# MOBILE DEVELOPMENT

INTENT

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# ANDROID’S THREADS

On certain occasions a single app may want to do more than one ‘thing’ at the same time. For instance, show an animation, download a large file from a website, and maintain a responsive UI for the user to enter data. One solution is to have the app run those individual concurrent actions in separate threads.

The Java Virtual-Machine provides its own Multi-Threading architecture (as a consequence the JVM & Dalvik-VM are hardware independence).

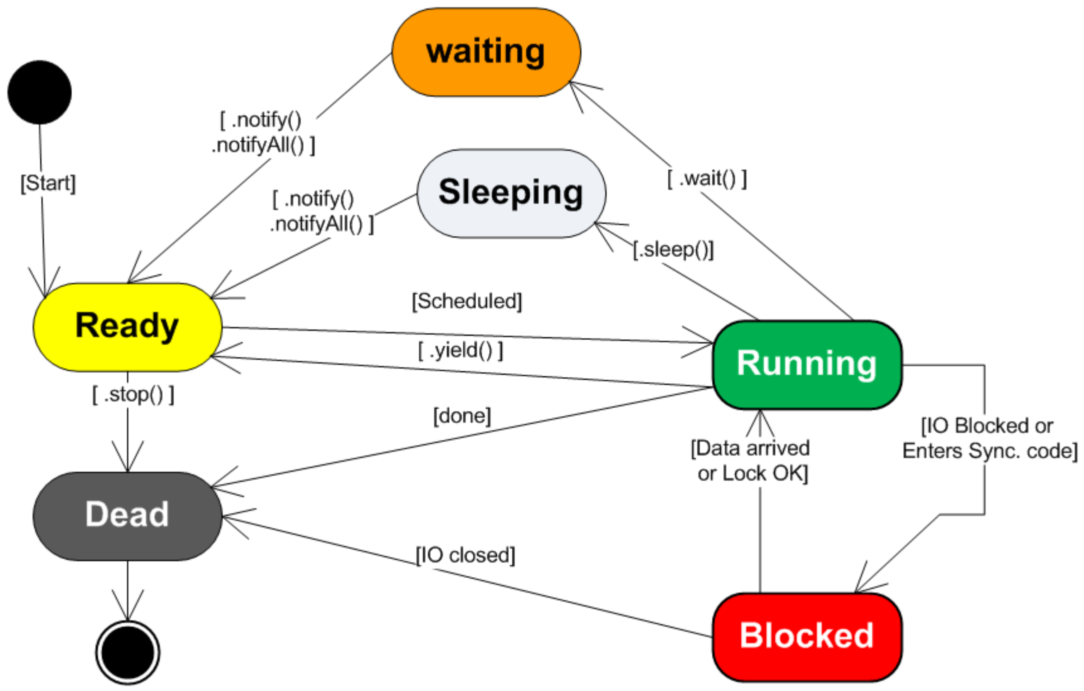
Threads in the same VM interact and synchronize by the use of shared objects and monitors .

Each virtual machine instance has at least one main thread .

Each thread has its own call stack. The call stack is used on method calling, parameter passing, and storage of the called method’s local variables.

# ANDROID'S THREADS
# (Life cycle of a Java thread)

Java threading provides its own abstraction of concurrent execution (which is hardware & OS independent). The activity diagram below shows the different possible states a Java thread could reach during its life-cycle.



# ANDROID’S THREADS
# (Creating and executing threads)

The following are two strategies for creating and executing a Java Thread

Style1. Create a new Thread instance passing to it a Runnable object.

```
Runnable myRunnable1 = new MyRunnableClass();
Thread t1 = new Thread(myRunnable1);
t1.start();
```

Style2. Create a new custom sub-class that extends Thread and override its run() method.

```
MyThread t2 = new MyThread();
t2.start();
```

In both cases, the start() method must be called to execute the new Thread. (Use runnable on classes that want to fork but already extend another class)

# ANDROID’S THREADS (Classic Java JDK monitors - mutex)

A monitor is a region of critical code executed by only one thread at the time. To implement a Java Monitor you may use the synchronized modifier, and obtain a mutually exclusive lock on an object (data or code). When a thread acquires a lock of an object (for reading or writing), other threads must wait until the lock on that object is released.

```
public synchronized void methodToBeMonitored() {
  // place here your code to be lock-protected
  // (only one thread at the time!)
}
public synchronized int getGlobalVar() { return globalVar; }
public synchronized void setGlobalVar(int newGlobalVar) { this.globalVar = newGlobalVar; }
public synchronized int increaseGlobalVar(int inc) { return globalVar += inc; }
```

Another expression to obtain a mutually exclusive lock on an object follows:

```
synchronized ( object ) {
  //place here your code to exclusively work on the locked object (only one thread at the time!)
}
```

**Warning**
**synchronized** doesn't support separate locks for reading and writing. This restriction creates lower than desired performance as no multiple-readers are allowed on a resource. A better solution is ReadWriteLocks

# ANDROID'S THREADS (Classic Java JDK monitors - mutex)

Better performance occurs when multiple threads are allowed to simultaneously read from a shared resource. Still, only one writer should be allowed in the critical region. Java supports dual Read/Write locks as shown below:

```
ReadWriteLock rwLock = new ReentrantReadWriteLock();
rwLock.readLock().lock();
  // multiple readers can enter this section
  // (as long as no writer has acquired the lock)
rwLock.readLock().unlock();
rwLock.writeLock().lock();
  // only one writer can enter this section,
  // (as long as no current readers locking)
rwLock.writeLock().unlock();
```

# ANDROID'S THREADS (JAVA SEMAPHORES)

Counting Semaphores maintain a pool of n permits. They can act as a gate guardian that allows up to n threads at a time, as well as (2) a mechanism for sending signals between two threads.

In the fragment below a semaphore reserves up to n permits. A thread trying to enter the critical section will first try to acquire n1 of the remaining passes, if all of the n1 are obtained it enter the critical section, and then release n2 passes. If all requested passes cannot be obtained the thread waits in the semaphore until they become available (Caution: starvation, seniority rights)

```java
int n = 1;
Semaphore semaphore = new Semaphore(n);
semaphore.acquire(n1);
// put your critical code here
semaphore.release(n2);
```

# ANDROID'S THREADS (Java JDK BlockingQueues)

The BlockingQueue class exposes a synchronized queue to any number of producers and consumers. It is implemented using one of the following concrete classes: ArrayBlockingQueue, DelayQueue, LinkedBlockingDeque, PriorityBlockingQueue, and SynchronousQueue.

- ArrayBlockingQueue<String> queue = new ArrayBlockingQueue<String>(4);
- Producer producer = new Producer(queue);
- Consumer consumer = new Consumer(queue);
- new Thread(producer).start();
- new Thread(consumer).start();

| **Producer(s)** | **BlockingQueue** | **Consumer(s)** |
|---|---|---|
| queue.put("Data1");<br>...<br>queue.put("Data2"); | → → | queue.take()<br>. . .<br>queue.take() |

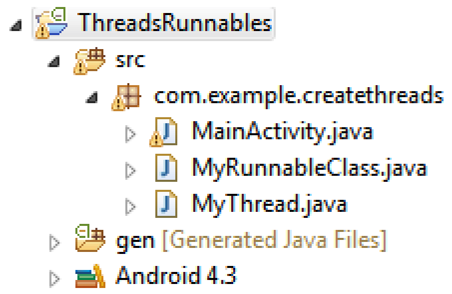
# ANDROID'S THREADS (Example: creating 2 threads)

1. (Style1) Create a common Thread, pass a custom Runnable.

2. (Style2) Create a custom Thread, override its run() method.

```java
public class MainActivity extends Activity {
  @Override
  public void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.activity_main);
    Runnable myRunnable1 = new MyRunnableClass();
    Thread t1 = new Thread(myRunnable1); t1.start();
    MyThread t2 = new MyThread(); t2.start();
  }//onCreate
}
```

```java
public class MyRunnableClass implements Runnable {
  @Override
  public void run() {
    try {
      for (int i = 100; i < 105; i++){
        Thread.sleep(1000);
        Log.e ("t1:<<runnable>>", "runnable talking: " + i);
      }
    }
    catch (InterruptedException e) { Log.e ("t1:<<runnable>>", e.getMessage() ); }
  }//run
}//class
```



