

Project Modeling an access control system (MASTER INFORMATIQUE IL)

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1 Steps of the project

The project should be carried out within a group of at most 4 students from msc IL students. Each group will make an electronic file under the form of a zip archive whose name will be of the form `texttt group-x-name.zip` where x is the number of the group and name is the name of one of the members of the group and it will contain the elements following :

- A short (4 A4, times 10pt, pages) document containing the case study chosen and specifying the correctness (safety or security) properties expected from the model to be built . informations derived from the analysis. The document is developed from the resulting models and may contain more informations. This part is not technical but should readable for a non Event-B user.
- A text file of analysis and presentation of the study carried out : a synthetic presentation of the models, indication of the choices made, difficulties, invariants, safety properties. Each machine or refinement should be proved deadlock-free and you can use ProB.
- the Rodin project archive developed with comments in Event-B components.
- the small demonstration program built from the models : you can use plugins available for translating Event-B models into C or C++ or Java or Python or ... or you can simply use a direct way to translate an event as

name
WHEN
 $G(x)$
THEN
 $x := f(x)$
END

The event *name* can be translated by the following code

Listing 1 – Code for name

```

1
2
3 // name code
4 if (G(x)) { x = f(x);}
5 ...

```

pname
ANY
 p
WHERE
 $G(x,p)$
THEN
 $x := f(x,p)$
END

The event *pname* can be translated by the following code

Listing 2 – Code for name

```

1
2
3 // name code
4 // get est un fonction qui renvoie une valeur
5 // pour p satisfaisant G(x,p)
6 p = get(G(x,p));
7 if (G(x,p)) { x = f(x,p);}
8 ...

```

The function $get(G(x,p))$ is not always defined in a programming language. For instance, if $G(x,p)$ is mentioning a predicate as $p \in A$, A should be a finite set and you should define it as an enumerated set with at least two elements. Hence, this step should be made as simple as possible since the translation is depending on the possibility of define sets in a programming language.

- **March 5, 2021** Send the archive `groupe-x-nom.zip` containing the different elements required.
- You can ask questions by appointments an it is simpler to ask questions rather than to work in the wrong direction.

The next sections are introducing the possible case studies but each case study is a problem related to the access control with administration of rights. I suggest to use the access control archive as a pattern for your project.

2 Subject 1 The access card SUICA

2.1 What is SUICA?

The Suica is a prepaid e-money card for moving around and shopping. There is no more need to buy a ticket from a vending machine. Just touch your Suica to the ticket gate and the fare is automatically deducted from your Suica. The Suica can be used not only for JR East trains, but subways and buses as well. See the Suica Map for transportation systems you can use with the Suica.

The Suica can also be used to pay for things with e-money. Buy soft drinks and coffee from vending machines and on the train. Even buy a newspaper at the station kiosk without fiddling for coins. For traveling in Japan, the Suica makes a more pleasant trip.

2.2 Riding Trains

Simply touch the Suica card to the reader at the ticket gate when out and about. There is no need to purchase a ticket from a vending machine. The fare is automatically calculated at the station where you get off. When you get off the train, the fare will be calculated at that station. If the balance is insufficient, however, you will need to add more money to your Suica.

Additional tickets must be purchased to use the Suica for travel on a limited express, express or Green Car. The Suica cannot be used for travel on the Shinkansen. Valid Areas and Transportation Systems

The Suica can be used on JR East lines in the Tokyo metropolitan area as well as for subways, buses and the Tokyo Monorail that connects Haneda Airport with Tokyo.

In addition to the Tokyo area, the Suica can be used for certain transportation systems in the Sendai and Niigata, Hokkaido, Tokai, West Japan and Kyushu areas.

2.3 Recharge the Suica

The Suica can be loaded and used as many times as desired.

The Suica can be loaded up to a maximum of 20,000 yen at Automatic Ticket Vending Machines and Fare Adjustment Machines displaying the Suica mark.

Only yen may be used to load a card. A credit card cannot be used to load a Suica.

2.4 Networks and companies

There are several companies and networks and when you travel, your route may require to change the network and you have to retouch the access point.

2.5 Complementary Informations

The access card SUICA is described on the website of the Japanese companies and on French websites. Please consult these sites to get more informations.

