User Manual

DCU
CONTROL SYSTEM
PLATFORM
-
QUICK START
GUIDE

User Manual

DCU Control System Platform – Quick Start Guide

07/04/2024

Contents

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1   Introduction

The aim of this chapter is to show a new user of DCU Control System Platform a in simple step by step procedure:

- How to set-up computer for DCU control design.

- How to set and program a new DCU unit using control design tools.

- How to set-up computer for DCU visualization.

2   Installing DCU Control System Platform software

2.1   Installed software

Complete DCU Control System Platform includes multiple software packages with its specific purposes. The packages include:

- Java Runtime Environment (JRE). JRE is often already installed in operating systems. If you are sure that Java JRE or JDK (Java Development Kit) is already installed in your computer you may skip installation of JRE. DCU Control System Platform supports any version of Java starting from version 5 or even earlier (not tested).

- W/M/L AMP (Windows/Mac/Linux Apache – MySQL - PHP) Stack. This open-source software package contains database (MySQL) for data recording, http server and its tools (Apache, PHP) for visualization using web-pages. If an AMP stack is already installed in your computer, you may skip installation of this component.

- Scilab/Xcos computational platform. This scientific software is used for control design, programming, validation and optimization. Alternatively, you may use another version of Scilab/Xcos starting from version 5.4.1 or Matlab/Simulink starting from release 2008 or even earlier (not tested).

- User Command Center (UCC) service. This is a Java application interface service transferring data between control units, design tools, database, and visualization web-pages.

- DCU Design Tool, design examples, and documentation. This is an interactive toolbox running inside Scilab or Matlab platform providing comfortable interface for control design and programming.

2.2   Simple installation using installer

Windows OS installation procedure

1) Download Windows installer or Linux Ubuntu installer.

2) In case of Windows, double-click the installer. For Linux Ubuntu, unpack installer files, open terminal and go to installer folder (for example by: cd dcu-linux-2020-64bit) and run command ./dcu-install.sh. Then follow

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instructions for installation. You may select components to be installed if your are expert, otherwise keep all components selected for installation.

2.3   Step by step expert installation procedure

In case of other operating systems such as Mac OS, or other Linux distributions, the DCU platform may be installed step by step using separate packages.

Step 1 - Install Java Runtime Environment

On many operating systems Java Runtime Environment is pre-installed. To check if JRE installed:

Windows OS

Open Command Prompt and type:

```
java -version
```

Linux OS

Open a terminal program (xterm, Terminal, …) and type

```
java -version
```

Response to this command should be displaying of actual version of JRE. If the response is that such command does not exist, JRE is probably not installed or its directory is not registered within system environment. Check installed programs and if java is not installed, install actual version of JRE:

Windows OS

Search for any Java JRE download for Windows on Internet (typically Oracle Java JRE), download installer file, and double click the file to start installation.

Linux OS

For example on Ubuntu go to Ubuntu Software Center → Java → OpenJDK Java Runtime → Install, or open Terminal and type

```
sudo apt-get install openjdk-8-jre
```

Step 2 - Install middle-ware and visualization software

Download and install any (W/L/M)AMP (Windows / Linux / MacOS Apache-MySQL-PHP) package. For example:

Bitnami free LAMP stack for Linux, or WAMP stack for Windows, or MAMP stack for MAC OS (http: : bitnami.com/stacks/infrastructure).

AMPPS free stack for Linux, or WAMP stack for Windows, or MAMP stack for MAC OS (http: : ampps.com)

XAMPP free stack for Linux, or WAMP stack for Windows, or MAMP stack for MAC OS (https: : www.apachefriends.org/index.html)

Windows OS

Download installer file, and double click the file to start installation.

Linux OS

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Install MySQL server, Apache server, Phpmyadmin tool. The most actual installation configuration settings can be found in dcu_ubuntuXX.sh file of the Ubuntu installation folder.

Note: In case of visualization process data server, the computer has to be set to start automatically after power failure. Also operating system needs to start automatically without waiting on user boot selection. Example of setting these parameters for NUC mini PC with Linux Ubuntu 12.04 is shown below.

1) Press F2 during minPC startup to call Bios. In Bios go to Advanced Setup - Power and for the parameter "After Power Failure" select the option "Power ON".

2) open grub file as a root by typing in terminal : sudo gedit /etc/default/grub

3) set parameter GRUB_TIMEOUT=3 (wait only 3 seconds with boot menu)

4) Add parameter GRUB_RECORDFAIL_TIMEOUT=3 (wait only 3 seconds with boot menu after a failure)

Step 3 - Install and set scientific control design platform

Free open-source control design platform is Scilab/Xcos. Supported version is Scilab 5.5.2, higher versions has minor problems with Xcos. Commercial scientific computational platform Matlab can be used as well, tested was version Matlab 2014, higher versions may need to adapt DCU design toolbox.

