IoT Developer Survey Results

April 2017

DRAFT – NOT FOR DISTRIBUTION

iot eclipse.org

IEEE Internet of Things

AGILE

council

SURVEY INTRODUCTION

- The Eclipse IoT Working Group, IEEE IoT, AGILE IoT and IoT Council co-sponsored an online survey to better understand how developers are building IoT solutions.

- The survey was open from February 7 until March 17, 2017.
  A total of 713 individuals participated in the survey. Each partner promoted the survey to their communities through social media and web sites.

- A similar survey was conducted in 2015 and 2016.
  Details are available at:

  - http://www.slideshare.net/IanSkerrett/iot-developer-survey-2015
  - https://www.slideshare.net/IanSkerrett/iot-developer-survey-2016

KEY FINDINGS

KEY FINDINGS - TOP 5 IoT INDUSTRIES
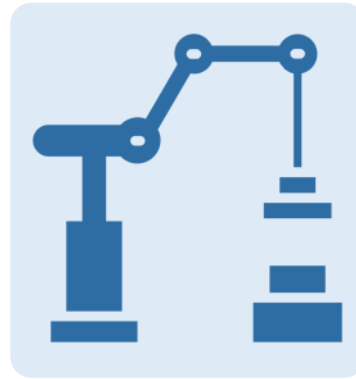
and trends from previous years

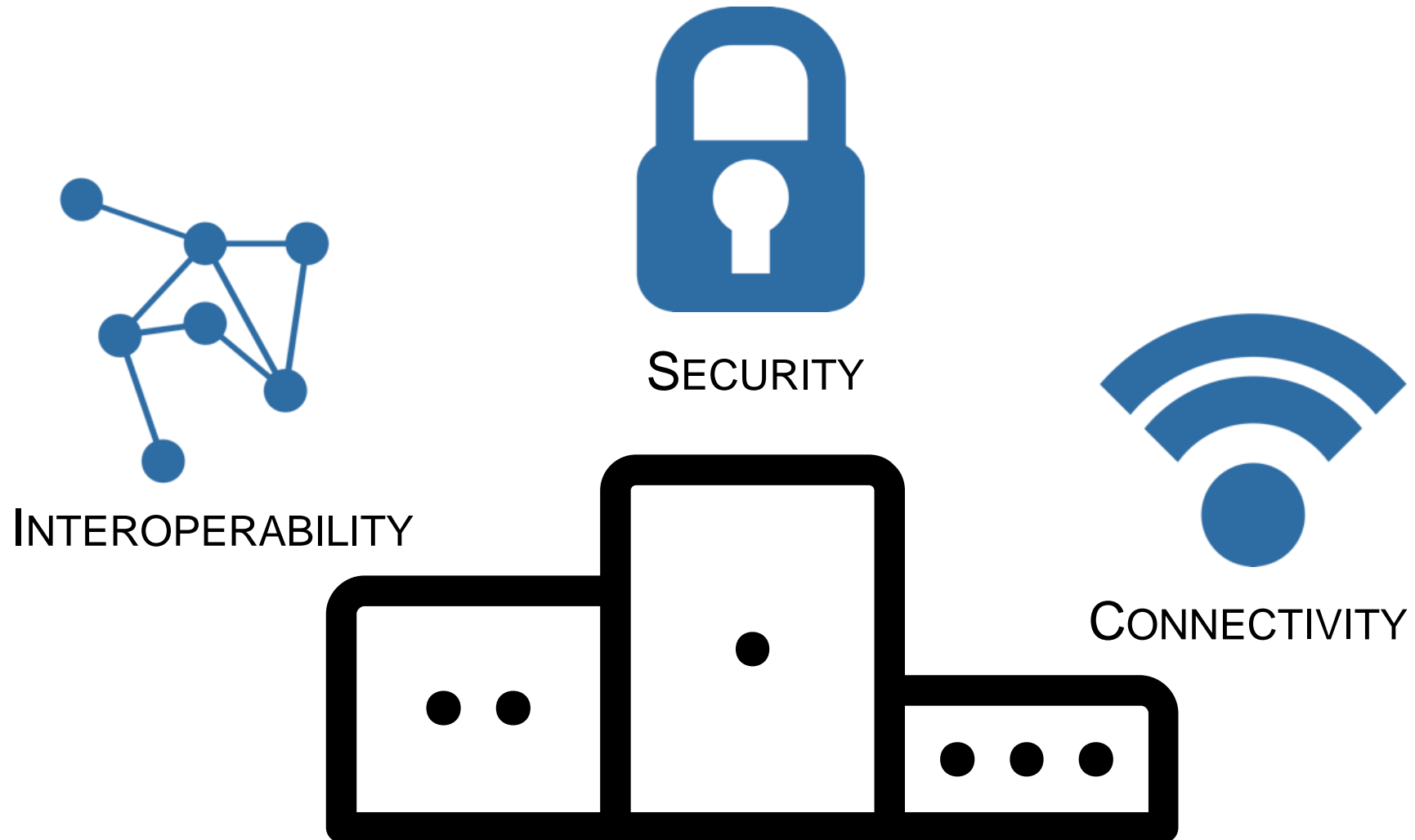

HOME AUTOMATION	IoT PLATFORM	INDUSTRIAL AUTOMATION	ENERGY MANAGEMENT	CONNECTED CITIES
=	=	↗	↗	↗

KEY IoT CONCERNS

INTEROPERABILITY

SECURITY

CONNECTIVITY

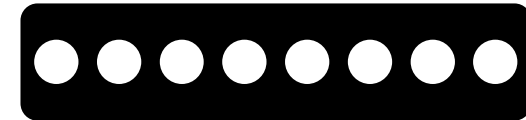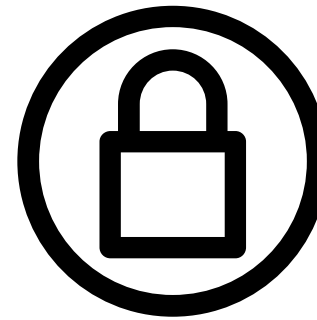# KEY IoT SECURITY TECHNOLOGY
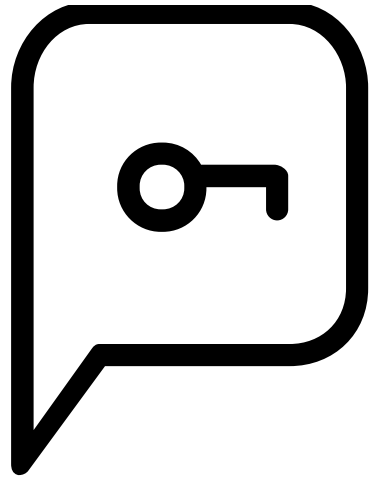
COMMUNICATION SECURITY
(TLS, DTLS, …)

DATA ENCRYPTION

TOP IOT PROGRAMMING LANGUAGES

CONSTRAINED
DEVICES

GATEWAYS

IOT
CLOUD

C/C++

Java

Java

Java   python™

C/C++   python™

JS   node

JS
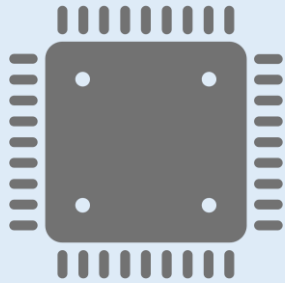
python™

TOP IoT OPERATING SYSTEMS & DISTROS
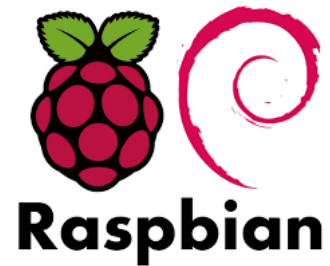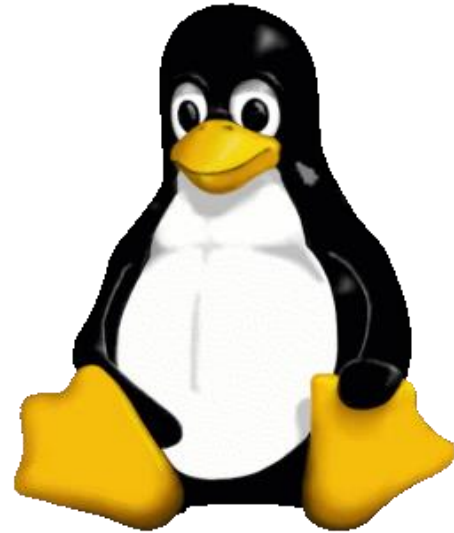
CLOUD PLATFORMS OF CHOICE FOR IoT

GROWTH OF NEW CONNECTIVITY TECHNOLOGIES

LPWA Technologies

IoT Experience

IoT Experience

What is your primary experience with building IoT solutions?

Legend:
- I develop IoT solutions for my company
- I am researching IoT solutions for my company
- I develop IoT solutions in my spare time only
- I am learning about IoT technology in my spare time
- No experience
- Other

Pie chart values: 35%, 20%, 12%, 20%, 8%, 5%
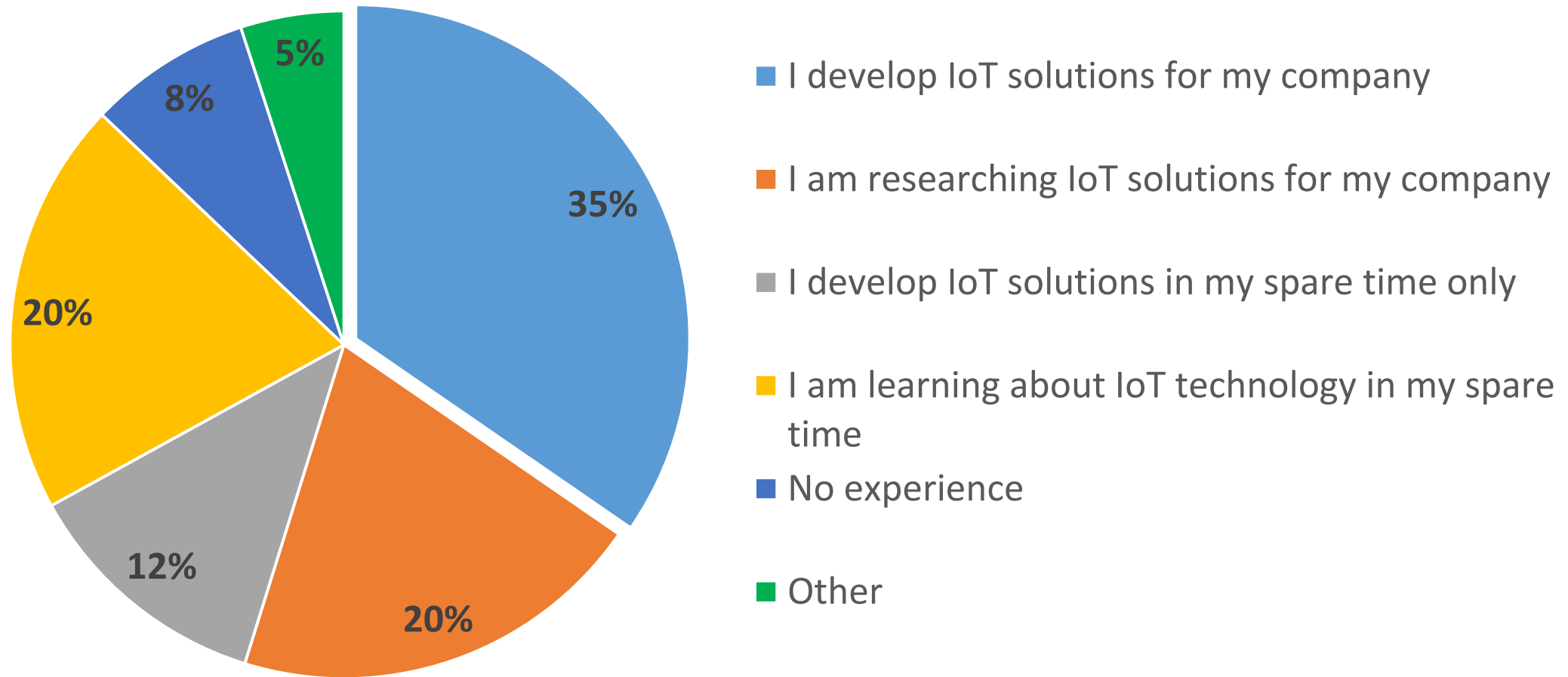
COMPANY PLANS FOR IoT

What is your company's plan for IoT solutions?
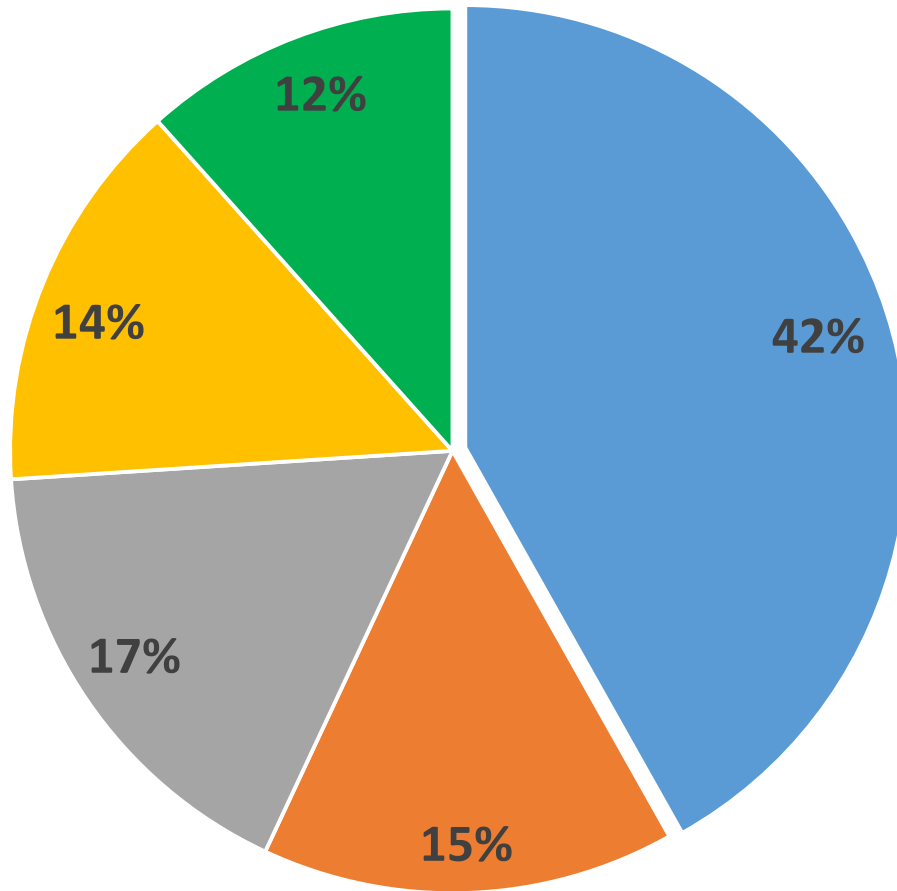
- 🟦 My company develops and deploys IoT solutions today
- 🟧 My company plans to develop and deploy IoT solutions in the next 6 months
- ⬜ My company plans to develop and deploy IoT solutions in the next 7-18 months
- 🟨 My company has no plans to develop IoT solutions
- 🟩 Don't know

KEY INDUSTRIES

What industry or industries best describe(s) the type of IoT solutions you have built or will build?

