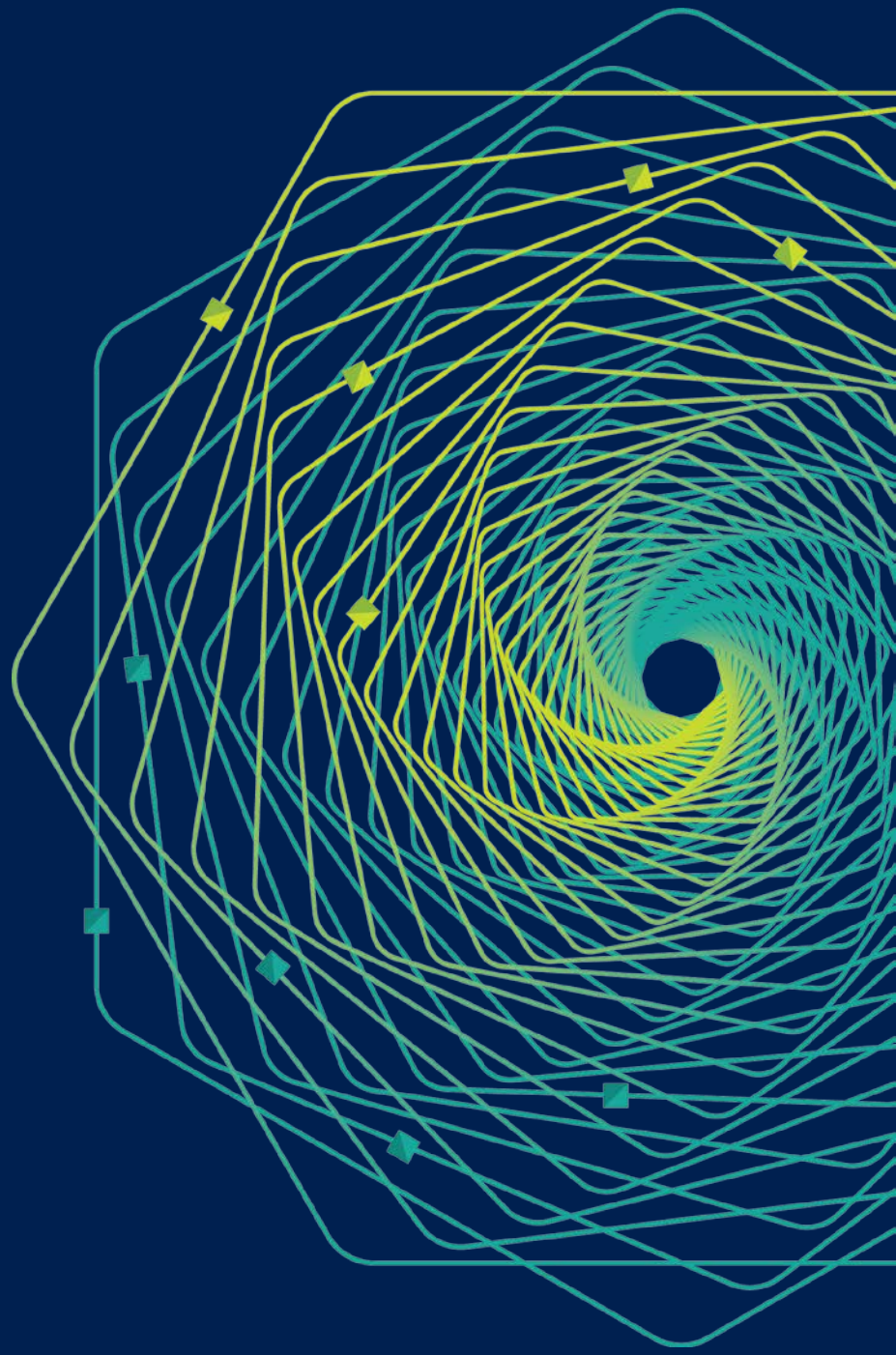
Microsoft

Research Faculty Summit 2018

Systems | Fueling future disruptions



Microsoft

The Rise of Confidential Computing

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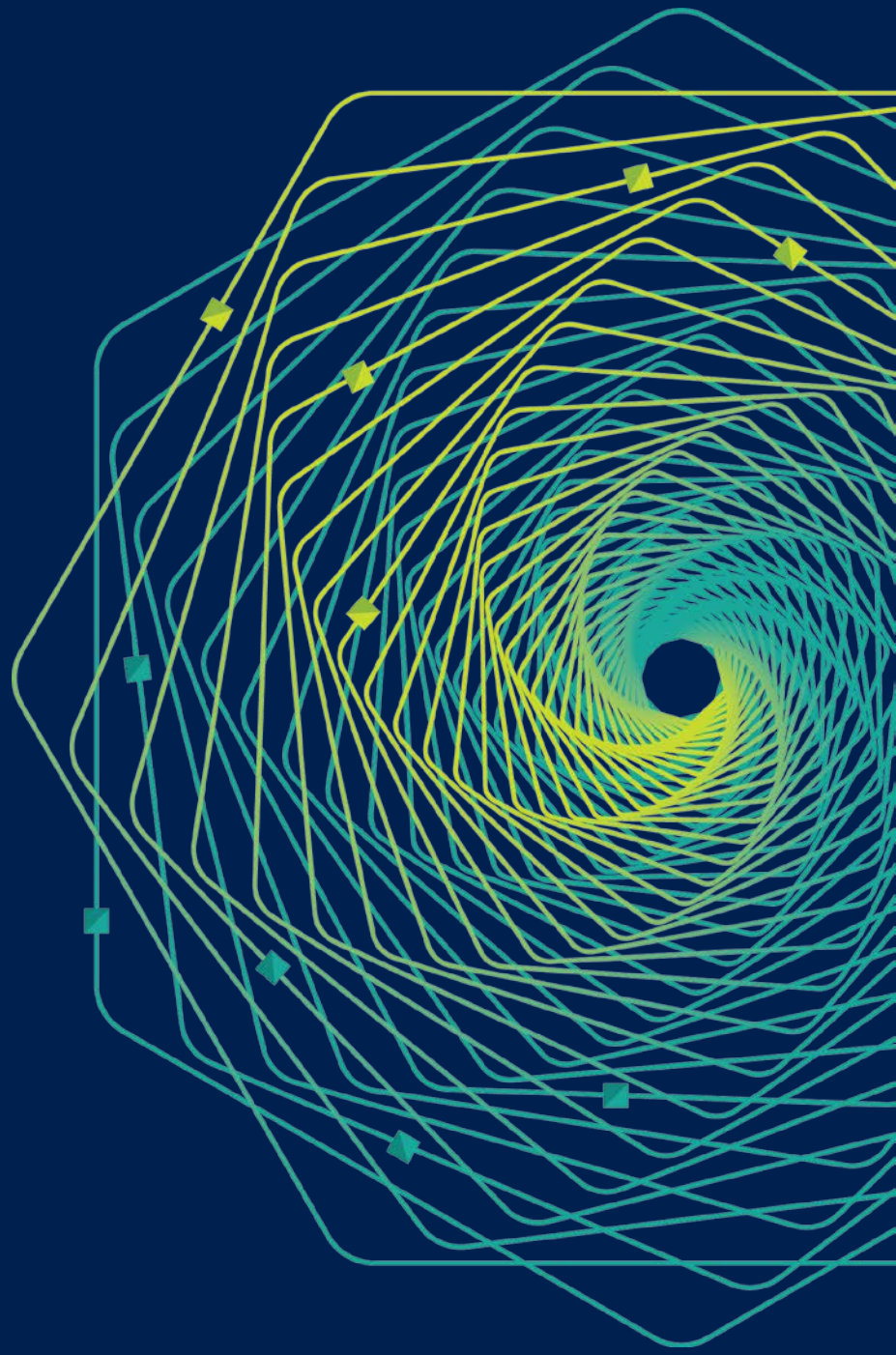


Cloud Data Threats

Customer cloud data concerns:

- Malicious privileged admins or insiders
- Hackers exploiting bugs in the infrastructure
- Third-party access without customer consent

Data Protection

At rest

Encrypt inactive data when stored in blob storage, database, etc.

Examples:

- Azure Storage Service Encryption for Data at Rest
- SQL Server Transparent Database Encryption (TDE)

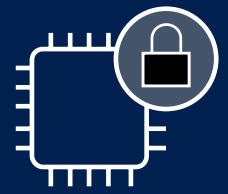
In transit

Encrypt data that is flowing between untrusted public or private networks

Examples:

- HTTPS
- TLS

In use



Protect/Encrypt data that is in use during computation

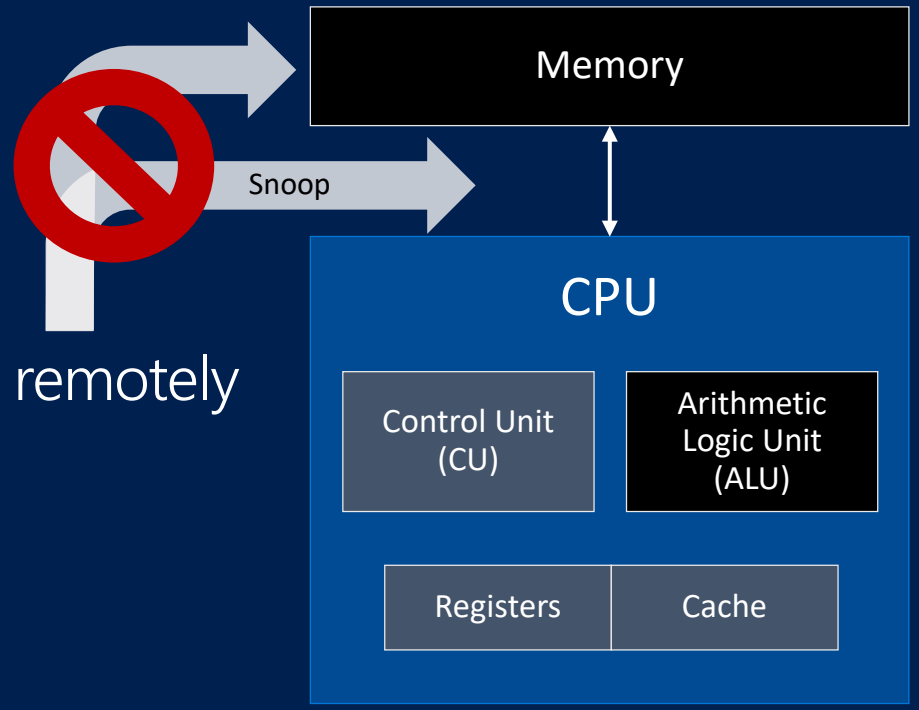
Examples include:

- Trusted Execution Environments
- Homomorphic encryption

Trusted Execution Environments (TEEs)

Protected container:

- Isolated portion of processor & memory
- Code & data cannot be viewed or modified from outside



