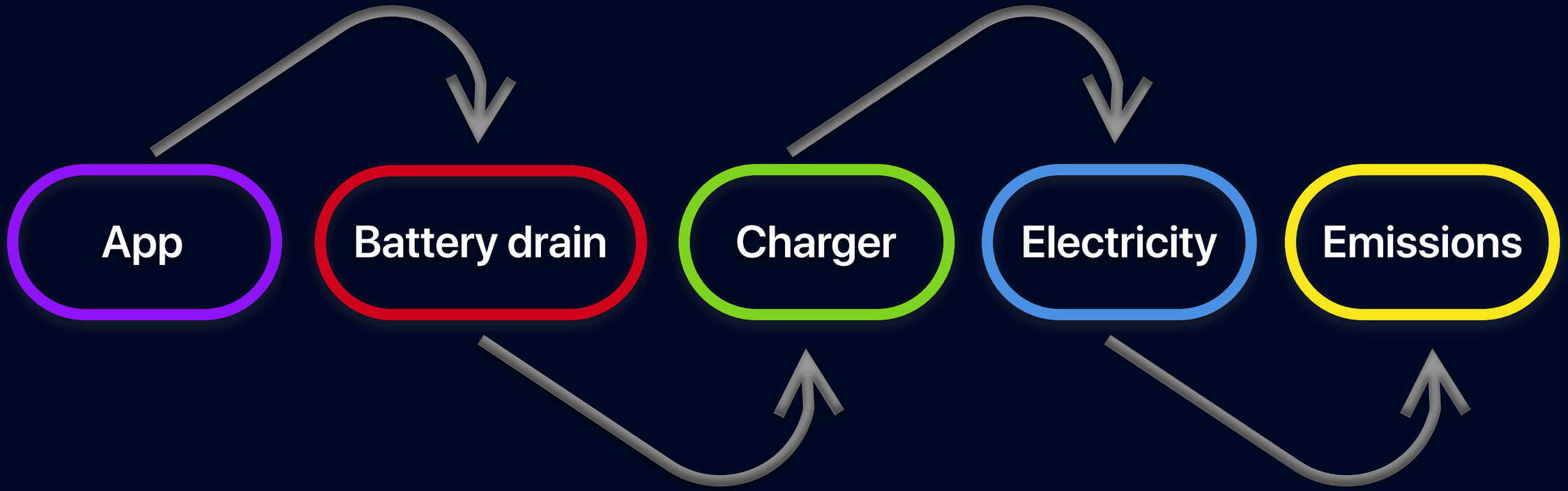
"Green" Development: is it a thing?