Industry	Percentage
IoT platform / middleware	41.6%
Home automation	41.1%
Industrial automation	36.4%
Connected / smart cities	33.4%
Energy management	33.3%
Building automation	26.1%
Agriculture	25.5%
Healthcare	22.7%
Automotive	21.4%
Transportation	20.1%
Education	17.2%
Environment	16.4%
Utilities	16.1%
Wearables	14.2%
Security / public safety	12.9%
Public utilities	11.3%
Retail	10.9%
Security / defense	9.4%
Fitness	7.9%
Banking / financial / fintech	7.9%
Vending	7.0%
Collaborative and sharing...	4.5%

KEY INDUSTRIES / TRENDS 2016-2017

IoT platform / middleware — 41.6%
Home automation — 41.1%
Industrial automation — 36.4%
Connected / smart cities — 33.4%
Energy management — 33.3%
Building automation — 26.1%
Agriculture — 25.5%
Healthcare — 22.7%
Automotive — 21.4%
Transportation — 20.1%

2016
2017
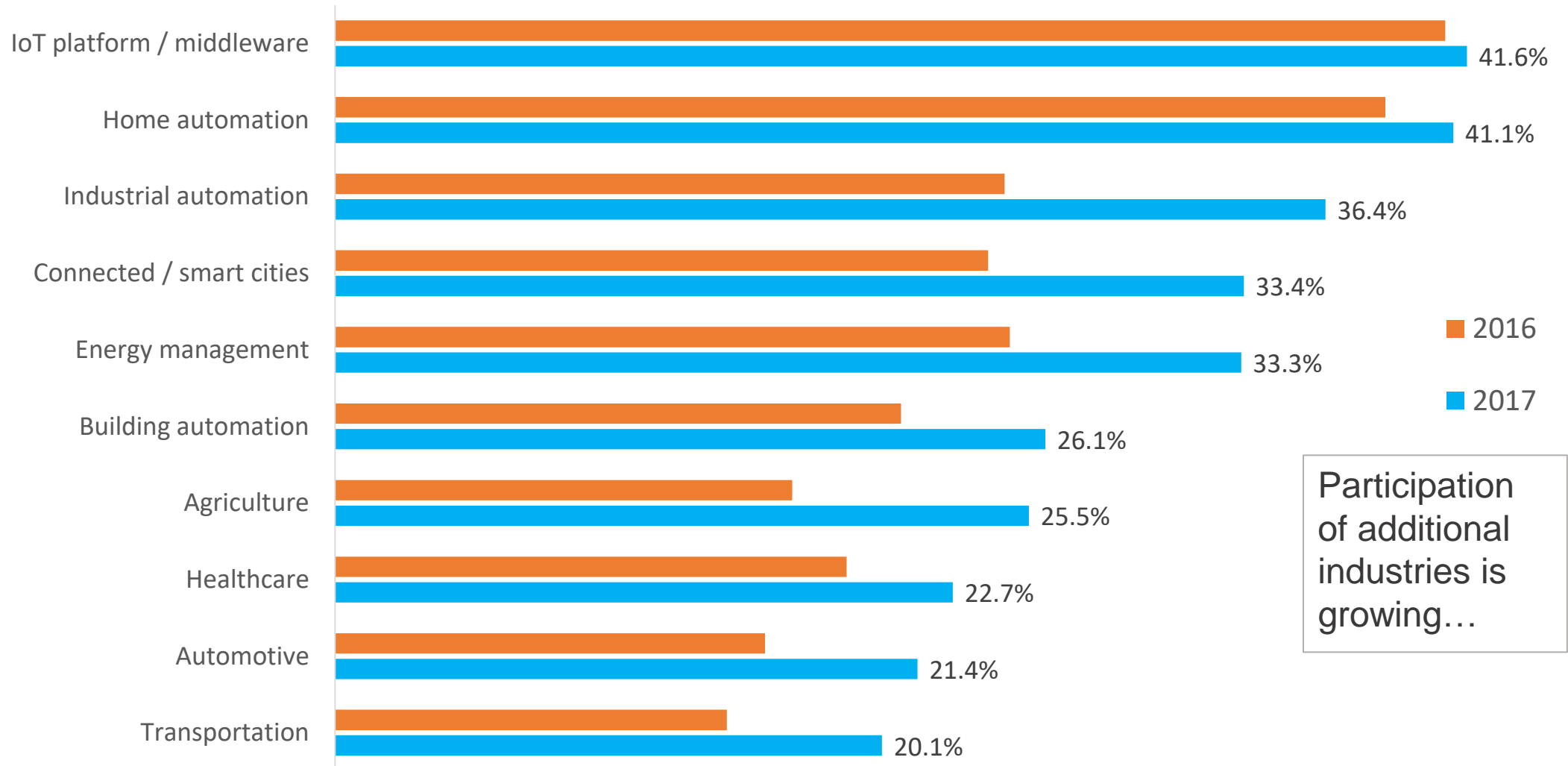
Participation of additional industries is growing…

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TOP IoT CONCERNS

What are your top 2 concerns for developing IoT solutions?

Concern	Percentage
Security	46.7%
Interoperability	24.4%
Connectivity	21.4%
Integration with hardware	19.3%
Standards	15.0%
Return on investment (ROI)	14.8%
Cost	14.7%
Scalability	14.1%
Privacy	13.7%
Performance	12.3%
Data analytics	12.3%
Complexity	9.0%
Maintenance	8.2%
Certification / conformance	4.4%
Other	3.8%
I don't know	2.4%
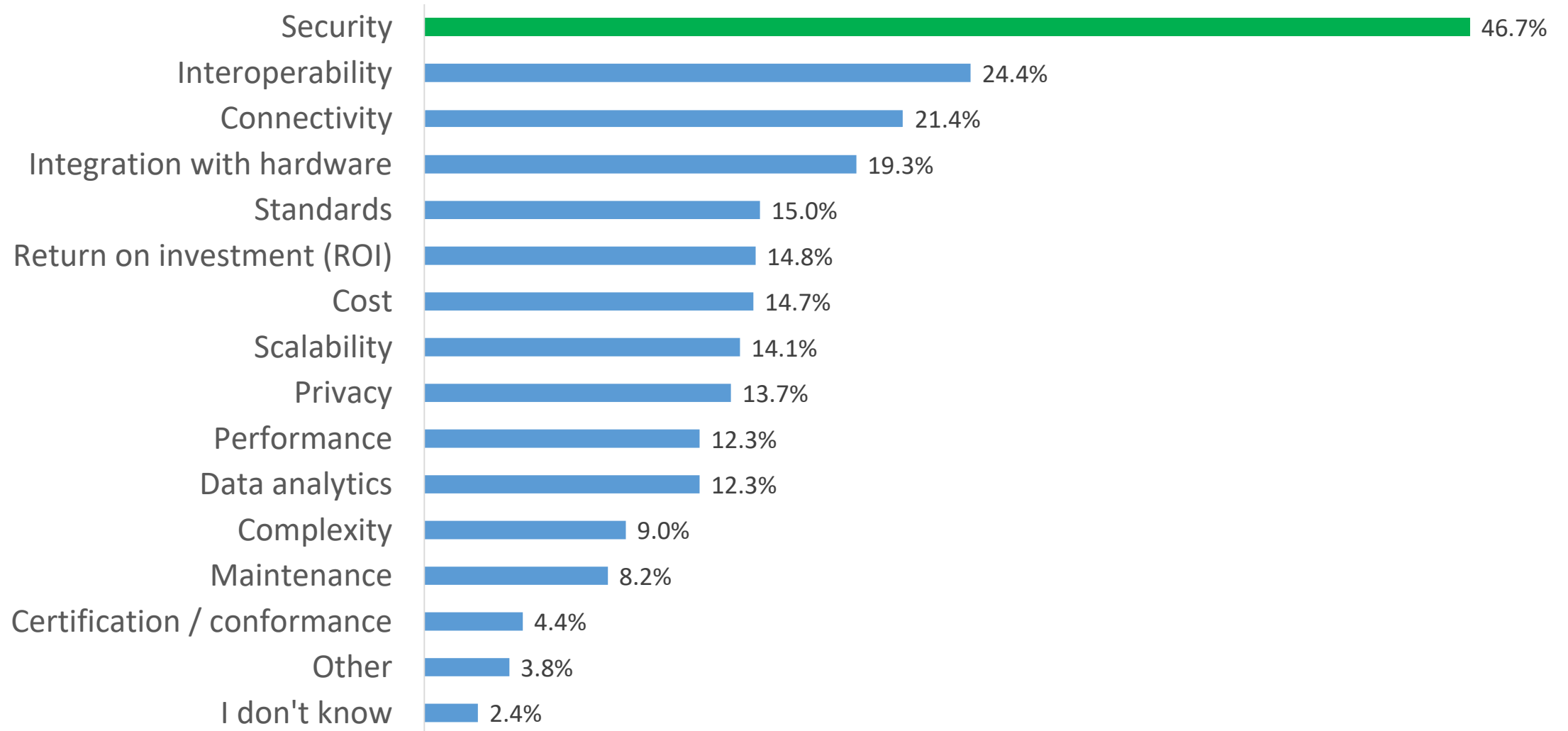
Top IoT Concerns / Trends 2015-2017

Security
- 43.70% (2015)
- 47.40% (2016)
- 46.7% (2017)

Interoperability
- 30.70% (2015)
- 29.40% (2016)
- 24.4% (2017)

Connectivity
- 18.10% (2015)
- 22.30% (2016)
- 21.4% (2017)

Integration with hardware
- 22.90% (2015)
- 20.90% (2016)
- 19.3% (2017)

Legend:
- 2015
- 2016
- 2017

Security continues to be the key concern; Interoperability might be decreasing.
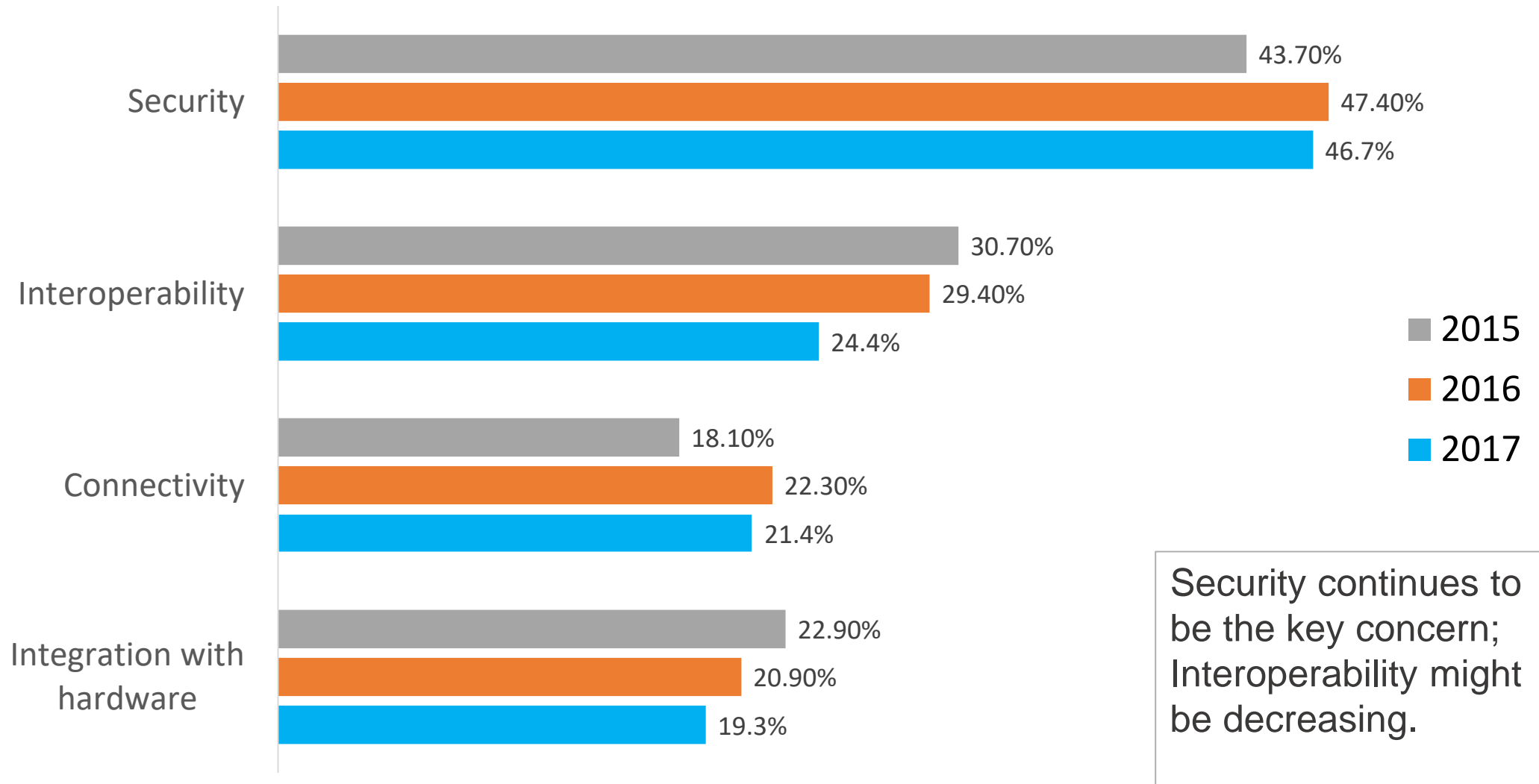
TECHNOLOGY USED FOR IoT

OVERALL SUMMARY OF LANGUAGE USAGE

Which of the following programming languages, if any, do you use to build IoT solutions?

