Compute Cluster Server Lab 1: Installation of Microsoft Compute Cluster Server 2003

In order to use the high performance cluster effectively, it is necessary to use a family of quite complicated software systems. For a long time the users of Windows clusters have had to use simultaneouslysoftware from several vendors. With the release of Compute Cluster Server 2003 (CCS) Microsoft company provided a complete spectrum of software, which is necessary for the efficient use of clusters and the development of the parallel programs, which totally use the available computational power.

Lab Objective

The lab objective is to learn how to install and configure Microsoft Compute Cluster Server 2003 on the computational cluster. The lab assignments include:

- Exercise 1 – Get Compute Cluster Pack (CCP) 2003 and CCP 2003 SDK
- Exercise 2 – Install the head node
- Exercise 3 – Install the computational nodes
- Exercise 4 – Install the client workstation
- Exercise 5 – Test the Compute Cluster Server

Estimated time to complete this lab: **90 minutes**.

Overview of Microsoft Compute Cluster Server 2003

Microsoft Compute Cluster Server 2003 (CCS) is an integrated platform for maintaining high performance computations on cluster systems. CCS consists of the operating system Microsoft Windows Server 2003 and a set of interfaces, utilities and management infrastructure – Microsoft Compute Cluster Pack (CCP). SDK, which contains the necessary tools for developing programs for CCS, is also provided with CCP. Besides, Microsoft Visual Studio 2005, which is an integrated development environment (IDE) for parallel programs and contains a compiler and the program debugger developed with the use of the technologies MPI and OpenMP, is logically connected with Microsoft Compute Cluster Server 2003.

As the computational cluster nodes we may use 64-bit processors of the family x86 and, at minimum, 512 Mb RAM and 4 Gb of available HDD memory.

The operating system Microsoft Windows Server 2003 (Standard, Enterprise or Compute Cluster Edition) must be installed on the computational cluster nodes.

Microsoft MPI, which is an implementation of the standard MPI 2 by Argonne National Labs, is included in CCP. MS MPI is based on MPICH 2 and supports the complete MPI API with more than 160 functions. MS MPI in Windows Compute Cluster Server 2003 uses the WinSock Direct protocol for the best performance and the efficient use of the processor. MS MPI may use any Ethernet connection supported by Windows Server 2003, it can also use such connections as InfiniBand or Myrinet with the use of WinSock Direct drivers provided by hardware vendors. MS MPI supports the programming languages C, Fortran 77 and Fortran 90. Moreover, Microsoft Visual Studio 2005 includes a parallel debugger operating with MS MPI. Developers may start their MPI application on several computational nodes and the Visual Studio will be automatically connected with the processes on each node. The developer can temporarily suspend the application and look through the variable values in each process separately.

Besides MS MPI, CCP includes a convenient system of job management, which allows the developer to look through the states of all the assigned jobs, collect the statistics, set the program launches for a specific time, terminate the needless programs etc. The job management system provides various interfaces including a command line interface, a graphical interface, COM, a web-service and some others.

The Windows Compute Cluster Server 2003 supports 5 different network topologies. Each node may have from 1 to 3 network interface cards. The correct choice of the topology to be used is necessary for the optimum functioning of the computational cluster.

## Exercise 1 – Get Microsoft Compute Cluster Server 2003

The lab student is assumed to have access to the cluster of the appropriate hardware configuration - the 64-bit version of the operating system Windows Server 2003 must be installed and configured on the computational nodes of the cluster. Thus, we only have to download, install and configure Microsoft Compute Cluster Pack and if necessary the Compute Cluster Pack SDK.

To execute this Lab you have to download the evaluate version of the Microsoft Compute Cluster Server 2003 at the Microsoft site (http://www.microsoft.com/windowsserver2003/ccs/evaluation/trial/default.mspx). But it is necessary to have Windows Live ID (Microsoft .NET Passport) to register on the site. Windows Live ID is a unique access code in a special service developed by Microsoft. Windows Live ID allows the user to register on different sites under a single account. So, the first step in getting CCP is the registration of Windows Live ID (if you don't have one yet).

Task 1 – Sign Up for .NET Passport

Open the browser Internet Explorer (version 6 or later) and execute sequentially the following steps:

- Enter **https://www.passport.net** in the browser address line - and press the key **Enter**,
- In the left part of the window choose the option "**Sign up**" to register a new login,
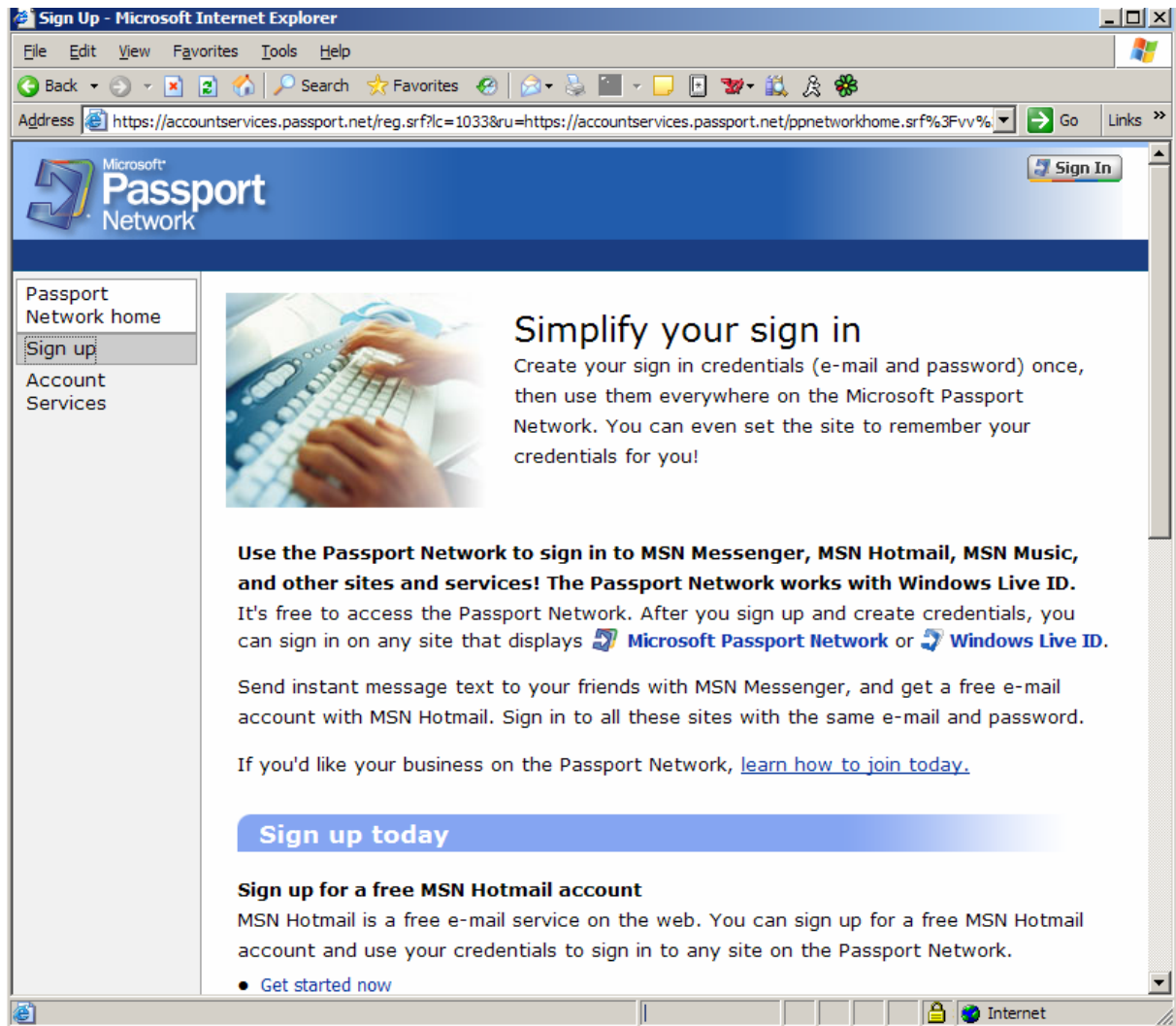
- Follow the instructions, which appear on the screen,
- Choose, whether to use the available e-mail address or to get a free one (you are hereinafter assumed to sing up for a new e-mail address) and press the button **Continue**,
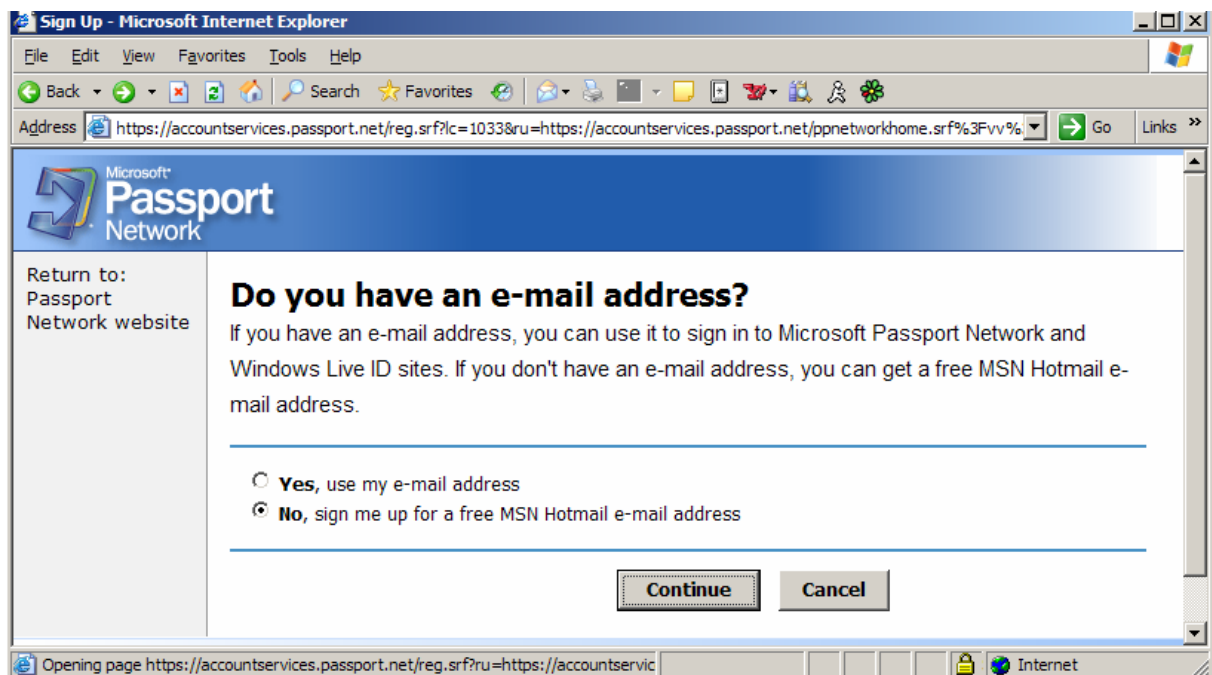
- Enter the information necessary to sign in for a free e-mail address, read carefully the Service Agreement and press the button **I accept** in case you agree,

- Congratulations! You have been signed up for a .NET Passport!

Task 2 – Download the evaluation version of Microsoft Compute Cluster Server 2003

Open the Internet Explorer browser (if it was not opened yet) and execute sequentially the following steps:

- Enter in the address field of the browser "**http://www.microsoft.com/windowsserver2003/ccs/evaluation/trial/default.mspx**" and press the key **Enter**,
- Select the option **View trial options**,
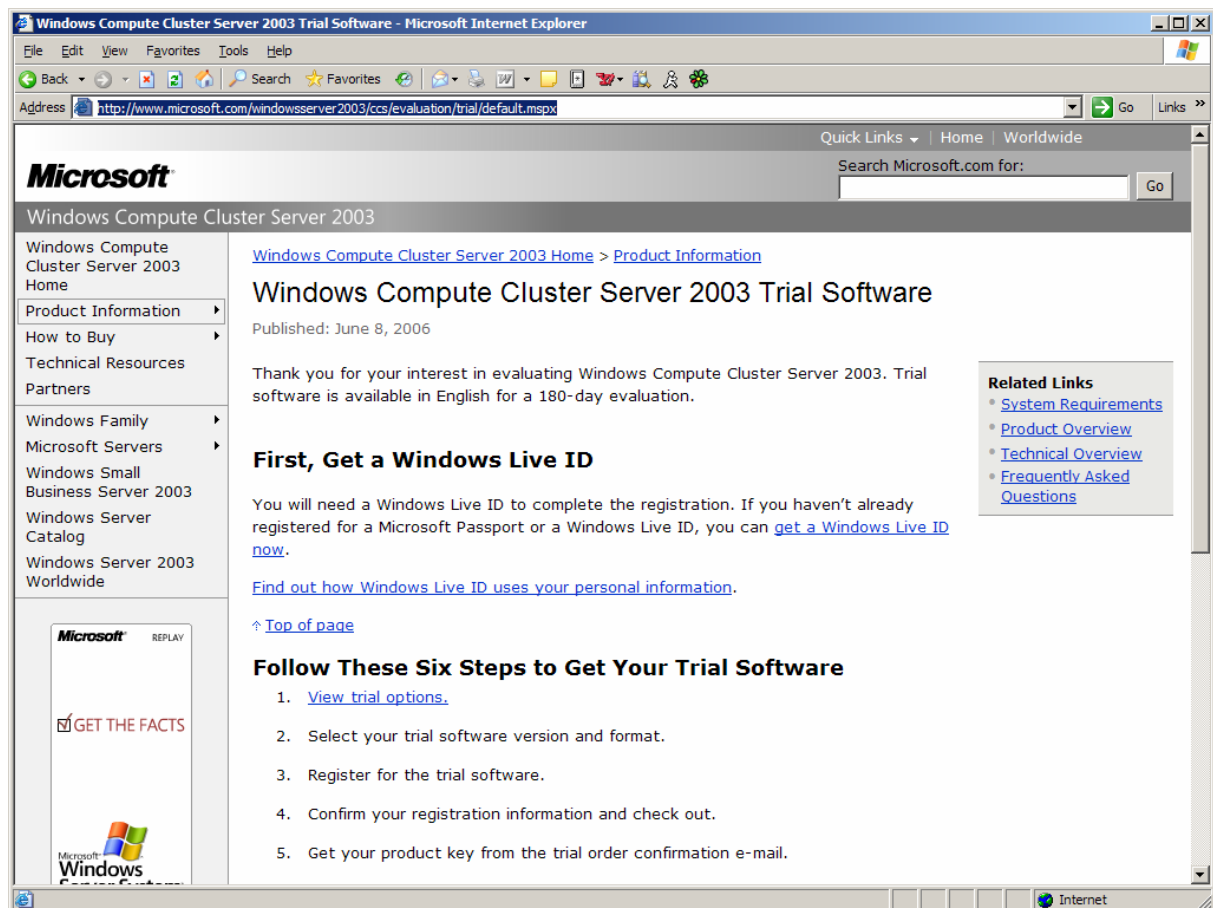
- There are 2 alternatives for obtaining the evaluation version: either downloading of the CD disk images from the Internet or the post order. You can select that method of delivery which is more convenient for you. It is assumed that you select the downloading of the CD images from the Internet. Click the link **Download the Software** to register in the system and to start downloading the images,
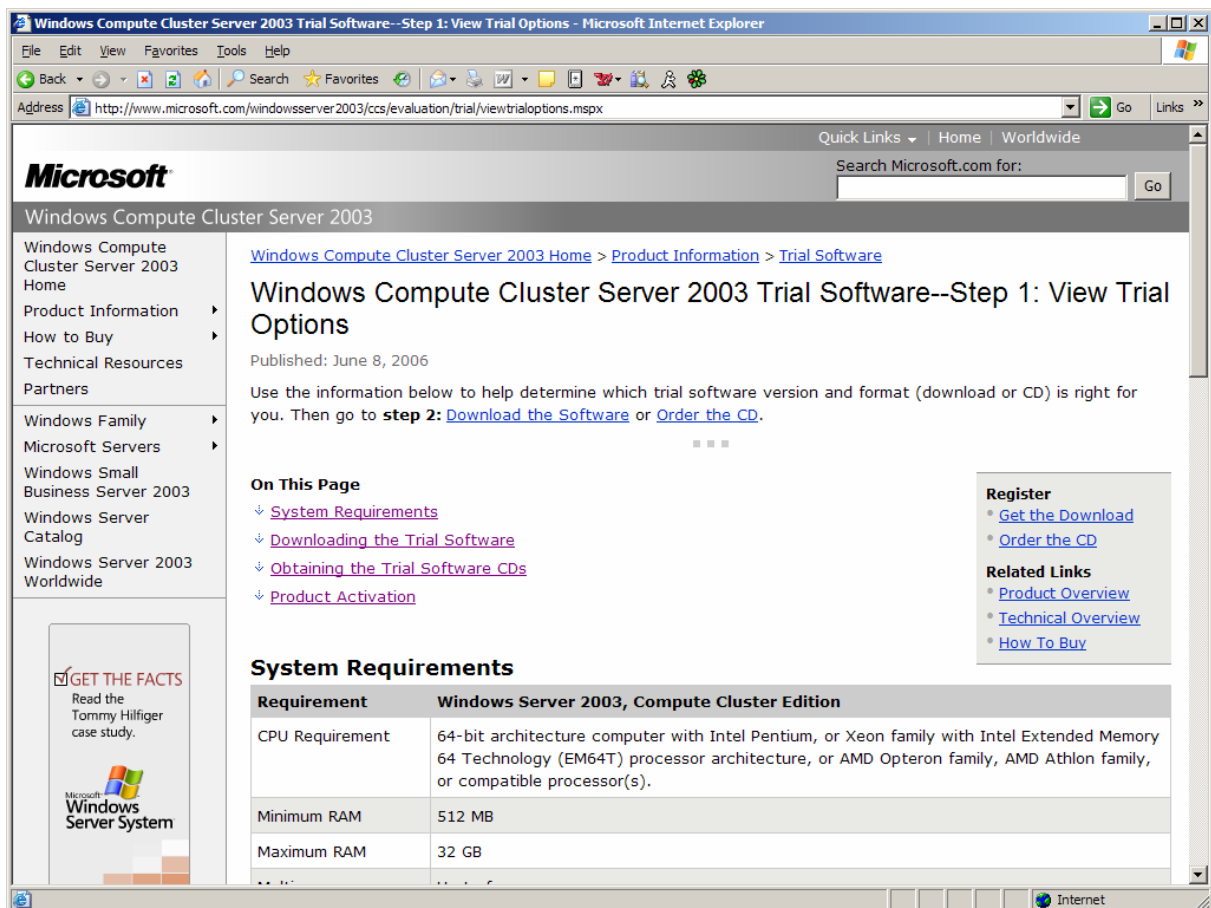
- Click **I agree** to start the registration,
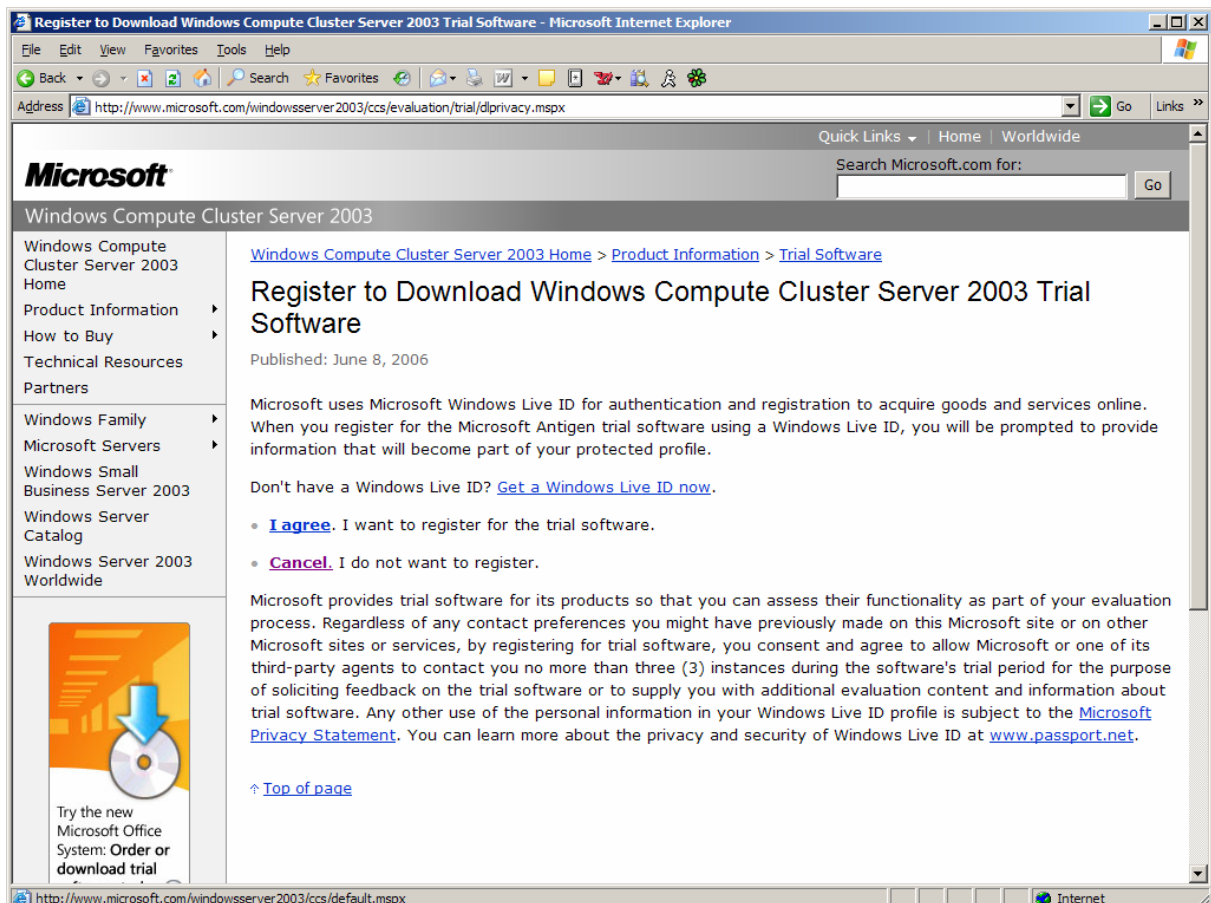
- Enter the .**NET passport,** which was registered in Task 1 and the **password**. Press the button **Sign In**,

