Data-Driven Network Automation with Nautobot

Internet2 Technology Exchange 2023

Josh VanDeraa
Quick Intros

Nautobot Introduction

Nautobot: Core Capabilities

Nautobot: Golden Configuration

Nautobot: Device Lifecycle

Nautobot: Circuit Maintenance
Karl Newell (Network Software Architect, Internet2)

Experience

• 20+ years in the IT industry
• 8+ years in networking
• Focus in automation for 4+ years
  • NGI automation
  • Insight Console
Josh VanDeraa (Managing Consultant)

Experience

• 24 years in the networking industry
• 13 years in large retail
• Travel, Managed Services, and Consulting experience since
• Focus in automation for 8+ years

Twitter: @vanderaaj      LinkedIn: https://www.linkedin.com/in/josh-vanderaa/
Who is Network to Code

Network Automation Solutions Provider

We are laser-focused on helping companies transform the way their networks are deployed, managed, and consumed using network automation and DevOps technologies.

A Diverse Team, with Deep Expertise

Engineers and developers in network automation, software and security, with leadership from vendors, integrators, and top tier consulting firms - all drive value to our clients.

Nautobot

Our data first approach motivated us to develop Nautobot. A purpose built network source of truth and automation platform offering superior flexibility, extensibility and control that caters to any network design.

Driven by Community & Industry Collaboration

Rooted in Community, NTC believes Industry-wide collaboration is the catalyst needed for true innovation. Host 28,000+ members and 300+ channels at slack.networktocode.com

Industry Recognized Thought Leaders

Working with clients across all industries and geographies, we promote a vendor- and tool-agnostic approach, making automation a reality for any network.
Nautobot In Use
Introduction to Source of Truth
(Intent vs. Reality)
Understanding Source of Truth

- Source of Truth is all about intentions and planning.
- It is about the expected state.
- Source of Truth data drives parts, labor, and configurability.
Understanding Network Configuration Data (cont’d)

Designs should drive configuration

<table>
<thead>
<tr>
<th>Data Point</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface</td>
<td>Ethernet1</td>
</tr>
<tr>
<td>Description</td>
<td>connects to WAP...</td>
</tr>
<tr>
<td>Mode</td>
<td>access</td>
</tr>
<tr>
<td>VLAN</td>
<td>5</td>
</tr>
</tbody>
</table>
interface Ethernet1
description connects to WAP-HQ-Bldg-5-Floor-3-Closet-1
switchport mode access
switch access vlan 5

Data Point | Value
--- | ---
Interface | Ethernet1
Description | connects to WAP...
Mode | access
VLAN | 5

Designs should drive configuration
Source of Truth is the Foundation

- Enables data-driven network automation
- De-couples CLI syntax and API calls from data
- Enables vendor-agnostic network automation
- Allows architects and engineers to focus on network designs
- Provide traceability and history of the Source of Truth

More data, more insights.
Intent vs. Reality

Intent - the *desired* state of the network.

Reality - the *discovered* state of the network.

Note: The Nautobot SSoT framework can be used to synchronize data from any tool (intended and reality) into Nautobot based on use case and desired outcomes.
**Intent vs. Reality**

Intent - the *desired* state of the network

Reality - the *discovered* state of the network

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*Note: The Nautobot SSoT framework can be used to synchronize data from any tool (intended and reality) into Nautobot based on use case and desired outcomes.*
About Nautobot

Source of Truth and Network Automation Platform

- Open source community project created in 2021
  - *Apache 2 License*
- Sponsored by Network to Code
- Purpose-built to **drive network automation**
Nautobot Use Cases

Network Source of Truth

- Devices
- IP Addresses
- VLANs
- ASN
- ...
- Custom

- User-Defined Relationships
- Custom Fields
- Data Validation
- Git as a Data Source

Network Automation Platform

- Use Open Source Apps
- Build Custom Apps
- Save 70% development time using the platform

Powered by APIs and NetDevOps extensibility & integrations

{ REST }  GraphQL  Extensible Plugin System

webhooks  git
Exploring a Network Data Model

Includes Models and Relationships Between Models

Device Role: **peering-router**

Device Role: **distribution**

Prefix: **10.1.1.0/24**

Prefix: **192.168.1.0/24**

Prefix: **172.19.1.0/24**

Prefix: **172.19.2.0/24**

Prefix: **172.19.3.0/24**

Prefix: **172.19.4.0/24**

Circuit Provider: **ATT**

Cable Status: **provisioning**

Interface Role: **uplink**

Device Status: **active**

Site: **datacenter**
Exploring a Network Data Model

Includes Models and Relationships Between Models

Device Role: **peering-router**

Device Role: **distribution**

IP Address

Prefix

Circuit

Circuit Provider: **ATT**

Site: **datacenter**

Interface Role: **uplink**

Device Status: **active**

Cable Status: **provisioning**

Includes Models and Relationships Between Models

@networktocode | Confidential
Nautobot - The Data
How is the SoT Populated?

