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PROCEED and Crowd-sourced Formal Verification

DARPA Cyber Colloquium
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Report Documentation Page

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Do you trust the cloud?



Source: Library of Congress/Flickr

Secure communications...



Source: General Services Administration

Secure storage...



Secure computation?

Source: Christopher Bowns/Flickr

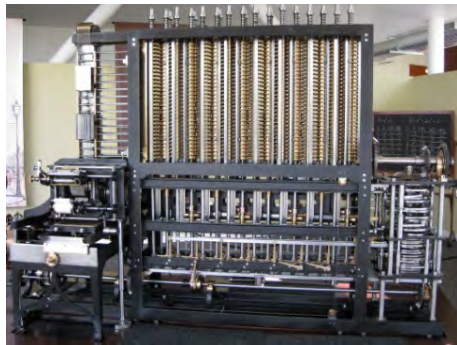


PROgramming Computation on Encrypted Data (PROCEED)

Goal: practical computation on encrypted data without decrypting

Potential Applications

- Email content-filtering guard between networks with different classification levels
- Privacy-preserving cloud-based voice over IP service
- Secure cloud-based mapping service that cannot determine your location, route, or destination



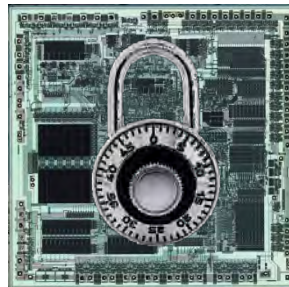
Source: Catherine Helzerman / Flickr

150 years

1832 - 1982

Babbage Difference Engine

7 Orders of Magnitude



Source: Flylogic Engineering LLC; Corbis

Intel 80286

2010 - 2015

5 years



Source: Corbis

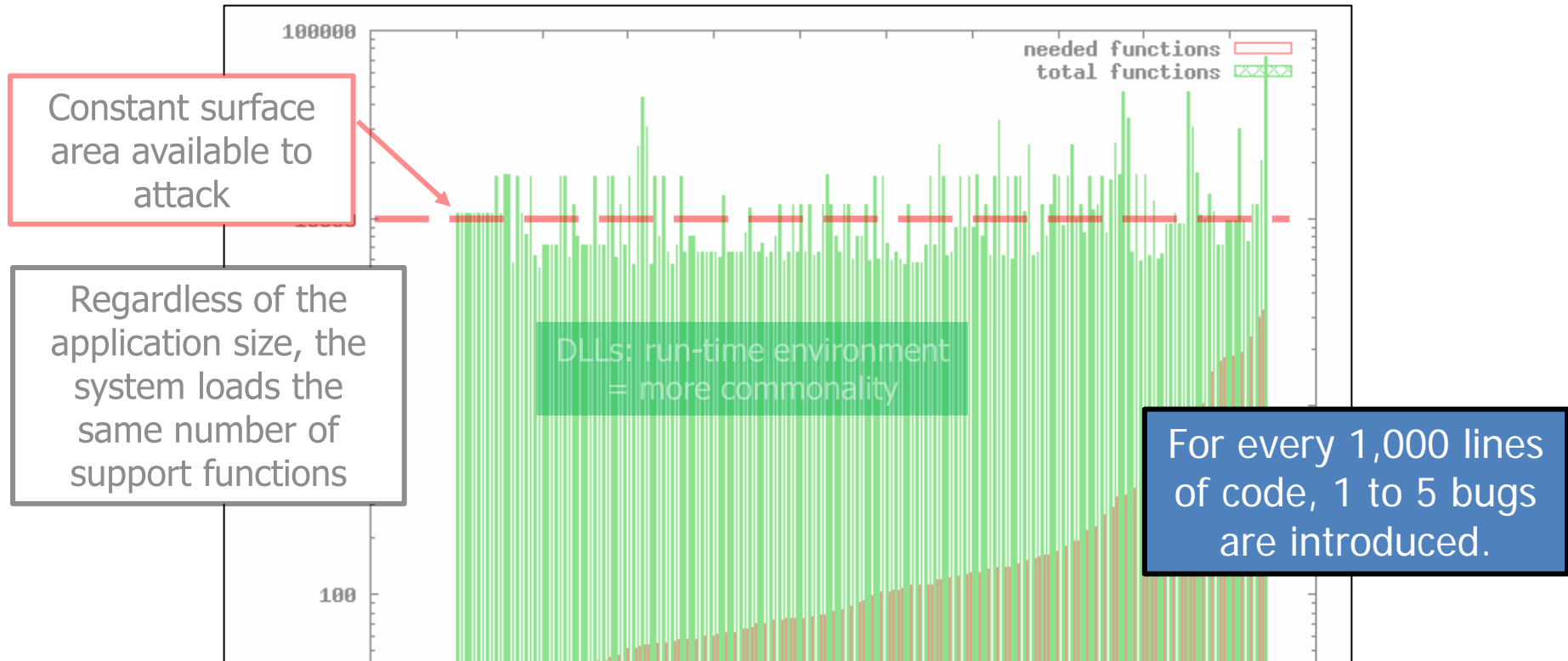
Encrypted NAND Gate



Crowd Sourced Formal Verification (CSFV)



The Problem



Are there fundamental scientific reasons that prevent us from doing better?
No: *"There are no intrinsic laws of nature in cyber-security as there are in...physics, chemistry, or biology."*
[JASON Report on Science of Cyber-Security, 2010]



Formal Verification

- Formal verification can obtain 0.1 - 0.5 bugs per KLOC, however:
 - Extremely expensive: software development costs increase by 2x to 100x
 - seL4 microkernel formal verification took 11 person-years
 - Fundamental formal verification problems resist automation
 - Computationally undecidable: Heuristics have improved, but remain incomplete



