



FOG computing v síti IoT

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Konference EurOpen



IoT : Data Collection



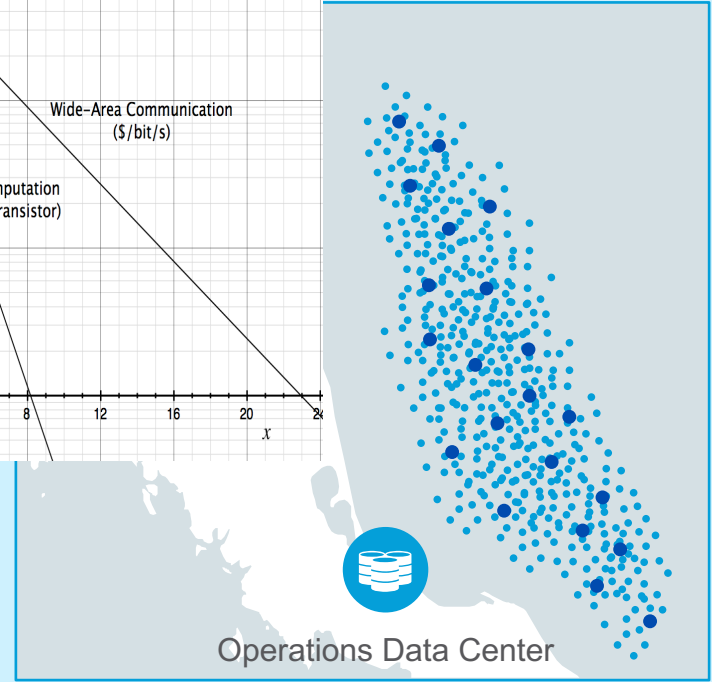
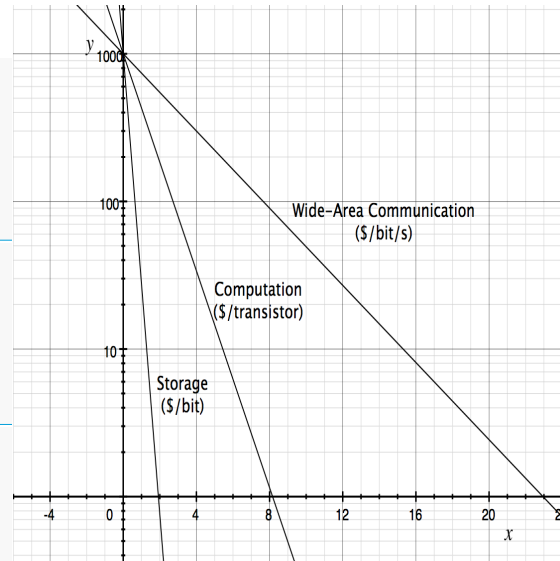
The Real World: Data Constraints

7000 oil wells

Acoustic and temperature sensors generate 1 GB/day from each well

300 rigs with data collection and processing potential

3G connection with operations data center

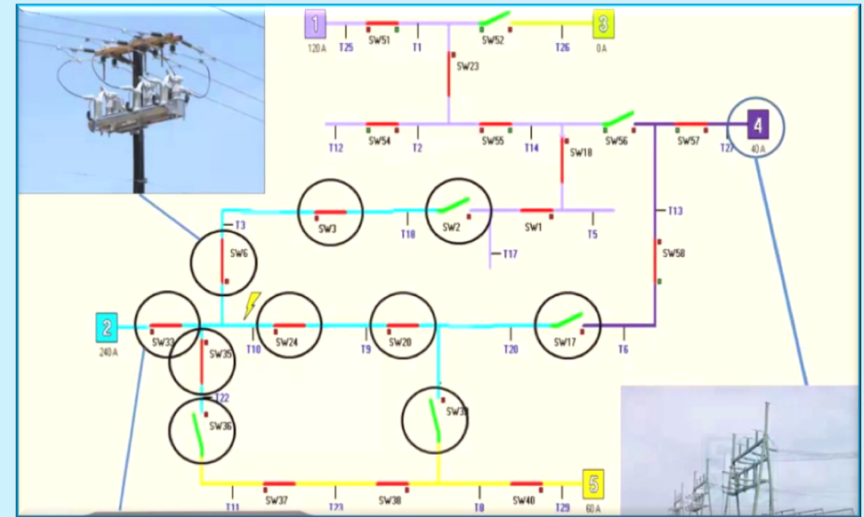


The Real World: Latency Constraints

Smart grid fault restoration

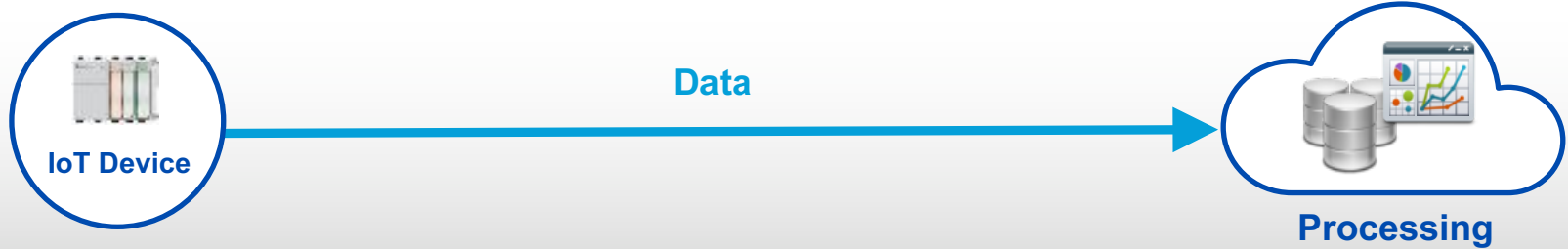
Automation enabled by communication among teams of reclosers

Requires fog application response and latency of $< 50\text{ms}$

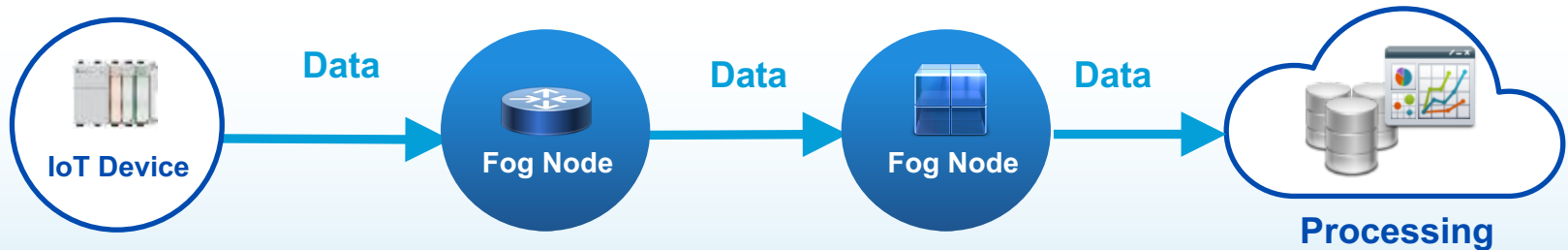


The Need for Fog ?

