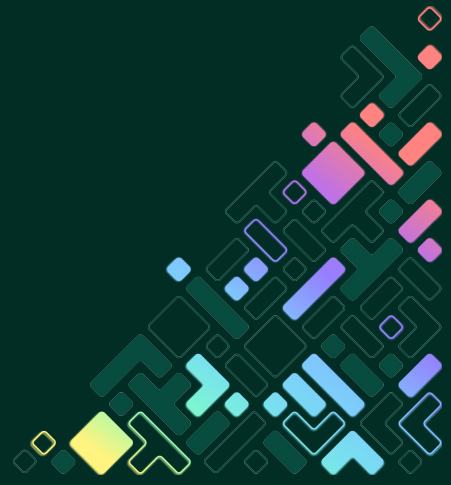


# Application Development with TDD

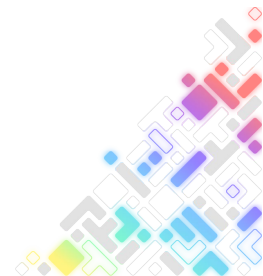
## Getting Started

**Luis Ubieda**  
Lead FW Engineer



# Agenda

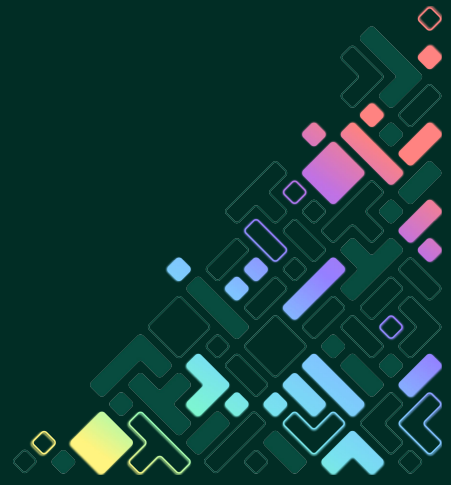
- Intro
- Basics of Test-Driven Development (TDD)
- TDD in Zephyr
- Faking dependencies (Device-Tree Nodes and Subsystems)
- Live Demo
- Q&A



# Intro



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# About Me

Luis Ubieda

- Electrical Engineer
- Lead Firmware Engineer @ [Croxel](#)
- 7 Years developing Firmware
- Based in Melbourne, FL (Space Coast)
- Passion for Technology, Electronics and IoT
- First Zephyr Contribution on 2021
- Free-Time: Fitness and Sports
- Blogger: <https://embeddedtales.blog>
- First Time Speaker at EOSS

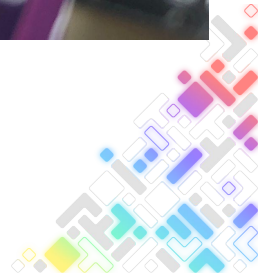
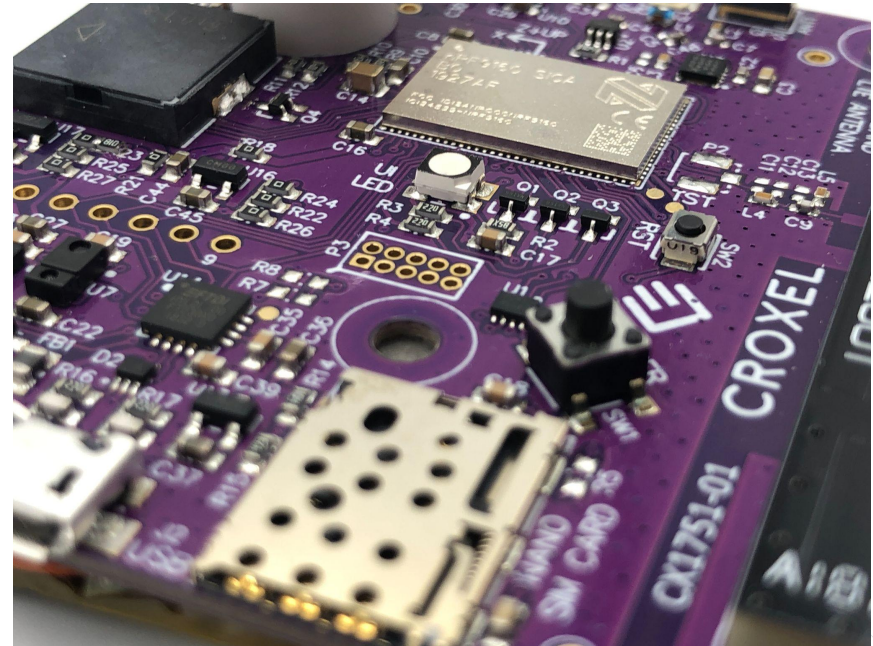