Language	Percentage
Java	60.9%
C	60.5%
C++	48.0%
Python	46.6%
JavaScript	43.1%
Node.js	35.8%
Assembler	20.3%
PHP	18.2%
C#	16.6%
Lua	10.1%
R	10.0%
Go	9.4%
Other	6.6%
Ruby	6.1%
SWIFT	4.5%
Rust	3.9%
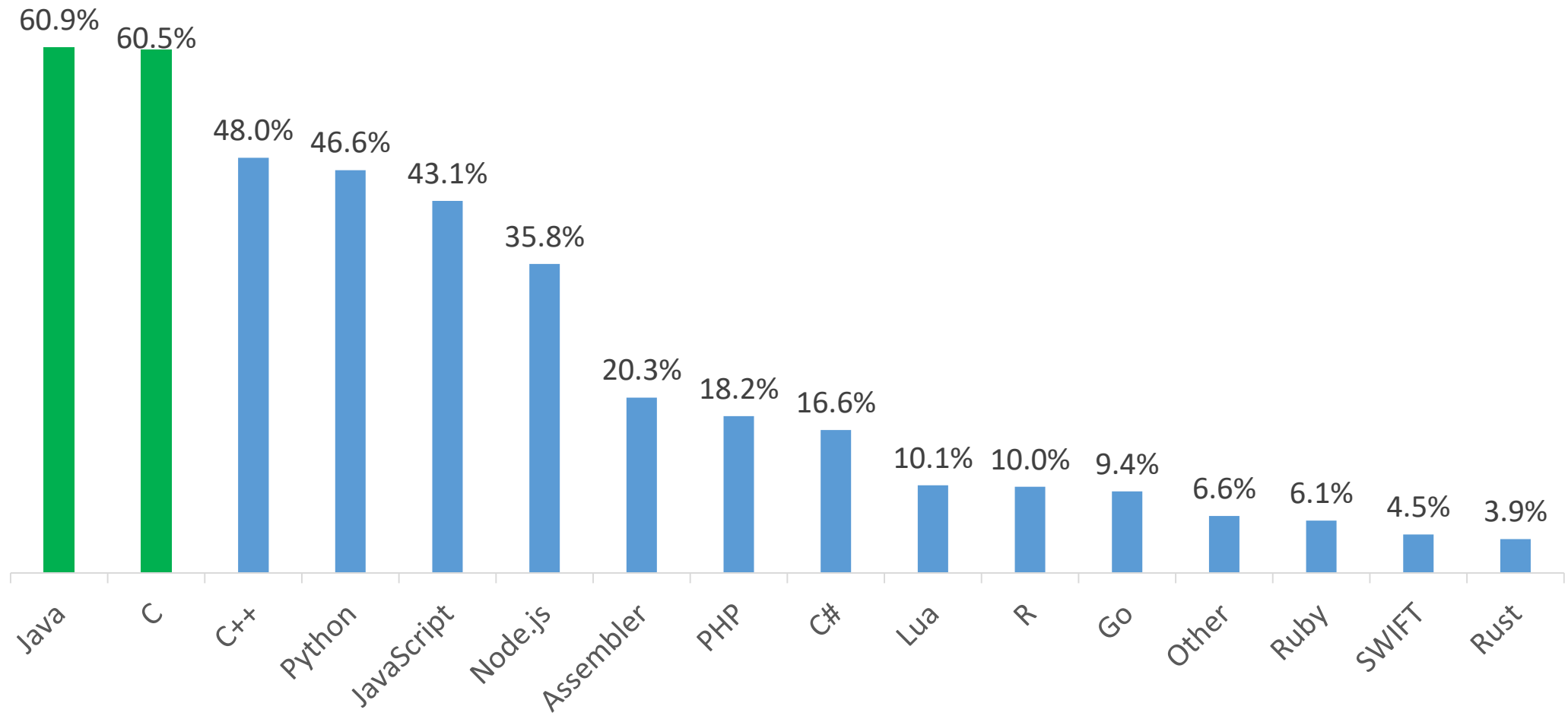
PROGRAMMING LANGUAGES – CONSTRAINED DEVICES

Which of the following programming languages, if any, do you use to build IoT solutions? (Constrained Devices)

Language	Percentage
C	56.4%
C++	38.3%
Java	21.2%
Python	20.8%
Assembler	18.9%
JavaScript	10.3%
Node.js	8.5%
Lua	7.1%
C#	5.7%
Other	3.4%
PHP	3.0%
Ruby	2.0%
R	1.8%
Go	1.8%
SWIFT	1.4%
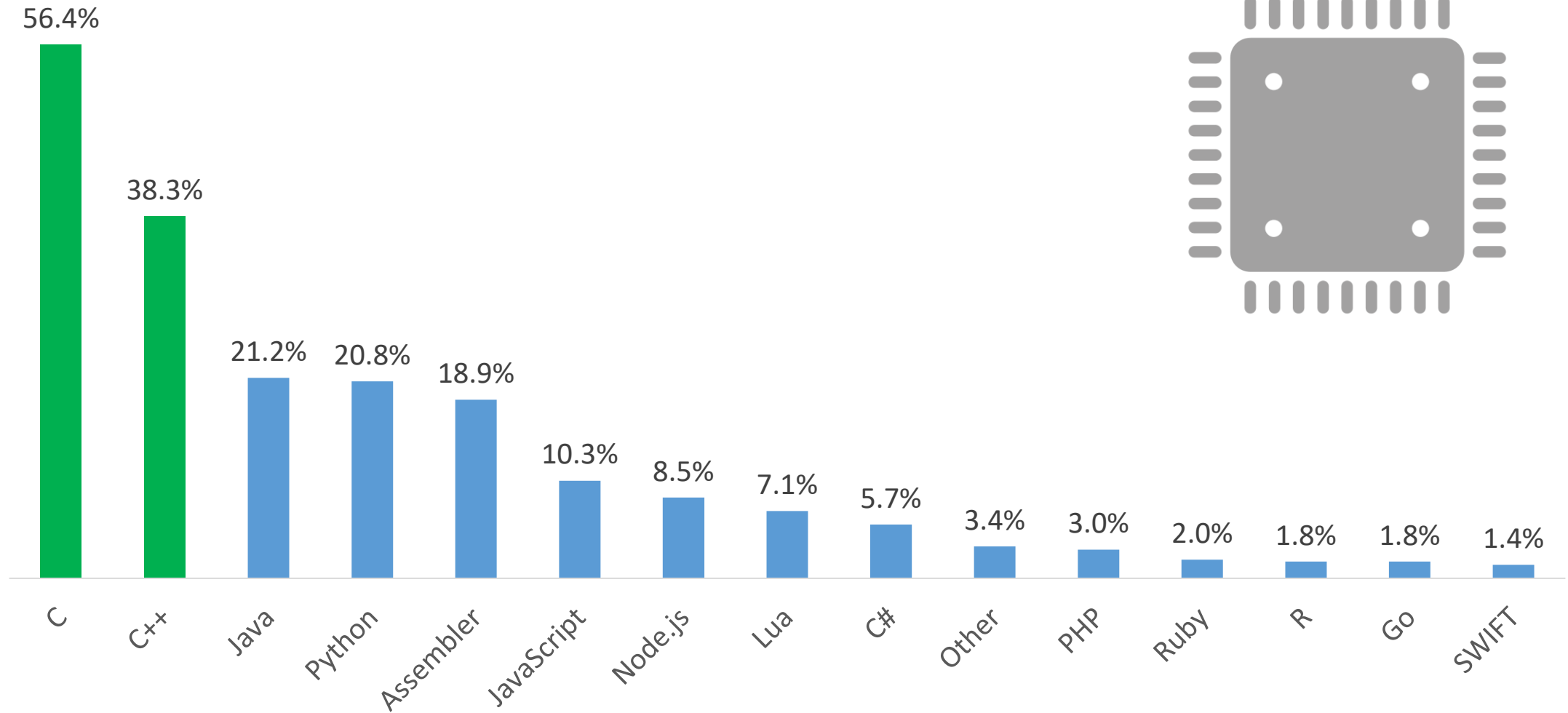
PROGRAMMING LANGUAGES – IoT GATEWAYS

Which of the following programming languages, if any, do you use to build IoT solutions? (Gateways)

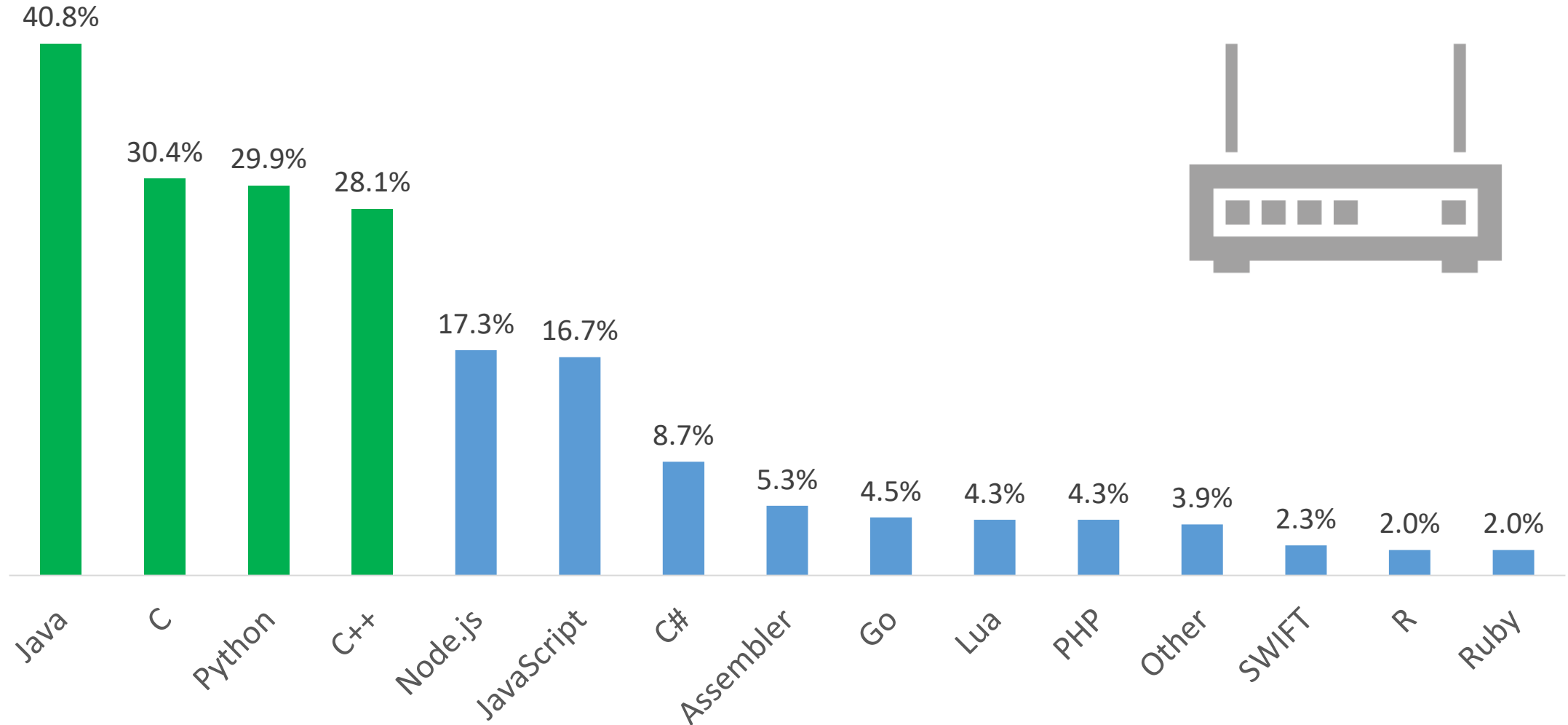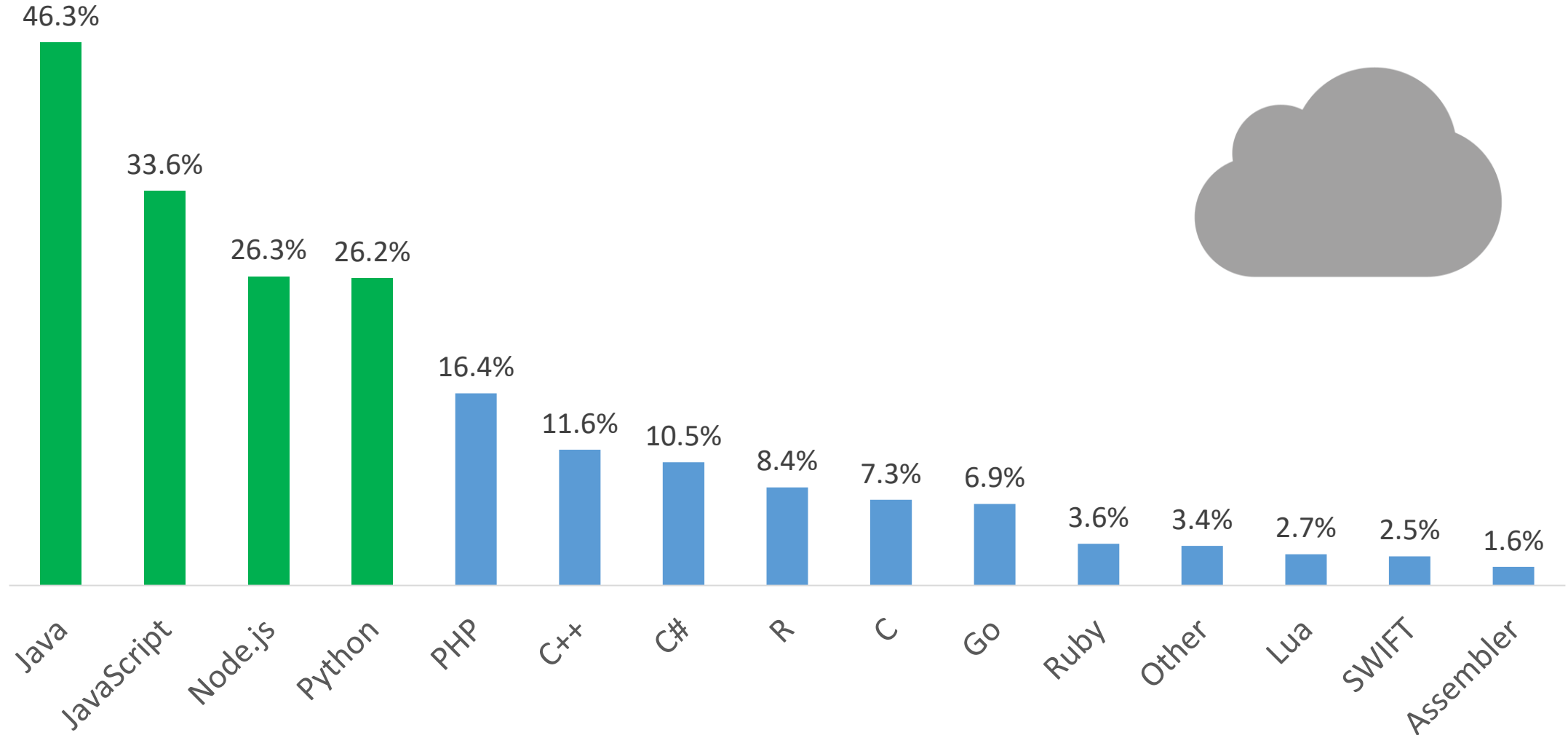| Language	Percentage
Java	40.8%
C	30.4%
Python	29.9%
C++	28.1%
Node.js	17.3%
JavaScript	16.7%
C#	8.7%
Assembler	5.3%
Go	4.5%
Lua	4.3%
PHP	4.3%
Other	3.9%
SWIFT	2.3%
R	2.0%
Ruby	2.0%

PROGRAMMING LANGUAGES – IoT CLOUD

Which of the following programming languages, if any, do you use to build IoT solutions? (Cloud Platform)

Trends for Alternative IoT Operating Systems

Which operating system(s) do you use for your IoT devices? (Summary)

- Linux: 81.5%
- No OS / Bare-metal: 29.5%
- Windows: 27.7%
- FreeRTOS: 17.7%
- Contiki: 14.9%
- MBed: 10.1%
- Other: 10.1%
- RIOT: 9.6%
- TinyOS: 9.2%
- Other: 9.0%
- Zephyr: 3.3%

