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SIEGate

Secure Information Exchange Gateway

DOE - Cybersecurity for Energy Delivery Systems

GPA User's Forum – August 14, 2013

DOE Project -- SIEGate

Secure Information Exchange for Grid Operations

A generalized, security hardened appliance for the exchange of real-time grid operating information.

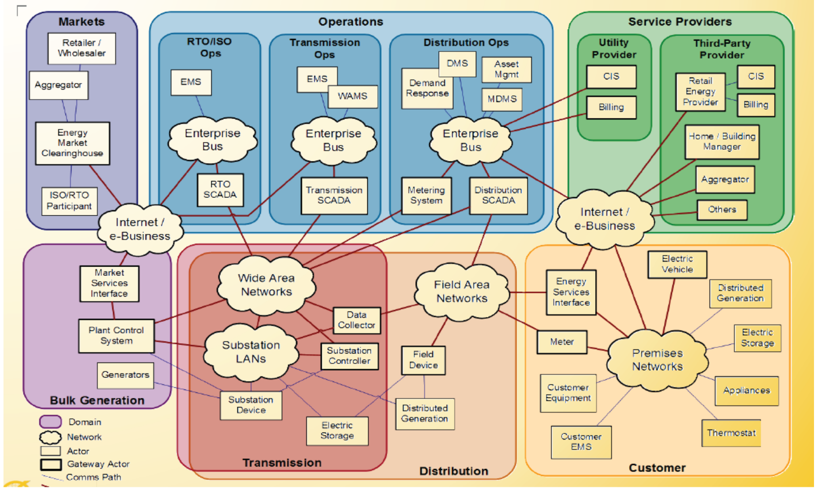
- Open source
- Productized by Alstom
- Security tested by PNNL
- Demonstrated by PJM
- NERC provides cost share via NASPI project

DE-OE536

SIEGate: Technical Approach and Feasibility

- **Current Situation**
  - Complex communication interactions using multiple protocols, many without security
  - Need a unified secure communication mechanism

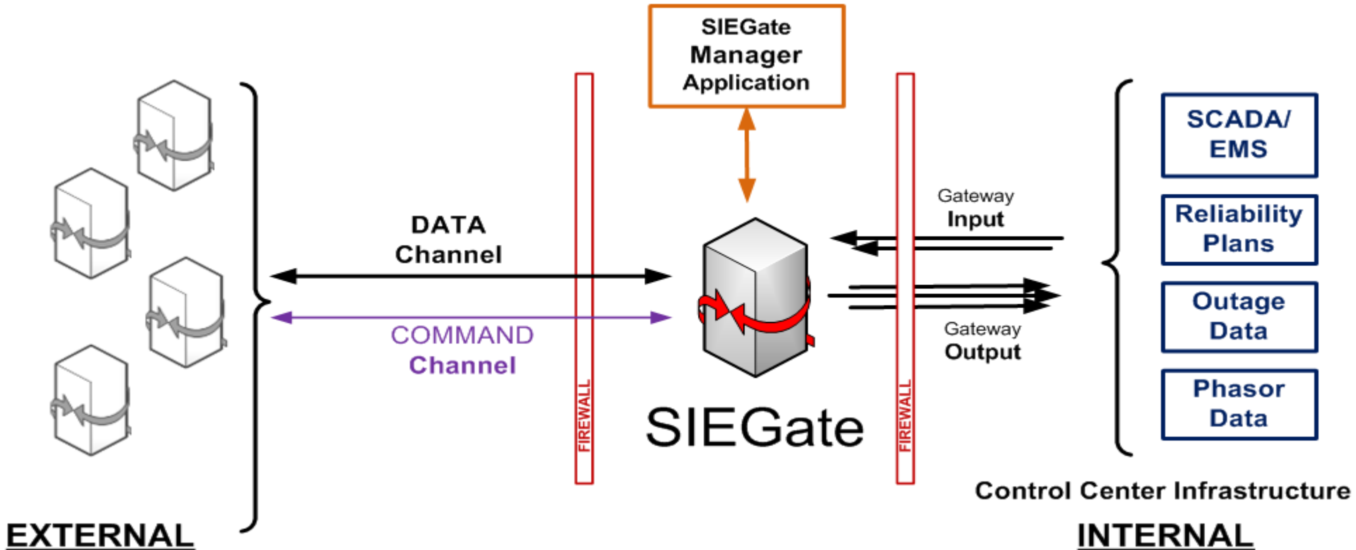
Smart Grid Architecture (Source: NIST)



- **Development Approach**
  - **Security built throughout**
    - Defense in depth
  - **High Performance**
    - Real-time, Built to purpose, Reliable, Flexible
  - **Multiple Protocols**
    SCADA, Synchrophasors, File-based
  - **Free, Open Source**
    Accelerated innovation
    Unencumbered commercialization
    Proven foundational codebase

SIEGate: Technical Approach and Feasibility

- **SIEGate adds value for grid operators**
  - Reduces configuration management costs
  - Improves security posture through a single point of interface
  - Reduces risk of non-compliance



