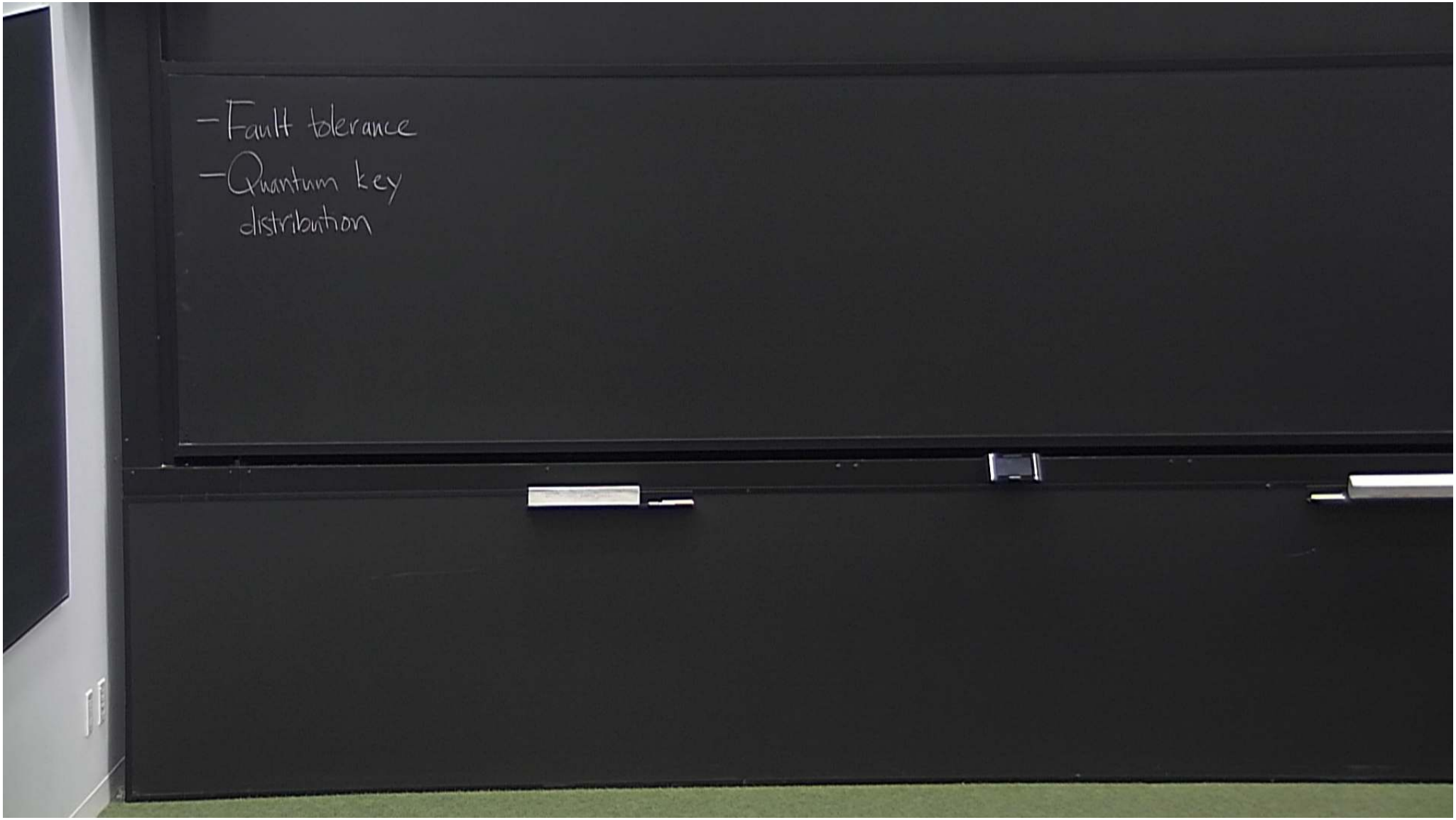
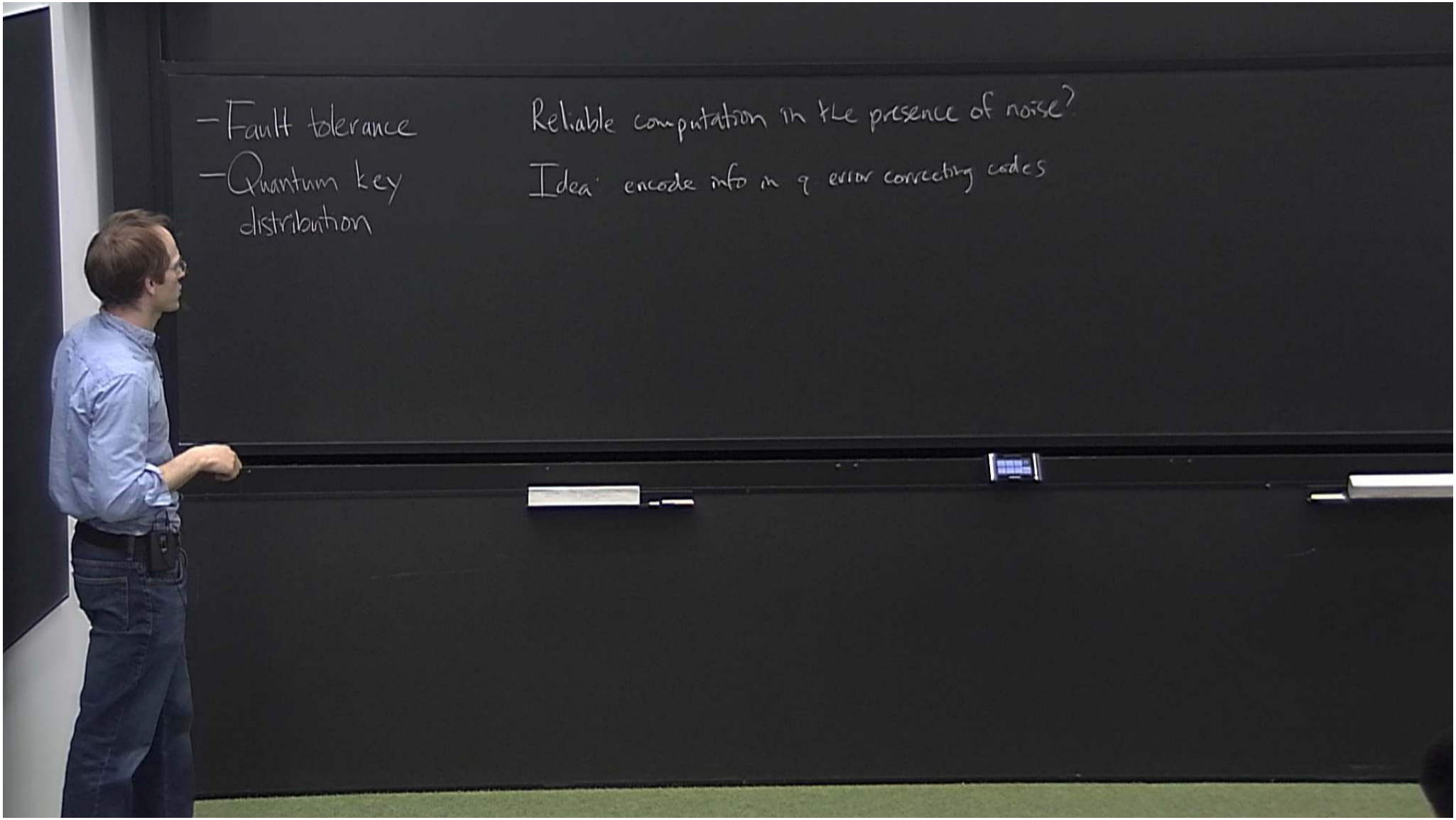
Title: 12/13 PSI - Quantum Information Review Lecture 14

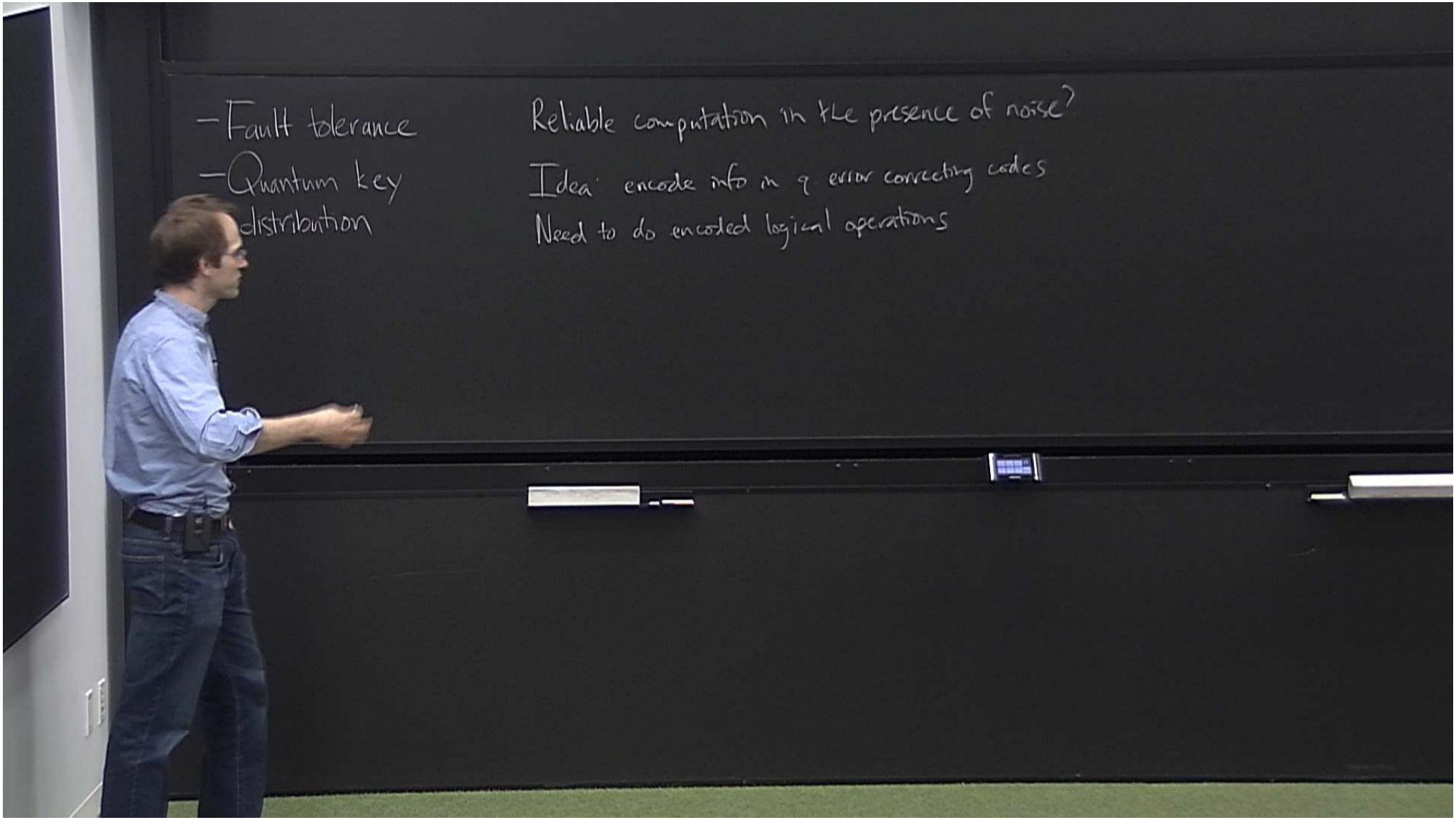
Date: Mar 08, 2013 10:15 AM

URL: http://www.pirsa.org/13030053

Abstract:


- Fault tolerance
- Quantum key distribution


- Fault tolerance
Reliable computation in the presence of noise?
- Quantum key distribution
Idea: encode info in q error correcting codes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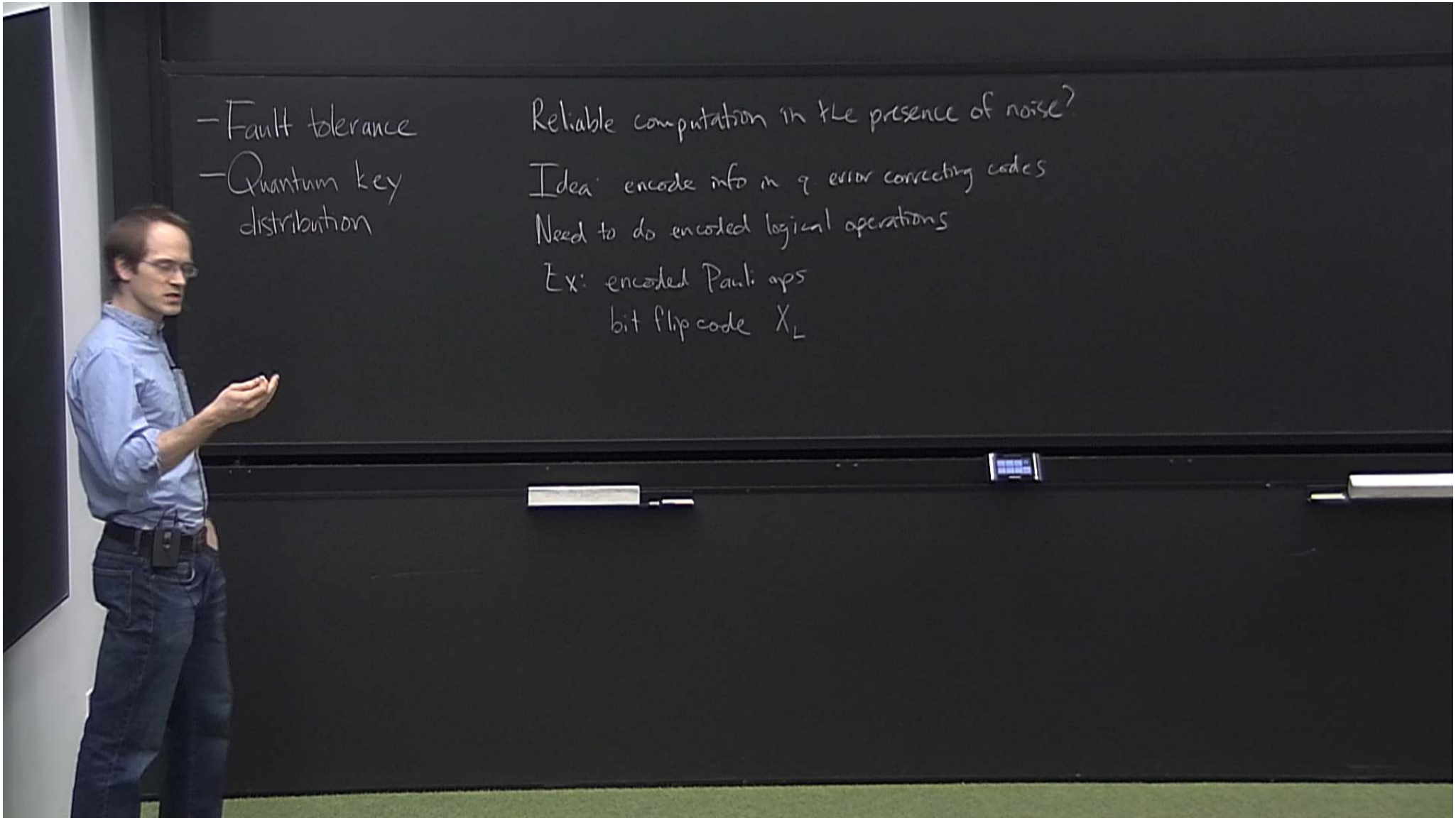
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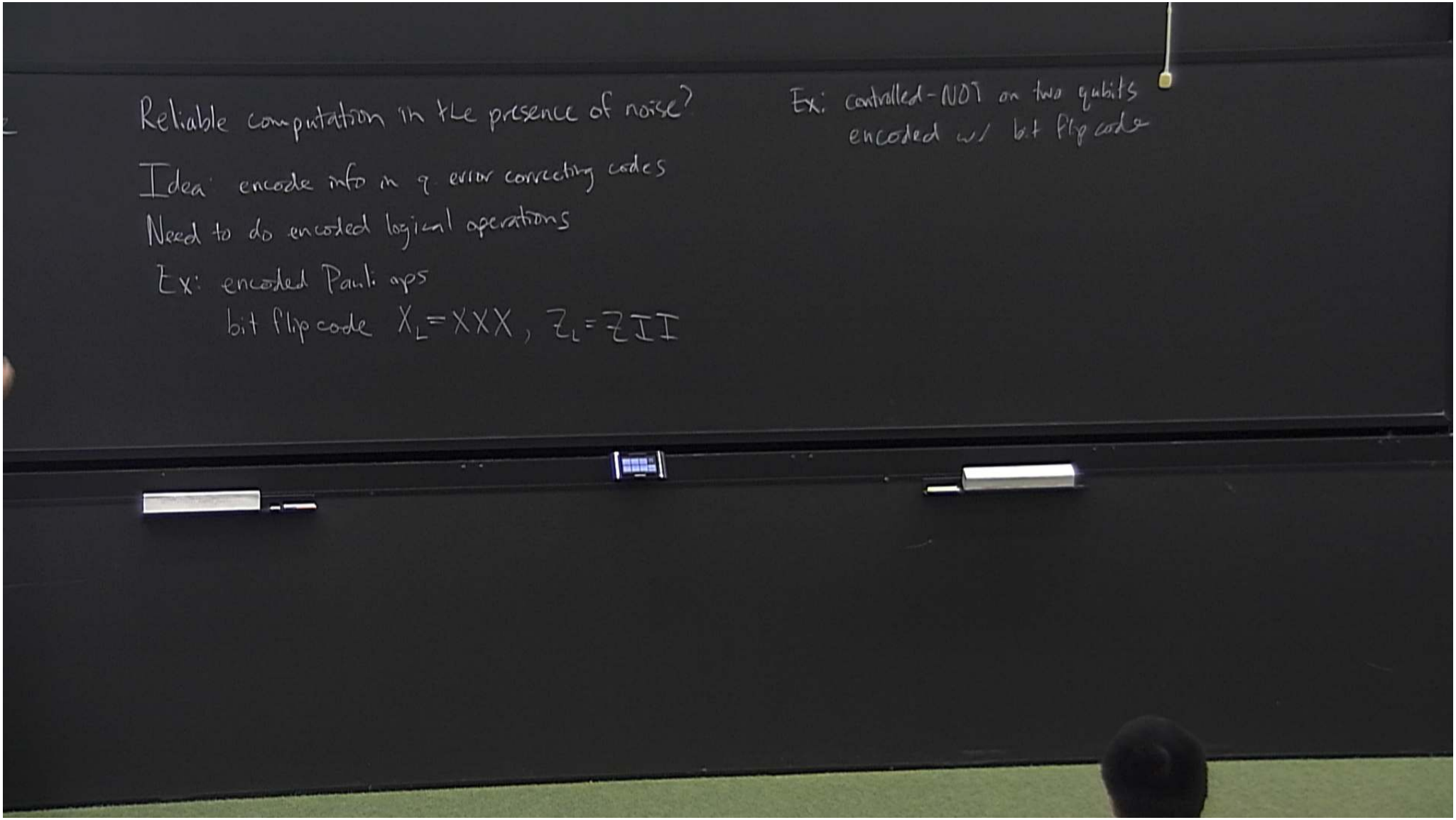

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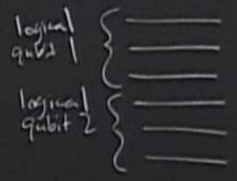

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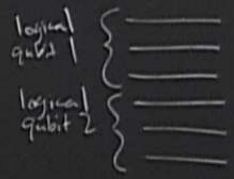

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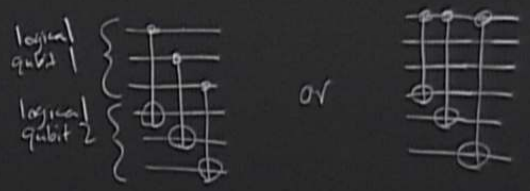

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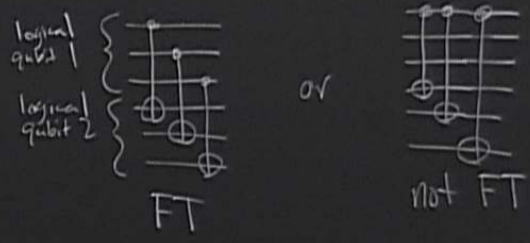

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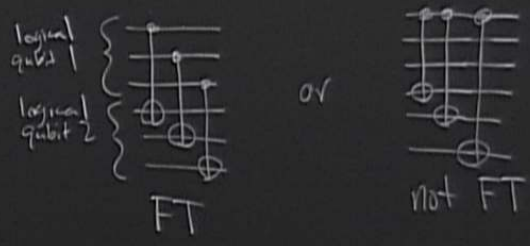

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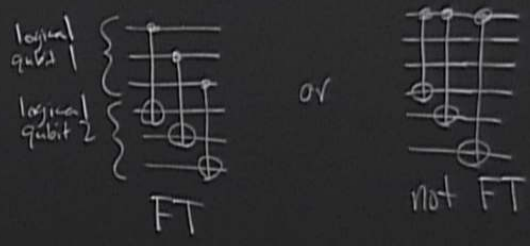

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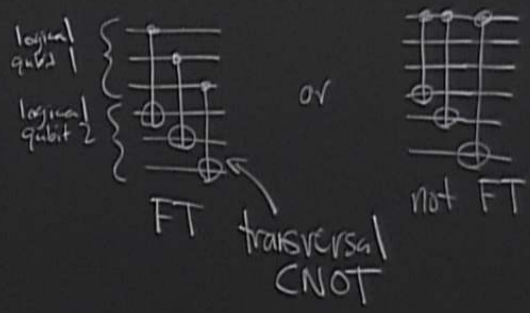

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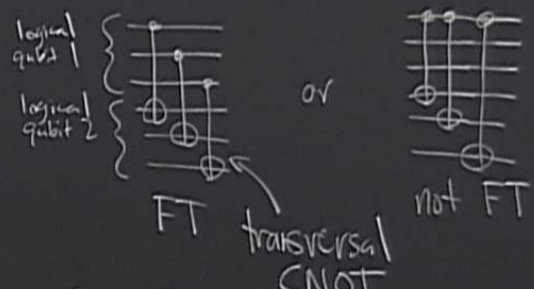

Steane 7-qubit lets us do lots of gates transversally

First, design fault-tolerant implementations of gates so that errors with prob p

$\rightarrow$ logical error rate $O(p^2)$.

Then concatenate the construction.

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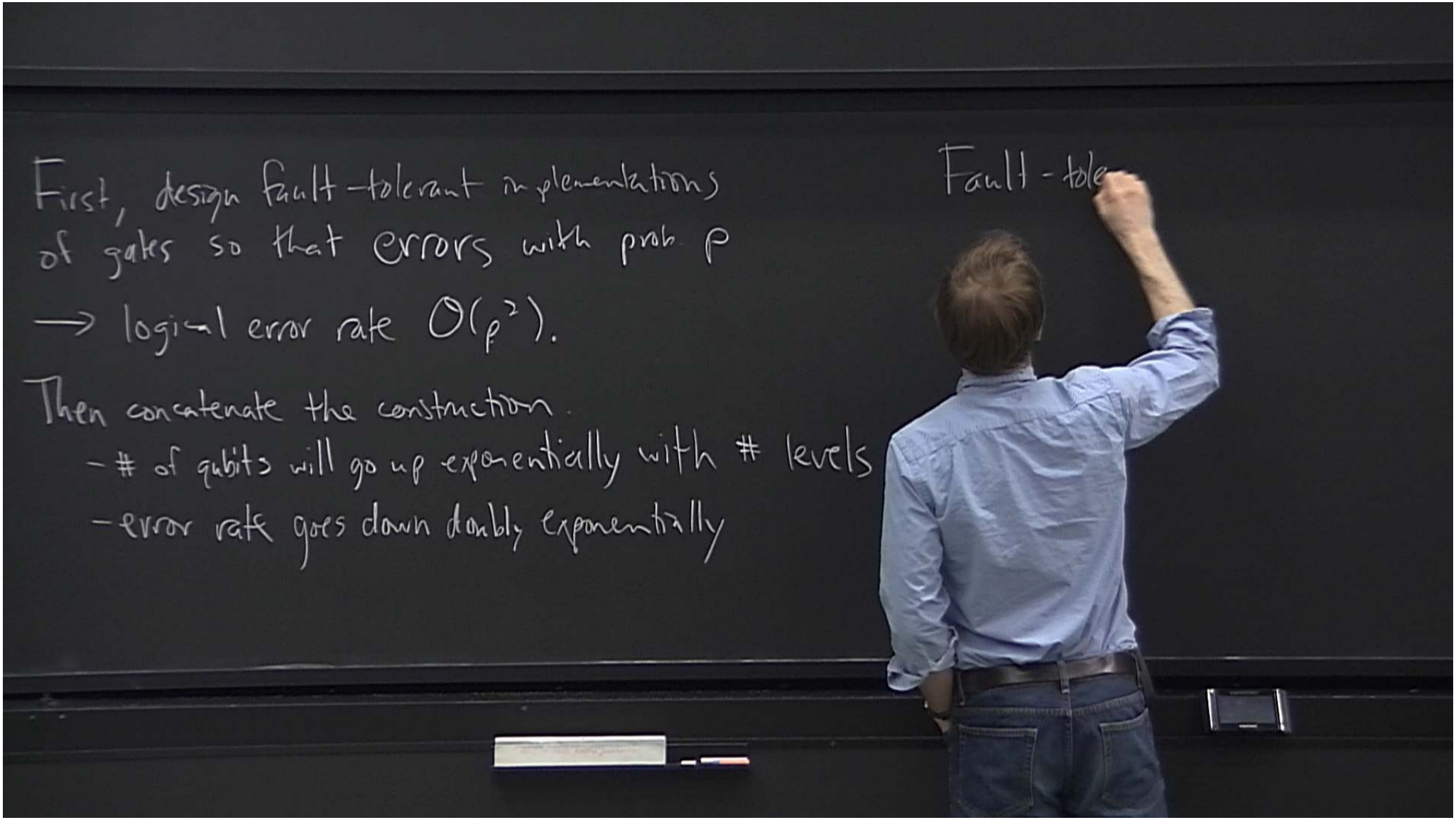
- # of qubits will go up exponentially with # levels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- error rate goes down doubly exponentially
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Fault-tolerant threshold theorem

If the prob. of error is below some fixed threshold then we can compute for an arbitrarily long time with effectively no error.

