Pica8 White Paper

Pica8 Automation Framework: Simplifying Open-White Box Networking for the Enterprise

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Pica8 Automation Framework: Simplifying Open–White Box Networking for the Enterprise

Open, white box networking is proving to be a viable solution for enterprises looking for an alternative to proprietary switches at the network edge. But installing dozens or hundreds of switches at multiple remote locations, such as retail stores, is not without its challenges.

The challenges include code installation, licensing, configuration and provisioning, all of which require manual intervention – time-consuming tasks when many switches are involved. Lack of out-of-the-box support for in-band management compounds the issue, making it challenging to perform these functions remotely.

To address these issues, Pica8 worked with a Fortune 50 customer that was installing Pica8 switches in hundreds of its U.S. retail locations to modernize its aging Cisco network. The customer helped define requirements that would enable it to install switches more easily and quickly.

Using these requirements as a starting point, Pica8 developed the Pica8 Automation Framework, a set of server-based tools and agents, based on the Ansible automation framework that largely automates the process of installing Pica8 software on open, white box and brite box switches. This document describes the challenges Pica8's Automation Framework addresses, the features and functionality the framework provides, and a roadmap for future enhancements.

The Problem

In the open networking world, the Open Networking Install Environment (ONIE) comes pre-installed on white box switches and can be used to automate initial code installation, along with Zero Touch Provisioning (ZTP) for con-figuration and provisioning of the switch. However, these tools are designed for a datacenter environment where the switches are assumed to have a dedicated out-of-band management network. By contrast, typical campus and branch office networks are deployed with in-band management, which renders ONIE and ZTP unusable because they are not designed to operate over an in-band management scheme.

Another issue is license management. Software from Pica8 (like many other vendors) can be freely downloaded but requires a license key for activation. License keys are tied to the specific switch hardware for which the license was purchased. Customers access the keys from the web-based Pica8 License Portal, which acts as a licensing server. This process works reasonably well when installing a small number of switches but can be tedious when enterprises are trying to deploy hundreds or thousands of switches.

The Solution

To address these issues, along with other aspects of automation, Pica8 developed the Pica8 Automation Framework. The framework is based on Ansible, the open source automation tool delivered under the auspices of the AWX Project. Red Hat also offers a licensed version, Ansible Tower. While Ansible was originally developed to automate server deployment, Ansible AWX and Tower address network deployment and configuration.

Both offer a web-based interface providing role-based access control, pushbutton deployment, centralized logging and auditing. They support provisioning of network switches, centralized deployment and installation of configuration files, orchestration of multiple deployments, periodic health checks, backup configurations, automated upgrades and more.

A series of Ansible "playbooks" enable even IT personnel who are not Ansible experts to implement automated routines. Using playbooks ensures the routines are run the same way every time, driving consistency across the network.

The Pica8 Automation Framework comprises Ansible server-based tools deployed on a virtual machine (VM) in either a public or private cloud. The overall automation process flow for the framework is shown in Figure 1 and each component is described more fully in the sections that follow.

