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4th European STAMP Workshop 2016

STPA Tutorial - Part 2

Tutorial Example - Railroad Crossing

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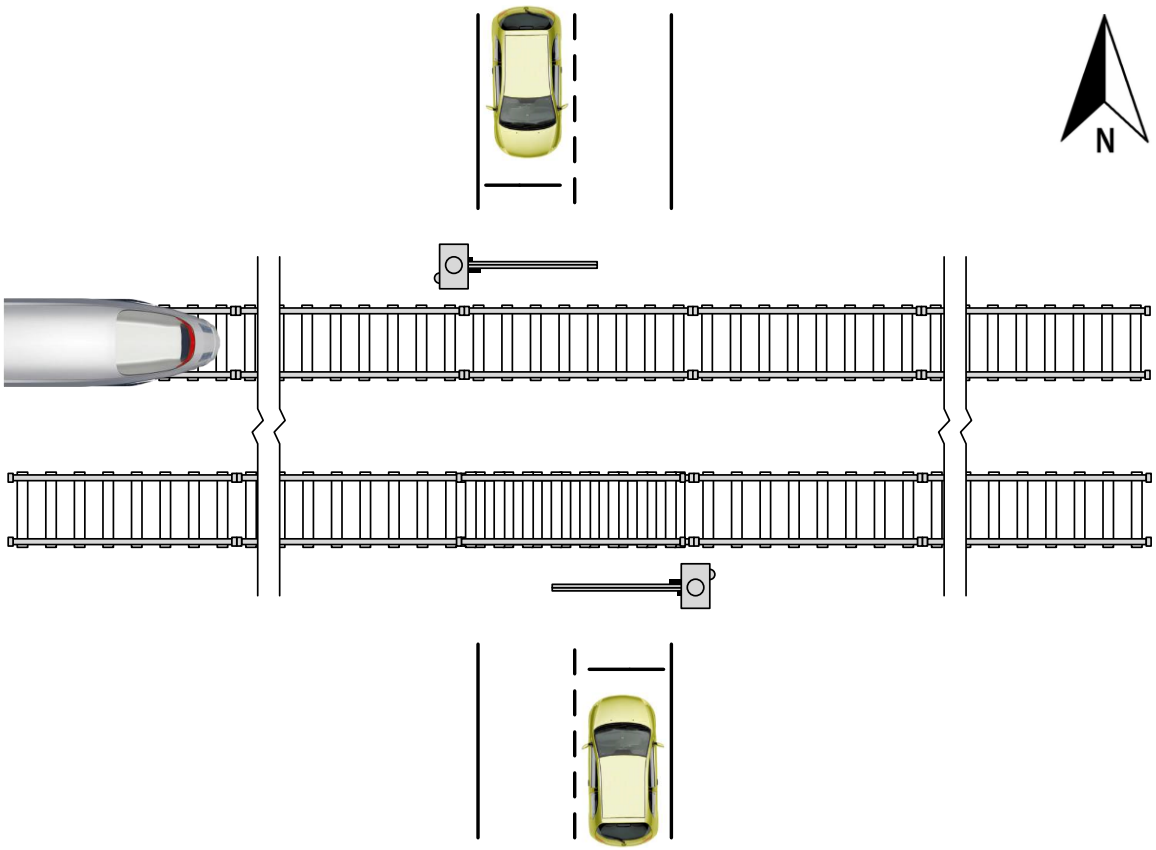
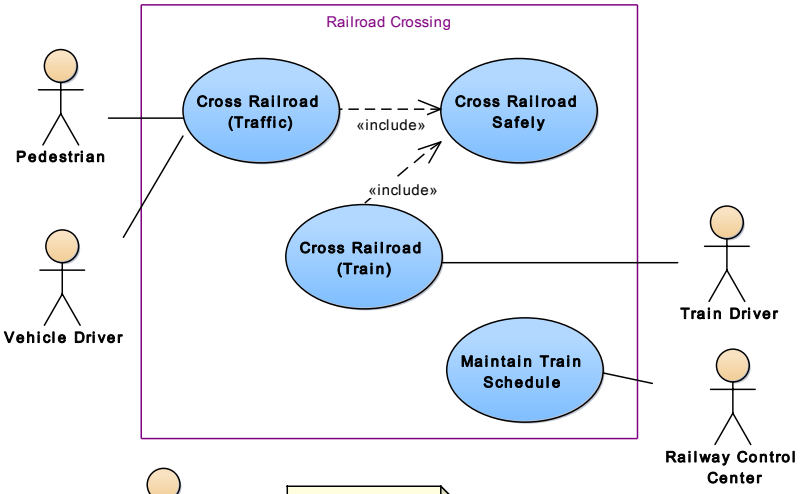
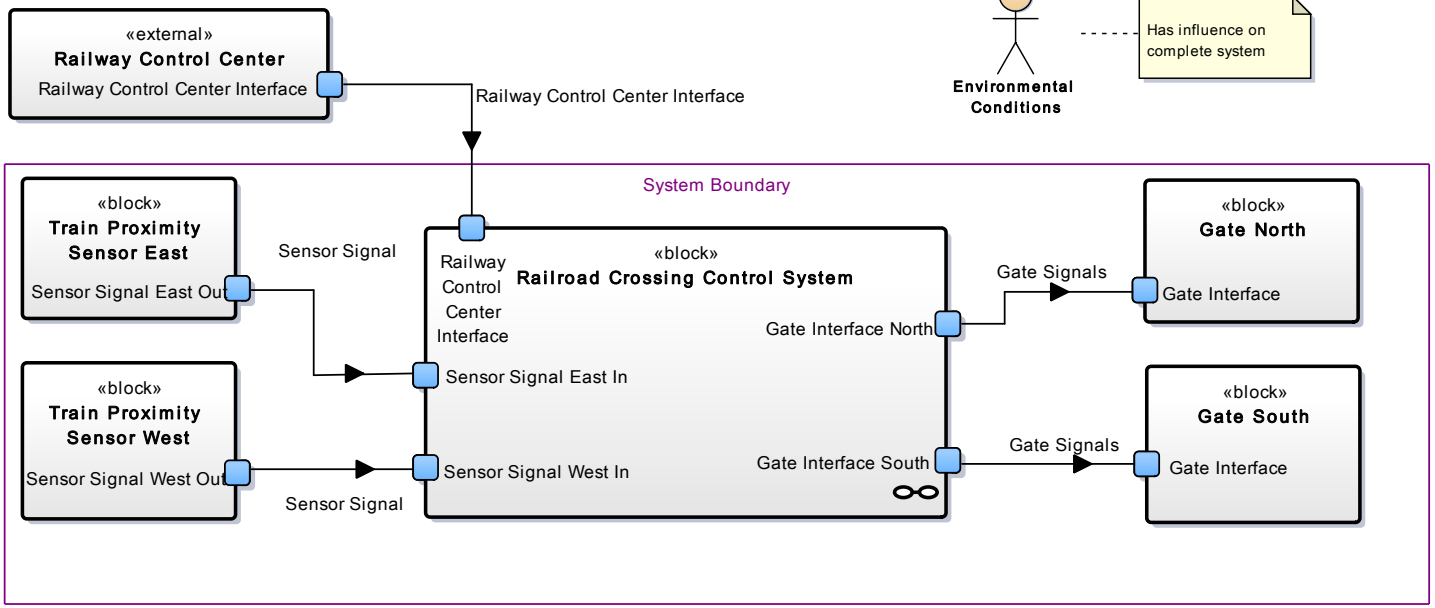


