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IOx 2.0 – Docker all the way

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DEVNET-2529

CISCO *Live!*

Barcelona | January 27–31, 2020



Agenda

- Edge Compute and IOx
- IOx application packages
- Demo
- Docker on IOx
 - Native Docker support
 - Docker remote workflow
- Demo
- Wrap up

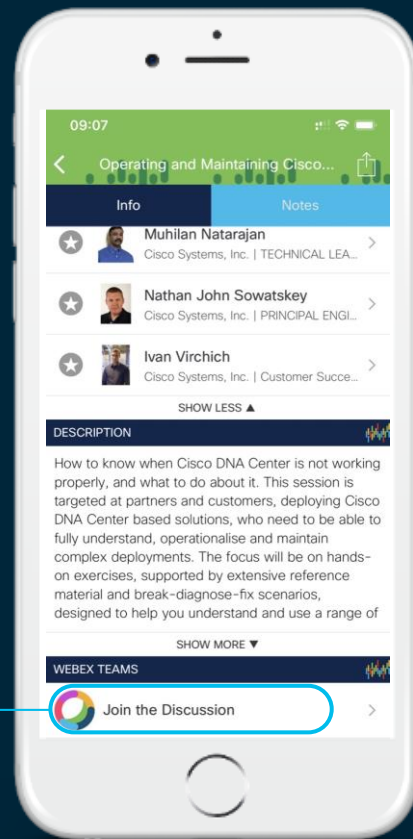
Cisco Webex Teams

Questions?

Use Cisco Webex Teams to chat with the speaker after the session

How

- 1 Find this session in the Cisco Events Mobile App
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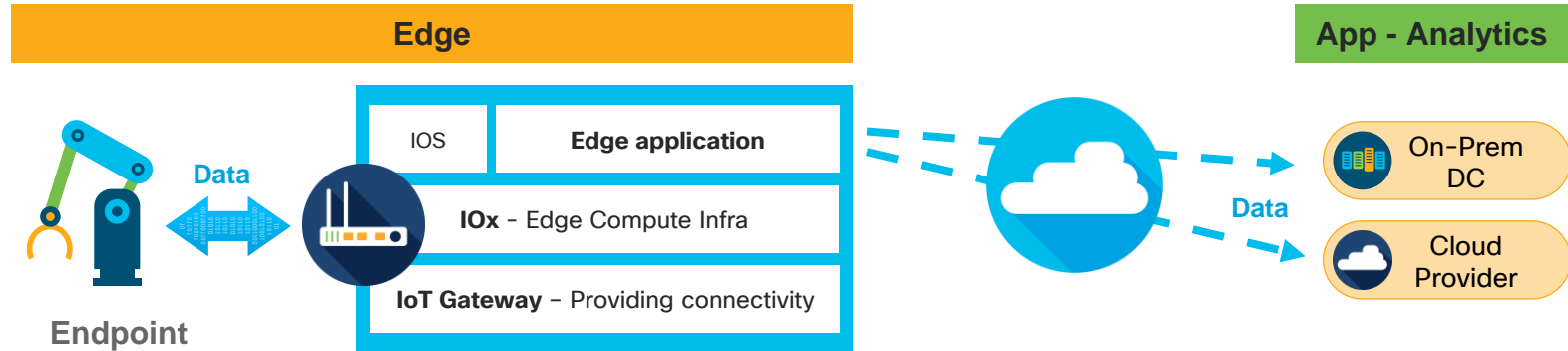
Edge compute and IOx

*A distributed
computing paradigm which
brings computation and data
storage closer to the location
where it is needed*

Wikipedia

Edge Computing

Near-edge, decentralized processing of data



Take processing to the data to improve latency and reduce bandwidth requirement

Why compute at the edge?

There may not be enough network bandwidth



Data reduction

Most of the data is not interesting



Filtering

The use of data may be at the edge



Latency optimization

Computation can be optimized for some purposes



Partitioning

Data normalization



Application simplification

Data redirection based on the content of the data



Dynamic changes

Edge computing – use case examples



Traffic control and driver safety

Collect data from vehicle and weather sensors to control traffic lights and display warning dashboard



