OpenBuildingControl

—

TAG meeting

Michael Wetter
Philip Haves
Jianjun Hu
Milica Grahovac

February 20, 2018

Lawrence Berkeley National Laboratory

Presentation Contents

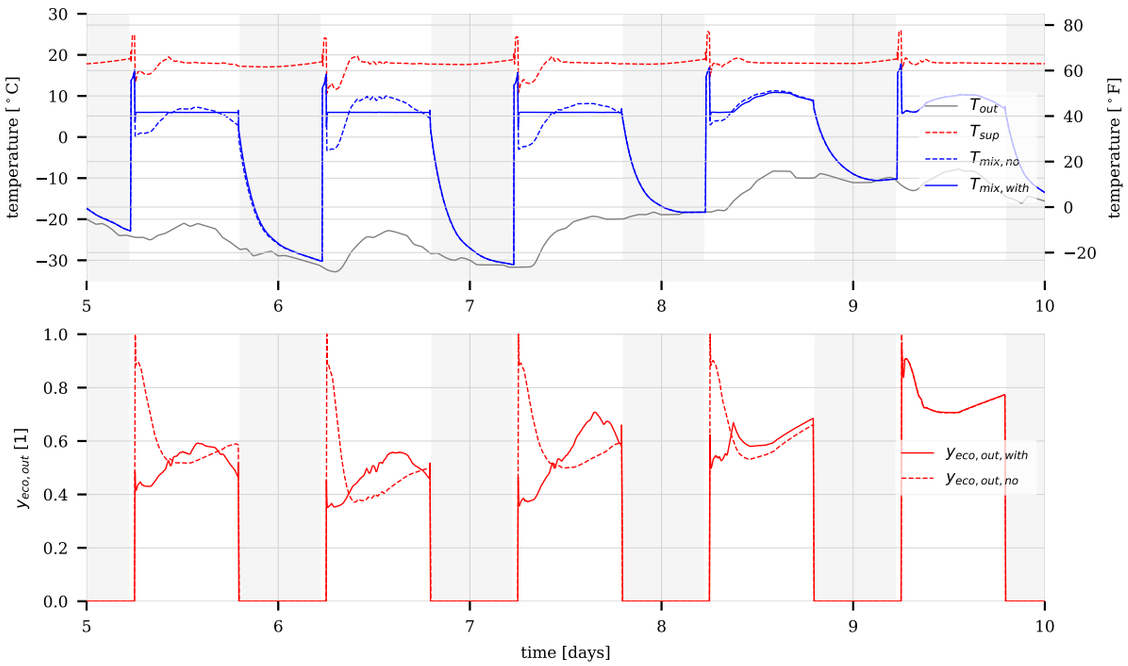
- 1st case study and dissemination
- Guideline 36 release
- Next case study
- Chiller plant sequences
- CDL export
- Verification
- Timeline
- Open discussion

