

Digital Twin of Building Automation with BACnet

Building automation in the area of conflict of interests

“User-oriented building technology” is the title of a series of lectures that will be announced with the flyer for the Building Services (TGA) congress on April 2 and 3, 2020 in Berlin. Of course, the technology has to be based on the user and the customer is king! Really?

On the one hand, the user of building technology systems is not always the same as the person who procures them, and on the other hand, not all customers see through the complexity of modern technology, which manufacturers and the market advertise effectively. Purchased devices can often do much more than one actually needs. And, honestly, do you know all the functions and programs of your washing machine and do you actually need and use them? Wouldn't one with less refinement and easier operation have met your needs? It would probably have been cheaper to buy and operate.

The interests of the manufacturers of systems and components as well as the trade that sells them, the planners and the system integrators who plan and implement them on behalf of the customer and those who should ultimately use and operate the technology offered to them, lead - wanted or unwanted - to a compromise that is usually not an advantage for the operator.

If you take into account that the standardized requirements for the BACnet interface are in revision 22 (EN ISO 16484-5) and the "protocol-neutral" rules for BACS planning, hardware and implementation since 1995/2004 (VDI 3814 / EN ISO 16484-1, -3) exist unchanged in revision 1, it becomes clear that the overall solution cannot meet the current requirements. The connection from the BACS Functions to the information, i.e., to the BACnet properties, is missing.

In this area of conflict of divergent interests, it is therefore important that the customer formulates his requirements for building technology and its automation precisely and demands that they be fulfilled - given the feasibility. Not all planners, manufacturers and integrators provide that, some follow philosophies, market strategies and proprietary product lines that run counter to the goals of the customer.

The most important requirements relate to the information we need from the automation system to control the mechanical systems. In the BACnet jargon, information that we need to reduce energy expenditure or to adapt the convenience of use to the needs is in the "Properties" that are contained in the BACnet objects.

Interoperable solutions with BACnet for landlords with a large real estate portfolio

Companies with a larger real estate portfolio must demand interoperable multi-vendor solutions in order to be able to use economies of scale and to reduce the dependency on integrators and BACnet device manufacturers.

Integrators or manufacturers who know that the client is dependent on them will use this position sooner or later. Only by means of simple and standardized solutions can the human resource dilemma at the real estate locations be countered on the basis of clear corporate guidelines based on the global BACS standards.

BACnet is the data communication protocol that best supports the interoperability of building automation components. This has prevailed internationally, but is interpreted and applied differently in practice, which often counteracts the hoped-for interoperability. All the more so if there are no concrete specifications on the part of the client or the planner. Then the systems are “optimized” by executing companies for the benefit of implementation or due to time pressure or to their own, often proprietary company philosophy and not in terms of operation.

There are also numerous communication gaps in the implementation of building technology projects and their automation:

- organizational (client, planner, integrator, operator, user),

- technical (heating, air conditioning, ventilation, electrical engineering, building automation, information technology, security) and
- time (idea, specifications, planning, work planning, implementation, acceptance, operation).

And there exists currently no continuous, IT-conform process.

Simple, uniform standard systems and specifications

Uniform mechanical systems (e.g., heating circuit, domestic water heating) and components (e.g., aggregates as pumps or fans) offer planners and integrators the advantage of being able to use ready-made implementation templates, reduce the risk of reworking on the construction site, support automated quality management and lead to synergies and savings in acceptance and visualization, but especially in the operation of the systems.

For larger real estate portfolios, the client's goal must therefore be to implement simple, uniform and easy-to-operate solutions, i.e., standardized mechanical systems and components with unique IDs, descriptions and largely predefined functions. For this purpose, the BACnet objects and in particular their properties must be specified with all important information and proprietary BACnet objects and properties must be prohibited to ensure interoperability, knowing that this may limit the variety of solutions and providers. This reliably covers the requirements of a large number of real estates. Due to their special position, individual buildings will, however, require an individual solution.