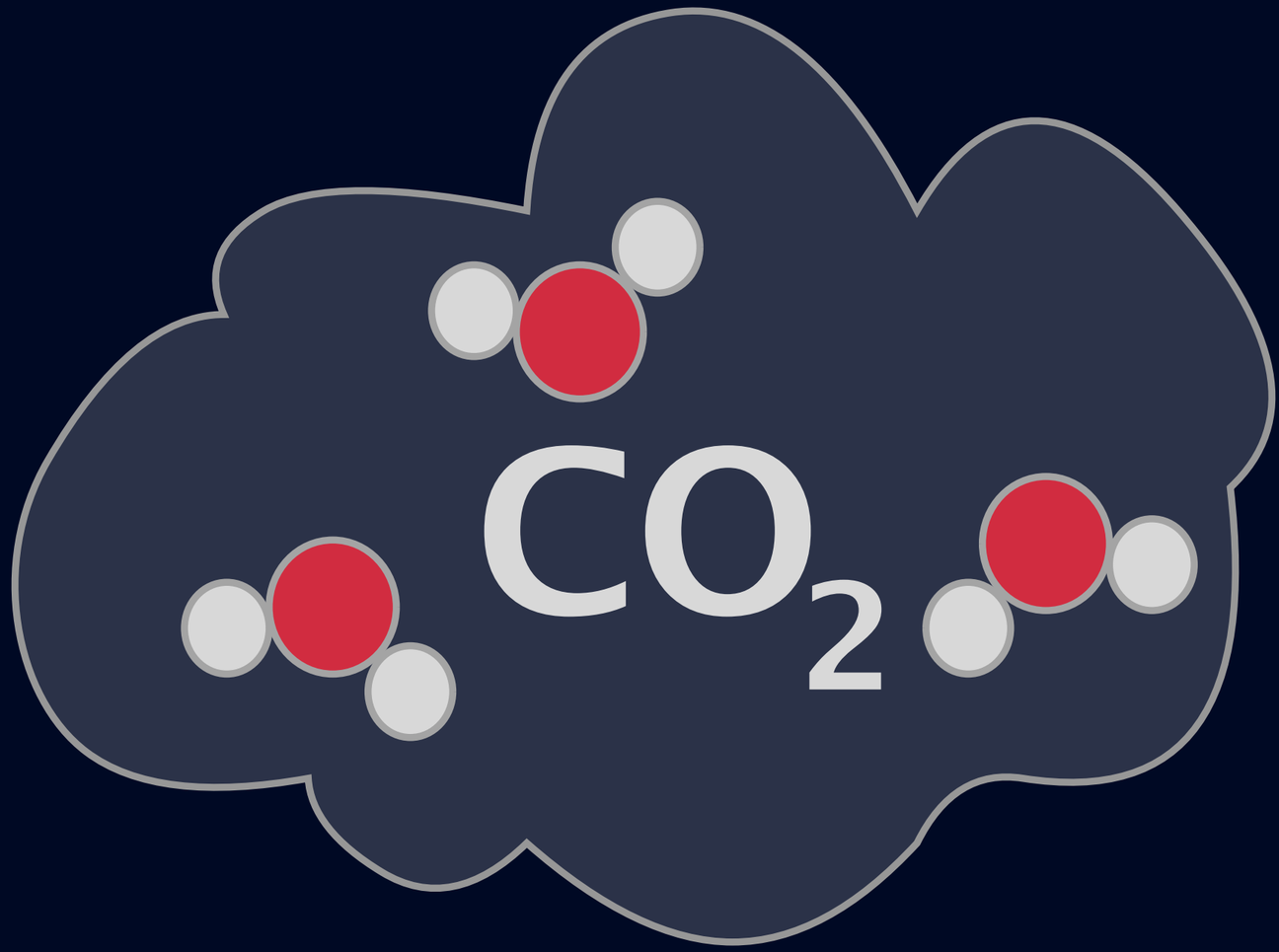
🍏 Aleksandra Komagorkina
@akomagorkina

"Green development is a real estate development concept that carefully considers social and environmental impacts of development."

— Wikipedia


App
Battery drain
Charger
Electricity
Emissions

What are these emissions?



To obtain 1kWh from coal or fuel, 800g of CO2 will be rejected in the atmosphere during combustion of fossil fuel

— J. Bernard, Sciences et vie 214 (2001) 68

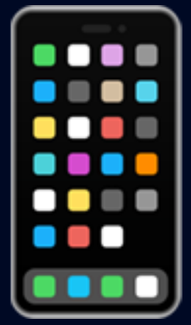
How much energy do you need to charge your iPhone?

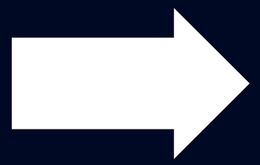
iPhone 11 Pro Max battery holds a charge of * 3500 mAh. If you fully drain and recharge your phone everyday, then over a year you would have to feed it about 5489 watt hours, or 5.5 kWh.

