

The background features a vibrant, abstract design with a color gradient from dark blue on the left to bright yellow and white on the right. The design consists of overlapping, wavy horizontal bands and a series of radiating lines that create a sense of motion and energy, resembling a stylized sunburst or a dynamic wave pattern.

CISCO *Live!*

Let's go



The bridge to possible

WebSockets and Webhooks

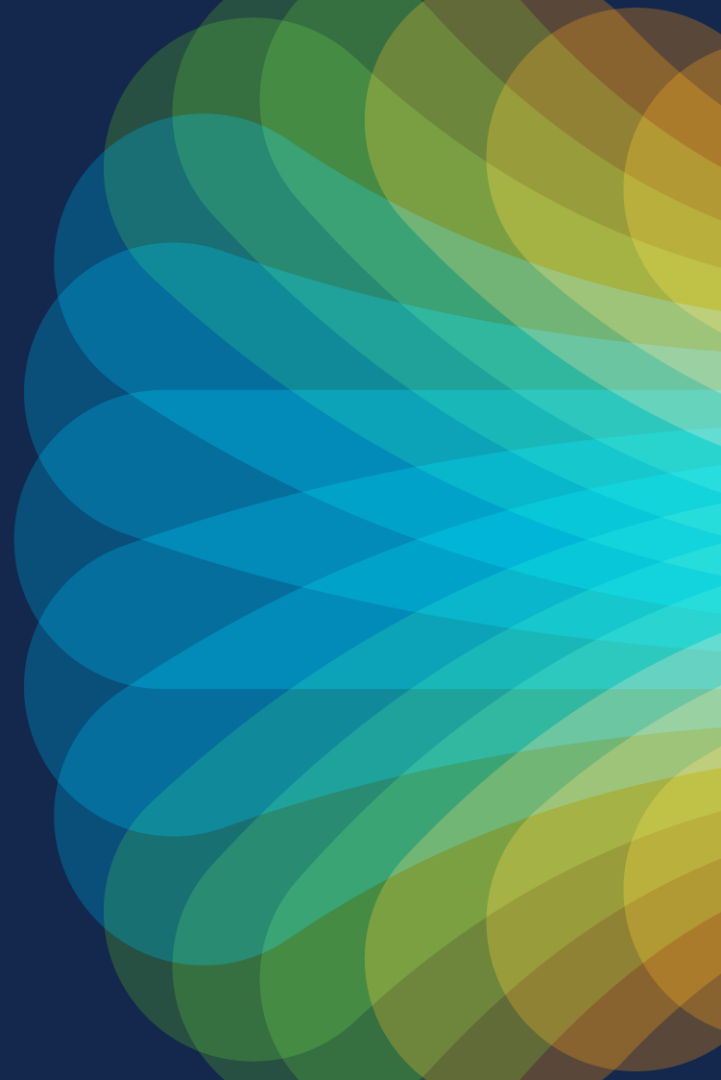
Embed network intelligence into your applications

Adrian ILIESIU, Senior Technical Leader
@aidevnet

Agenda

- WebSockets
 - Demo
- Webhooks
 - Demo
- Conclusion
- Resources

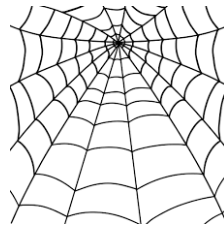
WebSockets



What is a WebSocket?

- **Communication protocol** used to send/receive data on the Internet (RFC6455)
- Like HTTP but much better and more efficient (TCP ports 80 & 443)
- Persistent **2-way** connection between client <--> server
- Easy to build **real-time** applications:

- Online games
- Financial trading
- Collaboration apps
- **Notifications**
- Chat



+



= ?

