Robotics and Autonomous Systems

Lecture 23: LeJOS and Jason

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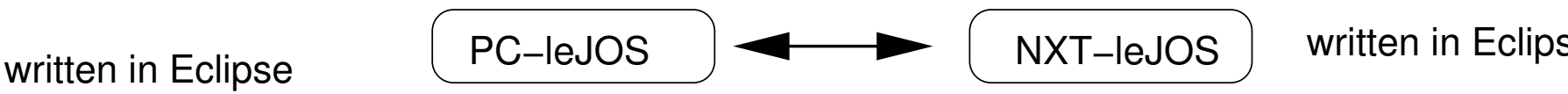
Today

- Today we will just go through an example of how to interface Jason with LeJOS
- This is essential to be able to do Assignment 2.

Jason and LeJOS



Jason and LeJOS

written in jEdit
or Eclipse

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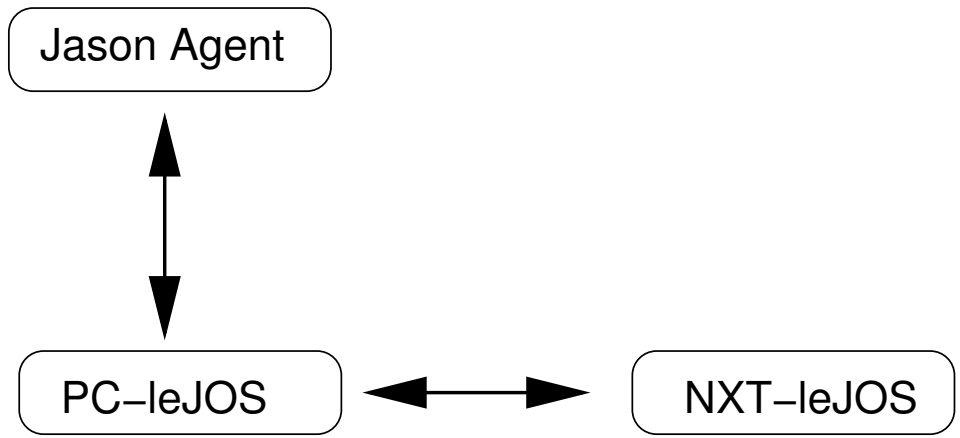

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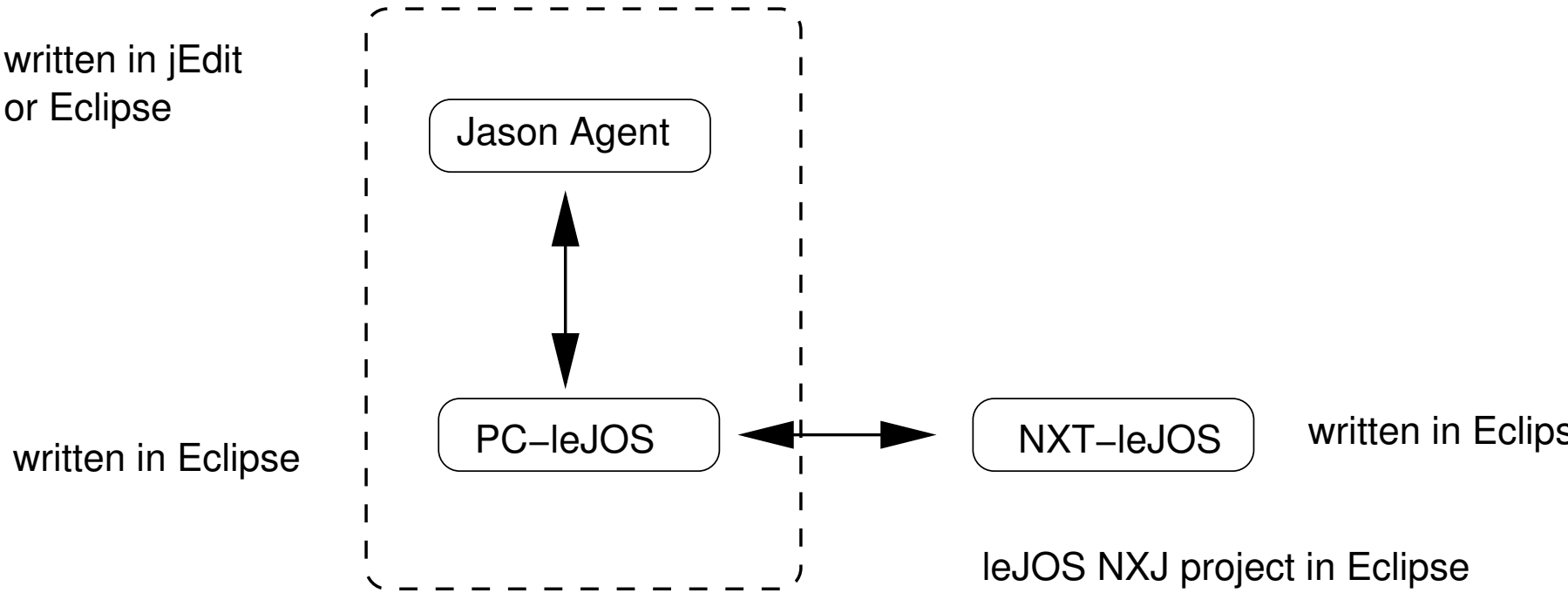
Jason and LeJOS



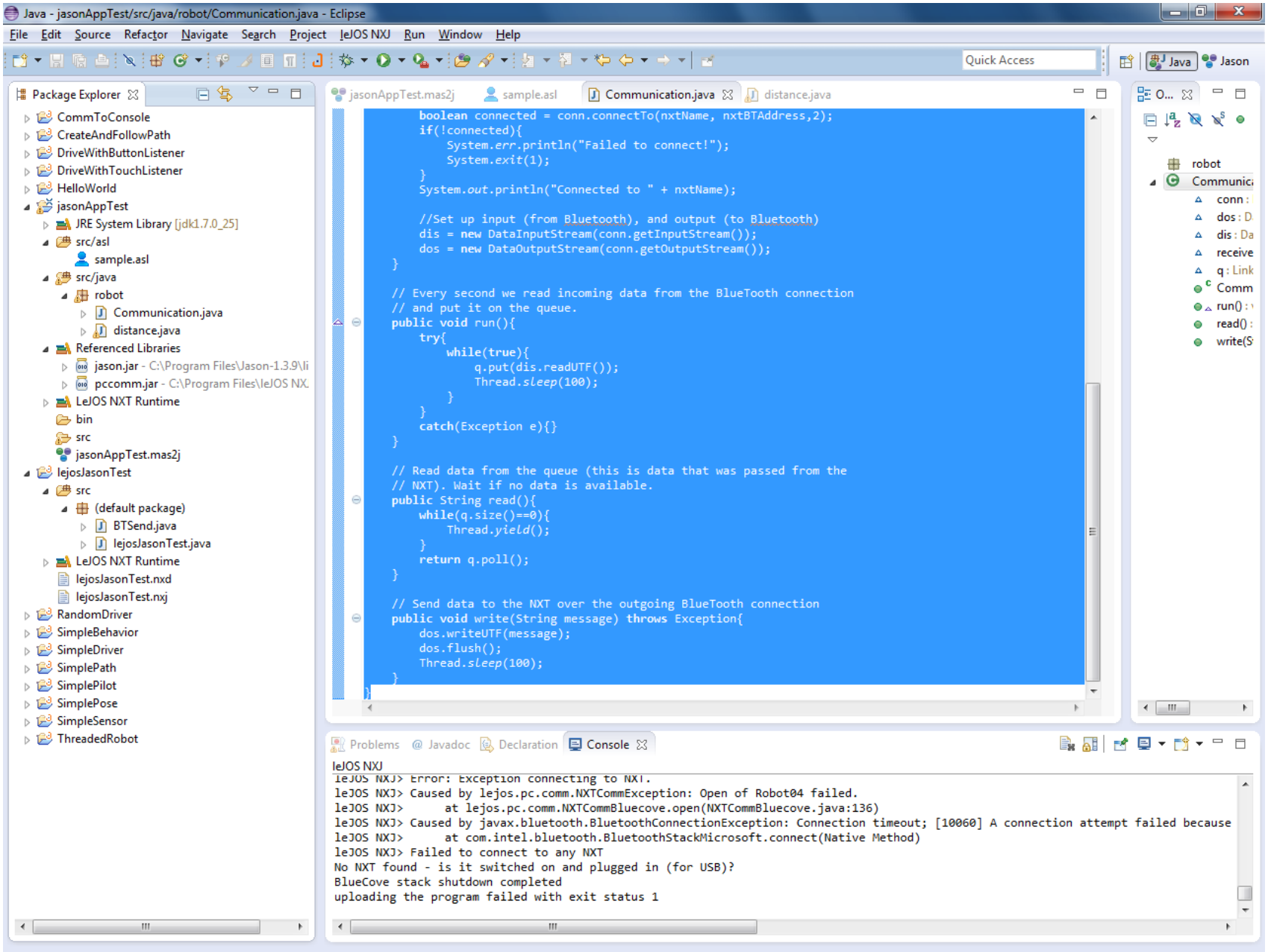
Jason Project in Eclipse containing a package with PC LeJOS code. The project loads classes for PC LeJOS

