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Horizontal IoT Application Development using Semantics

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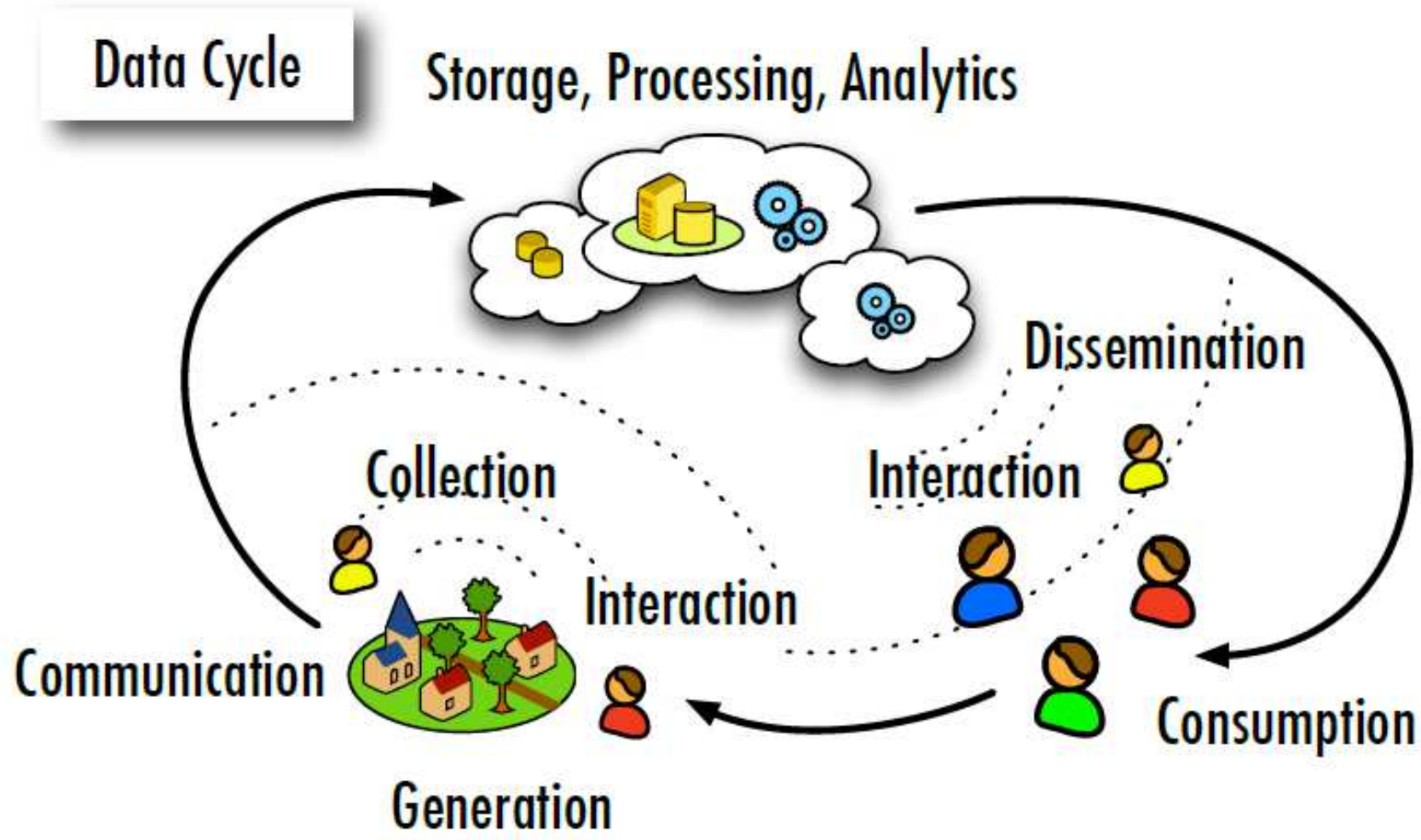
Roadmap

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

Introduction - Ingredients

- **Low-cost sensors, actuators, tags**
- **Networking chips**
- **Lightweight software development frameworks**
- **Low power communication protocols**
- **Growing trend of making everything “connected”**
- **Availability of cloud platform and smart devices**
- **New business opportunities**

