# Software Engineering Completeness

***Knowing when you are Done and why it matters***

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## Who Am I

- Starting using C++ professionally in 1991

- Professional Career
  - Systems Analyst & Architect
  - 21 years as a consultant
  - Bloomberg Ticker Plant Engineering Lead

- Conference talks focused on practical Software Engineering
  - Based in the real world
  - Take something away and be able to use it

## Why?

## What does "*Done*" mean?

### Dictionary Definition:

**Done**: to work on (something), to bring it to *completion* or to a *required state*.

## What does “*Done*” mean for Engineering?

The Scrum Guide says the definition of “*Done”* is a **formal description of the state of the Increment when it meets the quality measures required** for the product.

The definition of “*Done”* is a formal description of your quality standards.

## Why bother?

The benefits of establishing a definition of **“Done”** include **creating a shared understanding and unified language for software delivery**, ensuring that new employees have **access to tribal knowledge and process expectations**

## Example

The goal of your project is to develop 10 new product features and deploy them to users. But you haven't deployed any of them yet.

Your completion percentage is 0/10 = 0%.

(This is where a manager/developer will say: "But we've coded and tested five of them; 50% of them are done!")

Real Question should be:
**When** do we expect < something specific > to be deployed and active everywhere in Production aka “***done”*****?**

## Basic Terminology

What is the *Business Value* of Software Engineering?

Delivering desired product outcomes in incremental steps

Why incremental steps ?

- Shorter time horizons
- Lower risk
- Better feedback from customers

## Basic Terminology

What is the *Business Value* of Software Engineering?

Software Value is actualized when it’s

- Available
- Usable
- Reliable

Software Value (future looking)

- Configurable
- Flexible
- Fix issues quickly
- Evolve quickly

## Production Changes

What types of improvement are delivered to Production?

- New Features
- Bug fixes
- Feature Flag changes
- Configuration
- Technical Debt reduction
  - ❑ Refactoring
  - ❑ Deprecation
- Environment / Infrastructure
  - ❑ New compiler version
  - ❑ Machine architecture

## Production Changes

What other types of change are delivered to Production?

- Broken functionality
- Missing functionality
- Performance issues
- Security issues
- System unreliability

## Production Changes

What’s in a commitment to deliver change?

## Know what are you delivering

**What are Acceptance criteria (AC)**?

Acceptance criteria are the conditions a software product must meet to be accepted by the user

Good acceptance criteria should possess:

- **Clarity:** Straightforward and easy to understand for all team members and the customer
- **Conciseness:** The criteria should communicate the necessary information without unnecessary detail
- **Testability:** Each criterion must be verifiable and clearly determined whether it has been met
- **Observable:** The focus should be on delivering results visible to the customer

Note: AC describe *what* the change will do *not* the *how*

## Know what are you delivering

### Writing Acceptance criteria (AC)

- Written by you/product owner
- Shared with the team
- Reviewed and validated with the customer/proxy

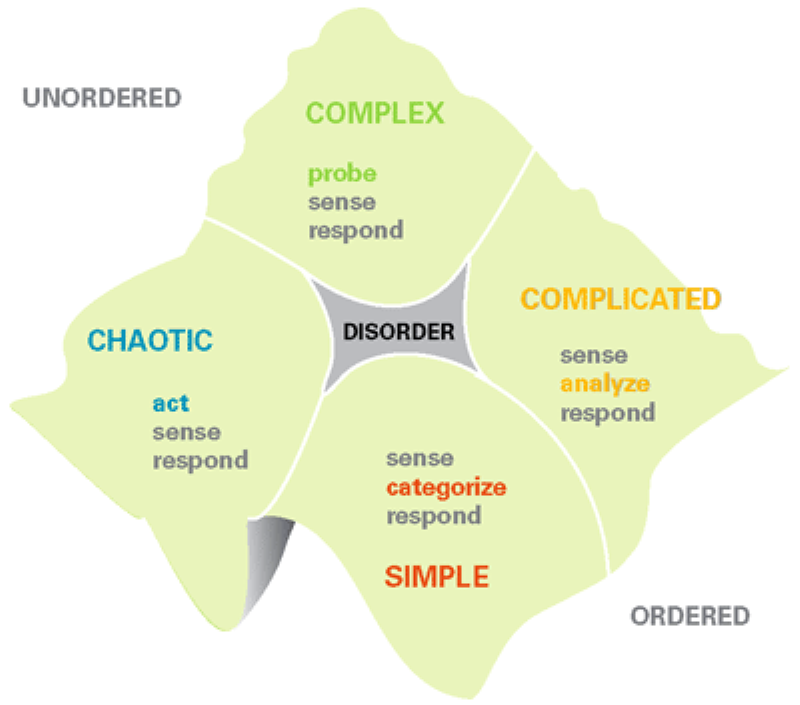
Can use the Given/When/Then Gherkin style

**Scenario**: Reference machines in bad health swapped out of QA daily comparison testing
**Given:** Scheduling daily suite of comparison testing between a test and reference machine
**When:** A reference machine has either a BUILDING tag, Non-standard software or a bad environment
**Then:** Replace reference machine used with a machine from the backup list
**And**: Repeat this check

## Problem Domains?

What is the domain of the Change?

