Next Generation Campus Architecture

Старые и новые подходы к построению локальных сетей

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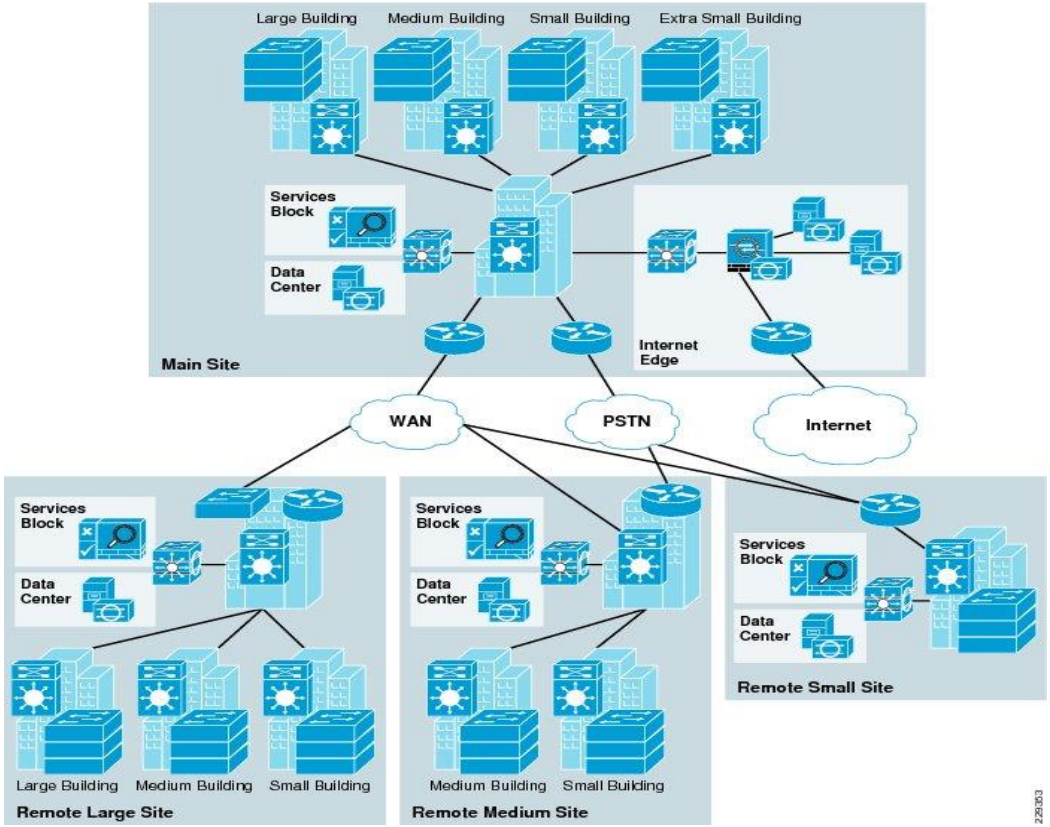
Systems Engineer

14 November 2017

Example of Computer Network (Enterprise)



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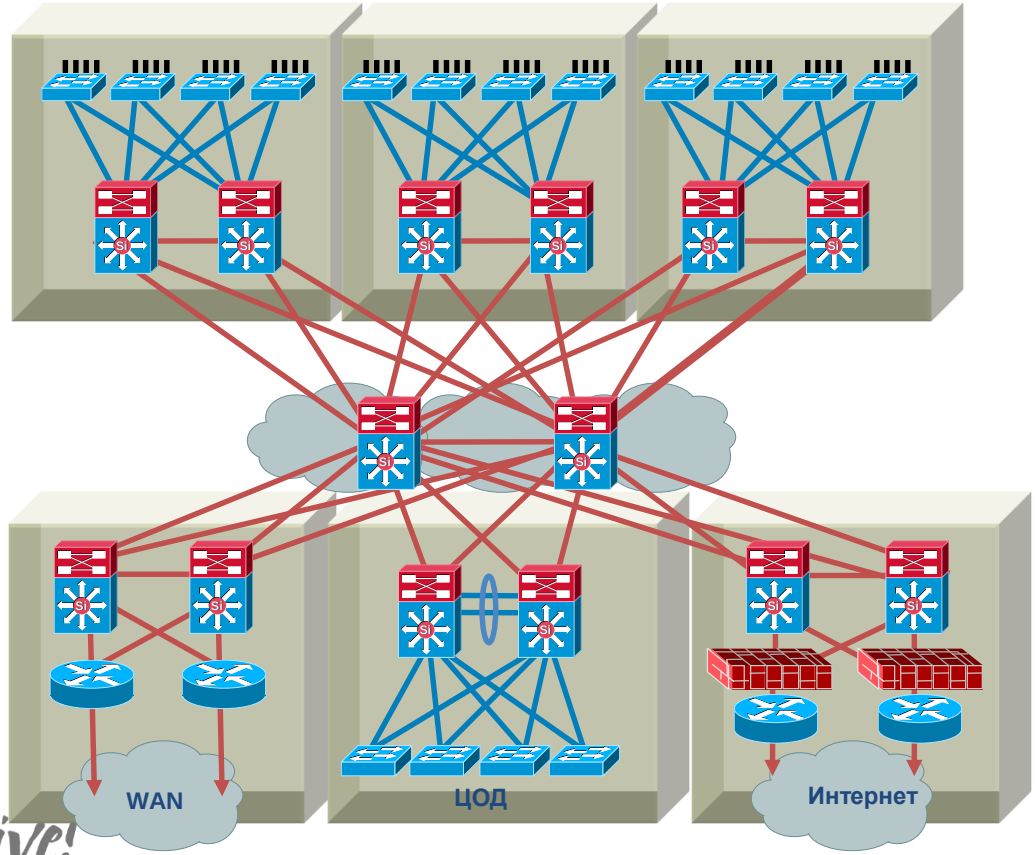
Иерархический кампус



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Оверлейный дизайн

Figure 1 *Layer 2 overlay–connectivity logically switched*

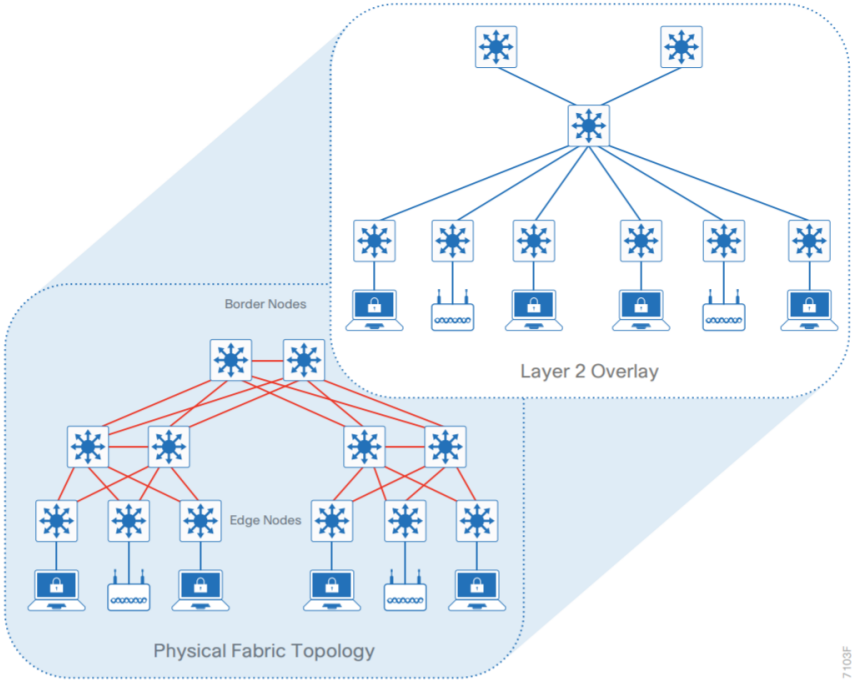
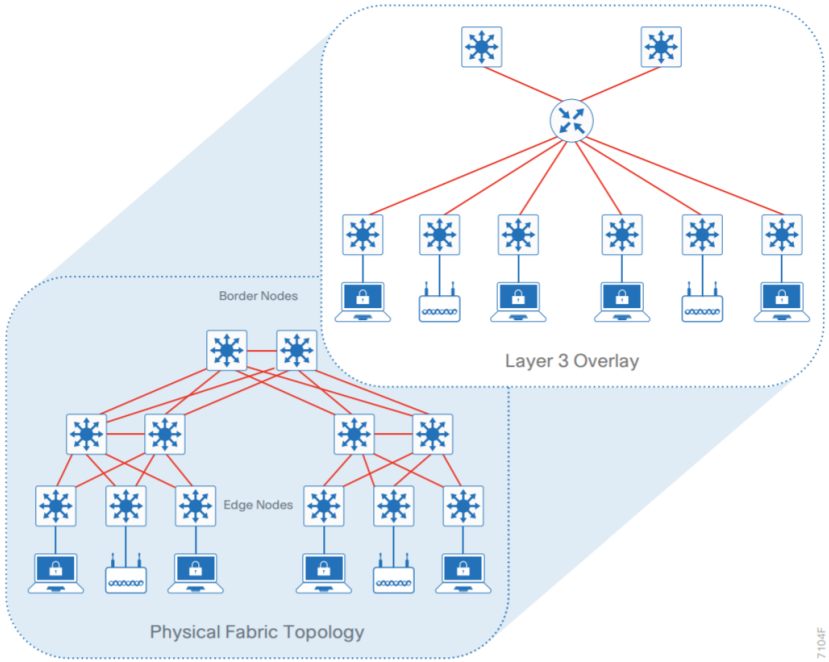


Figure 2 *Layer 3 overlay–connectivity logically routed*



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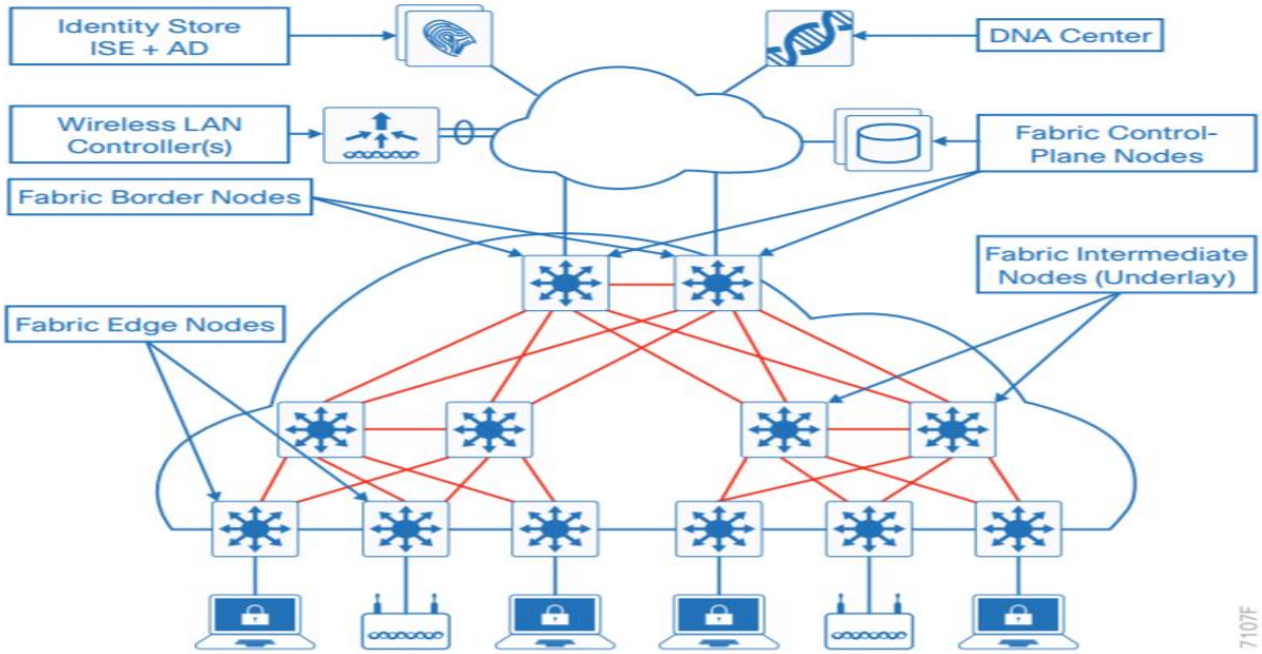
Новая архитектура с использованием «фабрики»

Figure 5 SD-Access solution and fabric components



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Существующая модель управления сетью

Ручная настройка каждой отдельной коробки

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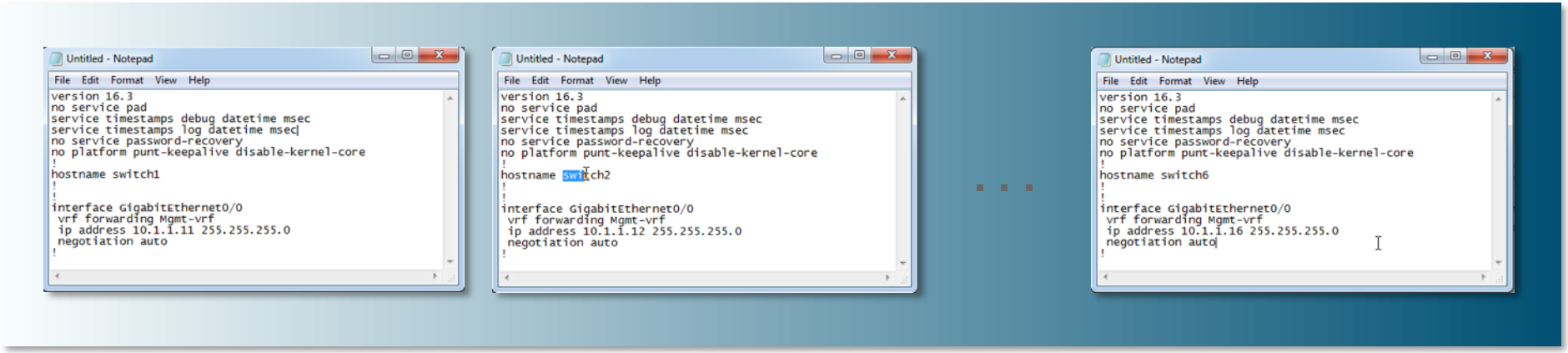
Блокнот – самое распространённое средство автоматизации

Блокнот – не самое лучшее средство автоматизации



Programmability Reason #1

Делать повторяемые вещи проще

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Преимущества от Enterprise SDN