*Rocket Launch every other week at the Space Coast.  
Image Source: [visitspacecoast.com](https://visitspacecoast.com)*



# About Croxel

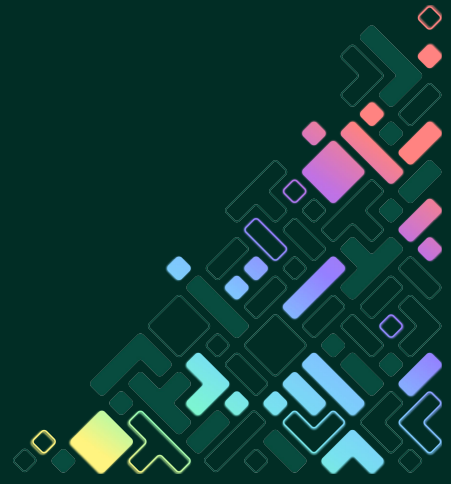
- Deep Zephyr RTOS expertise for tailored, technically sound solutions.
- End-to-end product development capabilities aligned with your goals.
- Rapid prototyping and low-power optimization for faster time-to-market.
- Seamless integration with your teams across all areas of development.
- Active contributions to the Zephyr Project and continuous community involvement.



# Basics of Test-Driven Development



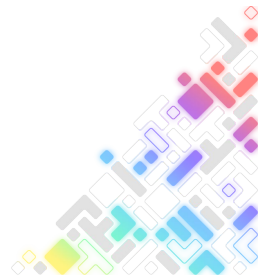
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# Basics of Test-Driven Development (TDD)

