In-Class Activity, Architecture for NdR Case Study:

Univaq Street Science is an event organized in the context of the European Researchers Night (Notte di Ricercatori (NdR)) in L'Aquila, Italy. It is a scientific exhibition event organized by the University of L'Aquila. In this event, the research community and the public are brought together from the morning until late at night to share a combination of entertainment and information. This event takes place throughout the entire city. As an example of a demonstrative scenario, we will take the NdR held in the city centre, in which performances, lectures, demonstrations, and workshops take place in its squares, main streets, and buildings. From our experience in organizing this event in the city, we captured some sources of evidence:

1. About 35,000 visitors come to the NdR every year.
2. Late hours usually have more crowds than early hours.
3. The weather (e.g., rain, hot) and its changes influence visitors' preferences in what to see and where to stay.
4. Visitors cannot quickly locate the availability of parking lots, thus increasing the traffic in the centre.
5. Different entertainment events take place in different venues with limited capacity.

There is no provision for the visitors to get the seat availability of venues. Our research group has been invited to provide new services to improve the quality of the visiting experience. These services are related to parking lot control and venue crowd management.

Automated Parking Control

The City centre is the most attractive place. Thus more crowds are found in this location. However, only two parking lots are available with a capacity of 200 and 150 parking slots, respectively. These parking lots are created in an ad-hoc way a day prior to the event. This means that the visitors need to be notified about the availability in a particular parking lot and redirected accordingly to reduce the traffic congestion in the centre. These parking lots are located closer to the main venue where the most important event takes place.

Automated Venue Entry Management

During the NdR event, there will be some significant events in multiple indoor venues in the city centre. Each of these venues hosts some entertainment as well as infotainment events. However, there are space limitations in each of these venues, which allow entry to only a certain number of visitors with entrance tickets at a given instant time. (In this work, we focus on three venues located in the city center with a seating capacity of 500, 200, and 200 seats, respectively). This calls for services that can automatically manage the venue entry by considering the number of people inside the venue and providing real-time updates to the visitors on venue availability.

Requirements

With the help of the above two services, the system will provide the visitor with the following set of functionalities:
1. Venue availability - Visitors should be able to check if any venue is available or not. If a particular venue is not available, then the system should be flexible in suggesting other venues where seats/tickets are available. The system can use the sensor information to provide this data (e.g., QR code readers, people counters, etc.)
2. Parking lot availability - Visitors should be able to check if a space is available in a parking lot or not. Depending on the venue preference of the users as well as the availability of the parking lots, the system should dynamically list the different parking lots available closer/near the preferred venue - This will also be based on the parking lot sensors (e.g., a parking mat that can count cars, cameras, etc.)
3. Booking/Ticketing service - For booking tickets to venues/entertainment events. The system shall provide ways to book a ticket based on the number of bookings. This will take into account the total capacity of the venue and the number of tickets that have already been sold.
4. Weather forecast services - Visitors should be able to get a forecast of the day, and they can use this to select an indoor or outdoor event.
5. Recommendation - Visitors should be able to mark their set of the preferred type of events (e.g., scientific events, concerts, etc.). Based on this and the popularity of different events, the system should be able to provide recommendations to visitors.
6. Visualization and Analytics - The system should provide the administrators of the NdR event with the ability to get analytical information on the number of people booked for an event, free spaces in a venue, the total number of parking lots filled, etc.

Constraints:

1. NdR being a one-day event and the fact that it takes place in the city centre, we need to use battery-powered sensors as external power sources are limited. However, sensors may run out of power. The system should make use of intelligent mechanisms to save power.
2. Since there are 35,000 attending the event (and even more using the application), the application should be scalable to support even up to 1000 requests/second.

Goal:

1. List down the functional requirements, Non-functional requirements, stakeholders and concerns. In all the cases, focus on the most important ones.
2. Identify the subsystems and components

3. What are some of the key quality attributes and what is the corresponding tactics that you intend to use?
4. Create a high-level diagram of the system - Use the notion of systems and subsystems
5. What kind of architectural patterns can be used?
    a. Provide a simple explanation in 2-3 lines (focus on quality attributes)
    b. Use simple diagrams to represent the architecture using the selected patterns.
6. Design a microservice-based architecture for the NdR system.
    a. List the contexts
    b. What are the hidden and shared modules? (The class may not have covered everything)
    c. Create the final diagram with the different microservices and corresponding databases
        i. What communication protocol will be used between the microservices as well as for the North-south traffic?
        ii. What about the data exchange format?