Data Cycle in IoT Applications



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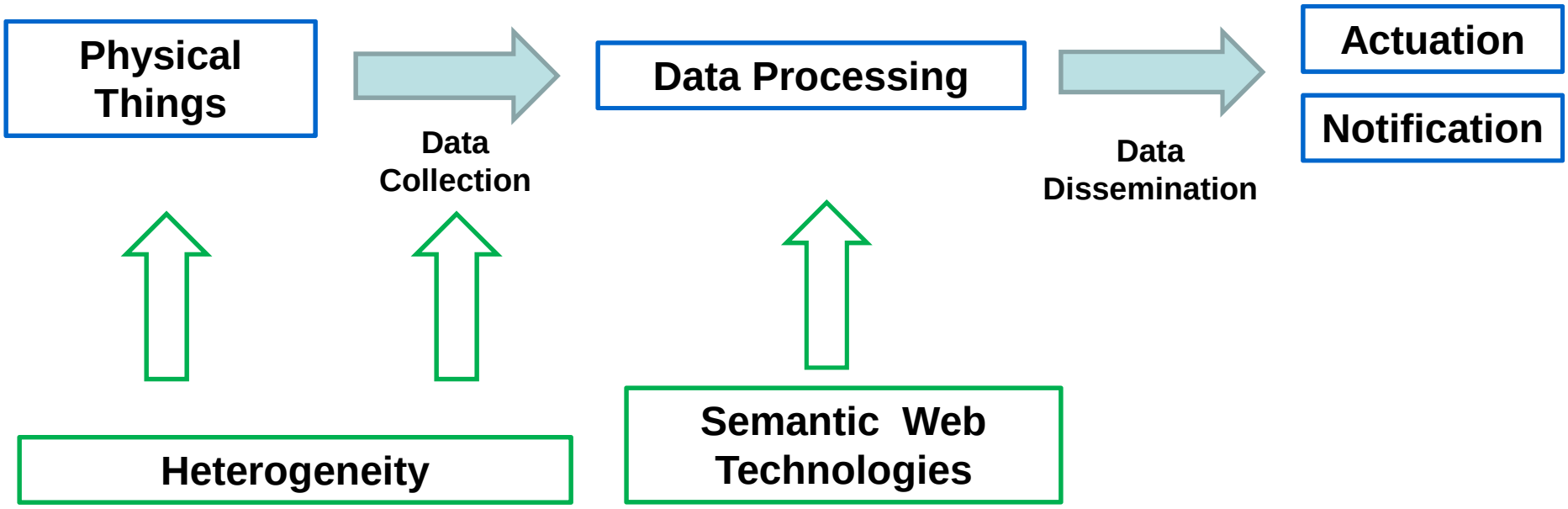
Challenges

- **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

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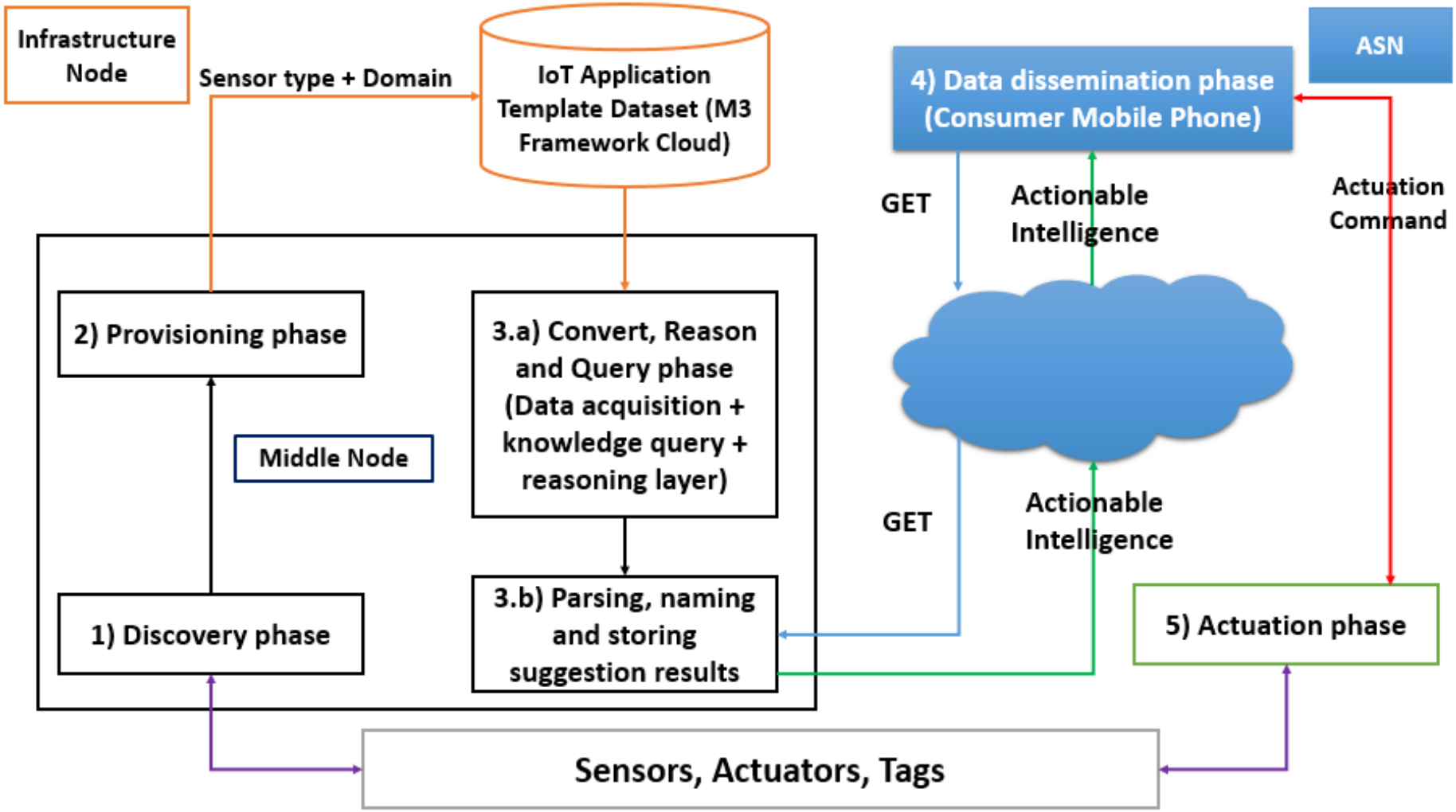
Horizontal IoT Application Development Framework