Jason and LeJOS

- A Jason agent is interfaced with a LeJOS PC program
  - The robot provides the environment for the agent.

  which in turn communicates with an NXT brick.
- The Jason agent uses an action `distance` to obtain information about the distance read by the US sensor on the NXT brick.
- The action is hooked to a method of a LeJOS PC program, which obtains the reading through BT from the NXT brick.
- The program is run as a Jason project

Jason and LeJOS



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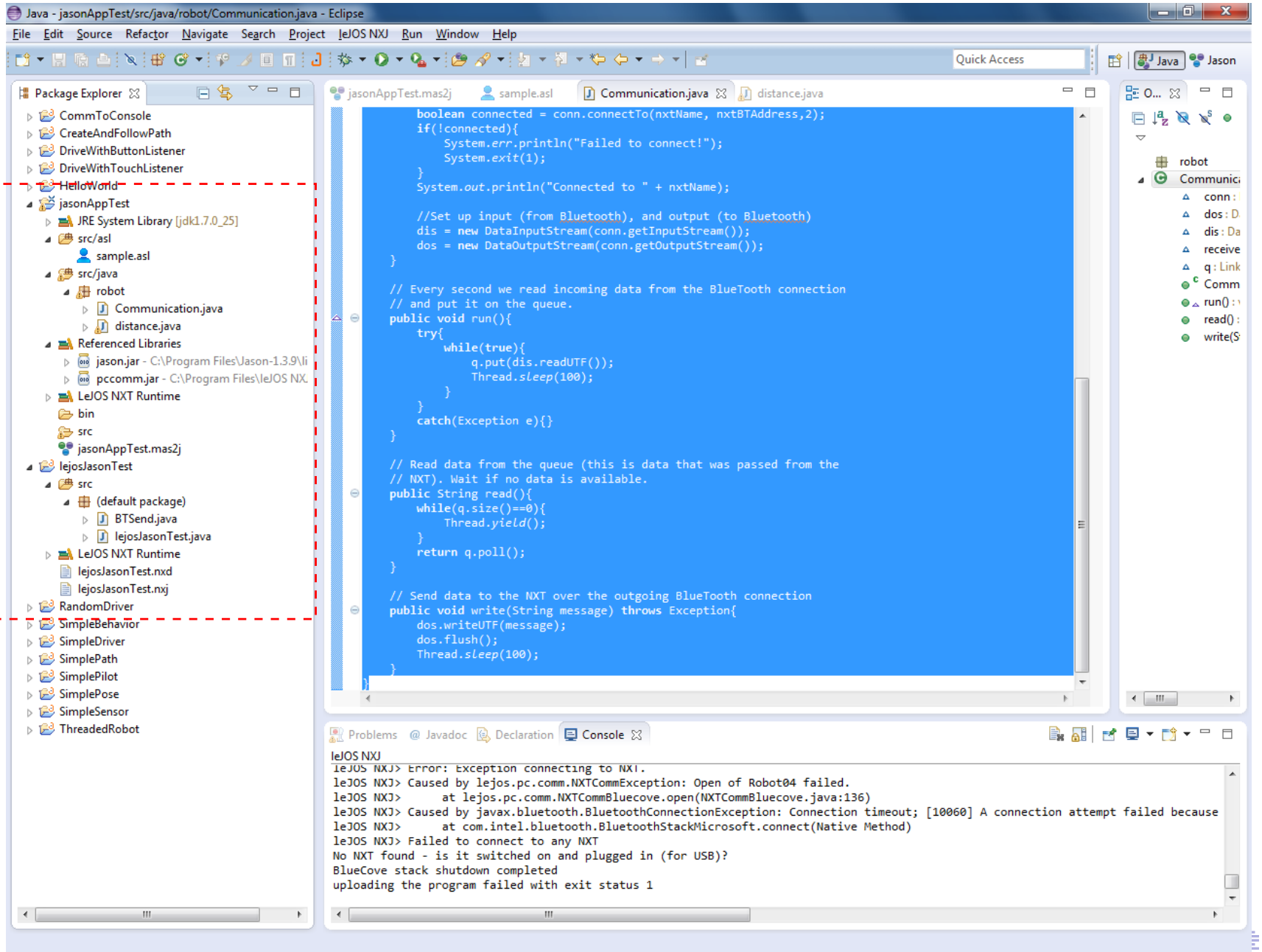
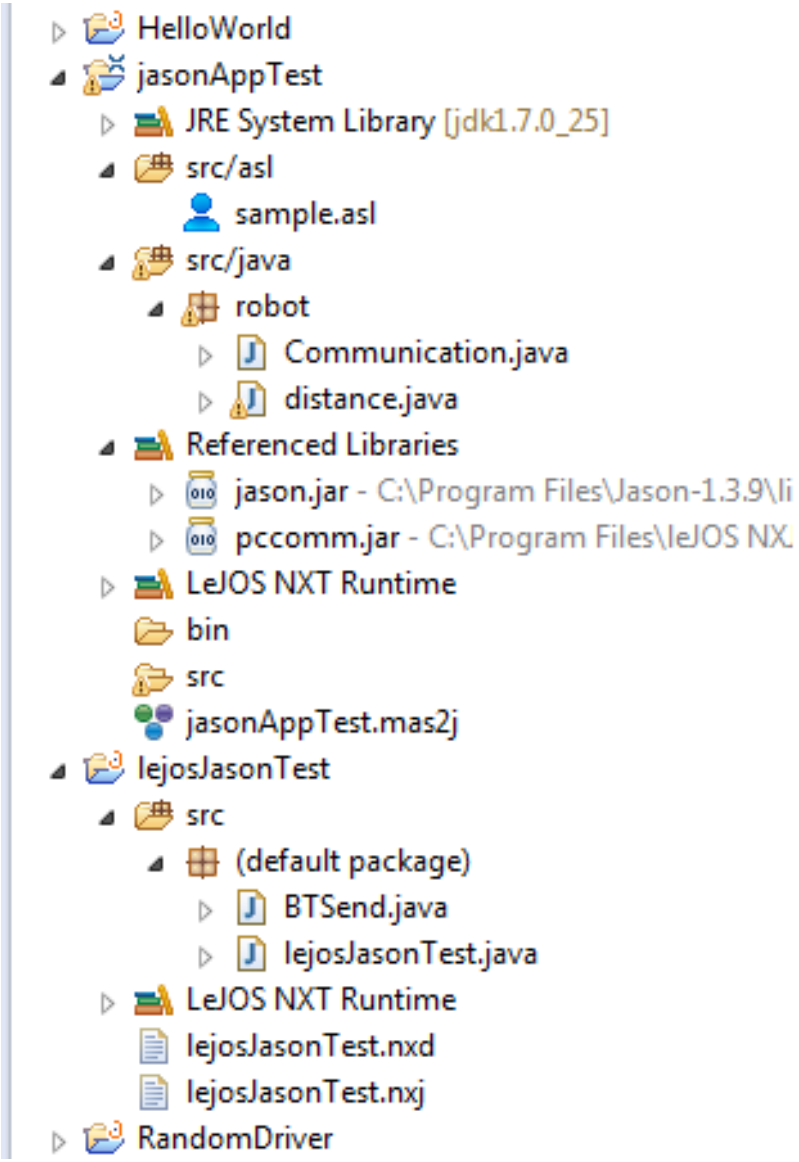
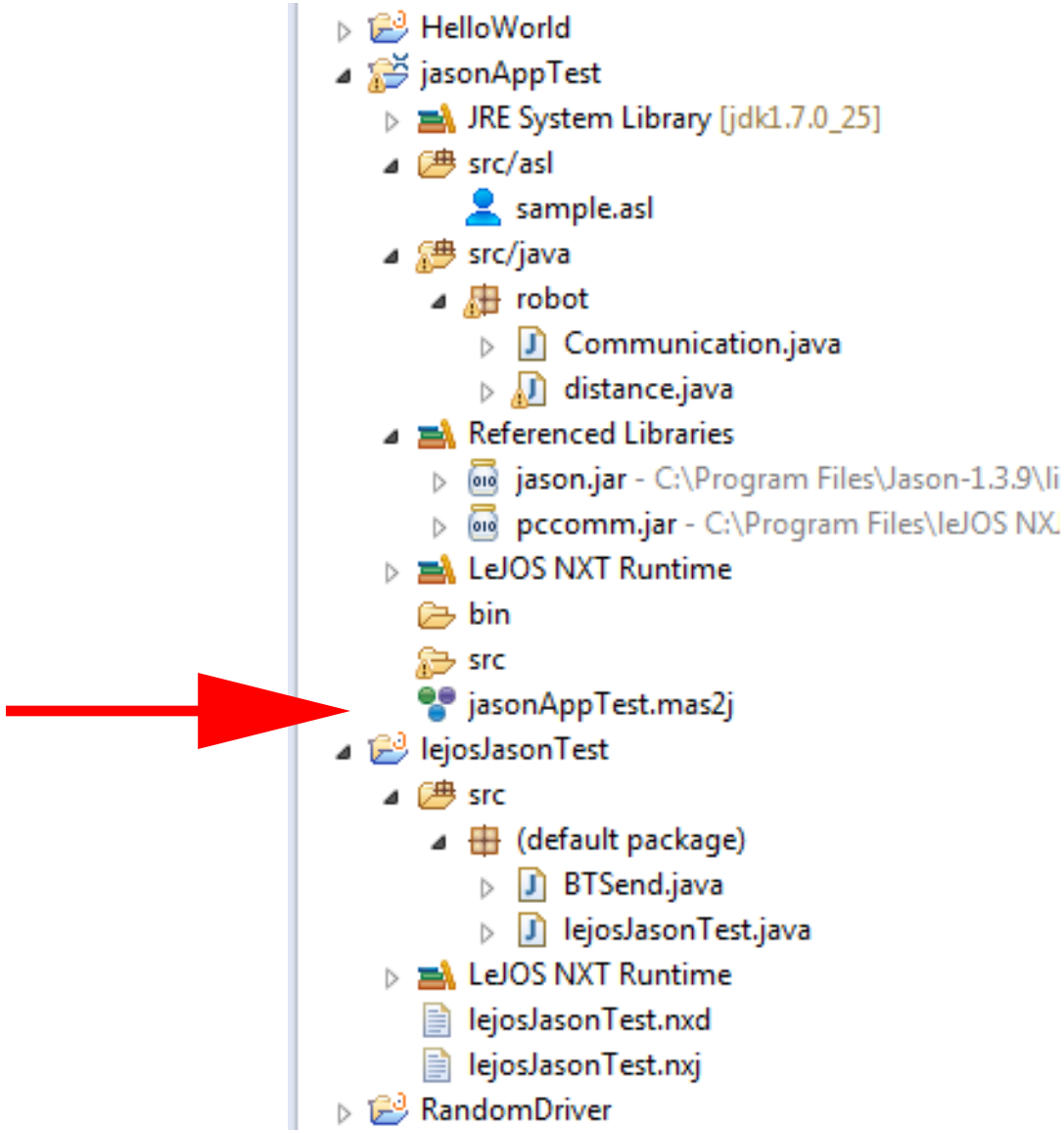