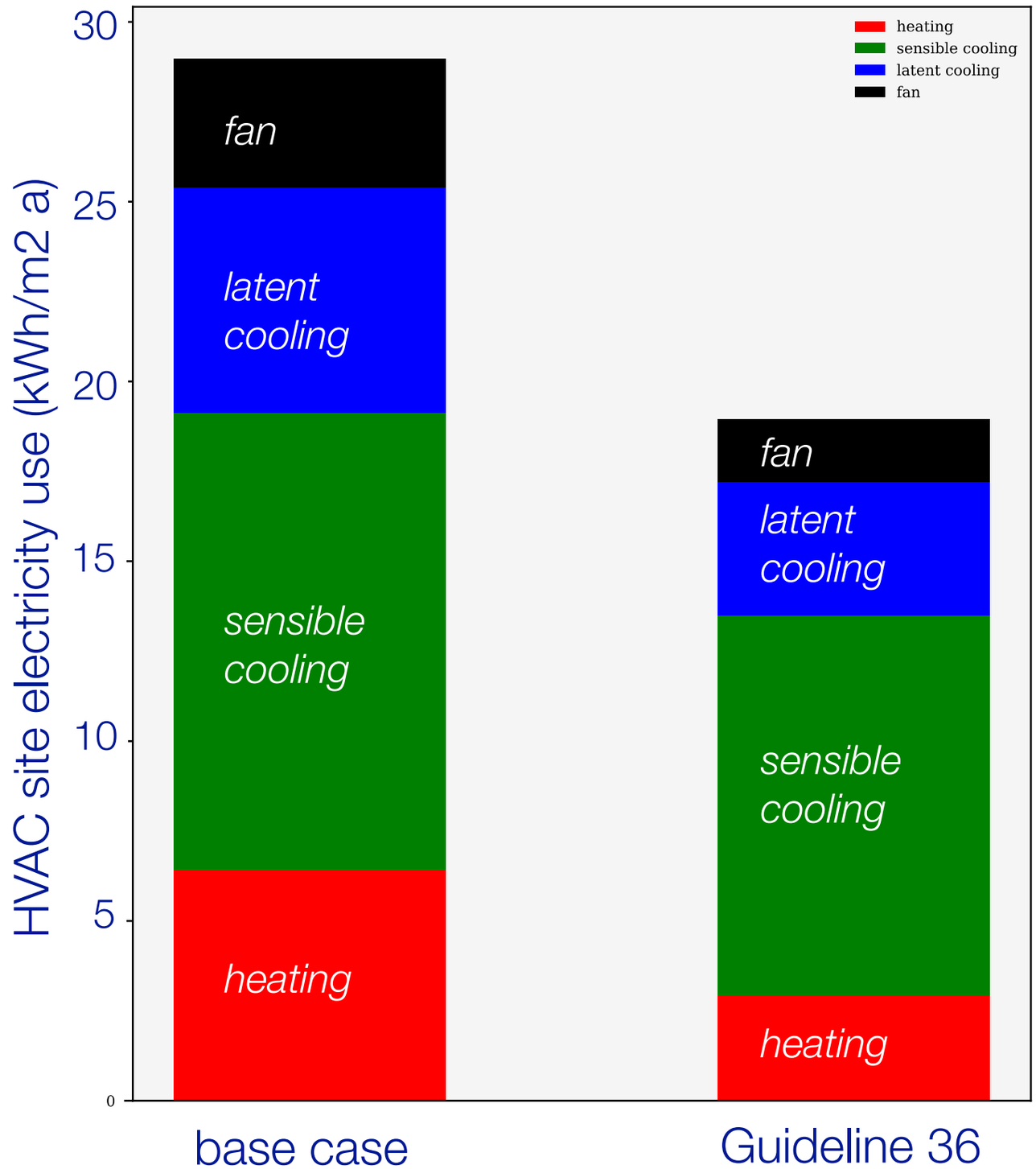
Key take-aways of 1st case study

~30% annual site HVAC energy savings for Chicago, solely due to controls.

Can simulate actual control sequences, with dynamic response.

Packaging of sequences is important, because interpretation and implementation of the sequences was more time-consuming and error-prone than anticipated.





Dissemination

Released Guideline 36 package with Modelica Buildings library.

Presented project to ASHRAE Guideline 36 committee on Jan. 22, 2018.

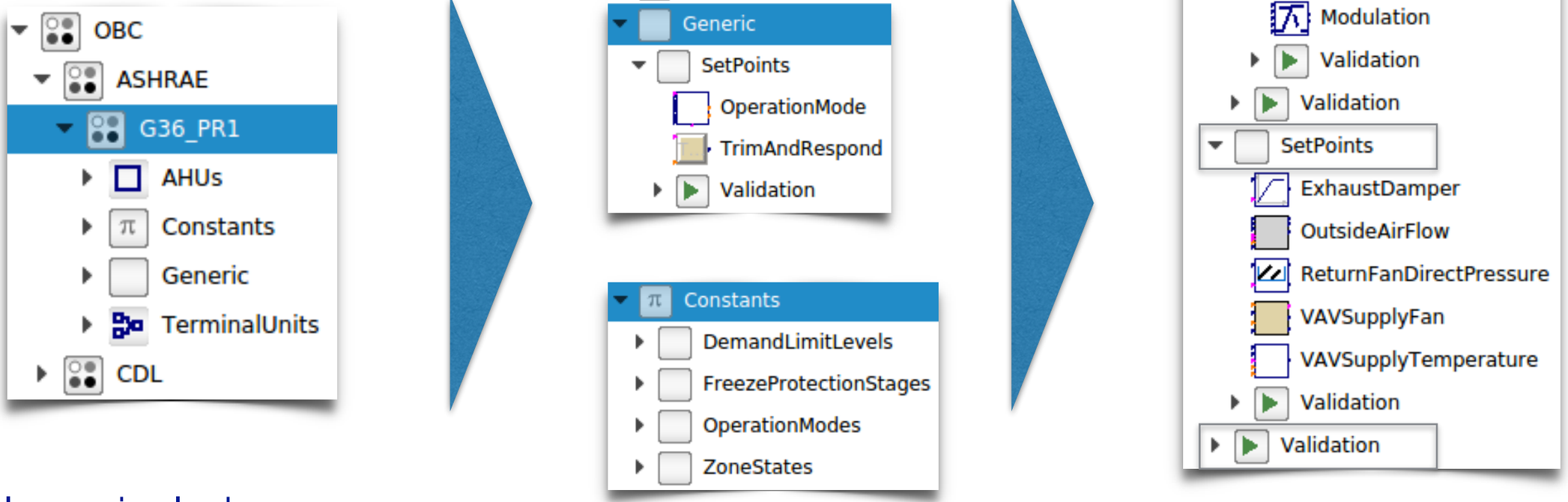
Submitted paper for SimBuild 2018.

Present work at IBPSA Project 1 Expert Meeting end of February 2018.

Posted development version of CDL parser at https://github.com/lbl-srg/modelica-json

Guideline 36 Release

Released Guideline 36 sequences with Buildings library 5.0.0



Release includes

- VAV models used for case study
- 34 test cases/ examples

http://simulationresearch.lbl.gov/modelica/

Next Case Study

Primary system.
Case study report due to DOE & CEC by October 1.

Objectives

Implement, test and demonstrate a primary sequence

Use real building data:

- Plant model
- Measured loads
- Compare actual performance with simulation

Demonstrate generation of English language documentation from CDL.

