



Blockchain and Additive Manufacturing

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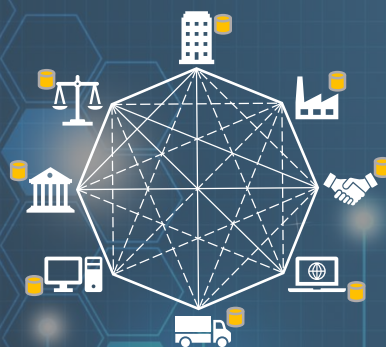
Blockchain Basics



Centralized Ledger
All parties reconcile their local databases with a version maintained and controlled by a trusted central party



PERMISSIONED
Nodes need permission from a central entity to access the network and make changes



PUBLIC
Anyone can join and perform the function of a Node, have a wallet, view the ledger

How many copies of the Ledger are there

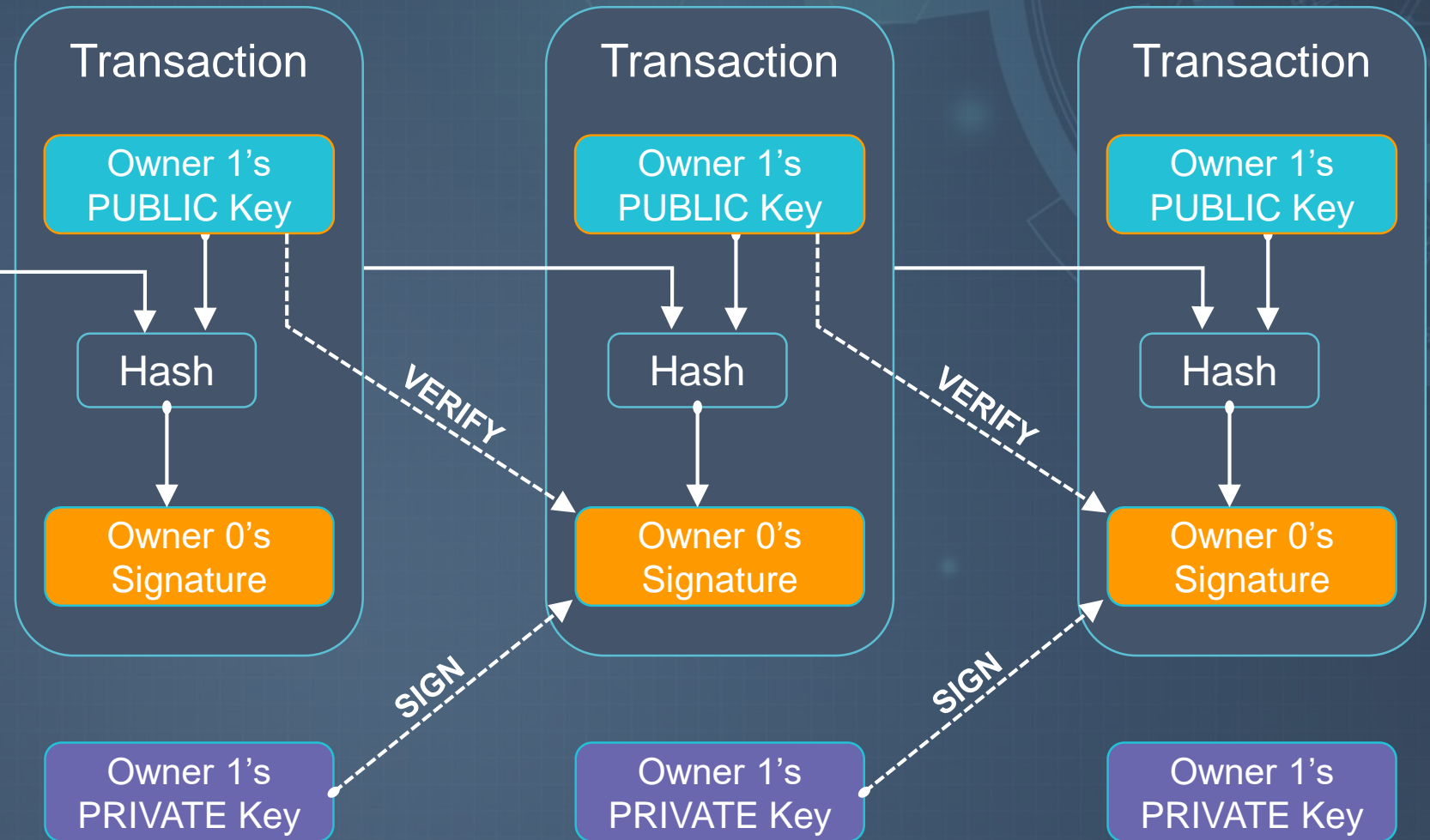
One Copy

Many Copies

Distributed Ledger
Each node in a P2P network stores a full copy of the entire ledger. Every proposed addition to the ledge is communicated to all nodes.

