

ARGUMENTATION-BASED COORDINATION IN IOT: A SPEAKING OBJECTS PROOF-OF-CONCEPT

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OUTLINE

1. Why argumentation-based coordination in IoT?
2. The Speaking Objects vision
3. Real world prototype
 - PoC deployment
 - Feasibility

IOT SYSTEMS TODAY

Common design considers devices as simple providers of *services*:

- sensing services => raw data
- actuating services => commands

Likewise, most designs adopt a centralised, *cloud-based* perspective:

1. raw sensor data collected at a control point
2. there analysed to inform decision making algorithms
3. finally actuator commands generated and sent

IOT SYSTEMS TOMORROW

Devices becoming smarter by *embedding* AI algorithms:

- sensors: raw data => situations => **state of affairs**
- actuators: commands => rules => **goals**

Deployments moving to *Fog/Edge*, massive scale:

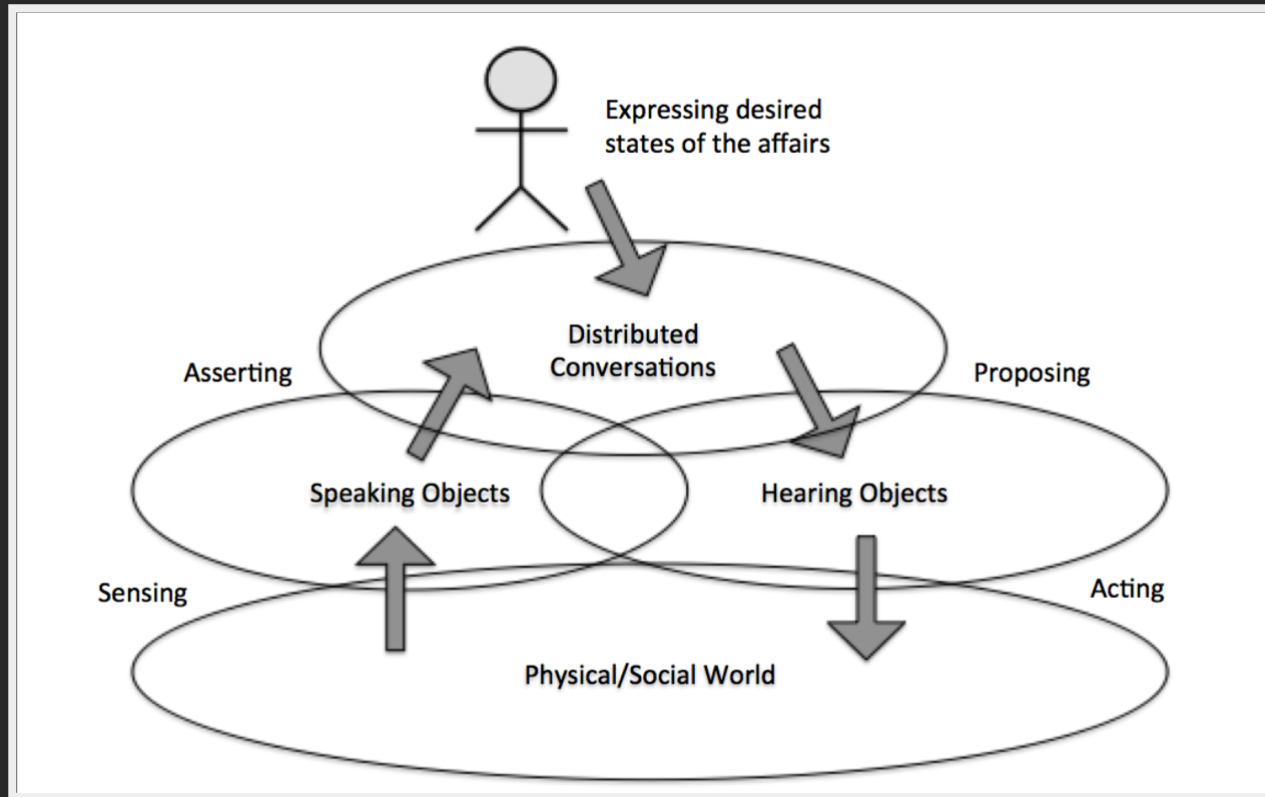
- distributed sensing and control
- **decentralised coordination**
- local actions => global effects

PARADIGM SHIFT

Coordination => **argumenting** about current and future “state of the affairs”:

- sensors => "speaking" objects
- actuators => "hearing" objects
- protocols => argumentation frameworks

SPEAKING OBJECTS: CORE IDEA



SPEAKING OBJECTS: COORDINATION

Interaction is the focal point (vs. Smart Objects)

- Speaking-to-Speaking => shared understanding
- Speaking-to-Hearing => planning
- Hearing-to-Hearing => joint deliberation

Dialogue types to frame **conversational coordination**

SPEAKING OBJECTS: EXAMPLE



FROM THEORY TO PRACTICE

- Target scenarios:
 - detect *home invasion*, act accordingly
 - detect *energy saving* opportunities, act accordingly
- Requirements:
 1. *affordable* devices, easy acquisition => scalability, time to market
 2. *distributed* deployment => scalability, faithful to Speaking Objects vision
 3. p2p interaction => scalability, faithful to Speaking Objects vision
 4. basic argumentation => coordination, faithful to Speaking Objects vision

ISSUES: CONTEXT VS. COMMONSENSE

Contextual knowledge is:

- highly dynamic
- situated in time and space
- tied to specific goals and functions
- e.g. data streams from sensors

Commonsense knowledge is:

- quasi-static
- non situated
- general purpose
- e.g. relative concepts such as short vs. tall, hot vs cold
- e.g. basic cause => effect laws such as light on => illumination higher

Where to put it? Context at the Edge vs. commonsense
in the Cloud?

ISSUES: ABSTRACTION GAP

Goal-orientation vs. commands:

- **commands** => no processing => cheap Edge devices
- reactive rules => little processing => Edge/Fog devices?
- planning => medium processing => Edge/Fog devices + AI?
- **goals** => heavy processing => Cloud only?

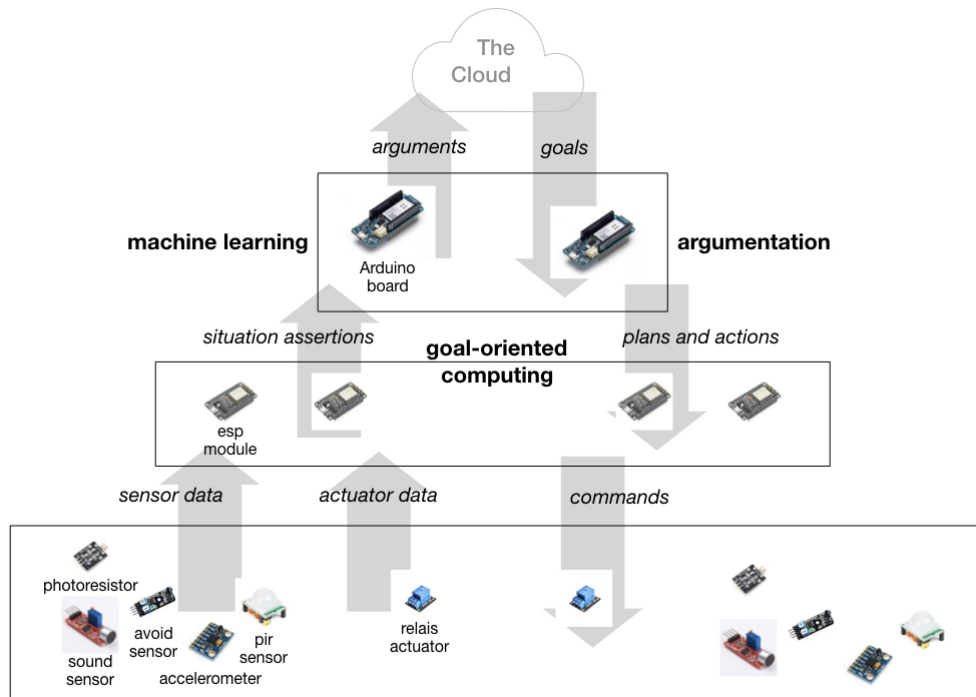
Agents at the Edge?

Situations vs. perceptions:

- **raw data** => no processing => cheap Edge devices
- aggregate information => little processing => Edge/Fog devices?
- information fusion => medium processing => Edge/Fog devices + AI?
- **situation recognition** => heavy processing => Cloud only?

Machine learning at the Edge?

