Lecture #8
System Services & Sensors

Mobile Applications 2019-2020

Background Tasks

- Sending logs or tracking user progress.
- Upload images, videos or session data.
- Synching data.
- Processing data.

Options

Options

- Threads
- Executors
- Services
- AsyncTasks
- Handlers and Loopers
- Coroutines

- Jobs (API 21+)
- GcmNetworkManager
- SyncAdapters
- Loaders
- AlarmManager
- WorkManager

Battery Optimizations

Battery Optimizations

- Doze mode
- App standby

Battery Optimizations

- Doze mode
- App standby

- Limited implicit broadcasts

Battery Optimizations

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- Release cached wakelocks
- Background service limitations

Battery Optimizations

- Limited implicit broadcasts

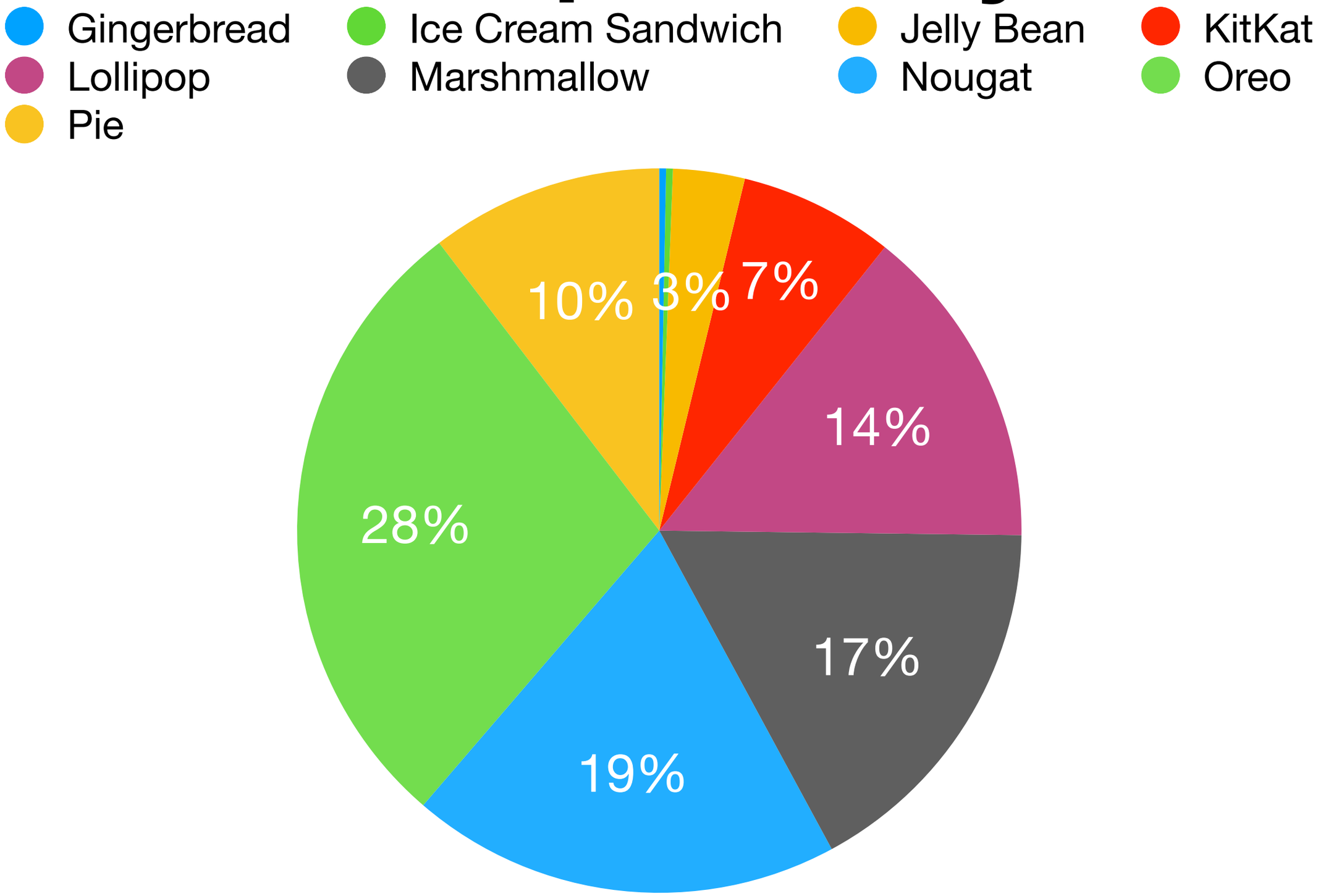
- Release cached wakelocks
- Background service limitations

- App standby buckets
- Background restricted apps

Compatibility

https://developer.android.com/about/dashboards/ (May 7th, 2019)

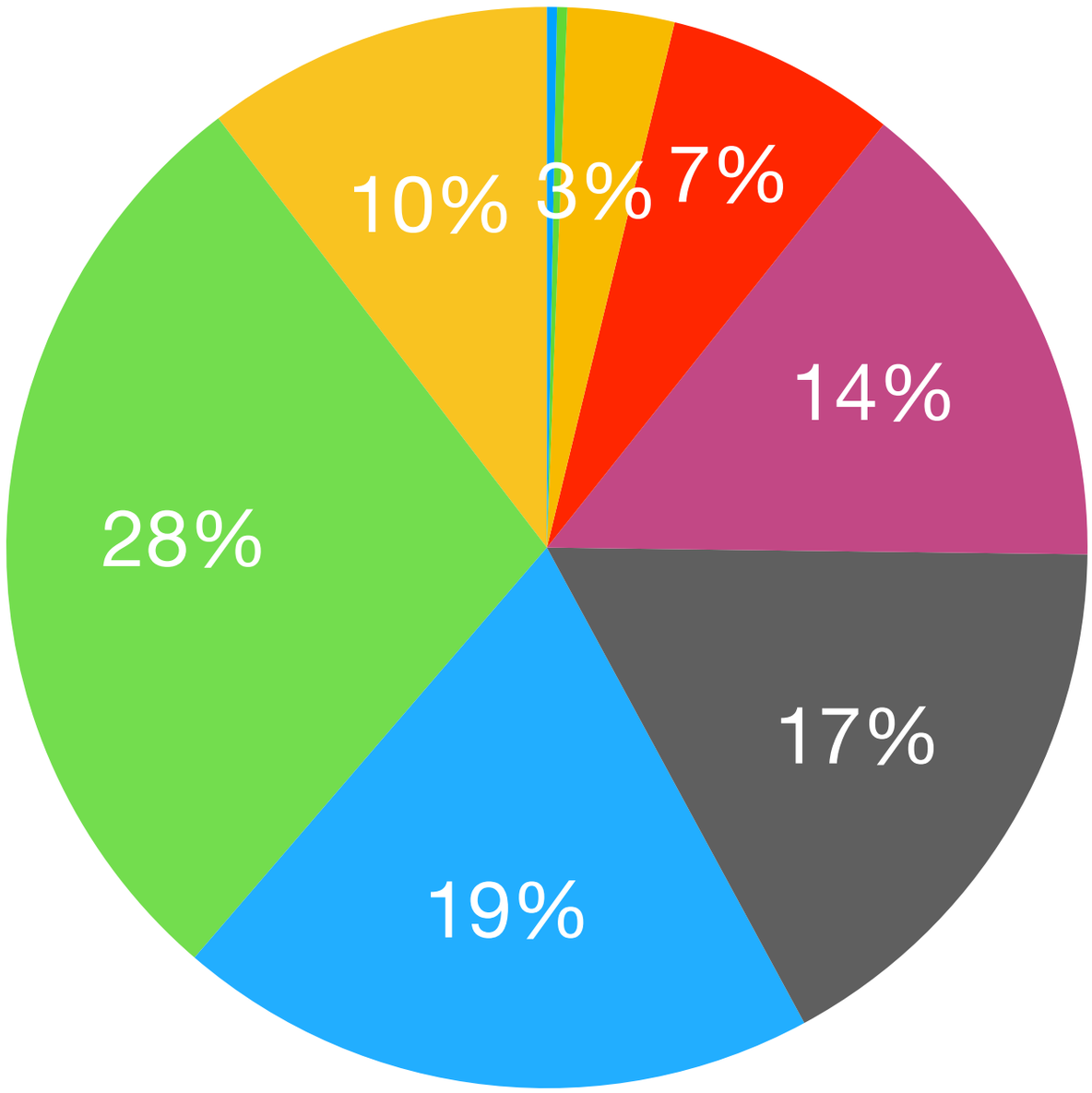
Compatibility



https://developer.android.com/about/dashboards/ (May 7th, 2019)

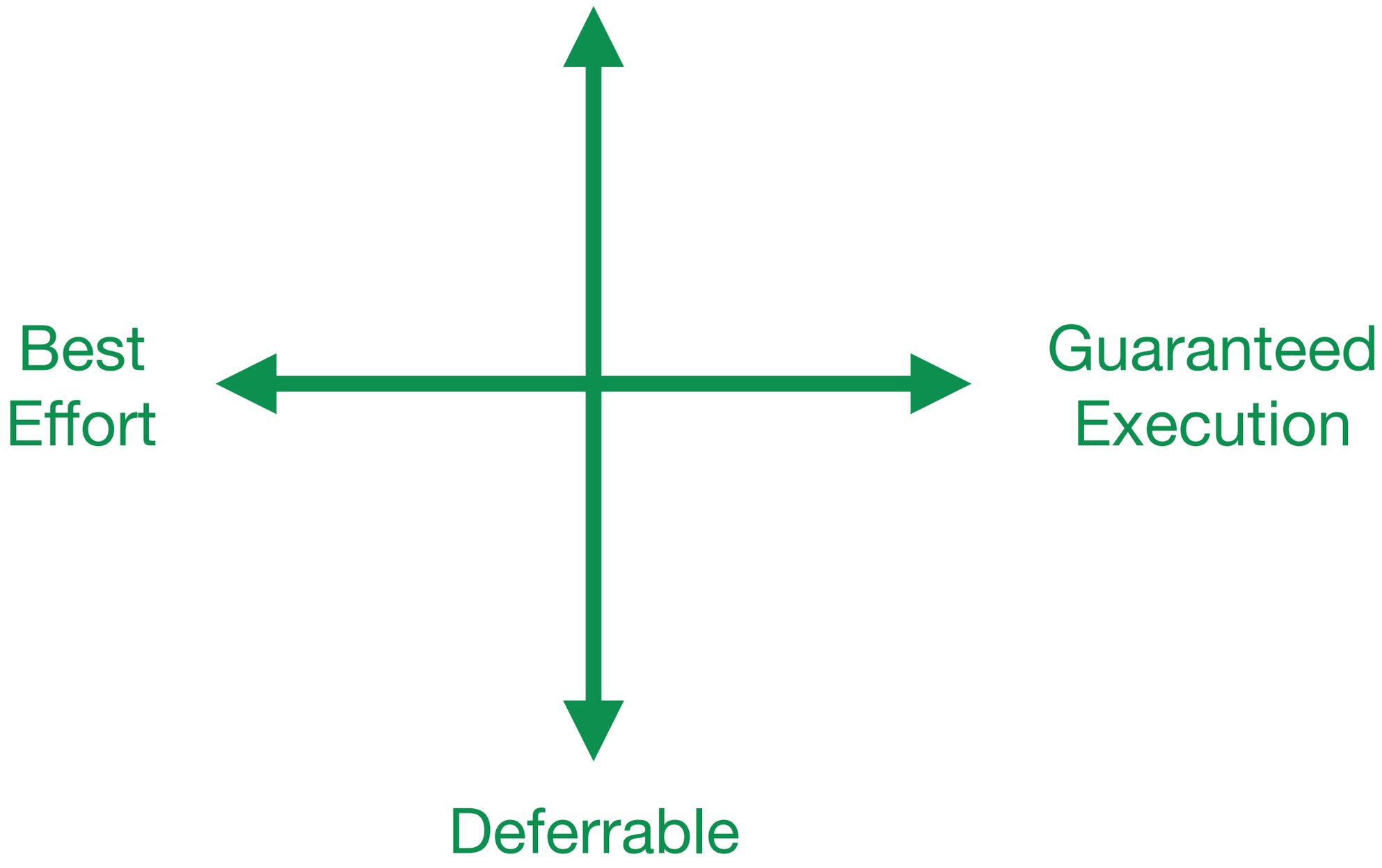
Compatibility

Gingerbread
Ice Cream Sandwich
Jelly Bean
KitKat
Lollipop
Marshmallow
Nougat
Oreo
Pie