The "Chain" in the Blockchain

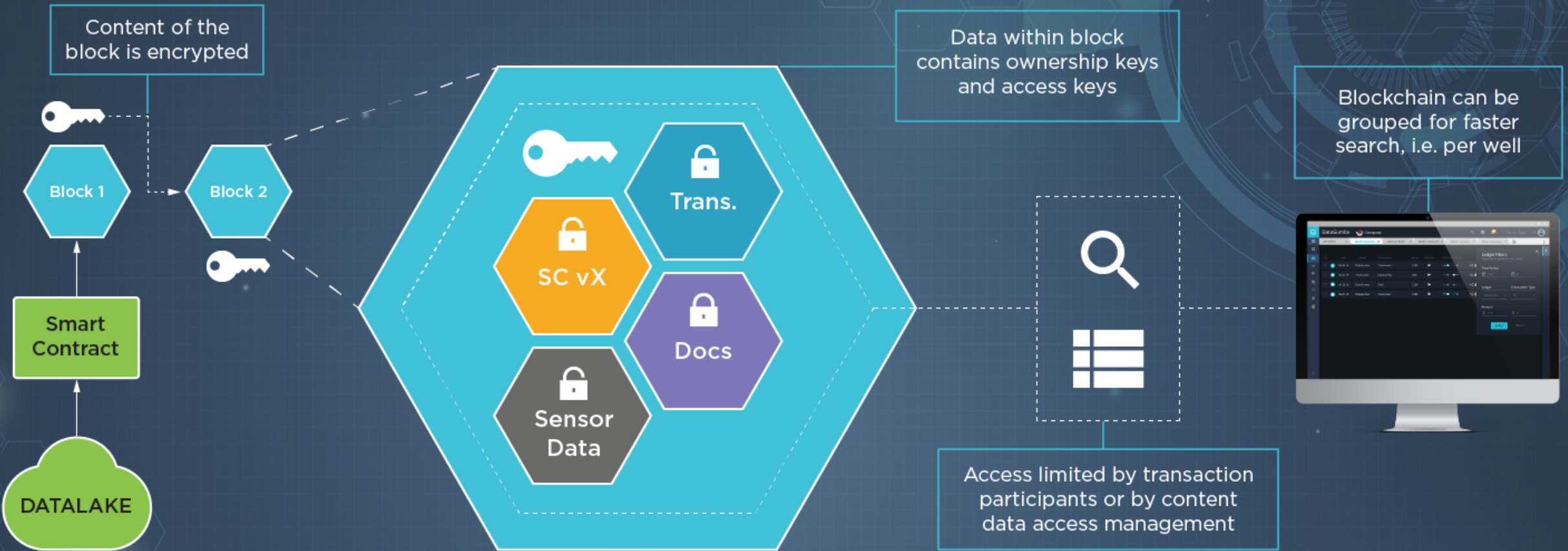
- A blockchain is an ordered sequence of blocks.
- Each block contains the hash of the preceding block.
- Any change to any block would require re-hashing all the blocks coming after. (**security**)



Benefits of Blockchain Technology

Distributed Database	Accessible to all parties; no central controller; no intermediaries involved in transaction verification
Peer-to-Peer Transmission	Node-to-Node communication; store and forward to all
Transparency with Pseudonymity	Every transaction visible to every node; Nodes are ID'd via 30-plus-character alphanumeric address; transactions occur btwn addresses
Irreversibility of Records	Once on the block records cannot be altered; linked to the block before; chronologically ordered; available to all others on the network

Data Gumbo Blocks



Smart Contracts

A **smart contract** is a computer protocol design to automate the performance of a contract.

A key evolution of blockchain is the ability to add smart contract logic that consumes data on the block and can automatically execute terms and conditions absent of an intermediary.

- Automate the transaction
- Remove inefficiencies
- Guaranteed execution of terms
- Terms tested in advance
- Full audit trail available to all
- All participants have the same record of transactions
- Fully secure

Data Gumbo Smart Contracts v 1.0

DATA GUMBO DataGumbo

PROFILE STATISTICS BILLING COMPANY USER MANAGEMENT **SMART CONTRACT**

Account Dashboard Marketplace Messages Notifications Developers Settings Help

Smart Contract	Owner	Participants	Smart Code	From	To	Status
Test contract	DataGumbo	Statoil, Company1, GlobalLoop	First script	06/01/2017 00:00	06/12/2018 00:00	Active
Smart Contract						Pending
						Pending
						Pending
						Pending
						Pending
						Pending
						Pending
						Pending
						Pending

Smart Contract

Name: Test contract

Owner: DataGumbo

Participants*: Statoil, Company1, GlobalLoop

From*: 06/01/2017 00:00

To*: 06/12/2018 00:00

Smart Code*: First script

Lock:

Note: any note !!!

