



SAKARYA ÜNİVERSİTESİ
Bilgisayar ve Bilişim Bilimleri Fakültesi
Bilgisayar Mühendisliği Bölümü

BSM 313
NESNELERİN İNTERNETİ VE UYGULAMALARI

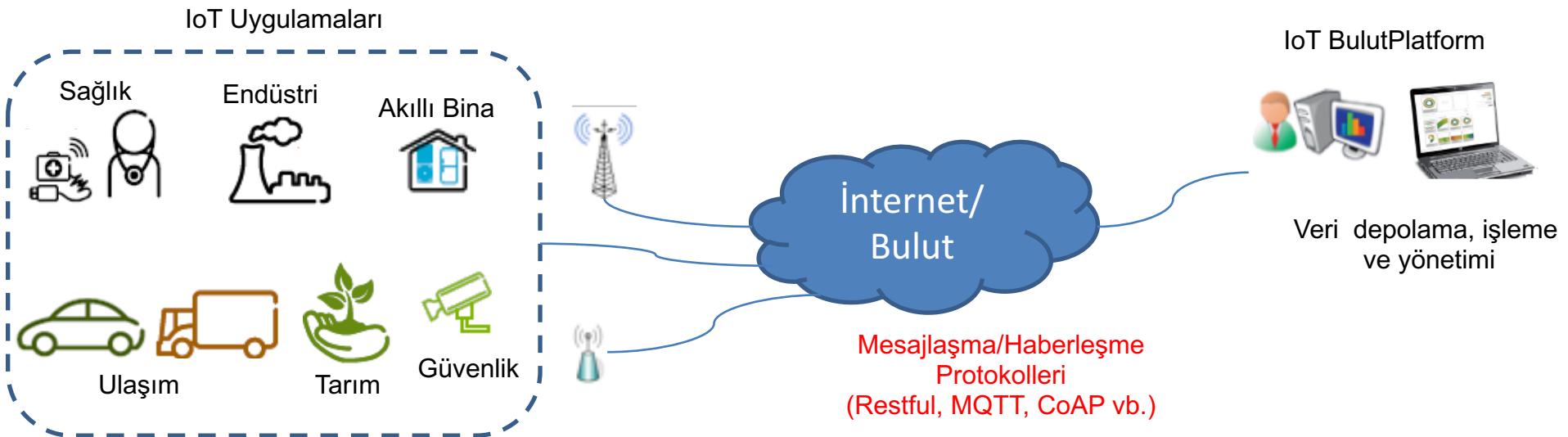
(Internet of Things (IoT) and Applications)

**NESNELERİN İNTERNETİ
UYGULAMALARINDA KULLANILAN TEKNOLOJİLER**

Doç. Dr. Cüneyt BAYILMIŞ



IoT Uygulamalarında Kullanılan Teknolojiler



IoT Yardımcı Teknolojiler

- RFID
- NFC
- Bluetooth Low Energy
- GSM
- GPS vb.

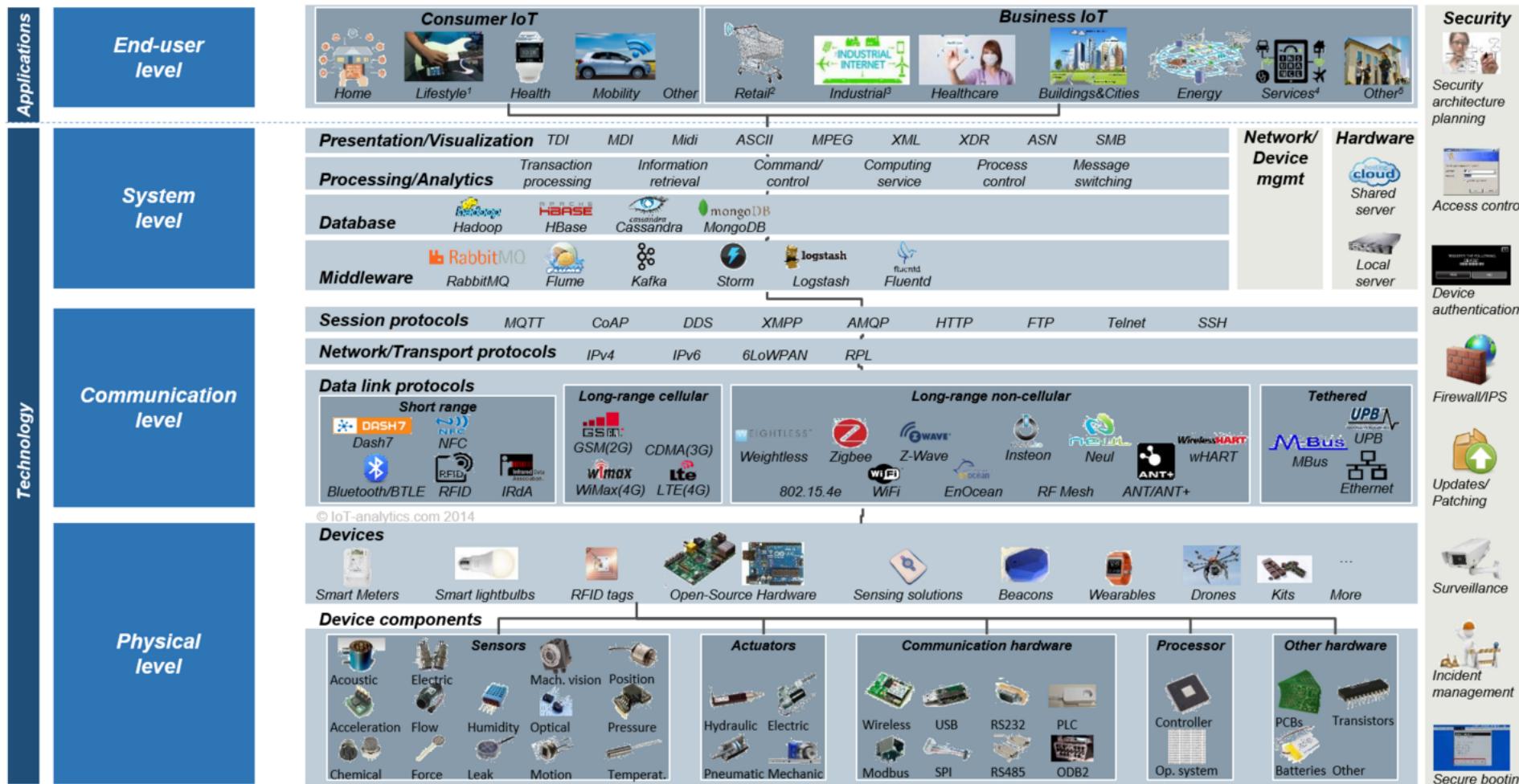


Nesnelerin Interneti Teknoloji / Protokol Mimarisi



IoT Analytics – Quantifying the connected world

Internet of Things – Technology architecture



IoT Ağ ve Bileşenleri

❑ Nesnelerin interneti ağ bileşenleri

Bilgi Teknolojileri
(Information Technology, IT)



İşlemsel Teknoloji
(Operational Technology, OT)



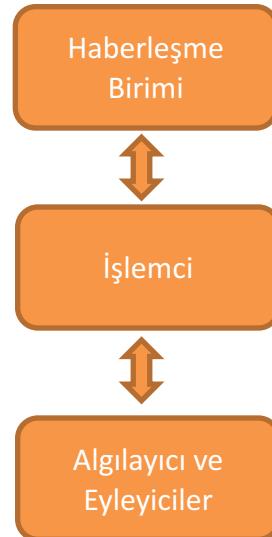
Akıllı Nesneler
(Smart Objects)

❑ İşlemsel teknoloji, doğru zamanda doğru kişi için doğru bilgi ulaştırma.

❑ IoT Akıllı Nesne

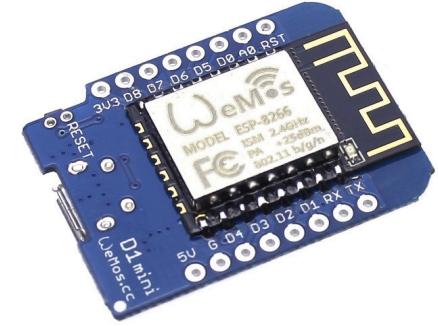
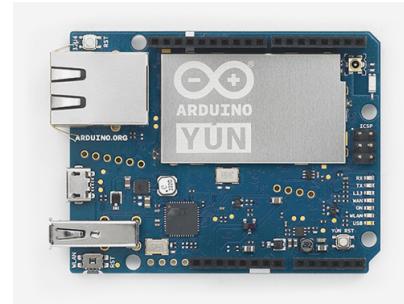
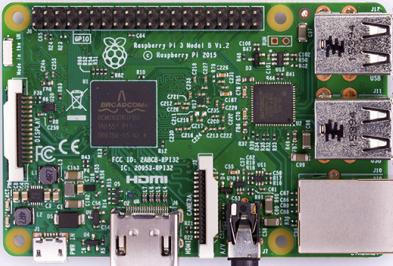


❑ Veri işleyebilen, akıllı karar verme yeteneğine sahip, birbirleri ve internet ile haberleşebilen fizikselselementler.