Абстракция

Brownfield and Greenfield
Embedded best practices
Massive Simplicity

Контроль

Centralized policy
Network wide deployment
Dynamic Network Agility

Автоматизация

Zero touch deployment
Day 0 to Day N
Lower TCO

Программируемость

Published NB API’s
Cisco and Partner Apps
Openness

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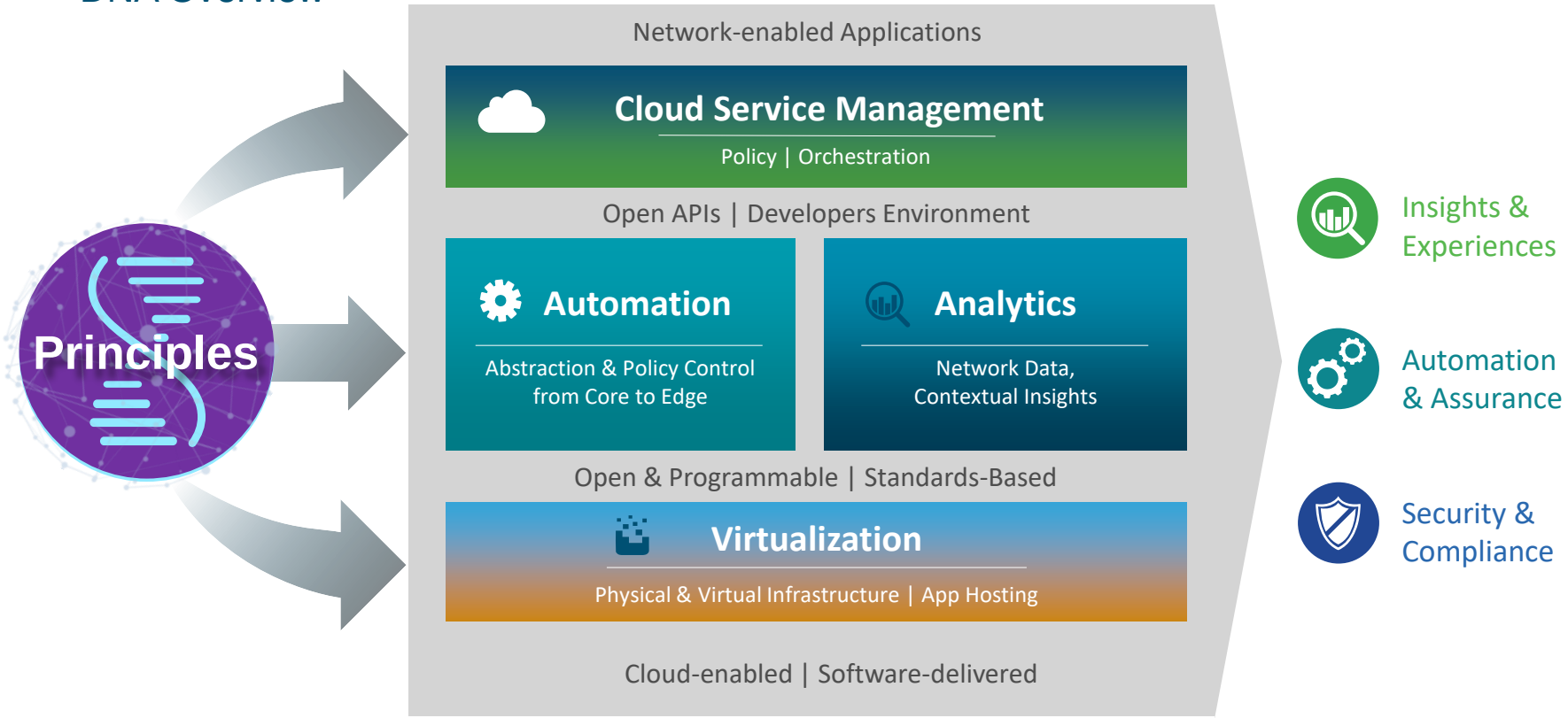
Cisco Digital Network Architecture

DNA Overview



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Идеи, заложенные в Cisco DNA

1. **Любое повторяемое и хорошо описанное действие можно автоматизировать.**
2. Автоматизация на сети предполагает превращение сети в единый организам (абстракция).
3. В идеале автоматизация – программно управляемая (SDN).
4. **Любая автоматизация требует обратной связи (аналитика).**
5. Имея готовую аналитику есть смысл её переиспользовать (ИБ, планирование, работа с клиентами и тп.).
6. **Виртуализация сетевых функций даёт возможность разворачивать сервисы (сетевые приложения) по требованию (Enterprise NfV).**
7. **Потребление сетевых услуг в идеале должно быть «как из облака» (сервисный портал).**
8. **Безопасность должна быть учтена везде от А до Я.**

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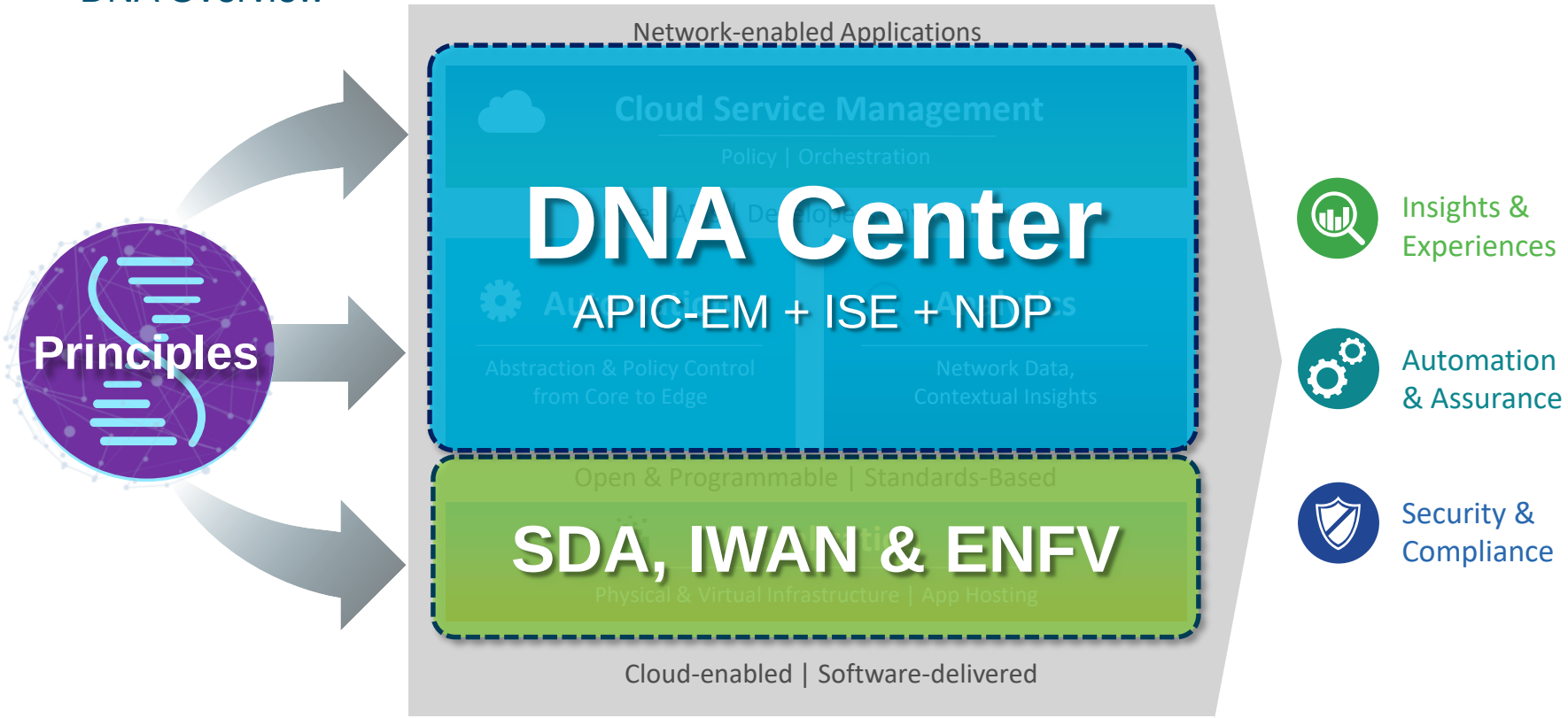
Cisco Digital Network Architecture

DNA Overview



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Как строим локальные сети?

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Какие бывают коммутаторы Cisco?

Коммутаторы

ЦОД

Data Center Switches

Meet the stringent requirements of the next-generation data center.

- Nexus 9000
- Nexus 7000
- Nexus 5000
- Nexus 3000
- Nexus 2000 Series Fabric Extenders

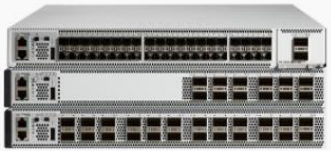
rights reser

Кампусная сеть

LAN Access Switches

Deploy mobility with ease, strengthen security, and simplify your network.

- Catalyst 9400
- Catalyst 9300
- Catalyst 4500E
- Catalyst 3850
- Catalyst 3650
- Catalyst 2960-X/XR
- Catalyst 2960-L



LAN Core and Distribution Switches

Get powerful campus switching solutions with uncompromised scale and services.

- Catalyst 9500
- Catalyst 6800
- Catalyst 6500
- Catalyst 4500-X
- Catalyst 3850
- Nexus 7000

IoT

Industrial Ethernet Switches

Deploy scalable and secure switching in your industrial network.

- Industrial Ethernet 5000
- Industrial Ethernet 4010
- Industrial Ethernet 4000
- Industrial Ethernet 3000
- Industrial Ethernet 2000
- Industrial Ethernet 1000

LAN Digital Building Switches

Extend deployments outside the wiring closet with small, flexible switches.

- Catalyst Digital Building Series
- Catalyst 3560-CX
- Catalyst 2960-CX
- Catalyst 2960-L
- Meraki MS220-8 Series

Выбор коммутатора доступа

Коммутаторы

Доступ / Access

[Q1] В чём специфика портов доступа?

- **Точка «входа» в сеть**

1. Правильная точка идентификации клиента сети
2. Необходимая точка применения сетевых сервисов
3. Возможная точка применения политик безопасности
4. Интересная точка сбора статистики

НУЖЕН УМНЫЙ «ДОСТУП»

технологии

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Управление и мониторинг

[Q2] Как упростить управление?

- **Cisco Prime Infrastructure v3**
  - Централизованна система управления сетевыми устройствами
- **Cisco APIC-EM / DNA-C**
  - SDN-автоматизация сценариев
- **Embedded Event Manager (EMM)**
  - Програмируемость сетевых устройст

[Q3] Как упростить управление политиками досутпа?

- **Cisco Identity Services Engine**
  - Ролевой и контекстный доступ к сети пользователей и устройств

[Q3] Как упростить мониториг сети?

- **Cisco StealthWatch**
  - Сбор и анализ сетевой статистики (NetFlow)

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DNA – системы управления и мониторинга

SDN сценарии (applications) автоматизации

APIC-EM

Ролевые политики доступа

ISE

Традиционное управление через визарды, шаблоны и задания

Prime Infrastructure

Продвинутый мониторинг сетевого трафика, аномалей и угроз

StealthWatch

cisco

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Cisco Catalyst 2960-L

- Дешёвый гигабитрый коммутатор
- Простая настройка
- Есть 10G аплинки

Поддерживает:

- ✓ Простой визард первичной настройки
- ✓ Кластеризация (не стекируемый)
- ✓ Централизованное управление с Cisco PIv3
- ✓ 0-day deployment (SDN)

Ограничения:

- LAN LITE
- Ограниченная поддержка .1x

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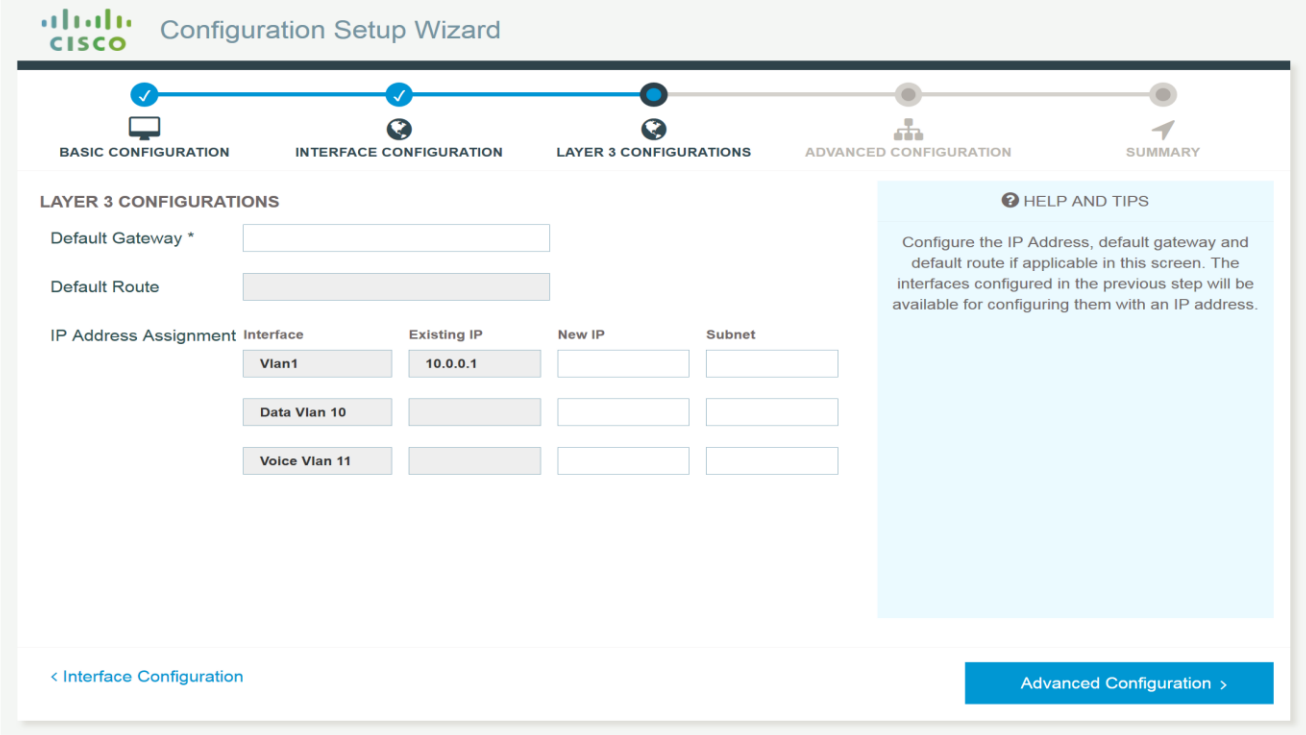
Routed Access – будет доступен везде!

2960L	2960X	3650/3850/4500E	3650/3850/4500E	C9K
Lan Lite	Lan Base	Lan Base	IP Base	Network Essentials
includes Routed Access	**includes** Routed Access	**includes** Routed Access	**includes** Routed Access & VRF	**includes** Routed Access
▪ Default-route ▪ Static ▪ RIP	▪ RIP ▪ EIGRP Stub ▪ OSPF(200 routes) ▪ PBR ▪ PIM Stub Multicast (up to 200 routes)	▪ RIP ▪ EIGRP Stub ▪ OSPF (1000 routes) ▪ PBR ▪ PIM Stub Multicast (up to 1000 routes)	▪ 3 Virtual Networks for SD-Access	▪ RIP ▪ EIGRP Stub ▪ OSPF (1000 routes) ▪ PBR ▪ PIM Stub Multicast (up to 1000 routes)
IOS 15.2(6)E	IOS 15.2(6)E	IOS XE 16.6/3.10E	IOS XE 16.6/3.10E	IOS XE 16.5

Простота первичной настройки одной коробки



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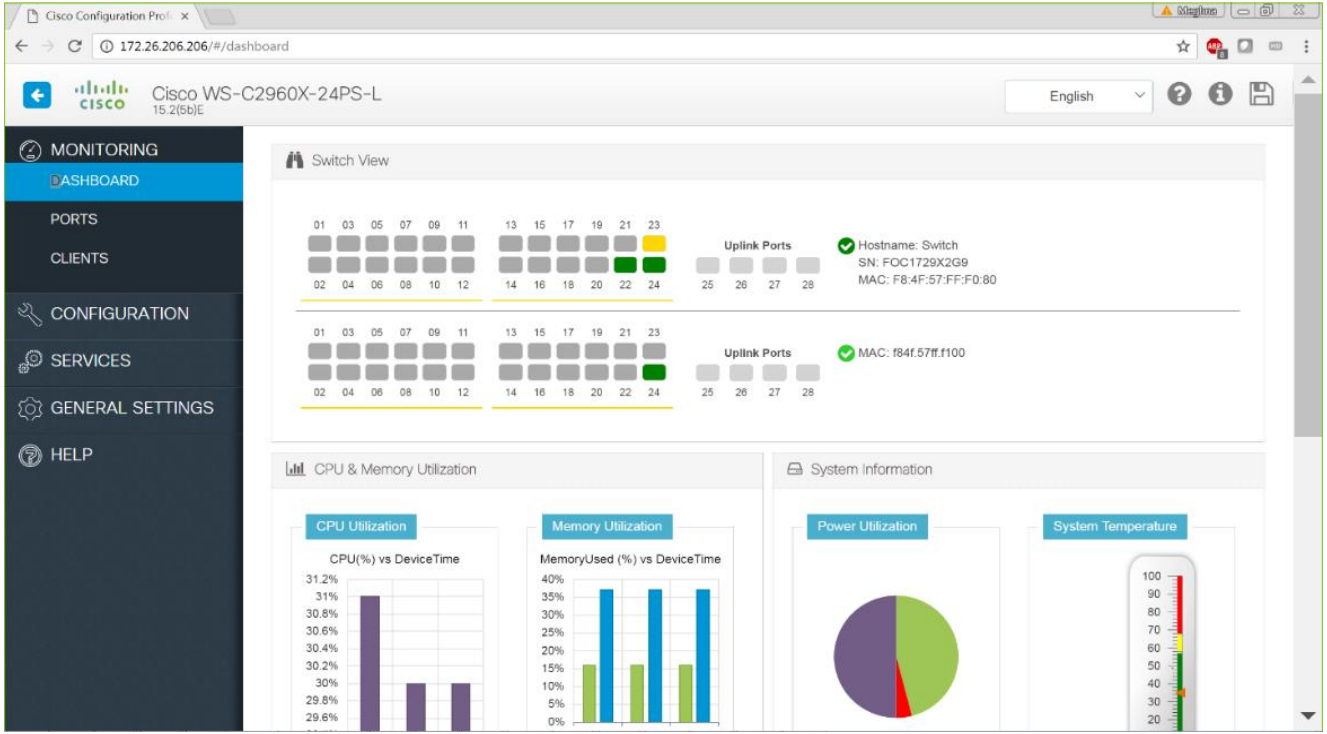
Простота сопроводжения



