Fogget-about-it grow management system

Preparing the groundwork for the next agricultural revolution.

Problem definition:

- Over the last few years, there has been research into the cultivation technique known as “fogponics”, a high-intensity form of agriculture which benefits more from automation than any other.

- This project provides a management and control system for a fleet of fogponics units that can be extended to other use-cases.

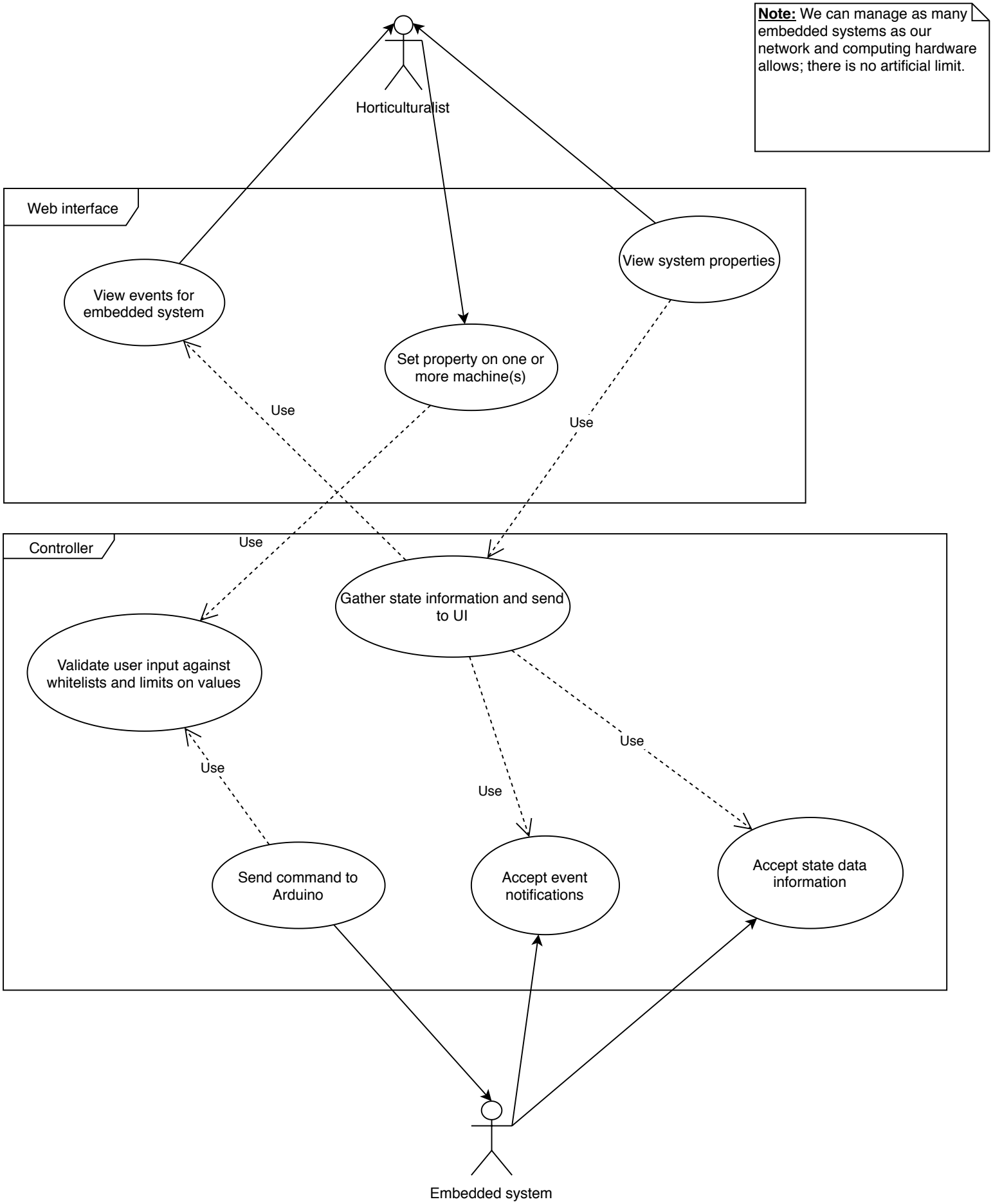
- This is in continuation of a project I have been running off and for half a year. The physical prototype is (mostly) built but lacks a control panel.