Hardware-based TEE

Supports attestation: proving of identity both locally and remotely

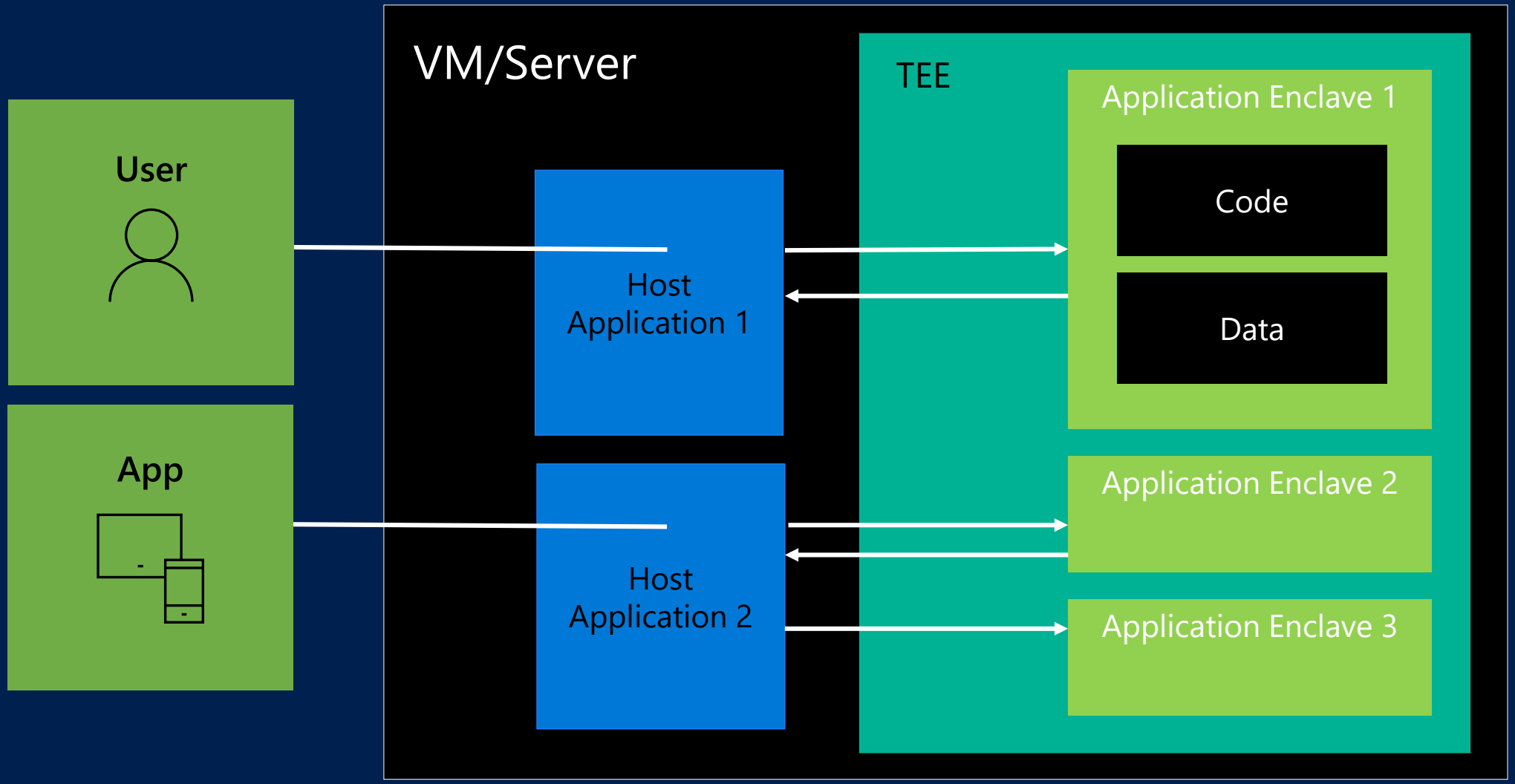
Supports sealing: persisting secrets

Examples:

Intel SGX

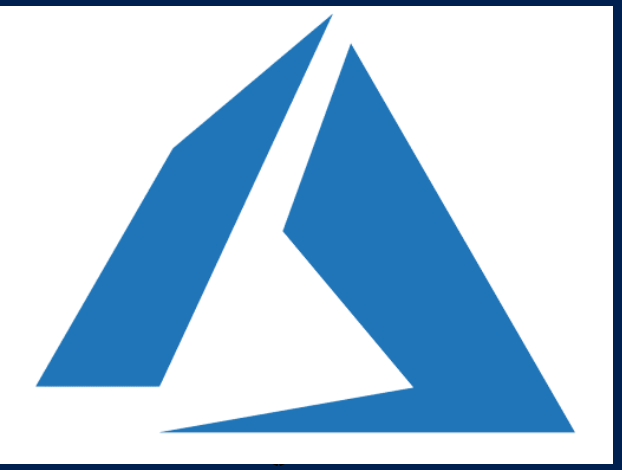
Virtualization Based Security (VBS) aka Virtual Secure Mode

TEE application architecture



Azure Confidential Computing

Azure and confidential computing



Working with silicon partners to enable Confidential Computing

Building software to deploy, manage, and develop secure TEE applications on Azure

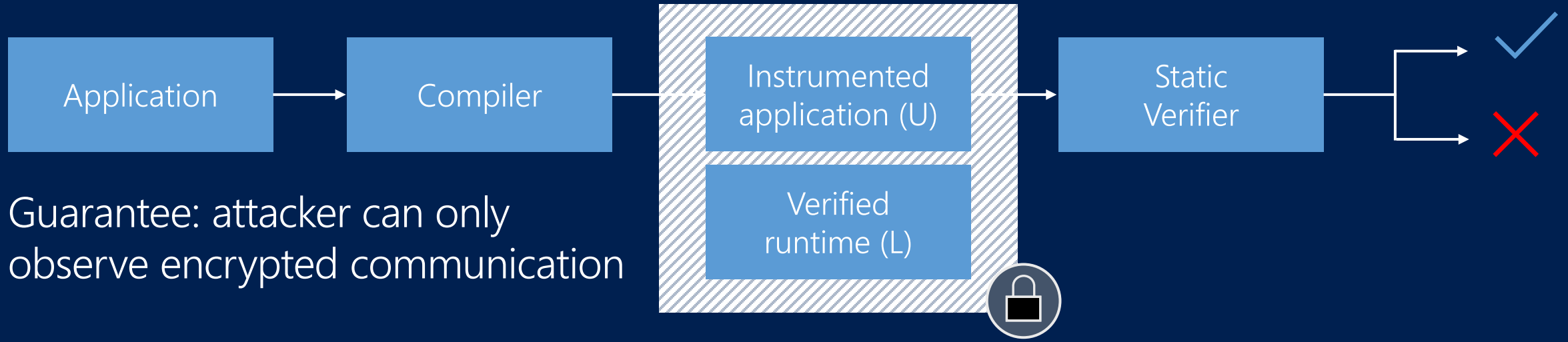
Designing and developing services to support attestation in the cloud

Enabling confidential PaaS and SaaS services

Preventing direct information leaks

Problem: code in enclaves may unintentionally write secrets out

Solution: use a compiler that instruments memory accesses & verify that instrumented binary does not leak secrets



