A System Model for Managing Requirement Trace Matrices via Statistical Artifact Change Analysis

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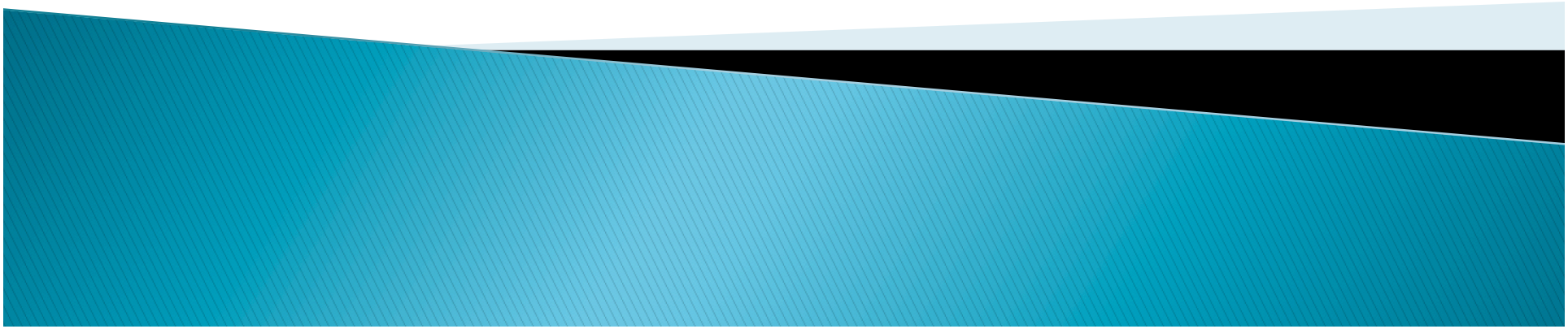
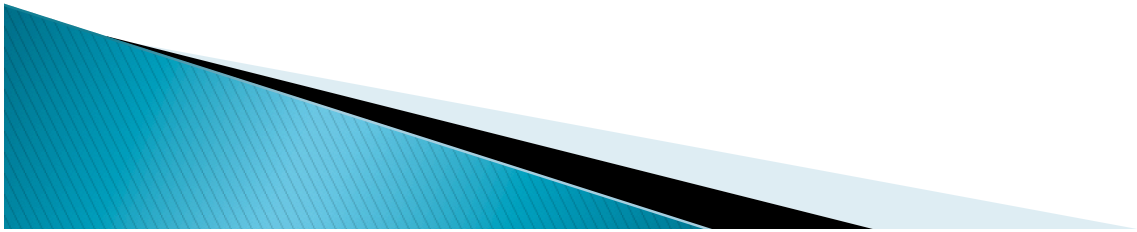


Research Problem

- The Requirements Traceability Matrix (RTM) is utilized to:
  - Link deliverables to requirements
  - Identify Overlap
  - Ensure fulfillment
- Critical Change Management Tool
  - Highly effective in identifying collateral impact of change
- In dynamic landscapes, the RTM can easily fall out of a known validity
  - Rapid Change

Motivation

- One of the major challenges facing the implementation of traceability is the cost.
  - Systems grow in size and complexity
  - Systems become more dynamic
  - Manual generation of RTM is a tremendous undertaking
    - When the is manual generation required?
    - “After each change” may not be feasible.
    - “Allowing multiple changes may result in missed overlaps

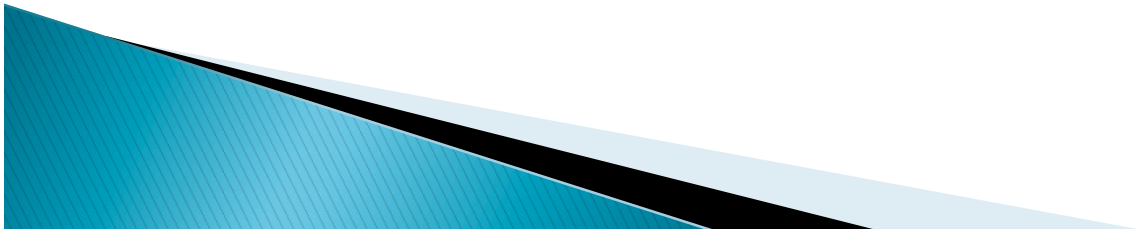


Motivation (cont)

