



Cross-domain IoT Application Development for Smart Home



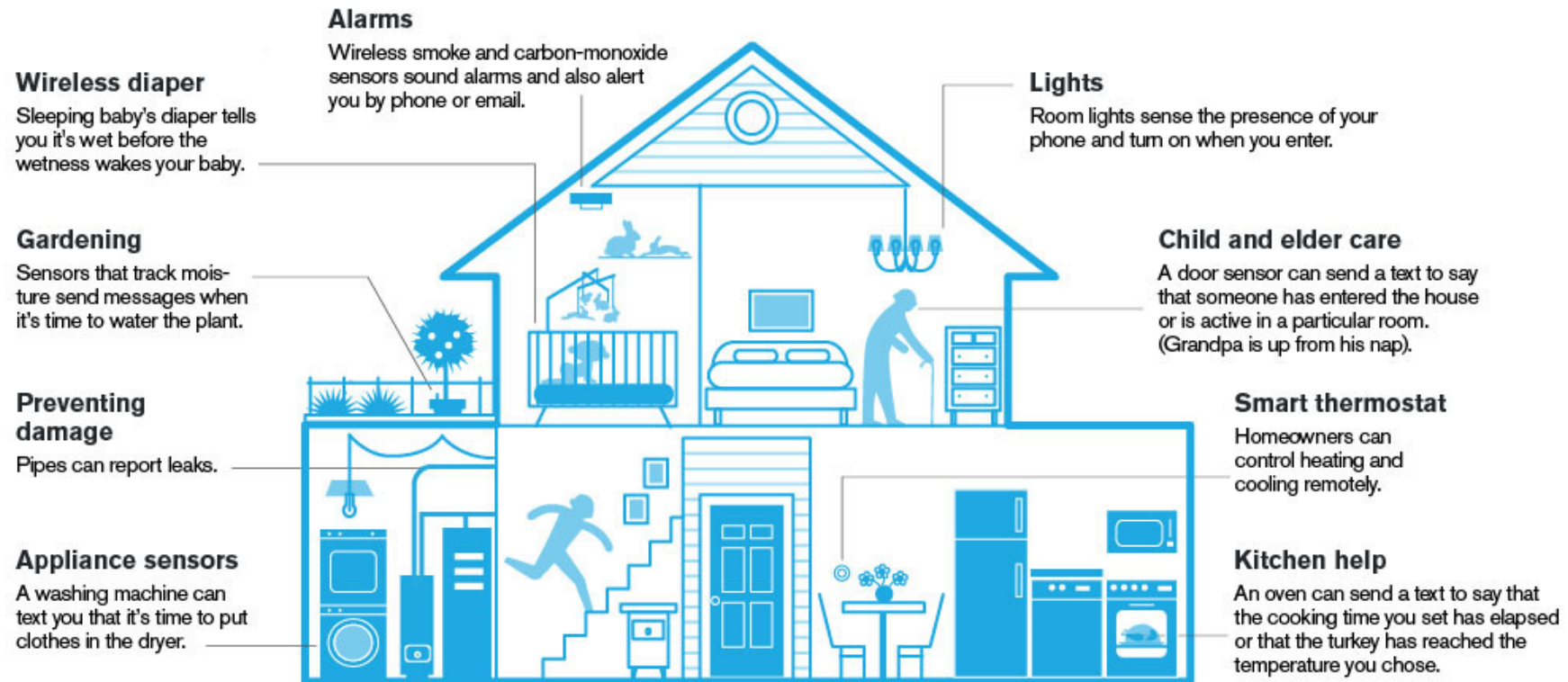
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Roadmap

- **Introduction**
- **Challenges**
- **State-of-the-Art**
- **Cross-domain IoT application development framework**
- **Conclusion**

