



# **Swarm Minimum Broker: an approach to deal with the Internet of Things heterogeneity**

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Marcelo Knörich Zuffo  
mkzuffo@lsi.usp.br  
University of São Paulo, Brazil



**Scientific  
counselors**

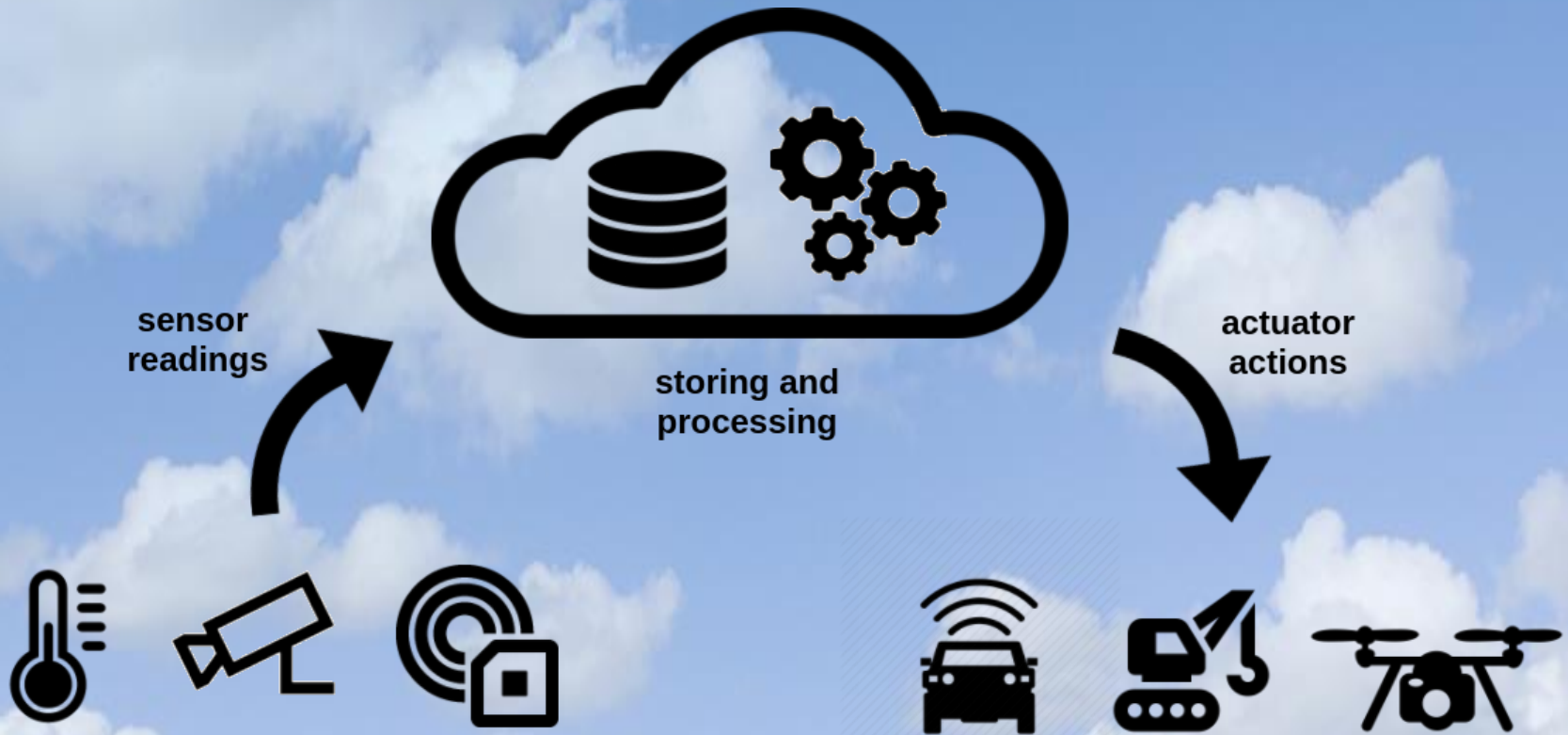
## **OUR TEAM**



**Researchers**



**Interns and  
trainees**



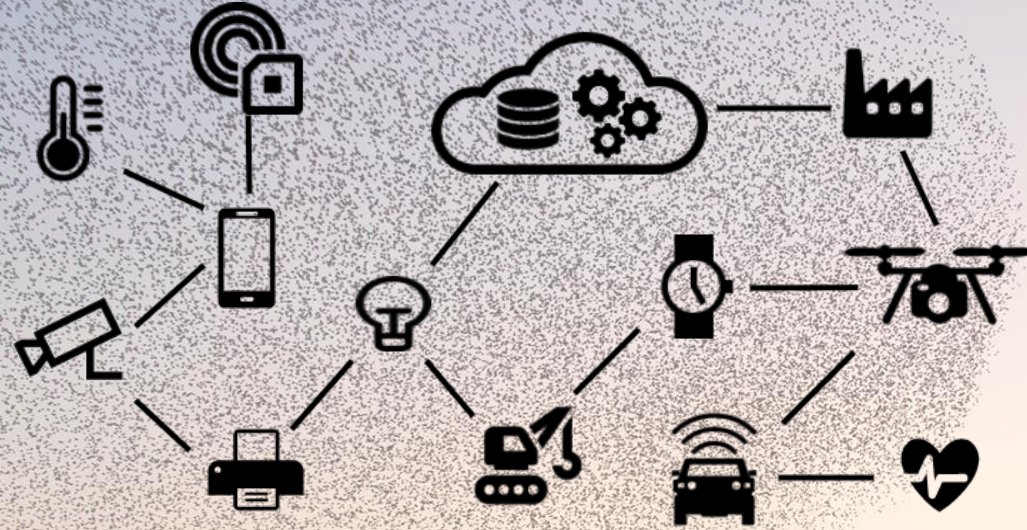