HTTP

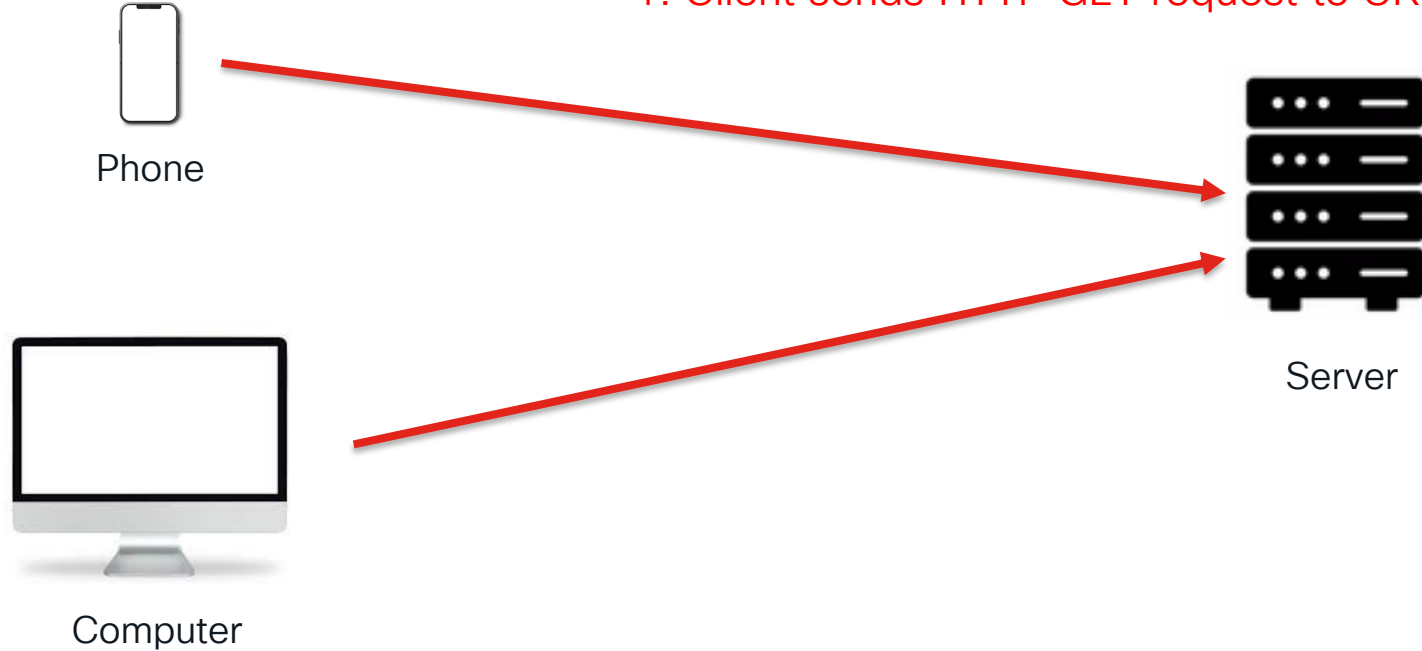
- Half-duplex (like walkie-talkie)
 - Traffic flows in 1 direction at a time
 - Connection closes after 1 request/response
 - Large headers (1000s of bytes)
 - 150ms to establish new TCP connection for each HTTP message
 - Polling overhead
1. Request from client to server
 2. Response from server to client

WebSocket

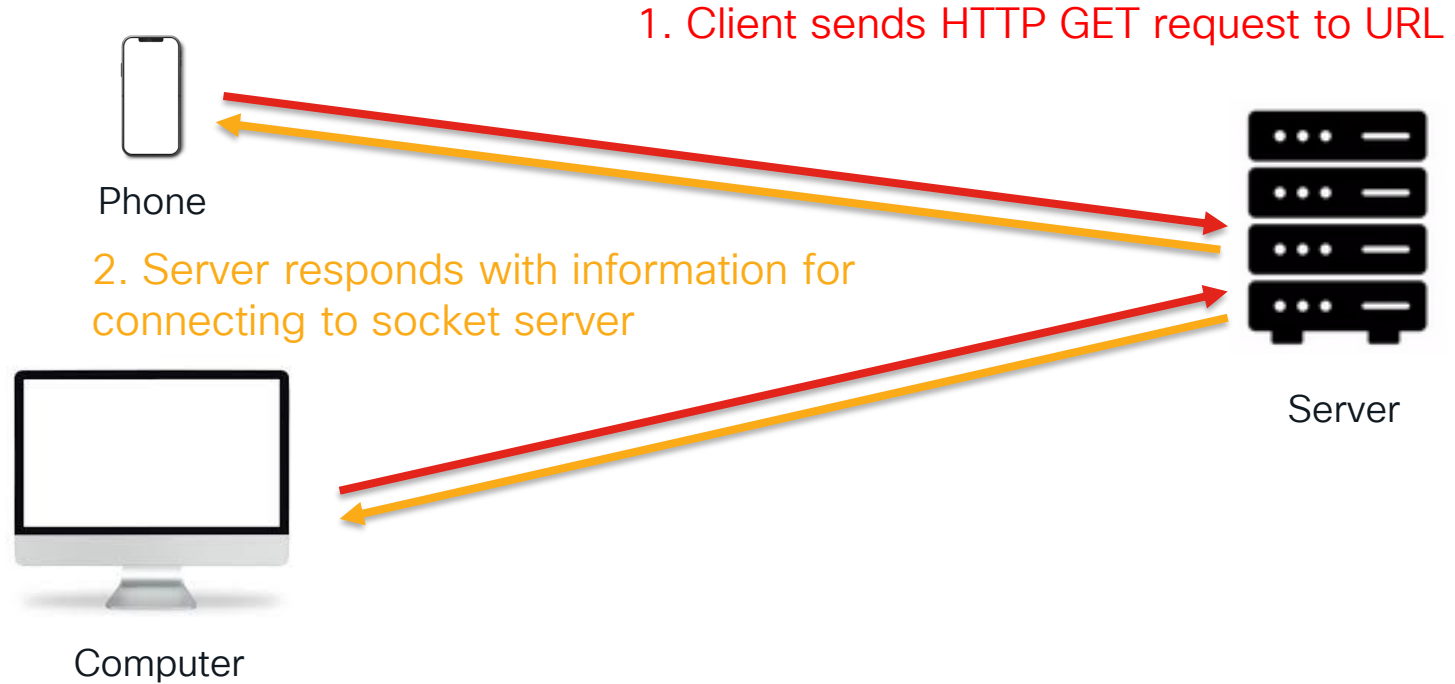
- Full-duplex (like phone)
- Bi-directional traffic flow
- Connection stays open
- Uses “frames” (2 bytes)
- 50ms for message transmission
- No polling overhead
- Both client and server are simultaneously “transmitting” and “listening”

