Tutorial at Datasys Congress 2021

Extract “Feature Architecture”

of your Software Application

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Tajmilur Rahman, PhD, is an **assistant professor** in the department of Computer and Information Science at **Gannon University** in Erie, Pennsylvania, United States. Dr. Rahman received his doctorate degree in 2018 from Concordia University, Montreal QC, Canada.

His overarching research interest is to **investigate release engineering practices** in software systems. His research interests also include **software engineering** & **data science**, understanding the significance of software architecture for **long lasting software systems**, and providing tool support to the community to nurture **software feature architecture**. He is also interested in studies on software engineering education.

Dr. Rahman is the first author who extracted *feature-architecture*. His currently ongoing research works include, software release management, software quality prediction in rapid-release, predict potential architectural drift, and software engineering education.

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Outline

- Software architecture
- Why we must be aware of architecture
- How do we extract software architecture
- Traditional approach
- Modern release engineering
- Trunk based development
- Feature toggles
- Feature architecture
- Extracting Feature Architecture
- Benefits of Feature Architecture

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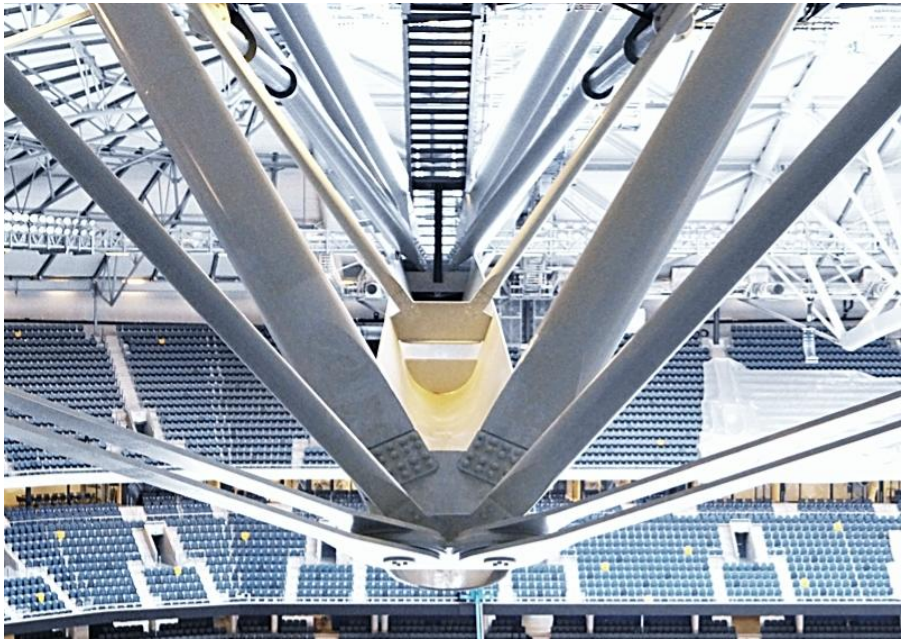
Software Architecture

- Fundamental structure/organization of a system



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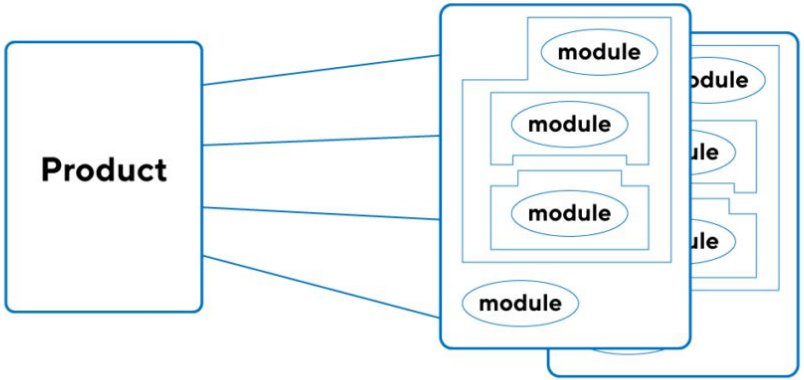
Software Architecture

- Fundamental structure/organization of a system

> “Architecture is an abstract description of the entities in a system and relationships between them.[1]
>
> *- Zhang Jianfei, Senior Technical Expert, Alibaba*



Software Architecture

> Software architecture is a draft of the system.[1]
>
> - Zhang Jiang, Senior Technical Expert, Alibaba

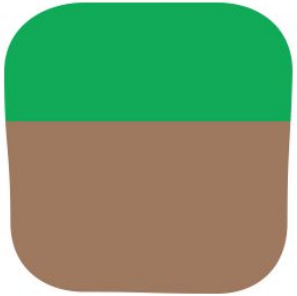
> Software architecture is the design decisions that need to be made early in a project.[4]
>
> - Martin Fowler, ThoughtWorks

Why architecture matters?

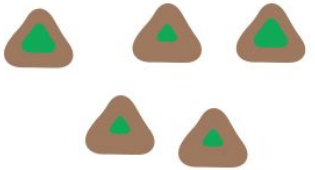
Poor architecture contributes to generating a lot of “cruft”

*Any software system has a certain amount of **essential** complexity required to do its job...*

