

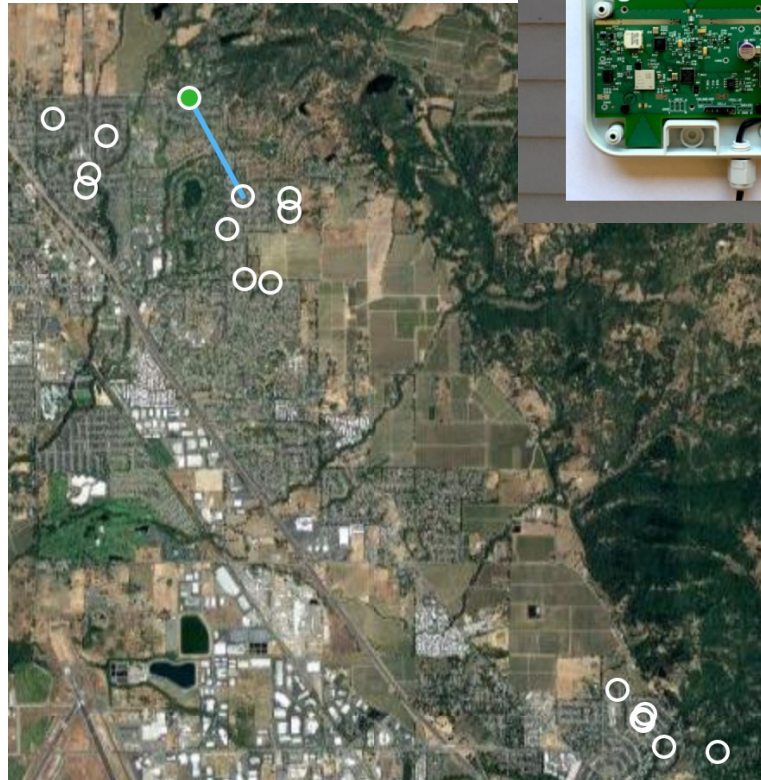
Distributed Transaction Ledger for Utility-Scale Solar

A PROPOSED COLLABORATION BETWEEN OPERANT
SOLAR CORPORATION AND UCLA

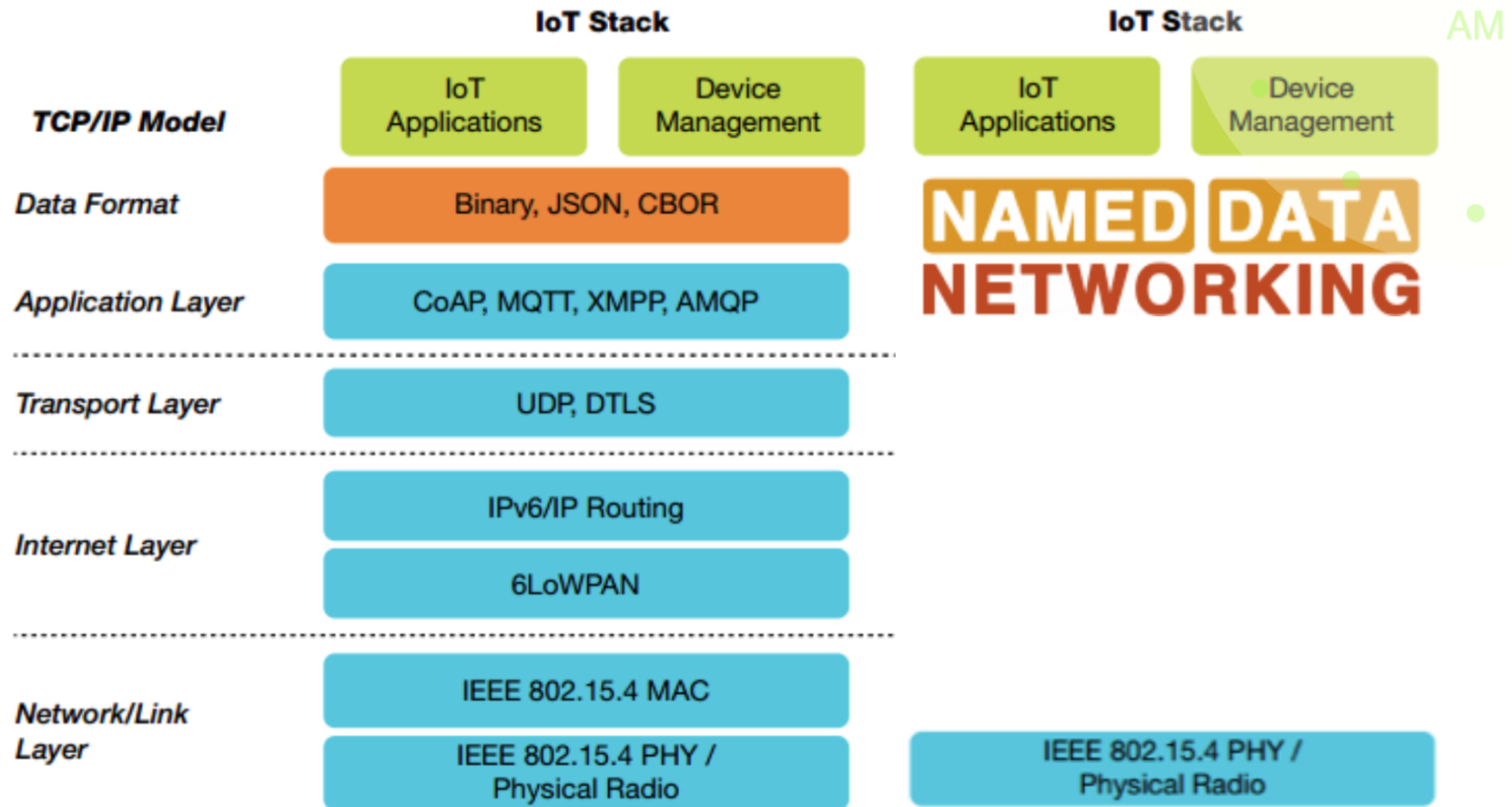
Background: Operant Solar

- ◇ funded under US Dept of Energy SunShot program
- ◇ Operant gateway has primary cellular link/ WiFi/LoRa wireless mesh (½ to 5 mile range)
- ◇ Provides inexpensive, secure, resilient communication at low data rate (small packets)
- ◇ Implemented using NDN with geo forwarding

