Programming Handheld Systems

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Threads, AsyncTasks & Handlers

Today's Topics

Threading overview

Android's UI Thread

The AsyncTask class

The Handler class

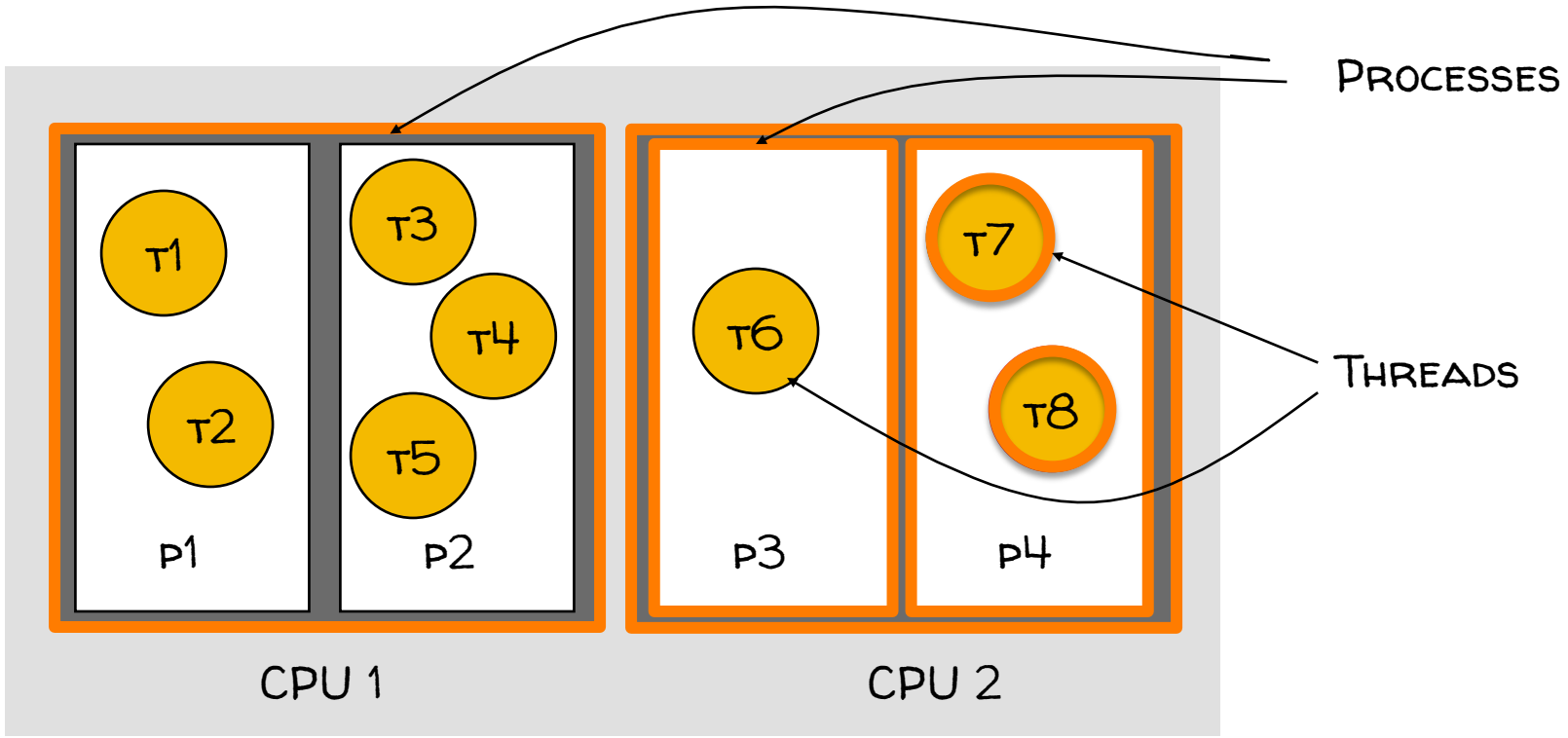
What is a Thread?

