



Cell Site Router Automation using Zero Touch Provisioning (ZTP)

Powered by NSO Based Solution

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23-June-2020

Agenda

- Challenges with Cell Site Router Automation for SPs
- Solution Architecture
- Case Study Service 1 – Port Turn up / Tech Add
 - NSO Stacked Services
 - Yang models for Inventory Management
 - Templates for Pre & Post checks
 - Order Lifecycle Management
 - Synchronization of Device Models & Service Models
- Case Study Service 2 – Zero Touch Provisioning
 - SNMP Traps
 - Pre-commissioning services
 - SSH Connection Adapters
 - Golden Config Templates
 - Device Config Reports
 - Order Lifecycle Management
- Business Outcomes / Bottomline

Service Provider's Imbroglia

- Nonstandard configs on network devices
- Manual MOPs
- “*Cheat Sheet*” is the knowledge base
- Network growth due to Mobility
- Scalability at risk
- Time to Market
- More work with existing/
reduced manpower
- OPEX pressures

Thinking About Network Automation.....



Seems easy .. Huh....

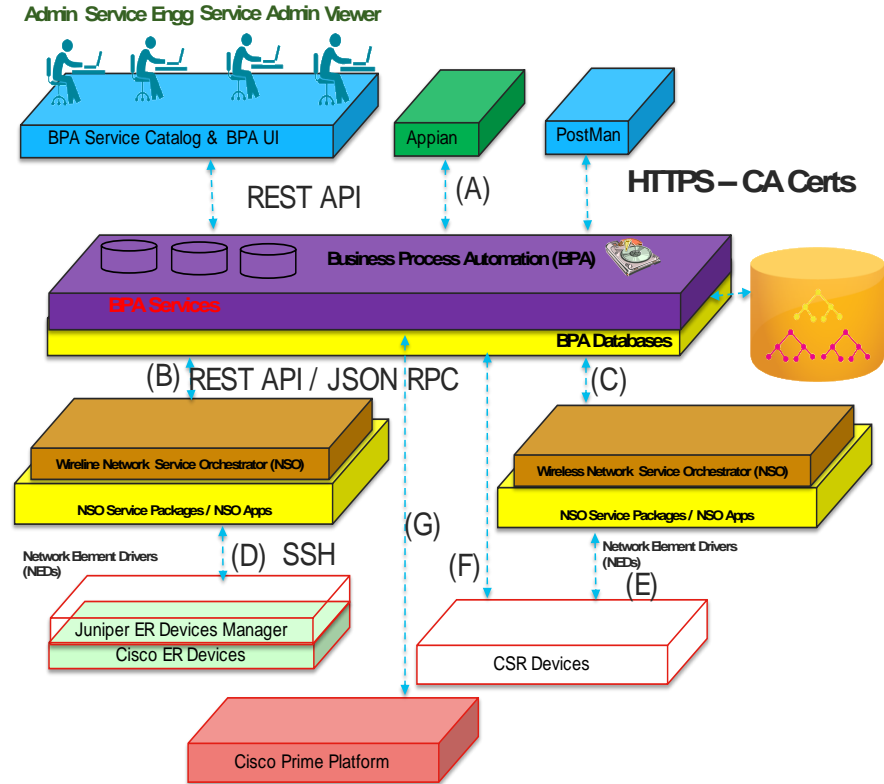
Problem Statement

- Need massive overhaul of network infrastructure to evolve existing 4G networks & futuristic 5G networks
- Legacy systems are unable to onboard existing managed devices into a centralized system
- Unable to scale managed devices to meet market demand
- Realization that manual approach applied to envisioned architecture was too costly and likely error prone.
- Limited ability to manage service deployments on greenfield (new) devices & brownfield (old) devices

The Solution

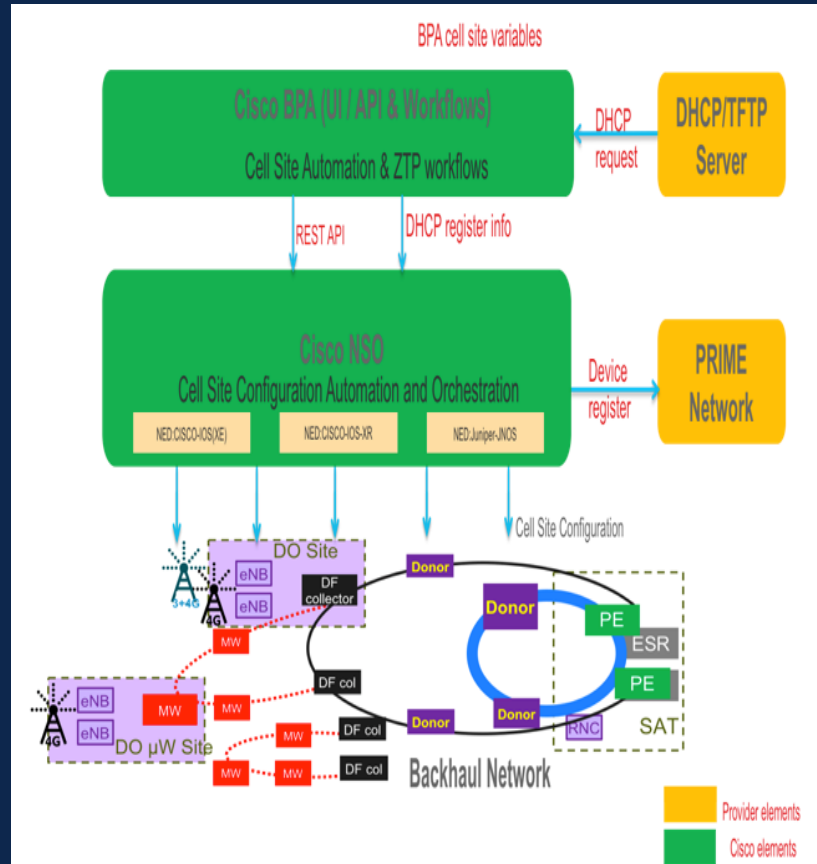
- Deployment of Network Services Orchestrator (NSO) powered solution to enable Zero Touch Provisioning (ZTP) of 4G/ LTE network infrastructure
- Simplified and unified user experience by automating workflows to create efficiencies at scale
- Key Automation use cases:
 - ✓ TechAdd / Port Turn-Up Service on brownfield devices
 - ✓ Pre-commissioning & Cell Site Routers (CSR) onboarding using ZTP

