IOT BASED FLOOD MONITORING

AND

EARLY WARNING

A project report submitted in partial fulfilment

Of the requirements for the degree of B.E in

COMPUTER SCIENCE AND ENGINEERING

By

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1. Introduction

Since the term was coined by Kevin Ashton in 1999, the Internet-of-Things (IoT) has been an obvious trend and has crept into our everyday life, for example, appearing as Internet-connected home appliances such as a WiFi-enabled, programmable thermostats or LED light bulbs embedded with a ZigBee radio chip. Such home appliances are directly, or via a gateway, connected to the Internet so that end-users can access them remotely from anywhere at any time perhaps mostly through smartphones; for example, set the desired temperature of rooms while driving back to home from workplace.

Related Works

IoT envisions everyday objects and industrial products to be connected together, sharing their information over the Internet, working and interacting in a cooperative way, and thus building a smart environment. Many research works have been working on realizing IoT middleware for smart solutions in a variety of application domains. Brouwers et al. developed a pragmatic middleware framework for mobile phone sensing that provides features fine-grained user-level control to protect privacy of smartphone users [4]. The proposed middleware was implemented on the Android platform outlining an architecture featuring a publish and subscription framework and evaluated with a localization application.

IoT Middleware and oneM2M Standard

In particular, a few literature reviews over the past years summarized issues and challenges on requirements for IoT middleware by examining relevant articles [21]. Razaque et al. highlights the importance of middleware for the IoT, which allows massive amounts of heterogeneous devices to be connected by means of diverse networks and platform technologies, supporting interoperability across physical and virtual objects and enabling a wide range of applications and services

oneM2M-Based Scenarios for Sensing and Actuation Capabilities

The oneM2M standard supports resource-oriented architecture (ROA) and adopts a layered model as shown in **Figure 1**. **Figure 1** illustrates the oneM2M reference architecture whose environments are divided into two domains: infrastructure domain where an infrastructure node (IN) locates and field domain where middle nodes (MNs), application service nodes (ASNs), and application dedicated nodes (ADNs) locate. IN, MN, ASN have to contain common service entities (CSEs) which provide common service functions (e.g., the functional requirements described in **Table 1**) to other CSEs or application entities (AEs) which provide application service logics (e.g., sensing and actuation). Networking services are provided by network service entities (NSEs) located in the underlying network service layer. More details are well described in the previously published literature [35].

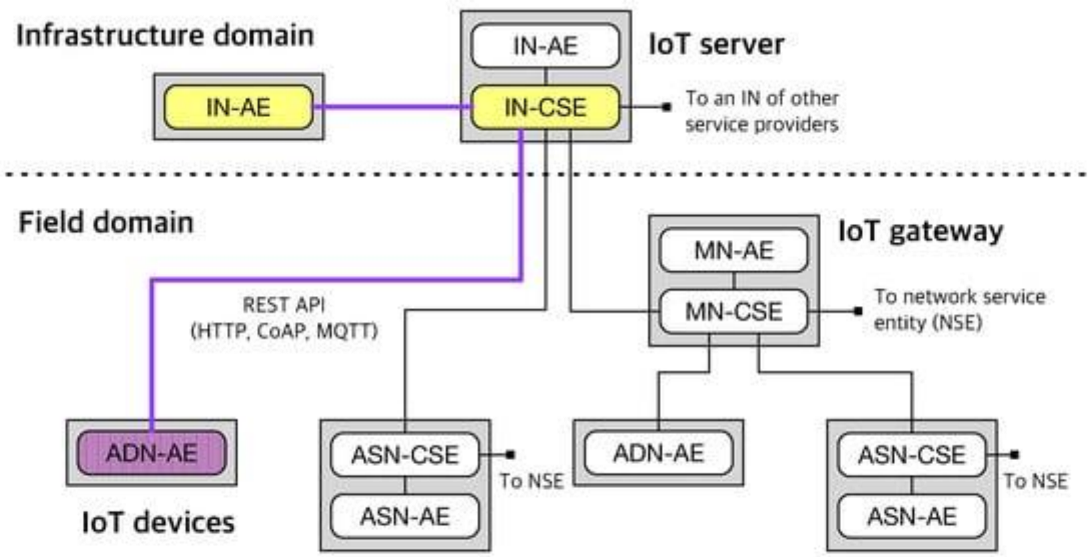


Figure 1. The oneM2M reference architecture.