The client's requirements, for example the content of the specification, usually include Definitions

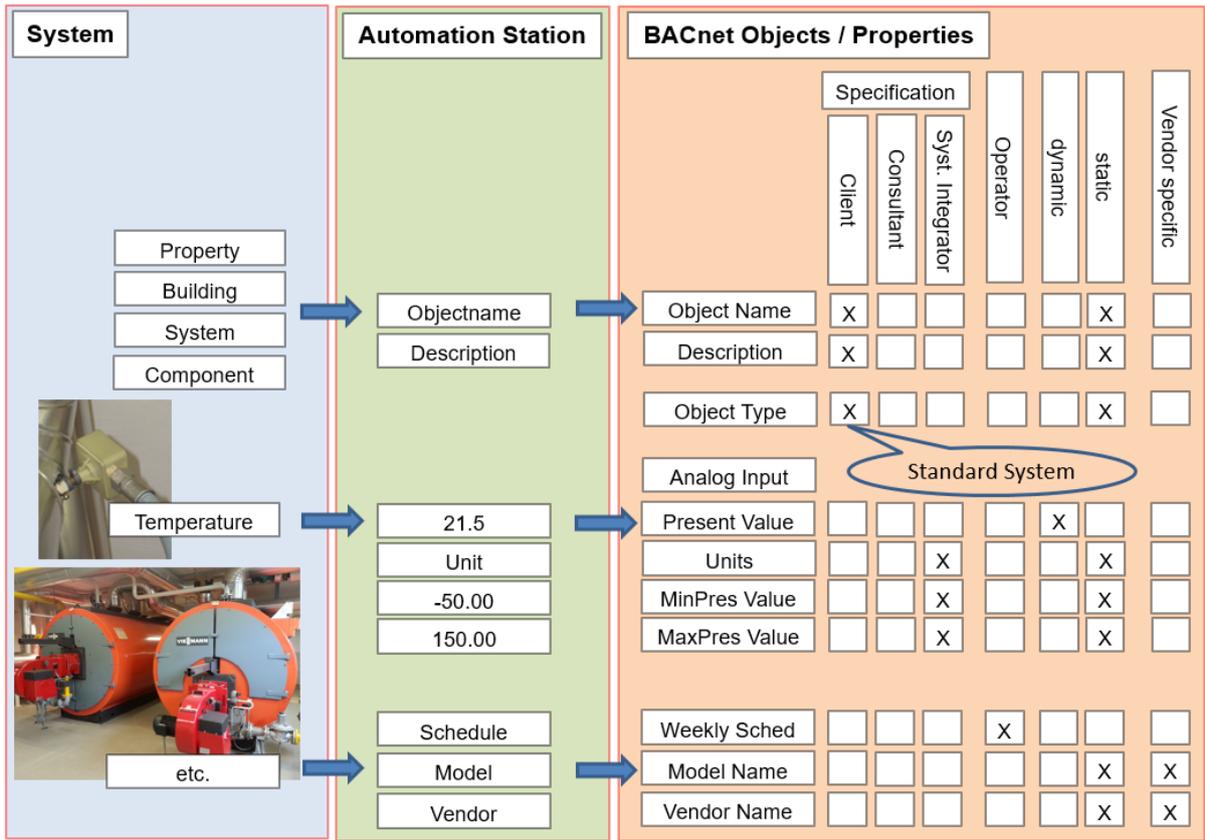
- of the network and its security regulations,
- the nature of the automation stations and the management and operating equipment,
- the addressing system of the data points or BACnet objects, the systems and components,
- for message and information management,
- for planning and implementation documents,
- for visualization and type of image display,
- for general operator requirements, etc.

This content of specifications with the exception of the specifications for properties can be assumed to be generally known.

Less common - and in this sense new - are, however, the topics and guidelines outlined below, which are urgently recommended to owners with larger real estate portfolios.

Competence Matrix

In the competence matrix, all relevant BACnet properties (all information contained in the BACnet objects, such as the name, state condition, unit, limit values, parameters, etc.) of the BACnet objects currently approved in the client's specifications are listed in a spreadsheet with a short description of the respective property and its possible specification of the client. This is used to determine who has to fill in which settings or values (client, user, planner, manufacturer, integrator or the system itself).



