Who takes the driver seat for ISO 26262 and DO 254 verification?

Reconciling requirement based verification with coverage-driven verification

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Motivation

- ISO and DO users are often hesitant about advanced verification techniques
  - Results in lesser productivity
  - Is that grounded?
  - If yes, what can be done to help?

Agenda

- Intro
  - CD/CR
    - Context
    - Origins
  - RBV
    - Context
    - Origins
- Areas for consideration
  - reduced verification scope
  - Result stability
  - Coverage tracking gap
- Summary

CD/CR verification

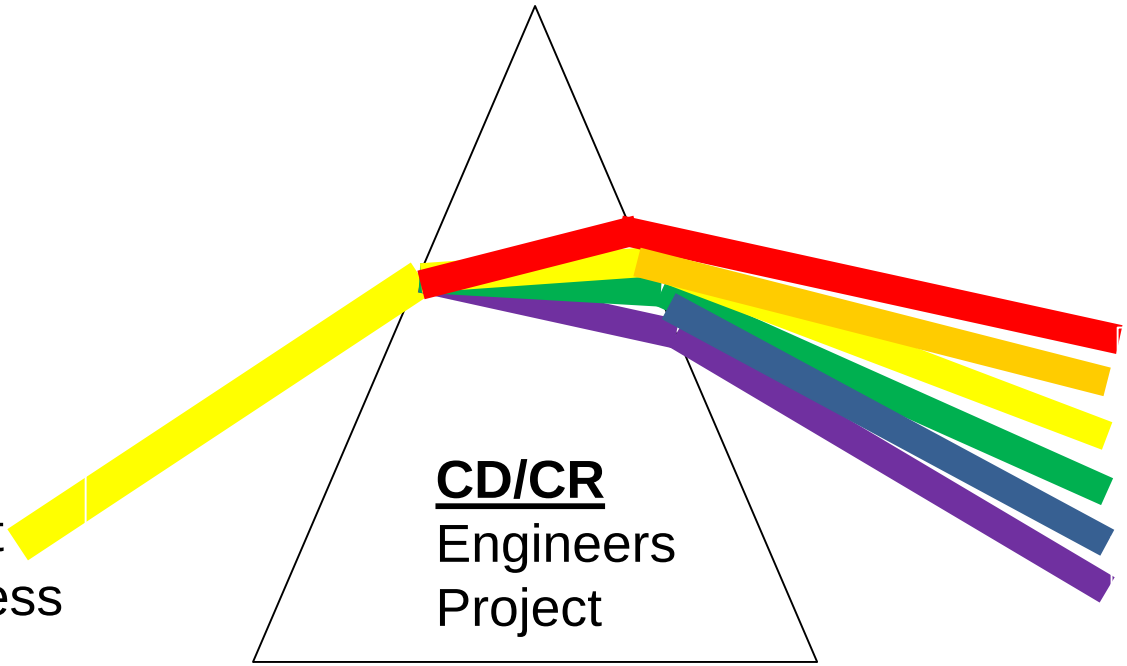
- Context
  - Blocks getting too big to be verified by directed tests
  - Interactions between “independent” blocks not tested
  - Tailored for “RTL block verification” problems
- Added value
  - Open degrees of freedom to stimuli
  - Allow unexpected bugs to be found
  - Improved and more reliable metrics

RBV

- Context
  - Safety critical systems in mil-aero/medical/automotive
  - Need to make sure spec and docs 100% match deliverables
  - “RTL block verification” is just a tiny concern
- Added value
  - Full vertical/horizontal traceability
  - Requirement change cost can be estimated
  - Ownership, responsibility, liability clearly defined
  - Any value at RTL design and verification level?

RBV and CD/CR

- Its complicated…
  - Management wants control
  - Engineers are after efficiency
  - Where are the trade-offs?



RBV
Management
Overall process

CD/CR
Engineers
Project

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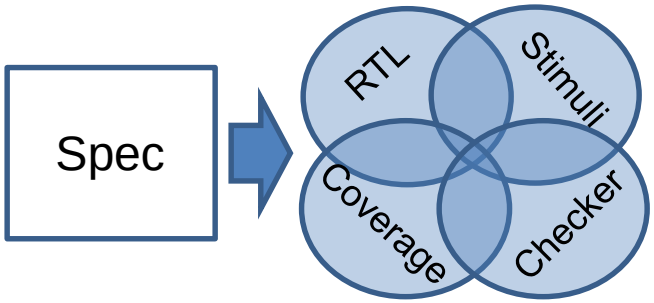
reduced verification scope

- Low level requirement scope is fairly limited
  - Determined by management/tracking convenience
  - Not by design/verification concerns
- Is that “micro-management” from a CD/CR testbench perspective?
  - Does CD/CR require a wider scope?

