

DOI <https://doi.org/10.15407/csc.2021.02.052>

UDC 004.414.25

**P.B. TIUTIUNNYK**, student,  
National Technical University of Ukraine  
“Igor Sikorsky Kyiv Politechnic Institute”,  
03056, Peremohy Ave 37, Kyiv, Ukraine,  
artyoda05@gmail.com

**N.A. RYBACHOK**, PhD (Eng.), Senior Lecturer,  
National Technical University of Ukraine  
“Igor Sikorsky Kyiv Politechnic Institute”,  
03056, Peremohy Ave 37, Kyiv, Ukraine,  
rybachok@pzks.fpm.kpi.ua

## CREATING WEB APPLICATION FOR ORGANIZING TEAMWORK ONLINE USING MICROSOFT AZURE CLOUD SERVICES

---

*By analyzing the problem of the subject area, the function of the software system for organizing team work in the online mode are determined. Based on the service of the Microsoft Azure cloud platform, the architecture of the corresponding software system has been developed. The features of the first iteration of the software implementation of the system are described and the choice of technologies for its implementation is substantiated.*

**Keywords:** remotework, onlinework, teamwork, Microsoft Azure, cloudservices, AzureAppService, AzureSignalRService, Azure-Functions, AzureServiceBus, Azure SQL Database, MongoDBAtlas, AzureBlobStorage.

### Terminology

#### Problem Statement

With the development of communication technologies and the Internet, the opportunity to conduct teamwork online arose. This type of work has many advantages as more convenient individual work schedules and increased productivity due to fewer interruptions [1]. Special software systems are used to organize teamwork. But along with the important benefits, remote work creates new problems.

That is why the creation of web application for organizing team work online, which is aimed at solving problems typical for remote communication, is important. Since the use of cloud resources

and services (cloud-first strategy) today is becoming common not only for commercial enterprises, but also for government organizations [1], the developed software should be focused on the use of cloud services, for example Microsoft Azure.

To do this, the following tasks must be solved:

- identify the main problems that are inherent in the remote communication of team members;
- review existing software systems used to organize teamwork;
- identify the main functions which are common for software systems of this type;
- design the architecture of the software system, using the services of the cloud platform Microsoft Azure and based on the functions of the system;

