Android

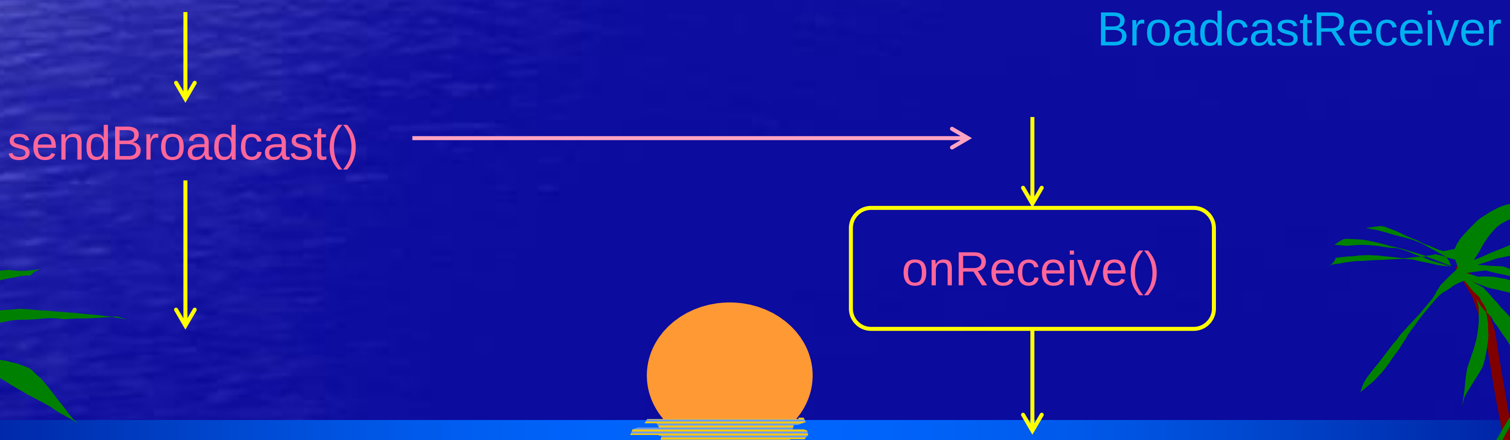
Broadcasts
Services
Notifications

Broadcast receivers

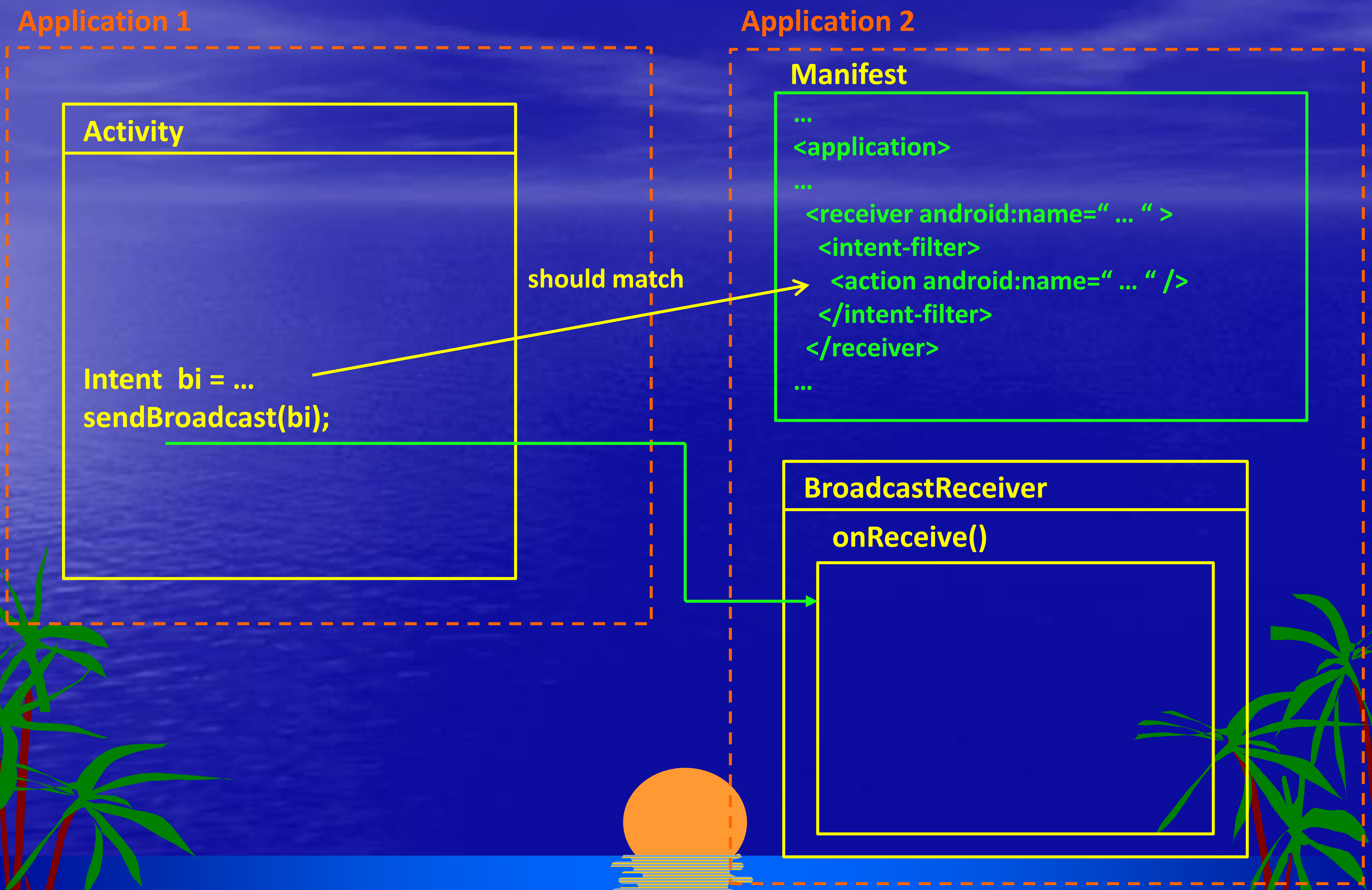
- Application components that can receive 'intents' from other components
  - Broadcast receivers can be declared in the manifest or registered dynamically
  - They can have an associated ACTION or cross-application explicit intent
  - They are invoked using sendBroadcast()
    - It needs an intent matching the declared one (action) or package and class name
    - The intent can transport extra data
    - sendBroadcast() can be invoked by any other application component (Activity, Service, Content Provider) in the same or other application (with restrictions after API 26)
  - Broadcast receivers extend class BroadcastReceiver
    - They must override the method onReceive()
    - They don't have any user interface
  - The application containing the Broadcast receiver is activated and the onReceive() method invoked

Broadcast Receivers

- Receives notifications (intents) sent by other applications (mainly the by the OS components)
  - Inherits from *android.content.BroadcastReceiver*
  - Can be declared in the <receiver> tag in the Manifest
  - Can be declared programmatically (Context.registerBroadcast())
  - Normally execute in response to calls to *Context.sendBroadcast(Intent)*
  - The *onReceive(context, intent)* method executes



Sending a broadcast



```
Intent  bi = …
sendBroadcast(bi);
```

```
…
<application>
…
 <receiver android:name=“ … “ >
   <intent-filter>
     <action android:name=“ … “ />
   </intent-filter>
 </receiver>
…
```

Broadcast receiver example

The receiver

```
public class MyReceiver extends BroadcastReceiver {
   @Override
   public void onReceive(Context context, Intent intent) {
         String msg = intent.getStringExtra(“somename”);
         //Do something
   }
}
```

