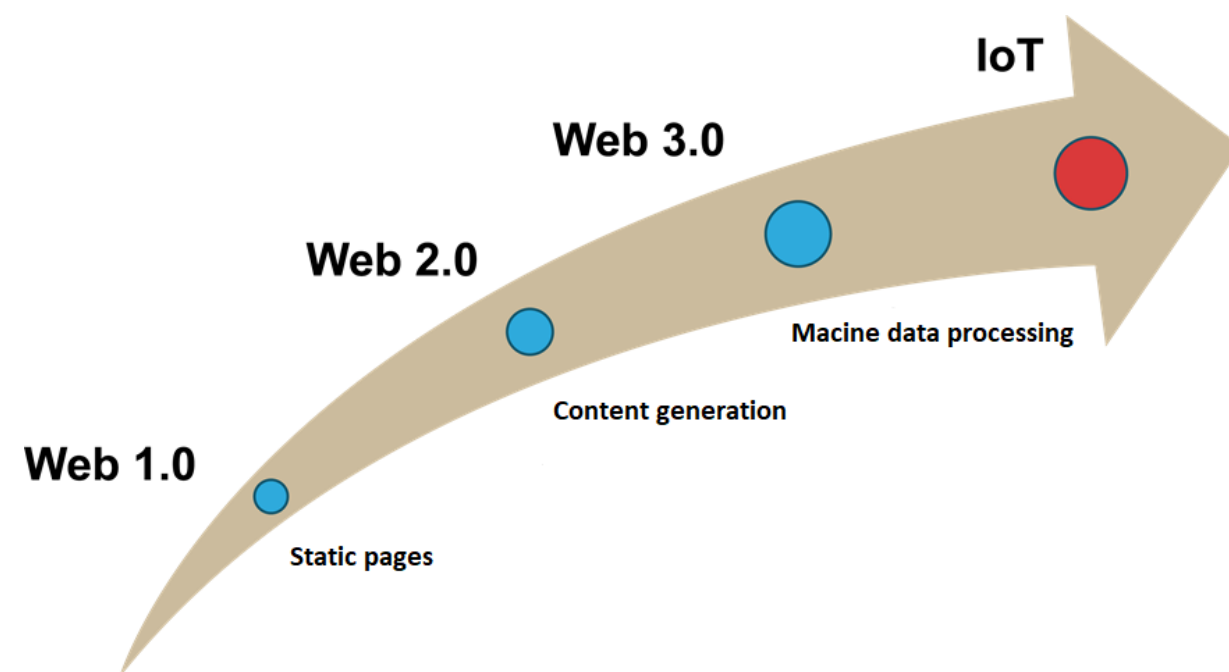


# AUTOMATIC CONTROL SYSTEM “SMART INTERCOM”

**The Internet of things (IoT)** is the network of physical devices, vehicles, home appliances and other items embedded with electronics, software, sensors, actuators, and network connectivity which enables these objects to connect and exchange data.

**Home automation systems** - systems capable to perform actions and solve certain everyday tasks without human involvement.



## Using developed system user is able to:

- Lock/unlock the door over internet
- Lock/unlock the door using his smartphone
- Communicate with his visitors form any point of the planet
- Issue the guest a temporary personal pass with limited life time
- Conduct audit and statistics of visitors.

## Requirements to the system:

- System should be distributed
- System should have terminal device with user friendly interface
- System should have user friendly mobile application
- Cloud technologies should be used for server side development and deployment
- Cross platform technologies should be used for mobile application development

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					Automatic control system “Smart intercom”	Лист.	Масса	Масштаб	
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						ХАІ зр. 362М			
Н. Контр.		Дергачов К.Ю.							

EXISTING SOLUTIONS

Functionality of existing solutions overview

Criteria	Variants			
	Xiaomi MI Smart Home Suite	Ring Video Doorbell	Saful Intercom System	Developed system
Mobile application	+	+	+	+
Remote lock/unlock	-	-	-	+
Video conferencing	+	+	+	+
Access via internet	+	-	+	+
Guest pass	-	-	-	+
Access without smartphone	-	+	+	+
Smart home integration	+	+	-	+
Audit of events	-	-	-	+
Decentralized structure	+	-	-	+

