Run LLMs on your Phone

Your one stop guide to building LLM powered mobile apps

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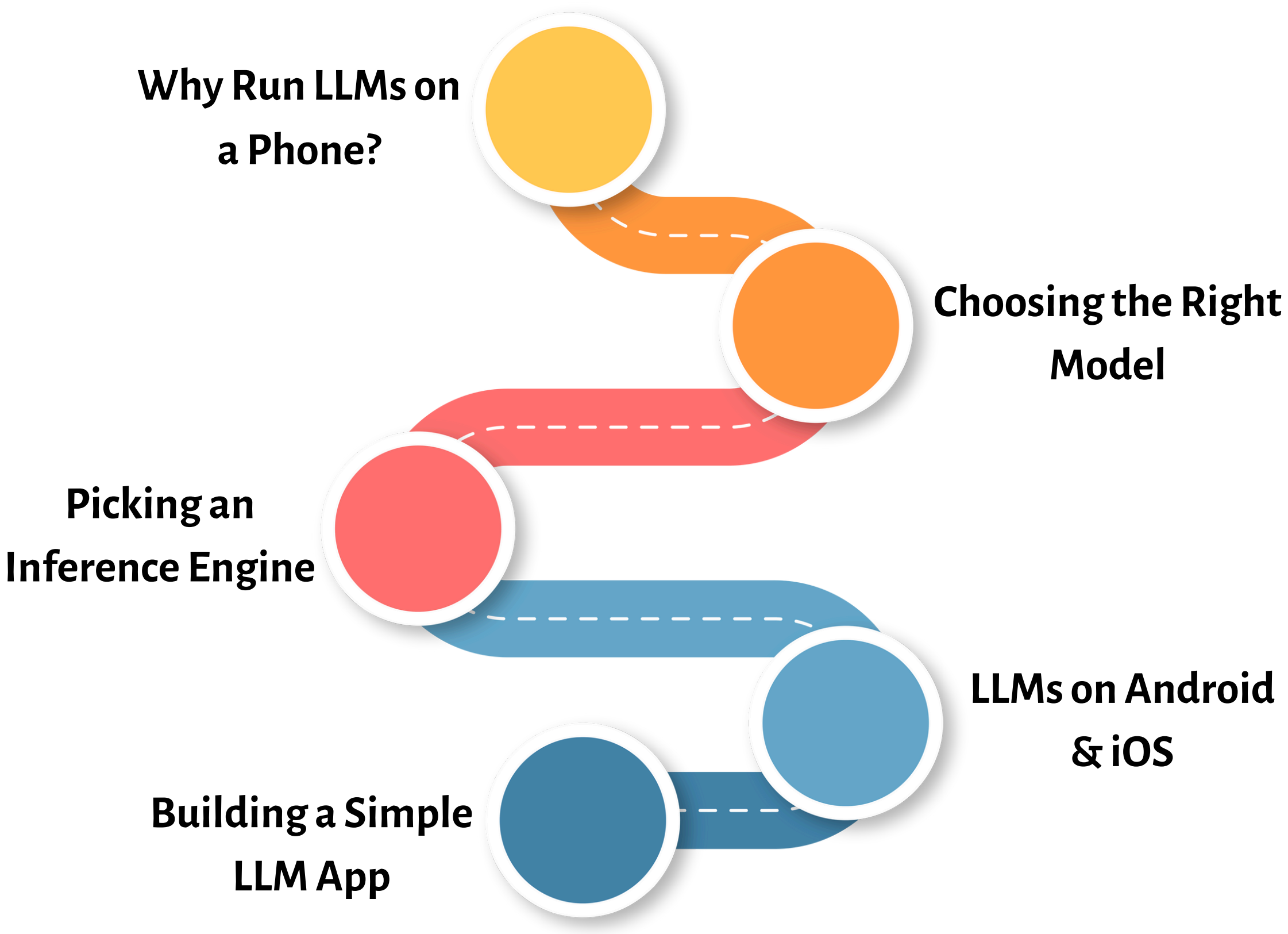
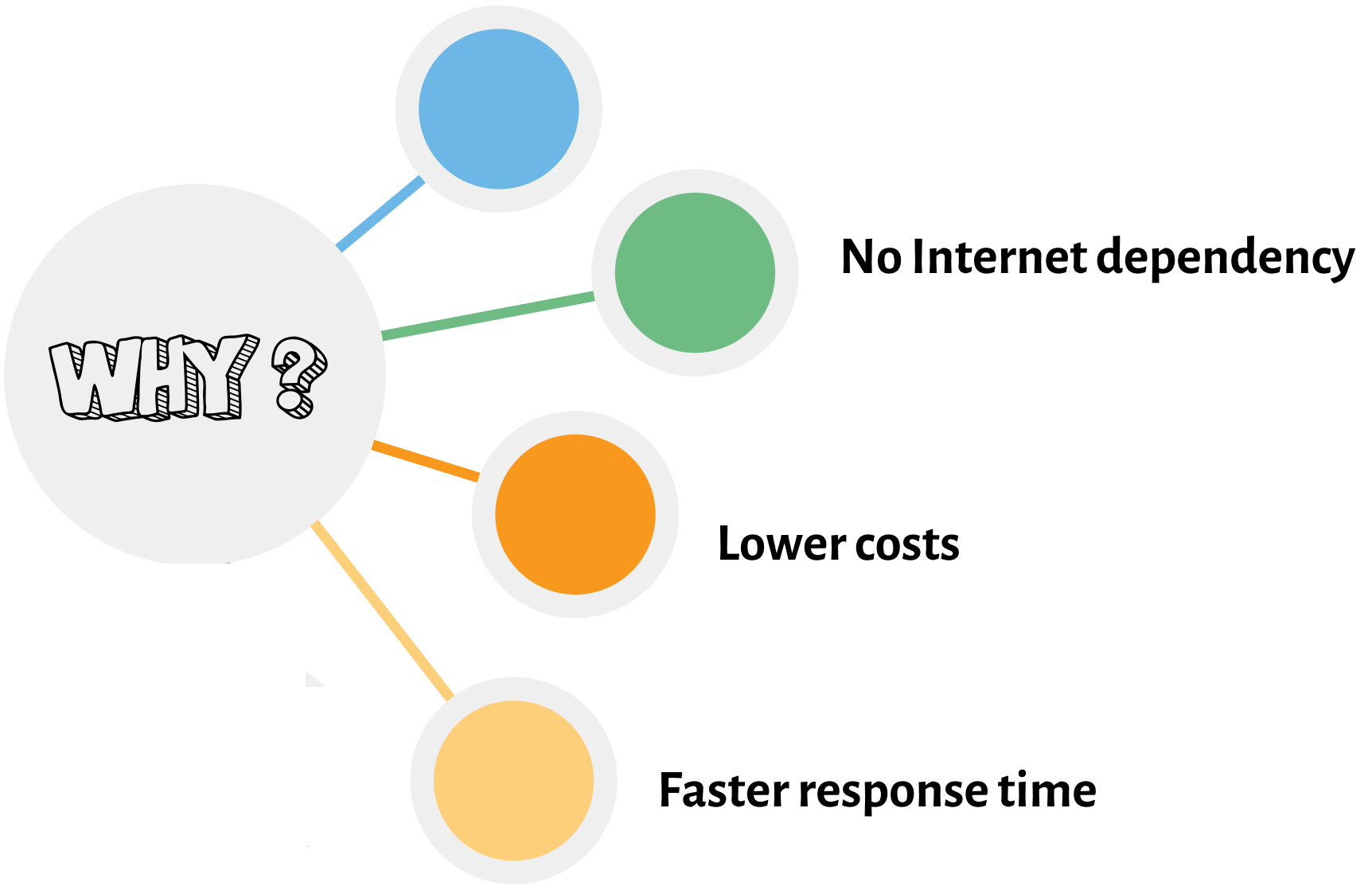
Introduction