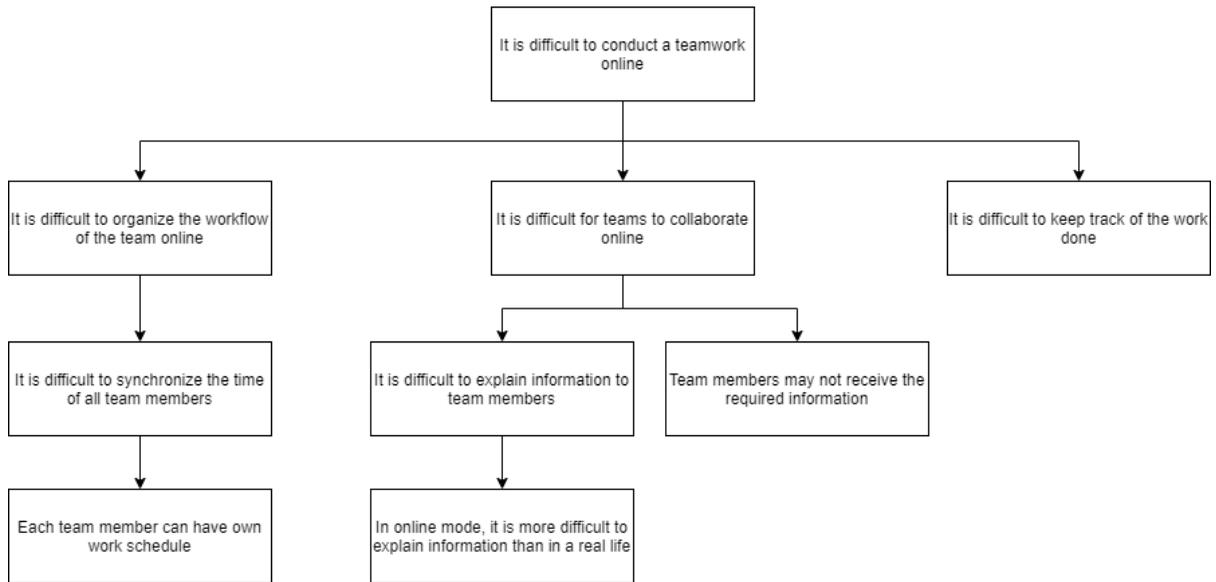


Fig. 1. Problem tree

- perform software implementation of the system (select development technologies and develop system using them);
  - analyze the developed system.
- The purpose of this work is to create a web application for organizing teamwork online

### Causes of Problems in Organizing Teamwork Online

First of all, during the remote work of team members there is the problem of synchronization of various meetings and events that are necessary to conduct the work process. The main reason for this is the unique schedules of each employee, who can work at will at any time of the day and even in different time zones. Under such conditions, without information about the plans of team members, it is impossible to choose a time that could satisfy at least the majority.

However, even a well-timed meeting does not guarantee that team members will show up, as potential participants may forget about the meeting or not receive relevant information about it at all.

Also, a significant problem faced by 88% of employees [2] working remotely, according to surveys,

is the growing number of misunderstandings with their colleagues compared to working in normal conditions. At the same time, 83% [2] of respondents believe that their work processes are overly dependent on emails.

If the software system is inaccessible as web application, it is required for users to install the necessary software, which reduces the ease of use.

In addition to misunderstandings when working with colleagues, 88% of surveyed employees [2] working remotely indicate that there are incompatible practices in their work processes that affect performance. In most cases, these problems arise because of bad organization and the lack of a clear structure of tasks and goals.

The above problems can be displayed as a problem tree in Fig. 1.

### Review of Software Systems for Online Cooperation

The three most popular services [4] for online cooperation have been selected for review.

**Zoom.** Zoom is a software for video conferencing [5]. The system is one of the most popular collaboration tools. Its capabilities are used by 36% of

surveyed employees who work remotely [4]. The system is available on Windows, Linux, MacOS, iOS, Android.

The main functions of this application include:

- scheduling of meetings and events for users;
- support for audio and video conferencing up to 100 participants and 40 minutes for free accounts and up to 1000 participants without time limits for premium accounts;
- ability to present the screen during video conferencing;
- exchange of messages in group and personal chats;
- file sharing support;
- platform extensibility with plug-ins and third-party programs based on the Zoom platform.

The disadvantage of Zoom is the limitation on the number of participants and the time limit for audio and video conferencing in the free version. While restrictions on the number of participants is not a problem for most teams, restrictions on a meeting duration does not allow to always complete meetings in one session and bring inconvenience for a team.

Zoom also doesn't have the tools to organize users into permanent groups, so you need to find and add team members individually each time.

In addition, you must install a client to use the capabilities of online conferencing, because there is no web application for Zoom.

**MS Teams.** MS Teams – is a software for organizing teamwork from Microsoft [6]. The system is one of the most popular collaboration tools. Its capabilities are used by 19% of respondents who work remotely [4]. The system is available on Windows, MacOS, iOS, Android and has web application.

The main functions of this solution include:

- scheduling of meetings and events for users;
- support for audio and video conferences for up to 100 participants and 60 minutes for free accounts and up to 10,000 participants and 24 hours for premium accounts;
- exchange of messages in group and personal chats;
- the ability to present the screen during video conferencing;
- file sharing support;

- integration of the platform with other Microsoft services and extensibility of the platform with third-party plug-ins;

- grouping users into teams that can share files and information with each other via specialized channels and have common meetings and events.

The disadvantage of MS Teams is the limitation on the number of participants and time limit for audio and video conferencing in the free version.

An additional advantage of MS Teams is that it has plug-ins from services used to organize the workflow, such as Atlassian Jira and Azure Boards. This allows the team to receive real-time updates on the status of their tasks.