*... but most systems contain **cruft** that makes it harder to understand.*

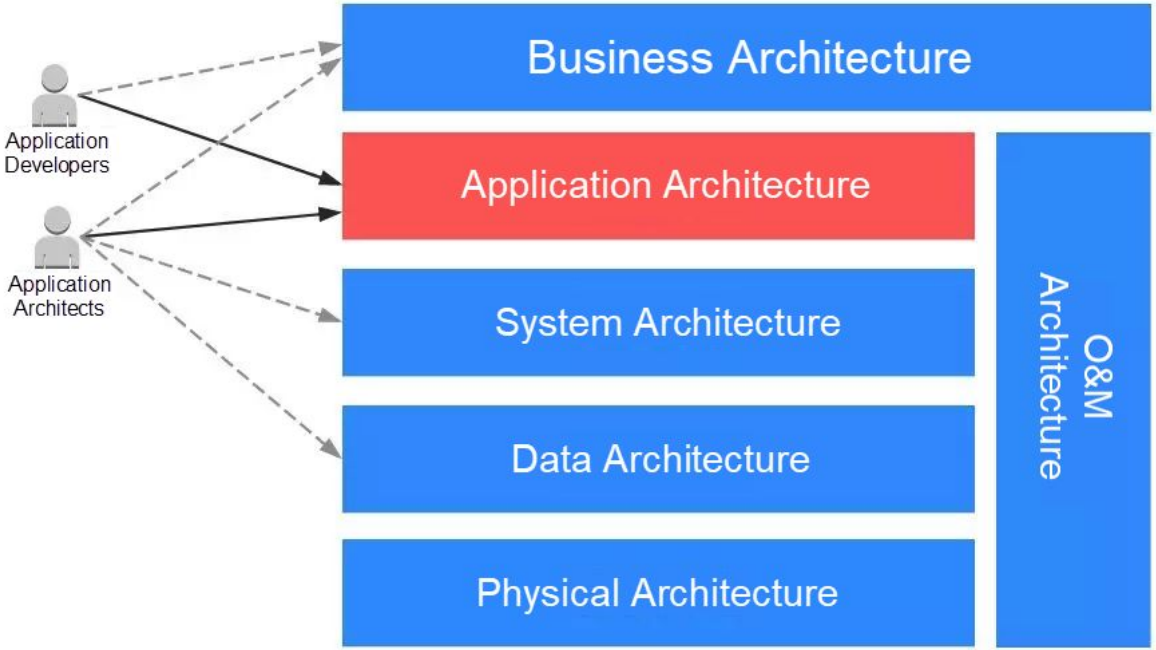


*Cruft causes changes to take **more effort***



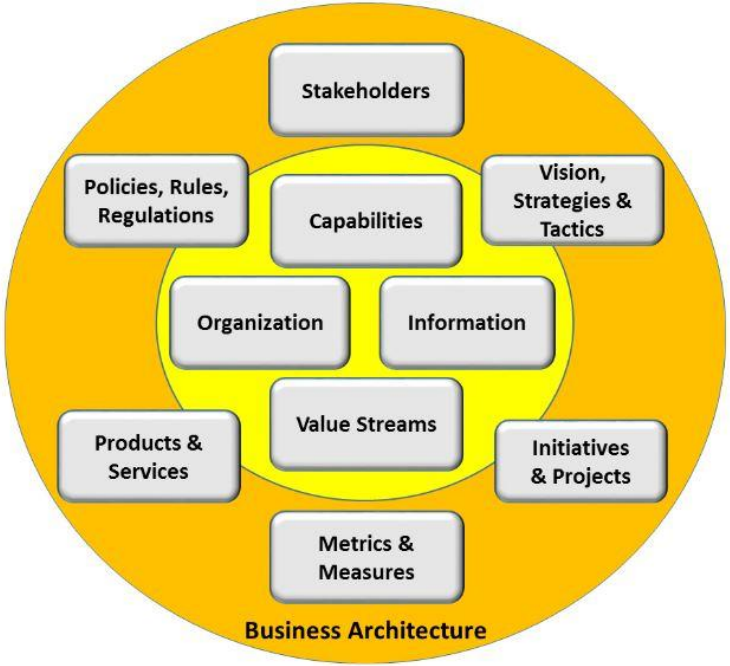
The technical debt metaphor treats the cruft as a debt, whose interest payments are the extra effort these changes require.

Software Architecture Categories



Business Architecture

- Directed by
  - Business model analysts
  - Business domain experts
  - Industry experts



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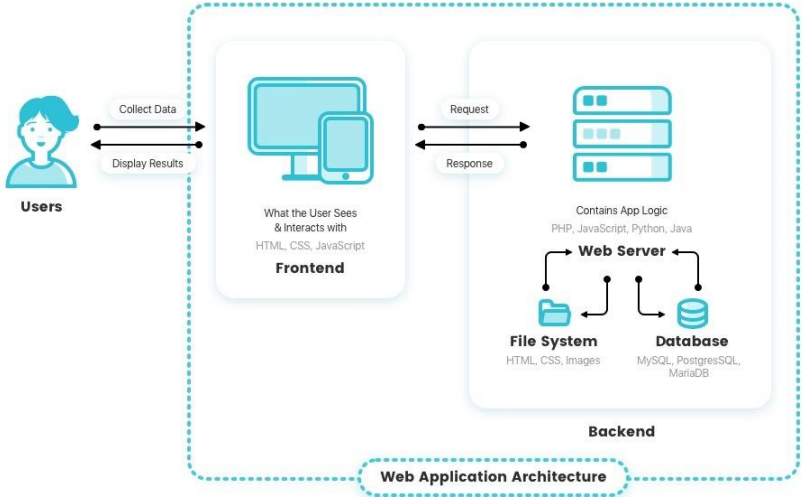
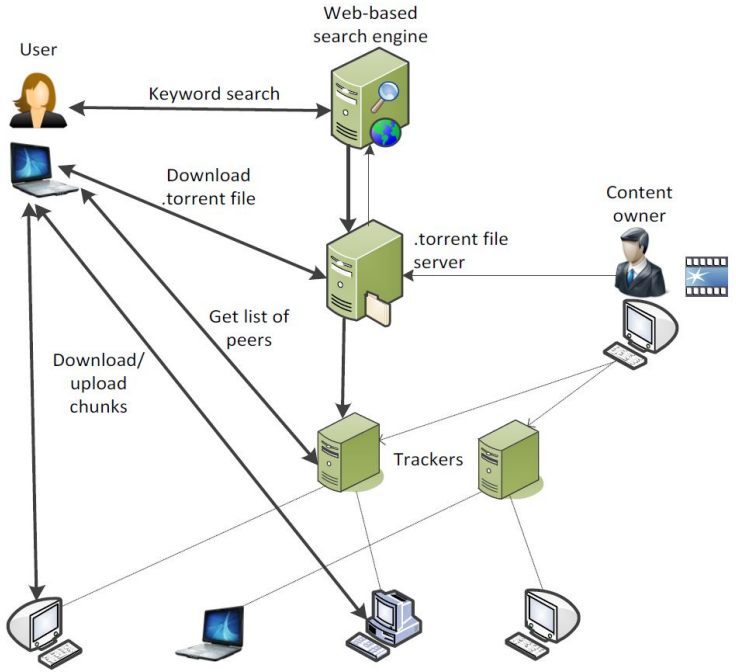
Application Architecture

- Directed by
  - Application Analysts:
    - Design application layers
    - Application specifications
    - API and Data integration / interaction protocols



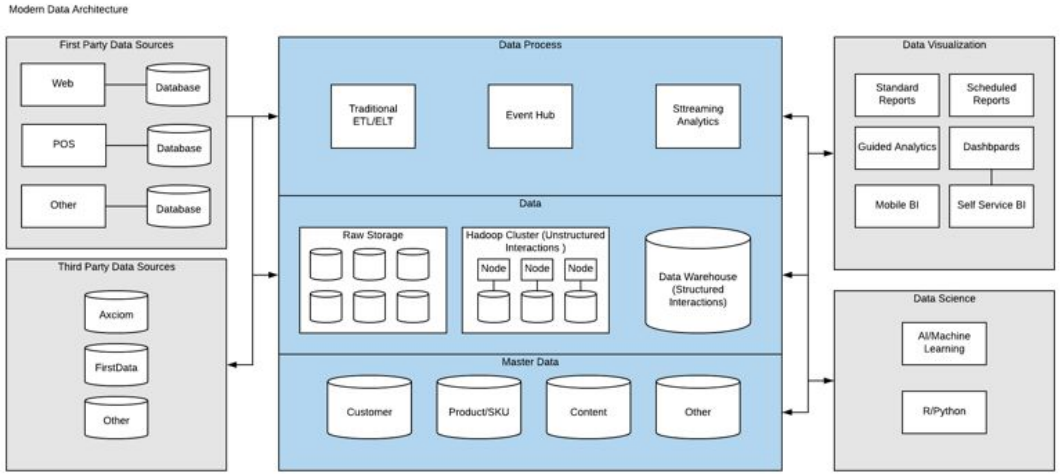
Distributed System Architecture

- Architect needs to keep balance among
  - Consistency
  - Availability
  - Partition tolerance