- No idea
  - ❑ But we are looking at sizing it
  - ❑ Unknown risk but suspect its small
- Simple
  - ❑ Known and straightforward
  - ❑ No external dependencies
  - ❑ Low risk
- Complicated
  - ❑ Lots of moving parts
  - ❑ Needs analysis
  - ❑ Multiple potential right answers
- Complex
  - ❑ Lots of unknowns
  - ❑ External dependencies
  - ❑ Moderate/High risk (needs managing)



Cynefin framework

## Requirements and scope?

What is Project scope?

**Project Scope** refers to the complete list of features or deliverables of a project

These deliverables are created using the requirements of the project. It can also specify items that are out of scope

**Scope Creep:** expanding the list of features or deliverables from those originally agreed

**Requirements**: specify what the change should do in Unambiguous and bounded terms

## Timescale Specificity?

When will the change/bugfix be “*done*”?

- Whenever, in the hands of the gods …
- Soon, a wee while …..
- Couple of weeks, a month or so ….
- Actual date: 21 Sep 2024

Most engineers have misplaced optimism on timelines
Assumes a best case scenario and (usually) are using a poor definition of “*done*”

Question often forgotten: When will <Change> start!

*Timescale estimation clarity is affected by preceding domain type

## Good Estimates?

Good estimates create trust and political capital with your customers

How to give better estimates:

- Break changes down into smaller pieces
- Have specific requirements / scope
- Embrace empirical reality
- Lean towards contingency fund for delays
- As time progresses, uncertainty lessens
  - ❑ Communicate this better information to stakeholders

## Are we Done?

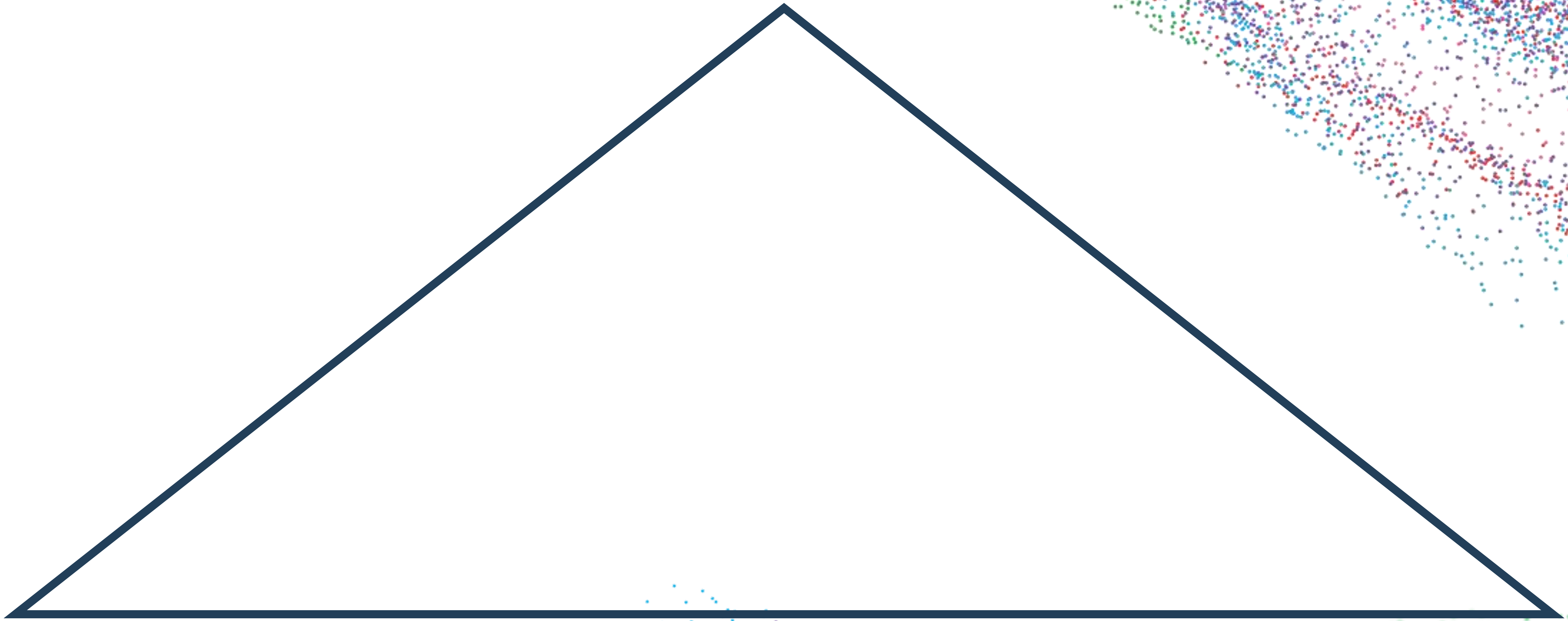
Forewarning:

~~**School of thought :** Never commit to anything concrete or easily measurable aka *be slippery*~~

~~Being vague, lack of preciseness, more about providing cover for potential failure rather than achieving positive outcomes~~

Let's begin ….

Software Engineering Completeness Pyramid



## Development Done?

Have the changes been verified and applied?