2.6 Work to do

The work to do is to provide an Event-B model of the system controlling the access to the metro lines of Tokyo. If you read the informations, you will understand that there are several companies and that, when travelling in the metro, you can change from a company to another one after having used the card which is recording your travel cost. The goal is to build a small system able to simulate the access control system called SUICA.

The project should be conducted in a team of at most 3 persons. Each group should write an electronic report as a ZIP archive named `group-x-name.zip` containing :

- x is the number of the group and name is the name of one person of the group.



FIGURE 1 – Card SIUCA

- a report of the analysis and explanation of the machines and the cointexts used for modelling the system : explanations of invariants, checking POs, validating each machine, each context, detailing the safety properties, ...
- the Rodin archive of the project
- a small program designed from the Event-B models.

3 Subject 2 The PARAFE system

3.1 PARAFE

The PARAFE system is used for controlling the access in country like France when people are arriving in an airport as for instance CDG. The system includes the following equipments :

- an access tunnel for crossing the border with two doors/.
- a reader for the passport located at the in door and the door for entering the tunnel; the reader is able to read any passport and to get informations from the person of the assport.
- a reader for controlling the access to the outside from the second door and the entry in France; the reader is able to identify the finger prints or to control a camera.

The real system is on the figures 2 and 3. When somebody is inside, the system can check that there is at most one person. The protocol is defined as follows.

- reading the passport and opening the first door when the person is authorized.
- When the first door is open, the person moves into the tunnel and then the door is closed if there is at most one person.
- When the door is closed, the person inside the tunnel is pressing a button and the camera is checking that the person on the photo is the person of the passport.
- The second door is then opened and the person should get out.
- When the person is moving out and when the person is outside, the second door is closed.

3.2 Work to do

The work to do is to provide an Event-B model modelling the PARAFE system.

The project should be conducted in a team of 3 or 4 persons. Each group should write an electronic report as a ZIP archive named `group-x-name.zip` containing :

- x is the number of the group and name is the name of one person of the group.
- a report of the analysis and explanation of the machines and the cointexts used for modelling the system : explanations of invariants, checking POs, validating each machine, each context, detailing the safety properties, ...