Scilab/Matlab are high-level scientific programming platform for signal processing, dynamic modelling, identification, control design and optimization. Xcos/Simulink are Scilab/Matlab tool for drawing and simulating dynamic models. Download and install Scilab/Xcos (www.scilab.org) or Matlab/Simulink (from your Mathworks account). Because the DCU design tool inside control design platform loads a dynamic library of MySQL database and a library of UCC interface, on some operating systems, the libraries must be placed into correct operating system directory and/or a C compiler needs to be installed. See below.

Scilab for Windows OS

Download installer file, and double click the file to start installation.

Scilab for Linux OS

Open Terminal, and type:

```
sudo apt-get install scilab
```

Older version of Scilab will probably be installed, but its components are necessary to run new version of Scilab. When installation complete, download the newest version of Scilab from www. scilab.org as compressed .tar file. Decompress the downloaded file. To run Scilab go to decompressed Scilab directory scilab directory/bin and run executable file "scilab".

Sometimes displaying of graphs (command plot) is not working properly. In such case install graphic package `libgl1-mesa-swx11` using command:

```
sudo apt-get install libgl1-mesa-swx11
```

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Matlab for Mac OS X

Download and install Matlab from Mathworks site according to instructions. Next, copy MySQL library from dcudesigntool/ucccalls/macos/libmysqlclient.18.dylib to standard operating system library directory, typically: usr/lib/.

Matlab for Windows

Download and install Matlab from Mathworks site according to instructions. In case of Matlab platform under Windows 64-bit operating system, appropriate c compiler (Microsoft Visual C++) and development kit (Microsoft Windows SDK) needs to be installed and properly set before using DCU design tool inside Matlab platform. To check required compiler for any version of Matlab and operating system, see

http://www.mathworks.com/support/sysreq/previous_releases.html

For example in case of Matlab R2009b and Windows 7 64-bit operating system, install Microsoft Visual Studio 2008 Express Edition with all components and Microsoft Windows SDK for Windows Server 2008 and .NET Framework 3.5., see explanation at

http://www.mathworks.com/matlabcentral/answers/98351-how-can-i-set-up-microsoft-visual-studio-2008-express-edition-for-use-with-matlab-7-7-r

Sometimes it is also needed to indicate to operating system path to compiler and to the installed compiler path to header files and to libraries. To set path to compiler, add to the environment variable "Path" path to the compiler, for example:

C:\Program Files (x86)\Microsoft Visual Studio 9.0\VC\bin\amd64

To define path to header files and to libraries, two operating system environment variables need to be created: INCLUDE and LIB.

INCLUDE containing path to installed compiler include files

C:\Program Files (x86)\Microsoft Visual Studio 9.0\VC\include

LIB containing paths to installed compiler and SDK libraries

C:\Program Files (x86)\Microsoft Visual Studio 9.0\VC\lib\amd64; C:\Program Files\Microsoft SDKs\Windows\v6.1\Lib\x64

In case of 64-bit Windows indicated libraries must be 64-bit libraries. To add the environment variables into Windows 7 environment, go to

Control Panel\System and Security\System and click

"Change settings"->"Advanced"->"Environment Variables"

Matlab for Linux

In case of Matlab platform on Linux copy MySQL library into appropriate system library directory (/lib) or install MySQL C connector. Also fonts may be needed to display properly user interface. To install fonts type:

To install fonts open Terminal, and type:

```
sudo apt-get install xfonts-base xfonts-100dpi xfonts-75dpi gsfonts-X11 gsfonts-other
```

When installed, start Scilab and in Preferences rise maximum used memory limits at least to 2048MB or more to accelerate Scilab processing. To rise the memory limits,

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go to menu Edit→Preferences, section Java Heap Memory, rise limits and click OK. When done, close Scilab and on next Scilab start the new memory limits will be applied.

Step 4 - Download DCU design tool and UCC

Download (www.prosystemy.sk) and place into your computer DCU design toolbox either for Scilab or for Matlab. The package includes:

– DCU design toolbox - graphical interactive tool for programming and monitoring DCU. The toolbox is developed in Scilab/Matlab environment (running in Scilab/Matlab).

– Library of Xcos/Simulink control functions for programming DCU. DCU control application is drawn in Xcos/Simulink where it can also be simulated.

– Examples of control design projects.

– User command center (UCC) - middle-ware service performing all communications with DCUs.

Step 5 - Start control design platform (Matlab or Scilab) and DCU control design tool

In case of Scilab environment, change actual directory of Scilab to DCU design tool and type "exec dcudesign.sci".

In case of Matlab environment, change actual directory of Matlab to DCU design tool and type "dcu".

3   Start DCU Design

3.1.1   Start installed DCU Design Tool

During DCU Control System Platform installation shortcut for DCU Design Tool start is created. Click the shortcut, and all software necessary for design is started automatically. Namely User Command Center, Scilab or Matlab design platform, and DCU Design Tool inside design platform are launched. When launched you have to first enter MySQL database login and password to UCC and then to Scilab/Matlab window, see Figure 1. When login and password entered, UCC starts serving and DCU Design Tool main Window is opened and user may start to design control system, see Figure 2. In case of Scilab Xcos windows may open as well. Xcos can be closed for the moment, it is opened only for initialization purposes.