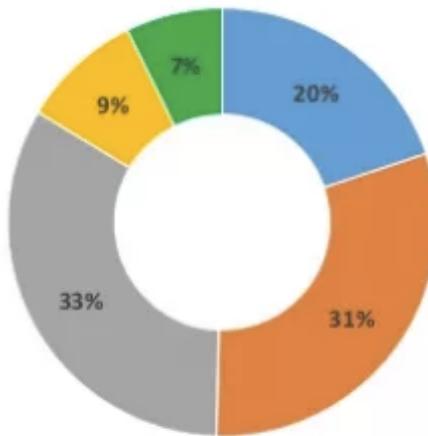
IoT Donanım Örnekleri

❑ Açık kaynaklı donanımlar



USAGE OF OPEN HARDWARE

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

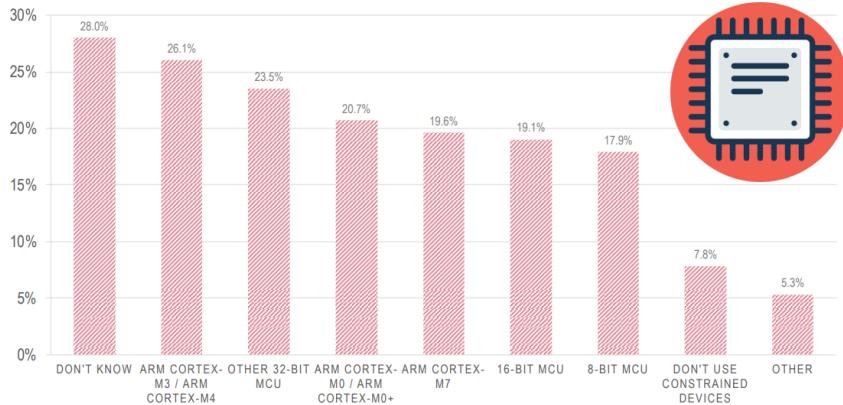


- Yes, my company deploys IoT solution using an open hardware platform
- Yes, my company prototypes IoT solutions using an open hardware platform
- Yes, I have experimented with open hardware in my spare time
- No, but I intend to experiment with open hardware in the next 6 months
- Never used open hardware

IoT Donanım Mimarileri

IoT HARDWARE ARCHITECTURES

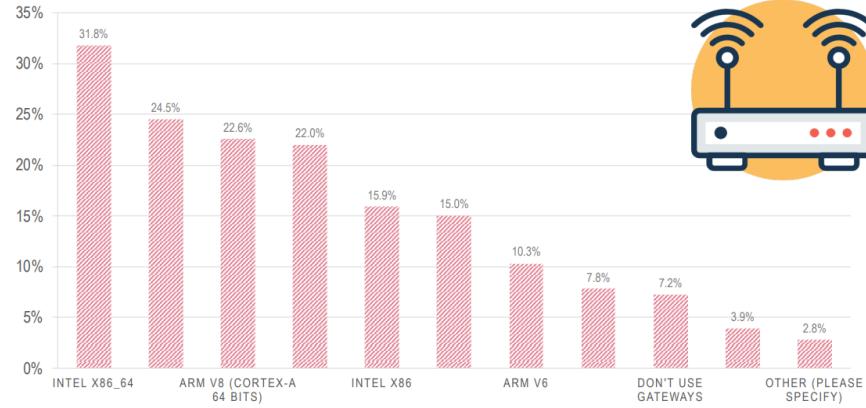
What hardware architectures are you using for your IoT constrained device(s)?



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IoT HARDWARE ARCHITECTURES

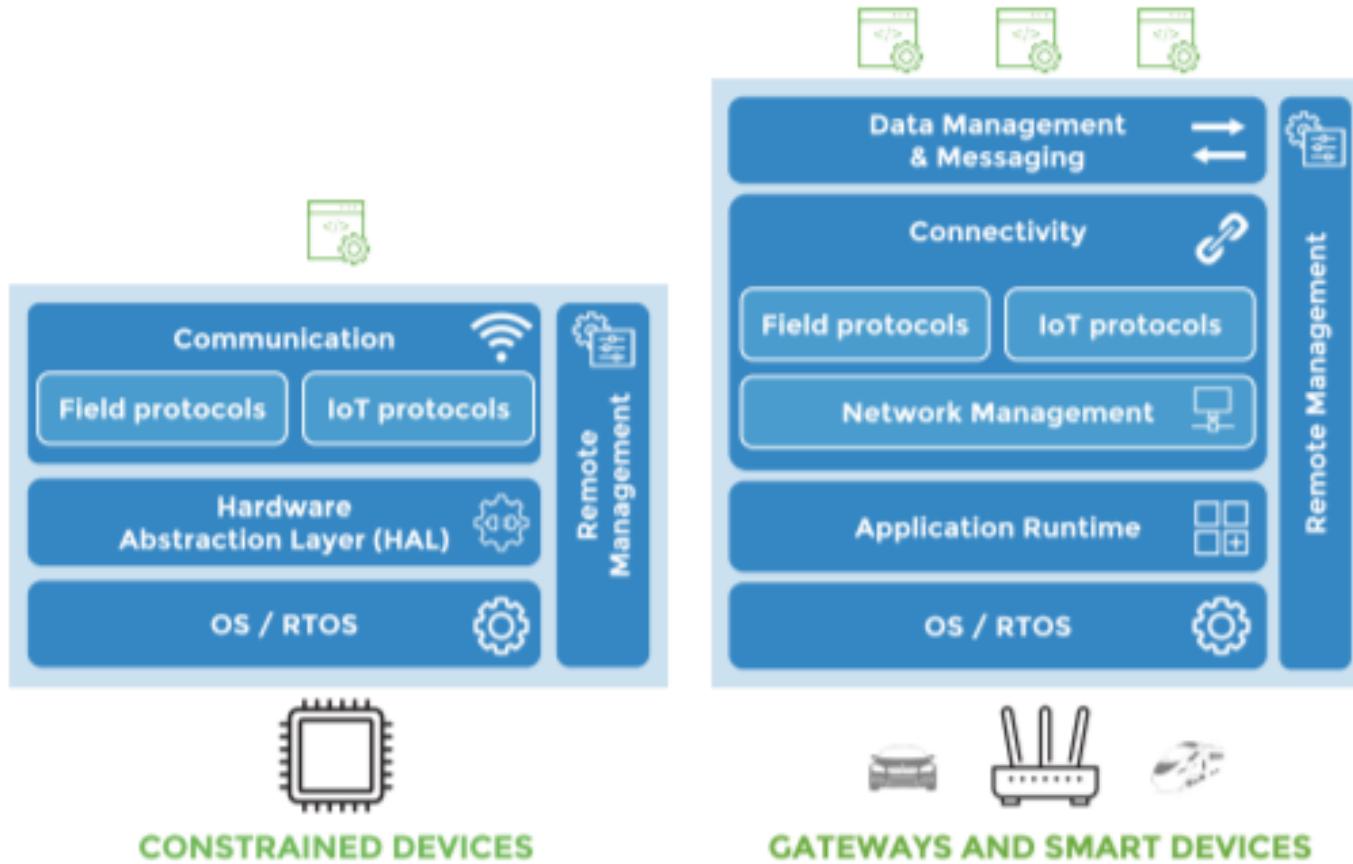
What hardware architectures are you using for your IoT gateway(s)?



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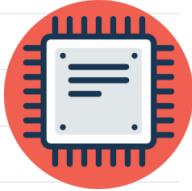
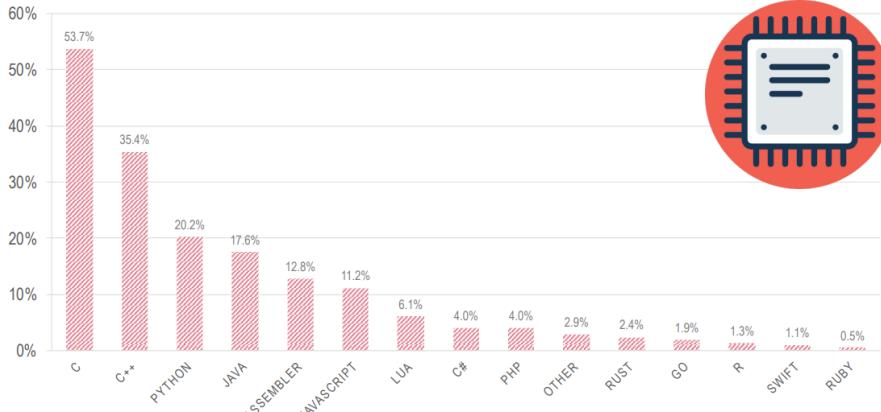
IoT Nesne Gömülü Yazılım Modelleri



IoT Nesnelerini Programlama Dilleri

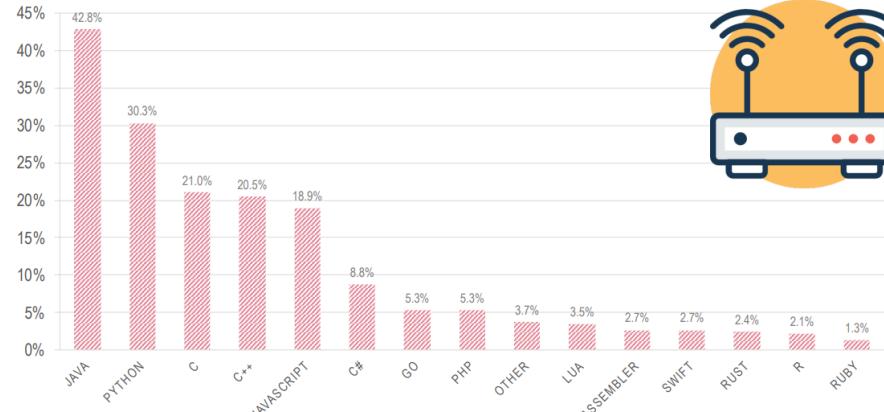
PROGRAMMING LANGUAGES – CONSTRAINED DEVICES

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



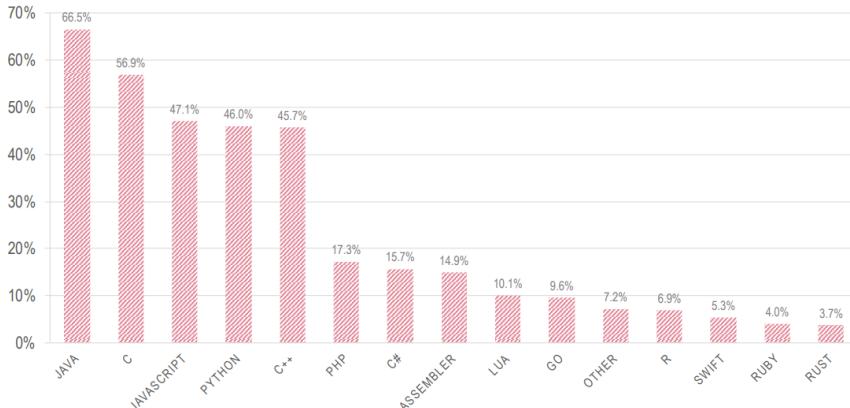
PROGRAMMING LANGUAGES – IoT GATEWAYS

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



OVERALL SUMMARY OF PROGRAMMING LANGUAGES

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

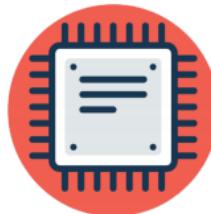


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IoT Nesnelerini Programlama Dilleri

