IoT & Edge Developer Survey Report

September 2022
Thank you for sharing the survey with your communities!
Welcome to the 2022 IoT & Edge Developer Survey Report

The 2022 survey was conducted with the following objectives:
1) To gain insights into the IoT & edge computing industry landscape;
2) To understand the challenges IoT & edge computing developers are facing; and
3) To help identify the opportunities for enterprise IoT & edge computing stakeholders in the IoT & edge computing open source ecosystem.

Read this report to learn more about the key findings and industry trends for IoT & edge computing stakeholders.
Sponsored by the Eclipse IoT, Eclipse Edge Native, and Eclipse Sparkplug Working Groups, the 2022 IoT & Edge Developer and Adoption Survey was conducted from April 1 to June 15, 2022.

910 developers, committers, architects and decision makers were surveyed, with participation from across the globe and within a broad range of industries. 69% of survey participants are both open source committers and users, a 20% Increase over 2021.
Executive Summary

- **Java, C and C++** are the most widely used programming languages for **constrained devices**. Developers indicate that **Java is the preferred language** for IoT gateways and edge nodes.

- **MQTT continues to be the most widely used IIoT communication protocol**, though there seems to be increased **fragmentation**. HTTP/HTTPS and REST show slight decreases in IIoT usage compared to 2021, while alternative communication protocols (TCP/IP, AMQP0.9, In house/proprietary) have seen noticeable growth.

- **64-bit ARM architectures** are gaining ground with gateway and edge node suppliers.

- **Edge computing is gaining traction in real world applications** as top edge computing workloads all show significant increases in adoption.

- **The IoT Middleware market is still young!** AWS IoT (32%), Microsoft Azure IoT (22%), and Google Cloud IoT Platform (17%) were the top three options. As Google decides to discontinue their IoT middleware race, Middleware market diversification seems to be expanding.

- **Concerns around connectivity are on the rise this year**, making it one of the top 3 challenges developers face, along with security and data collection & analytics.
Executive Summary

- There is increased public cloud fragmentation and the big three are being challenged. Despite continued dominance, Amazon AWS with 36% usage (-8% in 2022), Microsoft Azure with 18% (-11% in 2022), and Google Cloud Platform with 16% (-4% in 2022) have all lost ground in a growing competitive landscape.

- Agriculture (23%) has emerged as the leading industry for IIoT and edge computing technology, followed by industrial automation (22%) automotive (20%) and energy & smart cities (17%).

- Connectivity (47%), data collection & analytics (26%) and security (26%) are the top three concerns for IoT & edge developers in 2022, with connectivity growing by 9% compared to 2021.

- Artificial intelligence (38%) was the most frequently selected edge computing workload.

- Container images (49%) are the most frequently selected edge computing artifact.

- Linux is the most widely used operating systems for constrained devices (43%), as well as for IoT gateways & edge nodes (51%).
Key Finding 1.1

Primary Industry Verticals

- **Agriculture**
  - 2022: 23%
  - 2021: 26%

- **Industrial Automation**
  - 2022: 22%
  - 2021: 24%

- **Automotive**
  - 2022: 20%
  - 2021: 20%

- **Energy Management**
  - 2022: 17%
  - 2021: 21%

- **Smart Cities**
  - 2022: 17%
  - 2021: 22%
Agriculture is now the top industry for IIoT and edge computing technology adoption (at 23%, compared to 26% in 2021). Industrial automation comes in second place (22%) with slight decrease compared to 2021.

The education industry shows a steady effect compared to 2021 at 17% also along with building automation. Both verticals may have been negatively impacted by shifting priorities due to COVID-19 but started to show steady adoption in preparation for a slight increase in the next few years.

Automotive (20%) comes in third, developments happening in this industry are massive and promising, its forecasted that this industry shows substantial growth in the next few years.

Energy management and smart cities are tied both come in at 17%, a 3% and 5% decrease respectively over 2021.
Key Finding 2

For Constrained Devices: It’s a Linux and FreeRTOS World:

- Linux (43%), FreeRTOS (22%) and No OS/Bare-metal (19%) are the top OS choices for constrained devices.

- Zephyr shows slight decrease (from 10% in 2021 to 8% in 2022).

- New OSes show promising growth in the next few years such as Oniro (3%).

Top Operating System for Constrained Devices:

- Linux: 43%
- FreeRTOS: 22%
- No OS / Bare-metal: 19%
- Mbed OS: 10%
Linux and Windows Dominate IoT Gateways & Edge Nodes OS landscape

- Linux (51%), Windows (42%) and Azure Sphere (10%) are the top OS choices for IoT gateways and edge nodes.
- AIX comes in at 9% for 2022.