3.2   Start DCU Design Tool component by component

Step 1 - Start MySQL database service

For some (L/W/M)AMP package installations MySQL service is started automatically after computer restart. If not, start MySQL service manually:

Windows OS

For Bitnami WAMP Stack go to All Programs → Bitnami WAMP Stack → wampstack manager tool. When the manager tool is started, start MySQL service.

Linux OS

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Go to lampstack directory and run the file manager-linux.run. When the manager tool is started, start MySQL service.

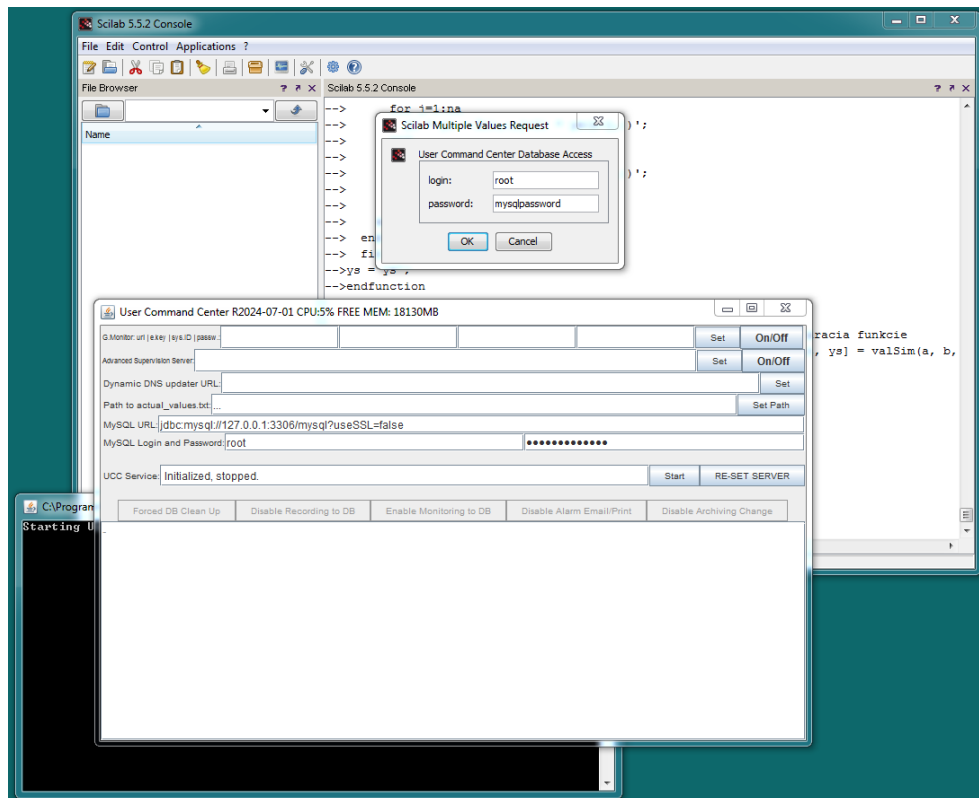
Figure 1: Launching DCU Design Tool

Step 2 - Start UCC service and connect to database

Windows OS

Run the file start_ucc.bat in DCU design tool directory.

Linux OS

Run the file start_ucc.bat in DCU design tool directory.

Enter the database login and password and click Start button to connect to database and start service. Alternatively, edit the file autostart_ucc.bat by entering correct database login and password. Running autostart_ucc.bat file will then automatically start the service and connect to database using the specified login and password. When started, UCC service checks configuration database "dcuUserCommConfig" for configuration tables of visualization and creates (if not created) process data history recording databases.