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Prime Infrastructure

cisco

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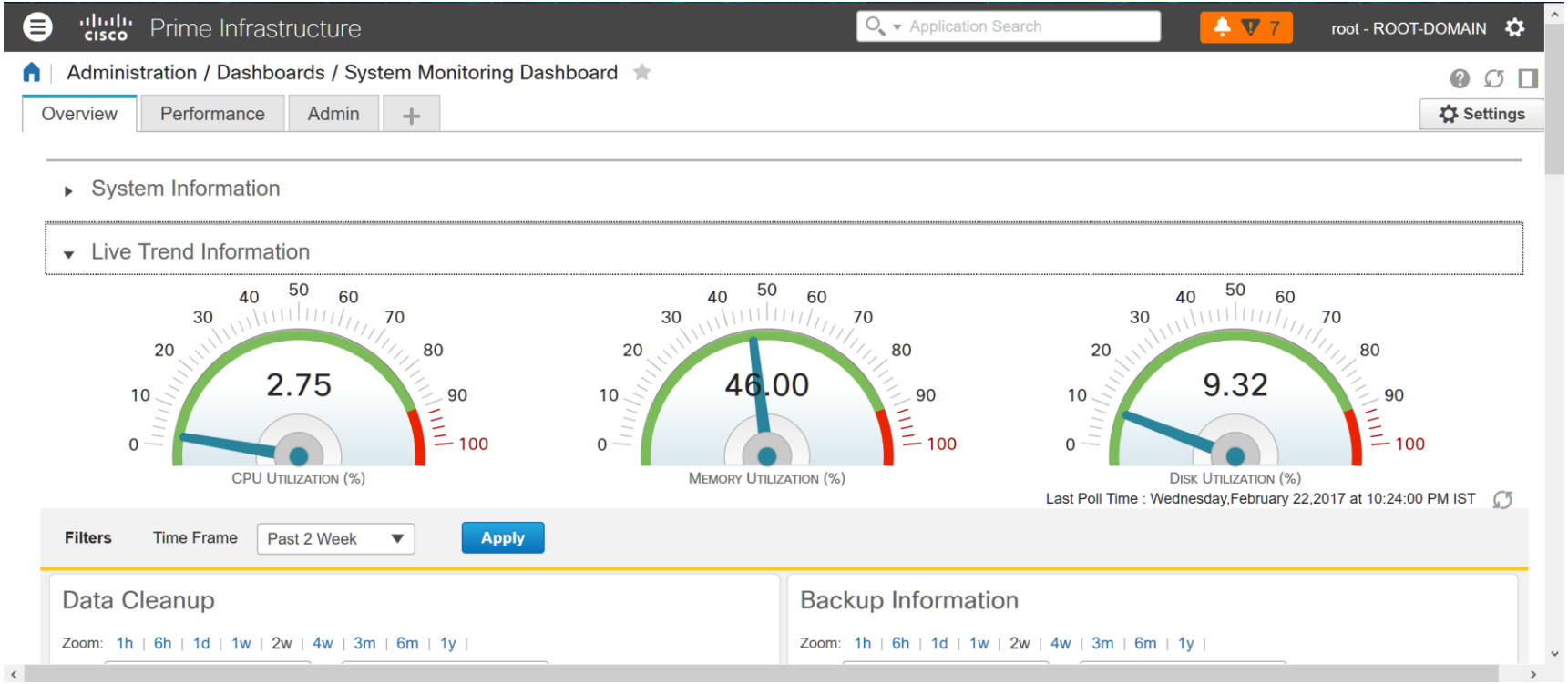
System Dashboard – Overview



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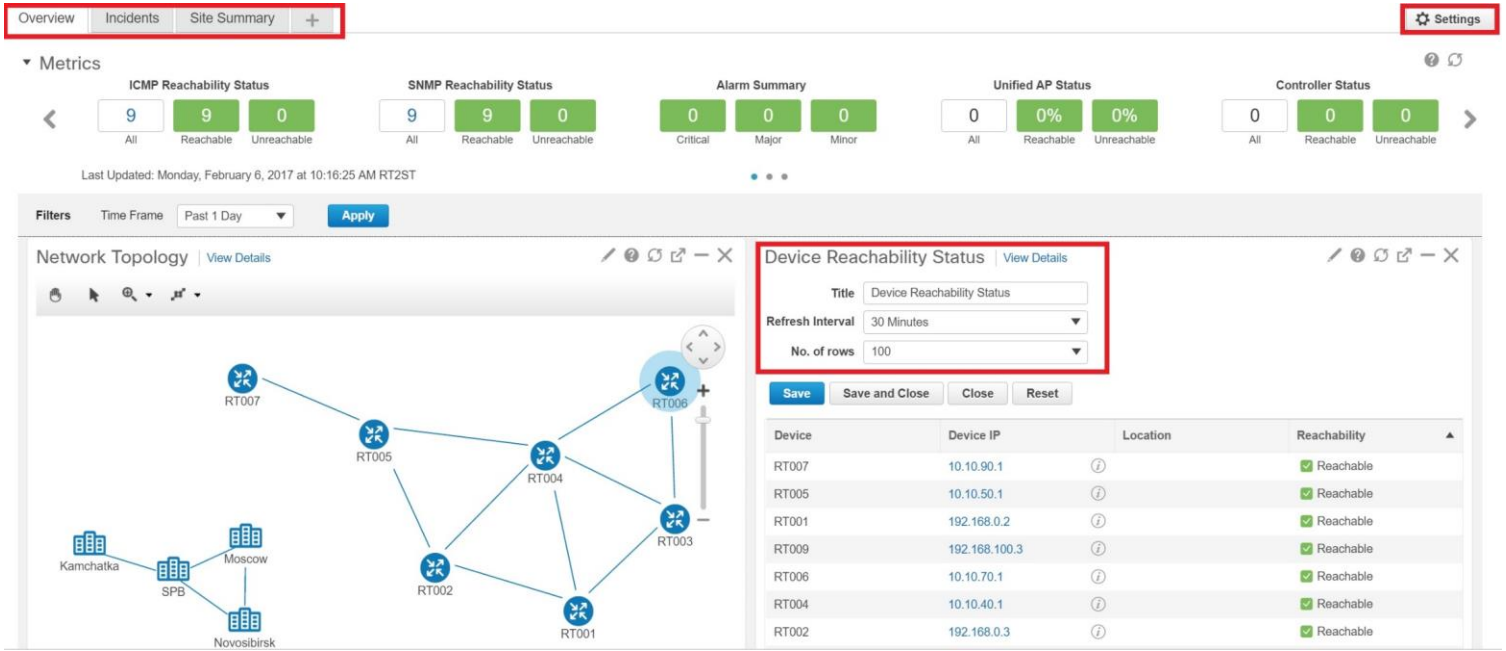
Полностью настраиваемая консоль



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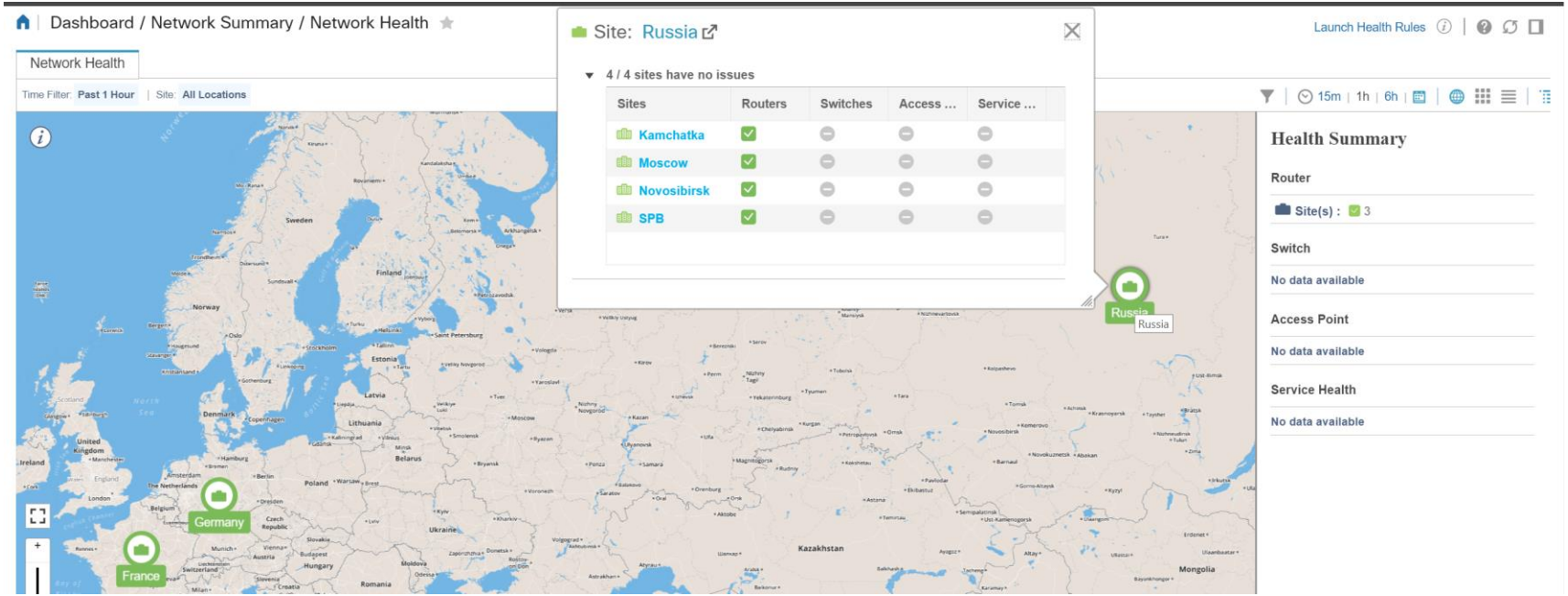
Вся сеть на одной странице



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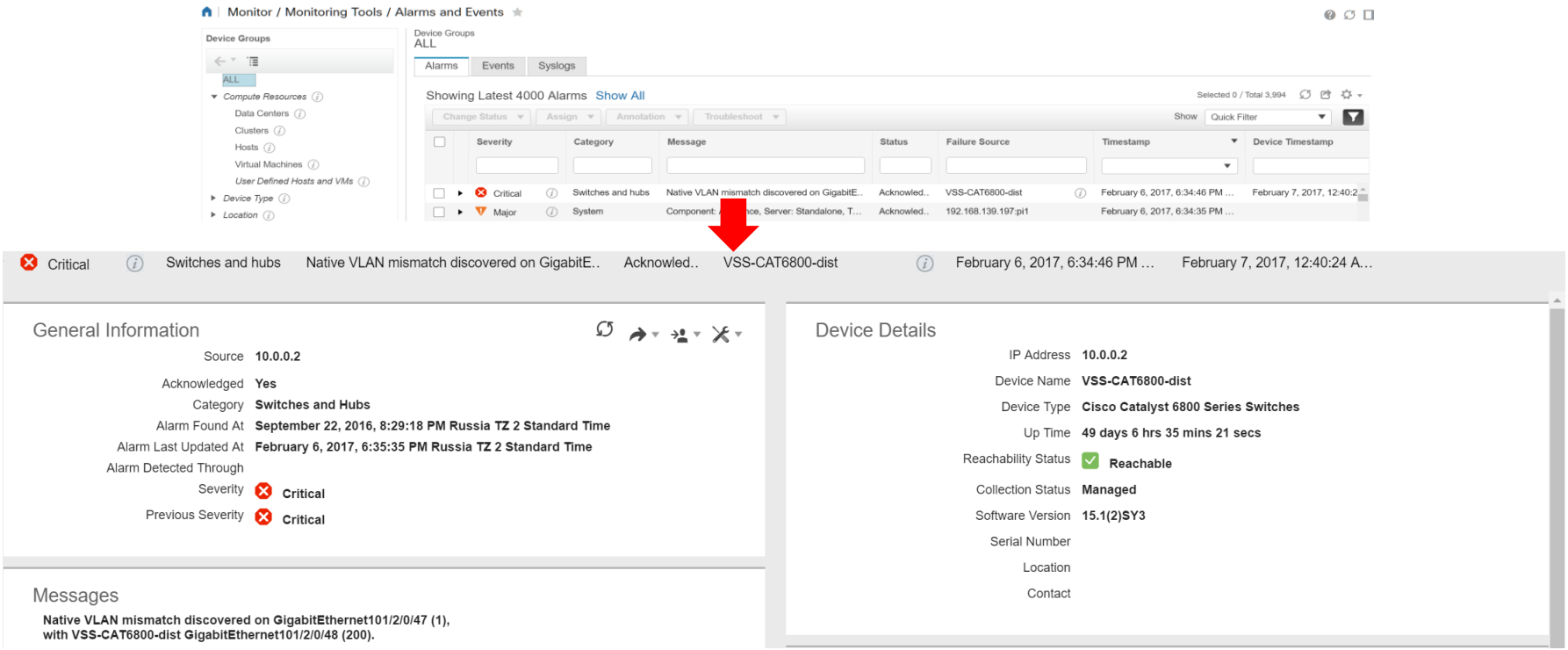
Детализация по каждому инциденту



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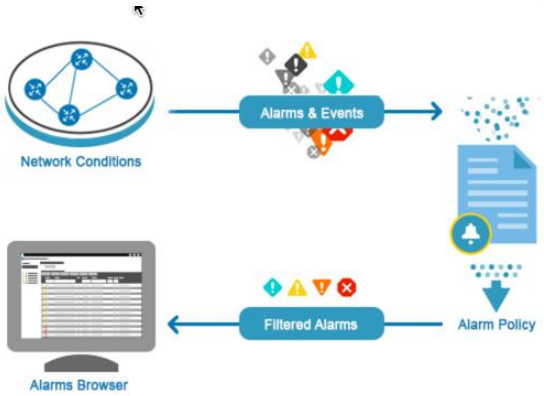
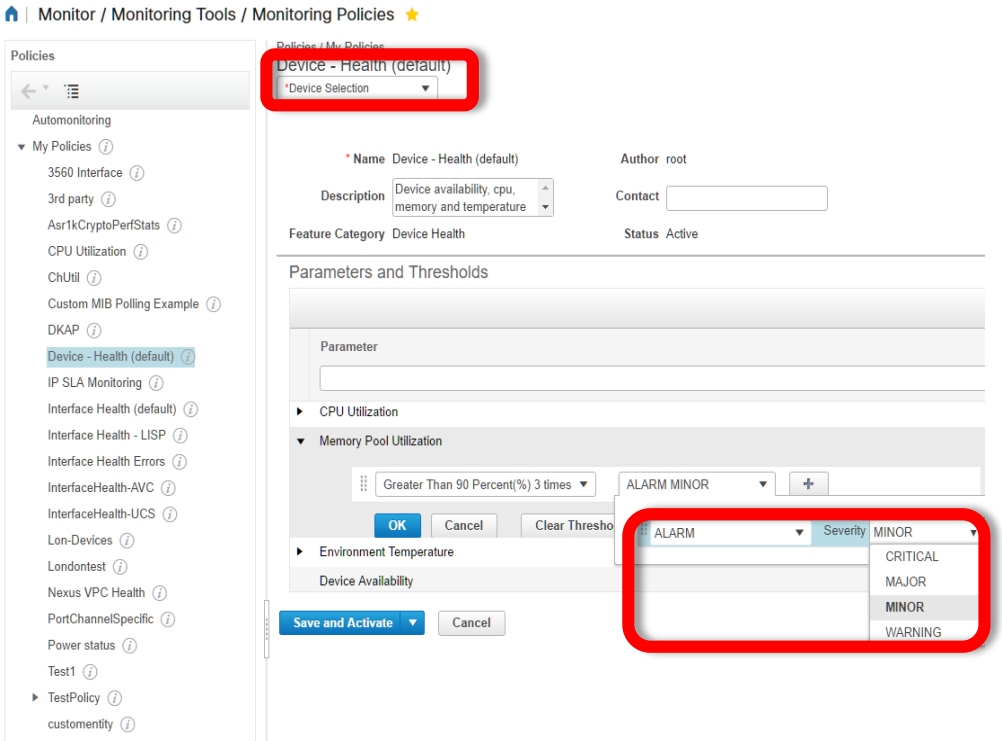
Настройка параметров оповещения