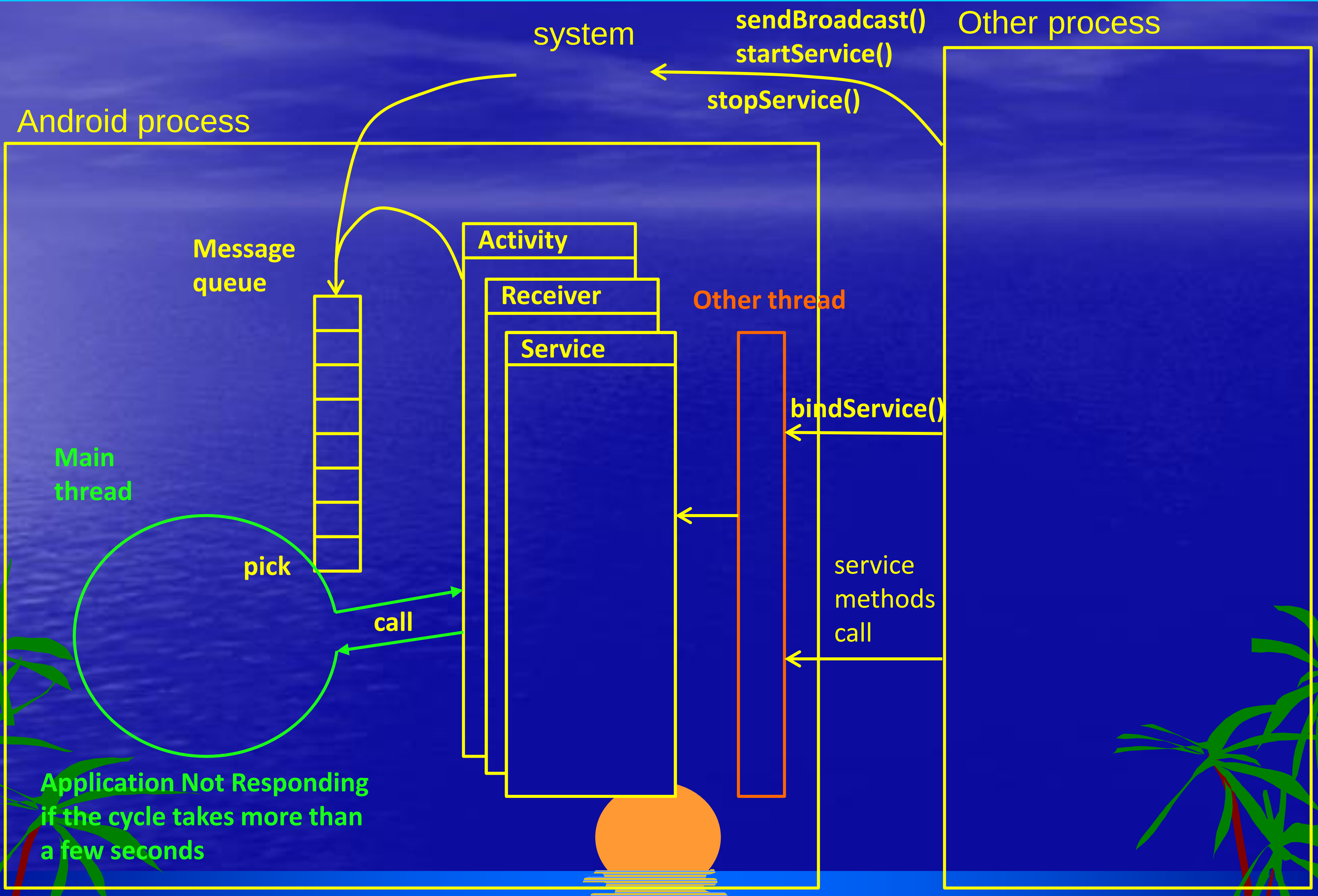
Manifest definition

```
<manifest>
  <application>
    …
    <receiver android:name=“.MyReceiver”>
      <intent-filter>
        <action android:name=“org.feup.intents.test” />
      </intent-filter>
    </receiver>
    …
  </application>
  …
</manifest>
```

The broadcast Activity

```
Public class MyActivity extends Activity {
   …
   private void invokeReceiver() {
      Intent broadcast = new Intent (
                                    “org.feup.intents.test”);
      broadcast.putExtra(“somename”, “Hello”);
      sendBroadcast(broadcast);
   }
   …
}
```

