OpenBuildingControl:
Digitizing the control delivery process
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Presentation Contents

- What is OpenBuildingControl

- Control Description Language

- OpenBuildingControl - Next 3 years

- Potential Collaboration with ASHRAE
  - Control Description Language as an ASHRAE Standard
  - Guideline 36 Reference Implementation
  - Sequence Selection and Configuration Tool

- Discussion & Next Steps

Change in process

Current state

- Current process results in sub-optimal performance.

- Sequence design is not well understood.

- Hard to estimate savings of sequence alternatives.

- Sequence errors are introduced in the process of documenting, interpreting and programming the sequences.

- As built sequences are rarely accurately documented.

Digitized process

Higher quality

- Designer starts with a library of sequences, including ASHRAE Guideline 36.

- Performance of sequence alternatives can be simulated.

- Tools are provided to verify and document "as built" sequences.

- Guideline 36 has a vendor-neutral reference implementation.

More efficient process

- Sequences are in a machine readable format called the "Control Description Language (CDL)"

- Controls contractor can translate the CDL file for costing and implementation into their programming language.

What is missing?

Why now?

BACnet

Haystack

Language for control logic

Brick
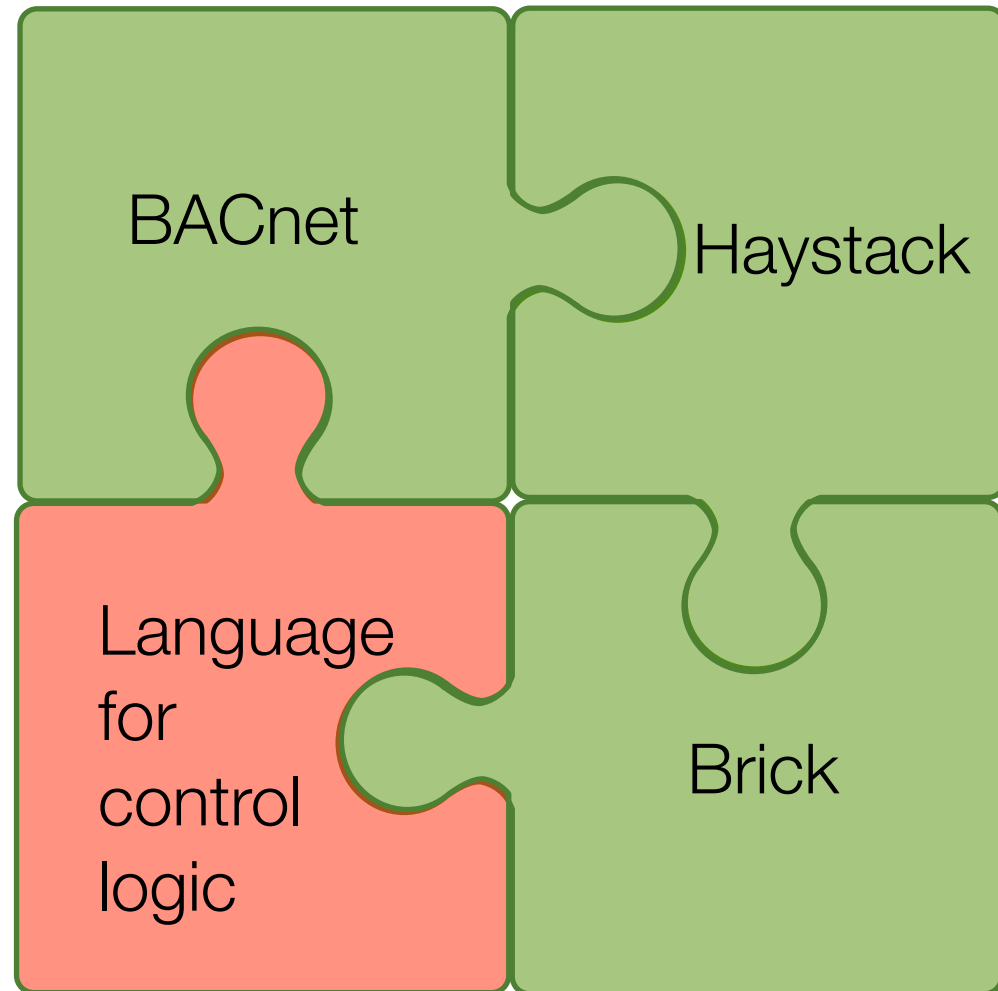
Convergence of

- semantic web
- declarative modeling language for building system & control
- collection of best-in-class control sequences
- capability to simulate actual feedback control coupled to energy models
- code generation for machine-to-machine translation
- need for grid-interactive efficient buildings