**Current IoT is cloud-centric**



- The Swarm is **edge-centric**
- Cloud is not the main participant
- Constitute a **P2P network of small resource devices.**

# The Swarm: a P2P Network

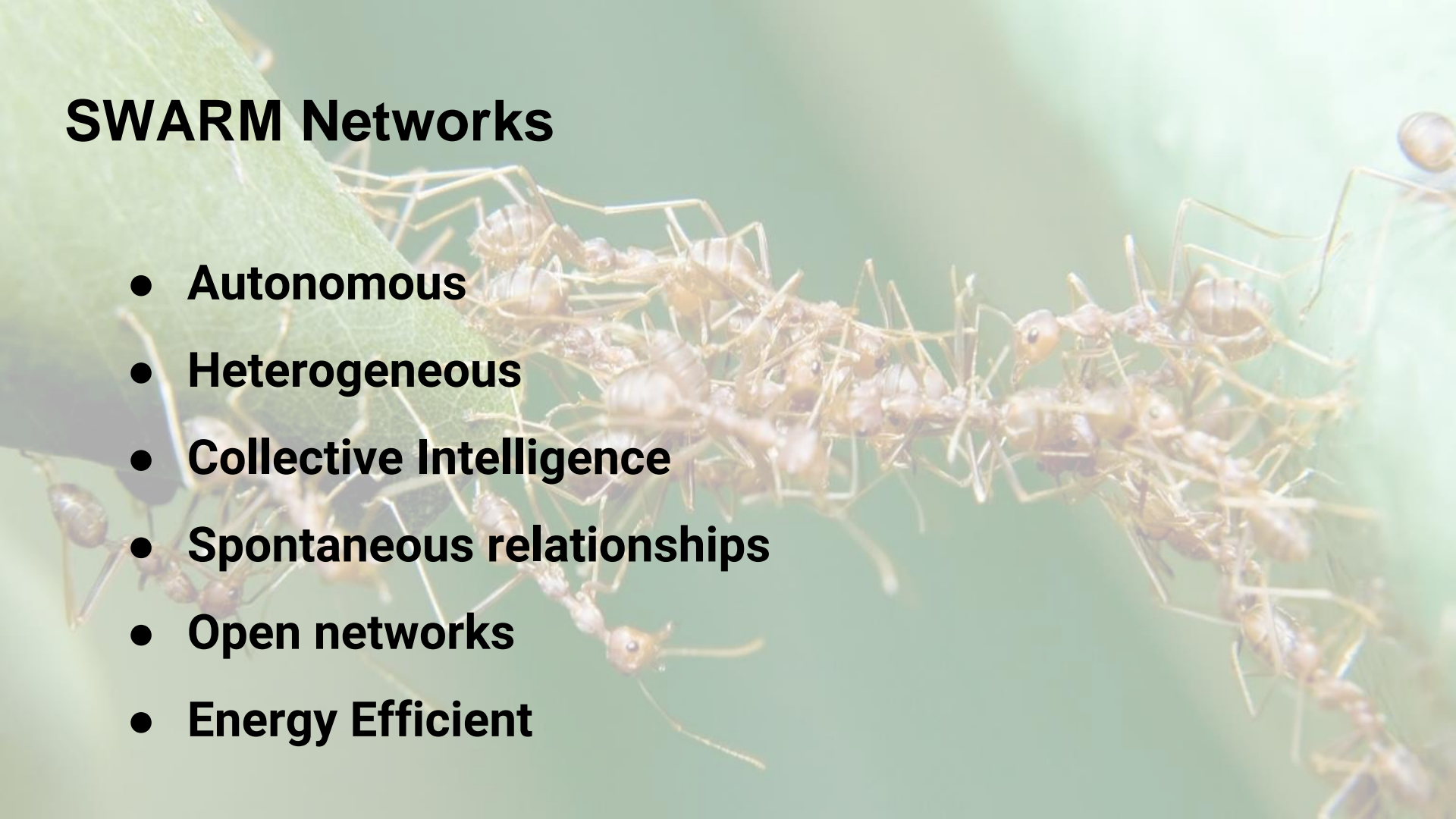
The Swarm network is composed of **intelligent individuals** that behave similarly to a society, showing an **organized behavior** that results in an emergent **collective intelligence**.





