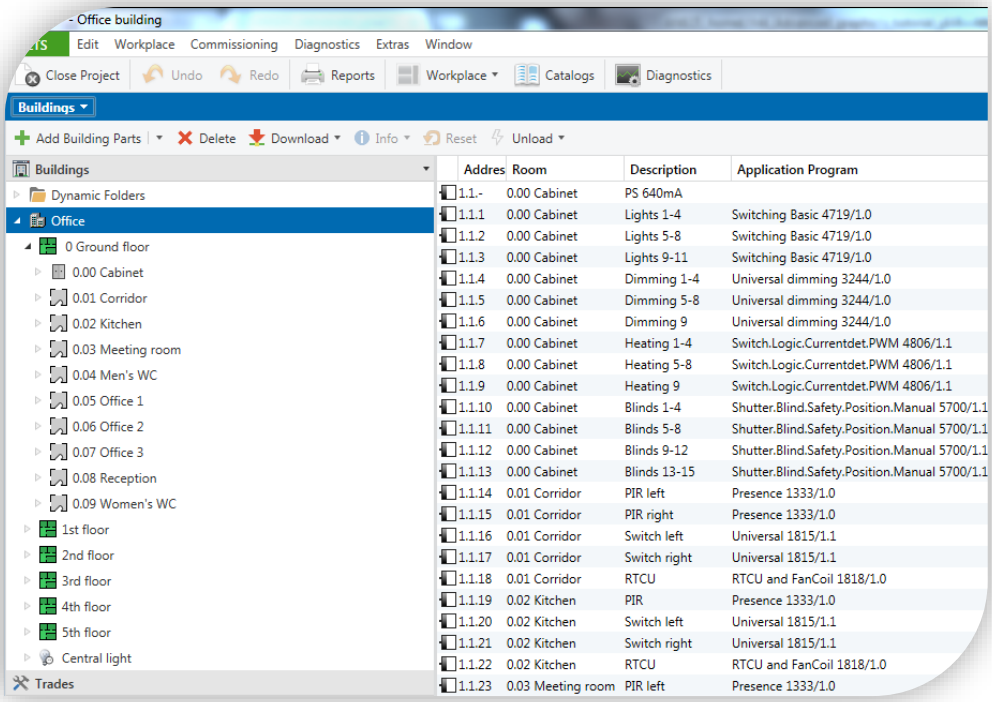
★★★

Basic / Advanced / Expert

Application note

Advanced project's tutorial

How to create a complex project with emphasis on BMS export



Schneider Electric

Safety Information

Important Information

Read these instructions carefully before trying to install, configure, or operate this software. The following special messages may appear throughout this bulletin or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.



The addition of either symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠DANGER
DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠WARNING
WARNING indicates a potentially hazardous situation which, if not avoided, can result in death or serious injury.

⚠CAUTION
CAUTION indicates a potentially hazardous situation which, if not avoided, can result in minor or moderate injury.

NOTICE
NOTICE is used to address practices not related to physical injury. The safety alert symbol shall not be used with this signal word.

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- Do not base your maintenance or service actions solely on messages and information displayed by the software.
- Do not rely solely on software messages and reports to determine if the system is functioning correctly or meeting all applicable standards and requirements.
- Consider the implications of unanticipated transmission delays or failures of communications links.

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1 Introduction

This application note describes process of creation of complex project from beginning to the end with emphasis to easy multiplication of project or its parts and interconnection of different BMS technologies such as KNX and BACnet. It can be also beneficial in case of

Application note describes step by step creation of project for commercial buildings. Described example project represents medium size office building with six identical floors with following properties:

Description	Floor	Total
Floor area	2 wings 300 m^2 each	Circa 3600 m^2
Rooms	9 rooms + 1 cabinet per wing	96 rooms / 12 cabinets
Number of KNX devices	106	636
Number of KNX GAs	544	3264

Table 1 Sample project properties

This project was made to set all amounts (devices, GA addresses, TP traffic) on the edge of permitted amounts. All real KNX devices were replaced by Wiser for KNXs simulating their traffic on KNX TP bus.

Following KNX data point types were used in sample project:

Data Point types	Usage
1-bit DPT 1.xx	Switching ON/OFF (lights, heating, blinds control)
4-bit DPT 3.007 (3bit controlled)	Dimming control
1-byte DPT 20.xx	Status of dimming and blinds
2 Byte DPT 7.xx	Temperatures
Time DPT 10	Date
Date DPT 11	Time

Table 2 Data points used in sample project

A glossary is available in the appendix chapter of this document. Please refer to it whenever necessary.

1.1 Competencies

This document is intended for readers who are certified KNX partners, have basic experience with BMS (SBO) systems and have been trained on Wiser for KNX, spaceLYnk products. Integration should not be attempted by someone who is new to the installation of either product. Additionally recommended knowledge:

- Reading of construction documentations
- Basic knowledge of MS Excel
- Basic knowledge of IP technologies and principles

1.2 System prerequisites

Software	Version	Download
Wiser for KNX	Fw 2.1	http://www.schneider-electric.com
spaceLYnk	Fw 2.1	http://www.schneider-electric.com
ETS 5.5.4	Build 1158	http://www.knx.org/knx-en/software/ets/download/index.php
Notepad ++	v6.5.5	http://notepad-plus-plus.org/
SBO enterprise	1.6	http://www.buildings.schneider-electric.com

Table 3 Software versions of used software

2 Before your project start

2.1 Obtaining all relevant documentation and project specification

2.1.1 Plans and drawings

A well-made KNX project should be designed according to the scope of the project, which must be absolutely clear and understood by all involved parties.

Preparations and sufficient amount of information is crucial.

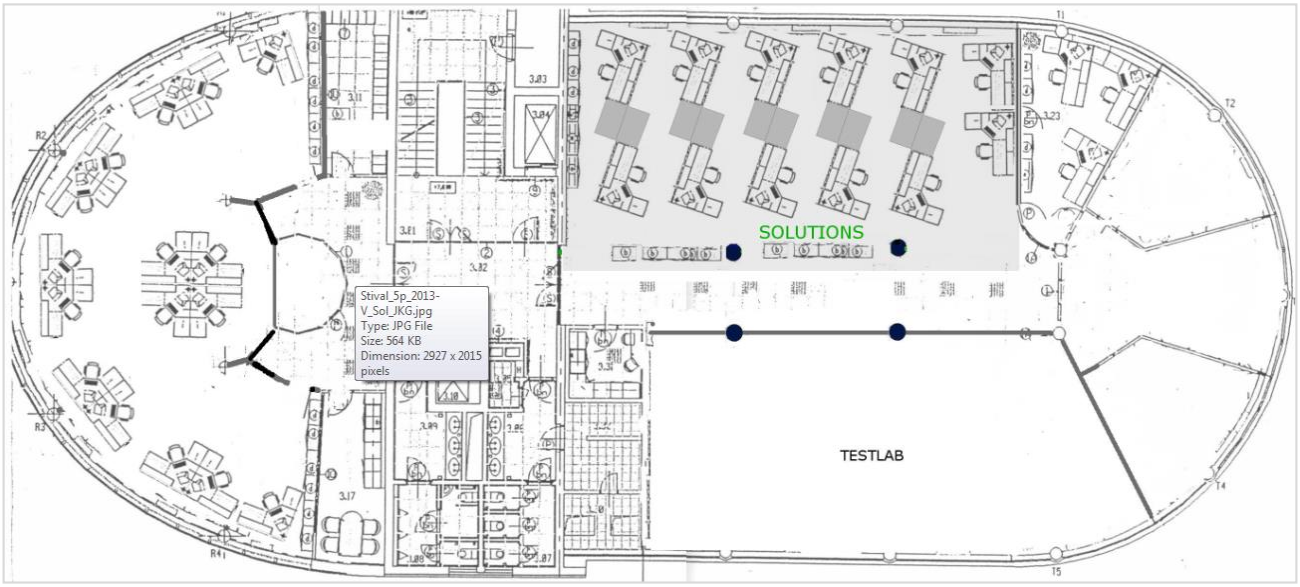
Proverb: “The more you sweat in training, the less you bleed in battle!” is very accurate.

Just replace *sweat* with *prepared information* and *battle* with *spent time and money*.

Plans and drawings are important for proper understanding of rooms, devices and functions location.

Project documentation should contain:

- Drawing of the building with measures and detailed description including type of structure (walls, ceilings, service openings).
- Tender documentation which contains building purpose and use, number of occupants, restrictions and applied regulations.
- Room numbers/names from project which will be used across the whole project (ETS, BMS and visualization).
- Security and fire security plans can be also very useful, as it can be important to adapt topology to reflect given security zones (usually divided by security doors/walls).
- Detailed function description from the customer. This is one of the most important information to get for successful project completion.
- Project/ offer from competition (if available). Useful for matching functions and philosophy of installation convenient to customer. Example: some companies have typical layout/logic of their push buttons which may be copied during the installation.
- Use project management tools such as MS Project for large and complex projects.
- Proper drawings, preferably in electronic form may also help with future visualization of project. Do not hesitate to give them to professional graphic that will create synoptic and eye catching visualization.



Picture 1 AutoCAD drawing



Picture 2 3D visualization

2.1.2 Technical specification, functionality and regulations

Start by considering the mechanical design with the electrical design and don't separate the two as there are many cross over points and many aspects that could be designed together. Very often one part of the controls system could be covered within the mechanical specification (e.g. physical placing of switchboards) and another part within the electrical specification, both separated by strict works packages.

Technical specifications are important for proper selection of technology, equipment and devices. Wireless devices or even wired connection may be limited due to building structure or size and it is very important to determine proper technologies as soon as possible.

Design to save installation / cabling. Promote the use of a site-wide IP network especially for communication between different technologies (KNX – BACnet). A CAT6 data network installed by a data cabling company throughout a building is now a standard feature. Use it for your IP network for communication around the building to save on installation, labour and materials. The structured cabling network is very reliable and is a single asset to maintain. KNX installation has a very little bandwidth and will not overload the network.

Listen and observe usage of building. Different functionality may be needed for corridor at the airport or in the hospital. It is also important for selecting of proper devices.

Examples: basic motion detectors may not have master/slave function, which may be limiting in long corridors setup. Missing advanced or logic functions may be also limiting for use of certain push buttons or switching actuators. It is also very important to select proper equipment for dimming of lights or control of blinds as there is many technologies and rapid advance especially in lighting sector. Some dimmers can only control classic resistive load, advanced can also handle capacitive/inductive load (fluorescent lights, LEDs) and be ready for future upgrades/refurbishment.

Properly managed project should be able to be evaluated at any time. You should be able to tell if you are under or over budget, if you are ahead or behind schedule, and how far from the scope you are. Thanks to this knowledge the right decisions can be made, and if necessary, corrections such as fast tracking or crashing can be made.

