Blockchain for Optimized Security and Energy Management (BLOSEM)

Spring FE Project Review Meeting – May 19, 2021
David Tucker, NETL
Grant Johnson, Ames Laboratory
Agenda

➢ Project Objectives
➢ Energy Use Cases
➢ Unified Testing Platform
➢ BLOSEM Use Case Demonstrations
➢ Current State of Blockchain Research
BLOSEM Goals & Objectives

Blockchain for Optimized Security and Energy Management (BLOSEM)

- **Create a multi-lab, unified testing platform (BLOSEM UTP)** that has interoperability to support a wide variety of blockchains. This testing environment will be representative of the modern grid of the future by encompassing generation, transmission, distribution, and end user (edge) for the electric grid.

- **Identify and implement specific use cases** that leverage inherent features of blockchain & ledger-based technologies to prevent, detect, and mitigate cyber-attacks.

- **Accelerate the pipeline of validated cyber-physical security concepts** from laboratory to utility sector, de-risking through standardized metrics and testing.

**GMLC Project 5.2.3**: Secure Communications of Information used for Grid Operations, for Normal Operations, and/or during Emergency Response

**Sponsors:**

BLOSEM Project Status

Use Case Selection

Preliminary Design

Detailed Design

Implementation

Demonstration

Conclusion

Today
USE CASE DOWN SELECTION
# Energy Blockchain Use Cases

<table>
<thead>
<tr>
<th>Utility Communications and Configuration Management</th>
<th>Device/Sensor Coordination and Data Integrity</th>
<th>Supply Chain</th>
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<tr>
<td>1 SDN for control center and substation coordination (Sub-case #1)</td>
<td>5 Grid automation, sensor integration, autonomous data acquisition from grid assets</td>
<td>10 Secure ID (Identity Management)</td>
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<td>11 Supply Chain Security, Life Cycle Monitoring, and Real-time Auditing</td>
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<td>3 Remote DER Control and Coordination</td>
<td>7 Create an access protected and immutable library of Process Knowledge</td>
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<td>13 Optimizing Restart from System Interruptions (blackstart, black sky, etc.)</td>
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<td><strong>Market</strong></td>
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<td>14 Grid Services Marketplace (Energy Focus)</td>
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<td>Utility Communications and Configuration Management</td>
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<td>Grid Services Marketplace (Energy Focus)</td>
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Final Selection of Use Cases

Supply Chain Security, Life Cycle Monitoring, and Real-time Auditing

- Improve asset lifecycle tracking process by logging events that change the configuration and relevance of an asset to operations
- Valid for manufacturer to delivery to install to maintenance to decommissioning
- Timescale: Event-driven

DER Coordination and Control: Supporting Secure Wholesale Market Participation and Information Exchange with Generation

- Facilitate DER aggregators (DERA) bidding into both the day-ahead (DA) and real-time (RT) energy markets
- Validate that expected performance of the DERA does not cause challenges for secure distribution system operation
- Timescale: minutes; hours/day

Dynamic Controls of Demand Response from Generation

- Facilitate dynamic controls for generation application by improving authenticity & integrity of change requests to operations
- Valid for responding to load demand changes and frequency regulation
- Timescale: Seconds; Continuous
BLOSEM UNIFIED TESTING PLATFORM
Objectives:
Enable the project goal of de-risking and accelerating Blockchain applications for energy systems:

• Enable the ability to rapidly connect blockchain solutions with grid emulation environments, including hardware-in-the-loop and co-simulation configurations
• Decouple the dependencies of the specific blockchain under test to enable modularity, interoperability, and reusability to more rapidly connect and evaluate diverse blockchain solutions
• Develop core functionality to enable the flow of data and commands in a use case agnostic manner, easily extendible to new grid emulation system configurations

Core Functional Responsibilities:

• Connectivity
  – Communication interfaces for providing the incoming/outgoing requests and events
• Control and Data Flow
  – Platform for enabling the flow of information. Extends interfaces to process and route from source to destination.
• Time Synchronization and Management
  – Enable the coordination of time within asynchronous, concurrent environments that may need to synchronize for shared data and operations.
• Testing Infrastructure
  – Platform for hosting, recording, and analyzing the testing metrics for the Blockchain and the Use Case
• System Automation and Data Orchestration
  – Enabling configurability and automation of defining resources and connections within the BLOSEM environment.
UTP Core Component Responsibilities

- **Blockchain Nodes**
- **Blockchain Networks**
- **Network Services Exchange**
- **Blockchain Node or Network Services**

**UTP Core**

1. **Connectivity**
   - Blockchain & Lab

2. **Control & Data Flow**
   - Blockchain, Co-Simulation, & Lab

3. **Timing**
   - Blockchain, Co-Simulation, & Lab

4. **Testing**
   - Blockchain & Use Case

5. **Orchestration**
   - Configure & Deploy

**Grid Emulation**

- **Network Services Exchange**
- **Grid Emulation Networks**
- **Grid Emulation Node or Network Services**
- **Grid Emulation Nodes**
Providing logging and application infrastructure for measuring the performance of a blockchain solution to meet the needs of use case tasks

Preliminary categories of testing metrics:

- Latency
- Throughput
- Repeatability
- Failure Rate
- Scalability
- Transaction Scheduling
- Privacy
- Security
USE CASE – SUPPLY CHAIN
Use Case Research Goals:
• Is the device or software that shipped the same asset that was received?
• Is the device or software deployed in operations the same asset that continues to be installed and operating?
• What is the risk introduced and the urgency of remediation when a vulnerability has been discovered or a cyber incident has occurred?
  • Can this traceability and risk assessment be applied to hardware and software sub-components?
• What vulnerability and cyber incident information is required to be shared broadly across organizations, and what must be kept to sharing within sub-groups of the network stakeholders?