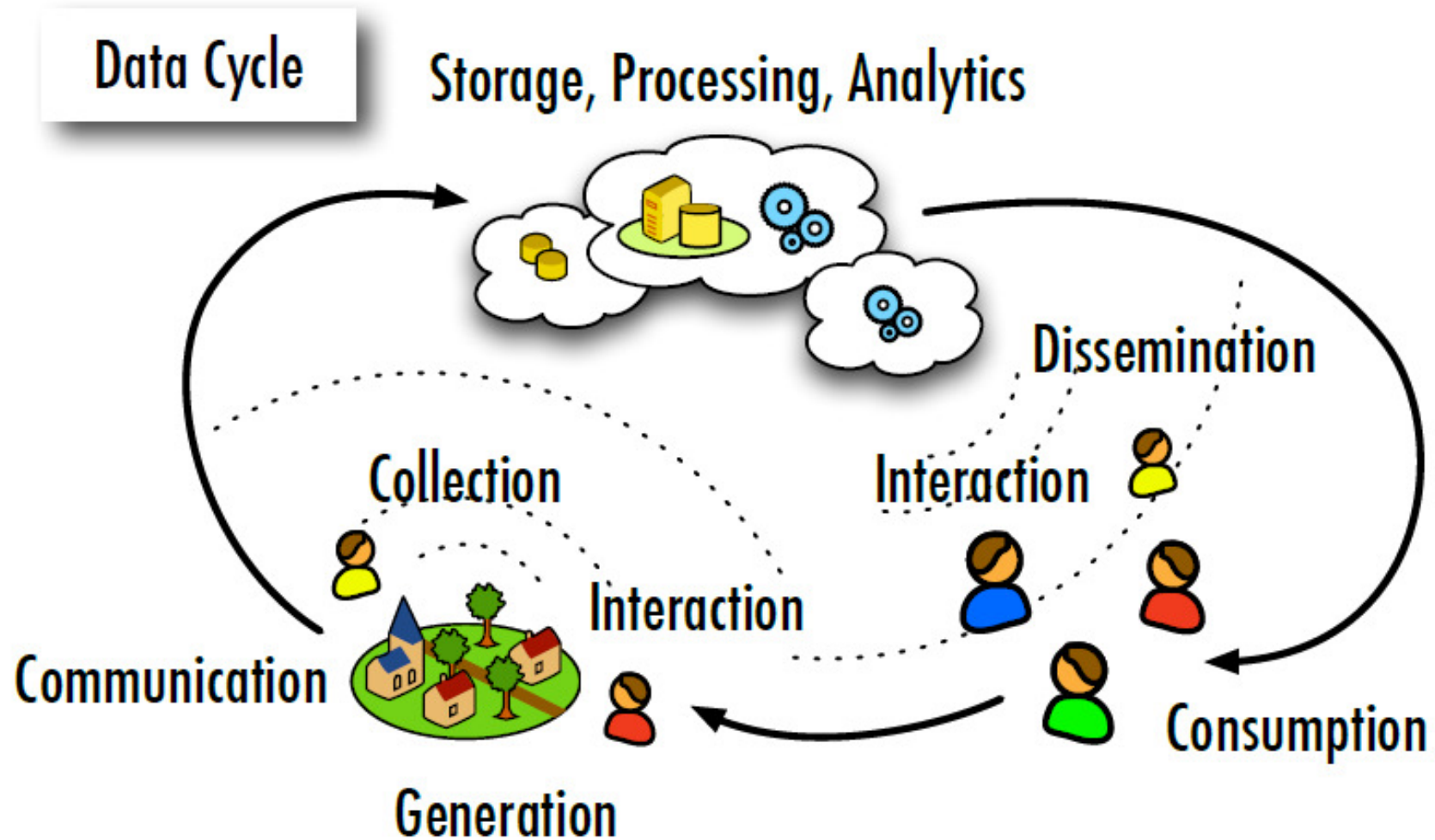
Introduction

Smart Things Automate the Home



Source: market-intel.info

Data Cycle in Smart Home Applications



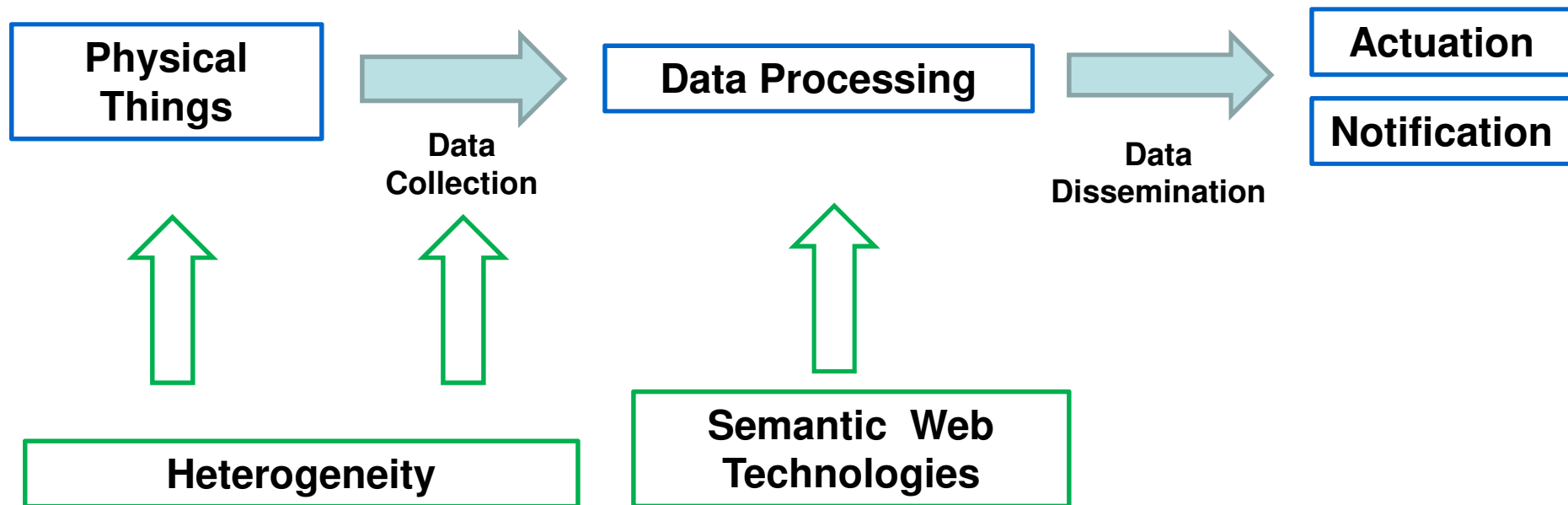
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Challenges

- **Connecting heterogeneous things**
- **Combine data from different sensors and domains**
- **Uniform representation, treatment and interpretation of sensor data for cross domain applications**
- **Uniform application development framework for any smart home scenario**
- **Deploy across multiple platforms (cloud, home gateway)**
- **Derive actionable intelligence allowing humans or things to react**
- **Support resource discovery, automatic management, provisioning while maintaining interoperability**
- **Preserve privacy through secure mechanisms**

Solution: Semantic Web Technologies



- **But semantics along is not sufficient**
- **Still need components for**
 - Resource discovery, provisioning, automatic management of things
 - Deployment platform, support for actuators

