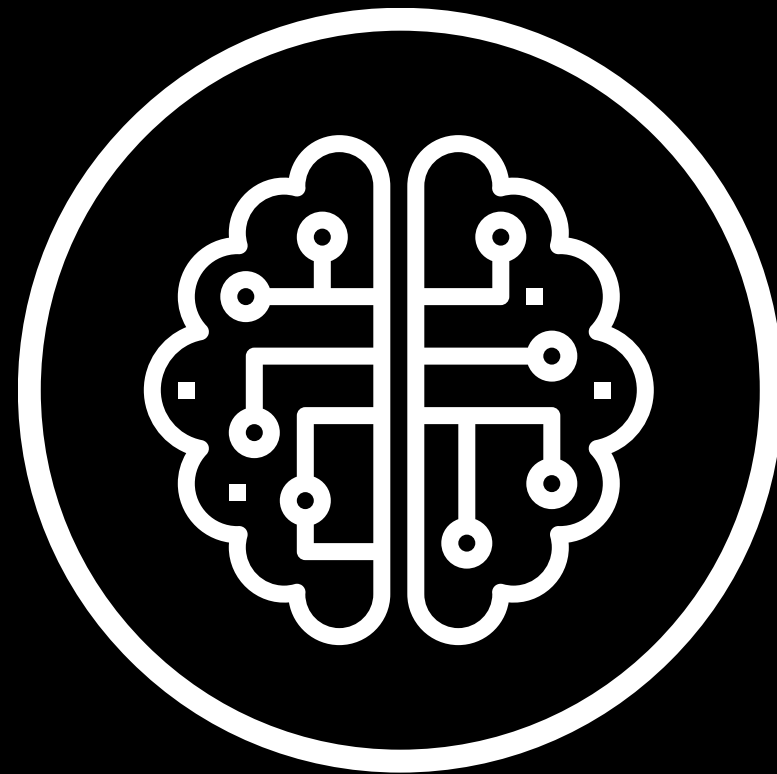
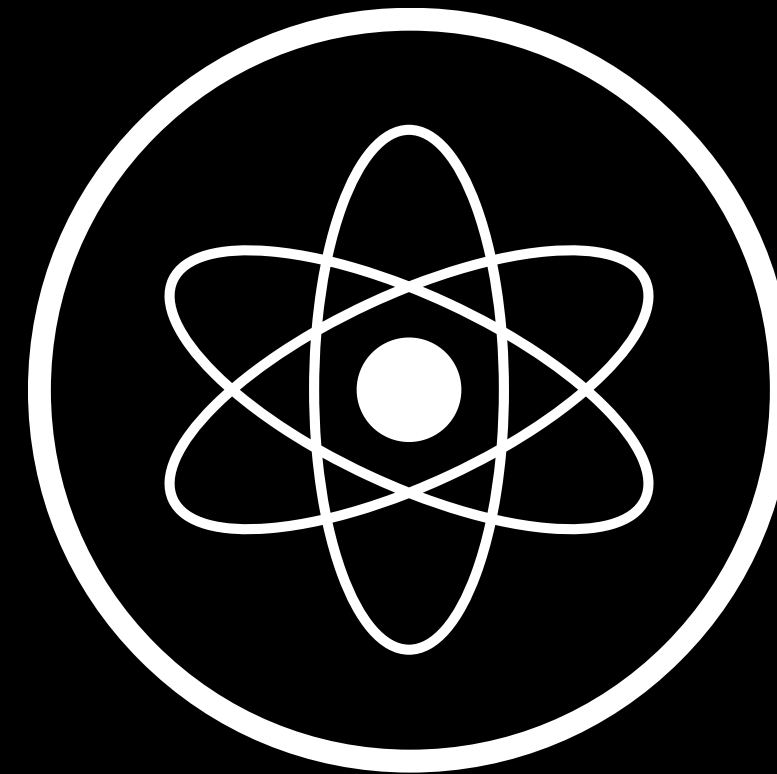


CAN QUANTUM COMPUTING IMPROVE THE EFFICIENCY OF THE PAYMENTS SYSTEM?

GOODLABS INTELLIGENCE ENGINEERING



Classic



Quantum

RESEARCH & ENGINEERING TEAM

QUANTUM



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DIRECTOR A.I. & EMERGING.
PHD, QUANTUM



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QUANTUM+A.I.
PHD, QUANTUM

FINANCE



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HEAD, LANGUAGE A.I.
POSTDOC, NLP



HASSAN MASOOD
CONVERSATION A.I.
PHD CANDIDATE, NLP



SAFIA KANWAL
LANGUAGE A.I. IN MOBILE
PHD, NLP

GENERATIVE & A.I. ENGINEERING



PETER BERRINGTON
DIRECTOR, A.I. ENGINEERING
BSC, COMPUTER SCIENCE



ALEX OSTROVSKY
A.I. ENGINEERING
BSC, COMPUTER SCIENCE

FRAUD



HUSSAIN JABER
DIRECTOR FRAUD &
FINANCIAL CRIME



HIEU NGO
REFORMED FRAUDSTER
ADVISOR

MEDICINE



CHRIS SMITH
DIRECTOR, MEDICAL A.I.
PHD, BIOMED PHYSICS

COLLABORATION PROJECT

IMPROVING THE EFFICIENCY OF PAYMENTS SYSTEMS USING QUANTUM COMPUTING*

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GoodLabs Studio, University of Waterloo

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GoodLabs Studio

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Bank of Canada

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Bank of Canada

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GoodLabs Studio, University of Waterloo

