From Scripting to Intent

From how to what

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Ductus

Objective

- Describe what scripting and intent really are, without resorting to buzzwords
- Give a real-world example, using VLANs
- Define what a service really is, and how that relates to intent
- Show where workflows and templates fit into all of this
- Discuss what source of truth really means
- Show a service model for SDWAN

Scripting vs Intent

- **Scripting** is automation at its simplest level
- A **script** takes in some variables, it runs, and it performs the logic it is coded for
- An **intent** orientated system uses services to describe where you want the system to be, and the system will get itself to that state

Are these things really the same?

- Take variables
- Do stuff
- Return

A little computer science theory

Imperative

- Specify how to do something

Declarative

- Specify what the end state should look like, not how to get there
- Using:
  - Data
  - Models
  - Functions

Real World Application

Let's consider a simple example for managing customer VLANs (Virtual Local Area Networks).

- VLAN = network segmentation technique that divides a physical network into multiple logical networks, allowing devices in separate VLANs to communicate as if they were on different physical networks.
- It enhances network security and performance by isolating broadcast domains, controlling traffic flow, and enabling policy enforcement based on logical groupings rather than physical locations.

Simplified VLAN Service

- Need to construct VLANs that cross multiple devices, each device has one client port
- Each edge device has some number of trunk ports, which are directly connected to other edge devices
- To configure a VLAN, the client port needs to be configured, and the VLAN needs to be added to all necessary trunk ports

A little (applied) computer science theory

Imperative

- Create a VLAN
  - For each edge device
    - Add VLAN to client port
    - Add VLAN to applicable trunk ports
- Document
  - Which devices have which VLANs
  - Which VLANs are in use

Declarative

- State:
  - List of existing VLANs
  - Physical Map of network
- Intent
  - VLAN between ports

Problems, regardless

- What about after the VLAN is created?
- When should assurance checks be run?
- How to ensure we don't end up using the same ID twice?
- How do we know if we got the ports right?

Model it!

- Model a database with:
  - Intended physical network
  - Shared resources
  - Intended VLANs
- Intent:
  - Each VLAN should exist and traffic should be able to flow between all connected ports

Now for the models

Service Model

- vlan
  - id
  - name
  - description
  - devices
    - name
    - client-port

Resource Model

- device
  - ip-address
  - type
  - client ports
  - trunk ports
- network
  - vlans
  - connections
    - device/port a
    - device/port z

VLAN from an API

```
curl -X POST https://api.network-device.com/v1/vlans \
  -H "Content-Type: application/json" \
  -H "Authorization: Bearer YOUR_API_TOKEN" \
  -d '{
  "id": 100,
  "name": "Marketing_VLAN",
  "description": "VLAN for the marketing department",
  "devices": [
    {
      "name": "Switch1",
      "client": "MarketingDept",
      "port": "GigabitEthernet0/1"
    }
```

So far...