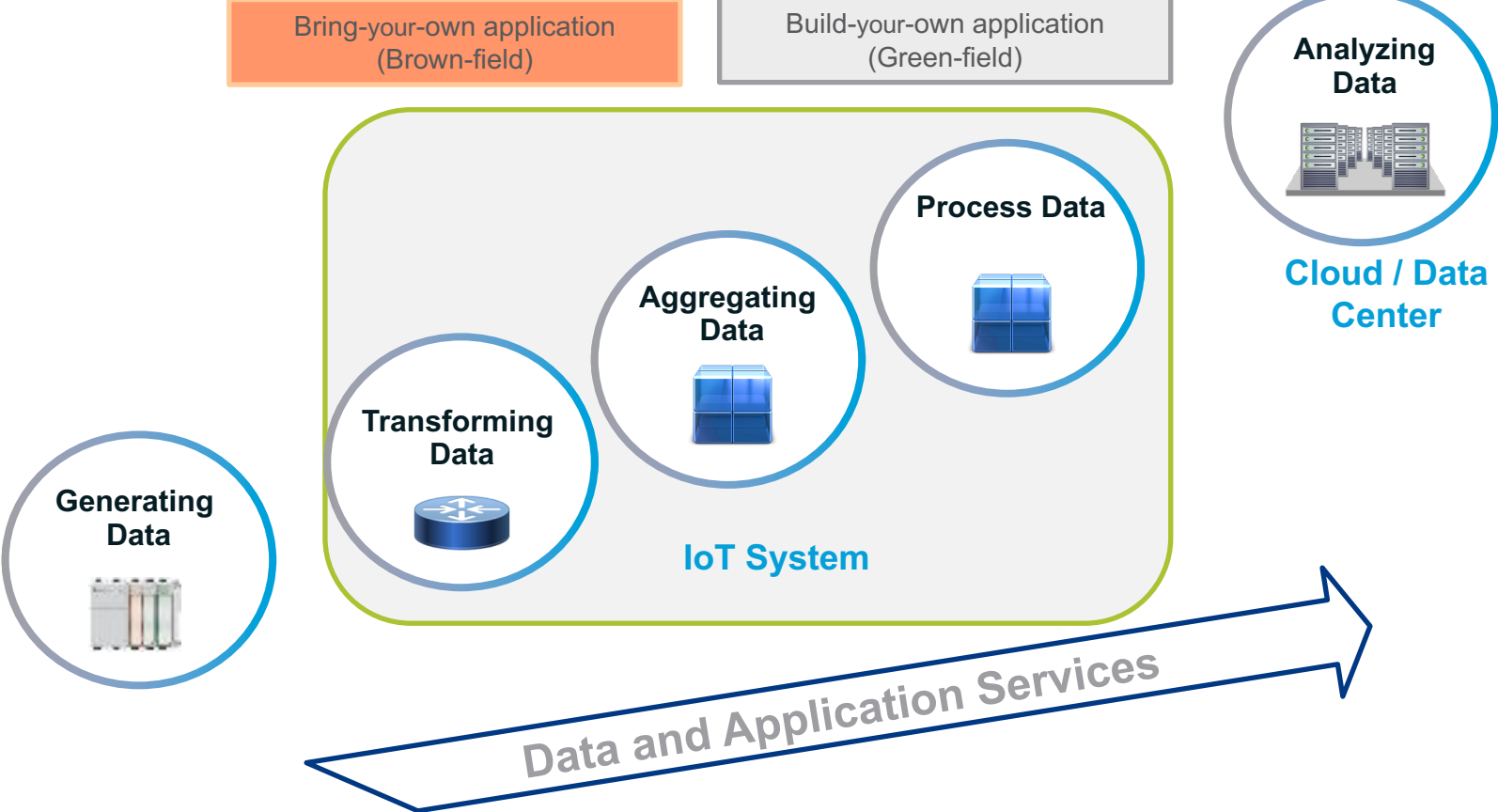
Traditional Approach – Take Data to the Processing



Take Processing to the Data



We looked into application patterns.....



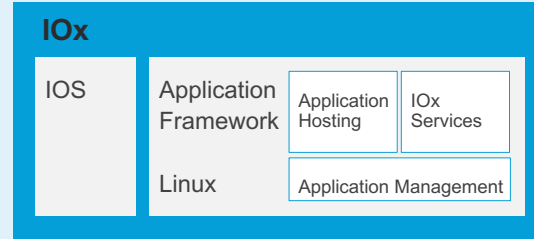
Fog Computing elements

Fog-Ready Network Infrastructure

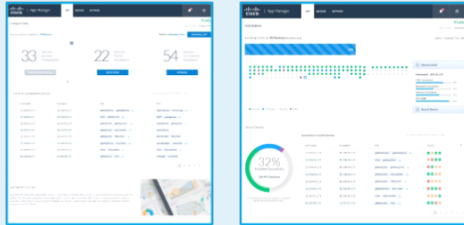


- IR 809/829, CGR 1120/1240, C819
- IE4k Concept app hosting ISR4k, etc.

