



University of Maribor

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Faculty of Organizational Sciences

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## **Information system development**

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## 1 Intro

### 1.1 Business system description

The Faculty of Organizational Science is an educational and research higher education institution. Faculty employees and students use faculty computers for the purposes of scientific research, education and professional activities. Establishing a WireGuard VPN connection would give them access to the faculty network. This connection between the network and their personal computer would be secure and accessible only to employees and students. It could be used to access tools and programs available on the faculty's computers, which would make it easier to work and install them on personal computers.

### 1.2 The goal of the business system

The goal of the business system is to provide employees and students with easy access to all the data they need to establish a VPN connection to the faculty network. This would allow access to the VPN network only to users who have been assigned an identity within the software solution, while being able to control the local IP addresses assigned to users and their rights on the network.

### 1.3 The mission of developing a software solution

The software solution made in the Oracle APEX tool, which is based on the SQL database relational database system, aims to securely and reliably exchange the necessary configuration files and certificates for the successful establishment of a VPN WireGuard connection.

## 2 Technology description

### 2.1 WireGuard VPN connection

Wireguard is a new protocol for establishing a VPN connection between two devices. Wireguard is supposed to be faster, more secure and simpler compared to other VPN protocols (OpenVPN, IPsec ...). To establish a connection between two devices, the user needs to know the external IP address of the device with which he wants to establish a connection, the "listening port" and the public key of the device. The device must store the user's public key and local IP, which will be assigned to him when establishing a VPN connection.

### 2.2 PGP Encryption

Encryption is defined as a security process that ensures the reliable exchange of data between two communication pages, in a way that they are read and accepted in the correct form only by certain users. The receiver opens or. decrypts the data file only with a unique key, as without it the data is inaccessible. Pretty Good Privacy oz. PGP is a special type of encryption process, which also involves authentication in electronic communications. In 1991, Phill Zimmermann made an encryption method based on a system of public and private keys. The key is a set of 256 or more characters that are intended to close or. opening the contents of the files. The system works in such a way that the content that the user closes can only be opened with the appropriate key. The public key can be shared if we want the other party to open the file, but its purpose is to strictly close the files. The content is opened only with a private key, and its secrecy is strictly taken care of. Figuratively, PGP is a system of two locks with one key for closing and the other for opening. GNU Privacy Guard - GPG software is most commonly used to use the PGP system.

### 2.3 Oracle APEX

Oracle Apex is a low-code development platform that enables the development of secure business applications. We do not need knowledge of HTML and CSS programming languages to use the application. It uses the 3-tier Oracle RAD architecture. Oracle RAD is a technology fund based on three components: Oracle REST Data Services (ORDS), Oracle APEX, and Oracle Database. REST data service is a Java application that allows programmers with SQL knowledge and databases to develop a REST API for a database. APEX is a low-code development platform that enables application development. Oracle Database, on the other hand, is a secure, integrated database. The request we make is sent via a browser via a web server to the database. All processing, data processing and business logic is performed in the database. This means that the request from the browser is sent to ORDS, where it is specified in the Oracle database to execute it. Within the database, the request is processed by Oracle Apex, when the request is executed it is sent back via ORDS to the browser.

### 2.4 PL/SQL

PL/SQL is a procedural programming language, a logical upgrade of the Structured Query Language. It is used for embedded SQL commands and contains variables, constants, cursors, iteration and iterations, conditional logic, and loops. It belongs to the fourth generation of programming languages and only works with the Oracle database. Unlike classic programming languages (Java, C ++ ...), PLSQL provides certain security standards when manipulating data and tables. PLSQL makes data processing easier and faster, as it is a simpler programming language than Java and other similar languages and runs faster and more efficiently. It consists of blocks of a certain format (Declare, executable and exception section - first and third options) which can also be nested and can share functionalities and variables. It contains subroutines that are functions or procedures in this case. The function returns or displays the result and the procedure only executes certain commands. PLSQL is based on standard programming logic, which means it also uses conditional commands, loops, and loop methods such as if, for, while. When writing PLSQL blocks, DML (Database Manipulation Language) functions are also allowed: select, insert, update, delete, merge but not DDL (Data definition Language). The recommended method of working with PLSQL is to use the dynamic SQL and software benefits that PLSQL provides.

### 3 System modeling

#### 3.1 Context diagram

In the context diagram (Figure 1), we presented the basic process that must be performed to establish a connection between a student or professor's personal computer and the network of the Faculty of Organizational Sciences. We have shown the basic connections that take place between the server, the database and the user.

