January 29, 2024

ParkSmart GTA Project

DSMM - Maple Mapping

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I. PROJECT OVERVIEW

The *ParkSmart GTA* project of Maple Mapping focuses on developing an innovative parking availability map for drivers in Greater Toronto Area (GTA), aiming to streamline the process of finding and reserving parking spaces in advance. By addressing urban congestion in GTA, particularly in the downtown core, the project aims to enhance daily commutes and city visits, making them more convenient and less stressful. The main objective is to identify essential data types, sources, and the overall data architecture needed for the parking availability map. The project also involves developing a data strategy to ensure the efficiency and effectiveness of the data-driven parking solution.

The *ParkSmart GTA* project will have a user-friendly application interface that allows a wide range of users from tech-savvy to those less familiar with mobile applications to use it with ease.

Features of the ParkSmart GTA Application

- **Pre-Book Your Spot:** Enabling users to plan ahead by reserving a parking space for the specific hours they need, as well as in advance of their arrival. This not only guarantees a spot but also eliminates the stress of last-minute searches for parking.
- **Effortless Check-In:** Upon arriving at the designated parking space, users simply open the app and scan their booking. This quick and seamless check-in process provides users with immediate access to their reserved parking space, streamlining the overall parking experience.
- **Assigned Parking Space:** Eliminating the uncertainty of finding a parking spot by assigning users a specific plot number upon check-in. This ensures that users can easily locate their designated space, saving time and reducing frustration.
- **Time Management:** Prompting user to enter the hours they intend to park when making a reservation. If they exceed the allotted time, the app implements a penalty system to encourage prompt exits, maintaining a fair and efficient use of parking spaces.

II. DATA REQUIREMENTS

As the foundation for seamless functionality of *ParkSmart GTA* project, a thorough understanding of data requirements is important. This section outlines the specific data elements essential to power the

innovative parking availability map, ensuring precision, relevance, and efficiency in delivering a user-centric and data-driven parking solution for Greater Toronto Area (GTA) drivers.

Realtime Parking Data

- **Occupancy Information:** Real-time statistics on the current occupancy of parking spaces in various parts of the Greater Toronto Area (GTA).
- **Availability Status:** This indicates if a parking place is available or occupied.

Geospatial Data

- **Location Coordinates:** Precise geographical coordinates used to correctly map parking spots' locations.
- **Street and Area limits:** Geospatial data that defines the limits of streets and parking zones in the Greater Toronto Area.

Parking Rules and Restrictions:

- **Time-based Restrictions:** Information about time-based parking limitations, such as time-limited parking or no-parking zones during certain hours.
- **Permit Requirements:** Data about parking sites that need permits, including the types of permits authorized.

Infrastructure and Facility Data:

- **Parking Facility Information:** Specifics on parking facilities, such as capacity, and accessible features.
- **Infrastructure modifications:** Provides updates on any modifications or developments in parking infrastructure that may influence availability.

User feedback and ratings:

- **User Reviews:** Rate parking spaces, provide feedback, and help enhance the overall user experience.

Mobile and Sensor Data:

- **Mobile App Data:** Information from mobile applications used by drivers to locate parking spots or provide any updates, e.g. if there’s ongoing maintenance.

- **Sensor Data:** Integration of sensors in parking lots to offer real-time occupancy data. (Overhead and Inground sensors)