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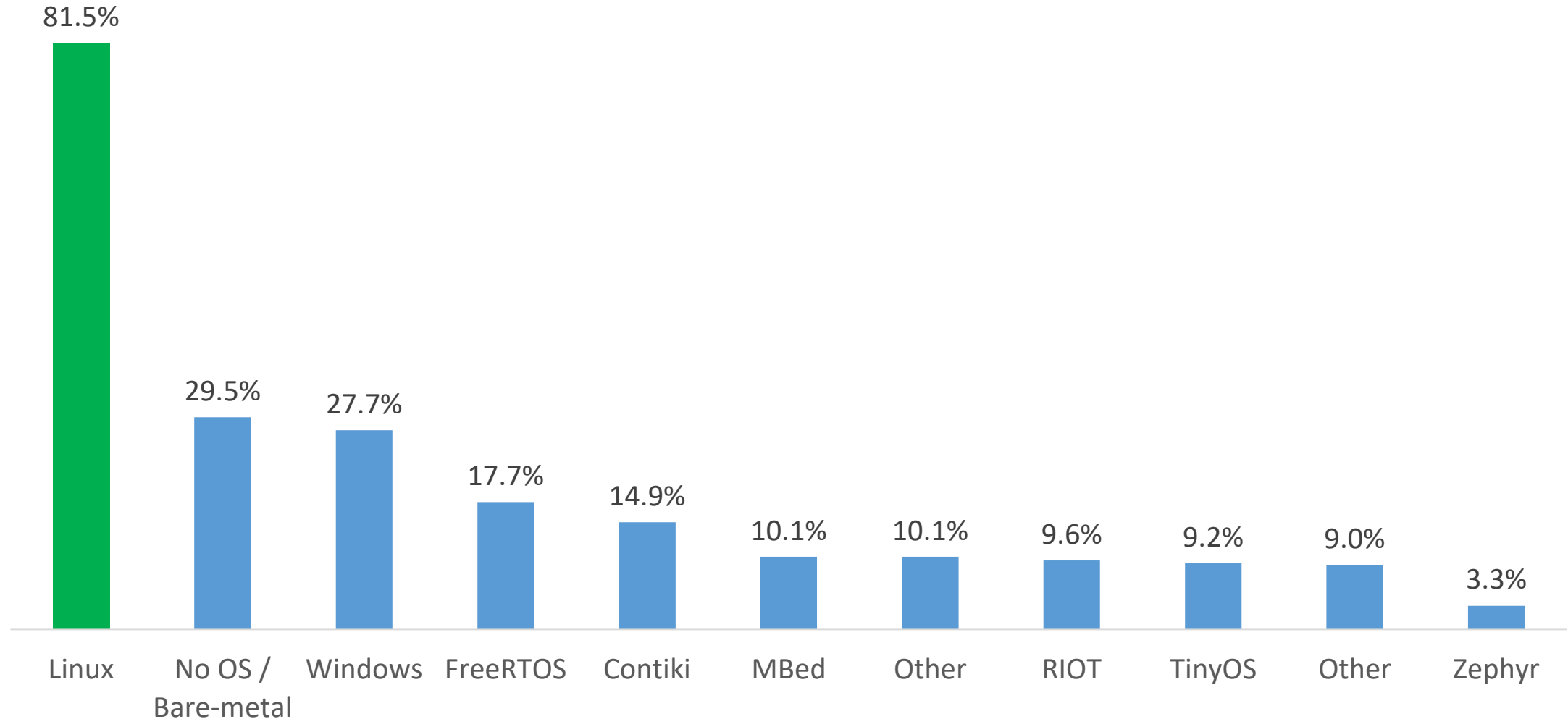
ALTERNATIVES TO USING LINUX FOR IoT

29.5%

27.7%

17.7%

14.9%

10.1% 10.1%

9.6%

9.2%

3.3%

2015
2016
2017

No OS /
Bare-metal   Windows   FreeRTOS   Contiki   MBed   Other   RIOT   TinyOS   Zephyr

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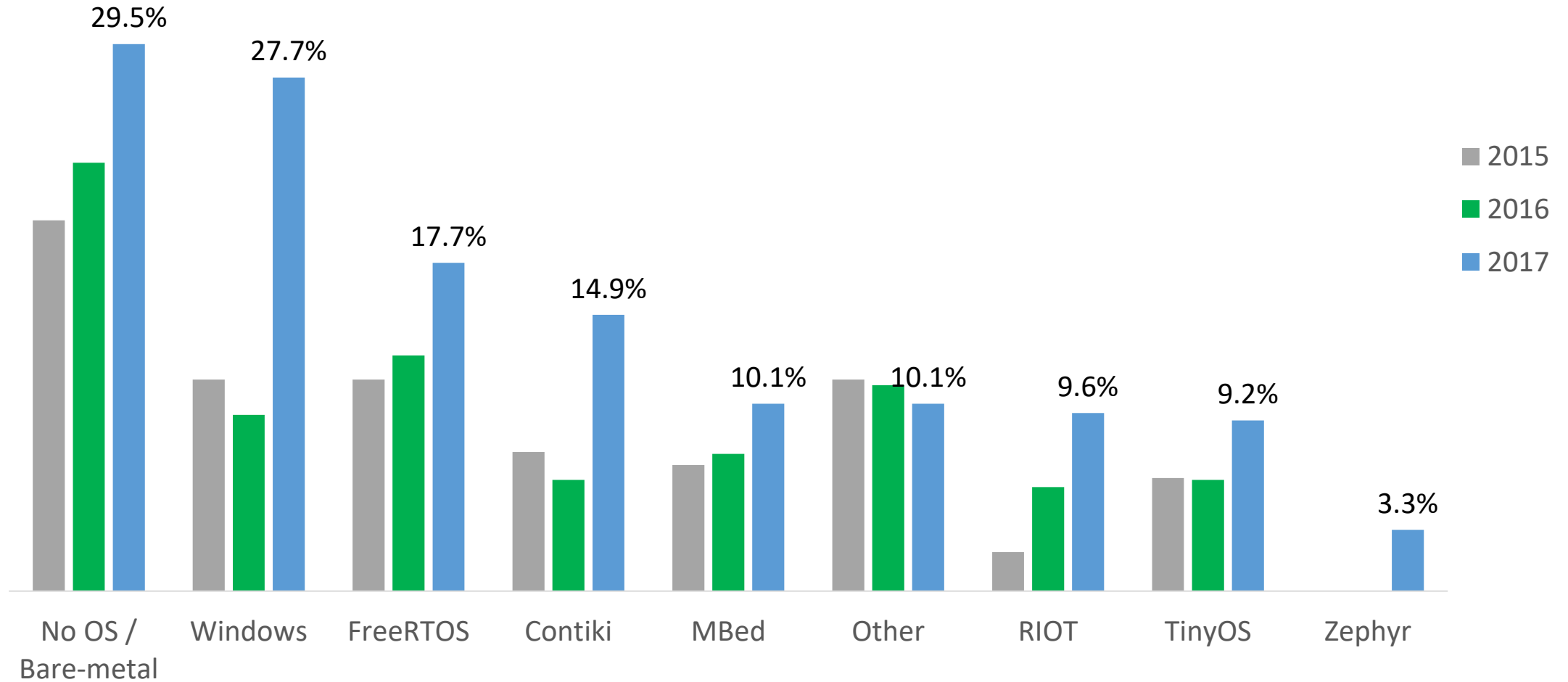
IoT Operating Systems – Constrained Devices

Which operating system(s) do you use for your IoT devices? (Devices)

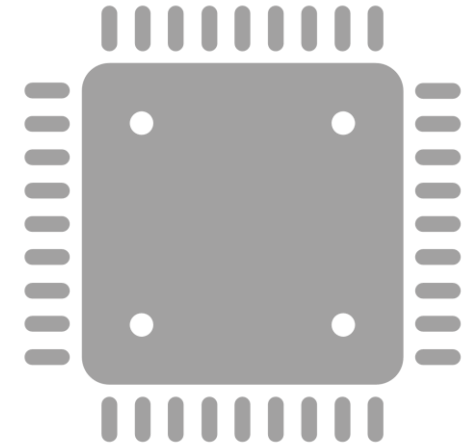| OS	Percentage
Linux	44.1%
No OS / Bare-metal	27.6%
Windows	14.6%
FreeRTOS	15.0%
Contiki	13.4%
MBed	8.9%
Other	7.8%
RIOT	8.4%
TinyOS	8.0%
Zephyr	2.9%
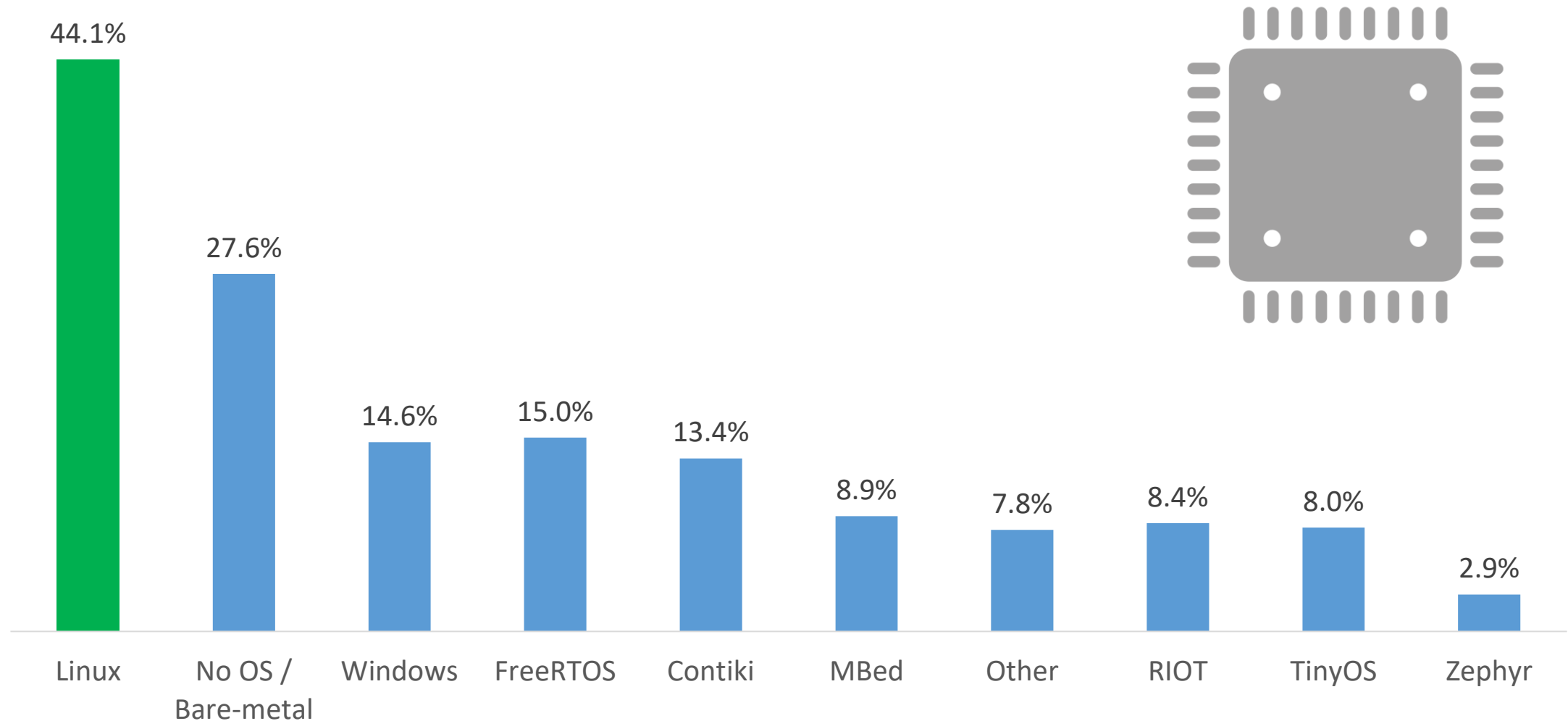
IoT Operating Systems – IoT Gateway

Which operating system(s) do you use for your IoT devices? (Gateway)

OS	Percentage
Linux	66.9%
Windows	20.5%
Other	5.5%
FreeRTOS	5.0%
No OS / Bare-metal	4.1%
Contiki	4.1%
RIOT	3.6%
TinyOS	3.0%
MBed	2.5%
Zephyr	1.2%
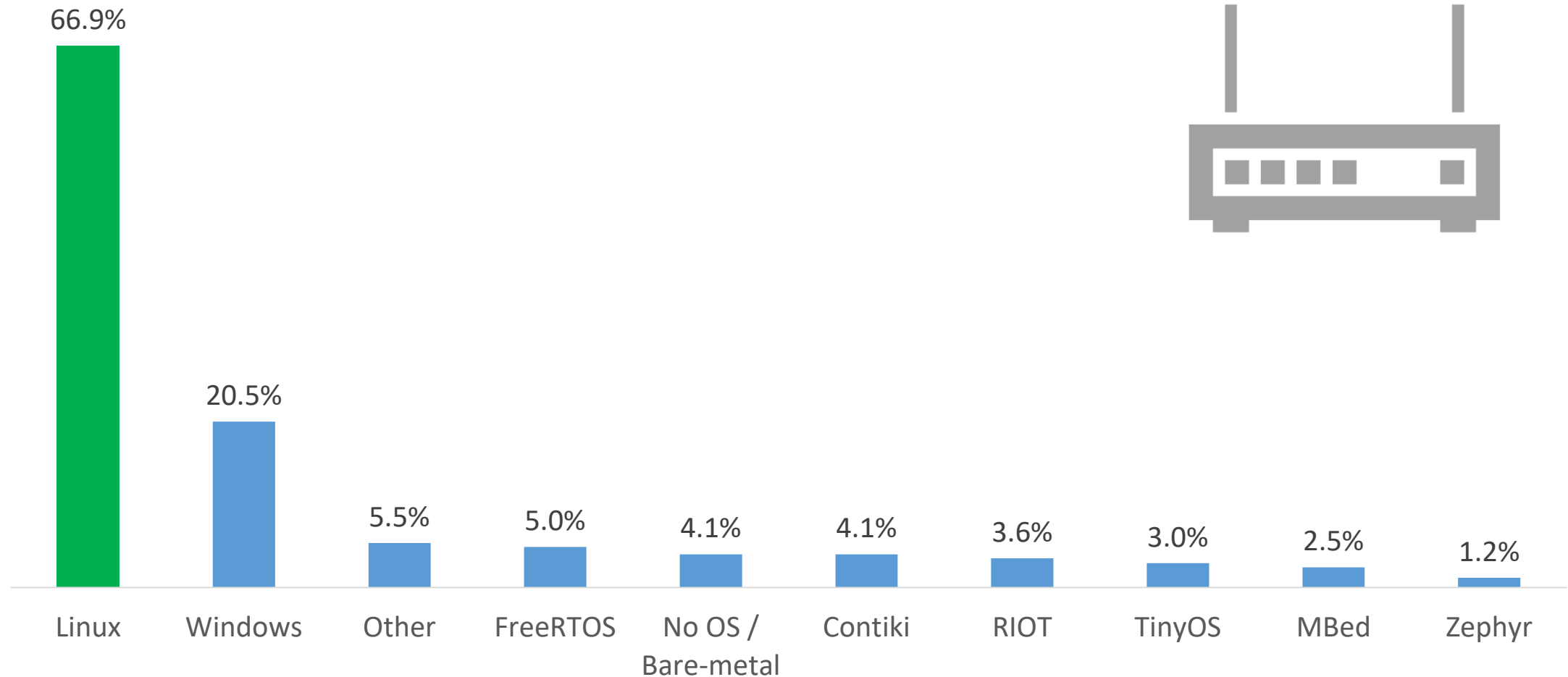
IoT Operating Systems / Linux Distros for IoT

If you are using Linux, what distribution do you typically use for your IoT solution?

