

Developing IoT solutions with Windows 10 and Raspberry Pi

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Tech Evangelist

Session Objectives And Takeaways

1. Understand how IoT solutions work and how the Microsoft platform is central to IoT development.
2. Get an overview of the IoT landscape and what offerings are available to makers in the marketplace right. Also: Understand how the different IoT components all work with Microsoft's platform (largely, Azure).
3. Know the tools needed for IoT development and know where to start to build my own IoT solutions.

Agenda

Brief Introduction to IoT

1. IoT on Windows 10
2. Devices in the Maker Space
3. Services for IoT in Microsoft Azure

Demo: Windows Watering System
on Arduino UNO and Arduino YÚN
on Raspberry Pi 2

Conclusion

What is IoT?

"At its core, IoT is simple: it's about connecting devices over the internet, letting them talk to us, applications, and each other."

The Guardian

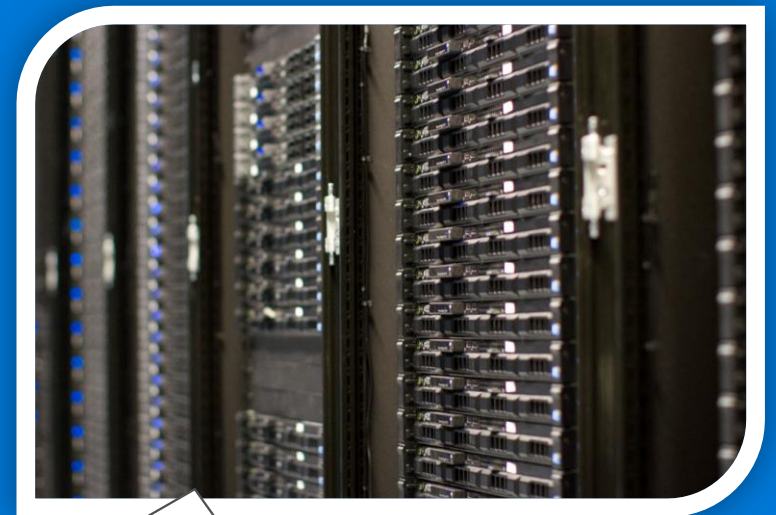
Brief Introduction to IoT

Windows 10 IoT Core



Universal Windows Platform (UWP)

```
settings[0].compareTo("") != 0) {  
    if (name.compareTo("") != 0) {  
        name += " ";  
    }  
    name += etr.getString(settings[i]);  
    else if (settings[0].compareTo("d") == 0) {  
        if (name.compareTo("") != 0) {  
            name += " ";  
        }  
        name += DateUtils.format(etr.getDate(settings[i]));  
    } else if (settings[0].compareTo("n") == 0) {  
        if (name.compareTo("") != 0) {  
            name += " ";  
        }  
        name += etr.getDouble(settings[i]);  
    }  
    comSysNumber = etr.getDouble(settings[i]);  
    f = NumberFormat.getInstance().format(comSysNumber);  
    return f;  
}
```



Microsoft Azure

IoT – Why Now?

Devices are getting cheaper and more plentiful

Developing applications for embedded systems does not require a PhD in electrical engineering any longer

Cloud computing is becoming more accessible

Microsoft supports all three trends

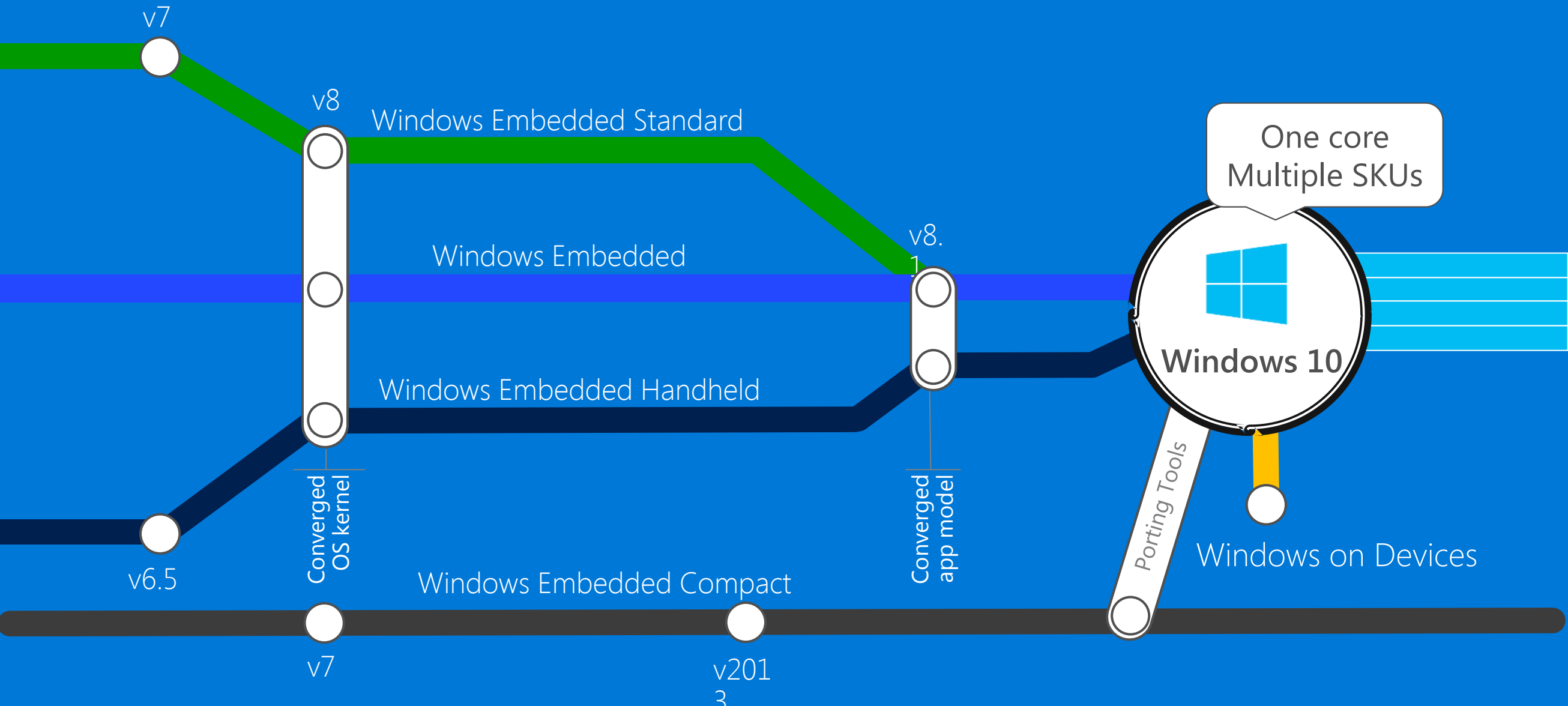
IoT on Windows 10

"Windows 10 represents the culmination of our platform convergence journey with Windows now running on a single, unified Windows core."

Kevin Gallo
Dir., Windows Dev Platform

A converged core means we
can leverage our Windows
dev skills for IoT solutions

IoT Platform Convergence



Windows 10 and the IoT SKUs

- Windows 10 comes with three IoT SKUs
 - Windows 10 IoT Core
 - Windows 10 IoT for mobile devices
 - Windows 10 IoT for industry devices
- Windows 10 IoT Core is available for preview on windowsondevices.com – when released, it'll be free
- IoT Core currently supports Raspberry Pi 2 and MinnowBoard Max
- Available for preview to the general public