- Select **Yes** if you are currently in the USA and **No** if otherwise. Press the button **Continue**,

- Fill the fields in the page form and press the button **Continue** at the bottom of the page,

- To confirm that the email address, which was entered in the form, is correct an email with a special link will be sent to you. You must click the link to confirm that the email address is correct,
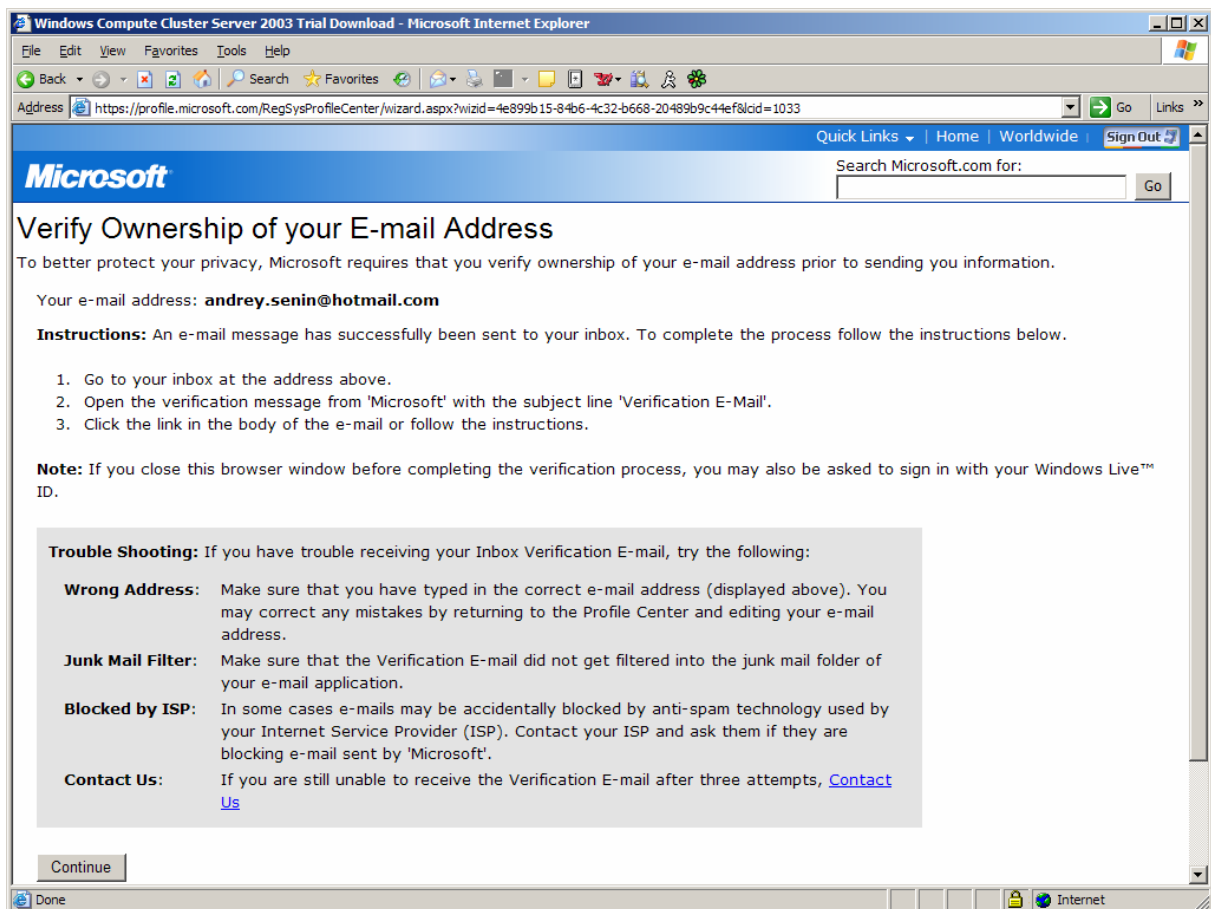
- Open your email client and find out the message with the subject **Verification E-mail** from **Microsoft**. Open the link in your browser. When the page is loaded press the button **Continue**,
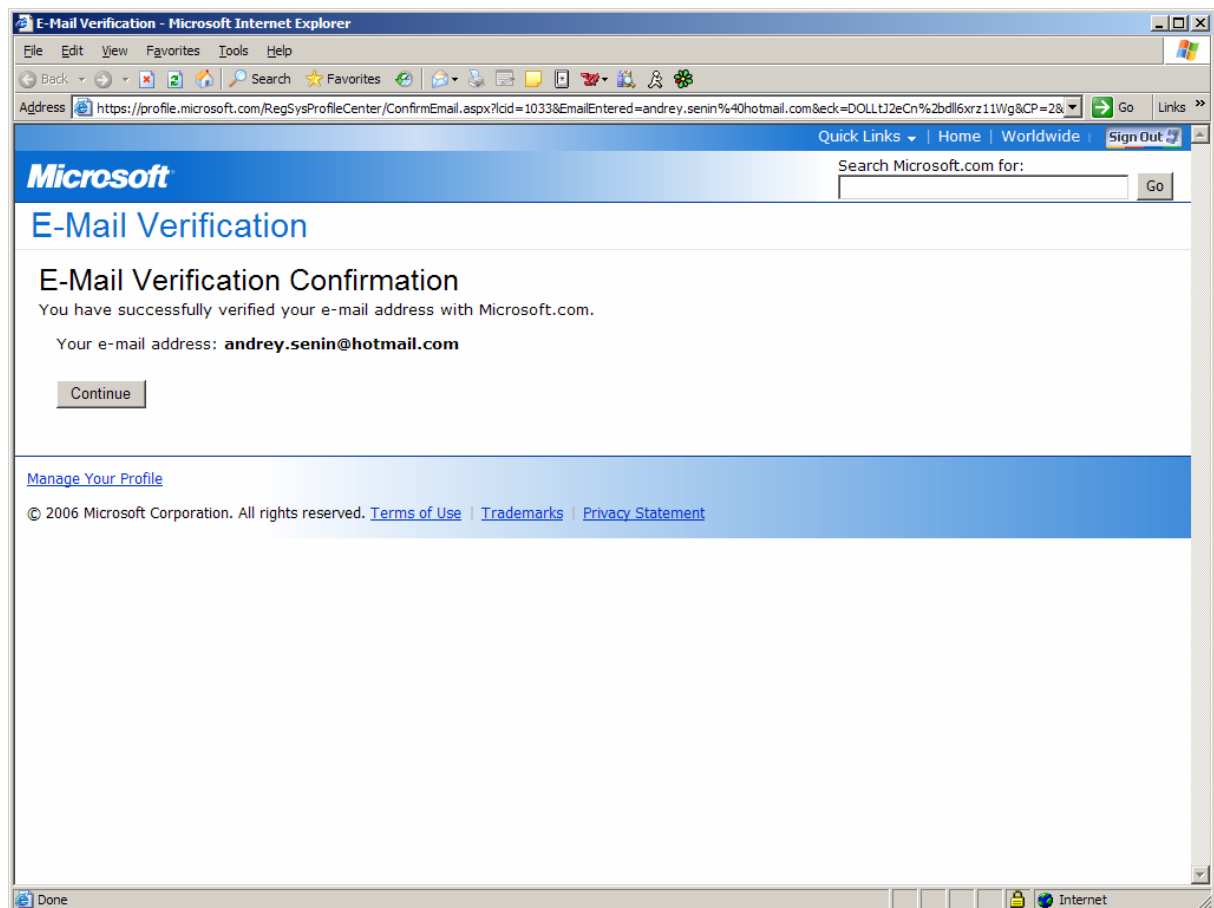
- In the list **Country** select the country when you want the bill be delivered (in case of downloading Microsoft Compute Cluster Server 2003 from the Internet no payment will be enforced, that's why the price in the bill will be equal to 0 USD). Press the button **Continue**,

- Enter your post address and your postal code. Press the button **Continue**,

- A copy of the bill will be shown in your browser ((in case of downloading Microsoft Compute Cluster Server 2003 from the Internet no payment will be enforced, that's why the price in the bill is 0 USD). There is the **Terms and Conditions** for using the evaluation version at the bottom of the page. Read the terms carefully. In case you agree with the conditions tick **I accept this agreement** and press the button **Place order**,
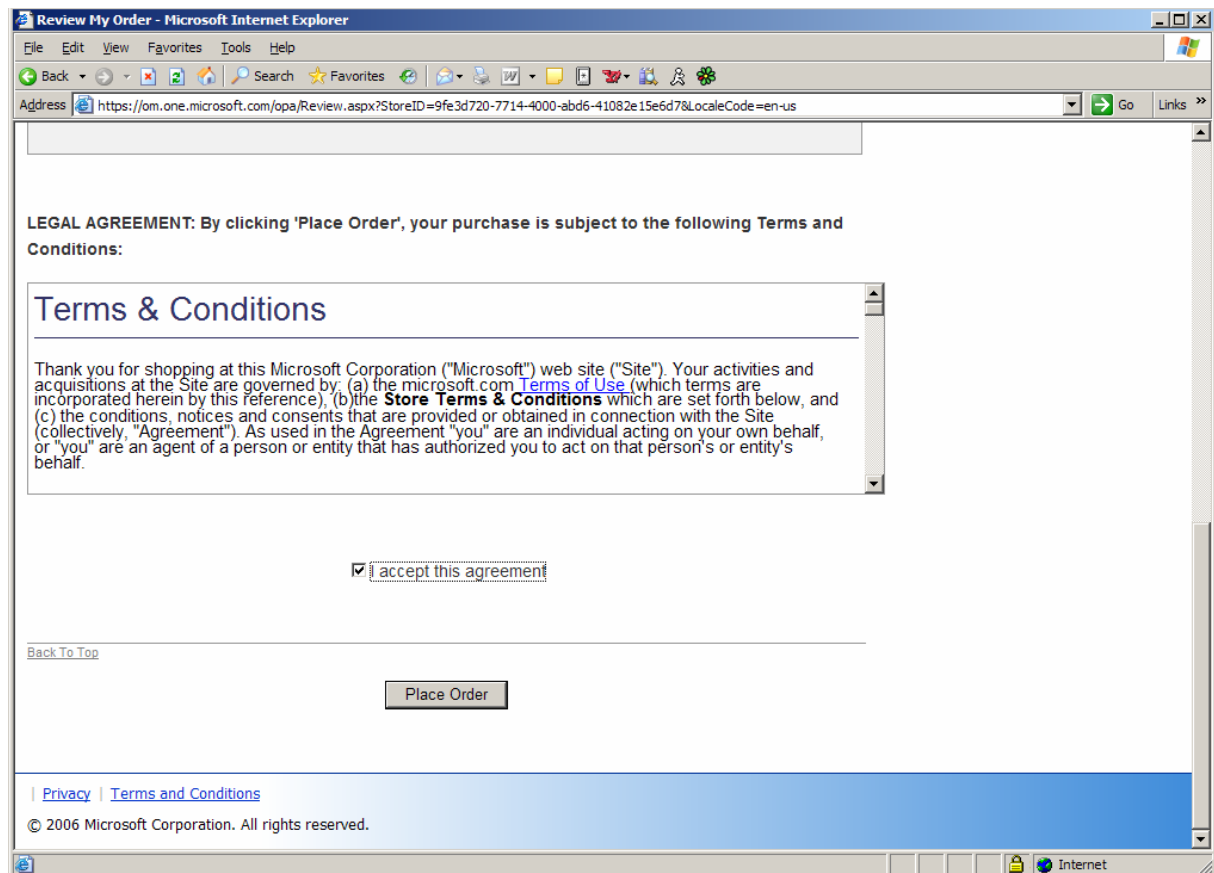
- The 180 days valid registration code of the product will be shown (the code is hidden with the "**X**" symbols). Click the link to start downloading Microsoft Compute Cluster Server 2003 (http://www.microsoft.com/windowsserver/ccs/trial/installinstruct.mspx),
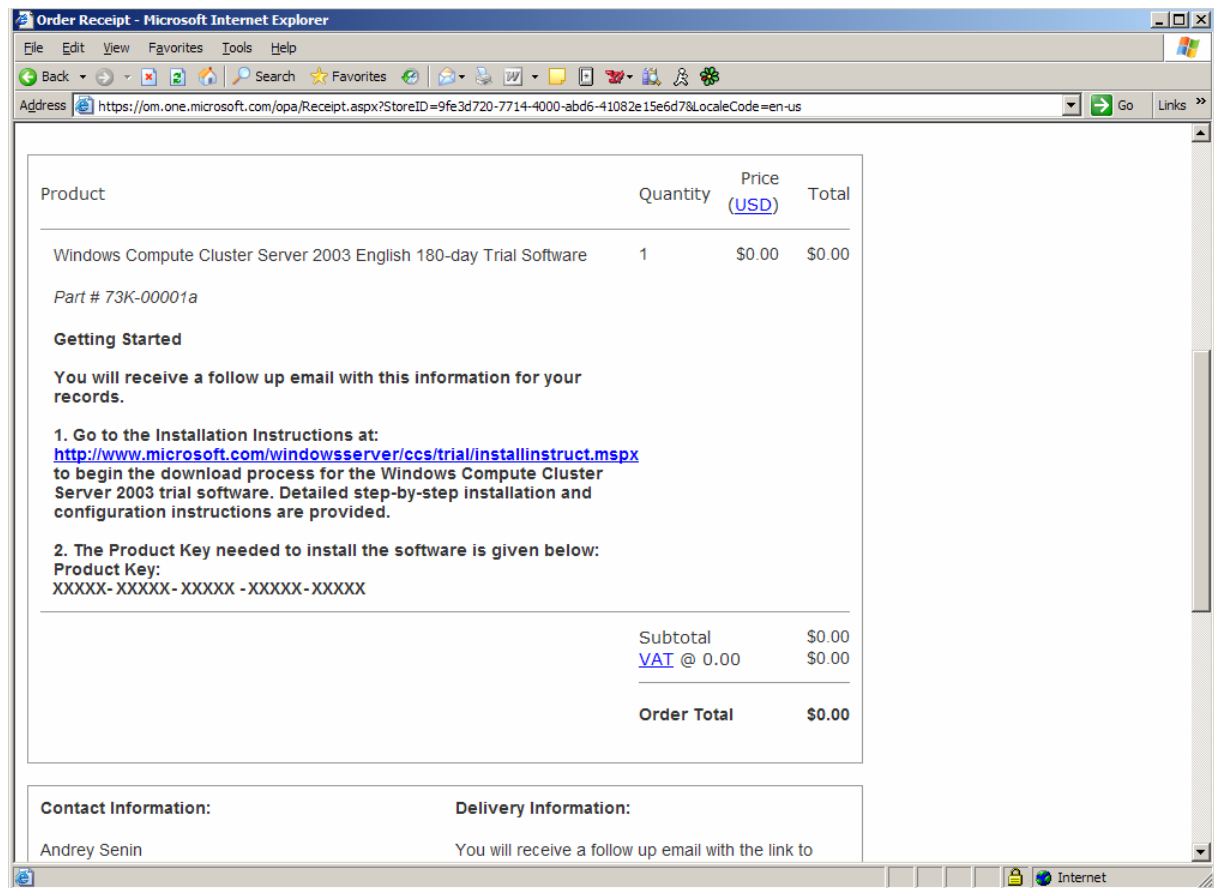
- The displayed page contains the links to the CD images of Microsoft Windows Server 2003, Compute Cluster Edition and Microsoft Compute Cluster Pack. You can download the images in the regular way (click on the link, press the button **Save** in the opened window, select a folder to save the image and press the button **Save**). You can save the CD images on CD or use any CD emulator,
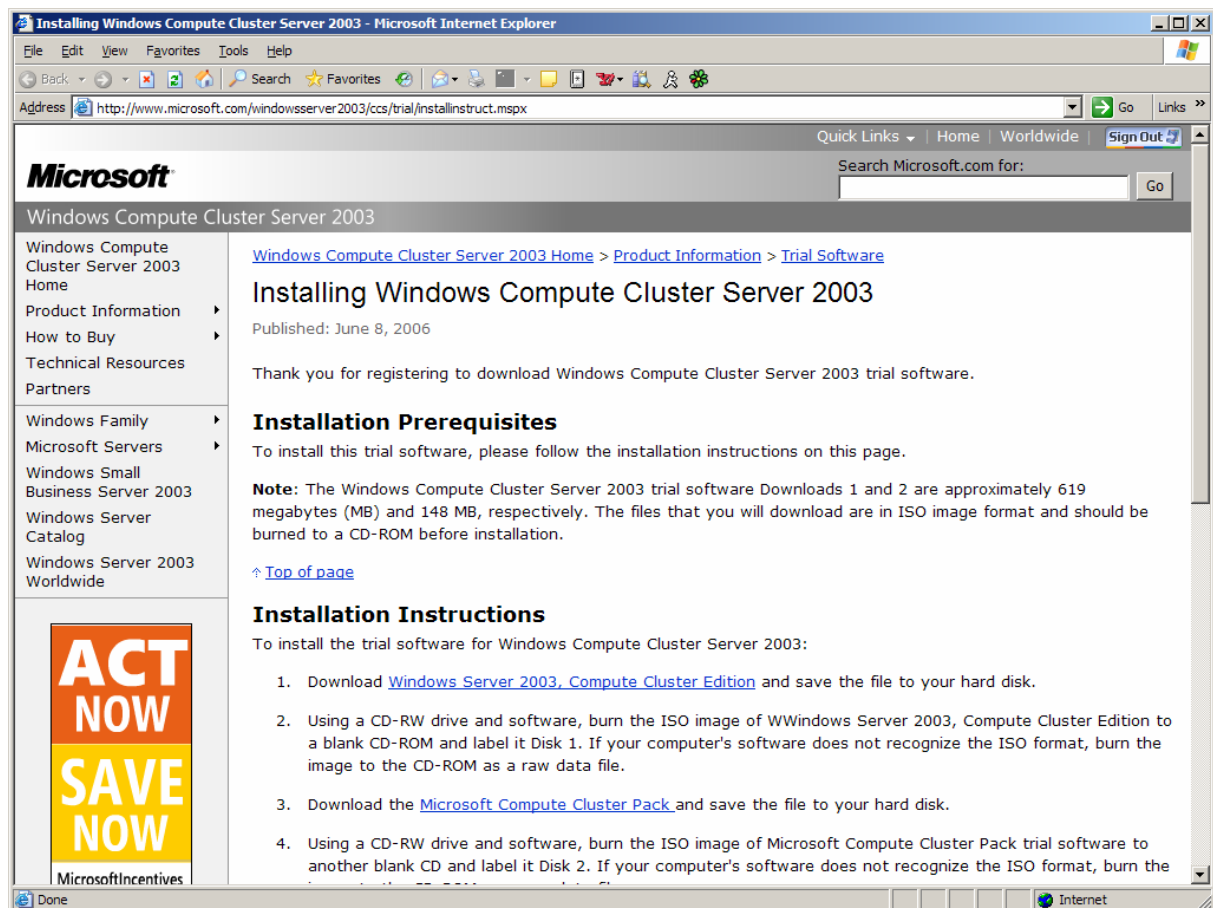
- The process of downloading Microsoft Compute Cluster Server 2003 is finished now.