Thomas Lo
GoodLabs Studio

Danica Marsden
Bank of Canada

Vladimir Skavysh
Bank of Canada

arxiv.org/abs/2209.15392

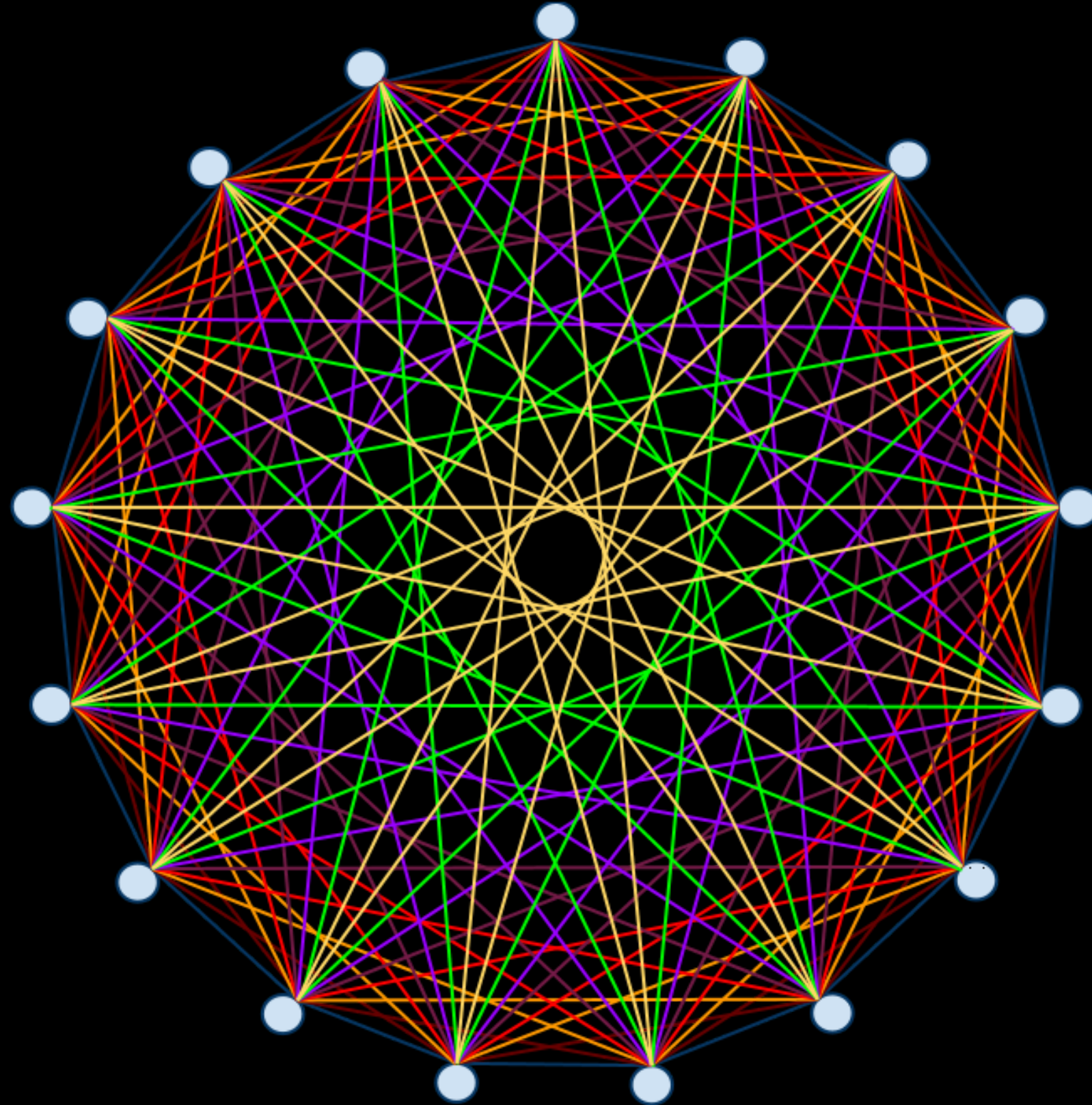


THE CHALLENGE

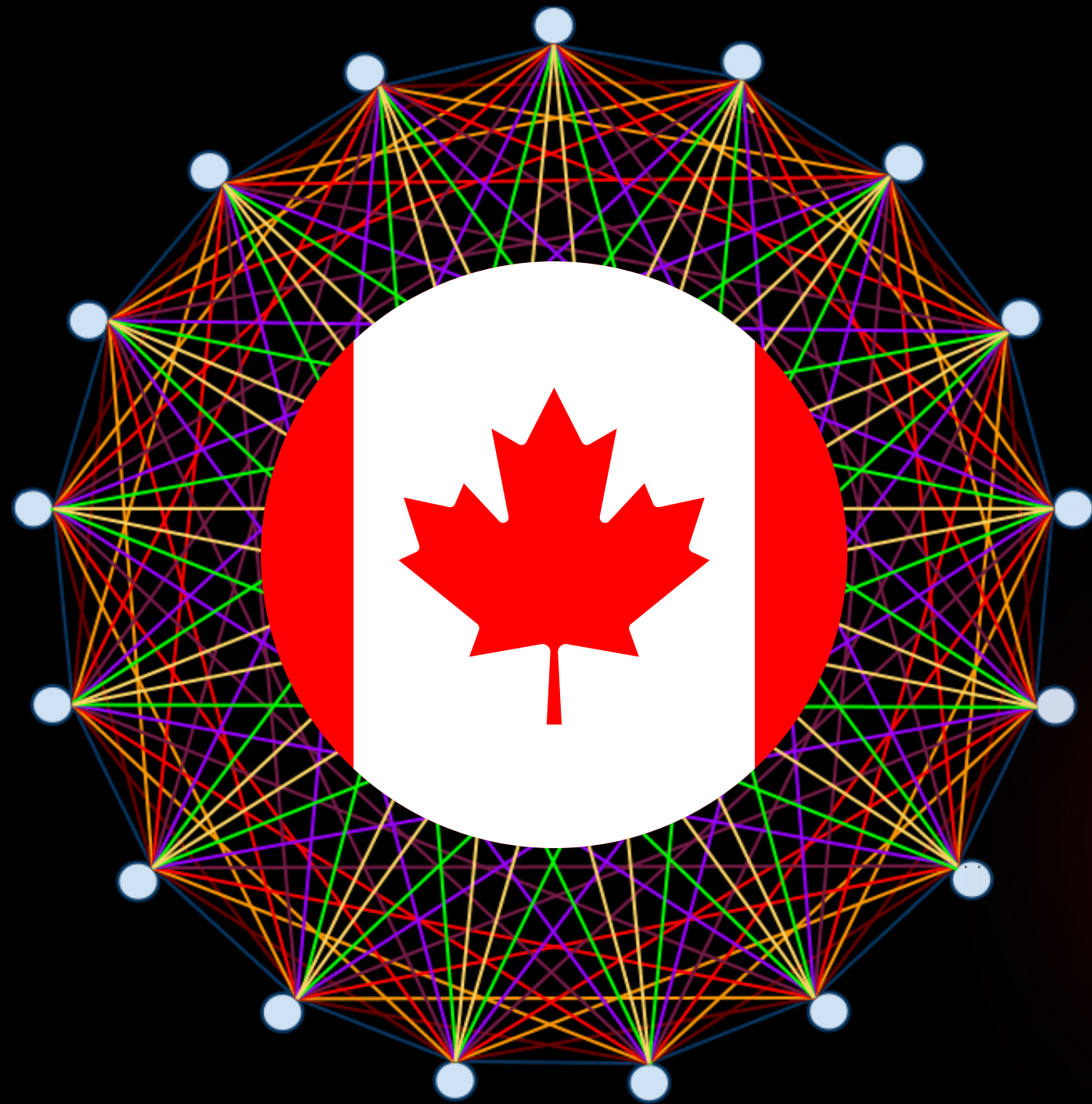
HIGH VALUE PAYMENT SYSTEMS

	Deferred Net Settlement	Realtime Gross Settlement
RISK		
EFFICIENCY		

COMPLEX PAYMENTS NETWORK



PAYMENTS CANADA LYNX



17

Financial
Institutions

50K

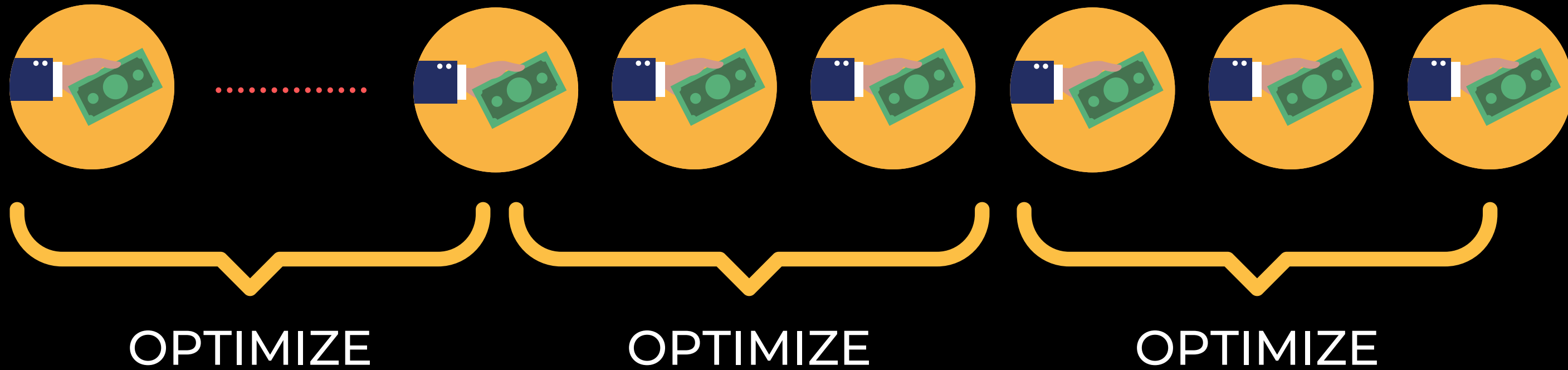
Daily
Payment
