

Requirements Testing: Turning Compliance into Commercial Advantage

**Mike Bartley,
Test and Verification Solutions**

- **Business advantages**

Some theory



- **Requirements management**
- **Mapping requirements to tests**



Some practice

Some reflection



- **Using SQL**
- **Recording test results**

- **Software requirements are much more complex**

- missed deadlines
- exceeded budget
- inability to meet project reqs

- **Poor and Changing Requirements have been the main cause of project failures for years**

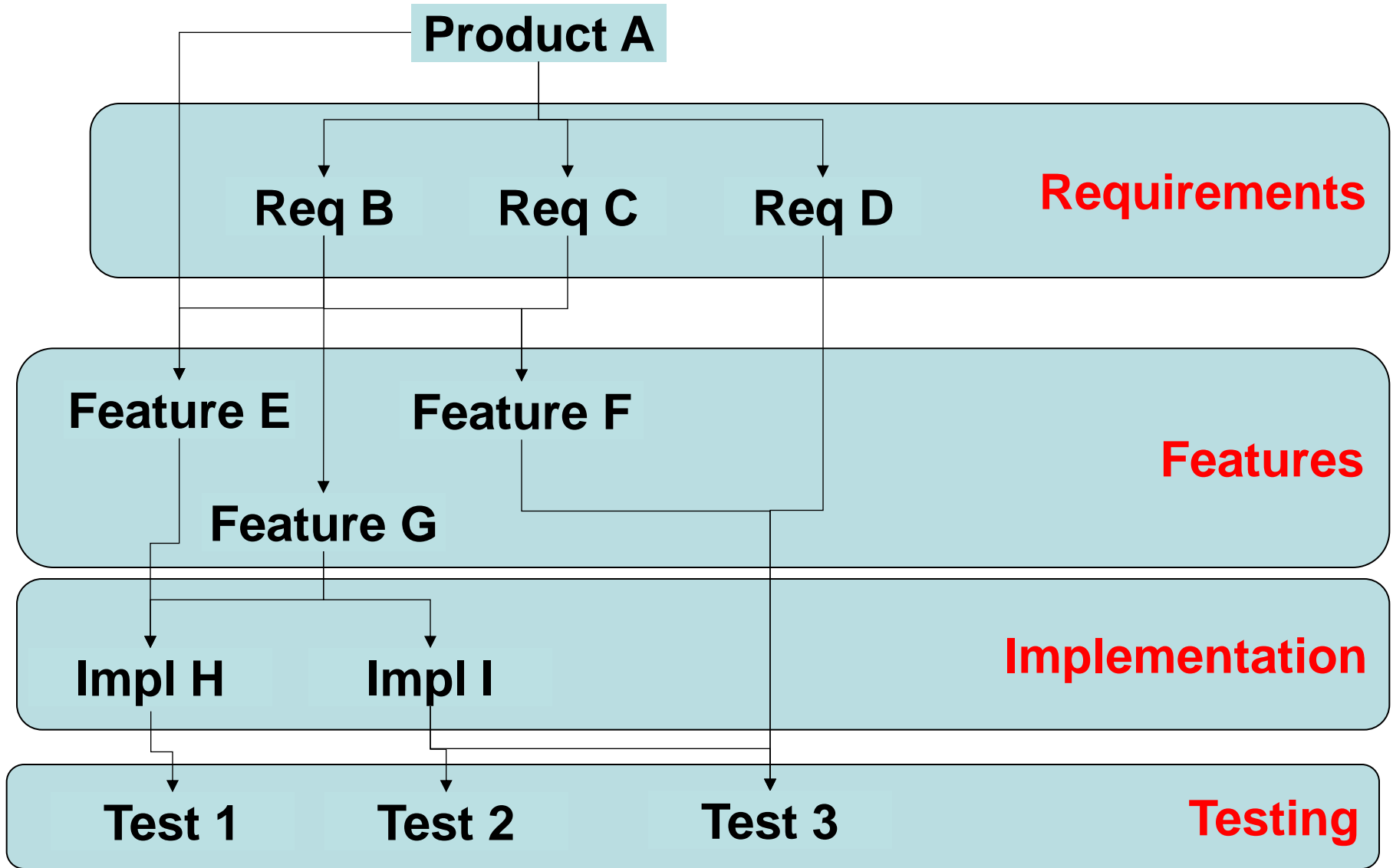
- Bull 1998 (203 interviews) major causes of failure:
 - Highest = breakdown in communications (57%)
- Chaos Report 1995 (308 managers):
 - Highest = incomplete requirements (13.1%)

Agile attempts to solve this issue with requirements

- **Over the years we have learned many ways to capture requirements:**
 - Documents (User / Marketing Requirements Documents)
 - Use Cases or Stories
 - Specification by Examples
 - Tests as Specifications
 - Formal specifications
- **But how do we make sure**
 - Requirements are implemented
 - And tested

**Some industries
Mandate this**

Ensuring Requirements are Implemented and Tested



- **Requirement**

- Client Service Operator finds all current clients in the system where their total value of sales between 2 specified dates is above a specified value