Processes and receivers / services



Services

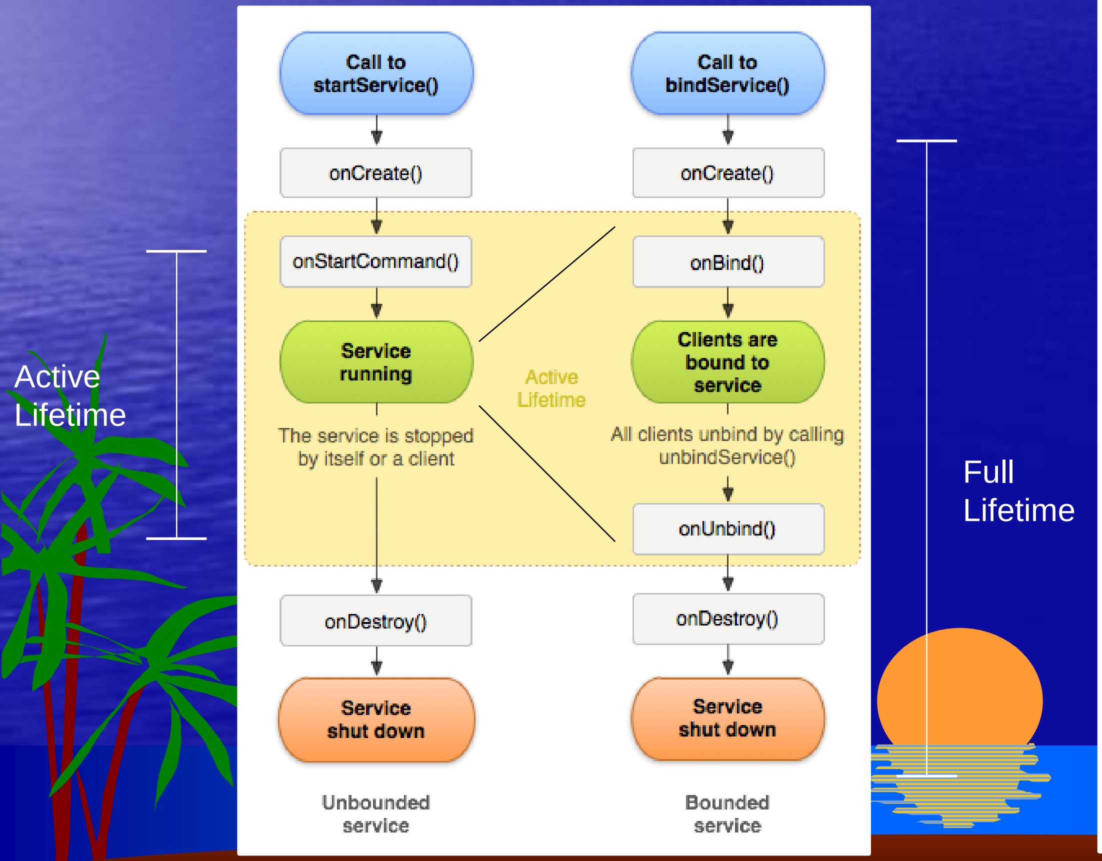
- Can be invoked from other clients
  - Clients are in the same process or in other processes
    - Using a local intent (class) or an implicit one (action)
  - Services don´t have an user interface
  - If the service process is not in memory it is started
    - the onCreate() method is executed
  - Any client can invoke a service asynchronously
    - calling startService() which will invoke onStartCommand()
    - stopService() will try to terminate the service (onDestroy() is invoked in this procedure)
    - A service can terminate itself calling stopSelf()
  - A client can call bindService() to establish a channel and obtain a service interface (remote call service)
    - The client can then call the interface methods

