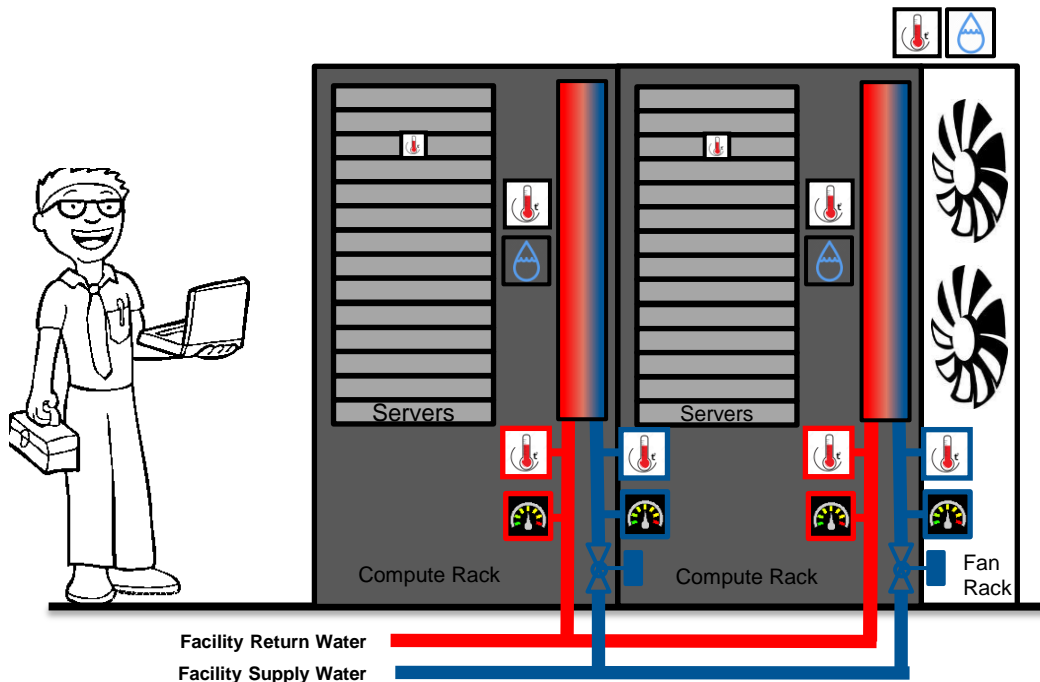


Cray Liquid Cooling Control

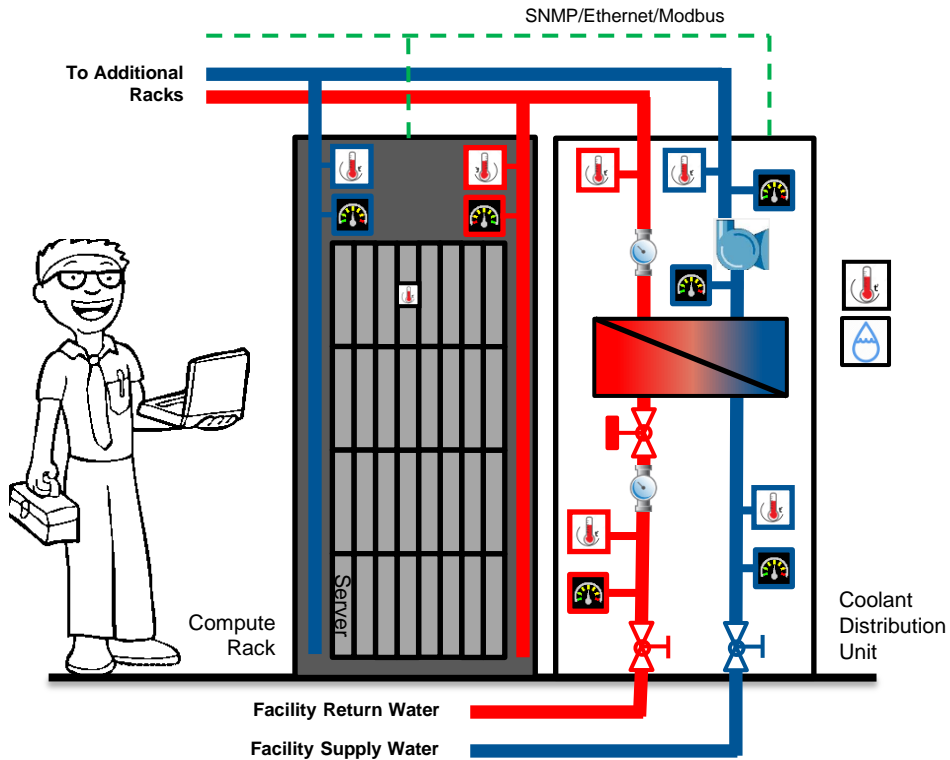
Wade Doll
Principal Infrastructure Architect
Cray Inc.

Cray XC40 Liquid Cooling Control



- **Monitor Before Operation**
 - Pressure at coil inlet is within range
 - Water temperature entering coil is within range
 - Environmental dew point is within range
- **Control During Operation**
 - Adjust coil inlet valve to maintain air temperature within range
 - Adjust fan speed to maintain CPU temperatures within range
- **Non Operational Control**
 - Power off: Coil inlet valve fully closed
- **Expectations of Facility**
 - Supply water temperature within range
 - Pressure differential & flow within range
 - Water chemistry within range

Cray Next-Gen Liquid Cooling Control Concept



- **Monitor Before and During Operation**
 - Pressure differential and flow across heat exchanger (HEX) is within range
 - Water temperature entering the HEX is within range
 - Environmental dew point is within range
 - Secondary fluid chemistry is within range
- **Control During Operation**
 - Adjust HEX valve to maintain:
 - Secondary supply temperature & dew point within range
 - Primary side flowrate & temperature within range
 - Adjust secondary pump speed to maintain:
 - Secondary side flowrate & pressure within range
- **Expectations of Facility**
 - Supply water temperature within range
 - Pressure differential & flow within range
 - Water chemistry within range
 - Optional: Facility communication with CDU

Future Opportunities

- **Tighter integration of facility and CDU cooling controls**
 - Via SNMP/Ethernet/ModBus communication
 - CDU telemetry data & control available: pressures, flows, temperatures, valve position, status, power..etc
 - Commercial CDU vendors: Eaton Williams, Motivair
- **Specific facility integration methods are TBD**
 - Need better understanding of benefits
 - Facility cooling time response is a concern
 - Control complexity and reliability is a concern
 - Can't preclude data centers not willing to "integrate"
 - Historically Cray has intentionally isolated itself from the facility
 - Future systems will open up more opportunities

Questions / Discussion?