Requests

\$500B

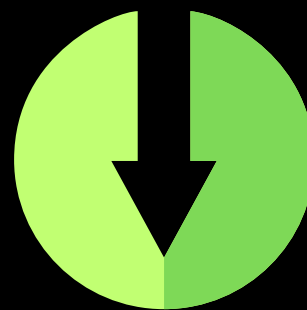
Daily
Dollar Volume

OUR SOLUTION

A PAYMENT PREPROCESSOR

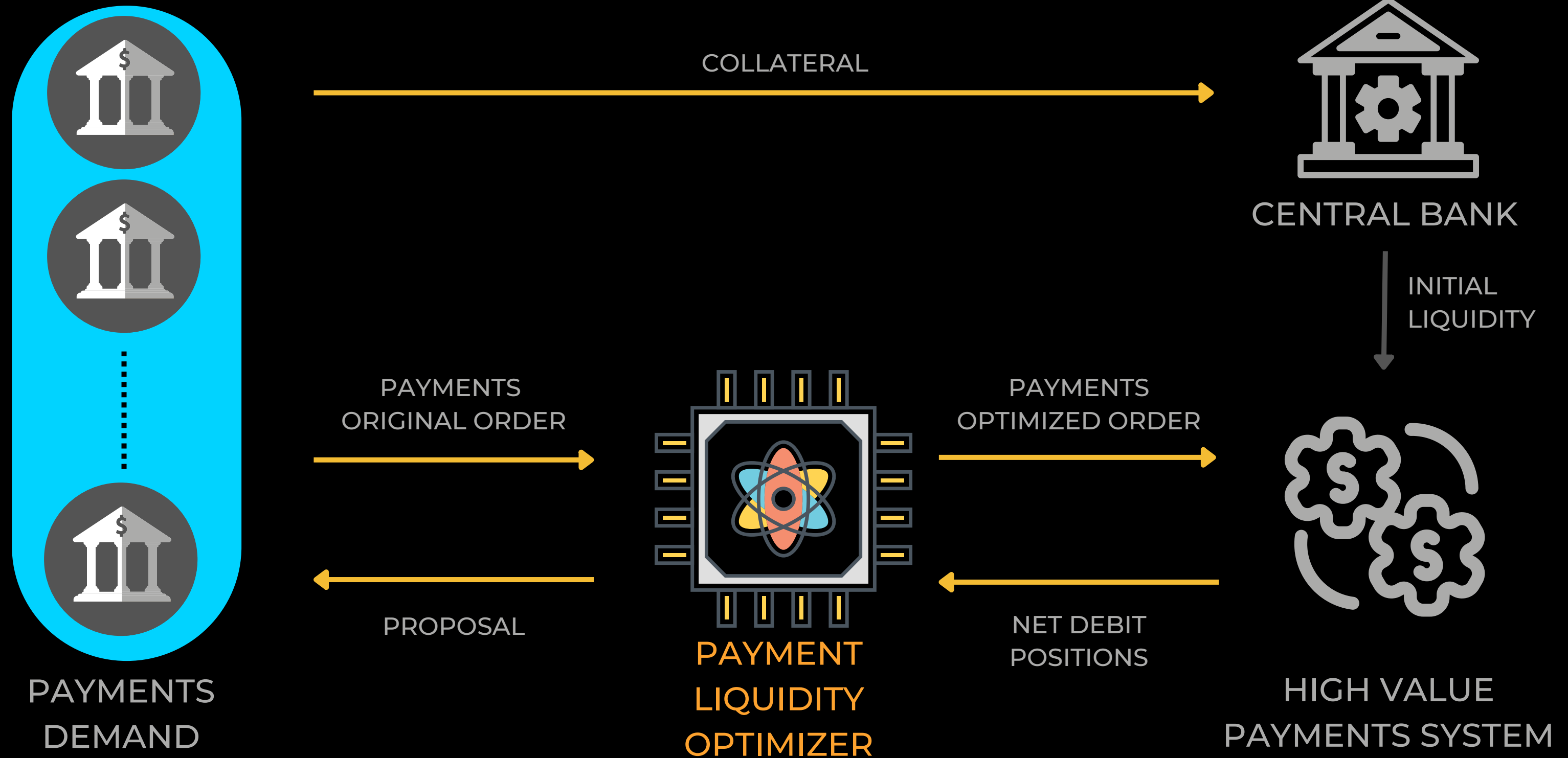


SETTLEMENT
RISK

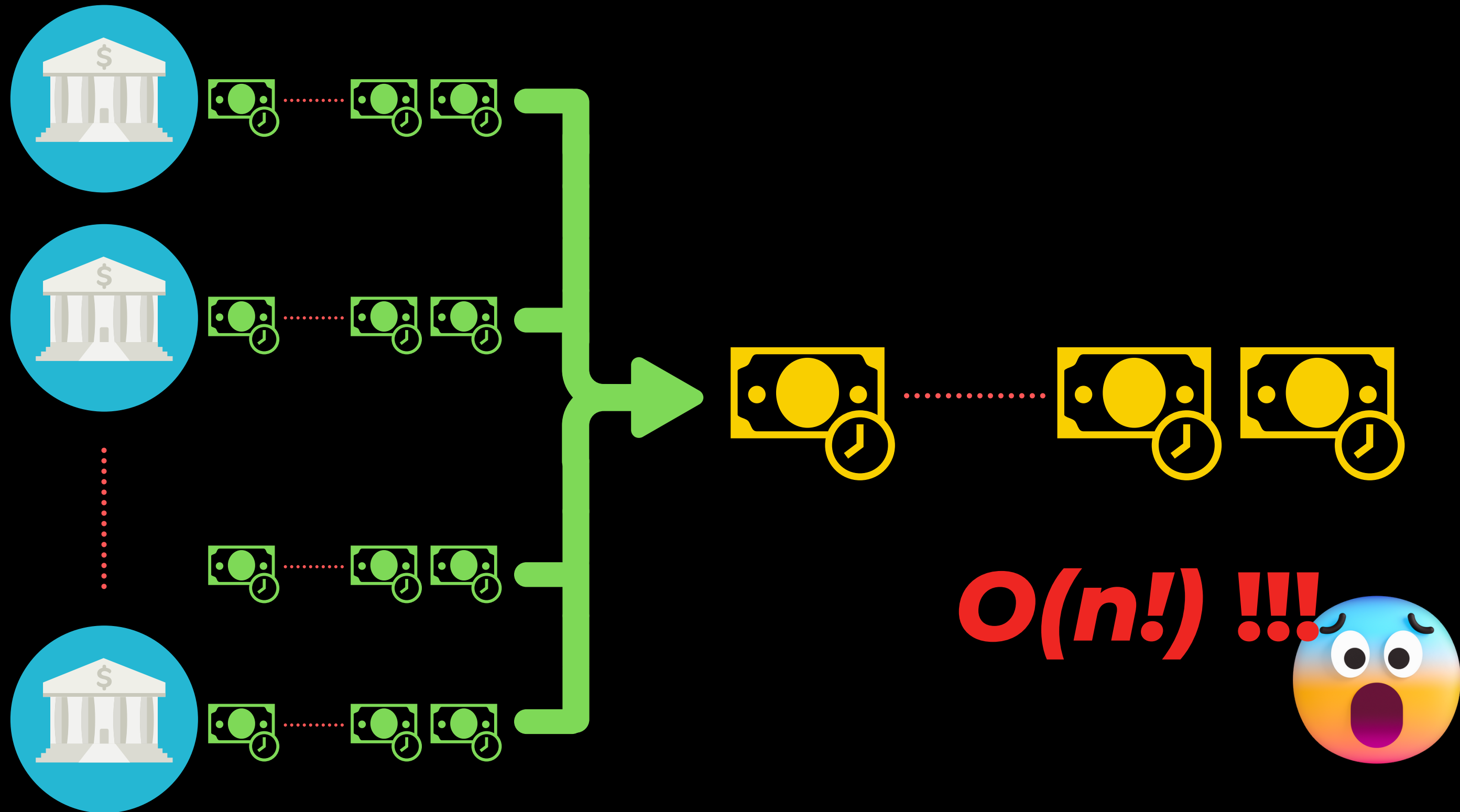


LIQUIDITY
INEFFICIENCY

A PAYMENT PREPROCESSOR

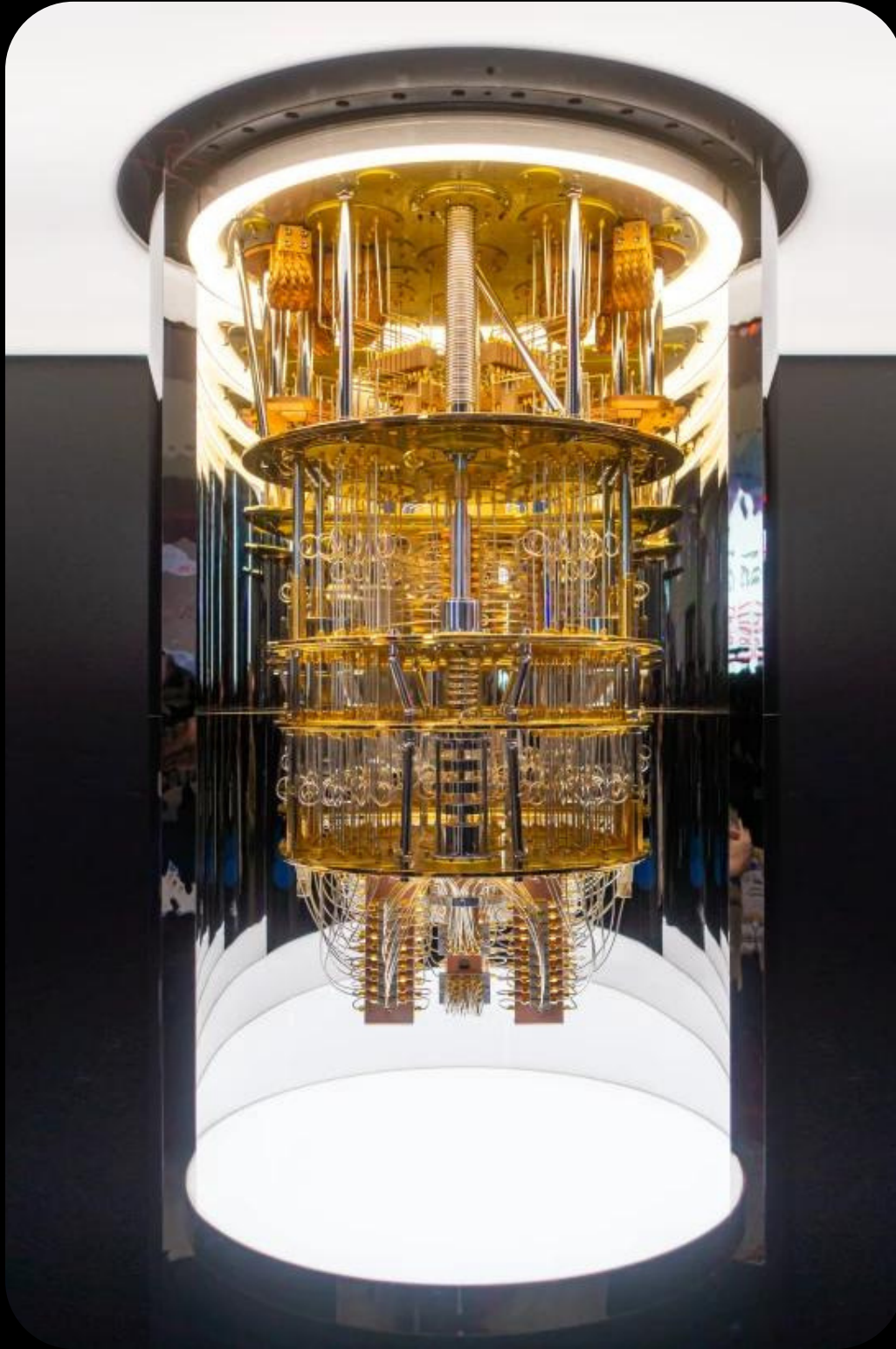


A PAYMENT PREPROCESSOR

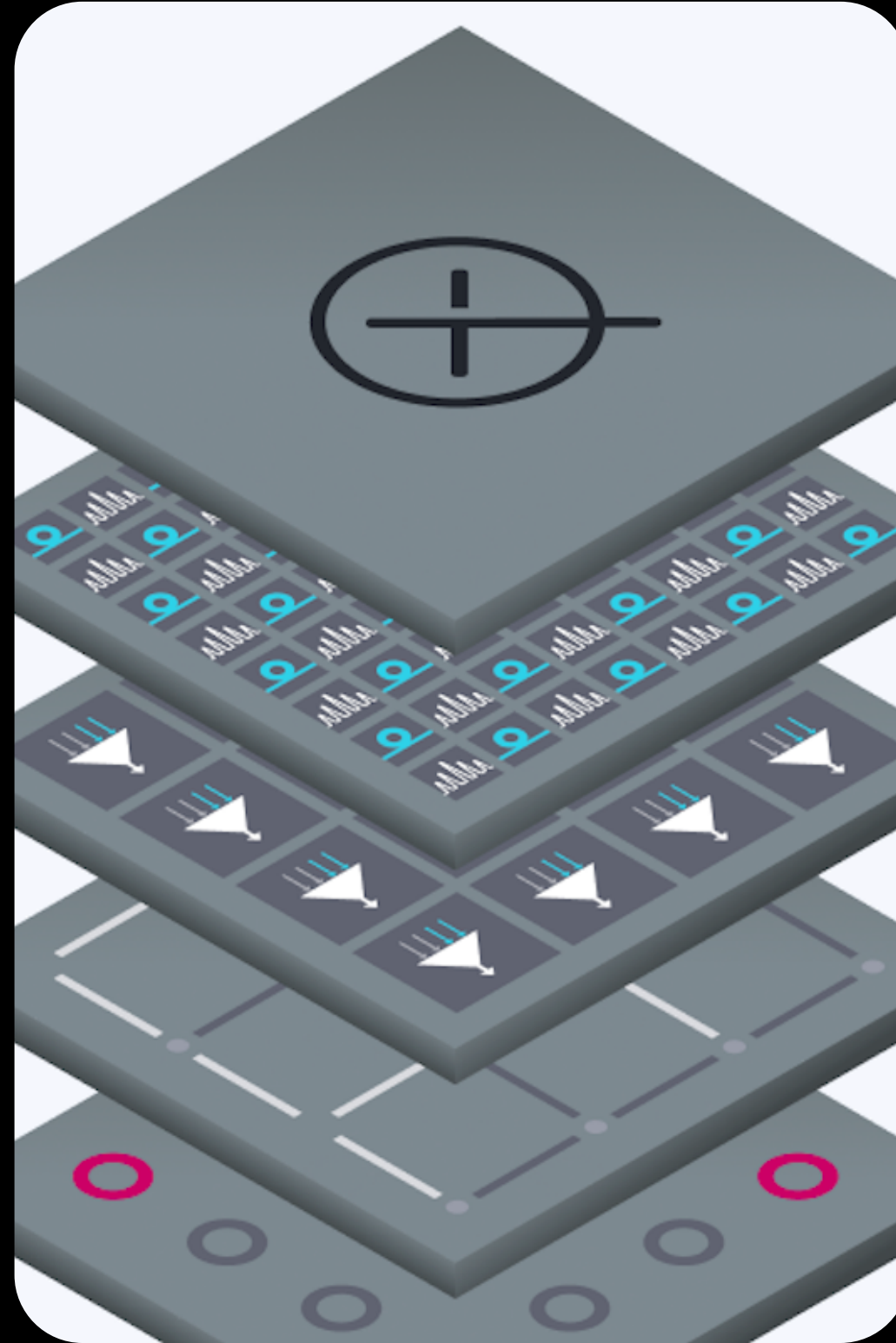


QUANTUM COMPUTING

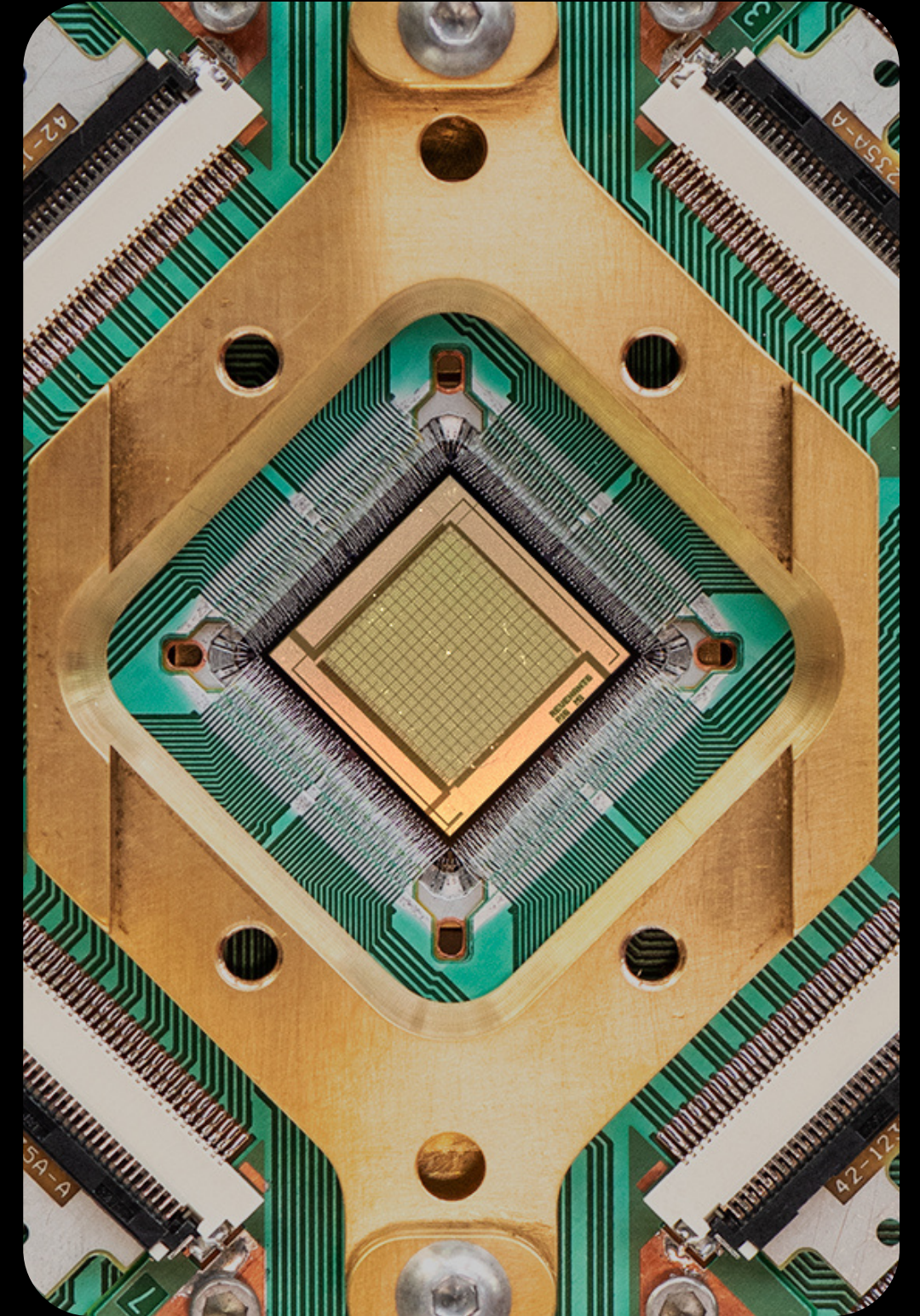
QUANTUM COMPUTING



