



OPNT

Optical Positioning, Navigation and Timing

Using DLT/Blockchain for Timing Verification and Compliance

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Discussion Content

- Framing:
 - Regulated Industries have timing compliance requirements → need to demonstrate
 - Traceability to UTC which requires a documented, unbroken calibrated chain
 - DLT provides a chain of evidence that is strongly tamper-resistant, as well as able to automatically be shared with regulators
- We outline a potential for timing as a service (TaaS), with compliance as a service (Caas) added on:
 - Terrestrial network based TaaS design
 - DLT unbroken chain of calibrations and tests -> store on TaaS DLT
 - Customer equipment measurement options -> add to TaaS DLT
 - Further possibilities to add to TaaS DLT?
 - Sharing with regulator options
- Conclusions

TaaS Offering Mental Model:

Monthly Price-Based Delivery Matching Performance Required

Potential/Sample Use Cases and Relative Price Comparisons

SLA-Based Accuracy to "Base" ->	<1us	<500ns	<250ns	<125ns	<75ns	<25ns	<5ns	<1ns	Nationwide Cyber- Forensics
Relative to "Global Base"	\$	\$	\$\$\$	\$\$\$	NA	NA	NA	NA	
Relative to "GPS plus National UTC Base"	\$	\$	\$\$	\$\$\$	\$\$\$	\$\$\$\$	\$\$\$\$\$	\$\$\$\$\$	
Relative to "Intra-Region GPS UTC Base"	\$	\$\$	\$\$	\$\$	\$\$	\$\$\$	\$\$\$\$	NA	
Relative to "Intra-Metro GPS UTC Base"	\$	\$	\$	\$	\$	\$\$	\$\$	\$\$\$	
Relative to "City-Core Base"	\$	\$	\$	\$	\$	\$\$	\$\$	\$\$\$	

