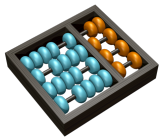

# AUTOMATED TRACKING SYSTEM OF GOODS FOR THE WHOLESALE AND RETAIL SEGMENTS IN THE FOOD INDUSTRY

MSc Research Proposal

UNIVERSITY OF CAMPINAS | INSTITUTE OF COMPUTING

Discipline: MO911 - Introduction to Methodologies for Development of Research Project

Professor: Ariadne Maria Brito Rizzoni Carvalho

Student: Marcelo Oliveira Fernandes | RA 160109

January 15th, 2021

# AGENDA

- Introduction
- Literature Review
- System Overview
- Research Proposal
- Timeline
- References

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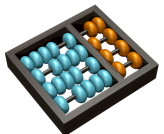

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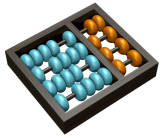

# INTRODUCTION

# INTRODUCTION

- Scope of the research is focused on wholesale and retail segments:
- There are many systems available in the industry. Some of these key system features are:
  - Store floor automation
  - Allocation of employees
  - Flow of information
  - Reduction of levels of exposure rupture
  - Correct pricing of items
  - Receiving goods
  - Inventory control
  - Replacement of products
- Main goals:
  - Maximize sales
  - Improve shopping experience to the end customers
  - Minimize losses

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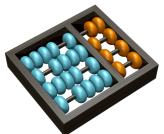

# INTRODUCTION (cont.)

- Known issues:
  - Semi-automated processes
  - Bottleneck
  - Security
- Research goal
  - Deploys passive sensors network
  - Automatically monitor merchandises
  - Extend available tasks
  - Enhance productivity
  - Enhance security
  - Minimize losses

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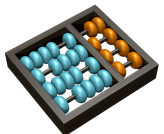

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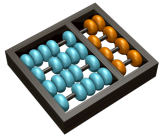

# LITERATURE REVIEW

# LITERATURE REVIEW

- Business case: Amazon Go[1]
  - Grocery store does not have a checkout point
  - Clients collect their required merchandise and leave the store
  - Charges are directly addressed to their Amazon account
- Architecture of these systems is complex
  - Sensors connected to wireless/ wireline networks
  - Provide indoor location of the products and information about their availability
  - Data is sent out to a core location
  - Automated tasks are generated

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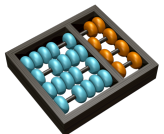

# LITERATURE REVIEW (cont.)

- Indoor localization of the goods is key for the whole process[5]
- Diversity of indoor active and passive sensors
  - Camera
  - RFID tags [6]
  - Printed sensors [7]
- Wireless networks
  - Wireless Local Area Network (WLAN)
  - Geomagnetic-Based Positioning System
  - Ultra-Wideband (UWB)
  - Wifi [8]
  - ZigBee [9]
  - Wireless Sensor Network (WSN) [10]
  - Radio Frequency Identification (RFID)

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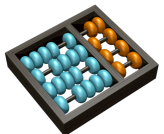

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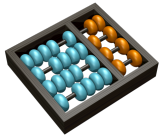

# SYSTEM OVERVIEW

# SYSTEM OVERVIEW

- Proposed design is based on the following IoT architecture layers
  - Sensors
  - Network
  - Support and Data
  - Application
  - Management and Security
- These modules are assembled as shown next