Jason and LeJOS



Jason and LeJOS



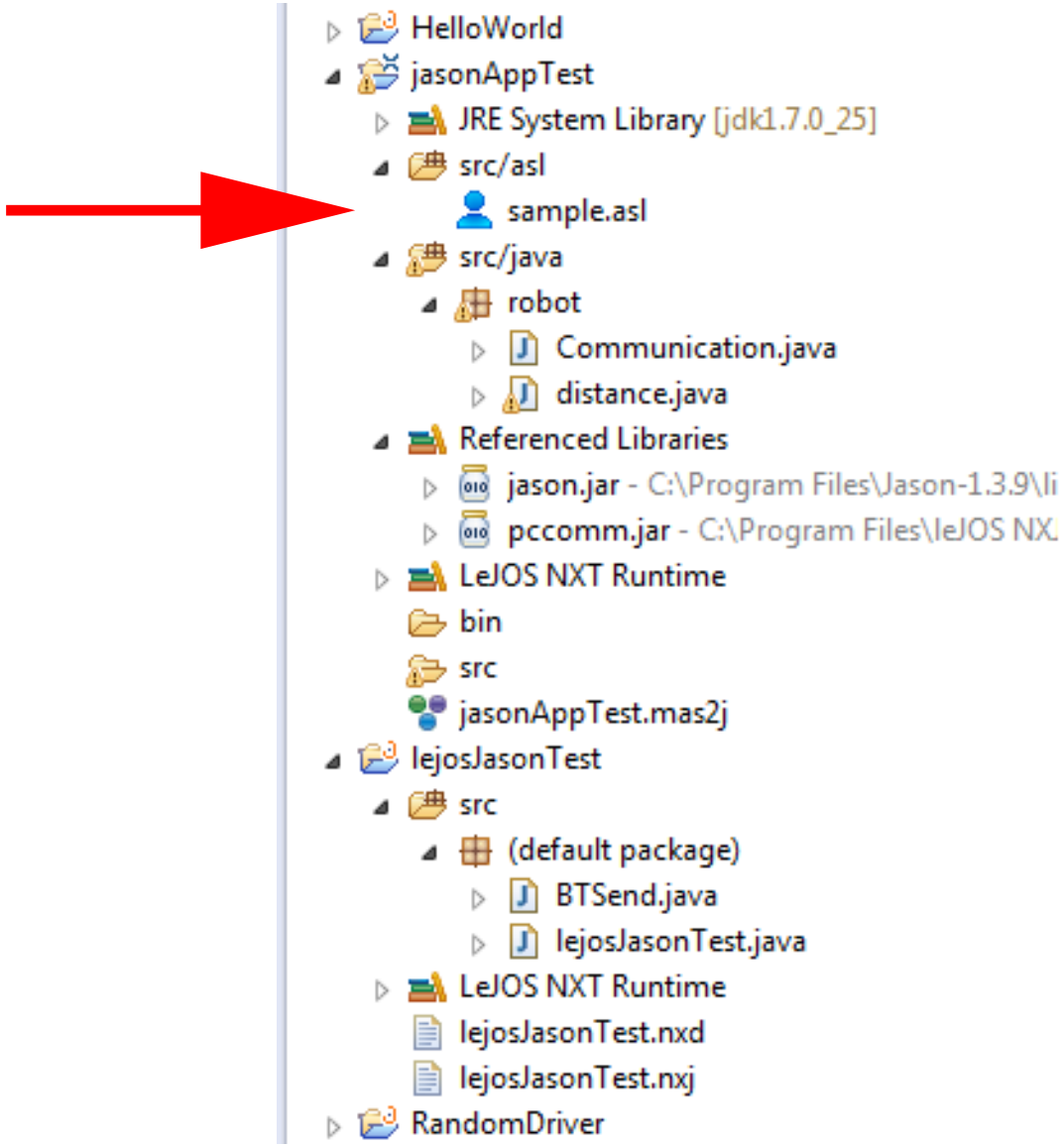
The MAS file

```
MAS jasonAppTest {

  infrastructure: Centralised

  agents:
    agent1 sample;

  classpath:
    "C:/Program Files/leJOS NXJ/lib/pc/*.jar";
    "C:/Program Files/leJOS NXJ/lib/pc/3rdparty/*.jar";

  aslSourcePath:
    "src/asl";
}
```

The MAS file

- Note the classpath to the leJOS PC library.
- This tells Jason where these files are.
- The compilation of the Jason part is carried out by Jason, invoked by Eclipse.
- Since this compilation involves compiling leJOS/PC code, Jason needs to know where the library is.
- (Since Jason is written in Java, a Jason program could include any other Java library also).