- Dynamic Landscapes
  - Rapidly changing requirements
  - New requirements being generated
  - Concurrent development being implemented
    - Identifying Overlap before problems arise
- Growth in Size and Complexity
  - Over time, a system being constructed has a tendency to grow larger.
  - With growth comes complexity.
  - Size and Complexity can generate overlap and reuse.

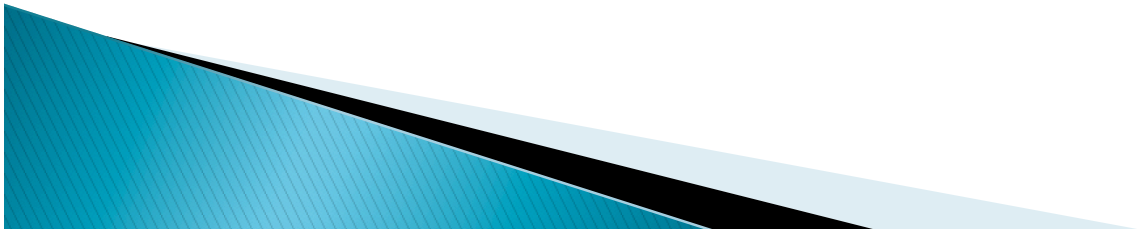
Motivation (cont)

- What is the value of knowledge about the changing Requirements Traceability?
  - We can certainly understand the cost associated with the RTM.
- The value of understanding the impact of change to a System / System of Systems
- The value of understanding the impact of change to a RTM



Background

- How is the problem being solved today?
  - Many different areas of research focus on the effective utilization of the RTM.
  - Not a significant amount of research built around determining confidence in the RTM and determining the need for regeneration.
- Automated RTM Management
- Manual Generation and Management
- IR Techniques

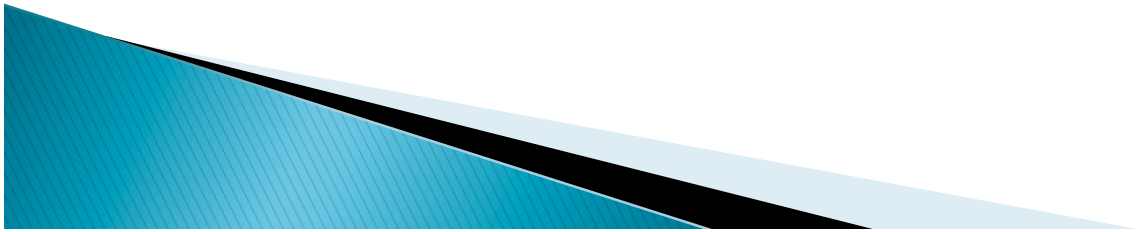


Related Work

- Automated RTM Management
  - Software with the purpose of maintaining the links between requirements and deliverables.
  - Effective for the mining of information from an RTM.
  - Ineffective at generating the RTM.
  - Highly ineffective at identifying the effectiveness of the RTM as systems evolve without additional assistance.

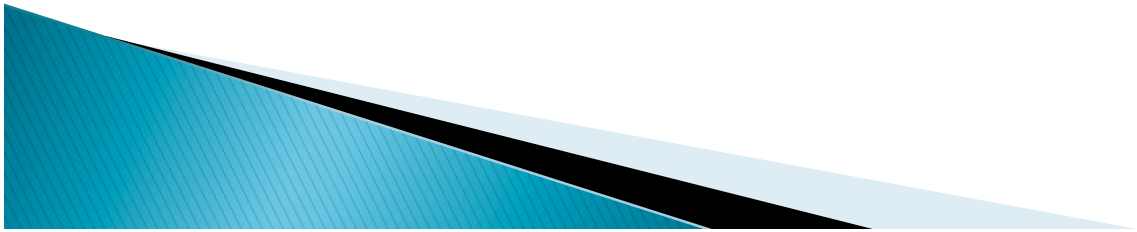
Related Work

- Manual Generation of the RTM.
  - Intensely time consuming.
  - Requires high levels of expertise and knowledge of the system in question.
  - Based on the effort required for generation, a risk of being outdated before full generation exists.
- Research is being conducted in the area of speeding the delivery of the RTM.
  - Significant increases, but still significant effort.
  - Value Based RTM Generation.