- Met the change Acceptance Criteria?
    - ❑ Fully vs partially
- Passed all testing driven by the validation system?
    - ❑ Unit tests/integration all passed
    - ❑ Added tests for a new change
- Passed code review and been committed into the repository?
    - ❑ Executed in a structured sane manner
- Merged into a package for Production release?
    - ❑ Ready for deployment

Is the change ( in behavior ) code complete?

## Deployment Done?

Are the changes deployed everywhere?

- What is the pace of deployment through stages
- When is the code deployed ***Everywhere***
- Any staggered dependencies needing tracking
- Any code freezes imminent

## Feature Flags

What is a Feature Flag?

**Feature flags** are a software development tool that allow you, at runtime, to enable or disable a change without modifying the source code or requiring a rollback/redeploy.

Safety based if-statements are placed in the code base that act as circuit breakers for "*untested*"[1] code

1: Untested in production

## Feature Flag Enablement Done?

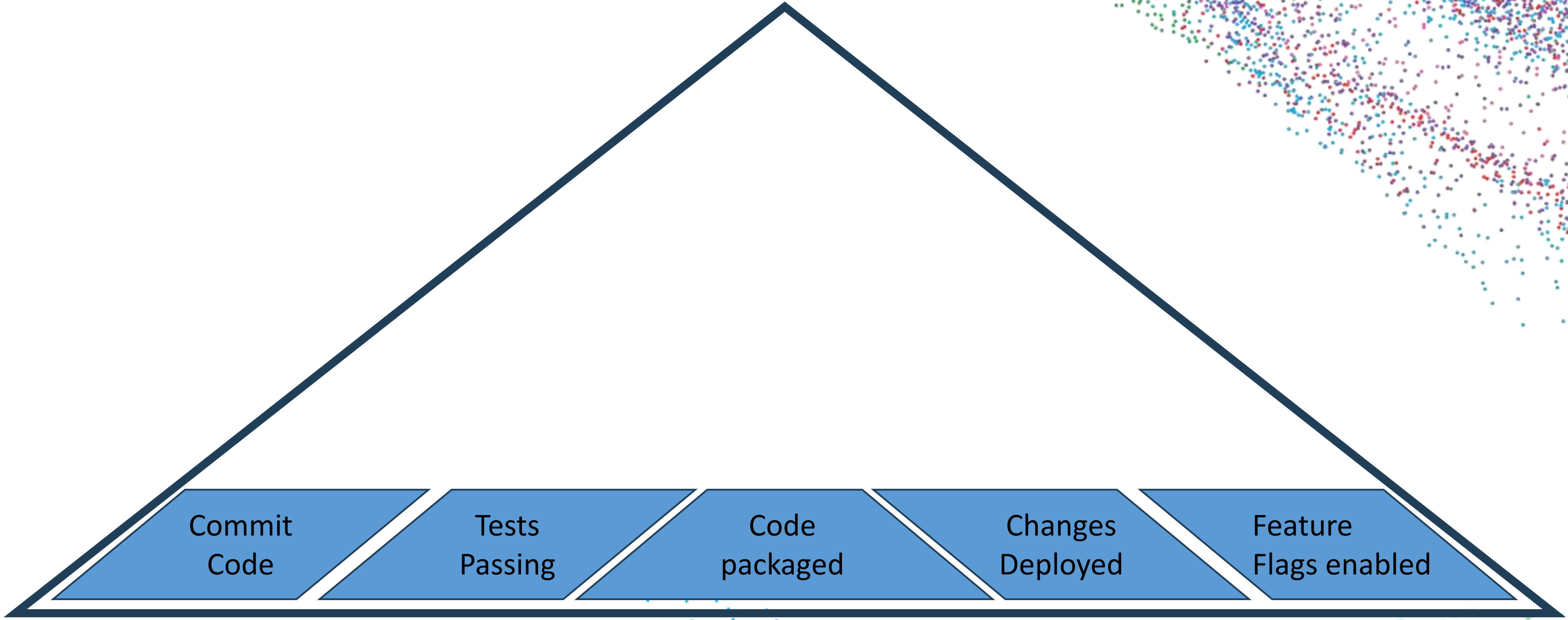
Deployed code that's not being utilized is not useful (yet)

Are Feature flags enabled everywhere in Production?

- What is the pace of enablement?
- When is enablement complete?
- *When is the feature flag being removed?

*Dealt with in later section

## Software Engineering Completeness Pyramid



## Survival Achieved

Congratulations, you’re a competent hacker

## Rationale!

Why is **survival** not enough?

Any system where engineering is invested completely in feature change/bug fixing will devolve, over time, into a complex brittle codebase.

Efforts are needed to stabilize/reverse the entropy in the code base.

## Code Health Basics

What is software decommissioning?

Decommissioning is the strategic process of retiring outdated software and related infrastructure, to streamline and enhance overall maintainability/efficiency.

Two types

- Code that is structurally never able to be accessed
  - ❑ Actual functions that are never called
  - ❑ Find with static analysis tools – Coverity, cppcheck, IDE
- Functions never accessed with current user input
  - ❑ Monitor usage in production over a “length of time”
  - ❑ Feature flag removal

## Decommissioning done?

Any decommissioning needed?