Ring Video Doorbell



Saful Intercom System

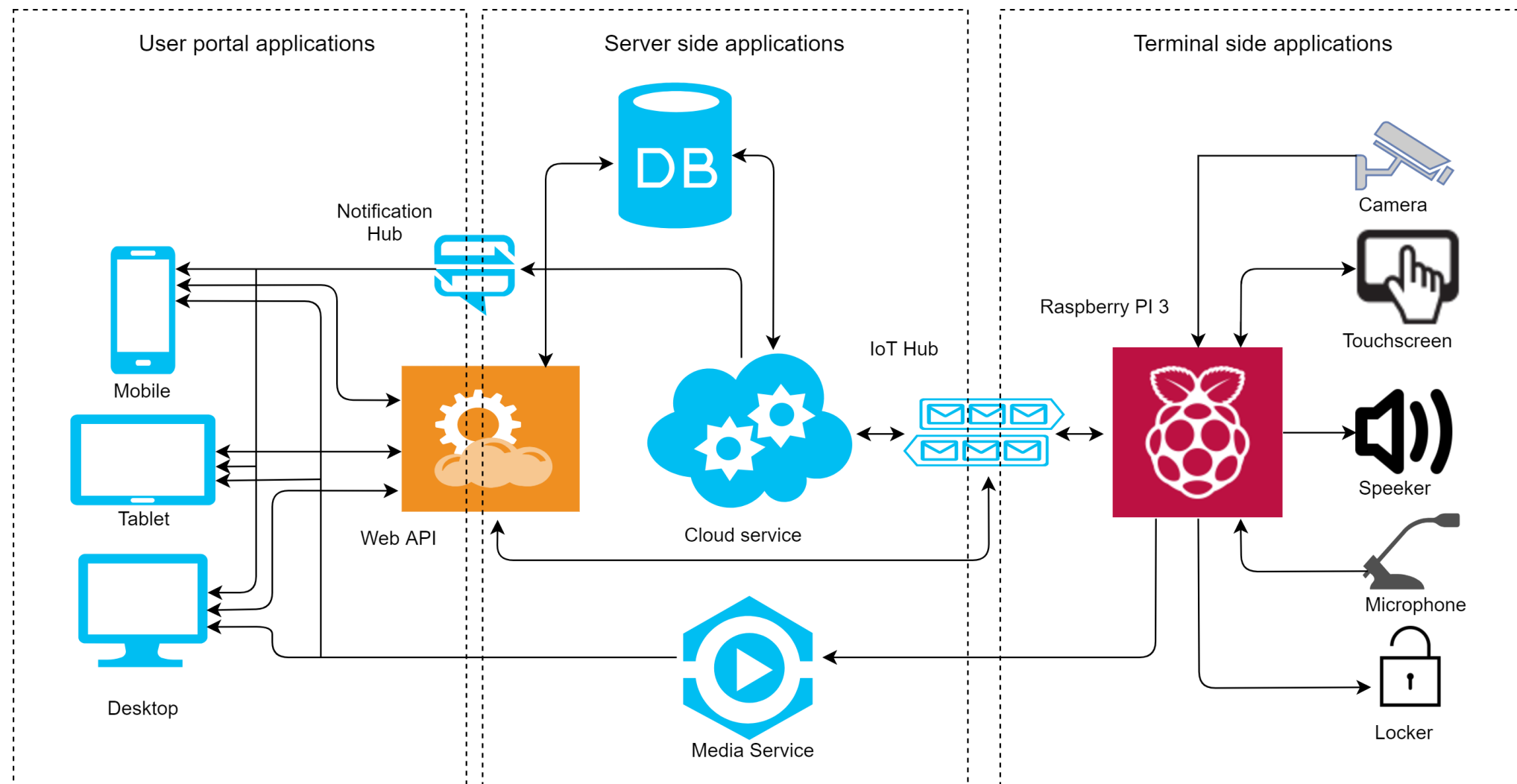


Xiaomi MI Smart Home Suite

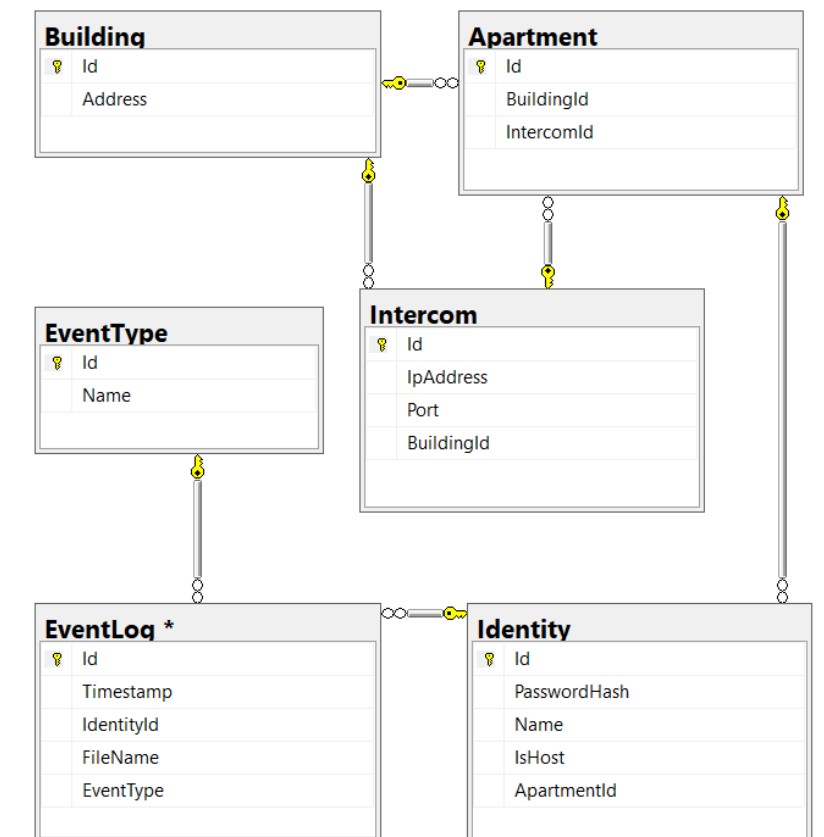


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					Existing solution	Лист.		Масса	Масштаб
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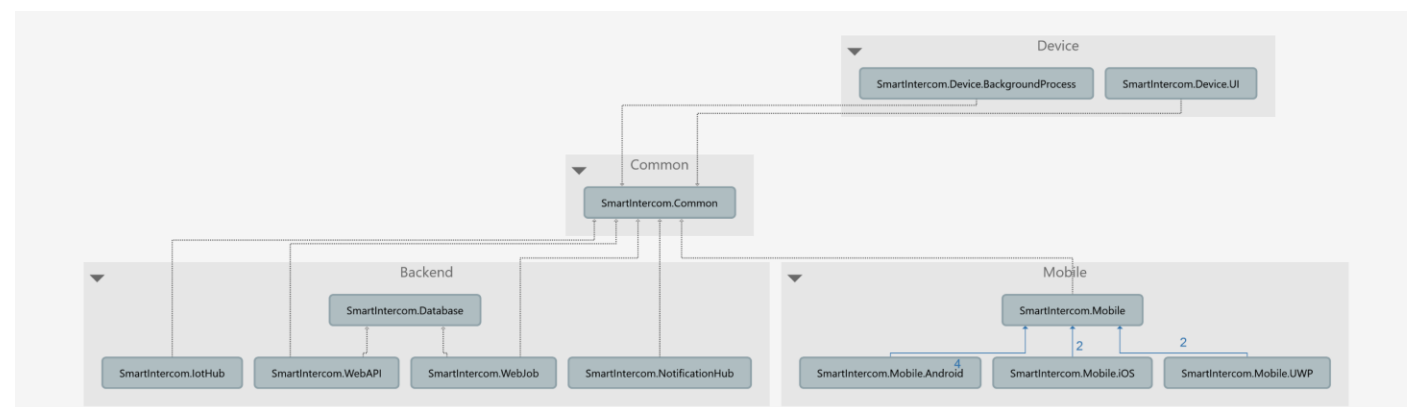
# SYSTEM STRUCTURE



## Database structure diagram



## Solution structure diagram



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# USED TECHNOLOGIES

## Requirements to technologies

- IoT development support
- Cloud development support
- Mobile development support
- Test automation support
- Common programming language
- Free for non commercial usage

## Technological base

- C# programming language
- .Net Framework 4.6.2
- Windows 10 IoT Core
- Microsoft Azure
- NUnit

## Windows 10 IoT Core

- X86 and ARM architectures support
- Raspberry Pi 3 support
- Low hardware requirements
- Drivers
- Microsoft .NET Framework, C#
- Universal Windows Platform
- Remote control
- Remote debugging