Goal: Bridge silos between design and operation through digitized process that realizes energy savings of advanced control sequences

Codify best practice   **Design**   **Implement**   **Verify against original design intent**
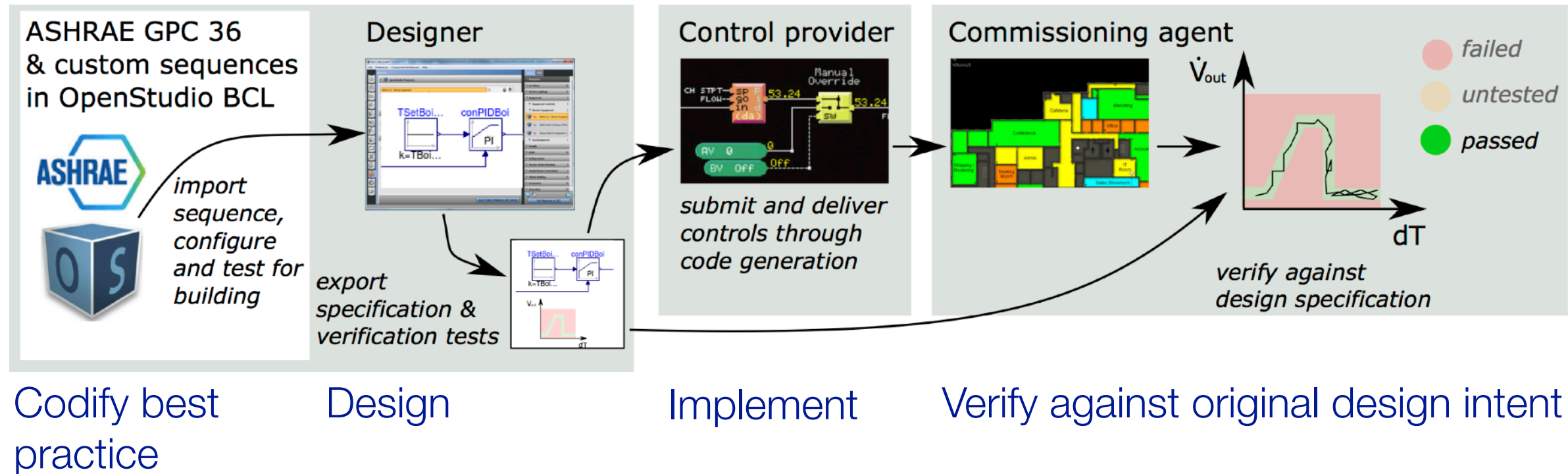
We will need a standardized language to express the control sequences and transmit them through the whole process in machine-readable format.
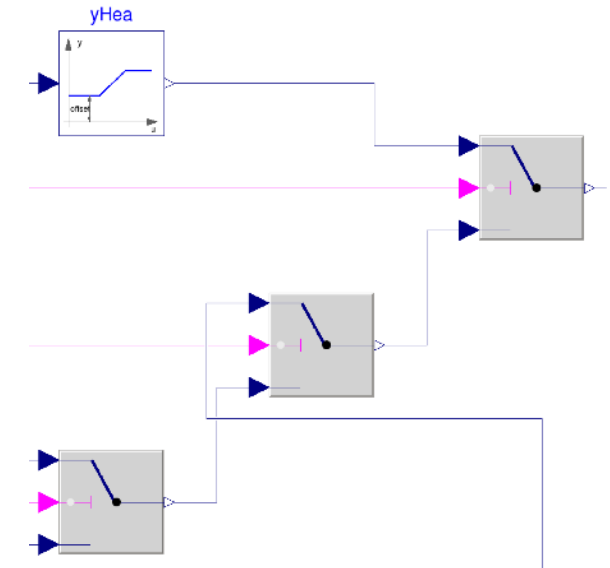
https://obc.lbl.gov

What is the Control Description Language?
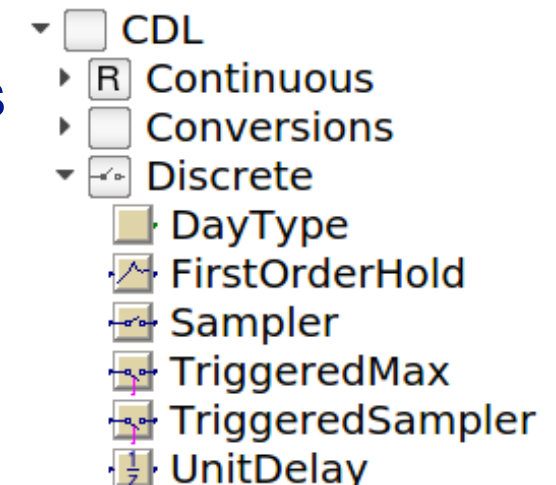
What is the Control Description Language?