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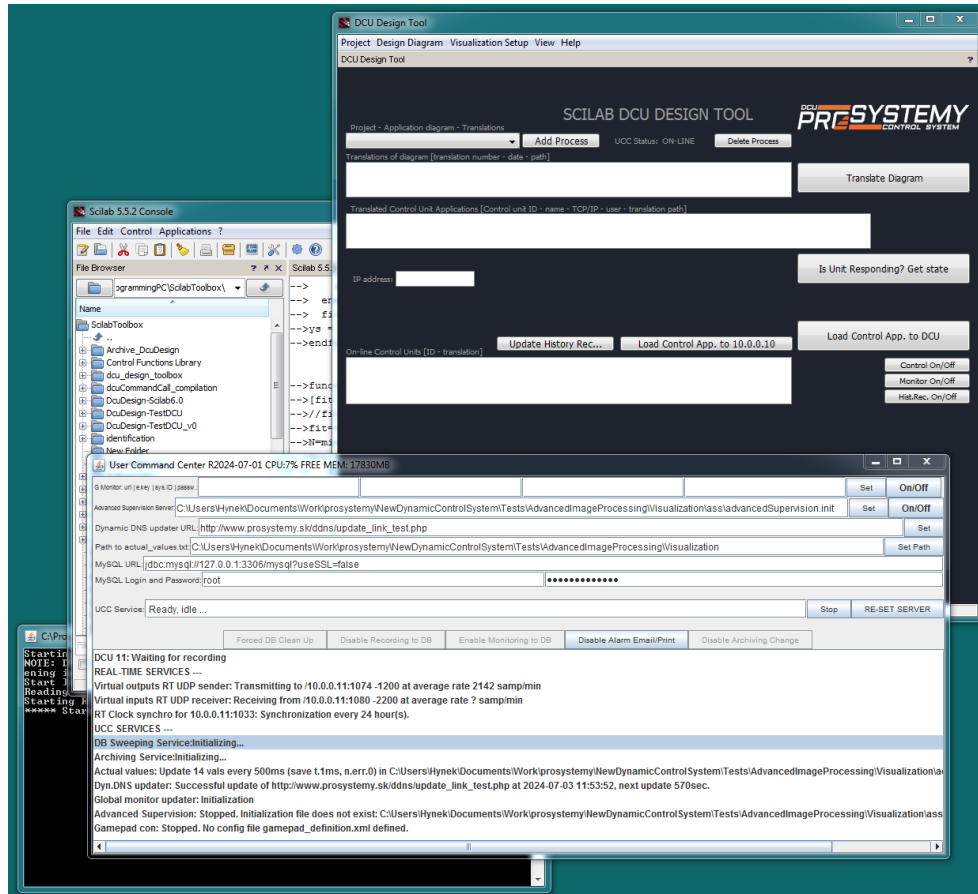
Figure 2: DCU Design Tool started

Step 3 - Start control design platform and DCU design tool

Start Scilab or Matlab. In Scilab/Matlab go to directory containing DCU design tool files: File → Change current directory. In Scilab command line type:

```
exec dcudesign.sci
```

In Matlab command line type:

```
dcu
```

Design tool will start and will asks for MySQL database login and password. Then, it opens the main window of DCU design tool and in case of Scilab Xcos opens as well. Xcos can be closed for the moment, it is opened only for initialization purposes.

4 Basics of programming DCU

4.1 Step 1 - Open an example of control design project

In DCU design tool go to Project → Open and select one example project from DCU design examples, i.e. in example's directory select project file .prj. Project data are

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loaded into the design tool and displayed in the main window, see Figure 3. User can now edit the opened project and its control application diagram.

4.2 Step 2 - Modify control application diagram and simulate

Behavior of DCU is defined by control application diagram. The diagram is drawn in Xcos (Simulink) dynamic simulator. To open project's actual diagram go to menu Design diagram → Open actual. Xcos/Simulink is started and diagram is opened.

Control application for one DCU is defined inside super-block (group of blocks) which has at the beginning of its name "dcu::" string, see Figure. Main control application may contain multiple DCU controllers. To edit control application of a DCU, double-click the DCU super-block. The actual diagram of the corresponding super-block opens and user can start add, remove, edit control functions and its connections. All control functions are in library diagram that is in DCU design tool directory. Notice, that control function has always at the beginning of its name the string "cfn::". It indicates to translator that it is control function and not some simulation block.
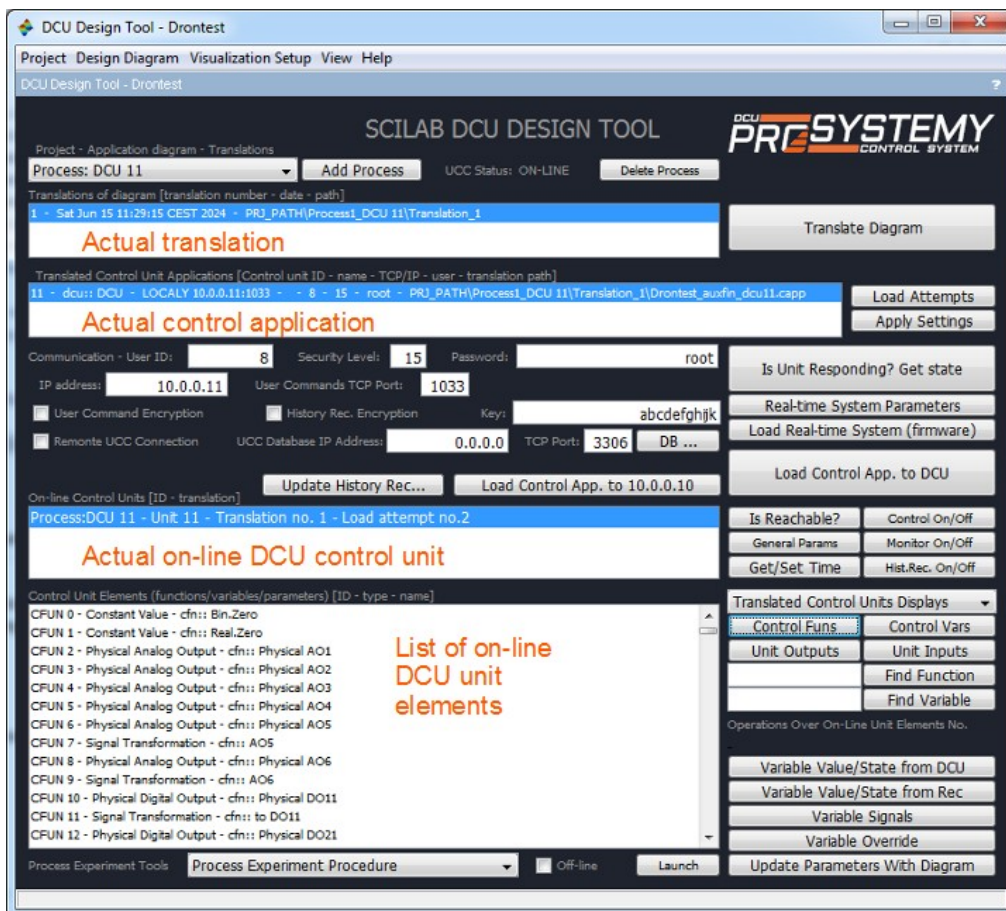
Figure 3: Opened project in DCU Design Tool window.