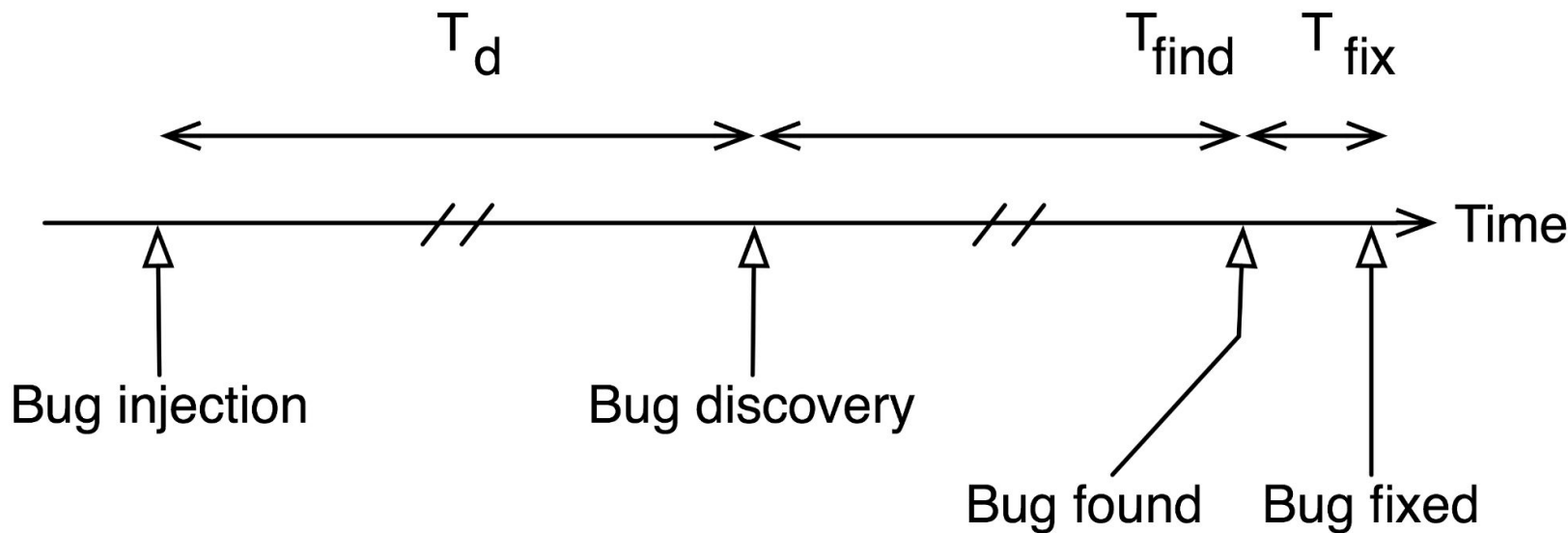
## Fundamentals

- Comes from Extreme Programming (XP).
- Opposite to typical Waterfall-type development (develop first, test later).
- Focuses on **incremental** development.
- Embraces the fact that **bugs are inevitable**.
- Relies on capturing and passing **Unit Tests** as means to develop the application.



# Basics of Test-Driven Development (TDD)

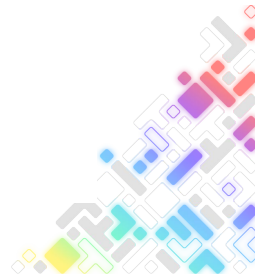
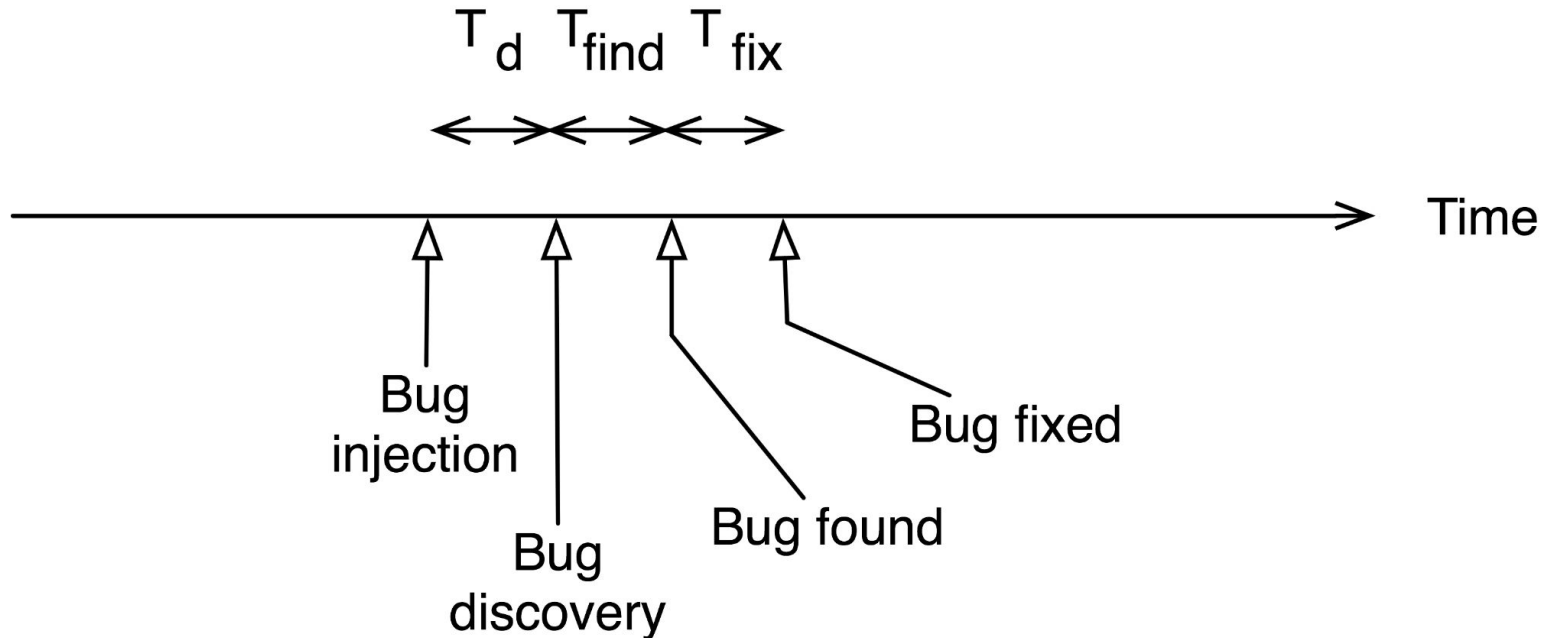
## Bugs in a Regular Development Cycle