- Convenient control panel
- Free for noncommercial usage

## Microsoft Azure

- Azure App Services
- Azure Mobile Services
- Azure WebJob
- Azure IoT Hub
- Azure Notification Hub
- Azure SQL Database service
- Azure Api Management
- Azure Media Services

## Development environment

- Microsoft Windows 10 operation system
- Microsoft .Net Framework 4.6
- Microsoft Visual Studio 2017
- JetBrains ReSharper 10
- Windows 10 SDK
- Mobile development SDK
- Mobile Emulator
- Microsoft SQL Server Express
- Microsoft SQL Server Management Studio
- Microsoft Azure Subscription
- Git for Windows
- IoT Dashboard
- IoT Remote Client



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					Used technologies	Лист.	Масса	Масштаб	
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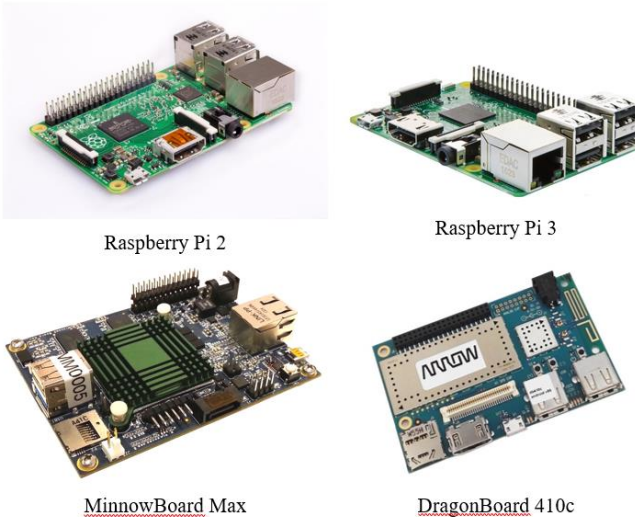


MEANS OF IMPLEMENTATION

Requirements to hardware

- Windows 10 IoT Core support
- CPU 1000 MHz
- 1 GB memory
- 3 USB ports
- Ethernet, Wi-Fi adapters
- GPU
- 3.5 mm audio jack
- 8 GB storage memory
- GPIO
- Touch screen
- Camera 1024 X 768