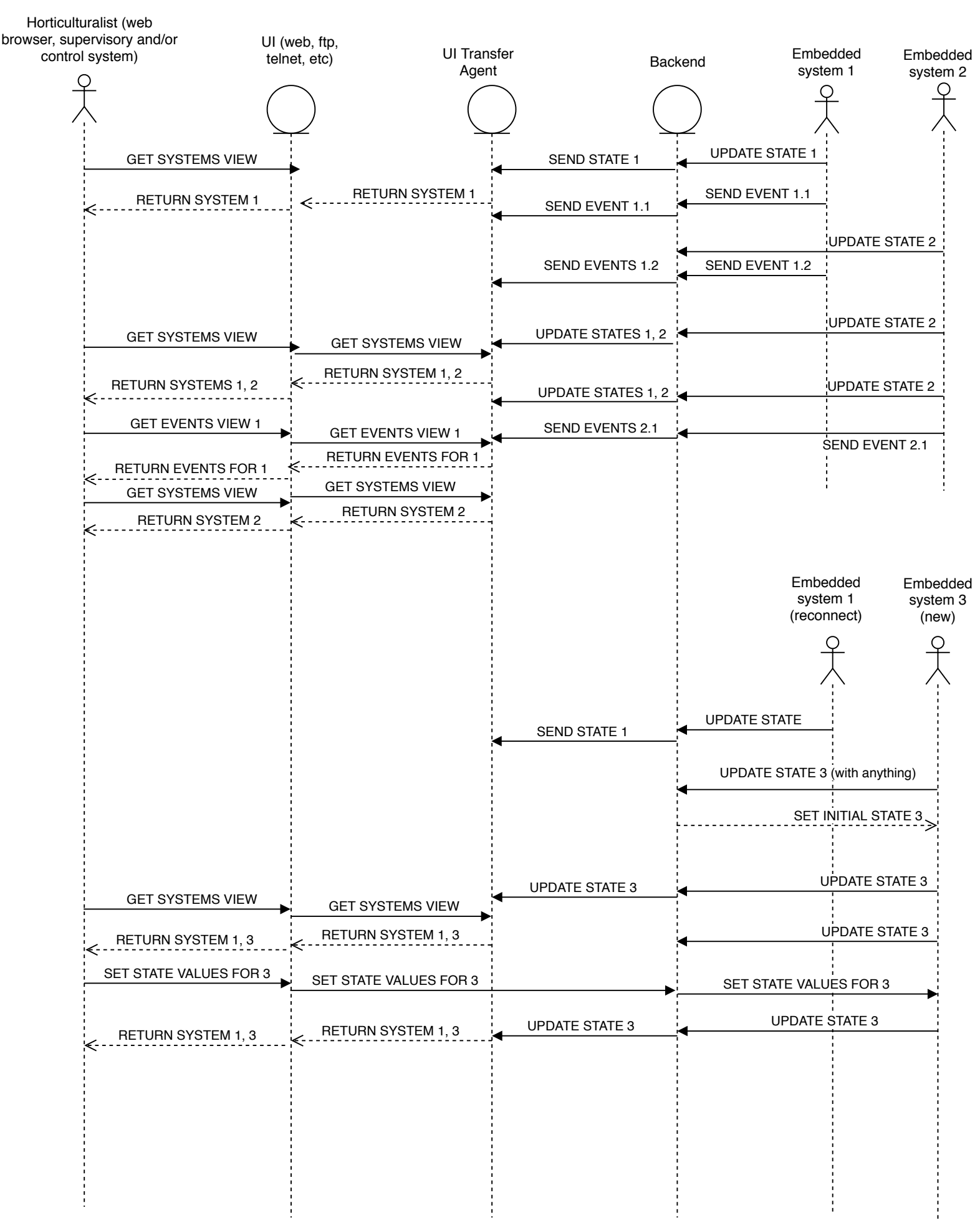
We got ourselves a control panel.