RBV vs. CD/CR process(1)

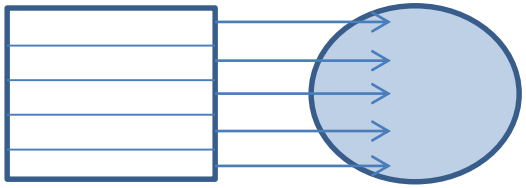
CD/CR

- Ideal process
  - Analyze spec holistically
  - Find commonalities, abstract
  - Implement
- Confidence derived from models overlapping



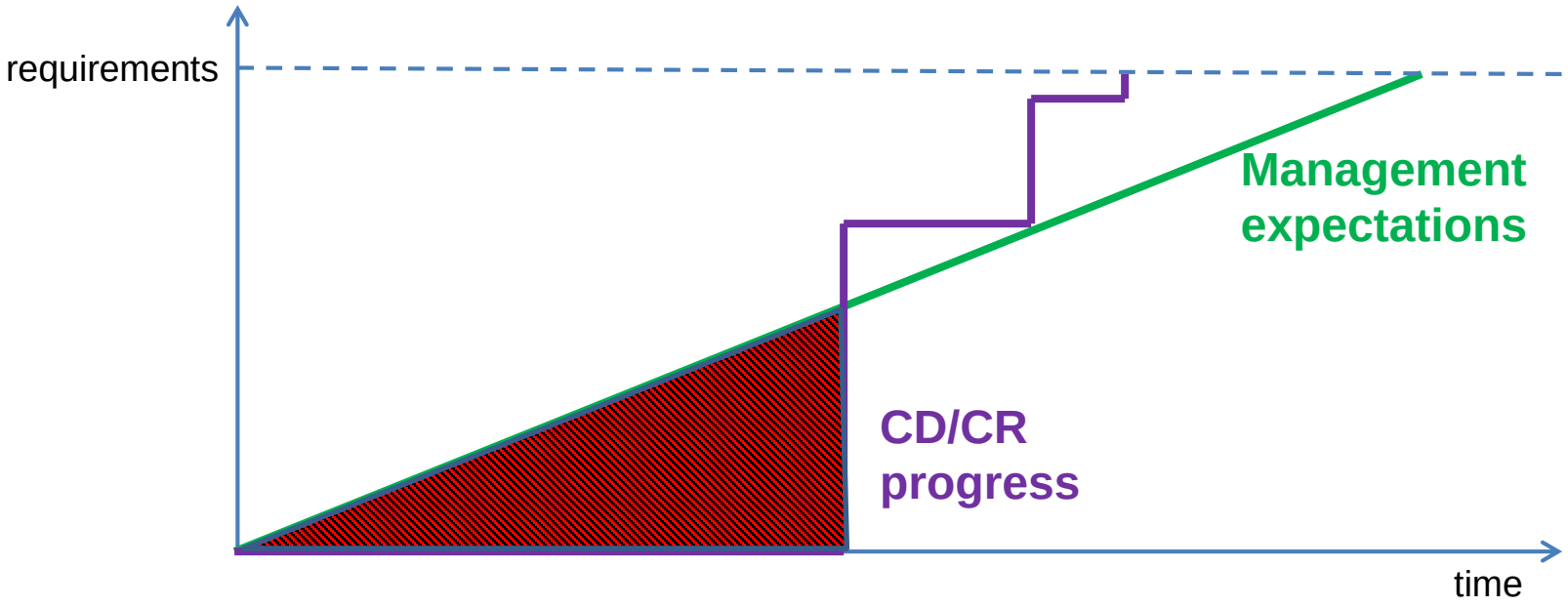
RBV

- Ideal process
  - Break spec into requirements
  - Implement
- Confidence derived from 100% requirements mapped



RBV vs. CD/CR process(2)

- Management tends to track number of requirements implemented
  - Hard to track CD/CR this way



Example (1)