- **Features**

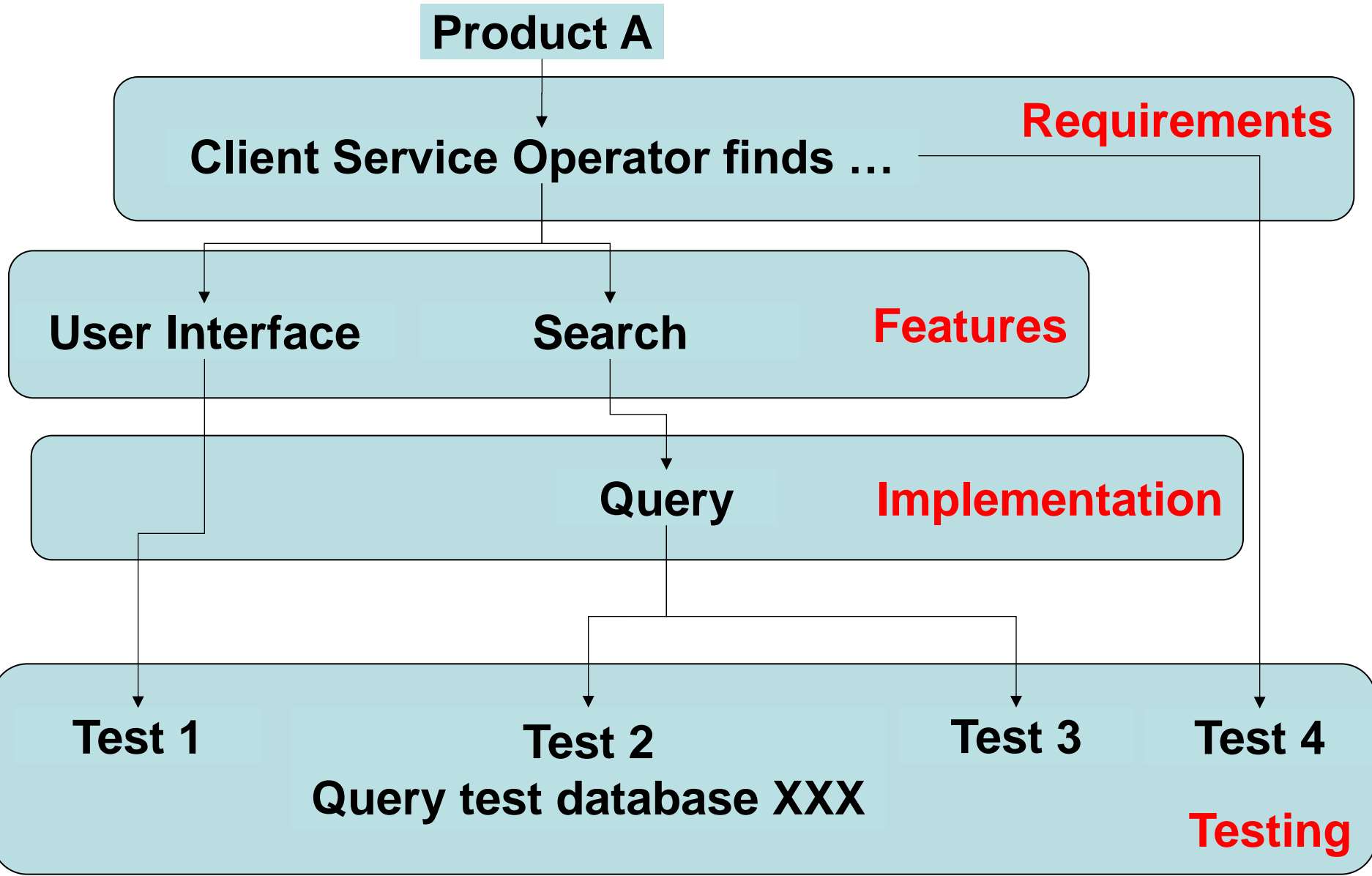
- User (with suitable privilege) can search system for current clients where total value of sales between 2 specified dates is above a specified value
- User Interface
 - allows a user to select the report, select date range etc

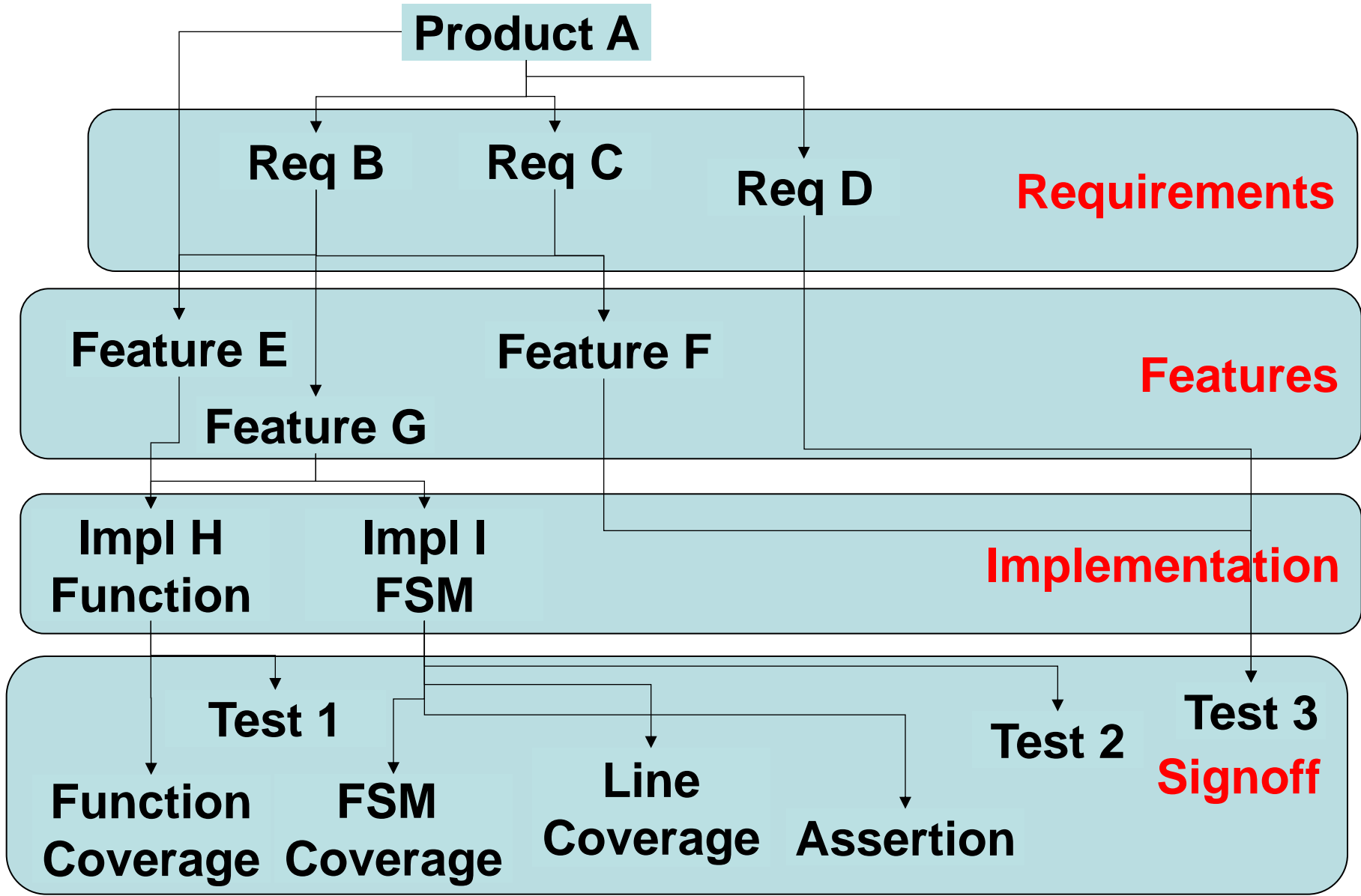
- **Implementation Aspects**

- For every transaction in the system the following data must be stored
 - Revenue value, Date and Client reference
- Need a query to find clients where total transaction value between 2 dates is above specified value
- Authorisation, Exceptions, Etc.

