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CS 2310: Exercise 3
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PART A) Convert the active index you constructed in Exercise #2 into a Petri net (or an E-net).

Petri Net

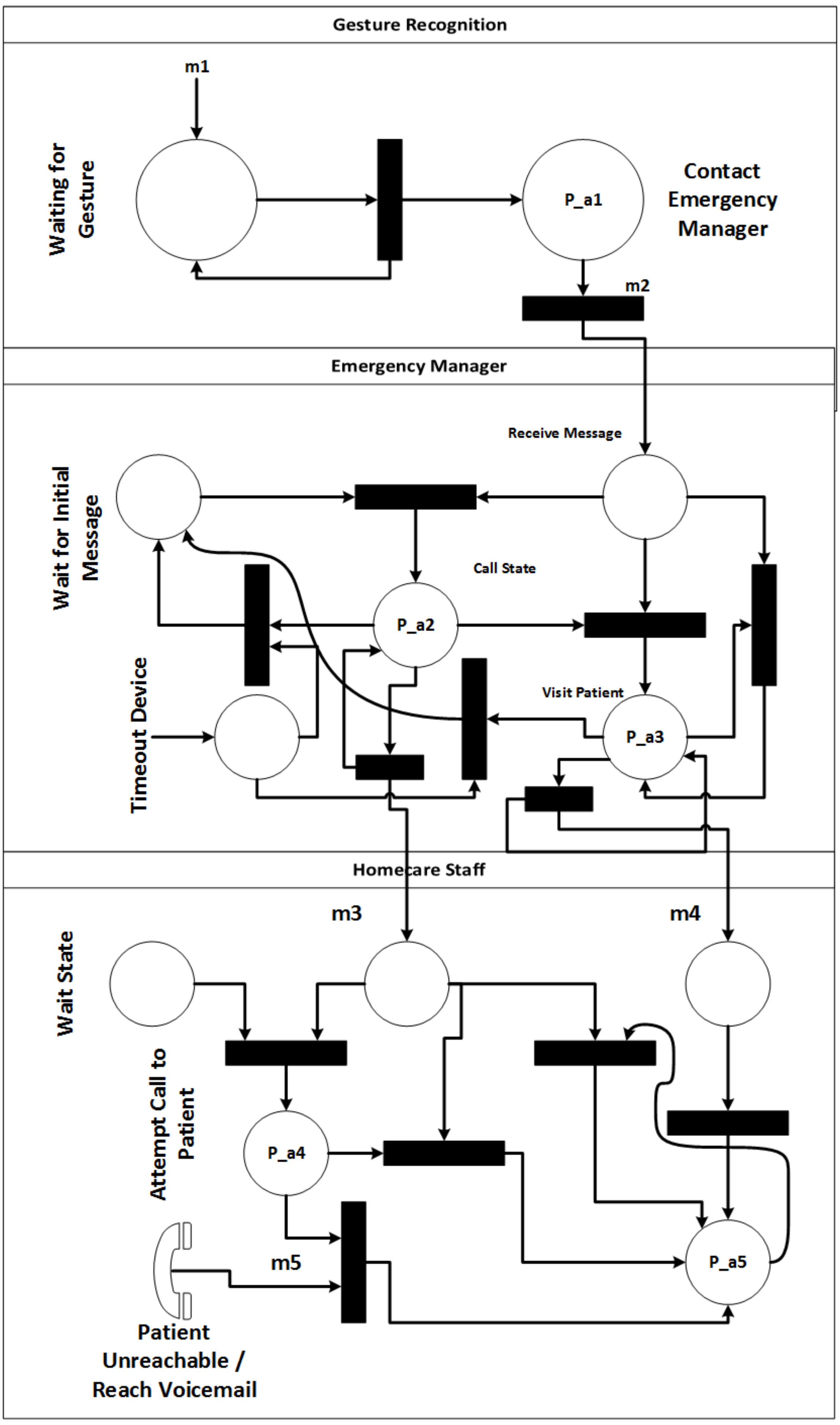
Note, the numberings between messages here and actions are consistent with my former diagram. I am simply including these labels for consistency between the two drawings.

NOTE: AS IN THE PREVIOUS ASSIGNMENT, I ASSUME THAT THE EMERGENCY MANAGER HAS SOME TIMEOUT MECHANISM THERE THAT WILL ENABLE IT TO RETURN TO WAIT STATE AFTER SOME TIME PERIOD ELAPSES. HOWEVER, IN THE CASE OF THE HEALTHCARE STAFF, THERE IS NO TIMEOUT. WE ASSUME THAT THE HEALTHCARE WORKER WILL MANUALLY RESET THE SYSTEM AFTER THEY MAKE SURE THAT THE PATIENT IS HEALTHY.

The actions listed here correspond exactly to the actions from my HW 2 assignment. So, a state labelled P_a3, for instance, is responsible for managing action 3. Also, I tried to illustrate where the messages from exercise 2 fit into this framework.

The basic idea for the gesture recognition part is to always be ready to receive a gesture, then to dispatch that gesture to the emergency manager via m2. The emergency manager is more complicated, as it needs to maintain whether to send the call patient or visit patient message. The first time it receives a message, it will consume the wait token and move to the call state. If enough time elapses and no other message is received, a timeout device fires and places a token into the timeout device and returns the token to the waiting state. However, if in the meantime, another message comes in, the system moves to the visit patient state. The system then will send visit patient messages. Again, a timeout mechanism is available. After so much time, the emergency manager can timeout and return from the visit patient state to the waiting state. Note that even though the token is not in the waiting state, the system can still handle input messages based on the circuitry provided. In this instance, the wait token is a sort of Boolean flag.

The homecare staff can receive two types of messages, either visit patient messages or call patient messages. The first time a call patient message comes in, someone tries to call the patient. If another call patient message comes in, we immediately try to visit patient by ambulance. However, if we are trying to call the patient and can't reach the patient, we move from the call state to the visit state as well. Any messages received to visit the patient directly result in an immediate visit. Note no timeout mechanism exists here because we assume that the healthcare staff themselves will manually reset the system for this patient after their visit or phone call after they have verified the patient's health condition and status.