Compared single board computers



	Raspberry Pi 2	Raspberry Pi 3	MinnowBoard Max	DragonBoard 410c
CPU	900MHz Quad-Core ARM Cortex A7	1.2GHz Quad-Core ARM Cortex A53	1.3GHz x86/x64	1.2GHz Quad-Core ARM Cortex A53
Memory	1GB	1GB	2 GB	1GB
GPU	Broadcom Video Core IV @ 250MHz (no DirectX or Hardware Acceleration support)	Broadcom Video Core IV @ 400MHz (no DirectX or Hardware Acceleration support)	Intel HD Graphics	Qualcomm Adreno 306 @ 400MHz (only 720p / 1280 x 720 supported)
USB	4x USB 2.0	4x USB 2.0	1x USB 2.0, 1x USB 3.0	2x USB 2.0
Network	10/100/1000 MBit/s Ethernet	Wi-Fi 802.11 b/g/n Ethernet, Bluetooth 4.1	10/100/1000 MBit/s Ethernet	Wi-Fi 802.11 a/b/g/n, Bluetooth 4.1
Video Output	HDMI, DSI	HDMI, DSI	Micro HDMI	HDMI, DSI
Audio Output	Analog via 3.5 mm jack	Analog via 3.5 mm jack	Digital via HDMI	Digital via HDMI
Peripheral	24x GPIO pins 1x Serial UART 2x SPI bus 1x I2C bus	24x GPIO pins 1x SerialUART 2x SPI bus 1x I2C bus	10x GPIO pins 2x Serial UARTs 1x SPI bus 1x I2C bus	11x GPIO pins 2x Serial UARTs 1x SPI bus 2x I2C bus

