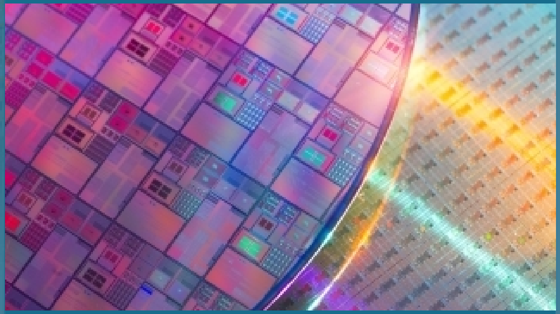
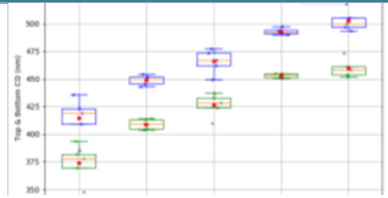
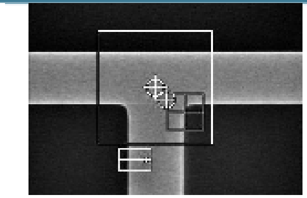
SAND2023-08203C

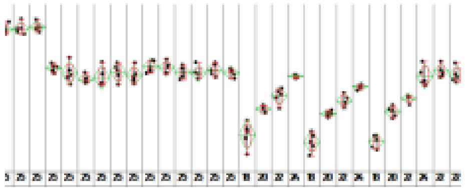
Sandia National Laboratories

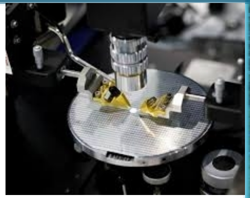
Microelectronics that are continuously verifiable by their users…as inspired by cryptography











Dr. Nick Pattengale, Sandia National Laboratories

Presented in the half day workshop - **Securing the U.S. Electronics Supply Chain** – at the 2023 DARPA Electronics Resurgence Initiative 2.0 Summit