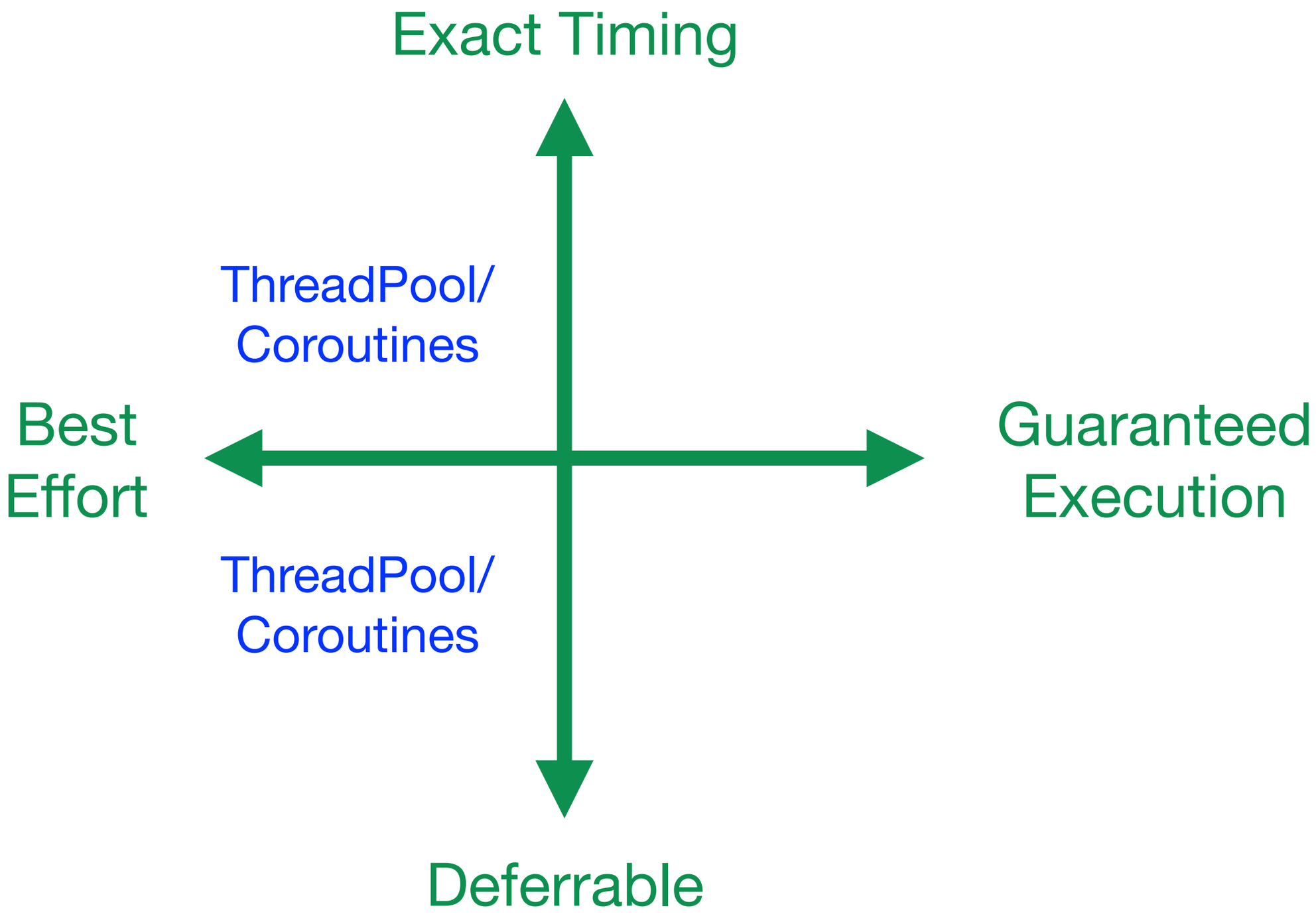


https://developer.android.com/about/dashboards/ (May 7th, 2019)