Windows 10 IoT Editions

Windows 10 IoT for industry devices

Desktop Shell, Win32 apps, Universal apps and drivers

Minimum: 1 GB RAM, 16 GB storage

X86/x64

Windows 10 IoT for mobile devices

Modern Shell, Mobile apps, Universal apps and drivers

Minimum: 512 MB RAM, 4 GB storage

ARM

Windows 10 IoT Core

Universal Apps and Drivers

No shell or MS apps

Minimum: 256MB RAM, 2GB storage

X86/x64 or ARM



Windows
Updates



Visual Studio &
UWP



New User
Interfaces



Security &
Identity



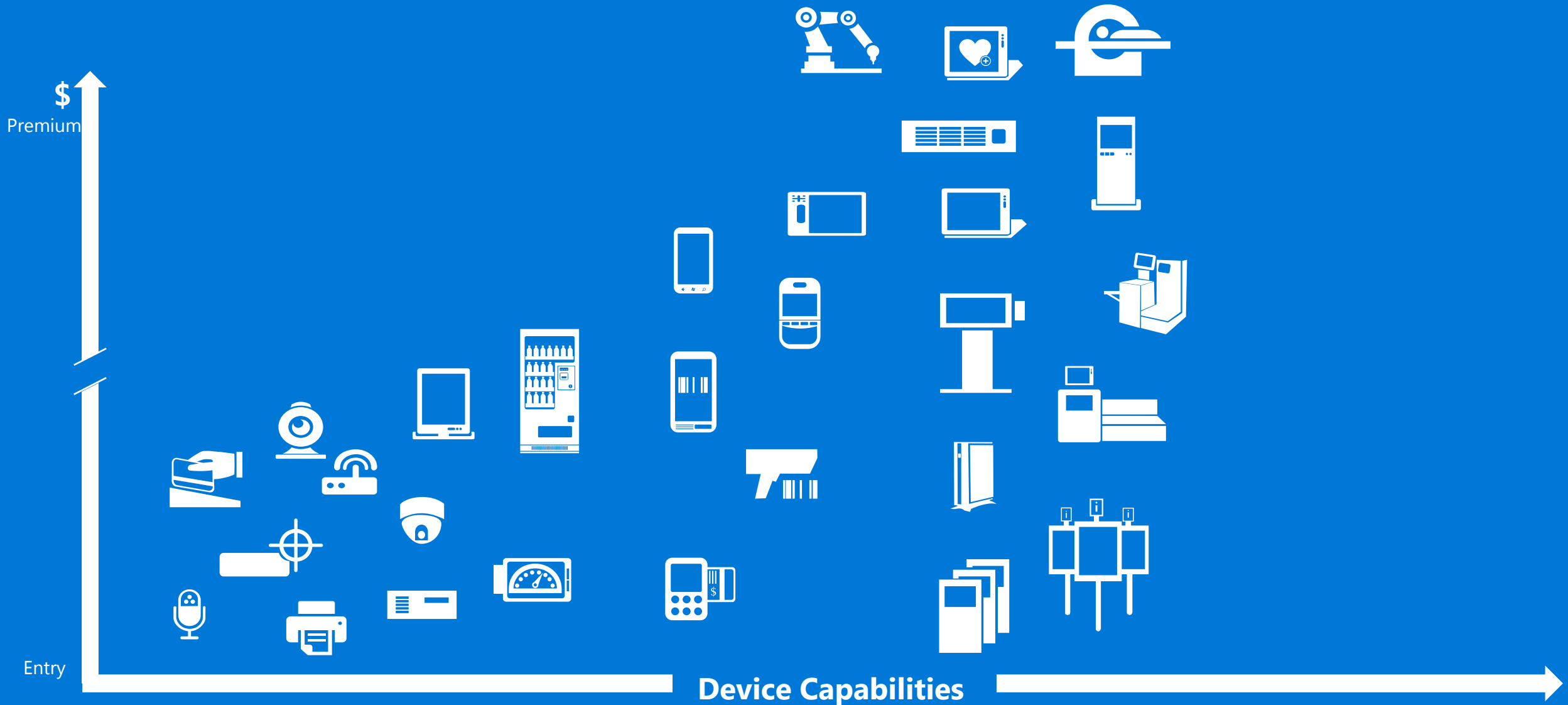
AllJoyn

Integrated
Device
Connectivity



Microsoft
Azure IoT

Windows for Industry Devices



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Windows for Industry Devices

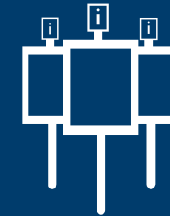
Windows 10 IoT for industry devices

Desktop Shell, Win32 apps, Universal Windows Apps and Drivers
1 GB RAM, 16 GB Storage
X86



Windows 10 IoT for mobile devices

Modern Shell, Universal Windows Apps and Drivers
512 MB RAM, 4 GB storage
ARM



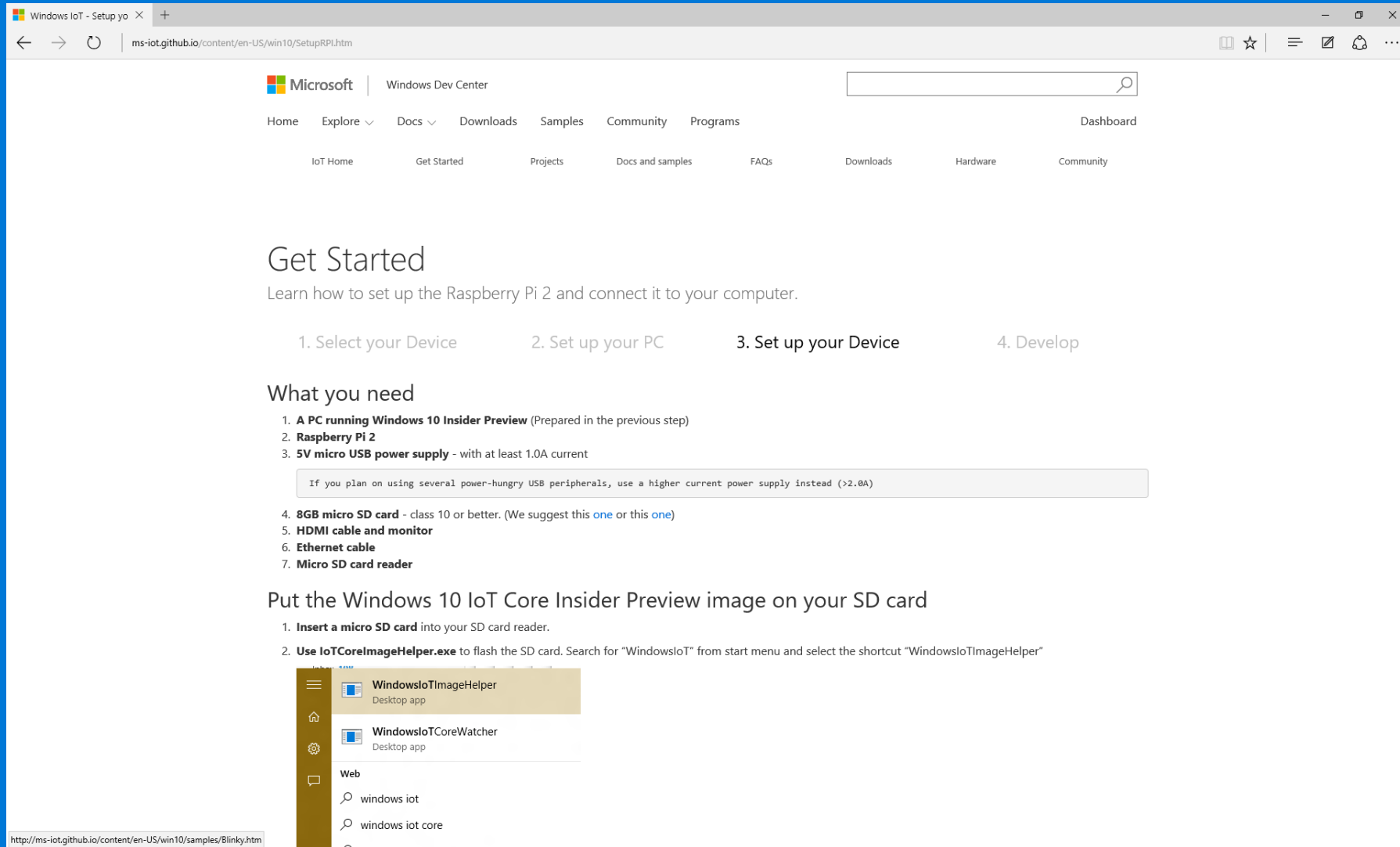
Windows 10 IoT Core

No Shell, Universal Windows Apps and Drivers
256MB RAM, 2GB storage
X86 or ARM

Device Capabilities

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Installing Windows 10 IoT Core



The screenshot shows the 'Windows IoT - Setup' page in a web browser. The page is titled 'Get Started' and provides instructions for setting up a Raspberry Pi 2. It includes a navigation menu with links like 'Home', 'Explore', 'Docs', 'Downloads', 'Samples', 'Community', and 'Programs'. The main content area lists the steps for getting started and the hardware requirements for the setup.

Get Started
Learn how to set up the Raspberry Pi 2 and connect it to your computer.