**Proven Pilot Network
with >99.3% Reliability**



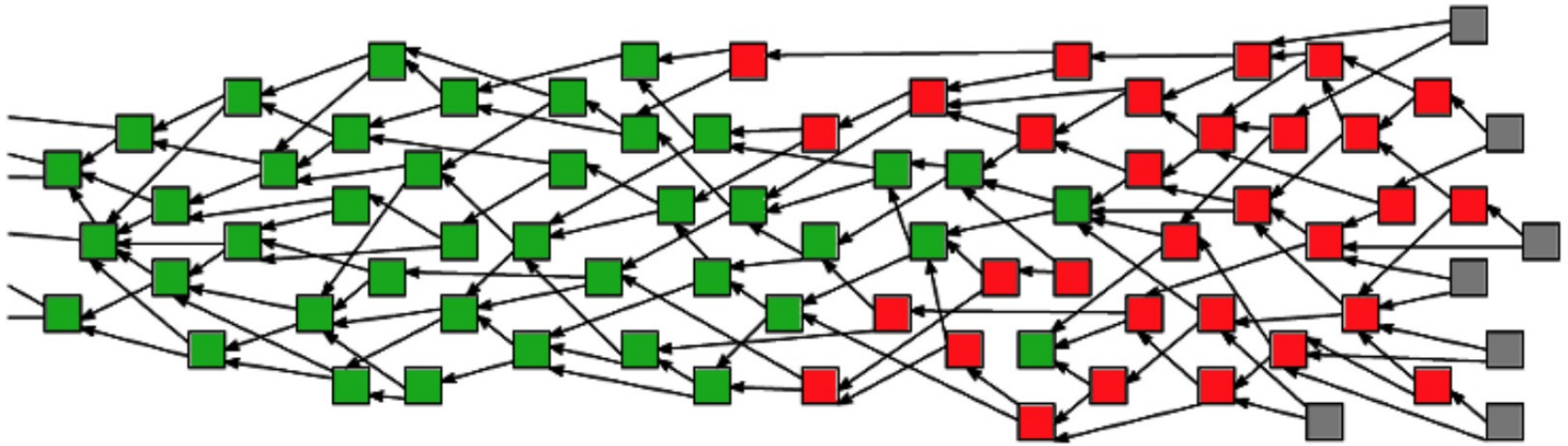
Comparison: different protocol stacks



Integrating Blockchain technology

- ◇ National electric grid is critical infrastructure and utility solar is deeply integrated as project sizes become larger
- ◇ Using Blockchain technology to create a distributed immutable transaction ledger
 - Storing energy production data
 - Financial partnerships of large solar are complex and records must have business integrity
 - Making utility control signals and site alarms permanently and securely available for review to detect intrusion after the fact
- ◇ Expecting to significantly improve security for utility and commercial solar projects

IOTA – “Next generation Blockchain”



- ◇ *Scalable, lower POW, survives offline periods*
- ◇ *Grey blocks: leaves*
- ◇ *Red blocks: have been endorsed by other nodes*
- ◇ *Green blocks: have been indirectly referenced by ALL the grey blocks*

Transaction process in IOTA: a 3-step process

- ◇ Signing the transaction inputs
- ◇ Tip Selection: use MCMC (Markov chain Monte Carlo) to randomly select two tips (i.e. unconfirmed transactions), have your transaction refer to them
- ◇ Proof of Work: In order to have your transaction accepted by the network, you need to do some **Proof of Work**

Operant: replacing POW with Proof of Authentication (POA)

- ◇ Replace anonymity with a proof of identity
 - appropriate for the use case
- ◇ Operant gateway design already assigns each node (running NDN) security certificate
 - Used to sign each transaction
- ◇ A strong synergy between the existing work and this proposed POA-based ledger.
- ◇ Plan: integrate the POA ledger into the gateway and demonstrate the resulting system in a live mesh network.

Transaction process in Operant

- ◇ Find two selected tips and check their validity
- ◇ Pack the transaction info, referred tip names + hashes into an NDN data packet
 - All NDN data packets are crypto-secured by design
- ◇ Publish the data packet and inform others.
 - utilizing NDN native multicast delivery and Sync to reliably propagate all updates to all nodes

Our advantages

- ◇ POA: a digital signature verification, much less processing intensive
- ◇ POA invites identity into the system
 - all peers monitor each other's transaction
 - Using app-specific info to reason about whether a device's transaction is valid, to detect misbehavior intrusion.
- ◇ Plan to use the ledger to record the misbehavior report
 - so that a compromised device will not be trusted in the future

Unique feature in proposed solution

- ◇ The ledger is implemented precisely at the point of generation (the solar equipment)
- ◇ Compared with IOTA based on TCP/IP: our solution is self-contained
 - No need to maintain the IP addresses of other nodes
 - don't need external means for transaction dissemination

Real world wireless link demo