Top Operating Systems For IoT Gateways & Edge Nodes

- Linux: 51%
- Windows: 42%
- Azure Sphere: 10%
- AIX: 9%
Key Finding 2.2

Linux Distributions Employed in IoT Solutions

- Ubuntu (Classic, Server): 23%
- Raspbian: 20%
- Alpine: 18%
- Debian: 17%
- CentOS: 13%
- Yocto Project: 11%
- Ubuntu Core: 11%
- Red Hat Enterprise Linux: 11%
- Automotive Grade Linux: 9%
- Linus: 8%
- OpenWrt or equivalent (e.g., Linino, LEDE): 8%
- Other (please specify): 7%
- uClinux: 4%
- Fedora/Fedora IoT: 4%
- Tizen: 2%
- Wind River Linux: 2%
Edge Computing are gaining ground as all workloads respectively increased Y-on-Y. **Artificial intelligence** (38%) is the most common workload for edge gateways /edge nodes. **Control logic, data exchange between multiple nodes, and data analytics** round out the top 4 edge computing workload.
Containers are the most commonly used edge computing artifacts for both edge gateways and edge servers.
**Key Finding 4.1**

Top Edge Computing Container Orchestrations Used for IoT Solutions

- **2022**
  - **Docker**: 43%
  - **Eclipse Kanto**: 13%
  - **Eclipse Fog05**: 9%
  - **Other Kubernetes**: 12%
  - **None**: 17%

- **2021**
  - **Docker**: 49%
  - **Eclipse Kanto**: 21%
  - **Eclipse Fog05**: 21%
  - **Other Kubernetes**: 18%
  - **None**: 21%

Docker is the most commonly used edge computing container orchestration, Eclipse Kanto shows promising 9% usage in 2022.
Key Finding 5

Concerns around connectivity are on the rise!

IoT & Edge Computing Developer Concerns

2022
- Connectivity: 47%
- Data Collection & Analytics: 26%
- Security: 26%
- Deployment: 20%
- Integration Complexity: 18%

2021
- Connectivity: 38%
- Data Collection & Analytics: 26%
- Security: 46%
- Deployment: 31%
- Integration Complexity: 29%
Key Finding 5.1

Top Edge Computing Artifacts Deployed for IoT Solutions

- **Connectivity** 47% (38% in 2021), **data collection & analytics** 26% (26% in 2021) and **security** 26% (46% in 2021) continue to be the top three developer concerns in 2021.

- **An increase in connectivity** concerns underscores the lack of computational capacity for efficient built-in security.

- Security still resembles major concern despite the percentage drop (from 46% in 2021)

- A decrease in deployment-related concerns (from 31% to 20% in 2022) indicates that less solutions are moving past the PoC phase and developers are focusing more on successful solutions rollout to assure overall better user experience.

- Concerns around **integration complexity** have also decreased (by 11% compared to 2021). As the number of deployments increase, developers see less complexity in the need for additional integrations with complementary technologies and systems.
Java, C, C++, Python, and JavaScript dominate the IoT & edge space, as they do in the rest of the IT market.
Java, Python, Javascript and C dominate as programming languages for the IoT gateways & edge nodes in 2022.
Key Finding 7

- MQTT still leads communication protocols in 2022 despite a -11% drop compared to 2021.
- Slight decrease in HTTP/HTTPS (-2%) and REST (-1%) communication protocols in 2022 compared to 2021.
- 3% increase in TCP/IP in 2022 compared to 2021 (21%).

MQTT continues to be the most widely used IIoT communication protocol, though there seems to be increased fragmentation.

Preferred IIoT Communication Protocols

<table>
<thead>
<tr>
<th>Protocol</th>
<th>2022</th>
<th>2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTTP/HTTPS</td>
<td>24%</td>
<td>26%</td>
</tr>
<tr>
<td>TCP/IP</td>
<td>24%</td>
<td>21%</td>
</tr>
<tr>
<td>REST</td>
<td>22%</td>
<td>23%</td>
</tr>
<tr>
<td>MQTT</td>
<td>33%</td>
<td>44%</td>
</tr>
</tbody>
</table>
Most Used Connectivity Technologies

- **WiFi**: 36% (45% in 2021)
- **Ethernet**: 29% (40% in 2021)
- **Cellular (LTE, 4G, 5G, etc)**: 22% (30% in 2021)
- **Bluetooth/Bluetooth Smart**: 20% (20% in 2021)

Top Connectivity Technologies Being Used are WiFi 36% (45% in 2021), Ethernet 29% (40% in 2021) Cellular (LTE, 4G, 5G, etc) 22% (30% in 2021) and Bluetooth/Bluetooth Smart 20% (20% in 2021).
Communication security (e.g. TLS, DTLS) (26%), analytics/anomaly detection (24%), data encryption (24%) are the most used security related technologies in IoT/edge solutions, JSON web token (16%) and OTA updates (15%) follows the top 3 mentioned above.
Key Finding 10

- While ARM continues to dominate, ARM Cortex-M0 / M0+ usage has shown a slight increase from 25% in 2021 to 26% in 2022.

- ARM Cortex-M3 / M4 usage shows a drop in 2022 from 33% in 2021 compared to 24%.

- ARM Cortex-M7 usage has dropped 9% since 2021.