The MAS file


HelloWorld
jasonAppTest
JRE System Library [jdk1.7.0_25]
src/asl
sample.asl
src/java
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(default package)
BTSend.java
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LeJOS NXT Runtime
lejosJasonTest.nxd
lejosJasonTest.nxj
RandomDriver

The agent

```
/* Initial beliefs and rules */

/* Initial goals */

!start.

/* Plans */

+!start : true
    <- robot.distance(Object);
    .print("Distance is", Object);
    .wait(1000);
    !start.
```

The agent

- Begin with the (aptly named) goal `!start`
- This calls the actions:

```
robot.distance
.print
.wait
```

- Then reinvokes `!start`
- Jason equivalent of an infinite loop.

The agent

- Where does `robot.distance` come from?

The agent

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- It is part of the environment.

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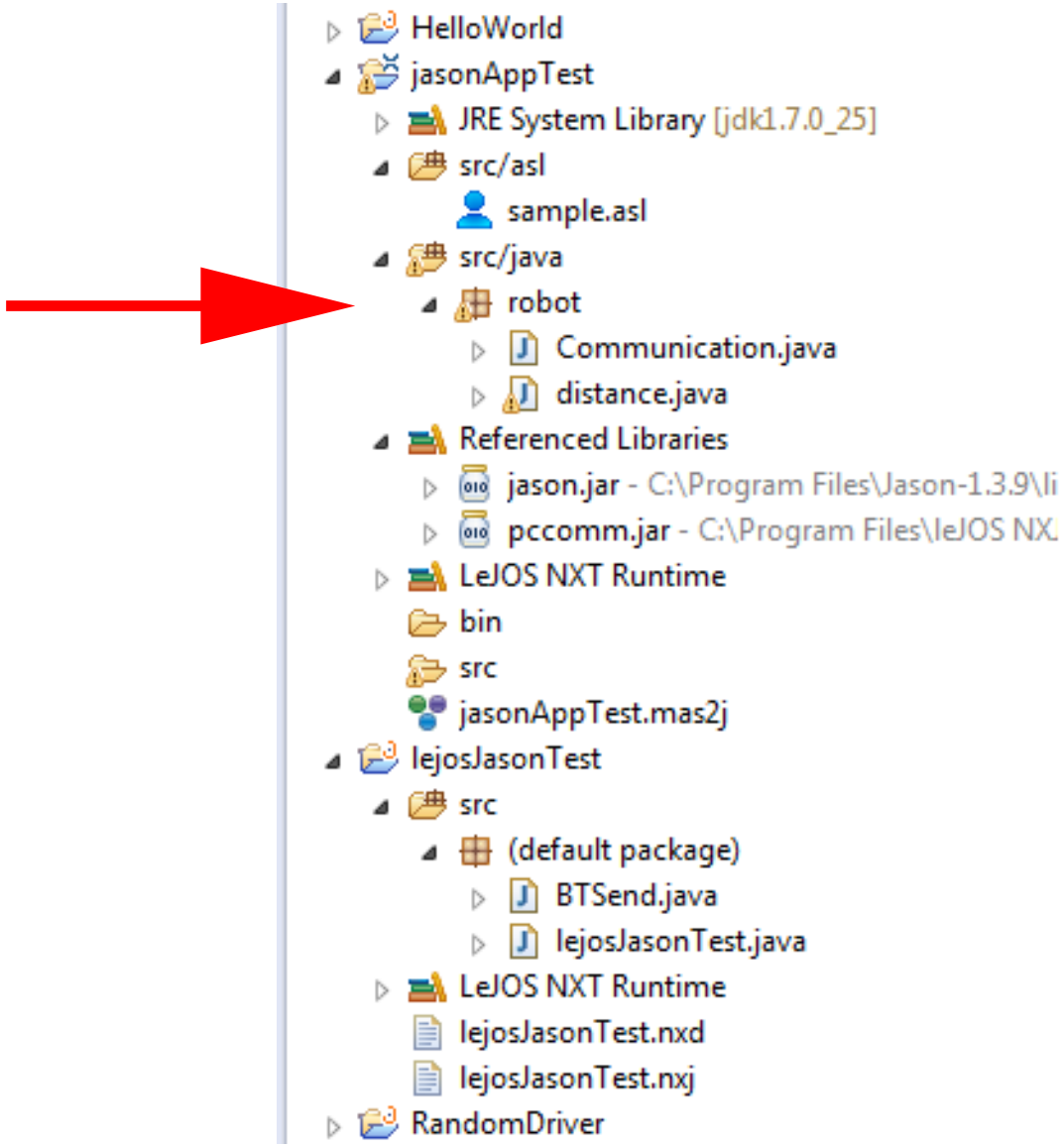
- Which in this case is provided by the robot.

The agent

- Where does `robot.distance` come from?
- It is part of the environment.
- Which in this case is provided by the robot.
- It is a command to the robot to do something.

The agent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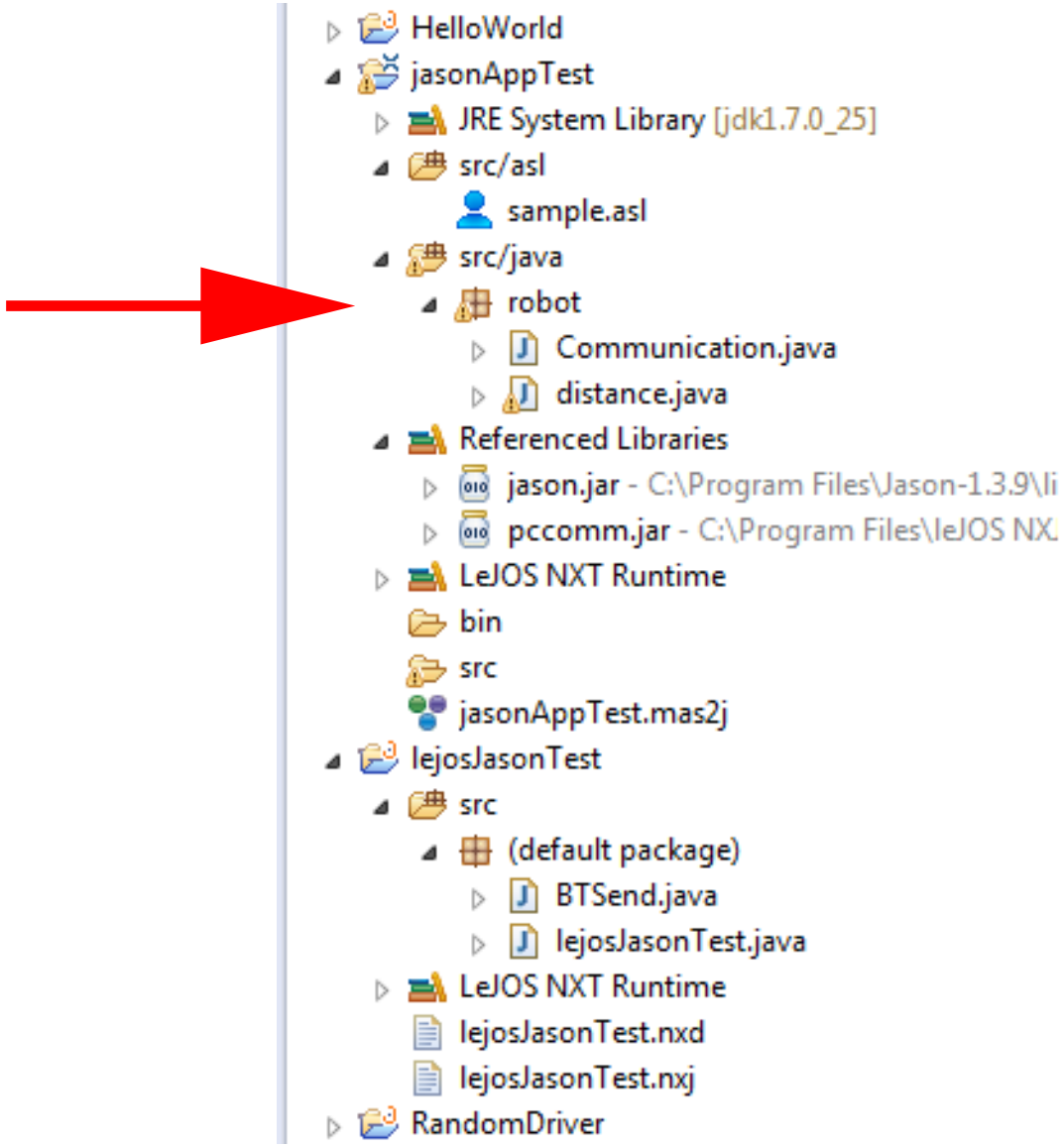
The agent

- This is the package that provides the “environment” in which the `sample.asl` agent runs.
- It is a Java program that runs on the PC.
  - Provides the `distance` command.
- As far as Jason is concerned, that is all it needs to know.