**Skype.** Skype is a software that provides Internet telephony, audio and video conferencing and instant messaging services [7]. The system is one of the most popular collaboration tools. Its capabilities are used by 17% of surveyed employees who work remotely [4]. The system is available on Windows, MacOS, iOS, Android and has web application.

The main functions of this solution include:

- support for audio and video conferences for up to 100 participants;
- exchange of messages in group and personal chats;
- the ability to present the screen during video conferencing;
- support for audio calls to regular phones via Internet telephony;
- file sharing support.

The disadvantage of Skype is the lack of time management tools. Skype users do not have calendar functionality, but it is possible to inform other users about their own availability status.

Also, Skype does not have the tools to organize users into permanent groups, so each time you need to find and add team members individually.

## **Defining the Function and Software System for Organizing Teamwork Online**

According to the results of the review, the functions to be implemented in modern systems for organizing teamwork online are identified as following:

- maintaining individual and joint calendars;
- organization of audio or video conferences;
- messaging;
- file exchange;
- screen presentation;
- availability of a web application;
- organization of users into permanent groups;
- task management according to the chosen development methodology.

Implementation of these functions in the software system will solve the problems common for the remote work.

### **Software Architecture Based on the Microsoft Azure Services**

The developed software is a web application built on a client-server architecture. The client part provides high-level functions:

- customer interaction with the system and use of its capabilities;
- display of data received from the server part;
- support for online meetings between system customers.

The server part of the software system provides functions:

- processing of requests received from the client part;
- interaction with the database;
- sending notifications about the processing of requests to add new messages and appointments to other web clients and via email.

The AGILE iterative development methodology, in which requirements and solutions evolve through cooperation between multifunctional teams capable of self-organization, was chosen to manage the tasks.

Figure 2 shows the architecture of the software system. It is based on the use of the following services of the cloud platform Microsoft Azure [8]:

- Azure App Service;
- Azure SignalR Service;
- Azure Functions;
- Azure Service Bus;
- Azure SQL Database;
- MongoDB Atlas;
- Azure Blob Storage.

Azure App Service is a web service provided by the cloud platform and is used to quickly create fully functional cloud web applications.

Azure SignalR Service is also a web service and provides easy addition of real-time functionality for cloud applications.

Azure Functions belongs to the category of calculation services and provides the ability to perform event-driven serverless calculations (launch the appropriate functions).

Azure Service Bus is a reliable messaging service provided as a service or as a hybrid integration. Used to process the message queue.

Azure SQL Database is a scalable relational database service provided. It is a fully managed SQL database, where resource management is automated to accelerate software development.

MongoDB Atlas is a cloud service that provides automated non-relational database services based on the MongoDB database core.

Azure Blob Storage is a cloud storage that provides file storage and management services.

Consider in more detail the services of the developed system.

The Client web application service is responsible for hosting the client part of the web application and is an Azure App Service. It is associated with a domain name by which users can take the SPA application and use it to access the functions of the software system via HTTP and the SignalR library, which uses the WebSocket protocol.

To process requests from the client side, there are several services implemented as Azure Functions, which are designed to interact with different entities and respond to HTTP requests and SignalR Service, which is used to implement real-time interaction.

The first of the HTTP request handlers is the Credentials service. He is responsible for registering and authorizing users into the system. For authorized users, the service provides a special JWT token, which is used by other services to authorize the user. Also, during registration, the service is responsible for sending the activation letter to the queue of the email service (Service Bus). The authority service stores entity data in a relational database.

