movizon CONTROL v4 Installation Guide

System Overview

movizon CONTROL (short: “MC”) is a software that is specialised in controlling Automated Guided Vehicles (AGVs) in an industrial environment. movizon CONTROL is no executable application on its own, but a package of Java servlets ready to be hosted by a Java servlet container or application server. For more details please see the chart displayed on the last page of this document.

FOSS List

The following free and open-source software (FOSS) packages are used in movizon CONTROL:

Product name	Version	Homepage	License	movizon CONTROL usage
H2 Database	1.4.197	www.h2database.com	MPL 2.0	[optional] embedded production database
HikariCP	3.1.0	github.com/ brettwooldridge/HikariCP	Apache License 2.0	JDBC connection pool management
Gson	2.8.8	github.com/google/gson	Apache License 2.0	JSON serialisation / deserialisation
Three.js	r131	threejs.org	MIT License	[client side only] 3D visualisation
Monaco Editor	0.27.0	microsoft.github.io/ monaco-editor	MIT License	[client side only] script code editor

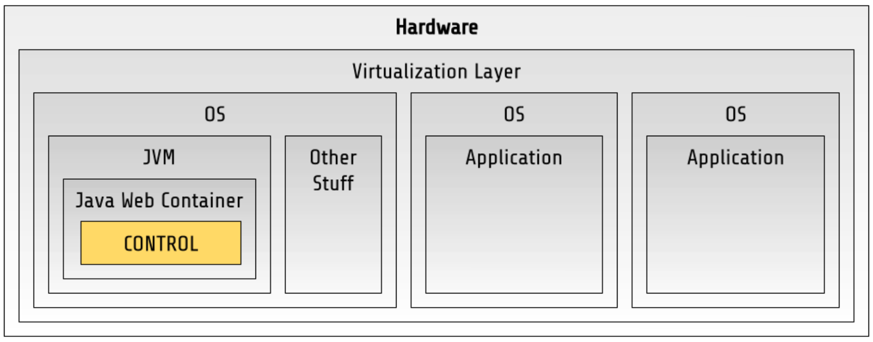
System Requirements

Server Hardware

A manufacturer of an application has to provide system requirements. The application in this case is your AGV system: movizon CONTROL as a framework plus its modules and project specific customization together with the interfaces and network architecture needed to communicate with your AGVs and other connected systems. Since your AGV system most likely is or will be first of its kind, it is impossible to define exact system requirements in advance. What we can do here is to give you insights into how movizon CONTROL is working to help you to build a suitable hosting environment.

Resource Sharing

All information in this document regarding hardware requirements assumes that any provided hardware is solely dedicated to operate movizon CONTROL. In reality, the available resources have to be shared. Every layer that is superordinate to movizon CONTROL only offers a share of the allocated resources based on its configuration - which is not the responsibility of movizon. When dimensioning the server hardware, please keep the surrounding architecture in mind which, in simplified form, could look like this:

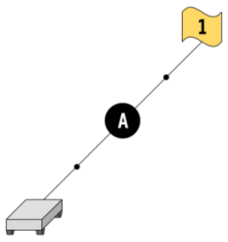
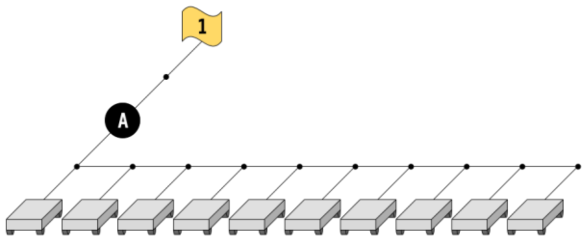
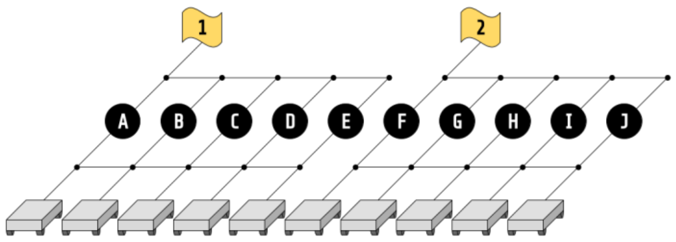