The agent

- This is the package that provides the “environment” in which the `sample.asl` agent runs.
- It is a Java program that runs on the PC.
  - Provides the `distance` command.
- As far as Jason is concerned, that is all it needs to know.
- In reality this program talks to an NXT robot.

The agent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Communication

- Two bits:
  - `Communication.java`
  - `distance.java`

Communication.java

```
package robot;

import java.io.*;
import java.util.concurrent.LinkedBlockingQueue;

import lejos.pc.comm.NXTConnector;

public class Communication implements Runnable{

  NXTConnector conn;
  DataOutputStream dos;
  DataInputStream dis;

  String received;
  LinkedBlockingQueue<String> q;
```

Communication.java

- This is the communication infrastructure object.
- `NXTConnector` to provide the connection.
- Two `streams`, for passing data over the connection.
- A `LinkedBlockingQueue<String>` for buffering data for transport.
- The whole thing is `Runnable` to allow it to be easily threaded.

Communication.java

```
public Communication(String nxtName, String nxtBTAddress){
  received=null;
  q = new LinkedBlockingQueue<String>();

  // Open up a BlueTooth connection
  conn = new NXTConnector();
  boolean connected = conn.connectTo(nxtName, nxtBTAddress,2);
  if(!connected){
    System.err.println("Failed to connect!");
    System.exit(1);
  }
  System.out.println("Connected to " + nxtName);

  //Set up input (from Bluetooth), and output (to Bluetooth)
  dis = new DataInputStream(conn.getInputStream());
  dos = new DataOutputStream(conn.getOutputStream());
}
```

Communication.java

- Pretty standard communication stuff.
- Exploits the Java/LeJOS infrastructure.
- Key line is
  `conn.connectTo(nxtName, nxtBTAddress,2);`
  which opens the connection.

Communication.java

- Then we add:

```
public void run(){
  try{
    while(true){
    q.put(dis.readUTF());
    Thread.sleep(100);
    }
  }
  catch(Exception e){}
}
```

Communication.java

- The “main” of the `Runnable`
  - Is kicked off when the `Runnable` is popped into a thread.
- Every tenth of a second it grabs from the input stream.
- Puts what it gets into the `q`.

Communication.java

- And:

```
public String read(){
  while(q.size()==0){
    Thread.yield();
  }
  return q.poll();
}
```

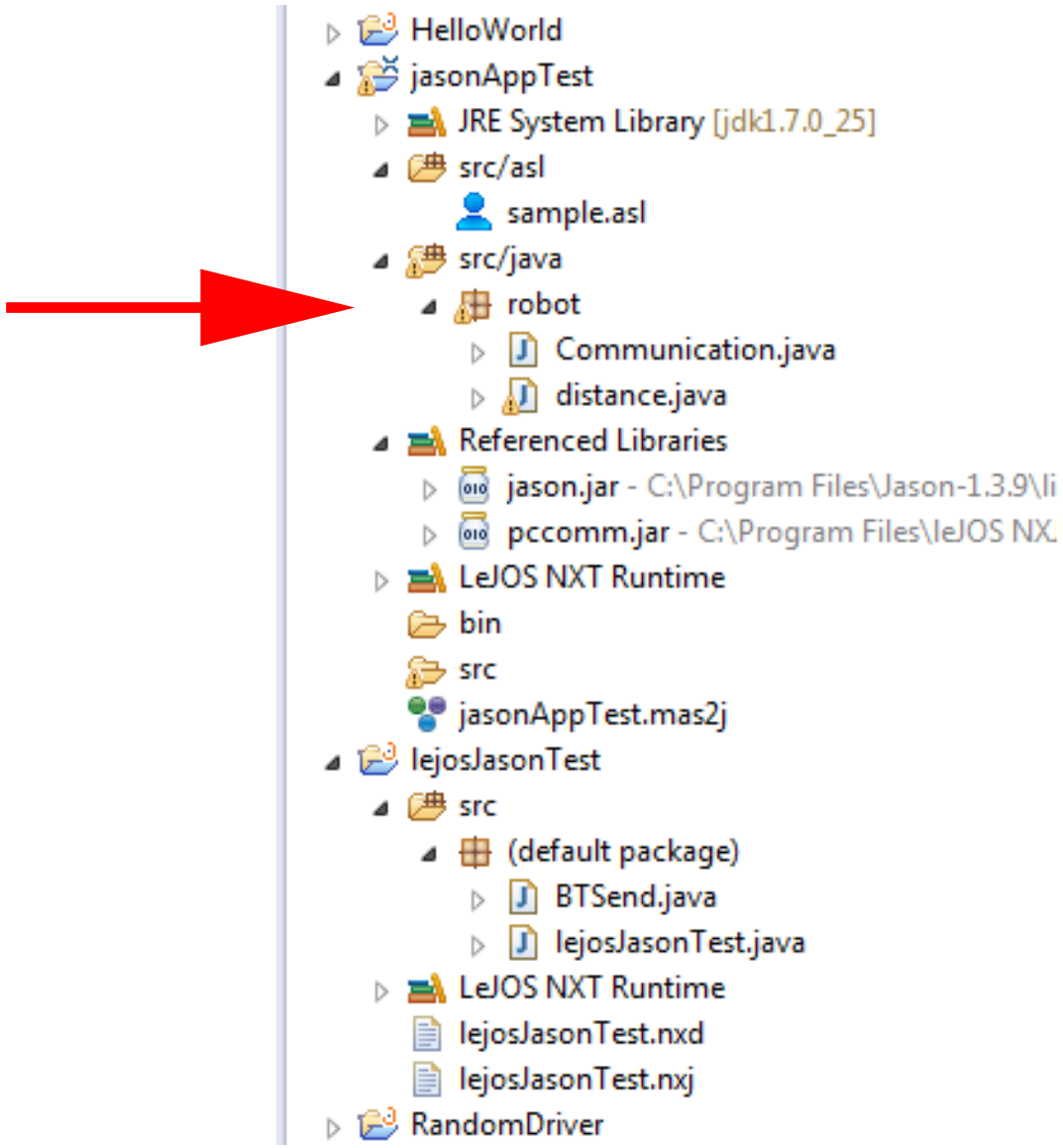
Communication.java

- Main interface function — read from the q.
- The reason for the q is to make this asynchronous
- Communication happens when it happens, and the results are stored in the q.
  Happens when the NXT is ready.
- The Jason program causes the q to be read when it is ready.
- q handles the slack.
- Being a blocking queue, it can't be over-filled, and it causes a wait if it is empty.

`Communication.java`

- `Communication.java` also provides a `write` method, but the example doesn't use it.

