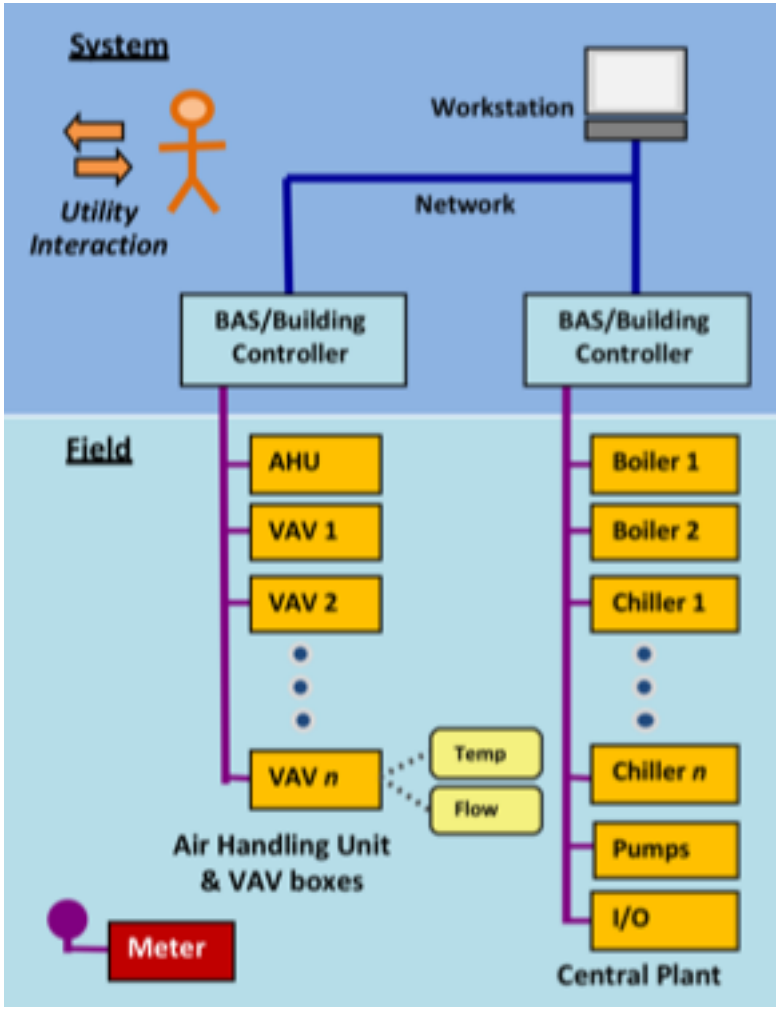
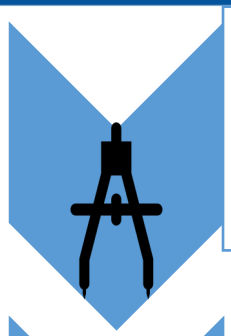
Building Control System Components

- Controllers
- End devices (sensor, actuators, etc.)
- Communications
- User interface
- Systems integration
- Control Logic (sequences, system coordination, applications)



Building Control System Design and Delivery



Specification
Sequence
Drawings

Submittal
Control Programs
Installed System

Functional Test
Validation
Documentation

Operation
Optimization
Apply Tools

Challenges

The process for designing and delivering controls is error prone:

- Controls are specialized and it is hard for engineers to develop highly efficient sequences.
- We lack tools to test the effectiveness of a controls sequence.
- The controls contractor must interpret the sequence and express it in their proprietary programming language
- This logic needs to be interpreted by commissioning agents, owners, and service technicians

ASHRAE Solutions

Standard 135 (BACnet):

- Standard communications protocol allowing for open communications between controllers.

Guideline 13:

- Recommended specification language

Guideline 36:

- A library of high- performance sequences. These will help engineers and designers to select best in class sequences.