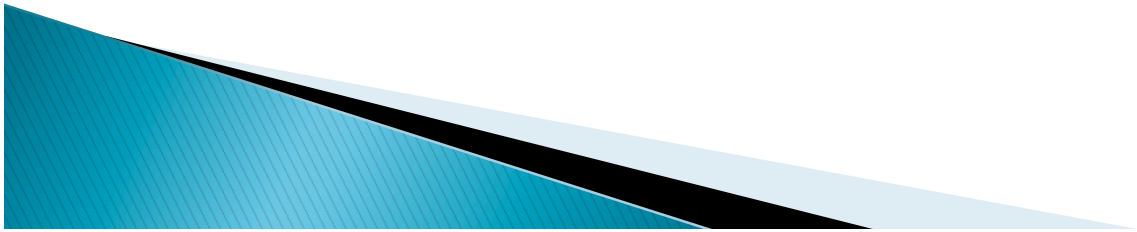
Related Work

- Information Retrieval Methods
  - Several areas and methods are being researched
  - Latent Semantic Analysis of artifacts
  - Clustering of artifacts
  - Effectiveness varies greatly
    - ~50% precision and ~50% recall are median results.
    - Precision or recall can be increased at the expense of the other.
    - Not effective enough to make decisions regarding change management.



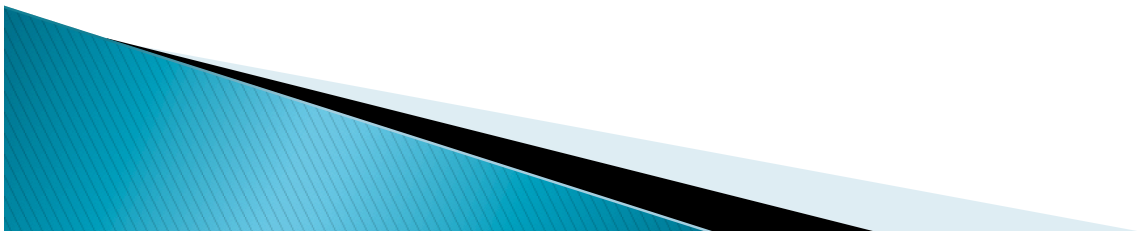
New Technical Idea

- Identify the confidence in an RTM based on changes since generation.
  - All changes will be classified according to some generated taxonomy of change.
  - Based on this taxonomy of change, what changes will have the greatest impact on the RTM?
  - What combinations of changes will indicate a loss of confidence in the RTM?



New Technical Idea (cont)

- Taxonomy of Change
  - All change can be broken into set categories.
  - Taxonomy may be different for
    - Software Engineering
    - Systems Engineering
    - Systems of Systems Engineering



New Technical Idea (cont)