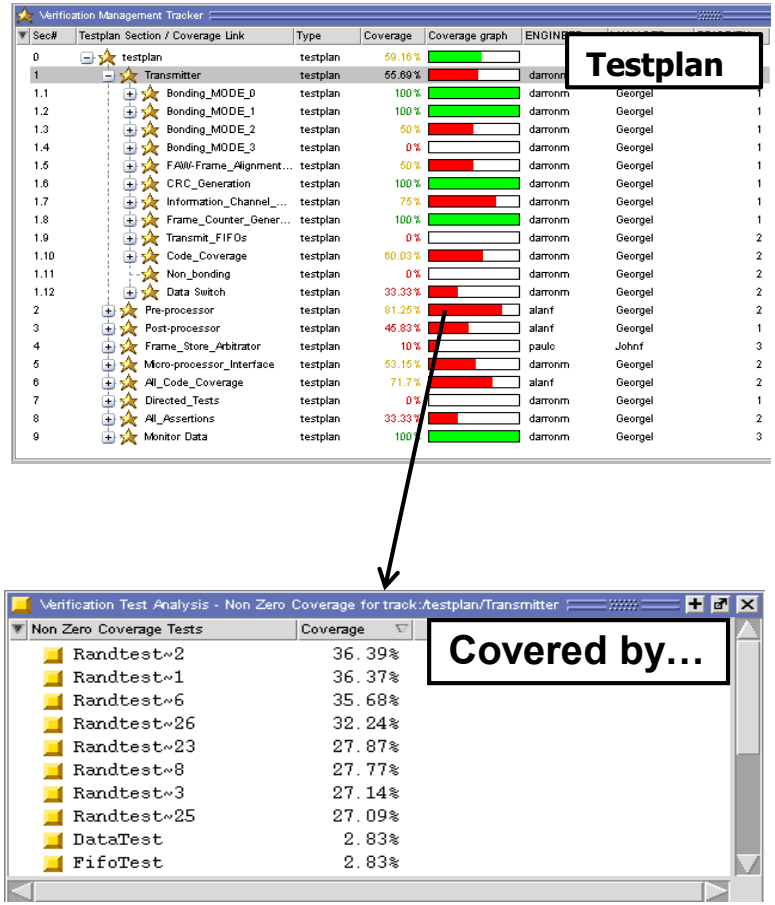
- A DMA controller with configurable AMBA interface
  - i.e. AXI3, AXI4
- CD/CR process:
  - Read AXI3/AXI4 spec carefully
  - Try to find all common points
  - Single generator, Single checker
  - <10 tests
  - Coverage using crosses
- Very similar to design

Example (2)

- Management asks difficult questions:
  - Why does the stimuli generation takes so long?
    - “Well, I’m reading the spec holistically…”
  - How many of the requirements did you already do?
    - “Well, can’t say, my test generates all stimuli together…”
  - A requirement has changed, what do we have to rerun?
    - “mmm…”

Solutions (1)

- "Cover" whatever you do
  - Even if initially it is all 0
- Advanced coverage databases answer:
  - % of requirements
  - Tests that need to be rerun
  - Regression efficiency, trends, etc



Solutions (2)

- This will only partially address the problem
  - Link from requirements to results will be there
  - But the results will be at 0 for relatively long
- Team experience and verbal skill often determine
  - Need to align management on expected results
  - Need to be able to explain why