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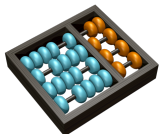
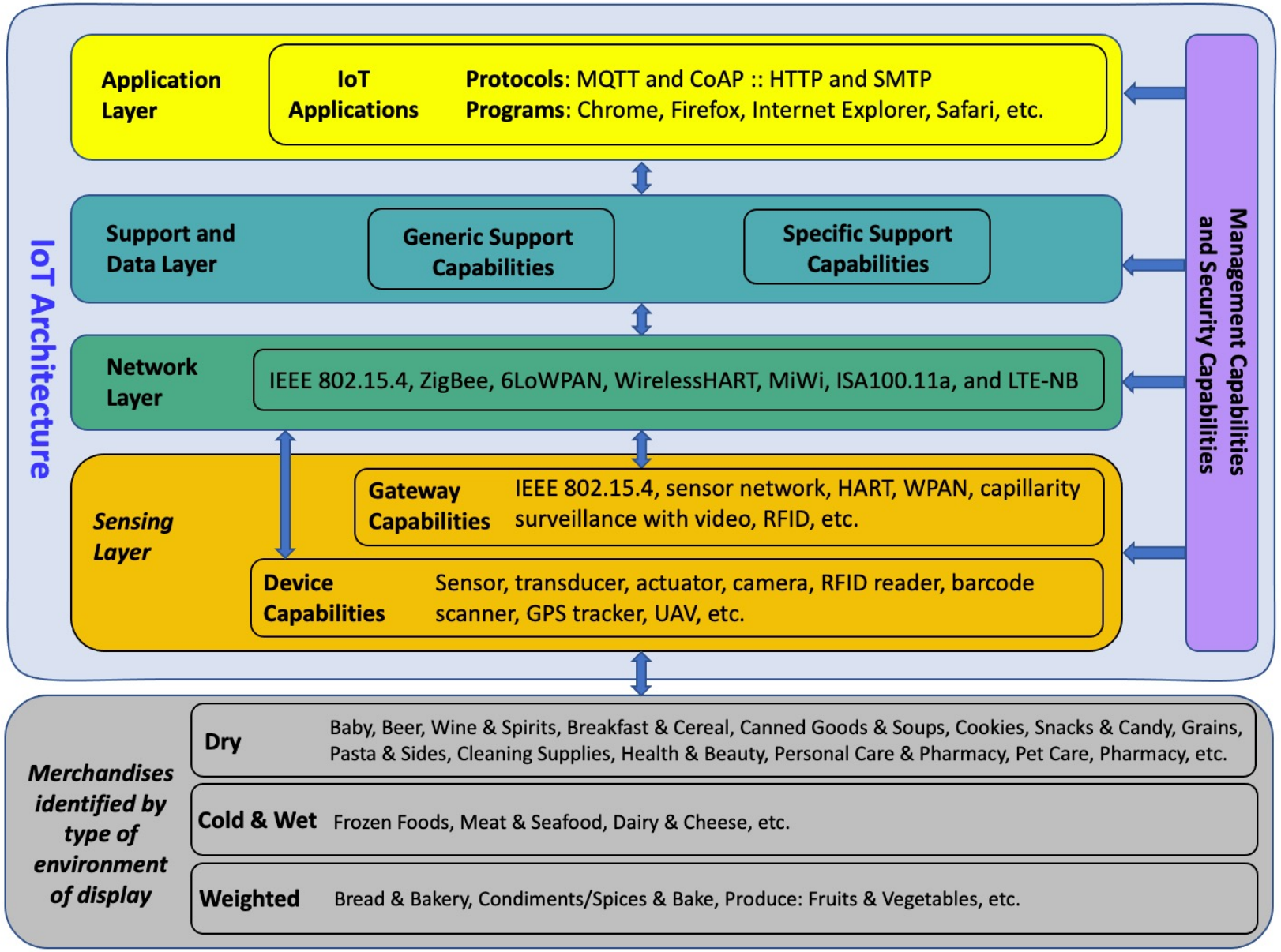
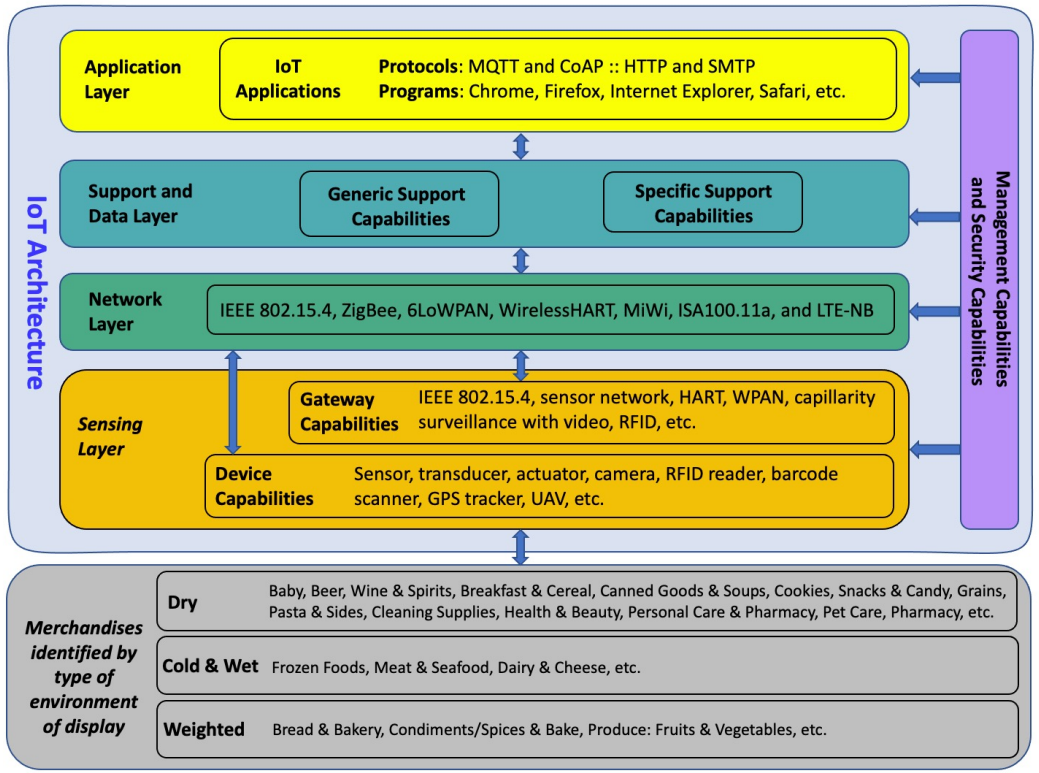