Solution Architecture



Cell Site Router (CSR) Automation – Port Turn Service

- ❑ CSRs provides data plane for cell sites to support 3G / 4G networks
- ❑ Edge port turn up service provisioning in brownfield network for service activation
- ❑ Delta configuration on IPA/ER/CSR to enable port turn-up
- ❑ Transactional atomicity across multiple NSO instances
- ❑ Automatic rollback across multiple NSOs spanning of different transactions
- ❑ Validations against Port turn up Inventory matrix
- ❑ MOP Prechecks procedures for deployment readiness verification
- ❑ Custom business processes for failure remediations, notifications, self healing
- ❑ Order Lifecycle Management for managing multiple services



Stacked Service Models - Port Turn-up / Tech Add Services

```
module tech-add-csr-stack-service { // Wireless NSO based stack service
  namespace "http://sprint.cisco.com/tech-add-csr-stack-service";
  prefix tech-add-csr-stack-service;
  organization "Sprint Technology Addition";
  description "Tech-Add CSR stack service";
  augment /ncs:services {
    //
  }
  list tech-add-csr-stack-service {
    description "Tech-Add CSR stack service";
    uses ncs:service-data;
    ncs:servicepoint tech-add-csr-stack;
    key service-key;
    1 reference
    leaf service-key {
      tailf:info "Service key";
      type string;
    }
    leaf service-name {
      tailf:info "Service name";
      type string;
    }
    list hosts {
      key csr-host-name;
      1 reference
      leaf csr-host-name {
        tailf:info "CSR device/host name";
        mandatory true;
        type leafref {
          path "/ncs:devices/ncs:device/ncs:name";
        }
      }
      leaf enable-validation {
        tailf:info "validation enable flag";
        type boolean;
        default true;
      }
    }
  }
}
```

```
module tech-add-er-stack-service { // Wireline NSO based stack service
  namespace "http://sprint.cisco.com/tech-add-er-stack-service";
  prefix tech-add-er-stack-service;
  organization "Sprint Technology Add";
  description "Tech-Add ER stack service";
  augment /ncs:services {
    //
  }
  list tech-add-er-stack-service {
    description "Tech-Add ER stack service";
    uses ncs:service-data;
    ncs:servicepoint tech-add-er-stack;
    key service-key;
    1 reference
    leaf service-key {
      tailf:info "Service key";
      type string;
    }
    leaf service-name {
      tailf:info "Service name";
      type string;
    }
  }
}
```

Order / Service Data Validation Using Yang Models

- ❑ TechAdd Type: Applicable for the provided OEM type
- ❑ Port: Reserved for provided OEM Type & Tech Add Type
- ❑ VLAN ID : Corresponds to OEM Type & Backhaul Design

May 20, 2020, 1:03:38 PM

Failed

Validation

Validation failed: node-oam-ip-subnet is needed when switch-oem-type is ERC ; node-oam-ip-subnet-mask is needed when switch-oem-type is ERC

Yang Definitions for Inventory Management

```
1 module sprint-preload-data {
2   namespace "http://sprint.cisco.com/sprint-preload-data";
3   prefix sprint-preload-data;
4   description "Sprint preload data for Inventory Management";
5   ...
6   container preload {
7     ...
8     list tech-adds {
9       key 'switch-oem-type tech-add-type';
10      ...
11      1 reference
12      leaf switch-oem-type {
13        mandatory true;
14        tailf:info "OEM type";
15        type string;
16      }
17      1 reference
18      leaf tech-add-type {
19        mandatory true;
20        tailf:info "Tech-Add type description";
21        type string;
22      }
23    }
24  }
25 }
```

```
1 module sprint-preload-data {
2   namespace "http://sprint.cisco.com/sprint-preload-data";
3   prefix sprint-preload-data;
4   description "Sprint preload data for Inventory Management";
5   ...
6   container preload {
7     ...
8     list static-route-data{
9       ...
10      key "switch-oem-type vlan-id backhaul-design";
11      ...
12      1 reference
13      leaf switch-oem-type{
14        tailf:info "OEM type";
15        type string;
16      }
17      1 reference
18      leaf vlan-id{
19        tailf:info "vlan id";
20        type string;
21      }
22      1 reference
23      leaf backhaul-design{
24        tailf:info "backhaul design information";
25        type string;
26      }
27    }
28  }
29 }
```

```
1 module sprint-preload-data {
2   namespace "http://sprint.cisco.com/sprint-preload-data";
3   prefix sprint-preload-data;
4   description "Sprint preload data for Inventory Management";
5   ...
6   container preload {
7     ...
8     list ip-offset-data{
9       ...
10      ...
11      list bfd-preference-data{
12        ...
13        ...
14        tailf:action bfd-preference-data-action {
15          tailf:actionpoint 'bfd-preference-data-actionpoint';
16        }
17        tailf:action ip-offset-data-action {
18          tailf:actionpoint 'ip-offset-data-actionpoint';
19        }
20        tailf:action load-tech-add-data {
21          tailf:actionpoint tech-add-data-action;
22        }
23        tailf:action load-static-route-data {
24          tailf:actionpoint static-route-data-action;
25        }
26        tailf:action load-tech-add-octet {
27          tailf:actionpoint tech-add-octet-action;
28        }
29        tailf:action load-all {
30          tailf:actionpoint load-all-action;
31        }
32      }
33    }
34  }
35 }
```

