



# 2023 Iot & Edge Developer Survey Report

October 2023



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## Welcome to the 2023 IoT & Edge Developer Survey Report

Within these pages, you'll find pivotal insights and emerging industry trends crucial for IoT and edge computing stakeholders

The 2023 survey was conducted with a threefold purpose:

- Uncover unique insights into the IoT & edge computing industry landscape.
- Gain a better understanding of the challenges confronting IoT & edge computing developers.
- Identify opportunities for enterprises and other stakeholders within the IoT & edge computing open source ecosystem.

We trust that you will find this report to be insightful and welcome your questions and feedback.



## Executive Summary

- **Development is increasing across all sectors. Industrial automation is now the top area of focus** (33%, up from 22%), followed by **agriculture** (29%, up from 23%), **building automation, energy management and smart cities** (all at 24%).
- **Developers indicate an increase of activity towards designing solutions for smarter buildings and cities.** Building automation, connected/smart cities, energy management, transportation, and public utilities all rank high on the list of projects being worked on. The nexus between these focus areas cannot be ignored.
- **Software supply chain security** has become an essential issue for IoT/Edge developers, with **70%** saying that it is important to their work.
- **Control logic (40%) surpassed artificial intelligence (37%)** as the most common edge computing workload. Does this imply a renewed focus on the practical aspects of delivering real-world solutions? Only time will tell.
- **MQTT expands IIoT communication protocol leadership.** Nearly half of developers (49%) indicate that MQTT is their preferred IIoT communication protocol, with **MQTT + Sparkplug** checking in at 8%.
- **5G is enabling accelerated IIoT adoption.** Cellular adoption has **doubled since 2022** (44% vs 22% in 2022) largely due to 5G penetration, while **WiFi** (38% vs 36% in 2022), **Ethernet** (38% vs 29% in 2022) and **Bluetooth/Bluetooth Smart** (23% vs 20% in 2022) continue to be viable options.



## Executive Summary

- **Eclipse Foundation projects are gaining momentum in container orchestration.** While Docker continues to be the most popular option for container orchestration at the edge, several Eclipse projects are building traction, including Eclipse ioFog (11%), Eclipse Kura (9%), and Eclipse Kanto (9%).
- **The withdrawal of IoT middleware providers has created an opportunity for innovators to enter the market.** Google Cloud IoT Platform, Bosch IoT Suite, IBM Watson IoT, and SAP Internet of Things all exited the market during 2022. While nearly half of respondents indicated a relationship with one or more of these providers, only 12% of them have migrated to a new provider.
- **Developers indicate that Java is the preferred language** for IoT gateways and edge nodes, while **C, C++, and Java** are the most widely used programming languages for **constrained devices**.
- Various flavors of **Linux** are the most widely used operating system choice for constrained devices (43%, same as 2022). However, embedded RTOS options like **FreeRTOS** and **Zephyr** are finding traction.
- **ARM continues to dominate the embedded landscape while RISC-V makes inroads.** For constrained devices, ARM architectures continue to gain ground over 2022. Gateways and edge devices continue to lean towards 64-bit architectures. In both scenarios, **RISC-V options from OpenHW Group** are generating increased interest.

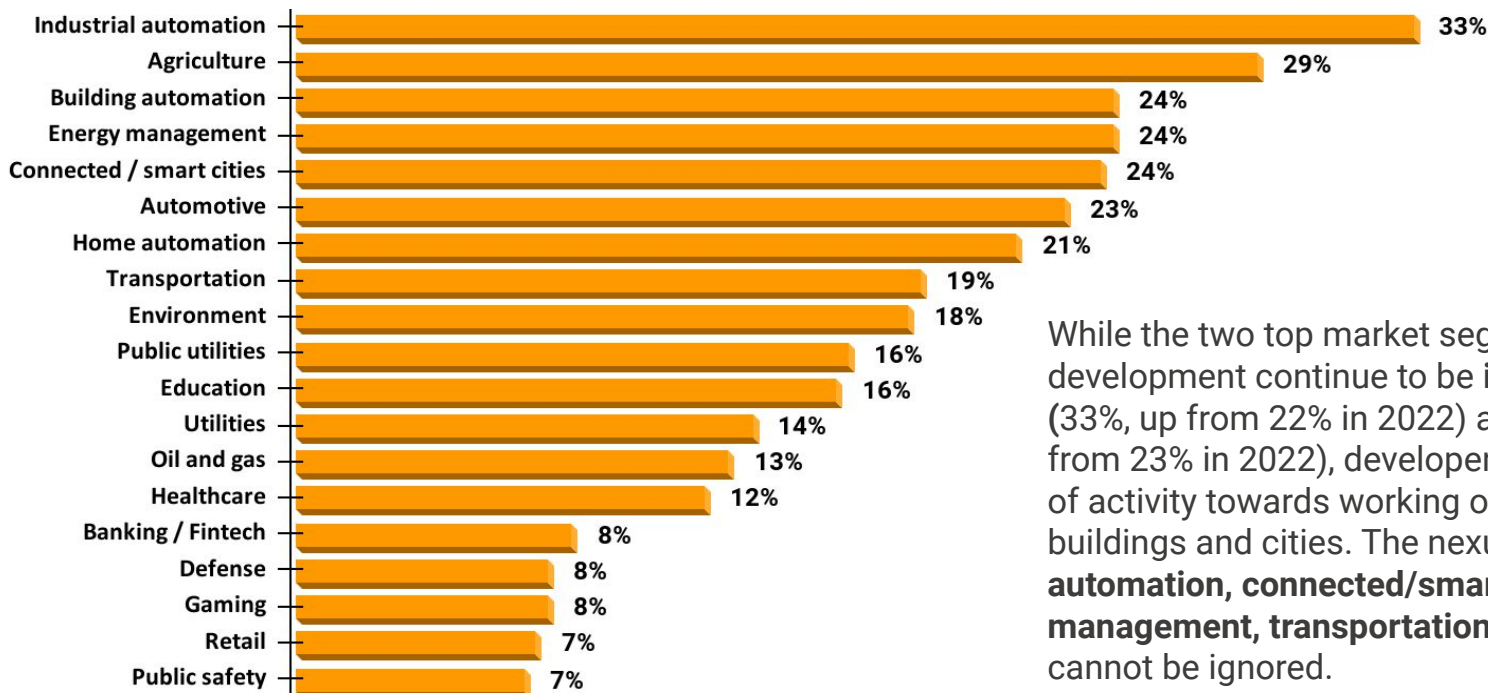


The background features a large orange circle on the left side. To its right, there are several horizontal, wavy lines in shades of orange, yellow, and blue, creating a sense of motion. Binary code (0s and 1s) is scattered across the background, particularly on the right side.

# ..... Key Findings



# Development is Increasing Across All Segments



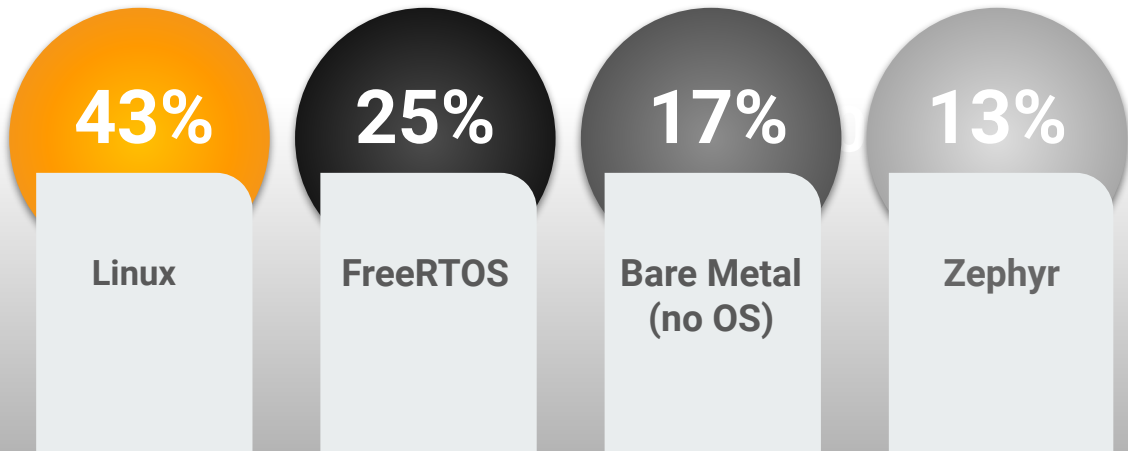
While the two top market segments for solution development continue to be **industrial automation** (33%, up from 22% in 2022) and **agriculture** (29%, up from 23% in 2022), developers indicate an increase of activity towards working on solutions for smarter buildings and cities. The nexus between **building automation**, **connected/smart cities**, **energy management**, **transportation**, and **public utilities** cannot be ignored.