*Nautobot provides several methods to get you up and running quickly*

- **Data Aggregation**
- **Network Importer** (Automated collection)
- **Onboarding App** (Manual Population)
The Need for Valid Data

“Automation is only as good as the data that drives it.” --Anonymous

10 deny tcp any any any
20 permit tcp 10.0.0.0 255.255.255.0 any
Extensibility Features Summary

Tailor Nautobot to your network design requirements

- Status
- Tags
- Dynamic Groups
- Secrets
- Git as a Data Source
- Relationships
- Export Templates
- Config Contexts
- Config Contexts JSON Schemas
- Jobs
- Computed Fields
- Custom Fields
- Custom Links
- Custom Models, UI & APIs
How is the SoT Populated?

Nautobot provides several methods to get you up and running quickly

Data Synchronization & Normalization

Network Importer

Automated collection

Data Aggregation

SoT Database

Onboarding App

Manual Population
The Need for Valid Data

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Extensibility Features Summary

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- Custom Links
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Integrating & Using Nautobot
What’s Next After Data Population?

Nautobot offers a variety of ways to leverage the platform, here are a few suggestions to start:

- Populate interface descriptions to describe what is connected informed by the SoT
- Leverage ChatOps to retrieve information via your favorite chat application
- Tracking circuit maintenance events
- Begin tracking device lifecycles programmatically
Nautobot Apps (aka plugins) allow developers to invent and implement entirely new functionality.

Apps break into two levels of overall functionality, extensions and apps.

Can provide:
- Models (and integration with core)
- Views
- REST APIs
- Inject content into core pages
- Data Validation

Plugins are Python packages which are installed by the Nautobot user.
# Nautobot’s Growing App Ecosystem - Over 25 Apps to Date

<table>
<thead>
<tr>
<th><strong>Ansible ChatOps</strong></th>
<th>Perform common Ansible AWX/Tower operations using ChatOps</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arista CloudVision ChatOps</strong></td>
<td>Perform common CloudVision operations using ChatOps</td>
</tr>
<tr>
<td><strong>Arista CloudVision SSoT</strong></td>
<td>Synchronize data between Nautobot and CloudVision</td>
</tr>
<tr>
<td><strong>IP Fabric ChatOps</strong></td>
<td>Perform common IPF operations using ChatOps</td>
</tr>
<tr>
<td><strong>Capacity Metrics</strong></td>
<td>Expose key data in Nautobot as Prometheus endpoints</td>
</tr>
<tr>
<td><strong>Circuit Maintenance</strong></td>
<td>Dynamically manage circuit maintenance notifications in Nautobot</td>
</tr>
<tr>
<td><strong>Golden Configuration</strong></td>
<td>Automate backups, generate configs, and perform configuration compliance</td>
</tr>
<tr>
<td><strong>Data Validation</strong></td>
<td>Add validation rules to ensure corporate standards and proper data hygiene</td>
</tr>
<tr>
<td><strong>Device Onboarding</strong></td>
<td>Simplifies onboarding and re-onboarding devices into Nautobot</td>
</tr>
<tr>
<td><strong>Grafana ChatOps</strong></td>
<td>Retrieve any Grafana panel directly from Chat</td>
</tr>
<tr>
<td><strong>Device Lifecycle Management</strong></td>
<td>Track EOL, software versions, and contract data in Nautobot</td>
</tr>
<tr>
<td><strong>Meraki ChatOps</strong></td>
<td>Perform common Meraki operations using ChatOps</td>
</tr>
<tr>
<td><strong>Nautobot ChatOps</strong></td>
<td>Perform common Nautobot operations using ChatOps</td>
</tr>
<tr>
<td><strong>Cisco ACI ChatOps</strong></td>
<td>Perform common ACI operations using ChatOps</td>
</tr>
<tr>
<td><strong>Welcome Wizard</strong></td>
<td>UI wizard that simplifies getting started with Nautobot</td>
</tr>
<tr>
<td><strong>Version Control</strong></td>
<td>Add Git concepts such as branch, merge, and PR directly into Nautobot</td>
</tr>
<tr>
<td><strong>Single Source of Truth</strong></td>
<td>Pluggable framework that enables 3rd party data synchronization with Nautobot</td>
</tr>
<tr>
<td><strong>IP Fabric Single Source of Truth</strong></td>
<td>Synchronize data between Nautobot and IP Fabric</td>
</tr>
<tr>
<td><strong>Infoblox Single Source of Truth</strong></td>
<td>Synchronize data between Nautobot and Infoblox</td>
</tr>
<tr>
<td><strong>ServiceNow SSoT</strong></td>
<td>Synchronize data between Nautobot and ServiceNow</td>
</tr>
</tbody>
</table>

