White box testing concepts

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This session

- Unit testing concepts for C/C++/.Net etc
  - Unit testing tools
- Testing related terms
  - Memory Leak
  - Test/Code Coverage
  - Performance Profiler
  - Dynamic test
- Brief demo of professional testing tool
  - Cantata++
- Discussions
  - Always welcome

Status of assignments

- Doubts ?
- Progress ! !
- Results ??
- Suggestions

Unit testing

How to test the programs of different technology ?

- C
- C++
- Microsoft technologies VB/.Net
- Web related (PHP,ASP,JSP..etc.)

How to do unit testing of above technologies ?

Unit test tools

- AdaTEST
- AQtest
- Aunit
- C++Test
- Cantata
- Check
- COMPUTE
- CppUnit
- csUnit
- CTA++
- CTB
- cUnit
- CUT
- dotunit
- EasyMock
- GrandTestAuto
- HarnessIt
- HtmlUnit
- HttpUnit
- JavaScript
- JsUnit
- JsUnit
- JTestCase
- JUnit
- JUnitEE
- JUnitX
- LingoUnit
- MinUnit
- Mock Creator
- Mock Objects
- MockMaker
- Mockry
- NUnit
- ObjcUnit
- OCUnit
- OTF - An
- PalmUnit
- PBUnit
- PerlUnit
- phpAsserUnit
- PhpUnit
- PyUnit
- QtUnit
- Ruby/Mock
- SUnit
- TagUnit
- TBGEN
- TBrun
- Test Mentor - Java Edition
- unit++
- vbUnit3 Basic
- VectorCAST
- XMLUnit
- XSLTunit

http://www.testingfaqs.org/t-unit.htm

Testing related terms

- Memory Leak
- Test/Code Coverage
- Performance Profiler
- Dynamic test

What is memory leak

- What
  - Allocating memory without releasing later
- Why bad
  - Reduce performance
  - May cause crashes
- How to solve
  - Find out where exactly memory is leaked

C/C++ memory leak

- In C/C++, it is possible to allocate space for objects (variables) dynamically during program execution. After finishing use of a dynamically allocated object, it is necessary to explicitly release the memory consumed by the object, particularly before pointers to the object go out of scope.

Memory leak example

- When a variable is created by a “usual declaration”, i.e., without **new**, memory is allocated on the “stack”.

```
{
  int i = 3;        // memory for i and obj
  MyObject obj;     // allocated on the stack
  ...
}
```

So when we delete them ??

- When the variable goes out of scope, its memory is automatically deallocated (“popped off the stack”).

```
// i and obj go out of scope,
// memory freed
```

Memory leak example...

- To allocate memory dynamically, we first create a pointer, e.g., **MyClass* ptr;**
- **ptr** itself is a variable on the stack. Then we create the object: **ptr = new MyClass(*constructor args*);**
- This creates the object (pointed by **ptr**) from a pool of memory called the “heap” (or “free store”).
- When the object goes out of scope, **ptr** is deleted from the stack, but the memory for the object itself remains allocated in the heap:

```
{
  MyClass* ptr = new MyClass();    // creates
object….. …
}   // ptr goes out of scope here -- memory leak!
```

Memory leak example...

To prevent the memory leak, we need to deallocate the object's memory before it goes out of scope:

```
{
  MyClass* ptr = new MyClass();   // creates an object
  MyClass* a = new MyClass[n];    // array of objects
  ...
  delete ptr;  // deletes the object pointed to by ptr
  delete [] a; // brackets needed for array of objects
}
```

For every **new**, there should be a **delete**.
For every **new** with brackets **[],** there should be a **delete []**

Test/Code coverage

- Precondition
  - Software product under development
  - Test suite

Test / Code coverage provides a measure of how well test suite actually tests the product.