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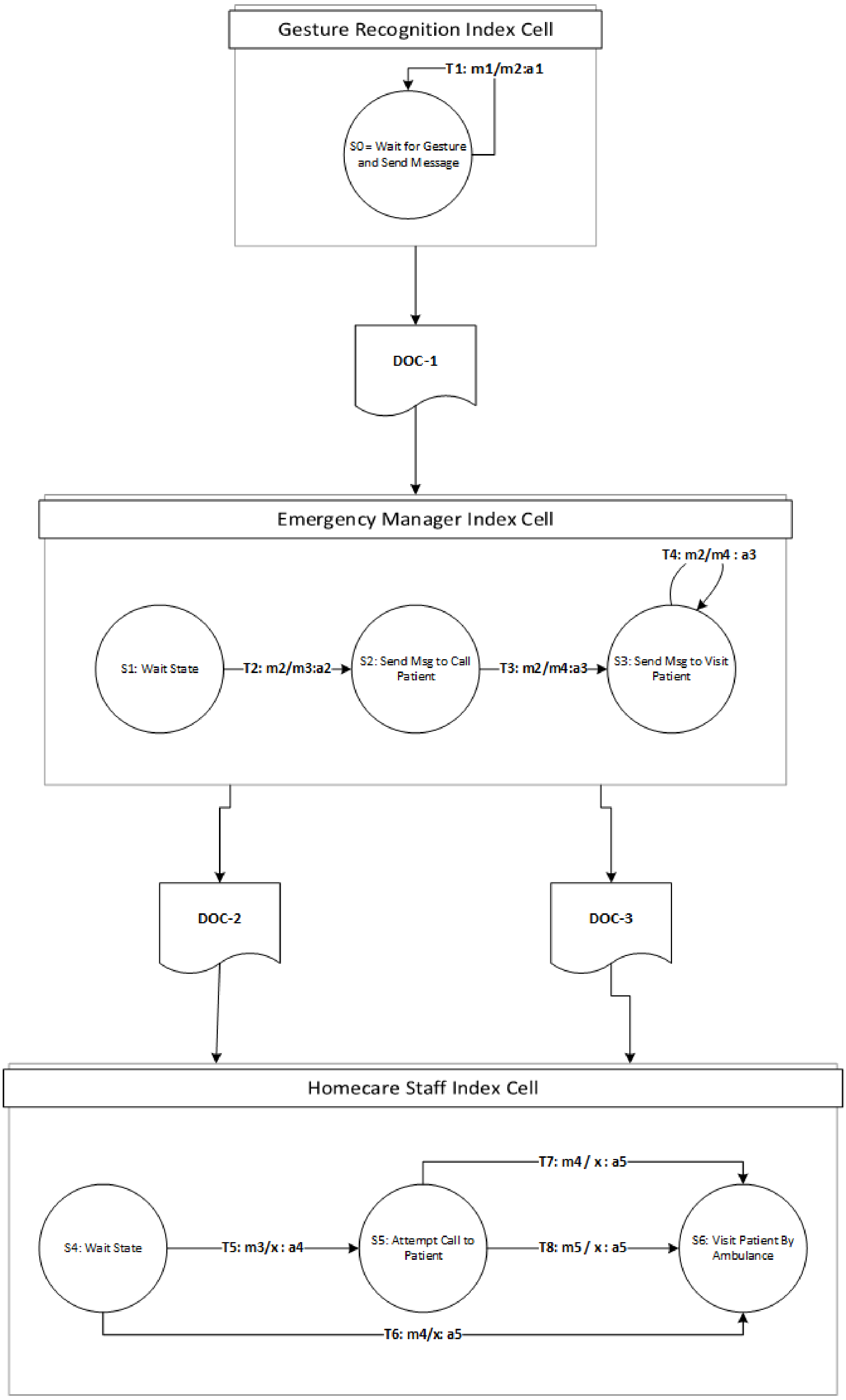
PART B) Take the diagram you drew in part (c) of Exercise #2. Redraw it here (because you may want to make some changes), and now use the marked Petri net to illustrate the scenario. You can draw a sequence of marked Petri net to show how the system works.

The following is the drawing I drew in PART (c) of Exercise #2. The following pages will trace through the above Petri net (converted to a marked Petri net) illustrating exactly how the system works.


Gesture Recognition Index Cell
T1: m1/m2:a1
S0 = Wait for Gesture and Send Message
DOC-1
Emergency Manager Index Cell
T4: m2/m4 : a3
S1: Wait State
T2: m2/m3:a2
S2: Send Msg to Call Patient
T3: m2/m4:a3
S3: Send Msg to Visit Patient
DOC-2
DOC-3
Homecare Staff Index Cell
T7: m4 / x : a5
S4: Wait State
T5: m3/x : a4
S5: Attempt Call to Patient
T8: m5 / x : a5
S6: Visit Patient By Ambulance
T6: m4/x: a5