- If replacing something, have we planned for the removal/decommissioning of the older functionality
- Feature flag removal?
  - ❑ Eliminate dead branching of code
- Removal of bespoke functionality now standardized
  - ❑ Algorithms
  - ❑ Optionals
  - ❑ Variants
  - ❑ Expected

## Code Health Basics

What is software refactoring?

**Refactoring** is the disciplined process of changing a system's software in such a way that it does not alter the function of the code yet improves its internal structure and/or efficiency.

Why is refactoring needed?

Tactical => Strategic change/implementation

- ❑ Time challenges
- ❑ Refactoring time not budgeted
- ❑ Inadequate time to research
- ❑ Poor code reviews

Note: No refactoring, over time, will lead inevitably to a system rewrite

## Refactoring done?

Any Refactoring needed due to :

- Recurring / Duplicated Patterns in code
- Low readability/maintainability code
  - ❑ Code smells
  - ❑ Overly complicated / redundant logic
- Paradigm changes

## Code Health Basics

What is Technical Debt?

**Technical Debt:** Cost of reworking/fixing code in the future due to limited quick solutions (shortcuts) implemented now

Unnecessary Complexity in the codebase

Fomented by
- Deadlines
- Firefighting
- Cleverness / premature optimisation
- Lack of standards / proper code reviews
- Lack of skills / seasoning / poor culture
- Organic growth
- Poor documentation

* Over a span of time

## Tech Debt Basics

“There is nothing so permanent as a temporary decision”
- Knapton

Categories of Technical Debt:

- Intentional
  - ❑ Taken on consciously for strategic reasons
  - ❑ Items placed on backlog to mitigate
- Unintentional
  - ❑ The non-strategic result of doing a poor job
  - ❑ No plan to mitigate

“A project isn’t done until you go back and adjust whatever it was you took on as technical debt; *and everybody agrees this is how we define ‘done,’”*
- Knapton

## Tech Debt Basics

Tracking Tech Debt:

- Make a list with key attributes
  - ❑ Effort Size
  - ❑ Severity
- Be intentional
  - ❑ Add to list when suboptimal solutions used
- Keep visible
  - ❑ Prioritize on roadmaps
  - ❑ Tech Debt sprints
- Advocate/Champion for improving the codebase
  - ❑ Highlight business risks
  - ❑ Time to market
  - ❑ Maintenance load

maintenance load: How much time and effort are developers spending on tasks that *are not* adding features or removing features?

## Tech Debt Done

Tech Debt prevention :

- Coding standards
- Code review guidelines
- Design review
- Tracking
  - ❑ Champion its demise
- Training
- Proper timeline planning

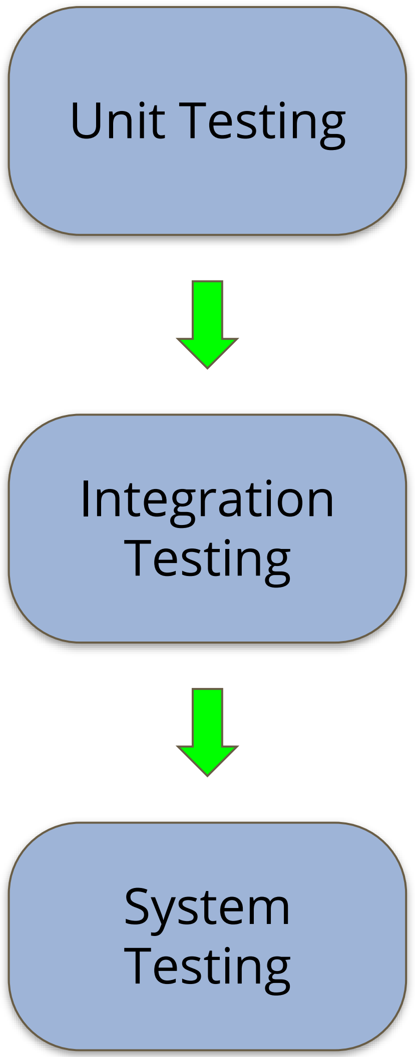
## Testing Done?

All Testing Pillars accounted for?

- Unit
- Integration
- System end-to-end (QA)

*Maintain quality through testing*

## Testing Pillars



- Mock/stub classes/functionality
- Easy to set up tests
- Short feedback loop
- Easier error investigation
- Exhaustive(happy/unhappy path) testing

- Mock/stub executables
- Harder to set up tests
- Medium feedback loop
- Difficult error investigation
- Happy path testing

- No dependencies mocked
- Synthetic data
- Happy path testing
- Long feedback loop
- Hard error investigation

## Testing Done?

When we find problems in functionality, are we leveraging the experience?