FIGURE 2 – Parafe 1



FIGURE 3 – Parafe 2

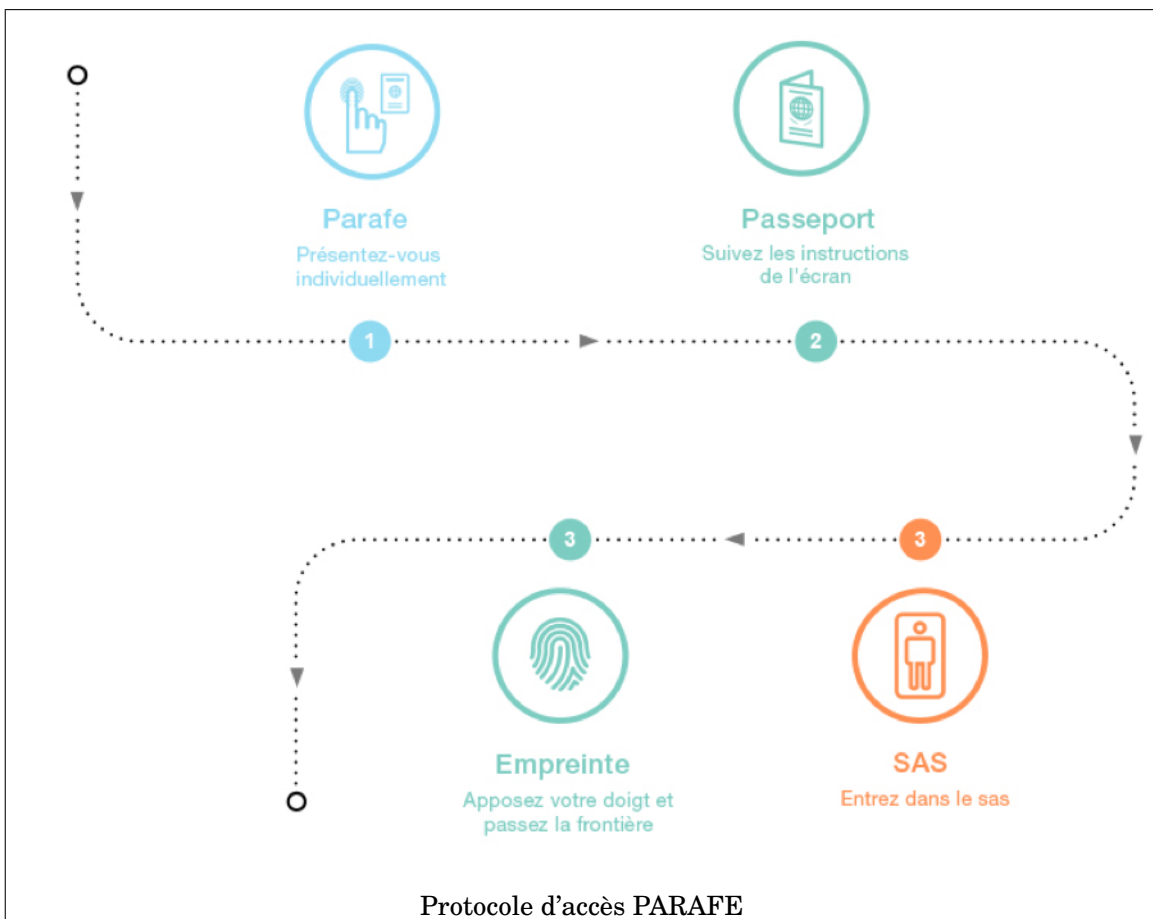


FIGURE 4 – Protocole Parafe

- the Rodin archive of the project
- a small program designed from the Event-B models.

4 Subject 3 Hotel Key Card Access Control System

We plan to develop a system for controlling the access to rooms in a hotel. There are commercial products that exist and that can be used for this purpose and we give an example of the company hune.

4.1 The solution proposed by HUNE : THE LATEST ELECTRONIC CARD LOCK SYSTEM

The case study is the system proposed by the company hune at the following link : <http://www.hunelock.com>
We are reproducing the text of the website in the next lines.

The first electronic card lock should be launched in 1975 and that is a magnetic lock. And then the electronic card lock system is applied for civil use such as more and more hotel will use this keyless system to upgrade their image and also bring convenience to guests. The history of electronic card lock can be divided into few stages : Magnetic card lock, IC card lock, RF card lock and Iot card lock. And the electronic card lock system for them also have a evolution history.

Magnetic Card Lock *Actually the magnetic card system was firstly used in electric power supply and water supply system as data collection and then be applied in civil use. Because of its lower cost and basic fulling, in some of the small scale old school classic hotel, they still reserve the magnetic card lock system. As the first generation electronic card lock system, it has the basic function of book reservation, emergency unlock and guest unlock and also some manufactures launched the elevator controller for hotels. But the disadvantage of magnetic card is very easy to get damage , card can not be formatted and also have lower security level. It not good for some big scale hotel management. latest-electronic-card-lock-system*



IC Card Lock *IC card lock system should be the 2nd generation of electronic card lock system. Even its information still can not be formatted and reuse, but its advantage is have higher security level. Some classic branded hotel or hotels established around 1995-2010. the-latest-electronic-card-lock*

