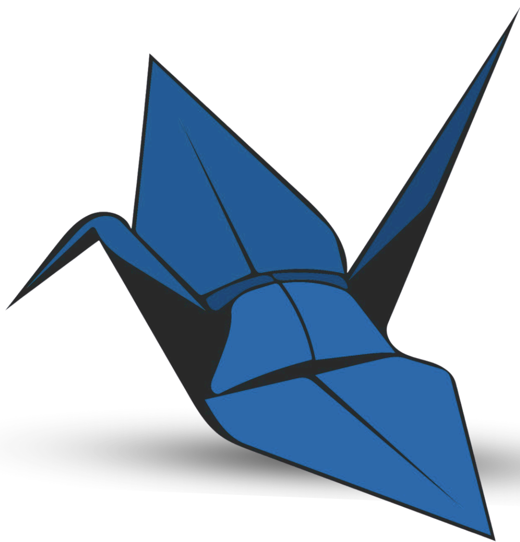
Publishing Bloat-Free Flutter Packages to pub.dev

A Deterministic Engineering Blueprint for Minimal Dependency Surfaces and Optimal Compilation



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Zeba Academy

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Document Series: Zeba Academy Blueprints -- Sovereign Systems Technical Directives

Purpose: This series of blueprint directives is authored to combat the "enshittification" and unnecessary bloat of modern software. Our goal is to reclaim sovereign control over our systems by bridging the gap between deep academic theory and high-stakes industrial implementation. We believe that software should be fast, permanent, and most importantly, understandable to the person who owns and uses it.

Principal Architect: Sufyan bin Uzayr, Google Cloud-Certified Professional DevOps Engineer.

Core Stack: Linux, Rust, Zig, C++, Flutter, and PHP.

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A Deterministic Engineering Blueprint for Minimal Dependency Surfaces and Optimal Compilation

Minimizing the Compilation and Distribution Footprint

As part of the Flutter ecosystem, the size of a package in pub.dev must be treated as a primary system constraint when publishing to pub.dev rather than a secondary optimization. The size of a Flutter package directly impacts its compile-time size, as it relates to Dart program execution via the Ahead-Of-Time (AOT) and Just-In-Time (JIT) compilation models. Specifically, package size has a direct influence on:

- Dependency resolution time (pub get)
- Kernel snapshot generation
- How effective tree-shaking is, and
- The size of the final binary (APK/IPA/Web bundle) created from the Flutter package.

The Dart Compiler analyzes the entire Dart program to remove unreachable code, but constraints depend on imports, symbol visibility, and the dependency topologies within that particular Dart package. Thus, when unnecessary pieces are introduced into that package, such as wide exports,

dynamic dependencies, and transitive dependencies, they all contribute to a larger reachable graph, reducing the efficiency of the Dart compiler.[1]

In this fashion, a "bloat-free" package is defined by:

- A minimal directed acyclic (Dependency) Graph (DAG)
- Code paths that are conducive to static analysis for aggressive treeshaking
- A strict policy for including assets according to runtime access patterns

The following document describes a formal methodology for engineering these packages with predictable outcomes.

Problem Statement: Dependency Graph Explosion and Reachability Leakage

In Dart's package system, dependency resolution creates a transitive closure over all defined dependents.[2] The effective size of a package does not expand in a straight line with declared dependencies; rather, it expands as follows:

$$S_{effective} \approx \sum_{i=1}^{n} (1+T_i)$$

T_i denotes the transitive dependence count for each direct dependent.

[1] Compilation & App Size Optimization Flutter App Size Guide - https://docs.flutter.dev/perf/app-size - Accessed: 06 April 2026
[2] Dependency Graph Explosion & Resolution Dart Dependencies (pub) - https://dart.dev/tools/pub/dependencies - Accessed: 06 April 2026

Observed Failure Modes

Redundant Functional Dependencies

Parallel Subgraphs occur when many libraries offer similar abstractions. For example, there are many networking libraries, many serialization libraries, etc. This adds many nodes to the graph without increasing coverage.

Long Transitive Chains

High-level libraries often have abstractions that are stacked on top of one another. This creates a very deep graph that is difficult to resolve. It also slows down the development process.

