Network Programmability using Python

Борисенко Олексій
Cisco DevNet developer advocate
16.03.2019

Про мене

Emacs vs Vim
Tabs vs spaces

Information-Era Network		Digital-Ready Network
From Manual, Rigid, Device-Centric to	>	Automated, Flexible, Networkwide
Closed and Hardware-Centric		Open, Programmable, Software-Driven
Manual Box-by-Box Management		Networkwide, Policy-Based Automation
Perimeter-Based Reactive Security		Proactive, Context-Based Security Everywhere
IT and Historical Analytics		Business and Real-Time Analytics

Нагороди за активну участь

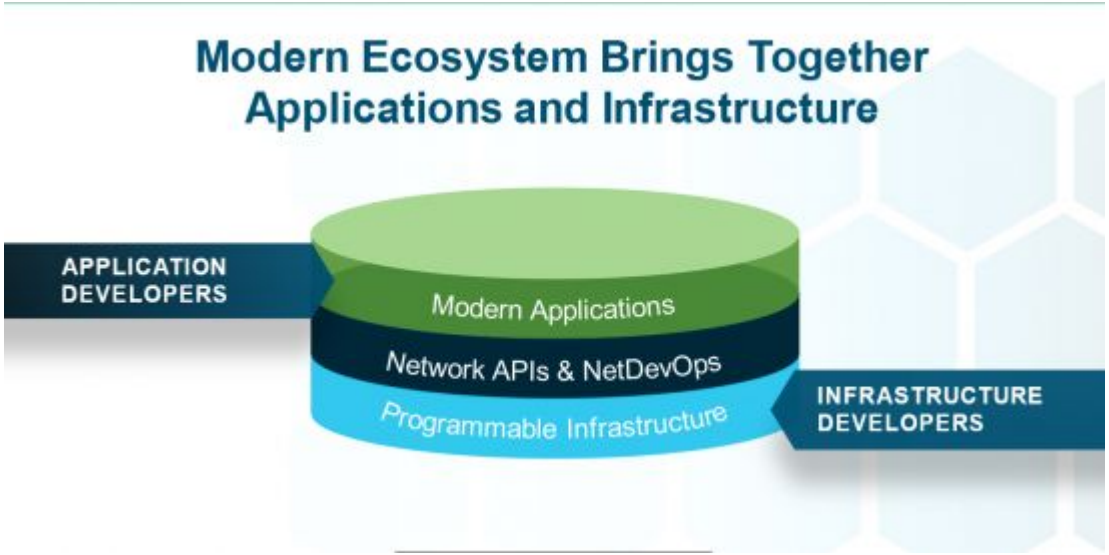
Що таке мережа?

Людина, Сім’я, Місто, Країна, Світ…
PAN, LAN, MAN, WAN, INTERNET…

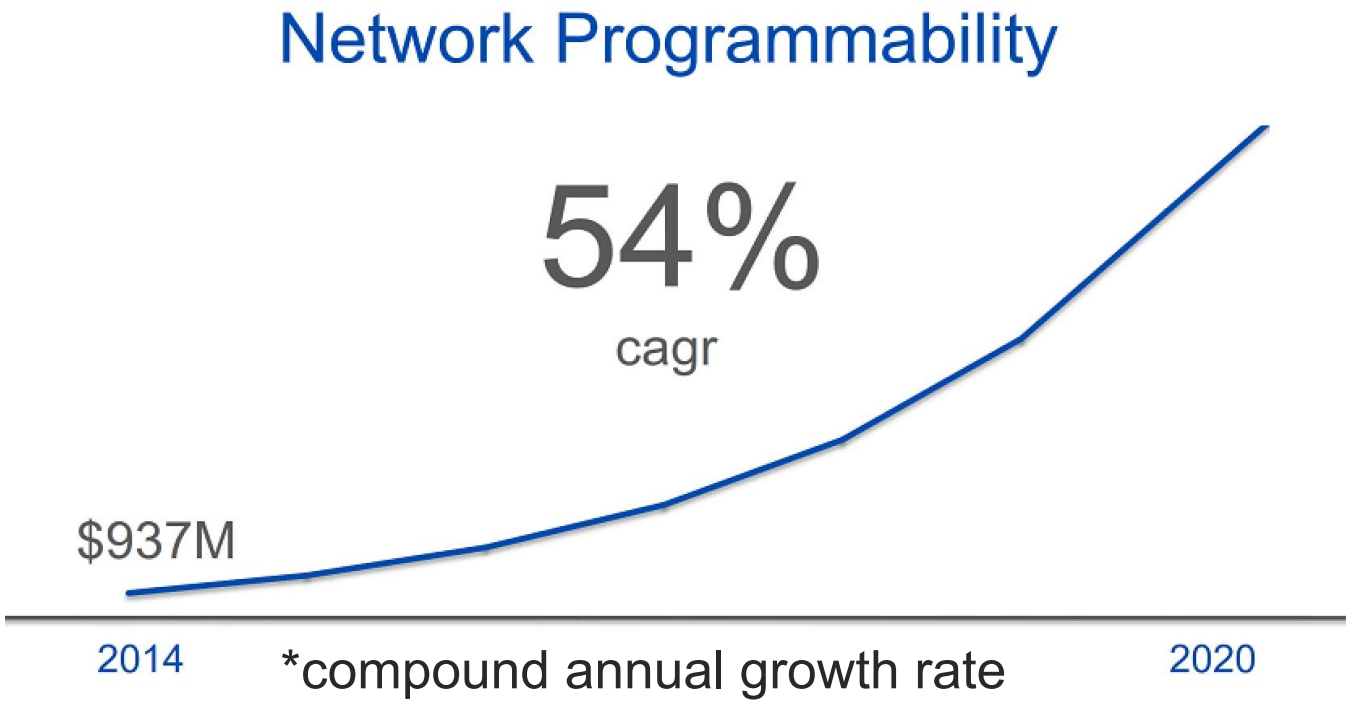
Personal Area Network
Local Area Network
Metropolitan Area Network
Wide Area Network