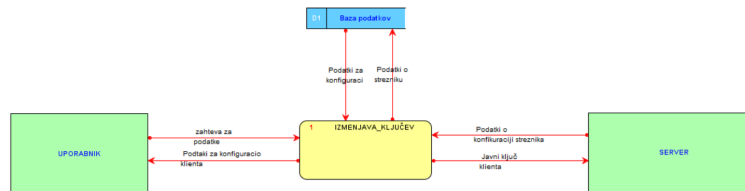


Figure 1: Context diagram

#### 3.2 Logical data model

In the logical data model (Figure 2), we showed which tables will be made in the ER diagram. We also define the columns that will appear in each table, as well as how the tables will be interconnected, according to which keys. In this model, we also show what the properties of each column will be. Will it contain numbers, letters, mixed characters, how many characters can we write in it.

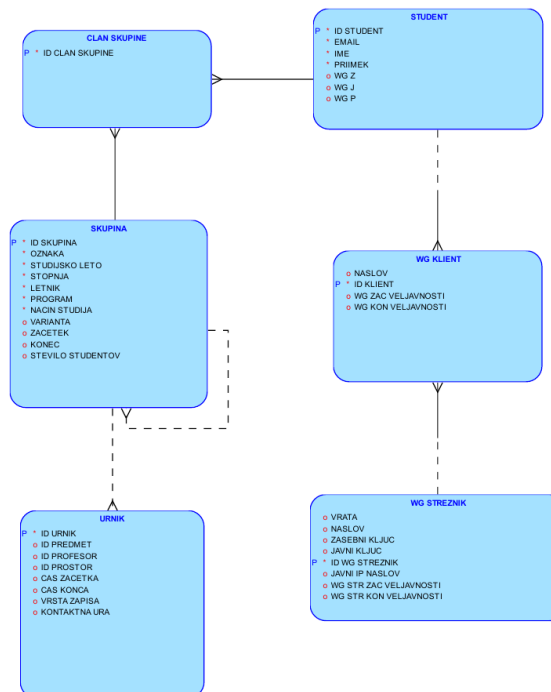


Figure 2: Logical model

### 3.3 Structure of system — ER diagram

The ER diagram or entity relational diagram (Figure 3) shows the objects about which we want to collect data. This data is called attributes that contain the properties of the entity. We have assigned the role of the appropriate key to certain attributes, which means that there is only one piece of information that accurately identifies the person or connection. You can use it to search for users or links in a table. We added a link between the wireguard server and client table, indicating that multiple clients can access a single wireguard server. However, multiple clients can connect to one wireguard server. We also made a one-to-many connection between the client and student tables. This means that one student can have multiple clients.

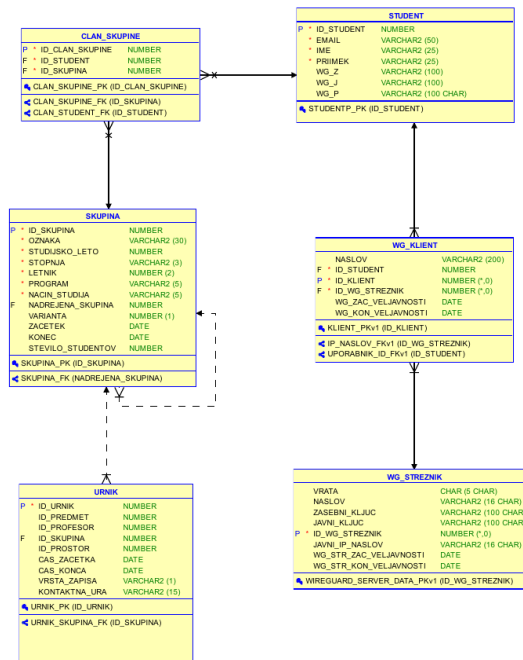


Figure 3: ER diagram

## 4 Application description

With the Oracle Apex tool, we created a web application that will provide students with easy and secure access to data to generate a VPN connection via the Wireguard system to the faculty network. In addition to accessing data to generate a VPN connection, professors will also have access to server data, schedule overview, administration, and automatic configuration information.

Two users are listed below and you can view our web application on the Oracle Apex page. 1 is a user who has permits as a professor and 2 has a student permit. You can access the app from the URL: **WireGuard locksmithh**.

#### User with professor authorization

- profesor@um.si
- profesor100

#### Student user

- EP992583@domena.nn
- uporabnik12



Figure 4: WireGuardLS Log In

#### 4.1 Information about server

On the first page of server data, to which only professors have access, we made a printout of data or information about connections that are currently active on the server. At the beginning, we have printed information about the server, its public key, IP address and other information, which can be seen in Figure 4.