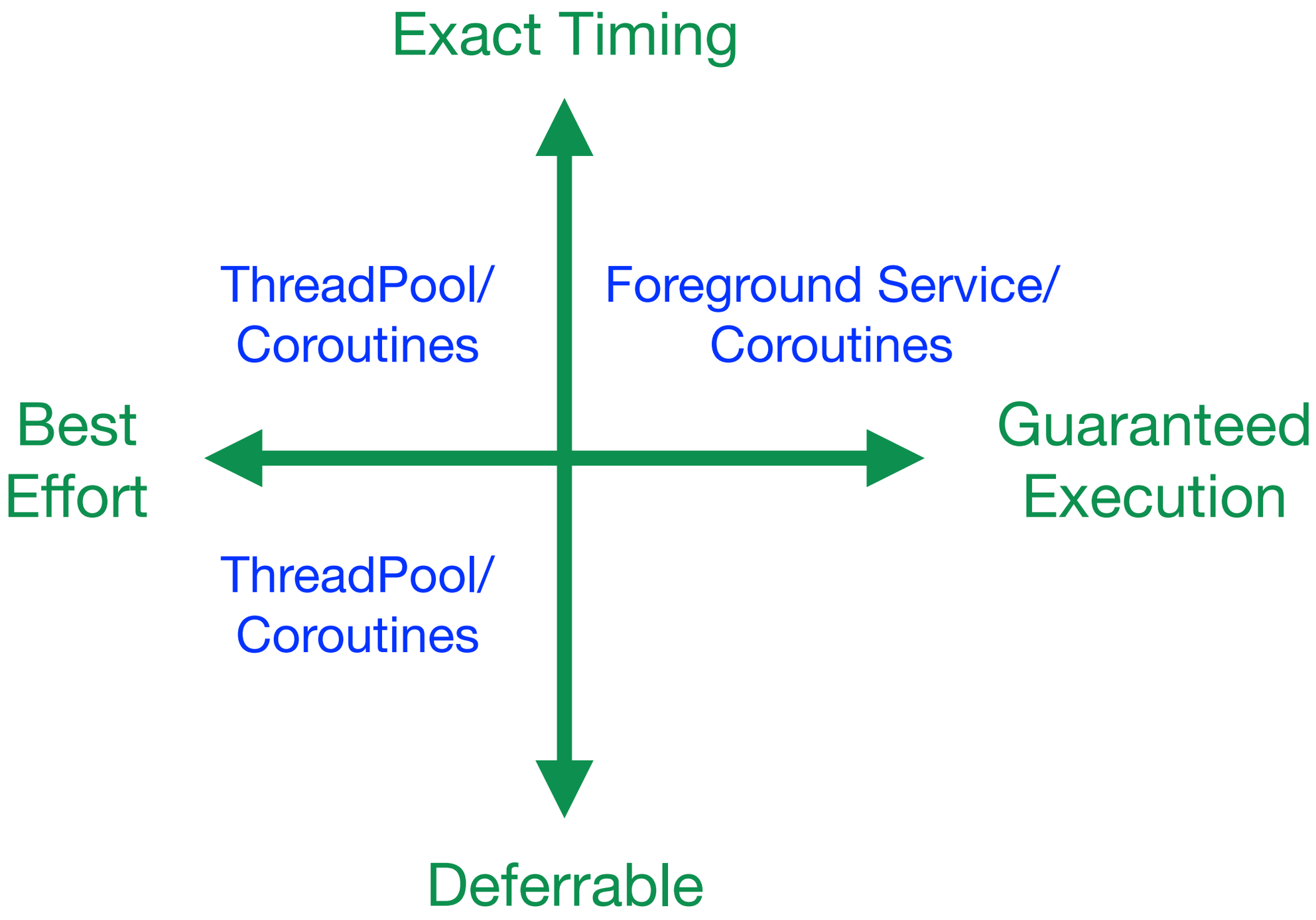
Requirements



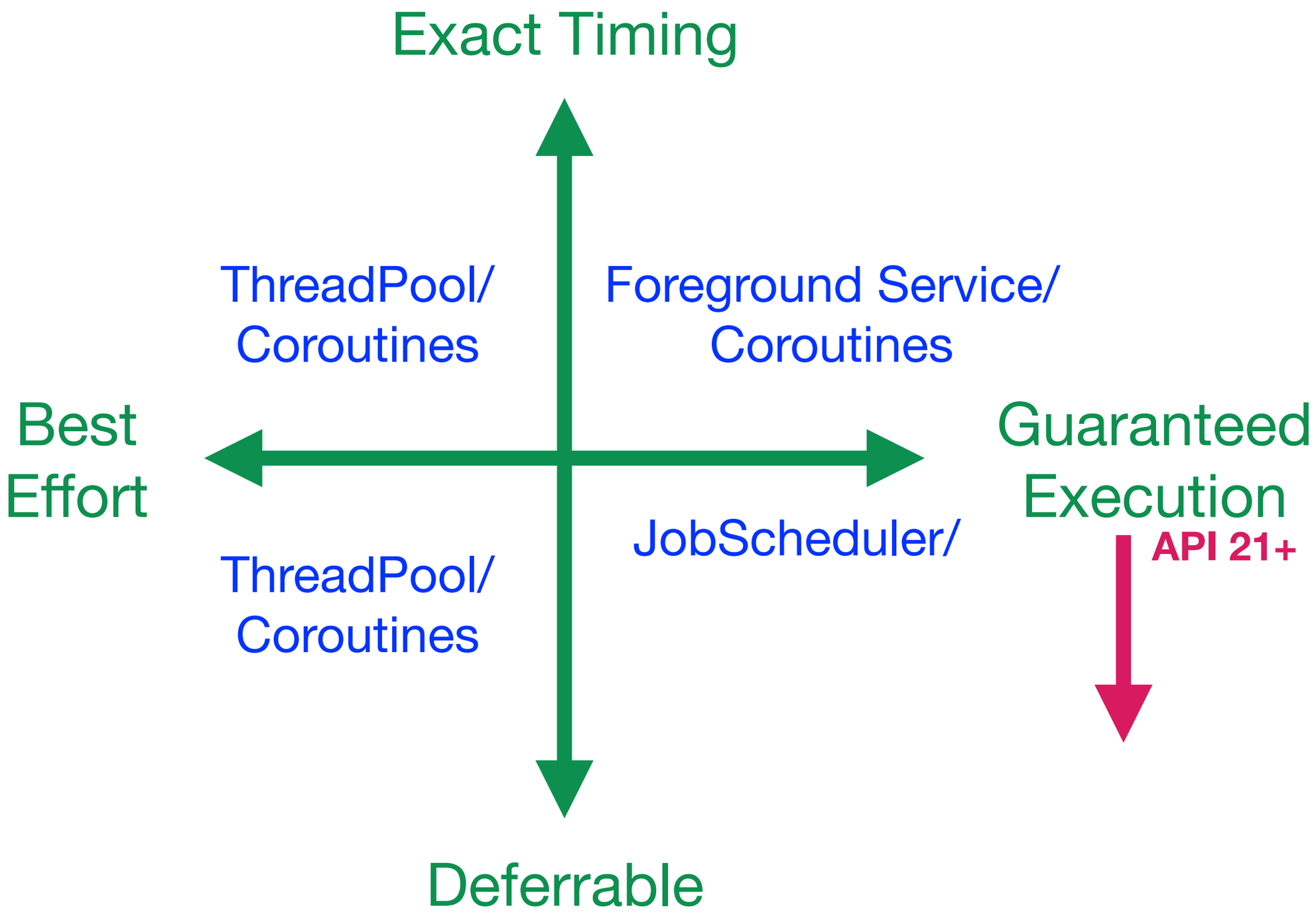
Requirements



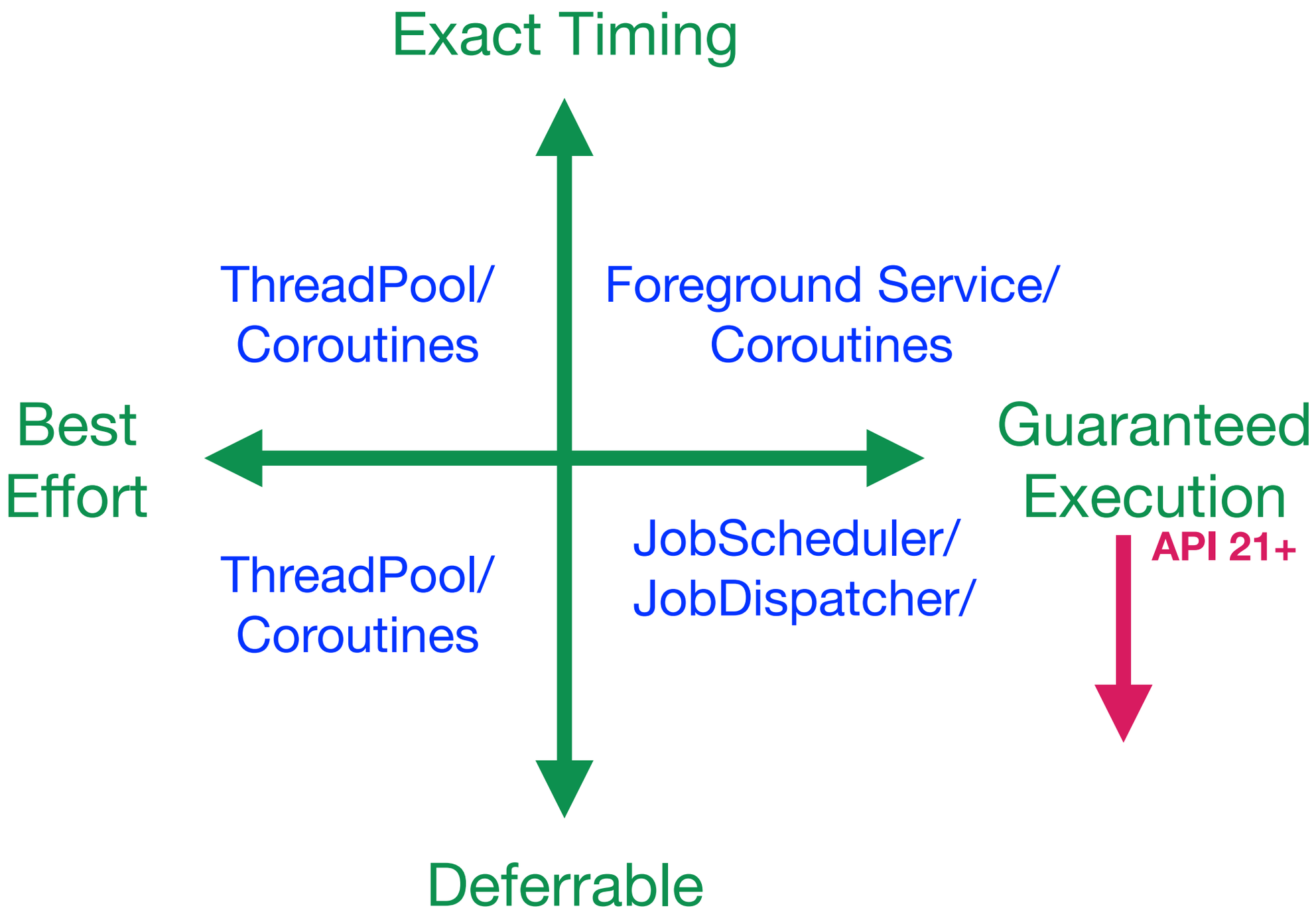
Requirements



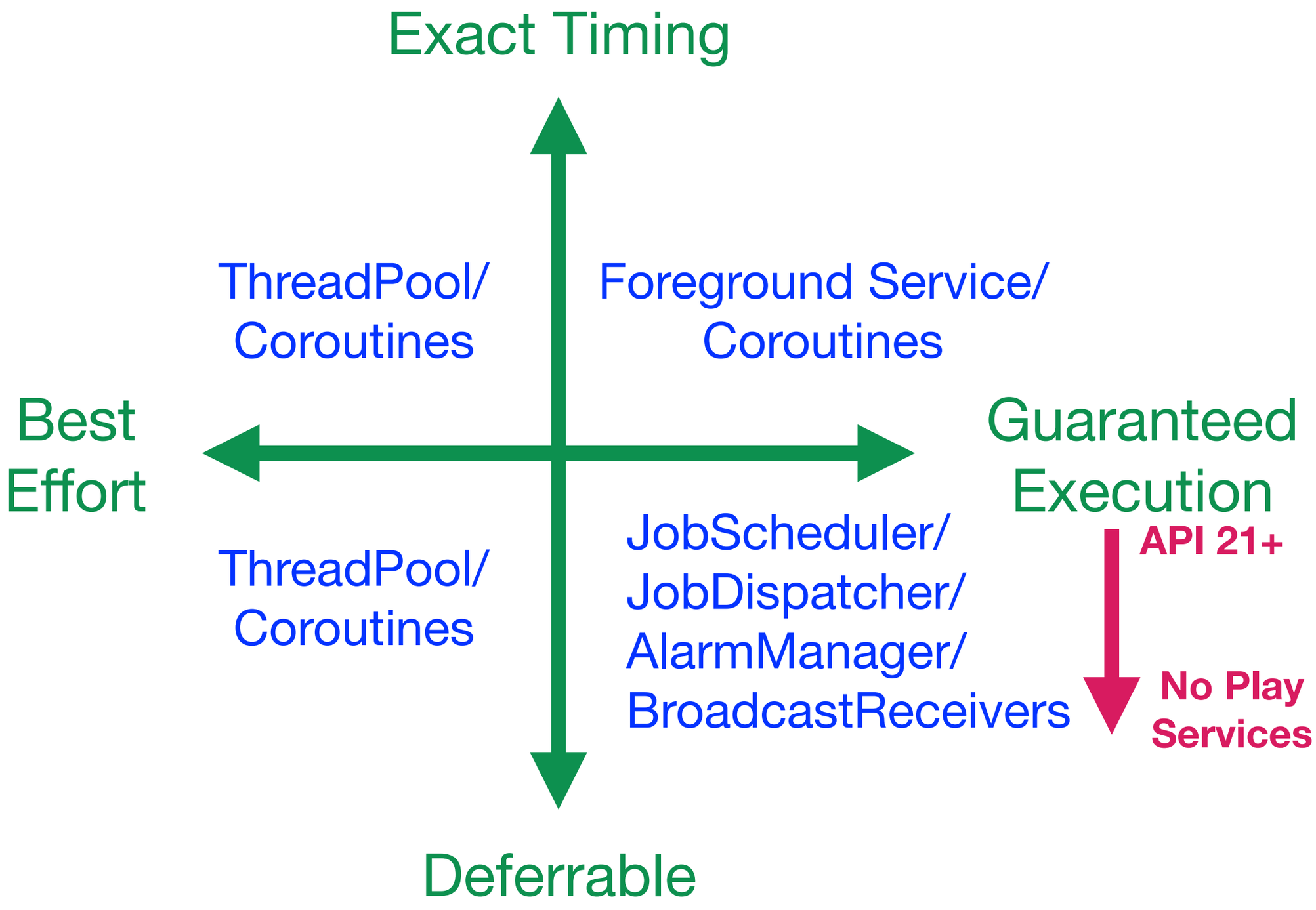
Requirements



Requirements



Requirements



Requirements

Exact Timing

ThreadPool/
Coroutines

Foreground Service/
Coroutines

Best
Effort

Guaranteed
Execution

ThreadPool/
Coroutines

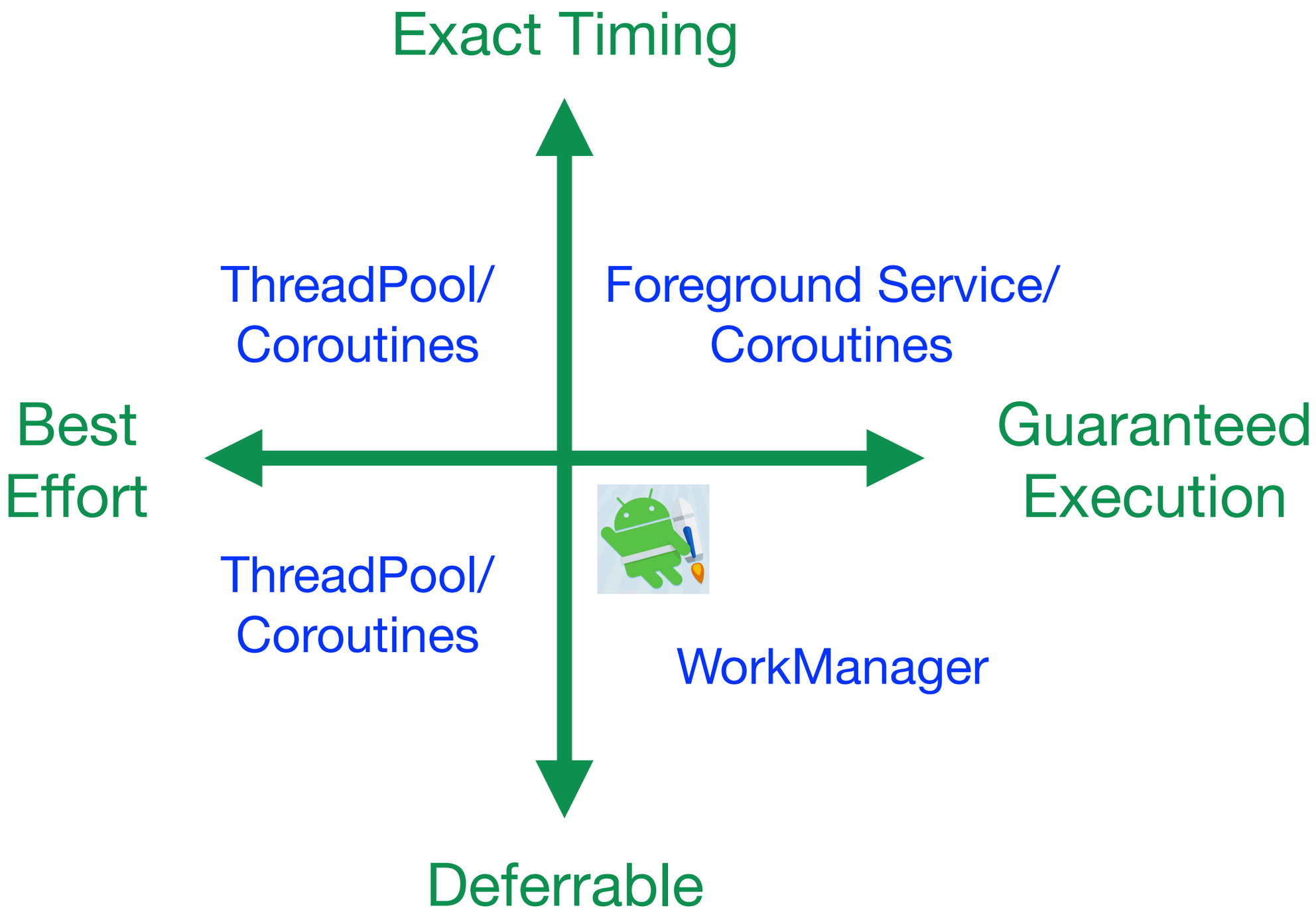
JobScheduler/
JobD
Alarm
Broa

API 21+

No Play
Services

Deferrable

Requirements



Services

- Perform long-running operations in the background.
- It does not provide a user interface.
- Continues to run even is the user switches to another application.
- Eg.:
  - Network transactions.
  - Play music.
  - Perform I/O.
  - Use a content provider.