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State-of-the-Art

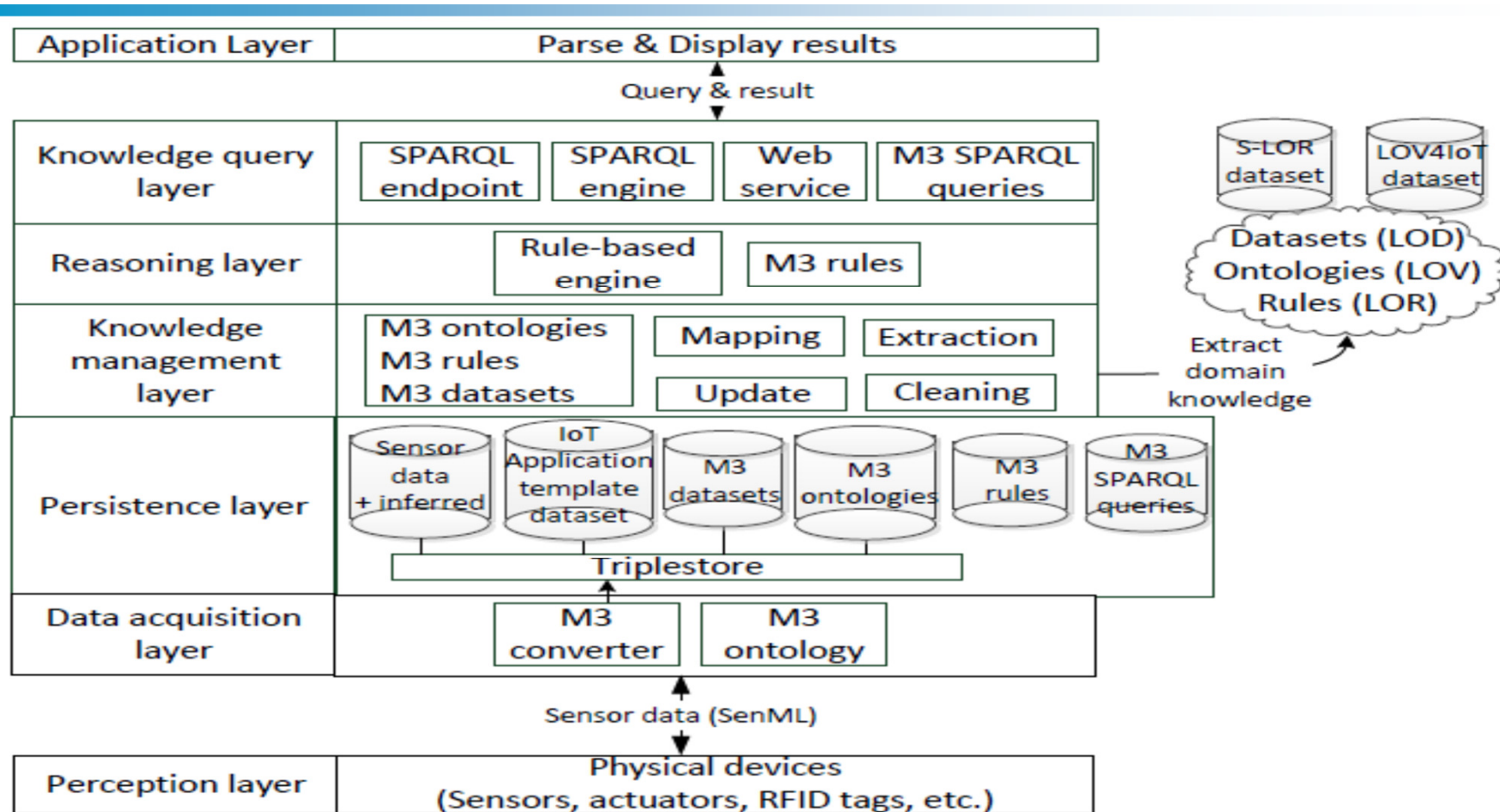
- **The reasoning engines and semantic algorithms in a mobile app are largely based on internal sensors.**
 - No consideration towards external sensors (deployed in smart home).
 - No dynamic discovery of sensors.
- **Current initiatives are largely focused on domain specific scenarios.**
 - What about cross-domain (horizontal scenarios)
- **Interoperability issue**
 - No common catalogue exists for sensors, measurements, units, and domain names.
- **Not oriented to a standard**

Source: S. K. Datta, A. Gyrard, C. Bonnet and K. Boudaoud, "oneM2M Architecture Based User Centric IoT Application Development," *Future Internet of Things and Cloud (FiCloud), 2015 3rd International Conference on*, Rome, 2015, pp. 100-107