Use Case Pain Point Objectives:
• Asset information isn’t trusted or traceable.
• Asset tampering, cloning, and imposter device
• Missing or limited asset information
• Asset vulnerability and/or cyber threat issues aren’t widely shared.
• Not all information is digitized.
• Opportunity to automate the impact assessment of a cyber incident or vulnerability
Supply Chain – Implementation Plans

➢ Digital Objects for Lifecycle Information
  • Catalog Assets
    o Vendor published device definition – HW/SW subcomponents and linked to vulnerabilities
  • Operations Assets
    o Operationally deployed asset with installation details and custom configurations
  • Vulnerability Events
    o Participant disclosed metadata linked to a Catalog item
  • Maintenance Events
    o Logging changes to the configuration of an operationally deployed asset (e.g. repairs, updates, location, etc.)

➢ Applying to three categories of assets:
  • Software Applications
    o Executables and dependencies installed in operations
  • Embedded Systems
    o Electrical, mechanical, and embedded software sub-components
  • Hardware Only Sensors
    o Supplementing with compute to participate

➢ Embedding functions for challenge/response re-verification of device hosted configuration
Supply Chain – Blockchain Architecture

Ordering Organization

Vendor Organization

Utility Organization

Regulator / Threat Info Provider Organization

MSP

CA
Users
Admins
Affiliations

MSP

CA
Users
Admins
Affiliations

MSP

CA
Users
Admins
Affiliations

Catalog Asset
API
Express JS

Vulnerability
Event
API
Express JS

Operations Asset
API
Express JS

Maintenance
Event
API
Express JS

Notify
Verify
Verify
### Supply Chain – Metadata Discussion

#### Hardware Bill of Materials for logic bearing components

#### Software Bill of Materials for NTIA minimum fields and dependency relationships
- NTIA minimum fields

#### Communication – Port / Protocol for automating network control

#### Installation Metadata for automating Risk assessment decisions
- Owner
- Location – Site ID, Business Unit
- Impact – PERA Zone, Category, Classification

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USE CASE – DER COORDINATION & CONTROLS
DER Coordination Use Case
DER Coordination Scope & Objectives

Objectives:
- Examine and demonstrate BLOSEM platform components for blockchain-based grid operations use-cases.
- Facilitate distributed communications architecture across disparate DER owners and energy entities.
- Establish trust anchors with integrity and confidentiality through blockchain in a trustless environment.

In Scope:
- Flexible access controls + address grid constraints
- Address tier-bypassing (FERC Order 2222)
  - Double-counting, distribution factor
- Contract mediation (delegation of control authority)
- Communication with utility-owned generation

Out of Scope:
- Control system design (leverage from existing work)
- Non-FERC 2222 architectures
- Peer-to-peer markets (markets in general)

Entities in Scope:
- Distributed Energy Resource (DER) owners – through lab resources
- DER Aggregators (DERA)
- Distributed System Operators (DSO)
- Utility owned generation
- Independent System Operators (ISO) / Regional Transmission Operators (RTO) – No SCUC/SCED modeled
CURRENT STATE OF BLOCKCHAIN RESEARCH
Activities

• Literature review/survey of blockchain projects
• Mapping use cases to BLOSEM categorization matrix

Scopes

Blockchain projects and R&D efforts within U.S. DOE and U.S. Power utility industries

A Survey of Blockchain Research & Development Activities

Outcomes

• BLOSEM Categorization Matrix; Energy System Domains and Blockchain Properties
• R&D Opportunities and Recommendations
• Early September – submission for journal publication
CONCLUSION
- BLOSEM team seeks to create a multi-lab, unified testing platform (BLOSEM UTP) that has interoperability to support a wide variety of blockchains and accelerate the pipeline of security solutions from laboratory to industry.

- Surveyed and down selected Energy use cases of Blockchain
  - Inputs collected from within the project team, industry advisors, and DOE program managers
  - Delivered the Use Case Milestone Report in September 2020

- Developing a Unified Testing Platform to rapidly connect new use cases to laboratory grid emulation environments and evaluate new blockchain solutions
  - Abstracting Blockchain connections from Laboratory components
  - Designing evaluation frameworks for Use Case fit to a Blockchain under test
  - Closed the Preliminary Design Requirements Review in February 2021

- Publishing a journal article for the current state of Blockchain energy research and a framework for assessing the Blockchain research portfolio
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Thank you!

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