

CENG 49x - Computer Engineering Design  
Project Proposal Form

**Important Notes**

1. Please read carefully, and follow the instructions below to fill in this form.
2. A project could be proposed by (i) a student or a student group, (ii) a company, or (iii) a faculty member of the department by filling in this form and submitting it to [49x.coordinators@ceng.metu.edu.tr](mailto:49x coordinators@ceng.metu.edu.tr) by e-mail. For a project proposal, there might be a sponsoring company supporting the project and providing some form(s) of resources for the project.
3. Each project will be carried out by a group of 4 students over the course of 7.5 months, which amounts to 30 person\*months. It is very important that your project's workload is around 30 person\*months. Please make sure that you have at least a rough justification about the workload of the project.
4. The reader won't necessarily be an expert in the project's field. So, please avoid jargon and if you use an abbreviation, make sure to include its expanded form. The proposal should be understandable by a 3rd year CENG student.
5. If your proposal might contain a patentable idea or any type of intellectual property, please first make sure to follow the appropriate steps (apply for a patent, etc.) before sending your idea to us. Once this form is received from you, the instructor(s) and the department has no responsibility regarding the intellectual properties of your project/idea.
6. All sources and documentation developed for this course are assumed to be public domain (GPL, CC or similar license) by default. If you need any exception for license and disclosure of project work, please specify this in detail in "Intellectual Property" section of the form.
7. Please note that source codes, documents and issue tracking will be kept in department servers. No restrictions can be requested for limiting faculty and assistants access to student work.
8. Instructions to fill in this form are given in italic fonts and in parentheses. To provide an input for a section of the form, delete the instruction and provide your input in place of the deleted instruction. In the final form that you will submit, there shouldn't be any instructions left over.
9. If you feel that a particular instruction is not relevant to your project proposal, please use a proper explanation for this, rather than ignoring the instruction.
10. The final form should not exceed 5 pages including everything (even this page). Please use Arial, Normal, 11pt fonts and single line spacing.
11. The final form should be submitted as a PDF file.

**Acronym and Title**

BIKESHARE - Cloud-based Integrated Asset Tracking and Payment System for Urban Bike Sharing System

**Target**

☒ This proposal can be announced to all student groups. It can be assigned to any student group.  
☐ This proposal is restricted to the following students/groups.

**Proposer Information**

Names(s):	<i>Haldun Yıldız, Parabol Yazılım Ltd. Şti.</i>
Email(s):	<i>haldun.yildiz@paraboly.com</i>

**Supervisor**

☐ The project will be supervised by \_\_\_\_\_.  
☒ The project can be supervised by any faculty member. Suggestions: CEVAT ŞENER

## Project Description

Cycling is enjoying a favourable press the world over as a “a good thing” in the economic, environmental and social spheres. In education, encouraging children to cycle is saving \$445 million a year on the cost of school transport in the Netherlands. It is also keeping pupils in better condition and so lowering their healthcare costs. Due to the increasing urban problems (air quality, congestion, noise etc..) with the increasing population and private-vehicle ownership rate, the bike sharing systems have started to get popular and widely supported by the public around the world. <sup>[3]</sup>

The proposed project will use smart-lock sensors to connect bikes to a central cloud platform and establish one or bi-directional communication between the field and center. The project will provide an opportunity to broaden skills and knowledge of emerging communication protocols, payment systems and cloud technology.

One of the most beneficial usage areas of “smart lock” system is the primarily **asset tracking/security and secondarily integrated payment** in smart cities context. The envisaged end product of the project will be **an asset tracking/security and payment system** which gathers/receives the data from smart lock sensors embedded to the bicycles over a city’s bike sharing network, even at the outskirts of a city. Secondly, the mobile bike application will be integrated to mobile payment systems for public transportation, which is recently started to be used in Ankara as well. <sup>[4]</sup>

The project envisages a smart bike sharing system; consisting of;

- a) A mobile application for managing the “smart lock” (opening/closing the lock via communication between mobile application and cloud-based central software) and integrated payment process of bike-sharing system.
- b) A smart lock for communicating with the mobile phone and central software.
- c) The cloud-based central software which enables the monitoring, analysis (how many bikes are available? The total daily/weekly revenue etc..) and management of the bike-sharing system.

