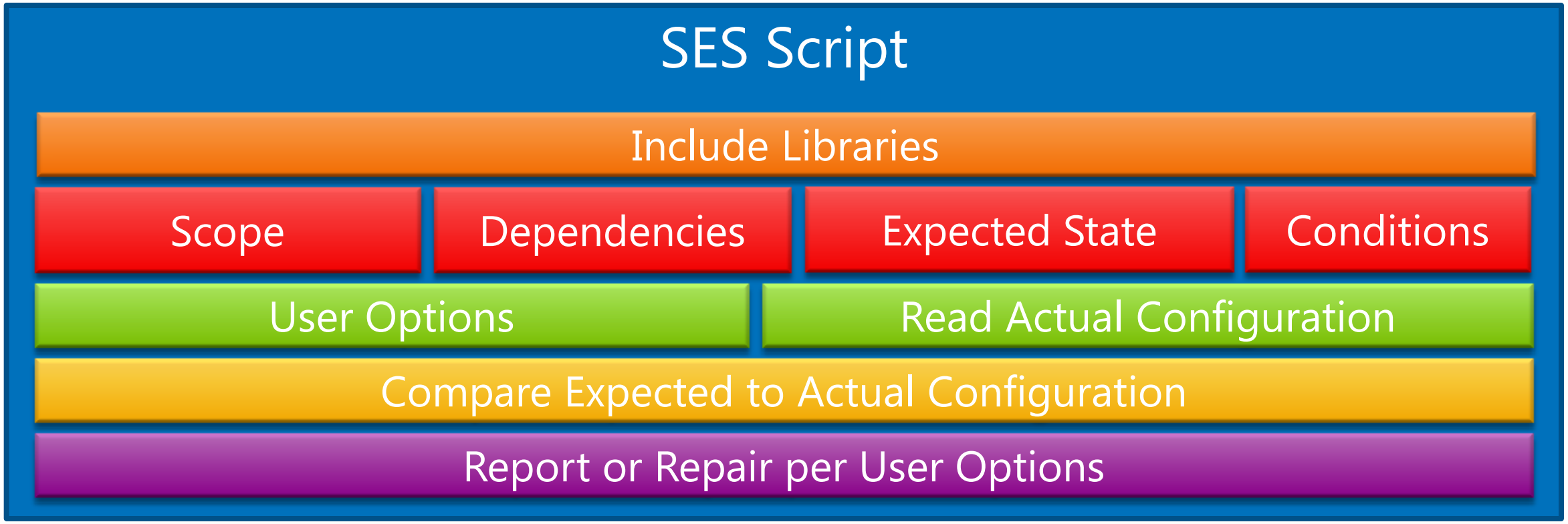
- Minimize Cruft
- Design Updates
- Post-Maintenance Verification
- Operational Simplicity
  - Limit Variations
- Deployment Efficiency/Accuracy

Approach

- Device configurations are a series of configlets
- Comparing a configlet against a standard is easy
- When they do not match; fix it

```
set system name-server a.b.c.d
set system tacplus-server w.x.y.z
set system host-name router
set firewall policer icmp-policer if-exceeding bandwidth-limit 1m
set firewall policer icmp-policer if-exceeding burst-size-limit 10k
set firewall policer icmp-policer then discard
set system syslog archive size 1m
set system syslog archive files 20
set system syslog user * any emergency
set system syslog host c.d.e.f any info
set system syslog host c.d.e.f kernel notice
set system syslog host c.d.e.f facility-override local1
set system syslog host c.d.e.f explicit-priority
```