1. Select your Device
2. Set up your PC
3. Set up your Device
4. Develop

What you need

1. **A PC running Windows 10 Insider Preview** (Prepared in the previous step)
2. **Raspberry Pi 2**
3. **5V micro USB power supply** - with at least 1.0A current

If you plan on using several power-hungry USB peripherals, use a higher current power supply instead (>2.0A)

4. **8GB micro SD card** - class 10 or better. (We suggest this [one](#) or this [one](#))
5. **HDMI cable and monitor**
6. **Ethernet cable**
7. **Micro SD card reader**

Put the Windows 10 IoT Core Insider Preview image on your SD card

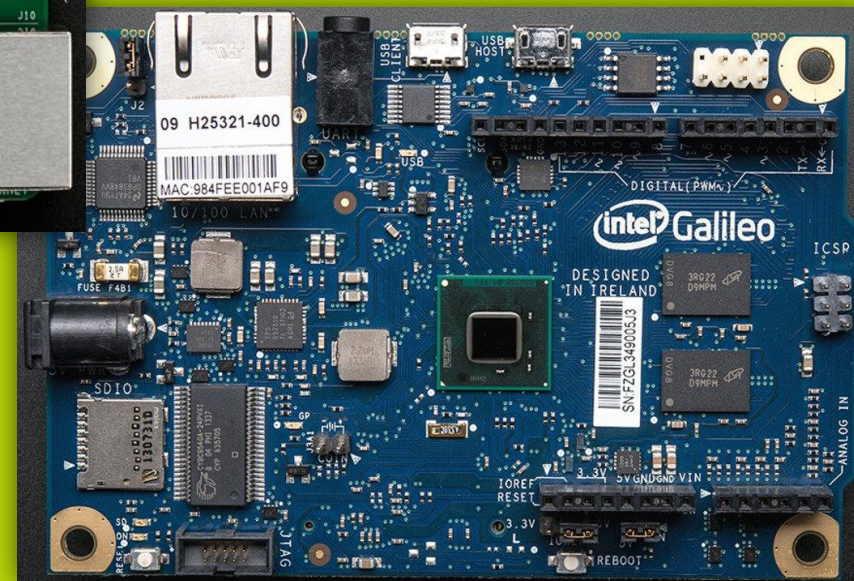
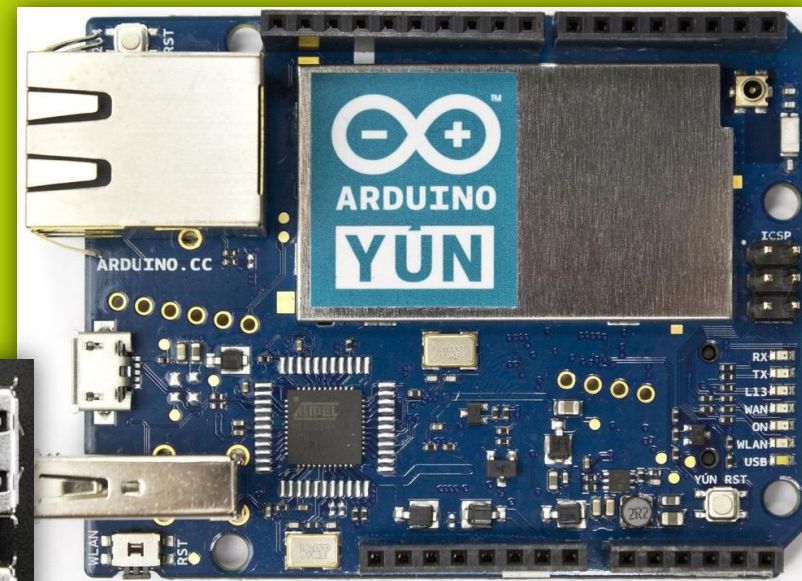
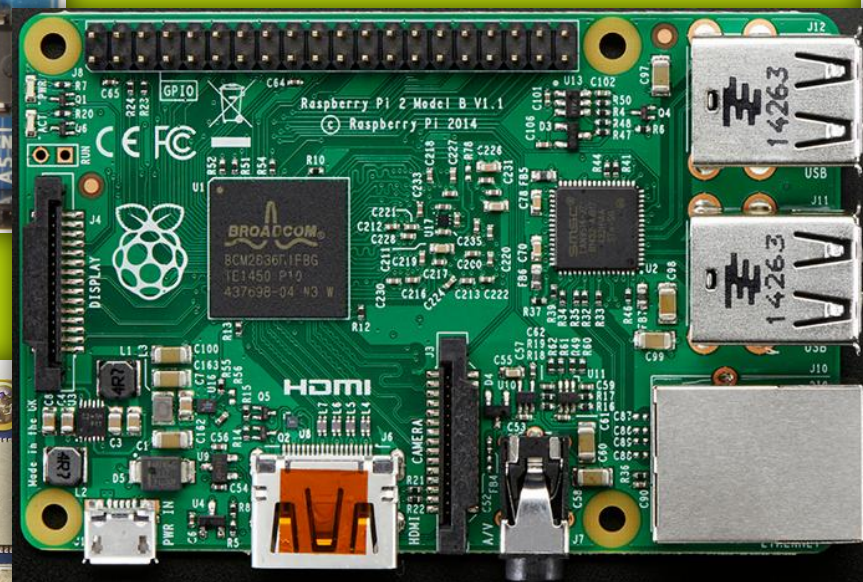
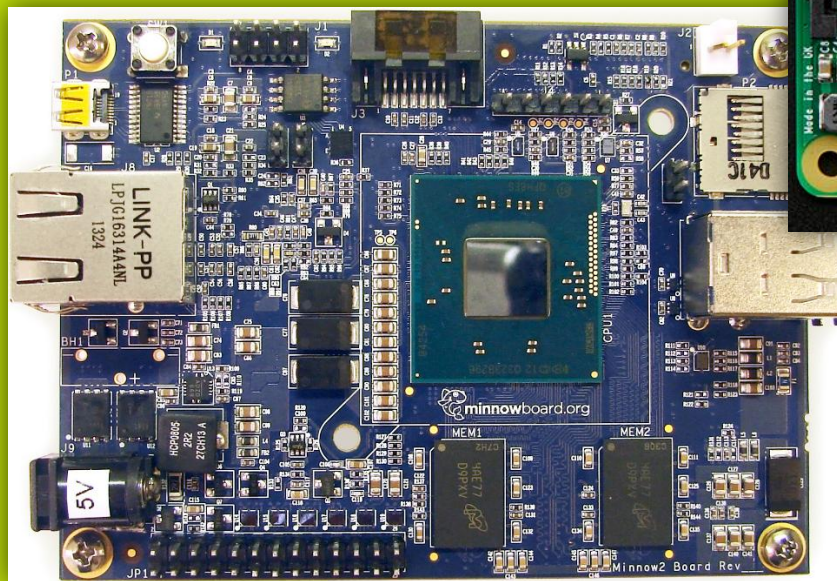
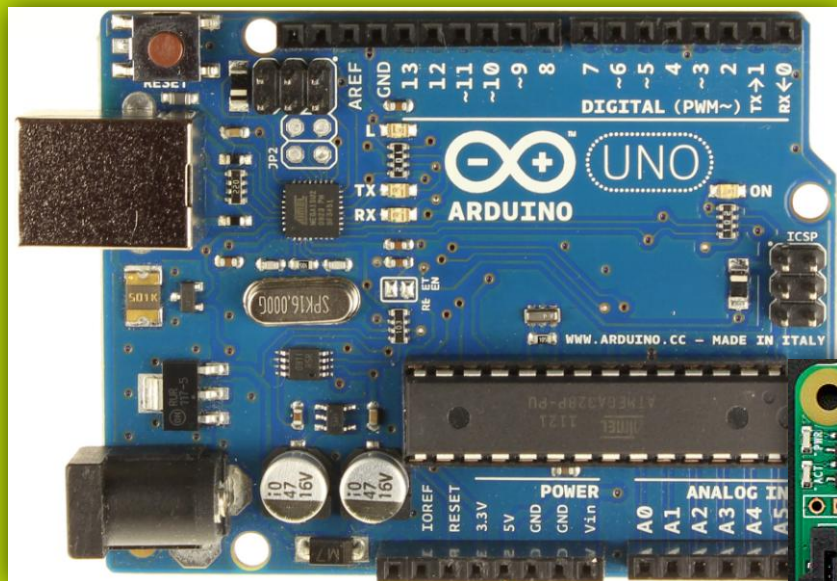
1. **Insert a micro SD card** into your SD card reader.
2. **Use IoTCoreImageHelper.exe** to flash the SD card. Search for "WindowsIoT" from start menu and select the shortcut "WindowsIoTImageHelper"

The screenshot also shows a Windows Start menu search for 'WindowsIoT', with results for 'WindowsIoTImageHelper' and 'WindowsIoTCoreWatcher'.

Tool 1: Using Windows 10
and UWP to develop apps
for IoT devices

Devices in the Maker Space

How many in here are
makers?



...and many more!

