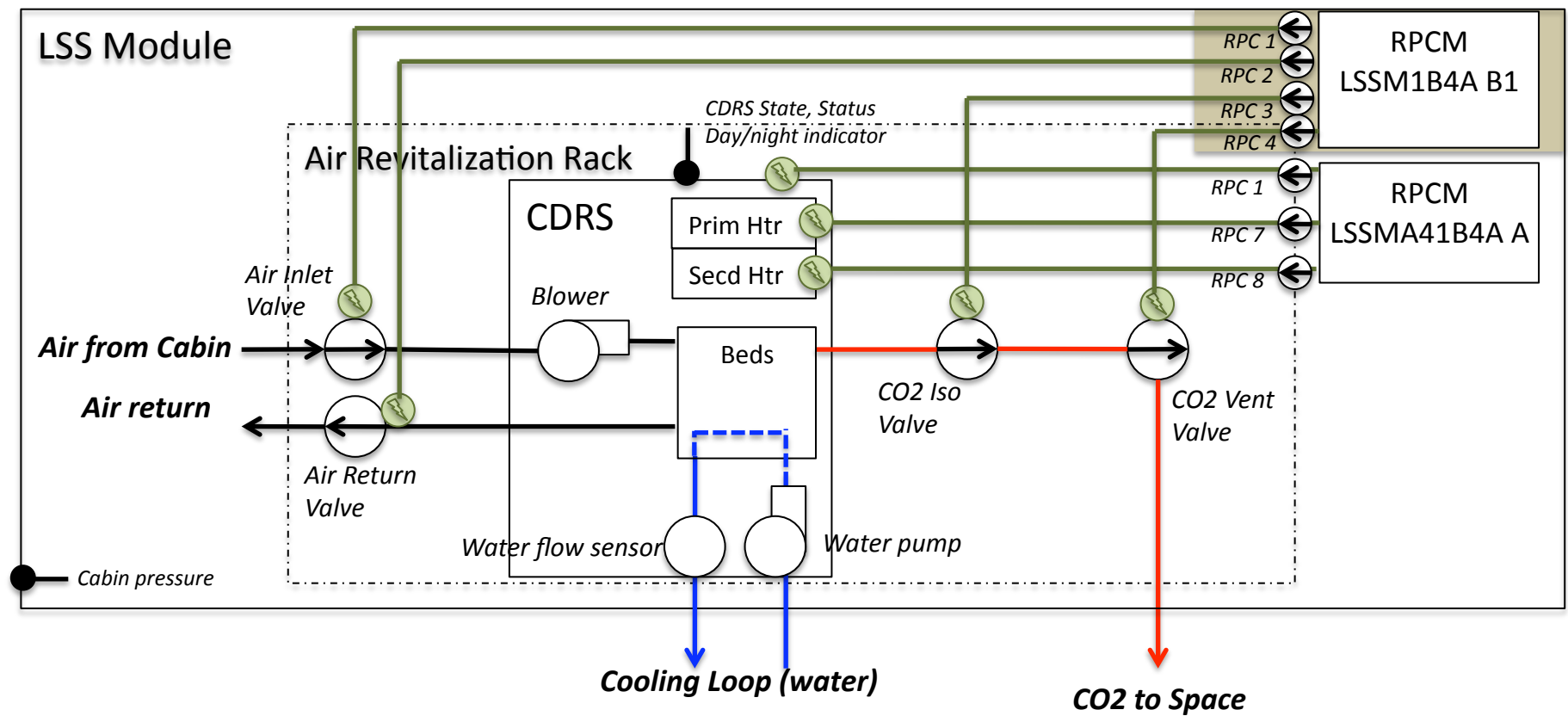


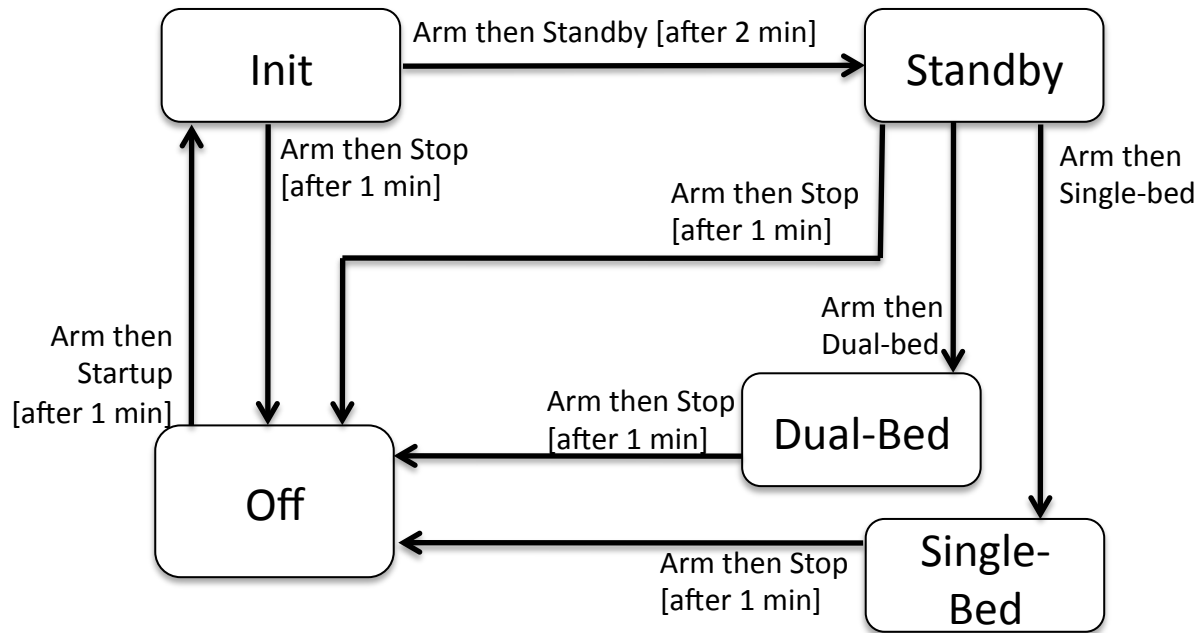
# Model for Spacecraft Sim



# BioSim Components

- Modules
  - Use same cabin layout, crew model, food model, and water model as default; put CDRS in Maintenance module
  - LSS\_Module
    - Suggest you rename Maintenance Module in existing BioSim and put all components in that module
    - SimEnvironment with a volume and initial pressure and gas percentages
  - CDRS
    - PowerConsumer, AirConsumer, AirProducer, CO2Producer, HeatConsumer
    - See CDRS state machine on next page
  - Heaters
    - HeatProducer, PowerConsumer
    - Both primary and secondary heaters produce heat at the same rate
    - Heaters operate at fixed rate of heat production = rate of CDRS heat consumption
    - Heaters only operate in CDRS States = Standby, Dual-bed, Single-bed
  - Water pump
    - WaterConsumer, WaterProducer, PowerConsumer
    - Water consumption rate = water production rate
  - Blower
    - AirConsumer, Air Producer, PowerConsumer
    - Air consumption rate = air production rate
  - Power store
    - PowerProducer (very large store)
    - Connected to RPCMs
  - RPCM
    - PowerProducer, PowerConsumer
    - Power input rate = power output rate

# CDRS State Machine



- Status
  - When State = {Init, Standby, Dual-bed, Single-bed, Off}, Status = State
  - When preparing to transition between states, Status = Armed
  - When transitioning between states, Status = <target-state>-in-progress
    - e.g., transition Init to Standby, State = Init and Status = Standby-in-progress

- Behavior in state
  - Init
    - Air produced and consumed at TBD rate (same rate)
    - These rates are half the Standby rate
    - CDRS Blower state = on; rate = air rate
    - CDRS Pump state = on; rate = on rate
    - No consumption of heat
  - Standby
    - Air produced and consumed at TBD rate (same rate)
    - Heat consumed at 25% of max rate
    - CDRS Blower state = on; rate = air rate
    - CDRS Pump state = on; rate = on rate
  - Dual-Bed
    - Air produced and consumed at TBD rate (same rate)
    - CO2 produced at TBD rate
    - CO2 in cabin air reduced at TBD rate