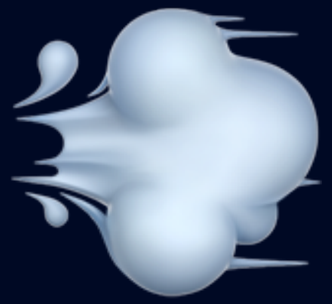
— Forbes

In January 2019, 900 million iPhones were in use worldwide

— macrumors.com

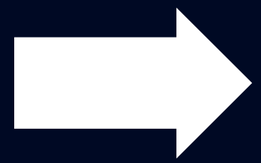


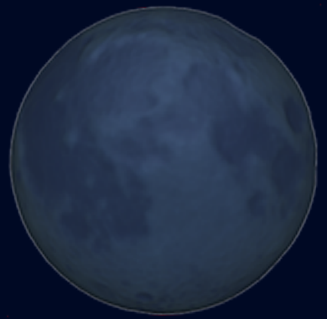




5.5 kWh

4.4 kg





0.9
billion people

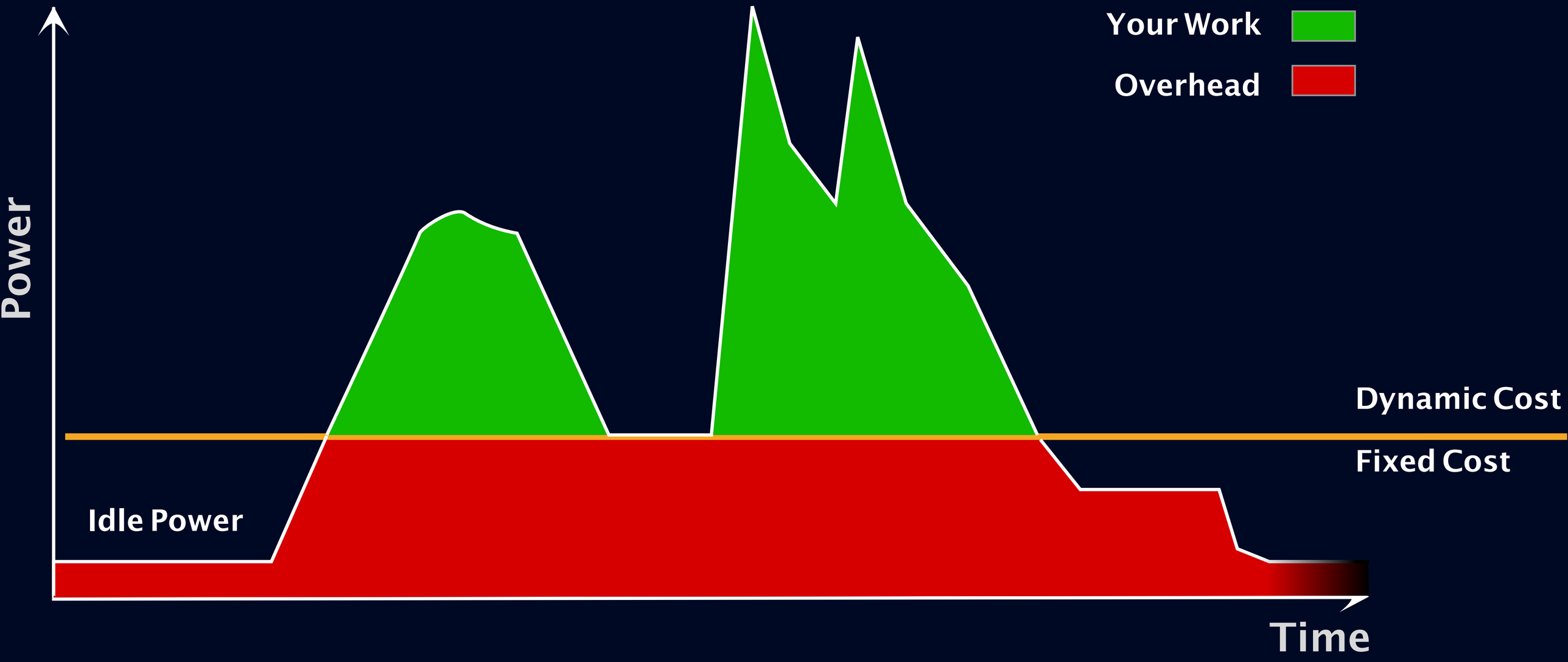
3.96
million tons

What can we do?