Q: For which industry or industries are you building IoT solutions? (Select all that apply)



# Developer Embedded OS Preferences on Constrained Devices

**Linux** (43%), and **FreeRTOS** (25%) are the top embedded OS choices for constrained devices. A solid 17% of developers prefer no OS at all, while **Zephyr** enjoys a respectable 13%, compared to only 8% in 2022.



Q: Which embedded operating system(s) do you use for your constrained devices? (select up to three)



# Developer OS Preferences on IoT Gateways & Edge Nodes

**Linux** (58%, up from 51%), **Windows** (29%, down from 42% ) and **Android** (25%) are the top OS choices for IoT gateways and edge nodes, with **AIX** maintaining at 9% (same as 2022). **Azure Sphere**, at 8%, dropped out of the top four.

58%

Linux

29%

Windows

25%

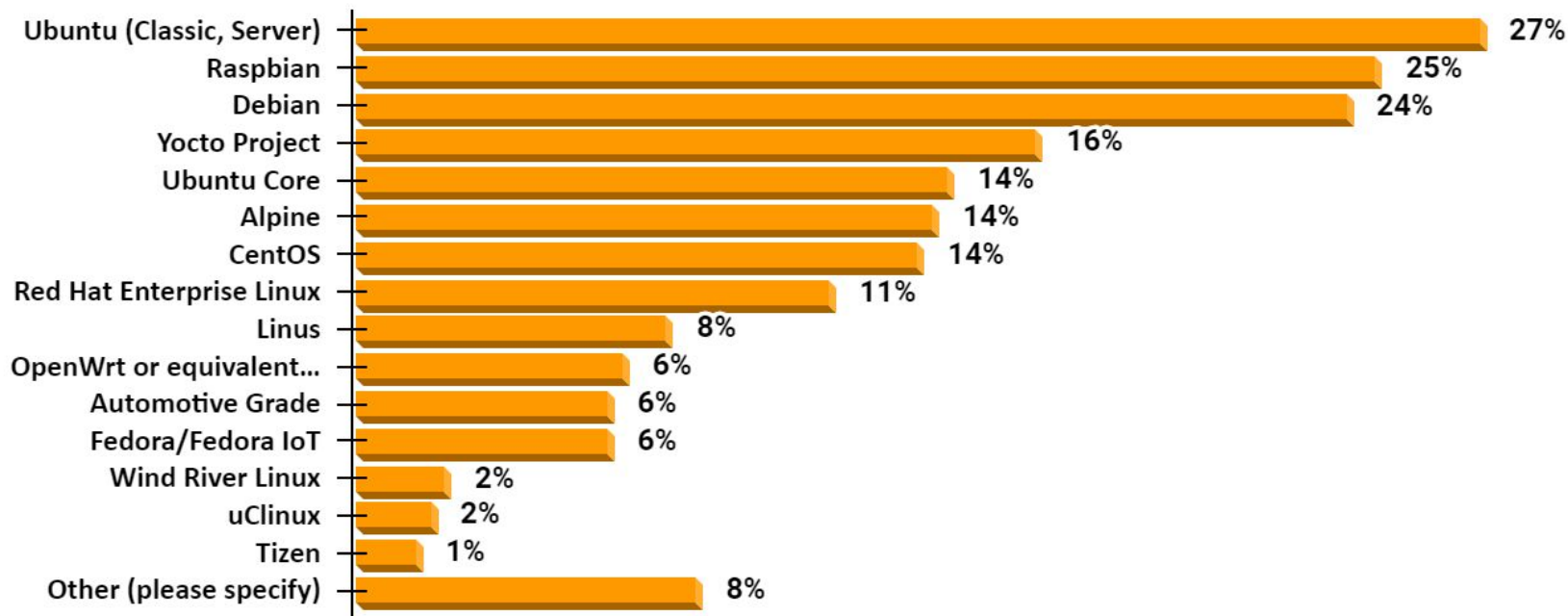
Android

9%

AIX

Q: Which operating system(s) do you use for your IoT gateways & edge nodes? (select up to three)

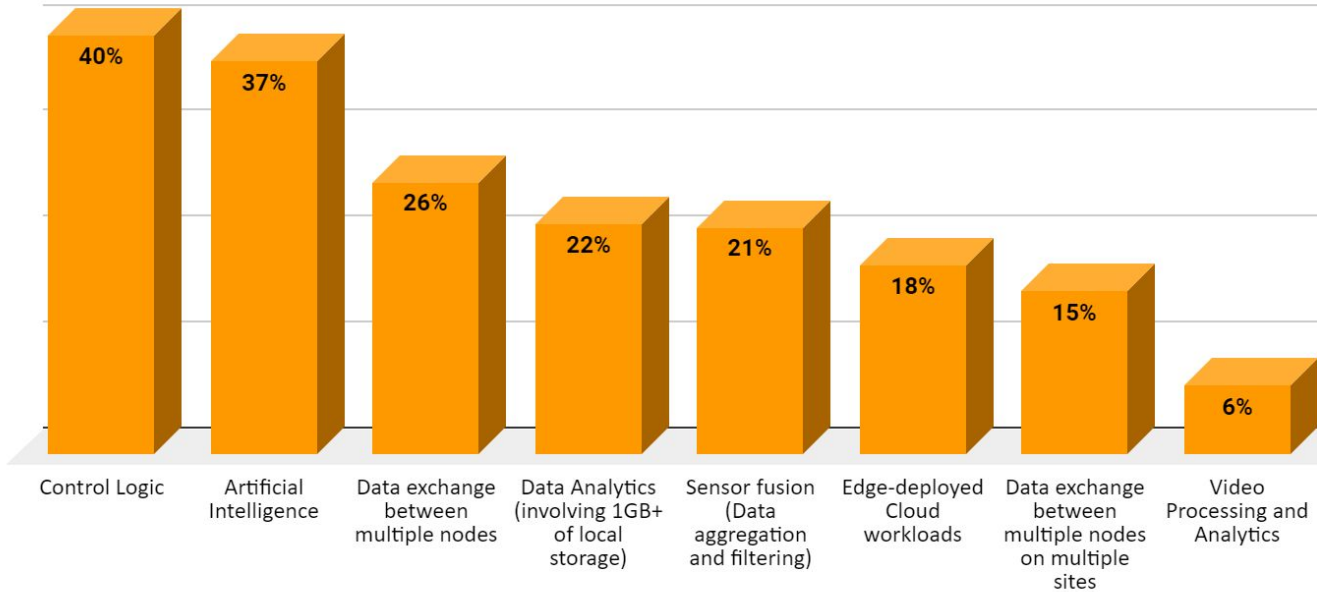
# Developers Work With a Broad Range of Linux Distributions



Q: If using Linux for your IoT solutions, what distribution do you typically employ? (Select up to three)