Roadmap

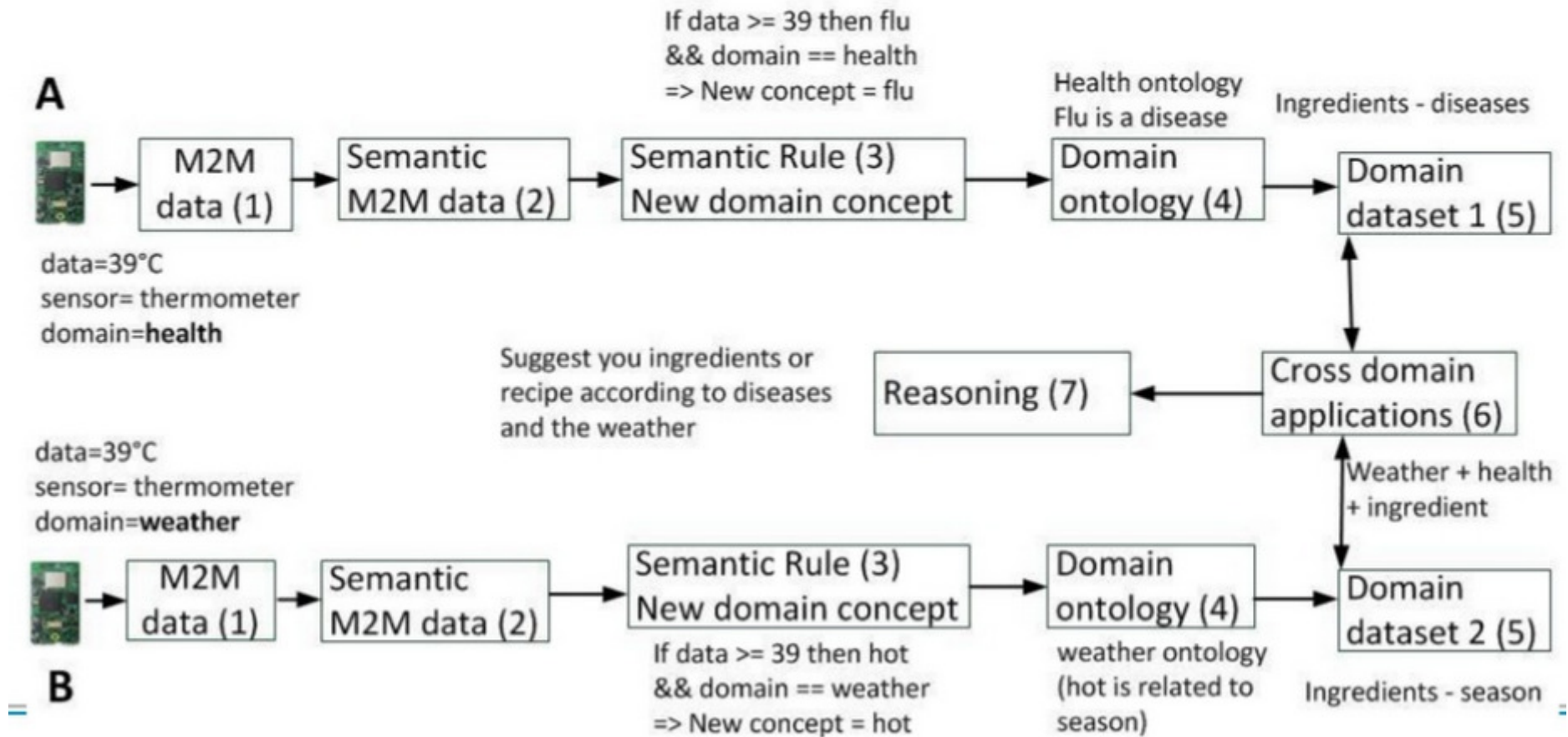
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Machine-to-Machine Measurement Framework



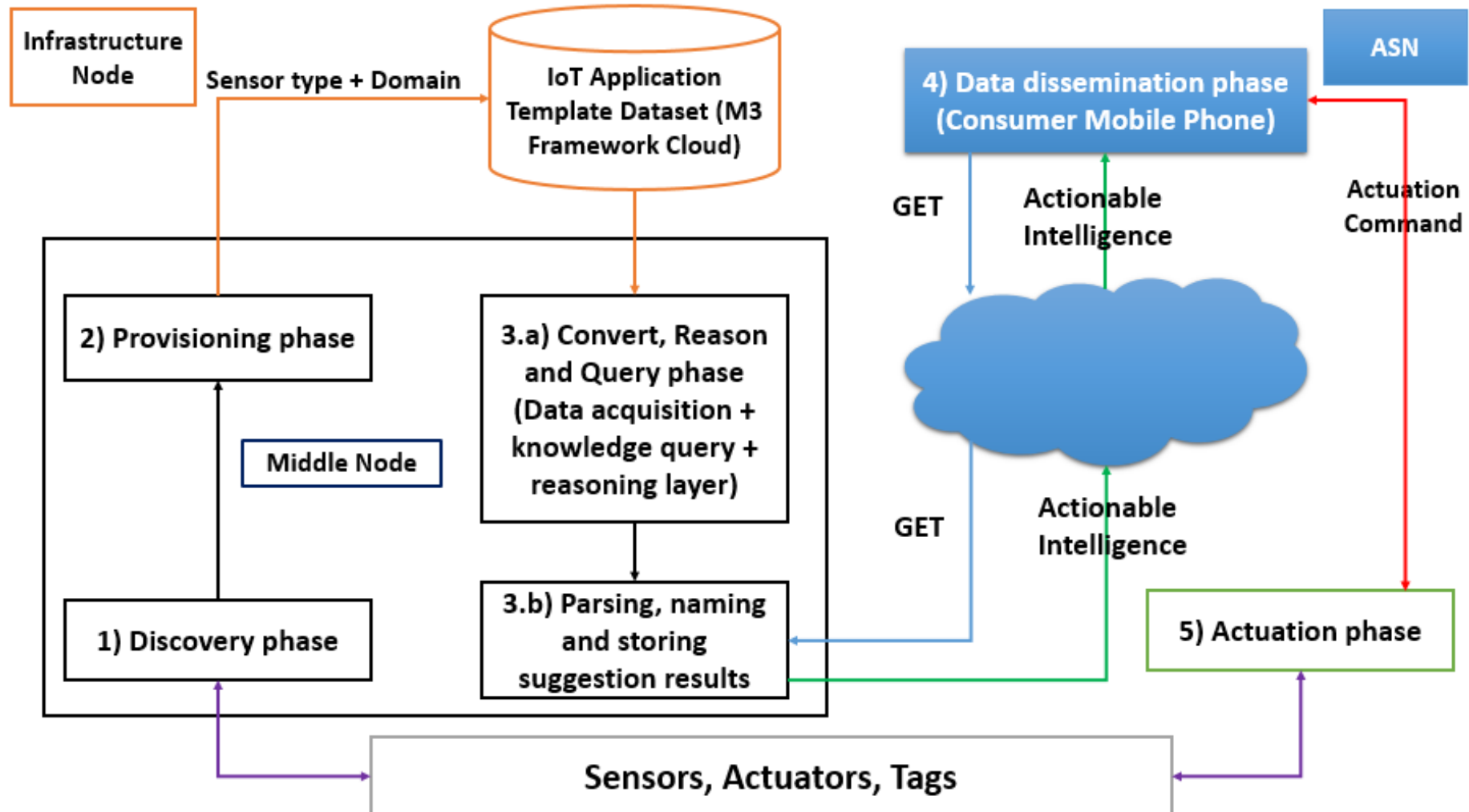
Source: A. Gyrard, S. K. Datta, C. Bonnet and K. Boudaoud, "Cross-Domain Internet of Things Application Development: M3 Framework and Evaluation," *Future Internet of Things and Cloud (FiCloud)*, 2015 3rd International Conference on, Rome, 2015, pp. 9-16