Global Financial Mkts

Critical Infrastructure

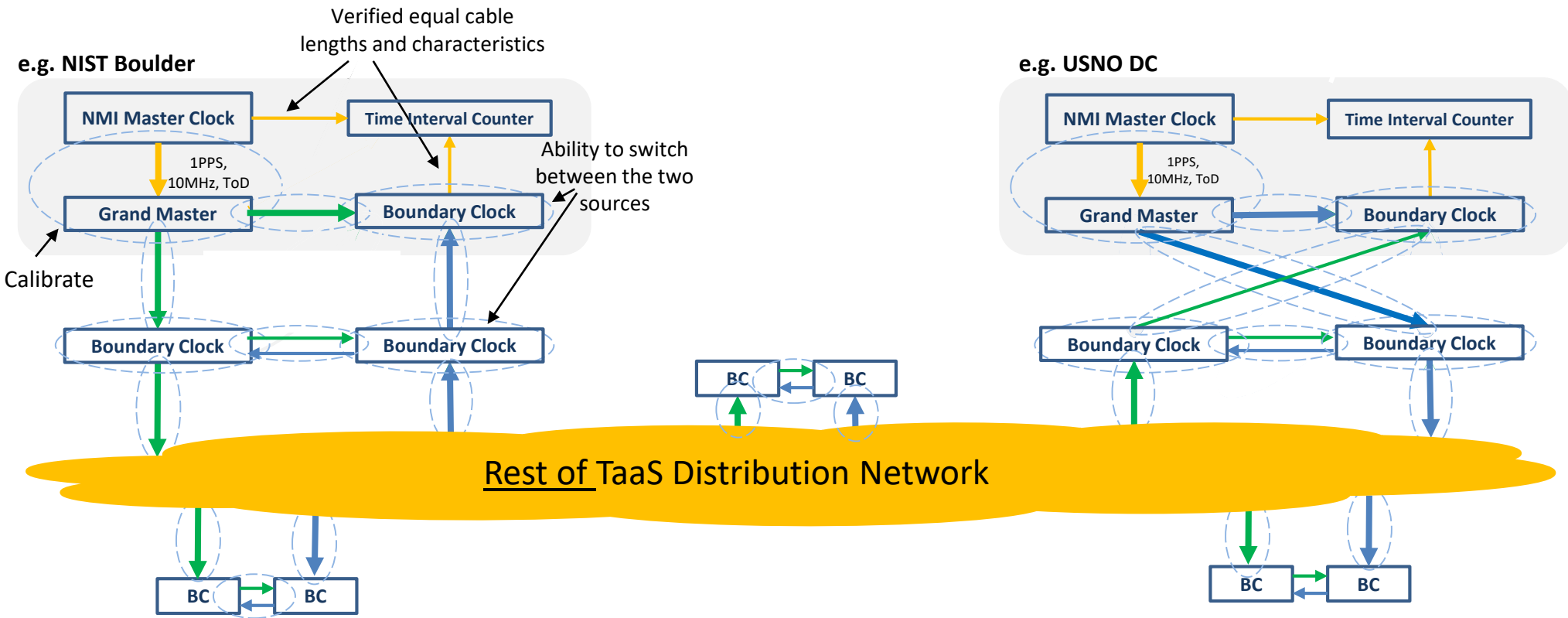
5G/Indoor/US 911

Autonomous vehicles

Critical and Valuable Data to TaaS Offering

- Initial TaaS network/solution setup, and growth
 - The equipment
 - The installation
 - Calibration
 - Test/verification
- Steady state operations
 - Interrupt/error conditions
 - Periodic status queries
 - Periodic test/verification reconfigurations (e.g. loop backs)
 - Random test/verification reconfigurations?
- Other?

Initial Setup, and Growth

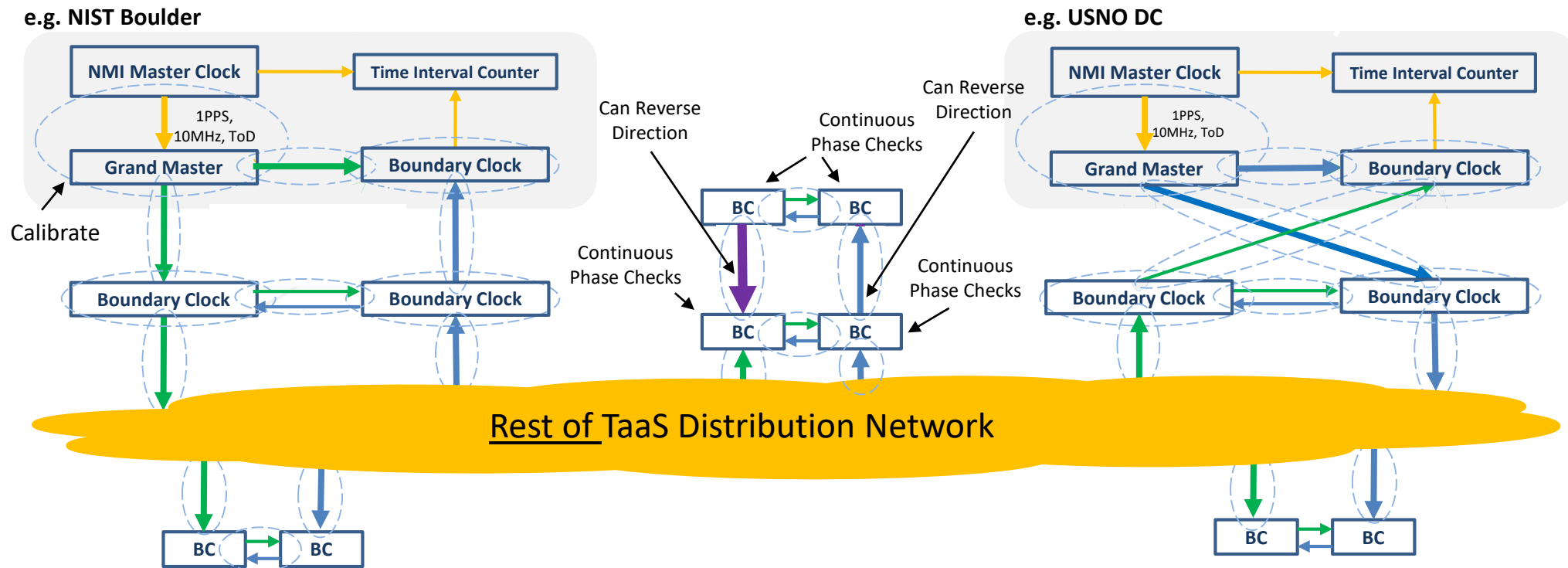


Geographically separated, interrelated steps and results

Securely store all of the actions, results, and associated data for records and later use, **on (TaaS) DLT?**