If time allows (depending on possible 3rd party contribution), demonstrate translation of sequence from CDL to a proprietary language.

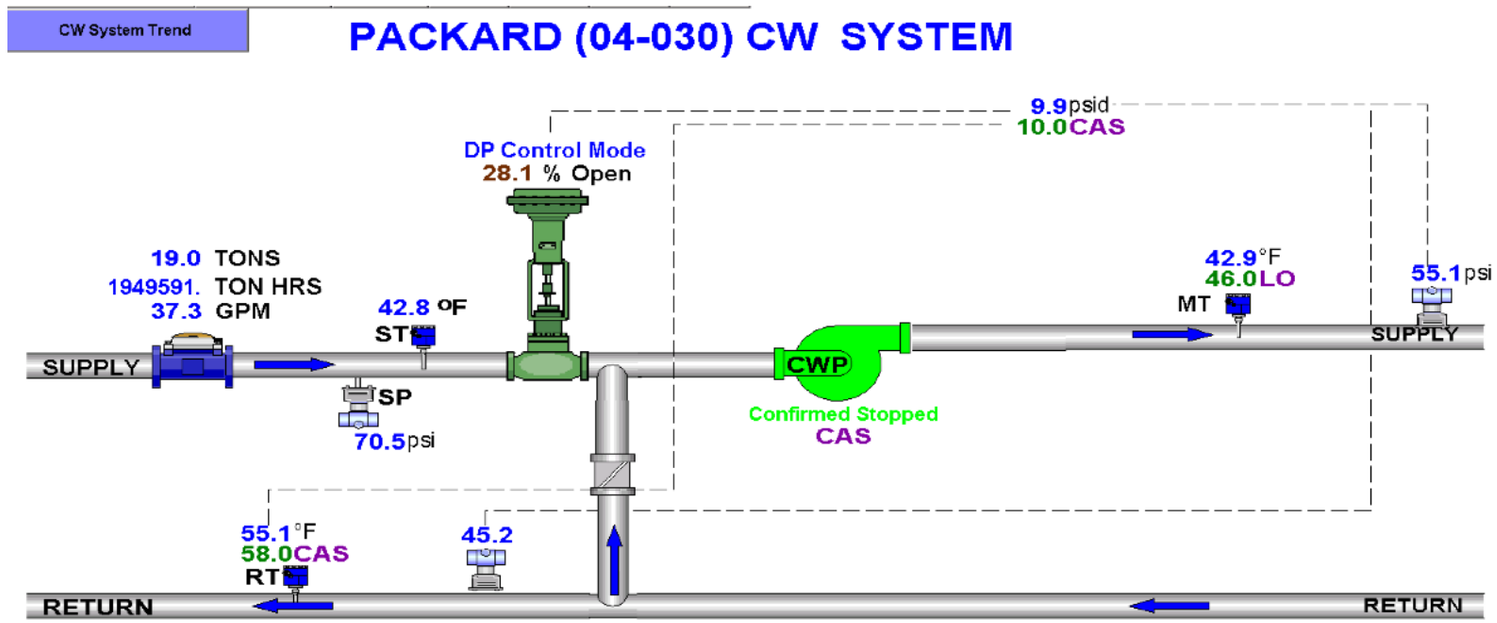
Case Study Options

1. Measured secondary loads from Stanford building driving chiller plant simulation model matching G 36 candidate chiller plant sequence currently being implemented
    - Demonstrate simulation comparison of G 36 and simpler sequences (similar to Case Study 1 but with real load data as input)

2. Measured secondary loads from Oracle building driving model of actual chiller plant chosen to be similar to sequence currently being implemented.
    - Model actual sequence and adapted G 36 candidate and compare
    - If translator available for controls in real plant, implement G 36 sequence in real controls, demonstrate process and compare performance

Stanford Packard EE Bldg

Source of measured loads: chilled water supply and return temperature and flow rate



Need to calculate Trim & Respond reset requests

Oracle

Buildings: 2

Square Footage: Building 1 - Sqft 177,598 - 5 Floors

Building 2 - Sqft 173,276 - 5 Floors

Controls: Automated Logic Corp (ALC)

Controls Vendor: SunBelt Controls

Design: Steve Taylor – Taylor Engineering

Mechanical Systems:

- Building 1
  - (1) 167 Ton Multistack Chiller
  - (1) 461 Ton Carrier Chiller
  - Waterside Economizer
  - 1 Boiler 2.1MBTU Low NOx
- Building 2
  - (2) 310 Ton Carrier Chillers
  - Waterside Economizer
  - 1 Boiler 2.1MBTU Low NOx
- VFD's Installed on virtually everything Cooling Towers, Pumps, Motors