Semantic Reasoning

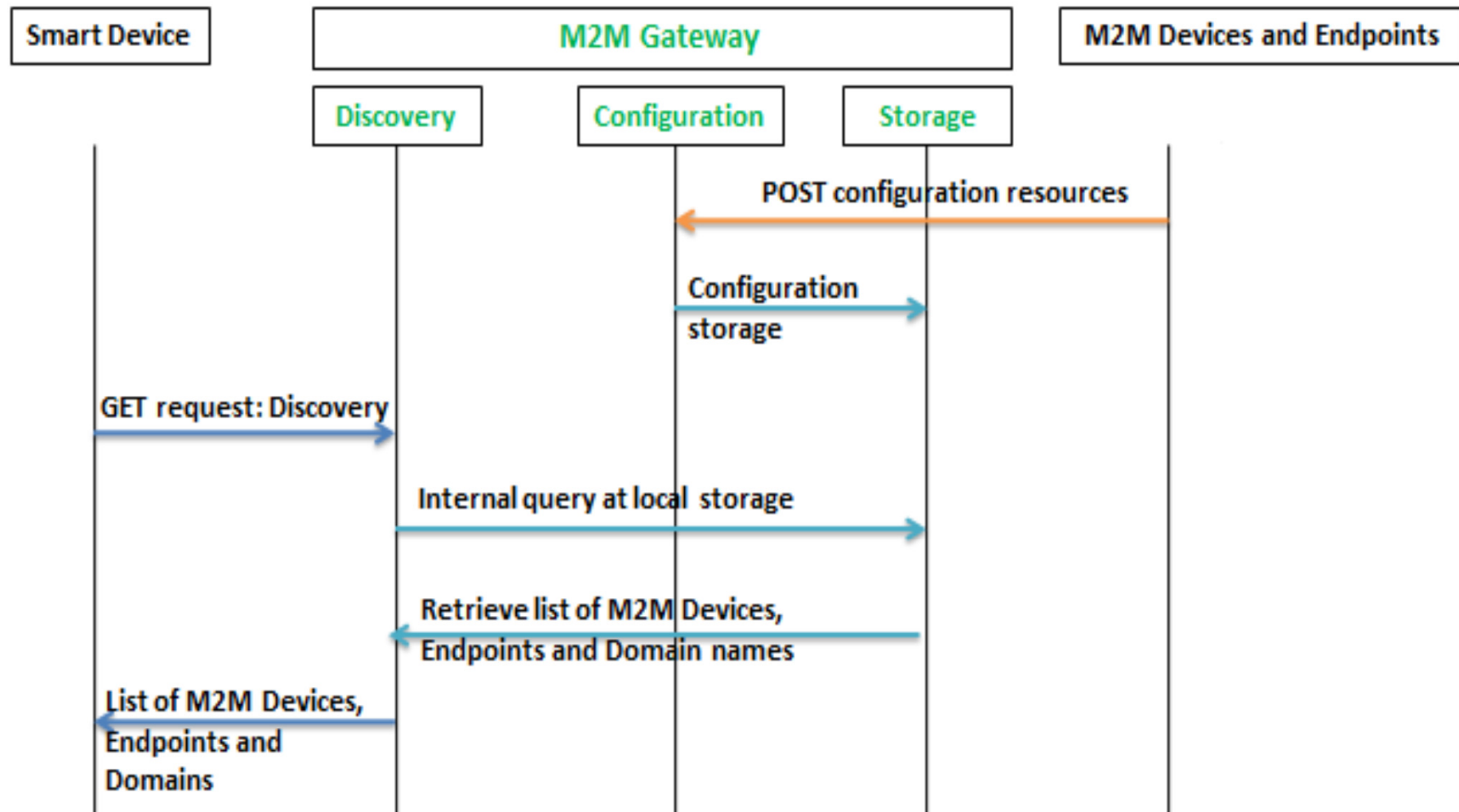


Source: Gyrard, A.; Bonnet, C.; Boudaoud, K., "Enrich machine-to-machine data with semantic web technologies for cross-domain applications," in *Internet of Things (WF-IoT), 2014 IEEE World Forum on*, pp.559-564, 6-8 March 2014