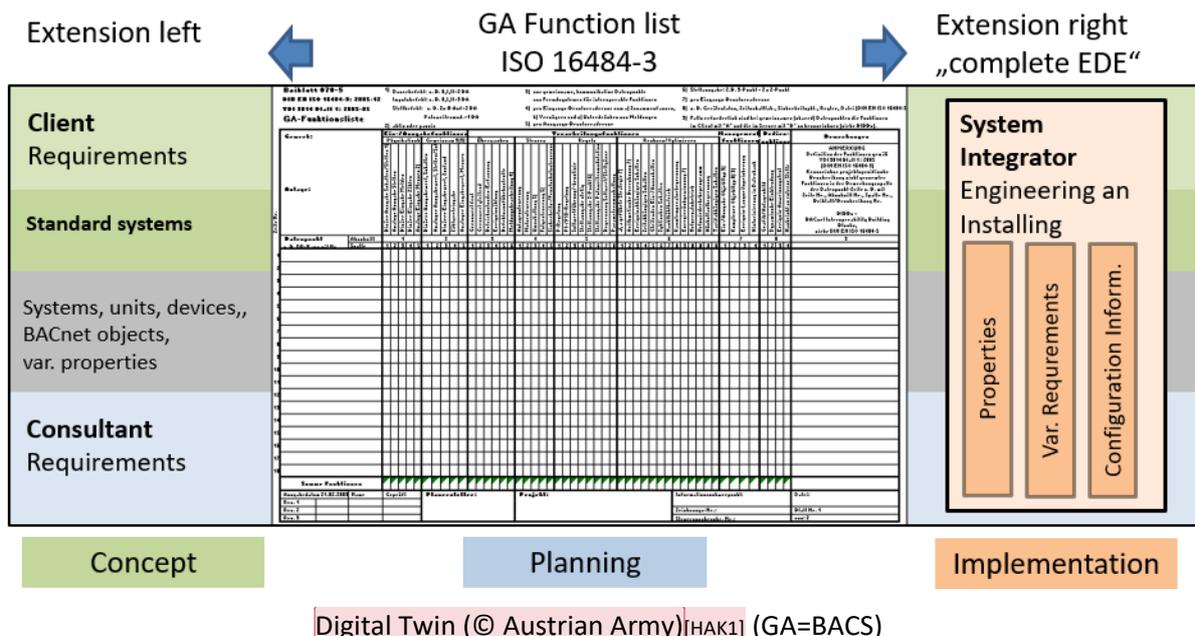
Derivation of the competence matrix (© Austrian Army)

Practice has proven the need for such clarification of responsibility for individual properties and their value content. In the absence of such a stipulation in the BACS standards, the owner and user are "surprised" by the various configuration settings depending on the manufacturer and integrator, which call into question the future interoperability of the components in the network.

Digital Twin of building automation with BACnet

In the case of the digital twin, the existing BACS Function List in accordance with EN ISO 16484-3 is expanded to the left by the client's defined standard systems and standard components and supplemented to the right with the BACnet properties and configuration settings of the implementation ("complete EDE table" – for engineering data exchange).

While the EDE table contains only a few BACnet properties as recommended by the BACnet Interest Group Europe (BIG-EU) and the Working Group for Mechanical and Electrical Engineering of State and Local Authorities (AMEV) in Germany, the "Complete EDE table" has to contain all BACnet objects, the properties together with the values and the configuration information used on the automation station.



Digital Twin (© Austrian Army)[HAK1] (GA=BACS)

In this way, an integrated process is supported in a simple manner and on the basis of a commonly used spreadsheet system, from the client's specifications through planning to engineering and operation of building automation and control systems.

In autumn 2019, the cci Dialog GmbH published the book "Digital twin of building automation with BACnet - Instructions for low-effort system integration" (ISBN 978-3-922420-66-8) written by Dipl.-Ing. Hans KRANZ and Hofrat Dr. Rupert FRITZENWALLNER.