Virtual Private Network

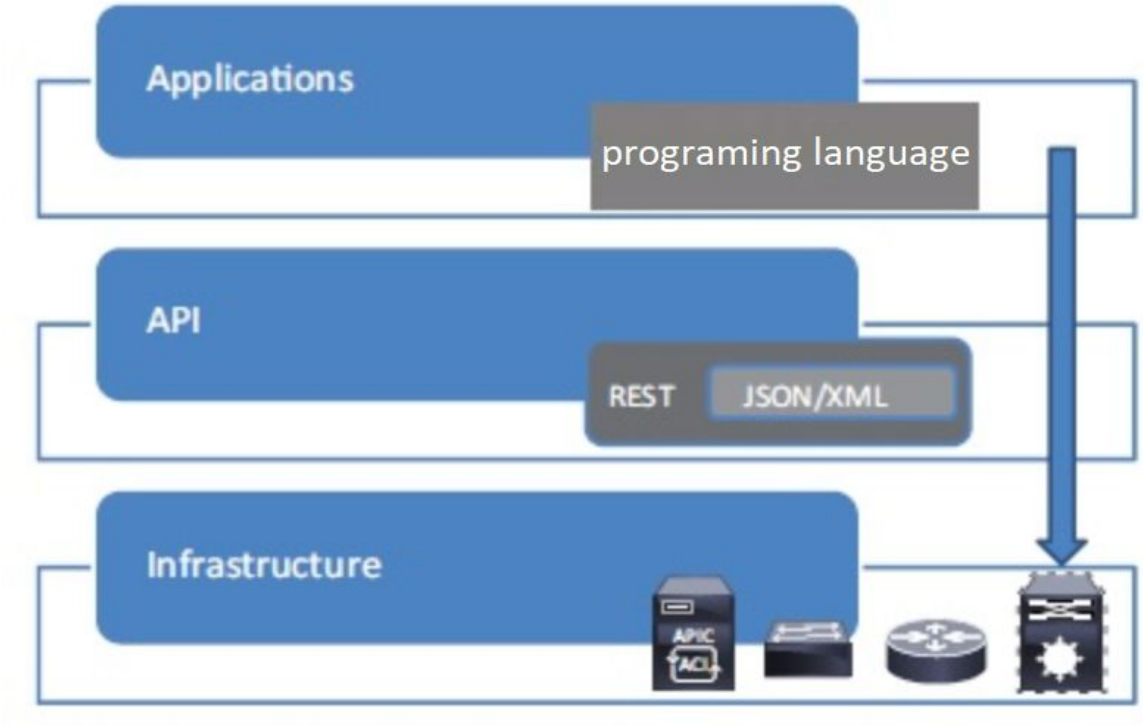
Application / Infrastructure



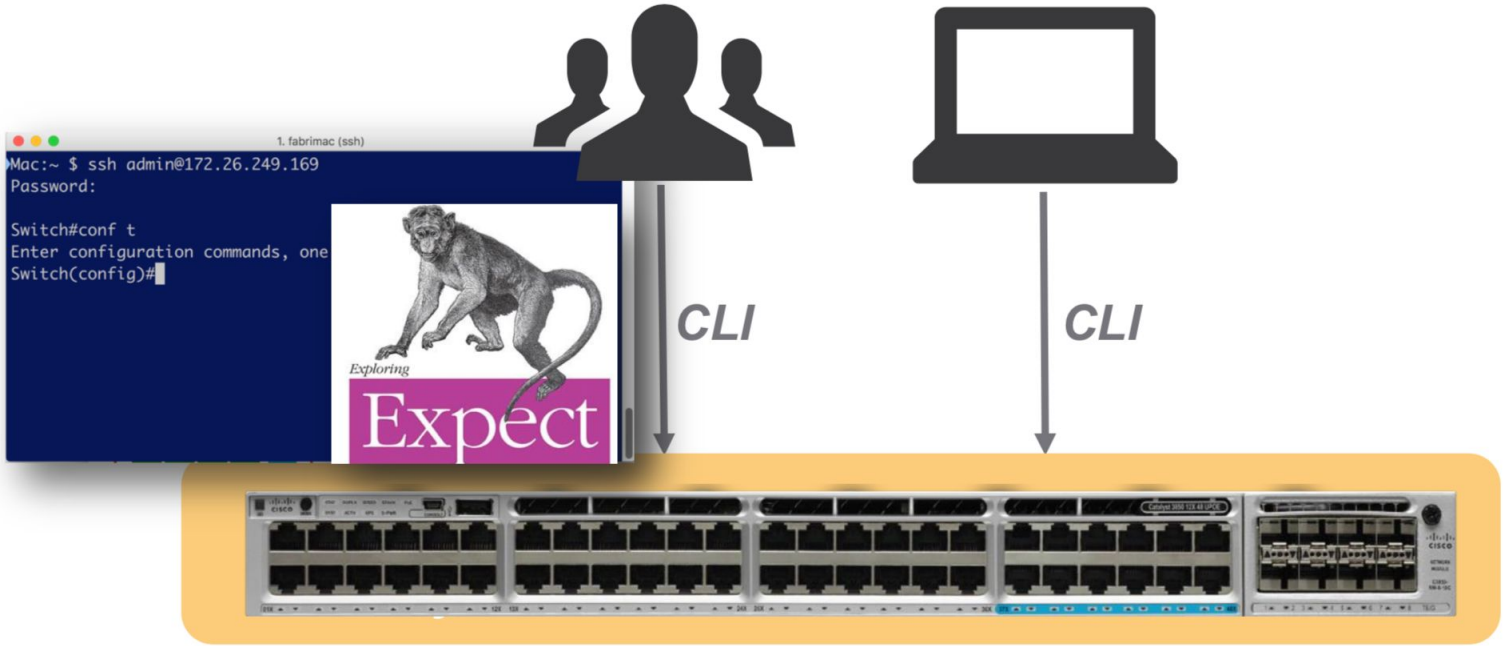
What is Network Programmability?