    - Heat consumed at max rate
    - CDRS Blower state = on; rate = air rate
    - CDRS Pump state = on; rate = on rate
  - Single-Bed
    - Air produced and consumed at TBD rate (same rate)
    - CO2 produced at TBD rate
    - CO2 in cabin air reduced at TBD rate
    - Heat consumed at TBD rate
    - These rates are 50% of Dual Bed rates
    - CDRS Blower state = on; rate = air rate
    - CDRS Pump state = on; rate = on rate
  - Off
    - No production of air or CO2
    - No consumption of air
    - No consumption of heat
    - CDRS Blower state = off; rate = 0
    - CDRS Pump state = off; rate = 0.

# BioSim Actuators

- Air Inlet Valve Position Actuator: Opens or closes Air Inlet Valve. Air Inlet Valve RT Status Sensor must equal “Ena” for this actuator to work.
- Air Return Valve Position Actuator: Opens or closes Air Return Valve. Air Return Valve RT Status Sensor must equal “Ena” for this actuator to work.
- Air Inlet Valve RT Status Actuator: Enables (ena) or inhibits (inh) Air Inlet Valve position from being changed
- Air Return Valve RT Status Actuator: Enables (ena) or inhibits (inh) Air Return Valve position from being changed
- CO2 Isolation Valve Position Actuator: Opens or closes CO2 Isolation Valve. CO2 Isolation Valve RT Status Sensor must equal “Ena” for this actuator to work.
- CO2 Isolation Valve RT Status Actuator: Enables (ena) or inhibits (inh) CO2 Isolation Valve position from being changed
- CO2 Vent Valve Position Actuator: Opens or closes CO2 Vent Valve. CVV RT Status Sensor must equal “Ena” for this actuator to work.
- CVV RT Status Actuator: Enables (ena) or inhibits (inh) CO2 Vent Valve position from being changed
- CDRS Water Pump LSSMB1 RT Status Actuator: Enables (ena) or inhibits (inh) CDRS Water Pump LSSMB1 state from being changed by CDRS Actuator commands.
- CDRS Blower LSSMB1 RT Status Actuator: Enables (ena) or inhibits (inh) CDRS Blower LSSMB1 state from being changed by CDRS Actuator commands.
- Day/night Indicator Actuator: sets state of the day/night indicator to {day, night, day-night}
- CDRS Actuator: changes the state of the CDRS; commands include Startup, Standby, Dual-bed, Single-bed, Stop.

