Software Requirements Specification

Garcon

Version 2.0

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Record of Changes

Date	Version	Description of Change
13.03.2019	1.0	First release. Context and Use case diagrams.
20.03.2019	2.0	Final release. Full SRS document

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1 Introduction

1.1 Purpose of the System

"Garcon" system basically relies on "Smart Campus" idea. The system is developed for providing various facilities about basic campus related activities such as reporting a campus related issues, asking information about buildings or activities at the campus, booking transactions etc. Thanks to the large number of IoT devices placed in various parts and buildings of the campus, it is aimed that all campus people (students, academic people, staff, guests etc.) access and utilize these services in an easy way.

1.2 Scope

- The system will consist of mainly a lot of IoT devices called "Garcon" when viewed by normal campus people from outside. Main goal of these devices, as the name "Garcon" implies, are providing campus related services to people to facilitate their life at the campus.
- Garcon devices will be basically voice-activated and very intelligent devices. They just need to ID card verification to be ready for help to the users.
- By swiping their ID card, campus people can communicate with Garcon devices with just voice, and can ask some directions, campus activities, accommodation or transportation opportunities in the campus or they can make reservations at restaurants and guesthouses in the campus or they can report any infrastructural or cleaning related issues to be solved quickly by related staff.
- The system will have a voice-to-text translator device inside Garcon IoT devices and will translate human voice commands to text for understanding user intent at the back-end services.
- At the back-end, the system will contain Azure IoT Cloud Service that is developed by Microsoft. This Cloud service will be responsible for understanding the meaning of user intent and deciding and executing the tasks as a response to the user.
- The system will work in collaboration with CRM (Customer Relationship Management) System. IoT devices can create tickets according to user's reports or booking activities, and CRM System will be responsible for fulfilling user requests according to these tickets.
- There will be a sensor system as hardware that is connected with Azure IoT Cloud Service continuously, and Garcon devices can gather locational, infrastructural information from these sensors every time needed (e.g. when creating a ticket about heating problem in some classroom).
- There will be a University Information service for giving response to the user about basic campus related information such as map, ring hours, cafeteria menus etc.

- The system will also work in collaboration with Microsoft Campus Link Application. This application will be accessed from mobile devices and users can reach additional information about their requests from Garcon devices and they can also trace their booking requests or tickets' status.

1.3 System Overview

1.3.1 System Perspective

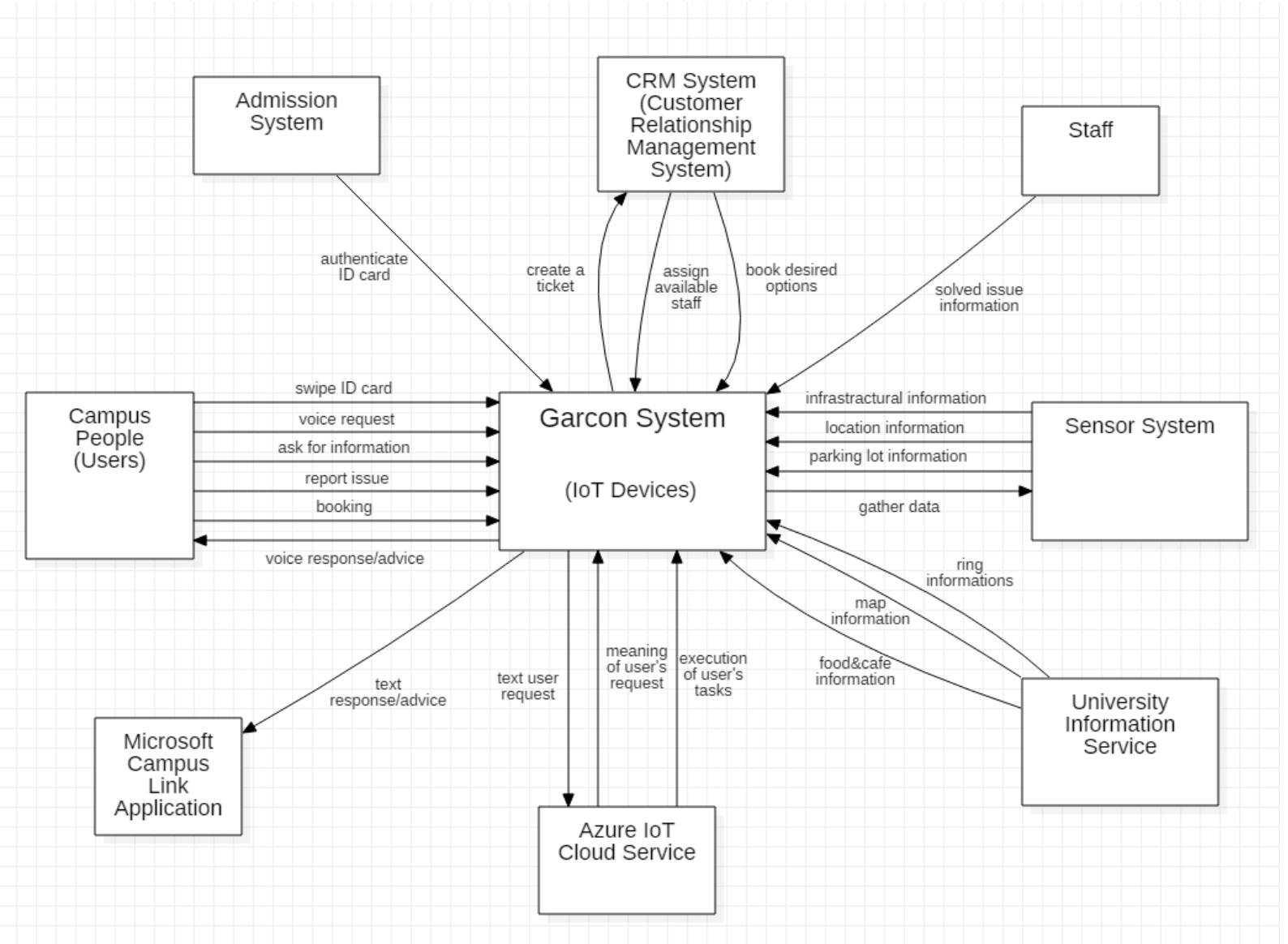

Figure 1: Context Diagram

"Garcon" is not a part of a larger system. However, it collaborates with different systems. Basically, Garcon system can be thought as set of IoT devices placed at different buildings and parts of the campus. However, it is not enough to serve all system capabilities with just these smart devices. At first stage, these devices need a back-end logic to realize all of their capabilities, and this back-end logic is provided

by Azure IoT Cloud Service mainly. The system needs an Admission System to identify their users. The system also needs to lots of informations to execute their tasks, and those informations are supplied by Sensor system and University Information Service. There is also a need for CRM system to notify real people about Garcon's requests and naturally, there is a need for staff to accomplish some tasks (e.g. cleaning somewhere, booking a room at guesthouse) according to Garcon's user's requests. All in all, Garcon can not be divided into subsystems. However, it gets a lot of help from other systems to accomplish their tasks and to give useful responses to the user.

