Quantum Key Distribution (QKD)

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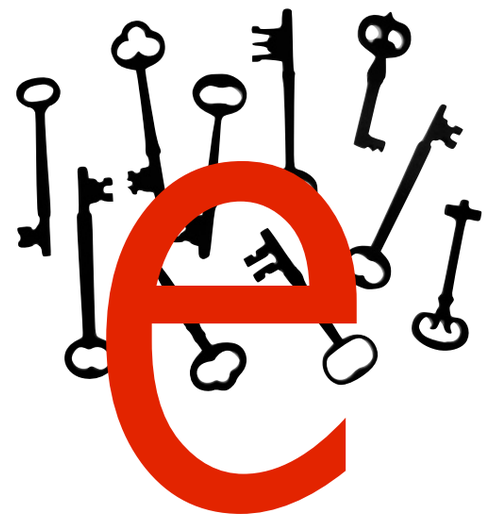
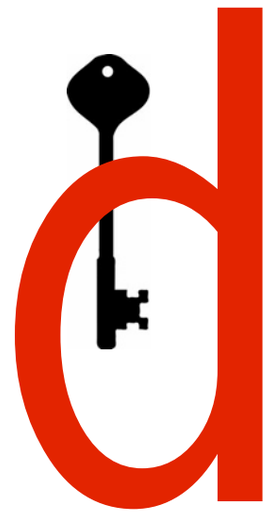
Classical Key Distribution

RSA Encryption

- Relies on two distinct large prime numbers
- factorization of prime
- exponential problem
- limited only by computational power

Message: “SEAS” “01000101”





Public Key

$c = m^e \pmod{n}$

Encode

“01000101”