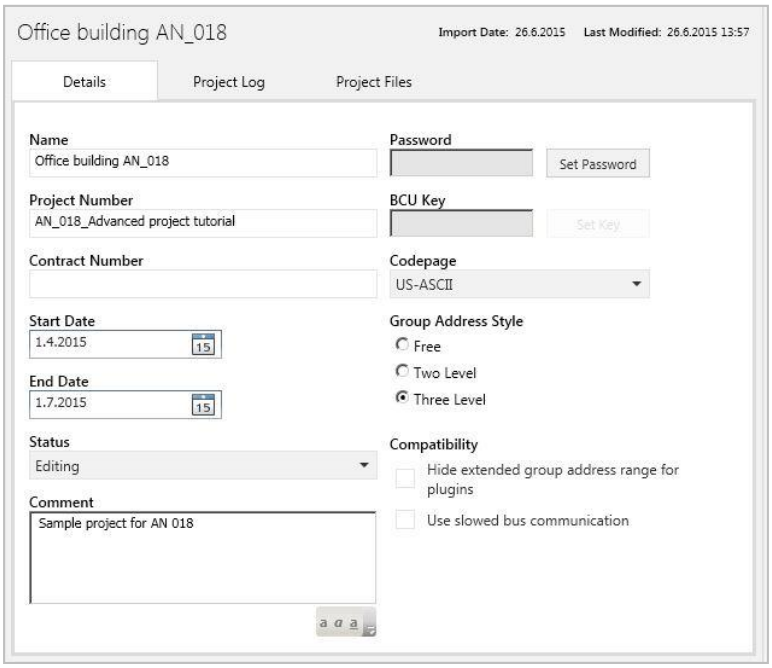
Regulations and legal requirements can be limiting for selection and amount of technologies, equipment and devices. Regulations and legal requirement are varying from country to country.

3 Creating ETS project

3.1 Before you start

3.1.1 ETS project

New project is easy to handle when properly described. Start at the very beginning with description of ETS project itself. Click on the project you want to edit. In the right side of the screen you have all the information about the project. Fill in all fields. In *Details* tab, comment the project with every useful thinking you want to remember in the future. In *Project Log* tab, you can add different information like the modifications you done since the last time you opened the project, what you do not have done yet. Project or its parts can be protected by a password. Finally, in *Project Files* tab, you can add all the files about this project, for example DWG blueprint files, technical documentation about KNX devices, IP addresses structure, etc…



Picture 3 Project's credentials window

NOTE: Don't forget to save your project regularly! It's a basic advice, but many system integrators forget this step. Use the *Export* function in ETS to save your project in ETS (.knxproj file) on a NAS, in the cloud, or any secured place you'll find it in case of complete crash of your computer.

3.2 Topology

3.2.1 Structuring and planning reserves

Always observe a reserve of approximately 15 to 20% per line segment. I.e. for single TP line with maximum of 64 bus devices, maximal planned amount should be 50 to 55 bus devices. Same rules apply for main and backbone lines.

Devices used in central functions should be installed in main lines or in backbone lines.

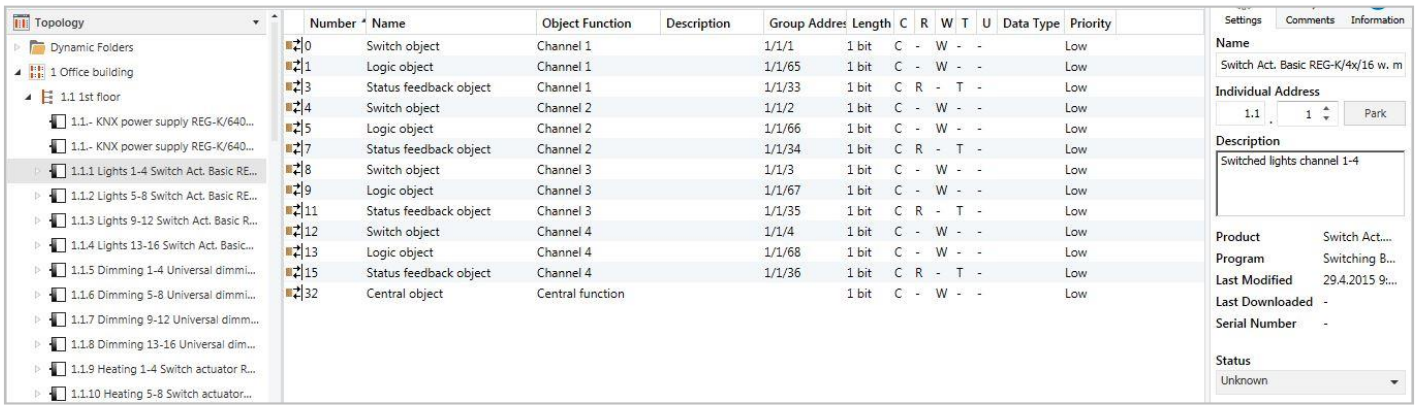
Devices of connecting room groups should also be put in the same line segment. Under no circumstances several segments in a room should be mixed, unless the upper limit of 64 (or 50 with reserve) has been exceeded. In that case, this should be clearly documented!

On the same floor (or in the same building) you should if possible only install one area (do not fill up when one or two lines are free).

Line coupler is used in the sample project as a solution extending possible number of KNX devices to 128 per line. Each floor contains extended line with 106 KNX devices.

3.2.2 Systematic devices description

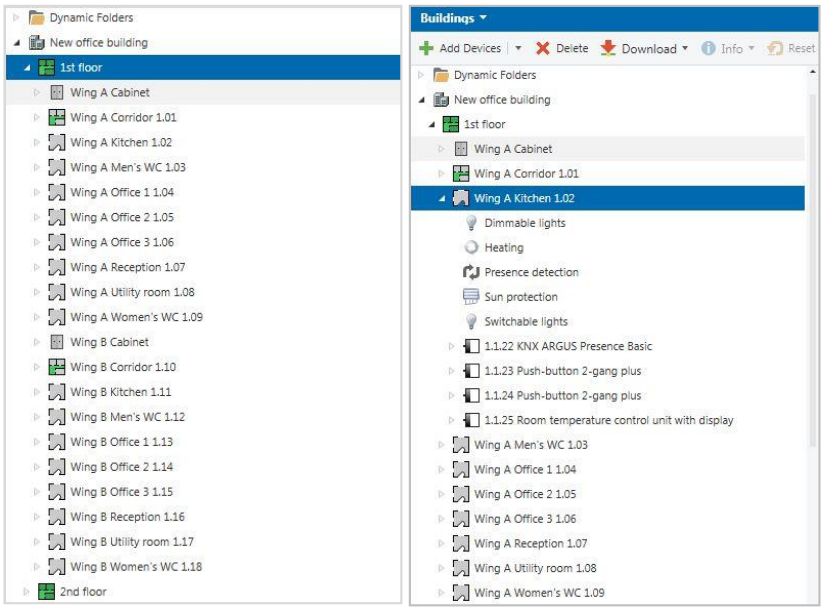
All KNX devices in the sample project are simply and clearly described by their individual address and name. Second number in address is signalling floor where the device is installed. Room description is visible in *Room* column; further description can be placed in the *Comment box* (80 characters max.) and *Installation notes*.



Picture 4 KNX devices description in ETS 5

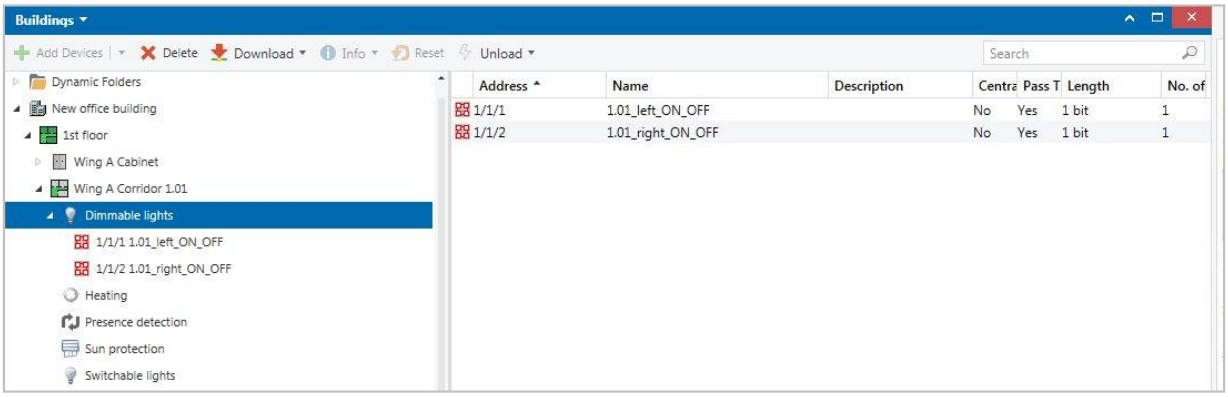
3.2.3 Inserting devices

Devices should be inserted into the building structures first securing that everybody will clearly see where each device is placed. Report from building overview can serve as installation guide for physical placing of KNX devices.



Picture 5 Building overview in ETS 5

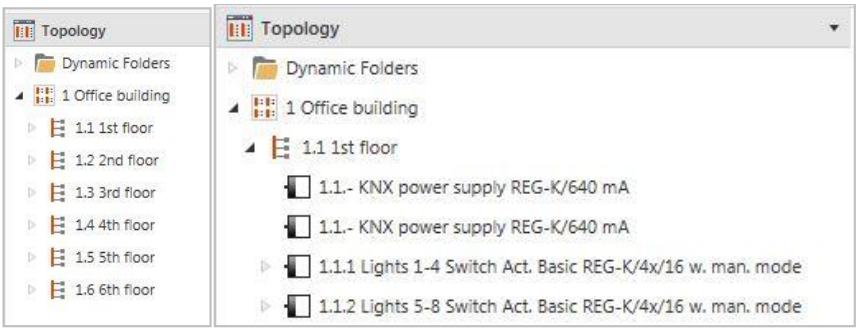
Don't forget to add *Functions* for every room, in the building structure. These functions can receive group addresses, and your projects are thereby more easy to read and understand. Do not hesitate to use them.



Picture 6 Function overview in ETS 5

Devices should be also present in the *Topology* list.

Six lines corresponding with six office building's floors in sample project:



Picture 7 Topology overview in ETS 5

It is possible to speed-up installation of devices by pre-programming all KNX devices "on the table" and fit them already programmed; this will prevent need to access back side of device after placing. Installation of pre-programmed devices can be done by any electrician and not only certified KNX partner to same time and money.

Note: Always clearly write device's individual address on each KNX device it before installation. Colour distinction between different lines/areas may be also helpful.



Picture 8 KNX device description

3.3 Group addresses (GA)

3.3.1 Creating GA in the ETS

It is recommended to use 3-level structures. 2-level structure historically used in the ETS1 is practically not used in new projects anymore. Free level structure with 16 bit address range may be necessary for very large projects with large amount of group addresses in the same line/area, but may be limiting with use of older plug-ins for ETS or some older visualization devices (touch panels) which may not support free addressing.

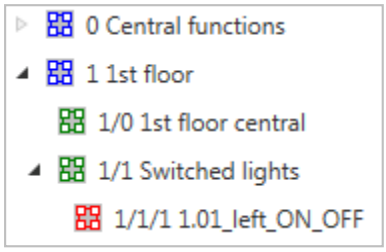
3 level structures allow you to have up to 255 GA addresses in one middle group which is sufficient for most small and middle size projects.

It is common practice to reserve addresses beginning with 0 for central functions.

