A BRIEF INTRODUCTION TO BLOCKCHAIN

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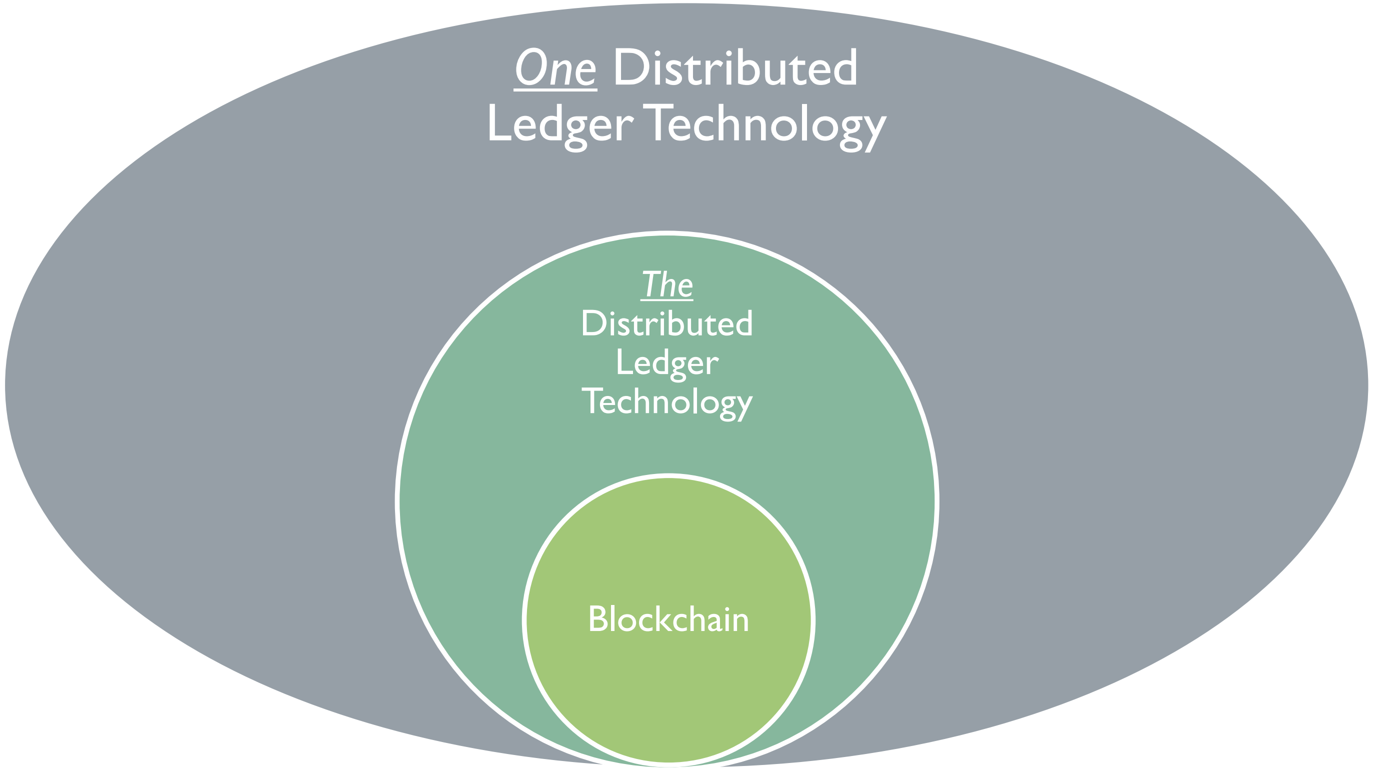
WHAT IS BLOCKCHAIN?

"To understand the power of blockchain systems, and the things they can do, it is important to distinguish between three things that are commonly muddled up, namely the bitcoin currency, the specific blockchain that underpins it and the idea of blockchains in general."

The Trust Machine, THE ECONOMIST, Oct. 31, 2015

WHAT IS BLOCKCHAIN?



One Distributed Ledger Technology
The Distributed Ledger Technology
Blockchain

- One technology that enables the creation of a *distributed ledger*

OR

- A synonym for *distributed ledger technology*

OR

- The specific technological protocol underlying the virtual currency Bitcoin

WHAT ARE THE ELEMENTS OF BLOCKCHAIN?