# Control Logic Surpasses AI as Most Common Edge Workload

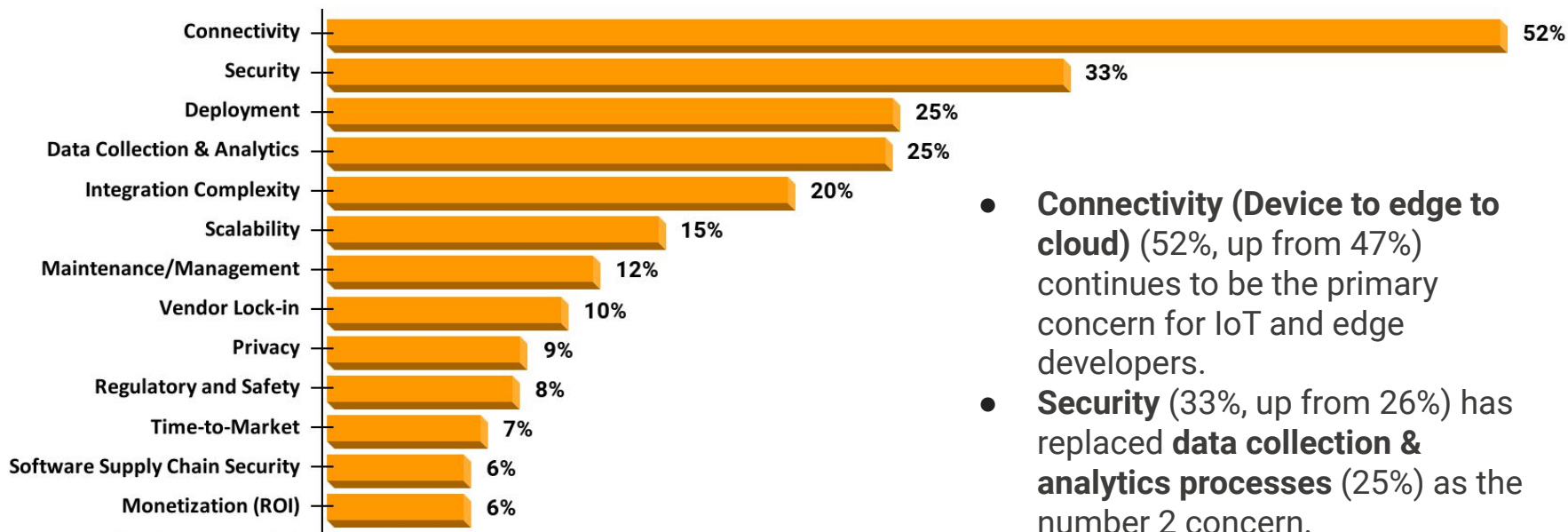


40% of respondents identify **control logic** as the top edge computing workload in this year's survey, with **artificial intelligence** maintaining a close second (37%).

Q: If your IoT solution leverages edge gateways and/or edge nodes, what types of edge computing workloads are you running? (Select up to three)



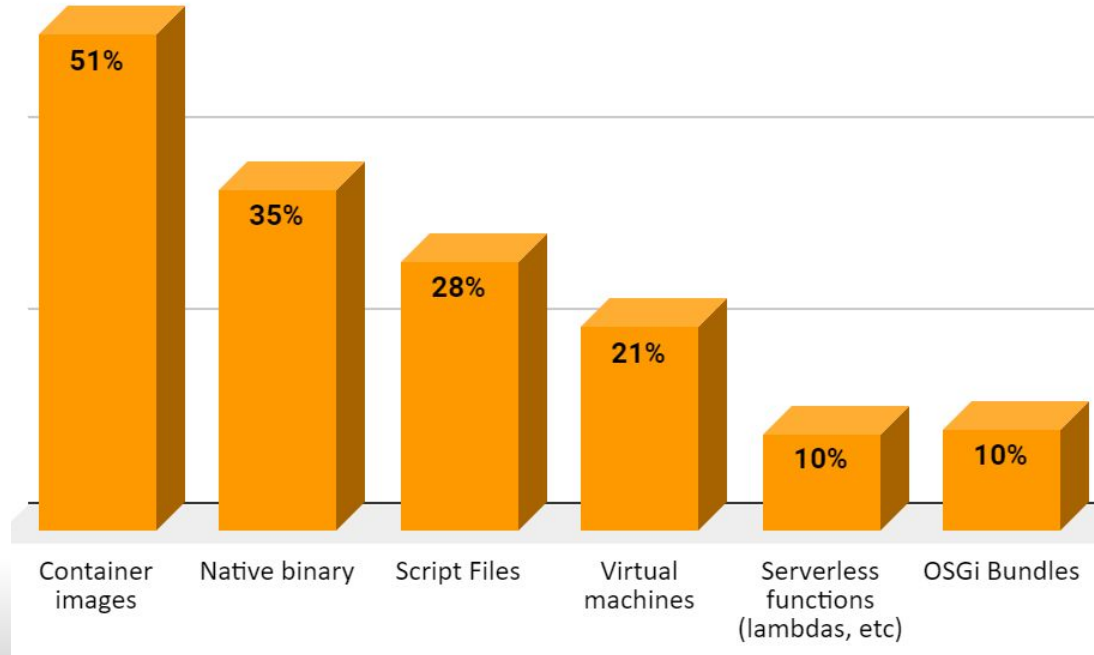
# Connectivity Continues to be the Top Developer Concern



Q: What are your primary IoT development concerns? (Select up to 3)



# Top Edge Computing Artifacts

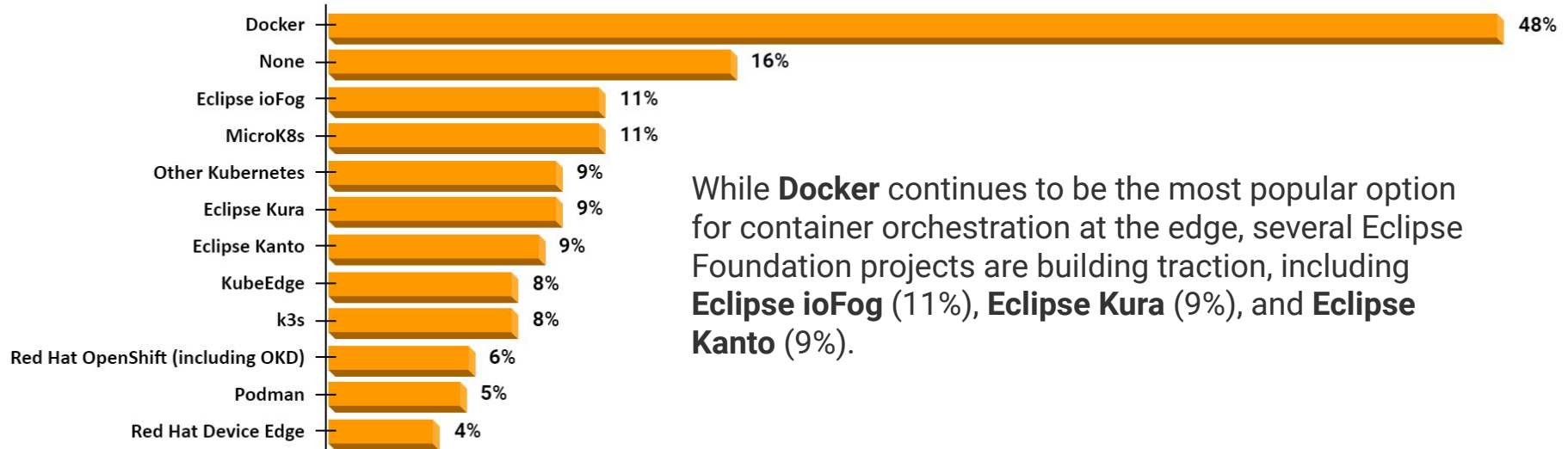


**Container images** continue to be the most commonly used edge computing artifacts for both edge gateways and edge servers.

Q: If your IoT solution leverages edge computing, what kind of artifact(s) do you deploy? (Select up to three



# Eclipse Projects Gain Momentum in Edge Container Orchestration



Q: If your IoT solution leverages Edge Computing, which container orchestration solution(s) do you use?  
(Select up to three)





# Developer Language Preferences on IoT Gateways & Edge Nodes

**Java** is the preferred development language for IoT Gateways and Edge Nodes, followed by **Python**, **Javascript**, and **C++**.