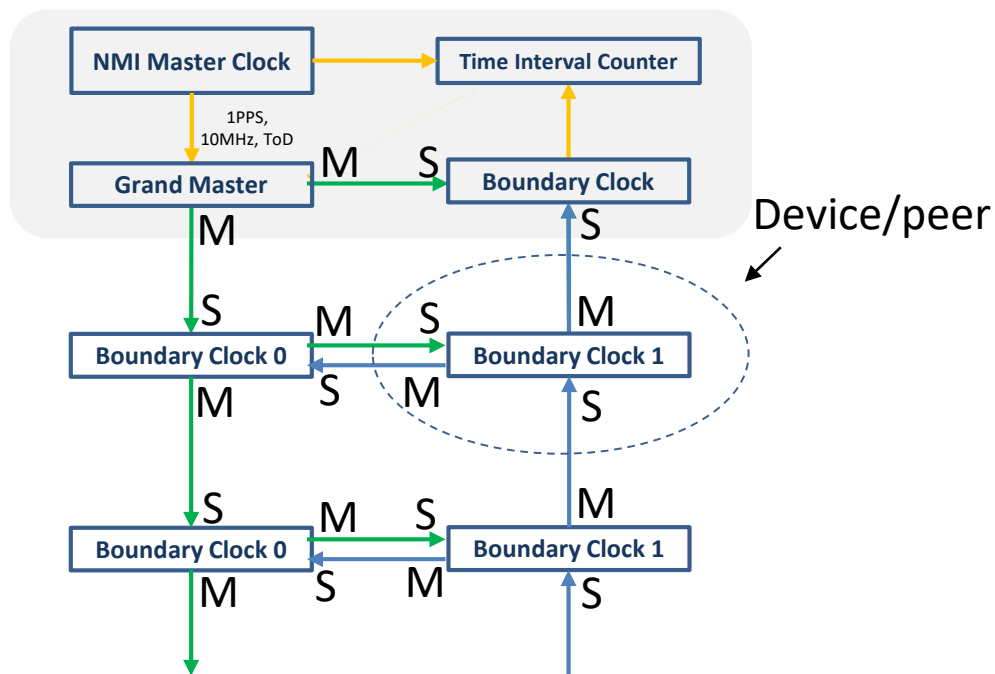
Incorporation of Dual-Direction / "Loop Arounds"



As compared to one-way only mechanisms such as GPS, ability to transmit and receive provides material advantage to establish and maintain Veracity

Peer to peer steps and agreement of results amenable to use of DLT Smart Contracts?

Steady State Operations, Per Device



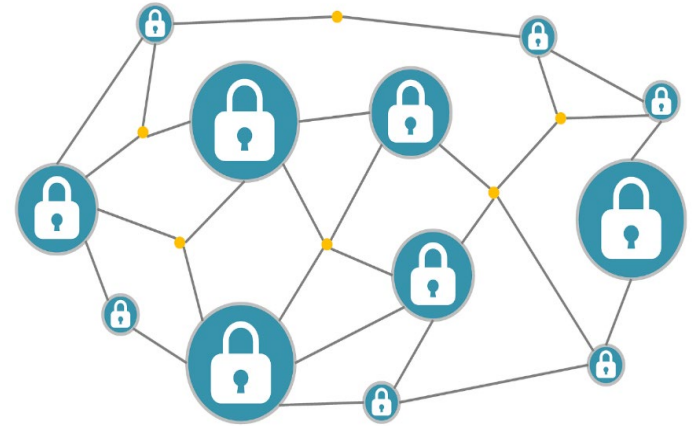
- Device "Events":
 - Device Queries via the Management Interface
 - Device Changes Initiated via the Management Interface
 - Device Interrupts
- Sample Content of Each Query:
 - Timestamp of the event
 - The port role of each port
 - The MAC address of each peer
 - The status of each link
 - Round trip time from every slave-side port
 - Offset time in picoseconds between each standby clock input to the active clock input

Constant generation of valuable new data throughout lifecycle
 Same opportunity to **store on DLT** for later use