Fetching Inventory Data from NSO (1)

GET http://10.155.248.199:8080/api/running/preload/deep Send

Params Authorization Headers (8) Body Pre-request Script Tests Settings

TYPE
Basic Auth

The authorization header will be automatically generated when you send the request. [Learn more about authorization](#)

Username: cisco
Password: *****
 Show Password

Status: 200 OK Time: 977 ms Size: 66.55 KB Save

Body Cookies Headers (7) Test Results

Pretty Raw Preview Visualize XML

```
1
2
3 <preload xmlns="http://sprint.cisco.com/sprint-preload-data" xmlns:y="http://tail-f.com/ns/rest" xmlns:sprint-preload-data="http://sprint.cisco.com/sprint-preload-data">
4   <tech-adds>
5     <switch-oem-type>ALU</switch-oem-type>
6     <tech-add-type>MIMO_TDD_2_5#3</tech-add-type>
7     <asr901-port>M4</asr901-port>
8     <asr903-port>G10/3/5</asr903-port>
9     <asr920-port>G10/0/13</asr920-port>
10    <n540-port>G10/0/13</n540-port>
11    <nv-vlan-1>16</nv-vlan-1>
12    <nv-vlan-2>17</nv-vlan-2>
13    <nv-ip-offset-1>+4</nv-ip-offset-1>
14    <nv-ip-offset-2>+4</nv-ip-offset-2>
15    <df-vlan-1>4</df-vlan-1>
16    <df-vlan-2>5</df-vlan-2>
17    <df-ip-offset-1>+14</df-ip-offset-1>
18    <df-ip-offset-2>+14</df-ip-offset-2>
19    <ran-type>Macro</ran-type>
20    <negotiation>neg auto</negotiation>
21    <media-type>SFP</media-type>
22  </tech-adds>
23  <tech-adds>
24    <switch-oem-type>ERC</switch-oem-type>
25    <tech-add-type>DBA1_CDMA_1900#1</tech-add-type>
26    <asr901-port>G10/9</asr901-port>
27    <asr903-port>G10/2/7</asr903-port>
28    <asr920-port>G10/0/7</asr920-port>
29    <n540-port>G10/0/7</n540-port>
30    <nv-vlan-1>2</nv-vlan-1>
31    <nv-vlan-2>3</nv-vlan-2>
32    <nv-ip-offset-1>+2</nv-ip-offset-1>
33    <nv-ip-offset-2>+2</nv-ip-offset-2>
34    <df-vlan-1>4 (untagged)</df-vlan-1>
35    <df-vlan-2>tb</df-vlan-2>
36    <df-ip-offset-1>+7</df-ip-offset-1>
37    <df-ip-offset-2>8</df-ip-offset-2>
38    <ran-type>Macro</ran-type>
39    <negotiation>no neg auto</negotiation>
40    <media-type>SFP</media-type>
41  </tech-adds>
```

Fetching Inventory Data from NSO (2)

```
<tech-adds>
  <switch-oem-type>STA</switch-oem-type>
  <tech-add-type>MiniMacro_TDD_2.5#1/Daisy Chain CSR</tech-add-type>
  <asr901-port>NA</asr901-port>
  <asr903-port>Gi0/4/7</asr903-port>
  <asr920-port>Gi0/0/23</asr920-port>
  <ncs540-port>Gi0/0/0/19</ncs540-port>
  <nv-vlan-1>15.0</nv-vlan-1>
  <nv-vlan-2>tbd</nv-vlan-2>
  <nv-ip-offset-1>DHCP</nv-ip-offset-1>
  <nv-ip-offset-2>tbd</nv-ip-offset-2>
  <df-vlan-1>15.0</df-vlan-1>
  <df-vlan-2>tbd</df-vlan-2>
  <df-ip-offset-1>DHCP</df-ip-offset-1>
  <df-ip-offset-2>tbd</df-ip-offset-2>
  <ran-type>MiniMacro</ran-type>
  <negotiation>neg auto</negotiation>
  <media-type>SFP</media-type>
</tech-adds>
<static-route-data>
  <switch-oem-type>ALU</switch-oem-type>
  <vlan-id>16</vlan-id>
  <backhaul-design>NV</backhaul-design>
  <vrf>CDN</vrf>
  <ne-type>MIMO</ne-type>
</static-route-data>
<ip-offset-data>
  <switch-oem-type>STA</switch-oem-type>
  <evc-type>PTP</evc-type>
  <offset1>0</offset1>
  <offset2>0</offset2>
  <offset3>1</offset3>
  <offset4>1</offset4>
  <bh-ip-subnet>255.255.255.254</bh-ip-subnet>
</ip-offset-data>
<bfd-preference-data>
  <switch-oem-type>ALL</switch-oem-type>
  <er-device-type>MX</er-device-type>
  <vrf-name>ALL</vrf-name>
  <bh-type>Dedicated Ethernet, MW</bh-type>
  <primary>
    <bfd>NA</bfd>
    <minimum-interval>NA</minimum-interval>
    <multiplier>NA</multiplier>
    <tag>NA</tag>
  </primary>
  <secondary>
    <bfd>NA</bfd>
    <minimum-interval>NA</minimum-interval>
    <multiplier>NA</multiplier>
    <metric>NA</metric>
    <tag>NA</tag>
    <preference>250</preference>
  </secondary>
</bfd-preference-data>
```