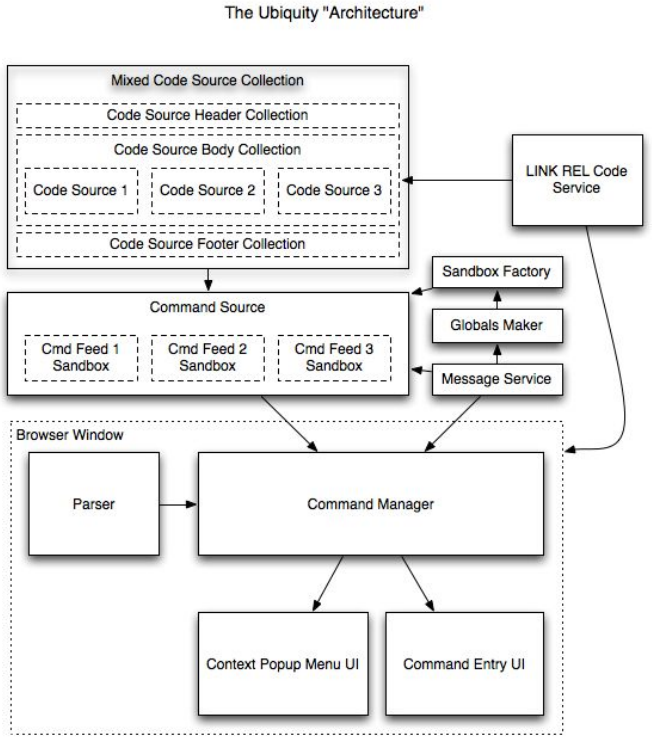
Data Architecture

- Data governance
  - Important for large systems
  - Unify data definition specifications
  - Standardize data expression
  - Unified data processing platform



Physical Architecture

- Focuses on the layout
  - Data center construction
  - Network topology
  - Servers
  - Storage
  - Hosts



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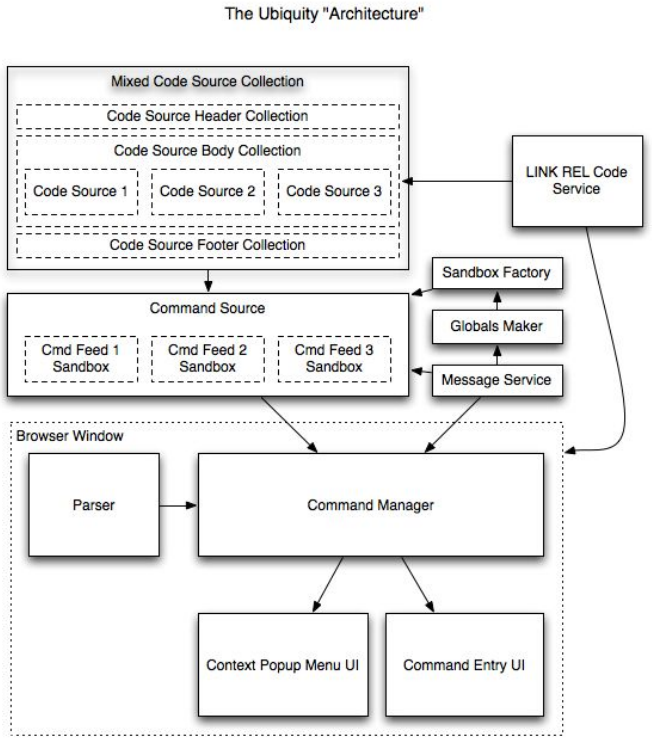
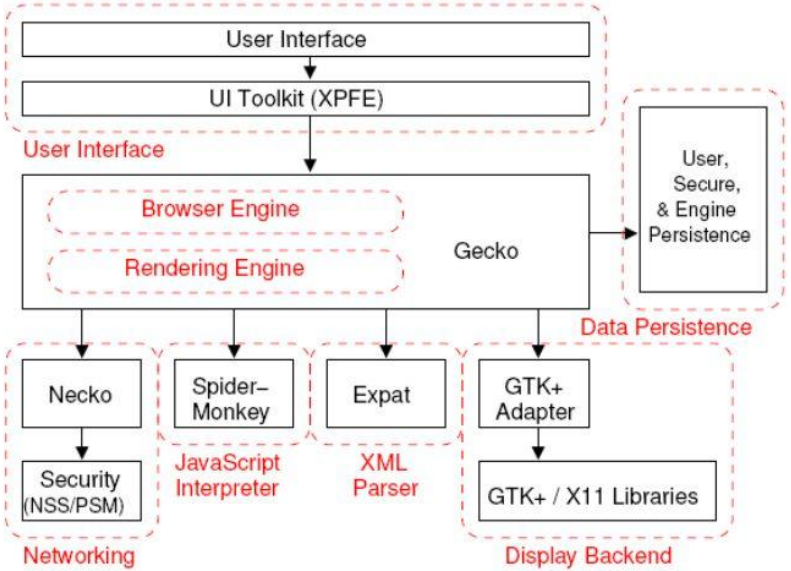
Physical Architecture

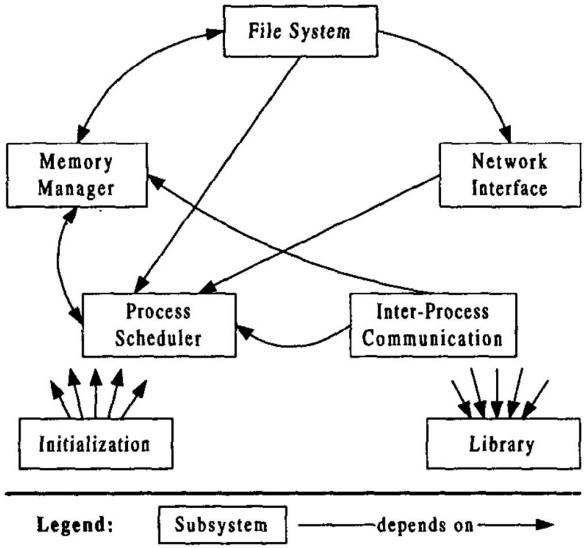
- Types
  - Conceptual Architecture
  - Concrete Architecture



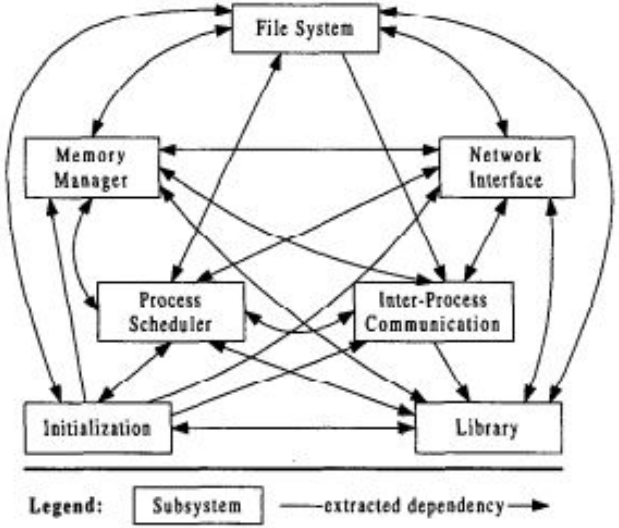
Conceptual Architecture



Conceptual and Concrete Architecture - Linux Kernel



Conceptual Architecture



Concrete Architecture

Responsibilities of Architects

- Make complex things simple
- Refine thinking for better understanding of complex systems
- Build an easy-to-understand arch.

Architecture & Agility

Many developers now prefer no architectural design for greater agility.

They think it is fine just to get started on the work.

> “
> It can mean anything from a high-level design sketch with little relationship to technology, code, or the actual system being built[2] to a big, rigid up-front design with a lot of class and code-level minutiae.[3]

Why be Aware of Architecture?

> Project teams aren’t paid for meeting a process but for delivering running software!

