An Edge-based Abstraction for Enabling Cooperation in Internet of Things Applications

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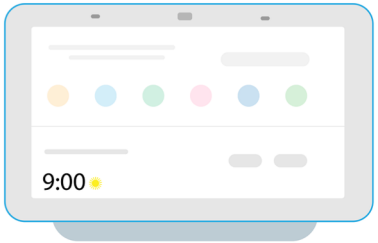
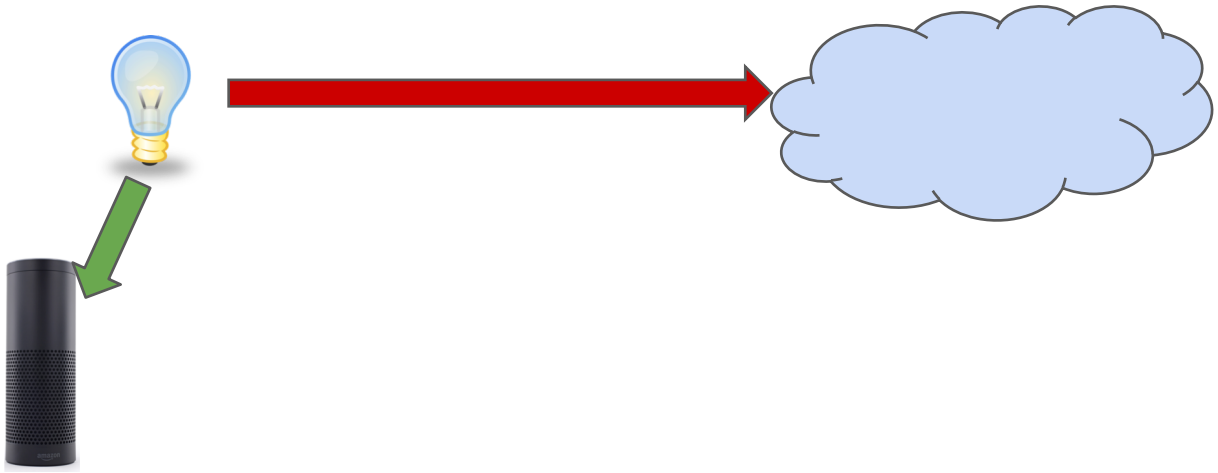
IoT and The Edge

- The IoT is the merging of the physical and the digital.
  - Connected roads/transit
  - Smart homes/buildings
  - Environmental monitoring
  - Personal health improvement



Why The Edge?

- The edge provides numerous benefits over the cloud
  - Latency
  - Privacy
  - Security



Industry Edge/Cloud Solutions

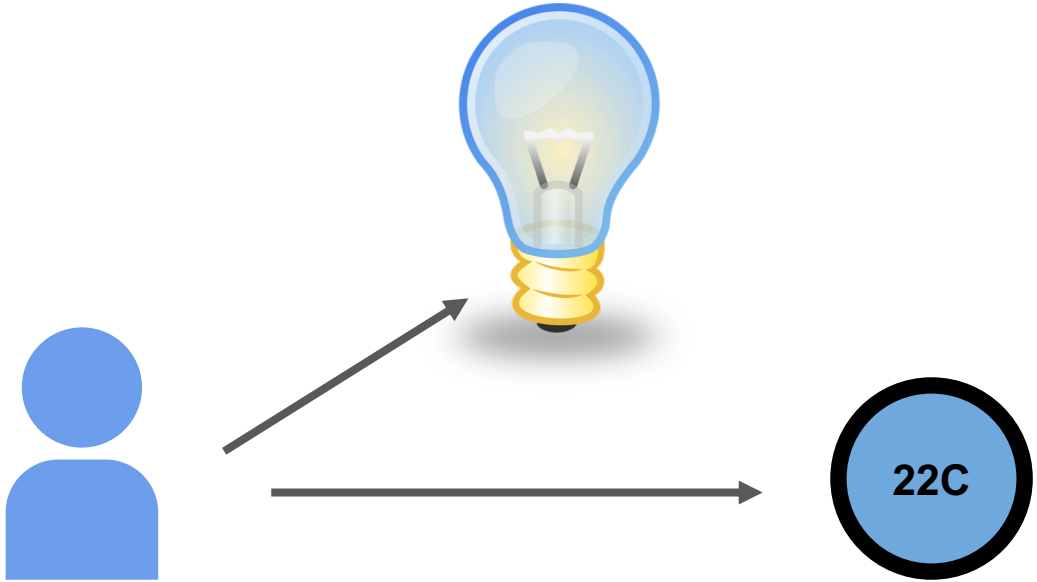
Pros	Cons
• Writing applications is often much easier, **especially if you utilize *their sensors and actuators*.**	• Lack of interoperability • Few standards • Systems just call functions, little (or no) understanding of context.

