Fujitsu, Oct. 11, 2016

Proving Bitcoin Solvency

Dan Boneh
Stanford University

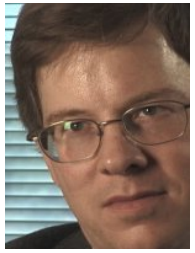
Joint work with

Gaby Dagher, Benedikt Bunz, Joe Bonneau, and Jeremy Clark

… but first: Computer Security at Stanford

Alex Aiken
software analysis

Dan Boneh
applied Crypto,
web security



David Dill
verification and
secure Voting

Dawson Engler
static analysis

David Mazières
Op. Systems

Phil Levis
IoT Security

John Mitchell
protocol design,
online ed.

Mendel Rosenblum
VM's in security

Security events at Stanford

- Annual security workshop
  //forum.stanford.edu/events/2016security.php

- Security seminar
  //crypto.stanford.edu/seclab/sem.html

- Computer security courses
  //seclab.stanford.edu/

- Stanford Advanced Computer Security Certificate
  //scpd.stanford.edu/computerSecurity/

New Bitcoin course

- **Courses**:
  - CS55N (freshmen seminar): ten ideas in computer security
  - **CS155: Computer Security**
  - **CS251: Blockchain technologies: Bitcoin and friends** (new)
  - **CS255: Intro to Crypto**
  - CS259: Security analysis of network protocols
  - CS355: Graduate course in cryptography

- Stanford Advanced Computer Security Certificate

  http://scpd.stanford.edu/computerSecurity/

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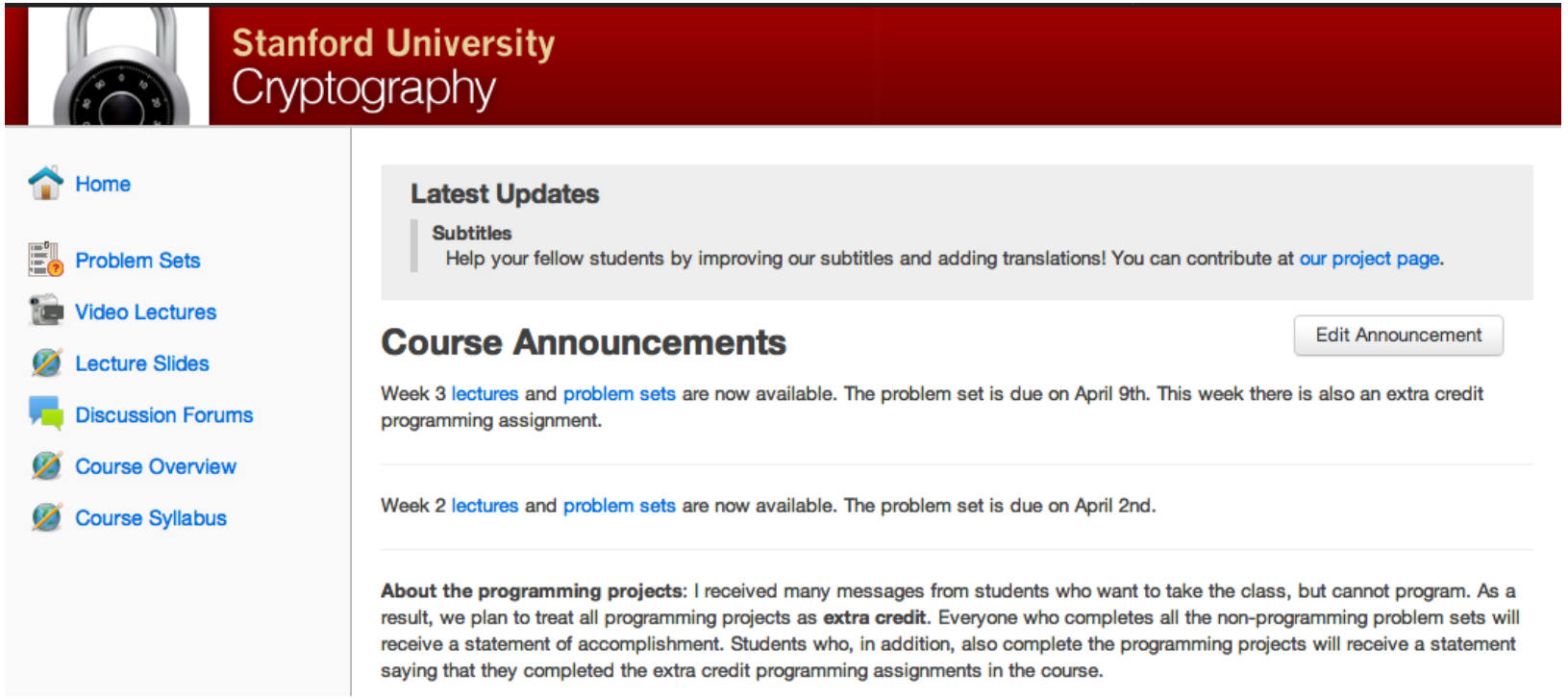
new