Fetching Inventory Data from NSO (3)

```
bfd-preference-data>
  <switch-oem-type>STA</switch-oem-type>
  <er-device-type>ASR9K</er-device-type>
  <vrf-name>sat-exdmz</vrf-name>
  <bh-type>Dedicated Ethernet</bh-type>
  <primary>
    <bfd>fast-detect</bfd>
    <minimum-interval>200</minimum-int
    <multiplier>3</multiplier>
    <tag>100</tag>
  </primary>
  <secondary>
    <bfd>fast-detect</bfd>
    <minimum-interval>400</minimum-int
    <multiplier>3</multiplier>
    <metric>250</metric>
    <tag>200</tag>
  </secondary>
/bfd-preference-data>
<y:operations>
  <bfd-preference-data-action>/api/running/preload/_operations/bfd-preference-data-action</bfd-preference-data-action>
  <ip-offset-data-action>/api/running/preload/_operations/ip-offset-data-action</ip-offset-data-action>
  <load-tech-add-data>/api/running/preload/_operations/load-tech-add-data</load-tech-add-data>
  <load-static-route-data>/api/running/preload/_operations/load-static-route-data</load-static-route-data>
  <load-tech-add-octet>/api/running/preload/_operations/load-tech-add-octet</load-tech-add-octet>
  <load-all>/api/running/preload/_operations/load-all</load-all>
</y:operations>
</preload>
```

Pre & Post-checks using Process Templates

Template Id: TechAddPreCheckCSRMacro	Device Name: KSOPXC01-CSR-01	Commands Evaluation Result: Pass
show interfaces Gi0/0/4 include up		Rules Evaluation Result: Pass
show run interface Gi0/0/4 include service		Rules Evaluation Result: Pass
show run interface bdi42		Rules Evaluation Result: Pass
show run interface dummy		Rules Evaluation Result: Fail
show run interface bdi34		Rules Evaluation Result: Pass
show version dummy		Rules Evaluation Result: Pass



Pre/Post Check
Execution
Summary

show run interface bdi34	Rules Evaluation Result: Pass
Execution Time: 04/10/20, 09:44 AM	
#Rule1 Rule : no ip address	Operation : Contains Result : Fail
#Rule2 Rule : invalid input	Operation : Contains Result : Pass
#Rule3 Rule : incomplete command	Operation : Contains Result : Fail
<input checked="" type="checkbox"/> Show Command Output	
show run interface bdi34	
% Invalid input detected at '' marker.	
KSOPXC01-CSR-01#	



Regex based
Pre/Post Check
execution

Pre & Post checks using Process Templates (2)

sh run interface Gi0/0/14 | service Rules Evaluation Result **Pass**

Execution Time: 05/15/20, 10:22 AM

#Rule1 Operation : Script Result **Pass**

Rule:	
Is Car Type Ncs	0
Vlan Id 1	15
TextFSM Template	cisco_ios_show_run_interface_1_service.template
Analysis Script	techadd_precheck_csr_minimacro_v2_4_show_run_interface_analysis.py

Show Command Output

```
service-policy input ingress-marking-policy
service instance 15 ethernet
K50FX01-C518-01#
```

Details:			
Name	Value	Info	Status
Service Instance Configuration check	15	Payload's vlan id: 15 matched with Command Output vlan id: 15	Passed



TextFSM
Template based
Pre/Post Check
execution

techadd_precheck_csr_minimacro_v2_4_show_run_interface_analysis.py show run interface ANALYSIS



```
View - Script
import devpackage.DataProvider as DeviceDataProvider
import simplejson

dp = DeviceDataProvider.DeviceDataProvider(context)
ctype = DeviceDataProvider.CollectionType

PARAMS: vlanID, isCarTypeMcs
def main(*args):
    @_job_execution_log()
    """Executing the techadd precheck csr minimacro analysis standalone script 4"""
    }
    # Capture script inputs
    inputs = context.get("INPUTS")
    parsed_json = simplejson.loads(inputs)

    # Extract the input fields from parsed json
    vlanIDPayload = str(parsed_json["vlanID"])
    isCarTypeMcs = int(parsed_json["isCarTypeMcs"])
```

cisco_ios_show_run_interface_1_service.template show run interface | service TEMPLATE



```
View - Template
Value Required VLANID (15+)
Start
^\\s+service\\s+instance\\s+${VLANID}\\s+ethernet -> Continue.Record
```


Pre & Post checks using Process Templates (3)

Executions

Process Templates Executions Analytics Diff Scripts

Delete From Date To Date

CSV Excel

Execution Id	Template	Device Name	NSO Instance	Overall Result	Execution Date	Actions
<input type="checkbox"/>	techadd					
<input type="checkbox"/> 5ee084ee7341820035f00778	TechAddPreCheckEROneIP	DF-IPA-12	wireline	false	06/10/20, 01:59 AM	
<input type="checkbox"/> 5ee0848ddf962e0044567459	TechAddPreCheckEROneIP	DF-IPA-11	wireline	false	06/10/20, 01:58 AM	
<input type="checkbox"/> 5ede54d80d0b9a003ec979c5	TechAddPreCheckCSRMinim...	KSOPXC01-CSR-01	wireless	true	06/08/20, 10:10 AM	
<input type="checkbox"/> 5ede54913f5536003cfbad86	TechAddPreCheckEROneIP	DF-IPA-12	wireline	false	06/08/20, 10:09 AM	
<input type="checkbox"/> 5ede49075190f100318636d5	TechAddPreCheckEROneIP	DF-IPA-11	wireline	false	06/08/20, 09:19 AM	
<input type="checkbox"/> 5ede481ad21aa2004ad9c106	TechAddPreCheckCSRMacro	KSOPXC11-CSR-11	wireless	true	06/08/20, 09:15 AM	
<input type="checkbox"/> 5ed7aa6ef1b58c0045dd6f4a	TechAddPreCheckEROneIP	DF-IPA-11	wireline	false	06/03/20, 08:49 AM	
<input type="checkbox"/> 5ed65c211b5d4600365af492	TechAddPreCheckEROneIP	DF-IPA-11	wireline	false	06/02/20, 09:03 AM	
<input type="checkbox"/> 5ed65a8ec7cb1a003d797fd8	TechAddPreCheckEROneIP	DF-IPA-11	wireline	false	06/02/20, 08:56 AM	
<input type="checkbox"/> 5ed652322a277f00427768f7	TechAddPreCheckEROneIP	DF-IPA-11	wireline	false	06/02/20, 08:20 AM	