TOP IoT PROGRAMMING LANGUAGES

Devices



Gateways



Cloud

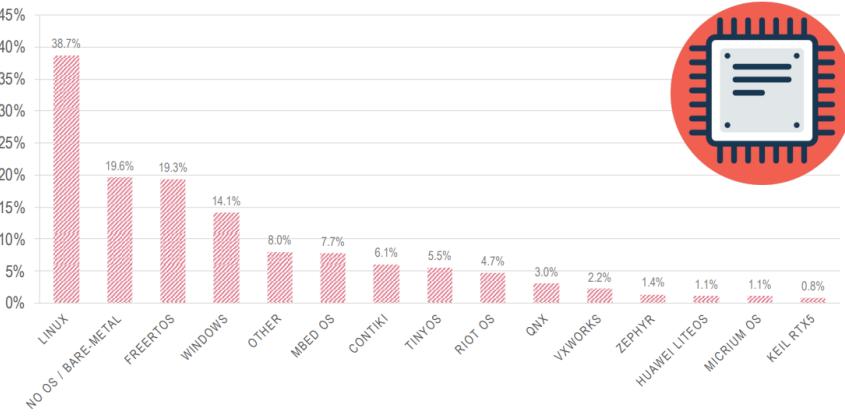


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IoT Donanımlarında Kullanılan İşletim Sistemleri

IoT OPERATING SYSTEMS – CONSTRAINED DEVICES

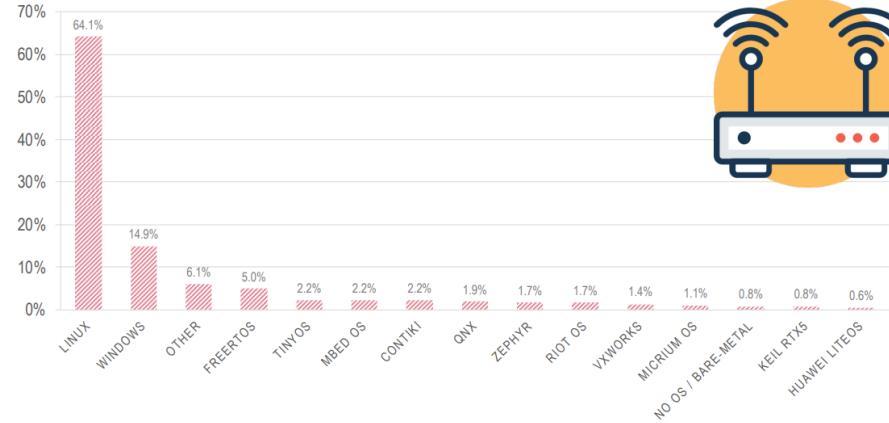
Which operating system(s) do you use for your IoT devices? (Constrained Devices)



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IoT OPERATING SYSTEMS – IoT GATEWAY

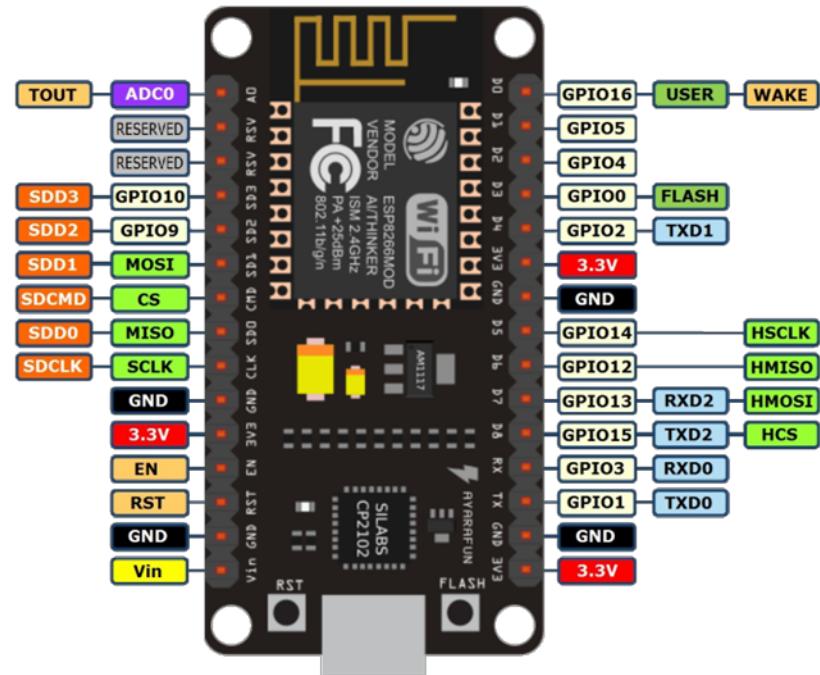
Which operating system(s) do you use for your IoT devices? (Edge / Gateway)



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Ders Uygulamalarında Kullanılan ESP8266 WiFi Modülüne Sahip NodeMCU

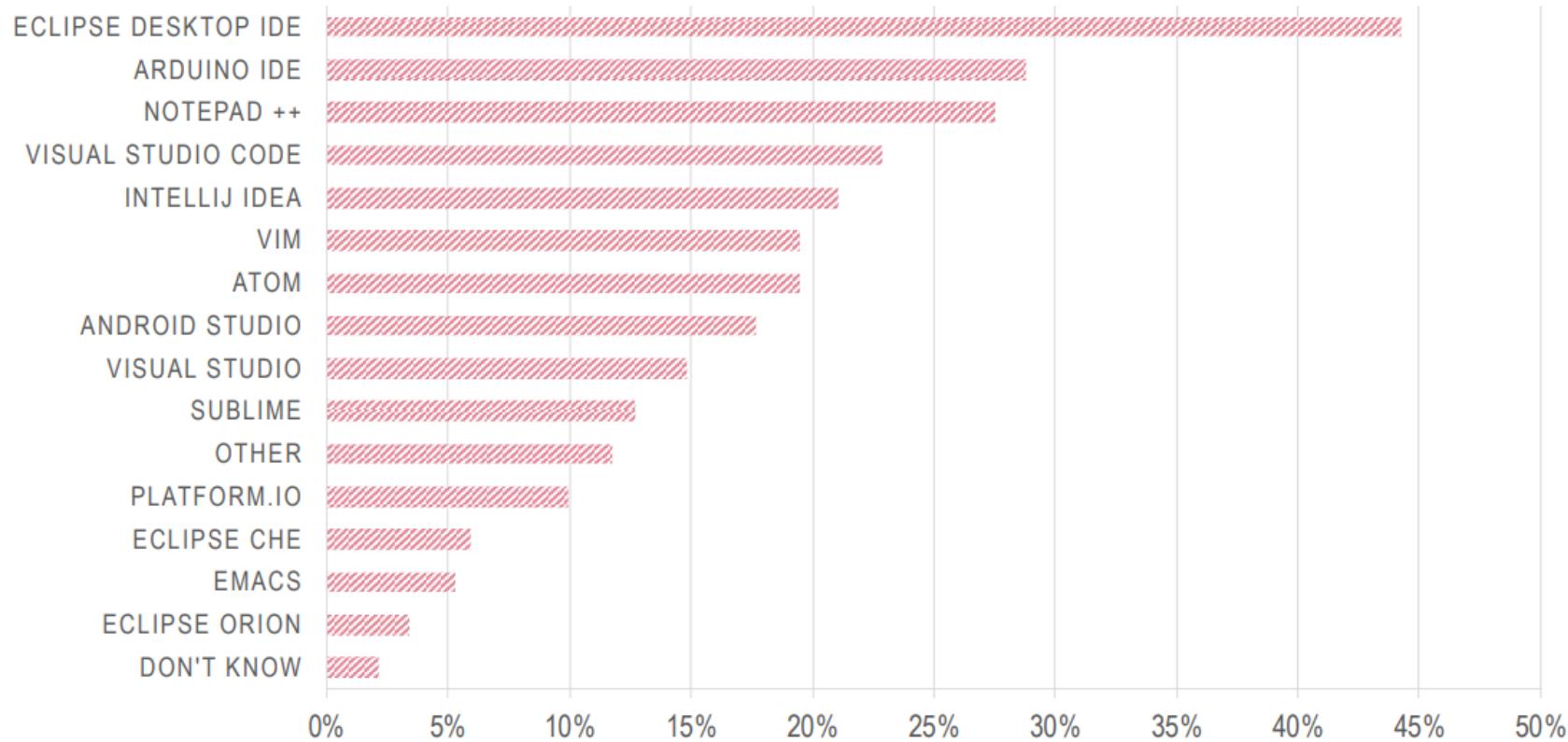
CPU	80MHz (varsayılan) veya 160MHz
Bellek	64 KB Komut, 96 KB Veri
Wireless Standart	802.11 b/g/n
GPIO	16 Pin
Haberleşme Protokol	SPI, I2C, UART
Analog Pin	10 bit ADC
Güç	3.3 VDC