IoT architecture of a supermarket, adapted from ITU-T Recommendation Y.2060 [11]

# SYSTEM OVERVIEW – SENSOR LAYER

- Responsible for the interface between the merchandises and the wireless segment of the network layer
- Standard supermarket has an average of 50,000 products or SKU's [12]
- One-on-one match with the number of sensors physically attached to these products
- Merchandises are resting on the shelves or in movement inside the carts
- Geographic position are tracked
- Passive sensors (tags) should be inexpensive

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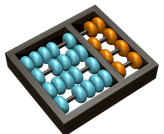
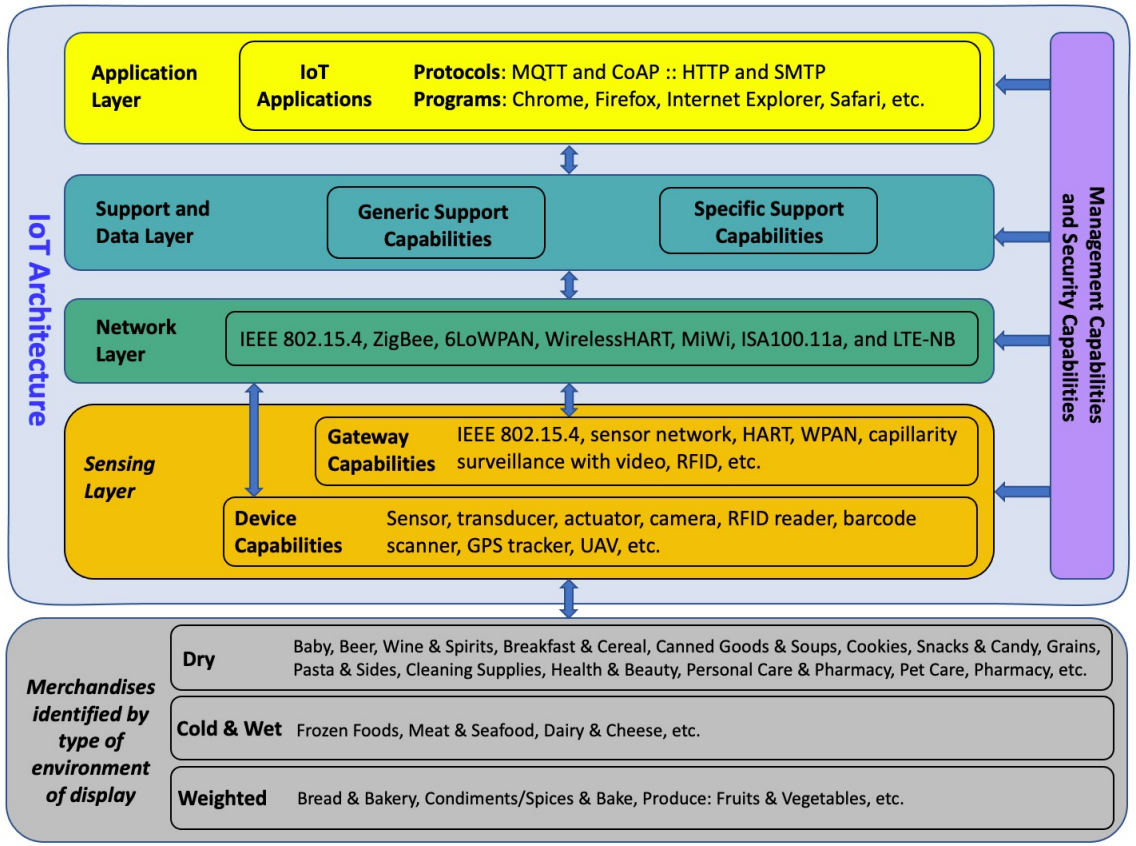


# SYSTEM OVERVIEW – SENSOR LAYER (cont.)

- Passive sensors must have low-power consumption
- Passive sensors must be reachable by the wireless network
- The tag has a unique