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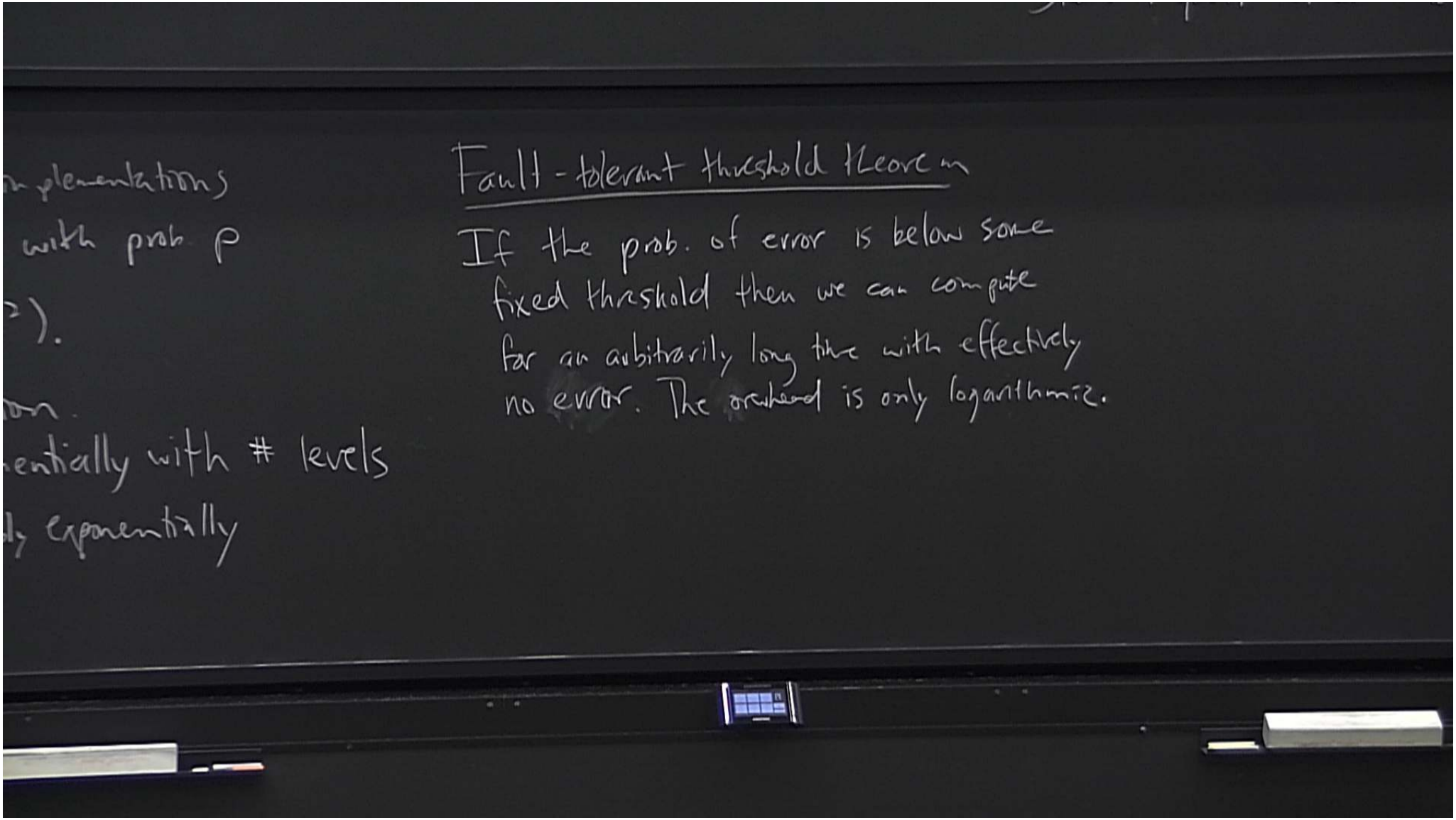
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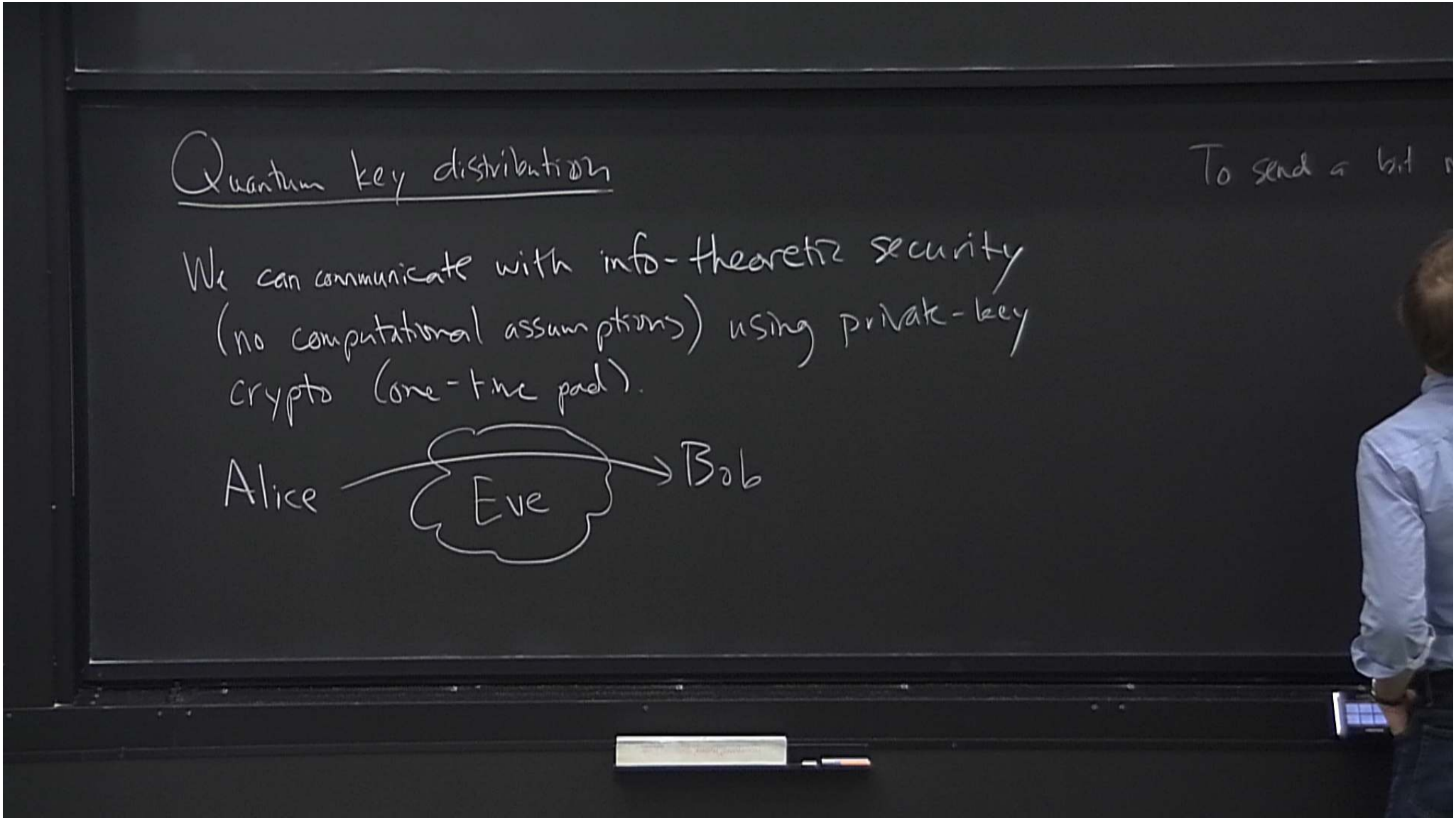
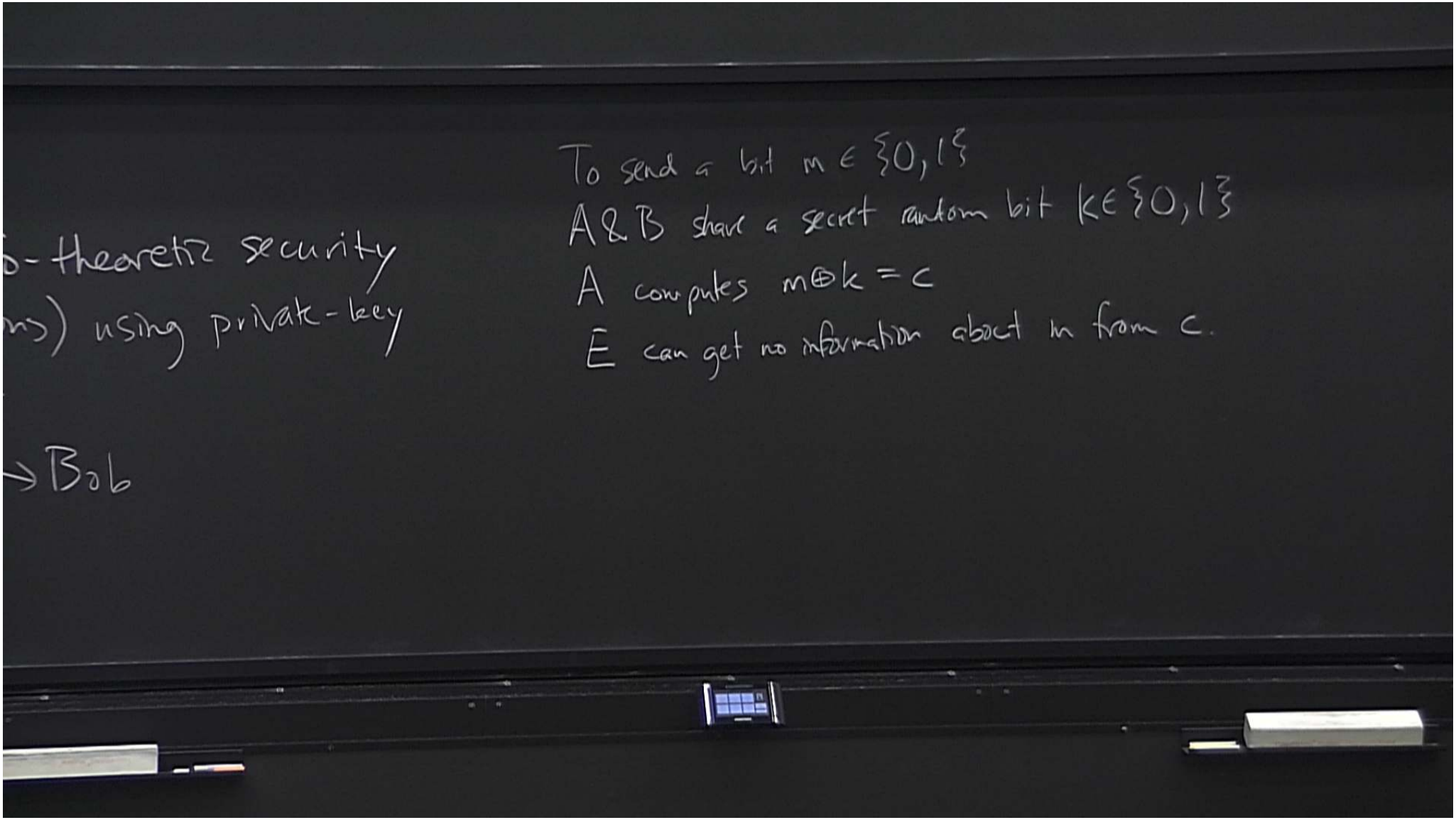

