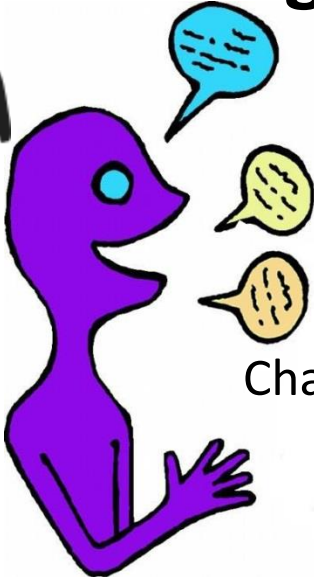


W3C<sup>®</sup>



# The Language User Interface to the Internet of Things: Tools, Standards and Resources



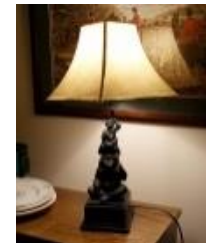
Deborah A. Dahl, Ph. D.

Conversational Technologies

Chair, W3C Multimodal Interaction Working Group

Mobile Voice 2016

San Jose



# Growth of The Internet of Things

“In total, we project there will be 34 billion devices connected to the internet by 2020, up from 10 billion in 2015. IoT devices will account for 24 billion...Nearly \$6 trillion will be spent on IoT solutions over the next five years.” [Business Insider](#)

What's in the Internet of Things?

# Internet of Things Stack

user

Visible to user

Speech, natural language,  
dialog

Interaction (visual, auditory, haptic)

Development tools

Application (control home, shop in store...)

Browser, iOS,  
Android...

Software platform (Open Web Platform, other cross-platform,  
native)

mobile device, computer,  
wearable, robot, ambient...

UI device

Session (HTTP, WebSocket, WebRTC, UPnP, EchoNet, RTPC, RPC, CoAP...)

Transport (TCP, UDP, Bluetooth, NFC, 3G/4G, ZigBee...)

Behind the scenes

things



# What about the user interface?

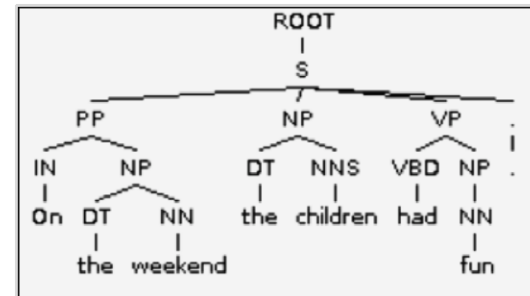
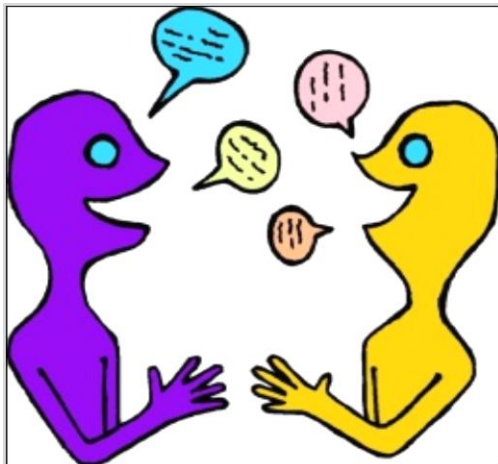
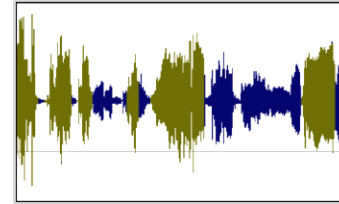
- People want to interact with connected things
- It's not practical for every thing to have its own GUI
- Natural language is a good approach
- Consistent across things
  - Accommodates different form factors
  - Most likely speech
  - Accommodates complex intentions

