PARKSMART - AN IOT PARKING SYSTEM FOR A SMART CAMPUS

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INTRODUCTION

The Internet of Things (IoT) is the interconnection of everyday objects, via embedded computing devices and the internet, for the purpose of sending and receiving data. An IoT parking system enables the availability of parking spaces to be communicated to a user via a mobile application, reducing time and fuel spent searching for a parking space on a daily basis.

OBJECTIVES

- Develop a system which can accurately and reliably communicate parking availability in real time
- Provide the most cost effective solution possible
- Keep the system energy efficient, increasing operational time on a single battery charge
- Make the system scalable to accommodate any parking lot size
- The system should be robust and easy to maintain
- Communicate data through a user-friendly mobile application, built using the Android framework

SYSTEM DESIGN

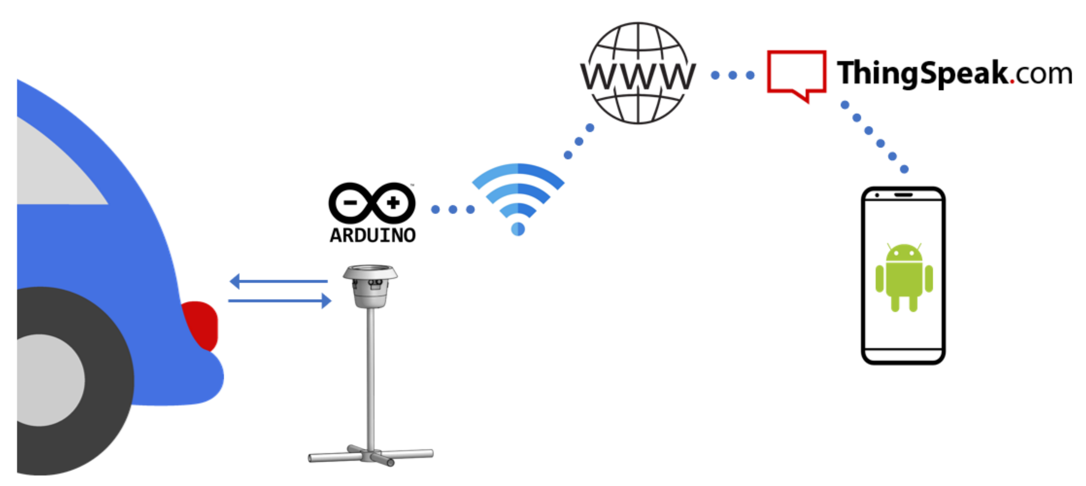

Figure 1: Overall depiction of the implemented system

System Features

- Parking space availability detection
- Empty spaces are communicated to users through a user-friendly mobile application
- System updated approximately every 30 s
- Functions during active parking hours (7 am - 3 pm)
- Fail-safes in place in case of node failures

Hardware Setup

- Ultrasonic distance measurement sensor
- Arduino Nano microprocessor
- ESP8266 based Wi-Fi module
- 2.4 GHz radio module
- 2*AA batteries + 5 V boost converter

SYSTEM DESIGN (CONT.)

Software Setup

- Scalable RF communication mesh is designed (refer to Figure 2)
- System complexity increases with increasing number of parkings if low cost node design is maintained
- Node data is aggregated and uploaded through a single Wi-Fi module (Sink Node)
- Optimised data upload through the ThingSpeak MQTT broker
  - Minimal connection and upload time
  - Small payload size
- User-friendly mobile application built for Android
- Parking lot data is retrieved by the application through the provided ThingSpeak API
- Mobile application automatically refreshes with updated parking bay availability data