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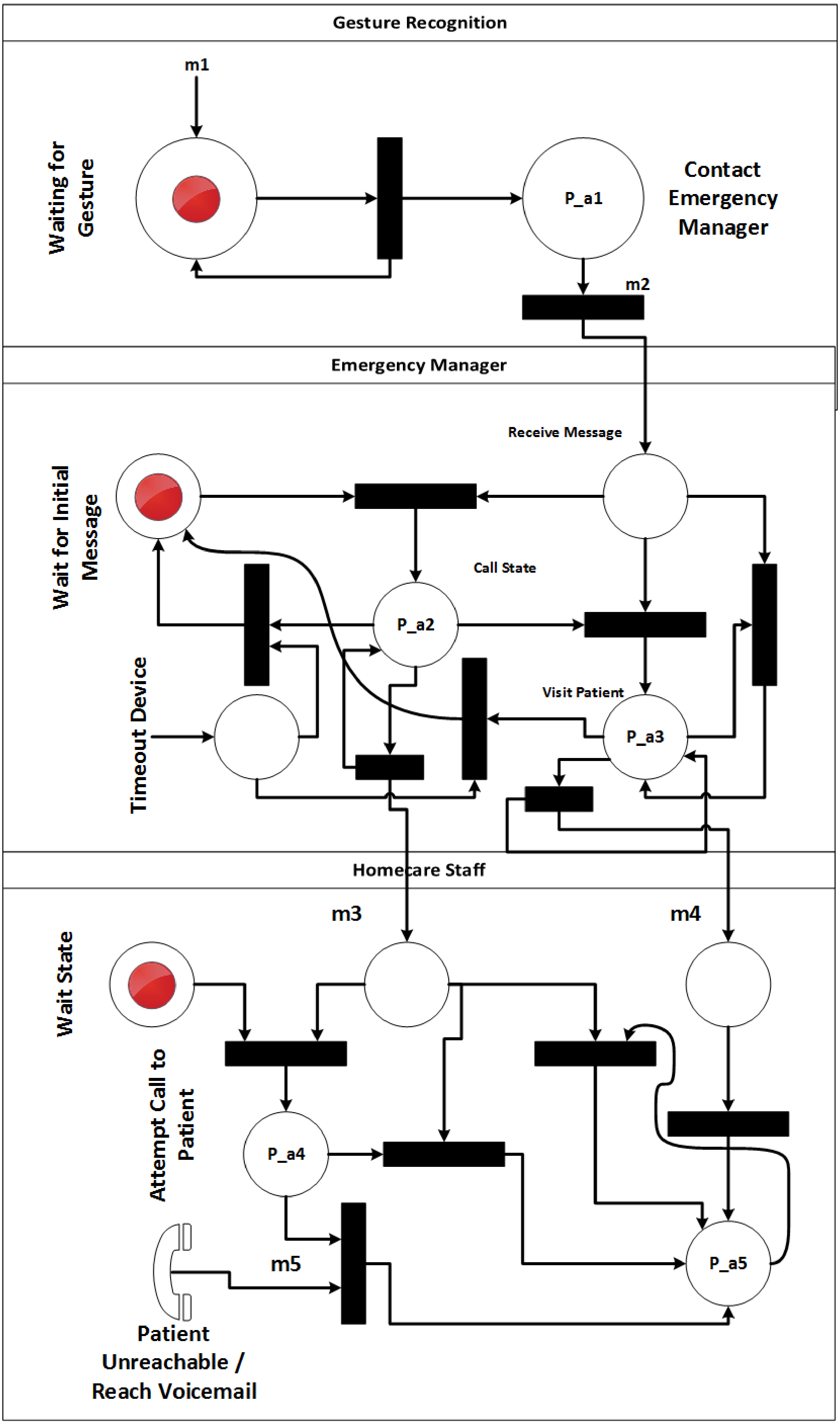
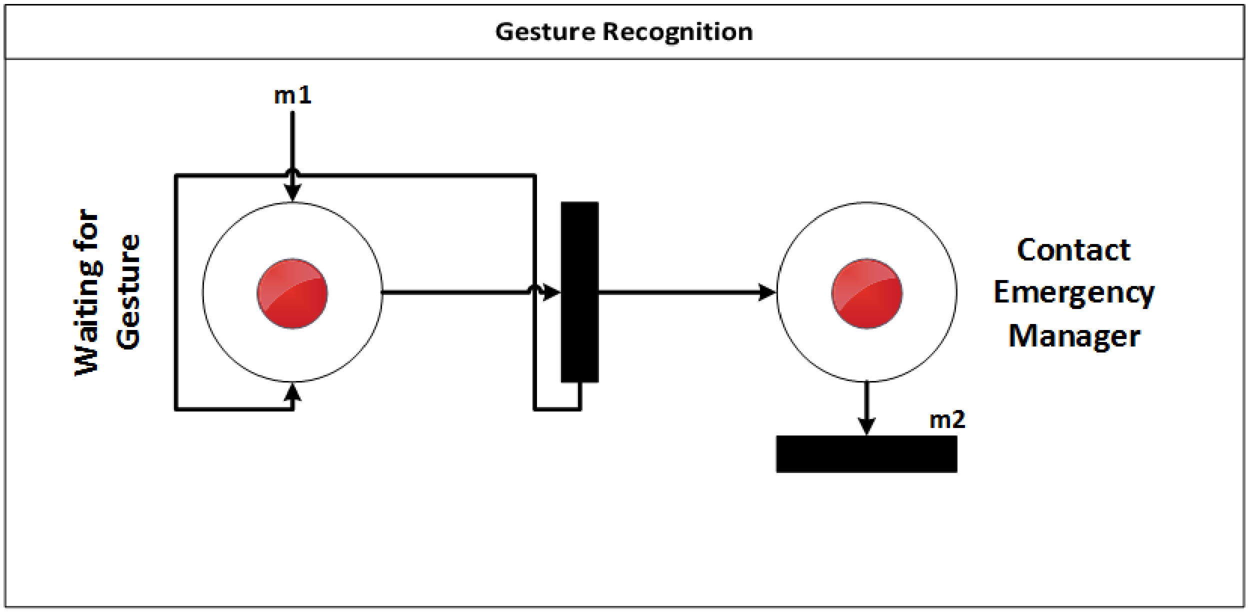
Initialization State: Whole System Armed and Waiting (marked Petri net)
Token is illustrated with the red dot. Note that all three sub-systems start with their own token. Also note that the timeout device may generate a token periodically. Also the phone may generate its own token as well when the patient is called but cannot be reached.

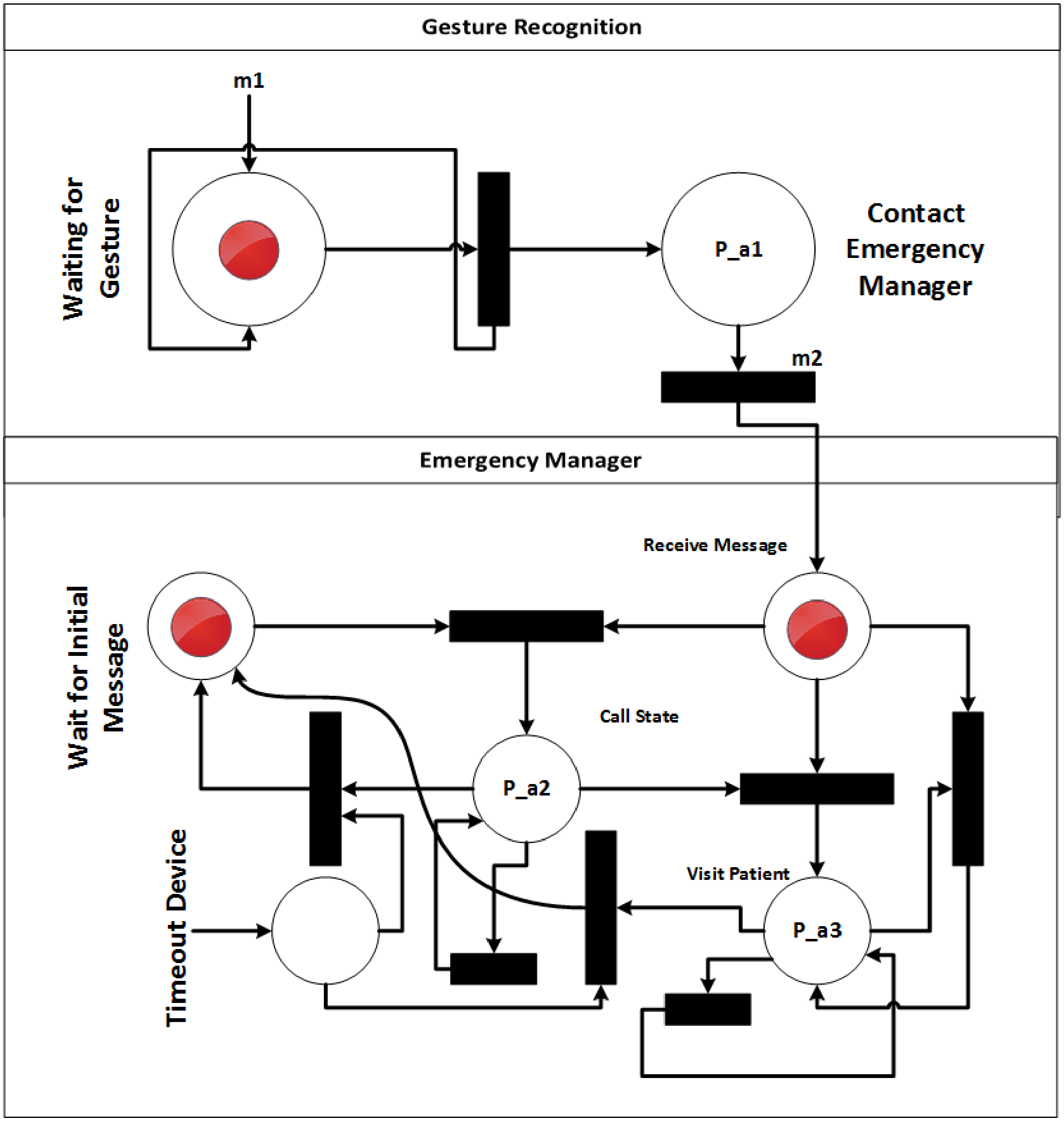


Note that P_a5 is the dispatch ambulance state (I did not put a text label on it).