36%

Java

31%

Python

28%

Javascript

26%

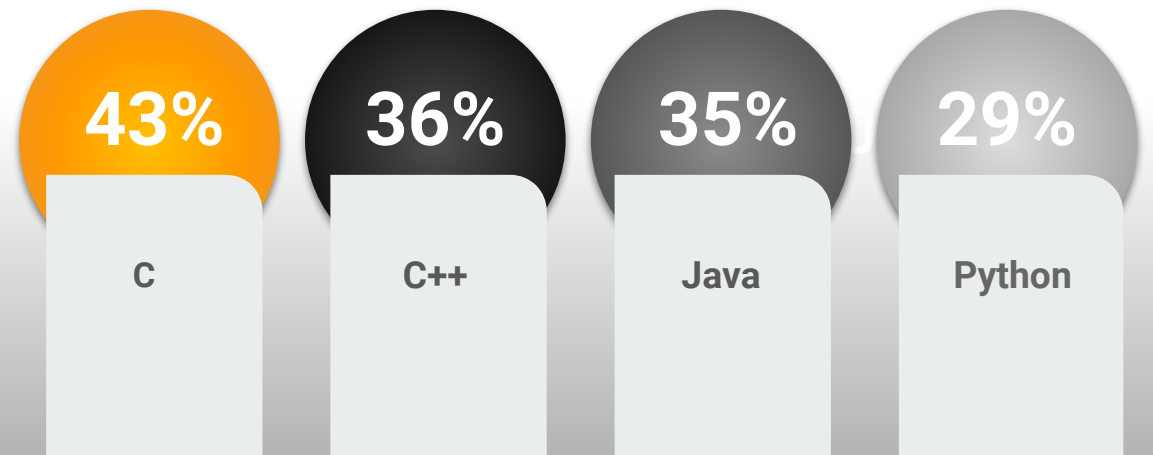
C++

Q: Which of the following programming languages do you use to build on IoT Gateways & Edge Nodes? (Select up to three)



# Developer Language Preferences on Constrained Devices

**C, C++, Java, and Python** are the programming languages of choice for development on constrained devices.

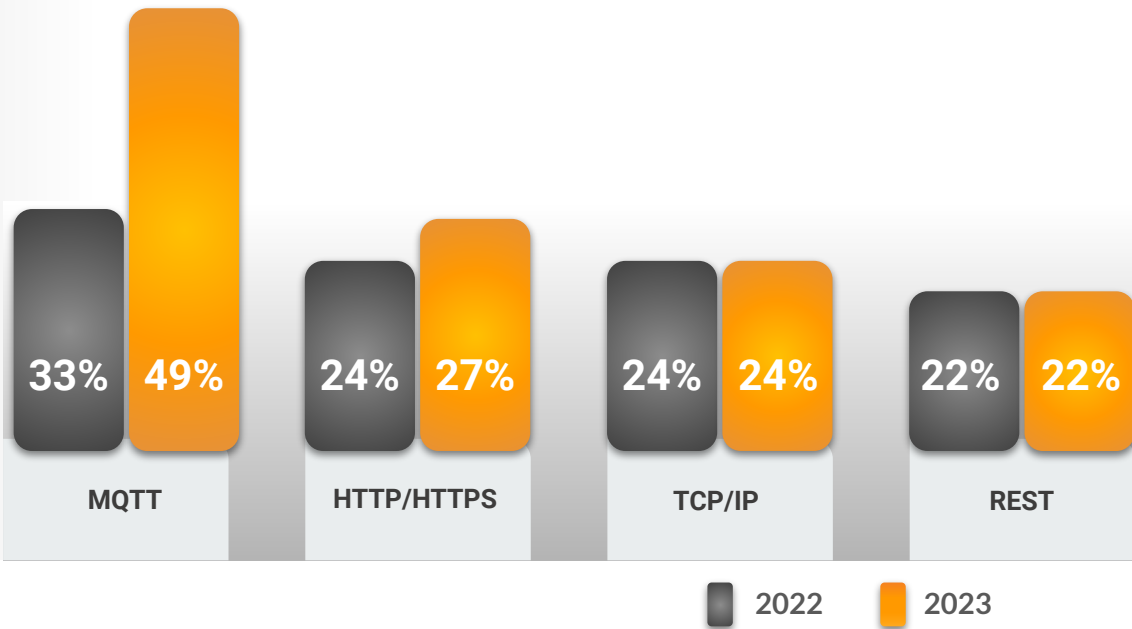


Q: Which of the following programming languages do you use to build on constrained devices? (Select up to three)



# MQTT's Continued Leadership in IIoT Communication Protocols

- Nearly half (49%) indicate that MQTT is their preferred IIoT communication protocol.
- **HTTP/HTTPS** also saw a slight increase in usage (+3%), while **TCP/IP**, and **REST** maintained their positions from 2022.
- **MQTT + Sparkplug** checked in at 8%.



Q: What communication protocol(s) do you use? (Select up to three)

# 5G Propels Cellular to the Top Connectivity Option



**Cellular**  
(LTE, 4G, 5G, etc)  
**44%**



**Ethernet**  
**38%**



**WiFi**  
**38%**



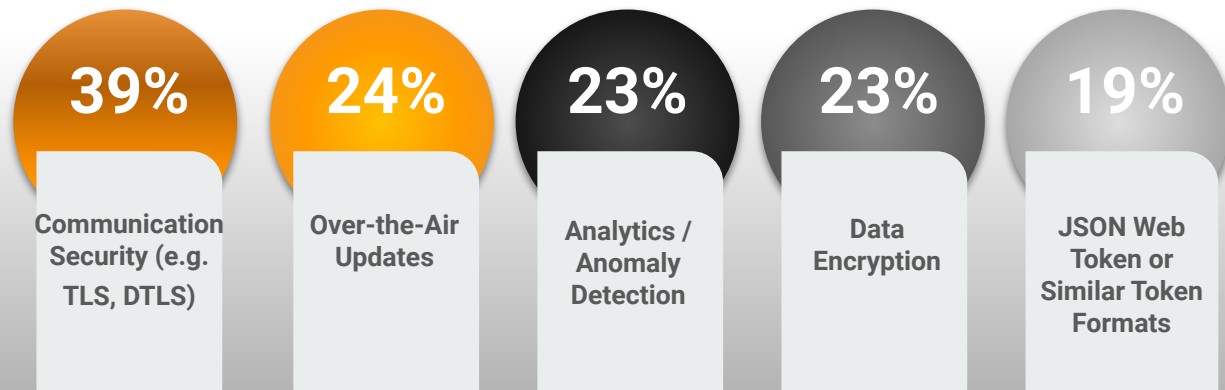
**Bluetooth/Bluetooth**  
**Smart**  
**23%**

Top connectivity technologies being used are **cellular** at 44% (22% in 2022), **WiFi** at 38% (36% in 2022), **Ethernet** at 38% (29% in 2022) and **Bluetooth/Bluetooth Smart** at 23% (20% in 2022).

Q: What connectivity protocol(s) do you use? (Select up to three)

# Most Favored Security Technologies for IoT/Edge Solutions

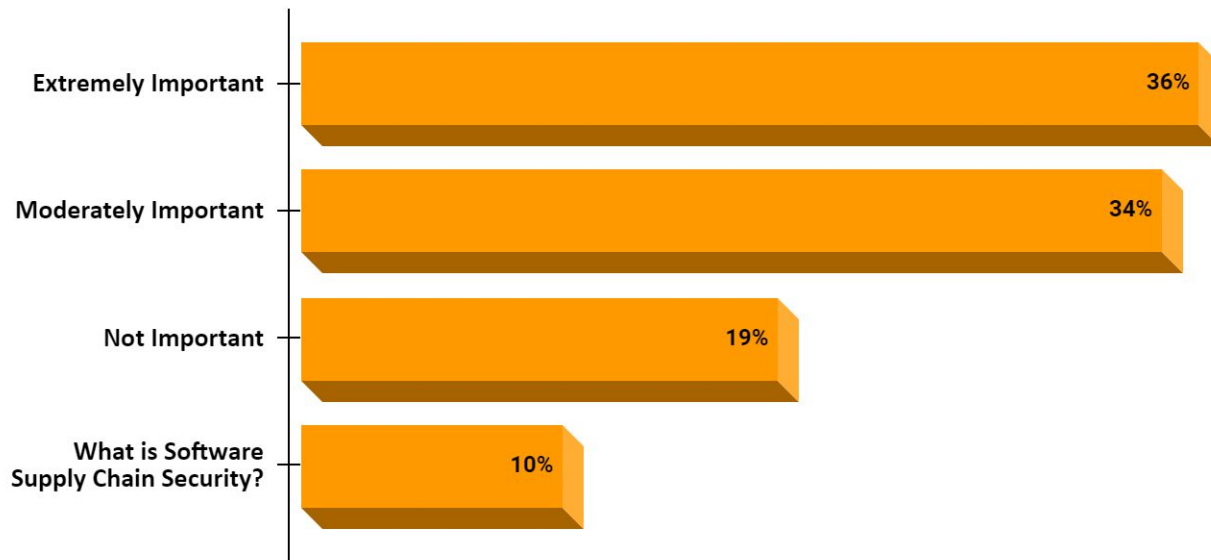
**Communication security (e.g. TLS, DTLS)** continues to be the most widely used security technology (**39%, up from 26%**), while **over-the-air updates** leapfrogged the other contenders to move into the number 2 spot (**24%, up from 15% in 2022**).



