UM Cluster: Service of distributed calculations

This guide describes several practical steps for creating a distributed computing system based on Universal Mechanism software

2024

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1. Introduction

Distributed computing service UM Cluster is a part of the Universal Mechanism software. The service allows you to perform distributed calculations of scanning projects on computers in your local network. Calculating a project in parallel can provide significant overall time savings and significantly improve the efficiency of your network environment.

UM Cluster consists of two parts: client and server. When in this document we use the term **UM Cluster** or simply **Cluster** we mean the distributed computing system as a whole. We will call the server part of the distributed computing system as **UM Cluster Server** and the client part, respectively, **UM Cluster Client**.

Both the server and client parts of the **UM Cluster** belong to Universal Mechanism software.

The client part contains all the software components necessary for calculations and does not require a complete Universal Mechanism to be installed on every client computer. Computers with the installed client part of the cluster are called *client computers*.

The license policy of Universal Mechanism does not apply any restrictions on the number of used client computers, regardless of whether Universal Mechanism is installed on those computers or not. The client part is distributed as a standalone installation package which you can download via this link: http://www.universalmechanism.com/en/pages/index.php?id=3.

After installation, the client part of the cluster is located in the folder **Program Files\UM Software Lab\UM Cluster Client.** The server part of the cluster is located in the folder **Program Files\UM Software Lab\Universal Mechanism\9\bin.**

Compatibility

Server and client parts can be installed on the following operating systems: **Windows 7/8.1/10**, **Windows Server 2008/2012R2/2016/2019**. The client part can be installed on any of the listed operating systems, including the server one.

What we will learn

1. How to install the client part on computers without installed "Universal Mechanism" using the **UM Cluster Client** standalone installation package.
2. Understand at a basic level on which components of the Windows operating system the **UM Cluster** depends.
3. Create lists of computers in **UM Cluster Server** that will be used in distributed computing.
4. Check the availability of client computers for the **UM Cluster Server**.
5. Install the client part on remote computers using the **UM Cluster Server**.
6. Run projects using a **UM Cluster**.

2. UM Simulation and cluster server interaction

In practice, **UM Cluster Server** is called by **UM Simulation** if the **Distributed Calculations** checkbox is activated. The cluster server will distribute tasks to preconfigured computers, perform calculations and return the results.

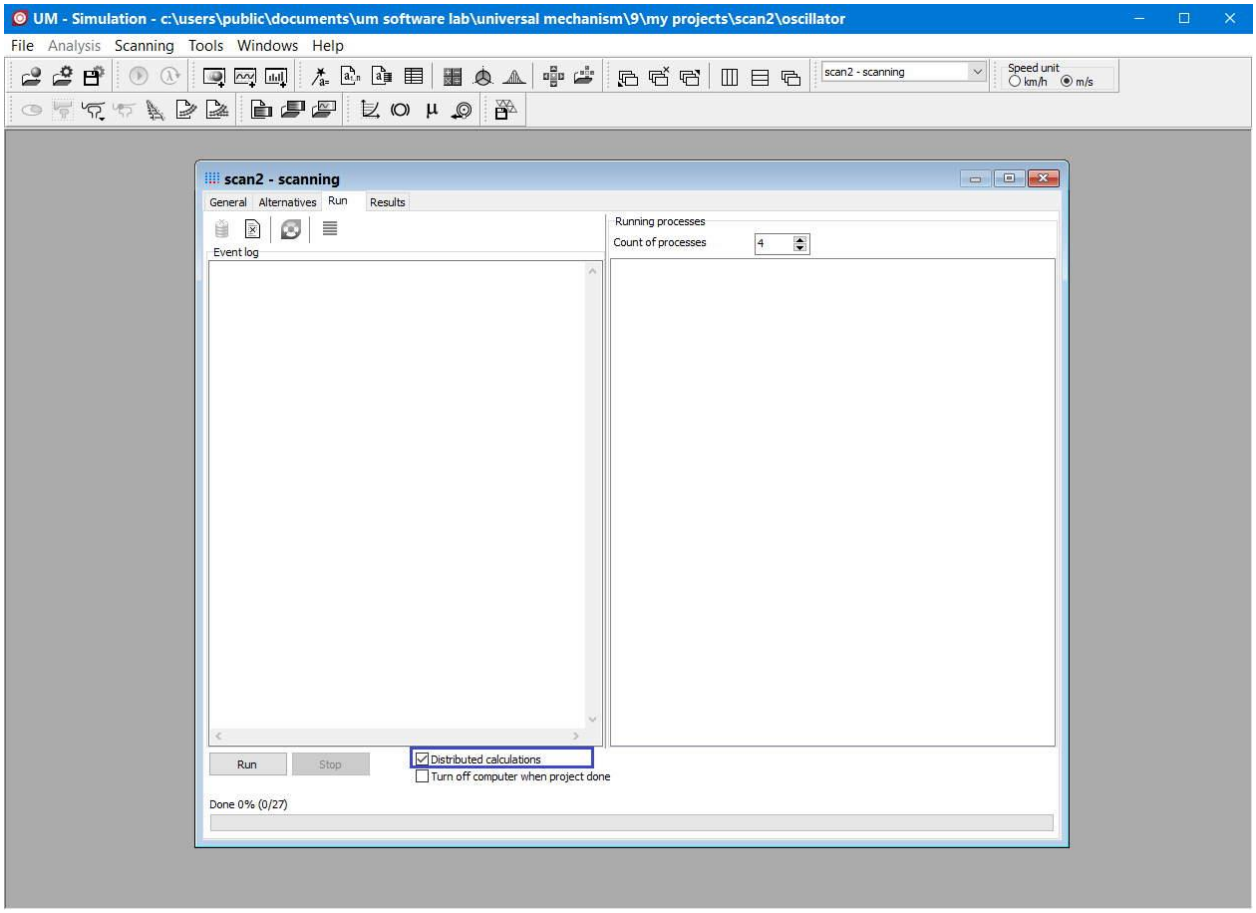

Figure 2.1. Launch project using cluster

If at the moment of starting calculations the cluster server is not running, **UM Simulation** will start it. However, before calling the server from **UM Simulation**, it is necessary to perform initial **UM Cluster Server** configuration.

For the normal functioning of the cluster server, we need to do the following:

1. Install the client part on computers that will be involved in distributed calculations using a stand-alone installation package.
2. Create a list of computers that will take part in distributed computing in the **UM Cluster Server** program.
3. Check the interaction between server and client parts.

All of these steps will be reviewed in subsequent sections of this document.

3. Configuring client computers

3.1.1. The main mechanisms of the operating system

UM Cluster Server uses built-in networking mechanisms (services, subsystems) of the Windows operating system that allows you to interact with client computers remotely.

The client-server interaction means:

- file exchange between server and client computers;
- running the **UM Solver** on client computers;
- control of experiments execution on client computers.

These system mechanisms allow by default the interaction of computers on the local network on server operating systems (Windows Server 2008/2012/2016/2019) and usually block it on user systems (Vista, Windows7/8/10).

Here is a list of the main operating system entities that define remote computer access:

1. **UAC** (User Access Control);
2. Server service (**Server**);
3. Remote registry service (**remoteregistry**);
4. **Windows Firewall**.

An incorrect state of at least one of these elements on a client computer can lead to the impossibility of normal interaction between the server and that client computer. For short, we will call these four entities **USRF**, by the first letters of their names.