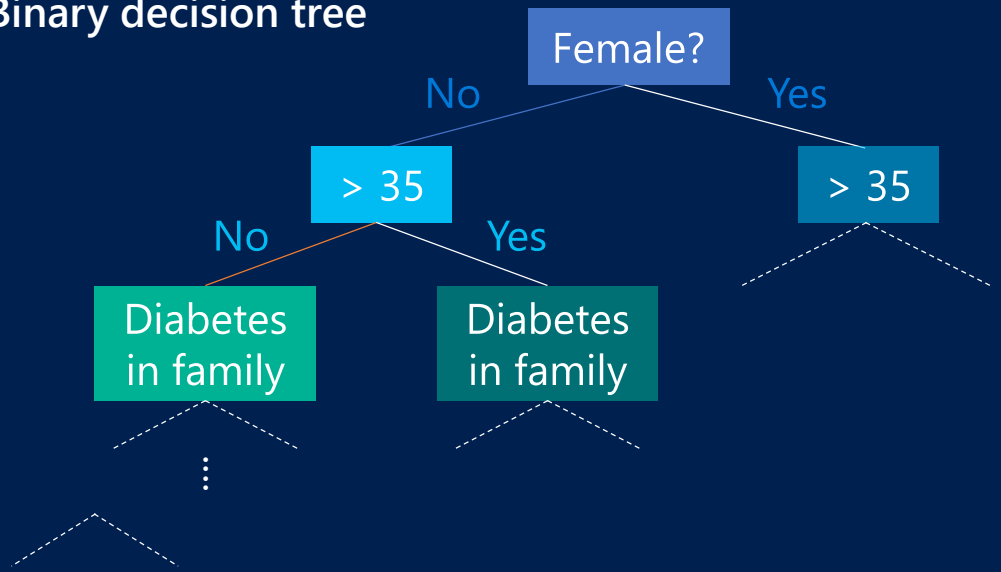
Guarantee: attacker can only observe encrypted communication

Preventing indirect information leaks

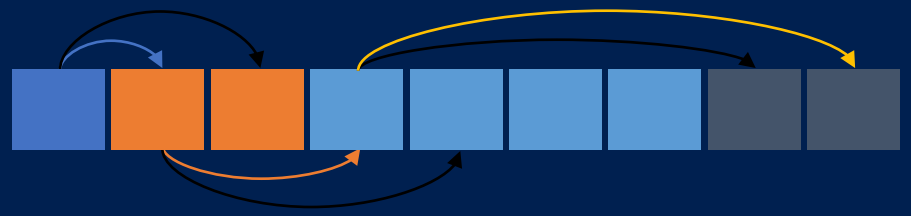
Problem: memory/disk access patterns may leak information

Solution: use compiler and hardened libraries that prevent leaks with data oblivious primitives

Binary decision tree



Memory



Accesses from 2 predictions

Demo:
Oblivious computing

Example confidential computing scenarios

Always encrypted storage with SQL Server

Enabling scalable and confidential blockchain networks with Coco Framework

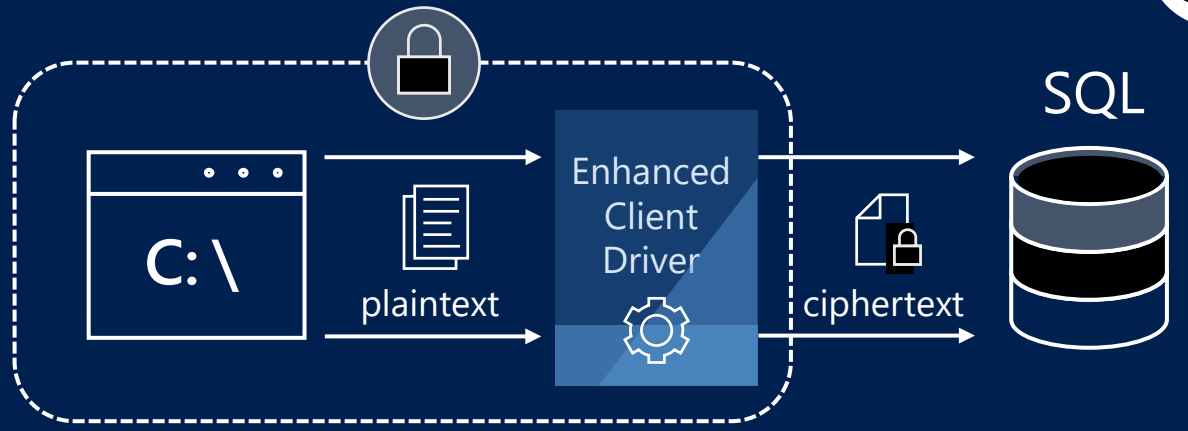
Financial data processing

Secure multi-party machine learning

SQL Always Encrypted

Protects sensitive data in use from high-privileged yet unauthorized SQL users both on-premises and in the cloud