Network Programmability

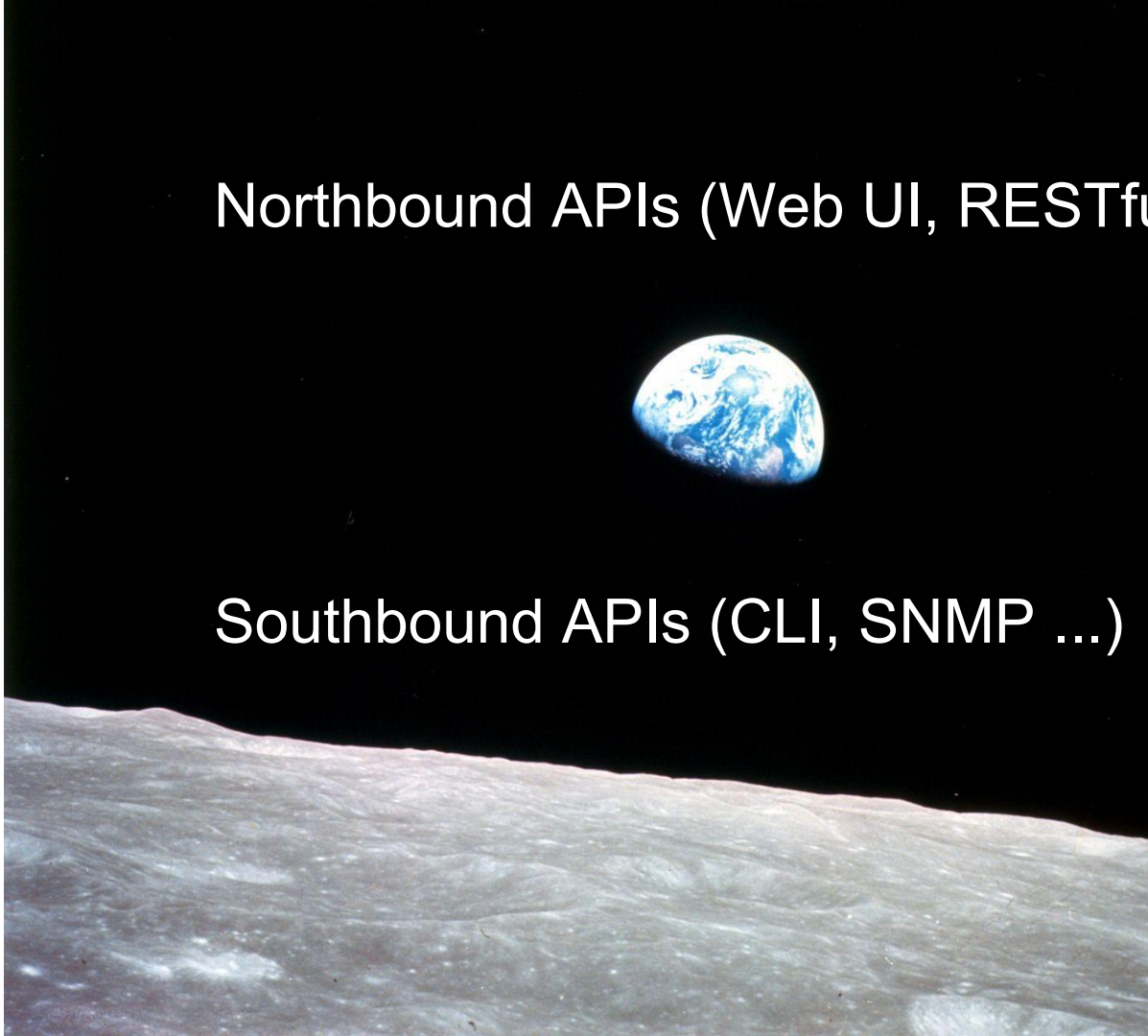


Управління конфігурацією сьогодні



PYCON ODESSA

Available APIs



Управління конфігурацією сьогодні

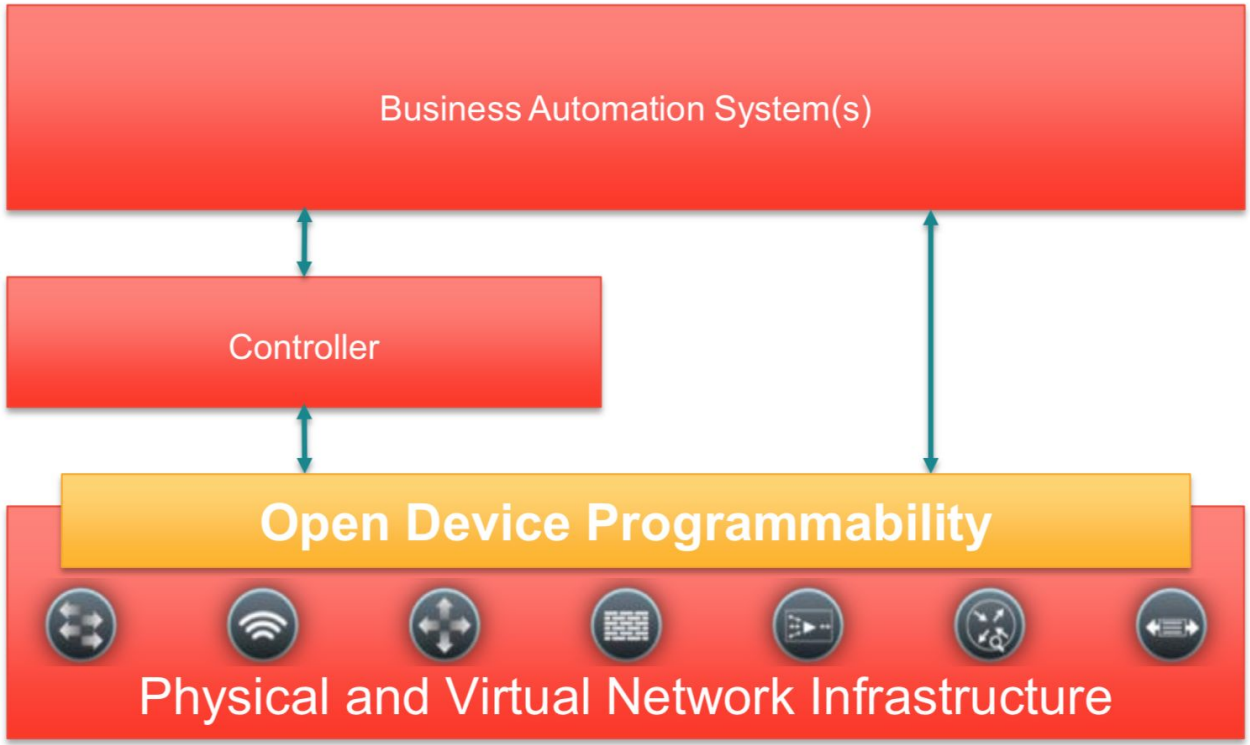
APIs can have various **Properties**

- **Transport** (SSH, HTTP)
- **Encoding** (XML, JSON, ProtoBuffer)
- **Data structure** (Data Models)

Python for the Enterprise

PYCON ODESSA

Python for the Enterprise



Python for the Enterprise

- Use OpenConfig model for configuration and operational state data, and perform NETCONF actions.
- Use NETCONF to communicate with the routers to get, manipulate and delete configurations in a network.
- Model-Driven configuration and operation of Multi-Vendor or Multi-OS routers across the network.