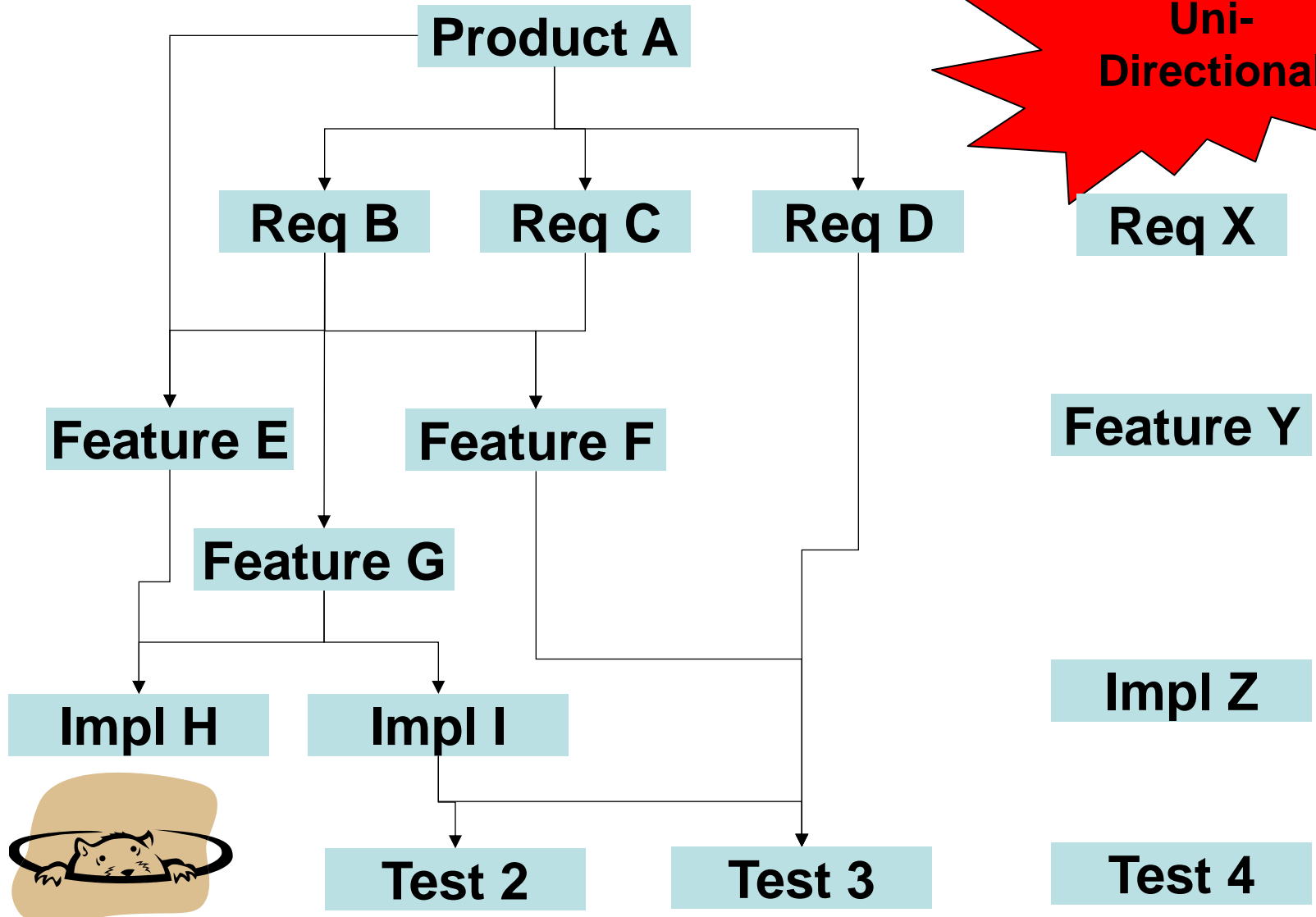
- **Tests**

- Query test database XXX with dates “d1/m1/y1” and “d2/m2/y2”.
Expected result = “client1”,...





Test Holes and Test Orphans!



- **Test Orphans Waste Time and Effort!**
 - How many tests do you have where you cannot remember what they are testing?
 - What % of your test suite is like this?
 - How much time do you spend running tests where you are not sure of the value of the test?
- **Test Holes Introduce Risk!**
 - A requirement is missing a test
 - Do you know how many of your requirements are not tested?

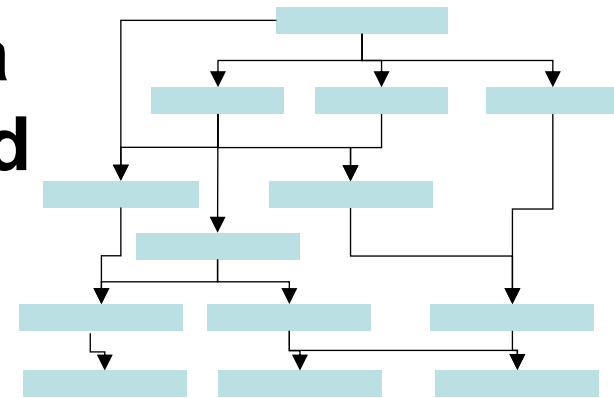
- **Many use a traceability matrix**
 - Which supports requirements tracing
 - **But will not support status, results and history**

Requirement Identifiers	Reqs Tested	REQ 1.1	REQ 1.2	REQ 1.3
Test Cases	5	3	2	3
1.1.1	1	x		
1.1.2	2		x	x
1.1.3	2	x		x
1.1.4	1			x
1.1.5	2	x	x	

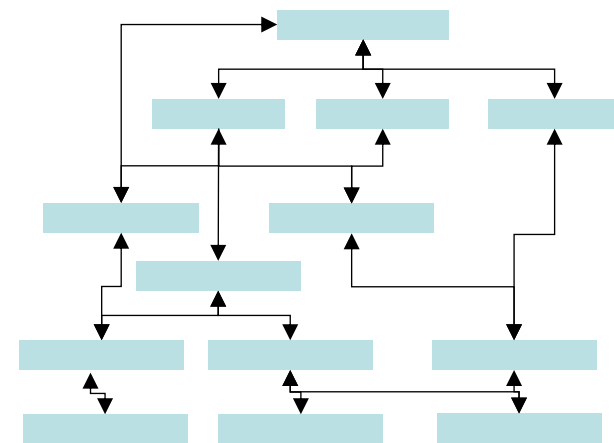
- **Example tools:**
 - Doors, Reqtify, Enterprise Architect, Jira, ...
- **Requirements get mapped down to features, design, units and can even get to code**
- **Until it comes to testing**
 - At best they just map to tests without any connection to
 - Test status
 - Test results
 - Results history

**Making it difficult
to track progress**

- **“the ability to follow the life of a requirement, in both a backward and forward direction”**
[Gotel and Finkelstein, 2006]