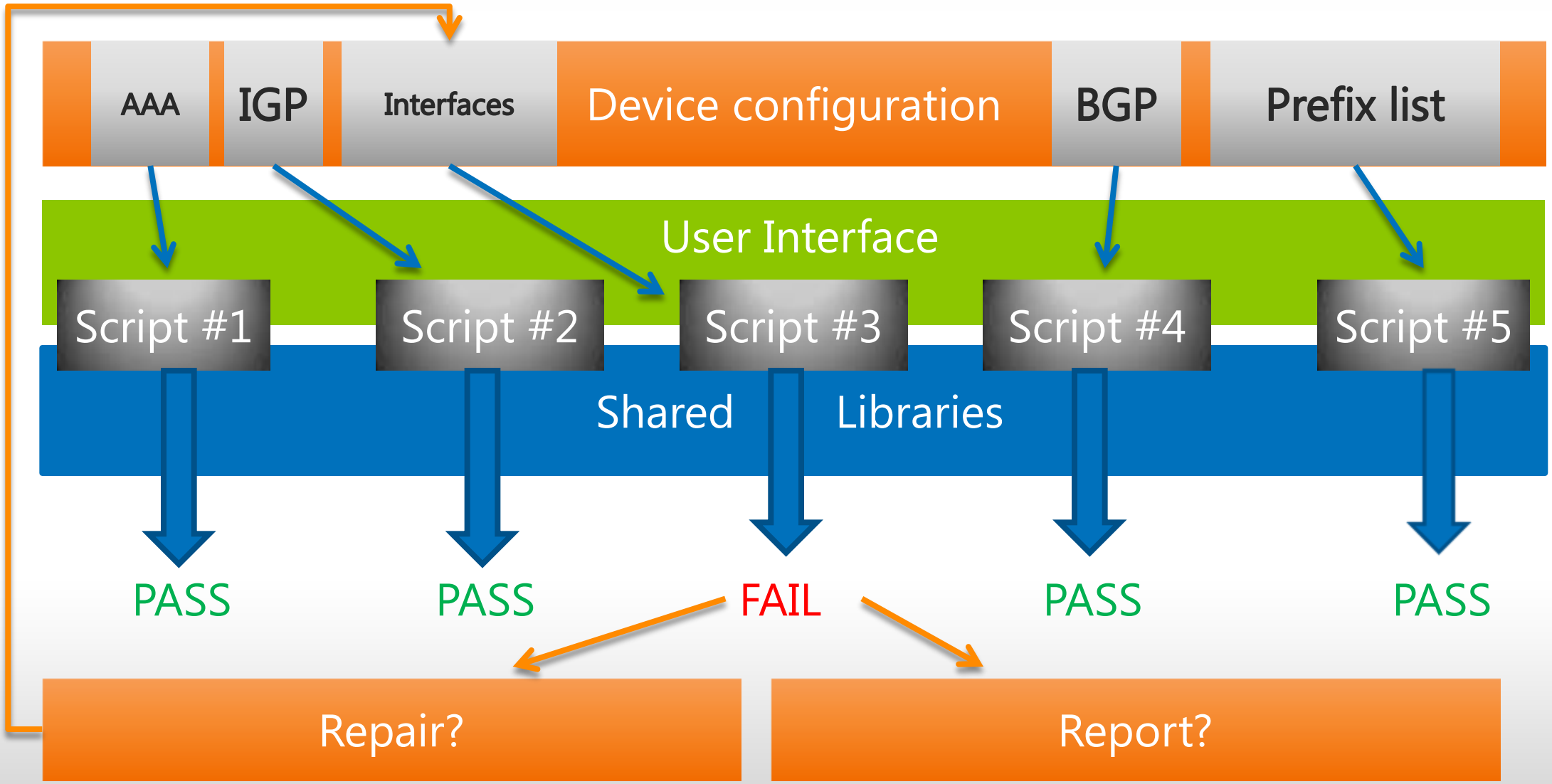
Logical Design



Libraries

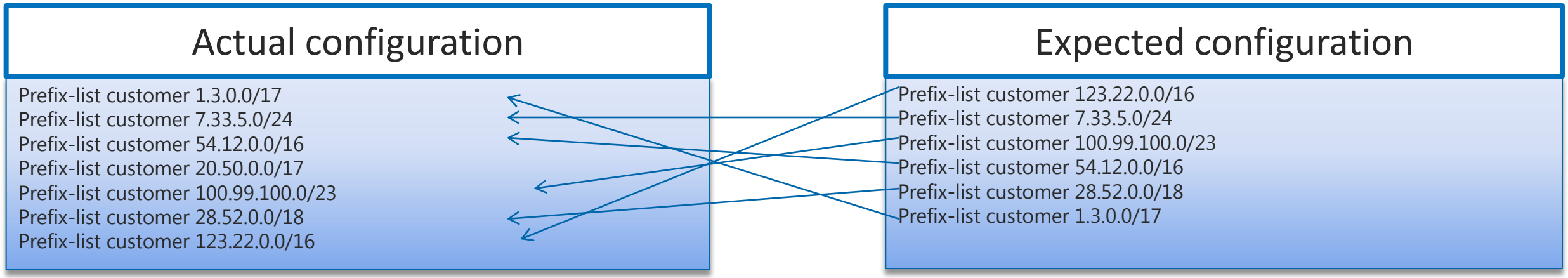
- Functions used by all scripts
- Keeps the scripts lightweight

Work flow


AAA
IGP
Interfaces
Device configuration
BGP
Prefix list
User Interface
Script #1
Script #2
Script #3
Script #4
Script #5
Shared Libraries
PASS
PASS
FAIL
PASS
PASS
Repair?
Report?

Condition Examples

RULE:
LOOSE MATCH



PASS

RULE:
STRICT MATCH

Actual configuration	
Prefix-list customer 1.3.0.0/17	√
Prefix-list customer 7.33.5.0/24	√
Prefix-list customer 54.12.0.0/16	√
Prefix-list customer 20.50.0.0/17	✖
Prefix-list customer 100.99.100.0/23	√
Prefix-list customer 28.52.0.0/18	√
Prefix-list customer 133.22.0.0/16	√

Expected configuration
Prefix-list customer 133.22.0.0/16
Prefix-list customer 7.33.5.0/24
Prefix-list customer 100.99.100.0/23
Prefix-list customer 54.12.0.0/16
Prefix-list customer 28.52.0.0/18
Prefix-list customer 1.3.0.0/17

FAIL

Remove:
Prefix-list customer 20.50.0.0/17

RULE:
STRICT ORDER MATCH

Actual configuration	Expected configuration
Prefix-list customer 1.3.0.0/17 Prefix-list customer 7.33.5.0/24 Prefix-list customer 54.12.0.0/16 Prefix-list customer 200.50.0.0/17 Prefix-list customer 100.99.100.0/23 Prefix-list customer 28.52.0.0/18 Prefix-list customer 133.22.0.0/16	Prefix-list customer 133.22.0.0/16 Prefix-list customer 7.33.5.0/24 Prefix-list customer 100.99.100.0/23 Prefix-list customer 54.12.0.0/16 Prefix-list customer 28.52.0.0/18 Prefix-list customer 1.3.0.0/17

FAIL

Remove:
Prefix-list customer
Add:
Prefix-list customer 133.22.0.0/16
Prefix-list customer 7.33.5.0/24
Prefix-list customer 100.99.100.0/23
Prefix-list customer 54.12.0.0/16
Prefix-list customer 28.52.0.0/18
Prefix-list customer 1.3.0.0/17

Dependencies

- Multi-part configurations separated into different scripts.
- Example:
  - Script 1: peer group
    - Script 2: BGP policy
      - Script 3: prefix-list
      - Script 4: as-path

Initial deployment

- Initially deployed to audit 4 device roles
- 230 scripts created
  - average 60 lines of code each
- 4000+ variations were discovered.
  - Variations ranged from cosmetic to situations that could contribute to service impacting events

Challenges

- Vendors
  - Different configuration formats
  - Behavior / Functionality
- Initial Cleanup
  - Standards can conflict with the current operating state
- Script conflicts
  - 2 or more scripts with different outcomes for the same configuration
- Script Coverage
  - Must account for all configurations to achieve maximum benefit

Other Use Cases

- Config Generator
  - By combining the output of all the template scripts, it is possible to create a base configuration for a new device
- Framework leveraged for incremental changes

Questions?

Thank you

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