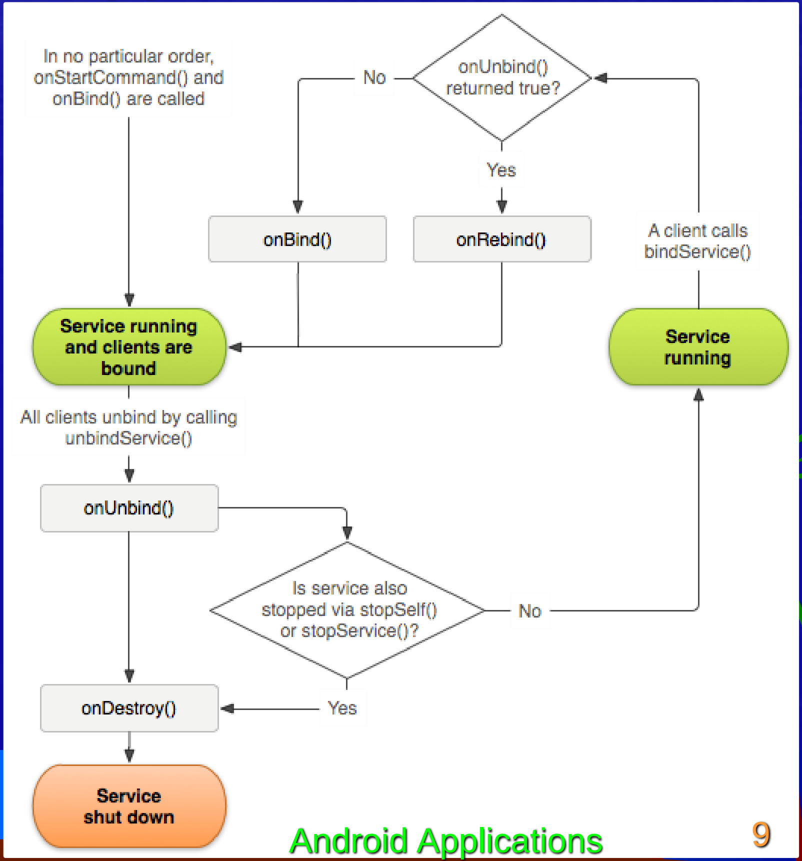
Services

- Services are freed when
  - Stopped explicitly
    - stopService() from the client
    - stopSelf() on the service itself
  - Android needs the memory or resources they occupy, terminating the service (always after onStartCommand() had returned)
    - Services have high priorities, but less then the active Activity
- They can be automatically brought to memory again if terminated by Android
  - Depending on the onStartCommand() return value
    - START_NOT_STICKY – they are not brought to memory until a new startService() is executed
    - START_STICKY – they are brought to memory again, but with a NULL intent
    - START_REDELIVER_INTENT - they are brought to memory again with the last processed intent

Services and their lifecycle

❖ Creation
- Can be initiated and terminated from other parts
- Or the service can be created by a connection (bind)
- A service inherits from *android.app.Service*




In no particular order, onStartCommand() and onBind() are called
No
onUnbind() returned true?
Yes
onBind()
onRebind()
A client calls bindService()
Service running and clients are bound
Service running
All clients unbind by calling unbindService()
onUnbind()
Is service also stopped via stopSelf() or stopService()?
No
onDestroy()
Yes
Service shut down

Service skeleton

```
import android.app.Service;
import android.content.Intent;
import android.os.IBinder;

public class MyService extends Service {
   @Override
   public void onCreate() {
      // TODO: Actions to perform when service is created.
   }

   @Override
   public IBinder onBind(Intent intent) {
      return null;   // mandatory but should return null for
                     // non remote call services
   }

   @Override
   public int onStartCommand(Intent intent, int flags, int startId) {
        // Usually launch a background thread to do processing.
      return Service.START_NOT_STICKY;    // or other value
   }

   @Override
   public void onDestroy() {
      // TODO: Actions to perform when service is destroyed
   }
}
```

Manifest:

```
<service   android:name=".MyService"/>
```

Calling the service

```
// Implicitly start a Service
Intent myIntent =
          new Intent(MyService.ORDER_PIZZA);
myIntent.putExtra("TOPPING", "Margherita");
startService(myIntent);


// Explicitly start a Service in the same process
startService(new Intent(this, MyService.class));
```

Stopping the service

```
// With the same intent
stopService(new
                Intent(MyService.ORDER_PIZZA));

// Stop a service with the service name (same proc).
ComponentName service =
     startService(new Intent(this, MyService.class));
...
stopService(new Intent(this, service.getClass()));

// Stop a service explicitly in the same process
Class serviceClass =
        Class.forName(service.getClassName());
stopService(new Intent(this, serviceClass));
```

IntentService

- It's a special purpose Service subclass that creates a single worker thread
  - The intent received on onStartCommand() is passed to the method that the worker thread executes
  - Successive calls on onStartCommand() are queued
  - You only have to override and implement onHandleIntent()

```
public class MyService extends IntentService {
   public MyService() {
      super("MyService");
   }

   @Override
   protected void onHandleIntent(Intent intent) {
      // Do the work in this single worker thread
      // and return
   }
}
```

ResultReceiver

- Mechanism to return a result to an Activity (or other component activated by an Intent) from other component or thread (using a Handler())
  - It is created on the destination with onReceiveResult() overridden
  - As this class is Parcelable their objects can be passed in Intents
  - The recipient sends results using send(), triggering a call to onReceiveResult()