IC3000



Reduce machine downtime

Collect machine data and perform analytics to eliminate machine down time

IOx

IR829



Fleet management

Real-time Telemetry for operational efficiency and driver analysis

IOx

IR829



Secondary substation automation

Remotely configure and operate Virtual SCADA for telemetry and automation

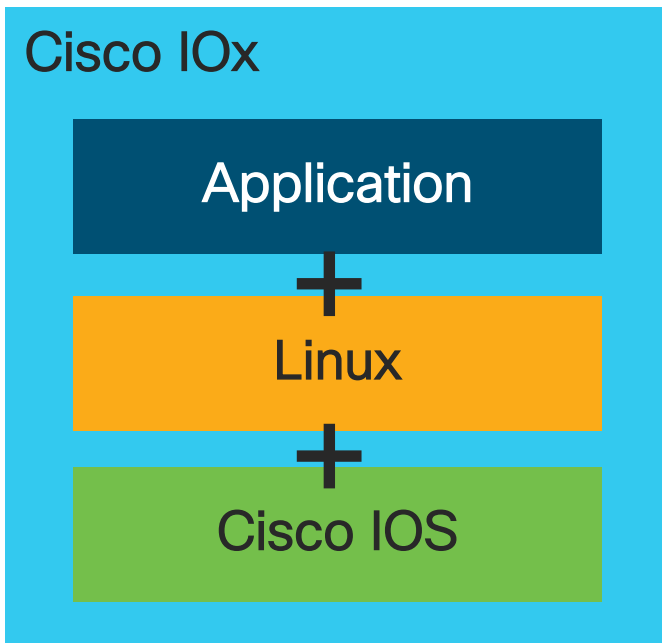
IOx

IR1101

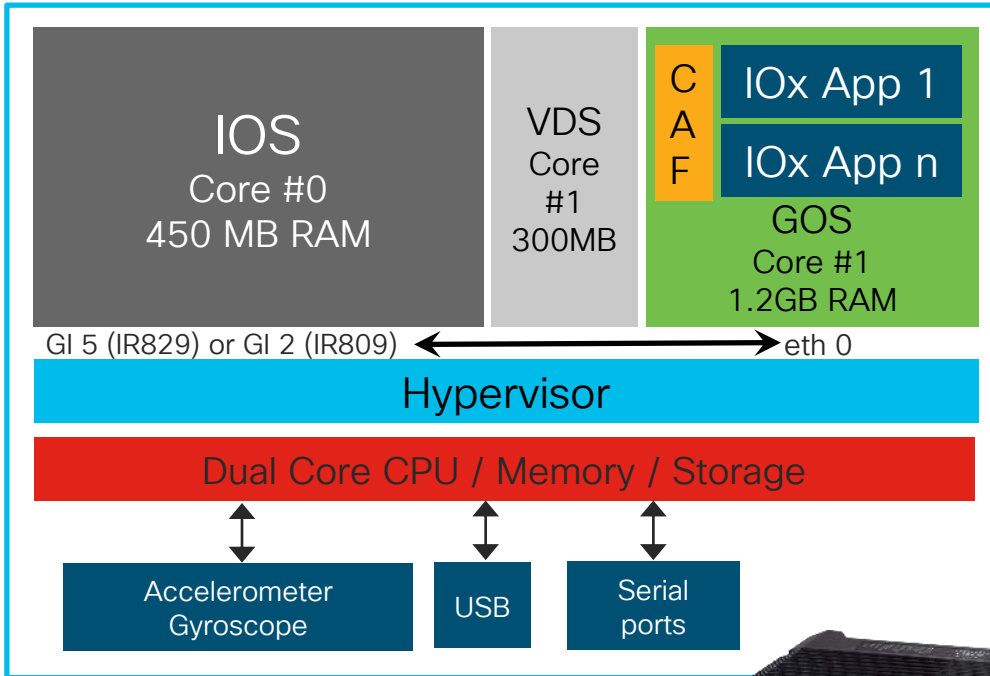


Cisco IOx

- Enables **hosting applications** and services **at network edge**
- Available on different Cisco hardware platforms
- Full application **life cycle**:
 - Development
 - Distribution and Deployment
 - Hosting
 - Monitoring and Management
- Leverage **secure connectivity** of Cisco IOS
- On-prem or cloud-based management



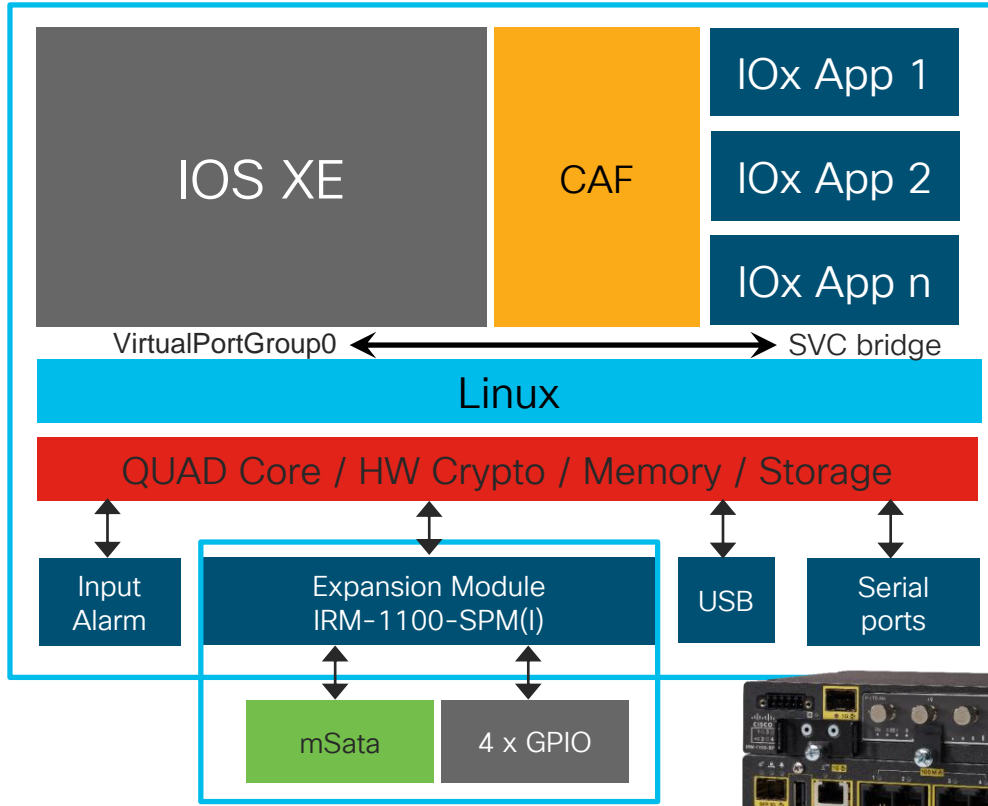
Cisco IOx – Architecture example (IR829)