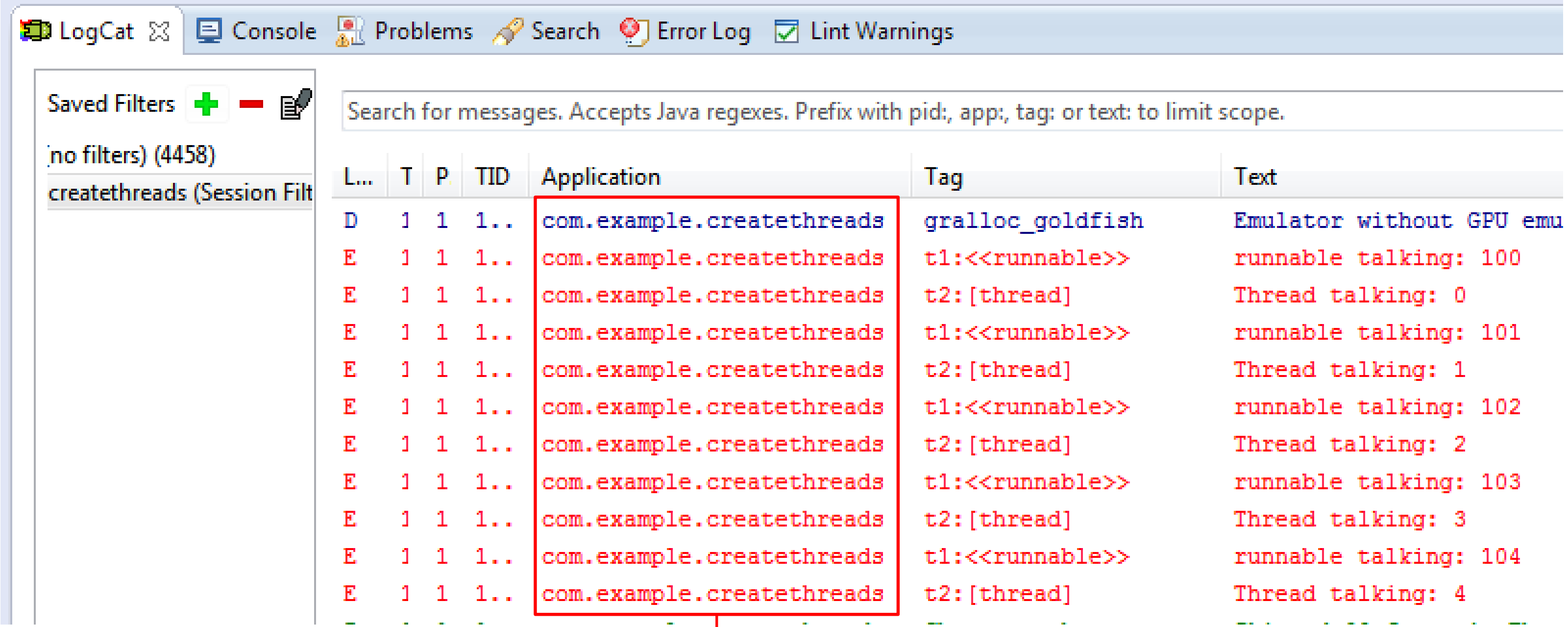

```java
public class MyThread extends Thread{
  @Override
  public void run() {
    super.run();
    try {
      for(int i=0; i<5; i++){ Thread.sleep(1000); Log.e("t2:[thread]", "Thread talking: " + i); }
    }
    catch (InterruptedException e) { Log.e("t2:[thread]", e.getMessage() ); }
  }//run}
```

You need to implement the Runnable interface and provide a version of its mandatory run() method.
Thread.sleep(1000) fakes busy work, the thread sleeps 1000 milisec (see LogCat)

You need to extend the Thread class and provide a version of its mandatory run() method.
Thread,sleep(1000) fakes busy work, the thread sleeps 1000 milisec (see LogCat)

# ANDROID’S THREADS (Example: creating 2 threads)

Creating (executing) two threads using different programming styles.




| L... | T | P | TID | Application | Tag | Text |
|---|---|---|---|---|---|---|
| D | 1 | 1 | 1.. | com.example.createthreads | gralloc_goldfish | Emulator without GPU emu |
| E | 1 | 1 | 1.. | com.example.createthreads | t1:<<runnable>> | runnable talking: 100 |
| E | 1 | 1 | 1.. | com.example.createthreads | t2:[thread] | Thread talking: 0 |
| E | 1 | 1 | 1.. | com.example.createthreads | t1:<<runnable>> | runnable talking: 101 |
| E | 1 | 1 | 1.. | com.example.createthreads | t2:[thread] | Thread talking: 1 |
| E | 1 | 1 | 1.. | com.example.createthreads | t1:<<runnable>> | runnable talking: 102 |
| E | 1 | 1 | 1.. | com.example.createthreads | t2:[thread] | Thread talking: 2 |
| E | 1 | 1 | 1.. | com.example.createthreads | t1:<<runnable>> | runnable talking: 103 |
| E | 1 | 1 | 1.. | com.example.createthreads | t2:[thread] | Thread talking: 3 |
| E | 1 | 1 | 1.. | com.example.createthreads | t1:<<runnable>> | runnable talking: 104 |
| E | 1 | 1 | 1.. | com.example.createthreads | t2:[thread] | Thread talking: 4 |

Interleaved execution of threads: t1 and t2. Both are part of the CreateThreads process

# ANDROID’S THREADS (Advantages of multi-threading)

The various functional components of an application could be abstracted around the notion of serial or parallel actions.

Serial actions could be implemented using common class methods, while parallel activity could be assigned to independent threads.

Threads could share the data resources held in the process that contain them.

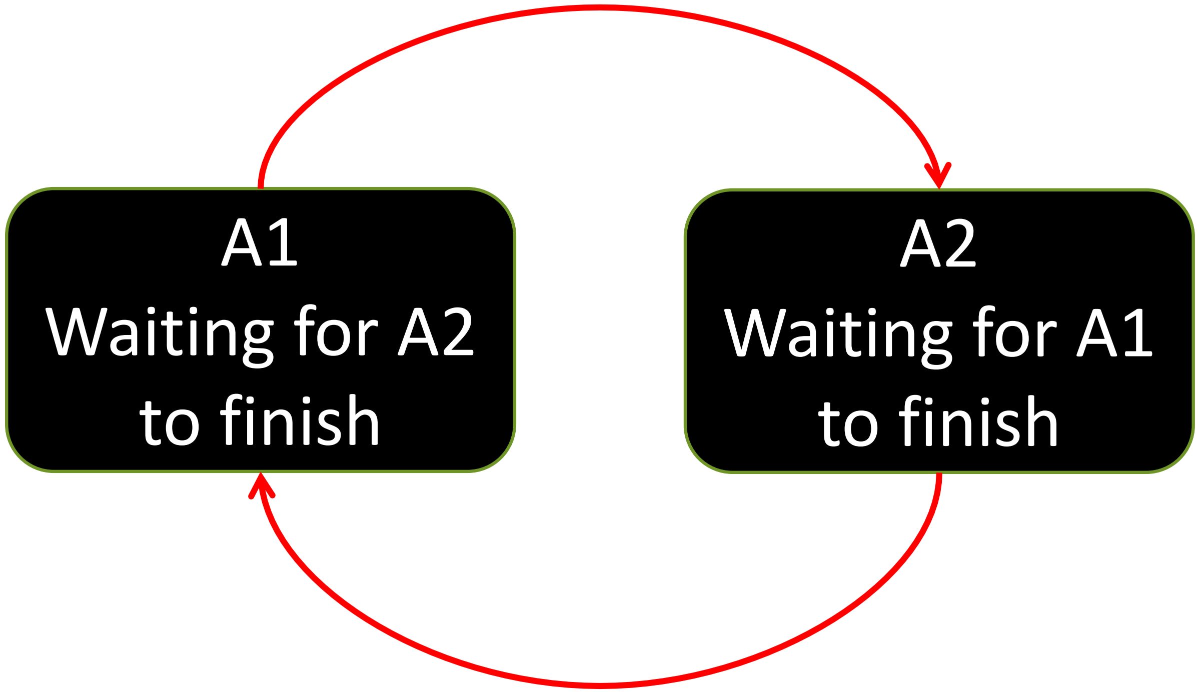
Responsive applications can be easily created by placing the logic controlling the user’s interaction with the UI in the application’s main thread, while slow processes can be assigned to background threads.

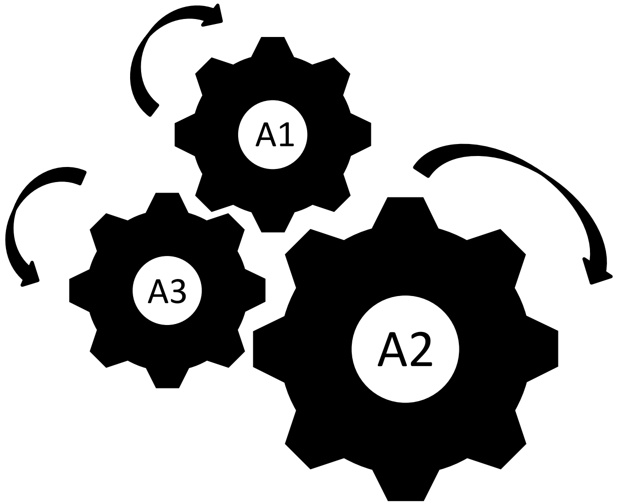
A multithreaded program operates faster on computer systems that have multiple CPUs. Observe that most current Android devices do provide multiple processors.

# ANDROID’S THREADS (Disadvantages of multi-threading)

1. Code tends to be more complex

2. Need to detect, avoid, resolve deadlocks



# ANDROID'S STRATEGIES FOR EXECUTION OF SLOW ACTIVITIES

Problem: An application may involve the use of a time-consuming operation. When the slow portion of logic executes the other parts of the application are blocked.

Goal: We want the UI (and perhaps other components) to be responsive to the user in spite of its heavy load.

Solution: Android offers two ways for dealing with this scenario:

- 1. Do expensive operations in a background service, using notifications to inform users about next step.
- 2. Do the slow work in a background thread.