During the cluster client installation from the stand-alone installation package, optimal settings are applied to the client computer.

3.1.2. Installing the client part on a computer

To install the client part on a computer in your local network use the following instructions.

1. Download the standalone client installation package from the Universal Mechanism website: http://www.universalmechanism.com/en/pages/index.php?id=3
2. Launch **UMClusterClient.exe** file on selected computer.
3. Wait for the installation to finish and restart the computer.
4. After restarting the computer, make sure that all the labels necessary for configuring the operating system components are highlighted in green, as shown in Figure 3.1.

If the user operating system on the client computer has been preconfigured, the client can be installed or upgraded directly from the cluster server.

Network access control on client computers is performed using the **UM Monitor** program. After installing the client part, the **UM Monitor** program is automatically launched every time when user logs on to the system. By default, it is minimized in the lower right corner of the screen, next to time.

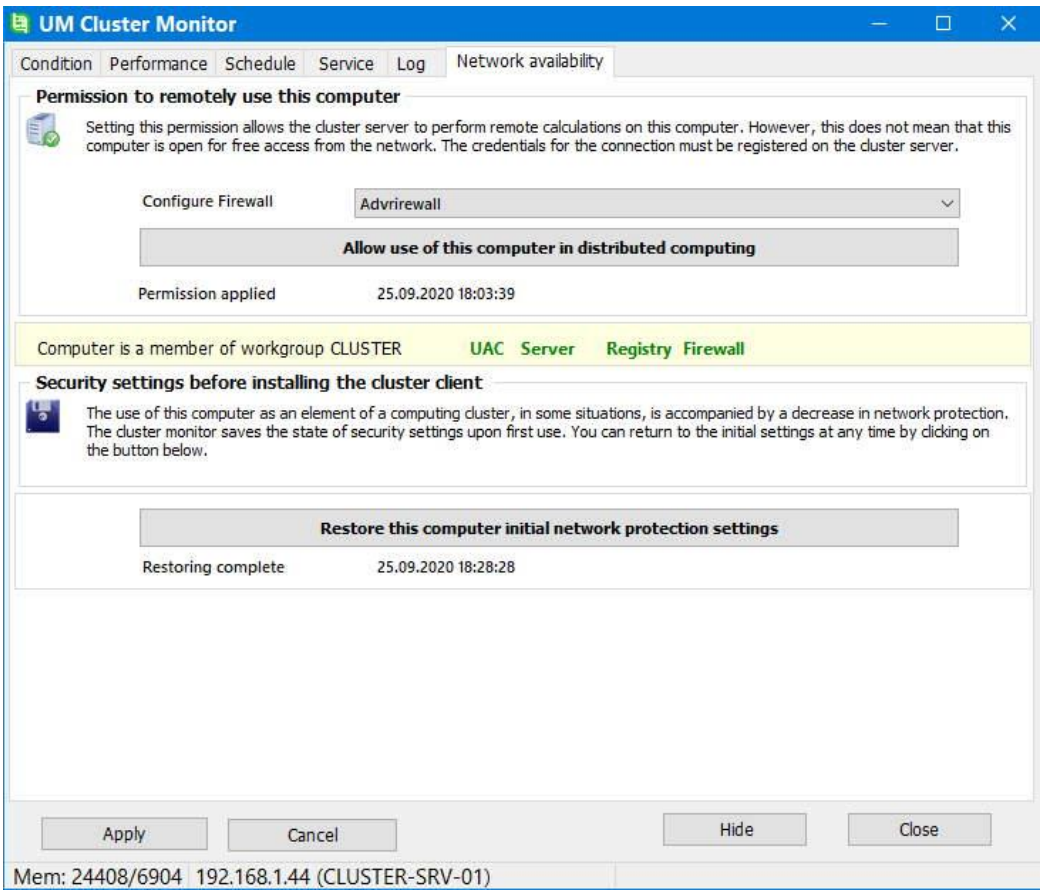

Figure 3.1. UM Monitor: control access to client computer

In Figure 3.1. all system components affecting the normal interaction of the client computer with the cluster server are shown in green. This is the normal state of the computer that the user should see after installing the client.

Over time, for various reasons, changes may occur on client computers that affect the state of the **USRF** components. System mechanisms that block the access of the cluster server to the client computer are highlighted in red in Figure 3.2.

Pressing the button **Allow use of this computer in distributed computing** will setup the necessary parameters, after that the program will offer to restart the computer. If after a reboot the access labels are displayed in green, then this computer can be used in distributed computing.

The client computer can be returned to the state before the cluster client was installed at any time by clicking the **Restore this computer initial network protection settings** button.

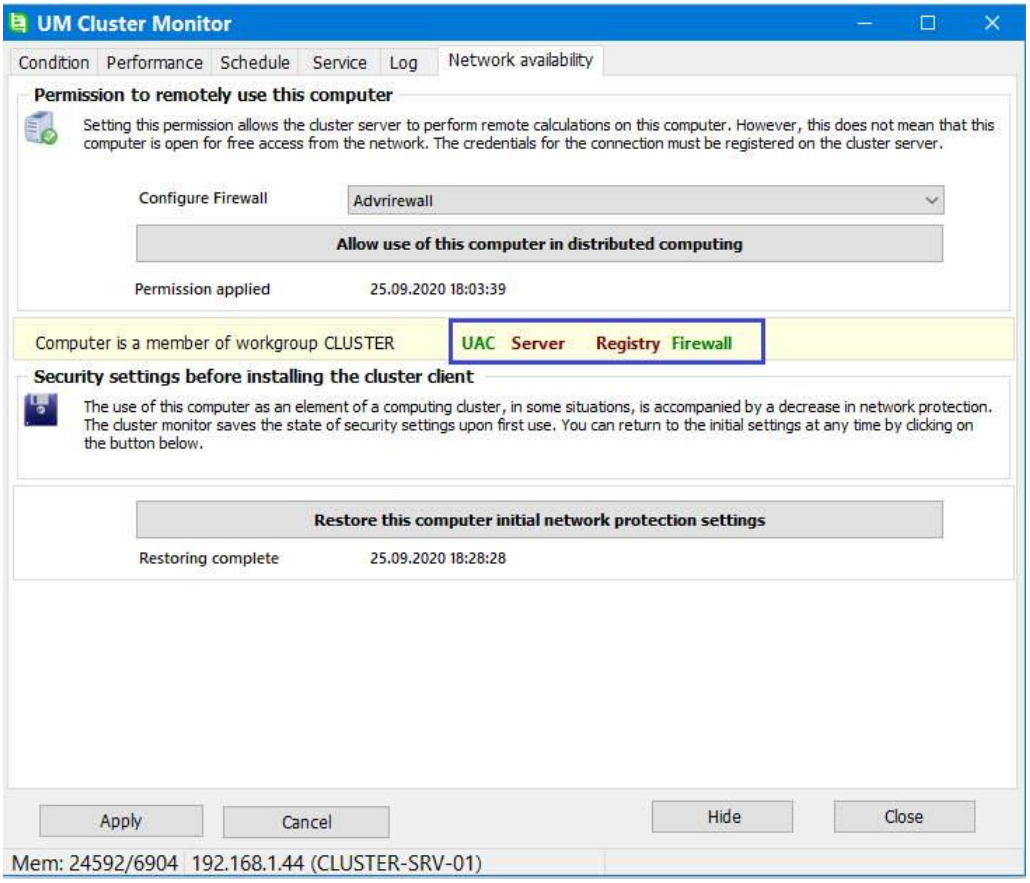

Figure 3.2. **Server** and **Remote Registry** services are not started

4. Configuring Cluster Server

To properly configure your cluster server for distributed calculations you should create a list of client computers and check their functionality. **UM Cluster Server** contains a wizard that creates a list of client computers, installs the client part of **UM Cluster** on them and checks the functionality of components on computers as one action. This section will lead you through the creation of a simple cluster of three computers including a server. Computers will be added to the list manually one by one.