Q: Which security-related technologies do you use on your IoT/edge solutions: (Select up to three)

# Software Supply Chain Security Is Important to 70% of Developers

**Software supply chain security** has become an important issue with IoT/edge developers, with 70% saying that it is important to their work.

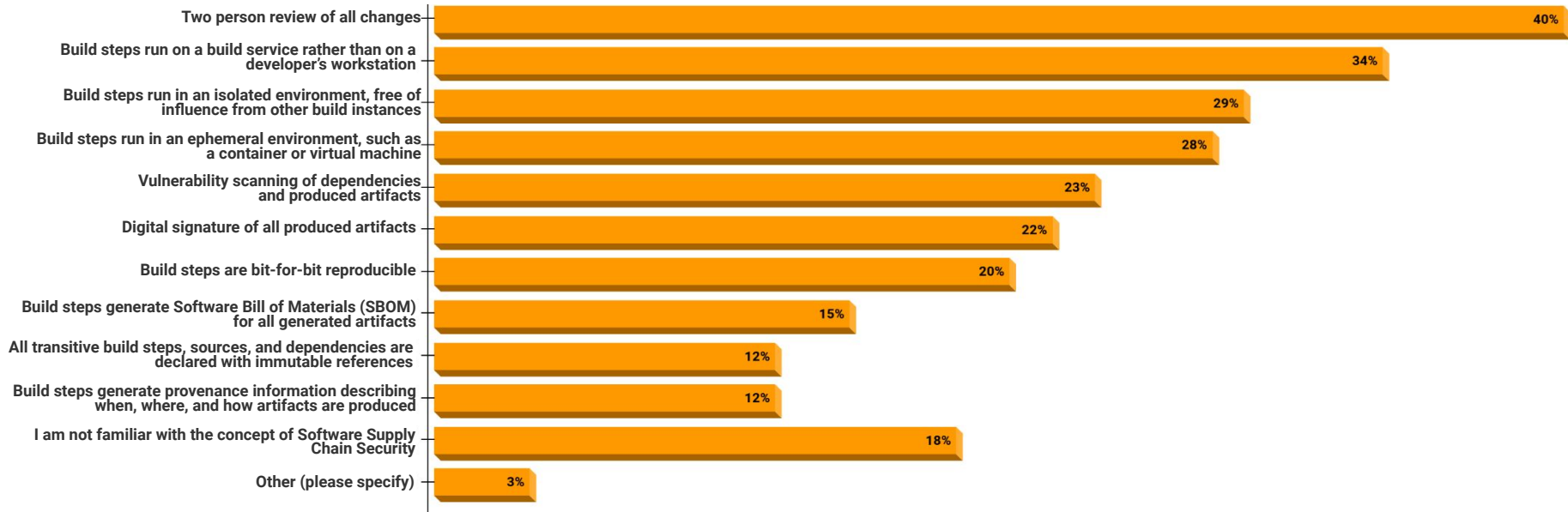


Q: How important is Software Supply Chain Security to your IoT/edge solutions?





# Usage of Software Supply Chain Security Best Practices

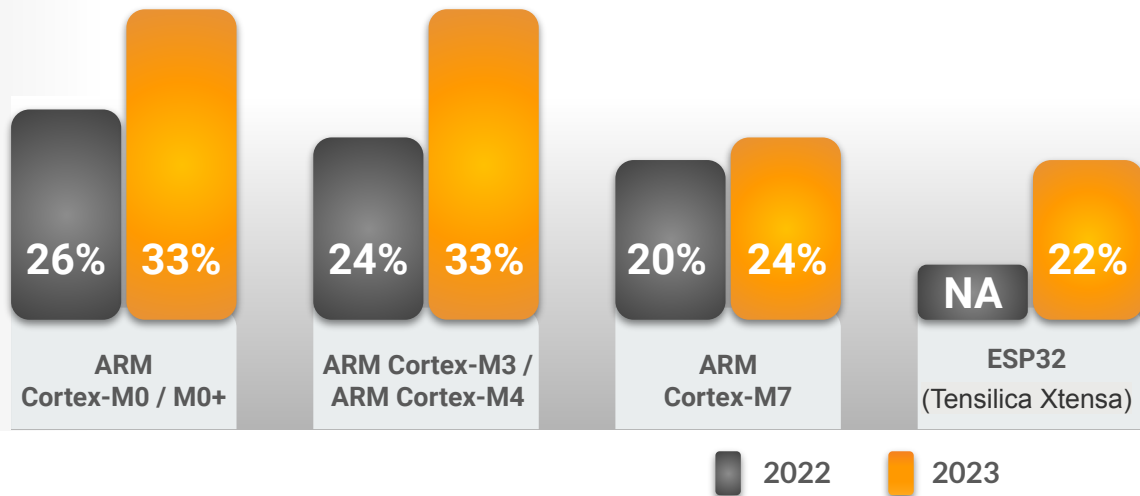


Q: Among these Software Supply Chain Security best practices, which ones do you implement for your IoT/edge solutions?  
(Check all that apply)



# Hardware Architecture Usage for Constrained Devices

- ARM continues to dominate the constrained device landscape. In particular, **ARM Cortex-M0 / M0+** and **ARM Cortex-M3 / M4** usage shows substantial increases over 2022.
- New to this survey, the Espressif Systems **ESP32 (Tensilica Xtensa)** is used by an impressive 22% of respondents.
- RISC-V architectures from OpenHW Group** (CORE-V CVE2, CVE4) are gaining momentum with 7%.

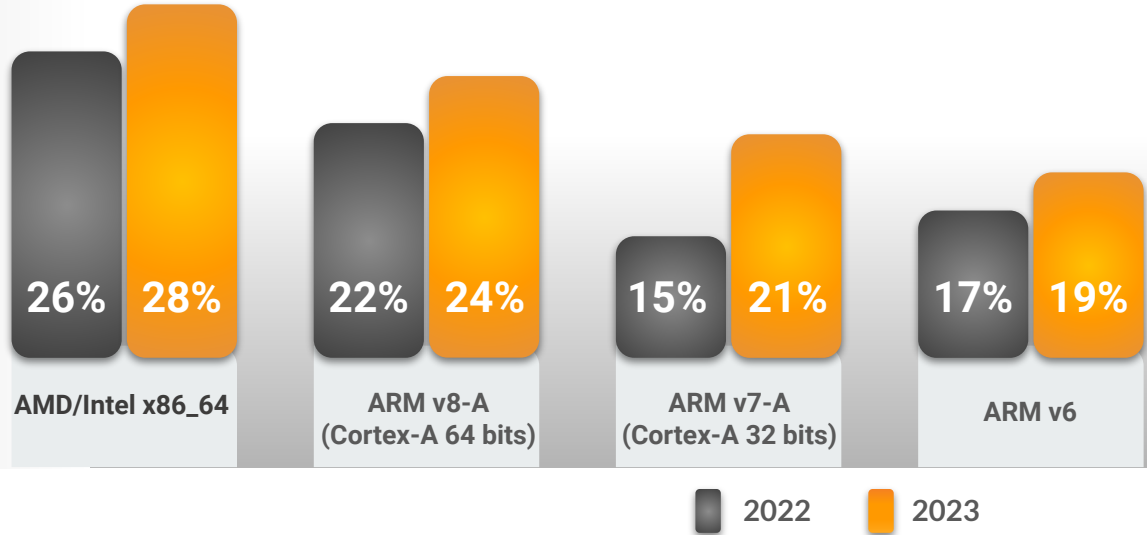


Q: What hardware architecture(s) do you use for constrained devices? (Select up to three)



# Hardware Architecture Usage for IoT Gateways and Edge Nodes

- 64-bit architectures continue to gain ground in gateways and edge nodes.
- AMD/Intel x86-64** usage shows marginal growth from 26% in 2022 to 28%.
- Overall, ARM architectures are dominant, with the 64-bit **v8-A**, the **v7-A** and **v6** all showing up in the top 4 and other family members (v7-M, v8.2A, V9, v7-R) lagging not too far behind.
- The new OpenHW Group CORE-V (CVA6) makes its debut at 4%.



