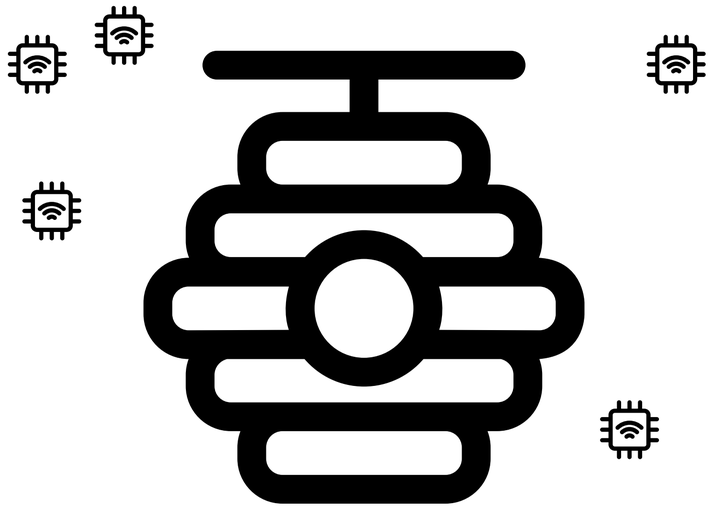
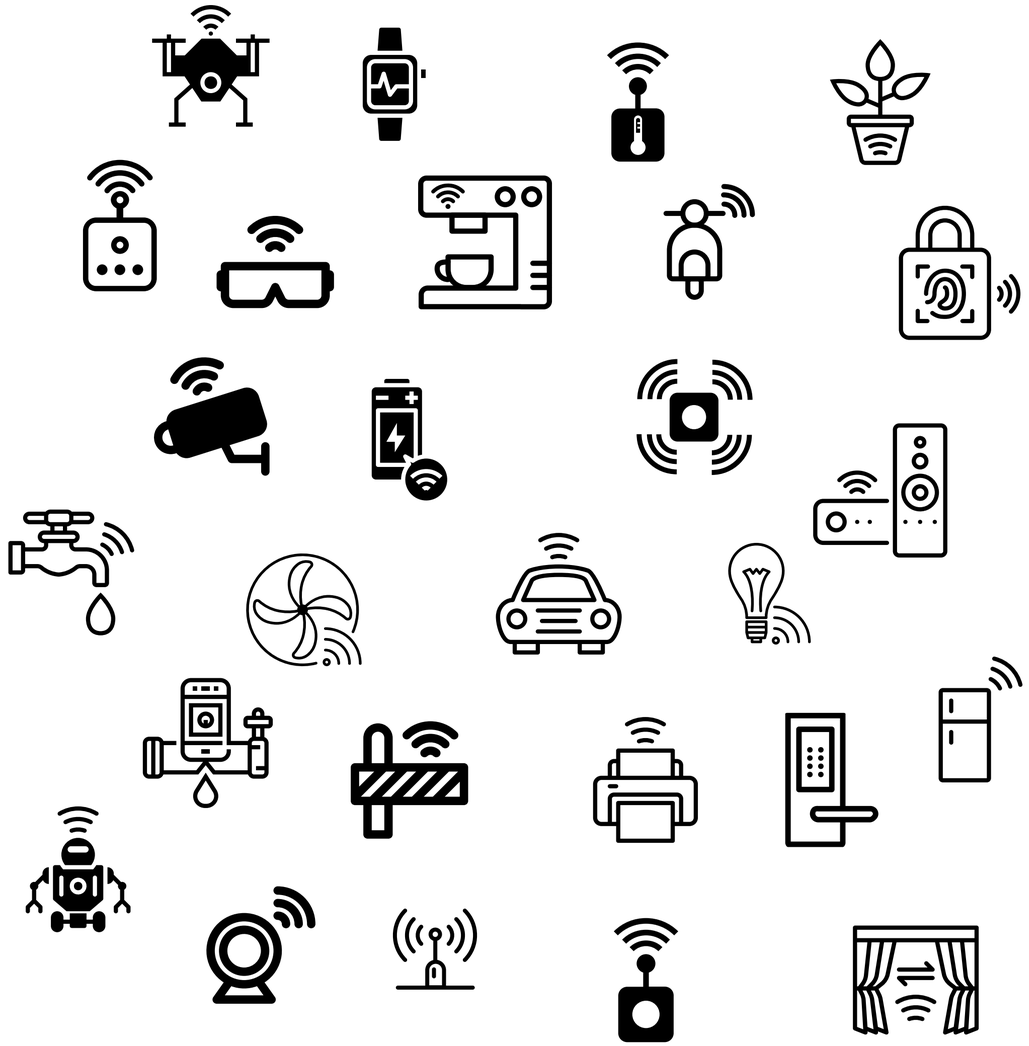
More Than The Sum of Its Things

Resource Sharing Across IoTs at The Edge

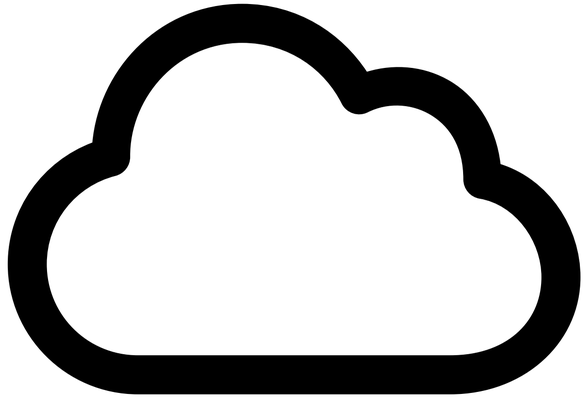


Aliaa Essameldin, Mohammed Nurul Hoque, Khaled A. Harras

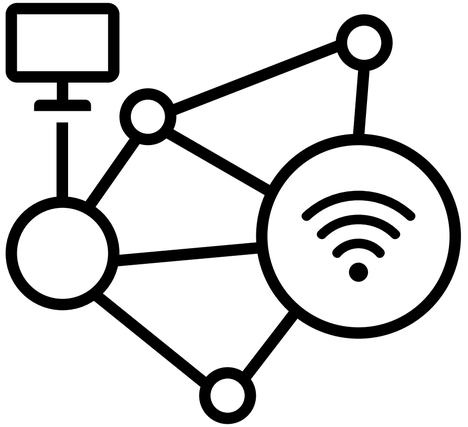
Growth and Diversity of Applications



Heterogeneous Devices

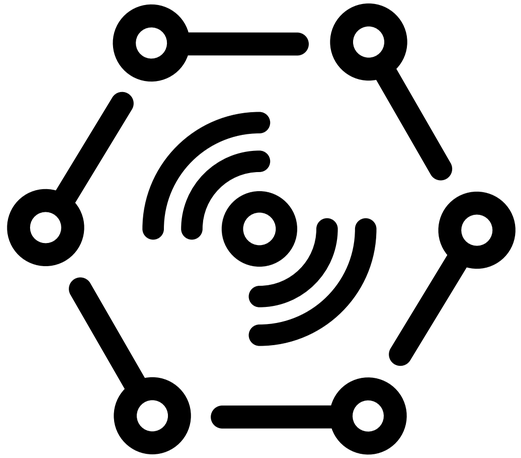


Middleware

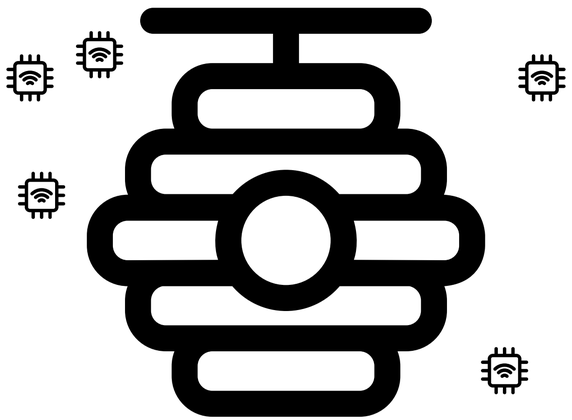


The Objective

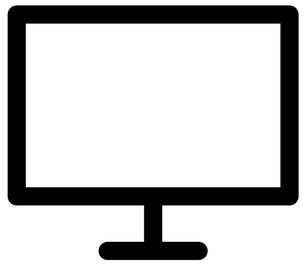
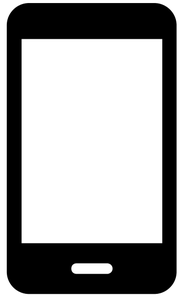
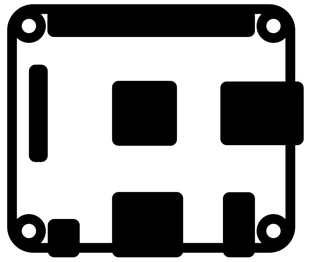
Seamless resource and context sharing at the edge

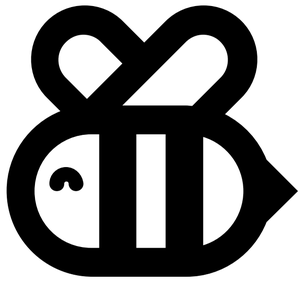
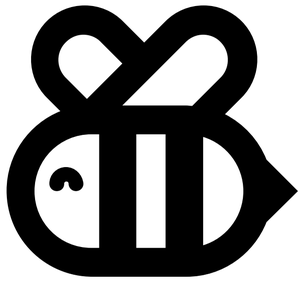
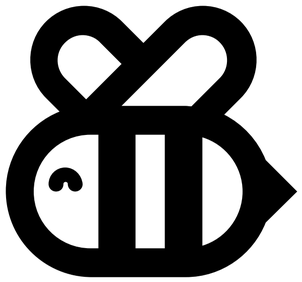
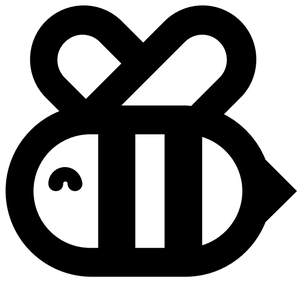
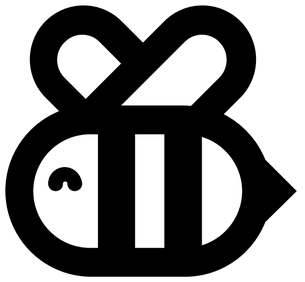


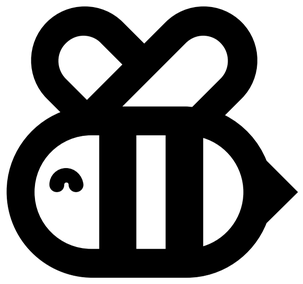
The Hive



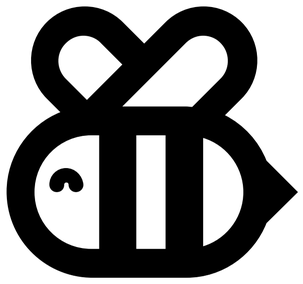
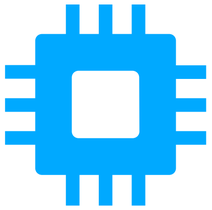
What is The Hive?