- Type 1 **Hypervisor** running directly on the IR800 hardware
- Virtual Device Server (VDS) – handles device's sharing, eg. Console, USB,...
- Guest-OS (GOS) hosts IOx applications
- Full **isolation** between IOS and GOS
- Communication through **internal virtual Ethernet** connection



Cisco IOx – Architecture example (IR1101)



- IOS running on **Linux**
- **CAF** (Cisco Application Framework) running as a process
- CAF controls IOx applications and resources
- L3 IOS communication through **internal VirtualPortGroup**
- **vNIC** per application/container
- CPU Architecture: **ARM 64v8**

Cisco IOx – Portfolio

Compute Gateway

Dedicated **compute gateway** designed to be fully secure and remotely managed



IC3000

Network with Edge compute

Lower TCO with **integrated network and edge-compute** functionalities. Extensive coverage of connectivity options (cellular, WiFi, Ethernet, Low power Mesh etc.)



IR809



IR1101



IR829



Catalyst IE3x00



CGR 1120, 1240
& compute module

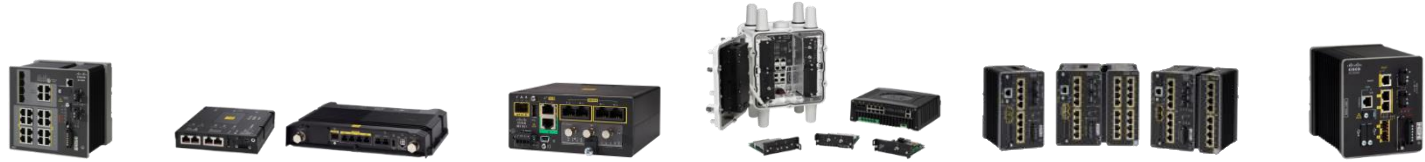
Purpose-build for Industrial environments

Ruggedized | Built for IoT | Industries Certified

Proven Cisco Technology

Intent-based Networking to the IoT Edge

Cisco IOx – IoT platform hardware overview



	IE4000	IR8x9	IR1100	CGR 1000	IE3400	IC3000
Ruggedized HW	IP30 -40° C to +70° C	IR809: IP30 IR829: IP40 -40° C to +60° C	IP30 -40° C to +60° C	CGR1120: IP30 CGR1240: IP67 -40° C to +70° C	IP30 -40° C to +75° C	IP30 -40° C to +60° C
Architecture	PPC32	X86_64	ARMv8	X86_64	ARMv8	X86_64
CPU	PowerPC ~600 MHz 1 dedicated core for IOx	Intel Rangeley 1.25GHz 2-core with 50% of one core to IOX	Marvell 4-core ARMv8 Cortex- A72 CPU, 1.2GHz	4-Core 800Mhz AMD Gx-410VC on Compute module	4-core Zynq UltraScale+ ARMv8 Cortex- A53 - 1.2GHz	Intel Rangeley 1.25GHz 4- core
Memory	512 MB	2GB with 760MB for IOX	4GB with 2GB for IOX	4GB	4GB with 2GB for IOX	8GB
Storage mSATA for R/W longevity	256 MB flash storage	512MB-1.5GB storage, 50-100GB (mSATA SKU)	4 GB with 2 GB reserved for IOX	64 (50)- 128 (100) GB mSATA	2 GB + SD	64 -128 GB mSATA

IOx Application Packages

IOx Application Packages

- Compressed **packages of code or binaries** that can be deployed to the Cisco Application Hosting Framework (CAF)
- Different **types** of applications depending on your needs
 - **Docker** container based
 - Platform as a Service (**PaaS**)
 - Linux Container (**LXC**)
 - Kernel Virtual Machine (**KVM**)
- IOx application package :
 - Package Descriptor
 - Package Configuration
 - Binaries, code, libs, virtual disks, root FS, images
- **Different architectures**: x86, ARM, PowerPC



IOx Application Packages

Example package.yaml

- **Lifecycle**: Deployed – Activated – Running
- Package descriptor: **package.yaml**
 - Required resources
 - Required devices
 - Network configuration
 - Command to run
 - ...
- **config.ini**: Configuration bootstrapping
- **activate.json**: Set activation options

```
descriptor-schema-version: "2.2"

info:
  name: "iox_docker_pythonweb"
  description: "simple Python Webserver"
  version: "1.0"
  author-link: "http://www.cisco.com"
  author-name: "Jens Depuydt"

app:
  cpuarch: "x86_64"
  type: docker
  resources:
    profile: c1.small
    network:
      -
        interface-name: eth0
        ports:
          tcp: [9000]

  startup:
    rootfs: rootfs.tar
    target: ["python", "/webserv.py", "9000"]
```

IOx Application Packages – Local Manager

Local IOx application management with GUI

Deploy, activate, start and troubleshoot IOx application packages for a single device

The screenshot displays the Cisco IOx Local Manager web interface. At the top, the Cisco logo and 'Cisco Systems Cisco IOx Local Manager' are on the left, and user information 'Hello, developer | Log Out | About' is on the right. A navigation bar contains tabs: Applications (selected), Cartridges/Layers, System Info, System Setting, System Troubleshoot, and Device Config.