Conflicts or Cooperation

- Applications sharing the same physical space are likely to interfere
  - Cooperation
    - E.g., using the same sensor can enable reuse
  - Conflicts
    - E.g., setting the same light(s) to different intensity

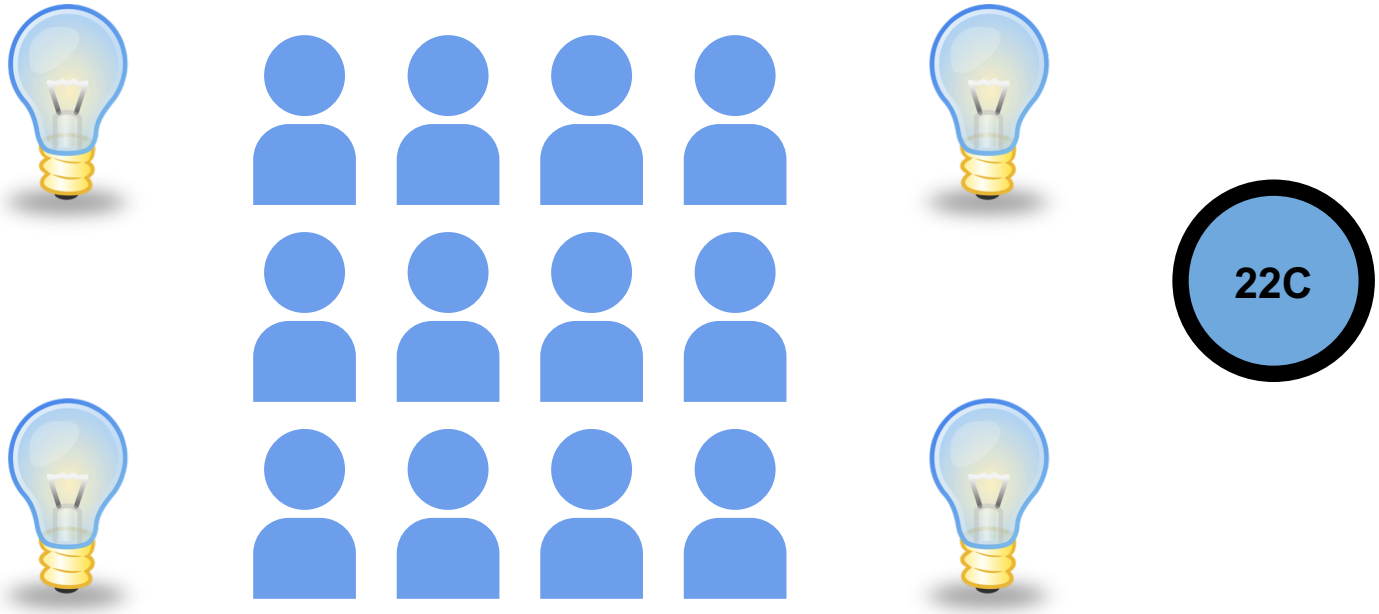
Motivating Example

- A single person wants to control their environment



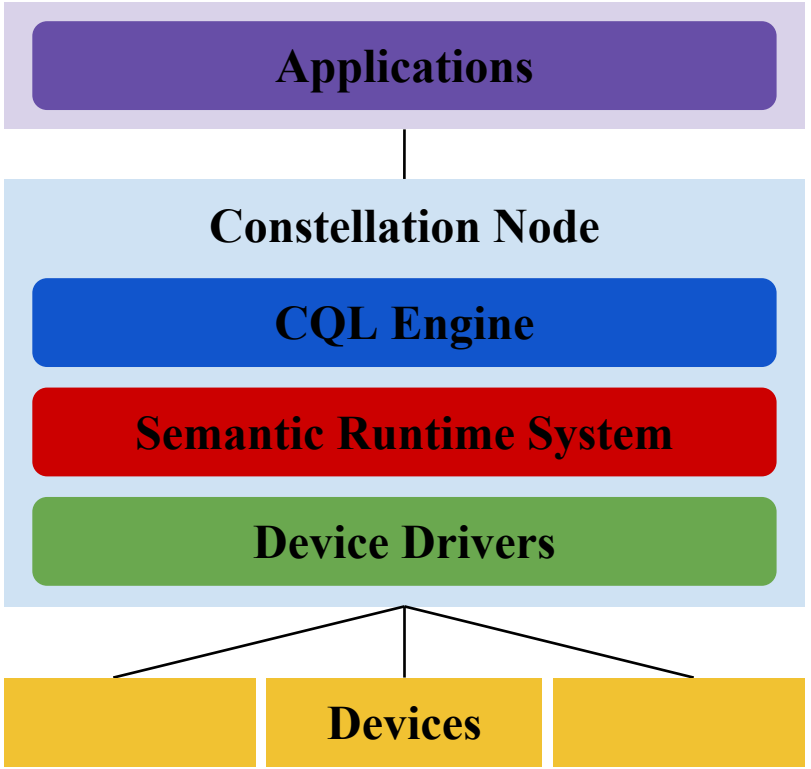
Motivating Example

- Many stakeholders seeking control of many devices



Our Solution: Constellation