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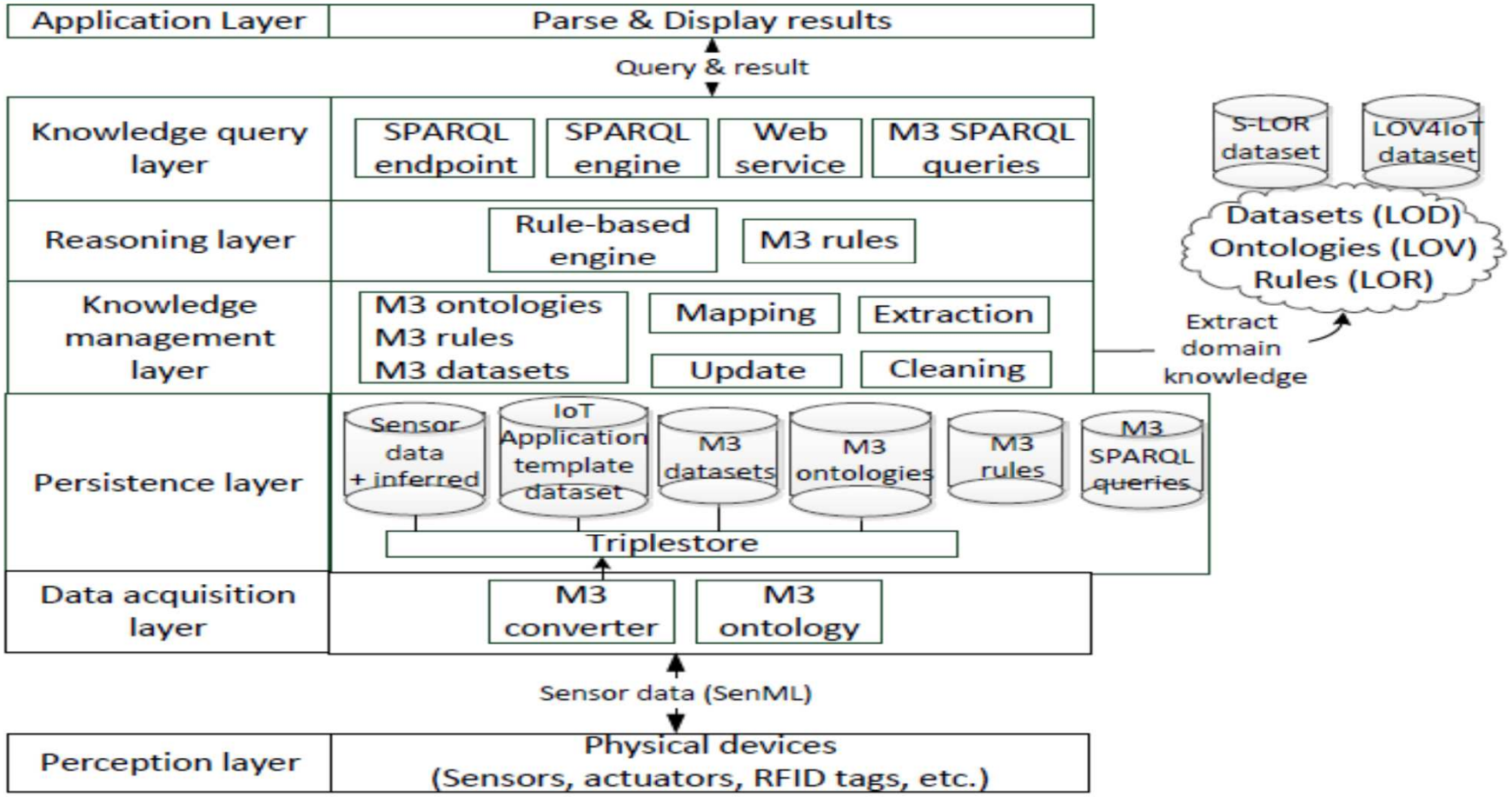
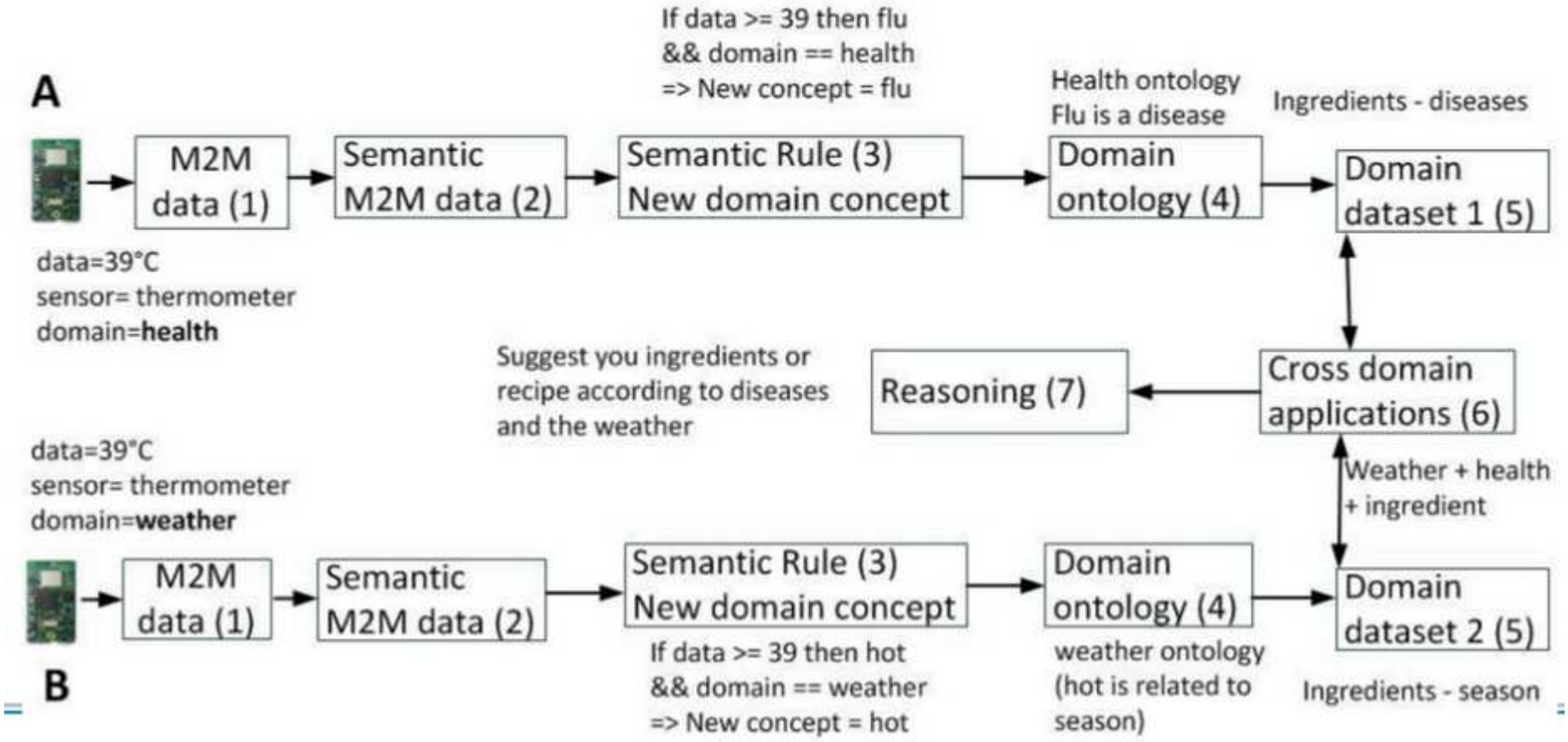
Machine-to-Machine Measurement (M3) Framework