# SWARM Networks

- **Autonomous**
- **Heterogeneous**
- **Collective Intelligence**
- **Spontaneous relationships**
- **Open networks**
- **Energy Efficient**

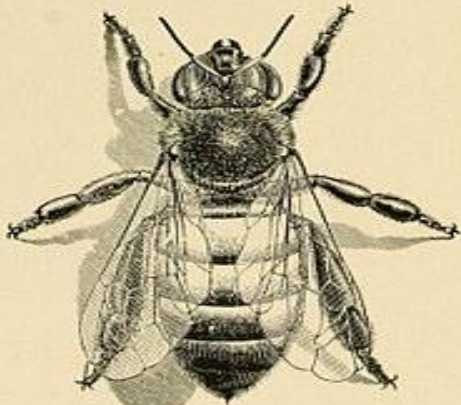


# The Problem: **Heterogeneity**

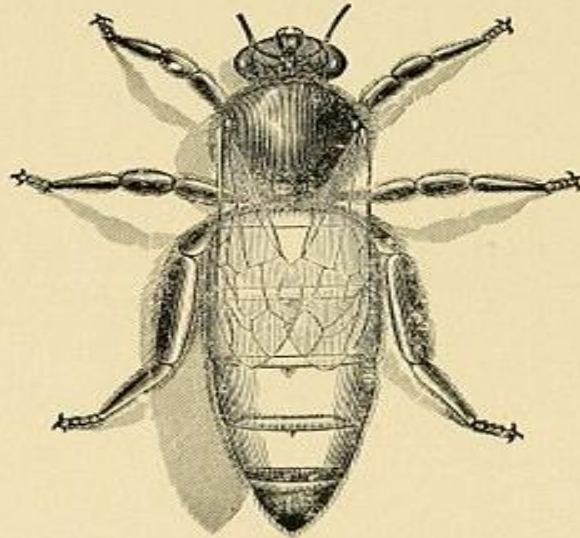
One of the main problems for **IoT implementations**

In this paper we address on resource heterogeneity, with a focus on **low constraint devices**

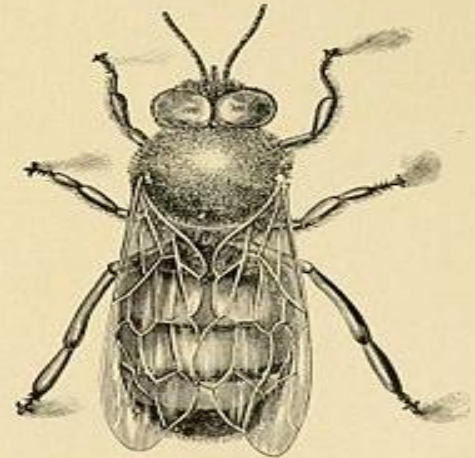
## The Edge of the Edge



WORKER.



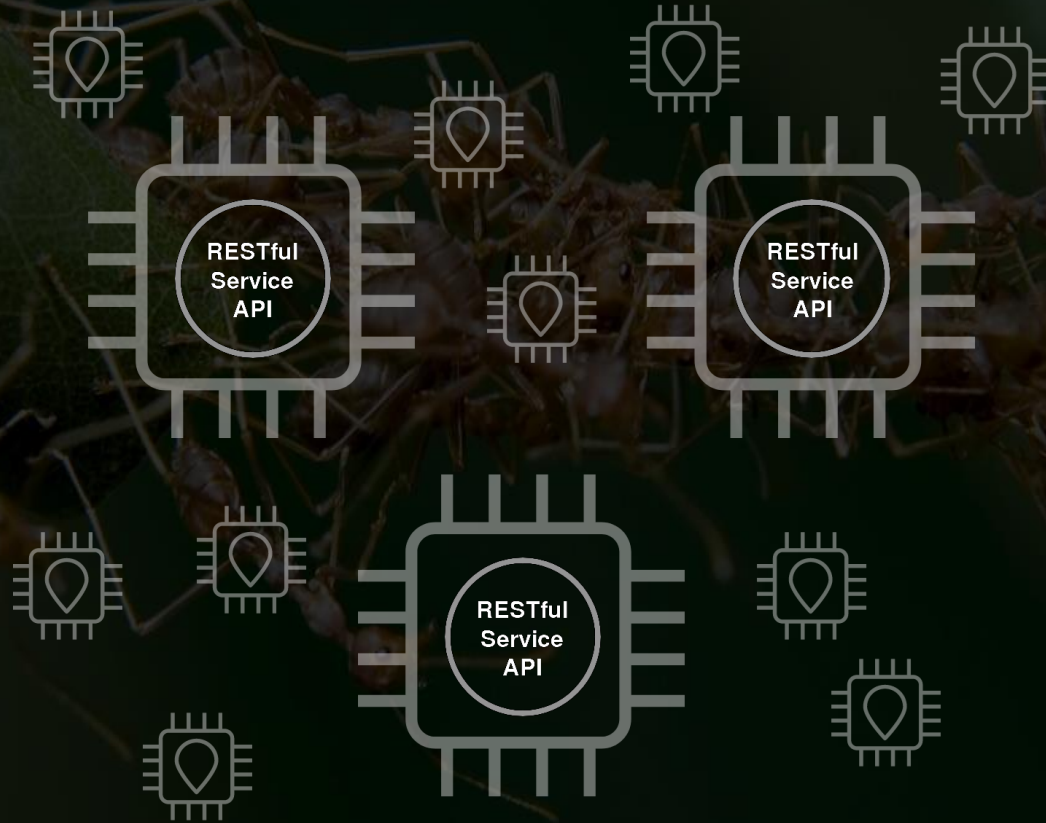
QUEEN.