Below we consider basic steps for creating a list of client computers.

4.1. Setting up a list of computers

4.1.1. Starting the cluster server for the first time

Start the **UM Cluster Server** from the Windows main menu: **Universal Mechanism 9 x64 > Tools > UM Cluster Server**. When you start the cluster server for the first time, it looks like the one shown in Figure 4.1. The list of computers is empty. Make sure the server has identified its computer name, IP-address (in the lower right corner of the window) and the boundaries of the local network in which it is located.

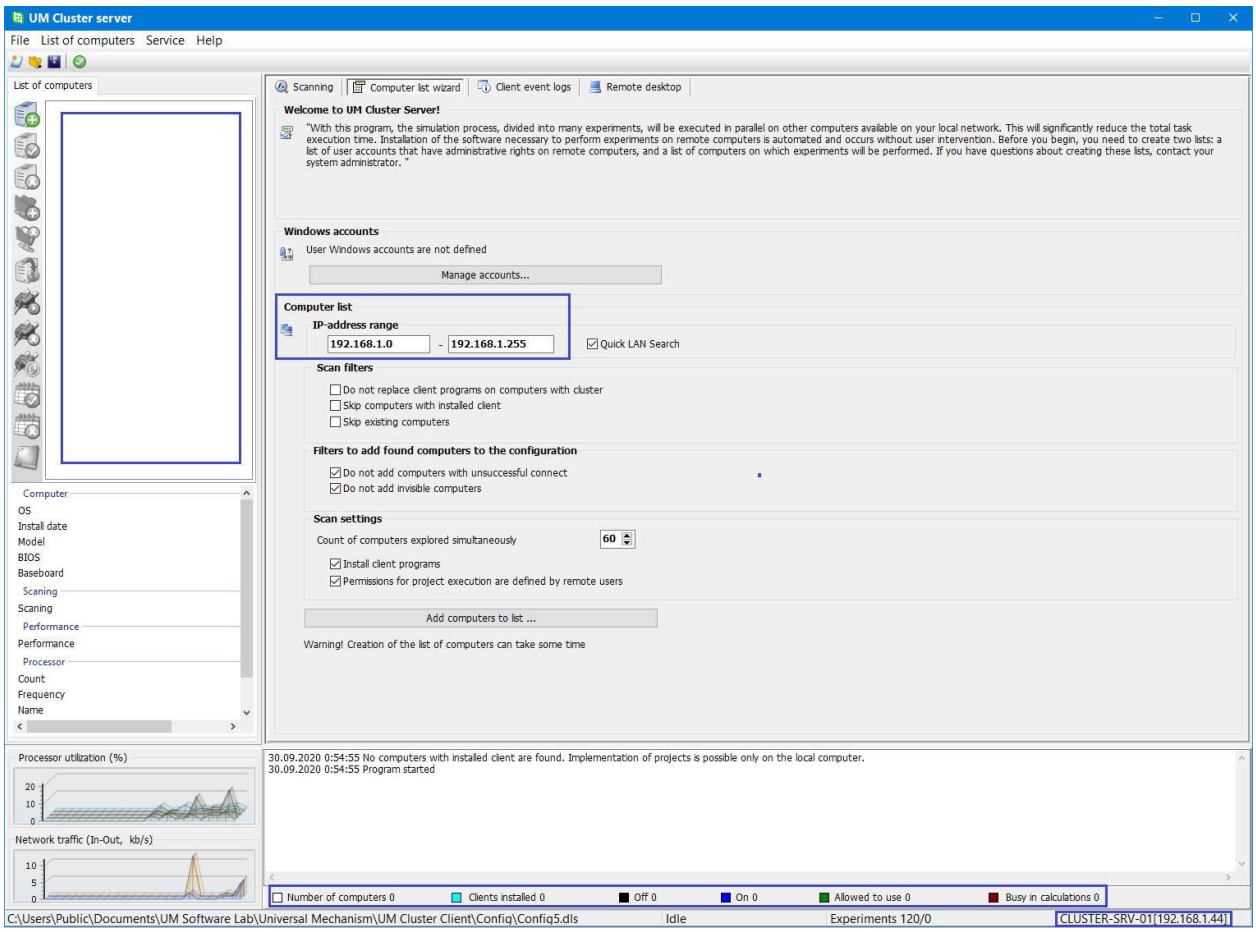

Figure 4.1. **UM Cluster Server** after the first run

4.1.2. Adding the cluster server itself to the list of client computers

On the left panel, which manages the list of computers and operations on them, the only **Add computer** button is available.

Clicking the **Add computer** button opens the dialog for entering computer parameters. Let's add the cluster server itself to the list, its address is visible in the lower right part of the **UM Cluster Server** window. Since we are adding the same computer where the cluster server is located, there is no need to enter a username and password, just enter the IP-address of the computer and its name. After adding the server itself to the list, we have already created a working cluster, but since the cluster server now can run projects only on the computer on which it is installed, there is no practical sense to use the cluster in projects.

4.1.3. Adding a remote computer to the list of client computers

Now let's add the computer with previously installed client part to the list. Then we used a standalone installation package to install a client part on remote computers.

It was described in the Sect. 3.1.2 "*Installing the client part on* a computer ", p. 5. We need to know the address of this computer and the login/password of an administrator on that computer. In this document a computer with the address 192.168.1.54 will be added, in your case it will be a different address.

Below find some notes regarding adding a new computer.

- If you input the IP-address of a computer that actually exists in your local network, then when you exit the IP-address field, the program will automatically fill-in the computer name, if this field is still empty. Similarly, when you enter a computer name, the program will automatically determine its IP-address. There is the following rule: if you know the name of the computer, start with typing the name; if you know the IP-address, start with it.
- The program does not allow you to enter duplicate IP-addresses or computer names.
- When entering a username, it is recommended to do it according the template shown in Figure 4.2.: "**COMPUTER_NAME\USER_NAME**".
- The list of computers stored between sessions of the program, and later it can be completed both manually and via re-running the wizard. The list of computers and accounts associated with them are available only for the **UM Cluster** program. This data is stored encrypted and protected by strong cryptographic algorithms.

When typing the password, let's intentionally *enter any wrong password*.

Now there are two computers in our cluster.

