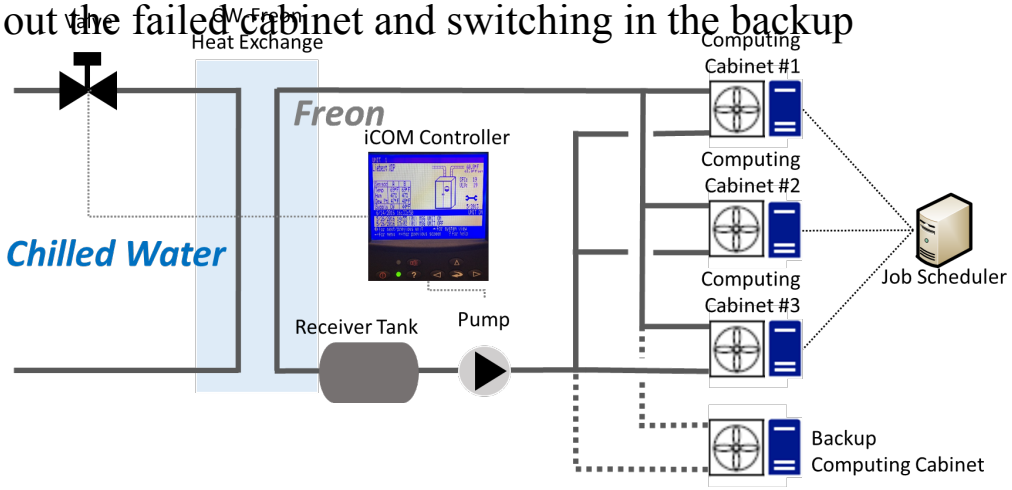
Group Activity: Super computing node with cooling
TMR with a Twist

- Imagine a node of a new supercomputer with its cooling system set up as in the figure below – similar to what we looked at iearlier n class.
- The computing nodes are in three cabinets with a backup node in a separate cabinet, ready to switch in, in the event that any one single cabinet fails. The three 'primary' cabinets run in a triple modular redundant (TMR) mode with an additional backup (TMR + backup).
- The job scheduler's functionality includes:
  - General scheduling
  - The ability to vote of the outputs of the three cabinets
  - Upon detecting a failure, switching out the failed cabinet and switching in the backup cabinet

- In addition to keeping a set of compute cabinet operational, it is critical to keep the cooling system functional. The valve, pump and the controller plays a critical role in the cooling system.



Group Activity: TMR with Backup

1. Identify the components that are in series and those that are in parallel. (Treat the JVE logic as a single box/component.).
2. The system administrator is concerned that the cooling cabinet can fail at any point which results in the failure of the system. She modifies the system by opening the back of the compute cabinets, and takes advantage of the room temperature (controlled by the HVAC system) to cool the compute cabinets. Now, the supercomputer remains operational if either the cooling cabinet or the HVAC system remains operational.
   - Draw the reliability block diagram for the modified system. (The cooling cabinet includes the valve, heat exchange, receiver, pump, and the iCOM controller.)

- Note that based on the TMR, at least two components of TMR_B should be operational for the computing node to be operational.

Group Activity: TMR with Backup

3.a Derive the reliability of the 'TMR + backup' system (R_{TMR_B}). (Assume that the detection accuracy of the scheduler c is 1. i.e., 100% accurate)

3.b Load sharing can cause reliability degradation in parallel systems. Assume that every time a CC fails, the reliability of the remaining CCs halves.

- Is the failure of the CCs independent? Explain your answer qualitatively.
- Given that two CCs have failed, derive the formula for the reliability of the 'TMR + backup' system?