How do WebSockets work?

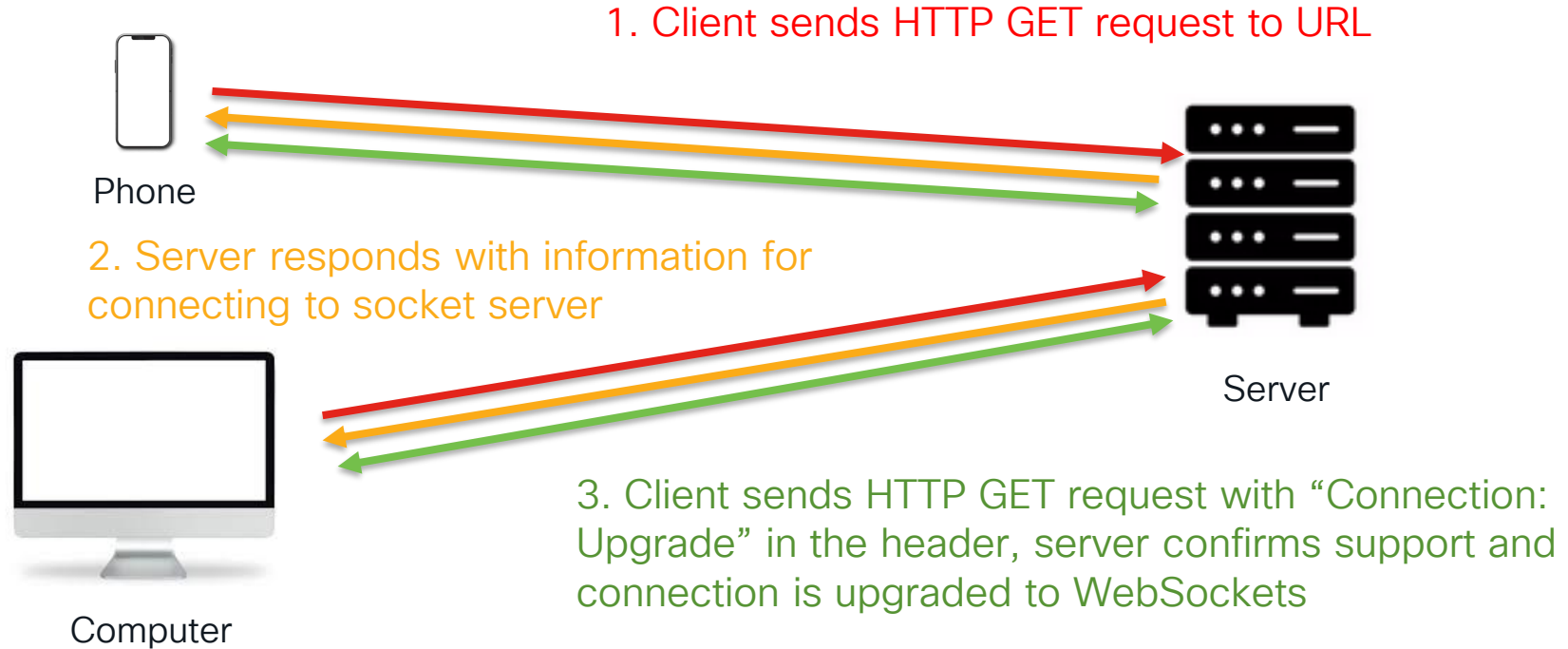
1. Client sends HTTP GET request to URL



How do WebSockets work?



How do WebSockets work?