Figure 1

Automation Process Flow
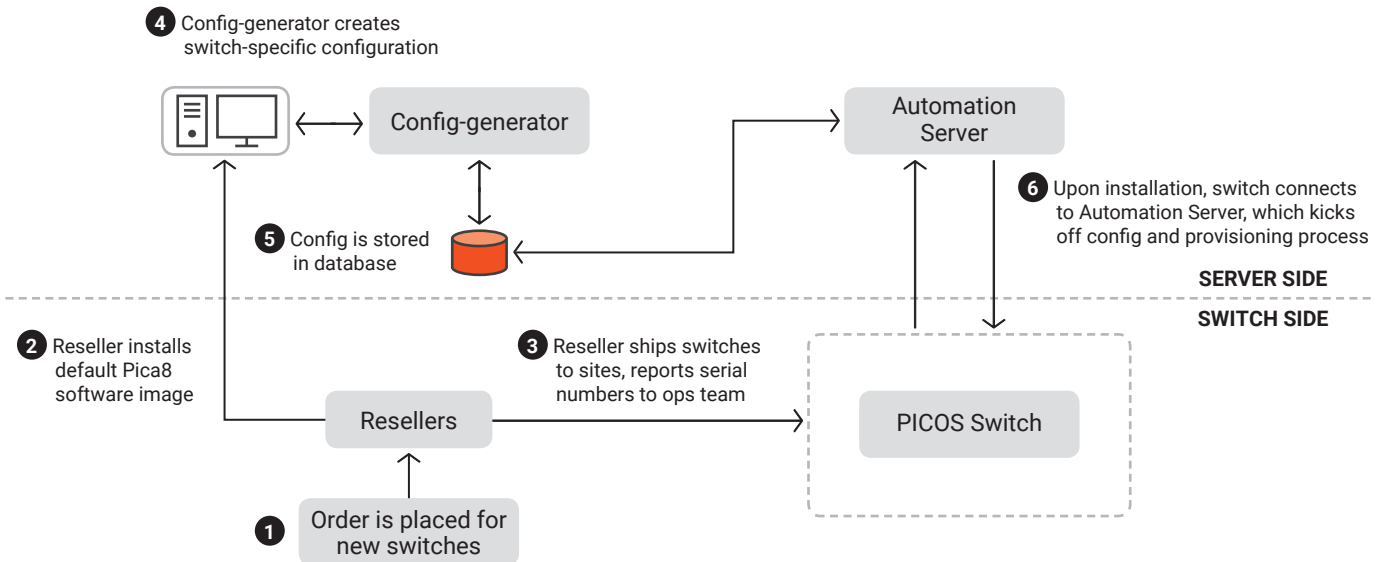
The process starts with an order being placed for new switches to be shipped to a branch location, such as a store. Upon receiving the order, a reseller typically prepares the switches by installing the default Pica8 software image and performing a basic hardware test. The reseller then ships the switches to the specified site and reports the switch serial numbers back to the operations team. An administrator then uses the configuration tool to create a switch-specific configuration that is stored in the database. When the switch is installed and powered up at the remote site, an auto-connection script enables it to find the automation server and register with it; this kicks off the configuration, update and provisioning process.

The Automation Server has the following components:
- Configuration Manager
- Image Manager
- License Manager
- Automation Manager

Configuration Manager

The Configuration Manager is a GUI-based utility that allows the customer to define the standard ("Golden" configuration to be deployed on its switches along with any region- or site-specific variations. The tool enables the uploading of configurations, editing of existing configs and marking any site-specific parameters. All configurations are tied to specific switches by the switch serial number and stored in a database.

Typically, global and regional configurations are pre-loaded into the tool by the customer. The workflow for generating site-specific configs is triggered when the Configuration Manager receives the serial numbers of the switches that have been shipped to a site for installation. Samples of the configuration screens for editing the global, regional and site-specific switch configurations are shown in Figures 2, 3 and 4 below.

Figure 2

Global Config TMPL Edit

Global Config Name	glob-as4610-54p-
Switch Model	as4610-54p ▾
Generic Global File	Choose File No file chosen
Security Global File	Choose File No file chosen

✔ Generate   ✖ Reset

Figure 3

Regional Config TMPL Edit

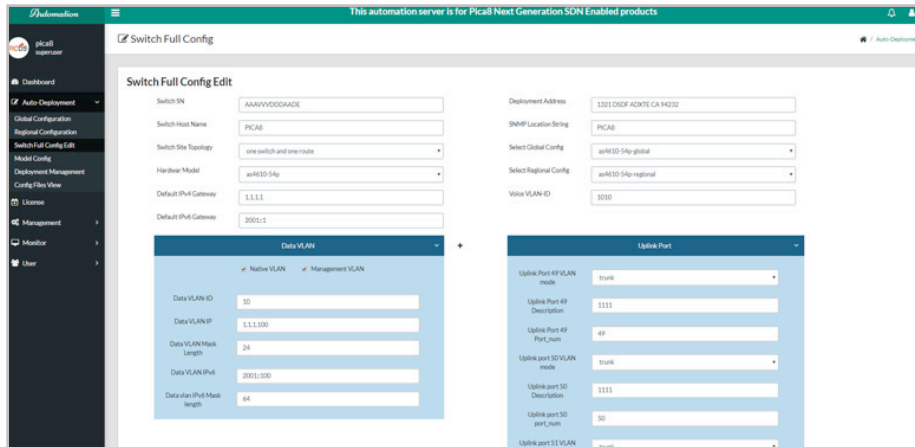|	
Regional Config Name	regional-
AAA Server IP	1.1.1.1;2.2.2.2;3.3.3.3
Timezone	(UTC -08:00) America/Dawson ▾

✔ Generate   ✖ Reset

Figure 4

Image Manager

The Image Manager is used to upload and maintain one or more versions of the PICOS® image files for each of the switch models that might be supported. (PICOS is the Linux-based open NOS solution from Pica8.) When a switch is provisioned, it ensures the correct version of PICOS is installed.