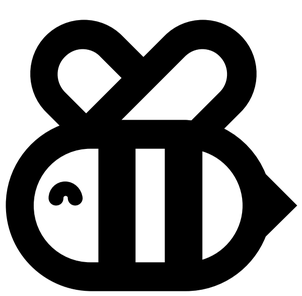




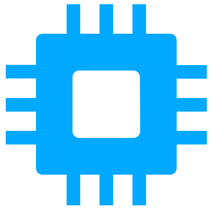
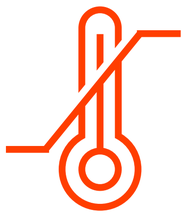
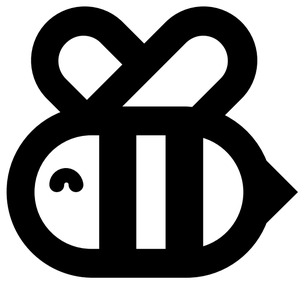






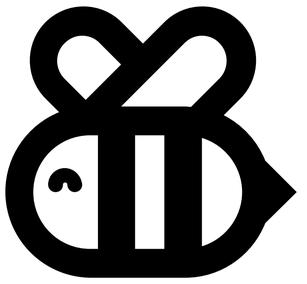


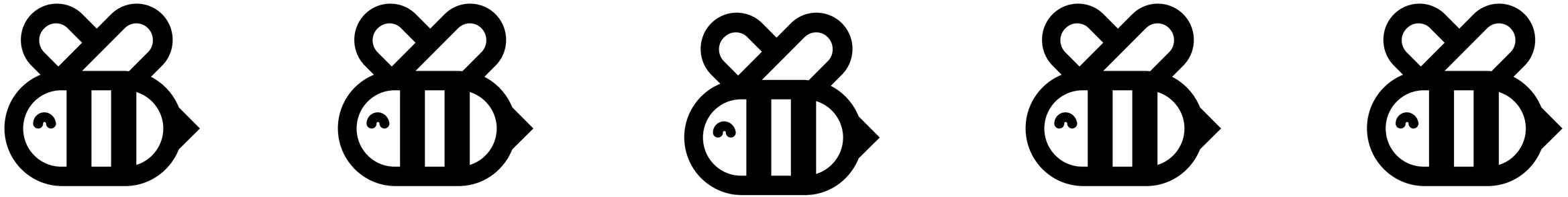


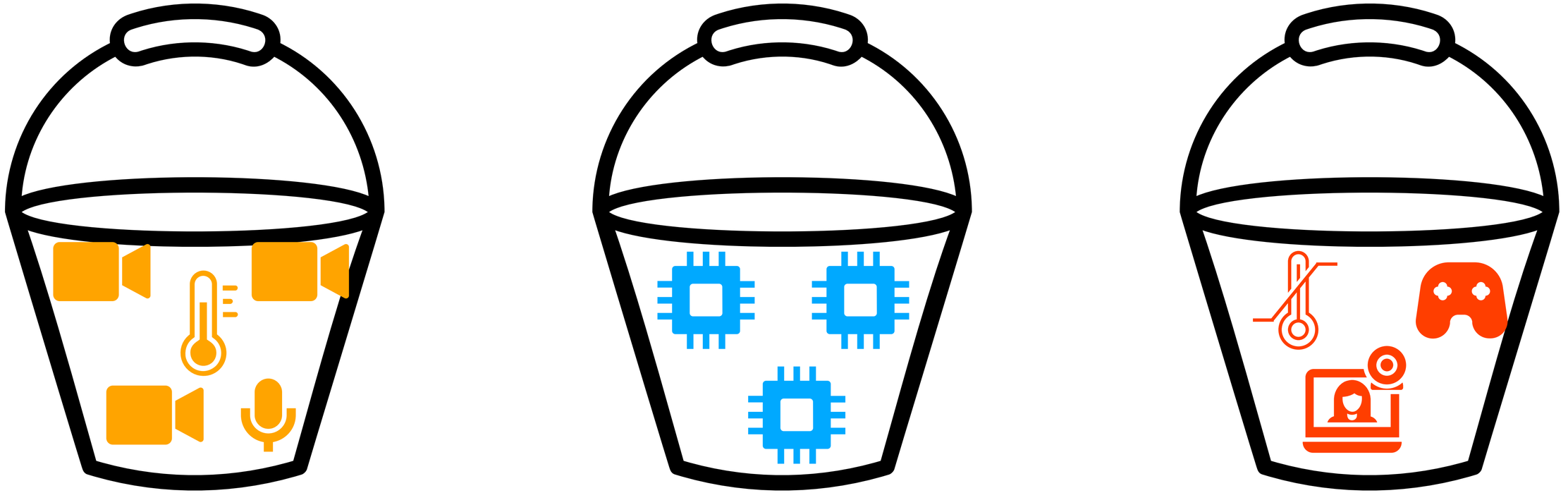







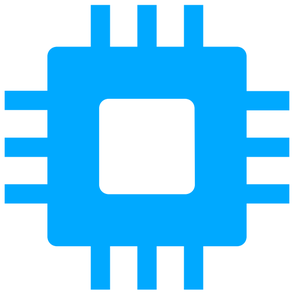


What is The Hive?

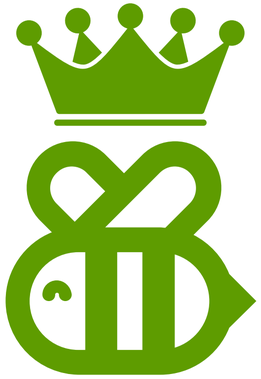
Edge-based middleware system maximizes resource sharing among IoT devices

Stage 1

Stage 2



Stage 3



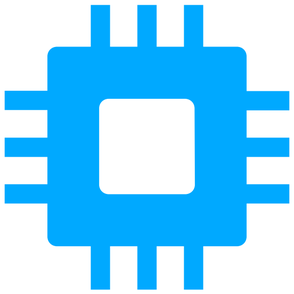
What is The Hive?

Data Exchange

Decouple applications and sensors

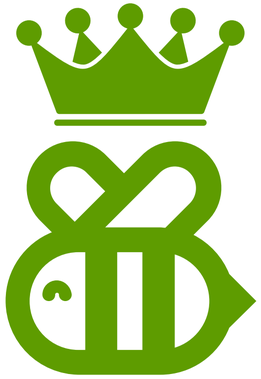
Processing

Share compute information



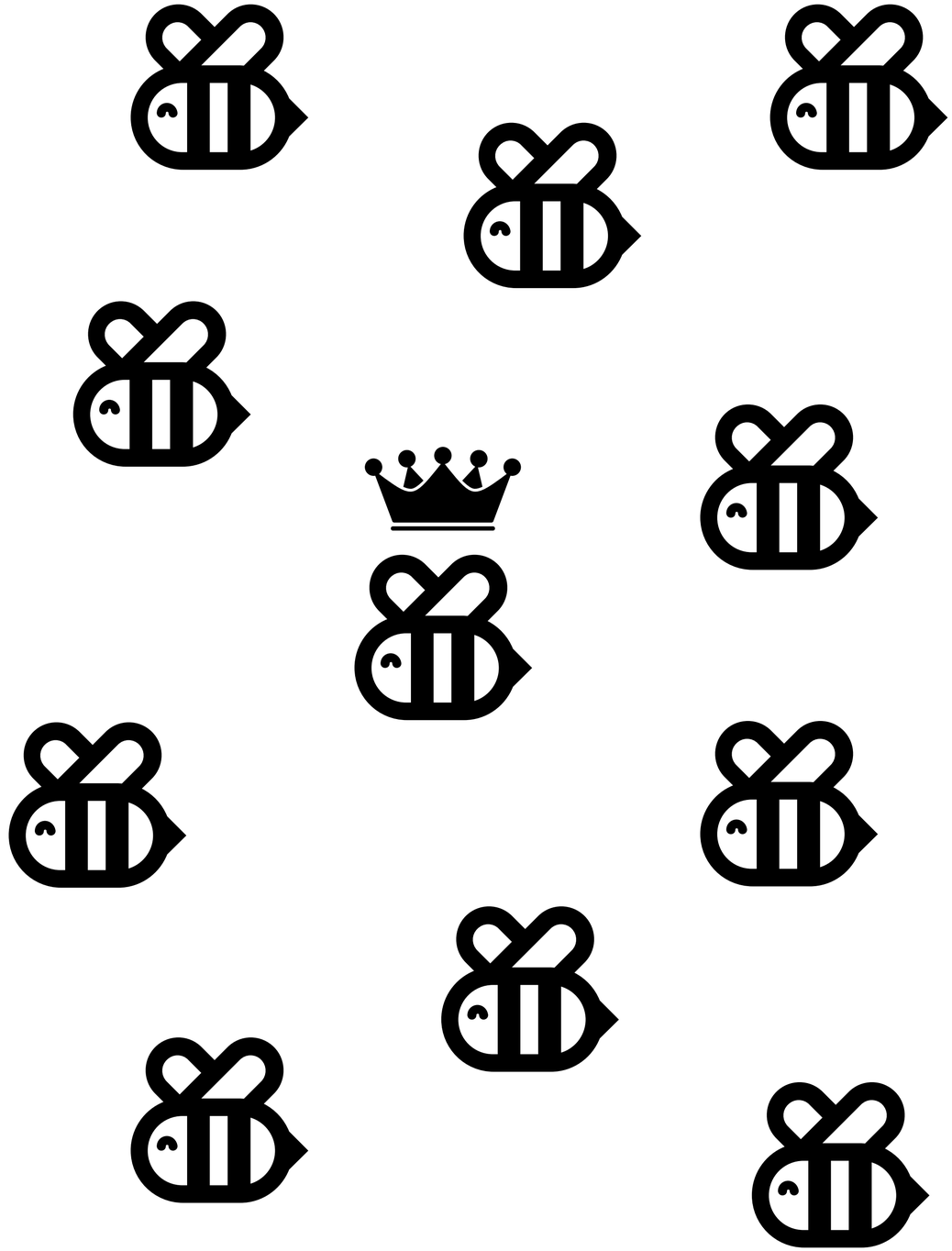
Core

Gather data and make decisions



Hive Protocol

Governs communication across all bees



Agenda

2. Related Work
3. Hive Motivation and Objectives
4. Hive System Architecture
5. Hive Protocol
6. Preliminary Assessment
7. Video Integration and Evaluation
8. Conclusion and Future Work