NETCONF

NETwork CONFiguration protocol

- IETF Standard [rfc6241, rfc 6242]
  - Transaction based
  - Configure, manipulate & delete the config. [get-config, edit-config & delete-config]
  - Query Operational data [get]
- Operations are realized on top of RPC [remote procedure calls]
  - Uses XML data encoding

Source :
https://www.cisco.com/c/en/us/td/docs/iosxr/ncs5500/programmability/63x/b-programmability-cg-ncs5500-63x/b-programmability-cg-ncs5500-63x_chapter_011.html

```
|  +--Get-config
|  +--Edit-Config
|     +--Merge
|     +--Replace
|     +--Create
|     +--Delete
|     +--Remove
|     +--Default-Operations
|        +--Merge
|        +--Replace
|        +--None
|  +--Get
|  +--Lock
|  +--UnLock
|  +--Close-Session
|  +--Kill-Session
```

YANG

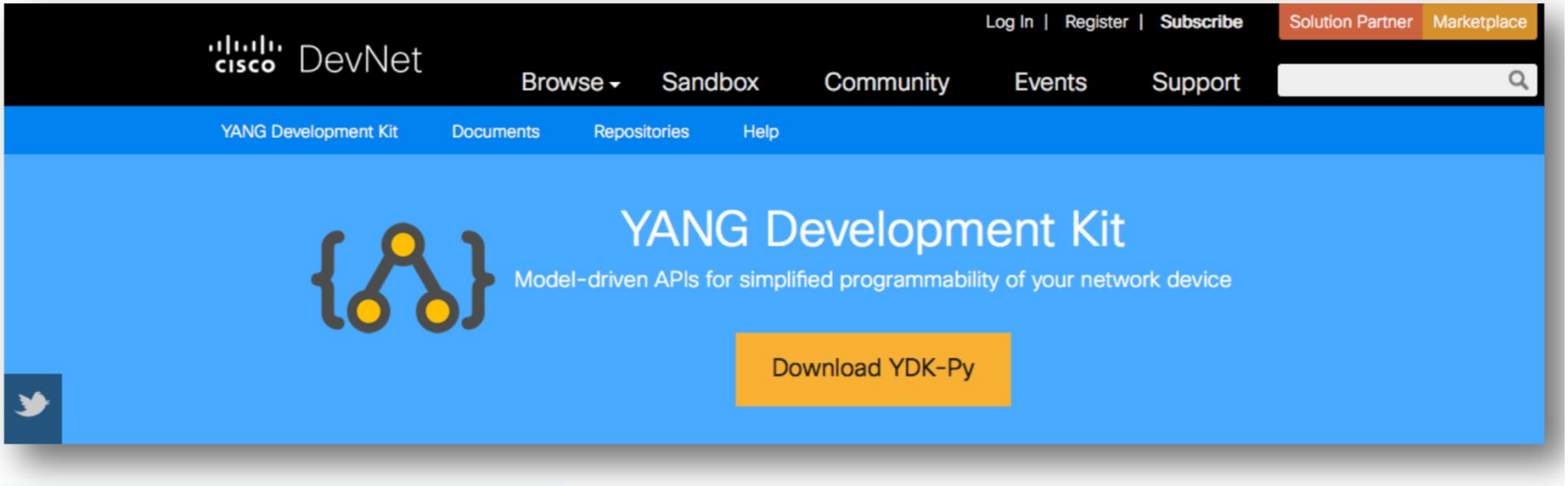
Yet Another Next Generation

- YANG is a data modeling language used to model configuration and state data manipulated by the NETCONF protocol
- IETF Standard [rfc6020]
  - specifically targeted to the needs of configuration management
  - Easy to read, to promote adoption.
  - Provides mechanisms to validate models of configuration data for semantics and syntax.

```
module: openconfig-interfaces
  +--rw interfaces
     +--rw interface* [name]
        +--rw name                -> ../config/name
        +--rw config
        |  +--rw type             identityref
        |  +--rw mtu?             uint16
        |  +--rw name?            string
        |  +--rw description?     string
        |  +--rw enabled?         boolean
        +--ro state
        |  +--ro type             identityref
        |  +--ro mtu?             uint16
        |  +--ro name?            string
        |  +--ro description?     string
        |  +--ro enabled?         boolean
        |  +--ro ifindex?         uint32
        |  +--ro admin-status     enumeration
        |  +--ro oper-status      enumeration
        |  +--ro last-change?     yang:timeticks
        |  +--ro counters
        |     +--ro in-octets?              yang:counter64
        |     +--ro in-unicast-pkts?        yang:counter64
        |     +--ro in-broadcast-pkts?      yang:counter64
        |     +--ro in-multicast-pkts?      yang:counter64
        |     +--ro in-discards?            yang:counter64
        |     +--ro in-errors?              yang:counter64
        |     +--ro in-unknown-protos?      yang:counter32
        |     +--ro out-octets?             yang:counter64
        |     +--ro out-unicast-pkts?       yang:counter64
        |     +--ro out-broadcast-pkts?     yang:counter64
        |     +--ro out-multicast-pkts?     yang:counter64
        |     +--ro out-discards?           yang:counter64
        |     +--ro out-errors?             yang:counter64
        |     +--ro last-clear?             yang:date-and-time
```

YDK – The YANG Development Kit

- https://developer.cisco.com/site/ydk/



OpenConfig

http://www.openconfig.net/

What is OpenConfig?

OpenConfig is an informal working group of network operators sharing the goal of moving our networks toward a more dynamic, programmable infrastructure by adopting software-defined networking principles such as declarative configuration and model-driven management and operations.

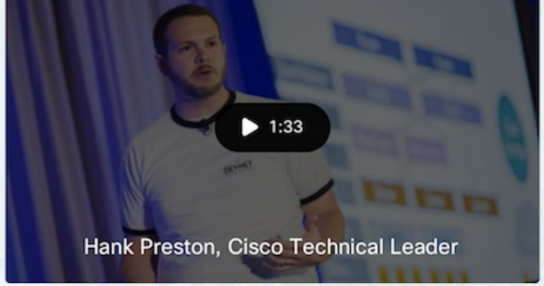
Common data models

Our initial focus in OpenConfig is on compiling a consistent set of vendor-neutral data models (written in YANG) based on actual operational needs from use cases and requirements from multiple network operators.

pyangbind	PyangBind is a plugin for pyang which converts YANG data models into a Python class hierarchy.	link

Get hands on with the New Network

Watch this short video to learn what you can do on this page



Learn to program with the network

Get Started with the Cisco DNA Learning Track

From basic coding skills to using controller and devices level APIs, the Cisco DNA learning track walks you through getting started with network-powered apps.

See Learning Track

Network Programmability for Application Developers

Learn about network programmability from the perspective of an Application Developer. Contains information about basic networking concepts in addition to interfaces like RESTCONF.

See Learning Track

Chat with Us!

https://developer.cisco.com/site/dna-demo/

PYCON ODESSA

NETCONF Client

- Satisfies the prerequisites for an SSH/TLS connection
- Opens/Ends a NETCONF session
- Sends NETCONF RPCs requesting/changing configuration/Operation data
- Optional
  - Syntax and Semantics Verification.
  - locks/unlocks the candidate configuration / temporary configuration
- Open source clients available:
  - libnetconf: NETCONF library in C
  - ncclient: Python library for NETCONF clients
  - https://github.com/ncclient/ncclient

NETCONF Client

```
from ncclient import manager

with manager.connect(host=host, port=830,
                     username=user, hostkey_verify=False,
                     device_params={'name':'junos'}) as m:
    c = m.get_config(source='running').data_xml
    with open("%s.xml" % host, 'w') as f:
        f.write(c)
```

Де попрактикуватись?

https://devnetsandbox.cisco.com/RM/Topology

ALWAYS-ON SANDBOX

IOS XR Programmability

The IOS XR Programmability Sandbox provides an environment where developers and network engineers can explore the programmability options available in this routing platform. These include Model Driven Programmability with YANG, Data Models/NETCONF/gRPC, Streaming Telemetry, Service-Layer APIs and Application Hosting.