Extract Architecture for Better Agility

> “ Continuous attention to technical excellence and good design enhances agility

Extract Architecture for Better Agility

> “ It can mean anything from a high-level design sketch with little relationship to technology, code, or the actual system being built[2] to a big, rigid up-front design with a lot of class and code-level minutiae.[3]

> “ Continuous attention to technical excellence and good design enhances agility

Too many patches

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Better Agility

> “
> Continuous attention to the architectural drift enhances agility
>
> - Tajmilur Rahman PhD

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Extract Architecture

- To keep track of architectural drift
- Build awareness about adding new features
- Know when you increasing coupling or decoupling

Extract Architecture

How?

Approaches to Extract Architecture

- Traditional physical (modular) architecture
- Feature toggles to extract architecture

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Modern Release Engineering

- Rapid release / shorter version of release cycle
- Trunk based development
- Continuous integration and continuous delivery

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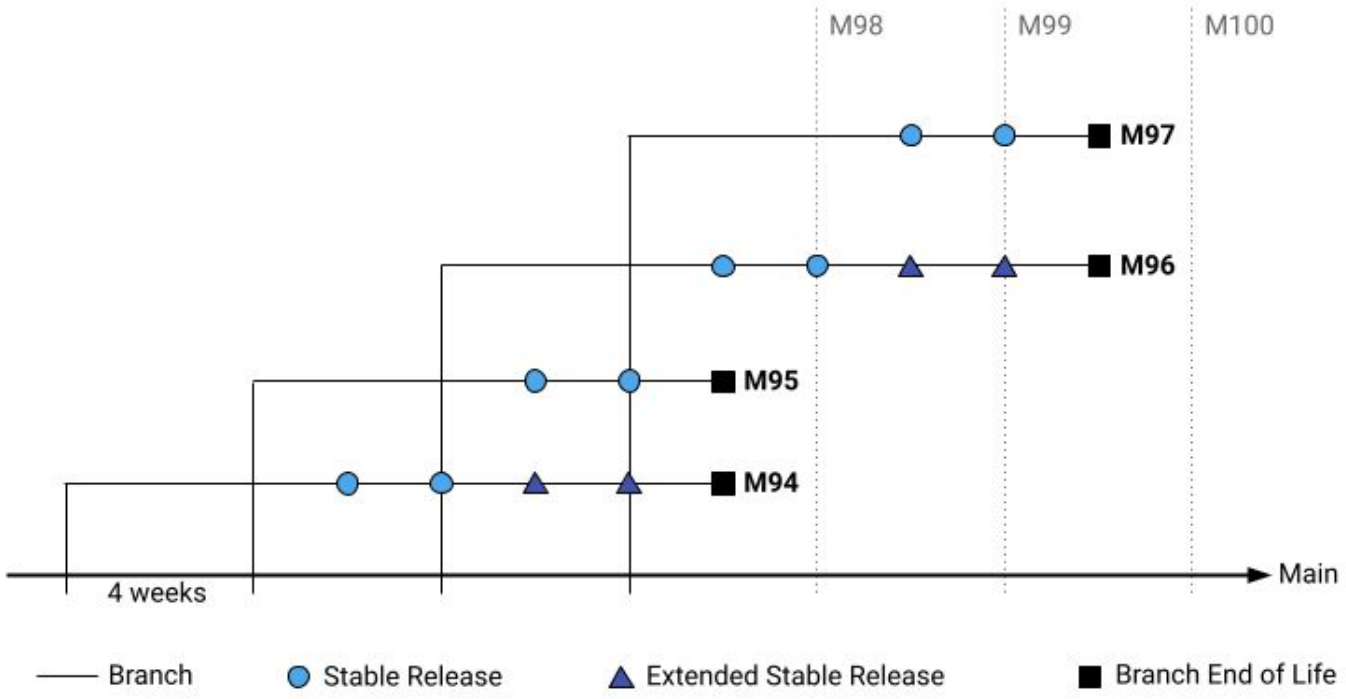
Chrome’s 4 week rapid release plan



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Feature Toggles

- A variable used in an if condition
- Hides unfinished code already merged into the trunk
- Allows controlled release of features

Feature Toggles

- Feature Toggles / Flags / Flips

File: config.properties

```
graphic_features {
        ENABLE_3D_GRAPHIC=true
        ENABLE_TOUCH_SCREEN=true
}
```

File: RenderGraphics.java

```
if(graphic_features.ENABLE_3D_GRAPHIC) {
        render3DGraphics();
} else {
        render2DGraphics();
}
```

GPU Switches / Toggles in G-Chrome

```
// Copyright 2015 The Chromium Authors. All rights reserved.
// Use of this source code is governed by a BSD-style license that can be
// found in the LICENSE file.

#include "gpu/config/gpu_switches.h"

namespace switches {

// Disable GPU rasterization, i.e. rasterize on the CPU only.
// Overrides the kEnableGpuRasterization flag.
const char kDisableGpuRasterization[] = "disable-gpu-rasterization";

// Disables mipmap generation in Skia. Used a workaround for select low memory
// devices, see https://crbug.com/1138979 for details.
const char kDisableMipmapGeneration[] = "disable-mipmap-generation";

// Allow heuristics to determine when a layer tile should be drawn with the
// Skia GPU backend. Only valid with GPU accelerated compositing.
const char kEnableGpuRasterization[] = "enable-gpu-rasterization";

// Select a different set of GPU blocklist entries with the specified
// test_group ID.
const char kGpuBlocklistTestGroup[] = "gpu-blocklist-test-group";