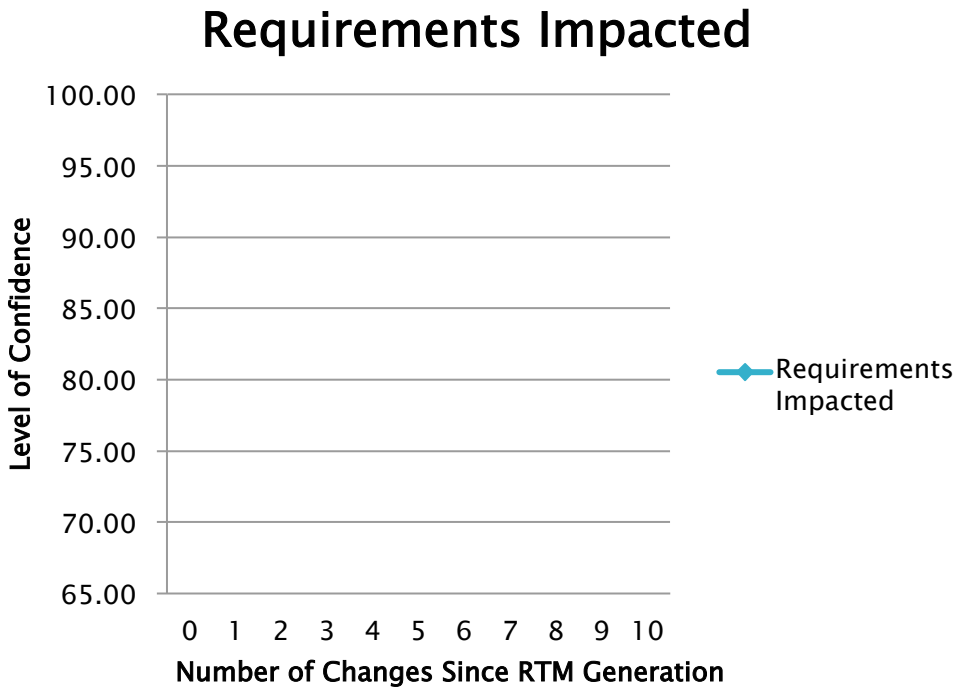
- Requirements Engineers are familiar with
  - Deliverables
  - Requirements
  - The RTM linking the two
- Based upon the changes applied since the last generation of the RTM
  - Changes are classified via their respective Taxonomy of Change
  - The order of change may have an impact as well
    - Interesting follow up questions generated from this model.

New Technical Idea (cont)

- Develop a tool which will mine changes from version management systems and identify changes.
  - Attempt to automate the classification of change in a taxonomy of change.
- Results in a system which will
  - Rapidly identify the types of changes taking place
  - The order of the changes taking place
  - The statistical likelihood of the RTM being impacted by change
    - Confidence in the RTM is derived from this data.

Research Hypothesis

- Based on the number of changes seen in a system, the confidence in the RTM will diminish
  - Confidence being the likelihood of correctness
  - We expect different types of change to have different impact



Research Approach

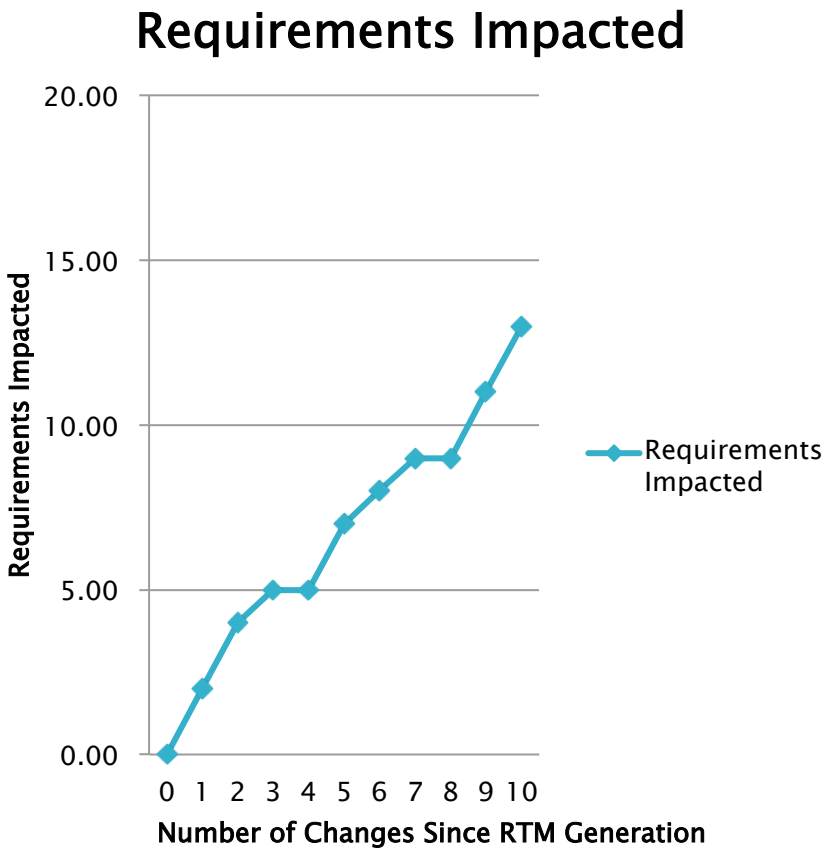
- Utilize OSS projects with a substantial version history
  - Gantt
  - ReactOS
  - jHotDraw
- Utilize validated traces as a starting point for further analysis.
- Identify and classify changes between known versions.
- Retrace at major (stable) releases.
- Based on the impact of changes between traced versions, we will derive the statistical model.