:)

Functional requirements:

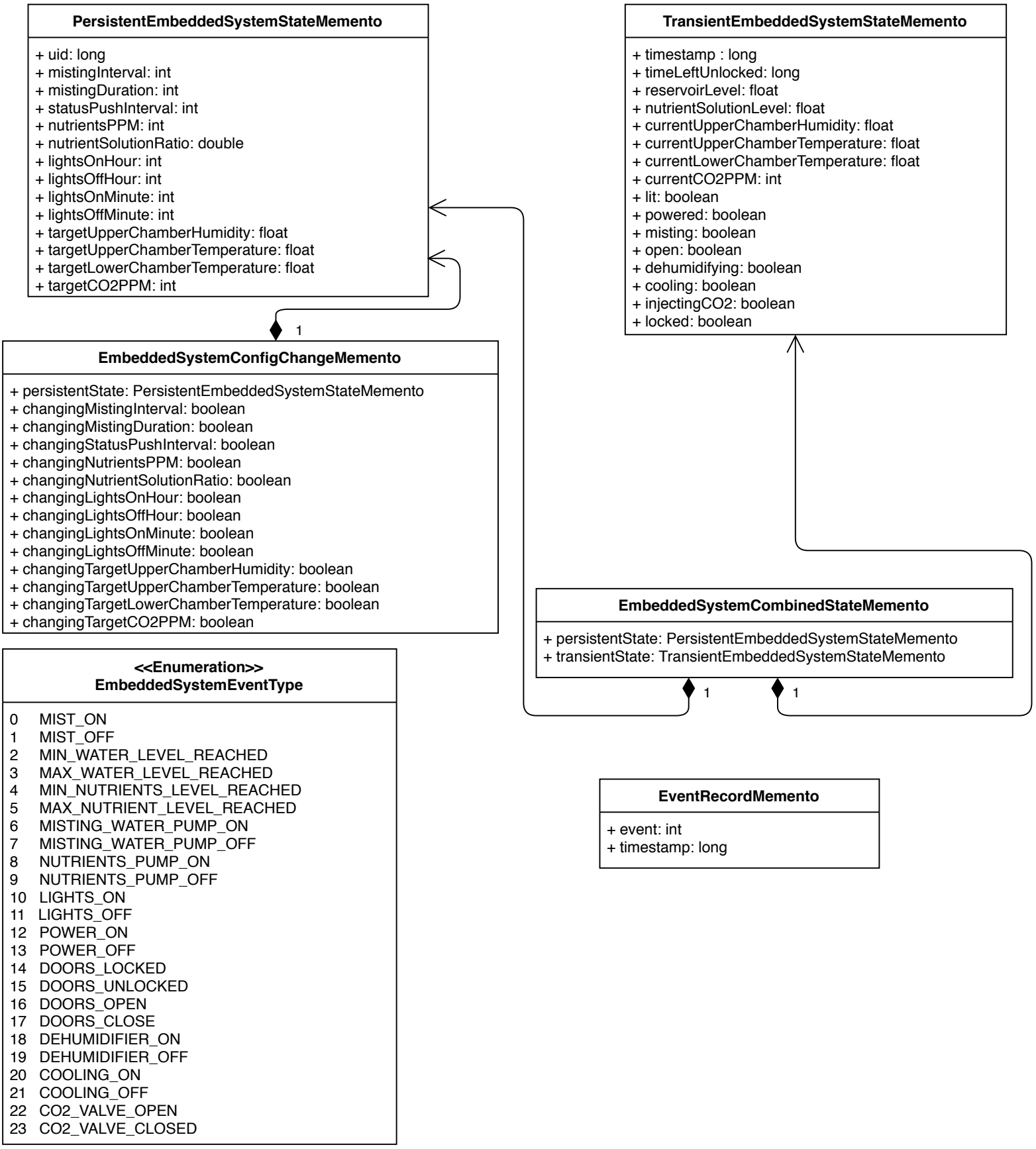
- We're building a basic control system for an IoT use-case.
- The control system gathers and updates the current state information of the embedded systems growing plants.
- It must also be able to maintain a list of recent events for perusal by the end-user.
- New systems are to be automatically given sane defaults and added to the system pool. The only user responsibility must be sourcing the embedded system with a unique 64-bit integer ID.
- The end-user must be able to change settings.
- These settings must be validated in order to correct against nonsense inputs.
- "Computer, set the rooting chamber to -273 degrees C…"
- The embedded system running the grow environments should do their its own validation as good engineering, but layers of safety protect against screwups downstream.
- In effect, it acts as an application firewall.
- That's basically it as far as *functional* requirements go.