- An Edge-based OS-like abstraction for managing access to underlying IoT resources.



CQL Examples

```
FIND DEVICES WITH Temperature geoLoc=(12.345, 11.111) AS TEMPS

FIND DEVICES WITH furnaceOn geoLoc=(12.345, 11.111) AS FURNACE
```

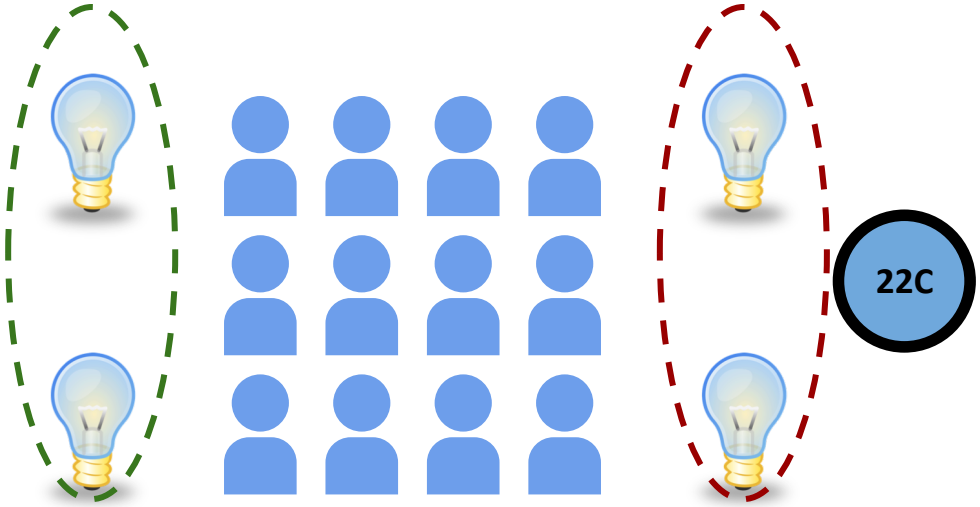
```
SENSE Temperature FROM TEMPS PERIOD 30 SEC

ACTUATE furnaceOn ON FURNACE PARAMS intensity=40
```

```
EVENT maintainTemp

        ACTUATE furnaceOn ON FURNACE PARAMS intensity=40

WHEN (SENSE Temperature FROM TEMPS PERIOD 30 SEC) < 70
```