Application Framework



Fog Application Management



Developer Tools

- 1 Understand IOx**
Understand IOx and review the technology behind computing at the edge.
- 2 Read the Docs**
Look at the available reference documentation.
- 3 Build an Application**

Partner ecosystem



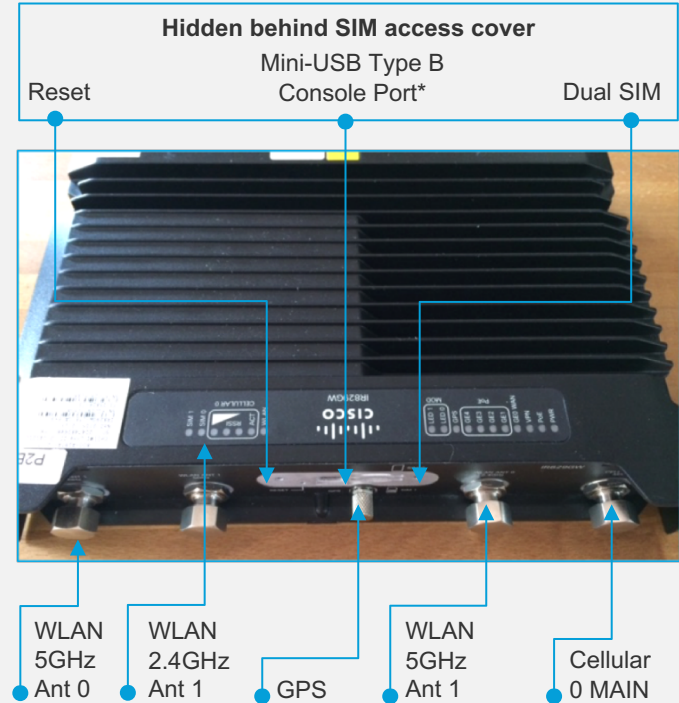
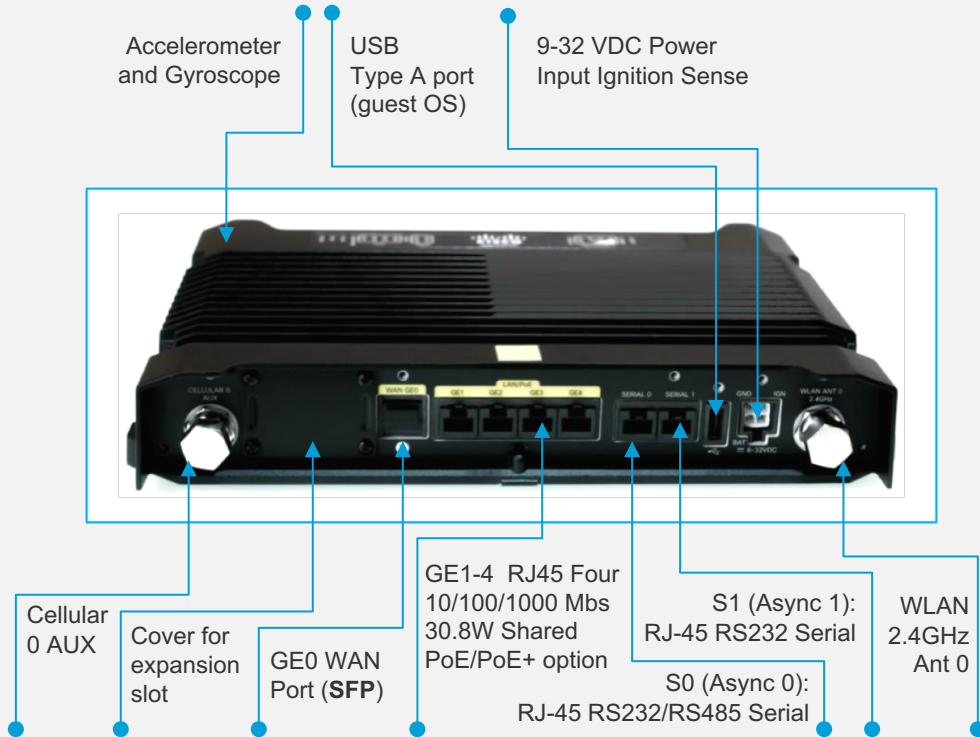
Network infrastructure

Fog-Ready Network Infrastructure



Broad Connectivity	Proven Security	Industrial Grade	Policy-Based Management
<ul style="list-style-type: none">▪ Ethernet▪ Cellular 3G, 4G LTE▪ Wi-Fi	<ul style="list-style-type: none">▪ HW-accelerated encryption▪ IPSec VPN▪ 802.1x▪ Firewall▪ Identity services	<ul style="list-style-type: none">▪ Ruggedized for shock/vibration, humidity, temperature, dust▪ DC power supplies	<ul style="list-style-type: none">▪ Centralized control▪ Network▪ Security▪ Fog applications

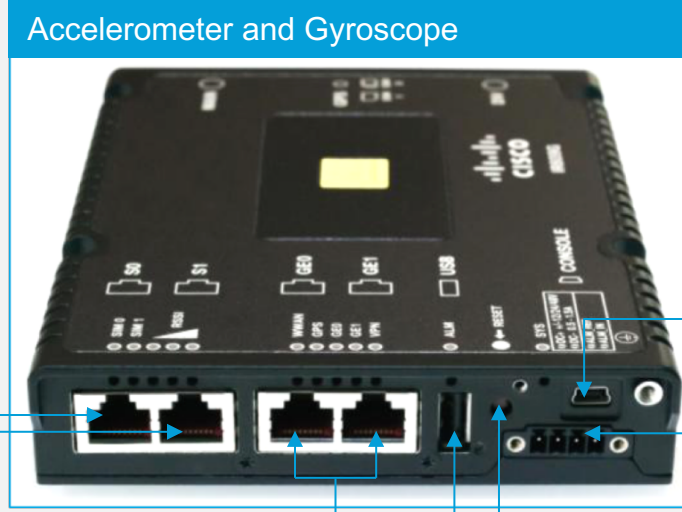
Cisco 829 Industrial Routers



Cisco 809 Industrial Integrated Services Routers



Cellular AUX GPS Cellular MAIN
Dual SIM (behind SIM access cover)



Accelerometer and Gyroscope

S0 (Async 0): RJ-45 RS232/RS485 Serial
S1 (Async 1): RJ-45 RS232 Serial

10/100/1000Base-T

Mini-USB Type B Console Port

9.6-60 VDC Power Input
1 x Digital Input Alarm Port

Reset

USB 2.0 Type A port (guest OS)

