Developing IoT solutions with Windows 10 and Raspberry Pi 2

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Microsoft

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?

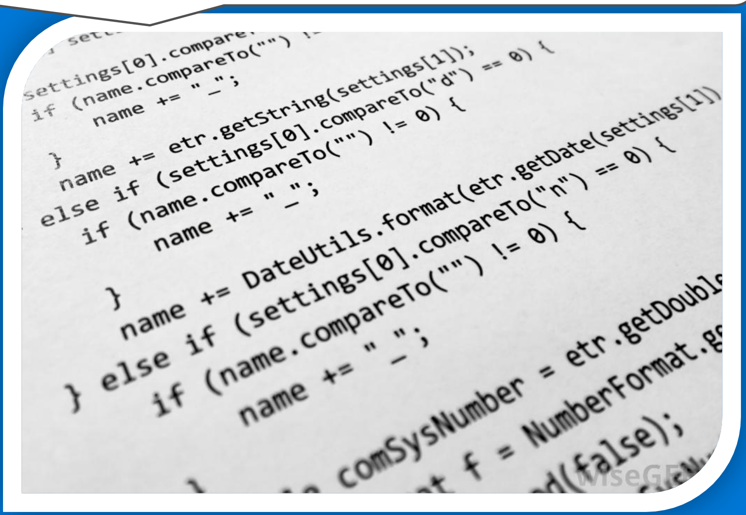
"At its core, IoT is simple: it's about connecting devices over the internet, letting them talk to us, applications, and each other."

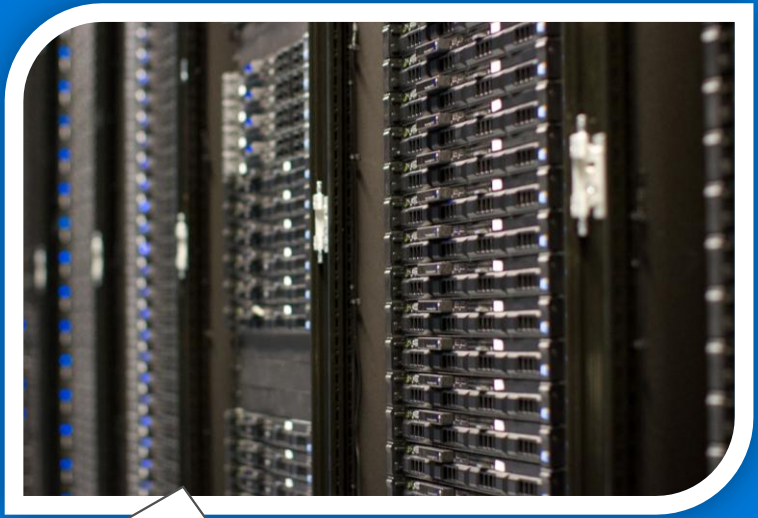
The Guardian

Brief Introduction to IoT

Windows 10 IoT Core

Universal Windows Platform (UWP)