Using Threads: Interaction between Android threads (Main and background) is accomplished using

- (a) a main thread Handler object and
- (b) posting Runnable objects to the main view.

# ANDROID’S STRATEGIES FOR EXECUTION OF SLOW ACTIVITIES (Handler class)

The main thread may use its MessageQueue to manage interactions between the main and background threads it creates.

The message queue acts as a semaphore protected priority-queue with the capacity to enqueue tokens containing messages or runnables sent by the secondary threads.

By protocol, children threads must request empty tokens from the ancestor’s queue, fill them up, and then send back to the parent’s queue.

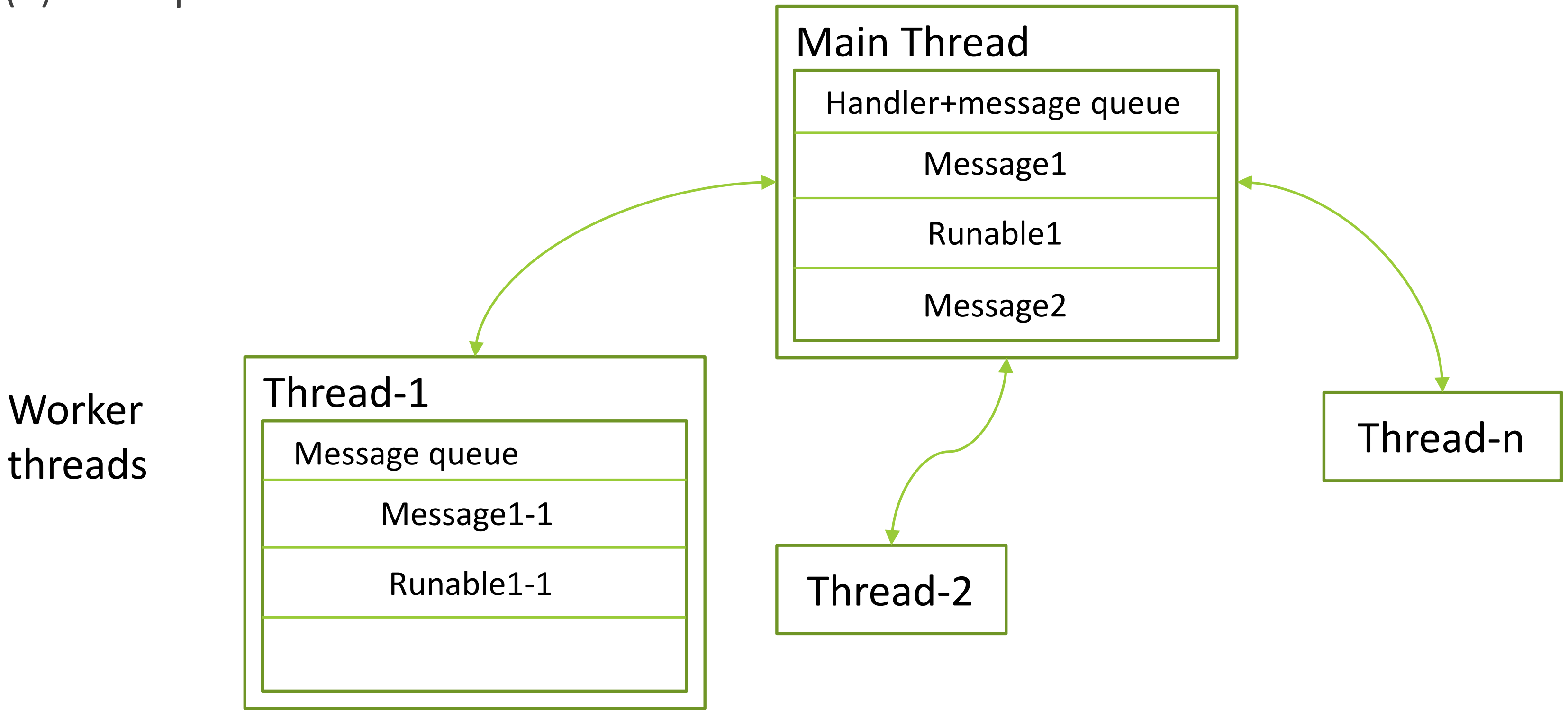
In Android’s architecture each thread has a MessageQueue. To use it, a Handler object must be created.

The Handler will enqueue messages and runnables to the parent’s message queue. Those requests will later be executed in the order in which they are removed (dequeue) from the message queue.

# ANDROID'S STRATEGIES FOR EXECUTION OF SLOW ACTIVITIES (Handler class)

A Handler is used to support two important operations:

- (1) to schedule messages and runnables to be executed as some point in the future; and
- (2) to enqueue an act



# ANDROID’S STRATEGIES FOR EXECUTION OF SLOW ACTIVITIES (Warning)

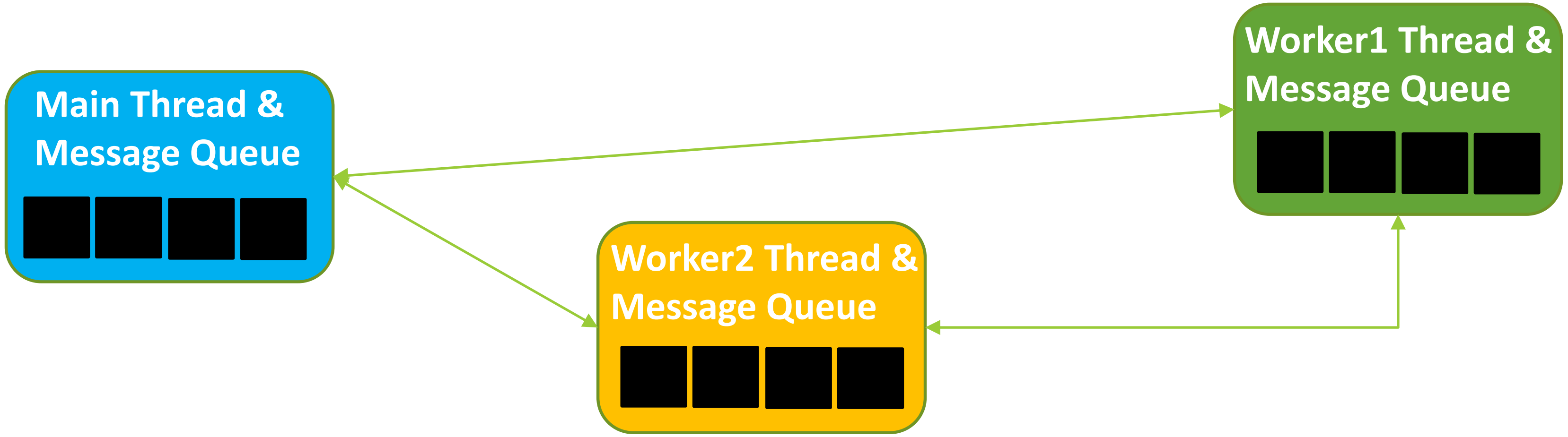
Threads cannot touch the app’s UI. Android’s background threads are not allowed to interact with the UI.

- Only the main process can access the activity’s view and interact with the user. Consequently all input/output involving what the user sees or supplies must be performed by the main thread.
- A simple experiment. Add a Toast message to the run() methods implemented in Example1. Both should fail!
- Class variables (defined in the Main thread) can be seen and updated by the threads

# ANDROID'S STRATEGIES FOR EXECUTION OF SLOW ACTIVITIES (Inter-Thread communications)

Typically the main UI thread sets a handler to get messages from its worker threads; however each worker thread could also define its own handler.

A handler in the worker thread creates a local message-queue which could be used to receive messages from other threads (including main).



# ANDROID’S STRATEGIES FOR EXECUTION OF SLOW ACTIVITIES (Handler-Message protocol)

A background-to-foreground thread communication is initiated by the background worker (producer) by requesting a message token from the main thread (consumer). The obtainMessage() method is used to negotiate the acquisition of the token, which acts as a special envelope with various pre-defined compartments for data to be inserted.

