

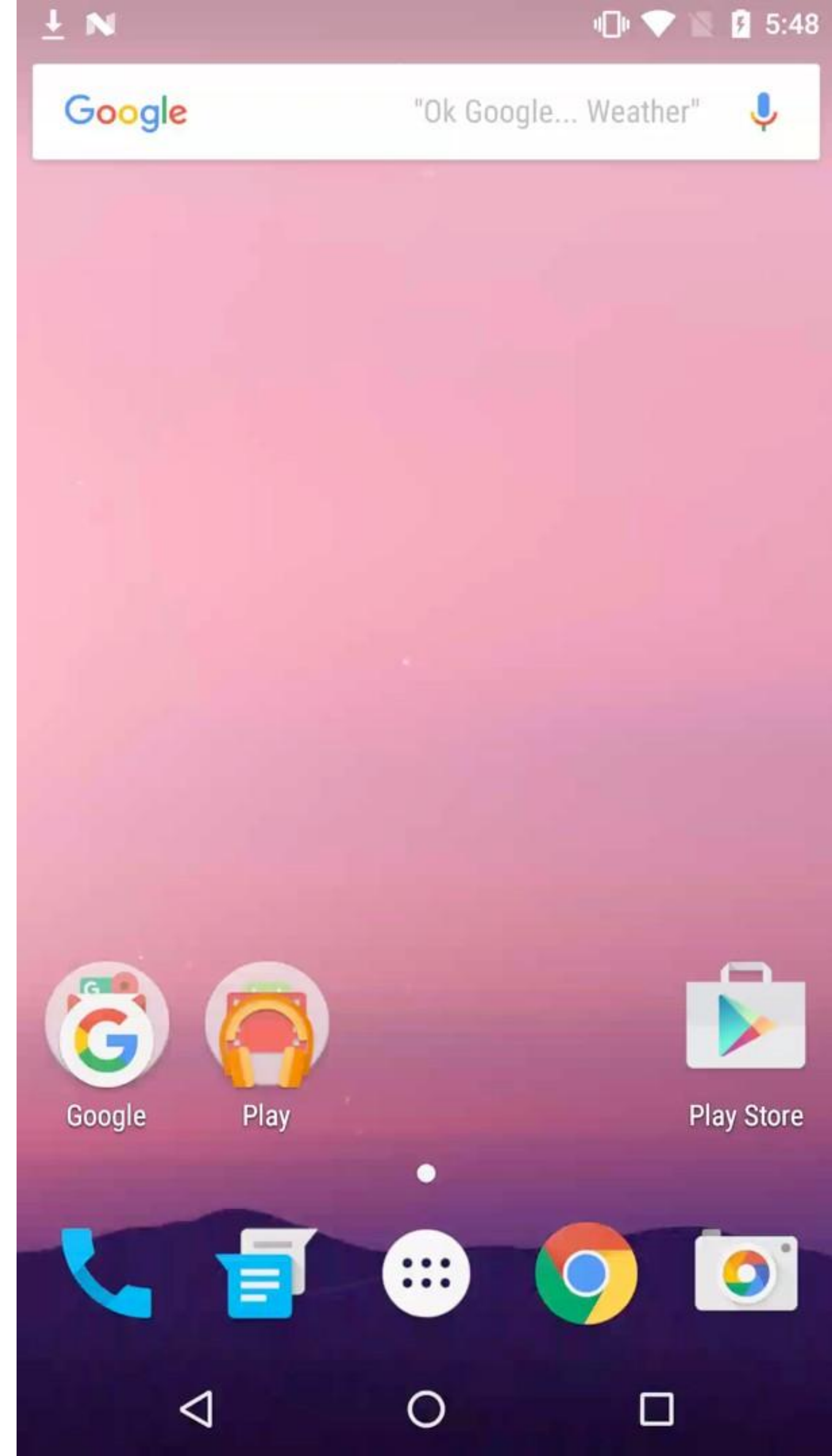


What's New in N

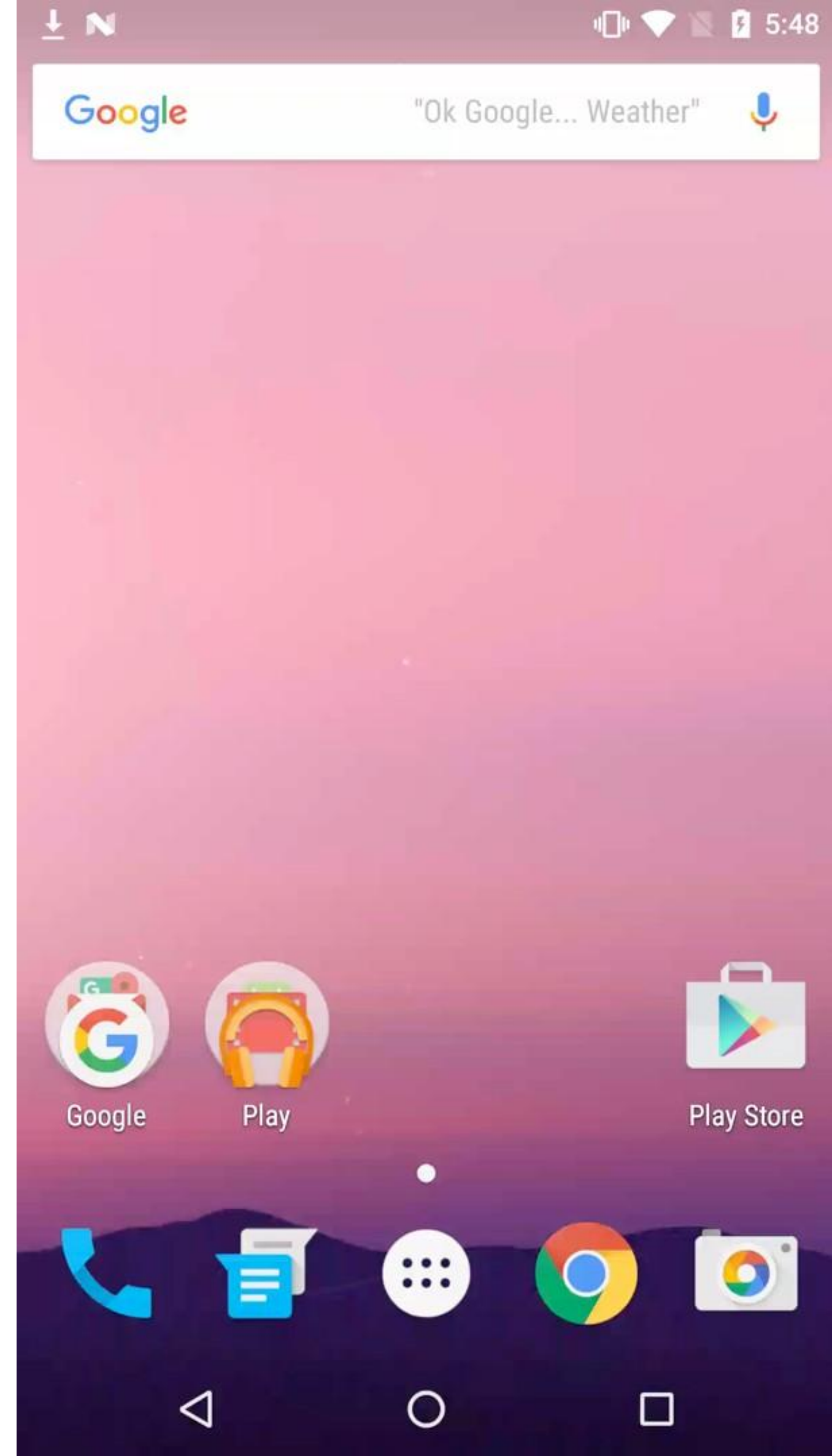
User Facing Features

Multi-Window: Split Screen

Multi-Window: Split Screen

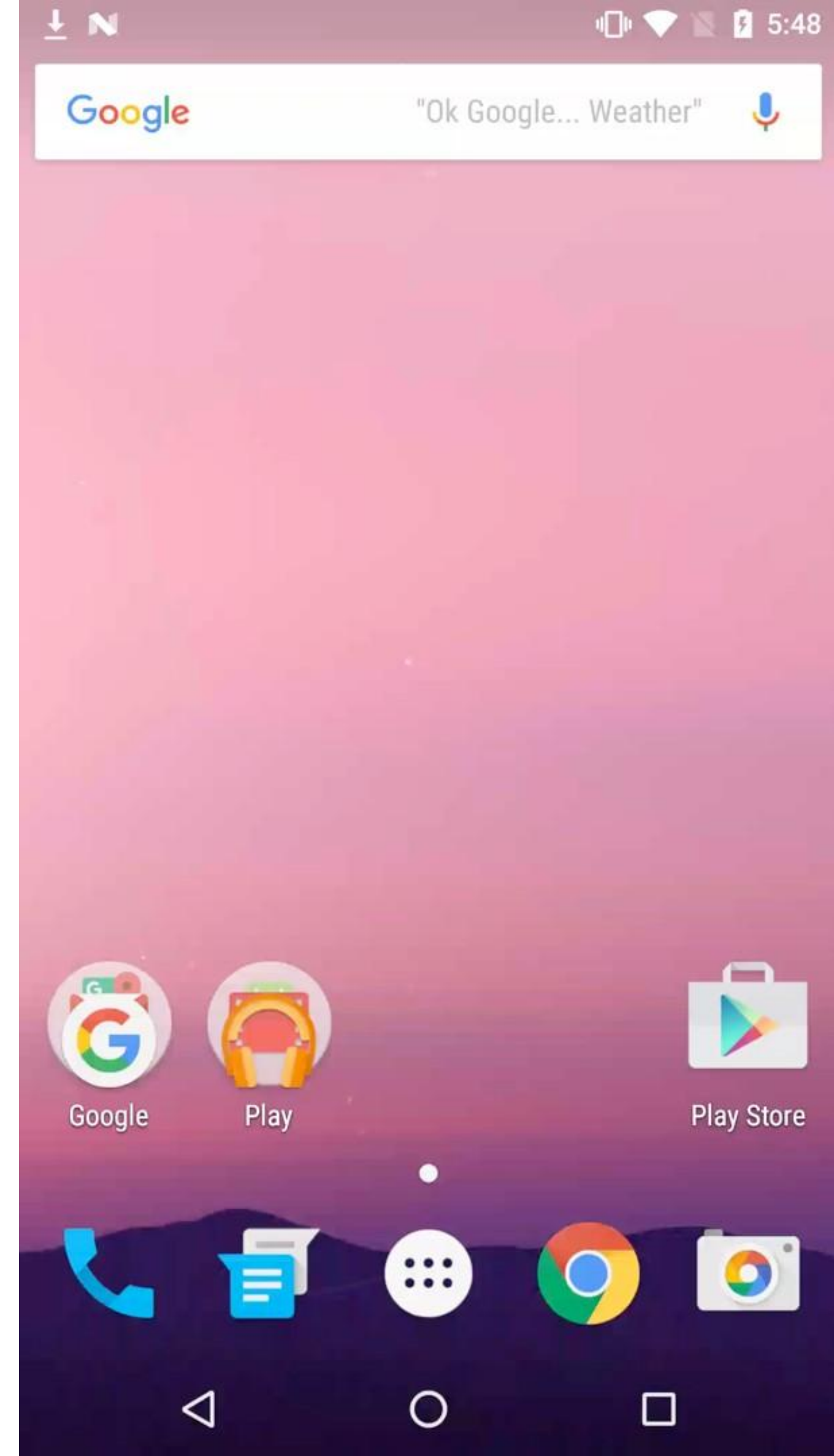


Multi-Window: Split Screen



Multi-Window: Split Screen

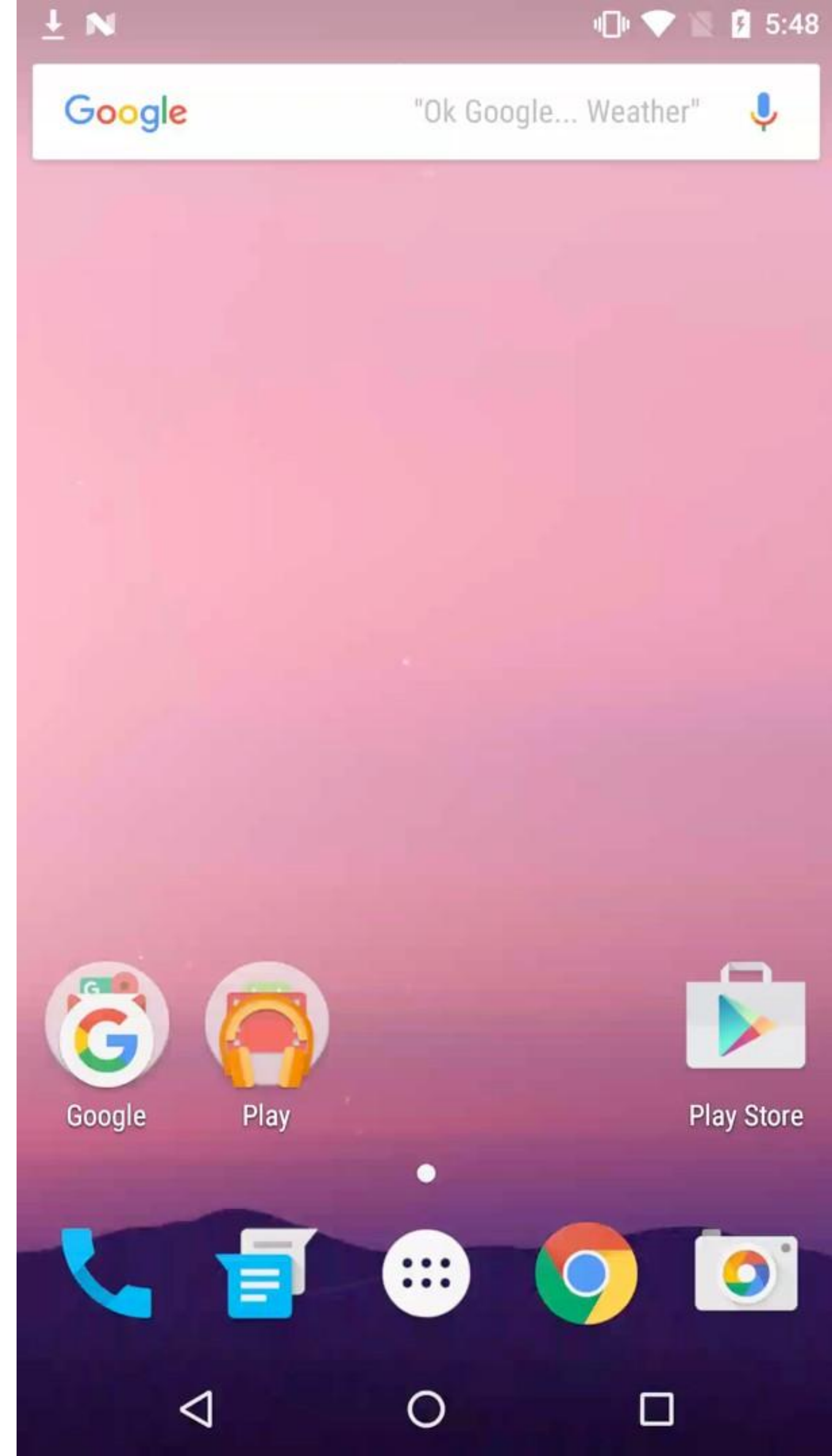
```
android:resizeableActivity=["true" | "false"]
```



Multi-Window: Split Screen

```
android:resizeableActivity=["true" | "false"]
```

```
<activity android:name=".MyActivity">  
    <layout android:defaultHeight="500dp"  
        android:defaultWidth="600dp"  
        android:gravity="top|end"  
        android:minimalSize="450dp" />  
</activity>
```

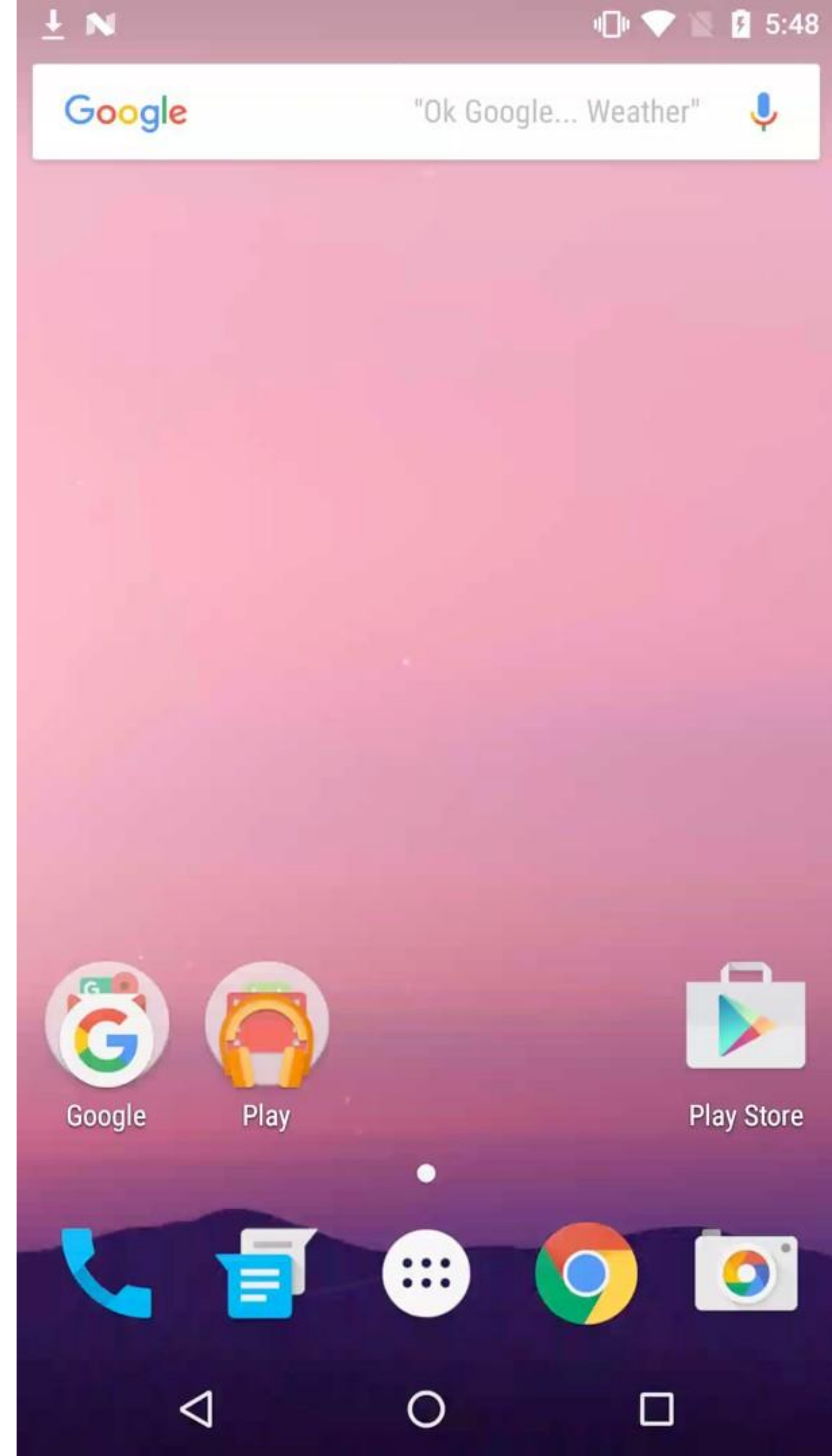


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```

```
Activity.inMultiWindow()    Activity.  
onMultiWindowChanged()
```