Current GA version in SQL Server 2016/17 and Azure SQL DB



Client side Encryption

Client-side encryption of sensitive data using keys that are ***never*** given to the database system

Encryption Transparency

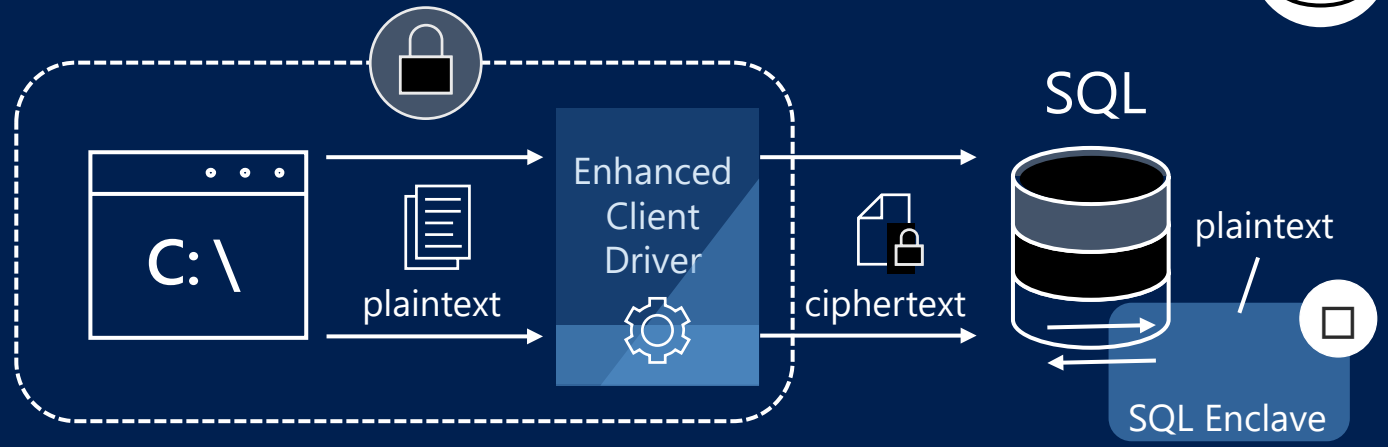
Client driver transparently encrypts query parameters and decrypts encrypted results

Queries on Encrypted Data

Support for equality comparison, including join, group by and distinct operators via deterministic encryption

Confidential SQL Always Encrypted

Protects sensitive data in use **while preserving rich queries and providing in-place encryption**



Secure computations inside SQL Enclave

SQL Server Engine delegates operations on encrypted to the SQL Enclave, where the data can be safely decrypted and processed

Rich Queries

pattern matching (LIKE), range queries (<, >, etc.), sorting, type conversions, support for non-bin2 collation, and more

In-place Encryption

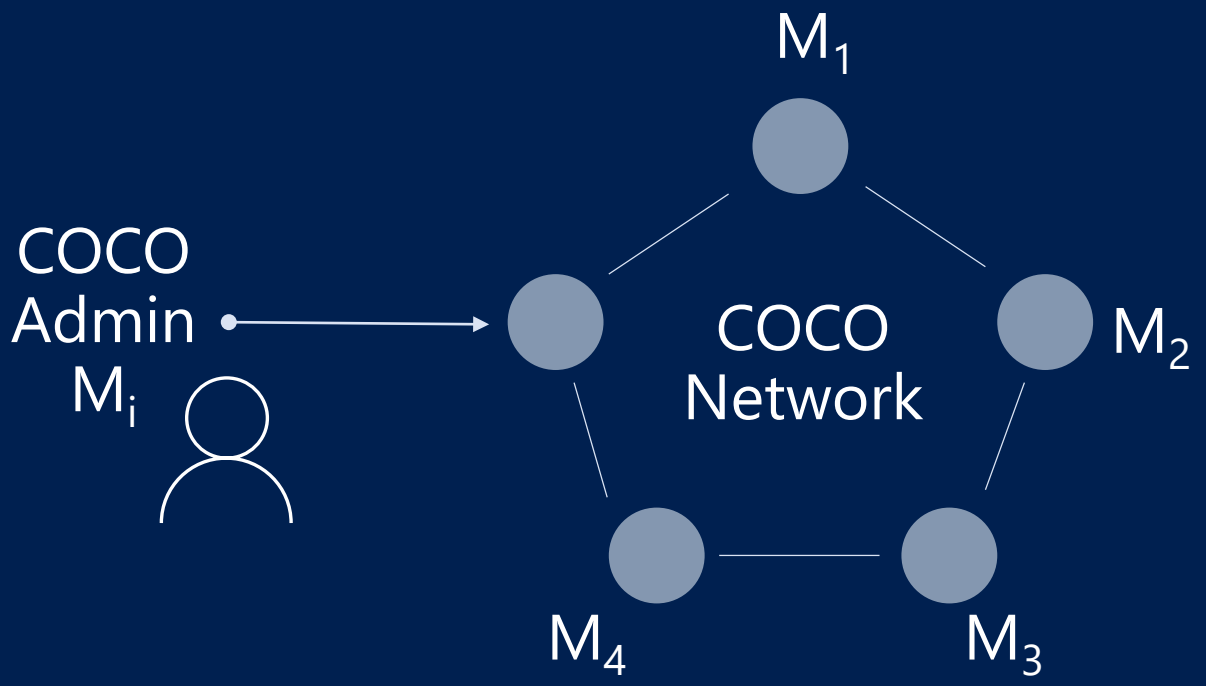
SQL Enclave can perform initial data encryption and key rotation, without moving the data out of the database