Cisco IOx

IOx: Application Framework and Services

Distributed Compute

Execute applications within the fog

Secure Communications

Use Cisco® IOS® Software networking and **security services**

Rapid System Integration and Application Management

Connect with IOx services; manage simply at scale



Fog Applications

Customer | Partner | Cisco

IOx

Cisco® IOS®
Software
Enabled

Network Services
Security Services

Application
Framework

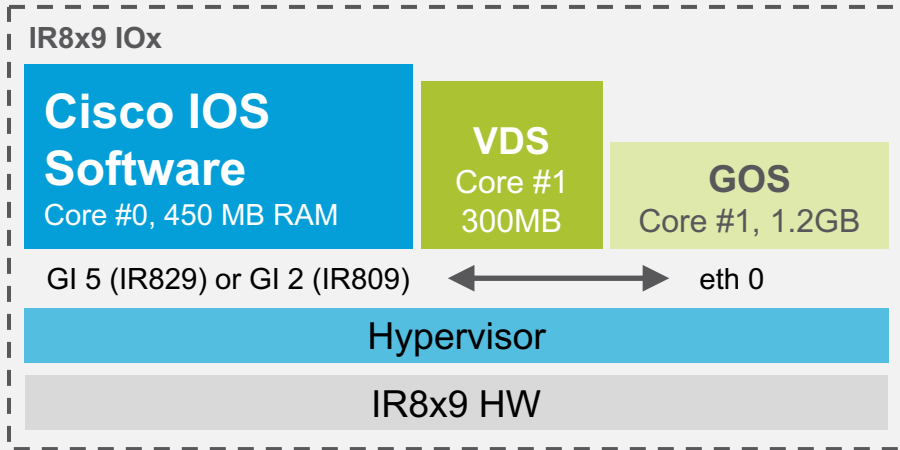
Application Hosting
Java, Python
LXC, Docker

IOx Services
Sensor Data Connectivity
Fog Data Services
Cloud Connectivity
Messaging

Linux

Application Management
Monitoring Management Debugging
Local Manager

IOx Architecture example : IR8x9



- Guest OS (GOS): Linux Yocto distribution
- Virtual Device Server (VDS): handles device sharing, e.g., Console, USB,... not seen from users

- **IOx architecture provides full protection between Cisco® IOS® Software and guest OS, unlike most competitors' industrial gateways**
- Cisco IOS Software and guest OS communicate through an internal virtual Ethernet connection

Bring-your-own applications: Choice of deployments

PaaS Style Applications

- Self-contained apps, portable
- Write-once, deploy across platforms
- Python, Java
- Small code foot print



***Bring-your code,
packages & OS***

Container Applications



- Self-contained apps but tied to Host OS kernel version
- Low-level access, Custom RPMs
- Packaged as LXC containers or Docker
- Ideal for bring-your-own runtime



***Bring-your-code;
We provide Run-Time***

- ✓ SDK to package the apps
- ✓ Devnet: New Documentation, Samples

VM Packaged Applications

- Apps packaged as complete virtual machines, not tied to Host OS.
- Ideal for BYOI
- KVM
- Limited App management



Bring-your-VM

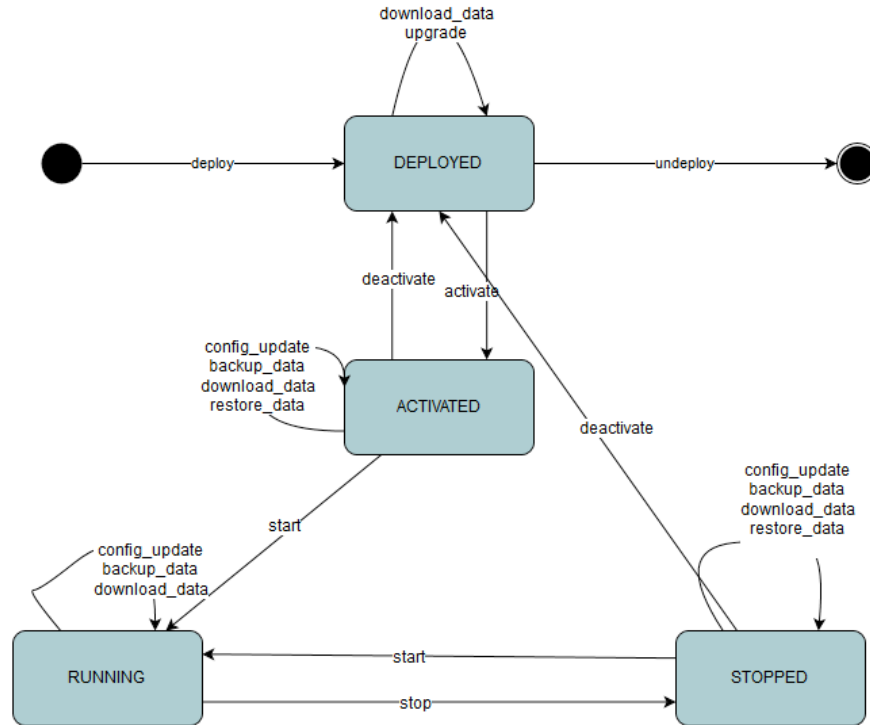


Routers / Switches at the edge

Network Infrastructure Support

Product	CPU Frequency (MHz)	Relative Performance	Available RAM for Apps	Persistent Storage Available for Apps	Supported Applications Types		
					VM	PaaS	LXC
C819	400	1x	256 MB	256 MB	Yes	Yes (Python)	Yes
IE4K	600	1.15x	512 MB	256 MB	No	Can support PaaS	Yes
IR829/809	625	1.2x	720 MB	256 MB	No	Yes (Python, Java)	Yes
CGM-SRV-64	1.2GHz	8.1x	3.5 GB	5 GB	Yes (Windows VM)	Yes (Python, Java)	Yes