- Gates on north and south side.
- Trains arrive from west or east side.
- Railroad Crossing Control System detects incoming train and secures the crossing for the train to pass.
- Once the train has passed, cars and people are allowed to cross again (safely).

Tutorial Example - Railroad Crossing

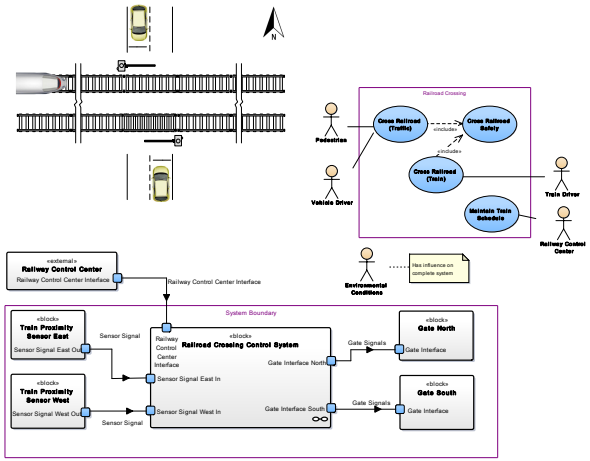
- The designers perspective?
  - Railroad crossing system seen as a SysML model.





Group Activity - STPA Step 1

- Assume the scope has been set.
  - System boundary + System Level Accidents/Hazards
- The next step is to build a HCS for our system that will support the identification of Unsafe Control Actions.
- We will try to do this as a group activity:
  - We will distribute you a bunch of HCS variations.
  - Discuss the differences and construct your own HCS (see next slide) that you will use for a Step 1 analysis.
  - Go through a few CA and document any UCA on the template tables.
  - Time for the activity: approx. 35 minutes.
  - We will collect the results and make them available later.



Hierarchical Control Structure

???

UCA's

Group Activity - STPA Step 1

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- Proceed as follows for building a HCS:
  - Identify all potential controllers involved in this system
    - Includes their “interface”, i.e. control output and feedback input.
  - Identify what type of element they act on
    - On another controller, directly on a process?
  - Put controllers and processes into a control hierarchy by following the control path.
  - Identify the feedbacks going back to the controllers.
  - Take assumptions and extend the design model where necessary.

  - You can use the flipcharts to capture your HCS(es).

A few Comments

- It is imperative to document the functional behavior of the controllers in a complete and accurate way.
  - The HCS drawing is not sufficient to perform an analysis.
  - Accurately defining a controllers task and role helps to identify misunderstandings!
- Starting to search for UCA close to the controlled process tends to simplify the effort.
  - Whether a {CA, keyword, context} leads to a hazard is easier to see “close” to the process.
  - Analyzing the impact of {CA, keyword} and determining a relevant context at the upper hierarchy echelons is not always straightforward.
- STPA is “robust”
  - If you do not put an entity on the HCS it will show up in the Control-Loops. It is hard to miss something.

Real World Example - Feedwater Level Control of Nuclear Power Plant

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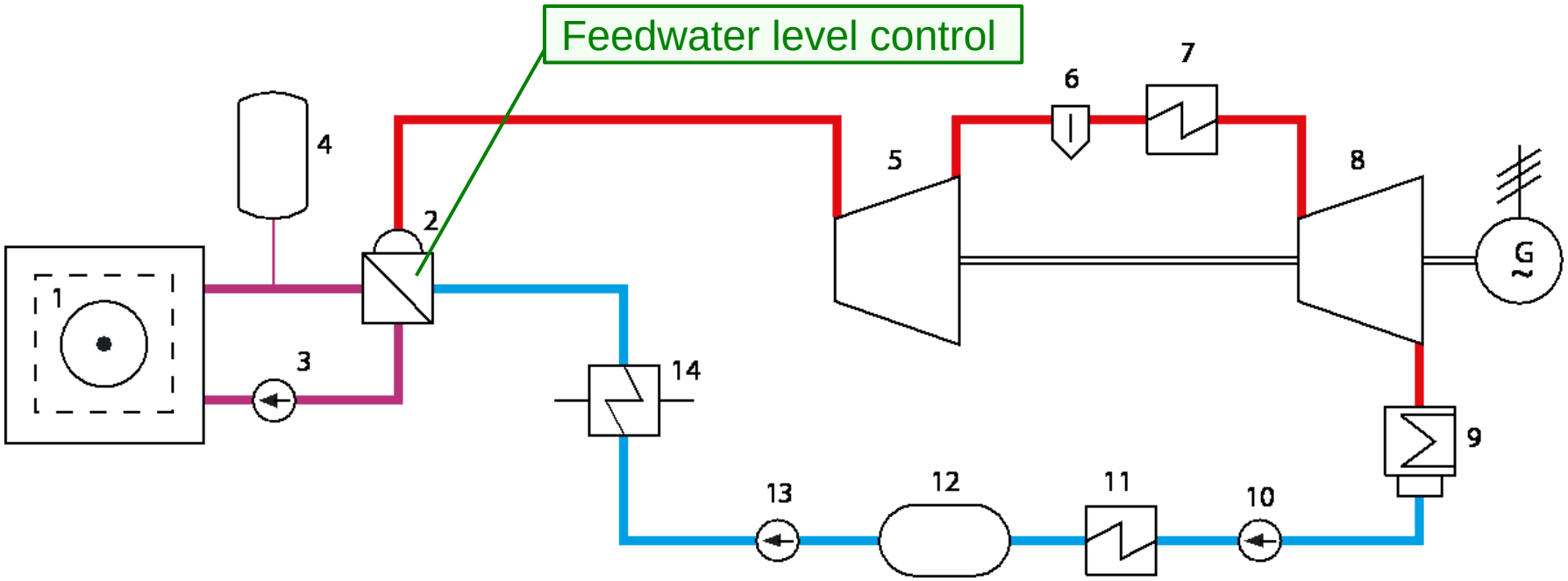

