LEADERS OF DIGITAL TRANSFORMATION

Department of transport and development of road transport infrastructure of Moscow City

Moscow Metro

TECHNICAL SPECIFICATION

TASK 08

A service for monitoring and adaptive distribution of requests for serving from passengers with limited mobility

1. Relevance of the Task

Since 2014, the Passenger Mobility Support Center of the Moscow Metro State Unitary Enterprise has processed over 1.5 million requests for assistance within the metro and at social facilities across Moscow. With the increasing daily volume of these assistance requests, there is a pressing need to enhance the logistics planning between these requests.

Requests are currently taken over the phone by operators and entered into the database. Currently, these requests are manually distributed among employees.

An automated system for managing requests to assist passengers with reduced mobility will optimize the process of acceptance, distribution, and monitoring of these requests. This will increase the efficiency of staff operations and enable more timely responses to changes in the flow of requests.

The target audience includes operators, staff involved in assisting passengers with reduced mobility, as well as managers and administrators responsible for managing requests and monitoring task completion. Additionally, the system could be beneficial for analysts and planners working with data on requests and completed tasks.

2. Description of the Task

Develop a service that will:

- Accept requests from operators;
- Pre-distribute them optimally among employees for the specified day;
- Track the completion of requests in real-time;
- Adaptively adjust schedules in real-time to changing conditions (schedule disruptions) and "reassign" employees to fulfill requests.

The center supports the following categories of passengers:

- (ИЗ) – Visually impaired (total, assistance within the metro)
- (ИС) – Partially visually impaired (low vision, assistance within the metro)
- (ИС) – Hearing impaired (mainly assistance in orientation)
- (ИК) – Wheelchair users (movement in a wheelchair)
- ИО) – Mobility impaired (assistance with movement and/or on stairs/escalators)
- (ДИ) – Children with disabilities (often moving in a wheelchair)

- (ПЛ) – Elderly (assistance with movement and/or on stairs/escalators)
- (РД) – Parents with children (child assistance)
- (РДК) – Parents with strollers (help with a stroller)
- (ОГД) – Organized groups of children (assistance within the metro)
- (ОВ) – Temporarily mobility impaired (post-operation, fractures, etc.)
- (ИУ) – People with mental disabilities

The center has sections within the metro system (each employee assigned to a specific section, with their immediate supervisor in that section):
(ЦУ)-1, ЦУ-2, ЦУ-3, ЦУ-3(Н), ЦУ-4, ЦУ-4(Н), ЦУ-5, ЦУ-8
Employee work hours in sections:
7:00 - 19:00, 8:00 - 20:00 – ЦУ-1, ЦУ-2, ЦУ-8
7:00 - 19:00, 8:00 - 20:00, 10:00 - 22:00 – ЦУ-3, ЦУ-4, ЦУ-5
20:00 - 8:00 – ЦУ-3(Н), ЦУ-4(Н)

3. User Flow

The interface may consist of 7 forms.

Main Screen - where all requests are displayed. Administrators, specialists, and operators can view and make changes to all requests.

Passenger Screen - passenger information and the ability to edit it. Accessible to administrators, specialists, and operators.

Request Screen - information about the request. Full access for administrators, specialists, and operators for viewing and editing. Limited access for accompanying staff; they can view information and change the status to Accepted; Inspector Departed; Inspector On Site; Trip; Request Completed; Passenger Delayed; Inspector Delayed.

Employee Workday Registration Screen - list of added employees, information about their work, and making changes. Full access for administrators, specialists, and operators for viewing and editing.

Request Distribution Screen - visually displays requests on a graph with movements between requests, allowing selection and making changes by clicking on the selected request. Accessible to administrators, specialists, and operators.

User Registration Screen - user registration and role assignment. Accessible to administrators and specialists.

Employee Registration Screen - registration, modification, and role assignment for employees, accessible to administrators and specialists. List of positions: administrator, specialist, section chief (hereinafter - ЦУ), senior

inspector (hereinafter - ЦСИ), operator (hereinafter - ЦИО), inspector (hereinafter - ЦИ).

Operator Path:

The operator navigates to the main page of the system.

If a request is being made for a new passenger:
The operator clicks on the "New Passenger" button.
Fills in the necessary information in the passenger form.
Clicks the "Save" button.
Then clicks the "Create New Request" button.
Fills in the necessary information in the request form.
Clicks the "Send" button.
A list of generated requests appears on the main screen.

If a request is being made for a previously entered passenger:
The operator finds the passenger via search on the main screen.
Then clicks the "Create New Request" button.
Fills in the necessary information in the request form.
Clicks the "Send" button.
A list of generated requests appears on the main screen.