Pre & Post checks using Process Templates (4)

```
tailf:action netconf-exec {
  tailf:actionpoint netconf-exec;
  tailf:info "Execute show commands on netconf device";

  // Input requires sshport num and command or list of commands
  input {
    leaf device {
      mandatory true;
      type leafref {
        path "/ncs:devices/ncs:device/ncs:name";
      }
    }

    leaf sshport {
      mandatory true;
      tailf:info "The port on which the SSH server listens on the device";
      type inet:port-number;
    }
  }

  choice command-choice {
    leaf command {
      tailf:info "Singular command to run on device";
      mandatory true;
      type string {
        pattern "show.*|set.*" {
          error-message "error: only show commands are allowed to be executed on devices.";
        }
      }
    }
    leaf-list commands {
      tailf:info "Batch of commands to run on device";
      min-elements 1;
      type string {
        pattern "show.*|set.*" {
          error-message "error: only show commands are allowed to be executed on devices.";
        }
      }
    }
  }
}

// Output will return a list of results keyed by command w/
// corresponding output from device
output {
  list result {
    tailf:info "Output(s) of given user command(s)";
    key command;

    leaf command {
      tailf:info "The command that was issued";
      type string;
    }

    leaf config {
      tailf:info "The corresponding config output to the command";
      type string;
    }
  }
}
```

```
... @ActionCallback(callPoint = "netconf-exec", callType = ActionCBType.ACTION)
... public ConfXMLParam[] show(DpActionTrans trans, ConfTag name, ConfObject[] kp, ConfXMLParam[] params) throws DpCallbackException {
```

```
tailf:action execCommand {
  tailf:actionpoint exec-command;
  tailf:info "Returns device configuration from CDB.";
  input {
    leaf device-ip {
      tailf:info "Device on which command needs to be executed.";
      mandatory true;
      type inet:ip-address;
    }
    leaf auth-group {
      tailf:info "Auth Group to connect to the device";
      mandatory true;
      type leafref {
        path "/ncs:devices/ncs:authgroups/ncs:group/ncs:name";
      }
    }
    leaf auth-details {
      type boolean;
      default false;
    }
    leaf command {
      tailf:info "Command to be executed on the device.";
      mandatory true;
      type string;
    }
    leaf port {
      type uint16;
      default 22;
    }
  }
  output {
    leaf success {
      type boolean;
    }
    leaf message {
      description "Device command output or error message";
      type string;
    }
  }
}
```

```
... @ActionCallback(callPoint = "exec-command", callType = ActionCBType.ACTION)
... public ConfXMLParam[] execCommand(DpActionTrans trans, ConfTag name, ConfObject[] kp, ConfXMLParam[] params){
```

Port Turn up Service - Order Life Cycle Management



Order Lifecycle Management includes:

- ❑ Provisioning
- ❑ Upgrades
- ❑ Approvals
- ❑ Service Decommissioning
- ❑ Audit & Compliance Reviews
- ❑ Alarms & Notifications

Order Milestones:

- ❑ Validation
- ❑ ER Check-Sync ER Pre-Checks ER Dry-Run ER Commit
- ❑ CSR Check-Sync CSR Pre-Checks CSR Dry-Run CSR Commit
- ❑ Delete Rollback ER Delete Rollback CSR

Order Lifecycle Management (2)

Dynamic Form
rendering based on
Yang Model Definitions



Create TechAdd

CIQ ID	Augment ID *	Cascade ID *
Tech Add Type *	Backhaul Design *	Switch OEM Type *
ER1 Host Name	ER2 Host Name	CSR Host Name *
CSR Type *	Port *	VLAN ID 1 *
Subnet Mask 1 *	IP Subnet Address 1 *	Default Router IP Address 1 *

ALL ORDERS **TECH ADD ORDERS** ZTP DARK FIBER ZTP NETWORK VISION

From Date To Date

↓ CSV ↓ Excel

Order #	BPA Tracking ID	CIQ ID	Augment ID	Cascade ID	Tech Add Type	Created By	Status	Action
1400	See0d545e24aa00...	NVGF12SD	KSAPXC059-6	KSAPXC059	CDMA_800/1900#2	admin	Paused	
1399	See08ceb5b37b500...	NVASA00CS	KSAPXC059-6	KSAPXC059	CDMA_800/1900#2	admin	Deleted	
1398	See0870311fad500...	NVASA74DSA	KSAPXC059-6	KSAPXC059	CDMA_800/1900#2	admin	Paused	
1397	See084335e24aa00...	NVASA76320	KSOPXC479	KSOPXC414	MiniMacro_TDD_2.5...	admin	Paused	
1393	Secfb374e928ec00...	Test1235	KSOPXC008	KSOPXC034	MIMO_TDD_2.5#3	admin	Paused	
1392	Secfb0c4eef20d003...	Test1234	KSOPXC009	KSOPXC034	MiniMacro_TDD_2.5...	admin	Failed	
1387	Secdf50169ac25004...	NVVVV454502	KSOPXC7345N20 F	KSOPXFC2907	CDMA_800/1900#2	admin	In-Process	
1384	Secdf249c129a77002...	NVASAF405	KSOPXC479	KSOPXC414	MiniMacro_TDD_2.5...	admin	In-Process	
1376	Secde48a9b727bd00...	NVASAF4057	KSOPXC479	KSOPXC414	MiniMacro_TDD_2.5...	admin	Completed	
1375	Secde45eb13012b00...	DFTA006565	KVIPXAZC546	KVIPXAZC667	FDD_800/1900#2	admin	Completed	