Thursday, August 24, 2023

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

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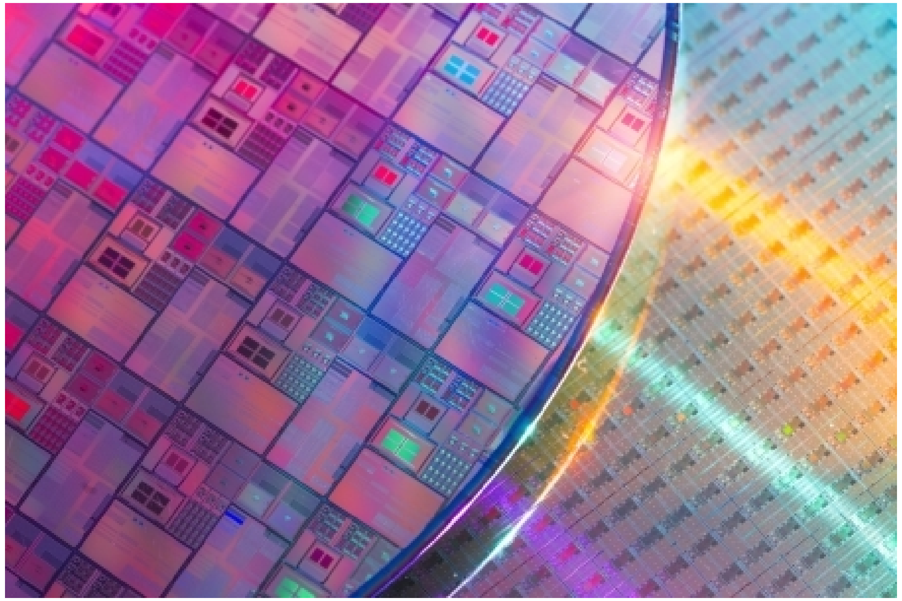
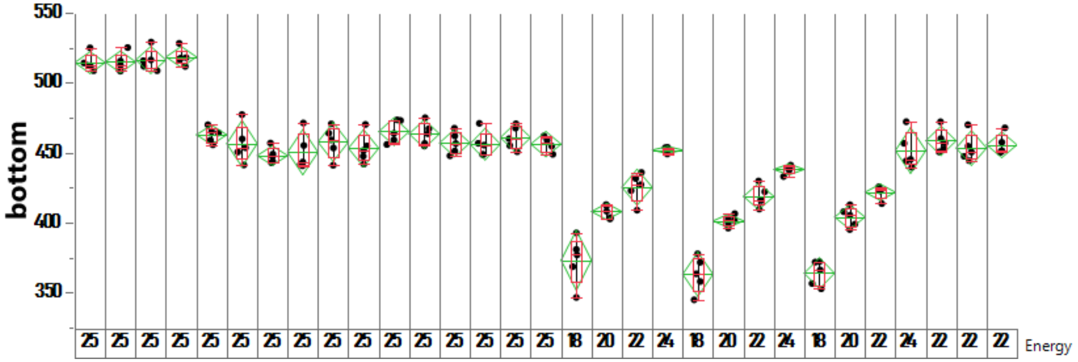
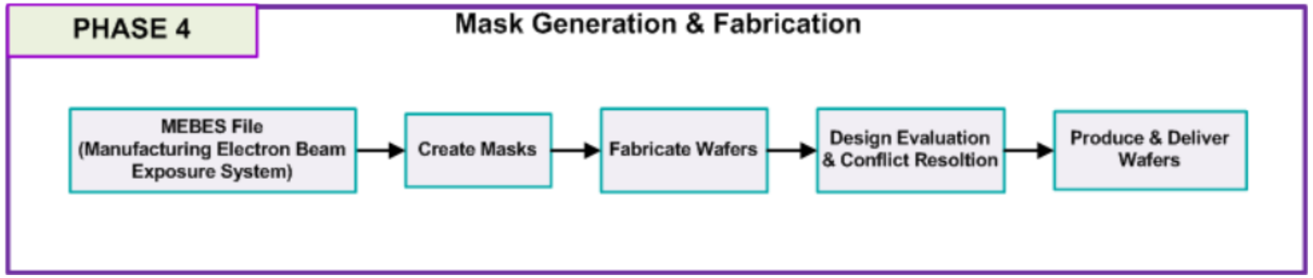
Outline

- Motivation
- Audacious Vision
  - Current approaches, limitations
  - What is different about our approach?
- Tangible starting points
- Measuring success







Motivation

IEEE TRANSACTIONS ON COMPUTER-AIDED DESIGN OF INTEGRATED CIRCUITS AND SYSTEMS, VOL. XX, NO. X, XXXX 202X

Hardware Trojan Insertion in Finalized Layouts: From Methodology to a Silicon Demonstration

Tiago Perez, Samuel Pagliarini, Member, IEEE

Our work details, for the first time, how effortlessly a HT can be inserted into a finalized layout

https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9956883

dr0wned – Cyber-Physical Attack with Additive Manufacturing

Sofia Belikovetsky, *Ben-Gurion University of the Negev*
Mark Yampolskiy, *University of South Alabama*
Jinghui Toh, *Singapore University of Technology and Design*
Jacob Gatlin, *University of South Alabama*
Yuval Elovici, *Ben-Gurion University of the Negev, Singapore University of Technology and Design*

We develop a sabotage attack against a specific 3D-printed quadcopter propeller, causing its mid-flight failure, ultimately leading to the quadcopter's fall and destruction.

https://www.usenix.org/system/files/conference/woot17/woot17-paper-belikovetsky.pdf