1.3.1.1 System Interfaces

Admission Interface: This interface authenticates user's ID card information by searching user's ID card number in the DBMS of the Garcon. If there is not matching card information, user can not be allowed to communicate with Garcon system.

Backend Understanding & Deciding Interface: This interface works on Cloud basically, and its main task is meaning deduction from user's request and deciding what will be the next task of the system. It gets user's request as a text, and then interpret it to execute one of the system's doable task. After deciding this appropriate doable task, it informs Garcon about the response.

Backend Sensor Management Interface: This interface is always active, and ready for gathering data from sensors that is placed different parts of the campus. It also checks whether sensors are working properly or not. If there is a malfunction for any sensors, it informs Garcon about that to creating a ticket without needing any user report.

University Information Interface: This interface is used to gather all university related static information (map, ring, building etc.) when it is needed. If the user's intent is learning one of these data, this interface will be active.

CRM Interface: This interface is used for communication between Garcon and CRM (Customer Relationship Management System). CRM is very important for our system because it is one of the most important component of the system that provides a visible and useful job at the end of the day. Through this interface, Garcon sends tickets and mails to CRM according to user's request.

1.3.1.2 User Interfaces

General Garcon (Campus People) Interface: Garcon interface offers just a simple informative screen for all campus people as seen in the Figure 2. It shows a message at the top of the screen to inform users about what he/she can do with this interesting device (e.g. "Issues with the building? Let us know!" message in Figure 2). Also, a picture is shown to tell the user, he/she must first swipe his/her ID card and identify himself/herself before starting to communicate with the device. In fact, this design is

quite sufficient when thinking about what Garcon can do for its users because its real power comes from its ability to be activated by sound.

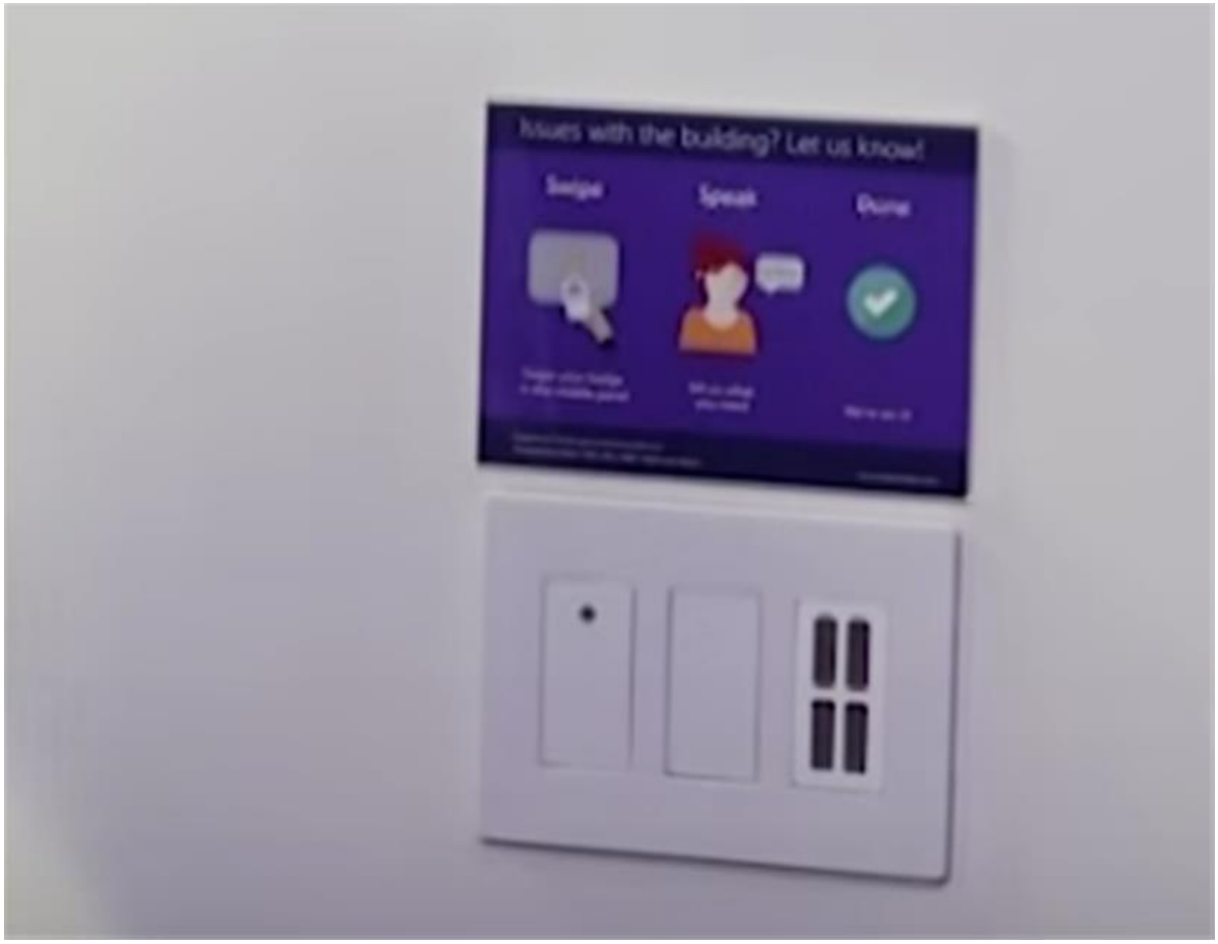

Figure 2: Garcon IoT device main screen

Microsoft Campus Link Interface: This interface is one of the main assistant of Garcon devices because Garcon users can reach extra informations and advices in addition to Garcon's responses through Microsoft Campus Link interface. Actually, when a user asks something to these devices, Garcon generally responds him/her and directs him/her to Microsoft Campus Link Interface to gain more information about the topic. Garcon also notifies this application about user's all requests from the Garcon. Users can reach Microsoft Campus Link Application from mobile devices and when they join with their usernames and passwords, they can automatically see their last interactions with Garcon and also, they can see Garcon's response and extra additional information related to this response (Figure 3). Furthermore, from the perspective of reporting issue and booking capabilities of Garcon, users can trace their reports' and booking requests' status from this application.