- Create tests based on production problems (for next time)
- Adequate test coverage for scenarios - BDD?
- Move tests down the feedback chain to ultimately unit tests
  - ❑ Unit testing – Minute(s)
  - ❑ Automated system integration testing – Hour(s)
  - ❑ End-to-end QA – Week

* Automation of testing is key

## Rationale!

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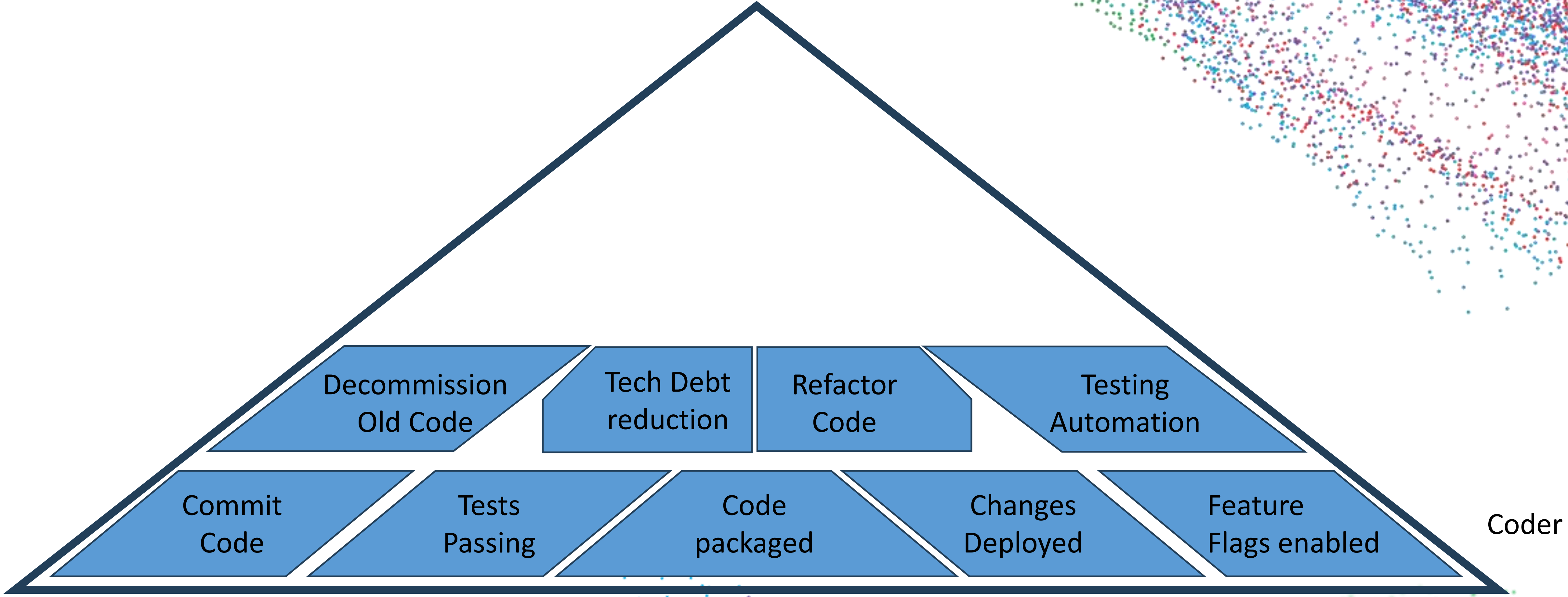
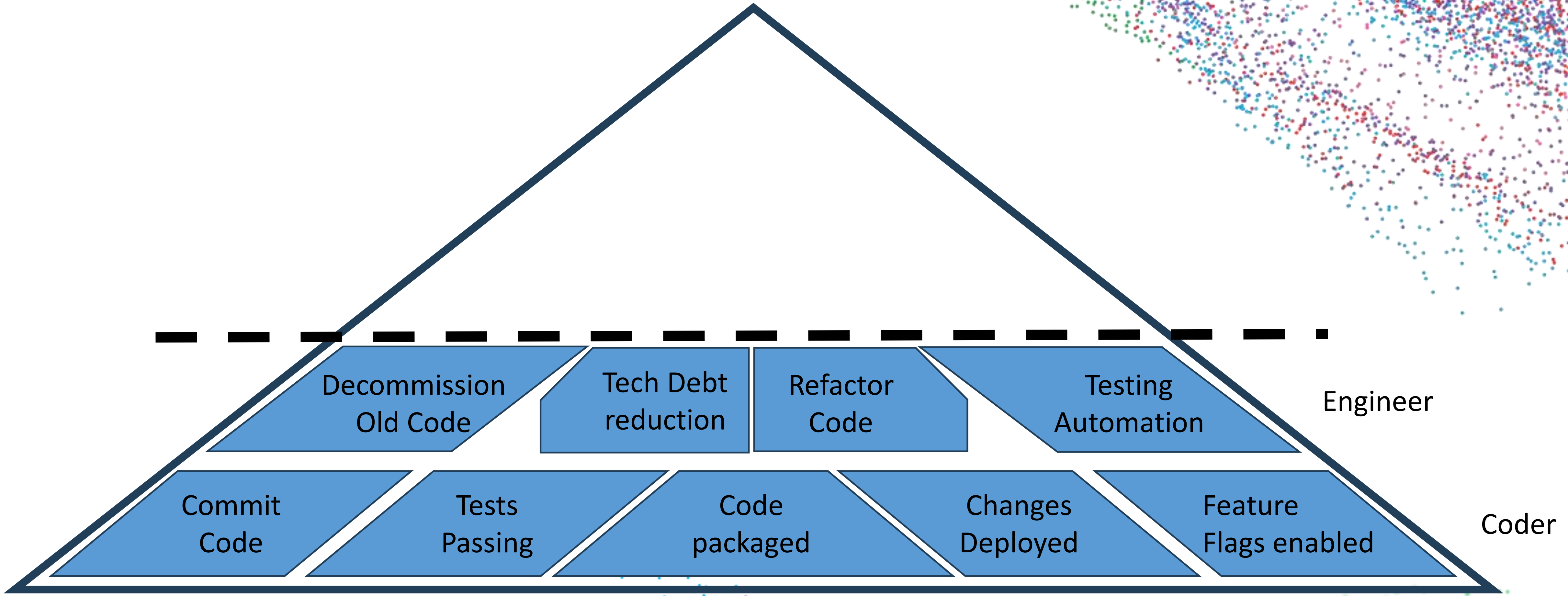


## Sustainability Achieved

Congratulations, you’re a competent engineer

## Software Engineering Completeness Pyramid



## Rationale!

Why is **sustainability** not enough?