Figure 5: Information about server

Below this record, we have information about all devices or Peers that currently have the option of connecting to the server. This information contains the public key and the IP address. An example is shown in Figure 5.

```

[Peer]
PublicKey = +61mtP4PeQFJJox207i0NiWVAOrb4volb8ZbgPIMiHs=
AllowedIPs = 0.0.0.0/0

[Peer]
PublicKey = yfvpWdpt6Ktsfthkae1Q56zHTEunBirYpLoaLajUZFI=
AllowedIPs = 0.0.0.0/0

[Peer]
PublicKey = sFUOHwug87BPkbYL8BJbaJKHR+wUCbOuOTy1SILoYRU=
AllowedIPs = 0.0.0.0/0

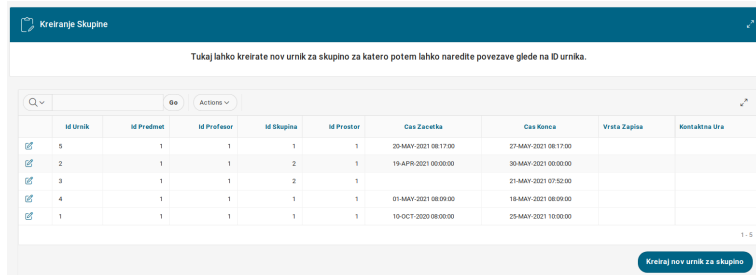
[Peer]
PublicKey = 0xAWlqDMti8xf8r9SpTgaQ8n8IJzwlg6BzylM4FnqSU=
AllowedIPs = 0.0.0.0/0

[Peer]
PublicKey = 159NJZ5M5uBCJf4yuW/lqhKy5D6a0EuRg+JzzNz5zjs=
AllowedIPs = 0.0.0.0/0
  
```

Figure 6: Information about connected peers

## 4.2 Schedule overview

The next page is an overview of the schedule, just as only professors have access to the first page. This page is divided into two parts. In the first (upper) part we have the option to create a new schedule for the group. This means that we create a new record for which we can then make a connection according to the schedule. This part of the page is shown in Figure 6. We can see that all the groups that have created a group for the lecture are listed here.



	Id Uznika	Id Predmet	Id Profesor	Id Skupina	Id Prostor	Cas Zacetka	Cas Konca	Vrsta Zapis	Kontaktina Ura
5	1	1	1	1	1	20-MAY-2021 08:17:00	27-MAY-2021 08:17:00		
2	1	1	1	2	1	19-APR-2021 00:00:00	30-MAY-2021 00:00:00		
3	1	1	1	2	1	21-MAY-2021 07:52:00			
4	1	1	1	1	1	01-MAY-2021 08:09:00	18-MAY-2021 08:09:00		
1	1	1	1	1	1	10-OCT-2020 08:00:00	25-MAY-2021 10:00:00		

Figure 7: Creating new schedule for group

Clicking on the "Create a new group" button opens a new page (Figure 7) on which we create a new appointment or block of appointments. Enter the ID of the subject for which we will create a new lesson, ID of the professor who leads the lecture or tutorial, ID of the group that will have the lecture or tutorial, ID of the room where the lecture will take place, start and end time of the lecture, type of record and contact time.



Figure 8: Creating new appointment

At the bottom of the page (Figure 8), establish a link for the desired group. We enter the schedule ID of which group we want to create a link and the program will activate links for students in this group.

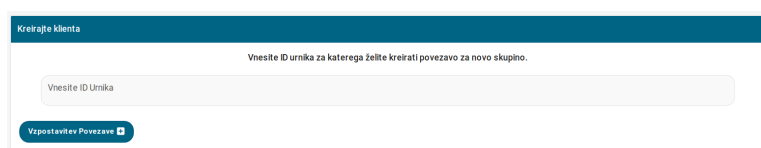


Figure 9: Creating the connection for new client

### 4.3 Client configuration

Both professors and students, has access to the client configuration. On this page we can find information about your configuration, which we then just transfer to the configuration file on Wiregurad. The application creates or displays data depending on which user we log in with. An example of one of the configurations can be seen in Figure 10.

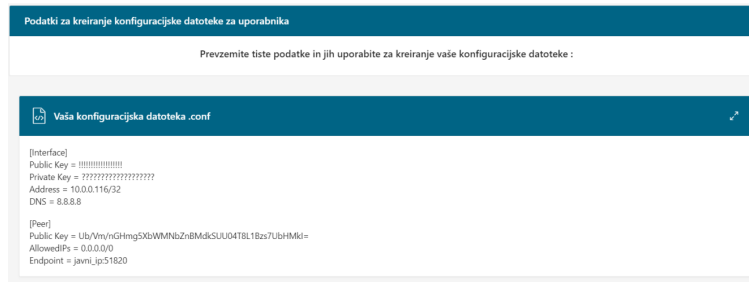


Figure 10: Configuration file

### 4.4 Administration

On the administration side, we have several sections and options for editing links, but this part is for professors only, so students do not have access to it. In the first part (Figure 11) we can create a connection for students who already have a VPN connection or are added to the student apex table and assign them to which server they can connect and the hour from when to when their connection will be valid.