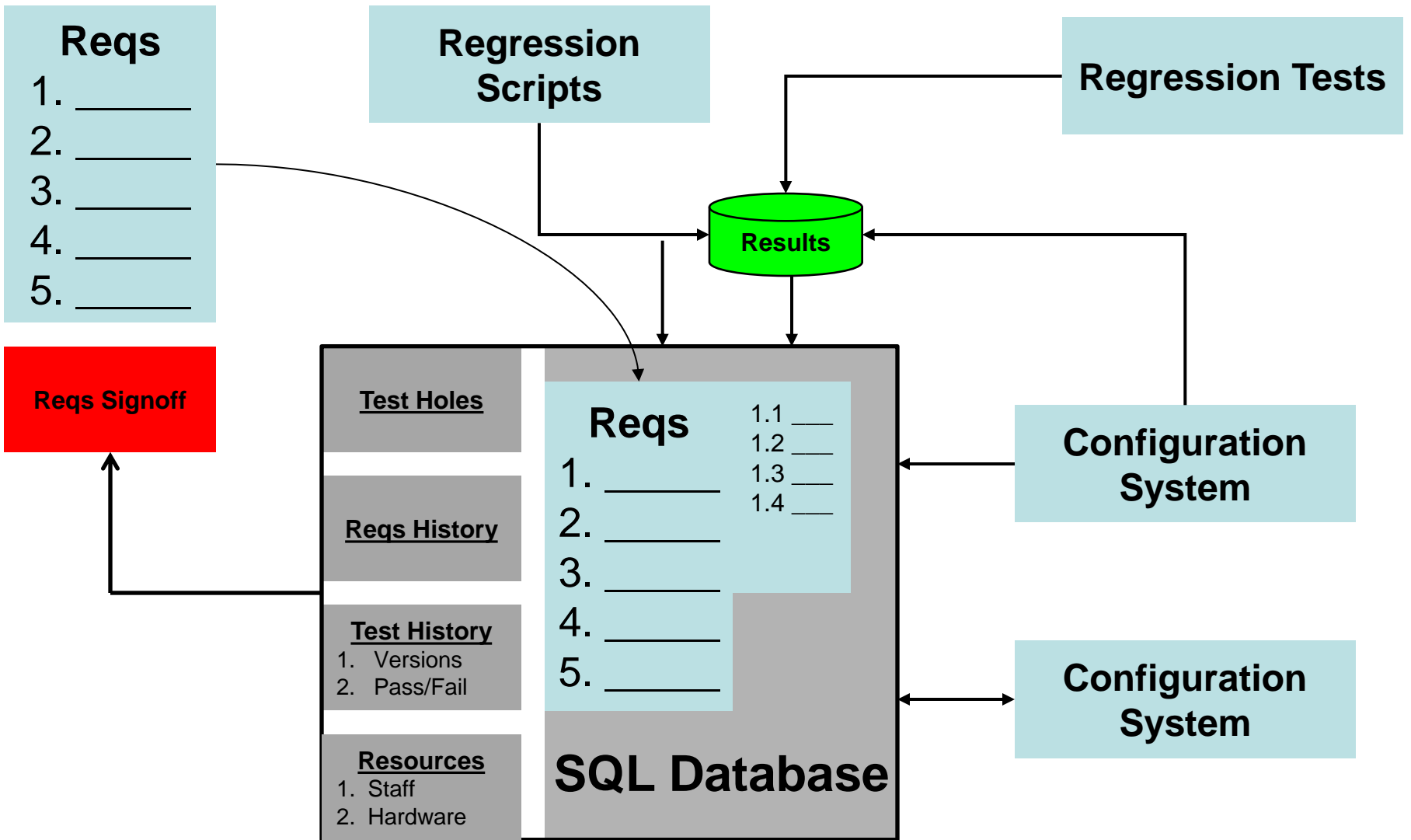


- **Requires bi-directional relationships in the requirements tree**
- **Advantages**
 - Orphan features/code
 - Business advantages – later!



- **Requirements management helps to record requirements and manage their implementation**
 - Can identify test holes
- **Bidirectional requirements mapping allows us to trace in both directions**
 - Identify orphan code and tests
 - And we will see impact and risk analysis
- **Want to also associate test status to requirements**

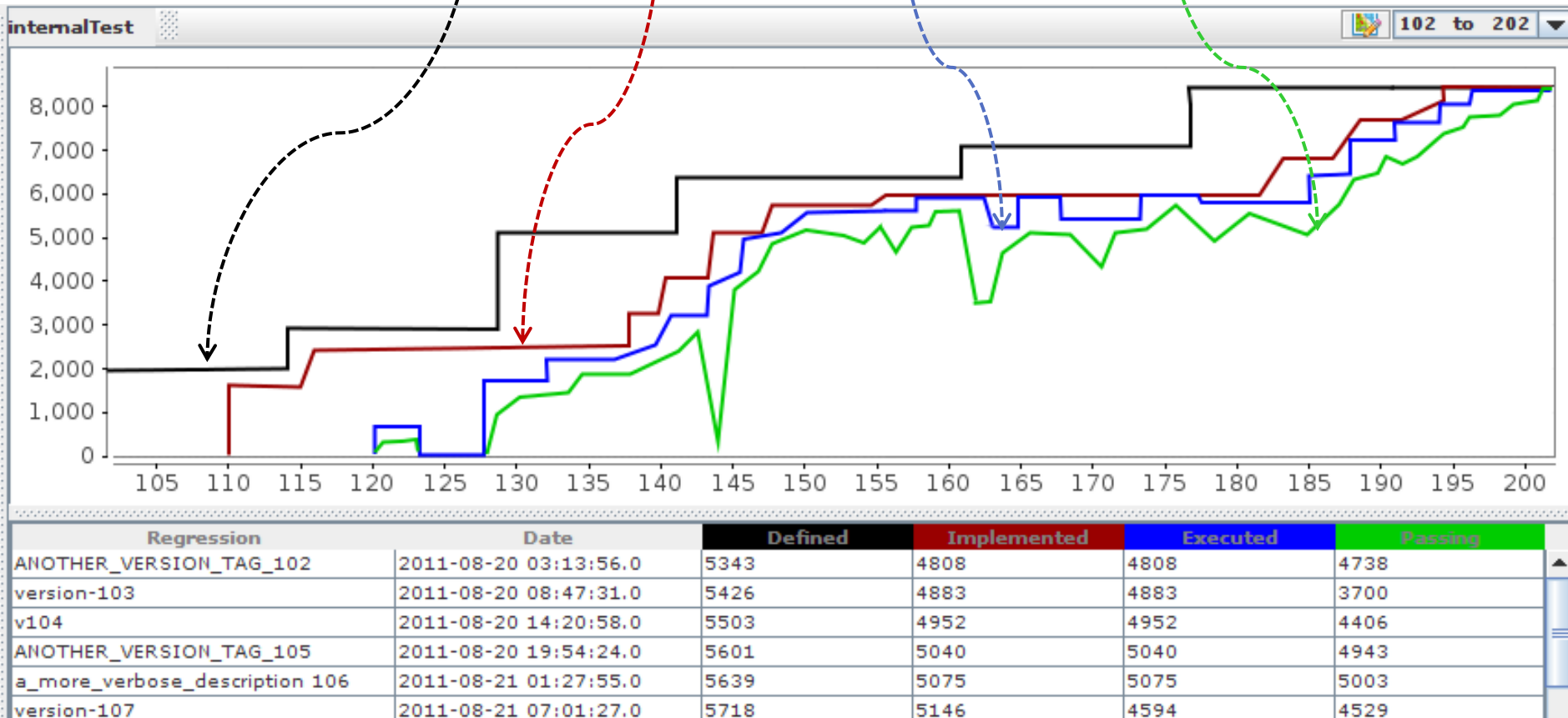
Using SQL for Requirements Management and Testing



So what do we want to track regarding testing?