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

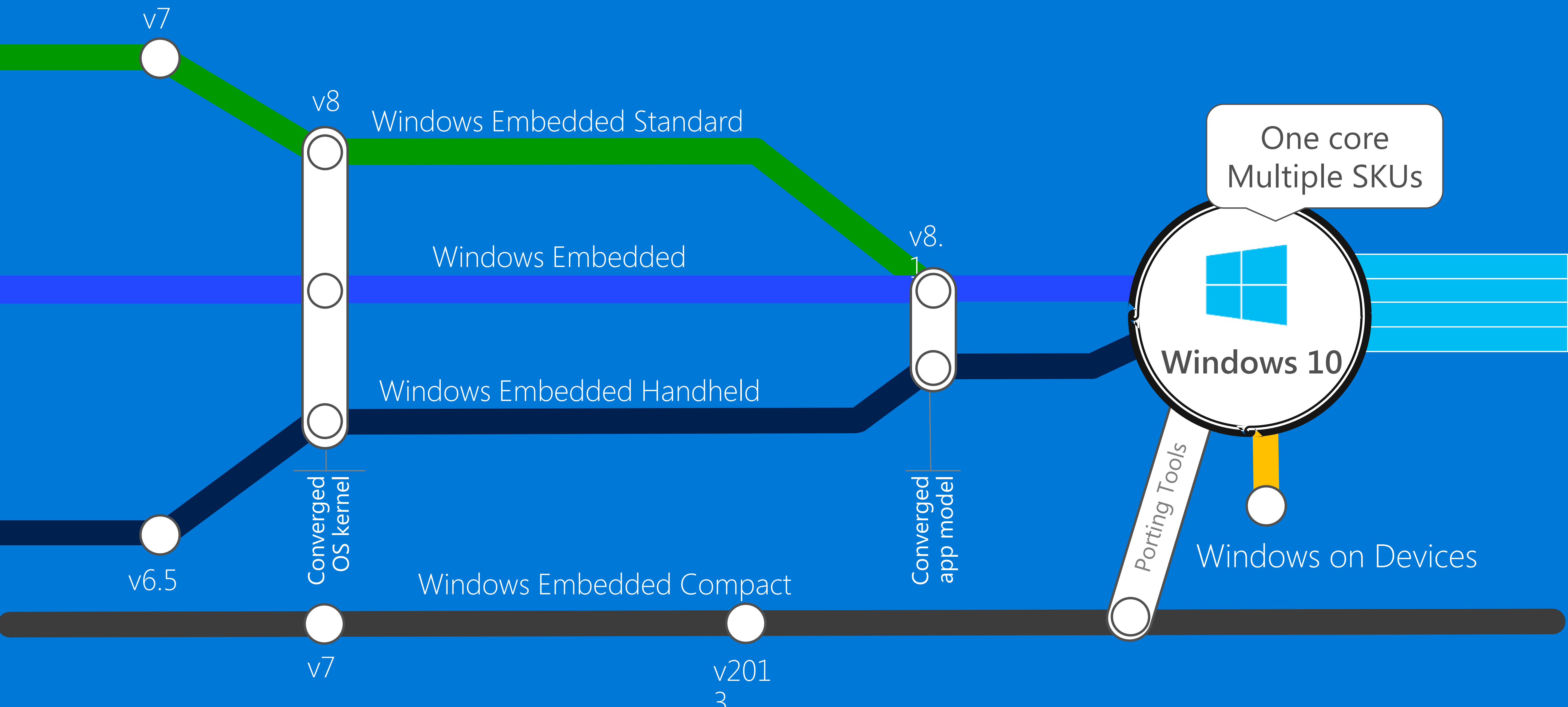
IoT on Windows 10

"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

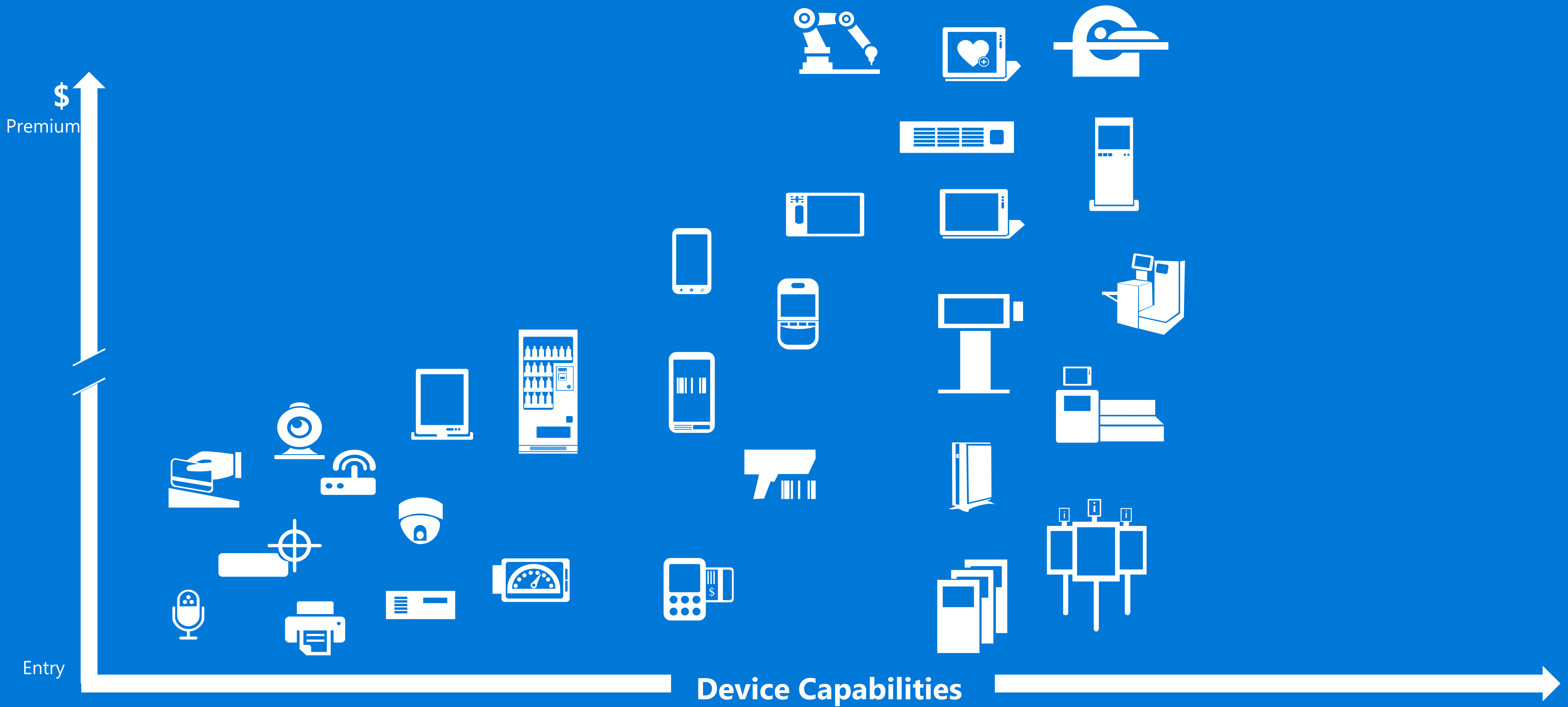
Windows 10 IoT for mobile devices
Modern Shell, Mobile apps, Universal apps and drivers
Minimum: 512 MB RAM, 4 GB storage
ARM

Windows 10 IoT Core
Universal Apps and Drivers
No shell or MS apps
Minimum: 256MB RAM, 2GB storage
X86/x64 or ARM

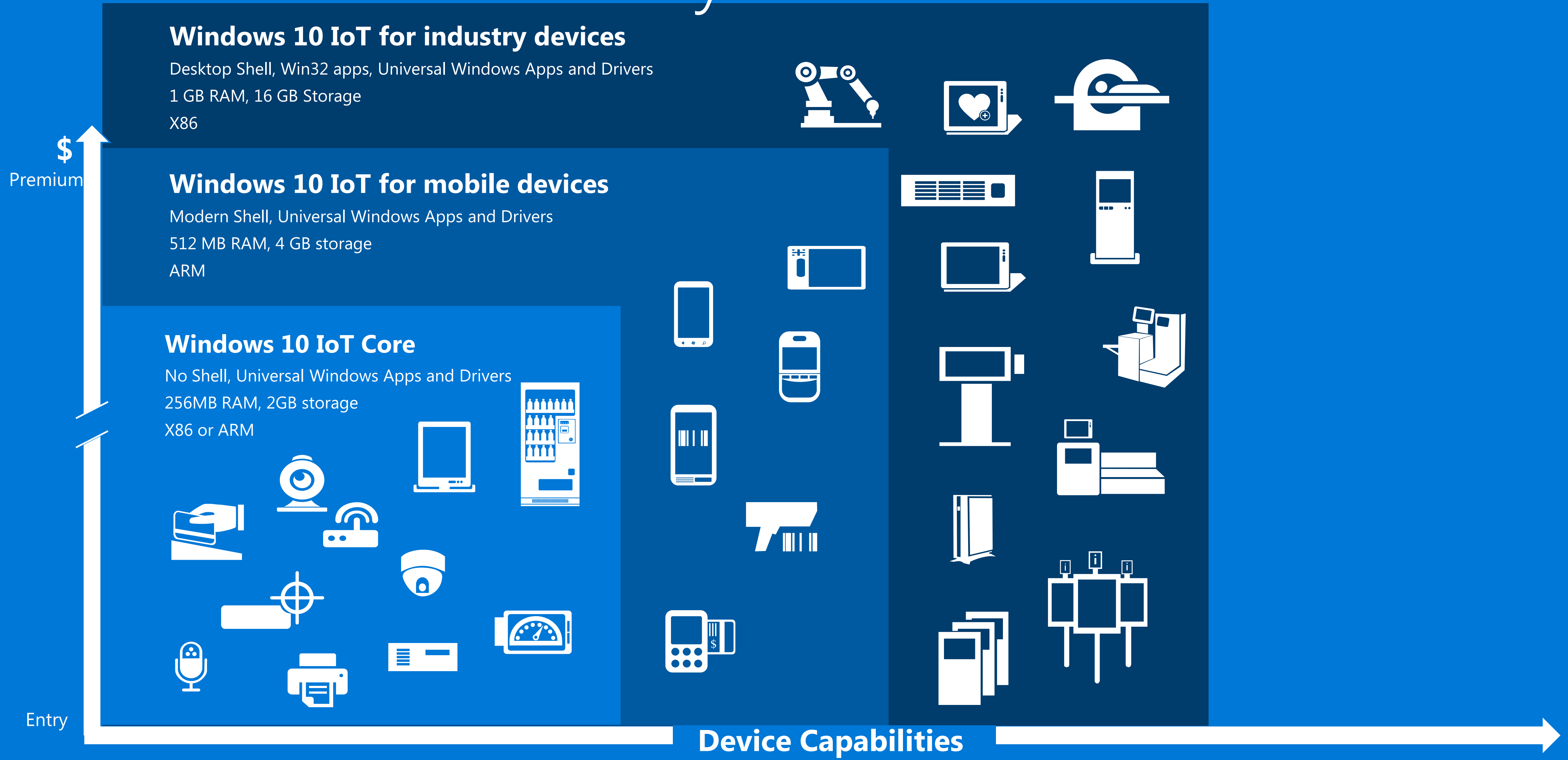
+

- Windows Updates
- Visual Studio & UWP
- New User Interfaces
- Security & Identity
- AllJoyn Integrated Device Connectivity
- Microsoft Azure IoT