POC: ARCHITECTURE



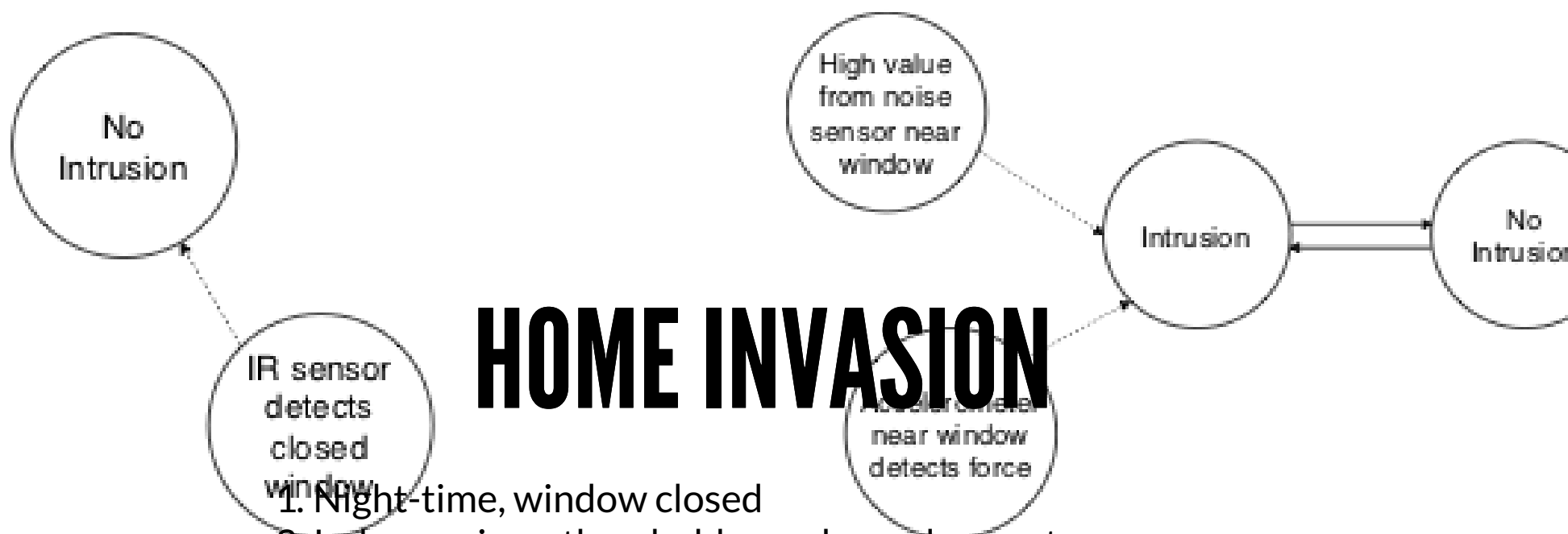
- *Cloud* (laptop PC): arbitration, **goal** setting
- *Fog* (Arduino / ESP): embedded AI, **arguments** generation, planning
- *Edge* (sensors / actuators): raw data, commands

POC: FEASIBILITY

Device	Price	Availability	Store
Arduino MKR 1000 Wi-Fi	30,99	wide	Official Arduino store
Esp 8266	1,55	wide	Amazon
Ir Sensor (avoid)	3,00	wide	Amazon
Sound Sensor	1,00	wide	Amazon
MPU6050 (accelerometer)	4,00	wide	Amazon
Pir sensor	2,90	wide	Amazon
Relay	3,05	wide	Amazon