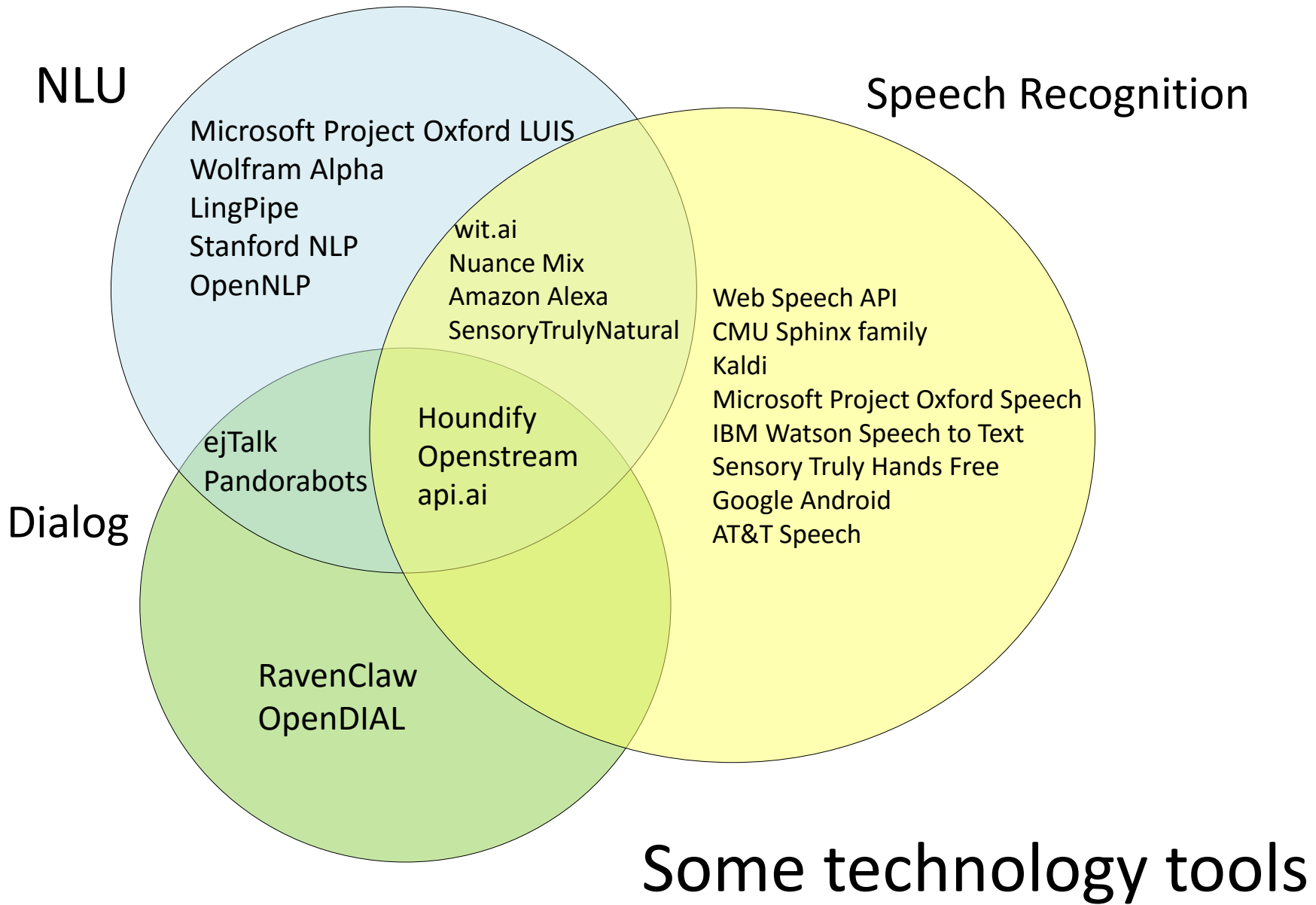
# Bringing natural language to the Internet of Things

- Tools: technologies and software
- Standards: UI and communication standards
- Resources: organizations

# Tools: Technologies and Software

- Speech recognition
- Natural language understanding
- Dialog management









# Standards

- Open Web Platform
- EMMA 2.0 – complex, multimodal user intentions and system outputs
- Discovery and Registration
- W3C Device and Sensor API's – standard access to device capabilities (camera, microphone, file system)
- SCXML – manages state machines
- MMI Architecture – coordinates multimodal interaction
- Web Sockets – two-way client-server communication
- WebRTC – efficient media transfer between browsers



# W3C Open Web Platform

- Provides a layer of abstraction across devices (mobile, computer, other form factors) – a browser

- Presentation Tools



Cascading Style Sheets

- Programming

Document Object Model

API's

Javascript

- Communication

HTTP

Web Sockets

WebRTC

# XML EMMA 2.0

```
<emma:emma xmlns:emma="http://www.w3.org/2003/04/emma"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" version="2.0"
xsi:schemaLocation="http://www.w3.org/2003/04/emma
http://www.w3.org/TR/2009/REC-emma-20090210/emma.xsd">
```

```
<emma:interpretation
```

```
  id="aer6284818"
  emma:lang="en-US"
  emma:start="12484888"
  emma:end="12489900"
  emma:confidence="0.9"
  emma:medium="acoustic"
  emma:mode="voice"
  emma:process="http://acme.org/asr_nlu"
  emma:tokens="sushi restaurants near portland oregon">
```

```
<command>search restaurant</command>
```

```
<attrs>
```

```
<location>
```

```
  portland, oregon
```

```
</location>
```

```
<cuisine>
```

```
  sushi
```

```
</cuisine>
```


```
</attrs>
```


```
</emma:interpretation>
```


```
</emma:emma>
```