1 Reactor
2 Steam generator
3 Reactor coolant pump
4 Pressuriser
5 High-presure turbine
6 Water separator
7 Superheater
8 Low-pressure turbine
9 Condenser
10 Condensate pump
11 Low-pressure preheater
12 Feedwater tank
13 Feedwater pump
14 High-pressure preheater

System Architecture (reconstructed from manufacturers design documentation)

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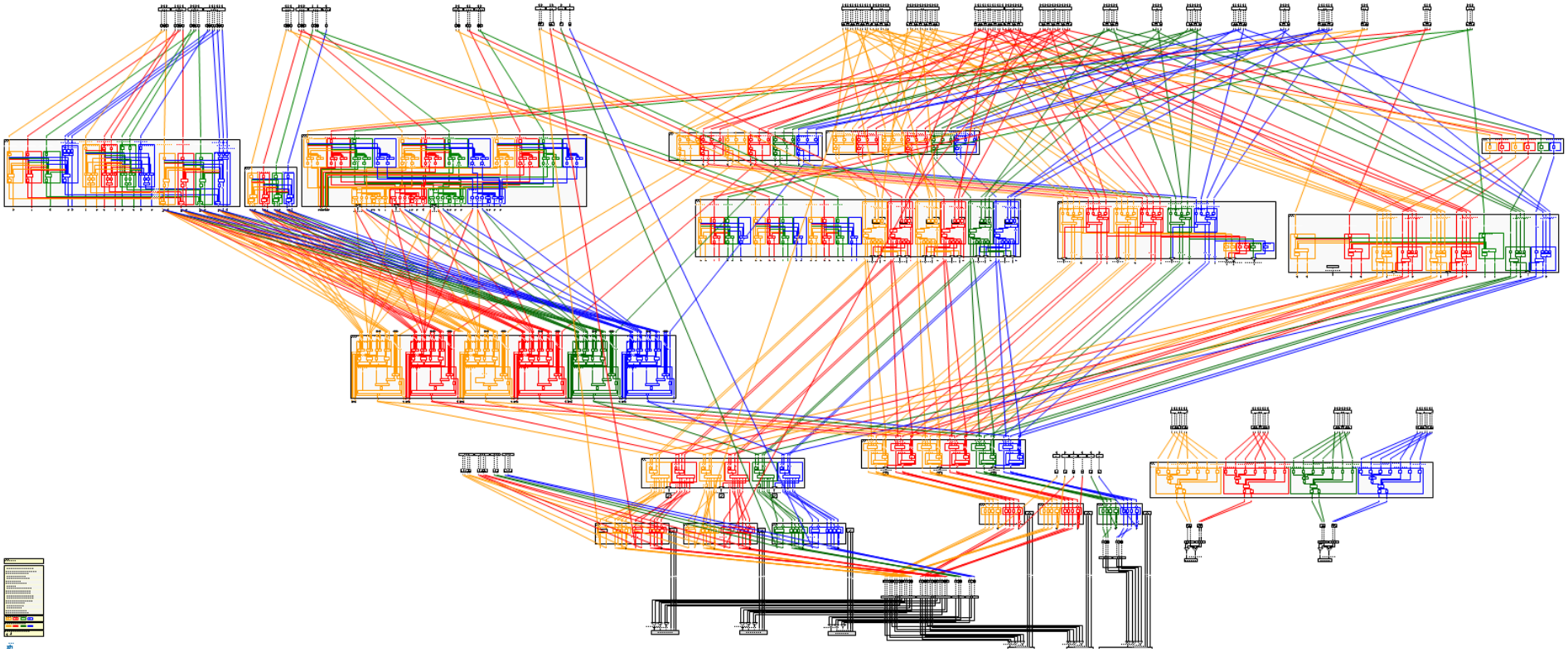

Now... where do you want to start?