# Basics of Test-Driven Development (TDD)

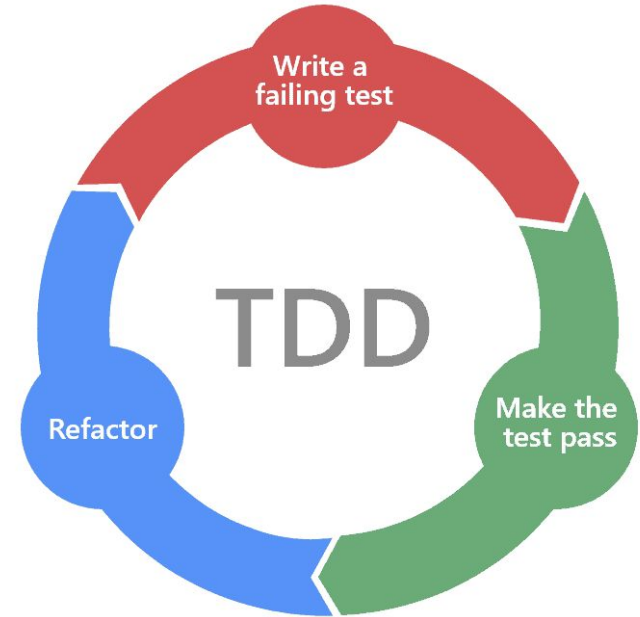
## Bugs in a TDD Development Cycle



# Basics of Test-Driven Development (TDD)

## Steps to Progress on TDD

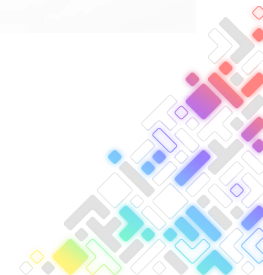
- Start with a List of Requirements.
- From requirements to a List of Tests.
- One test at a time.
- Iteration Cycle: **Fail** -> **Pass** -> **Refactor**.
- Capture new test-cases while iterating.



# Basics of Test-Driven Development (TDD)

## Example Requirements - Motion Detection Engine

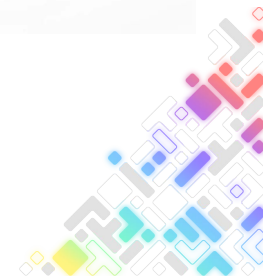
1. The Possible Motion states are: Movement, Idle or Unknown.
2. Upon initialization the motion state is Unknown.
3. Idle means no motion has occurred in the last 5 seconds.
4. Movement means detecting at least  $2 \text{ m/s}^2$  acceleration on any axis for at least 1 second.
5. A Motion State change triggers an event to users.