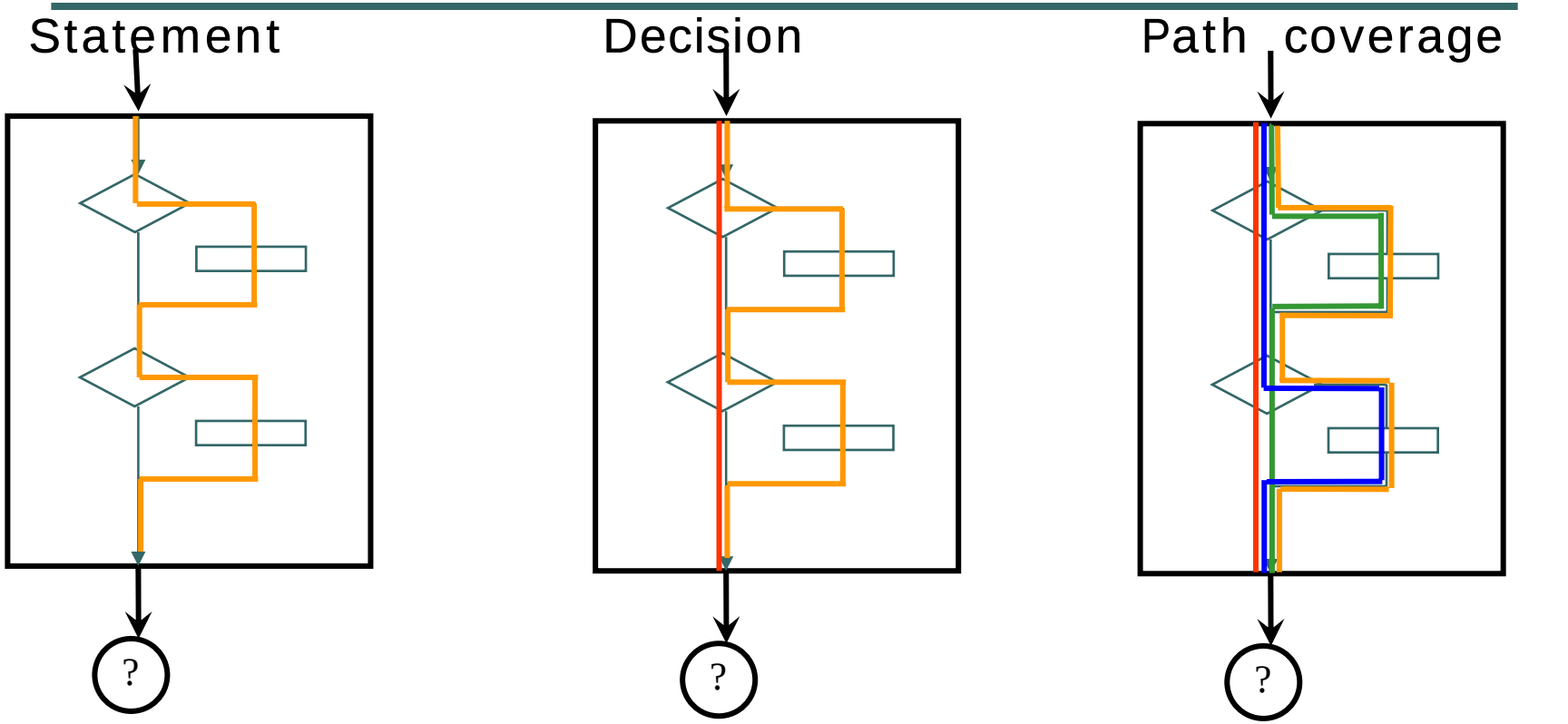
Test/Code coverage analysis

- Coverage analysis is a way of measuring how much of the code has been exercised during testing
- Coverage analysis can be used to determine when sufficient testing has been carried out
- Coverage analysis can identify unexecuted code structures
  - Add more test cases?
  - Remove dead or unwanted code!

An optional aspect is:

- Identifying redundant test cases that do not increase coverage

Test/Code coverage – examples



1 2 4 test cases

Type of coverage

- Statement coverage
- Basic block coverage
- Decision coverage
- Condition coverage
- Branch coverage
- Loop coverage

Coverage analysis tools:

- Bullseye Coverage
- Cantata++
- CodeTEST
- LOGISCOPE
- Panorama C/C++
- Rational PureCoverage
- TCAT C/C++
- GCT

Reference: http://testingfaqs.org/t-eval.html

Performance profiler

- Code profiling is the process of benchmarking the execution to understand where the time is being spent in terms of code execution
- Which lines of code are responsible for the bulk of execution time?
- How many times is this looping construct executed?
- Which approach to coding a block of logic is more efficient?
  - Without profiling, the answer to the above questions becomes a guessing game.