A technology that:

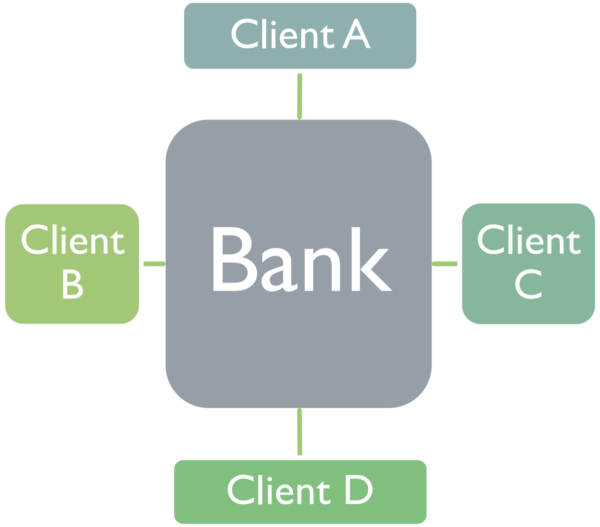
permits transactions to be gathered into blocks;

cryptographically chains blocks in chronological order; and

allows the resulting ledger to be accessed by different servers.

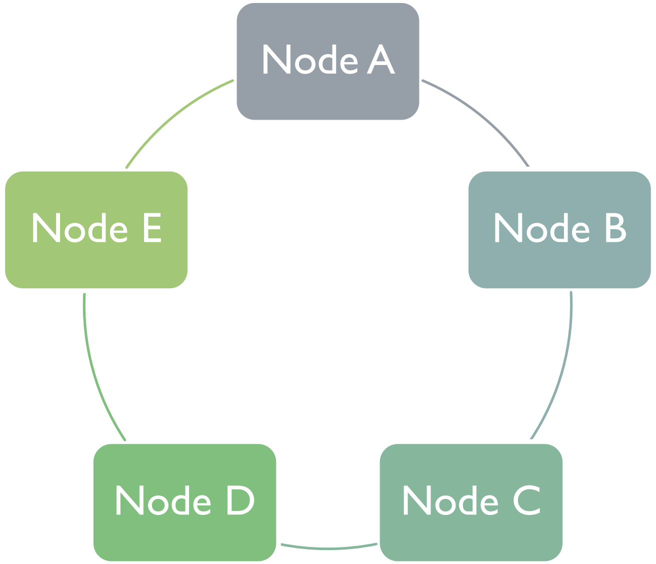
WHAT IS A DISTRIBUTED LEDGER?

Centralized Ledger



- There are multiple ledgers, but Bank holds the "golden record"
- Client B must reconcile its own ledger against that of Bank, and must convince Bank of the "true state" of the Bank ledger if discrepancies arise