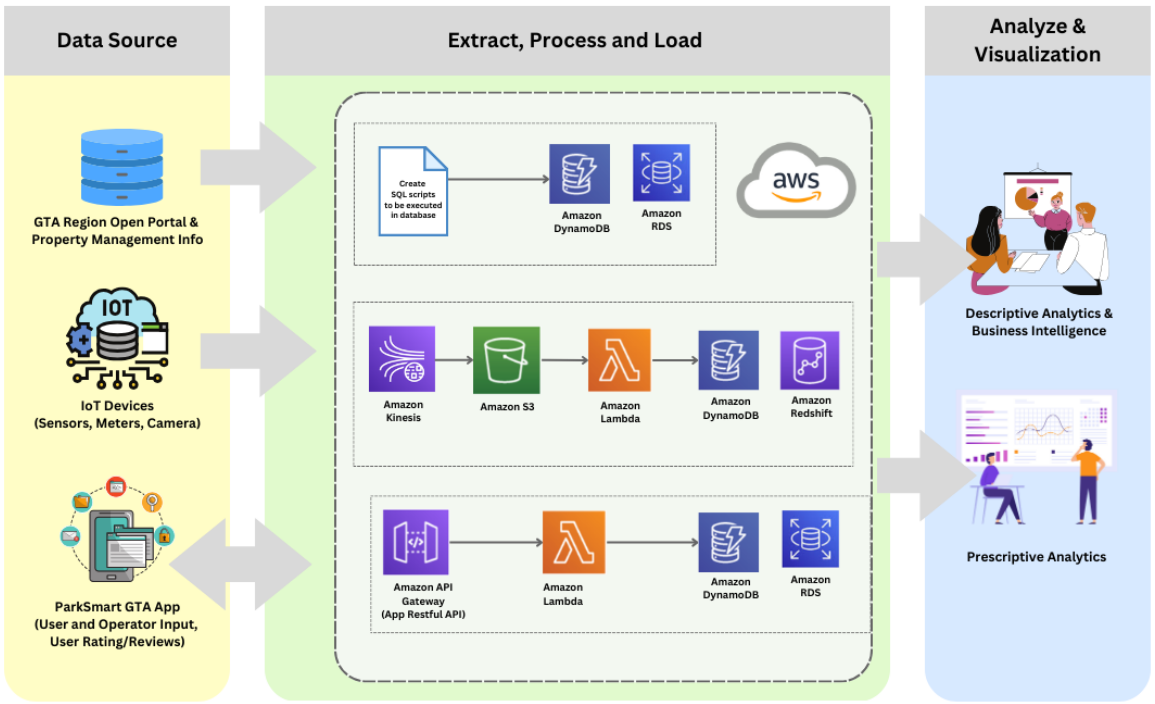
Accessibility Information:

- **Individuals with Disabilities:** Information regarding the accessibility of parking spaces for those with impairments.

III. Data Architecture

The data architecture for *ParkSmart GTA* project involves integrating information from three main sources: the GTA Region Open Portal, property management systems and IoT devices. Leveraging AWS services such as Amazon Kinesis, Lambda and S3, and RDS, DynamoDB, and Redshift for storage, the project establishes a robust data processing and storing workflow. The architecture supports dynamic access for business analysts and/or data scientists through tools like Microsoft Power BI, enabling in-depth analysis and/or prescriptive insights for efficient parking management.

Image 1: Data Architecture of ParkSmart GTA Project



Data Sources

1. **GTA Region Open Portal:** Publicly available data from the GTA Region Open Portal providing regional information, regulations, and other relevant data. We will collaborate with every region in the Greater Toronto Area to provide complete and accurate information based on the data requirements necessary for developing the application.
    - Toronto: https://www.toronto.ca/city-government/data-research-maps/open-data/
    - Peel: https://data.peelregion.ca/
    - York: https://www.york.ca/york-region/statistics-and-data/open-data
    - Durham: https://opendata.durham.ca/
    - Halton: https://conservationhalton-camaps.opendata.arcgis.com/
2. **Property Management Data:** Data sourced from property management systems, including details about parking spaces, occupancy, rules, and property-specific information.
3. **IoT Devices:** Real-time data from IoT devices such as sensors, meters, and cameras providing information on parking space occupancy, usage patterns, and potentially environmental data.

Data Processing Workflow

The data processing workflow will exemplify a state-of-the-art approach to information management. Collected data will be meticulously extracted, processed, and loaded, utilizing the AWS cloud environment, employing various AWS services such as Kinesis, S3, Lambda, RDS, DynamoDB, Redshift, etc. Amazon S3 is envisioned as the comprehensive data lake, aggregating information from diverse IoT devices like sensors, meters, and cameras installed in parking entrance and spaces. Leveraging AWS Lambda functions, data from these IoT devices and the *ParkSmart GTA* app will undergo systematic processing before being seamlessly stored in databases such as RDS, DynamoDB, and/or Redshift—a crucial aspect warranting further discussion. The processed data will then be curated within the chosen databases, fostering accessibility for business analysts and data scientists to identify intricate data patterns and offer insightful prescriptive analyses.