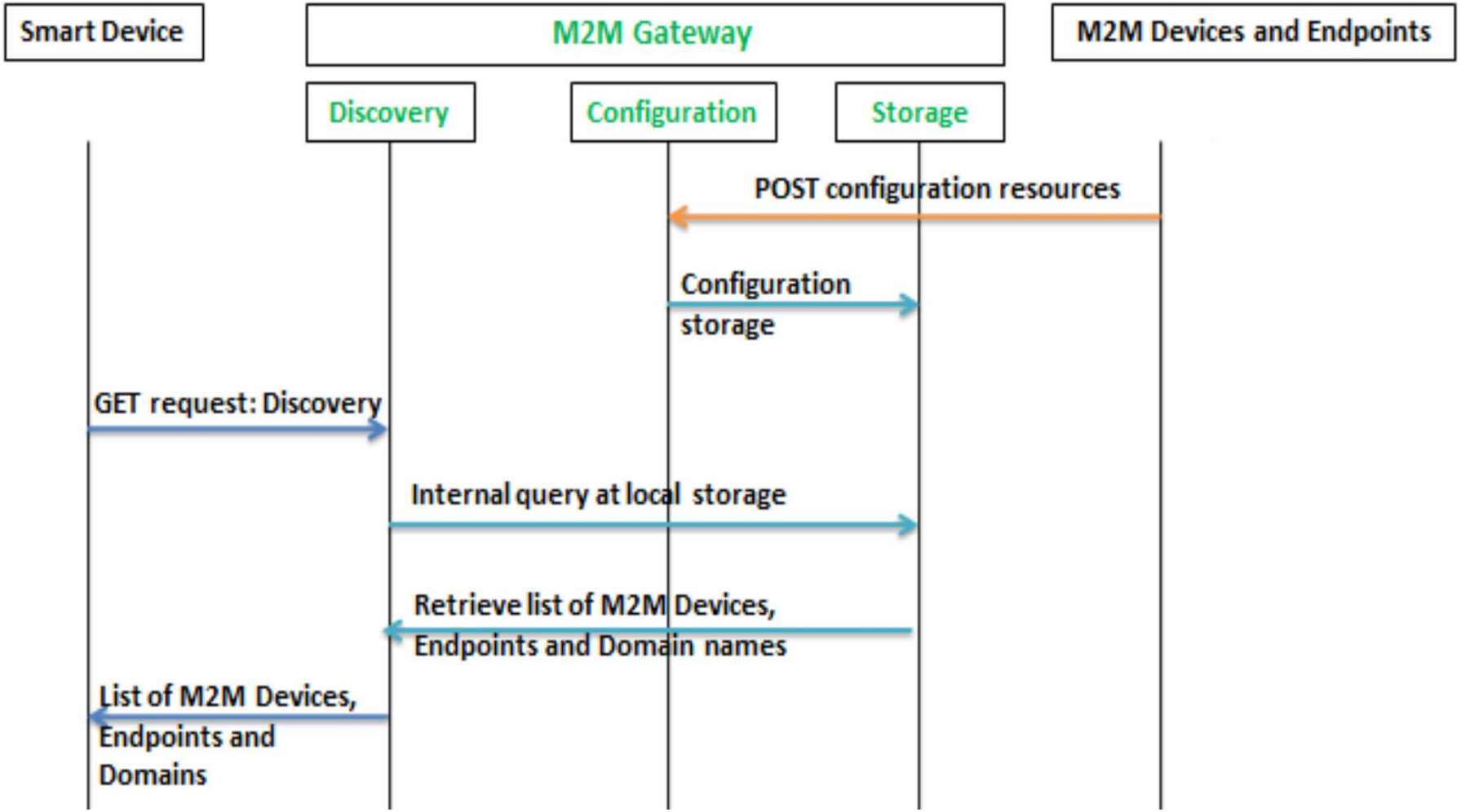
Source: A. Gyrard, S. K. Datta, C. Bonnet and K. Boudaoud, "Cross-Domain Internet of Things Application Development: M3 Framework and Evaluation," *Future Internet of Things and Cloud (FiCloud), 2015 3rd International Conference on*, Rome, 2015, pp. 9-16