Distribution	Percentage
Raspbian	45.5%
Ubuntu / Ubuntu Core	44.0%
Android	21.8%
Yocto Project	14.1%
Other	12.4%
Android Things	10.3%
Don't use Linux	9.2%
OpenWrt or equivalent	9.0%
uClinux	3.8%
Huawei LiteOS	1.7%
Tizen	1.5%
Ostro Linux	1.1%
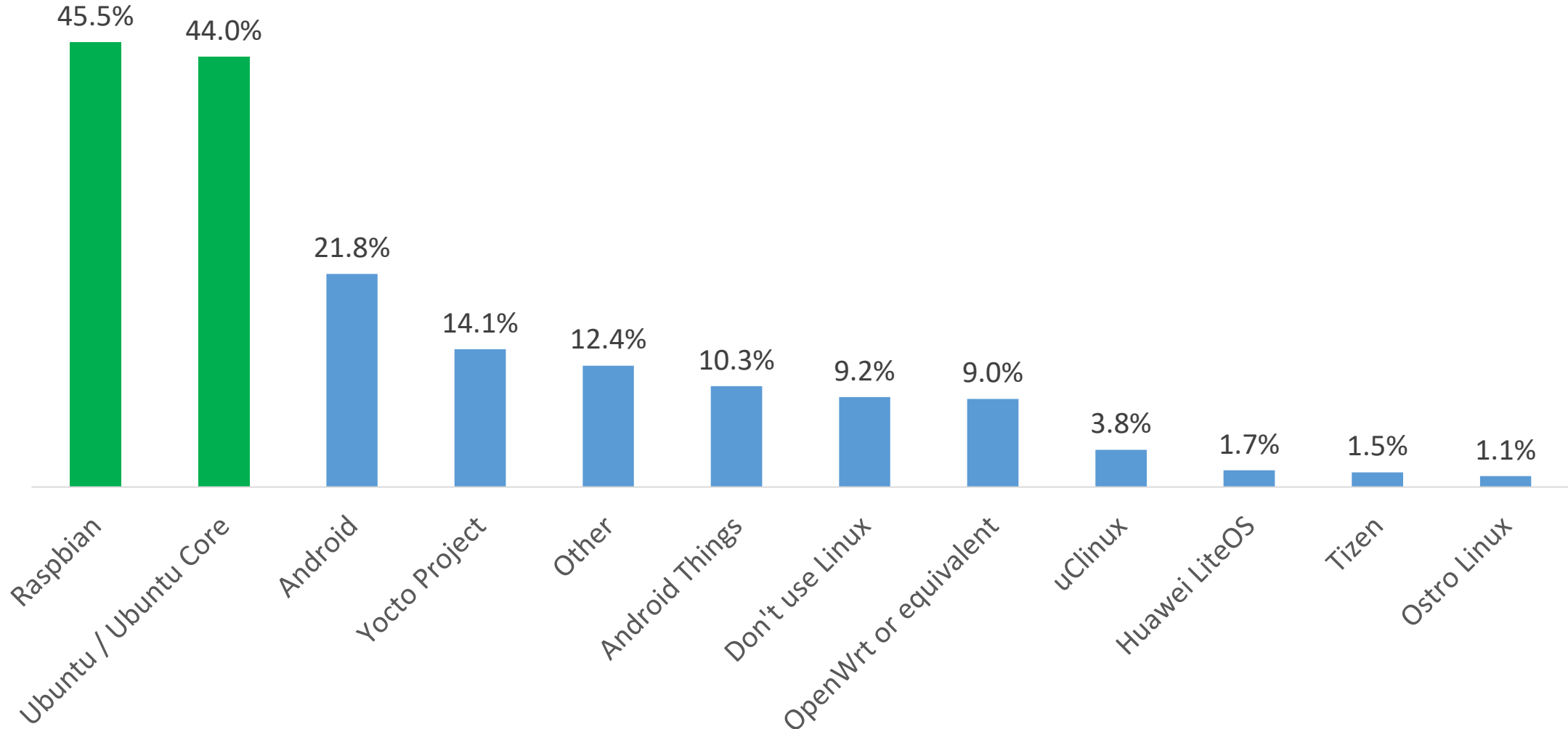
IoT Hardware Architectures

What hardware architectures are you using for your IoT constrained device(s)?

Architecture	Percentage
ARM Cortex-M3 / ARM Cortex-M4	36.9%
ARM Cortex-M0 / ARM Cortex-M0+ / ARM Cortex-M1	33.4%
16-bit MCU	27.7%
Don't know	22.8%
ARM Cortex-M7	22.4%
8-bit MCU	22.3%
Other	6.6%
Don't use constrained devices	4.6%
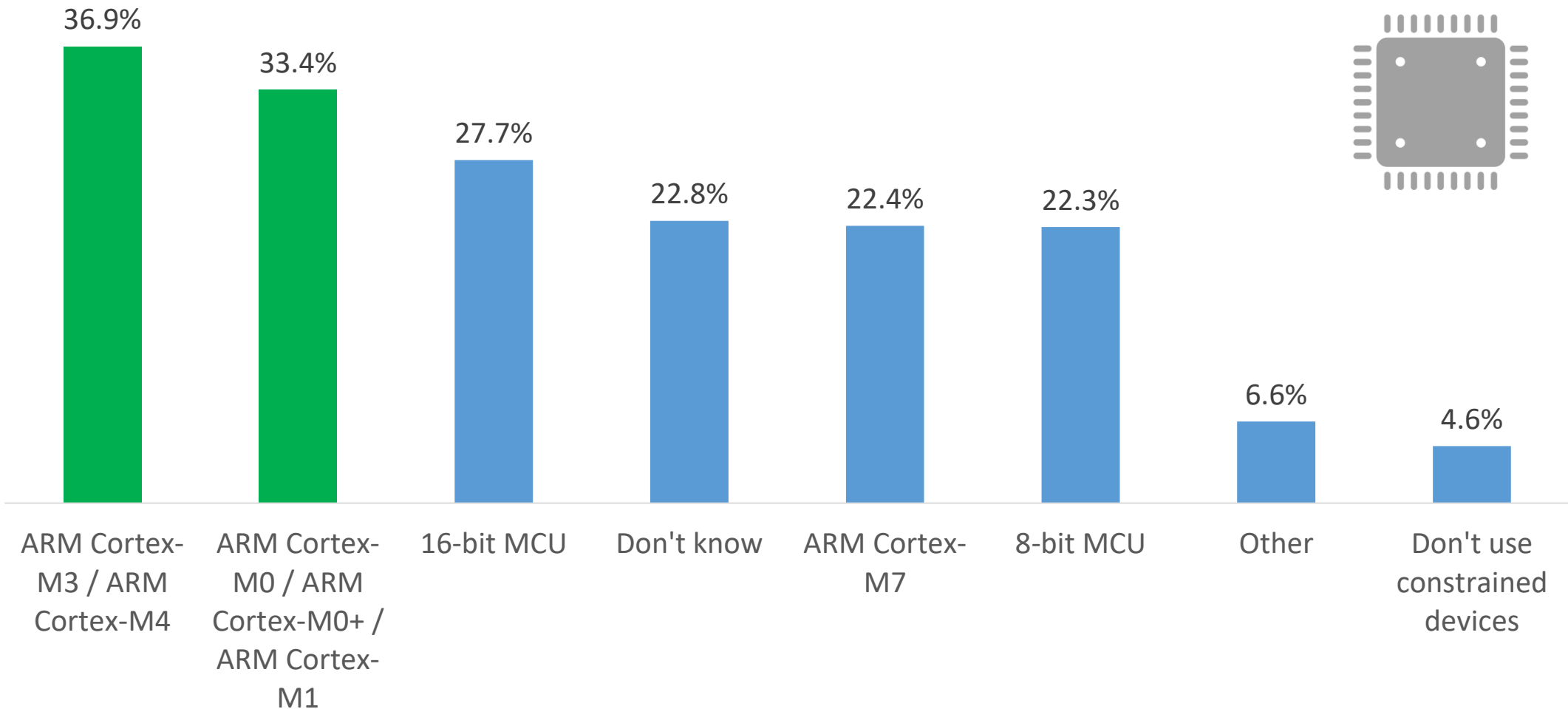
IoT Hardware Architectures

What hardware architectures are you using for your IoT gateway(s)?

Bar chart values:
- Intel x86_64: 32.5%
- ARM v7-A (Cortex-A 32 bits): 27.8%
- Intel x86: 21.8%
- ARM v8 (Cortex-A 64 bits): 20.7%
- Don't know: 19.6%
- ARM v7-M (Cortex-M): 17.4%
- ARM v6: 11.1%
- ARM v7-R (Cortex-R): 9.3%
- Don't use gateways: 7.4%
- MIPS: 6.2%
- Other: 3.6%
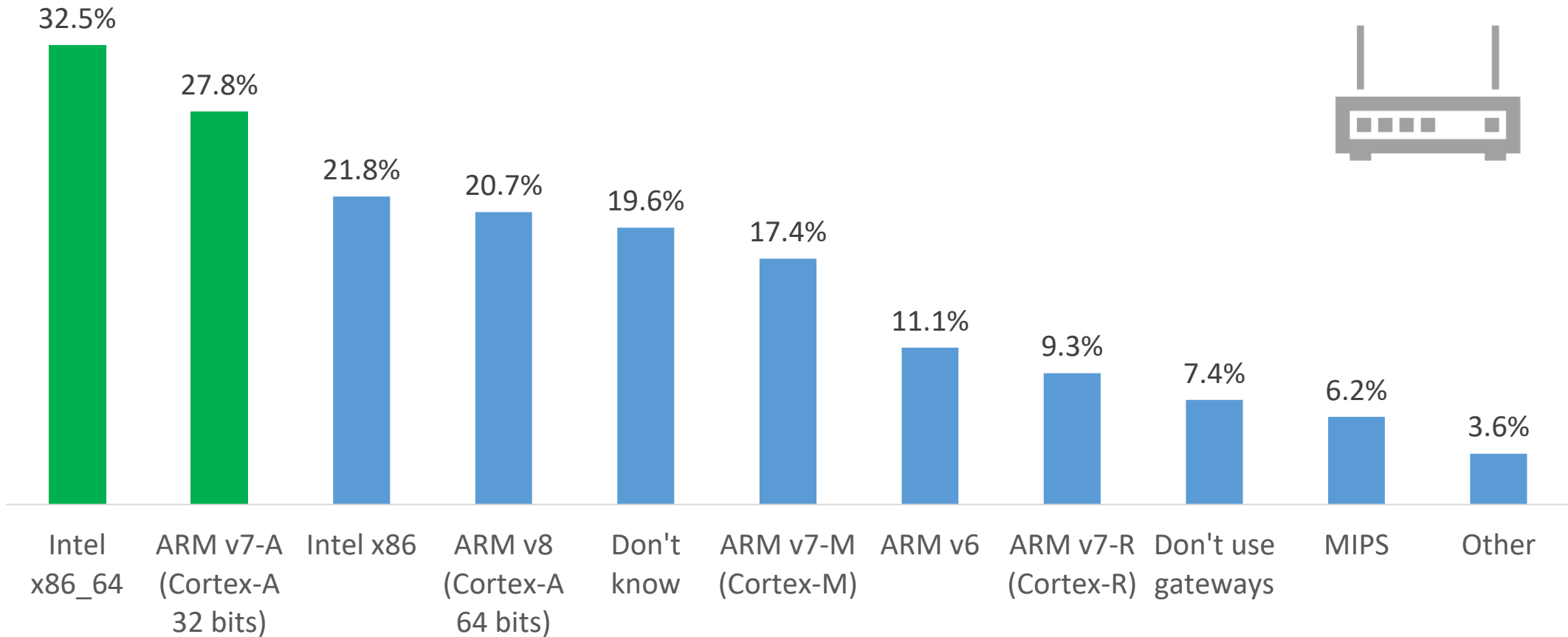
IoT Software Features

What software features are included in your IoT solution?

Feature	Percentage
Data analytics	52.6%
Mobile application	47.0%
Integration with existing back-end systems	43.9%
Cloud hosted application	43.5%
User application running on a device	37.4%
Machine learning	29.5%
Computer vision	19.9%
Trusted execution environment	13.4%
Voice recognition	13.2%
None	5.5%
Other	3.1%
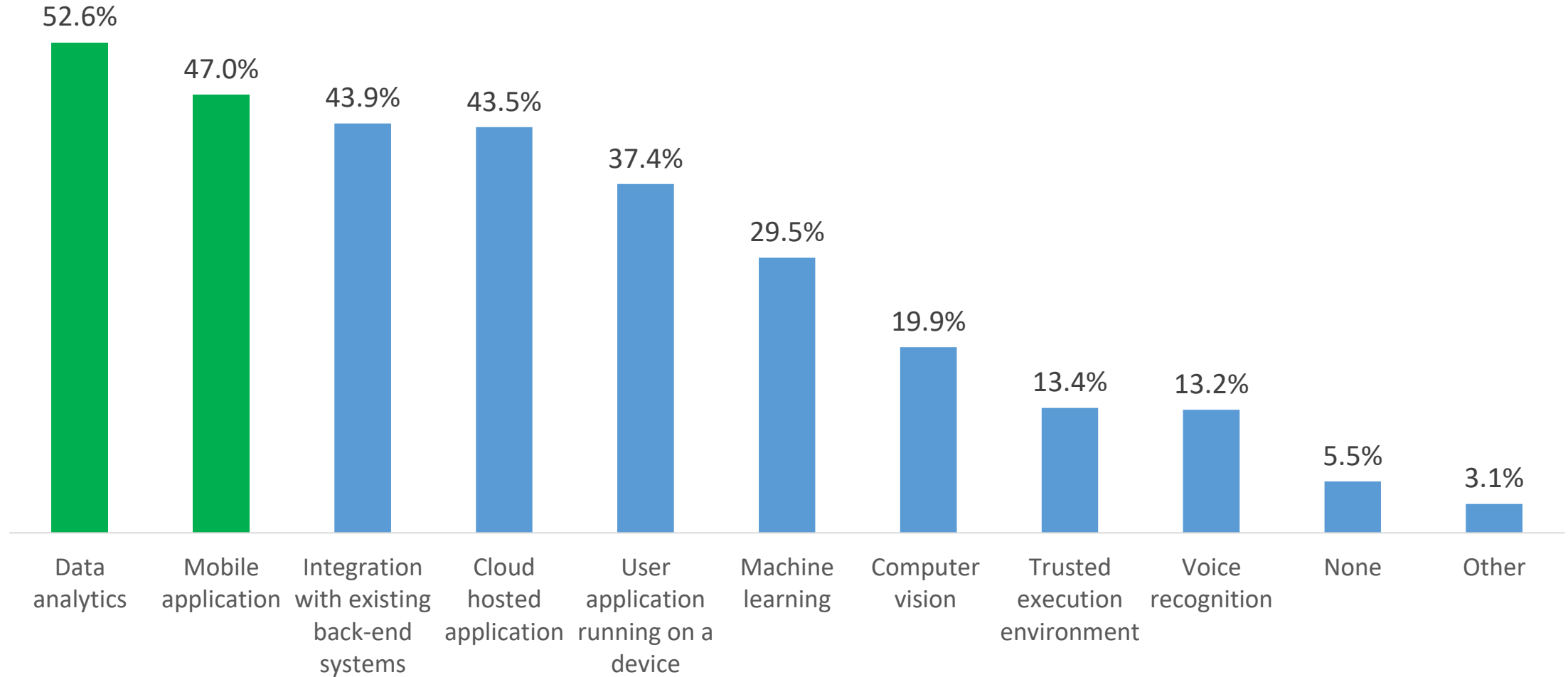
IoT Security

Which of the following security-related technologies do you use in your IoT solution?