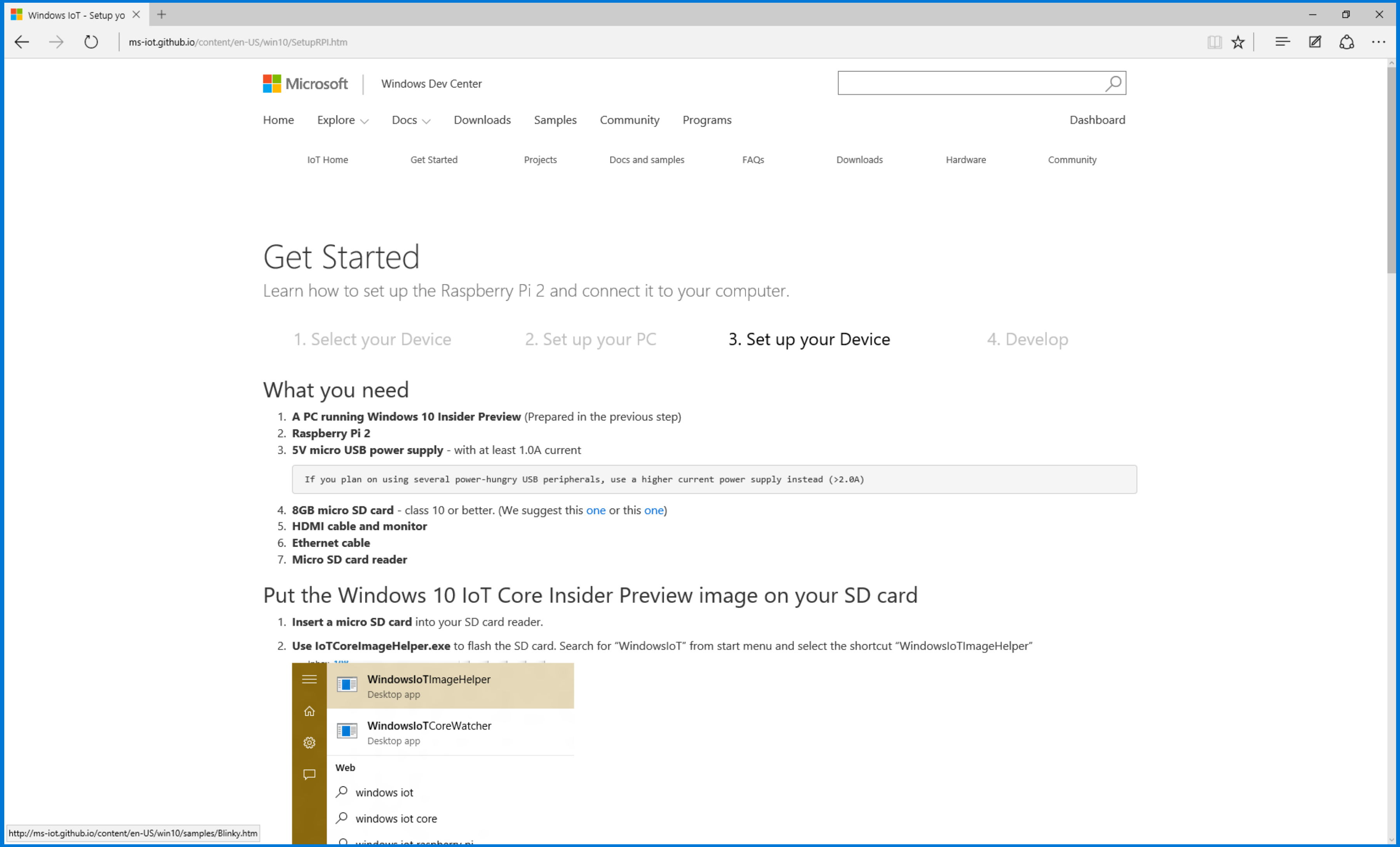
Windows for Industry Devices



Windows for Industry Devices



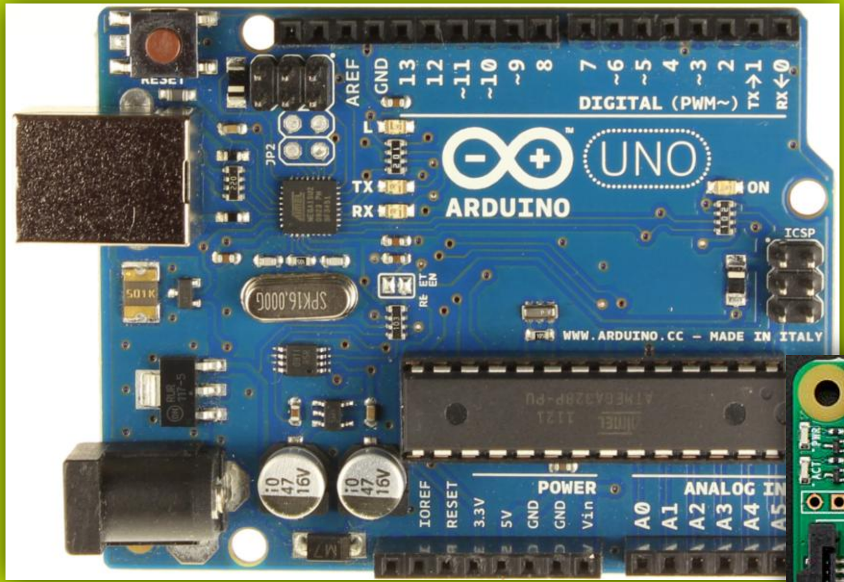
Installing Windows 10 IoT Core

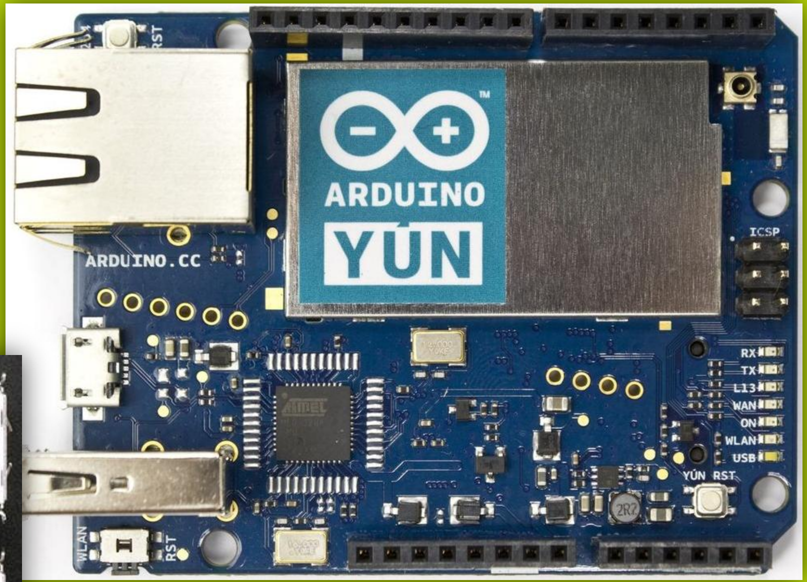


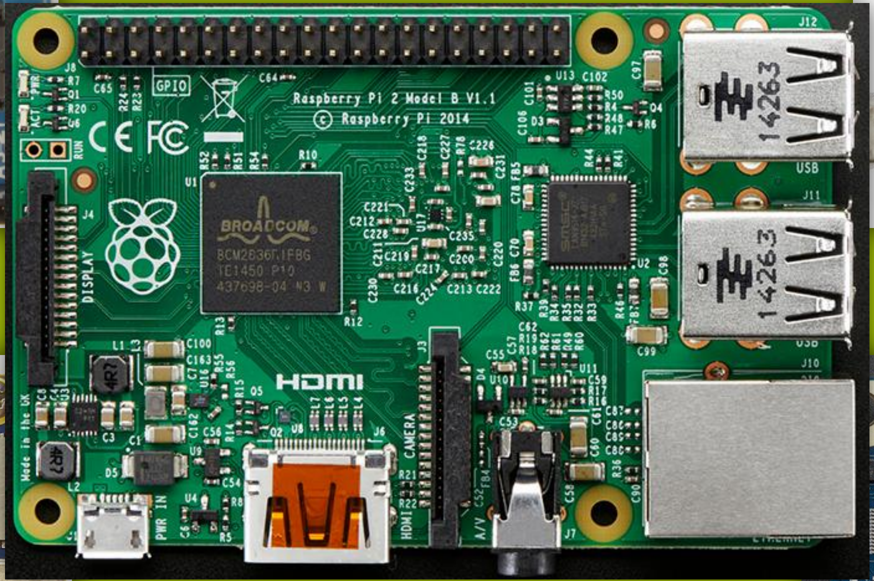
Tool 1: Using Windows 10 and UWP to develop apps for IoT devices