To define general parameters of a DCU controller (sampling times, IP address, users, Modbus settings,...), click right mouse button on opened super-block diagram and select "Set Context" (in Simulink click right mouse button on DCU block and select

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Edit Mask→Initialization tab). All general parameters are defined in the diagram context (mask initialization) of the DCU, see Figure 5.

To simulate control application diagram, click Start simulation button (empty right arrow) in the main diagram (containing DCU super-blocks). Dynamic simulation is launched. To define simulation settings, go to menu Simulation → Setup.

Simulation may be slow due to large number of control functions. Therefore, it is more efficient to

- Create a new empty diagram (in main diagram menu File → New diagram).

- Copy DCU super-block context into the context of this new diagram.

- Copy a part of control application to be tested in simulation into this new diagram.

- Define desired simulation settings in Simulation → Setup.

- Place source blocks (steps, constants, signal generators) into the new diagram and connect them to tested piece of control application.

- Start simulation in the new diagram.

When satisfactory copy the validated part of the diagram back to main DCU diagram.

Finally export image of the diagram (click File→Export) as capp_xx.png file into "project/Visualization/process/image" folder, where xx is the ID number of the DCU unit, typically 11 (see Figure 4). It will be used for on-line visualization.
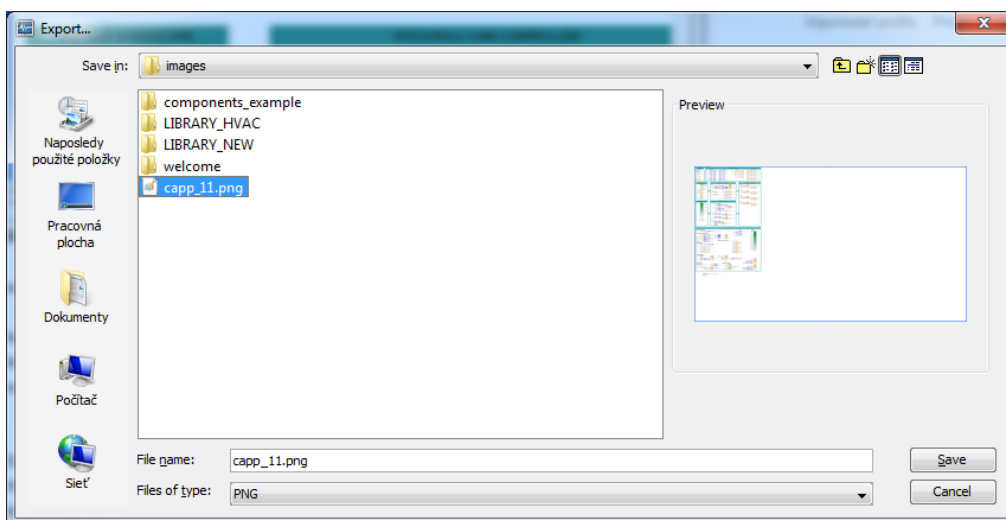
Figure 4 : Export of control application diagram into image.

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Figure 5: Control application diagram of a DCU.

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4.3   Step 3 - Translate control application diagram

When all modifications of control application diagram are done, save the diagram. Next click the button "Translate Diagram" in the main window of DCU design tool. Translation process reads diagram and save its structure into XML file ready for download (file with extension .capp). When translation done, it appears in the list of translations (first list from the top of the main window).