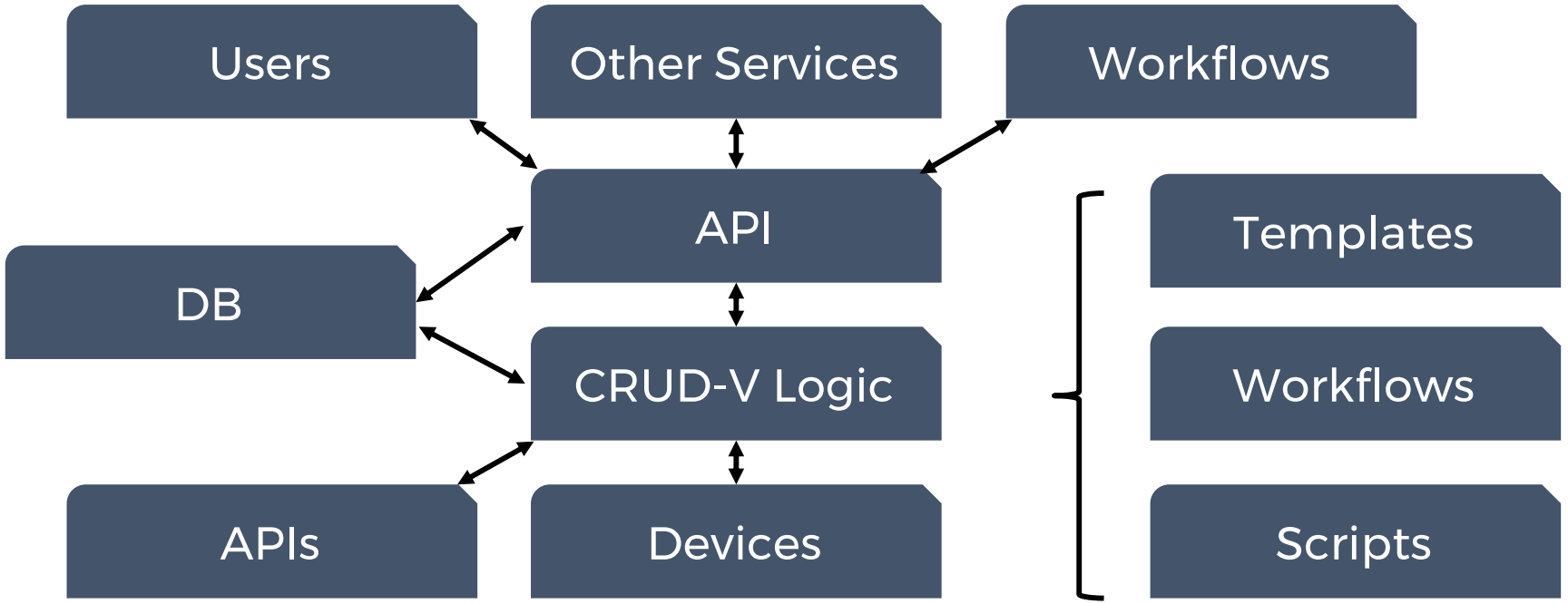
We have learned

- The difference between imperative and declarative
- example model

Now what?

- Generic automation architecture
- Services
- Templates
- Workflows
- Sources of truths
- SDWAN Example

Generic Service Oriented Intent Driven Automation



What is a service?
How does it relate to intent?

- API
- Database
- Hierarchical model
- Service model defines intended state, not process to get there
- Service is a noun, not:
  - CreateVlan service
  - DeviceRemove service

- Instead
  - vlan
  - device
- Services can be treated as resources themselves by other services

Templates

- Fundamentally declarative
  - Write what you want to see in terms of config
- May need a bridge between the declarative template and the device
- At least need some way to effectively run the template and apply its results to a device

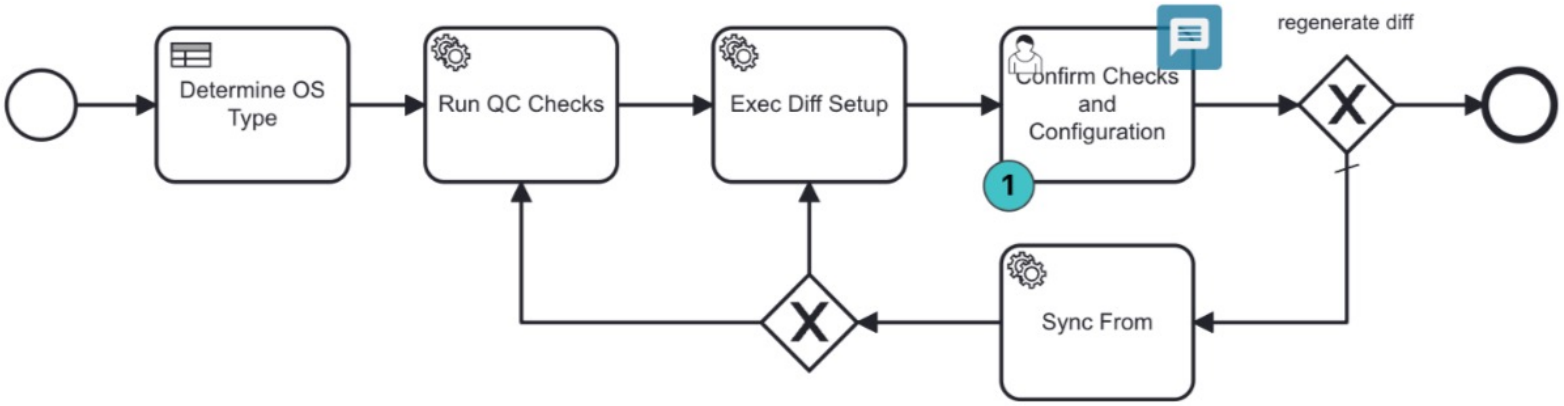
VLAN Template

```
! Create the VLAN
vlan {{ id }}
 name {{ description }}
! Configure interface
interface {{ client_port }}
 description Interface for {{ description }}
 switchport mode access
 switchport access vlan {{ id }}
 no shutdown
!
end
```