IoT Nesnelerini Programlamak İçin Kullanılan Editörler

TEXT EDITORS / IDES

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

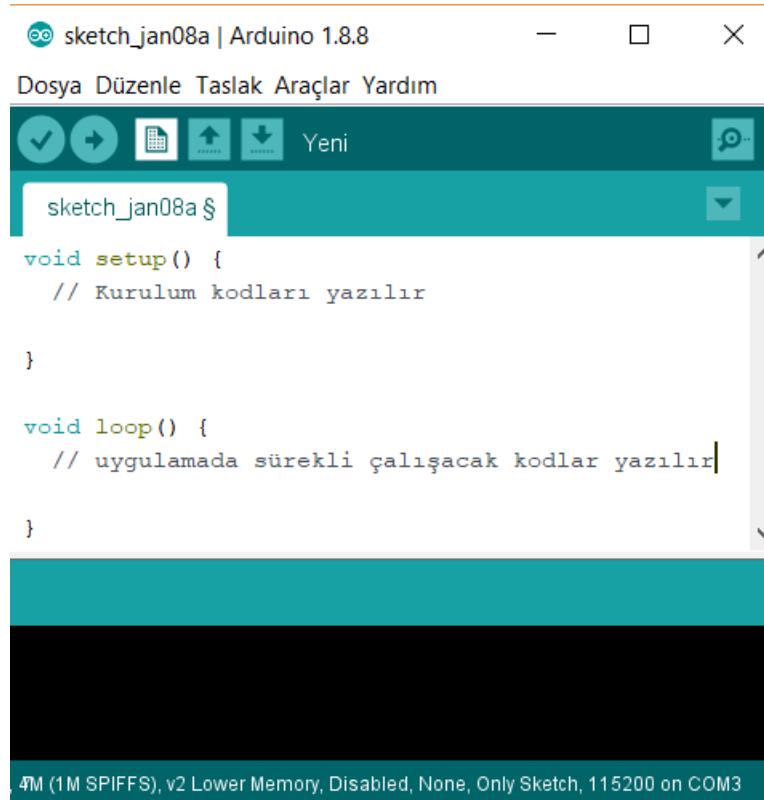


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NodeMcu Programlama İçin Arduino IDE Ortamı

- ❑ www.arduino.cc adresinden işletim sisteminize uygun IDE'yi ücretsiz olarak indirebilirsiniz.
- ❑ Programlama için C dili kullanılır.
- ❑ Birçok sensör vb. cihazlar ile farklı protokollerin kolay kullanımına yönelik geniş kütüphane desteği bulunmaktadır.
- ❑ Arduino IDE dışında Eclipse AVR, Arduino for Visual Studio gibi farklı editörler ile de program geliştirilebilir.



The screenshot shows the Arduino IDE interface. The title bar says "sketch_jan08a | Arduino 1.8.8". The menu bar includes "Dosya", "Düzenle", "Taslak", "Araçlar", and "Yardım". The toolbar has icons for file operations like new, open, save, and upload. The code editor window contains the following C code:

```
void setup() {
    // Kurulum kodları yazılır
}

void loop() {
    // uygulamada sürekli çalışacak kodlar yazılır
}
```

At the bottom of the code editor, there is a status bar with the text "4M (1M SPIFFS), v2 Lower Memory, Disabled, None, Only Sketch, 115200 on COM3".

NodeMcu Programlama İçin Ardunio Komutlar Genel Bakış

❑ Seri İletişim Komutları:

- Serial.begin (9600); //setup fonksiyonu içerisinde seri iletişim baud hızını ayarlar 1200, 2400, 9600, 14400...
- Serial.print ("merhaba"); // seri port ekranına yazmak (seri porttan üzerinden göndermek) için
- Serial.end (); // seri iletişim sonlandırır
- Serial.available (); // seri porttan okunacak veri olup olmadığını kontrolü
- Serial.read (); // seri porttan veri okuma
- Arduino Mega gibi birden fazla seri port desteği olan kartlarda seri portlar sırasıyla Serial, Serial1, Serial2 şeklinde tanımlanır.

❑ Dijital Pin Giriş/Cıkış olarak ayarlanması:

- pinMode (pin no, OUTPUT); // setup fonksiyonu içerisinde ilgili pin çıkış olarak ayarlandı (örneğin LED bağlı)
- pinMode (10, INPUT); // setup fonksiyonu içerisinde 10 nolu pin giriş olarak ayarlandı (örneğin buton bağlı)

❑ Dijital Pin değer okuma ve yazma:

- deger=digitalRead (pin); // İlgili dijital pindeki değeri oku ve deger degiskenine aktar
- digitalWrite (pin no, HIGH); // İlgili pin lojik 1 olarak ayarlandı (örneğin LED'in anodu bağlı ise yandı)
- digitalWrite (10, LOW); // 10 nolu pin lojik 0 olarak ayarlandı (örneğin LED'in anodu bağlı ise söndü)

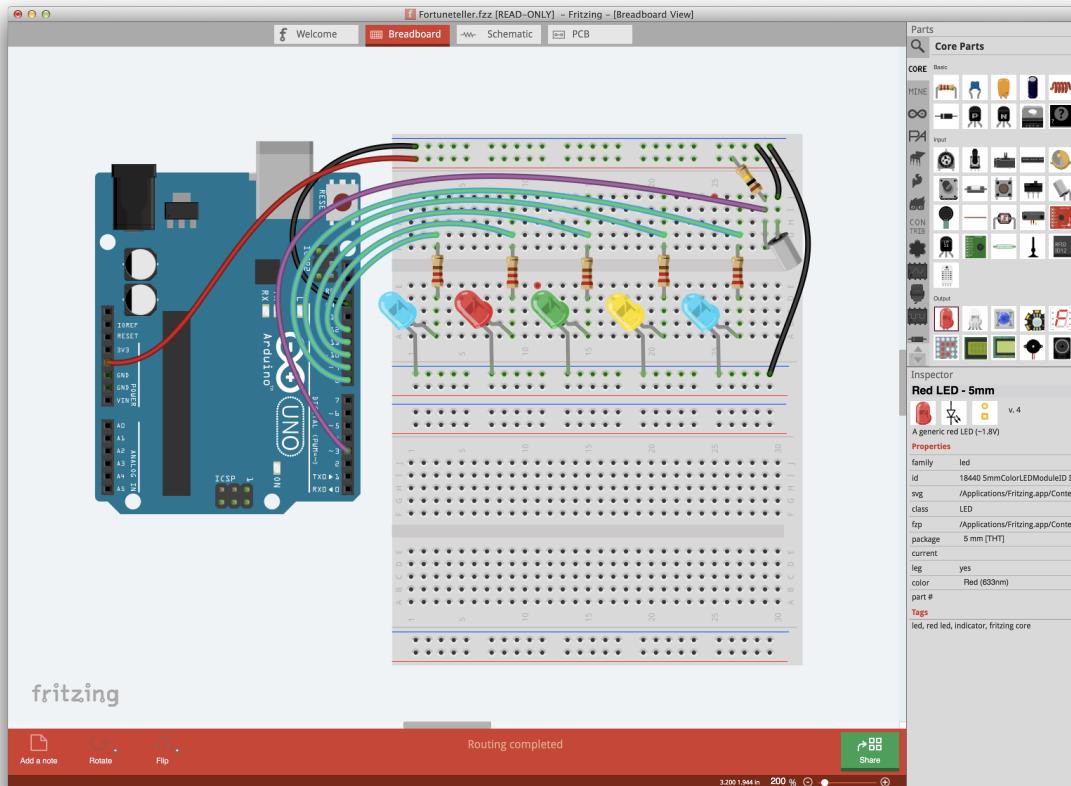
❑ Analog Pin değer okuma ve yazma:

- deger=analogRead (pin); // İlgili analog pindeki değeri oku ve deger degiskenine aktar (A0 analog pin 0)
- digitalWrite (pin, deger); // İlgili analog pin'e deger değişkenindeki değer aktarılır



Devre Tasarımı İçin Fritzing

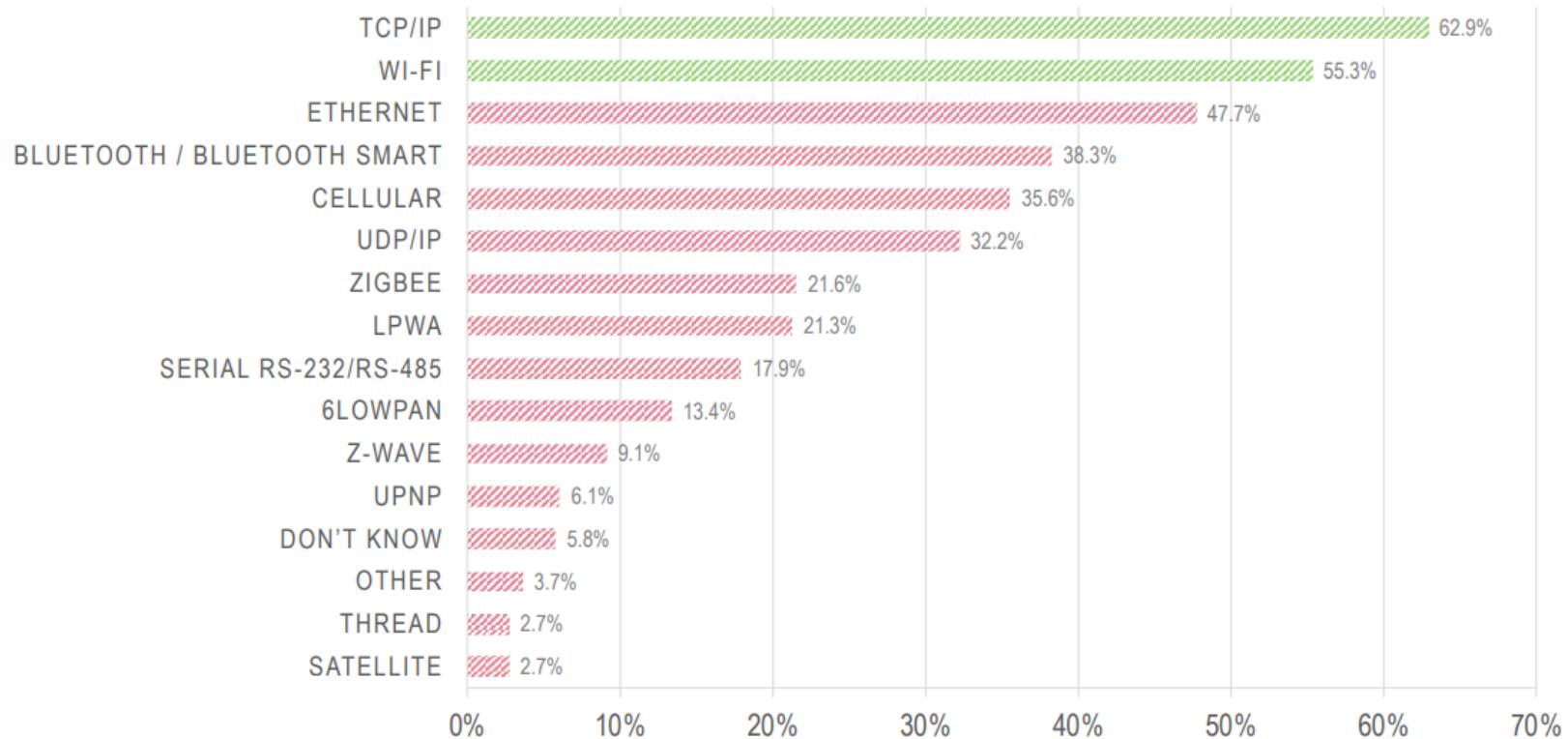
- ❑ Fritzing.org adresinden devre tasarım yazılımını ücretsiz olarak indirebilirsiniz.
- ❑ Sürükle bırak şeklinde devre elemanlarını tasarım alanına taşıyabilirsiniz.
- ❑ Baskı devre ve şema çıkarımına izin vermektedir.