Implementation of sequences for primary systems

Process

Solicited and obtained sequences for primary systems from

- ARUP London
- Taylor Engineering

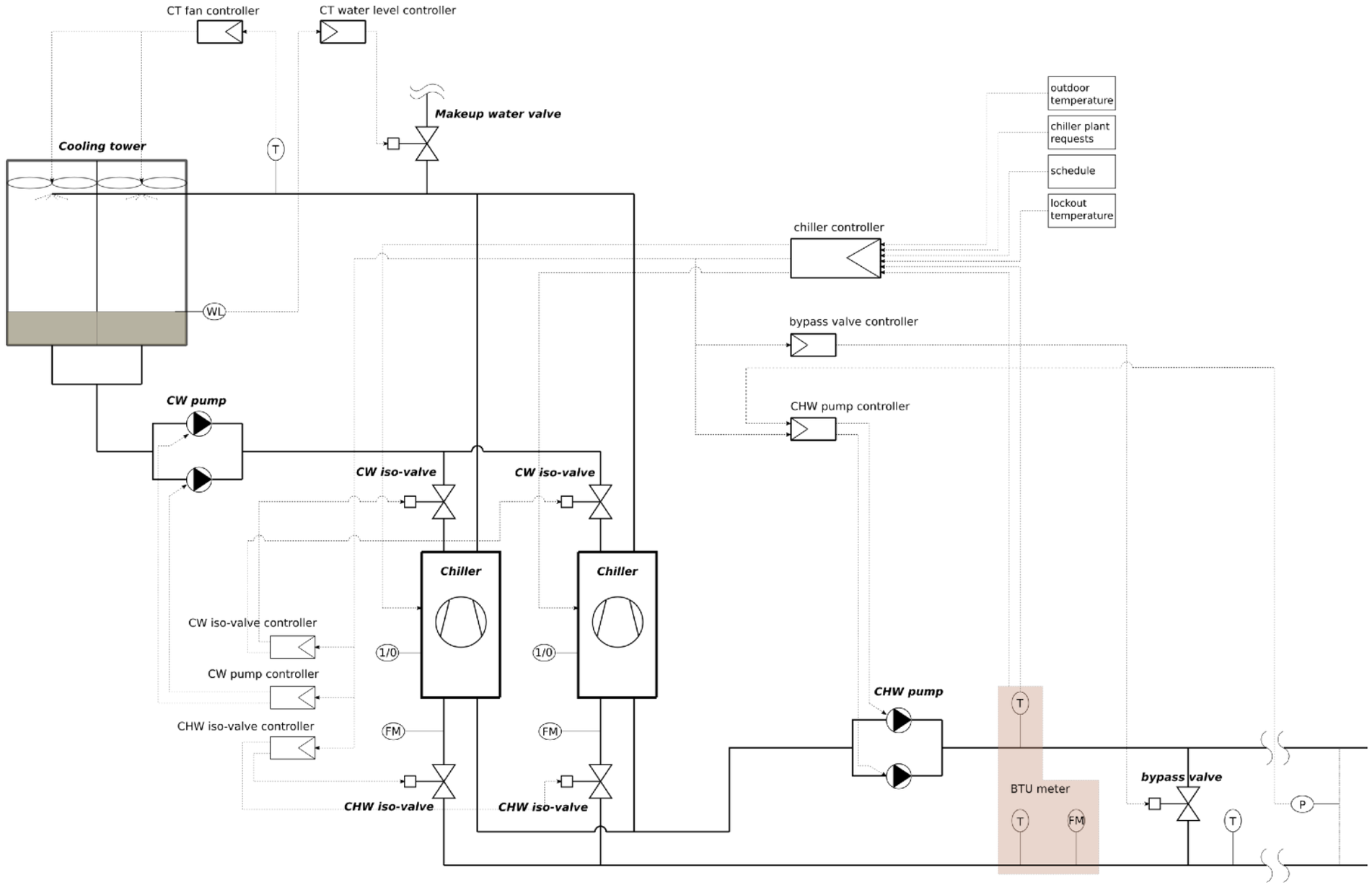
TAG expressed that sequences for automated facade and lighting are not a priority.

(But for SOEP, we want to have ready-to-use sequences and we plan to add simple sequences.)

Chiller plant sequences

Based on typical plant control schematics and sequences from “ASHRAE Fundamentals of Chilled Water Plant Design and Control SDL, Chapter 7. Controls”.

It will be included in “ASHRAE RP-1711: Advanced sequences of operation for HVAC systems — Phase II Central plants and Hydronic systems”