Order Tracking

Dashboard with Admin RBAC Privileges

The screenshot displays the Cisco Business Process Automation dashboard. The top navigation bar includes the Cisco logo, the text "Business Process Automation", and the user profile "Network Architect" with a notification bell icon showing "11" and a user icon. The main dashboard area is titled "Dashboard" and contains a grid of 15 service tiles, each with a blue icon and a label:

- Service Center (wrench and screwdriver icon)
- Form Builder (document icon)
- Device Manager (server rack icon)
- Service Catalog (shopping cart icon)
- Process Templates (document with list icon)
- Golden Config Templates (document with gear icon)
- Config Validator (checkmark icon)
- Workflows (network diagram icon)
- Service Topology (network diagram with gear icon)
- Network Topology (network diagram icon)
- Market Variances (building icon)
- Device Activation (monitor with star and phone icon)
- Migration (document with arrows icon)
- Commit Manager (network diagram icon)
- OS Upgrade (refresh/circular arrow icon)

Dashboard with Engineer RBAC Privileges

The screenshot displays the Cisco Business Process Automation dashboard for a user with Engineer RBAC privileges. The interface includes a top navigation bar with the Cisco logo and the text "Business Process Automation". The user's name, "test techaddsvcengr", is visible in the top right corner, along with a profile icon and a dropdown menu containing "Profile", "Preferences", and "Logout". The main dashboard area is titled "Dashboard" and contains eight tiles, each representing a different tool or feature:

- Service Center (represented by a wrench and screwdriver icon)
- Form Builder (represented by a document icon)
- Device Manager (represented by a server rack icon)
- Service Catalog (represented by a shopping cart icon)
- Process Templates (represented by a document with a list icon)
- Golden Config Templates (represented by a document with a gear icon)
- Config Validator (represented by a document with a checkmark icon)
- Workflows (represented by a network diagram icon)
- Service Topology (represented by a network diagram with a gear icon)

NSO Controller Synchronization

Settings

Controllers SMTP Support Password Settings Ticketing Data Purging Settings Appliance +

Add Delete

CSV Excel

Controller Name	Controller Type	Host	Sync Status	Actions
wireline	NSO	10.155.248.199	Success	[Info] [Refresh] [Edit] [Delete]
wireless (Default)	NSO	10.86.183.197	Success	[Info] [Refresh] [Edit]

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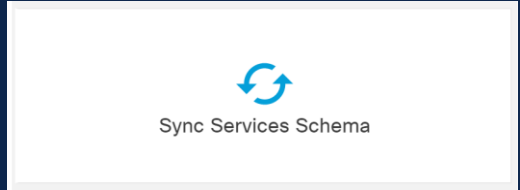
Controller View

Name	wireline	Controller Type	NSO
Schema	HTTP	Host	10.155.248.199
Port	8080	Username	clisco
Zone	Default	Default NSO	false
LSA Node	false		

Sync Service

Select Groups Search

Service Point	NSO	Sync Status	All	Add	Delete	Download	Edit	Show	Upload
/ncs:services/tech-add-csr-ncs:tech-add-csr-ncs	wireless	true	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
/ncs:services/tech-add-csr-stack-service:tech-add-csr-stack-service	wireless	true	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
/ncs:services/tech-add-csr-asr:tech-add-csr-asr	wireless	true	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
/ncs:services/ztp-nv-csr-service:ztp-nv-csr-service	wireless	true	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
/ncs:services/sprint-stacked:sprint-stacked/policy-option	wireline	true	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
/ncs:services/sprint-stacked:sprint-stacked/class	wireline	true	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
/ncs:services/sl3vpn-junos:sl3vpn-junos/port	wireline	true	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
/ncs:services/sl3vpn-junos:sl3vpn-junos/cos/trafficControlProfiles	wireline	true	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



Cell Site Router Automation – Zero Touch Provisioning (ZTP) Service

Enable 4G / 5G Network Infrastructure to onboard new greenfield Cell Site Routers (CSR) to enhance LTE coverage capabilities

- ❑ Pre-commissioning of auxiliary devices
- ❑ Synchronization with Inventory Databases
- ❑ SNMP Trap listeners
- ❑ Whitelisting devices
- ❑ Device onboarding
- ❑ Prechecks / post checks
- ❑ Service provisioning on auxiliary devices
- ❑ Determination & removal of temporary dynamic interface components
- ❑ Element Manager Integration for monitoring

