Android Services & Security: Programming Started Services (Part 1)

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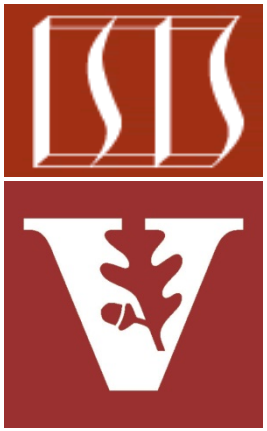

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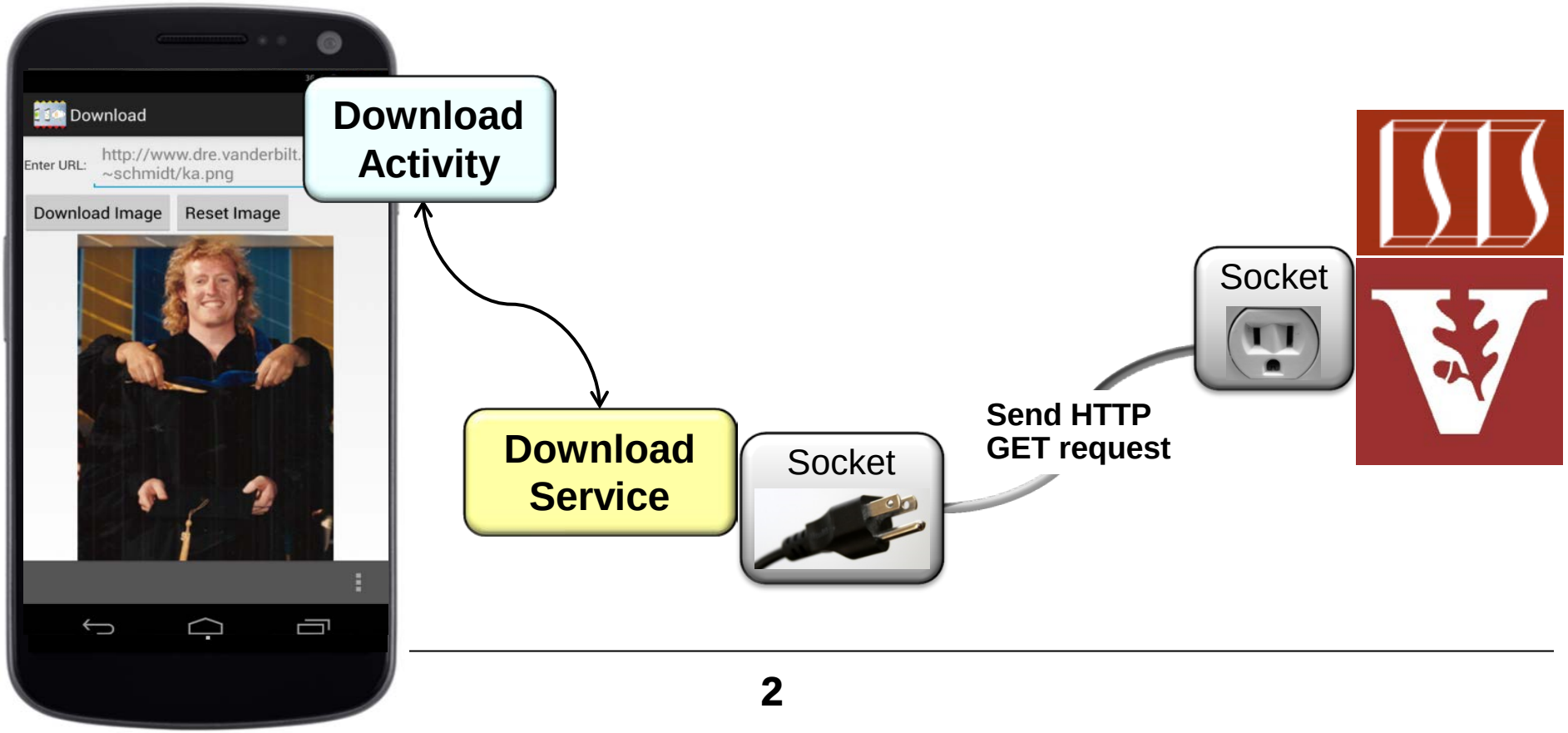
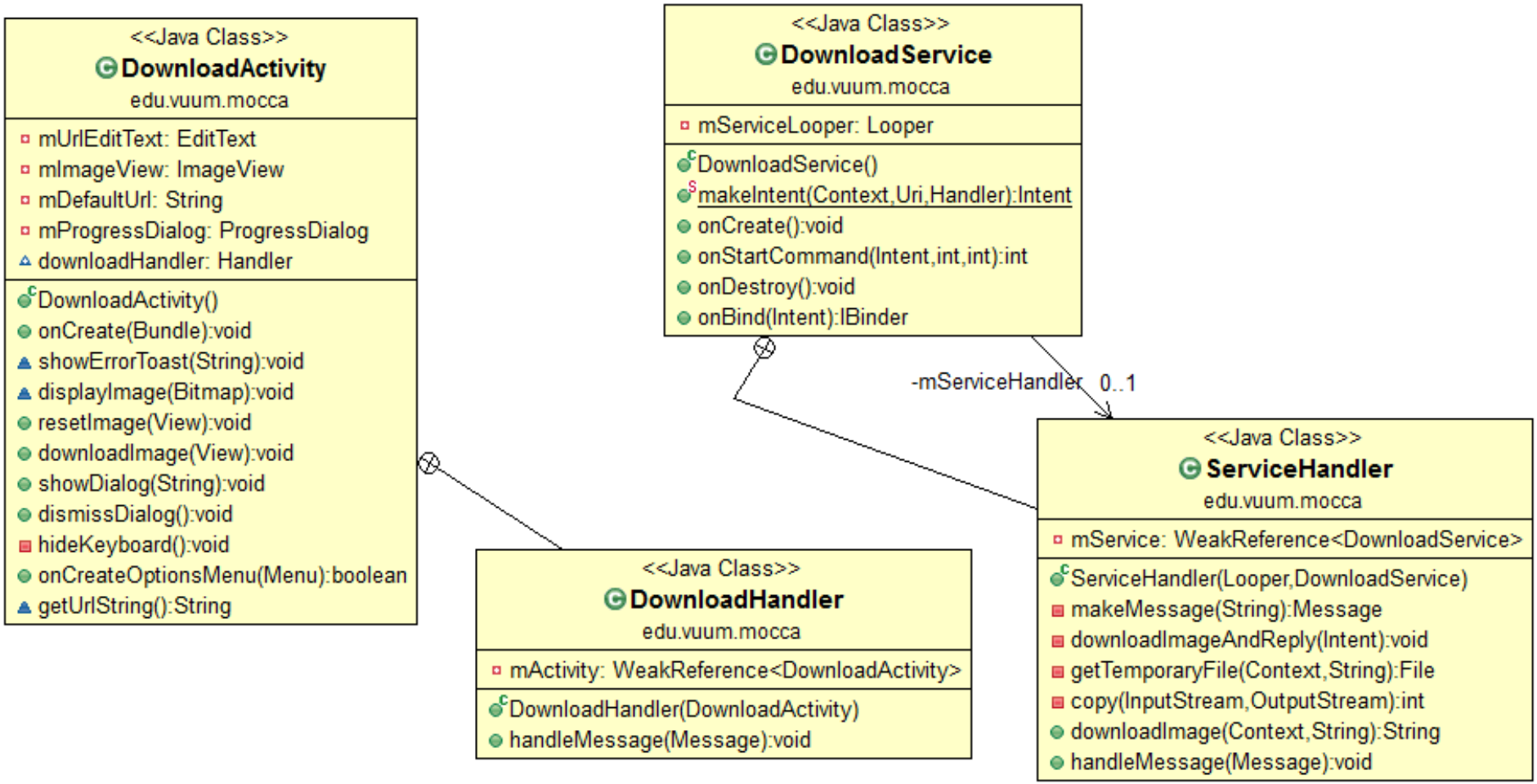
Learning Objectives in this Part of the Module

- Understand how to program a Started Service
  - e.g., a Download Application that uses a Started Service to retrieve & display an image from a remote server

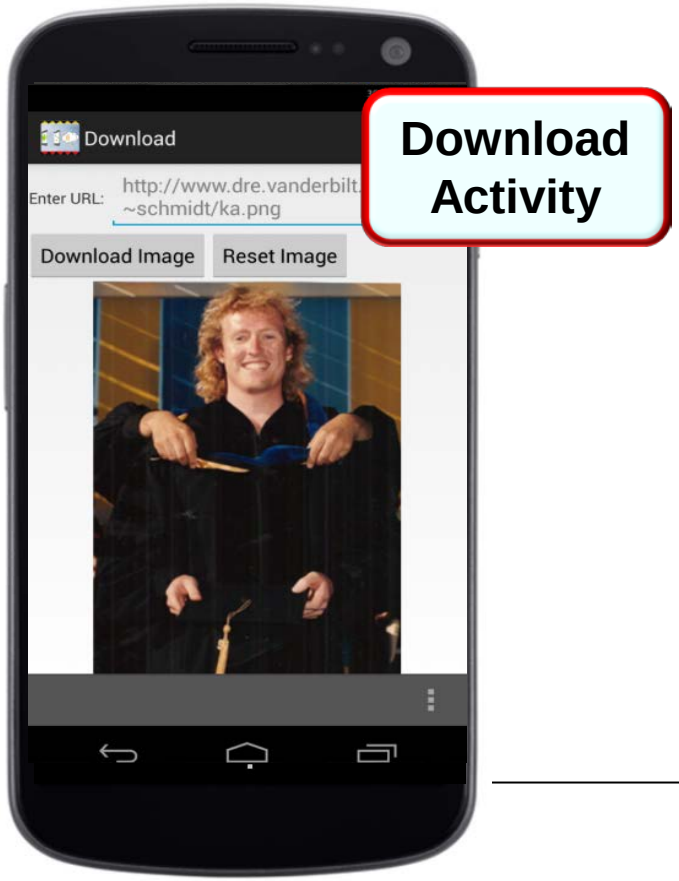


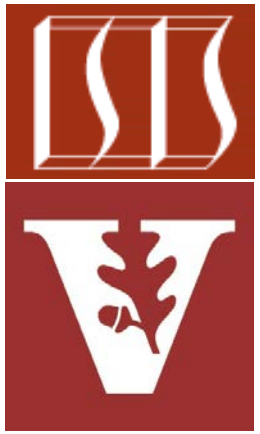
Download Application Overview



Download Application Overview

1. DownloadActivity uses startService() to launch a DownloadService





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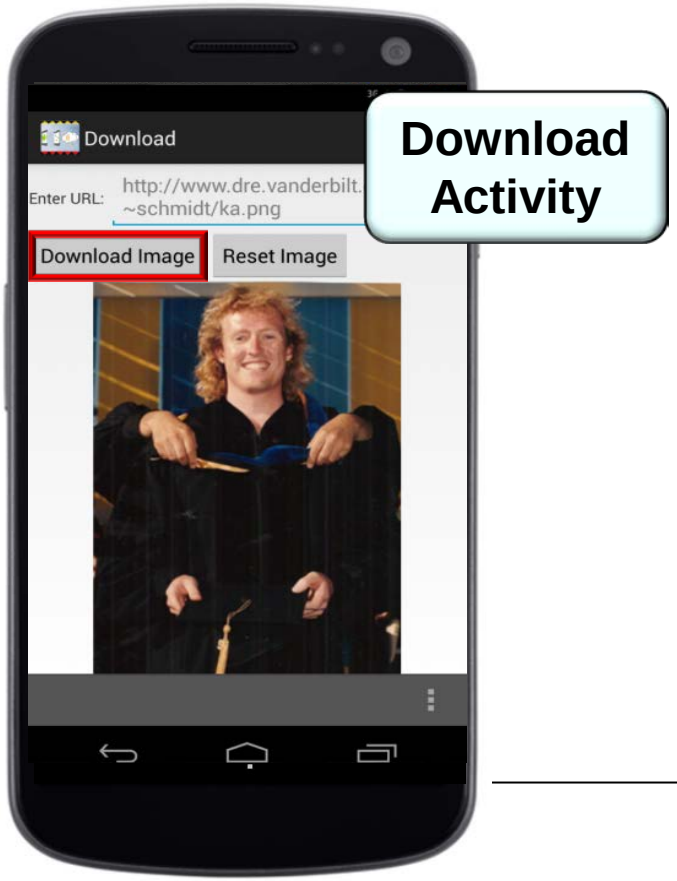

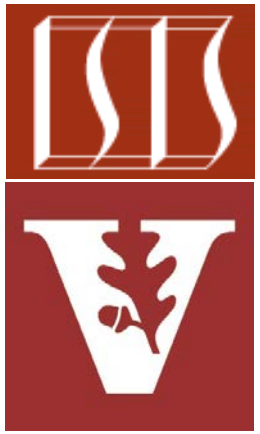

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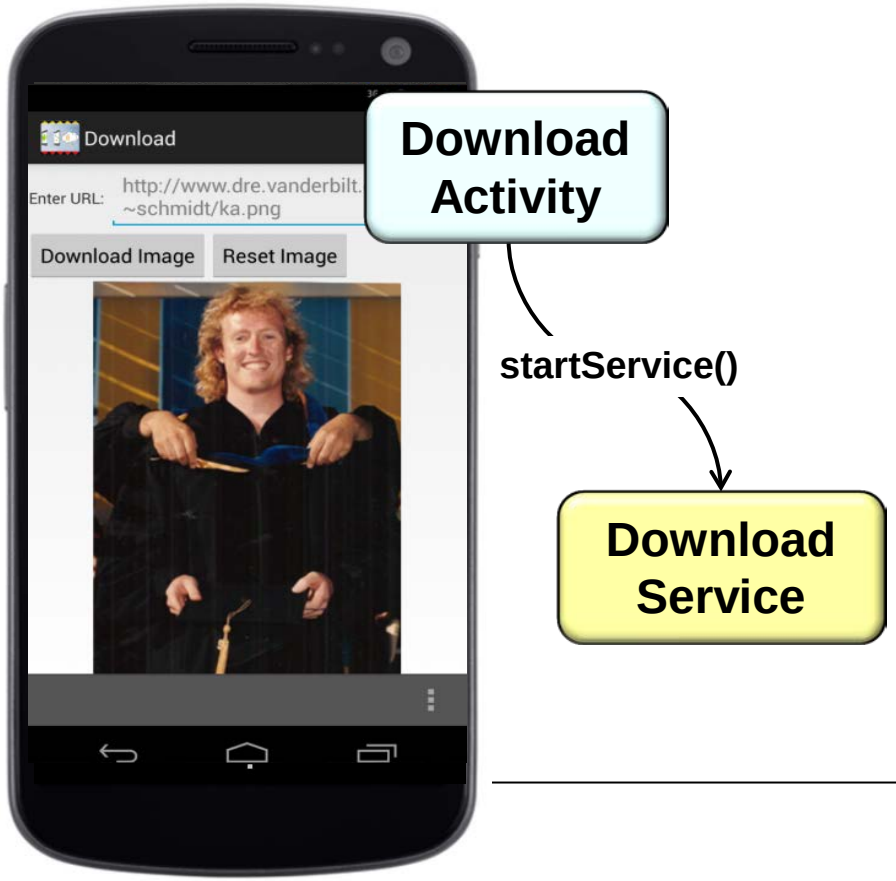

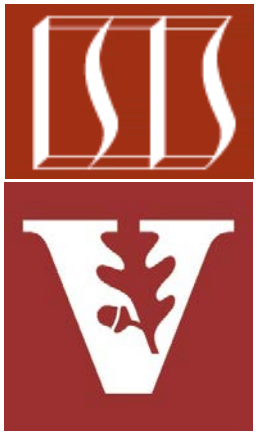

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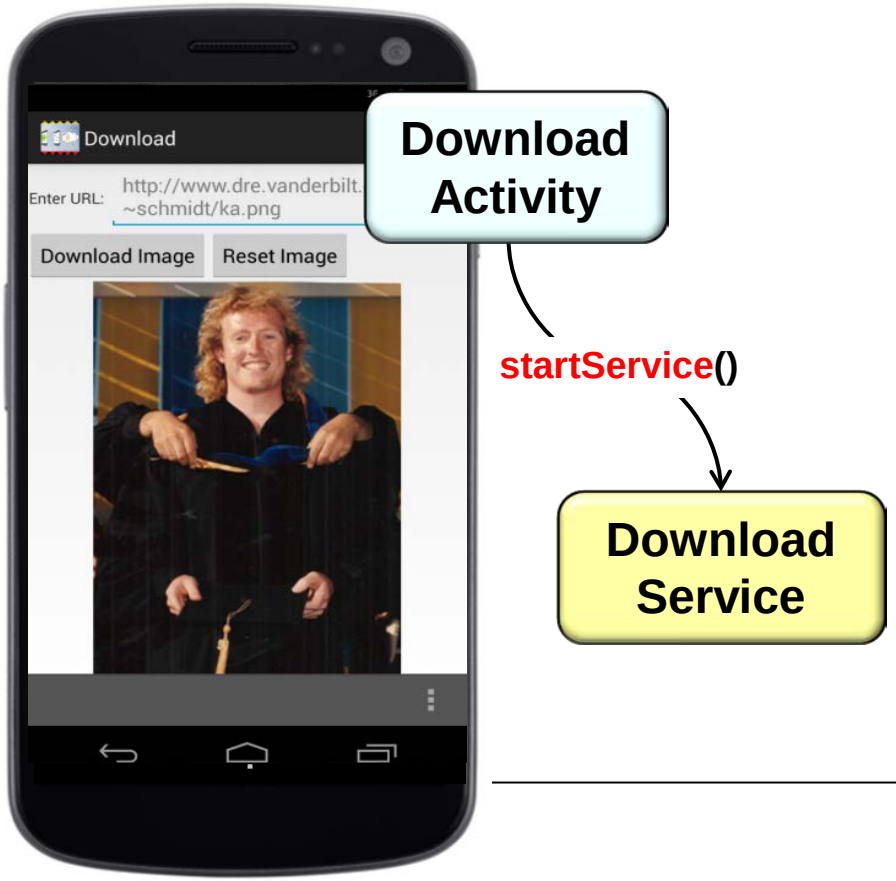
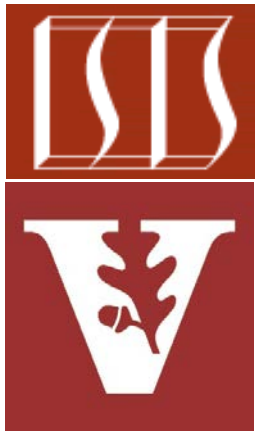
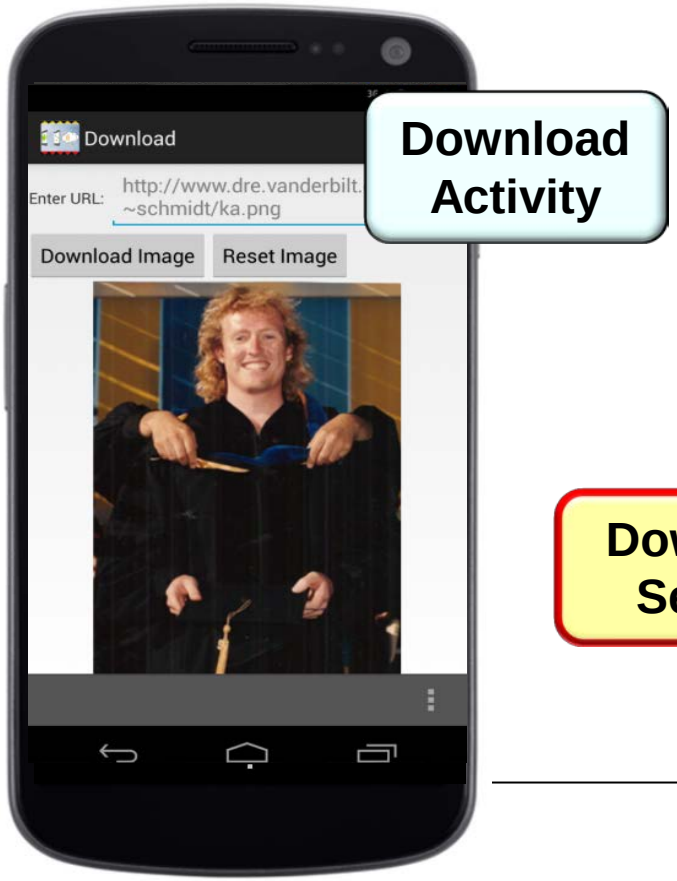
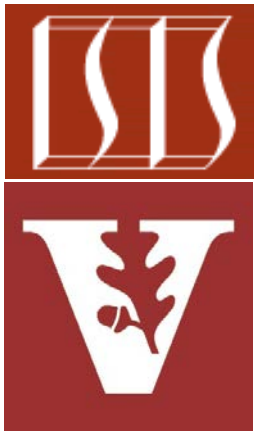