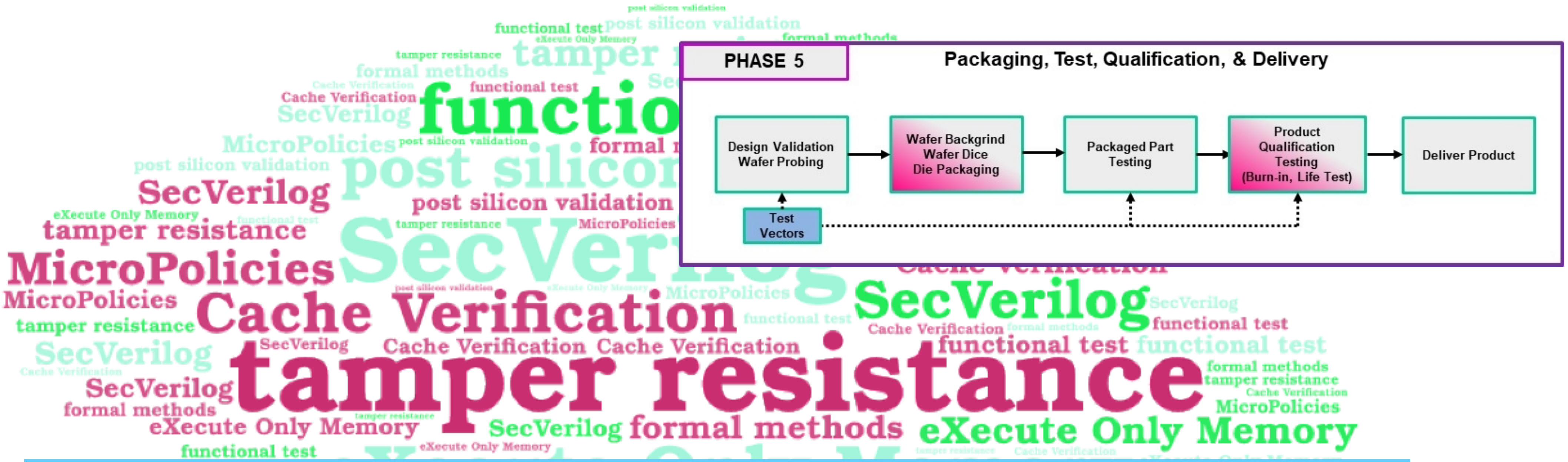
Audacious Vision

Users must be able to continuously measure and verify that...
- chip operations are to (chip) requirements
- only requested chip operations are performed
- real time security attributes (entropy, emanations, etc.)

Manufacturers needn't sacrifice confidence in their sensitive/proprietary

Gaps this exposes
- users must trust manufacturers, entire supply chain
- very little assurance capability exposed *post-boot*
- manufacturers must trust other entities (e.g. mask shop)

Current Practice, Limitations



Gaps this exposes

- users must trust manufacturers, entire supply chain
- very little assurance capability exposed *post-boot*
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Current Trends, do they address our vision?

- Zero Trust Architecture (ZTA) emphasizes continuous authentication
- Our vision (hardened data architectures) **complements** ZTA by measuring and verifying data, when possible, for intrinsic properties

