Challenge Problems for the ACL2 Community

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First, the good news…

- ACL2 has been shown to scale to industrial problems
  - Microprocessor verification
  - Operating system kernel verification
  - Verifying compiler
  - Many more
- The use of ACL2 has been accepted by certification authorities
- The world is beginning to appreciate executable formal specifications
- Security is being taken much more seriously by digital system designers
- New techniques are leveraging ACL2's proof automation and pushing it to new heights (depths?)

Some challenge problems that seem within reach

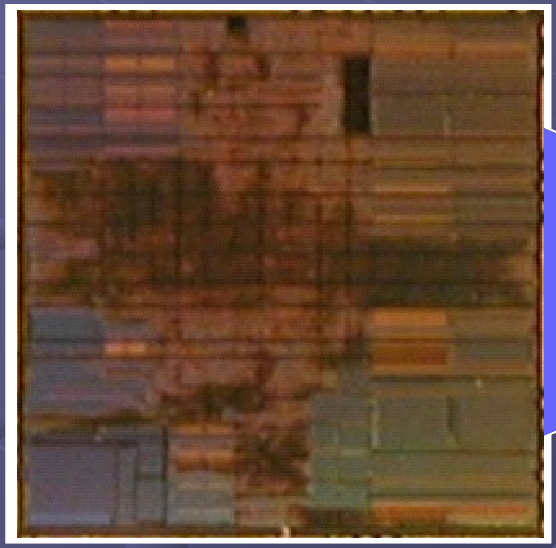
- Formally verified virtualization system for a commercially popular microprocessor
- Verified cross-domain systems
- Verified user mode networking stack
- Verified secure middleware
- Verified full JVM implementation
- Verified complex embedded real-time control systems
- Verifiable language system that would combine the best of Java, ML, Lisp, C#, etc., and that could take full advantage of modern multi-chip, multi-core computing systems
  - Including verified abstract data types
- "21st century CLInc stack"

Some challenges for ACL2 itself

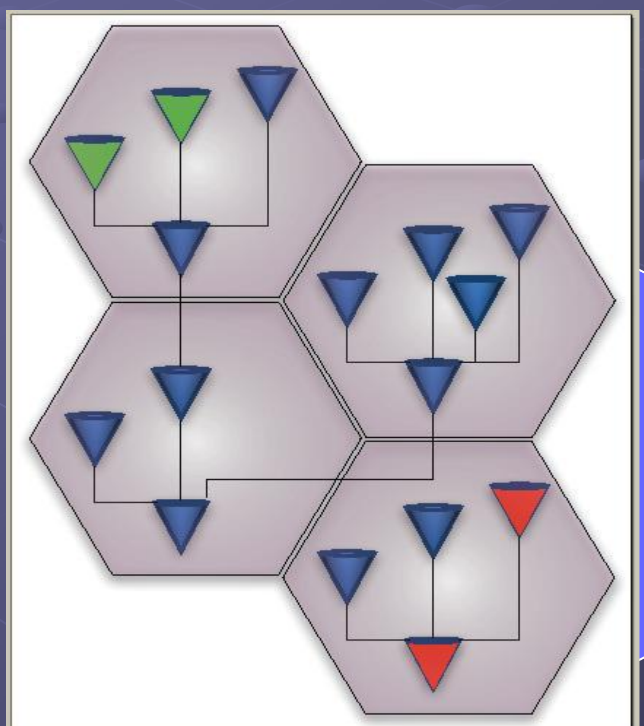
- ACL2 should provide much better support for reasoning about “real-world” Lisp programs
- ACL2 still doesn’t know enough about computer arithmetic
- Integration with other tools – HOL connection is promising, but we need more
- Functional languages are inherently parallelizable, yet ACL2’s support for parallelism is limited
- Lisp Development Environments were cutting edge 20 years ago; now, they are way behind the times
- ACL2 is still too difficult for non-logicians to use; ACL2s is a step in the right direction
- Some problems are inherently higher order