What else?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distance.java

```
package robot;

import jason.*;
import jason.asSemantics.*; // to do unification
import jason.asSyntax.*;    // to handle AgentSpeak
                            // syntax.

public class distance
          extends DefaultInternalAction {

  Communication comm;
  Thread commThread;
```

distance.java

- This is the connection to Jason.
- We create a Jason action by extending its default code for an action.
- This action will be a `read` from a `Communication` object.

distance.java

```
public distance(){
  comm = new Communication("NXT", "00:16:53:1a:a7:11");
  commThread = new Thread(comm);
  commThread.start();
}
```

distance.java

- The constructor opens up a channel using the `Communication` object.
- Note that this relies on the address of the specific NXT that you are connecting to.
- Not only is it paired, but it is coded to the robot.

distance.java

```
public Object execute(TransitionSystem ts,
                      Unifier un, Term[] args)
  throws Exception{

  String message = comm.read();
  StringTerm result = new StringTermImpl(message);

  return un.unifies(result,  args[0]);
}
```

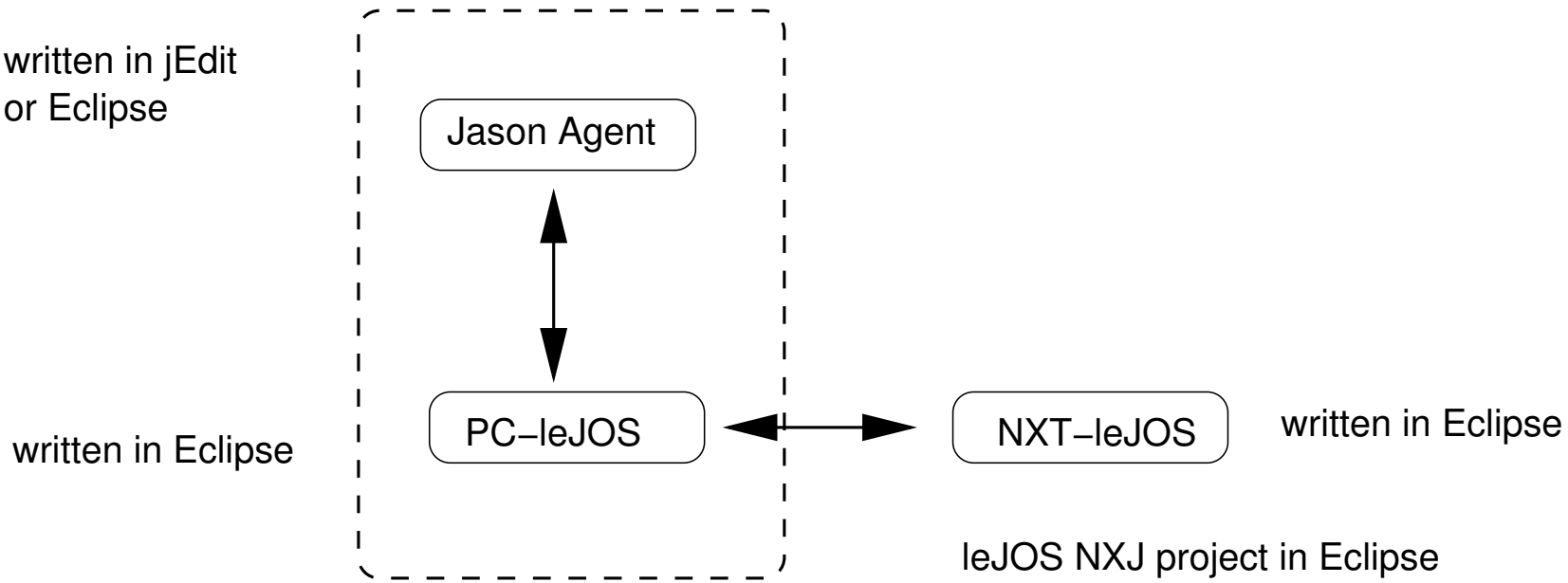
distance.java

- This is what gets called when Jason executes `robot.distance`
- `ts` is the state when the action is called.
  - So actions can refer to the agent state.
- `un` captures the unification
  - Gives you the access to the values of the variables in the plan which are referenced by the action.
- `args` are the arguments of the action.

distance.java

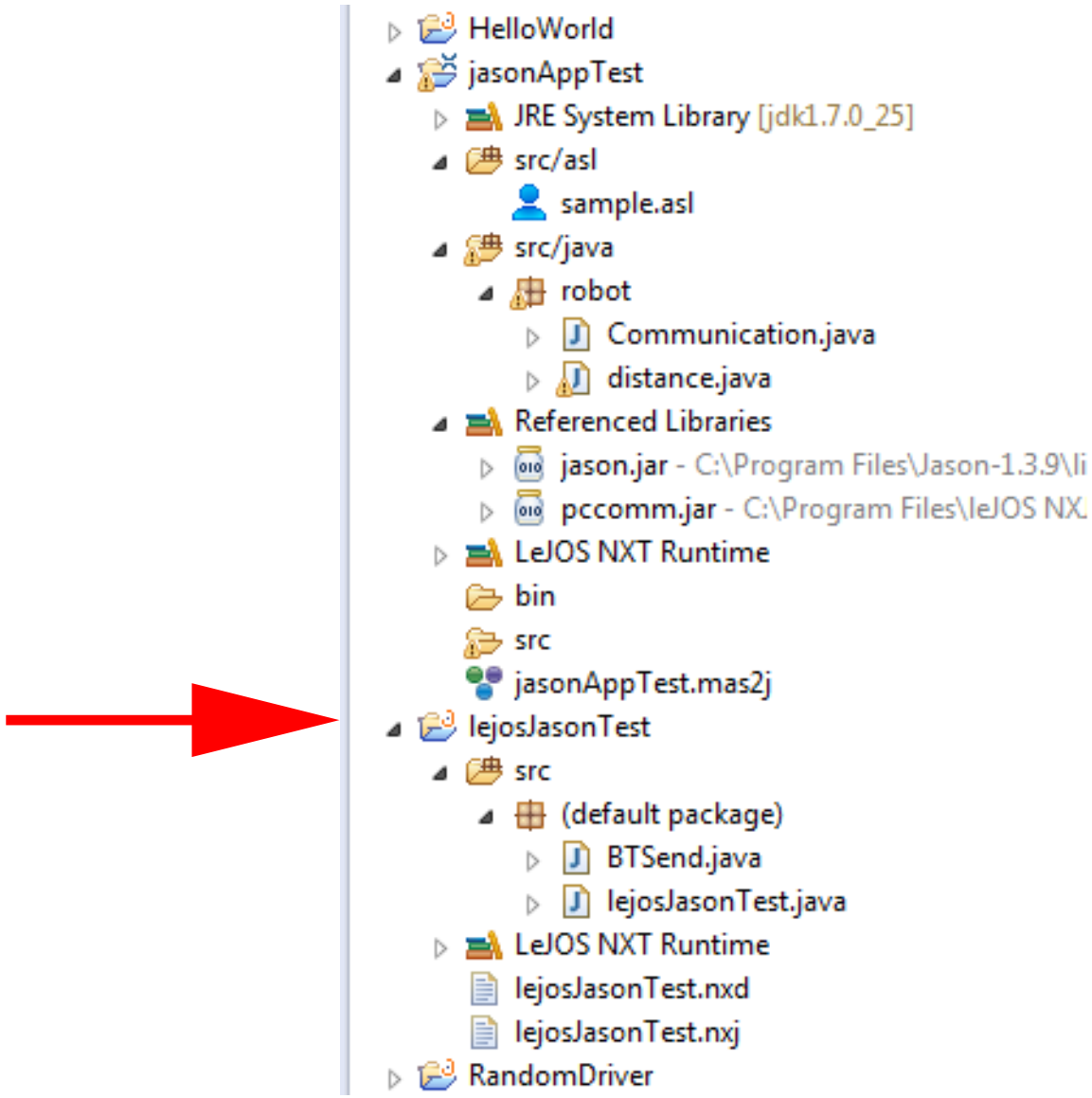
- This winds up what happens on the Jason side.
- More now to discuss what happens on the LeJOS side.
- This is just a regular LeJOS program.

On the LeJOS side



Jason Project in Eclipse containing a package with PC LeJOS code. The project loads classes for PC LeJOS

On the LeJOS side



BTSend.java

```
public class BTSend implements Runnable{
  Queue<String> q;
  NXTConnection conn;
  DataOutputStream out;

  public BTSend(NXTConnection conn){
    q = new Queue<String>();
    this.conn=conn;
    out=conn.openDataOutputStream();
  }
```

BTSend.java

- Looks a lot like `Communication.java`
- Uses `NXTConnection` to provide a connection over BlueTooth.
- Uses a (regular) `q` to load up data to send.
- Only has an output stream.