```

chromium/src/refs/heads/main/gpu/config/gpu_switches.cc

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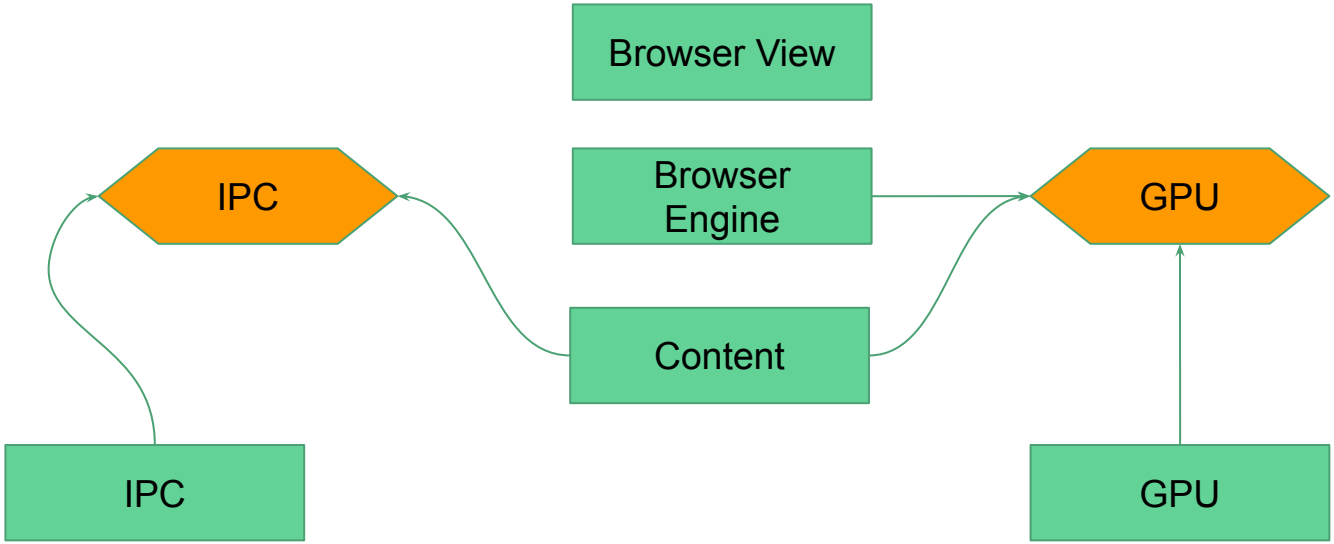
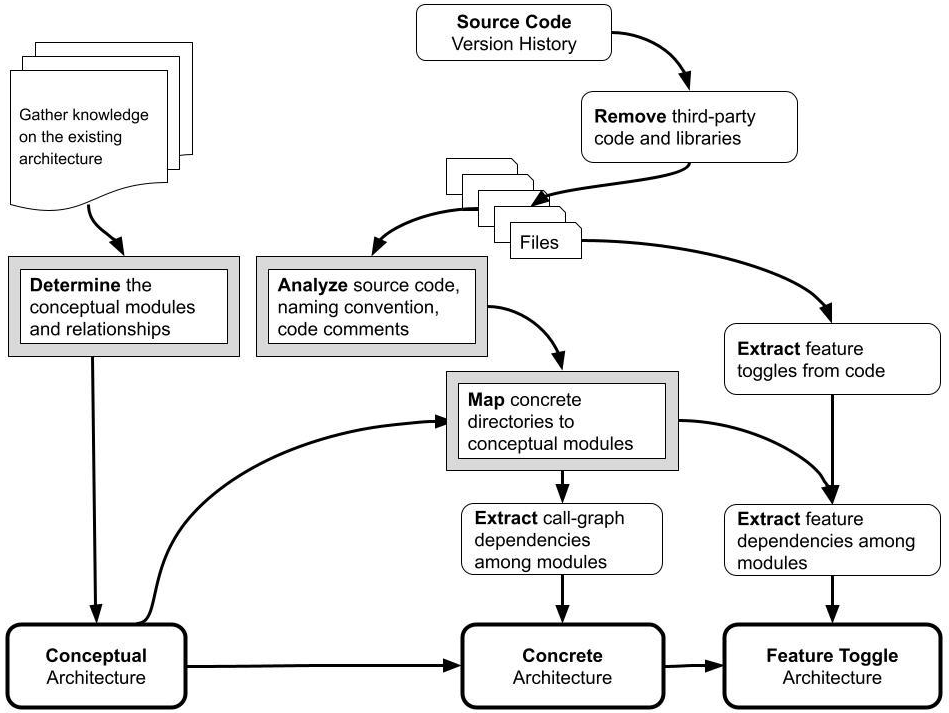
Feature Architecture

- Architecture that represents the features crosscutting the physical/modular architecture
- Shows relationships that are not visible in a modular architecture
- Shows which features are crosscutting which modules
- Shows which modules containing which features
- How two modules are dependent via common features

Feature Architecture



Extract Feature Architecture from Toggles



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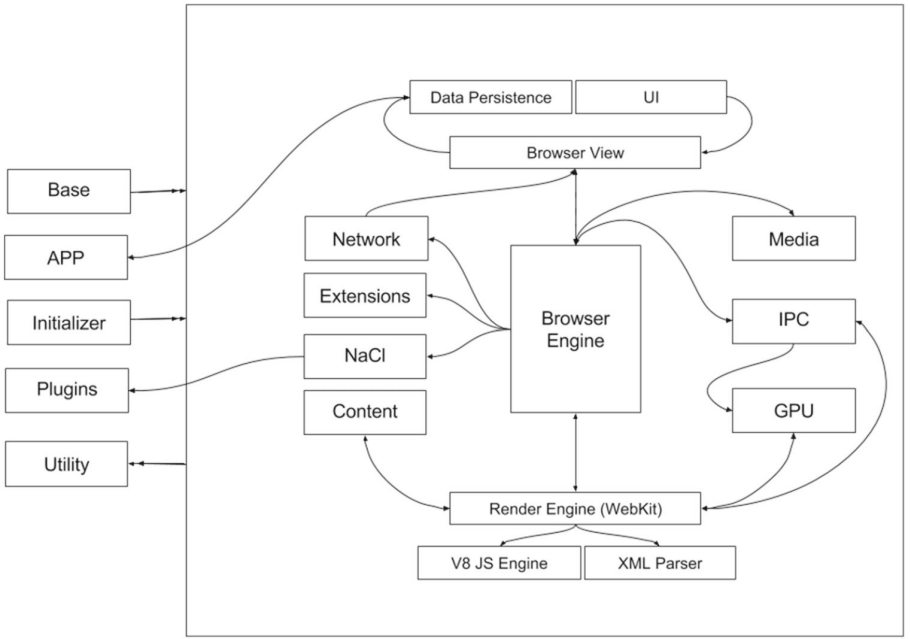
Conceptual Architecture

Gather knowledge on the existing architecture

- The initial architecture designed by architects
- If no initial architecture, then construct the conceptual architecture



Extract Feature Architecture from Toggles[5]

1. Gather knowledge on the existing architecture
2. Collect / construct the conceptual architecture
3. Take the source code and ignore all third-party code and libraries
4. Analyze naming convention, directory structure, file path
5. Map files/directories with conceptual modules
6. Extract call-graph and module-module relationships to construct the concrete architecture
7. Extract feature toggles
8. Find out feature dependencies with modules based on the map at step 5
9. Plot the *feature dependencies* and normalize based on the concrete architecture

Modular / Concrete Architecture

Traditional approach:

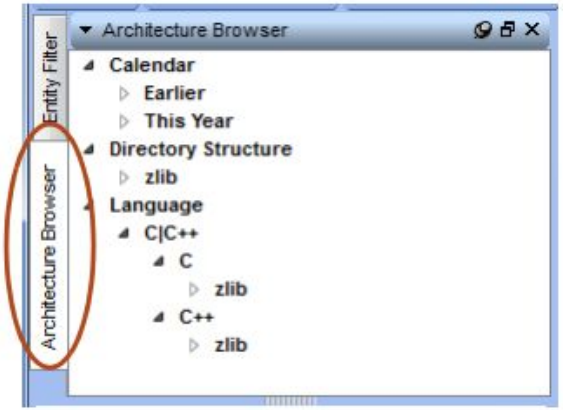
- Bowman et. al[6]
- Used automated tool (LsEdit) to extract relations from the source code then combined these relations into a concrete system architecture.
- We can use “Understand” by SciTools

Modular / Concrete Architecture

Architecture Browser[7]:

The Architecture Browser allows you to manage *architectures*. It shows a list of all the defined architectures in the database and provides a way to navigate individual architectures.

For example, this window shows the auto-architectures provided with *Understand*: Calendar, Directory Structure, Languages. The architectures are expanded somewhat here to show the top-level nodes for an example application.