Recommended format of 3 level group addresses is following:

floor number / function / description

Sample group address 1/1/1 (first floor/switched lights/left light in the room 1.01)



Picture 9 GA description in ETS 5

Recommended description format for group address is following:

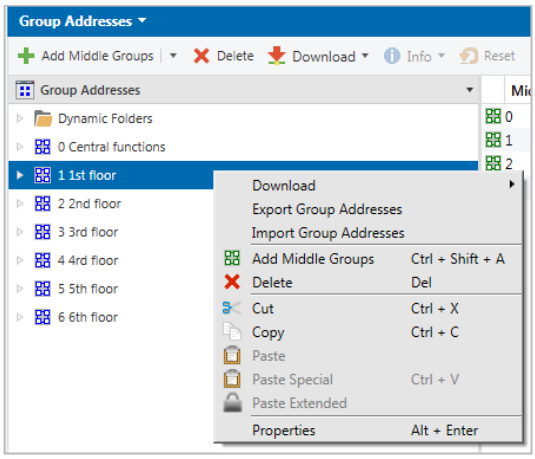
1.01 = floor number. room number (or room name)

left = location of light in the room, detail may be also provide in number format in larger installations

ON_OFF = specification of GA function

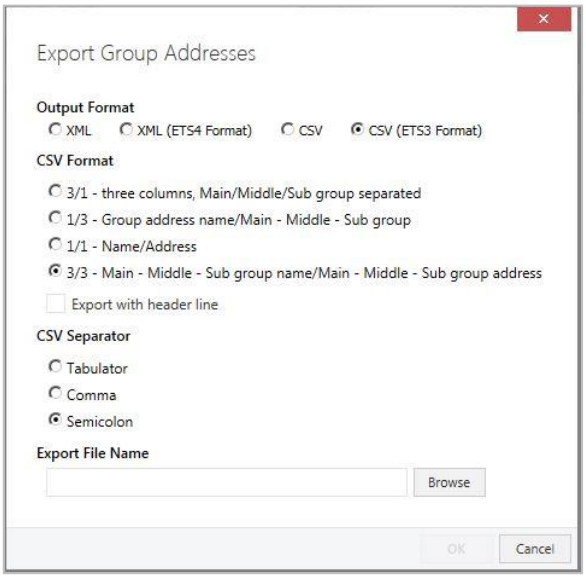
3.3.2 Export/import of GAs

Copying of large amount of group addresses is limited in ETS application. Group addresses can be easily pre-made outside ETS application and imported as a CSV file. It is important to keep exact format accepted by ETS. Best way to get a template is to use *Export of group addresses* function from existing part of project (e.g. single floor) or sample project. Once the structure is created, it can be exported and it can be used in multiple projects. This will allow you to know, for example in all the projects you manage group addresses beginning with 1/1 are matching with all ON/OFF commands for lights. In the BUS monitor, you can quickly see group address and associated functions in case of problems.



Picture 10 Export/import window in ETS 5

Recommended setting for CSV file export:



Picture 11 GA export dialog in ETS 5

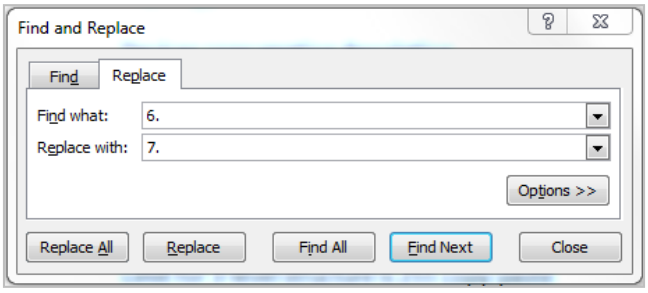
Exported table can be easily modified in the MS Excel:

A1 | Main

	A	B	C	D	E	F
1	Main	Middle	Sub	Main	Middle	Sub
2	6th floor			6		
3		6th floor central		6	0	
4		Switched lights		6	1	
5			6.01_left_ON_OFF	6	1	1
6			6.01_right_ON_OFF	6	1	2
7			6.02_left_ON_OFF	6	1	3
8			6.02_right_ON_OFF	6	1	4
9			6.03_ON_OFF	6	1	5
10			6.04_left_ON_OFF	6	1	6

Picture 12 MS Excel spreadsheet with GA export from ETS 5 project

Use *Find and replace* tool for mass alternating of group addresses, names or parameters. Sample picture is showing replacing all floor numbers in selected cells in column C representing name of group a ddress from 6.xx to 7.xx (sixth to seventh floor):



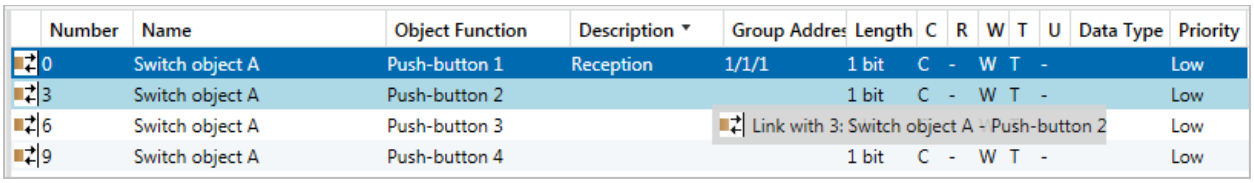
Picture 13 MS Excel Find and replace tool's dialog window

Demo project contains 6 identical floors. Group addresses can be modified for whole room in one go. This is unlikely to happen in real installation. Copying will be limited to room or single group addresses.

3.3.3 Fast linking of GA

Classic manual linking of GA is time consuming procedure especially in medium to large scale projects.

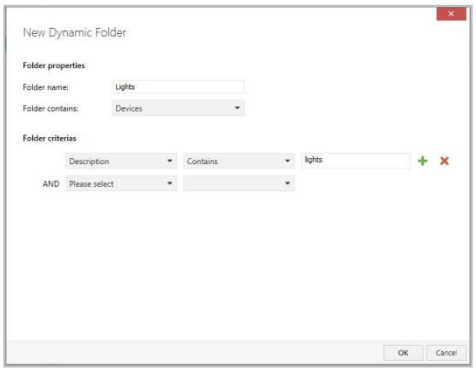
Faster way of group addresses linking. Drag-and-drop a group object to a group object! When you want to assign the same or some of the assigned group addresses of a group object to another one simply drag-and-drop the first one to the second one. You have all the assigned group addresses of the first group object, assigned to the second one. If you don't need all of them, you can unlink the undesired ones.



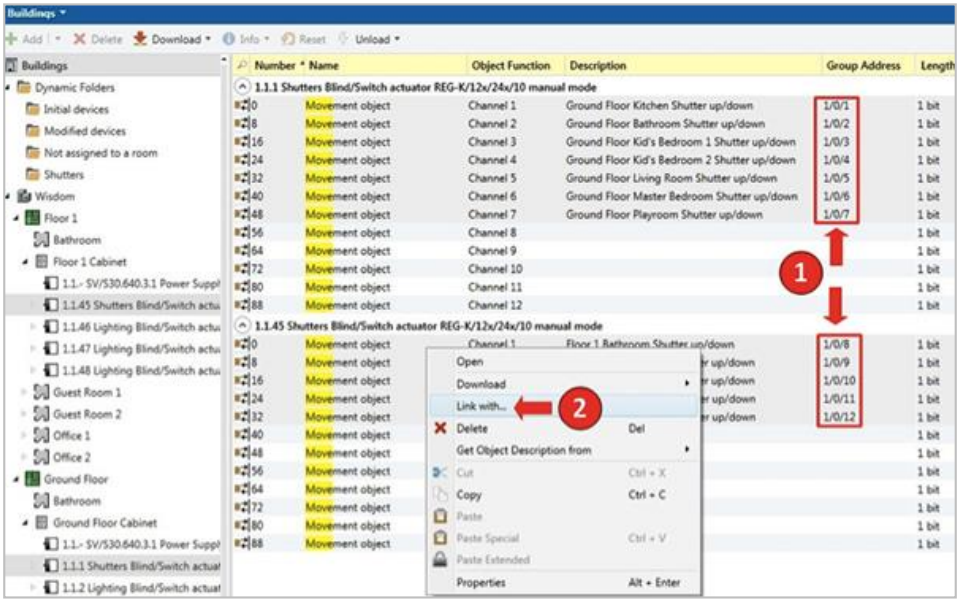
Picture 14 Copying GA links from one object to another in ETS 5

In large-scale project you want to assign the same group addresses, dedicated to central functions, scenes etc, to many group objects or, to many different sets of group objects. The optional use of the dynamic folder tool can save time while searching the appropriate devices' group objects that you want to link, as shown below.

- Give the devices an appropriate description
- Create a new dynamic folder
- Configure the filtering criteria of the dynamic folder
- Click on the dynamic folder to see the filtering result
- Select the devices that you want, and with a right click of the mouse, choose the option Open. After that, you will get the results as shown picture below, where you can select the desired group objects of the selected devices and again, with a right click of the mouse, choose the option Link with…

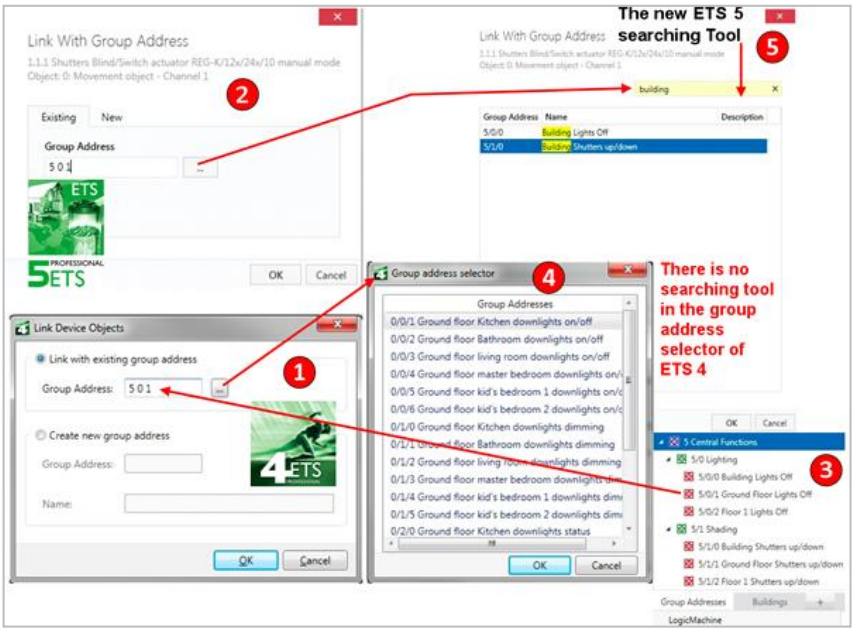


Picture 15 Dynamic folder dialog in ETS 5



Picture 16 Selection of the appropriate devices' group objects for fast group address linking

You are now ready to do the massive fast group address linking. You can see the group address selectors. Whatever you use, it is good practice to have to one side a printed group addresses report so that you can quickly find the desired group addresses without changing your current workplace. That is crucial, especially for the users of ETS 4, as there is not a group address searching tool in its group address selector as in ETS 5 so they will struggle with having to do endless scrolling up and down in order to find the desired group addresses. After you have selected the desired group address and clicked OK, all of the chosen devices' group objects will get this group address simultaneously.