Conceptual view

- Parallel computation running in a process

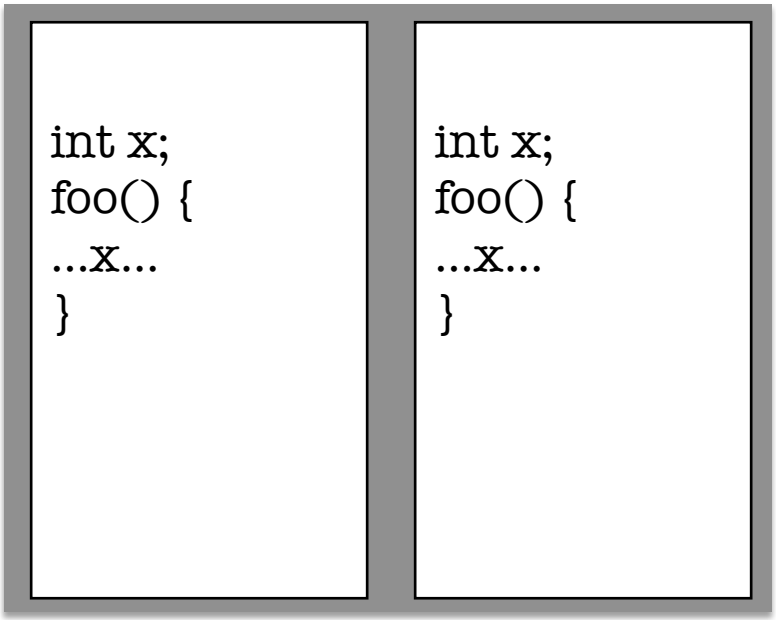
Implementation view

- A program counter and a stack
- With heap and static areas that are shared with other threads

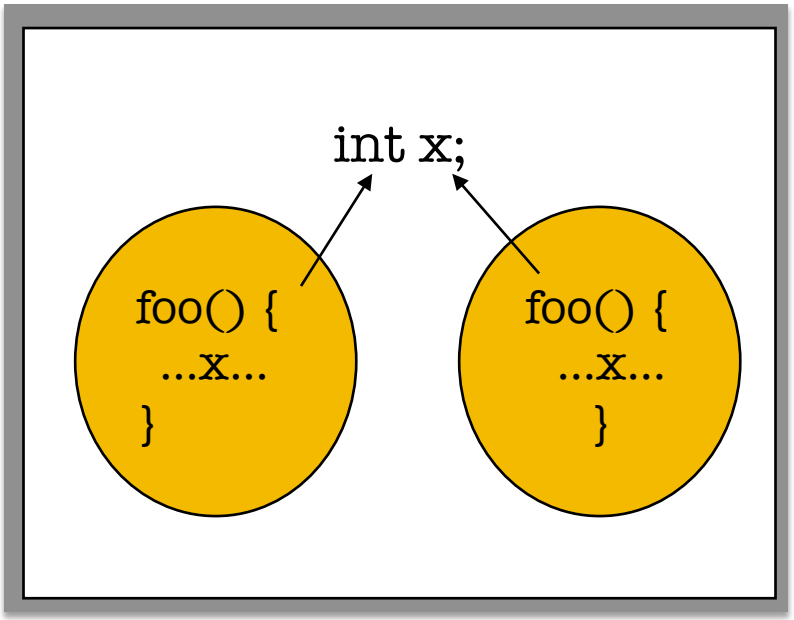


Computing Device

Processes vs. Threads



Processes typically don't share memory



Threads within a process can share memory

Java Threads

Represented by an object of type Java.lang.Thread

Threads implement the runnable interface

```
void run()
```

See:

http://docs.oracle.com/javase/tutorial/essential/concurrency/threads.html

Some Thread Methods

void start()

Starts the Thread

void sleep(long time)

Sleeps for the given period

Some Object Methods

void wait()