Exercise 2 – Install the Head Node

It will be assumed in this Exercise and Exercise 3 that Microsoft Windows Server 2003 is already installed and configured in accordance with documentations for the operation system.

Know more about CCS 2003

Each computer operating under Compute Cluster Server 2003 belongs to one of the following three types:

- **Head node** is the node, which supports the queue of cluster jobs and distributes the jobs among the compute nodes,
- **Compute node** is the node, on which the programs are executed,
- **Client node** is the node, on which Microsoft Compute Cluster Pack (CCP) s installed for accessing the head node in order to queue the task, to obtain the computation results and to control the course of program execution.

The cluster can have only one head node, the number of compute and client nodes is not limited. A computer may combine several functions. Thus, the head node may be also a compute node and there may be client programs installed on the compute node.

The CCS installation should always start with installing the head node, which is done manually.

Task 1 – Install the Head Node

To install Microsoft Compute Cluster Pack on the cluster head node you should follow these step-by-step instructions:

- Start the installation program **setup.exe** in the folder, where you have downloaded Microsoft Compute Cluster Pack to. In the new window, press the button **Next**,
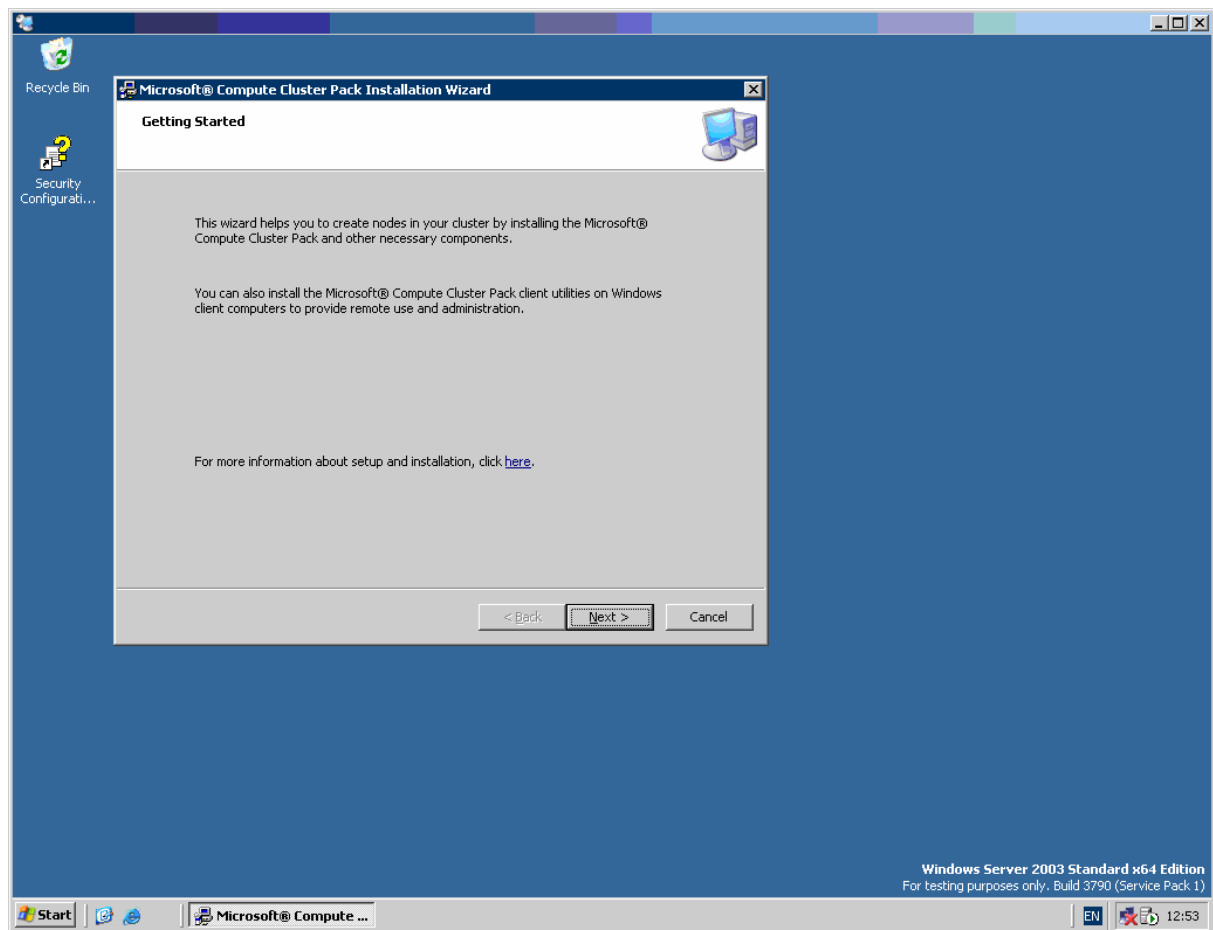
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- Read the license agreement carefully. Choose the option **I accept the terms in the license agreement** in case you agree to the license agreement terms of using CCS 2003 and press the button **Next**,
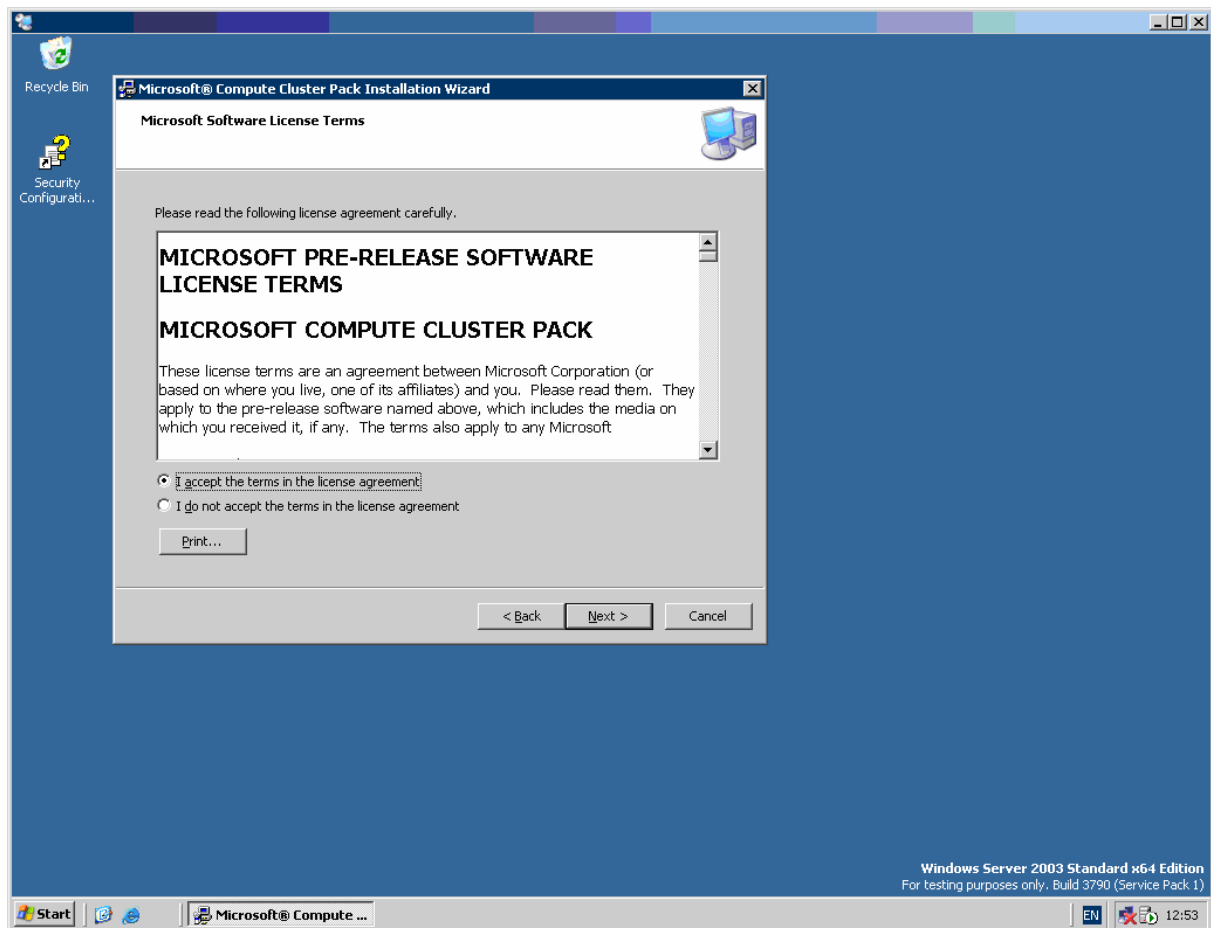
- In the new window choose **Create a new compute cluster with this server as the head node**. Tick **Use this head as a compute node** if you want to use the head node as a compute node also. Press the button **Next**,
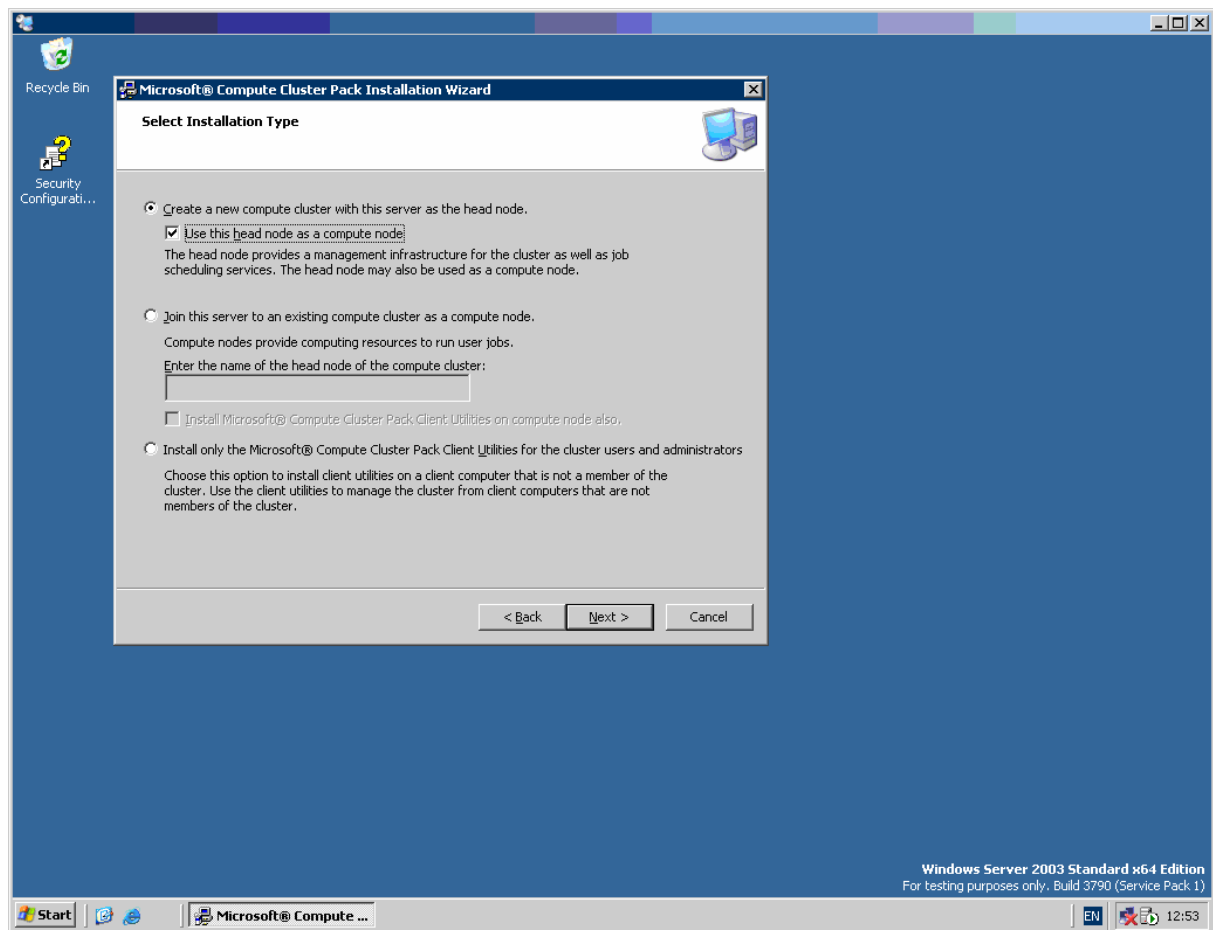
- Choose the directory where you are going to install CCP. To change the default directory, press the button **Browse…** and select the desirable directory. Press the button **Next**,

- Install all the software given in the list of the new window sequentially. In order to start the installation you should select the corresponding item in the list and press the button **Install**. The installation will be carried out according to the documentation for the program being installed. It is recommended that the installation should be carried out exactly in the order, which is given in the list. Microsoft Compute Cluster Pack is the last one to be installed,