Try our homeworks and projects

- Sta

Online Courses

//www.coursera.org/learn/crypto



Course open to the public

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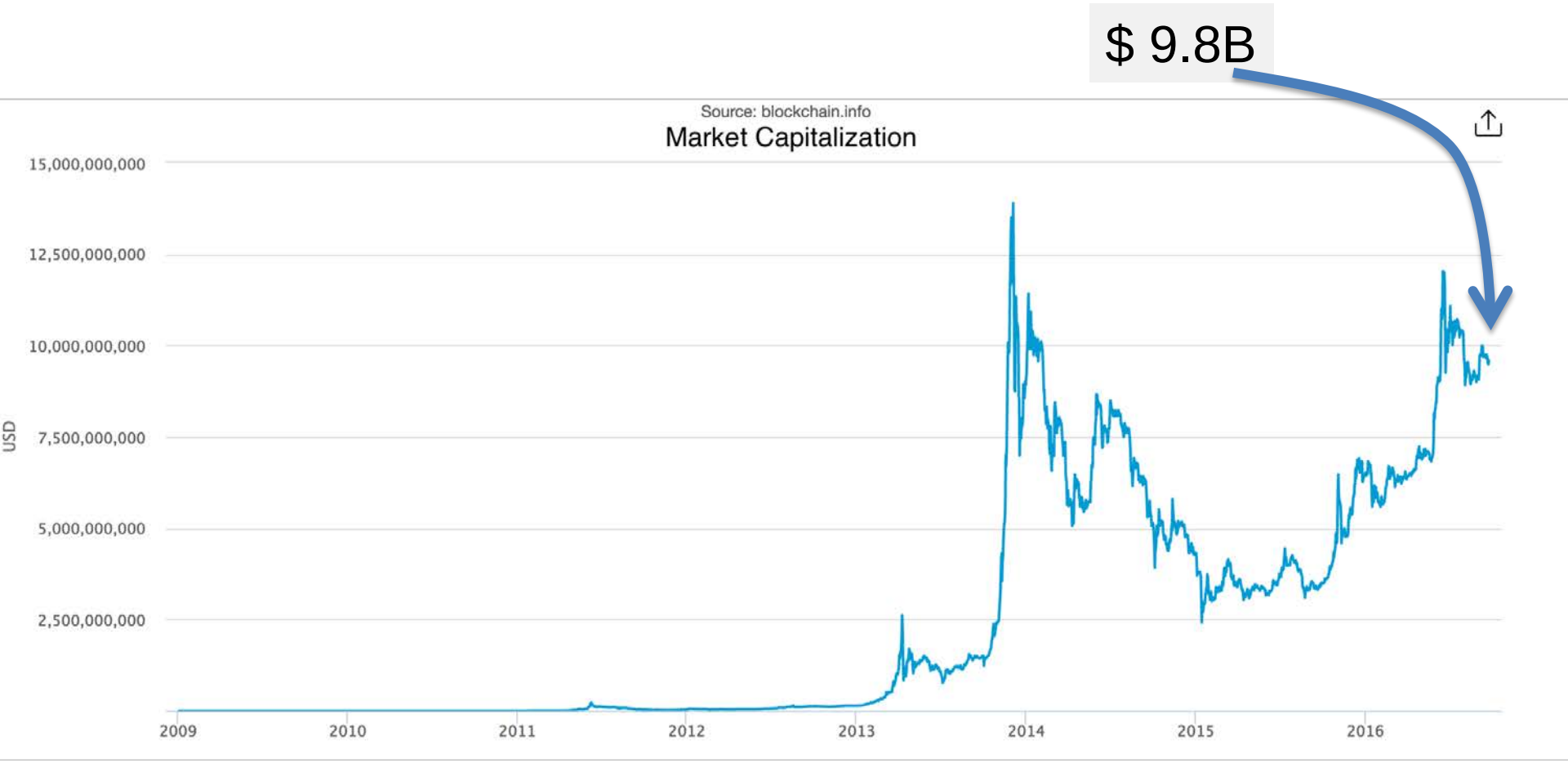
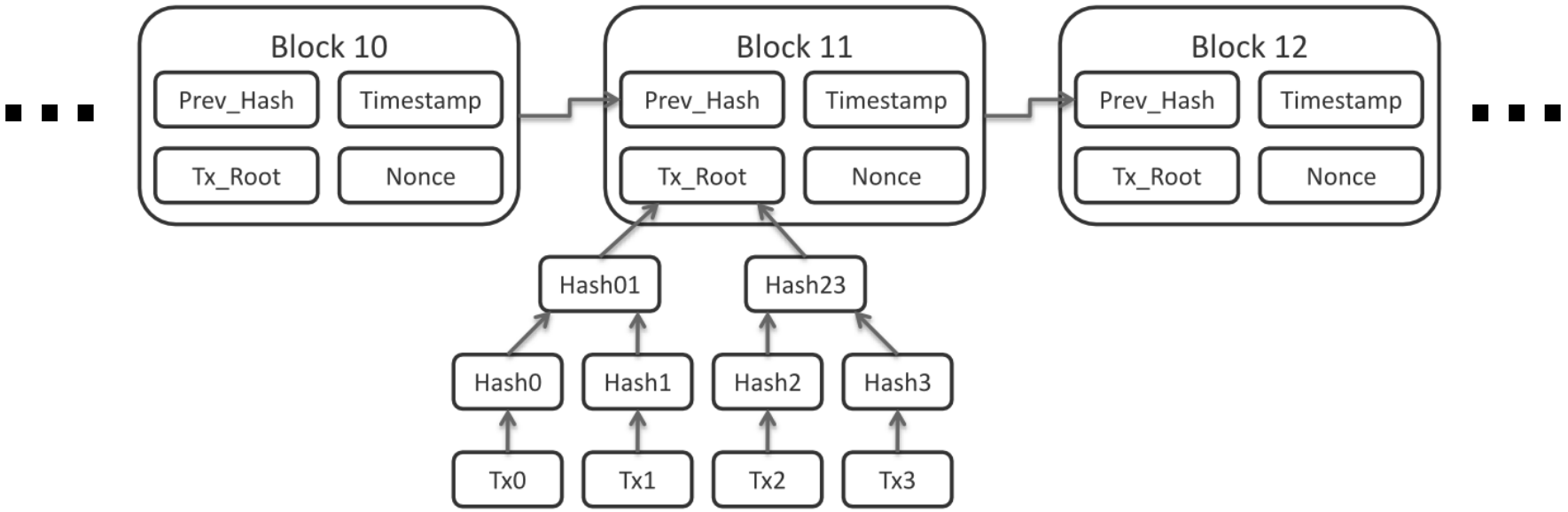
Bitcoin: first successful crypto currency