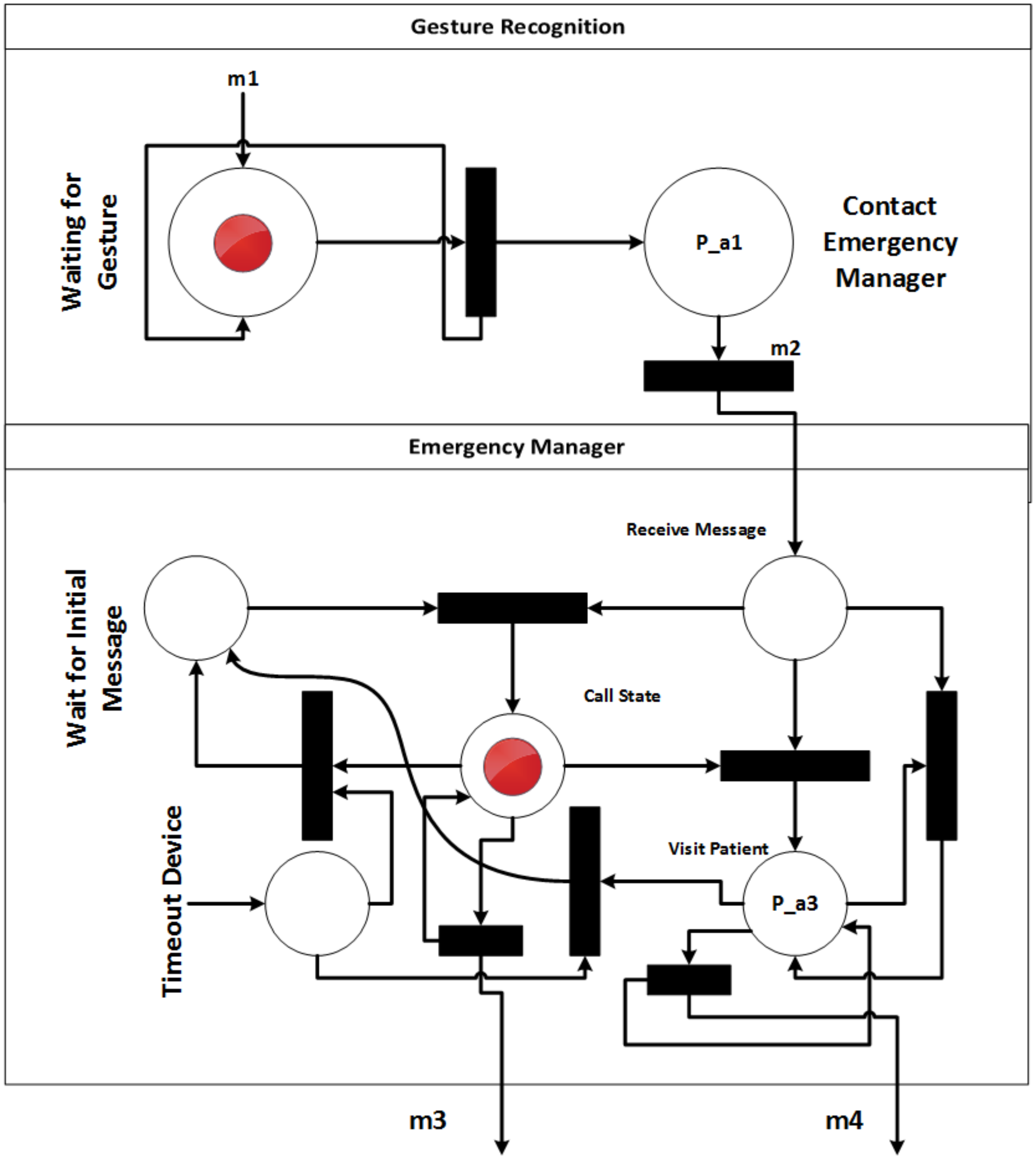
The system detects the patient's gesture. Note that the token becomes two tokens – one continues on to flow to the emergency manager, whereas the other token returns immediately to the waiting for gesture state. This ensures that if the patient is to make another gesture immediately, it will not be lost and minimizes the amount of time the "waiting for gesture" state is not available. Note that only the gesture recognition stage is shown here.



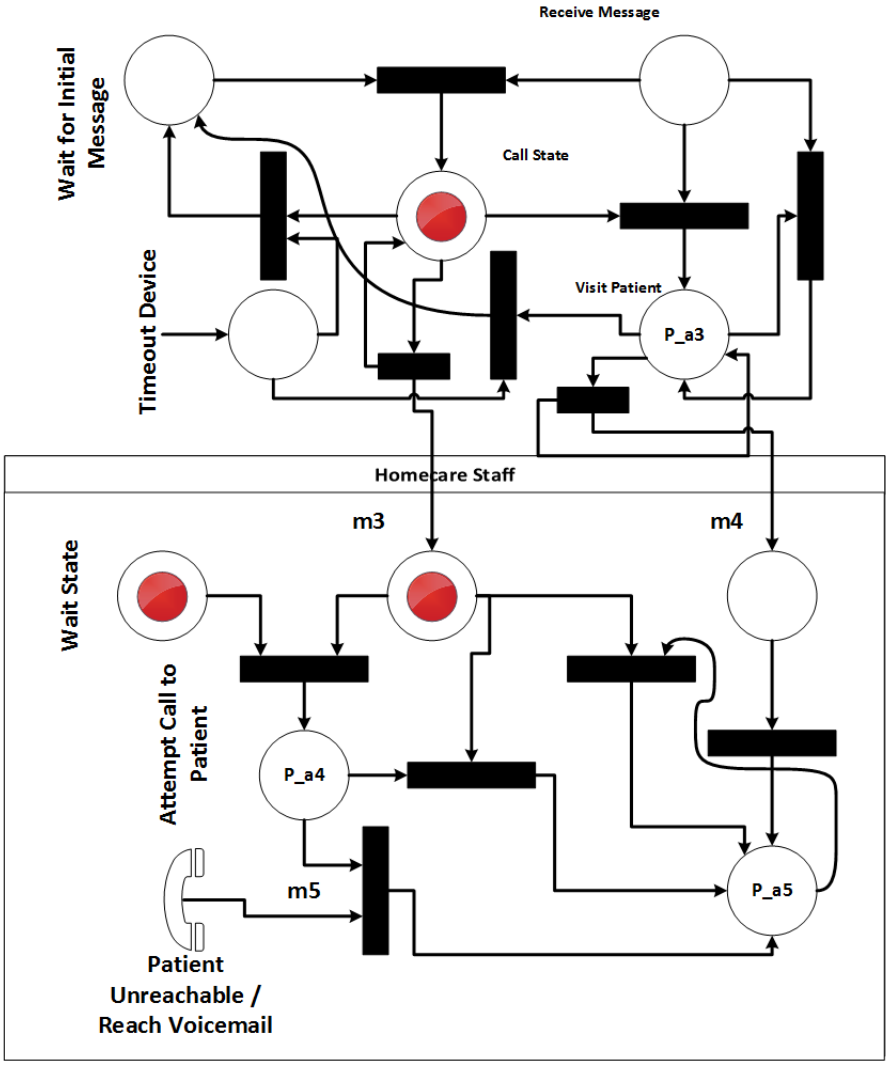
Next, the emergency manager is notified of the event. Only GR and EM are shown for brevity. Note, between this state and the next state, the emergency manager console display will show "document-1" as described in exercise 2, showing an increase in help requests with the patient's information requesting assistance.