Current thread waits until another thread invokes notify() on this object

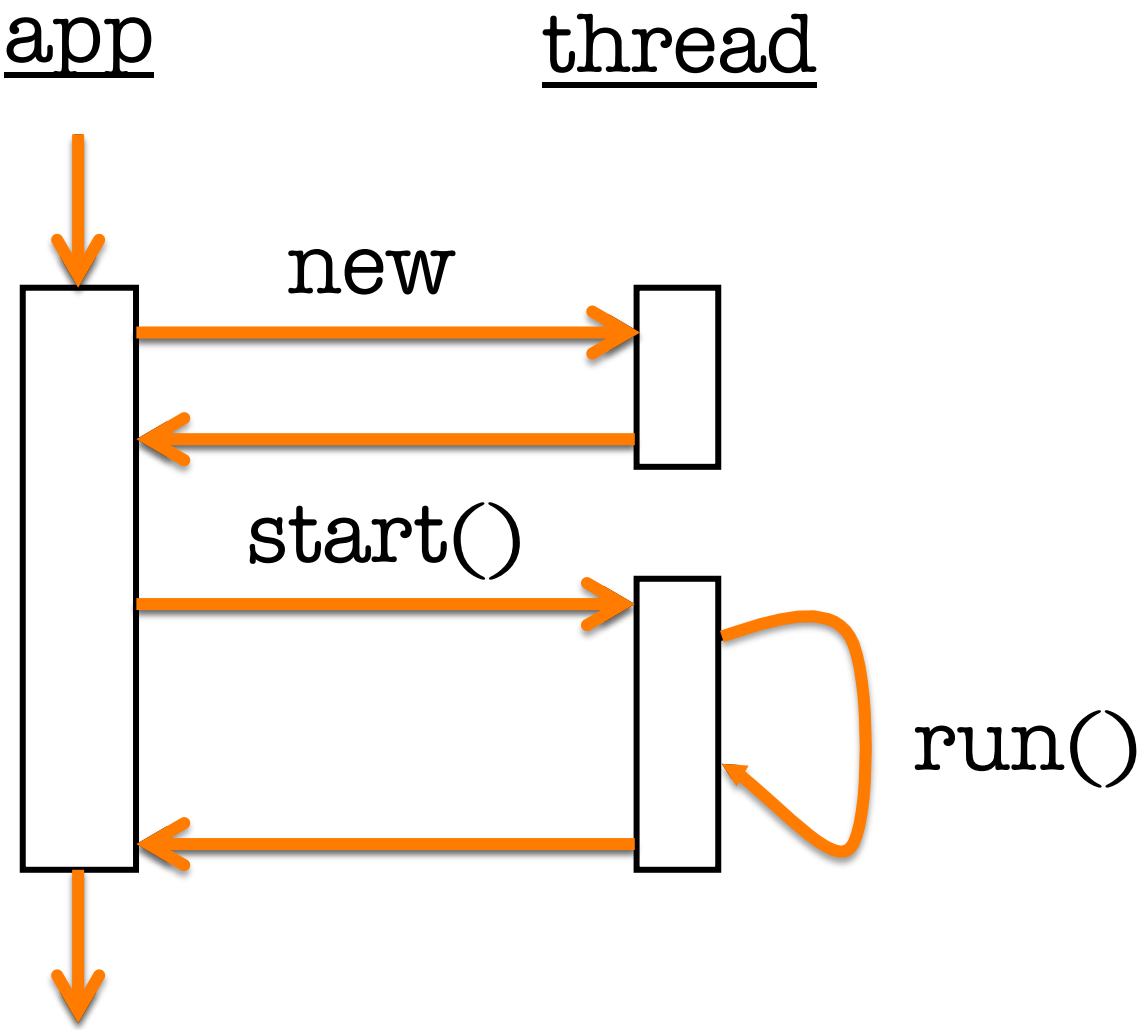
void notify()

Wakes up a single thread that is waiting on this object

Basic Thread Use Case

- Instantiate a Thread object
- Invoke the Thread's start() method
  - Thread's run() method get called
- Thread terminates when run() returns