Semantic Reasoning

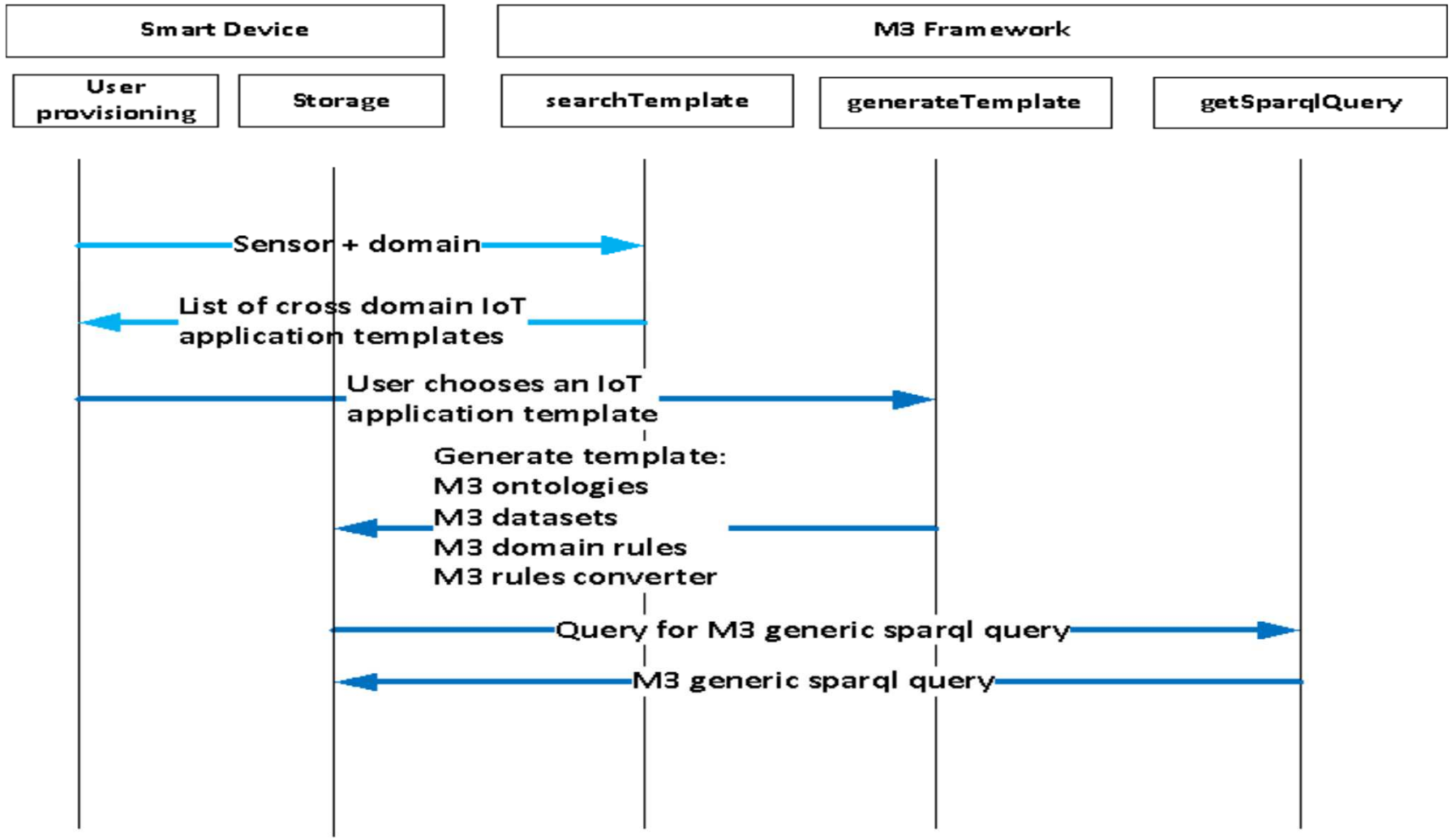


Source: Gyrard, A.; Bonnet, C.; Boudaoud, K., "Enrich machine-to-machine data with semantic web technologies for cross-domain applications," in *Internet of Things (WF-IoT), 2014 IEEE World Forum on*, pp.559-564, 6-8 March 2014