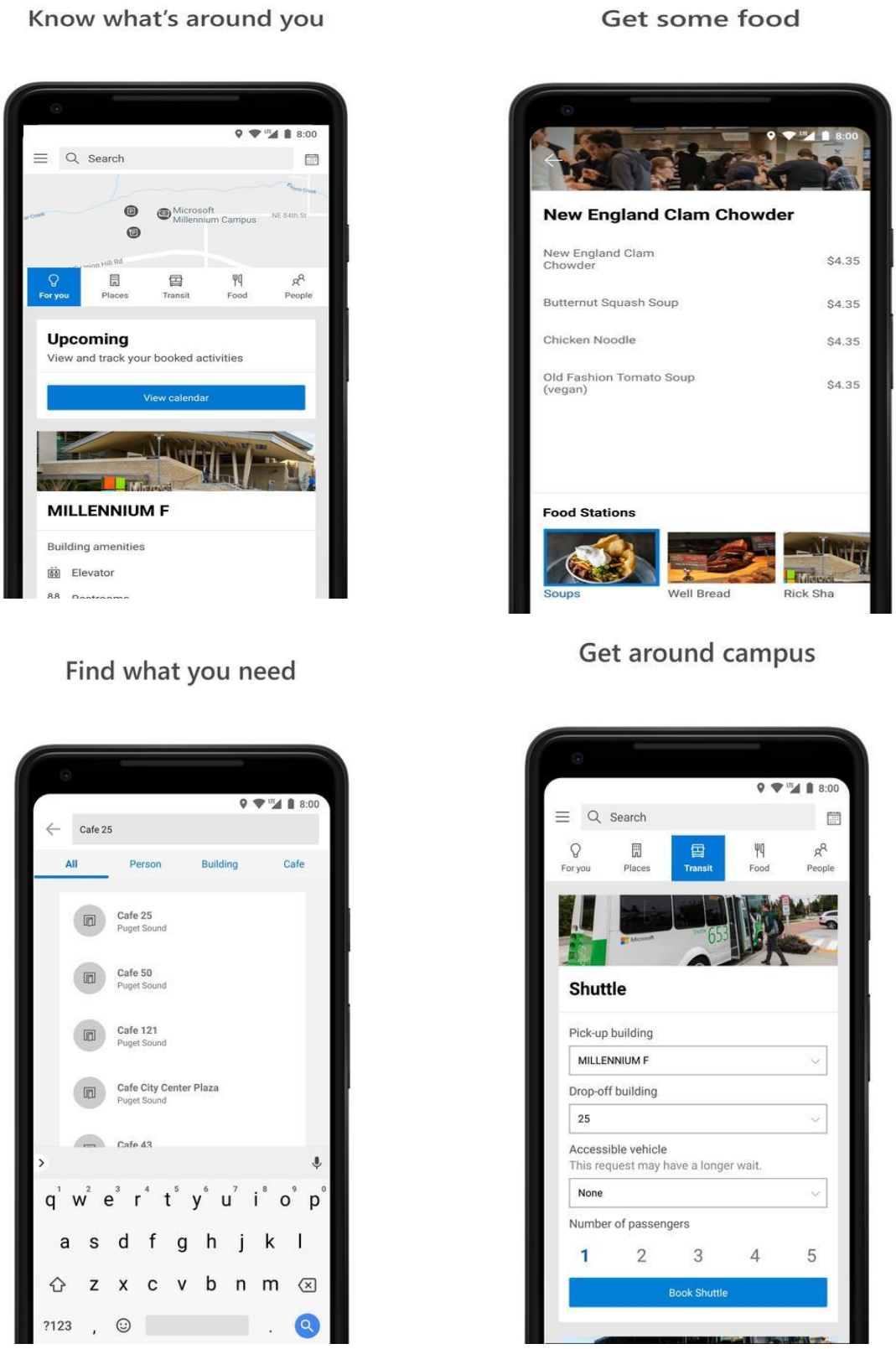

Figure 3: Microsoft Campus Link Application Interface

Staff Interface: Garcon devices also have another special interface which is “Staff Interface”. This interface can be active only when any staff swipes his/her ID card to the device, and then at the first stage, these users are welcomed with the screen that shows the open status issue tickets and the device asks whether the user (who is also staff in fact) have solved any one of these issues or not. And then, of course, staff can inform the device about solving any issue or not through this interface. After this stage, staff can also use Garcon with General Garcon interface.

1.3.1.3 Hardware Interfaces

The system uses a voice-to-text translator inside Garcon IoT devices. Also, the system uses sensors that can be controlled remotely to be placed at various points on the campus, and these sensor devices must be compatible with Azure IoT Cloud Service. Moreover, the assistant Microsoft Campus Link application can be reached smart phones and any other mobile devices.

1.3.1.4 Software Interfaces

- **DBMS:** Garcon system uses a database to store university related people’s and guests’ ID card information and their Microsoft Campus Link user names if any. It also stores tickets that have been created.

- **Microsoft Campus Link:** Users can gain additional information about campus, and can trace their requests status’ from Garcon’s by using this application.

- **Operating System:** Windows 10 IoT will be used for our Garcon devices as operating system.

1.3.1.5 Communications Interfaces

Garcon system uses **MQTT** (Message Queuing Telemetry Transport) protocol to provide communication between IoT devices. **AMQP** (Active Message Queueing Protocol) would also be used while messagging between services. Actually, in our case, Microsoft IoT services will implement these protocols.

1.3.1.6 Memory Constraints

Memory is not a big deal for our system because majority of tasks are handled by Azure IoT Cloud Service. Nonetheless, Garcon needs enough memory to perform user communication tasks and to perform basic database operations of course.

1.3.1.7 Operations

The operations of Garcon system can be grouped as follows:

Campus People (User) and Staff Operations:

- Identify oneself by swiping ID card
- Communicate with IoT device by voice
- Report cleaning issue
- Report infrastructural issue
- Request booking a table at cafe
- Request booking an available room
- Ask cafe & menu information
- Ask ring hours
- Ask direction & location
- Ask available parking lot

Staff Operations:

- Inform IoT devices about solved issues

Admission Operations:

- Authenticate ID card

Microsoft Campus Link Operations:

- Show text response of Garcon
- Provide additional information

Other System Operations:

- Understand the user's request
- Decide the response and take appropriate action
- Create ticket
- Provide infrastructural information
- Provide location information
- Provide available parking lot information
- Provide map information
- Provide ring & accommodation related information
- Provide food & cafe information

CRM Operations:

- Assign available staff for issues
- Book desired options

These will be explained in 1.3.2.

1.3.2 System Functions

Functionalities (use cases) of Garcon system is summarized below.