Basic Thread Use Case



ThreadingNoThreading

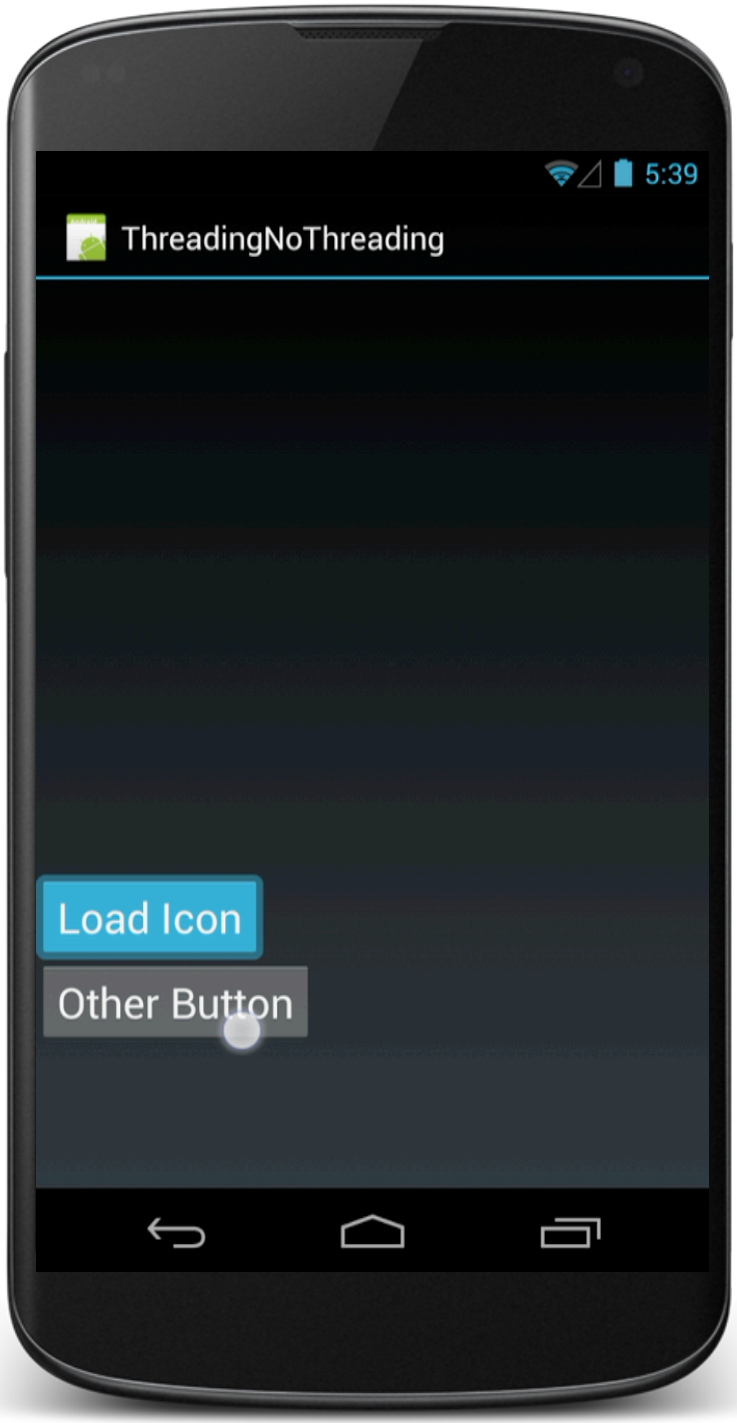
Application displays two buttons

LoadIcon

- Load a bitmap from a resource file & display
- Show loaded bitmap

Other Button

- Display some text

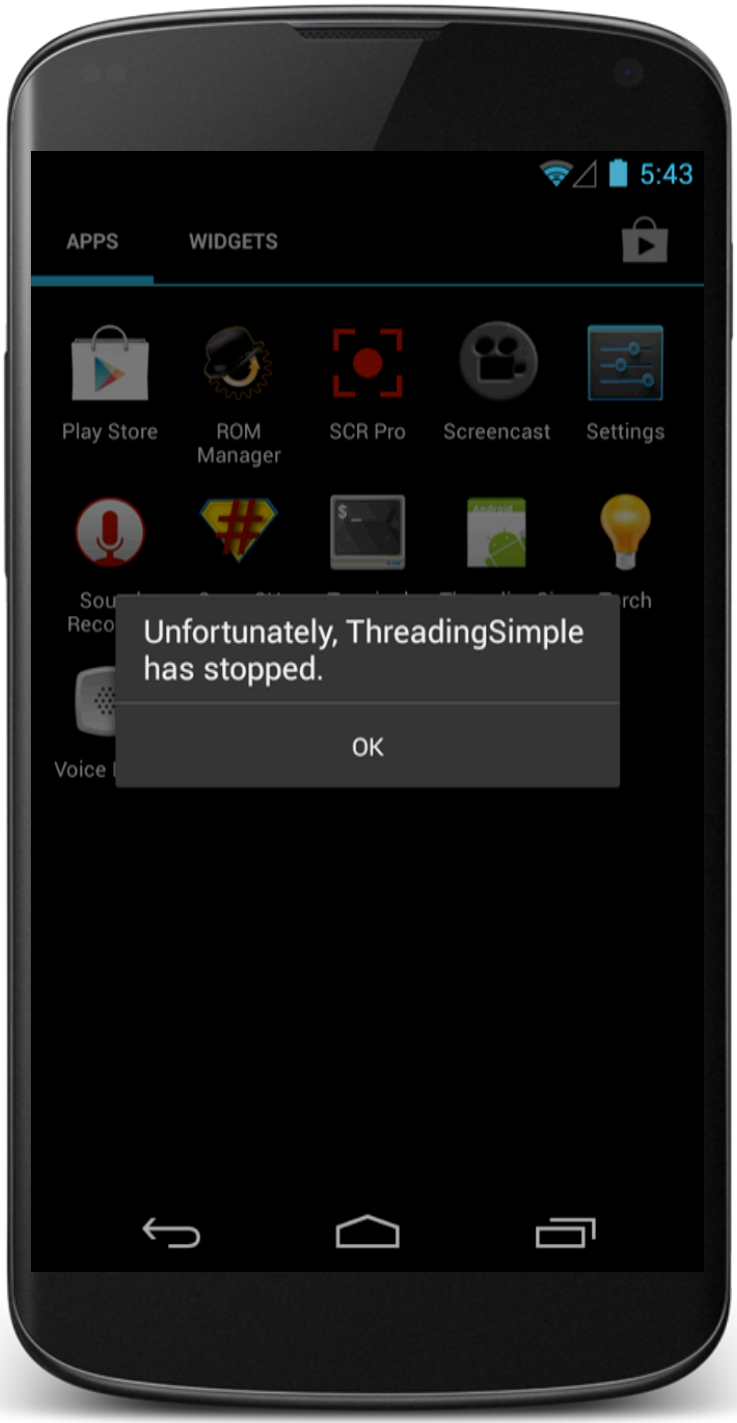

5:39
ThreadingNoThreading
Load Icon
Other Button

ThreadingSimple

Seemingly obvious, but incorrect, solution:

Button listener spawns a separate thread to load bitmap & display it

Demonstration of ThreadingSimple project in the IDE


5:43
APPS
WIDGETS
Play Store
ROM Manager
SCR Pro
Screencast
Settings
Unfortunately, ThreadingSimple has stopped.
OK

The UI Thread

Applications have a main thread (the UI thread)

Application components in the same process use the same UI thread

User interaction, system callbacks & lifecycle methods handled in the UI thread

In addition, UI toolkit is not thread-safe

Implications

- Blocking the UI thread hurts application responsiveness
  - Long-running operations should run in background threads
- Don't access the UI toolkit from a non-UI thread

Improved Solution

Need to do work in a background thread, but update the UI in the UI Thread

Android provides several methods that are guaranteed to run in the UI Thread

boolean View.post (Runnable action)

void Activity.
runOnUiThread (Runnable action)


5:45
ThreadingViewPost
Load Icon
Other Button
I'm Working

Demonstration of

ThreadingViewPost project in the IDE

AsyncTask

Provides a structured way to manage work involving background & UI threads

AsyncTask

Background thread

- performs work
- Indicates progress

UI Thread

- Does setup
- Publishes intermediate progress
- Uses results

AsyncTask

Generic class

```
class AsyncTask<Params, Progress, Result> {
  ...
}
```

Generic type parameters

- Params – Type used in background work
- Progress – Type used when indicating progress
- Result – Type of result

AsyncTask

void onPreExecute()

- Runs in UI Thread before doInBackground()

Result

doInBackground (Params...params)

- Performs work in background Thread
- May call
  void publishProgress(Progress... values)

