

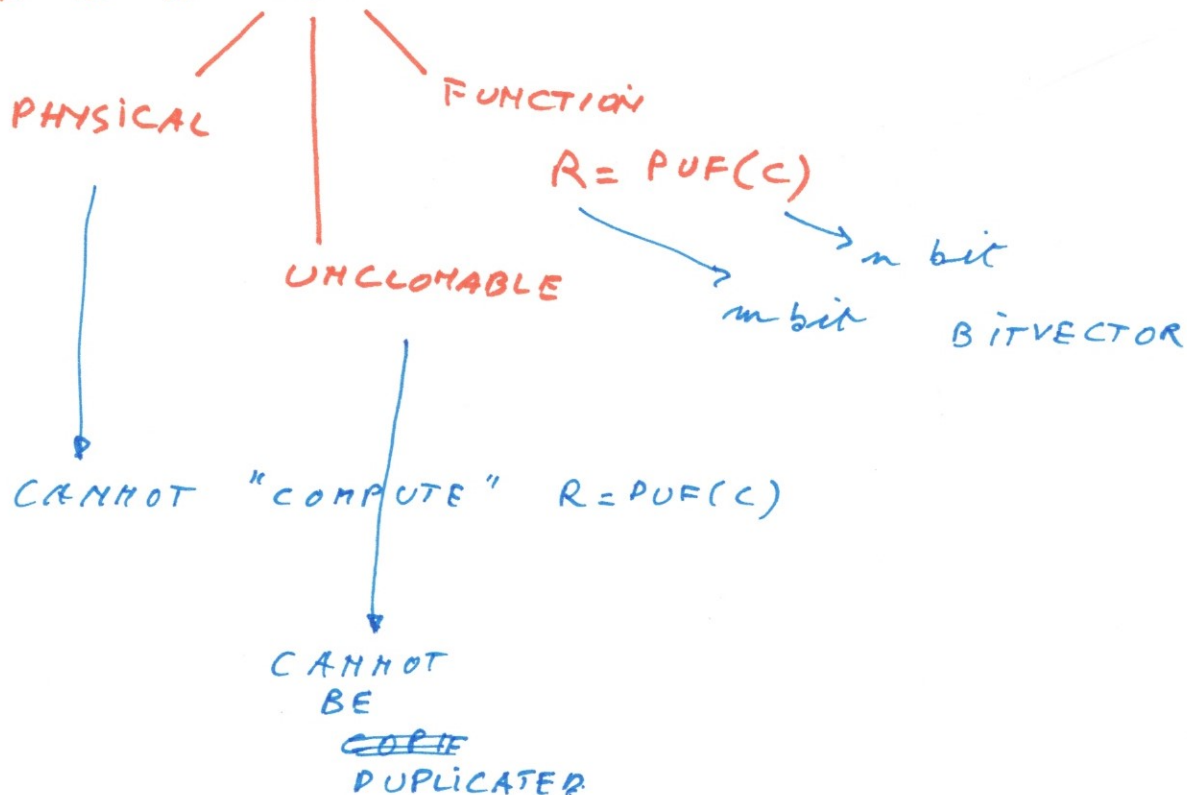
CHIP BIOMETRIC

- RING OSCILLATORS

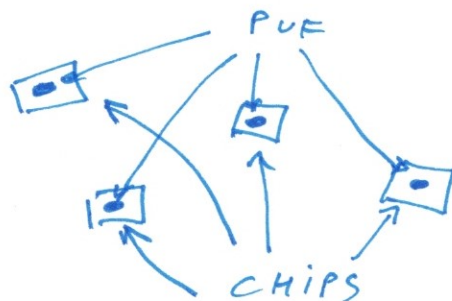
- CONTROLLED PRR

→ PUF PHYSICALLY UNCLONABLE FUNCTION

① WHAT IS A PUF

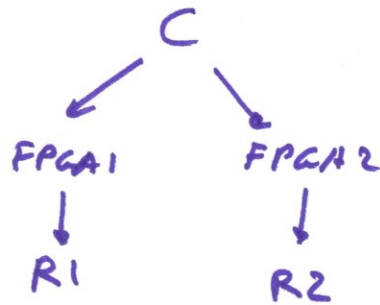


② WHAT DO WE WANT TO ACHIEVE



PROPERTY 1:

PUF: UNIQUE

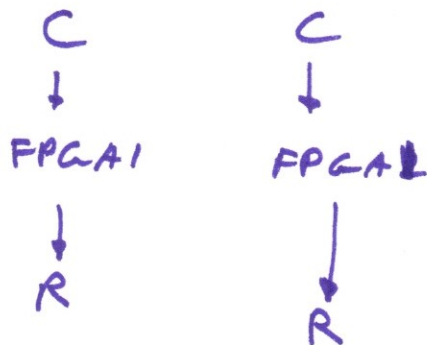


$$E \left(HD(PUF_1(C), PUF_2(C)) \right) = \frac{m}{2}$$

(R is m bits)

PROPERTY 2:

PUF: NOISELESS



$$E \left(HD(PUF_1(C), PUF_1'(C)) \right) = 0$$

* HAMMING WEIGHT
= # '1' IN BITSTRING

$$HW(00111) = 3$$

$$HW(10100) = 2$$

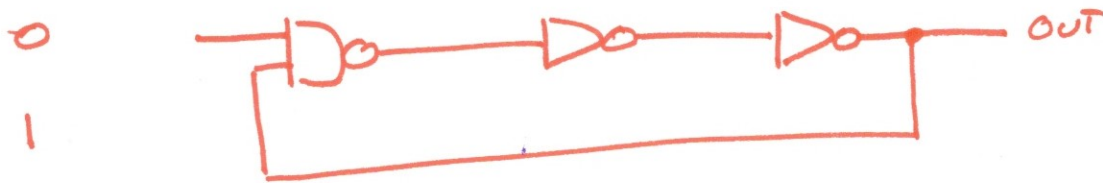
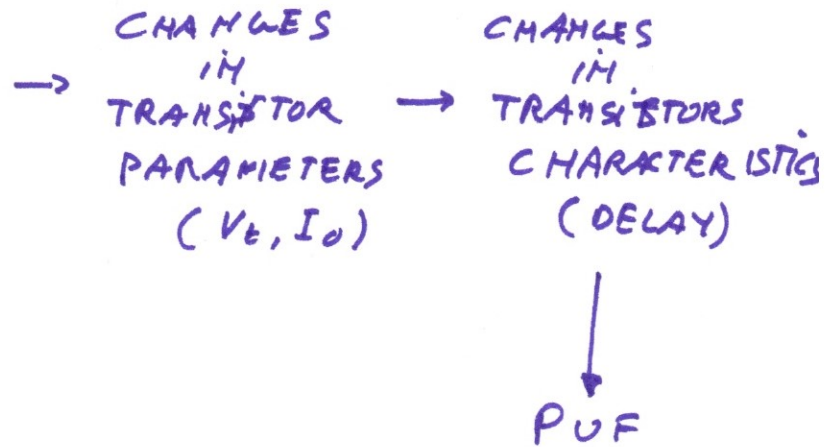
* HAMMING DISTANCE
= # DIFFERENT BITS
IN 2 BITSTRINGS

$$HD(011, 010) = 1$$

$$HD(1011, 1011) = 0$$

'VARIATIONS' = NO 2 CMOS TRANSISTORS ARE IDENTICAL

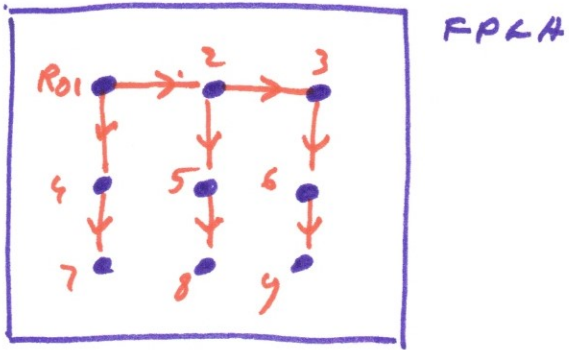
- ① PROCESS
 - DOPING
 - OXIDE
- ② LITHOGRAPHY
 - DEVICE DIMENSIONS
- ③ ENVIRONMENT
 - TEMPERATURE
- ④ AGING



$$f_{ro} = \frac{1}{2(t_{AND} + t_{INV1} + t_{INV2})}$$

- RO-PUF

5



$R: f_{RO_i} < f_{RO_j} ? \quad 1 : 0$
for all (i,j) pairs