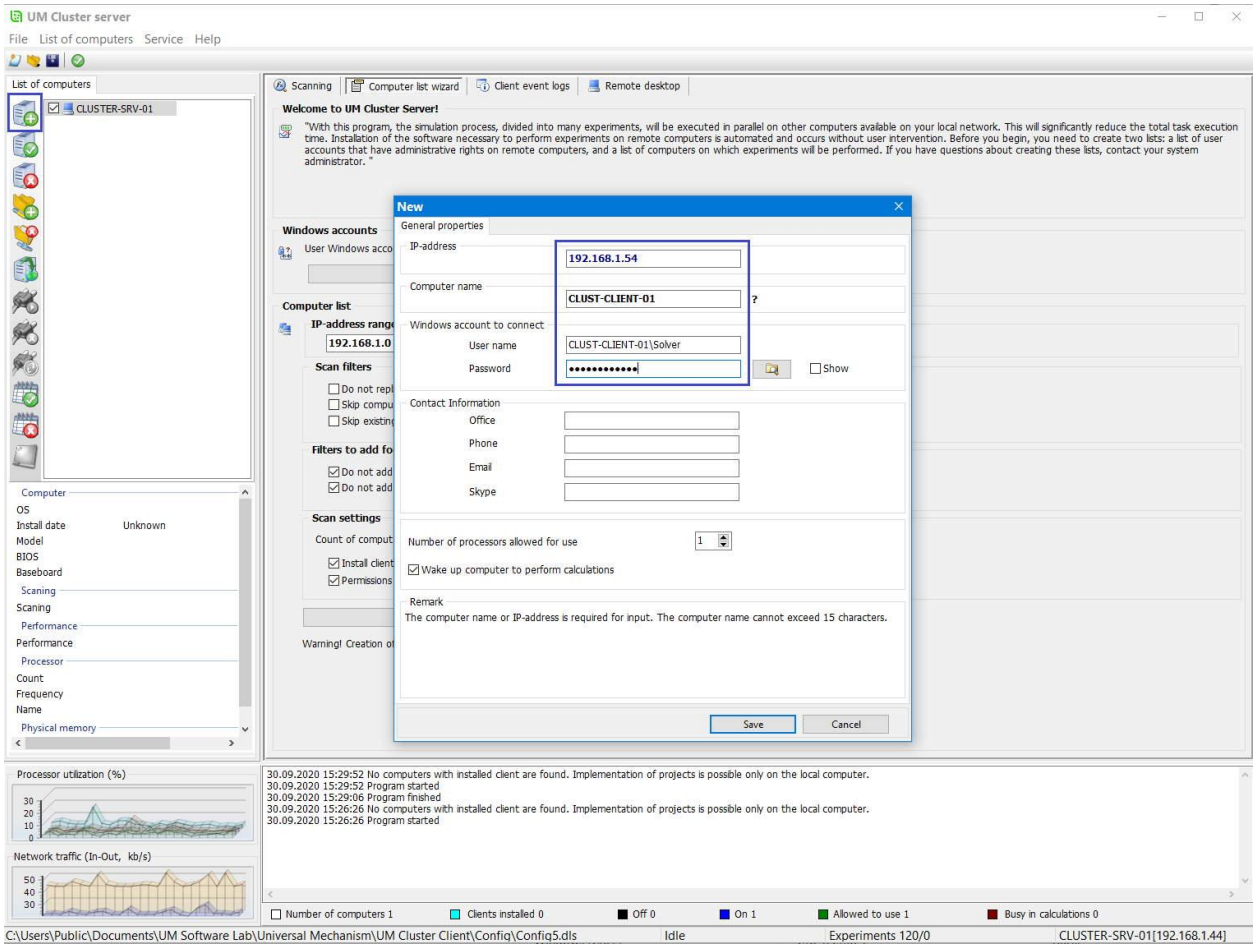

Figure 4.2. Addition of a new computer to the list

4.1.4. Choosing computers for projects

You need to tick the checkbox with the computer name to make it involved in the execution of scanning projects. When you try to select the newly added computer, the system will give an error highlighted in Figure 4.3.

The error means that the server "does not know" if the cluster client is installed on the newly added computer. This is not checked when adding a computer.

The server can detect the presence of a client on a remote computer in two ways: get the parameters of this computer or perform a forced reinstallation of the client on this computer.

Let's try to request the parameters of the computer we just added by clicking on the **Explore computer hardware** button highlighted in Figure 4.4.

Remember, we intentionally entered the wrong password, so when connecting to the computer, the program returned the **Invalid username or password** error. The server event log is located at the bottom of the server window, see Figure 4.4. Operation failed.

All cluster components are closely related to the services of the Windows operating system. If there is no access to these services or services work abnormally, you can see a message with an error code and its description in the main program event log or in context controls. This is usually enough to identify the problem and fix it.