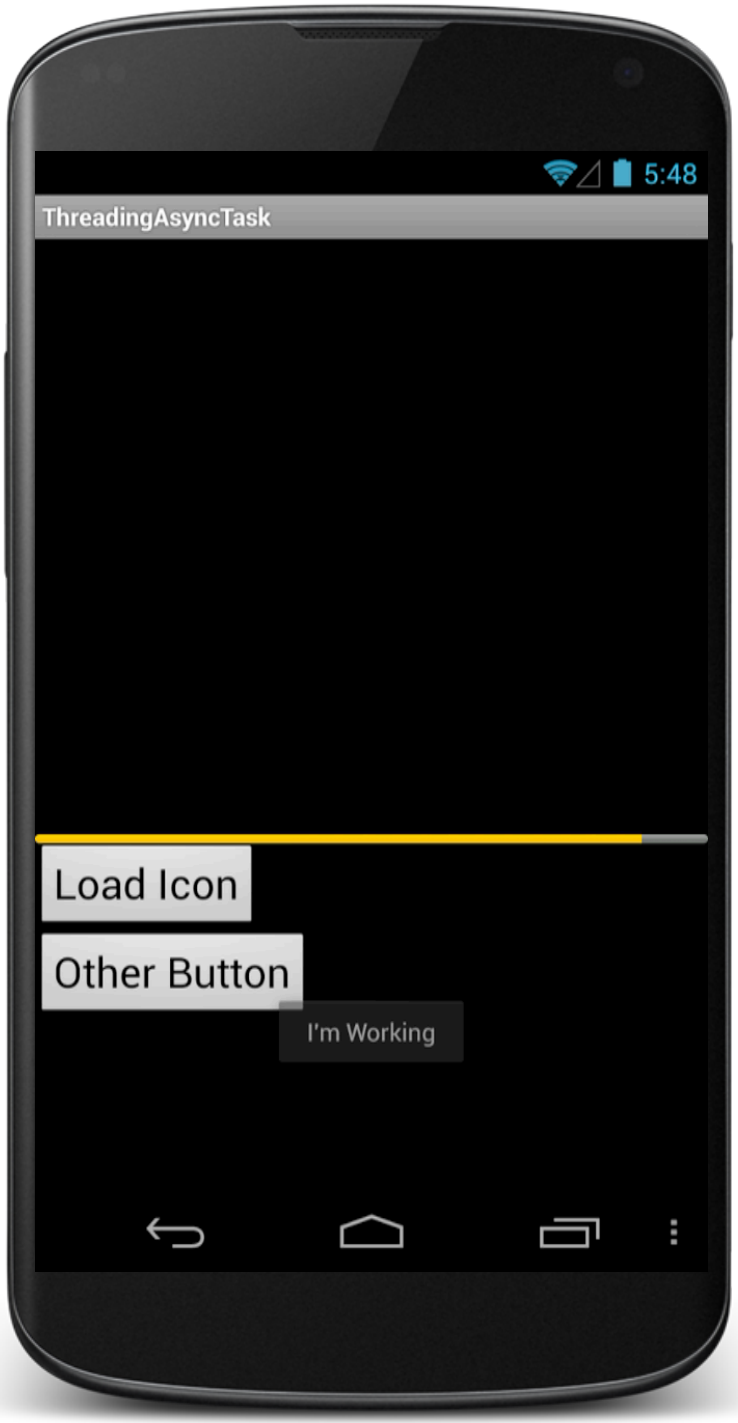
AsyncTask

void
onProgressUpdate (Progress... values)

Invoked in response to publishProgress()

void onPostExecute (Result result)

Runs after doInBackground()


5:48
ThreadingAsyncTask
Load Icon
Other Button
I'm Working

Demonstration of

ThreadingAsyncTask project in the IDE

Handler

Each Handler is associated with a Thread

One Thread can hand off work to another Thread by sending Messages & posting Runnables to a Handler associated with the other Thread

Handler

Runnable

- Contains an instance of the Runnable interface
- Sender implements response

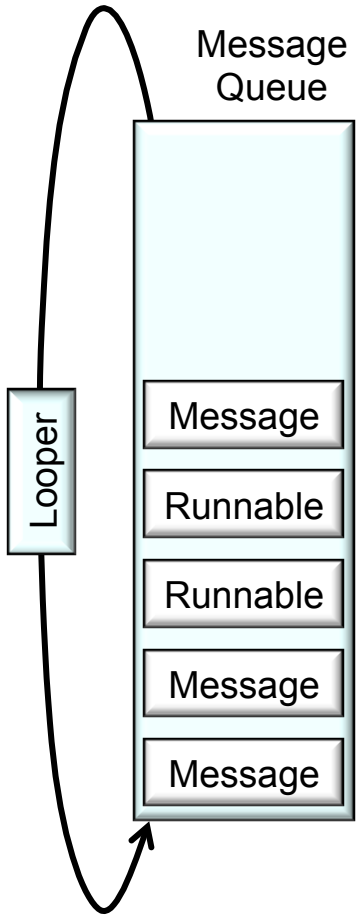
Message

- Can contain a message code, an object & integer arguments
- Handler implements response

Handler Architecture

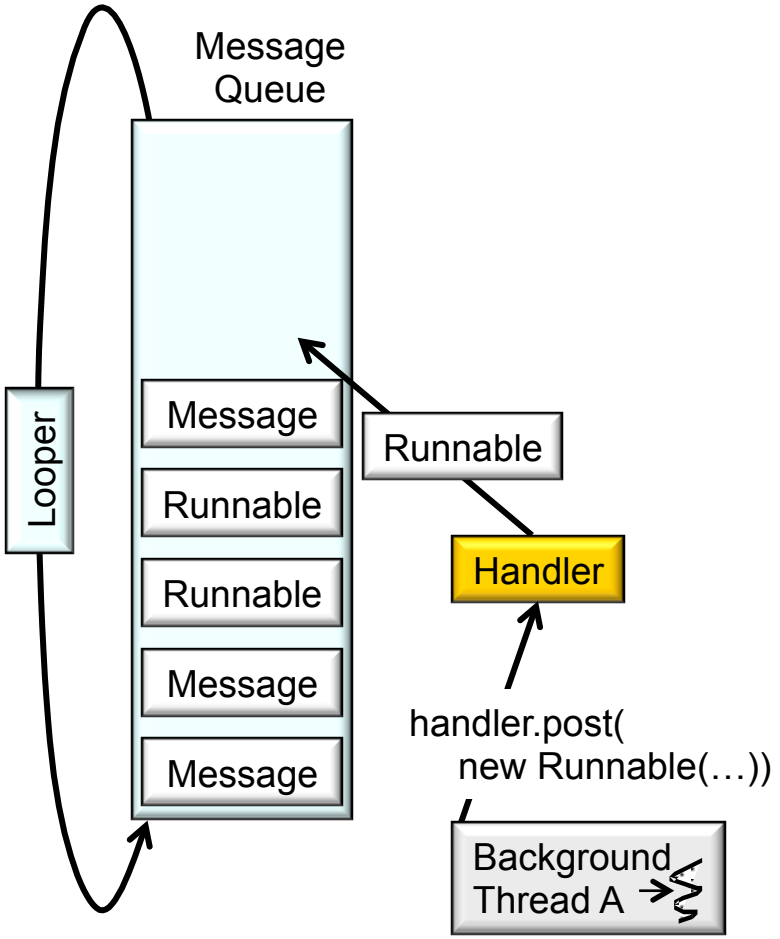
Each Android Thread is associated with a messageQueue & a Looper