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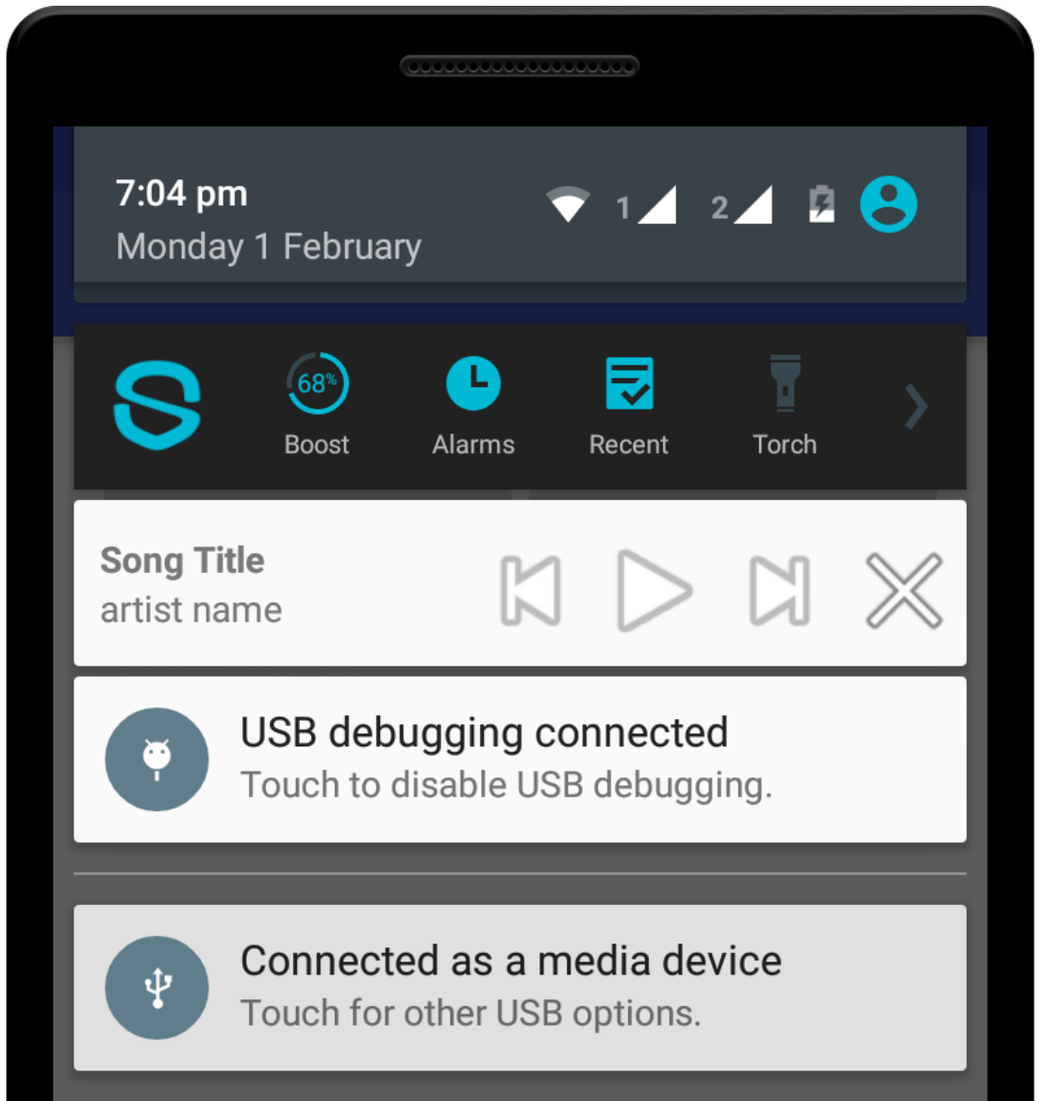
Services

Services

- Types:
  - Foreground

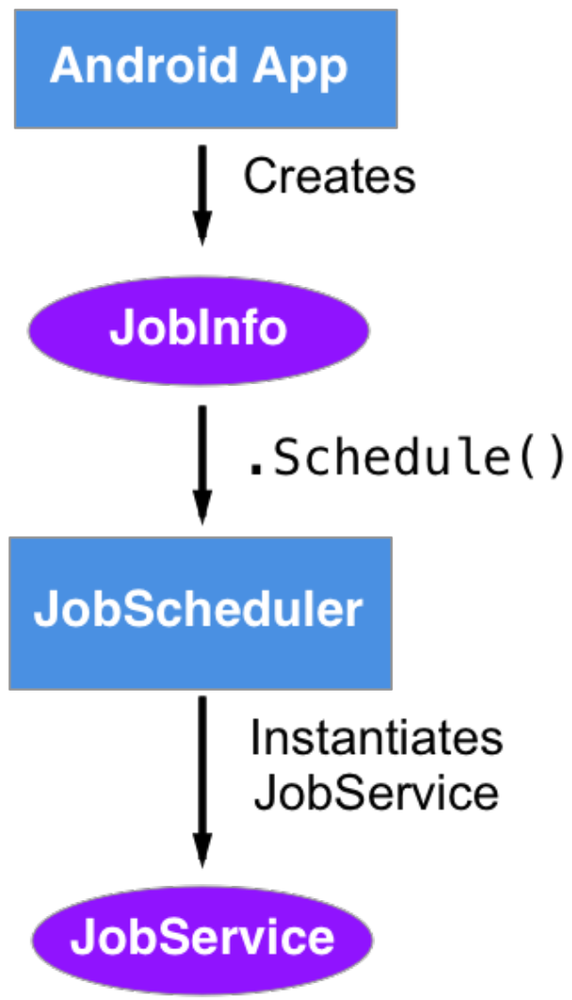
Performs some operation that is noticeable to the user.



Services

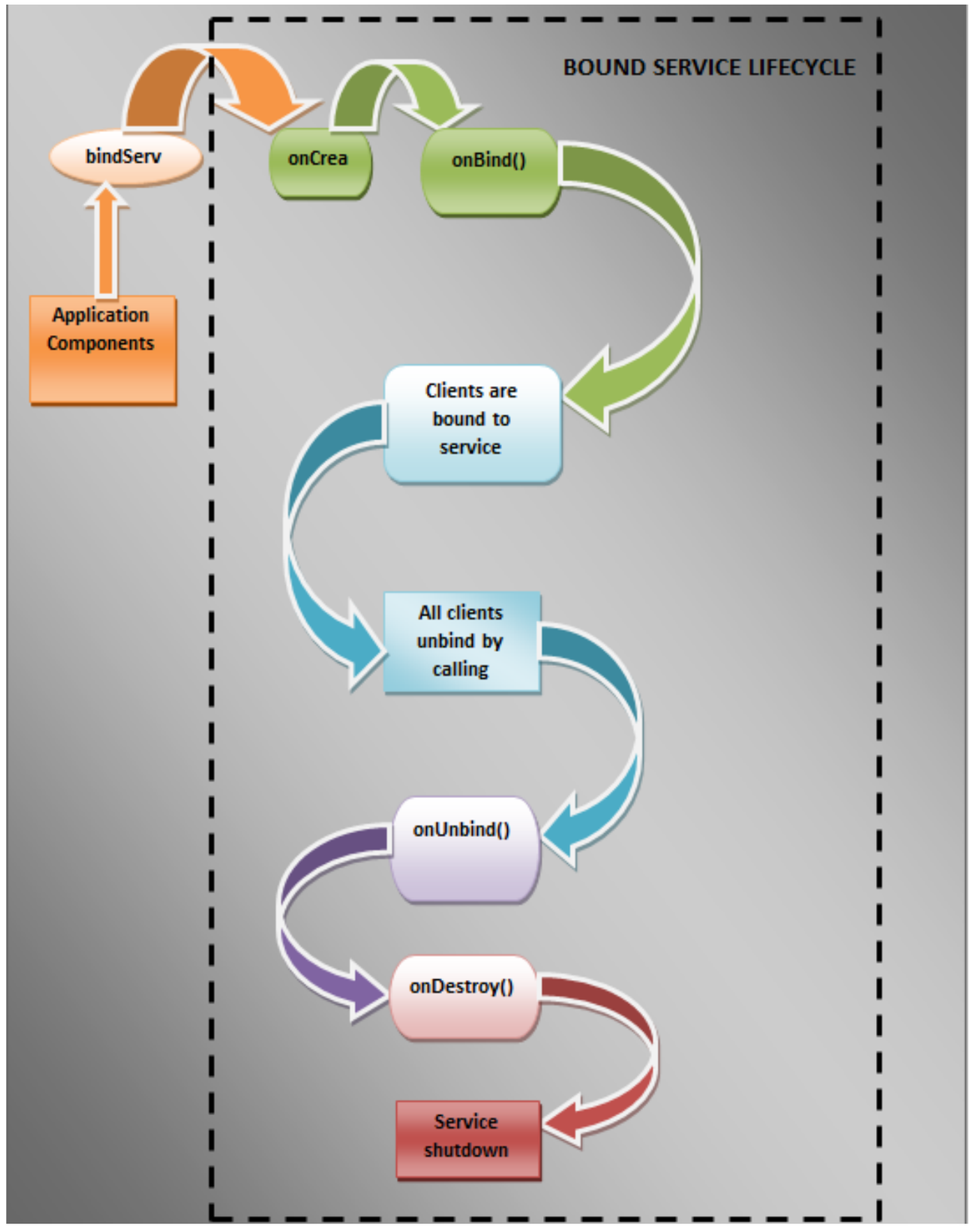
- Types:
  - Foreground
  - Background

Performs an operation that isn't directly noticed by the user.



Services

- Types:
  - Foreground
  - Background
  - Bound



Basics

https://developer.android.com/guide/components/services

Basics

- onStartCommand()

The system invokes this method by calling `startService()` when another component (such as an activity) requests that the service be started.

When this method executes, the service is started and can run in the background indefinitely.

If you implement this, it is your responsibility to stop the service when its work is complete by calling `stopSelf()` or `stopService()`.

If you only want to provide binding, you don't need to implement this method.

https://developer.android.com/guide/components/services

Basics

- onStartCommand()
- onBind()

The system invokes this method by calling `bindService()` when another component wants to bind with the service (such as to perform RPC).

In your implementation of this method, you must provide an interface that clients use to communicate with the service by returning an `IBinder`.

You must always implement this method; however, if you don't want to allow binding, you should return null.

https://developer.android.com/guide/components/services

Basics

- onStartCommand()
- onBind()
- onCreate()

The system invokes this method to perform one-time setup procedures when the service is initially created (before it calls either `onStartCommand()` or `onBind()`).

If the service is already running, this method is not called.

https://developer.android.com/guide/components/services

Basics

- onStartCommand()
- onBind()
- onCreate()
- onDestroy()

The system invokes this method when the service is no longer used and is being destroyed.

Your service should implement this to clean up any resources such as threads, registered listeners, or receivers.

This is the last call that the service receives.

https://developer.android.com/guide/components/services

Declaring a service in the manifest

```
<manifest ... >
  ...
  <application ... >
      <service android:name=".ExampleService" />
      ...
  </application>
</manifest>
```

https://developer.android.com/guide/topics/manifest/service-element

Declaring a service in the manifest

```
<manifest ... >
  ...
  <application ... >
      <service android:name=".ExampleService"
          android:description="Service Description"
      />
      ...
  </application>
</manifest>
```

https://developer.android.com/guide/topics/manifest/service-element

Creating a Service

- Service
  - Base class for all services.
  - Create and manage a new thread on your own.

```
class HelloService : Service() {
  private var mServiceLooper: Looper? = null
  private var mServiceHandler: ServiceHandler? =

  // Handler that receives messages from the thr
  private inner class ServiceHandler(looper: Loo
    override fun handleMessage(msg: Message) {
      // Normally we would do some work here, li
      // For our sample, we just sleep for 5 sec
      try {
        Thread.sleep(5000)
      } catch (e: InterruptedException) {
        // Restore interrupt status.
        Thread.currentThread().interrupt()
      }
      // Stop the service using the startId, so
      // the service in the middle of handling a
      stopSelf(msg.arg1)
    }
}
override fun onCreate() {
 // Start up the thread running the service.
 // separate thread because the service normal
 // main thread, which we don't want to block.
```

```
class HelloService : Service() {
  private var mServiceLooper: Looper? = null
  private var mServiceHandler: ServiceHandler? = null

  // Handler that receives messages from the thread
  private inner class ServiceHandler(looper: Looper) : Handler(looper) {
    override fun handleMessage(msg: Message) {
      // Normally we would do some work here, like download a file.
      // For our sample, we just sleep for 5 seconds.
      try {
        Thread.sleep(5000)
      } catch (e: InterruptedException) {
        // Restore interrupt status.
        Thread.currentThread().interrupt()
      }
      // Stop the service using the startId, so that we don't stop
      // the service in the middle of handling another job
      stopSelf(msg.arg1)
    }
  }
}
override fun onCreate() {
 // Start up the thread running the service.  Note that we create a
 // separate thread because the service normally runs in the process's
 // main thread, which we don't want to block.  We also make it
 // background priority so CPU-intensive work will not disrupt our UI.
 HandlerThread("ServiceStartArguments",
     Process.THREAD_PRIORITY_BACKGROUND).apply {
   start()
   // Get the HandlerThread's Looper and use it for our Handler
   mServiceLooper = looper
   mServiceHandler = ServiceHandler(looper)
```

```
        // separate thread because the service normally runs in the process's
        // main thread, which we don't want to block.  We also make it
        // background priority so CPU-intensive work will not disrupt our UI.
        HandlerThread("ServiceStartArguments",
                Process.THREAD_PRIORITY_BACKGROUND).apply {
            start()
            // Get the HandlerThread's Looper and use it for our Handler
            mServiceLooper = looper
            mServiceHandler = ServiceHandler(looper)
        }
    }
    override fun onStartCommand(intent: Intent, flags: Int, startId: Int): Int {
        Toast.makeText(this, "service starting", Toast.LENGTH_SHORT).show()
        // For each start request, send a message to start a job and deliver the
        // start ID so we know which request we're stopping when we finish the job
        mServiceHandler?.obtainMessage()?.also { msg ->
            msg.arg1 = startId
            mServiceHandler?.sendMessage(msg)
        }
        // If we get killed, after returning from here, restart
        return START_STICKY
    }

    override fun onBind(intent: Intent): IBinder? {
        // We don't provide binding, so return null
        return null
    }
    override fun onDestroy() {
        Toast.makeText(this, "service done", Toast.LENGTH_SHORT).show()
    }
}
```

Creating a Service

- Service
  - Base class for all services.
  - Create and manage a new thread on your own.