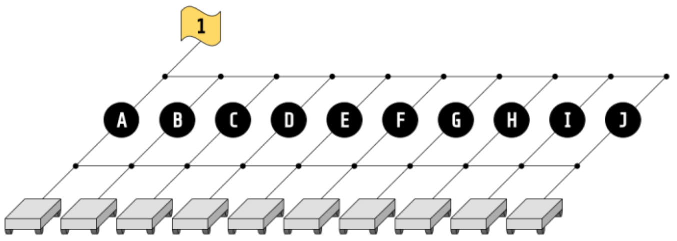
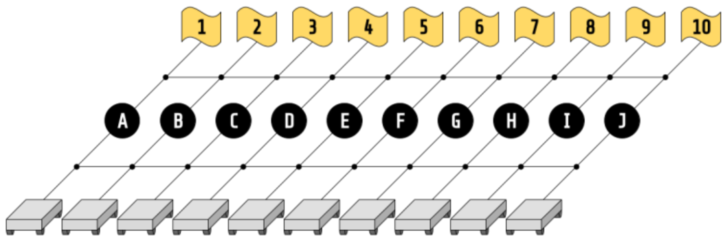
Performance Impact Factors

How does the size of the AGV system correlate with the needed hardware resources? First, it is all about the CPU. movizon CONTROL needs to calculate and optimize constantly a lot of options. Due to the architecture of the runtime these calculations primarily utilize the CPU of your system. In most use cases the biggest performance impact is derived from the following three elements:

- The number of AGVs that can be assigned to a job
- The number of route options for an AGV from current position to job destination
- The number of jobs that can be done by multiple AGVs

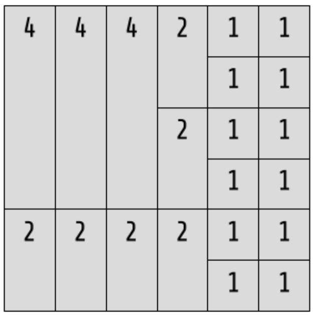
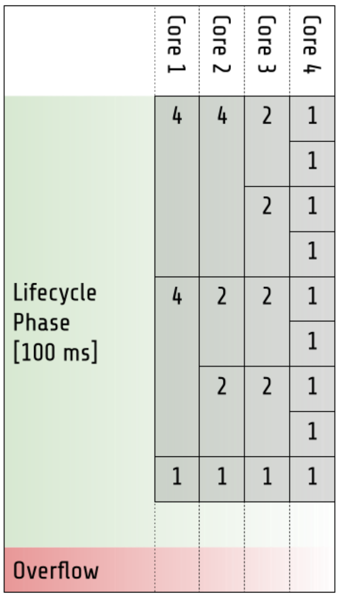
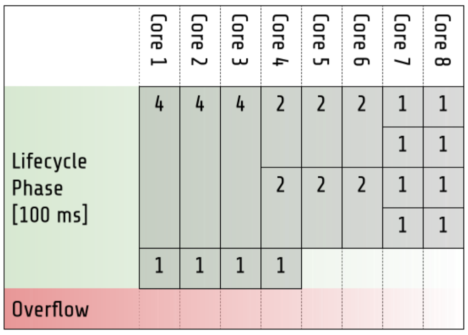
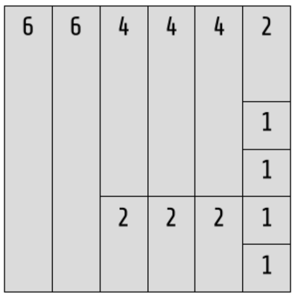
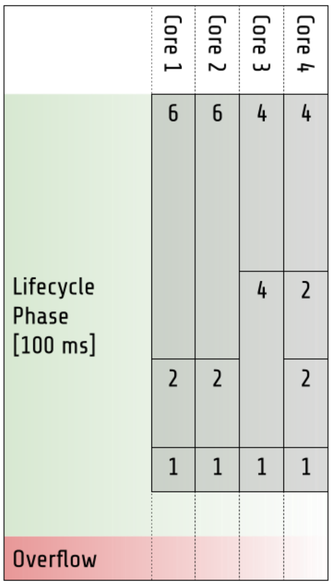
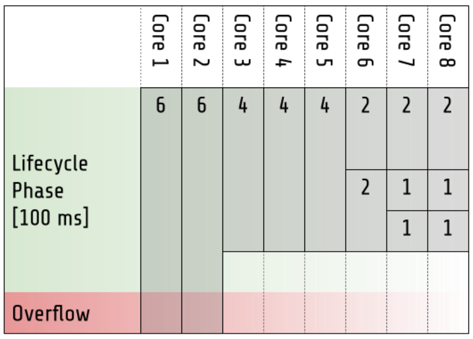
If you want to expand your current AGV system managed by movizon CONTROL, please refer to the following table to get an approximation of the expected increase in the CPU load:

AGV Options per Job	Route Options per AGV	Jobs	Performance Impact Factor	Graph
1	1	1	**1**	
10	1	1	**10**	
5	5	2	**50**	

AGV Options per Job	Route Options per AGV	Jobs	Performance Impact Factor	Graph
10	10	1	**100**	
10	10	10	**1000**	 1 2 3 4 5 6 7 8 9 10 A B C D E F G H I J

CPU Selection

Calculations in movizon CONTROL are executed in scripts or modules each of which can perform one or multiple tasks. Each task runs in a separate thread. movizon CONTROL can't manage the distribution of threads on CPU cores directly, but the JVM will try to utilize all cores if allowed by the operating system. Ideal for running movizon CONTROL would be a CPU with a lot of fast cores, but from a financial point of view you have to choose between a CPU with more but slower cores and a CPU with less but faster cores. Latter is better in most cases even if the CPU load could vary according to the structure of modules and scripts in your application:

Task structure 6 x 6	CPU with 4 fast cores	CPU with 8 slow cores
	 Core 1 Core 2 Core 3 Core 4 Lifecycle Phase [100 ms] Overflow	 Core 1 Core 2 Core 3 Core 4 Core 5 Core 6 Core 7 Core 8 Lifecycle Phase [100 ms] Overflow
	 Core 1 Core 2 Core 3 Core 4 Lifecycle Phase [100 ms] Overflow	 Core 1 Core 2 Core 3 Core 4 Core 5 Core 6 Core 7 Core 8 Lifecycle Phase [100 ms] Overflow

RAM

As a rule of thumb: For best performance let the size of the memory be at least the size of the production database used by movizon CONTROL in your AGV system.

Hard Disk Space

- Some space for the production database wherever it is located, exact values depend on the project
  - Size of database in small projects is under 1 MB
  - Size of database in large projects is about 10 MB
  - Size is not growing because database is for resource persistence, not for history data
- A maximum of 1 GB of local hard disk space for logfiles, more details here

Server Software

- GraalVM Community / Enterprise 21 | Java 11 based
- Java web container that supports Java Servlet 3.1 specification (JSR 340) or higher
  Recommendations: Apache Tomcat 9 or Jetty 11
- Any operating system that supports both packages above

Browser UI

- Up-to-date browser with Blink engine, for example
  - Google Chrome starting at version 28
  - Microsoft Edge starting at version 79

Network

- Full WLAN coverage in the operating area of the AGVs
- For most AGV types: fixed server address
- Infrastructure that supports WebSocket connections
- Low-delay data throughput, standard communication frequency of movizon CONTROL is 10 Hz
- Permanently open UDP and TCP ports, for more details please ask for a project specific communication structure chart

System Preparation

Please refer to the manual of the chosen servlet container or application server for general setup information. movizon CONTROL runs with the default configuration of common servlet containers after installation, so no universally applicable mandatory configuration steps can be listed here. Additional modules or packages of a Java EE application server in comparison with a plain servlet container should be deactivated because movizon CONTROL does not need any of them. Regarding security settings please follow your organisation's policies.