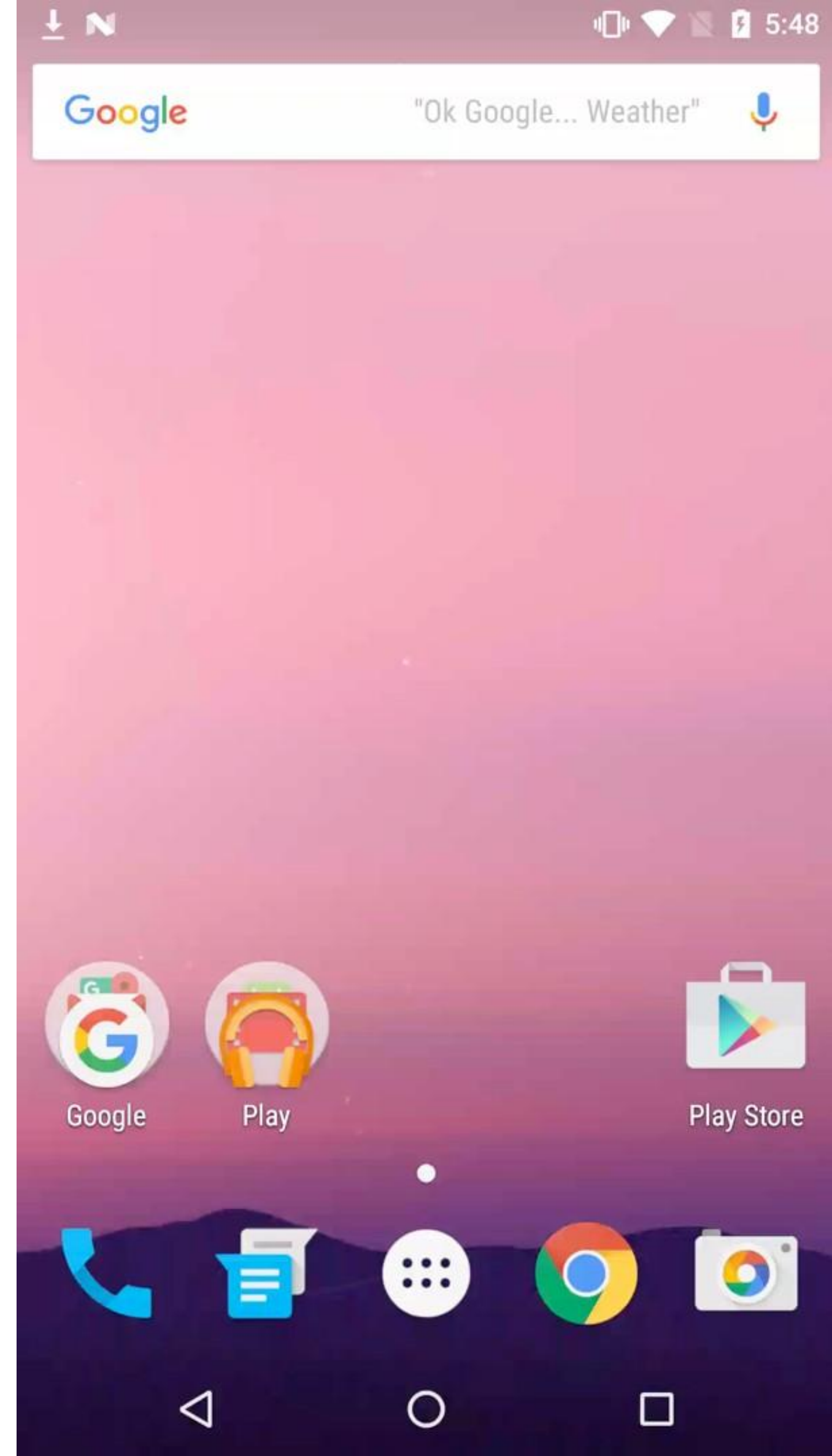
Multi-Window: Split Screen

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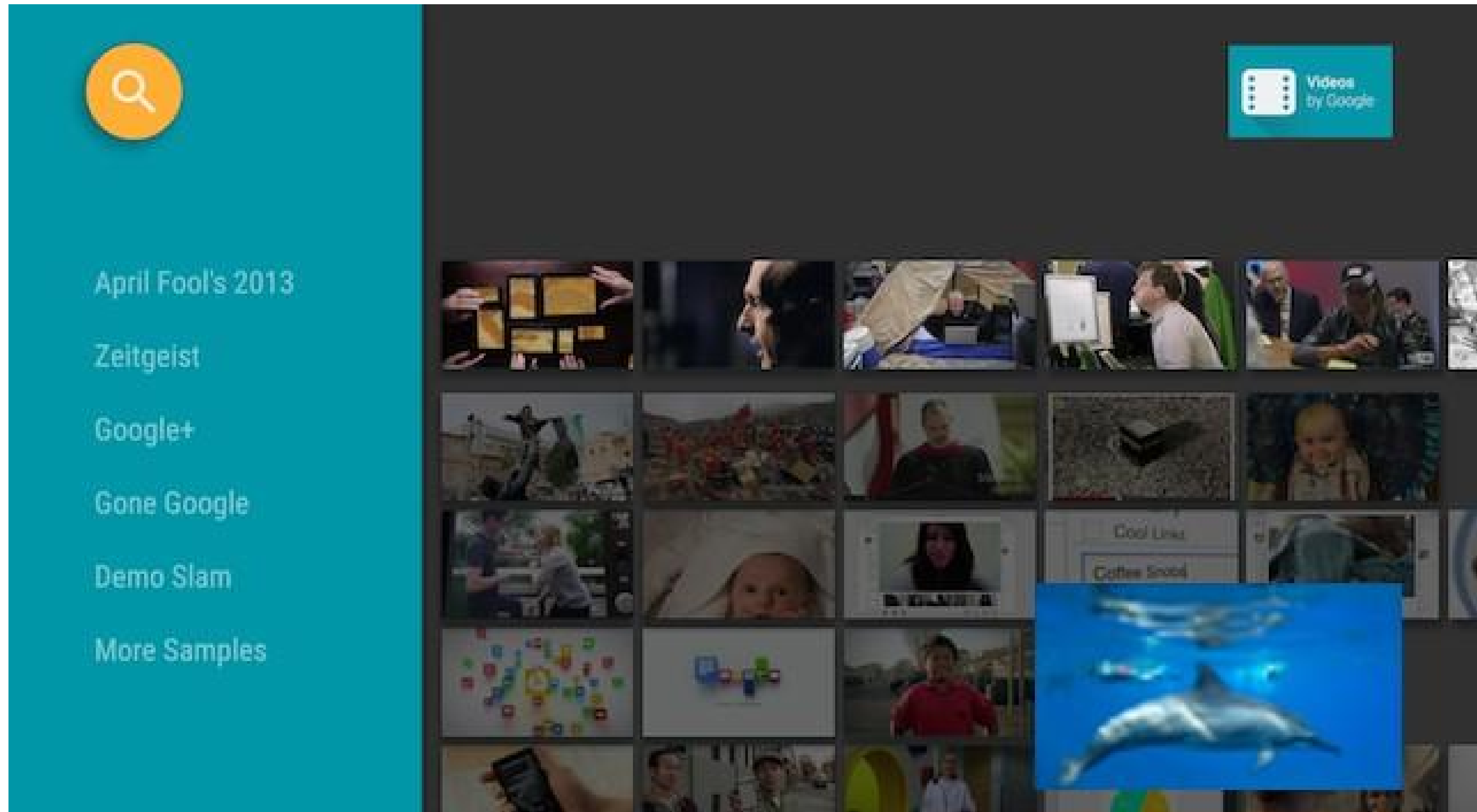
```
<activity android:name=".MyActivity">  
    <layout android:defaultHeight="500dp"  
        android:defaultWidth="600dp"  
        android:gravity="top|end"  
        android:minimalSize="450dp" />  
</activity>
```

```
Activity.inMultiWindow()    Activity.  
onMultiWindowChanged()
```

```
Intent.FLAG_ACTIVITY_LAUNCH_TO_ADJACENT
```



Multi-Window: Picture-in-Picture



Multi-Window: Picture-in-Picture

```
android:supportsPictureInPicture=["true" | "false"]
```

Multi-Window: Picture-in-Picture

`android:supportsPictureInPicture=["true" | "false"]`



`Activity.inPictureInPicture()`

`Activity.onPictureInPictureChanged()`

`Activity.enterPictureInPicture()`

April Fools 2013

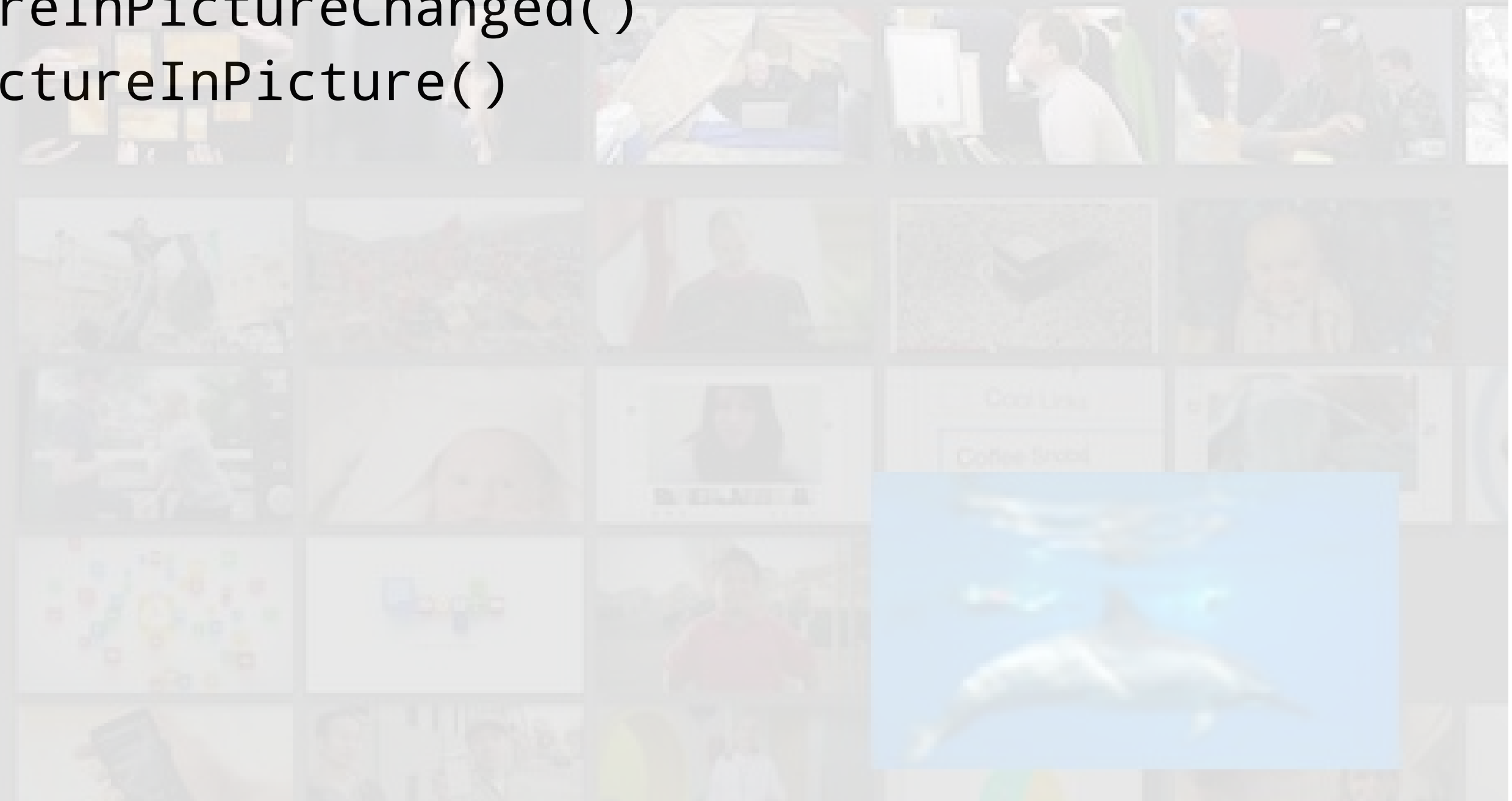
Zeitgeist

Google+

Gone Google

Demo Slam

More Samples



Drag and Drop

Drag and Drop



Drag and Drop

`android.view.DropPermissions`



Drag and Drop

`android.view.DropPermissions`

`View.startDragAndDrop()`



Drag and Drop

`android.view.DropPermissions`

`View.startDragAndDrop()`

`View.DRAG_FLAG_GLOBAL` `View.`

`DRAG_FLAG_GLOBAL_URI_READ`

`View.DRAG_FLAG_GLOBAL_URI_WRITE`



Drag and Drop

`android.view.DropPermissions`

`View.startDragAndDrop()`

`View.DRAG_FLAG_GLOBAL` `View.DRAG_FLAG_GLOBAL_URI_READ`
`View.DRAG_FLAG_GLOBAL_URI_WRITE`

`View.cancelDragAndDrop()` `View.updateDragShadow()`



Drag and Drop

`android.view.DropPermissions`

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`View.cancelDragAndDrop()` `View.updateDragShadow()`

`Activity.requestDropPermissions()`



Drag and Drop

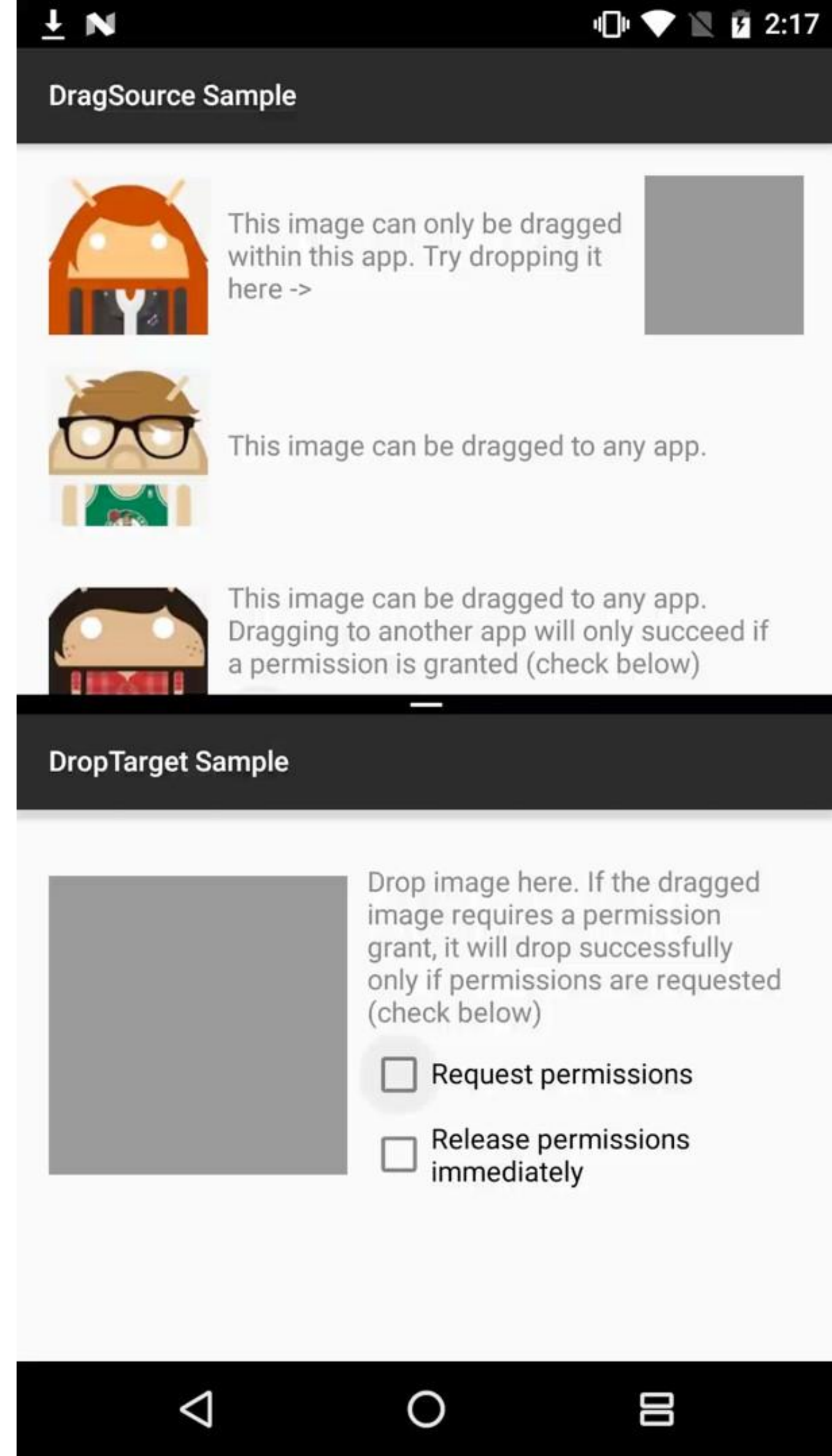
`android.view.DropPermissions`

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Drag and Drop

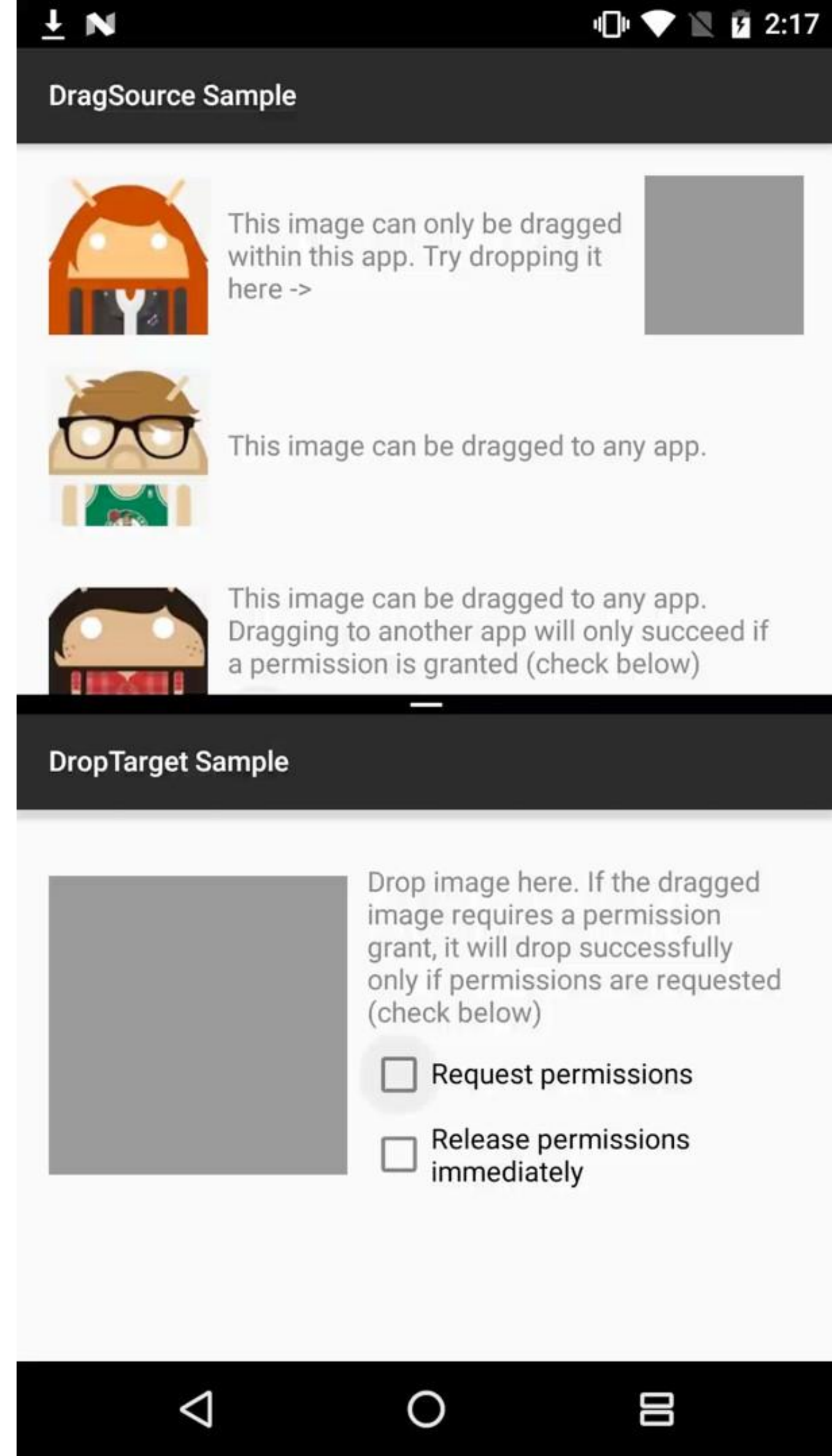
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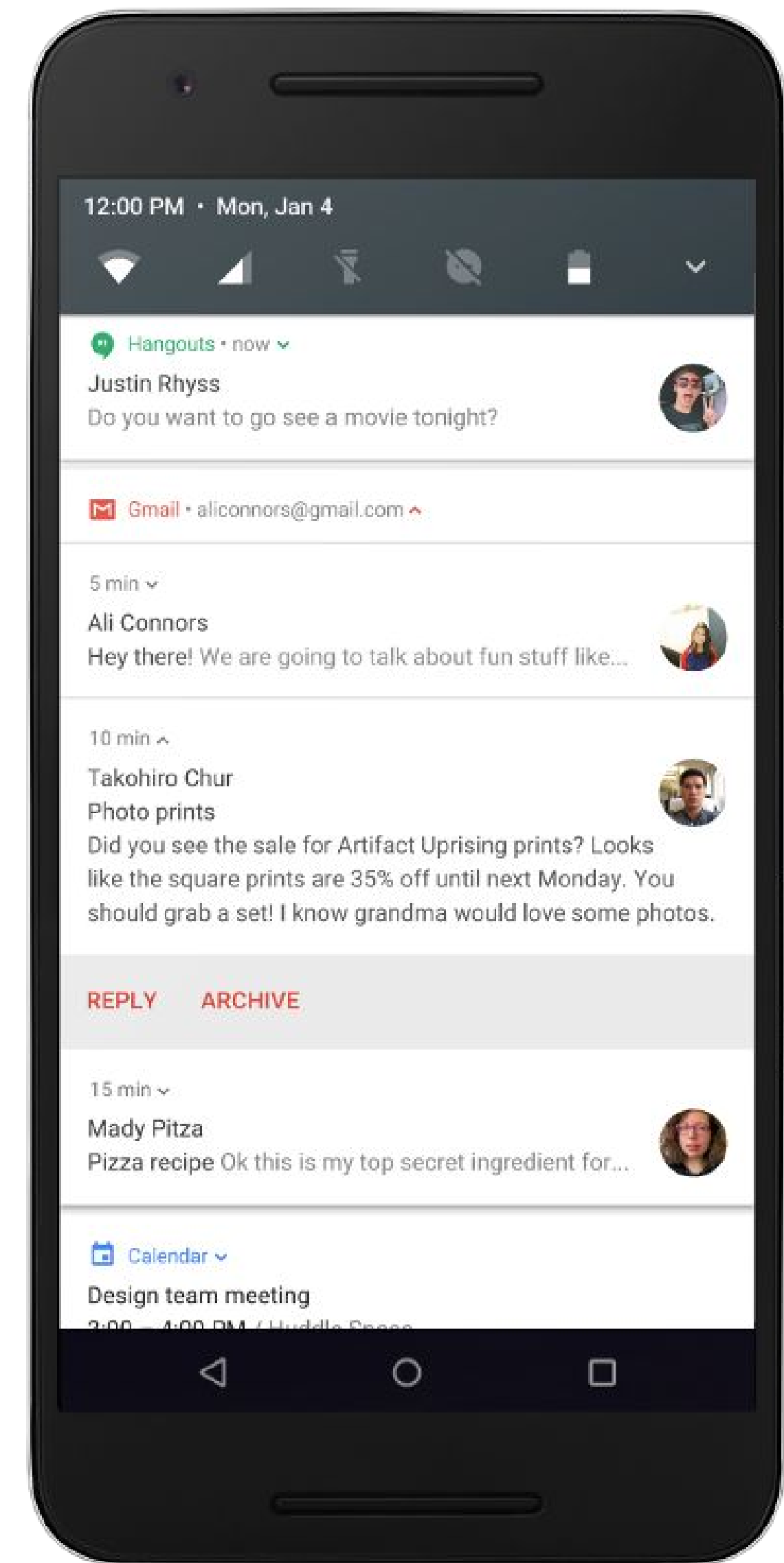
`View.DRAG_FLAG_GLOBAL` `View.DRAG_FLAG_GLOBAL_URI_READ`
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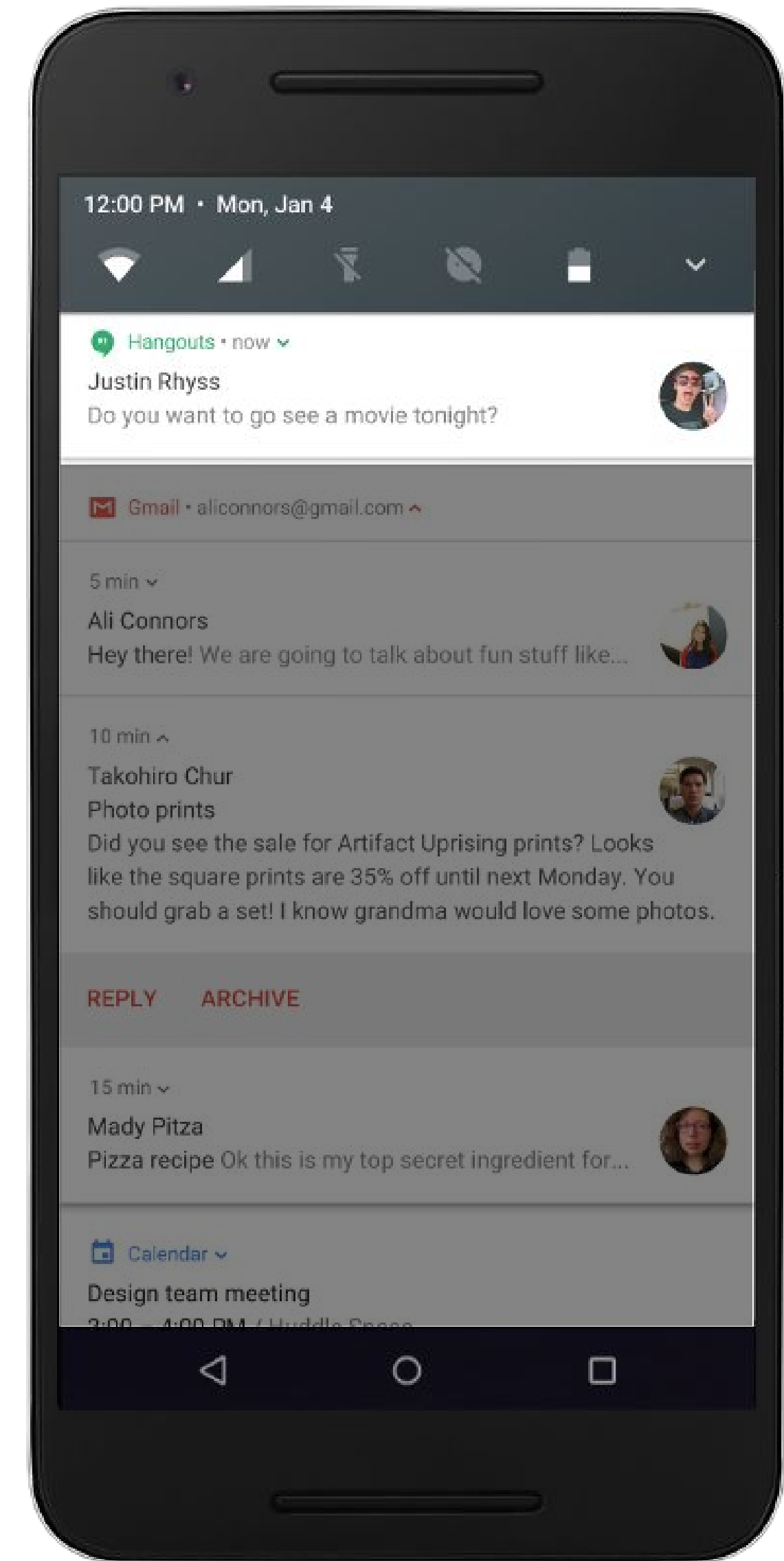


