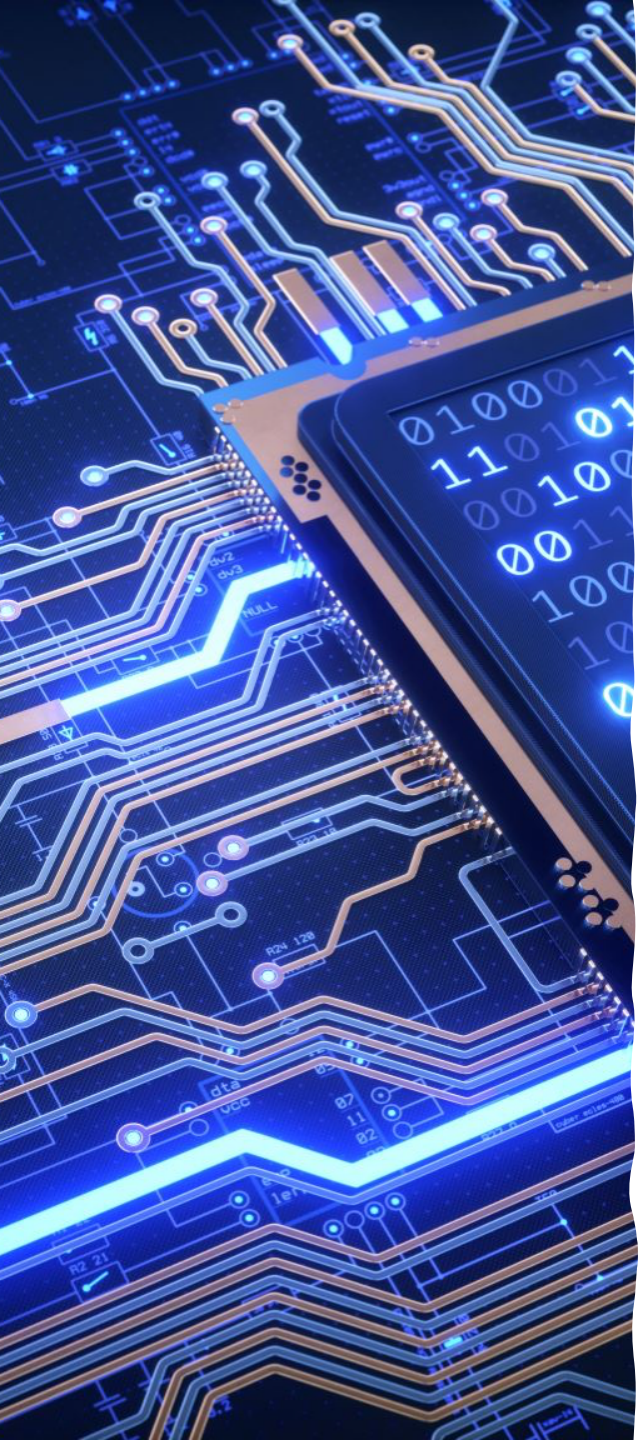


IoT and Blockchain

Dr. Phillip G. Bradford (University of Connecticut, Stamford CT. **USA)**

phillip.bradford@uconn.edu,

Outline

Two virtual RPIs

Simple network model

SSH on RPIs

Message-digest hashing and public keys systems

Two Raspberry Pis

Running two QEMU VMs

Communication with Raspberry Pis

Running Two RPIs

Duplicate RPi folder

RPi_1
RPi_2

Both contain the files:

2021_01_11-raspios-…-lite.img
2021_01.qcow2
qemukernel
versatile-pb.dtb

QEMU State model

The system state is saved on the image (qcow2 file)

Multiple autonomous VMs require multiple images

~/Rpi_1/

~/Rpi_2/

Simple network model

Both RPIs

hostfwd=tcp::5022-:22

hostfwd=tcp::5023-:22

Simple network model

Both RPIs

hostfwd=tcp::5022-:22

hostfwd=tcp::5023-:22

Running Two RPIs

Two terminals

Term1> cd Rpi_1

Term2> cd Rpi_2

qemu-system-arm -M versatilepb

-cpu arm1176

-m 256 -hda "./2021-01.qcow2"

-net nic -net user,hostfwd=tcp::5022-:22

-dtb "./versatile-pb.dtb"

-kernel "./qemukernel"

-append "root=/dev/sda2 panic=1 rootfstype=ext4 rw" -no-reboot

Running Two RPIs

Duplicate RPi folder:

Rpi_1

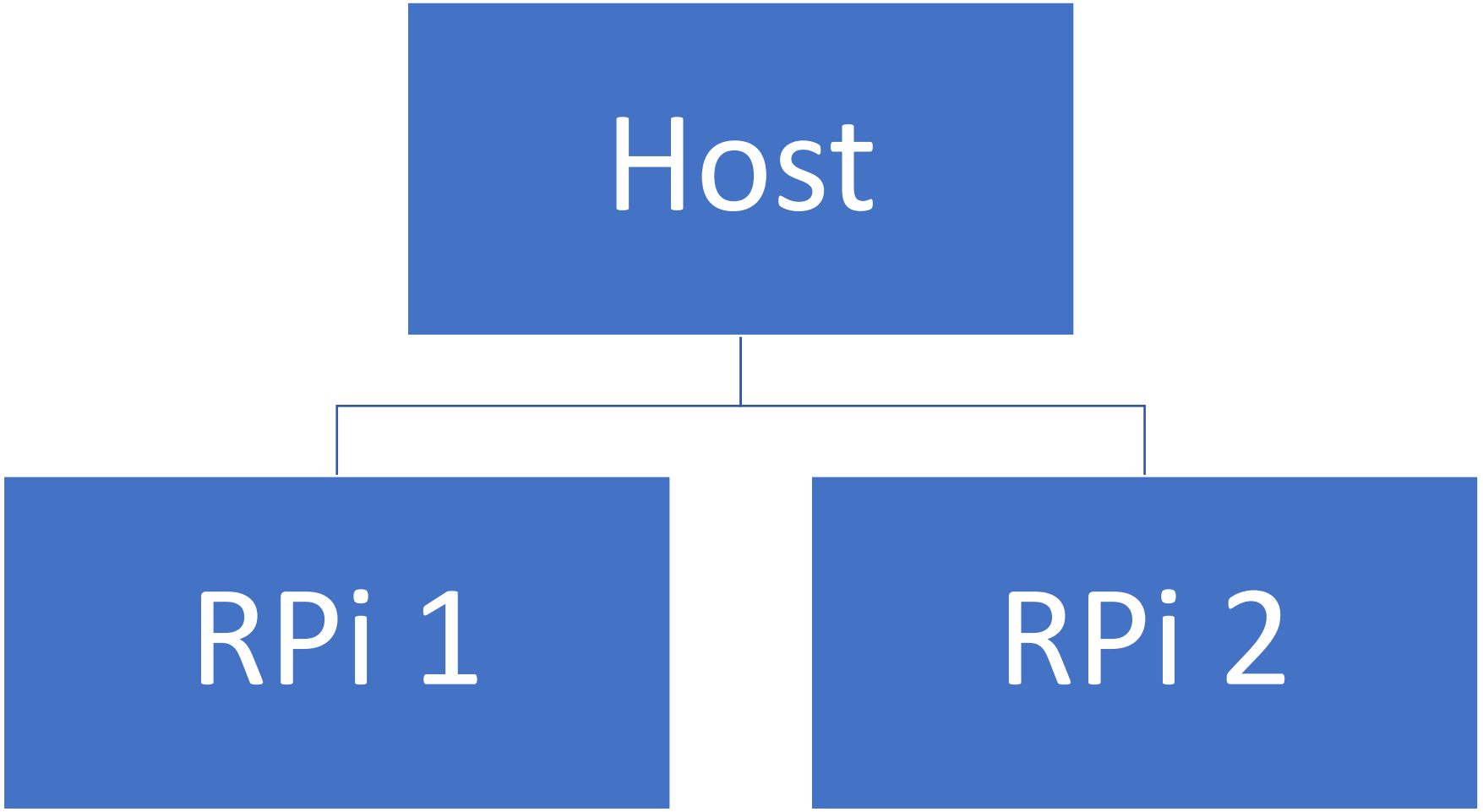
Rpi_2

The qcow2 file should be different for each RPi

Run qemu from both folders

Guests and Hosts

System virtualization



SSH

Secure shell via ports 502X

Communication path

Host → RPI_1

Host → RPI_2

Installation

Install git on RPIs

Windows 10: easy ssh

MacOS: generate public-secret key pairs

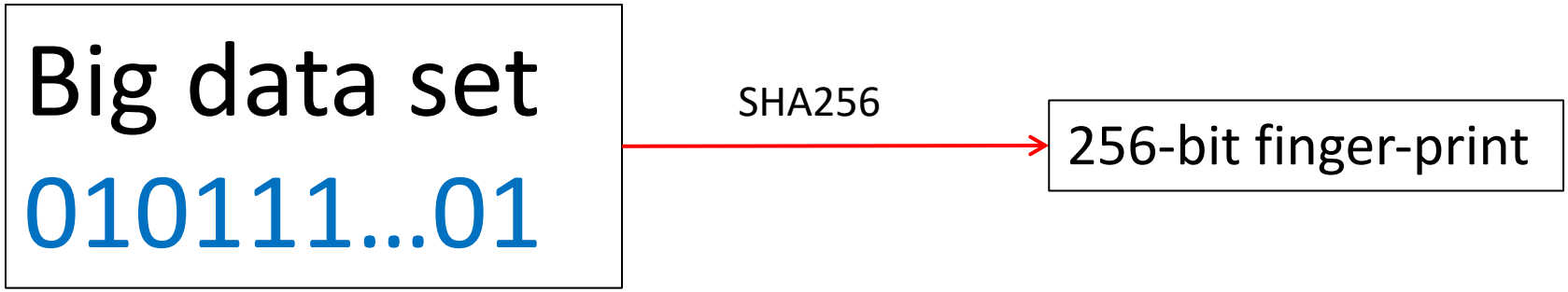
- put public key hash in known_hosts
- secret key in keychain
- push public key to RPIs

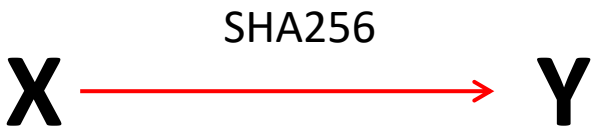
Message digest hash functions