Picture 17 Comparation of GA linking in ETS 4 and ETS 5

3.3.4 Automatic filter tables

Project designer does not have to deal with the correct creation of filter tables provided that the project contains all information regarding inputs and outputs (=senders and receivers). ETS will automatically generate valid table. Creation of the table starts with the download of the coupler. Filter tables are not displayed, but they are loaded directly into the coupler.

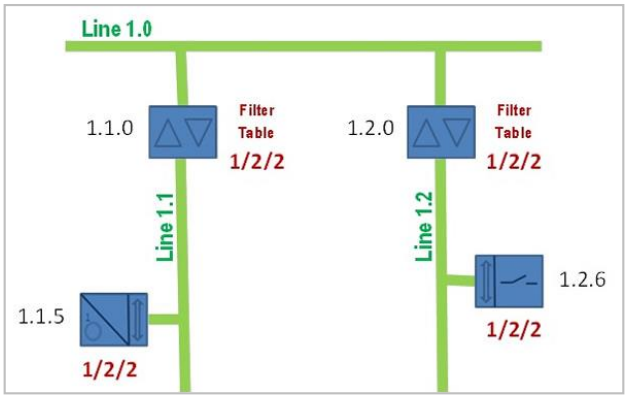
3.3.5 Manually created filter tables

There are cases in which the tables cannot be generated correctly because of the fact that devices receive or send telegrams, whose parameters cannot be set in ETS for instance gateways or visualization programs (hL/sL in our case). This option will allow KNX installation to work with virtual object from visualization or gateways such as Modbus readings or weather data from internet in case of hL/sL.

3.3.6 Manually adding GA to the filter table

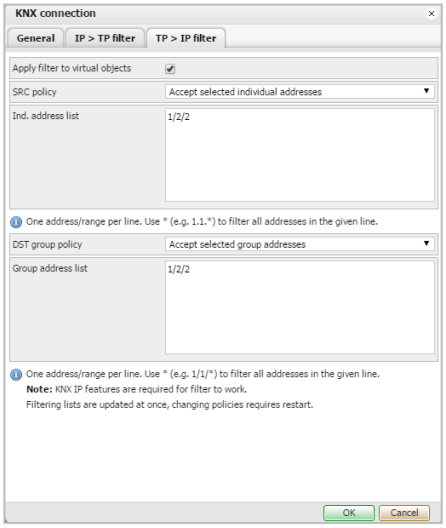
KNX supervision software packages use KNXnet/IP for connection with KNX network. For this reason ETS does not have KNX equipment with the necessary group objects to link to a group address. You have to create the necessary filter tables of the line couplers and/or area couplers manually. This applies for use of hL/sL as couplers.

Example: Pushbutton with physical address 1.1.5 in one line controls a switch actuator with physical address 1.2.6 in another line and telegram 1/2/2 goes from one line to another line in the same area and in different areas.



Picture 18 Basic sample of filtering

KNX pushbutton 1.1.5 control the switch actuator 1.2.6, we have to associate the group objects from both the pushbutton 1.1.5 and the switch actuator 1.2.6 with a group address (for example 1/2/2). For the telegram sent by the pushbutton in line 1.1 to reach the switch actuator in line 1.2, it has to cross the line coupler 1.1.0 to the area main line and then the line coupler 1.2.0 to the 1.2. For this to happen, ETS automatically puts this into the filter tables of the line couplers when you connect both KNX devices to the group address 1/2/2. For this reason, apart from downloading the pushbutton and the switch actuator, you also have to download the group addresses to the line couplers = hL/sL in our case.

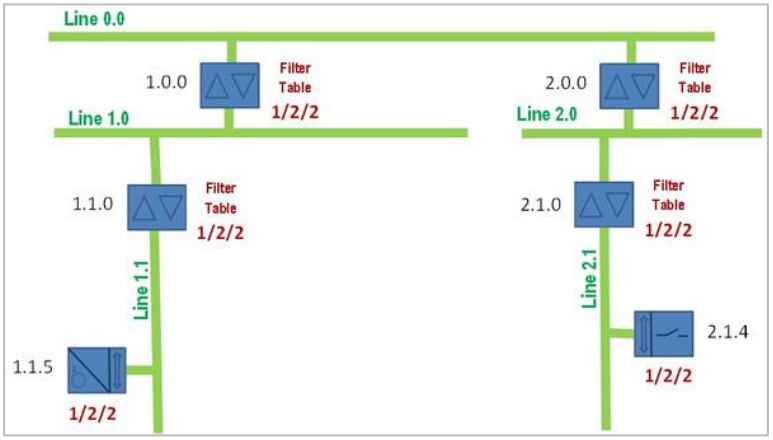


Picture 19 KNX filtering table window in hL/sL

Note: *Mass edit* of filtered object is not available in Wiser for KNX.

Group address	Object name	IP > TP filter	TP > IP filter
2/1/1	2.01_left_ON_OFF	☐	☐
2/1/2	2.01_right_ON_OFF	☐	☐
2/1/3	2.02_left_ON_OFF	☐	☐

Picture 20 Filtering options available in spaceLYnk



Picture 21 multiple filtering sample

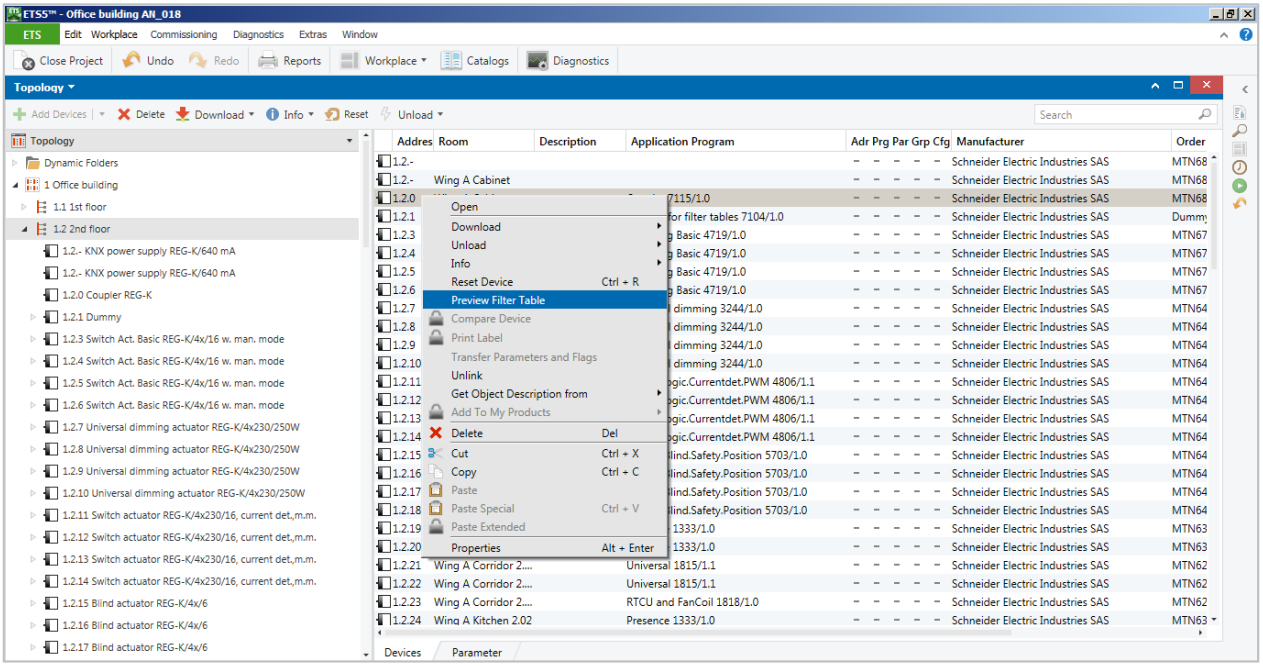
Same thing happens when the pushbutton 1.1.5 needs to control a switch actuator 2.1.4 connected to a different area. But now when you connect the object groups from both devices to the same group address 1/2/2, ETS inserts this group address not only in the filter tables from the line couplers 1.1.0 and 2.1.0, but also in the area couplers 1.0.0 and 2.0.0. In this case, you have to remember that you also have to download the new filter table not only the line couplers, but to the area couplers too.

In order for a telegram to be routed to a line/area coupler, two conditions must be met:

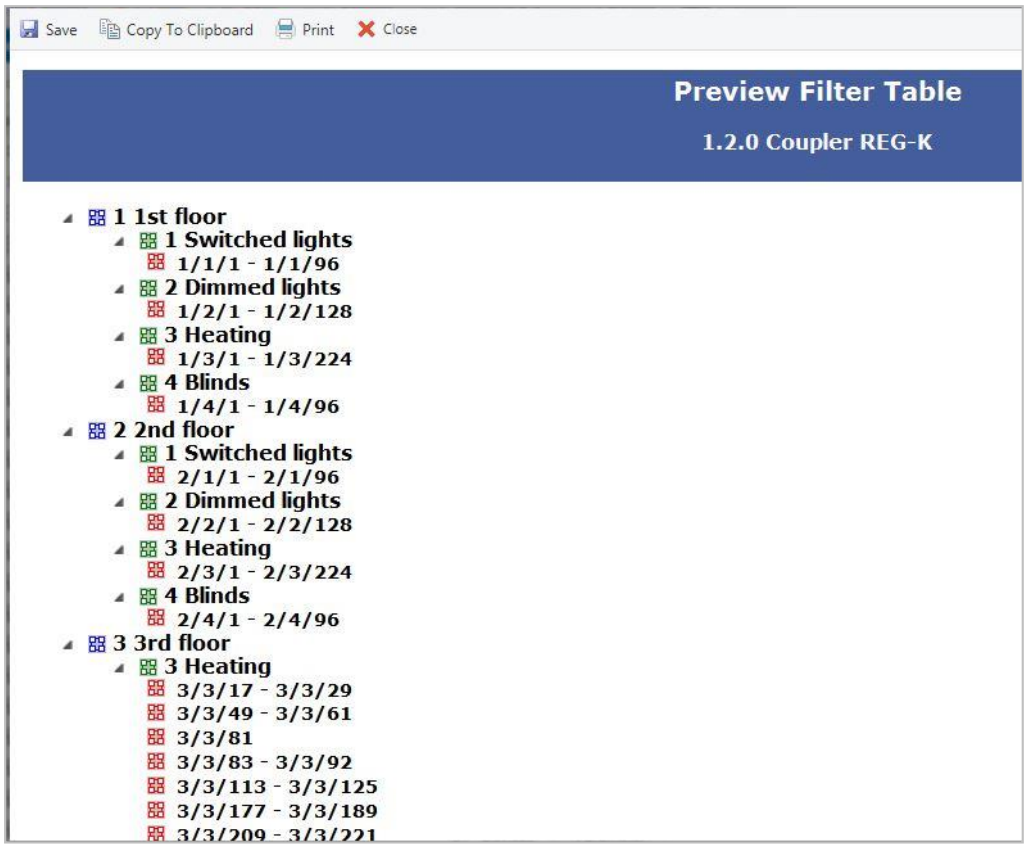
1) The target address (group address) in a telegram has to belong to the filter table of the line/area coupler (hL/sL)
2) The routing counter has to be higher than 0.