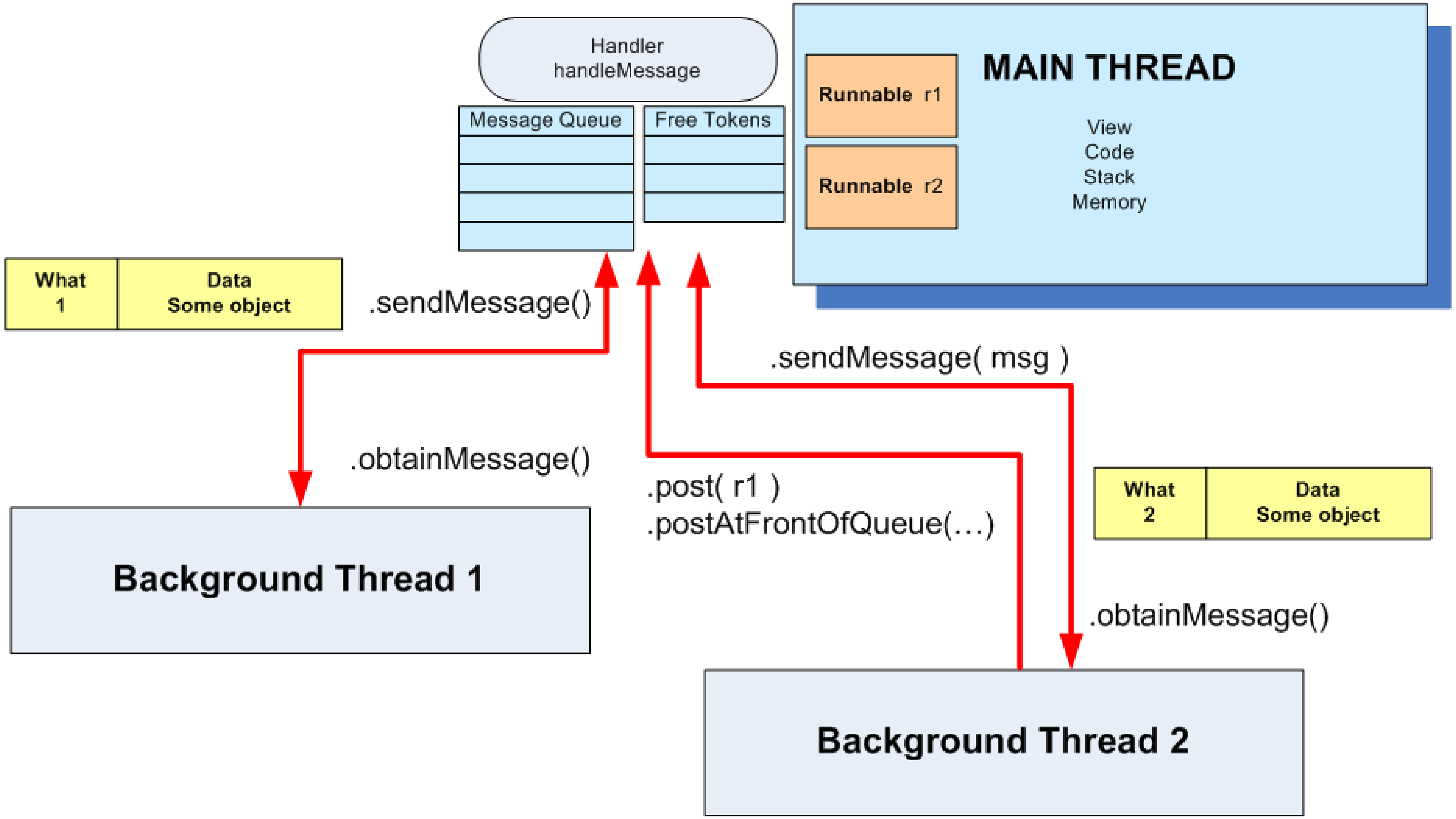
After the empty token is received, the background thread can enter its local data into the message token. Local data could be anything ranging from a few numeric values to any custom object. Finally the token is attached to the Handler’s message queue using the sendMessage() method.

The consumer’s Handler uses the handleMessage() method to listen for new messages arriving from the producers.

A message taken from the queue to be serviced, could either

- Pass some data to the main activity or
- Request the execution of runnable objects through the post() method.

# ANDROID'S STRATEGIES FOR EXECUTION OF SLOW ACTIVITIES (Handler-Message architecture)



# ANDROID'S STRATEGIES FOR EXECUTION OF SLOW ACTIVITIES (Using Messages)

| Main Thread | Background Thread |
| --- | --- |
| ...<br>Handler myHandler= new Handler() {<br>  @Override<br>  public void handleMessage(Message msg) {<br>    // do something with the message...<br>    // update GUI if needed!<br>    ...<br>  }//handleMessage<br>};//myHandler<br>... | ...<br>Thread backgJob = new Thread (new Runnable (){<br>  @Override<br>  public void run() {<br>    // do some busy work here<br>    // ...<br>    // get a token to be added to the main's message queue<br>    Message msg= myHandler.obtainMessage();<br>    ...<br>    // deliver message to the main's message-queue<br>    myHandler.sendMessage(msg);<br>  }//run<br>});//Thread<br>// this call executes the parallel thread<br>backgroundJob.start();<br>. . . |

# ANDROID'S STRATEGIES FOR EXECUTION OF SLOW ACTIVITIES (Using Runnables)

<table>
<tr><th>Main Thread</th><th>Background Thread</th></tr>
<tr><td>

```
...
Handler myHandler = new Handler();
  @Override
  public void onCreate(Bundle savedInstanceState){
    ...
    Thread myThread1 = new Thread(backgroundTask, “backAlias1”);
    myThread1.start();
  }//onCreate
...
// this is the foreground runnable
private Runnable foregroundTask = new Runnable() {
  @Override
  public void run() {
    // work on the UI if needed
  }
...
```

</td><td>

```
// this is the "Runnable" object
// representing the background thread
private Runnable backgroundTask = new Runnable () {
  @Override
  public void run() {
    // Do some background work here
    myHandler.post(foregroundTask);
  }//run
};//backgroundTask
```

</td></tr>
</table>

# ANDROID’S STRATEGIES FOR EXECUTION OF SLOW ACTIVITIES (obtainMessage method)

To send a Message to a Handler, the thread must first invoke obtainMessage() to get the Message object out of the pool.

There are various versions of obtainMessage(). They allow you to create an empty Message object, or messages holding arguments

**Example**

```
// assume thread 1 produces some local data
String localData = “Greetings from thread 1”;
// thread 1 requests a message & adds localData to it
Message mgs = myHandler.obtainMessage (1, localData);
```

# ANDROID'S STRATEGIES FOR EXECUTION OF SLOW ACTIVITIES (sendMessage methods)

There is a number of sendMessage...() methods that can be used by secondary threads to send messages to their corresponding primary thread.

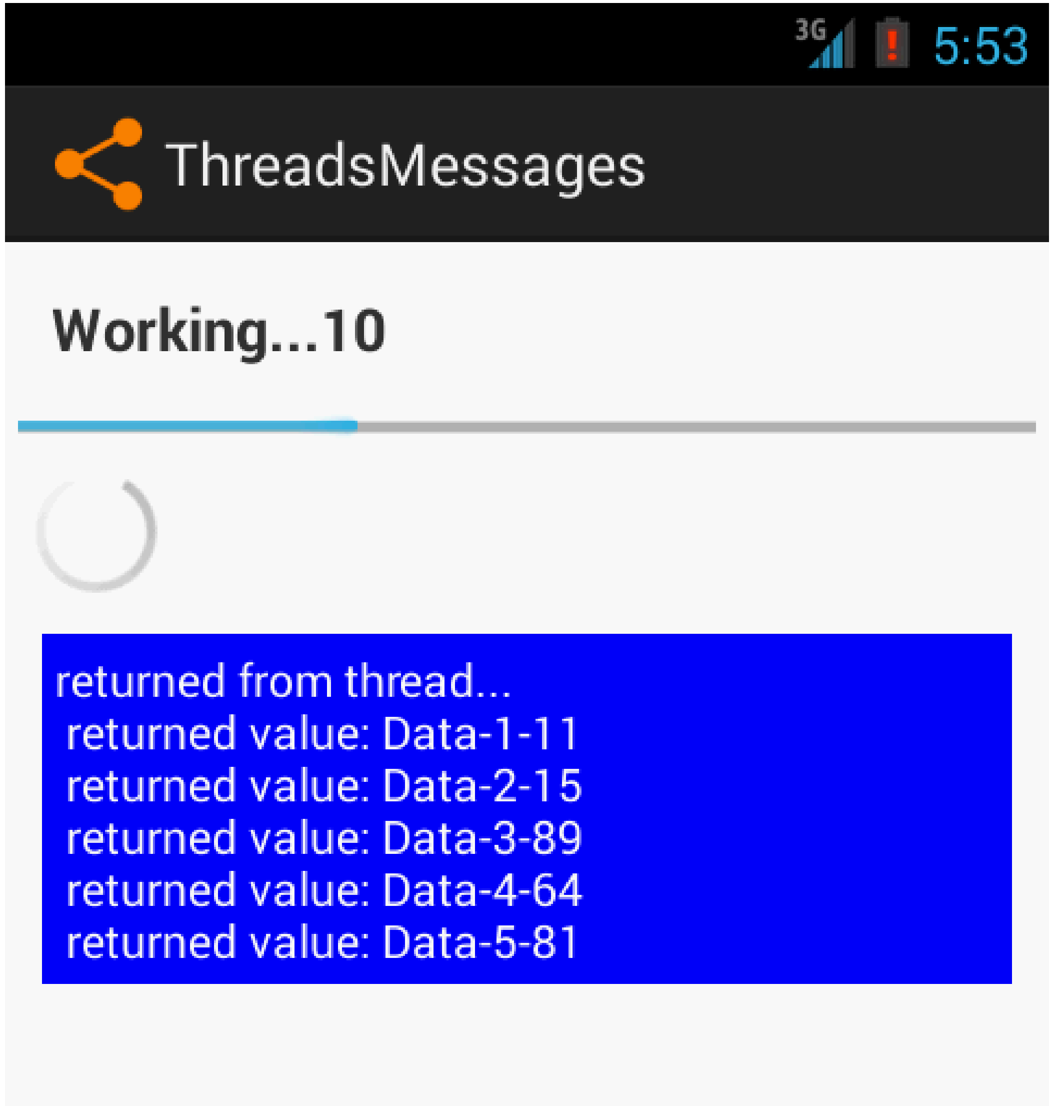
- sendMessage() puts the message at the end of the queue immediately
- sendMessageAtFrontOfQueue() puts the message at the front of the queue immediately (versus the back, as is the default), so your message takes priority over all others
- sendMessageAtTime() puts the message on the queue at the stated time, expressed in the form of milliseconds based on system uptime (SystemClock.uptimeMillis())
- sendMessageDelayed() puts the message on the queue after a delay, expressed in milliseconds

# ANDROID'S STRATEGIES FOR EXECUTION OF SLOW ACTIVITIES (Processing incoming messages)

To process messages sent by the background threads, your Handler needs to implement the listener: handleMessage( Message msg )

which will be called with each message that appears on the message queue.