Facts of profiler

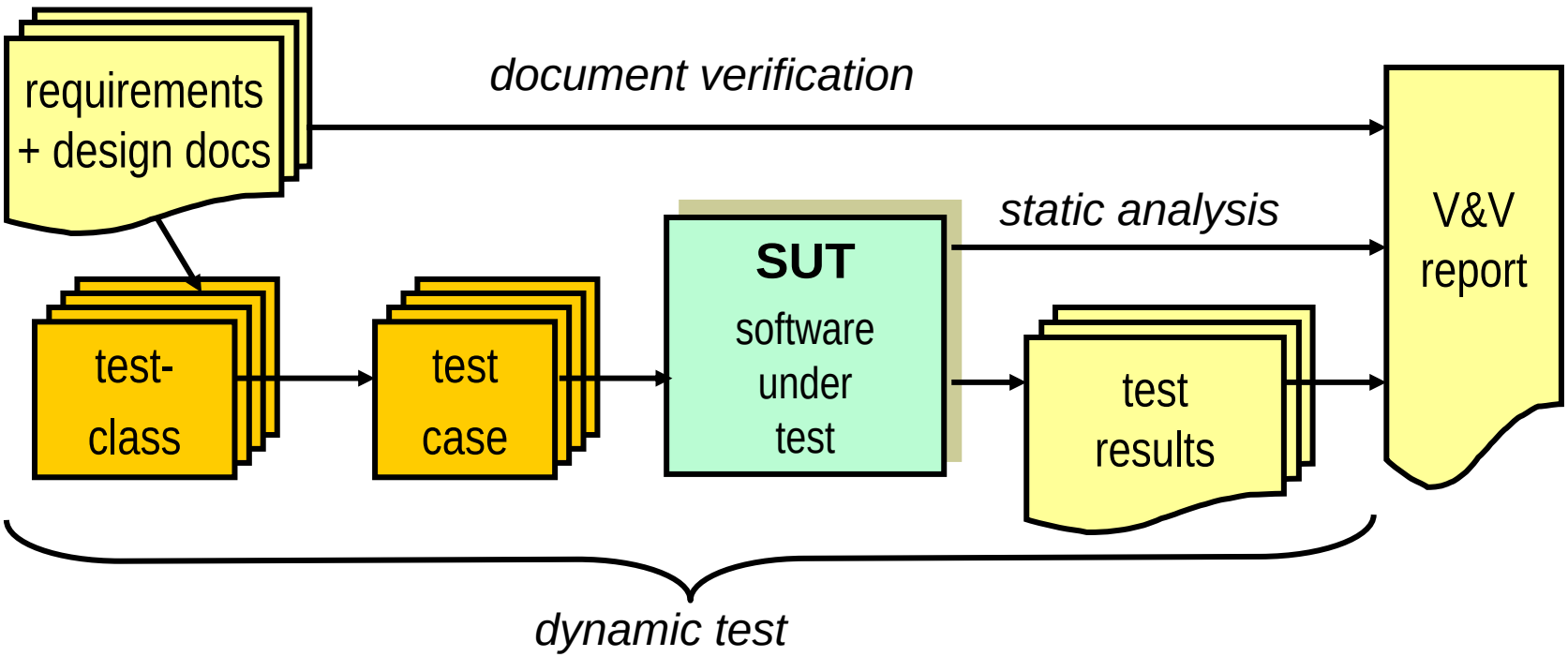
- Why/When we need ?

  Profiler will pinpoint slow code and allow us to drill down to examine it, so code can be optimized and performance can be improved

- How it works ?

  Profiler runs while we are using our application and records the frequency and time spent in each line of code

What is dynamic test



C /C++ testing tool

Professional Software Testing Tools Cantata++

(Tools brief presentation)

Overview Cantata++

- Dynamic Testing
  - Executing the software
  - Under known conditions
  - Verifying results against expected outcomes
- Code Coverage
- Integration Testing
- Host-Target Testing
- Static Analysis metrics
- Generation of code metrics
  - Does source code meets quality and maintainability standards?
- Cantata++ for C and Cantata++ for C++ are two very common industry accepted tools for testing

Unit testing features

- Wizard driven template test script generation
- Automated checking of expected results
- Black / White box techniques
- Simulation of external software (Stubs)
- State transition testing
- Real-time performance analysis
- Automated regression testing