Understand how energy is used on the iPhone

CPU

Device wake


Your Work
Overhead
Power
Dynamic Cost
Fixed Cost
Idle Power
Time

Networking operations

Graphics, animations, and video

Location

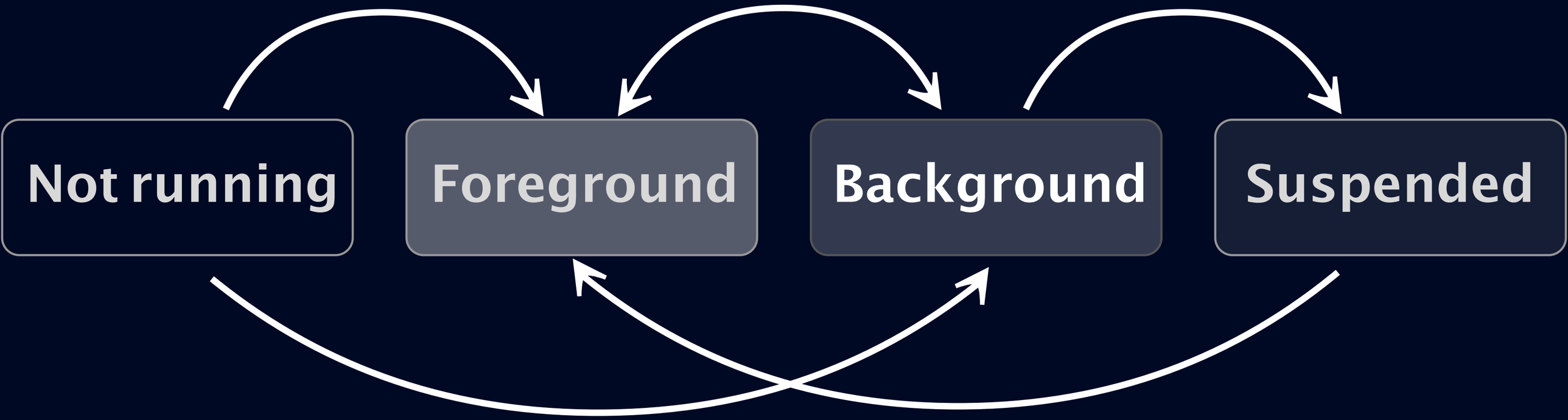
Motion

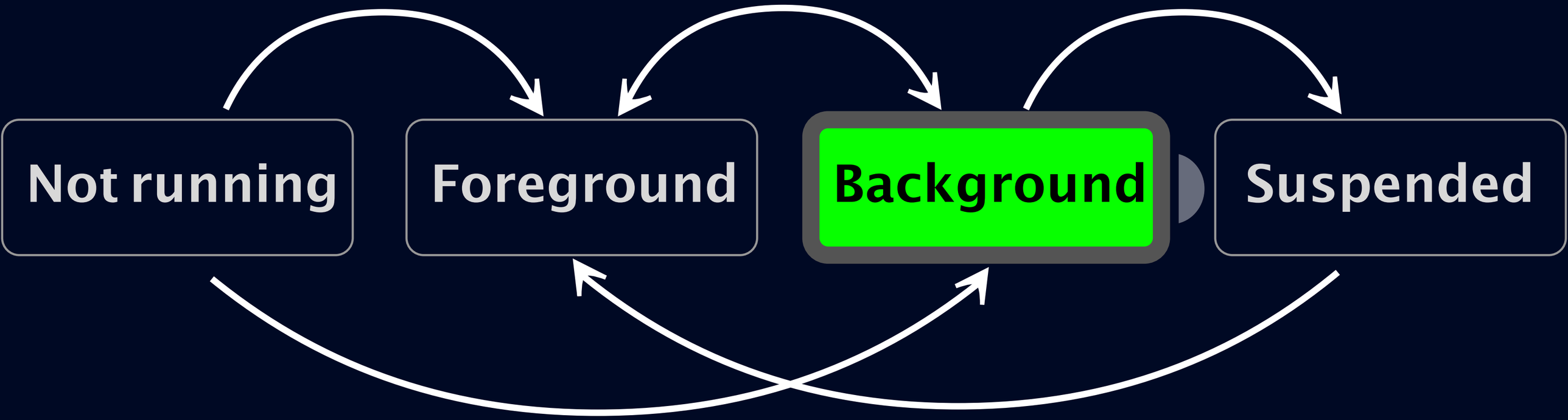
Bluetooth

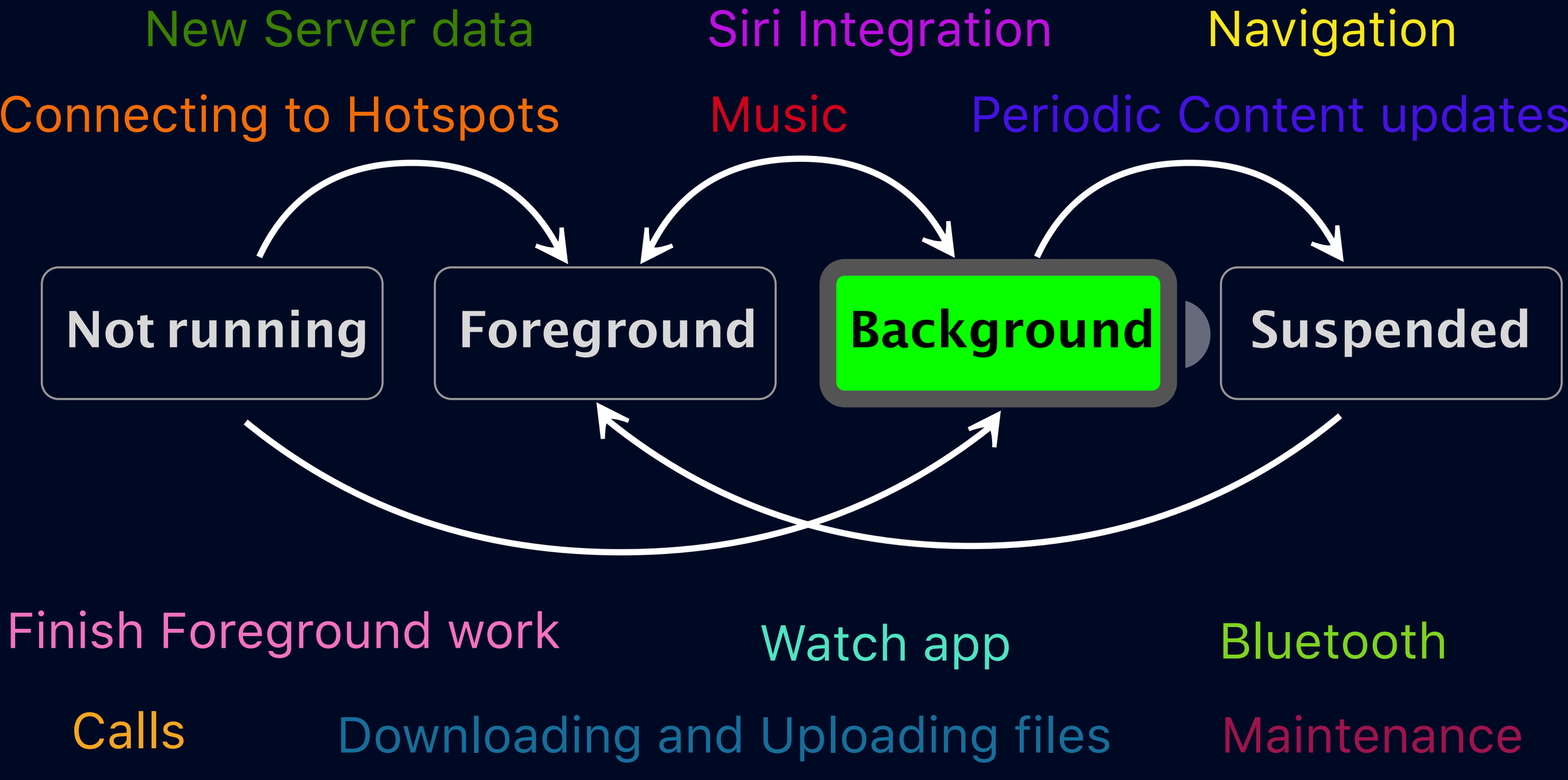
iOS Energy-Saving technologies:

- Integrated Hardware & Software
- Intelligent App Management
- Network Operation Defferal
- Task Prioritization
- Developer Tools

Background


Not running
Foreground
Background
Suspended


Not running
Foreground
Background
Suspended


New Server data
Siri Integration
Navigation
Connecting to Hotspots
Music
Periodic Content updates
Not running
Foreground
Background
Suspended
Finish Foreground work
Watch app
Bluetooth
Calls
Downloading and Uploading files
Maintenance

Energy waste in background

- Not notifying the system when background activity is complete
- Playing silent audio
- Performing location updates
- Interacting with Bluetooth accessories
- Downloads that could be deferred

What can we do?