Firewall Settings

movizon CONTROL includes a UDP server to communicate with the AGVs. Each AGV will send telegrams from its own address to the server, while movizon CONTROL uses a single UDP port (configurable, default 2222) for outgoing telegrams. Please ask for a project specific communication structure chart and set your firewall rules carefully.

ATTENTION: If no target shows up inside CONTROL (see browser UI or server logs), one can safely assume that there is a network or firewall problem. Tools like Wireshark listen to telegrams right after the network adapter, so communication might still be cut off by the firewall of the server's operating system.

Database Connection

movizon CONTROL reads all resources from the production database on startup and keeps them in memory. During runtime there is no read access any more. Changes to the resources are collected and written to the database once per core loop run (default setting 10 Hz). JDBC connections are managed by an integrated connection pool manager. For each resource type in movizon CONTROL one database table is used to store all resources of this type. There is no need to prepare database tables because movizon CONTROL creates them automatically if needed. Each table contains only two columns, the first one is for the ID of the resource, the second one holds a JSON string representation of the whole resource.

Using the Embedded H2 Database (Recommended)

movizon CONTROL ships with an embedded H2 database that is very much suited for the use case described above. If not configured otherwise via JNDI, this database will be connected automatically on startup. It uses (or creates if not present) a single-file-datasource with the path [MC_BASE]/WEB-INF/config.mv.db.

Connecting an External Database

It is possible to connect an external production database to movizon CONTROL. Do this at your own risk and only if you have experience in configuring and operating the database type you want to use. It may or may not run reliably with good performance for your project in your system environment. Theoretically, most SQL databases should work with movizon CONTROL. As far as we know, customers have successfully connected MySQL and Oracle databases. To connect an external database, connection details have to be deposited as a JNDI entry in the appropriate configuration file of the container. In case of using Apache Tomcat this configuration file would be conf/context.xml and the entry could look like this:

Example of JNDI entry to connect a MySQL database to movizon CONTROL

```
<Resource name="jdbc/tcOperation" auth="Container" type="javax.sql.DataSource"
   maxTotal="20" maxIdle="10" maxWaitMillis="-1"
   username="ADMIN" password="r7Gh4k-6#z" driverClassName="com.mysql.jdbc.Driver"
   url="jdbc:mysql://localhost:1433/movizoncontrol"/>
```

LDAP Connection

Users in movizon CONTROL can be externally authenticated (not authorized!) via LDAP. Since user requests are strictly stateless each request must be authenticated for itself. Therefore user credentials will be sent unencrypted to an authentication service that can be connected to movizon CONTROL with the help of a JNDI entry like this:

Example of JNDI entry to connect an LDAP authentication service to movizon CONTROL

```
<Resource name="ldap/tcAuthentication" auth="Container" type="javax.naming.ldap.LdapContext"
   factory="com.gsfleetcontrol.tc.kernel.LDAPFactory" singleton="false"
   java.naming.factory.initial="com.sun.jndi.ldap.LdapCtxFactory"
   java.naming.provider.url="ldap://192.168.178.88:389"
   java.naming.security.authentication="simple"
   java.naming.security.principal="UID=admin,OU=people,DC=gsf,DC=de"
   java.naming.security.credentials="e4RE$dw2+a" />
```

Deployment

movizon CONTROL will be provided as a zipped folder whose size is less than 20 MB. If the hosting environment demands a war archive simply rename *.zip to *.war and deploy. If not, unpack the archive and copy it into the deployment directory off the hosting container. movizon CONTROL uses annotations to describe its servlet so don't look out for a web.xml file.

Startup

After deployment start or restart your servlet container or application server if needed. movizon CONTROL logs events separately from the logging system of the container. Those logfiles are located in [MC_BASE]/logfiles. Up to 1000 files will be created - each with a maximum of 1 MB - before the oldest will be overwritten. Look into the latest logfile (named server_0.log) to verify a clean startup. If movizon CONTROL's logfiles folder is empty, refer to the logfiles of the container because it might have caught a more serious problem.