Rejzek M. *Use of STPA in digital instrumentation and control systems of nuclear power plants.* 2nd European STAMP Workshop; 2014, Germany

Identification of Functional Entities

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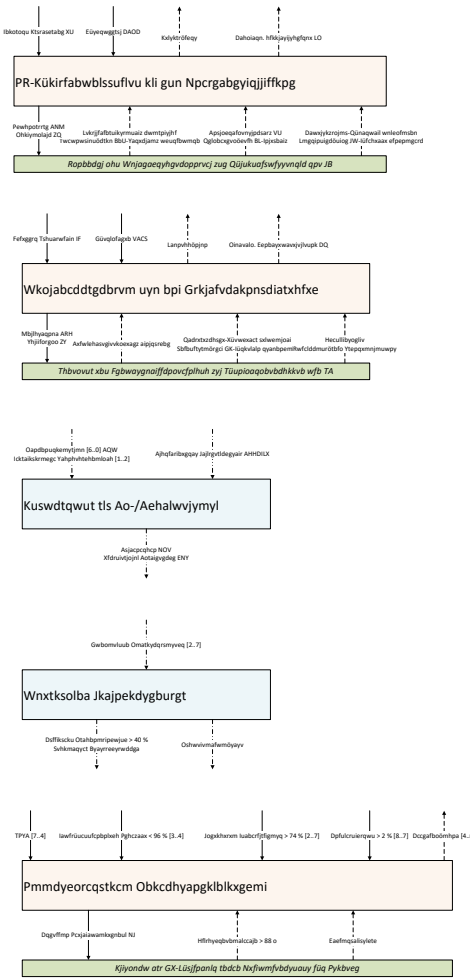
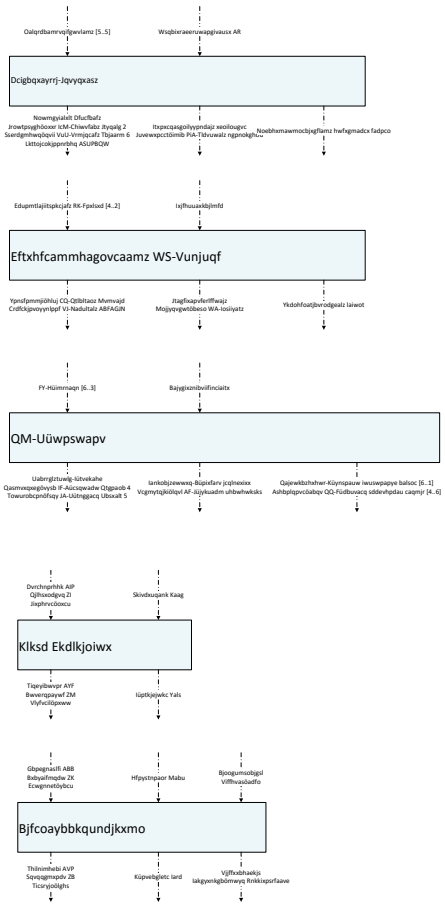
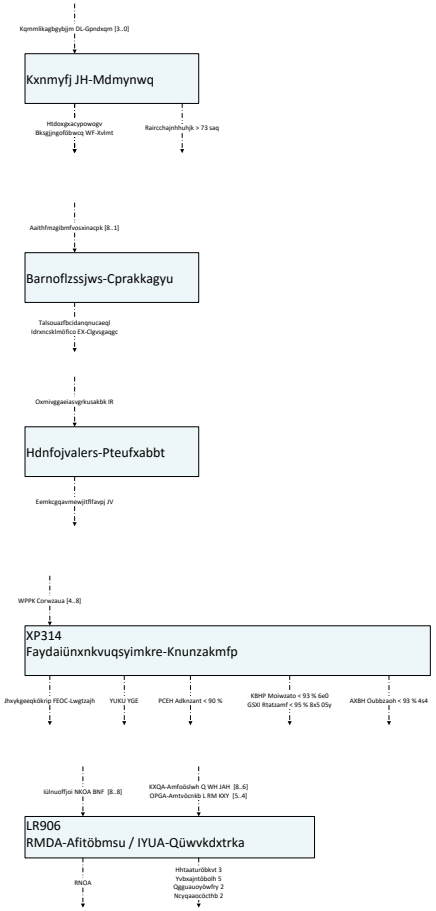
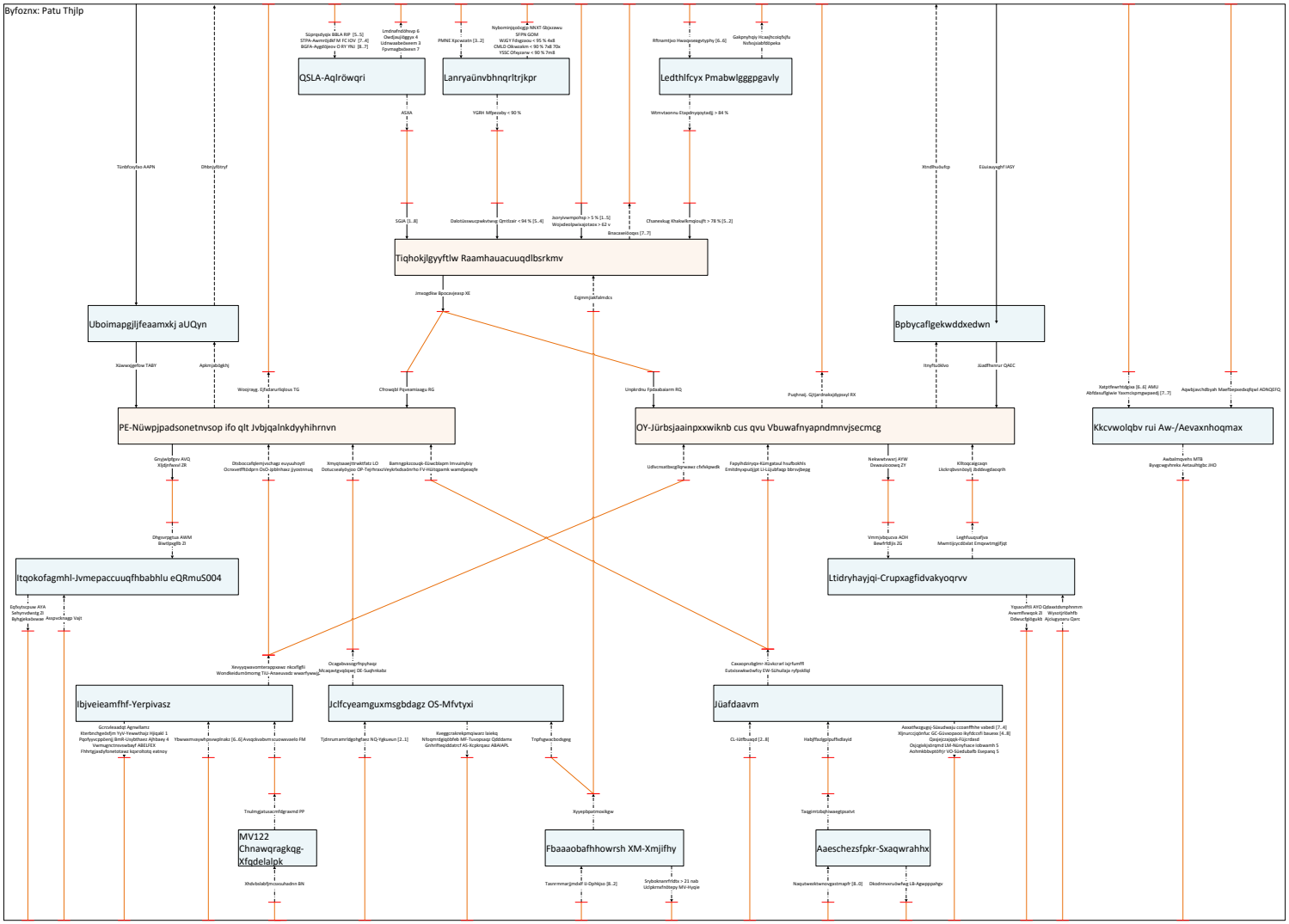