ALWAYS-ON SANDBOX

NETCONF/YANG and RESTCONF on IOS XE

The NETCONF/YANG and RESTCONF on IOS XE Always On Sandbox provides an environment to developers and network engineers to test their applications or scripts that use model driven programmability, using the new standard device interfaces for network configuration and operations. Learn about about Standard Device Interfaces & Models on DevNet.

PYCON ODESSA

Python implementations

- **CPython (default)**
- **Cython**
- **IronPython**
- **Jython**
- **PyPy**

Паралелізм в Python

- Concurrency - кілька завдань виконуються на перекриваються періодах часу
- Parallelism - кілька завдань, що відбуваються одночасно

Типові підходи:

- Мультипроцессор
- Threads
- Асинхронне програмування

Мультипроцессор на Python

• Створює кілька інтерпретаторів Python як вилки, які можуть працювати на декількох ядрах процесора
• Більш високі витрати над потоками
• Складніше спілкуватися між процесами
• Вищий обсяг пам'яті
• Ефективне розподілення навантаження на обчислювальну потужність процесора через декілька ядер

Зробити Python додатки для мережі швидше з асинхронними фреймворками

- asyncio
- tornado
- gevent

All I/O heavy use-cases

- Web back-end
- REST API interaction
- Database interaction

- Interaction with network devices

App inside

I can run Apps inside my Router!!

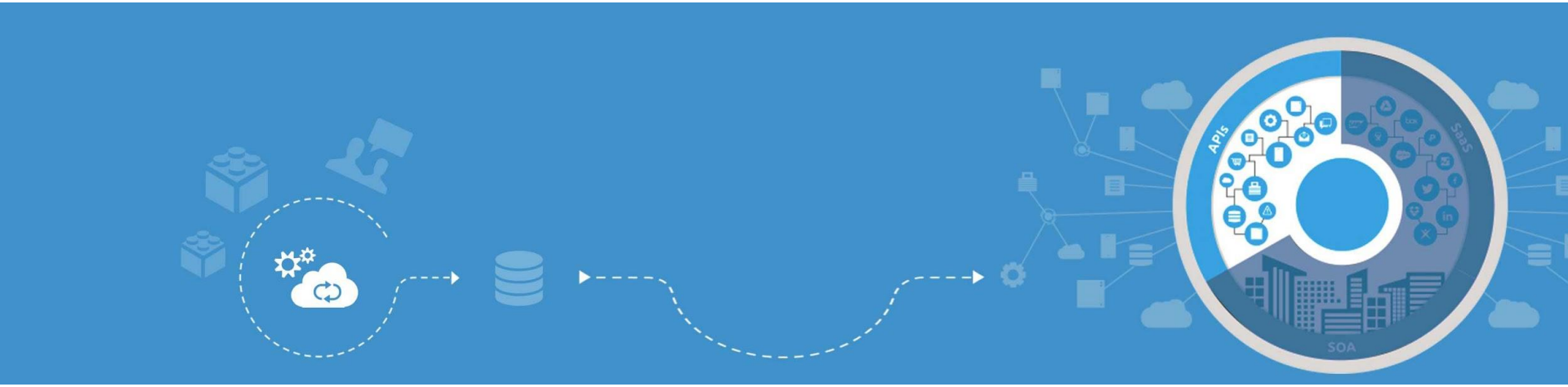
Wait, **why** would I run an app inside my router?

- Python environment
- Asset management Apps
- Deploy probes anywhere
- Telemetry gathering/local processing
- Option to enable unsigned containers
- Any 3rd party KVM
- Libvirt based format / YAML manifest file

