

CS 2310
Instructor: Prof. S. K. Chang

Just in Time (JIT) E-Learning Medical Application

Step1: Scenario design

Aimee Pail Brown
Subrata Acharya

Scenario Description 1:

Patient is able patient.

Patient periodically takes his/her heart rate by sensor equipment. The sensor equipment takes reading and sends data to Patients Current Condition class to update class. The Condition Class will then periodically send updates to the Patient record, especially if an unordinary event occurs. Eventually in the scenario, an alarm is detected from the sensor equipment. This alarm message is propagated to the 1) the patient to inform him/her, 2) the patient's current condition class, 3) the patient's records class, 4) the Primary Hospital of the Patient, 5) the Primary Medical Expert, and 6) the Medical Assistant. All of these classes return an Acknowledgement to inform sensor that the Alarm message has been received. The Expert class and the nurse class will also send an ACK to the Hospital. The Expert will then request a query to the Patient Condition class to gather more information about Patient's other physical conditions that could help diagnosis the problem. The results are returned to the Expert. He sees that he does not need to dispatch a nurse to the residency of the Patient and that the Patient can perform an Action himself. The Experts sends the Action to the Patient and the Patient acknowledges receipt of the Action. The Expert then queries the Patient Conditions to see Patient's Condition after the Action. The Expert sends a message to inform the Patient that his condition is ok.

Included with the alarm message is a time parameter, Tc. This time parameter is important in prioritizing the messages as they are propagated throughout the network. The time parameter will inform the participants of the network the criticality of the message so that the higher Time Critical messages can be handled with higher urgency than lower Time Critical messages.

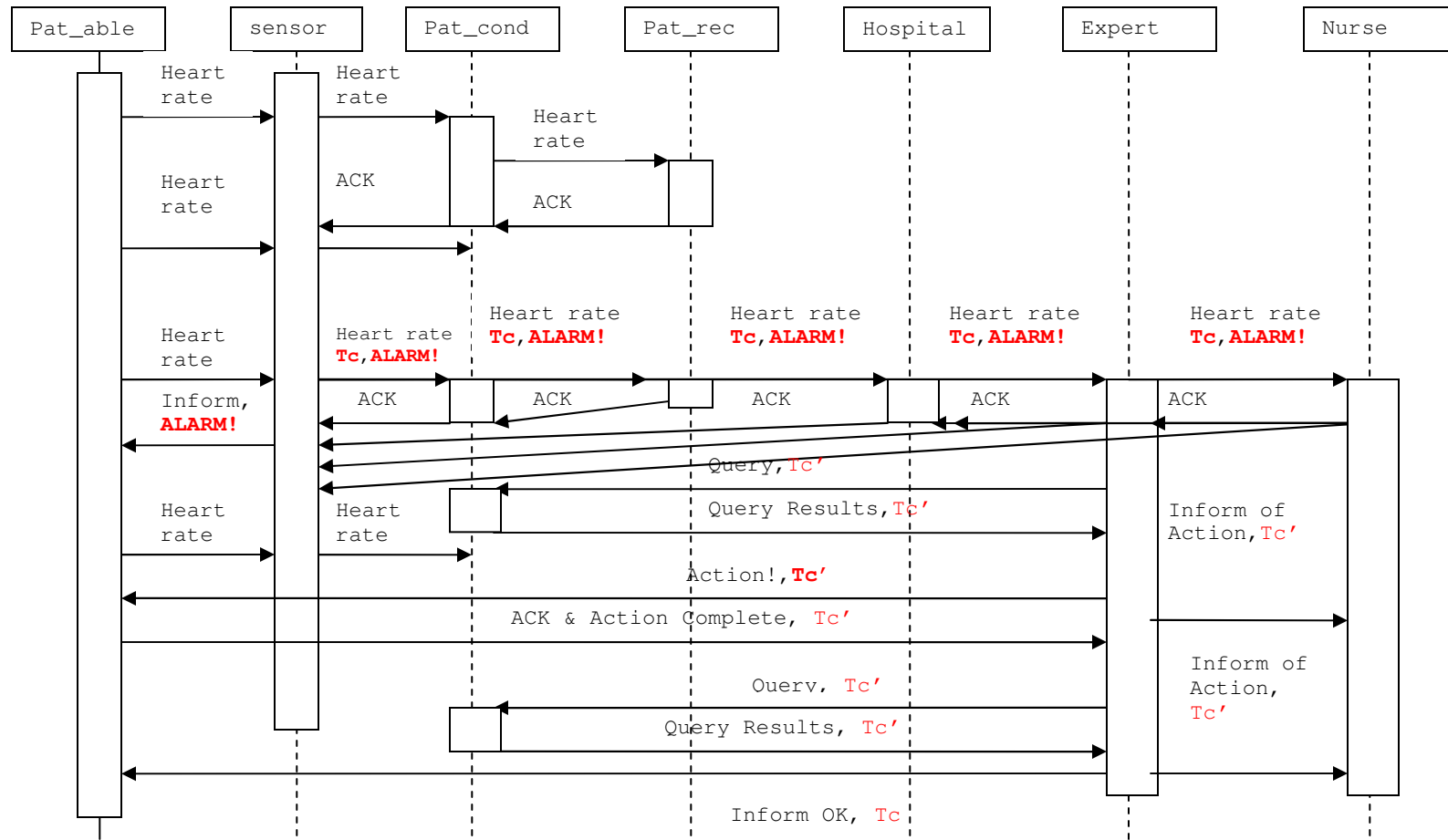
In this scenario, when the alarm is detected by the sensors, the alarm is propagated to the recipients with a time parameter of T_c . The T_c is then analyzed. If $T_c + T_{normal} > T_s > T_c$ (the time parameter is still within the time allowed for time critical messages to be acted on), a new T_c , T_c' , is calculated $T_c + T_{normal}$. If $T_c + T_{alarm} > T_s > T_c + T_{normal}$, the message is now of a higher priority than that of a normal critical message. Message of this type are acted upon immediately.