The main content area shows three application cards:

- webservice** (status: RUNNING): simple docker python webserver on port 9000. Type: docker, Version: 1.0, Profile: c1.medium. Resource usage: Memory 2.0%, CPU 3.9%. Actions: Stop, Manage.
- MQTT** (status: DEPLOYED): simple IOX MQTT random generator to topic iox/test. Type: docker, Version: 1.2, Profile: c1.small. Resource usage: Memory 1.0%, CPU 1.9%. Actions: Activate, Upgrade, Delete.
- NodeJS** (status: ACTIVATED): Simple Docker Style app that runs a nodejs server. Type: docker, Version: 1.0, Profile: c1.small. Resource usage: Memory 1.0%, CPU 1.9%. Actions: Start, Deactivate, Manage.

IOx Application Packages – ioxclient

- **CLI tool** to manage IOx on devices
- Can be used to package apps
- OS X, Windows, Linux

```
[jedepuyd@cen7 ~]$ ioxclient app list
Currently active profile : lab
Command Name: application-list
Saving current configuration
List of installed App :
1. webserver ---> RUNNING
2. MQTT ---> DEPLOYED
3. NodeJS ---> ACTIVATED
[jedepuyd@cen7 ~]$ ioxclient app stop webserver
Currently active profile : lab
Command Name: application-stop
App webserver is Stopped
```

IOx Application Packages - Steps

1. **Build**: Container (LXC or Docker), VM or PaaS app (Python or Java)
2. **Prepare** for deployment (for example: export root FS)
3. Create **package.yaml**
4. Create IOx **package** using ioxclient
5. **Deploy**
6. **Activate**
7. **Start**
8. ***Profit***



DEMO – IOx Application Packages

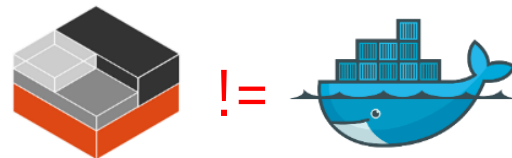
Docker on IOx platforms

Docker on IOx – Before native Docker

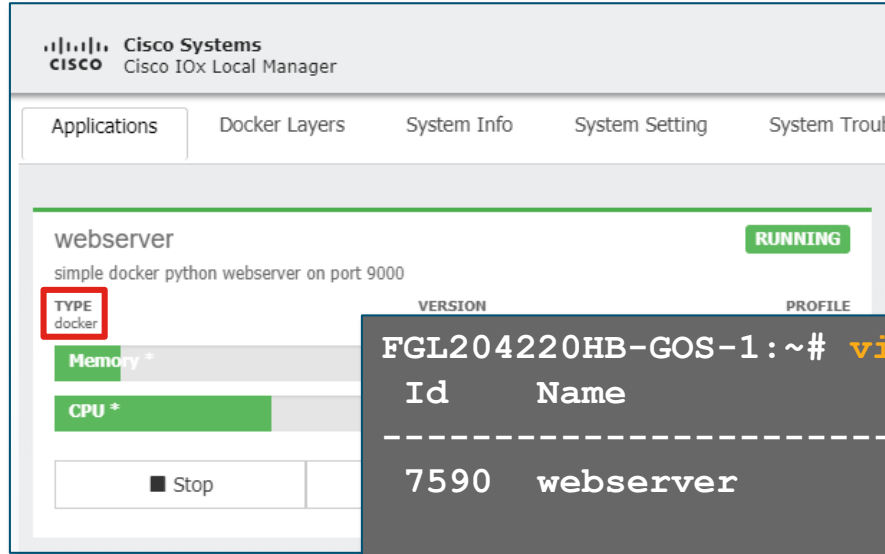
IOx supports running Docker containers since IOx AC3 (version 1.2)

Steps when deploying a Docker containers with IOx <AC9

1. CAF parses the docker image format
2. Understands the dependencies and ordering from the image layers.
3. Uses AUFS to union mount the layers in the appropriate order
4. Puts a READ/WRITE layer as the top most layer
5. Applies SMACK labels to the entire rootfs similar to LXC
6. **Creates LXC container and runs with libvirt lxc driver**



Docker on IOx – Before native Docker



```
FGL204220HB-GOS-1:~# virsh -c lxc:/// list
Id      Name                               State
-----
7590    webserver                          running
```

```
FGL204220HB-GOS-1:~# virsh lxc-enter-namespace webserver /bin/sh
FGL204220HB-GOS-1:/# cat /proc/1/cgroup
10:debug:/
9:perf_event:/apphosting.partition/lxc-7590-webserver.libvirt-lxc
8:net_cls:/apphosting.partition/lxc-7590-webserver.libvirt-lxc
...
```


Docker on IOx – Native Docker

Non-native Docker causes **difficulties with porting** existing Docker based containers to IOx due to **lack of compatibility**.