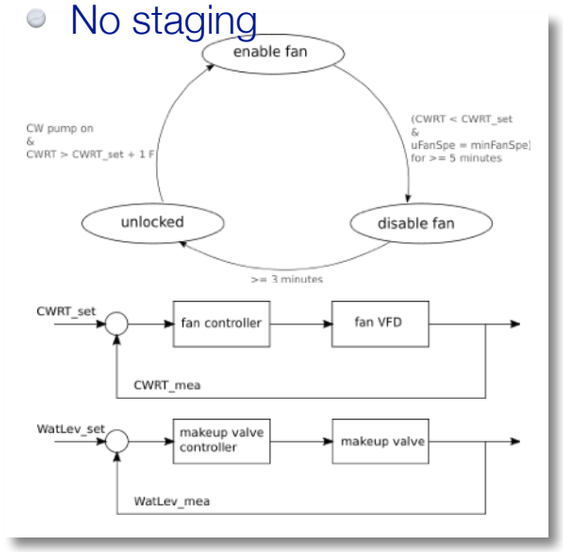
Chiller plant sequences

Break down to subsequences

Generalize the sequences

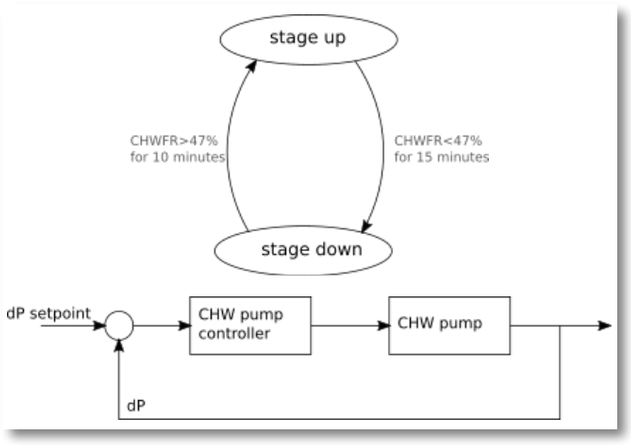
Cooling tower:

- VFD fans
- No staging



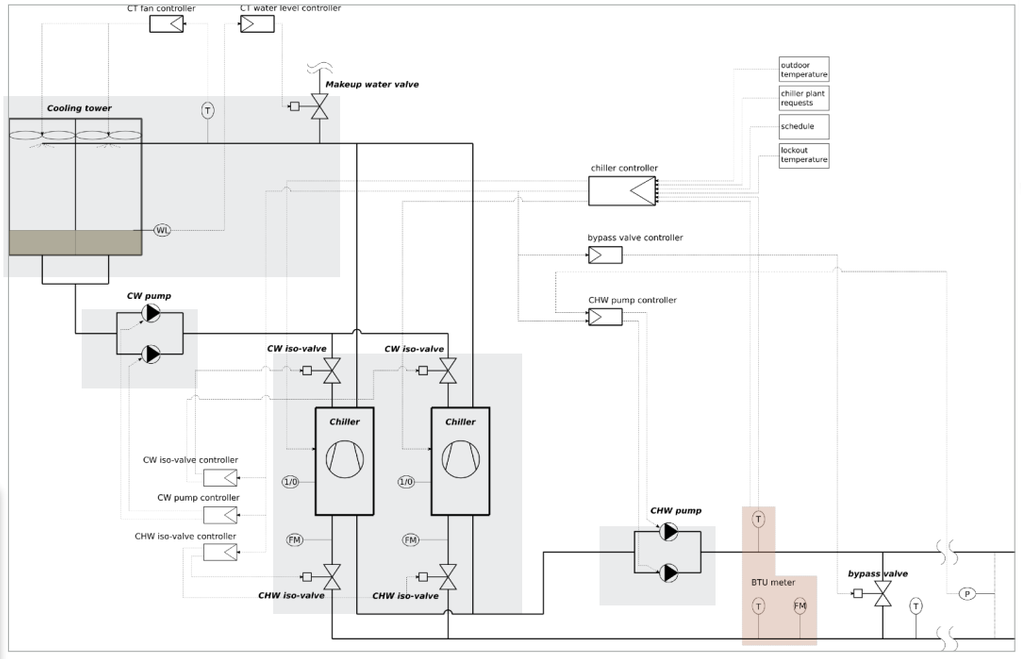
Chiller water pump:

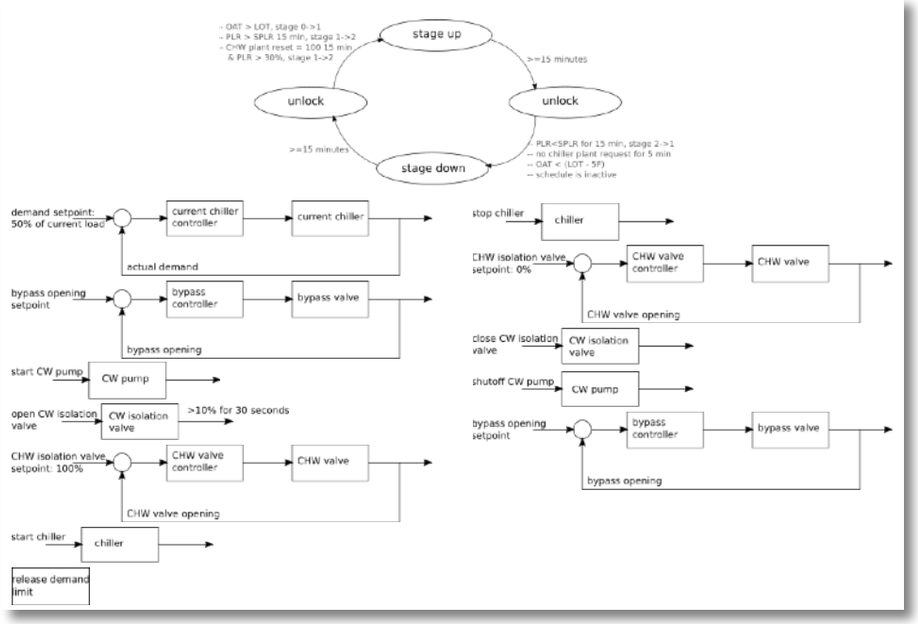
- VFD pump



General sequences:

- Trim & respond reset logic
- Lead/lag and lead/standby alternation





Chiller_staging:

- staging logic: up / down
- chiller: on / off
- CW iso-valve: modulate on/off
- CW pump: ConSpe, on/off
- by-pass valve: modulate
- CHW iso-valve: modulate on/off

Questions:

There are many different primary side sequences, such as

- primary-only / primary-secondary
- with / without WSE
- constant / variable speed chiller
- with / without pony chiller
- with / without VFD CW pump
- with / without cooling tower staging,
- constant / variable / staging speed cooling tower fan
- with / without Dolphin system, etc.