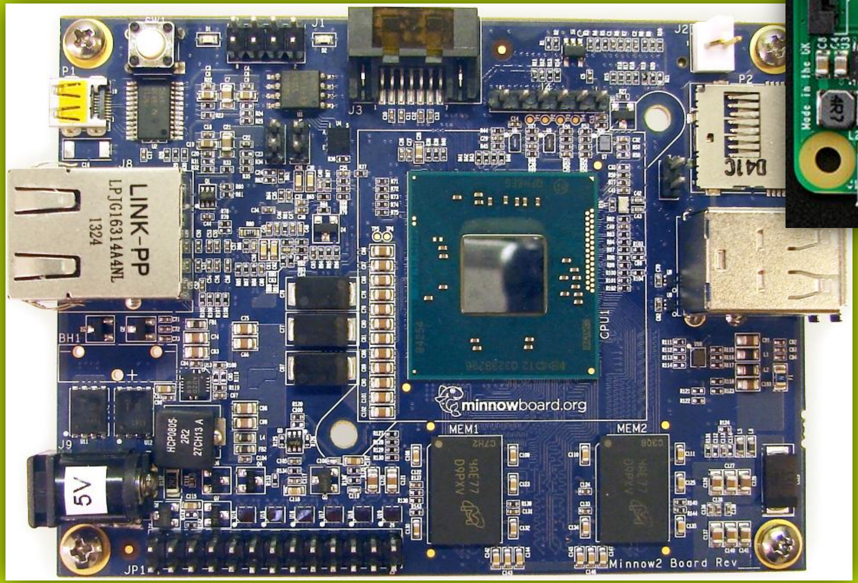
Devices in the Maker Space

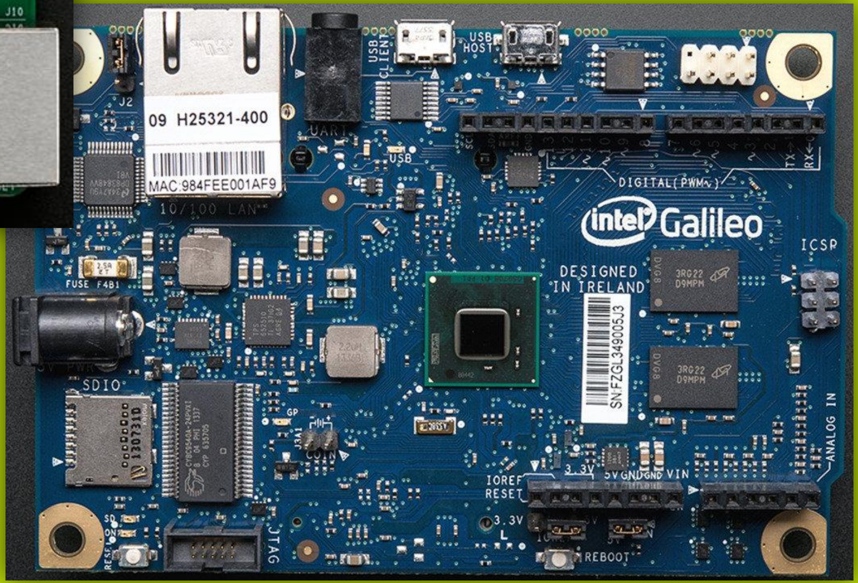
How many in here are makers?





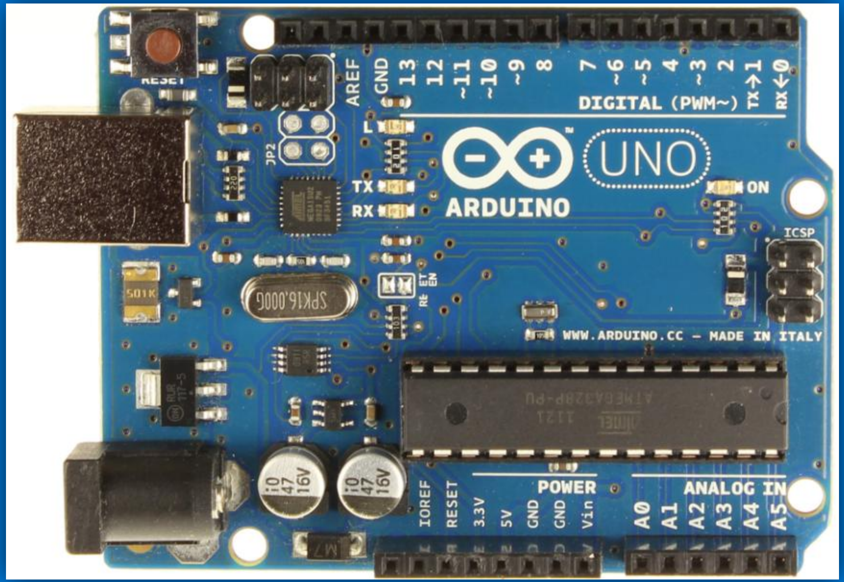






...and many more!

Arduino UNO

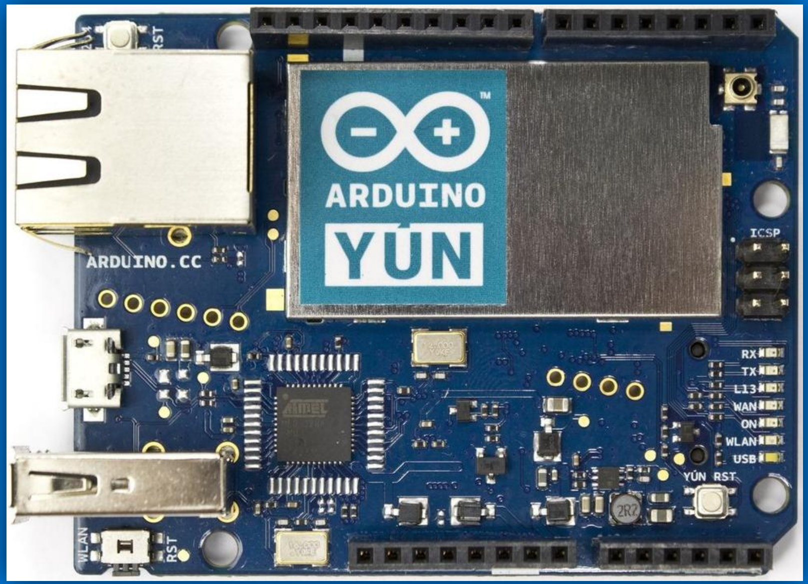


Processor: ATmega328P
Speed: 16 MHz (8-bit AVR)
Storage: 32 KB
Memory: 2 KB
OS: Wiring
Voltage: 5V DC
GPIO: 20 (14 digital, 6 with PWM, 6 analog input pins)
Release Date: September 24, 2010 (approx. $25)

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

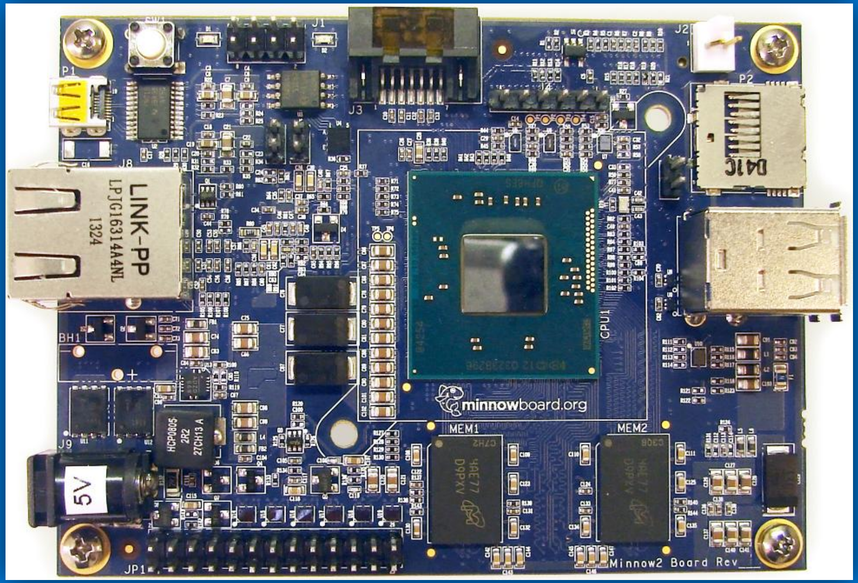
GPIO: 20 (14 digital, 6 with PWM, 12 analog input pins)