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**Partner Integrations | Standalone Solutions | Custom Development**

*Nautobot as platform compliments any network automation strategy.*

[go.nautobot.com/apps](go.nautobot.com/apps)
Nautobot App - Floor Plan Plugin
**Config Compliance - Fully Leveraging Golden Config**

- **Intended configuration**: generated with [Jinja2 templates and the Nautobot Golden Config App](#), pushed to a Git repo
  - Data comes from YAML files and data in Nautobot via a GraphQL query (SoT Aggregation Query)
- **Configuration Backups**: [Nautobot Golden Config App](#), pushed to a Git repo
- **Config Compliance**: [Golden Config Nautobot App](#) pulls intended and backup configs from repos and analyzes them according to the defined rules
Configuration Compliance - UI Screenshots

### Dashboard View

- **Device**
  - nyc-spine-01.infra.ntc.com
  - jcy-spine-01.infra.ntc.com
  - jcy-spine-02.infra.ntc.com
  - nyc-spine-02.infra.ntc.com
  - jcy-tnr-01.infra.ntc.com
  - nyc-leaf-02.infra.ntc.com
  - jcy-tb-01.infra.ntc.com
  - nyc-leaf-01.infra.ntc.com
  - nyc-tb-01.infra.ntc.com
  - nyc-tnr-02.infra.ntc.com
  - nyc-tnr-01.infra.ntc.com

### Device Compliance Views

#### Status Page

- **Backup Config**
- **Intended Config**
- **Compliance Details**

- **Aggregate Data**

- **Run Job**

- **Delete Selected**
Config Compliance - Fully Leveraging Golden Config

SoT Data -> Generate Configuration -> Intended Config

Network Devices -> Config Backup -> Actual Config

Compliance Engine

LOG
Status: Non-Compliant

Intended Configuration:
logging server (A.B.C.D): 5 port 2200

Actual Configuration:
logging server (A.B.C.D): 5 port 2200

Extra Configuration:
logging server (A.B.C.D): 5 port 2200

NTP
Status: Synchronized

Configuration:
ntp server (A.B.C.D) default
ntp server (A.B.C.D) preferred
Configuration Compliance - UI Screenshots

Dashboard View

- Device
  - nyc-spine-01.infra.ntc.com
  - jay-spine-01.infra.ntc.com
  - jay-spine-02.infra.ntc.com
  - nyc-spine-02.infra.ntc.com
  - jay-rh-01infra.ntc.com
  - nyc-leaf-02.infra.ntc.com
  - jay-leaf-01infra.ntc.com
  - jay-leaf-01infra.ntc.com
  - nyc-leaf-01infra.ntc.com
  - jay-bb-01infra.ntc.com
  - nyc-bb-01infra.ntc.com
  - jay-bb-02infra.ntc.com
  - nyc-bb-01infra.ntc.com
  - jay-rh-01infra.ntc.com

Device Compliance Views

Configuration Compliance - nyc-spine-01.infra.ntc.com

- Feature Navigation
  - Compliant
  - Non-Compliant
  - Clear

- Arista EOS - ntp
- Arista EOS - snmp
- Arista EOS - infr
- Arista EOS - host
- Arista EOS - dns