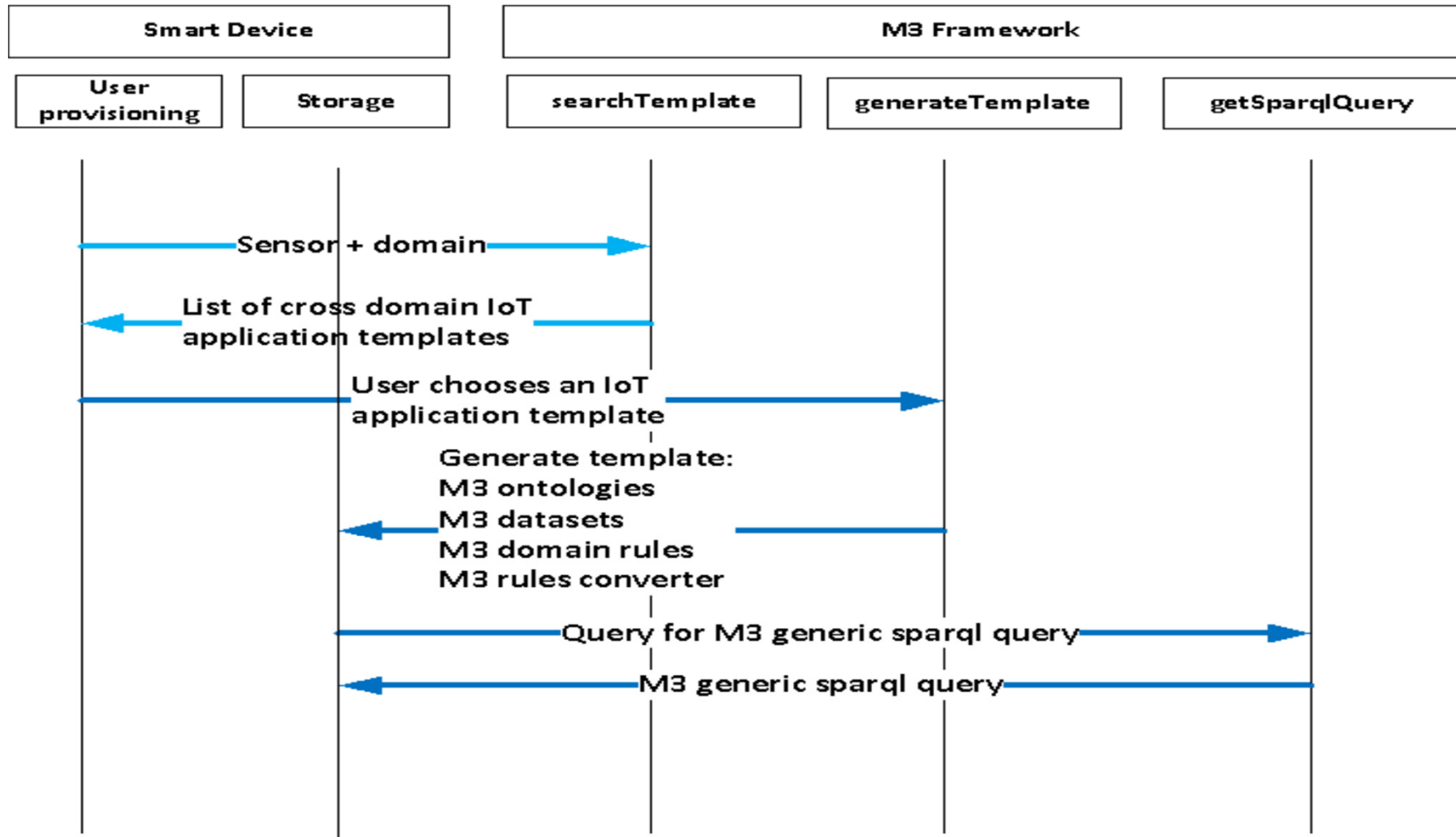
Cross-Domain Framework



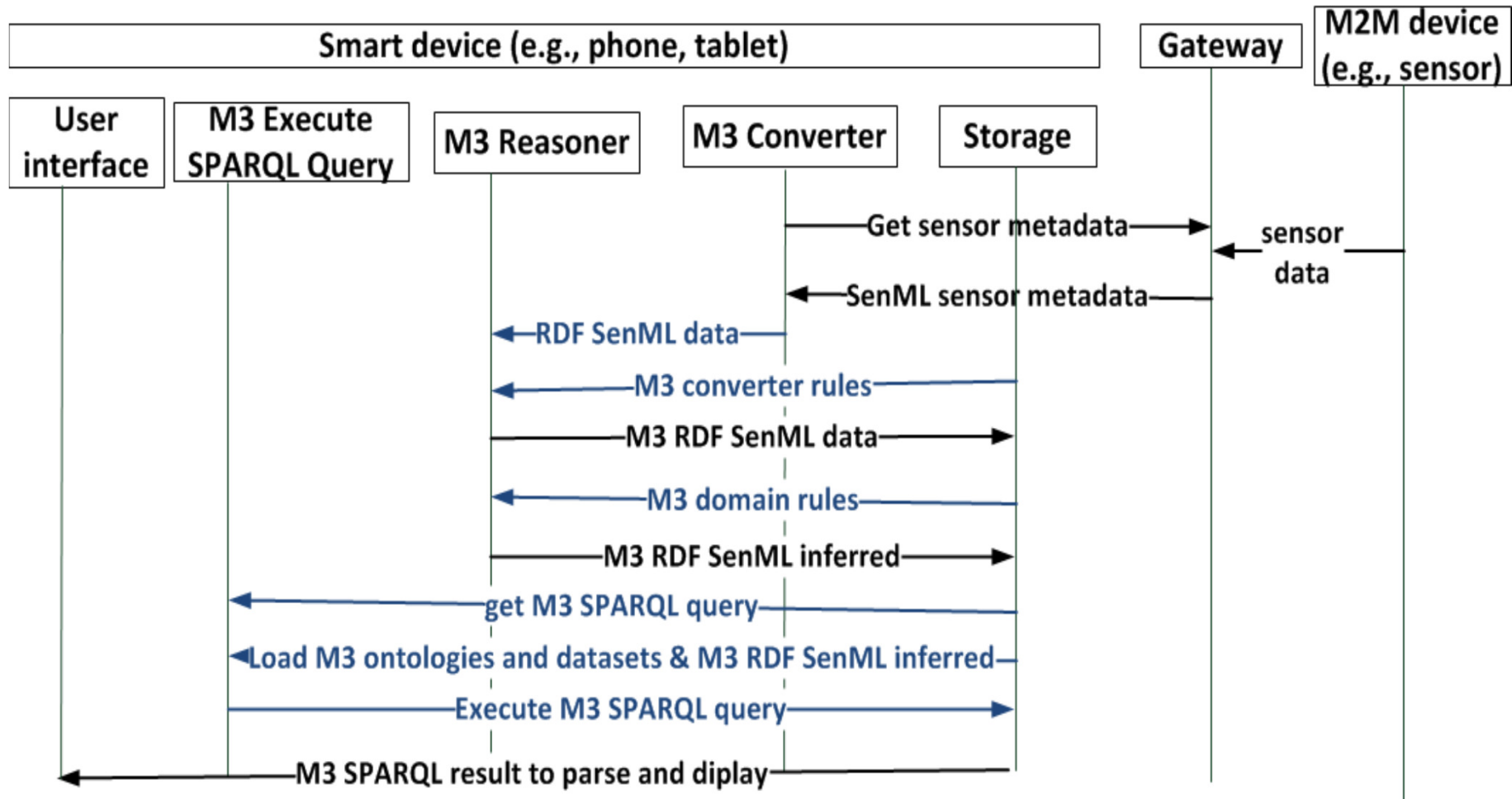
Discovery Phase



Provisioning Phase



Convert, Reason and Query Phase