Рішення та приклади

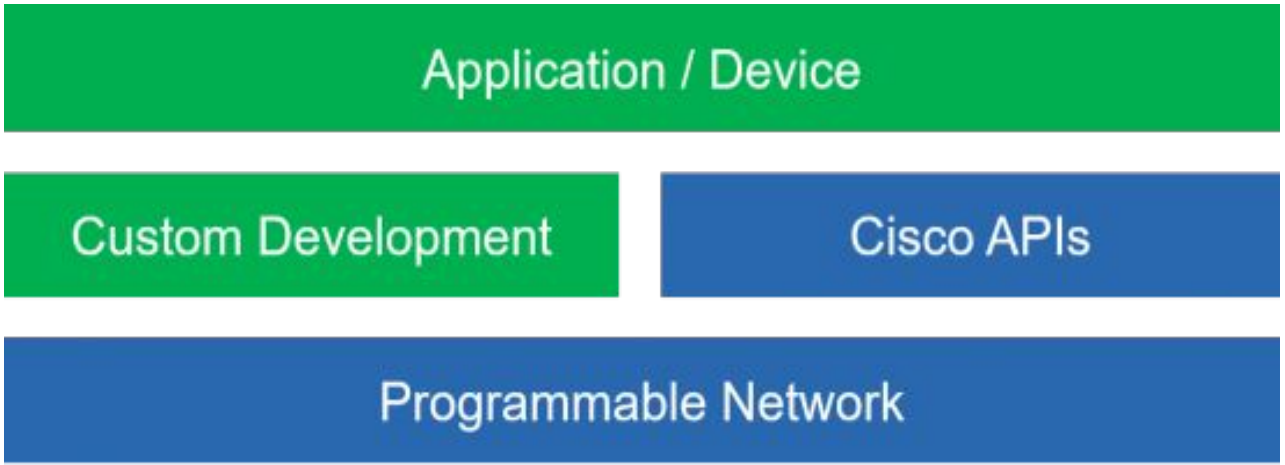
DEVNET

developer.cisco.com



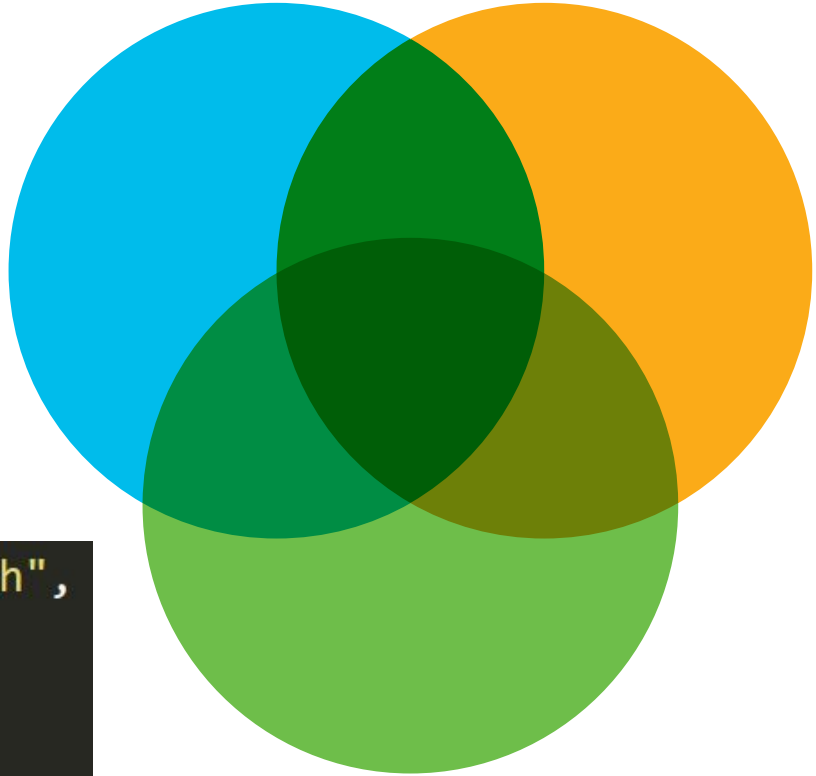
Cisco DevNet - це програма для програмістів та інженерів, яка допомагає розробникам та фахівцям у галузі IT, які хочуть писати додатки та розвивати інтеграцію з продуктами, платформами та інтерфейсами Cisco.

API ecosystem



Cisco API - це просто

- формат JSON
- NETCONF
- RESTful

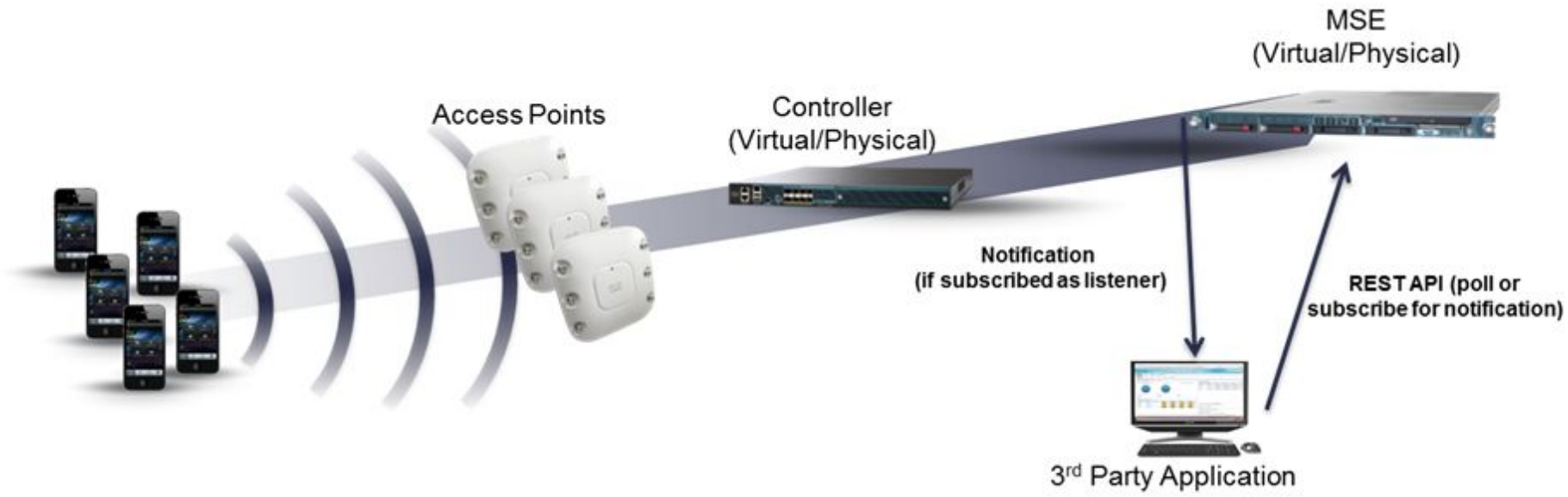


```
"type": "Cisco Catalyst 3560X-24P Switch",
"family": "Switches and Hubs",
"lastUpdateTime": 1534873901321,
"upTime": "102 days, 16:40:34.12",
```

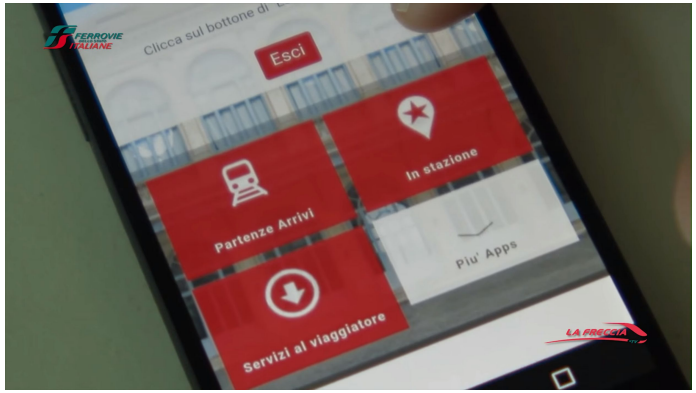
PYCON ODESSA

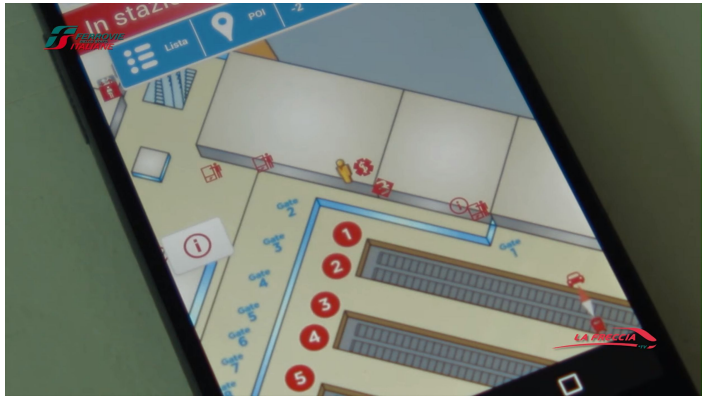
Огляд рішень та програм: CMX

Connected Mobile Experiences (CMX)