There, the handler can update the UI as needed. However, it should still do that work quickly, as other UI work is suspended until the Handler is done.




# ANDROID'S STRATEGIES FOR EXECUTION OF SLOW ACTIVITIES (Ex: Main-Background communication using messages)

In this example, the main thread presents a horizontal and a circular progress bar widget signaling the progress made by a slow cooperative background operation.

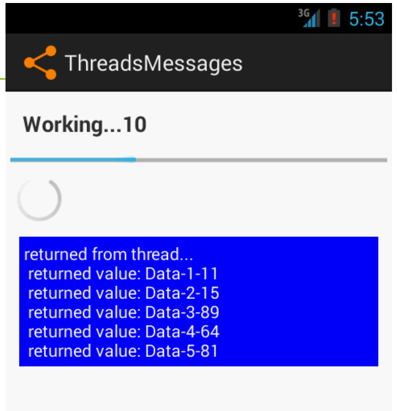
To simulate the job performed by the worker thread, some randomly generated result is periodically sent to the main thread.

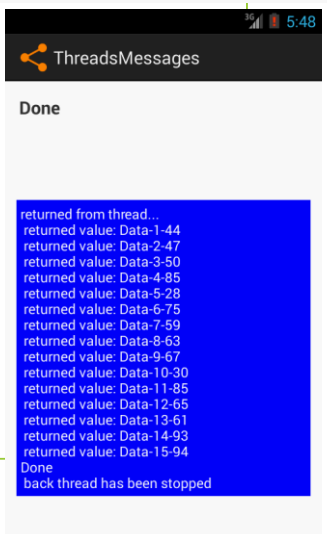
These values are used to update the app's UI and maintain the user informed of the actions realized by the background process.

# ANDROID’S STRATEGIES FOR EXECUTION OF SLOW ACTIVITIES (Ex: Main-Background communication using messages)

## XML Layout

```
<?xml version=“1.0” encoding=“utf-8”?>
<LinearLayout xmlns:android= “http://schemas.android.com/apk/res/android” android:layout_width=“match_parent”
                  android:layout_height=“match_parent” android:background=“#44ffff00”
                  android:orientation=“vertical” android:padding=“4dp” >
 <TextView        android:id=“@+id/txtWorkProgress” android:layout_width=“match_parent”
                  android:layout_height=“wrap_content” android:padding=“10dp”
                  android:text=“Working ....” android:textSize=“18sp” android:textStyle=“bold” />
 <ProgressBar     android:id=“@+id/progress1” style=“?android:attr/progressBarStyleHorizontal”
                  android:layout_width=“match_parent” android:layout_height=“wrap_content” />
 <ProgressBar     android:id=“@+id/progress2” android:layout_width=“wrap_content” android:layout_height=“wrap_content” />
 <ScrollView      android:id=“@+id/myscroller” android:layout_width=“match_parent” android:layout_height=“wrap_content” >
  <TextView       android:id=“@+id/txtReturnedValues” android:layout_width=“match_parent”
                  android:layout_height=“wrap_content” android:layout_margin=“7dp”
                  android:background=“#ff0000ff” android:padding=“4dp”
                  android:text=“returned from thread...” android:textColor=“@android:color/white” android:textSize=“14sp” />
 </ScrollView>
</LinearLayout>
```



# ANDROID'S STRATEGIES FOR EXECUTION OF SLOW ACTIVITIES (Ex: Main-Background communication using messages)

**MainActivity.java**

```java
public class ThreadsMessages extends Activity {
  ProgressBar bar1, bar2; TextView msgWorking, msgReturned; ScrollView myScrollView;
  // this is a control var used by backg. threads
  protected boolean isRunning = false;
  // lifetime (in seconds) for background thread
  protected final int MAX_SEC = 30;
  // global value seen by all threads – add synchonized get/set
  protected int globalIntTest = 0;
1 Handler handler = new Handler() {
    @Override
    public void handleMessage(Message msg) {
2     String returnedValue = (String)msg.obj;
      //do something with the value sent by the background thread here
      msgReturned.append("\n returned value: " + returnedValue );
3     myScrollView.fullScroll(View.FOCUS_DOWN);
      bar1.incrementProgressBy(1);
      //testing early termination
      if (bar1.getProgress() == MAX_SEC){
        msgReturned.append("\nDone \n back thread has been stopped"); isRunning = false;
      }
      if (bar1.getProgress() == bar1.getMax()){
        msgWorking.setText("Done");
4       bar1.setVisibility(View.INVISIBLE); bar2.setVisibility(View.INVISIBLE);
      }
      else { msgWorking.setText("Working..." + bar1.getProgress() ); } } }; //handler
```

```java
@Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle); setContentView(R.layout.main);
    bar1 = (ProgressBar) findViewById(R.id.progress1);
5   bar1.setProgress(0); bar1.setMax(MAX_SEC);
    bar2 = (ProgressBar) findViewById(R.id.progress2);
    msgWorking = (TextView)findViewById(R.id.txtWorkProgress);
    msgReturned = (TextView)findViewById(R.id.txtReturnedValues);
    myScrollView = (ScrollView)findViewById(R.id.myscroller);
    // set global var (to be accessed by background thread(s))
    globalIntTest = 1;
  }//onCreate
```

# ANDROID'S STRATEGIES FOR EXECUTION OF SLOW ACTIVITIES (Ex: Main-Background communication using messages)

## MainActivity.java

```
public void onStart() {
 super.onStart();
 Thread background = new Thread(new Runnable() {
 public void run() {
  try {
   for (int i = 0; i < MAX_SEC && isRunning; i++) {
    // try a Toast method here (it will not work!) fake busy busy work here
6   Thread.sleep(1000); // 1000 msec.
    // this is a locally generated value between 0-100
    Random rnd = new Random(); int localData = (int) rnd.nextInt(101);
    // we can see & change (global) class variables [unsafe!]. Use SYNCHRONIZED get-set accessor MONITORs
    String data = "Data-" + getGlobalIntTest() + "-" + localData;
    increaseGlobalIntTest(1);
    // request a message token and put some data in it
7   Message msg = handler.obtainMessage(1, (String)data);
    // if this thread is still alive send the message
8   if (isRunning) { handler.sendMessage(msg); }
   }
  }
  catch (Throwable t) {/* just end the background thread*/ isRunning = false; }
  }});// Thread
 isRunning = true;
 background.start();
}//onStart
```

```
9 public void onStop() { super.onStop(); isRunning = false; }//onStop
x  // safe thread access to global var (not needed here-only one backthread!)
  public synchronized int getGlobalIntTest() { return globalIntTest; }
  public synchronized int increaseGlobalIntTest(int inc) { return globalIntTest += inc; }
}//class
```

# ANDROID’S STRATEGIES FOR EXECUTION OF SLOW ACTIVITIES (Ex: Main-Background communication using messages)

**Comments**

1. The MainActivity creates a Handler object to centralize communications with a background thread that it plans to spawn.

2. The listener handleMessage accepts each of the messages sent by the worker class. Both have agreed on passing a string. Here msg -the input data object- is casted to String type.

3. Each arriving msg is displayed in the app’s UI. The horizontal progress bar is advanced, and (if needed) the ScrollView is forced to show its last entry (which is appended at the bottom of its multiline TextView).

4. When the simulation time is over, the progress bars visibility is changed (another option we could apply is View.GONE, which dismisses the views and reclaims their space).

5. The maximum value the horizontal progress bar can reach is set to be MAX_SEC. The statement bar1.setProgress(0) moves the progress indicator to the beginning of the bar.