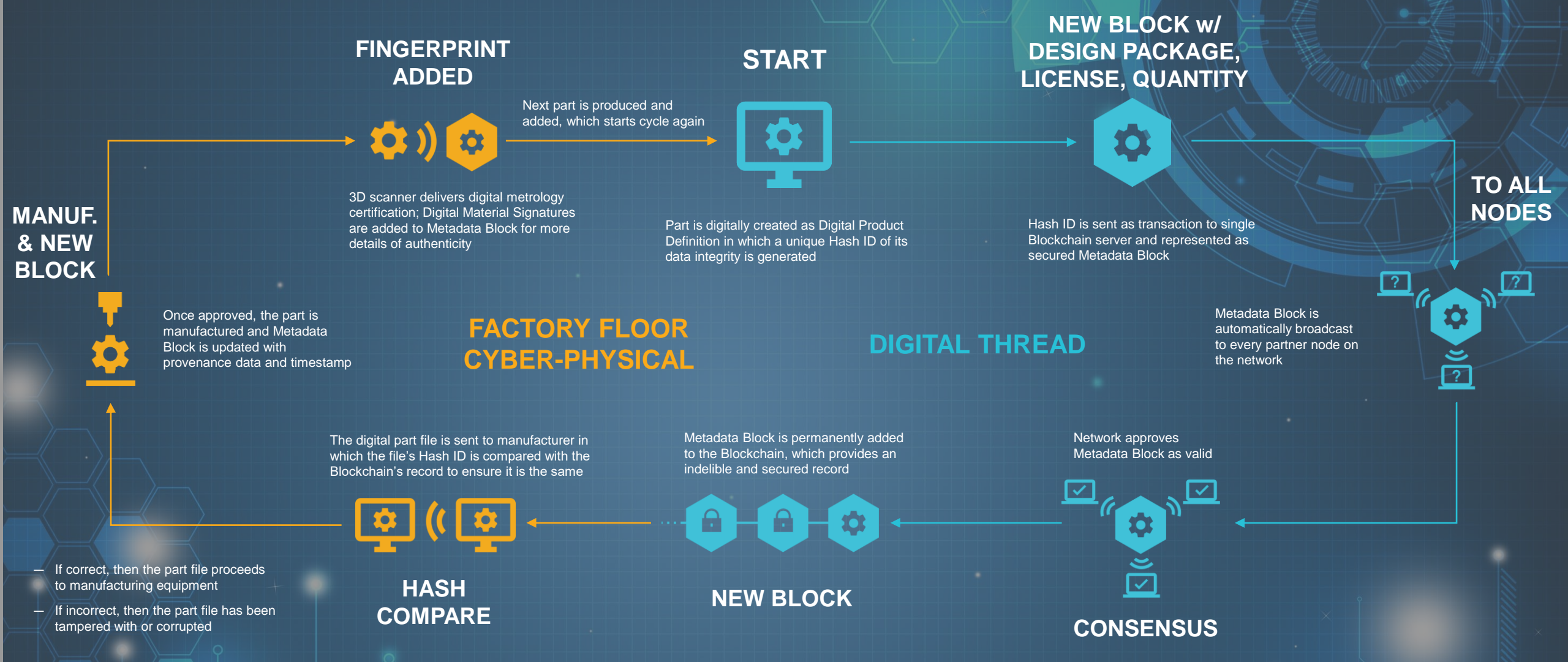
CANCEL OK

Edit Smart Code

```
845 if (store.dateTo < dtTo) store.dateTo = dtTo;
846
847 return null;
848
849 calcbonus:
850
851 const int savingsOP = 45; // Operator saving (%)
852 const int feeOP = 5; // Operator DG Fee (%)
853 const int feeCON = 5; // Contractor DG Fee (%)
854 const int bonusCON = 45; // Contractor bonus (%)
855 const double sixMavg = 4.21; // Drilling Connection 6 months avg
856 const int spreadRate = 6000; // Spread rate (USD)
857
858 var jsonRoot = (JsonObject)JsonConvert.DeserializeObject(data);
859 var json = jsonRoot["Summary"];
860 var connectionDuration = double.Parse(json["Time Drilling Connections (ms)"].ToString(), CultureInfo.Invariant);
861 var totalDCType = double.Parse(json["Num DCs"].ToString(), CultureInfo.InvariantCulture);
862
863 var accAvgMS = TimeSpan.FromMilliseconds(0);
864 if ((connectionDuration != 0) && (totalDCType != 0))
865 {
866     var averageDrillingConnection = connectionDuration / totalDCType;
867     accAvgMS = TimeSpan.FromMilliseconds(averageDrillingConnection);
868 }
869 var AccAverageDCMin = accAvgMS.TotalMinutes;
870
871 double drillingGainLoss = Math.Round((sixMavg - AccAverageDCMin) * totalDCType, 2);
872 double savingsUSD = Math.Round((spreadRate / (24 * 60)) * drillingGainLoss, 2);
873
874 //Distribute the savings and bonus
875 double keepOP = Math.Round((savingsUSD * savingsOP) / 100, 2);
876 double payOPDG = Math.Round((savingsUSD * feeOP) / 100, 2);
877 double payCONDG = Math.Round((savingsUSD * feeCON) / 100, 2);
878 double payCON = Math.Round((savingsUSD * bonusCON) / 100, 2);
879
```