IoT Bağlantı Protokolleri

CONNECTIVITY PROTOCOLS

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



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Top 3 connectivity protocols



TCP/IP

54.1%



WiFi

48.2%



Ethernet

41.1%

TCP/IP, WiFi and Ethernet dominate usage with **Satellite and Thread more than doubling** year over year

Usage of specialized connectivity solutions (LPWA, Zigbee, 6LoWPAN, Z-Wave, Satellite) hovers between 8 and 15% each

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IoT Mesajlaşma/Haberleşme Protokollerine Genel Bakış

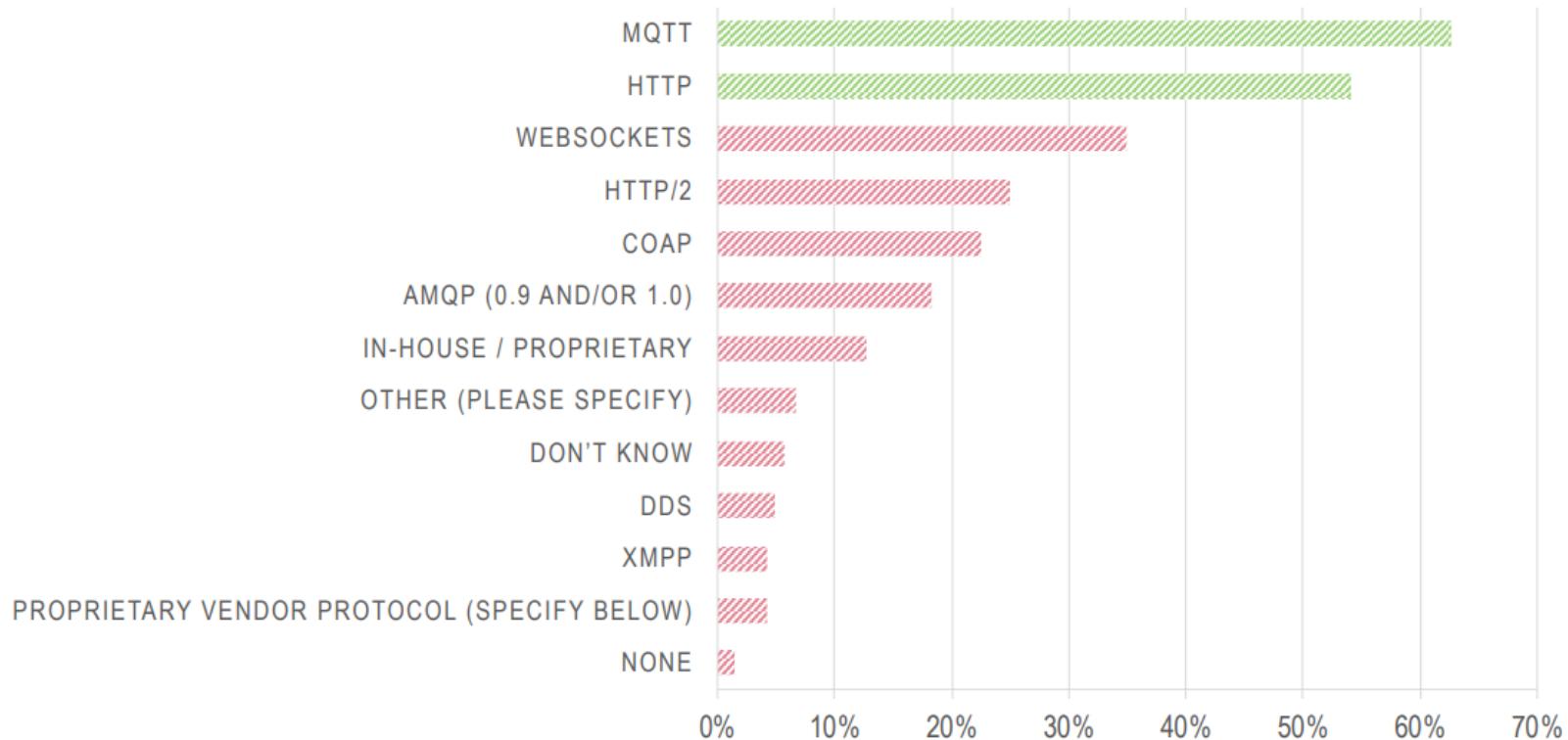
- ❑ Ağ üzerinden birlikte çalışabilen makineden makine etkileşimi/haberleşmeyi desteklemek için tasarlanmış yazılım sistemleri ‘Web Servisleri’ olarak adlandırılmaktadır.
- ❑ Web Servisleri kavramı, IoT konusunda uygulama/haberleşme protokollerinin içerisinde ele alınmaktadır.
- ❑ Uygulama/Haberleşme Protokolü seçiminde kısıtlı donanıma sahip IoT cihazlarının kaynak kullanımı CPU, bellek vb. kaynaklarını efektif kullanabilmesi kriteri gözönünde tutulmalıdır. Bu nedenle IoT uygulamalarının hafif (lightweight) protokoller ile haberleşme ihtiyacı vardır.



Nesnelerin İnterneti Mesajlaşma Protokollerı

MESSAGING STANDARDS

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



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Top 3 communication protocols



HTTP

49%



MQTT

42%



Websockets

26%

Almost 50% of participants use HTTP (likely for RESTful web services) with MQTT strongest of the IoT-specific protocols

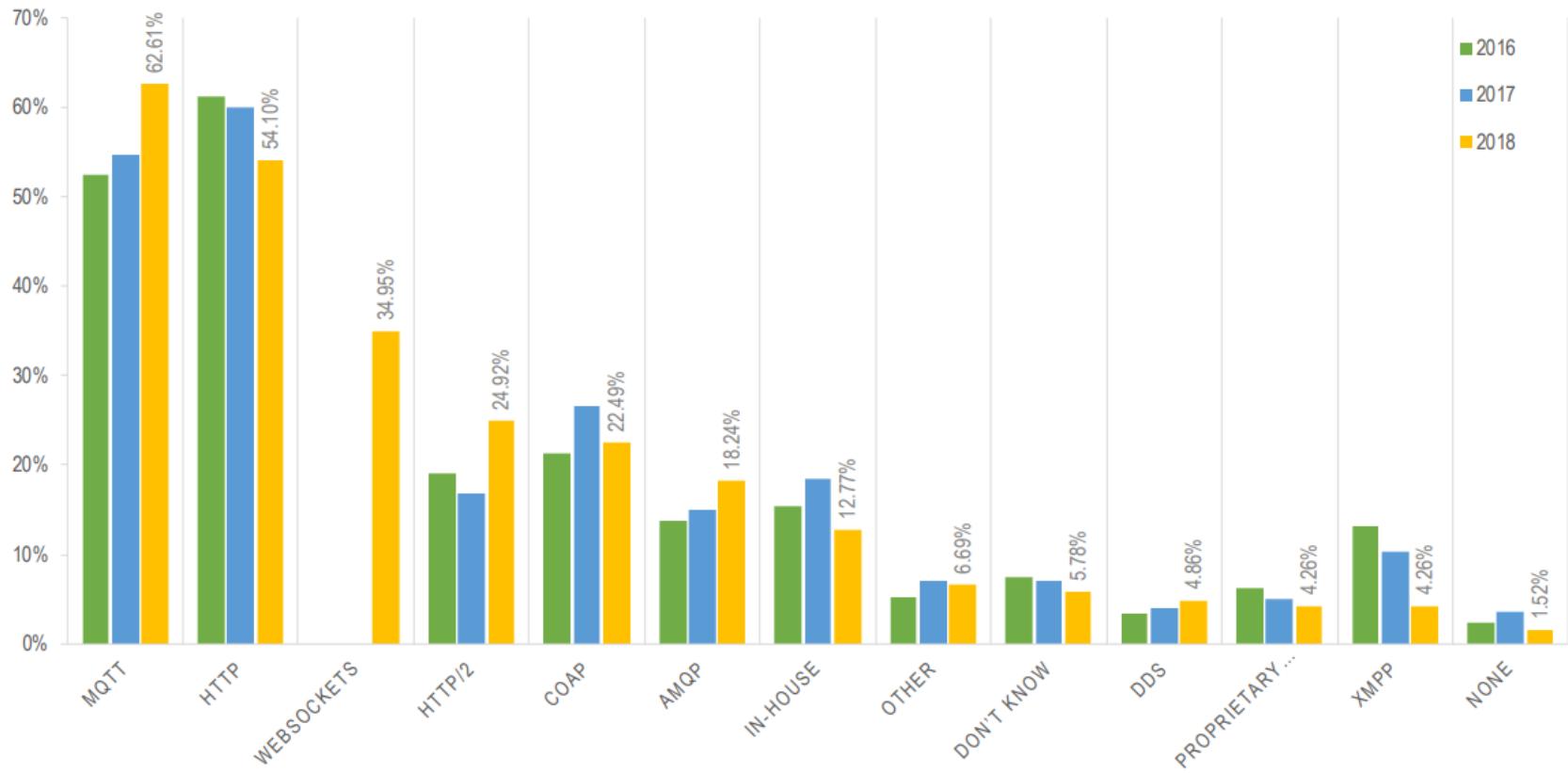
Websockets and HTTP/2 are also strong (around 25%) with CoAP usage significantly lower at 15%

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Nesnelerin İnterneti Mesajlaşma Protokollerı

MESSAGING STANDARDS - TRENDS



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IoT Bulut Platformları

❑ IoT uygulamalarının doğası gereği nesneler tarafından üretilen/elde edilen verilerin internet ortamında depolanacağı ve görselleştirileceği/analiz edileceği ortamlara ihtiyaç vardır.