# Possible JSON EMMA 2.0

```
{
  "emma:id": "aer6284818",
  "emma:lang": "en-US",
  "emma:start": 12484888,
  "emma:end": 12489900,
  "emma:medium": "acoustic",
  "emma:mode": "voice",
  "emma:process": "http://acme.org/asr_nlu",
  "emma:tokens": "sushi restaurants near portland oregon",
  "emma:interpretation": {
    "emma:confidence": 0.9,
    "command": "search_restaurant",
    "attrs": {
      "cuisine": "sushi",
      "location": "portland oregon"
    }
  }
}
```

 metadata

 input

 meaning

# Industry Resources

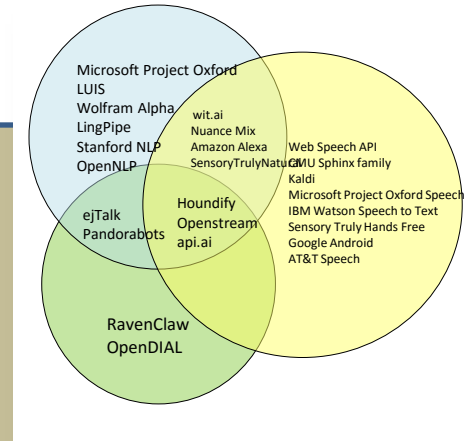
- Single company
  - Google/Nest Weave
  - Apple HomeKit
  - Philips Hue
  - Samsung Smart Things
- Generic Middleware
  - OpenHAB
  - Alljoyn
  - Open Source Automation
- (some) Internet of Things Consortia
  - Internet of Things Consortium
  - Industrial Internet Consortium
  - Hypercat
  - Allseen Alliance
  - Open Inteconnect Consortium

# Standards Resources

- W3C
  - Web of Things Interest Group Task Forces
    - Thing description
    - Security and privacy
    - API's
  - Multimodal Interaction (MMI) (voice/multimodal user interface)
  - Devices and Sensors (access to device capabilities)
  - Geolocation (device location)
  - Spatial Data on the Web
- IETF
  - IPv6
  - 6LoWPAN
  - UDP
  - HTTP

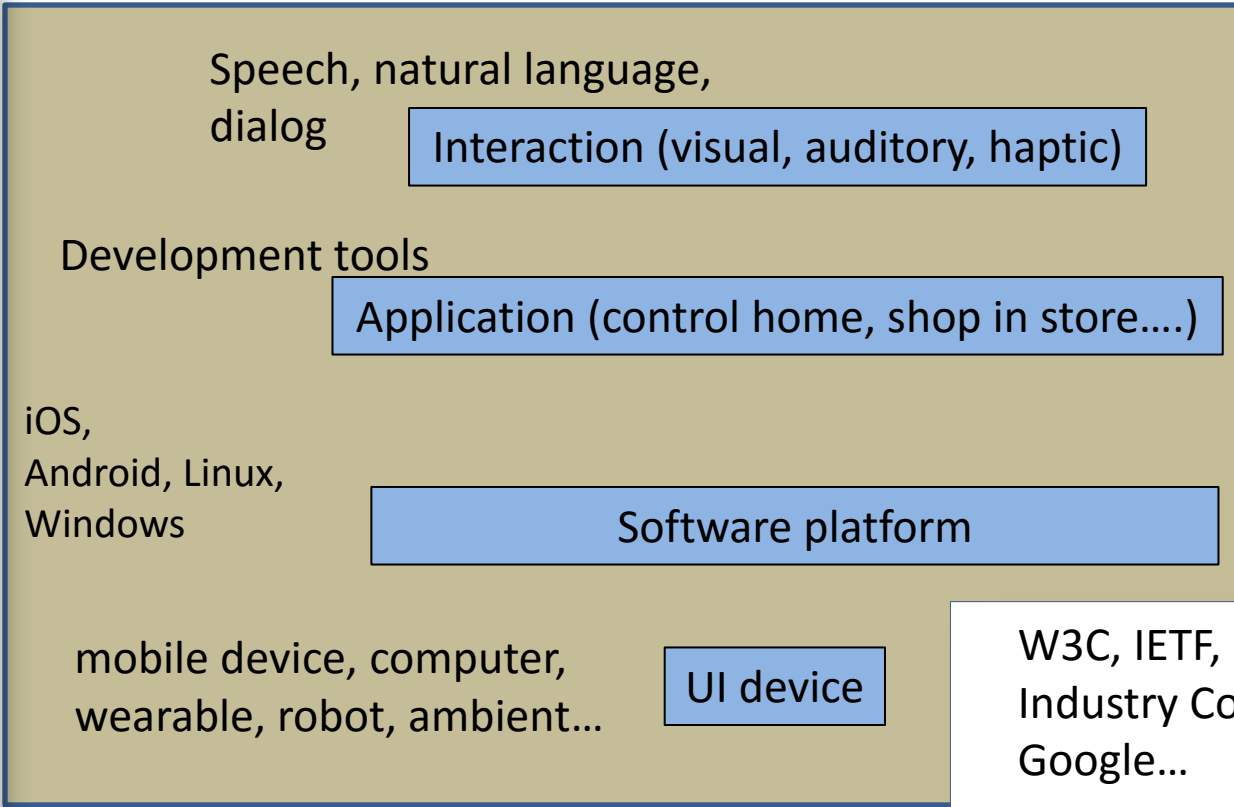
# Tools, Standards and Resources for the Language Interface to the Internet of Things

user



- HTML
- CSS
- SVG
- EMMA
- Javascript
- DOM
- Open Web Platform
- Web API's
- MMI
- WebSockets
- WebRTC
- HTTP

Standards



Resources  
W3C, IETF, OpenHAB, Alljoyn, Industry Consortia, Apple, Google...

things