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

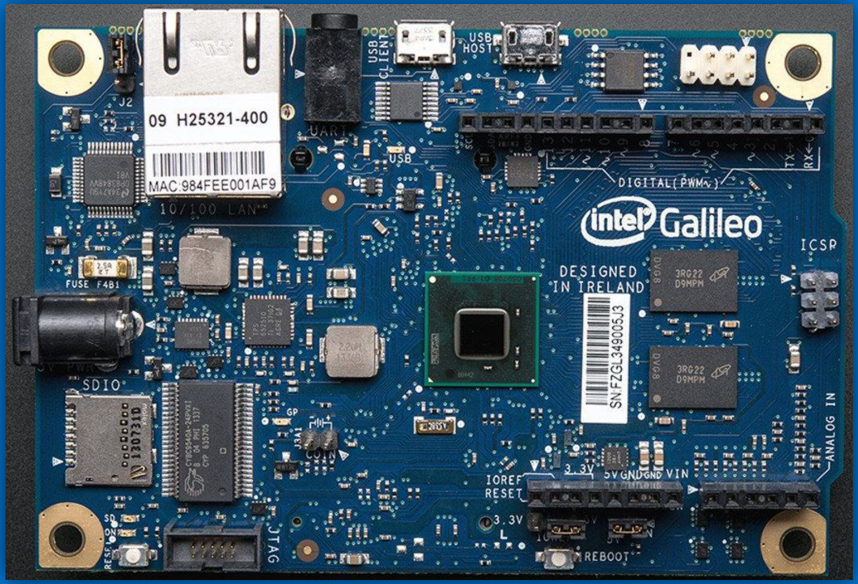
Memory: 256 MB

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

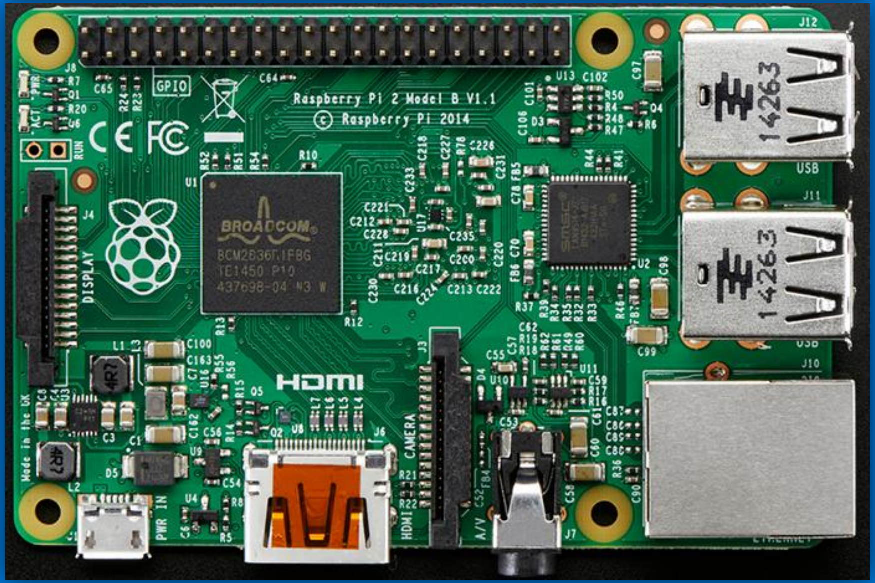
Memory: 1 GB

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 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)

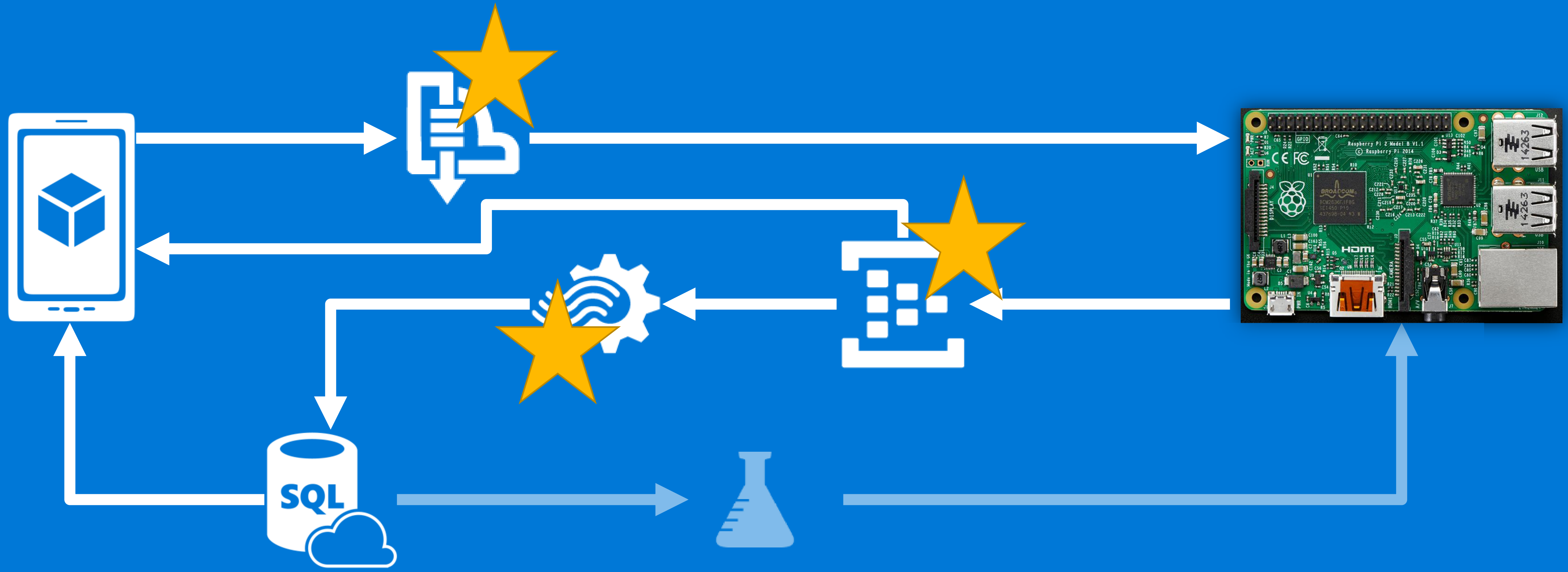
Tool 2: Using maker boards supported by Windows 10 to run UWP apps