A declarative language for expressing block-diagrams for controls (and requirements)

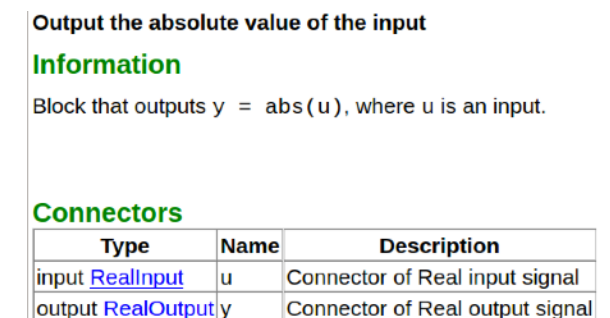A graphical language for rendering these diagrams.

A library with elementary input/output blocks that should be supported [through a translator] by CDL-compliant control providers

Example: CDL has an adder with inputs u1 and u2, gains k1 and k2, and output
y = k1*u1 + k2*u2.

A syntax for documenting the control blocks and diagrams.

Output the absolute value of the input

Information

Block that outputs y = abs(u), where u is an input.

Connectors

Type	Name	Description
input RealInput	u	Connector of Real input signal
output RealOutput	y	Connector of Real output signal

A model of computation that describes the interaction among the blocks.
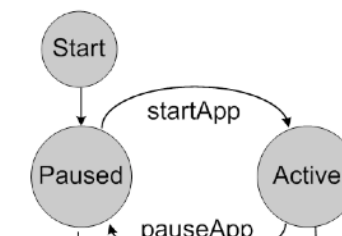
What sequences are implemented?

Status of Sequence Implementation

- Specified Control Description Language CDL (http://obc.lbl.gov/specification/cdl.html)

- Implemented VAV sequences from Guideline 36 (public review draft 1).

- Demonstrated 30% HVAC site energy reduction compared to sequences published by ASHRAE 10 years ago. (http://simulationresearch.lbl.gov/wetter/download/2018-simBuild-OpenBuildingControl.pdf)

Ongoing

- Implementation of chiller plant sequences from ASHRAE RP-1711.

- Obtaining approval to implement VAV sequences from Guideline 36 official release.

- Developing translator from CDL to Eikon from Automated Logic Control (with Dave Robin).

- Specification of Control Sequence Selection and Configuration Tool.