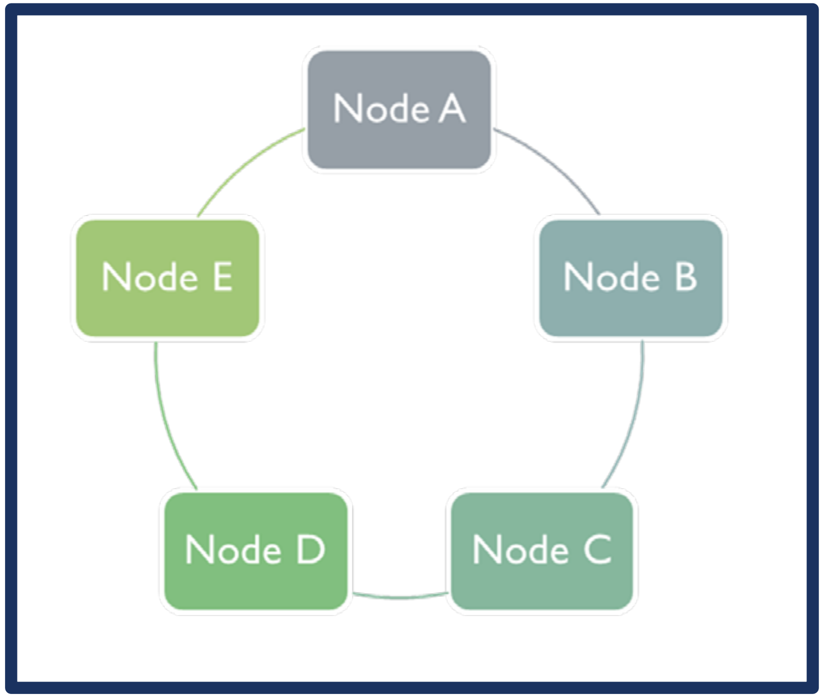
Distributed Ledger



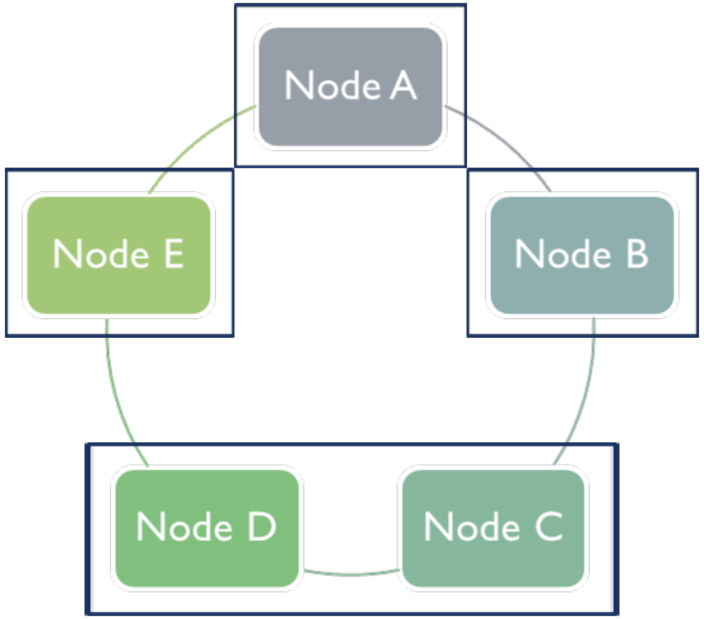
- There is one ledger. All Nodes have some level of access to that ledger.
- All Nodes agree to a protocol that determines the "true state" of the ledger at any point in time. The application of this protocol is sometimes called "achieving consensus."

WHAT IS A DISTRIBUTED LEDGER?

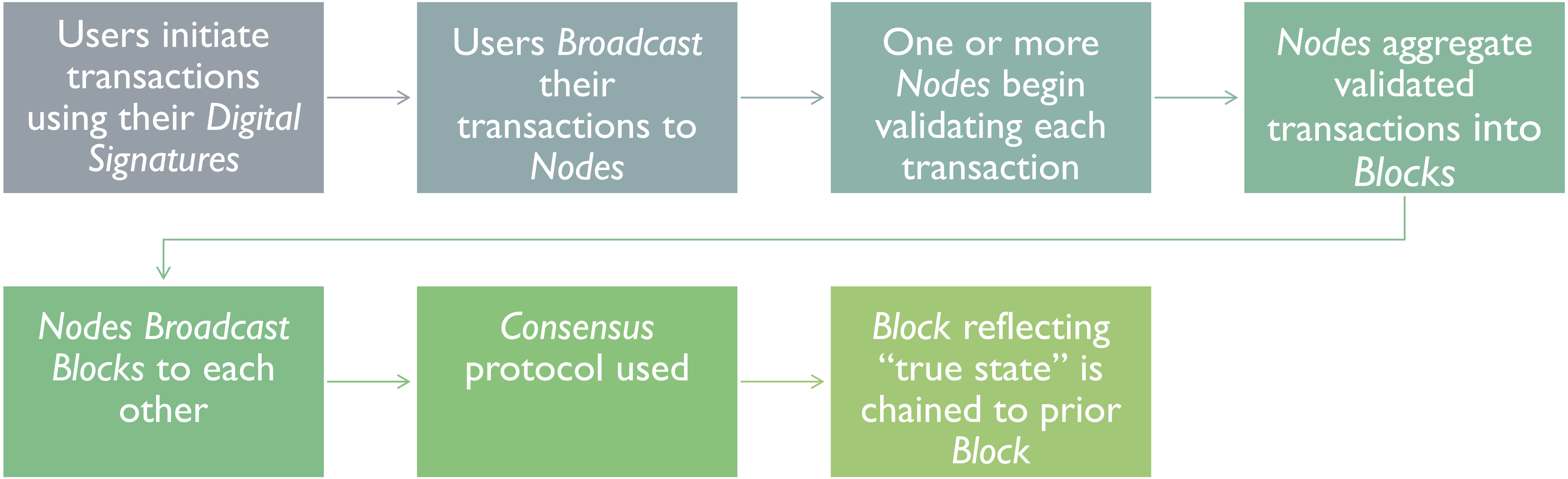
Single Entity



Multiple Entities



HOW MIGHT A DISTRIBUTED LEDGER WORK?