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class HelloService : Service() {
  private var mServiceLooper: Looper? = null
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  // Handler that receives messages from the thr
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    override fun handleMessage(msg: Message) {
      // Normally we would do some work here, li
      // For our sample, we just sleep for 5 sec
      try {
        Thread.sleep(5000)
      } catch (e: InterruptedException) {
        // Restore interrupt status.
        Thread.currentThread().interrupt()
      }
      // Stop the service using the startId, so
      // the service in the middle of handling a
      stopSelf(msg.arg1)
    }
}
override fun onCreate() {
 // Start up the thread running the service.
 // separate thread because the service normal
 // main thread, which we don't want to block.
```

Creating a Service

- Service
  - Base class for all services.
  - Create and manage a new thread on your own.
- IntendService
  - Subclass or Service.
  - Uses a worker thread.
  - Implement onHandleIntent()

```
/**
 * A constructor is required
 * with a name for the worker thread.
 */
class HelloIntentService :
  IntentService("HelloIntentService") {
 /**
  * The IntentService calls this method
  * from the default worker thread with
  * the intent that started the service.
  * When this method returns, IntentService
  * stops the service, as appropriate.
  */
  override fun onHandleIntent(intent: Intent?) {
    try {
      Thread.sleep(5000)
    } catch (e: InterruptedException) {
      // Restore interrupt status.
      Thread.currentThread().interrupt()
    }
  }
}
```

Service Management

Service Management

- Starting a service

```
Intent(this, HelloService::class.java).also {
  intent -> startService(intent)
}
```

Service Management

- Starting a service
- Stopping a service

```
stopService()
// or
stopSelf()
```

Notify the User

Notify the User

- Toast Notifications

```
val text = "Hello toast!"
val duration = Toast.LENGTH_SHORT

val toast = Toast.makeText(applicationContext, text, duration)
toast.show()
```

Notify the User

- Toast Notifications
- Status Bar Notifications

```
val pendingIntent: PendingIntent =
 Intent(this, ExampleActivity::class.java).let { notificationIntent ->
  PendingIntent.getActivity(this, 0, notificationIntent, 0)
 }

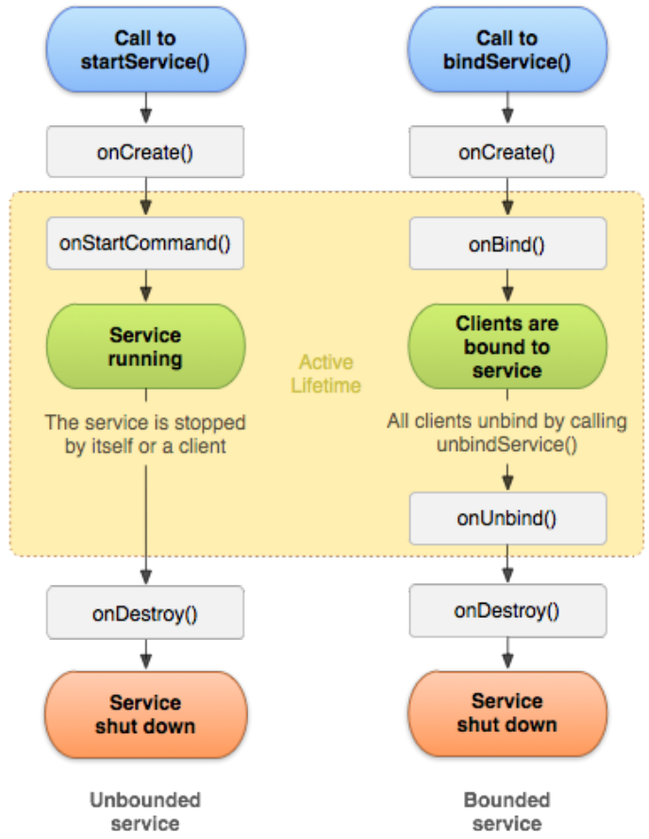
val notification: Notification = Notification.Builder(this,
  CHANNEL_DEFAULT_IMPORTANCE)
 .setContentTitle(getText(R.string.notification_title))
 .setContentText(getText(R.string.notification_message))
 .setSmallIcon(R.drawable.icon)
 .setContentIntent(pendingIntent)
 .setTicker(getText(R.string.ticker_text))
 .build()

startForeground(ONGOING_NOTIFICATION_ID, notification)
```

Service Lifecycle

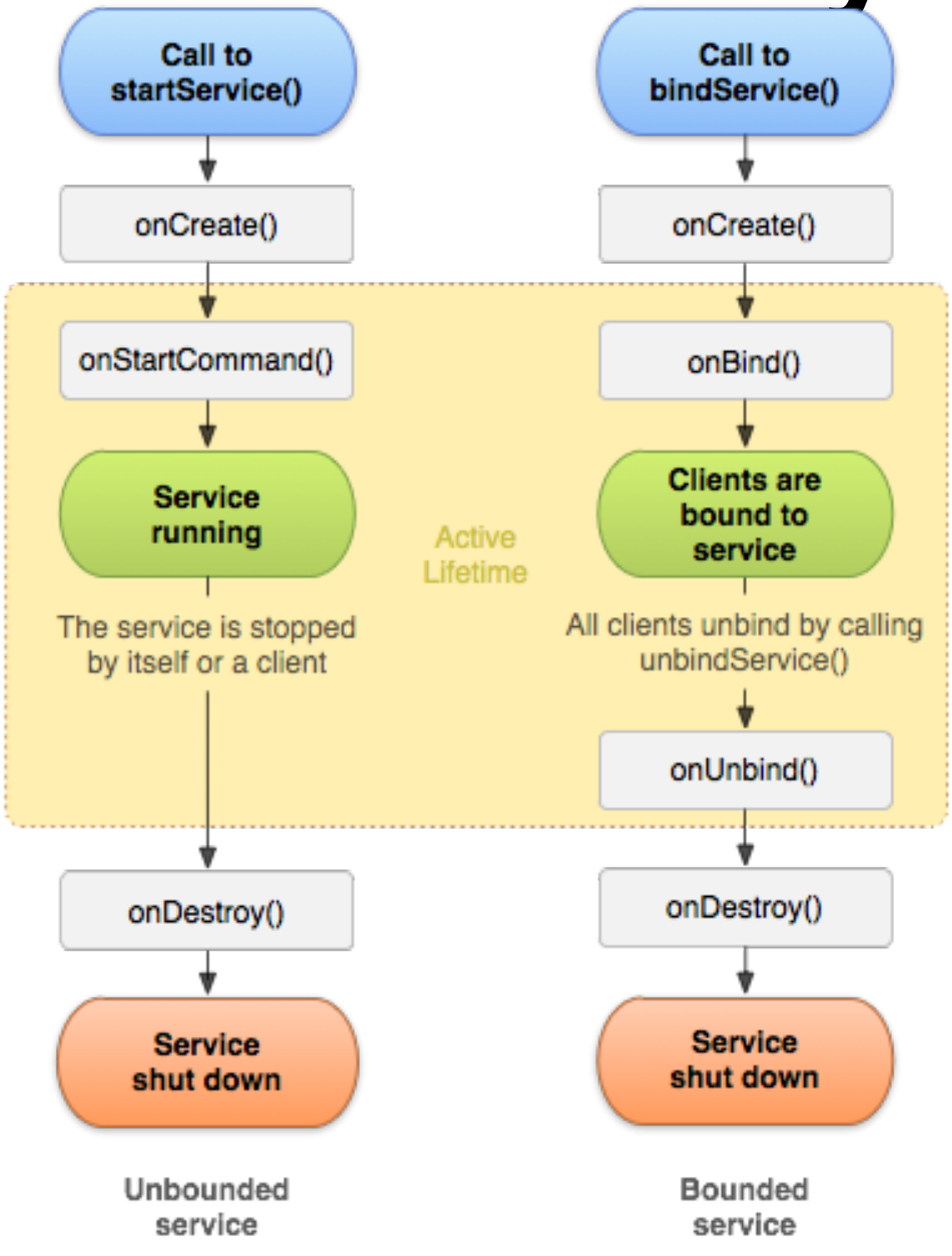
```
class ExampleService : Service() {
 private var mStartMode: Int = 0 // how to behave if the service is killed
 private var mBinder: IBinder? = null // interface for clients that bind
 private var mAllowRebind: Boolean = false // whether onRebind should be used

 override fun onCreate() {
  // The service is being created
 }
 override fun onStartCommand(intent: Intent?, flags: Int, startId: Int): Int {
  // The service is starting, due to a call to startService()
  return mStartMode
 }
 override fun onBind(intent: Intent): IBinder? {
  // A client is binding to the service with bindService()
  return mBinder
 }
 override fun onUnbind(intent: Intent): Boolean {
  // All clients have unbound with unbindService()
  return mAllowRebind
 }
 override fun onRebind(intent: Intent) {
  // A client is binding to the service with bindService(),
  // after onUnbind() has already been called
 }
 override fun onDestroy() {
  // The service is no longer used and is being destroyed
 }
}
```



Service Lifecycle

DEMO



Alarm Manager

- Alarm types:
  - ELAPSED_REALTIME
  - ELAPSED_REALTIME_WAKEUP
  - RTC
  - RTC_WAKEUP

Alarm Manager

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  - ELAPSED_REALTIME
  - ELAPSED_REALTIME_WAKEUP
  - RTC
  - RTC_WAKEUP

```
alarmMgr?.setInexactRepeating(
        AlarmManager.ELAPSED_REALTIME_WAKEUP,
        SystemClock.elapsedRealtime() + AlarmManager.INTERVAL_HALF_HOUR,
        AlarmManager.INTERVAL_HALF_HOUR,
        alarmIntent
)
```

Alarm Manager

- Alarm types:
  - ELAPSED_REALTIME
  - ELAPSED_REALTIME_WAKEUP
  - RTC
  - RTC_WAKEUP

```
alarmMgr?.setInexactRepeating(
        AlarmManager.ELAPSED_REALTIME_WAKEUP,
        SystemClock.elapsedRealtime() + AlarmManager.INTERVAL_HALF_HOUR,
        AlarmManager.INTERVAL_HALF_HOUR,
        alarmIntent
)

// Cancel the alarm.
alarmMgr?.cancel(alarmIntent)
```

https://developer.android.com/training/scheduling/alarms

Alarm at 14:00

```
// Set the alarm to start at approximately 2:00 p.m.
val calendar: Calendar = Calendar.getInstance().apply {
    timeInMillis = System.currentTimeMillis()
    set(Calendar.HOUR_OF_DAY, 14)
}

// With setInexactRepeating(), you have to use one of the AlarmManager interval
// constants--in this case, AlarmManager.INTERVAL_DAY.
alarmMgr?.setInexactRepeating(
        AlarmManager.RTC_WAKEUP,
        calendar.timeInMillis,
        AlarmManager.INTERVAL_DAY,
        alarmIntent
)
```

DEMO

Alarm at 14:00