- ThingSpeak,
- adafruit,
- Firebase,
- TeMBoo,
- IBM Watson IoT,
- Microsoft Azure IoT,
- Amazon Web Services (AWS) IoT,
- ThingWorx IoT Platform,
- Carriots,



IoT Bulut Platformları

ThingSpeak

- ❑ <https://thingspeak.com>
- ❑ ThingSpeak IoT platformunu öne çıkaran özelliği veri analiz ve görselleştirme işlemlerini MATLAB ile gerçekleştirmesidir.
- ❑ Arduino, Raspberry Pi, BeagleBone, Particle Photon and Electron gibi gömülü sistemler ile birlikte çalışabilir.
- ❑ MQTT yayın desteği vardır.
- ❑ Olay programlama, uyarı/alarm oluşturma gibi özellikleri vardır.
- ❑ Twitter ile kullanılabilmektedir.
- ❑ Ücretsiz olarak kullanılabilmektedir.
- ❑ Açık API desteği vardır.



Apps

ThingSpeak channels store data. Upload data from the web or send data from devices to a ThingSpeak channel. Use these apps to transform and visualize data or trigger an action. See Tutorial: ThingSpeak and MATLAB to create a channel. [Learn more](#) about MATLAB® inside ThingSpeak.

Analytics

MATLAB Analysis
Explore and transform data.

MATLAB Visualizations
Visualize data in MATLAB plots.

Plugins
Display data in gauges, charts, or custom plugins.

IoT Bulut Platformaları

ThingSpeak Kullanımı

- ❑ <https://thingspeak.com> adresinden üye olduktan sonra veri gönderimi için kanal oluşturulur.

The screenshot shows the ThingSpeak interface with a navigation bar at the top. The 'Channels' tab is selected. Below it, the 'My Channels' section displays two entries:

Name	Created
AnalogDeger	2016-10-18
MesafeSensoru	2016-10-20

Each channel entry includes a row of buttons for 'Private', 'Public', 'Settings', 'API Key', and 'Data Import / Export'.

- ❑ Gömülü sisteme veri gönderimi ve alımı için API Key elde edilir.

Write API Key

Key

Read API Keys

Key

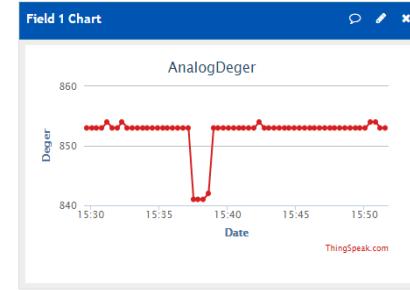
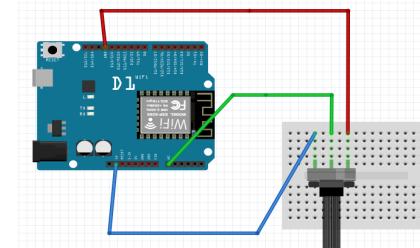


Ardunio + ESP8266 WiFi (WEMOS) ile ThingSpeak Veri Gönderimi

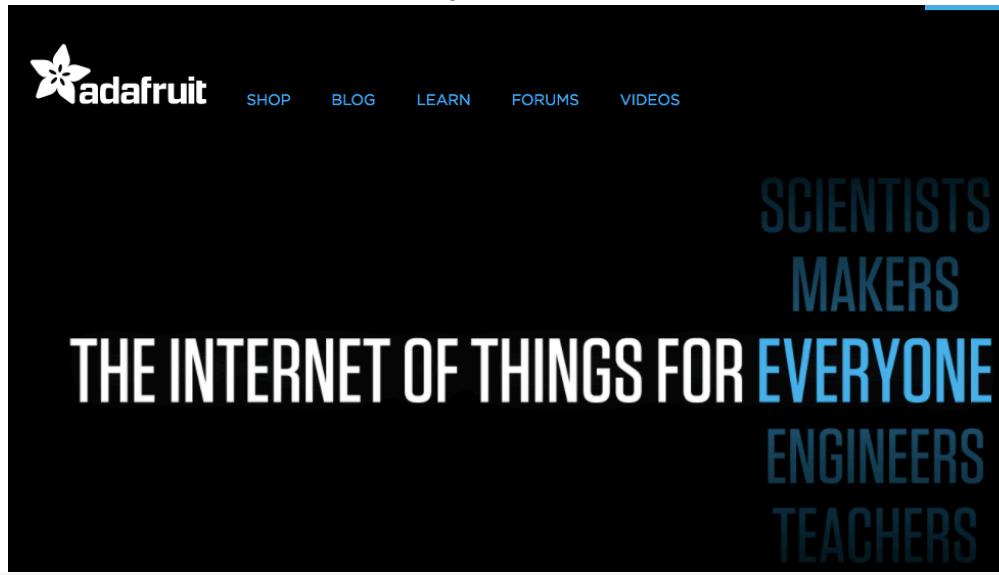
```
#include <ESP8266WiFi.h>
String apiKey = "YUY42ACR5VYF92UB";
const char* ssid = "TurkTelekom_TDDFA";
const char* password = "GdXm2avm";
const char* server = "api.thingspeak.com";
int deger=0;
WiFiClient client;
void setup()
{
Serial.begin(115200);
delay(10);
WiFi.begin(ssid, password);

Serial.println();
Serial.println();
Serial.print("Connecting to ");
Serial.println(ssid);
WiFi.begin(ssid, password);
while (WiFi.status() != WL_CONNECTED)
{
delay(500);
Serial.print(".");
}
Serial.println("");
Serial.println("WiFi connected");
}
```

```
void loop()
{
deger = analogRead(A0);
Serial.println(deger);
if (client.connect(server,80)) {
String postStr = apiKey;
postStr += "&field1=";
postStr += String(deger);
postStr += "\r\n\r\n";
client.print("POST /update HTTP/1.1\n");
client.print("Host: api.thingspeak.com\n");
client.print("Connection: close\n");
client.print("X-THINGSPEAKAPIKEY: "+apiKey+"\n");
client.print("Content-Type: application/x-www-form-urlencoded\n");
client.print("Content-Length: ");
client.print(postStr.length());
client.print("\n\n");
client.print(postStr);
Serial.print("deger: ");
Serial.print(deger);
Serial.println("Sending data to Thingspeak");
client.print("\n\n");
}
client.stop();
Serial.println("Waiting 20 secs");
delay(20000);
}
```



- ❑ <https://io.adafruit.com>
- ❑ Kolay kullanım ve en az programlama ihtiyacı ile veri bağlantılarını sağlamayı amaçlamaktadır.
- ❑ REST ve MQTT API desteği vardır.
- ❑ Ücretsiz olarak kullanılabilmektedir.
- ❑ Kullanıcıya Dashboard oluşturmaya imkan verir.



IoT Bulut Platformları

adafruit

Your Dashboards

NAME	DESCRIPTION	VISIBILITY	ACTIONS
Akıllı Ev		Private	
Ev Otomasyonu		Public	
Welcome Dashboard	Your first dashboard.	Private	

[CREATE DASHBOARD](#)

CREATE A NEW DASHBOARD

DASHBOARD NAME

[CANCEL](#) [CREATE DASHBOARD](#)

CREATE A NEW BLOCK



A toggle button is useful if you have an ON or OFF type of state. You can configure what values are sent.

[CREATE](#)



A momentary button works similarly to a hardware push button.

[CREATE](#)



The slider works well if you have a range of values you need to send.

[CREATE](#)



A gauge is a read only block type that shows a fixed range of values.

[CREATE](#)



A text block can be used to send data as well as view data.

[CREATE](#)



A stream block can be used to view the rolling history of data for multiple feeds.