So now, let’s look ahead 5 years…

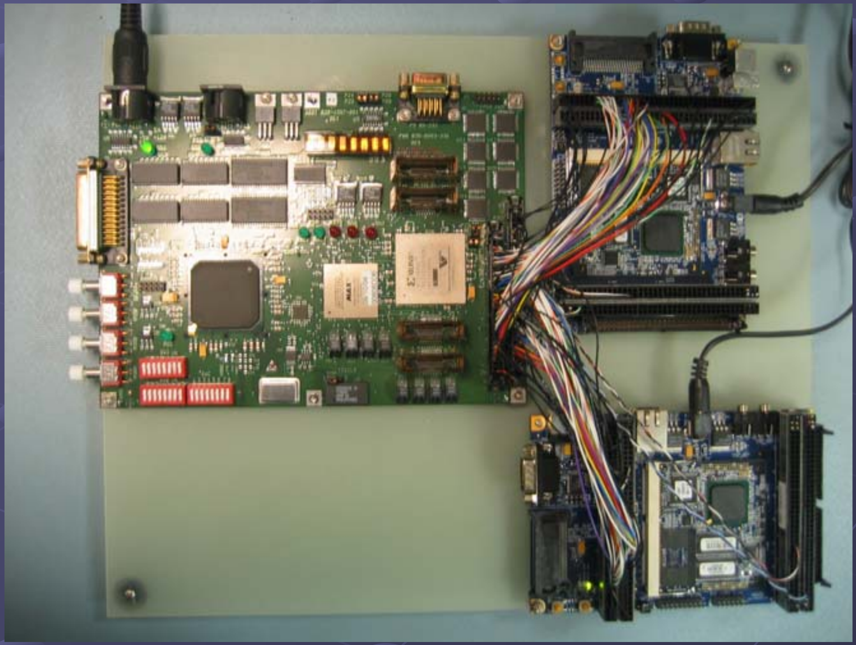
- Our intrepid formal methods guy, Guy, heads to work, driving a car with a formally verified engine control system. He can afford a nice car because he has profit sharing, and his employer makes lots of money on formal methods.



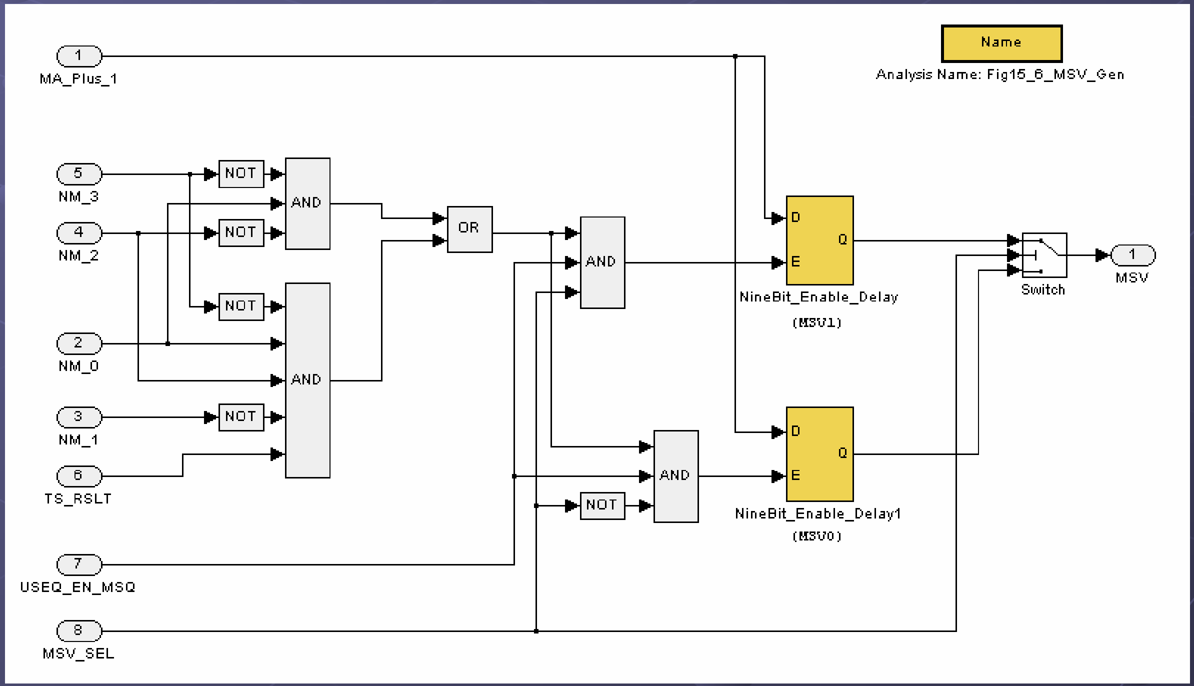
- Guy downloads a parallel proof dispatch/visualization system released the night before by an Australian developer. The downloaded code is inspected by a bytecode verifier that has been proven correct.



