Contents

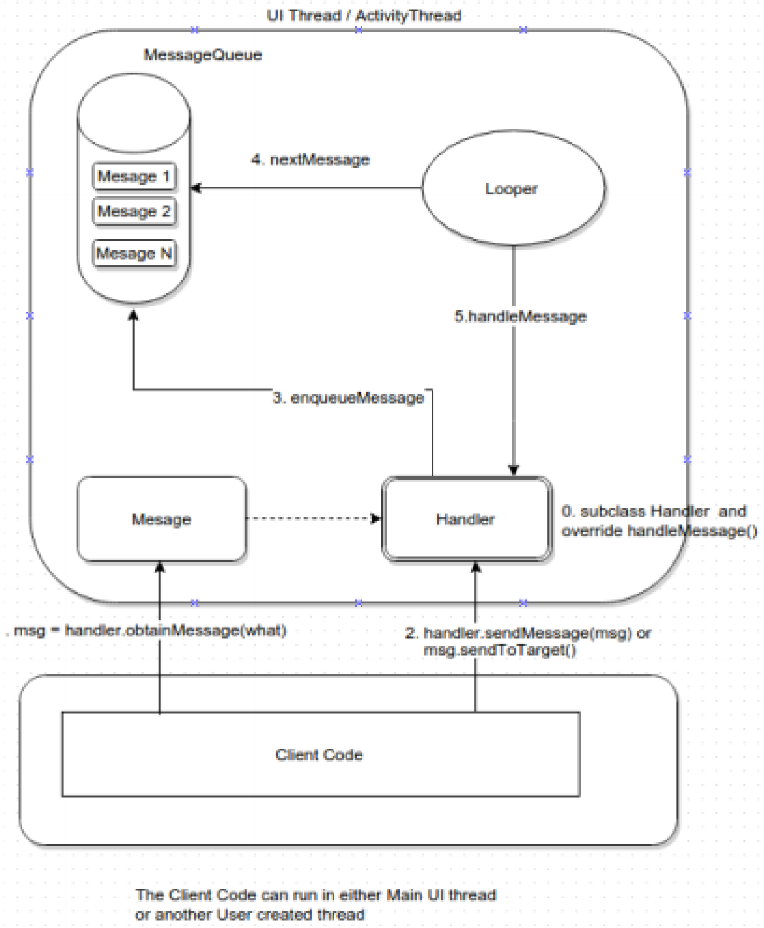
1 Thread of Execution

Android applications use a **single thread model**. A single thread of execution called **main**. It is started when a process is created.

- Handles and dispatches user interface events: drawing the interface, responding to interactions. E.g. onClick...()
- Handles activity lifecycle events: onCreate(), onDestroy. For all components in an application
- HandlerThread

2 Looper and handler

- HandlerThread
  - Extension of Thread with support for a Looper
- Looper
  - Each HandlerThread can have one Looper
  - A Java thread dies when the run method returns
  - Maintains a MessageQueue
  - Looper.loop(): loops through the MessageQueue and processes waiting Messages
- Message
  - A task to be completed
  - Might contain data, reference to a Runnable object
- Handler
  - Attached to a Looper
  - Enqueues messages in the Looper MessageQueue
  - Configurable delivery
  - Handles messages from the MessageQueue
  - Threadsafe
  - One Looper can have many Handlers associated with it


UI Thread / ActivityThread
MessageQueue
Mesage 1
Mesage 2
Mesage N
4. nextMessage
Looper
5.handleMessage
3. enqueueMessage
Mesage
Handler
0. subclass Handler and override handleMessage()
. msg = handler.obtainMessage(what)
2. handler.sendMessage(msg) or msg.sendToTarget()
Client Code
The Client Code can run in either Main UI thread or another User created thread

2.1 Splitting threads

- Long (ish) running code that does not involve the UI
  - E.g. an image download
  - Occurs in a separate thread of execution
  - Still tightly coupled to an activity
  - Not allowed to do network communication in the UI thread
- Instantaneous code that does involve the UI
  - E.g. drawing the image that has been downloaded
  - posted to the UI thread responsible for a particular View to execute, logically parceled up as a Runnable object
  - Risk of orphaned threads

3 AsyncTask

A convenience class for making complex asynchronous worker tasks easier. Worker / blocking tasks are executed in a background thread. Can get data back using **results callback**, and it's executed in the UI thread. With each AsyncTask that is spun off, a thread is created and destroyed, which might be a performance issue. We can solve this by implementing implement a thread pool.