DLT: From U. Cambridge: DLT Conceptual Framework

A DLT system is a system of electronic records that

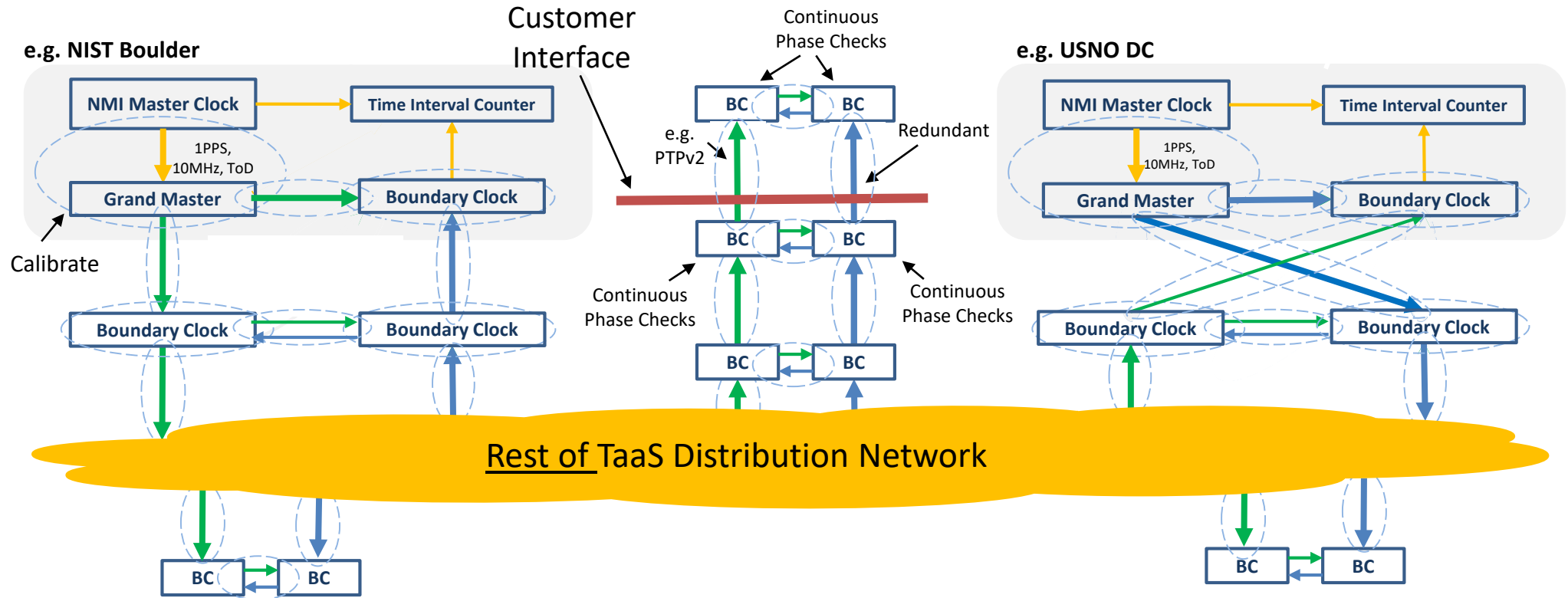
- i. enables a network of independent participants to establish a consensus around
- ii. the authoritative ordering of cryptographically-validated ('signed') transactions. These records are made
- iii. persistent by replicating the data across multiple nodes, and
- iv. tamper-evident by linking them by cryptographic hashes.
- v. The shared result of the reconciliation/consensus process - the 'ledger' - serves as the authoritative version for these records.



Using DLT/Blockchain for Timing Verification

- **Store calibration, verification of accuracy, and record of operations in a blockchain system to ensure both veracity and availability.**
 - This would provide security against both incidental and intentional distortion of data.
 - It also would allow sharing the data with regulators and customers who might want a way of checking the veracity of the data.
- **Add customers' own time measurements to the blockchain system.**
 - In finance or electric power, give access to regulators
 - The entity running the timing network could provide **Compliance as a Service**: demonstrate compliance with any timing requirements.