License Manager

The License Manager performs several functions. It obtains licenses from the Pica8 License Portal for switches being installed for the first time and updates licenses of switches that are reaching the end of their support entitlement. It also generates an inventory report of all licenses currently installed on Pica8 switches deployed in the customer's network.

Automation Manager

The Automation Manager brings all the pieces together to automate the complete process of switch/network discovery, code update, installation of configuration and license, and remote activation of the switch in the network.

The Automation Framework in Practice

When a new switch is shipped to a remote site, such as a branch office or retail store, it comes with a default Pica8 PICOS image pre-installed in the factory, or by a distributor, reseller or systems integrator. This is critical to the success of this process, because a new switch outfitted only with ONIE will not have the ability to perform network discovery through an in-band management network and initiate the automated downloads.

Upon arrival at the site, a local technician simply installs the switch into the designated rack, plugs in power, and connects networking cables to local devices as well as the uplink switch/router. Details of how this works are shown in Figure 5

Figure 5

Auto-connection: New Switch Deployment at Branch/Store

■ Default Script runs in switch at power-up
■ Performs basic functions to establish in-band connection and register with Automation Server

```
Power-on  →  Enable LLDP  →  Use LLDP to
                              Detect inband  →  config te-1/1/49
                              VLAN              VLAN DHCP
```
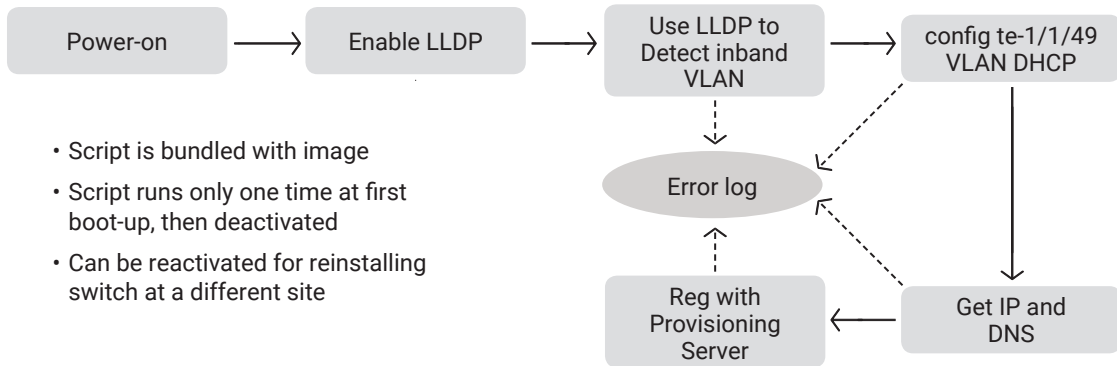
• Script is bundled with image
• Script runs only one time at first boot-up, then deactivated
• Can be reactivated for reinstalling switch at a different site

```
                    Error log

Reg with                      Get IP and
Provisioning  ←               DNS
Server
```