Waveshare 5inch HDMI LCD



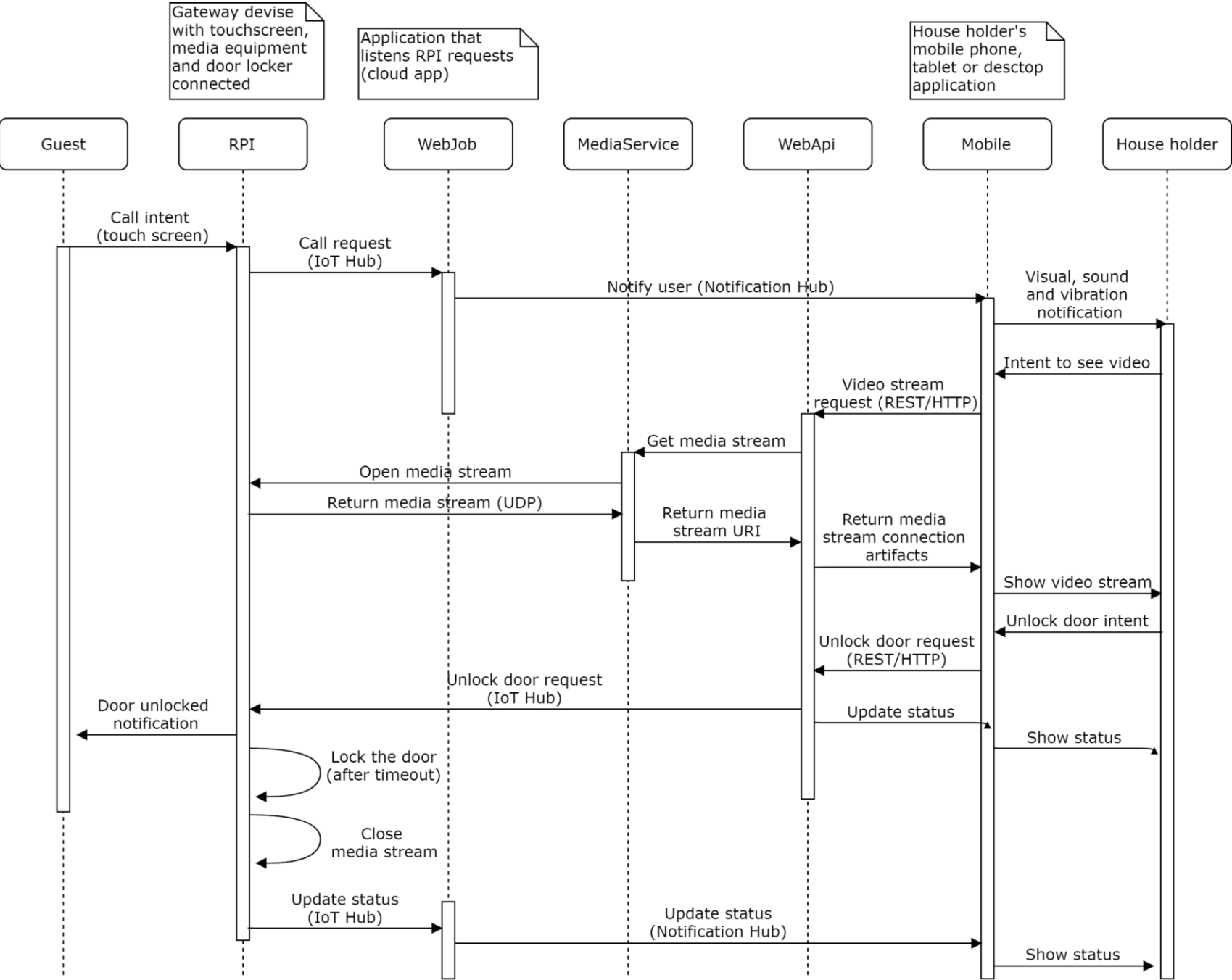
Microsoft Lifecam HD-3000



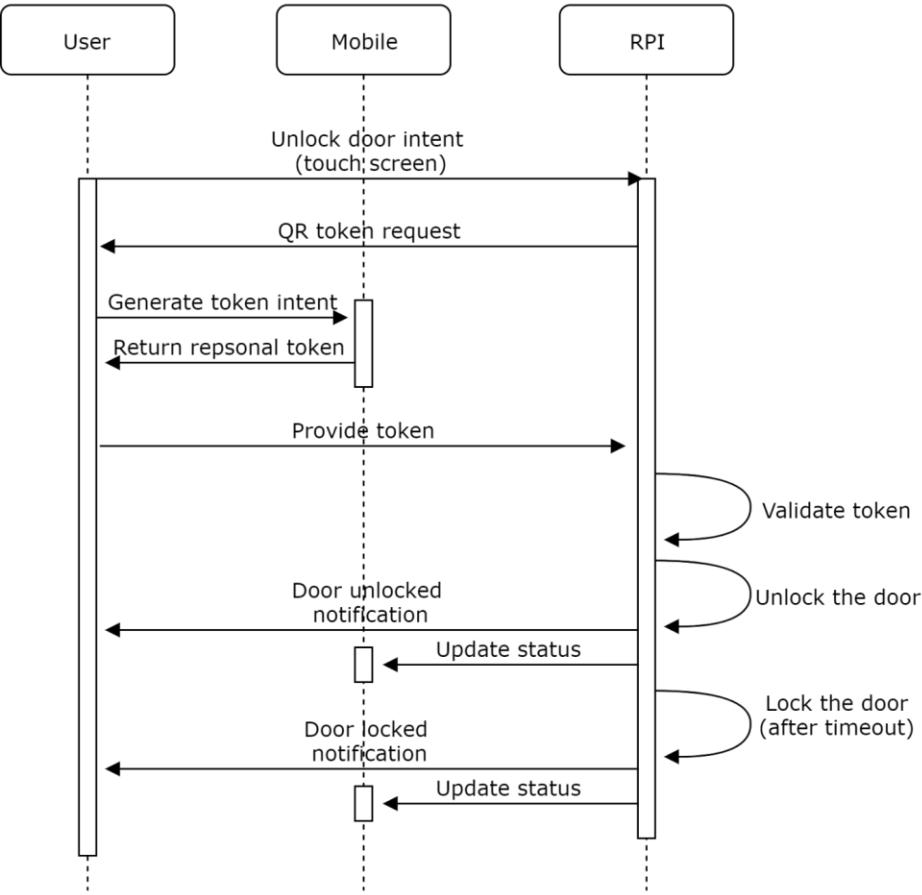
					ДР.362М.8.151				
					Means of implementation	Лист.		Масса	Масштаб
Изм.	Лист	№ докум	Підпис	Дата			у		
Розроб.		Гончар Ю.О.							
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ALGORITHMS AND DIAGRAMS

The sequence diagram of the system “Smart intercom” main workflow



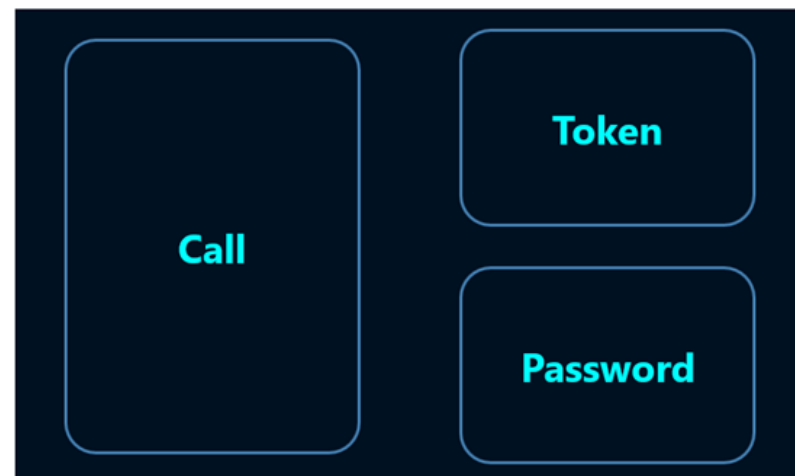
The sequence diagram of the system token authorization workflow



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					Algorithms and diagrams					
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Розроб.		Гончар Ю.О.								
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					Лист 6		Листів 10			
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# SIMULATION RESULTS