IBM/Google



Xanadu

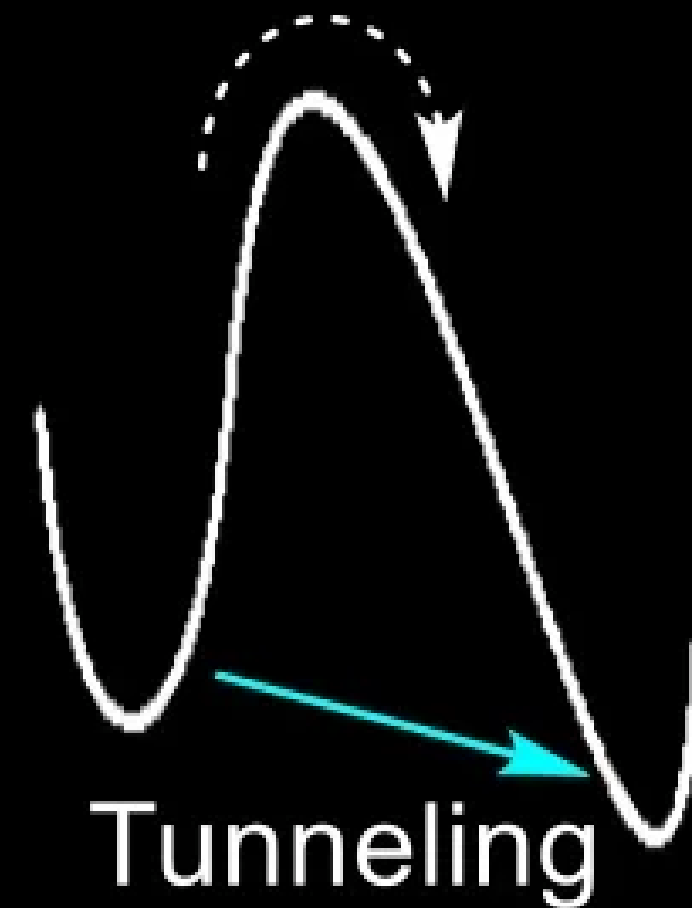


D-Wave

QUANTUM ANNEALING

- VERY SPECIALIZED HARDWARE
- CAN ONLY SOLVE DISCRETE OPTIMIZATIONS
- MAPS THE PROBLEM ONTO A PHYSICAL SYSTEM AND THEN “ANNEALS” TO FIND GROUND STATE
- TAKES ADVANTAGE OF QUANTUM EFFECTS TO OUTPERFORM CLASSICAL

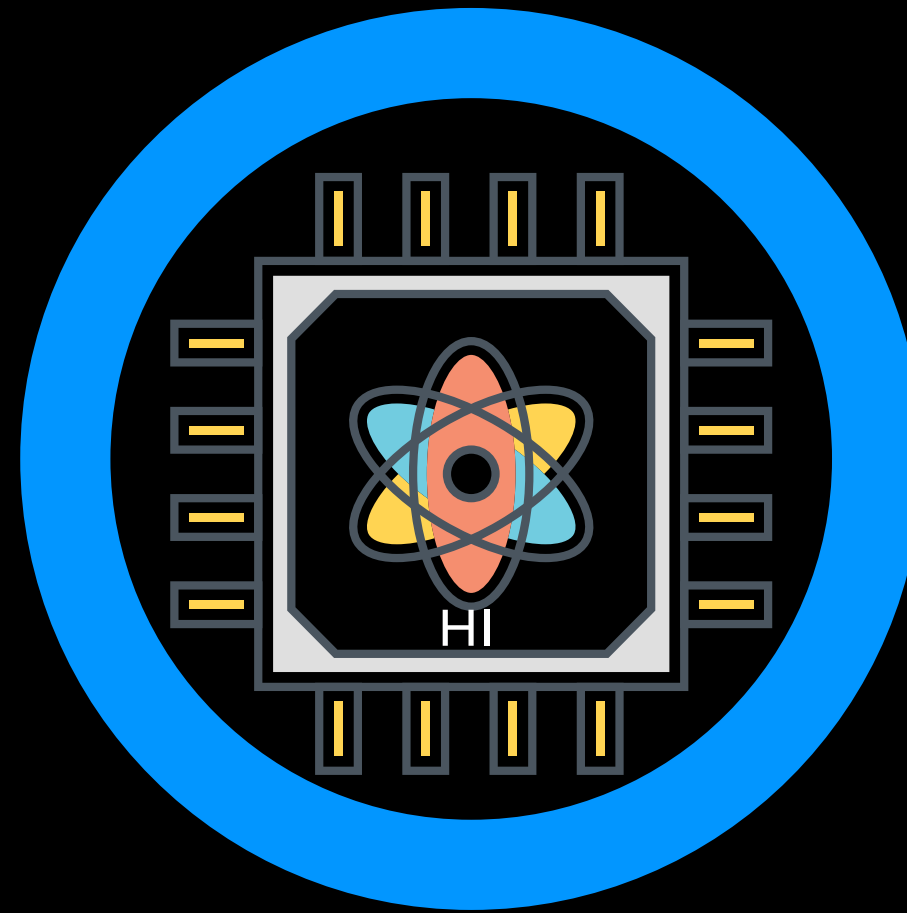
Classical Path



D-WAVE QUANTUM ANNEALER



Constrained
Quadratic Model
Solver (CQM)



5,000 Qubits
1,000,000 Variables
100,000 Constraints



700
Maximum
Payment Requests

OBJECTIVE FUNCTION

Initial
Liquidity

Optimize Liquidity
Utilization

$$H = \sum_{\alpha} b_{\alpha} + \sum_{\alpha, t} \lambda_1 \left(b_{\alpha} + N_{\alpha} + \text{mNDP}_{\alpha} + \sum_{\tau \leq t} \sum_i f(\alpha, i) \cdot x_{i, \tau} - s_{\alpha}(t) \right)^2$$
$$+ \sum_i \lambda_2 \left(1 - \sum_t x_{i, t} \right)^2 + \sum_t \lambda_2 \left(1 - \sum_i x_{i, t} \right)^2$$