During normal communication, when the telegram is sent, the routing counter is equal to 6, and each time it crosses a line coupler or area coupler (as well as the line repeaters) it is decreased by one unit. This is used to avoid the continuous circulation of a telegram through a KNX network with an error in the installation. For the issue this article covers, it is not of fundamental importance, but it is referenced since it is one of the conditions for a telegram to be routed to a line/area coupler.

ETS automatically creates this filter table each time you link the group objects to the group addresses. If you take a look at the simple project created, once you open the filter table of each line/area coupler after linking the group objects, you can see each group address belonging to the filter table.



Picture 22 Filtering table in ETS 5



Picture 23 Filtering table preview in ETS 5

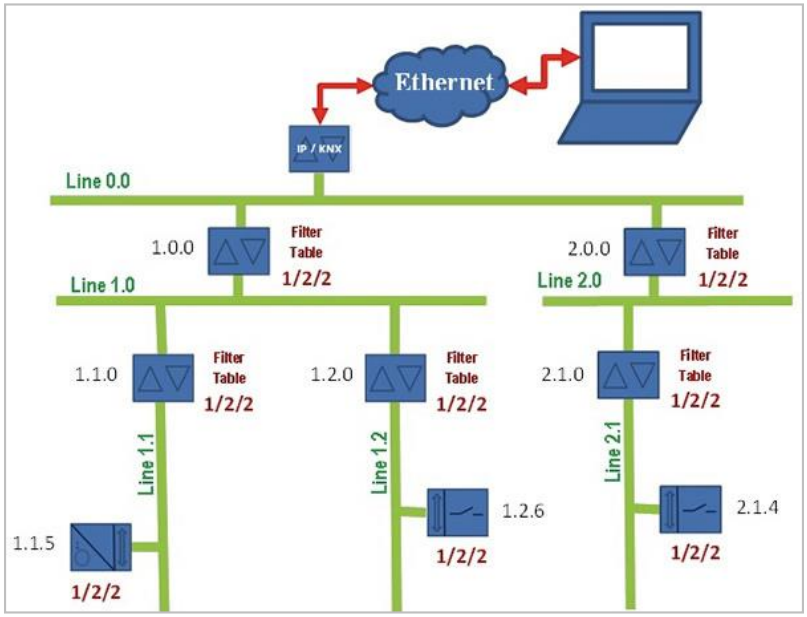
Remember that for the line/area couplers to have the filter table loaded into their memory, you have to download their application program with the group addresses.

Note: Remember that each time you make any modification to the installation, such as creating another connection that affects the filter tables, you must not only download the KNX devices where you have made the modifications but also download again the line/area couplers for each filter table that has been modified. This is a very common mistake – we always remember to download the equipment for which we have made changes, but forget that the filter tables of the line/area couplers have also been modified automatically by ETS.

3.3.7 Adding Visualisation Software via an IP Interface

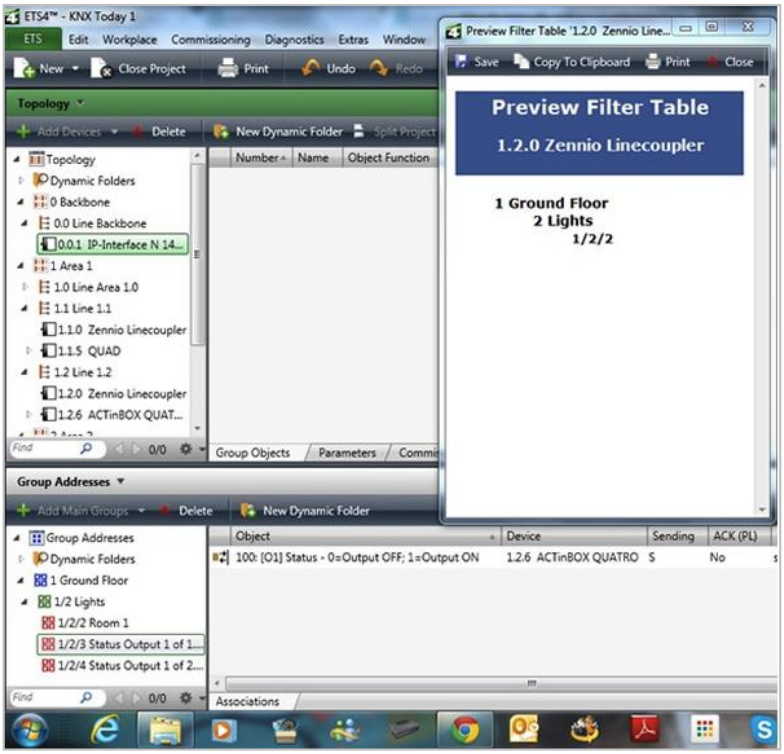
As recommended, if you have just one area, then all central interfaces should always be placed on main lines. If you have more than one area, you should place all central interfaces on the backbone line (Line 0.0). This reduces the number of telegrams in the KNX network.

Using our previous example, we are now going to place an IP interface where our visualisation software communicates with the network. To keep things simple, we are just going to add two group addresses: one for the status of output 1 of the device 1.2.6, and the other one for output 1 of the device 2.1.4 as shown below.



Picture 24 Advanced filtering sample including IP

When we include the group addresses for the status, we see that we have only the group object from the KNX actuators, and there are no communication groups on the side of the IP interface. If you check the filter table of the line/area couplers, you can verify that there are no changes, since we have not connected the group address to any device in the backbone, as shown in below.



Picture 25 filter table preview in ETS 4

3.3.8 Manually adding the group addresses to the filter table of the line/area couplers

To manually add the group addresses to the filter tables of line/area couplers, you must push the group addresses from the Group Address view to the respective lines in the Topology view. But you have to be very careful to push the group address to the line area and to the backbone; otherwise if you just push the group address to the backbone line, this will just be added to the area coupler and not to the line coupler. So, you also have to push the group address to the line area if they are to be added to the filter table of the lin e coupler.

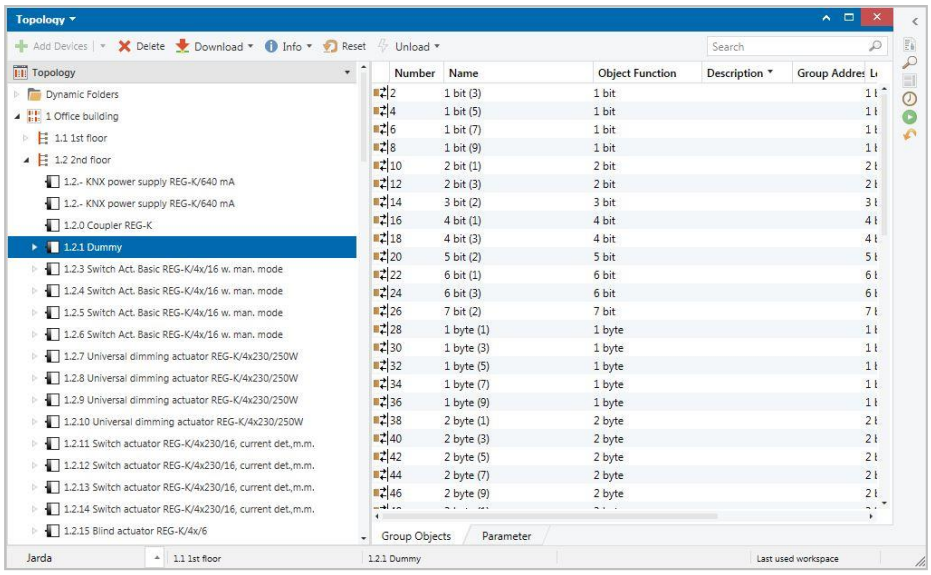
The big disadvantage of this method is that you have to make the links carefully for each line/area coupler, and you can only see the links if you look at the preview of the filter table of each line/area coupler.

3.3.9 Using a dummy device to automatically include the group addresses in the filter tables

A dummy device is simply an image of a device that represents the visualisation device. This allows us to introduce a device in the backbone line and link group objects to the address groups that we want to transfer to the backbone line.

You can download these dummy applications from KNX Member web pages directly. These have been developed by KNX members specifically for this purpose, and they are very easy to use, but you can also use any other device as long as it accepts several connections, but make sure that you correctly identify such a device as a dummy and not as a real device.

As you can see in below, if you introduce a dummy in the backbone line, you can now link group objects with the group addresses you want to connect to the backbone so that the visualisation software can check their values.



Picture 26 Dummy device in backbone

The big advantage of this technique is that you can easily check that each group's addresses are connected to the backbone for the purpose of communication to the visualisation software, either by looking at the object groups of the dummy device or looking for the object groups inside each group address. The dummy has several object groups, and in the parameterisation of the dummy, you can select the dimension of the group objects.

3.3.10 spaceLYnk as a filtering device

See chapter 2.3 “KNX and IP router Settings” in spaceLYnk User Guide for details.

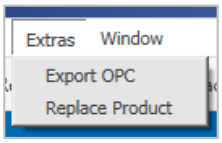
spaceLYnk can not only act as an IP router in KNX installation, but can be also used as commissioning and diagnostic device. In installation containing hL/sL there is no need for USB REG-K interface anymore.

Note: There is one exception. BUS monitor is not working with hL/sL.

4 Export and splitting of KNX project

4.1.1 Export of KNX project

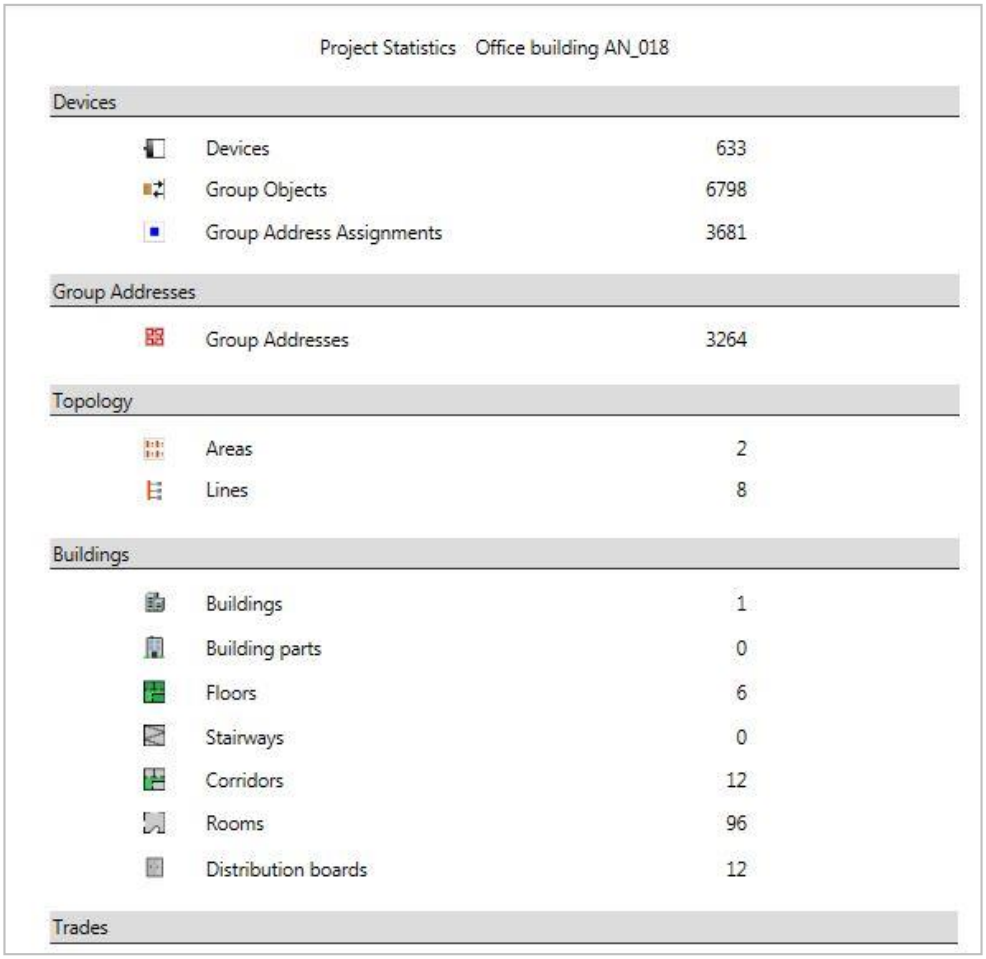
Whole project can be exported as an ESF file using *Export OPC* function in *Extras tab*.