# ANDROID'S STRATEGIES FOR EXECUTION OF SLOW ACTIVITIES (Ex: Main-Background communication using messages)

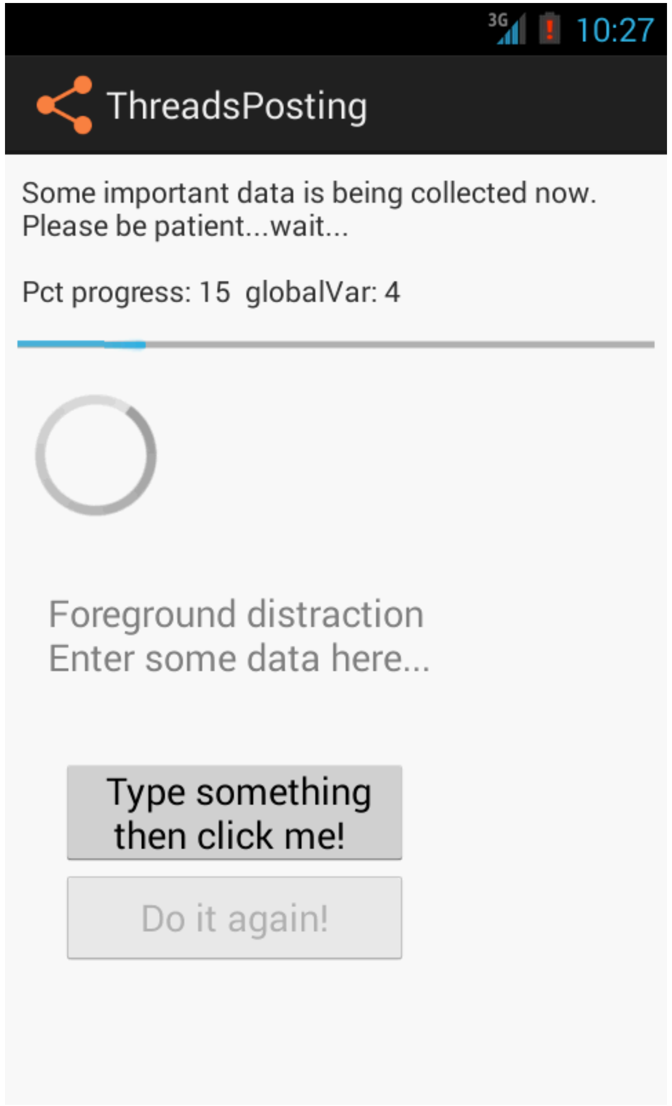
**Comments**

6. The worker thread simulates busy work by sleeping 1000 miliseconds. Afterward, a randomly generated number (0-100) is produced and attached to an outgoing string. The variable globalIntTest defined in the main thread can be seen and changed by the back worker. After incrementing, its updated value is also attached to the outgoing message.

7. The background thread obtains an empty message token from the main's thread message queue. A basic empty message has compartments for an integer and an object. The statement handler.obtainMessage(1, (String)data) moves the value 1 to 'What' (the integer) and the locally produced string data to the object container.

8. The global variable isRunning becomes false when the main thread is stopped. The secondary thread checks this variable to guarantee it is not sending a message to a non-active thread.

9. When the main thread reaches its termination (onStop) it changes the boolean isRunning to false. Background thread uses this flag to decide whether or not to send a message. When false no message is delivered.



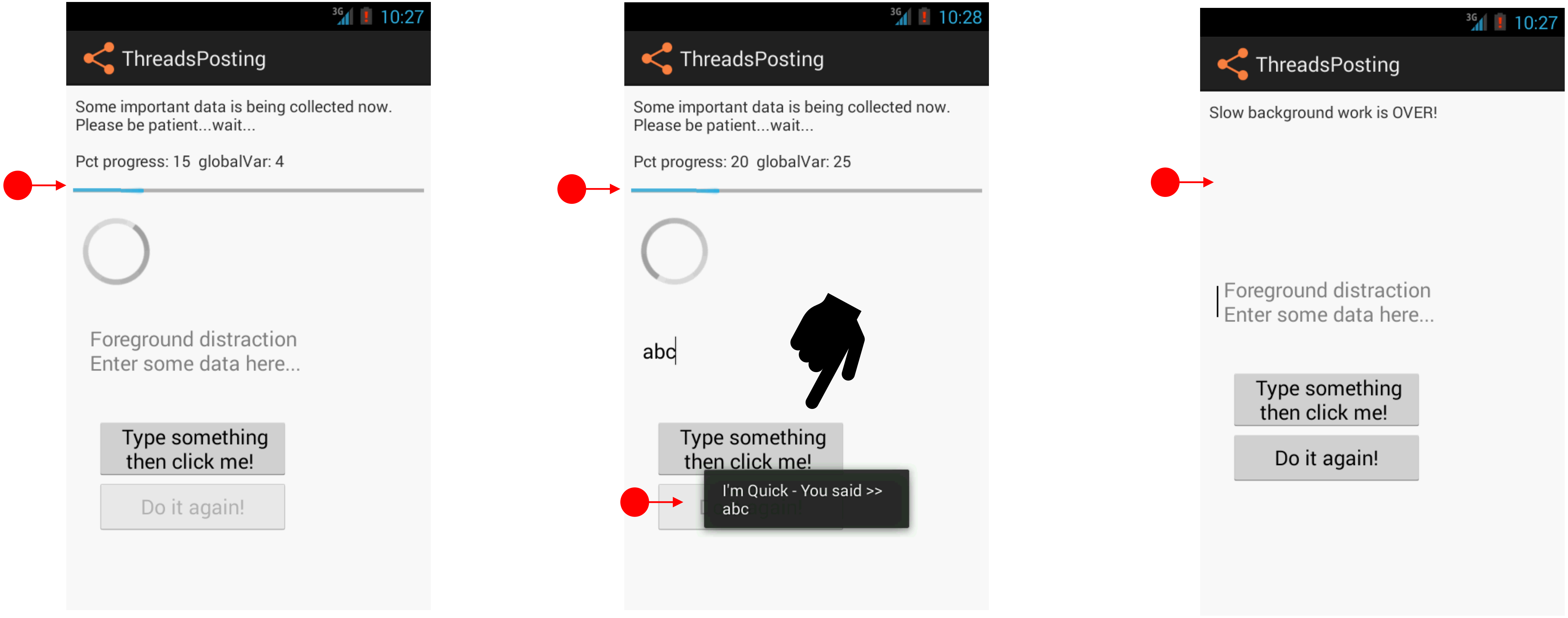

# ANDROID'S STRATEGIES FOR EXECUTION OF SLOW ACTIVITIES (Ex: using handler & post & runnables)

We will tackle again the problem presented earlier as previous example.

We want to emphasize two new aspects of the problem: it continues to have a slow background task but it is coupled to a fast and responsive foreground UI.

This time we will provide a solution using the posting mechanism to execute foreground runnables.

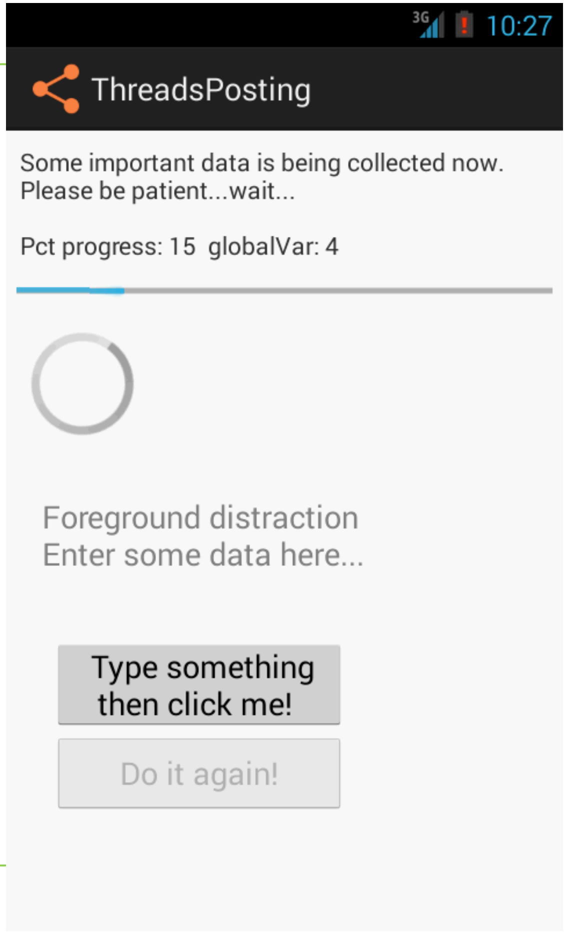
# ANDROID'S STRATEGIES FOR EXECUTION OF SLOW ACTIVITIES (Ex: using handler & post & runnables)



# ANDROID’S STRATEGIES FOR EXECUTION OF SLOW ACTIVITIES (Ex: using handler & post & runnables)

## Layout

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android" android:layout_width="match_parent"
              android:layout_height="match_parent" android:background="#22002222"
              android:orientation="vertical" android:padding="6dp" >
 <TextView    android:id="@+id/lblTopCaption" android:layout_width="match_parent"
              android:layout_height="wrap_content" android:padding="2dp"
              android:text= "Some important data is been collected now. Patience please..." />
 <ProgressBar android:id="@+id/myBarHor" style="?android:attr/progressBarStyleHorizontal"
              android:layout_width="match_parent" android:layout_height="30dp" />
 <ProgressBar android:id="@+id/myBarCir" style="?android:attr/progressBarStyleLarge"
              android:layout_width="wrap_content" android:layout_height="wrap_content" />
 <EditText    android:id="@+id/txtBox1" android:layout_width="match_parent"
              android:layout_height="78dp" android:layout_margin="10dp"
              android:background="#ffffffff" android:textSize="18sp" />
 <Button      android:id="@+id/btnDoSomething" android:layout_width="170dp"
              android:layout_height="wrap_content" android:layout_marginLeft="20dp"
              android:layout_marginTop="10dp" android:padding="4dp"
              android:text="Type Something Then click me!" />
 <Button      android:id="@+id/btnDoItAgain" android:layout_width="170dp"
              android:layout_height="wrap_content" android:layout_marginLeft="20dp"
              android:padding="4dp" android:text="Do it Again!" />
</LinearLayout>
```



# ANDROID'S STRATEGIES FOR EXECUTION OF SLOW ACTIVITIES (Ex: using handler & post & runnables – MainActivity.java)