# Basics of Test-Driven Development (TDD)

## Example List of Tests (Initial) - Motion Detection Engine

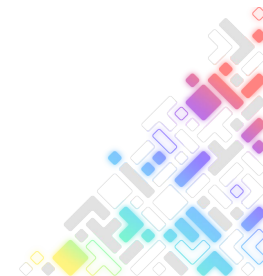
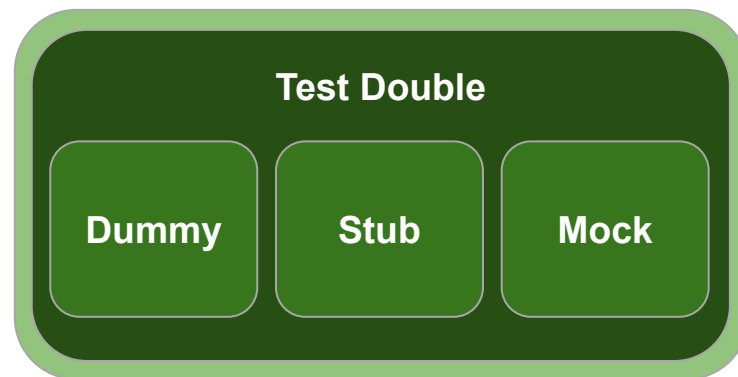
1. Initializing the Module starts the Motion Detection Engine.
2. Initial State is Unknown.
3. Callback is triggered on a state change.
4. Transition to Idle state if no motion in 5 seconds.
5. Transition to Movement state if Motion is sustained for 1 second
6. Once entered, stay in Movement state for 5 seconds.
7. Sustained motion while in Movement extends the motion state.



# Basics of Test-Driven Development (TDD)

## Faking Dependencies

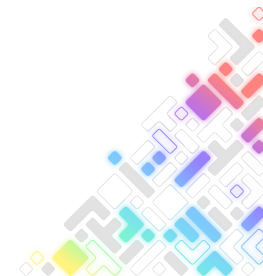
- Unit Under Test (UUT) relies on dependencies.
- Faking a dependency means replacing it by a **Test Double**, abstracted to the UUT.
- Test Double sets and manages expectations and returning parameters.
- Types of Test Doubles: Dummy, Stub, Mock.
- It may be done manually or by using Frameworks (e.g: CMock, CppUTest, FFF).



# Basics of Test-Driven Development (TDD)

## Benefits of TDD

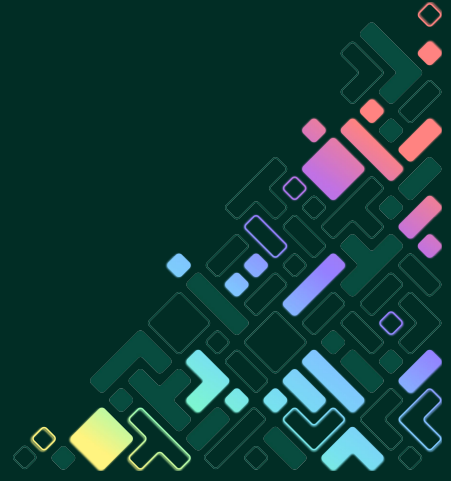
- Software Development without needing Hardware.
- Catch bugs easier and faster.
- Definition of Done is clear.
- Improve Predictability of Development Cycle.
- Code-base feels less “fragile”.
- Overall Improvement of Code Quality.



# TDD in Zephyr



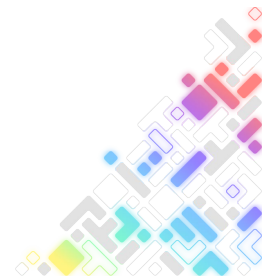
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# TDD in Zephyr

## Testing Frameworks Available

- ZTest, Zephyr Test Framework.
- FFF, Mocking.
- Twister, Test Runner.
- BabbleSim, Radio Simulator (e.g: Bluetooth).
- Pytest, Integration tests.





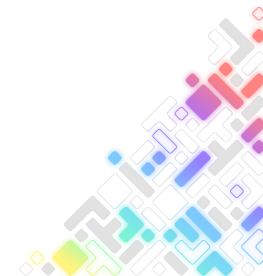
# TDD in Zephyr

## Pros

- Extensive Boards support.
- Inherent Abstractions and Generalized APIs
- Testing Frameworks Available.