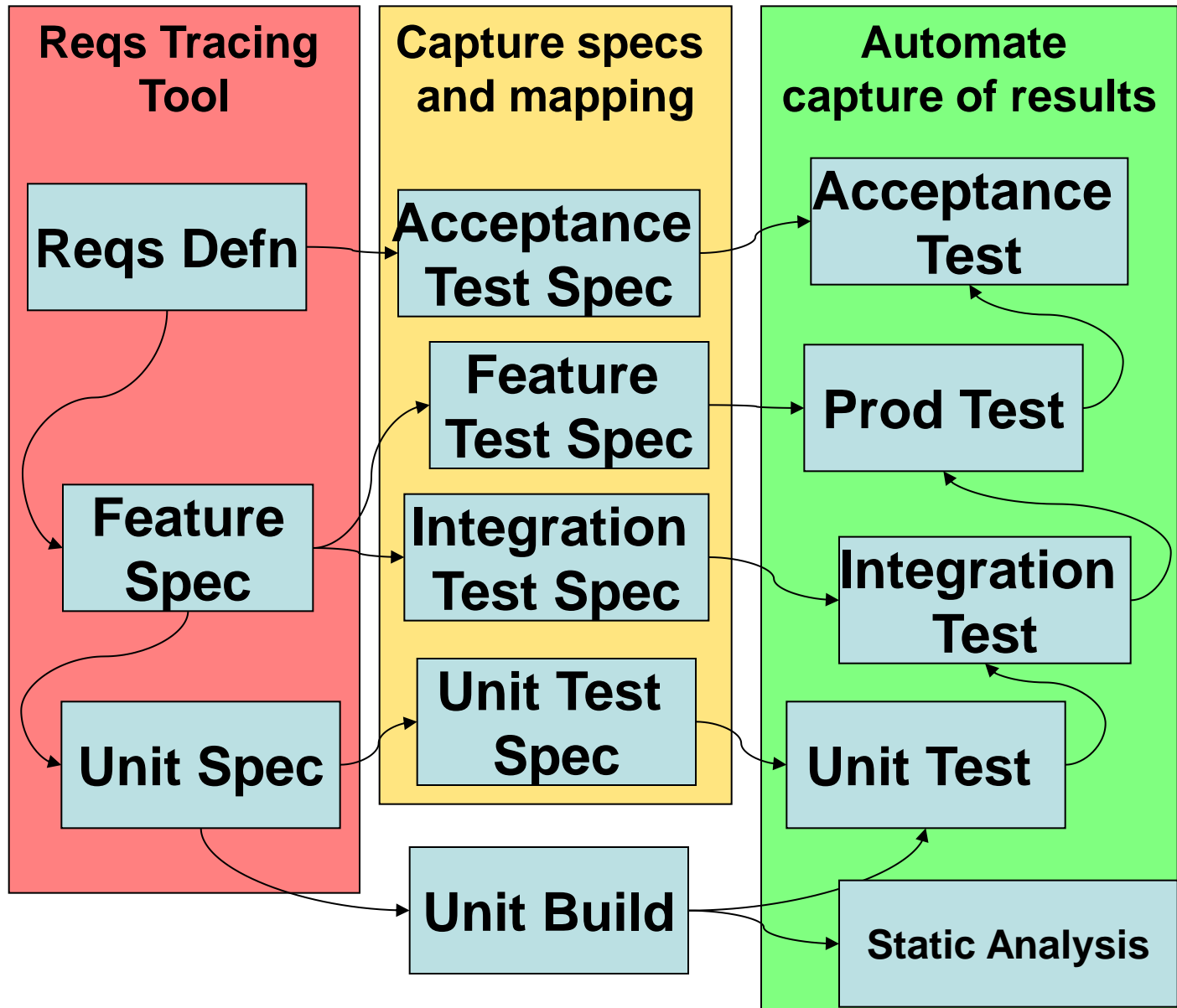
Start tracking testing from the start

- Are tests defined, **written**, **executing**, **passing**?



- **Importing requirements into the SQL database**
 - Using XML
 - Able to export back using XML
- **Add a simple API to get test results into the database**
 - Regression started, configuration information
 - Test started, test status
 - Regression complete
- **Extract coverage information automatically**
 - And store automatically into the database

Experiences of applying Requirements-Based Testing Supporting Sequential Development



Parallel development of verif plans and verification (TTM)

Improve specifications through test definitions

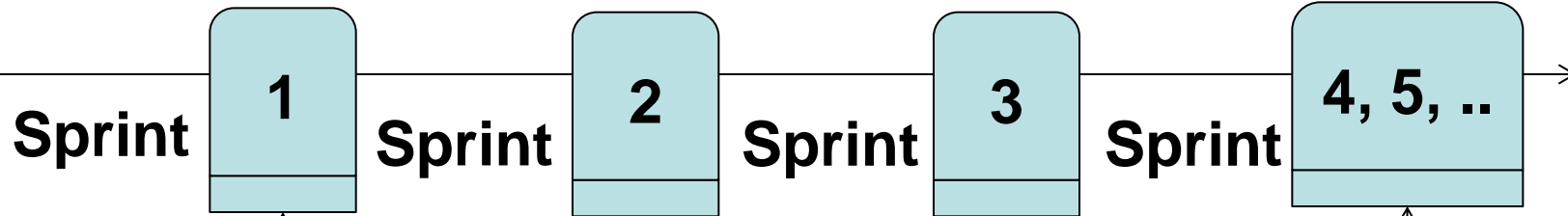
Map tests to reqs, features, etc,

Capture results

- **Important in building rigorous software systems**
 - U.S. Food and Drug Administration (FDA)
 - Mandatory for CMMI level 2 and above,
 - Mandatory for Certification in Aeronautics (DO-178B, DO-254), Railway Transportation (EN-5012x), Automotive (ISO26262,), Medical Systems (FDA 21 CFR), Other (IEC 61508),

Experiences of applying Requirements-Based Testing Supporting Iterative Development