Public key systems

SHA message digest function
Public key systems: RSA

SHA256 finger-prints





Given SHA256 output **Y**, not feasible to find input **X** where **SHA256(X) = Y**

Hash functions: simplified

Outputs three decimal digits

Hash("Buy ETH") → 372
Hash("Buy BTC") → 281
Hash("Sell ETH") → 870

Any integer x in {0, 1, 2, …, 999} and any string X we have:

$$\mathbf{P[Hash(X) = x] = \frac{1}{1000}}$$

Collision intractability

SHA256 digests giant strings into 256 bits

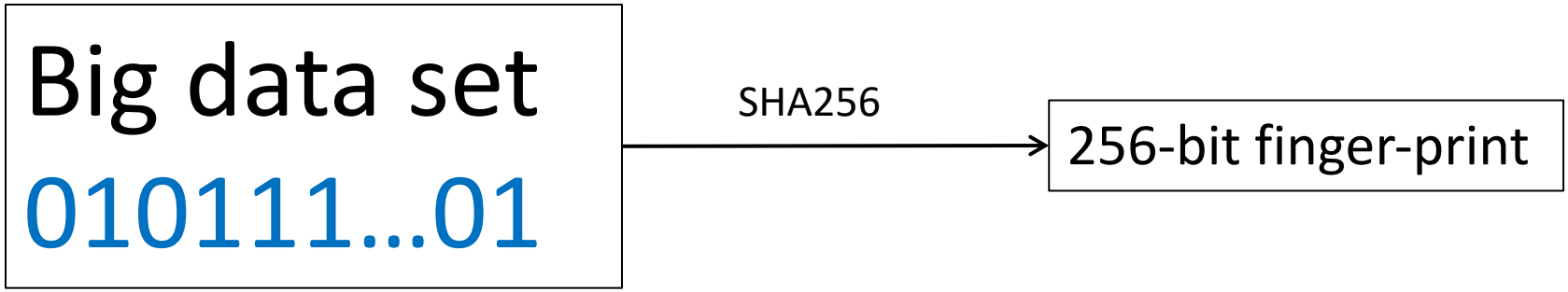
How many decimal digits in 2^{256} ?