A successful startup of movizon CONTROL is also indicated by displaying the login or licensing screen after calling the browser UI with one of the following URLs:

Main UI	Scheme	[PROTOCOL]://[SERVER_ADDRESS]/[MC_BASE]/
	Example	https://127.0.0.1:8080/movizoncontrol
Main UI with auto login	Scheme	[PROTOCOL]://[SERVER_ADDRESS]/[MC_BASE]?username=[USERNAME]&password=[PASSWORD]
	Example	https://127.0.0.1:8080/movizoncontrol/?username=observer&password=project2020

ATTENTION: While movizon CONTROL allows Unicode characters in passwords, only ASCII characters may be used inside URLs. Please choose passwords accordingly if you want to use the auto login feature.

Licensing

It is not possible to log in and work with movizon CONTROL without a valid license. Licenses are deposited on a remote license server. To retrieve a license it is necessary that movizon CONTROL was started on the customer system beforehand. So if you are greeted with the licensing screen after calling movizon CONTROL's browser UI, please follow the displayed instructions. You should have an email stating the ID of the registered license owner to use in order to request your license.

ATTENTION: movizon CONTROL ensures that a user for the registered owner of the license is always present and has full access to all resource types. This user can't be deleted or limited in any way.

Maintenance

movizon CONTROL is designed as a maintenance free application. No mandatory actions need to be planned. Depending on the use case and project, a regular backup of logfiles and the database would be optional actions. movizon CONTROL's hosting environment is likely to be serviced regularly. Although movizon CONTROL can be shut down and restarted via container for this purpose without loss of data, make sure to consult the AGV service team in advance so that they have the chance to ensure safe conditions on the AGV side too.

ATTENTION: In case of using the embedded H2 database please note that the H2 driver locks the database during runtime of movizon CONTROL. On Linux systems it might even look like you've successfully copied the database, but your copy will be hollow. So to create backups of the database, movizon CONTROL must be stopped by shutting down the hosting container.

Update

Since most of our customers use offline production servers, there is no remote update procedure for movizon CONTROL. New versions of movizon CONTROL will be provided just like the package for the first installation, so an update is basically a redeployment. If you use the embedded H2 database please take it over to the new version manually. You might also want to save movizon CONTROL's logfiles before deleting the previous version.

ATTENTION: Please beware if you want to rename and keep the last version of movizon CONTROL inside the deployment directory of your servlet container. If multiple instances of movizon CONTROL tries to startup, only the random first instance will be able to bind the UDP ports if their numbers collide. You can change UDP ports anytime after startup via browser UI.