Arduino UNO

Processor: ATmega328P

Speed: 16 MHz (8-bit AVR)

Storage: 32 KB

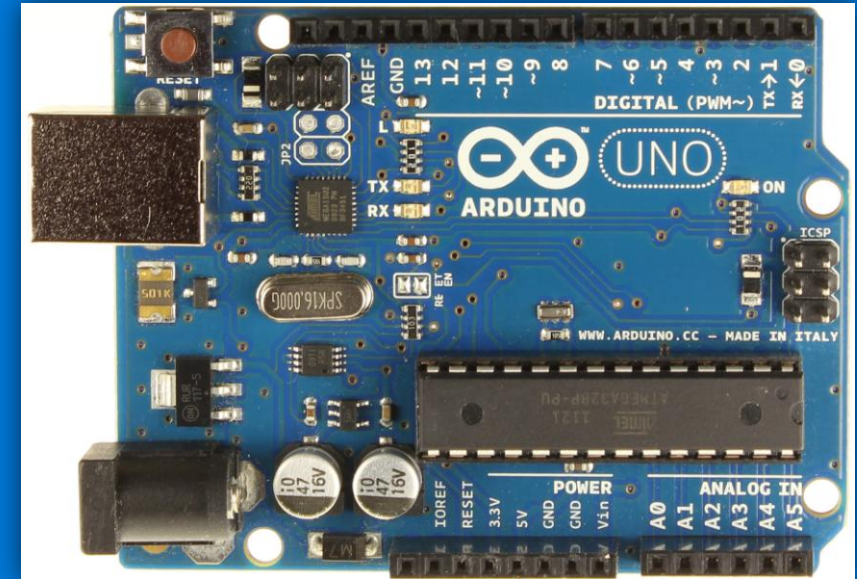
Memory: 2 KB

OS: Wiring

Voltage: 5V DC

GPIO: 20 (14 digital, 6 with PWM, 6 analog input pins)

Release Date: September 24, 2010 (approx. \$25)



Arduino YÚN

Processor: Atmega32U4 and Atheros AR9331

Speed: 16 MHz / 400 MHz

Storage: 32 KB / 64 MB

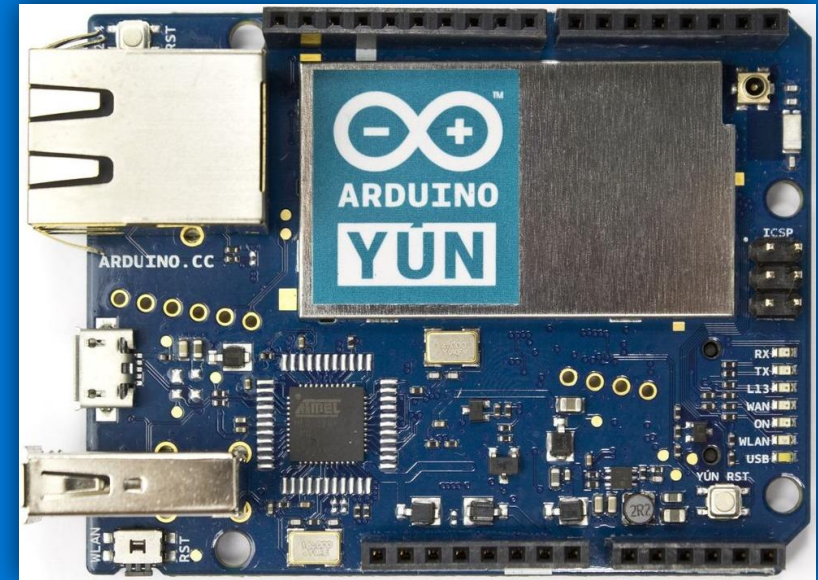
Memory: 2 KB / 16 MB

OS: Wiring / Linino

Voltage: 5V DC

GPIO: 20 (14 digital, 6 with PWM, 12 analog input pins)

Release Date: September 10, 2013 (approx. \$75)



MinnowBoard MAX

Processor: 64-bit Intel® Atom™ E38xx Series SoC

Speed: 1.33-1.75 GHz (Dual Core)

Storage: SD Card

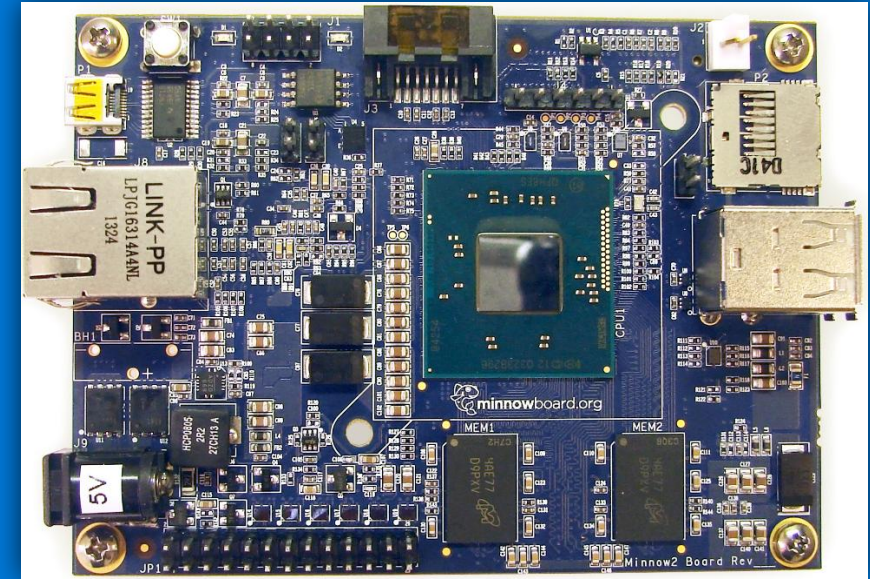
Memory: 1 GB (\$99) or 2 GB (\$139)

OS: Windows 10 and others

Voltage: 5V DC

GPIO: 8 (2 with PWM) + SATA2, 2*USB, SPI, I2C, more

Release Date: June 2014 (\$99-\$139)



Intel Galileo

Processor: Intel Quark X1000

Speed: 400 MHz

Storage: SD Card

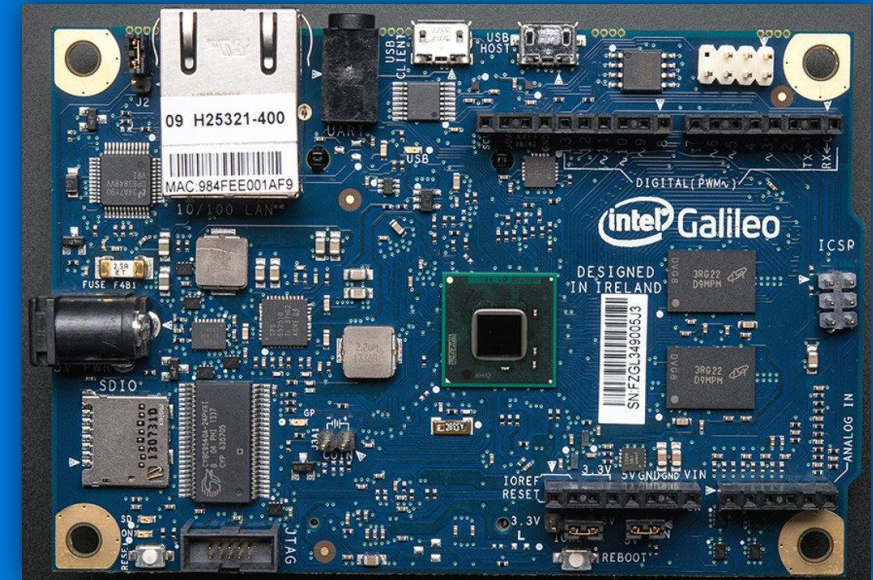
Memory: 256 MB

OS: Windows 8.1 and others

Voltage: 5V DC

GPIO: 20 (14 digital, 6 with PWM, 6 analog input pins)

Release Date: October 17, 2013 (approx. \$70)



Raspberry Pi 2

Processor: Broadcom BCM2836

Speed: 900 MHz quad-core ARM Cortex-A7

Storage: SD Card

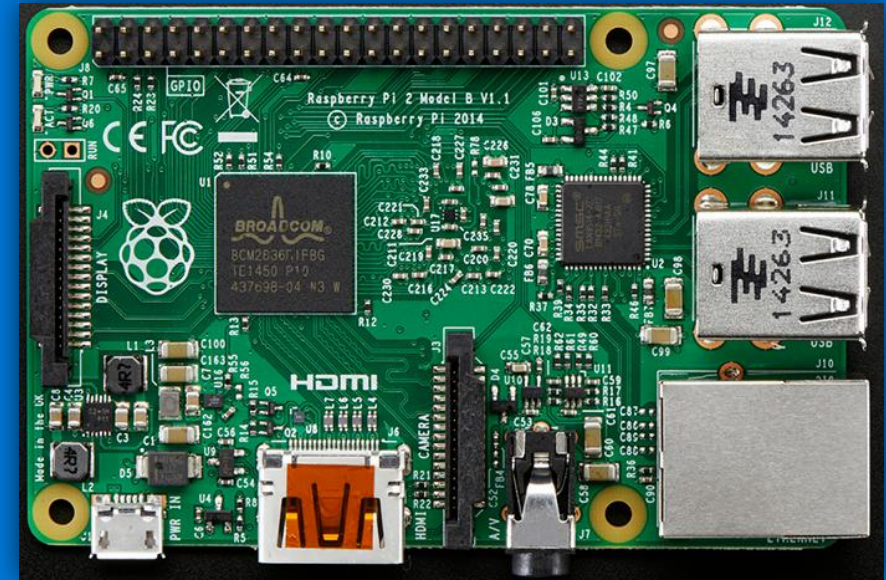
Memory: 1 GB

OS: Windows 10 and others

Voltage: 5V DC

GPIO: 17 (only digital)

Release Date: February 2015 (\$35)



So far the Raspberry Pi 2
appears to be the most
interesting of the bunch

Today I brought...

