$\text{Log10}(2^{256}) > 77$

One third of 77 is about 25 decimal digits

$$\mathbf{P[SHA_{1/3}(X) = y]} = \frac{1}{10000000000000000000000000}$$

SHA256 standard



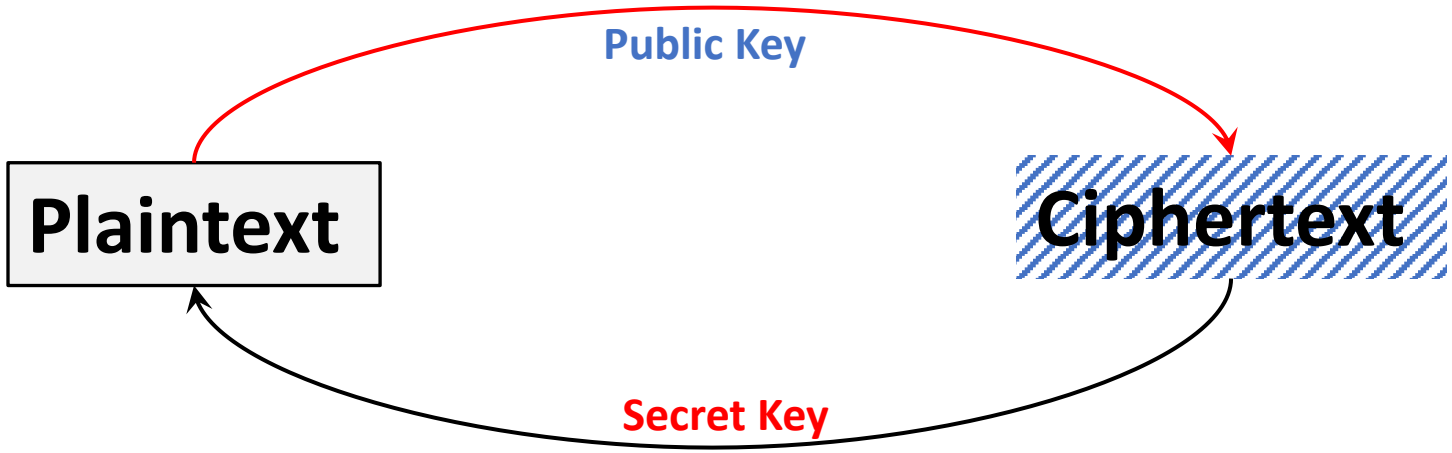
SHA-256: Secure Hash (Digest) Algorithm

- Designed by NSA and standardized by NIST (1994-2001)

SHA-256 Hashing

- One-way
- Digital finger-prints
- Digest takes up to 2^{64}-1 bit input and outputs 256 bit output

Public Key Systems: secret message



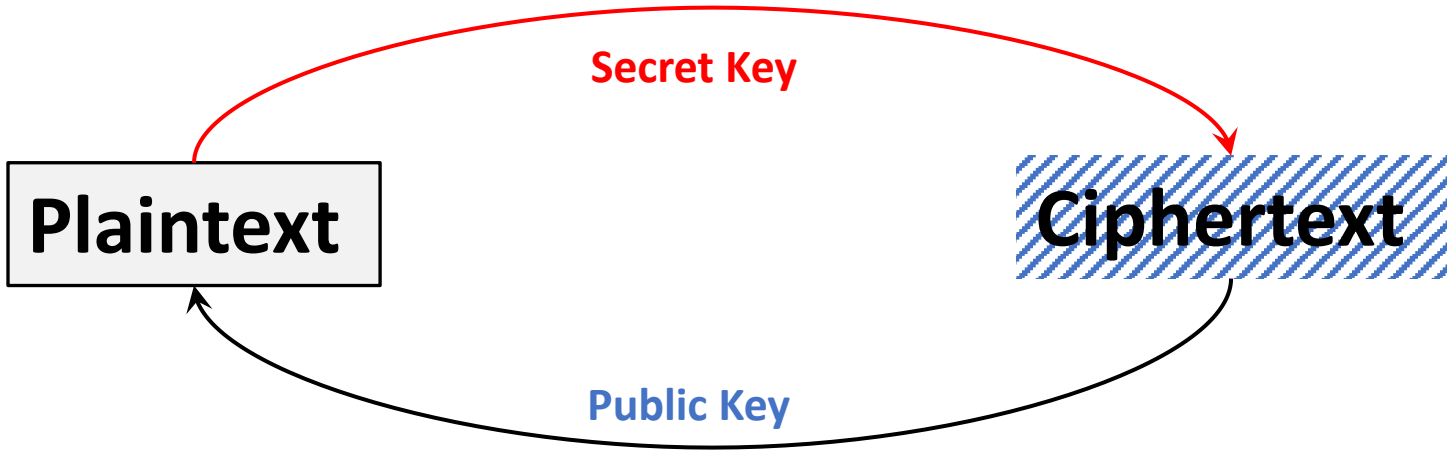
Generate two keys

- The public Key is open to the world
- The secret key is secret, **only** you know it

Knowing the public key, intractable to find secret key

Each key is the other's cryptographic inverse

Public Key Systems: proving secret key



Take today's news as plaintext

Encrypt it with secret key and post cipher text

Anyone with public key can get the plaintext

Public key systems

Proving you have a secret key

$$E_S[T] = C$$

$$D_P[C] = T$$

Letting anyone send you a secret message

$$E_P[T] = C$$

$$D_S[C] = T$$