DRONE.

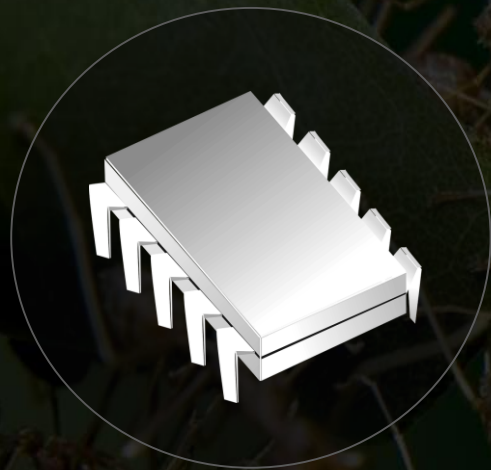
# In Swarm:

## Device functionalities are wrapped by Services





# The Swarm Broker



**Device**

+



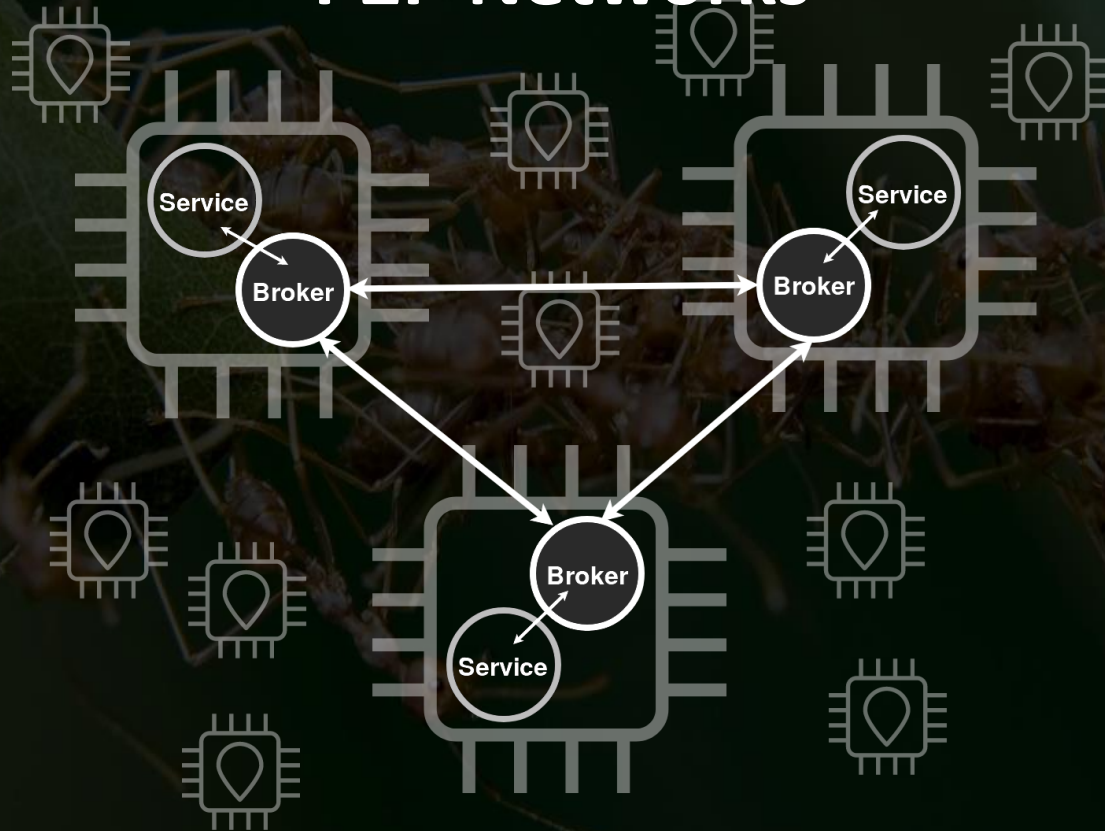
**Broker**

=



**Swarm Insect**

# Broker: a communication mediator on P2P Networks



## Application Services

### Platform Services (Broker)

Discovery  
Service

Registry  
Service

Access  
Control  
Service

Binding  
Service