- Wait till the program of CCP installation copies the required files,
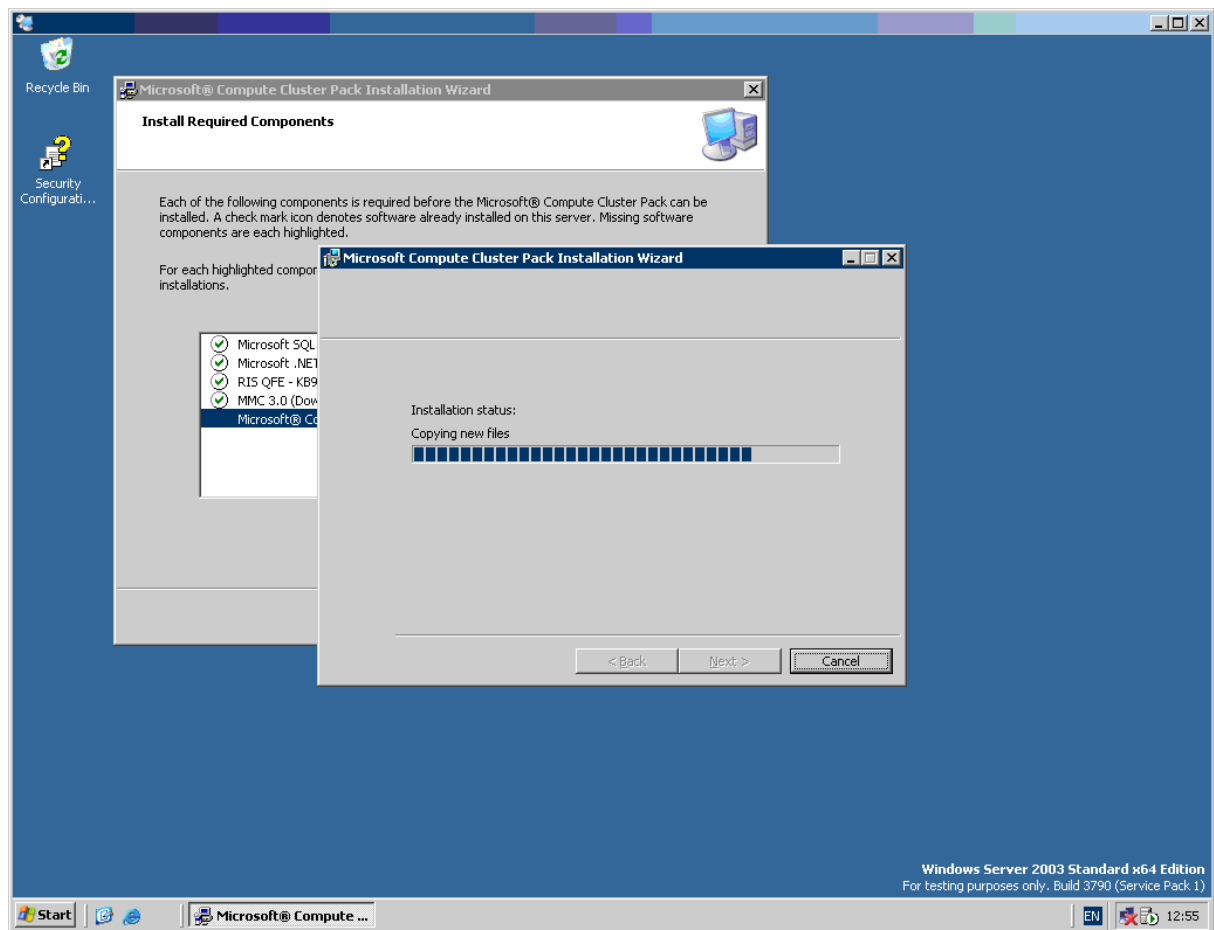
- After copying the necessary files, press the button **Finish**,
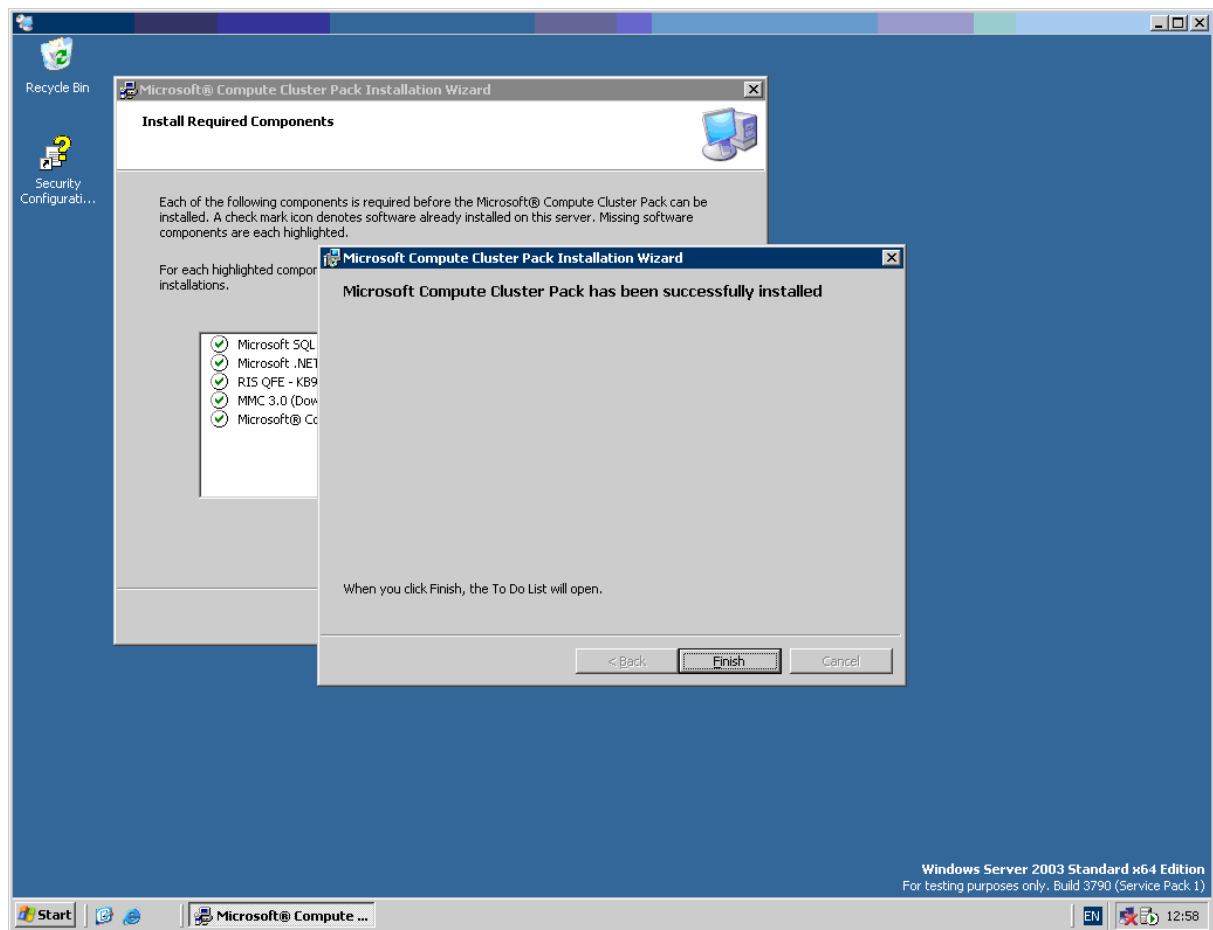
- This is the end of the head node installation and you may pass over to configuring the node.

Task 2 – Configure the Head Node

The window **To Do List**, which contains the list of system settings, will appear after the installation of the head node.
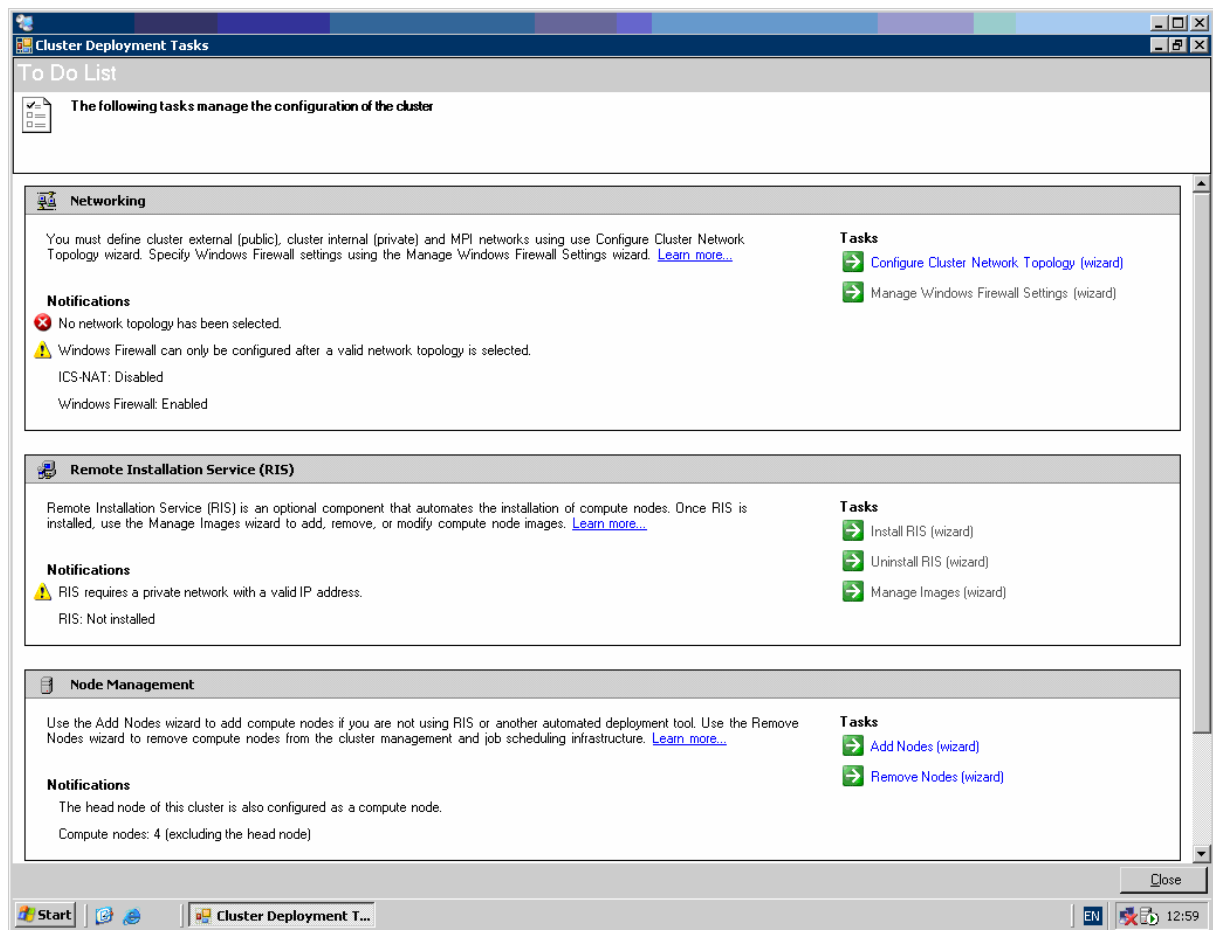
The list of settings includes the following:

- The item **Configure Cluster Network Topology (wizard)**, which makes possible to set the cluster network topology for optimum efficiency (see the subsection Cluster Network Topology below),

- The item **Manage Windows Firewall Settings (wizard)**, which allows the user to configure Microsoft Firewall (if the latter has been installed). Additional information on the setting is given in Compute Cluster Administrator Guide, supplied with CCS 2003,

- The item **Remote Installation Service (RIS)** which allows to control the system images for remote installing compute nodes. The use of RIS allows the user to decrease installation time significantly. However, the consideration of this problem is beyond the scope of this Lab. Additional information may be obtained in the documentation on Remote Installation Services,

- The item **Node Management**, which allows to add and eliminate compute nodes to and from the cluster. In case you use the approach described in this Lab, compute nodes are added automatically,

- The item **User Management**, which makes possible to give rights to the users of the CCS 2003 cluster (see the section Cluster User Management below).

Cluster Network Topology

Microsoft Compute Cluster 2003 makes possible to choose the most suitable cluster network topology among the 5 predetermined topologies. The correct choice of the topology will allow you to optimize the execution of your MPI program and the cluster as a whole. The following concepts are used for the description of the topologies:

- **Public network** is a corporate organization network connected to the head node and (possibly) to the compute cluster nodes. The users connect to the head node via the public network in order to control the execution of their programs. MPI traffic will be directed through the public network only if there is no private network or MPI network,

- **Private network** is a dedicated network aimed at communicating between the compute cluster nodes. This network (if it is available) will be used for administrative traffic (the remote desktop, the installation of compute nodes with the use of RIS etc.). Besides, if there is no special MPI network, MPI traffic will be directed through the private network,

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- **MPI network** is a dedicated network (which is probably the fastest one among all the mentioned networks), through which the traffic of MPI programs is directed. If you program does not use MPI libraries to transmit messages in the network, then MPI network will not be used.

Below you will see the description of the network topologies used in CCS 2003:

- **All nodes only on Public network**. All the nodes in this configuration are connected to the public network (and only to the public network). All the network traffic (MPI and administrative traffic) is directed through the public network,
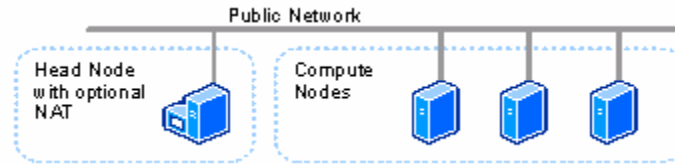
- **All nodes on Public and Private networks.** All the nodes in this configuration are connected to the public and the private networks. All the network traffic (MPI and administrative traffic) is directed through the private network,
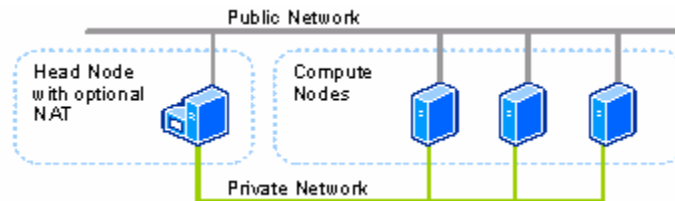

- **Compute nodes isolated on Private networks.** Only the head node in this configuration is connected to the public network while all the compute nodes may get access to the public network only via NAT service (the service of network address transformation) on the head node. The network traffic (MPI and administrative traffic) is directed through the private network,
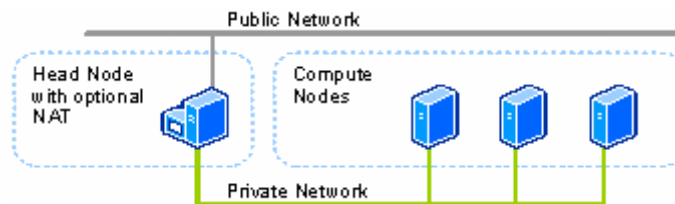
- **All nodes on Public, Private and MPI networks.** All the nodes in this configuration are connected to public, private and MPI networks. The administrative traffic is directed through the private network and MPI traffic –through the MPI network,
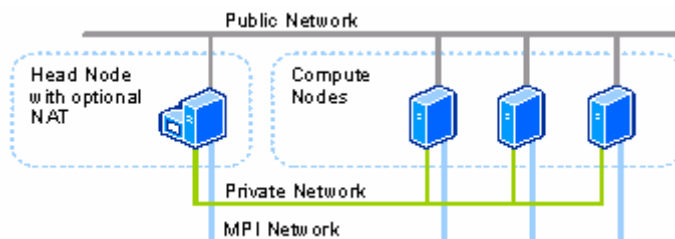
- **Compute nodes isolated on Private and MPI networks.** Only the head node is connected to the public network while all the compute nodes may access the public network only by means of NAT service on the head node. The administrative traffic is directed through the private network and MPI traffic –through the MPI network.

Cluster User Management

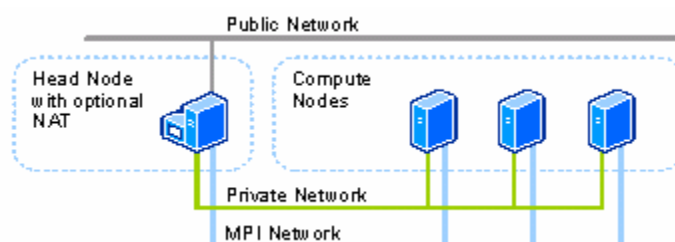The User Management Wizard (the button **Manage Cluster Users and Administrators**) makes possible to set the required rights to the CCS 2003 cluster users. Follow these step-by-step instructions to set the rights to the users:

- Select the item **Manage Cluster Users and Administrators** in the list **To Do List**,
- Press the button **Next** in the new window,
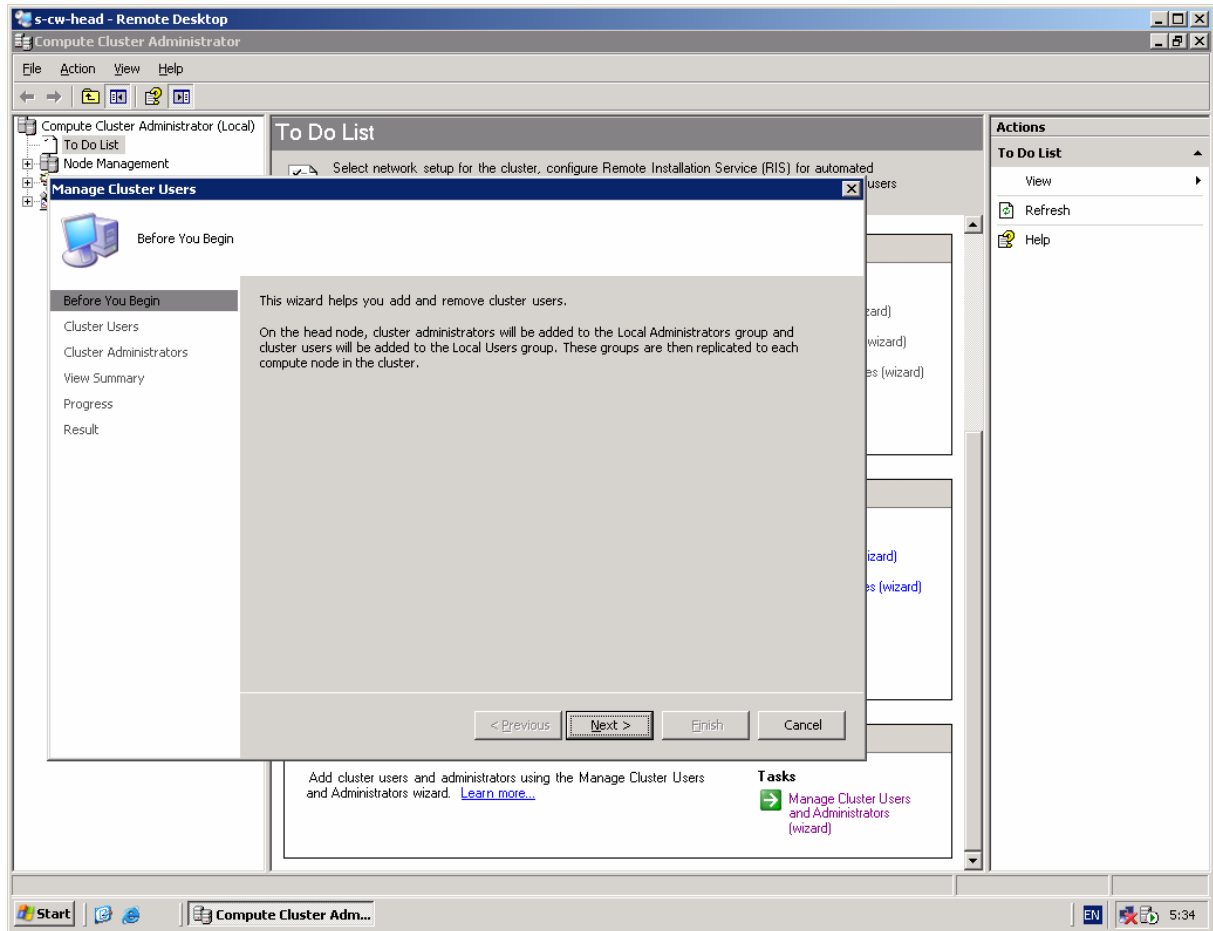
- You will see the list of users and groups, who are allowed to launch the programs on the cluster. To add a new user or a group, enter the name in the field **Add a user or group using the format domain\user"** and press the button **Add**. To delete a user or a group from the list use the button **Remove**. After the editing of the user list press the button **Next**,
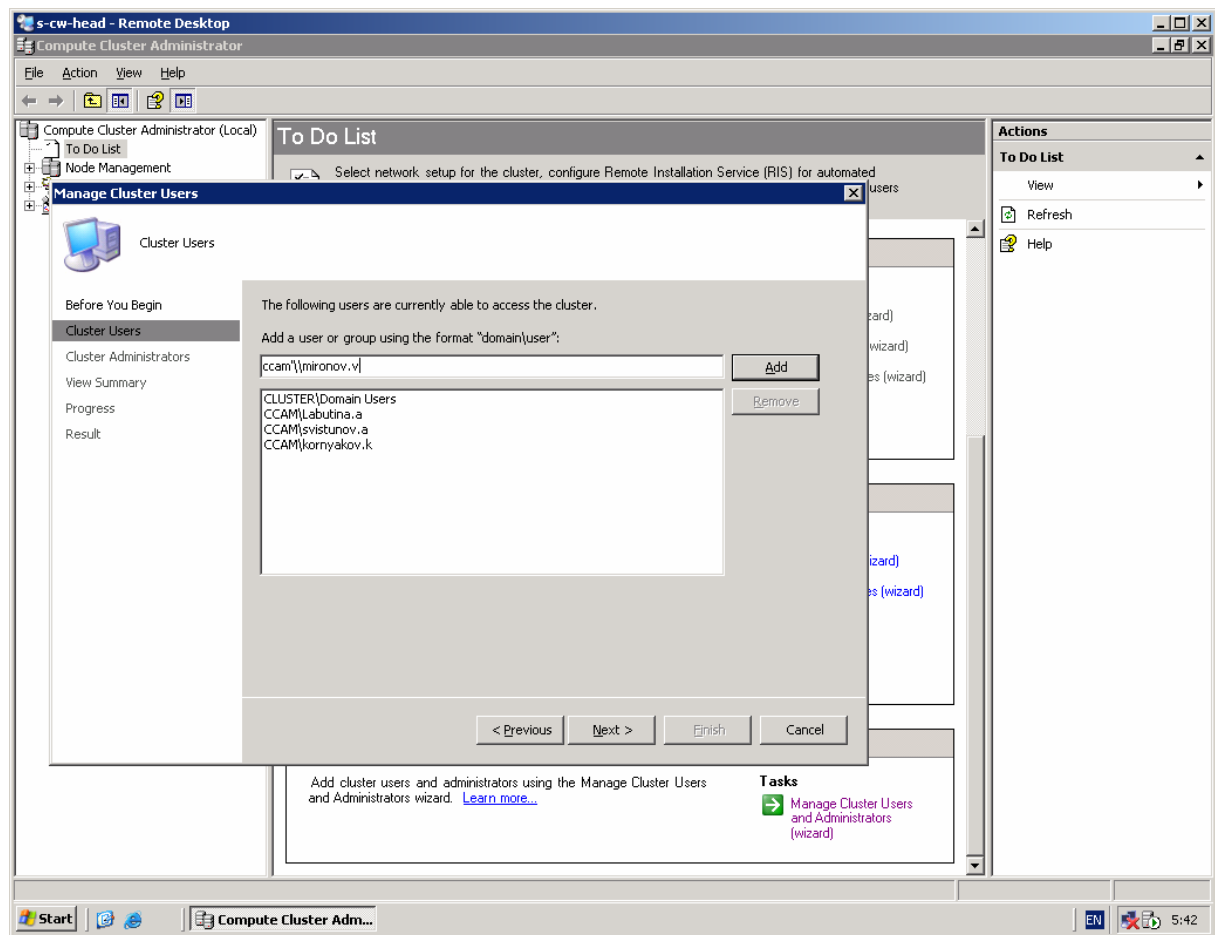
- You will see the list of users and groups, who have the CCS 2003 administrator rights. The administrators have the right to add and delete the nodes to and from the cluster, to cancel the tasks of other users and have some additional rights. The method of editing the list is analogous to the one described for the previous window. After the editing of the administrator list press the button **Next**,
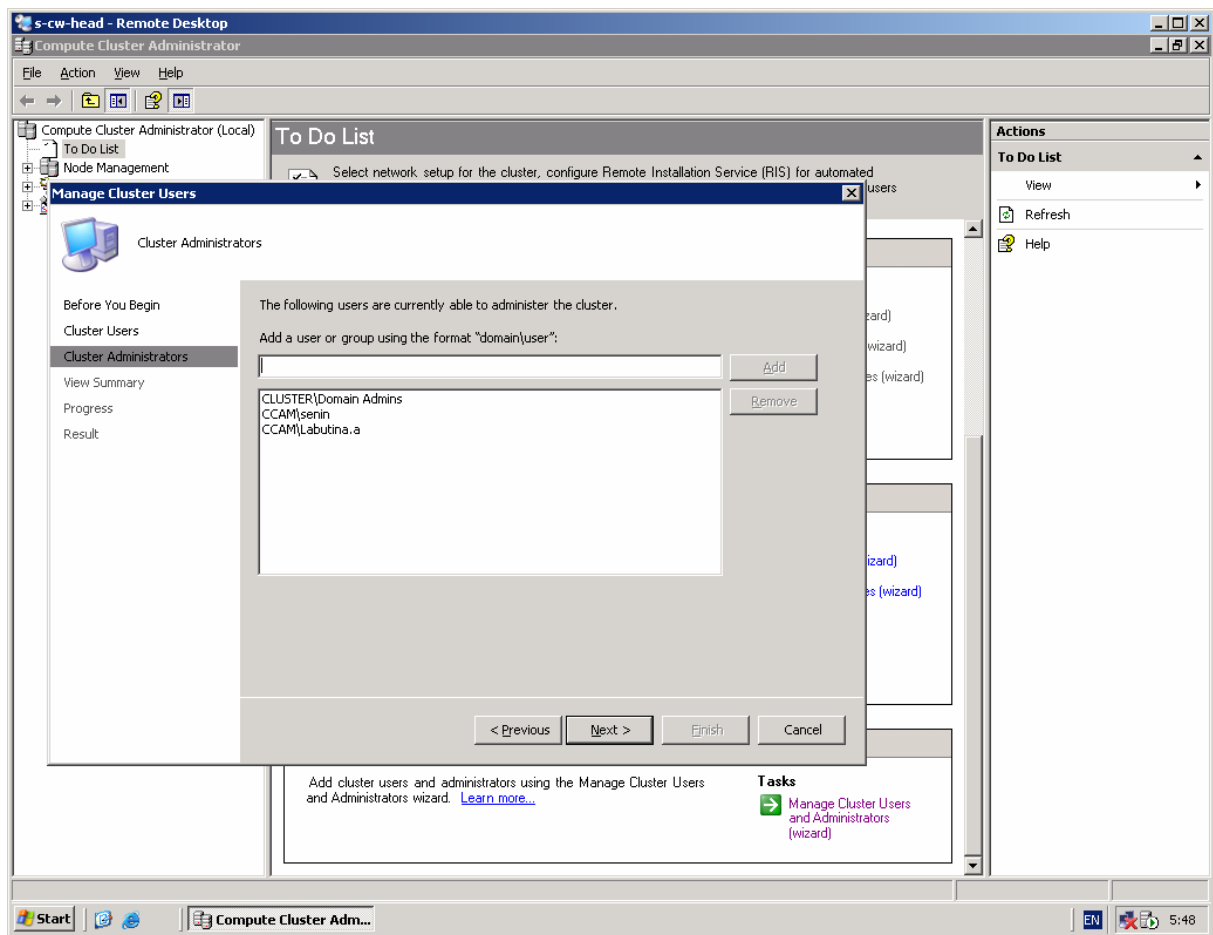
- In the new window press the button **Finish** to complete the editing of the cluster users.

Exercise 3 – Install the Compute Node

There are two types of compute node installation possible:

- Manual installation of each node,
- Network installation with the use of Remote Installation Service (RIS).

The second approach is preferable for the clusters with medium and large number of compute nodes, as it makes possible to make the installation process maximum automated and to reduce the installation time considerably. However, this approach is not described in this Lab, as learning the RIS has to be the subject of another Lab.

Task1 –Install the Compute Node Manually

In order to install Microsoft Compute Cluster Pack on the compute cluster node, follow these step-by-step instructions:

- Start the installation program **setup.exe** in the folder containing Microsoft Compute Cluster Pack. Press the button **Next** in the new window,
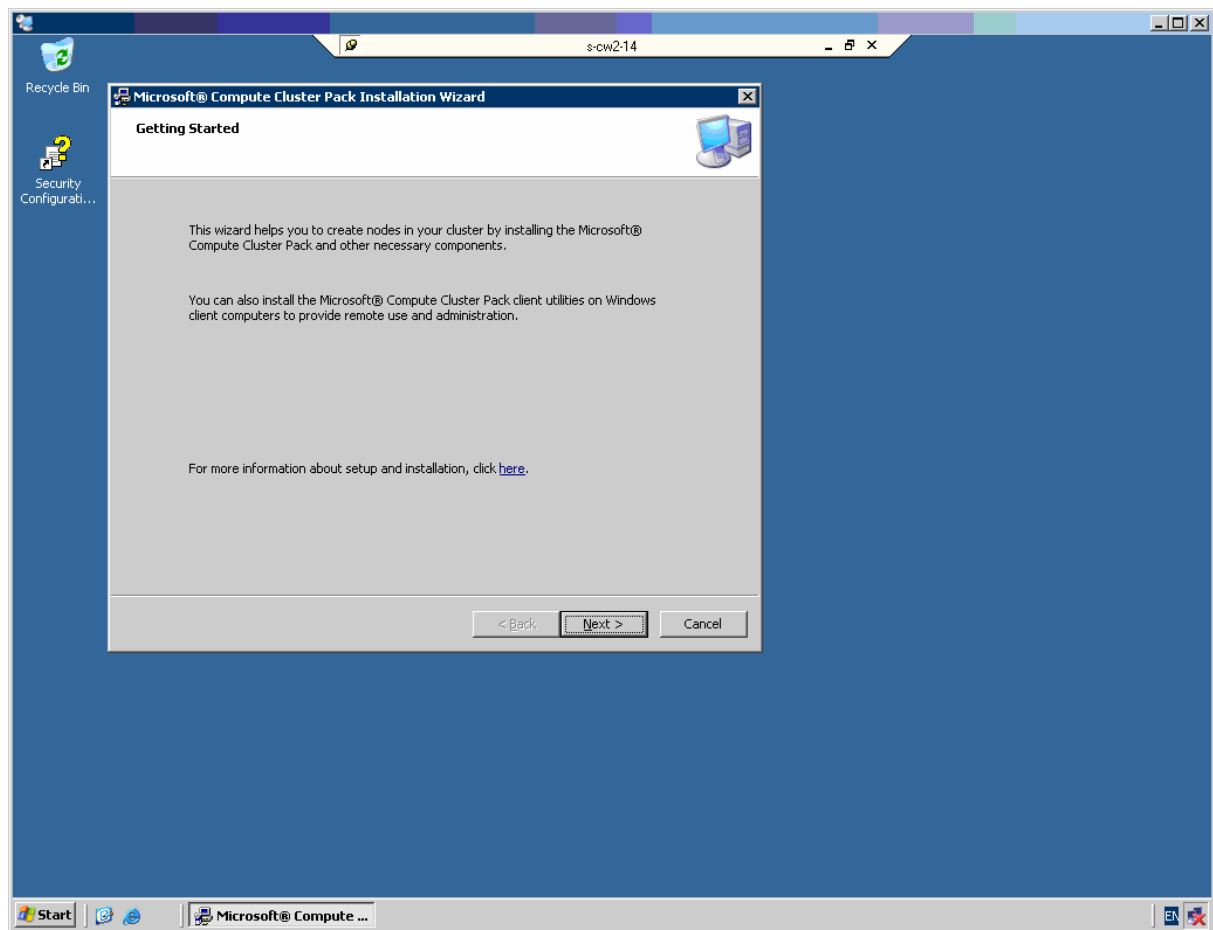
- Read the license agreement carefully. Choose the option **I accept the terms in the license agreement** in case you agree to the license agreement terms of using CCS 2003 and press the button **Next**,
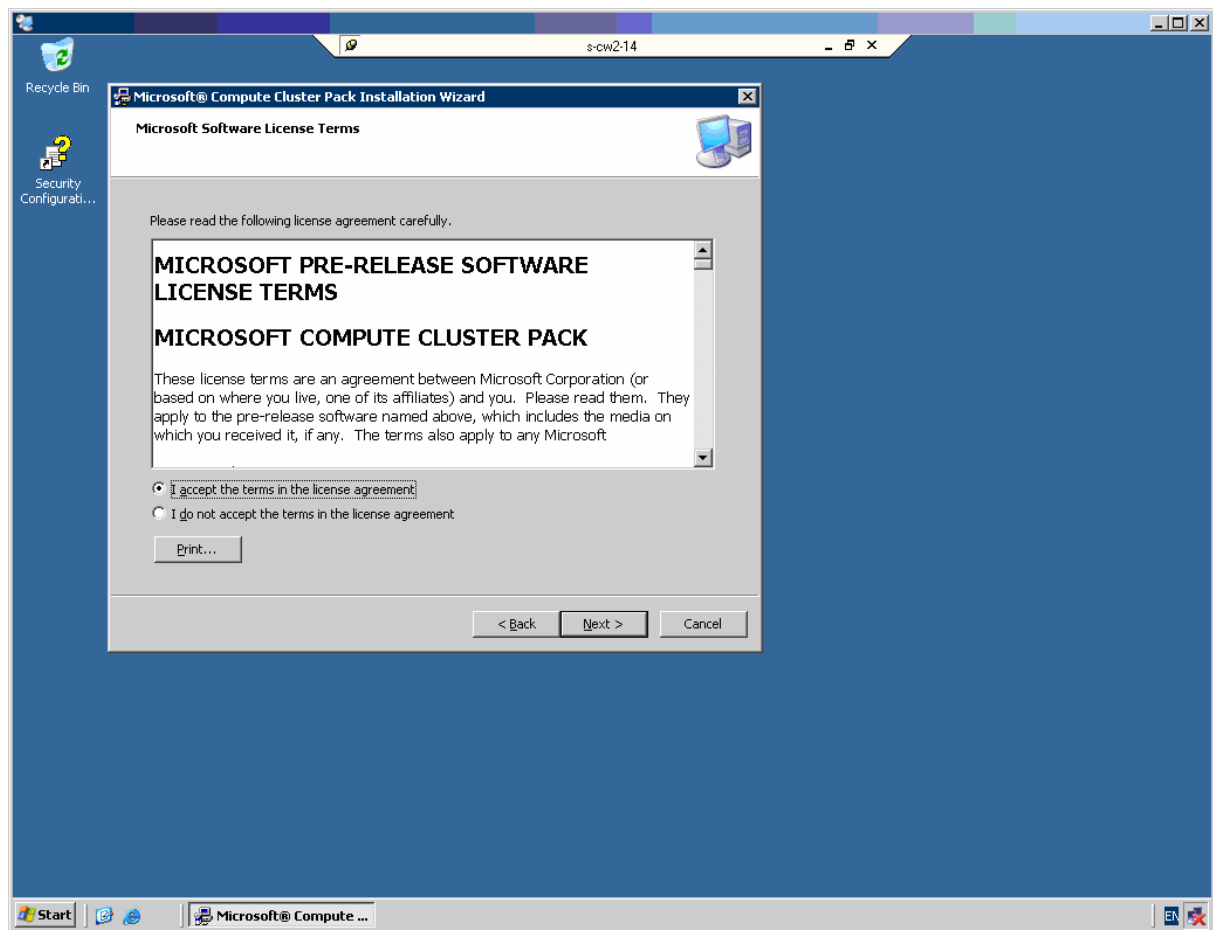
- In the new window choose **Join this server to an existing compute cluster as a compute node**. Enter the name of the head node in the field **Enter the name of the head node of the compute cluster**. If you want to install client utilities (in order to look through the job queue or/and to manage the compute nodes) tick **Install Microsoft Compute Cluster Pack Client Utilities on compute node also**. Press the button **Next**,
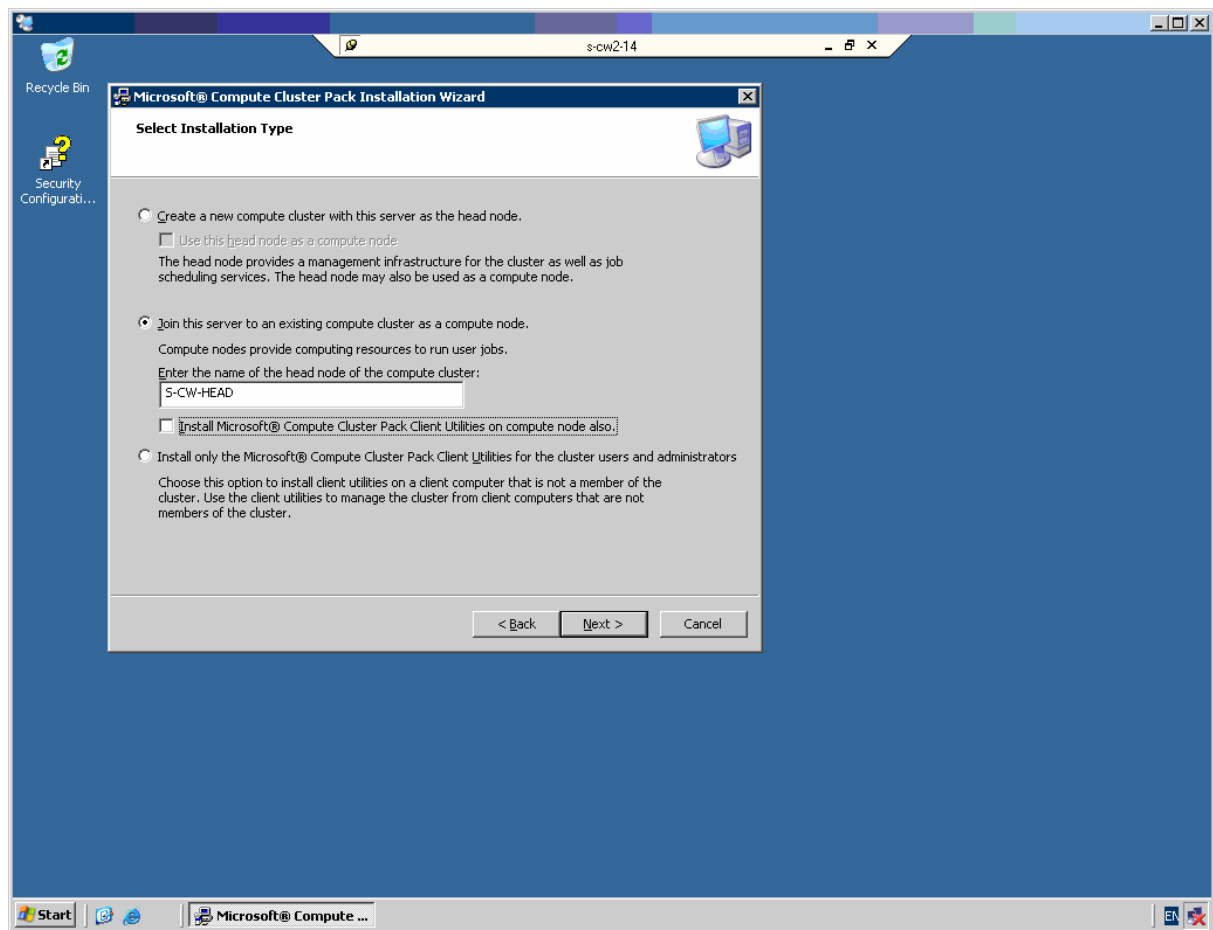
- Choose the directory where you are going to install CCP. To change the default directory press the button **Browse…** and select the desirable directory . Press the button **Next**,
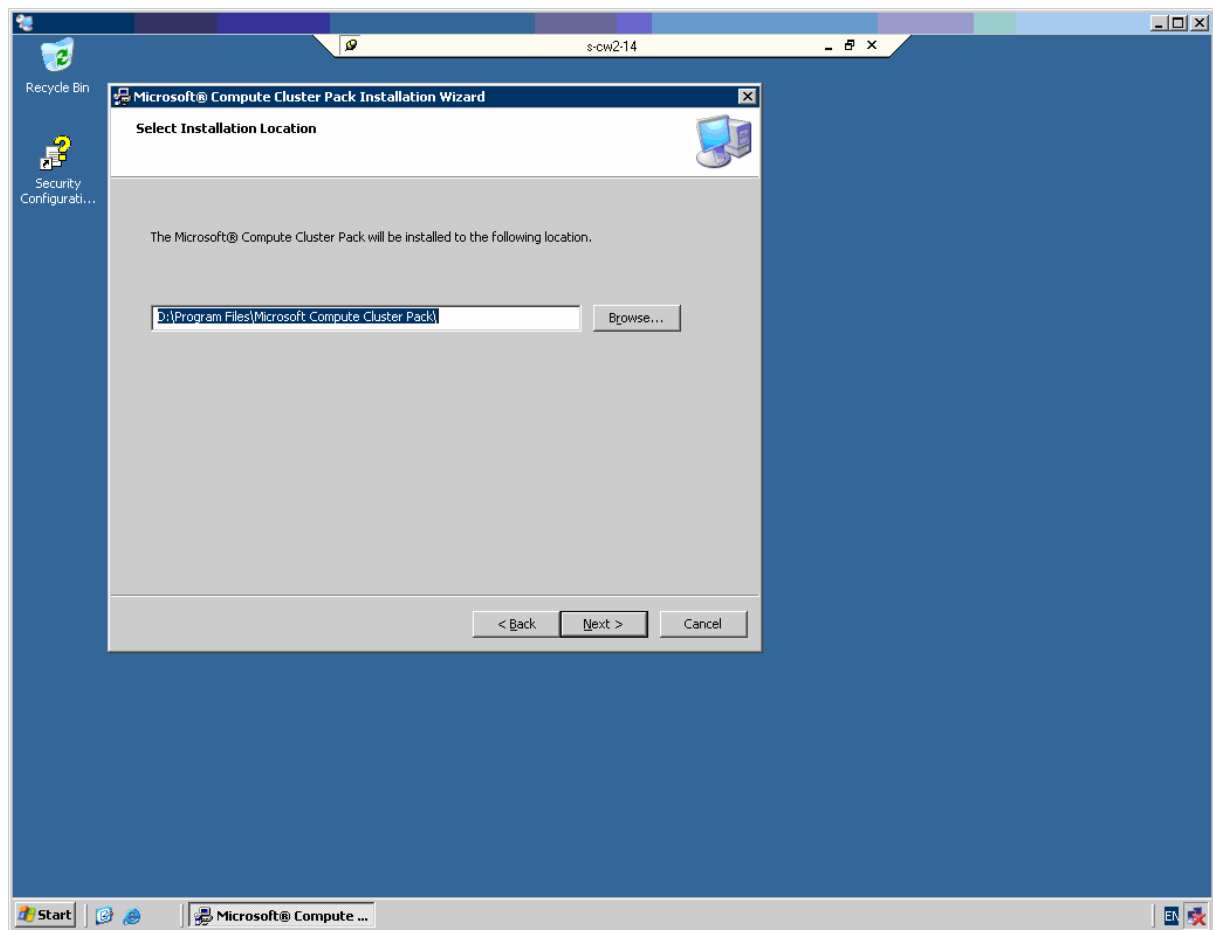
- Install all the software given in the list of the new window sequentially (usually you will need only Microsoft .NET Framework 2.0). In order to start the installation you should select the corresponding item in the list and press the button **Install**. The installation will be carried out according to the documentation for the program being installed. It is recommended that the installation should be carried out exactly in the order, which is given in the list. Microsoft Compute Cluster Pack is the last one to be installed,