Research Approach

- Utilize Traces Generated by Institute for Software Engineering and Automation
  - Reuse methods for creation of additional traces for additional releases of software
  - Working closely with Dr. Alexander Egyed
- Utilize Software Engineering Graduate Students to create Taxonomy of Change
- Tool to Automatically Mine Changes and classify them.

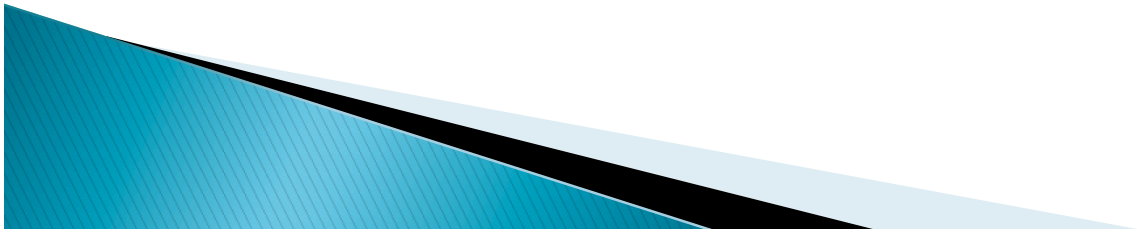
Evaluation Methods

- Examine the totality of changes between versions.
  - Based on the types of changes that have taken place, evaluate the total impact.
  - Identify the impact of individual changes.
  - Based on the types of change identified, identify the impact of changes.
- Other interesting questions.
  - Do some changes appear together?
  - Are certain combinations more impactful?
  - At some number of changes, does it no longer matter what kind of change is being made?



Preliminary Results

- Requirements for tracing have been identified and documented in all three OSS projects.
- Initial Traces have been collected.
- Data gathering exercises have begun with Gantt versions.
  - 2.0.8 -> 2.0.9
  - 2.0.9 -> 2.0.10
- Examination of change repository data for projects is being conducted.



Preliminary Results

- Our research is still in the preliminary phases.
  - Initial examination of results (Gantt) is scheduled for the end of 2011.
  - Taxonomy of change has been identified.
  - Frequency and Impact of different types of change is being analyzed.
  - Original hypothesis will be tested based on collected Gantt data.
    - Results of this experiment will drive the continuation of research in this area.

Potential Impact (SE & SoS)

- Modification of taxonomy will allow for rapid scaling between:
  - Software Engineering
  - Systems Engineering
  - Systems of Systems Engineering
- Knowledge of RTM Reliability
- A greater understanding of the impact of specific types of change to a System / SoS.
- A greater understanding of the impact of specific types of change to the RTM

Conclusion & Future Work

- Few conclusions at this time.
  - The Taxonomy of Change has been established.
    - Initial research shows that all change can be accounted for.
    - New categories may be uncovered with additional research.
- Future Work
  - Should all change be included in the research?
    - Changes that are later reversed?
    - Delta of change to a version is 0, but what if other changes occur between the initial and reversal?

Questions?

- Follow up questions or comments can be directed to Benjamin Deaver
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