The Device Set (DevSet)

```
FIND DEVICES WITH toggleLight geoLoc=(12.345, 11.111) AS LIGHTS
```

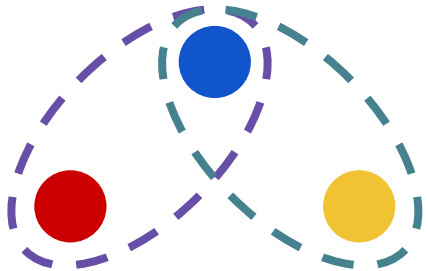
- DevSets are sets of functionally equivalent devices.



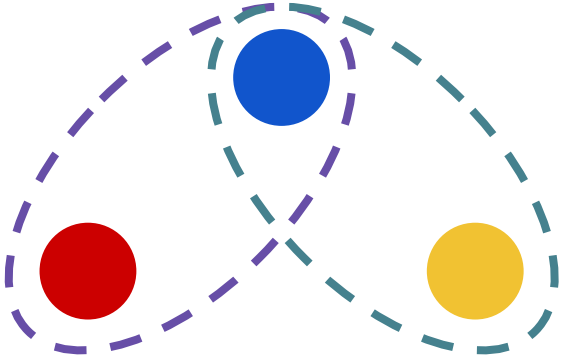
DevSet Choice

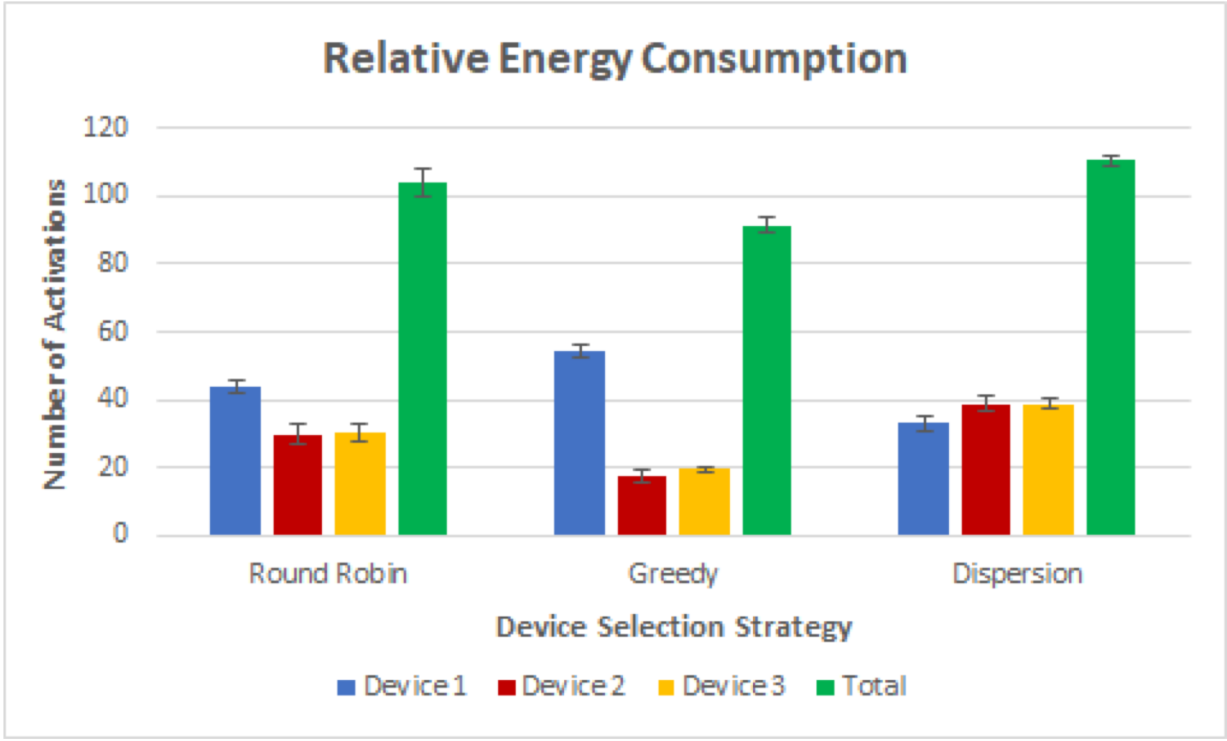
- Semantic Runtime schedules what device to use when
  - Based on metric to be optimized (latency, accuracy, energy, etc.)