[CREATE](#)

io.adafruit.com/UyeAdi/DashboardAdi

<https://io.adafruit.com/ick1994/akilli-ev>

STEP 2: CHOOSE FEEDS

Add up to 1 feed

SEARCH

NEW FEED NAME

[CREATE](#)

FEED/GROUP

LAST VALUE

RECORDED

ACTION

ick1994

FEED/GROUP	LAST VALUE	RECORDED	ACTION
Alarm Sistemi	ON	5 days ago	CHOOSE
photocell	145	17 days ago	CHOOSE
alarmdurum	Ev Guvenli Durumda!	4 days ago	CHOOSE
alarmdurumu	ON	4 days ago	CHOOSE
redlight	0	17 days ago	CHOOSE
bluelight	0	17 days ago	CHOOSE
greenlight	0	17 days ago	CHOOSE
lambabuton	OFF	5 days ago	CHOOSE
sicaklikdurum	12.38	4 days ago	CHOOSE

[NEXT STEP >](#)



WEMOS ile MQTT Protokolü Kullanarak adafruit Veri Gönderimi

❑ Adafruit bağlantı kodları

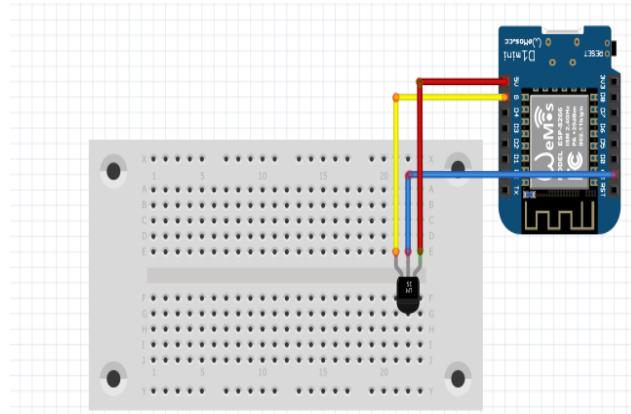
```
#include <ESP8266WiFi.h>
#include "Adafruit_MQTT.h"
#include "Adafruit_MQTT_Client.h"

/***************** WiFi Access Point *****

#define WLAN_SSID      "AndroidAP1"
#define WLAN_PASS      "sahin162"

***** Adafruit.io Setup *****

#define AIO_SERVER      "io.adafruit.com"
#define AIO_SERVERPORT  1883
#define AIO_USERNAME    "ick1994"
#define AIO_KEY         "4986d110c4cd4024ab8131e160ebc998"
```



❑ Adafruit MQTT fonksiyonları

```
// Create an ESP8266 WiFiClient class to connect to the MQTT server.
WiFiClient client;

Adafruit_MQTT_Client mqtt(&client, AIO_SERVER, AIO_SERVERPORT, AIO_USERNAME, AIO_KEY);
```

❑ Adafruit Feedleri

```
***** Feeds *****

// Notice MQTT paths for AIO follow the form: <username>/feeds/<feedname>
Adafruit_MQTT_Publish alarmdurum = Adafruit_MQTT_Publish(&mqtt, AIO_USERNAME "/feeds/alarmdurum");
Adafruit_MQTT_Publish sicaklikdurum = Adafruit_MQTT_Publish(&mqtt, AIO_USERNAME "/feeds/sicaklikdurum");
// Setup a feed called 'onoff' for subscribing to changes.
Adafruit_MQTT_Subscribe onoffbutton = Adafruit_MQTT_Subscribe(&mqtt, AIO_USERNAME "/feeds/alarm-sistemi");
Adafruit_MQTT_Subscribe lambadurum = Adafruit_MQTT_Subscribe(&mqtt, AIO_USERNAME "/feeds/lambabuton");
Adafruit_MQTT_Subscribe kapidurum = Adafruit_MQTT_Subscribe(&mqtt, AIO_USERNAME "/feeds/alarmdurumu");
```

WEMOS ile MQTT Protokolü Kullanarak adafruit Veri Gönderimi

MQTT Bağlantı Fonksiyonu

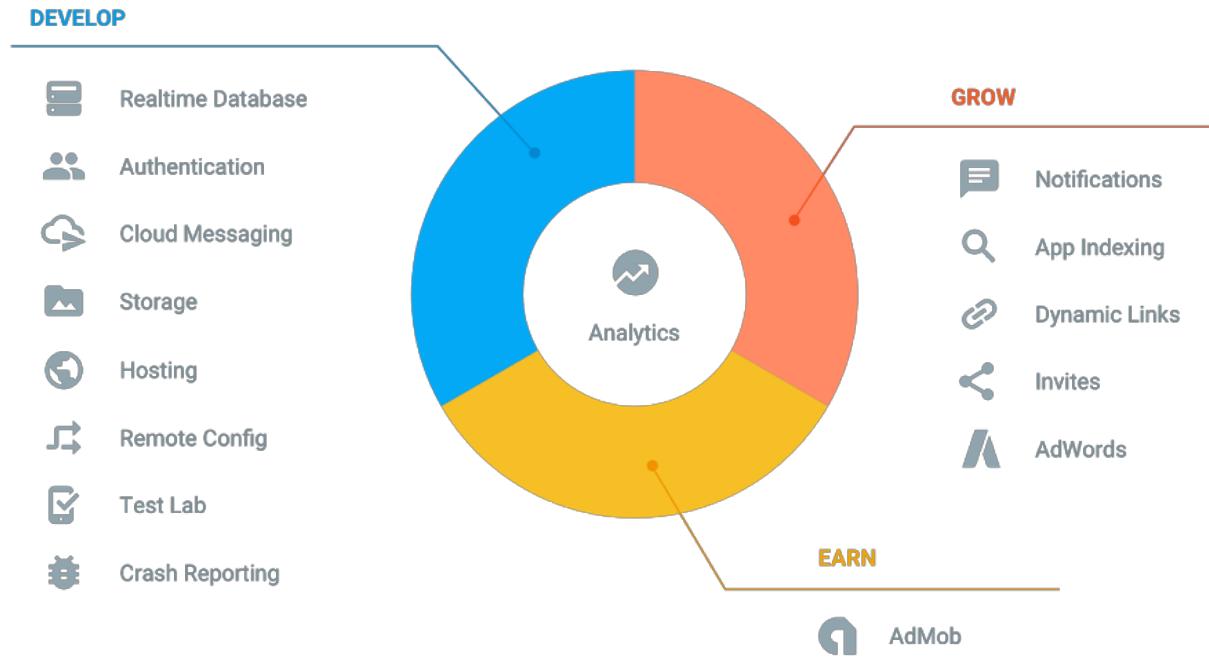
```
void MQTT_connect() {  
    int8_t ret;  
  
    // Stop if already connected.  
    if (mqtt.connected()) {  
        return;  
    }  
  
    Serial.print("Connecting to MQTT... ");  
  
    uint8_t retries = 3;  
    while ((ret = mqtt.connect()) != 0) { // connect will return 0 for connected  
        Serial.println(mqtt.connectErrorString(ret));  
        Serial.println("Retrying MQTT connection in 5 seconds...");  
        mqtt.disconnect();  
        delay(5000); // wait 5 seconds  
        retries--;  
        if (retries == 0) {  
            // basically die and wait for WDT to reset me  
            while (1);  
        }  
    }  
    Serial.println("MQTT Connected!");  
}
```

```
void setup() {  
    Serial.begin(115200);  
    delay(10);  
    // Connect to WiFi access point.  
    Serial.println(); Serial.println();  
    Serial.print("Connecting to ");  
    Serial.println(WLAN_SSID);  
    WiFi.begin(WLAN_SSID, WLAN_PASS);  
    while (WiFi.status() != WL_CONNECTED) {  
        delay(500);  
        Serial.print(".");  
    }  
    Serial.println();  
    Serial.println("WiFi connected");  
    Serial.println("IP address: ");  
    Serial.println(WiFi.localIP());  
}  
void loop() {  
    MQTT_connect();  
    olculendeger = analogRead(sicaklikSensor); //A0'den değeri alacak  
    olculendeger = (olculendeger/1024)*5000; //değeri mV'a dönüştürecek  
    sicaklik = olculendeger /12,0; // mV'u sıcaklığı dönüştürecek  
    sicaklik=sicaklik-10;  
    Serial.print(F("\nSending sıcaklık val "));  
    Serial.print(sicaklik);  
    Serial.print("...");  
    sicaklikdurum.publish(sicaklik);  
}
```





- ❑ <https://firebase.google.com/>
- ❑ Google'ın gerçek zamanlı veri depolama özelliği olan bulut tabanlı platformudur.
- ❑ Kullanım verilerinin analizi, bildirim gönderme, uygulama testi gibi işlemlerin yerine getirebilecek kontrol/yönetim paneli sunar.





- ❑ NoSQL veritabanı kullanarak kullanıcılarla cihazlar arasında verileri gerçek zamanlı olarak saklayan ve senkronize eder. JSON veri formatını kullanır.
- ❑ Güncellenmiş veri, bağlı cihazlar arasında milisaniyeler içinde senkronize edilir ve uygulamamız çevrimdışı durumdaysa veriler saklanır ve ağ bağlantısı olduğunda senkronize edilir.

The screenshot shows the Firebase Project Overview page for a project named 'akiz-sau'. The 'Project Settings' section is highlighted with a red circle, and the 'Project ID' field, which contains 'akiz-sau.firebaseio.com', is also highlighted with a red circle. The 'Project Settings' section includes fields for 'Project name', 'Public name', 'Project ID', and 'Web API key'. Below this, the 'Your Apps' section displays three app icons: 'Akiz-SAU' (Android), 'Akiz-SAU' (iOS), and 'Akiz-SAU' (Web).



- ❑ Arduino temelli uygulamalar için <https://github.com/firebase/firebase-arduino/> adresindeki başlık dosyası kullanılabilir.
- ❑ Firebase Bağlantı kurmak için **HOST** adresi ve **AUTH** gizli anahtar eklenir.

```
String HOST = "ornek.firebaseio.com";  
String AUTH = "anahtarkodu";  
Firebase.begin(HOST, AUTH);
```

- ❑ Değer yazma “ornek.firebaseio.com/” adresinin altında sayı json verisi oluşturulur.

```
Firebase.setFloat ("sayı", 42.0);
```