Picture 27 Export dialog in ETS 5

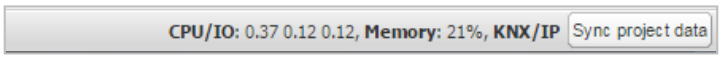
ESF file is basic text file which can be easily modified in text editor such as Notepad++ (freeware). It will be necessary to split ESF due to fact that sample project contain 544 GAs per floor (3264 GAs in total) and recommended limit for spaceLYnk serving as BACnet gateway is 500 points (GAs).

Number of devices, GA and other project statistic can be viewed in *ETS Project report.*



Picture 28 KNX project statistic in ETS 5

As the limit is only recommended and spaceLYnk is serving only as a gateway it is OK to export all 544 GAs. Always observe CPU load of hL/sL to ensure proper function.

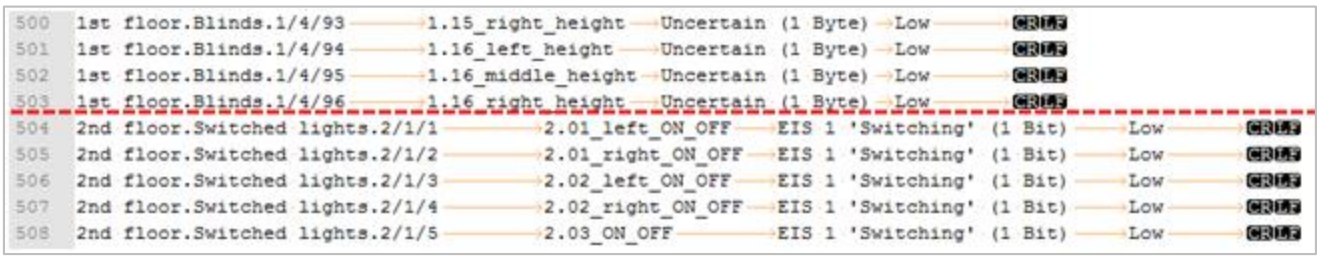


Picture 29 CPU load example of hL/sL

Note: In sample installation 2000 BACnet objects were exported from single spaceLYnk with optimal KNX TP BUS load (400 telegrams/ min) before it reached recommended maximal spaceLYnk CPU load of 0.75.

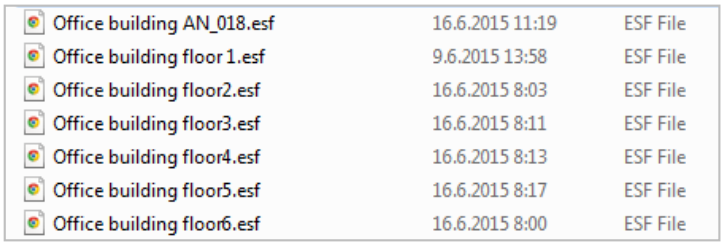
4.1.2 Splitting of KNX project

Structure of sample project was clearly defined during creation. It is easy to see beginnings and ends of floors, which will serve as points to split file according to the floor for import into the spaceLYnk. Select all group addresses belong to the certain floor and simply delete the rest. Notepad ++ freeware was used in this case but basically any text editor can be used.



Picture 30 Splitting of ESF file in Notepad++

You will get separate files serving for spaceLYnk in each floor. Do not forget to name created files properly and always attach original complete ESF file for any further changes. All files should be se stored directly in project folder as stated in chapter 3.1.1 ETS project.



Picture 31 List of ESF files for sample project

For advanced filtering/editing ESF file can be also opened and edited in MS Excel.

	A	B	C	D	E
1	Office building AN 018				
2	1st floor.Switched lights.1/1/1	1.01_left_ON_OFF	EIS 1 'Switching' (1 Bit)	Low	0/1/1
3	1st floor.Switched lights.1/1/2	1.01_right_ON_OFF	EIS 1 'Switching' (1 Bit)	Low	
4	1st floor.Switched lights.1/1/3	1.02_left_ON_OFF	EIS 1 'Switching' (1 Bit)	Low	
5	1st floor.Switched lights.1/1/4	1.02_right_ON_OFF	EIS 1 'Switching' (1 Bit)	Low	
6	1st floor.Switched lights.1/1/5	1.03_ON_OFF	EIS 1 'Switching' (1 Bit)	Low	
7	1st floor.Switched lights.1/1/6	1.04_left_ON_OFF	EIS 1 'Switching' (1 Bit)	Low	
8	1st floor.Switched lights.1/1/7	1.04_right_ON_OFF	EIS 1 'Switching' (1 Bit)	Low	

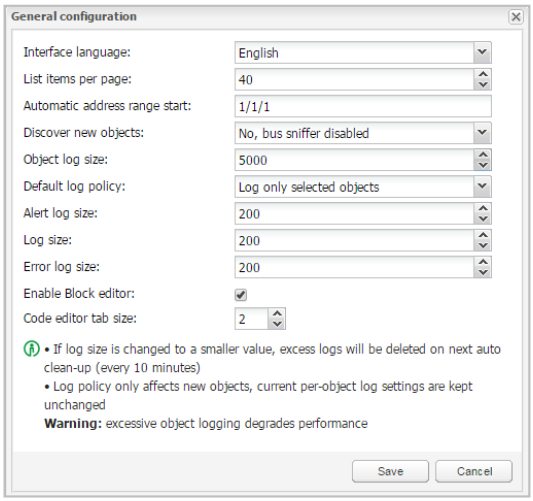
Picture 32 MS Excel view od ESF file

4.1.3 Import of divided project to hL/sL

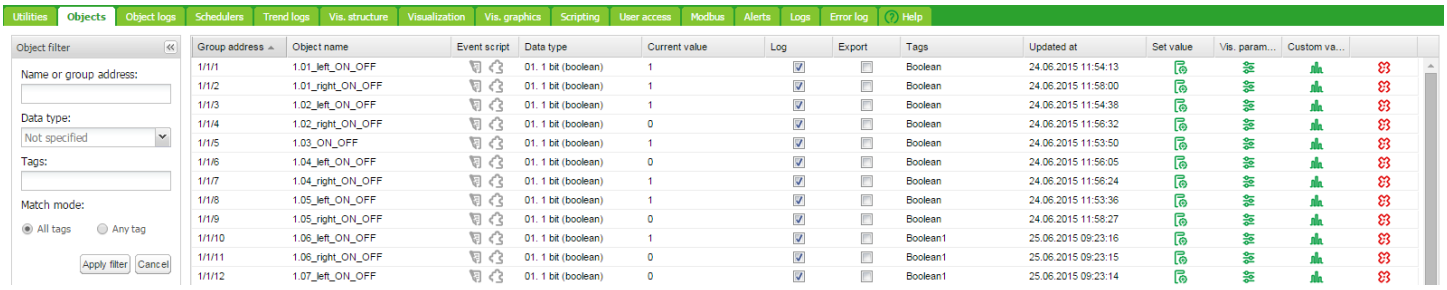
Divided project can be imported to appropriate Wiser for KNXs as database of KNX objects for KNX TP traffic simulation and spaceLYnks for BACnet object export to the SBO.

Prior to object import set following options in General configuration TAB:

- *List item per page* option should be set accordingly to the resolution of your screen.
- KNX BUS sniffer option *Discover new objects* should be disabled.
- *Object log size* option should be set to maximal size (5000 entries).



Picture 33 General Configuration window



Picture 34 List of Objects in Wiser for KNX

Note: Logging of objects can be switched on temporarily to check proper function of Traffic generator scripting, but it is strongly recommended to disable it as logging of hundreds entries per minute causing high CPU load of Wiser for KNX.

5 Connecting of cooperating technologies through spaceLYnk

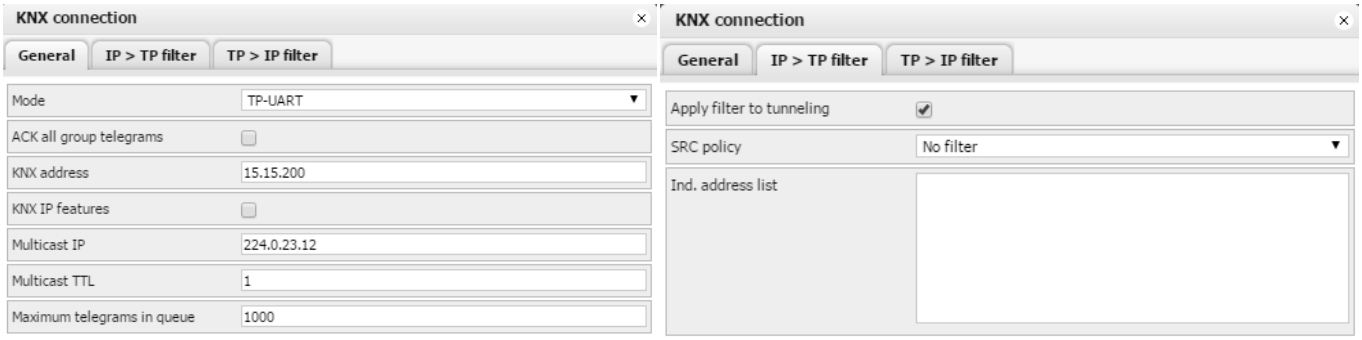
5.1 Connection with BMS

5.1.1 Benefits

KNX, Modbus or BACNet configures the field automation level – of the Automation Pyramid in a building. A BMS (Building Management System) is a different layer (the top one) in this pyramid, so with the correct BMS solution every system can be linked. OPC (only for KNX) have a big brother (the BMS Server) where the complete integration solution for smart buildings in this scalable, independent and interoperable software can be found. KNX + BACnet are the perfect combination of reliability, functionality and performance in a Building Automation Solution.