Have you ever waited too long for LLM's response? Or are you worried about sending sensitive data to third party?

LLMs can be slow, expensive, and privacy-invasive. Running them locally on your phone unlocks faster, private, and offline AI interactions.
In this post, we'll cover:

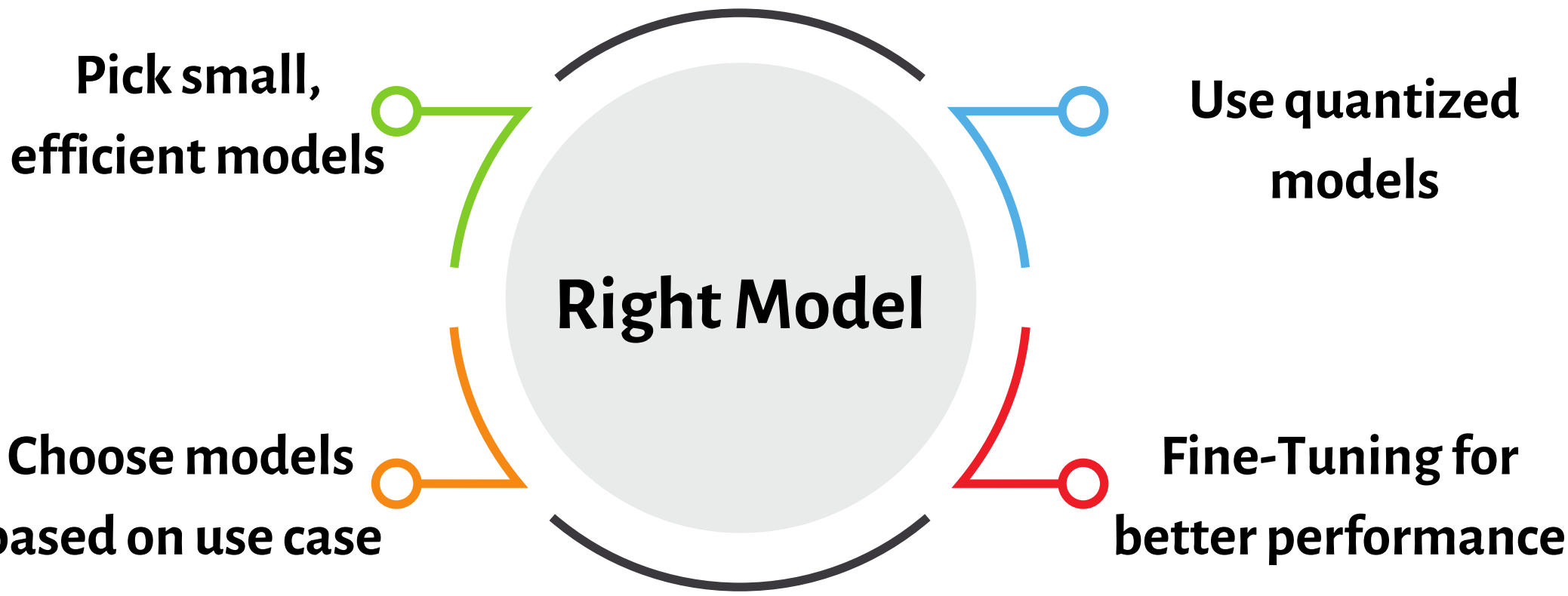


Why Run LLM on a Phone?



- **Privacy & Data security**: Cloud-based LLMs send your data to external servers, posing security risks. Running locally keeps data private, avoiding leaks.
- **No Internet dependency**: AI apps should work anywhere, anytime, even without internet. On-device LLMs enable offline assistants, useful for travel, remote areas.
- **Lower costs**: Cloud-based APIs charge per request, increasing costs over time. Running LLMs locally eliminates recurring expenses, making AI more affordable.
- **Faster response time**: Cloud LLMs suffer from latency due to server communication. Local execution ensures instant responses, essential for real-time applications.