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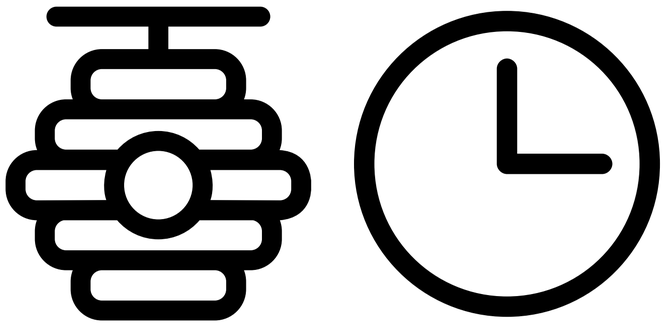
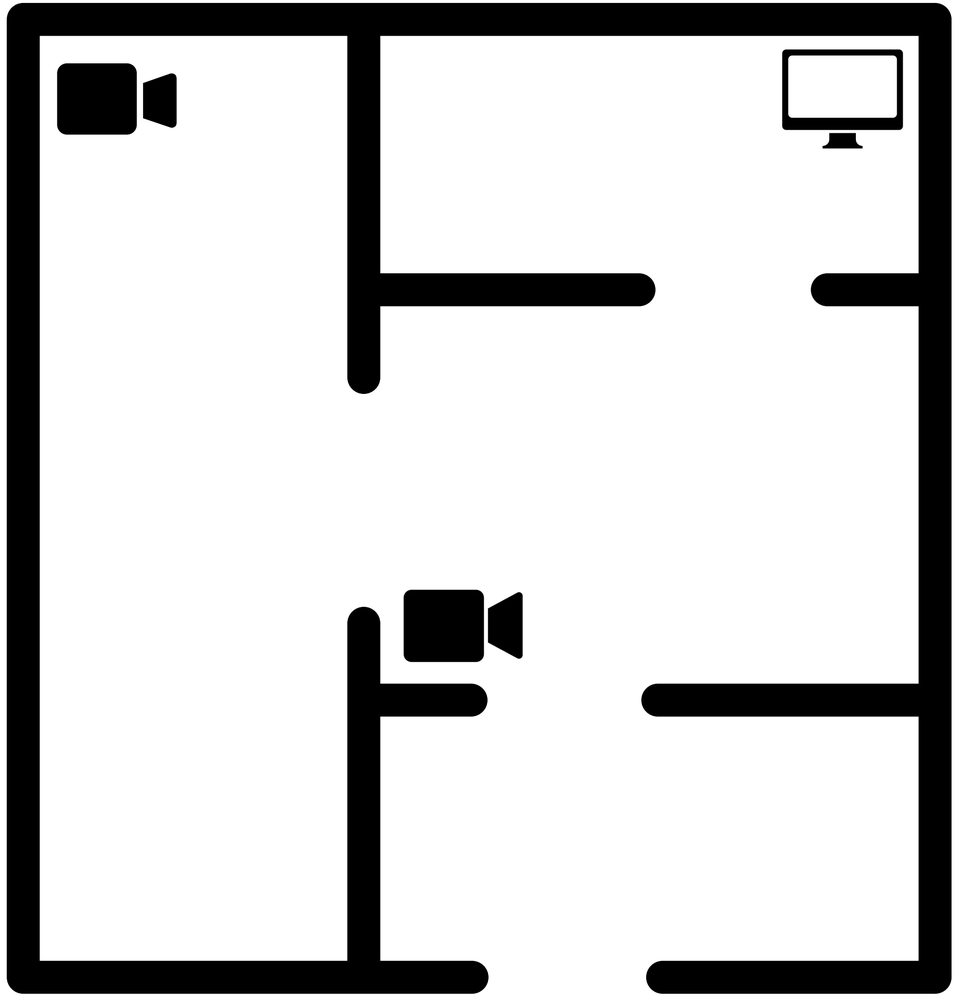
When to Hive?



Scenario 1

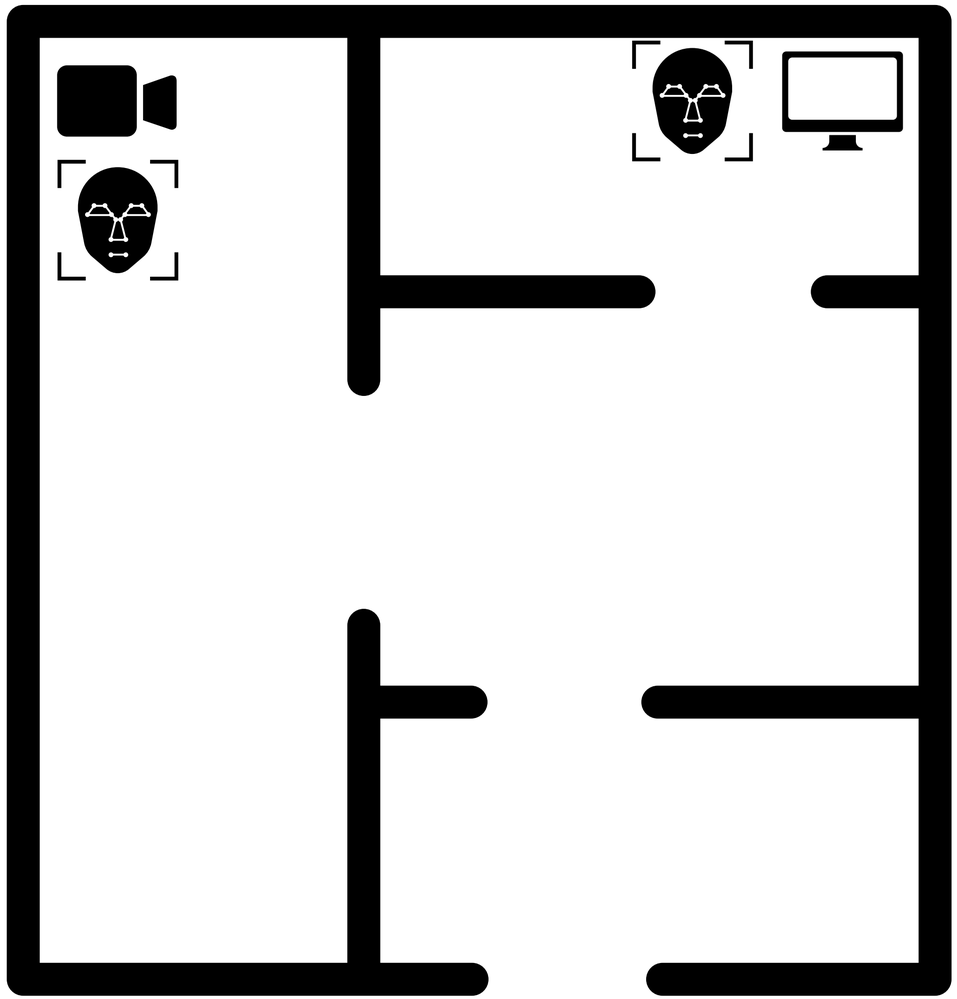
I walk and talk on a video call. Zoom starts uses video from my home camera system.



Scenario 2

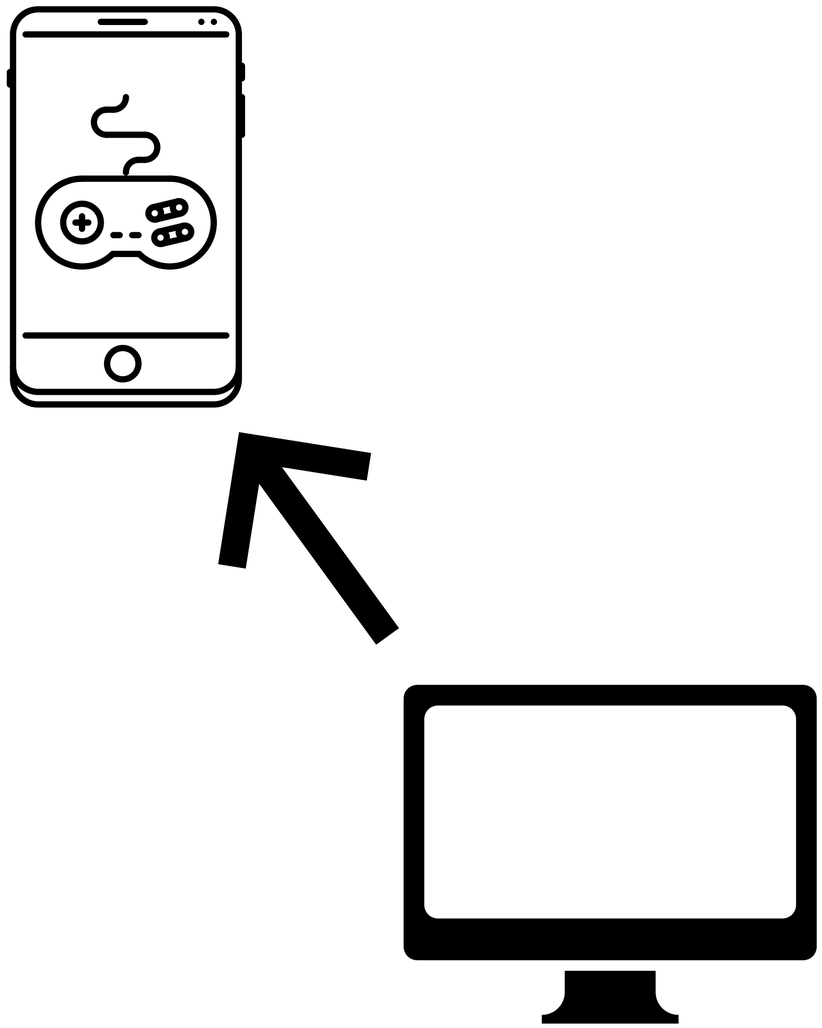
Both zoom and my camera’s security software use a common module to run facial recognition, so computation is saved.

*Assume Zoom is using video from my home camera system.



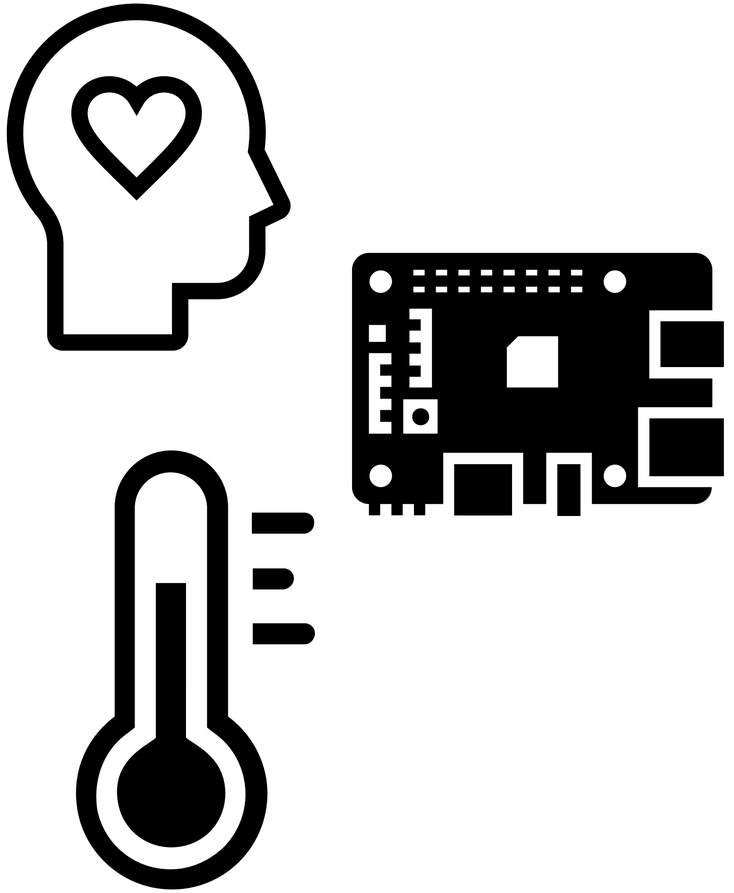
Scenario 3

A game on my phone begins to use compute resources on my laptop



Scenario 4

A mental health monitoring system factors in temperature readings from a raspberry pi.