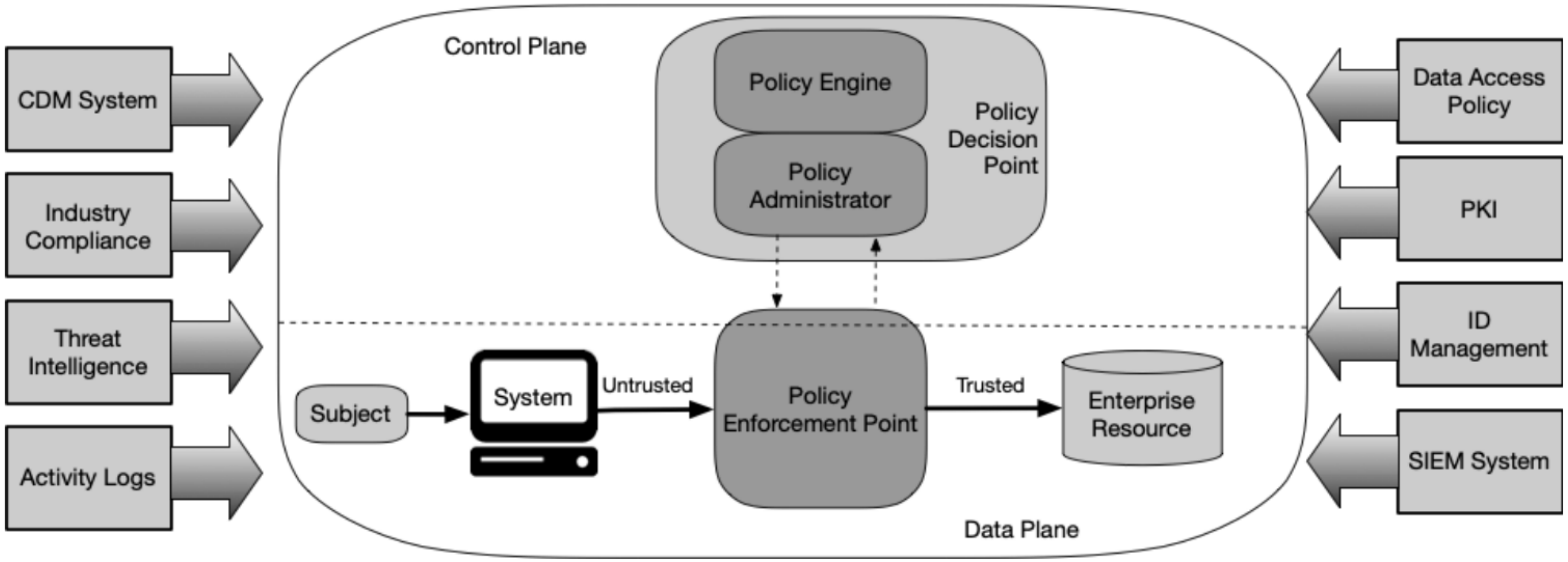
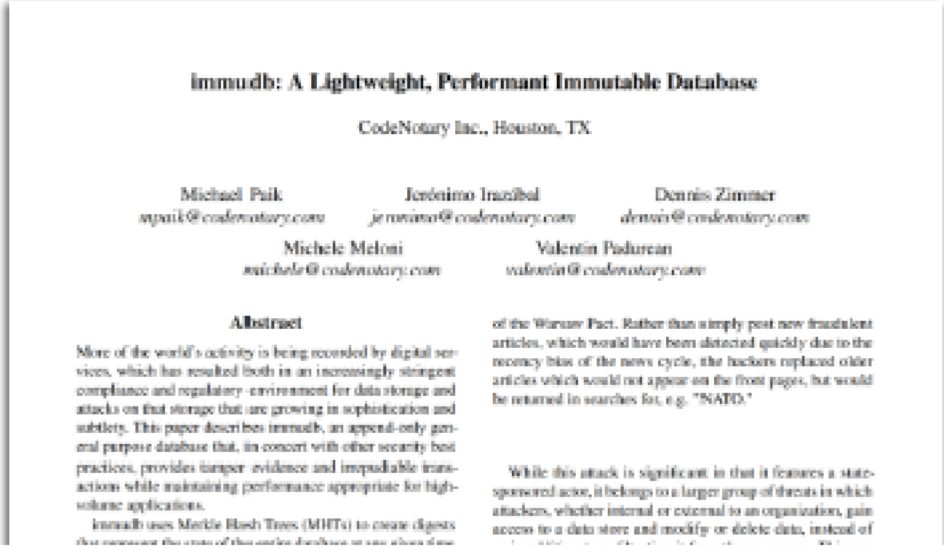


Figure 2: Core Zero Trust Logical Components

https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-207.pdf

Significant Technical Advances


immudb: A Lightweight, Performant Immutable Database

CodeNotary Inc., Houston, TX

Michael Paik mpaik@codenotary.com
Jerónimo Irazábal jeronimo@codenotary.com
Dennis Zimmer dennis@codenotary.com
Michele Meloni michele@codenotary.com
Valentin Padurean valentin@codenotary.com