Status Page

- Device
  - Backup Status
  - Intended Status
  - Compliance Status
  - Actions

Status

- AAA
  - Status
  - Non-Compliant
  - Compliant

Intended Configuration

- Username
  - Privilege
  - Secret

Actual Configuration

- Username
  - Privilege
  - Secret

Missing Configuration

- Username
  - Privilege
  - Secret

Extra Configuration

- Username
  - Privilege
  - Secret

Backup Config

- Aggregate Data

Intended Config

- Compliance Details

Run Job
# Hardware Notices

<table>
<thead>
<tr>
<th>Name</th>
<th>Reference</th>
<th>Release Date</th>
<th>End of Sale</th>
<th>End of Support</th>
<th>End of Software Releases</th>
<th>End of Security Patches</th>
<th>Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device Type: DCS-7150S-24 - End of support: 2024-12-01</td>
<td>DCS-7150S-24</td>
<td>2021-11-09</td>
<td>2021-12-01</td>
<td>2024-12-01</td>
<td>2023-12-01</td>
<td>2023-12-01</td>
<td><a href="#">open</a></td>
</tr>
</tbody>
</table>
# Software Lifecycle

## Software List

<table>
<thead>
<tr>
<th>Name</th>
<th>Version</th>
<th>Alias</th>
<th>Device Platform</th>
<th>Release Date</th>
<th>End of Software Support</th>
<th>Long Term Support</th>
<th>Pre-Release</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arista EOS - 4.24.8M</td>
<td>4.24.8M</td>
<td>—</td>
<td>Arista EOS</td>
<td>2021-10-11</td>
<td>2023-04-05</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Arista EOS - 4.26.4M</td>
<td>4.26.4M</td>
<td>veos-lab</td>
<td>Arista EOS</td>
<td>2021-12-12</td>
<td>2024-04-15</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Cisco IOS - 12.2(33)SXI14</td>
<td>12.2(33)SXI14</td>
<td>Cat6500-Sup720</td>
<td>Cisco IOS</td>
<td>2014-09-22</td>
<td>2017-08-31</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Cisco IOS - 16.9.1</td>
<td>16.9.1</td>
<td>Fuji-16.9.1</td>
<td>Cisco IOS</td>
<td>2018-07-19</td>
<td>2023-04-05</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Cisco IOS - 720 ROMMON 8.5(4)</td>
<td>720 ROMMON 8.5(4)</td>
<td>—</td>
<td>Cisco IOS</td>
<td>2010-01-12</td>
<td>2015-04-30</td>
<td>✓</td>
<td>✗</td>
</tr>
</tbody>
</table>
Circuit Maintenance
Manual Process

1. NSP sends maintenance notification
2. Network engineer parses notification and manually updates systems
3. Network engineer enters maintenance info on calendar
4. Network engineer emails internal group to notify of maintenance
5. Maintenance window updates

\[ \ldots x 100s-1000s \text{ of circuits} \]
Automated Solution

1. NSP sends maintenance notification

2. Circuit Maintenance
   Fetch, Parse & Populate

3. Automatically organized maintenances in Nautobot

4. Workflow Example 1:
   Monitoring System Automation

5. Workflow Example 2:
   Drain the plane on circuit
Nautobot - Automation
Network Automation

**Nautobot Jobs**
Run Jobs defined in Python from Nautobot itself. Provides an inventory methodology and direct access to the data needed to automate.

**Ansible Content Collection**
Ansible Content Collection for Nautobot provides methods for retrieving data through lookup plugins, using Nautobot as an Inventory, and Modules to update Nautobot as necessary.

**Python SDK**
Python SDK - pynautobot, that interacts with Nautobot, and builds itself dynamically based on what applications are installed to Nautobot.

**Go-Nautobot | Terraform**
Go-Nautobot for working with GoLang. Terraform provider for working within Terraform.
Nautobot Actions

**Webhook**
Sends off customized webhook payload to a webhook receiver

**Jobhook**
Think Webhook, but instead Nautobot launches a Job, with context data of what was changed. Allowing interactions with multiple systems and gathering data from other sources if needed.

**Ansible EDA**
Ansible EDA is monitoring the Nautobot changelog and receives events on object changes, then Ansible kicks into gear!
Demos

Ansible Content Collection
- Review of Ansible Inventories Available
- Get the next available IP Address, within a Tagged range

Python SDK
- Nornir Inventory
- Gather data using the GraphQL interface
Nautobot Source of Truth

- Source of Truth for Network (Infrastructure) Data
  - Automate from the Data
  - Relationships of Devices, Interfaces, Circuits
- Extend capabilities through Nautobot Apps
- Consolidate Network Automation Power Tools and build your own Jobs where you get enterprise logging and JobResults capabilities
- Integrate with tooling via APIs and SDKs

https://www.networktocode.com
https://demo.nautobot.com