TECHNIQUES AND LESSONS FROM SOFTWARE VERIFICATION

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LARS
NASA/JPL Laboratory for Reliable Software

Software Verification Methods we used on MSL

- Redefined ***Code Review*** Process, based the ***Scrub*** tool
- New JPL-wide ***Coding Standard*** for Mission Critical Software
- Required ***Certification Courses*** for Software Developers
- Integration of ***Static Source Code Analysis*** with every build and release & with code reviews (Coverity, Codesonar, Semmle, Uno)
- Thorough ***Logic Verification*** of various MSL software subsystems with the ***Spin*** Model Checker
  - Example 1: data management subsystem (MRF)
    - Outcome: complete redesign
  - Example 2: instrument library manager (IML)
    - Outcome: revision to prevent race conditions

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THE JPL CODING STANDARD FOR C

http://lars-lab.jpl.nasa.gov

LEVELS OF COMPLIANCE

- LOC-1: language compliance
- LOC-2: predictable execution
- LOC-3: defensive coding
- LOC-4: code clarity
- LOC-5: MISRA *shall* compliance
- LOC-6: MISRA *should* compliance

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THE POWER OF 10 RULES

1. Restrict to simple control flow constructs
2. Do not use recursion and give all loops a fixed upper-bound
3. Do not use dynamic memory allocation after initialization
4. Limit functions to no more than ~60 lines of text
5. Use minimally two assertions per function on average
6. Declare data objects at the smallest possible level of scope
7. Check the return value of non-void functions; check the validity of parameters
8. Limit the use of the preprocessor to file inclusion and simple macros
9. Limit the use of pointers. Use no more than *N* level of dereferencing
10. Compile with all warnings enabled, and use source code analyzers

http://spinroot.com/p10/

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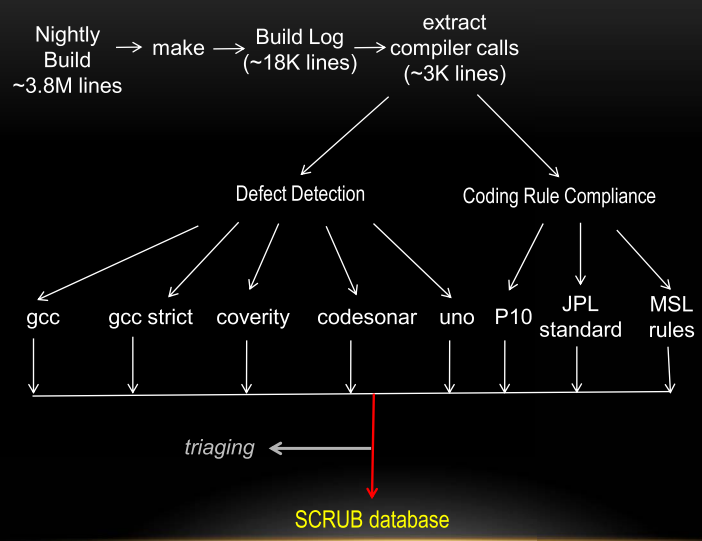
GENERATION OF TOOL REPORTS



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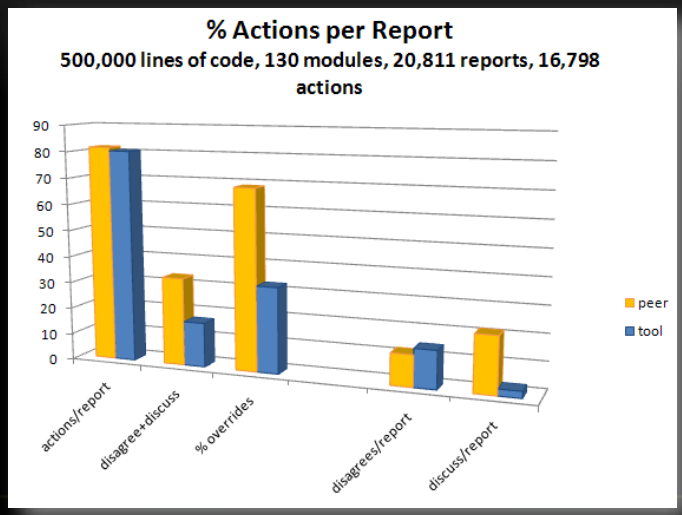
~80% OF ALL REPORTS LED TO A *CODE FIX*

(BOTH FOR PEER AND TOOL GENERATED REPORTS)



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TESTING

- in test-based verification one often treats all code alike
  - but it is usefule to distinguish:
    - *deterministic* (e.g., math) routines and
    - *non-deterministic* (e.g., reactive) code

	Current Method	Better	Best
math routines (deterministic)	sampling-based testing	randomized (fuzz) testing + static analysis	Pre- & Post-conditions, loop invariants, theorem proving
reactive code (concurrent)		?	logic model checking

these methods are very useful although none are "logically complete" and some are not "logically sound"

Swarm verification

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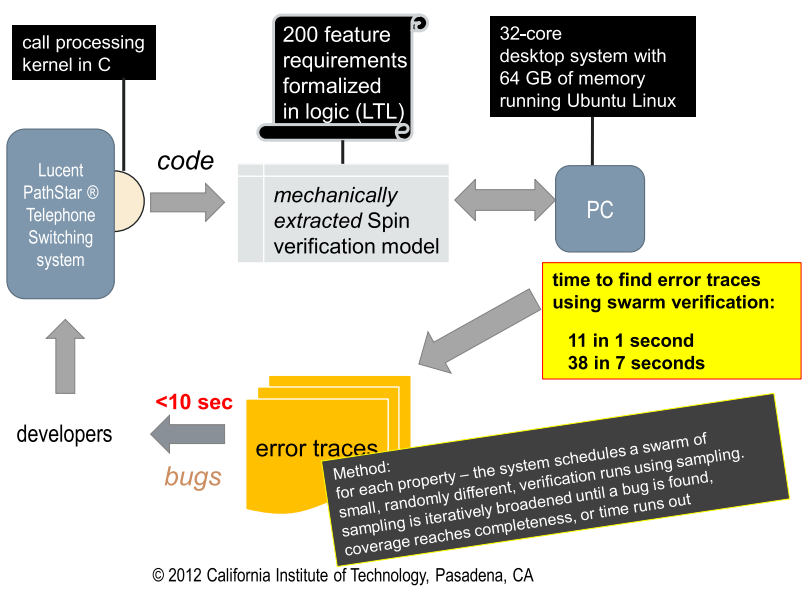
Swarm verification

proof of concept example



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