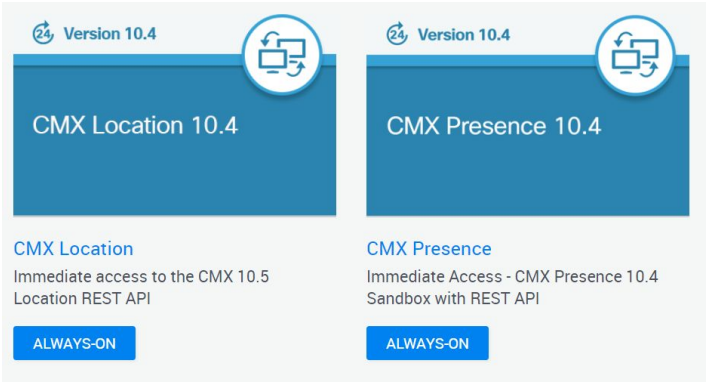


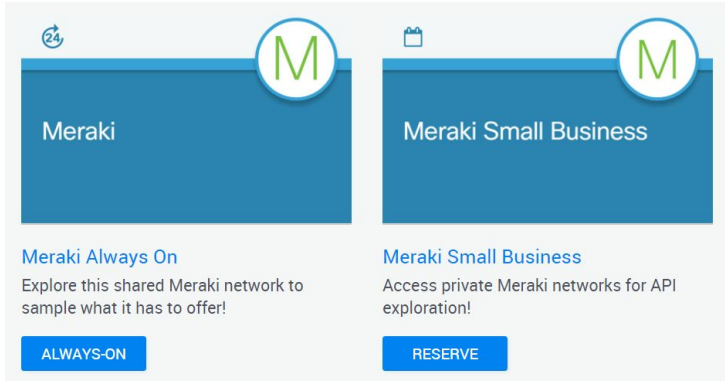
Огляд рішень та програм: CMX





Що використовувати для тестування:



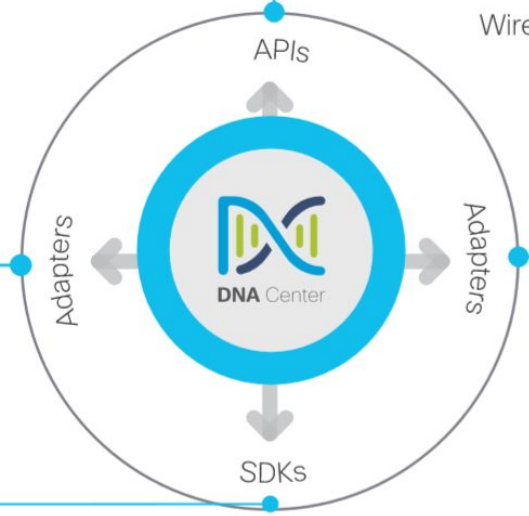


IT and network system process adapters

ServiceNow	ITSM
Infoblox	IPAM
Tableau	Reporting

Business and network intent APIs

- Application Policy
- Assurance
- Wireless Provisioning
- Plug-n-Play
- Topology
- Software Image Management (SWIM)
- Network Inventory/ Discovery
- Command Runner
- Template Programmer
- eNFV Provisioning



Cross-domain adapters

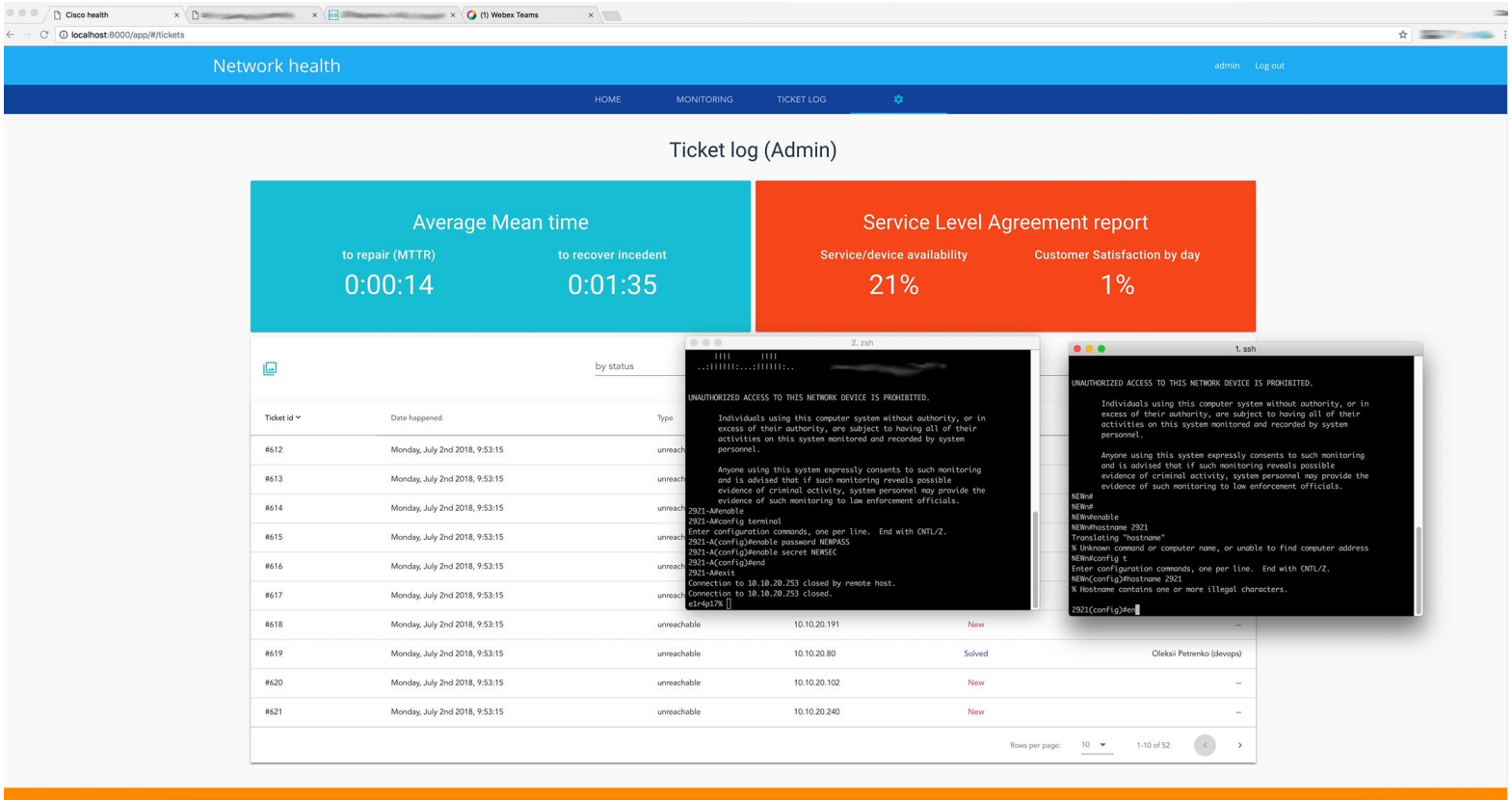
Networking	Cisco Meraki
Security	Cisco Stealthwatch