Integration testing additional features

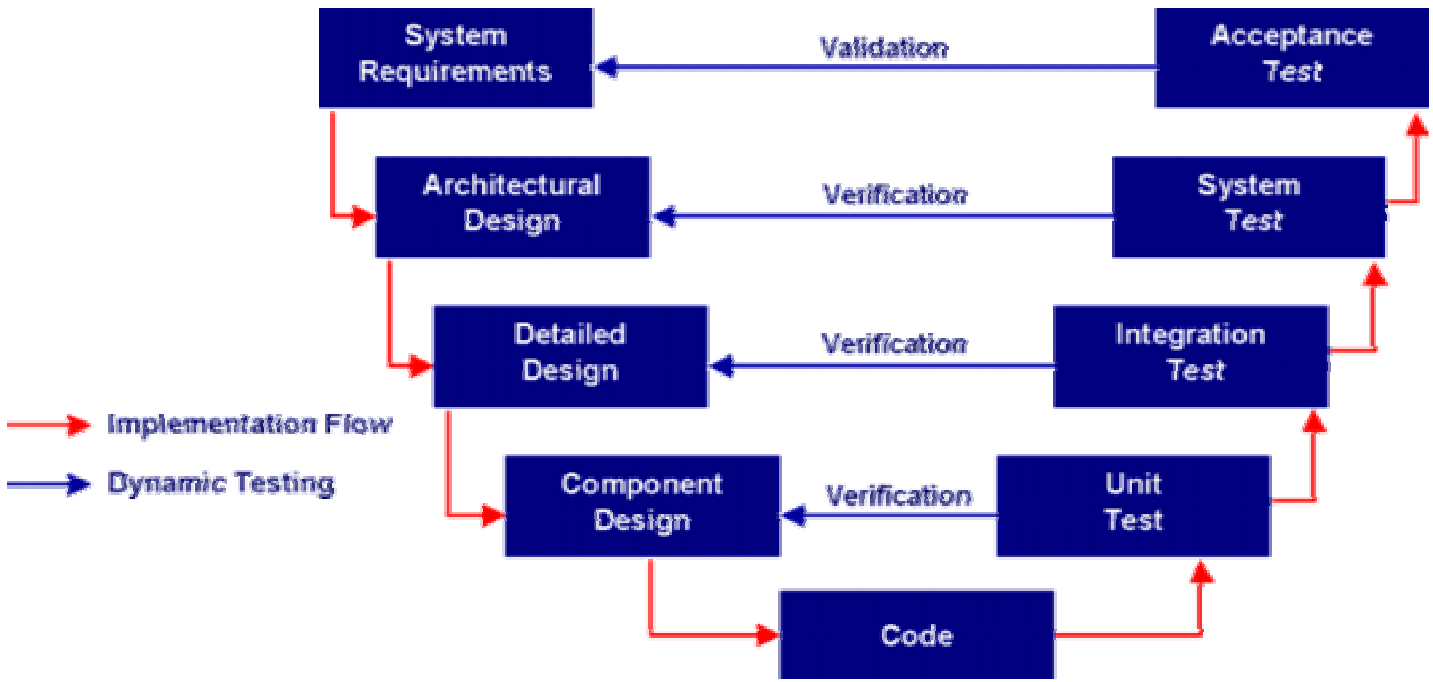
- Total control over external interfaces (Wrapping)
- Call sequence validation
- User observation tests
- Mulit-threaded test execution

Overview - Aims

- Repeatable
- Automatic
- Auditable
- Portable
- Measurable
- Productive and Efficient

Overview – Software Lifecycle

- Software development follows a life-cycle model. The V-Model is a useful example, but there are many different life-cycles.



Cantata++ can be used at all stages of the lifecycle

How stubbing works

Cantata++ Creates a Stub function containing programmable instances for the external object, which are called by the source code under test and replace the original external object (software, firmware or hardware)

Overview – Dynamic Testing

- Host and Target testing
  - Test on development platform and in the target environment
- Regression testing
  - Automated re-execution of tests
- White-box and Black-box testing
  - Testing with and without knowledge of the code
- Isolation testing
  - Testing with simulation of external code interfaces