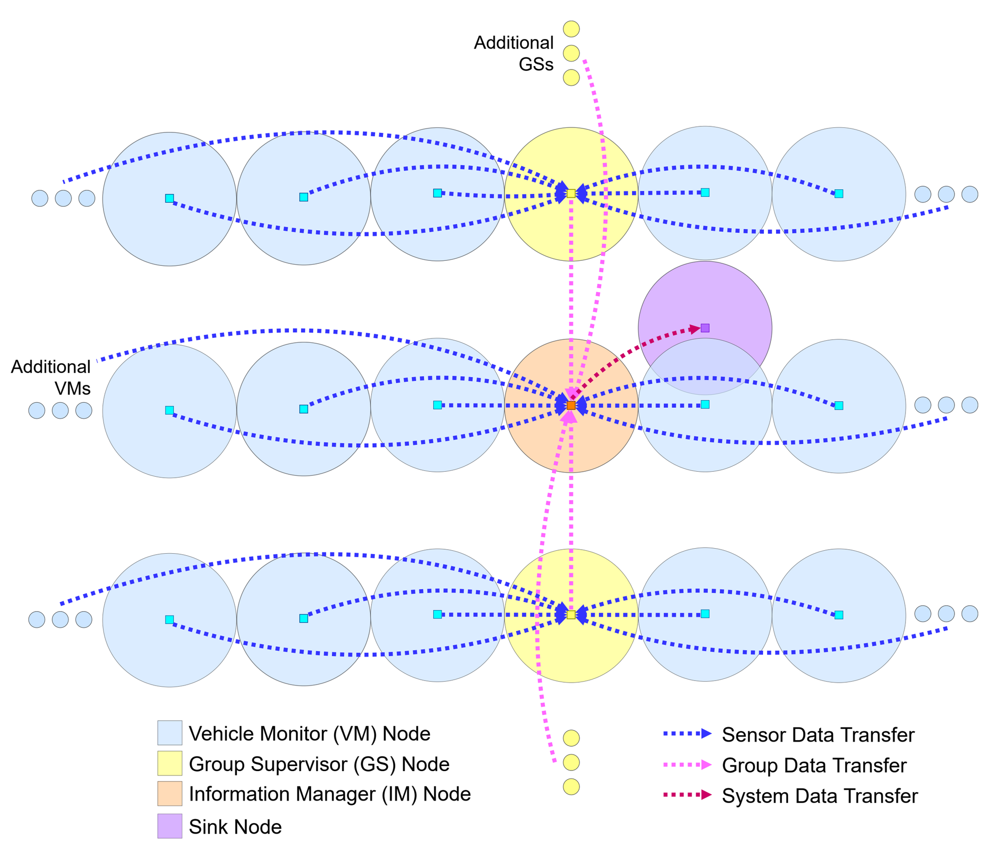

Figure 2: Data retrieval of parking avalability from sensor nodes to sink node

Smart System Operation

- Figure 3 demonstrates the interaction between role-specific nodes
- A full cycle incurs an average operation time of approximately 1.6 s