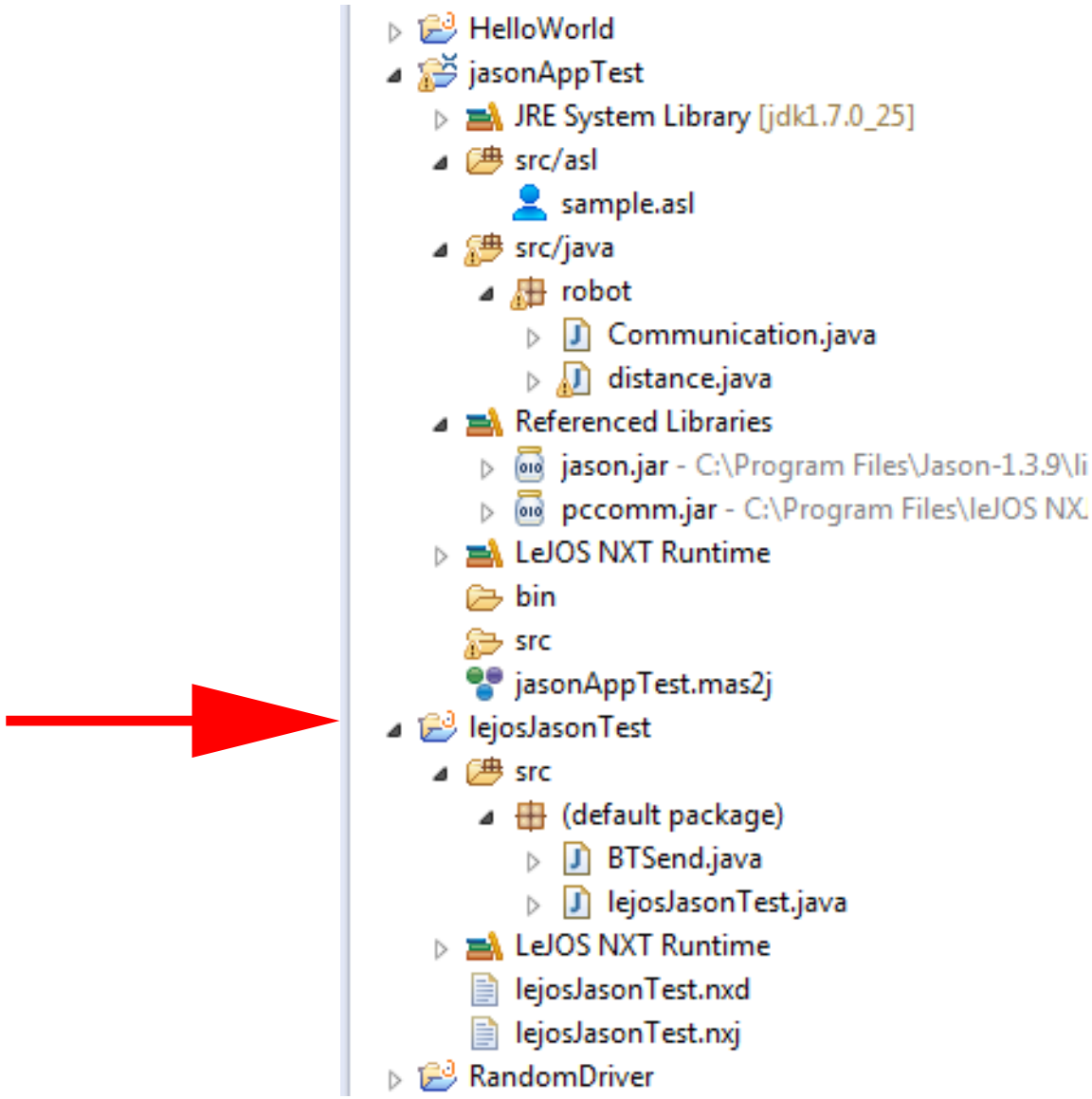
BTSend.java

```
public void run(){
  try{
    while(true){
      while(q.empty()){
        Thread.yield();
      }
      out.writeUTF((String)q.pop());
      out.flush();
    }
  }
  catch (Exception e) {}
}
```

BTSend.java

- Do nothing if q is empty.
- Else pop an item off the q and send it to the output stream.

On the LeJOS side



lejosJasonTest.java

```
import lejos.nxt.LCD;
import lejos.nxt.SensorPort;
import lejos.nxt.UltrasonicSensor;
import lejos.nxt.comm.Bluetooth;
import lejos.nxt.comm.NXTConnection;

public class lejosJasonTest {
  static UltrasonicSensor us;
  static NXTConnection conn;
  static BTSend sender;
  static Thread senderThread;
```

- Make use of `BTSend` to communicate over the `NXTConnection`

lejosJasonTest.java

```
public static void main(String[] args) throws Exception{
  us= new UltrasonicSensor(SensorPort.S3);
  int distance;

  System.out.println("Waiting");
  conn = Bluetooth.waitForConnection();
  System.out.println("Connected");

  sender = new BTSend(conn);
  senderThread = new Thread(sender);
  senderThread.setDaemon(true);
  senderThread.start();

  while(true){
    distance = us.getDistance();
    LCD.clear();
    LCD.drawString(distance+"", 0, 0);
    sender.write(distance+"");
    Thread.sleep(3000);
    }
  }
}
```

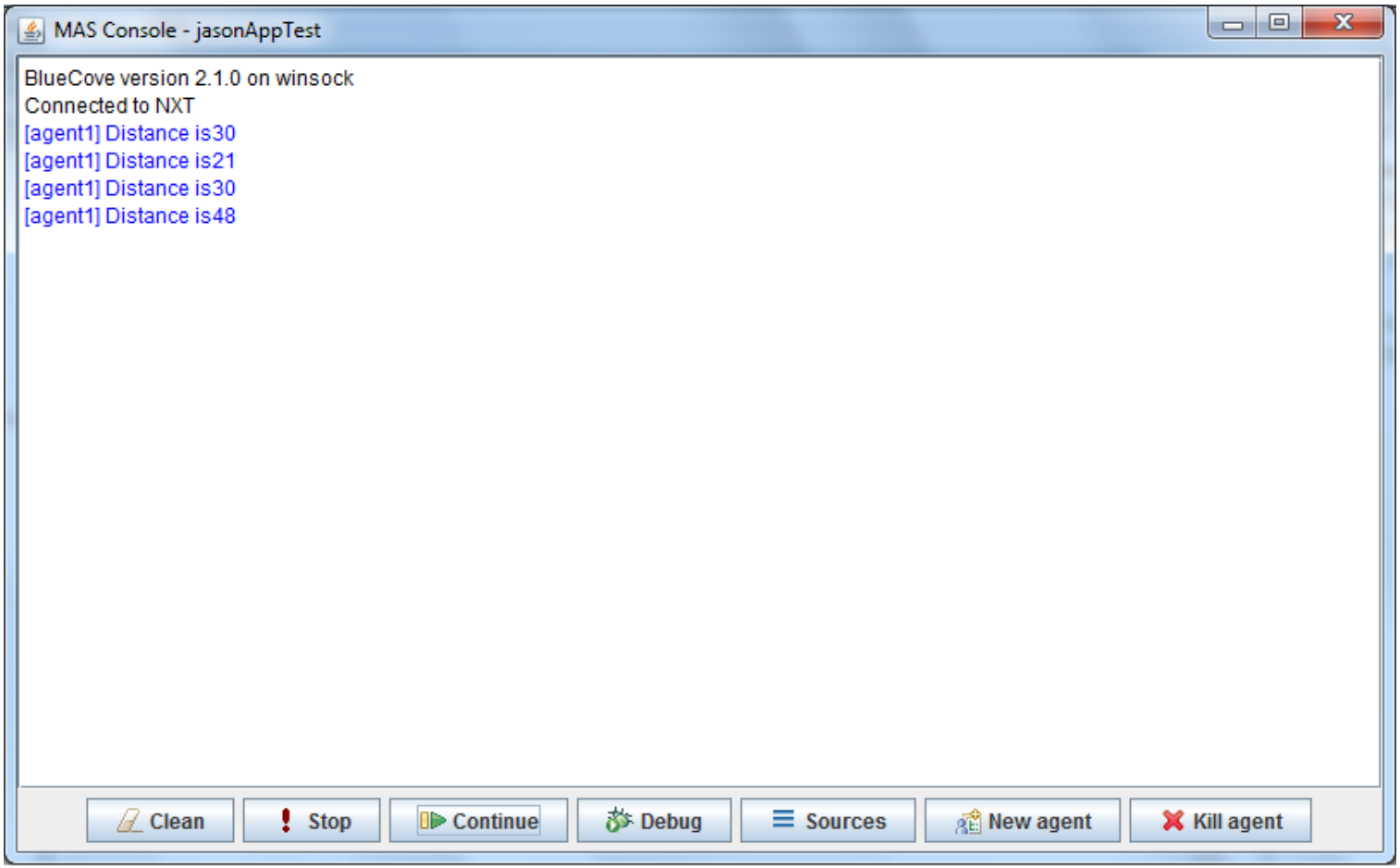
lejosJasonTest.java

- Open a Bluetooth connection.
- Use this to instantiate the `BTSend` object (which gives communication over the link)...
- ... and kick that communication off in its own thread.
- (That is what the `start` does.)
- Then, every three seconds, read the ultrasound sensor and send the result over the connection.