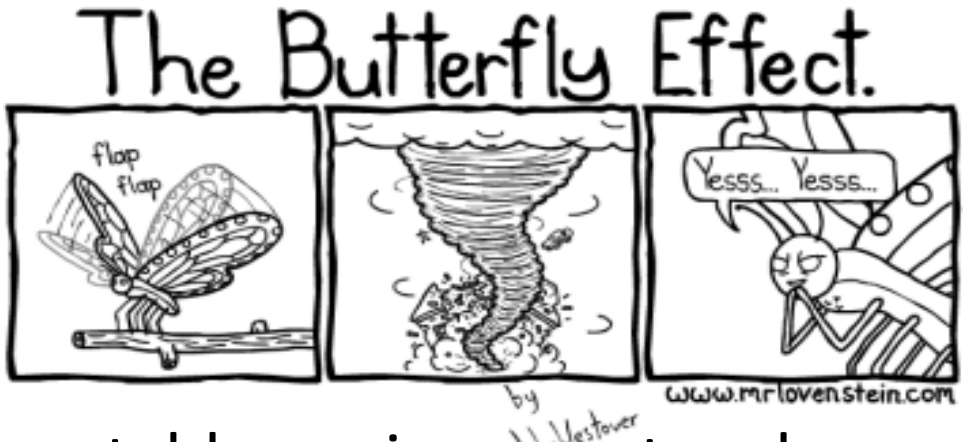
Result stability

- ISO/DO demand that results are repeatable and reproducible
  - Allow easier auditing, configuration management, liability
- Is that problematic with a CD/CR verification environment?
  - Intuitively, some will say yes, is that intuition true?

CR result stability basics

- @ same code/seed/simulator results are stable
  - Very similar to non-random + seed
- Code modification can changes results
  - Can be true for non-random as well
- But, changes will be bigger with random
  - Invalidate list of tests/seeds to some extent
  - Reduce coverage

Introducing: random stability



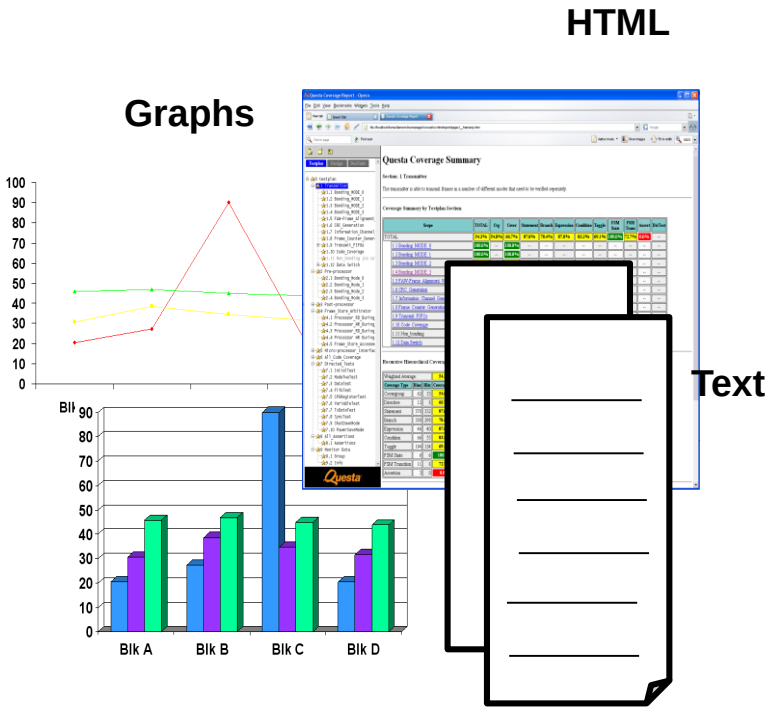
- In a random stable environment code modifications impacts are:
  - Minimal
  - Local
  - Easily traced back to code modification

Solutions (1)

- Make your environment random stable
  - Use UVM (version > 1.1d)
    - Provides a robust infrastructure
  - Follow specific coding guidelines
    - Most make sense anyhow
    - Can be found here

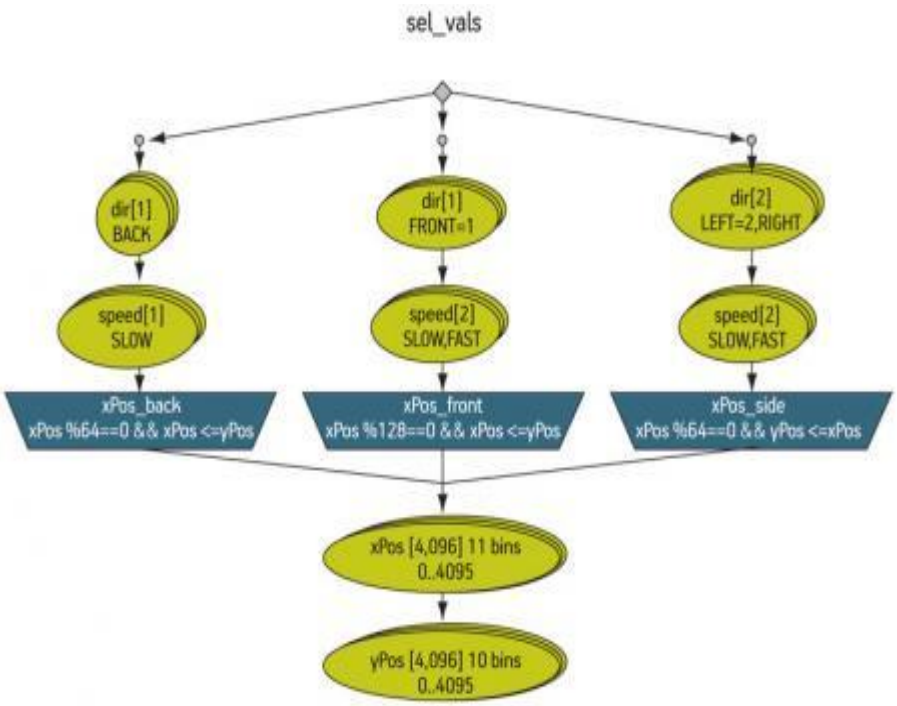
Solutions (2)

