The Line-Following LEGO Robot

and programming the LEGO Mindstorms in general

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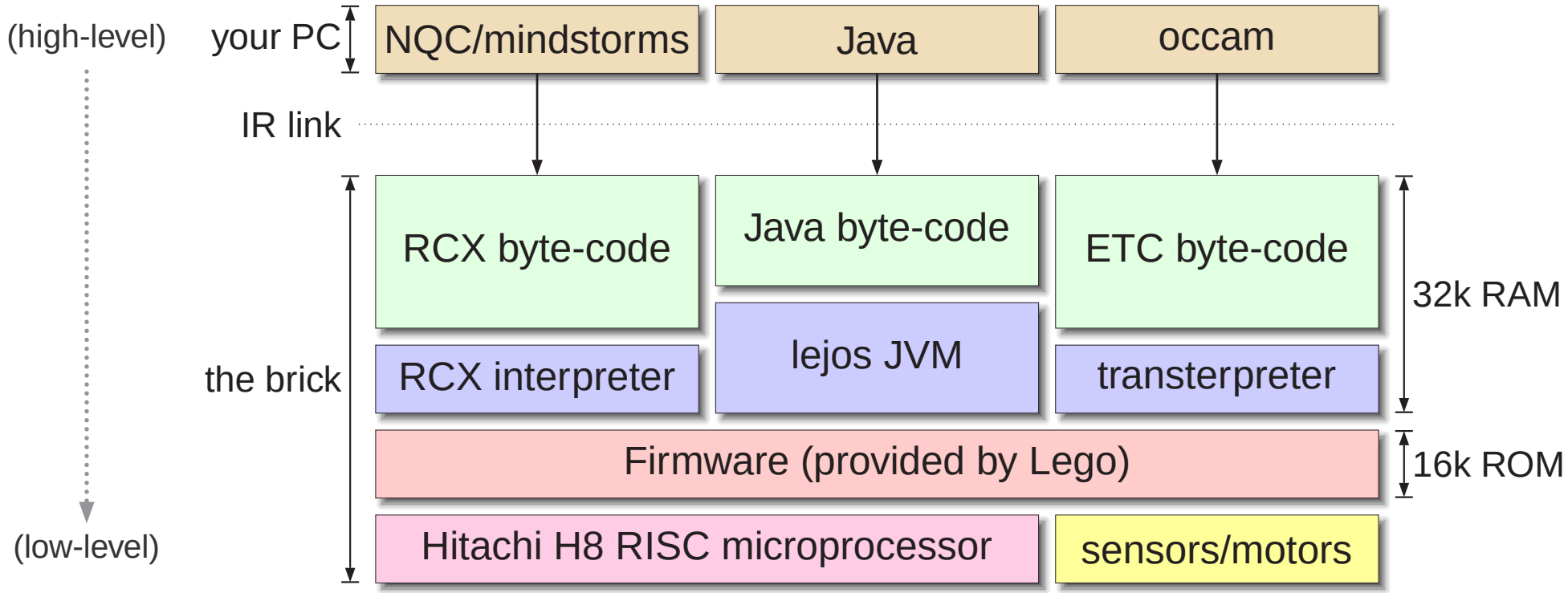
Lego Programming

- This is fun! :-)
- Uses the Lego Mindstorms “brick”
- Can drive up to 3 motors and respond to 3 sensor inputs
  - sensors include: touch, light, rotation
  - also has an IR port
- The brick contains:
  - a small 8-bit RISC architecture chip (16 MHz)
  - some memory: 32 kb of RAM, 16 kb of ROM
  - interface gadgetry (inputs, outputs, IR, buttons, display), and batteries

Lego Programming

- Programming the brick:
  - humans like abstract (or high-level) program code
  - not the low-level code the H8 processor actually executes