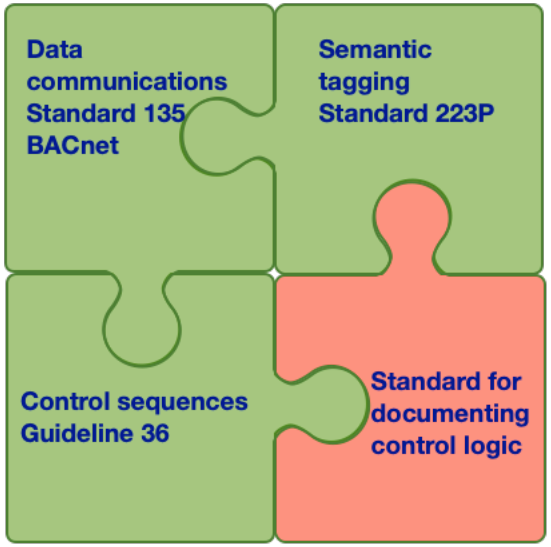
Standard 223P:

- Proposed standard for semantic tagging, allowing for improved identification of data in control systems

What is Still Needed?

Digital tools to simplify the controls design, delivery, commissioning and operational process

1. Tools to allow the design engineer to select and edit a high- performance sequence that meets the project requirements.
2. Express this sequence in the traditional verbose format as well as in a digital ”Control Description Language” – or CDL.
3. Allow the engineer to test the sequence in energy models.
4. The contractor can take the CDL file and use it to prepare their submittals, as well as program controllers.
5. Additional tools help verify the programming for the commissioning agent.
6. The system logic is now documented in CDL.



OpenBuildingControl

- Project funded by the Department of Energy with support from the California Energy Commission and a broad group of industry partners.
- Work started in 2016
- Key deliverables:
  - Definition of CDL
  - Development of a new version of Energy Plus that supports controls simulation
  - Library of CDL routines including those in ASHRAE Guideline 36
  - Development of tools for design and verification

Control Logic Description Standard

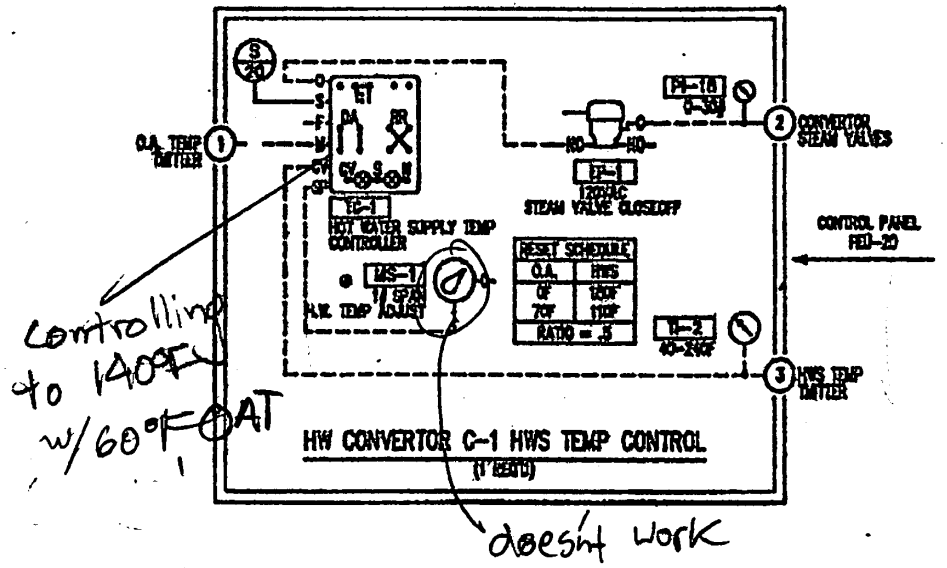
What is it and why do we need it?