Q: What hardware architecture(s) do you use for IoT gateways and edge nodes? (Select up to three)

# Types of Data Being Stored from IoT/Edge Solutions

The most common types of IoT data being gathered and stored are **device information (44%)**, **time series data (36%)**, and **contextual data (35%)**.

44%

Device  
Information

36%

Time Series  
Data

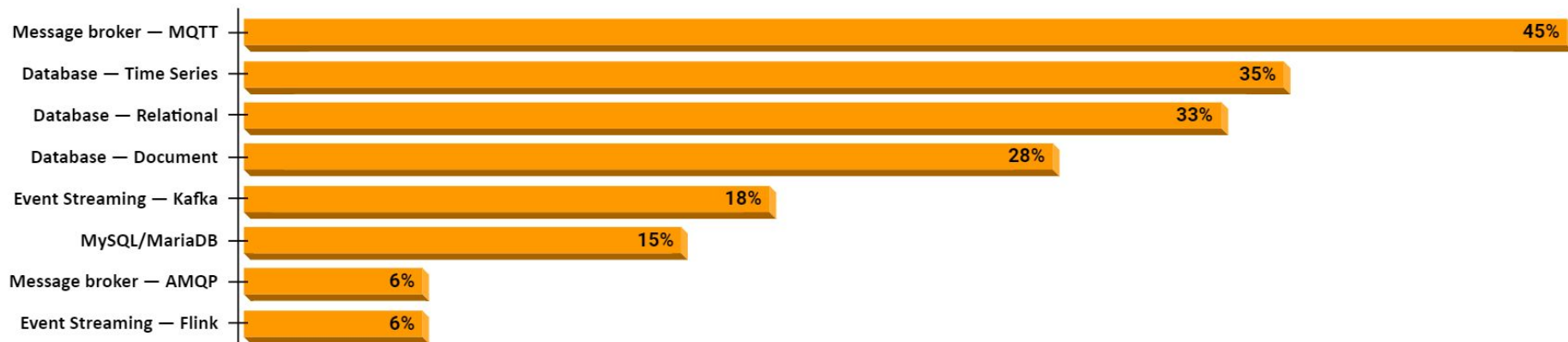
35%

Contextual Data (e.g.  
adding location or  
geospatial context to  
device, sensor, etc.)

Q: What type of IoT data/information do you store either in a database or data store? (Select up to three)



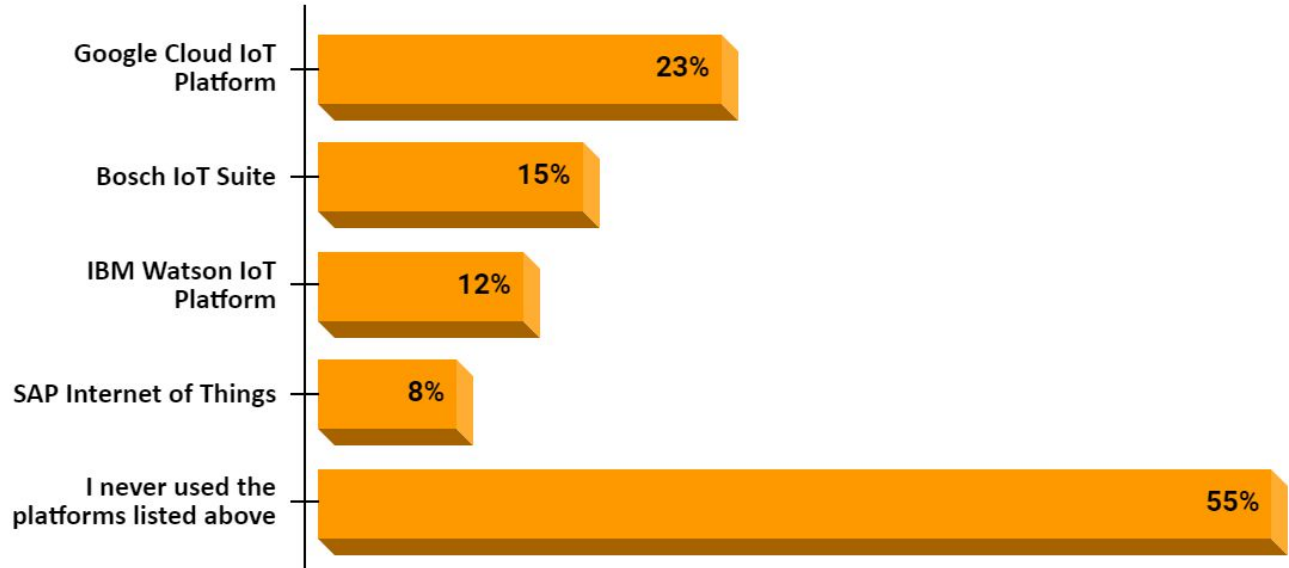
# MQTT is Preferred for Messaging Infrastructure



Q: Which of these technologies are you using in your messaging infrastructure? (Select up to three)

# Impact of Discontinued Middleware Offerings

While 55% of participants did not use any of the middleware offerings that were discontinued by multiple vendors in 2022, a significant number of them were left without a provider, opening the door for more agile providers to enter the market and service these customers.



Q: Have you used or are you still a user of any of the following discontinued IoT middleware?





# Vast Majority Have Not Yet Migrated to New Middleware

If you used any of the discontinued IoT middleware listed above, have you migrated to a different IoT middleware?



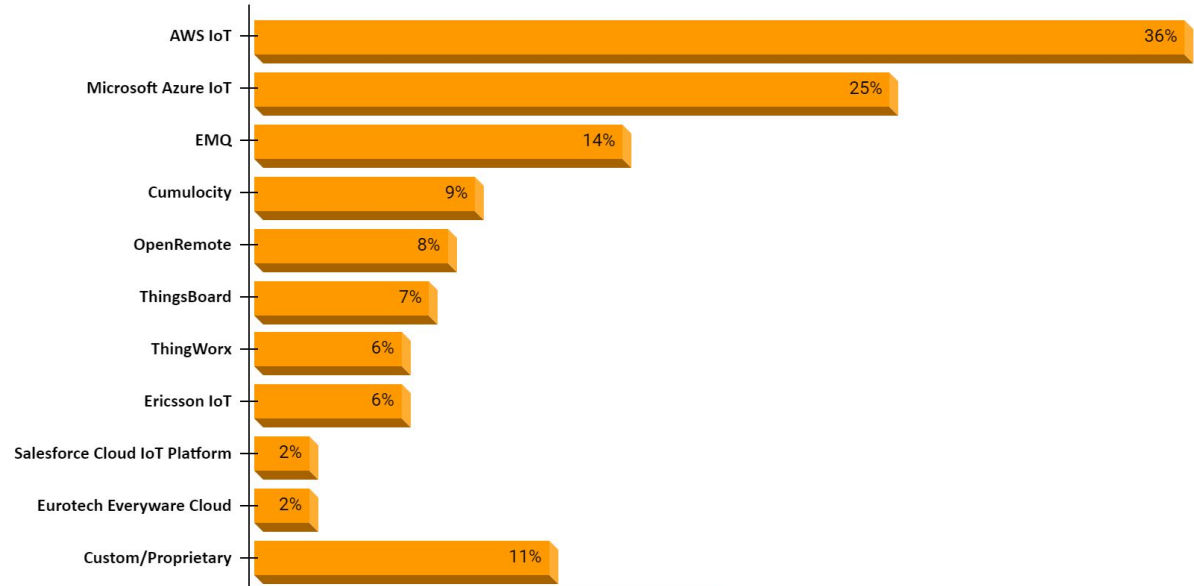
Q: If you used any of the discontinued IoT middleware, have you migrated to a different IoT middleware?



# There is Opportunity for Middleware Alternatives

While **AWS IoT** (36%) and **Microsoft Azure IoT** (25%,) continue to be the dominant players in IoT middleware, the discontinuance of other major offerings has left a vacuum.

While the market remains relatively fragmented, there is opportunity for new and emerging middleware offerings that are purpose built and/or aligned to specific applications or vertical markets.