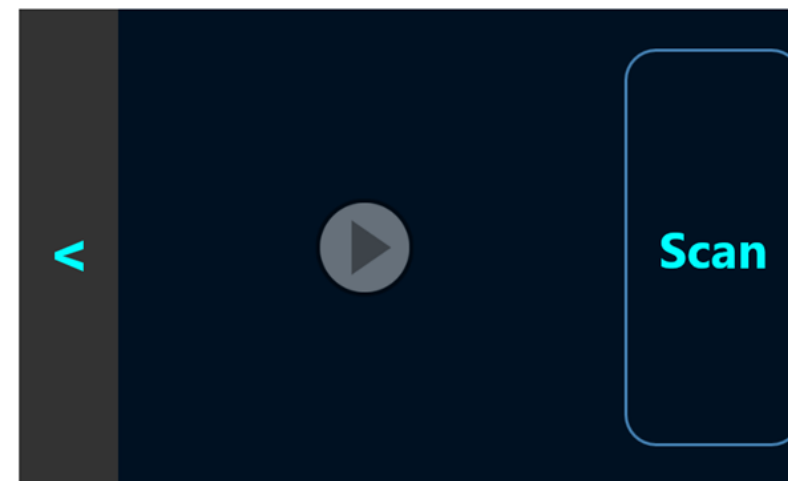
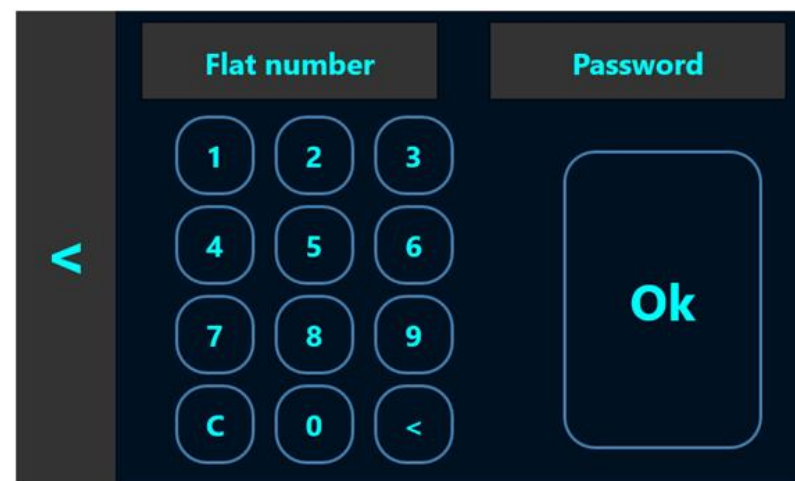
The Main page of the terminal application



The Call intent page of the terminal application



The Password authorization page of the terminal application The Token authorization page of the terminal application



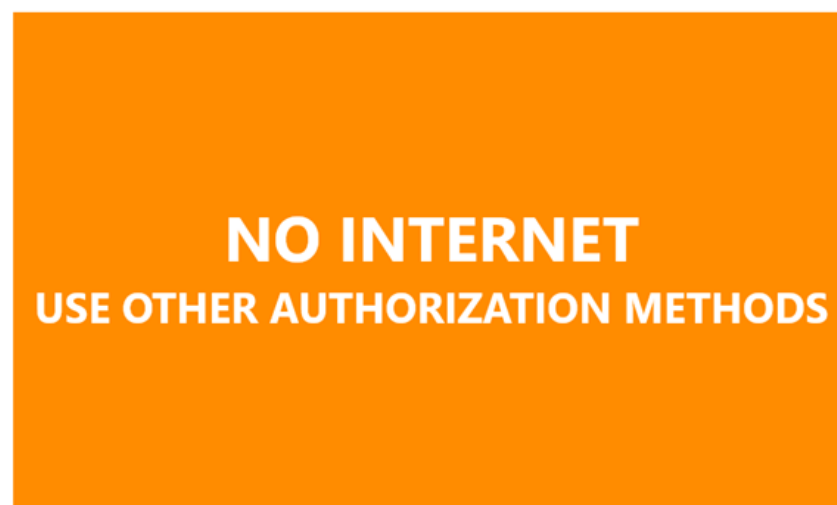
## Simulation purposes

- Allows to speed up development
- Allows to debug during development
- Simplifies UI design
- Reduces costs spent for environment rent
- Allows to automate testing
- Simplifies UI testing
- Reduces amount of deployment errors
- Increases development convenience

## Simulation instruments

- Software development kit
- Environment emulator
- Debugging engine
- Test automation engine

The Connection failure notification page of the terminal application



					ДР.362М.8.151				
					Simulation results	Лист.	Масса	Масштаб	
Изм.	Лист	№ докум	Підпис	Дата			у		
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# TESTING RESULTS

## Tests groups

### By the test object:

- 1) functional testing;
- 2) performance / load / stress testing;
- 3) usability testing;
- 4) user interface testing (UI testing);
- 5) security testing;
- 6) localization testing;
- 7) compatibility testing.

### By degree of isolation:

- 1) unit testing;
- 2) integration testing;
- 3) system testing.

### By the level of readiness

- 1) alpha testing;
- 2) beta testing;
- 3) acceptance testing.