4.4   Step 4 - Connect designer computer to DCU

There are two possibilities for connection of designer computer with DCU, see Figure 4. In case of connecting to one DCU, computer may be connected to DCU using Ethernet crossover cable. In case of connecting to a network of DCU (standard Ethernet local area network is used for networking DCUs), computer is connected to the network using standard Ethernet cable.
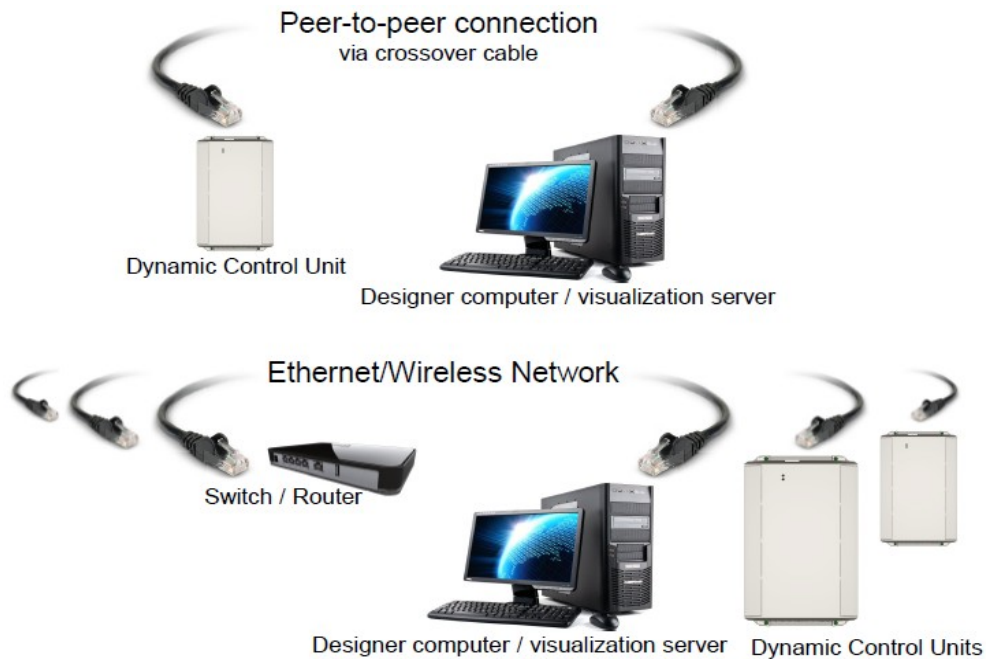

Figure 4: Connecting DCU to designer computer.

4.5   Step 5 - Check/Set communication settings

Actual translation is shown in the translation list, translated DCU is displayed in the control unit application list (below) with its communication settings, i.e. settings for communicating with each DCU.

Selecting DCU application will display actual communication settings of the selected DCU. These settings are initially (after translate) taken from general parameters specified for each DCU in context of the diagram. If modified, the settings are applied by clicking on the button "Apply Settings".

To check if the communication settings are correct use the buttons on the left side of the communication settings:

– Button "Is Unit Responding? Get actual state" asks DCU for actual state

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information and displays answer if some.

For examples in DCU design tool, communication settings are set to default values preset in any new DCU.

4.6   Step 6 - Load control application into DCU

To load translated control application into selected DCU (selected in the list of translated DCU) click on the button "Load Control Application Into Units". Communication settings are used for loading.

For the first load of control application into a new DCU, its communication settings are set default. If your control application settings differ from default values, use the button "Load Unit With Default Comm. Settings". Control application will be loaded into DCU using factory default communication settings. Successfully loaded DCU appears in the list of on-line units.

Now you can start control application inside control units. DCU tool asks to start the application after application load or click "Control Mode" button. Actual control application state is read and displayed together with Start/Stop application buttons.

4.7   Step 7 – Start on-line DCU control and monitoring

To start history recording of process control variables into database click "Hist.Rec. On/Off". Actual state of history recording is displayed together with Start/Stop buttons. Similarly monitoring may be started/stopped by clicking on "Monitor On/Off" button. Monitoring and history recording are the same procedures of recording process data into database. Difference between monitoring and history recording is defined by user. For each process variable/input/output user may define sampling time for history recording and sampling time for monitoring. History recording is intended for long-term visualization and archiving purposes. Monitoring is intended for short-term on-line application validation by designer. If you are not sure about your process control variable settings, start both history recording and monitoring for first tests.

Buttons on the side of on-line units list allow user to

–   Display general parameters of actual control application, button "General Parameters".

–   Get/Set DCU actual time and date, button "Get/Set Time/Date".

–   Start/stop control application, button "Control App. Mode".

–   Start/stop monitor recording, button "Monitor". History recording service must be running on designer computer.

–   Start/stop history recording. Again history recording service must be running on designer computer.

Buttons on the side of on-line unit elements list allows to enlist control functions/variables of selected on-line DCU (upper part) and to do operations over control functions/variables (lower part).