In our work, we focus on the sensing and actuation capabilities for IoT devices, so three components are mainly considered from the oneM2M reference architecture as highlighted in **Figure 1**: IoT server (IN-CSE), IoT device (ADN-AE), smartphone application (IN-AE). We assume that all three components can talk to each other via oneM2M standard-defined REST APIs on HTTP, CoAP, or MQTT protocols. With this assumption, we can image sensing and actuation scenarios between IoT devices and smartphone applications as demonstrated in **Figure 2** and **Figure 3**.

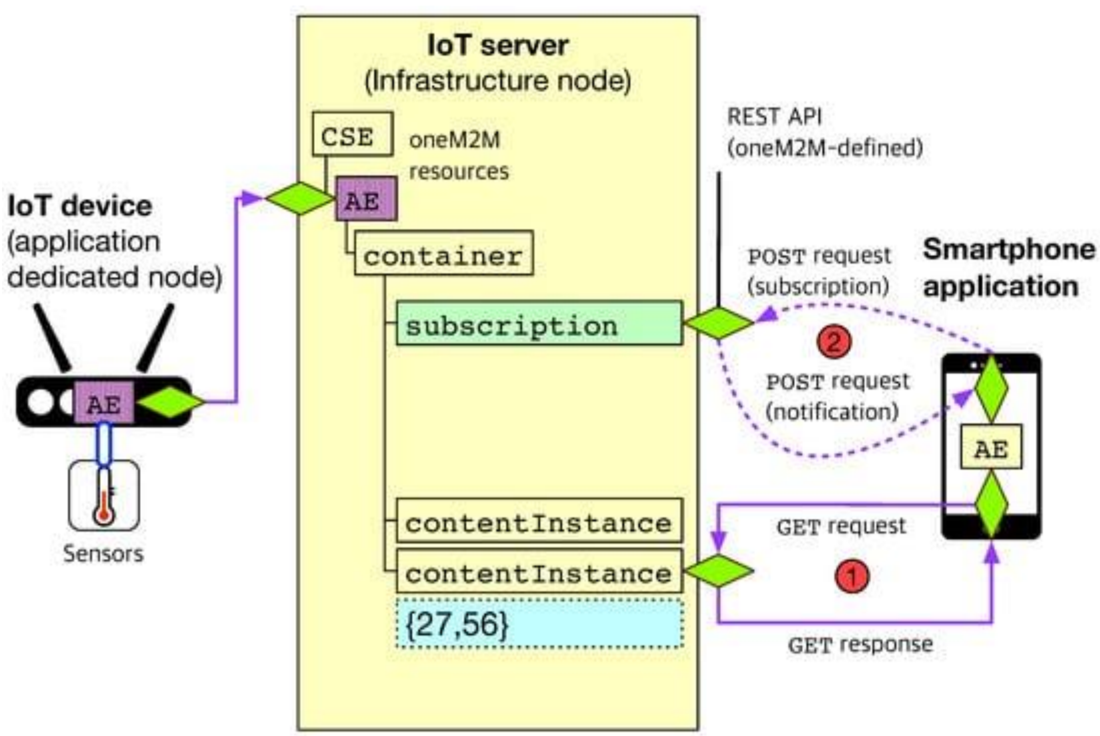


Figure 2. The proposed sensing scenario using oneM2M standard-based sensing capabilities.