The handshake

- Client sends:

--- request header ---

```
GET
/socketW2OM/Potf4WGMUt/vFMgQ7w6EUOCBonqeYK2jFvCP
DKF5LFcu5ea6v/WcccAuRbm+qKhjvEvwu/ukymvGul96GOHZ1f
Fr6Sce041cuChZCfz0JXog5y9iUKlofi84UswURGylKaw2fhedCJ
fj461cX/BhsHypvqM1AivQA1gwRg= HTTP/1.1
```

Upgrade: websocket

Host: 10.10.10.177

Origin: https://10.10.10.177

Sec-WebSocket-Key: FtK1+TbzPV4dHiuPQW+Z/Q==

Sec-WebSocket-Version: 13

Connection: Upgrade

- Server responds:

--- response header ---

HTTP/1.1 101 Switching Protocols

Server: nginx/1.7.10

Date: Sat, 14 Jan 2023 05:55:11 GMT

Connection: upgrade

Sec-WebSocket-Accept: FzXeL1fziR8iOHfBd2szRy7SKZ0=

Upgrade: websocket

Strict-Transport-Security: max-age=31536000;
includeSubDomains

X-Frame-Options: SAMEORIGIN

Content-Security-Policy: block-all-mixed-content; base-uri
'self'; default-src 'self'; script-src 'self' 'nonce-
xxUytQEYI3o8U8bZX6PRnfwdh1c139fQ'; style-src 'self' 'nonce-
xxUytQEYI3o8U8bZX6PRnfwdh1c139fQ'; img-src 'self';
connect-src 'self'; font-src 'self'; object-src 'self'; media-src
'self'; form-action 'self'; frame-ancestors 'self';

Advantages and disadvantages

- Advantages:
 - Great for real-time applications
 - Low latency
 - Low overhead
 - Less traffic
- Disadvantages:
 - Not good for retrieving old historical data
 - Not largely implemented for network monitoring
 - Varied support in Internet browsers

Cisco Open NX-OS – Login function

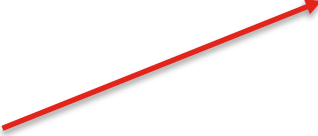
```
def nxosLogin():
```

```
    response = requests.post(  
        'https://' + config['nxos_login']['address'] + '/api/aaaLogin.json',  
        headers = {'Content-Type': 'application/json'},  
        data = json.dumps(nxosLoginTemplate),  
        verify = False  
    )
```

```
    responseDict = json.loads(response.text)  
    token = responseDict['imdata'][0]['aaaLogin']['attributes']['token']
```

```
    message = "NXOS Login successful."  
    writeLog(message)
```

```
    return token
```



```
nxos_login:  
    address: "10.10.10.177"  
    username: "admin"  
    password: "admin"
```

Cisco Open NX-OS – Login function (cont.)

```
def nxosLogin():
```

```
    response = requests.post(  
        'https://' + config['nxos_login']['address'] + '/api/aaaLogin.json',  
        headers = {'Content-Type': 'application/json'},  
        data = json.dumps(nxosLoginTemplate),  
        verify = False  
    )
```

```
    responseDict = json.loads(response.text)  
    token = responseDict['imdata'][0]['aaaLogin']['attributes']['token']
```

```
    message = "NXOS Login successful."  
    writeLog(message)
```

```
    return token
```



```
{  
    "aaaUser" : {  
        "attributes" : {  
            "name" : "admin",  
            "pwd" : "admin"  
        }  
    }  
}
```

Cisco Open NX-OS – Login function (cont.)

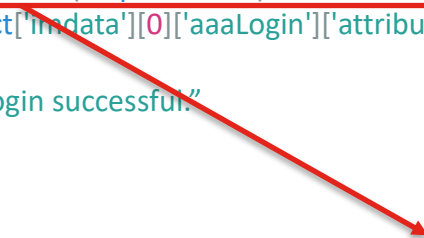
```
def nxosLogin():
```

```
    response = requests.post(
        'https://' + config['nxos_login']['address'] + '/api/aaaLogin.json',
        headers = {'Content-Type': 'application/json'},
        data = json.dumps(nxosLoginTemplate),
        verify = False
    )
```

```
    responseDict = json.loads(response.text)
    token = responseDict['imdata'][0]['aaaLogin']['attributes']['token']
```

```
    message = "NXOS Login successful."
    writeLog(message)
```

```
    return token
```



```
{
  "imdata": [
    {
      "aaaLogin": {
        "attributes": {
          "token": "RPLUpnB3atz8LUsj6yOMYZDZ6XrEI58kO45...=",
          "siteFingerprint": "",
          "refreshTimeoutSeconds": "600",
          "guildleTimeoutSeconds": "1200",
          "restTimeoutSeconds": "300",
          "creationTime": "1674424630",
          ...
        }
      }
    }
  ]
}
```