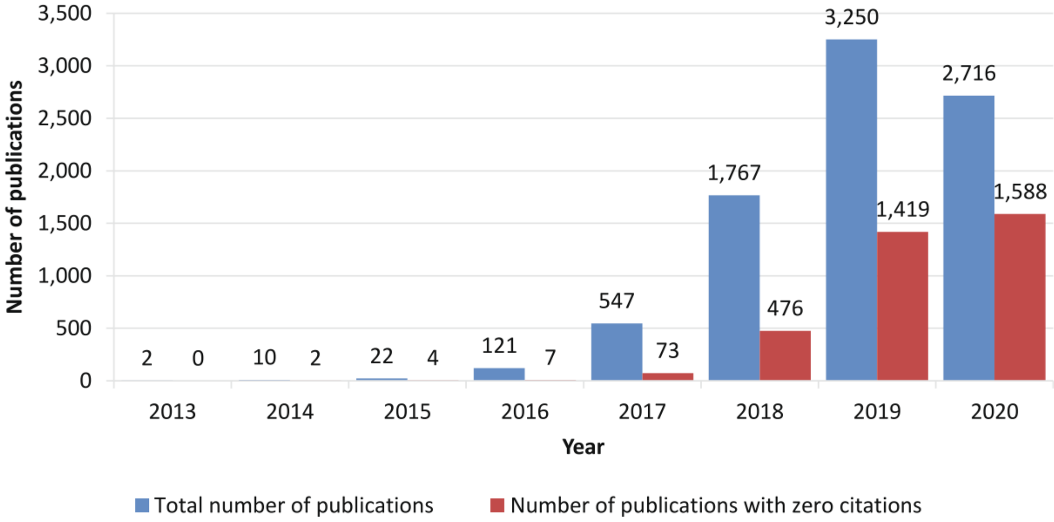
Abstract

Much of the world's activity is being recorded by digital services, which has resulted both in an increasingly stringent compliance and regulatory environment for data storage and attacks on that storage that are growing in sophistication and subtlety. This paper describes immudb, an append-only general purpose database that, in concert with other security best practices, provides tamper evidence and irrepudiable transactions while maintaining performance appropriate for high-volume applications.

immudb uses Merkle Hash Trees (MHTs) to create digests ...

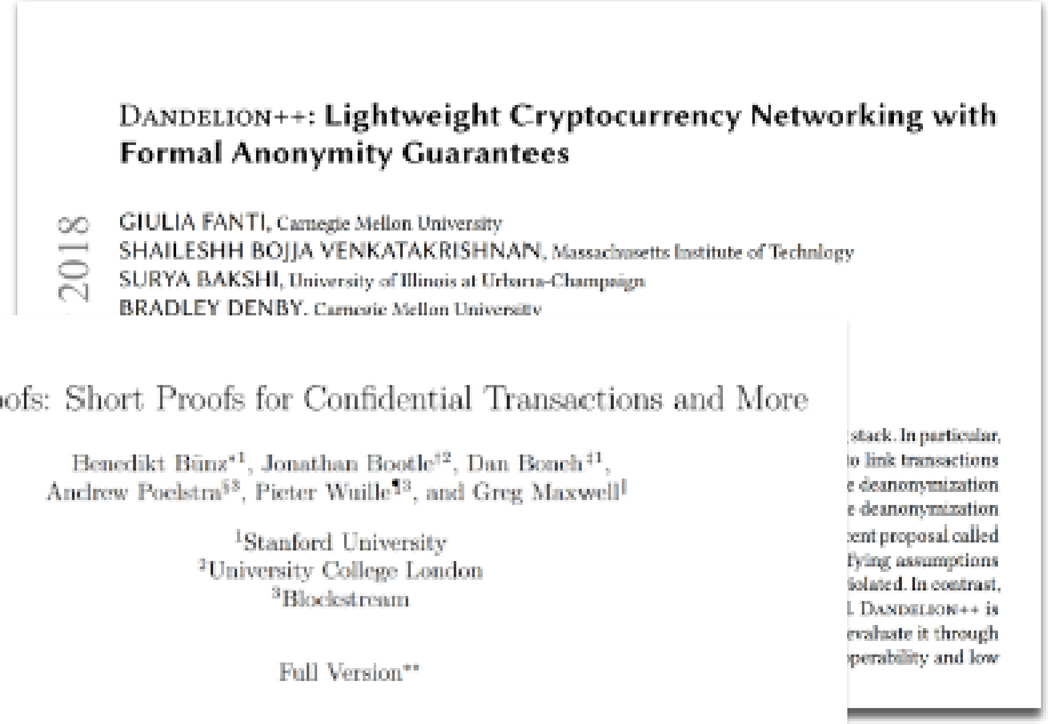
of the Warsaw Pact. Rather than simply post new fraudulent articles, which would have been detected quickly due to the recency bias of the news cycle, the hackers replaced older articles which would not appear on the front pages, but would be returned in searches for, e.g. "NATO."