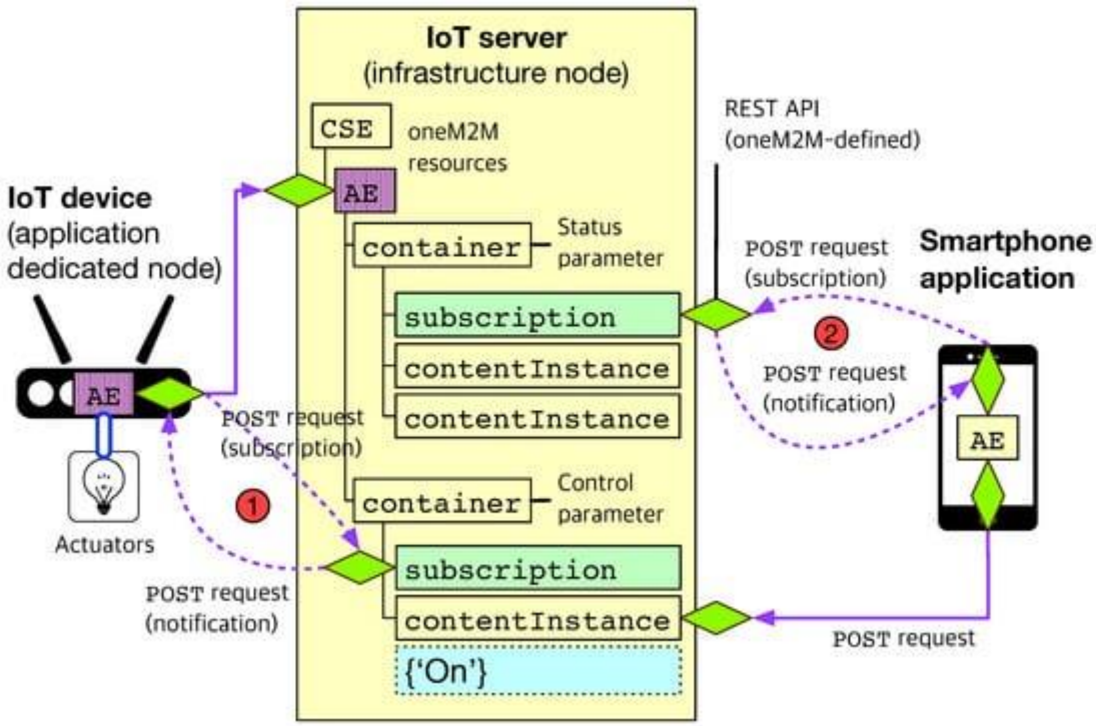
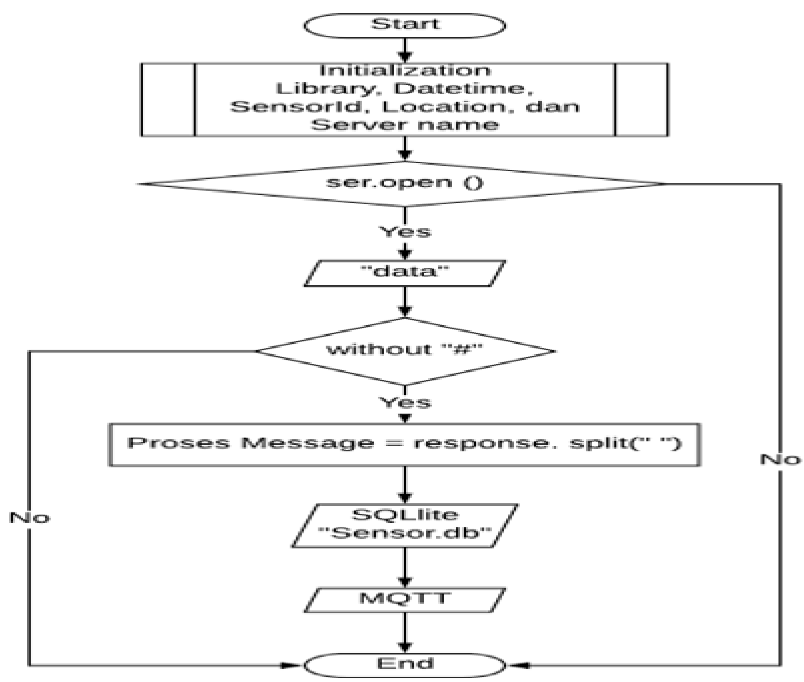


Figure 3. The proposed actuation scenario using oneM2M standard-based actuation capabilities.