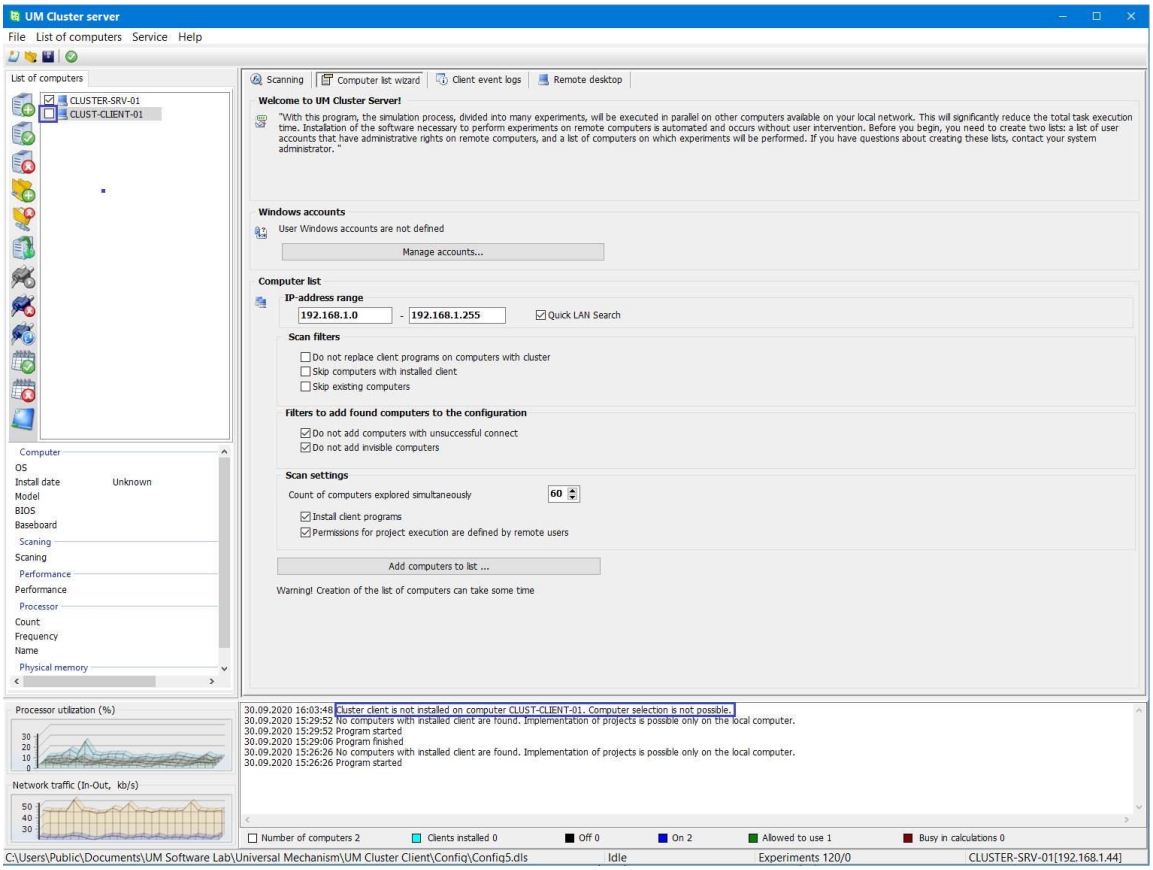

Figure 4.3. Unable to use a computer in distributed calculations

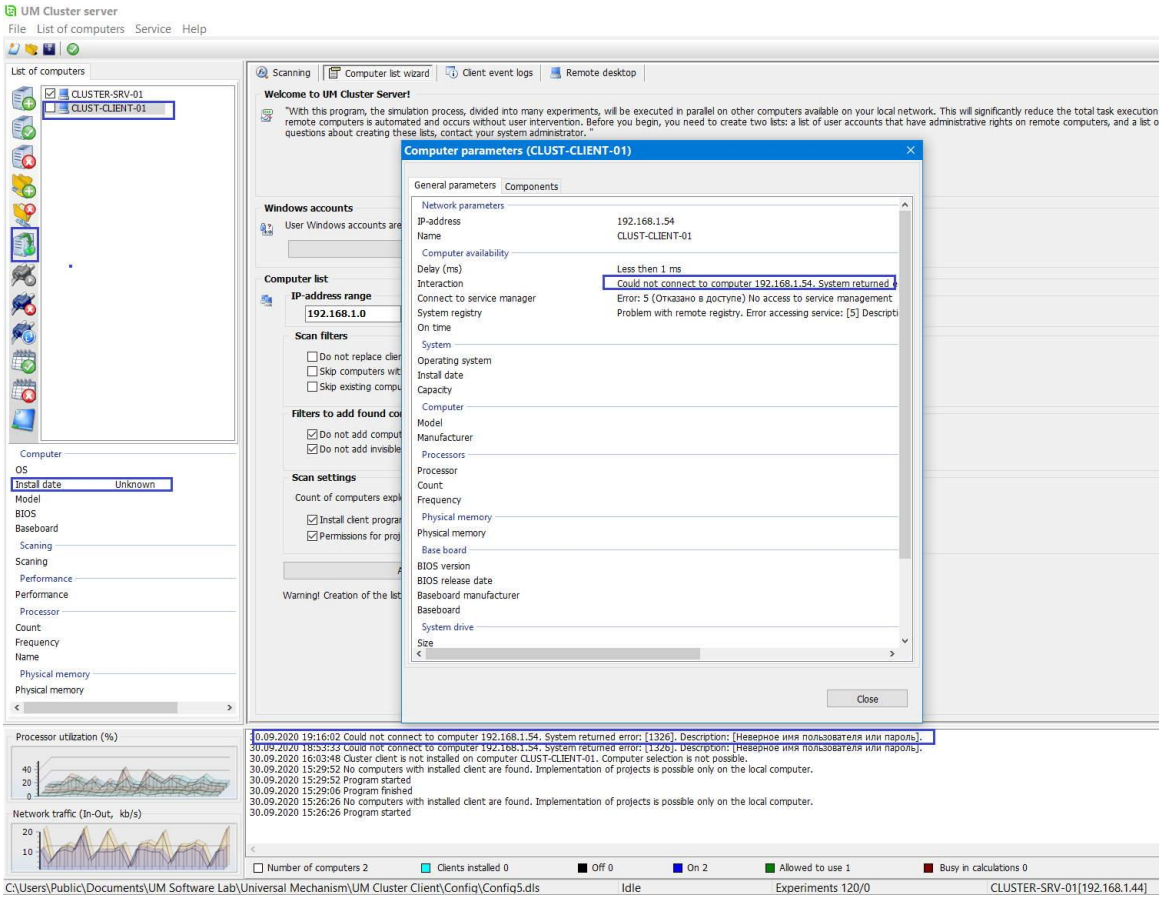

Figure 4.4. Access to the computer was denied while getting its parameters

Select the added computer in the list, double-click on it and in the appeared computer properties window replace the password with the correct one. Now try to get the computer parameters again.

In Figure 4.5 you can see that the connection to the remote computer was completed without errors and the cluster server was able to determine hardware parameters of this computer.

Now we can select this computer, and it will be involved in distributed computing.

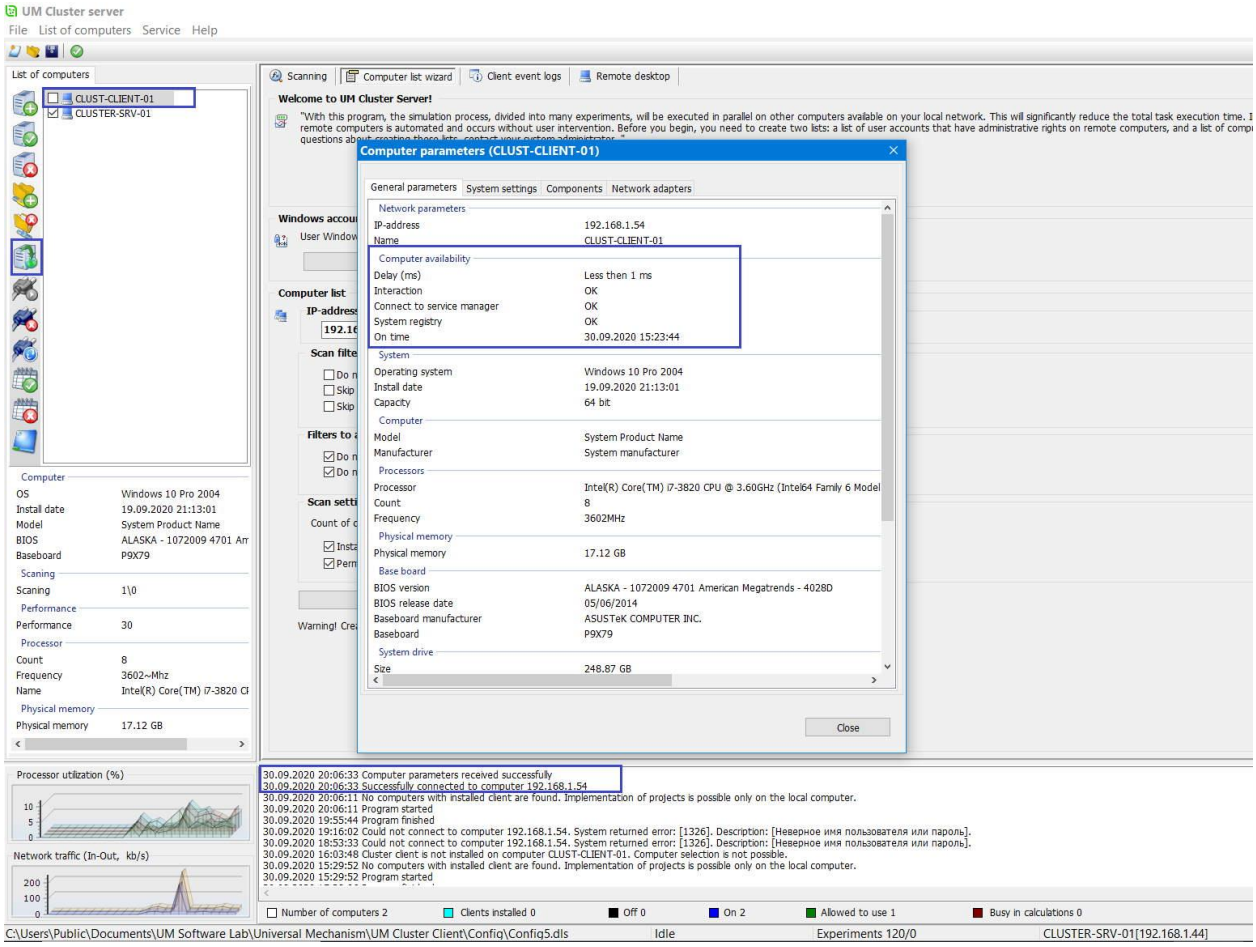

Figure 4.5. Computers hardware parameters

4.1.5. Adding a third computer to the cluster

Add one more computer pre-configured using the **UM Monitor** program into the cluster. This document will add a computer with the IP-address 192.168.1.38, in your case it will be a different address.