Control Logic Description

- Controls logic needs to be clearly documented
- Historically the showed the logic graphically

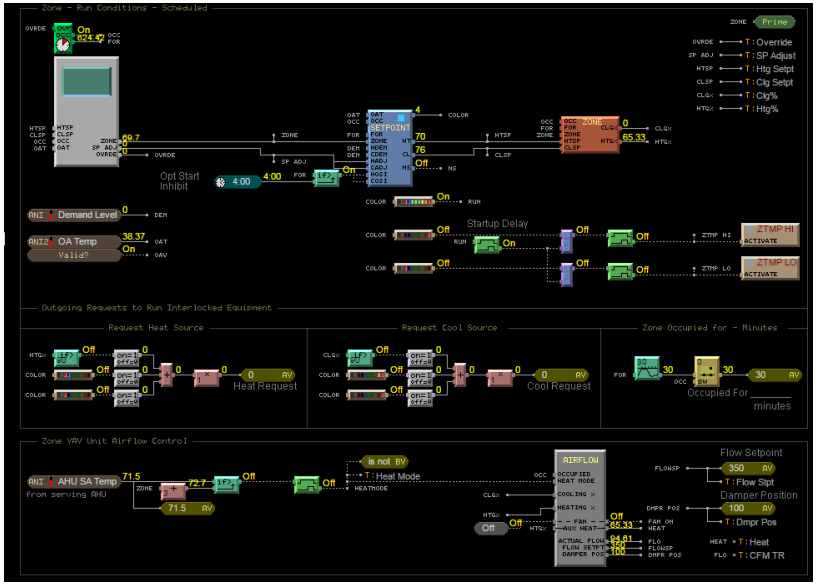
SEQUENCE OF OPERATION

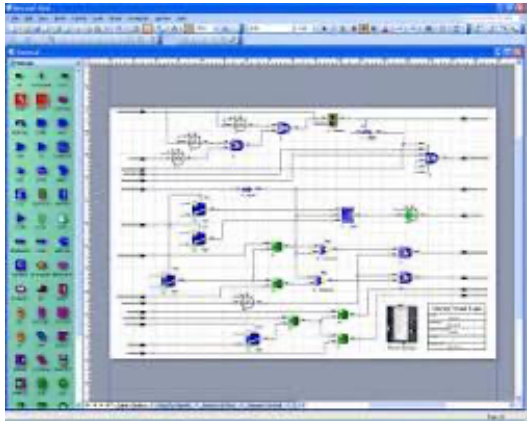
HOT WATER SUPPLY TEMPERATURE CONTROL.
THE LEAD HOT WATER PUMP SHALL RUN CONTINUOUSLY. ON A FALL IN OUTSIDE AIR TEMPERATURE BELOW THE SETPOINT OF TS-C0, THE LAG HOT WATER PUMP SHALL BE STARTED.
ON A RISE IN HOT WATER SUPPLY TEMPERATURE AS SENSED BY TT-1, RECEIVER/ CONTROLLER TC-1 SHALL MODULATE N.C. 2/3 CAPACITY STEAM VALVE V-1D CLOSED TO THE CONVERTOR. ON A CONTINUED RISE IN HOT WATER SUPPLY TEMPERATURE, N.C. 1/3 CAPACITY STEAM VALVE V-1C SHALL BE MODULATED CLOSED TO THE CONVERTOR AS REQUIRED.
ON A RISE IN OUTSIDE AIR TEMPERATURE AS SENSED BY TT-2, THE HOT WATER SUPPLY TEMPERATURE SETPOINT SHALL RESET DOWNWARD ACCORDING TO THE DESIRED RESET SCHEDULE.
BOTH DDC AND PNEUMATIC CONTROL:
THE STEAM VALVES SHALL BE FULLY CLOSED THROUGH EP-1 WHENEVER THE HOT WATER PUMPS ARE STOPPED.