*Issue – not sure how you model CDRS “arm and fire” commands in BioSim*

# BioSim Actuators

- For RPCM LSSMA41B4A A, x=1-8
  - RPC[X] Position Actuator: sets state of RPC switch to {open, closed}. RPC[x] Open Command Inhibit Sensor must equal “Ena” to set “open” and RPC[x] Close Command Inhibit Sensor must equal “Ena” to set “close” .
  - RPC[x] Open Command Inhibit Actuator: Enables (ena) or inhibits (inh) RPC switch being opened
  - RPC[x] Close Command Inhibit Actuator: Enables (ena) or inhibits (inh) RPC switch being closed
  - Configuration
    - RPC 1 must be closed for CDRS to be powered
    - RPC 2-6 are not used
    - RPC 7 must be closed for the primary heater to be powered
    - RPC 8 must be closed for the secondary heater to be powered
- For RPCM LSSM1B4A B1, , x=1-4
  - RPC[X] Position Actuator: sets state of RPC switch to {open, closed}. RPC[x] Open Command Inhibit Sensor must equal “Ena” to set “open” and RPC[x] Close Command Inhibit Sensor must equal “Ena” to set “close” .
  - RPC[x] Open Command Inhibit Actuator: Enables (ena) or inhibits (inh) RPC switch being opened
  - RPC[x] Close Command Inhibit Actuator: Enables (ena) or inhibits (inh) RPC switch being closed
  - Configuration
    - RPC 1 must be closed for CO2 Vent Valve to be powered
    - RPC 2 must be closed for CO2 Isolation Valve to be powered
    - RPC 3 must be closed for Air Return Valve to be powered
    - RPC 4 must be closed for Air Inlet Valve to be powered

# BioSim Sensors

- Air Inlet Valve Position Sensor: reading of Air Inlet Valve Position Actuator state; {open, closed}
- Air Return Valve Position Sensor: reading of Air Return Valve Position Actuator state; {open, closed}
- Air Inlet Valve RT Status Sensor: reading of Air Inlet Valve RT Status Actuator state; {ena, inh}
- Air Return Valve RT Status Sensor: reading of Air Return Valve RT Status Actuator state; {ena, inh}
- CO2 Isolation Valve Position Sensor: reading of CO2 Isolation Valve Position Actuator state; {open, closed}
- CO2 Vent Valve Position Sensor: reading of CO2 Vent Valve Position Actuator state; {open, closed}
- CVV RT Status Sensor: reading of CVV RT Status Actuator state; {ena, inh}
- CO2 Isolation Valve RT Status Sensor: reading of CO2 Isolation Valve RT Status Actuator state; {ena, inh}
- CDRS Water Pump LSSMB1 RT Status Sensor: reading of CDRS Water Pump LSSMB1 RT Status Actuator state; {ena, inh}
- CDRS Water Pump LSSMB1 State Sensor: reading of CDRS Water Pump LSSMB1 state; {on, off}
- Water flow Sensor: reading of the water flow rate out of CDRS; 0 if CDRS Water Pump LSSMB1 state = off and TBD if CDRS Water Pump LSSMB1 state = on
- CDRS Blower LSSMB1 RT Status Sensor: reading of CDRS Blower LSSMB1 RT Status Actuator state; {ena, inh}
- CDRS Blower LSSMB1 State Sensor: reading of CDRS Blower LSSMB1 state; {on, off}
- Day/night Indicator Sensor: reading of day/night indicator actuator; {day, night, day-night}
- CDRS State sensor; reading of CDRS state; {init, standby, dual-bed, single-bed, off}
- CDRS Status sensor: reading of the CDRS status; {init, standby, dual-bed, single-bed, off, armed, startup-in-progress, standby-in-progress, stop-in-progress}
- Cabin pressure: pressure of the Maintenance Module in PSI

# BioSim Sensors

- For RPCM LSSMA41B4A A, x=1-8
  - RPC[x] Position sensor: reading of RPC switch position; {open, closed}
  - RPC[x] Open Command Inhibit Sensor: reading of RPC switch open command inhibit actuator state; {ena, inh}
  - RPC[x] Close Command inhibit Sensor: reading of RPC switch close command inhibit actuator state; {ena, inh}
- For RPCM LSSM1B4A B1, , x=1-4
  - RPC[x] Position sensor: reading of RPC switch position; {open, closed}
  - RPC[x] Open Command Inhibit Sensor: reading of RPC switch open command inhibit actuator state; {ena, inh}
  - RPC[x] Close Command inhibit Sensor: reading of RPC switch close command inhibit actuator state; {ena, inh}