Third-party SDKs

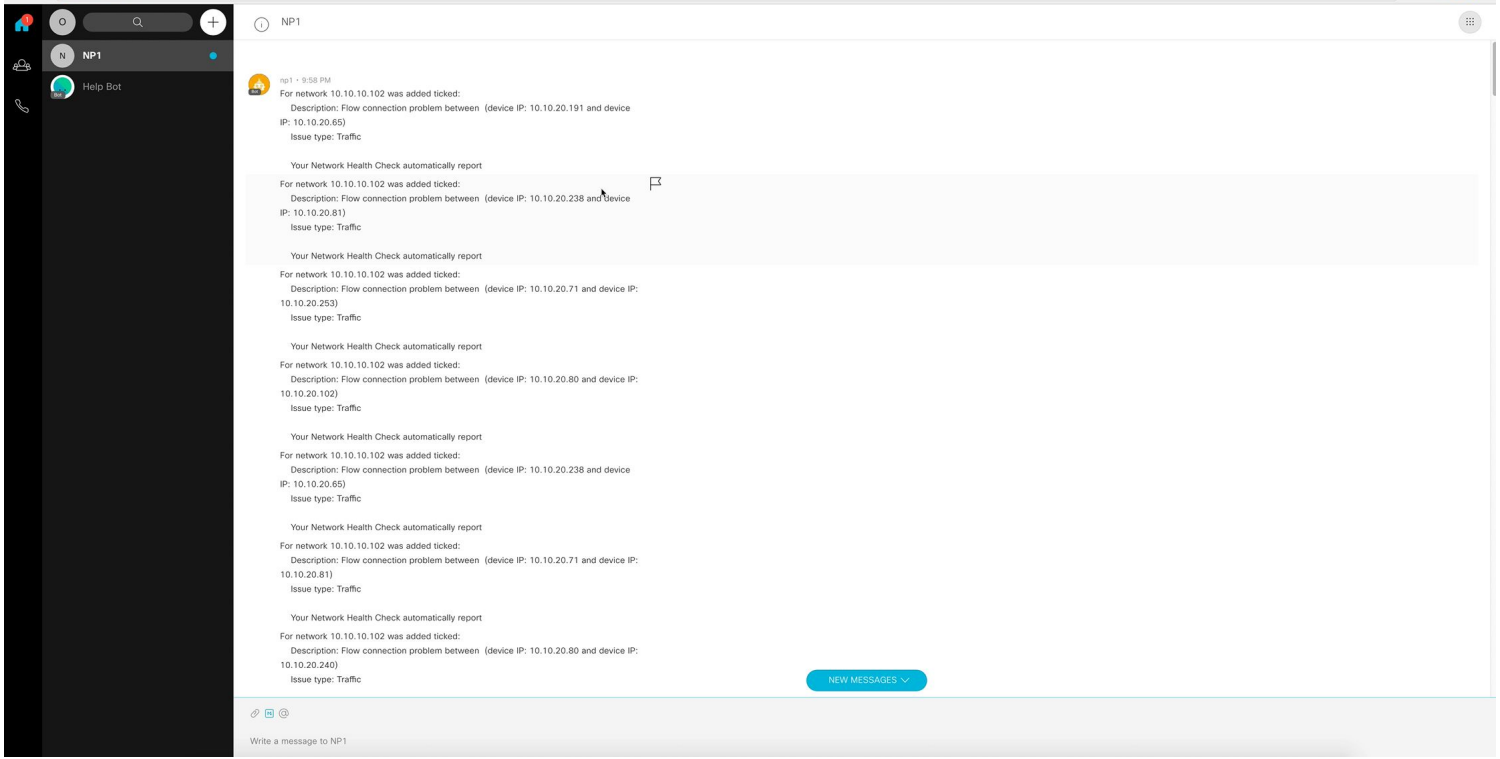
Map third-party network devices to data model

Level 1 operations support:
discovery, inventory, topology, availability, health score

Cisco DNA Center, 3d party app



Інтеграція 3d party app з Webex Teams



https://apphub.webex.com

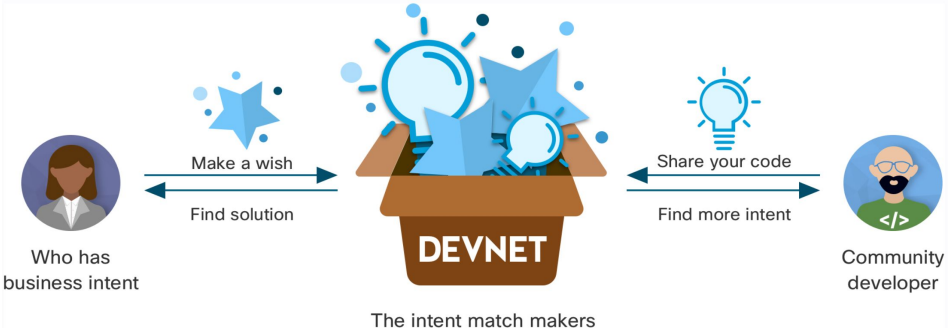
Огляд рішень та програм

Marketplace

https://marketplace.cisco.com/home

Cisco Ecosystem Exchange

https://developer.cisco.com/ecosystem/solutions/



https://developer.cisco.com/codeintent/

Cisco DevNet

API

RESTful API з документацією та можливістю тестування

Простота

SDK & integrations

Software Development Kit’s для різних рішень Cisco.
Великий вибір інтеграції з різними продуктами та сервісами (Trello, SalesForce, Jira, GitHub, Zendesk, Twitter та ін.)

Готові рішення

Ком’юніті

Модулі для навчання за різними напрямками на https://learninglabs.cisco.com/
Підтримка Cisco ком'юніті - https://community.cisco.com/t5/technology-and-support/ct-p/technology-support
DevNet support: https://developer.cisco.com/site/support/

Підтримка від спільноти

Open-source та інші можливості

1. https://creations.devnetcloud.com/
2. https://github.com/cisco
   https://github.com/CiscoDevNet
3. **Code Exchange**
   https://developer.cisco.com/codeexchange/
4. **Безкоштовні Sandbox та HW lab для тестування коду / додатків**
   https://developer.cisco.com/site/sandbox/
5. **NetDevOps site**
   https://developer.cisco.com/netdevops

Запитання

E-mail & Cisco Webex Teams

https://twitter.com/alex_dev_k

balexey@cisco.com

Приєднуйтесь та практикуйтесь

developer.cisco.com


CISCO