5.1.2 Sample project properties

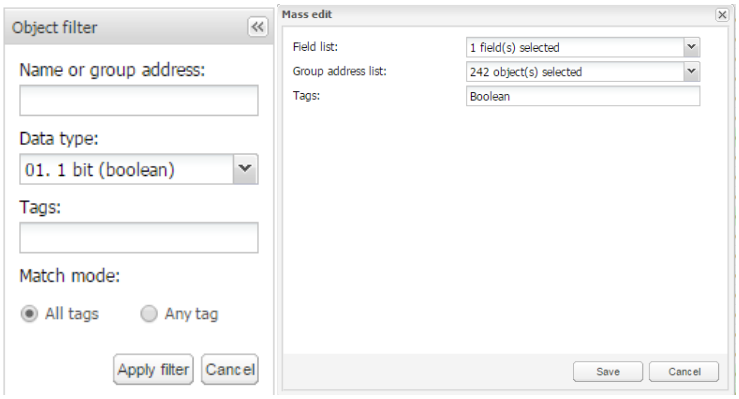
In sample project 6 Wiser for KNXs are only used as a “virtual TP traffic generators” each representing one floor of building with 106 KNX devices in one extended line. All IP features are disabled and *Apply filter to tunnelling* is switched ON for disabling of all IP communication.



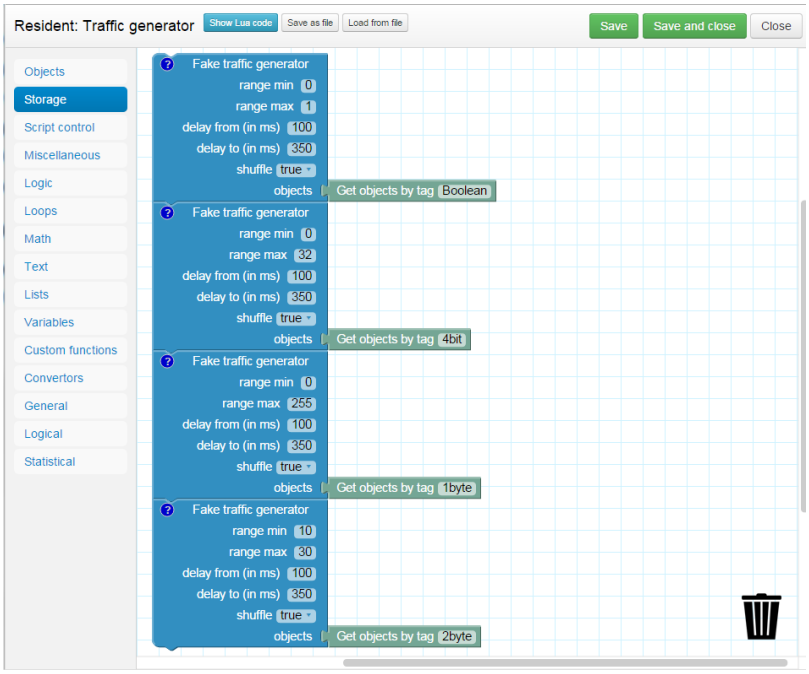
Picture 36 hl/sL filtering windows

Block function “Fake traffic generator” used in resident script is thoroughly described in *AN024_Block_functions_for_spaceLYnk_and_Wiser for KNX_controller_v1.0*.

All GA with the same data type are filtered and tagged by *Mass edit* function and subsequently controlled by single function block *Fake traffic generator*.

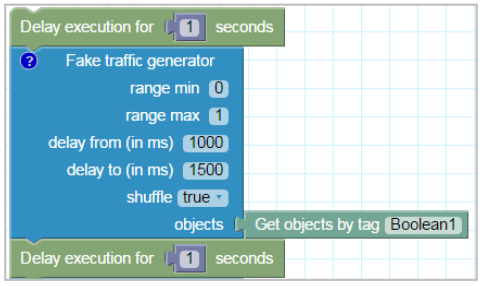


Picture 37 Mass edit selection in hL/sL



Picture 38 Traffic generator function block for 4 different data types

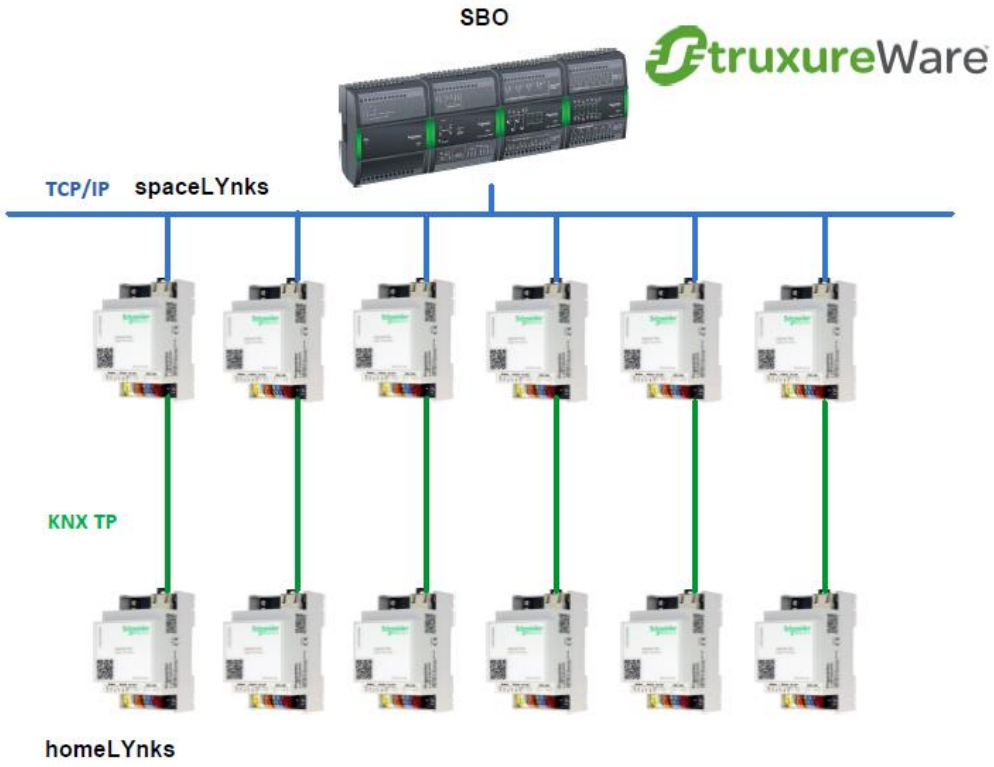
Note: Amount of generated traffic can be controlled by setting the delays in Fake traffic generator. For gaps between each script execution Delay execution function block can be inserted.



Picture 39 Delay Execution function block sample

5.1.3 Sample project topology

spaceLYnks are used as IP line couplers with filter tables and each of them is serving as a BACnet server for exporting all KNX GA of connected KNX TP lines into the SBO via IP.



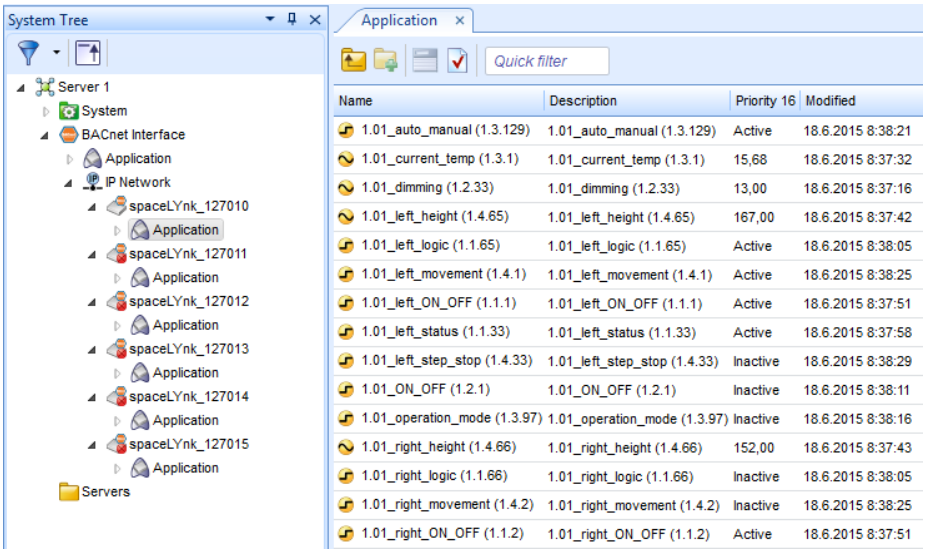
Picture 40 Sample project topology

5.1.4 Creation of BACnet server and import of objects

All steps of creation of BACnet server in hL/sL and export of KNX objects to the SBO are thoroughly described in the AN001_Wiser for KNX_integration_using_BACnet_v1.4.

5.1.5 Import of sample project to the SBO

All 6 floor were imported into the separately Application folders and can be seen in *IP network* overview.

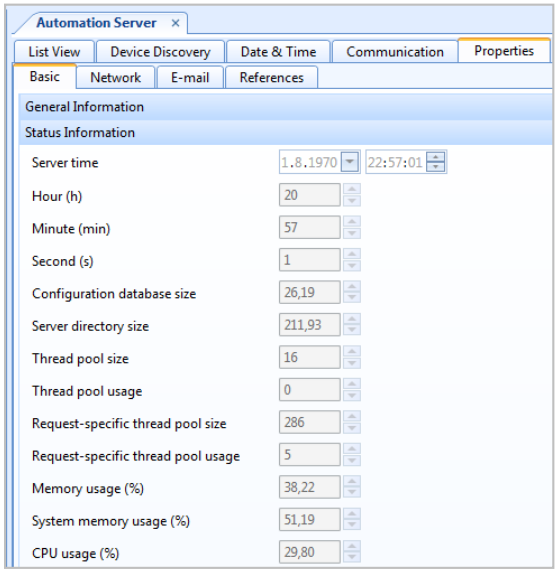


Picture 41 SBO view of exported BACnet points

Note: Some data types are not supported (e.g. Date and Time objects in our sample project) and will be ignored by SBO during BACnet export. Check manual of the SBO for details.

5.1.6 CPU Load of SBO

SBO is designed to handle large amount of data in big projects and even with maximal amount of imported data from six connected spaceLYnks sending around 2400 BACnet objects/min CPU load is relatively low (30%).

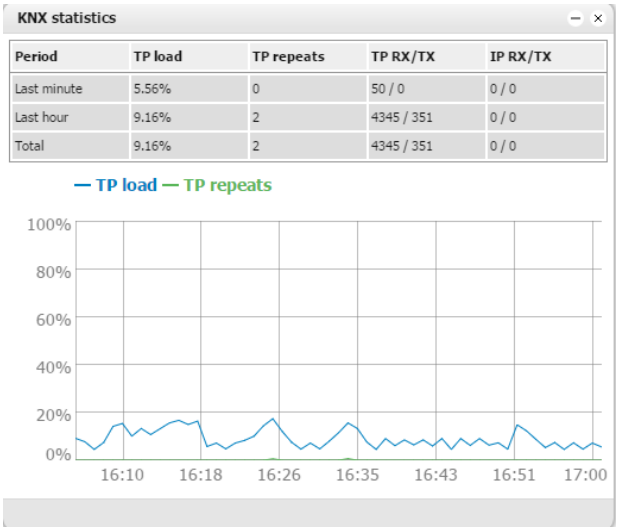


Picture 42 SBO server status information

6 Limits, diagnostic

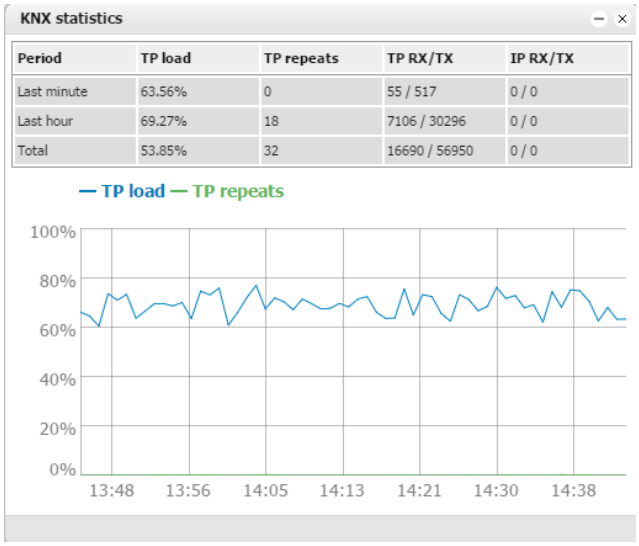
6.1.1 KNX TP limits of traffic

All six types of KNX data points are evenly distributed to the TP BUS via 6 Wiser for KNXs which are simulating real traffic via script. Real average traffic is shown in the similar sized installation using hL/sL build-in KNX statistics tool. This tool is very convenient and it is showing same statistics as BUS monitor in the ETS. Values are available for last hour with minute/hour/total summary. Repeated telegrams and total incoming outgoing traffic are also recorded.