The token flows to the call state. A message m3 is dispatched and sent to the healthcare staff. However, a copy of the token is left in the call state. If any further gestures arrive (before some timeout) the system will move to the visit patient state and remain there, sending m4, the visit patient message.



A copy of the token flows to the homecare staff call state message receiver system. Note the new token present in the homecare staff region.



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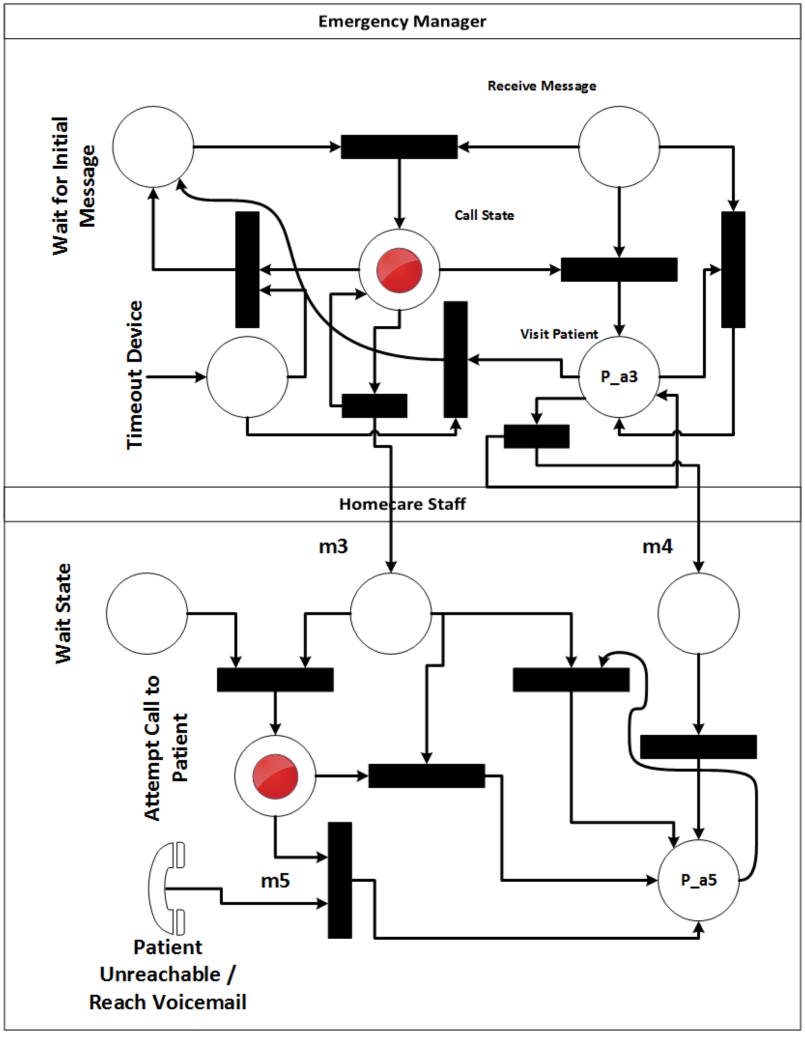
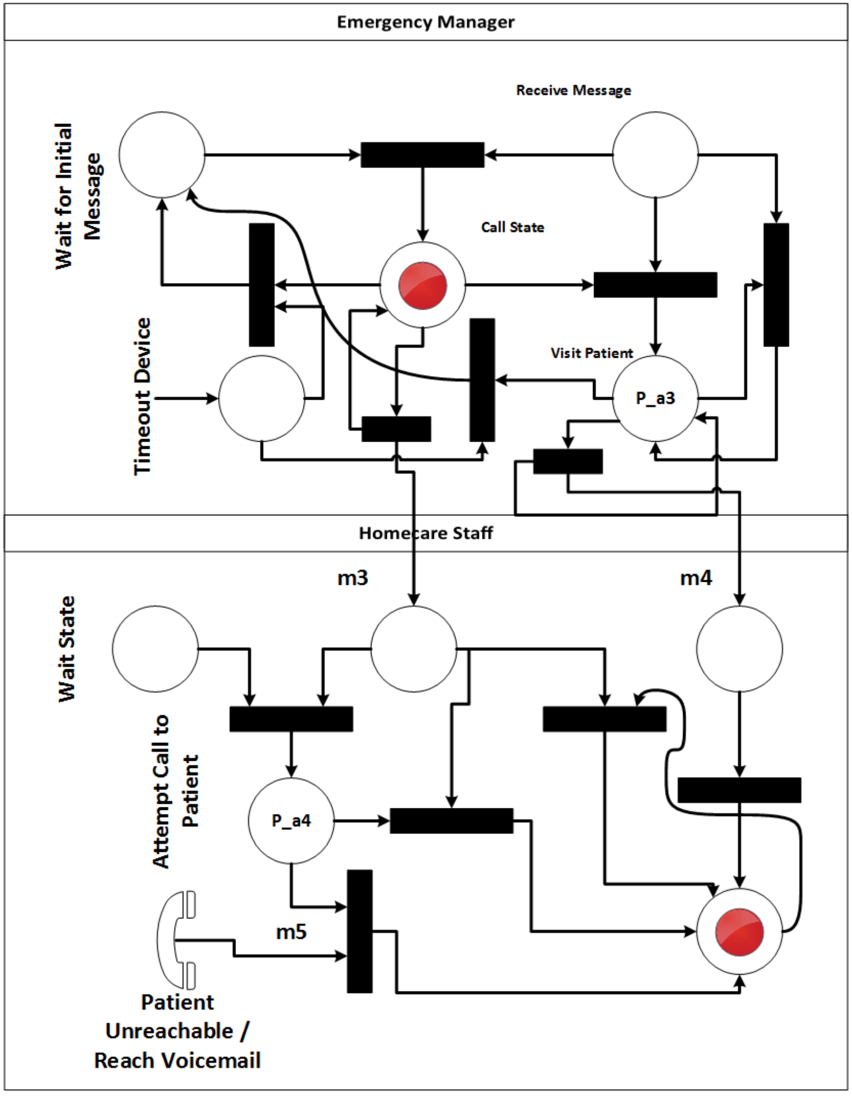
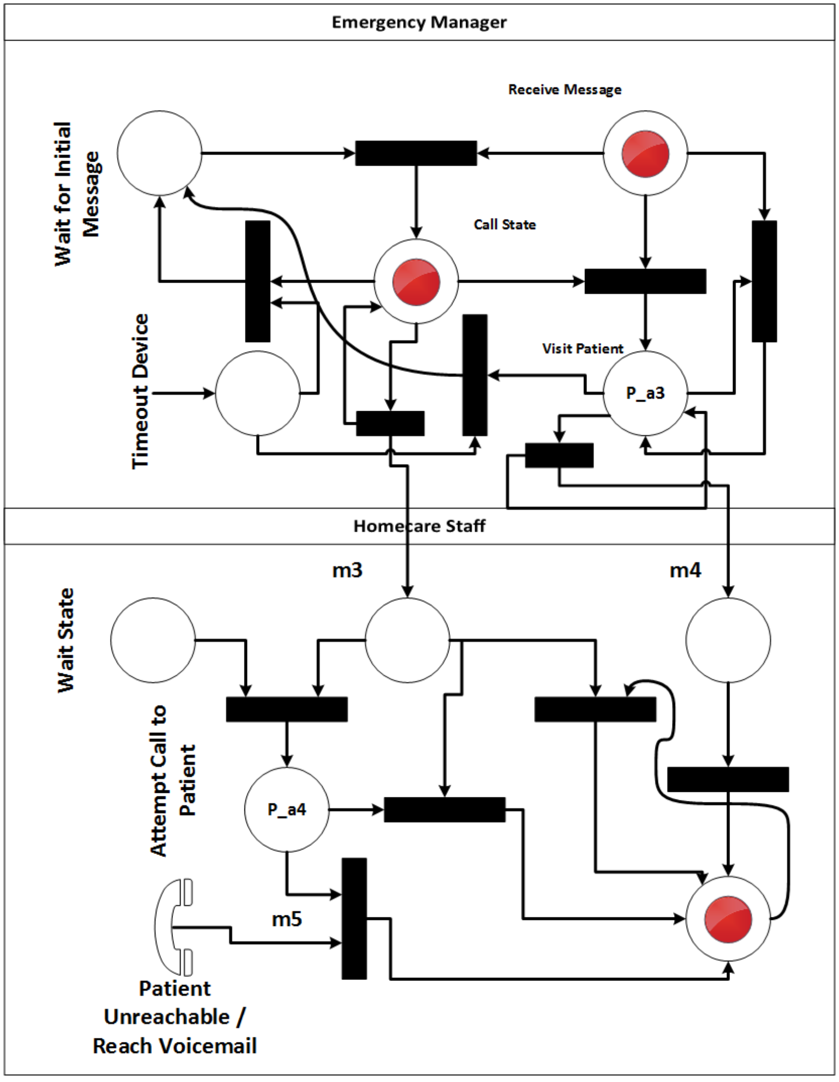
A call to the patient is attempted after the patient's request appears on the homecare staff's callback screen (document-2). A worker viewing the screen attempts to call the patient back.