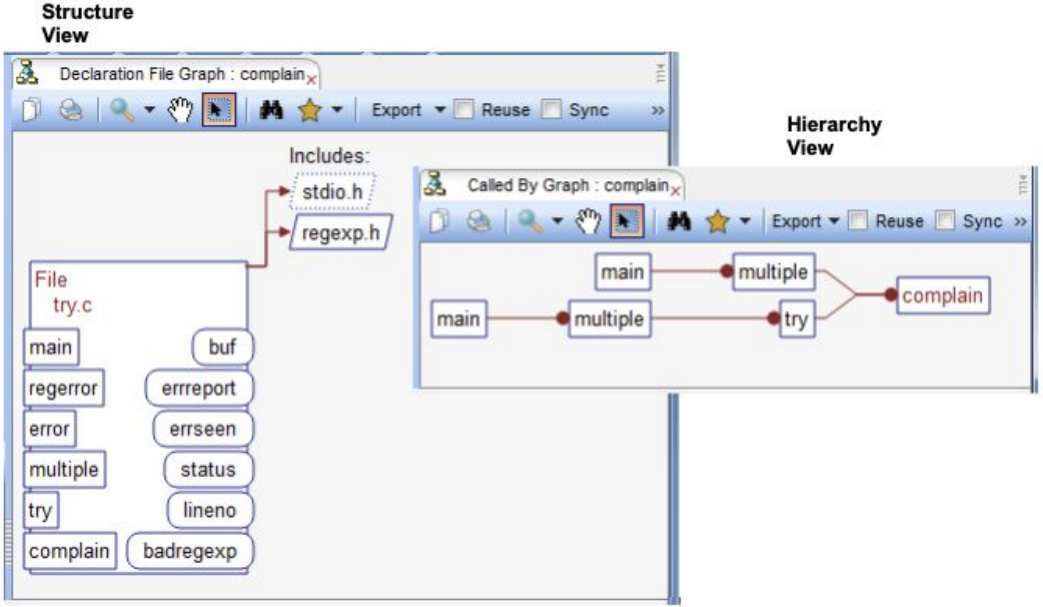


You can use the auto-architectures, create your own architectures, import and export architectures (as XML files), generate graphs and metrics for any level in an architecture hierarchy, and combine architectures through filtering.

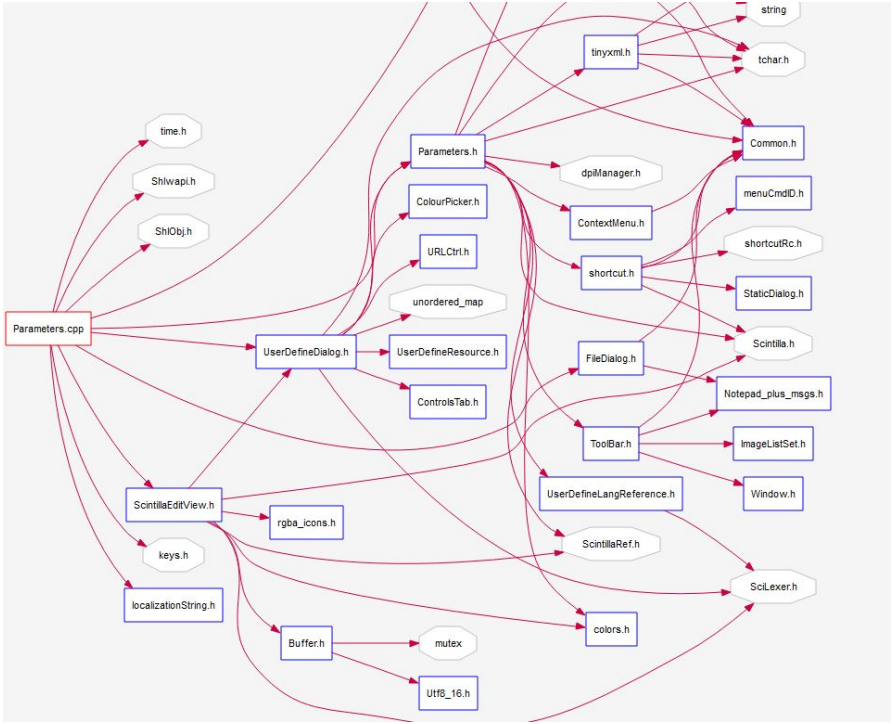
Modular / Concrete Architecture

Architecture Browser[7]:

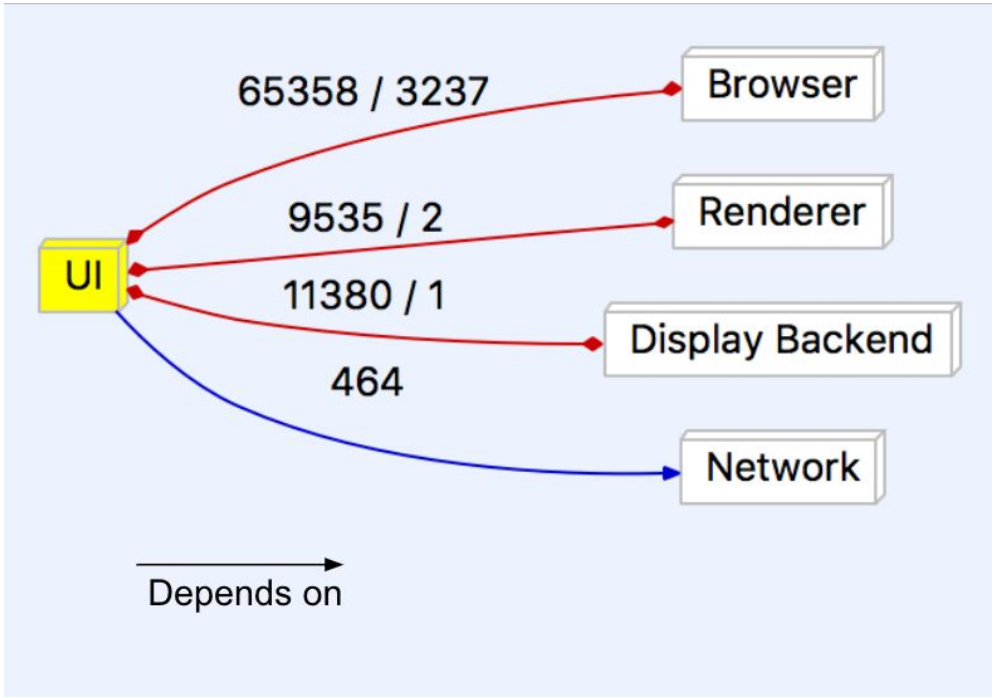
- Understand analyzes your software code and creates a database containing information about the entities and the relations between entities.
- The database can be browsed using various “graphical view” windows.
- Hierarchy views show relations between entities.
- Each view follows a relation (for instance “Calls”) from the starting entity (that you inquired about) through its children and successors.
- Structure views quickly show the structure of any entity that adds to the structure of your software (for instance a package, function, procedure, or task).