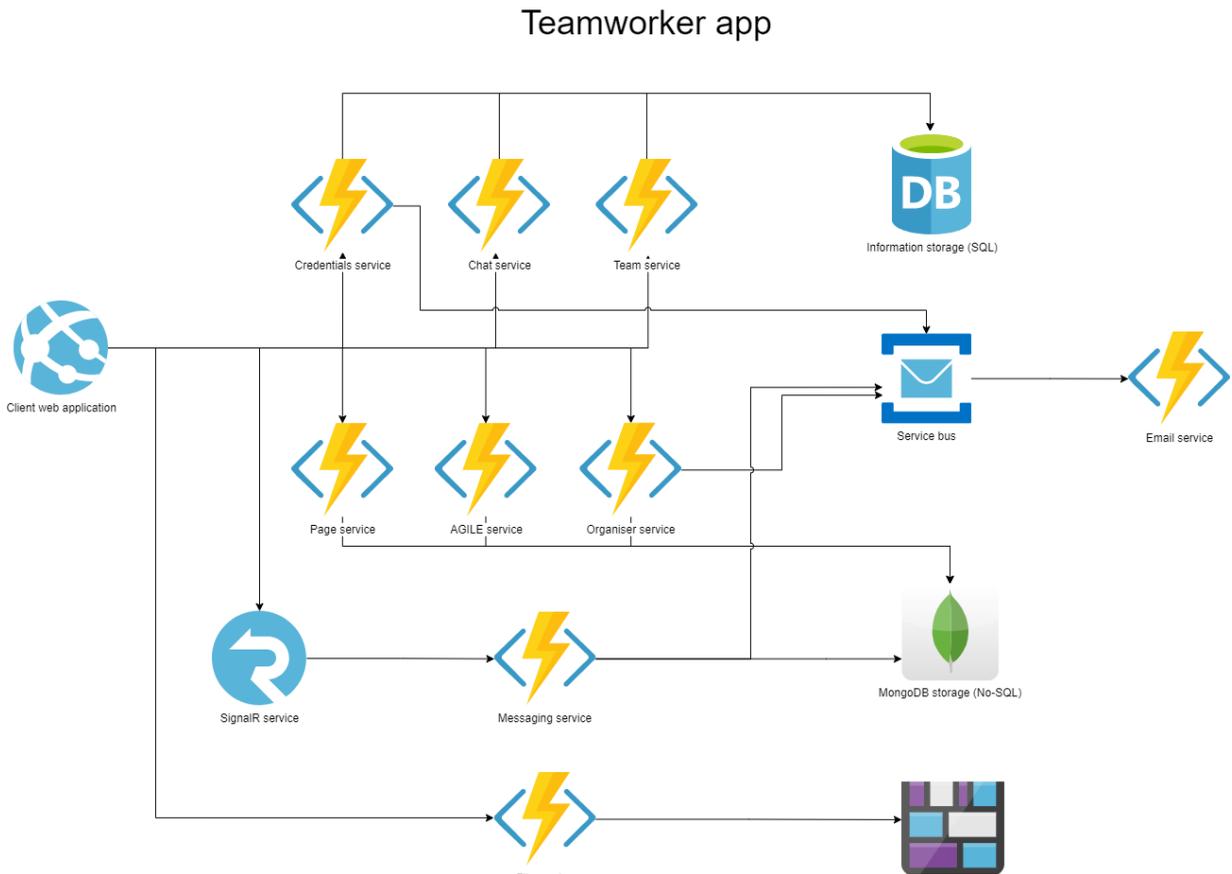


Fig. 2. Software system architecture

The Chat service is responsible for creating and editing the chat entity and its relationship with users. It is activated via an HTTP request and requires the appropriate user rights to work properly, such as being a chat administrator to change its name. The chat service stores entity data in a relational database.

The Team service is responsible for creating and editing the team entity and its relationship with users. It is activated via an HTTP request and requires the appropriate user rights to work correctly, such as being a team administrator to change its name. It is responsible for creating the appropriate chat and KANBAN board for newly formed teams. The command service stores entity data in a relational database.

The Page service is responsible for creating and editing the page entity and saving it in a non-relational database.

The AGILE service is responsible for creating and editing entities related to the AGILE methodology and storing them in a non-relational database. For the first iteration of the software system, AGILE tools are represented only by the KANBAN board.

The Organizer service is responsible for creating and editing the meeting entity and storing it in a non-relational database. Also, when creating a new appointment, the service is responsible for sending a reminder letter to the queue of the email service (Service Bus).