Figure 11: Generating the connection for client

The next function we can do is to extend the validity of only one student whose connection will expire soon. Enter the student ID and validity until when we want to extend the connection. This can be seen in Figure 12.

Figure 12: Renewal of the client validity



In the next section (Figure 13), we can check how many students have a currently valid connection.

Figure 13: Checking the number of active connections

Then we can also delete all past connections (Figure 14).

Figure 14: Removing expired clients

On the administration page, we also have listed all the clients that were entered to create the connection, their IP address, student ID, client ID, Wireguard server ID, and the beginning and end of the connection validity. An example is shown in Figure 15 below.

Naslov	Id Student	Id Klient	Id Wg Streznik	Wg Zac Veljavnosti	Wg Kon Veljavnosti
10.0.0.100/32	990041	100	1	10/10/2020	5/25/2021
10.0.0.101/32	990045	101	1	10/10/2020	5/25/2021
10.0.0.102/32	990049	102	1	10/10/2020	5/25/2021
10.0.0.103/32	990077	103	1	10/10/2020	5/25/2021
10.0.0.104/32	990083	104	1	10/10/2020	5/25/2021
10.0.0.105/32	990109	105	1	10/10/2020	5/25/2021
10.0.0.106/32	990111	106	1	10/10/2020	5/25/2021
10.0.0.107/32	990129	107	1	10/10/2020	5/25/2021
10.0.0.108/32	990131	108	1	10/10/2020	5/25/2021
10.0.0.109/32	990139	109	1	10/10/2020	5/25/2021
10.0.0.110/32	990177	110	1	10/10/2020	5/25/2021
10.0.0.111/32	990189	111	1	10/10/2020	5/25/2021

Figure 15: View of all clients

## 4.5 AutoConfig-Info

On the back of our application (Figure 16 below), professors can see all the information about periodic tasks (Jobs). For the printed scheduled periodic rules, the program will automatically check for the existence of courses that start within two hours of starting it, and then it will create a Wireguard VPN client for all students who have obligations according to the schedule during this time. At the same time, all expired Wireguard clients will be deleted at each execution. We can upload a file with all the periodic tasks to our computer and have an even better overview of them.

**Info o periodičnih opravilih**

Za spodaj izpisana načrtovana periodična pravila bo program avtomatsko preveril obstoj predmetov, ki se začnejo v roku dveh ur od trenutka zagona le-tega, nato pa bo za vse studente, ki imajo po umiku v tem času obveznosti kreiral klientsa za Wireguard VPN.

Istovčasno pa se bodo ob vsaki izvedbi pobrisali vsi že pretečeni wireguard klientsi.

Owner	Job Name	Job Style	Job Creator	Client Id	Job Type	Job Action	Schedule Type	Start Date	Repeat Interval	
WKSP_PIS2021	AVTOKONFCTRTJBLOK	REGULAR	APEX_PUBLIC_USER	NEJC.CELJK@STUDENT.UM.SI111679248087857	PLSQL_BLOCK	begin wg_konfiguracija.avtoKonfiguracija(); end;	CALENDAR	4/20/2021	freq=daily; byhour=16; byminute=50; bysecond=0;	T
WKSP_PIS2021	AVTOKONFDRUGJBLOK	REGULAR	APEX_PUBLIC_USER	NEJC.CELJK@STUDENT.UM.SI111679248087857	PLSQL_BLOCK	begin wg_konfiguracija.avtoKonfiguracija(); end;	CALENDAR	4/20/2021	freq=daily; byhour=10; byminute=05; bysecond=0;	T
WKSP_PIS2021	AVTOKONFPRVJBLOK	REGULAR	APEX_PUBLIC_USER	NEJC.CELJK@STUDENT.UM.SI1268159939176	PLSQL_BLOCK	begin wg_konfiguracija.avtoKonfiguracija(); end;	CALENDAR	3/31/2021	freq=daily; byhour=7; byminute=50; bysecond=0;	T
WKSP_PIS2021	AVTOKONFTRETJBLOK	REGULAR	APEX_PUBLIC_USER	NEJC.CELJK@STUDENT.UM.SI111679248087857	PLSQL_BLOCK	begin wg_konfiguracija.avtoKonfiguracija(); end;	CALENDAR	4/20/2021	freq=daily; byhour=14; byminute=05; bysecond=0;	T

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Figure 16: Information on periodic tasks

## 5 Conclusion

In the project of building an information system, we successfully created an application with the Oracle Apex tool. The application for students offers quick and easy access to a configuration file in which they get data to create a secure Wireguard VPN connection to the network of the Faculty of Organizational Sciences. Professors and others with granted access also have other functions available. They can create, delete and add users, appointments and groups and have an overview of the entire system. By creating this application, we learned about working in groups on a real project. We cooperated with the client, negotiated and tried to satisfy his requirements as much as possible. The end result is an application that suits the client and is satisfied with its operation.