

IoT Engineering

11: Voice Control for Connected Products

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Slides: tmb.gr/iot-11



Overview

These slides introduce *voice control for devices*.

How a voice command can control actuators.

How a voice query can read sensor values.

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Prerequisites

The [Raspberry Pi](#) with [Node.js](#) hosts our "backend".

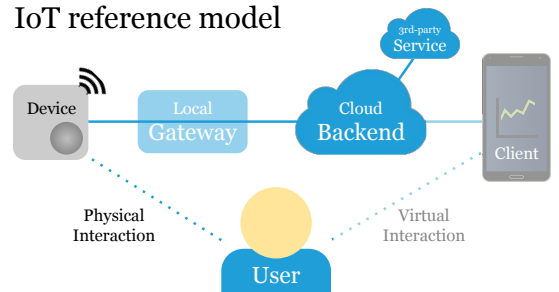
For voice control we'll use an [Echo](#) or [Echosim.io](#).

Examples are based on the [Alexa](#) voice service.

Note: Slides are in beta, examples will be updated.

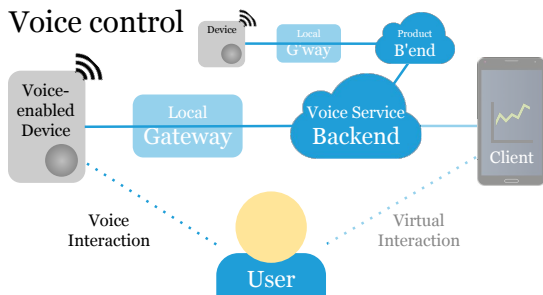
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IoT reference model



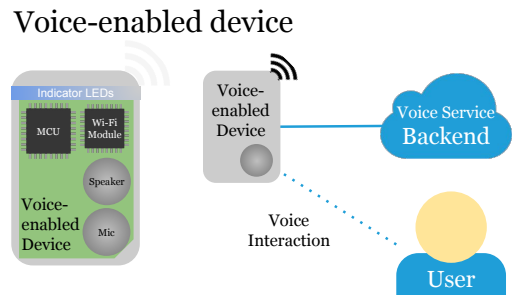
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Voice control



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Voice-enabled device



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Voice-enabled device

A voice interface can be a separate device, e.g. [Echo](#).
Or a connected product that is (also) voice-enabled*.
In any case there is a mic, an indicator and a speaker.
Processing audio is done at a voice service backend**.

*Example [dev kits](#). **Or locally w/ edge computing. 7

Voice services

A voice service provides natural language processing.
Voice services include [Alexa](#), [Siri](#) & [Google Assistant](#).
[Dialogflow](#) is a meta service to use multiple services.
[Snips.ai](#) is a local alternative to cloud-based solutions.

Why care? Amazon sold [100 M devices](#) with Alexa. 8

Voice interaction

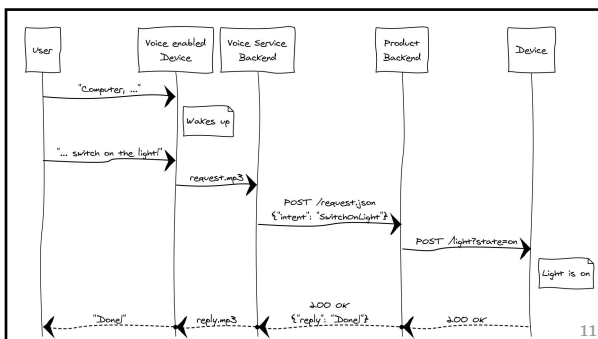
Voice interaction provides a "natural" user interface.
Interaction patterns include *commands* and *queries*.
A command usually changes device or database state.
A query can query live or historical data of a device.

Most voice interactions are short and specific. 9

Voice command

A users starts with a wake word, e.g. "Computer, ...".
The device records each request as an audio stream.
The voice service backend infers the speaker's intent.
A Webhook call posts the intent, e.g. in JSON format.
The product backend transforms it into actions.