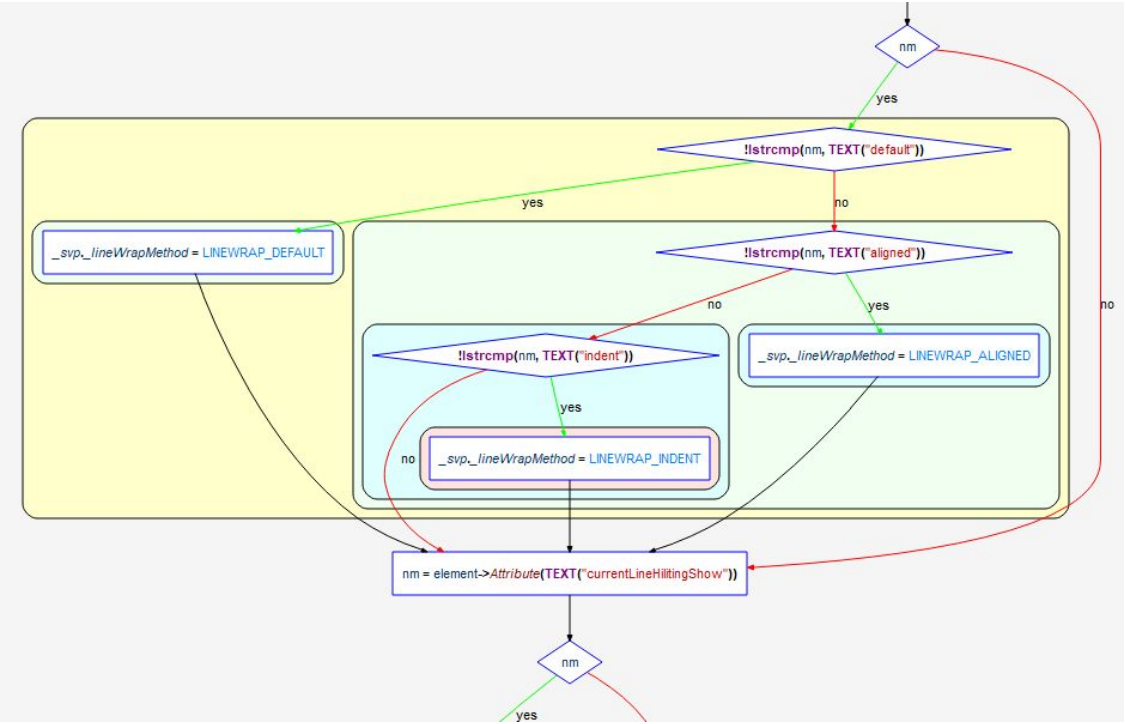
Modular / Concrete Architecture



Modular / Concrete Architecture



Modular / Concrete Architecture



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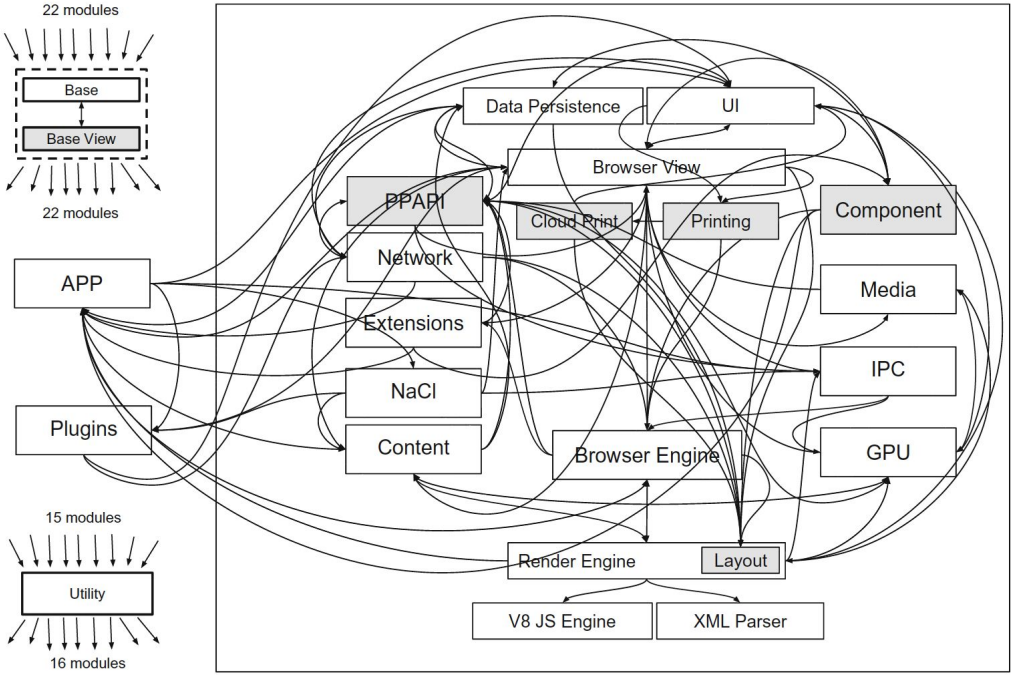
Modular / Concrete Architecture

Once directories, dependencies, call-graph are extracted:

1. Map the directory/file paths with conceptual modules

Path	Conceptual Module
content/public/common/speech_recognition_result.**cc**	Content
content/public/common/url_constants.**cc**	Content
chrome/common/ipc_channel_posix.cc	Chrome
ipc/common/mailbox_struct_traits.h	IPC
gpu/ipc/common/mailbox_struct.cc	GPU
ipc/common/ipc_switches.cc	IPC

Modular / Concrete Architecture



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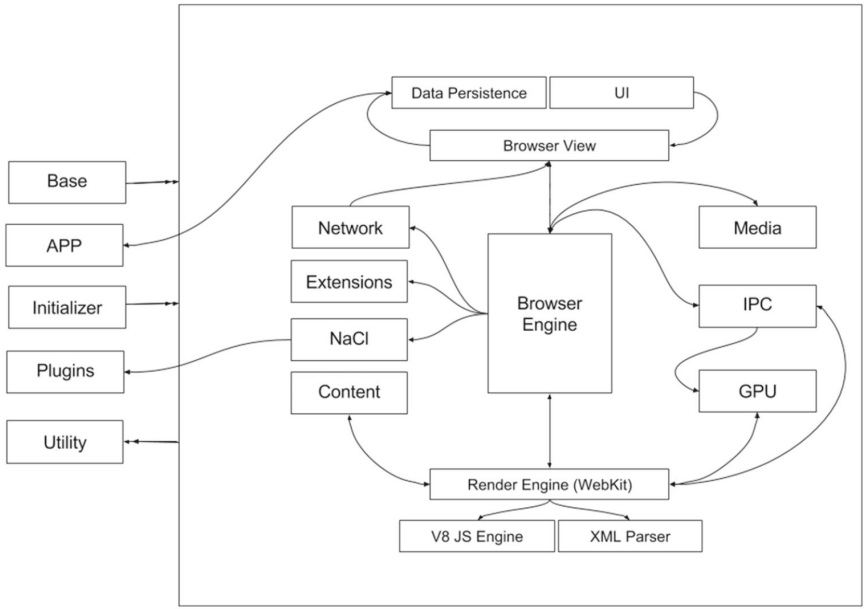
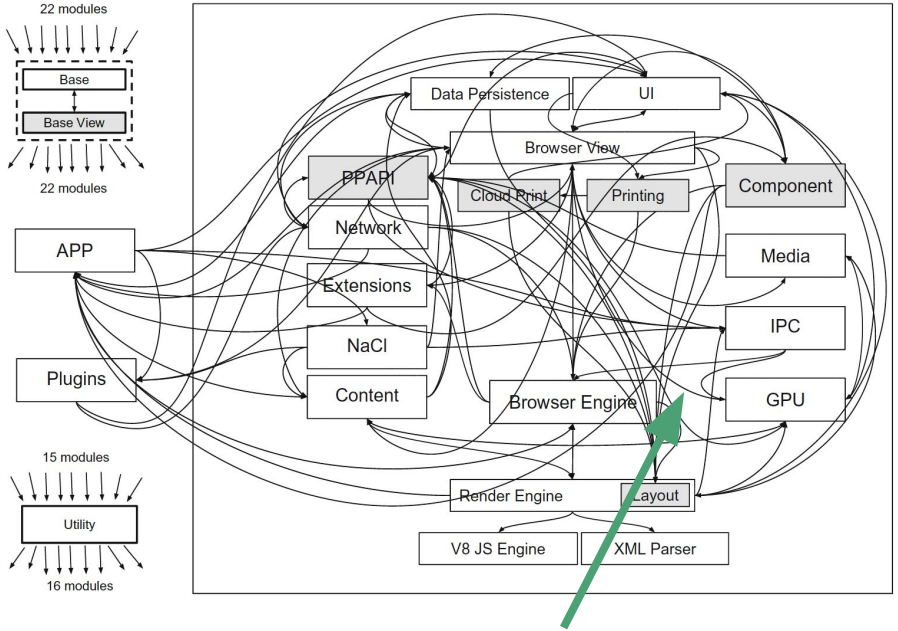
Modular / Concrete Architecture