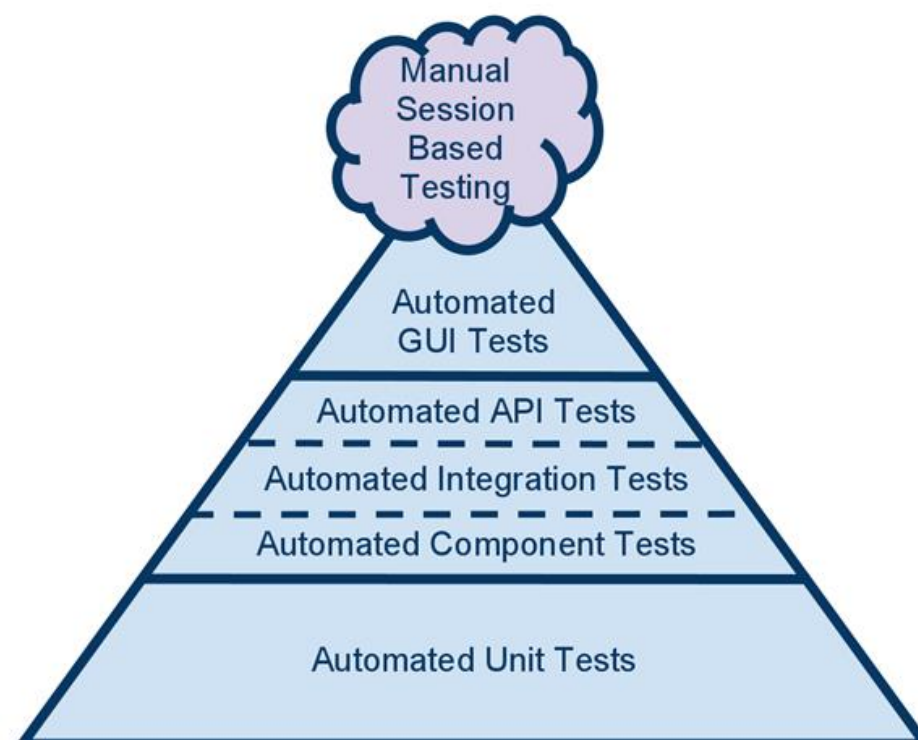
### By the level of automation:

- 1) manual testing;
- 2) automated testing.

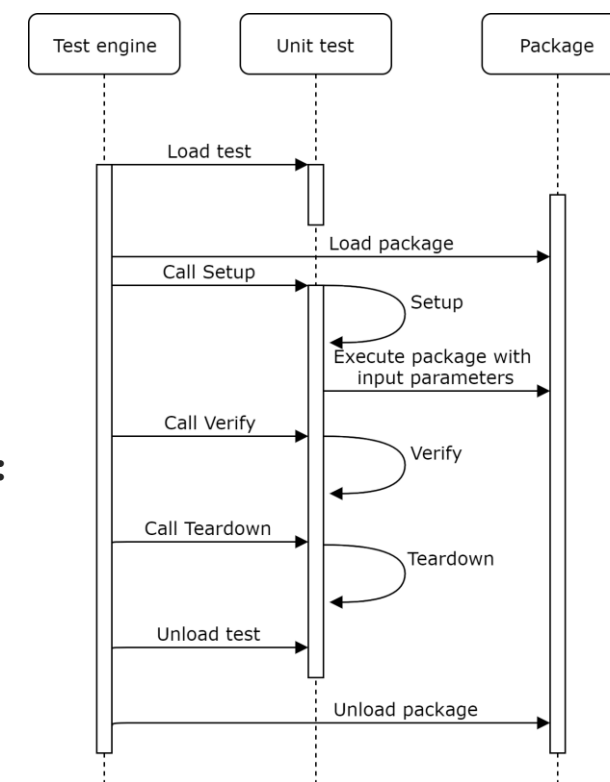
### By knowledge about the system under test:

- 1) black box testing;
- 2) white box testing;
- 3) testing by the "gray box" method.