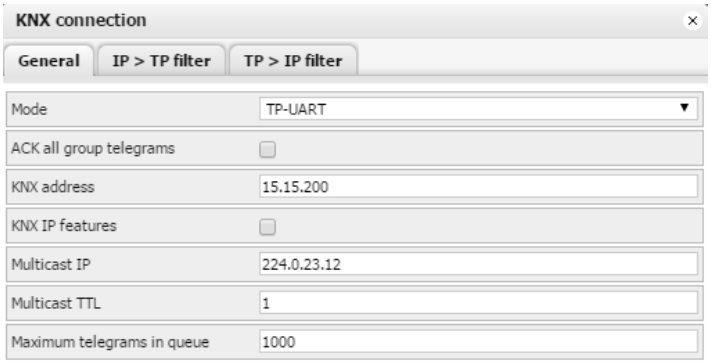
Picture 43 TP load of real project

All telegrams (data points) in sample project are relatively small, recommend maximal traffic of 500 telegrams/min is not causing high CPU load of hL/sL (around 0.5) and causing only ~66% of maximal TP BUS load (traffic) with very low amount of repeated telegrams. In real installations such a big traffic is usually registered only when installation is started. Actual TP load reached up to 300% in first few seconds.



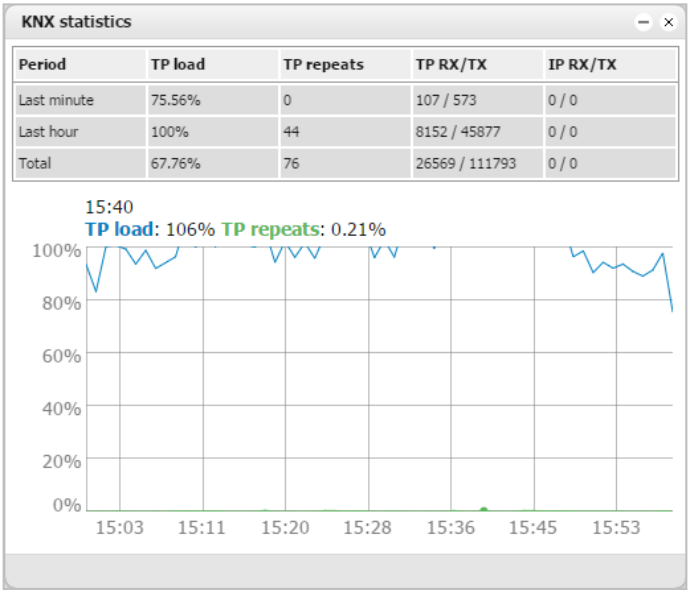
Picture 44 TP load with recommended amount of telegrams/min

Note: Low number of repeated telegrams thanks to hL/sL scalable cache memory (up to 1000 telegrams).



Picture 45 Maximum telegrams in queue setting

Practical limit for sample project is around 800 telegrams/min on TP BUS. CPU load of connected spaceLYnk reached 1.00 (100%) and number of repeated telegrams increased dramatically. Recommended CPU load of hL/sL is maximally 0.75 for seamless running. It is depending not only on number of telegrams but also a number of users, complexity of visualization etc.

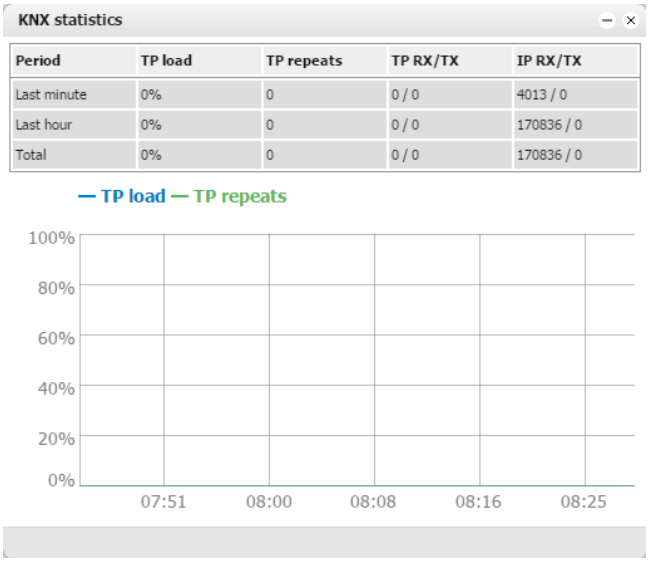


Picture 46 Maximal TP load statistic

Note: Load higher than 100% is not displayed in graph. Actual value can be displayed by pointing mouse on place in the graph curve.

6.1.2 IP limits of traffic

IP limits of traffic are more than 50x higher comparing with TP BUS speed caused by 9600 bit/s bandwidth of original KNX/EIB BUS which concept is 25 years old. If communication proceeds solely on IP basis is faster and it is recommended to shift all traffic which is not directly on the field busses to IP environment as soon as possible.



Picture 47 IP traffic statistic

6.1.3 Memory usage and CPU load of spaceLYnk

Observation of spaceLYnk used memory and CPU load helps to have stabile and fast responding installation. Obtained values can be logged visualized as short term graph with up to 200 values or used as an input for a trend logs.

Simple resident/scheduled script is logging five minutes averages of used memory and CPU load:

```
data = io.readfile('/proc/meminfo')
total = data:match('MemTotal:%s+(%d+)')
avail = data:match('MemAvailable:%s+(%d+)')
used = (tonumber(total) - tonumber(avail)) / 1000
data = io.readfile('/proc/loadavg')
load = tonumber(data:split(' ')[ 1 ])
log(used, load)
```

Log time	Script name	Message
29.04.2016 12:22:01	Memory Usage	* arg: 1 * number: 60.388 * arg: 2 * number: 0.14
29.04.2016 12:20:01	Memory Usage	* arg: 1 * number: 61.332 * arg: 2 * number: 0.12
29.04.2016 12:18:01	Memory Usage	* arg: 1 * number: 60.44 * arg: 2 * number: 0.07
29.04.2016 12:16:00	Memory Usage	* arg: 1 * number: 60.316 * arg: 2 * number: 0.11
29.04.2016 12:14:00	Memory Usage	* arg: 1 * number: 59.82 * arg: 2 * number: 0.39
29.04.2016 12:12:01	Memory Usage	* arg: 1 * number: 59.708 * arg: 2 * number: 0.71

Picture 48 log entries' with Memory use and CPU load of spaceLYnk

6.1.4 spaceLYnk CPU temperature monitoring

Temperature of spaceLYnk processor can be monitored by resident/scheduled script. Recommended period is one minute to capture peaks caused by high processor load (e.g. during start). Obtained values can be logged visualized as short term graph with up to 200 values or used as an input for a trend logs.

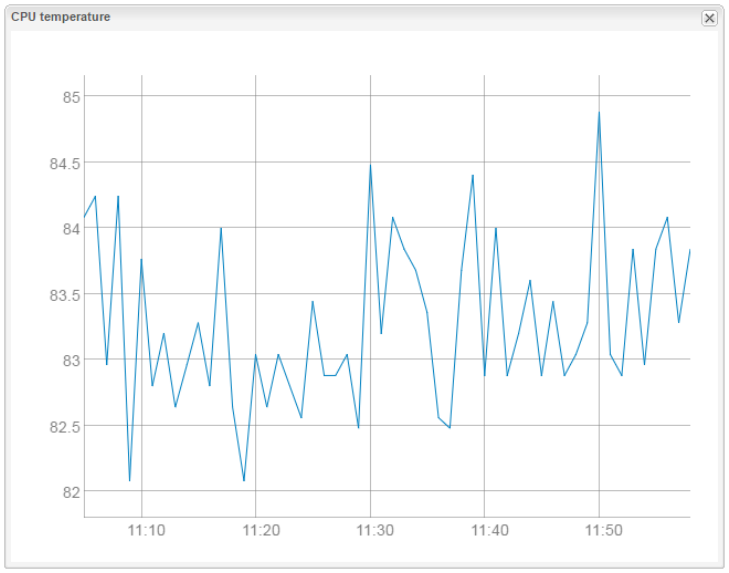
Script code (group write):

```
function readtemp()
    local temp, count, path = 0, 10, "/sys/bus/iio/devices/iio:device0/in_temp8_raw"

    for i = 1, count do
        temp = temp + tonumber(io.readfile(path)) or 0
    end

    return math.floor(temp / count * 2.53 - 2730) / 10
end


grp.write("5/6/1", readtemp())
```



Picture 49 CPU temperature graph

Note: Revise your spaceLYnk load or check ambient temperature inside cabinet if temperature stays over 100 °C for longer period of time.

Group for graph must be logged.

7 Conclusion

Properly made KNX project is key feature for successful realisation of whole installation. It is important to obtain all relevant information and implement them into the project from the very beginning and follow all rules. Properly made KNX project is easy to modify, split or replicate.

Wiser for KNX and spaceLYnk are very useful bricks for complex projects providing bridge between field busses and supervising BMS technologies.

Amount of assigned tasks should be taken into the consideration when Wiser for KNX or spaceLYnk is deployed as gateway.

Wiser for KNX and spaceLYnk can also serve as powerful tool for simulation and testing of solutions before they are deployed in real life.

Appendix

7.1 Glossary

The following table describes the acronyms and defines the specific terms used in this document.

Abbreviation	Description
SE	Schneider Electric
GA	(Group Addresses) KNX Group address
hL	Wiser for KNX
sL	spaceLYnk
CSV	(Comma Separated Values) plain text format used in
ESF	(External Source Format) file extension of ETS export for OPC. It is basic text file containing name and properties of GA used in the ETS project.
OPC	(Open Platform Communications) Series of standard and specifications for industrial telecommunication.
PLC	(Programmable Logic Controller) Industrial computer used for automation processes.
SBO	StruxureWare Building Operation integrated monitoring, control and management platform from SE
GUI	(Graphical User Interface)

Table 2: specific terms

7.2 Quotations

Topology pictures used in this application are from *KNX TP1 Topology* document available online on www.knx.org .

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