- Выбор событий для срабатывания оповещений
- Назначение оповещений на Device Groups/Location Groups, Port Groups

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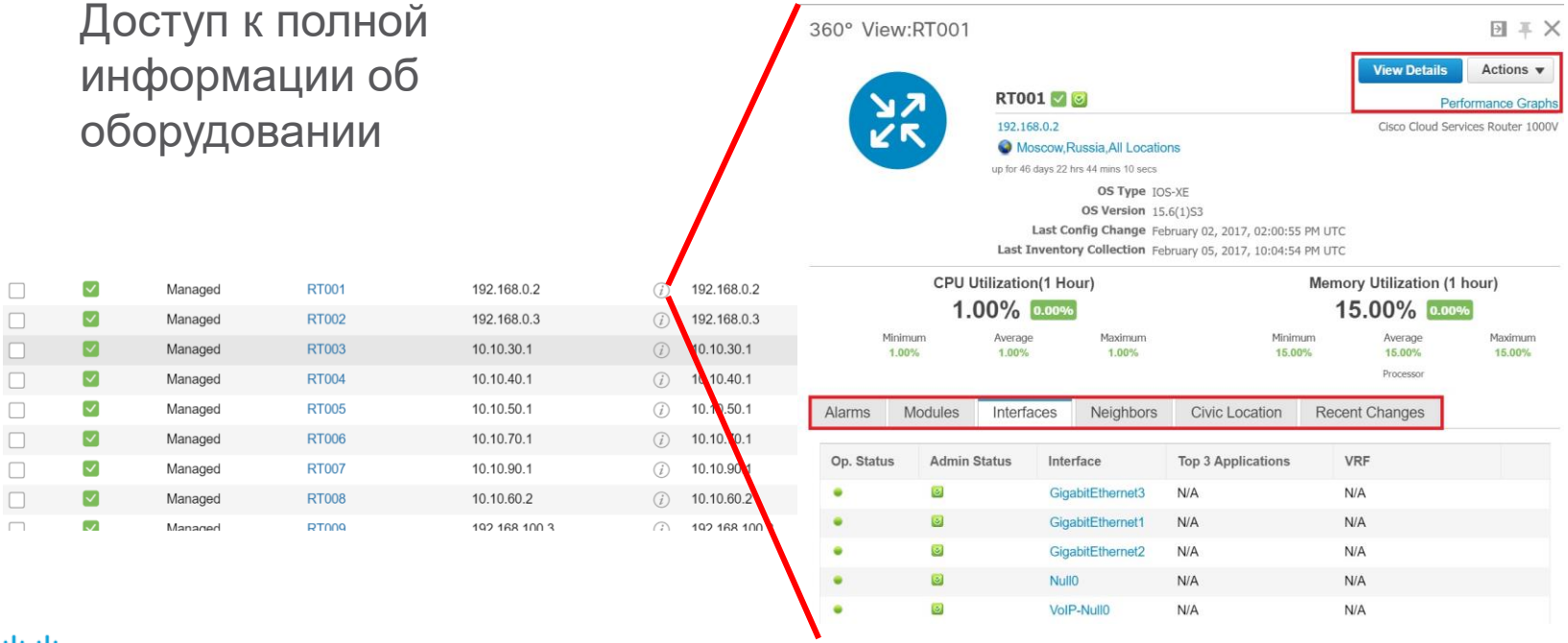
Инвентаризация

Доступ к полной информации об оборудовании



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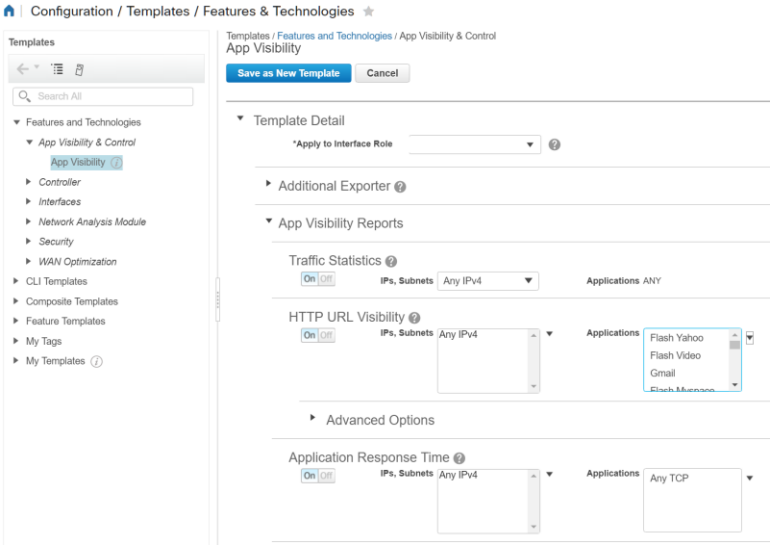
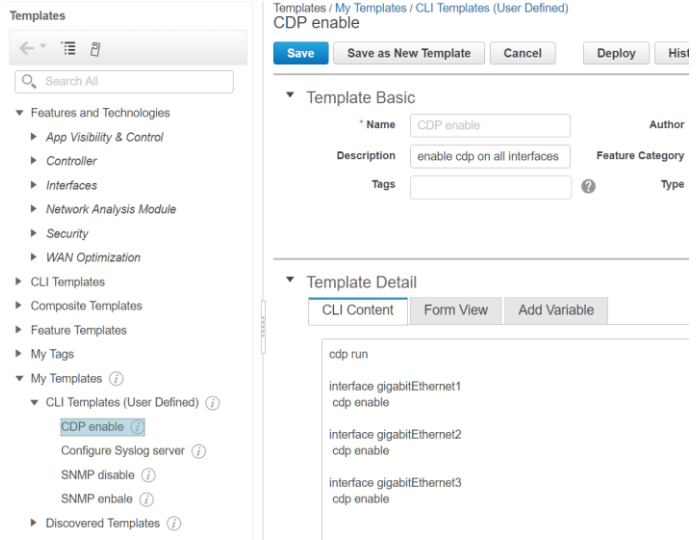
Конфигурация оборудования

Использование преднастроенных шаблонов



Создание собственных шаблонов



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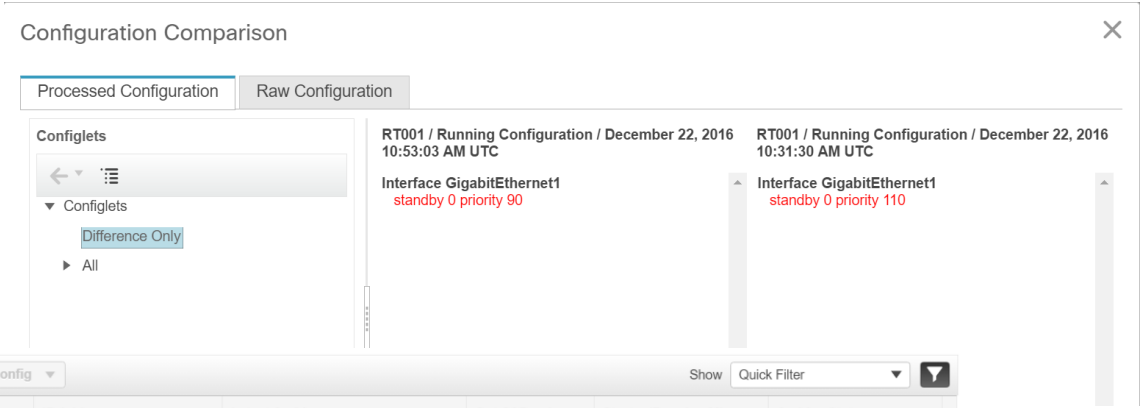
Управление конфигурациями

- Архивирование
- Восстановление
- Сравнение



Schedule Archive | Overwrite | Deploy Config | Export Latest Config | Show | Quick Filter

Name	Device Type	IP Address	Latest Archive	Out Of Band	Startup/Running Mism...	Archive Status
RT001	Cisco Cloud Services Router 1000V	192.168. 0. 2	February 6, 2017 12:07:15 PM UTC	Yes		Yes
RT002	Cisco Cloud Services Router 1000V	192.168. 0. 3	February 2, 2017 2:00:37 PM UTC	Yes		Yes
RT003	Cisco Cloud Services Router 1000V	10. 10. 30. 1	February 2, 2017 2:13:06 PM UTC	Yes		Yes
RT004	Cisco Cloud Services Router 1000V	10. 10. 40. 1	February 2, 2017 4:52:45 PM UTC	Yes		Yes
RT005	Cisco Cloud Services Router 1000V	10. 10. 50. 1	February 2, 2017 2:00:40 PM UTC	Yes		Yes
RT006	Cisco Cloud Services Router 1000V	10. 10. 70. 1	February 2, 2017 2:00:53 PM UTC	Yes		Yes
RT007	Cisco Cloud Services Router 1000V	10. 10. 90. 1	February 2, 2017 2:00:32 PM UTC	Yes		Yes
RT008	Cisco Cloud Services Router 1000V	10. 10. 60. 2	February 2, 2017 2:18:47 PM UTC	Yes		Yes
RT009	Cisco Cloud Services Router 1000V	192.168.100. 3	February 2, 2017 2:00:56 PM UTC	Yes		Yes

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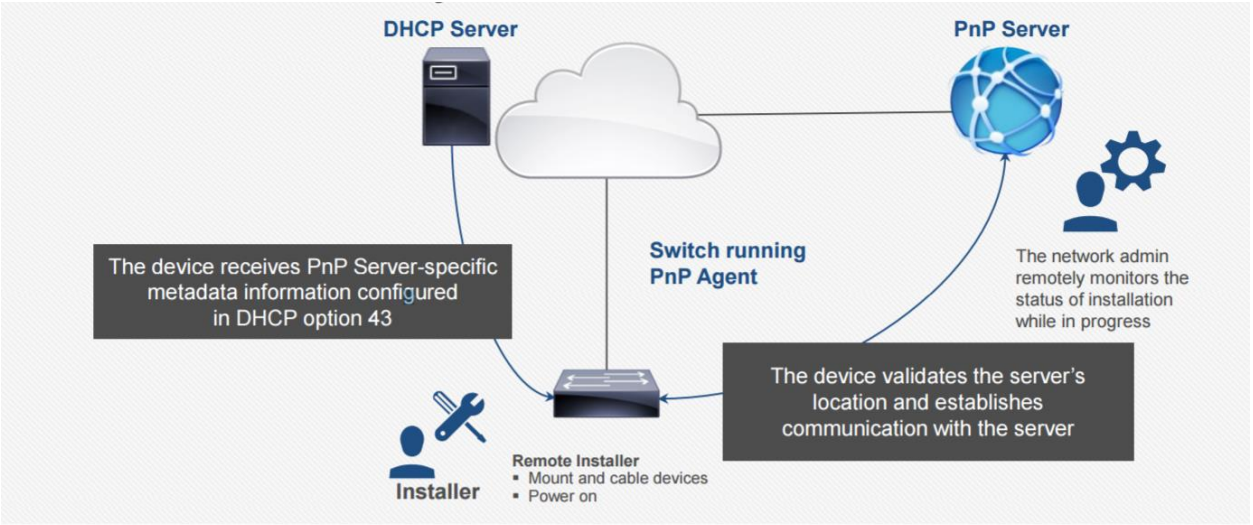
Централизованный 0-day deployment

5 способов первичной настройки в нулевой день БЕЗ участия админа



Prime Infrastructure v3 ⟷ APIC-EM PnP ⟷ PnP Cloud

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Cisco Catalyst 2960-X

- ❑ Гигабитный стекируемый коммутатор (L2+/L3)
- ❑ Самый распространённый коммутатор доступа

Поддерживает:

- ✓ Централизованное управление с Cisco PIv3
- ✓ Поддерживает большенство сценариев работы с ISE
- ✓ Автоматизация настройки QoS (AutoQoS)
- ✓ Может «маркировать» трафик метками безопасности (SXP)
- ✓ Экспорт Full NetFlow
- ✓ 4 SPAN/RSPAN

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802.1x Port Modes

Single Host
(Default; Single MAC allowed in Data Domain)

Multi Domain
(Single MAC allowed in Data and Voice Domains)

Multi Auth
(Single MAC allowed in Voice Domain
Multi MAC allowed in Data Domain
per MAC per VLAN in Data Domain)

Multi Host
(Only First MAC need to Authenticate
Following MACs are not Authenticated)