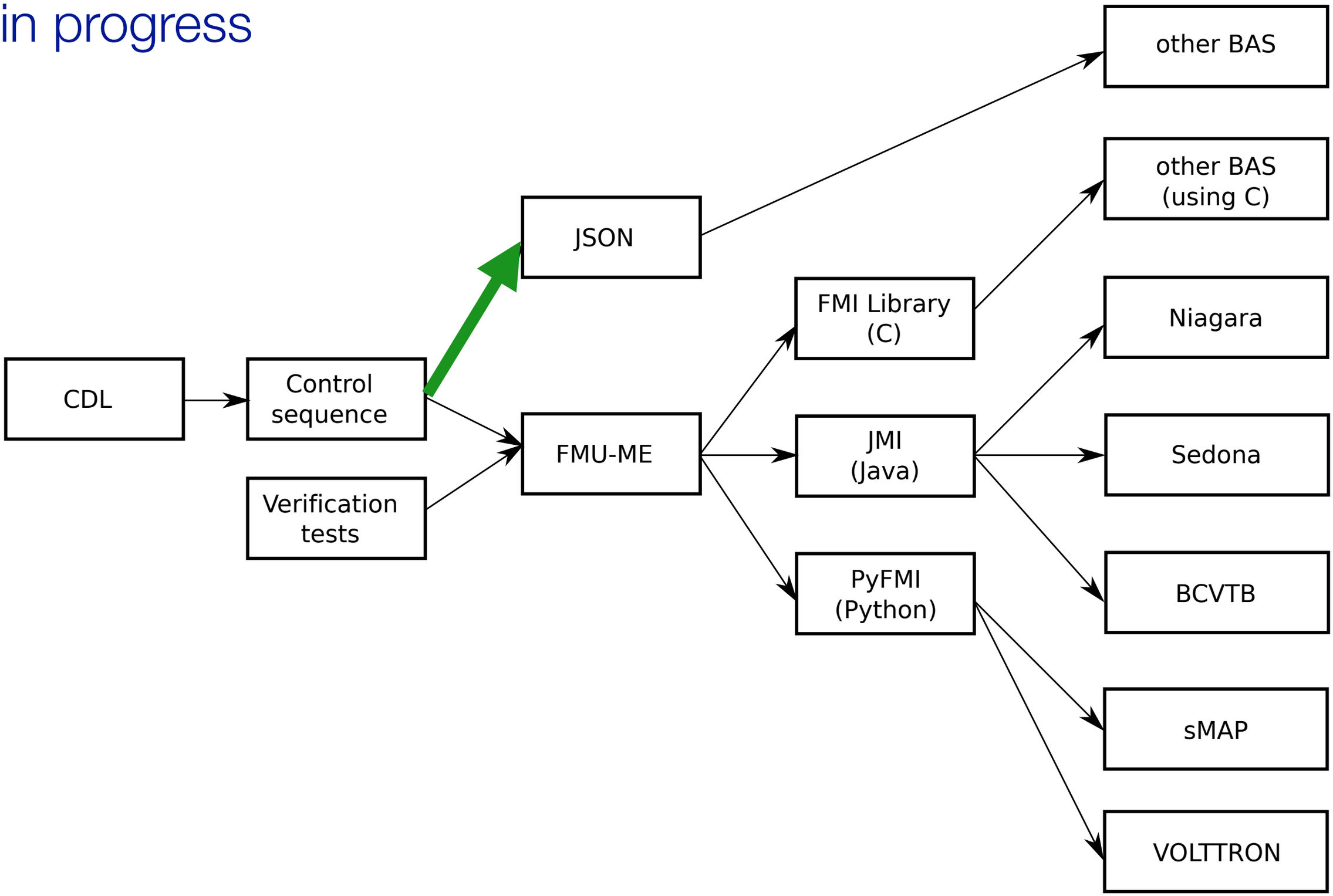
Which ones are highest priority?

How can they be modularized to allow users to create sequences “a la carte”?

Did G36 committee (or RP1711 team) decide what water side sequences will be included?