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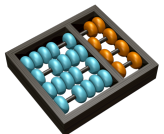
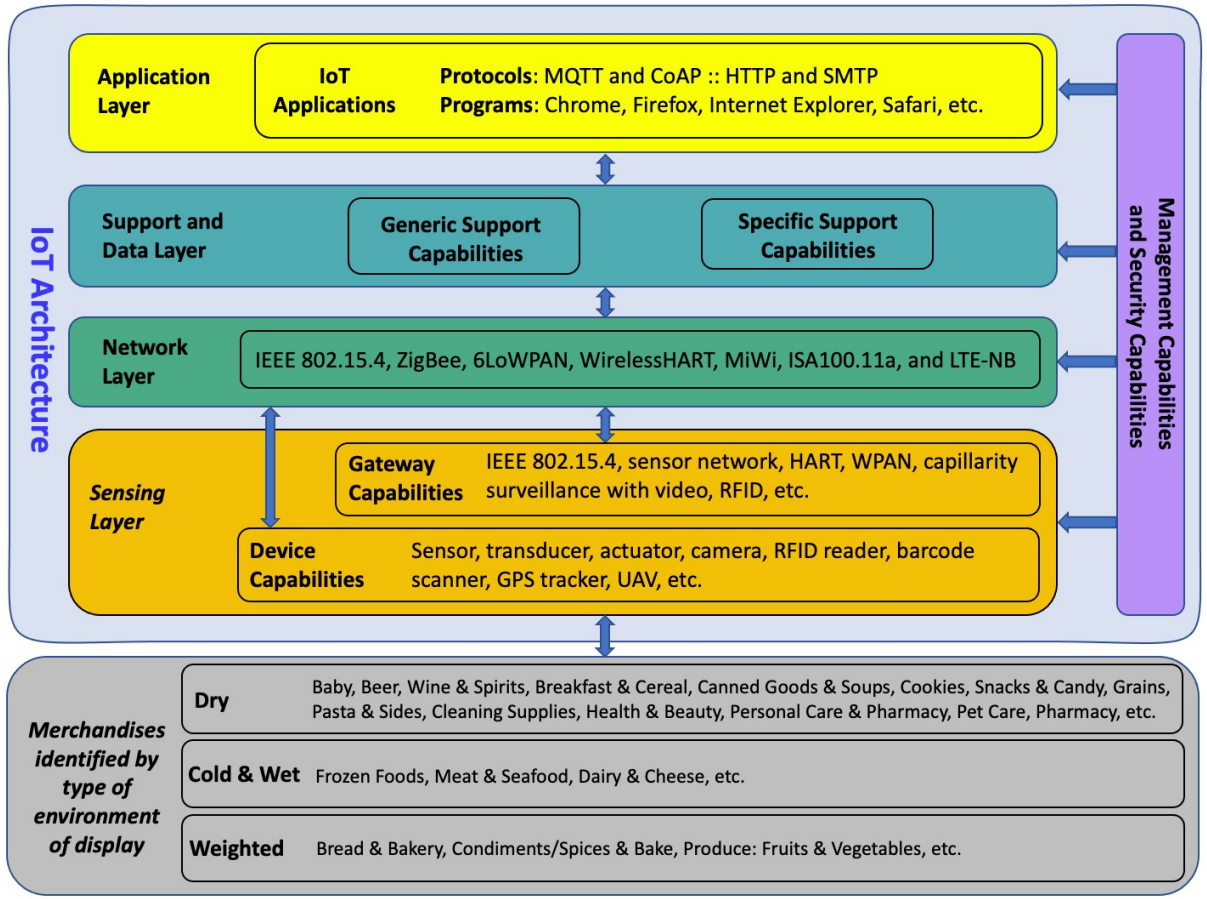


# SYSTEM OVERVIEW – NETWORK LAYER

- Main challenges to overcome in this layer
  - Deal with a large concentration of sensors
  - Products position
  - Products can also be stored on upper shelves
  - Products can be inside of carts
  - Positioning algorithms are key for location tracking