A real-time interaction service (SignalR service) is used to process SignalR requests. It al-

allows you to place users in special hubs that are responsible for processing requests from hub members and passing notifications and reminders to other members. In the first iteration, such procedure is a message processing. It consists of several steps:

- sending a message by the user;
- message processing with special Azure Function;
- after successfully saving the message in storage, notification is sent to other chat participants or if the participant is not online, the reminder letter is queued for email service.

The Messaging Service is responsible for creating and editing the message entity and storing it in a non-relational database. Unlike other services implemented as Azure Function, this service does not process HTTP requests, but changes in the SignalR service.

The Service Bus queue is the Azure Service Bus service. It is a conditional data structure of FIFO format, and stores requests for sending emails, which are processed by the Email service which sends the required letter. The letter is sent through a third-party email service provider that receives a request to send email via SMTP.

The File Service is responsible for the placement of files in storage and generating URL links which application users can use to obtain previously saved files. This service is not implemented for the first iteration of the web application development.

## **Description of Software Implementation**

Features of the first iteration of the software system:

- AGILE tools are represented only by KANBAN board;
- interaction in real time is represented only by notifications of new messages;
- adding file sharing between users is postponed until the next iteration.

The C # programming language and the ASP.NET Core platform were chosen to develop the server part, as this programming language and

technology provides the greatest opportunities for creating a high-quality program and is architecturally neutral, safe and highly productive. Its biggest advantage is the high integration with the Azure cloud services.

The JavaScript programming language was chosen to develop the client part, as it provides the best opportunities for creating a web application and full integration with HTML and CSS.

Angular was chosen as the framework because it uses the Typescript programming language and a component architecture approach which is highly productive and scalable.

Testing was performed by Gray Box Testing. Both the code and the software product itself are checked for compliance with the functional requirements. Among the functional tests, unit and integration tests are performed. Non-functional tests are represented by performance and interface testing.

## **Conclusions**

Web application that solves the problems arising in the organization of team work online was developed using Microsoft Azure cloud services.

For the first time, the architecture of this software system type based on Microsoft Azure cloud services has been proposed. The architecture is flexible and can be extended by adding new modules.

Possibilities for improving the implementation of the software system in the following versions have been identified:

- expanding the tools of the AGILE methodology by including Scrum approaches;
- expanding real-time interaction, including receiving notifications and reminders about meetings, editing team pages and KANBAN boards;
- adding the ability to share files between users;
- expanding interaction with messages (forward, reply, edit, delete);
- adding notifications other than email, such as Telegram messages.

The implementation of these additional functions will not affect the created architecture of the software system.

## REFERENCES

1. IT-companies called on the Ukrainian parliament to speed up the transition of state bodies to technology. [online] Available at: <<https://www.unian.ua/science/it-kompaniji-zaklikali-ukrajinskiy-parlament-priskoriti-perehid-derzhorganiv-na-hmarni-tehnologiji-novini-11037572.html>> [Accessed 16 Oct. 2020]. (In Ukrainian).
2. Benefits of working remote. [online] Available at: <<https://www.statista.com/statistics/1111396/benefits-of-working-remote-2020/>> [Accessed 2 Apr. 2021].
3. Going remote: Leading dispersed teams. [online] Available at: <<https://www.institutelm.com/resourceLibrary/going-remote-leading-dispersed-teams.html>> [Accessed 8 March 2021].
4. Most used collaboration tools used for remote work in the United States in 2020. [online] Available at: <<https://www.statista.com/statistics/1123023/top-collaboration-tools-for-remote-workers-in-the-us/>> [Accessed 6 Jan. 2021].
5. Zoom. [online] Available at: <<https://zoom.us/>> [Accessed 16 Oct. 2020].
6. MS Teams. [online] Available at: <<https://www.microsoft.com/en-ww/microsoft-teams/group-chat-software>> [Accessed 6 Jan. 2021].
7. Skype [Електронний ресурс]. Режим доступу: <https://www.skype.com/en/> [Accessed 16 Oct. 2020].
8. Overview of Azure Services. [online] Available at: <<https://docs.microsoft.com/ru-ru/learn/modules/intro-to-azure-fundamentals/tour-of-azure-services/>> [Accessed 14 Oct. 2020]. (In Russian).