Sustainability means to maintain the current state of the code. The Code (development) itself does not live in a vacuum but in an eco-system.

Efforts are needed in the areas of **manual toil reduction, capacity planning and general observability within the system**.

## Change of Emphasis

Probably not!

## System Reliability

How healthy is your system?
Are changes impacting your systems ( aggregate ) health?

Can you catch problems before your clients notice?

## System Reliability

Do you have System health monitoring?

Operational Metrics

- Latency – Time taken to service a request (response time)
- Traffic/Throughput - How much stress is the system taking, at a given time, from users or transactions processing through the service
  - ❑ e.g. How is latency affected by throughput (requests per minute)
- Saturation – overall capacity/utilization of the service (%CPU/RAM/disk net free, queue depths)
- Errors – Rate of failing requests to total requests – assuming requests are well-formed

Any other metrics tailored for your system

## System Reliability

Using System health monitoring:

- Automatic alarms
  - ❑ Avoid “eyes on glass”
  - ❑ Imminent outages
- Monitoring Trends over spans of time
  - ❑ Capacity planning

## Production Support

Any new technology/features (to you) being introduced?

- Supported by current operations
  - ❑ Or supported by developers
- Effective distributed triage
  - ❑ Widely known / not a singular person
  - ❑ Effective logging
  - ❑ Support runbooks

## Strategic Vision

***Strategic* vision**: Decisions that are long-term and influence future actions.

Dealing with:

- Business shifts
- Technology shifts
- Future-proofing

Usually weighing tradeoffs for a number of solution

## Strategic Vision

Strategic Planning and decisions - recognition

- Many people/stakeholders are involved
  - ❑ More people, more strategic
- Timespans for decisions are long
  - ❑ Longer time horizons, more strategic
- Longer-term outcomes
  - ❑ Not easy to change

## Improvement Planning

Broad scale functionality changes require:

- Many stages / iterations needed
  - ❑ Big bang approach generally sub-optimal
  - ❑ Mitigate risk to current production
- What are predicted timelines/effort for this?
  - ❑ Longer time horizons so less certainty
  - ❑ Non-trivial releases will need fixes/features added
- Many external dependencies
  - ❑ Co-ordination and communication become critical and time consuming

## Architectural Design

Strategic local re-engineering

- Broad complex changes in system architecture
- Vision for managing future performance
- Where to target the system for most benefit
- Leveraging existing technologies or introducing new ones

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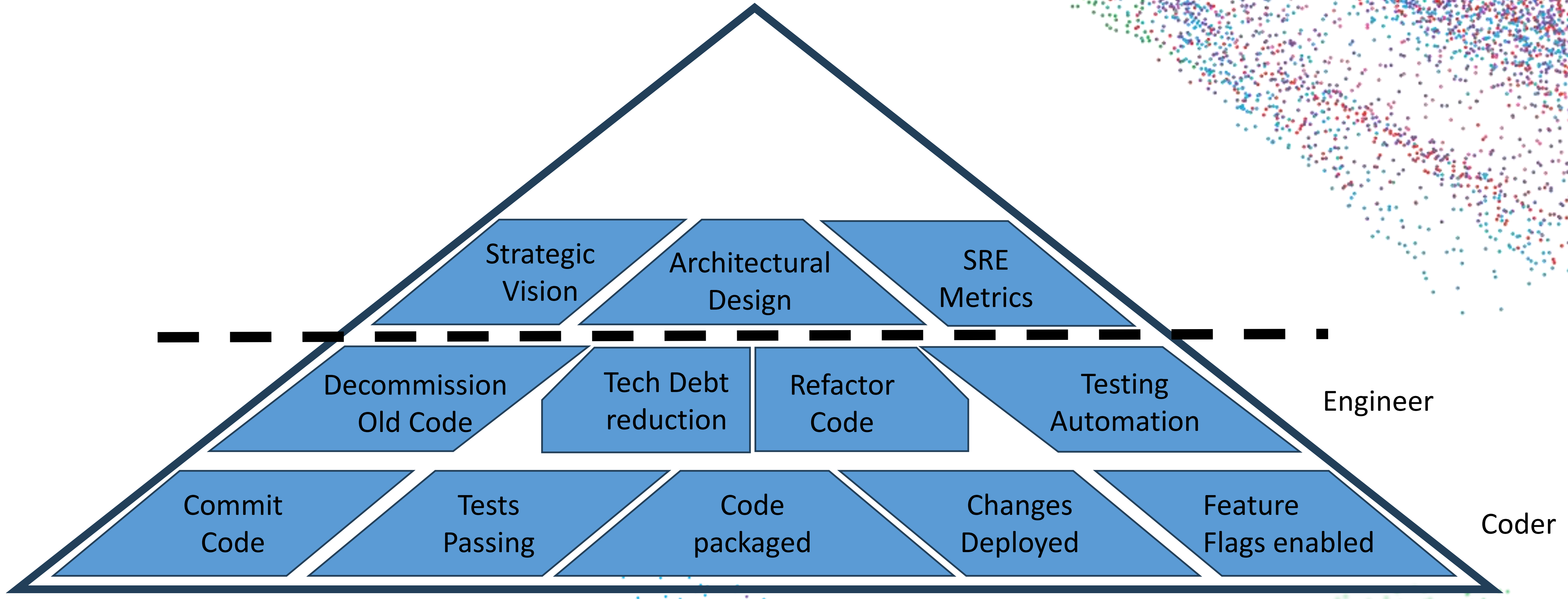