- Wait till the installation program copies all the requires files,
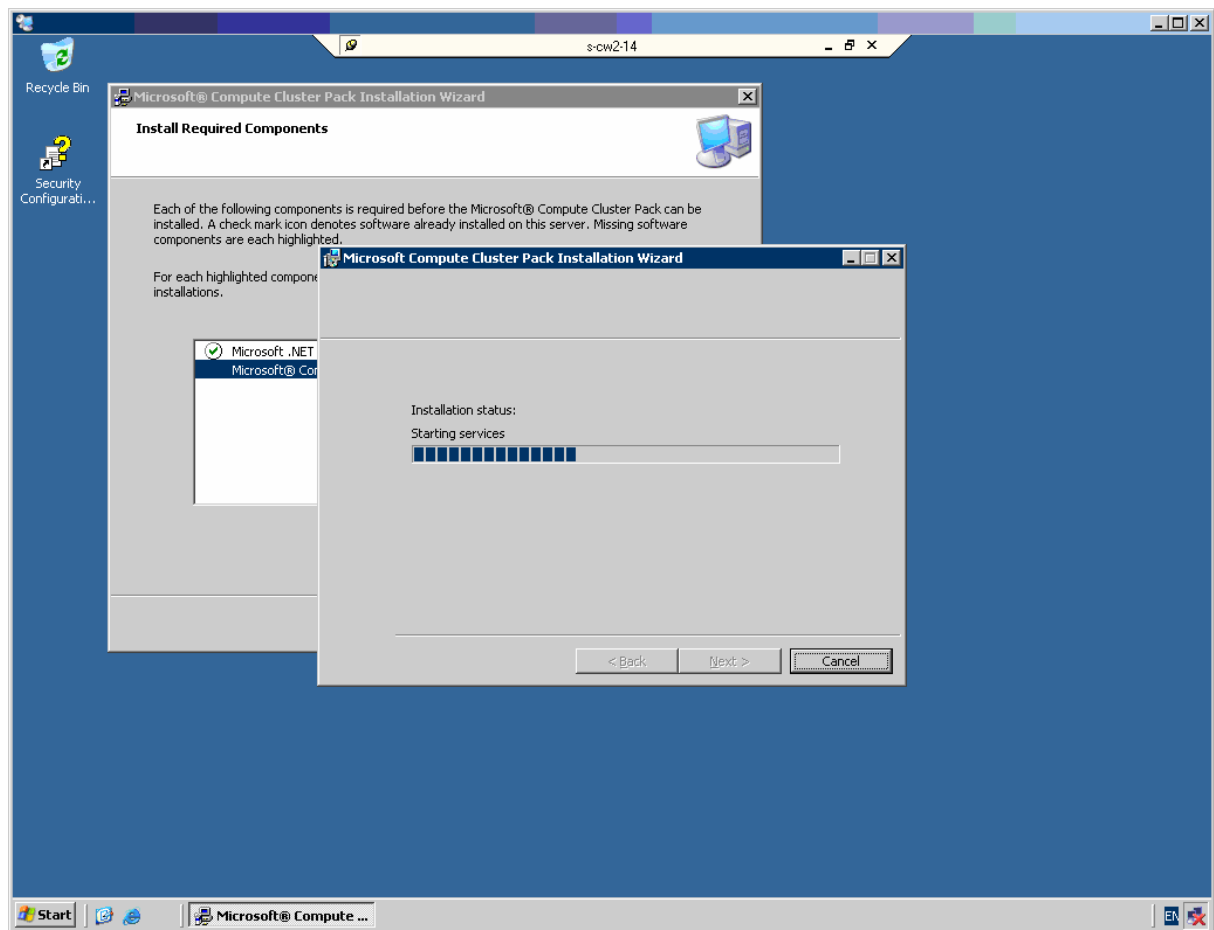
- When the files are copied, press the button **Finish**,
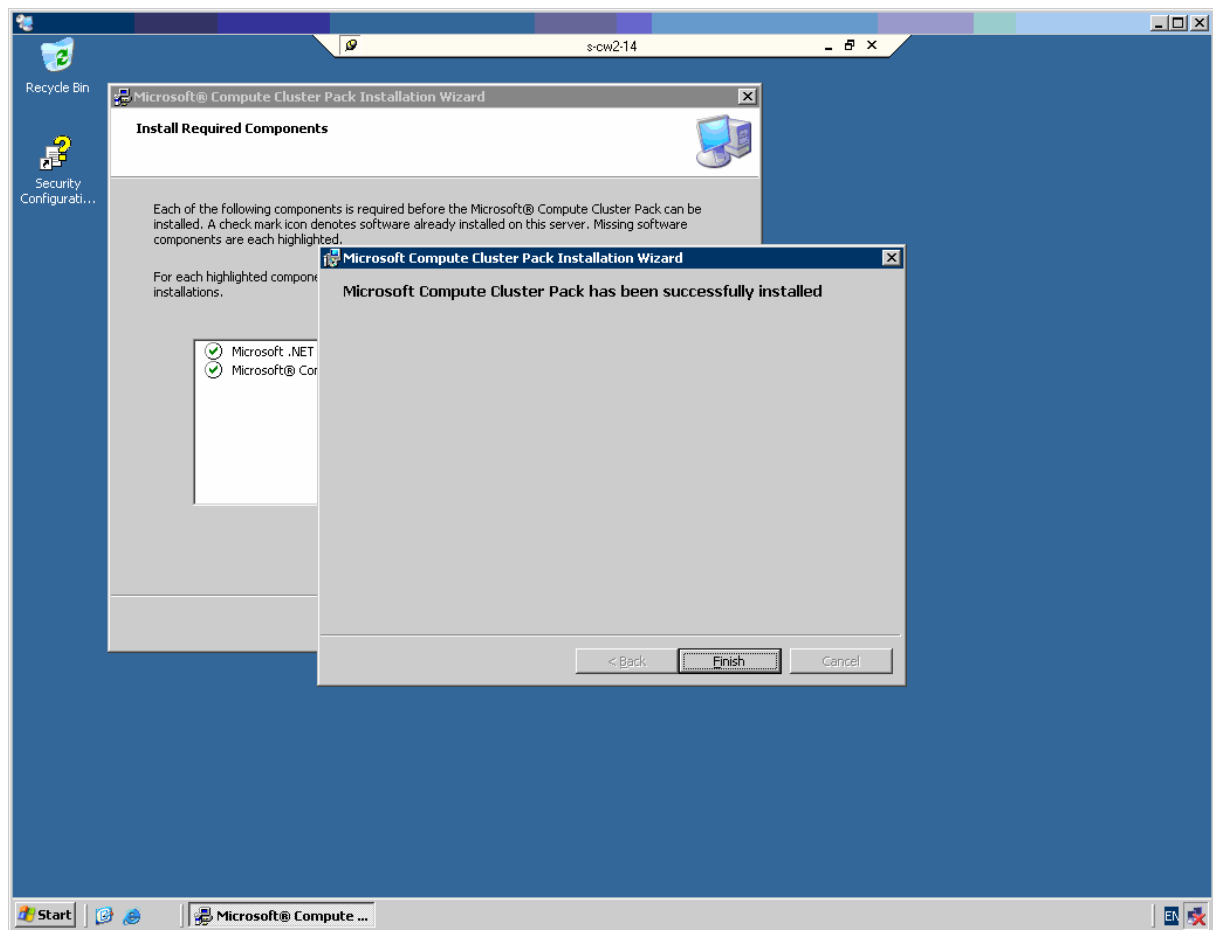
- The installation of software for the compute node is finished. Now it is necessary to approve the use of the compute node. Connect to the head node of CCS 2203 as the administrator, open the cluster administrator console (**Compute Cluster Administrator**): **Start->All Programs->Microsoft Compute Cluster Pack->Compute Cluster Administrator**. A new installed node with the status "**Pending Approval**" will appear in the list of the compute nodes. Click on the node with the right mouse button and choose the option **Approve** in the context menu. To activate the node click the right mouse button once again on the node and choose the option **Resume**.
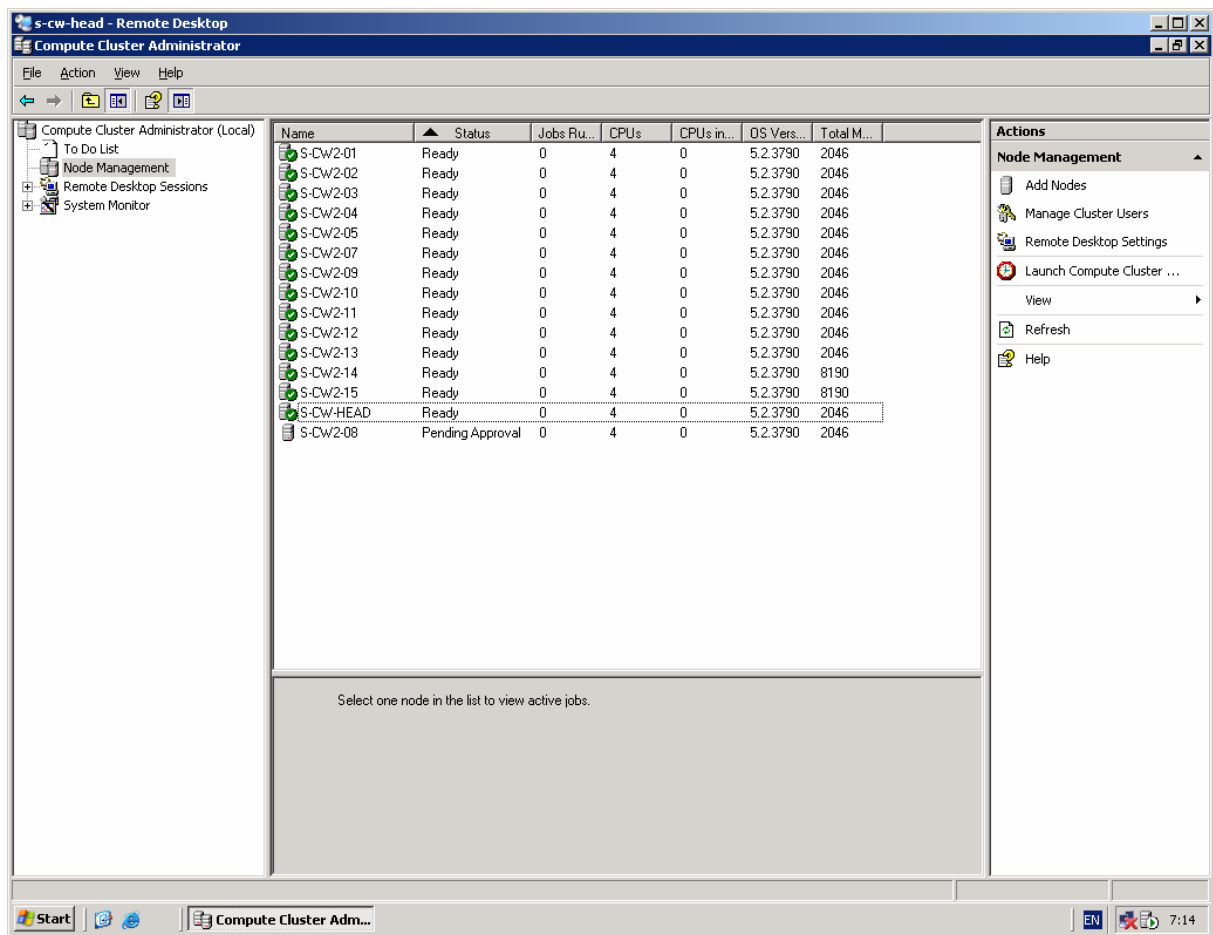
- This is the final step of the manual node installation.

Exercise 4 – Install the Client Node

In order to submit new jobs to execute on the cluster, to receive the results of the computational experiments, to control the course of computations and also (if you have the required rights) to execute administrative operations on the CCS 2003 cluster, it is necessary to install the corresponding software on the client node.