Function	Summary
Identify oneself by swiping ID card	Lets user identifes himself/herself to the device to start communication with Garcon.
Communicate with IoT device by voice	Lets user communicates with and request something from the device by voice.
Report cleaning issue	Lets user reports any kind of cleaning issue to related staff.
Report infrastractural issue	Lets user reports any kind of infrastractural issue such as heat or lighting problem of any building to related staff.
Request booking a table at cafe	Lets user requests for booking a table at any cafe inside the campus.
Request booking an available room	Lets user requests for booking any room of campus for organizational meeting or booking a room from a guesthouse.
Ask cafe & menu information	Lets user asks any cafe and its menu informations provided that this cafe is inside the campus.
Ask ring hours	Lets user asks about transportation opportunities inside the campus and their timing schedule.
Ask direction & location	Lets user asks any special location and directions for that location which is inside the campus.
Ask available parking lot	Lets user asks parking lot which is available for the time being (real time).
Inform IoT devices about solved issues	Lets staff inform Garcon system afet he/she solves the specific issue.
Authenticate ID card	Authenitcates the user of the system according to his/her ID card informations, and allows him/her to use system.
Show text response of Garcon	Lets users see Garcon's reponses to their requests and more additional information about the responses.
Provide additional information	Provides additional information about Garcon's feedbacks and tasks such as tracing their booking request status for users.
Understand the user's request	Lets the system understands what the user intent.

Decide the response and take action	Lets the system interprets user request, and decides what will be the next executed task.
Create ticket	Lets the system creates a ticket about any kind of issue that is reported by user.
Provide infrastractural information	Lets the system provides necessary infrastractural information about reported issues while creating a ticket.
Provide location information	Lets the system provides necessary location information for both user's information demand and issue tickets (while detecting the exact location of the issue by using sensors).
Provide available parking lot information	Lets the system provides available parking lot information according to data comes from the sensors which are placed at parking lots in the campus.
Provide map information	Lets the system provides map information to satisfy user's location or direction demand.
Provide ring & accommodation related information	Lets the system provides ring & accommodation related information to satisfy related user demand.
Provide food & cafe information	Lets the system provides food & cafe information to satisfy related user demand.
Assign available staff for issues	Lets the system assign available staff to solve reported issues.
Book desired options	Lets the system make a reservation for desired options by the user.

Table 1: System functions

1.3.3 User Characteristics

The target users of the Garcon system can be divided into 4 different categories. The first category is ordinary Campus people (e.g. students, academic people), and actually, this category is expected to benefit most from the system. The basic thing that the users in this category need is to have ID cards with them and communicate with the system by identifying themselves to the system through these cards. These users are also expected to be mobile device users and be able to follow their activities with Garcon from Microsoft Campus Link application.

The second category is guests, and these users also have same opportunities with ordinary Campus people about using the Garcon devices. They just need to receive guest card from security while entering to the campus to use Garcon system.

The third category is Campus staff. These users also utilize from the system like ordinary Campus people. However, they can also use the system with staff UI (user interface). Therefore, these staff are able to inform the system about solving issue tickets by using staff UI of the Garcon devices.

The last category is System admins. The system knows all system admins beforehand because their ID card information were saved to the system DBMS as System admin. Therefore, although the system does not have any special graphical user interface for System admins, Garcon is ready to get special administrative commands from System admins whenever encountering them. Thus, System admins should be experts about these special administrative commands of the System because they will maintain the system, analyze the problems about the system etc.

Commonly, all of these users of the system just know the very user-friendly and simple UI of the system and communicate with the system by just voice. Learning to use Microsoft Campus Link application at mobile devices is also be expected all of these users.

1.3.4 Limitations

- **Regulatory policies:** Since Garcon keeps the personal information of the users after identify them with their ID cards, these personal informations should not be published.
- **Hardware limitations:** Garcon uses Sensor system to gather some specific infrastructural or locational information from the sensors that are placed at different places in the campus. Thus, these sensors should be fast enough and send necessary data with very limited delay to the system to allow Garcon device respond quickly to the user. Voice-to-text translator of the system also should run without any delay.
- **Interfaces to other applications:** Garcon devices must work in collaboration with Microsoft Campus Link application to inform application about all user activities in real time.
- **Parallel operation:** This is one of the main limitation of the system. All Garcon devices at the campus must work simultaneously with each other, and any Garcon device should not block the activities of any other Garcon device at the campus.
- **Audit functions:** The system does not involve financial operations. Thus, there is no such limitation.
- **Control functions:** Controlling the system components' relations are handled by Azure IoT Cloud Service, and any user of the system can not be allowed to control any system related task.
- **Higher-order language requirements:** System should be created with high level object-oriented programming language such as C# with .NET developed by Microsoft. For mobile Microsoft Campus Link application, again C# with Xamarin can be used due to compatibility reasons with our main Garcon system.
- **Signal handshake protocols:** MQTT (Message Queuing Telemetry Transport) and AMQP (Active Message Queueing Protocol) protocols will be implemented by Microsoft Azure IoT.

- **Quality requirements:** User related informations and ticket informations should be kept safe at the database.
- **Criticality of the application:** Garcon system is not a critical system at all. There is no life-threatening result due to any kind of system failure. One important thing is that pre-defined user card informations and ticket related informations should not be lost for continuity of the system.
- **Safety and security considerations:** Communication between the components of the system and system database must be secured from outside attacks.
- **Physical / mental considerations:** Anyone who can communicate with voice can use Garcon system.

1.4 Definitions

Term	Definition
ID card	Identification card
CRM system	Customer relationship management system
API	Application programming interface
IoT device	Internet of things device
UI	User interface
MQTT	Message Queuing Telemetry Transport
AMQP	Active Message Queueing Protocol
Campus people	Students, academic people

Table 2: Definitions

2 References

This document is written with respect to ISO / IEC / IEEE 29148-2011 standard:

IEEE. (2011, December 1). 29148-2011 – ISO/IEC/IEEE International Standard - Systems and software engineering – Life cycle processes – Requirements engineering.

Other Sources:

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3 Specific Requirements

3.1 External Interfaces

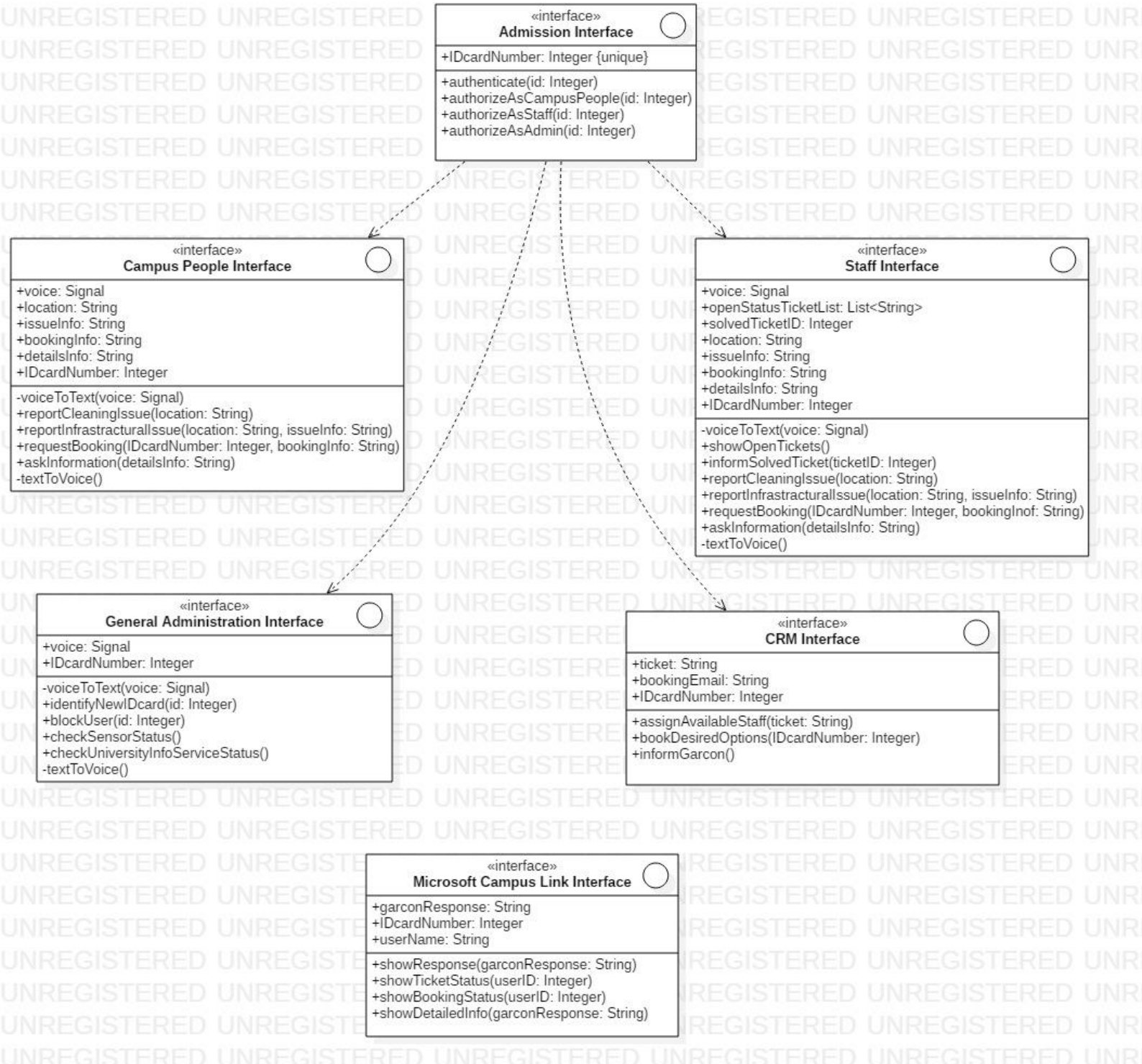

Figure 4: External Interfaces Class Diagram

- **Admission Interface:** This is the entrance interface to continue to work with Garcon system. The main purpose of this interface is making authentication and authorization operations of the users. Its input comes from the ID card of the user, and as output, system authorizes the user as ordinary campus people, staff or system admin. Timing is important for this interface, and the process should be done very quickly.

- **Campus People Interface:** This is the general Garcon interface for campus people (students, academic people). At the first stage, this interface keeps current user's ID card number up to the end of the current transaction. The main input of this interface is human voice of course. According to the user's voice command, this interface also keeps necessary data about user's request as attribute, and runs related operation to give a meaningful response to the user at the end. There should be a very limited time between the user's command and the system's response.

- **Staff Interface:** This interface is very similar to Campus People Interface. However, there are also additional operations which are useful for staff users of the system. Staff can see the open status ticket list on the Garcon screen after passing admission interface, at the first time. They also can inform the system about solved issue tickets with this interface.

- **General Administration Interface:** This interface is created for System admins. Again, after passing admission interface, system admins are recognized by the system according to their ID numbers, and they can give extra administrative commands to the system such as identifying a new ID card information for the system, blocking an existing card information or checking system's other crucial components (sensors, other services' status etc.). Timing is not very important for this interface.

- **CRM Interface:** This interface is used for CRM staff to realize some of the user requests. With this interface, CRM staff can reach the issue tickets and emails that contains information about user's booking requests. According to these data, CRM staff can do necessary jobs, and inform the system about the results.

- **Microsoft Campus Link Interface:** This interface is used for assistant mobile application of our system. According to user's ID card number, user's Microsoft Campus Link account are informed about all transactions between the user and the Garcon system. Timing is also very important to see the results on this application. However, it depends on the availability and number of the personnel who can fulfill the requests of the user at that time.