Notifications



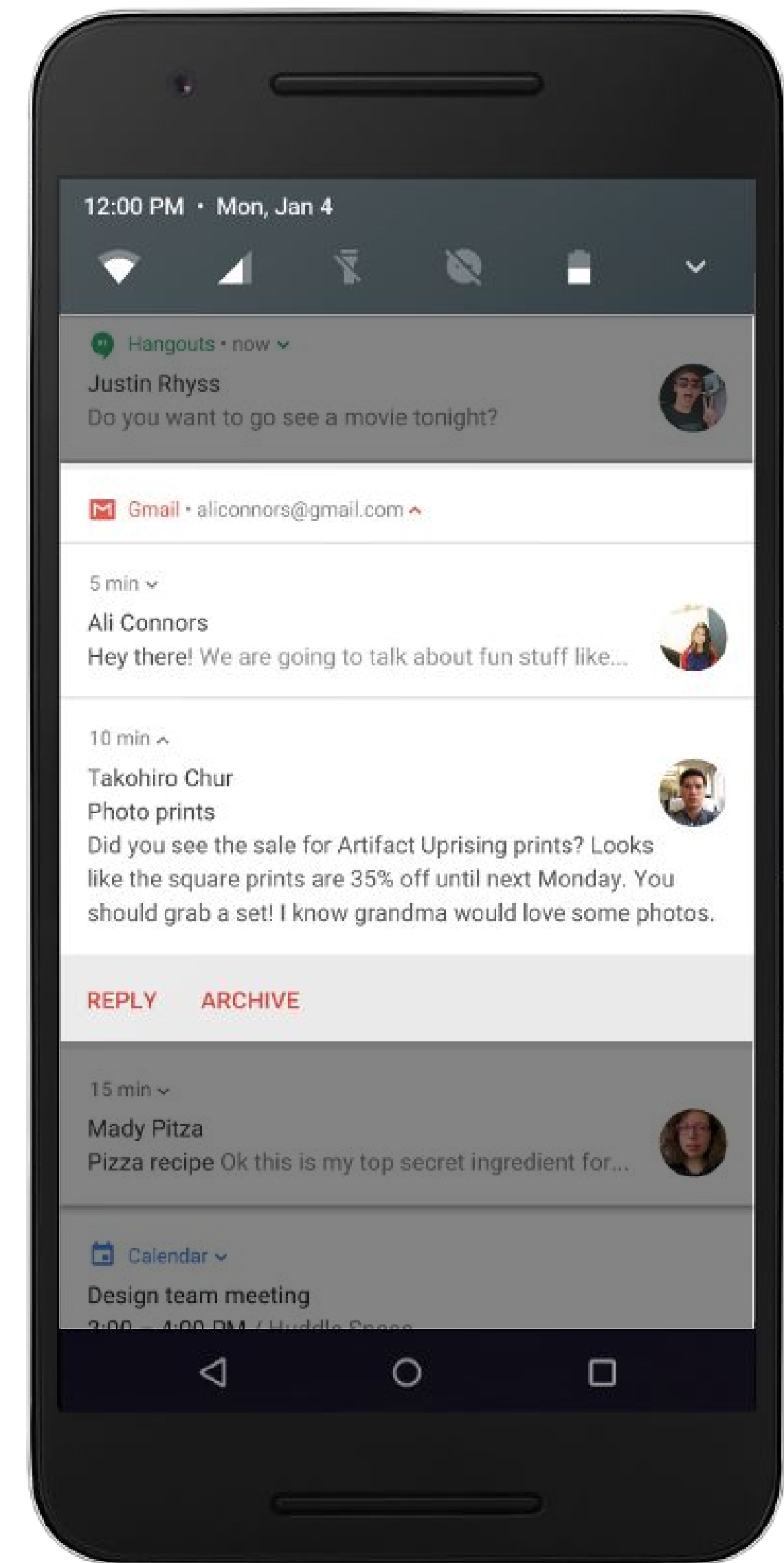
Notifications

- New templates



Notifications

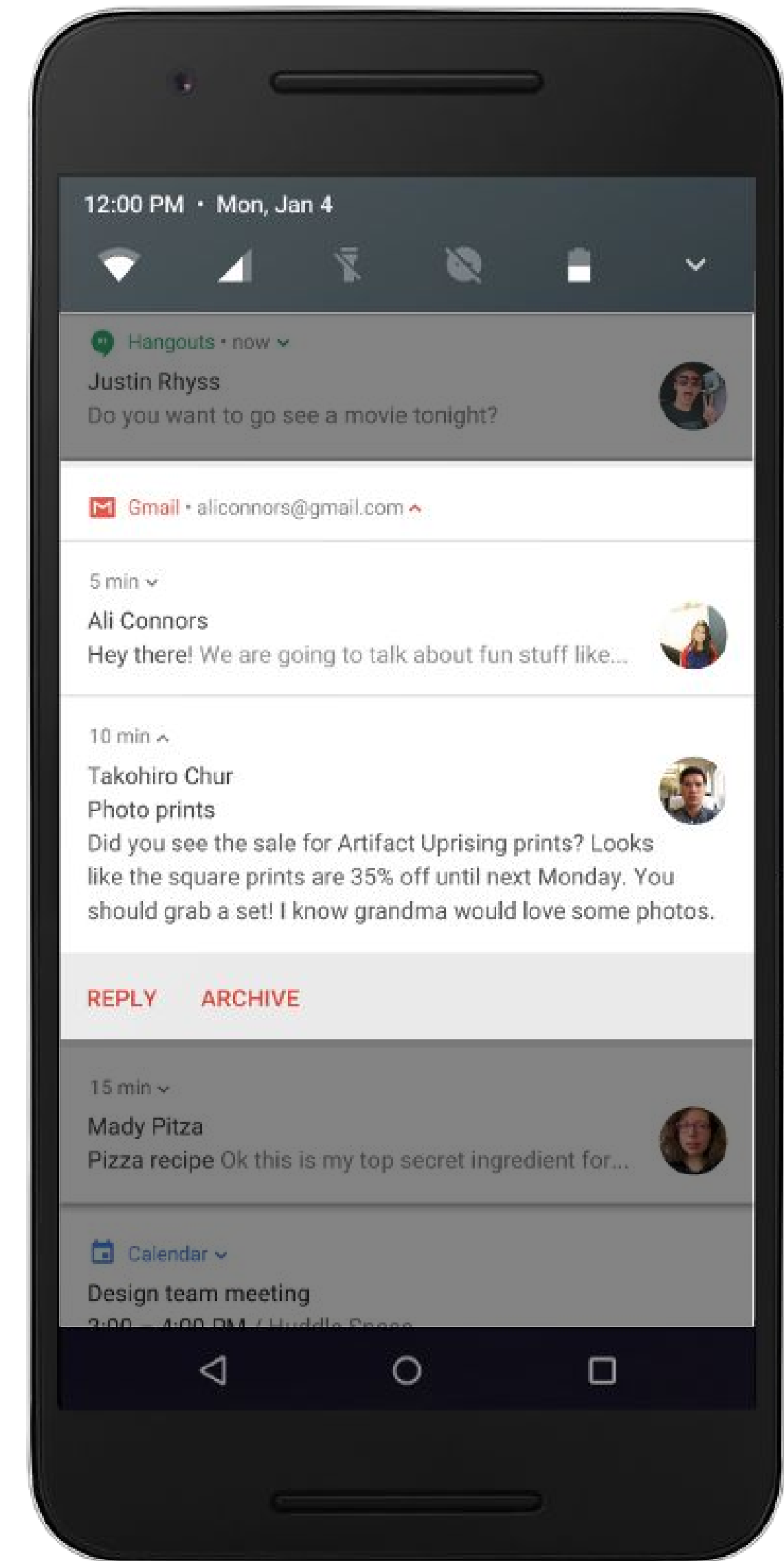
- New templates
- Bundled notifications



Notifications

- New templates
- Bundled notifications

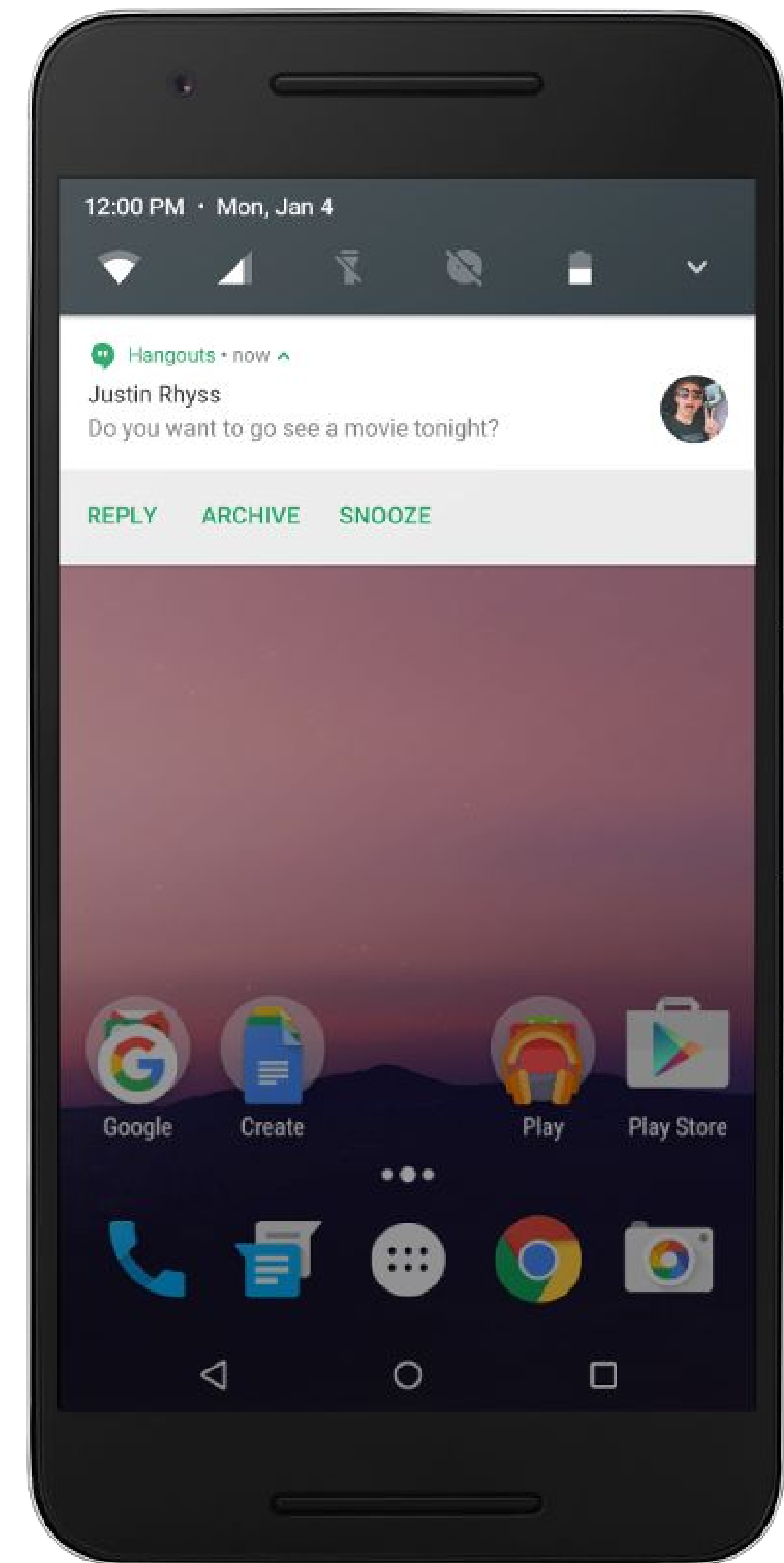
```
ApplicationCompat.Builder.setGroup(String);
```



Notifications

- New templates
- Bundled notifications
- Direct reply

```
ApplicationCompat.Builder.setGroup(String);
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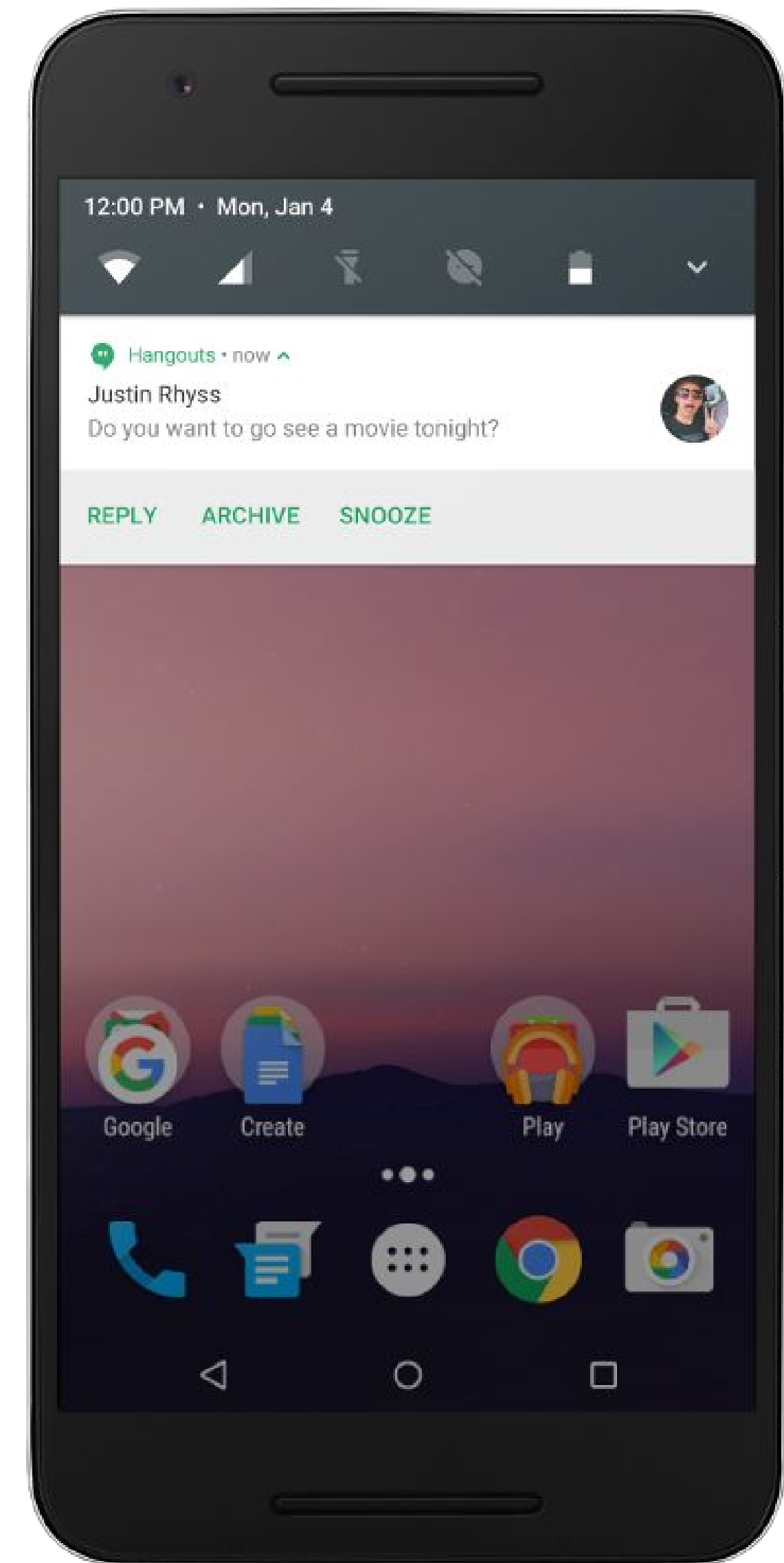


Notifications

- New templates
- Bundled notifications
- Direct reply