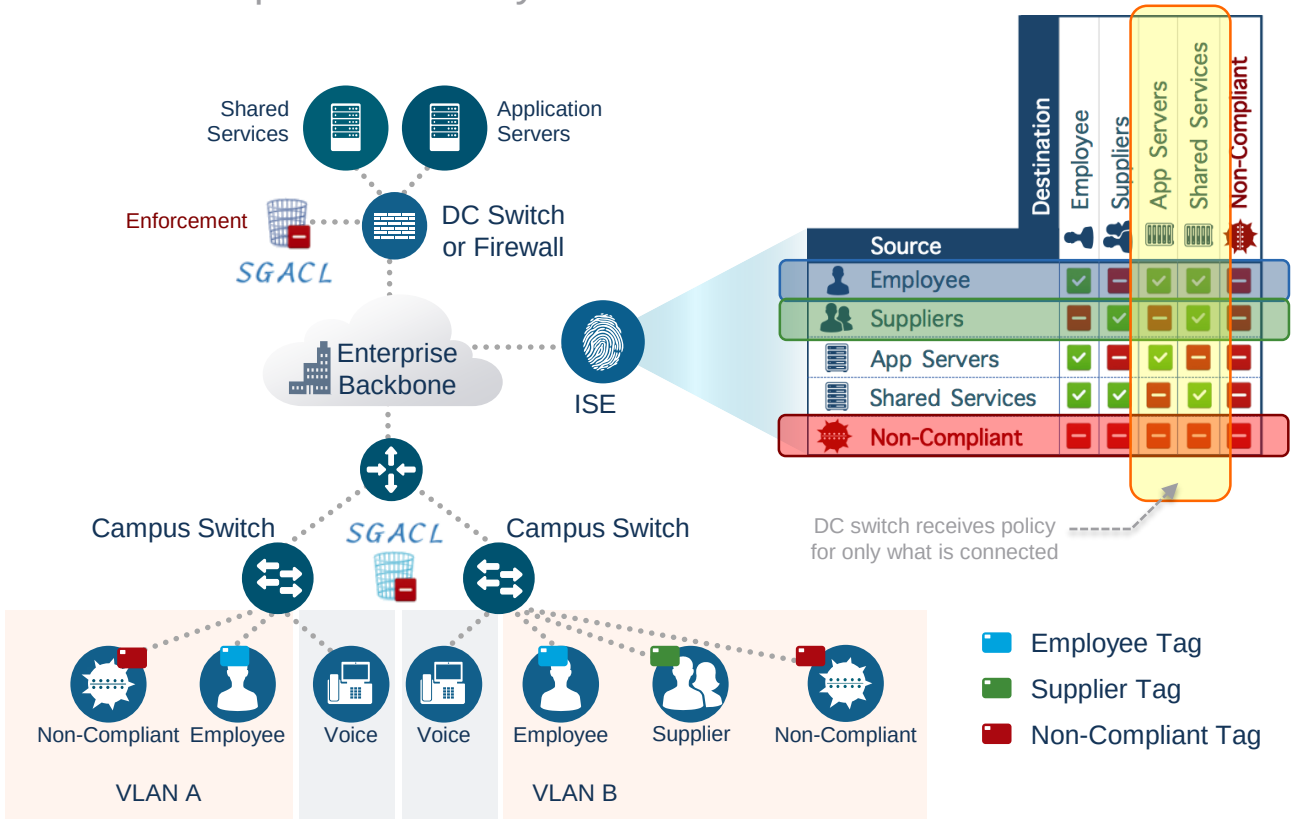
Cisco TrustSec

Simplified access control with Group Based Policy

Enforcement
Group Based Policies
ACLs, Firewall Rules

Propagation
Carry “Group” context through the network using only SGT

Classification
Static or Dynamic SGT assignments



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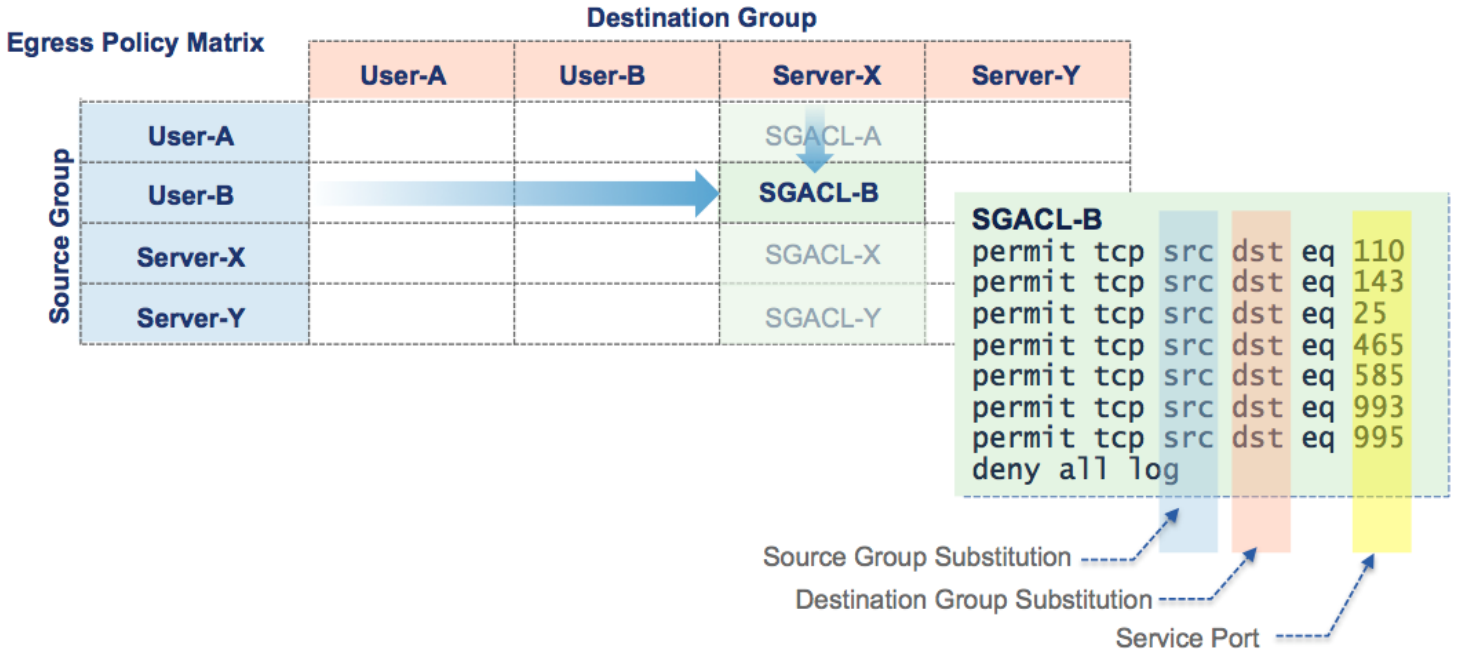
Security Group Access Control Lists



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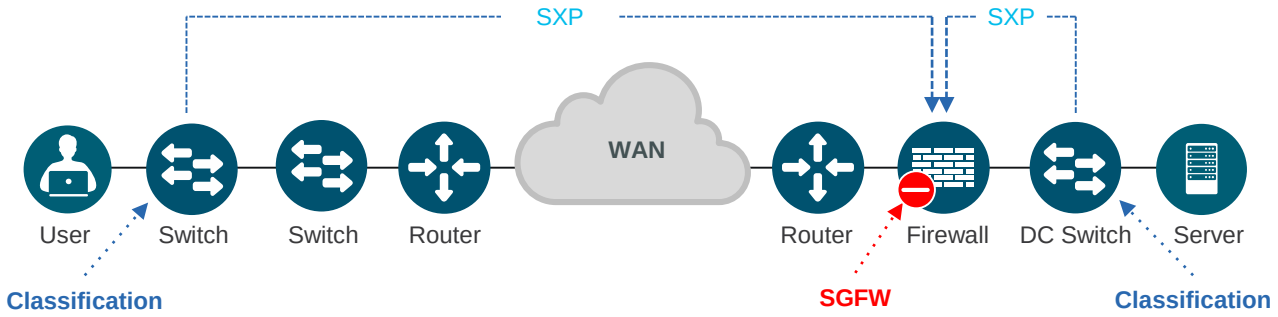
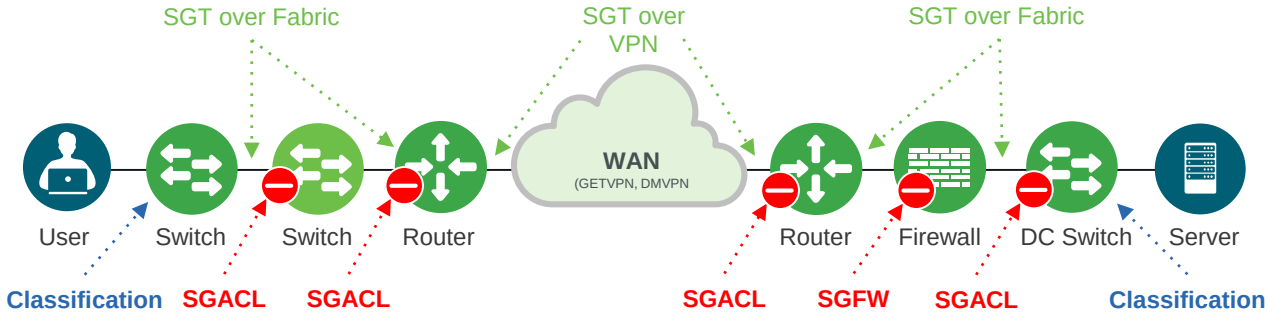
Cisco TrustSec

SGT Propagation & Enforcement Options

Heterogeneous
L2 / L3 Networks



TrustSec Capable
L2 / L3 Networks



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Cisco Catalyst 3650

- ❑ Гигабитный стекируемый коммутатор (L3)
- ❑ Поддержка mGig и UPoE
- ❑ Програмируемый ASIC UA-DP

Поддерживает:

- ✓ Централизованное управление с Cisco PIv3
- ✓ ISE: SGT-ACL
- ✓ L2 шифрование MACSec (IEEE 802.1AE)
- ✓ Экспорт Full NetFlow + возможность реакции на аномалии
- ✓ MPLS
- ✓ VXLAN
- ✓ LISP
- ✓ SPAN / RSPAN / ERSPAN

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Catalyst 3850/3650

For Your Reference

Differences & Similarities

Features / Scale	Catalyst 3650	Catalyst 3850
Stacking BW	160G / 9	480G / 9
Stackpower	No	Stackpower
Uplinks	Fixed uplinks	Modular uplinks
Stacking Module	Optional	Built-in
Memory/Flash	4GB /2GB	4GB / 2GB
Power	Dual (FRU)	Dual (FRU); XPS
L3 Features	OSPF, PIM, BGP, EIGRP	OSPF, PIM, BGP, EIGRP
Smart Operations	Client, Director	Client, Director
Trustsec	SGT MACSEC	SGT MACSEC
AVC	Flexible Netflow, CPRC Wireshark	Flexible Netflow, CPRC Wireshark
HA	SSO	SSO

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Cisco Catalyst 3850

- ❑ Новый стекируемый коммутатор (L3)
- ❑ Встроенные стек-модули для данных и питания
- ❑ Програмируемый ASIC UA-DP следующего поколения
- ❑ Медные / оптические порты 1G/10G + выбор аплинковых модулей

Поддерживает:

- ✓ Централизованное управление с Cisco PIv3
- ✓ ISE: SGT-ACL
- ✓ L2 шифрование MACSec (IEEE 802.1AE)
- ✓ Экспорт Full NetFlow + возможность реакции на аномалии
- ✓ MPLS
- ✓ VXLAN
- ✓ LISP
- ✓ SPAN / RSPAN / ERSPAN

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Стекирование (данные) на 3650/3850

480G

160G

Catalyst 3850

3 lengths of cable: 0.5m, 1m, and 3m

3 rings vs 1 ring in 3650

Catalyst 3650

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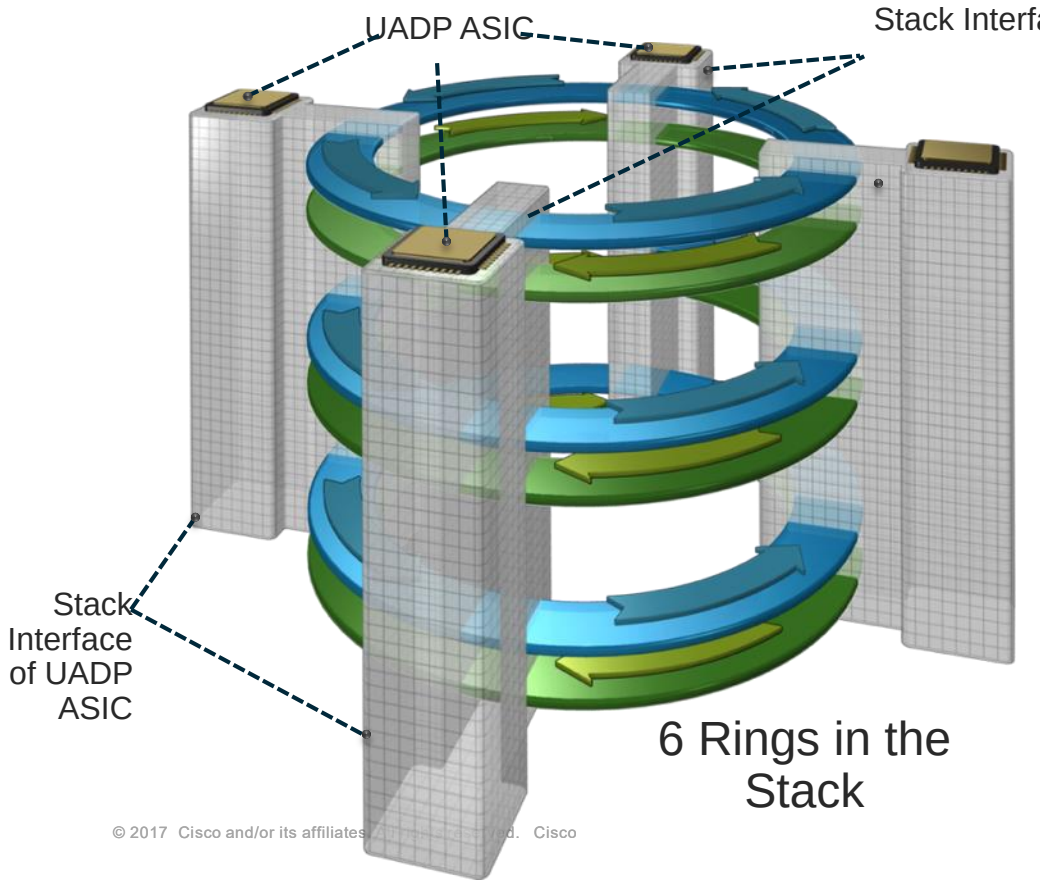
The Stack Ring

480 Gbps capacity



- 6 rings in total
- 3 rings go East
- 3 rings go West
- Each ring is 40Gbps
- 240Gbps uni-direction
- Spatial Reuse= 480Gbps

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Assuming 4 x 24-port 3850 Switches

Стекирование (питание) на 3850

“Zero-Footprint” RPS deployment

- Provides RPS functionality with Zero RPS Footprint
- Pay-as-you-grow architecture – similar to the Data Stack
- 1+N Redundancy with Inline Power
- Up to 4 Switches in a StackPower
- Multiple StackPower Possible within one Data Stack
- Flexible Installation, Better Efficiency

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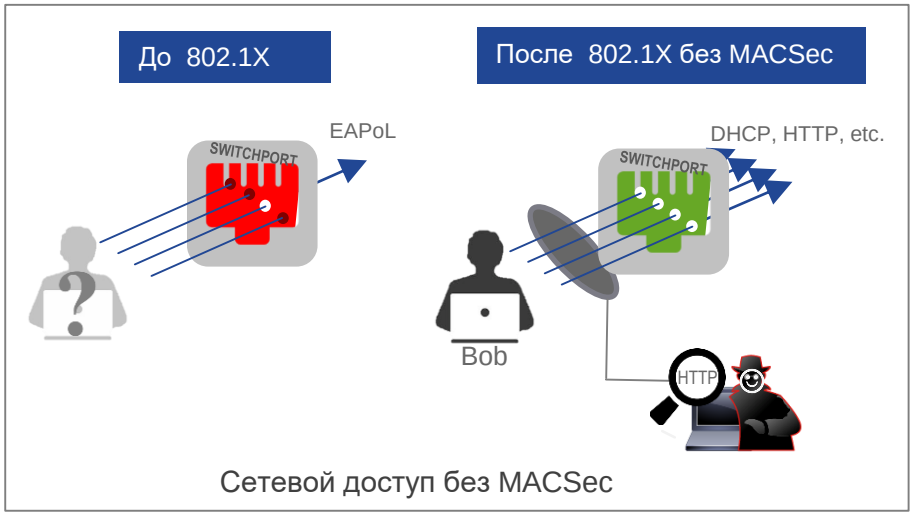
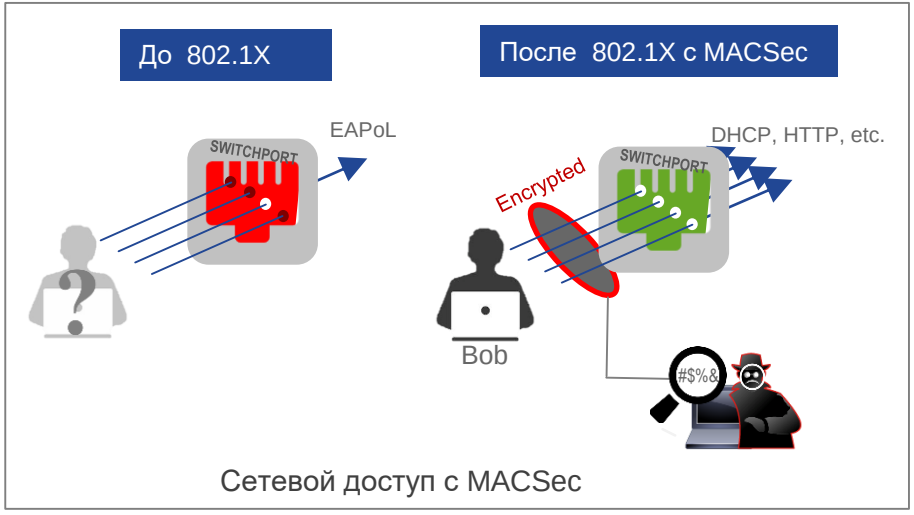
Что такое MACSec ?