```
// Set the alarm to start at approximately 2:00 p.m.
val calendar: Calendar = Calendar.getInstance().apply {
    timeInMillis = System.currentTimeMillis()
    set(Calendar.HOUR_OF_DAY, 14)
}

// With setInexactRepeating(), you have to use one of the AlarmManager interval
// constants--in this case, AlarmManager.INTERVAL_DAY.
alarmMgr?.setInexactRepeating(
        AlarmManager.RTC_WAKEUP,
        calendar.timeInMillis,
        AlarmManager.INTERVAL_DAY,
        alarmIntent
)
```

JobScheduler

- Register the Service

```
<service
    android:name=".MyJobService"
    android:permission="android.permission.BIND_JOB_SERVICE"
    android:exported="true"/>
```

JobScheduler

- Register the Service

```
<service
    android:name=".MyJobService"
    android:permission="android.permission.BIND_JOB_SERVICE"
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```

- Schedule a Job

```
val builder = JobInfo.Builder(jobId++, serviceComponent)
```

JobScheduler

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```
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    android:name=".MyJobService"
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```

- Schedule a Job

```
val builder = JobInfo.Builder(jobId++, serviceComponent)
builder.setMinimumLatency(delay.toLong() * TimeUnit.SECONDS.toMillis(1))
```

JobScheduler

- Register the Service

```
<service
    android:name=".MyJobService"
    android:permission="android.permission.BIND_JOB_SERVICE"
    android:exported="true"/>
```

- Schedule a Job

```
val builder = JobInfo.Builder(jobId++, serviceComponent)
builder.setMinimumLatency(delay.toLong() * TimeUnit.SECONDS.toMillis(1))
builder.setOverrideDeadline(deadline.toLong() * TimeUnit.SECONDS.toMillis(1))
```

JobScheduler

- Register the Service

```
<service
    android:name=".MyJobService"
    android:permission="android.permission.BIND_JOB_SERVICE"
    android:exported="true"/>
```

- Schedule a Job

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builder.setMinimumLatency(delay.toLong() * TimeUnit.SECONDS.toMillis(1))
builder.setOverrideDeadline(deadline.toLong() * TimeUnit.SECONDS.toMillis(1))
builder.setRequiredNetworkType(JobInfo.NETWORK_TYPE_ANY)
```

JobScheduler

- Register the Service

```
<service
    android:name=".MyJobService"
    android:permission="android.permission.BIND_JOB_SERVICE"
    android:exported="true"/>
```

- Schedule a Job

```
val builder = JobInfo.Builder(jobId++, serviceComponent)

builder.setMinimumLatency(delay.toLong() * TimeUnit.SECONDS.toMillis(1))

builder.setOverrideDeadline(deadline.toLong() * TimeUnit.SECONDS.toMillis(1))

builder.setRequiredNetworkType(JobInfo.NETWORK_TYPE_ANY)

builder.run {
  setRequiresDeviceIdle(requiresIdleCheckbox.isChecked)
  setRequiresCharging(requiresChargingCheckBox.isChecked)
  setExtras(extras)
}
```

JobScheduler

- Register the Service

```
<service
    android:name=".MyJobService"
    android:permission="android.permission.BIND_JOB_SERVICE"
    android:exported="true"/>
```

- Schedule a Job

```
val builder = JobInfo.Builder(jobId++, serviceComponent)

builder.setMinimumLatency(delay.toLong() * TimeUnit.SECONDS.toMillis(1))

builder.setOverrideDeadline(deadline.toLong() * TimeUnit.SECONDS.toMillis(1))

builder.setRequiredNetworkType(JobInfo.NETWORK_TYPE_ANY)

builder.run {
  setRequiresDeviceIdle(requiresIdleCheckbox.isChecked)
  setRequiresCharging(requiresChargingCheckBox.isChecked)
  setExtras(extras)
}

(getSystemService(Context.JOB_SCHEDULER_SERVICE) as
JobScheduler).schedule(builder.build())
```

JobScheduler

- Register the Service

```
<service
    android:name=".MyJobService"
    android:permission="android.permission.BIND_JOB_SERVICE"
    android:exported="true"/>
```

- Schedule a Job

```
val builder = JobInfo.Builder(jobId++, serviceComponent)

builder.setMinimumLatency(delay.toLong() * TimeUnit.SECONDS.toMillis(1))

builder.setOverrideDeadline(deadline.toLong() * TimeUnit.SECONDS.toMillis(1))

builder.setRequiredNetworkType(JobInfo.NETWORK_TYPE_ANY)

builder.run {
  setRequiresDeviceIdle(requiresIdleCheckbox.isChecked)
  setRequiresCharging(requiresChargingCheckBox.isChecked)
  setExtras(extras)
}

(getSystemService(Context.JOB_SCHEDULER_SERVICE) as
JobScheduler).schedule(builder.build())
```

The Job

DEMO

Define The Job

```
class MyJobService : JobService() {
  override fun onStartCommand(intent: Intent, flags: Int, startId: Int): Int {
   activityMmessenger = intent.getParcelableExtra(MESSENGER_INTENT_KEY)
   return Service.START_NOT_STICKY
  }

  override fun onStartJob(params: JobParameters): Boolean {
   // The work that this service "does"
   // ...
   // Return true as there's more work to be done with this job.
   return true
  }

  override fun onStopJob(params: JobParameters): Boolean {
   // Stop tracking these job parameters, as we've 'finished' executing.
   // ...
   // Return false to drop the job.
   return false
  }
}
```

https://developer.android.com/topic/performance/scheduling

WorkManager

WorkManager

- Core Classes:
  - Worker

WorkManager

- Core Classes:
  - Worker

```
class CompressWorker(context : Context, params : WorkerParameters)
    : Worker(context, params) {
 override fun doWork(): Result {
  // The actual work!
  myCompress()
  // Indicate success or failure with your return value:
  return Result.SUCCESS
  // Returning:
  //  - RETRY tells WorkManager to try this task again later
  //  - FAILURE says not to try again.
 }
}
```

WorkManager

- Core Classes:
  - Worker

```
class CompressWorker(context : Context, params : WorkerParameters)
    : Worker(context, params) {
 override fun doWork(): Result {
  // The actual work!
  myCompress()
  // Indicate success or failure with your return value:
  return Result.SUCCESS
  // Returning:
  //   - RETRY tells WorkManager to try this task again later
  //   - FAILURE says not to try again.
 }
}
```

Runs on a background thread

WorkManager

- Core Classes:
  - Worker
  - WorkRequest
    - OneTimeWorkRequest
    - PeriodicTimeWorkRequest

```
val compressionWork = OneTimeWorkRequestBuilder<CompressWorker>().build()
WorkManager.getInstance().enqueue(compressionWork)
```

Constraints

```
// Create a Constraints object that defines when the task should run
val myConstraints = Constraints.Builder()
 .setRequiresDeviceIdle(true)
 .setRequiresCharging(true)
 // ...
 .build()

// then create a OneTimeWorkRequest that uses those constraints
val compressionWork = OneTimeWorkRequestBuilder<CompressWorker>()
 .setConstraints(myConstraints)
 .build()
```

Constraints

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// Create a Constraints object that defines when the task should run
val myConstraints = Constraints.Builder()
 .setRequiresDeviceIdle(true)
 .setRequiresCharging(true)
 // ...
 .build()

// then create a OneTimeWorkRequest that uses those constraints
val compressionWork = OneTimeWorkRequestBuilder<CompressWorker>()
 .setConstraints(myConstraints)
 .build()
```

Cancel the task

```
val compressionWorkId:UUID = compressionWork.getId()
WorkManager.getInstance().cancelWorkById(compressionWorkId)
```

https://developer.android.com/topic/libraries/architecture/workmanager/basics

Chained Tasks

```
WorkManager.getInstance()
.beginWith(workA)
  // Note: WorkManager.beginWith() returns a
  // WorkContinuation object; the following calls are
  // to WorkContinuation methods
 .then(workB) // FYI, then() returns a new WorkContinuation instance
 .then(workC)
 .enqueue()
```

Chained Tasks

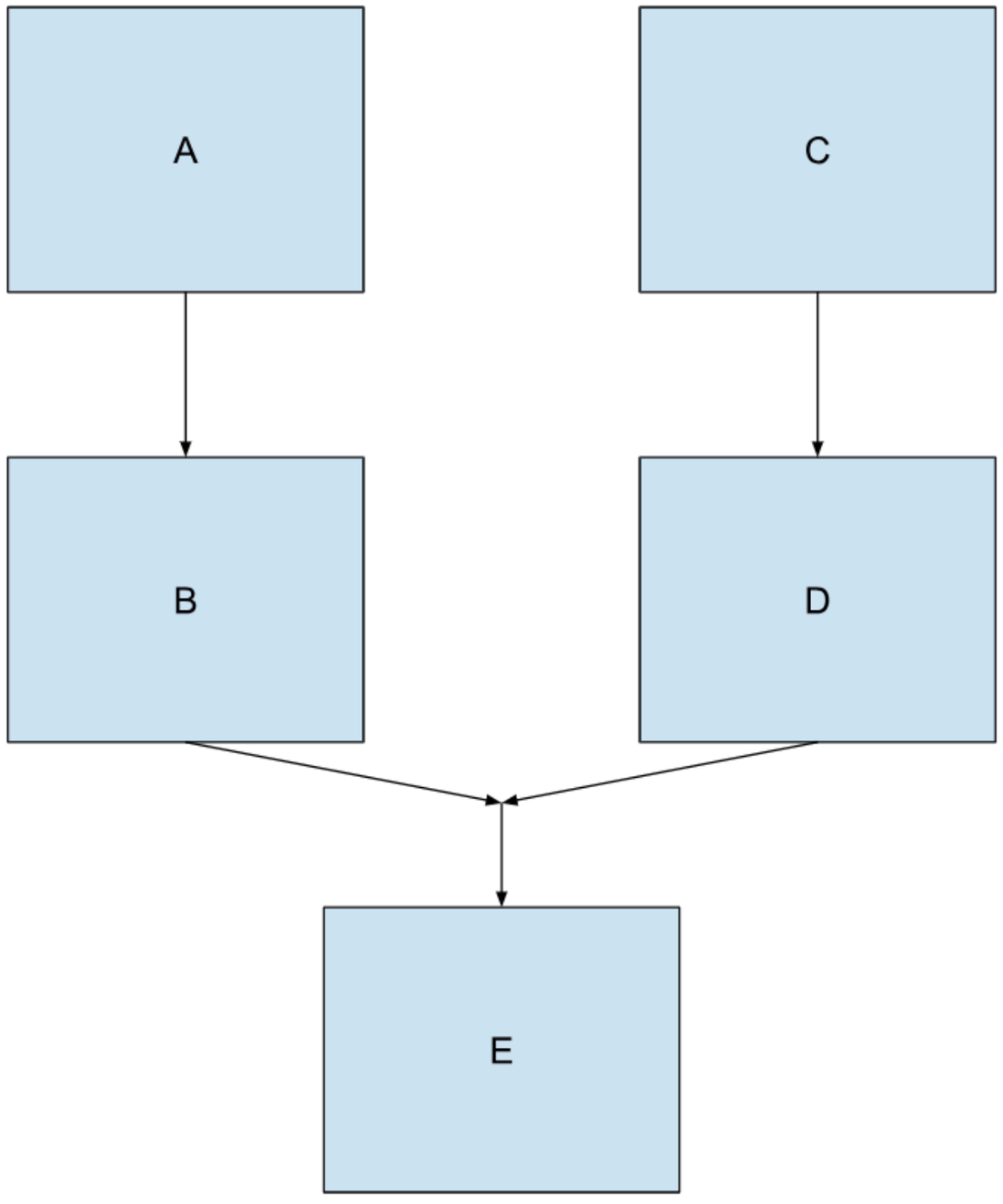
```
WorkManager.getInstance()
  .beginWith(workA)
    // Note: WorkManager.beginWith() returns a
    // WorkContinuation object; the following calls are
    // to WorkContinuation methods
   .then(workB) // FYI, then() returns a new WorkContinuation instance
    .then(workC)
    .enqueue()
```

```
WorkManager.getInstance()
     // First, run all the A tasks (in parallel):
     .beginWith(workA1, workA2, workA3)
     // ...when all A tasks are finished, run the single B task:
     .then(workB)
     // ...then run the C tasks (in any order):
     .then(workC1, workC2)
     .enqueue()
```