```
ApplicationCompat.Builder.setGroup(String);
```

```
input = RemoteInput.Builder[...].build();
```

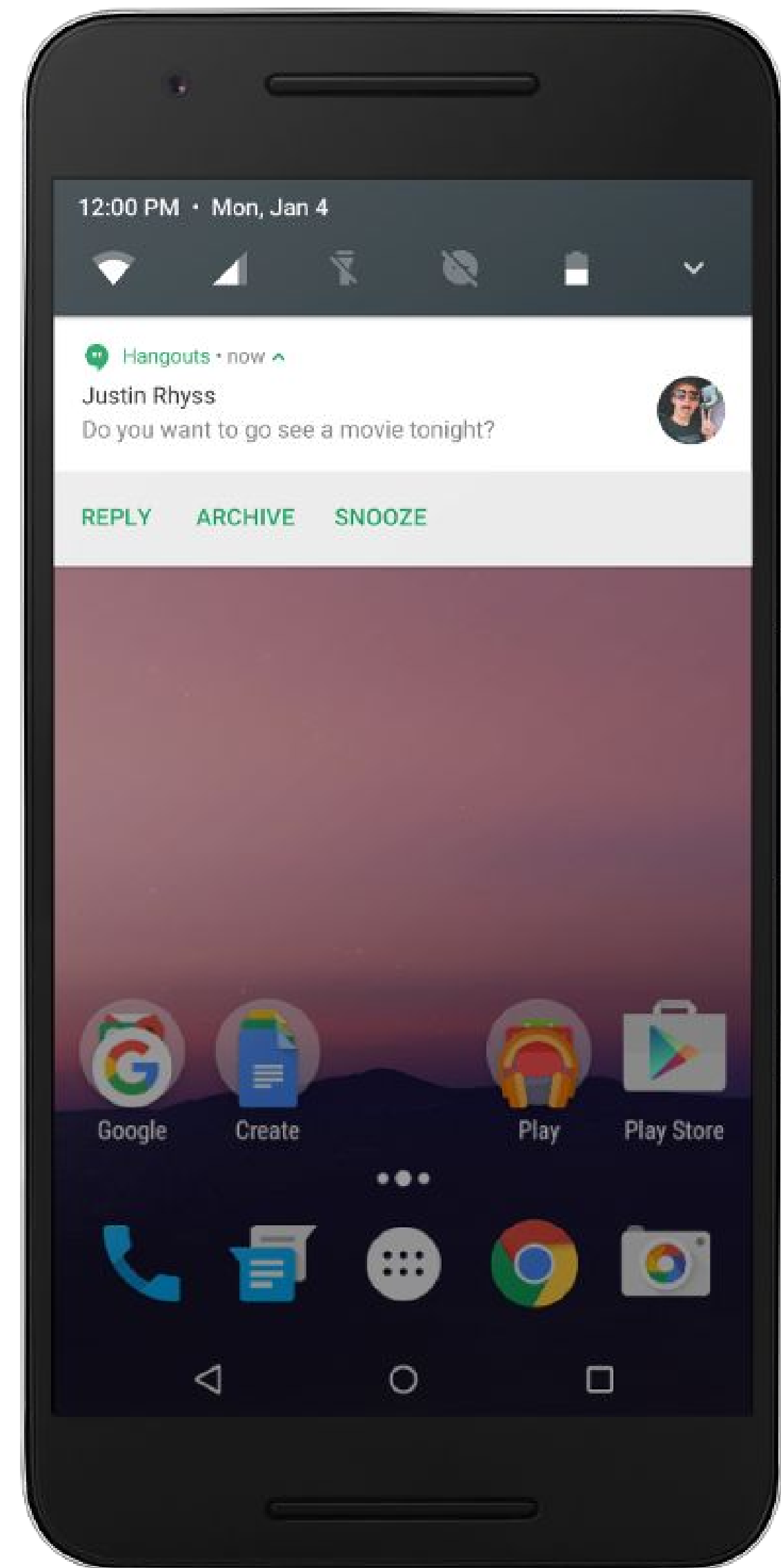


Notifications

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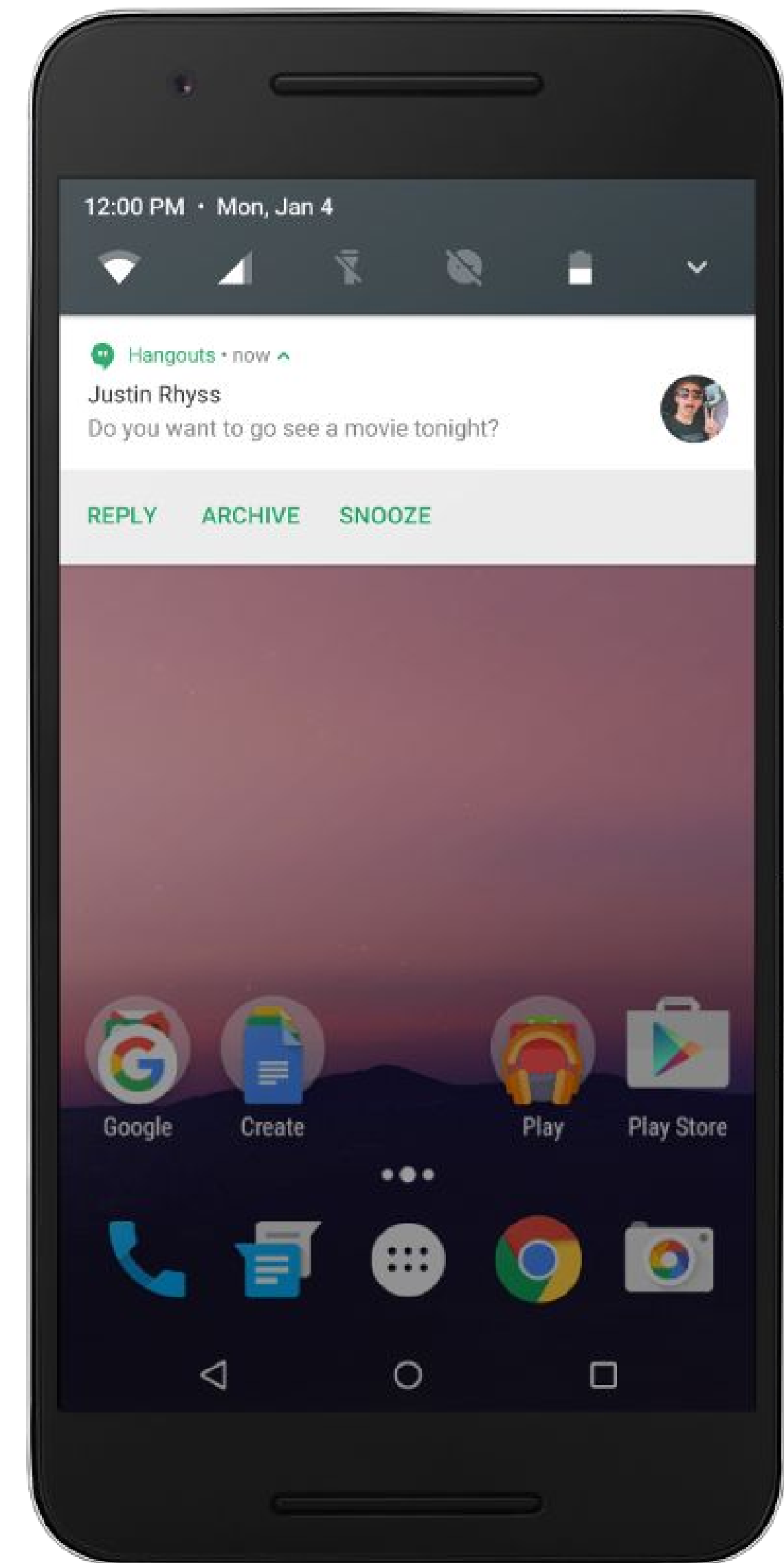
```
input = RemoteInput.Builder[...].build();  
action = Notification.Action.Builder[...].  
    addRemoteInput(input).build();
```



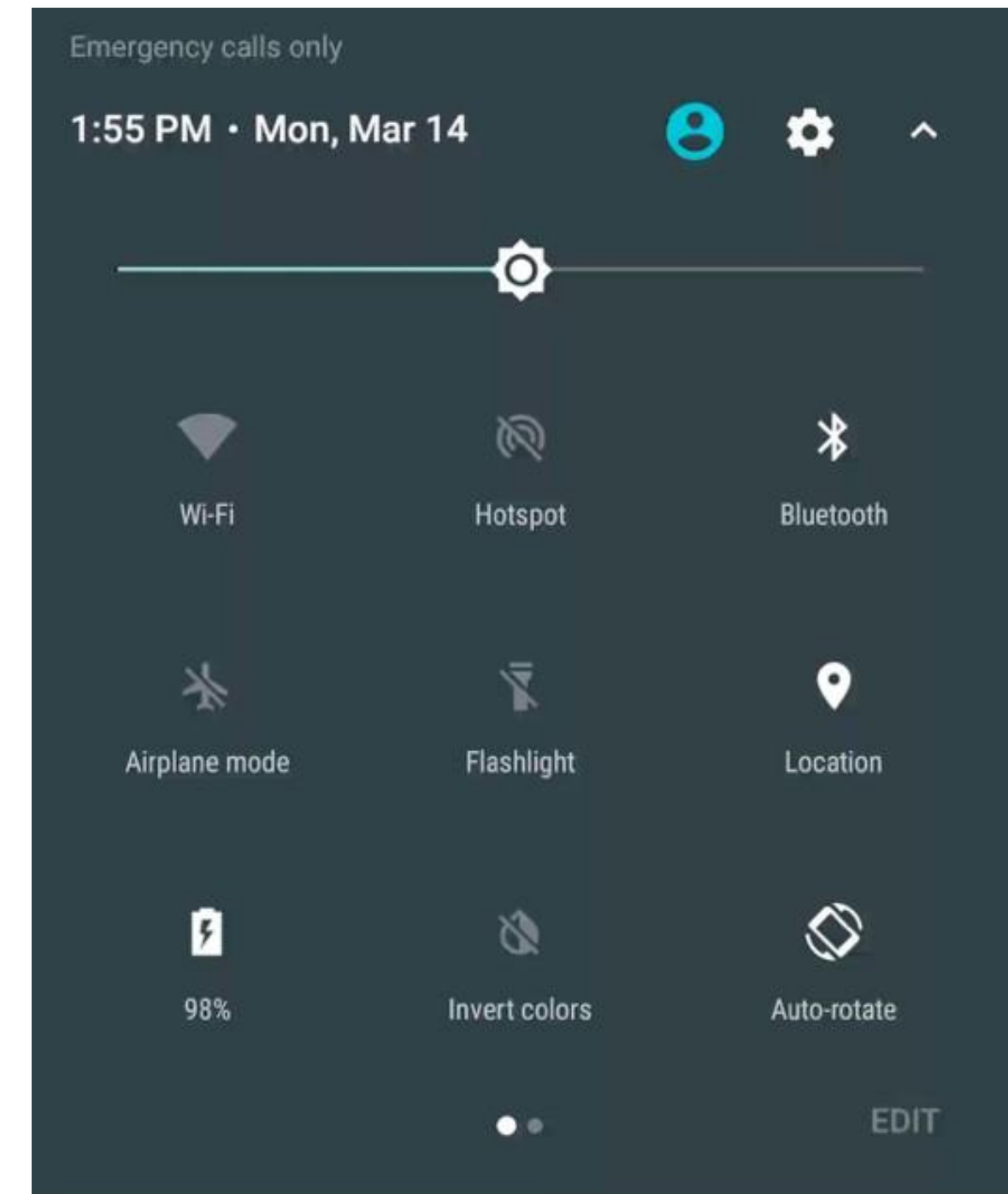
Notifications

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```
ApplicationCompat.Builder.setGroup(String);  
  
input = RemoteInput.Builder[...].build();  
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    addRemoteInput(input).build();  
Notification.Builder().addAction(action).build();
```



Quick Settings



 Android System

USB debugging connected

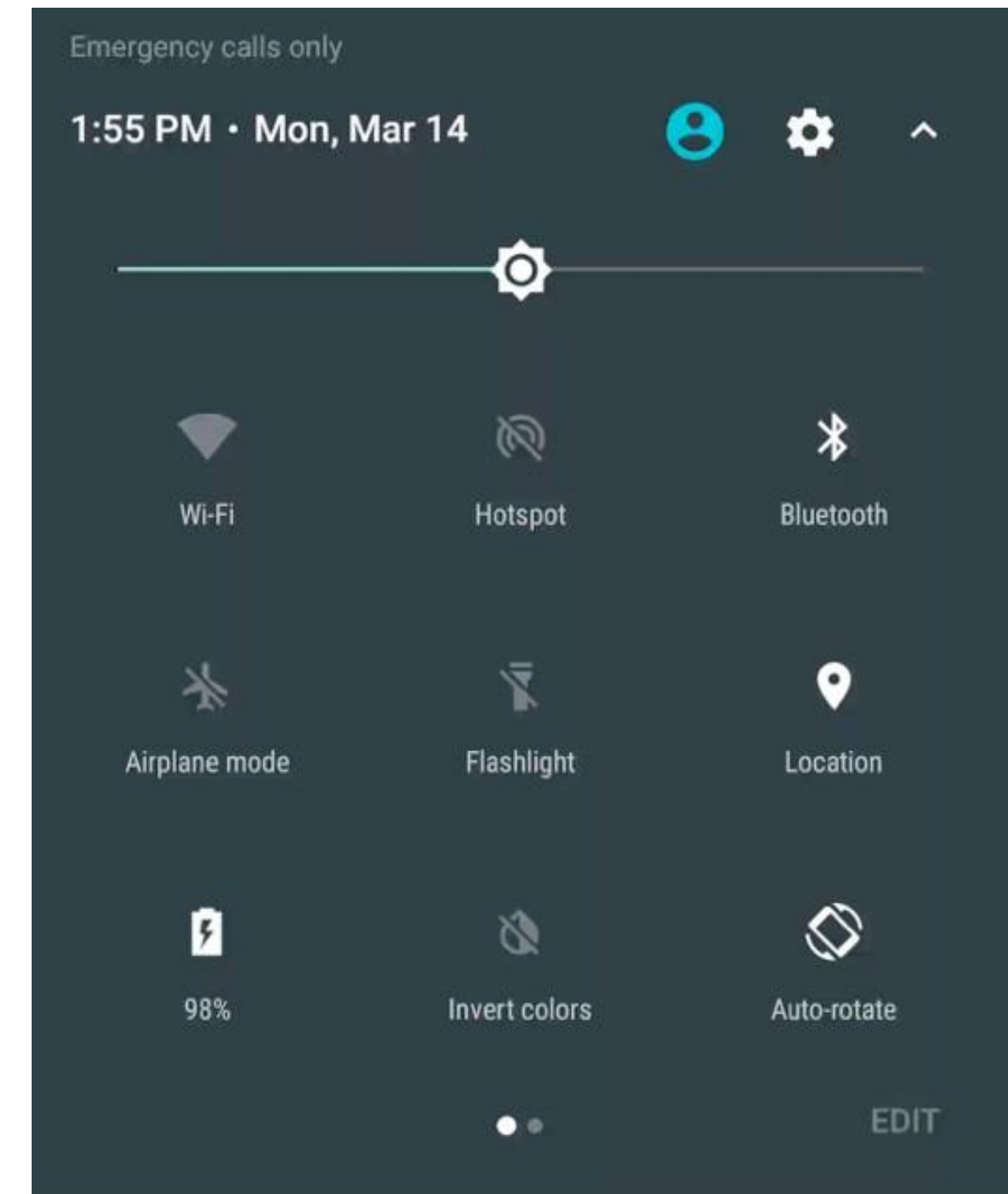
Touch to disable USB debugging.

Wi-Fi networks available

Open Wi-Fi networks available



Quick Settings



 Android System

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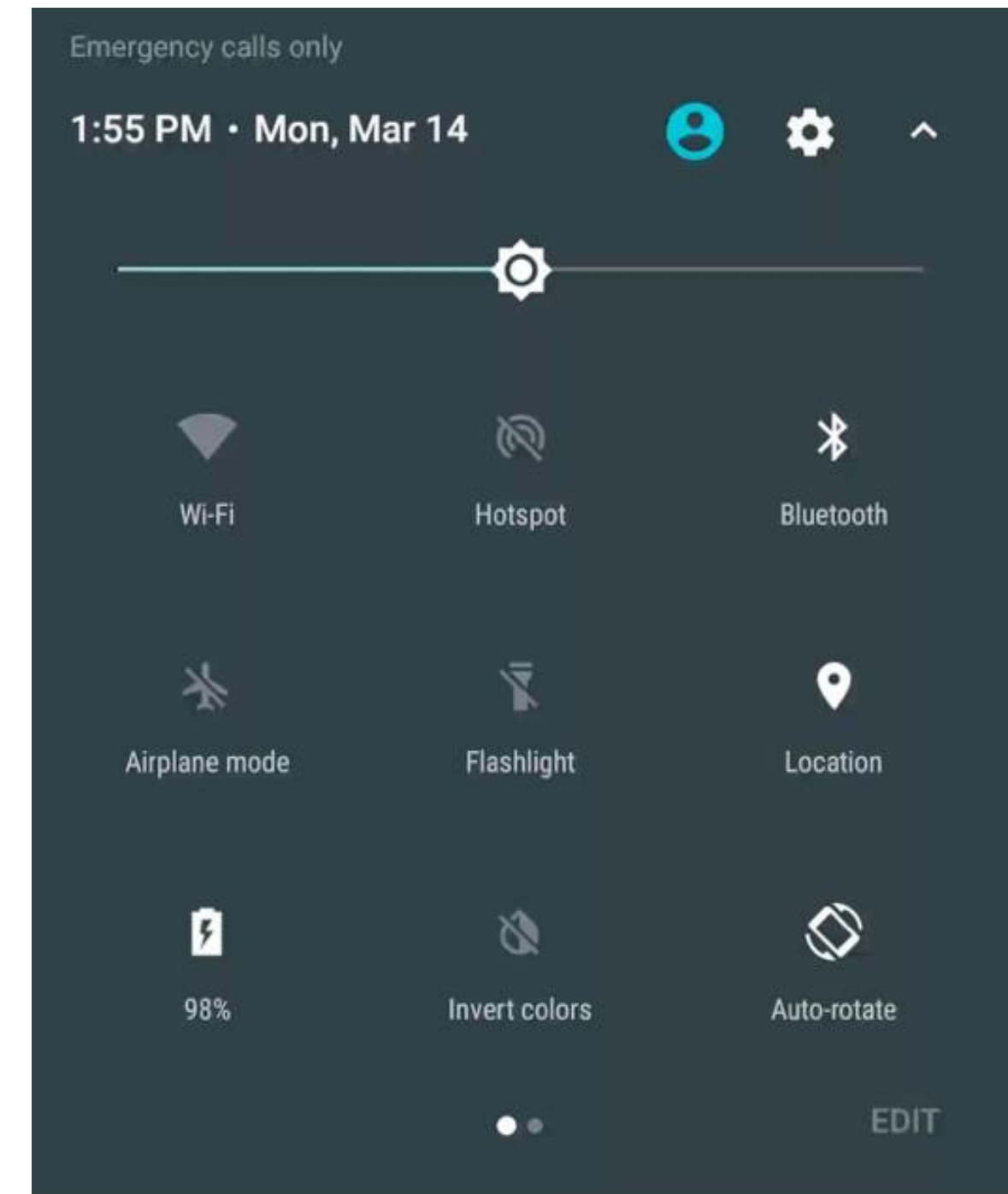
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Quick Settings

- User: change item order and selection



Android System

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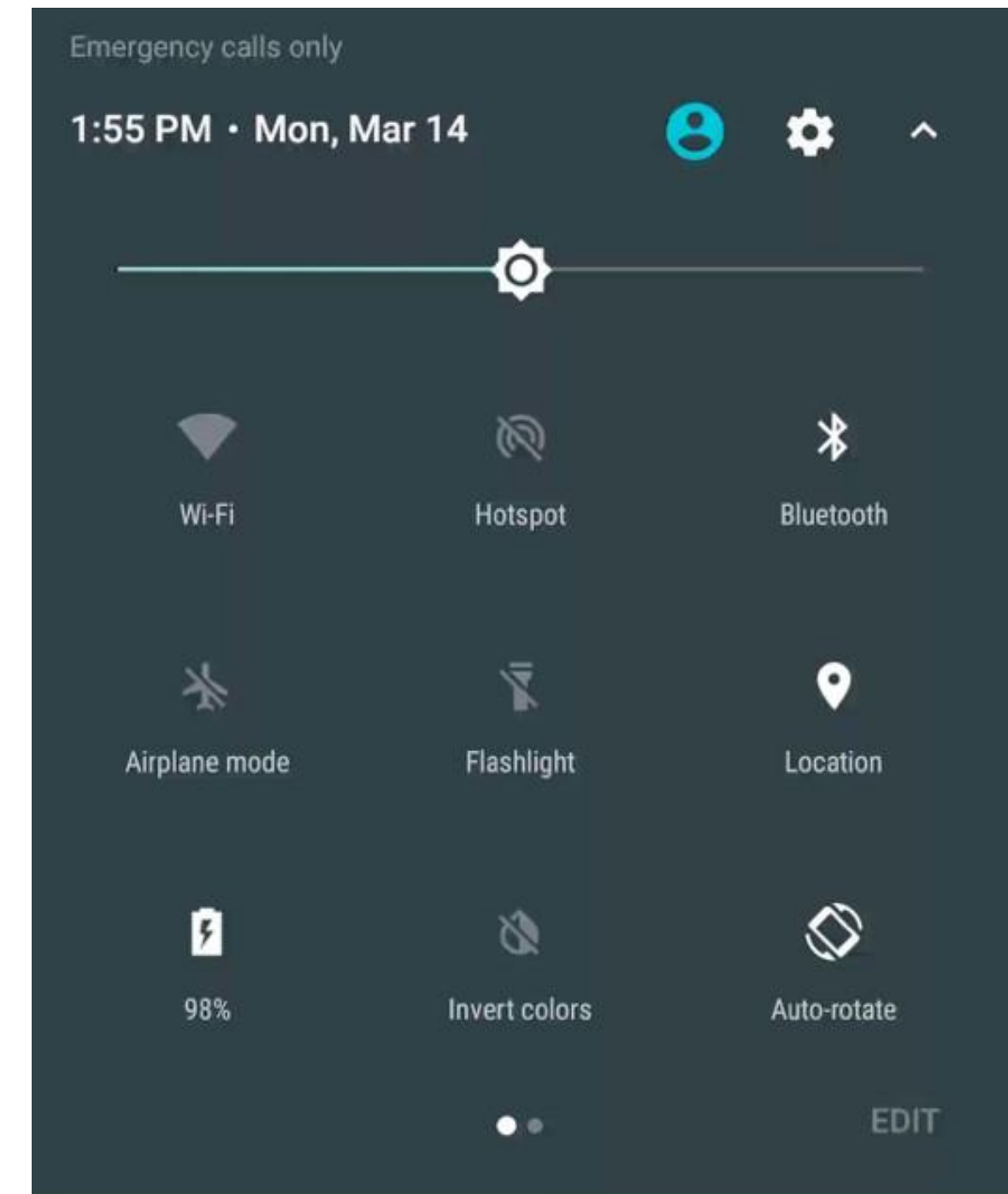
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Quick Settings

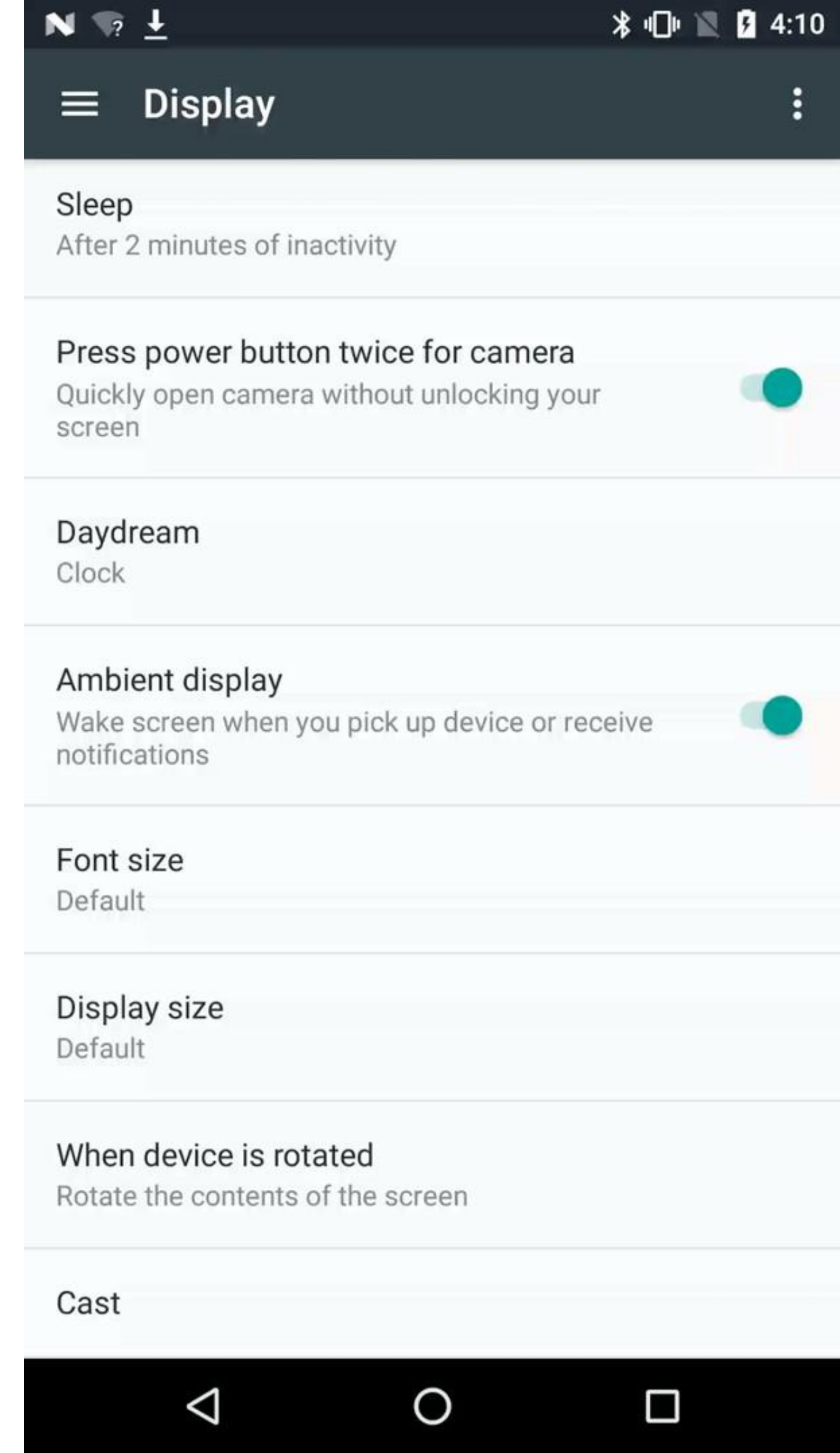
- User: change item order and selection
- Developer: Tile, TileService