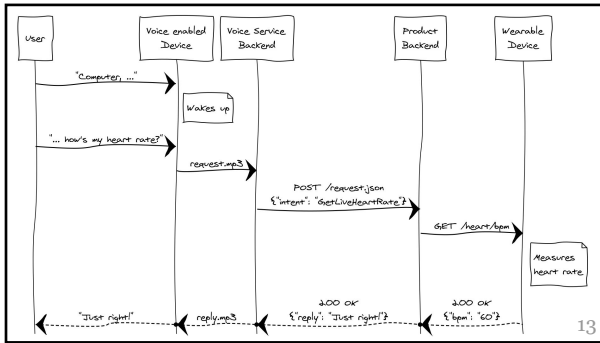
E.g. "Computer, switch on the light!" 10



Voice query

A users starts with a wake word, e.g. "Computer, ...".
The device records, backend infers the speech intent.
A Webhook call posts the intent, e.g. in JSON format.
The product backend transforms intent into queries.
It gets data from the device and formulates a reply.

E.g. "Computer, how's my heart rate?" 12



Wake word detection

If the voice device detects the *wake word* it wakes up.

E.g. "Alexa", "Computer", "Siri", or "OK Google".

Devices should not record audio before waking up.

A wake word protects privacy and preserves power.

It also provides a clear conversation starting point.

Wake word detection can be done in hardware.

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Amazon Alexa

[Alexa](#) is Amazon's cloud-based voice service.

"It converts spoken words to text using [automatic speech recognition](#), deduces the speaker's meaning using [natural language understanding](#), and provides the underlying customer intent to your skill."

— from the [Alexa Skills Kit](#) documentation.

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Alexa skills

Skills are apps for the Amazon Alexa voice service.

A skill runs on the product backend or as glue code.

Here are some examples of [smart home Alexa skills](#).

Amazon provides [blueprints of skills](#) to developers.

Custom Alexa skills [can be published](#) in the [store](#).

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Alexa Skills Kit SDK

The [Alexa Skills Kit](#) has a [Node.js SDK](#) to build skills.

It includes a simple [Node.js Hello World Alexa skill](#).

The examples use [AWS Lambda](#) to run glue code.

Here's how to [enable logging on AWS Lambda](#).

Consider using the [Smart Home Skill API](#).

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Hands-on, 15': Hello World Alexa skill

Build and deploy the [Hello World Alexa skill tutorial](#).

Use *Test* or [Echosim.io](#) to simulate an Alexa device.

[Read the docs](#) on intents, utterances and slots.

How would you integrate a product backend?

Deploying requires an [AWS account](#).

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Intents

```
{ "intents": [ // what a user intends
  { "intent": "GetLastFeeding" },
  { "intent": "GetFedToday" },
  { "slots": [
    { "name": "Date",
      "type": "AMAZON.DATE" }],
    "intent": "GetFedAtDate"
  }
] }
```

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Utterances

How a user expresses an intent.

GetLastFeeding when I last fed the fish
GetLastFeeding when I gave food to the fish

GetFedToday if I fed the fish
GetFedToday did I give the fish any food

GetFedAtDate if I fed the fish {Date}
GetFedAtDate did I feed the fish {Date}

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Slots

A *slot* is a placeholder for a class of variable input.

E.g. here, *Date* can be today, yesterday, May 4th, ...
GetFedAtDate did I feed the fish {Date}

The parsed date is transmitted in the Webhook call.

Every slot has a slot type, either [built-in](#) or [custom](#).

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Naming a skill

Amazon asks publishers to choose a unique name.

Ideally, the name is a generic word*, e.g. *fish tank*.

See also the Amazon [naming guidelines for skills](#).

*These will be gone quickly, like short DNS names.