Complete background tasks

Background Task Completion

- User expects immediate completion
- Protect completion

=> Give the app additional time to run in the backgrond before being suspended

Background Task Completion

```
UIApplication.beginBackgroundTask(expirationHandler:)

ProcessInfo.performExpiringActivity(withReason:using:)
```

Background Task Completion

```
// Guarding Important Tasks While App is Still in the Foreground
func send(_ message: Message) {
  let sendOperation = SendOperation(message: message)
  var identifier: UIBackgroundTaskIdentifier!
  identifier = UIApplication.shared.beginBackgroundTask(expirationHandler: {
     sendOperation.cancel()
     postUserNotification("Message not sent, please resend")
     // Background task will be ended in the operation's completion block below
  })
  sendOperation.completionBlock = {
     UIApplication.shared.endBackgroundTask(identifier)
  }
  operationQueue.addOperation(sendOperation)
}
```

Defer the download until the better time

Discretionary Background URL Session

```
// Set up background URL session
let config = URLSessionConfiguration.background(withIdentifier: "com.app.attachments")
let session = URLSession(configuration: config, delegate: ..., delegateQueue: ...)

// Set discretionary
config.discretionary = true
```

Discretionary Background URL Session

```
// Set timeout intervals
config.timeoutIntervalForResource = 24 * 60 * 60
config.timeoutIntervalForRequest = 60

// Create request and task
var request = URLRequest(url: url)
request.addValue("...", forHTTPHeaderField: "...")
let task = session.downloadTask(with: request)

// Set time window
task.earliestBeginDate = Date(timeIntervalSinceNow: 2 * 60 * 60)

// Set workload size
task.countOfBytesClientExpectsToSend = 160
task.countOfBytesClientExpectsToReceive = 4096
task.resume()
```

Also in background: BackgroundTasks Framework

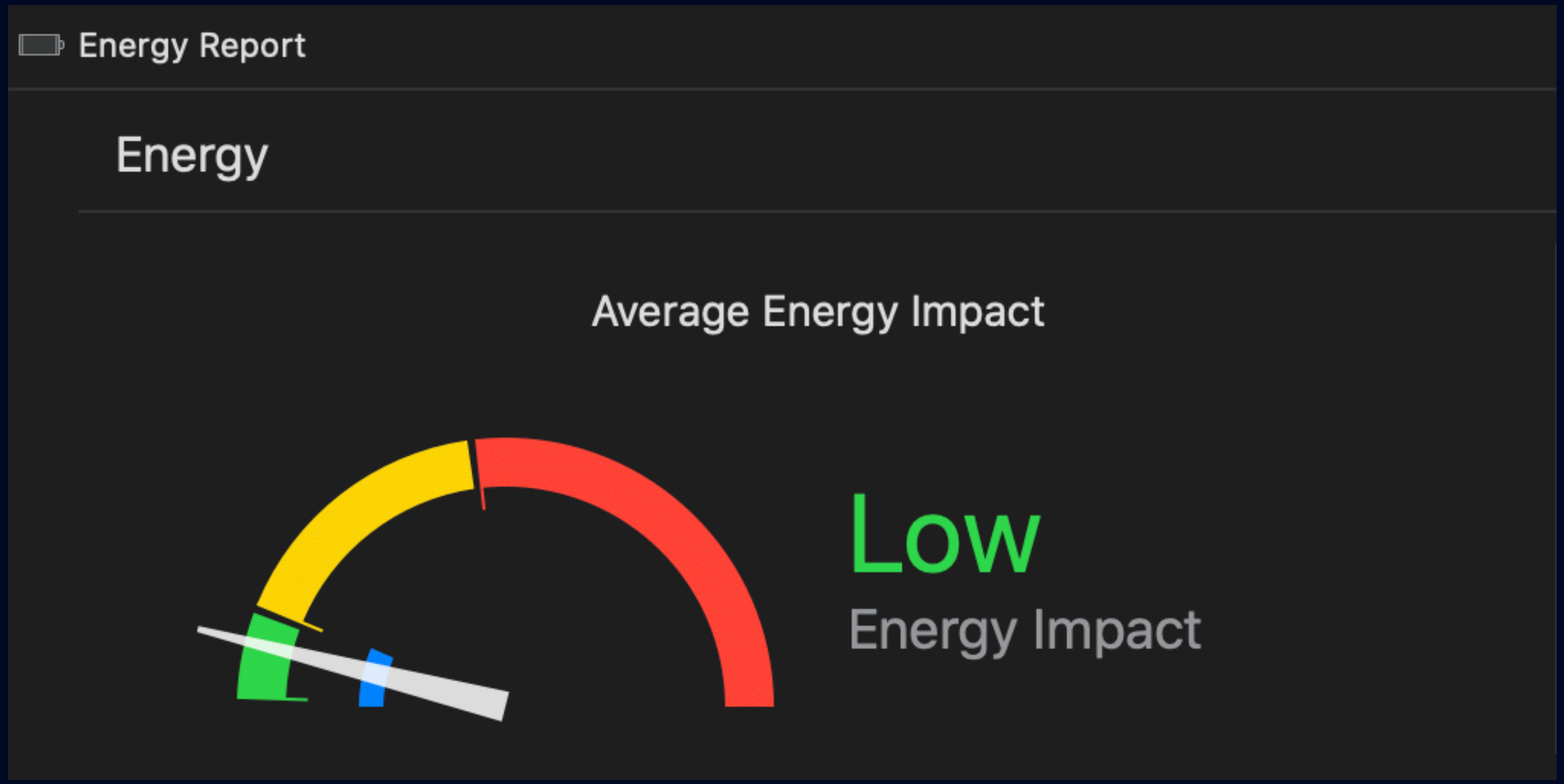
- ⚙️ Background Processing Tasks
- ⚙️ Background App Refresh Task