```
public class MainActivity extends Activity {
  ProgressBar myBarHorizontal, myBarCircular; TextView lblTopCaption; EditText txtDataBox; Button btnDoSomething, btnDoItAgain;
  int globalVar = 0, accum = 0, progressStep = 5; // progressStep = 1
  long startingMills = System.currentTimeMillis(); boolean isRunning = false; final int MAX_PROGRESS = 100; // int nWork = 1000;
  String PATIENCE = "Some important data is being collected now.\nPlease be patient...wait...\n";
1 Handler myHandler = new Handler();
  @Override
  public void onCreate(Bundle savedInstanceState) {
   super.onCreate(savedInstanceState);
   setContentView(R.layout.main);
   lblTopCaption = (TextView) findViewById(R.id.lblTopCaption);
   myBarHorizontal = (ProgressBar) findViewById(R.id.myBarHor);
   myBarCircular = (ProgressBar) findViewById(R.id.myBarCir);
   txtDataBox = (EditText) findViewById(R.id.txtBox1);
   txtDataBox.setHint("Foreground distraction\n Enter some data here...");
   btnDoItAgain = (Button) findViewById(R.id.btnDoItAgain);
   btnDoItAgain.setOnClickListener(new OnClickListener() {
    @Override
    public void onClick(View v) { onStart(); }// onClick
   });// setOnClickListener
   btnDoSomething = (Button) findViewById(R.id.btnDoSomething);
   btnDoSomething.setOnClickListener(new OnClickListener() {
    @Override
2   public void onClick(View v) { Toast.makeText(MainActivity.this, "I'm quick - You said >> \n" + txtDataBox.getText().toString(), 1).show(); }// onClick
   });// setOnClickListener
}// onCreate
```

# ANDROID’S STRATEGIES FOR EXECUTION OF SLOW ACTIVITIES (Ex: using handler & post & runnables – MainActivity.java)

```
@Override
protected void onStart() {
  super.onStart();
  // prepare UI components
  txtDataBox.setText(“”); btnDoItAgain.setEnabled(false);
  // reset and show progress bars
  accum = 0; myBarHorizontal.setMax(MAX_PROGRESS); myBarHorizontal.setProgress(0); myBarHorizontal.setVisibility(View.VISIBLE); myBarCircular.setVisibility(View.VISIBLE);
  // create-start background thread were the busy work will be done
3  Thread myBackgroundThread = new Thread( backgroundTask, “backAlias1”); myBackgroundThread.start();
}
// FOREGROUND: this foreground Runnable works on behave of the background thread, its mission is to update the main UI which is unreachable to back worker
private Runnable foregroundRunnable = new Runnable() {
  @Override
4  public void run() {
    try {
      // update UI, observe globalVar is changed in back thread
      lblTopCaption.setText( PATIENCE + “\nPct progress: ” + accum + “ globalVar: ” + globalVar );
      // advance ProgressBar
      myBarHorizontal.incrementProgressBy(progressStep); accum += progressStep; //try: myBarHorizontal,setProgress(accum*(MAX_PROGRESS/nWork))
      // are we done yet?
      if (accum >= myBarHorizontal.getMax()) {
        lblTopCaption.setText(“Slow background work is OVER!”); myBarHorizontal.setVisibility(View.INVISIBLE); myBarCircular.setVisibility(View.INVISIBLE); btnDoItAgain.setEnabled(true);
      }
    }
    catch (Exception e) { Log.e(“<<foregroundTask>>”, e.getMessage()); }
  }
}; // foregroundTask
```

Foreground runnable is defined but not started ! Background thread will requests its execution later

# ANDROID’S STRATEGIES FOR EXECUTION OF SLOW ACTIVITIES (Ex: using handler & post & runnables – MainActivity.java)

```
// BACKGROUND: this is the back runnable that executes the slow work
private Runnable backgroundTask = new Runnable() {
  @Override
  public void run() { // busy work goes here...
    try {
      for (int n = 0; n < 20; n++) {
        // this simulates 1 sec. of busy activity
        Thread.sleep(1000);
        // change a global variable here...
        globalVar++;
        // try: next two UI operations should NOT work
        // Toast.makeText(getApplication(), "Hi ", 1).show();
        // txtDataBox.setText("Hi ");
        // wake up foregroundRunnable delegate to speak for you
        myHandler.post(foregroundRunnable);
      }
    }
    catch (InterruptedException e) { Log.e("<<foregroundTask>>", e.getMessage()); }
  }// run
};// backgroundTask
}// ThreadsPosting
```

5 → public void run()

6 → myHandler.post(foregroundRunnable);

Tell foreground runnable to do something for us...

# ANDROID'S STRATEGIES FOR EXECUTION OF SLOW ACTIVITIES (Ex: using handler & post & runnables)

Comments

1. The MainActivity defines a message Handler to communicate with its background thread.

2. This Toast operation is used to prove that although the application is running a very slow background work, its UI is quick and responsive.

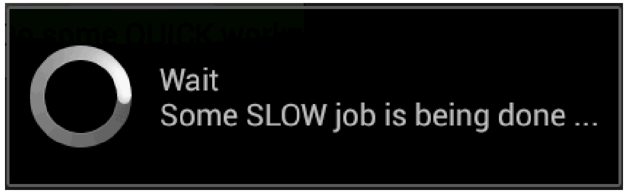
3. The background thread is created and started. We have opted for instantiating a common Thread object and passing to it a new custom Runnable (in our example: 'backgroundTask ' ).

4. The runnable foregroundRunnable will be called to act on behalf of the back worker to update the UI( which is unreachable to it). In our example the progress bar will be advanced, and the value of globalVar (defined in the main thread but updated by the back worker) will be displayed.

5. The back worker backgroundTask will simulate slow work (one second on each step). Then it will change the value of the variable globalVar which is part of the 'common resources' shared by both threads.

6. The command myHandler.post(foregroundRunnable) places a request in the main's MessageQueue for its foreground delegate to update the UI.

# USING THE ASYNCTASK CLASS




The AsyncTask class allows the execution of background operations and the publishing of results on the UI's thread without having to manipulate threads and/or handlers.

An asynchronous task is defined by a computation that runs on a background thread and whose result is published on the UI thread.

An asynchronous task class is defined by the following Types, States, and Method

| Generic Types | Main States | Auxiliary Method |
|---|---|---|
| Params,<br>Progress,<br>Result | onPreExecute,<br>doInBackground,<br>onProgressUpdate<br>onPostExecute. | publishProgress |

# USING THE ASYNCTASK CLASS

AsyncTask <Params, Progress, Result>

| **AsyncTask's generic types** |
|---|
| Params: the type of the input parameters sent to the task at execution. |
| Progress: the type of the progress units published during the background computation. |
| Result: the type of the result of the background computation. |

To mark a type as unused, use the type Void

Note:

The Java notation "String ..." called Varargs indicates an array of String values. This syntax is somehow equivalent to "String[]" (see Appendix)

# USING THE ASYNCTASK CLASS

Pseudo code:

```
private class VerySlowTask extends AsyncTask<String, Long, Void> {
  // Begin - can use UI thread here
  protected void onPreExecute() {}
  // this is the SLOW background thread taking care of heavy tasks cannot directly change UI
  protected Void doInBackground(final String... args) {
    ... publishProgress((Long) someLongValue);
  }
  // periodic updates - it is OK to change UI
  @Override
  protected void onProgressUpdate(Long... value) {}
  // End - can use UI thread here
  protected void onPostExecute(final Void unused) {}
}
```

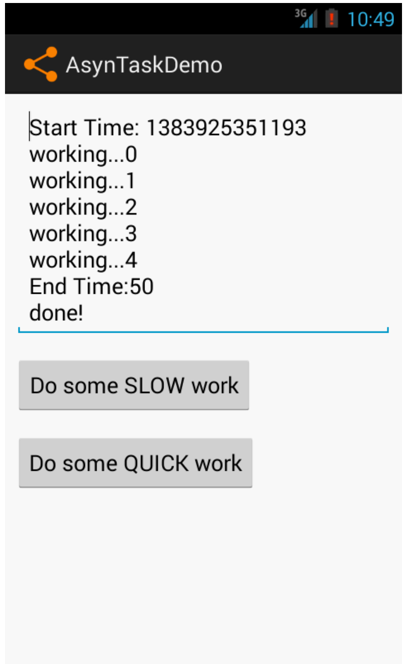
# USING THE ASYNCTASK CLASS

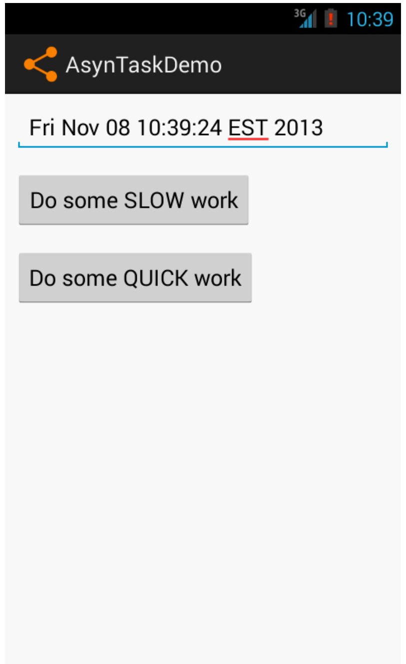
Methods

| |
|---|
| **onPreExecute()**, invoked on the UI thread immediately after the task is executed. This step is normally used to setup the task, for instance by showing a progress bar in the user interface. |
| **doInBackground(Params...)**, invoked on the background thread immediately after onPreExecute() finishes executing. This step is used to perform background computation that can take a long time. This step can also use publishProgress(Progress...) to publish one or more units of progress. These values are published on the UI thread, in the onProgressUpdate(Progress...) step. |
| **onProgressUpdate(Progress...)**, invoked on the UI thread after a call to publishProgress(Progress...). This method is used to inform of any form of progress in the user interface while the background computation is still executing. |
| **onPostExecute(Result)**, invoked on the UI thread after the background computation finishes. The result of the background computation is passed to this step as a parameter. |

# USING THE ASYNCTASK CLASS (EXAMPLE)

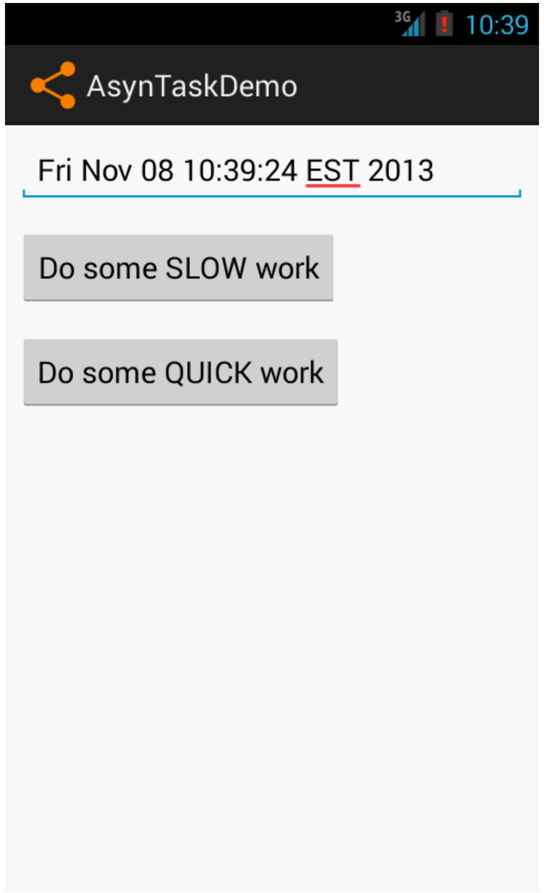
The main task invokes an AsyncTask to do some slow job. The AsyncTask method doInBackgroud(…) performs the required computation and periodically uses the onProgressUpdate(…) function to refresh the main's UI. In our the example, the AsyncTask manages the writing of progress lines in the UI's text box, and displays a ProgressDialog box.

# USING THE ASYNCTASK CLASS (Example: XML layout)

```
<?xml version="1.0" encoding="utf-8"?>
 <LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
                android:layout_width="match_parent"
                android:layout_height="match_parent"
                android:orientation="vertical" >
 <EditText      android:id="@+id/txtMsg"
                android:layout_width="match_parent"
                android:layout_height="wrap_content"
                android:layout_margin="7dp" />
 <Button        android:id="@+id/btnSlow"
                android:layout_width="wrap_content"
                android:layout_height="wrap_content"
                android:layout_margin="7dp"
                android:text="Do some SLOW work" />
 <Button        android:id="@+id/btnQuick"
                android:layout_width="wrap_content"
                android:layout_height="wrap_content"
                android:layout_margin="7dp"
                android:text="Do some QUICK work" />
</LinearLayout>
```



# USING THE ASYNCTASK CLASS (Example: MainActivity.java)

```
public class MainActivity extends Activity {
  Button btnSlowWork, btnQuickWork;
  EditText txtMsg;
  Long startingMillis;
  @Override
  public void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.activity_main);
    txtMsg = (EditText) findViewById(R.id.txtMsg);
    // slow work...for example: delete databases: “dummy1” & “dummy2”
    btnSlowWork = (Button) findViewById(R.id.btnSlow);
    this.btnSlowWork.setOnClickListener(new OnClickListener() {
      public void onClick(final View v) {
        new VerySlowTask().execute(“dummy1”, “dummy2”);
      }
    });
    btnQuickWork = (Button) findViewById(R.id.btnQuick);
    this.btnQuickWork.setOnClickListener(new OnClickListener() {
      public void onClick(final View v) {
        txtMsg.setText((new Date()).toString()); //quickly show today’s date
      }
    });
  }// onCreate
```

```
private class VerySlowTask extends AsyncTask<String, Long, Void> {
  private final ProgressDialog dialog = new ProgressDialog(MainActivity.this); String waitMsg = “Wait some slow job being done...”;
  protected void onPreExecute() {
    startingMillis = System.currentTimeMillis(); txtMsg.setText(“Start Time: ” + startingMillis);
    this.dialog.setMessage(waitMsg); this.dialog.setCancelable(false); //outside touch doesn't dismiss you
    this.dialog.show(); }
  protected Void doInBackground(final String... args) {
    // show on Log.e the supplied dummy arguments
    Log.e(“doInBackground>>”, “Total args: ” + args.length ); Log.e(“doInBackground>>”, “args[0] = ” + args[0] );
    try {
      for (Long i = 0L; i < 5L; i++) {
        Thread.sleep(10000); // simulate the slow job here . . .
        publishProgress((Long) i);
      }
    }
    catch (InterruptedException e) { Log.e(“slow-job interrupted”, e.getMessage()); }
    return null; }
  // periodic updates - it is OK to change UI
  @Override
  protected void onProgressUpdate(Long... value) {
    super.onProgressUpdate(value); dialog.setMessage(waitMsg + value[0]); txtMsg.append(“\nworking...” + value[0]); }
  // can use UI thread here
  protected void onPostExecute(final Void unused) {
    if (this.dialog.isShowing()) this.dialog.dismiss();
    // cleaning-up, all done
    txtMsg.append(“\nEnd Time:” + (System.currentTimeMillis() - startingMillis) / 1000 + “\ndone!”); } }}// MainActivity
```

# USING THE ASYNCTASK CLASS (EXAMPLE)

Comments:

1. The MainActivity instantiates our AsyncTask passing dummy parameters.

2. VerySlowTask sets a ProgressDialog box to keep the user aware of the slow job. The box is defined as not cancellable, so touches on the UI will not dismiss it (as it would do otherwise).

3. doInBackground accepts the parameters supplied by the .execute(…) method. It fakes slow progress by sleeping various cycles of 10 seconds each. After awaking it asks the onProgressUpdate() method to refresh the ProgressDialog box as well as the user's UI.

4. The onProgressUpdate() method receives one argument coming from the busy background method (observe it is defined to accept multiple input arguments). The arriving argument is reported in the UI's textbox and the dialog box.

5. The OnPostExecute() method performs house-cleaning, in our case it dismisses the dialog box and adds a "Done" message on the UI.

# APPENDICIES - Processes and Threads

Processes

1. A process has a self-contained execution environment. A process generally has a complete, private set of basic run-time resources (memory, system’s stack, ports, interruptions, semaphores, …)

2. Most operating systems support Inter Process Communication (IPC) resources such as pipes and sockets.

3. Most implementations of the Java virtual machine run as a single process.

Threads

1. Threads exist within a process. Threads share the process's resources (including memory).

2. Every process has at least one thread (called Main thread).

3. Each thread has the ability to create additional threads.

# APPENDICIES - Java Varargs example

What for?

The clause (Type ellipsis … varargs) plays a role in facilitating the creation of Java methods accepting a variable number of arguments all of the same type. It provides for a more flexible method calling approach, as shown in the example below.

- public void sum(Integer... items) {
  - int sum = 0;
  - for (int i = 0; i < items.length; i++) { sum += items[i]; }
  - Log.e(“SUM”, “The sum is ” + sum);
- }

The sum method accepts a Varargs of Integer values. It could be called with sum(1, 2, 3, 4); or alternatively sum(new Integer[] {1, 2, 3, 4} );

Clearly the syntax used in the first call is simpler.

# APPENDICIES
# (Temporary relief from Android’s watchful eye)

**Looking the other way**

Your application's main thread should remain responsive at all times, failure to do so generates dreaded ANR dialog boxes (Application Not Responding).

However you may briefly escape from your obligation to write well behaved, quick responding apps (as it may happen in the rush to test an idea you know well will be caught by the Activity Monitor as unacceptably slow). To do so, temporarily disable the system’s monitoring by adding to your activity the following code fragment.

```
StrictMode.ThreadPolicy policy = new StrictMode.ThreadPolicy.Builder().permitAll().build();
StrictMode.setThreadPolicy(policy);
```

Please notice this is an extremely poor remedy and should be replaced by a better strategy such as using Threads, AsyncTasks, or Background Services.