Hardware Architecture Usage for IoT Constrained Devices

<table>
<thead>
<tr>
<th></th>
<th>2021</th>
<th>2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARM Cortex-M0 / M0+</td>
<td>26%</td>
<td>25%</td>
</tr>
<tr>
<td>ARM Cortex-M3 / ARM Cortex-M4</td>
<td>24%</td>
<td>33%</td>
</tr>
<tr>
<td>ARM Cortex-M7</td>
<td>20%</td>
<td>16%</td>
</tr>
</tbody>
</table>

Don't Use Constrained Devices

COPYRIGHT (C) 2022, ECLIPSE FOUNDATION | THIS WORK IS LICENSED UNDER A CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENSE (CC BY 4.0)
Key Finding 11

64-bit ARM architectures are gaining ground with gateway and edge node suppliers.

- **AMD/Intel x86-64** usage shows a significant growth in 2022 (14% increase from 2021)
- **ARM v8** usage shows also an increase by 5% in 2022
- **ARM v6 & ARM v7-A (Cortex-A 32 bits)**-shows significant drop in 2022

<table>
<thead>
<tr>
<th>Hardware Architecture Usage for IoT/Edge Gateways and Edge Nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMD/Intel x86_64</td>
</tr>
<tr>
<td>2022 26%</td>
</tr>
<tr>
<td>2022 17%</td>
</tr>
<tr>
<td>2022 15%</td>
</tr>
</tbody>
</table>
Key Finding 12

Types of IoT Data/Information Stored In Database/Datastore

Device information (36%), time series data (26%), contextual data (26%) are the types of IoT/data/information stored in a database/datastore.
Key Finding 13

Message broker-MQTT still the most commonly used technology in messaging infrastructure in 2022.

Most Common Technologies Used In Messaging Infrastructure

- Message broker — MQTT: 29% in 2022, 41% in 2021
- Database — Time Series: 28% in 2022, 36% in 2021
- Database — Document: 25% in 2022, 23% in 2021
- Database — Relational: 21% in 2022, 19% in 2021
IoT Middleware: The Race Is Still Young

- IoT Middleware is dominated by AWS IoT (32%, -5% in 2021), Microsoft Azure IoT (22%, -5% in 2021), and Google Cloud IoT Platform (17%, -5% in 2021)

- Percentage drop of Google foreshadowed their decision to discontinue Google Cloud IoT platform

- The market is also seeing a rise of other middleware options: (Bosch IoT suite (11%), IBM Watson IoT platform (10%), cumulocity (10%).

- The diversity in responses indicates that this technology segment is still young and competitive.
Public Cloud and IoT: The Big Three Continue to Rule

Amazon AWS with 36% (-8% in 2021), Microsoft Azure with 18% (-11% in 2021), and Google Cloud Platform with 16% (-4% in 2021) continue their dominance of public IoT and cloud platforms. User's shows noticeable growth in using Kubernetes (14%) and other on-premises cloud (14%) in 2022.
Demographics
In Which Region Are You Located?

- Europe, Middle East & Africa: 36%
- Asia Pacific: 44%
- North America: 12%
- South America: 8%
What Best Describes Your Role?

- Developer: 37%
- Executive: 18%
- Engineering/R&D Management: 11%
- Other: 11%
- IT Management: 9%
- Engineer/R&D (Hardware): 6%
- Product Manager: 4%
- Marketing/Sales/Business Development: 3%
How Large is the Organization You Work For?

- Employees:
  - Fewer than 100 employees: 60%
  - 100-500 employees: 11%
  - 501-1,000 employees: 7%
  - 1,001-5,000 employees: 7%
  - 5,001-10,000 employees: 3%
  - 10,000+ employees: 12%
How Much Experience Do You Have Developing IoT/Edge Solutions?

- **2022**
  - 0-2 Years: 41%
  - 2-5 Years: 17%
  - 5-10 Years: 20%
  - More Than 10 Years: 13%
  - No Developer Experience: 8%

- **2021**
  - 0-2 Years: 37%
  - 2-5 Years: 19%
  - 5-10 Years: 18%
  - More Than 10 Years: 17%
  - No Developer Experience: 9%
Project Participation

2022

- 15% I am a committer on an open source project that builds technology for IoT/edge solutions
- 54% I use open source technology in IoT/edge solutions
- 44% I have experimented with IoT/edge open source technology, but don’t use it in IoT solutions
- 17% I have no experience with IoT/edge open source projects
- 18% I report bugs and feature enhancements to open source projects that provide IoT/edge technology
- 4% Other

2021

- 49% I am a committer on an open source project that builds technology for IoT/edge solutions
- 49% I use open source technology in IoT/edge solutions
- 44% I have experimented with IoT/edge open source technology, but don’t use it in IoT solutions
- 22% I have no experience with IoT/edge open source projects
- 20% I report bugs and feature enhancements to open source projects that provide IoT/edge technology
- 10% Other
Thank You!

To receive exclusive access to detailed industry research findings, join the Eclipse IoT Working Group.

Learn more:  
iot.eclipse.org  
edgenative.eclipse.org  
sparkplug.eclipse.org

Connect with us  
@EclipseIoT  
@EdgeNativeWG  
@SparkplugWG