Next

- Now we can run it.

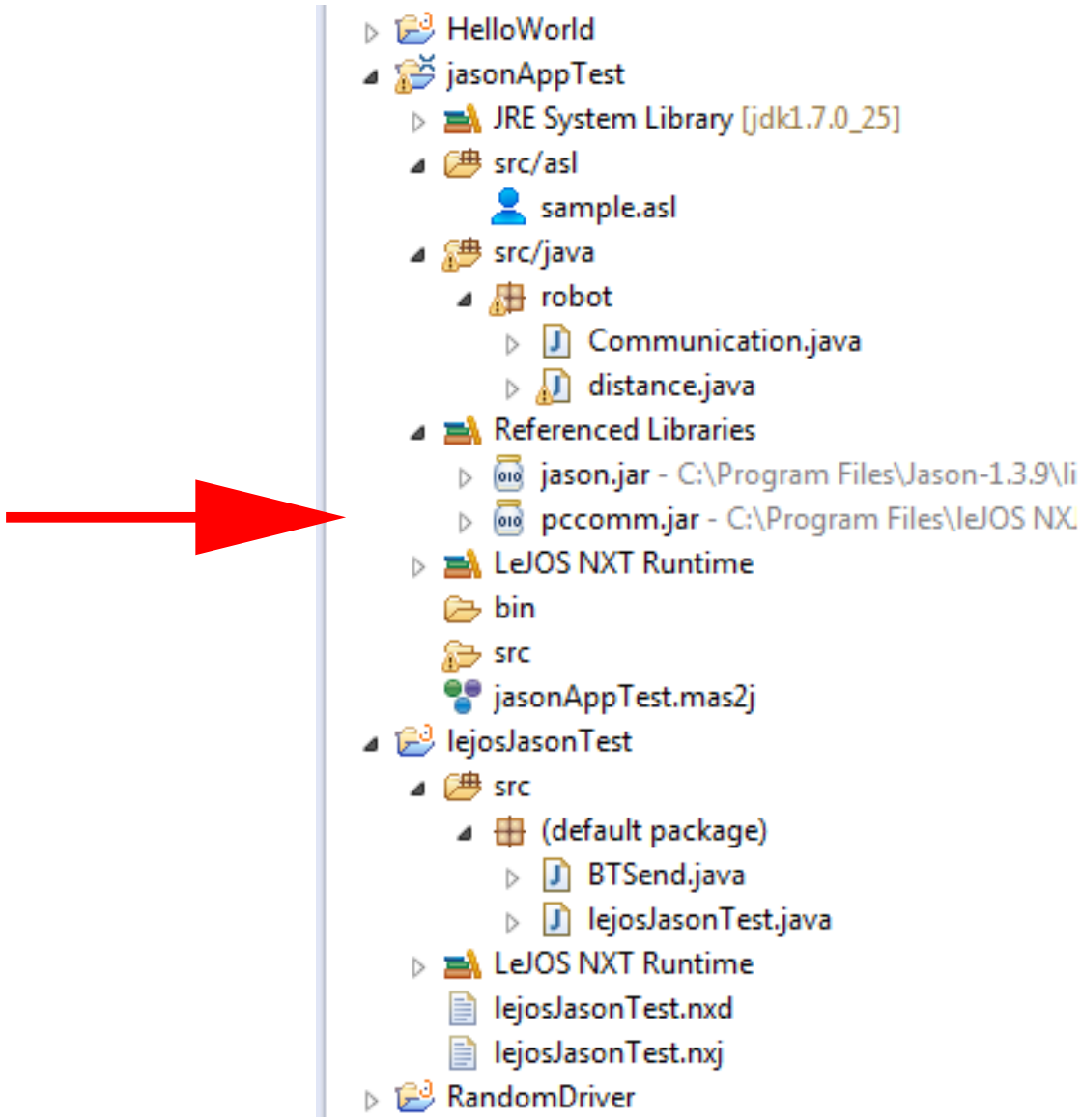
This is what you should see



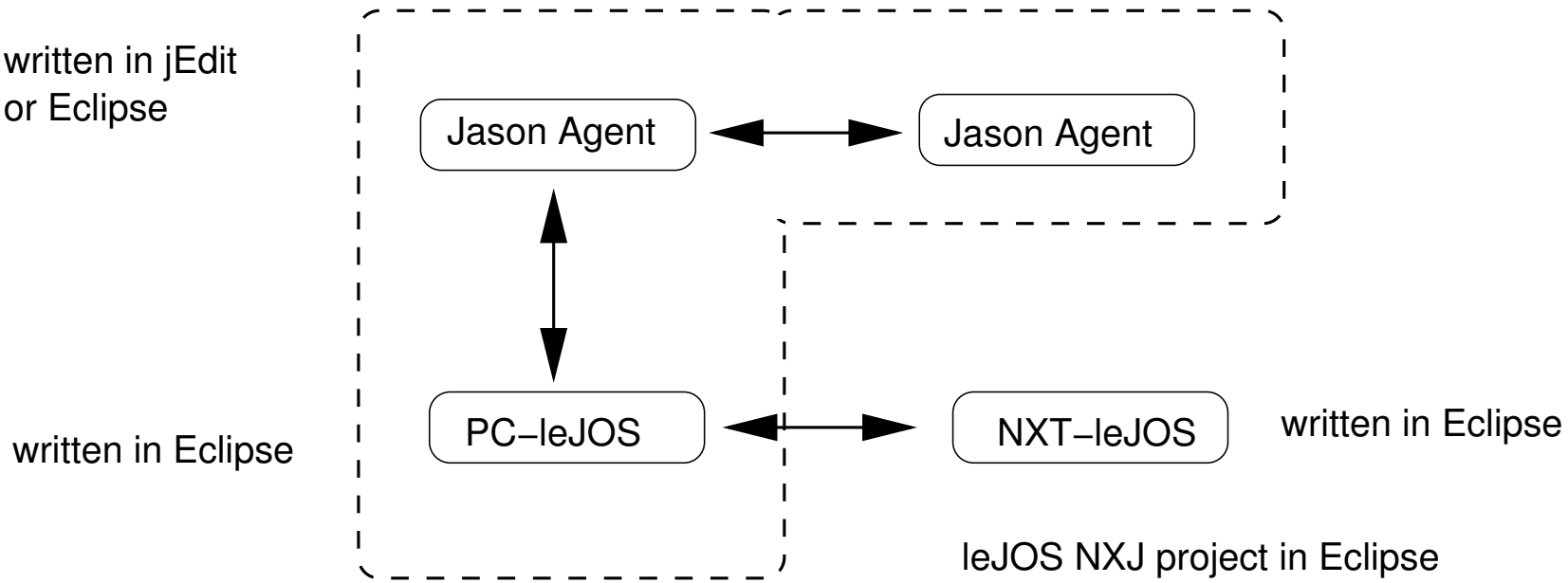
Note

- Even with these notes you will find it tricky getting things set up.

Need to include this



How the second assignment might look



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Summary

- This lecture looked at interfacing LeJOS to Jason.
- This allows a Jason agent to execute commands that have an effect on the NXT.
- (Note that this is not what happens in the example.)
- This general structure will likely be helpful in Assignment 2.