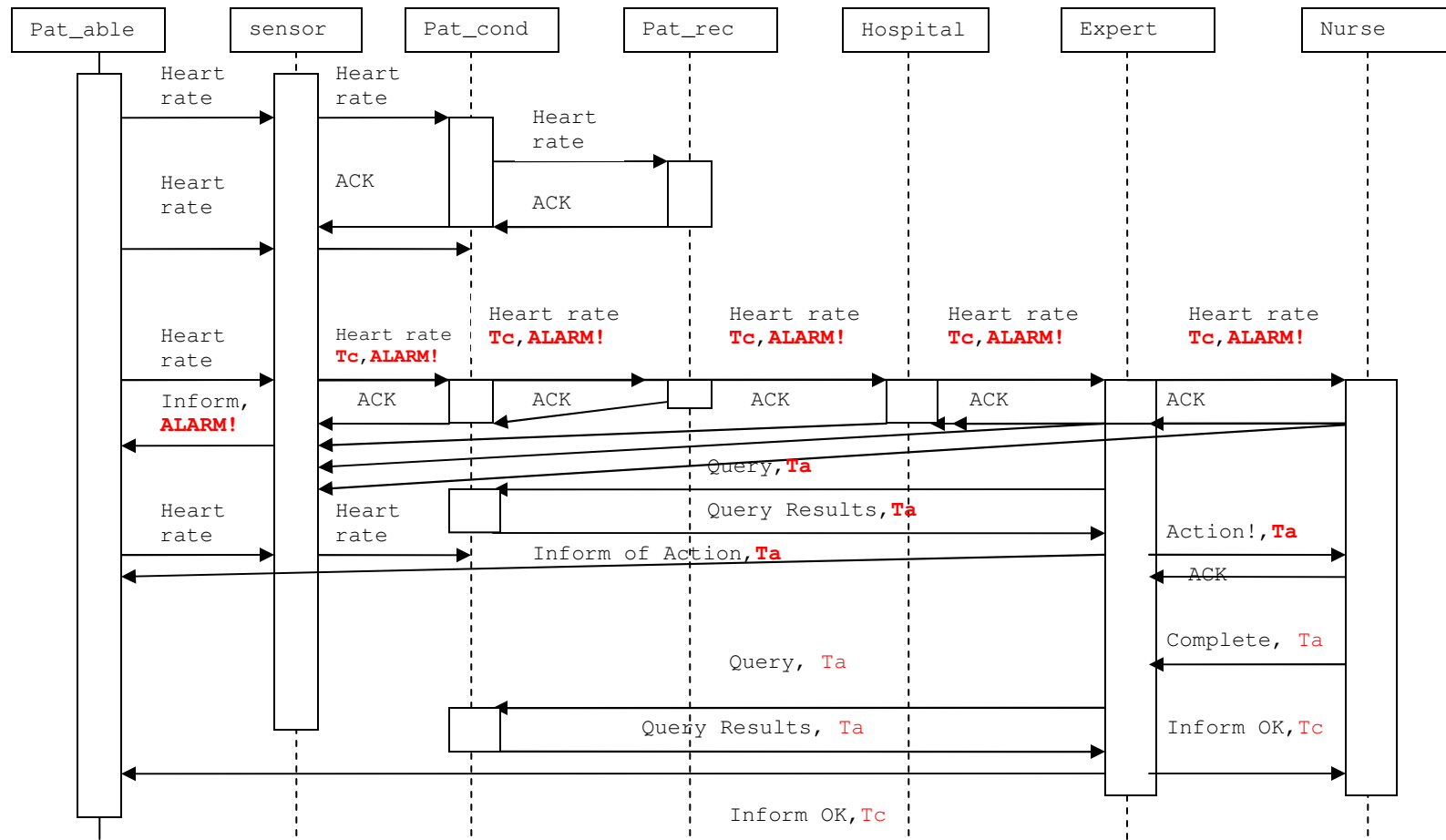
For example, if the expert sees that the message is in the T_{alarm} threshold, he could send a message to the nurse to act immediately instead of having the patient do the action him or herself. On the otherhand, if the expert sees that the T_c is still within the critical time threshold, he could instruct the patient the action to be performed along with the new T_c' to inform that the action should be done within the time specified.

