IoT Developer Survey Results
April 2017

DRAFT – NOT FOR DISTRIBUTION
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

SECURITY

INTEROPERABILITY

CONNECTIVITY
**KEY IOT SECURITY TECHNOLOGY**

*COMMUNICATION SECURITY (TLS, DTLS, …)*

*DATA ENCRYPTION*
TOP IoT PROGRAMMING LANGUAGES

CONSTRAINED DEVICES

C/C++

GATEWAYS

Java

C/C++

python

IoT CLOUD

Java

JS

node

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

- Amazon Web Services
- Microsoft Azure
- Google Cloud Platform
GROWTH OF NEW CONNECTIVITY TECHNOLOGIES

LPWA Technologies
IoT EXPERIENCE
What is your primary experience with building IoT solutions?

- 35% I develop IoT solutions for my company
- 20% I am researching IoT solutions for my company
- 20% I develop IoT solutions in my spare time only
- 12% I am learning about IoT technology in my spare time
- 5% No experience
- 8% Other
What is your company's plan for IoT solutions?

- **42%** My company develops and deploys IoT solutions today
- **14%** My company plans to develop and deploy IoT solutions in the next 6 months
- **17%** My company plans to develop and deploy IoT solutions in the next 7-18 months
- **15%** My company has no plans to develop IoT solutions
- **12%** Don't know

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

- 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**

<table>
<thead>
<tr>
<th>Industry</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>IoT platform / middleware</td>
<td>41.6%</td>
<td></td>
</tr>
<tr>
<td>Home automation</td>
<td>41.1%</td>
<td></td>
</tr>
<tr>
<td>Industrial automation</td>
<td>36.4%</td>
<td></td>
</tr>
<tr>
<td>Connected / smart cities</td>
<td>33.4%</td>
<td></td>
</tr>
<tr>
<td>Energy management</td>
<td>33.3%</td>
<td></td>
</tr>
<tr>
<td>Building automation</td>
<td>26.1%</td>
<td></td>
</tr>
<tr>
<td>Agriculture</td>
<td>25.5%</td>
<td></td>
</tr>
<tr>
<td>Healthcare</td>
<td>22.7%</td>
<td></td>
</tr>
<tr>
<td>Automotive</td>
<td>21.4%</td>
<td></td>
</tr>
<tr>
<td>Transportation</td>
<td>20.1%</td>
<td></td>
</tr>
</tbody>
</table>

Participation of additional industries is growing...
What are your top 2 concerns for developing IoT solutions?

- 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%
Security continues to be the key concern; Interoperability might be decreasing.
TECHNOLOGY USED FOR IoT
Which of the following programming languages, if any, do you use to build IoT solutions?
Which of the following programming languages, if any, do you use to build IoT solutions? (Constrained Devices)
Which of the following programming languages, if any, do you use to build IoT solutions? (Gateways)

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

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

- 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%

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

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

<table>
<thead>
<tr>
<th>Hardware Architecture</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARM Cortex-M3 / ARM Cortex-M4</td>
<td>36.9%</td>
</tr>
<tr>
<td>ARM Cortex-M0 / ARM Cortex-M0+ / ARM Cortex-M1</td>
<td>33.4%</td>
</tr>
<tr>
<td>16-bit MCU</td>
<td>27.7%</td>
</tr>
<tr>
<td>Don't know</td>
<td>22.8%</td>
</tr>
<tr>
<td>ARM Cortex-M7</td>
<td>22.4%</td>
</tr>
<tr>
<td>8-bit MCU</td>
<td>22.3%</td>
</tr>
<tr>
<td>Other</td>
<td>6.6%</td>
</tr>
<tr>
<td>Don't use constrained devices</td>
<td>4.6%</td>
</tr>
</tbody>
</table>
What hardware architectures are you using for your IoT gateway(s)?
What hardware components are included in your IoT solution?

- Sensors: 86.8%
- Actuators: 50.8%
- Gateway / hub device: 50.2%
- Edge node device: 36.2%
- Camera / video capture: 35.1%
- LCD display: 33.5%
- Touch screen: 25.4%
- Audio playback / speaker: 17.4%
- None: 4.5%
- Other: 4.1%
What software features are included in your IoT solution?

- **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%
Which of the following security-related technologies do you use in your IoT solution?
### Cloud Services for IoT

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

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

- Amazon AWS: 36.8% (2016), 42.7% (2017)
- Microsoft Azure: 20.8% (2016), 26.7% (2017)
- Google Cloud Platform: 16.9% (2016), 20.4% (2017)
- Private/On-premise cloud: 34.9% (2016), 18.4% (2017)
- IBM Bluemix: 16.9% (2016), 15.6% (2017)
What connectivity protocol(s) do you use for your IoT solution?