Any Docker image that runs on my PC **should run 'as-is'** on IOx platforms (keeping in mind architecture/resource constraints)

IOx AC9 introduced **native Docker** for a limited set of IOx platforms

- Full life cycle management of native docker apps through ioxclient/LM/FND/...
- Backwards compatibility
- Support for limited list of docker-runtime options .
- Shared volumes between containers, tmpfs mount, --net/--network and bind mount
- Layer by layer installation support for docker type apps.
- Bridge, Nat, Container and None type network support for native docker containers

Docker on IOx – Native Docker



Cisco Systems
Cisco IOx Local Manager

Applications Docker Layers System Info System Setting System Troubleshooting

webserver
simple docker python webserver on port 80

TYPE
docker

Memory *
CPU *

■ Stop

```
root@ic3k:~# virsh -c lxc:/// list
```

Id	Name	State
----	------	-------

```
root@ic3k:~# docker ps
```

CONTAINER ID	IMAGE	COMMAND
CREATED	STATUS	PORTS
NAMES		
c5b0a20b0a23	ioxpythonweb:1.0	"python /webserver.p..."
About a minute ago	Up About a minute	
webserver		
43322c999d72	cisco_sleep:latest	"/bin/sleep 10000000..."
About a minute ago	Up About a minute	0.0.0.0:40000->9000/tcp
webserver_sleep		

Docker on IOx – Remote Docker workflow

IOx AC10 introduced **remote Docker workflow**:

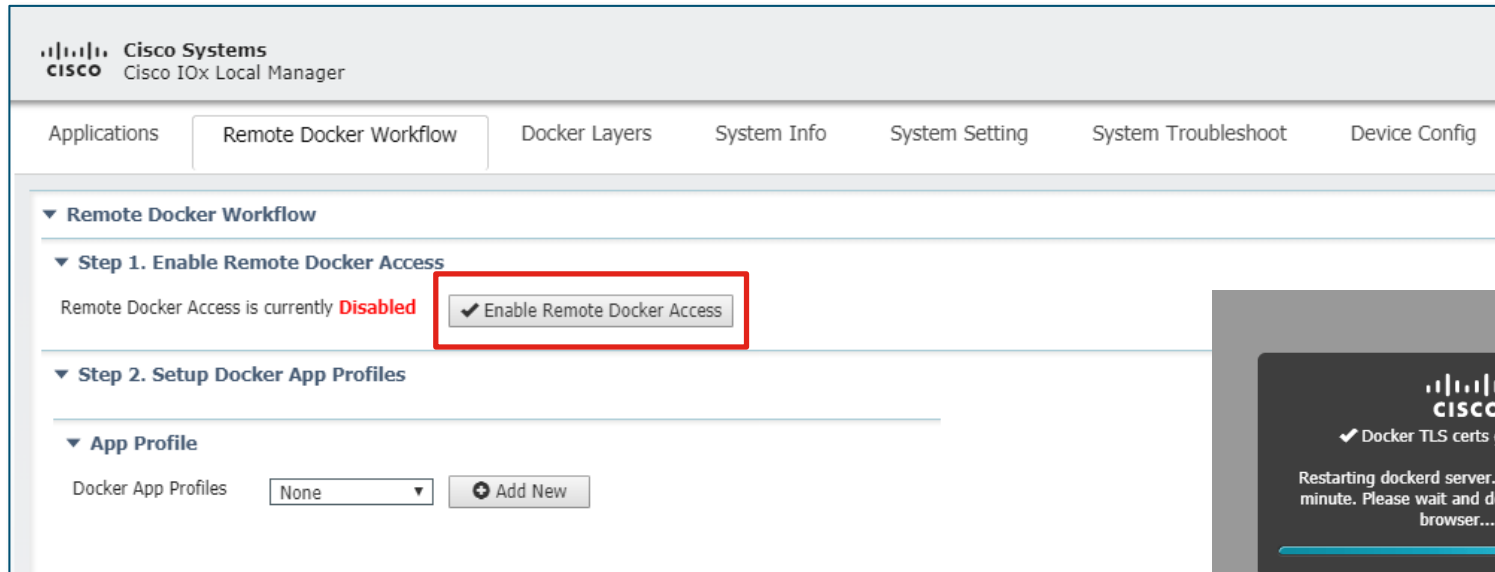
- **Directly deploy** containers without going through the full packaging cycle
- Containers installed through remote docker workflow are not manageable via ioxclient/LM/FD/GMM
- Use **docker cli for end-to-end app development**
- No ioxclient packaging
- **Minimal Cisco/IOx-specific knowledge required** for app development
- **Quick on-boarding** of new developers
- Easy for expert developers to **quickly iterate** through app development process

Remote Docker workflow – Get started

1. **Enable** remote docker engine access via Local Manager
2. Create **docker app profile** with required resources: cpu, memory, disk, network interfaces and peripherals via Local Manager
3. App profile creation will generate associated docker runtime options for usage from docker run command
4. Setup **remote docker engine access environment** in development machine
5. **Use** the generated docker run options and desired docker image for app development

Remote Docker workflow - Enable

By default, Docker engine web server on Cisco platform is disabled



Cisco Systems
Cisco IOx Local Manager

Applications | **Remote Docker Workflow** | Docker Layers | System Info | System Setting | System Troubleshoot | Device Config

▼ Remote Docker Workflow

▼ Step 1. Enable Remote Docker Access

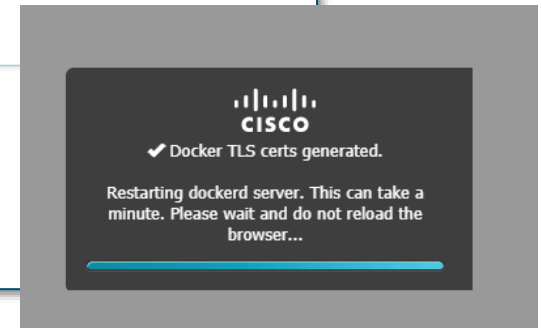
Remote Docker Access is currently **Disabled**