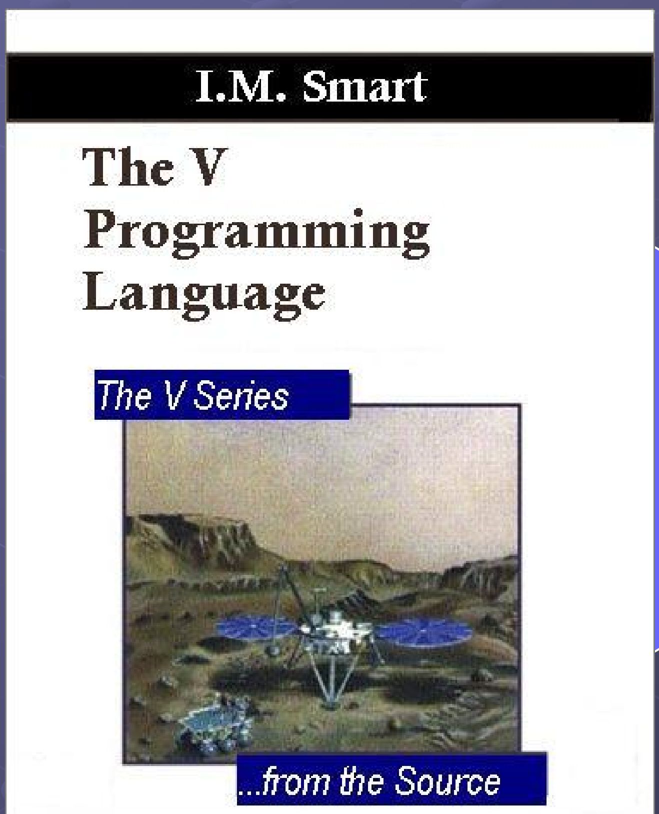
- Guy attends a design review for a security product prototype, based on a formally verified microprocessor design. The prototype is ready within weeks, and works as anticipated.



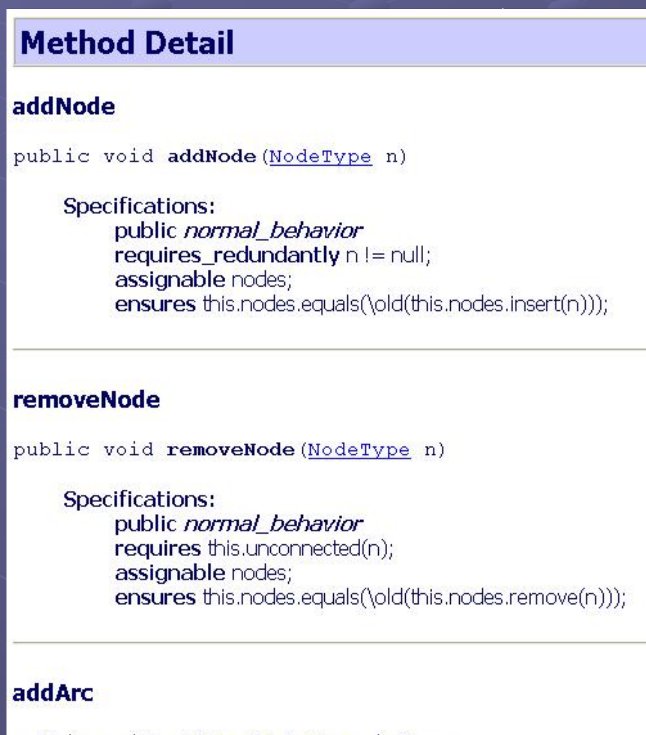
- Over lunch, Guy has an idea on how to extend a previously verified product to a new domain. He realizes that he can incrementally verify the new functionality while reusing most of the existing proofs. He adds his new functionality to the architectural-level model, imports it into his proof system, and reverifies a key property. His employer is happy.



- At the end of the day, Guy heads to the CHAIRS (Confluence of HOL, ACL2, Isabelle, and Refutation-based Systems) Workshop. At the airport, he checks out the spec for the V language, a formally verifiable language environment that is the hot new successor to Java/C++/C#/etc.



- Meanwhile, a graduate student in New Mexico works on a massive verified V application in his dorm room along with other Internet-based developers. He has never freed live memory, suffered a buffer overflow attack, made a pointer arithmetic mistake, or had an undetected array bounds error.



Method Detail

addNode

```
public void addNode(NodeType n)
```

Specifications:
    public *normal_behavior*
    requires_redundantly n != null;
    assignable nodes;
    ensures this.nodes.equals(\old(this.nodes.insert(n)));

removeNode

```
public void removeNode(NodeType n)
```

Specifications:
    public *normal_behavior*
    requires this.unconnected(n);
    assignable nodes;
    ensures this.nodes.equals(\old(this.nodes.remove(n)));

addArc

```
public void addArc(NodeType inFrom
```