While this attack is significant in that it features a state-sponsored actor, it belongs to a larger group of threats in which attackers, whether internal or external to an organization, gain access to a data store and modify or delete data, instead of ...



https://www.sciencedirect.com/science/article/pii/S1319157822000891

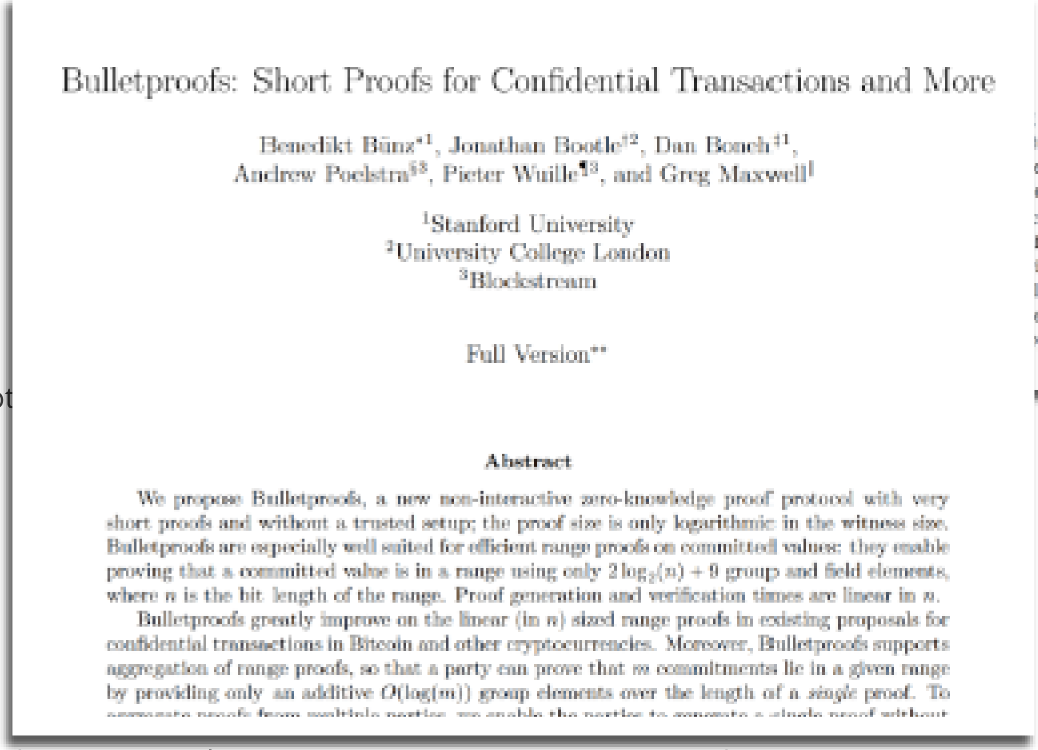
lot


DANDELION++: Lightweight Cryptocurrency Networking with Formal Anonymity Guarantees

2018

GIULIA FANTI, Carnegie Mellon University
SHAILESHH BOJJA VENKATAKRISHNAN, Massachusetts Institute of Technology
SURYA BAKSHI, University of Illinois at Urbana-Champaign
BRADLEY DENBY, Carnegie Mellon University

...stack. In particular, ...to link transactions ...e deanonymization ...e deanonymization ...ent proposal called ...fying assumptions ...isolated. In contrast, ...l DANDELION++ is ...evaluate it through ...operability and low


Bulletproofs: Short Proofs for Confidential Transactions and More

Benedikt Bünz[*1], Jonathan Bootle[†2], Dan Boneh[‡1], Andrew Poelstra[§3], Pieter Wuille[¶3], and Greg Maxwell[∥]

[1]Stanford University
[2]University College London
[3]Blockstream

Full Version[**]

Abstract

We propose Bulletproofs, a new non-interactive zero-knowledge proof protocol with very short proofs and without a trusted setup; the proof size is only logarithmic in the witness size. Bulletproofs are especially well suited for efficient range proofs on committed values: they enable proving that a committed value is in a range using only $2\log_2(n) + 9$ group and field elements, where n is the bit length of the range. Proof generation and verification times are linear in n.