Two Development Versions

- **Engine Development (ED) Version**
  - Incorporates a new "advanced core" that improves internal system security
  - Available as source-code for download
  - Currently undergoing refinement and testing
- **Feature Development (FD) Version**
  - Includes all the features and functionality of SIEGate with the exception of the "advanced core"
  - Ready for use and evaluation within pre-production control center environments
  - Release Candidate 2 posted and available for download and installation

Feature Development Release Candidate

- **Support for Multiple Data Classes**
  - Real-time data, e.g., SCADA and phasor data
  - File-based data exchange
  - Notifications for broadcast to all nodes
- **TLS Connections for SIEGate data exchange**
- **Tools to setup trusted SIEGate unions and to automate configuration synchronization**
- **Many improvements over the openPG in management and configuration**
- **Built using new .NET 4.5 Grid Solutions Framework**

With Release of “FD” Version of SIEGate, openPG has been retired

- **SIEGate provides all openPG functionality – and more.**
- **SIEGate has stronger security and better performance**
- **SIEGate is actively undergoing additional testing and refinement**

PNNL Testing (“ED” Version)

- **Test plan established**
  - Structured evaluation
    - Code review
    - Data validation
    - Key Management
  - Exploratory Tests
- **Review and testing initiated in June 2013**

PJM Demonstration (“FD” Version)

- **Demonstration plan developed**
  - Bench testing within PJM Lab
  - Data exchange between PJM & GPA
  - Security Testing
  - Optionally, data exchange with others
- **Installation scheduled for August 29th**

Entergy-TVA-MISO Implementation

- **SIEGate (FD) Release Candidate 2 in service at Entergy and TVA as of August 6, 2013**
- **No issues discovered in installation or configuration**
- **TVA Gateway configured so that Entergy may subscribe to any of approximately 800 measurements from TVA**
- **SIEGate installed at MISO and is being configured for exchange of phasor data with Entergy**

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SIEGate Technical Details

SIEGate: Summary

- **Objective**

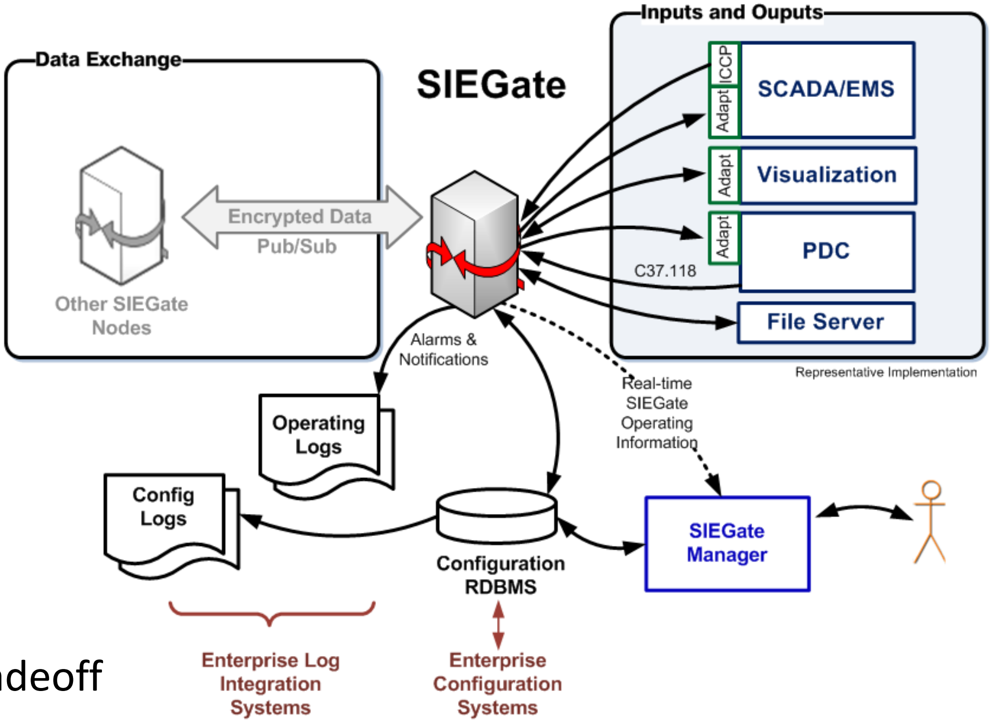
  To commercialize an appliance that enables the secure exchange of all types of reliability and market data among grid operating entities and provide a next-generation platform for GPA Open* products

- **Design Approach**
  - Lower risk by building upon the open source phasor gateway
  - Create an extensible platform
  - Design security throughout
  - Balance real-time and security needs
  - Conduct thorough bench tests to identify and fix security defects

- **Technical Goals**
  - Maintain time-series framework compatibility
  - Provide enhanced performance with new core
  - Leverage intelligent responsibility separation
- **Development Partners**
  - Grid Protection Alliance; University of Illinois
- **Test and Demonstration Partners**
  - Pacific Northwest National Laboratory, Alstom Grid, and PJM Interconnection