Quantum key distribution
To send a bit
We can communicate with info-theoretic security (no computational assumptions) using private-key crypto (one-time pad).
Alice
Eve
Bob


o-theoretic security
ns) using private-key
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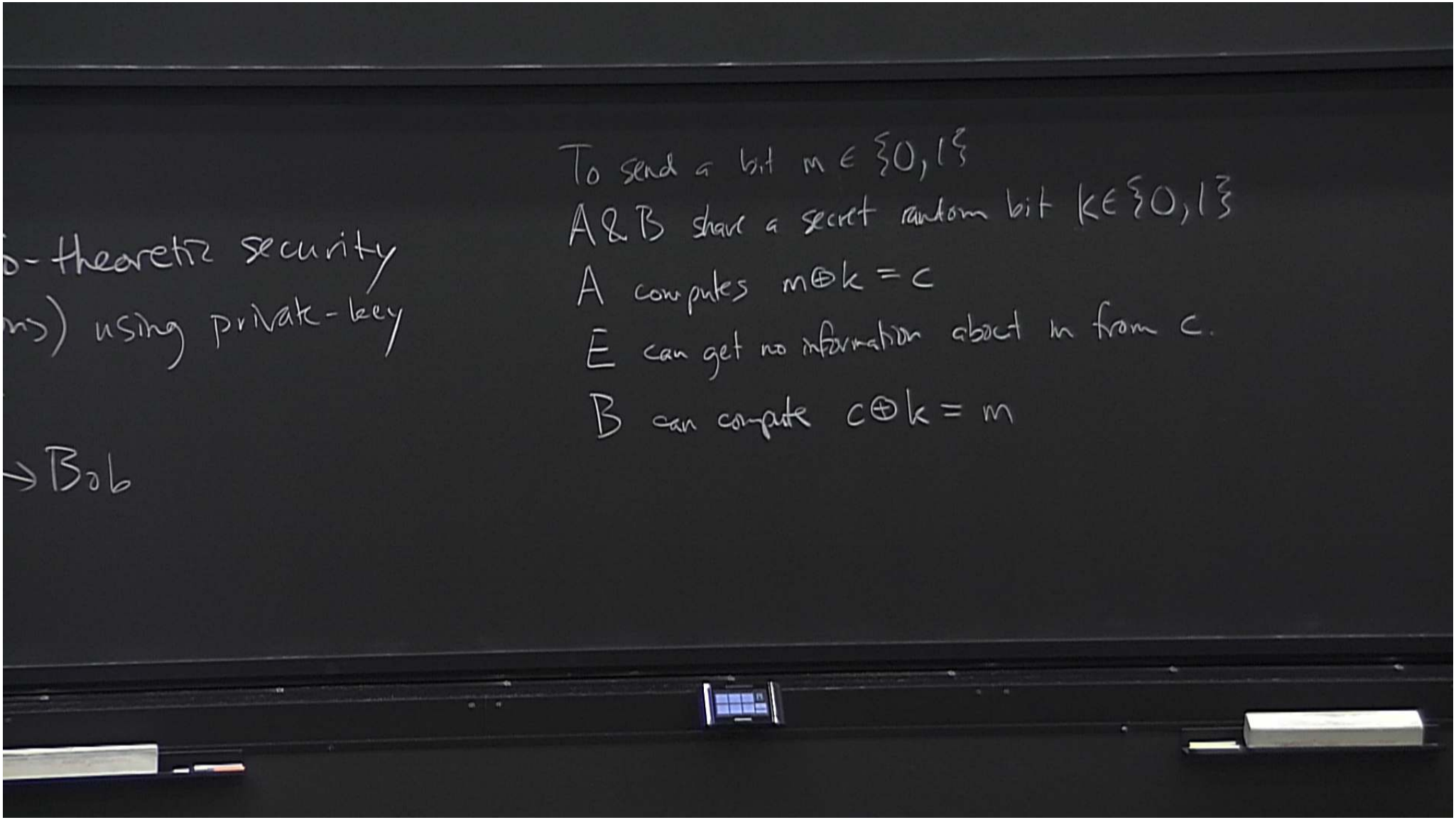
To send a bit m ∈ {0,1}
A & B share a secret random bit k ∈ {0,1}
A computes m ⊕ k = c
E can get no information about m from c.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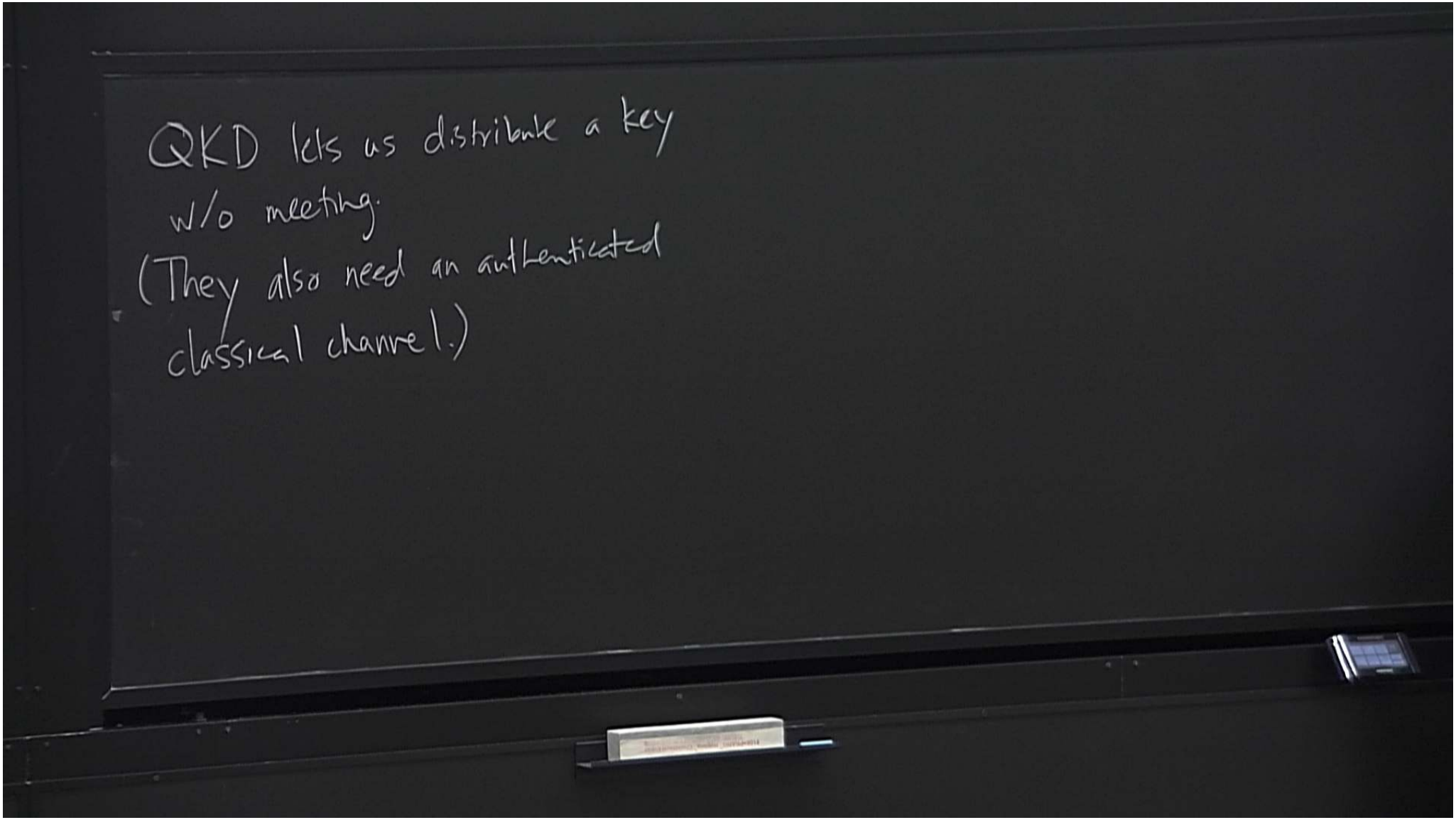