A MessageQueue holds Messages and Runnables to be dispatched by the Looper



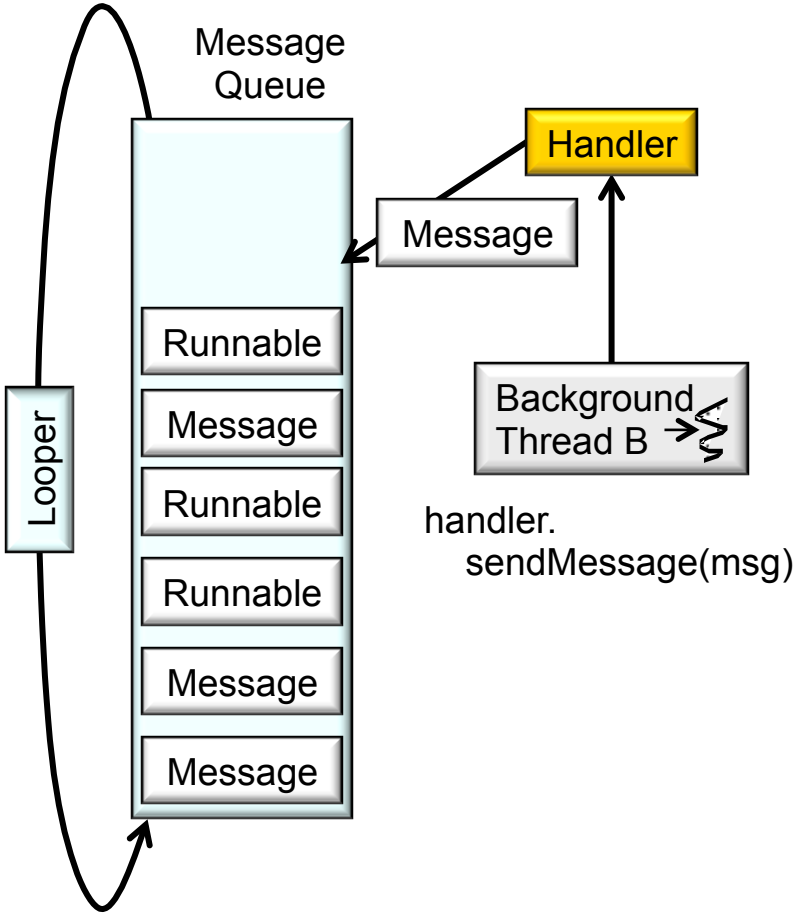
Handler Architecture

Add Runnables to MessageQueue by calling Handler's post() method



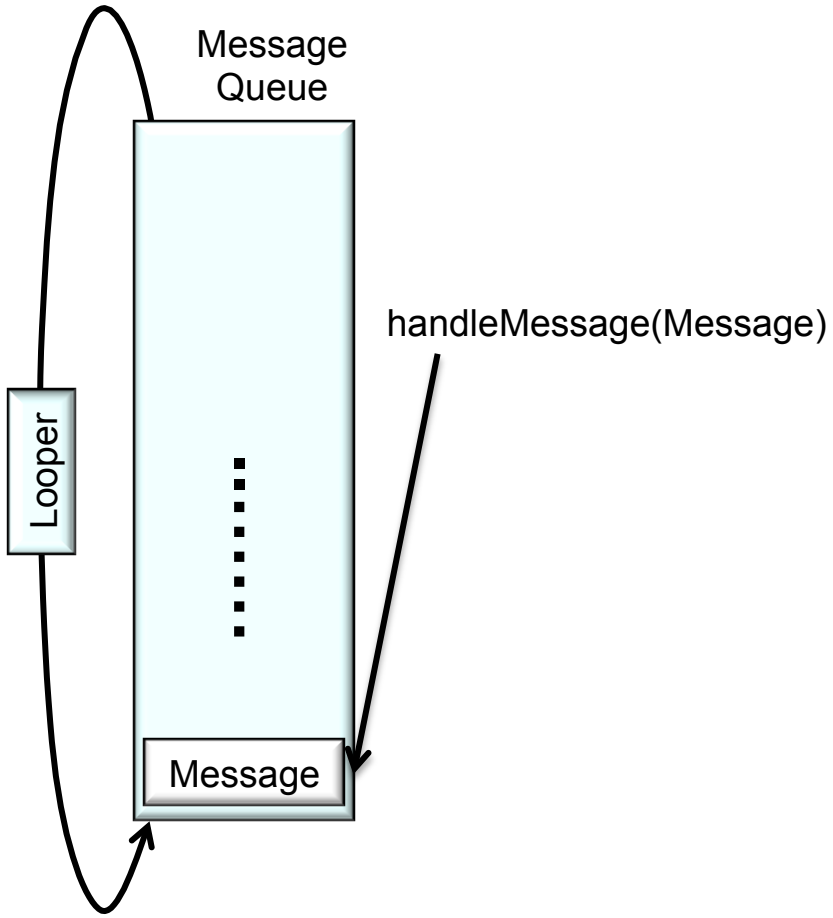
Handler Architecture

Add Messages to MessageQueue by calling Handler's sendMessage() method



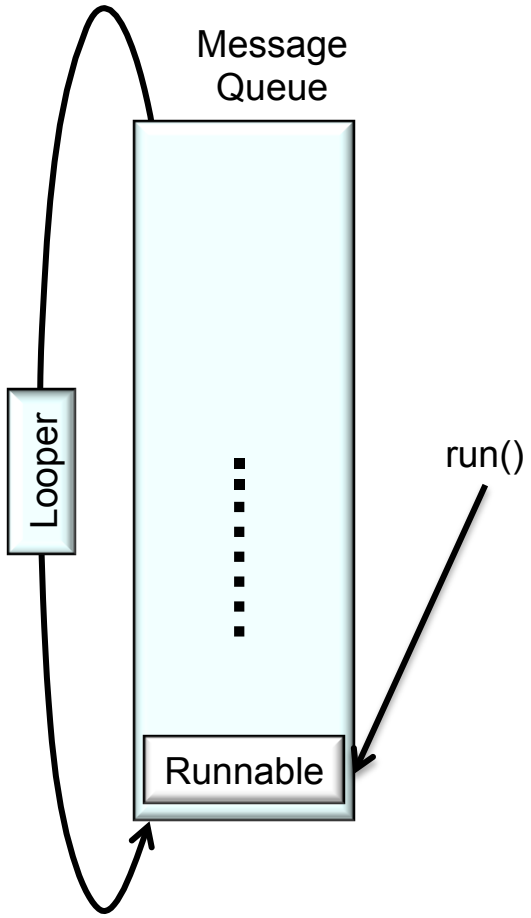
Handler Architecture

Looper dispatches Messages by calling the handler's handleMessage() method in the MessageQueue's Thread



Handler Architecture

Looper dispatches Runnables by calling their run() method in the MessageQueue's Thread



Runnables & Handlers

boolean post(Runnable r)

Add Runnable to the MessageQueue

boolean
postAtTime(Runnable r, long uptimeMillis)

Add Runnable to the MessageQueue. Run at a specific time (based on SystemClock.upTimeMillis())

boolean
postDelayed(Runnable r, long delayMillis)

Add Runnable to the message queue. Run after the specified amount of time elapses

Messages & Handlers

Create Message & set Message content

- Handler.obtainMessage()
- Message.obtain()

Message parameters include

- int arg1, arg2, what
- Object obj
- Bundle data

Many variants. See documentation

Messages & Handlers

sendMessage()

Queue Message now

sendMessageAtFrontOfQueue()

Insert Message now at front of queue

sendMessageAtTime()

Queue Message at the stated time

sendMessageDelayed()

Queue Message after delay

Demonstration of the ThreadingHandlerMessages and ThreadingHandlerRunnable

Projects in the IDE

Next Time

Alarms