There are three ways for the development of an integrated payment system;

1) Using one of the widely-used payment processing systems (such as lyzico...) API >>> The firm registration (Parabol can give the external support) to lyzico’s payment platform and utilizing lyzico’s existing API services for payment processing integration. (The risk >>>> The credit card information must be encrypted and stored for the security reasons.)

**2) In-app purchase service (Google Play, AppStore), another way of using an existing payment processing system’s infrastructure. >>> RECOMMENDED, the project team will use the existing libraries and APIs for in-app purchase service development. (Third-party open source)**

3) The agreement with the Ankara Metropolitan Municipality (AMM) for the integration of the proposed mobile application with AMM’s public transportation mobile payment application, “CepBilet”. (This way can be burdensome due to the administrative permissions, therefore it is not recommended. It can be proposed to the municipality after the project is tested in one of the two payment methods mentioned above.)

## Tentative Plan

The planned work packages' (WP) start and end dates are given below. This plan can change depends on the school holidays or supervisor's recommendations and any other specific conditions.

1. Literature Research  $(0.5) \times 8 = 4$  man/-month
2. System Analysis & Design  $(0.5) \times 6 = 3$  man/month
3. Mobile Application Development  $(1.0) \times 8 = 8$  man/month
4. System & Payment System Algorithm Development & Integration  $(1.0) \times 5 = 5$ m/m
5. Preparing the Cloud Server for the project.  $(1.0) \times 4 = 4$  man/month
6. Creating backend services  $(1.0) \times 4 = 4$  man/month
7. Integration and Testing  $(0.5) \times 4 = 2$  man/month

The planned start and end dates are on above graph. This plan can change depends on the school holidays or supervisor's recommendations and any other specific conditions. The mobile application and payment system algorithm development (WP 3 and 4) will be the most critical packages for bringing a solid outcome from the project. Therefore, these packages needs the allocation of close to 50% of whole human resources (assuming max. 30 man/month). The cloud services are the second important aspect of the project due to providing the functional service (bike tracking & payment system) in a reliable and scalable architecture & infrastructure. Therefore, nearly %25 of whole human resources are allocated in WP 5 and 6.

**“Smart Lock” hardware is not a necessity for the mobile application development and cloud integration at the beginning. Though our firm will assist the project team for the design and production of “smart lock”. (Further explanation is in “External Support” part.)**

## Similar Products/Projects

<sup>[1]</sup> I LOCK IT

<sup>[2]</sup> BITLOCK

<sup>[5]</sup><sup>[6]</sup> Public Bike Sharing System in Tartu

*As shown in the references, there are companies and cities enables smart bike sharing infrastructures. In Tartu's SmartEn Project, with Tartu's smart card or mobile app, they have successfully covered most of Tartu with bike sharing network. Currently, the municipality is able to track and citizens are able to use and make the payment for the bikes in Tartu.*

## Contributions, Innovation and Originality Aspects of the Project

*The envisaged end-product will help to decrease the monitoring costs of bikes for the city authorities. Smart-locks average battery life is 5 years which prevents the frequent maintenance costs. Furthermore, smartlock sensors can be enhanced with alarm-generating capabilities which will be activated in case of physical attempts at stealing the bikes or not brought to bike stations for a pre-defined time. (the alarm rings if the bike is not parked in any station after 24 hours) Furthermore, smartlocks can use a wide range of communication channels (Bluetooth, NFC, QR Code) which eases the infrastructure requirements and compatibility issues.*

*Finally, the proposed project will transform the “dumb” field assets (bicycle locks, bicycle docks/parking lots.) into “smart” devices in the cities.*

### **USE CASE:**

*The mobile application will enable the automatic opening/closing and start/end of the payment process for bikes **equipped with smart locks** which are placed on **fixed positioned bike dockers (parking lots)***

*1) The user logs in to the mobile application via its identity number. (Enables the tracking for possible theft scenarios)*