Coco Framework:
Confidential Consortium Blockchain Framework

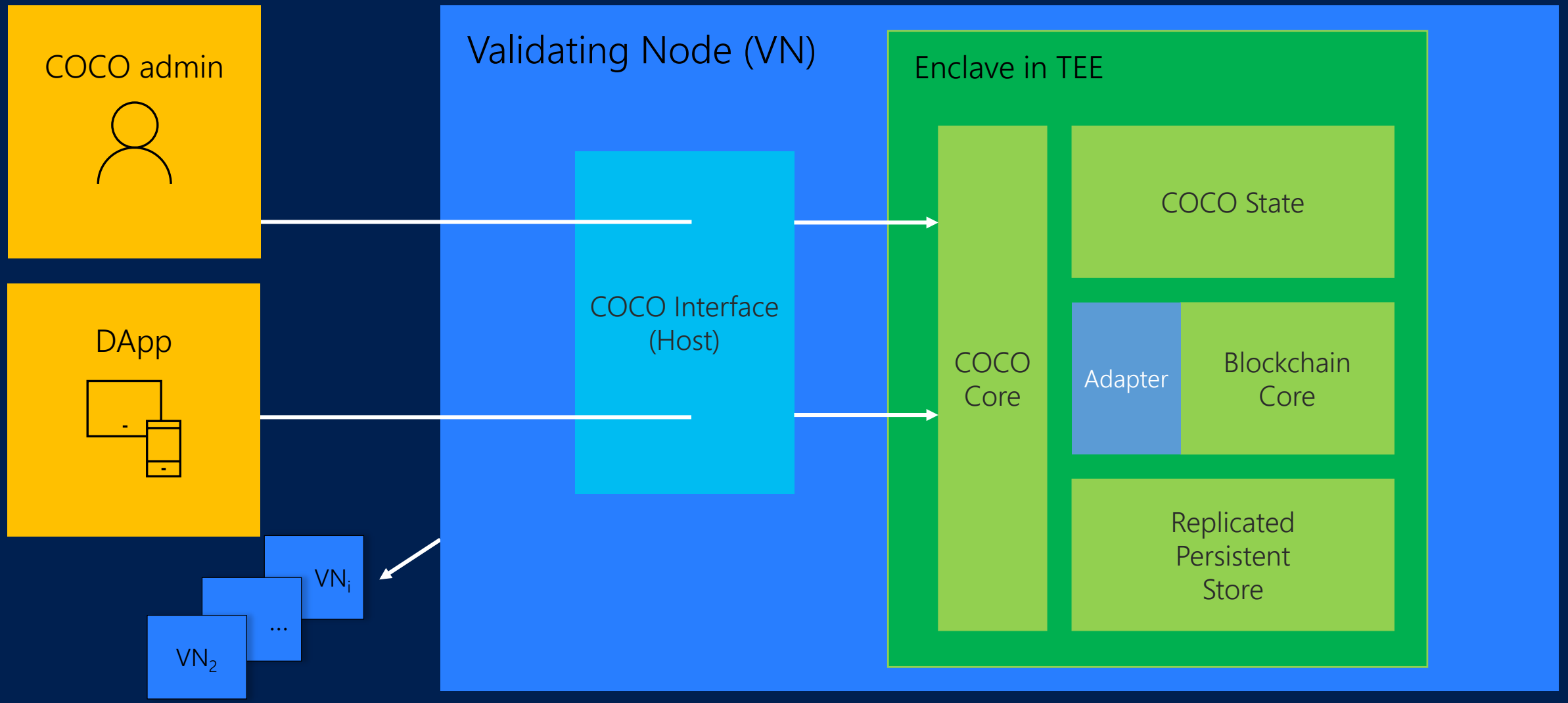
Open-source framework that enables high-throughput (~100x), fine-grained confidentiality, and consortium governance for blockchain