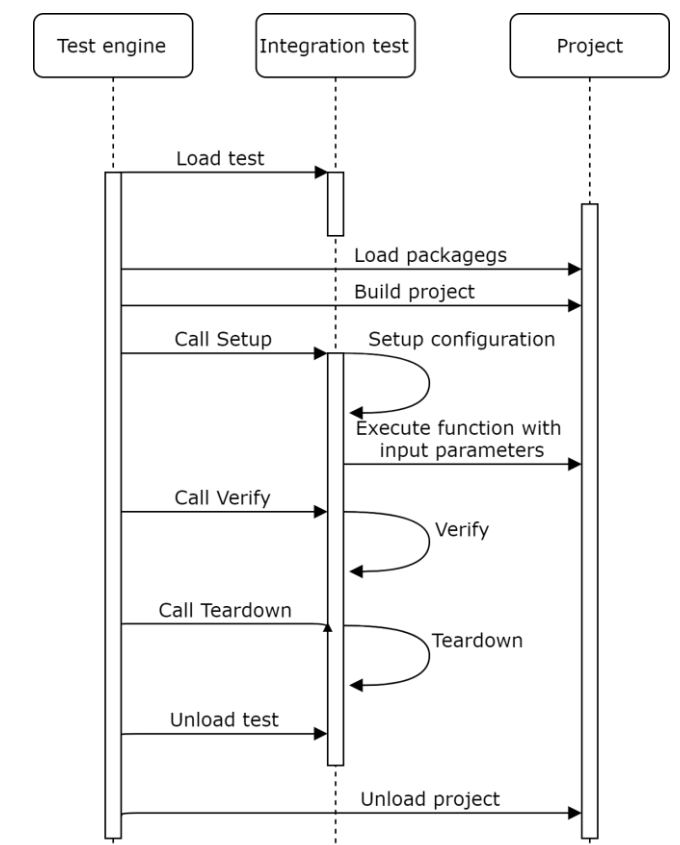
## Software testing automation pyramid



## Unit testing sequence diagram



## Integration testing sequence diagram



The system test suite consists of **154 unit tests**, **43 integration tests** **24 user interface test** and suite for acceptance testing. By the moment of writing this paper all tests were executed successfully.

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					Testing results				
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Лист 8

Листів 10



EXPERIMENTAL RESULTS

The Main page of the terminal application

Camera

Raspberry Pi 3



Touch screen

The Call intent page of the terminal application



The Password authorization page of the terminal application



The Door is opened notification page of the terminal application



The Door is opened notification page of the terminal application



The Token authorization page of the terminal application



The Connection failure notification page of the terminal application



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# ECONOMICAL JUSTIFICATION FOR THE SYSTEM DEVELOPMENT

Calculation of production costs and product prices by item

№	Topics	Amount, UAH	Description
1	Materials and bought products	2440	From table 6.3
2	Wage	133991.81	
3	Additional wage	20098.77	15% from wage
4	Deductions to social funds	33899.93	22% from wage and additional wage
5	Amortization	139.65	$\frac{25\% \cdot p \cdot 54}{12 \cdot 22}$
6	Shop management costs	13399.18	$P_{\text{yц}} = \text{WAGE} \cdot \frac{H_{\text{SM}}}{100}$
7	General plant costs	26798.36	$P_{\text{wage}} = \text{WAGE} \cdot \frac{H_{\text{wage}}}{100}$
8	Cost price (C)	230767.7	p.1+....+p.7
9	Profit (P)	46153,54	20% from C
10	Price without VAT	276921,24	P+C
11	VAT	55384.25	20% from price without VAT
12	Price with VAT	332305.5	p.10+p.11

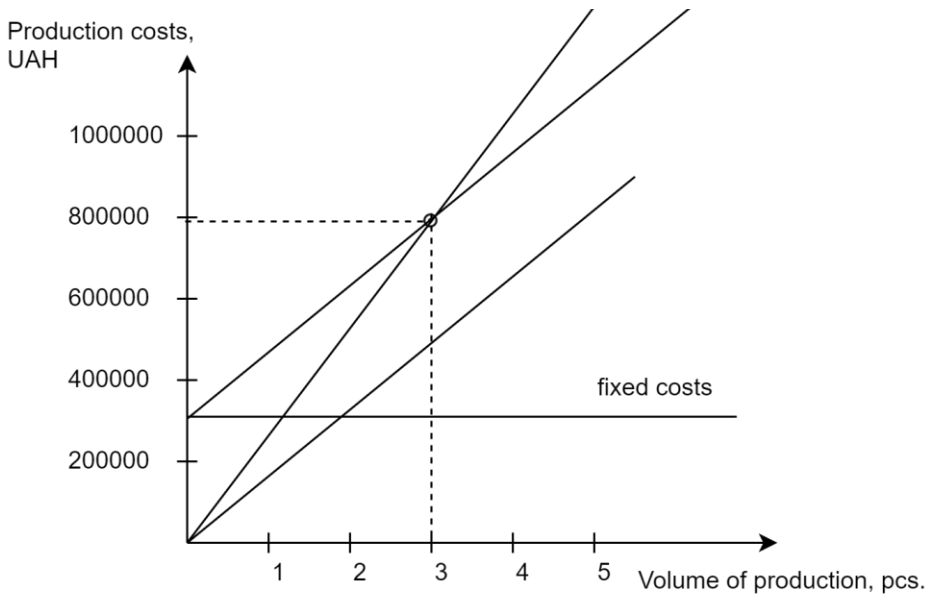
Composition of work

Positions	Official salaries, UAH	
	Month	Day
Lead software engineer	40000	1818.18
Software engineer	25000	1136.36
Software testing engineer	15000	618.82
Systems engineer	20000	909.09

The list of bought products

Name of product	Technical designation	Quantity of products in a system	Unit price, UAH	Amount UAH
1	2	3	4	5
Single board computer	Raspberry Pi 3	1	1000	1000
Touch screen	Waveshare 5 inch LDC	1	1300	1300
HDMI cable	HDMI	1	70	70
USB cable	USB	2	35	70
Total				2440

Break-even point figure



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					Economical justification for the system development	Лит.	Масса	Масштаб
Изм.	Лист	№ докум	Подпис	Дата		у		
Розроб.		Гончар Ю.О.						
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