- Arduino UNO
- Arduino YÚN
- Intel Galileo (running Windows 8.1)
- Raspberry Pi 1 (running Raspbian)
- Raspberry Pi 2 (running Windows 10)

- MinnowBoard MAX is in the WoD program but I do not own one (donations are welcome)

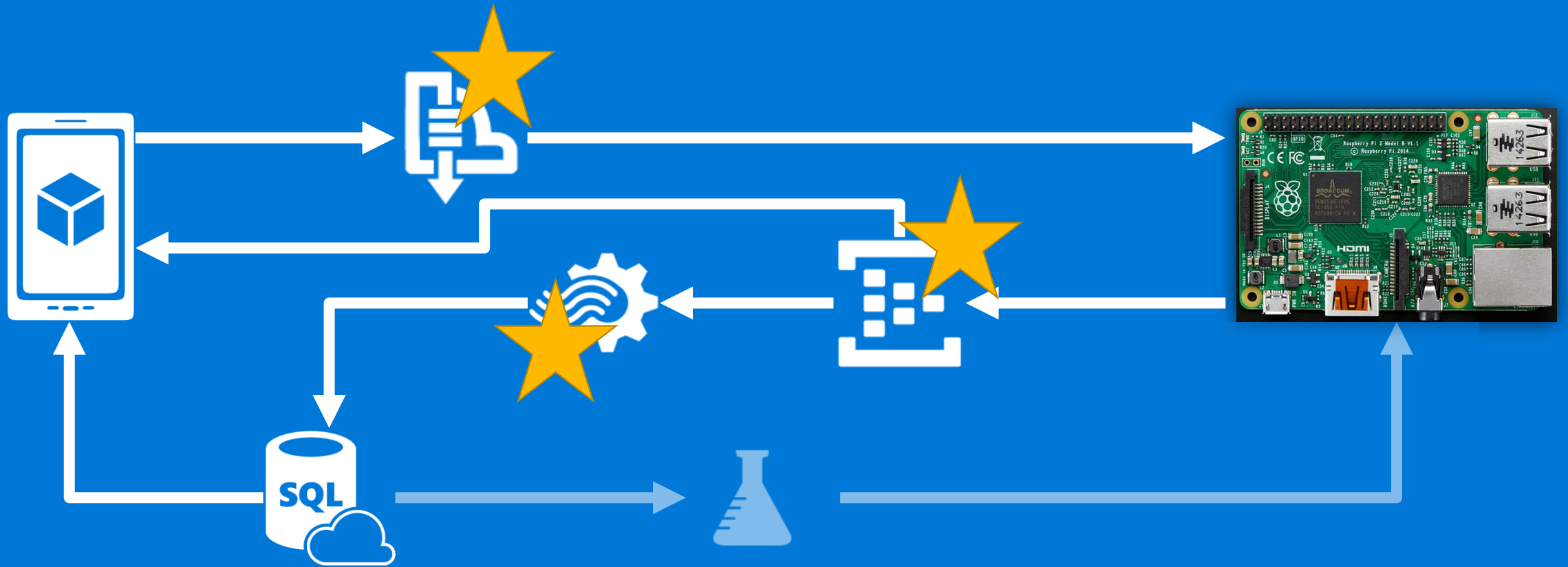
Tool 2: Using maker boards
supported by Windows 10
to run UWP apps

IoT Services in Azure

IoT Services in Microsoft Azure, July 2015

Device Connectivity	Storage	Analytics	Presentation & Action
 Event Hubs	 SQL Database	 Machine Learning	 App Service
 Service Bus	 Table/Blob Storage	 Stream Analytics	 Power BI
 External Data Sources	 DocumentDB	 HDInsight	 Notification Hubs
	 External Data Sources	 Data Factory	 Mobile Apps
			 BizTalk Services

Watering System Architecture



Services for Device Connectivity

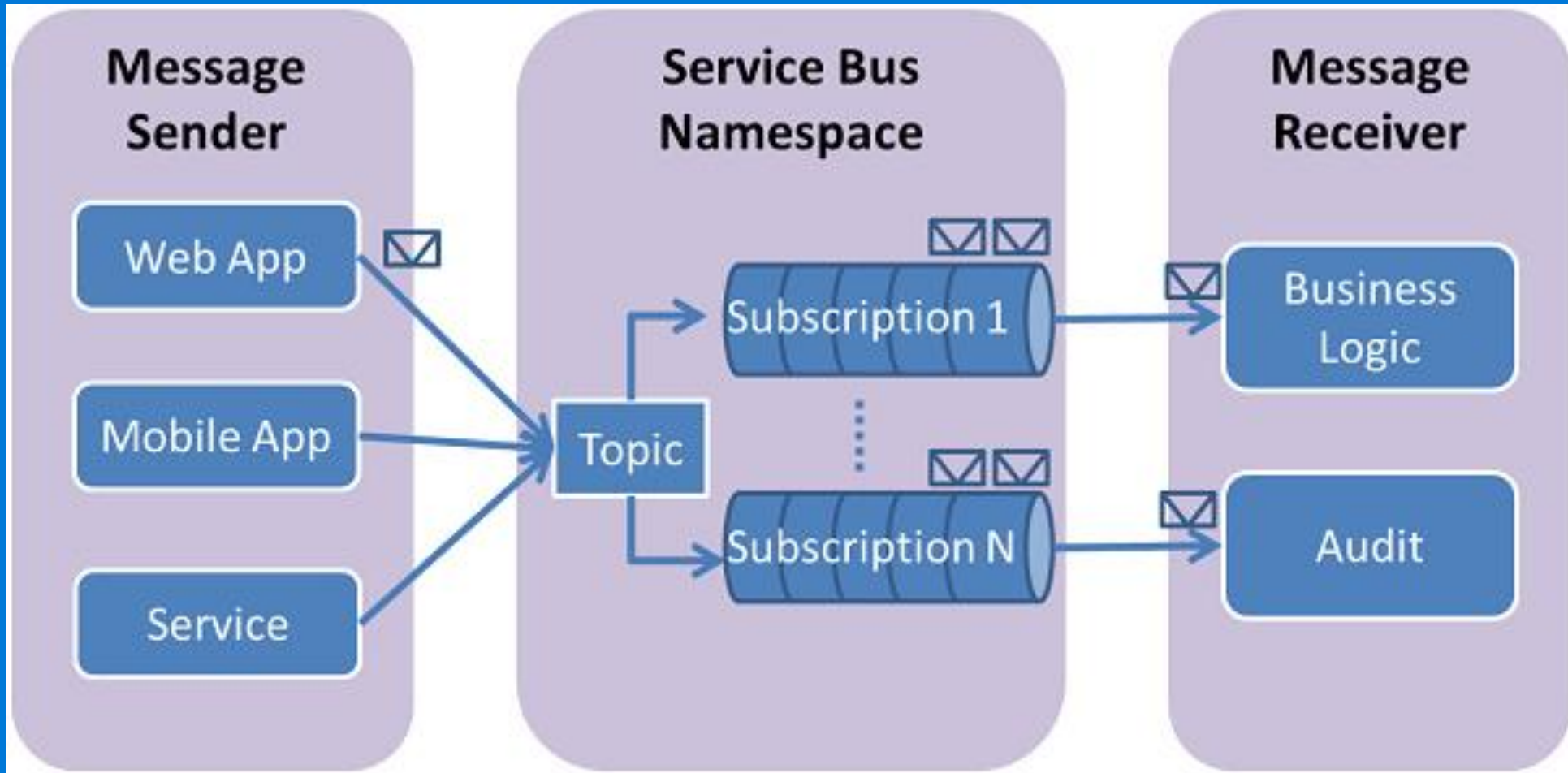
Azure Service Bus Topics

- Sending messages from a mobile client
- Consuming messages via a subscription on the IoT device
- Using the AMQP 1.0 protocol

Azure Event Hubs

- Great for telemetry
- Possible to ingress millions of events per second (>1 GB/s)
- Examples of events include sensor readings (e.g., a humidity sensor)

Azure Service Bus Topics



Azure Service Bus Topics

The screenshot displays the Azure portal interface for configuring a Service Bus Topic. The top navigation bar includes 'Microsoft Azure', 'CREDIT STATUS', 'Subscriptions', and a user profile icon. The left sidebar contains various Azure service icons. The main content area is titled 'wateringcommands' and includes tabs for 'DASHBOARD', 'MONITOR', 'CONFIGURE', and 'SUBSCRIPTIONS'. The 'CONFIGURE' tab is active, showing the 'general' settings section. This section includes fields for 'DEFAULT MESSAGE TIME TO LIVE' (set to 1 minute), 'DUPLICATE DETECTION HISTORY' (set to 10 minutes), a 'PUBLISHING' section with a 'FILTER MESSAGE BEFORE PUBLISHING' checkbox, and a 'TOPIC STATE' dropdown set to 'Enabled'. Below this is the 'shared access policies' section, which contains a table with columns 'NAME' and 'PERMISSIONS'. The table lists three policies: 'ManagePolicy' (permissions: Manage, Send, Listen), 'SendPolicy' (permissions: Send), and 'ListenPolicy' (permissions: Listen). At the bottom of the policies table is a 'NEW POLICY NAME' input field. The 'shared access key generator' section at the very bottom has a 'POLICY NAME' dropdown set to 'ManagePolicy'.