Product Backlog



- Agree Feature Spec
- Define tests
- Map tests to features

- Beta release
- Execute tests
- Record results in DB

- Maintain feature
- Execute tests
- Record results in DB

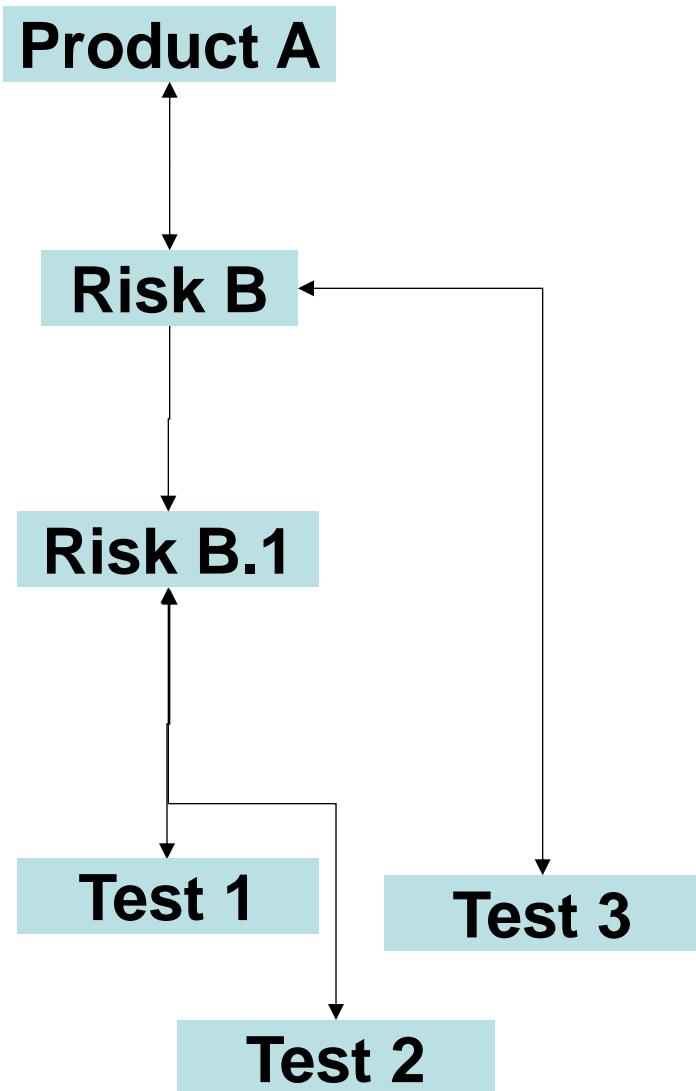
- Production release
- Execute tests
- Record results in DB



Not strictly scrum?

- **Requirements management helps to record requirements and manage their implementation**
- **Bidirectional requirements mapping allows us to trace in both directions**
 - Identify orphan code and tests
- **Record multiple test status rather than just pass/fail**
 - defined, **written**, **executing**, **passing**
- **Using an SQL database to record test data**
 - The mapping
 - The status

We will now see how this can create significant business advantage



- **Risk**

- Search for clients whose total value of sales between 2 specified dates is above a specified value returns wrong result
 - Probability = Low
 - Impact = High
- Risk**

- **Tests**

- Query test database XXX with dates “d1/m1/y1” and “d2/m2/y2”. Expected result = “client1”,...

- **Searching the test database**

- Prioritise tests according to risk
- Calculate remaining risk
 - A passing test mitigates risk

Improved Time-To-Market through Prioritisation and Risk Analysis

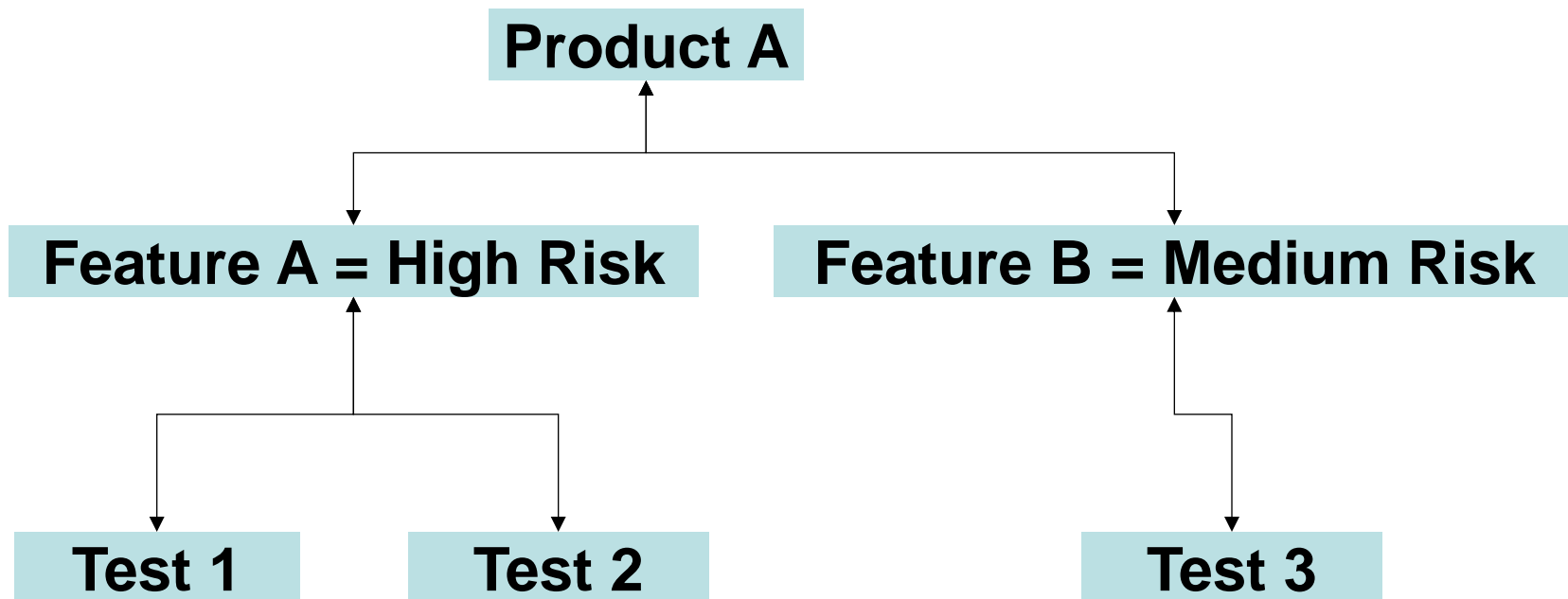
Requirement Priority Unit 1 Integration System Acceptance

Requirement	Priority	Unit 1	Integration	System	Acceptance
Req 1	1	✓	-	-	-
Req 2	1	✓	-	-	-
Req 3	1	x !	✓	-	-
Req 4	1	✓	-	-	-
Req 5	1	✓	-	-	-
Req 6	2	✓	✓	-	-
Req 7	2	x	✓	-	-
Req 8	3	x	x !	✓	✓
Req 9	1	-	-	✓	✓