Workflows

- Usually imperative, state machine, a verb (CreateVlan workflow)
- We say how to do it, not what is has to be
- Allows you to track and control multi-stage changes
- Can be useful to glue resources together, but is not itself a service
- Could be called by a service, could call services

Workflow example



Sources of Truths

- Physical state of network
  - Intended physical state of network
- Behavior of network
  - Configuration of network
  - Intended configuration of network
  - Intended network services
- History of mapping between all of the above

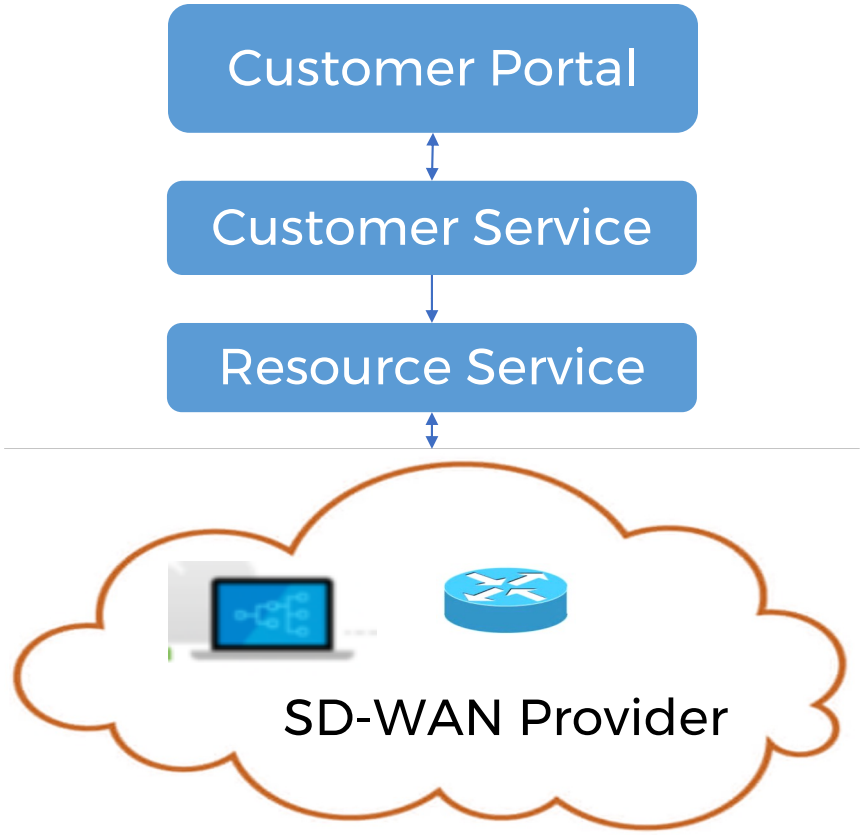
SDWAN

- SDWAN allows multiple customer sites to be connected across disparate links using a single overlay network

SDWAN Service

- A managed SDWAN service
- Want to have some way to provide default and easy to use QOS policies, as well as specific overrides for customer-specific applications
- Let's look at how we can use a service to allow us to show intent

Architecture



Traffic classification and QOS

```
+--rw traffic-classification
|  +--rw policy* [id]
|     +--rw id          string
|     +--rw rule* [id]
|        +--rw id             string
|        +--rw src-ip?        inet:ipv4-prefix
|        +--rw dest-ip?       inet:ipv4-prefix
|        +--rw protocol?      string
|        +--rw src-port?      uint16
|        +--rw dest-port?     uint16
|        +--rw dscp?          uint8
+--rw qos-policies
|  +--rw policy* [id]
|     +--rw id                                  string
|     +--rw qos-class?                          string
|     +--rw bandwidth-percentage?               decimal64
|     +--rw priority?                           uint8
|     +--rw traffic-classification-policy-id?   -> /traffic-classification/policy/id
+--rw qos-profiles
|  +--rw profile* [id]
|     +--rw id          string
|     +--rw name?       string
|     +--rw policy* [policy-id]
|        +--rw policy-id    -> /qos-policies/policy/id
```