Download Application Overview

1. DownloadActivity uses startService() to launch a DownloadService
2. The DownloadService retrieves the image & stores it in a file on the device





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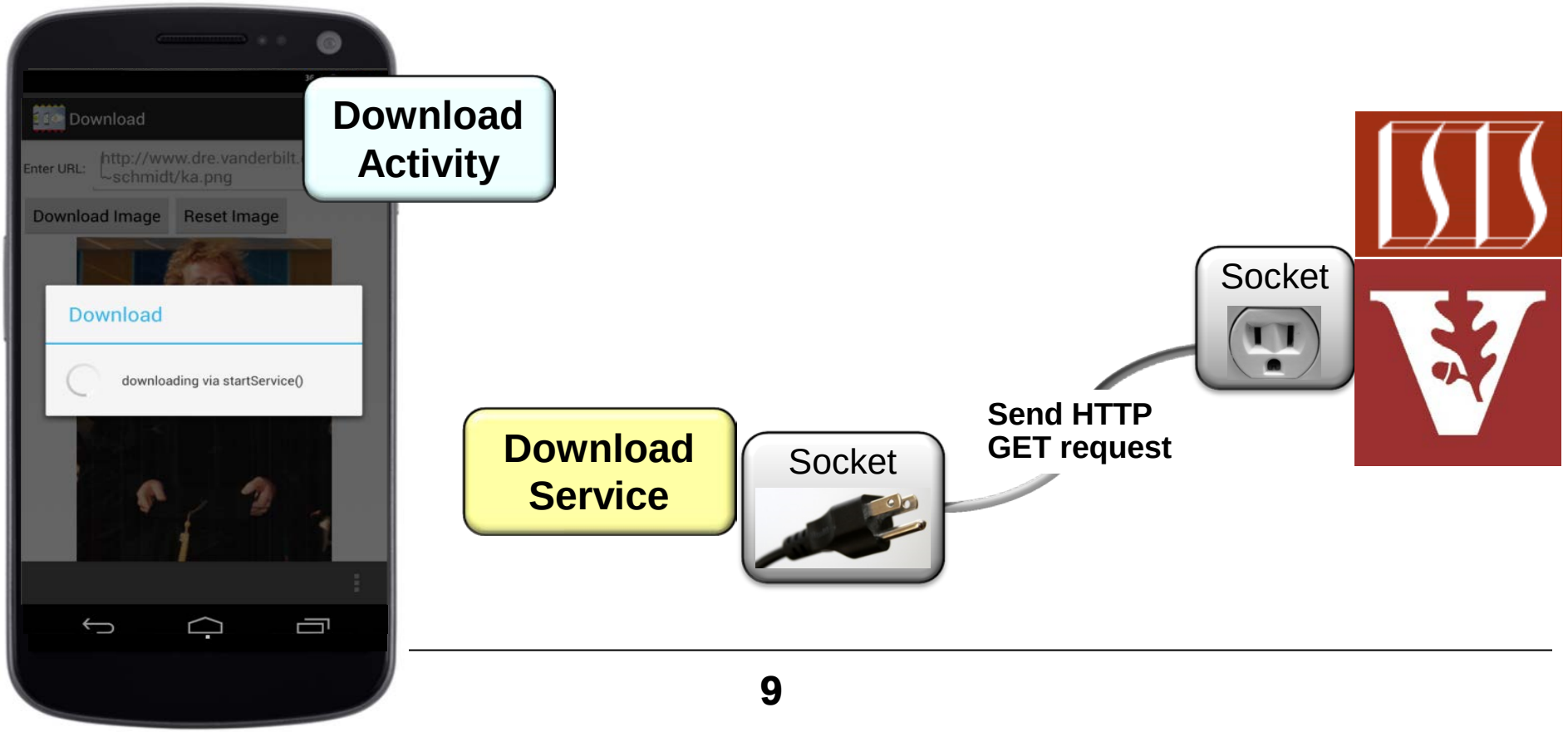

Download Application Overview

1. DownloadActivity uses startService() to launch a DownloadService
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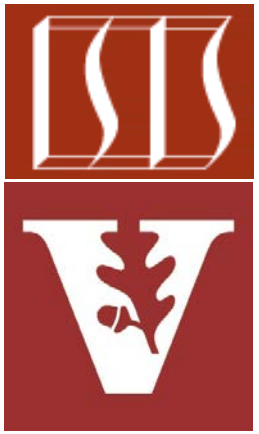
3. The DownloadService returns the pathname of the file back to the DownloadActivity, which then displays the image



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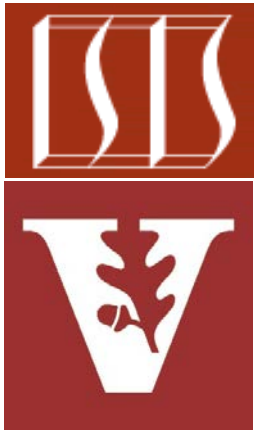

We'll just cover steps 1 & 2 in this part

Download Application Overview

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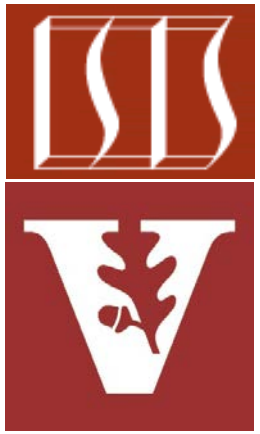

See upcoming parts on “Activity & Service Communication”

Tips to Understand the Download Application

- Run/read the code & watch the video carefully to understand how it works

github.com/douglascraigschmidt/POSA-14/tree/master/ex/DownloadApplication

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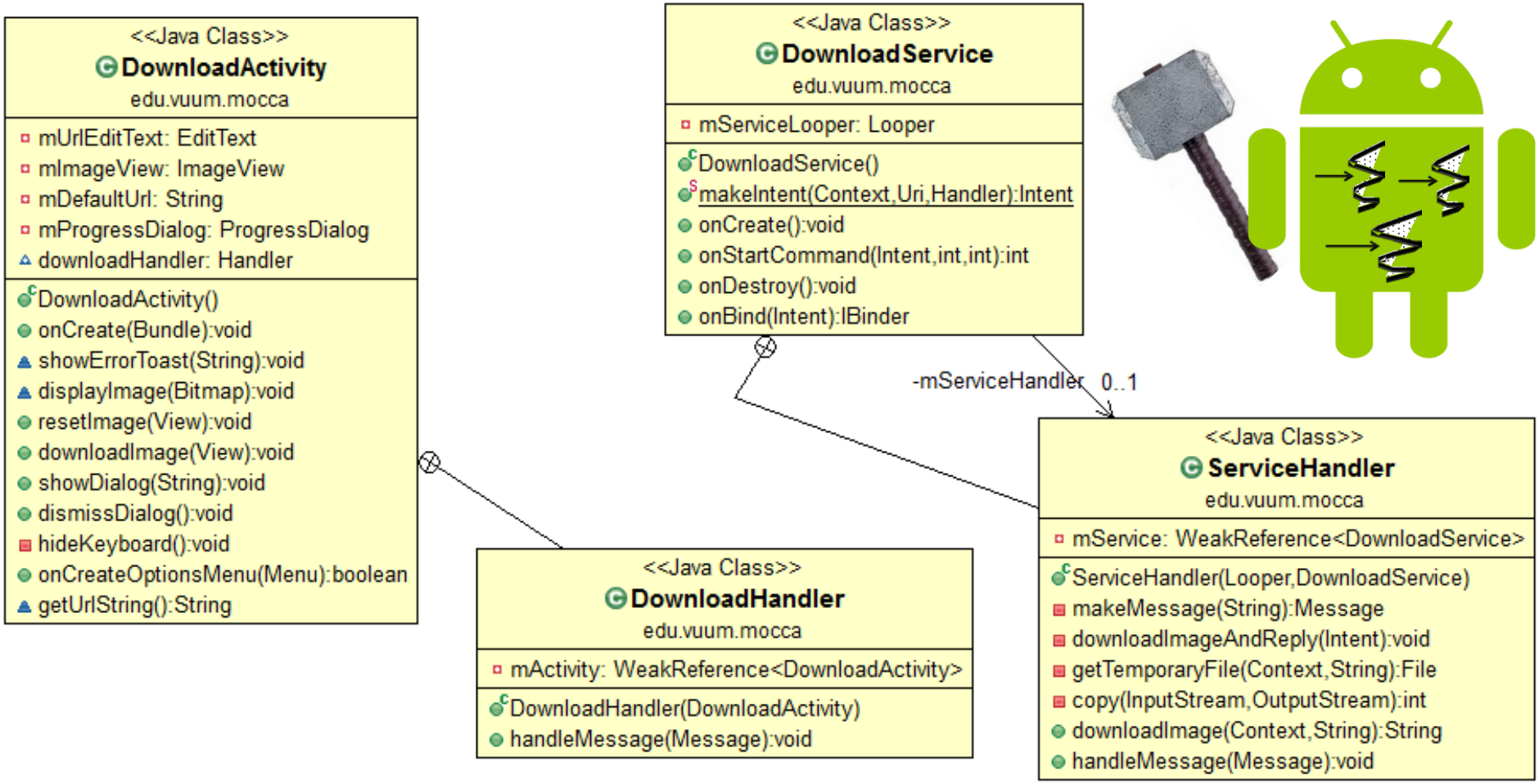
- Run/read the code & watch the video carefully to understand how it works
- This example is complex since many classes & Android mechanisms are used

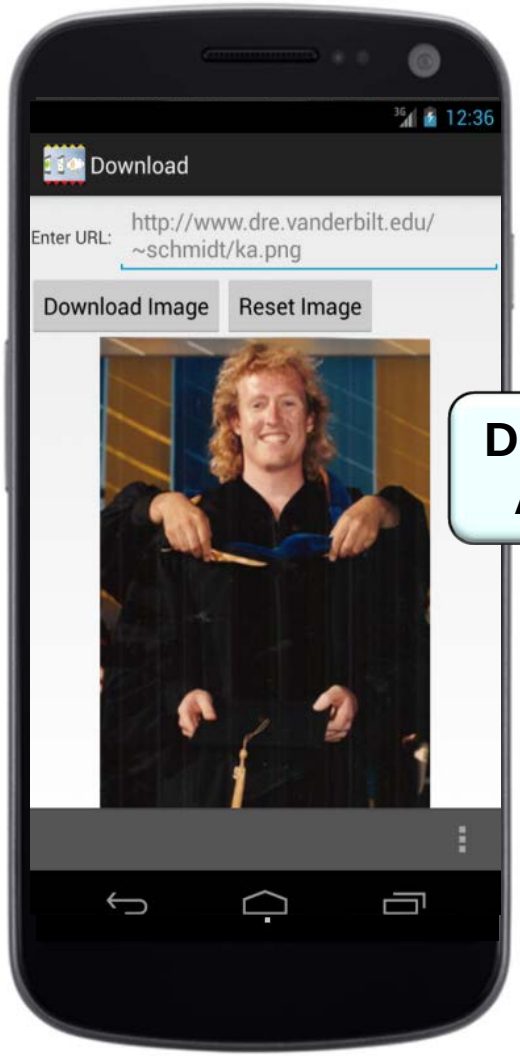


Tips to Understand the Download Application

- Run/read the code & watch the video carefully to understand how it works
- This example is complex since many classes & Android mechanisms are used
  - We therefore analyze it from various perspectives

Programming Started Services (Part 1)

Programming a Started Service



Download Activity

Download Service

Socket

Socket

Send HTTP GET request

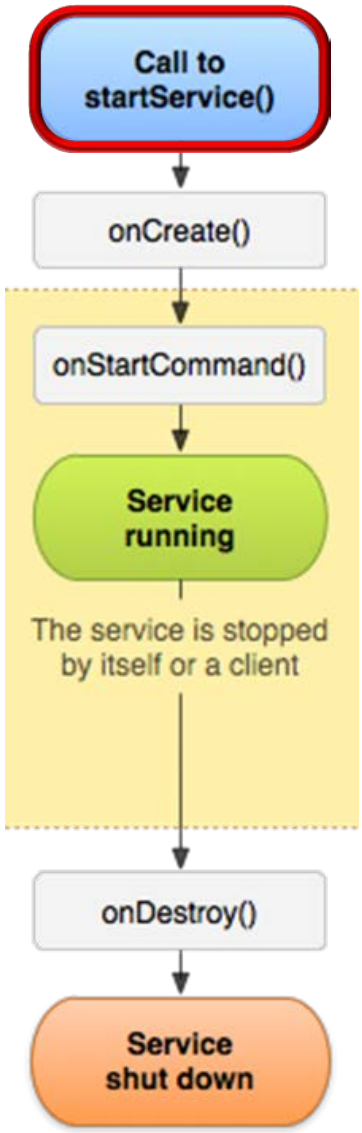
Launching a Started Service

- A client launches a Started Service by calling startService()

```
Intent intent =
  DownloadService.makeIntent
    (this, Uri.parse(url), downloadHandler);

startService(intent);
```

Download Activity



Launching a Started Service

- A client launches a Started Service by calling startService()
  - e.g., Download Activity creates an Intent that identifies the DownloadService & supplies a URL parameter via Intent data that tells Service what image to retrieve

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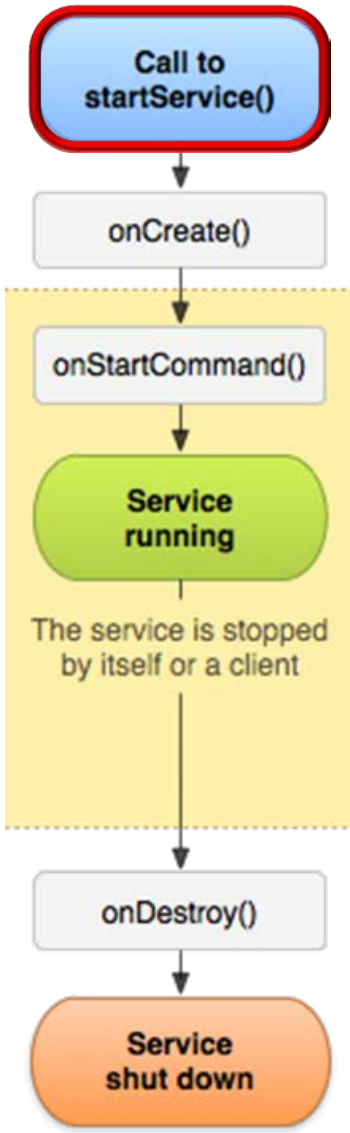

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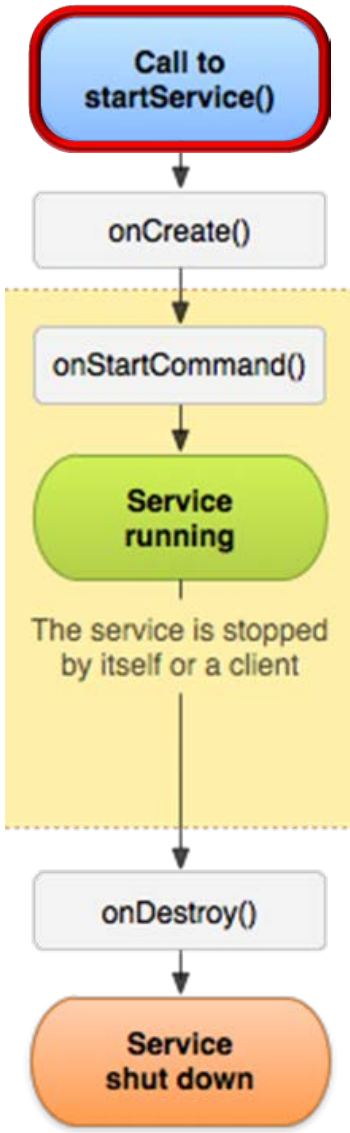

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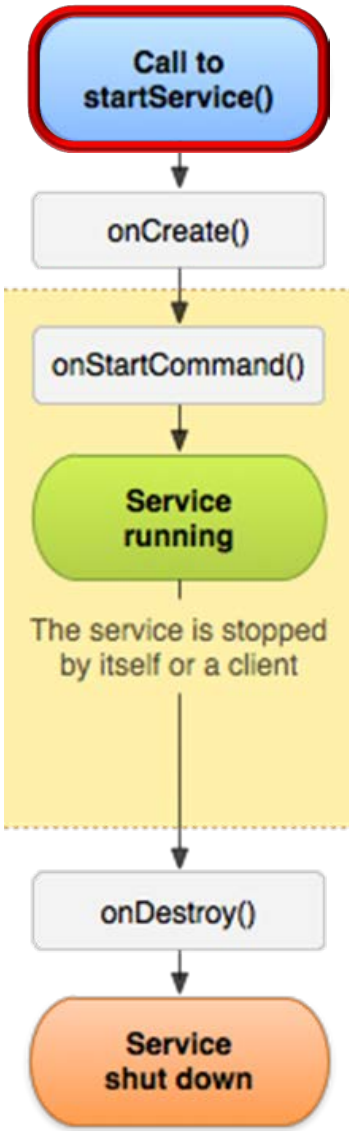
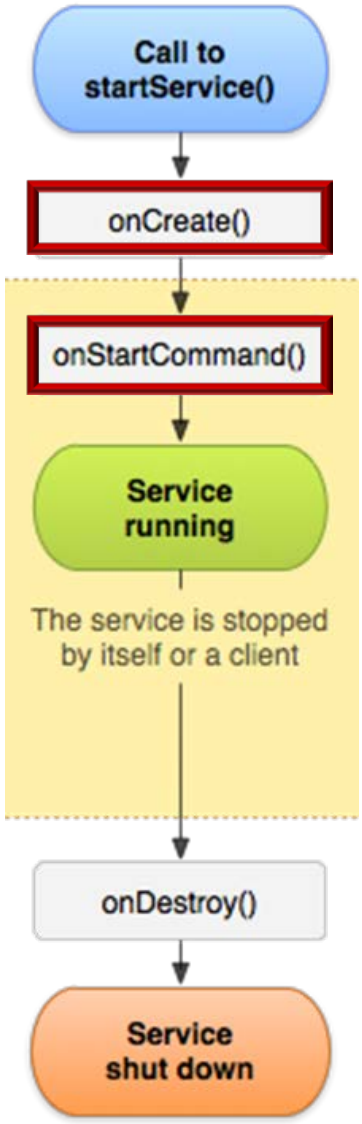
Download Activity