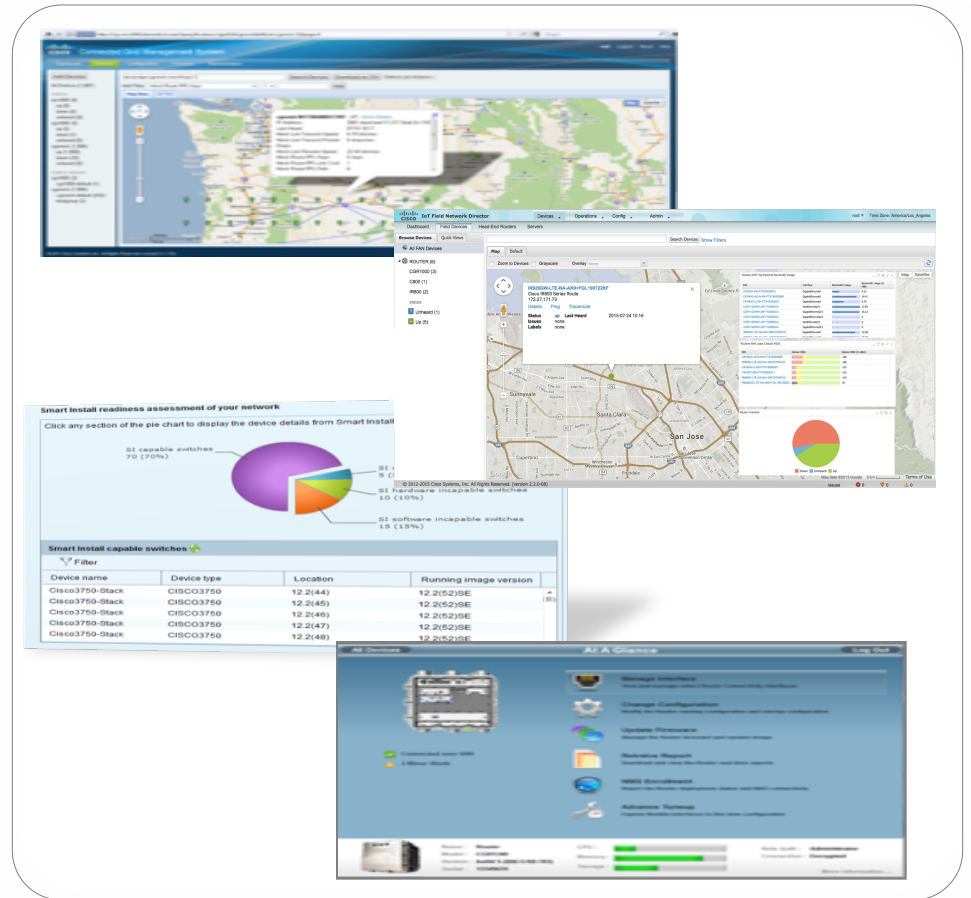
Application States



Management

Field Network Director

- Scalable to Millions of Devices
- Secure Zero Touch Deployment
- Inventory & Asset Visualization
 - via Google Maps & others
- Performance Management
 - Backhaul & access proactive management
- Fault and Outage Management
 - Collect & process alarm events from selected routers and endpoints
- Cyber Security Policy Compliance
- North Bound API
 - MDM, SIEM, SCADA, OMS, etc



Cisco Fog Director

Easy to use/ integrate

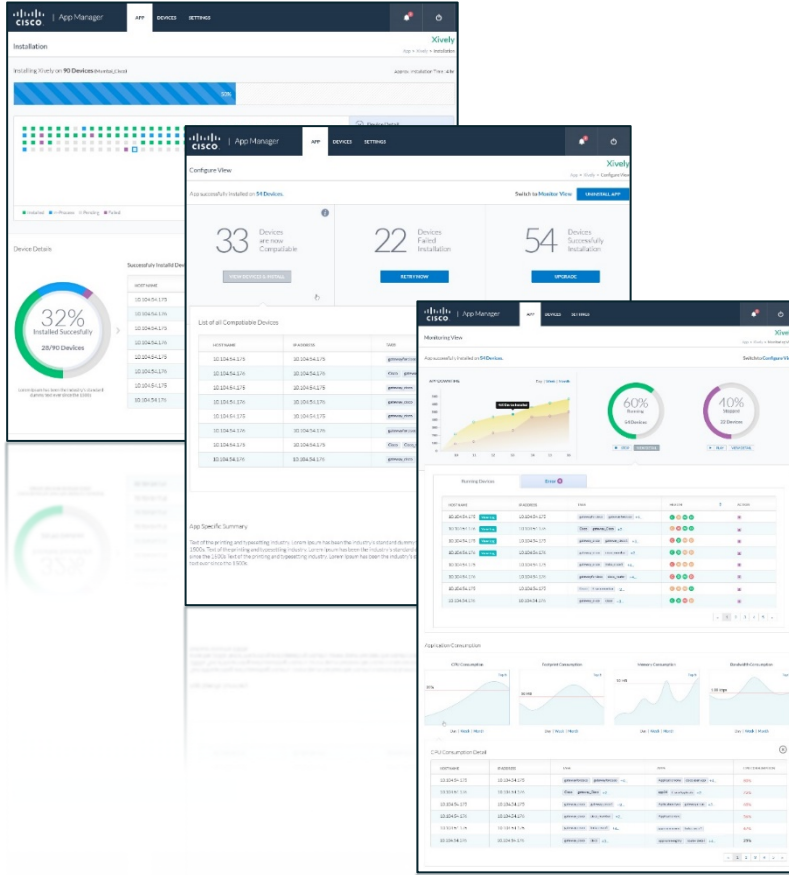
- Simplified application lifecycle management
- Stand Alone UI or may be integrated into 3rd party applications restful APIs

