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

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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

Visible to user

Speech, natural language, dialog

Interaction (visual, auditory, haptic)

Application (control home, shop in store….)

Development tools

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

Browser, iOS, Android...

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
Some technology tools

NLU
- Microsoft Project Oxford LUIS
- Wolfram Alpha
- LingPipe
- Stanford NLP
- OpenNLP

Speech Recognition
- Web Speech API
- CMU Sphinx family
- Kaldi
- Microsoft Project Oxford Speech

Dialog
- Houndify
- Openstream
- api.ai
- ejTalk
- Pandorabots

RavenClaw
OpenDIAL

Some technology tools
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
  - HTML
  - Cascading Style Sheets
- Programming
  - Document Object Model
  - Javascript
  - API’s
- 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"
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

Interaction (visual, auditory, haptic)

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

Development tools

Speech, natural language, dialog

Software platform

iOS, Android, Linux, Windows

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

UI device

UI

Language Tools

Resources

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

Standards

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