4 Services

An Application Component that

- Has no UI
- Represents a desire to perform a longer-running operation. I.e. longer than a single-activity element of the task
- Threads are associated with the activity that started them i.e. could be orphaned

Activities are loaded/unloaded as users move around app, where as services **remain for as long as they are needed**. Can expose functionality for other apps: one service **may be used by many applications**, which allows to avoid duplication of resources

4.1 What services are not

- Not a separate process
  - Runs in the same process as the application in which it is declared (by default)
- Not a thread
  - One thread per Application
  - Handles events for all components
  - If you need to do things in the background, start your own thread of execution

4.2 Uses of Services

- MP3 Playback: Want to play audio while the user is doing other things
- Network Access: long download, sending email, polling email server for new mail.
- Anything that you dont want to interrupt the user experience for

4.3 Creating a Service

Services are designed to support communication with

- Local Activities (in the same process). For example: within VM
- Remote Activities (in a different process). For example IPC
- Multiple components
  - System services underpin much of Android core OS, but wrapped with various APIs

Services are components, similar to an Activities

- Register the service in the **manifest**
- Create a subclass of android.app.Service
- Handle the relevant **lifecycle methods**

4.4 Service lifecycle

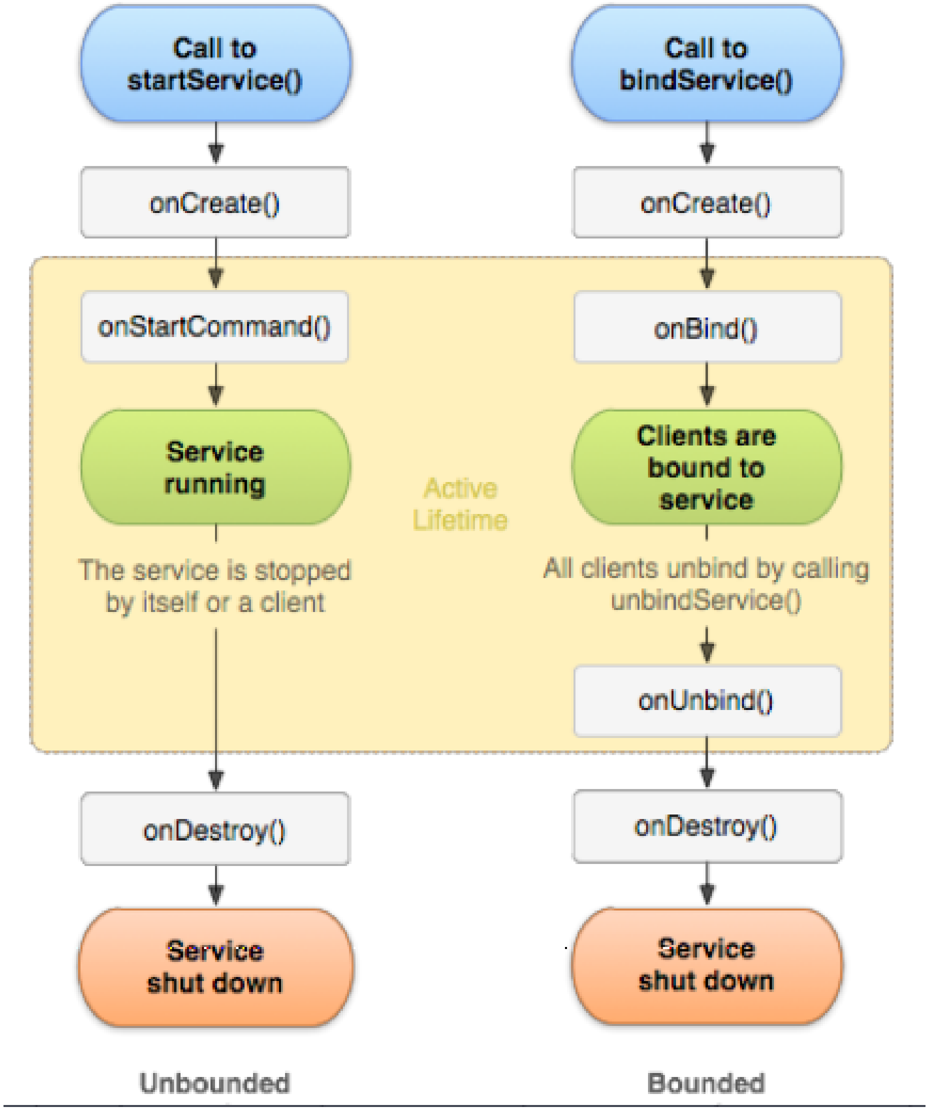
There are two ways of spawning a service:
Started (loosely coupled)

- Send an Intent to explicitly start the service with startService()
- c.f. Messages, starting Activities
- Will run / exist in the background indefinitely / until kills itself (Does not return results). For example: C.f email checking.
- Explicitly stop the service with stopService()
- User starts and stops it

Bound (tightly coupled)