Communication security — 48.3%
Data encryption — 43.2%
JSON web token or similar token formats — 34.4%
Public key infrastructure — 27.2%
OAuth & OpenID — 24.3%
Over the air update — 18.5%
No security technology is used — 16.4%
Security boot — 11.4%
Use of Hardware Security Module (HSM) — 10.6%
Use of Trusted Platform Modules (TPM) — 10.0%
Don't know — 9.3%
Other — 2.5%
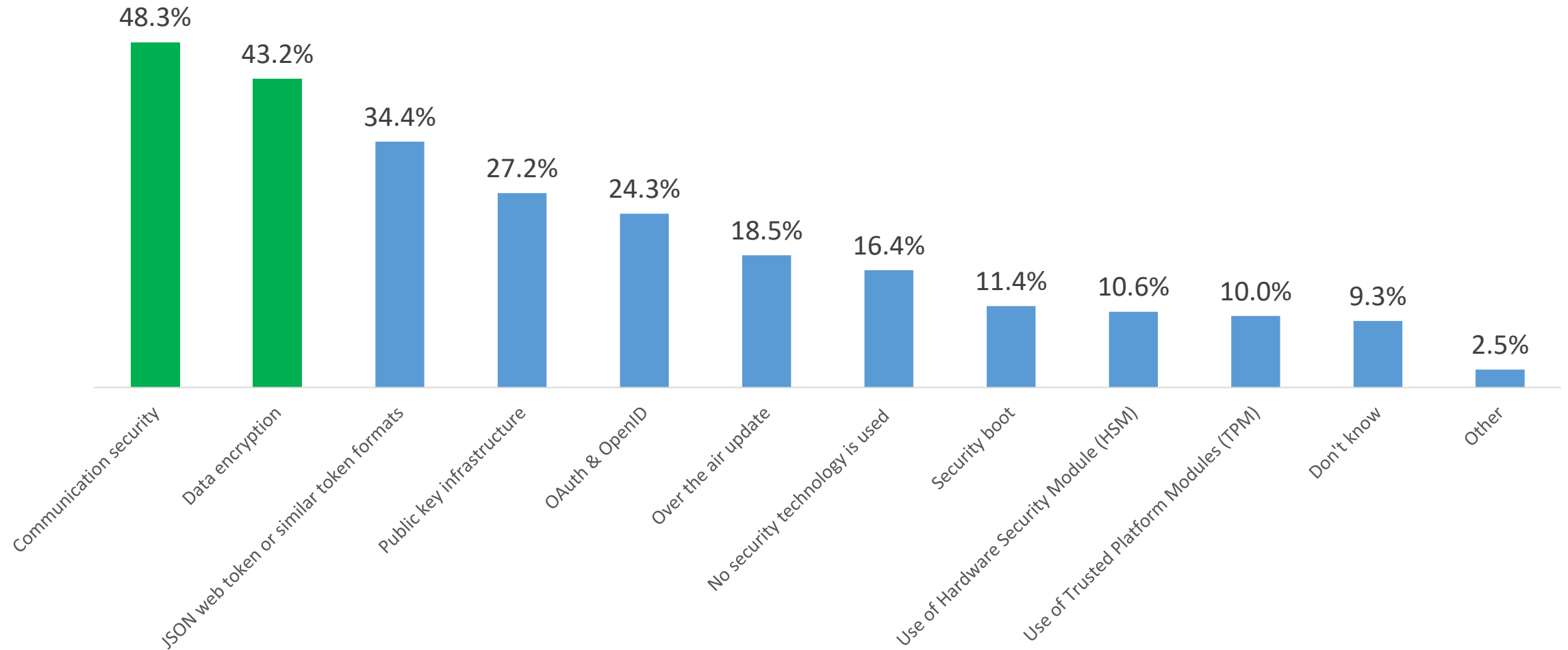
CLOUD SERVICES FOR IoT

Do you use, or plan to use, any of the following cloud service offerings for implementing your IoT solution?

Service	Percentage
Amazon AWS	42.7%
Microsoft Azure	26.7%
Google Cloud Platform	20.4%
Private/ On-premise cloud	18.4%
IBM Bluemix	15.6%
None	13.2%
OpenStack (On-premise)	12.3%
Don't know	11.9%
Other	9.1%
Red Hat OpenShift	7.9%
Cloud Foundry (On-...	7.3%
GE Predix	5.7%
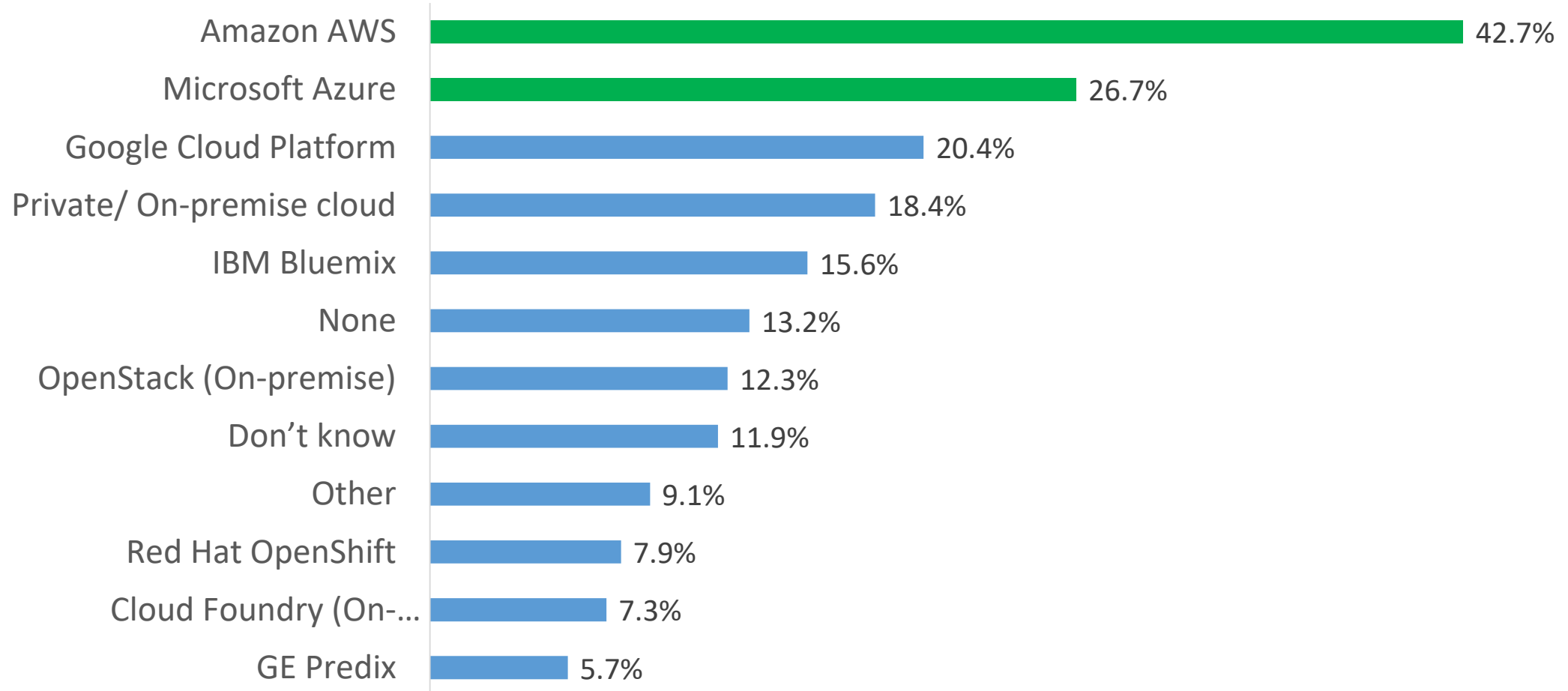
TRENDS OF CLOUD SERVICES FOR IoT 2016-2017

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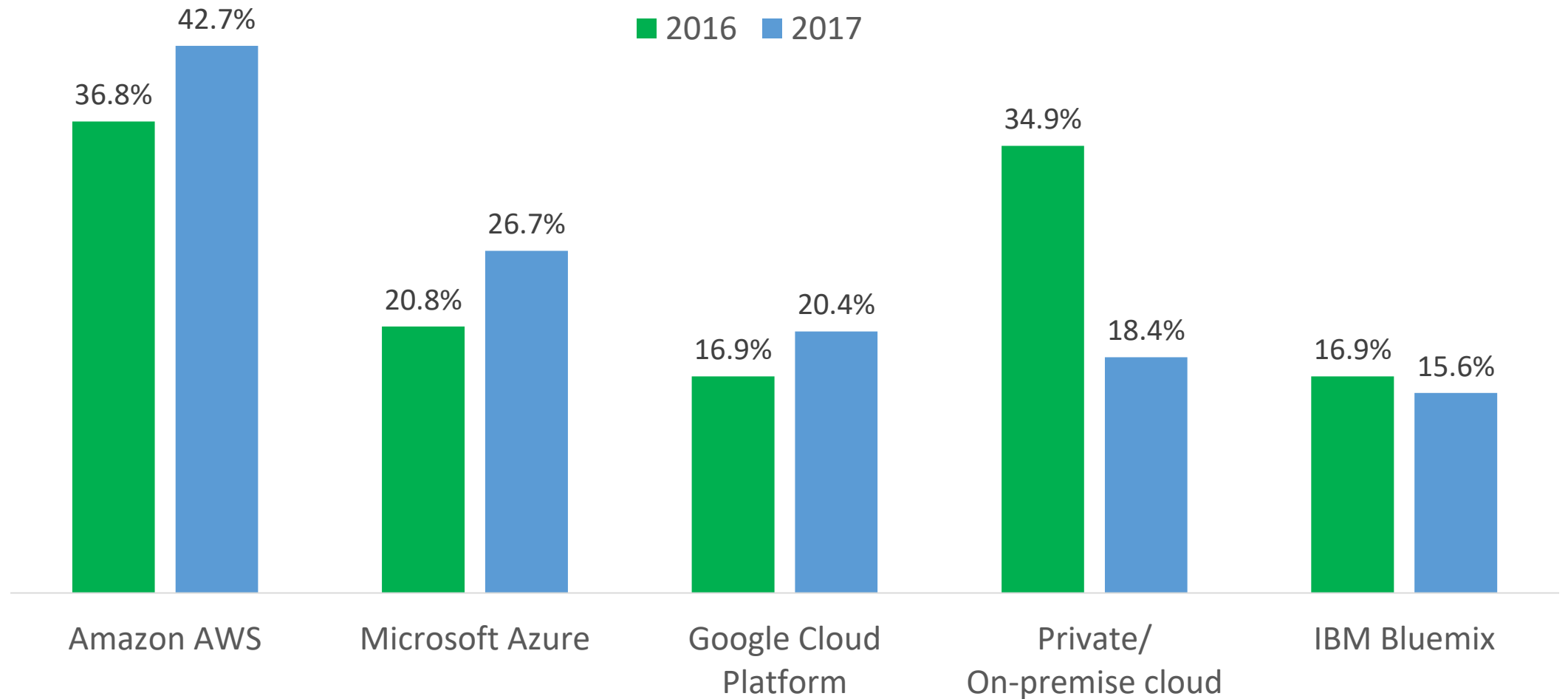
CONNECTIVITY PROTOCOLS

What connectivity protocol(s) do you use for your IoT solution?

Protocol	Percentage
TCP/IP	67.0%
Wi-Fi	66.4%
Ethernet	54.0%
Bluetooth / Bluetooth Smart	48.2%
Cellular	31.8%
Zigbee	27.6%
Serial RS-232/RS-485	24.6%
LPWA (LoRa, Sigfox, LTE-M, etc.)	22.4%
6LoWPAN	21.4%
UPnP	8.2%
Other	7.8%
Thread	6.4%
Don't know	3.8%
Satellite	3.6%

GROWTH OF NEW CONNECTIVITY PROTOCOLS

TCP/IP — 70.9%

Wi-Fi

Ethernet

Bluetooth / Bluetooth Smart — 35.8% / 40.9% / 48.2%

Cellular

Zigbee

Serial RS-232/RS-485

LPWA (LoRa, Sigfox, LTE-M,... — 17.3% / 22.4%

6LoWPAN — 12.9% / 16.2% / 21.4%

UPnP

Thread — 1.8% / 4.8% / 6.4%

Steady growth for Bluetooth, LPWA, 6LoWPAN

Thread still lagging behind

Legend: 2015, 2016, 2017

MESSAGING STANDARDS

What messaging protocol(s) do you use for your IoT solution?

Protocol	Percentage
HTTP	60.1%
MQTT	54.7%
CoAP	26.7%
In-house / proprietary	18.4%
HTTP/2	16.8%
AMQP	15.0%
XMPP	10.3%
Other	7.1%
Don't know	7.1%
Proprietary vendor protocol (specify below)	4.9%
DDS	4.0%
None	3.6%
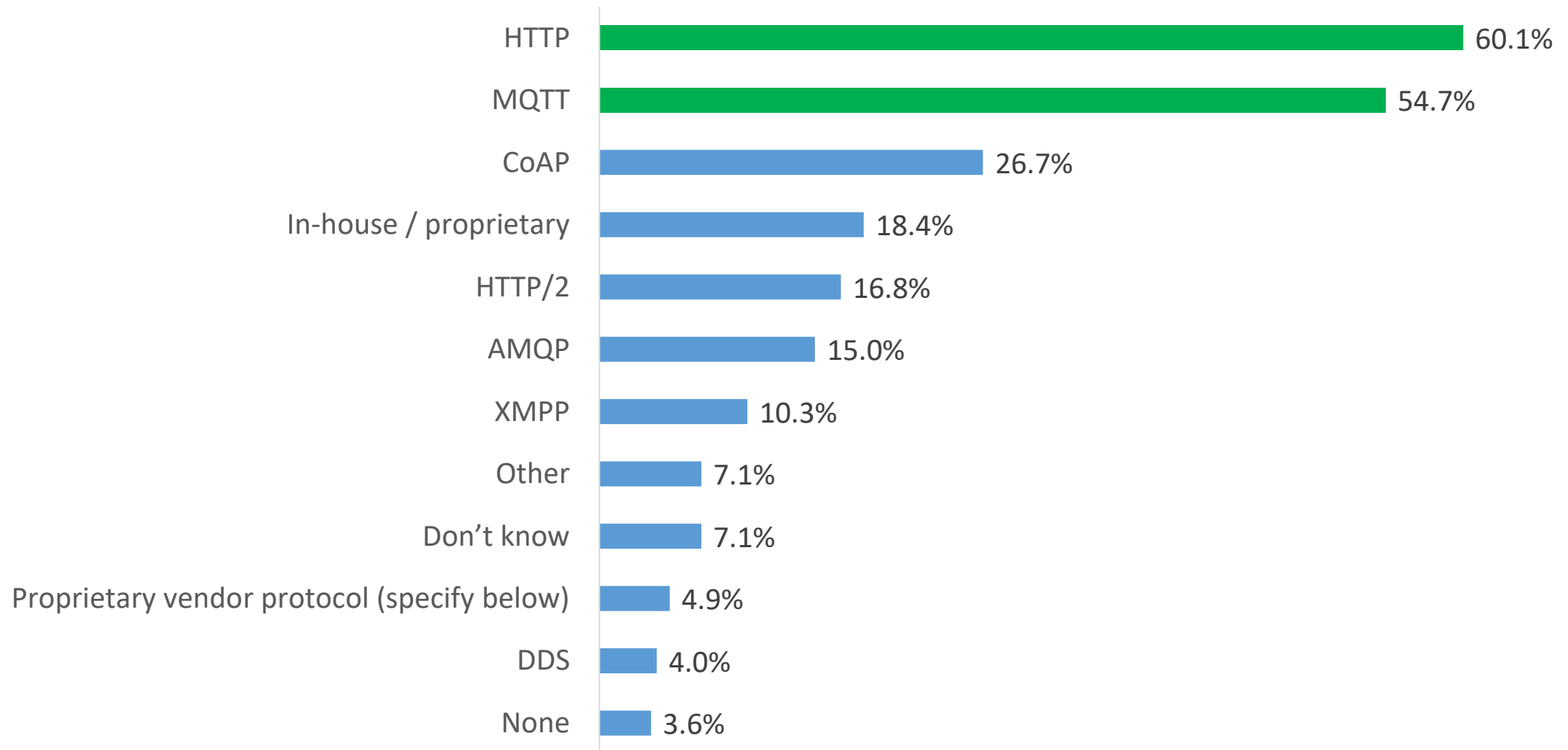
INDUSTRIAL PROTOCOLS

What industrial protocol(s) do you use in your IoT solution?