3.2 Functions

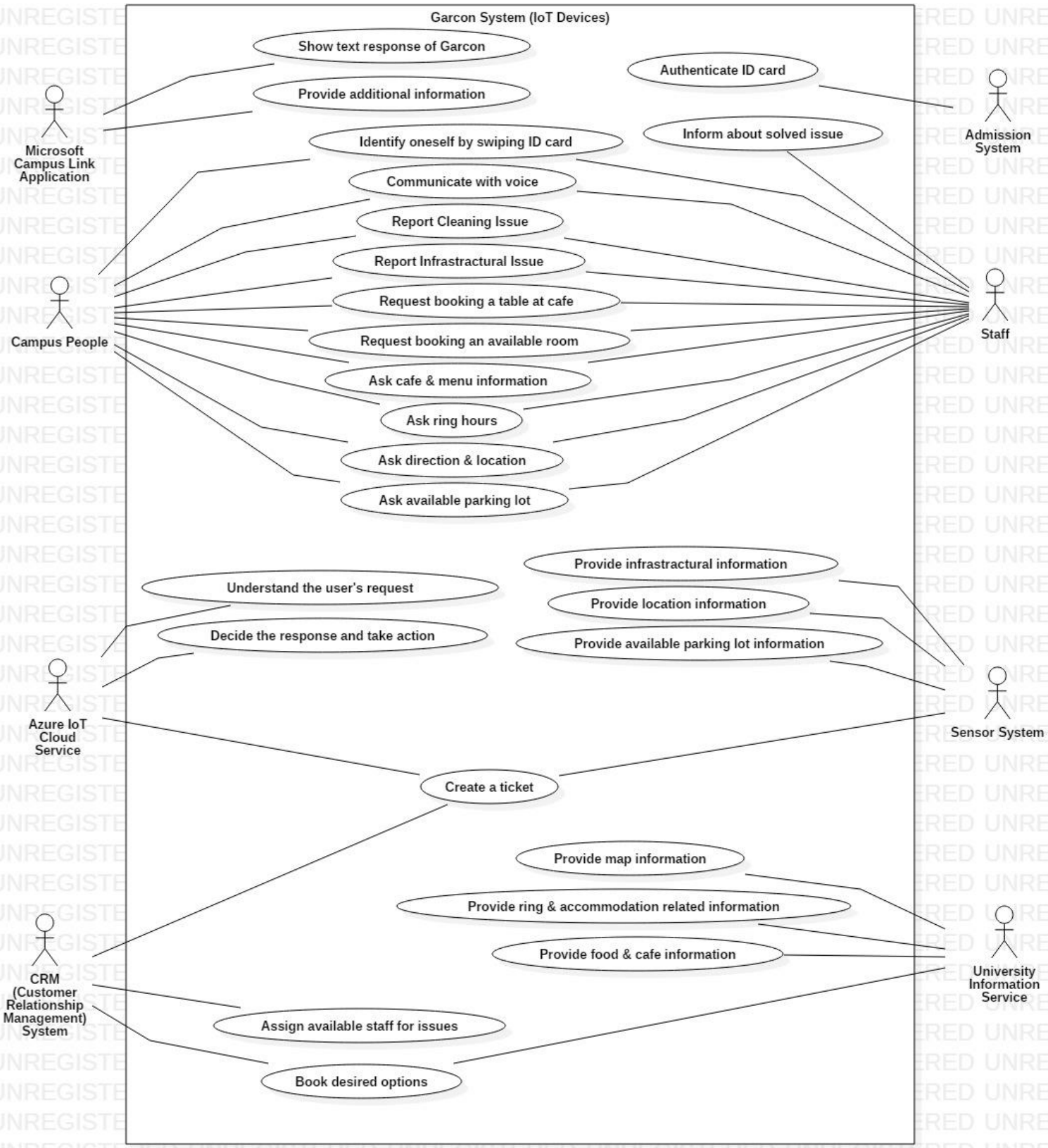

Figure 5: Use Case Diagram

Use case name	Create a ticket
Actors	CRM (Customer Relationship Management System), Azure IoT Cloud Service, Sensor System
Description	If any campus people (students, faculty members, guests with ID card etc.) or any staff reports any kind of issue, Garcon system collects appropriate and necessary informations for these desires and creates a ticket to achieve them.
Data	User voice, location information, infrastractural details of problem (temperature of room, lighting power of building etc.).
Preconditions	Sensor system must be ready to send necessary informations to create a ticket.
Stimulus	Garcon system is notified when voice is translated to text inside the IoT device.
Basic Flow	Step 1 – Garcon system is notified by voice-to-text translator inside the IoT device. Step 2 – Input text is sent to Azure IoT Cloud Service to meaning deduction. Step 3 – If the text is about reporting an issue, Azure IoT Cloud Service collects necessary data (location or technical details of the issue) from Sensor system related to interpreted input text. Step 4 – Azure IoT Cloud Service sends information of the task that will be executed (creating a ticket on this case) and related data to Garcon IoT device. Step 5 – Garcon IoT device creates a proper ticket related to issue and triggers an e-mail to CRM system about the ticket.
Alternative Flow #1	Step 3 – If the text is not about the reporting an issue, another task will be executed by Azure IoT Cloud Service.
Exception Flow	If any sensor hardware malfunctions during gathering data and can not perform its task, it will be recorded as an error.
Postconditions	CRM System can see the ticket and deal with it to solve the issue.