Data Dissemination Phase

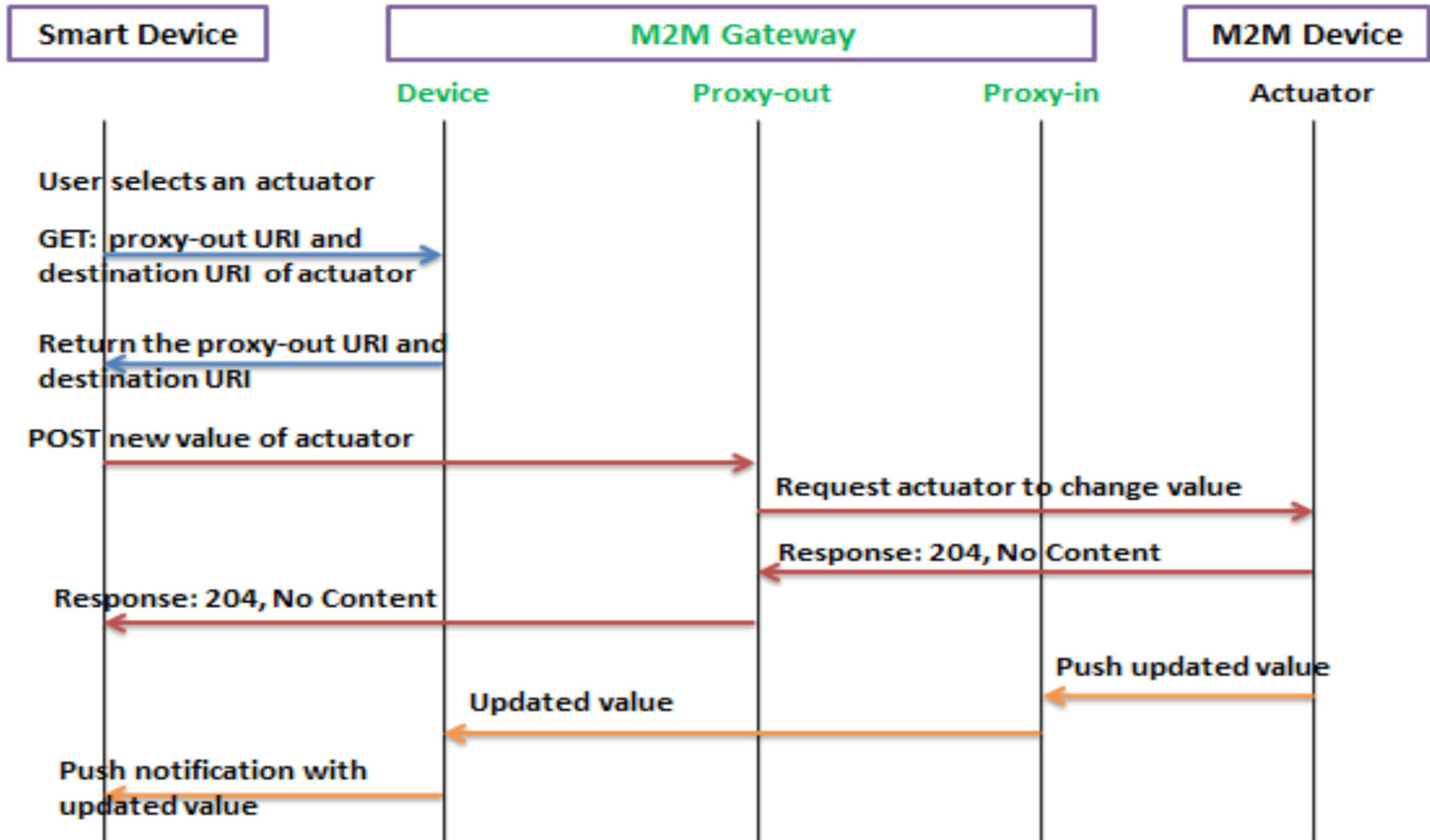
- **Based on HTTP GET**

- Consumer mobile phone request for actionable intelligence from Middle Node.