Protocol	Percentage
None	32.1%
Modbus	22.6%
Don't know	20.0%
CAN	18.0%
Industrial Protocol (EtherNet/IP, ControlNet,…	14.7%
OPC-UA (IEC 62541)	12.5%
Profibus, Profinet	6.8%
KNX	6.4%
BACNet	6.4%
EtherCat	5.7%
IEC 60870, 61850	3.7%
Other	3.3%
DNP3	3.1%
FOUNDATION fieldbus	2.2%
Sercos	1.1%
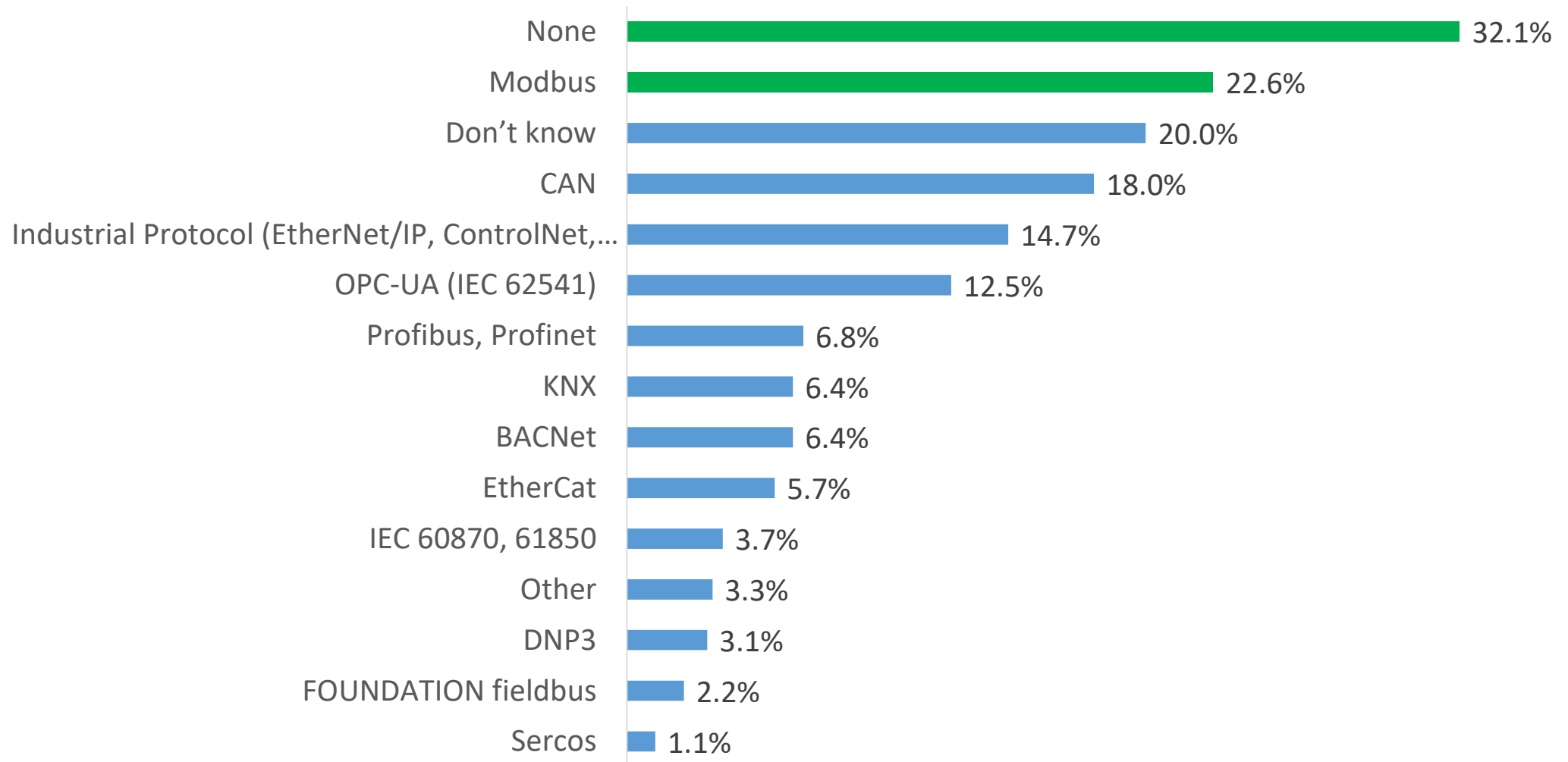
TEXT EDITORS / IDES

Which text editor(s) or IDE(s) do you use when building IoT solutions?

Editor	Percentage
Eclipse Desktop...	47.5%
Arduino IDE	29.3%
Vim	25.7%
Android Studio	22.4%
Visual Studio...	20.8%
Other	17.5%
Atom	16.5%
IntelliJ IDEA	14.3%
Sublime	10.8%
Emacs	9.0%
Don't know	6.7%
Platform.io	5.1%
Eclipse Orion	3.7%
Eclipse Che	3.7%
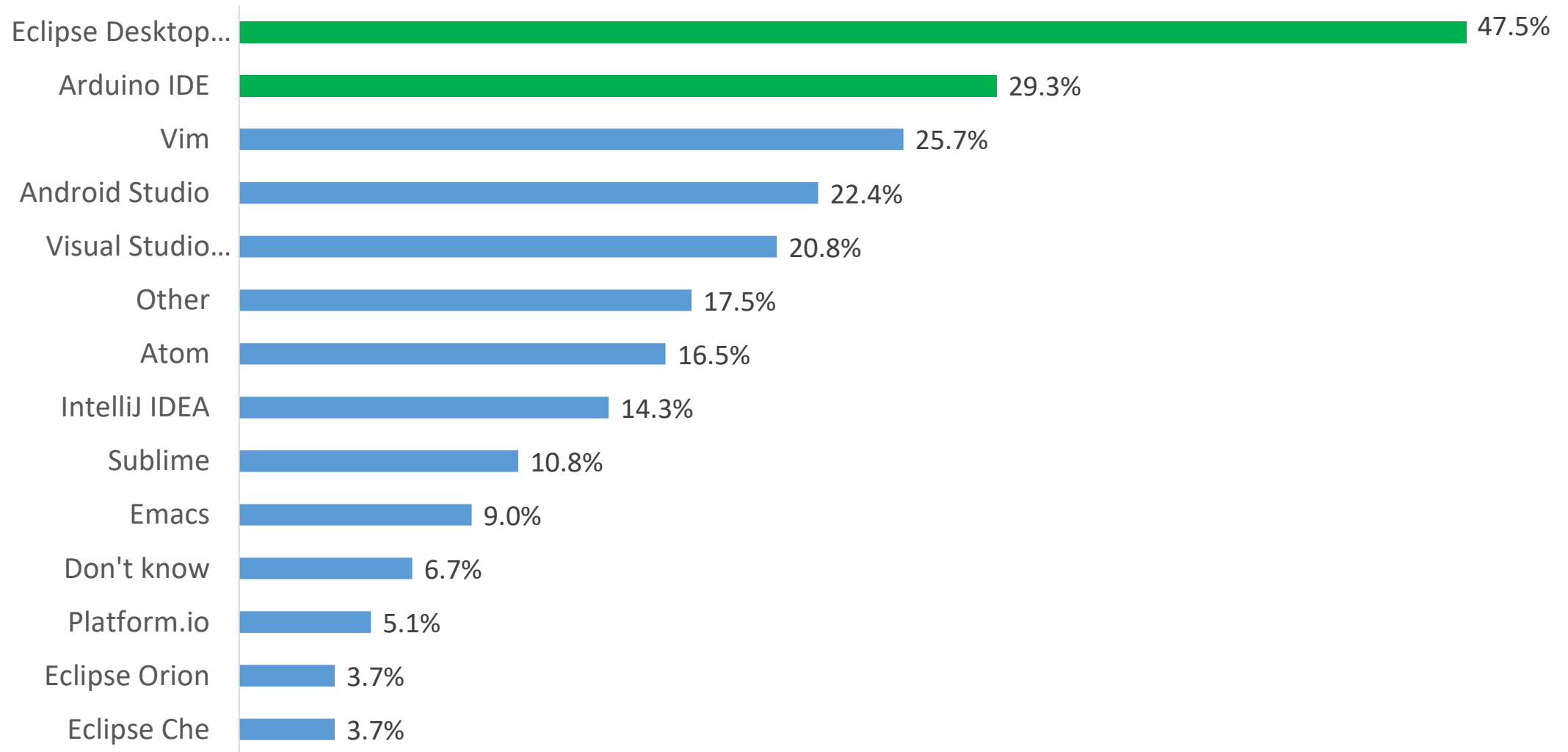
USAGE OF OPEN HARDWARE

Have you ever used any open hardware platforms like Raspberry Pi, Arduino, BeagleBone, etc.?
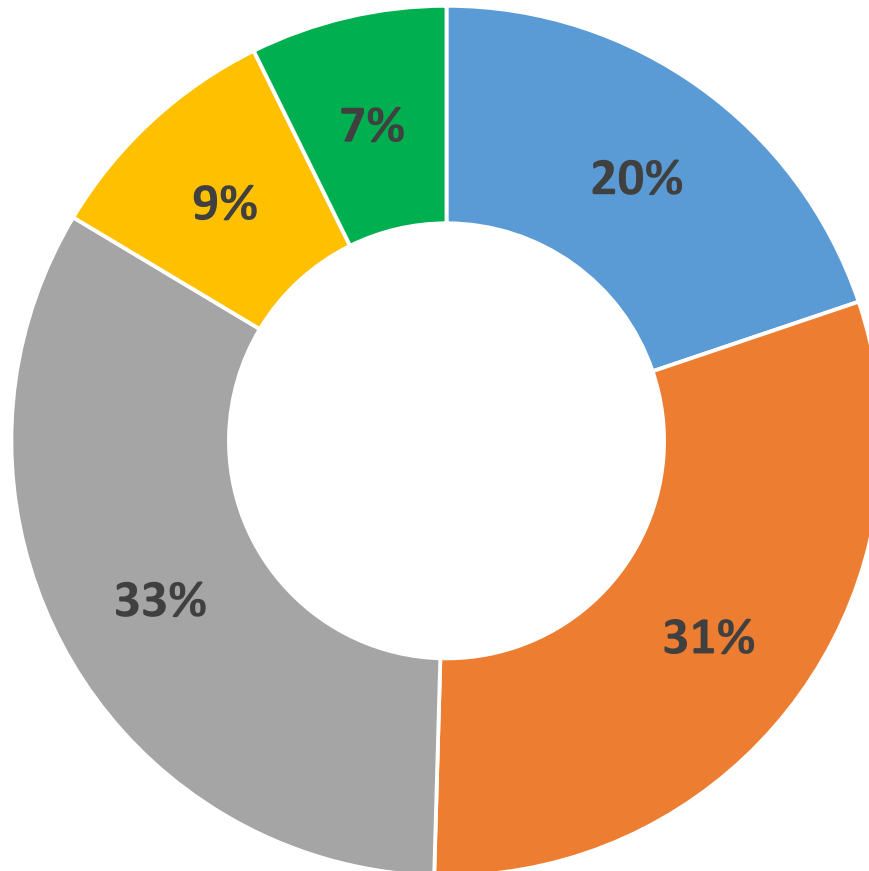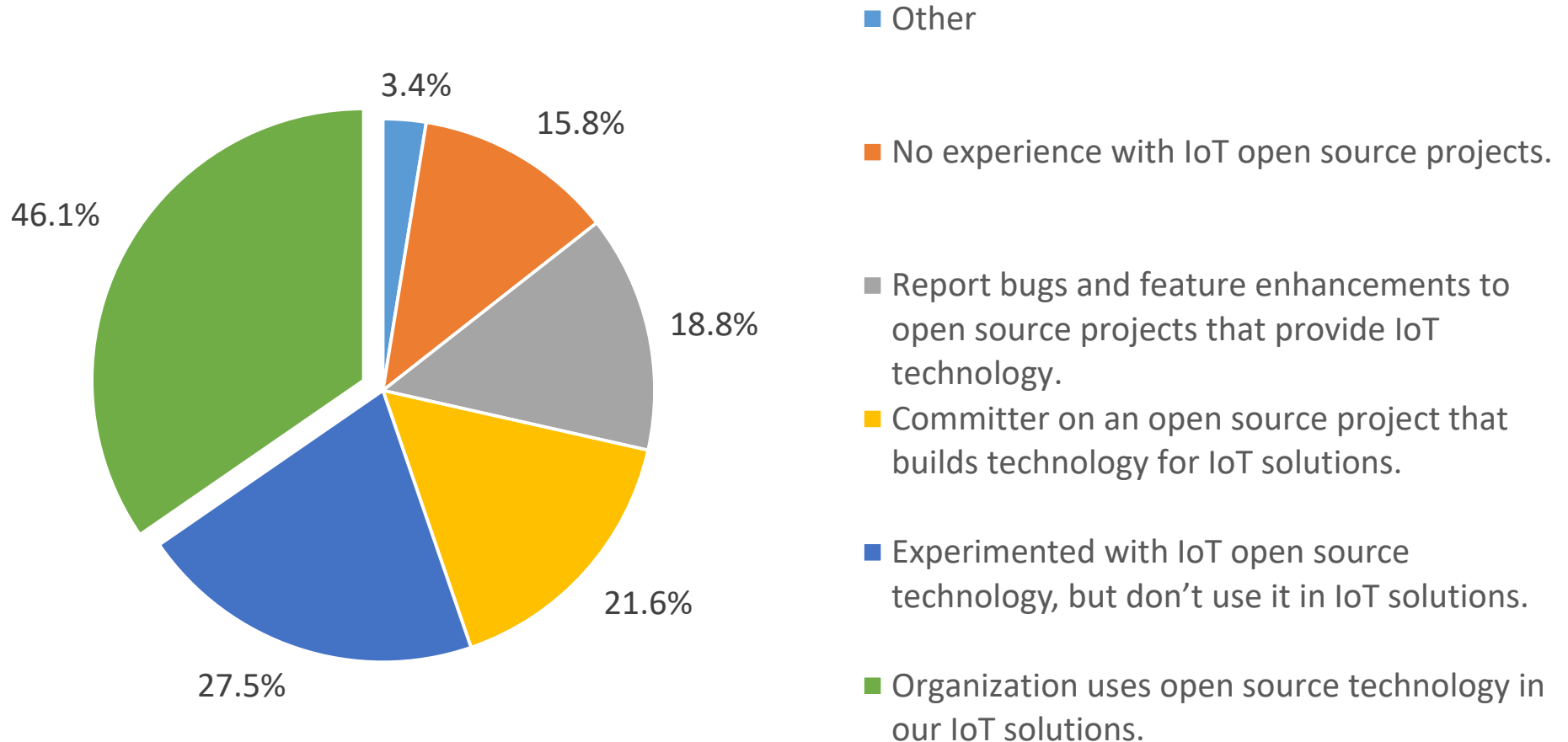

- ■ Yes, my company deploys IoT solution using an open hardware platform
- ■ Yes, my company prototypes IoT solutions using an open hardware platform
- ■ Yes, I have experimented with open harware in my spare time
- ■ No, but I intend to experiment with open hardware in the next 6 months
- ■ Never used open hardware

IoT Industry Perceptions

OPEN SOURCE POLICY

Which of the following statement(s) best describes your IoT open source project participation?