Task 1 – Configure the Client Node

To install the software Microsoft Compute Cluster Pack on the client node, follow these step-by-step instructions:

- Start the installation program **setup.exe** in the directory containing Microsoft Compute Cluster Pack. Press the button **Next** in the new window,
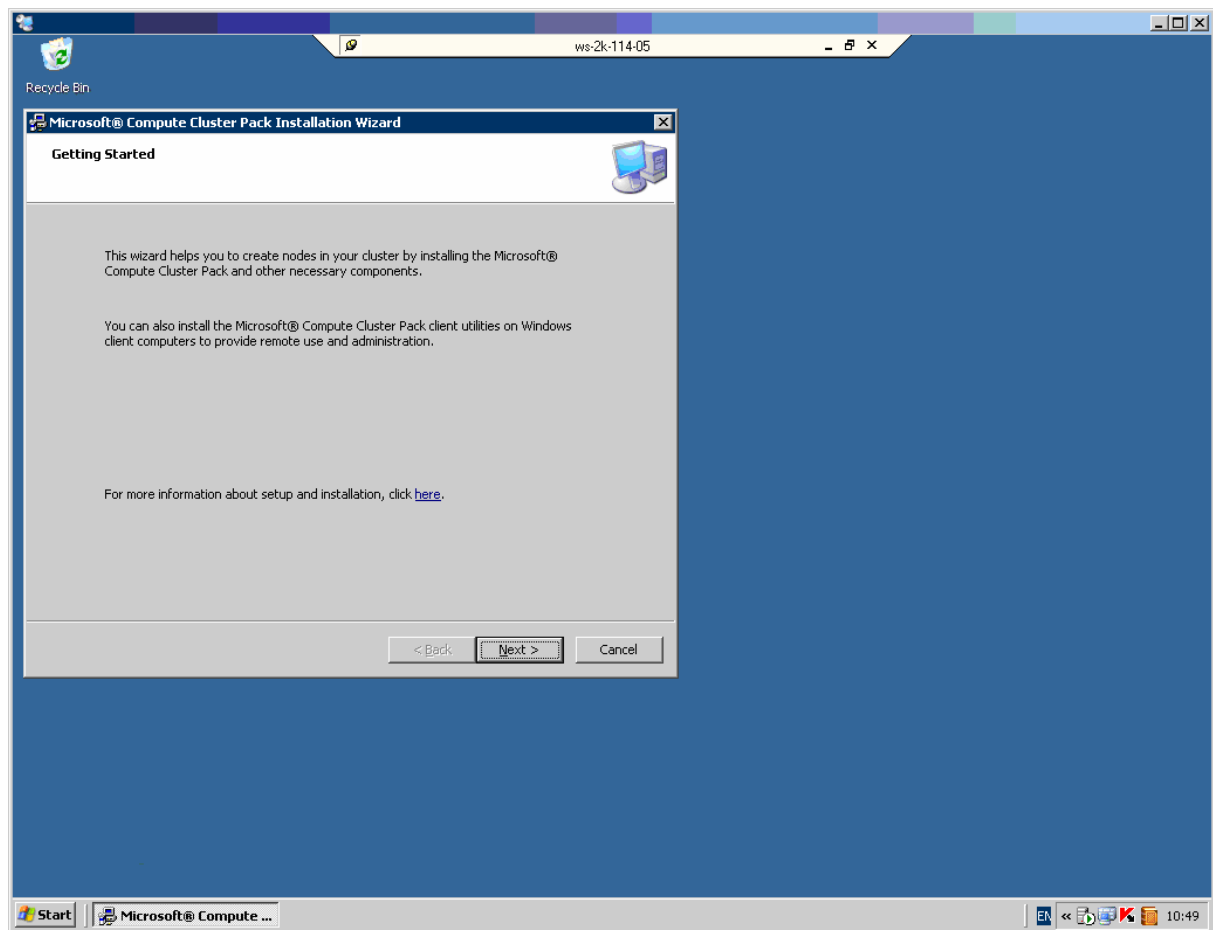
- Read the license agreement carefully. Choose the option **I accept the terms in the license agreement** in case you agree to the license agreement terms of using CCS 2003 and press the button **Next**,
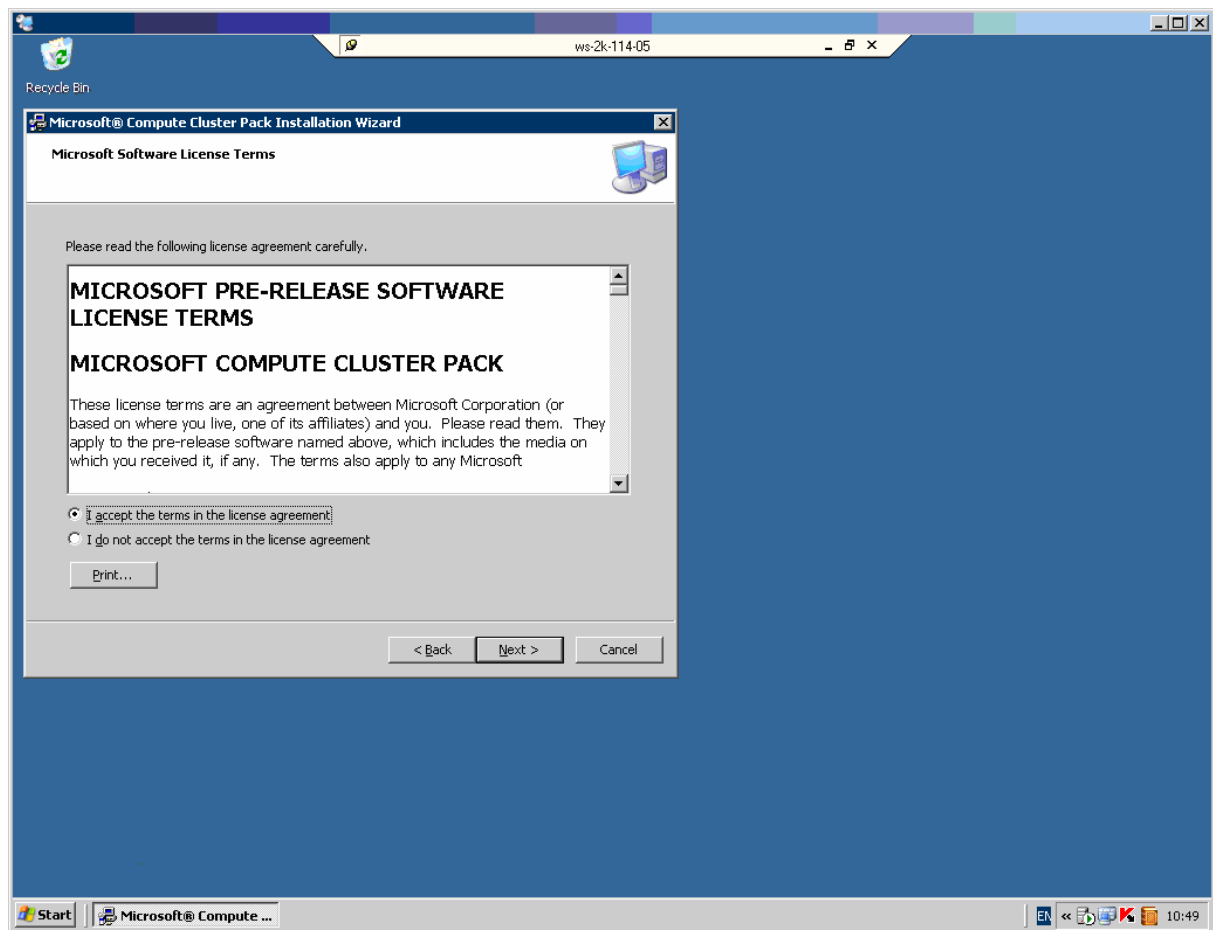
- In the new window choose **Install only the Microsoft Compute Cluster Pack Client Utilities for the cluster users and administrators**. Press the button **Next**,

- Choose the directory where you are going to install CCP. To change the default directory press the button **Browse…** and select the desirable directory . Press the button **Next** ,

- Install all the software given in the list of the new window sequentially. In order to start the installation you should select the corresponding item in the list and press the button **Install**. The installation will be carried out according to the documentation for the program being installed. It is recommended that the installation should be carried out exactly in the order, which is given in the list. Microsoft Compute Cluster Pack is the last one to be installed,

- Wait till the installation program copies all the requires files,

- When the files are copied, press the button **Finish**,

- This is the final step of the client node installation. The installed programs may be called from the menu **Start->All Programs->Microsoft Compute Cluster Pack**.

Exercise 5 – Test the Compute Cluster Server

In order to make sure that the installation has been performed correctly, we will launch on the compute cluster nodes the test program **hostname**, which prints the name of the node, where it was launched.

Task 1 – Run the Program on the Cluster

In this task we will run a copy of the program **hostname** on each cluster node. The program result (the output stream message) will be output in a text file:

- Open **Compute Cluster Job Manager**: **Start->All Programs->Microsoft Compute Cluster Pack->Compute Cluster Job Manager**,
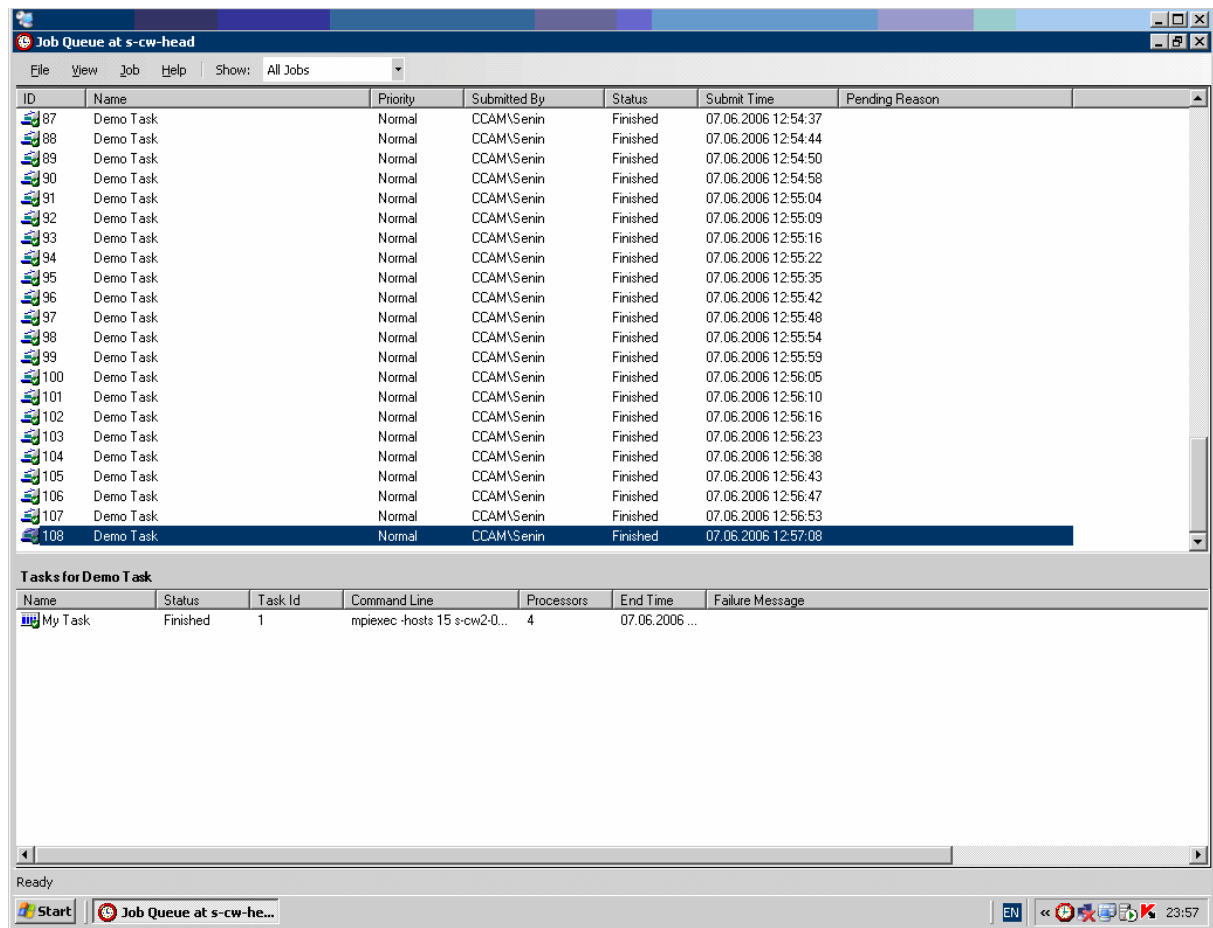
- Select the menu option **File->Submit Job**. In the new window enter the job name (the field **Job Name**) and go to the window tab **Processors**,
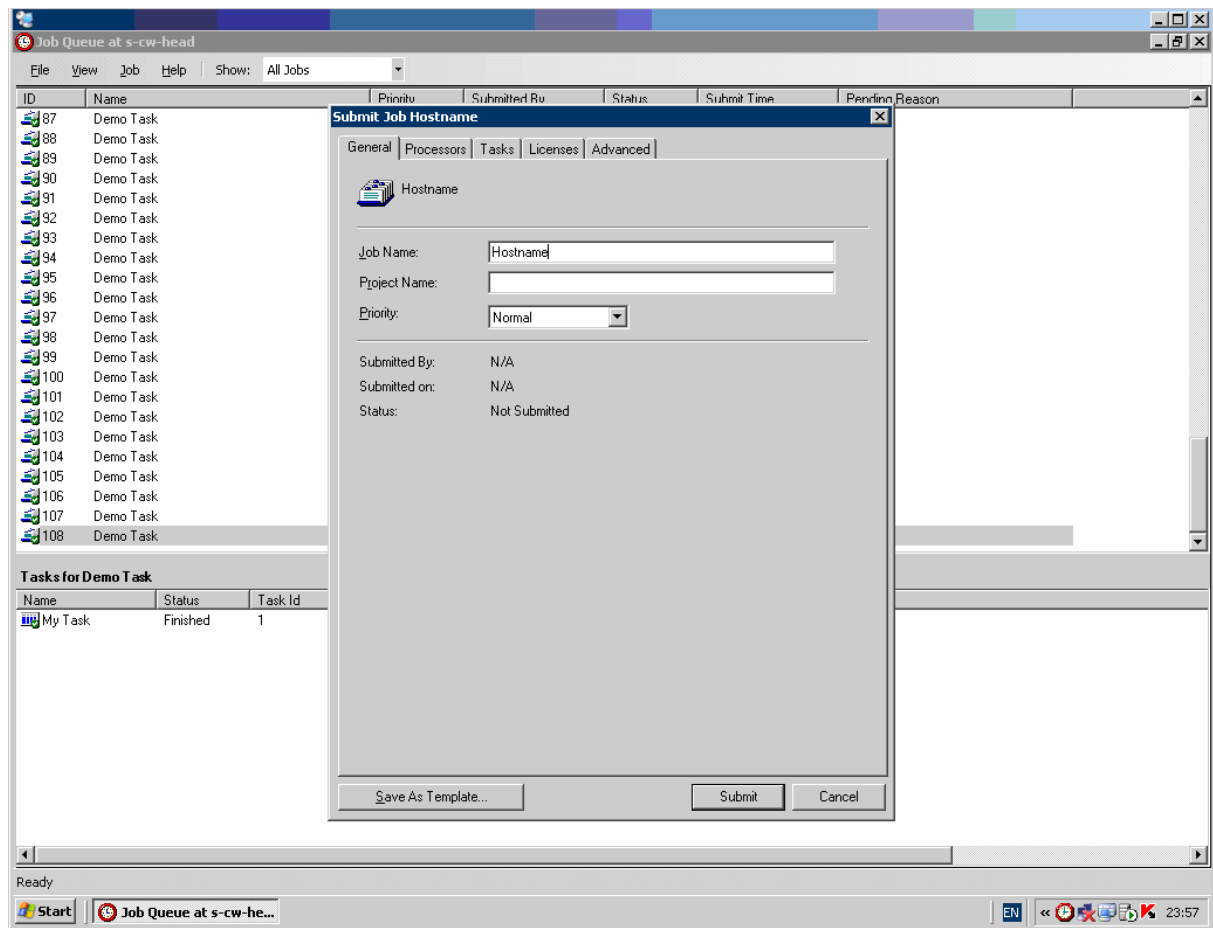
- The minimum unit given to the task is a compute node. If it is a multiprocessor node, all the node processors are given to the task. To start the program **hostname** on each compute node, specify the maximum number of the available system processors in the fields **Minimum required** and **Maximum required**. Then go to the window tab **Tasks**,
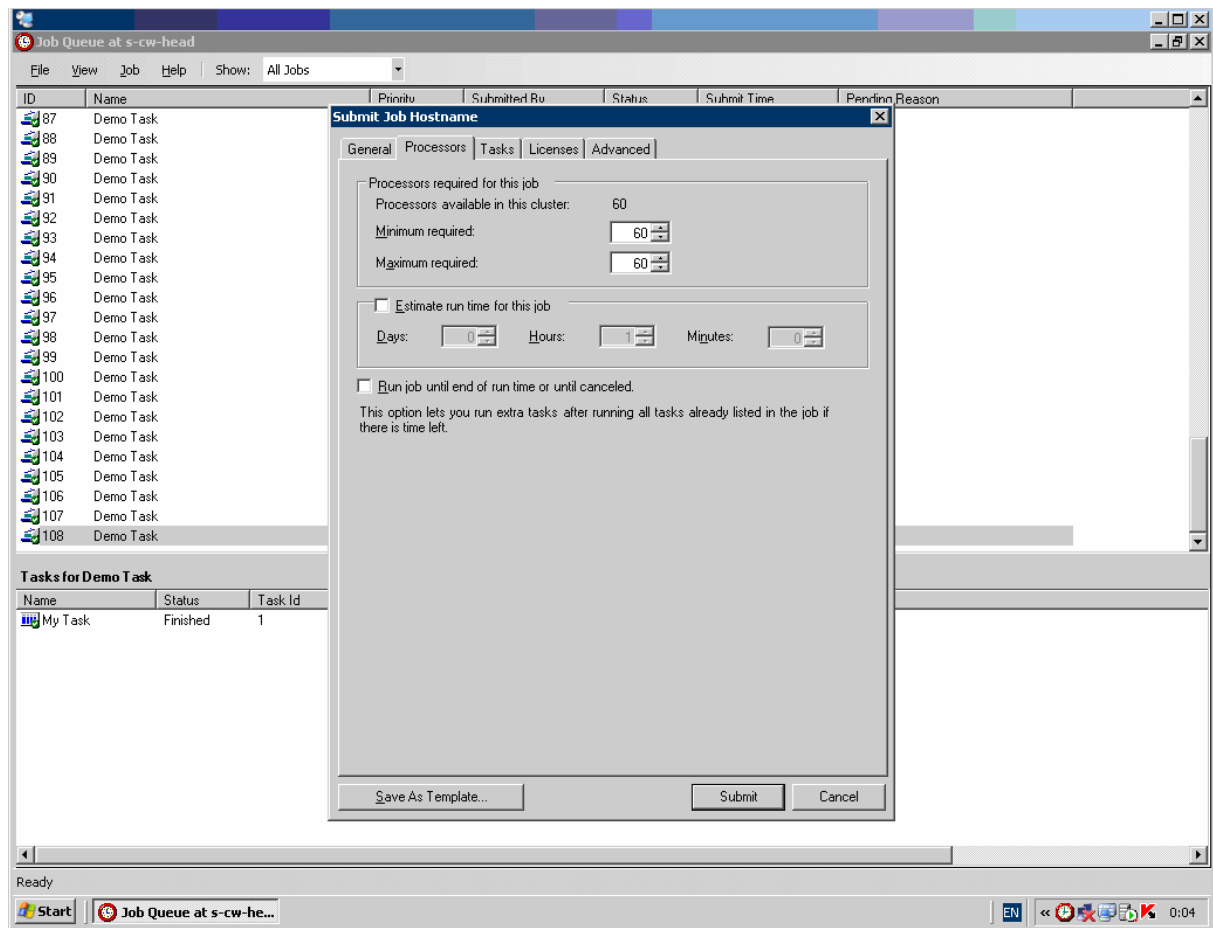
- Enter the task name (the field **Task Name**). Enter the command of the added task into the field **Command Line**:

  mpiexec –hosts <the number of nodes > <node 1> <the number of processes on node 1> … <node n> <the number of processes on node n> hostname.