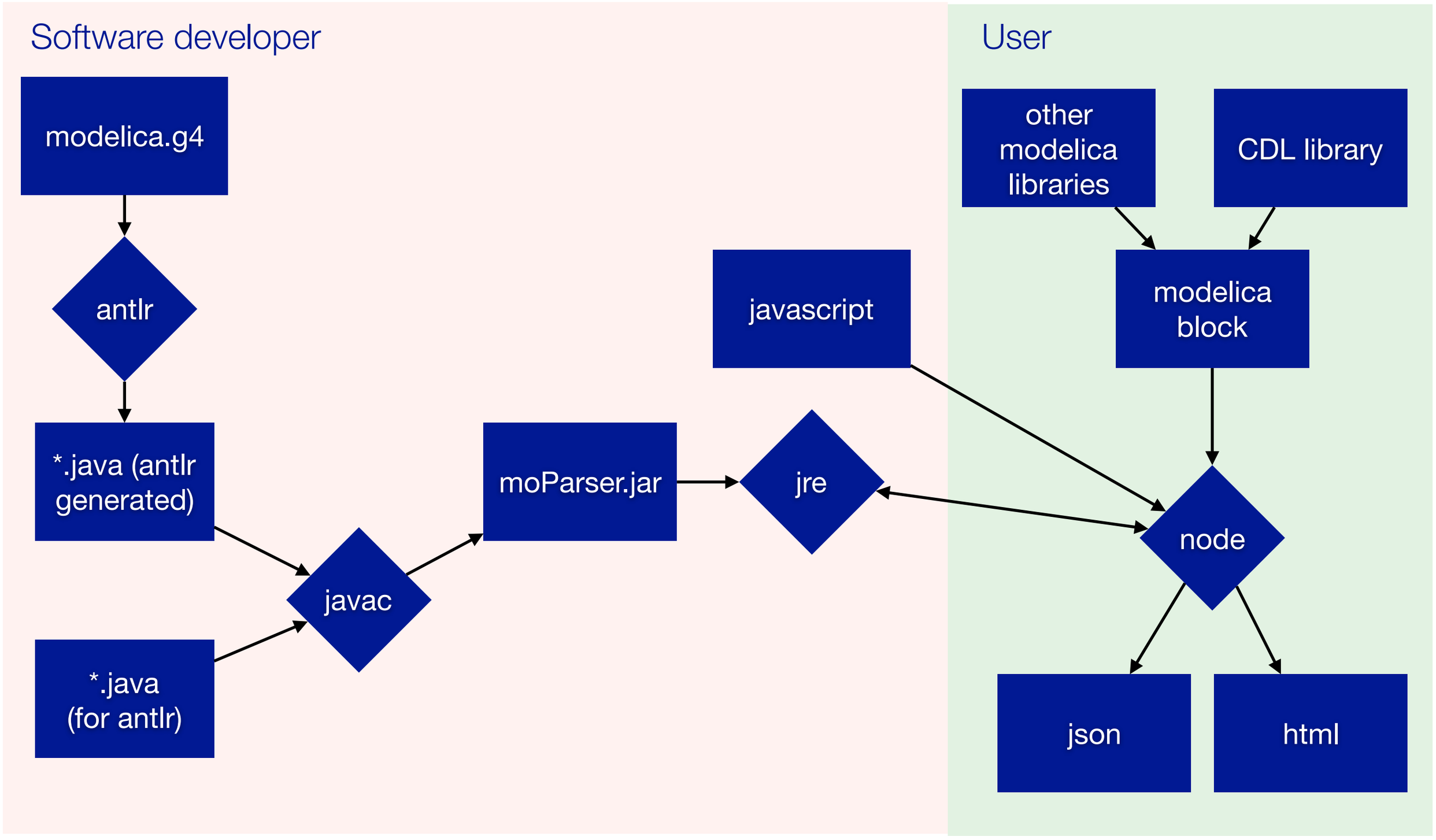
CDL export

Development of parser from CDL to JSON, and JSON to html in progress



Repository	Control sequences & verification test declarations	Executable format	Import libraries	Runtime environment