MACSec был спроектирован для использования совместно с IEEE 802.1X





- Шифрование Ethernet кадров на скорости работы сетевого порта
- Полностью прозрачно для пользователей и приложений
- Дёшево (значительно дешевле, чем IPSec-VPN)

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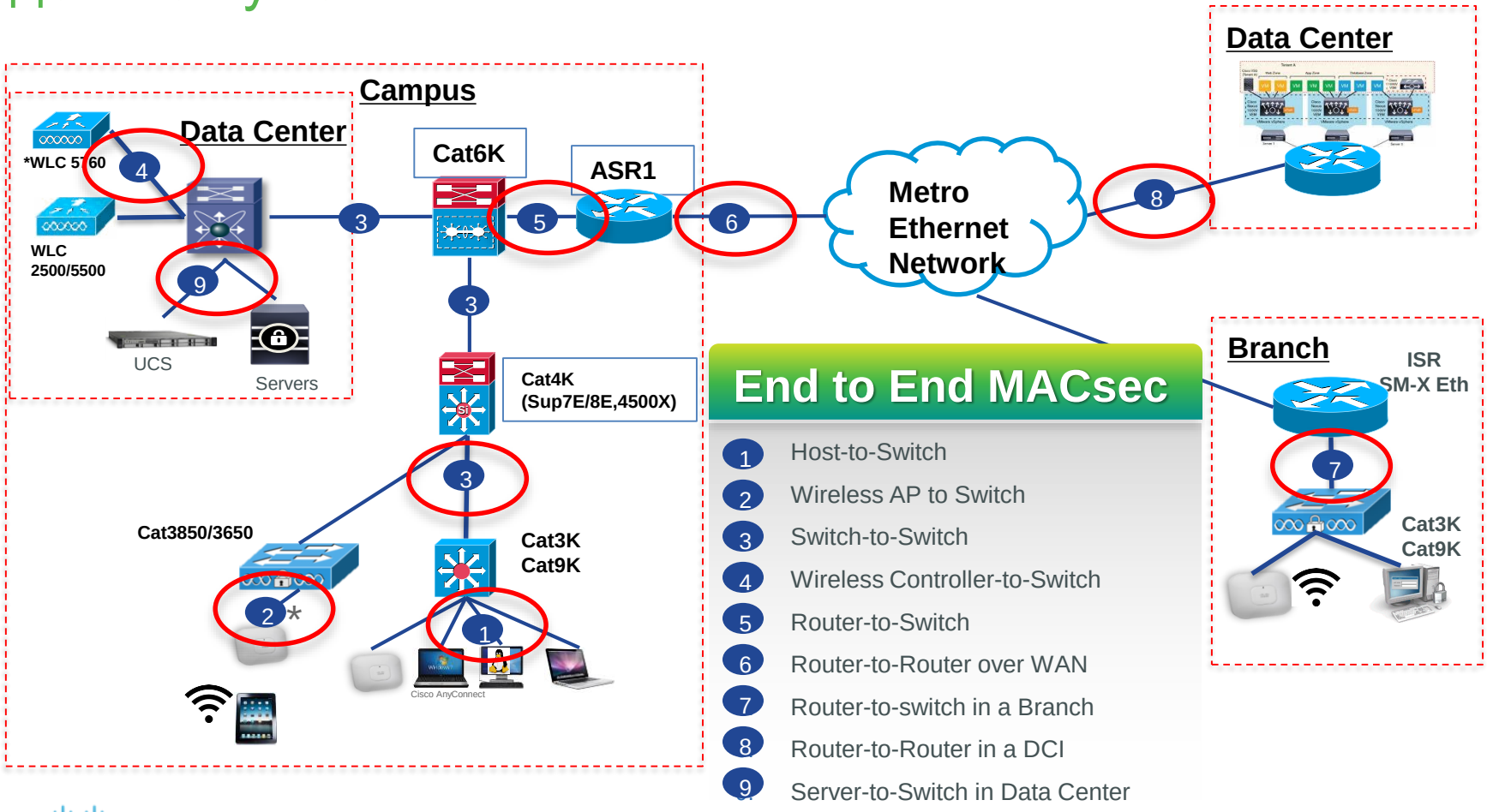
Где мне нужен MACsec?



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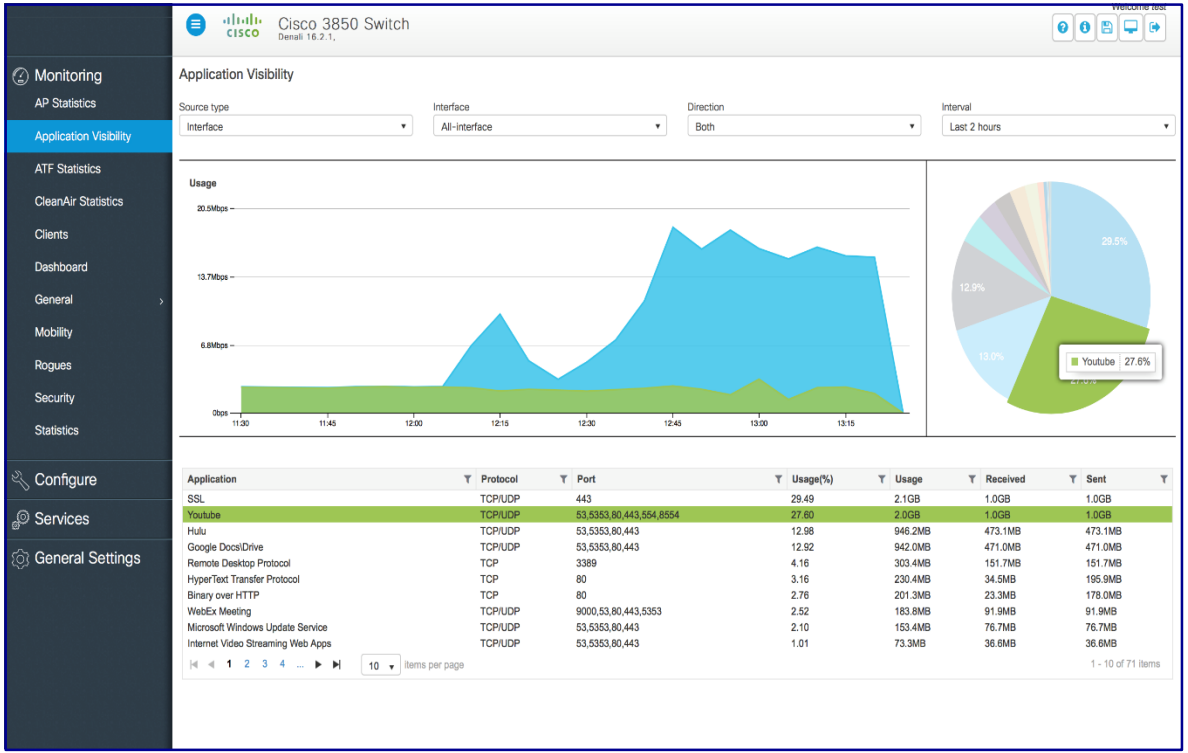
AVC on Catalyst 3850/9K

- Filter Monitoring Over Ingress/Egress interfaces and direction
- Identify Top Talkers
- Monitor Data over 2, 24 or 48 hours
- Monitor percentage Bandwidth usage



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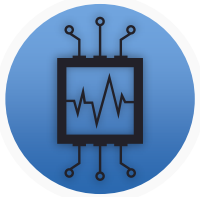
Используйте свою сеть по максимуму
Анализ NetFlow

Обнаружение аномалий

Обнаружение нарушений политик пользователями

Обеспечение видимости всего сетевого трафика

Сеть как сенсор (NaaS)



Сеть как защитник (NaaE)

Динамическая сегментация при обнаружении атаки

Внедрение контроля доступа на критических участках

Динамические политики доступа и контроля

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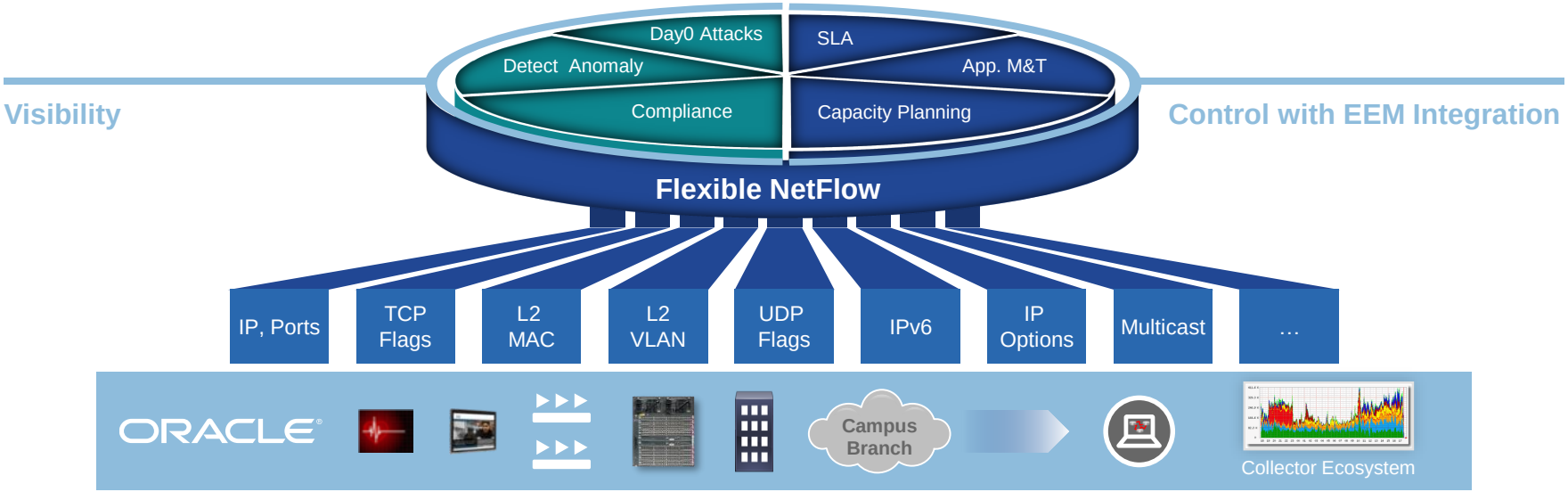
Flexible NetFlow

Unprecedented Application Visibility



BENEFITS

Lower CapEx

- Better insight for capacity planning, network upgrade

Lower OpEx

- Better service and user experience
- Increased IT staff productivity

FLEXIBLE NETFLOW CAPABILITIES

- Unprecedented visibility with new L2–7 fields
- Scalable, flexible flow monitors
- On-box customizable policy action with EEM
- Broad collector partner ecosystem

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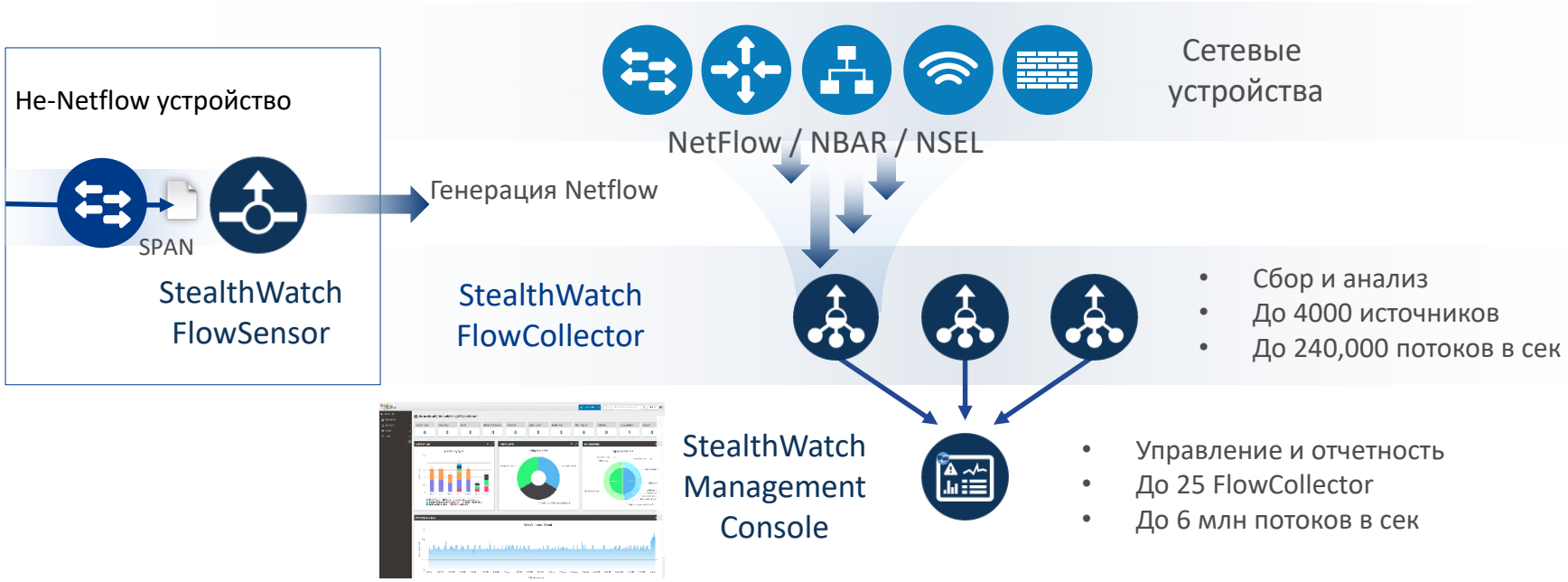
Обзор системы StealthWatch



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Интеграция сетевых устройств, системы сбора NetFlow (StealthWatch) и ISE

Network-as-an-Enforcer (NaaE)

Monitor

- Оценка «нормального» поведения сети
- Наблюдаемость трафика в реальном времени

Detect

- Поведенческий анализ
- Распознаване аномального поведения и атак

Analyze

- Хранение и анализ данных
- Готовность к аудитам
- Поиск первопричин
- Расследоване инцидентов

Respond

- Скорость поиска проблем и обнаружения атак
- Автоматическа реакция на аномалии и атаки
- «Забрать доступ» или «поместить в карантин»

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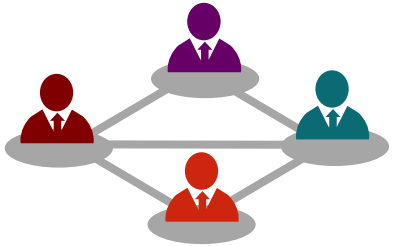
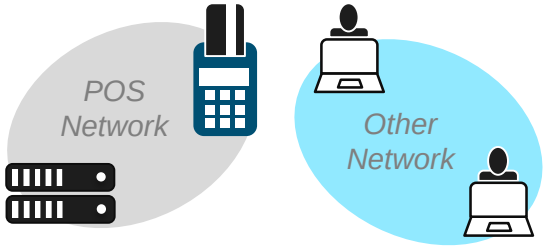
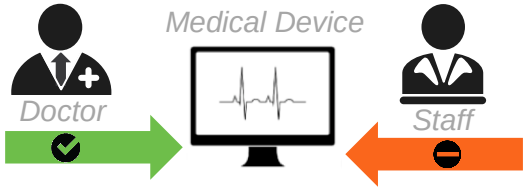
MPLS on Catalyst 3850/9K



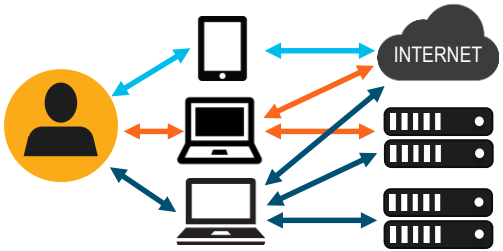
Line of business – BU segmentation



Payment Card Industry

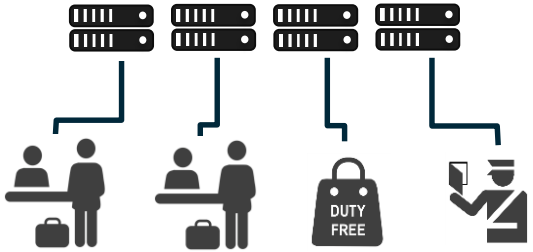


Hospital Network



Bring-Your-Own-Device (BYOD)

Mergers and Acquisitions



Multi-Tenancy

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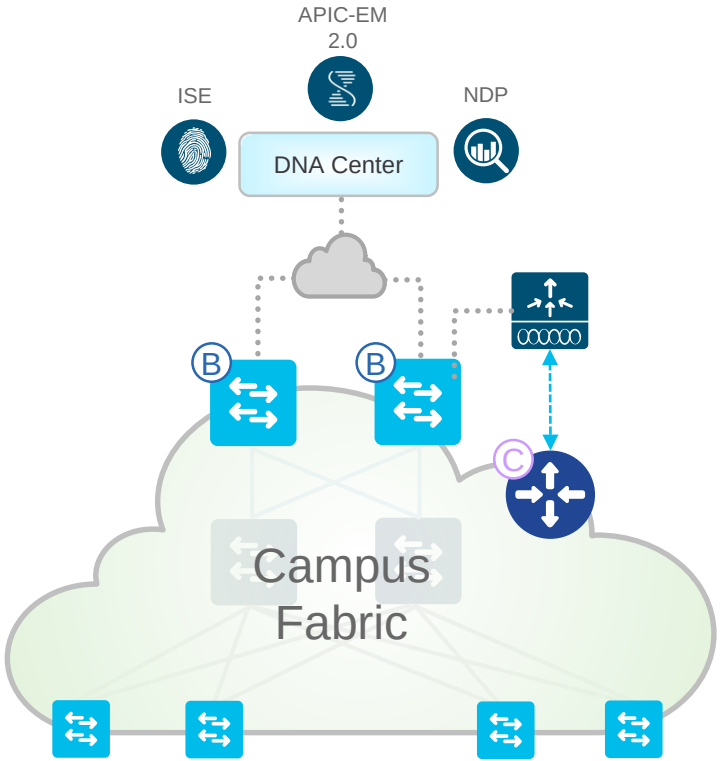
Что такое SD-Access?