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

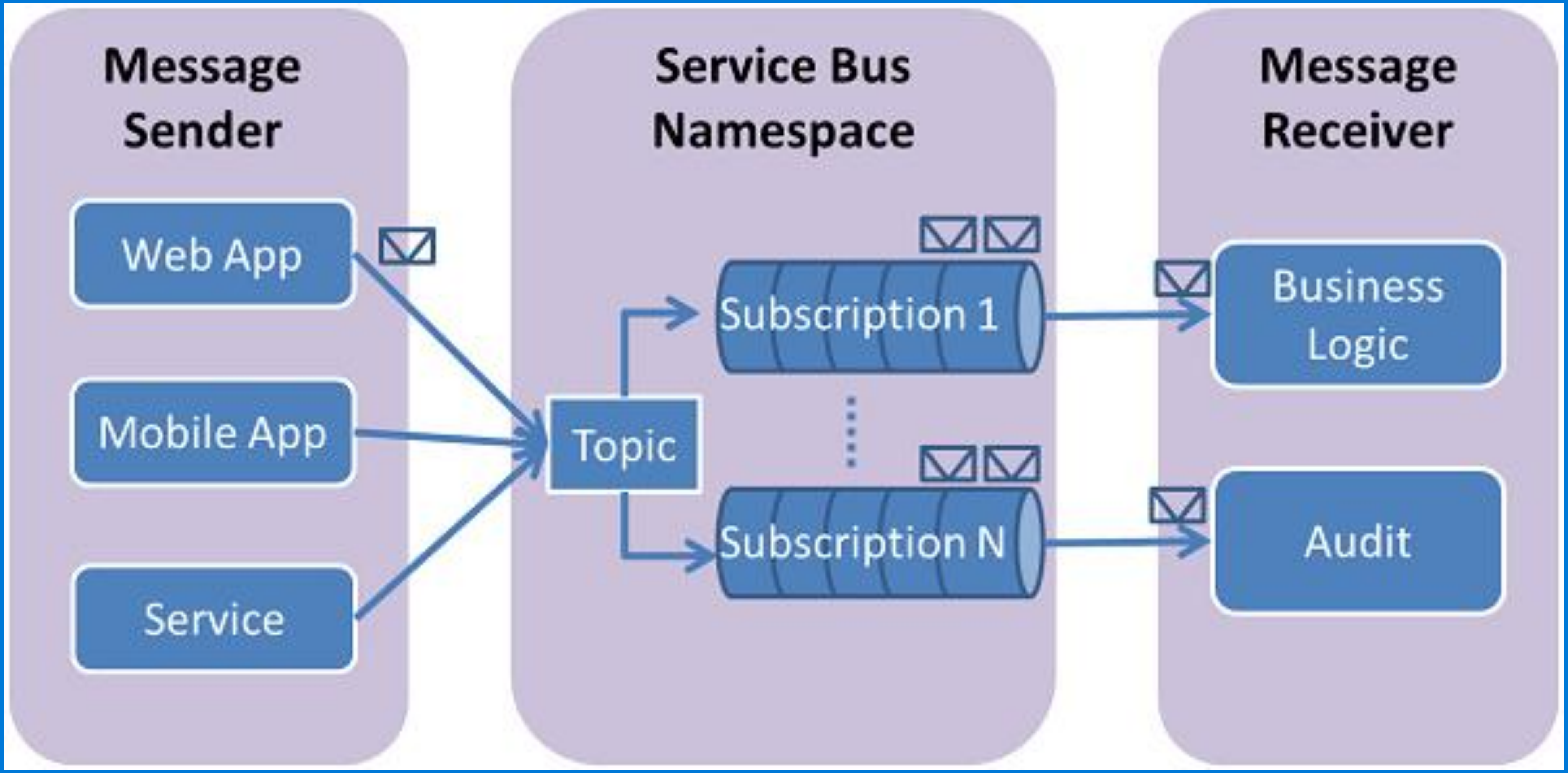
Azure Service Bus Topics

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

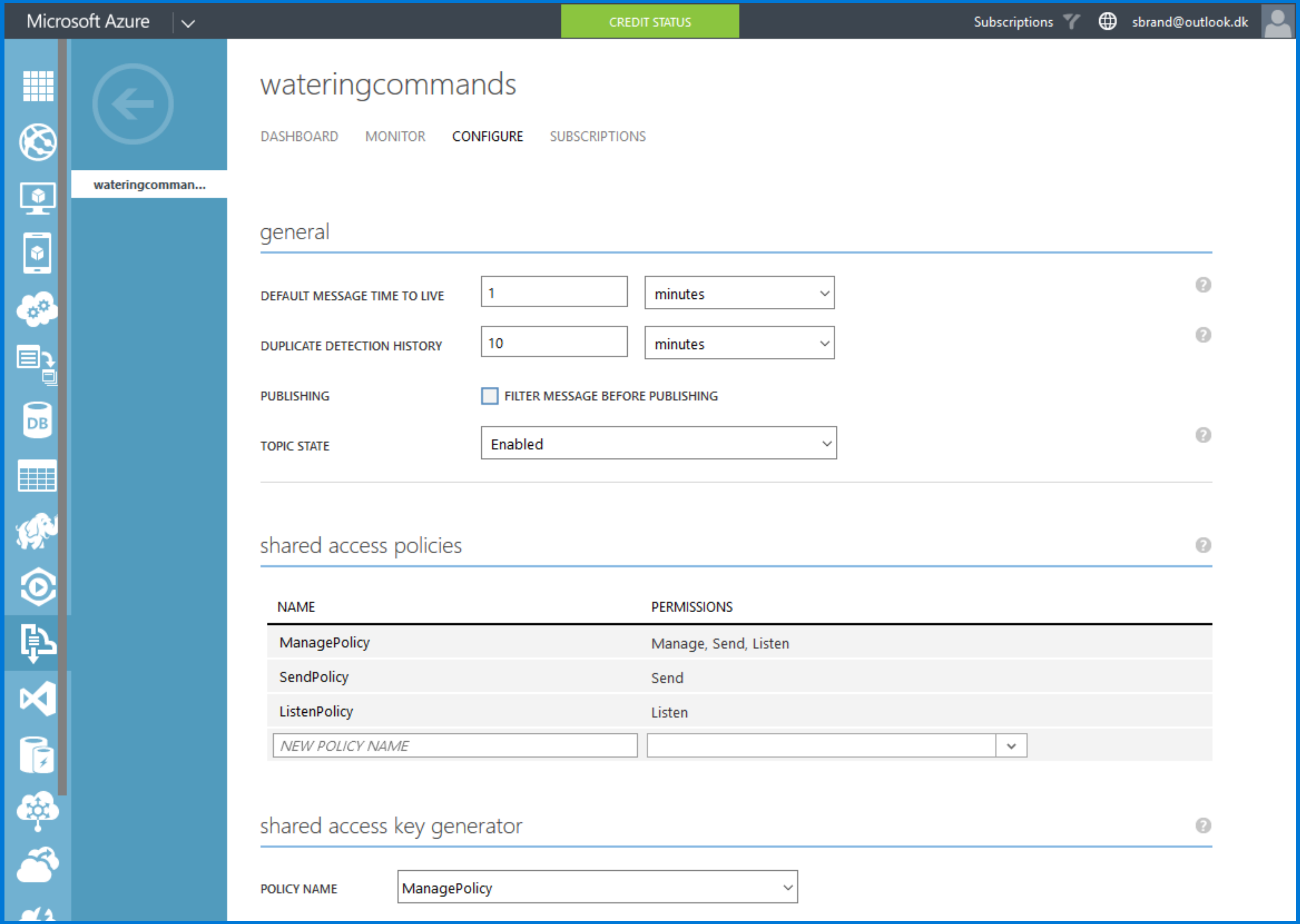
Azure Event Hubs

- 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



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.