Users initiate transactions using their *Digital Signatures*

Users *Broadcast* their transactions to *Nodes*

One or more *Nodes* begin validating each transaction

Nodes aggregate validated transactions into *Blocks*

Nodes Broadcast Blocks to each other

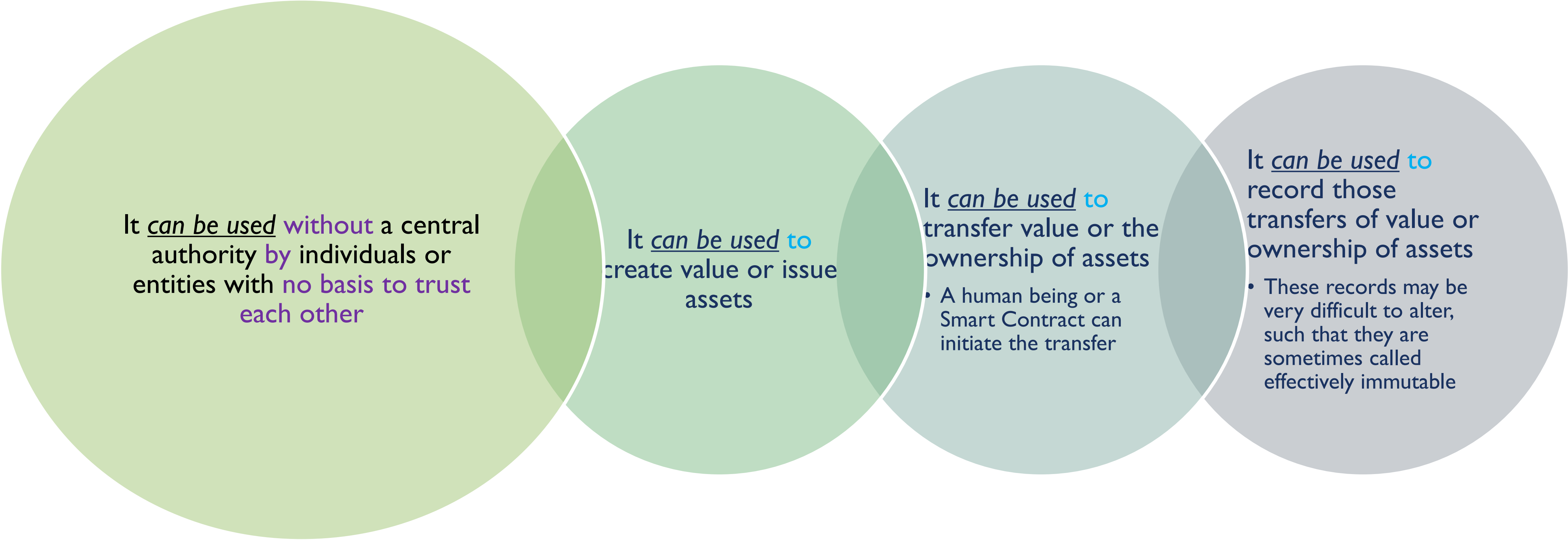
Consensus protocol used

Block reflecting “true state” is chained to prior *Block*

WHERE MIGHT A DISTRIBUTED LEDGER USE CRYPTOGRAPHY?

Initiation and Broadcasting of Transaction	• *Digital Signatures* • *Private/Public Keys*
Validation of Transaction	• *Proof of Work and certain alternatives*
Chaining Blocks	• *Hash Function*

THE POWER OF DISTRIBUTED LEDGERS



It *can be used* without a central authority by individuals or entities with no basis to trust each other

It *can be used* to create value or issue assets

It *can be used* to transfer value or the ownership of assets

- A human being or a Smart Contract can initiate the transfer

It *can be used* to record those transfers of value or ownership of assets

- These records may be very difficult to alter, such that they are sometimes called effectively immutable

The degree of trust between users determines the technological configuration of a distributed ledger.

DIFFERENT DEGREES OF TRUST: SOME EXAMPLES

- *Increasing Payment Efficiency*
  - *Increasing Payment Efficiency between Central Bank Members Only*
  - *Increasing Payment Efficiency between Central Bank Members and Other Banks in the Same Jurisdiction*
  - *Increasing Payment Efficiency between All Participants in the Wholesale Payments System in the Same Jurisdiction*
  - *Increasing Payment Efficiency between Participants in the Wholesale and Retail Payments System in the Same Jurisdiction*
  - *Increasing Payment Efficiency between Banks Across Jurisdictions*
  - *Increasing Payment Efficiency between All Participants in the Wholesale Payments System Across Jurisdictions*
  - *Increasing Payment Efficiency between Participants in the Wholesale and Retail Payments System Across Jurisdictions*

HOW MIGHT DISTRIBUTED LEDGER PROPOSALS DIFFER?

Participation	Open	Closed
Permission	Permissionless	Permissioned
Ledger Design	One ledger	One ledger or Segregated ledgers
Validation	Methodology depends on degree of trust between nodes. Where there is no basis for trust, may be achieved through proof of work, which requires the algorithmic solving of a cryptographic hash.	
Consensus Mechanism	Mechanism depends on degree of trust between nodes. Where there is no centralized authority, consensus may be determined algorithmically.	

QUESTIONS?

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