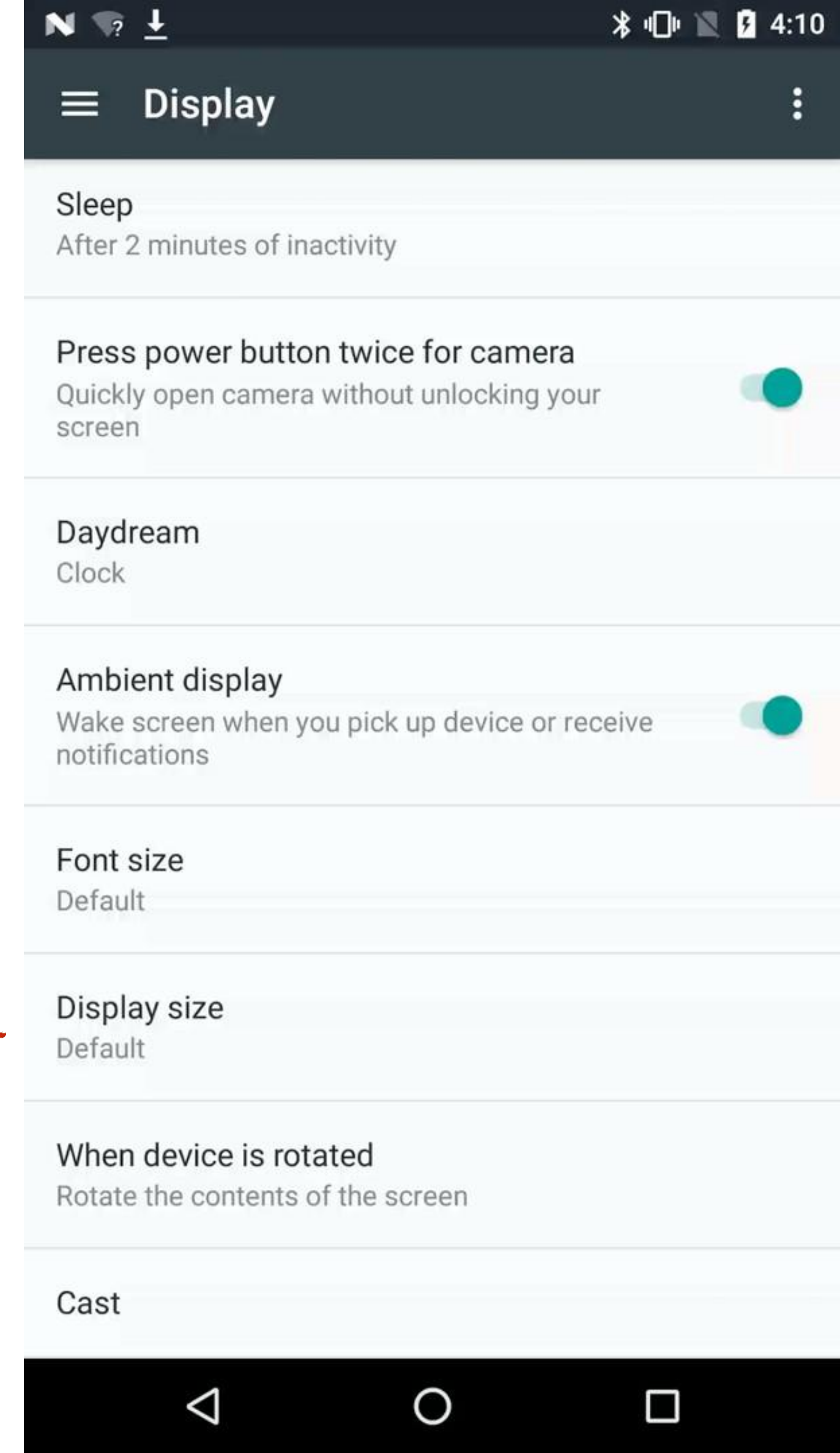
Android System
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Display Size

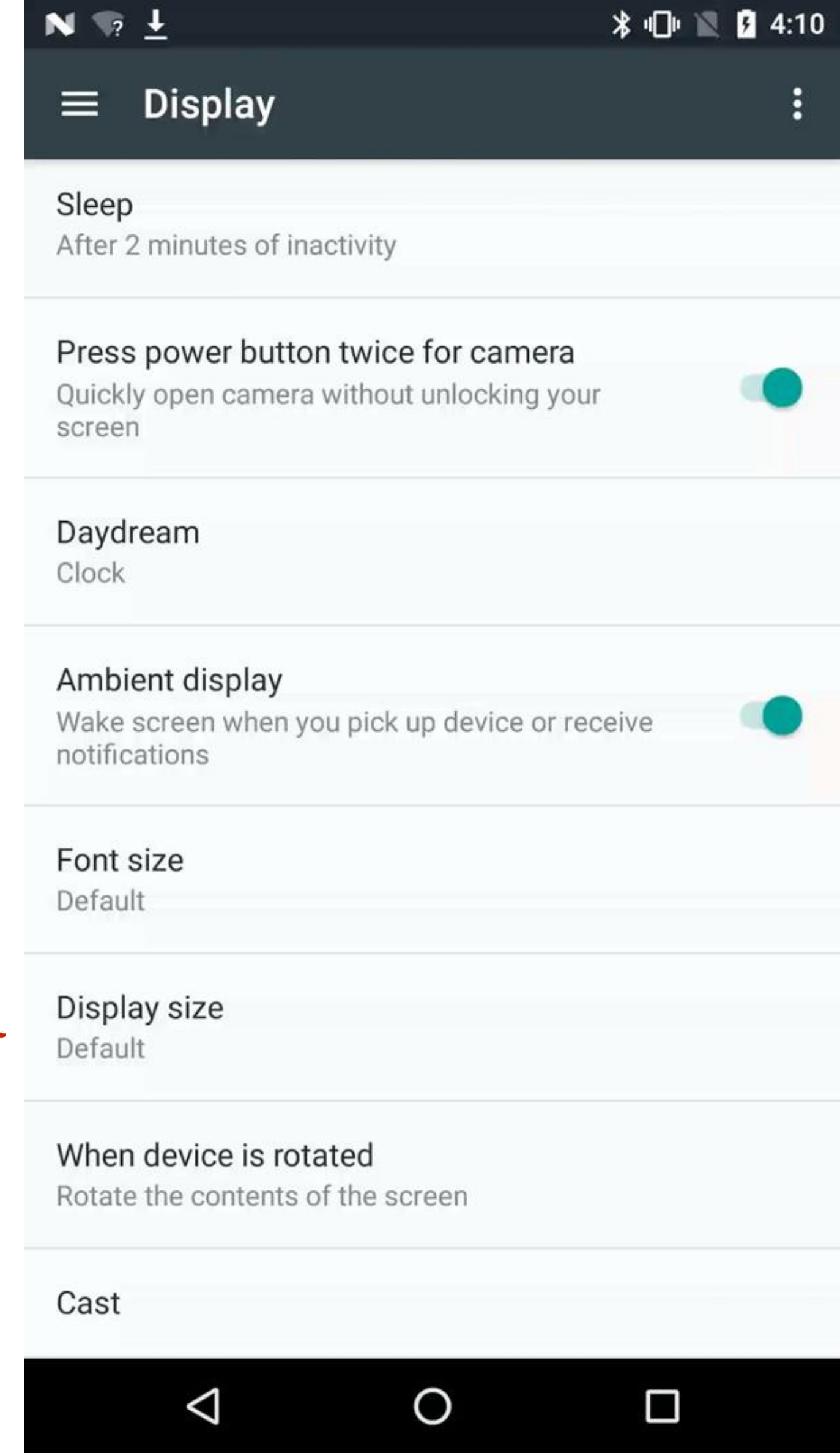


Display Size



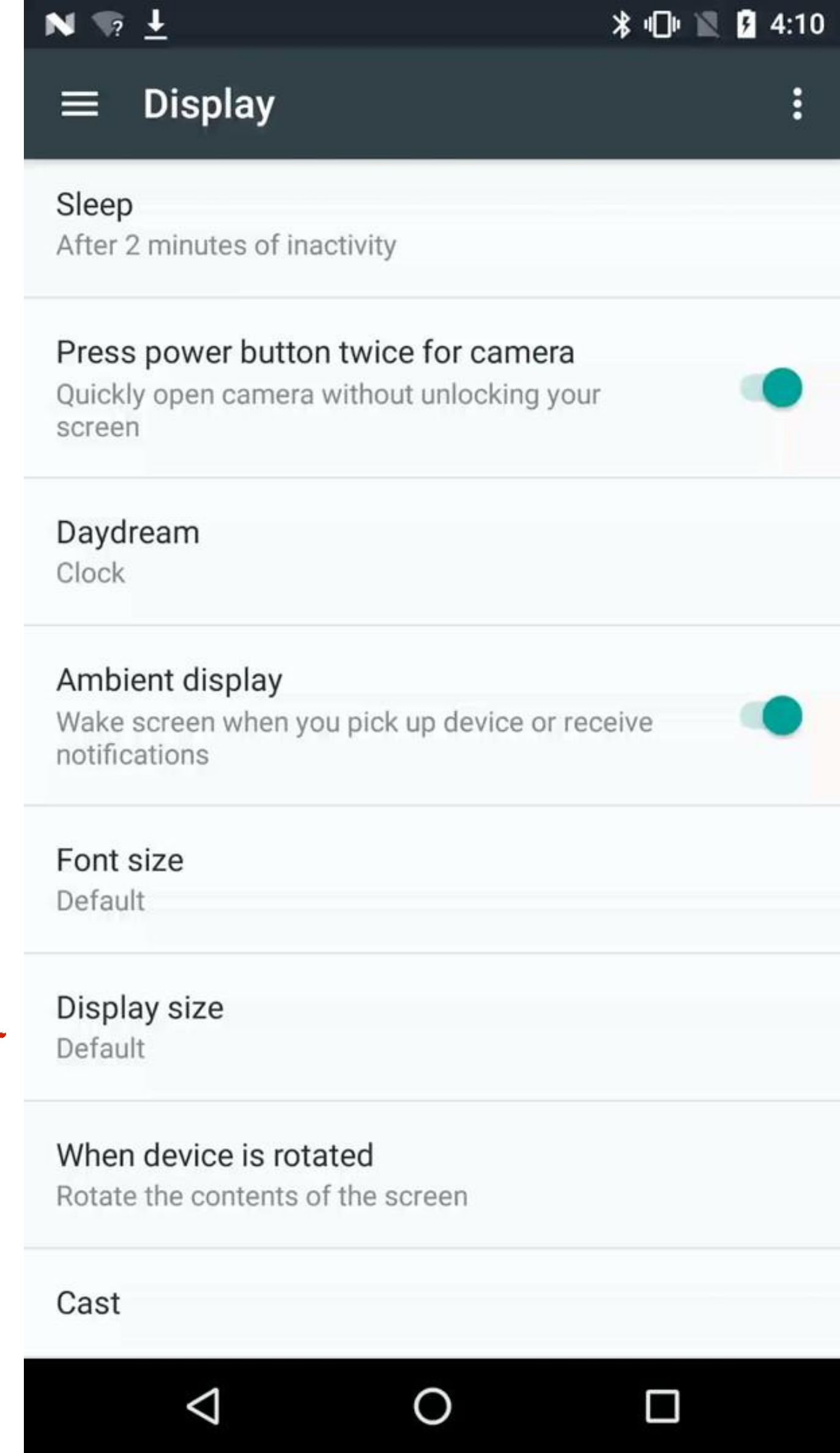
Display Size

- User-determined display size



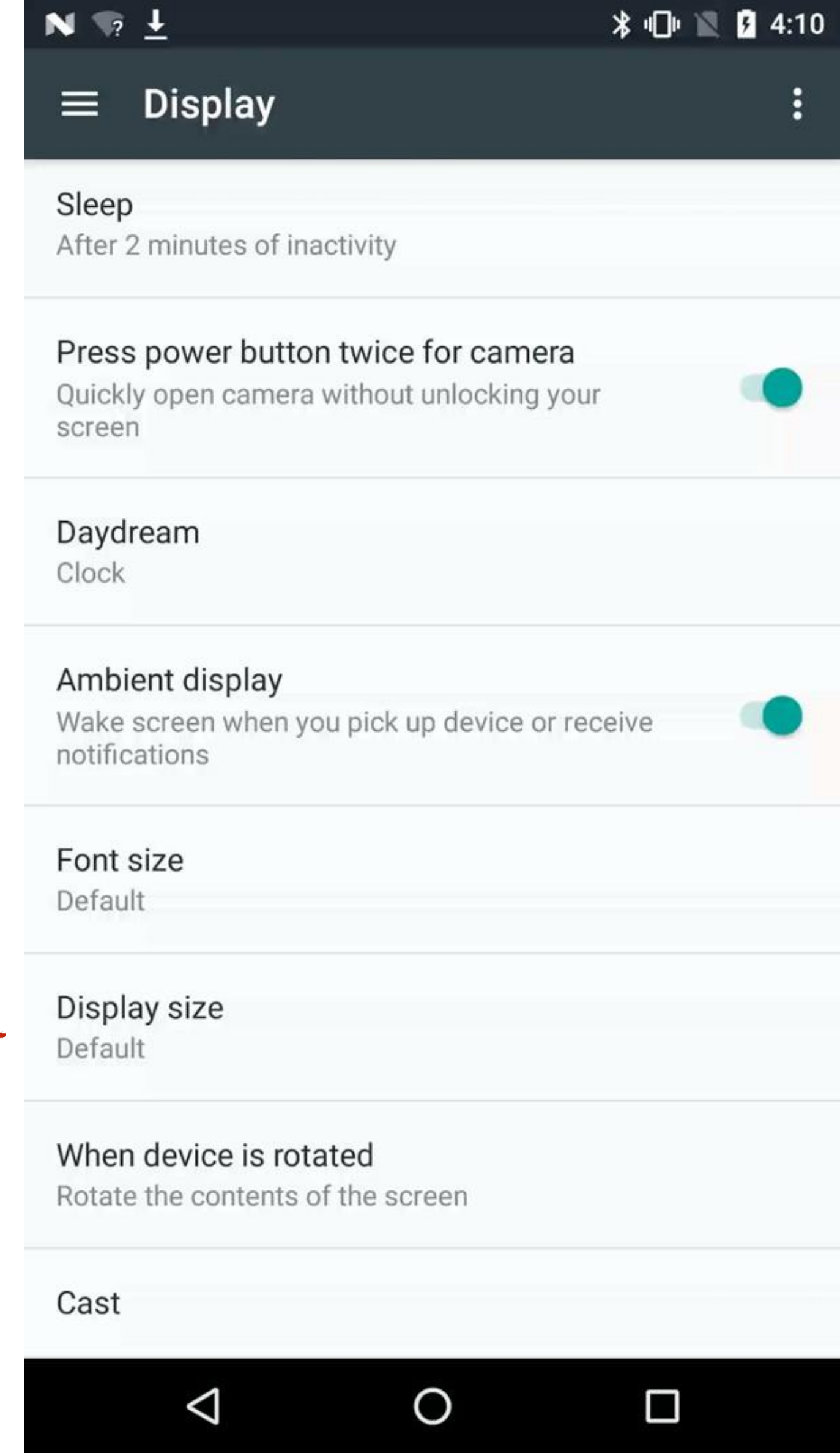
Display Size

- User-determined display size
 - *All* UI, not just text



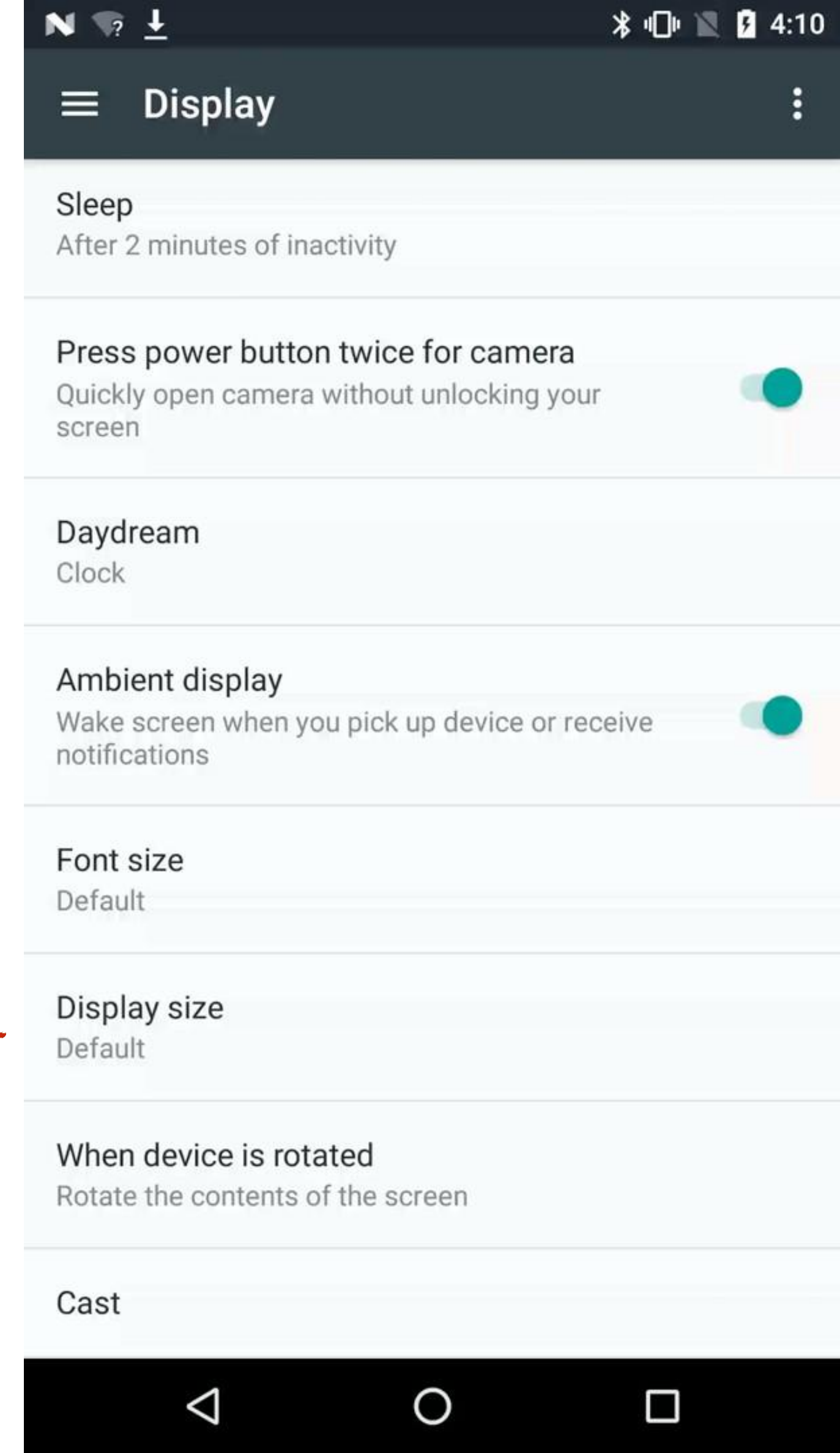
Display Size

- User-determined display size
 - *All* UI, not just text
- .85x - 1.45x



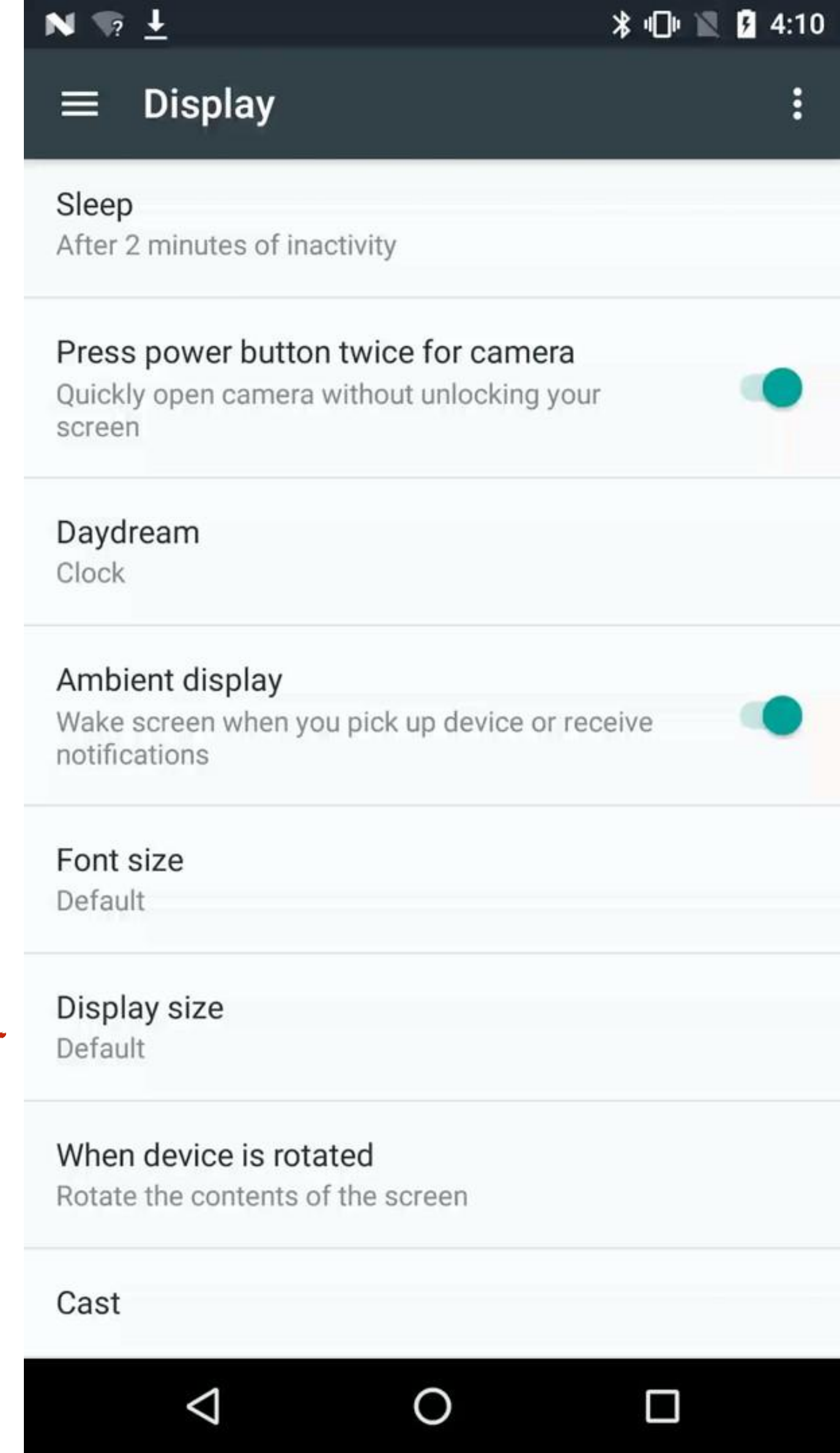
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- User-determined display size
 - *All* UI, not just text
- .85x - 1.45x
- Avoid px