QKD lets us distribute a key
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(They also need an authenticated
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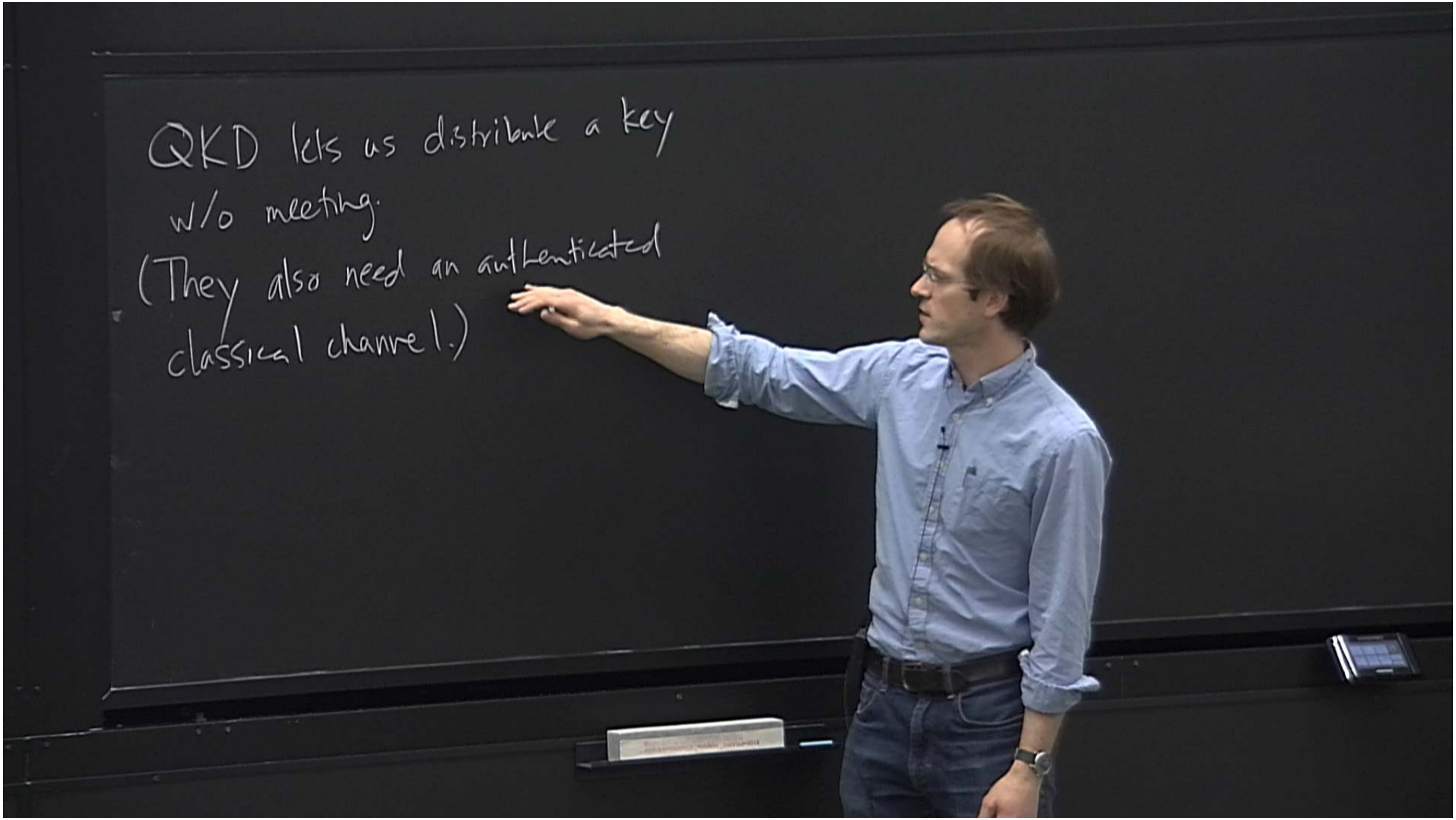
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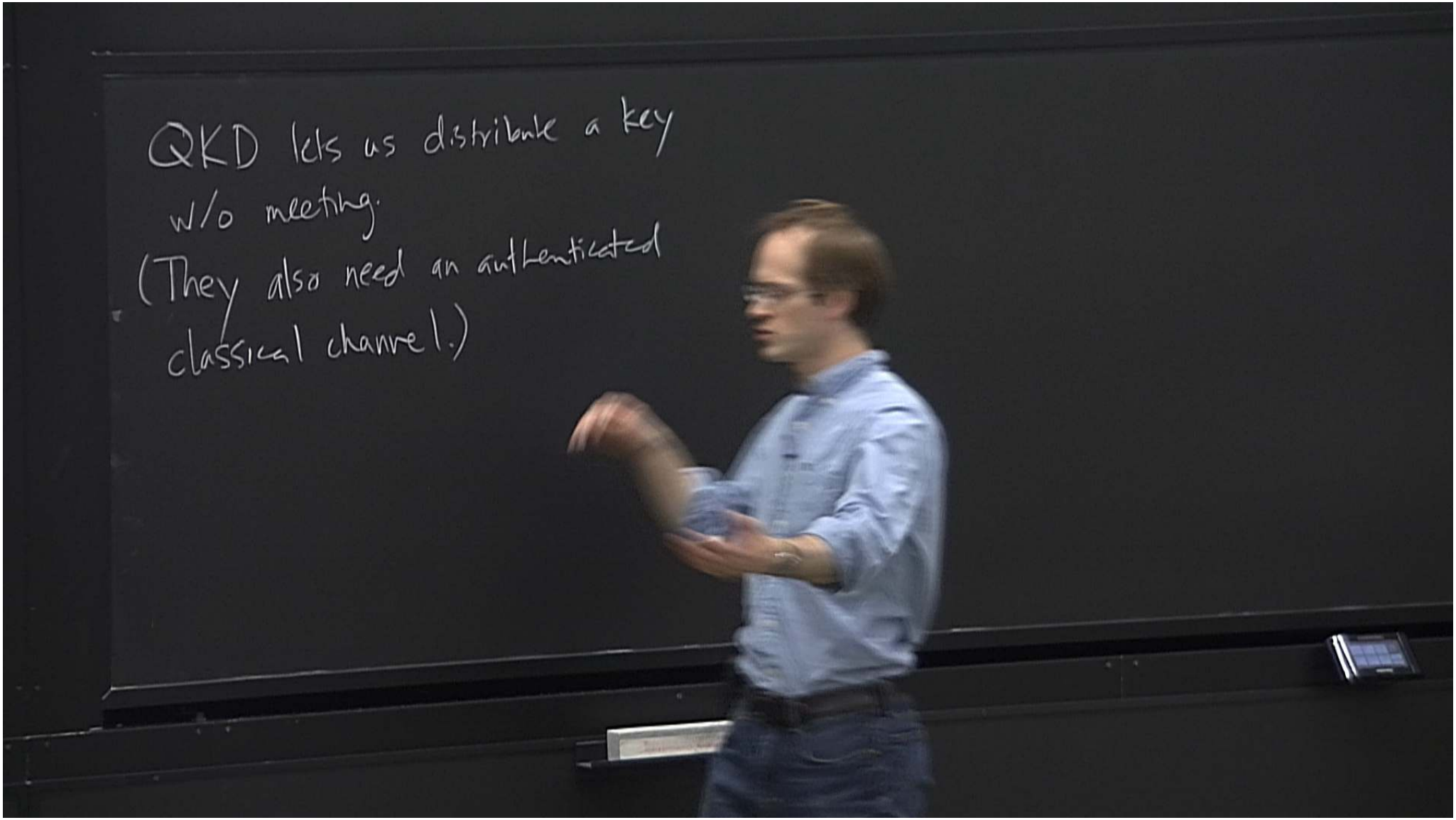
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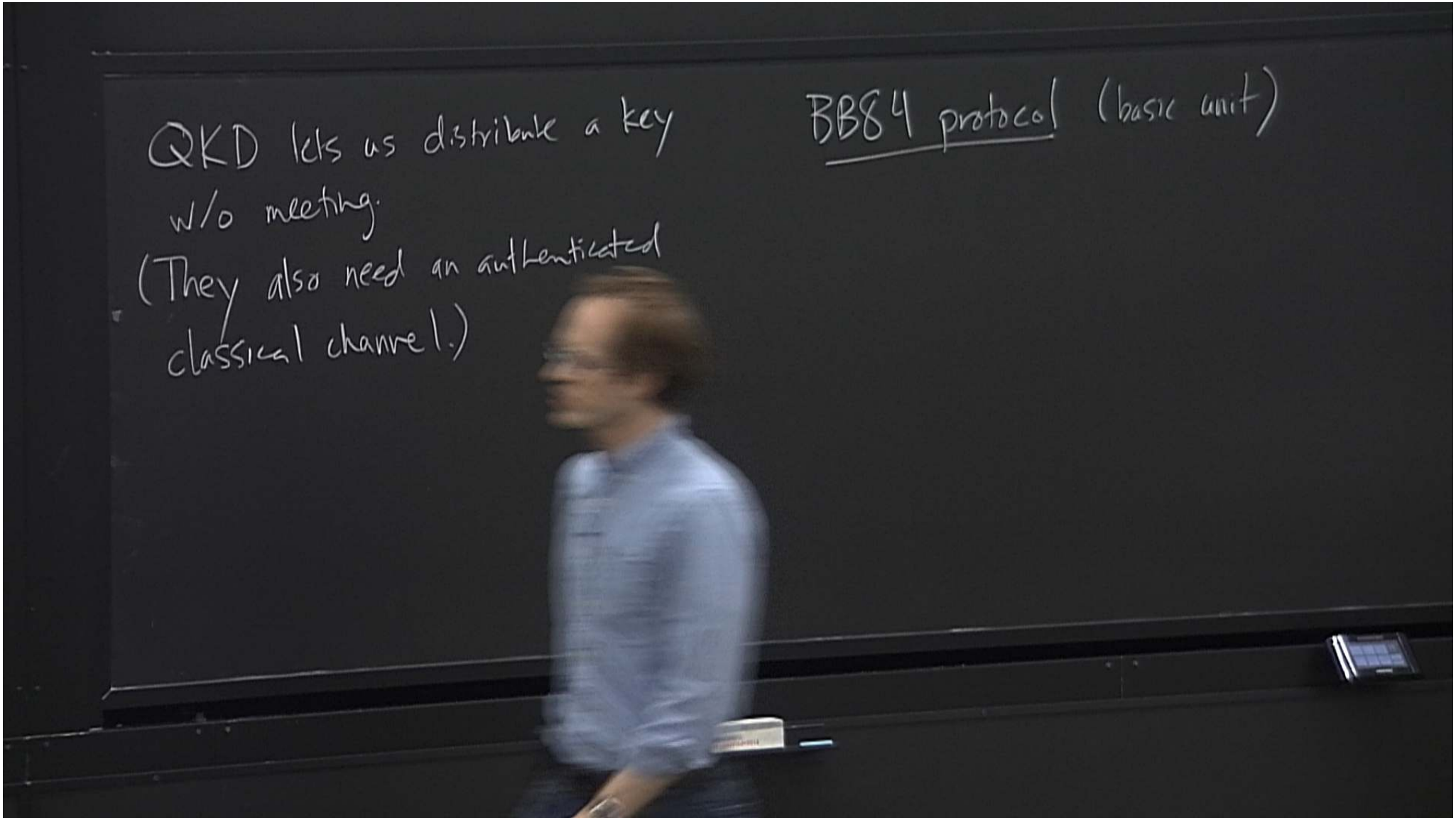
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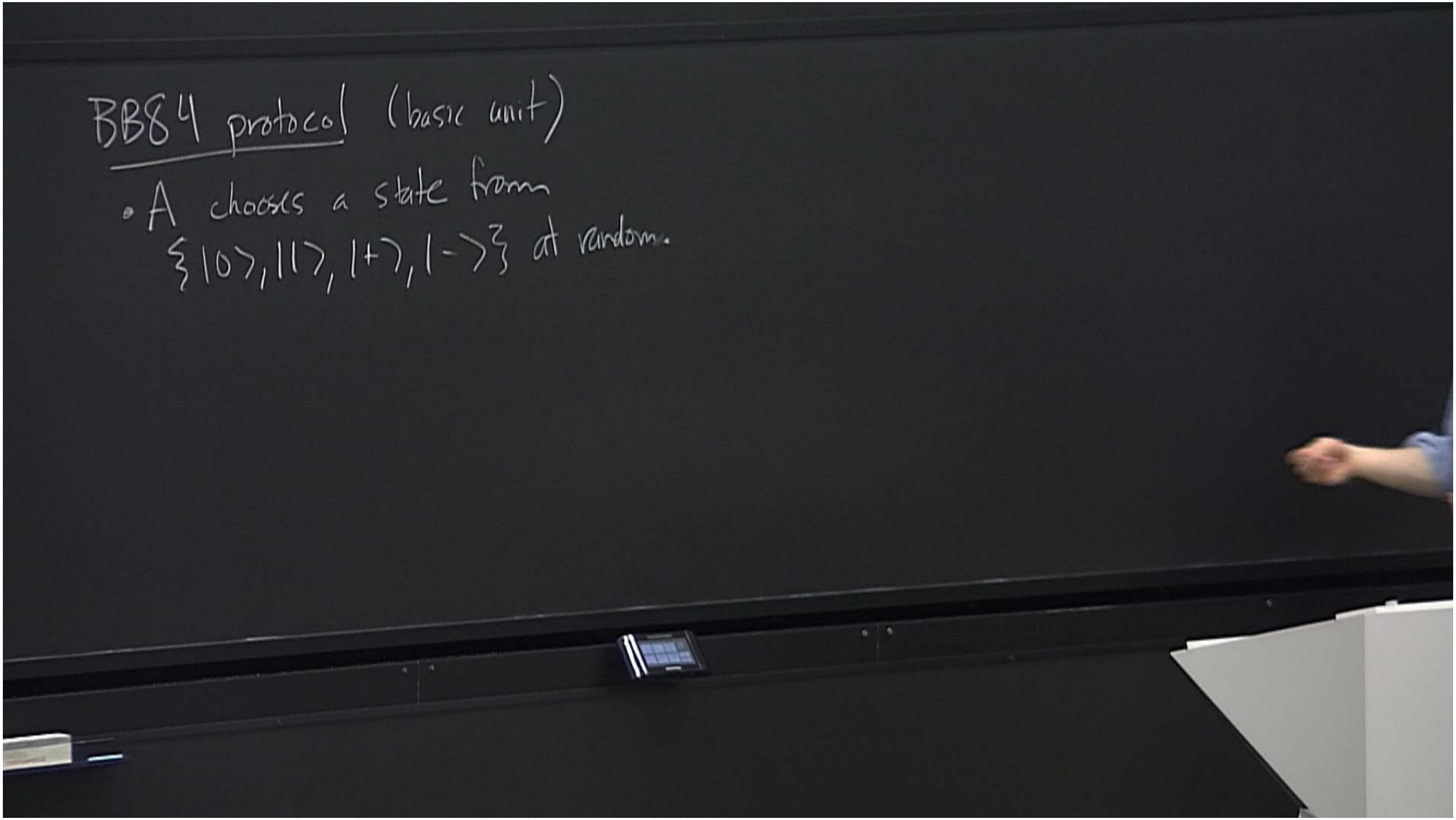