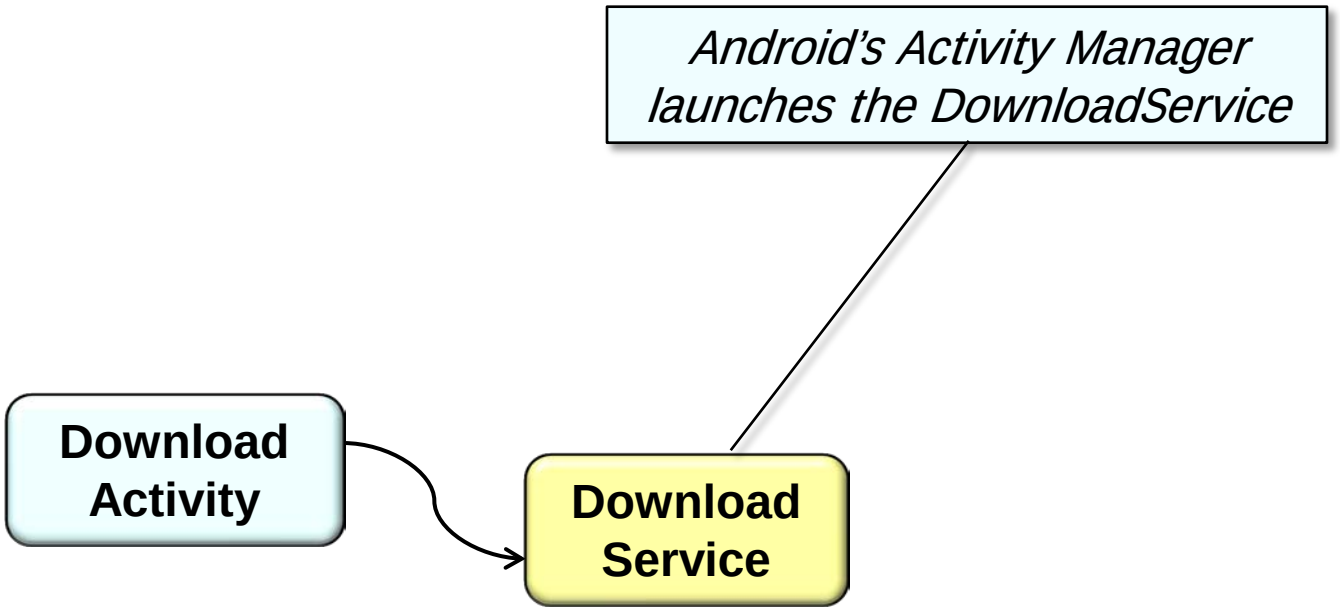
This call doesn't block the client while the DownloadService runs



Processing a Started Service

- In response to startService(), Android will launch the Service if it's not already running

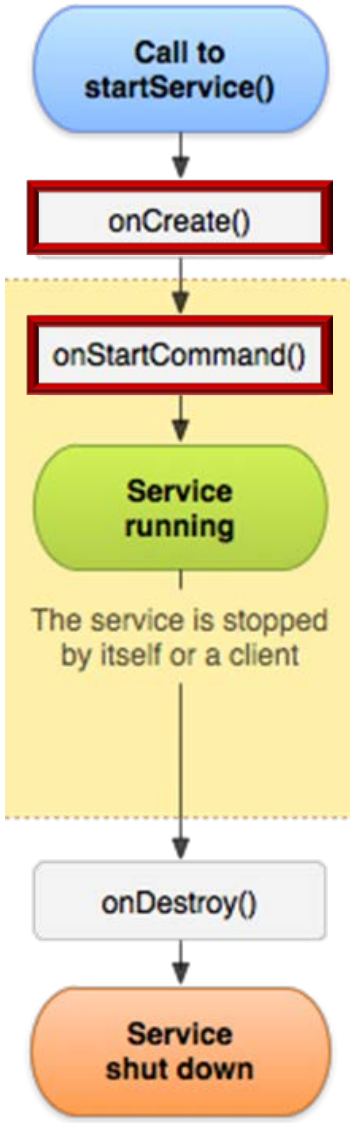




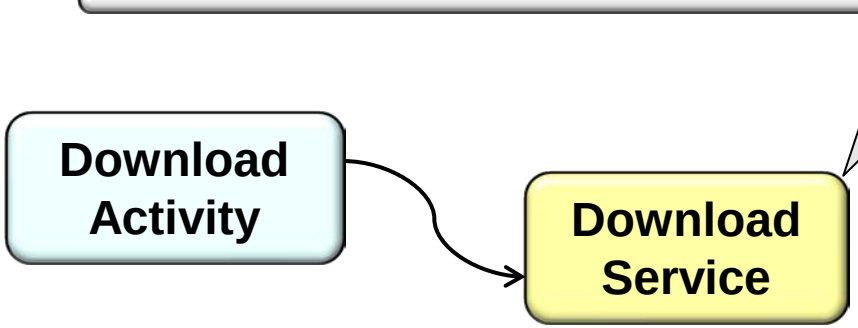
www.dre.vanderbilt.edu/~schmidt/PDF/Activator.pdf has more info

Processing a Started Service

- In response to startService(), Android will launch the Service if it's not already running
- Android then invokes the Service's onCreate() & onStartCommand() hook methods




```
public class DownloadService extends Service {
  public void onCreate() { ... }
  public int onStartCommand(Intent intent,
             int flags, int startId) { ... }
  ...
```



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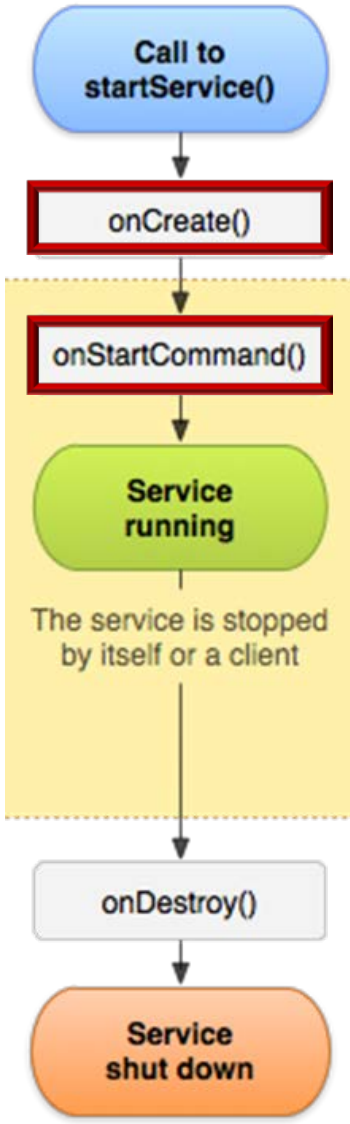


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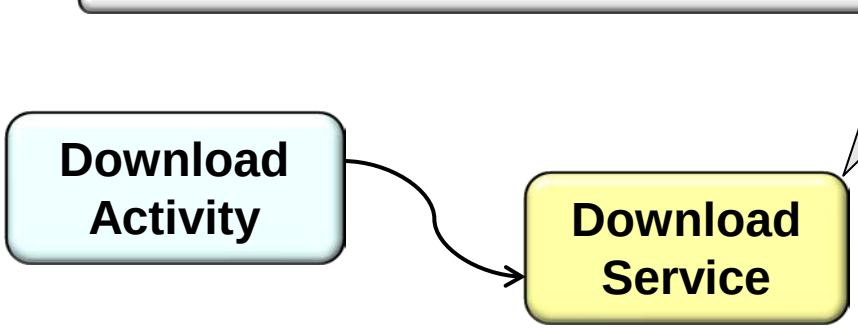


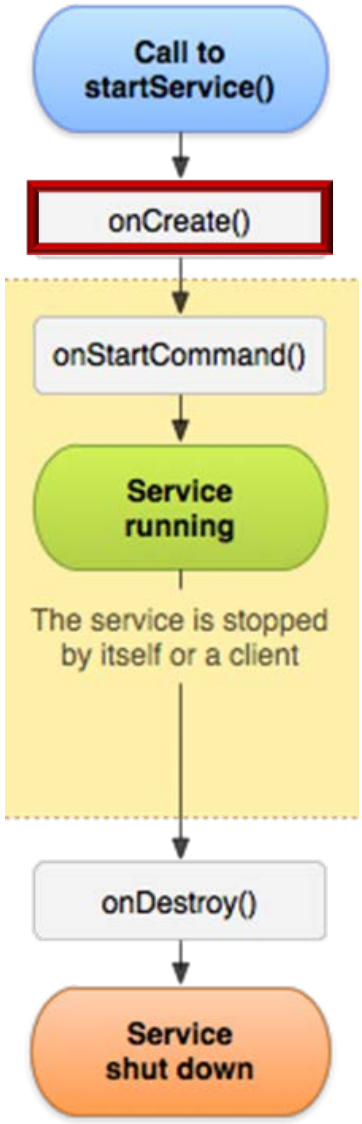
Processing a Started Service

- In response to startService(), Android will launch the Service if it's not already running
- Android then invokes the Service's onCreate() & onStartCommand() hook methods

onCreate() starts a HandlerThread

```
public class DownloadService extends Service {
  public void onCreate() {
    ...
  }
```

Download Activity → **Download Service**



Processing a Started Service

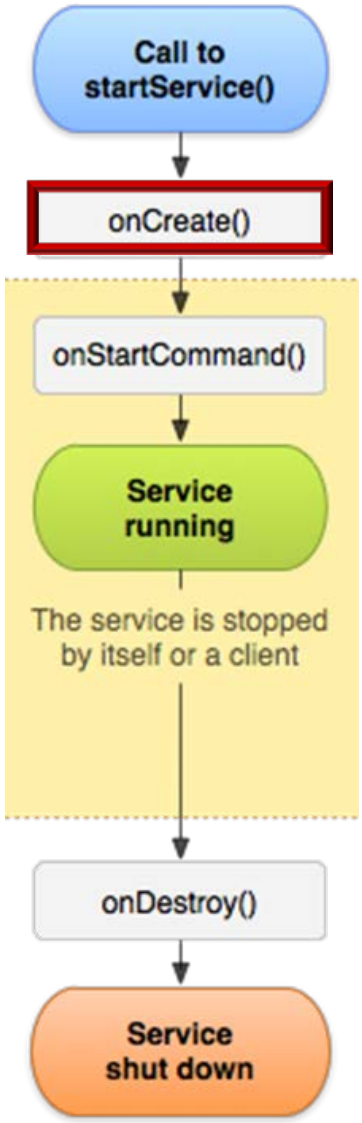
- In response to startService(), Android will launch the Service if it's not already running
- Android then invokes the Service's onCreate() & onStartCommand() hook methods

HandlerThread works with a ServiceHandler to download the image in the background & return pathname to client

```
public class DownloadService extends Service {
  public void onCreate() {
    ...
  }
```

Download Activity

Download Service



Programming Started Services (Part 2)

Processing a Started Service

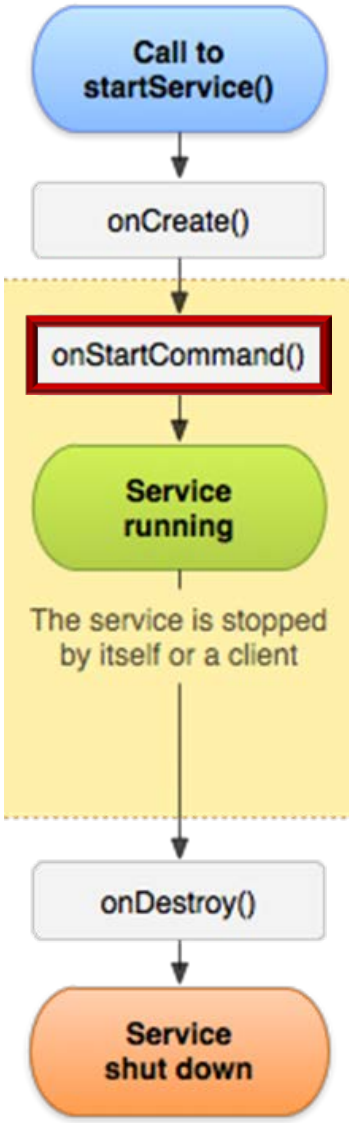
- In response to startService(), Android will launch the Service if it's not already running
- Android then invokes the Service's onCreate() & onStartCommand() hook methods

onStartCommand() sends the Intent to the background HandlerThread

```
public class DownloadService extends Service {
  public int onStartCommand(Intent intent,
                            int flags,
                            int startId)

  { ... }
```

Download Activity → **Download Service**



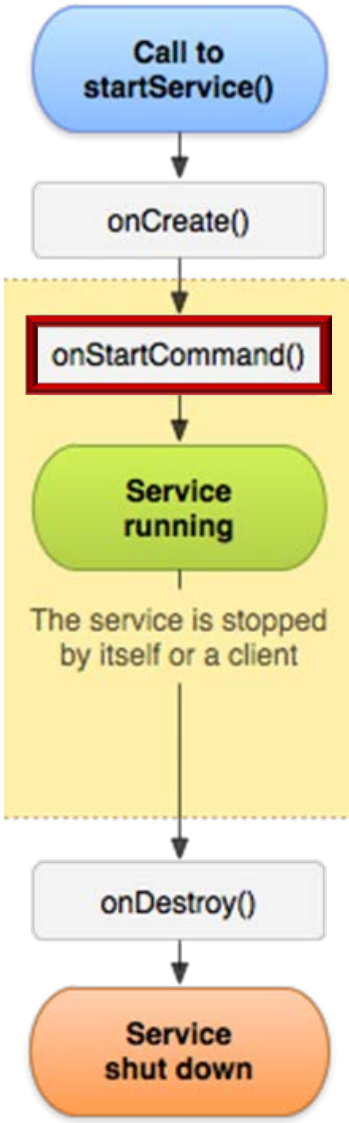
Processing a Started Service

- In response to startService(), Android will launch the Service if it's not already running
- Android then invokes the Service's onCreate() & onStartCommand() hook methods

onStartCommand() returns a result to Android, but not to the client

```
public class DownloadService extends Service {
  public int onStartCommand(Intent intent,
                            int flags,
                            int startId)
  { return ...; }
```

Download Activity → **Download Service**



Processing a Started Service

Return value tells Android what it should do with the Service if its process is killed while it is running

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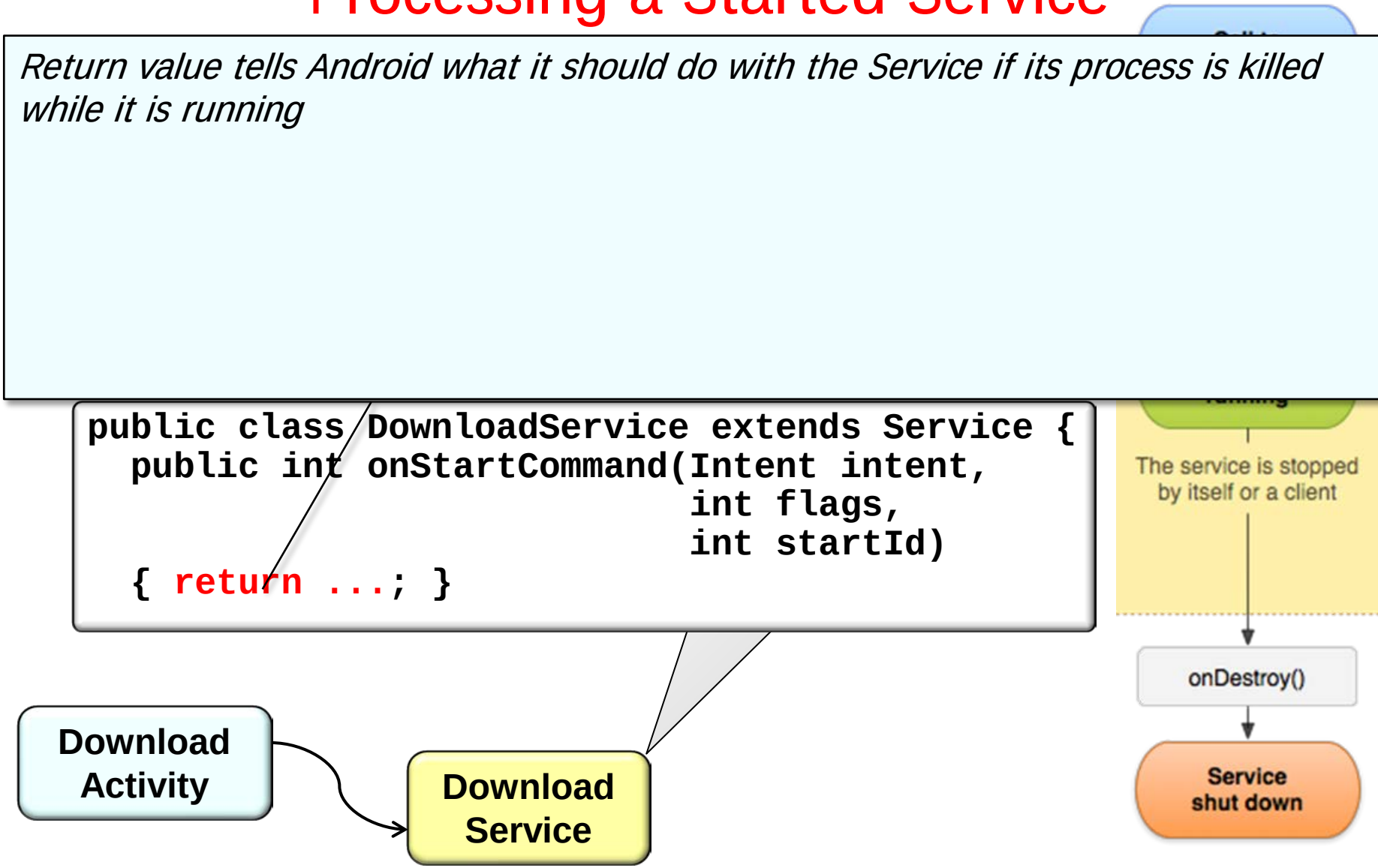

Processing a Started Service

Return value tells Android what it should do with the Service if its process is killed while it is running