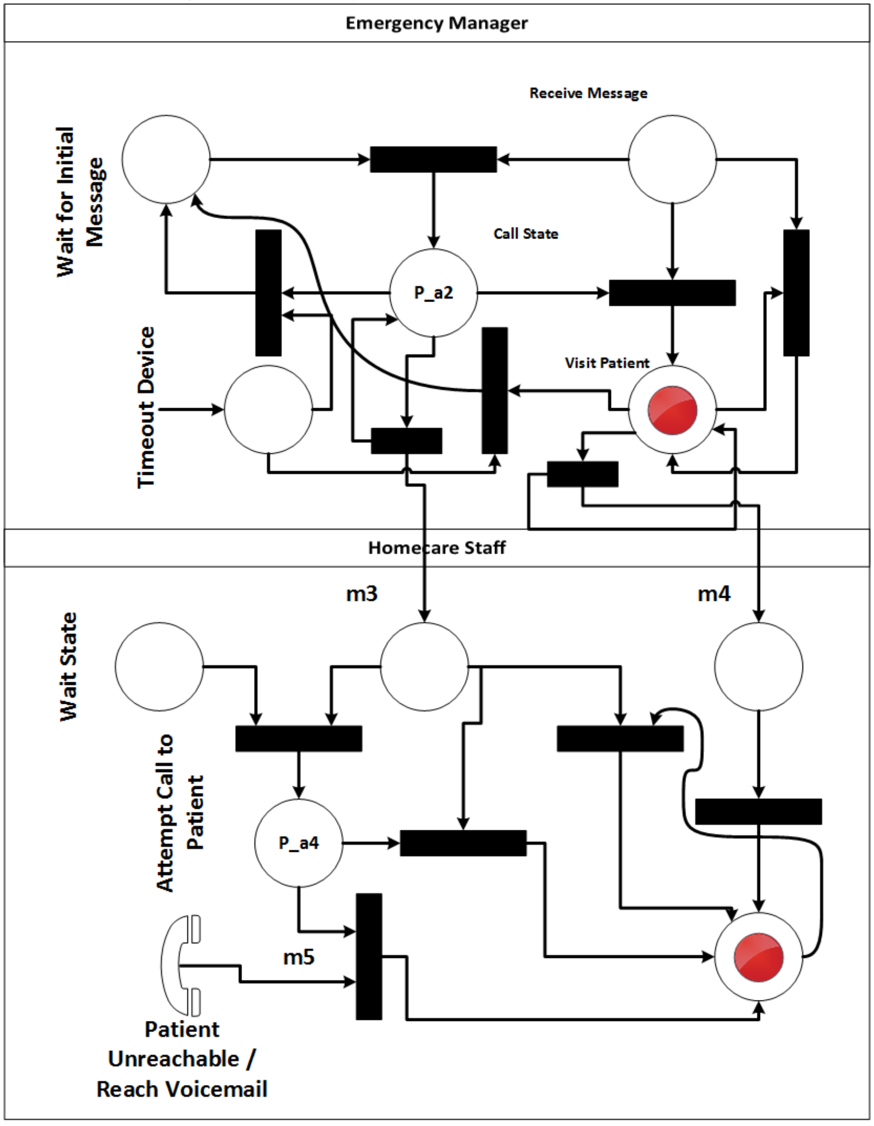
The patient fails to answer the phone and voicemail is reached. The failure is taken as an input (m5) and the token flows to the dispatch ambulance state. Note that any further messages to homecare staff will not change the fact that an ambulance is dispatched. All further tokens are consumed and the system remains in the dispatch ambulance state until it is manually overridden by a healthcare worker after verifying the patient's condition and having sent out an ambulance. The patient will appear on the document-3 (the ambulance dispatch queue) and a worker will queue the patient for an ambulance.



