Arm Everywhere

(Almost) A Demo of an Arm Cloud, Edge, and IoT Infrastructure
**Goal:** A complete global infrastructure, built entirely on Arm

**Warning:** This is a work in progress!

<table>
<thead>
<tr>
<th><strong>IoT Endpoints</strong></th>
<th><strong>Edge Nodes</strong></th>
<th><strong>Cloud Server</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Raspberry Pi</td>
<td>96Boards / Linaro</td>
<td>Ampere eMag, hosted by Packet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bare metal Arm Server</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Collecting the packaged data from the Edge Nodes</td>
</tr>
<tr>
<td>• Distributed across the globe</td>
<td>• 96Boards devices in North America and India</td>
<td>• Storing the data and running visualization dashboard</td>
</tr>
<tr>
<td>• Running Arm Mbed Linux OS</td>
<td>• Collecting the data streams from the IoT Endpoints</td>
<td></td>
</tr>
<tr>
<td>• Air Quality, Lightning Detection, GPS sensors</td>
<td>• Packaging and sending the data to the Cloud Server</td>
<td></td>
</tr>
<tr>
<td>○ Feed data to the nearest Edge Node</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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![Linaro Connect logo](Linaro-connect.png)
IoT Endpoints
Mbed Linux OS, Pelion Device Management

Arm Mbed Linux OS is a secure and stable platform for IoT devices, that runs a container engine.

- Allows for remote deployments of containers, for application installs and updates
- Allows for secure and safe operating system upgrades
- Has a central, web-based interface that shows connected (and offline) devices
  - Security and certificate management
  - Push containers to devices
  - Register and deregister devices
## Devices

View and manage your devices.

<table>
<thead>
<tr>
<th>Device ID</th>
<th>Endpoint name</th>
<th>Name</th>
<th>State</th>
<th>D.</th>
<th>Execution mode</th>
<th>Date created</th>
<th>Date bootstrapped</th>
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<tbody>
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</tr>
</tbody>
</table>
IoT Endpoint Ready for Deployment

Raspberry Pi 3B+

- SparkFun Qwiic pHat
- SparkFun GPS, Air Quality, and Lightning Detection sensors
- Many other sensor options exist as well
Currently Deployed Devices
Data Currently Being Captured

Customizable based on sensor selection. This demo uses:

- Temperature
- Humidity
- Barometric Pressure
- Total Volatile Organic Compounds (TVOC)
- Equivalent CO2
- Lightning Strikes
- GPS Coordinates / Location

Optional Sensors Include:

- Infrared
- UV Light
- Human Presence Detection
- Distance Measurement
- RFID Scanning
- Interfaces such as knobs, buttons, swipe gestures
- Relay and motor control
Potential Use Cases

- Sustainability Initiatives
- Environmental Monitoring
- Manufacturing / Factory
- Hospital / Medical Facility

- Retail
- Energy Sector
- Smart Cities
- Agriculture
Example Use Case
In the deserts of Arizona and the western United States, lightning sparks devastating wildfires.
Rapid detection is critical to contain the fires, in turn saving lives, wildlife, and dollars.
Let’s Revisit the IoT Endpoint

Raspberry Pi 3B+

- Lightning Detection
- Air Quality: CO2 and Particulates
- GPS
Current Status
IoT Endpoints

Working:

- Container creation is well understood, and Alpine / Python container base is built.
- Passing GPS and Air Quality sensor hardware from the Host OS to the container is resolved.
- Storing data locally.
- Deployment steps to provision a node and push a container to a node via Mbed Tools and Mbed CLI

Not Working:

- Communicating via MQTT to the outside world, from within the container.
- Lightning detection sensor is not available within a container yet.
- Data flowing up to Edge nodes or Server
Edge Node, Cloud Server

Working:
- Edge Nodes are provisioned and running.
- Server is deployed at Packet, InfluxDB installed, and Grafana dashboard installed and accessible via internet.

Not Working:
- Valid data flowing through the system.
Lessons Learned
Mbed Linux OS

Development has been much slower than anticipated:

● Embedded linux is much different than “regular” linux distributions.
  ○ No package management
  ○ Every change requires rebuilding, reflashing SD Card, re-pushing container, retesting, troubleshooting, and starting over.
● Mbed Linux did not have I2C enabled. Porting from Raspbian took weeks, just to enable reading data from the sensors.
● Mbed Linux is in beta. As a result, documentation is thin, and there are no example projects to draw knowledge from.
● Opencontainer Runtime (runc) is much less documented than Docker. Few examples for hardware passthrough.
Ecosystem Challenges

Development has been much slower than anticipated:

- No “standards compliant” Arm Desktop PC exists.
- Cross-architecture builds are difficult, even within Arm
  - 64-bit Armv8 Host, 32-bit Armv7 target
- Mbed Linux is using OCI, as opposed to Docker
  - Dockerfile versus config.json (far fewer examples)
  - No system to pull down images from a Docker Hub
- Had to use a Raspberry Pi to do development work
  - docker pull alpine
  - docker export alpine > rootfs.tar
  - (manually copy / paste files to Mbed Linux board)
  - runc run alpine
Fun Fact:

Most of our work has been done on Windows on Arm powered laptops, courtesy of the Arm Innovator Program!
Questions (and hopefully Answers!)

...And let’s continue the discussion, as well!
Thank you

Join Linaro to accelerate deployment of your Arm-based solutions through collaboration

contactus@linaro.org