*2) Scans the QR code on "smart lock" placed on the bike and opens the bike placed in fixed positioned bike docker. The payment process starts and the user is started to be tracked via mobile phone's GPS. (GPS data is sent to the cloud system via the mobile application)*

*3) The user goes to another bike docker and scans the QR code again and locks the bike on the bike docker. The payment process stops and the data is sent to the cloud system via the mobile application. In case of the theft, the user can be identified via the identity number which is entered in the first step.*

### **Success Measures**

- Positioning assets with high accuracy (<10 meters)
- Coverage area of the network (> ~100 km<sup>2</sup>)
- Availability of central cloud software (>99%)

### **Project Development Environment**

#### **Hardware:**

- Smart lock(s)
- A smartphone including NFC (Near-Field Communication, Bluetooth and QR-Code features)
- Bike Docker(s) (Parking Lot)

**A smart lock is hardware which will be embedded to the bikes and enables the automatic opening/closing via two-way communication with the mobile phone (application). It can use different communication channels such as Bluetooth, NFC, QR Code.**

*The smart lock's general features and use case can be examined in the following reference (GPS is the optional item in the scope of this project, it is NOT a necessity due to already-gathered GPS data from the mobile bike application);<sup>[7]</sup>*

*The smart lock will include the following components;*

- Steel circle (Physical opening and closing of the lock)
- Alloy box as the container (Contains all the components)
- GPS kit (Optional)
- Servo (Moves the steel circle for opening and closing)
- QR code (The communication component between the smartphone and the lock)

#### **Software (Suggested):**

- A mobile software application

- Technologies: Javascript (ReactJS, ReactNative etc.), CSS, Kotlin, Swift, Java

-Central Cloud Server

- Technologies: Microsoft Azure, AWS, Google Cloud etc.
- Backend
  - NodeJS, ExpressJS
- Communication Protocols:
  - HTTP, HTTPs etc
  - Kafka, RabbitMQ.
- Database
  - NoSQL, MongoDB
- Programming Languages:
  - Javascript (es6), TypeScript, NodeJS,, Java, Kotlin, Swift
- Version Control
  - Git
- Operating System
  - Linux based distributions like Debian, Ubuntu

## External Support

The company can provide the necessary hardware components (smartlocks) to develop smart locking and payment system.

The project group can visit and contact with the company, preferably twice a month. During these visits the company will be available for the mentoring and help to solve the issues, especially about the mobile application development for the smartlock (security) and integrated payment solution. All the data in the project will be collected as a part of the project. Parabol could set up test & pilot environment for the project by communicating the municipalities. It could also be possible to set up a test and demo platform on the campus.

***The most feasible way for the smart lock usage would be the "self-development/production of the smart lock" via the project team. The design process of the smart lock can be done via the project team through the external guidance/mentorship can be provided via the firm. The necessary components for the "smart lock", the access to our 3D printers for the production can be provided via the firm (Parabol).***

## Intellectual Property Information

The proposed project possible end product's intellectual property rights will be owned by the company. The high performance achieving project members can be invited for job positions in the company after graduations.

## Major Risks and Risk Plan

Risk 1: The primary hardware components (smart locks) and the integration of this hardware with mobile applications and payment systems are relatively new and not commonly used in Turkey. Therefore, the lack of this component and the lack of previous know-how will be a major risk/problem.

Contingency Plan 1: Parabol will provide guidance/mentorship and support for hardware procurement.

## References

- [1] <https://www.youtube.com/watch?v=mk75s02RRtw> and <https://www.ilockit.bike/en/>
- [2] <https://www.youtube.com/watch?v=KoF6yXsBIYc> and <https://bitlock.co/>
- [3] <https://www.pbsc.com/>
- [4] <https://www.ankara.bel.tr/haberler/baskentte-mobil-bilet-cep-bilet-donemi-basladi>
- [5] <https://smartencity.eu/about/solutions/public-bike-sharing-system-tartu/>
- [6] <https://www.tartu.ee/en/bikeshare>
- [7] <https://www.smartlockssupplier.com/products/Bicycle-Sharing-System-Bike-GPS-Smart-Lock.html>

*/\* End of the proposal \*/*