☒ Enable Remote Docker Access

▼ Step 2. Setup Docker App Profiles

▼ App Profile

Docker App Profiles: None ▼ + Add New

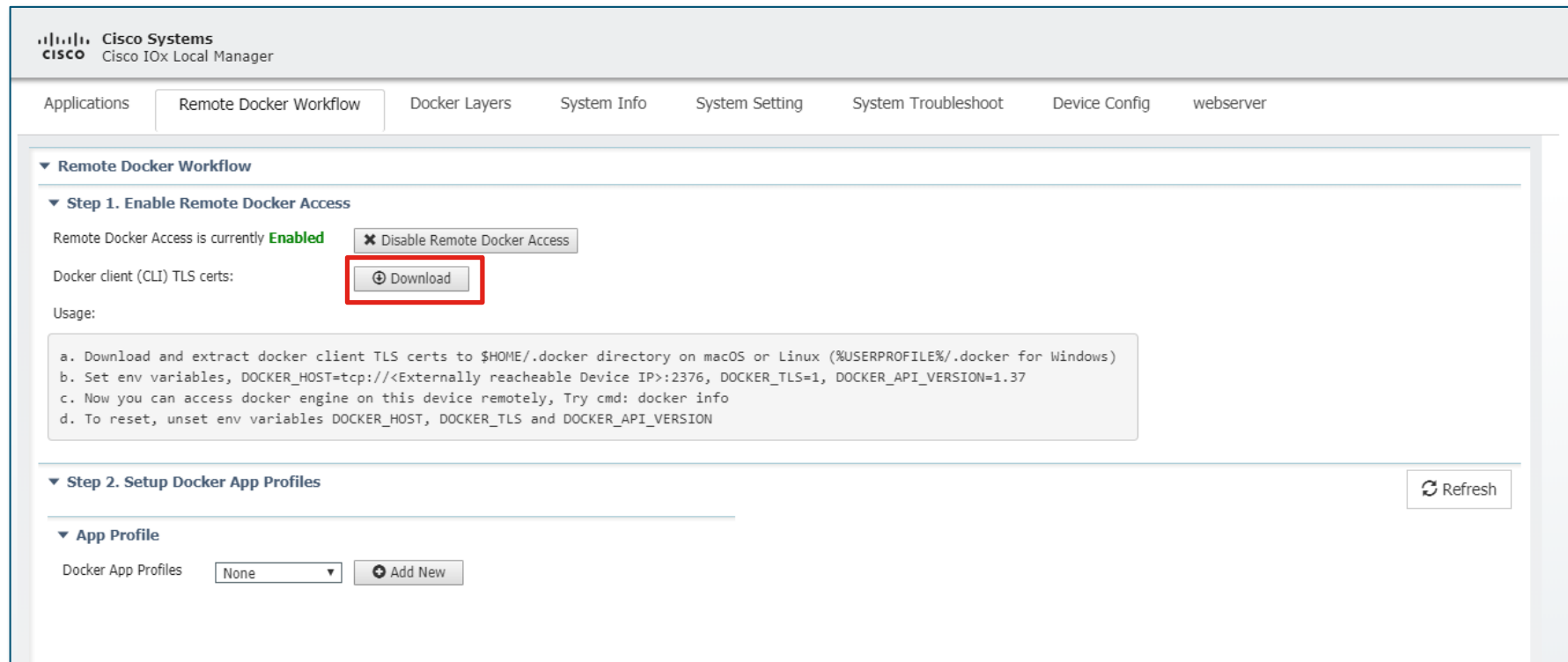


CISCO

✓ Docker TLS certs generated.

Restarting dockerd server. This can take a minute. Please wait and do not reload the browser...

Remote Docker workflow – Download TLS certs



Cisco Systems
Cisco IOx Local Manager

Applications Remote Docker Workflow Docker Layers System Info System Setting System Troubleshoot Device Config webserver

▼ Remote Docker Workflow

▼ Step 1. Enable Remote Docker Access

Remote Docker Access is currently **Enabled** [✕ Disable Remote Docker Access](#)

Docker client (CLI) TLS certs: [Download](#)

Usage:

- a. Download and extract docker client TLS certs to \$HOME/.docker directory on macOS or Linux (%USERPROFILE%/.docker for Windows)
- b. Set env variables, DOCKER_HOST=tcp://<Externally reachable Device IP>:2376, DOCKER_TLS=1, DOCKER_API_VERSION=1.37
- c. Now you can access docker engine on this device remotely, Try cmd: docker info
- d. To reset, unset env variables DOCKER_HOST, DOCKER_TLS and DOCKER_API_VERSION

▼ Step 2. Setup Docker App Profiles [Refresh](#)

▼ App Profile

Docker App Profiles [None](#) [Add New](#)