Policy  
Management  
Service

Contracting  
Service

Optimization  
Service

Accounting  
Service

Mediation  
Service

## Broker architecture



**2 implementations**



## Application Services

### Platform Services (Broker)

Discovery  
Service

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Management  
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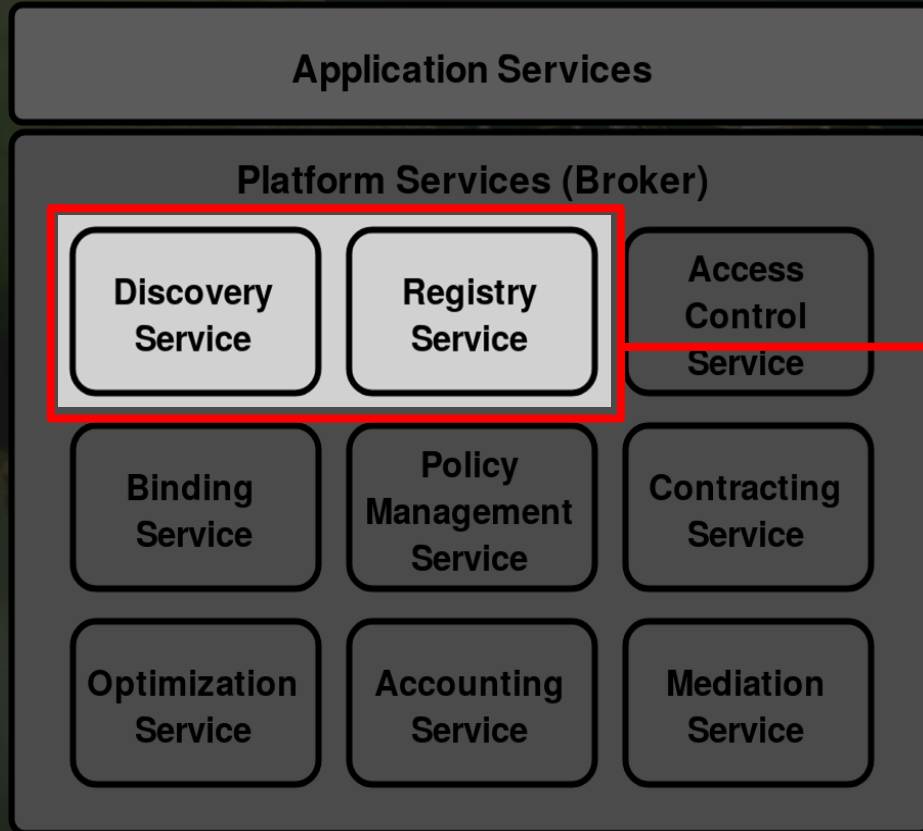
Contracting  
Service