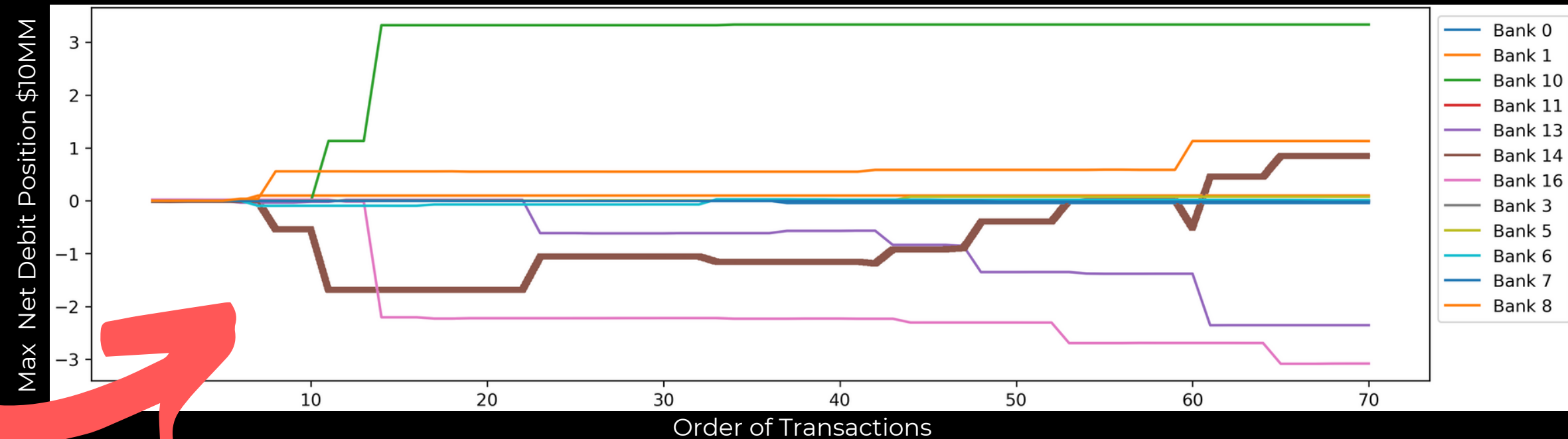
Each Payment
Settled Only Once

RESULTS

REORDERING SAVES \$MM

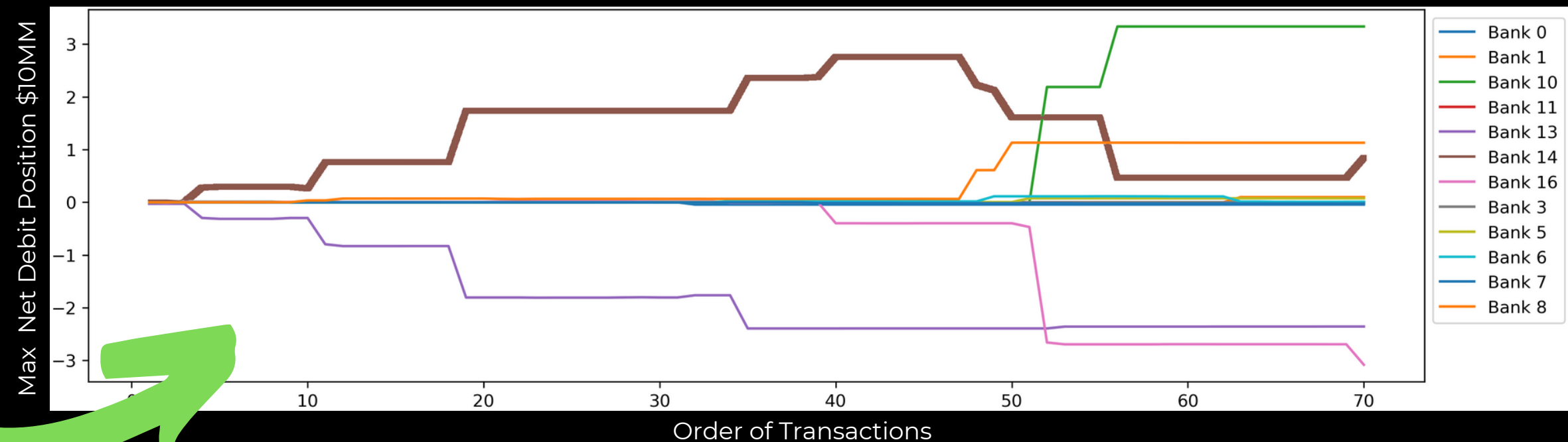
Original Queue - \$73M

More banks
with negative
balances



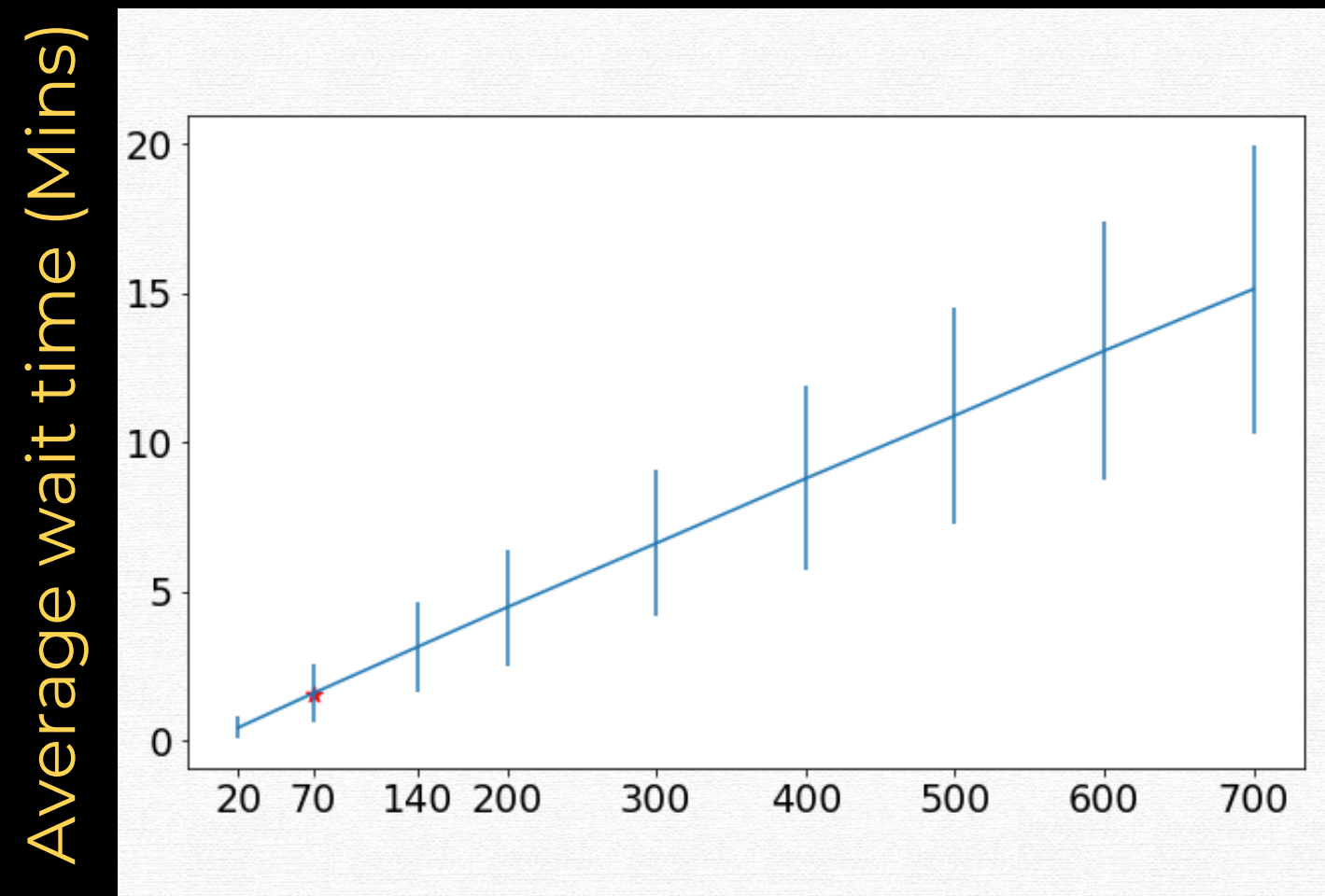