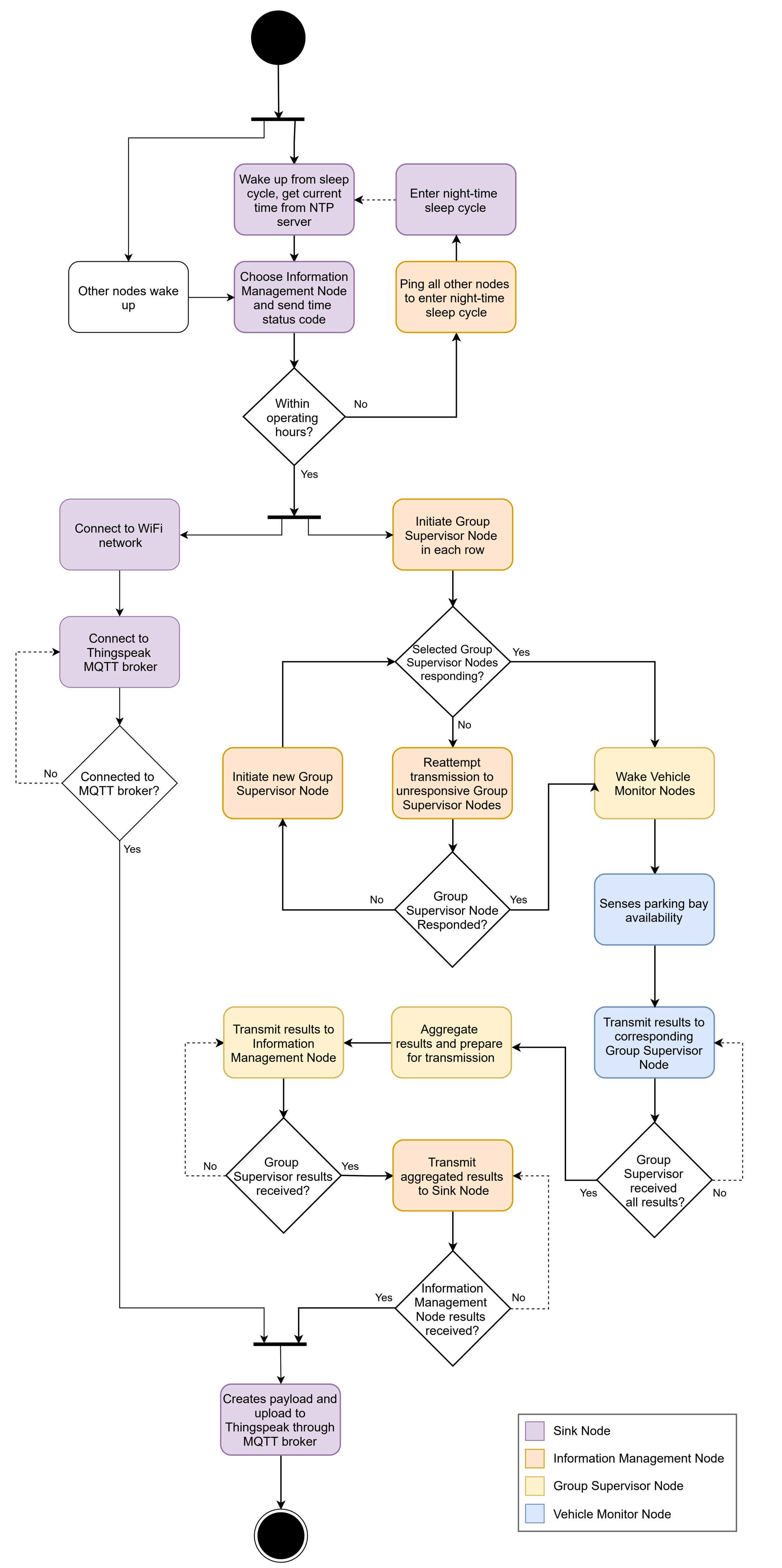

Figure 3: Detailed system interactions between role specific nodes

DEPLOYMENT

Construction Specifics

- PCB design for optimized production
- 3D printed sensor holders allow customised angles per node
- Waterproof encasing and tamper-proof lid
- Robust stand with runoff resistance

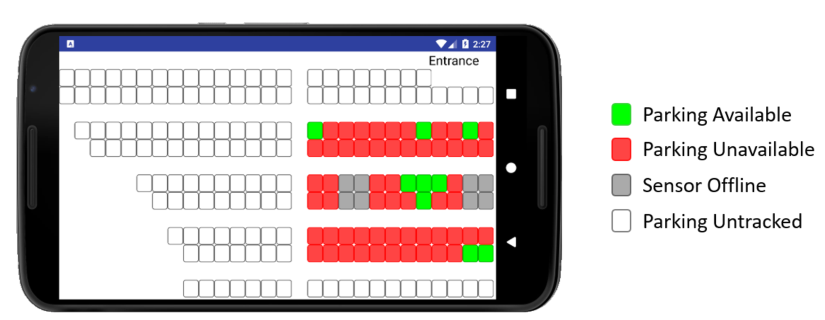

Figure 4: Screenshot of the developed mobile application

RESULTS & EVALUATION

System performance

- Estimated system lifetime on a single charge cycle is 276 days
- This lifetime is limited by the highest consumption node (refer to Figure 5)
- Mobile app data consumption is minimal with a refresh time of 5 s
- unupdated requests incur a cost of only 4 kB per request
- Data upload cost of implemented system is approximately 3.7 MB per month

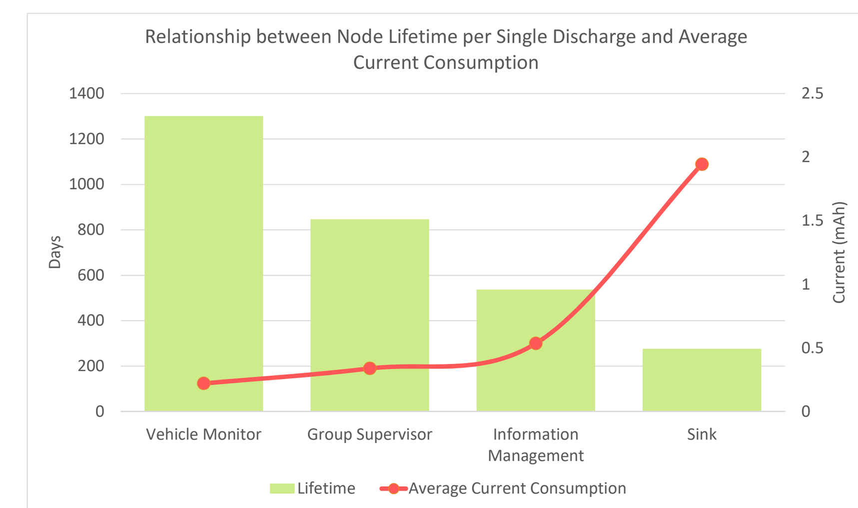

Figure 5: Graph depicting energy performance of the system

Number of Parkings	Payload Size (B)	Monthly Usage (MB)
1	60	0.08
72	262	3.77
192	582	8.38

Table 1: Data consumption of system scaling

FUTURE WORK

- An alternative row administrator node row is established if any of the current row administrators go down, allowing negative effects to be dramatically decreased.
- Allow sensors to take multiple consecutive readings, use this information to distinguish between the type of object being sensed. This will avoid false positives from pedestrians or other objects crossing the sensor path temporarily.
- Small application updates, including the option to manually refresh the parking lot page

CONCLUSIONS

A prototype IoT-based smart parking system has been designed which comminucates parking availability to