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Using the skill

"Alexa, ask *fish tank* to feed the fish!"

"Alexa, ask *fish tank* if I did feed the fish?"

"Alexa, ask *fish tank* did I feed the fish today?"

"Alexa, ask *fish tank* when did I last feed the fish?"

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Voice interaction design

Let users speak in their own words, adapt to them.

Individualize your entire interaction, be personal.

Collapse your menus, make all options top-level.

Talk with them, not at them — be relatable.

See [how to shift screen-first to voice-first design](#).

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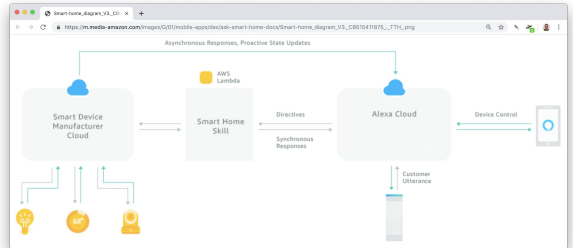
Hands-on, 10': Voice interaction design

Imagine a simple voice controlled connected device.
Find three use-cases and the corresponding *intents*.
Write down two realistic *utterances* for each intent.

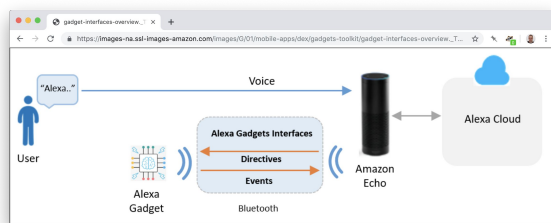
Be ready to present your results.

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Smart Home Skill API reference model



Alexa Gadgets Toolkit reference model



How gadgets interact with Alexa via Bluetooth.

Alexa Voice Service API

[Alexa Voice Service](#) allows to "voice-enable" devices.
Amazon lists [hardware dev kits](#) for manufacturers.
The [functional requirements](#) are defined in detail.
And a [user experience design guide](#) is provided.

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Dialogflow Natural Language Service

[Dialogflow](#) provides a natural language "meta" API.
The service works with Google, Amazon, Apple, etc.
It abstracts dialogs for chat bots and voice control.
You define [intents](#) and [entities](#) in different [contexts](#).
Your [fulfillment](#) server consumes Webhook calls.

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Privacy considerations

"Voice prints", like fingerprints, can identify people, e.g. the Alexa voice service supports [voice profiles](#).
Voice recordings are personal data* under the [GDPR](#), so for EU citizens it's possible to get their recordings.
Sending personal data to a cloud backend trades user privacy for use cases that are not possible on-device.

*Got an Alexa? Check [your personal archive](#).

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Unintended consequences

A [Southpark episode](#) spams people's shopping lists.
Normal sentences [trigger recording](#) of conversations.
[Judges issue warrants](#) to hand over Alexa recordings.
Amazon complies with [GDPR](#), but [sends wrong data](#).
And Amazon employees [listen to users recordings](#).

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Edge-device based solutions

Edge-based solutions often work without a backend.
[Snips.ai](#) is a simple, private-by-design voice assistant.
[Project Alias](#) is a privacy add-on for voice assistants*.
[Snowboy](#) is an on-device hotword detection engine.

*Here's a [video](#) of how it works.

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Hands-on, 10': Use cases in context

Come up with a use case for a *home, hotel & hospital*.
What changes with the context, what stays the same?
Who is the user? What does the system (not) know?
Who can see the data? How private is the data?

See [Alexa for business & hospitality](#) and [read this](#).

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Summary

We saw how a voice interface is connected to a device.
Backends are integrated via a simple Webhook call.
Voice interaction includes commands and queries.
Voice services provide intents, and values for slots.
Training a voice app means collecting utterances.

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Feedback or questions?

Write me on <https://fhnw-iot.slack.com/>
Or email thomas.amberg@fhnw.ch

Thanks for your time.

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