Case study for Assignment 3

INTRODUCTION

For Assignment 3 and for the final assignment, you will be performing requirements analysis on a fictional case study based on the KAOS method.

Study instructions

The draft of Assignment 3 is subject to a study load of five hours; the final version of Assignment 3 is subject to a study load of ten hours. The final assignment has been subdivided into various sub-assignments. The estimated number of hours you will need for each sub-assignment is indicated there. You will find the descriptions of the draft and final versions of Assignment 3.

Reading through this case study is included in the time you have for the draft of Assignment 3.

1 The case study

Here, we provide a description of 'COOL: a Car pOOLing support system' by Christophe Damas, Bernard Lambeau and Axel van Lamsweerde.

1.1 INTRODUCTION

Traffic congestion in the United States wastes 2.8 billion gallons of gas and significantly increases CO2 emissions every year. It causes more than 3.7 billion hours in travel delays. According to the U.S. Census Bureau, the use of cars by single persons has increased since 1980. In 2008, 76 percent of drivers were in single-occupancy vehicles (SOV) compared to 64 percent in 1980. In addition, SOVs produce 75 percent of all transportation emissions.

In a city like Brussels, cars produce 70 percent of all transportation emissions. The average car occupancy rate has decreased by 5% between 1990 and 2007, with currently 1.28 person by car. Individual cars are estimated there to cause 532 kilotons of CO2 every year, that is, 15% of total CO2 emissions. With an average of 2 persons by car, the contribution to CO2 emissions would drop to 340 kilotons, that is, 10% of total CO2 emissions; with an average of 4 persons by car, the contribution to CO2 emissions would drop to 170 kilotons, that is, 5 % of total CO2 emissions. Such figures clearly call for the increased use of public transportation and carpooling systems.

Carpooling (also known as car-sharing, ride-sharing, lift-sharing…) is the shared use of a car by a driver and one or more passengers. Further to reducing traffic congestion and pollution on roads, carpooling systems offer multiple benefits for people using them, including:

– *Saving money*: Sharing a ride with other people may result in distributing fuel costs among them.
– *Reducing stress*: Participants may rotate in using their own car; non-driving passengers are therefore relieved from driving their own car on certain rides.
– *Increasing social relationships*: Carpooling may provide social connections in an increasingly disconnected society.
– *Making journeys faster*: In certain countries such as the U.S., Canada or Australia, designated lanes on highways are reserved for carpooling, thereby making travel faster.

While most people understand the effectiveness and benefits of carpooling, the current ways of doing it are not convenient and flexible enough to meet the busy lives and variety of demands of today’s users.

1.2 A SIMPLE, IDEAL CARPOOLING SUPPORT SYSTEM

The recent advent of technologies such as GPSs, mobile phones, SMS messaging, PDAs and iPhones provides a unique opportunity for more effective and flexible carpooling through a distributed software-intensive system relying on such technologies.

This section outlines an ideal carpooling support system – where ideal means that a variety of exceptional situations are possible but not taken into account in this preliminary report. The initial problem description hereafter may be seen as a transcript from stakeholder interviews.

The system acts as a marketplace for drivers to offer their empty seats in real time and for non-driving travellers to use them under agreed conditions. A driver is matched in real time with anyone searching for a ride along a common route. The system should support GPS- enabled real-time ride matching, agreement among parties, payment management, and the management of information about passengers and routes. Effective carpooling may critically depend on the size of the marketplace; the system should therefore be attractive to drivers, in particular by not over-constraining them. Drivers are assumed to have a device with GPS navigation facilities and a touch screen such as a tablet or a smartphone.

More specifically, the system should be working in two modes.

In *sedentary mode*, a driver may enter or update his/her profile – typically: name, job, car(s), number of seats, preferences about passengers, usual routes and schedules, acceptable pick-up points along a route, etc. A non-driver (i.e. a passenger) similarly may enter or update a “symmetric” profile, similarly to that of a driver.

In *nomad mode*, the carpooling system matches drivers with passengers. In general, it then functions as follows:
– A driver offering a ride must specify through his/her smartphone the route he/she is going to drive for the proposed ride. In addition to the departure and destination points, a route includes the stops in-between where the driver is prepared to pick up passengers, together with his/her expected departure time. To ease route specification, the driver can select among standard stops known to be convenient between the departure

and destination points; he may also determine other, specific ones. Such specific stops will be made available for other drivers to reuse in their own selection. In addition to route specification, the driver must specify the number of seats available in his/her vehicle for this ride.

– A non-driver needing a ride must issue a request for a ride (through the internet). The request should specify the non-driver's departure and destination, an expected target arrival time and a maximum tolerable delay.

– A non-driver's request has to be matched with driver proposals that are not fully allocated yet, can meet a driver's route, and fit the pick-up/arrival place and time constraints. For matching pairs, a non-driver's fee has to be calculated for the ride, based on a per-kilometer default rate; the offer has to be communicated to both parties.

– When a matching pair agrees on the ride offer, instructions are to be issued to both parties for pick-up at the driver's stop location nearest to the departure point of the non-driver's route. The non-driver shall be provided with accurate, real-time information about the journey (through SMS or email) - so that he/she can know when the car is expected to arrive at the pick-up and arrival locations.

– When approaching the pick-up point, the driver shall receive an audio prompt reminding him/her to pull over.

– The driver then has to drive the non-driver to the stop nearest to the non-driver's destination, possibly taking other agreeing passengers at other stops along the route.

– At the end of his/her journey, the non-driver is charged the agreed fee, to be paid to the driver via the payment sub-system.

Safety and security are of utmost importance for effective carpooling. The following features should therefore be provided to address a variety of safety- or security-related concerns.

– An eBay-like evaluation mechanism shall be supported for trust management whereby drivers and non-drivers are encouraged to rate each other at the end of the journey. A small qualitative scale shall be used (e.g., "excellent", "good", "fair", "bad") with some room for short comments –e.g., to recommend enjoyable or on-time persons, or complain on driving-too-fast persons, drunk drivers, sexual harassment, etc.)

– A ride offer for a matching pair shall include, in addition to route, timing and fee information, the partner's picture and rating.

– Drivers and non-drivers must both authenticate themselves by entering their auto- generated PIN at the start of each journey.

– Every user shall be registered within the system (driver or non-driver).

– Journey progress shall be tracked into the system through GPS.

– Sensitive information in user profiles shall be kept confidential.

– Payment transactions and trust management shall be fully secure. In particular, a driver may change his/her evaluations but may not change the ratings and comments about him/her.

To further increase mutual trust and journey convenience, users shall be able to specify criteria that restrict matching pairs, such as high rating, specific gender (e.g. a female driver might wish to take female passengers only), non-smoking person, user they know or have already travelled with, community member (for shared ride to corporate headquarters or university campus), etc.

For further safety reasons, it should not be possible for drivers to interact with the software while driving (e.g., audio notification, no stop creation while moving, etc.)

The system should further meet other non-functional requirements such as the following:
– *Performance*: A real-time system requires acceptable response times.
– *Accuracy*: Any communicated data must reflect the real, actual situation.
– *Usability*: Many users are expected to have no or little background in computer science.
– *Robustness* against a wide variety of exceptional situations – e.g., temporary lack of connectivity, driver or non-driver not showing up, cancellations, traffic delays, etc.
– *Adaptability*: The system should be easy to reuse, extend, contract, or modify for a variety of situations such as: support of both occasional and regular journeys, long- distance trips, coping with extra space for luggage, distinction between time-critical and time-unconstrained journeys, varying distance units (kms vs. miles), varying payment units (money vs. ride credits).