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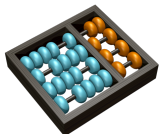
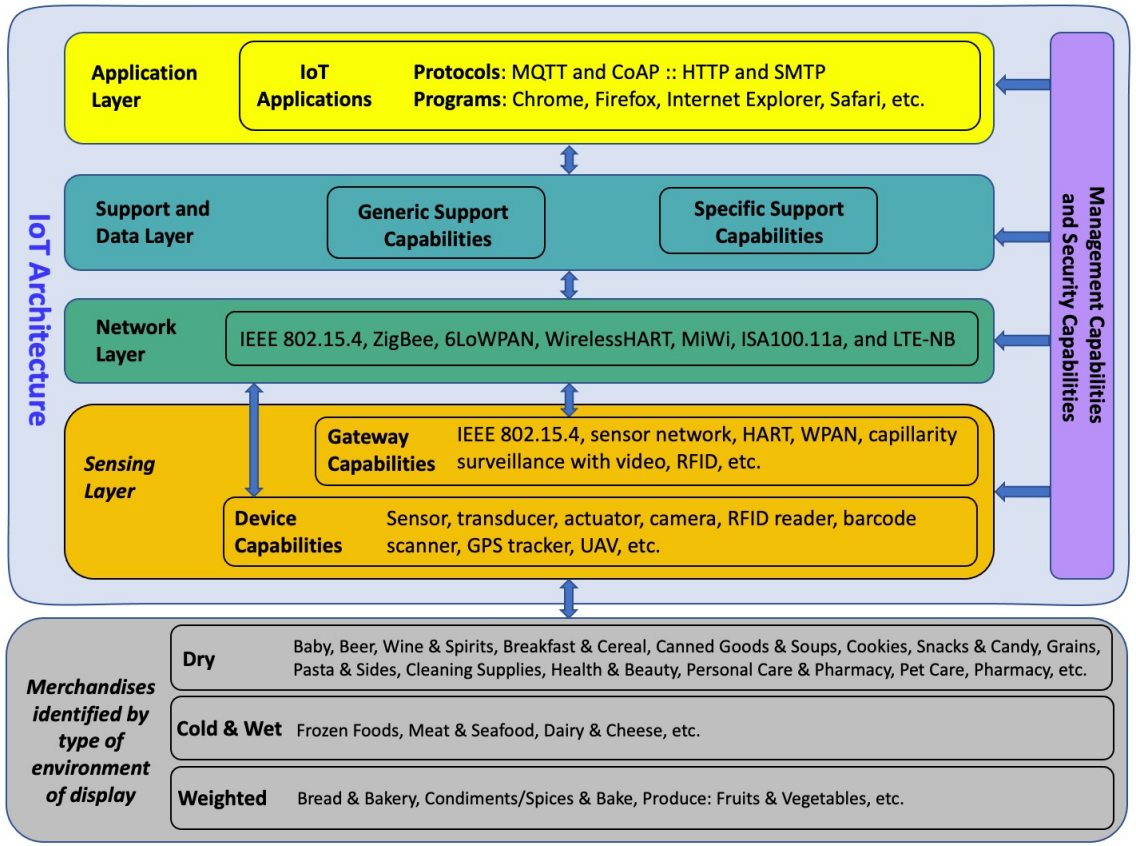


# SYSTEM OVERVIEW – NETWORK LAYER (cont.)

- Wireless network must be designed to provide a strong and reliable connection
  - Line of sight condition
  - Propagation phenomena affect the signal strength
  - Shadow areas
- Latency
  - Massive data processing
  - Middleware devices

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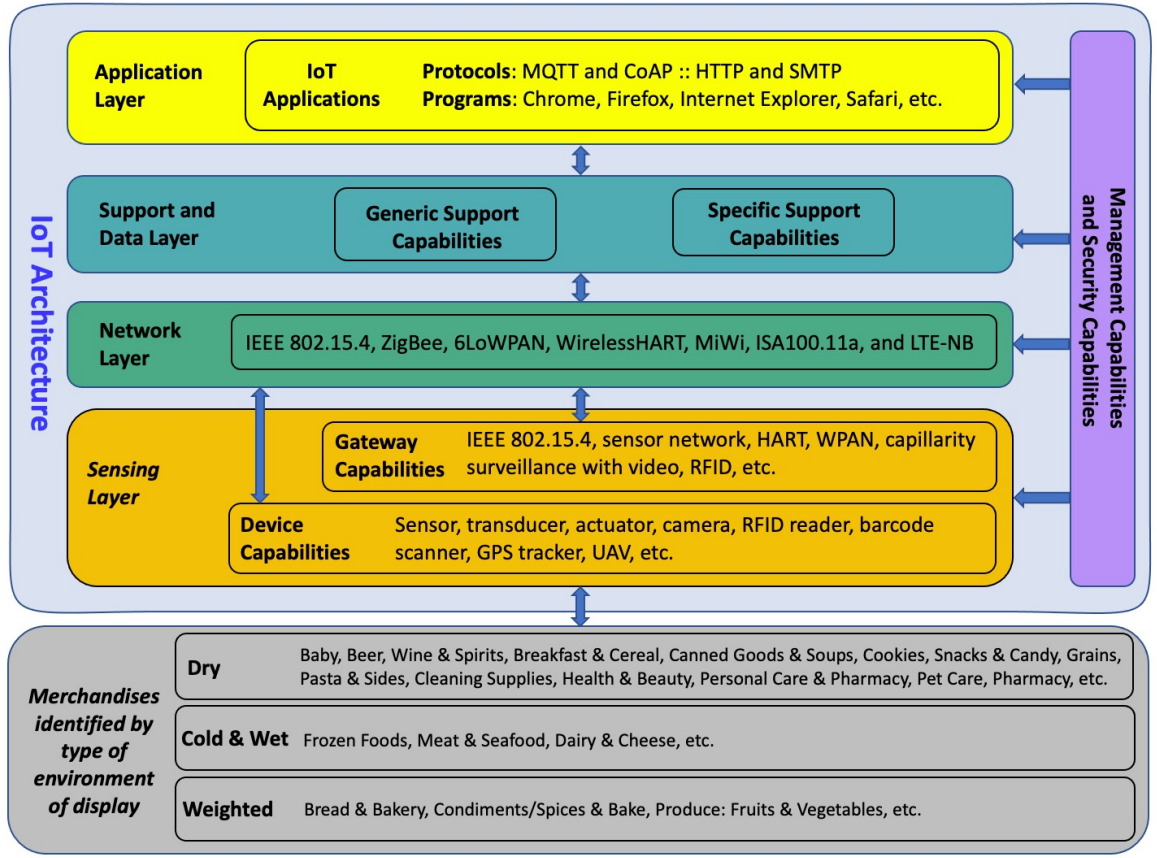
# SYSTEM OVERVIEW – SUPPORT AND DATA LAYER