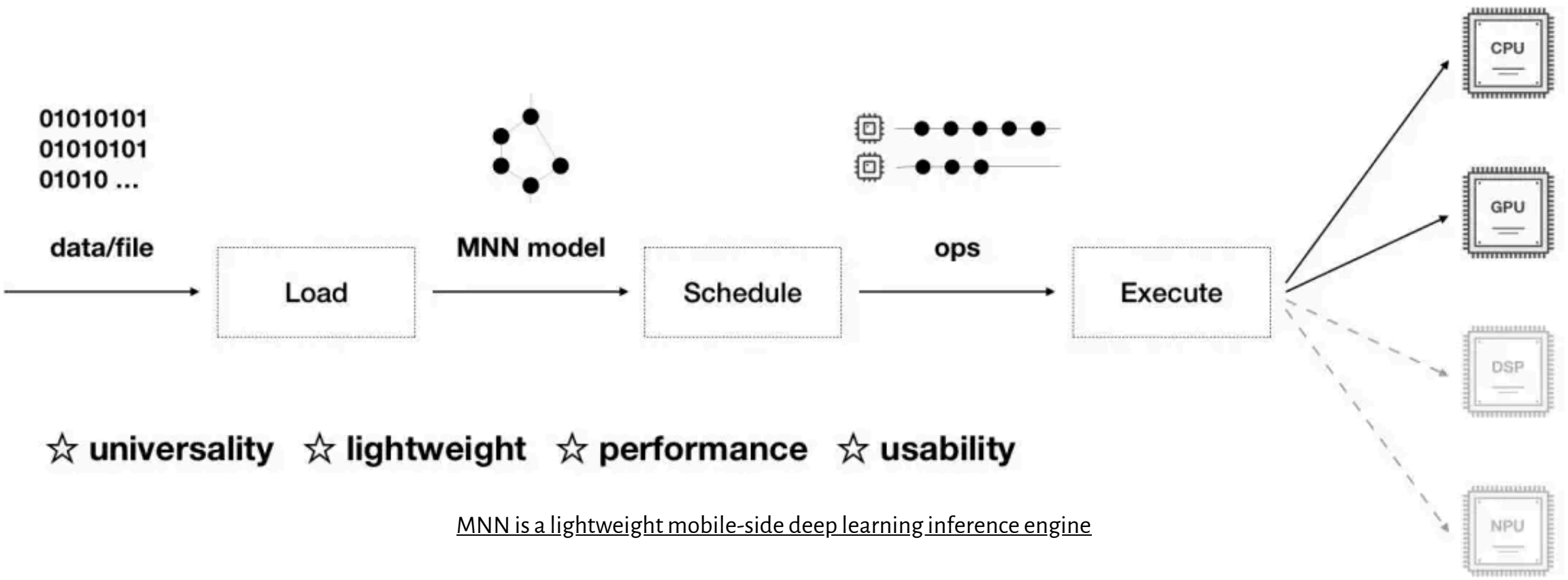
Choosing the Right Model



1. **Pick small, efficient models**: Large models like GPT-4 require too much power. Use lightweight models like Mistral-7B, Phi-2, or Gemma, optimized for mobile use.
2. **Use quantized models**: Quantization reduces model size and speeds up inference. Formats like GGUF and 4-bit int quantization make models run efficiently on phones.
3. **Fine-Tuning for better performance**: Pre-trained models can be optimized for tasks like summarization, and coding. LoRA fine-tuning makes models smaller and faster.
4. **Choose models based on use case**:

- Chatbots & general AI: Mistral-7B (GGUF)
- Code generation: Phi-2 (int4 quantized)