Optimization  
Service

Accounting  
Service

Mediation  
Service

Still needs **simplification** for  
devices with  
**very small resources**



## The Minimum Broker

The minimum software modules for a device to participate in the Swarm network

Special for resource constrained devices

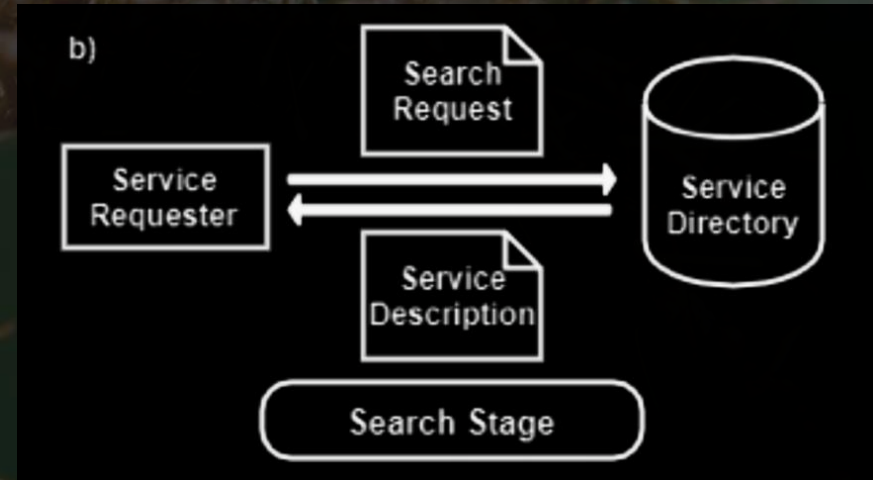
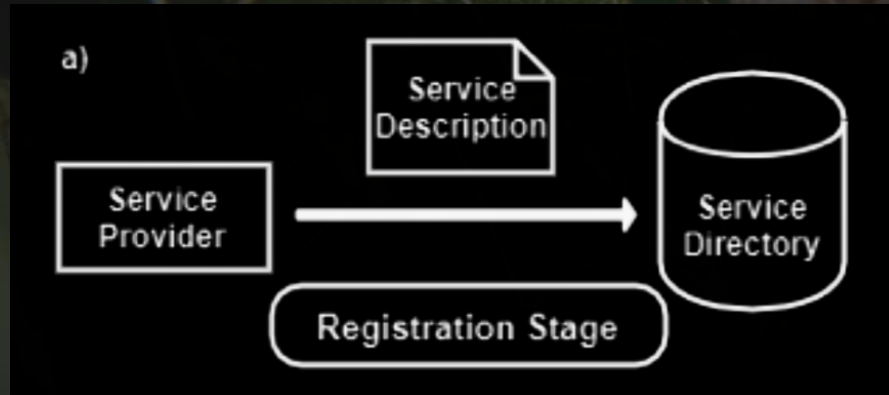
# Minimum necessary services: registration and discovery

Stage 1:

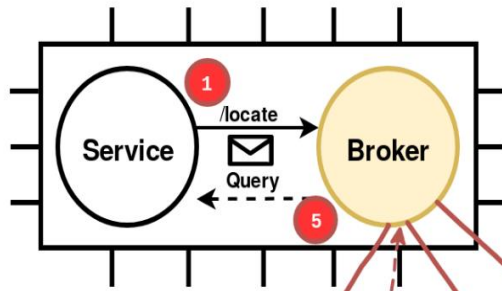
Service **registers** itself into  
Service Directory

Stage 2:

Service **searches** the  
Service Directory for other service







## The full locate process in 5 steps:

(1) A service asks Broker (originator) to find a service in the network.

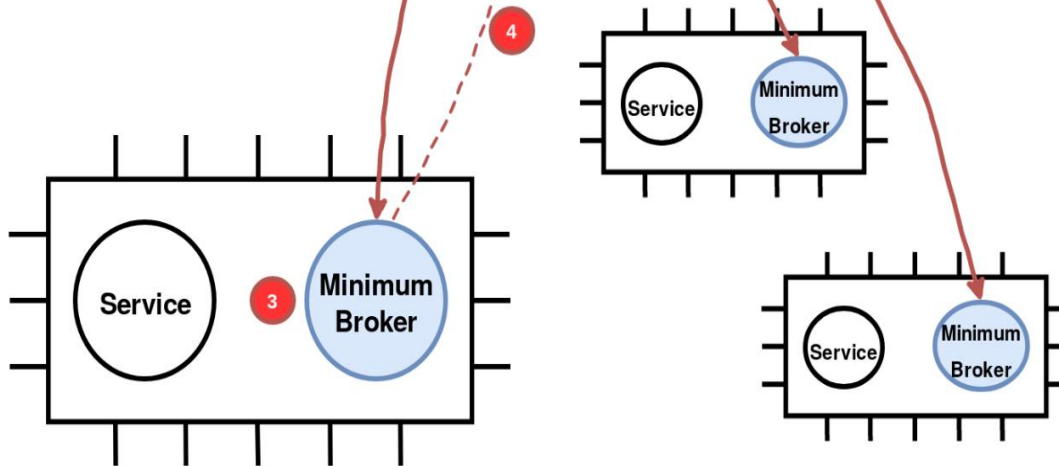
(2) The originator Broker sends a multicast request to the local network.

(3) A **Minimum Broker** receives the multicast SSDP request and searches for the requested service.

(4) If **Minimum Broker** finds the service it sends a response to the requester broker (unicast SSDP)

(5) The originator Broker sends a response to the requester with the services best descriptions found.

(6) A direct communication is established from service to service after the matching.