Our comprehensive service facilitates seamless transition of data within the AWS ecosystem. We will integrate several AWS services into our project:

1. **Amazon Dynamo DB:** It is a fully managed NoSQL database which means it does not rely on traditional database model. It allows for flexible schema-less data models and can be

automatically scaled based on the workload, making it an ideal choice for fast and scalable applications.

2. **Amazon Kinesis:** It is a platform for building real-time data streaming applications. It enables you to ingest, process, and analyze streaming data such as website clicks, IoT telemetry data, and more. Kinesis provides services like Kinesis Data Streams, Kinesis Data Firehose, and Kinesis Data Analytics to handle different aspects of real-time data processing. Kinesis seamlessly integrates with other AWS services enabling you to build end-to-end streaming data solutions.
3. **Amazon Redshift:** It is a fully managed data warehouse service in the cloud. It is designed for high-performance analysis using standard SQL queries. Redshift allows you to efficiently analyze large datasets and provides fast query performance through parallel processing and columnar storage.
4. **Amazon RDS (Relational Database Service):** It is a managed relational database service that supports multiple database engines such as MySQL, PostgreSQL, Oracle, and Microsoft SQL Server. It simplifies database administration tasks such as backups, patch management, and scaling, allowing you to focus on application development rather than database management.
5. **Amazon S3 (Simple Storage Service):** It is designed to store and retrieve any amount of data from anywhere on the web, making it a fundamental component for many cloud-based applications. It stores data as objects, which consist of data, a unique key, and metadata. It allows you to preserve, retrieve, and restore every version of every object stored while automatically replicates data across multiple geographically dispersed data centers.
6. **Amazon Lambda:** It is a serverless compute service that allows you to run codes without the need to provision or manage servers. With Lambda, you can execute code in response to events, such as changes to data in an Amazon S3 bucket, updates to a DynamoDB table, or HTTP requests via Amazon API Gateway. Lambda supports a variety of programming languages, including Node.js, Python, Java, Ruby, Go, and .NET.
7. **Amazon API Gateway:** It is a fully managed service provided by AWS that makes it easy to create, publish, maintain, and secure APIs at any scale. It acts as a front-door for your applications, allowing you to expose backend services, microservices, or serverless functions to external clients, such as mobile apps, web applications, or other services. It also offers a developer portal where you can publish API documentation, making it easy for developers to understand how to use your APIs.

The outlined data architecture for the ParkSmart GTA project leverages various AWS services to handle the end-to-end data lifecycle—from ingestion to processing to storage and analysis. This architecture is designed to be scalable, secure, and capable of providing real-time insights for better parking management. It allows business analysts and data scientists to explore and analyze data patterns, enabling informed decision-making and prescriptive analysis. As part of enhanced functionalities in the data workflow, we will employ effective monitoring systems to track system performance and user interactions. This will enable ongoing optimization and improvement aligned with real-world usage patterns. Additionally, we will implement strong data security measures, ensuring compliance with privacy regulations to safeguard user information and foster trust.

IV. RECOMMENDATIONS

While the primary focus of the ParkSmart GTA project is to develop an innovative parking availability map for drivers in Greater Toronto Area (GTA), certain recommendations extend beyond the project's current scope. These suggestions, though valuable, may involve additional considerations or resources and can be explored in future phases of development. Each recommendation aims to further enhance the overall functionality, sustainability, and user experience of the parking solution.

- **Sensor Technology Implementation:** Recommend property managers install sensor technology instead of cameras for cost-effective and efficient data collection on parking space availability.
- **Integration of Predictive Analytics:** Explore the integration of predictive analytics to anticipate future parking demand, enabling proactive management and improved user experience.
- **Localized Notifications:** Implement localized notifications to inform users of real-time parking availability, reducing search time and contributing to a more efficient parking experience.