Example of ResultReceiver

Recipient component
(an Activity)

```
//recipient Activity
public class MainActivity extends AppCompatActivity {
   // some variables (Activity state)
   ....

   @Override
   protected void onCreate(Bundle savedInstanceState) {
      ...
      Intent aService = new Intent(this, MyService.class);
      aService.putExtra(MyService.RESULT, new ResultReceiver(new Handler()) {
         @Override
         protected void onReceiveResult(int code, Bundle data) {
            super.OnReceiveResult(code, data);
            ....   // if code OK, use data and other Activity state
            ....
         }
      });
   }
}
```

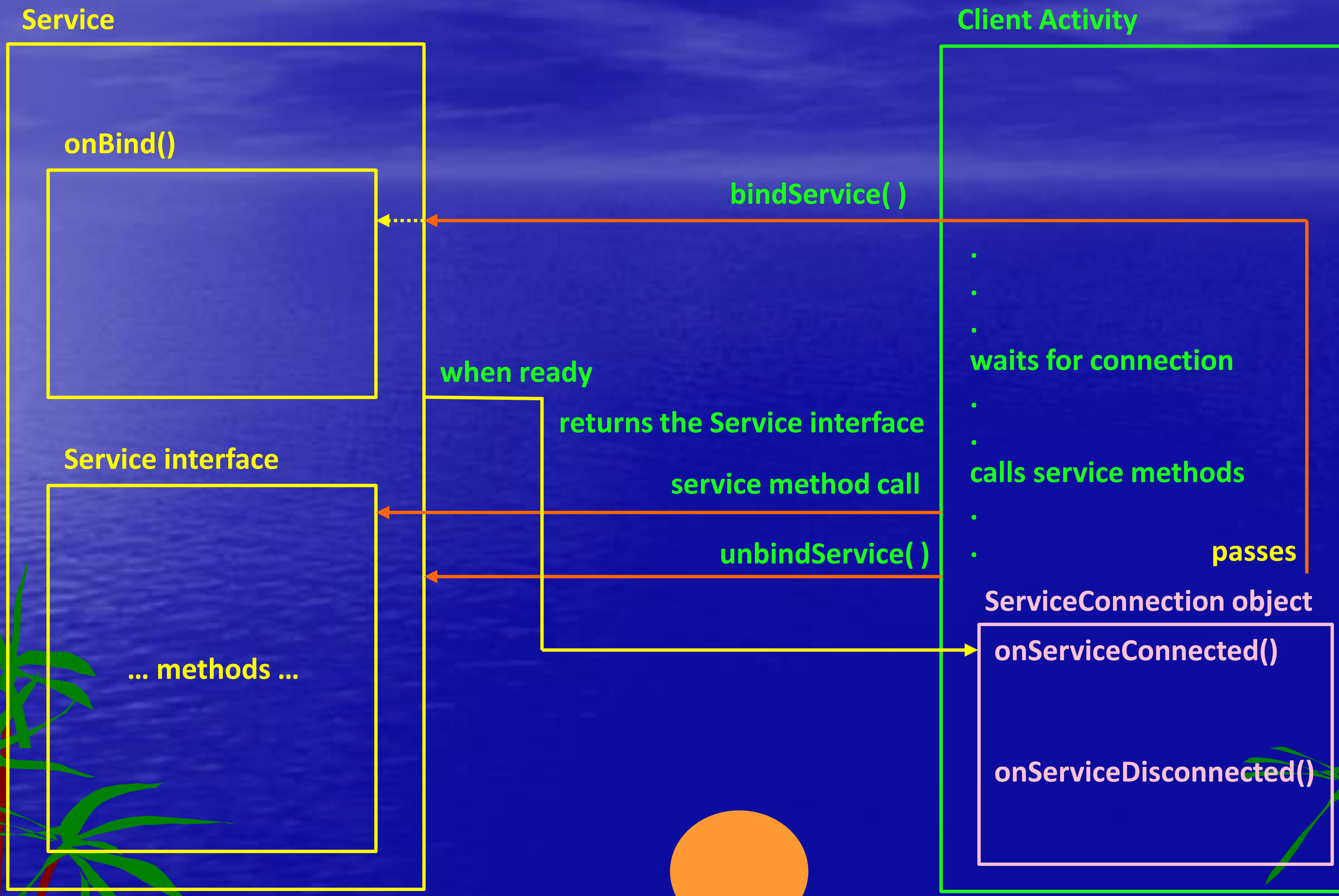
A service sending results

```
public class MyService extends Service {
   public final static String RESULT = “RemoteResult”;
   ....
   @Override
   public int onStartCommand(Intent i, int flags, int sId) {
      ResultReceiver rec = i.getParcelableExtra(MyService.RESULT);
      ....
      Bundle data = new Bundle();
      data.putString(“value”, “some data”);
      ....
      rec.send(1, data);
      return Service.START_NOT_STICKY;
   }
   ....
}
```