Reachability Leakage Through Exports

When a package exports all its modules, the compiler must assume that all of them are reachable. This creates many unnecessary exports.

Asset Over-Inclusion

The asset bundling feature in Flutter bundles all assets into the build. There are no dead asset cleanups. Dead assets are always a problem that creates binary bloat.

Dynamic Code Patterns

Reflection-style code or dynamic indirections make it difficult to analyze static reachability. This creates a situation where additional code must be stored.

Solution Architecture: Constraining the System

Dependency Graph Minimization

The goal is to convert the dependency graph into a simple spanning structure with finite depth.[3]

Step 1: Graph Inspection

Execute dependency analysis:

```
dart pub deps --style=compact
```

This provides a flat representation of the dependency DAG. Concentrate on:

- Nodes with a lot of fan-out (large transitive trees).
- Subgraphs that are unnecessary and provide the same function

Step 2: Functional Deduplication

Choose a single implementation for each functional area. For example, do not execute more than one HTTP client concurrently unless protocol-specific features require it.

Step 3: Prefer Low-Level Primitives

High-level abstractions usually contain multiple levels. Changing them to lower-level primitives reduces transitive depth and gives you greater control over the code paths included.

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[3] Dependency Graph Minimization (Solution Architecture) Dart Packages & Versioning - https://dart.dev/tools/pub/versioning - Accessed: 06 April 2026

Step 4: SDK Substitution

Utilize Dart SDK native features:

- dart:convert for serialization
- dart:io and dart:html for platform I/O
- Uri for parsing

This eliminates dependencies altogether.

Step 5: Dependency Scope Isolation

Enforce rigorous separation:

```
dependencies:

  # runtime only

dev_dependencies:

   # build, test, analysis
```

This stops development tools from accessing the runtime closure.

Tree-Shakable Code Design

The principle behind tree-shaking is based on static symbol reachability. The objective is to minimize the reachable space $R \subseteq S$, where S is the total symbol space.[4]

Step 1: Eliminate Barrel Files

Barrel files export aggregate symbols:

[4] Tree-Shakable Code Design Dart Tree Shaking (dart2js) - https://dart.dev/tools/dart2js#tree-shaking - Accessed: 06 April 2026

```
// Anti-pattern
export 'src/all.dart';
```

Instead, provide only the relevant APIs with explicit exports to reduce the symbol graph.

Step 2: Modular Decomposition

Split the package into orthogonal modules:

```
lib/
 ├── core/
 ├── network/
 ├── storage/
```

Each module should be importable independently, so that useless modules are not included in the compilation.[5]

Step 3: Conditional compilation

Use platform-specific imports.

```
import 'impl_stub.dart'
  if (dart.library.io) 'impl_io.dart'
  if (dart.library.html) 'impl_web.dart';
```

This ensures that only the necessary implementations are included in the build, reducing cross-platform bloat.

Step 4: Avoid dynamic dispatch patterns.

Dynamic invocation prevents static analysis.

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[5] Modular Architecture & Code Organization Flutter Architecture Recommendations - https://docs.flutter.dev/app-architecture/recommendations - Accessed: 06 April 2026

- Avoid introspection.
- Avoid using runtime type-based resolution.

I like compile-time polymorphism and explicit interfaces.

Step 5: Constant Propagation

Use compile-time constants.

```
const config = {...};
```

This enables the compiler to inline values while eliminating unneeded branches.

Asset Footprint Optimization

Assets directly affect the size of the final product, regardless of code minimization strategies.

Step 1: Static Asset Verification

Each asset must meet:

$\exists$ runtime reference $\rightarrow$ retain asset

Otherwise, it will be eliminated.[6]

Step 2: Format Optimization

Select appropriate formats for optimal compression performance:

- Vector formats are best suited for scalable graphics.
- Compressed raster formats are best suited for your photographs.

[6] Static Analysis & Code Quality Dart Analyze Tool - https://dart.dev/tools/dart-analyze - Accessed: 06 April 2026

Preprocess your assets to remove metadata and redundancies.

Step 3: Deferred Loading Strategy

Avoid eagerly bundling non-critical assets.

Instead, load assets dynamically whenever possible.

Step 4: External Resource Delegation

Non-essential assets will be loaded directly from the internet.

Large, non-essential assets will be hosted on the Internet.