- Generic support capabilities
  - Data processing or
  - Data storage
- Specific support capabilities
  - Requirements of diversified applications
  - Various detailed capability groupings

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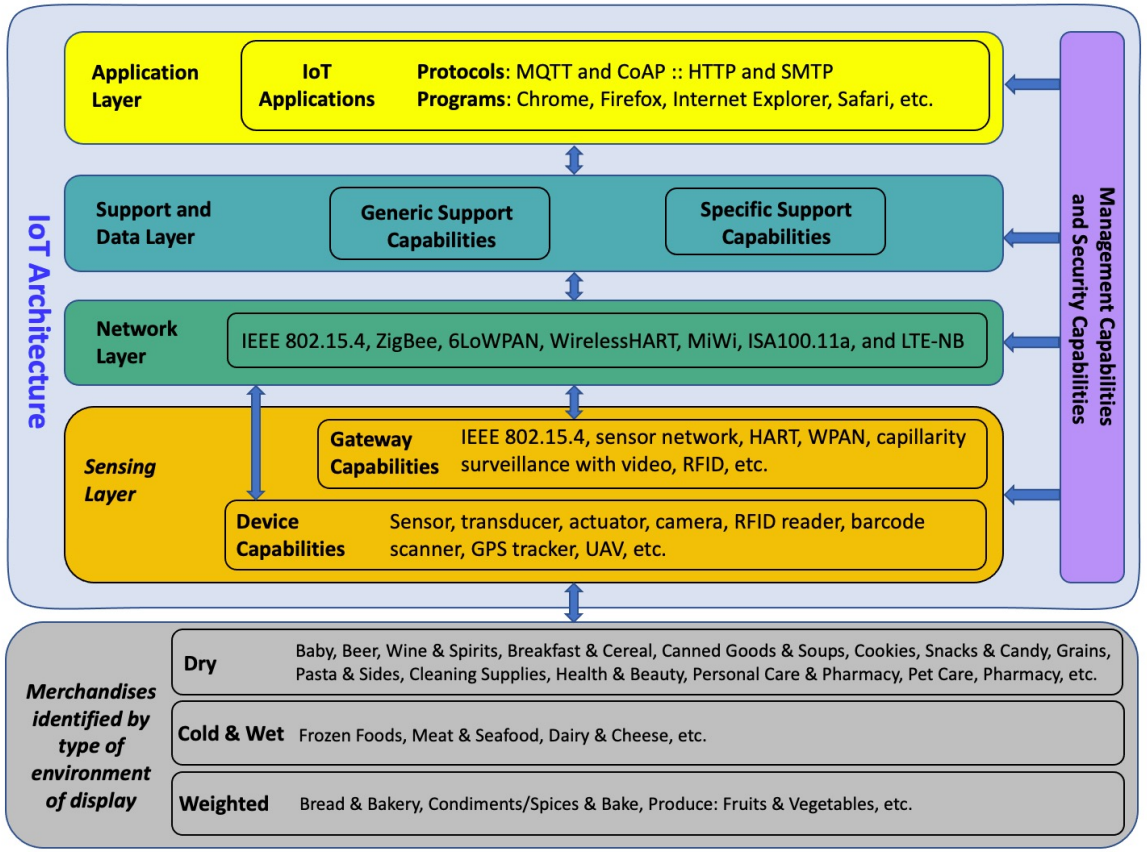
# SYSTEM OVERVIEW – APPLICATION LAYER