DEMO

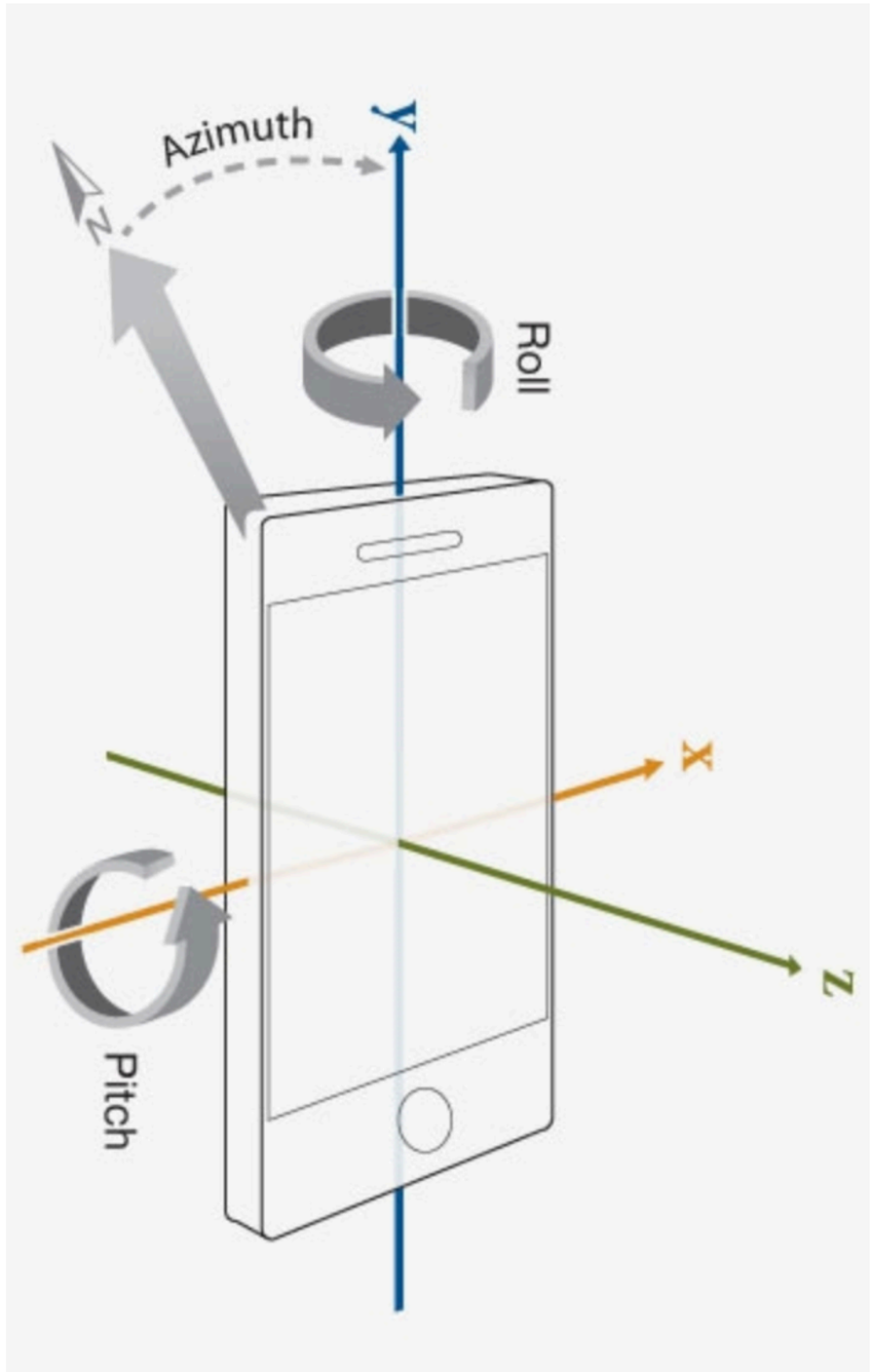
Chained tasks

```
val chain1 = WorkManager.getInstance()
  .beginWith(workA)
  .then(workB)
val chain2 = WorkManager.getInstance()
  .beginWith(workC)
  .then(workD)
val chain3 = WorkContinuation
  .combine(chain1, chain2)
  .then(workE)
chain3.enqueue()
```



https://developer.android.com/topic/libraries/architecture/workmanager/advanced

Sensors



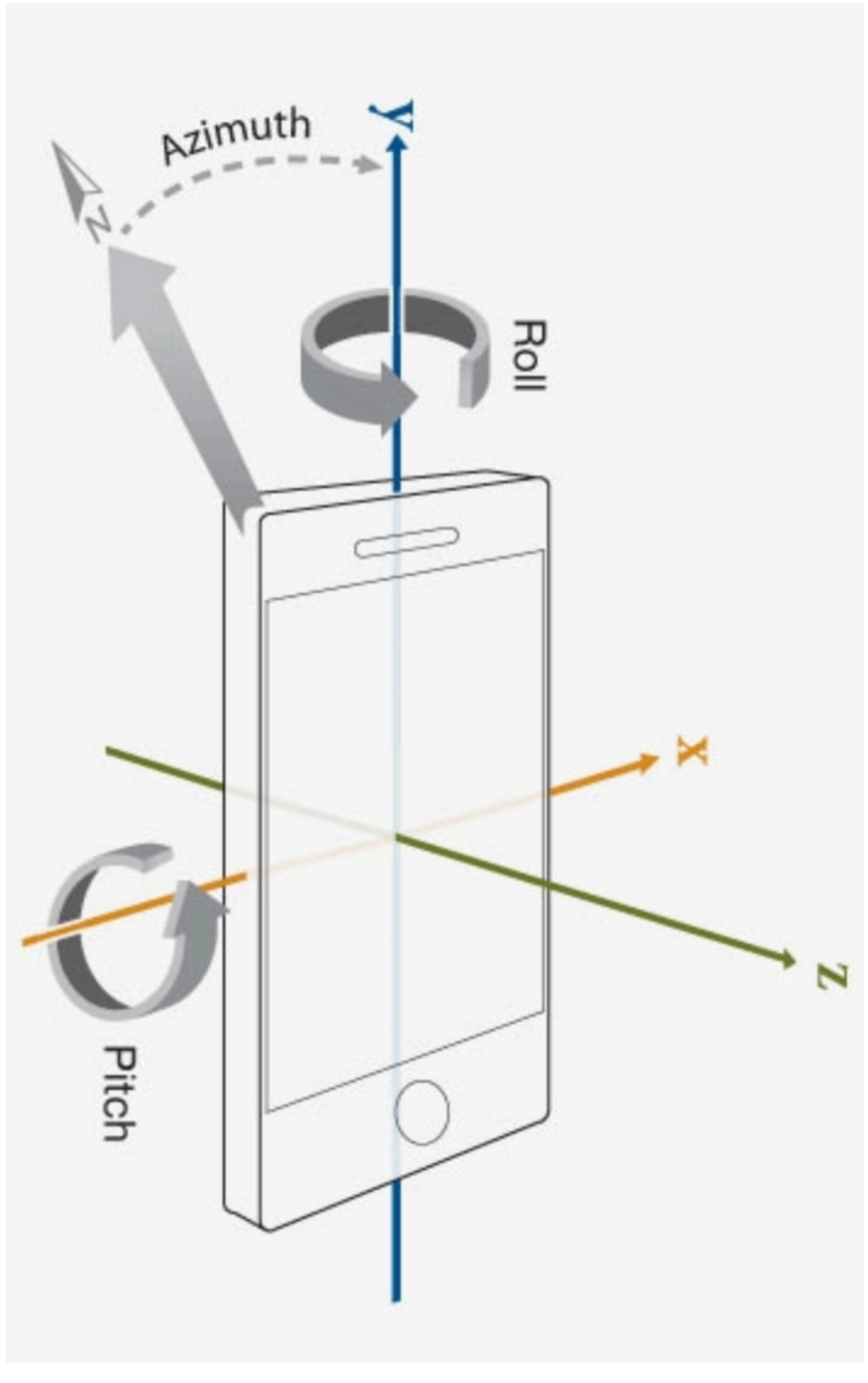
Sensors

- Motion

These sensors measure acceleration forces and rotational forces along three axes.

This category includes:

- Accelerometers.
- Gravity sensors.
- Gyroscopes.
- Rotational vector sensors.



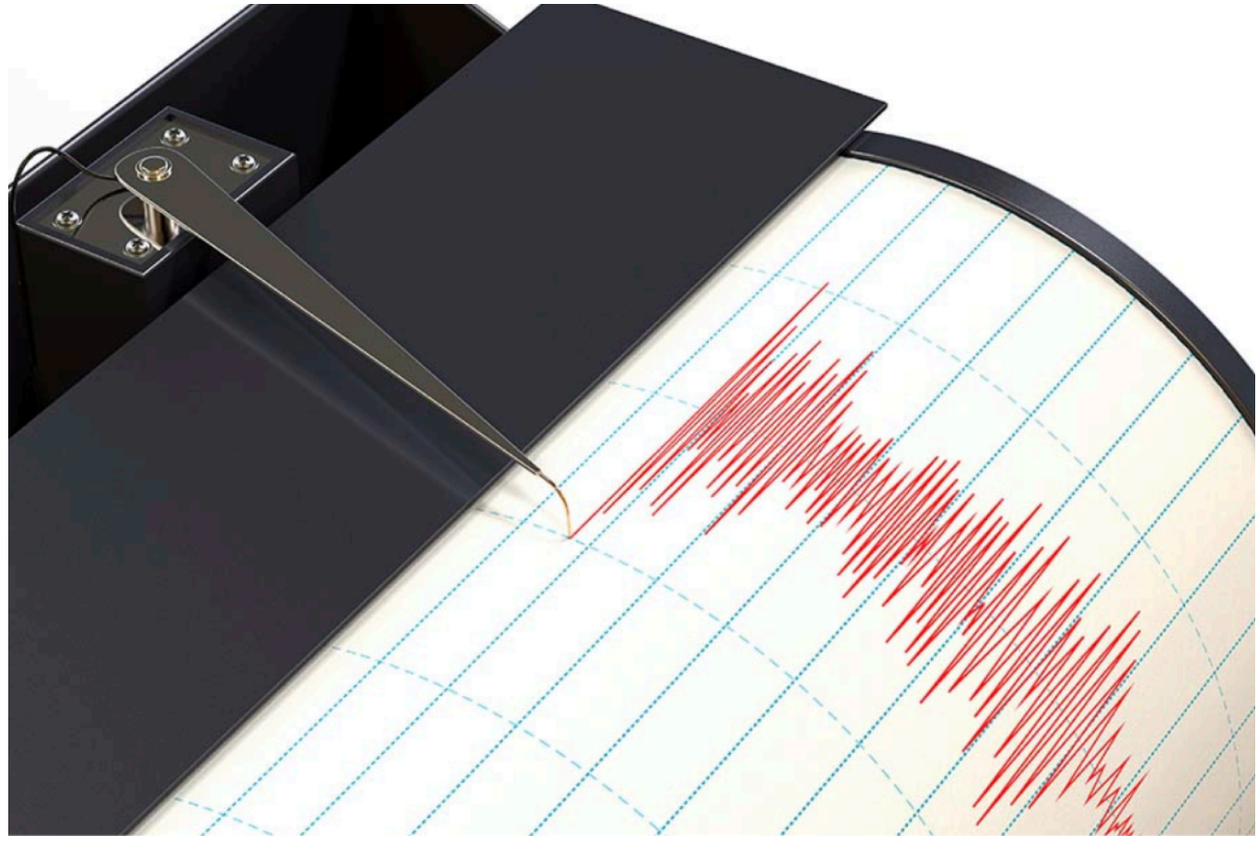
Sensors

- Motion
- Position

These sensors measure the physical position of a device.

This category includes:

- Orientation sensors.
- Magnetometers.