Cisco Open NX-OS – Subscribe function

```
def subscribe(loginToken):  
    subIds = []
```

```
    for sub in config['monitored_objects']:  
        response = requests.get(  
            "https://" + config['nxos_login']['address'] + sub + ".json?subscription=yes",  
            headers = {'Cookie': "APIC-cookie=" + loginToken},  
            verify = False  
        )  
        subIds.append(json.loads(response.text)['subscriptionId'])
```

```
    message = "Subscription successful. Subscription IDs:\n"  
    for subid in subIds:  
        message = message + subid + "\n"  
    writeLog(message)
```

monitored_objects:

- /api/mo/sys/intf/phys-[eth1/3]
- /api/mo/sys/intf/phys-[eth1/11]
- /api/node/mo/sys/bd/bd-[vlan-101]

Cisco Open NX-OS – Subscribe function (cont.)

```
def subscribe(loginToken):  
    subIds = []  
  
    for sub in config['monitored_objects']:  
        response = requests.get(  
            "https://" + config['nxos_login']['address'] + sub + ".json?subscription=yes",  
            headers = {'Cookie': "APIC-cookie=" + loginToken},  
            verify = False  
        )  
        subIds.append(json.loads(response.text)['subscriptionId'])  
  
    message = "Subscription successful. Subscription IDs:\n"  
    for subid in subIds:  
        message = message + subid + "\n"  
    writeLog(message)
```

Cisco Open NX-OS – Refresh function

```
def refresh():
    while True:
        time.sleep(55)

        with open(pathSubscriptionIds, "r") as handle:
            subscriptionIds = json.load(handle)

        loginToken = nxosLogin()

        message = "Subscription Refresh successful. Refreshed subscription IDs: \n"
        for sub in subscriptionIds:
            response = requests.get(
                "https://" + config['nxos_login']['address'] + "/api/subscriptionRefresh.json?id=" + sub,
                headers = {'Cookie': "APIC-cookie=" + loginToken},
                verify = False
            )
            print(response.text)
            if not json.loads(response.text)['imdata']:
                message = message + sub + "; "
            else:
                message = message + "Subscription " + sub + " could not be refreshed.\n"

        writeLog(message)
```

Cisco Open NX-OS – Main function

```
import websocket
import threading
import ssl
import os
```

```
if __name__ == "__main__":
    loginToken = nxosLogin()
```

```
    refreshThread = threading.Thread(target=refresh)
    refreshThread.start()
```

```
    websocket.enableTrace(True)
```

```
    ws = websocket.WebSocketApp("wss://" + config['nxos_login']['address'] + "/socket" + loginToken,
```

```
                                on_message = on_message,
                                on_error = on_error,
                                on_close = on_close,
                                on_open = on_open)
```

```
    ws.run_forever(sslopt={"cert_reqs": ssl.CERT_NONE})
```

```
def on_message(ws, message):
    outputToFile(message)
```

```
def on_error(ws, error):
    writeLog(error)
```

```
def on_open(ws):
    subscribe(loginToken)
```

```
def on_close(ws):
    os.remove(pathSubscriptionIds)
    message = "Socket was closed."
    writeLog(message)
```

Cisco Open NX-OS – Subscription output

```
{
  "subscriptionId": ["18374686505424650242"],
  "imdata": [{
    "l1PhysIf": {
      "attributes": {
        "adminSt": "up",
        "childAction": "",
        "dn": "sys/intf/phys-[eth1/11]",
        "modTs": "2023-01-22T06:04:36.208+00:00",
        "rn": "",
        "status": "modified"
      }
    }
  ]
}

{
  "subscriptionId": ["18374686505424650243"],
  "imdata": [{
    "l2BD": {
      "attributes": {
        "childAction": "",
        "dn": "sys/bd/bd-[vlan-101]",
        "operSt": "up",
        "rn": "",
        "status": "modified"
      }
    }
  ]
}
```

Webhooks

What is a Webhook?

- Webhooks are **automated messages** sent from apps when something happens
- Message is sent to a **preconfigured URL** when an event gets triggered
- **Faster and less resource intensive** than polling
- Like SMS notifications
- Used for:
 - Sending small amounts of data
 - Trigger automation workflows



How do Webhooks work?