To do this, you should repeat the steps described in the Sect. 3.1.2 "*Installing the client part on a computer*", page 5 and Sect. 4.1.3 *"Adding a remote computer to the list of client computers "*, page 9. Tick the check box with this computer name in the list of computers to include it into distributed computing after checking its availability as described in section in Sect. 4.1.4 "*Choosing computers for projects*", page 10.

You now have three computers on your list, including the cluster server.

4.1.6. Forced installation of the client part on remote computers

Now when we have three newly created and validated computers in our cluster, the operation of forced reinstallation of client components is not necessary, and we can already start executing distributed projects.

However, working with the cluster in the future, you will have to perform this operation from time to time. The reason is that you are working on a distributed system. You cannot rely on the fact that client computers will be in a usable state after some time.

When the cluster server checks the computers and reinstalls the client components, you can be sure that all computers on your list are ready for use in distributed computing. If during the installation process problems are detected on any of the computers, it will lose the status of the client computer, and you will find out about this not during the execution of the project, but in advance.

To install client programs, use the following steps.

1. Select all computers in the list using the *Ctrl+A* keys.
2. Click the **Install client programs to computer** button (*Ctrl + I*).

The server will install (reinstall) client programs on computers. This action will be performed for all selected computers, even for those computers whose versions of client components match the versions on your server.

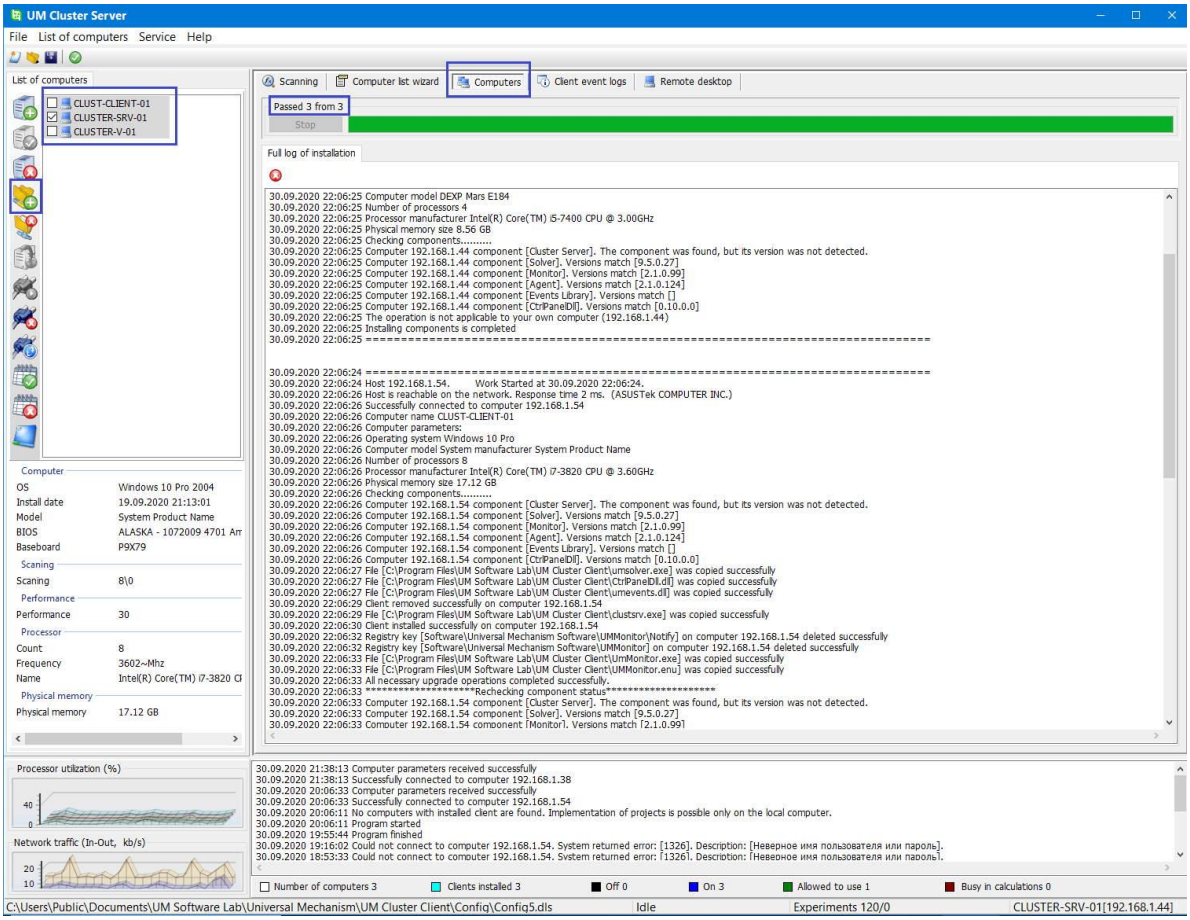

Figure 4.6. Installing (updating) client programs from the cluster server

During the installation of client components, the cluster server performs a detailed registration of all events. In case of errors, detailed information about them will also be recorded in the protocol.

The installation procedure is parallelized, takes a few seconds, does not require rebooting remote computers and does not cause any discomfort for users working on these computers interactively.

5. Preparing to launch a project

We have created a simple cluster of three computers and made sure that the client components are working. We are ready to launch projects. All aspects of **UM Cluster** operation, its settings, project execution are described in detail in the 23rd Chapter of the UM User's Manual. There are several important points to mention in this document.

- The calculation progress is configured by settings on the server and client side. The default settings are optimal for small projects. By default, the cluster server also takes part in the calculations as a client. In our example, when a cluster includes a small number of computers, its participation in the calculations is quite normal. But as the number of client computers grows, the server requires more and more system resources to manage the computation process, and its share in the total amount of computations decreases. Therefore, if 10 or more computers are used in the project, it is recommended to disable the **Allow this computer to be used as a cluster client** in the **UM Cluster Server** settings, see Figure 5.1.
- Both when installing the client part from a stand-alone installation package, and when installing it remotely from the cluster server, *all processors are allowed* to run projects. This can be inconvenient for interactive users during the execution of projects. The number of processors allowed for use to the cluster can be limited individually for each computer, both on the client and on the server side.
- All the main components of the cluster, such as server, monitor and agent, register important events in a special system event log that is created when the client program is installed on the computer. The contents of the log can be viewed both by standard means of the operating system, and directly from the cluster server.
- The cluster server at the beginning of the project execution can turn on remote computers over the network and turn them off after the completion of calculations. As a rule, in user operating systems, the ability to remote power on is disabled. Client computers must be preconfigured to enable this feature.