Table 3: Create a ticket function

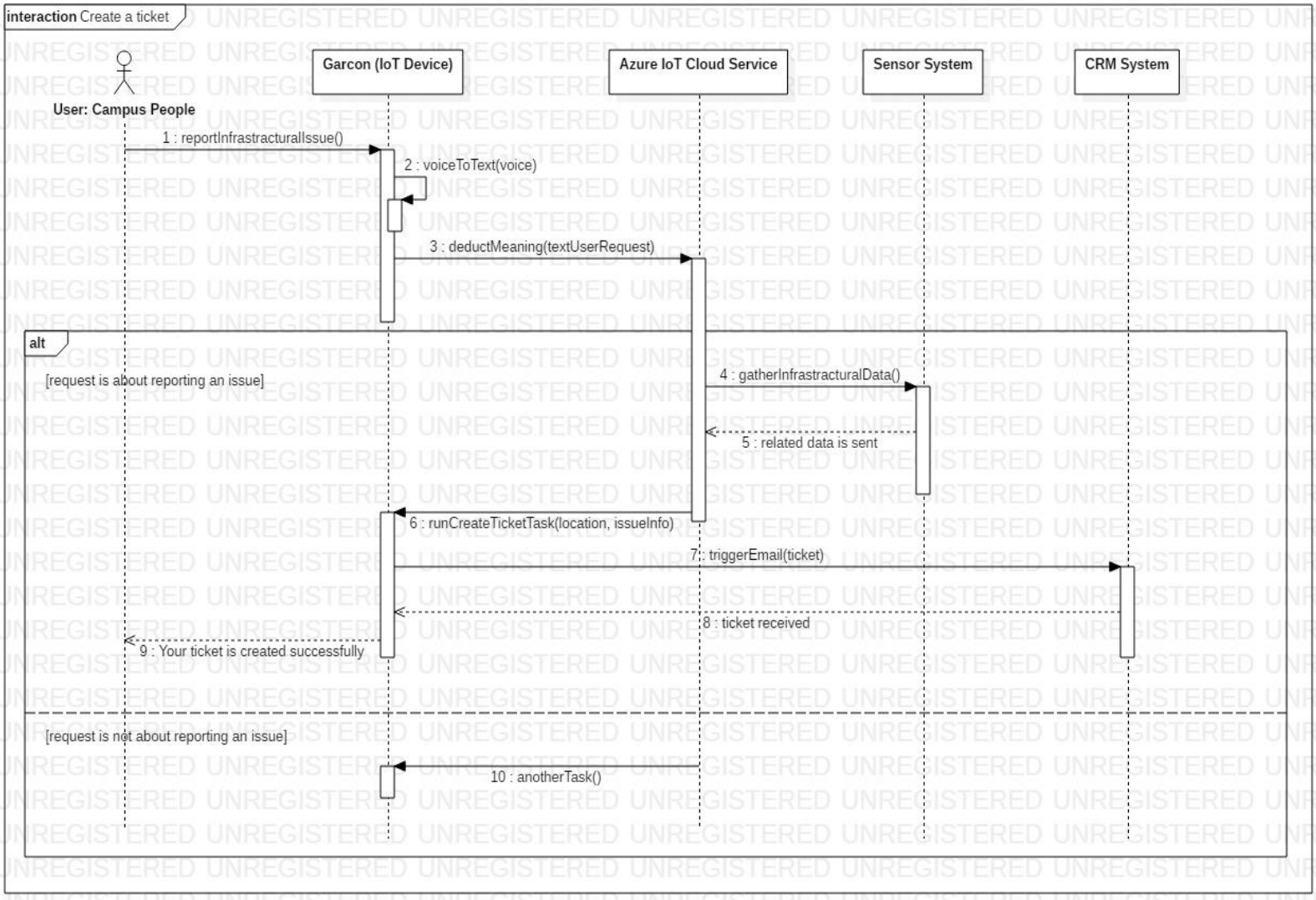

Figure 6: Create a ticket Sequence Diagram

Use case name	Book desired options
Actors	CRM (Customer Relationship Management System), University Information Service
Description	If any campus people (students, faculty members, guests with ID card etc.) or any staff requests booking for a table at cafe or a room at guesthouse, Garcon system searches available alternatives from the service and if possible books desired places in real-time.
Data	User voice, user ID card number, available places information for booking
Preconditions	User must request a booking by voice from the IoT device.
Stimulus	Garcon system is notified when Cloud service detects a request for booking from the user input.
Basic Flow	Step 1 – Garcon system is informed by Cloud service about booking request and desired options of user. Step 2 – IoT device gather available cafe or guesthouse options from University Information Service according to user's preferences. Step 3 – IoT device informs user with voice about available options. Step 4 – If the user chooses or approves clear option according to Garcon's respond, IoT device triggers an e-mail to CRM system about user's booking preference. Step 5 – Garcon informs user about the process and directs him/her to Microsoft Campus Link Application to track his/her booking status. Step 6 – CRM System books desired place for the user.
Alternative Flow	–
Exception Flow	Step 4 – If the user does not respond in limited time for approving or choosing clear option according to Garcon's respond, user's ID card authentication is terminated.
Postconditions	User can see his/her booking status from Microsoft Campus Link Application.

Table 4: Book desired options function

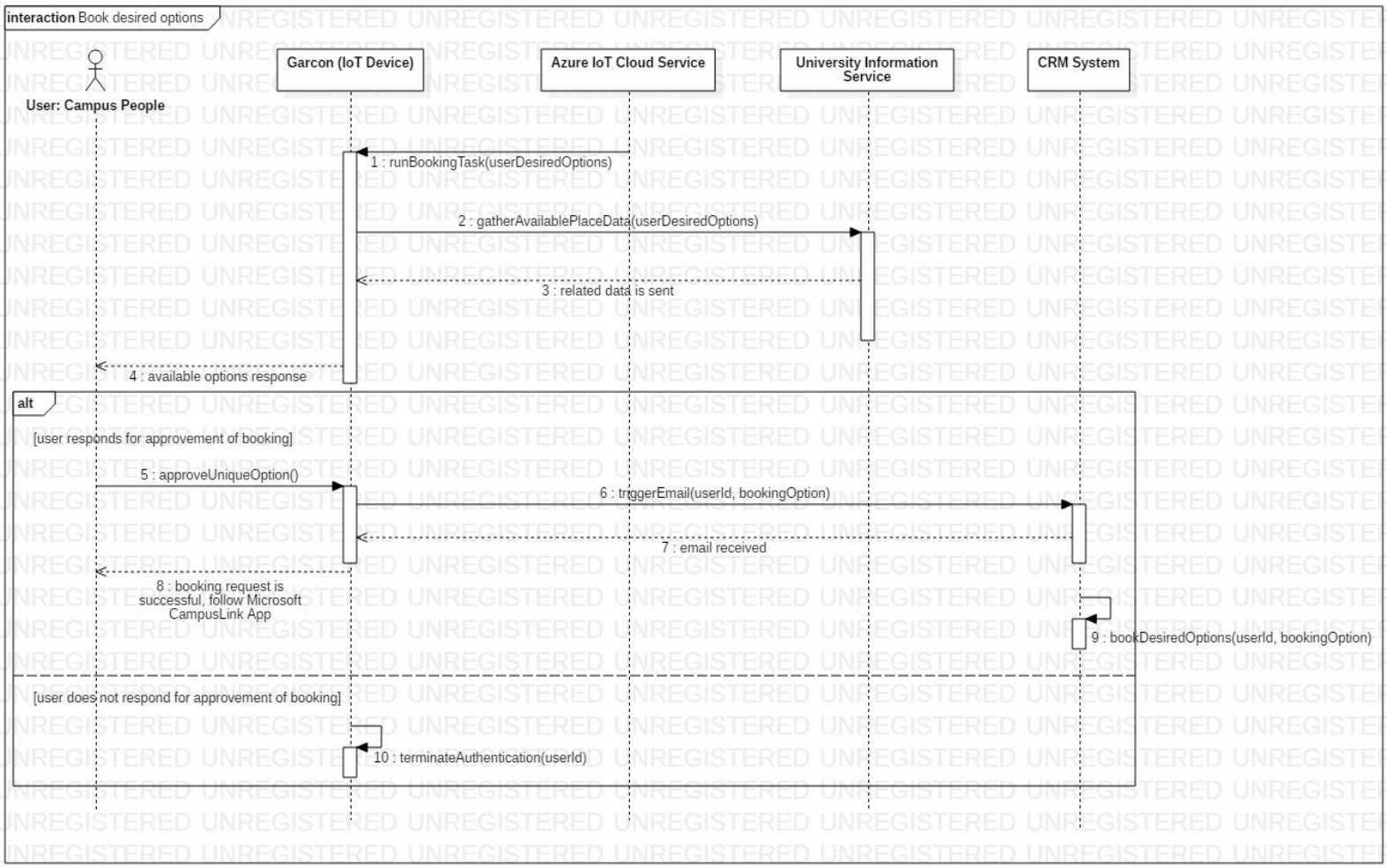

Figure 7: Book desired options Sequence Diagram

3.3 Usability Requirements

- Garcon devices shall show informative simple screens to the user about what the users can do by communicating these strange devices. The system shall be attractive for anyone in the campus from this point of view.
- Especially for the main target users (students, academic people, staff), Garcon devices shall respond every interaction of the user meaningfully even if the user says strange things (e.g. “tell me a joke”) to device.
- Garcon's voice shall be clear and loud enough. It shall warn the user kindly in situations where the user's voice is low.
- Garcon devices shall be user-friendly more than system-friendly. Garcon’s first aim always be helping to the user somehow. It should be able to guide user correctly even if it cannot fulfill the user's request successfully.
- For appropriate cases, at the end of each response, Garcons shall direct user to Microsoft Campus Link Application to get more information about what he/she is looking for.
- When the user enters his/her Microsoft Campus Link Application from his/her mobile phone, Garcon's response to the user and the extra information about the subject shall be seen as a pop-up message immediately in the application.

3.4 Performance Requirements

- ID card authentication and authorization processes of the user shall be completed in 500ms.
- The number of simultaneous users of the system in any time shall be 3000 users by considering the huge population of METU Campus.
- All active Garcon IoT devices shall work independently from each other at any time.
- The response timing of Garcon devices shall be less than 5 seconds for all and even extreme cases.
- Hardware used in the sensor system shall be resistant to unfavorable conditions and sensors' communication timing with Cloud shall be less than 1 second.
- Other information services’ communication timing with Cloud shall also be less than 1 second.
- The CRM system shall be in constant communication with the all university staff and fulfill the user requests as quickly as possible by considering personnel availability.