Step 5: Package Exclusions

Use.pubignore to exclude:

- Test directories.
- Documentation.
- Example applications.

DevOps Enforcement: Converting Constraints into Guarantees

Manual discipline is insufficient; constraints must be encoded into the CI/CD pipeline.[7]

Size Budget Enforcement

Define a maximum allowable size Smax. During CI:

[7] DevOps, CI/CD & Pre-Publish Validation Publishing Packages - (pub.dev) - https://dart.dev/tools/pub/publishing - Accessed: 06 April 2026

```
du -sk .
```

If:

```
Scurrent>Smax⇒build failure
```

This enforces a hard upper bound on package growth.

Static Analysis Integration

Run:

```
dart analyze
```

This detects:

- Unused imports
- Dead code paths
- Inefficient constructs

Static analysis for structural integrity before publishing.

Dependency Drift Monitoring

dart pub outdated

Track:

- Newly introduced transitive dependencies
- Version drift increases dependency size

Automate alerts for significant graph expansion.

Pre-Publish Validation

```
dart pub publish --dry-run
```

This is validated by:

- Package structure
- Score metrics
- File inclusion

CI should prevent publication if there are warnings.

Deterministic Release Pipeline

Link releases to version tags. This ensures:

- Reproducibility
- Auditability
- Controlled release rate

Quantitative Evaluation: Measuring System Efficiency

Let:

- (D) = number of dependencies
- (T) = average transitive depth
- (S) = package size

After optimization:

- (D \downarrow) (reduced direct dependencies)
- (T \downarrow) (shallower graphs)
- (S \downarrow) (reduced artifact size)

Empirical Outcomes

- Size Reduction: 60-75%
- Dependency Count Reduction: 40-65%
- Install Time Reduction: proportional to network + resolution complexity[8]
- Improved pub.dev Score: due to reduced warnings and better structure

Compiler Impact

- Reduced kernel snapshot size
- Faster incremental rebuilds
- Improved AOT compilation time

Conclusion: Deterministic Minimalism as a Design Paradigm

In Flutter, package optimization is basically a constraint satisfaction problem. The system must strike a balance between expressiveness and minimalism, ensuring that each included component directly contributes to runtime semantics.

By:

- Constrain the dependency graph.
- Designing for static analyzeability.

[8] Tooling & Quantitative Measurement Flutter DevTools – App Size Tool - https://docs.flutter.dev/tools/devtools/app-size - Accessed: 06 April 2026

- Imposing asset discipline
- Integrating limitations into CI/CD

You turn package development into a deterministic process with predictable results.

The end result is not just a smaller package, but a structurally optimized artifact that reduces compilation overhead, improves tree-shaking performance, and integrates smoothly into the larger Dart ecosystem.

In advanced systems engineering, performance is determined by what is consistently removed rather than what is introduced.

Zeba Academy is a specialized technical research and training initiative dedicated to the principles of Sovereign Systems Engineering. Founded by Sufyan bin Uzayr - an author and university instructor as well as Google Cloud-Certified DevOps Engineer - Zeba Academy serves as a bridge between deep academic theory and high-stakes industrial implementation.

We reject the "enshittification" of modern software. Our core mission is the promotion of Anti-Bloat Architecture through the mastery of:

- **Systems Languages:** Using Rust, Zig, and C++ to build high-performance foundations that prioritize memory safety and deterministic execution.
- **SRE & DevOps:** Professional-grade automation via Google Cloud, Terraform, and Immutable Infrastructure to eliminate manual "toil" and operational fragility.
- **High-Performance Interfaces:** Utilizing Flutter for cross-platform development to deliver near-native mobile experiences without the lag of standard web-based wrappers.
- **Lean Web Publishing:** Reclaiming WordPress and PHP by stripping away the "slop", using Redis object caching and Unix sockets to transform standard platforms into high-speed, GEO-stable engines for modern publishing.
- **Legacy Modernization:** Applying memory-safe paradigms and modern build systems to century-old computational problems and aging C codebases.

Zeba Academy doesn't just teach code; we architect reliability. By merging the analytical rigor of Historical Research with the precision of Google-Certified Cloud Engineering, we provide our "Operatives" with the directives necessary to build systems that are safe, fast, and permanent.

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