- Contains IoT applications
  - Protocol definition
  - Program definition

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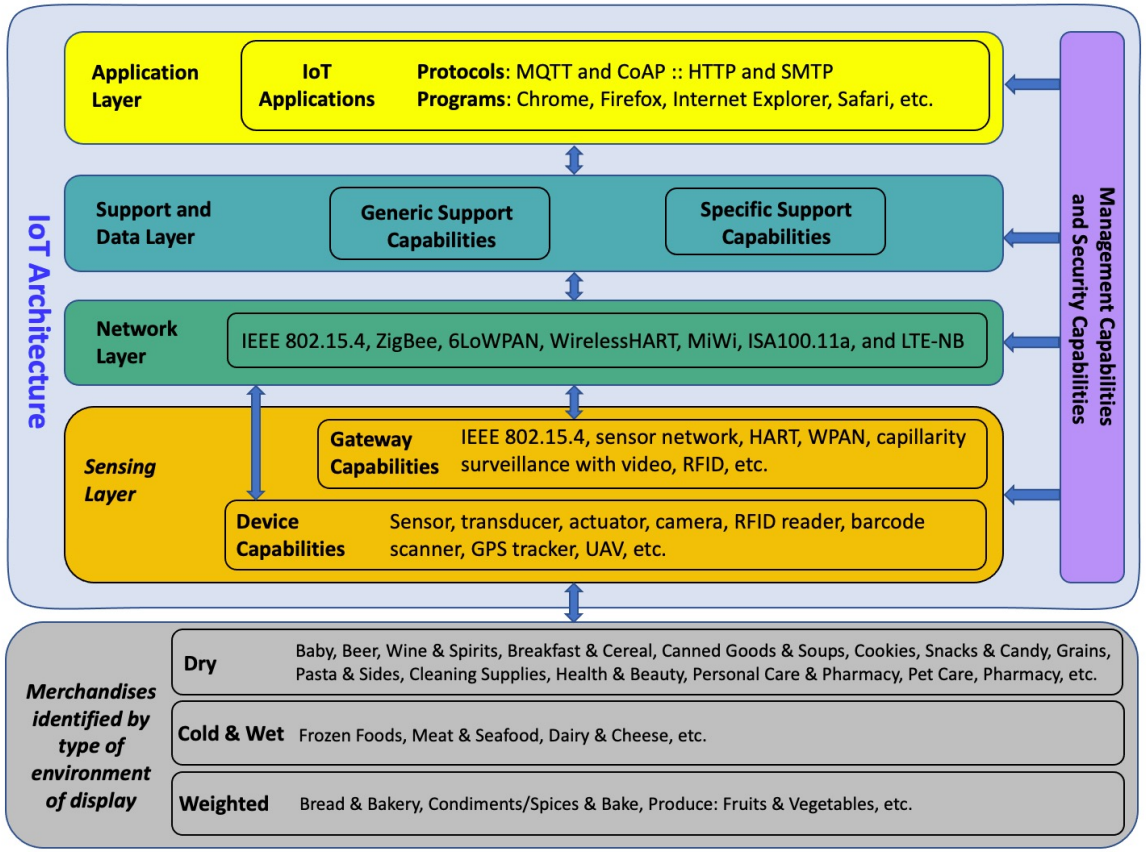
# SYSTEM OVERVIEW – MANAGEMENT CAPABILITIES LAYER

- IoT management capabilities
  - Traditional fault
  - Configuration
  - Accounting
  - Performance and security (FCAPS) classes
- Generic management capabilities
  - Device management
  - Local network topology management
  - Traffic and congestion management
- Specific management capabilities
  - Application-specific requirements

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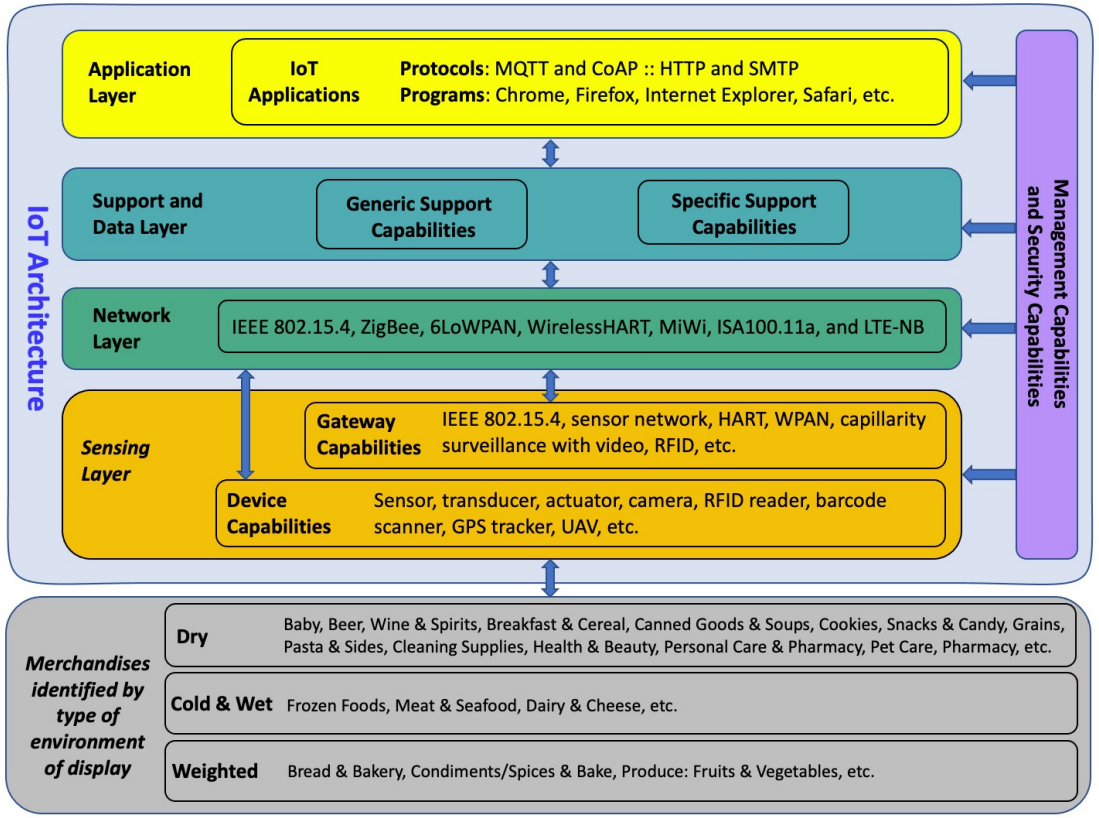
# SYSTEM OVERVIEW – SECURITY CAPABILITIES LAYER