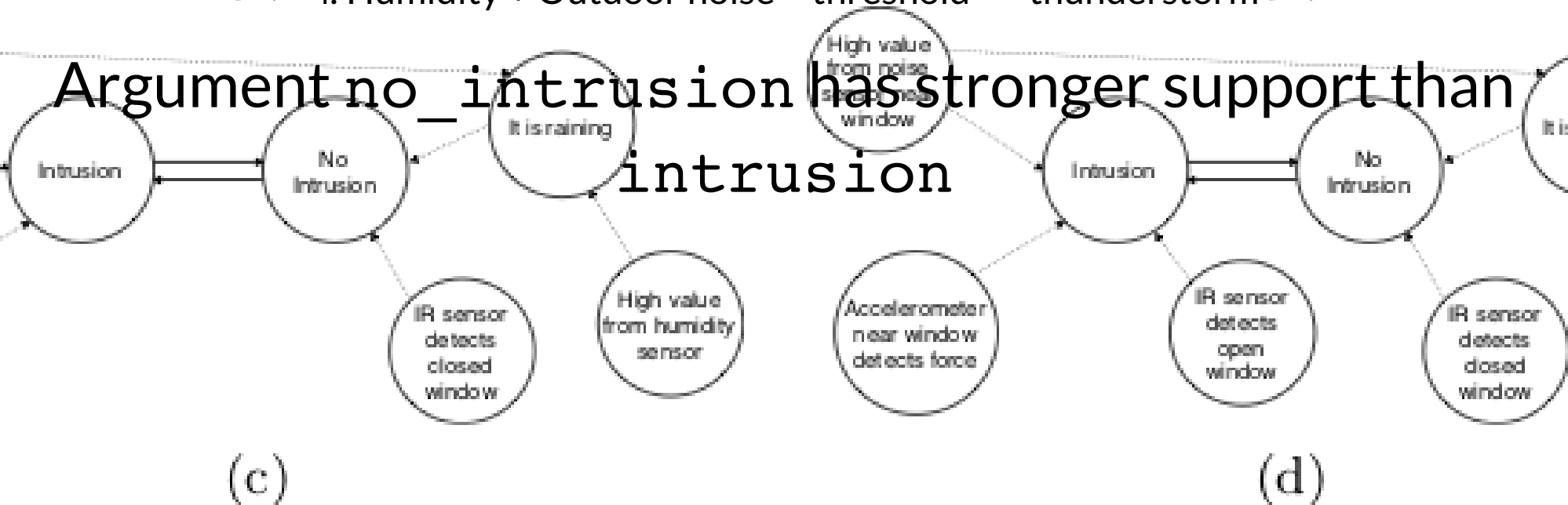
ESP modules *key enablers* of p2p

- wi-fi connection to local network for any device
- basic data processing and rule-based reasoning

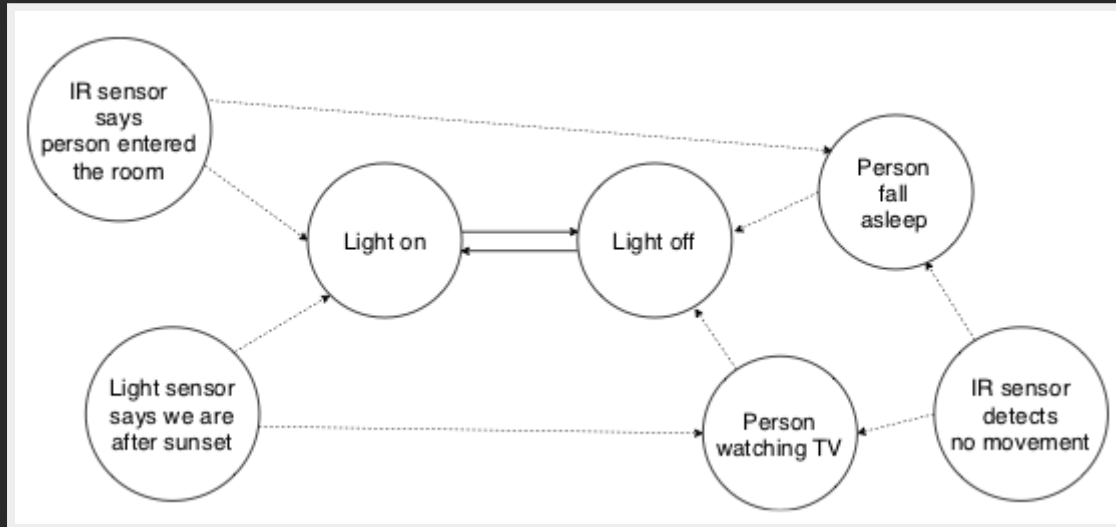


1. Night-time, window closed
2. Indoor noise > threshold => ask accelerometer
3. Force > threshold => ask humidity
4. Humidity + Outdoor noise > threshold => thunderstorm

Argument `no_intrusion` has stronger support than `intrusion`



ENERGY SAVING



- person + sunset => lights on
- TV on + preference => lights off
- no movement => asleep
- asleep => lights off

Rules are commonsense, perceptions are context

logic facts + ConceptNet knowledge base

LESSONS LEARNT

- **Key technologies** ready for Speaking Objects
- Unclear where / how to deploy **commonsense** knowledge
- **Weak agency** feasible at the Edge / Fog
- Need **AI benchmarks** assessing where the line between Edge and Cloud is

**THANKS
FOR YOUR ATTENTION**

QUESTIONS?

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