- *START_STICKY – Don't redeliver Intent to onStartCommand() (pass null intent)*

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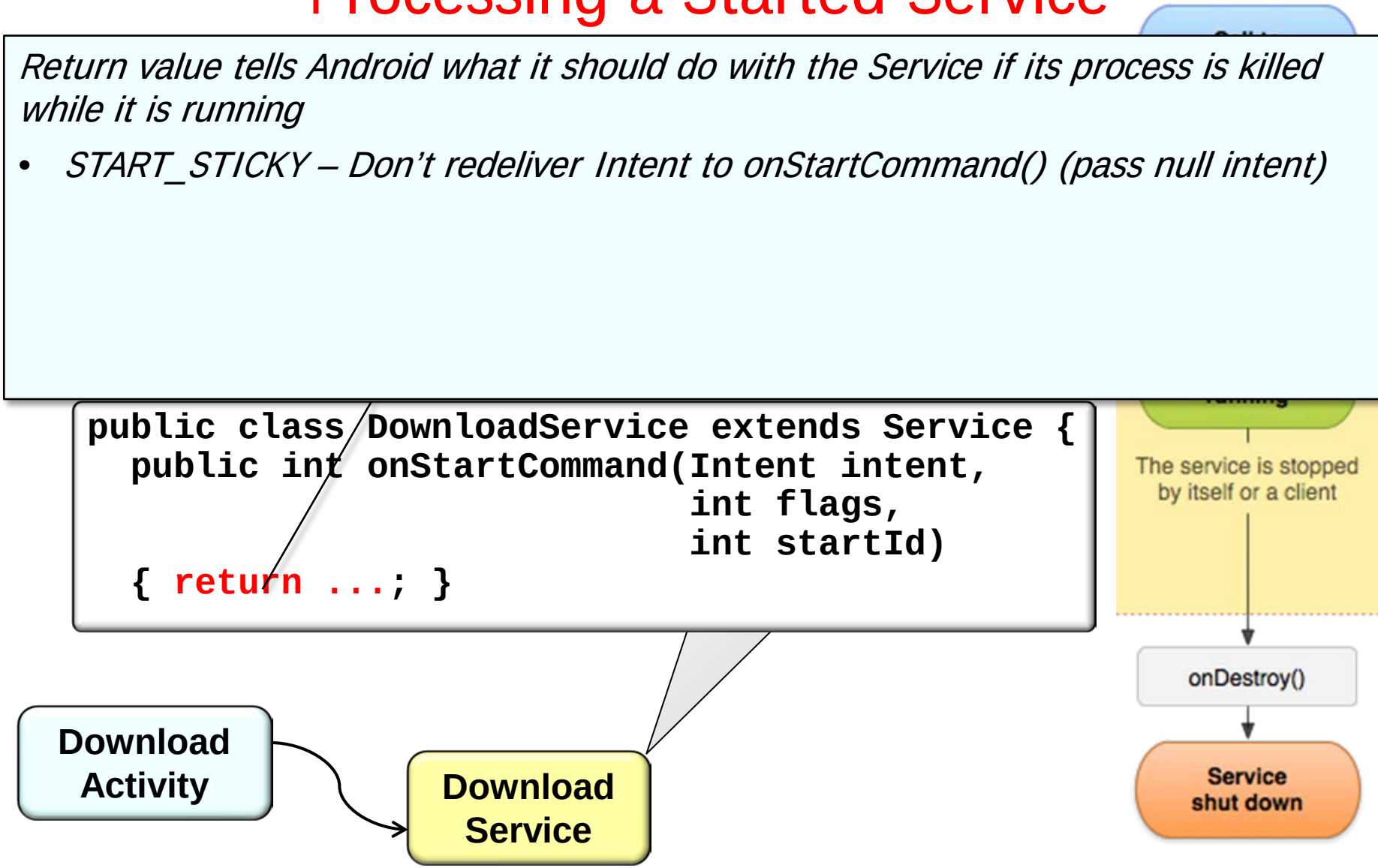

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- *START_STICKY – Don't redeliver Intent to onStartCommand() (pass null intent)*
- *START_NOT_STICKY – Service should remain stopped until explicitly started by some client code*

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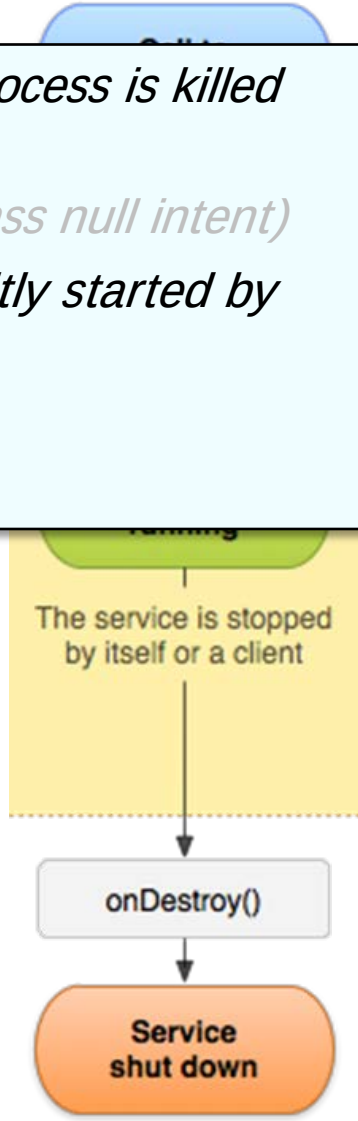
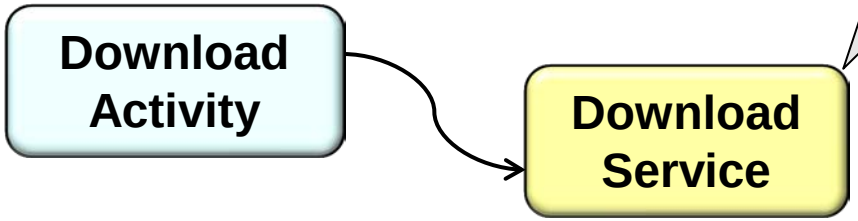


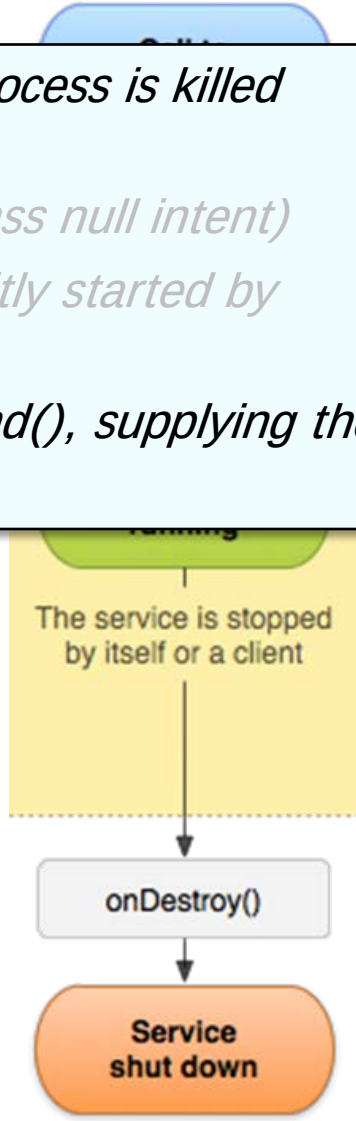


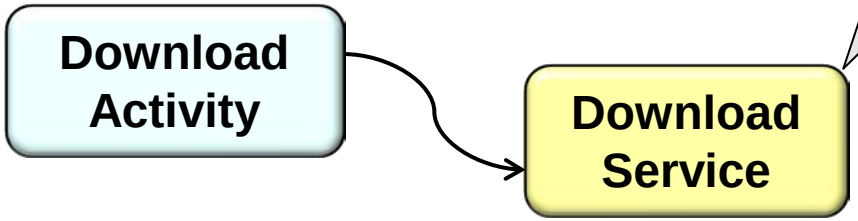
Processing a Started Service

Return value tells Android what it should do with the Service if its process is killed while it is running

- *START_STICKY – Don't redeliver Intent to onStartCommand() (pass null intent)*
- *START_NOT_STICKY – Service should remain stopped until explicitly started by some client code*
- *START_REDELIVER_INTENT – Restart Service via onStartCommand(), supplying the same Intent as was delivered this time*

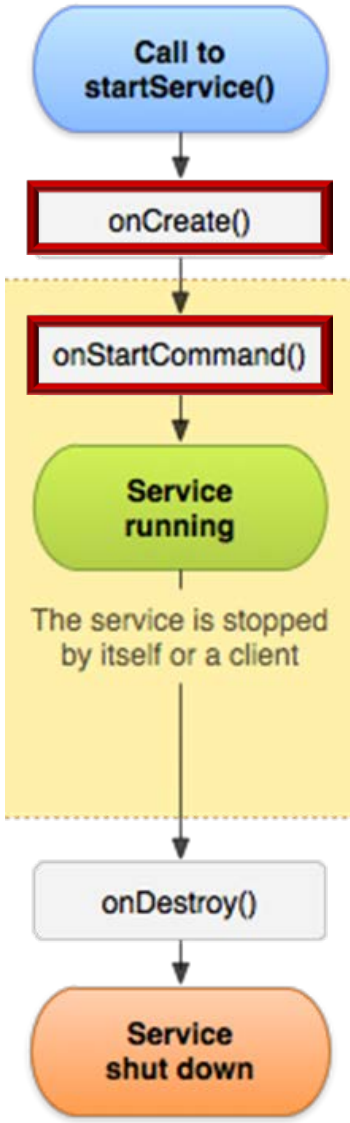
```
public class DownloadService extends Service {
  public int onStartCommand(Intent intent,
                            int flags,
                            int startId)
  { return ...; }
```





Processing a Started Service

- In response to startService(), Android will launch the Service if it's not already running
- Android then invokes the Service's onCreate() & onStartCommand() hook methods

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public class DownloadService extends Service {
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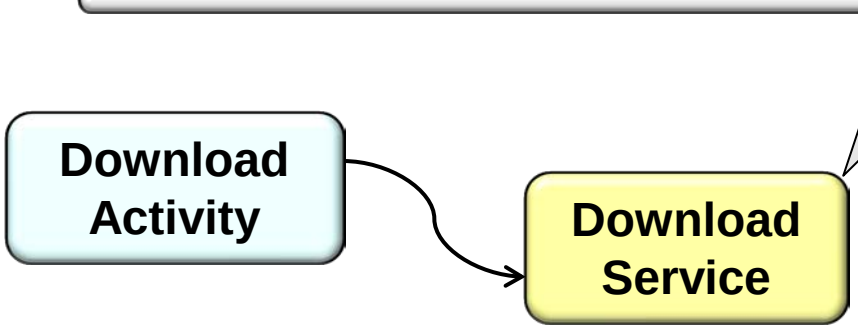
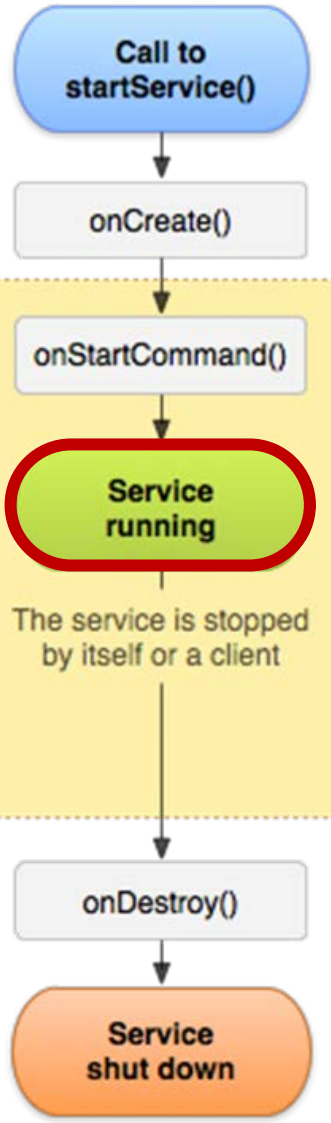
                            int flags,
                            int startId)
  { return ...; }
```



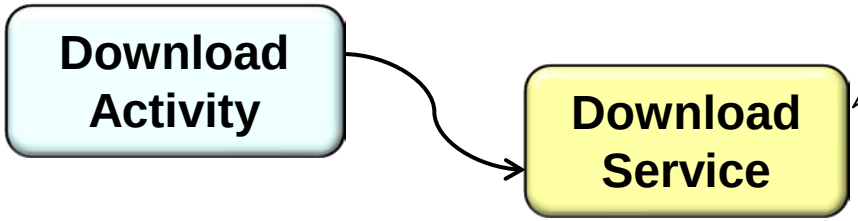
android-developers.blogspot.com.au/2010/02/service-api-changes-starting-with.html

Processing a Started Service

- In response to startService(), Android will launch the Service if it's not already running
- Android then invokes the Service's onCreate() & onStartCommand() hook methods
- A started service typically performs a single operation & often doesn't return a result to the client

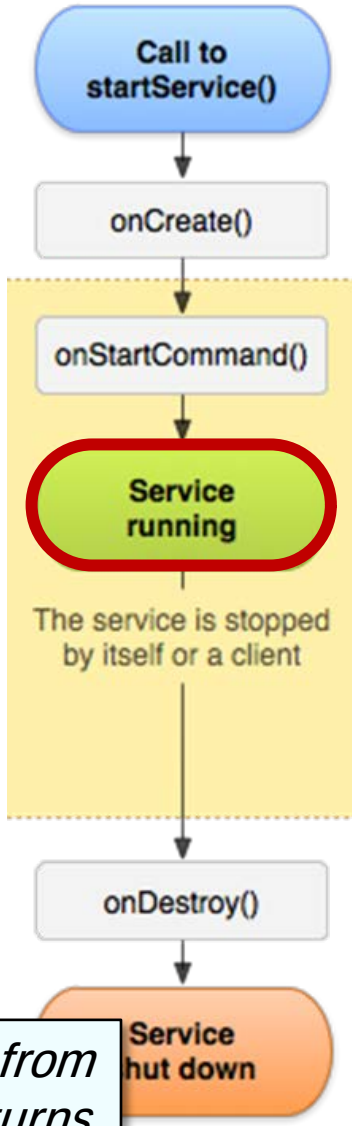



```
public class DownloadService extends Service {
  ...
  public void handleMessage(Message msg) {
      downloadImage((Intent) msg.obj);
      ...
```



Processing a Started Service

- In response to startService(), Android will launch the Service if it's not already running
- Android then invokes the Service's onCreate() & onStartCommand() hook methods
- A started service typically performs a single operation & often doesn't return a result to the client




```
public class DownloadService extends Service {
  ...
  public void handleMessage(Message msg) {
      downloadImageAndReply((Intent) msg.obj);
      ...
```

Download Activity

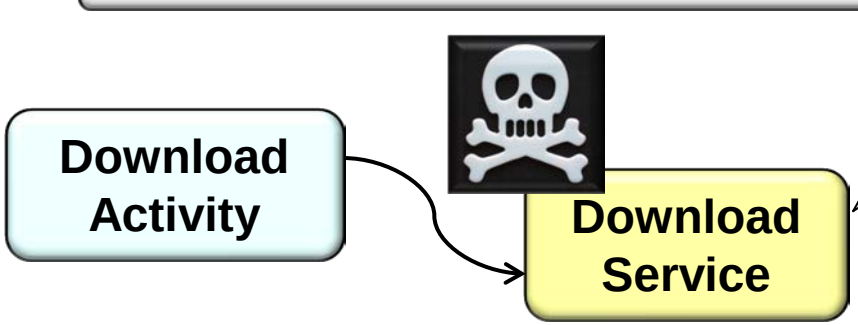
Download Service

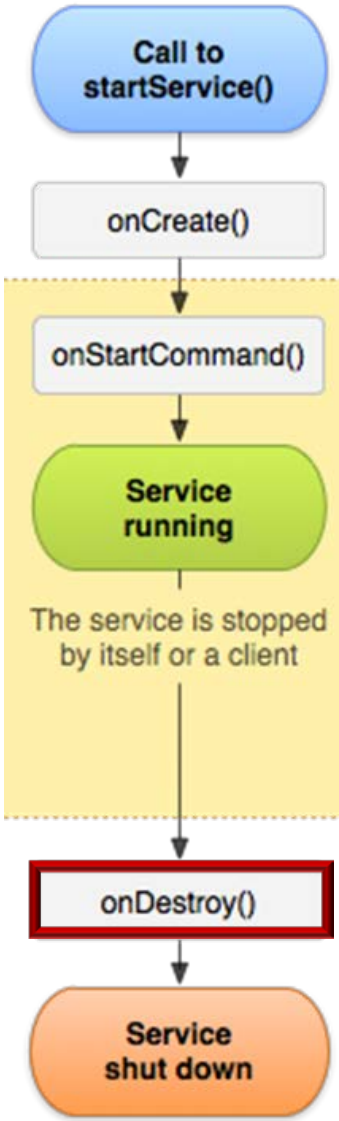
Retrieves an image from remote server & returns pathname to client

Stopping a Started Service

- When the operation is done, the Service can be stopped

```
public class DownloadService extends Service {
  ...
  public void handleMessage(Message msg) {
      ...
      stopSelf(msg.arg1);
```





Stopping a Started Service

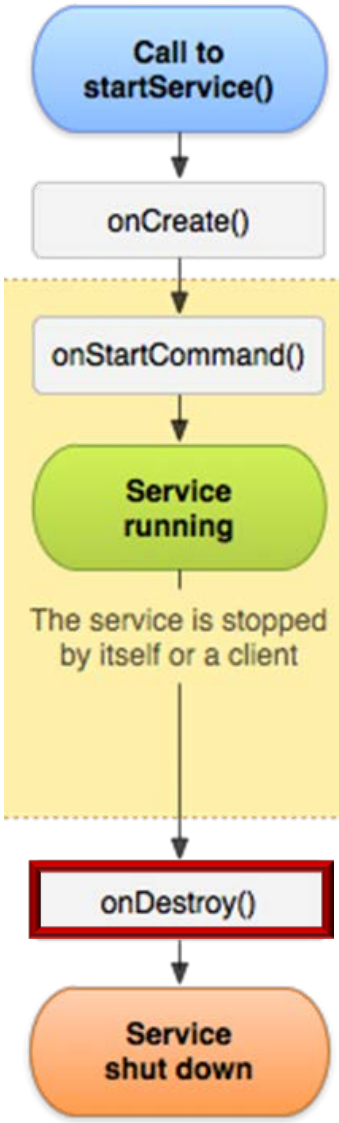
- When the operation is done, the Service can be stopped
  - e.g., the DownloadService call stopSelf() to shut itself down when it's done retrieving & processing an image

A Service that stops itself must be careful there aren't concurrent operations processing other Intents!