Remote Docker workflow – Create app profiles

▼ Step 2. Setup Docker App Profiles

Refresh

▼ App Profile

Docker App Profiles lab

Profile Name: lab

▼ App Resource

Profile: default

CPU 200 cpu-units

Memory 64 MB

Disk 10 MB

Avail. CPU (cpu-units) 10060 Avail. Memory (MB) 6336 Avail. Disk (MB) 85189

Submit Cancel

▼ App Network Interfaces

Name	Network Config	Description	Action
Add App Network Interface			

▼ App Peripherals

Device Type	Name	Label	Status	Action
Device Type: USB_storage				
Add		Cancel		

Remote Docker workflow – Use



1. **Build**
2. Docker **save/export**
3. Remote docker **load/import**
4. Remote docker **run**
5. ***Profit***

Or

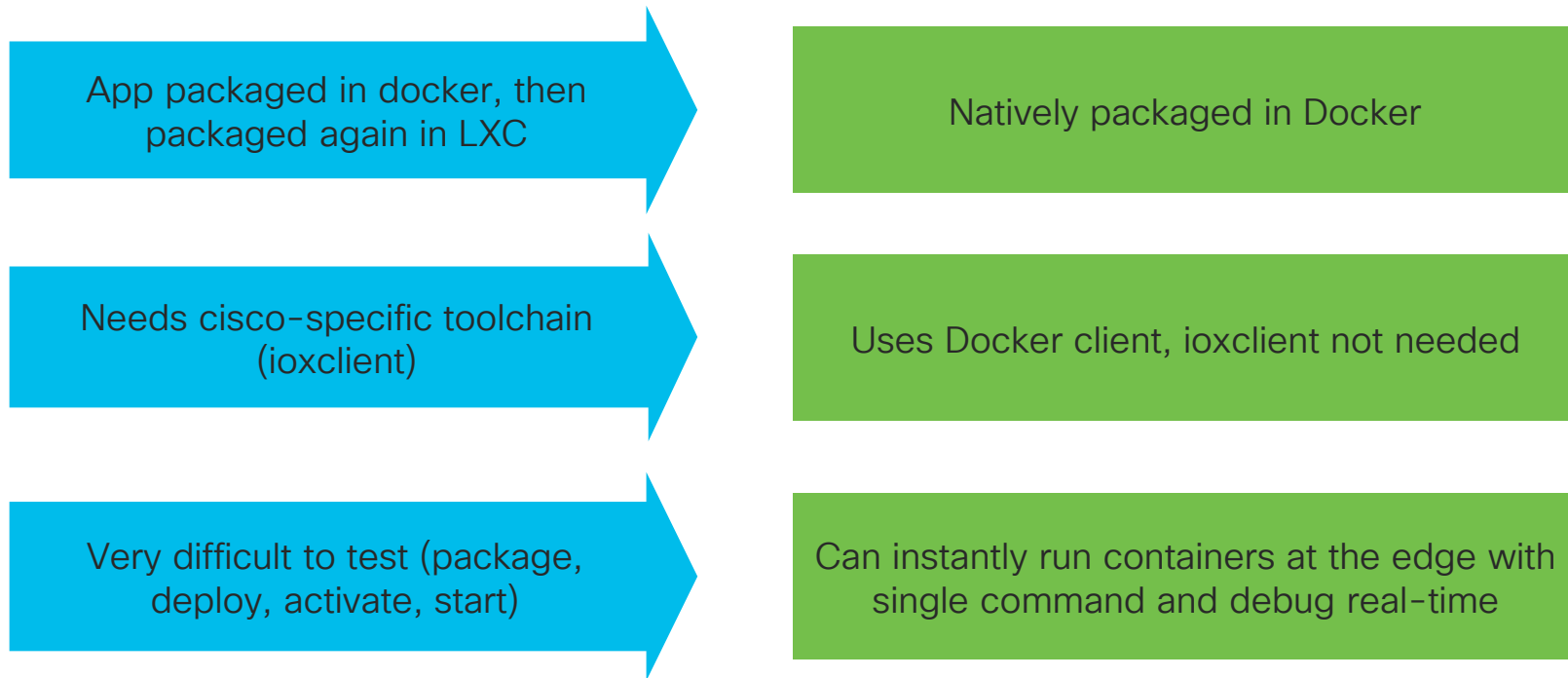
1. Remote docker **build**
2. Remote docker **run**
3. ***Profit***