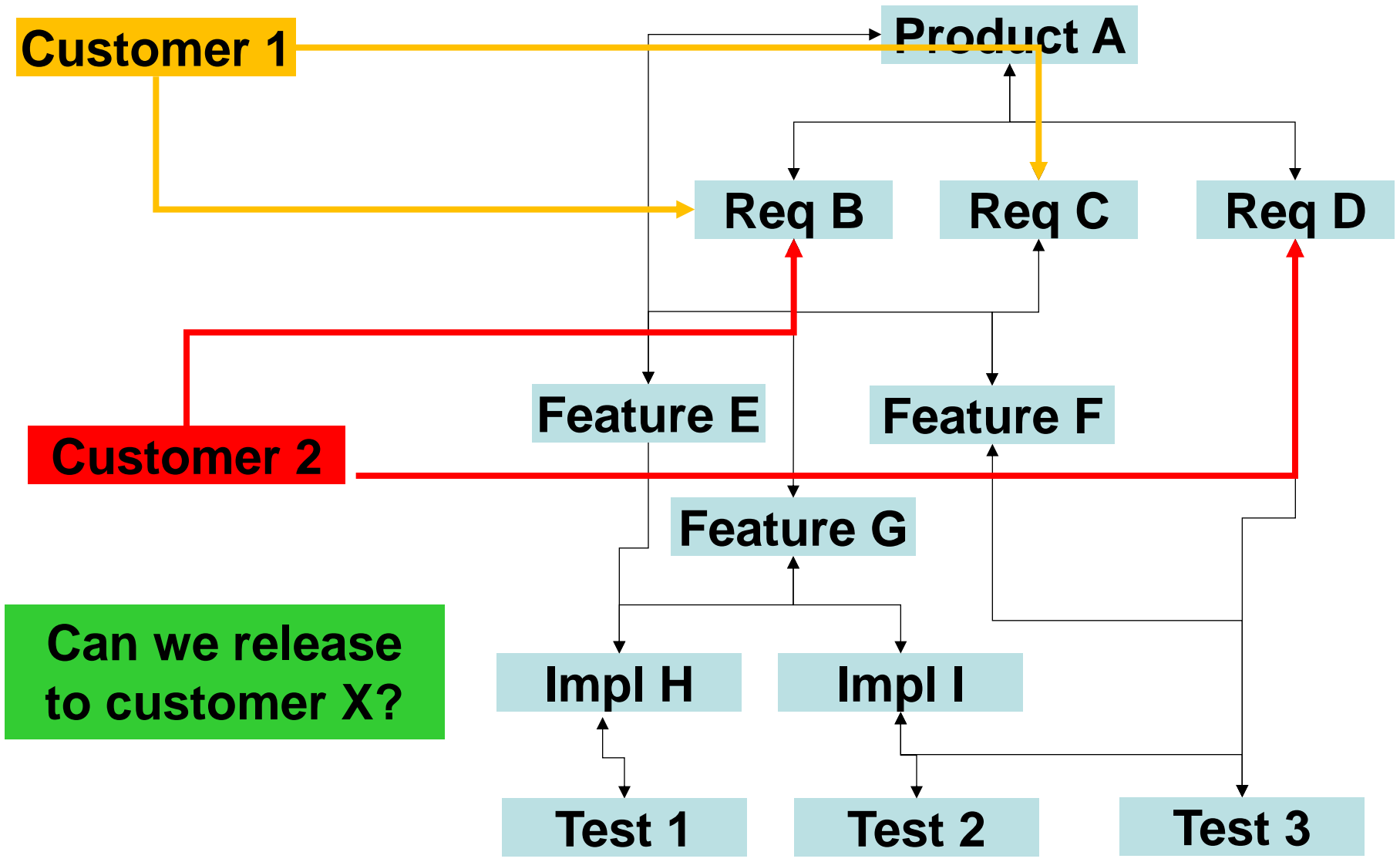
- **Release Unit level with known risk**
 - Close at higher level
- **Release with known risk**

- **Higher Risk = More testing**

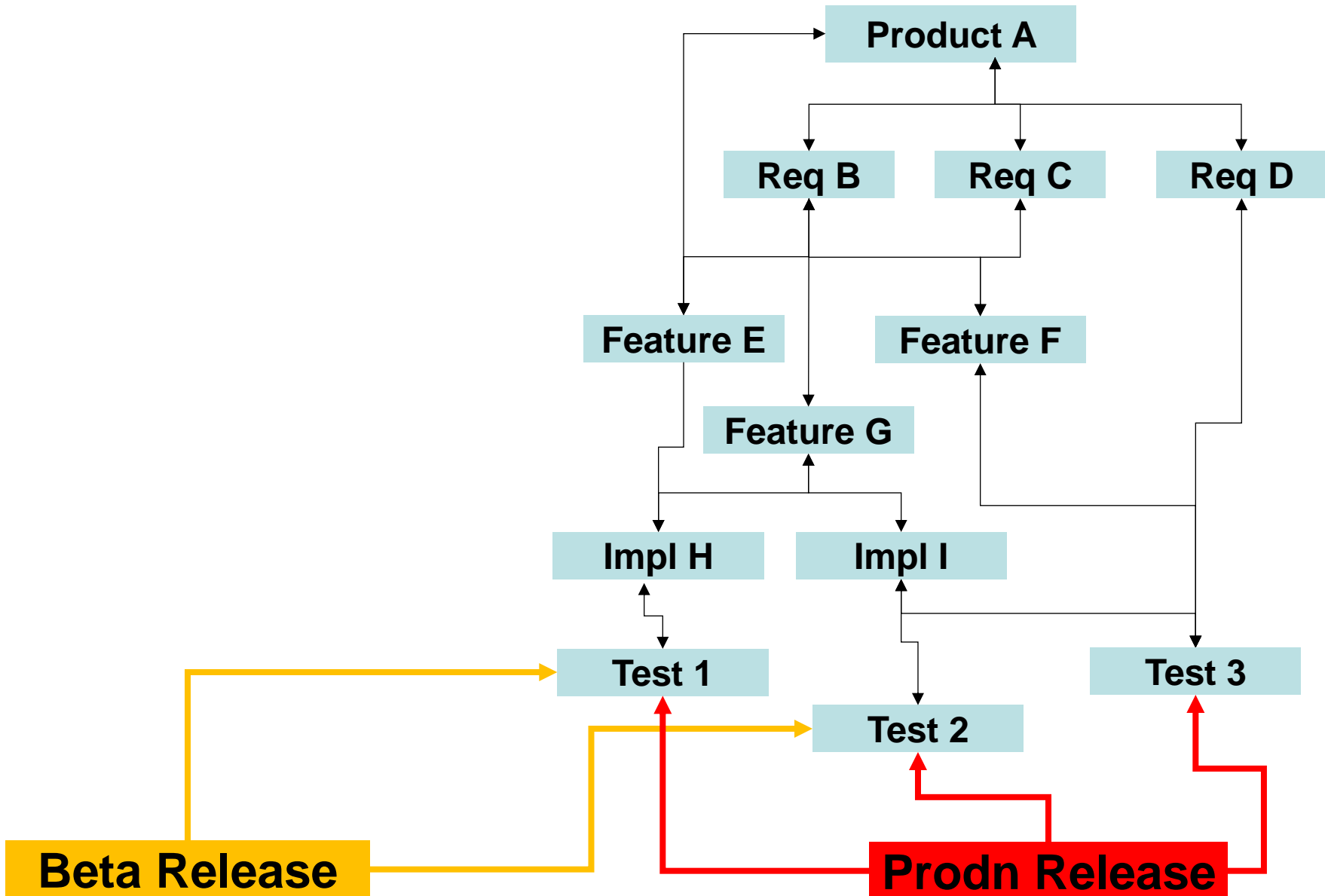
- Higher risks should have more tests
- Can add “risk field” to features based on likelihood of failure and impact of failure
- Can match level of testing to risk and ensure sufficient level of testing (using easy searches)