Book on the Digital Twin

BACnet implementation guide

In order to ensure the implementation of building technology projects and their automation in accordance with the client's specifications, an implementation guide including appointment allocation has been created in which the outputs of the respective project phase are specified and presented in the correct chronological order. Since usually several participants are involved in projects and the integrator for building automation at the end of the chain often only comes into play as a subcontractor, the chronological representation of the outputs is essential in order to prevent lost effort.

If the documents required by the BACS standard, such as

- Automation schematics,
- BACS-Function Lists,

- Function descriptions,
- network concept, etc.

are not based on the actually implemented mechanical systems and are not documented in a current hydraulic diagram, there is a risk of "stranded costs" due to the mostly large number of participants.

Due to the complexity of the projects, a structured processing with uniform terminology is absolutely necessary.

BACnet test tools

Reworking is time and cost intensive, among other things through repeated re-checking and judging correct implementation as well as through a possibly multiple "uploading" of the data of an automation station to the management and operator unit. The quality control, i.e. the checking of the implementation in accordance with the specification, has to be carried out by the contractor and not the client, but in the end it will be indispensable for the client to check whether the contractual agreements have been implemented.

This check cannot be carried out economically manually, so a simple tool was created in which the client's requirements can be maintained and the automated check is supported with the help of the digital twin of building automation.

By the IT-supported check clear errors, such as incorrect addressing, ObjectNames, descriptions, notifications, NotifyTypes, and points to be clarified, will be transmitted to the integrator for correction.

It is clear that several thousand Excel lines cannot be checked manually, so tools must be made available to the technician on site that are easy to use and nevertheless enable checking the work of the integrator.

There are Tools available on the market for reading out via the network the BACnet objects and content of the properties that are available and used on automation stations, also the settings made by the integrator - provided they have not been created "hidden".

Some tools also offer the option of comparing the client's or planner's specification with the actual implementation of the integrator and showing differences.

A large Austrian client therefore has developed a tool based on "BACeye" through Bernhard RAMROTH to be able to implement the task efficiently and effectively. This is an ideal tool for quality assurance.

Conclusion and outlook

Landlords with a larger real estate portfolio are well advised to require interoperable solutions with BACnet for GA projects and to specify their ideas in a specification and concrete guidelines for uniform and simple standard systems. Under no circumstances should these change the existing EN/ISO standards, but at most supplement them. Since this requires a high level of knowledge in the field of building technology and its automation, support from planners with sufficient BACS and BACnet know-how would be necessary, who should also be commissioned to monitor the implementation as part of the acceptance of projects

In addition to the client specifications on the topic of BACnet and BACS, a BACnet implementation guide and a BACnet test tool for the economical implementation of simple and uniform systems are essential, according to the authors' experience.

The raw material of digitization is structured information, i.e. the BACnet properties.

Digitization offers the opportunity to overcome gaps in understanding between the building owner, planner and integrator and to map the process from planning to implementation and commissioning, to avoid redundancies and to implement the goals of building automation.

The structured information in the form of predefined BACnet properties is the basis for supporting the organizational goals by means of a management and operator unit (MOU), which in the future will have to have more energy management functions and artificial intelligence.

Only when the parameters for the quality of use can be adapted to a changed need with the available staff during the use phase of the building and, in addition to other goals, the energy expenditure can be reduced, does building automation create added value and benefit.

It should be clear to all experts that the building automation must support the goals of the owner, operator and user in the life cycle of the real estate and that the focus is not the device manufacturer's or the integrator's implementation process.

If the operation of a facility can be optimized through building automation, investors and users will be ready to bear the investment costs of a properly installed building automation system. It is undisputed that standards and interoperability are a mandatory prerequisite for tapping the added value of digitization.

Authors:

	<p>Dipl.-Ing. Hans R. Kranz VDI former projectleader EN ISO 16484 Hans@Kranz.com</p> <p></p> <p>Hofrat Dr. Rupert FRITZENWALLNER Real Estate Applications in IKT&CySihZ r.fritzenwallner@hbv.gv.at</p>	
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