Private Key

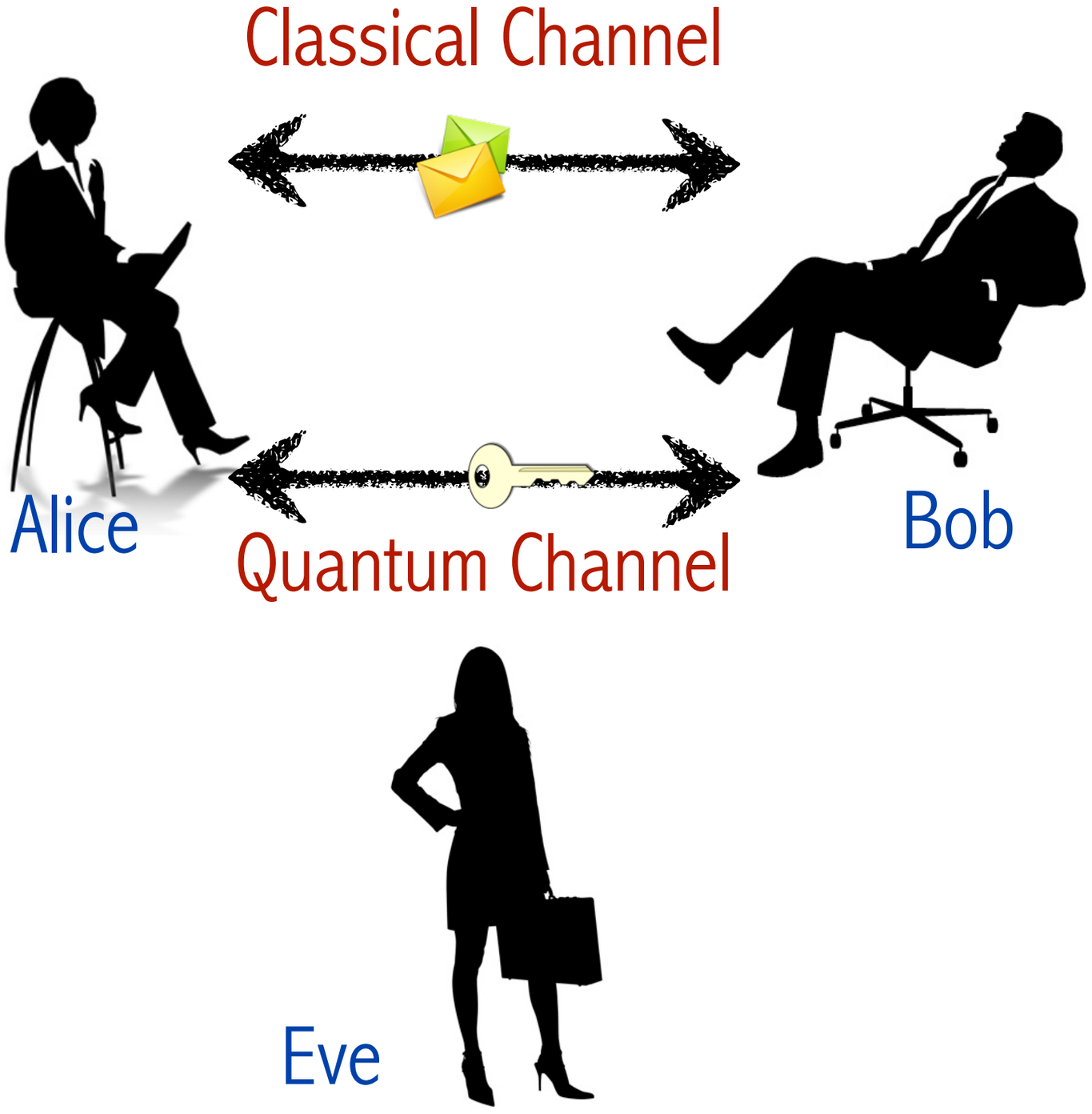
$m = c^d \pmod{n}$

Decode

“SEAS”

Quantum Key Distribution(QKD)

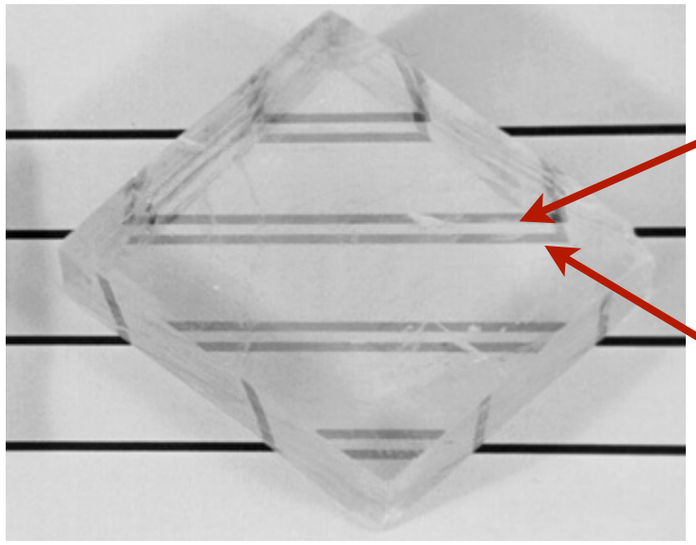
- relies on fundamental quantum mechanics
- unconditionally secure
- eavesdropper can be detected



BB84-Protocol

RSA Encryption

- Uses polarized light
- Uncertainty principle for single photons



V- Polarized

H-Polarized

Calcite Crystal

Measure

D

d

Diagonal Basis

P = 1/2

P=1/2

Measure

V

H

Rectilinear Basis

BB84-Protocol

How to share a secret key?

H/V Basis
H=0 →
V=1 ↑

D/d Basis
D=0 ↖
d=1 ↗

Quantum Channel

Bits	0	1	1	0	1	1	0	0	1	0	1
Alice's Random Basis	D	R	D	R	R	R	R	D	R	D	D
Photon Alice Sends	↖	↑	↗	→	↑	↑	→	↖	↑	↖	↗
Bob's Random Basis	D	D	R	R	R	R	D	D	R	R	D
Bits received by Bob	0	0	1	0		1	1	0	1		1