Microsoft Azure

CREDIT STATUS

Subscriptions sbrand@outlook.dk

wateringcommands

DASHBOARD MONITOR CONFIGURE SUBSCRIPTIONS

general

DEFAULT MESSAGE TIME TO LIVE 1 minutes

DUPLICATE DETECTION HISTORY 10 minutes

PUBLISHING ☐ FILTER MESSAGE BEFORE PUBLISHING

TOPIC STATE Enabled

shared access policies

NAME	PERMISSIONS
ManagePolicy	Manage, Send, Listen
SendPolicy	Send
ListenPolicy	Listen
NEW POLICY NAME	

shared access key generator

POLICY NAME ManagePolicy

AMQP 1.0 and HTTPS

- Advanced Message Queuing Protocol 1.0
 - AMQP is an open standard application layer protocol for message-oriented middleware.
 - More advanced than MQTT.
 - In Azure, it can be used for sending and receiving messages.
- HTTPS is supported too
 - HTTPS is supported for sending messages.
 - Some devices might not have client libraries for AMQP and, thus, HTTPS can be used instead to ingress events.
- Client libraries exist for many languages
 - I am using Azure SB Lite, which is an open source project on CodePlex.

Sending to Azure Service Bus Topic

```
public async Task SendToTopicAsync(string topic, string message)
{
    var builder = new ServiceBusConnectionStringBuilder(TOPIC_CONNECTION_STRING);
    builder.TransportType = TransportType.Amqp;

    var factory = MessagingFactory.CreateFromConnectionString(TOPIC_CONNECTION_STRING);

    TopicClient client = factory.CreateTopicClient(topic);

    MemoryStream stream = new MemoryStream(Encoding.UTF8.GetBytes(message));
    BrokeredMessage brokeredMessage = new BrokeredMessage(stream);
    brokeredMessage.Properties["time"] = DateTime.UtcNow;

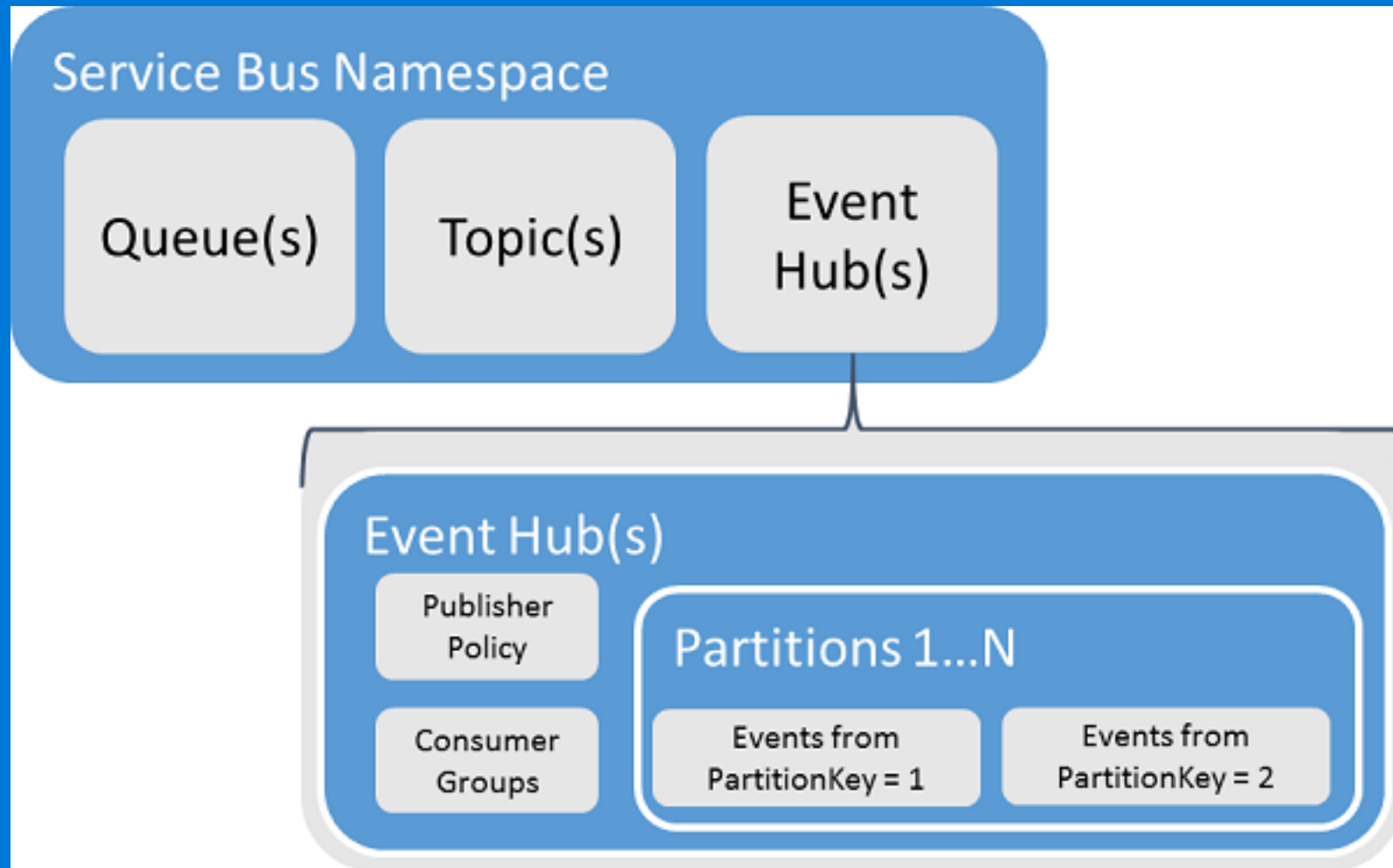
    await Task.Run(() => client.Send(brokeredMessage));

    client.Close();
    factory.Close();
}
```


Receiving from Azure Service Bus Topic

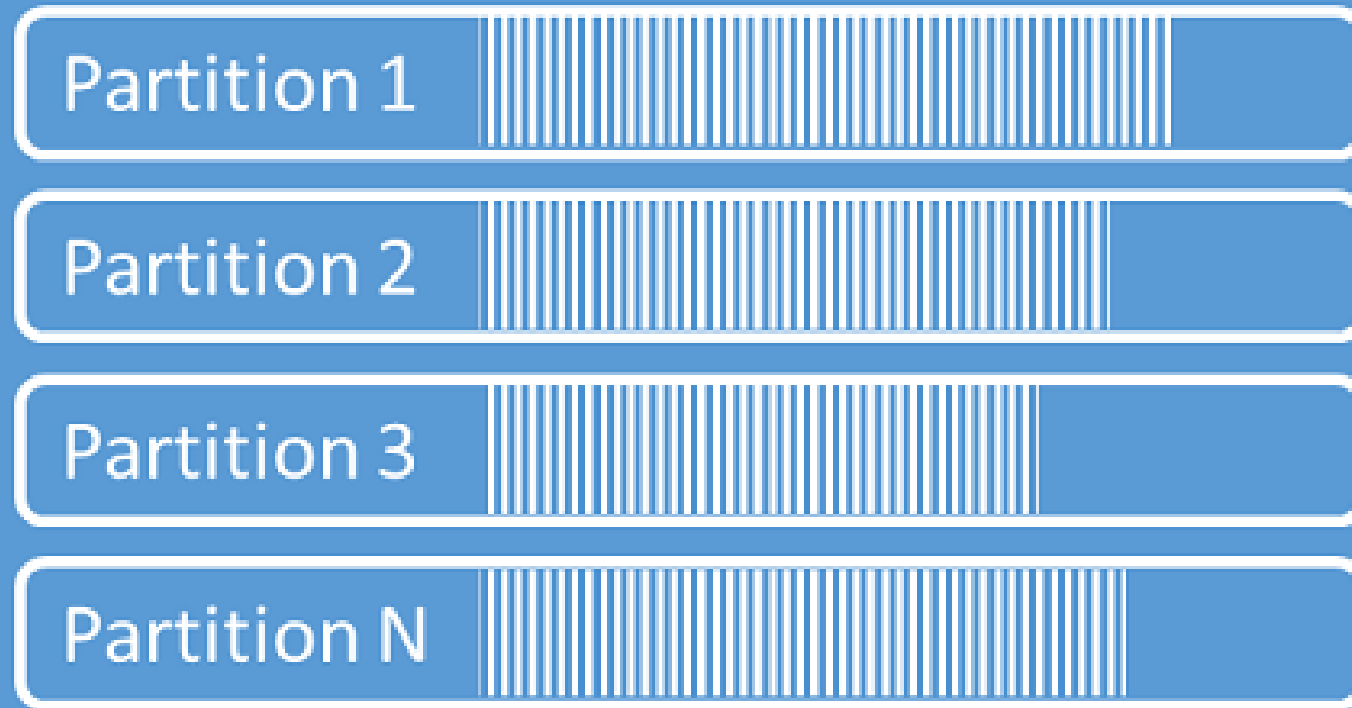
```
public async void ReceiveFromTopicSubscriptionAsync(string topic, string subscription)
{
    var builder = new ServiceBusConnectionStringBuilder(TOPIC_CONNECTION_STRING);
    builder.TransportType = TransportType.Amqp;
    var factory = MessagingFactory.CreateFromConnectionString(TOPIC_CONNECTION_STRING);
    SubscriptionClient client = factory.CreateSubscriptionClient(topic, subscription);
    while (true)
    {
        try
        {
            BrokeredMessage request = await Task.Run(() => client.Receive());
            request.Complete();
            BrokeredMessageReceived(this, new BrokeredMessageReceivedEventArgs(request));
        }
        catch (Exception ex)
        {
            // TODO: Handle bad message from WateringCommands topic
        }
    }
}
```