Legend:
- Other
- No experience with IoT open source projects.
- Report bugs and feature enhancements to open source projects that provide IoT technology.
- Committer on an open source project that builds technology for IoT solutions.
- Experimented with IoT open source technology, but don't use it in IoT solutions.
- Organization uses open source technology in our IoT solutions.

Pie chart values: 3.4%, 15.8%, 18.8%, 21.6%, 27.5%, 46.1%

IoT Consortiums

How would you rank your organization's perceived importance of the following IoT Consortiums to your IoT strategy? (1 = Important, 5 = Never heard of them)

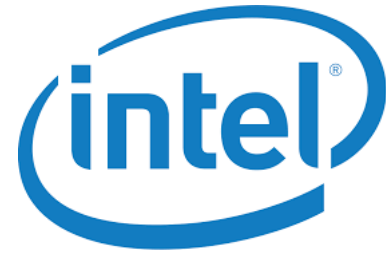|	Important	Neutral	Not Important	Don't Know	Never heard of them	Average Rating
IEEE	**233**	**125**	**30**	**51**	**9**	**1.83**
Eclipse IoT	**201**	**101**	**50**	**64**	**27**	**2.13**
Apache Foundation	**183**	**118**	**43**	**68**	**25**	**2.16**
W3C	**178**	**116**	**41**	**55**	**31**	**2.16**
IETF	140	112	35	80	57	2.53
LoRa Alliance	99	113	55	83	79	2.84
Industrial Internet Consortium (IIC)	89	117	40	91	92	2.95
OASIS	50	117	55	100	90	3.15
Open Connectivity Foundation (OCF)	75	91	42	89	117	3.20
OneM2M	54	95	49	88	120	3.31
Thread Group	41	107	53	88	120	3.34
OMA	44	103	42	101	126	3.39

EUROPEAN RESEARCH CONSORTIUMS

[Asked to European Respondents Only]
How would you rank your awareness for the following IoT related EU Research initiatives? (1 – Active Participant, 5 – No Knowledge)

	Active participant	Highly aware	Moderately aware	Somewhat aware	No Knowledge	Rating Average
FIWARE	5	25	37	27	149	**4.19**
IERC - European Research Cluster on the IoT	7	22	33	35	146	**4.20**
IoT-EPI - The European Platforms Initiative for the IoT	12	20	23	30	158	**4.24**
AIOTI - The European Alliance of IoT for Innovation	10	17	27	30	161	**4.29**
Hypercat	2	7	26	25	180	**4.56**

TOP IoT CORPORATE LEADERS

WHO RESPONDED?

JOB TITLE

What is your job title?

Legend:
- Developer — 28%
- Architect — 14%
- Testing — 1%
- Development Manager — 6%
- Product Manager — 5%
- Sales / Business Development — 2%
- Executive — 5%
- Researcher — 19%
- Student — 7%
- Independent Consultant — 6%
- Currently umemployed — 1%
- Other — 6%
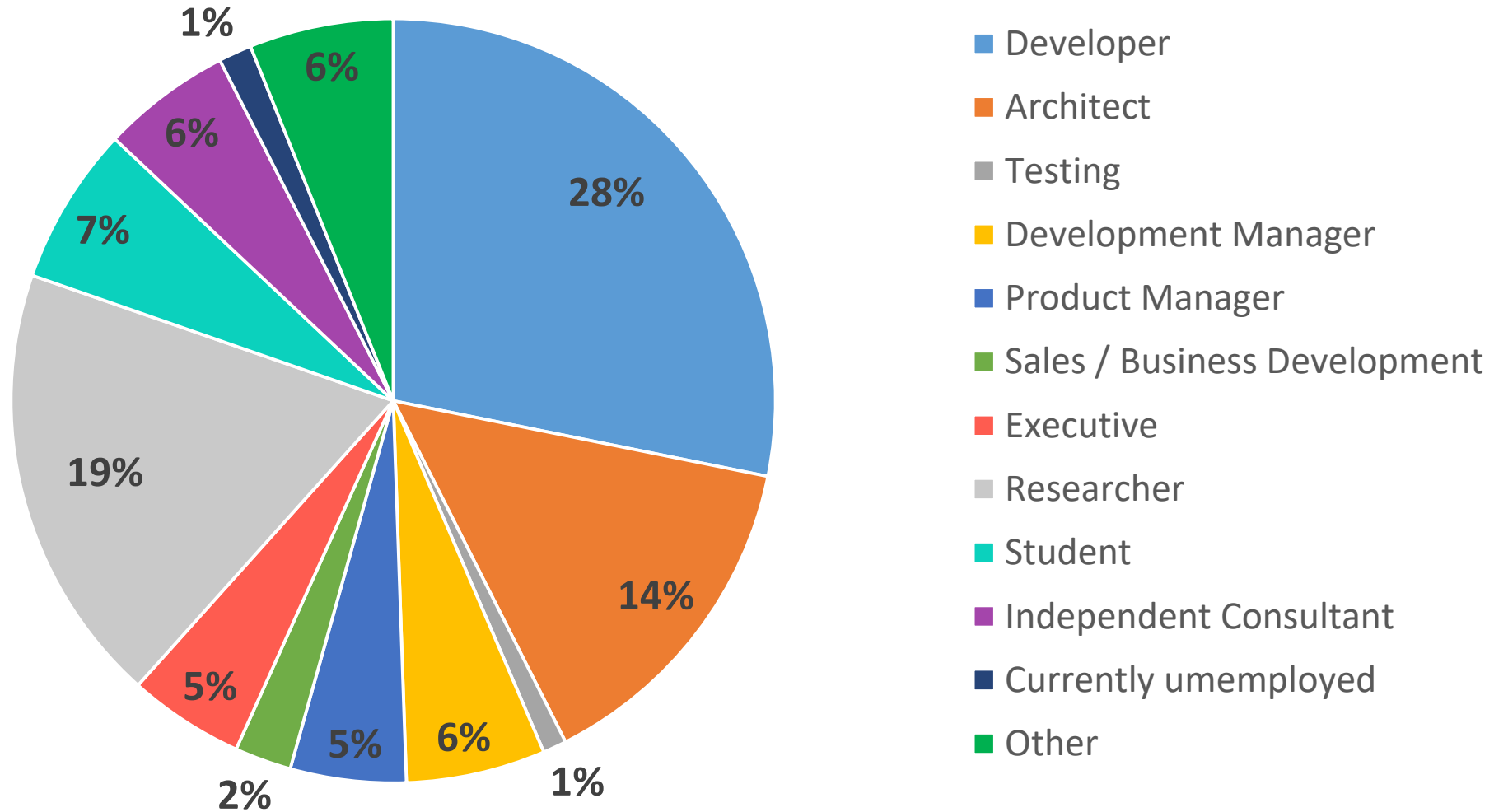
ORGANIZATION SIZE

How large is the organization you work for (# employees)?

1-49

50-500

501-5,000

5,000+

42.7%

20%

19.6%

17.7%

REGION

Where do you live?

North
America   **18.5%**

South
America   **7.3%**

Europe   **51.6%**

Africa +
Middle
East   **3.6%**

19.0%

Asia +
Pacific
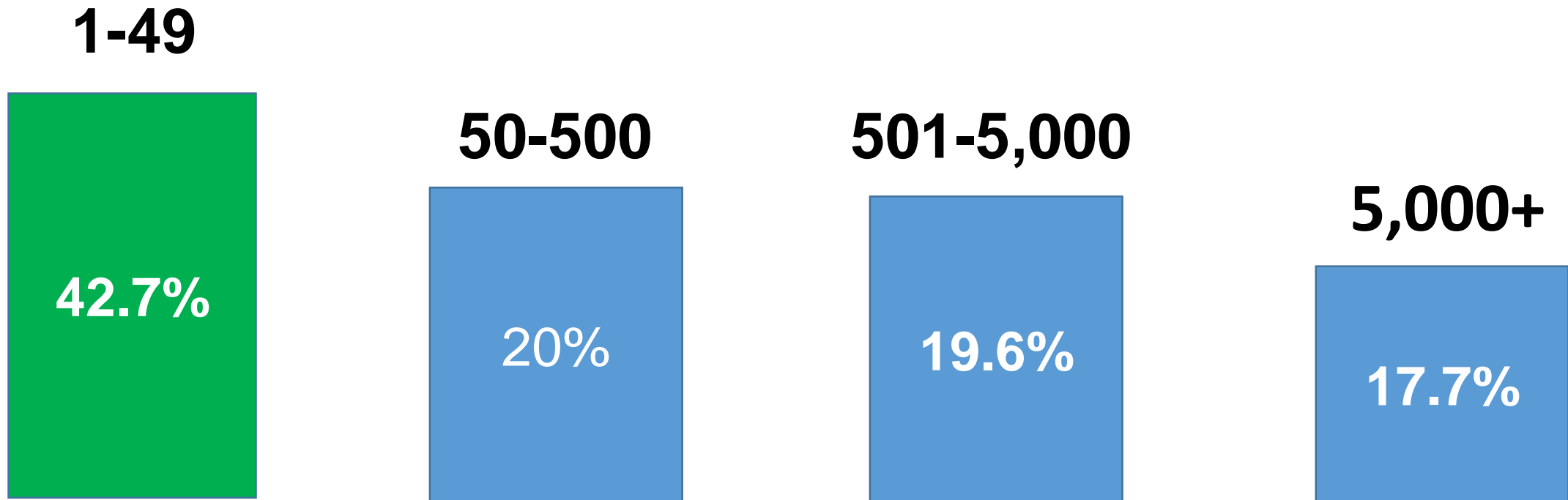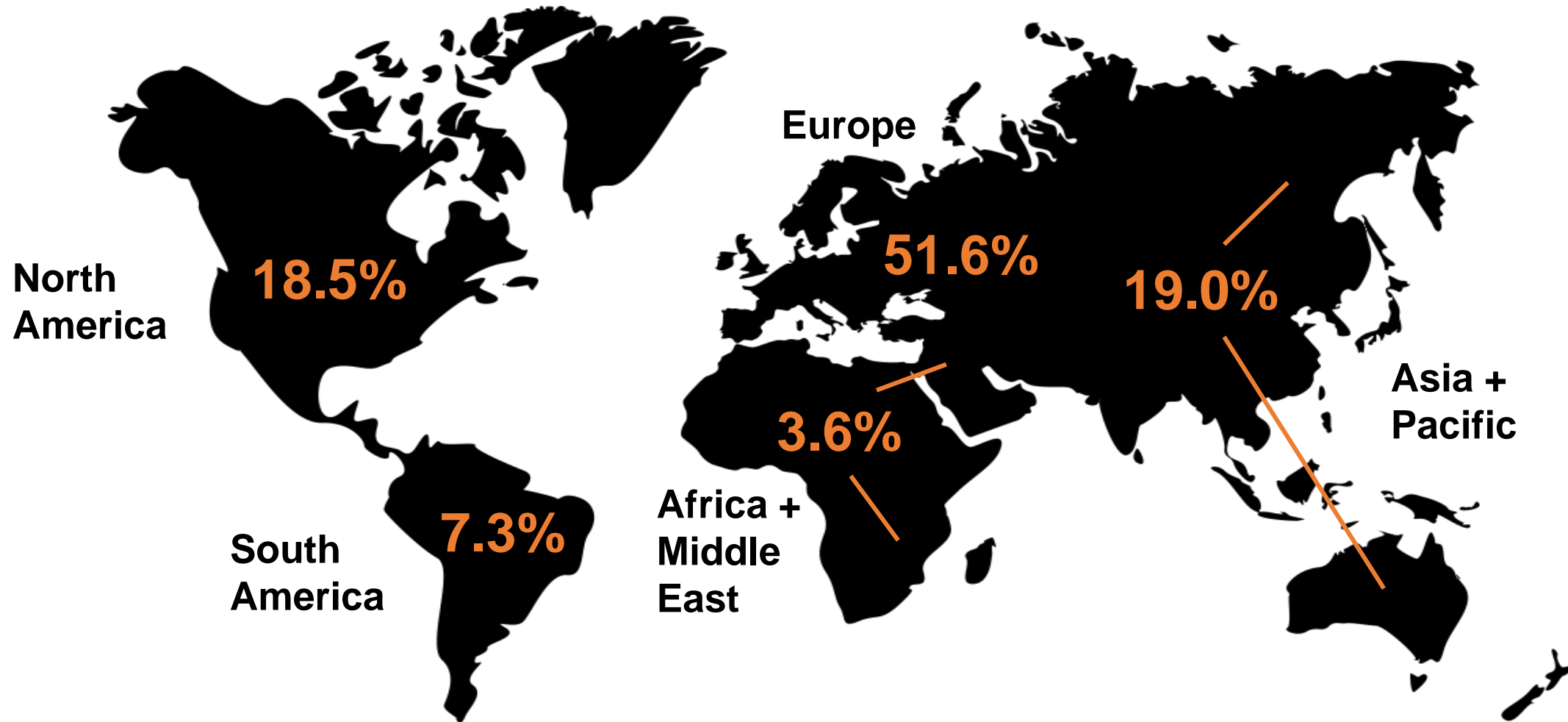
DIFFERENT RESPONDENT POOLS

DIFFERENT RESPONDENTS POOLS

The Survey was jointly sponsored by the Eclipse IoT Working Group, IEEE IoT and the AGILE IoT research project. Each sponsor group promoted the survey to their community.

A total of **713 individuals participated in the survey**. There were 255 respondents from the Eclipse community and 257 from the IEEE community. Given the size of these respondent pools, it is interesting to look at the differences between these two community.

The next page provides the details on the main differences. In general,

- It appears the experience within the IEEE community is more focused on research, while the Eclipse community was more likely to be working in deploying IoT solutions

- The language of choice in the Eclipse community was Java/C and in the IEEE it was C/Python.

- MQTT was a lot more popular in the Eclipse community.

- It would appear usage of AWS and Private Cloud is more popular within the Eclipse community

- For connectivity protocols, LPWA, 6LoWPAN and Bluetooth are all more popular in the IEEE community.

DIFFERENCES BETWEEN IEEE AND ECLIPSE IoT

Topic	All	IEEE	Eclipse IoT
Experience with IoT	Develop IoT Solutions (34.6%) Research IoT Solutions (20.2%)	Develop IoT Solutions (26.5%) Research IoT Solutions (27.6%)	Develop IoT Solutions (39.6%) Research IoT Solutions (11.4%)
Language Usage	Java (60.8%) C (60.5%) C++ (48%) Python (46.6%)	C(62.5%) Python (54.8%) C++(52.9%) Java (51.4%)	Java (73.5%) C (56.6%) JavaScript (42.8%) C++ (41.3%)
Security	Comm (48.3%) Encryption (43.2%) OTA (18.5%)	Encrption (44%) Comm (40%) OTA (14%)	Comm (51.8%) Encrypt (40%) OTA (22.3%)
Cloud Provider	AWS (42.7%) MS Azure (26.7%) GCP ((20.4%) Private (18.4%)	AWS (39.7%) MS Azure (25.6%) GCP (22.1%) Private (14.1%)	AWS (49.4%) MS Azure (29.6%) Private (21.6%) GCP (20.4%)
Message Protocol	HTTP (60.1%) MQTT (54.7%) CoAP (26.7%)	HTTP (52.8%) MQTT (43.6%) CoAP (24.6%)	MQTT (66.7%) HTTP (61.8%) CoAP (24.8%)
Connectivity	Bluetooth (48.2%) LPWA (22.4%) 6LoWPAN (21.4%) Thread (6.4%)	Bluetooth (50.5%) 6LoWPAN (26.8%) LPWA (25.8%) Thread (5.8%)	Bluetooth (43.2%) LPWA (19.1%) 6LoWPAN (11.7%) Thread (4.3%)

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