Campus Fabric + DNA Center (Automation & Assurance)



- **SD-Access**

  GUI approach provides automation & assurance of all Fabric configuration, management and group-based policy.

  Leverages DNA Center to integrate external Service Apps, to orchestrate your entire LAN, Wireless LAN and WAN access network.

- **Campus Fabric**

  CLI or API form of the new overlay Fabric solution for your enterprise Campus access networks.

  CLI approach provides backwards compatibility and customization, Box-by-Box. API approach provides automation via NETCONF / YANG.

  APIC-EM, ISE, NDP are all separate.

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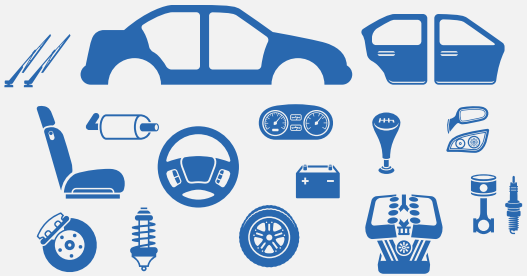
Simplification Creates Agility

DO-IT-YOURSELF ASSEMBLY AND INTEGRATION



SDN

READY TO GO

SD-Access

Faster Time to Market and Lower OpEx

Applications Are the Vehicle for Digital Business

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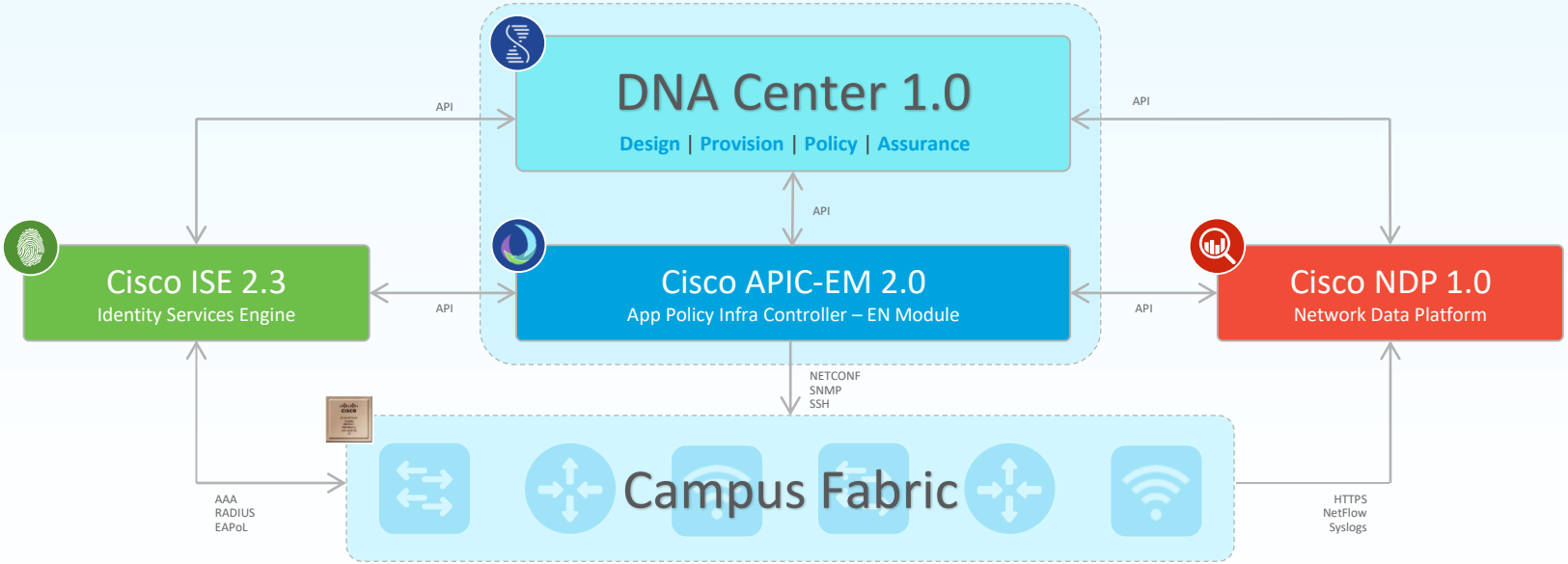
SD-Access

DNA Center – Service Components



Cisco Switches | Cisco Routers | Cisco Wireless

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Что «под капотом» SD-Access?

❑ **Набор софта:**

- Веб-интерфейс (DNA-C) на базе SDN-контроллера (Cisco APIC-EM v2)
- Cisco ISE для контроля ролевого и контекстного доступа к сети
- [опция] NDP для мониторинга
- [опция] StealthWatch для мониторинга (включая ETA) и Rapid Threat Containment (RTC)

❑ **Совместимое железо:**

- Поддержка LISP
- Поддержка VXLAN
- Поддержка SGT enforcement
- Поддержка Campus Fabric
- Поддержка VRF
- **[рекомендуемая опция]** Оборудование созданное с заделом на SD-Access (Catalyst 9k)

❑ **Cisco Validated Design**

https://www.cisco.com/c/dam/en/us/td/docs/solutions/CVD/Campus/CVD-Software-Defined-Access-Design-Guide-2017AUG.pdf

SD-Access – поддержка на оборудовании

Полная защита инвестиций

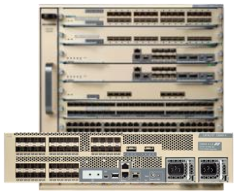
Switching

Catalyst 9400

Catalyst 9300

Catalyst 9500

Catalyst 4500E



Catalyst 6K

Nexus 7700

Catalyst 3850 and 3650

Routing

ASR-1000-X

ASR-1000-HX

ISR 4430

ISR 4450

CSRv

Wireless

AIR-CT5520

AIR-CT8540

Wave 2 Aps
(1800, 2800,3800)

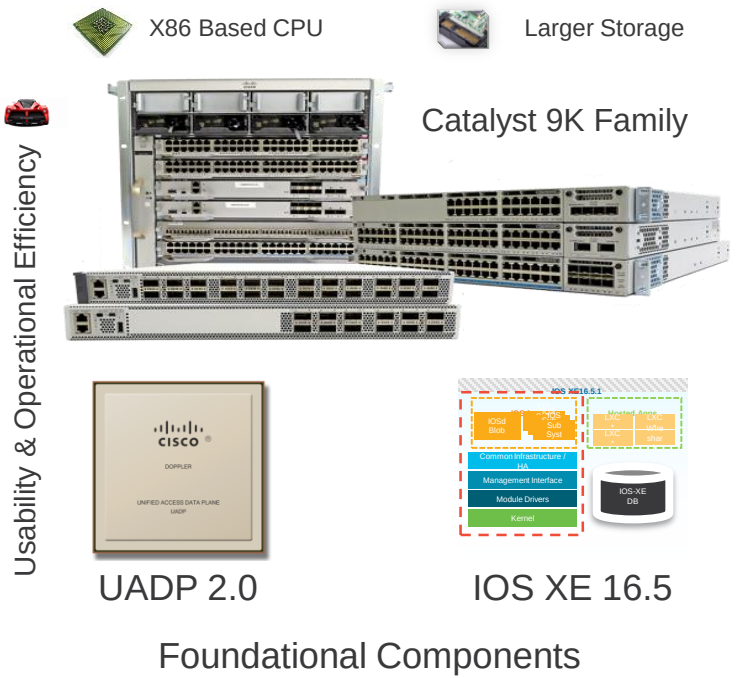
Wave 1 Aps
(1700, 2700,3700)*

Subtended Nodes

CDB

2960-CX
3560-CX

Catalyst 9K enables the New Era of Networking



Encrypted Traffic Analytics (ETA)

Resiliency with Patching & GIR

Programmability & Automation

Standards Leadership .3bt, .3bz, etc

Real time Streaming Telemetry

SD Access

Trustworthy Systems

3rd Party App Hosting

Fabric Enabled Wireless

Catalyst 9K – Built to see you through Next Decade

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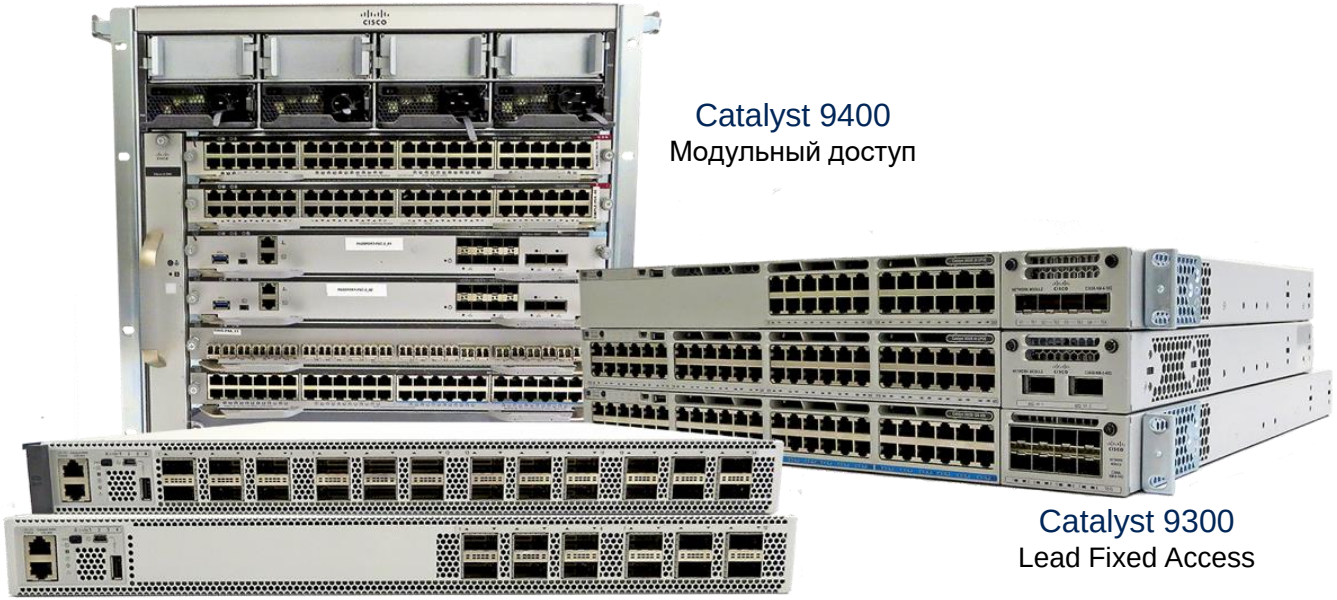
Семейство коммутаторов Catalyst 9K



Catalyst 9400
Модульный доступ

Catalyst 9300
Lead Fixed Access

Catalyst 9500
Lead Fixed Core

Cisco Catalyst 9000 инновации
UADP 2.0
Cisco IOS® XE Software
SD-Access
x86 CPU and containers
Encrypted Traffic Analytics (ETA)*
AES256/MACSEC256*
Trustworthy systems
StackWise® Virtual*
IEEE1588 and AVB*
NBAR2
Perpetual/fast PoE
Model-driven programmability
Patching/GIR
Streaming telemetry*

Единое ПО, возможности, лицензирование

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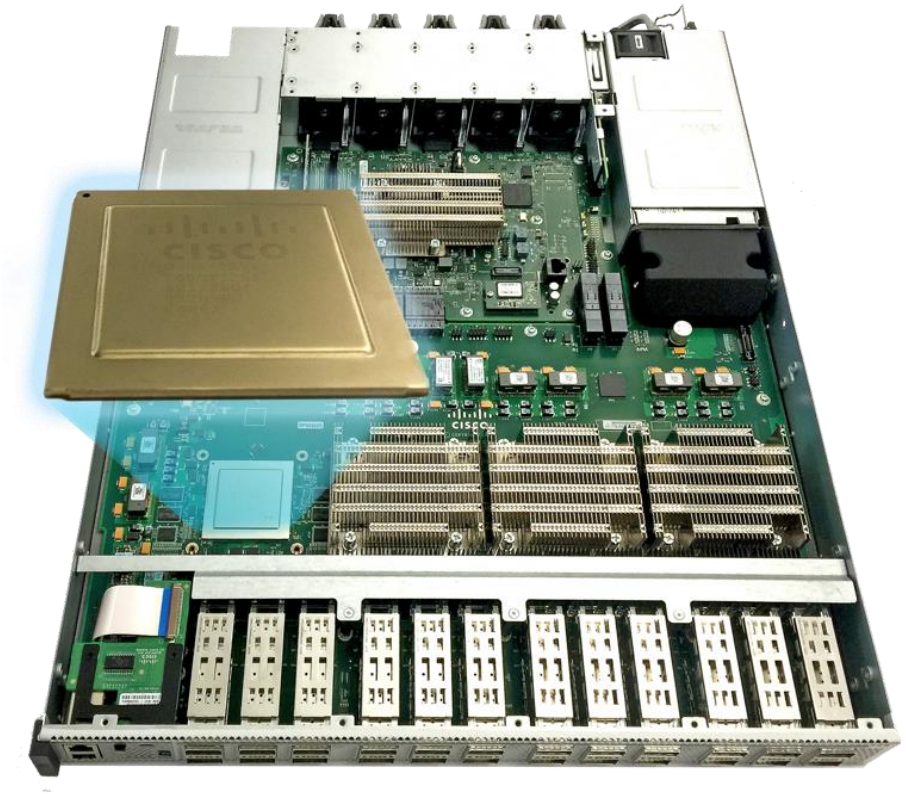
UADP 2.0 – Инновационный программируемый ASIC

- **Investment Protection**
  Flexible Pipeline
- **Universal Deployments**
  Adaptable Tables
- **Enhanced Scale/Buffering**
  Multicore resource share