Bulletproofs greatly improve on the linear (in n) sized range proofs in existing proposals for confidential transactions in Bitcoin and other cryptocurrencies. Moreover, Bulletproofs supports aggregation of range proofs, so that a party can prove that m commitments lie in a given range by providing only an additive $O(\log(m))$ group elements over the length of a single proof. To ...

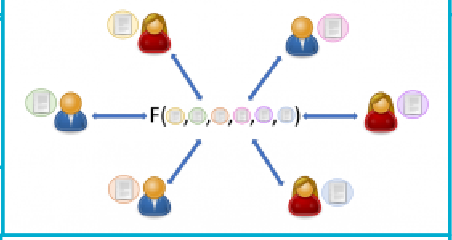
https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=8418611

Audacious, but tactically grounded starting points

- Integrity

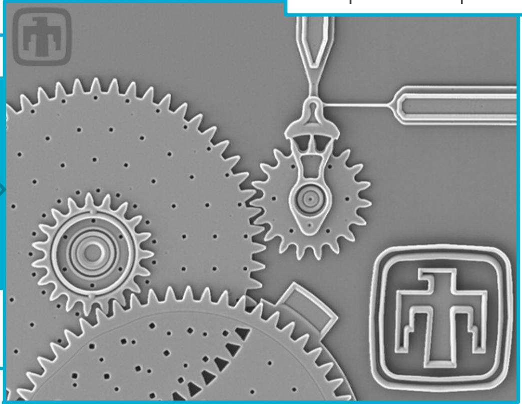
https://www.dolthub.com/blog/2022-03-21-immutable-database/

- Confidentiality



https://www.esat.kuleuven.be/cosic/blog/the-three-musketeers-of-secure-computation-mpc-fhe-and-fe/