Discovery Phase



Provisioning Phase



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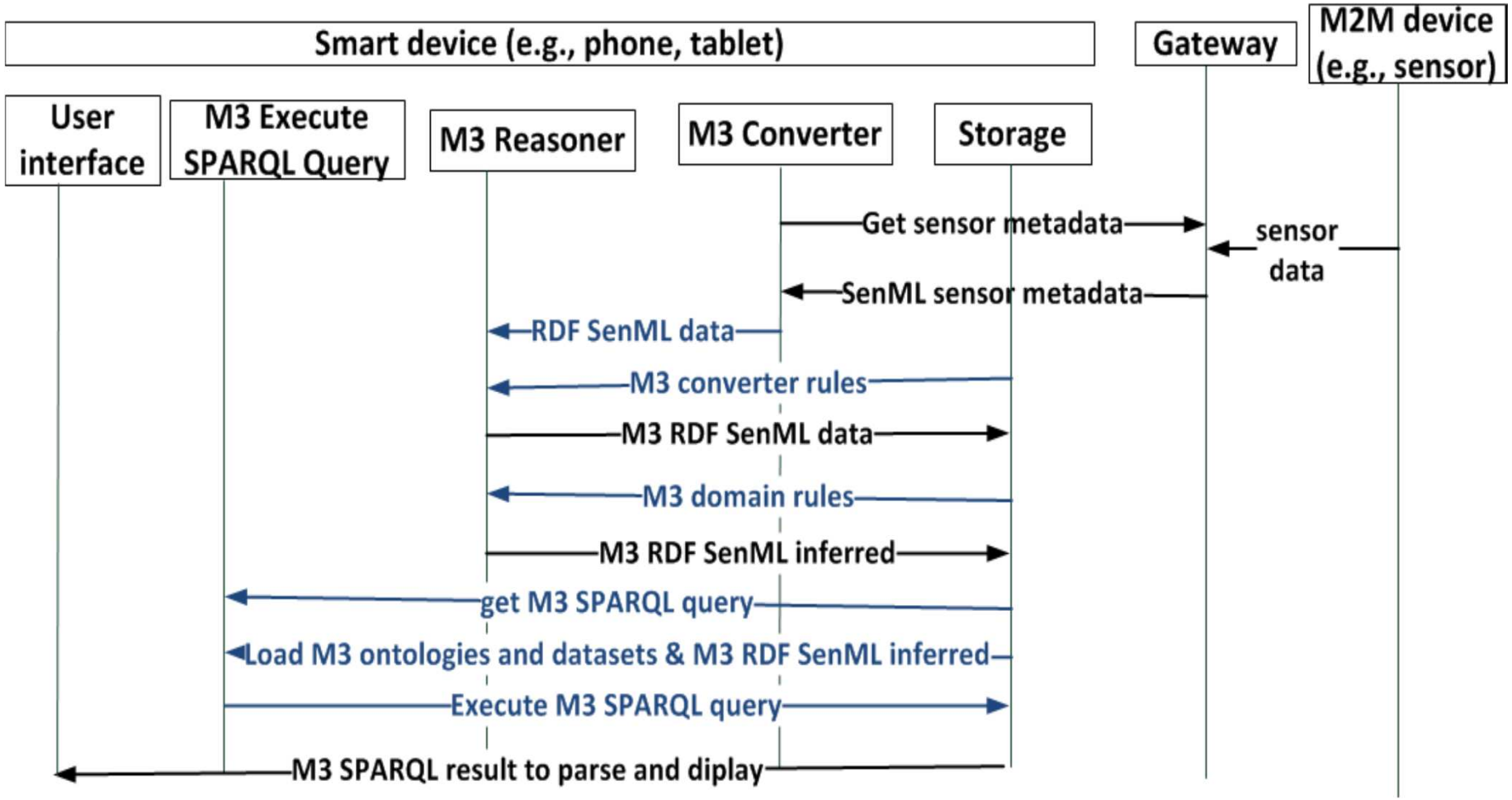
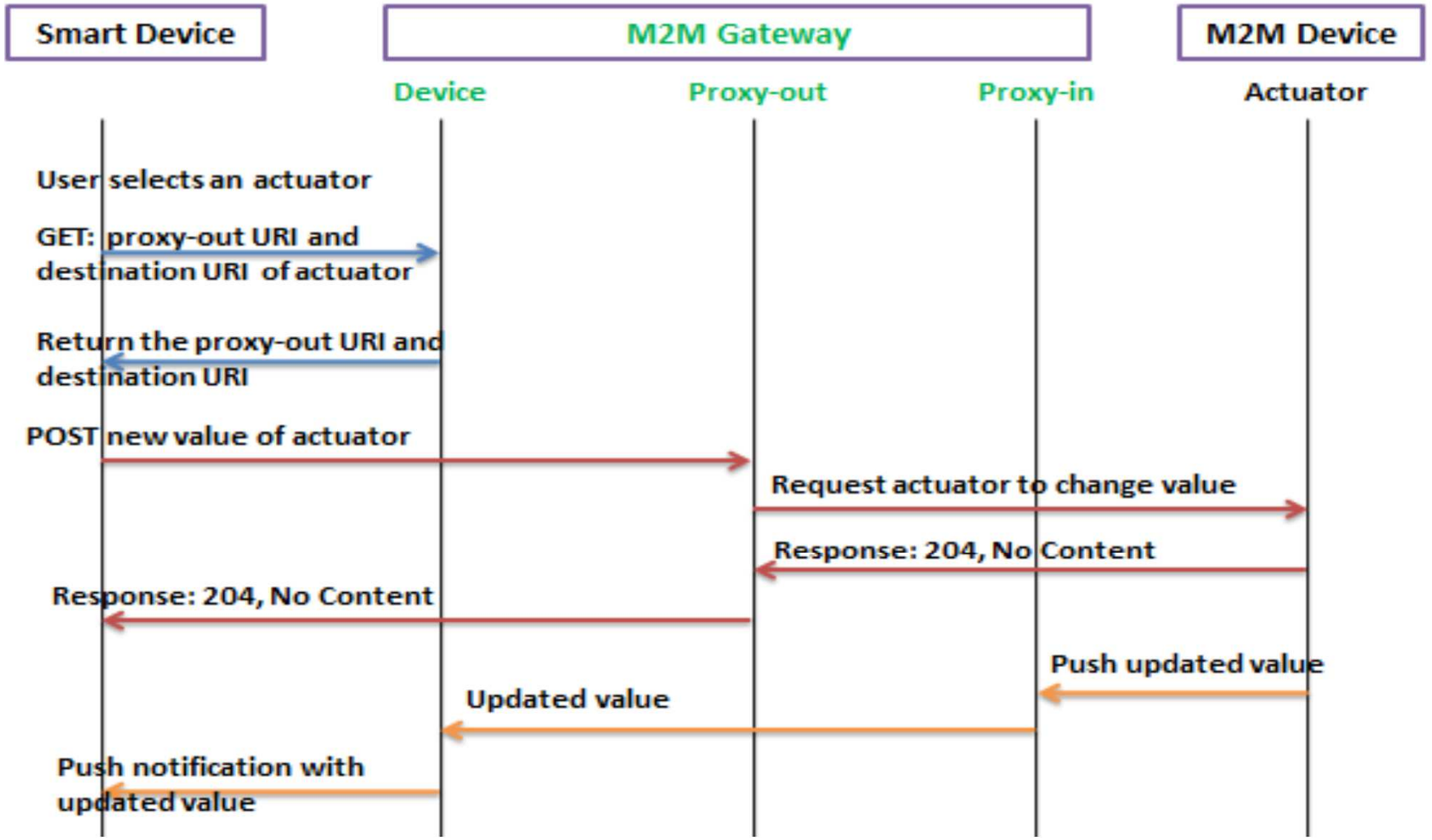
Convert, Reason and Query Phase