Picking an Inference Engine



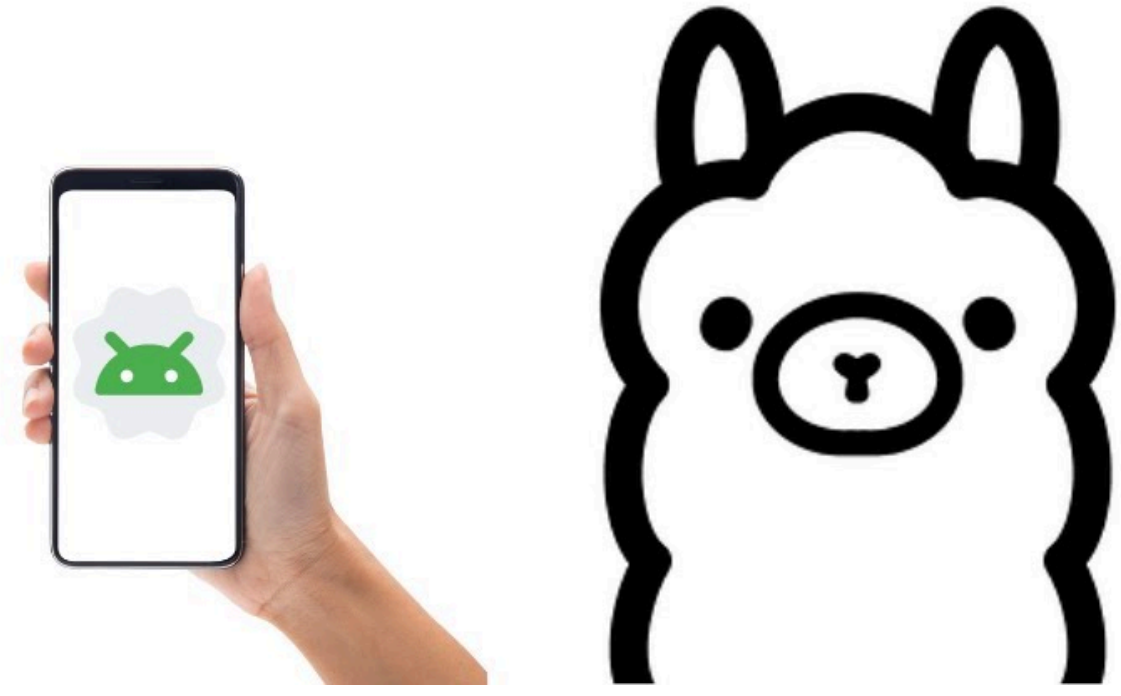
MNN is a lightweight mobile-side deep learning inference engine

1. **Use a lightweight engine for mobile**: General AI frameworks are too heavy for phones. Use llama.cpp (GGUF models), MobiLLM or ONNX Runtime.
2. **Leverage hardware acceleration**: AI inference is slow without acceleration. Use Core ML (Apple), MPS (iOS AI boost), CUDA/TensorRT (NVIDIA for Android), or NNAPI.
3. **Optimize for Low memory usage**: Phones have limited RAM, so use GGUF models with llama.cpp, TFLite , or ONNX Runtime Mobile to reduce memory needs.
4. **Match engine to your model:**

- Apple devices: Use Core ML or MPS for max efficiency.
- Android AI apps: Use TensorRT or TFLite for GPU speed-ups.