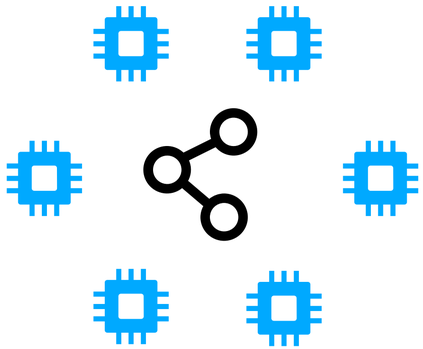


Goals

1. Sensor Data Sharing

2. Application Data Sharing

3. Compute Sharing



4. Optimal Sharing Decisions

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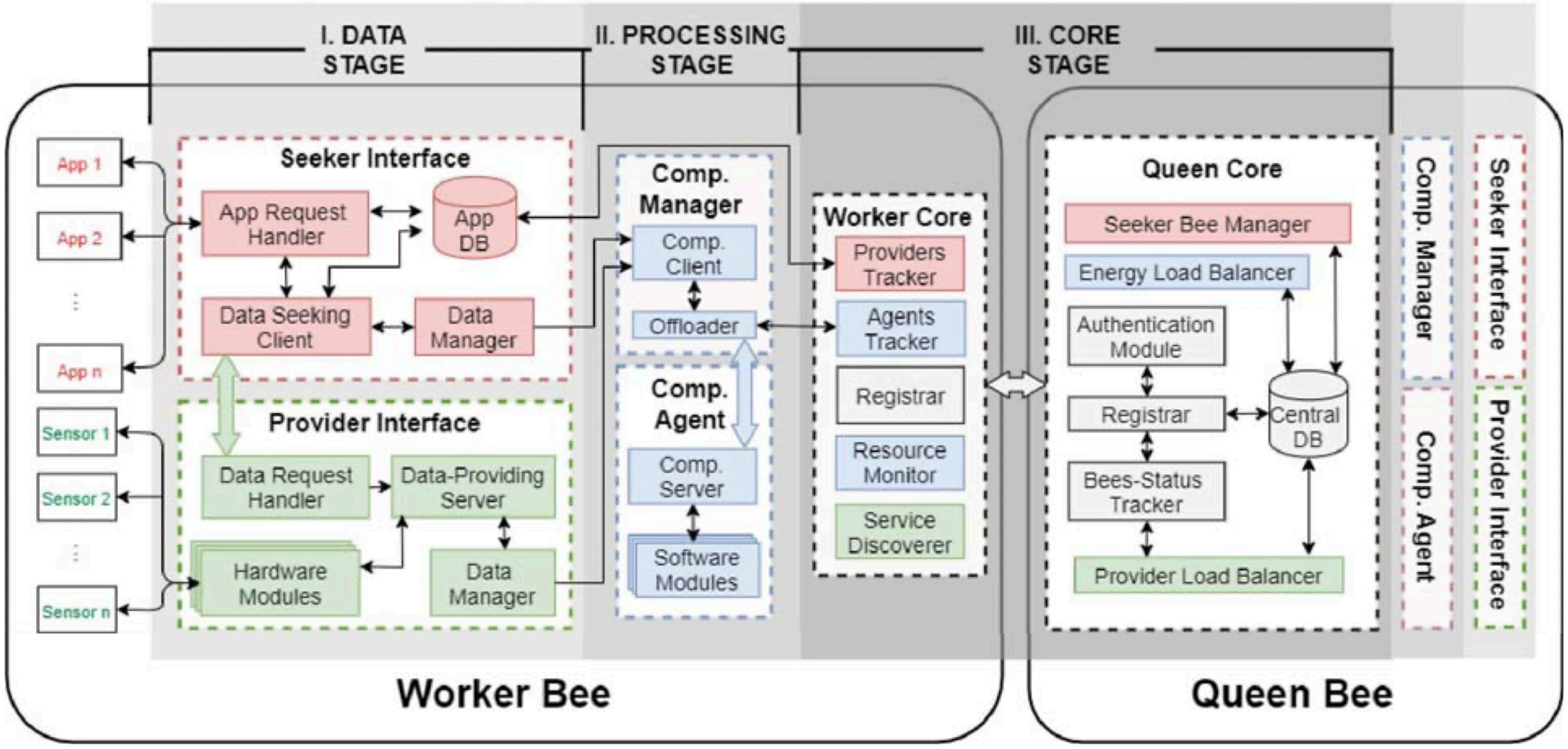
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App DB
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Data Manager
Provider Interface
Data Request Handler
Data-Providing Server
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Data Manager
Comp. Manager
Comp. Client
Offloader
Comp. Agent
Comp. Server
Software Modules
Worker Core
Providers Tracker
Agents Tracker
Registrar
Resource Monitor
Service Discoverer
Queen Core
Seeker Bee Manager
Energy Load Balancer
Authentication Module
Registrar
Central DB
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Comp. Manager
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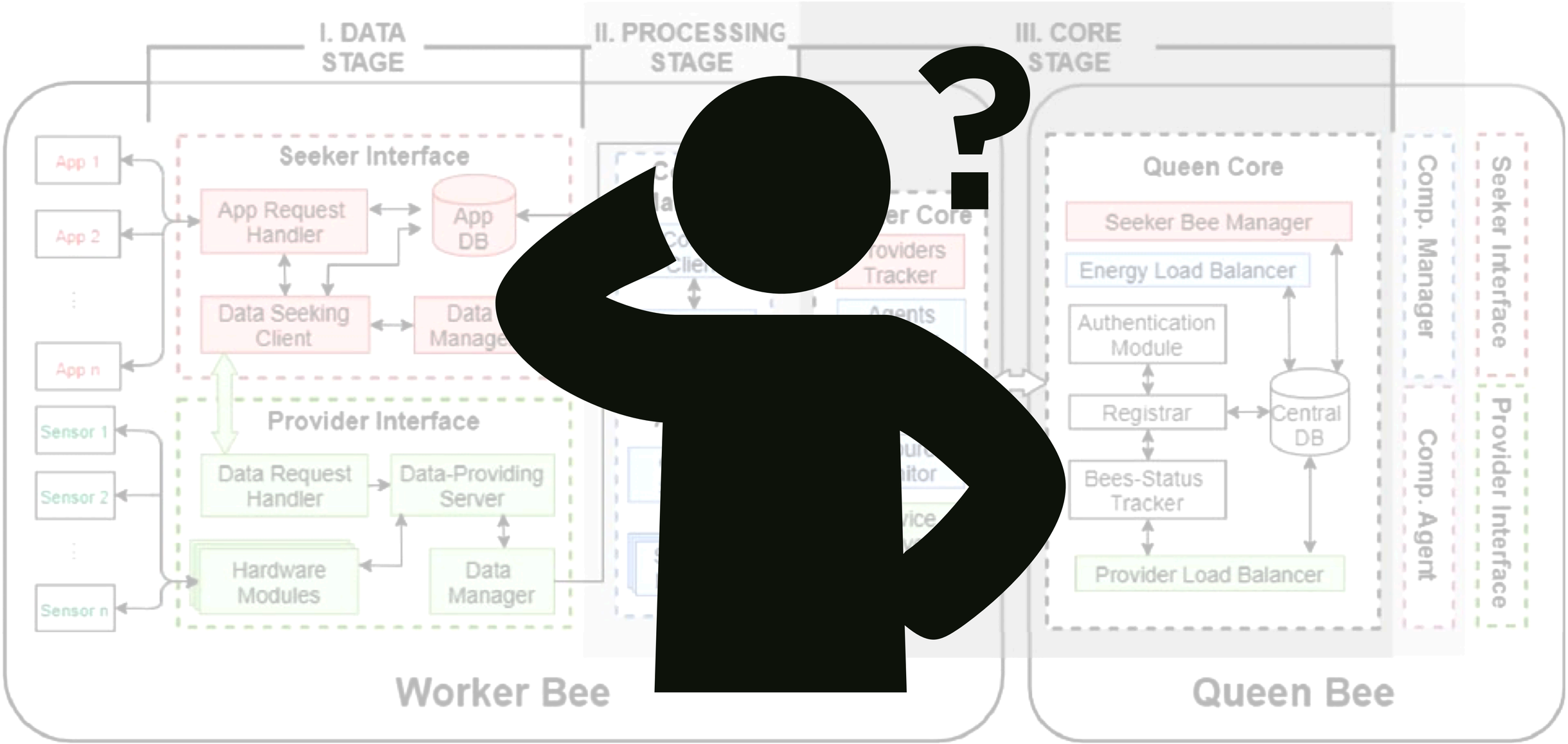
Queen Bee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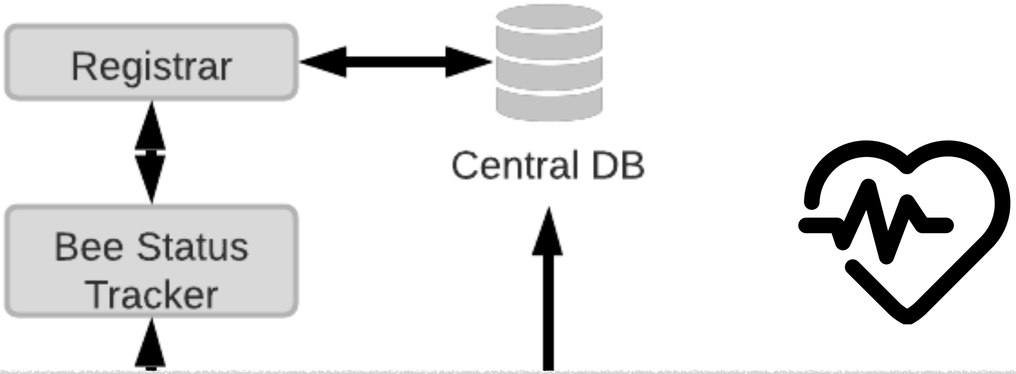
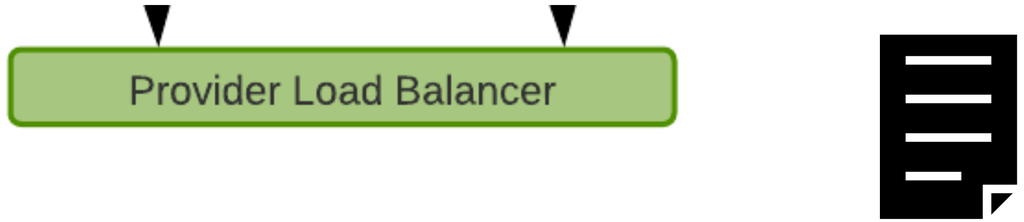
The Queen (Core)

Optimizing the System

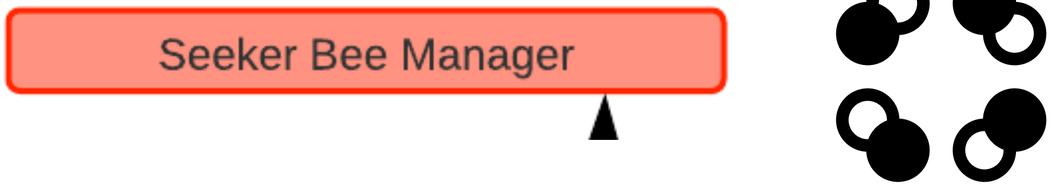
1. Track Worker Bees



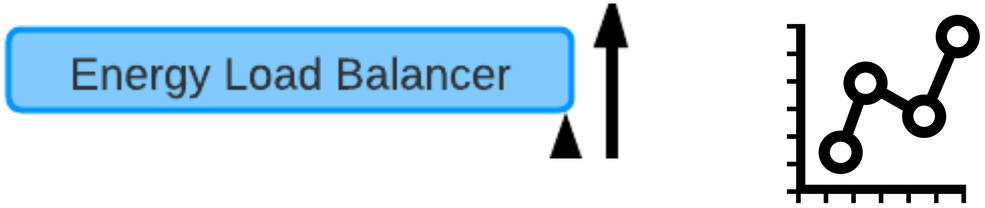
2. Collect List of Available Sensors From Workers