The two timing diagrams below show the change of actions depending on the time parameter:

In the first diagram, the Alarm is sent to the recipients simultaneously with the time parameter of T_c . When the recipients analyze the critical time parameter, they calculate that it is still within the time threshold allowed for time critical messages. So the new time parameter is calculated, which is now T_c' . Because the time parameter is not within the alarm threshold, the expert decides that the able patient can perform the action himself and sends the patient the action message along with the new T_c' . The new T_c' should be maintained incase this time parameter will fall into the alarm threshold later on.

In the second diagram, when the alarm message is propagated to the recipients, but this time the recipients analyze the time parameter and see that it now falls within the threshold of being an alarm, T_a . Because of this higher priority situation, the expert decides that he will have the nurse perform the action. Therefore, a message is sent to the nurse with a time parameter of T_a . The nurse then acknowledges the message and acts according. After the action is performed, the expert checks the patient's current health statistics and sees that the patient has resumed normal activity. The doctor will then send a message to the patient and the nurse to inform them of the results. This messages time criticality has now changed to a T_c since the patient is okay and to allow messages of higher priority to be acted on.





Note: Heart rate is an example of an alarm by an able patient. It could be a temperature, images, panic button, etc.

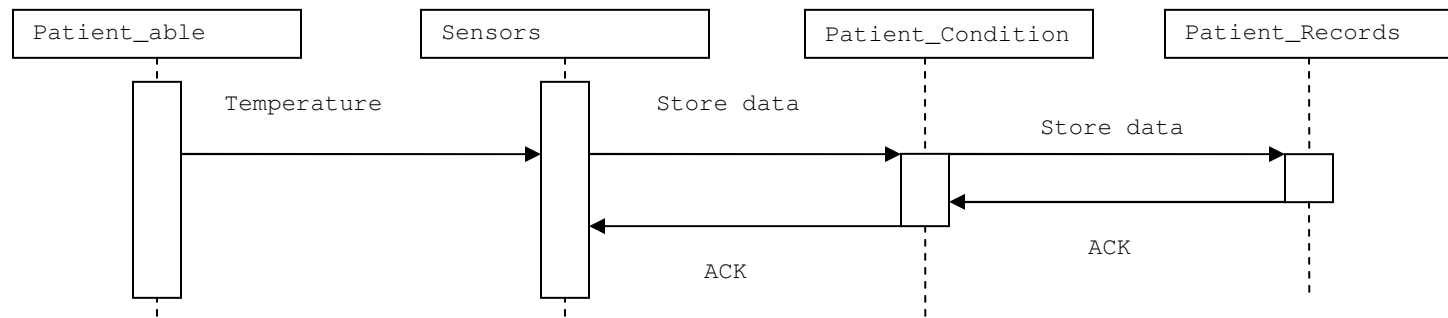
Alarm information and action reply could be hop-by-hop or end to end.

The action could be taken by the patient since he is able or a nurse or dispatcher on site could be sent to take appropriate actions. (Paramedical personal).

For the able scenario the alarm system detects the medical condition (heart rate, blood sugar level, etc.) and sends messages to the hospital/dispatcher. The dispatcher/hospital sends the messages to the health care personal (nurse, expert) and the required action is taken by the personal or nurse depending on time critical parameter and situation.

Timing diagram:

This scenario is continually happening in the JIT network. This is the scenario of the patient's condition being updated in the network. The timing in this project is abstract time and is continuously changing depending on the environment, patient condition, time critical thresholds, etc.



Scenario 2:

Description:

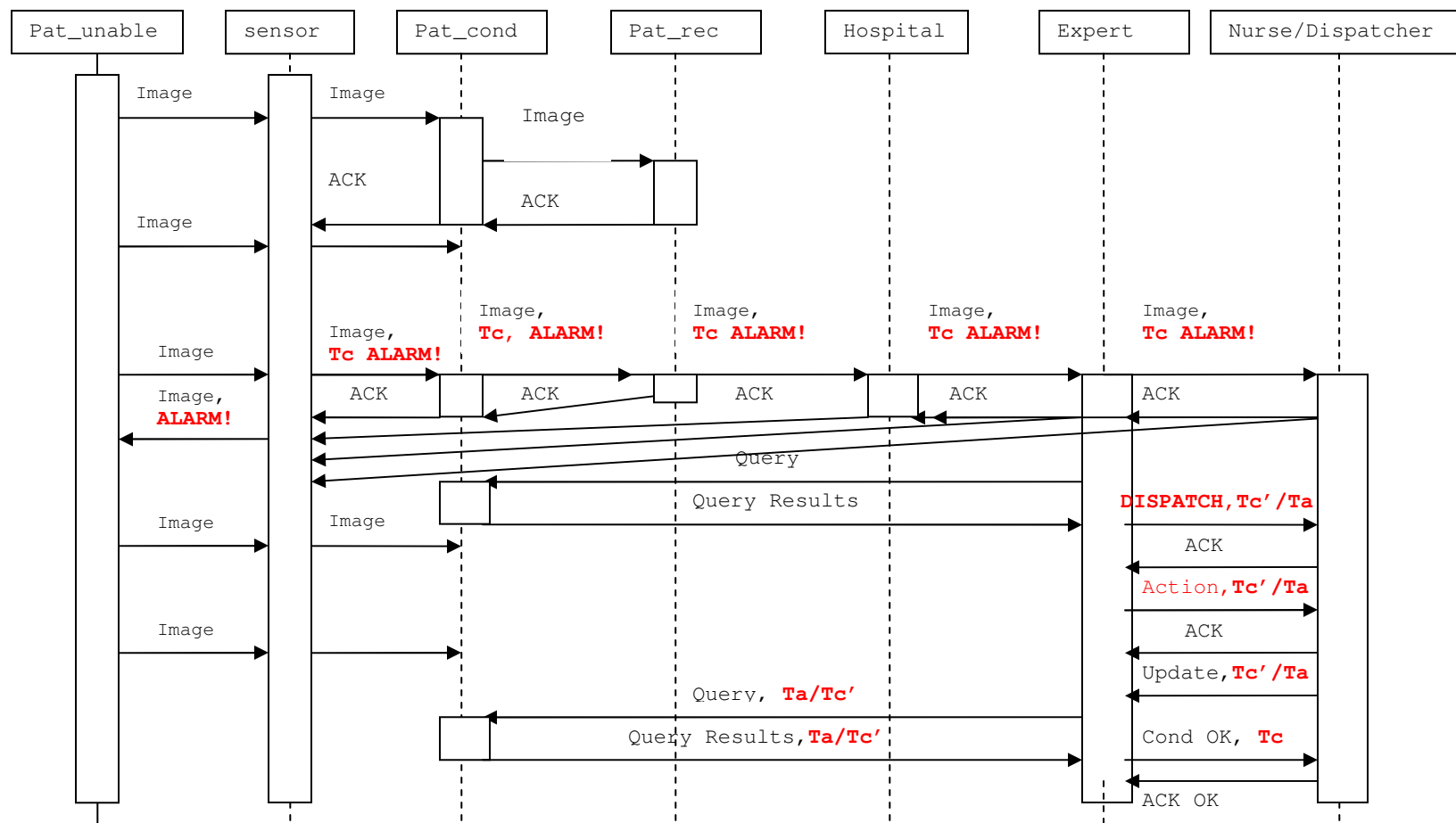
Patient is unable patient and has allowed the use of video sensors.

The sensor equipment takes videos/pictures and sends data to Patients Current Condition class to update class. The Condition Class will then periodically send updates to the Patient record, especially if an unordinary event occurs. Eventually in the scenario, an alarm is detected from the sensor equipment. This alarm is propagated to the 1) the patient to inform him/her, 2) the patient's current condition class, 3) the patient's records class, 4) the Primary Hospital of the Patient, 5) the Primary Medical Expert, and 6) the Medical Assistant. All of these classes return an Acknowledgement to inform sensor that the Alarm message has been received. The Expert class and the nurse class will also send an ACK to the Hospital. The Expert will then request a query to the Patient Condition class to gather more information about Patient's other physical conditions that could help diagnosis the problem. The results are returned to the Expert. He sees that he needs to dispatch a nurse to the residency of the Patient. The Experts sends the Dispatch message to the Nurse and the Nurse acknowledges the request. The Expert then sends an Action for the Nurse to perform on the patient. The Nurse acknowledges and will eventually send an update message to the Expert. The Expert then queries the patient's current condition and sends a message to the Nurse that the patient is OK. Nurse acknowledges the data.

Included with the alarm message is a time parameter, T_c . This time parameter is important in prioritizing the messages as they are propagated throughout the network. The time parameter will inform the participants of the network the critically of the message so that the higher Time Critical messages can be handled with more urgency than lower Time Critical messages.

In this scenario, when the alarm is detected by the sensors, the alarm is propagated to the recipients with a time parameter of T_c . The T_c is then analyzed. If $T_c + T_{normal} > T_s > T_c$ (the time parameter is still within the time allowed for time critical messages to be acted on), a new T_c , T_c' , is calculated $T_c + T_{normal}$. If $T_c + T_{alarm} > T_s > T_c + T_{normal}$, the message is now of a higher priority than that of a normal critical message. Message of this type are acted upon immediately.