Order Id: 1304	Service: ZTP Network Vision	Order Status:		
Created By: admin	Created Date: May 20, 2020, 3:50:28 PM	Updated Date: May 20, 2020, 5:24		
Running	Completed	Milestones	Retry Order History	Configured Devices
May 20, 2020, 3:50:33 PM	Complete	Precomm Validation Validation completed successfully		
May 20, 2020, 3:50:41 PM	Complete	Precomm ER Check-Sync Precomm ER Check-Sync completed successfully		
May 20, 2020, 3:51:01 PM	Complete	Precomm ER Pre-Checks Precomm ER Pre-Checks completed successfully		
May 20, 2020, 3:52:04 PM	Complete	Precomm ER Dry-Run Precomm ER Dry-Run completed successfully		
May 20, 2020, 3:52:21 PM	Complete	Precomm ER Commit Precomm ER Commit completed successfully based on approval received from system		
May 20, 2020, 4:11:24 PM	Complete	ZTP Device Activation DHCP IP Address = 120.0.0.26 Bootstap GW IP Address = 120.0.0.25 B/W Tracking Id = 5ec5581403cb16003d954ed Serial Number = CAF2027Y15N		
May 20, 2020, 4:13:37 PM	Complete	Validation Validation completed successfully		
May 20, 2020, 4:13:42 PM	Complete	CSR Onboarding CSR Onboarding completed successfully. Onboarded device details: Name 'K30PKYC13-CSR-13', IP Address '120.0.0.26', Auth Group 'ZTP_Test_92P'		
May 20, 2020, 4:13:49 PM	Complete	CSR Check-Sync CSR Check-Sync completed successfully		
May 20, 2020, 4:15:01 PM	Complete	CSR Dry-Run Day 0.5 CSR Dry-Run Day 0.5 completed successfully		
May 20, 2020, 4:16:14 PM	Complete	CSR Commit Day 0.5 CSR Commit Day 0.5 completed successfully based on approval/received from admin		
May 20, 2020, 4:16:44 PM	Complete	ERs Check-Sync ERs Check-Sync completed successfully		
May 20, 2020, 5:00:44 PM	Complete	ERs Pre-Checks ERs Pre-Checks completed successfully		
May 20, 2020, 5:07:30 PM	Complete	ERs Dry-Run Day 0.5 ERs Dry-Run Day 0.5 completed successfully		
May 20, 2020, 5:07:55 PM	Complete	ERs Commit Day 0.5 ERs Commit Day 0.5 completed successfully based on approval received from system		

ZTP Service (2)

Device Activation

From Date: To Date:

Serial No.	Device Name	Device Description	Onboard Status	Created On	Created By	Actions
<input type="checkbox"/>	CAT2037V1BE		Waiting	04/28/20, 12:47 PM	admin admin	
<input type="checkbox"/>	CAT2321V0C7		Waiting	04/28/20, 12:47 PM	admin admin	
<input type="checkbox"/>	FOX2043P19C		Waiting	04/28/20, 12:47 PM	admin admin	
<input type="checkbox"/>	CAT1838U2NB		Waiting	04/28/20, 12:47 PM	admin admin	
<input type="checkbox"/>	FOC2232P81E		Waiting	04/28/20, 12:47 PM	admin admin	
<input type="checkbox"/>	CAT2037V19N		Completed	04/28/20, 12:47 PM	admin admin	

Synchronization with Inventory Databases

May 20, 2020, 5:08:00 PM	<p>Complete</p> <p>Revise CSR IP Address Revise CSR IP Address completed successfully</p>
May 20, 2020, 5:08:03 PM	<p>Complete</p> <p>Get CSR DHCP BDI Get CSR DHCP BDI completed successfully</p>
May 20, 2020, 5:08:24 PM	<p>Complete</p> <p>Remove CSR Day 0 Static Config Remove CSR Day 0 Static Config completed successfully</p>
May 20, 2020, 5:19:18 PM	<p>Complete</p> <p>CSR Dry-Run Day 1 CSR Dry-Run Day 1 completed successfully</p>
May 20, 2020, 5:19:36 PM	<p>Complete</p> <p>CSR Commit Day 1 CSR Commit Day 1 completed successfully based on approval received from admin</p>
May 20, 2020, 5:20:13 PM	<p>Complete</p> <p>ER1 Delete Day 0 ER1 Delete Day 0 completed successfully based on deletion initiated by admin</p>
May 20, 2020, 5:23:36 PM	<p>Complete</p> <p>ERs Dry-Run Day 1 ERs Dry-Run Day 1 completed successfully</p>
May 20, 2020, 5:24:01 PM	<p>Complete</p> <p>ERs Commit Day 1 ERs Commit Day 1 completed successfully based on approval received from system</p>
May 20, 2020, 5:24:10 PM	<p>Complete</p> <p>Add VNE to Prime Network Add VNE to Prime Network completed successfully; Prime Network System: LabPrime01; Unit: 10.86.252.22; AVM: 500; key: KSOPXC13-CSR-13</p>