3. Decide optimal Seeker-Provider Pairings



4. Collect Resource Usage from Workers and Balance It



The Queen (Core)

Optimizing the System

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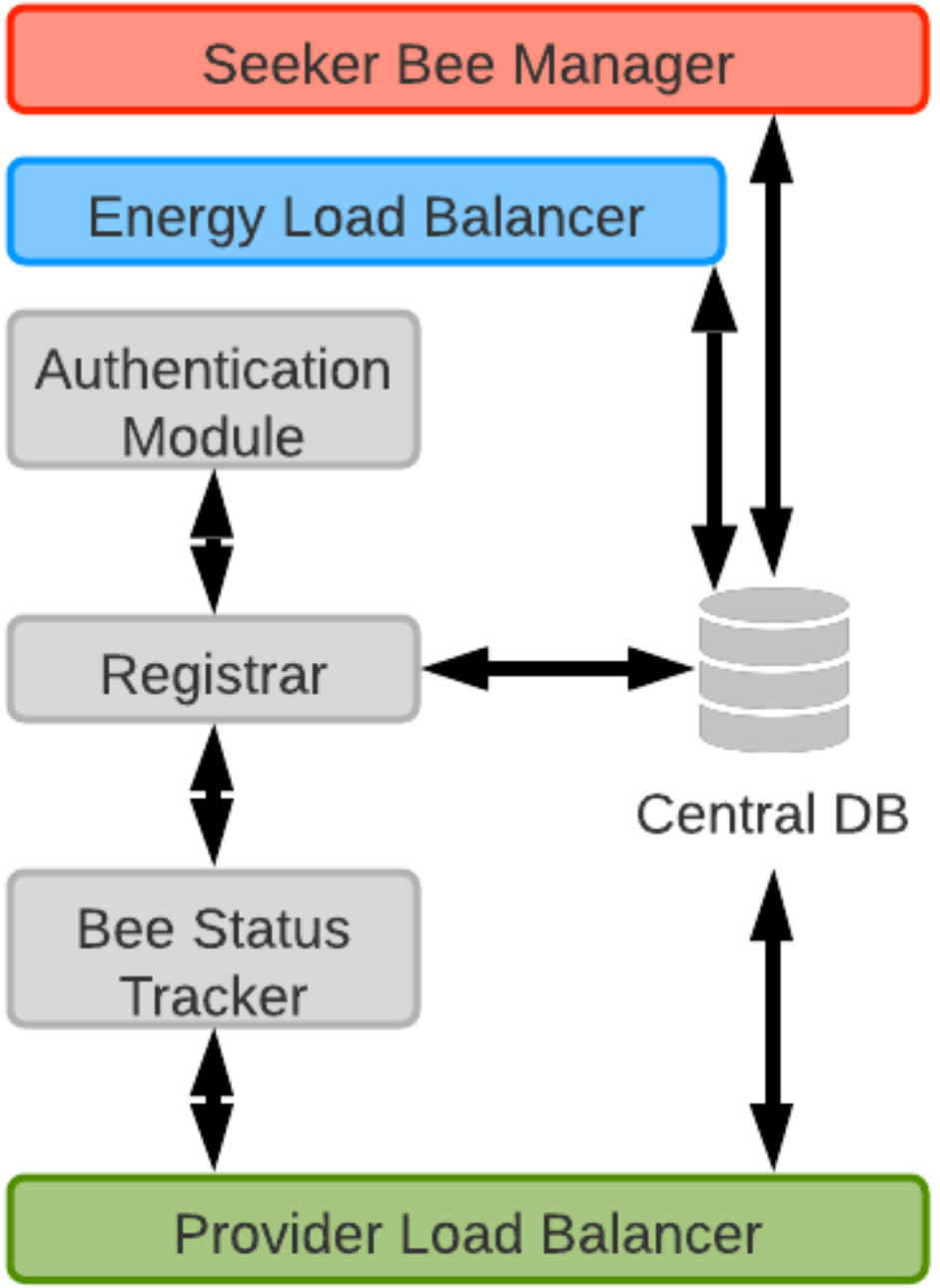

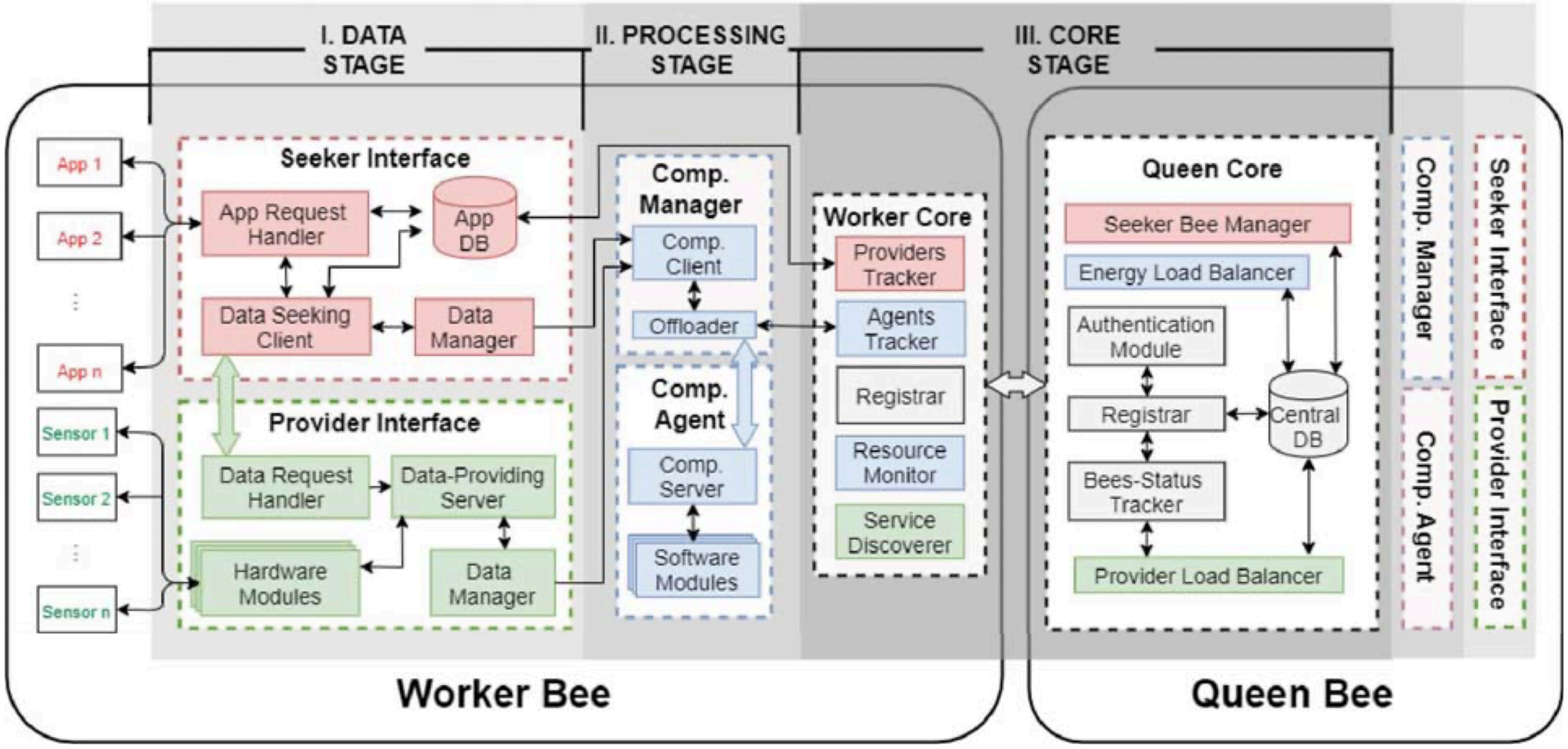
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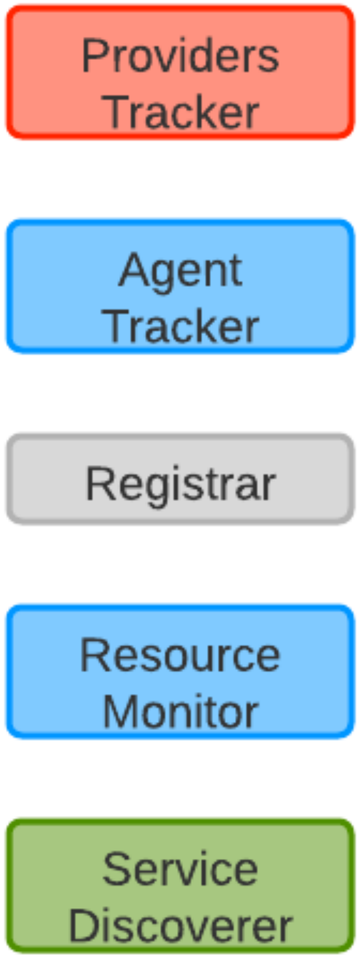
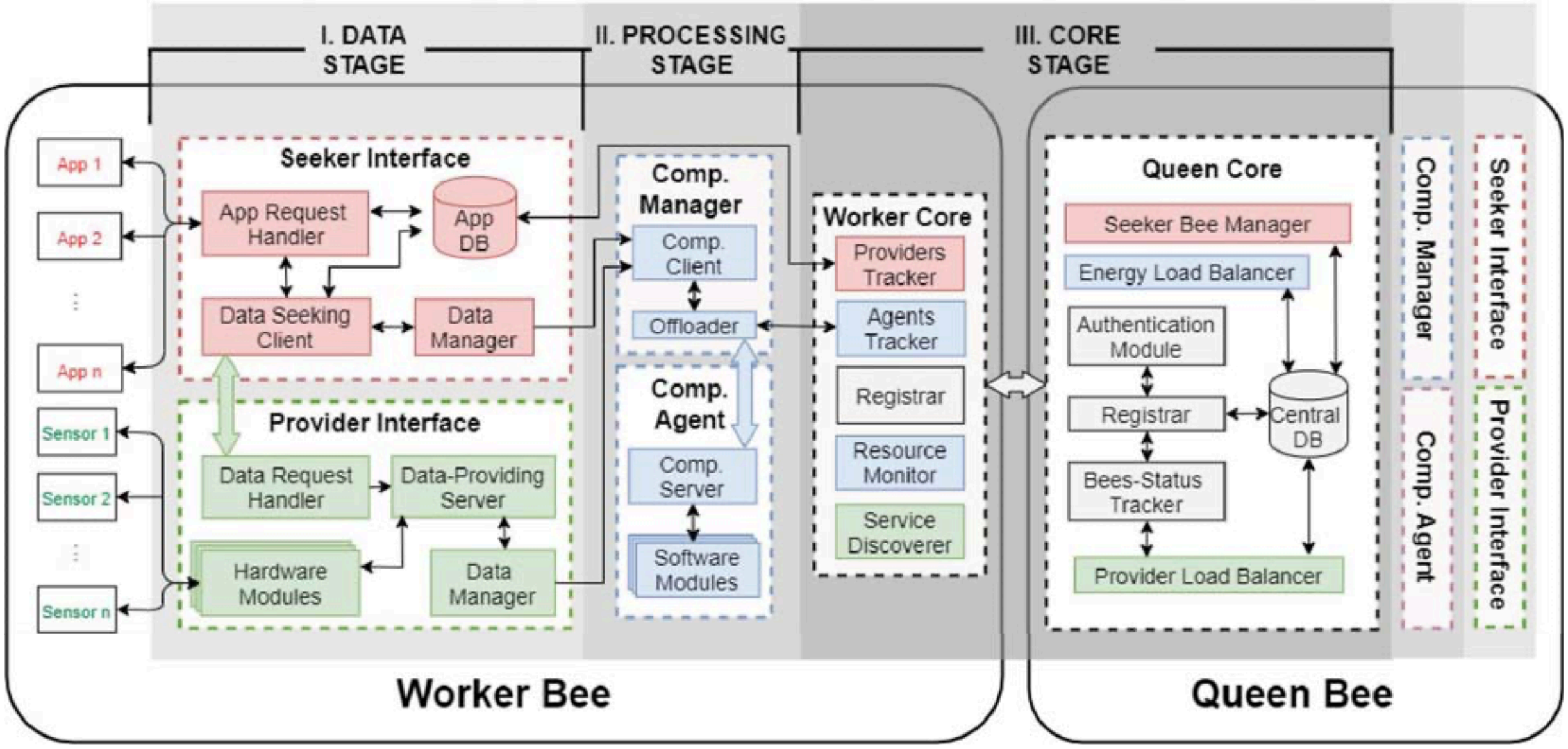
The Worker Core