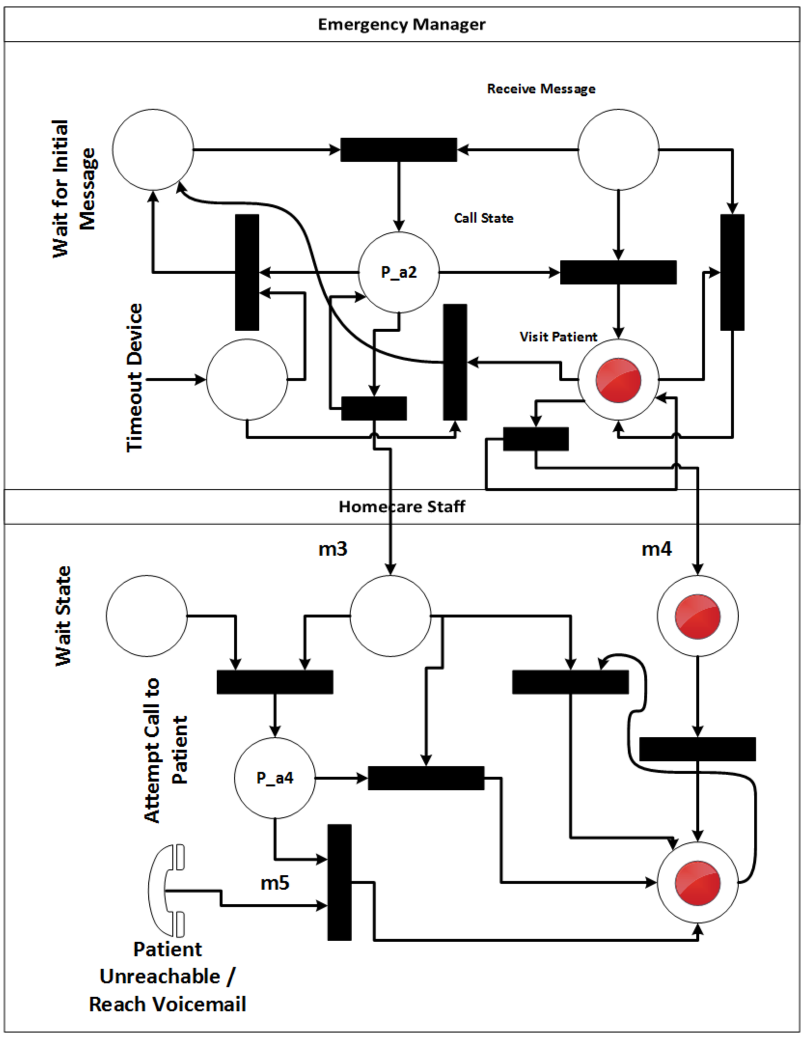
Let us now imagine, just for illustration, that the patient requests assistance again. I will **NOT** show the gesture recognizer again for brevity as it behaves exactly the same as before. **Let us assume the token has already flown to the EM.** Note that the token is still sitting in the call state from the previous call. It has not timed out yet.



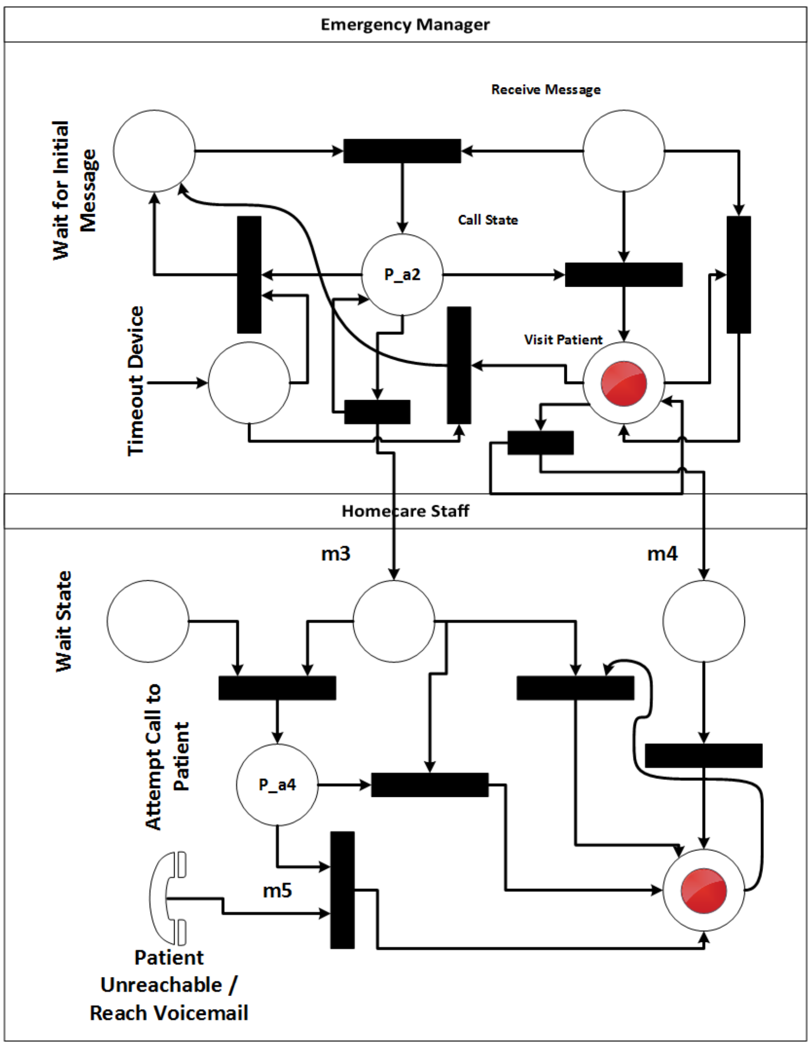
The token can only flow to the visit patient state – not the call state, because the wait for initial message token is missing. Thus, a message to visit the patient is sent to the healthcare staff.



A copy of the token flows to the healthcare staff.



The token is consumed and the system remains in the dispatch ambulance phase.



Other possibilities are possible, such as timeouts in the emergency manager, etc. but for brevity, I only display the basic scenario as described in exercise 2 here. For instance, a timeout could occur in the emergency manager – causing the token to flow back to the wait state of it / resetting it. This is not shown here as the original example has been demonstrated.