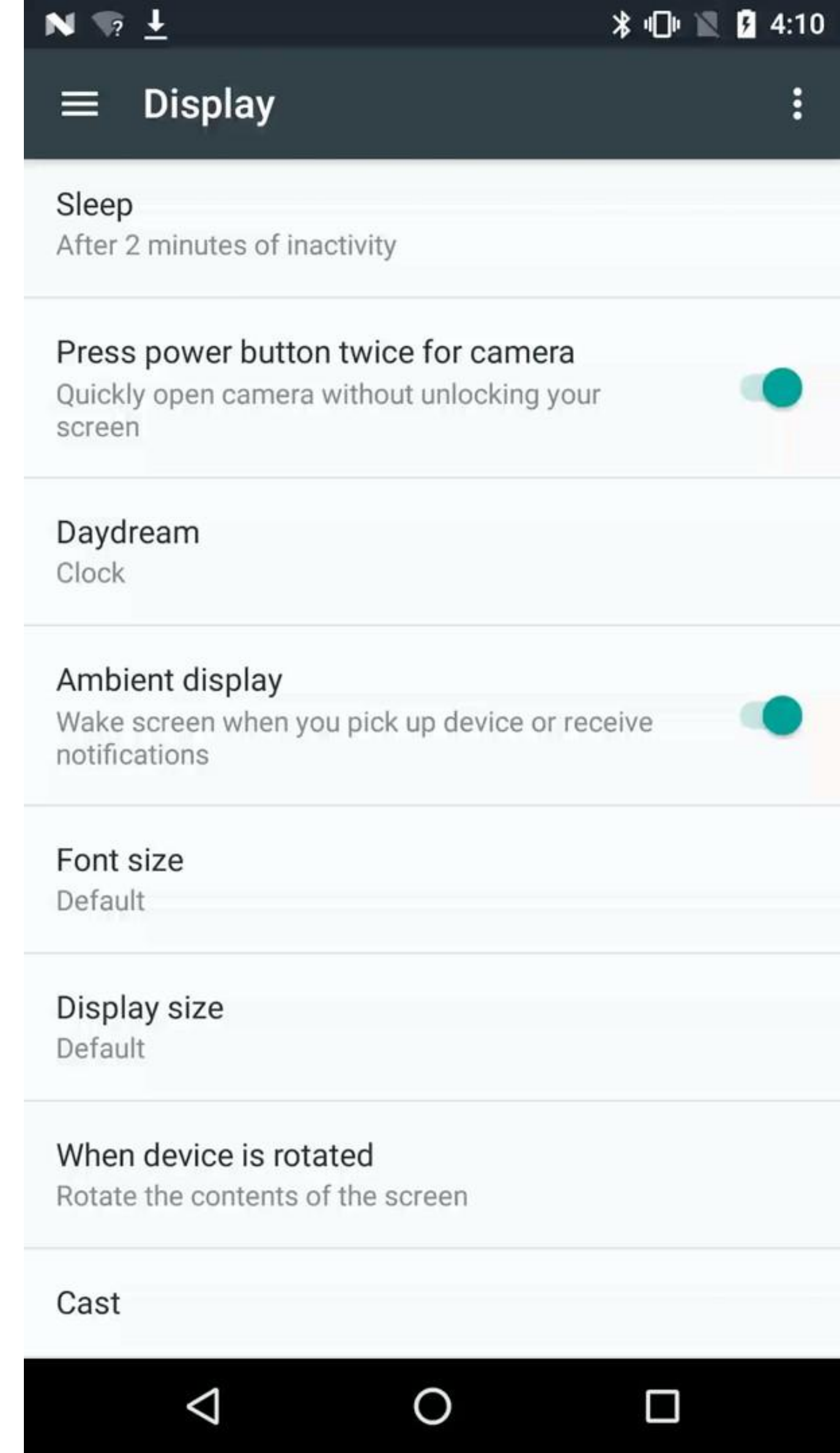
Display Size

- User-determined display size
 - *All* UI, not just text
- .85x - 1.45x
- Avoid px
- Ensure your app works well on sw320dp



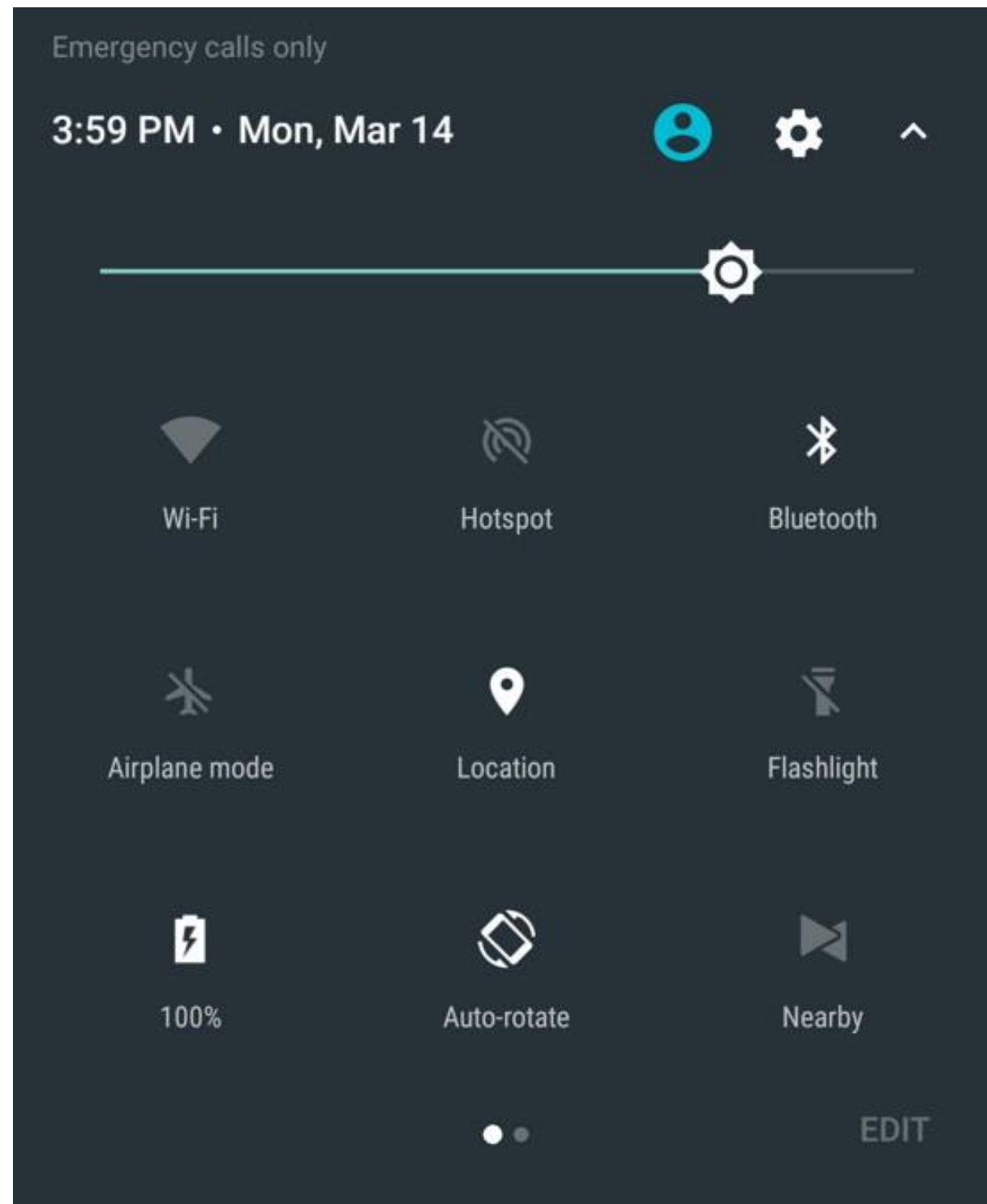
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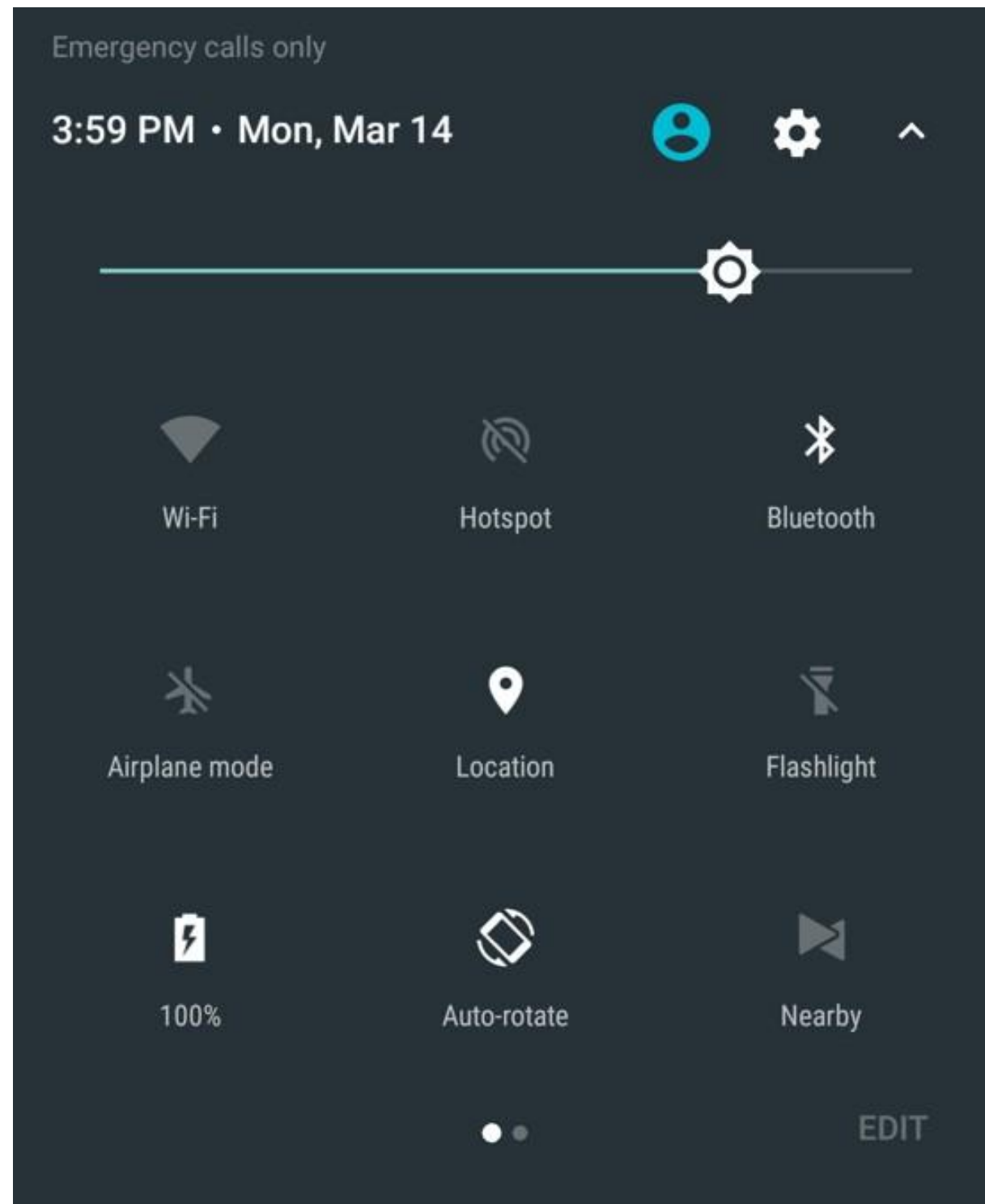
Display Size

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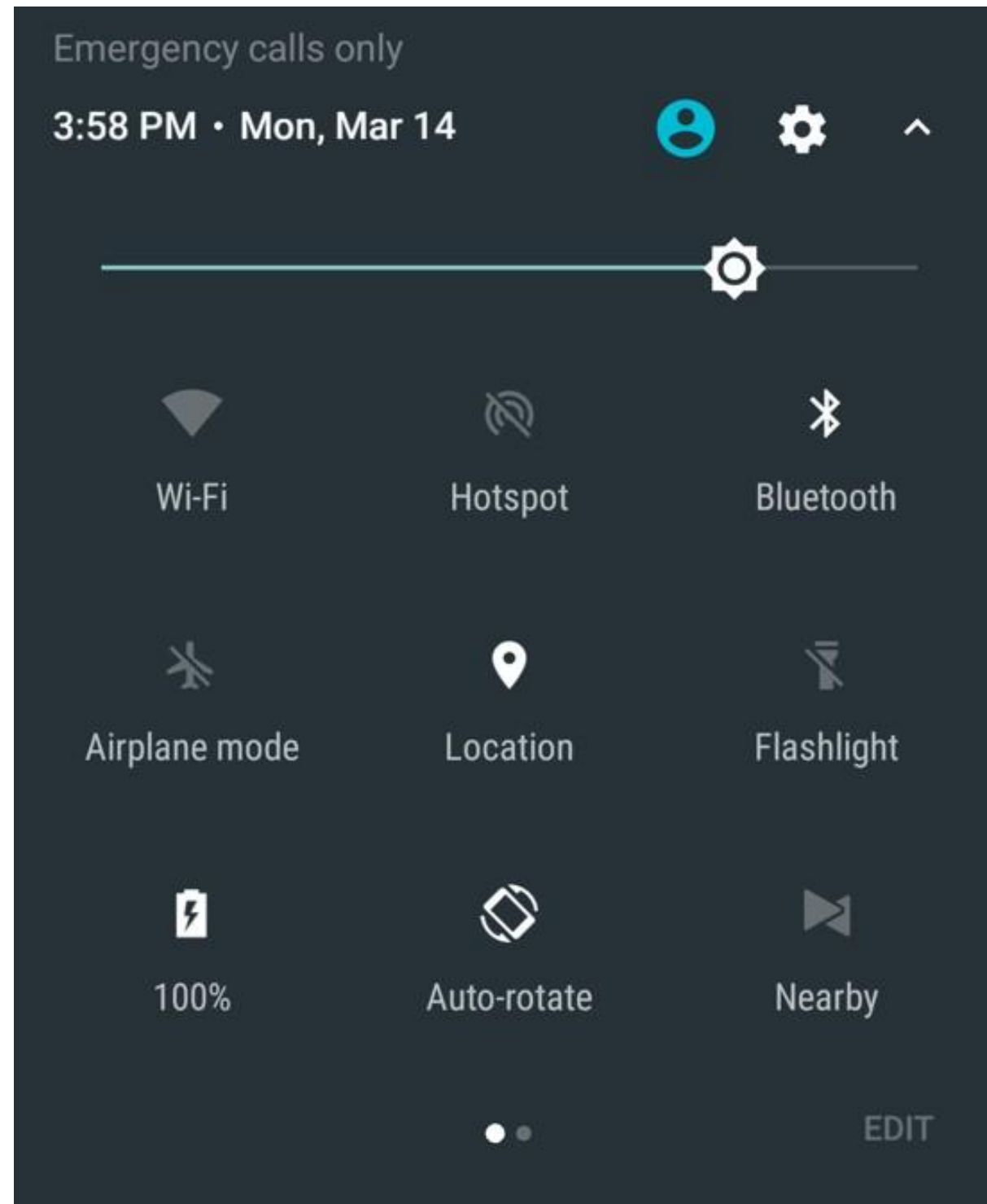


Default

Display Size



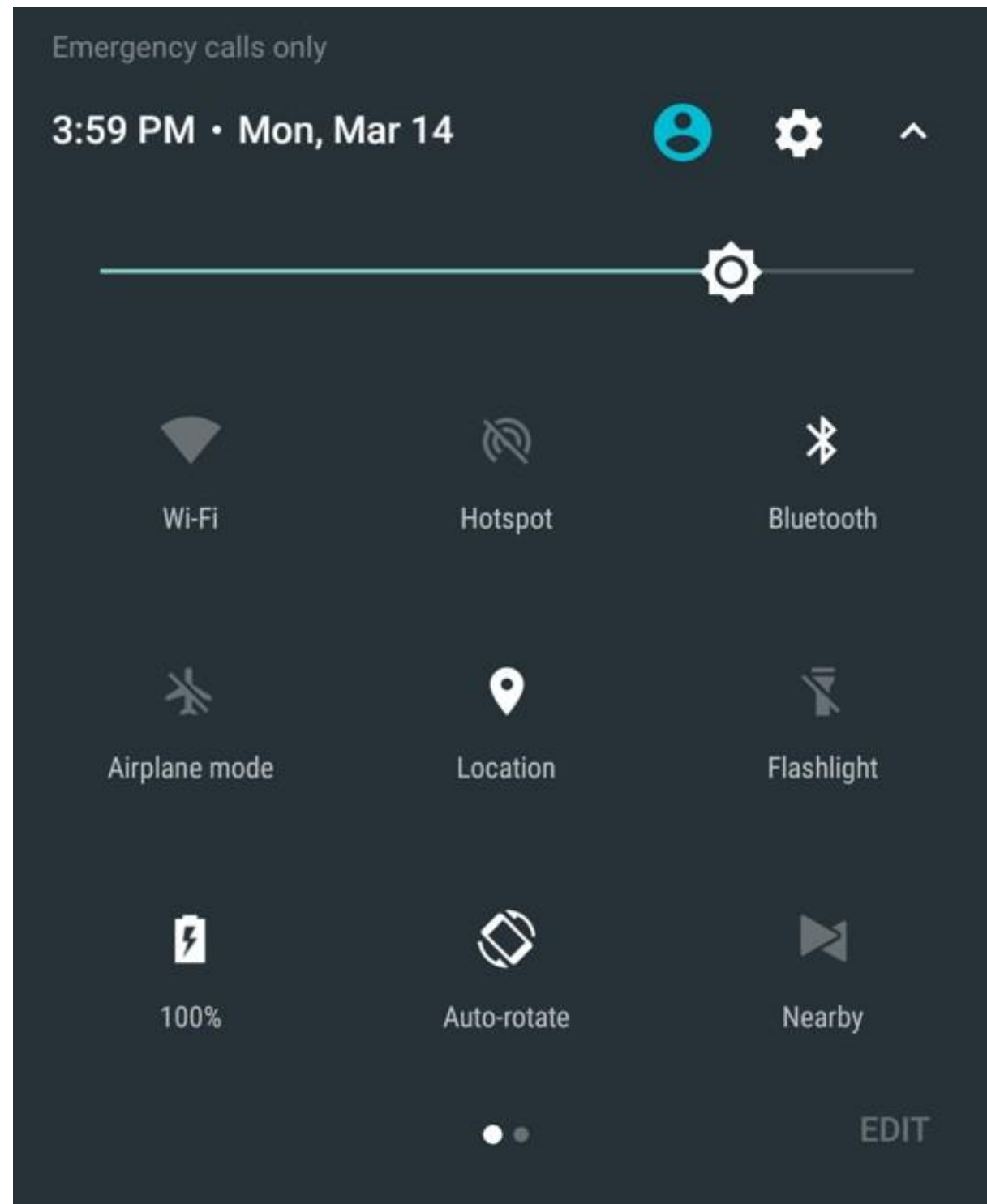
Default



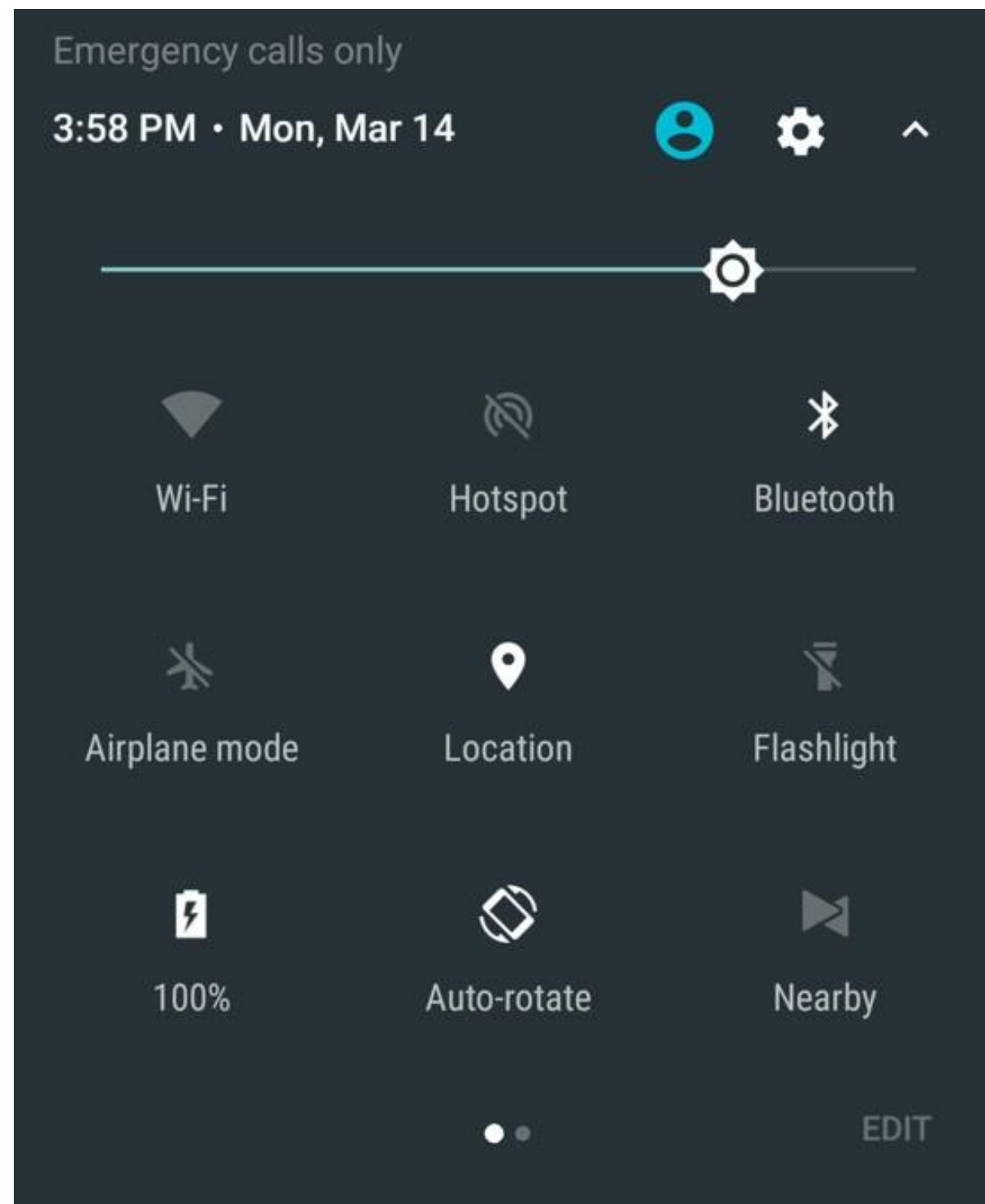
Font size "Largest"