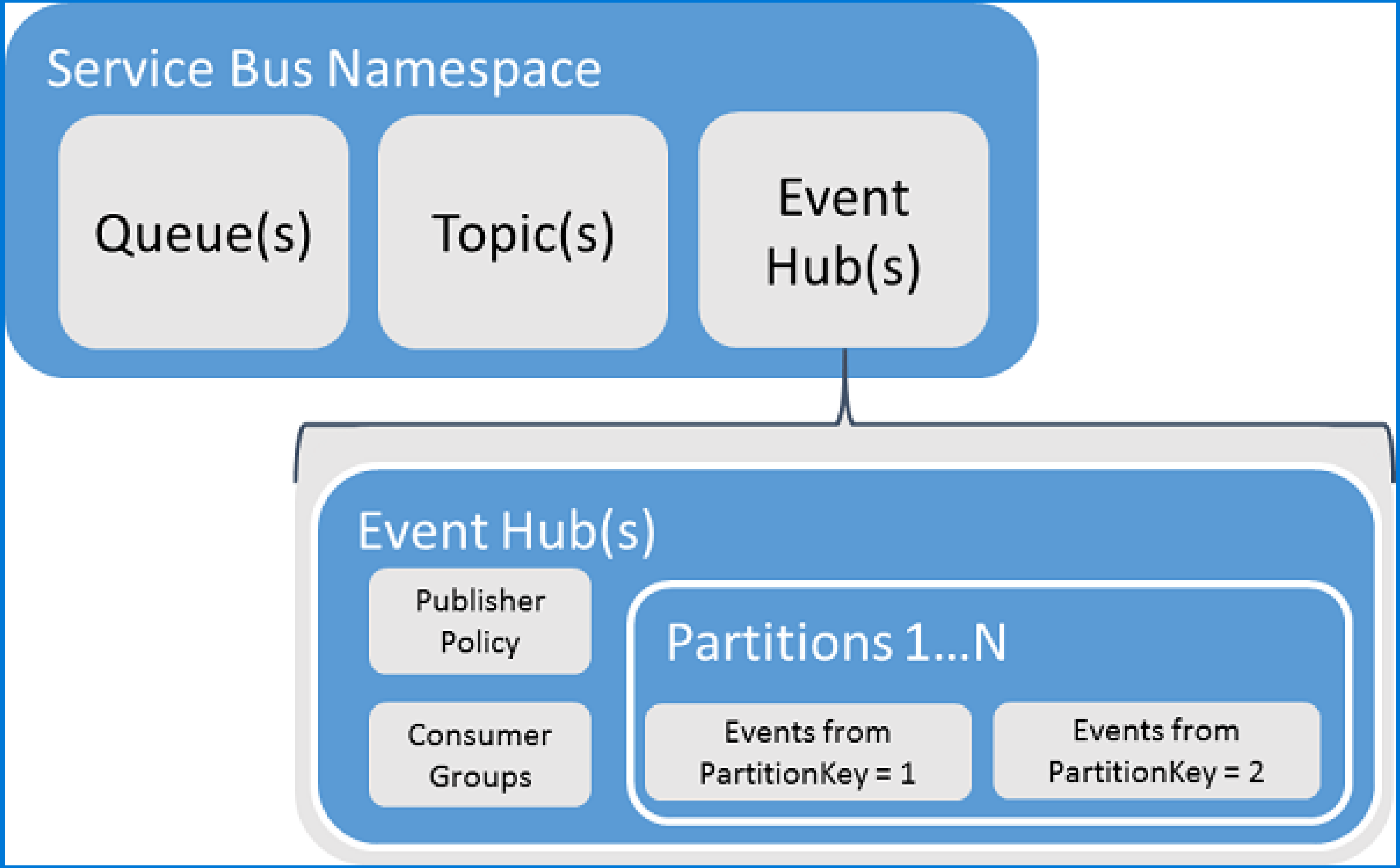
Sending to Azure Service Bus Topic

```
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();
}
```

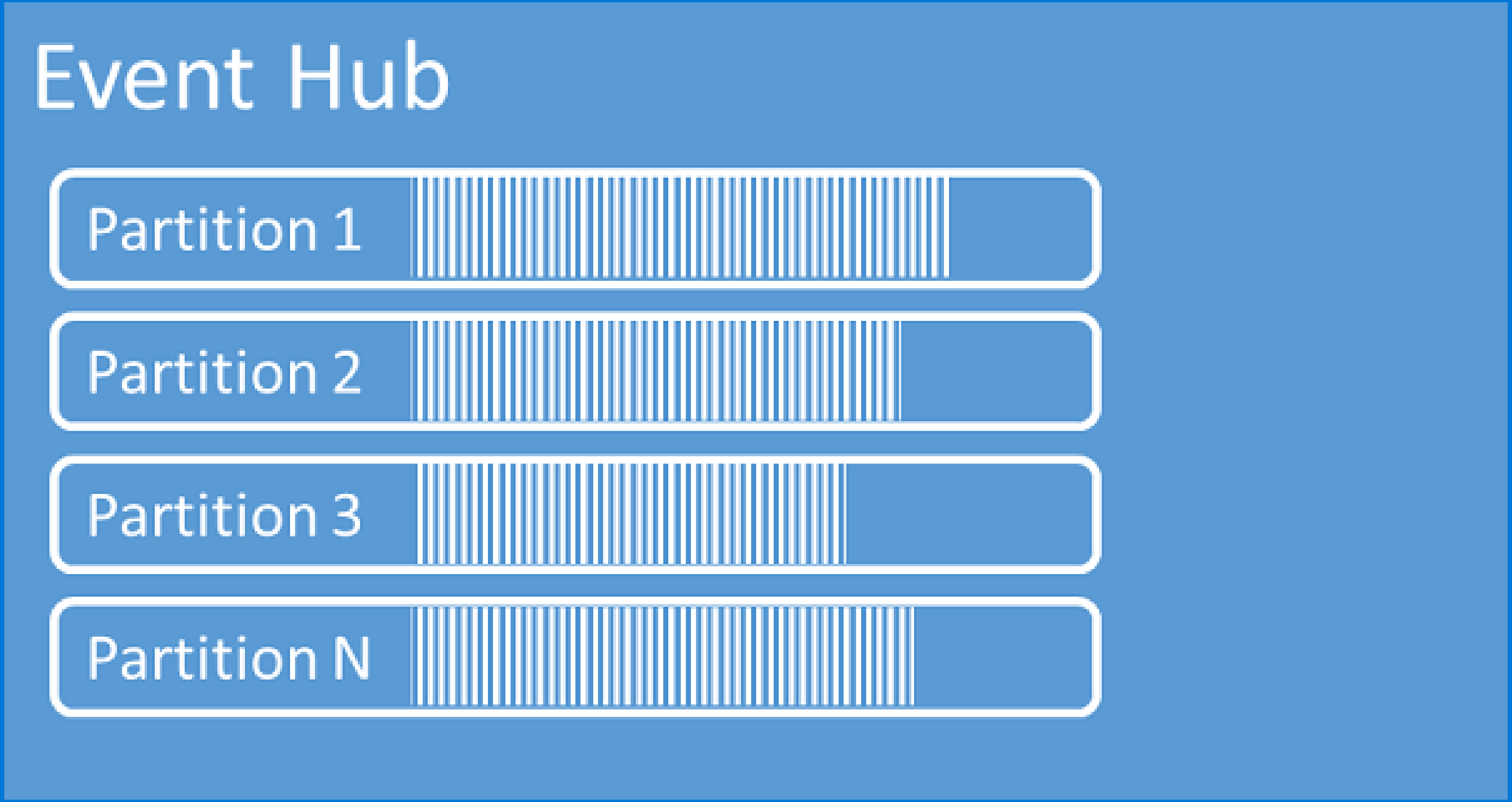
Receiving from Azure Service Bus Topic

```
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



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));
    }
}
```