More: Advances in App Background Execution, WWDC2019

If you can measure it – you can manage it

Monitor energy usage in the Debugger


NSSpainDemo @akomagorkina
Running NSSpainDemo on @akomagorkina
Energy Report
NSSpainDemo PID 1455
CPU 0%
Memory 21,6 MB
Energy Impact High
Disk Zero KB/s
Network Zero KB/s
Energy
Average Energy Impact
High
Energy Impact
Average Component Utilization
Overhead 70,3 %
CPU 13,4 %
Network 16,3 %
Location 0 %
GPU 0 %
Energy Impact
00:00.000
00:10.000
00:20.000
00:30.000
00:40.000
Component Utilization
Overhead CPU Network Location GPU Background
Application State
Foreground
Background Foreground Suspended
Thermal State
No device condition active
Nominal
Nominal Fair Serious Critical
Overhead
Overhead represents energy use as a result of bringing up radios and other system resources your app needs to perform work.


Energy Report
Energy
Average Energy Impact
Low
Energy Impact

Xcode instruments for optimisation

Measure energy impact with new Instruments:

- **XCTest Metrics**
  Performance of measure blocks
- **MetricKit**
  Framework for battery and performance metrics collection
- **Xcode Metrics Organizer**
  Aggregated battery, performance, and I/O metrics in Xcode

Collecting Metrics Using XCTest

```
// This test measures Launch Time
func testAppLaunchTime() {
  measure(metrics: [XCTOSSignpostMetric.applicationLaunch]) {
  XCUIApplication().launch()
 }
}
```

Adopting MetricKit to receive metrics

```
import MetricKit
// Conform to MXMetricManagerSubscriber protocol
extension AppDelegate: MXMetricManagerSubscriber {

    func subscribeToMetrics() { // Call from didFinishLaunching...
      let shared = MXMetricManager.shared
      shared.add(self)
    }

    // Receive daily metrics
    func didReceive(_ payloads: [MXMetricPayload]) {
      // Process metrics
    }
}
```

What else can we do better?

Adopt Low Data Mode

Suggested techniques for conforming to low data mode:

- Reduce image quality
- Reduce pre-fetching (of unused or rarely used resources)
- Sync less often using locally cached data more heavily.