## Complexities

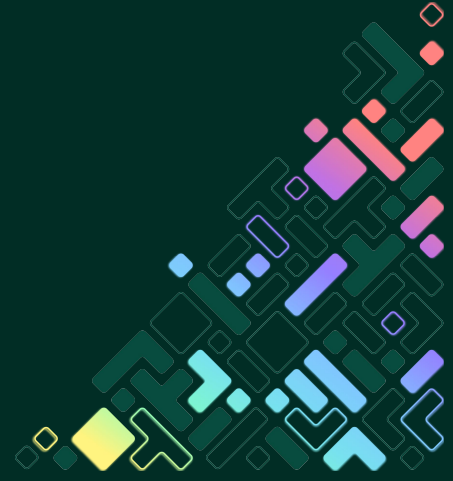
- Dealing with Device-Tree
- Dealing with Subsystems (Kconfig dependencies).



# Faking Dependencies



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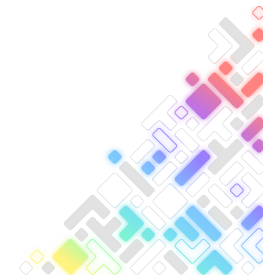
# Faking Dependencies in Zephyr - Subsystems

## Alternatives

- Use an existing Zephyr emulator.
- Implement a Test-Double.

## Implementing a Test-Double

- Approach: Link-Time Substitution.
- Disable Module using Kconfigs.
- Add minimal Test-Double, implementing the used APIs.



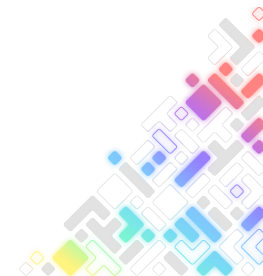
# Faking Dependencies in Zephyr - Device-Tree

## Alternatives

- Use an existing Zephyr emulator.
- Develop a Device-Tree Node Test-Double.

## Implementing a DT-Node Test-Double

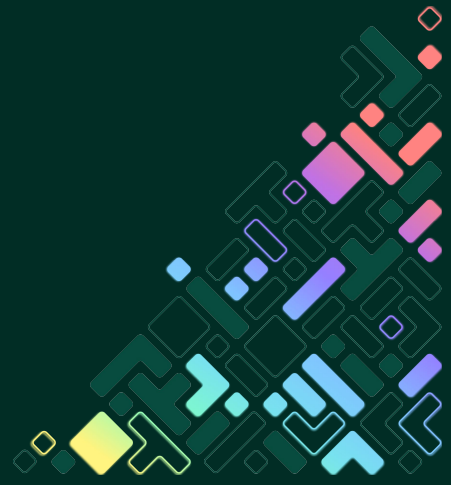
- Link Device-tree devices using Node-labels.
- Create a DT-Node Test-Double using the same APIs your dependency implements.
- Use the DT-Node Test-Double to emulate the expected behavior  
(set/check expectations, provide return parameters, etc).



# Live Demo



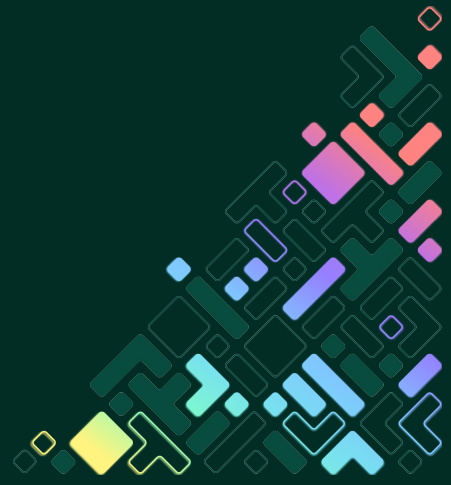
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# Q&A



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# Zephyr<sup>®</sup> Project

## Developer Summit