Note: We can manage as many embedded systems as our network and computing hardware allows; there is no artificial limit.
Horticulturalist
Web interface
View events for embedded system
Set property on one or more machine(s)
View system properties
Use
Use
Use
Controller
Gather state information and send to UI
Validate user input against whitelists and limits on values
Use
Use
Use
Send command to Arduino
Accept event notifications
Accept state data information
Embedded system


Horticulturalist (web browser, supervisory and/or control system)
UI (web, ftp, telnet, etc)
UI Transfer Agent
Backend
Embedded system 1
Embedded system 2
GET SYSTEMS VIEW
SEND STATE 1
UPDATE STATE 1
RETURN SYSTEM 1
RETURN SYSTEM 1
SEND EVENT 1.1
SEND EVENT 1.1
UPDATE STATE 2
SEND EVENTS 1.2
SEND EVENT 1.2
UPDATE STATE 2
GET SYSTEMS VIEW
GET SYSTEMS VIEW
UPDATE STATES 1, 2
RETURN SYSTEM 1, 2
RETURN SYSTEMS 1, 2
UPDATE STATES 1, 2
UPDATE STATE 2
GET EVENTS VIEW 1
GET EVENTS VIEW 1
SEND EVENTS 2.1
SEND EVENT 2.1
RETURN EVENTS FOR 1
RETURN EVENTS FOR 1
GET SYSTEMS VIEW
GET SYSTEMS VIEW
RETURN SYSTEM 2
RETURN SYSTEM 2
Embedded system 1 (reconnect)
Embedded system 3 (new)
UPDATE STATE
SEND STATE 1
UPDATE STATE 3 (with anything)
SET INITIAL STATE 3
UPDATE STATE 3
UPDATE STATE 3
GET SYSTEMS VIEW
GET SYSTEMS VIEW
RETURN SYSTEM 1, 3
RETURN SYSTEM 1, 3
UPDATE STATE 3
SET STATE VALUES FOR 3
SET STATE VALUES FOR 3
SET STATE VALUES FOR 3
UPDATE STATE 3
RETURN SYSTEM 1, 3
RETURN SYSTEM 1, 3
UPDATE STATE 3