Quantum Queue - \$55M

Less banks
with negative
balances

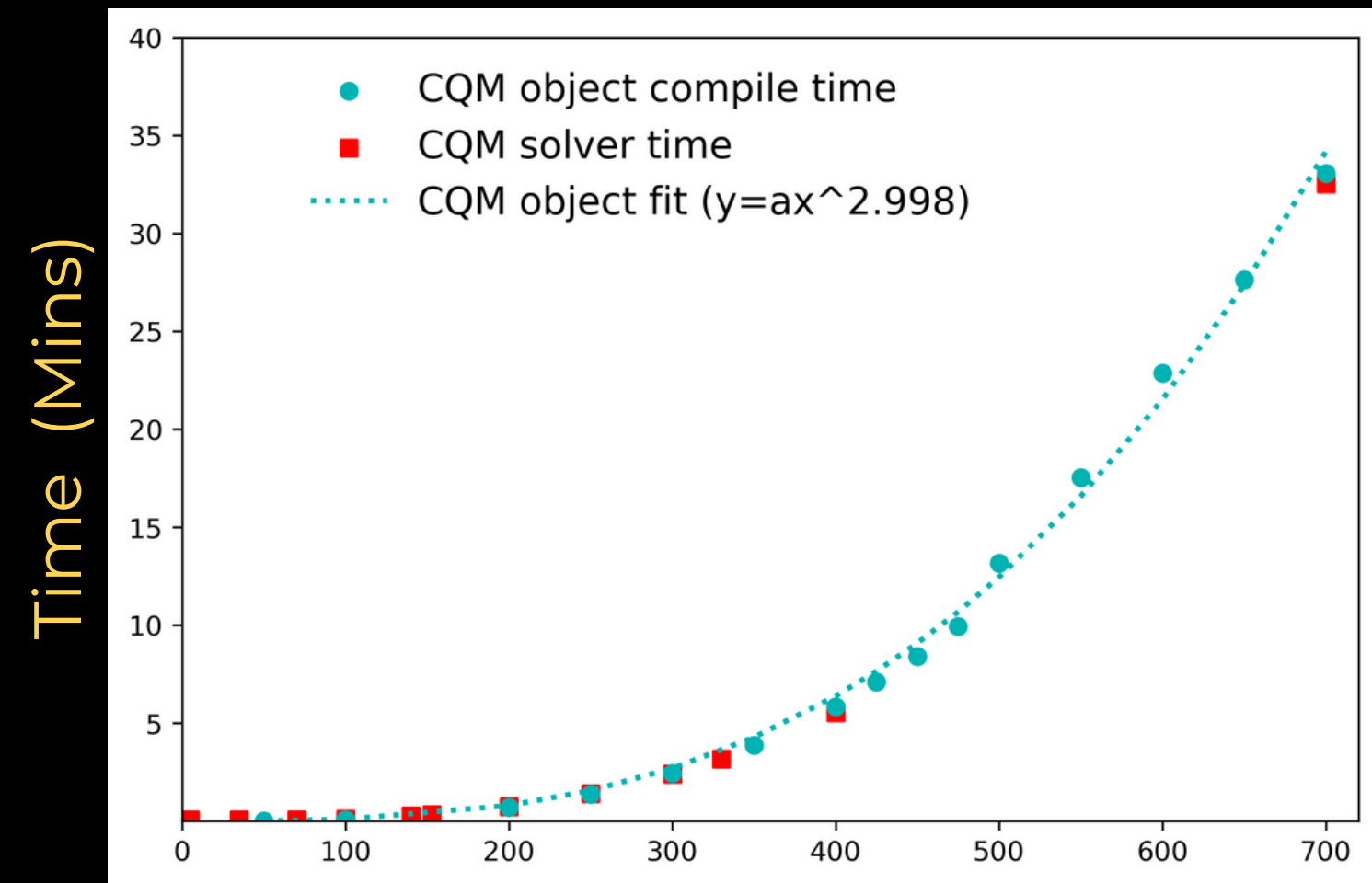


REAL-TIME CONSIDERATIONS

Collection Time



Compile and Solve Time

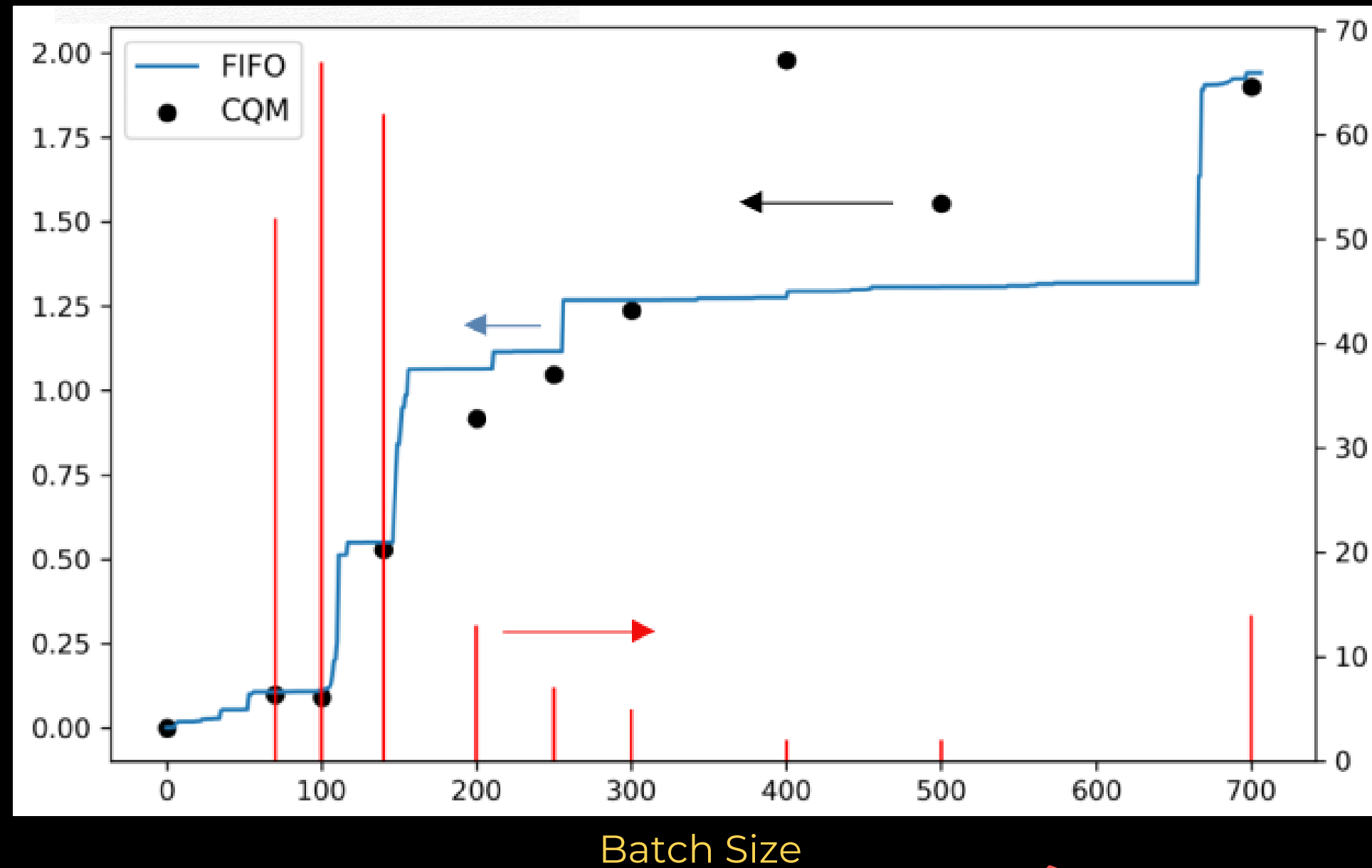


HOW BIG CAN QUANTUM GO?