Azure Event Hubs



Azure Event Hubs

Event Hub



Azure Event Hubs

- Based on a Partitioned Consumer model
 - In contrast to the Competing Consumer model employed by Queues and Topics.
 - The Competing Consumer model results in complexity and scale limits for stream processing applications.
 - Partitioned Consumer model enables for horizontal scaling
- Up to 1,024 partitions in a single hub
 - Default number of partitions is 16.
 - This number cannot be changed after the creation of the hub.
 - Publications to a partition (a single event or a batch) can be max. 256 KB.
- Partitions can be read from an offset
 - Allowing for correct replay of events in a partition.

Sending to Azure Event Hub Partition

```
public async Task SendToPartitionAsync(string message, string partitionId)
{
    var builder = new ServiceBusConnectionStringBuilder(EVENT_HUB_CONN_STRING);
    builder.TransportType = TransportType.Amqp;

    var factory = MessagingFactory.CreateFromConnectionString(EVENT_HUB_CONN_STRING);

    EventHubClient client = factory.CreateEventHubClient(EVENT_HUB_NAME);

    EventHubSender sender = client.CreatePartitionedSender(partitionId);

    EventData data = new EventData(Encoding.UTF8.GetBytes(message));
    data.Properties["time"] = DateTime.UtcNow;

    await Task.Run(() => sender.Send(data));

    sender.Close();
    client.Close();
    factory.Close();
}
```

Receiving from Azure Event Hub Partition

```
public async void ReceiveFromPartitionAsync(string partitionId, string eventHubEntity)
{
    var builder = new ServiceBusConnectionStringBuilder(EVENT_HUB_CONN_STRING);
    builder.TransportType = TransportType.Amqp;
    var factory = MessagingFactory.CreateFromConnectionString(EVENT_HUB_CONN_STRING);
    EventHubClient client = factory.CreateEventHubClient(eventHubEntity);
    EventHubConsumerGroup group = client.GetDefaultConsumerGroup();
    EventHubReceiver receiver = group.CreateReceiver(partitionId);

    while (true)
    {
        EventData data = await Task.Run(() => receiver.Receive());

        if (data == null)
            continue;

        EventHubMessageReceived(this, new EventHubMessageReceivedEventArgs(data));
    }
}
```

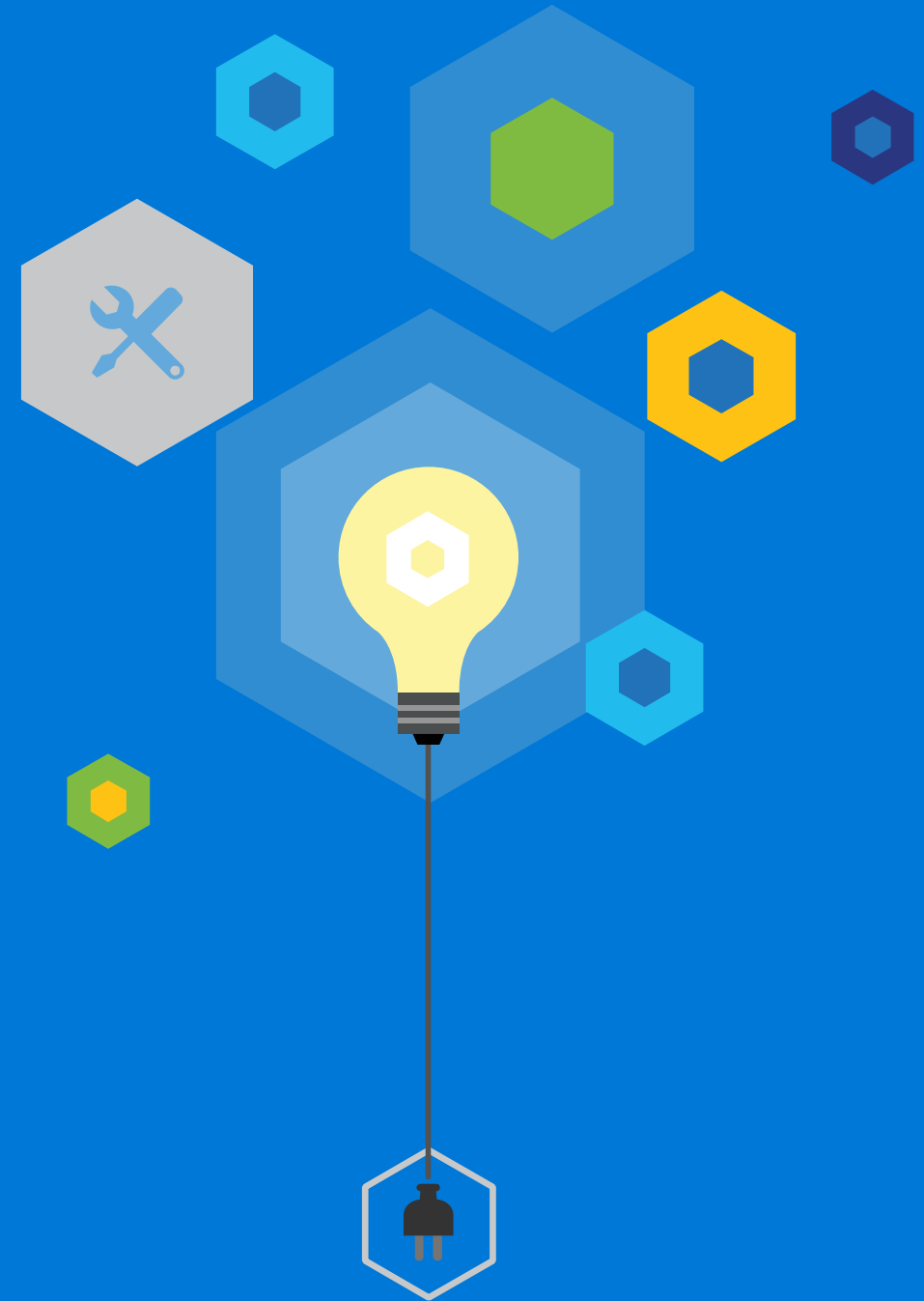
Azure Stream Analytics

- Perform real-time analytics for your Internet of Things solutions
- Stream millions of events per second
- Mission critical reliability, performance and predictable results
- Create real time dashboards and alerts over data from devices and applications
- Correlate across multiple streams of data
- Rapid development with familiar SQL-based language

Tool 3: Using Microsoft Azure to communicate with devices over the Internet

Demo: Windows Watering System

My career as a gardener





Abandoned garden
projects = unhappy
girlfriend ☹️

Shopping List

- 1 * Pantry Pump (12 V, 2 A)
- 1 * Battery (12 V, 4.5 Ah)
- 1 * Transparent Rubber Tube (10 meters)
- 1 * Bucket (5 liters)
- 1 * Battery Charger (12 V, 4 A)
- Some cables
- A new soldering iron
 - There was a great one on sale – yay! 😊

BILTEMA



Grill café

Vi har tændt op
for grillen og
det gode vejr

Grillet pølse m. brød
15 kr.
Fransk hotdog:
10 kr.
Fransk hotdog m. frankfurter:
25 kr.