Once the switch powers up, an agent built into the default PICOS image starts running. If the agent discovers no configuration on the switch, it then triggers the automation process. The agent first performs network discovery using LLDP to identify the adjacent links and VLANs, and establishes a path to a DHCP server to obtain the basic networking configuration to allow communication over the network. It then reaches out to the Pica8 Automation Server (via DNS name resolution) to trigger the update process.
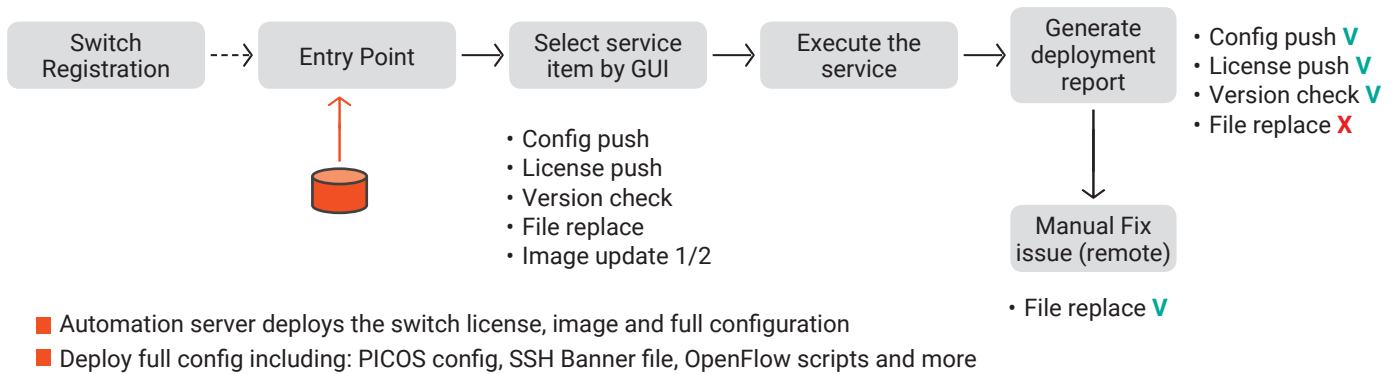
Once the Automation Server receives the trigger from the new switch, it identifies the switch by its serial number and pulls up its configuration from the local database. It checks the PICOS version required by the master config to the version on the switch and, if necessary, initiates a code update.

As part of this process customers can specify an Upgrade1 (single image on switch) or Upgrade2, which is a new image plus a backup of the previous image and config stored on switch. Upgrade 1 takes up less space on the switch but Upgrade2 allows immediate fallback to the previous image if there is a problem in bringing up the new image, or a manual fallback to the older image if needed at a later time.

Once the PICOS image is installed, the switch is rebooted and the new config is applied. If the installation is successful, the switch becomes fully active and operational on the network; its status is updated in the configuration database and a deployment report is generated. In the rare event some aspect of the deployment does not complete successfully, the configuration can be applied manually through the automation server. The automation server incorporates a dashboard that provides a snapshot of resource utilization and a summary of deployment statistics.

Figure 6

Automation Server Workflow

Switch Registration	--->	Entry Point	→	Select service item by GUI	→	Execute the service	→	Generate deployment report

- Config push **V**
- License push **V**
- Version check **V**
- File replace **X**

Select service item by GUI:
- Config push
- License push
- Version check
- File replace
- Image update 1/2

Manual Fix issue (remote)
- File replace **V**

■ Automation server deploys the switch license, image and full configuration
■ Deploy full config including: PICOS config, SSH Banner file, OpenFlow scripts and more

The automation process described above in Figure 6 can be applied simultaneously to dozens of switches being deployed across the same or different sites in the customer network. In practice, this supports a deployment rate of several hundred switches per week. (Actual scalability depends on the CPU and RAM in the VMs being used.) The automation server is designed for high availability with full active-active redundancy across two instances of the server and database.

Current Status

Several components of this framework, including the License Manager, are already operational and tested successfully for customer deployment. The complete set of tools has gone through final integration testing and is currently in beta test at customer accounts. Full production availability is expected by the end of Q1 2019.

Roadmap

Pica8 expects the Automation Framework will dramatically ease installation of Pica8 switches in large enterprise networks. Working with a number of Fortune 50 customers, we have also identified areas for further development and enhancement, including:

- Establishing detailed metrics for estimating system scalability based on VM resources deployed

- APIs to integrate with a customer database for automatic retrieval of global, regional and site-specific configuration information

- Enhancements to the ONIE standard that would allow for operation across in-band management without a pre-installed image or agent on the switch

The Pica8 Automation Framework is just the latest example of how Pica8 is taking a leading role in simplifying enterprise networking, thus reducing the workload on the scarce population of Tier-3 network support engineers. Another example is how PICOS, paired with Pica8's PicaPilot™ switch orchestration, configuration and management application, enables deployment of a leaf-spine network architecture across the enterprise. To learn more, download the free white paper, It's Time to Deploy the Leaf-Spine Architecture in the Enterprise.