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4.8 Step 8 – Display on-line control application in web interface

First set users using menu Visualization Setup → Visualization Structure (see Figure 6). If not set, default users root with password root and oper with password oper are defined.

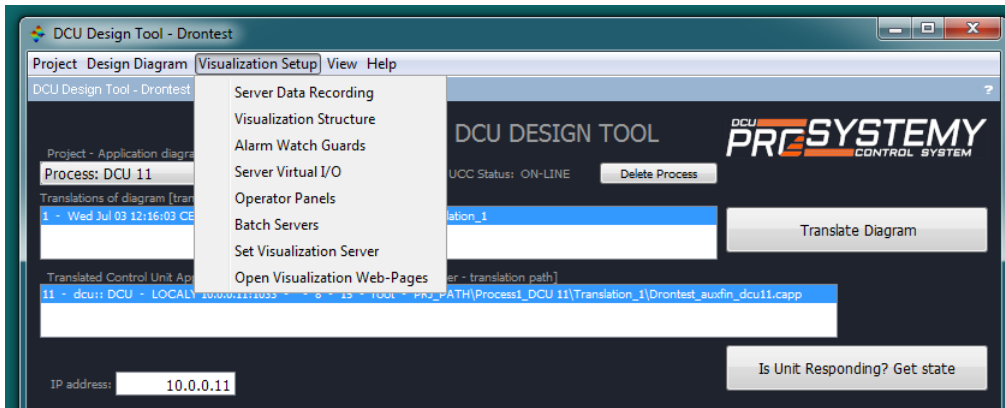Next set visualization server by Visualization Setup → Set Visualization Server

Figure 6: Setting visualization.

Next, in case of Windows, restart apache web-server, i.e. start Wampstack and click Restart., see Figure 7.
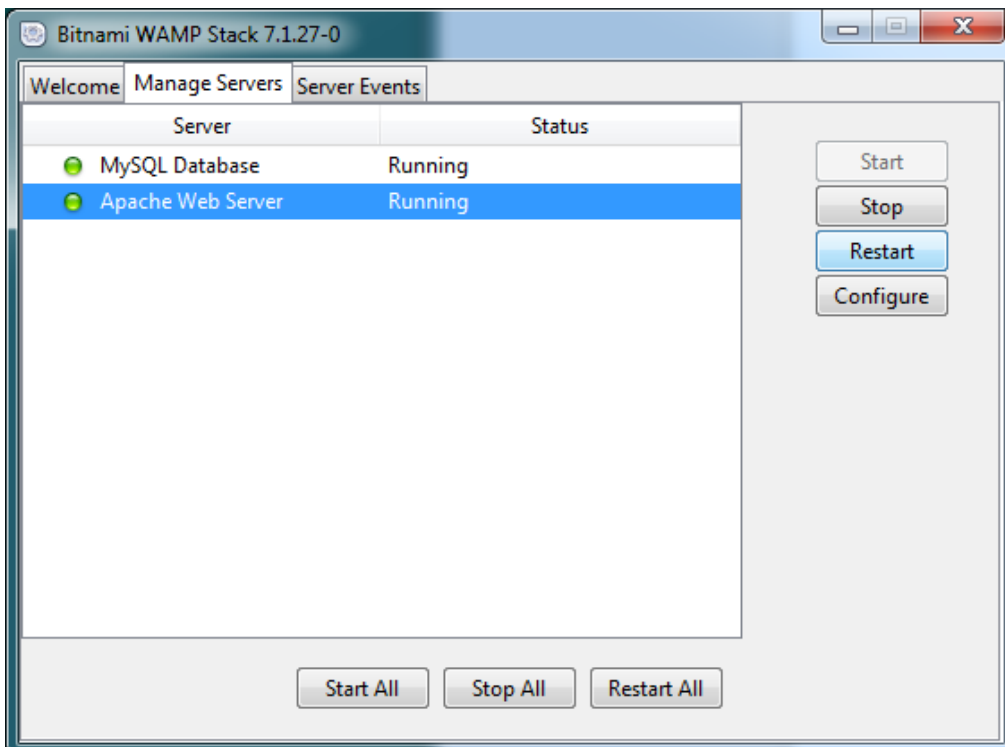

Figure 7: Bitnami wamp stack interface.