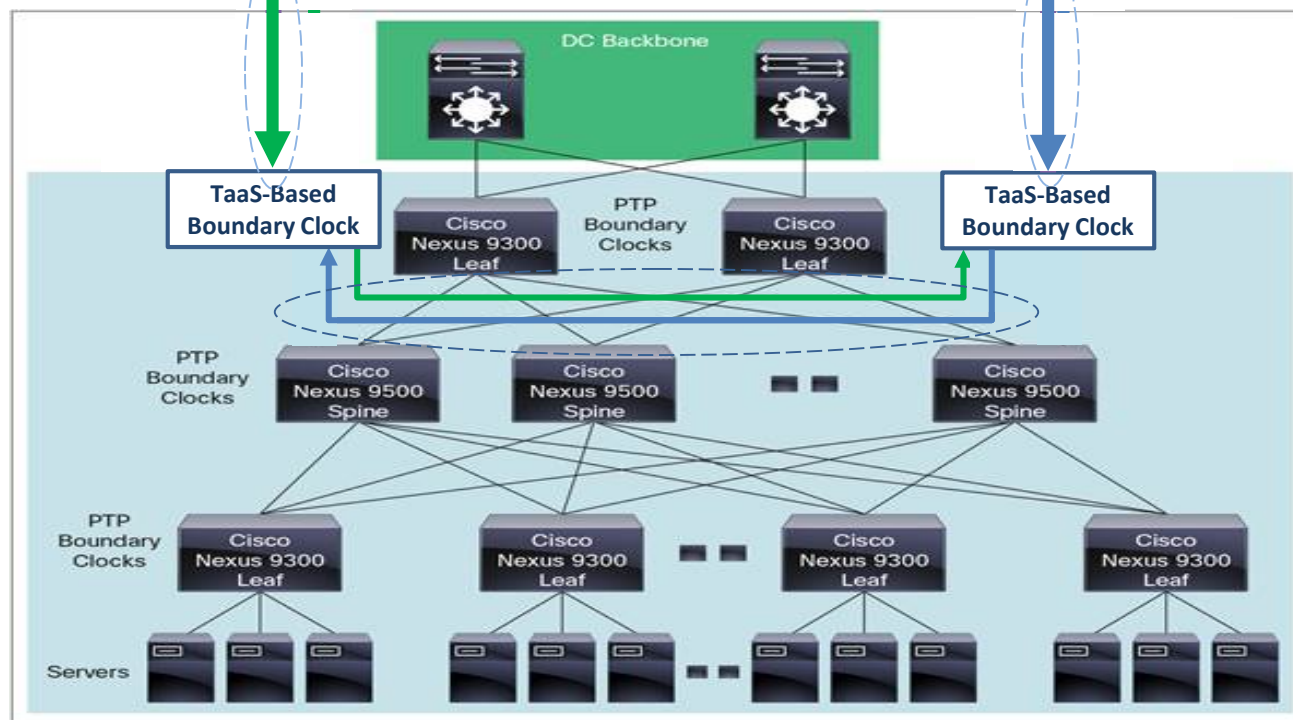
Delivery of TaaS to Customers



Utilizing same mechanisms as employed within TaaS core to establish and maintain Veracity to customers, including ability to secure on TaaS DLT

Example Using Cisco Data Center Model*

Terrestrial-Based Two-Way TaaS Solution



Initial setup and continued generation of valuable data

- Calibration
- Traceability
- Fault Detection and Recover
- Confidence in Own Operation
- **Contribution to Compliance Assurance**

Setup via Smart Contracts?