Remote call services

- Their functionality is invoked using RPC
  - Predefined interface specified via an AIDL file
  - Usually they are standalone in their own processes
  - Remote call services are activated (brought to memory and onCreate() invoked) through bindService() and can be freed when the last bound client calls unbindService()
    - When a service is ready to be called through its interface a callback onServiceConnected() is called on the client
    - There is also a onServiceDisconnected() callback on the client that is called when the service is not available (motivated by a crash or reclaimed by Android)

Remote call service



Example

Service interface is defined in an AIDL file

```
// This file is IStockQuoteService.aidl
package com.androidbook.services.stockquoteservice;

interface IStockQuoteService {
   double getQuote(String ticker);
}
```

The service must implement the interface

```
public class StockQuoteService extends Service {
   public class StockQuoteServiceImpl extends
                                    IStockQuoteService.Stub {
      @Override
      public double getQuote(String ticker)
                                    throws RemoteException {
         return 20.0;
      }
   }

   @Override
   public IBinder onBind(Intent intent) {
      return new StockQuoteServiceImpl();
   }
}
```

The client calling the service

```
…
bindService(new Intent(IStockQuoteService.class.getName()),
            serConn, Context.BIND_AUTO_CREATE);
…

private ServiceConnection serConn  =  new ServiceConnection()  {
   @Override
   public void onServiceConnected(ComponentName name,
                                  IBinder service) {
      stockService = IStockQuoteService.Stub.asInterface(service);
      callBtn.setEnabled(true);
   }
   @Override
   public void onServiceDisconnected(ComponentName name)  {
     callBtn.setEnabled(false);
     stockService = null;
   }
};

…
try {
   double val = stockService.getQuote("ANDROID");
   Toast.makeText(this, "Value from service is " + val,
                  Toast.LENGTH_SHORT)
     .show();
} catch (RemoteException ee) {
}
```

Notifications

- Are shown in the status bar
  - More details listed in the extended status drawer
  - They can produce sound, vibration and light leds
  - Created using a system service

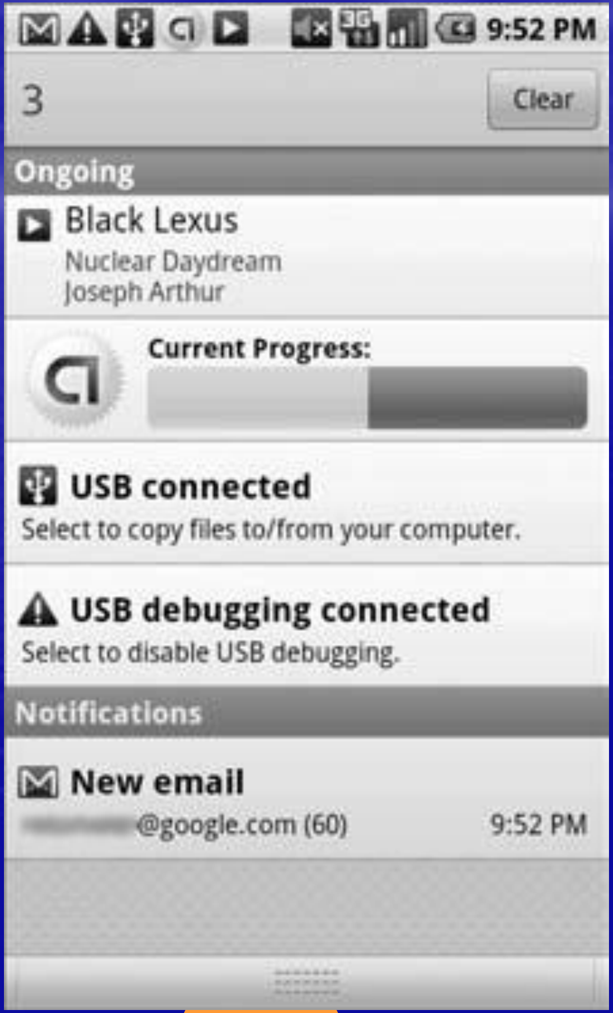
```
String svcName = Context.NOTIFICATION_SERVICE;
NotificationManager notificationManager;
notificationManager = (NotificationManager) getSystemService(svcName);
```