- Monitor coverage continuously
  - Minor changes can drop coverage numbers
  - Make sure you catch those early
  - Some coverage databases provide trend-analysis



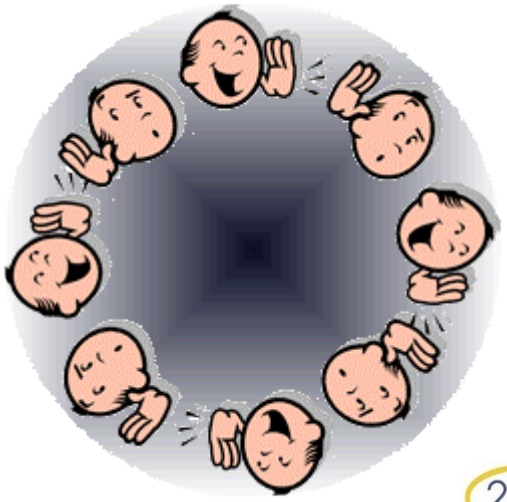
Solutions (3)

- Consider advanced stimuli methods
  - Graph based methods combine
    - The stability of directed testing
    - The coverage space of random
    - And make it all more efficient
  - Standardization ongoing at Accellera PSWG



Functional coverage tracking gap

- ISO/DO require link to “verification results”
  - Could be functional coverage, except:
    - Bug in coverage?
    - Bug in tool?
  - Auditing might require something less processed
    - Wave files
    - Log files
- How can you go from functional coverage to raw results?



SV coverage types

- Cover groups
  - Good for data and crosses
  - But tied to single event
- Assertions
  - Good for event sequences
  - But data is very simple

- We want both!
  - Complex data & crosses
  - Sequences of events
  - Go from coverage to multiple points of time/data

Example

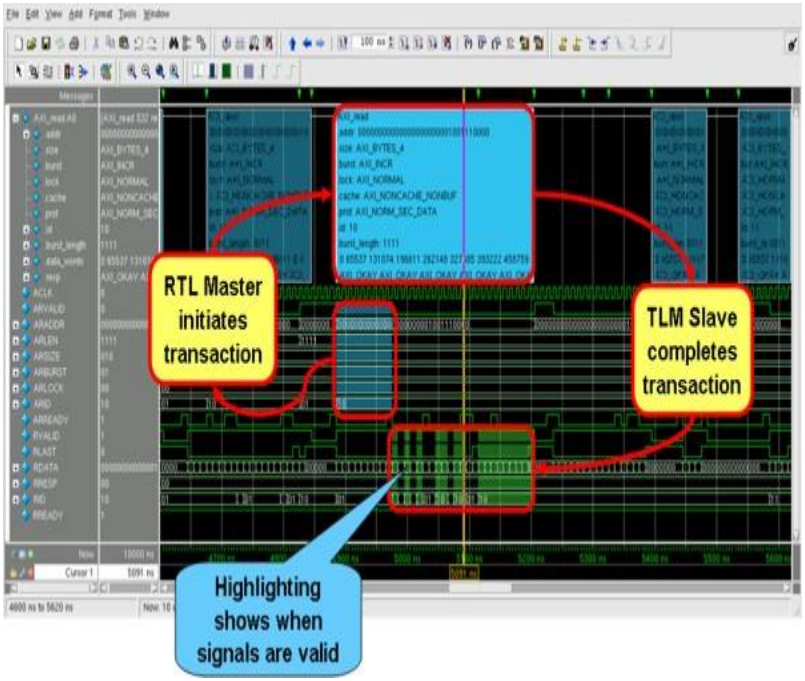
- Read request to secure zone gets OK response with garbage data
  - Two events: request & response
  - Data: address, request type, response, data
- Cover group implementation
  - Sampled at response time
  - Request time not captured
  - Response time capture?
- How do you go from cover group to wave?