- Generic security capabilities are independent of applications
  - Application layer
  - Network layer
  - Device layer
- Specific security capabilities are closely coupled with application-specific requirements

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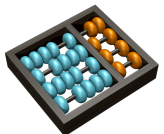

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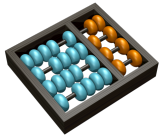

# RESEARCH PROPOSAL

# RESEARCH PROPOSAL – PROOF OF CONCEPT

- Build up environments to validate the architecture technical performance
  - Small Environment <= 100 SKUs
  - 100 < Medium Environment  <= 30.000 SKUs
  - Large Environment > 30.000 SKUs
- Main features validation
  - Tag localization and navigation
  - Tag information storage and update
  - Tag insertion/ deletion
- This project requires stakeholder sponsorship

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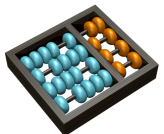

# RESEARCH PROPOSAL – ANALYSIS OF THE RESULTS

- Documentation
- Results
- Publication

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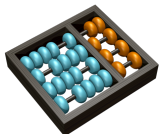

# RESEARCH PROPOSAL – CONCLUSION AND FURTHER RESEARCH

- Architecture technical performance
- Cost of the entire network vs. standard labor operation
- Cost-benefit analysis and user experience
- Further research
  - Integration with legacy systems
  - Attached passive sensors

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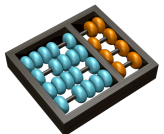

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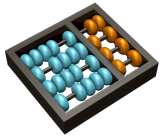

# TIMELINE

# TIMELINE

| | 2021 | | | | | | | | | | | | 2022 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *ROADMAP* | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 |
| Architecture Survey | | | | | | | | | | | | | | | | | | | | | | | | |
| Wireless Standards | | | | | | | | | | | | | | | | | | | | | | | | |
| Passive Sensor | | | | | | | | | | | | | | | | | | | | | | | | |
| Selection of Models | | | | | | | | | | | | | | | | | | | | | | | | |
| Unitary Testing | | | | | | | | | | | | | | | | | | | | | | | | |
| Mediation Device | | | | | | | | | | | | | | | | | | | | | | | | |
| Selection of Models | | | | | | | | | | | | | | | | | | | | | | | | |
| Unitary Testing | | | | | | | | | | | | | | | | | | | | | | | | |
| Architecture Integration Deployment | | | | | | | | | | | | | | | | | | | | | | | | |
| Server to Mediation Device | | | | | | | | | | | | | | | | | | | | | | | | |
| Mediation Device to Passive Sensor | | | | | | | | | | | | | | | | | | | | | | | | |
| Field Test - Functional Testing for: | | | | | | | | | | | | | | | | | | | | | | | | |
| Small Environment <= 100 SKUs | | | | | | | | | | | | | | | | | | | | | | | | |
| 100 < Medium Environment <= 30.000 SKUs | | | | | | | | | | | | | | | | | | | | | | | | |
| Large Environment > 30.000 SKUs | | | | | | | | | | | | | | | | | | | | | | | | |
| Documentation and Publication | | | | | | | | | | | | | | | | | | | | | | | | |

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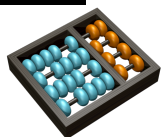

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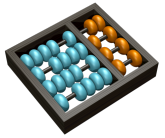

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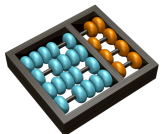

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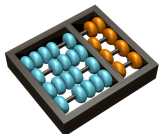

# Q&A

Thank you!

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