- 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: 48.2%
- Ethernet: 35.8%
- Bluetooth / Bluetooth Smart: 40.9%
- Cellular: 17.3%
- Zigbee: 12.9%
- Serial RS-232/RS-485: 16.2%
- LPWA (LoRa, Sigfox, LTE-M,...): 22.4%
- 6LoWPAN: 21.4%
- UPnP: 6.4%
- Thread: 4.8%

Steady growth for Bluetooth, LPWA, 6LoWPAN
Thread still lagging behind

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

- 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?**

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Usage Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>32.1%</td>
</tr>
<tr>
<td>Modbus</td>
<td>22.6%</td>
</tr>
<tr>
<td>Don’t know</td>
<td>20.0%</td>
</tr>
<tr>
<td>CAN</td>
<td>18.0%</td>
</tr>
<tr>
<td>Industrial Protocol (EtherNet/IP, ControlNet,...)</td>
<td>14.7%</td>
</tr>
<tr>
<td>OPC-UA (IEC 62541)</td>
<td>12.5%</td>
</tr>
<tr>
<td>Profibus, Profinet</td>
<td>6.8%</td>
</tr>
<tr>
<td>KNX</td>
<td>6.4%</td>
</tr>
<tr>
<td>BACNet</td>
<td>6.4%</td>
</tr>
<tr>
<td>EtherCat</td>
<td>5.7%</td>
</tr>
<tr>
<td>IEC 60870, 61850</td>
<td>3.7%</td>
</tr>
<tr>
<td>Other</td>
<td>3.3%</td>
</tr>
<tr>
<td>DNP3</td>
<td>3.1%</td>
</tr>
<tr>
<td>FOUNDATION fieldbus</td>
<td>2.2%</td>
</tr>
<tr>
<td>Sercos</td>
<td>1.1%</td>
</tr>
</tbody>
</table>

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

- 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%
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 (31%)
- Yes, my company prototypes IoT solutions using an open hardware platform (20%)
- Yes, I have experimented with open hardware in my spare time (33%)
- No, but I intend to experiment with open hardware in the next 6 months (7%)
- Never used open hardware (9%)
IoT Industry Perceptions
**Open Source Policy**

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

- 46.1%: Organization uses open source technology in our IoT solutions.
- 27.5%: Committer on an open source project that builds technology for IoT solutions.
- 18.8%: Experimented with IoT open source technology, but don’t use it in IoT solutions.
- 15.8%: Report bugs and feature enhancements to open source projects that provide IoT technology.
- 3.4%: No experience with IoT open source projects.
- 21.6%: Other
## 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)

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

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Active Participant</th>
<th>Highly aware</th>
<th>Moderately aware</th>
<th>Somewhat aware</th>
<th>No Knowledge</th>
<th>Rating Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIWARE</td>
<td>5</td>
<td>25</td>
<td>37</td>
<td>27</td>
<td>149</td>
<td>4.19</td>
</tr>
<tr>
<td>IERC - European Research Cluster on the IoT</td>
<td>7</td>
<td>22</td>
<td>33</td>
<td>35</td>
<td>146</td>
<td>4.20</td>
</tr>
<tr>
<td>IoT-EPI - The European Platforms Initiative for the IoT</td>
<td>12</td>
<td>20</td>
<td>23</td>
<td>30</td>
<td>158</td>
<td>4.24</td>
</tr>
<tr>
<td>AIOTI - The European Alliance of IoT for Innovation</td>
<td>10</td>
<td>17</td>
<td>27</td>
<td>30</td>
<td>161</td>
<td>4.29</td>
</tr>
<tr>
<td>Hypercat</td>
<td>2</td>
<td>7</td>
<td>26</td>
<td>25</td>
<td>180</td>
<td>4.56</td>
</tr>
</tbody>
</table>
Top IoT Corporate Leaders

IBM  
Amazon Web Services  
Intel  
Google  
Cisco  
Bosch  
Microsoft
How large is the organization you work for (# employees)?

- 1-49 employees: 42.7%
- 50-500 employees: 20%
- 501-5,000 employees: 19.6%
- 5,000+ employees: 17.7%
Where do you live?

North America: 18.5%
South America: 7.3%
Europe: 51.6%
Asia + Pacific: 19.0%
Africa + Middle East: 3.6%
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

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

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