BB84 protocol (basic unit)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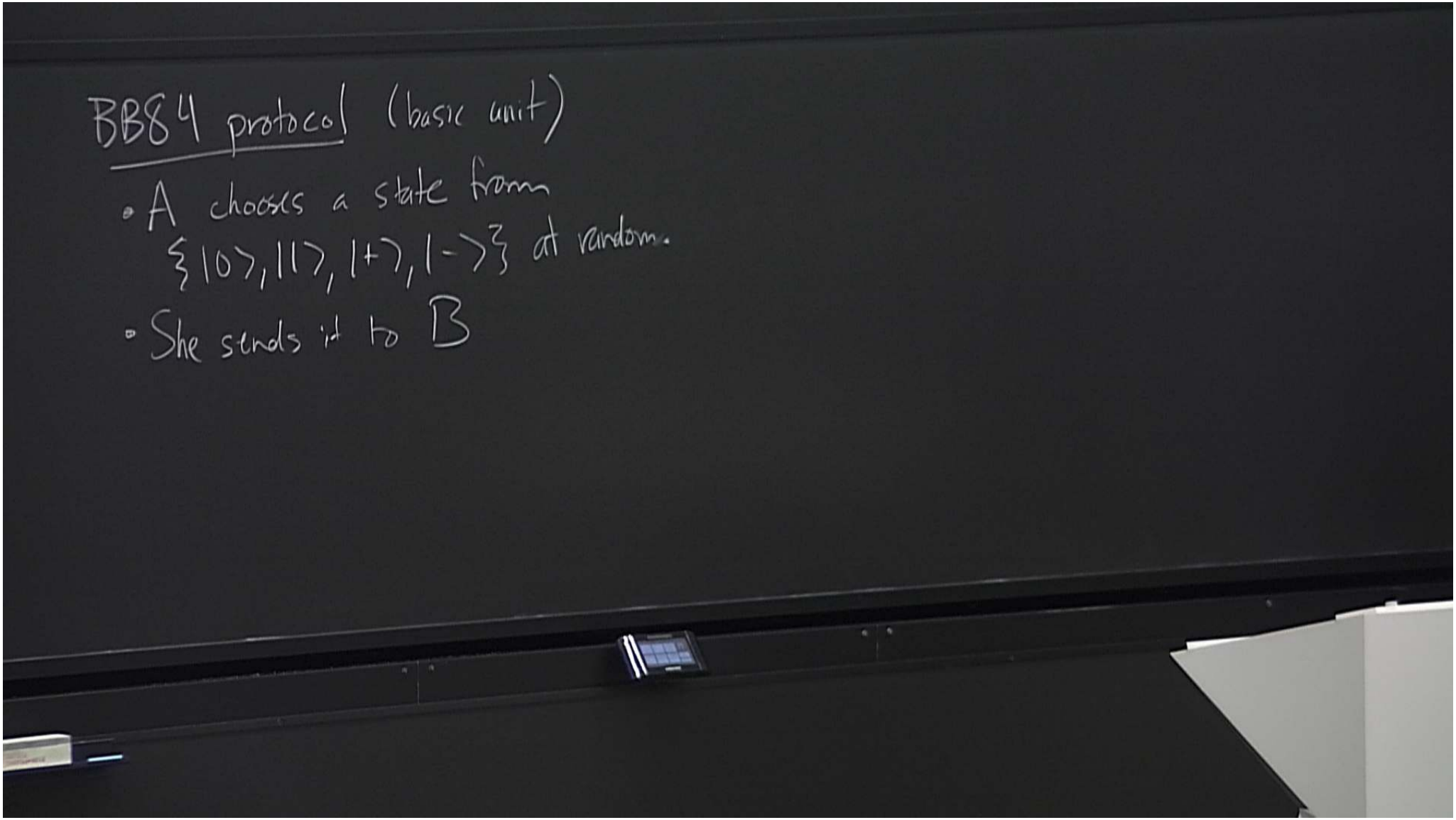
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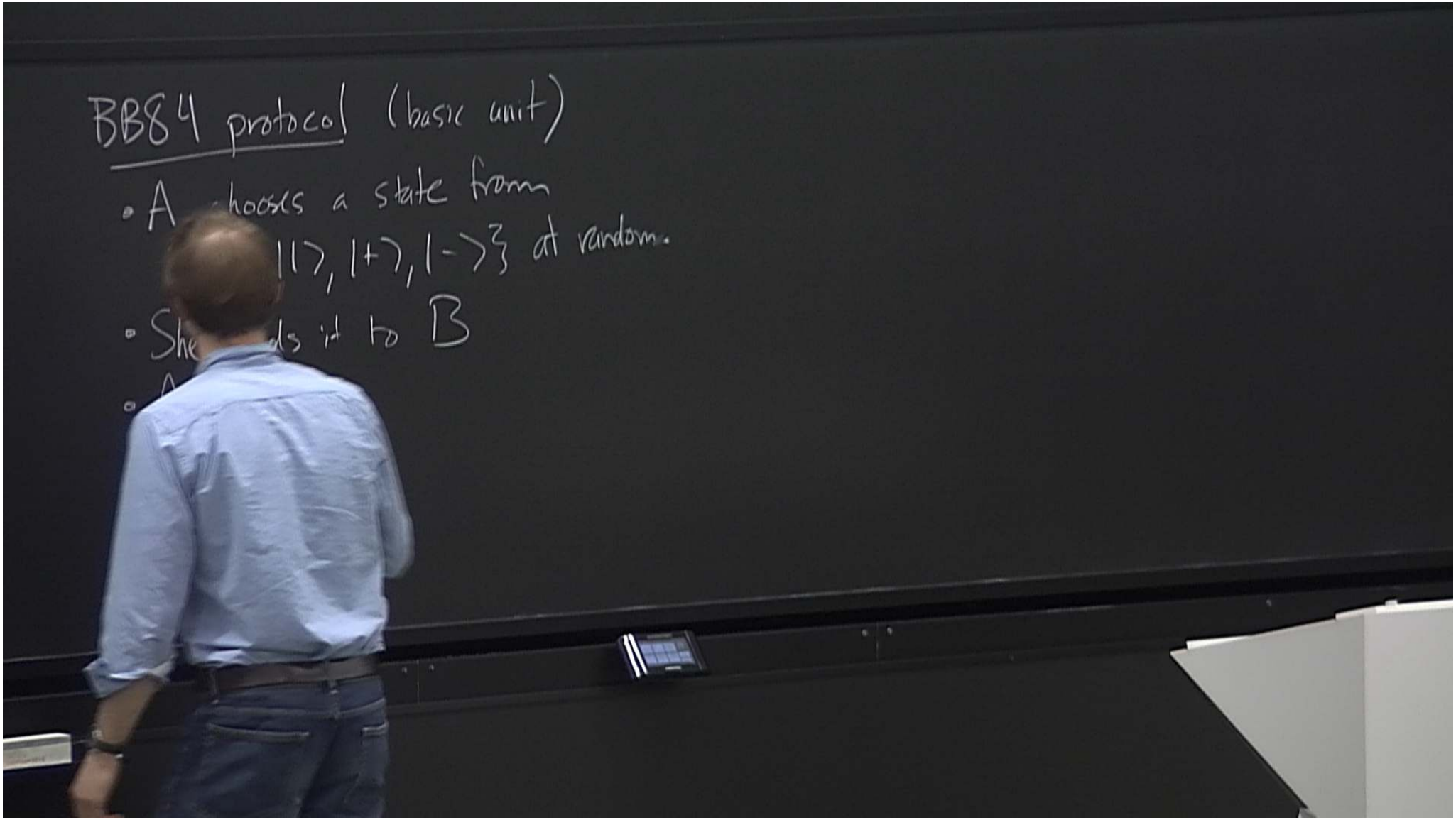
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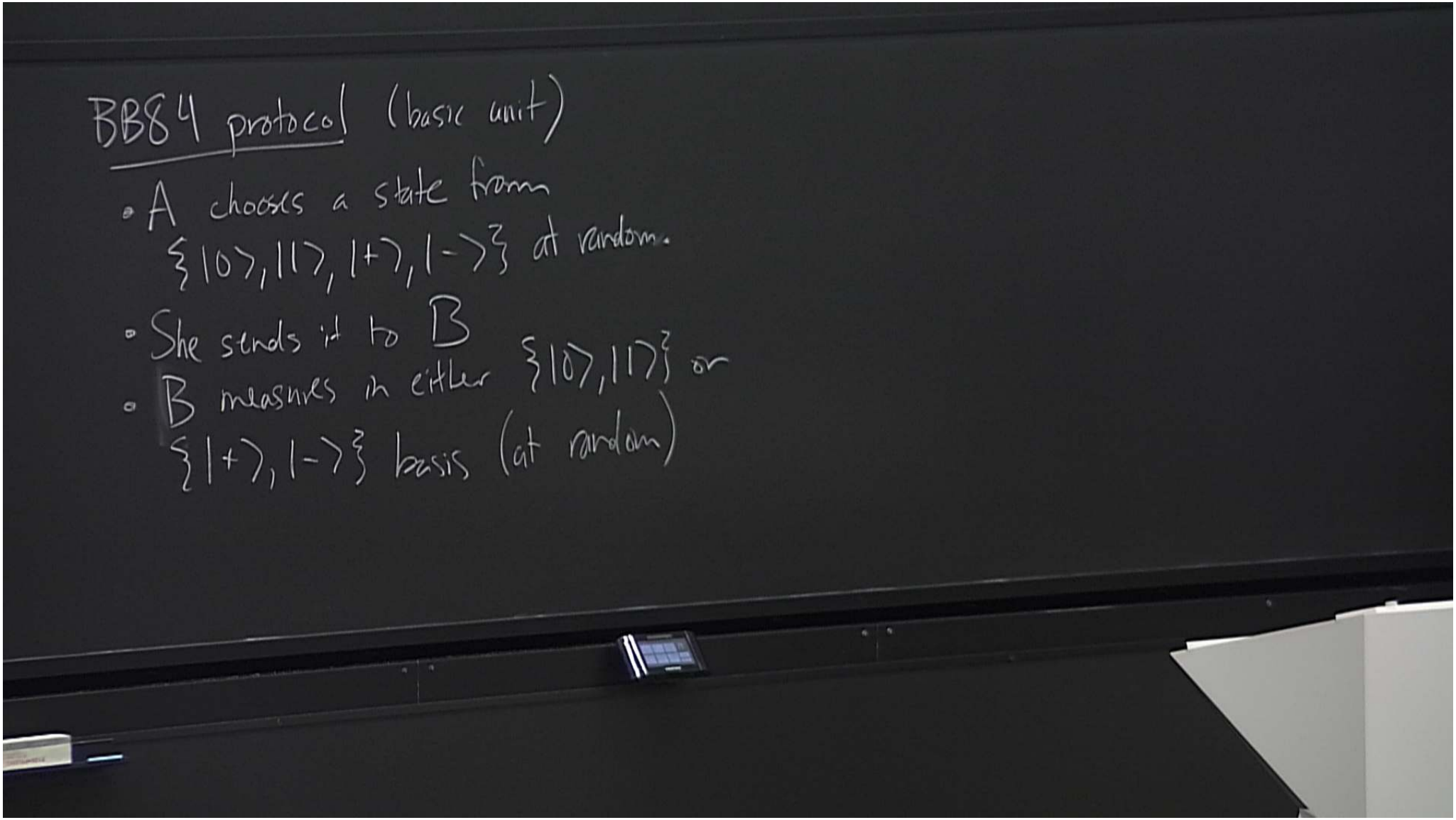
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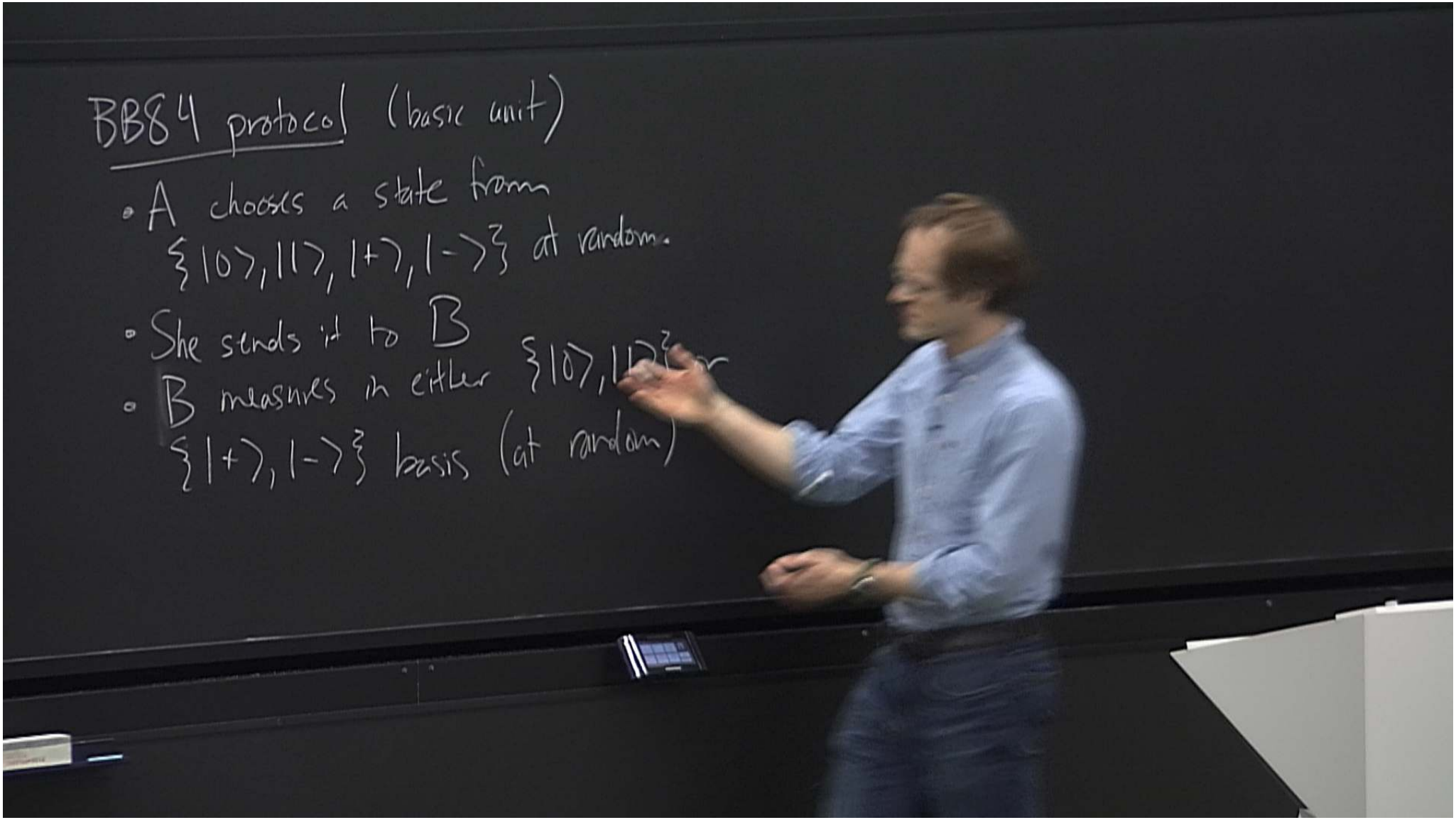
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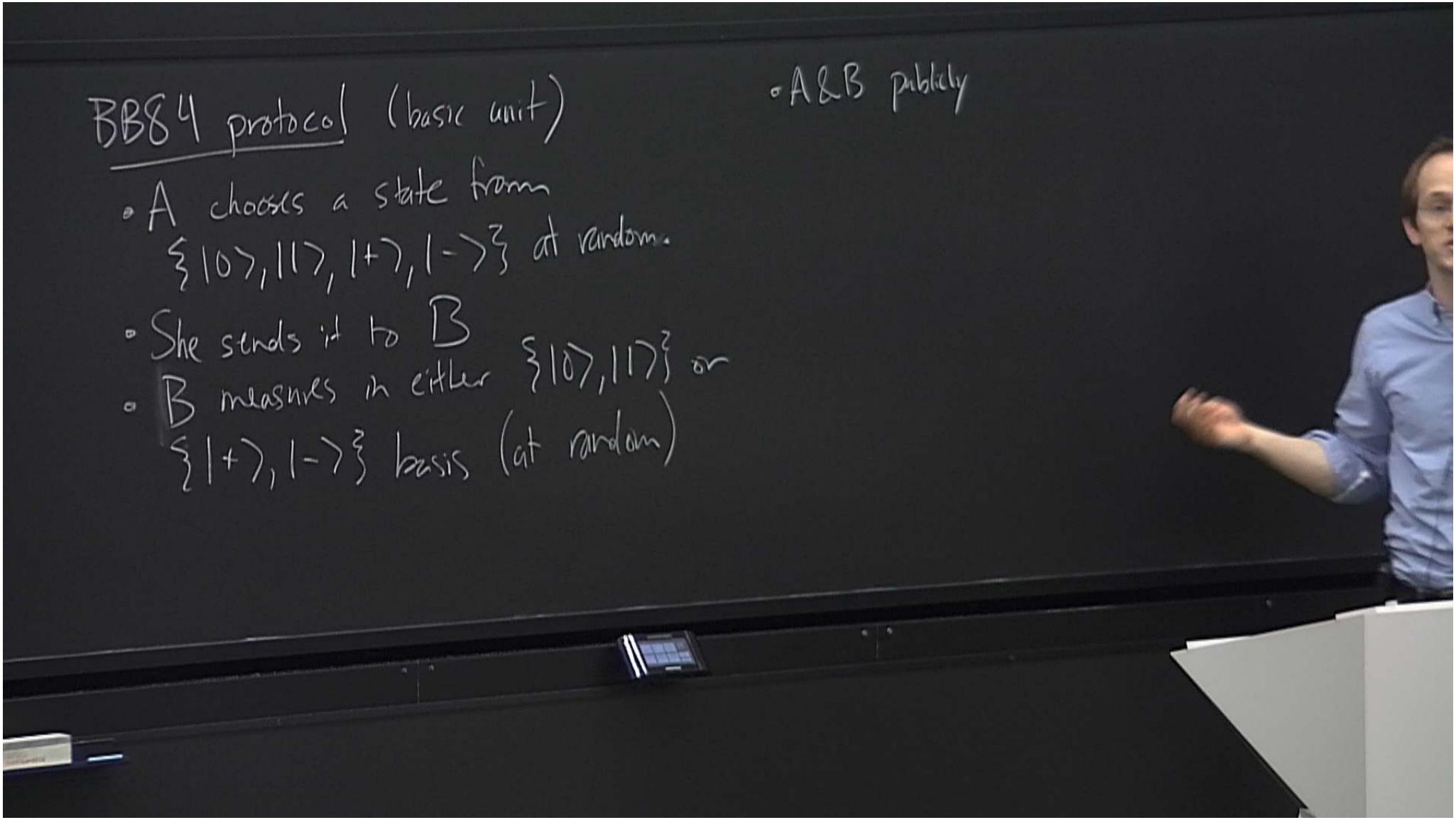