```
public class DownloadService extends Service {
  ...
  public void handleMessage(Message msg) {
      ...
      stopSelf(msg.arg1);
```

Download Activity

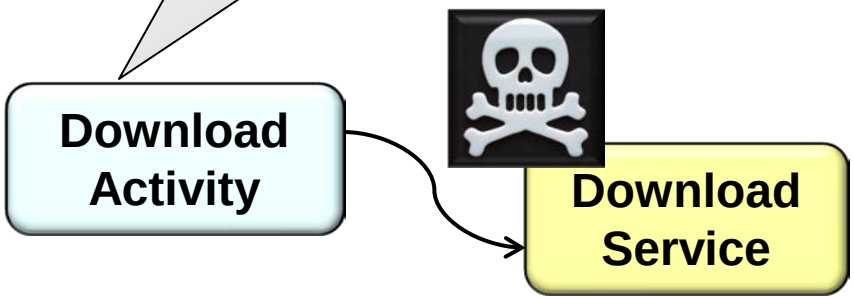
Download Service

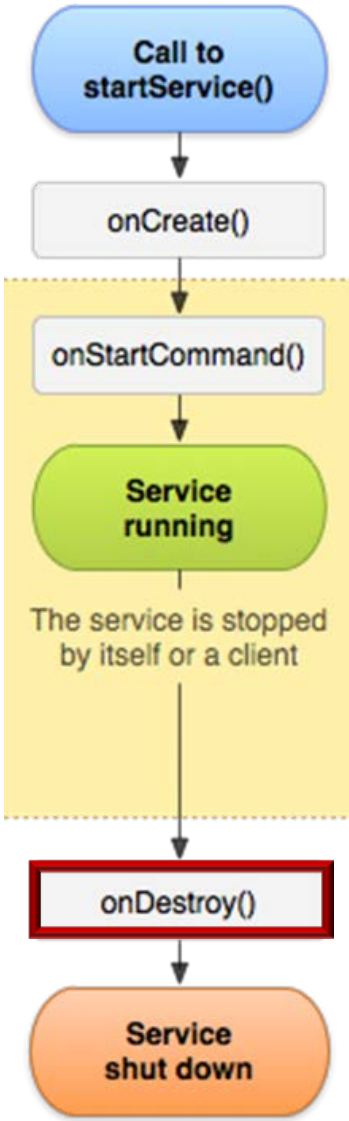


Stopping a Started Service

- When the operation is done, the Service can be stopped
  - e.g., the DownloadService call stopSelf() to shut itself down when it's done
  - Conversely, a Service can be shut down if stopService() is called by another component

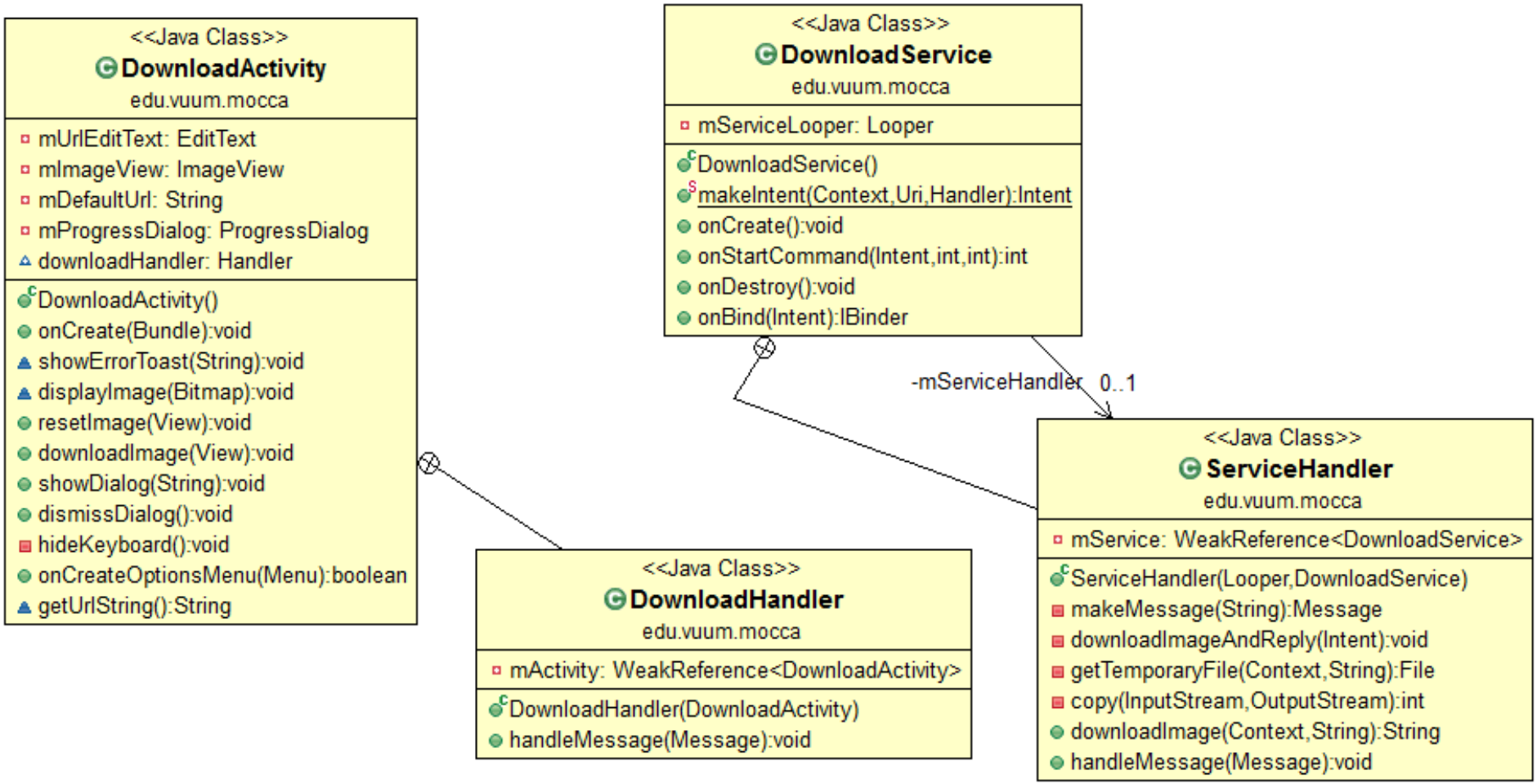
```
public class DownloadActivity ... {
  ...
  stopService(intent);
  ...
```



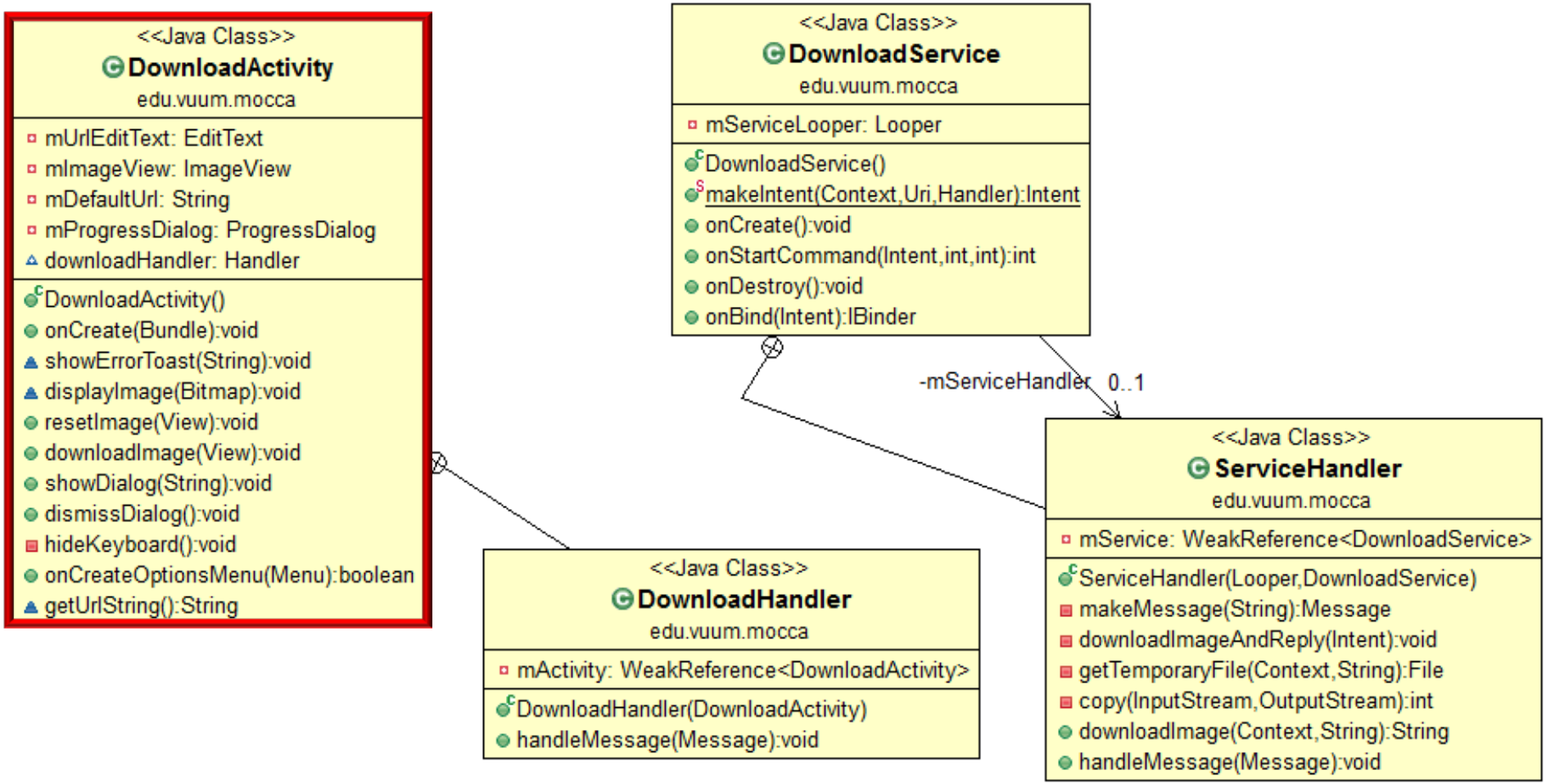


Design of the Download Application

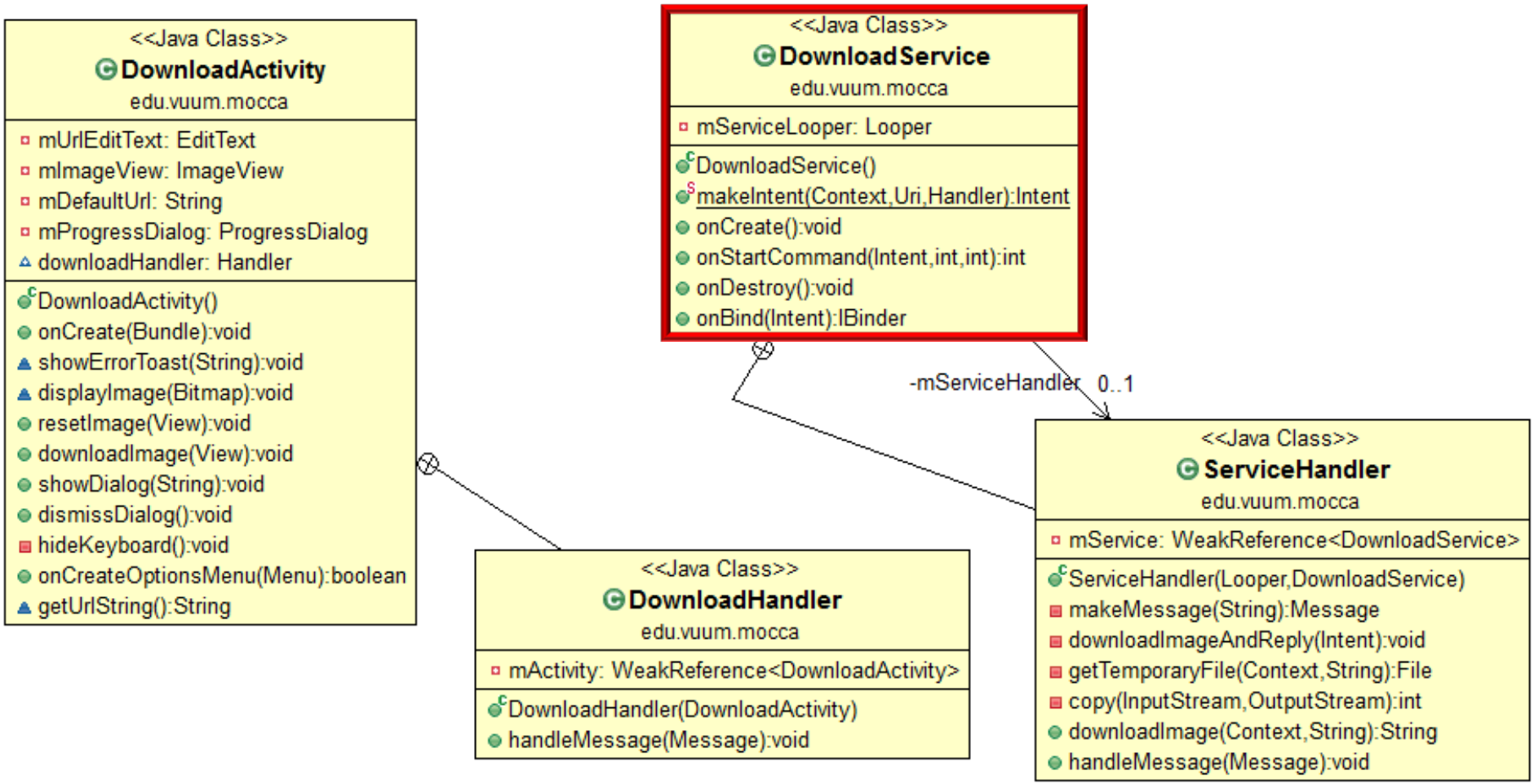
Design of the Download Application



Design of the Download Application

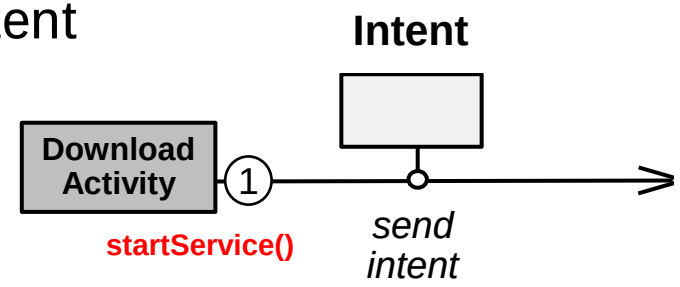


Design of the Download Application



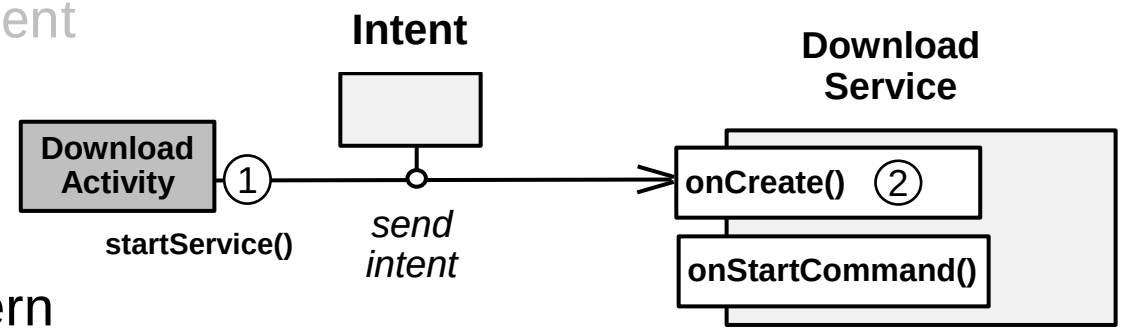
Design of the Download Application

- DownloadActivity sends an Intent via a call to startService()



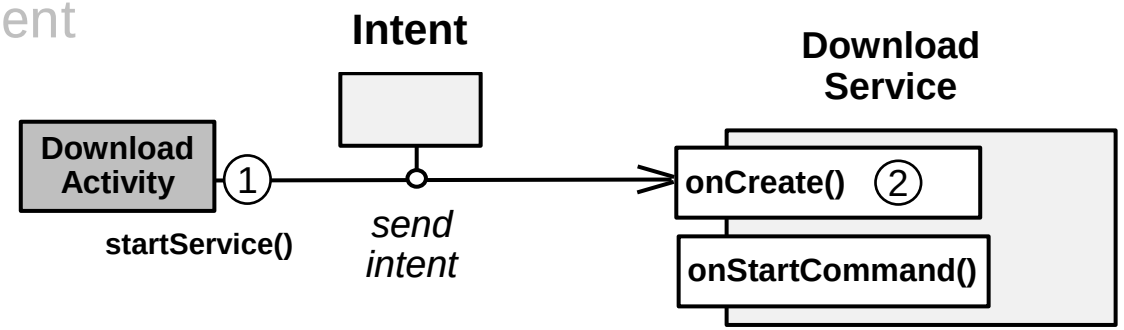
Design of the Download Application

- DownloadActivity sends an Intent via a call to startService()
- The DownloadService is launched on-demand
  - Based on the *Activator* pattern



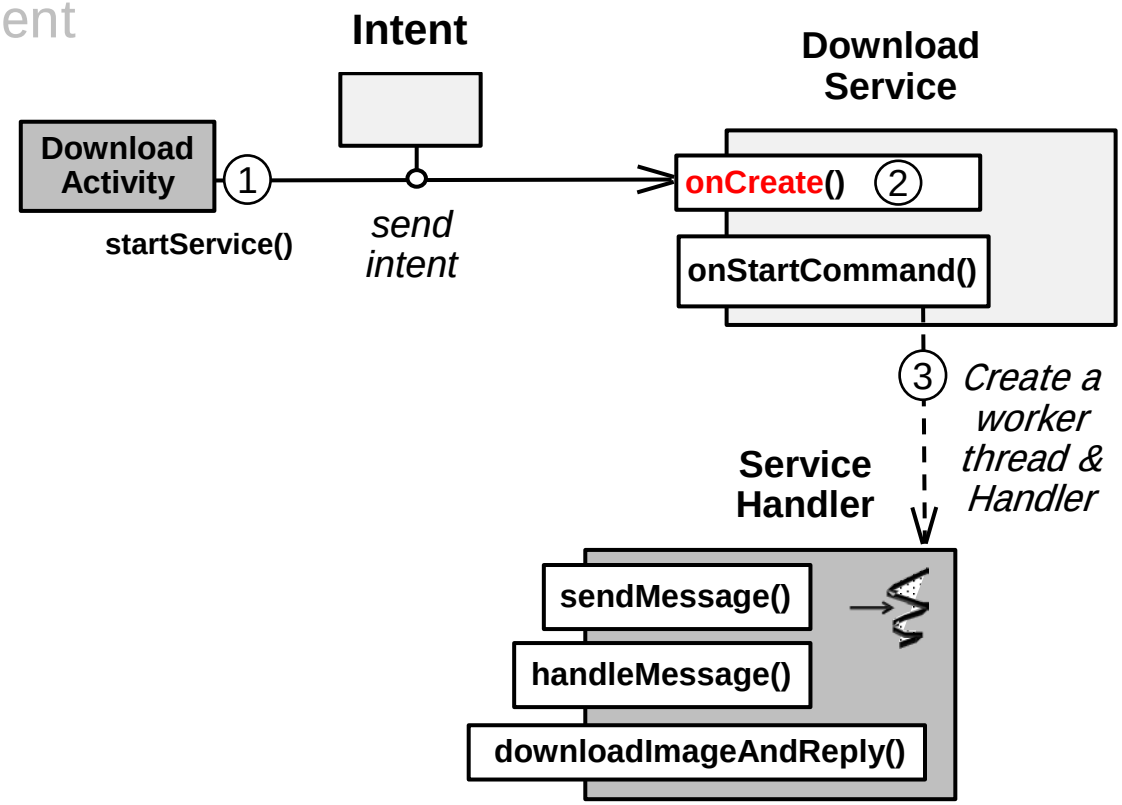
Design of the Download Application

- DownloadActivity sends an Intent via a call to startService()
- The DownloadService is launched on-demand
- DownloadService performs four main actions



