WARP Reliability Analysis Technical Specification

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Group Meeting Times: 3:30-4:30 on Mondays at the Library, 12:30-1:30 on Wednesdays in lab

1. Introduction:
    a. Overview: We need to complete the ReliabilityAnalysis and ReliabilityVisualization classes in the WARP code base so that they produce the *.ra output files. These files are a visualization of an end-to-end reliability analysis of a WARP input file.
        i. **Program Requirements**:
            1. ReliabilityVisualization must create a file visualization of a ReliabilityAnalysis for Warp to match the example *.ra files included with the program specification.
            2. ReliabilityAnalysis must perform a complete analysis of the given program schedule to meet the reliability requirements specified by the WorkLoad.
2. Solution:
    a. Design:
        i. Creating *.ra files will interact with input files that contain information about the flows being used. These input files are what the reliability analysis is going to be based off of. The design and solution will not alter these files, but rather, will create an analysis of the reliability of the flow as called for by the Warp main program.
        ii. **ReliabilityVisualization**: The design will incorporate steps to create the necessary layout for the *.ra files: a header, parameters used, nodes in the flow, and the math in each step of computing the Reliability Analysis.
            1. The class overrides the methods createVisualizationData() and createHeader() from the VisualizationObject class, as these are called by VisualizationImplementation in the process of building a visualization through the Warp main. The method createFooter() will not be overridden because the example *.ra output does not have a footer. Additionally, the method createTitle() will be implemented to parse the file title from the program.
        iii. **ReliabilityAnalysis**: The design will create a table that computes the reliability of each node in each time slot used in the analysis. This class will include the math to commute that reliability, the code that will create the table when created with the constructor taking a Program as a parameter, and will access the necessary instruction parameters given by WarpDSL.
            1. The current computational functionality of numTxAttemptsAndTotalTxCost() needs to be revised to account

for numFaults values other than the default, due to an error in the HW5 code.
2. The class needs to complete its entire analysis after being created using the constructor taking a Program as a parameter, and store it as an attribute(s).
3. The reliability analysis will be accessible through the getter methods getReliabilities() and verifyReliabilities(). The former will be used within the reliability suite, and the latter is used by WarpSystem.

b. Test Framework:
   i. Unit testing will be used to verify the functionality of the methods developed as part of the solution, and will be included with the verification of the *.ra output file result as the complete test suite.
   ii. **Tests**:
      1. Test if the correct math is being used in each step within Reliability Analysis from src->sink node.
      2. Test if *.ra file has the correct header.
      3. Test if *.ra file has the correct parameters listed.
      4. Test if *.ra file has the correct data in the schedule
      5. Implement unit tests for every method in ReliabilityAnalysis
      6. Implement unit tests for every method in ReliabilityVisualization

3. Timeline:
   a. Sprint 1 (Due April 10):
      i. Fill out this document -Group
      ii. Put high-level plans into ReadMe -Jackie, Andy
      iii. Create a full sequence diagram for when Warp is run with the -ra option -Matt, Jackson
      iv. Create plans and assign work -Group
   b. Sprint 2 (Due April 21):
      i. Update ReadMe to reflect updated plans and document who did what -Jackie
      ii. Fully code ReliabilityVisualization
         1. Implement createHeader() -Jackson
         2. Implement createTitle() -Jackson
         3. Implement createColumnHeader() -Jackson
         4. Implement createVisualizationData() -Andy
      iii. JavaDoc ReliabilityVisualization -Group, Jackson Review
      iv. Update UML diagrams -Matt
      v. Make tests for ReliabilityVisualization - Jackie, Matt
         1. Unit tests for each method -Matt, Jackie
         2. Test to verify output formatting -Matt
         3. Test to check math -Jackie
      vi. Plan Sprint 3 -Group
   c. Sprint 3 (Due May 5):

i. Update ReadMe - Jackie
ii. Fully code ReliabilityAnalysis
    1. Bug fix (2.a.iii.1) -Jackson
    2. Run reliability analysis from constructor with the following methods: -Jackson
        a. ReliabilityAnalysis(program)
        b. buildNodeMap()
            i. Create a ReliabilityNode class extending Node so that nodes in the NodeMap can hold data specific to the ReliabilityAnalysis
        c. buildReliablityTable()
        d. setInitialStateForReleasedFlows()
        e. carryForwardReliabilities()
        f. updateTable()
        g. setReliabilities()
        h. setReliabilityHeaderRow()
        i. getReliabilityHeaderRow()
        j. printRATable()
    3. Implement getReliabilities() -Andy
    4. Implement verifyReliabilities() and getFinalReliabilityRow() -Andy
iii. JavaDoc ReliabilityAnalysis -Group, Jackson Review
iv. Update UML diagrams -Matt
v. Make tests for ReliabilityAnalysis -Jackie, Matt
    1. Unit tests for each method -Jackie, Matt
    2. Stress tests for the analysis -Jackie, Andy
    3. Test to verify output data -Jackie, Matt

3/29 Meeting Notes:
PROGRAM SPECIFICATION: complete the ReliabilityAnalysis and ReliabilityVisualization classes such that they create the *.ra files available from ICON and evaluate the end-to-end reliability of WARP flows, as requested in the WarpTester main program. Do this even for the k-Fault model version of the code, using the -e and -m parameters if specified. Be sure to complete all methods declared in the class.