Primary sequence implementation
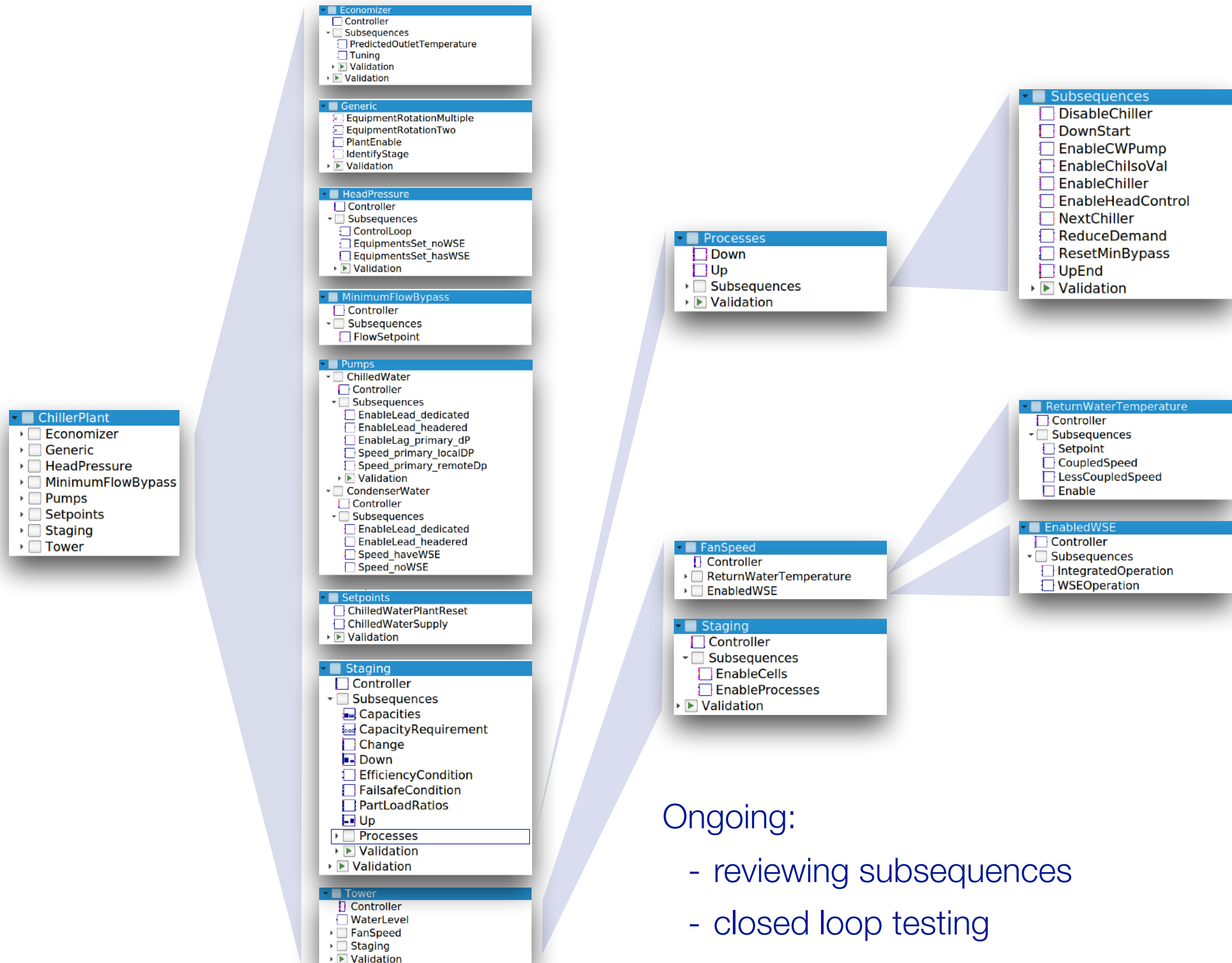
Ongoing:

- reviewing subsequences

- closed loop testing

Scope for
OpenBuildingControl Phase II

Partial List of Task of OpenBuildingControl Phase II

Sequence Implementation

Oct. 2020: Chiller & boiler plants (from RP 1711)
Oct. 2021: Radiant systems and chilled beams
July 2022: DOAS, fan coils, demand response

Sequence Selection and Configuration Tool

Apr. 2020: Specification reviewed by subset of G36 members
Oct. 2021: Alpha release
Oct. 2022: Final release

Adoption & Standardization

Jan. 2020: Demonstrated to G36 Committee how to express sequences in CDL &
                   export to Microsoft Word
Jan. 2021: Demonstrated how G36 compliance could be formally tested

Potential Collaboration with ASHRAE

Make CDL an ANSI/ISO Standard via ASHRAE

Title: CDL - A Control Description Language that enables a Digital Control Delivery Process

Purpose: To standardize a declarative programming language for digitizing the control delivery process, using a human and machine readable format suitable for

- Closed loop performance simulation of the control sequences

- Process to develop and specify sequences

- Machine-to-machine translation, or native use of the sequences for control platforms

- Verification of the correct implementation of the control sequences

Scope: This standard applies to control sequences for mechanical systems, active facades, and lighting systems.

Note: Out of scope is water treatment, security, transportation.