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



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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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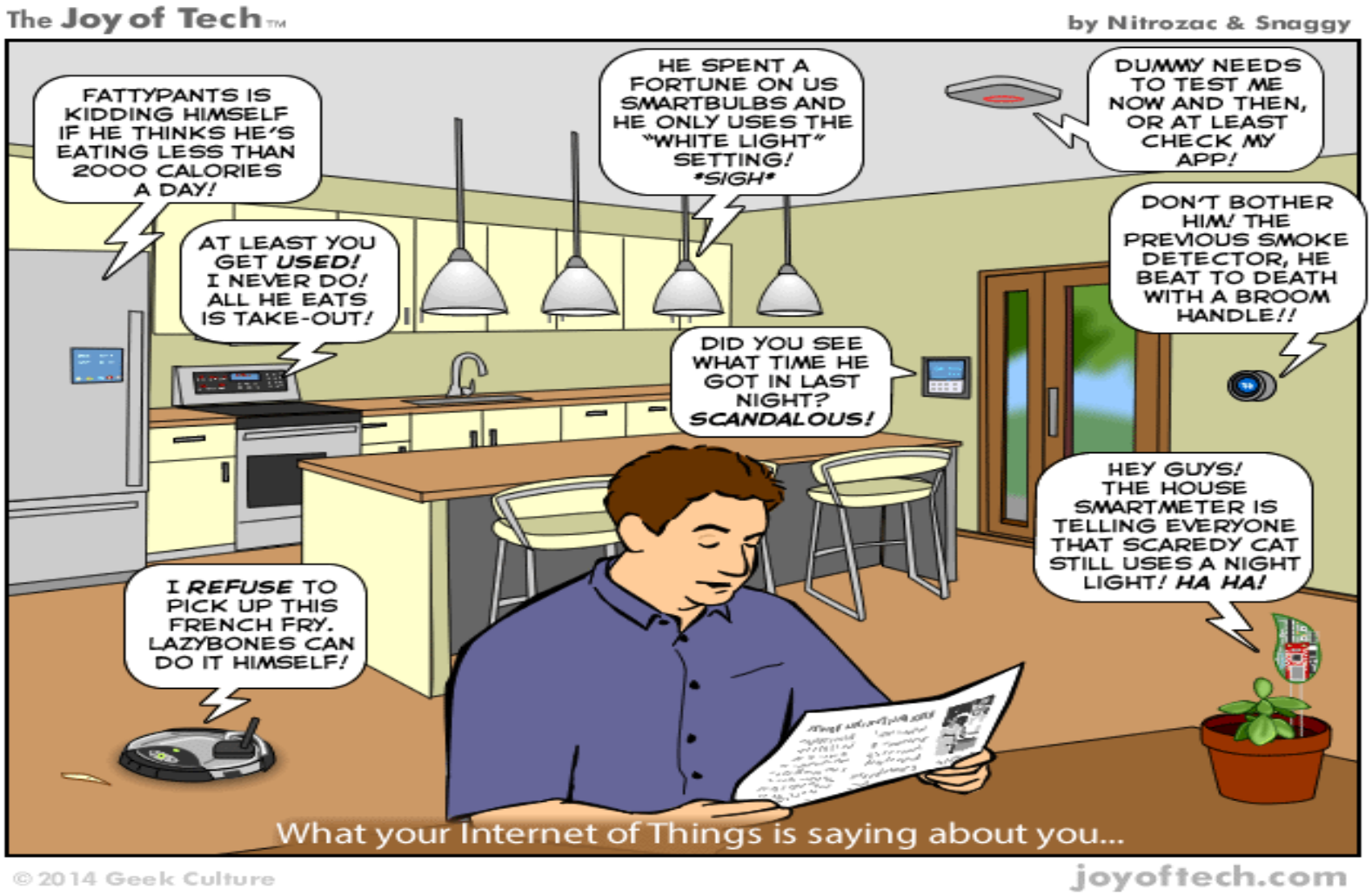
Conclusion

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

Acknowledgements:

1. The M3 Framework has been developed and maintained by Dr. Amelie Gyrard.
2. This work is supported by the Com4Innov Platform of Pole SCS and French research projects WL-Box and DataTweet (ANR-13-INFR-0008).

Sometime Soon …



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