Assisting the Queen in Optimizing the System

1. Asks Queen for Seeker-Provider Pairing for this Bee
2. Asks Queen which Agents this Bee should offload to
3. Register this Bee with the Queen
4. Answer Queen's Query for Resource usage
5. Answer Queen's Query for Available Sensors

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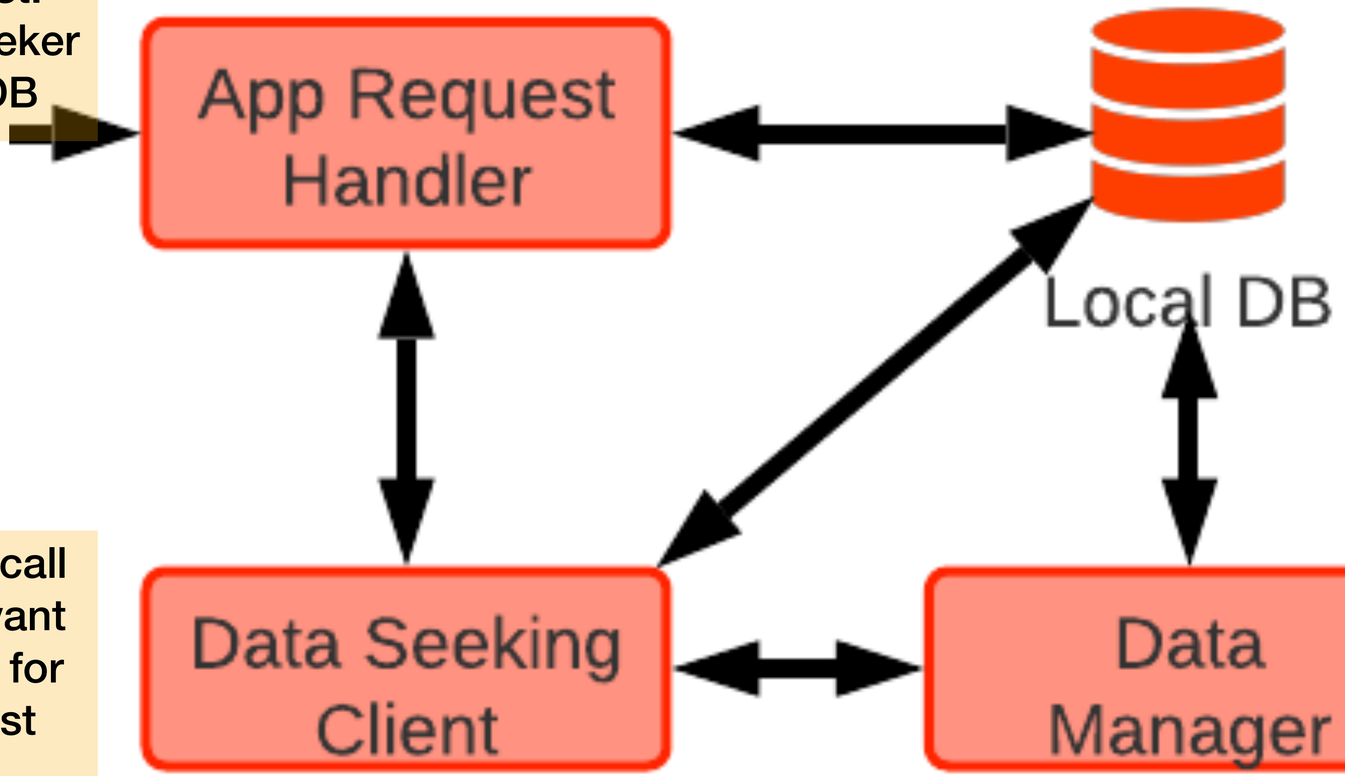
The Seeker Interface

Accessing the Hive's Resources

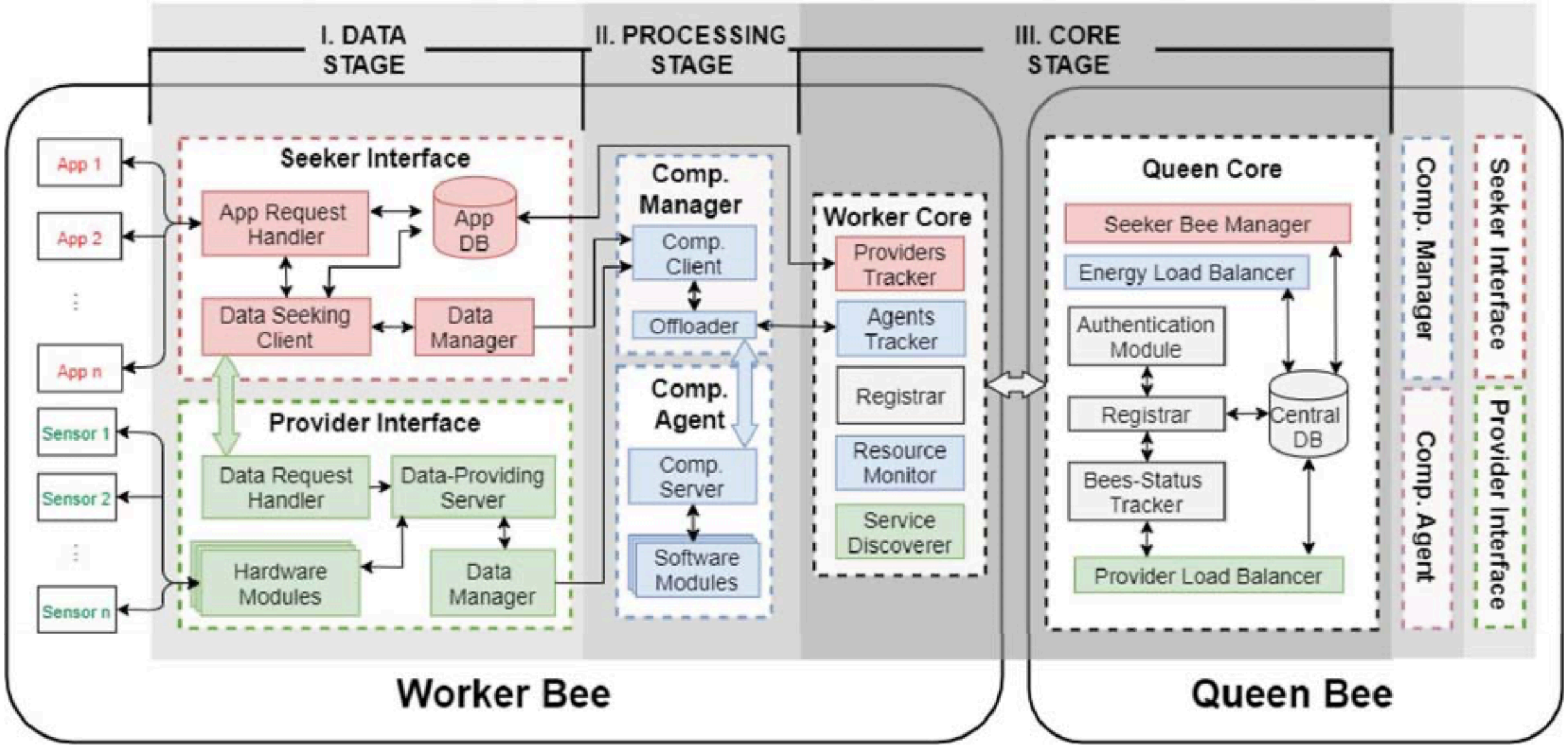
Receives and authenticates the request. Records seeker in Local DB