Example QOS Profile

```
qos-profiles: {
  profile: [
    {
      id: healthcare-profile,
      name: Healthcare Provider Profile,
      policy: [
        {
          policy-id: ehr-policy
        },
        {
          policy-id: medical-imaging-policy
        },
        {
          policy-id: telemedicine-policy
        }
```

Example QOS Policy

```
qos-policies: {
  policy: [
    {
      id: ehr-policy,
      qos-class: gold,
      bandwidth-percentage: 30.00,
      priority: 7,
      traffic-classification-policy-id: ehr-traffic-classification
    },
```

Example QOS Traffic Classification

```
traffic-classification: {
  policy: [
    {
      id: ehr-traffic-classification,
      rule: [
        {
          id: ehr-rule1,
          protocol: TCP,
          dest-port: 443,
          dscp: 34
        },
        {
          id: ehr-rule2,
          protocol: TCP,
          dest-port: 8443,
          dscp: 34
        }
      ]
    },
    {
      id: medical-imaging-traffic-classification,
      rule: [
```

SDWAN Service


```
+--rw sdwan-service
   +--rw customer* [customer-id]
      +--rw customer-id      string
      +--rw customer-name?   string
      +--rw vpn
      |  +--rw qos
      |  |  +--rw profile?   -> /qos-profiles/profile/id
      |  |  +--rw policy* [id]
      |  |     +--rw id                          string
      |  |     +--rw policy-id?                  -> /qos-policies/policy/id
      |  |     +--rw traffic-classification
      |  |        +--rw rule* [id]
      |  |           +--rw id           string
      |  |           +--rw src-ip?      inet:ipv4-prefix
      |  |           +--rw dest-ip?     inet:ipv4-prefix
      |  |           +--rw protocol?    string
      |  |           +--rw src-port?    uint16
      |  |           +--rw dest-port?   uint16
      |  |           +--rw dscp?        uint8
      |  +--rw site* [site-id]
      |     +--rw site-id       string
      |     +--rw site-name?    string
      |     +--rw ip-address?   inet:ipv4-address
      |     +--rw transport
      |     |  +--rw link* [link-id]
      |     |     +--rw link-id      string
      |     |     +--rw type?        enumeration
      |     |     +--rw latency?     decimal64
      |     |     +--rw bandwidth?   uint32
      |     |     +--rw jitter?      decimal64
```

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Adding QOS Profile to a Customer

```
sdwan-service: {
  customer: [
    {
      customer-id: customer1,
      customer-name: Healthcare Inc.,
      vpn: {
        qos: {
          profile: healthcare-profile,
          policy: [
            {
              id: additional-policy1,
              policy-id: critical-apps-policy,
              traffic-classification: {
                rule: [
                  {
                    id: ca-rule3,
                    protocol: TCP,
                    dest-port: 8080,
                    dscp: 46
                  }
                ]
              }
            },
            {
              id: additional-policy2,
```

Now what?

- Provide NETCONF or gNMIc interface based on model
- Create a webui and allow customers to manage their own settings based on the model
- Add telemetry support to model to enable customer-visible graphs of performance
- Integrate billing

So what?

- Customer wants to change, they can change their connections in minutes, not days waiting for change-request
- Customer can easily see what services they have
- Provider knows what the intent of their customers is, can connect that intent to reality (telemetry), and plan for capacity improvements
- Reduced risk for human error

Final Summary

- Scripting and intent are not in conflict, but they are not the same
- Imperative says how, declarative says what
- Resource hiding is the key to scalability

Q&A

- In what areas of network management do you see potential advantages of adopting an intent-driven approach?
- What hurdles or complexities might we anticipate when transitioning to an intent-driven automation model?
- What factors would influence your decision to move towards or away from an intent-driven automation strategy?

Thank you

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