Received 20.04.2021

## ЛІТЕРАТУРА

1. IT-компанії закликали український парламент прискорити перехід держорганів на хмарні технології. URL: <https://www.unian.ua/science/it-kompaniji-zaklikali-ukrajinskiy-parlament-priskoriti-perehid-derzhorganiv-na-hmarni-tehnologiji-novini-11037572.html>.
2. Benefits of working remote. URL: <https://www.statista.com/statistics/1111396/benefits-of-working-remote-2020/>.
3. Going remote: Leading dispersed teams. URL: <https://www.institutelm.com/resourceLibrary/going-remote-leading-dispersed-teams.html>.
4. Most used collaboration tools used for remote work in the United States in 2020. URL: <https://www.statista.com/statistics/1123023/top-collaboration-tools-for-remote-workers-in-the-us/>.
5. Zoom. URL: <https://zoom.us/>.
6. MS Teams. URL: <https://www.microsoft.com/en-ww/microsoft-teams/group-chat-software>.
7. Skype. URL: <https://www.skype.com/en/>.
8. Обзор служб Azure. URL: <https://docs.microsoft.com/ru-ru/learn/modules/intro-to-azure-fundamentals/tour-of-azure-services>.

Надійшла 20.04.2021

П.Б. Тотюник, студент, Нац. техн. ун-т України  
«Київський політехнічний інститут імені Ігоря Сікорського»  
(НТУУ «КПІ ім. І. Сікорського»),  
03056, Київ, просп. Перемоги, 37, Україна,  
artyoda05@gmail.com

Н.А. Рибачок, кандидат техн. наук, старший викладач,  
Нац. техн. ун-т України «Київський політехнічний інститут імені Ігоря Сікорського»  
(НТУУ «КПІ ім. І. Сікорського»),  
03056, Київ, просп. Перемоги, 37, Україна,  
rybachok@pzks.fpm.kpi.ua

## ВИКОРИСТАННЯ СЕРВІСІВ ХМАРНОЇ ПЛАТФОРМИ MICROSOFT AZURE ДЛЯ СТВОРЕННЯ ВЕБ-ДОДАТКУ З ОРГАНІЗАЦІЇ КОМАНДНОЇ РОБОТИ В ОНЛАЙН РЕЖИМІ

**Вступ.** З розвитком технологій зв'язку та мережі Інтернет з'явилася можливість для проведення командної роботи в онлайн режимі. Та разом із важливими перевагами віддалена робота створює нові проблеми.

**Метою** даної роботи є створення веб-додатку з організації командної роботи в онлайн режимі на основі сервісів хмарної платформи *Microsoft Azure*. Створення такої системи є актуальною задачею, бо дозволяє вирішити проблеми, характерні для дистанційного спілкування та використовує можливості сучасних хмарних платформ.

**Методи.** Проведено огляд поточної ситуації та існуючих проблем при організації командної роботи в онлайн режимі. Виконано аналіз існуючих програмних рішень, вказано їхні основні характеристики, переваги та недоліки. Визначено функції програмної системи, яка б вирішила проблеми, характерні при організації командної роботи в онлайн режимі.

**Результат.** Запропоновано архітектуру програмної системи для організації командної роботи в онлайн режимі на основі сервісів хмарної платформи *Microsoft Azure*. Описано особливості першої ітерації програмної реалізації системи та обґрунтовано вибір технологій для її реалізації. Зроблено висновки про можливості покращення системи в наступних версіях.

**Висновки.** Матеріали статті можуть бути корисними при виборі існуючих програмних засобів та на різних етапах розроблення нових програмних систем з організації командної роботи в онлайн режимі

**Ключові слова:** *дистанційна робота, онлайн робота, командна робота, Microsoft Azure, хмарні сервіси, AzureAppService, AzureSignalRService, AzureFunctions, AzureServiceBus, Azure SQL Database, MongoDBAtlas, AzureBlobStorage.*