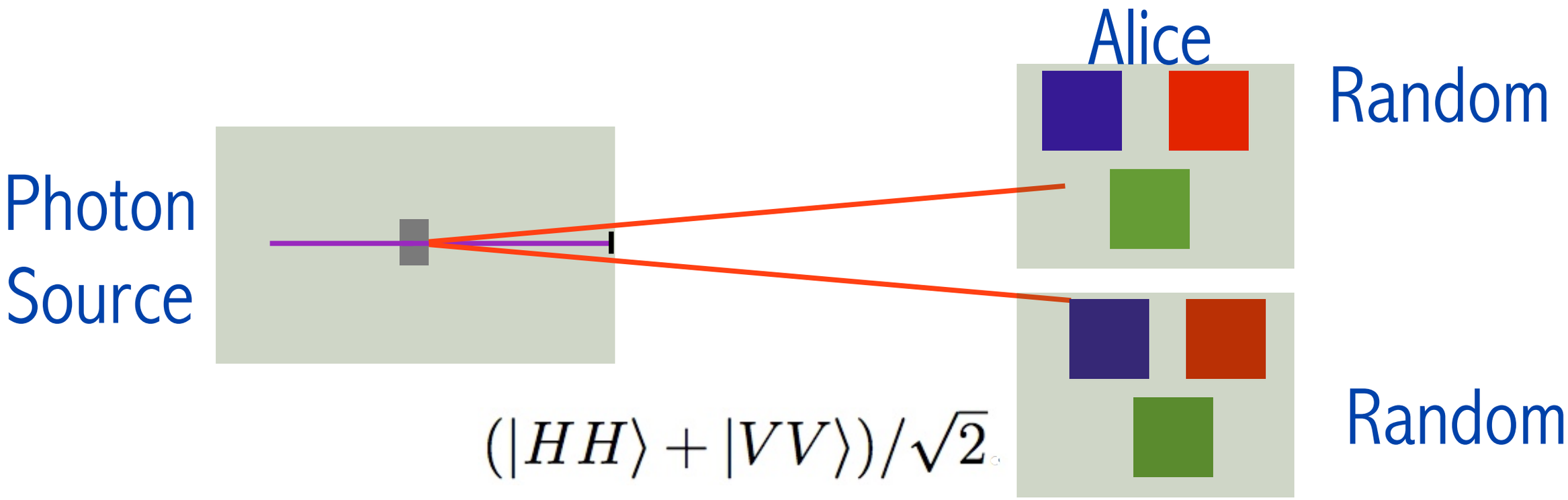
Public Channel

Bob Report Basis	D	D	R	R		R	D	D	R		D
Alice confirms correct ones	OK			OK		OK		OK	OK		OK
Shifted Key	0			0		1		0	1		1

Correlated measurements

Ekert's Protocol

Three Conjugate Basis: H/V, D/d, L/R

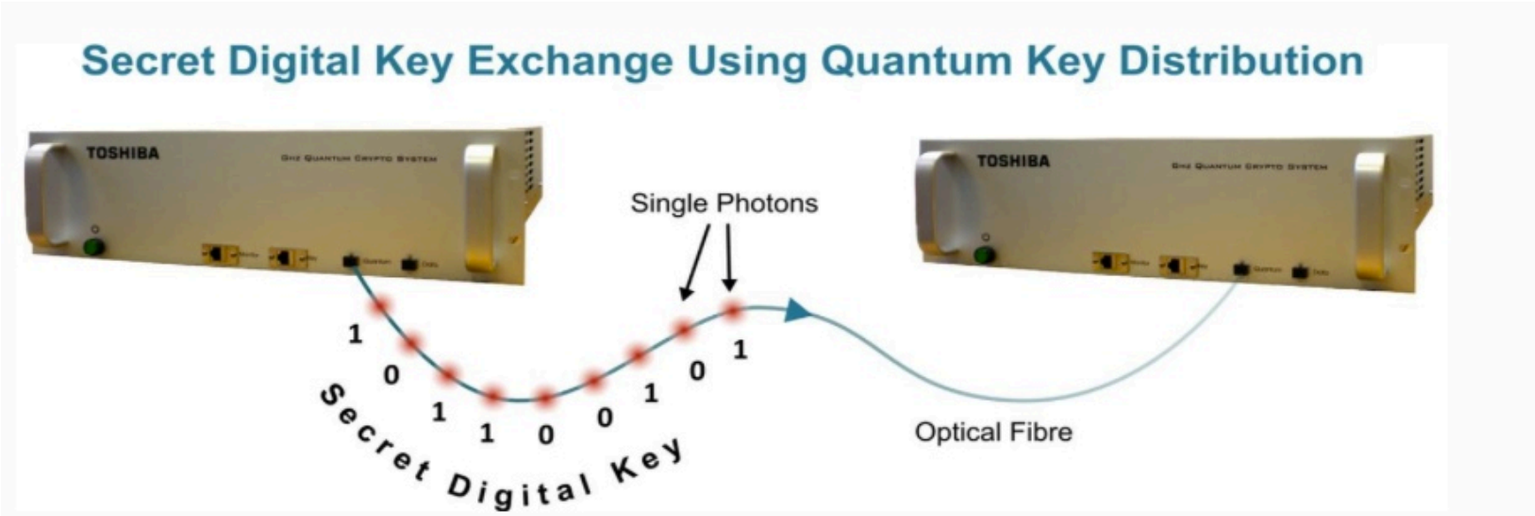


$$(|HH\rangle + |VV\rangle)/\sqrt{2}$$

- Shifted key is smaller
- More sensitive to eavesdropping

Conclusion

- 2009 Yamamoto, up to 105 km, 17 kbits/sec
- 2012 Shields, up to 90 km, ~1Gbits/sec



Future:

- High Key Generation Rate
- Noisy channel
- QKD over longer distances

Questions

Sources

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