The diagram below shows the addition of the time parameter T_c as part of the messages. When an alarm is first acknowledged, the message is sent to the recipients with a Time Critical parameter of T_c . When the recipients receive the message and analyze the T_c , the messages following can now include a T_c' or a T_a , depending if the analyzed T_c falls within the allowed time critical threshold or the time alarm threshold. In the diagram, note that some messages have the time parameter as T_c'/T_a . This means that the message can change its time parameter anywhere in the situation depending on the analysis of T_c . It is important that the time critical parameter is analyzed during each phase of this scenario so that it can change the time parameter to that of more urgency so that these messages can be propagated and handled with more priority than messages of lower time criticality.

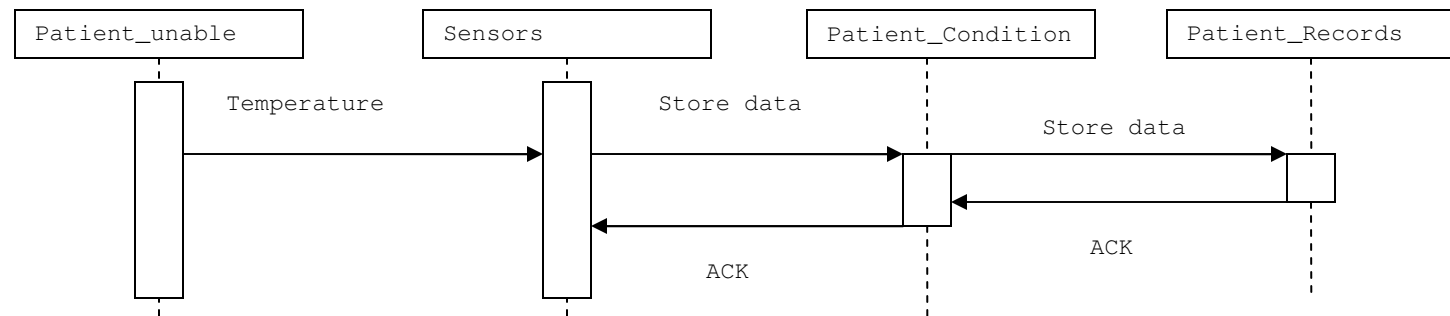


Notes: Heart rate is an example of an alarm by an unable patient. It could be a temperature, images, panic button, etc. Alarm information and action reply could be hop-by-hop or end to end. The action is taken by a nurse or dispatcher on site could be sent to take appropriate actions.

For the unable scenario the alarm system detects the medical condition (heart rate, blood sugar level, etc.) and sends messages to the hospital/dispatcher. The dispatcher/hospital sends the messages to the health care personal (nurse, expert) and the required action is taken by the personal. It is noteworthy that the patient is unable, hence has given rights to alarm devices to disclose information to medical personal for his benefit.

Timing diagram:

This scenario is continually happening in the JTT network. This is the scenario of the patient's condition being updated in the network. The timing in this project is abstract time and is continuously changing depending on the environment, patient condition, time parameter thresholds, etc.



Notes:

The system is adaptive and evolves with the changes in patient conditions, actions taken by medial experts or assistants, or the change in the environment. The rate of message exchange and action taken changes with the change in the alarm state. There is implicit feedback mechanism via the alarm system to make sure that the condition is resolved.

Scenario Description Detail: Messaging System

This term project follows the multimedia software engineering methodology to create a prototype for the JiT e-learning application scenario. This Just-in-Time application scenario is designed for Medical application in mind. The application is both critical and non-critical medical applications. The above scenario of JiT learning can readily be translated into similar scenarios according to the context - a senior citizen on-site can be assisted by a nurse on-line to give himself an injection; a physician on-site can be aided by a surgeon on-line to perform a surgical operation; and so on. By virtue of multicast and any-cast routing protocols, sensors are able to feed data continuously to multiple nodes in the network, so that multimedia information fusion is possible to answer queries and to process bids through the chronobot system. By tightening or loosening parametric values specifying the time constraints, the JIT scenarios can cover a wide spectrum of situations, ranging from disaster management with extremely strict timing constraints to assistive learning with more relaxed timing constraints.