Returns top providers for the request. Set by Providers Tracker In Worker Core

Makes the call to the relevant Provider(s) for the request

Responsible for any Data filtering or aggregations which get done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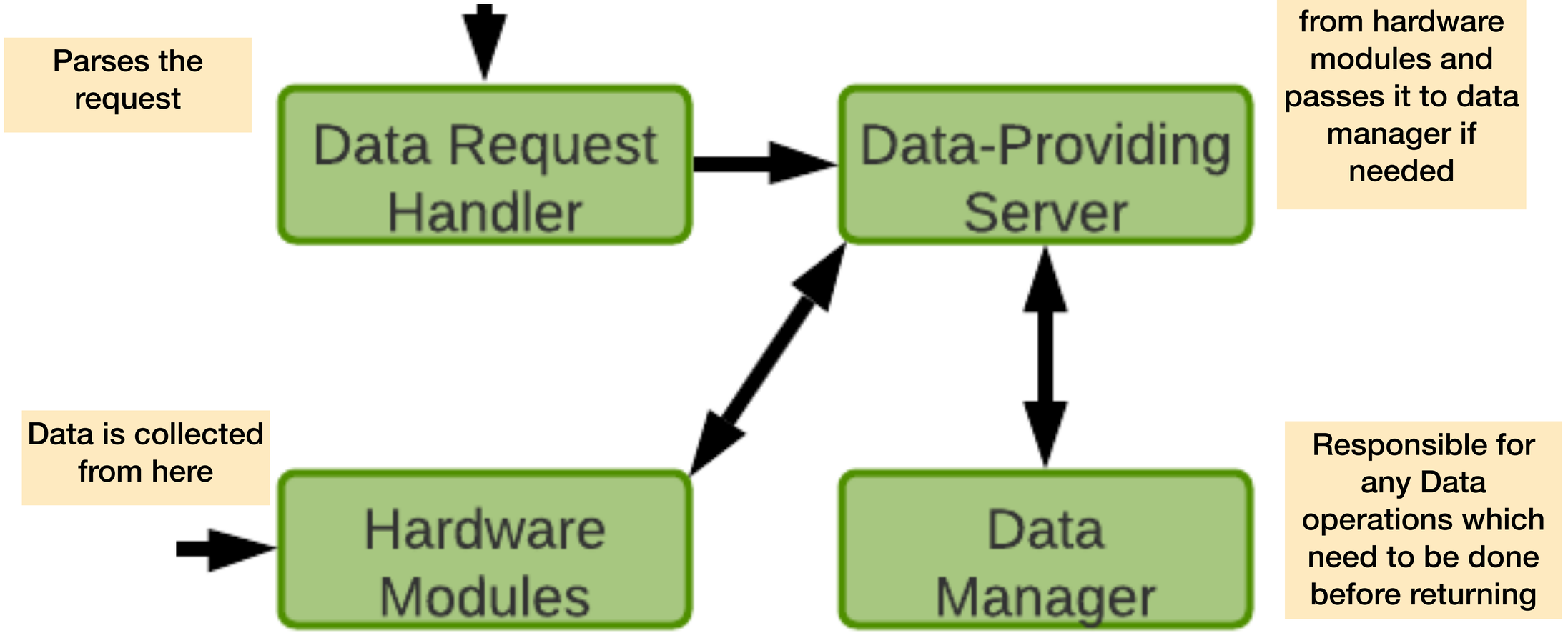
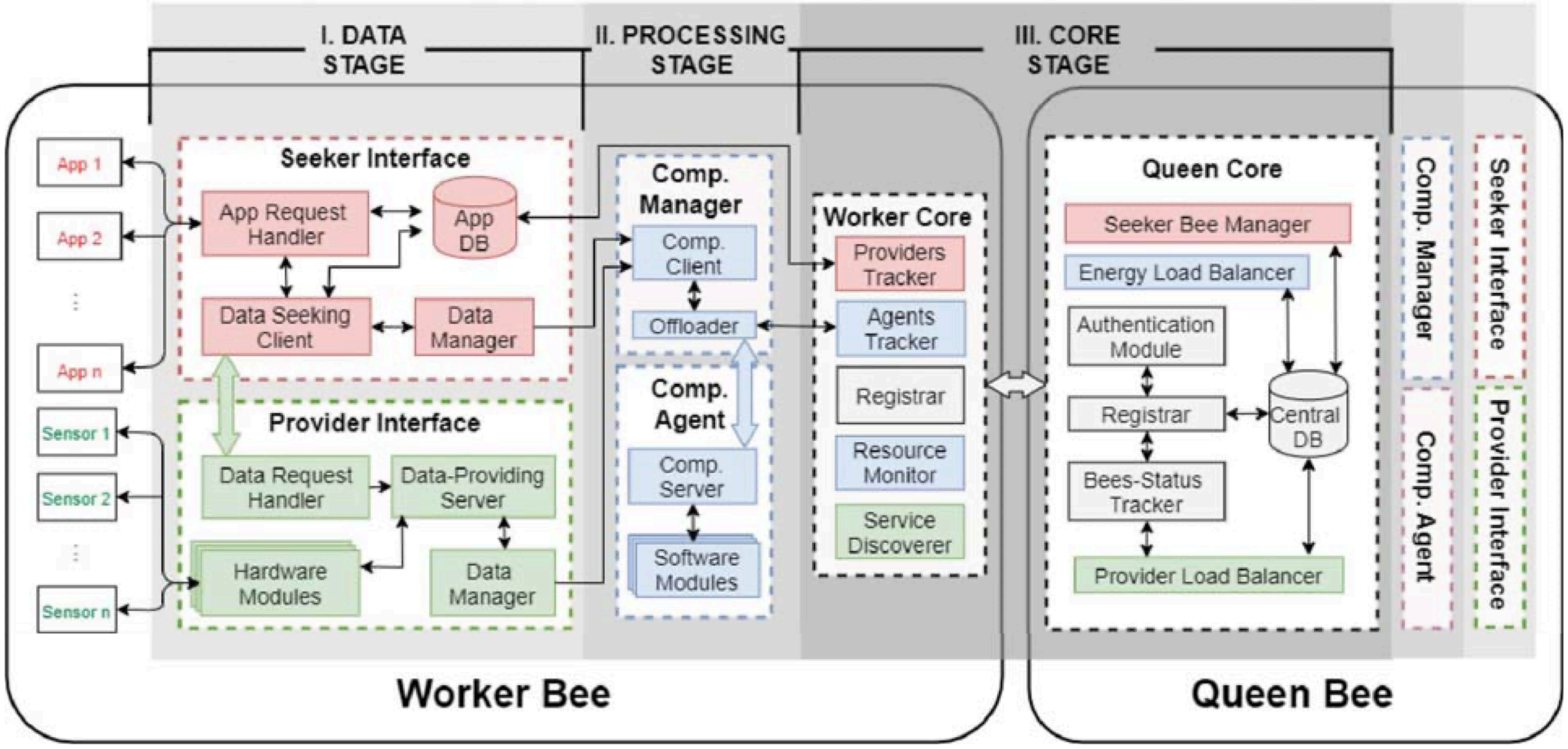
Worker Bee
Queen Bee

The Provider Interface

Answering Data Requests

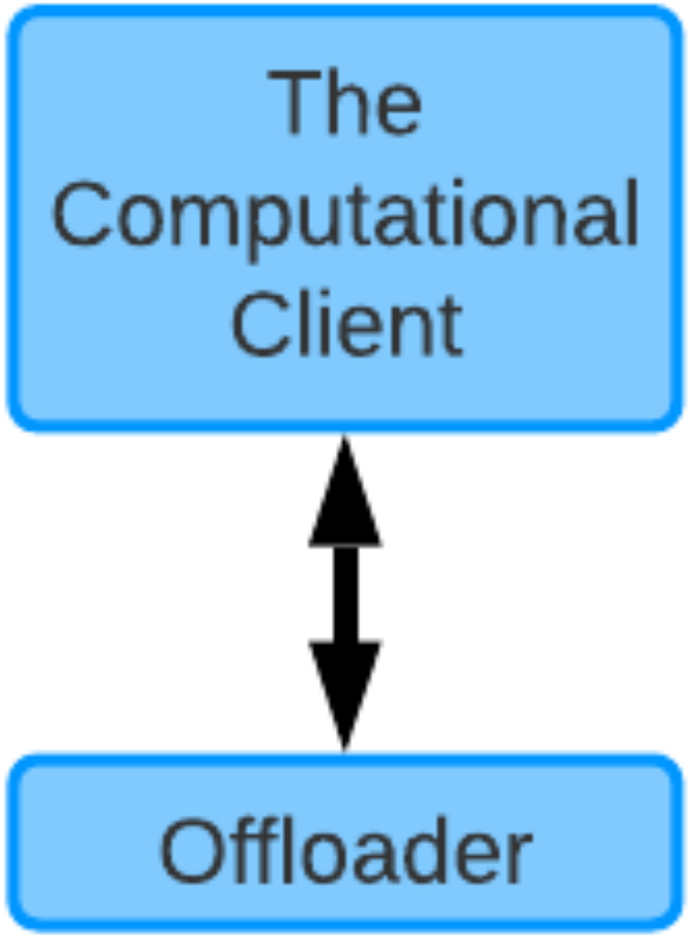



I. DATA STAGE
II. PROCESSING STAGE
III. CORE STAGE
App 1
App 2
App n
Sensor 1
Sensor 2
Sensor n
Seeker Interface
App Request Handler
App DB
Data Seeking Client
Data Manager
Provider Interface
Data Request Handler
Data-Providing Server
Hardware Modules
Data Manager
Comp. Manager
Comp. Client
Offloader
Comp. Agent
Comp. Server
Software Modules
Worker Core
Providers Tracker
Agents Tracker
Registrar
Resource Monitor
Service Discoverer
Queen Core
Seeker Bee Manager
Energy Load Balancer
Authentication Module
Registrar
Central DB
Bees-Status Tracker
Provider Load Balancer
Comp. Manager
Comp. Agent
Seeker Interface
Provider Interface
Worker Bee
Queen Bee

The Computational Manager

Allowing Access to Compute Resources

Receives processing requests and data streams

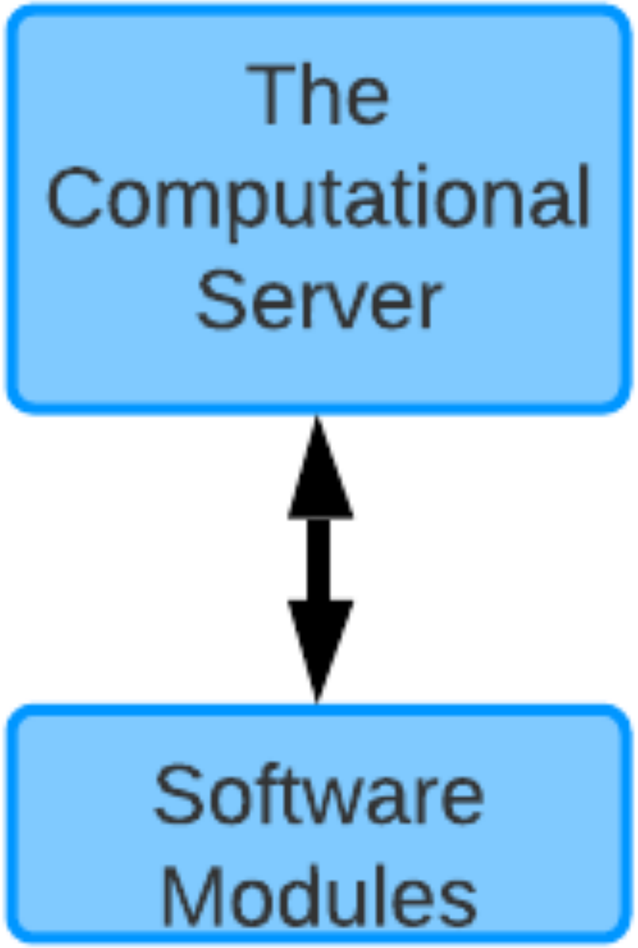


Contacts the appropriate Agent Bee (as determined by Agent Tracker In Worker Core) and passes results back to Seeker/Provider Interface