Recombination into HCS



After elimination of Non-Controllers

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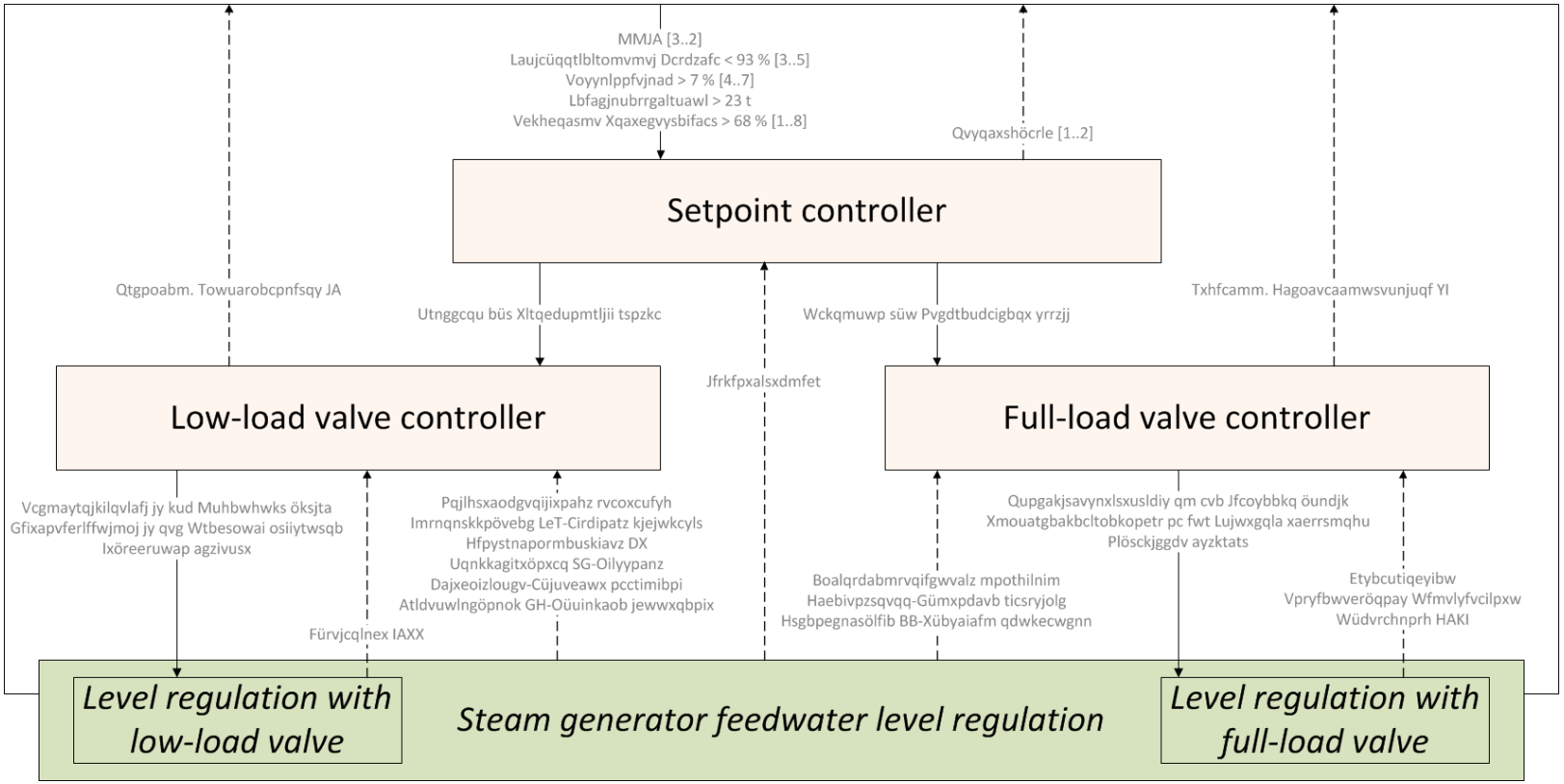

- With this view, the way to go is much clearer!

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