3.5 Logical Database Requirements

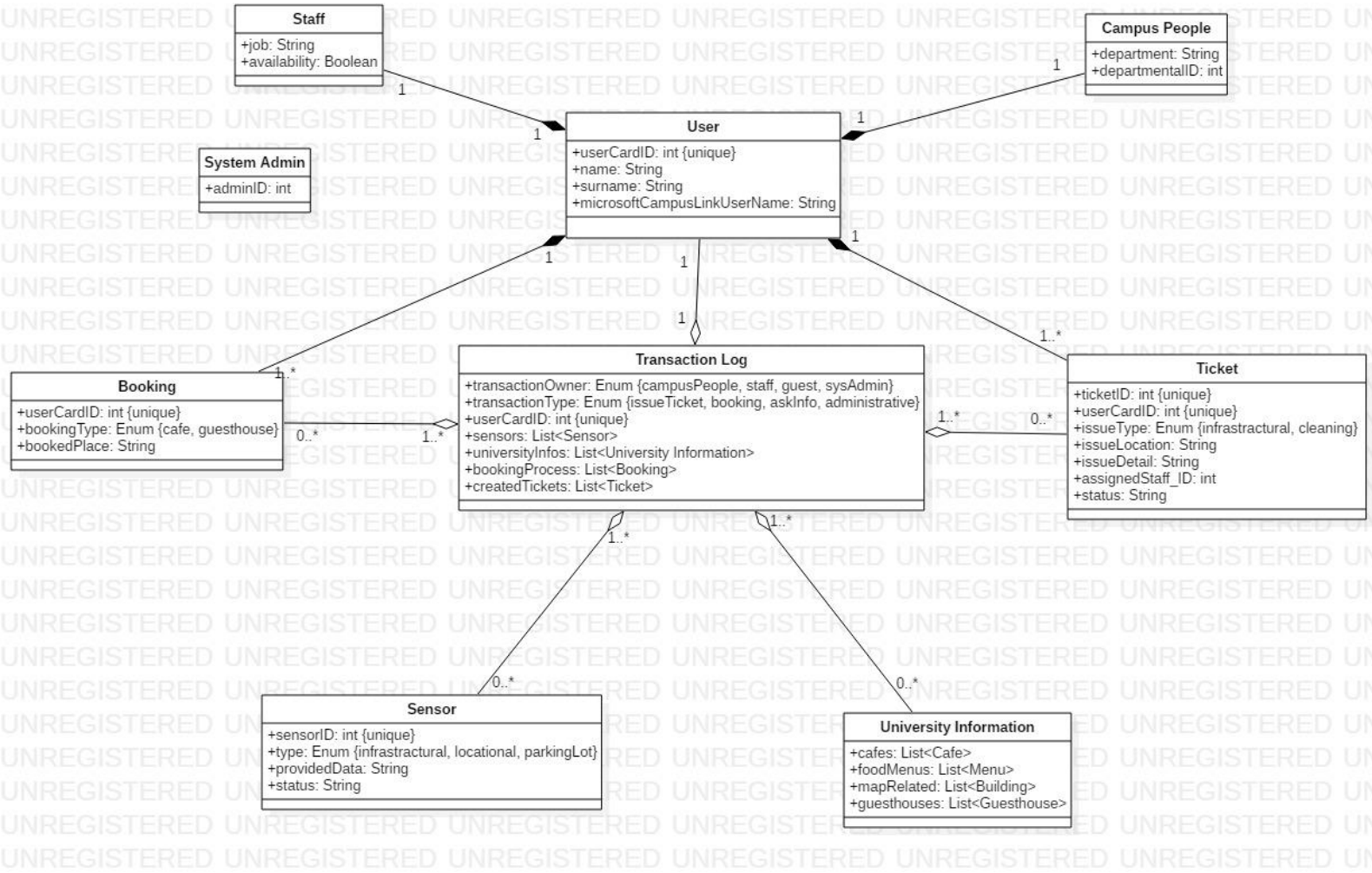

Figure 8: Logical Database Diagram

- User table shall keep all possible end users of the system.
- Staff and Campus People are weak entities and they have one-to-one relationship with User because they are special type of the user and they are meaningless without the existence of User.
- There will not be any table related to Guest users. Guest's informations shall be kept at User table.
- For system admins, there will be a distinct table that just keeps the admin ID.
- Transaction log table shall keep every transaction between any end user and the system. Its columns are created according to possible use cases of the system. All columns may not be completely filled for all use cases.
- There will be a one-to-one relationship between User and Transaction Log table since there can be only 1 user for each Garcon device at any time.
- Booking table shall keep user's confirmed and approved booking requests related data. Booking is weak entity and it has many-to-one relationship with User.

- Ticket table shall keep data related to issue tickets. It is also weak entity and it has also many-to-one relationship with User.
- Both Booking and Ticket tables has many-to-many relationship with Transaction Log table since there can be more than one booking process or there can be more than one reporting or viewing ticket process for any transaction (e.g. staff can see all open status ticket list in their transactions).
- Sensor table shall keep sensor hardware related data and it has many-to-many relationship with Transaction Log table.,
- University Information table shall keep various kind of data such as list of cafes, list of menus, list of buildings and list of guesthouses. Actually, these are all also distinct database tables of our system. However, they will not be detailed for the simplicity.
- University Information table also has many-to-many relationship with Transaction Log table since its data can be needed for any transaction.
- Only system admins shall be able to access all of these tables.
- System admins shall also be able to add new instance or delete existing instance from User table.
- CRM system shall be able to access Staff table and have a full control over Booking table specially.

3.6 Design Constraints

Overall, the system should meet all the regulations of Middle East Technical University. For legal purposes, system shall store the data about which user generates a specific issue report and which university staff resolves that specific issue.

3.7 Software System Attributes

Reliability: Database should be backed up regularly every day. Transaction logs should be checked regularly by system admins to detect any malicious activity that may realize due to users or the system itself. All components of the system should be checked in terms of functionality once a week. Any pending transaction of the system shall be realized at most in 24 hours.

Availability: System shall be available 7/24 normally. However, in the case of system or any component failure, all problems shall be fixed up to next workday latest.

Security: User's all informations in the system shall be kept safe and not shared to any external entity. Except system admins, it can not be possible to gather any information about system components and data flow between them.

Maintainability: Documentation shall be created in detail and clear as much as possible to adapt any kind of new personnel to the system easily. System complexity shall be decreased as much as possible. Moreover, since majority of system

components are developed by Microsoft (e.g. Azure IoT Cloud) in this project, system admins shall be in communication with the Microsoft staff for any maintenance problem.

Portability: Garcon concept basically relies on a Smart Campus idea and it can be implemented to any campus that has necessary technological infrastructure to perform main capabilities of the system.

3.8 Supporting Information

Garcon is basically an AI and IoT project that is inspired from Microsoft's Smart Campus project. At this version, the project is created mainly for Middle East Technical University by thinking socio-technological conditions of METU Campus. In the future, the project can be improved to more advanced levels easily if new applicable ideas emerge that can be a solution to some distinct problem in campus life.