Design of the Download Application

- DownloadActivity sends an Intent via a call to startService()
- The DownloadService is launched on-demand
- DownloadService performs four main actions
  1. Creates a ServiceHandler
     - Associated with a single HandlerThread



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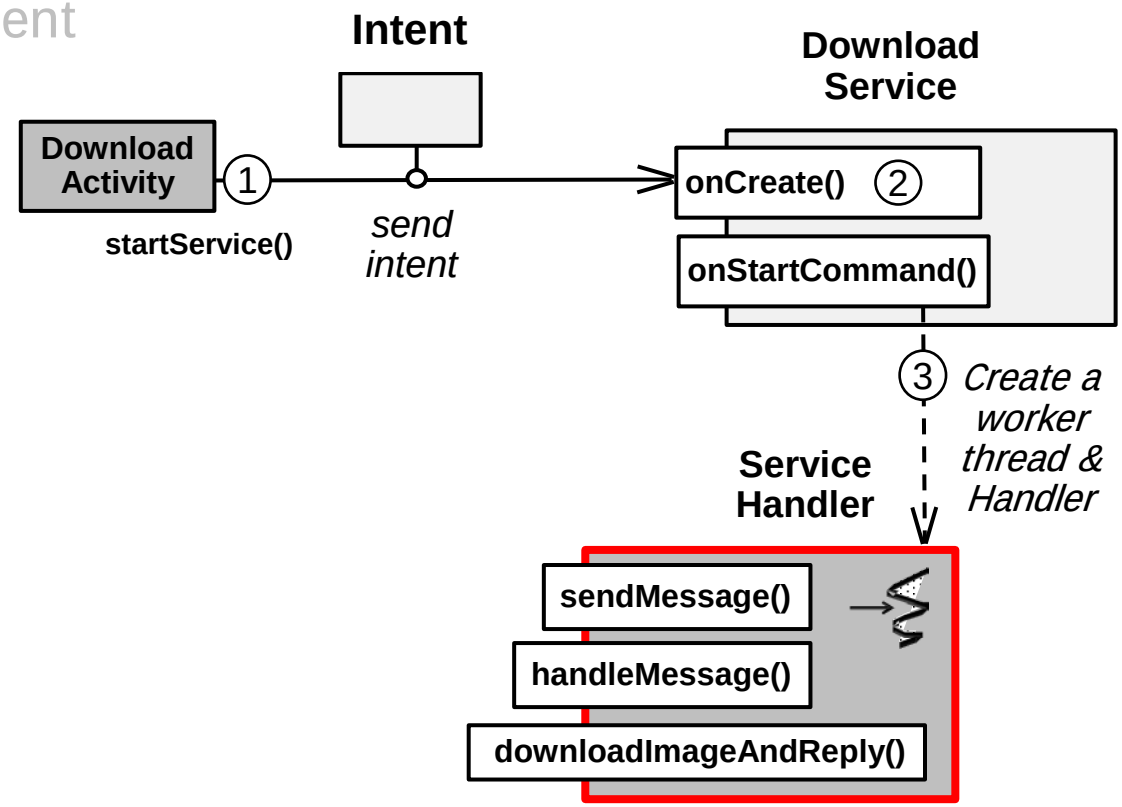

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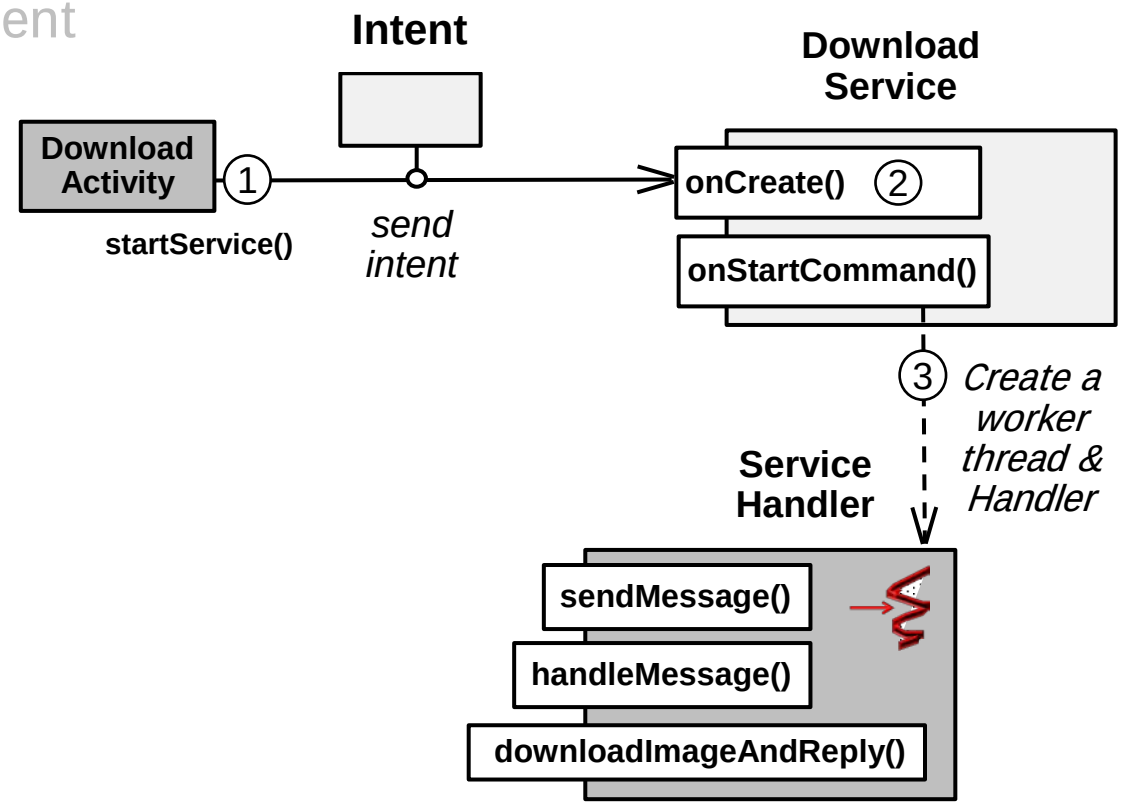

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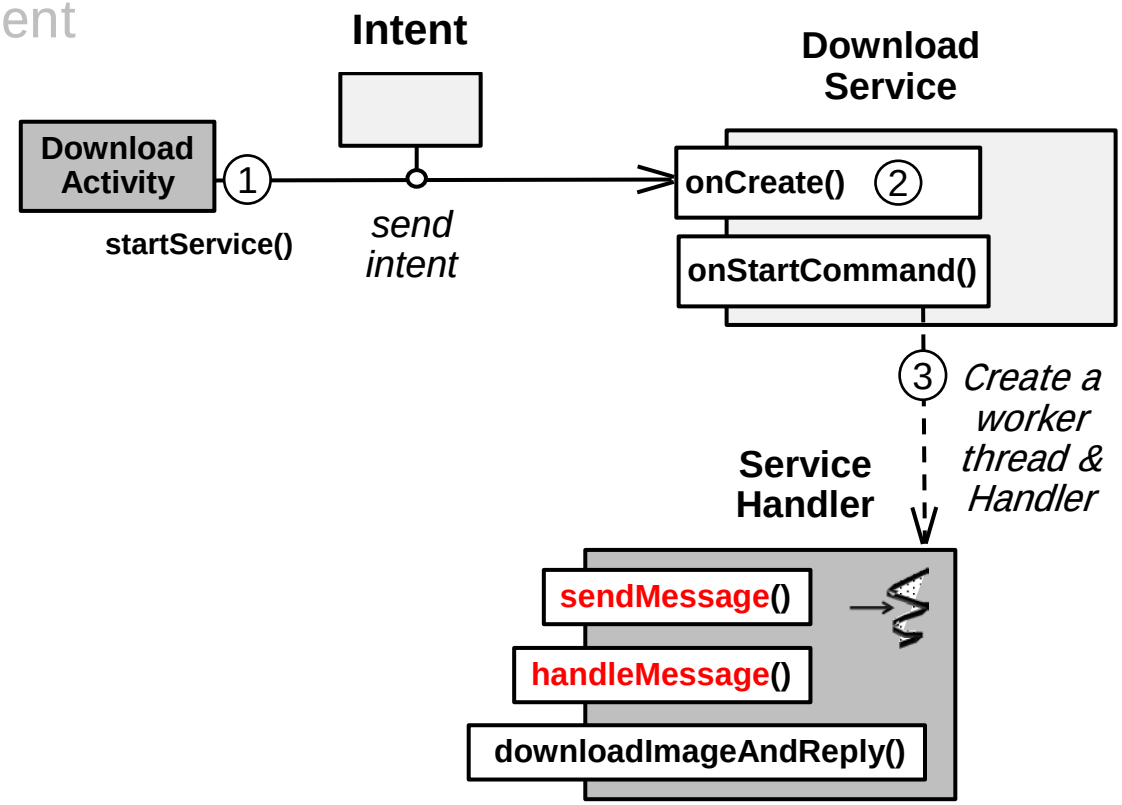

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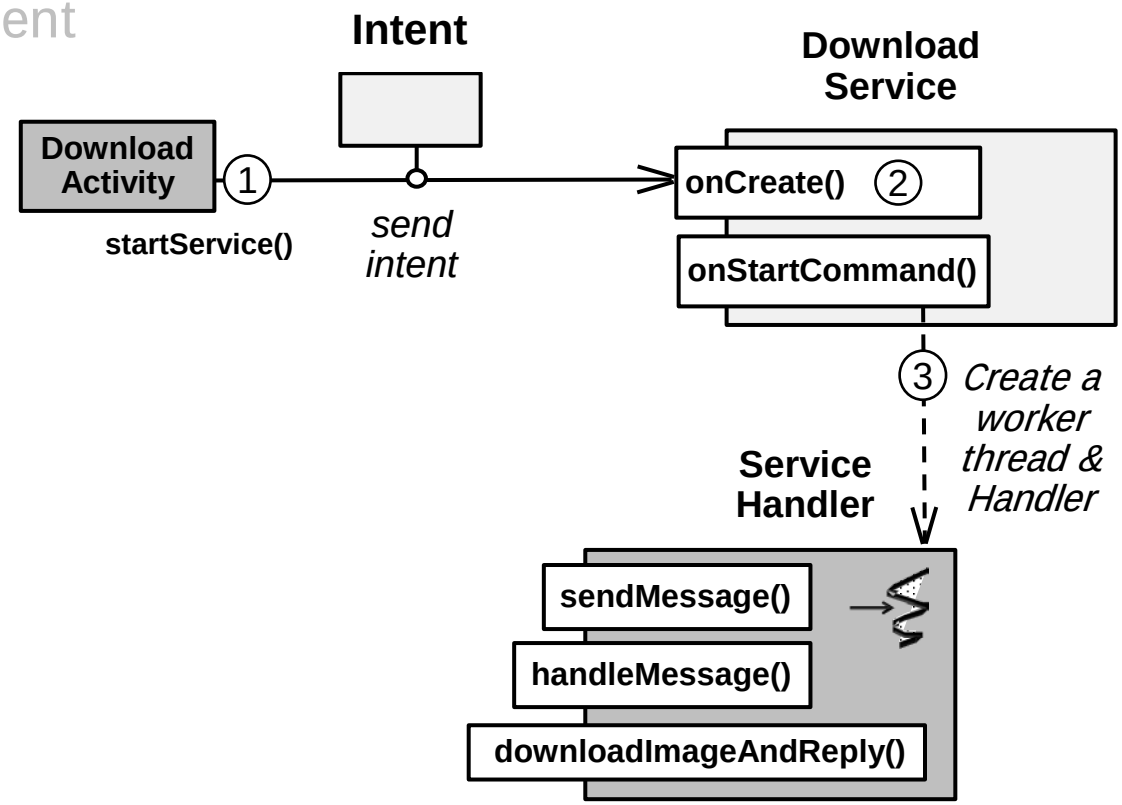
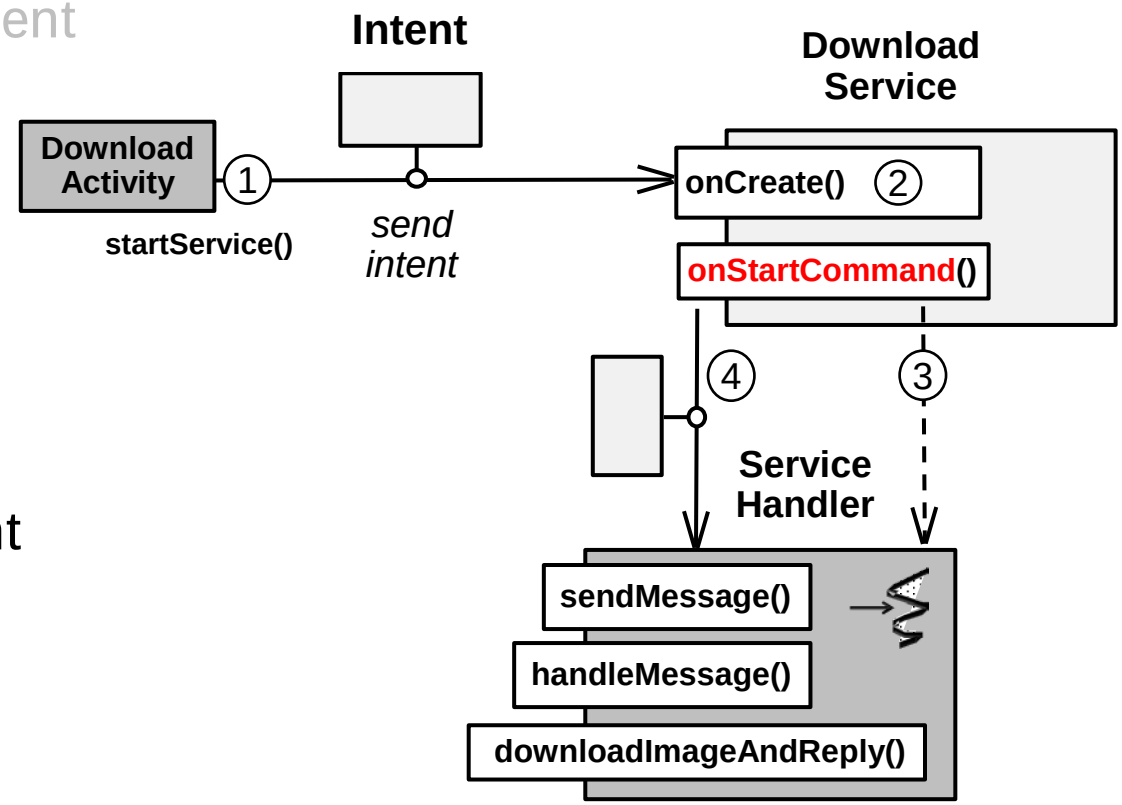


See earlier part on “Sending & Handling Messages with Android Handler”

Design of the Download Application

- DownloadActivity sends an Intent via a call to startService()
- The DownloadService is launched on-demand
- DownloadService performs four main actions
  1. Creates a ServiceHandler
  2. Receives & queues an Intent in the ServiceHandler



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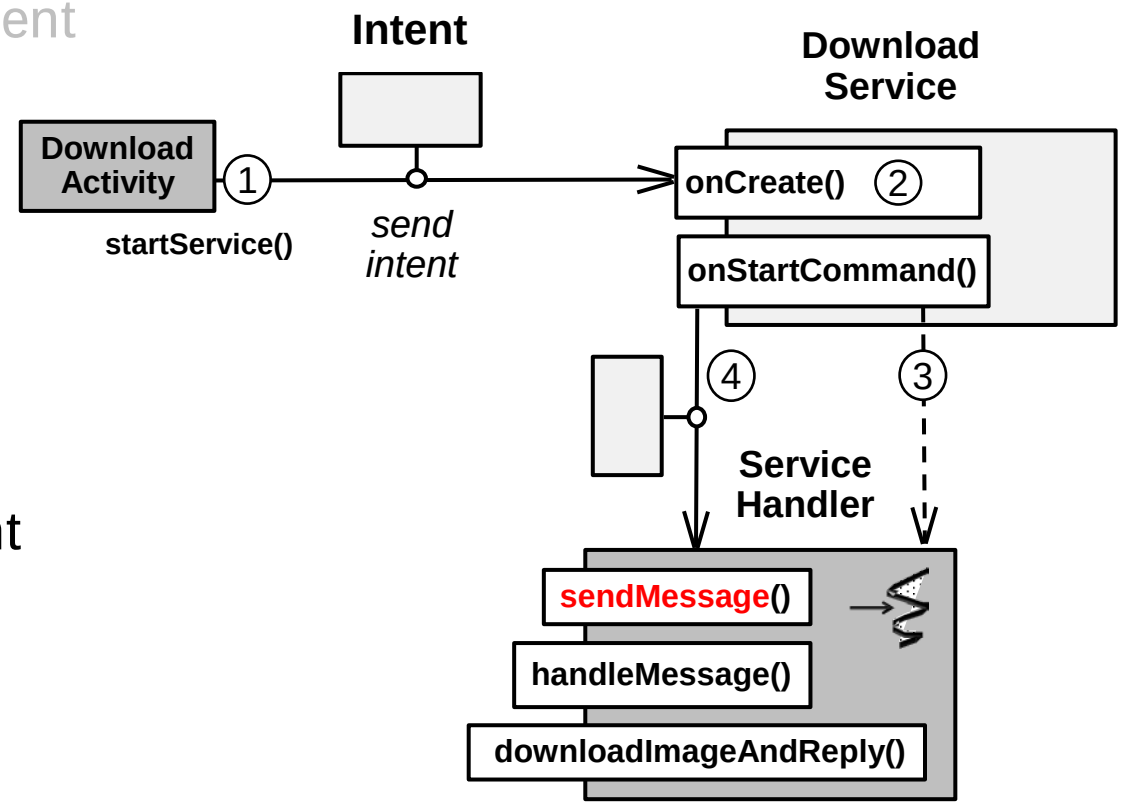

Design of the Download Application

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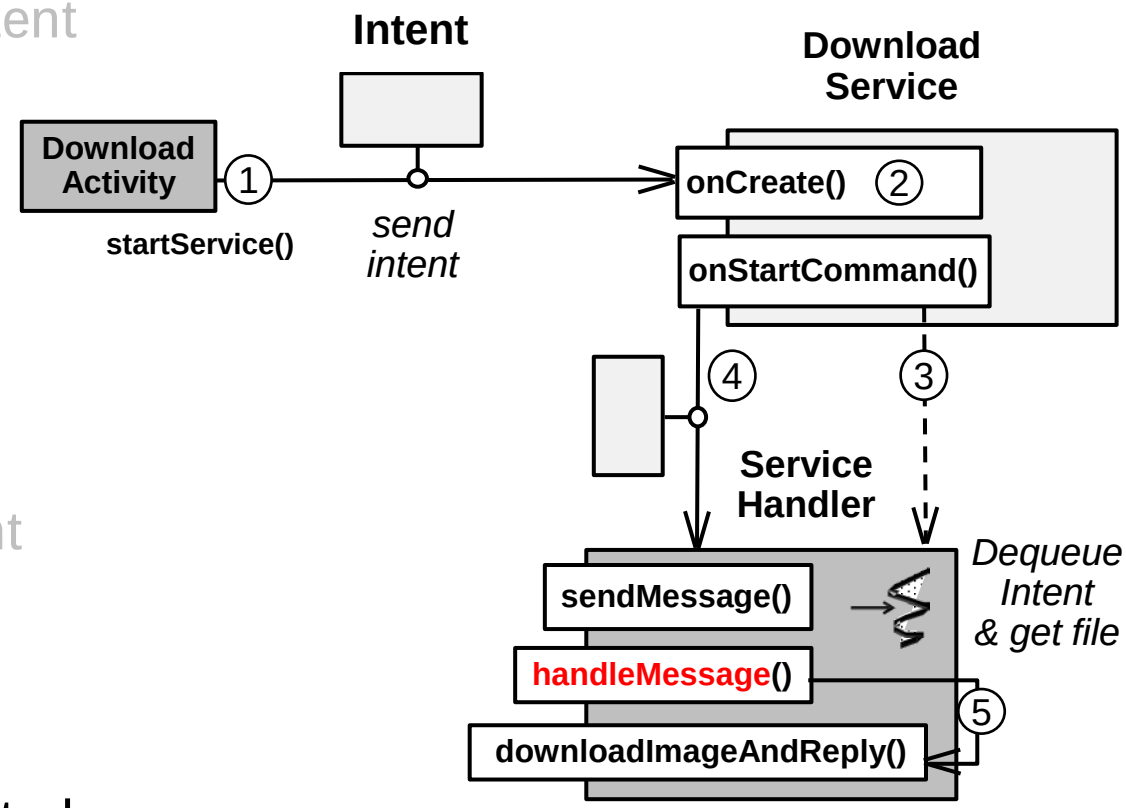
- The DownloadService is launched on-demand
- DownloadService performs four main actions
  1. Creates a ServiceHandler
  2. Receives & queues an Intent in the ServiceHandler
  3. ServiceHandler processes Intent "in the background"
     - Downloads image designated by the URL in the Intent