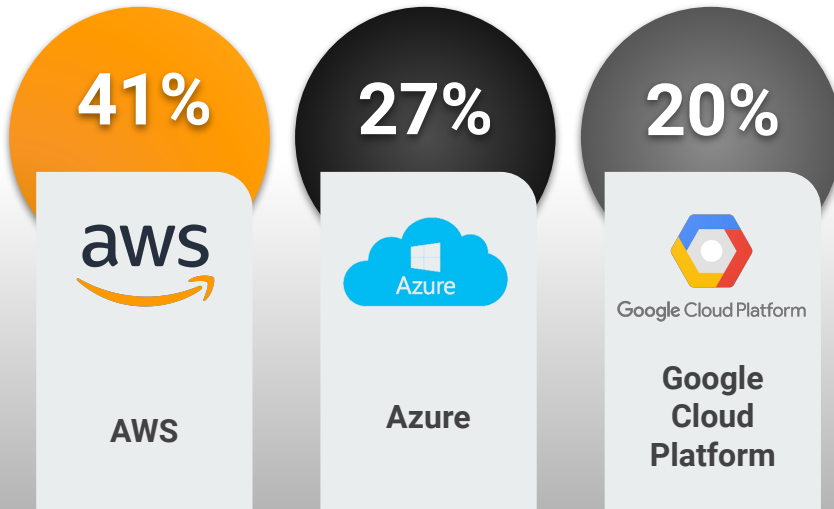


Q: Which of the following IoT middleware do you use? (Select up to three)

# Status Quo for IoT Cloud Platforms

**Amazon Web Services (AWS)** with **41%** (+5%), **Microsoft Azure** with **18%** (+9%), and **Google Cloud Platform** with **16%** (+4%) continue their dominance of public IoT and cloud platforms.

On premise options using Kubernetes (13%), Cloud Foundry (10%), and OpenStack (6%) are also finding their way into the IoT and edge ecosystem.



Q: Do you use any of the following platforms as part of your IoT solution? (Select up to three)



# ..... Recommendations



# Recommendations

- **Collaborate Across Projects and Industries:** Given the convergence of projects in building automation, smart cities, transportation, and energy management, there is an opportunity to foster collaboration and partnerships across projects and industries to deliver comprehensive solutions addressing real-world challenges.
- **Diversify OS and RTOS Adoption:** While Linux remains prominent for constrained devices, explore embedded RTOS options like FreeRTOS, Zephyr, and ThreadX. Evaluate OS choices to align with specific use cases.
- **Leverage MQTT for IIoT Communications:** Considering that nearly half of developers prefer MQTT for IIoT communications, companies should consider adopting MQTT, potentially combined with Sparkplug.
- **Prioritize Software Supply Chain Security:** With 70% of developers emphasizing the importance of software supply chain security, companies should implement robust measures to safeguard IoT and edge solutions.
- **Seize Opportunities in Middleware:** Exploit the void left by IoT middleware providers that exited the market in 2022, such as Google Cloud IoT Platform, Bosch IoT Suite, IBM Watson IoT, and SAP Internet of Things. New and purpose-built middleware offerings can cater to specific applications or vertical markets.



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# Methodology and Demographics







## Methodology

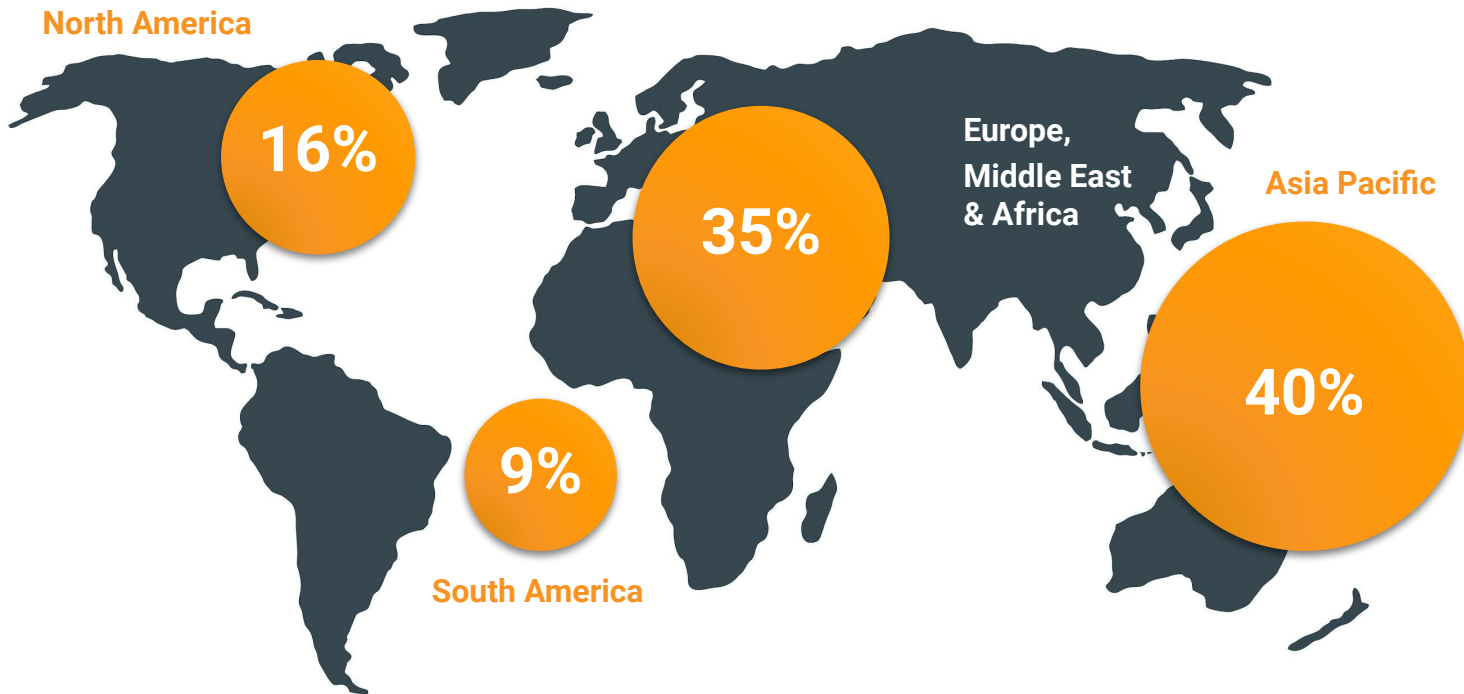
Sponsored by the [Eclipse IoT](#), [Eclipse Edge Native](#), and [Eclipse Sparkplug](#) Working Groups, the 2023 IoT & Edge Developer Survey was conducted from April 4 to July 5, 2023. The survey garnered participation through social media channels, the Eclipse Foundation websites, and the enthusiastic support of our valued members and partners.

A total of 1,037 respondents, comprising developers, committers, architects, and decision-makers, participated in the survey—a notable 15% increase from the previous year. These participants hail from diverse industries worldwide.

Among the respondents, 63% identified as open source users, with 21% actively contributing to open source projects.



## In Which Region Are You Located?



# Which Best Describes Your Role?

32%



Developer

18%



Executive

15%



Engineering/R&D  
Management

9%



Other

9%



IT Management

6%



Engineer/R&D (Hardware)