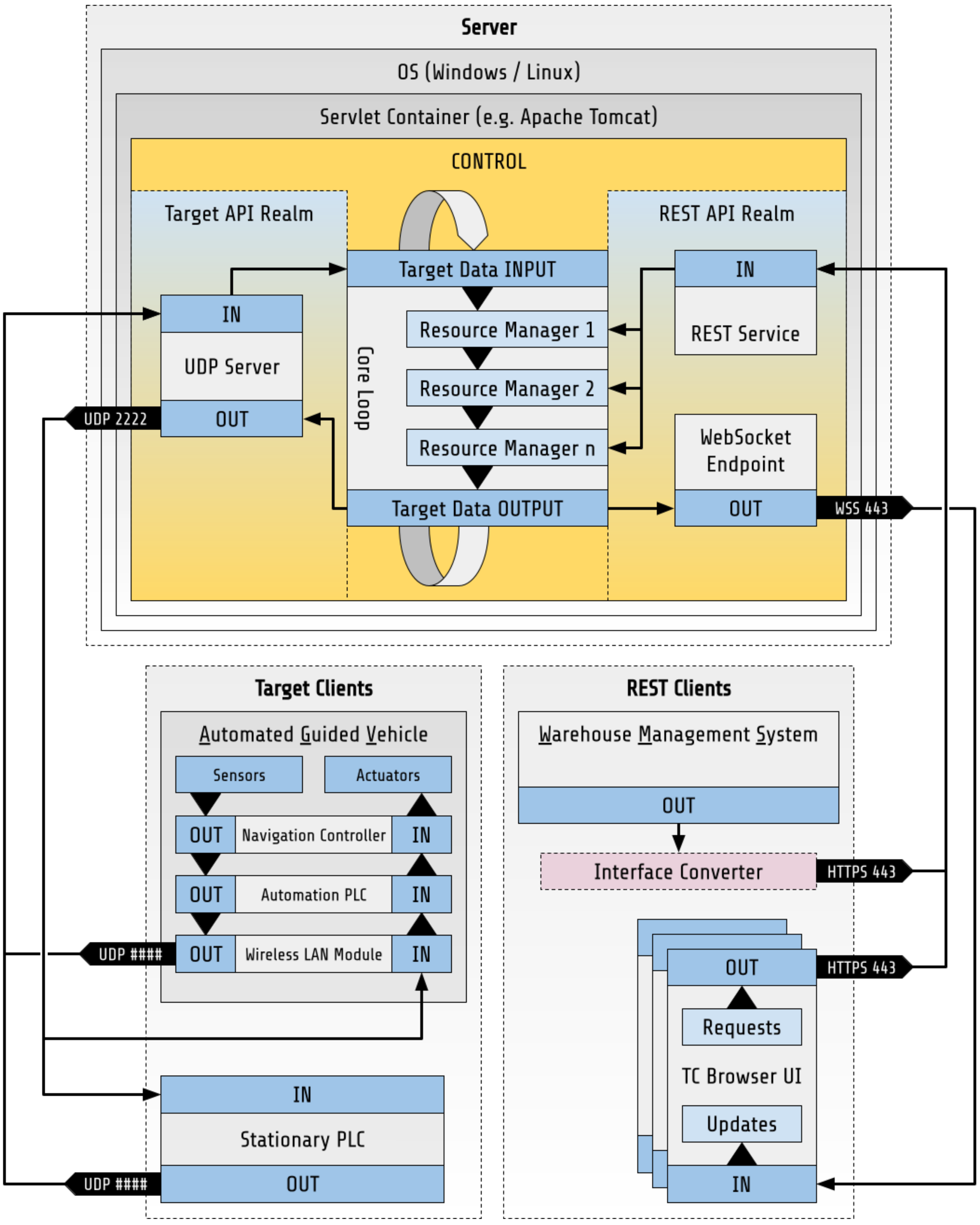
Example: Installation with Apache Tomcat

Follow these steps to create a basic hosting environment for movizon CONTROL:

1. Download and install GraalVM Community 21
2. Download and install Apache Tomcat 9
   For Windows the 32-bit/64-bit Windows Service Installer offers hassle-free installation
3. Deploy movizon CONTROL
   a. Unzip the provided movizon CONTROL archive
   b. Copy the unzipped folder into the webapps folder of Tomcat
   c. Rename the folder to "movizoncontrol" and check the resulting path:
      [TOMCAT_BASE]/webapps/movizoncontrol/WEB_INF/...
4. Start movizon CONTROL by starting Tomcat
   a. Either execute [TOMCAT_BASE]/bin/tomcat9.exe
   b. Or start the service manager at [TOMCAT_BASE]/bin/tomcat9w.exe
      If the service is already running, stop and start it again
5. Open a browser and call http://localhost:8080/movizoncontrol
6. Follow the instructions displayed after loading to request and apply your license

Data Flow

The following chart is not project specific but contains typical elements of a system running movizon CONTROL:


Server
OS (Windows / Linux)
Servlet Container (e.g. Apache Tomcat)
CONTROL
Target API Realm
REST API Realm
Target Data INPUT
Core Loop
Resource Manager 1
Resource Manager 2
Resource Manager n
Target Data OUTPUT
IN
UDP Server
OUT
UDP 2222
IN
REST Service
WebSocket Endpoint
OUT
WSS 443
Target Clients
Automated Guided Vehicle
Sensors
Actuators
OUT
Navigation Controller
IN
OUT
Automation PLC
IN
OUT
Wireless LAN Module
IN
UDP ####
IN
Stationary PLC
OUT
UDP ####
REST Clients
Warehouse Management System
OUT
Interface Converter
HTTPS 443
OUT
HTTPS 443
Requests
TC Browser UI
Updates
IN