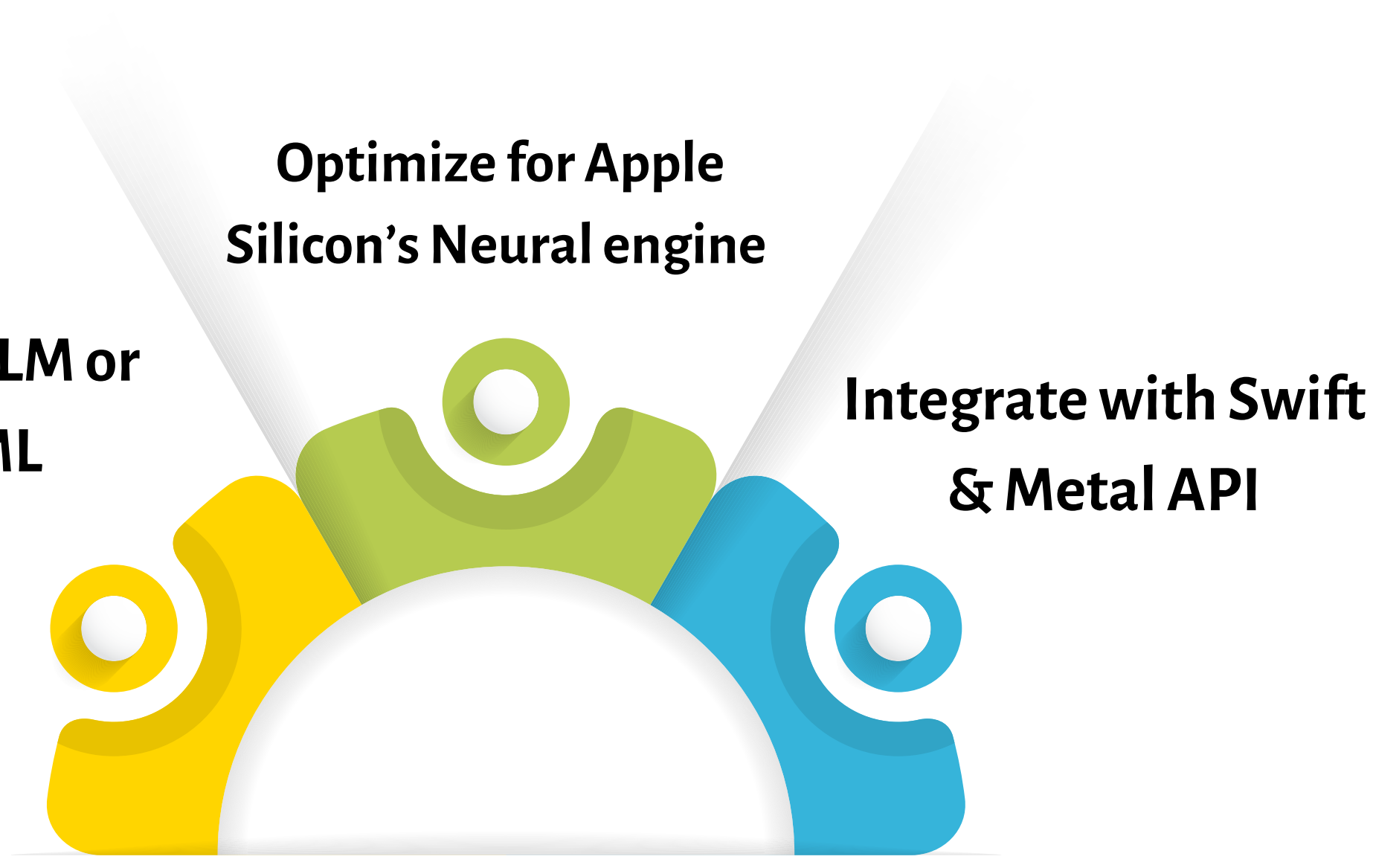
LLMs on Android

Run Offline LLMs on Android



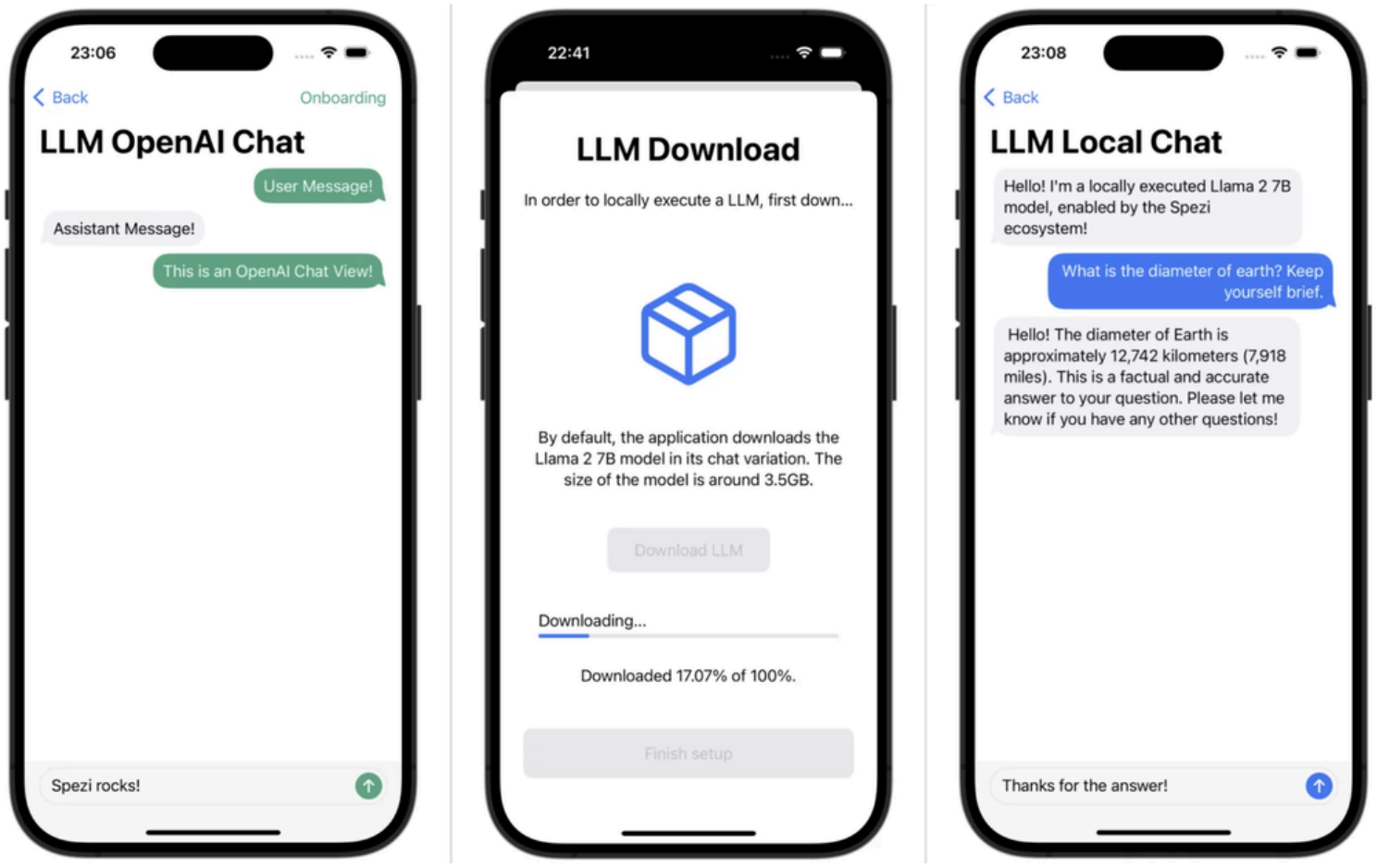
- **Use GGUF models with llama.cpp** – GGUF is a highly optimized format for running LLMs efficiently on mobile devices. llama.cpp enables on-device inference with minimal resource usage.
- **Deploy with Java/Kotlin + JNI bindings** – Since llama.cpp is written in C++, use JNI (Java Native Interface) bindings to call it from Java/Kotlin in Android apps.
- **Convert to TensorFlow Lite for speed** – TensorFlow Lite (TFLite) provides optimized execution for mobile hardware, using NNAPI or GPU acceleration for faster inference.

LLMs on iOS



- **Use MLC LLM or Core ML** – MLC LLM (from MLC AI) and Core ML enable efficient, Apple-optimized LLM execution directly on iOS devices.
- **Optimize for Apple Silicon’s Neural engine** – Apple's ANE (Apple Neural Engine) drastically improves inference speed and reduces battery drain compared to CPU-based execution.
- **Integrate with Swift & Metal API** – Use Swift for app development and Metal Performance Shaders (MPS) to accelerate model execution on the iPhone/iPad GPU.

Building a Simple LLM App



Source

1. **Choose your Tech stack**:
   - Android: Use React Native, Flutter, or native Kotlin for development.
   - iOS: Go with Swift (Core ML), React Native, or Flutter for cross-platform.
2. **Set up your backend:**
   - Local: Run models fully offline using llama.cpp, ONNX Runtime, or Core ML.
   - Server-Based: Host an LLM on a FastAPI/Flask backend if local execution is slow.
3. **Load the LLM in your App**:
   - Android: Use llama.cpp (GGUF models) or TensorFlow Lite for local inference.
   - iOS: Use Core ML models for optimized Apple Neural Engine (ANE) execution.
4. **Add a Chat interface**:
   - Flutter: Use the ChatBubble package for an interactive UI.

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