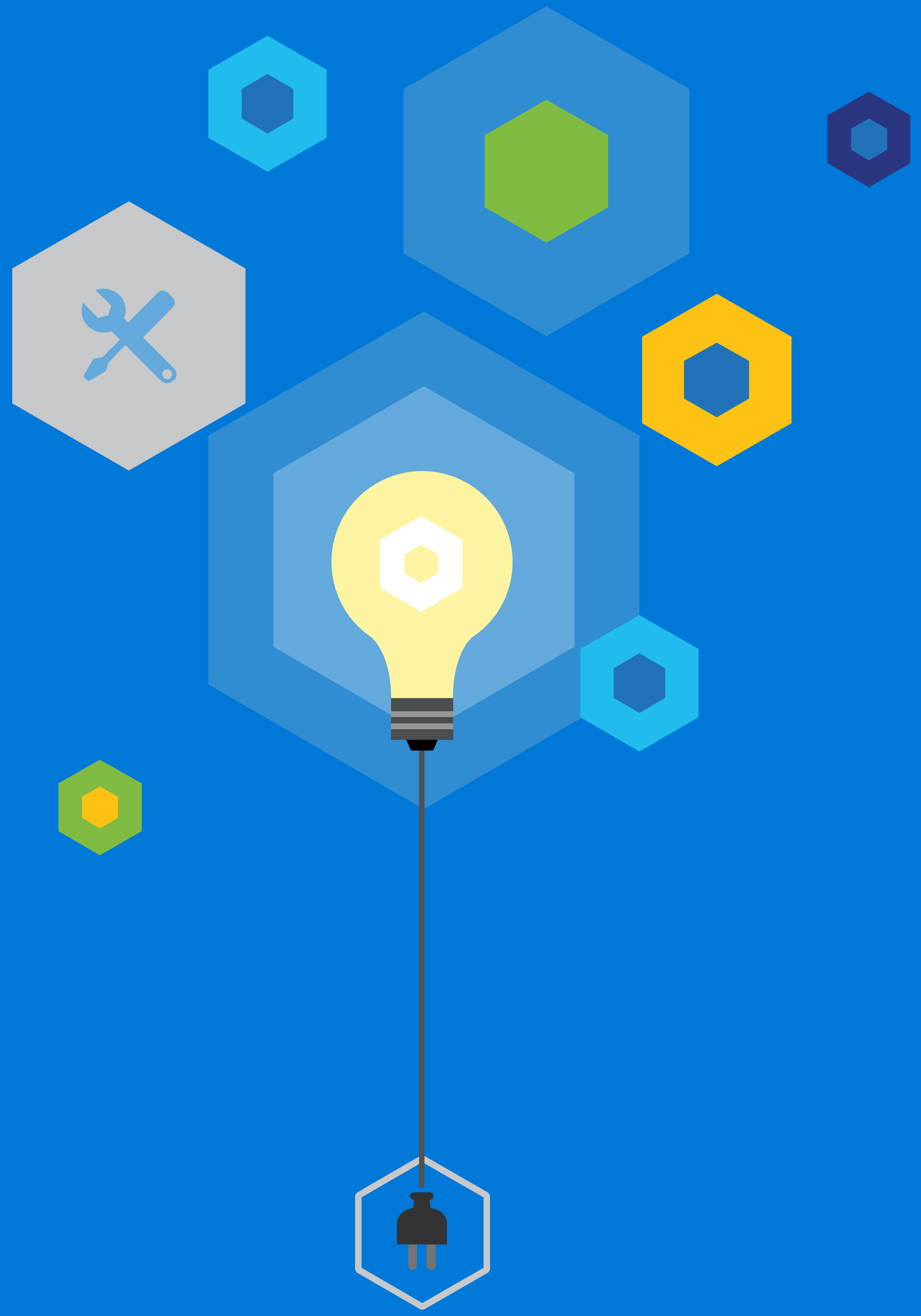
Azure Stream Analytics

- 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.
BILTEMA
BILTEMA
Cykler til alle

MC- batteri
Moottoripyörän akku
Motorsykkelbatteri
SMF
BILTEMA
Art. 80-274
Art. 80-271
Art. 80-273
Art. 80-277
Art. 80-279
Art. 80-267
Art. 80-268
12V 18.0 Ah
LITHIUM ION
SMART BATTERY CHARGER & STARTER
15A


42 43
VISKERBLADE
TWIN POWER CABLE
TWIN POWER CABLE
44 45


VÆRKTØJ
11
HVORFOR BETALE MERE
399,-
299,-
BMW 3-SERIES
AUDI A4
BILTEMA
TRÅDLØST DIGITALT BAKKAMERA
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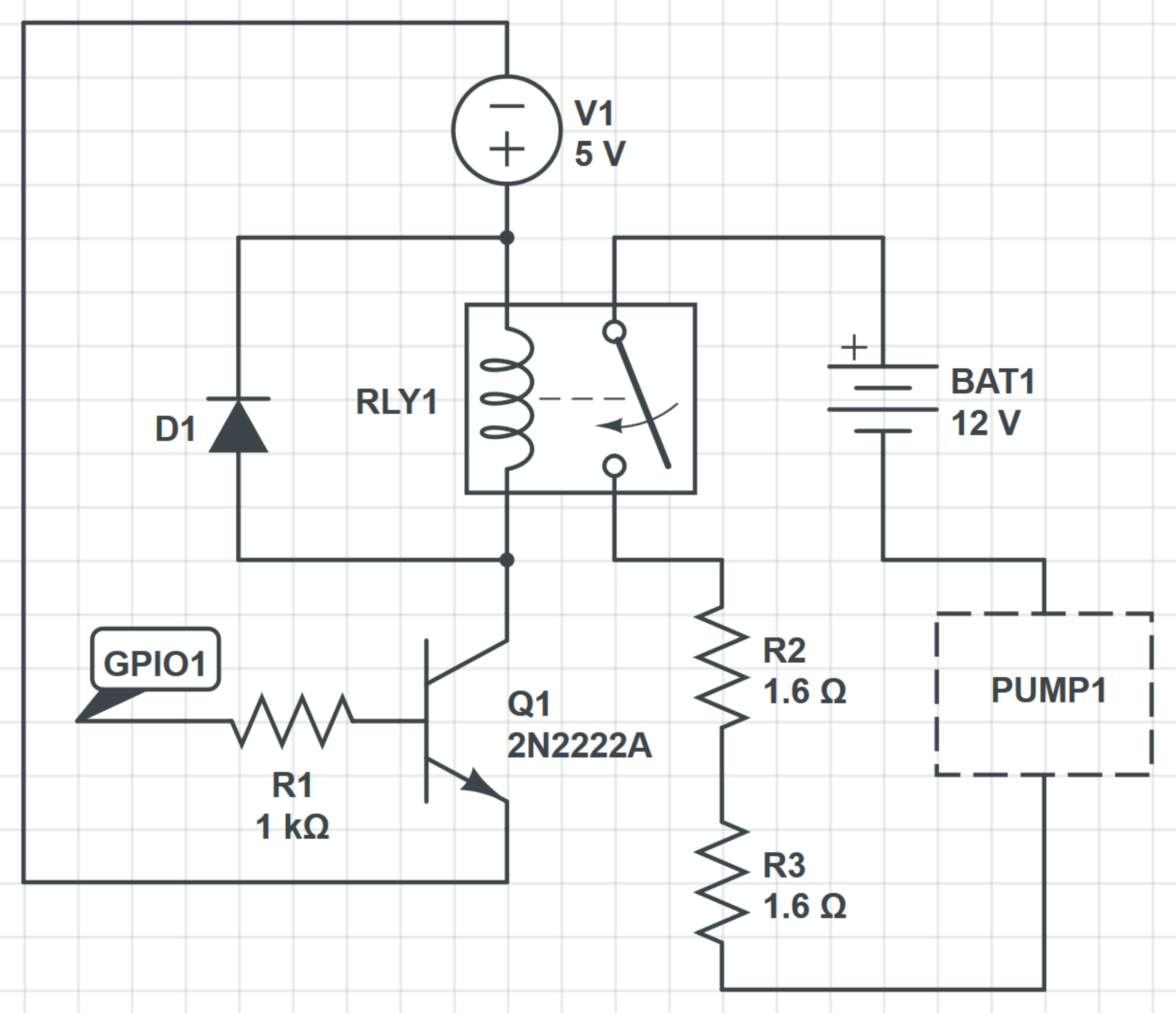
FREE FROM INTERFERENCE


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.
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*1.6Ω) = 6.4V



Let’s Code

Arduino

Intel Galileo

Raspberry Pi 2

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Q&A

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

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