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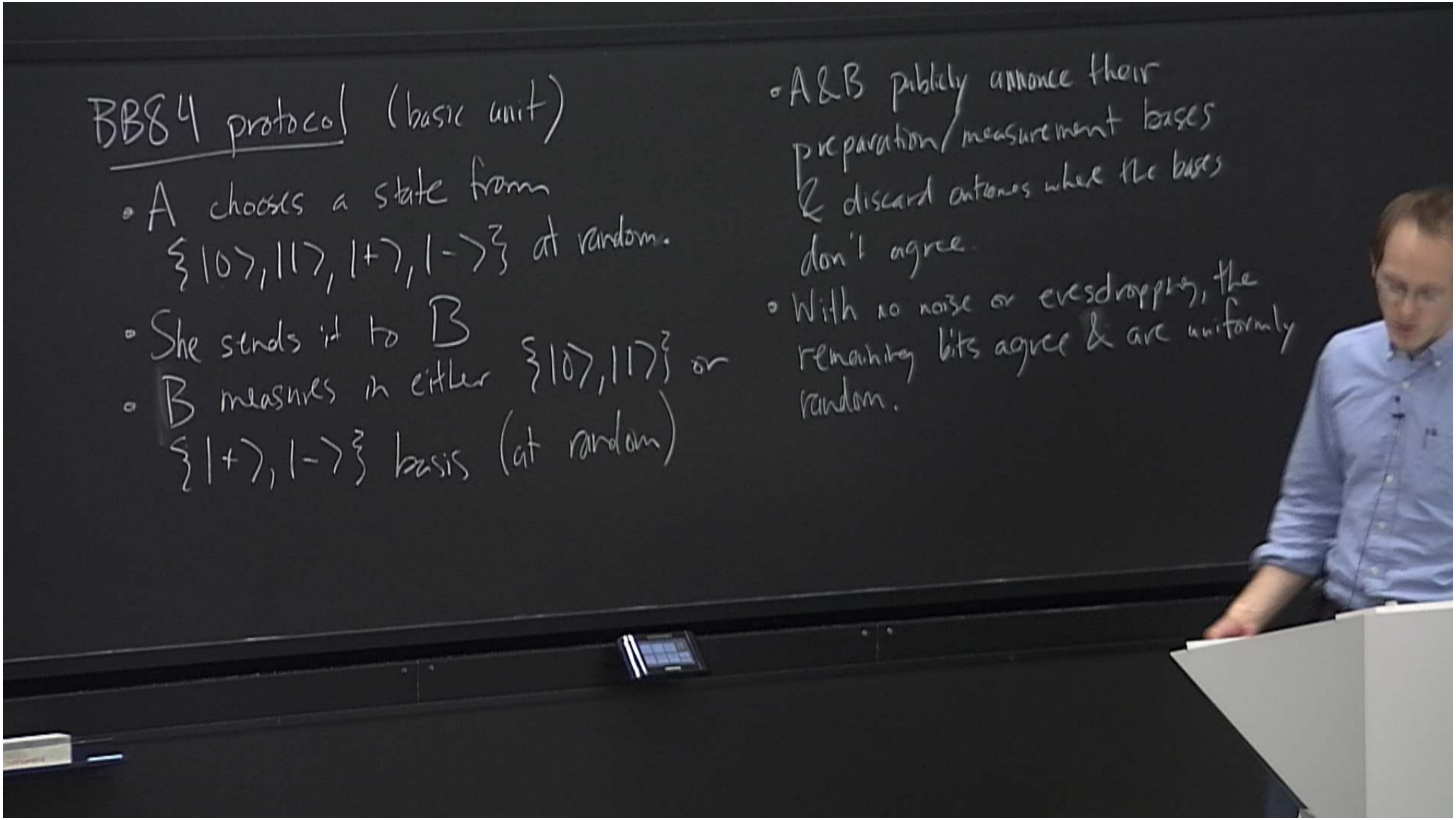
• A & B publicly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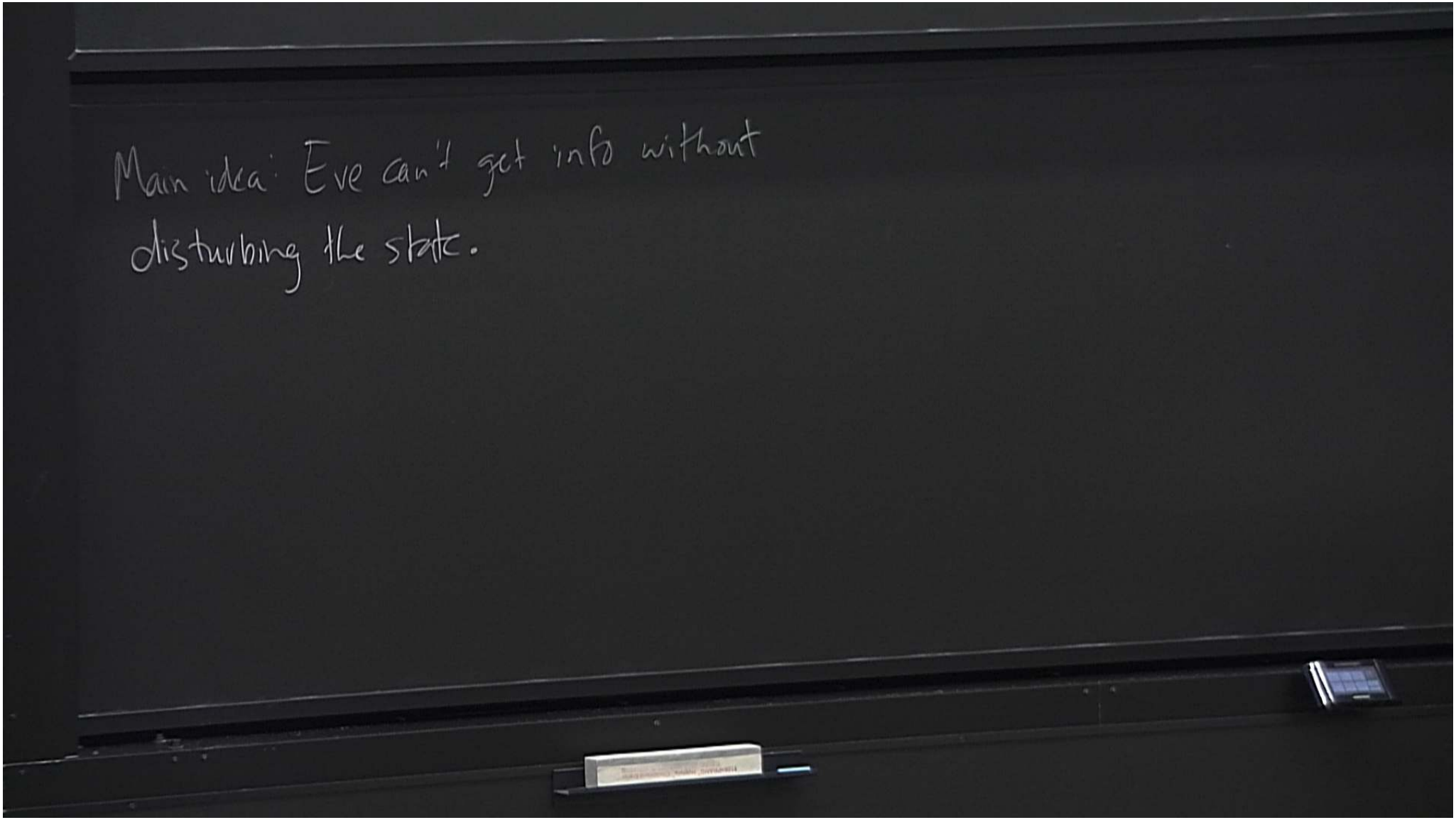
• B measures in either {|0>, |1>} or {|+>, |->} basis (at random)
• A&B publicly announce their preparation/measurement bases & discard outcomes where the bases don't agree.
• With no noise or eavesdropping, the remaining bits agree & are uniformly random.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E measures in a random basis