6%



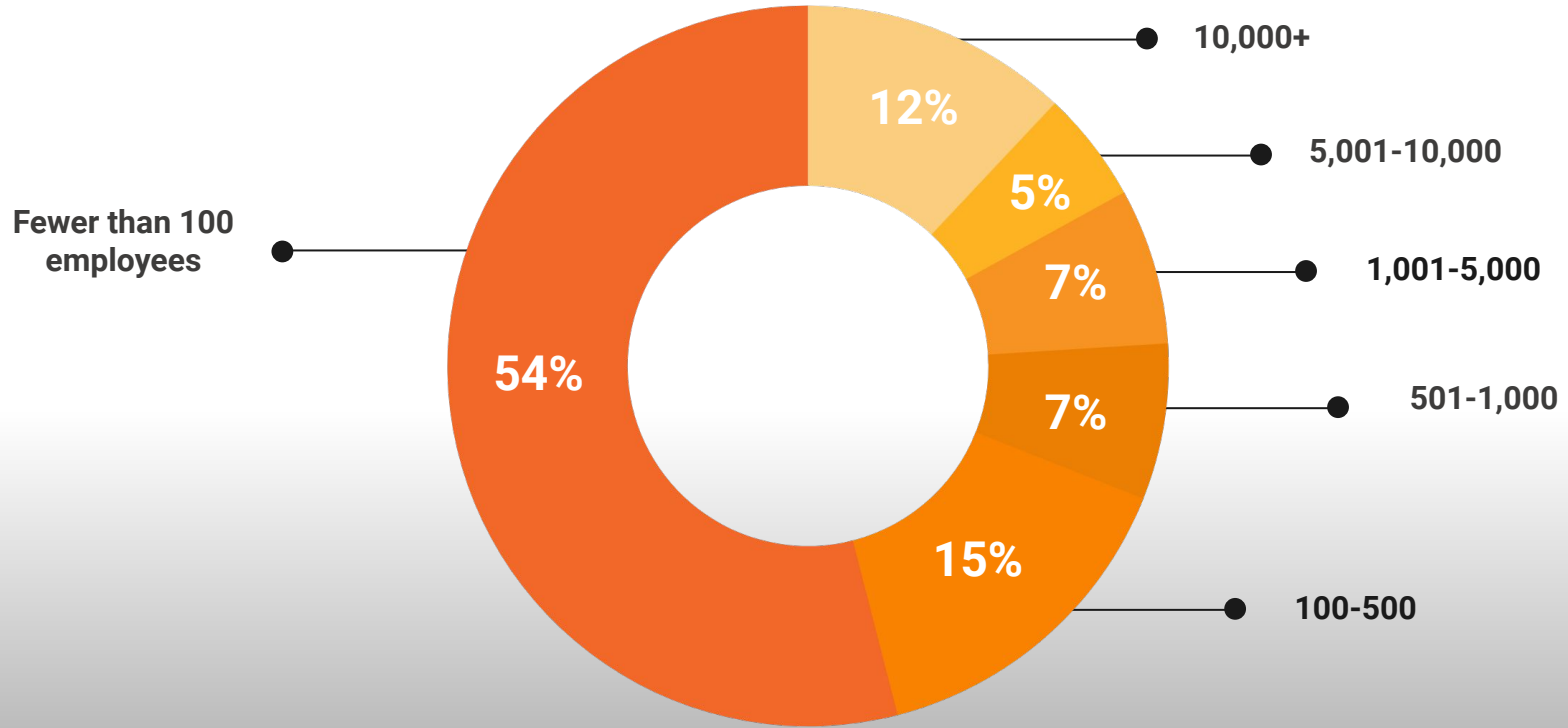
Product Manager

5%



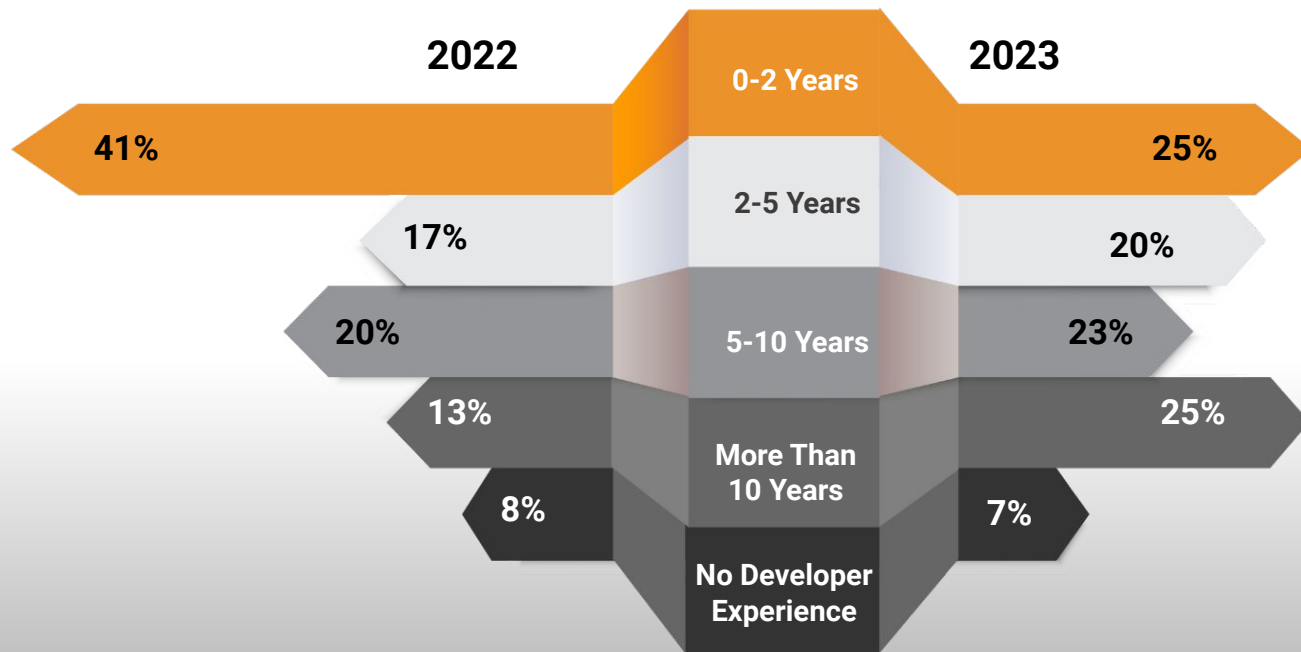
Marketing/Sales/Business  
Development

# How Large is the Organization You Work For?



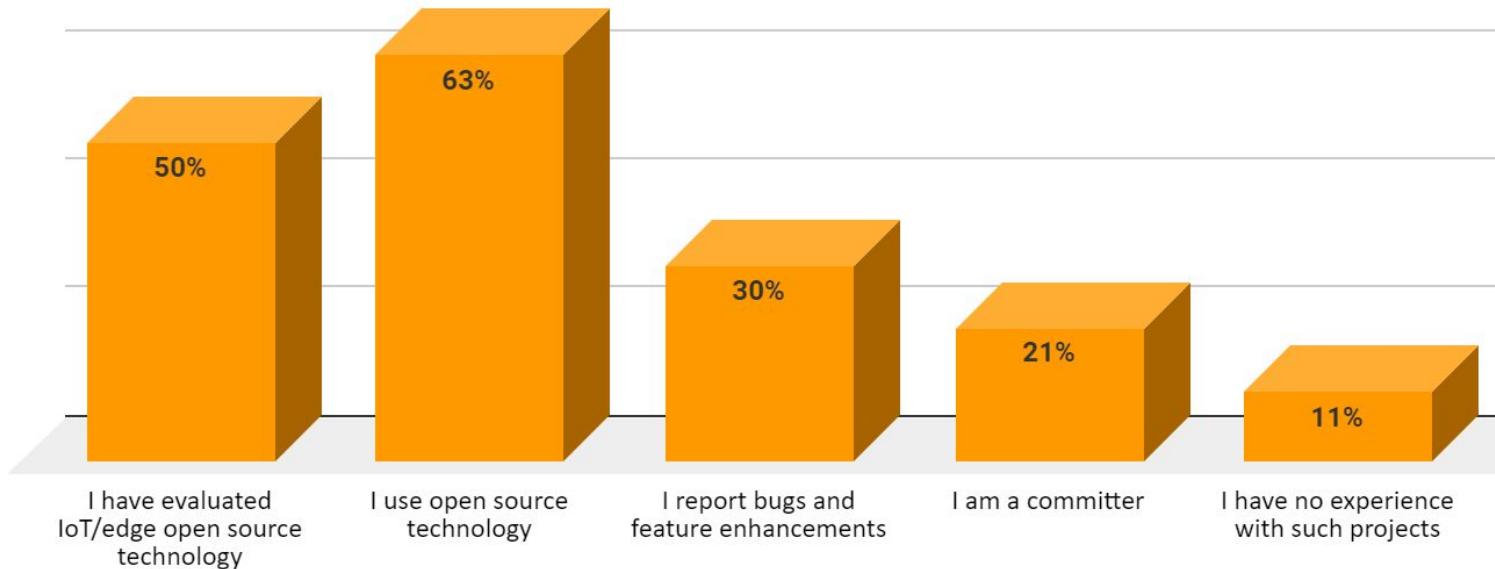


# How Much Experience Do You Have Developing IoT/Edge Solutions?





# Open Source IoT/Edge Project Participation



Q: Which statement(s) best describes your IoT/edge open source project participation? (Select up to three)

# Thanks to Our Survey Partners

Thank you for sharing the survey with your communities!



# Thank You!

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