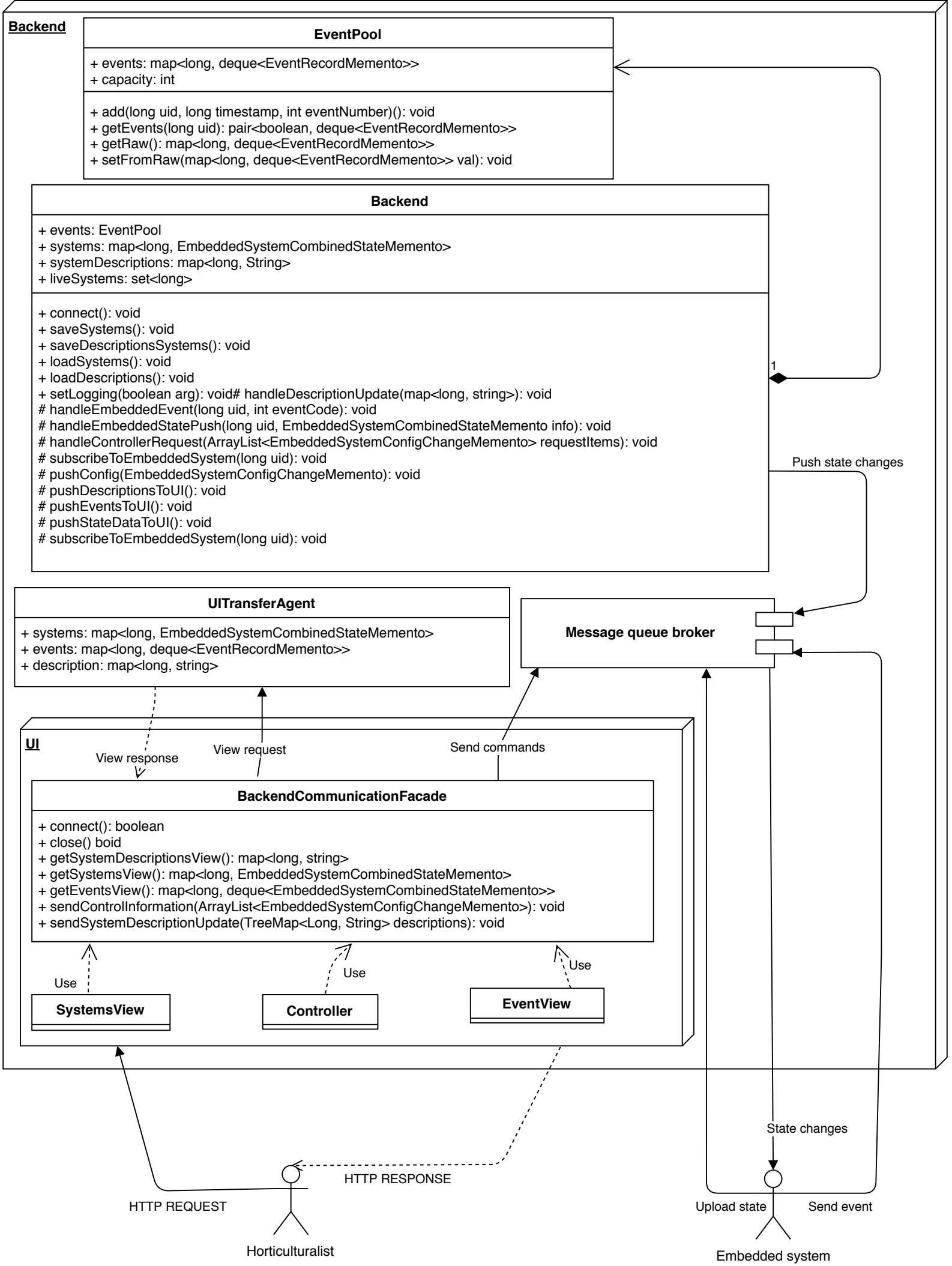
Design patterns:

- The main design pattern in use here is the memento pattern.
- Memento allows you to use state to represent logical items for recall when convenient.
- It is also really good for indicating your next intentions.
- Literally stands for “memory aid.”
- Also used in the web UI are builder patterns, but their use is perfunctory...
- Reusing code to write HTML tags to a page more neatly.
- Aside: I really wanted to keep it unix by using a simple command-line app, but we went that way instead and deep down I’m kinda glad I stepped out of my bubble.
- We also use a static factory method or two.
- However, they’re nothing too interesting as far as our use-case is concerned. They’re also completely perfunctory and don’t really warrant too much discussion.
- They’d be far more central for our purposes and worth talking about if we were writing a serializer, for example...


PersistentEmbeddedSystemStateMemento
+ uid: long
+ mistingInterval: int
+ mistingDuration: int
+ statusPushInterval: int
+ nutrientsPPM: int
+ nutrientSolutionRatio: double
+ lightsOnHour: int
+ lightsOffHour: int
+ lightsOnMinute: int
+ lightsOffMinute: int
+ targetUpperChamberHumidity: float
+ targetUpperChamberTemperature: float
+ targetLowerChamberTemperature: float
+ targetCO2PPM: int
TransientEmbeddedSystemStateMemento
+ timestamp : long
+ timeLeftUnlocked: long
+ reservoirLevel: float
+ nutrientSolutionLevel: float
+ currentUpperChamberHumidity: float
+ currentUpperChamberTemperature: float
+ currentLowerChamberTemperature: float
+ currentCO2PPM: int
+ lit: boolean
+ powered: boolean
+ misting: boolean
+ open: boolean
+ dehumidifying: boolean
+ cooling: boolean
+ injectingCO2: boolean
+ locked: boolean
1
EmbeddedSystemConfigChangeMemento
+ persistentState: PersistentEmbeddedSystemStateMemento
+ changingMistingInterval: boolean
+ changingMistingDuration: boolean
+ changingStatusPushInterval: boolean
+ changingNutrientsPPM: boolean
+ changingNutrientSolutionRatio: boolean
+ changingLightsOnHour: boolean
+ changingLightsOffHour: boolean
+ changingLightsOnMinute: boolean
+ changingLightsOffMinute: boolean
+ changingTargetUpperChamberHumidity: boolean
+ changingTargetUpperChamberTemperature: boolean
+ changingTargetLowerChamberTemperature: boolean
+ changingTargetCO2PPM: boolean
EmbeddedSystemCombinedStateMemento
+ persistentState: PersistentEmbeddedSystemStateMemento
+ transientState: TransientEmbeddedSystemStateMemento
1
1
<<Enumeration>>
EmbeddedSystemEventType
0 MIST_ON
1 MIST_OFF
2 MIN_WATER_LEVEL_REACHED
3 MAX_WATER_LEVEL_REACHED
4 MIN_NUTRIENTS_LEVEL_REACHED
5 MAX_NUTRIENT_LEVEL_REACHED
6 MISTING_WATER_PUMP_ON
7 MISTING_WATER_PUMP_OFF
8 NUTRIENTS_PUMP_ON
9 NUTRIENTS_PUMP_OFF
10 LIGHTS_ON
11 LIGHTS_OFF
12 POWER_ON
13 POWER_OFF
14 DOORS_LOCKED
15 DOORS_UNLOCKED
16 DOORS_OPEN
17 DOORS_CLOSE
18 DEHUMIDIFIER_ON
19 DEHUMIDIFIER_OFF
20 COOLING_ON
21 COOLING_OFF
22 CO2_VALVE_OPEN
23 CO2_VALVE_CLOSED
EventRecordMemento
+ event: int
+ timestamp: long