Finally open local web-page of DCU web interface. In windows the link is 127.0.0.1/dcu (web files are located in dcuproject/Visualization) in Linux the link is 127.0.0.1 (web files are located in var/www/html), see Figure 8.
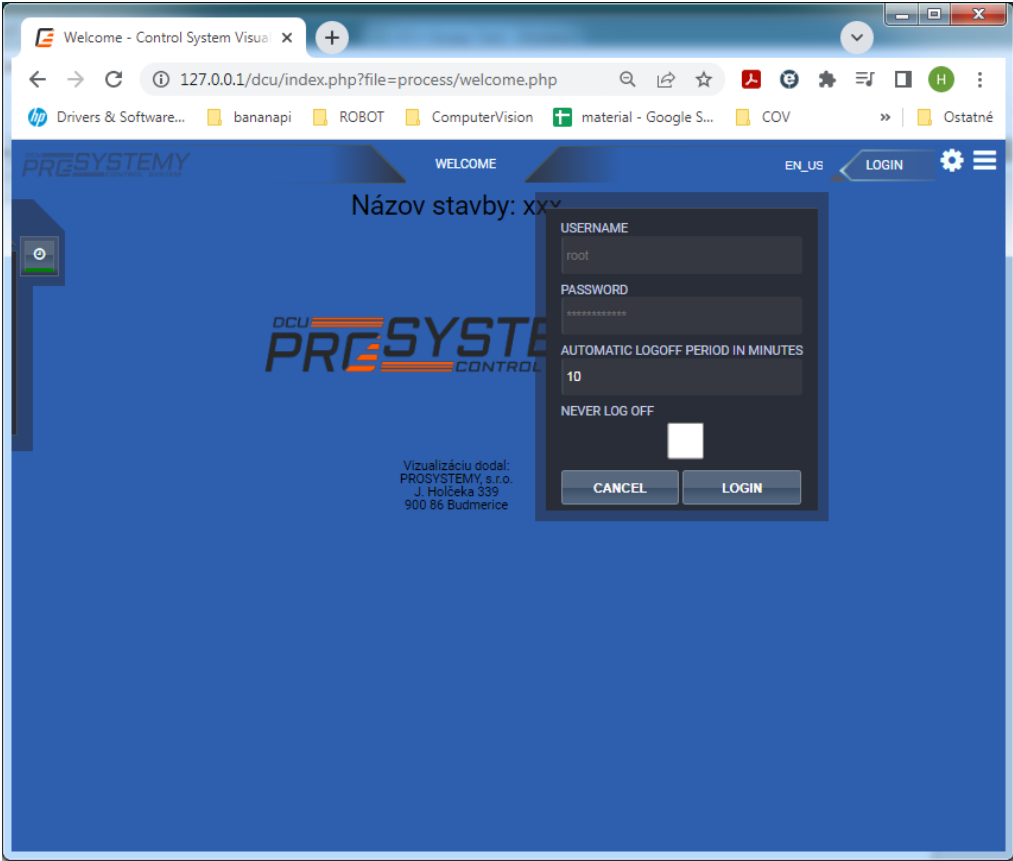
Figure 8: Default web interface.
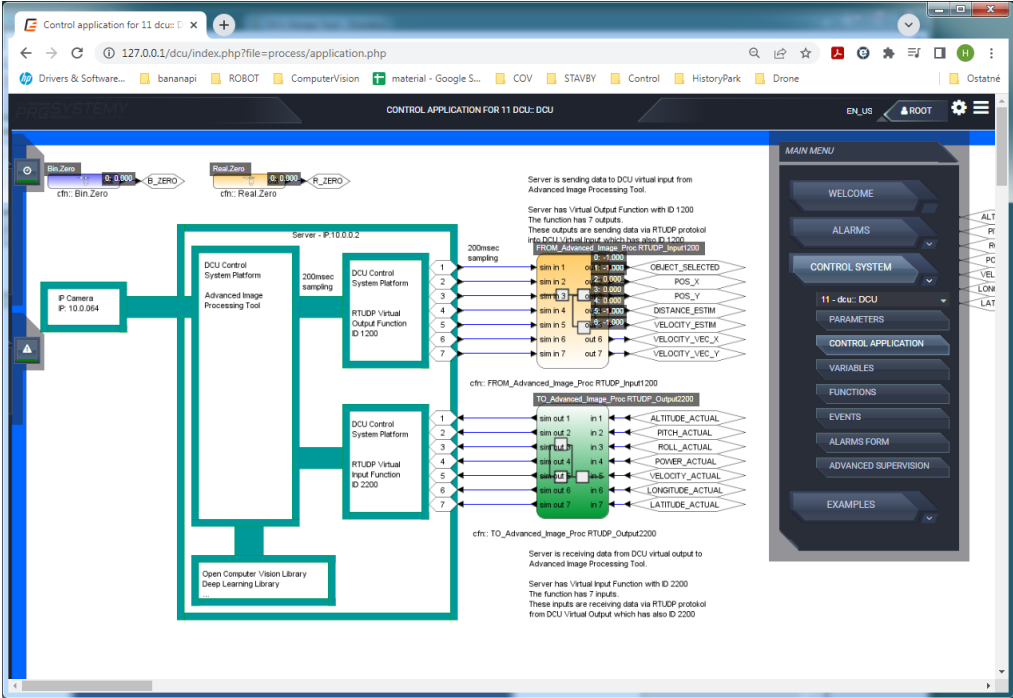
Now log-in and go to Control System → Control Application, see Figure 9.

Figure 9: Control application web interface.