Development of parser from CDL to JSON, and JSON to html in progress

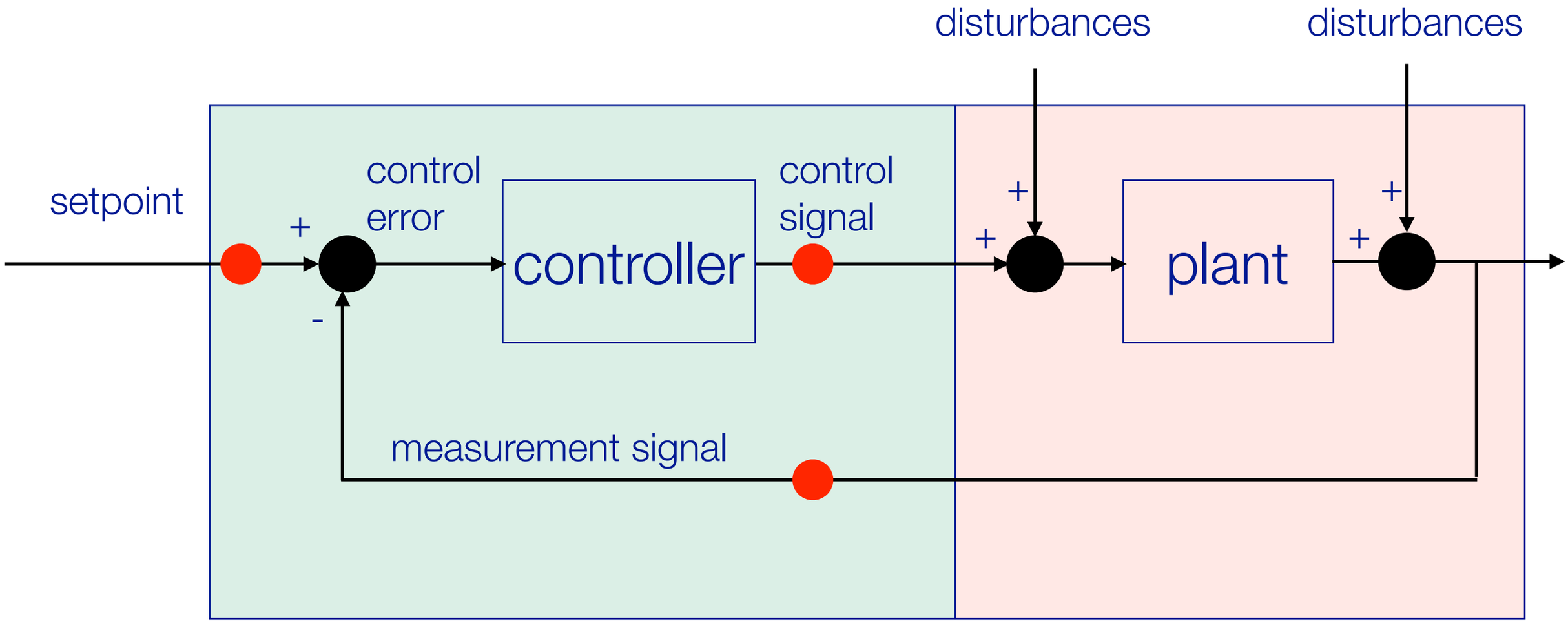


https://github.com/lbl-srg/modelica-json

Verification

Verification of control sequence

By April 1, demonstrated with an actual measured control response that the controls verification can signal satisfied, undecided and violated test results.



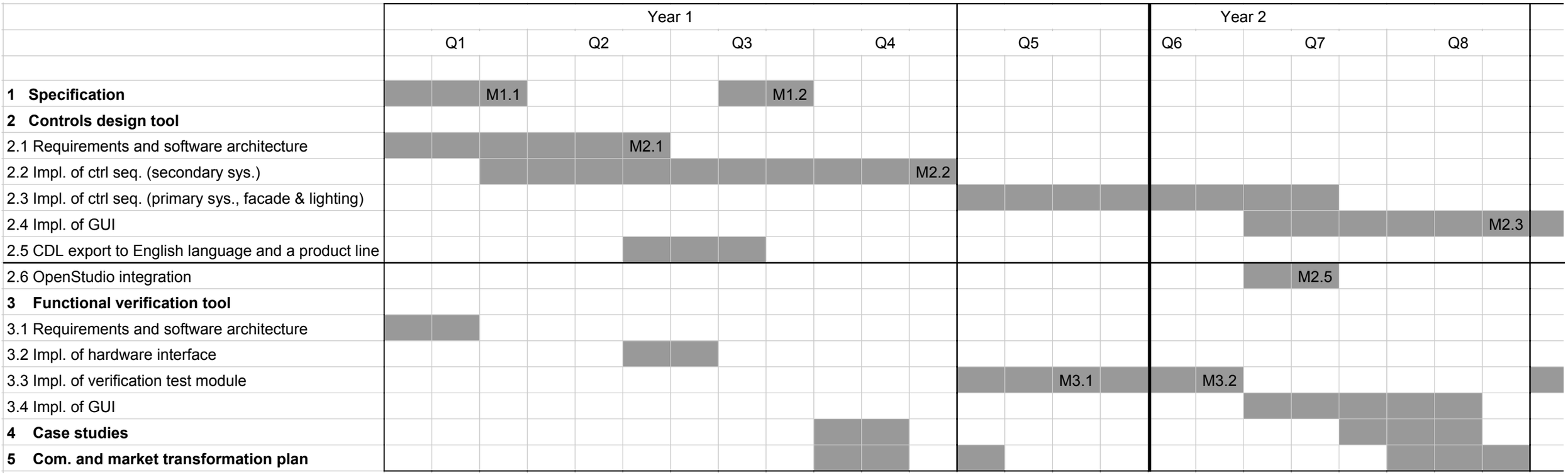
- Red points indicate which signals to verify against a CDL generated response.

Verification of control sequence

Can anyone on the TAG provide time series of a Guideline 36 sequence (ideally VAV single or multi-zone). Required data

- input signals (e.g., measured temperature)
- control parameters (such as proportional gains)
- output signals of the control sequence
- in case of differences, we would also need to be able to inspect the implemented sequence in order to understand where the differences come from

Milestone and progress



M3.1: By Q5, demonstrate with an emulated control response that the controls verification can signal satisfied, undecided, and violated test results.
M3.2: By Q6, demonstrate with an actual measured control response that the controls verification can signal satisfied, undecided, and violated test results.

Commercialization plan not yet started due to delays in subcontracting with ARUP, who would lead this task.

Questions and Discussion