Control Logic Description

- Control systems today utilize line or graphical programming
- Every control supplier has “built their own” solution for programming





```
05000     C ------------------------------------------------
05100     WAIT(3,"NLES.SNOWMELT.GO","NLES.SNOWMELT.TRIG",11)
05200     WAIT(3,"NLES.SNOWMELT.GO","NLES.SNOWMELT.TRIG",0)
05300     IF("NLES.SNOWMELT.ELEC_OVRD" .EQ. OFF) THEN SET (0,SECNDS)
05400     IF("NLES.SNOWMELT.TRIG" .EQ. ON) THEN GOTO 5700
05500     IF(SECNDS .GE. 3) THEN ON ("NLES.SNOWMELT.GO")
05600     GOTO 5900
05700     IF("NLES.SNOWMELT.TRIG" .EQ. OFF) THEN GOTO 5900
05800     IF(SECNDS .GE. 3) THEN OFF ("NLES.SNOWMELT.GO")
05900     IF("NLES.SNOWMELT.GO" .EQ. OFF .OR. "NLES.SNOWMELT.T01" .GT. 3600) THEN OFF ("NLES.SNOWMELT.ELEC_ENBL",
          "NLES.ICEMELT.OVERRIDE","NLES.SNOWMELT.GO") ELSE ON ("NLES.ICEMELT.OVERRIDE","NLES.SNOWMELT.ELEC_ENBL")
06000     SAMPLE(60) IF("NLES.SNOWMELT.GO" .EQ. ON) THEN "NLES.SNOWMELT.T01" = "NLES.SNOWMELT.T01" + 1 ELSE
          "NLES.SNOWMELT.T01" = 0
06100     C
06200     C
06300     C
06400     C
06500     GOTO 1900
```