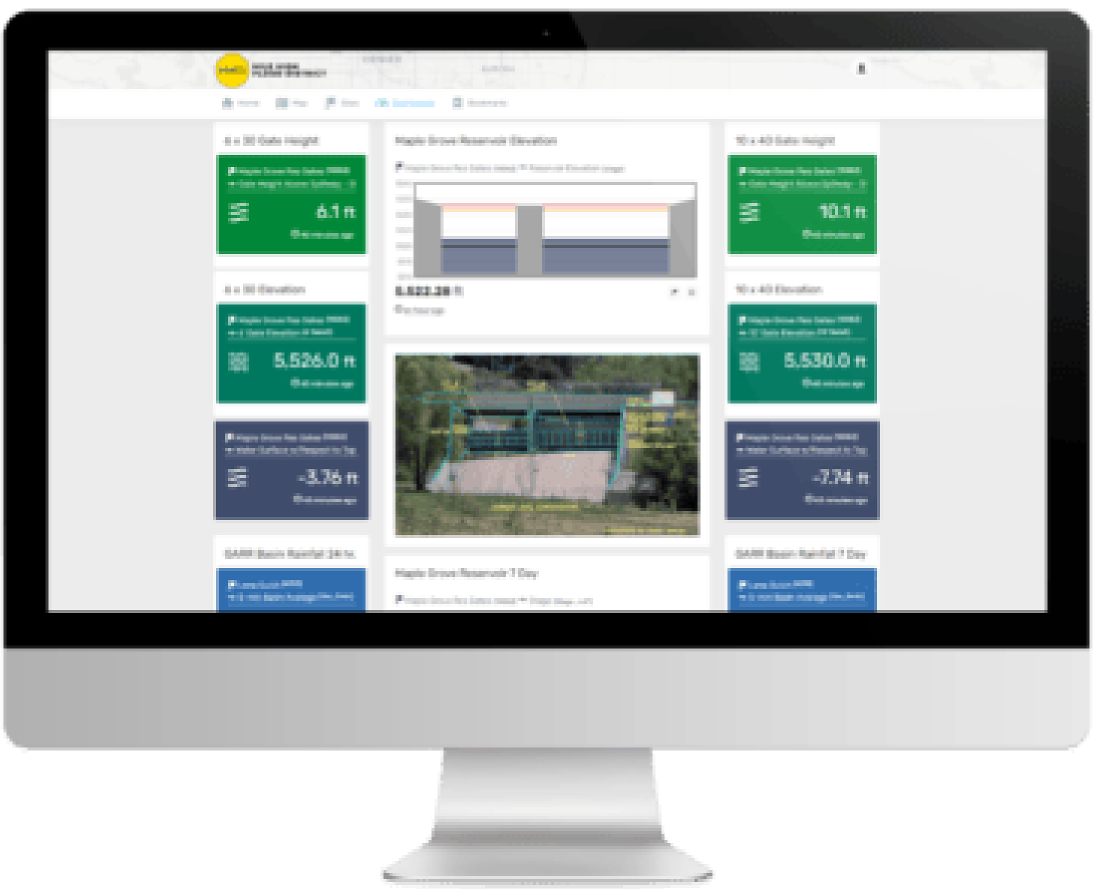
Real-time sensors and flexible telemetry

A complete, integrated flood monitoring system includes all the remote site hydrometeorological sensing instrumentation, communications equipment, central base station equipment, as well as data collection, archiving, processing, and management software designed for flood warning.

Real-time weather data provides essential information on intense or prolonged rainfall, rapid snowmelt, abnormal rise in seawater level, and excessive and rapid rainfall events. By monitoring these conditions, authorities can detect potential flood threats and issue timely warnings to communities in vulnerable areas.

With access to real-time weather data, authorities can send flood warnings to communities in threatened areas promptly. These warnings enable residents to prepare and take necessary precautions, such as evacuation or fortifying their properties. The availability of real-time data ensures that warnings are accurate and tailored to specific locations, maximizing their effectiveness.

Real-time weather data is indispensable before and during a flood. It helps identify impending flood conditions, aids in planning and designing flood warning systems, enables timely warnings to communities, enhances preparedness and response efforts, identifies high-risk areas, and optimizes dam and reservoir operations. By leveraging the power of real-time weather data, communities can better protect lives, safeguard property, and improve overall flood resilience.