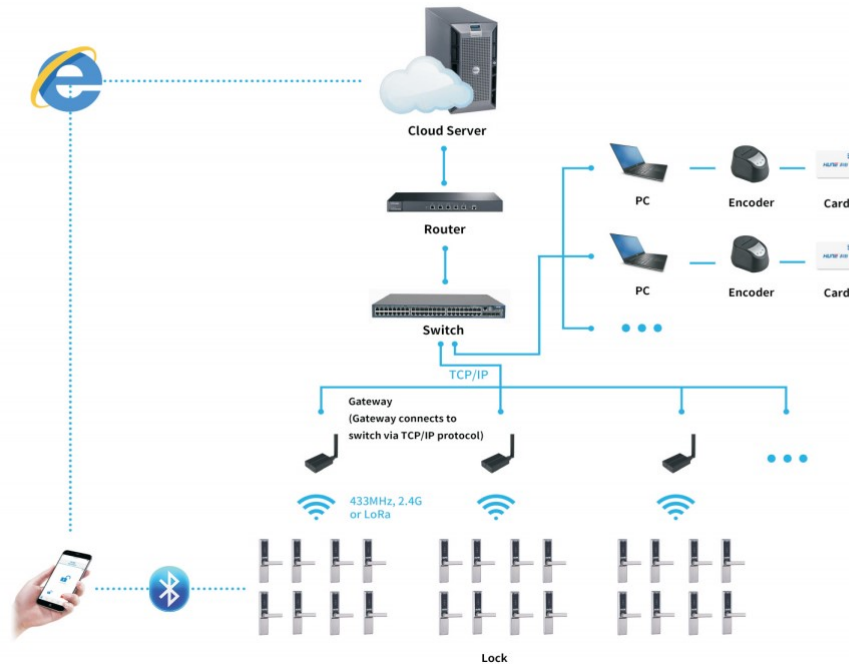


RF Card Lock *RF Card lock system is the most popular electronic card lock system until now. Even some manufactures add new unlock way such as BLE to it, they still reserve the RF card as media to their guests and staff. RF card lock system can be divided into Temic and Mifare system. Both of them has the advantage of touchless (The previous magnetic and IC card solutions should insert card to the lock to send command then unlock). This contact way is well protect the card from damage and more over, this electronic card lock system allow the card format, so data can be refreshed and for reuse. That is the good news to hotel management budget. As we mentioned above this electronic card lock system has both Temic and Mifare version. Temic is suitable to some small to medium scale hotels because of its small storage space. Most of the big hotel will required one card pass solution, which means you can use one card to entry car parking, enter all public areas and their own rooms, and also customers may use card to consume in the hotel restaurant, health care center or business center. It means this electronic card lock system should use card that reserve enough space other functions. But dont worry , Mifare card has 16 sections to meet this requirement. And that is why more big scale chain hotel will choose this system.*



IoT Card Lock As technology grow, the market has higher requirement to the electronic card lock system. For example, Smart City is a trend of the world, not only because of the convenience but also about the security. For example, you can track which ID has unlocked the door via records no matter you have to download or check remotely. And hotel management companies have urgent demand of this function. The recent popular transfer signal of IoT electronic card lock system for hotels is BLE or Lora. BLE system required more gateways then Lora and also Lora has lower power consumption rate. But BLE has advantage of appliance in many recent devices that Lora can not compare recently. Lora is more popular with the hotel management part because of its lower cost in devices allocation and low power consumption, which means management no need to change lock battery frequently. You can book room in APP of the hotel then pay to get your qualification to send request to the hotel cloud server. Hotel will have gateways to connect lock and send command. With RJ45, Wifi, 3G/4G signals, the gateway exchange information to the cloud then true the unlock function. But your phone need to connect to the internet whenever you would like to unlock outside the room. That is what you need to concern when you choose this solution. BLE is also popular because it has two ways to true the online booking function, even it require more gateways and have higher power consumption. The first way is similar to the Lora solution, which mean you need to connect to the internet to unlock in APP whenever you need. But If you dont want this solution, you can send request to the icloud server of the hotel, then hotel can send you the digital permit for your living period in that hotel, so in the rest time for your living, you just need to send permit to the lock via blue tooth signal to unlock is ok. And that required no internet signals.

HUNE Bluetooth Network Lock



4.2 Summary of the system

The key card management system of an hotel is managing the access control to rooms as well as facilities as the swimming pool, the leisure room, the pub, the restaurant the ... The system is providing the following functionalities :

- operations for modelling the interactions with the customer as check in, check out, billing, payment, reservation, ...
- actions for controlling the access of rooms, leisure rooms, restaurant room, extra services ... control of access of a given location
- recording the use of a service as leisure, swimming pool etc for billing to the customer
- managing the reservation of rooms and extra services ;

The properties of the system are for instance the following items :

- Only one card id gives access to a room at any time and is related to a customer. The right is temporary and has a starting date and a ending date.
- However, the cleaners have access to any room when the customer is not in the room ; they use a specific card id with tehir names.
- The security officer has access at any moment to any room and any locations of the hotel.
- When an alert is on for instance fire alarm, the rooms are no more locked.