More feasible
solutions
More liquidity
savings

\$ Billions

Aggregated
Maximum
Net Debit
Position



Number
of Feasible
Solutions

Less feasible
solutions
Less liquidity
savings

POWER OF QUANTUM

PROBLEM
SIZE

$$140 = 10^{240}$$

PAYMENTS BATCH SIZE NUMBER OF PERMUTATIONS

EXECUTION
TIME

$$16s \geq 2HR$$

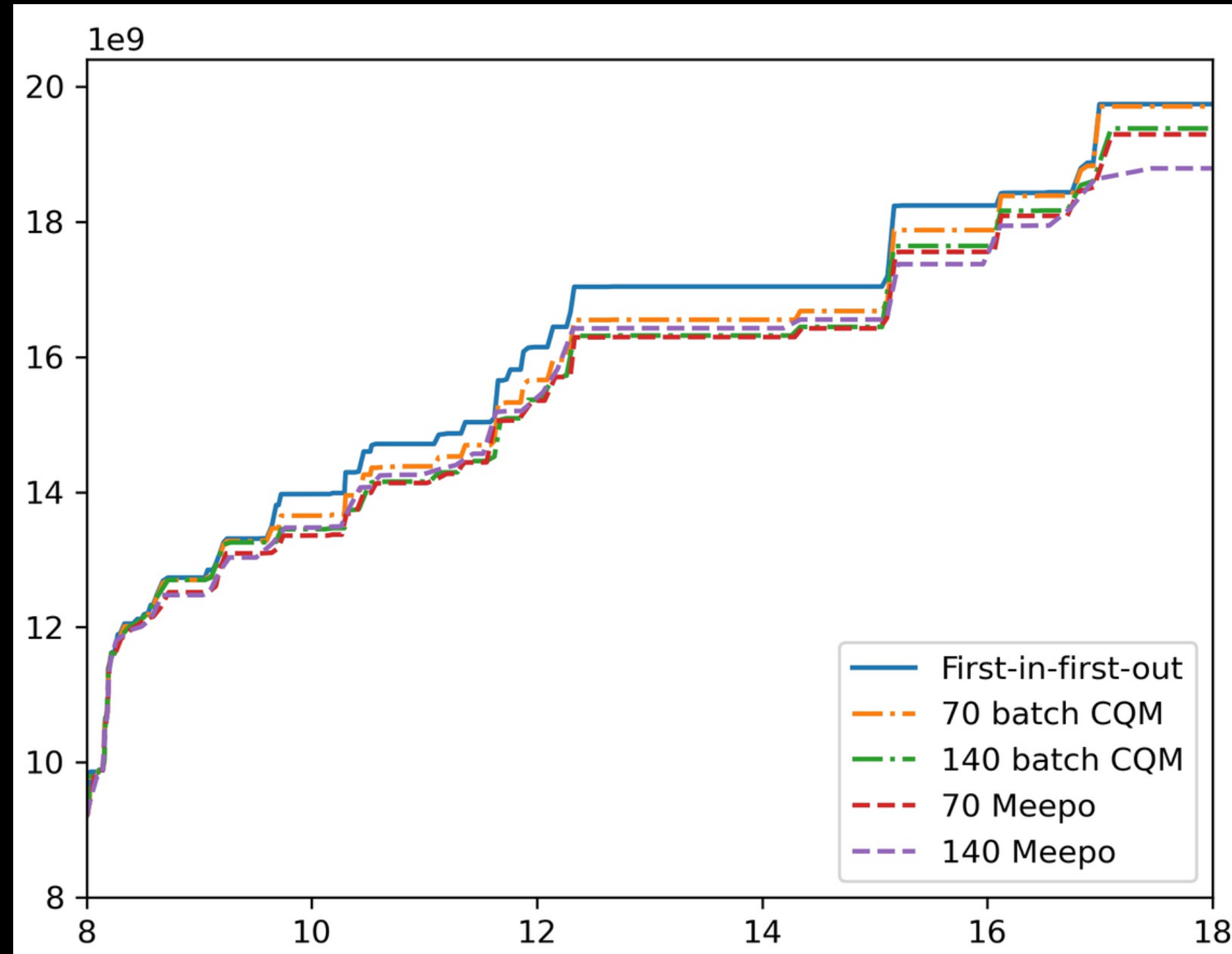
QUANTUM VS CLASSICAL

QUANTUM SAVINGS BY BILLION

*Meepo has a classical pre-processing algorithm to enhance the efficiency of the quantum algorithm

\$ Billions

Aggregated
Maximum
Net Debit
Position



FIFO

\$19.740 billion

Quantum 70

\$19.707 billion

Quantum 140

\$19.347 billion

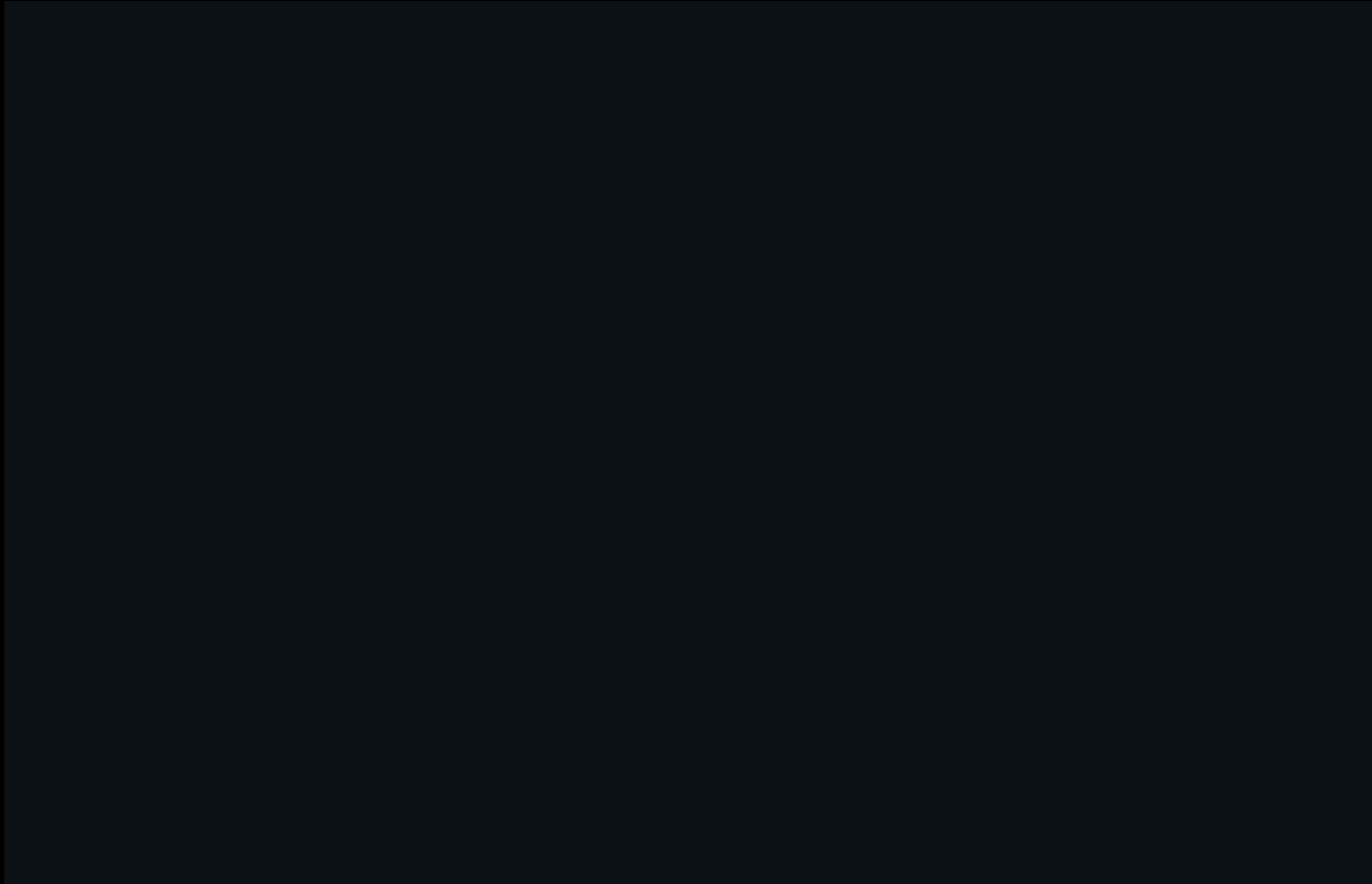
*Meepo 70

\$19.294 billion

*Meepo 140

\$18.793 billion

CLASSIC ALGO HORSERACE



DAILY SAVINGS RESULTS

	Avg Daily Liquidity Savings	Max Daily Liquidity Savings
Quantum 70	1.4% (\$239M)	\$1.26B
Meepo 70	2.0% (\$332M)	\$1.07B
Sliding Bucket	2.3% (\$387M)	\$1.19B
Meepo 140	3.0% (\$506M)	\$1.56B

WHAT WE HAVE ACHIEVED

- Reduce liquidity usage >\$500M daily while minimizing settlement risk
- Runs in real-time
- Quantum annealing can provide *real* value today!
- Payment reordering method can provide significant liquidity reductions

WHAT'S NEXT?

- Perform trial of quantum-powered optimization algo with live production data from an RTGS
- Optimize our hybrid algorithm to make better use of quantum advantages
- Apply our strategy to "single agent" problems
- Create AI models to predict future payments and handle edge-cases

QUESTIONS & ANSWERS

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A Presentation Crafted by GoodLabs Studio

GoodLabs was founded by serial tech entrepreneurs with a singular belief:
Business first software engineering delivers exceptional digital experience.

GoodLabs Studio is an advanced software innovation studio specialized in creating best-of-breed digital products and services. Our teams of passionate product designers, architects, and software engineers bring strong domain and technical expertise to walk alongside on your digital journey.

Visit us at <https://www.goodlabs.studio>
or email us at hello@goodlabs.studio