Display Size

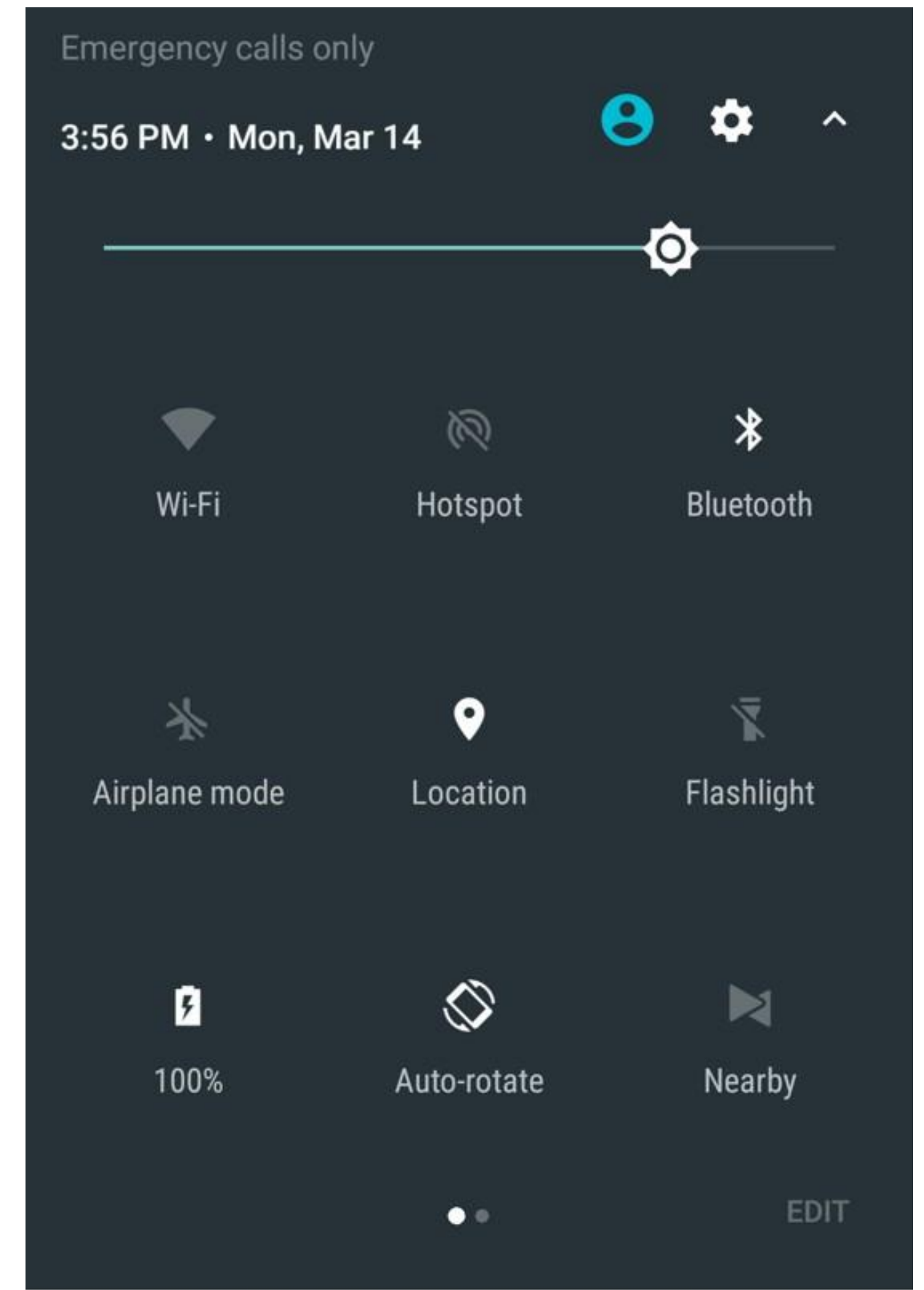
Display size “Largest”



Default



Font size “Largest”



Multi-Locale

Multi-Locale

- User can select multiple languages

Multi-Locale

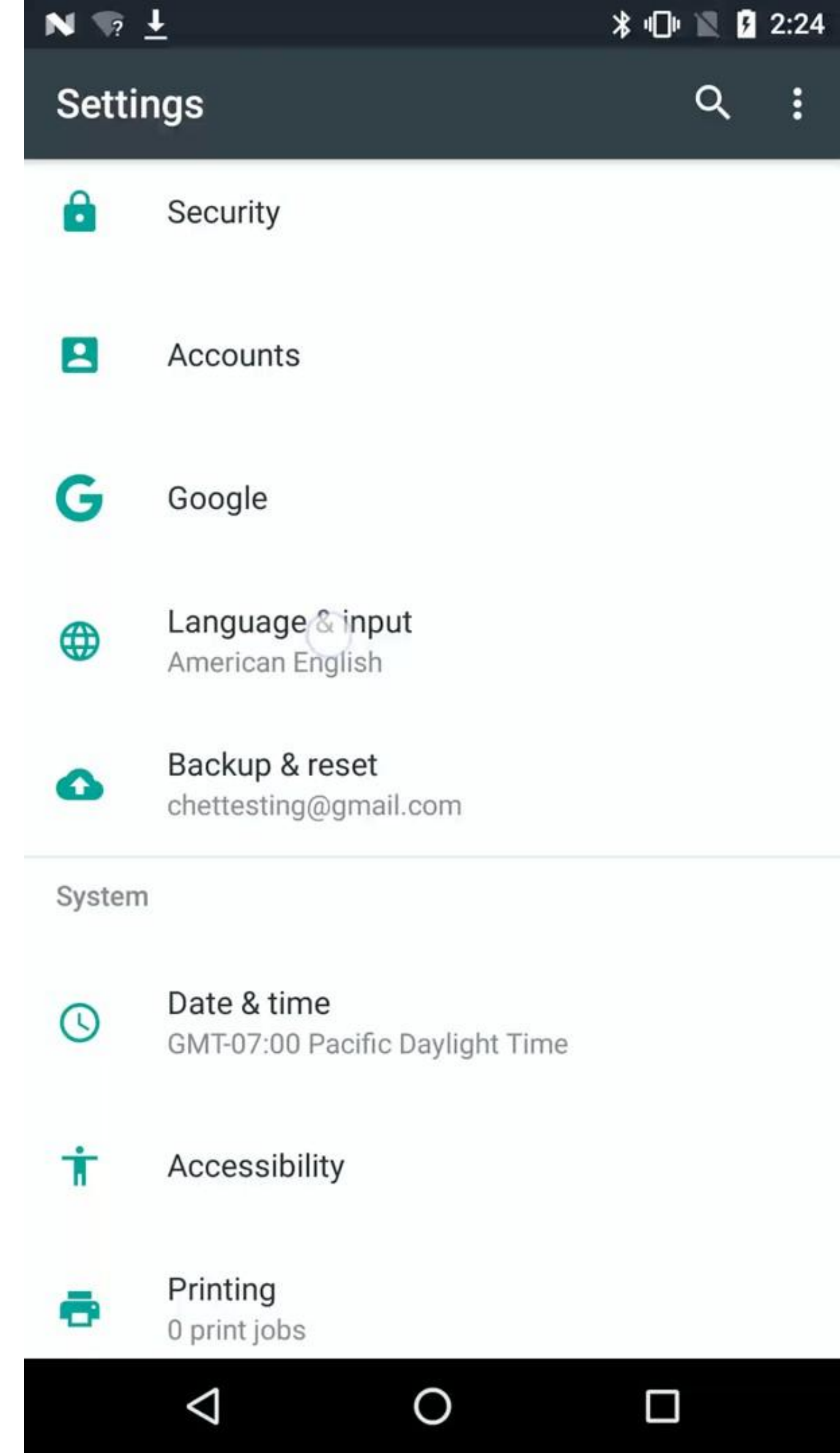
- User can select multiple languages
 - And order them

Multi-Locale

- User can select multiple languages
 - And order them
- Also added new languages, variants

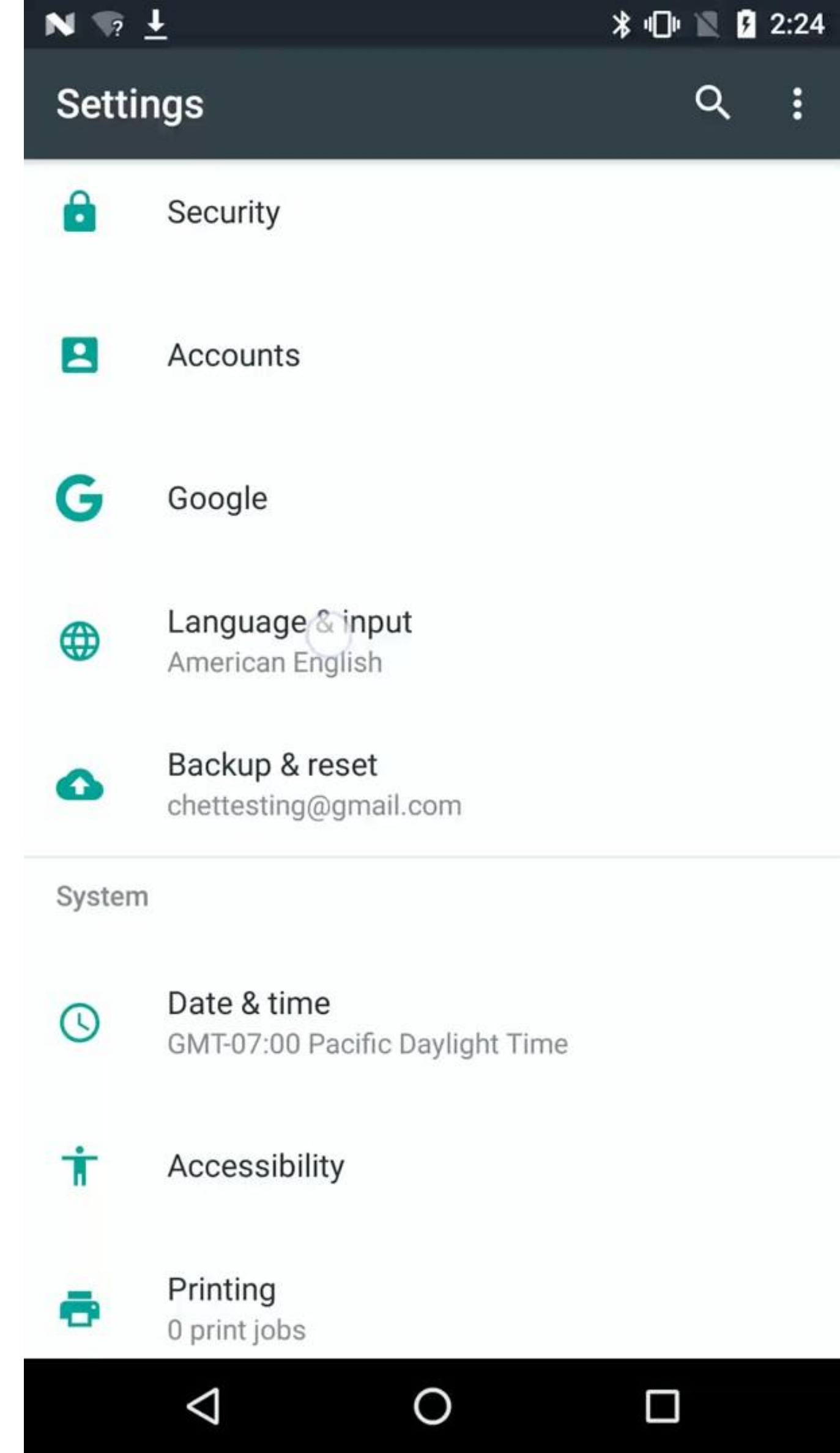
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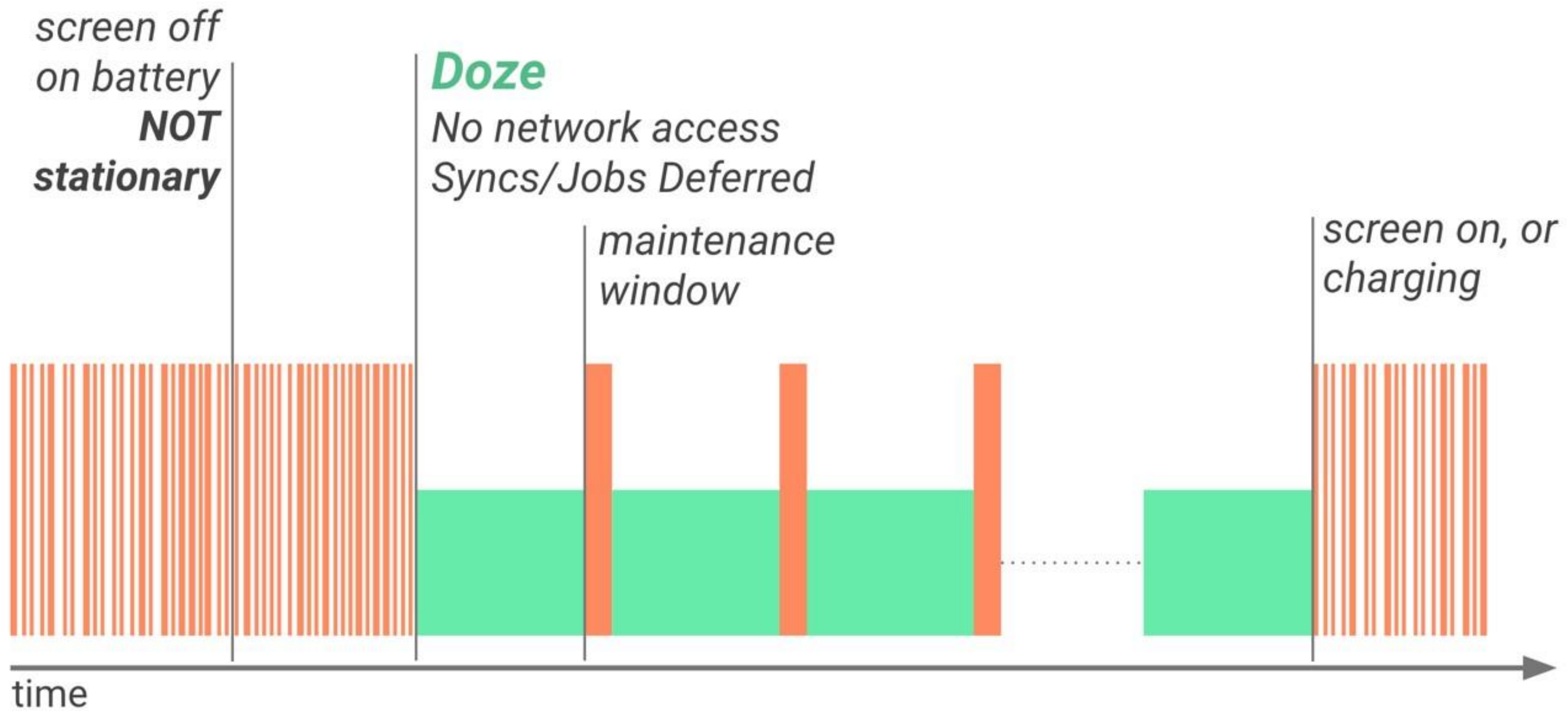


Multi-Locale

- User can select multiple languages
 - And order them
- Also added new languages, variants



Doze



Project Svelte

Project Svelte

ConnectivityManager.CONNECTIVITY_ACTION

Camera.ACTION_NEW_VIDEO Camera.

ACTION_NEW_PICTURE

! Goodbye

Project Svelte

ConnectivityManager.CONNECTIVITY_ACTION

Camera.ACTION_NEW_VIDEO Camera.

ACTION_NEW_PICTURE

JobScheduler

GCMNetworkManager

! Goodbye

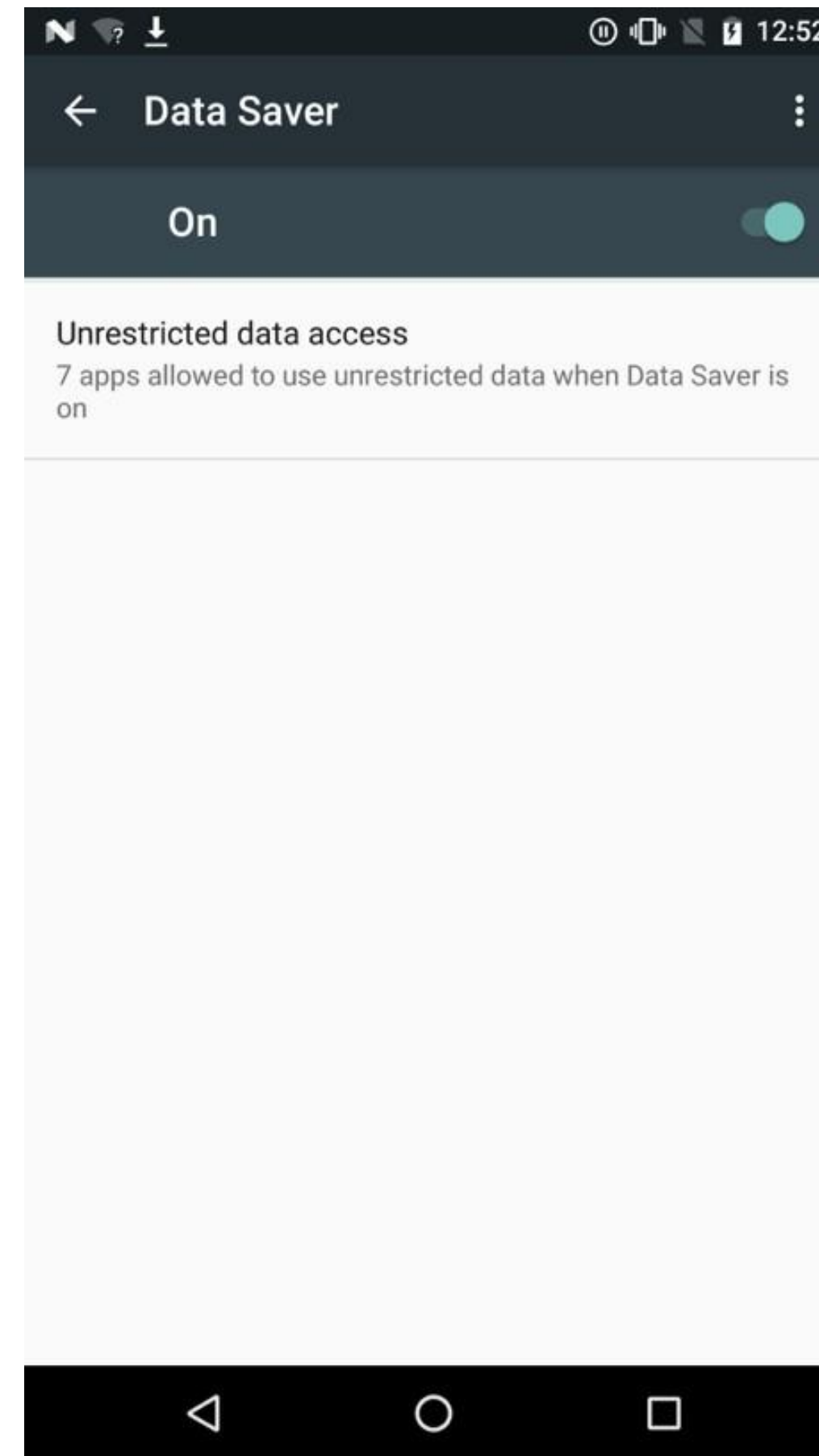
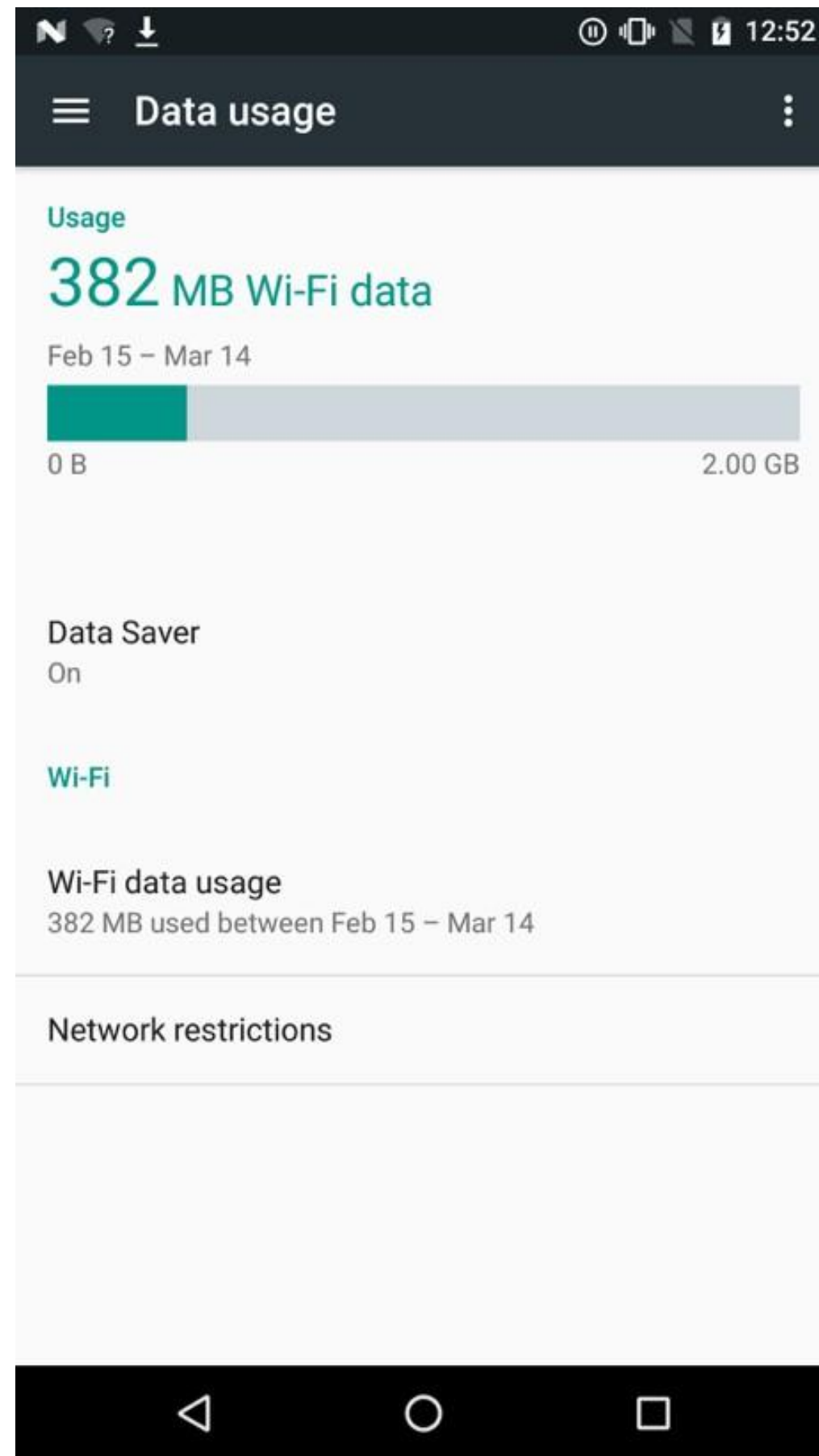
Hello!