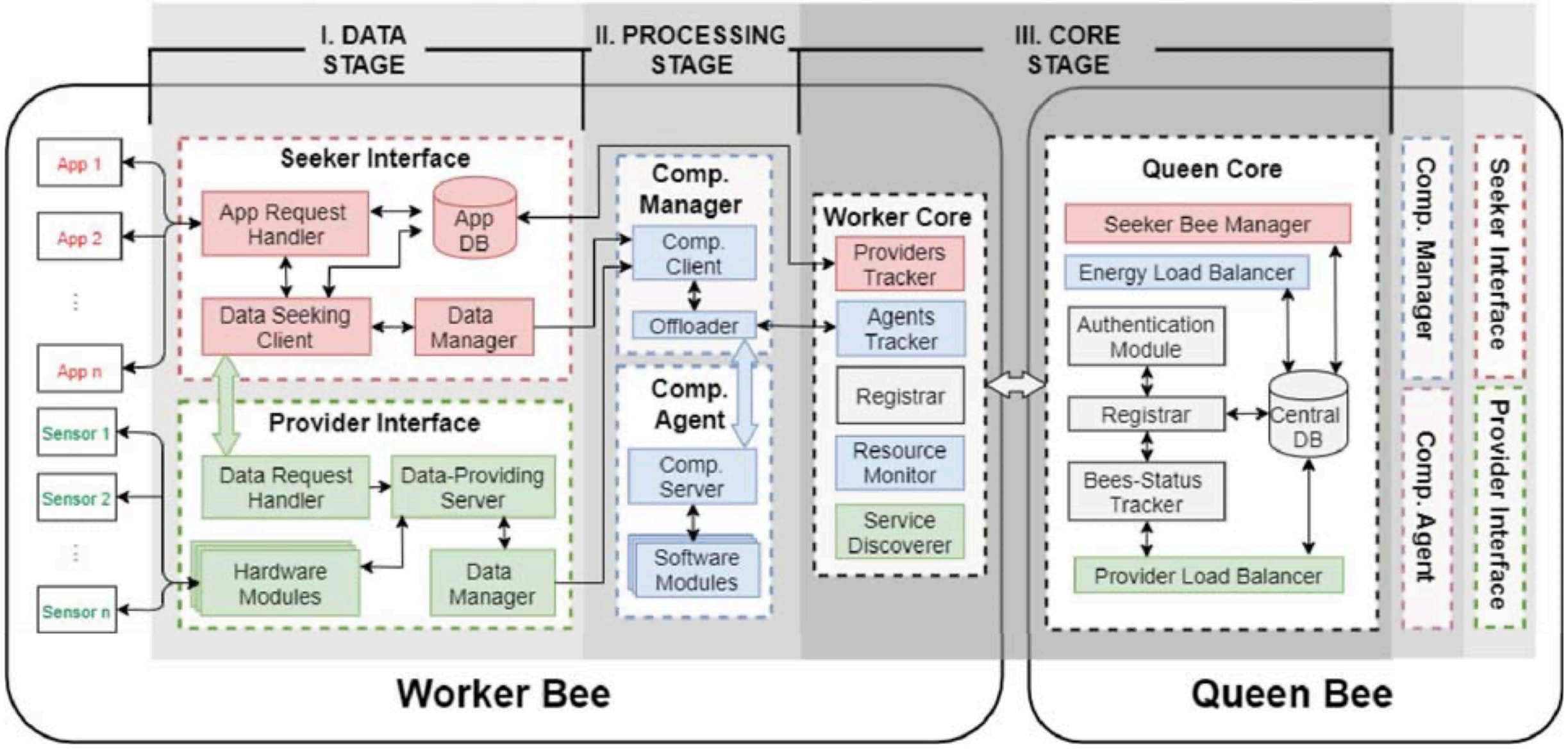
The Computation Agent

Performing computation for a manager

Receives processing requests, invokes software components, and passes back results



Contained code snippets that contain different computationally demanding algorithms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Agenda

2. Related Work
3. Hive Motivation and Objectives
4. **Hive System Architecture**
5. Hive Protocol
6. Preliminary Assessment
7. Video Integration and Evaluation
8. Conclusion and Future Work

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2. Related Work
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7. **Video Integration and Evaluation**
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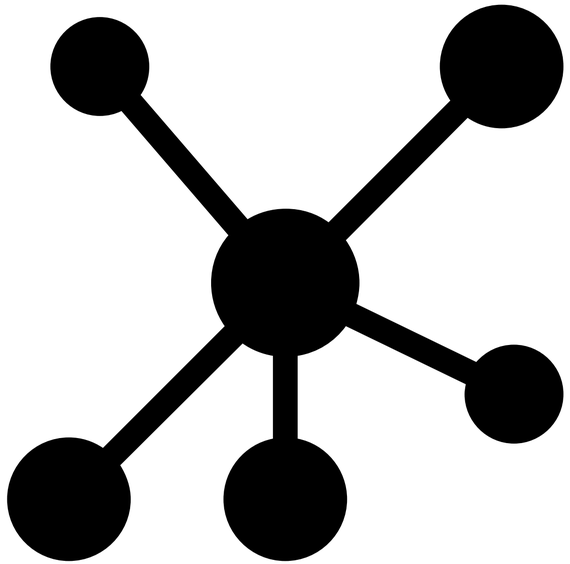
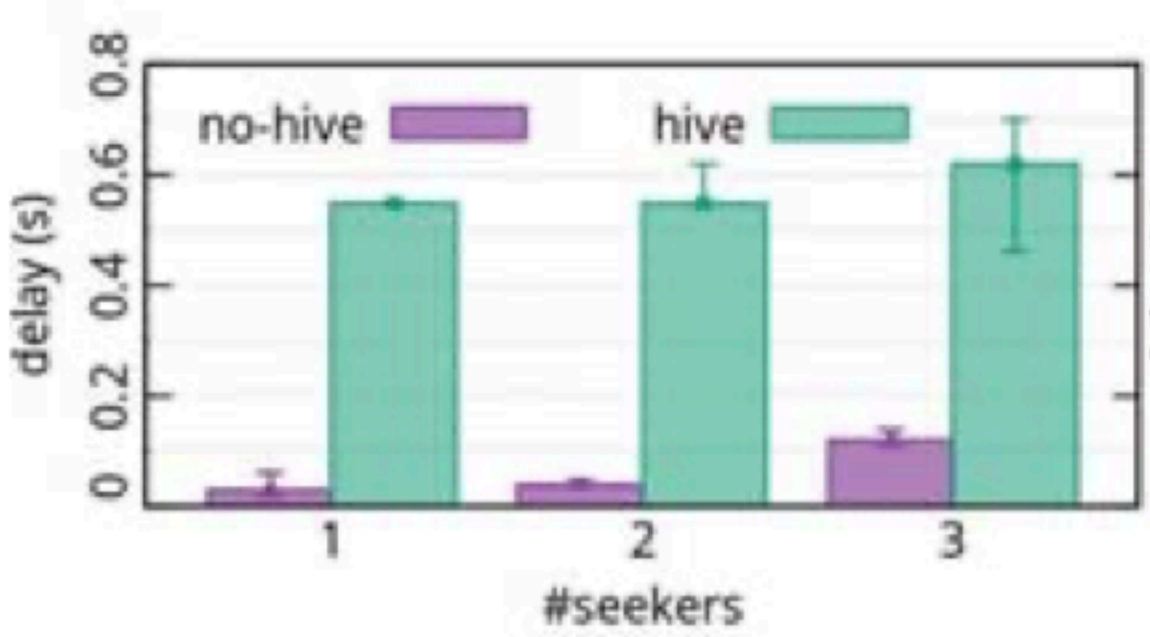
The Tradeoff

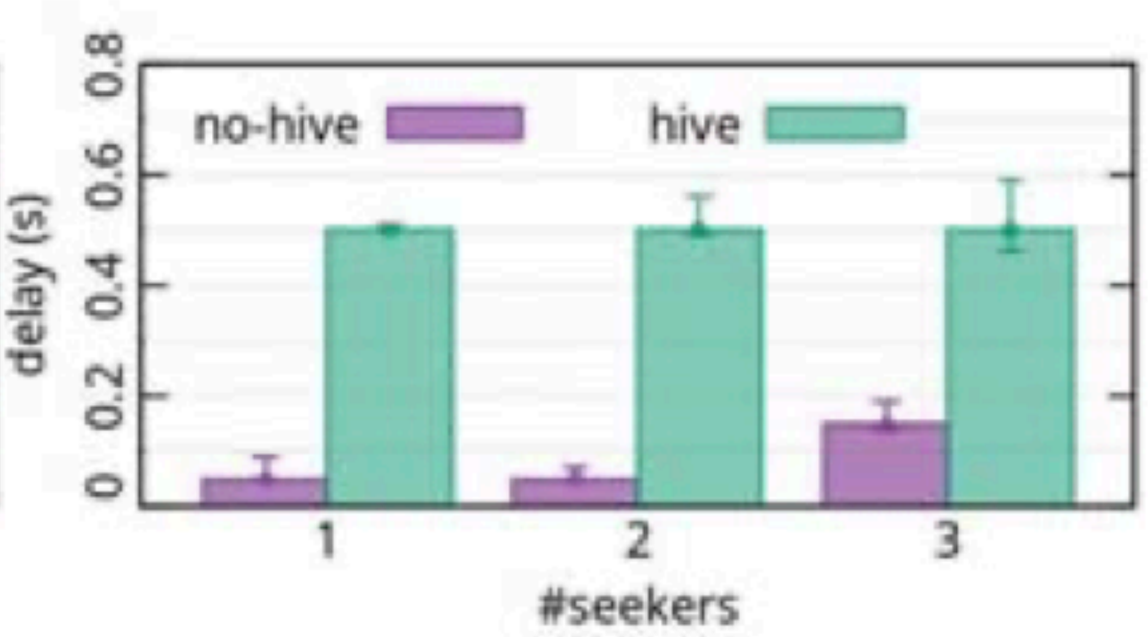


VS

The Tradeoff

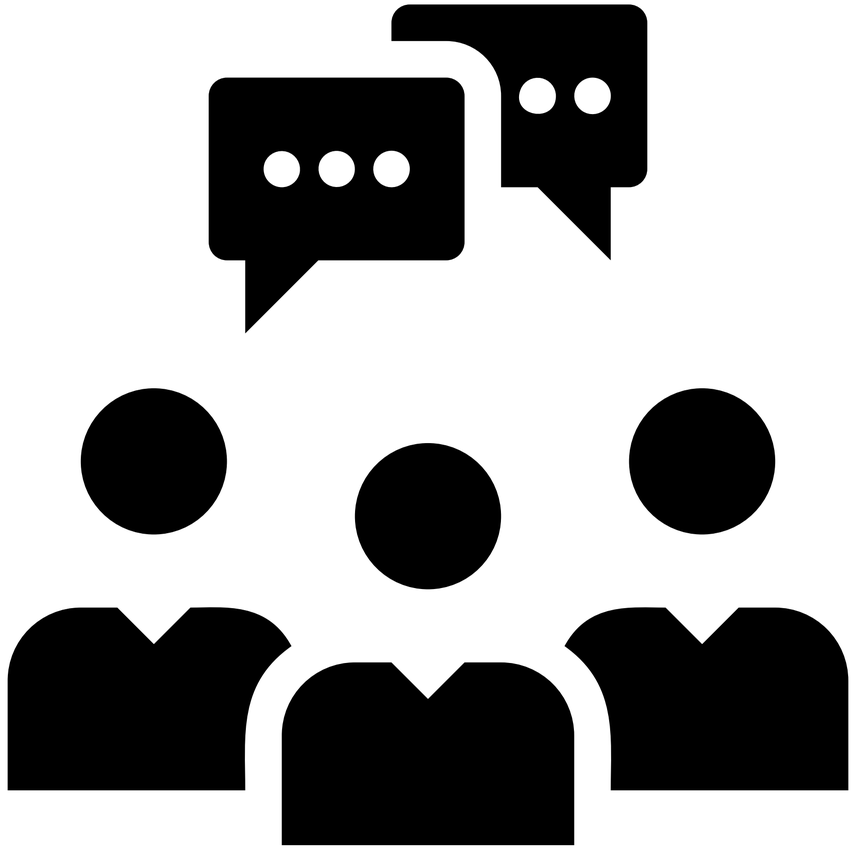


(a) 360p



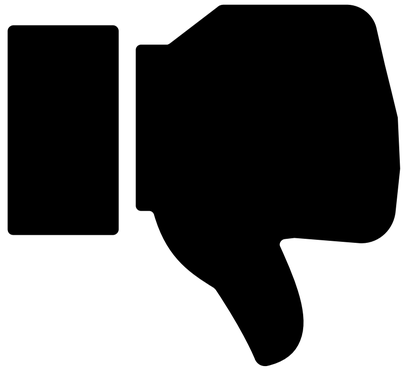
(b) 480p

Discussion



- **Good Abstractions.** The levels of abstraction align with the context.
- **Rigorously Tested.** Example of thorough experimentation.
- **Software Engineering.** All about the architecture.

- **Security.** Do I want all my devices talking with each other?
- **Applicability.** Not totally convinced by their usage cases.



Any Questions?

What other applications are there for the Hive?

What sort of security would have to be implemented in the Hive architecture?

Hive introduces additional delay in the network. What are some applications where this delay is unacceptable?