Guideline 36 Reference Implementation in CDL

Future versions of Guideline 36

- should contain a reference implementation in CDL, or

- contain sequence descriptions generated from their CDL implementation.
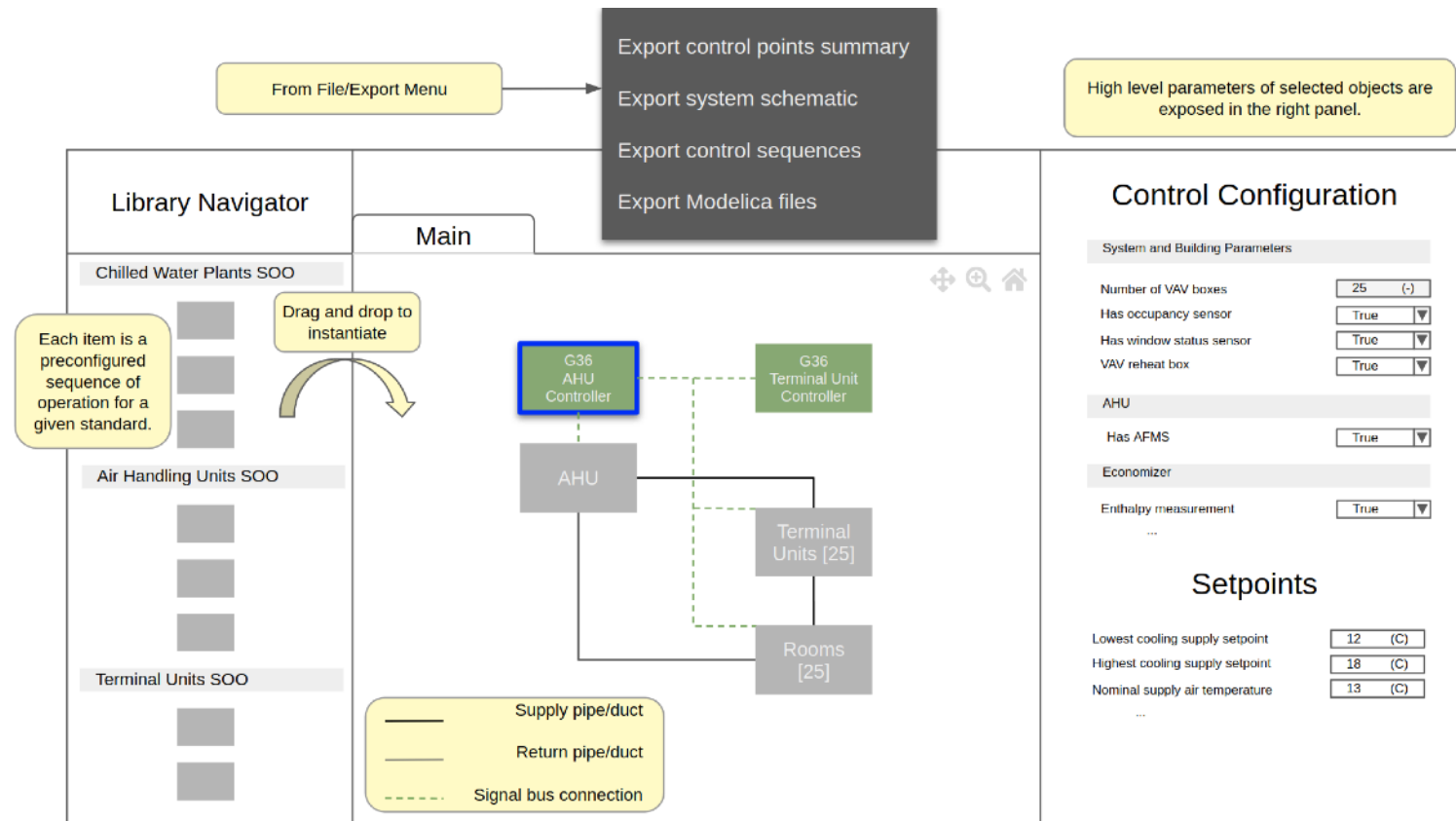
Needs:

- Structure sequences in encapsulated blocks with defined inputs, outputs, and parameters.

- Implement sequences in CDL.