Consumer

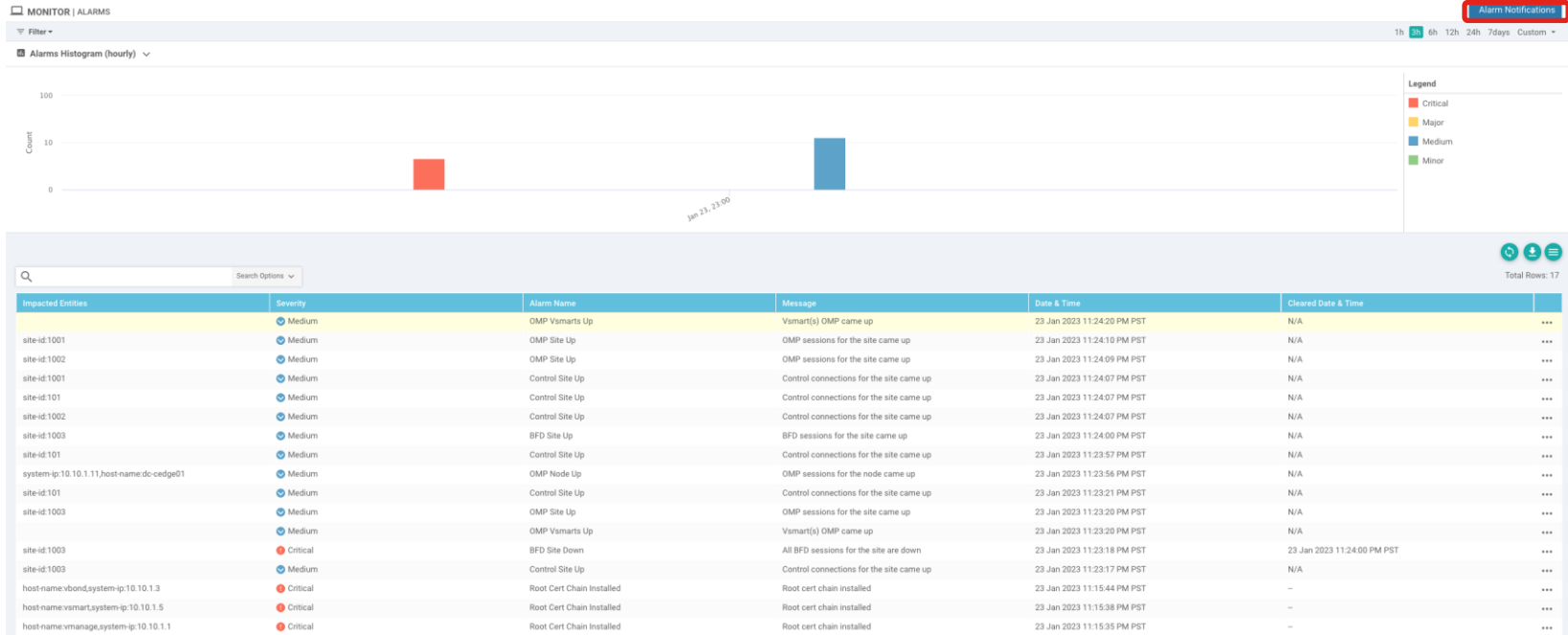


Provider



Webhook configuration for Cisco SD-WAN

- Step 1: Select “Alarm Notifications” from “Monitor -> Alarms”



Webhook configuration for Cisco SD-WAN (cont.)

Step 2:

- Enter a name for the webhook
- Select severity level (all, critical, major, medium, minor)
- Select alarm name (disk usage, process restart, etc.)
- Enable WebHook checkbox
- Provide the WebHook URL, username and password
- Select devices (all, custom)

MONITOR Alarms > Alarm Notifications

Name Webhook_notifications

Alarm Severity ▾

Severity

Critical × Major ×

Alarm Name

Interface Admin State Change × Interface State Change ×

Account Details ▾

☐ Email(Max: 10)

Email Threshold (Maximum emails sent in a minute) 5

☒ WebHook

WebHook URL

http://10.10.20.50:5001

Username

admin

Password

WebHook Threshold 100

Select Devices ▾

Add Cancel

Webhook configuration for Cisco SD-WAN (cont.)

Step 3:

- Enable “Alarm Notifications” under the Administration Settings

ADMINISTRATION | SETTINGS

Organization Name	DevNet Sandbox	View
vBond	10.10.20.80 : 12346	View Edit
Alarm Notifications	Disabled	
Enable Alarm Notifications: ☒ Enabled ☐ Disabled		
☐ Email Settings		
Save Cancel		
Hardware WAN Edge Certificate Authorization	Onbox	View Edit
Controller Certificate Authorization	Enterprise	View Edit
WAN Edge Cloud Certificate Authorization	Automated	View Edit
Web Server Certificate	18 May 2025 5:01:37 PM	CSR Certificate
Enterprise Feature Certificate Authorization		View Edit
Enforce Software Version (ZTP)		View Edit
Banner	Disabled	View Edit
Reverse Proxy	Disabled	View Edit
Statistics Setting		View Edit
Cloud onRamp for SaaS	Disabled	View Edit
Manage Encrypted Password	Disabled	View Edit
Cloud Services	Disabled	View Edit
SD-AVC Cloud Connector	Disabled	View Edit

Webhook configuration for Cisco SD-WAN (cont.)