Now we allow the server to use half of its available processors to perform calculations using the **UM Monitor** program. To do this, follow the instructions below.

- Open the **UM Monitor** program, which is minimized in the lower right corner of the screen by default.
- Go to the **Schedule** tab.
- From the **Templates** drop-down list, select **Allow half number of processors**, see Figure 5.2.

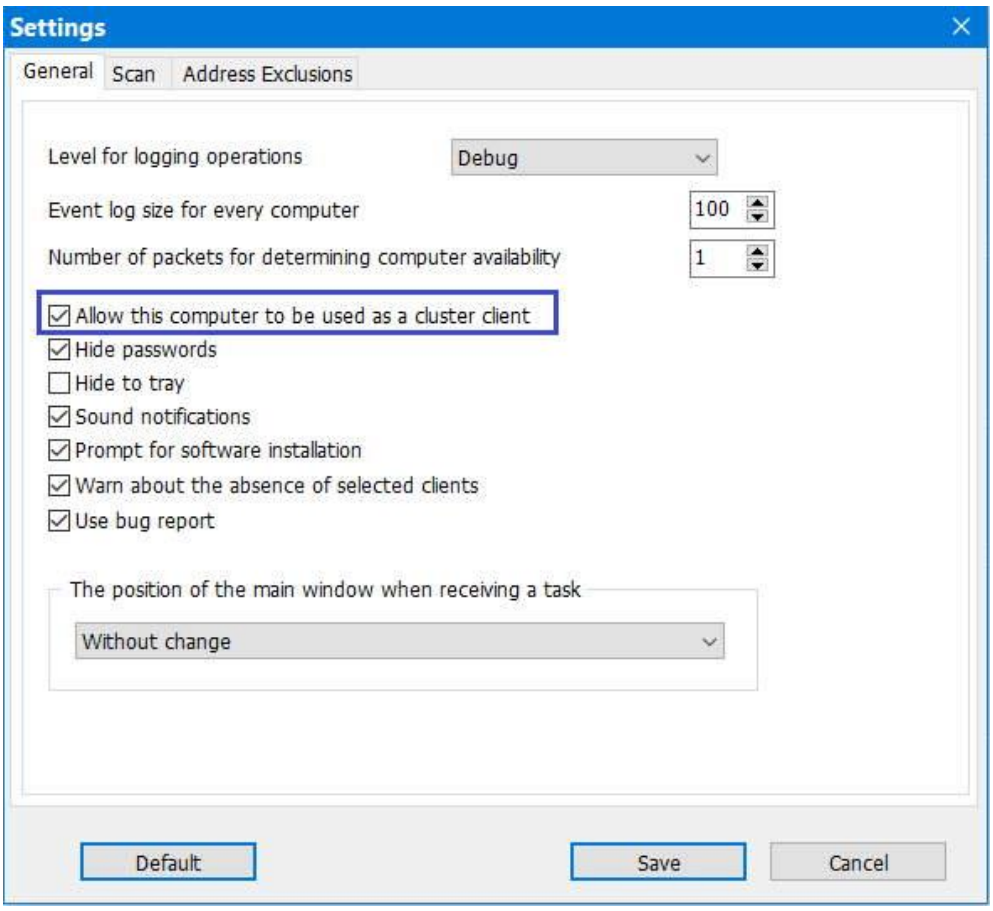

Figure 5.1. Cluster server settings. The cluster server will also do the calculations.

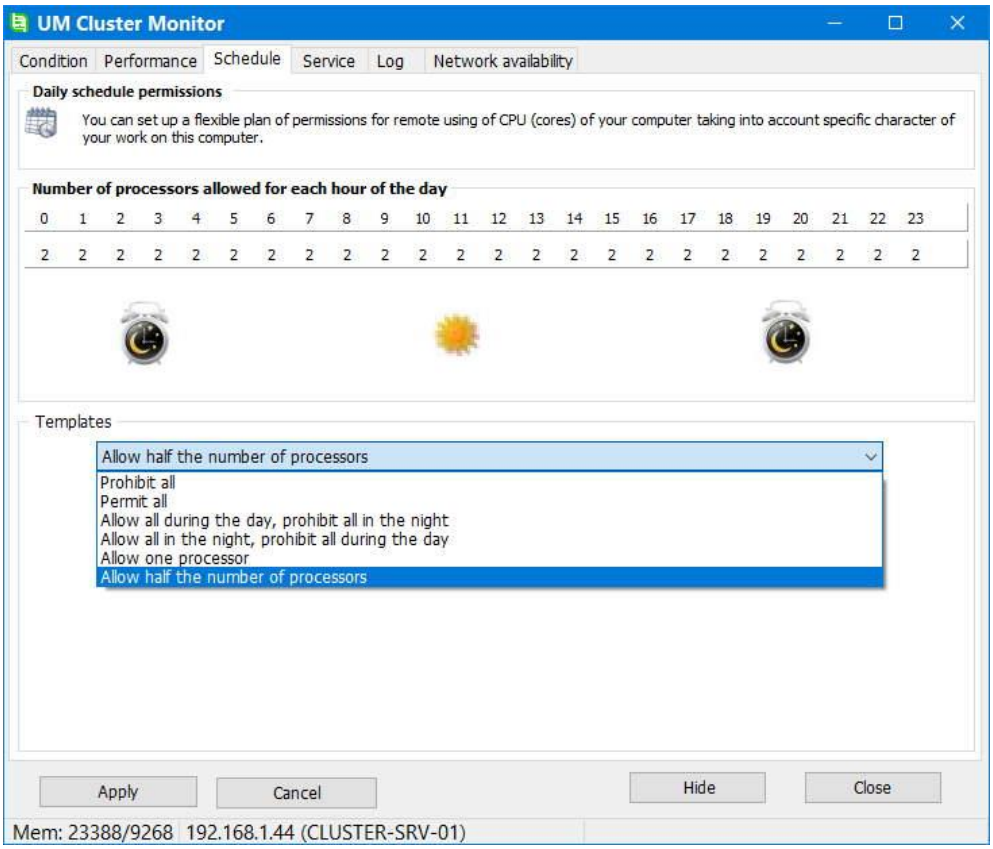

Figure 5.2 UM Monitor: Daily CPU Usage Permission

6. Launch of the project

From the **UM Simulation** program, we will launch a simple demo project, see Figure 2.1.

One of the computers we have added during the project execution will be automatically powered on over the network (see Figure 6.1), since the permission for this operation is set in the computer properties, see Figure 4.2, checkbox **Wake up computer to perform calculations**.

Statistical information about the finished experiments projects is displayed on the **Solved projects** tab, see Figure 6.2.

More details about the distributed computing system can be found in the 23rd Chapter of UM User's Manual.