- **Based on Push notification**

- Middle node uses Google Cloud Messaging platform to push actionable intelligence into Android powered devices.
- Apple Push Notification platform is used for iOS powered devices.

Actuation Phase



Deployment and Prototype

- **M3 Framework – Cloud**

- Developed using Jena Framework
- Available at - <http://sensormeasurement.appspot.com/>

- **Cross domain IoT application development framework – Android powered device acting as a home gateway**

- Developed using Android SDK and AndroJena

- **Initial testing performed with**

- Combining weather and vehicular sensors data
- Combining eHealth and home automation sensors data

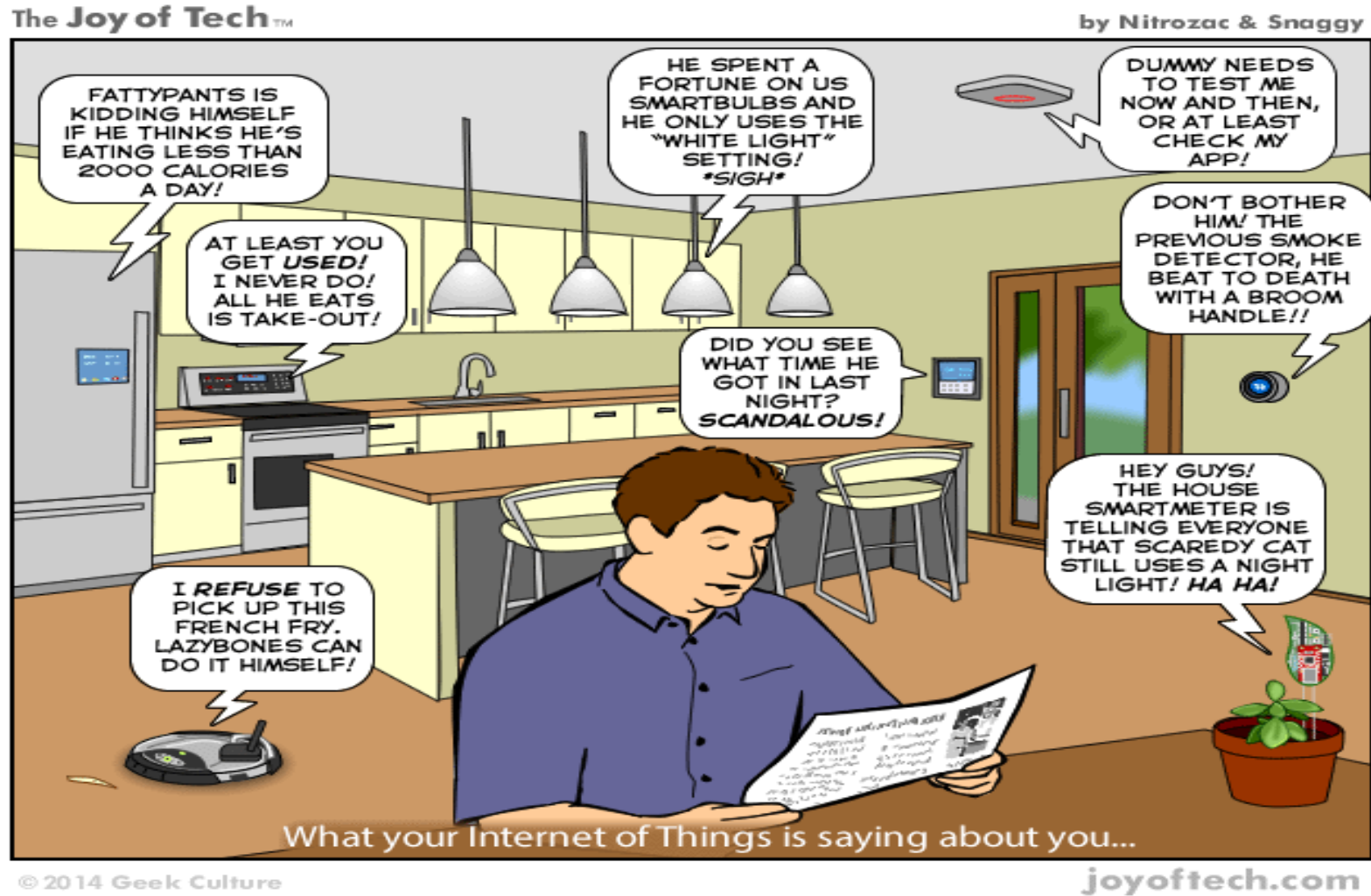
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Conclusion

- **In a nutshell,**
 - Challenges towards cross domain IoT application development framework in smart home
 - Limitations found in state-of-the-art
 - A semantic based framework for such development

Sometime Soon ...



감사합니다 Natick
Grazie Danke Ευχαριστίες Dalu
Thank You Köszönöm
Спасибо Dank Gracias
谢谢 Merci Seé
ありがとう

Obrigado

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