The salient features of JiT e-Learning are: adaptivity, evolvability, accurate information fusion and guaranteed service availability and reliability.

Users of the Senario:

1. Patient_able:

Patient that is capable to interacting with Medical Assistance Network

2. Patient_unable:

Patient that are not capable of interacting with network because of current state or limitations with knowledge (age) or physical ability

3. Medical Assistance (i.e. nurse):

One that has knowledge in the medical profession but not at the level of an expert

4. Expert (Surgeon, Doctor, Consultant):

One in the medical profession that has the most knowledge in the field

5. Hospitals:

Group of participating hospitals in the e-learning application network. The doctors and nurses users described above, reside at these facilities.

Messages

The Medical Network transports a variety of messages.

The types of messages include:

1. Patient's Medical State

- a.** Messages from the patient that indicates his/her current state. Such messages would include: heart-rate, temperature, blood pressure, etc.

- b. Images captured from the sensors located at the patient's residency.

These messages are useful to capture the injury/state of the patient that could be diagnosed over the network without the need to send medical assistance. The messages could also indicate that the patient needs assistance dispatched to their location as soon as possible. The patient will need to agree to use of images at the time of their initialization into the network.

2. Query Requests to obtain medical information from medical assistants or experts

3. Instructions / Actions

- a. These messages are diagnosis actions that are sent to the network. These message include:
 - i. **Nurse -> Patient:** the nurse is asserting an action for patient to do
 - ii. **Patient -> Nurse:** the patient is giving feedback as the assistance given by the nurse
 - iii. **Nurse -> Doctor:** the nurse is requesting medical expertise from the doctor
 - iv. **Doctor -> Nurse:** the doctor is responding to the nurse's request by providing actions or information

- v. The message included may be actions sent from the Nurse/Doctor to request a dispatcher to be sent to the patient's location. Message of this type could include:
 - 1. Nurse requesting action from dispatcher
 - 2. Dispatcher confirming that action will be made
 - 3. Dispatcher requesting location of patient's locality
 - 4. Dispatcher releasing updates of patient's current state, etc.

4. Initialization message

- a. These messages are sent when a patient first joins the Medical Assistance Network.

The messages will set up the patient current medical state, the release of the patient's medical history to the participating hospitals, the patient's location, patient's proximity to the participating hospitals.

- b. These messages will also need to be sent when a new hospital joins the network. These messages may need to update data as to which hospital is nearest a patient.

- c. These messages will also need to be sent when a new expert joins the network. Information as to what the expert's field of expertise will need to be propagated.
- 5. Communication between a patient and a hospital will need to be one on one. Because of the differing diagnosis of many doctors, this could lead to a delay in the medical assistance provided to the patient. A primary medical facility will need to be negotiated first. A secondary medical facility will also be determined.

It is to be noted that there is an initial stage of bidding of services and the client (patient) accepts one based on its criteria. These criteria could be **least response time, least cost, least distance**, etc.

Issues:

Some additional items that we may need to look into during the development of the project are:

1. What level of redundancy is essential to provide 100% service availability for such critical applications

2. Data sent should be concise and enough for medical service provider to comprehend the problem and provide necessary service.
3. The data is time critical and hence should be sent as soon as possible
4. There has to be a good synchronization between the medical service providers to optimize patient care
5. How do we control the amount of message in the network so that the network does not become overpopulated with messages, causing the network to perform poorly or perhaps even fail? Maybe we can add mechanisms to filter messages depending on the timestamp and type
6. We will need to establish time parameters with our medical network so that very critical cases have a higher priority than that of cases that are not
7. We will need to establish a flag on messages indicating the messages importance. Maybe these can be propagated through the network faster than other type messages