Model-Controller-View:

- Views are sent out the backend and into a separate utility that decouples data being sent out from the rest of the backend program; views talk to that program and don’t even talk about our backend.
- Commands and state changes are sent via MQTT. These represent the controls and the in-flight representation of the model, respectively.
- The web UI uses a custom Servlet as a controller that kicks up the MQTT client the very first time it runs.
- The views are gathered and formatted by custom tag classes invoked by an otherwise logic-free JSP page.
- This represents proper modern practices.


Backend
EventPool
+ events: map<long, deque<EventRecordMemento>>
+ capacity: int
+ add(long uid, long timestamp, int eventNumber)(): void
+ getEvents(long uid): pair<boolean, deque<EventRecordMemento>>
+ getRaw(): map<long, deque<EventRecordMemento>>
+ setFromRaw(map<long, deque<EventRecordMemento>> val): void
Backend
+ events: EventPool
+ systems: map<long, EmbeddedSystemCombinedStateMemento>
+ systemDescriptions: map<long, String>
+ liveSystems: set<long>
+ connect(): void
+ saveSystems(): void
+ saveDescriptionsSystems(): void
+ loadSystems(): void
+ loadDescriptions(): void
+ setLogging(boolean arg): void# handleDescriptionUpdate(map<long, string>): void
# handleEmbeddedEvent(long uid, int eventCode): void
# handleEmbeddedStatePush(long uid, EmbeddedSystemCombinedStateMemento info): void
# handleControllerRequest(ArrayList<EmbeddedSystemConfigChangeMemento> requestItems): void
# subscribeToEmbeddedSystem(long uid): void
# pushConfig(EmbeddedSystemConfigChangeMemento): void
# pushDescriptionsToUI(): void
# pushEventsToUI(): void
# pushStateDataToUI(): void
# subscribeToEmbeddedSystem(long uid): void
1
Push state changes
UITransferAgent
+ systems: map<long, EmbeddedSystemCombinedStateMemento>
+ events: map<long, deque<EventRecordMemento>>
+ description: map<long, string>
Message queue broker
UI
View response
View request
Send commands
BackendCommunicationFacade
+ connect(): boolean
+ close() boid
+ getSystemDescriptionsView(): map<long, string>
+ getSystemsView(): map<long, EmbeddedSystemCombinedStateMemento>
+ getEventsView(): map<long, deque<EmbeddedSystemCombinedStateMemento>>
+ sendControlInformation(ArrayList<EmbeddedSystemConfigChangeMemento>): void
+ sendSystemDescriptionUpdate(TreeMap<Long, String> descriptions): void
Use
Use
Use
SystemsView
Controller
EventView
State changes
HTTP RESPONSE
HTTP REQUEST
Upload state
Send event
Horticulturalist
Embedded system