- Step 4: Verify list of webhooks under “Alarms -> Alarm Notifications”

MONITOR Alarms > Alarm Notifications

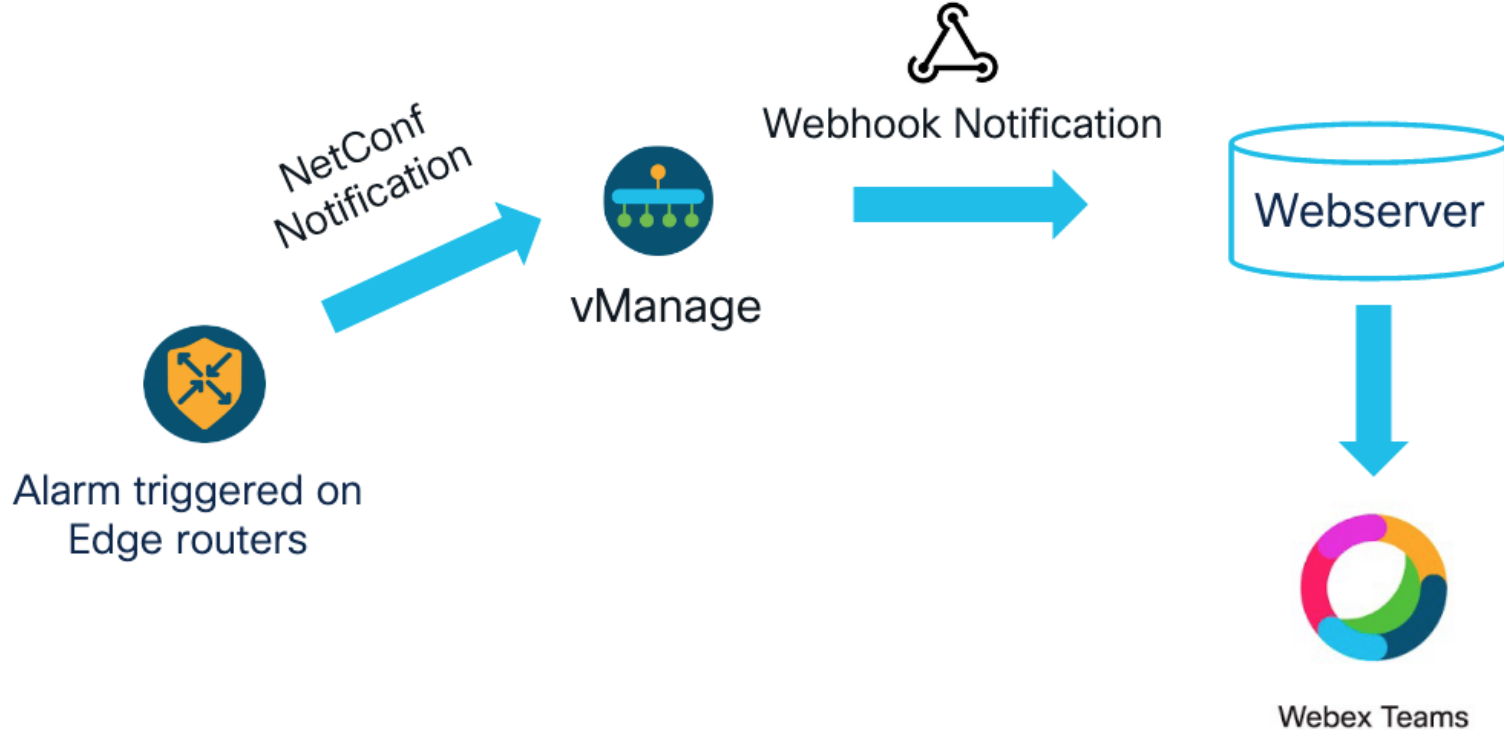
+ Add Alarm Notification

Search Options

Total Rows: 1

Notification Rule Name	Severity	Alarm Name	Devices Attached	Account Details	Updated By	Last Updated	Webhook URL	Webhook URL Execution Username	Action
Webhook_notifications	Critical, Major	Interface_Admin_...	7	--	admin	24 Jan 2023 12:1...	http://10.10.20.5...	admin	  