# Proof of Concept: **Smart-Office**

Ambient  
controller

Common  
Broker

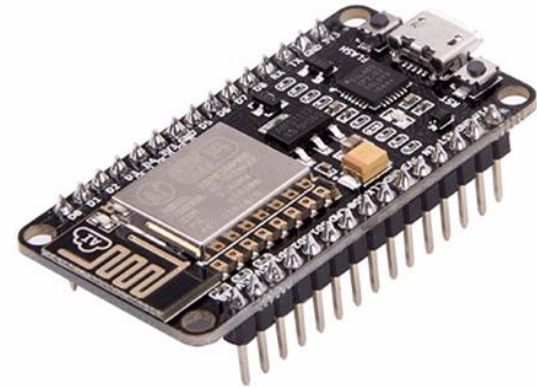
Light  
Switch

Infrared  
Receptor

**Minimum  
Broker**



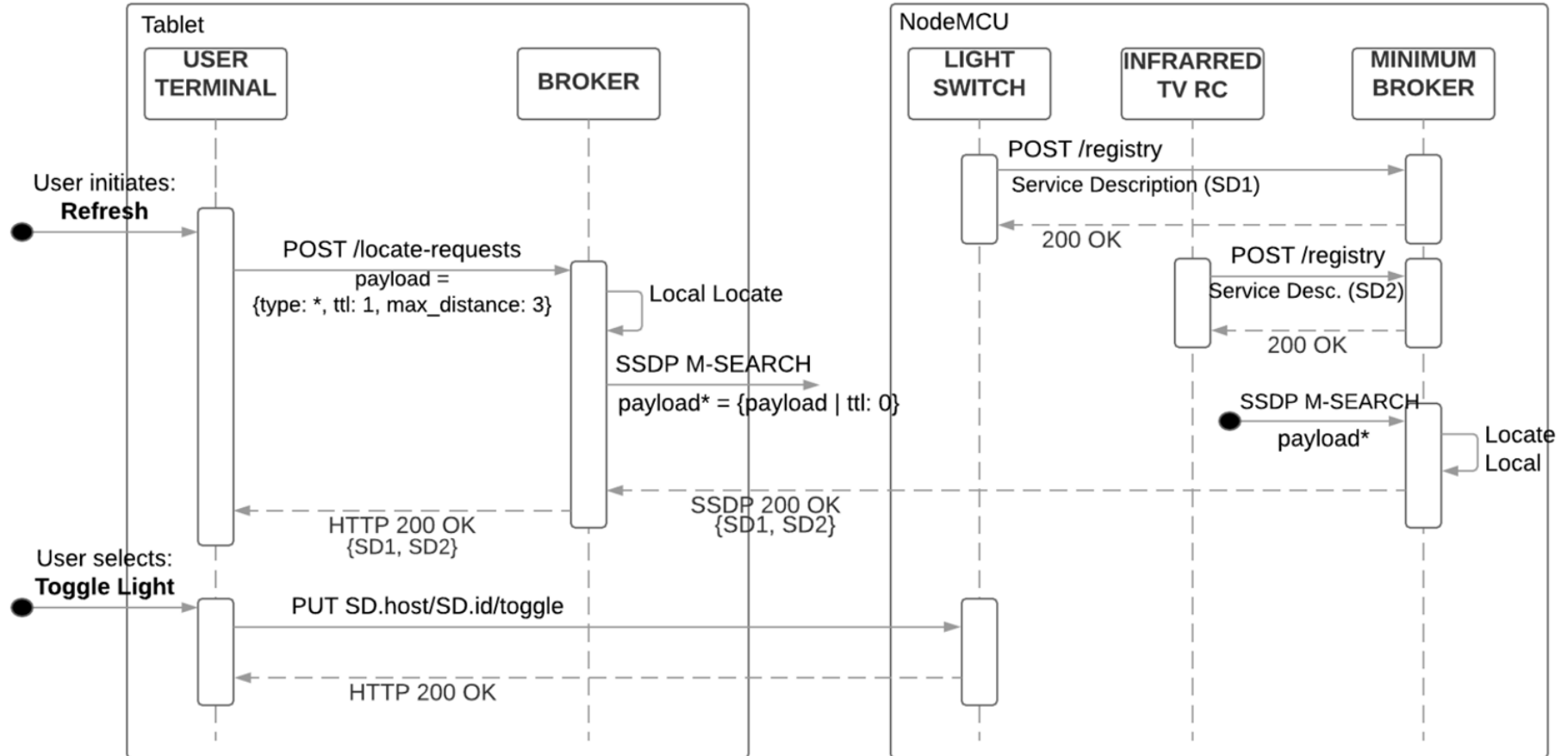
**Android Tablet**



**NodeMCU**

<https://en.wikipedia.org/wiki/NodeMCU>

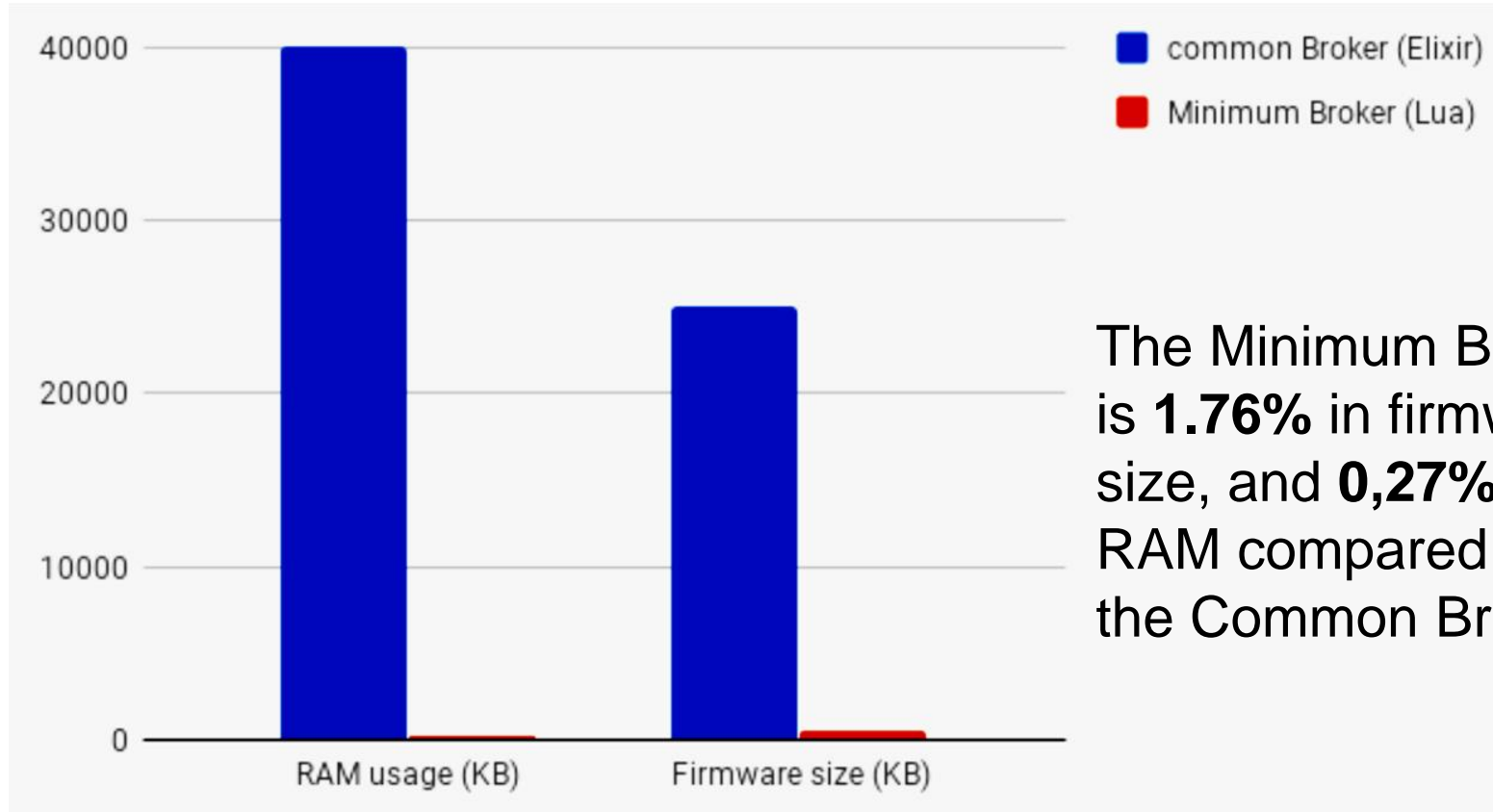
# Proof of Concept: Smart-Office





# Ultra low resource consumption

## Common Broker vs Minimum Broker



The Minimum Broker is **1.76%** in firmware size, and **0,27%** in RAM compared with the Common Broker.

# Conclusions

High scalability of Peer To Peer networking of low constraint devices is fundamental for the Swarm **heterogeneity**

The had proposed and successfully implemented a **Minimum Broker** in low constraint devices

We illustrated a scenario with a P2P network heterogeneous low constraint Brokers.

The minimum broker can bring collective intelligence to the **Edge of the Edge** in the Cloud

# Acknowledgements

Prof. Jan Rabaye UC Berkeley

USP Research Office

Insects that inspire us everyday



A large flock of birds, possibly starlings, is captured in flight against a soft, hazy sky at sunset or sunrise. The birds are concentrated in the upper right portion of the frame, creating a dense, textured pattern of dark silhouettes. The sky transitions from a pale blue at the top to a warm, orange-yellow glow near the horizon. The overall mood is serene and contemplative.

Questions?



A large flock of birds, possibly starlings, is captured in mid-flight against a soft, hazy sunset sky. The birds are concentrated in the upper right portion of the frame, forming a dense, dark, V-shaped pattern that tapers towards the top. The sky transitions from a pale blue on the left to a warm orange and yellow on the right, with a few wispy clouds visible. The overall mood is serene and majestic.

# Thank you

[mkzuffo@usp.br](mailto:mkzuffo@usp.br)