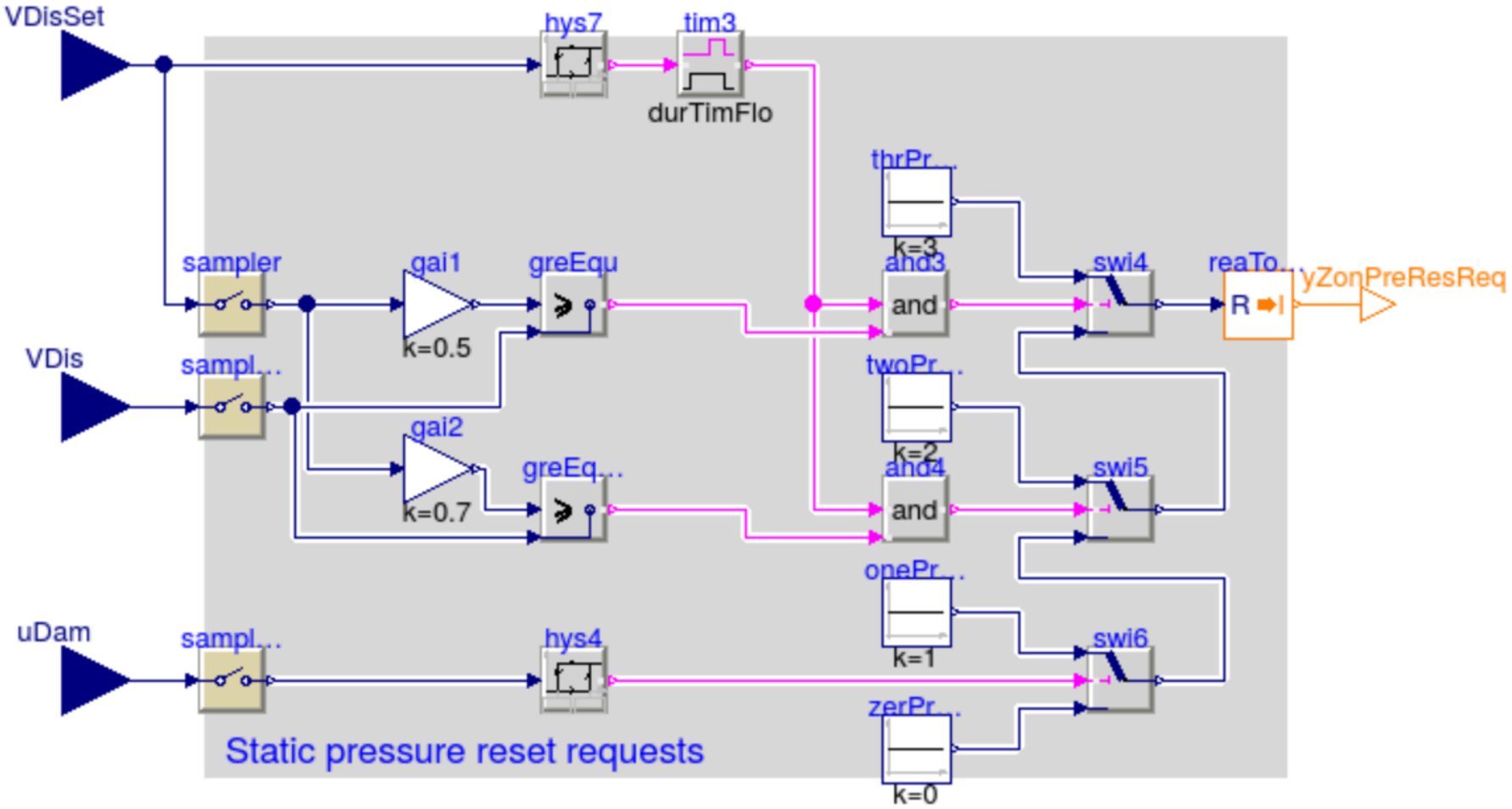
Control Logic Problems Today

- Interpreting the written sequence and developing the control logic requires significant interpretation and is error prone.
- Proprietary logic description
  - Without standards is the only viable option
  - May be less than ideal for designers, commissioning agents and owners
  - Can’t readily integrate with energy models and digital twins

Proposed Solution

- Develop a standard for controls logic descriptions, starting with the CDL work already completed by the Open Building Control project.
- Design Engineers:
  - More effectively specify efficient control sequences.
  - Incorporate controls sequences into energy models to evaluate sequence options and to test the sequence to discover potential errors.
- Controls Contractors:
  - Simplifies the process of documenting the controls design and programming the system.
- Commissioning Agents / Owners:
  - Improved and consistent documentation
  - Enables support for data analysis, digital twins, and grid integration.

Example

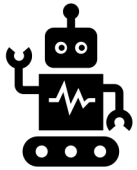

VDisSet
hys7
tim3
durTimFlo
thrPr...
k=3
sampler
gai1
greEqu
and3
and
swi4
reaTo...
yZonPreResReq
R
I
k=0.5
VDis
sampl...
twoPr...
k=2
gai2
greEq...
and4
and
swi5
k=0.7
onePr...
uDam
sampl...
hys4
swi6
k=1
zerPr...
k=0
Static pressure reset requests

Control Programming Process

CDL from Designer

CDL Compliant

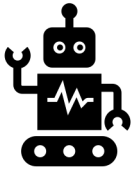
Review and Download into Controllers



Legacy

Review and Translate to Proprietary Programming Language

Download into Controllers



Next Steps:

- With the support of SGPC 36 and TC 1.4 a new standard for Controls Description Language has been proposed.
- The project has been approved by SPS and will be voted on by Standards at the Summer Meeting.
- Contact the speaker if you are interested in participating in this process!

Title: CDL - A Control Description Language for Building Environmental Control Sequences

Purpose: The purpose of this standard is to define a declarative graphical programming language for building environmental control sequences that are both human and machine readable designed for specification, implementation through machine-to-machine translation, documentation, and simulation.

Scope: This standard applies to building automation systems controlling environmental systems such as mechanical systems, active facades, and lighting.

Questions?

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