42 43

VISKERBLADE

UNDESERVICE

44 45

UNDESERVICE





VÆRKTØJ
11



TRÅDLØST DIGITALT BAKKAMERA

Til bilen, autocamperen, camping-
vognen eller til overvågning i hjemmet.

- Trådløs digital overførsel, der giver et mere stabilt signal og længere rækkevidde i forhold til analoge kameras.
- Med 4,3" monitor med høj opløsning, mulighed for hjælpelinjer til afstandsbemærkning og vendbart billede.
- Trådløs overførsel med op til 100 m rækkevidde.
- Vindtæt videokamera med indbygget sender, som nemt monteres med medfølgende beslag bag bilens nummerplade.
- Automatisk lysstyrkejustering med IR-lys.
- Monitoren fastgøres med en sikkerhedsbælte.
- Løsning med adapter til cigarettændelse.
- Forberedt til brug af 2 kameras.

DIGITAL NIGHT VISION CAMERA

799,00
43147

1499,00
43147

FREE FROM
INTERFERENCE



Grill café

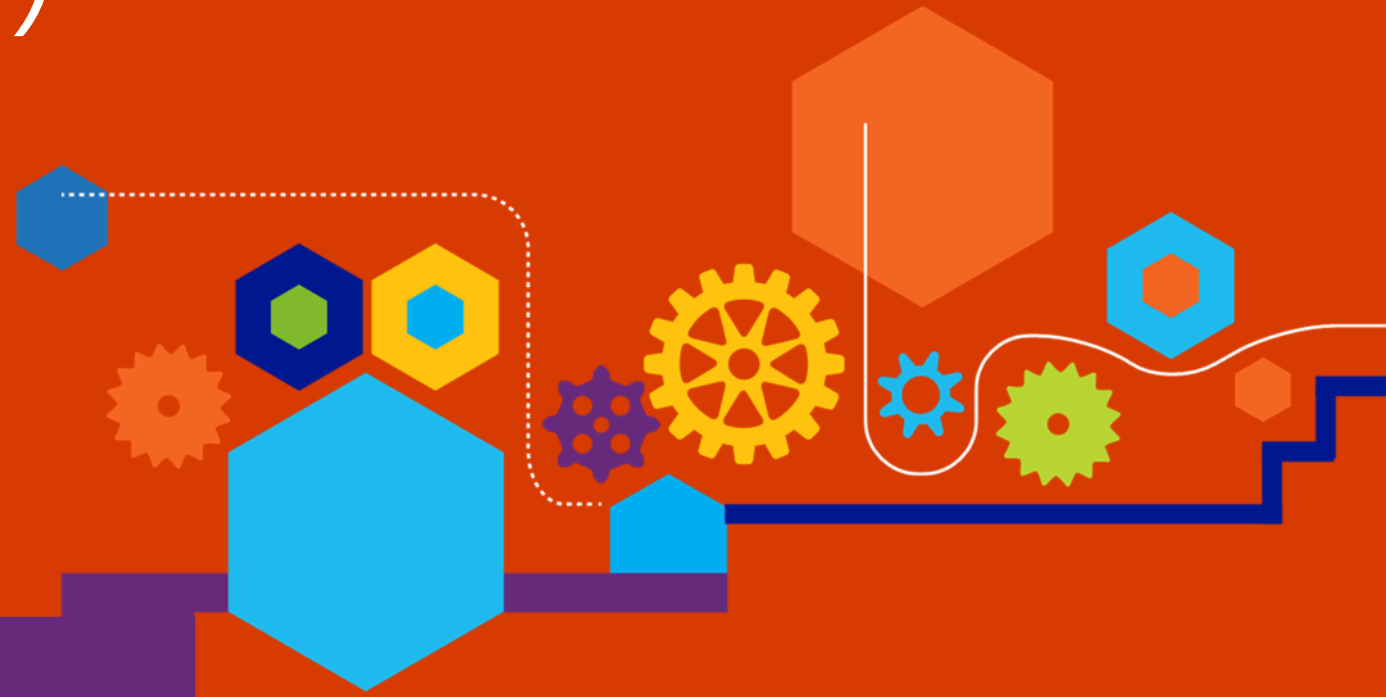
Vi har tændt op
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Grillet pølse m. brød
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BILTEMA

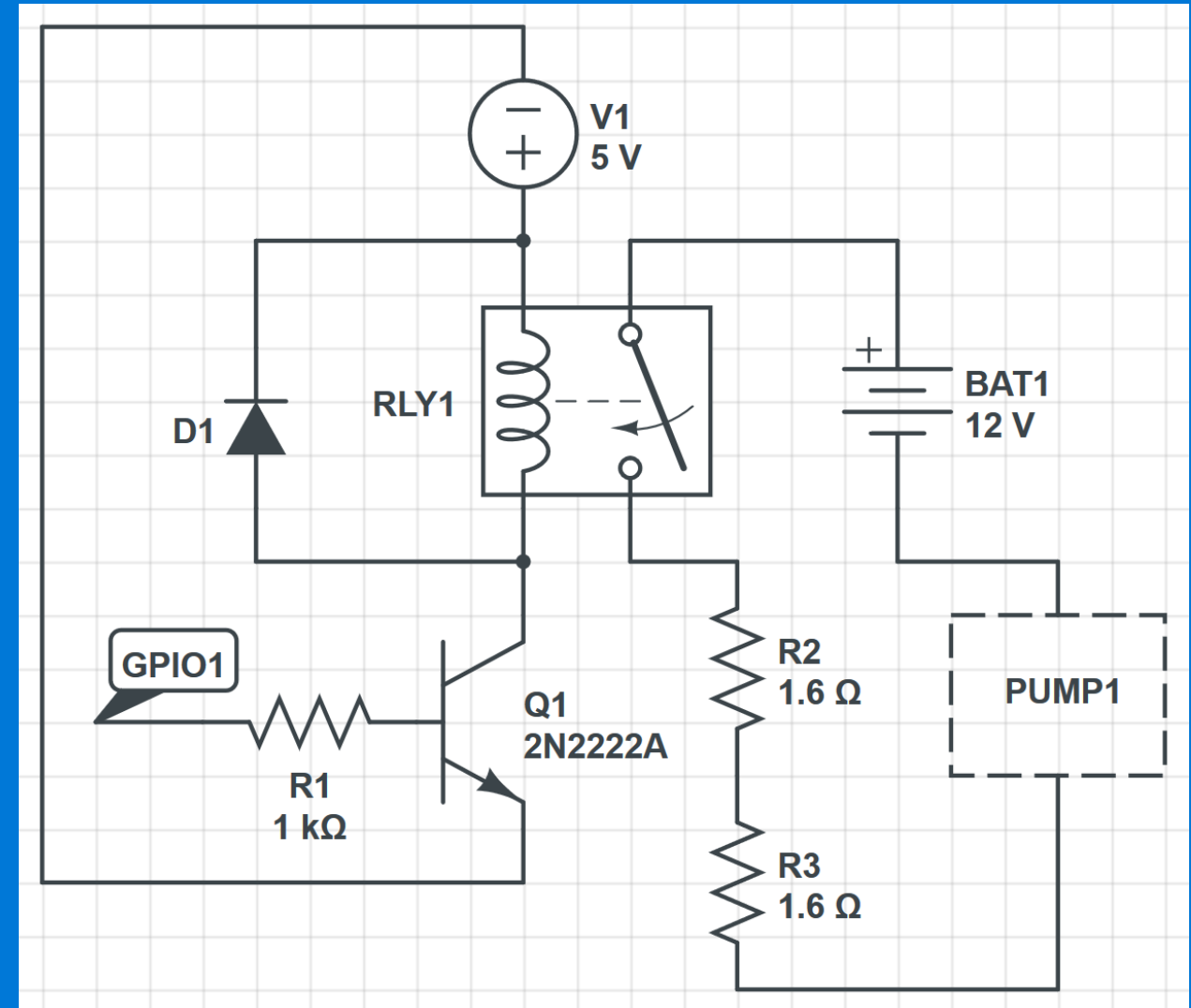


Alpha version using Arduino (video)



Electrical Circuit Design

- GPIO1 is controlled by one of the maker boards
- The pump was a little too strong so I reduced it with 2 * 1.6Ω resistors (~50% reduced power)
- Ohm's Law: $2A * (2 * 1.6\Omega) = 6.4V$



Let's Code

Arduino

Intel Galileo

Raspberry Pi 2

In Review: Session Objectives And Takeaways

1. Understand how IoT solutions work and how the Microsoft platform is central to IoT development.
2. Get an overview of the IoT landscape and what offerings are available to makers in the marketplace right. Also: Understand how the different IoT components all work with Microsoft's platform (largely, Azure).
3. Know the tools needed for IoT development and know where to start to build my own IoT solutions.



Q&A



If you have questions please proceed to the
Q&A MICROPHONE located in your session room.