Creates a trusted network of physical nodes on which to run a distributed ledger, providing secure, reliable components for the protocol to use

Through the use of TEEs able to simplify consensus and transaction processing



Coco Framework architecture



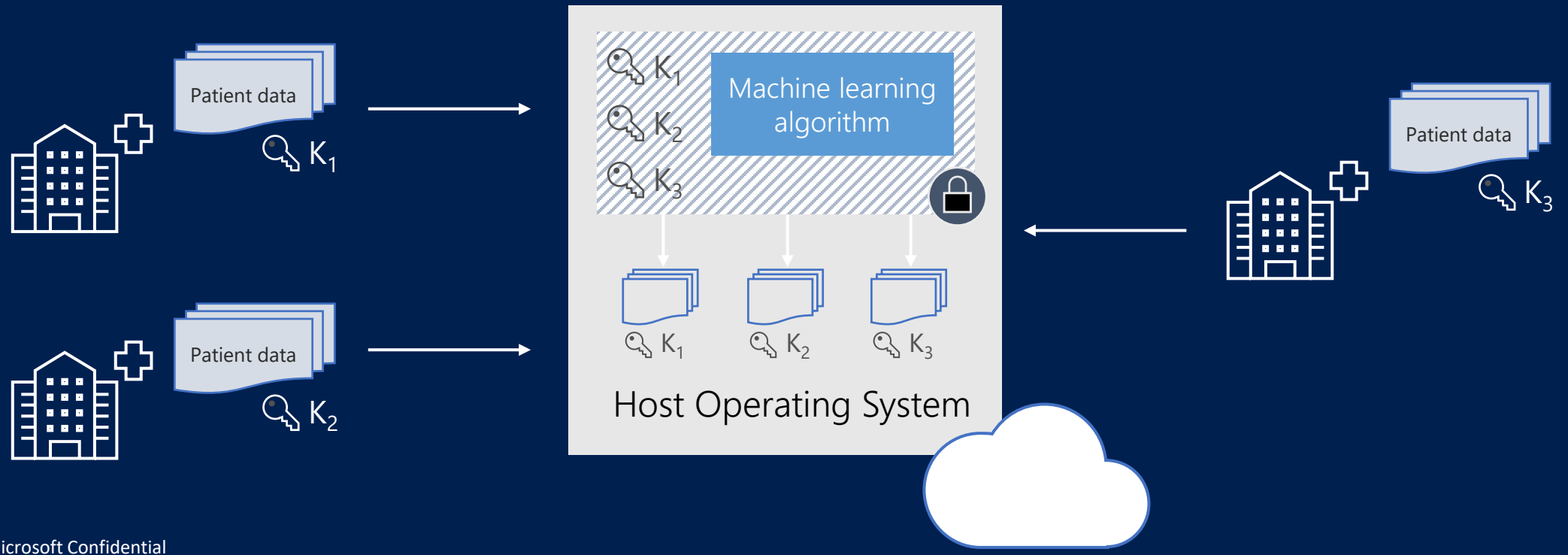
Demo:
Coco Ethereum versus Ethereum

Confidential multi-party machine learning

Partnered health facilities contribute private patient health data sets to train a ML model

Each facility only sees their respective data sets (aka no one, not even cloud provider, can see all data or trained model, if necessary)

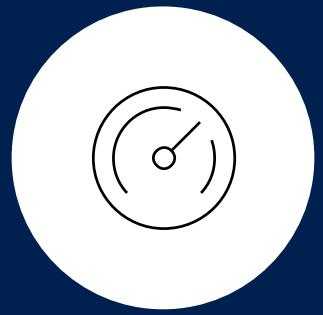
All facilities benefit from using trained model



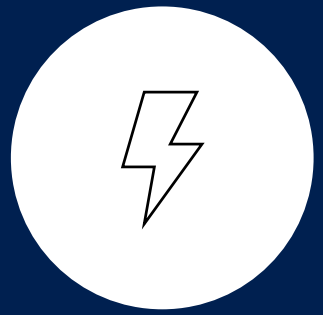
Demo:
Confidential multi-party ML

Summary

Confidential computing in the cloud is in its early stages



Microsoft is driving the direction & adoption of newer trusted execution environments in the cloud



Azure is empowering new secure business scenarios in the cloud

References

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Thank you!

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