Escort Staff Path:
The staff member logs into their account.
Opens the list of their requests (main screen, mobile version).
Views the current status of each request (filters only for their requests).
When changing their status, selects the status in the system and clicks the "Send" button.

Specialist Path:
The specialist navigates to the request distribution screen.
Clicks on the "Distribution" button.
After distributing requests for the entire day, they can adjust requests for employees (reassign to others or cancel) and clicks the "Confirm" button.
Requests are assigned to employees.
If real-time calculation of requests is needed considering changes, the specialist clicks on the "Adaptive Distribution" button.

4. Solution Requirements

Implementation should utilize a web service due to its adaptability to potential changes.

User Requirements:

What the user can do with the service

- **Passenger Registration:**

Registering a passenger.

We enter the passenger into the database and store the history of requests for this passenger.

- **Request Registration:**

Requesting assistance registration form. All essential parameters are entered for calculating how much time and how many employees will be needed for assistance.

- **Passenger Search:**

Search should be performed by passenger's full name or phone number.

- **Request Search:**

Search can be conducted by unique request identification number (ID), date, time, station (destination/arrival), request category, passenger's full name, request status, inspector's section assigned to the request, inspector's full name assigned to the request.

- **Monitoring of Requests for the Current Day:**

Main operator window. Displays a list of requests for the current day for monitoring their execution.

When clicking on a request, it should display all the request data and passenger data, as well as provide access to modify them.

- **Employee Registration:**

Each Center employee is registered with employee information, and a user role is assigned to them.

- **Employee Workday Registration:**

Entering information about the employee's start and end times of work. This information is necessary to determine the number of employees who have started their shift.

Employee workday registration can be performed by a user with any of the following roles: operator, specialist, administrator.

- Administrator:

Deleting requests, passengers, employees. Full user functionality.

- *Specialist:*

Registering and modifying employees, automatic distribution of requests among employees. All possible operator actions.

- *Operator:*

Creating and editing new passengers, requests, employee workdays. Viewing and searching all requests. Viewing change history.

- *Employee:*

Displaying request information.

Functional Requirements:

- Authentication and authorization of users must be implemented.
- Saving user change history.

Monitoring of requests for the current day.

It should display a list of requests in the form of a table and a filter component for searching by requests and passengers.

Automatic distribution of requests among employees.

Planned distribution of all requests for the day and adaptive adjustment of requests to changing conditions (change in request time, passenger delay, change in the number of required employees, starting or ending stations of the request, disruption of normal metro operation).

Visually, the component can be presented in the form of a timetable, showing the movements of employees.

The script takes data of employees who have started work for the day and requests for the day.

The main work of the script is based on calculating travel time on the metro.

Male employees can accompany all categories of passengers.

Main calculation conditions:

1. The request specifies the number of employees allocated to accompany the passenger. The number of men and women specified in the request should be taken into account, with priority given to having them from the same section (if possible). Compliance with the conditions indicated by male or female employees in the request must be met.

2. The priority for calculating employees is first all ЦИ, remaining requests after calculation can be assigned to ЦСИ.

3. After calculations, if there are requests for women remaining, a re-calculation of available men for the remaining requests is made, without considering the condition that there must be a female employee on the request.

4. The employee must arrive at the station no later than 15 minutes before the start time of the request.

5. Passenger waiting time (if they are late) is 10 minutes.

6. The time for accompanying categories of ИК, ДИ, ИО, ПЛ, ОВ may be increased by 5 minutes for each transfer.

7. Priority to reduce travel time between requests.

8. Requests between employees and sections should be distributed as evenly as possible.

9. Employees need to be provided with a 60-minute lunch break between requests. Lunch no earlier than 3.5 hours after the start of the workday and ending no later than 1 hour before the end of the workday.

10. The request cannot end after the end of the employee's workday.

11. Maximum priority for completing the maximum number of requests.

12. If there are any undistributed requests, the system should provide the most optimal choice for rescheduling the request time to fulfill it (after which the operator calls the passenger back and offers options for rescheduling the time. This is a last resort).

The service must have functionality for planned distribution of requests:
Requests are generated for the day. The end time of the request should not exceed the employee's working hours.
A preliminary calculation of requests for the following day is made, taking into account the working hours of employees and breaks. Pre-calculated requests are mandatory and cannot be excluded from calculation after adaptive request adjustment.