  Press the button **Add** to add the tasks to the job. Remember that a job may contain several tasks. That is why this operation (adding the task) may be repeated several times,
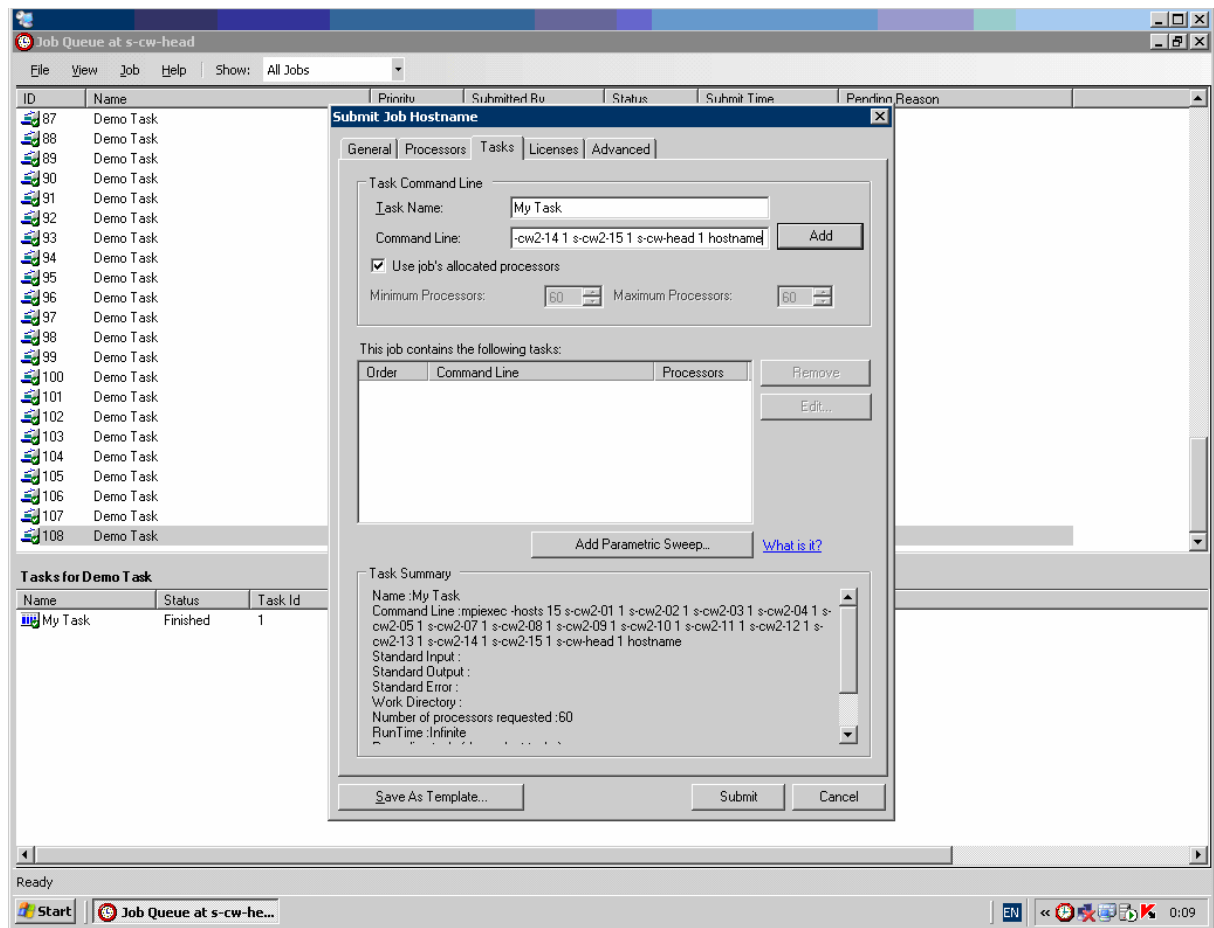
- Select the added task in the list of tasks and press the button **Edit** to set additional task parameters,
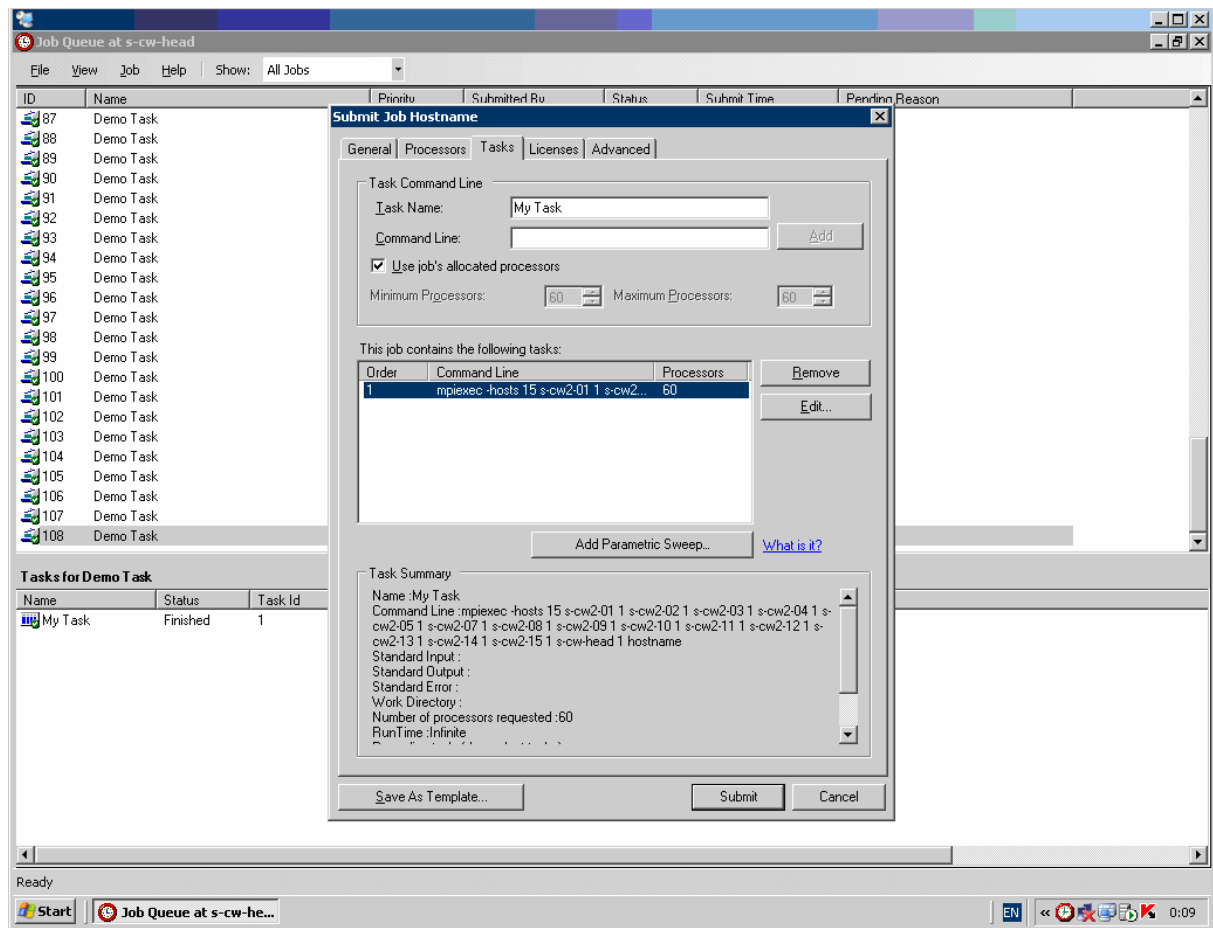
- In the new window enter the file path, where the standard output stream will be redirected to (the field **Standard Output**). Remember that the file must be accessible from each cluster node. That is why it is recommended to place the file on the network location. Press the button **OK** to confirm the changes you have made,
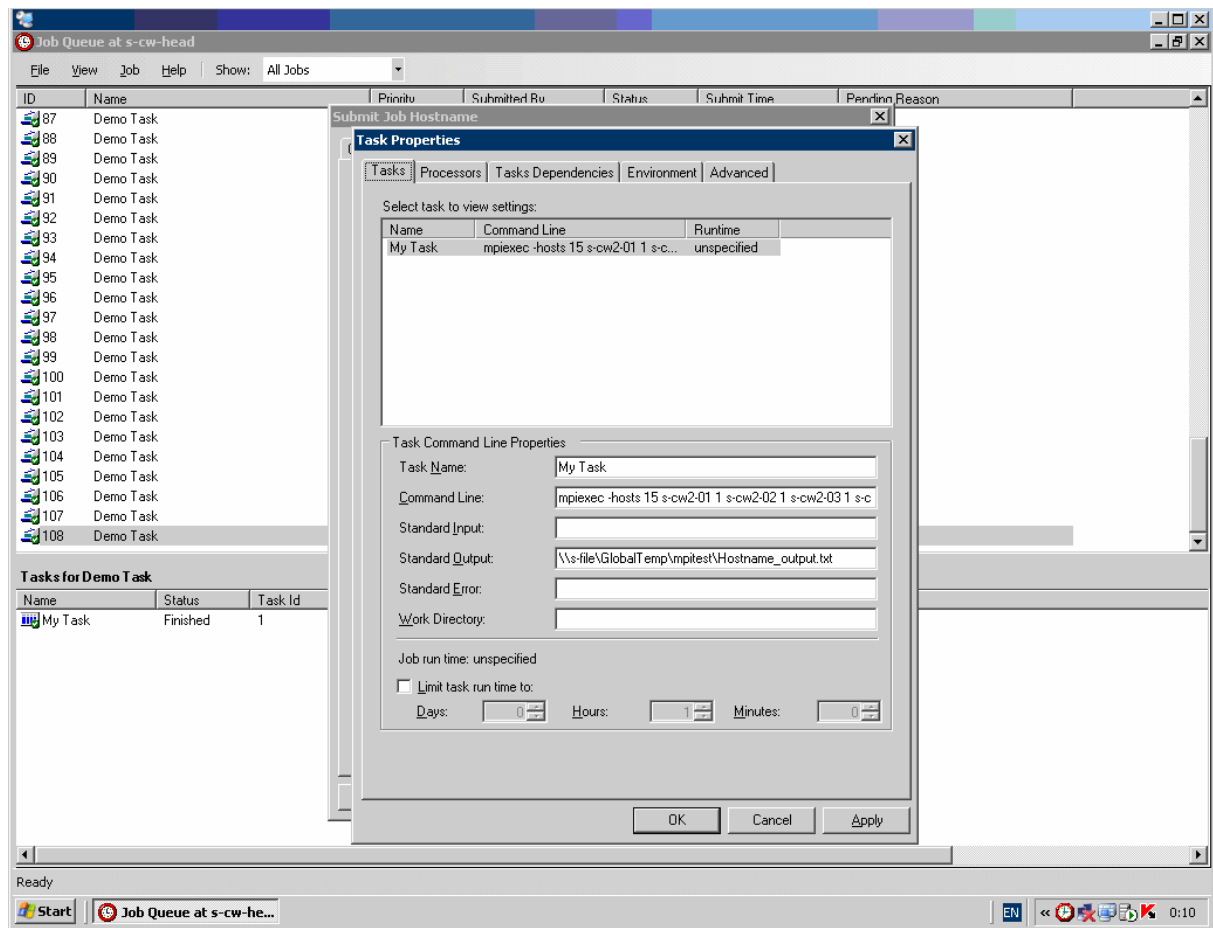
- You will see the window where you must enter the user name and the password that will be applied to start the job. The user must have the right to execute the program on the cluster (see the subsection Cluster User Management given above). To confirm press the button **OK**,
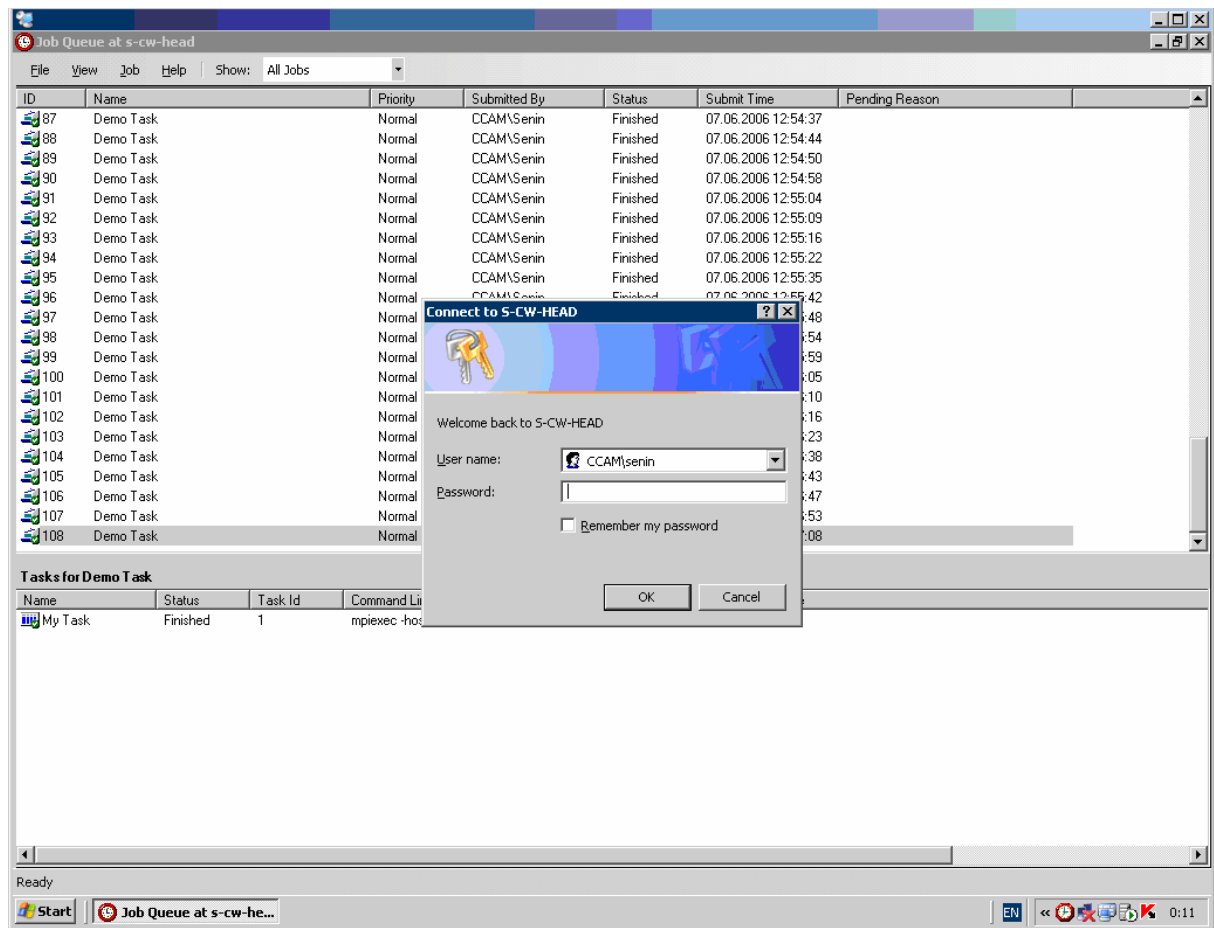
- The new job will appear in the list. After it is terminated, the job status will change for **Finished**,

Job Queue at s-cw-head

File   View   Job   Help   Show: All Jobs

ID	Name	Priority	Submitted By	Status	Submit Time	Pending Reason
88	Demo Task	Normal	CCAM\Senin	Finished	07.06.2006 12:54:44	
89	Demo Task	Normal	CCAM\Senin	Finished	07.06.2006 12:54:50	
90	Demo Task	Normal	CCAM\Senin	Finished	07.06.2006 12:54:58	
91	Demo Task	Normal	CCAM\Senin	Finished	07.06.2006 12:55:04	
92	Demo Task	Normal	CCAM\Senin	Finished	07.06.2006 12:55:09	
93	Demo Task	Normal	CCAM\Senin	Finished	07.06.2006 12:55:16	
94	Demo Task	Normal	CCAM\Senin	Finished	07.06.2006 12:55:22	
95	Demo Task	Normal	CCAM\Senin	Finished	07.06.2006 12:55:35	
96	Demo Task	Normal	CCAM\Senin	Finished	07.06.2006 12:55:42	
97	Demo Task	Normal	CCAM\Senin	Finished	07.06.2006 12:55:48	
98	Demo Task	Normal	CCAM\Senin	Finished	07.06.2006 12:55:54	
99	Demo Task	Normal	CCAM\Senin	Finished	07.06.2006 12:55:59	
100	Demo Task	Normal	CCAM\Senin	Finished	07.06.2006 12:56:05	
101	Demo Task	Normal	CCAM\Senin	Finished	07.06.2006 12:56:10	
102	Demo Task	Normal	CCAM\Senin	Finished	07.06.2006 12:56:16	
103	Demo Task	Normal	CCAM\Senin	Finished	07.06.2006 12:56:23	
104	Demo Task	Normal	CCAM\Senin	Finished	07.06.2006 12:56:38	
105	Demo Task	Normal	CCAM\Senin	Finished	07.06.2006 12:56:43	
106	Demo Task	Normal	CCAM\Senin	Finished	07.06.2006 12:56:47	
107	Demo Task	Normal	CCAM\Senin	Finished	07.06.2006 12:56:53	
108	Demo Task	Normal	CCAM\Senin	Finished	07.06.2006 12:57:08	
109	Hostname	Normal	CCAM\Senin	Finished	07.06.2006 13:11:27	

Tasks for Hostname

Name	Status	Task Id	Command Line	Processors	End Time	Failure Message
My Task	Finished	1	mpiexec -hosts 15 s-cw2-0...	60	07.06.2006 ...	

Compute Cluster Job Manager
Job 109 is finished.
Please click here for detailed information.

Ready

Start   Job Queue at s-cw-he...   EN   0:11

- The file where the output stream was redirected contains the list of compute nodes in the cluster.

```
Hostname_output.txt - Notepad
File  Edit  Format  View  Help

s-cw2-15
s-cw2-11
s-cw2-14
s-cw2-12
s-cw2-03
s-cw2-01
s-cw2-13
s-cw2-10
s-cw2-07
s-cw2-08
s-cw2-02
s-cw2-09
s-cw2-05
s-cw2-04
s-cw-head
```

Start | Job Queue at s-cw-head | mpitest | Hostname_output.txt...   EN   0:12

Discussion

- What software does Microsoft Compute Cluster Server 2003 contain?
- What are the head, the compute and the client nodes?
- What network topologies are used in CCS 2003?
- What methods of compute node installation do you know?
- What is Microsoft Compute Cluster SDK? Who might require it and for what purpose?