  - Specified in a Notification object through a Build class

```
// A small icon, a title and a text and mandatory (many other features)
// get the Notification object using the build() method
Notification notf = new Notification.Builder(this)
      .setContentText(message)                    // the main text of the notification
      .setContentTitle(title)                     // the first line (title)
      .setSmallIcon(R.drawable.nticon)            // icon on bar and notification
      .setWhen(System.currentTimeMillis())        // for ordering
      .setPendingIntent(PendingIntent pi)         // Activity to launch on tap
      .build();                                   // returns the notification object
notf.flags |= Notification.FLAG_ONGOING_EVENT;      // cannot be cleared
```

  - Sent using the notify() method of the service

Extended Notification Drawer



9:52 PM

3 Clear

Ongoing

Black Lexus
Nuclear Daydream
Joseph Arthur

Current Progress:

USB connected
Select to copy files to/from your computer.

USB debugging connected
Select to disable USB debugging.

Notifications

New email
[redacted]@google.com (60) 9:52 PM

Customized view notification with a RemoteViews object featuring an Icon, TextView and ProgressBar

Notifications with standard views

A customized notification

Layout specification

```
<?xml version="1.0" encoding="utf-8"?>
<RelativeLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:padding="5dp"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent">
      <ImageView android:id="@+id/status_icon"
        android:layout_width="wrap_content"
        android:layout_height="fill_parent"
        android:layout_alignParentLeft="true“ />
      <RelativeLayout android:layout_width="fill_parent"
        android:layout_height="fill_parent"
        android:paddingLeft="10px"
        android:layout_toRightOf="@id/status_icon">
          <TextView android:id="@+id/status_text"
            android:layout_width="fill_parent"
            android:layout_height="wrap_content"
            android:layout_alignParentTop="true"
            android:textColor="#000"
            android:textSize="14sp"
            android:textStyle="bold“  />
          <ProgressBar  android:id="@+id/status_progress"
            android:layout_width="fill_parent"
            android:layout_height="wrap_content"
            android:layout_below="@id/status_text"
           android:progressDrawable="@android:drawable/progress_horizontal"
           android:indeterminate="false"
           android:indeterminateOnly="false“ />
      </RelativeLayout>
</RelativeLayout>
```

Building the notification

```
Intent intent = new Intent(this, MyActivity.class);
PendingIntent pi = PendingIntent.getActivity(this, 0, intent, 0));
Notification notification = new Notification.Builder(this)
      .setSmallIcon(R.drawable.icon)
      .setContentText(“Custom Content”)
      .setWhen(System.currentTimeMillis())
      .setCustomContentView(new RemoteViews(this.getPackageName(),
                                        R.layout.my_status_window_layout)
      .setPendingIntent(pi);
      .build();
// allowing updates
notification.flags |= Notification.FLAG_ONGOING_EVENT;
// Putting state on the layout
notification.contentView.setImageViewResource(R.id.status_icon,
                                                         R.drawable.icon);
notification.contentView.setTextViewText(R.id.status_text,
                                                    "Current Progress:");
notification.contentView.setProgressBar(R.id.status_progress,
// emitting the notification                                 100, 50, false);
int notificationRef = 1;
notificationManager.notify(notificationRef, notification);
```

Cancel

```
// cancelling the notification
notificationManager.cancel(notificationRef);
```

Alarms

- Calls an application component periodically or after a specified time interval
  - Uses another system service

```
String svcName = Context.ALARM_SERVICE;
AlarmManager alarms;
alarms = (AlarmManager) getSystemService(svcName);
```

  - We can use the methods set(), setRepeating() or setInexactRepeating() to create alarms

```
int alarmType = AlarmManager.ELAPSED_REALTIME_WAKEUP;
long timeOrLengthOfWait = 10000;
String ALARM_ACTION = "ALARM_ACTION";

Intent intentToFire = new Intent(ALARM_ACTION);
PendingIntent pendingIntent = PendingIntent.getBroadcast(this, 0, intentToFire, 0);

alarms.set(alarmType, timeOrLengthOfWait, pendingIntent);
```