Adaptive request adjustment:
After planned distribution of requests, adaptive distribution can be selected.
Possible reasons for the need to use adaptive request adjustment:

- New request for the nearest time/day
- Employee absence (their requests are transferred to others).
- Request cancellation (gaps appear between requests)
- Passenger delay.
- Train delays (disruption of the subway train schedule).
- Increased request execution time (the request was completed later than calculated, it is necessary to check if it will be on time for the next request).
- Employee delay (when the employee is unable to make it to the request on time)

Non-functional Requirements:

The service must contain registration forms as provided in Appendix 1.
List of positions: administrator, specialist, section chief (further referred to as ЦУ), senior inspector (further referred to as ЦСИ), operator (further referred to as ЦИО), inspector (further referred to as ЦИ).
Interface Requirements:

- Interfaces for displaying all requests on the main screen, request distribution screen, and displaying the list of employees should work asynchronously, updating in real-time, enabling multiple people to work with the same list of requests and employees.
- In interfaces where data of a specific passenger, request, or employee are modified, if another employee already has this request open for editing, a warning should be issued (e.g., in the form of a pop-up window).
- The interface should fit on one screen with a resolution of 1920 by 1080.
- For interfaces used by employees, an adaptive mode should be implemented for use on mobile devices (a list of viewing their requests, and a form for viewing full data on a request, where the employee only needs to change the status).

System Requirements:

- The web service must provide a RESTful API for interaction with users.
- The API should support CRUD operations (Create, Read, Update, Delete) for the main entities of the system.
- The web service must ensure adequate error management and return appropriate HTTP statuses.

Security:

- All data exchanges between the client and server must occur over HTTPS protocol to ensure secure data transmission.
- Implementation of user authentication and authorization mechanisms using access tokens (e.g., JWT).
- Protection against major attacks such as XSS, CSRF, and SQL injections.

Performance:

- The web service must be optimized for high performance and quick response to requests.

Stack Requirements:
Programming language: at the developer's discretion.
Framework: a popular framework with easy support at the developer's discretion.
Database: relational databases such as PostgreSQL or MySQL, if another database is chosen, the decision must be justified in the documentation.

5. Presentation Requirements

Mandatory Slides:

Title Slide:

- Project Title.
- Logo (if available).
- Date and location of presentation.

Introduction:

- Brief description of the project's goal and objectives.
- Overview of key features of the web service.

Problem and Solution:

- Explanation of the problem the web service solves.
- Description of how the proposed solution helps solve this problem.

Functionality:

- Overview of the main functions and capabilities of the web service.
- Demonstration of the user interface (screenshots or video).

Technologies:

- Technologies and tools used in the development of the web service.
- Description of the main components of the architecture.

Advantages:

- Overview of the main advantages of using this web service.
- Support with examples or statistics, if available.

Contacts:

- Contact information for the development team.
- Links to the project's website and social media.

The presentation should be created in PDF or PPTX formats and sent to the client for review and use in the project presentation.

6. Documentation Requirements

Introduction:

- Overview of the main components and functionality of the web service.

Hardware and Software Requirements:

- List of hardware and software requirements for successful deployment and use of the web service.
- Instructions for installing and configuring the necessary software.

System Architecture:

- Overview of the web service architecture, including the technologies used, components, and their interactions.
- Diagrams explaining the structure and data flow within the system.

Deployment Instructions:

- Detailed steps for installing and configuring the web service on a server.
- Database configuration, environment setup, and application launch.

Usage Instructions:

- Description of available API methods and their parameters.
- Examples of requests and expected responses.
- Authentication and authorization instructions.

Clarifications Required from Participants:

Developers:

- Detailed explanations of architectural solutions and technologies used.
- Deployment and usage instructions for the components they developed.

Format and Distribution of Documentation:

The accompanying documentation is provided in DOCX or PDF formats and is sent to the client and all project participants for review and use according to their roles and responsibilities.

7. Data Sources

Real-time Requests and Employees Data

Data Format: JSON

Description: This data provides information on requests and employees collected over a 24-hour period. It includes details about the requests as well as data on the employees related to the execution of these requests. Request data contains information about the request itself, along with its execution and editing history. Employee data includes the date and time of the employee's shift during this 24-hour period.

Metro Station Travel Time and Transfers Data
Data Format: JSON
Description: These data are necessary for creating an algorithm for routing within the system. They contain information about the time required to travel between different metro stations and possible transfer points between metro lines. This information will optimize routes for users, taking into account factors such as travel time and the number of transfers. The provided data will be used for analysis, processing, and providing information to users through the web service. They are a key component of the system's functionality and will ensure its efficient operation.

8. Submission Requirements

Approved submission points on the platform:

Code:

- The full source code of the web service must be submitted on the platform in a repository with a corresponding description of the project structure and instructions for installation and execution.

Prototype:

- If a prototype or interface mockup exists, it must be provided in a format that allows viewing and interacting with interface elements (e.g., a link to an online prototype or Adobe XD, Figma files, etc.).