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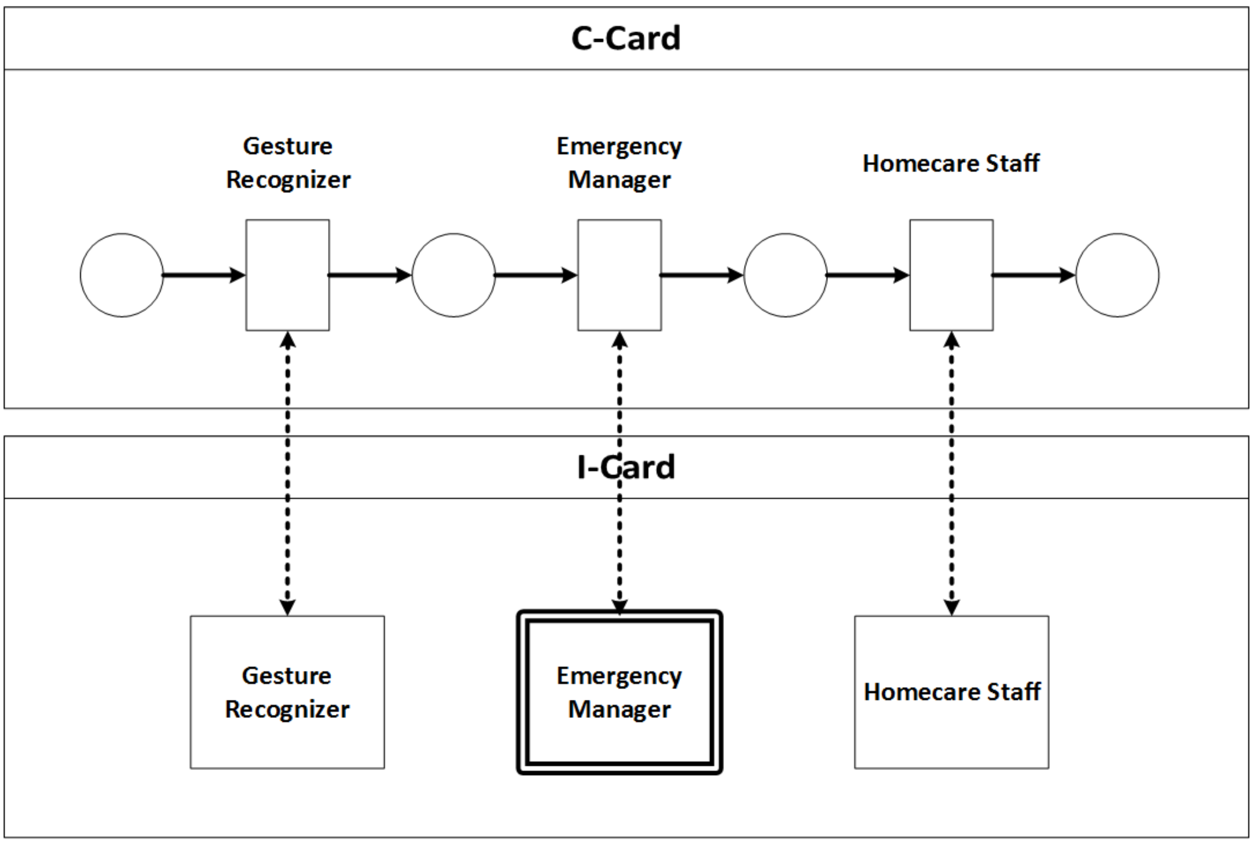
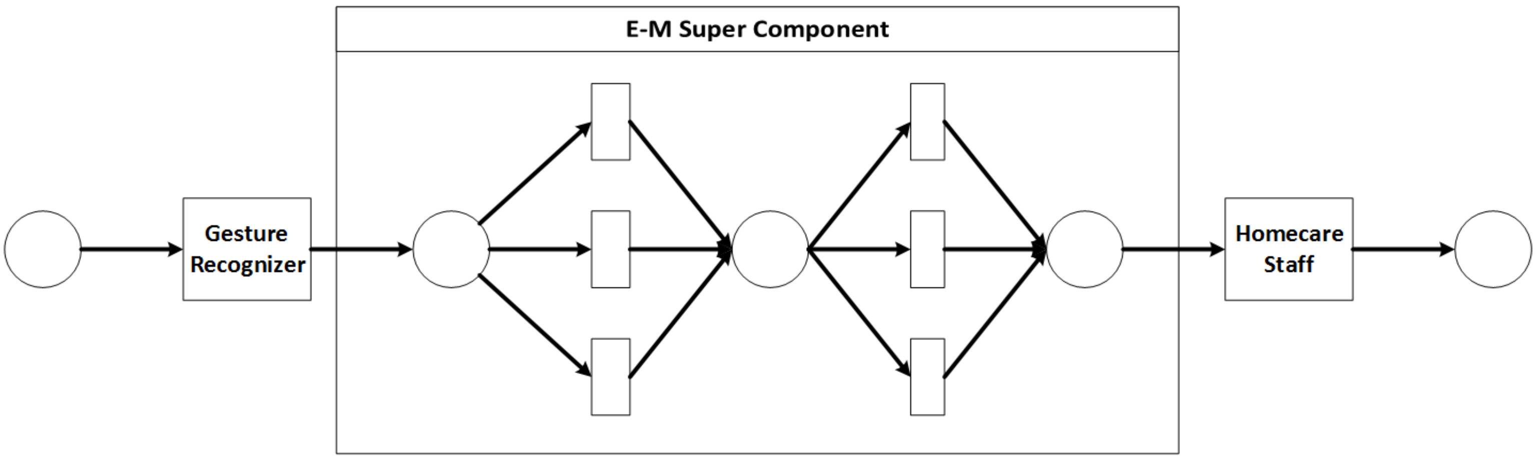
PART C) Suppose the emergency manager index cell corresponds to a super-component, i.e., the emergency manager can enumerate a number of feasible solutions and select the most appropriate one. Draw the personal health care system as a pair of (I-card, C-card), and convert it into an ordinary Petri net. (To do that, you need to assume a specific number of feasible solutions for the emergency manager to evaluate. Let us say three.)

Note: In my solution for Part C, I follow closely along the lines of Dr. Chang's notes here.



We now analyze the function of the emergency manager. The emergency manager is responsible for first, deciding what message to generate (call the patient or visit the patient). This first step can be viewed as a decision. Once the emergency manager has made that decision, it then must decide where to send that message, i.e. to whom in the healthcare staff. Thus, we can see two decisions made by the emergency manager – what and where. The exercise states to make 3 possible decision nodes for each decision, so that will be listed here (I suppose the third decision node could correspond to the dummy decision). We will get an emergency manager super component which looks like this.



After the gesture recognizer, the E-M super component first decides what message to send by choosing between three possible solutions. After deciding that, it then decides between three possible places to send that message. Once it has made the decisions, it sends it to the node it decided at the homecare staff.