DEMO – Remote Docker workflow

Wrap up

Docker on IOx after AC10



Cisco IOx – Development vs. Deployment



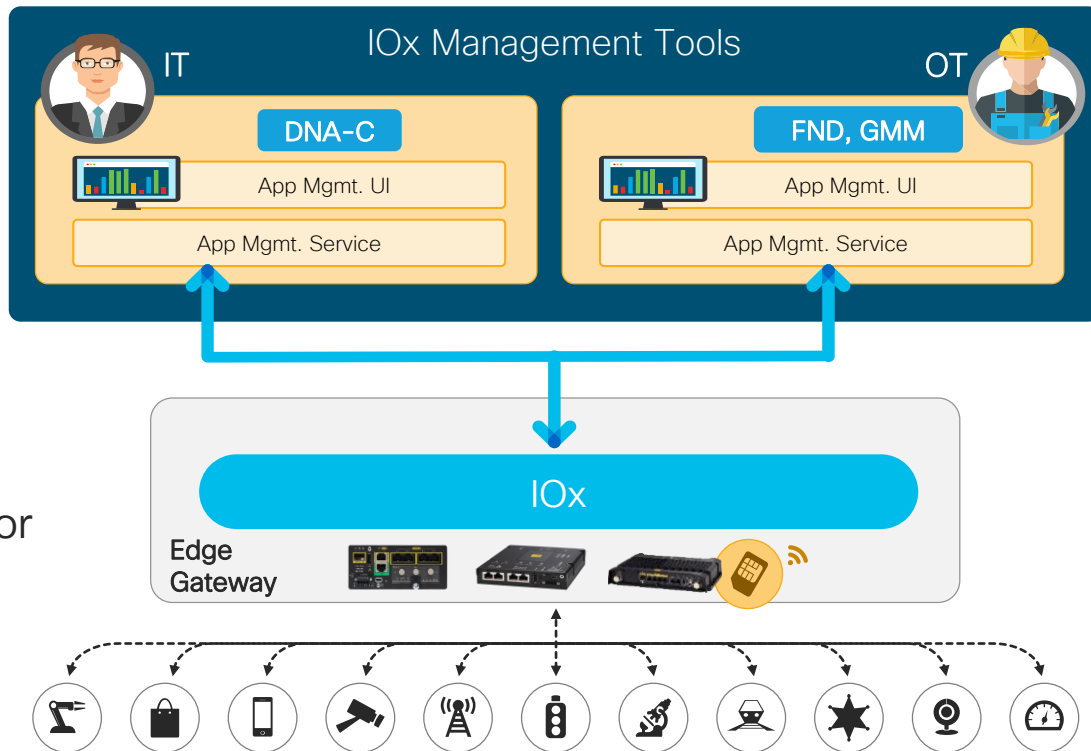
Single:

- Local Manager
- Ioxclient
- Docker



Mass:

- Field Network Director
- Kinetic GMM
- DNA-C



Learn & Explore About IOx On DevNet

Discover & Explore IOx



Learn about IOx on DevNet

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Documentation > iox-docs

Introduction to IOx

IOx Edge Compute Devices

IC3000-series

Platform Information

Device Setup

Phase 1 - Unboxing, Installing, and Connecting the IC3000

Phase 2 - Enter Developer Mode and Accessing Local Manager

Phase 3 - Connecting and Managing via Local Manager

Conclusion

Samples

IR 800-series

IR 1100 Series

IE 4000-series

CGR 1000 Compute Module

ISR 800-series

Catalyst 9000-series

ISR 4000/ASR 1000-series

Comparison of IOx Devices

Platform Support Matrix

Platform Specific Profiling Information

Feature Compatibility Matrix

IOx Resource Downloads

IOx Development Tools

ioxcient Reference

Docker Toolchain Setup

Phase 1 - Unboxing, Installing, and Connecting to the Cisco IC3000 Device

Unboxing the Cisco IC3000

For the complete details about unboxing the Cisco IC3000, refer to the Cisco IC3000 Industrial Compute Gateway Hardware Installation Guide at: [Click here](#)

Installing the Cisco IC3000

1. Review the general description of the unit in the Product Overview section of the Hardware Installation Guide. **Do not power on the IC3000 yet.**
2. Check the Equipment, Tools, and Connections section of the Hardware Installation Guide to ensure you have everything you need.
3. Assign the IP address of 169.254.128.4 with a netmask of 255.255.0.0 to the network interface on your computer for the installation.
Management Interface Configuration | Laptop Configuration |
IP address: 169.254.128.2 | IP address: 169.254.128.4 | Netmask: 255.255.0.0 | Netmask: 255.255.0.0 |
4. Connect the Management Ethernet interface on the IC3000 and connect IC3000 console to your laptop as shown below:

Console Connections:

- A RS232 use CAB-CONSOLE-RJ45 = or equivalent
- B USB use CAB-CONSOLE-USB = or equivalent

<https://developer.cisco.com/docs/iox/#!introduction-to-iox>

Experiment With IOx



IOx Learning Labs & Sandbox

Using IOx Sandbox in Cisco DevNet



Using IOx Sandbox in Cisco DevNet

Learn how to use Cisco IOx Sandbox in the DevNet Sandbox. The virtual environment is useful for development and testing, launches quickly, and allows you to test and demonstrate Fog Computing applications using Cisco IOx without physical devices other than a laptop computer and Internet access.

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

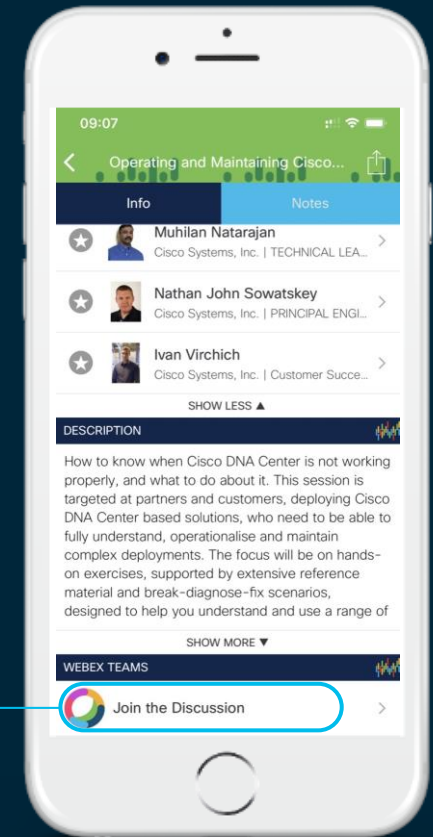
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