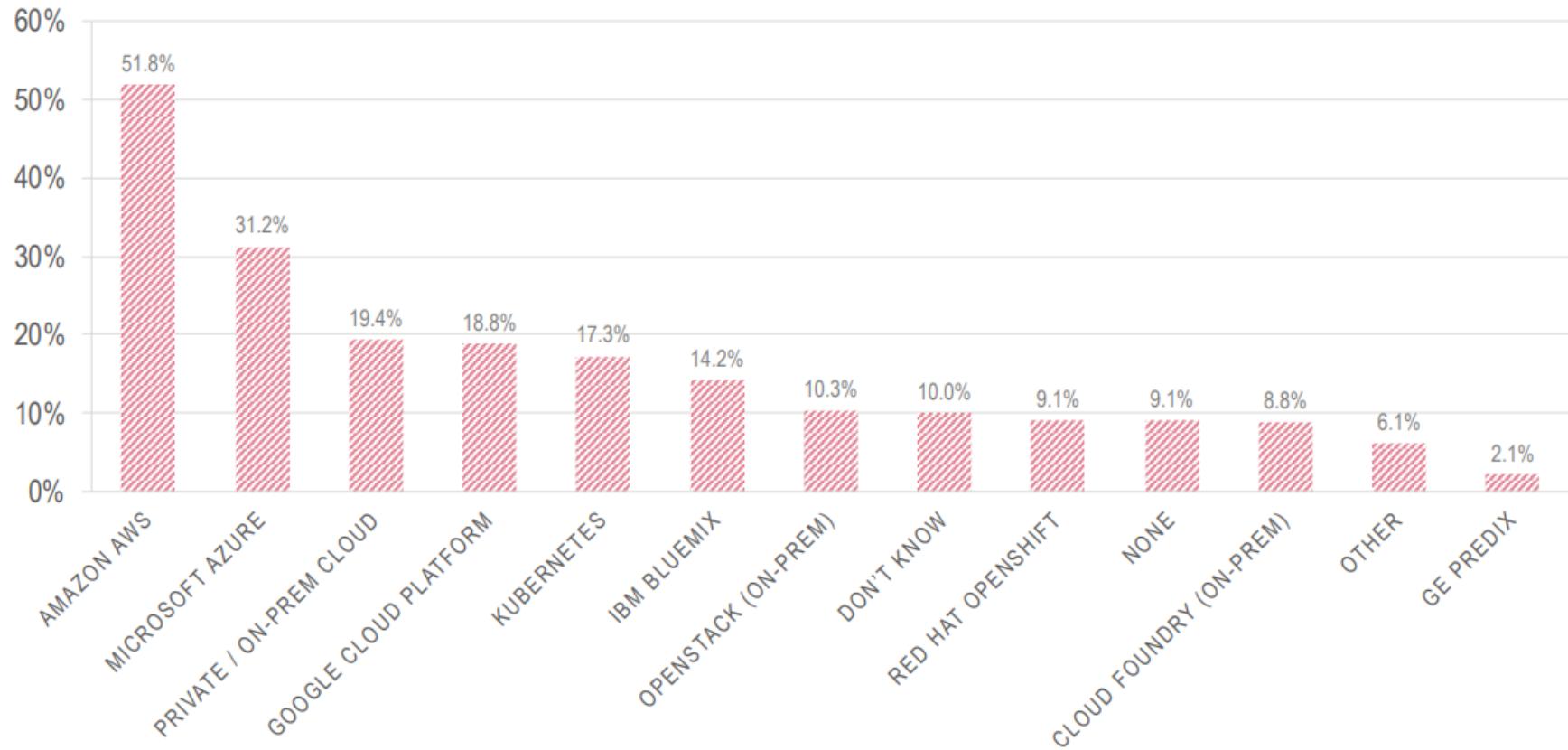
- ❑ Değer okuma “ornek.firebaseio.com/sayı” adresinin altında json verisi okuyoruz.

```
sayı = Firebase.getFloat("sayı");
```

IoT Uygulamaları İçin Bulut Servisler

CLOUD SERVICES FOR IoT

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

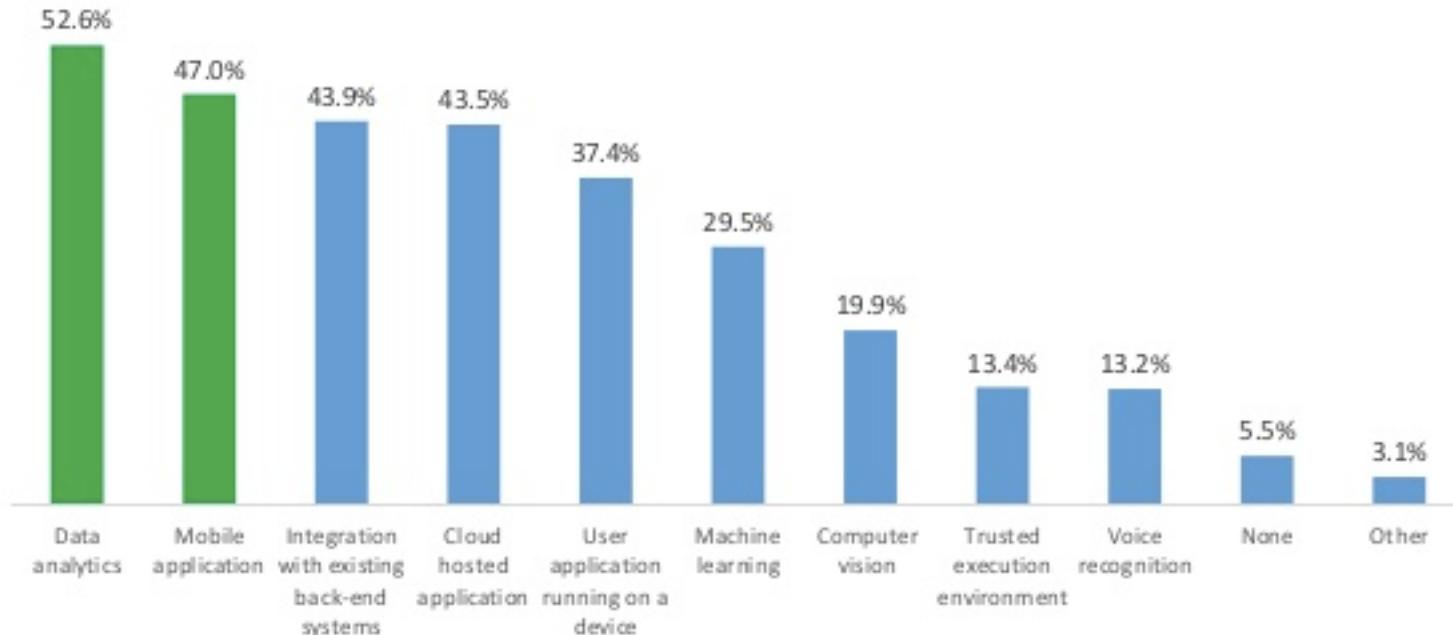


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SOFTWARE FEATURES IN IoT SOLUTIONS

What software features are included in your IoT solution?



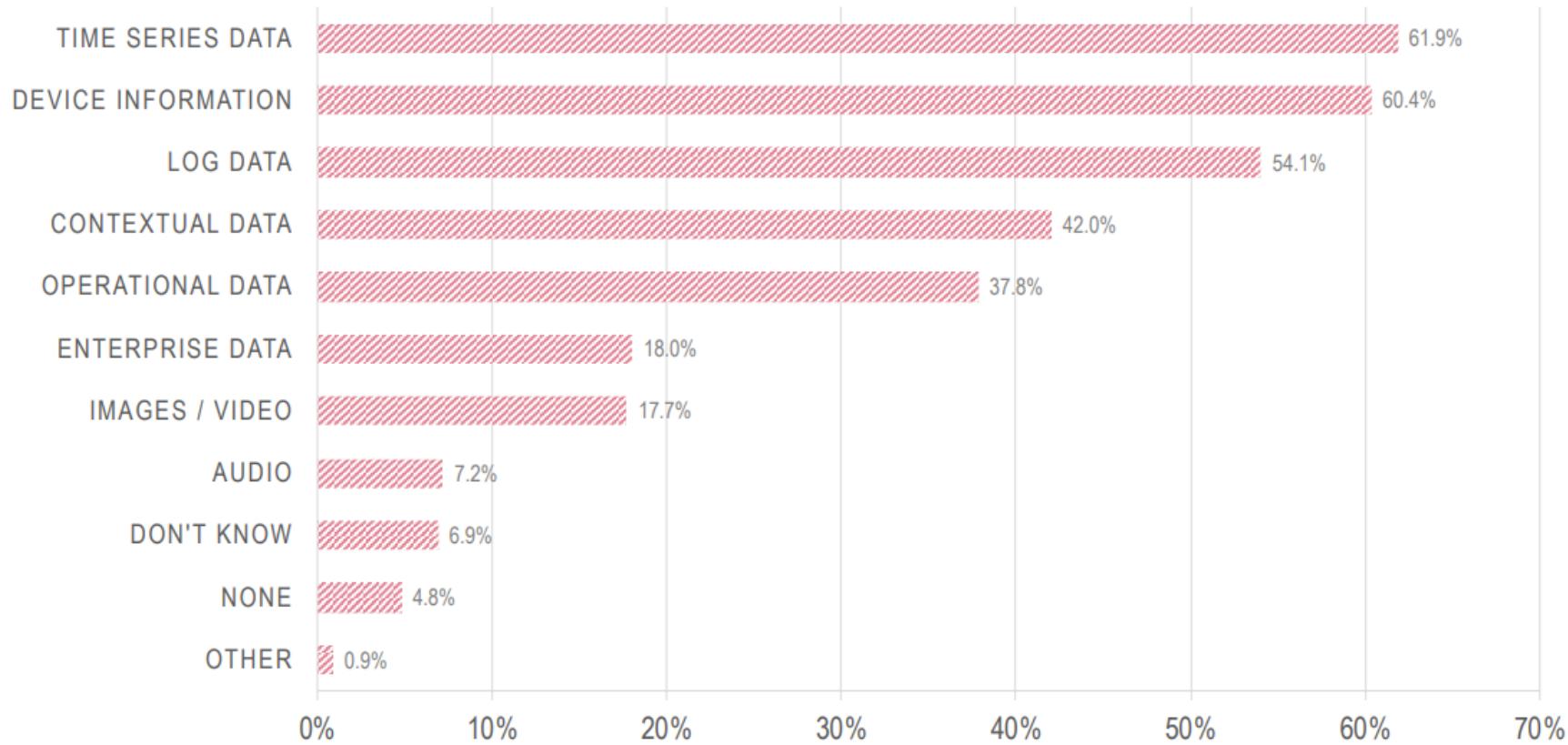
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IoT Uygulamalarında Veri Türleri

IoT DATA

What type of IoT data are you storing in a database or data store?



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KAYNAKLAR

❖ Temel Kaynaklar

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❖ Diğer Kaynaklar

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