- Bind to a service using bindService()
- Will run while any Activities are bound to it
- Actively using it
- Provides an interface (programmatic) for Activities to communicate with the Service
- Operating system starts and stops it

In both cases, if the service is not running it **will be created**. Note both are **the same service**. Different responsibilities for the lifecycle (If I start it, I have to stop it. If OS starts it, OS stops it when it decides to)



By nature, services are singleton objects (there can be only one). Service used by **many clients**. The Service sub-class object is instantiated if necessary

- `onCreate()` is called
- Either `onStartCommand` or `onBind` will be called depending on how the service has been ”called”
- `onCreate` / `onStart` / `onBind` are called in the context of the main UI thread. It now must spawn a worker thread to do any significant work
- Something calls `stopService()`, (could be the OS or user again)
- `onDestroy` can now be used to save work.

4.5 Implementing a service

Generic started service

- Runs persistently (Or stops itself when all work is done)
- Receives messages asking for more work to be done (Delivered via onStartCommand)

IntentService

- A simple, unbound service.
  - It assumes we dont have multiple requests that need to be handled concurrently.
  - Creates a queue of work to be done.
  - HandlerThread, Looper, Handler again.
- Handles one intent at a time to onHandleIntent()
  - Intents delivered via onStartCommand added to a queue
  - Stops the service after all start requests have been handled
  - I.e. sending emails fire and forget

4.6 Terminating services

A Service runs in the background indefinitely, even if the component that started it is destroyed.

- Termination of a service
  - Self-termination (calling stopSelf())
  - stopService() via an Intent
  - System termination (i.e. memory shortage Last recently used again)
- Avoiding termination as a foreground service
  - This is something the user should really know about or is aware of
  - Active in the Status Bar / shows a Notification
  - Is treated as important as a foregrounded Activity
  - startForeground()

Because services run indefinitely, we can use onStartCommand where return value determines how the service should be continued if it is destroyed.

- `START_NOT_STICKY`
  - After onStartCommand returns, do not recreate the service unless there are intents to deliver
- `START_STICKY`
  - Recreate the service and call onStartCommand again, but do not redeliver the last intent
- `START_REDELIVER_INTENT`
  - Recreate the service and call onStartCommand again, redeliver the last intent. Immediately resume the previous job, i.e. downloading a file

5 Notifications

We can use notification to let user know about operating service. This solves: orphaned thread problems as well as the fact that the original activity may no longer exist.

Status bar notification

- Maintained by the Service
- Can specify an Activity to launch if the user taps on it. We can return to the Activity that spawned the Service by using *Pending Intent*
- Can control the Service via buttons in the notification. Deliver Intents to the service, handle them -¿ its a Singleton

6 Communicating with Services

Bind to the Service

- If not explicitly started, will be started by the OS
  - when something binds to it
  - Then stopped if everything unbinds from it.
  - What if it is explicitly started?
- Provide an interface for clients (Activities) to interact with a Service
  - Provide a programmatic interface for clients
  - Fast and stable?

Extending the Binder class

- Return an interface via the onBind method
- Only for a Service used by the same application. Local services only. make method calls within the same JVM

Binder object asynchronously provides a reference to the service that we can call methods on

7 Remote Services

Making objects appear as if they exist in the local process. For communicating across process boundaries

- i.e. using a Service belonging to a different application / process
- Likely to be used by multiple processes at once
- Starting the service
- Declare the service as exported in the Manifest
- Must use implicity intents

8 Communicating with services

Messenger

- An interface for a service. Message based communication between processes. Is asynchronous and uses messages with bundles of data as payload instead of method calls.
- Queues Messages into a single Thread, handled sequentially
  - C.f. using a Handler to manage communication and concurrency between Threads
  - Allows a service to define a Handler. To respond to different types of Message objects
- Has an IBinder shared with the client. Passed to the client on service connection and used to send messages to the service

Bi-directional communication

- The client can have a Messenger too
- Provide a reference to the return Messenger in our Message

Messages must be Parcelable

8.1 Parcelable

Locally (same process) bound Services share the same process memory space. This makes it easy to call methods, transfer objects / references between classes. But how should different processes talk to one another?
java.io.Serializable

- Short-term persistence
- Write object ID, field via reflection / introspection
- Change the class / variable name, what happens?
- Slow

Parcelable

- Define a simple wire-protocol for writing primitives
- Re-create an object by passing salient data (c.f. deep copy)
- Immune to minor changes to class definitions
- Same interface, different class
- Supported by Android kernel driver
- Fast!

Reference section

atomic

Something that ”appears to the rest of the system to occur instantaneously” (One operation at a time).**Atomic operation** means an operation that appears to be instantaneous from the perspective of all other threads. You don’t need to worry about a partly complete operation when the guarantee applies.