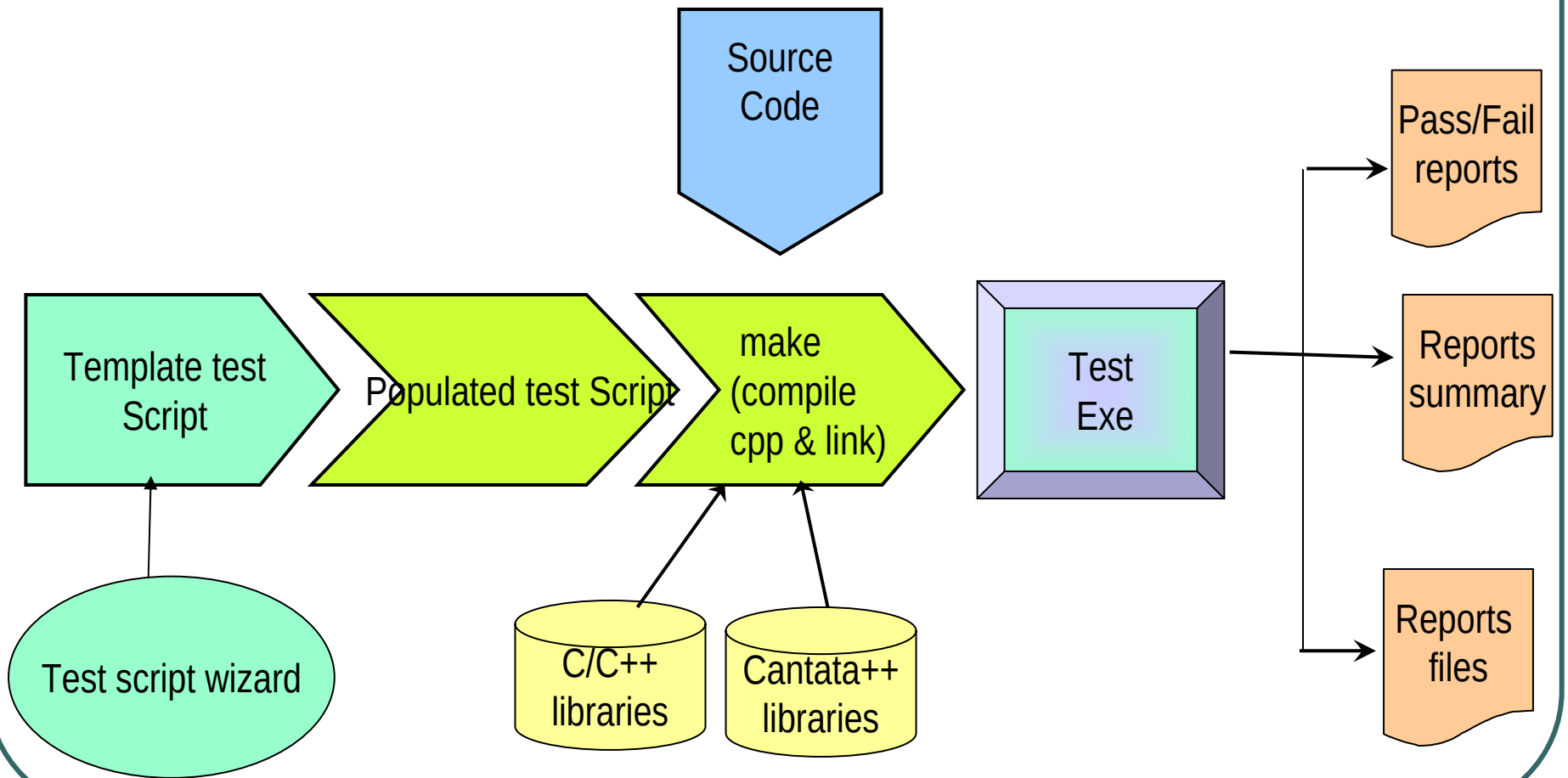
Overview – Coverage Analysis

- Measure and report coverage
- Set a Pass/Fail coverage checks for your project
- Metrics supported include:
  - Entry-Points
  - Statements
  - Decisions
  - Conditions

Overview – Static Analysis

- Derives metrics from the source code to help improve its quality
- Output data in CSV format for
  - Numerical or graphical analysis
- Provide objective data for
  - Code reviews, project management, end of project statistics
- Provide facilities to generate up to 300 source code metrics
  - Code construct counts, Complexity metrics, File metrics

How cantata++ works



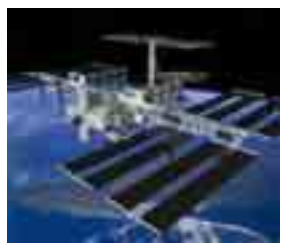
Cantata++ Customers

Nuclear Reactor Control - Thales

Train Control - Alcatel

Medical Systems – GE Medical

EFA Typhoon – BAe Systems



International Space Station – Dutch Space

Cantata++ running under Symbian – Nokia Series 60

Airbus A340 – Ultra Electronics

Further Information

- http://www.iplbath.com

Tool Summary

- **Objective test strategy should achieve**

"an acceptable level of confidence at an acceptable level of cost".

- **Tests should be**
  - Planned for in the project
  - Against specified requirements
  - As automated and repeatable as possible
  - Maintainable

Summary of testing

- Verify operation at normal parameter values
  (a black box test based on the unit's requirements)
- Verify operation at limit parameter values
  (black box)
- Verify operation outside parameter values
  (black box)
- Ensure that all instructions execute
  (statement coverage)
- Check all paths, including both sides of all branches
  (decision coverage)

Summary of testing

- Check the use of all called objects
- Verify the handling of all data structures
- Verify the handling of all files
- Check normal termination of all loops

  (part of a correctness proof)
- Check abnormal termination of all loops

Summary of testing

- Check normal termination of all recursions
- Check abnormal termination of all recursions
- Verify the handling of all error conditions
- Check timing and synchronization
- Verify all hardware dependencies

Statements of **(Watts Humphrey)**

The End

Thank You