Webhook notifications flow



Sample alert

```
{
  "entry_time": 1557638912000,
  "severity": "Medium",
  "rule_name_display": "Interface_State_Change",
  "severity_number": 3,
  "component": "VPN",
  "values_short_display": [
    {
      "if-name": "GigabitEthernet4",
      "host-name": "BR2-CSR1000v",
      "system-ip": "1.1.1.6",
      "new-state": "up"
    }
  ],
  "devices": [
    {
      "system-ip": "1.1.1.6"
    }
  ],
  "eventname": "interface-state-change",
  "receive_time": 1557638912888,
  "statcycletime": 1557638912000,
  "values": [
    ...
```

```
...
    "values": [
      {
        "if-name": "GigabitEthernet4",
        "vpn-id": "10",
        "host-name": "BR2-CSR1000v",
        "system-ip": "1.1.1.6",
        "new-state": "up"
      }
    ],
    "cleared_events": [
      "8459e3a0-5bea-4370-ab57-6f45f8022d66"
    ],
    "rulename": "interface-state-change",
    "active": false,
    "message": "The interface oper-state changed to up",
    "type": "interface-state-change",
    "acknowledged": false,
    "uuid": "7a514a95-7c24-4348-b7e9-8d6775a3bc36"
  ]
}
```

Setup webhook receiver server

```
from flask import Flask, request, jsonify
from webxteamssdk import WebexTeamsAPI
import json
import os
import datetime
import pytz
```

```
bearer_token = os.environ.get("bearer_token")
room_id = os.environ.get("room_id")
```

```
app = Flask(__name__)
```

```
@app.route('/', methods=['POST'])
def alarms():
```

```
    try:
```

```
        PDT = pytz.timezone('America/Los_Angeles')
```

```
        data = json.loads(request.data)
```

```
        message = f"Team, Alarm event : ***{data['rule_name_display']}*** is received  
vManage and here are the complete details <br><br>"
```

```
{
  "entry_time": 1557638912000,
  "severity": "Medium",
  "rule_name_display": "Interface_State_Change",
  "severity_number": 3,
  "component": "VPN",
  "values_short_display": [
    {
      "if-name": "GigabitEthernet4",
      "host-name": "BR2-CSR1000v",
      "system-ip": "1.1.1.6",
      "new-state": "up"
    }
  ],
  "devices": [
    {
      "system-ip": "1.1.1.6"
    }
  ],
  ...
}
```

from

Setup webhook receiver server (cont.)

```
temp_time = datetime.datetime.utcfromtimestamp(data['entry_time']/1000.)
temp_time = pytz.UTC.localize(temp_time)
message = message + '**Alarm Date & Time:** ' +
temp_time.astimezone(PDT).strftime('%c') + ' PDT'
temp = data['values_short_display']
for item in temp:
    for key, value in item.items():
        message = message + '<br> **' + key + ':** ' + value

message = message + '<br> **' + 'Details:' + '** ' +
"https://test.sdwanlab.com/#/app/monitor/alarms/details/" + data['uuid']

api = WebexTeamsAPI(access_token=bearer_token)
res=api.messages.create(roomId=room_id, markdown=message)

except Exception as exc:
    print(exc)
    return jsonify(str(exc)), 500
return jsonify("Message sent to Webex Teams"), 200

if __name__ == '__main__':
    app.run(host='0.0.0.0', port=5001, debug=True)
```

Webex Teams message



You 10:05 PM

Team, Alarm event : **Interface_State_Change** is received from vManage and here are the complete details

Alarm Date & Time: Sat May 11 22:28:32 2019 PDT

if-name: GigabitEthernet4

host-name: BR2-CSR1000v

system-ip: 1.1.1.6

new-state: up

Details: <https://test.sdwanlab.com/#/app/monitor/alarms/details/7a514a95-7c24-4348-b7e9-8d6775a3bc36>

Conclusions

- WebSockets and Webhooks are popular web technologies
- Websockets supported by: Cisco Open NX-OS, Cisco ACI, Cisco ISE, Webex Teams
- Webhooks supported by: Cisco SD-WAN, Meraki, Cisco DNA Center, ThousandEyes, Webex Teams, Cisco Intersight, Cisco SecureX
- Easy to integrate JSON formatted status and alert information received over websockets and webhooks
- Embed this information into applications to make them aware of infrastructure status in real-time

Resources

- <https://developer.cisco.com/codeexchange>
- <https://developer.cisco.com/docs/nx-os/#!cisco-nx-api-websocket-notifications>
- <https://developer.cisco.com/learning/labs/sd-wan-webhooks/getting-started-with-webhooks-on-cisco-sd-wan/>
- <https://github.com/aidevnet/Websockets-Webhooks>



The bridge to possible

Thank you

CISCO *Live!*

The background features a vibrant, abstract design with a color gradient from dark blue on the left to bright yellow and white on the right. The design consists of overlapping, wavy horizontal bands and a radial pattern of lines emanating from a bright white point on the right side, creating a sense of motion and energy.

cisco *Live!*

Let's go