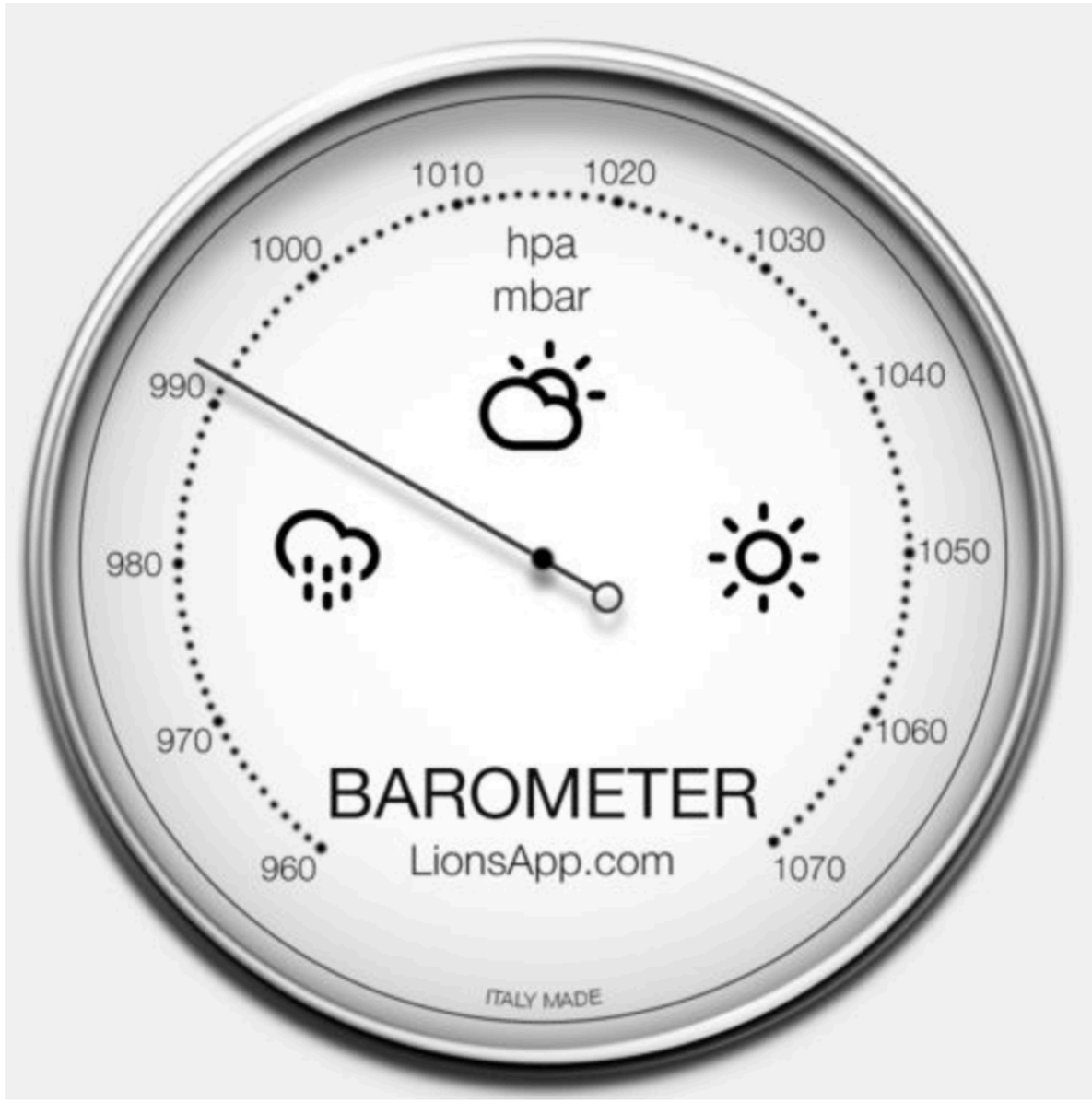
Sensors

- Motion
- Position
- Environment

These sensors measure various environmental parameters.

This category includes:

- Barometers.
- Photometers.
- Thermometers.



Framework

```
private lateinit var mSensorManager: SensorManager
...
mSensorManager = getSystemService(Context.SENSOR_SERVICE) as SensorManager
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Framework

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Framework

- SensorManager

```
private lateinit var mSensorManager: SensorManager
...
mSensorManager = getSystemService(Context.SENSOR_SERVICE) as SensorManager
```

```
val deviceSensors: List<Sensor> = mSensorManager.getSensorList(Sensor.TYPE_ALL)
```

Framework

- SensorManager
- Sensor

```
private lateinit var mSensorManager: SensorManager
...
mSensorManager = getSystemService(Context.SENSOR_SERVICE) as SensorManager
if (mSensorManager.getDefaultSensor(Sensor.TYPE_MAGNETIC_FIELD) != null) {
    // Success! There's a magnetometer.
} else {
    // Failure! No magnetometer.
}
```

Framework

- SensorManager
- Sensor

```
if (mSensorManager.getDefaultSensor(Sensor.TYPE_GRAVITY) != null) {
    val gravSensors: List<Sensor> =
      mSensorManager.getSensorList(Sensor.TYPE_GRAVITY)
    // Use the version 3 gravity sensor.
    mSensor = gravSensors.firstOrNull {
      it.vendor.contains("Google LLC") && it.version == 3
    }
}
if (mSensor == null) {
 // Use the accelerometer.
 mSensor = if (mSensorManager.getDefaultSensor(Sensor.TYPE_ACCELEROMETER)
       != null) {
   mSensorManager.getDefaultSensor(Sensor.TYPE_ACCELEROMETER)
 } else {
  // Sorry, there are no accelerometers on your device.
  null
 }
}
```

Framework

- SensorManager
- Sensor
- SensorEvent
- SensorEventListener

```
class SensorActivity : Activity(), SensorEventListener {
  private lateinit var mSensorManager: SensorManager
  private var mLight: Sensor? = null

  public override fun onCreate(savedInstanceState: Bundle?) {
    super.onCreate(savedInstanceState)
    setContentView(R.layout.main)

    mSensorManager = getSystemService(Context.SENSOR_SERVICE) as SensorManager
    mLight = mSensorManager.getDefaultSensor(Sensor.TYPE_LIGHT)
  }

  override fun onAccuracyChanged(sensor: Sensor, accuracy: Int) {
```

```
public override fun onCreate(savedInstanceState: Bundle?) {
  super.onCreate(savedInstanceState)
  setContentView(R.layout.main)

  mSensorManager = getSystemService(Context.SENSOR_SERVICE) as SensorManager
  mLight = mSensorManager.getDefaultSensor(Sensor.TYPE_LIGHT)
}

override fun onAccuracyChanged(sensor: Sensor, accuracy: Int) {
  // Do something here if sensor accuracy changes.
}

override fun onSensorChanged(event: SensorEvent) {
  // The light sensor returns a single value.
  // Many sensors return 3 values, one for each axis.
  val lux = event.values[0]
  // Do something with this sensor value.
}

override fun onResume() {
  super.onResume()
  mLight?.also { light ->
    mSensorManager.registerListener(this, light,
      SensorManager.SENSOR_DELAY_NORMAL)
  }
}

override fun onPause() {
  super.onPause()
  mSensorManager.unregisterListener(this)
}
}
```

Motion

Sensor	Sensor event data	Description	Units of measure
TYPE_ACCELEROMETER	SensorEvent.values[0]	Acceleration force along the x axis (including gravity).	m/s^2
	SensorEvent.values[1]	Acceleration force along the y axis (including gravity).	
	SensorEvent.values[2]	Acceleration force along the z axis (including gravity).	
TYPE_ACCELEROMETER_UNCALIBRATED	SensorEvent.values[0]	Measured acceleration along the X axis without any bias compensation.	m/s^2
	SensorEvent.values[1]	Measured acceleration along the Y axis without any bias compensation.	
	SensorEvent.values[2]	Measured acceleration along the Z axis without any bias compensation.	
	SensorEvent.values[3]	Measured acceleration along the X axis with estimated bias compensation.	
	SensorEvent.values[4]	Measured acceleration along the Y axis with estimated bias compensation.	
	SensorEvent.values[5]	Measured acceleration along the Z axis with estimated bias compensation.	

	`SensorEvent.values[1]`	Measured acceleration along the Y axis without any bias compensation.	
	`SensorEvent.values[2]`	Measured acceleration along the Z axis without any bias compensation.	
	`SensorEvent.values[3]`	Measured acceleration along the X axis with estimated bias compensation.	
	`SensorEvent.values[4]`	Measured acceleration along the Y axis with estimated bias compensation.	
	`SensorEvent.values[5]`	Measured acceleration along the Z axis with estimated bias compensation.	
`TYPE_GRAVITY`	`SensorEvent.values[0]`	Force of gravity along the x axis.	m/s^2
	`SensorEvent.values[1]`	Force of gravity along the y axis.	
	`SensorEvent.values[2]`	Force of gravity along the z axis.	
`TYPE_GYROSCOPE`	`SensorEvent.values[0]`	Rate of rotation around the x axis.	rad/s
	`SensorEvent.values[1]`	Rate of rotation around the y axis.	
	`SensorEvent.values[2]`	Rate of rotation around the z axis.	

https://developer.android.com/guide/topics/sensors/sensors_motion

Position

Sensor	Sensor event data	Description	Units of measure
TYPE_GAME_ROTATION_VECTOR	SensorEvent.values[0]	Rotation vector component along the x axis (x * sin(θ/2)).	Unitless
	SensorEvent.values[1]	Rotation vector component along the y axis (y * sin(θ/2)).	
	SensorEvent.values[2]	Rotation vector component along the z axis (z * sin(θ/2)).	
TYPE_GEOMAGNETIC_ROTATION_VECTOR	SensorEvent.values[0]	Rotation vector component along the x axis (x * sin(θ/2)).	Unitless
	SensorEvent.values[1]	Rotation vector component along the y axis (y * sin(θ/2)).	
	SensorEvent.values[2]	Rotation vector component along the z axis (z * sin(θ/2)).	
TYPE_MAGNETIC_FIELD	SensorEvent.values[0]	Geomagnetic field strength along the x axis.	μT
	SensorEvent.values[1]	Geomagnetic field strength along the y axis.	
	SensorEvent.values[2]	Geomagnetic field strength along the z axis.	
TYPE_MAGNETIC_FIELD_UNCALIBRATED	SensorEvent.	Geomagnetic field strength (without hard	μT

	`values[0]`	axis.	
	`SensorEvent.values[1]`	Geomagnetic field strength along the y axis.	
	`SensorEvent.values[2]`	Geomagnetic field strength along the z axis.	
`TYPE_MAGNETIC_FIELD_UNCALIBRATED`	`SensorEvent.values[0]`	Geomagnetic field strength (without hard iron calibration) along the x axis.	μT
	`SensorEvent.values[1]`	Geomagnetic field strength (without hard iron calibration) along the y axis.	
	`SensorEvent.values[2]`	Geomagnetic field strength (without hard iron calibration) along the z axis.	
	`SensorEvent.values[3]`	Iron bias estimation along the x axis.	
	`SensorEvent.values[4]`	Iron bias estimation along the y axis.	
	`SensorEvent.values[5]`	Iron bias estimation along the z axis.	
`TYPE_ORIENTATION`[1]	`SensorEvent.values[0]`	Azimuth (angle around the z-axis).	Degrees
	`SensorEvent.values[1]`	Pitch (angle around the x-axis).	
	`SensorEvent.values[2]`	Roll (angle around the y-axis).	
`TYPE_PROXIMITY`	`SensorEvent.values[0]`	Distance from object.[2]	cm

https://developer.android.com/guide/topics/sensors/sensors_position

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Environment

Sensor	Sensor event data	Units of measure	Data description
TYPE_AMBIENT_TEMPERATURE	`event.values[0]`	°C	Ambient air temperature.
TYPE_LIGHT	`event.values[0]`	lx	Illuminance.
TYPE_PRESSURE	`event.values[0]`	hPa or mbar	Ambient air pressure.
TYPE_RELATIVE_HUMIDITY	`event.values[0]`	%	Ambient relative humidity.
TYPE_TEMPERATURE	`event.values[0]`	°C	Device temperature.[1]

★ [1] Implementations vary from device to device. This sensor was deprecated in Android 4.0 (API Level 14).

https://developer.android.com/guide/topics/sensors/sensors_environment

Lecture outcomes

- Use existing system services.
- Define custom services.
- Understand the user notifications API.
- Consume data from sensors.