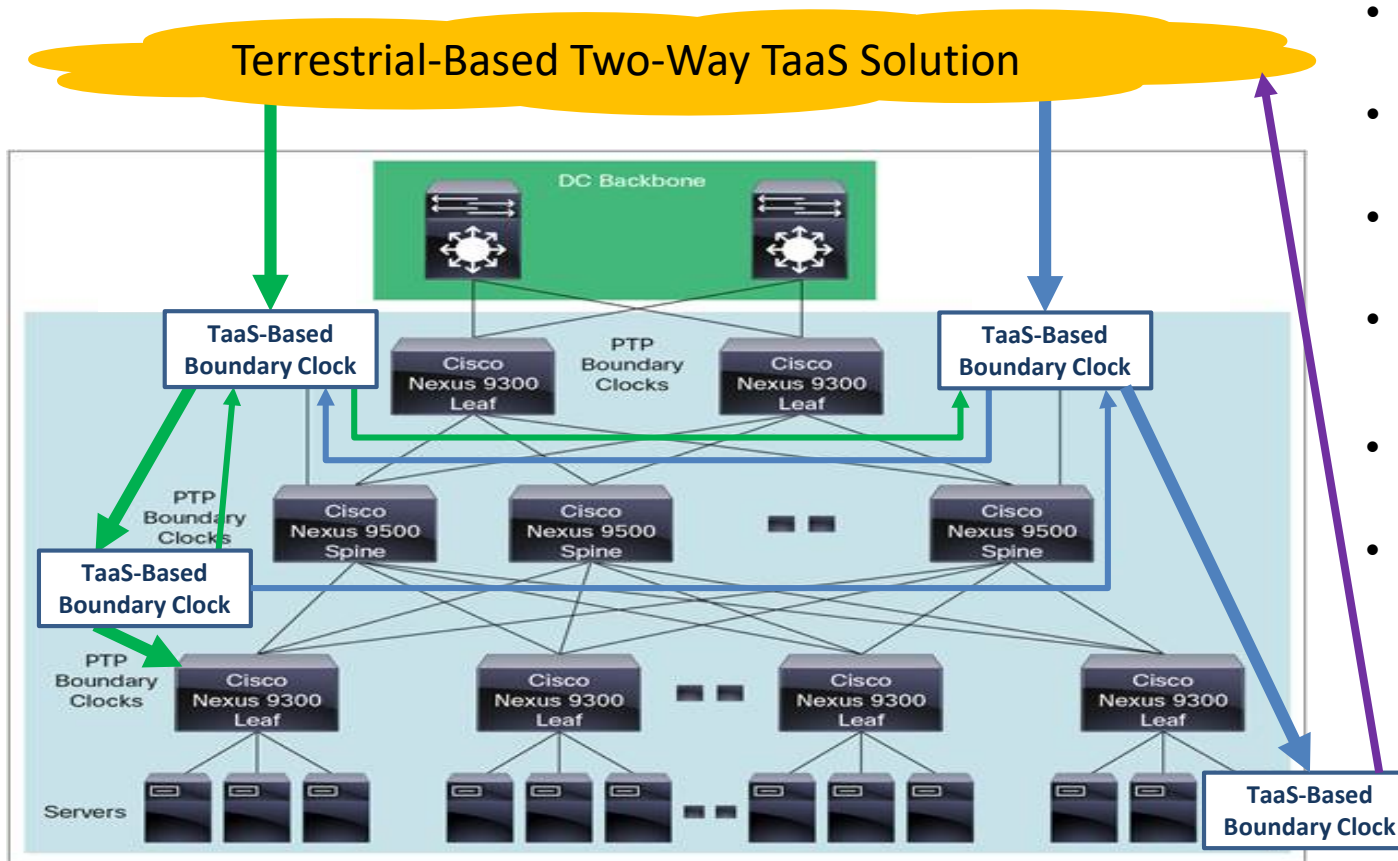
Operation via Smart Contracts?

Store results on TaaS DLT?

*Graphic from Cisco White Paper

https://www.cisco.com/c/en/us/products/collateral/switches/nexus-9000-series-switches/white-paper-c11-733921.html#_Toc413144456

Natural Extensions to Take it Further?



- Increasing Levels of Accuracy
- Increasing Levels of Reliability
- Increasing Levels of Veracity
- ... with the Potential to Do More
- **Also Including Potential Placement on TaaS DLT**
- **Including Sharable to Regulators**

*Graphic from Cisco White Paper

https://www.cisco.com/c/en/us/products/collateral/switches/nexus-9000-series-switches/white-paper-c11-733921.html#_Toc413144456

Further Still?

- Add customers' timestamp of their data from within their servers, also providing verification of timestamps to DLT
- All with common point of entry for time providers, time users, and regulators
- All delivered to the market as “Compliance as a Service” (CaaS)

Conclusions

- Dual-direction time distribution provides significant advantages over one-way only, including enhanced ability to prove veracity
- Use of DLT to securely store and retrieve full lifecycle data appears to be a natural in support of high performance, SLA-Based TaaS
- The same dual-direction mechanisms and DLT-based data capture are readily extendable to customer location time distribution and assurance
- To consider, benefits and techniques to also leverage for customers' timestamped results

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