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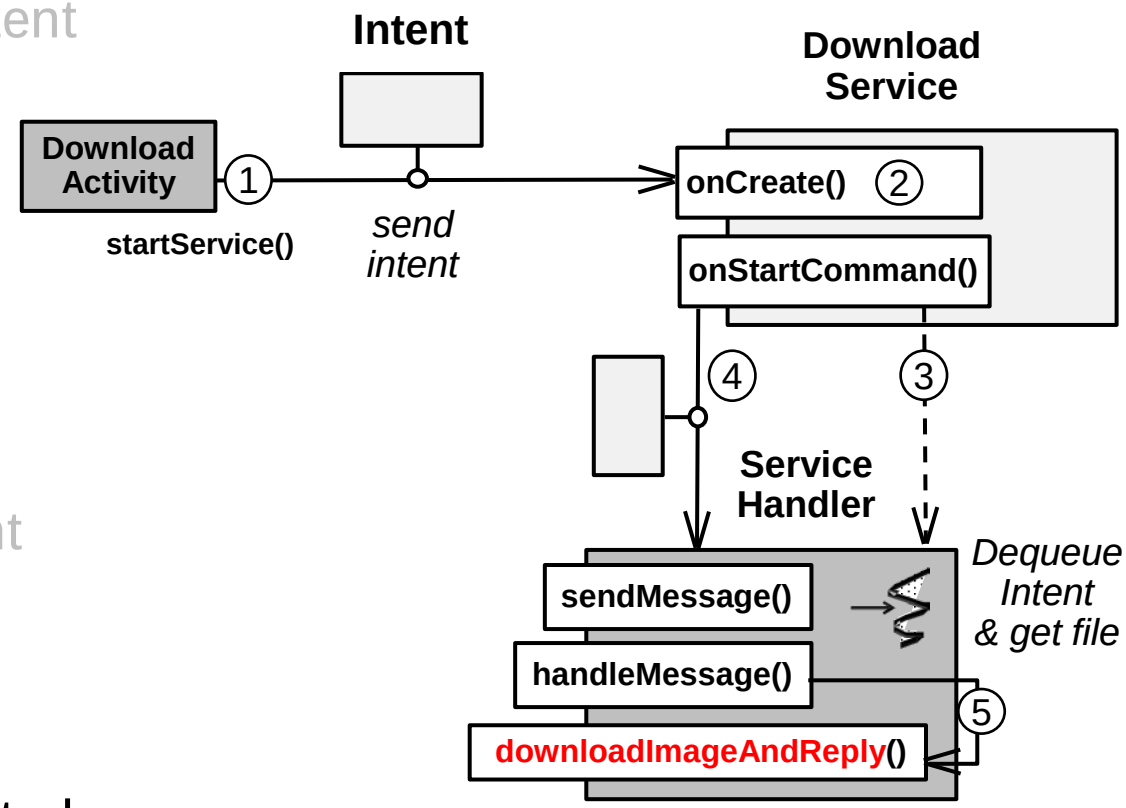

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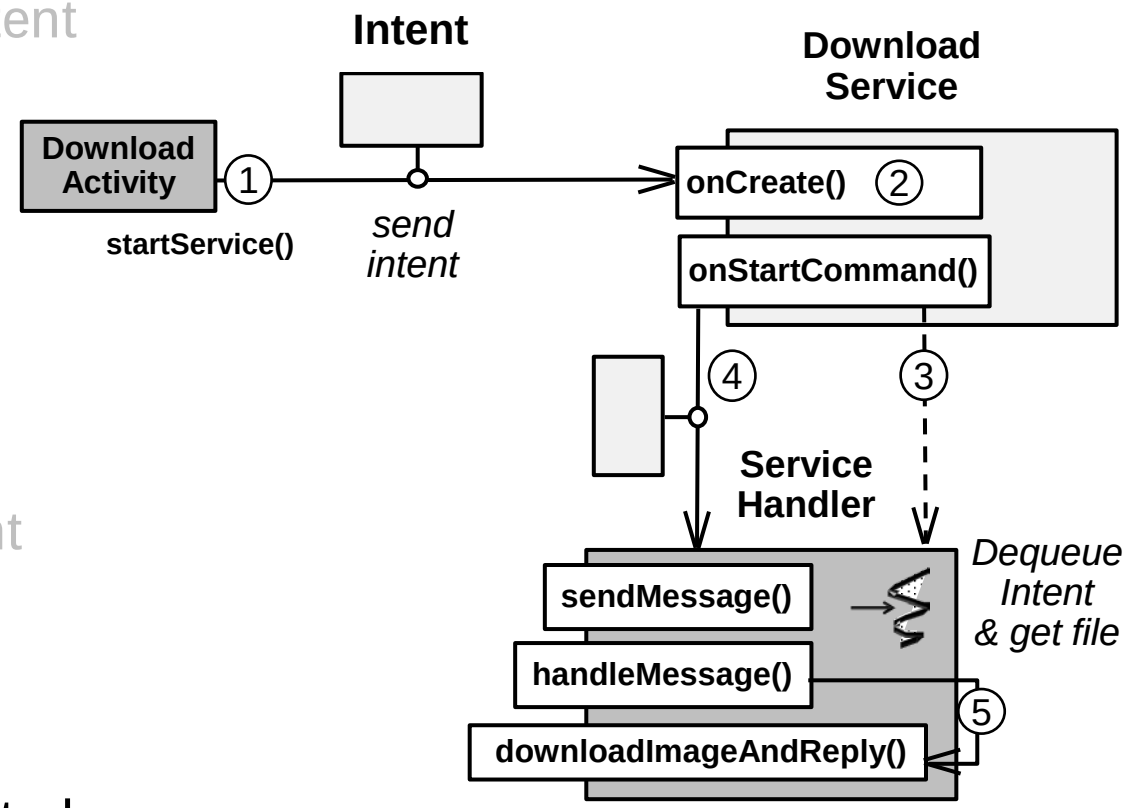
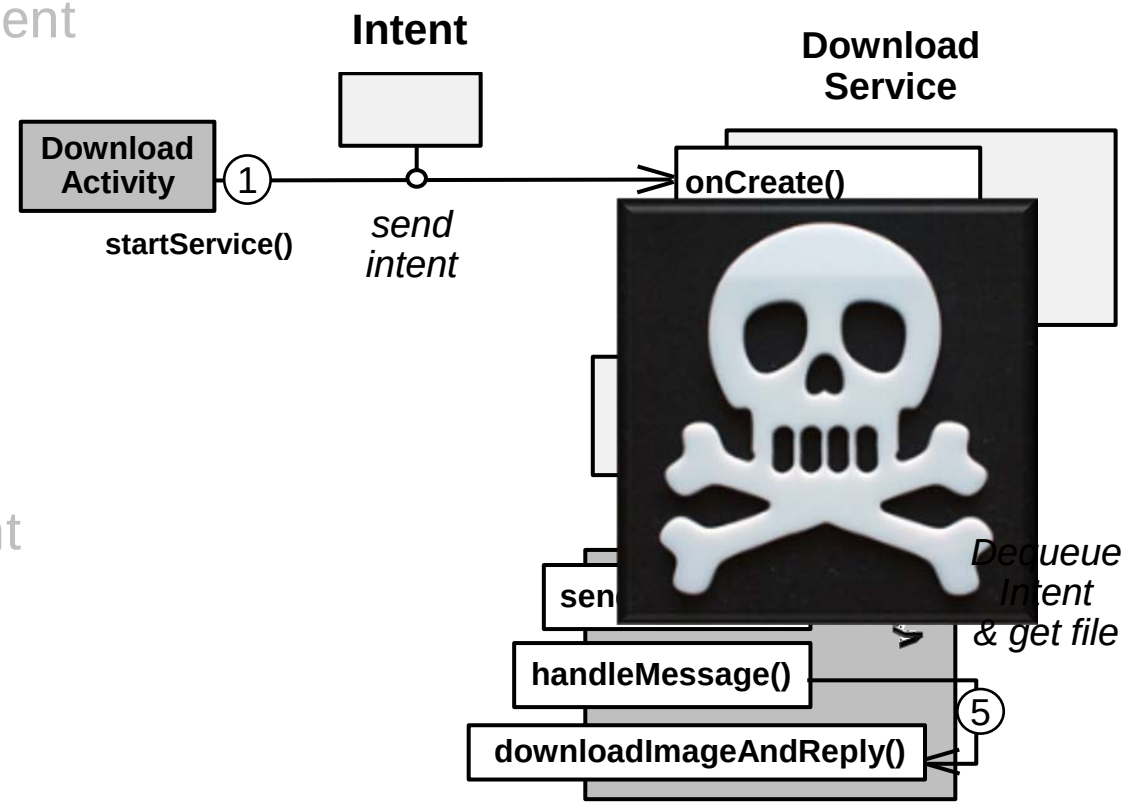


See upcoming parts on "Activity & Service Communication"

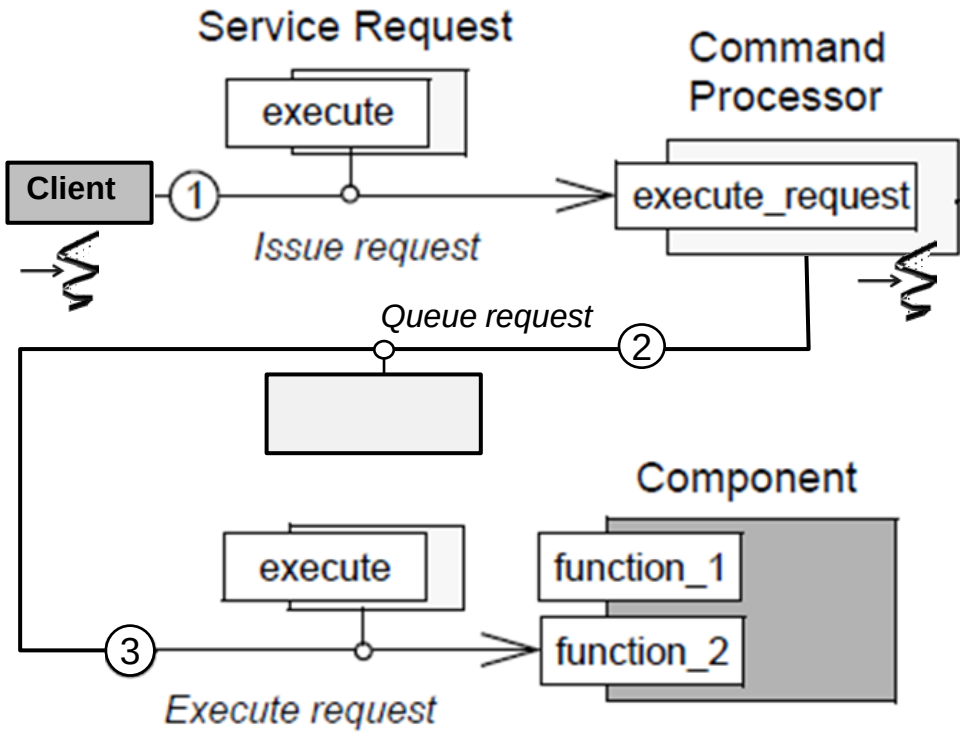
Design of the Download Application

- DownloadActivity sends an Intent via a call to startService()
- The DownloadService is launched on-demand
- DownloadService performs four main actions
  1. Creates a ServiceHandler
  2. Receives & queues an Intent in the ServiceHandler
  3. ServiceHandler processes Intent "in the background"
  4. Stops itself when there are no more Intents to handle



Design of the Download Application

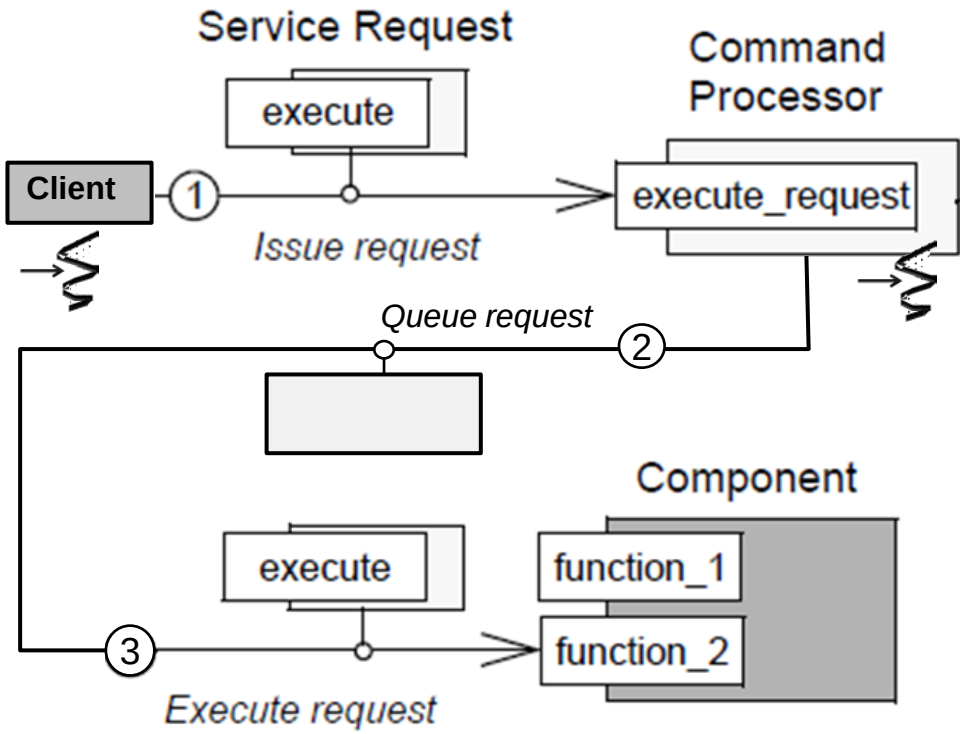
- DownloadActivity sends an Intent via a call to startService()
- The DownloadService is launched on-demand
- DownloadService performs four main actions
- This design is guided by the *Command Processor* pattern



www.dre.vanderbilt.edu/~schmidt/PDF/CommandRevisited.pdf has more info

Design of the Download Application

- DownloadActivity sends an Intent via a call to startService()
- The DownloadService is launched on-demand
- DownloadService performs four main actions
- This design is guided by the *Command Processor* pattern
  - Offload tasks from application's main Thread to a single backgroundThread

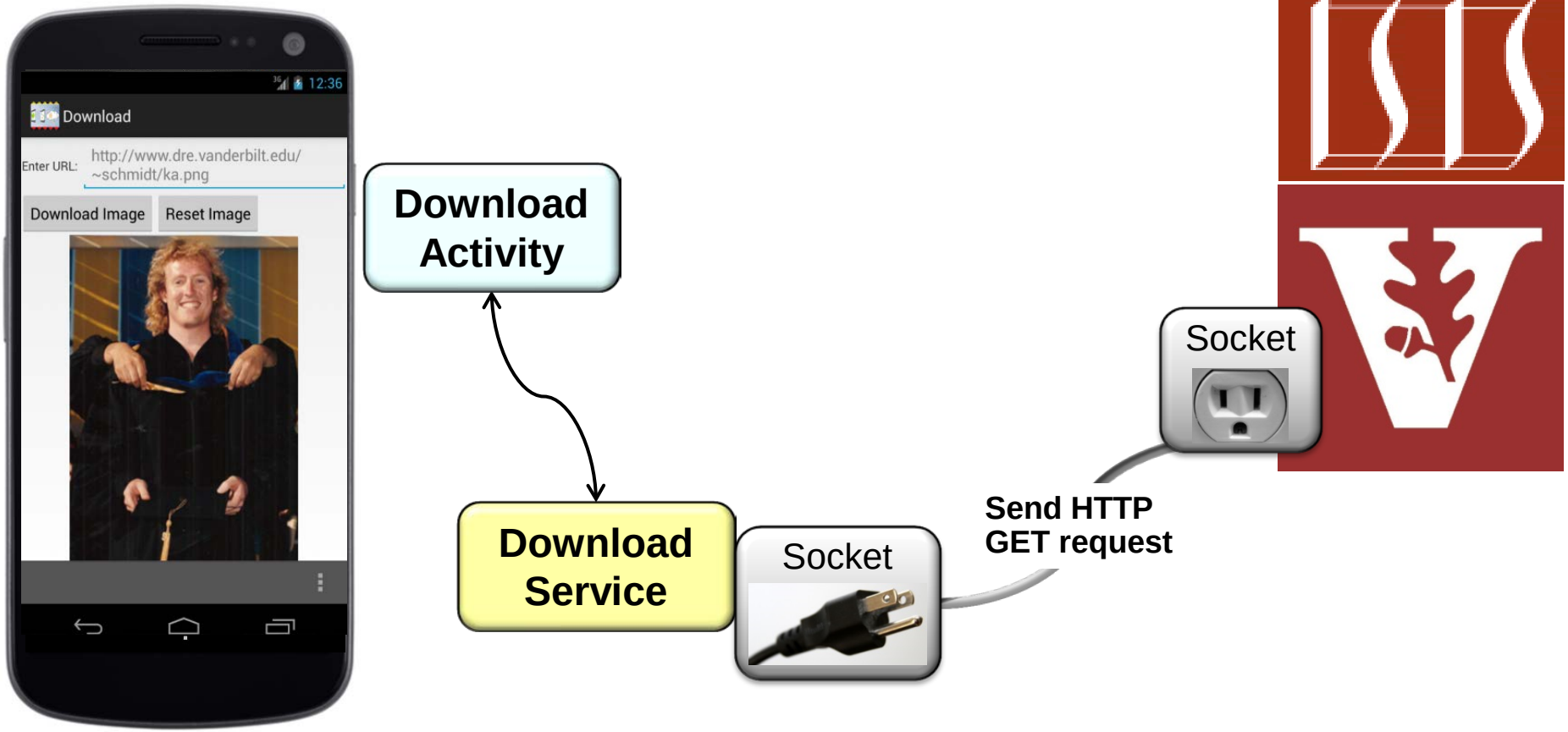


This pattern works if a Service needn't handle multiple requests concurrently