## System Reliability Achieved

Congratulations, you’re a competent systems engineer

## Rationale!

Why is overall **system reliability** not enough?

Engineering must align with the business’ needs.

Efforts are needed to communicate clearly, bidirectionally, that needs are being met and adapted to .

## Roadmaps?

What is a Roadmap meeting?

A formal meeting where a group assembles to discuss the current progress and future direction of a product or project

This is to ensure everyone is striving collaboratively towards shared objectives

## Business/Stakeholder involvement Done?

Roadmap meeting composition (Roles):

- Product owner
  - ❑ Creating your roadmap and presenting all your strategic goals
- Development representatives from each major area involved
  - ❑ Explain roadblocks, effort and timelines
- Executive stakeholder
  - ❑ When you need approval in your decision-making process
- Product manager / Delivery specialist
  - ❑ Long-range timelines

## Business/Stakeholder involvement Done?

Roadmap meeting addresses:

- Reviewing the Current Landscape
  - ❑ Any progress
  - ❑ Any Roadblocks
- Setting Strategic Direction
  - ❑ Where we are going
  - ❑ How we are getting there
  - ❑ Gaining consensus/buy-in
- Prioritization and Resource Allocation
  - ❑ In what order are items getting tackled
  - ❑ By Whom
- Action Planning and Collaboration
  - ❑ Actionable items with dates attached
  - ❑ Review long term timelines

## Future planning Done?

Are you prepared

- Software stability?
- Security vulnerabilities?
- System scalability?

Are you ready for

- New technical opportunities?
- New business opportunities?
- New regulation/restrictions?
- Staying competitive?