- Example strategies for energy consumption:
  - Round-robin
  - Greedy
  - Dispersion



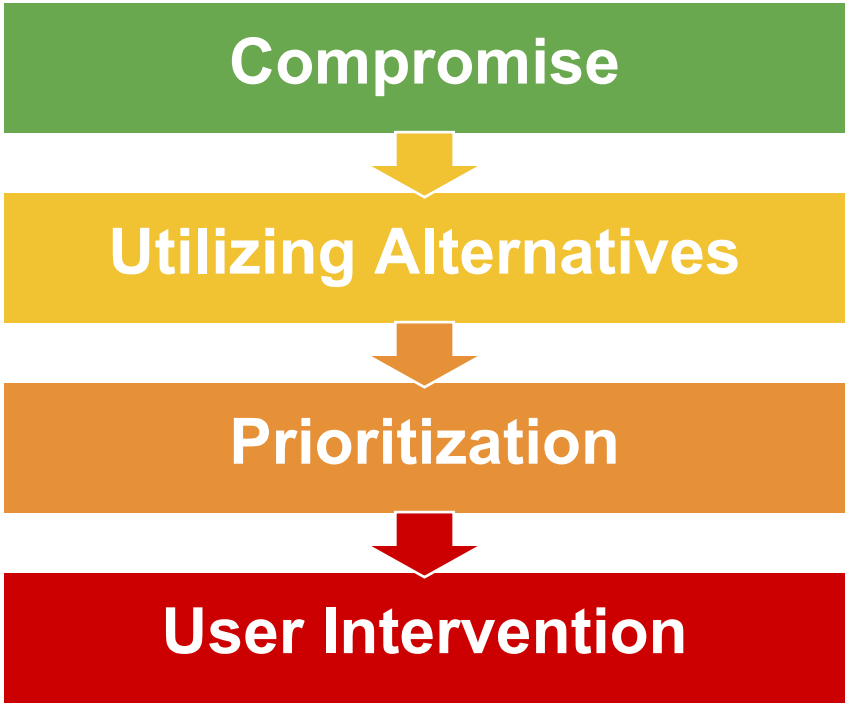
Preliminary Results





DevSets and Conflict Resolution

- Devices may be deemed functionally equivalent if they have similar effects, e.g., increasing light.



Conclusion

- The Internet of Things requires systems which can account for the semantic richness of the physical world.

- Constellation provides many examples and optimizations based on such semantics.

Questions/Discussion

- Desired feedback
  - Thoughts on potential use cases
  - Thoughts on the practicality or difficulties involved in putting such a system into practice
- Controversial Points
  - Assumption of interoperability
  - Privacy concerns
- Open Problems
  - Security
  - Extending for wider areas
- Depreciating Circumstances
  - Moore's Law, Next-Gen Networking, Heterogeneity/Interoperability