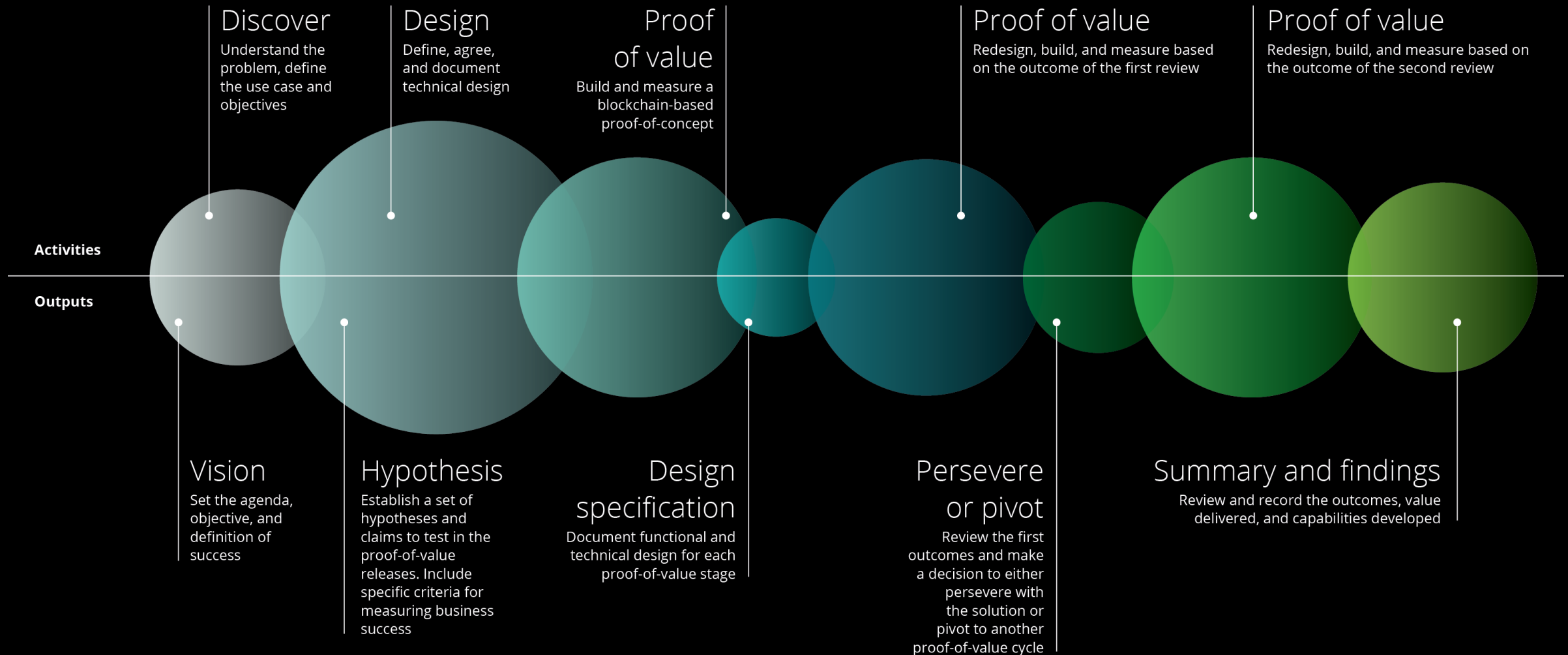
VALIDATE CANCEL OK

Additive Manufacturing Blockchain Flow



Make it real

Think big, start small, iterate, learn



Additional Resources

- YouTube video – One of the best 5 minute explanations of blockchain that I've found
- <https://youtu.be/l4CZjTyLYG4>
- Video was produced by the Centre for International Governance Innovation. You can search for them on YouTube and locate the video that way as well.
- If you want to interact with a blockchain and see how a simplified version of hashing and how blockchains can be 'broken' if a block of data is manipulated, try this out:
 - Recorded demo: <https://anders.com/blockchain/>
 - Try it yourself: <https://anders.com/blockchain/blockchain.html>



THANK YOU!

Any questions?

You can find me at
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