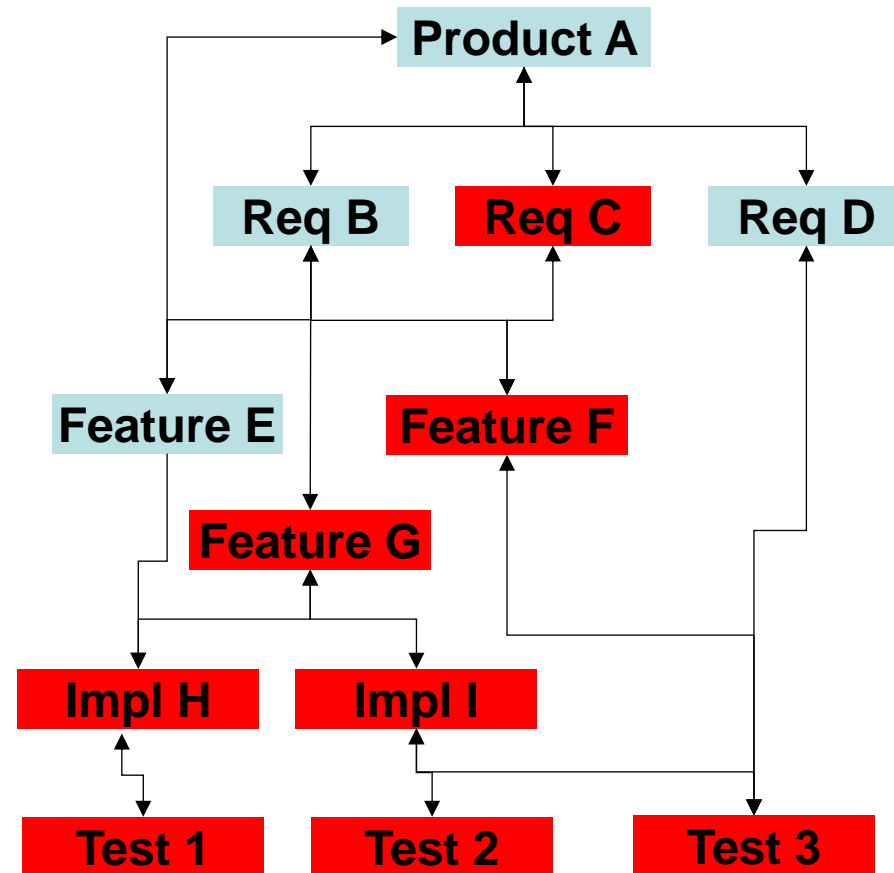
Filtering Requirements based on Customers



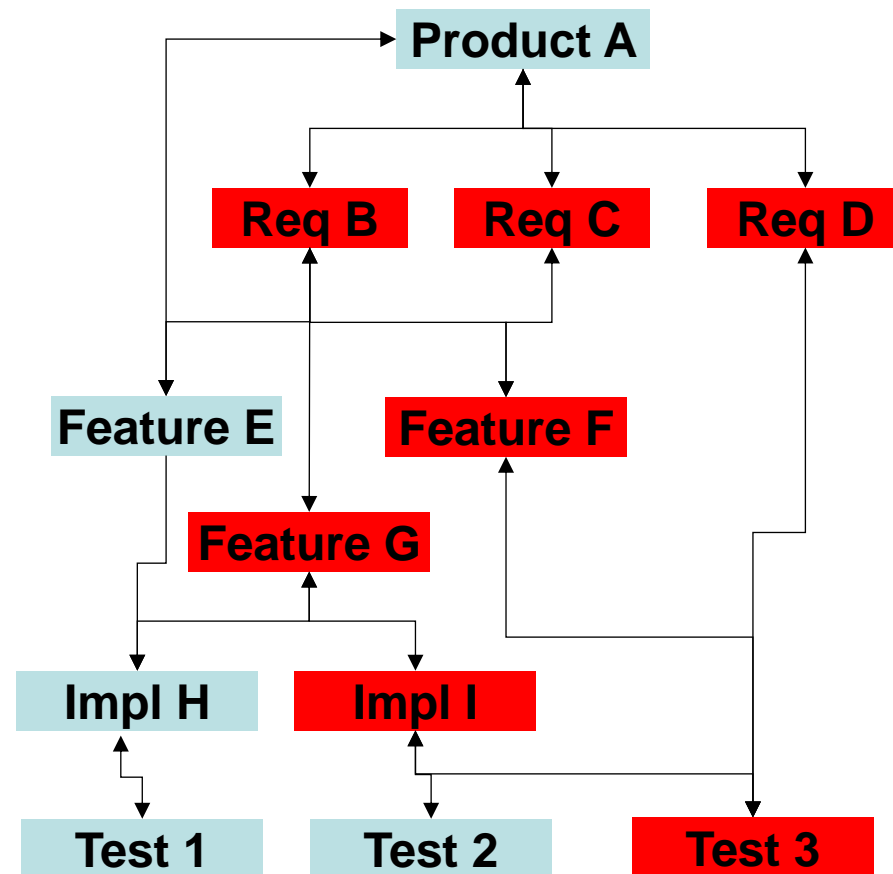
Can we release to customer X?



- How often do people ignore testing when assessing the impact of a change?
- What is the impact on changing Req C?



- What is the impact on dropping test 3?



- **Initial investment is relatively high**
 - Building initial SQL database
 - Ensuring requirements are recorded
 - Ensuring test information is stored
 - Mapping requirements to tests
- **Business advantage is huge**
 - Identify test holes and test orphans
 - Understanding status at all points in project
 - “Defined, written, running, passing”
 - Automation of analysis (risks, impact, release readiness)
 - Trend analysis
 - Better prediction of release readiness

- **Map requirements to tests**
- **Database to record mappings and results**
 - Store results from test automation
 - Record %'s of tests defined, **written**, **executing**, **passing**
- **Advantages**
 - Identify test holes and test orphans
 - Track the status of the whole verification effort
 - Use historical perspective for more accurate predictions
 - Better reporting of requirements status
 - Support for
 - Risk-based testing
 - Prioritisation and Risk Analysis
 - Filtering Requirements based on Customers and releases
 - Impact analysis
 - Support for regulatory-based requirements signoff



- **Mike Bartley**

- mike@testandverification.com
- Mike Bartley on LinkedIn
- Other materials on www.testandverification.com