Managing Application Resources

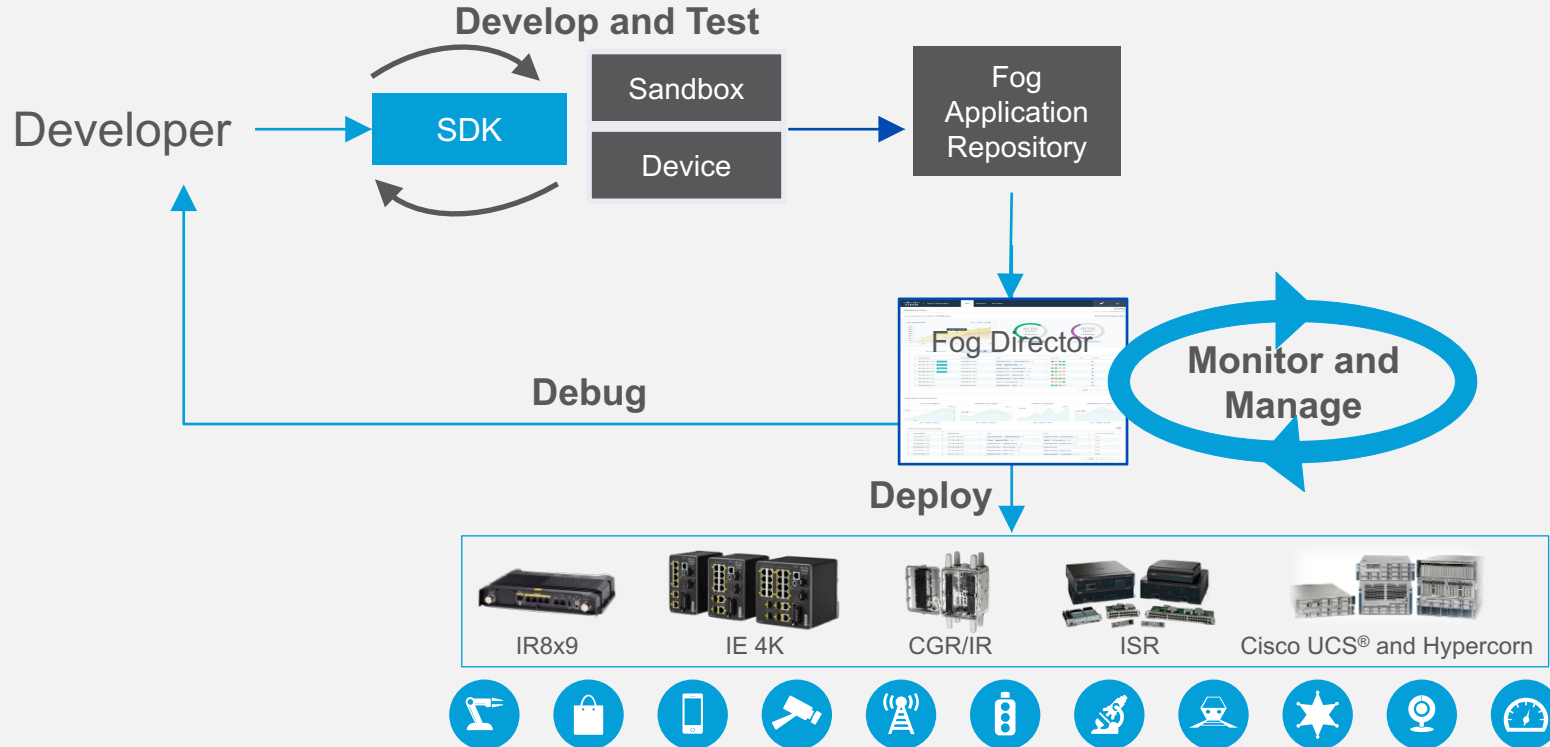
- Tracks IOx resource utilization (CPU, Memory, BW)
- Display per application and per device historical trends
- Establish per application status frequency from the onboard agent

Manage Application Lifecycle

- Stage the application image within the local application catalog
- Push changes to end-points
- Detailed application rollout tracking



Application Lifecycle



Cisco IoX Services

IoT Application Abstraction



Data Acquisition

- Protocols: understanding the bytes
- Device (machine specific) mapping
- Programmability



Data Processing

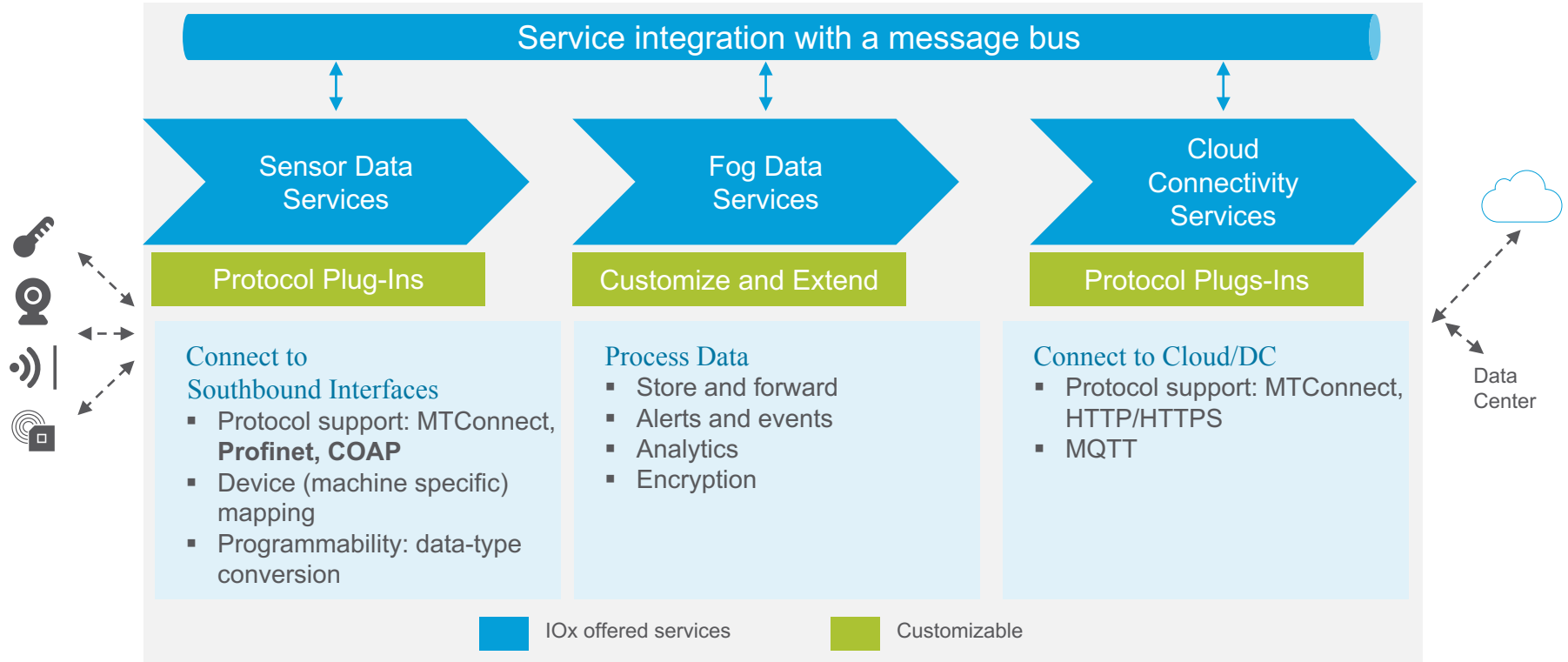
- Policy-driven processing
- Actionable information: alerts and events if you cannot send all the data to cloud
 - Data smoothing
 - Custom policies
 - Fog analytics



Data Push to Cloud/DC

- Connectivity to the cloud
- Transport
 - Reliable transport MQTT
 - Web-based transport HTTP/HTTPS
 - Connectivity to cloud/DC
 - Vendor-specific connectivity

IOx Services



Examples

Customer Example: Manufacturing



Challenges

- Common data collection and control
- Increase manufacturing line availability
- Improve workflow and factory processes