The system is described very simply and you may add features that are not required in these notes ?

4.3 Work to do

The work to do is to provide an *Event-B* model modelling the key card managing system.

The project should be conducted in a team of < 4 persons. Each group should write an electronic report as a ZIP archive named `group-x-name.zip` containing :

- x is the number of the group and name is the name of one person of the group.
- a report of the analysis and explanation of the machines and the cointexts used for modelling the system : explanations of invariants, checking POs, validating each machine, each context, detailing the safety properties, ...

- *the Rodin archive of the project*
- *a small program designed from the Event-B models.*

5 Subject 4 Highway Access Control

5.1 Controlling the access of highways

Le système que nous souhaitons modéliser est le système de péage des autoroutes (voir la figure 5). L'objectif est de construire un système chargé d'assurer le péage par les usagers du coût de l'utilisation de l'autoroute. L'évaluation du coût est calculée à l'aide du ticket présenté par chaque usager ou bien encore à l'aide du dispositif de télépéage. Lorsqu'un automobiliste arrive à un péage, soit il entre sur l'autoroute, soit il en sort. La figure 6 décrit le portique de péage et le dispositif à utiliser pour régler le coût, en insérant le ticket dans l'orifice prévu et en réglant le coût soit par chèque soit par de la monnaie.

Deux protocoles sont possibles :

Ticket S'il veut entrer sur l'autoroute, il appuie sur un bouton, le portique lui délivre un ticket qu'il conserve et qui lui permet d'avoir l'ouverture de la barrière et, enfin, il franchit le portique et entre sur l'autoroute. Le portique se referme dès que le véhicule a franchi le péage. La figure 5 montre les signaux indiquant que la voie peut être utilisée dans le cas où un ticket est remis à l'automobiliste. S'il veut sortir, il insère son ticket et règle la somme demandée (voir la figure 6); puis le portique s'ouvre et se referme dès que le véhicule a franchi le portique. Dans ce cas, on distinguera le règlement en sortie à un employé présent ou bien le règlement par carte bancaire en sortie.

Télépéage S'il veut entrer sur l'autoroute, il emprunte un portique indiquant qu'il est destiné et réservé au télépéage. Le portique n'est pas fermé et le véhicule est détecté à son passage du portique par un dispositif spécifique. Le dispositif lit l'identité du véhicule et enregistre la date d'entrée. La figure 5 montre les signaux indiquant que la voie peut être utilisée dans le cas où un ticket est remis à l'automobiliste. S'il veut sortir, il emprunte une voie dédiée à ce type d'accès.

On suppose que deux véhicules ne peuvent pas franchir le portique ouvert simultanément. Le système doit assurer le service de manière à ce que toute personne qui emprunte l'autoroute paie la redevance due. Il est important de discuter les cas particuliers quand un automobiliste a perdu le ticket ou bien encore quand il ne peut pas régler la somme. Quelques comportements peuvent être possibles et doivent être considérés dans votre modélisation. Si un véhicule franchit la barrière du télépéage sans disposer de la carte de télépéage, un message est envoyé aux services de sécurité de l'autoroute et la photographie de la plaque d'immatriculation est fournie. Il est important aussi d'envisager des cas particuliers où le véhicule ne sort pas l'autoroute après un délai donné et de prendre une décision à ce sujet comme prévenir les services d'urgence.

5.2 Work to do

The work to do is to provide an Event-B model modelling the key card managing system.

The project should be conducted in a team of < 4 persons. Each group should write an electronic report as a ZIP archive named `group-x-name.zip` containing :

- *x* is the number of the group and *name* is the name of one person of the group.
- a report of the analysis and explanation of the machines and the contexts used for modelling the system : explanations of invariants, checking POs, validating each machine, each context, detailing the safety properties, ...
- the Rodin archive of the project
- a small program designed from the Event-B models.



FIGURE 5 – Vue de péage et des portes



FIGURE 6 – Vue proche d'une entrée ou sortie de péage

6 Deadline of the work

The deadline for sending the electronic report is March 5, 2021 and the email address is dominique.mery@loria.fr with the subject “SUICA”.



Portique d'accès et point de contact carte