384K Flex Counters

Shared Lookup

Up to 240GE Bandwidth

Up to 2X to 4X forwarding + TCAM

Embedded CPUs

Up to 32MB Packet Buffer

Up to 64K x2 Netflow Records

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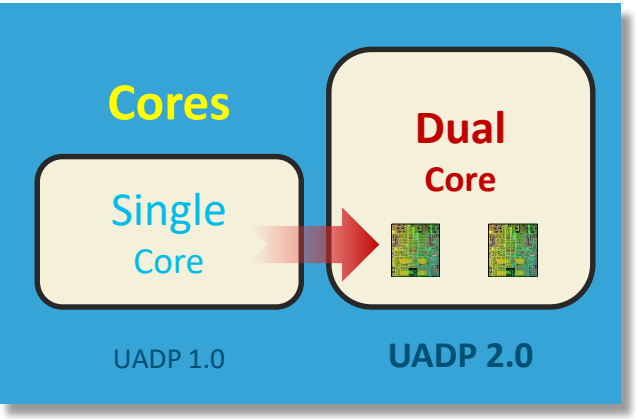
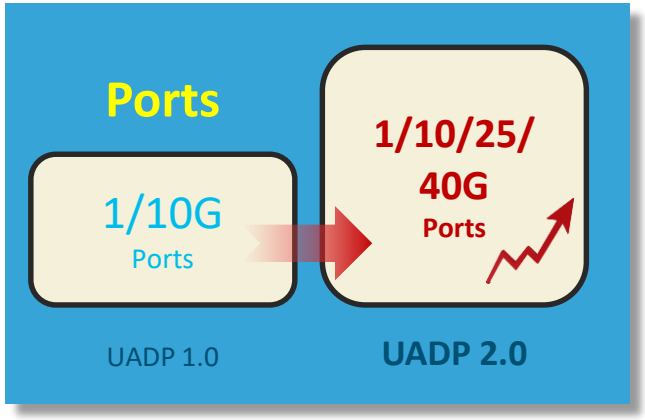
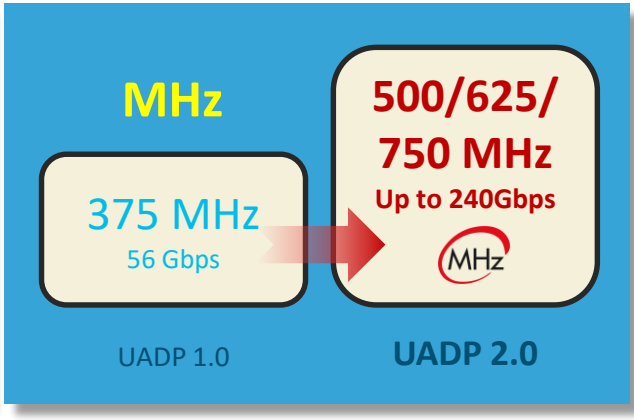
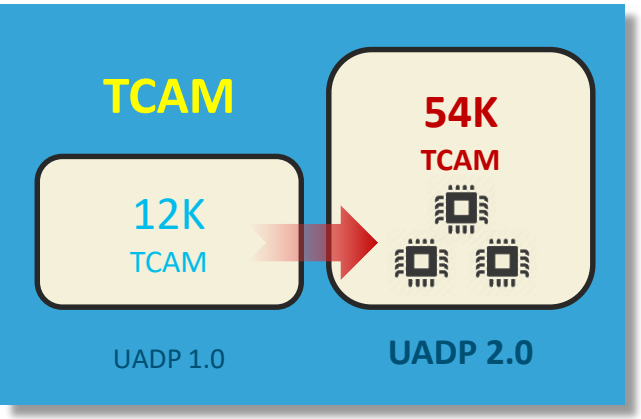
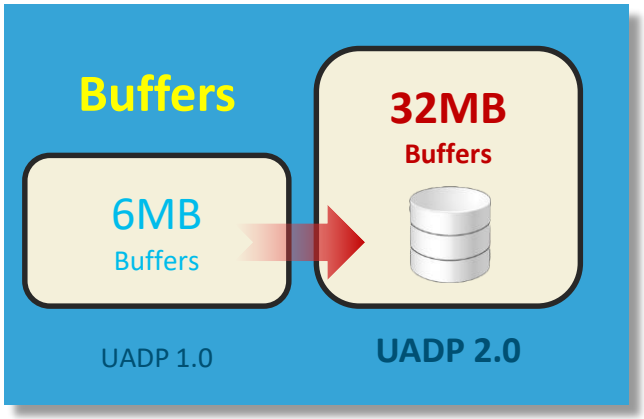
UADP Evolution – 1.0 vs 2.0











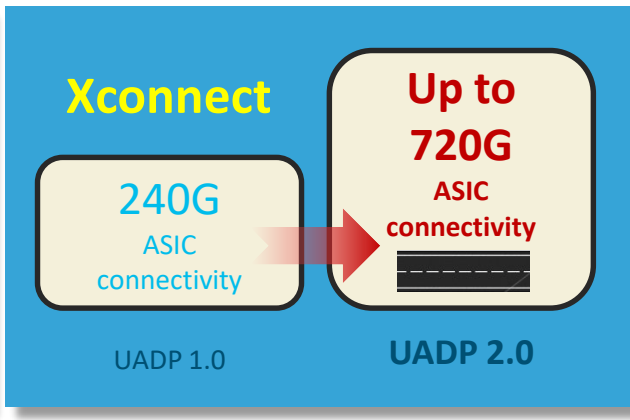


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Table 4 *SD-Access Edge Node Scale Constraints*

	Catalyst 3850/3650	Catalyst 9300	Catalyst 4500 Supervisor 8-E	Catalyst 9400 Supervisor Engine-1
Virtual Networks	64	256	64	256
Scalable Group Tags	4,000	8,000	2,000	8,000
Security Group ACLs	1,500	5,000	64,000	18,000

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Table 5 *SD-Access Border Node Scale Constraints*

	Catalyst 3850 (Fiber)	Catalyst 9500	Catalyst 6800	Nexus 7700 Supervisor 2E	ASR 1000 and ISR 4000
Virtual Networks	64	256	512	500	4,000
Scalable Group Tags	4,000	32,000	30,000	64,000	64,000
Security Group ACLs	1,500	32,000	30,000	64,000	64,000
IP to SGT Mappings	2,000	32,000	30,000	64,000	64,000
Fabric Control Plane Entries	4,000	96,000	25,000	Unsupported	200,000
IPv4 Routes	8,000	48,000	48,000	1,000,000 (XL) 256,000 (non-XL)	4,000,000 (16GB) 1,000,000 (8GB)
IPv4 Host Entries	16,000	96,000	48,000	1,000,000 (XL) 256,000 (non-XL)	4,000,000 (16GB) 1,000,000 (8GB)

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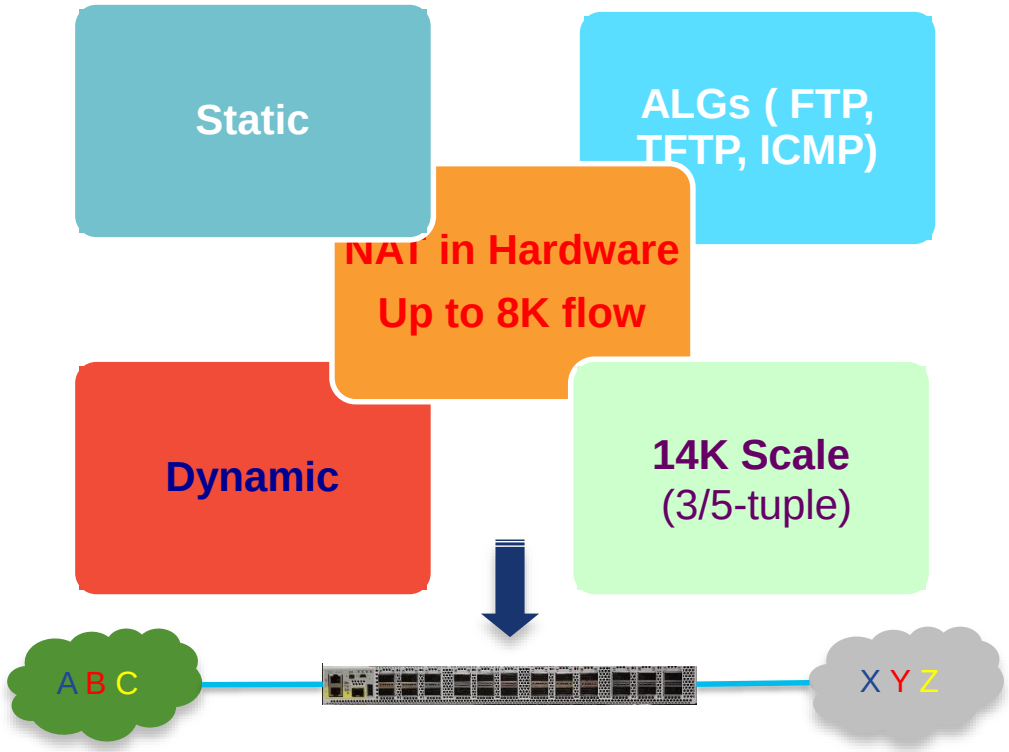
NAT/PAT on Catalyst 9500



INSIDE	OUTSIDE
A	X
B	Y
C	Z

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Network Requirements from Security

Before

Reduce Attack Surface
by Segmentation,
Access Control & Encryption

Software Defined Access

During

Malware & Threat Detection
through behavioral analytics

ETA

After

Rapid threat containment
through automated incident response

NaaE

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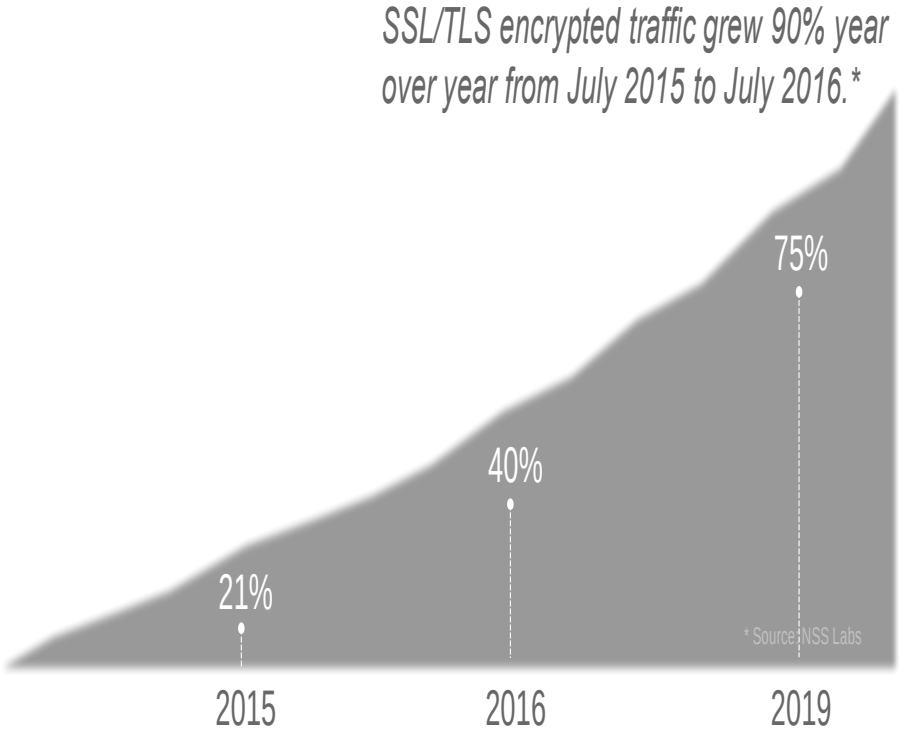
Encrypted Traffic is increasing



- Volume of encrypted traffic increased 21% → 40% from 2015→ 2016 (90% year over year)
- Gartner Predicts - 80% of all the web traffic will be encrypted by 2019
- 77% of all requests to Google servers are encrypted (in Feb 2016)
- 97% of Youtube traffic is encrypted

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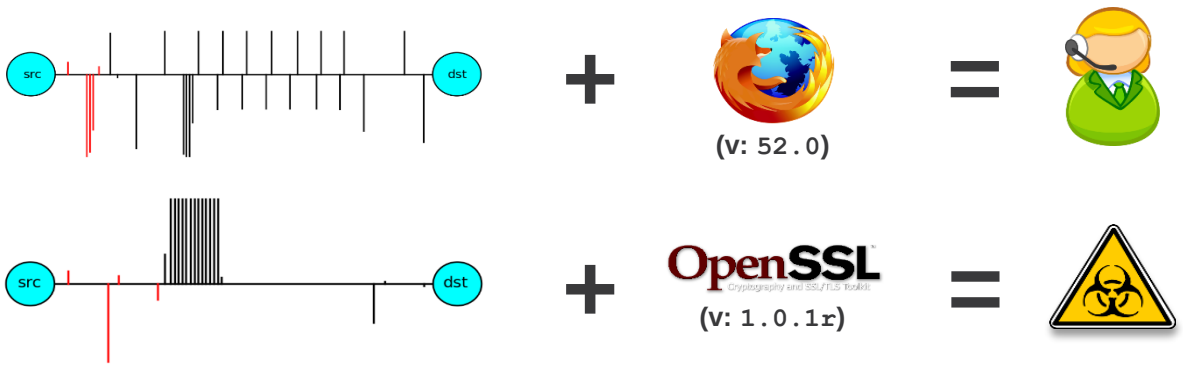
Как узнать в шифрованном трафике «зло»?

- 6 лет сбора статистики + машинное обучение + аналитика
- 180 патентов
- **Множество методов и техник**
- Точность 99%
- Ложных срабатываний 0,01%



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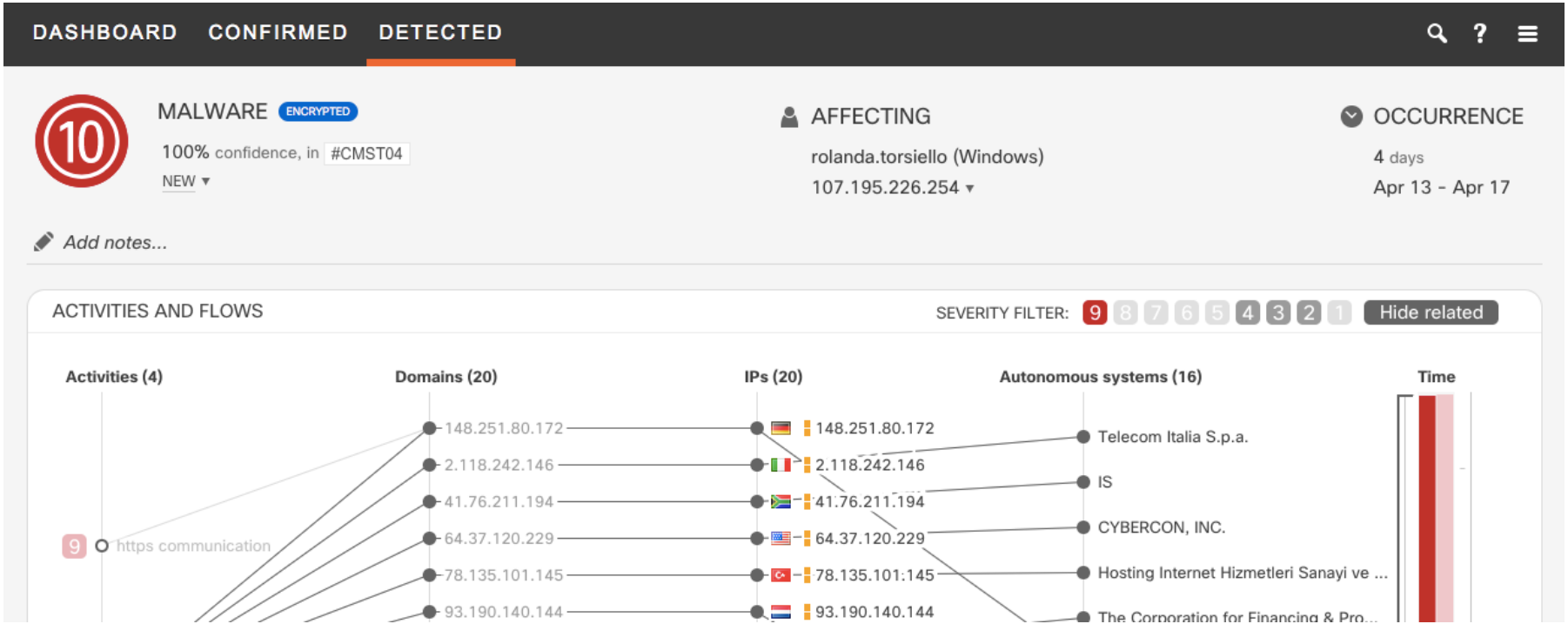
Encrypted Traffic Analytics: Example Incident



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Краткое сравнение

	Prime Infra v3	APIC-EM	L3	SPAN	NetFlow	SGT-ACL	MACSec	MPLS	ETA
2960L		PnP	LAN Lite	1 SPAN					
2960X		PnP, PT, QoS	Routed access	4 SPAN / RSPAN	NaaS	SXP			
3650		SDA	IP Serv VRF	ERSPAN	NaaE	1500	Все порты		
3850		SDA	IP Serv VRF	ERSPAN	NaaE	1500	Все порты		
9000		**SDA**	IP Serv VRF	**ERSPAN**	NaaE	5000	Все порты		

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