Data Saver

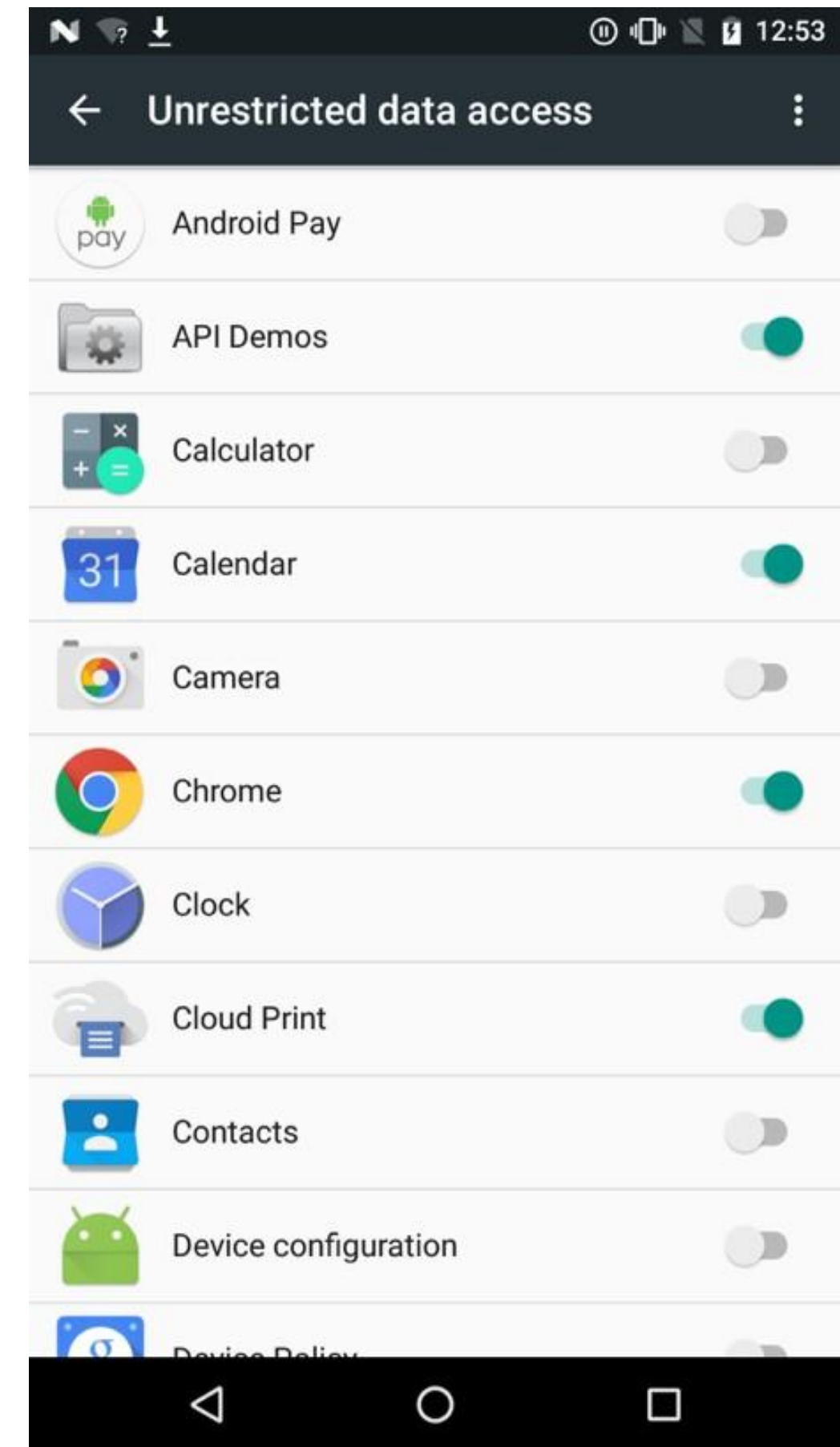
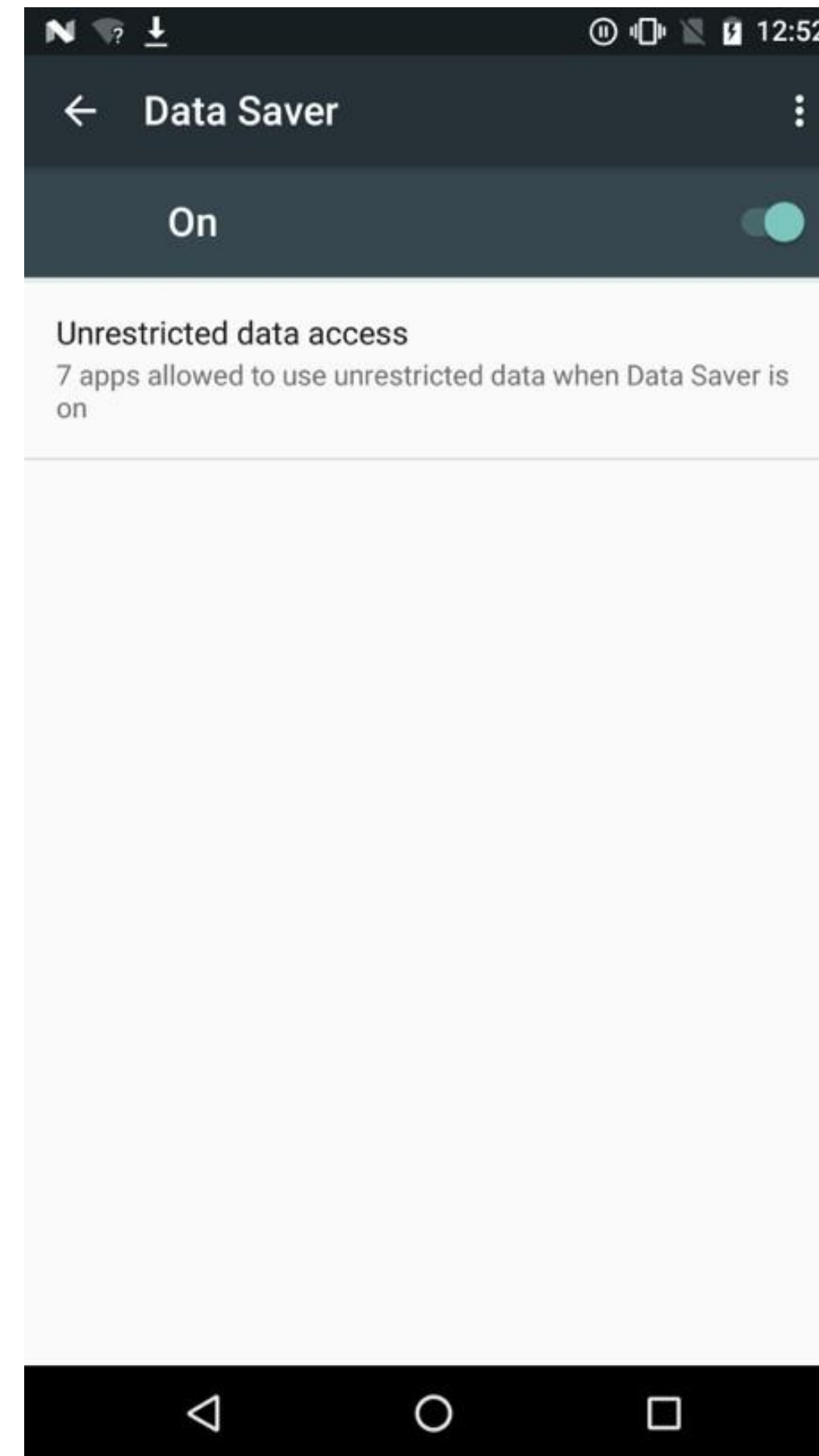
Data Saver



Data Saver



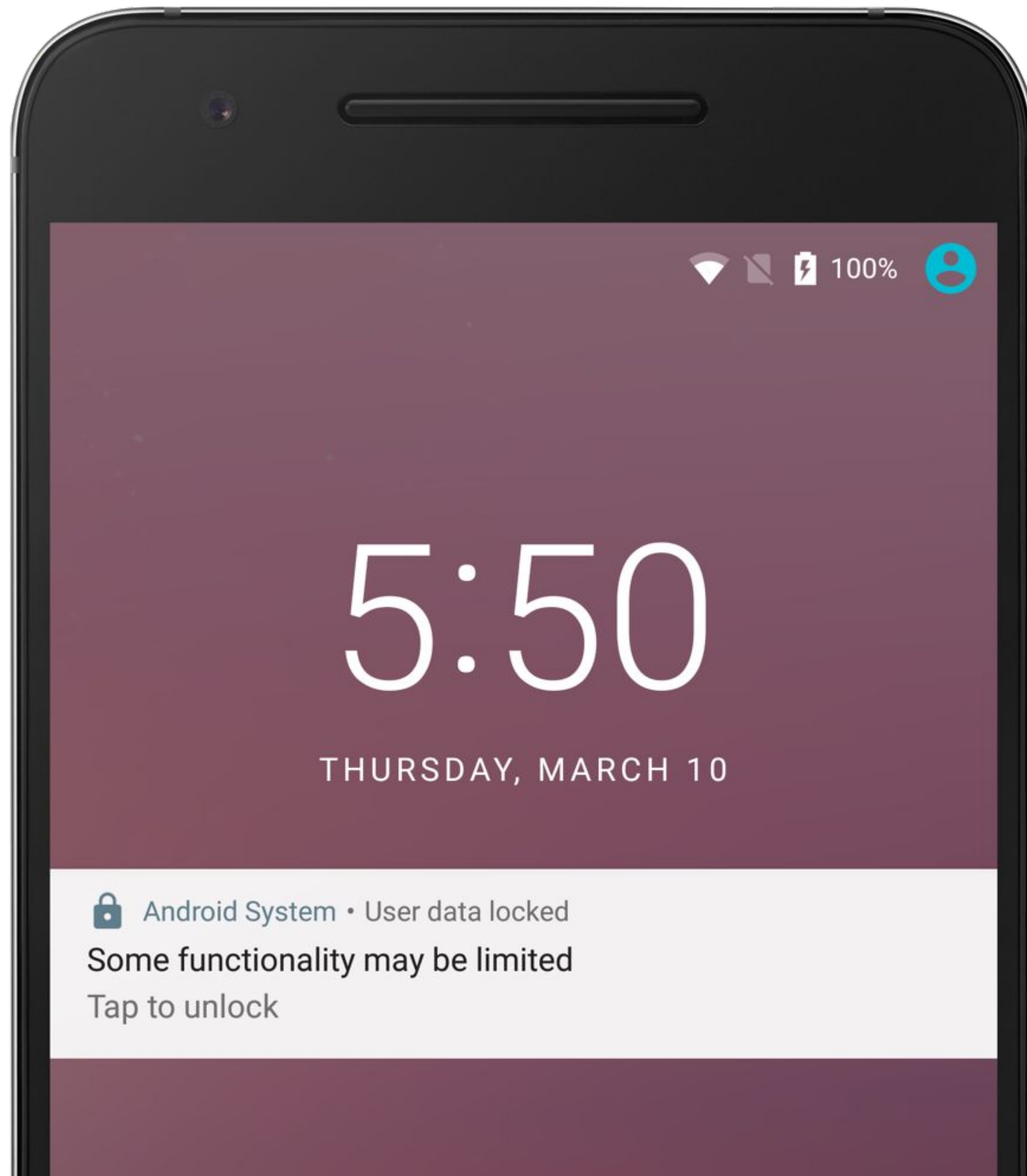
Data Saver



Data Saver

Data Saver

```
ConnectivityManager connMgr = (ConnectivityManager)
    getSystemService(Context.CONNECTIVITY_SERVICE);
if (connMgr.isActiveNetworkMetered()) {
    switch (connMgr.getRestrictBackgroundStatus) {
        case RESTRICT_BACKGROUND_STATUS_ENABLED:
            // bg data blocked, use less data in fg too
            break;
        case RESTRICT_BACKGROUND_STATUS_WHITELISTED:
            // App should limit usage in fg and bg
            break;
        case RESTRICT_BACKGROUND_STATUS_DISABLED:
            // data saver disabled, but still on metered network
            break;
    }
}
```



Direct Boot

- Improves startup time
- Limited app functionality after unexpected reboot

Direct Boot

- Apps must register

```
<receiver android:name=".MyBroadcastReceiver"  
    android:encryptionAware="true">  
    <intent-filter>  
        <action android:name="android.intent.action.LOCKED_BOOT_COMPLETED" />  
    </intent-filter>  
</receiver>
```

- Apps must use device encrypted storage

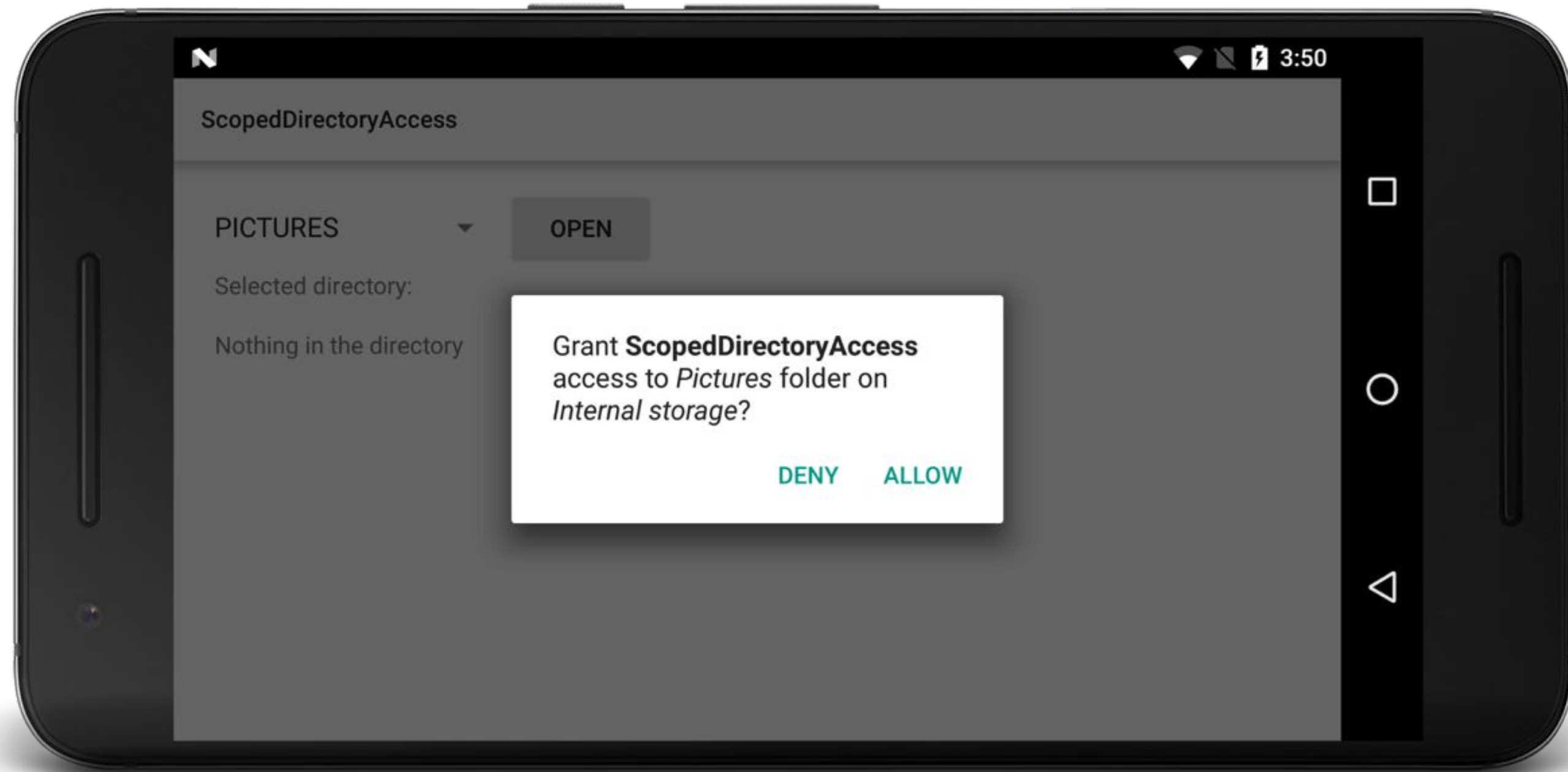
```
Context directBootContext = Context.createDeviceEncryptedStorageContext();  
FileInputStream in = directBootContext.openFileInput(dataFile);  
// Read data...
```

Direct Boot

- Enable Direct Boot on your device
 - *Developer options → Convert to file encryption*
 - This will **wipe your data**
- Use emulated Direct Boot

```
$ adb shell sm set-emulate-fbe true
```


Scoped Directory Access



Scoped Directory Access

```
StorageManager sm = (StorageManager) getSystemService(Context.STORAGE_SERVICE);
StorageVolume volume = sm.getPrimaryVolume();
Intent intent = volume.createAccessIntent(Environment.DIRECTORY_PICTURES);
startActivityForResult(intent, REQUEST_CODE);
```

```
@Override
public void onActivityResult(int requestCode, int resultCode, Intent data) {
    if (requestCode == REQUEST_CODE && resultCode == Activity.RESULT_OK) {
        ContentResolver cr = getActivity().getContentResolver();
        cr.takePersistableUriPermission(data.getData(),
            Intent.FLAG_GRANT_READ_URI_PERMISSION |
            Intent.FLAG_GRANT_WRITE_URI_PERMISSION);
        // Access directory with data.getData()
    }
}
```

Scoped Directory Access

```
StorageManager sm = (StorageManager) getSystemService(Context.STORAGE_SERVICE);  
StorageVolume volume = sm.getPrimaryVolume();  
Intent intent = volume.createAccessIntent(Environment.DIRECTORY_PICTURES);  
startActivityForResult(intent, REQUEST_CODE);
```

```
@Override  
public void onActivityResult(int requestCode, int resultCode, Intent data) {  
    if (requestCode == REQUEST_CODE && resultCode == Activity.RESULT_OK) {  
        ContentResolver cr = getActivity().getContentResolver();  
        cr.takePersistableUriPermission(data.getData(),  
            Intent.FLAG_GRANT_READ_URI_PERMISSION |  
            Intent.FLAG_GRANT_WRITE_URI_PERMISSION);  
        // Access directory with data.getData()  
    }  
}
```

VectorDrawable Performance

- Low-level performance improvements in N Preview
 - For both loading and rendering
- Inflation: ~20-80% Path
- parsing: ~80-90% First draw:
- ~40-45%
- Path morphing (AVD): ~30-90%

Developer Features

Runtime

- Faster interpreter
- JIT
 - Faster install times
 - Less space consumed on device
- Apps use partial AOT
 - Only for hotspots

Java 8 Language Features

- Require the Jack toolchain

```
android {  
    defaultConfig {  
        ...  
        jackOptions {  
            enabled true  
        }  
    }  
    compileOptions {  
        sourceCompatibility JavaVersion.VERSION_1_8  
        targetCompatibility JavaVersion.VERSION_1_8  
    }  
}
```

Lambdas

- Implemented using anonymous class
- Backward compatible with Gingerbread

```
Vertex[] v = new Vertex[100];  
// ...
```

```
Arrays.sort(v, (Vertex v1, Vertex v2) -> {  
    return v1.length() - v2.length();  
});
```

```
Arrays.sort(v, (v1, v2) -> v1.length() - v2.length());  
Arrays.sort(v, VertexFactory::compareVertices);
```

Default & Static Interface Methods

- Not backward compatible

```
public interface Renderable {  
    void draw(Canvas  
             c);  
    default bool isHardwareAccelerated() {  
        return false;  
    }  
  
    static int getMaxTextureSize() { return 2048; }  
}
```

```
public interface FrameListener {  
    default void onFrameStarted() { }  
    default void onFrameEnded() { }  
}
```

Repeating annotations

- Not backward compatible

```
@Repeatable(Exportables.class)
public @interface Exportable {
    String format() default "JSON";
}

public @interface Exportables {
    Exportable[] values();
}

@Exportable(format="JSON")
@Exportable(format="XML")
public class MyClass {
    // ...
}
```

Audio Latency

- Previous releases reduced native latency
- Low latency `AudioTrack` (40-70ms reduction)

```
AudioAttributes attributes = new AudioAttributes.Builder()  
    .setFlags(AudioAttributes.FLAG_LOW_LATENCY)  
    .setContentType(AudioAttributes.CONTENT_TYPE_MUSIC)  
    .build();
```

- Dynamic resize of `AudioTrack`
- buffers Underruns query

OpenGL ES 3.2

- GLES 3.1 + Android extension pack
 - Except EXT_texture_sRGB_decode
- Advanced blending equations
- Tessellation shaders
- Geometry shaders
- ASTC (LDR)
- Image atomics
- Floating point framebuffers

Vulkan

- Low-level, low-overhead, cross-platform 3D API
- Asynchronous/multithreaded command generation
- Intermediate shader binary format (SPIR-V)
- Offline shaders compilation Object-based API, no
- global state
- Explicit memory management and synchronization
- No error checking
- Not available in the preview SDK yet

adb shell

- Returns remote process exit status
- Pass-through `stdin`

```
$ cat README | adb shell wc -l
```

- Handles window size and terminal type
- Improved command line tools (`ls`, etc.)

New Developer Options

- HDCP checking
- Force activities to be resizable
- Enable multiprocess WebView
- Convert to file encryption

Improved Memory Analysis

- Heap dumps include stack traces
 - Allocation tracking must be turned on

```
$ adb shell am -track-allocation ...
```

- Native allocations tracking
- ahat

ICU4J

- Unicode and globalization support
- Subset exposed in `android.icu`
 - Avoids conflicts with `com.ibm.icu`
 - Deprecated and unstable APIs omitted
- Recommended over equivalent framework APIs
 - `java.text.BreakIterator` **vs**
`android.icu.text.BreakIterator`

NDK

- Clang 3.8
- GCC 4.9
- Switch to clang, GCC is deprecated!
- ARM toolchains default to arm7 arch

Support Library

d.android.com/tools/support-library

Support Library

- 23.2

d.android.com/tools/support-library

Support Library

- 23.2
 - Night Mode

d.android.com/tools/support-library

Support Library

- 23.2
 - Night Mode
 - Bottom Sheets

d.android.com/tools/support-library

Support Library

- 23.2
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 - VectorDrawable / AnimatedVectorDrawable
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 - RecyclerView AutoMeasure
 -

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Support Library

- 23.2
 - Night Mode Bottom Sheets
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- 23.1

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Support Library

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- 23.1
 - RecyclerView improved item change animations

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