ZTP Service Order Milestones

NSO SSH Connection Adapter

- ❑ Establish SSH sessions with devices not managed by NSO
- ❑ Execute commands both in config and non config modes
- ❑ SSH Connector requires below parameters:
 - hostname
 - port
 - username
 - password

```
public String executeCommand(String command) throws Exception {
    log.debug("executing command ... "+command);
    sb.setLength(0);
    sendCommand(command, out);
    readStream(prompt_pattern, true, 140000);
    String output = sb.toString();
    int commandIndex = output.lastIndexOf(command);
    if (commandIndex != -1) {
        output = output.substring(commandIndex + command.length());
    }
    return output.replace("{master}", "").trim() + "\n";
}
```

```
public String executeConfigModeCommand(String command) throws Exception {
    sendCommand("configure", out); // Enter configuration edit mode

    readPrompt(); // Wait to enter configuration mode
    sb.setLength(0);
    sendCommand(command, out);

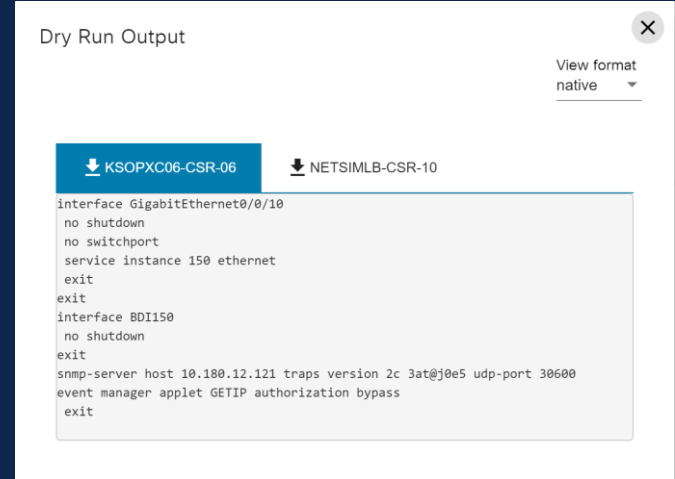
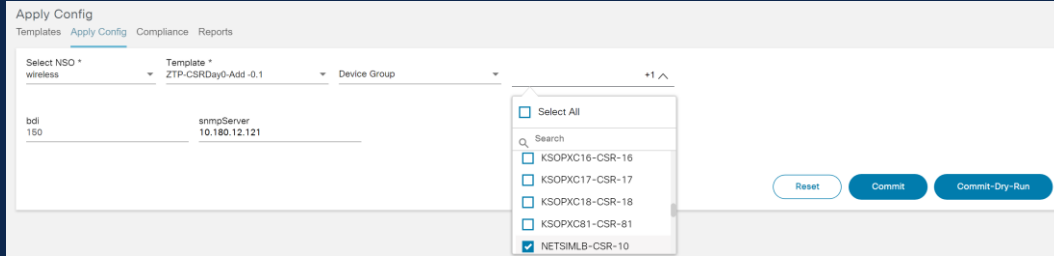
    readStream(prompt_pattern, true, 10000);
    String output = sb.toString();
    sb.setLength(0);
    log.info("command output : " + output);

    sendCommand("exit", out); // Exit configuration edit mode
    sendCommand("", out);

    readPrompt(); // Wait to exit configuration mode

    int commandIndex = output.lastIndexOf(command) + command.length();
    output = output.substring(commandIndex);
    return output.replace("{master}[edit]", "").trim();
}
```

Golden Configuration Templates



<https://bpa-wls-lab.lab.sprint.com/portal/bpa/api/v1.0/golden-config/templates/commit/dry-run?nsolInstance=wireless>



Commit Dry Run

<https://bpa-wls-lab.lab.sprint.com/portal/bpa/api/v1.0/golden-config/templates/commit/apply?nsolInstance=wireless>



Commit

Device Configuration Report

Order Tracking

Services Orders

Order ID: 1304 Service: 2TP Network Vision Order Status: Deleted

Created By: admin Created Date: May 20, 2020, 3:50:28 PM Updated Date: May 20, 2020, 5:24:09 PM

Running Completed Milestones Retry Order History **Configured Devices**

CSV Excel

Device Name	Action
ces-er70-kclab	
ces-er71-kclab	
KSOPXC13-CSR-13	

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Day 0 Day 0.5 Day 1

Dry Run Output

ces-er70-kclab ces-er71-kclab

```
interface TenGigE 0/5/0/2.3141
description TO-WLS-E_KSOPXC061_VIA_Donar_KSOPXC041_CDN
encapsulation dot1q 1809 second-dot1q 3141
service-policy input wls-edge-in
vrf      cdn-infra
ipv4 address 172.20.80.105 255.255.255.248
no shutdown
exit
interface TenGigE 0/5/0/2.3161
description TO-WLS-E_KSOPXC061_VIA_Donar_KSOPXC041_OAM
encapsulation dot1q 1809 second-dot1q 3161
service-policy input wls-edge-in
vrf      sat-exdmz
ipv4 address 172.20.80.113 255.255.255.248
no shutdown
exit
router static
vrf cdn-infra
address-family ipv4 unicast
172.22.2.104/29 Te0/5/0/2.3141 172.20.80.107 bfd fast-detect minimum-interval 200 multiplier 3 tag 100 description AEM_CDN_KSOPXC061_K
172.22.2.112/29 Te0/5/0/2.3141 172.20.80.107 bfd fast-detect minimum-interval 200 multiplier 3 tag 100 description DBA_CDN_KSOPXC061_K
172.22.2.96/29 Te0/5/0/2.3141 172.20.80.107 bfd fast-detect minimum-interval 200 multiplier 3 tag 100 description LTE_CDN_KSOPXC061_KSI
```

Pre / Post Check Execution Report

Process Executions Output X

Day 0 Process Execution

Day 0.5 Process Execution

Day 0.5 Process Execution

The screenshot displays a web browser window with the URL `bpa-wls-lab.sprint.com/portal/#/template/executions/id/5ec5a947ea3d7e003bf9f90`. The page title is "Business Process Automation" and the user is logged in as "Network Architect". The main content area is titled "Executions Output" and contains a table with the following data:

Template Id: ZTPNPreChecksER2	Device Name: ces-er71-klab	Commands Evaluation Result: Fail
show running-config KSOPXC061		Rules Evaluation Result: Pass
show running-config encapsulation dot1q 1810 second-dot1q 1810		Rules Evaluation Result: Pass
show running-config interface Te0/5/0/2.1810		Rules Evaluation Result: Pass
show running-config .1810		Rules Evaluation Result: Pass
show running-config encapsulation dot1q 1810 second-dot1q 162		Rules Evaluation Result: Pass
show running-config interface Te0/5/0/2.142		Rules Evaluation Result: Pass
show version dummy		Rules Evaluation Result: Fail
show version dummy		Rules Evaluation Result: Pass
show running-config 172.20.80.112		Rules Evaluation Result: Pass

Business Outcomes

- Migration of managed devices onto one platform for centralized management
- One dashboard to manage workflows and processes
- Scalable platform with an ability to flex with increased market demands
- Dramatically reduced labor costs due automation of provisioning devices
- Increased speed to value
- Reduce error rate

Bottomline

- \$4M in OpEx Savings with ZTP Automation/ year
- Unified platform for Order Lifecycle management & monitoring
- Exponential reduction in number of maintenance windows
- 10X faster CSR provisioning => 10 per week to 100 CSRs per week

Want to know
more?

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