Suggested techniques for conforming to low data mode:

- Mark background tasks as discretionary
- Disable auto-play
- Do not block user-initiated work, even though low data mode is on.

And we can do even more

Understand device conditions

How does the heat damage the batteries?

- 🌡️ Hot temperatures can cause permanent damage to batteries.
- ⚡ Components like the voltage indicator can be affected by heat
- 🧪 As batteries heat up, chemical reactions inside will also occur faster

SAVE ME

BE
A HERO

New tools in Xcode 11 for various temperatures

How to work with thermal state conditions?

- Register for `ProcessInfo.thermalStateDidChangeNotification`
- Use the `ProcessInfo.ThermalState` cases to react to thermal state changes
- Switch off background and unneeded functionality when thermal state is elevated

Actions on ProcessInfo.ThermalState

Thermal State	Recommendations	System Actions
Nominal	No corrective action needed	
Fair	Slightly elevated thermal state, apps can proactively start energy-saving measures	Photos analysis pauses
Serious	System performance is impacted, reduce CPU, GPU, and I/O usage	ARKit and FaceTime reduce FPS rate, Restore from iCloud is paused
Critical	Reduce CPU, GPU, and I/O usage, and stop using peripherals such as camera	ARKit and FaceTime drop FPS rate

Actions on ProcessInfo.ThermalState

Thermal State	Recommendations	System Actions
Nominal	No corrective action needed	
Fair	Slightly elevated thermal state, apps can proactively start energy-saving measures	*Photos analysis pauses*
Serious	System performance is impacted, reduce CPU, GPU, and I/O usage	ARKit and FaceTime reduce FPS rate, Restore from iCloud is paused
Critical	Reduce CPU, GPU, and I/O usage, and stop using peripherals such as camera	ARKit and FaceTime drop FPS rate

Actions on ProcessInfo.ThermalState

Thermal State	Recommendations	System Actions
Nominal	No corrective action needed	
Fair	Slightly elevated thermal state, apps can proactively start energy-saving measures	Photos analysis pauses
Serious	System performance is impacted, reduce CPU, GPU, and I/O usage	*ARKit and FaceTime reduce FPS rate, Restore from iCloud is paused*
Critical	Reduce CPU, GPU, and I/O usage, and stop using peripherals such as camera	ARKit and FaceTime drop FPS rate

Actions on ProcessInfo.ThermalState

Thermal State	Recommendations	System Actions
Nominal	No corrective action needed	
Fair	Slightly elevated thermal state, apps can proactively start energy-saving measures	Photos analysis pauses
Serious	System performance is impacted, reduce CPU, GPU, and I/O usage	ARKit and FaceTime reduce FPS rate, Restore from iCloud is paused
Critical	Reduce CPU, GPU, and I/O usage, and stop using peripherals such as camera	*ARKit and FaceTime drop FPS rate*

Subscribe to thermal state condition changes

```
NotificationCenter.default.addObserver(
        self,
        selector: #selector(reactToThermalStateChange(_:)),
        name: ProcessInfo.thermalStateDidChangeNotification,
        object: nil
)

@objc
func reactToThermalStateChange(_ notification: Notification) {
  print(ProcessInfo.processInfo.thermalState)
}
```

```
var thermalState = ProcessInfo.ThermalState.nominal {
  didSet {
    switch thermalState {
       case .nominal, .fair: // All good
          configuration.userFaceTrackingEnabled = true
          sceneView.rendersMotionBlur = true
       case .serious: // Something went wrong
          configuration.userFaceTrackingEnabled = false
          sceneView.rendersMotionBlur = true
       case .critical: // PANIC
          configuration.userFaceTrackingEnabled = false
          sceneView.rendersMotionBlur = false
       }
    }
 }
```

To sum up

- Think about Background
- Minimize Networking
- Measure as much as possible

With great power comes great responsibility

Further links & reading

- @DonnyWals on Supporting Low Data Mode in your app
- WWDC2019: Improving Battery Life and Performance
- WWDC2019:Designing for Adverse Network and Temperature Conditions
- Energy Efficiency Guide for iOS Apps

Thank you! 

@akomagorkina