Solutions

- Mazak SmartBox
- Cisco® IE 4000 Ethernet switch
- Fog application



Business Outcomes

- Continuous OEE improvement
- Predictive maintenance



Mazak: Machine Data Delivers Insight, Business Value

Cisco IoT and Connected Machines



Securely Connect

Immediately Transform

Deliver Insight

Customer Example: Cell Tower Asset Monitoring



Challenges

- No visibility for hurricane planning
- Costly to manage remote sites
- Losses due to asset theft



Solutions

- Operations dashboard and business intelligence in Cisco® cloud (Connected Assets solution)
- Fog application (Azeti Sonarplex)
- Cisco IR 829 router (IOx)



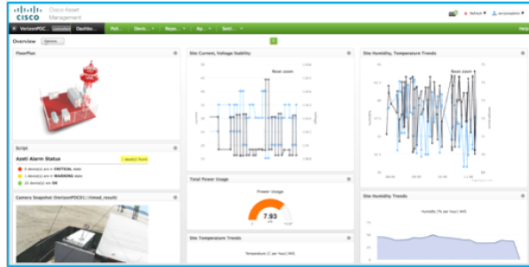
Business Outcomes

- Reducing workload for routine site checks
- Complete visibility into assets
- Cell tower battery life predictability

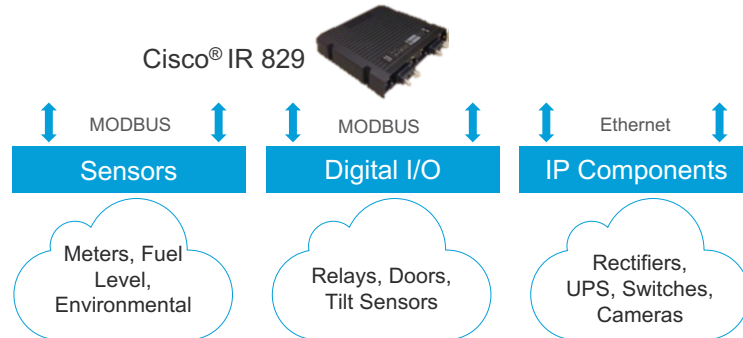


Site Asset Management

Cisco Cloud



Remote Site



Operations Control and Decision Support

- Historical trending
- Multisite correlation
- Remote asset management

Fog Application Running on IOx-based IR 829

- Local device control
- IoT sensor integration (analog, digital, legacy, etc.)
- Data aggregation/reduction
- VPN secured data link

DevNet and Developer Support Services

IOx DevNet Pages

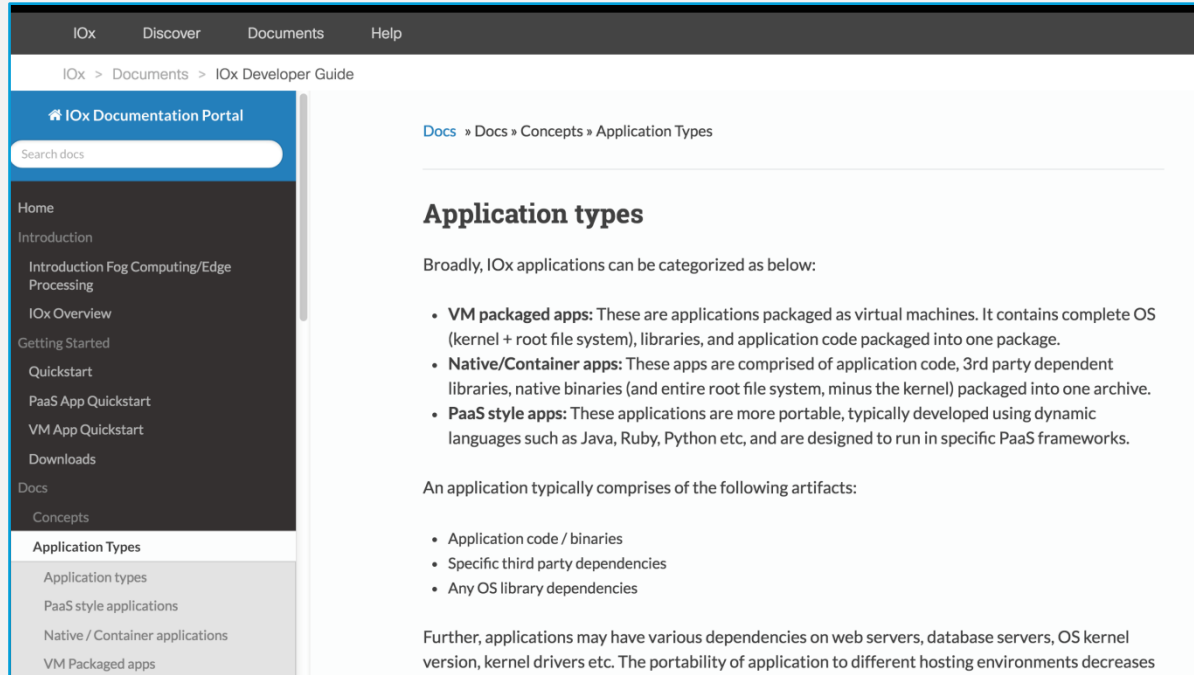
<https://developer.cisco.com/site/iox/>

The screenshot displays the IOx DevNet website interface. At the top, there is a navigation bar with the Cisco DevNet logo on the left and links for 'Log In', 'Register', 'Subscribe', 'Solution Partner', and 'Marketplace' on the right. Below this is a secondary navigation bar with 'Browse', 'Sandbox', 'Community', 'Events', and 'Support' menus, along with a search bar. A third bar contains 'IOx', 'Discover', 'Documents', and 'Help' links.

The main content area is divided into several sections:

- IOx Sidebar:** A vertical list of links: 'IOx Technical Overview', 'IOx Downloads', 'Community Forums', and 'IOx Sandbox', each with a right-pointing arrow.
- IOx Main Content:** A large, colorful navigation area with the 'IOx' logo in the center. It includes buttons for 'Application Catalog' and 'Application Management'. Below the logo are two main categories: 'IOS' (in a blue box) and 'Operating Systems' (in a green box, containing 'Distributed Compute' and 'IOx SDK and Services'). A section titled 'Platforms within the Network' includes 'Embedded Compute', 'Embedded Storage', and 'Accessible Interfaces'. At the bottom, there is a 'Sensors and Endpoints' section with several small icons.
- 1 Why IOx?:** A section with the heading '1 Why IOx?' and the text 'Understand the need for edge computing and how IOx enables it.' It features an image of people in a meeting and a glowing lightbulb.
- 2 What is IOx?:** A section with the heading '2 What is IOx?' and the text 'Understand IOx and review the technology behind computing at the edge.' It features an image of a person working at a computer with a green arrow pointing down to a server rack.
- 3 Get Started:** A section with the heading '3 Get Started' and the text 'Start developing applications for IOx.' It features an image of a person working at a computer with a green flag on a server rack.