More than a currency: the blockchain



Non-currency applications:

- Document management --- ensuring freshness
- Asset management

Solvency trouble

Technology | Fri Feb 28, 2014 2:30pm EST

Mt. Gox files for bankruptcy, hit with lawsuit

TOKYO | BY YOSHIFUMI TAKEMOTO AND SOPHIE KNIGHT

Solvency trouble

Mt. Gox:
lost roughly US$450M

Subsequent price crash

~50% have failed!

[Moore, Christin 2013]

Bitcoin: ensuring solvency

The problem: a Bitcoin "exchange" has:

- ***obligations*** to customers, and
- ***assets*** that it holds (knows secret key for assets)

Goal: prove ***assets ≥ obligations*** (solvency)
without revealing any info about assets or obligations
(i.e., a zero-knowledge proof)

Dagher-Bunz-Bonneau-Clark-Boneh (ACM CCS 2015) :

an efficient zero-knowledge protocol for this problem

Running protocol daily would have detected Mt. Gox troubles early

How?

Sub-protocol 1: create commitment **O** to total obligations:

- Commitment is binding, but reveals nothing about obligations
- Every user is given a secret key that lets it verify that its account balance is (uniquely) included in total sum

Sub-protocol 2: create commitment **A** to total assets:

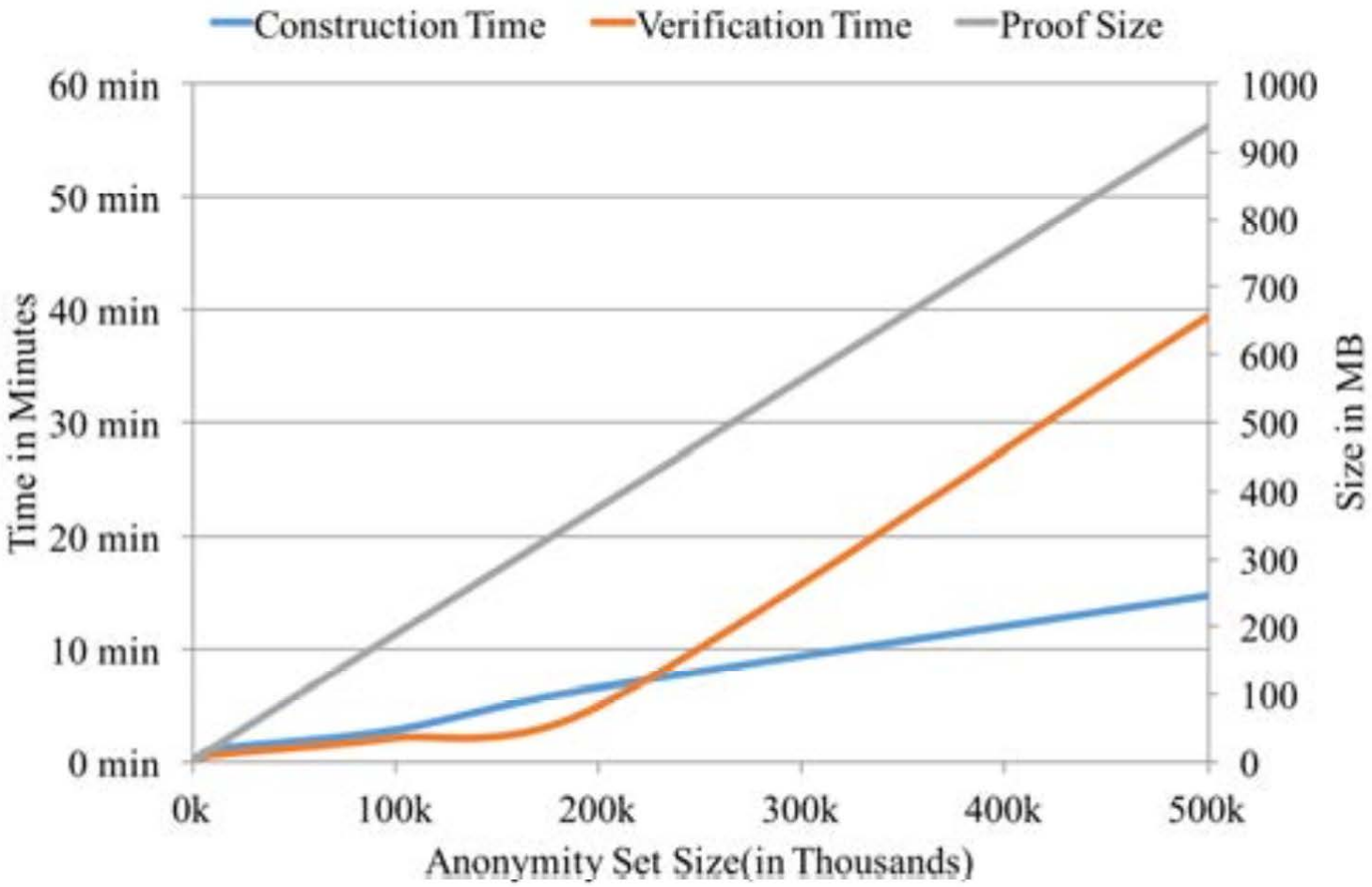
- Let $pk_1, \ldots, pk_n$ be public keys (addresses) on the block chain
- The exchange knows ***sk*** for a **subset** of these addresses
- Exchange proves:

  sum of balances for which it knows ***sk*** is value(**A**)

  nothing is revealed about which addresses the exchange owns

Sub-protocol 3: prove **value(A)** ≥ **value(O)**

Experiments



Deployment

- **Open source**
- **Supporting cold storage:**

  - An exchange stores the bulk of its assets in cold storage

    ⇒ cannot use assets in a daily solvency proof

  - Solution: valet key ("blinding" of secret key)

    sufficient for proof of solvency, but not to spend funds

THE END