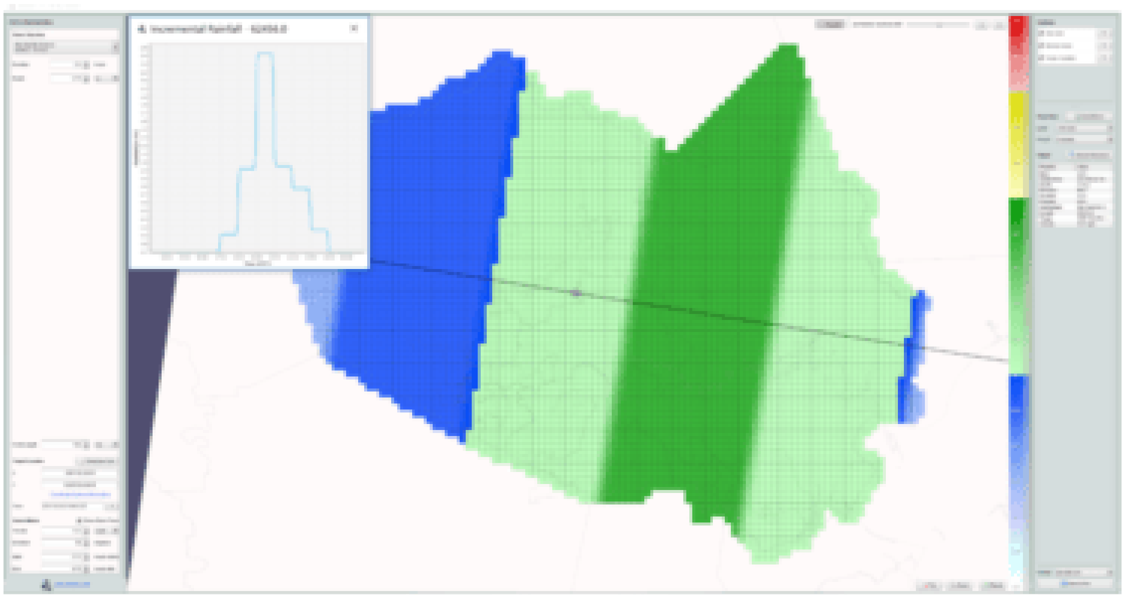


FLOOD WARNING SYSTEM

Be ready at every stage

Flooding is the most common and widespread of all weather-related natural disasters and is a threat in every part of the world primarily where rainfall occurs. With more people in the world at risk today from flooding than ever before, being prepared for floods is crucial to decrease negative effects of flooding in our communities.

Our range of tools help you take preventative measures against potential flooding and implement effective response plans. Additionally, they help you detect early signs of flooding and take decisive action to protect people and assets.



PREPARATION & ASSESSMENT TOOLS

Storm building and floodplain modeling

Our Storm Builder helps clients correctly apply dynamic design storm characteristics and achieve valid, reproducible hydraulic modeling results. That means we can help you understand how a storm of any scale, size, or type would impact your local area.

Through storm modeling and simulation, it is possible to predict the extent of flooding in different scenarios. By inputting various rainfall intensities and durations into computational models, experts can estimate the resulting water levels and potential flood areas. This information assists emergency managers in developing evacuation plans, allocating resources, and implementing preventive measures, ultimately reducing the impact of floods on communities.

Analyzing past storm data in combination with computational modeling allows for improved flood prediction. By creating "what if" scenarios and running simulations based on historical rainfall patterns, experts can refine flood prediction models. This iterative process enhances the accuracy and reliability of flood forecasts, providing advanced warning time for residents and enabling proactive response actions

REPORT

2022 State of Flood Risk Management

For many communities and organizations, flood risks continue to rise. AEM's *2022 State of Flood Risk Management Report* gives you the latest thinking from the professionals who are responsible for managing these risks. The report draws on survey responses from professionals across the globe who work for a wide range of organizations spanning both the public and private sectors. Get insights on the following:

- How flood risk stacks up against other weather risks
- The most common challenges tied to managing flood risk
- The overall impact of flooding in recent years
- The expected impact of flooding in 2023
- Policies and tools for managing flood risks
- Budgeting for flood risk management solutions

SOLUTION GUIDE

Flood Resilience and Planning

In this solution guide, you'll learn how to better prepare, design, and plan for flooding events, improve resiliency, and employ technologies that help protect lives and property, including:

- Managing and reducing the risk of floods to communities
- Technologies and services that support reducing flooding risks
- Planning and designing a Flood Early Warning System network

Are you prepared? Predictive tools to mitigate flood risk

The growing frequency and intensity of flood events around the world have driven the need for more accurate forecasting and real-time hydrologic simulation. A predictive flood modeling system can provide information necessary about flood timing and intensity for critical decision-making during an event, both forecast and in real time.

- Track real-time and forecast watershed response using hydrologic model-simulated output
- Maintain situational awareness of flood risks and impacts using real-time alerting
- Understand flooding risk levels faced by emergency responders during a rescue operation

- Utilize model output to keep emergency managers informed of when to cloIOse roads and issue evacuation notifications
- Leverage descriptive statistics and data downloads to assist with post-event analysis

conclusion

This study concludes that computer vision focuses on a single point in the field of view whereas IoT sensors provide more accurate real-time data to identify inundation levels. An IoT-based smart flood monitoring and alert system through a combination of HPC and Big-Data were proposed by Sood et al