Source: Corbis



Source: morgueFile



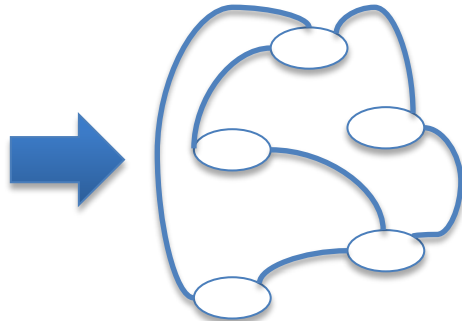
The Concept: Crowd Sourced Formal Verification

"Game-ify" Geeky Formal Verification

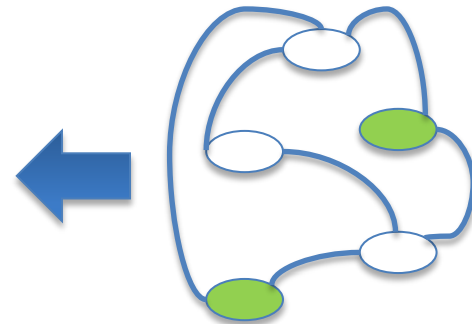
Applies game solutions to the original formal verification problem

Exploits a large user base requiring no formal verification expertise

Code



Model



Verified Model

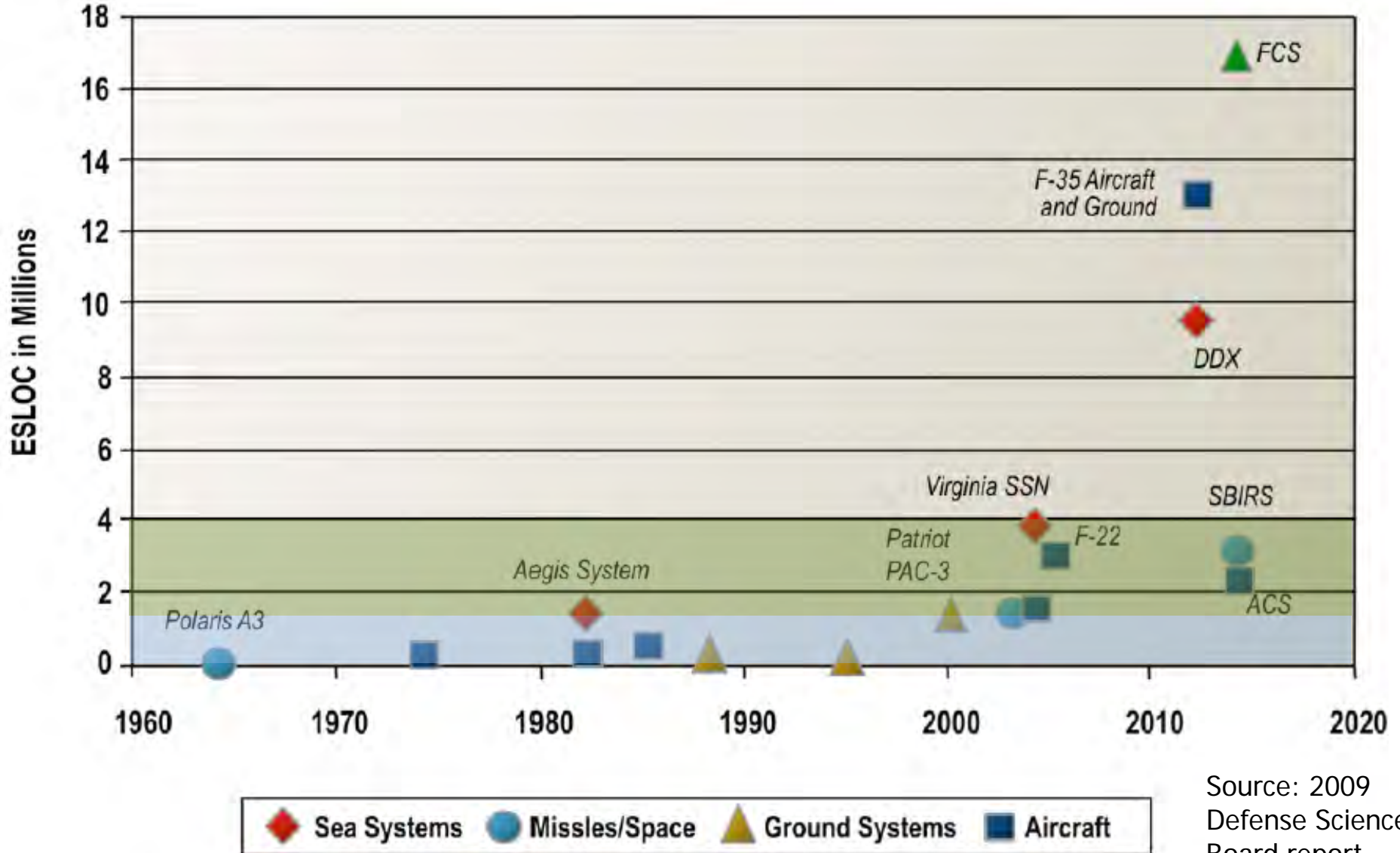
Verified Code

Source: University of Washington

CSFV New Capabilities



Scalability to DoD Software Systems



ESLOC = Executable Source Lines Of Code

Source: 2009 Defense Science Board report



Contact Information

Watch for Special Notice SN 12-17 to be released on FedBizOpps (fbo.gov)

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