Summary

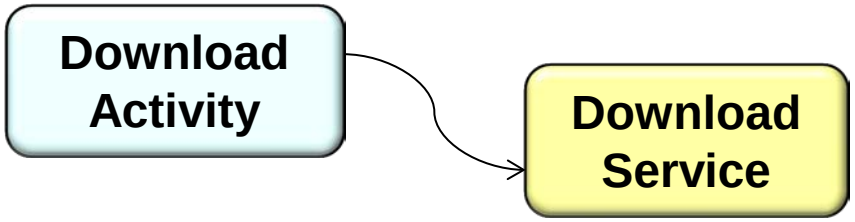
Summary

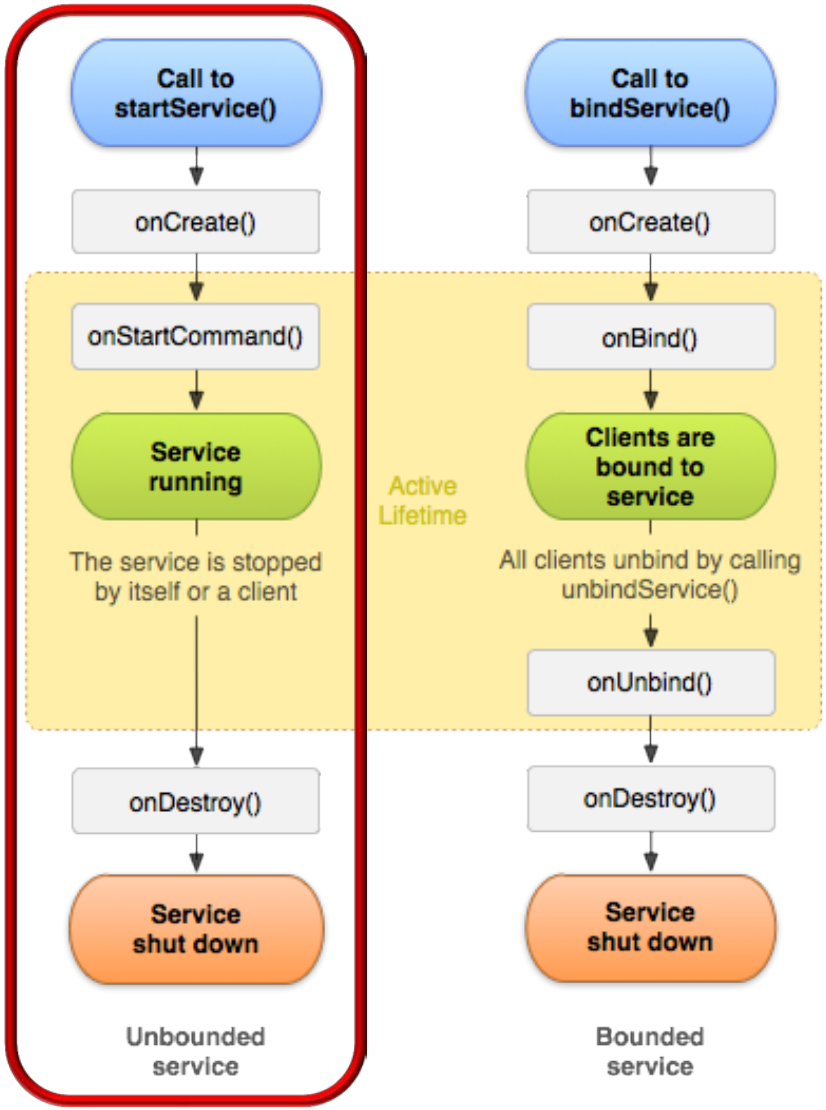
- The Download Application uses a Started Service to retrieve & display an image from a remote server



Summary

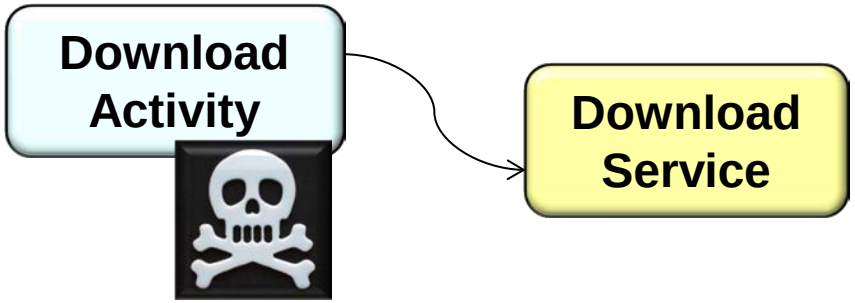
- The Download Application uses a Started Service to retrieve & display an image from a remote server
- When a Started Service is launched, it has a lifecycle that's independent of the component that started it

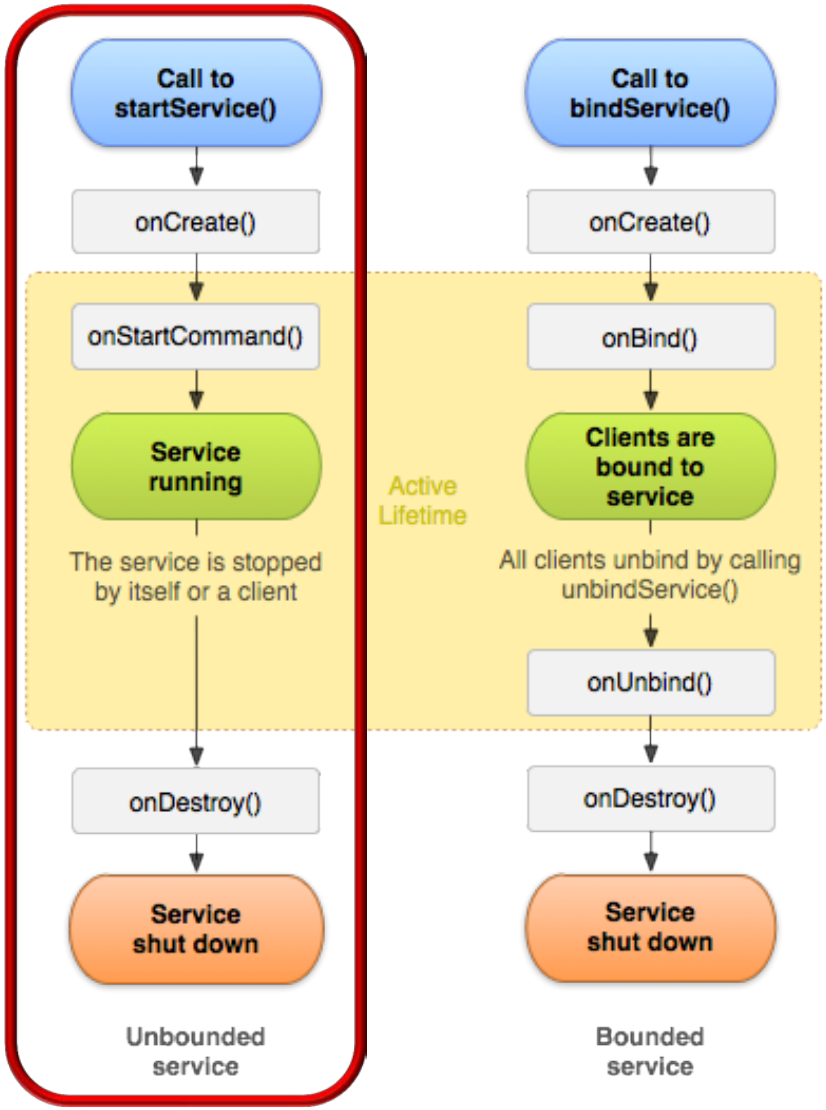




Summary

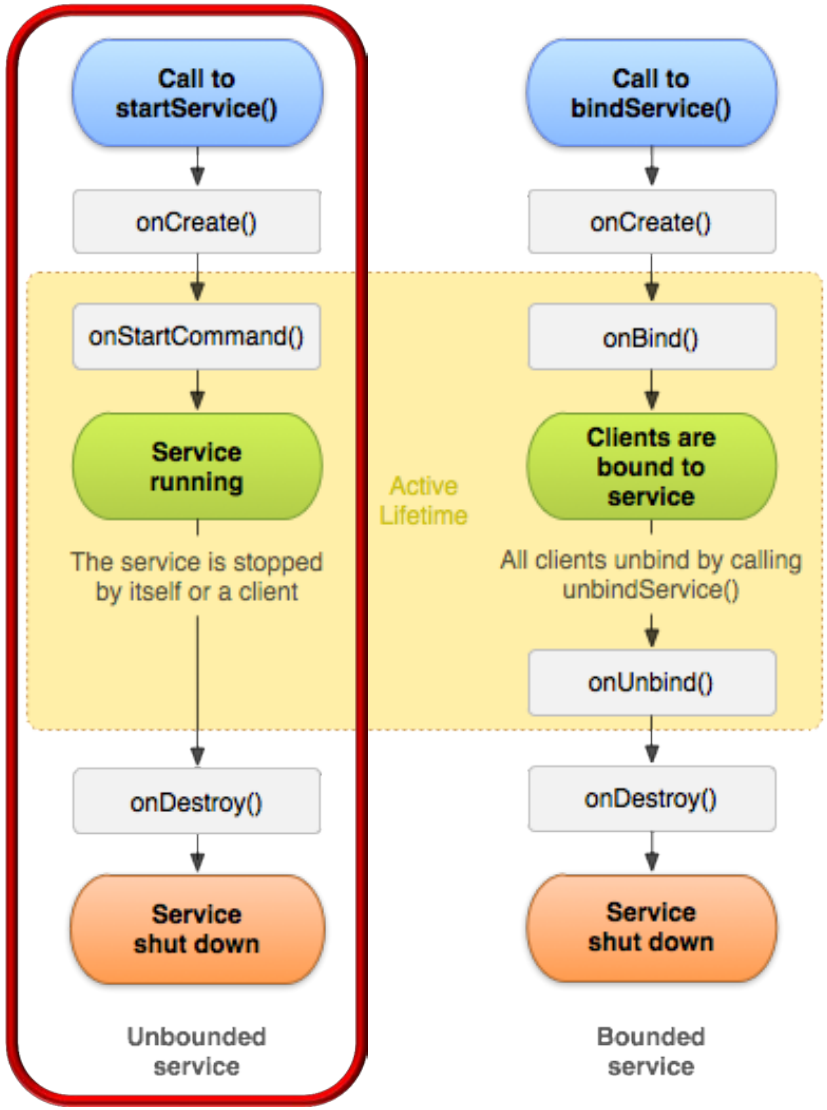
- The Download Application uses a Started Service to retrieve & display an image from a remote server
- When a Started Service is launched, it has a lifecycle that's independent of the component that started it
  - A Service can run in the background indefinitely, even if the component that started it is destroyed





Summary

- The Download Application uses a Started Service to retrieve & display an image from a remote server
- When a Started Service is launched, it has a lifecycle that's independent of the component that started it
- Started Services are driven by inversion of control



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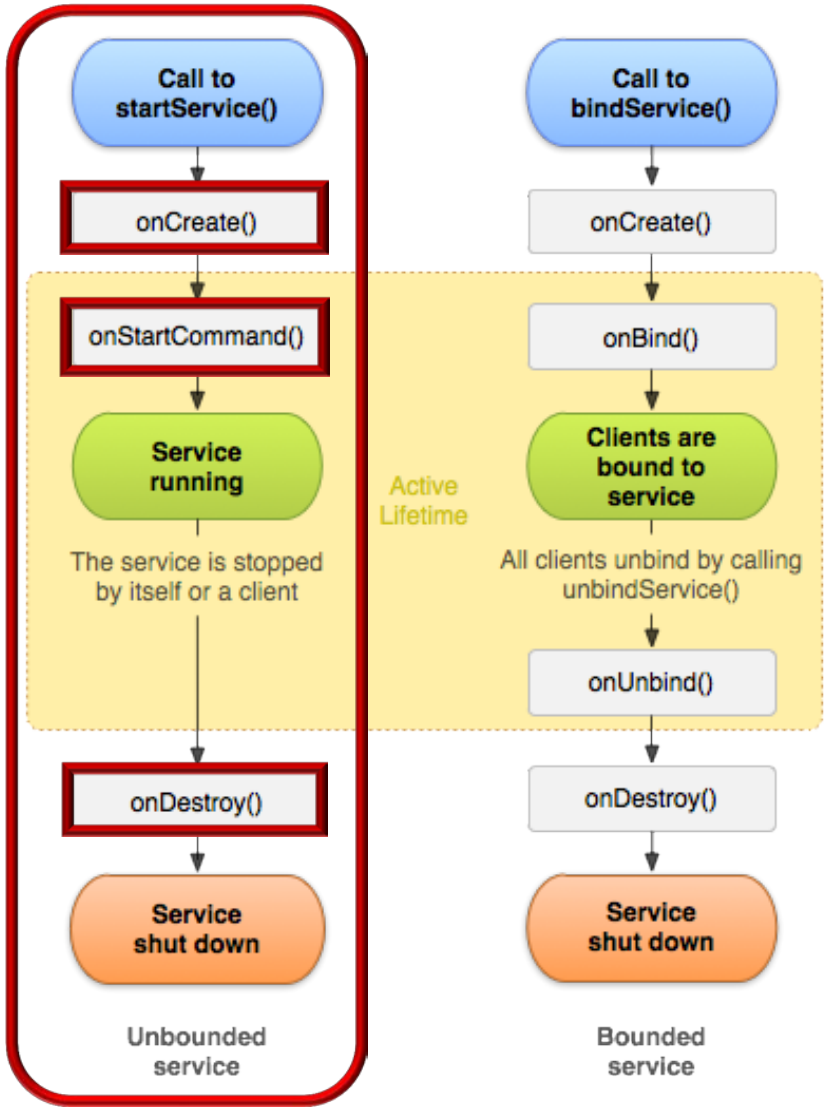

Summary

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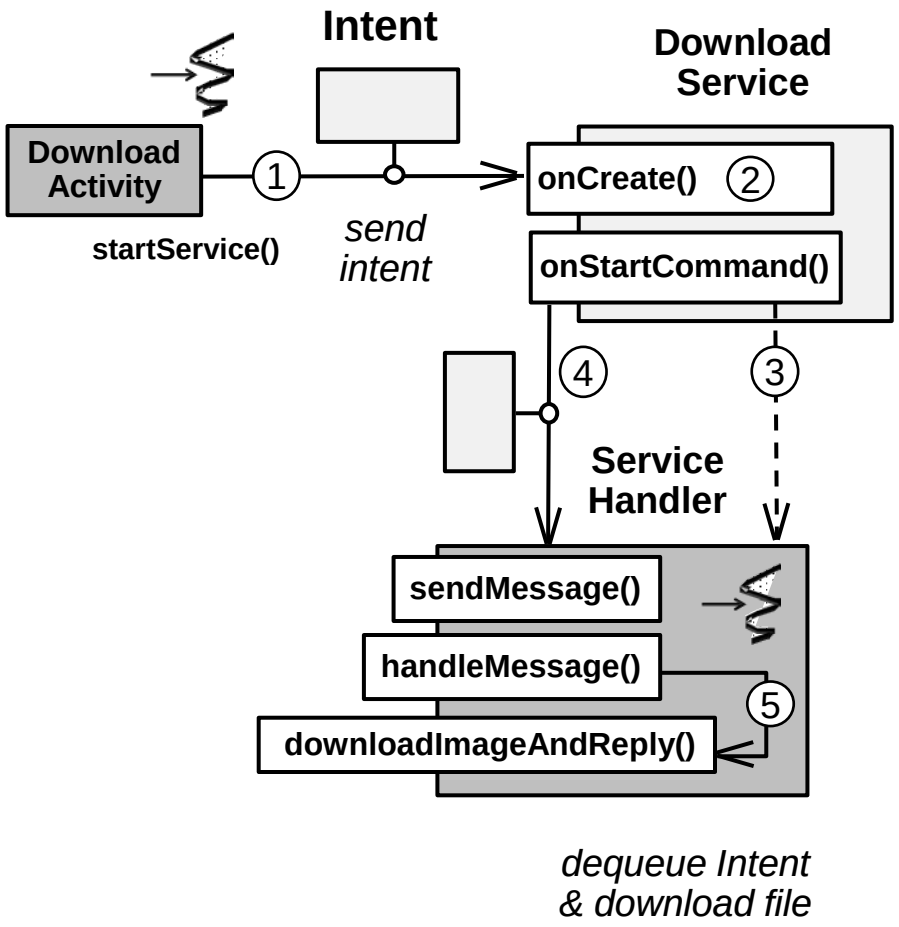

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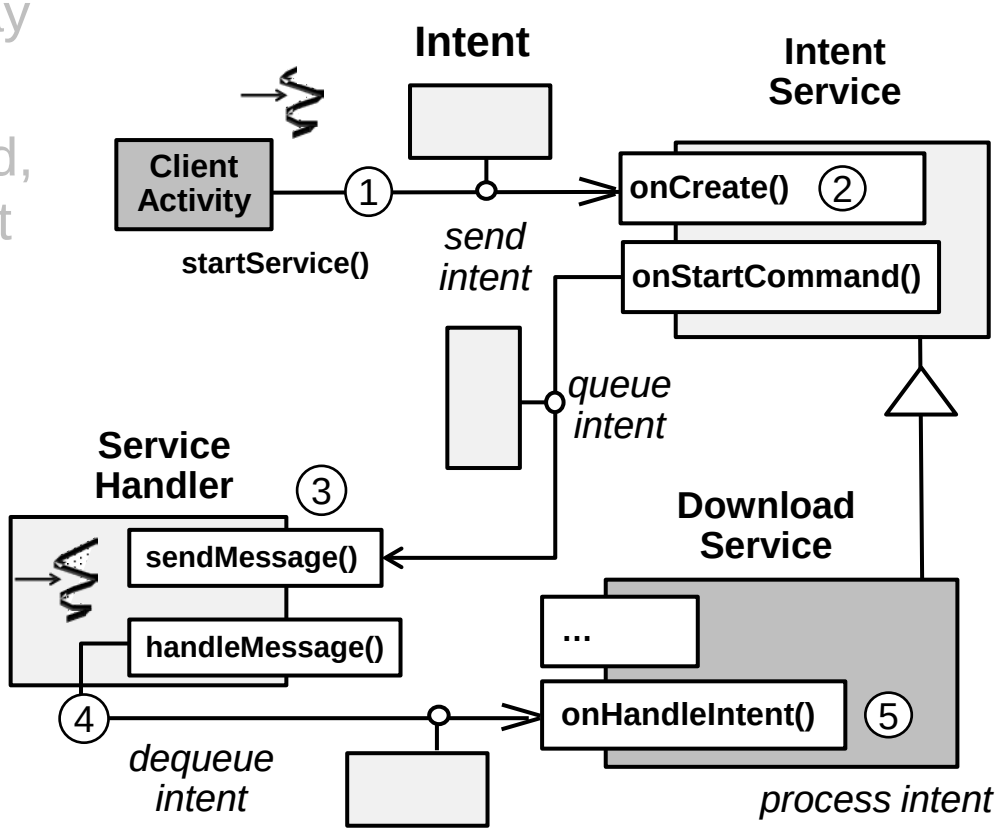

See upcoming parts on “The Command Processor Pattern”