- Ensure licensing is compatible for our funders (incorporated in DOE-sponsored software for use at no cost to users)
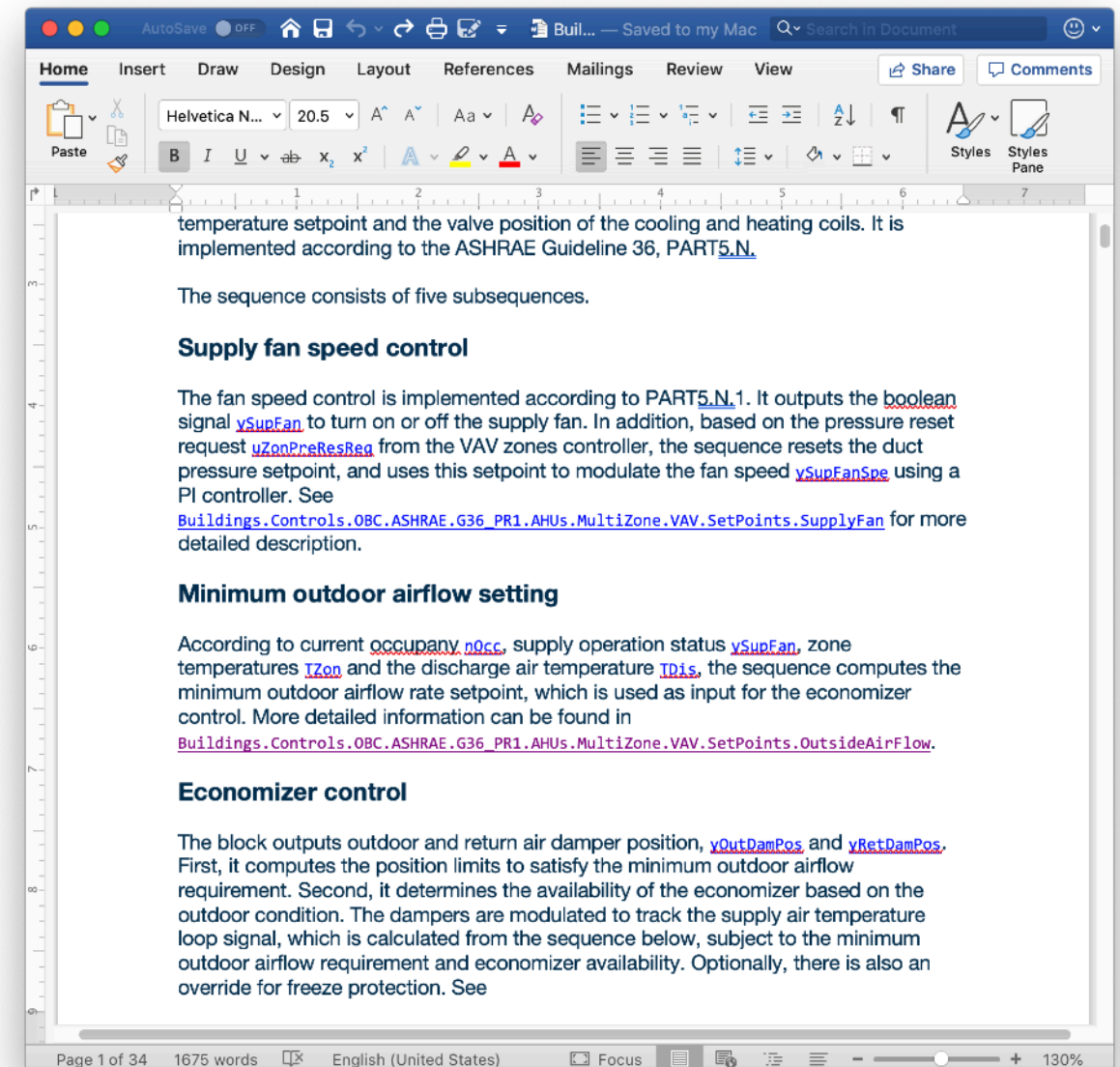
Sequence description generated from CDL in Word format.

Control Sequence Selection and Configuration Tool

- To be completed in OBC Phase II, specification has started
- Web-based and local use
- Automated Logic has offered use of their Control Spec Builder
- Target audience:
  Mechanical designers and energy modelers
- ASHRAE benefit:
  Provides an easy way for designers to select and customize sequences from Guideline 36
- Challenge:
  The tool will provide a free online way to design and customize sequences. DOE funding requires that it work without license fee or restriction. **We need to verify that this does not violate the ASHRAE copyright for the Guideline 36 document**.

Control Sequence Selection and Configuration Tool

Design engineer	• Specifies the equipment layout and the control sequences • Is assisted in the process by preconfigured templates	• Control points summary • System schematic • Description of control sequences in English language and CDL
Energy modeler	• Updates the model with equipment characteristics • Couples a thermal zone model	• Modelica files ready to simulate
Control provider	• Is provided with high quality and standard specifications • Translates CDL to actual building automation systems	
Commissioning agent	• Is provided with an executable "digital twin" of the control sequences to verify correct implementation	
Operator	• Is provided with comprehensively documented control sequences • Is provided with a "digital twin" that can assist in troubleshooting	

Discussions and Next Steps