Solutions(1)

- Home brewed
  - Print message to log with unique ID @ response, request
  - Print message to log before sampling covergroup
  - Match based on time/IDs
  - Lots of work with coverage report, log, wave

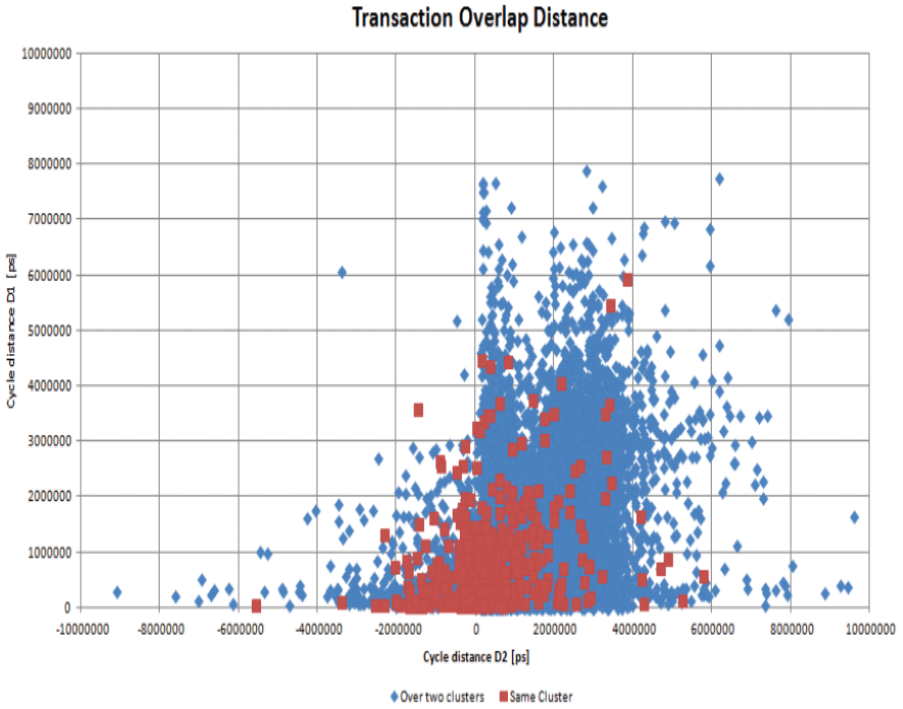
Solutions(2)

- UVM transaction recording
  - Allows linking from transaction to signals
  - Coverage->transaction
  - Transaction->wave/log



Solutions (3)

- Dynamic coverage
  - Post processing
  - Multiple events/data
- Requirements map to database queries
  - Get all data and events
  - No rerun @ requirement change



Summary

- ISO/DO teams should stay on top of advanced verification
  - Advanced verification is not a luxury
    - Matches design sizes and complexity
    - Can't be competitive otherwise
  - Gaps are easily created
    - And are very hard to close afterwards

Summary

- RBV and CD/CR can work together
  - But require upfront planning
  - Awareness to specifics
  - rigorous emphasis on coverage
- With good planning
  - Productivity can go >> directed tests
  - And ISO/DO support can improve

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Why Requirements Driven Verification?

- **Metric Driven Verification**
  - Allows us to define targets
  - And monitor progress

The metrics can become the end rather than the means to the end

- **Coverage Driven Verification**
  - Most common metric driven verification approach
  - Code Coverage
  - Functional coverage
    - Might be related to features

How often have do you chase a coverage goal with limited ROI?

- **Feature Driven Verification**
  - Features MIGHT be related to spec
    - Is that relationship captured?
  - Are features related to requirements?

Shouldn't everything we do be related to a requirement?

CD means CR

- CD flow:
  - Run tests
  - Look for coverage holes
  - Direct tests to those
- If we know what tests are doing, need for coverage is much smaller
  - And we can call that feature driven/requirement driven

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