Documentation:

- Detailed technical description of the project, including architectural solutions, technologies used, description of key components, as well as setup and management instructions for the web service.
- API documentation (if applicable), describing available methods and request-response formats.
- Testing report, including functional and integration testing results.

Presentation:

- Project presentation in PDF or PPTX format according to the requirements specified in section 5. Presentation Requirements.
- The presentation should provide an overview of the main features and functions of the web service, as well as its advantages and potential for development.

9. Evaluation Criteria

Approved evaluation criteria by the organizers:

1. Solution Effectiveness within the Given Task

- Completion of the maximum number of requests with the current staff.
- Correct operation of the service: evaluation is based on testing of core functions and error checking.
- Ability to expand the algorithm's logic, enhance program functionalities, and add additional conditions for calculation.
- Distribution of workload among employees (ideally, an average number of requests for all).
- Algorithm computation speed.
- Compliance of the program with the technical specification.

2. Technical Elaboration of the Solution

- Level of threat protection: Assessment of data transmission security level, protection against attacks, and compliance with security standards.

- User input processing: Evaluation of mechanisms to prevent attacks such as injections and XSS.

- Response speed: Evaluation of the time required to load pages and execute requests.

- Resource efficiency: Evaluation of server and client resource usage, minimizing delays and memory consumption.

3. Alignment of the Solution with the Given Task

- User Experience (UX): Assessment of interface usability, navigation intuitiveness, and clarity of presented information.

- Completeness of functional requirements implementation: Evaluation is based on how fully and accurately functional capabilities specified in the technical specification are implemented.

4. Team Approach to Problem Solving

- Visual Design (UI): Evaluation of the aesthetic design of the interface, its alignment with the project's goals, and meeting the expectations of the target audience.

- Completeness and Structuring: Assessment of the presence and quality of documentation describing the installation, configuration, usage, and maintenance of the web service.

- Clarity and Understandability: Evaluation of the accessibility and clarity of the provided documentation for developers and end-users.

5. Team Performance at the Pitch Session (only for the final evaluation)

- Presentation Quality: Assessment of the informativeness, structure, and persuasiveness of the project presentation.

- Completeness of Presented Materials: Evaluation of the presence of all required documents and prototypes, their relevance, and compliance with the specified formats.

Appendix 1

Fields Contained in Registration Forms

1. **Passenger Registration:**

Passenger's Full Name,
Contact Phone Numbers (with the ability to add descriptions),
Passenger's Gender,
Passenger Category,
Additional Information (a note for the passenger to improve the quality of service for a specific passenger),
Selection of the presence of an AED (Automated External Defibrillator). (Yes/No)

2. **Request Registration:**

Selection of a registered passenger.
Selection of departure-arrival stations (where to pick up and where to drop off).
Description of the meeting point and destination (two fields with descriptions of exits or directions).
Date of the request, meeting time.
Request acceptance method (by phone or through electronic services).
Transfers (shows which route the employee should take).
Stations (selection of stations from which we can meet the passenger).
Number of passengers.
Request category (filled in from the passenger, but can be changed by the

operator).
Number of assigned employees (males, females).
Adding luggage (type of luggage, weight, whether assistance is needed).
Request status (Not Confirmed; Under Consideration; Accepted; Inspector Departed; Inspector on Site; En Route; Request Completed; Identification; Waiting List; Cancelled; Rejected; Passenger is Late; Inspector is Late).
Additional Information (description of the passenger, required assistance, and other information necessary for accompanying this request).
Adding an employee to fulfill this request (Last Name and Initials, service area).

3. **Employee Registration for Handling Requests:**

Employee's Full Name.
Last Name and Initials.
Gender. (male, female)
Employee Shift. (1, 2, 1(Н), 2(Н), 5)
Employee Position (ЦСИ, ЦИ).
Work Hours. (07:00-19:00, 08:00-20:00, 20:00-08:00, 08:00-17:00)
Work Phone.
Personal Phone.
Employee ID Number. (8 digits)
Light Duty (employees who are prohibited from certain actions due to health conditions).

4. **Registration of an Employee's Work Day for Handling Requests:**

This component is necessary to determine the number of employees who have started their shift. The following information is entered:
Date of shift.
Work hours (07:00-19:00, 08:00-20:00, 20:00-08:00, 08:00-17:00 and the option to choose other work hours)
Status updates:
Day off (date range)
Sick leave (date range)
Vacation (date range)
Extra shift (working on a day off, date)
Educational leave (date range)
Change in work hours (if the work hours do not match the schedule)
Internship (requests only with a mentor)