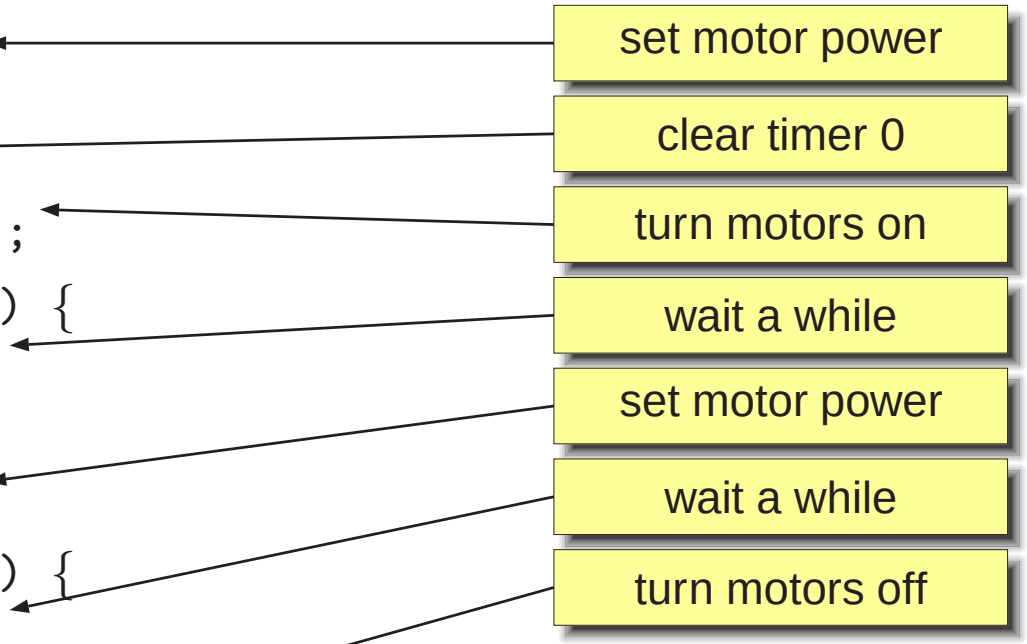
Lego Programming

- The firmware (software that is built into hardware) provides access to the device's inputs and outputs
  - also (initially) deals with downloading code via the IR port
- The various "interpreter" layers are where the magic happens
  - "RCX interpreter" runs RCX byte-code in the device
  - "lejos JVM" provides a (very basic) Java Virtual Machine that executes the Java byte-code
  - "transterpreter" runs ETC byte-code in the device
- The choice of language is up to the programmer — who only needs to deal with NQC, mindstorms, Java or occam (not any of the low-level stuff!)

Lego Programming

- NQC is a C-like language (not quite C):

```
task main ()
{
   SetPower (OUT_C, 3);
   SetPower (OUT_A, 3);
   ClearTimer (0);
   OnFwd (OUT_A + OUT_B);
   while (Timer(0) < 100) {
      /* do nothing!  */
   }
   SetPower (OUT_C, 2);
   while (Timer(0) < 200) {
      /* do nothing!  */
   }
   Off (OUT_A + OUT_B);
}
```



Lego Programming

- Java uses a special ‘brick’ API:

```
public class BrickTest {
   private static int x = 0;
   private static class MyTimer implements TimerListener {
      public void timedOut ()
      {
         if (x == 0) {
            Motor.C.setPower (2);
         } else {
            Motor.A.stop ();
            Motor.C.stop ();
         }
         x = x + 1;
      }
   }
```

Lego Programming

- And the programming is slightly different:

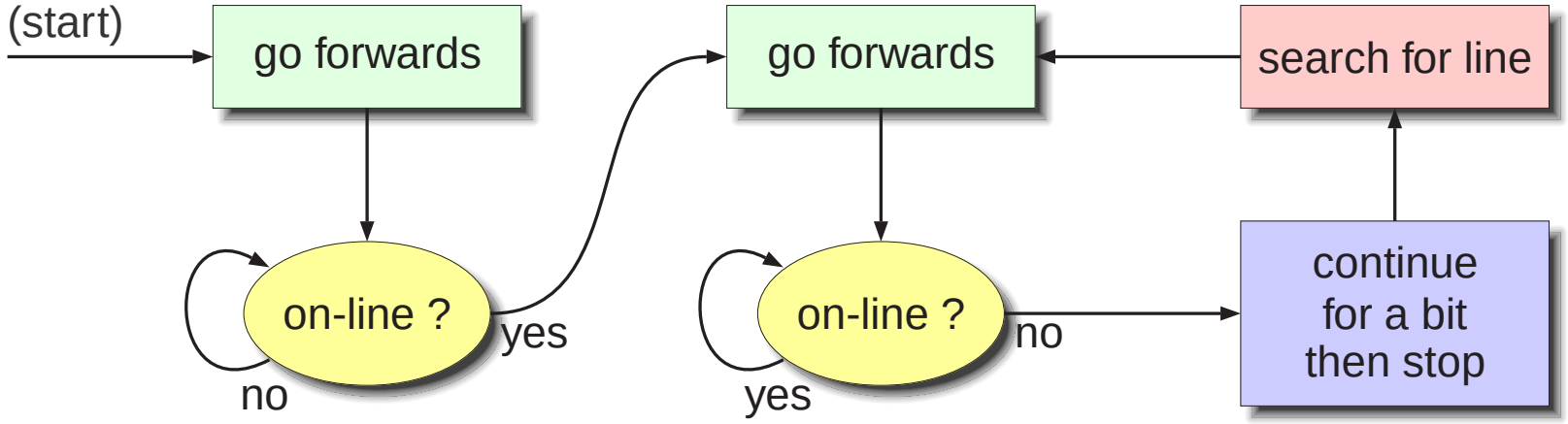
```
public static void main ()
{
   Motor.C.setPower (3);
   Motor.A.setPower (3);

   TimerListener tl = new MyTimer ();
   Timer tim = new Timer (1000, tl);

   Motor.A.forward ();
   Motor.C.forward ();
   tim.start ();

   // now do nothing forever (!)
   for (;;);
}
}
```

the first time the timer goes off, it changes the motor power (speed)

every time after that, if just turns the motors off

The Line Following Robot

- This robot attempts to follow a line drawn on the ground underneath it
  - two motors: left and right
  - one sensor: light
- Basic operation is this:



- Searching for the line is the hard part ...

The Line Following Robot

- Finding the line is done by turning the robot left and right (looking)
  - physical configuration of this robot helps :-)