## Rationale!

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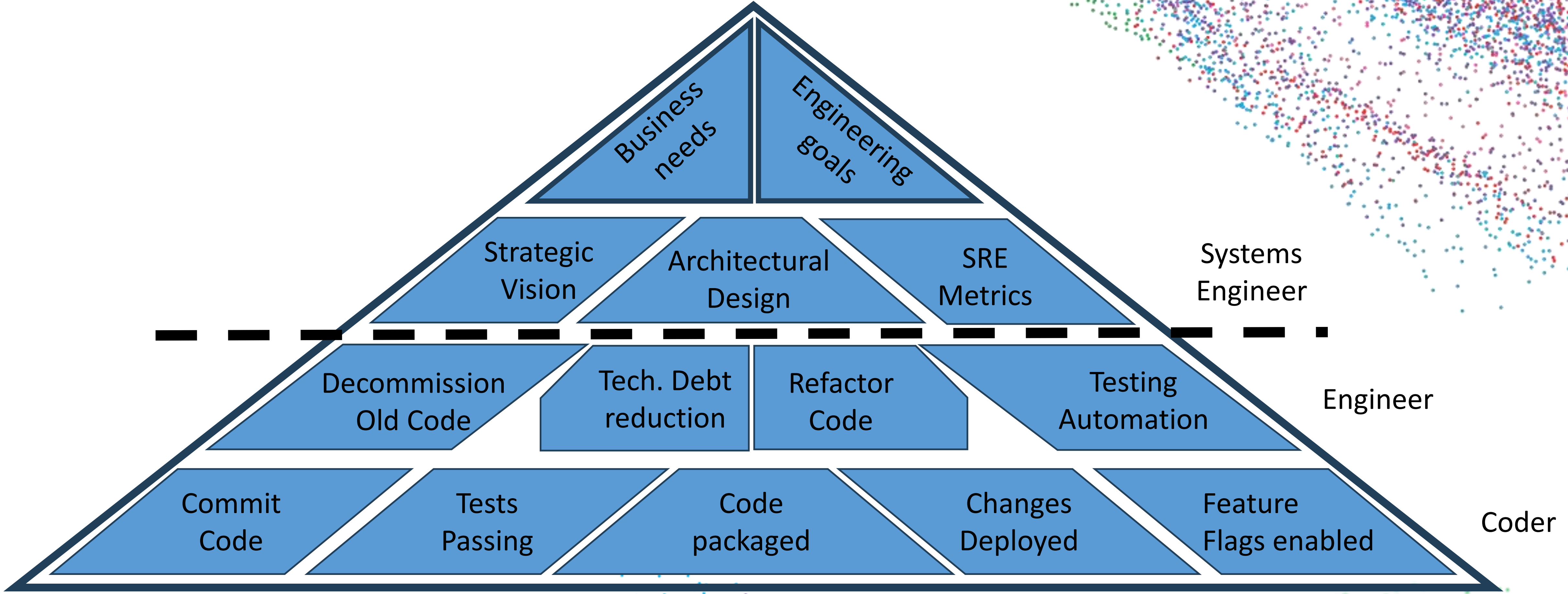
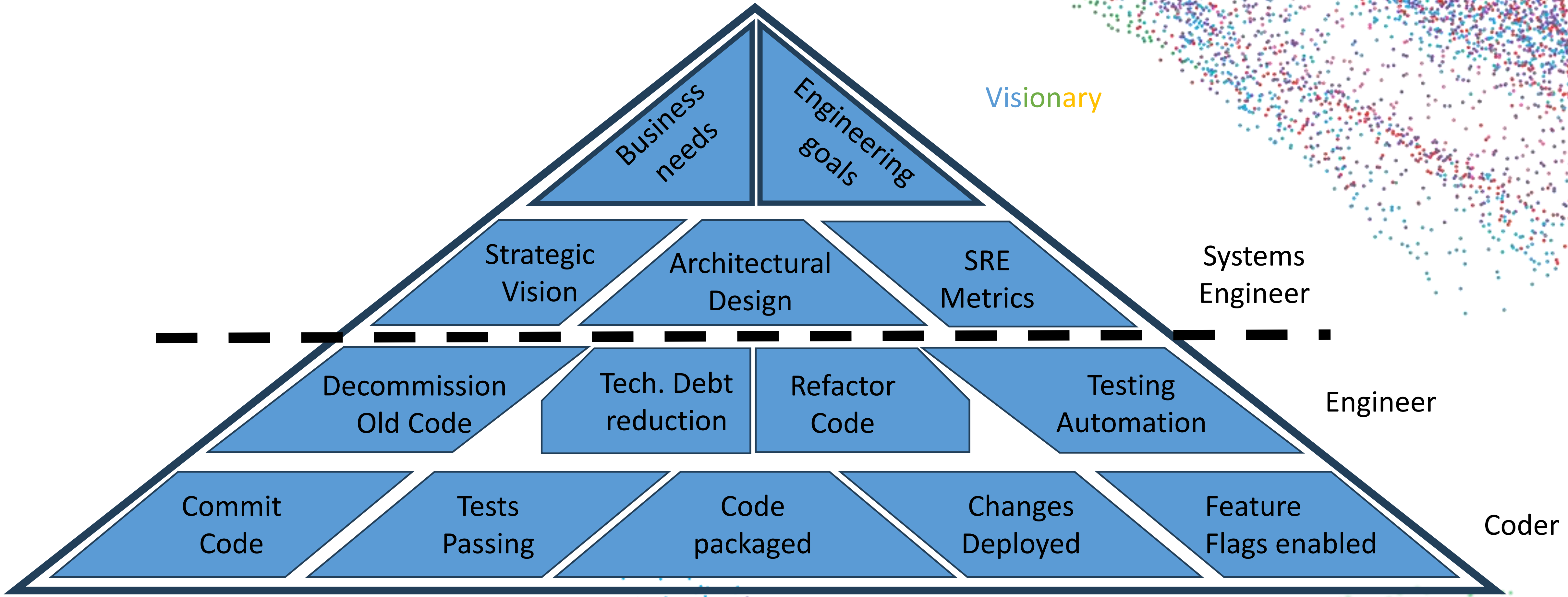
## Software Engineering Completeness Pyramid



## System & Business Alignment Achieved

Congratulations, you’re a visionary

## Software Engineering Completeness Pyramid



## Recap

Software Engineering: What level are you operating at?

- Future direction and market competitiveness
- System aggregate health and stability
- Code base health and sustainability
- Feature Implementation / Bug fix

## Recap

Software Engineering: When are you "*Done*"?

What type of "*Doneness*"?

- Be Specific on
  - ❑ Scope
    - ❑ Milestones and deliverables
    - ❑ Acceptance Criteria
    - ❑ Any follow-on work needed?
  - ❑ Time
    - ❑ Deliverable dates
    - ❑ Milestone dates
- Intentional Tech Debt
  - ❑ Remediation required
- Communicate clearly to stakeholders
  - ❑ Regular progress meetings/roadmaps

## Recap

Software Engineering: When are you “*Done*”?

- Feature/Bug-fix/Change is running smoothly and engaged **everywhere** in Production
- Well supported by the team
- Tech Debt is decreasing and not increasing
- Users/Clients are happy
  - ❑ Then, so is the business
- Structured maintainable Code
  - ❑ Happy developers
  - ❑ Retained engineers
- Poised to meet future challenges

## And Finally:

This presentation is well and truly
Done

Thank You

## Engineering Talks:

Retiring The Singleton Pattern: Concrete Suggestions on What to Use Instead
Redesigning Legacy Systems: Keys to success
Managing External APIs in Enterprise Systems
Exceptions in C++: Better Design Through Analysis of Real World Usage
Dependency Injection in C++: A Practical Guide

# Questions?

Contact: pmuldoon1@Bloomberg.net