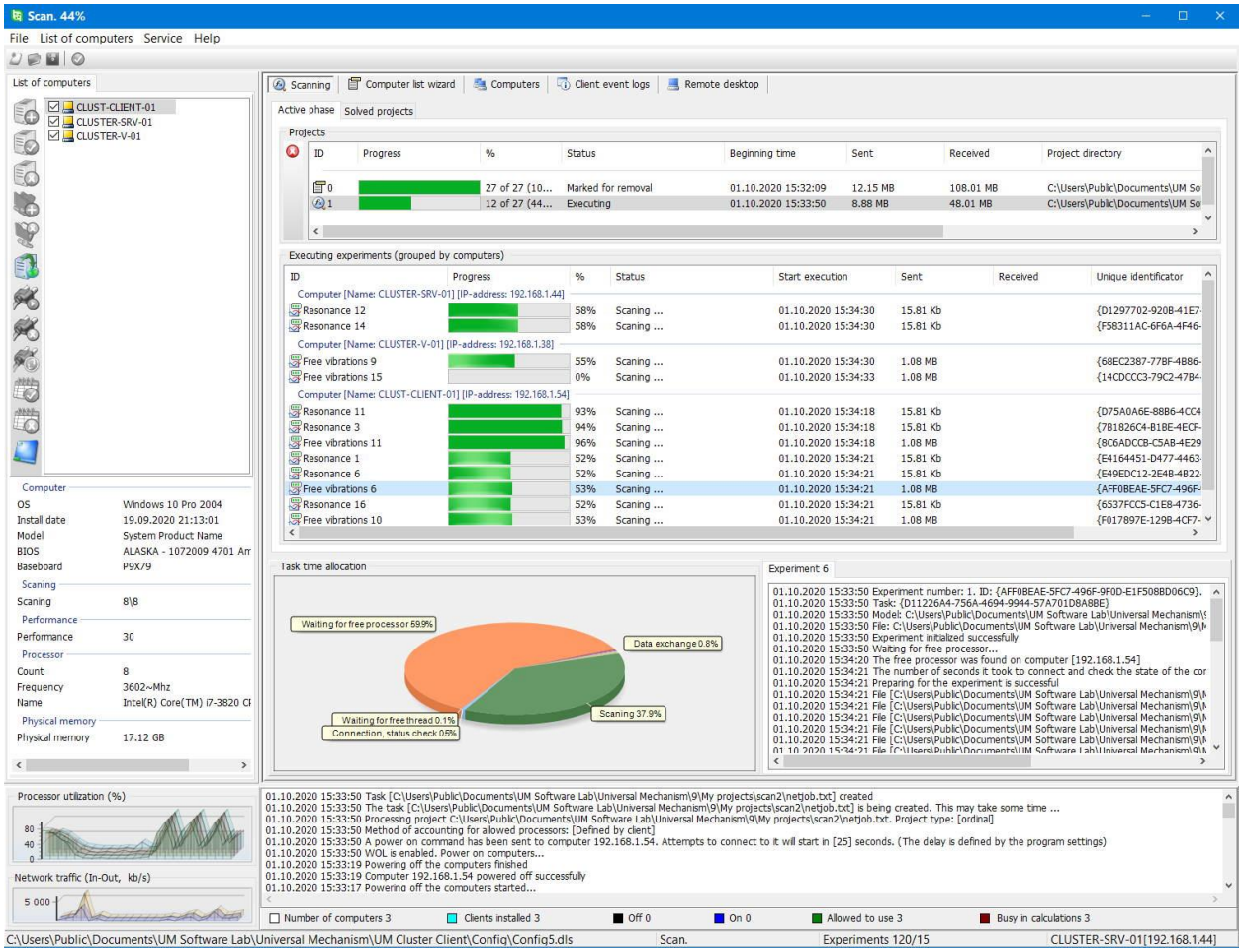

Figure 6.1. Project execution

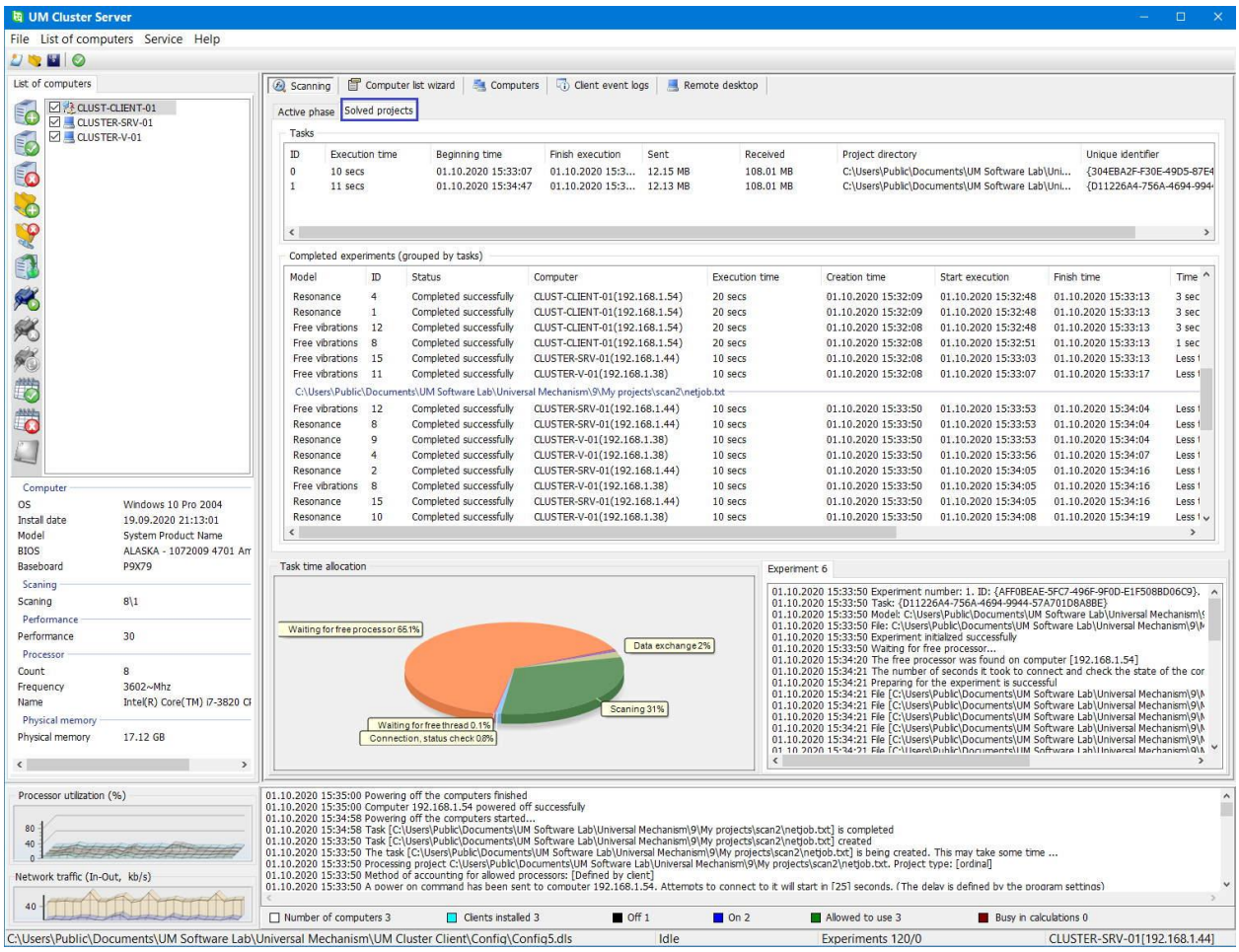

Figure 6.2 Information about completed projects