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Extract Feature Toggles

Extract feature toggles

```
compositor_switches.cc (chrome/ui/compositor)
content_switches.cc (chrome/content/public/common)
gaia_switches.cc (chrome/google_apis/gaia)
```

(a)

```
107  // Disable 3D inside of flapper.
108  const char kDisableFlash3d[]              = "disable-flash-3d";
109
110  // Disable using 3D to present fullscreen flash
111  const char kDisableFlashFullscreen3d[]    = "disable-flash-fullscreen-3d";
```

(b)

Map Feature Toggles with Modules

Features (toggle set)	Concrete Module
content_switches	Browser View
content_switches	Content
content_switches	GPU
ui_base_switches	UI
media_switches	Content

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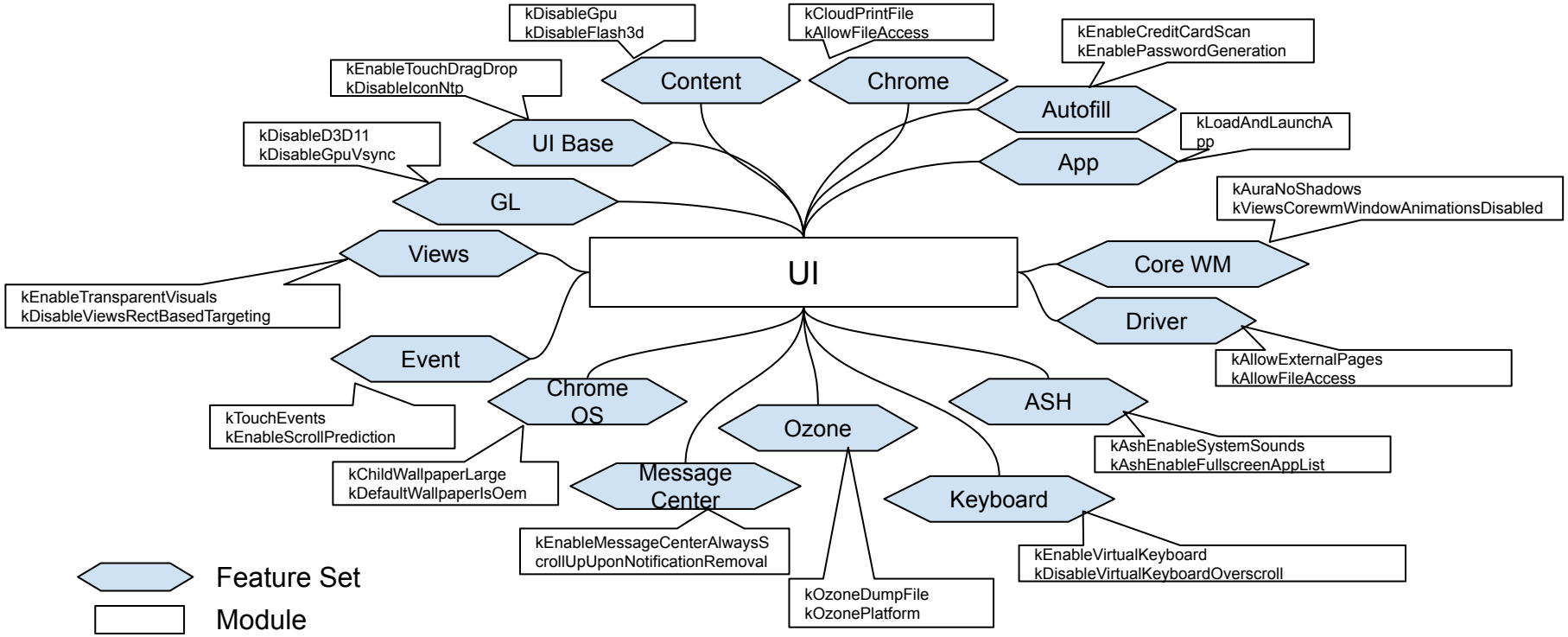
Feature Architecture for Each Concrete Module



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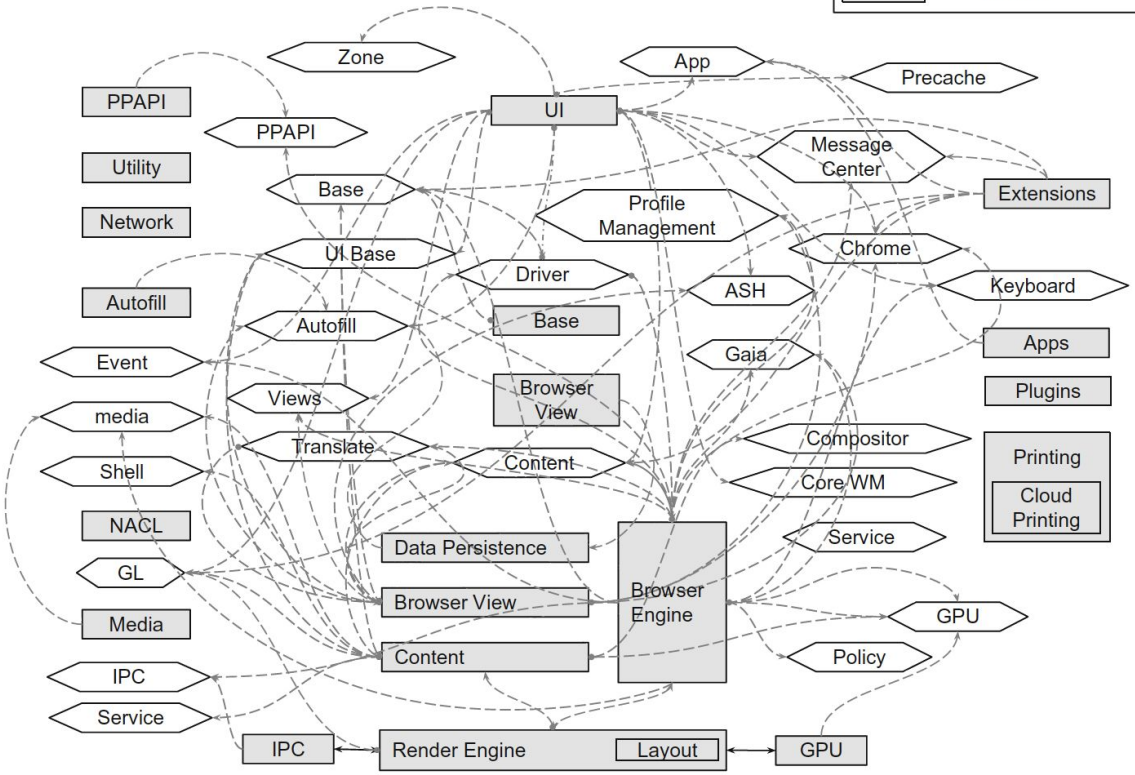

Feature Architecture

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Benefits of Feature Architecture

1. Better understand the dependencies among the modules
2. How features are cross-cutting modules
3. Developers need to know which modules are involved with a feature when modifying that feature
4. Helps making decision of adding new changes

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For more details

“The modular and feature toggle architectures of Google Chrome”

Rahman, M.T., Rigby, P.C. and Shihab, E., 2019. The modular and feature toggle architectures of Google Chrome. *Empirical Software Engineering*, *24*(2), pp.826-853.

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