With some probability, she learns a bit of key.

With some (also fairly large) probability, A&B will get bits that should agree but don't.

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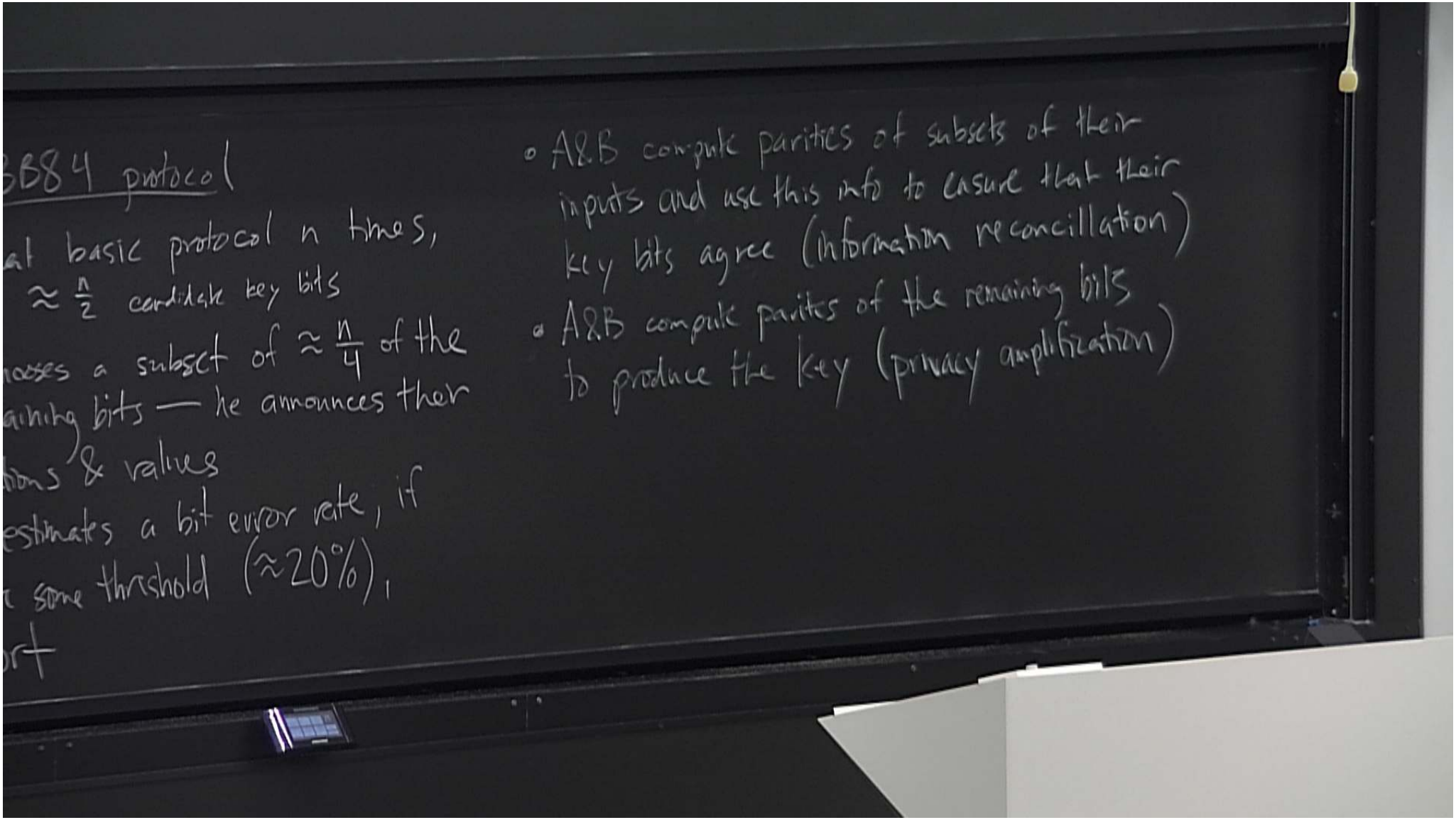
Full BB84 protocol

- Repeat basic protocol n times, get $\approx \frac{n}{2}$ candidate key bits
- A chooses a subset of $\approx \frac{n}{4}$ of the remaining bits — he announces their locations & values
- B estimates a bit error rate, if above some threshold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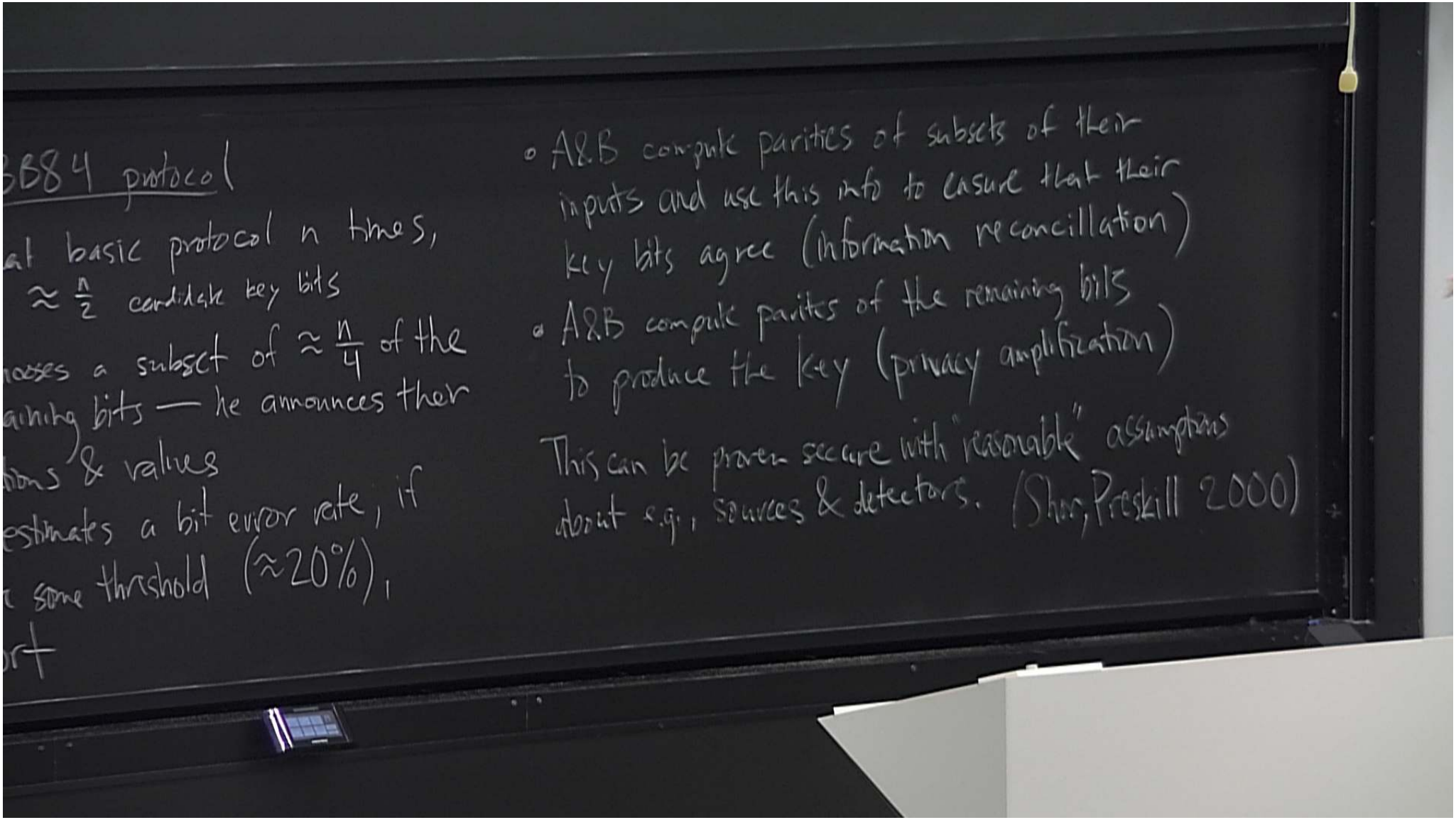
• A&B compute parities of subsets of their inputs and use this info to ensure that their key bits agree (information reconcillation)
• A&B compute parites of the remaining bits to produce the key (privacy amplification)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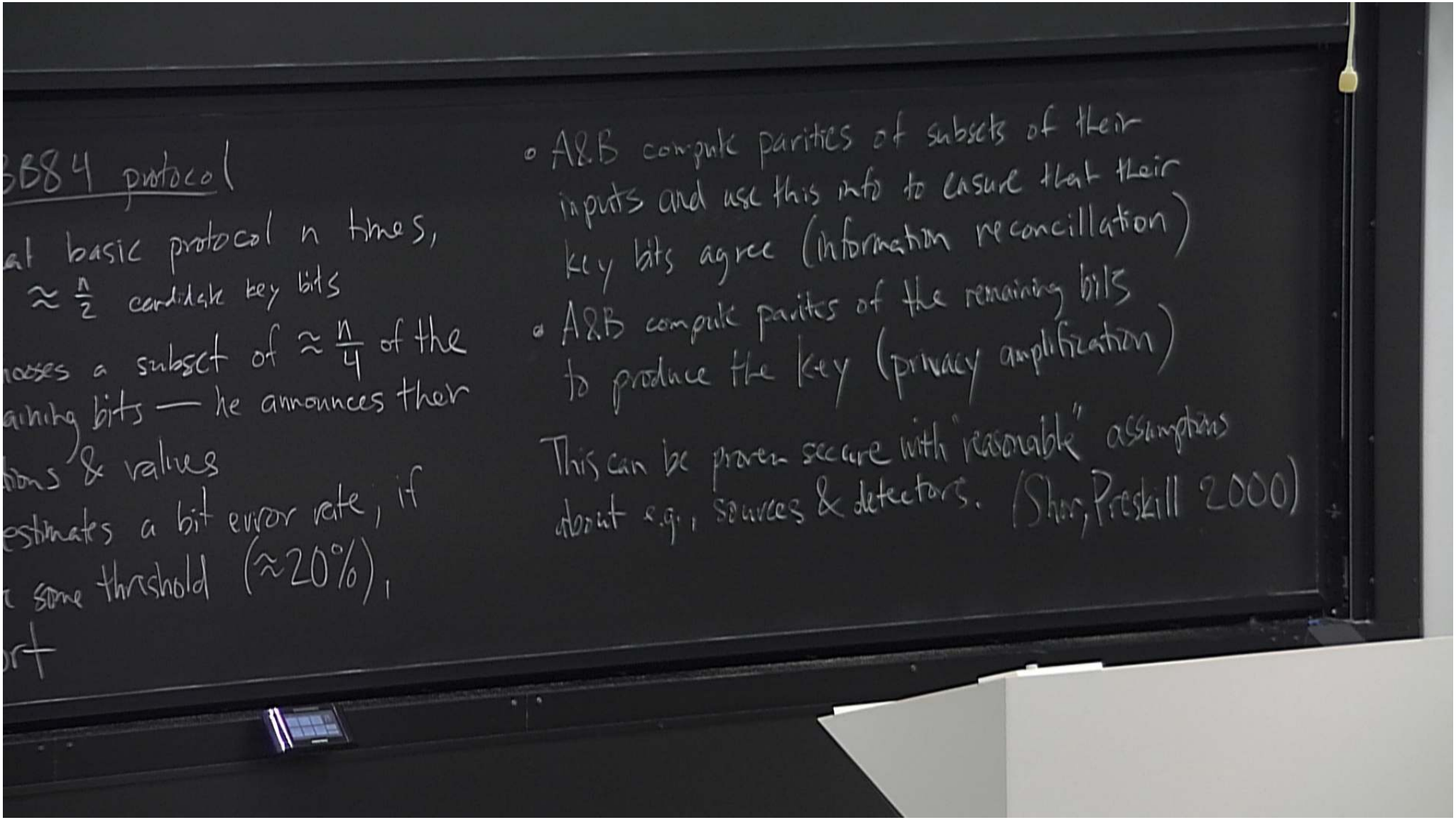
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