DevNet Provides IOx Documentation



The screenshot displays the IOx Documentation Portal interface. The top navigation bar includes links for IOx, Discover, Documents, and Help. The breadcrumb trail shows the path: IOx > Documents > IOx Developer Guide. The left sidebar, titled 'IOx Documentation Portal', contains a search bar and a list of navigation items: Home, Introduction (with sub-items for Introduction Fog Computing/Edge Processing and IOx Overview), Getting Started (with sub-items for Quickstart, PaaS App Quickstart, and VM App Quickstart), Downloads, Docs (with sub-items for Concepts and Application Types), and Application Types (with sub-items for Application types, PaaS style applications, Native / Container applications, and VM Packaged apps). The main content area shows the breadcrumb 'Docs » Docs » Concepts » Application Types' and the title 'Application types'. Below the title, it states 'Broadly, IOx applications can be categorized as below:' followed by a bulleted list: 'VM packaged apps' (described as applications packaged as virtual machines with complete OS, kernel, root file system, libraries, and application code), 'Native/Container apps' (described as applications with application code, 3rd party dependent libraries, native binaries, and entire root file system minus the kernel), and 'PaaS style apps' (described as more portable applications developed using dynamic languages like Java, Ruby, Python, etc., designed for specific PaaS frameworks). Below this, it states 'An application typically comprises of the following artifacts:' followed by a bulleted list: 'Application code / binaries', 'Specific third party dependencies', and 'Any OS library dependencies'. The final paragraph notes that applications may have various dependencies on web servers, database servers, OS kernel version, kernel drivers, etc., and that portability to different hosting environments decreases as dependencies increase.

DevNet Shows Sample App Development

The screenshot shows the DevNet documentation interface. The top navigation bar includes links for IOx, Discover, Documents, and Help. The left sidebar contains a tree view of documentation topics, with 'Python - REST API Server' selected. The main content area displays a terminal command, a section titled 'Writing package descriptor file', and a code snippet for a package descriptor file.

```
(restsense)~/restsense $ pip install -r requirements.txt
```

Writing package descriptor file

Lets write our application's package descriptor file. This has to be at the root of the application directory.

```
file: package_descriptor.yaml
```

```
descriptor-schema-version: 2.0
info:
  name: RESTSense
  description: "Get sensor data and expose them over RESTful APIs"
  version: "1.5"
  author-link: "http://www.cisco.com"
  author-name: "Cisco Systems"
app:
  type: paas
resources:
  profile: c1.small
  network:
    -
      interface-name: eth0
      ports:
        tcp: [9000]
# Specify runtime and startup
startup:
  runtime: python
  runtime-version: 2.7
  target: main.py
```

DevNet Provides a Virtual Test Bed

The screenshot shows the Cisco DevNet website interface. At the top, there are navigation links for 'Log In', 'Register', 'Subscribe', 'Solution Partner', and 'Marketplace'. Below this is a main navigation bar with 'Browse', 'Sandbox', 'Community', 'Events', and 'Support'. A search bar is located on the right. The breadcrumb trail indicates the current page is 'IOx > Documents > IOx Developer Guide'. A sidebar on the left contains a list of links: 'Getting Started', 'Python VM application', 'C VM application', 'C++ VM application', 'Package Selection VM application', 'IOx Enabled Devices', 'Supported Platforms', 'ISR 8xx Platforms', 'IR 8xx Platforms', 'Sandbox Environment', 'What is IOx Sandbox?', 'Usage', 'Troubleshooting', 'Common Troubleshooting Techniques', and 'Debugging Tools'. The main content area shows a breadcrumb trail 'Docs » Docs » IOx Enabled Devices » Sandbox Environment' and a heading 'What is IOx Sandbox?'. Below the heading, there is a paragraph: 'IOx sandbox is a general... and services. It is mea... IOx framework, devel... environment and does... on real IOx devices.' Another paragraph follows: 'This sandbox powers t... Usage' and 'You can experience th...'. An inset window shows a 'LAB MANAGEMENT' interface with a 'RESERVATION' tab for 'IOx-CAF'. It displays a network diagram with nodes 'VMRequest10 (IOx-CAF)', 'ABC3-v110 (ABC3-v110)', and 'AutoVMNetwork... (Auto)'. The diagram shows a 'POST' connection from the VMRequest node to the AutoVMNetwork node. Below the diagram, there is text about 'Type of Access' and 'Access Details'.

Shrnutí

- Pokračování trendu IoT, Industry 4.0
- Pokračující Integrace OT a IT oblastí (Internet/Ethernet)
- Akcent na:
 - bezpečnost
 - spolehlivost
 - jednoduchost
 - strukturovatelnost IoT řešení
- Klíčová součást FOG vrstva (loX, LXC, Docker)
- Přístup k API a Sandboxu (DEVNET) + partnerská řešení
- Důležitý prvek - nástroje pro vzdálenou správu



Literatura

Cisco IoT System: <http://www.cisco.com/c/dam/en/us/products/collateral/se/internet-of-things/brochure-c02-734481.pdf>

IE 4000 : <http://www.cisco.com/c/en/us/products/collateral/switches/industrial-ethernet-4000-series-switches/datasheet-c78-733058.html>

IR 809: <http://www.cisco.com/c/en/us/products/collateral/routers/809-industrial-router/datasheet-c78-734980.html>

IR 829: <http://www.cisco.com/c/en/us/products/collateral/routers/829-industrial-router/datasheet-c78-734981.html>

IoX 1.3: <http://www.cisco.com/c/en/us/td/docs/routers/access/800/software/guides/iox/release-notes/iox130rn.pdf>

IoX manual: <https://developer.cisco.com/site/iox/docs/>

Fog Director : <http://www.cisco.com/c/en/us/products/collateral/cloud-systems-management/fog-director/datasheet-c78-736766.html>

FND: <http://www.cisco.com/c/en/us/products/collateral/se/internet-of-things/datasheet-c78-696787.html>

Industrial Network Director: <http://www.cisco.com/c/en/us/products/collateral/cloud-systems-management/industrial-network-director/datasheet-c78-737848.html>