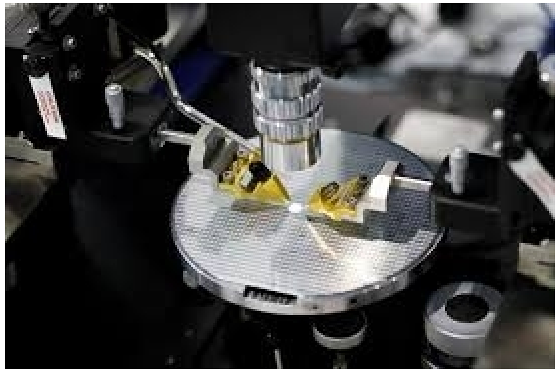
- New Features



https://www.sandia.gov/mstc

https://www.sandia.gov/mesa/fabrication-testing-and-validation-capabilities/

Measuring Success



Users must be able to continuously measure and verify that…

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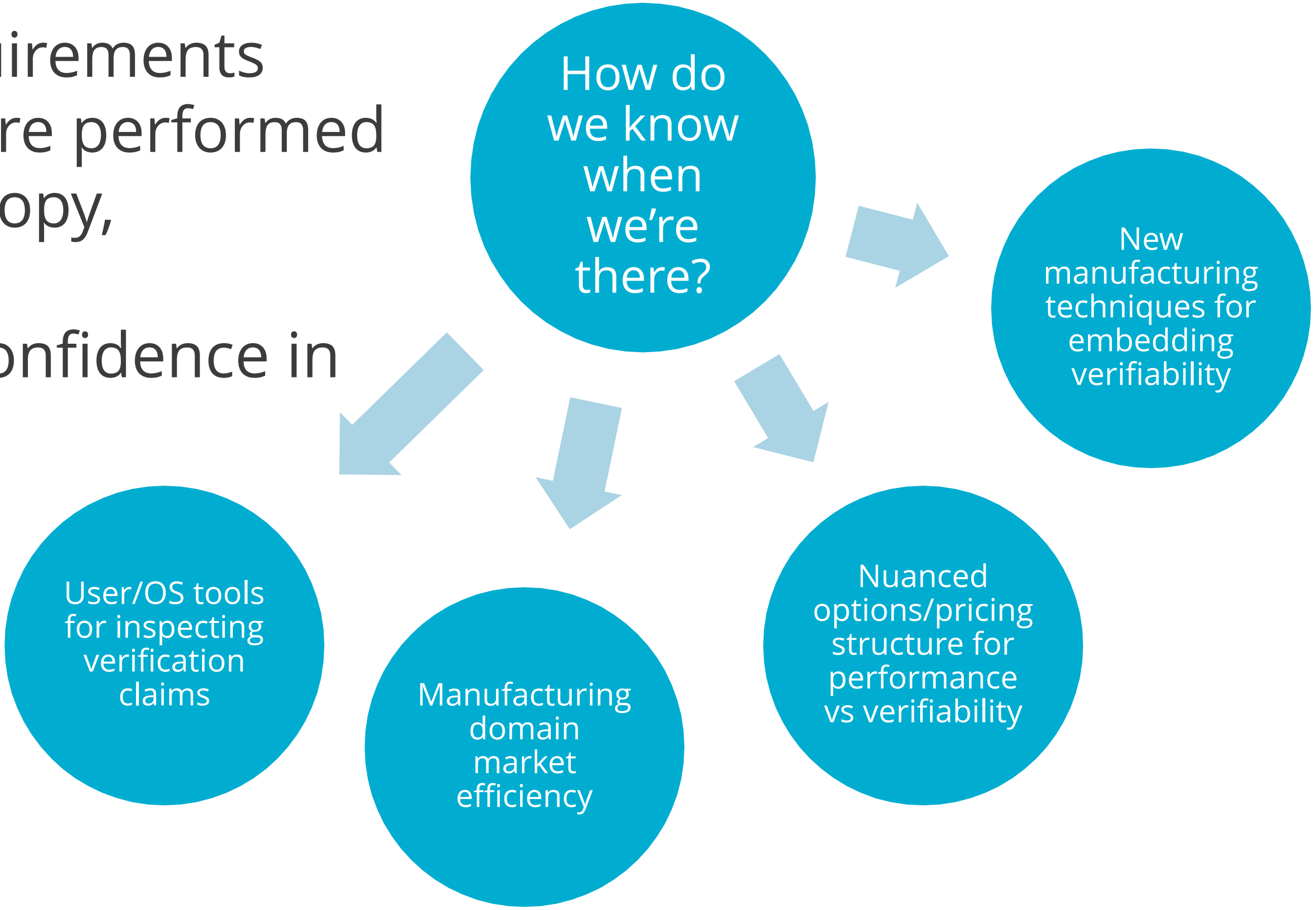

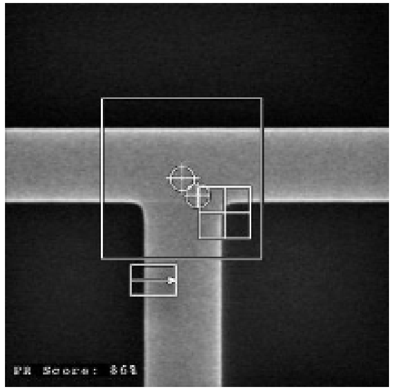

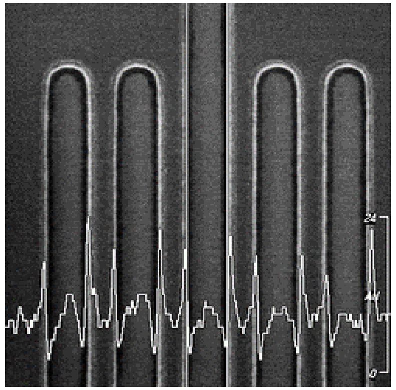

Thank You!

Questions? Email: ndpatte@sandia.gov