- To retrieve the instructions in each time slot, which is required to know which nodes probabilities to update and when, use ArrayList<InstructionParameters> getInstructionParameters(String instruction) in the WarpDSL class to parse the instruction string contained in a ProgramSchedule table entry. The class InstructionParameters() (defined in WarpDSL) allows you to access the parameters.
- Let M represent the Minimum Packet Reception Rate on an edge in a flow. That is, M = minPacketReceptionRate.The end-to-end reliability for each flow, flow:src->sink, is computed iteratively as follows:
    - The flow:src node has an initial probability of 1.0 when it is released. All other initial probabilities are 0.0. (That is, the rest of the nodes in the flow have an initial probability value of 0.0.)
    - Each src->sink pair probability is computed as newSinkNodeState = (1-M)*prevSnkNodeState + M*prevSrcNodeState This value represents the probability that the message has been received by the node SinkNode. Thus, the NewSinkNodeState probability will increase each time a push or pull is executed with SinkNode as a listener.

Main Task: Let ReliabilityAnalysis and ReliabilityVisualization perform reliability analysis and create an output file visualization with the *.ra suffix

Entry Point: Warp.java

Input: Input files are flows
Output: *.ra file and a reliability analysis

Control Flow:

File → Warp → VisualizationFactory → VisualizationImplementation
—

Make a function that:

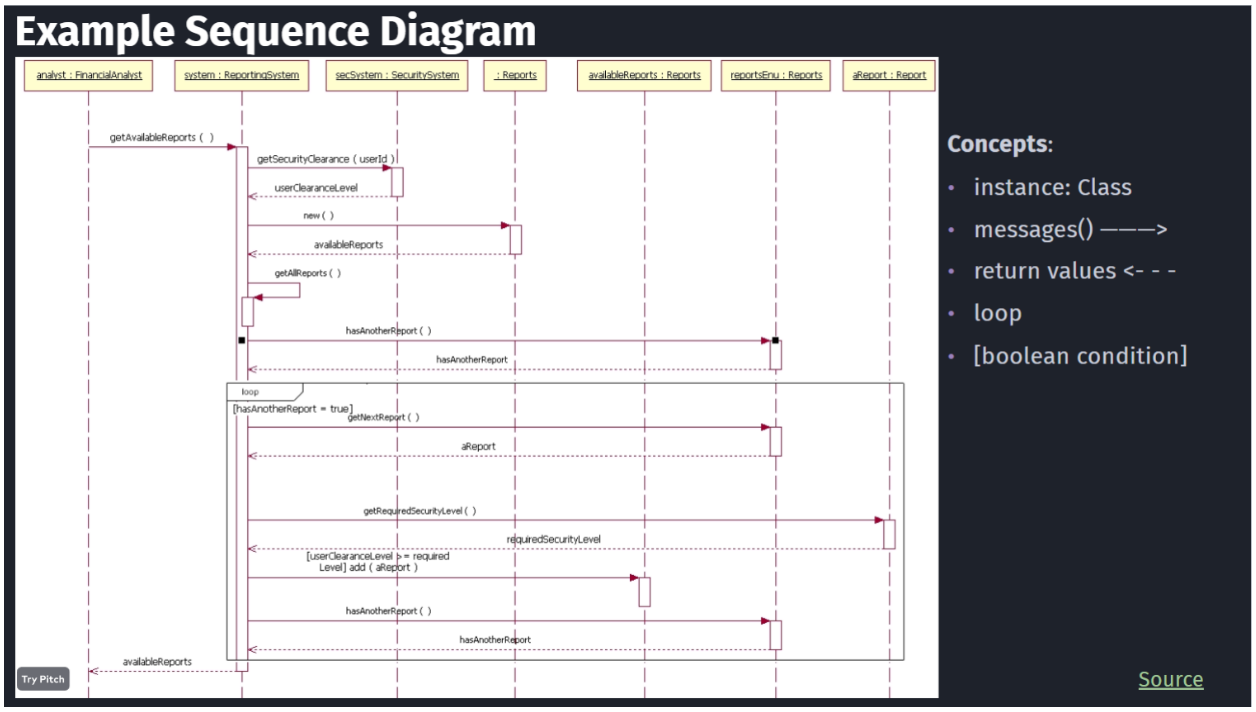
1) Creates a WarpDSL object and gets instructions
2) DO the .ra and perform an analysis
3) Put it into the constructor

4/3 Meeting Notes:

- Reliability Visualization will need the following methods, which are called by VisualizationImplementation:
  - visualization
  - fileVisualization
  - createFile

Sequence Diagram

4/10 Meeting Notes:

- 

Example Sequence Diagram

Concepts:

- instance: Class
- messages() ———>
- return values <- - -
- loop
- [boolean condition]

Source

4/12 Discussion Notes

What we need to have for ReliabilityVisualization and ReliabilityAnalysis

ReliabilityVisualization

- displayVisualization()
    - New GuiVisualization(title, header, data)
- createHeader()
    - Title
    - Calls to warp
- createVisualizationData()
    - ReliabilityTable reliabilities = call to ReliabilityAnalysis
        - for() loop for all the rows and columns (100 rows, number flows in warp for columns)
        - reliabilities
- createTitle

ReliabilityAnalysis

- Existing HW5 code
- verifyReliabilities
- buildReliabilities
- Set + get header row
- Print RATable

For sprint 2:

- Have ReliabilityVisualization coded & tested
    - should print 0's in the table - not the actual math yet
    - If we cannot finish, make sure to document what we plan on doing to finish. Finish for Sprint 3
- Java Doc / Test plans documented out so they can see where we're planning to go for Sprint 3
- Check files named similarly (analysis and visualization) for reference code to use
    - Verify workload, channel for verifyReliabilities
    - ProgramVisualization is similar to ReliabilityVisualization -> look for code here
- Java Docs on everything added (comments and files), update plans, any diagrams, README

For Sprint 3:

- Fully code the rest of ReliabilityAnalysis to have the math in the table
- Fix HW5 code (numFaults)

4/24 Meeting Notes:
- README
- UML diagrams
- JavaDoc
- Code correctness & fully code
    - ReliabilityAnalysis
        - Doing the math
        - Getting instructions
        - Existing HW5 code
        - verifyReliabilities
        - buildReliabilities
        - Set + get header row
        - Print RATable
- Junit tests
    - checkMath
    - getReliabilities
    - verifyReliabilities
        - check that all the nodes in the last flow is greater than the Min link reliability needed (line 164 in Reliability Analysis); returns true or false

4/25 Notes from Goddard:

checks program and workload are not null, returns

schedule = program.getSchedule()

nodeMap = new nodeMap

header should be in a separate method

checked if the node was source node or not - later will put 1.0 in table for all source nodes

dsl = new WarpDSL() to parse instruction parameters

loop through the period instructions in each row

```
for (string instruction : row)
        setReliabilities(reliabilities)
                return
```

flow name is only set when it is pushed or pulled, else it's 'unused' if unused, map is created from source and sink nodes of flowName

- We are parsing the instructions, building the table (first the dummy one set to 0.0, then change to the reliability one)
- Make sure JavaDoc is for ALL, not just what we're changing
- Add descriptions to Junit tests and make sure they're testing errors
- UML diagrams updated to match code
    - Methods in this should be the same that are being tested (at a minimum)
- Code review each other
    - Find errors
    - Improve

4/27 Notes from Goddard:

- Each node has 4 values, which can be seen on the input file as F0(a, b, c, d)
    - a = priority
        - Just a set priority instead of default
    - b = period
        - The length of time until the flow repeats. Will fail reliability if requirements are not met before this time passes
    - c = deadline
        - The deadline time to finish the flow. It will also fail reliability if requirements are not met before this time passes
    - d = phase
        - The offset from time 0 until the first release is possible. For example, a flow with phase 5 would not be able to start transmitting until timeslot 5. Currently, phase doesn't work in the scheduler, so we don't have much to worry with it.
- Verifying reliabilities:
    - Needs to check that the reliability requirement (e2e) is met in the last node in each flow at their respective deadline timeslots every time the flow finishes
        - workload.getHyperPeriod() / flow.getDeadline() = # of cells needed to check in a specific flow
        - We may want to make a structure to track flow indexes like our nodeIndexes map
    - Should only return false if the schedule has failed, we should make our own test file that fails intentionally

5/2 Notes from Goddard

- Only 80 points is actual code
    - Need javadocs for entire project, need to make sure to generate docs for every file in project

    - Goddard will look at ReadMe first to figure out what happened with project, then design document, then sequence diagram. They need to match what actually happens in our project
    - When he runs code, output needs to make sense and look right
- StressTest4 for testing when deadline is not met

RESET POINTS

```java
public ReliabilityRow getFinalReliabilityRow() {
       return this.reliabilities.get(this.reliabilities.size()-1);
}
```

```java
/**
*
*
* @return true if reliabilities have been met, false if not
*/
public Boolean verifyReliabilities() {
// TODO Auto-generated method stub
      ReliabilityRow t = this.getFinalReliabilityRow();

      for(int i = 0; i < t.size(); i++) {
            if(t.get(i) >= e2e) {
                  System.out.println(t.get(i) + " is greater than or equal to e2e");
                  return false;
            }
      }
return true;

}
```

Pseudo-code:

```
for(each sinknode){
    int deadline = node.deadline();
    if(reliabilities.get(node.columnIndex).get(deadline) < e2e)
        Return false;
```