SIEGate: Technical Design Challenges

- **Performance given system complexity**
  - Support multiple data types efficiently and securely
  - Support multiple priorities
  - Minimize latency and maximize throughput
- **High availability assurance**
  - Horizontal and vertical scalability
  - SIEGate stability and reliability
  - Graceful performance degradation
- **Security assurance**
  - Maximize security performance
  - Minimize security breach impact
  - Configurable security levels
  - Security versus simplicity/usability tradeoff



Engine Development

- **Adapting SIEGate to core design principles**
  - Modular design
  - Single responsibility principle
  - Flexibility for easy adaptation
  - Enhanced security – from the ground up
    - Services, Locked-down installation, Hardened OS

SIEGate: Technical Design Principles

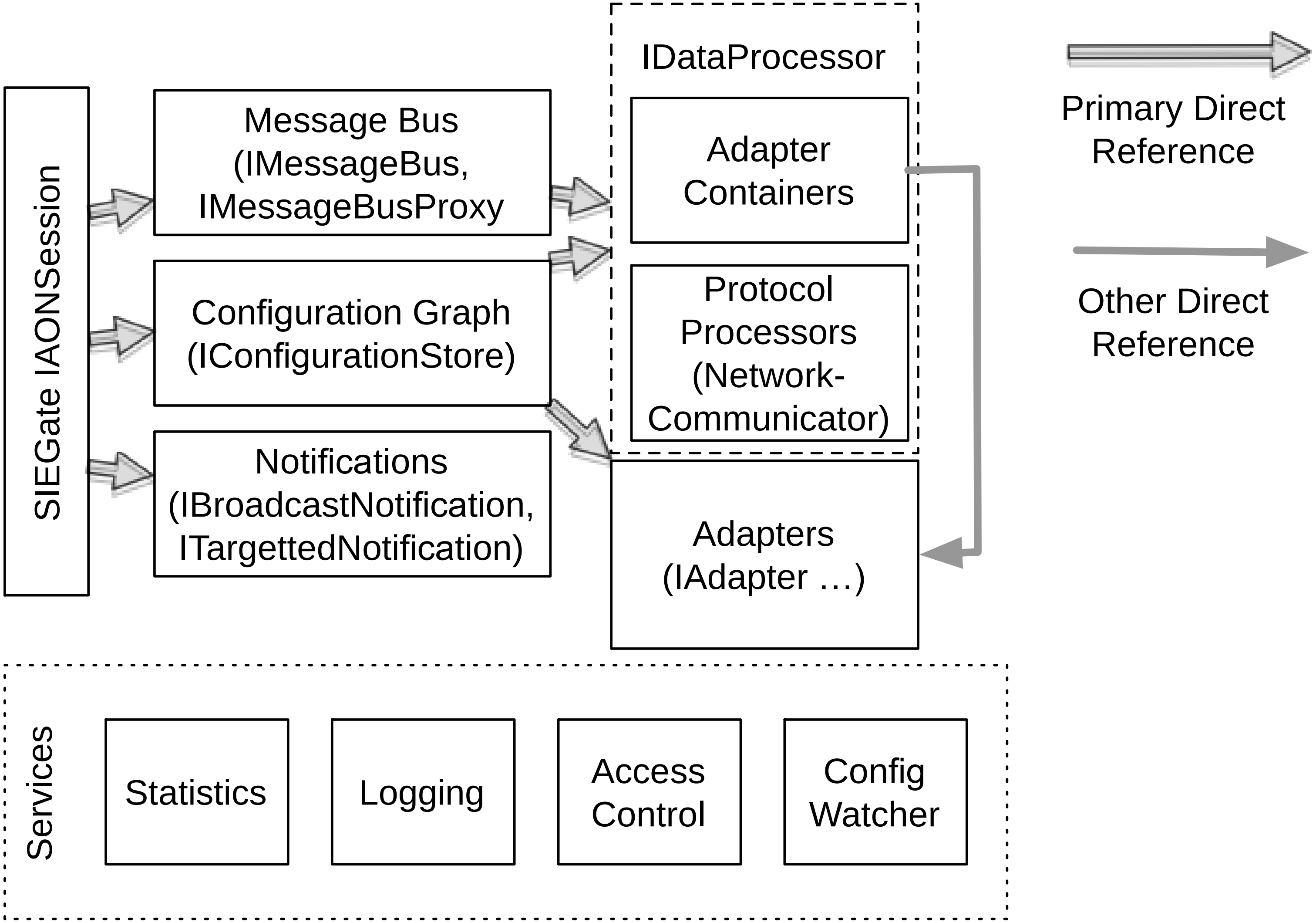
- Minimize thread-locking and contention
- Pre-compute criteria for decisions rather than on-the-fly
- Simplify resource access
- Choose heavy memory usage over heavy CPU
- Discard unneeded data as early as possible
- Provide extensibility & offloading
- Adhere to the single responsibility principle
- Maintain a layered approach to security and defenses
- Design components to operate with least privilege
- Leverage existing, tested components
- Pluggable component architecture

ENGINE DEVELOPMENT DEEP DIVE: MODULARITY IN CORE

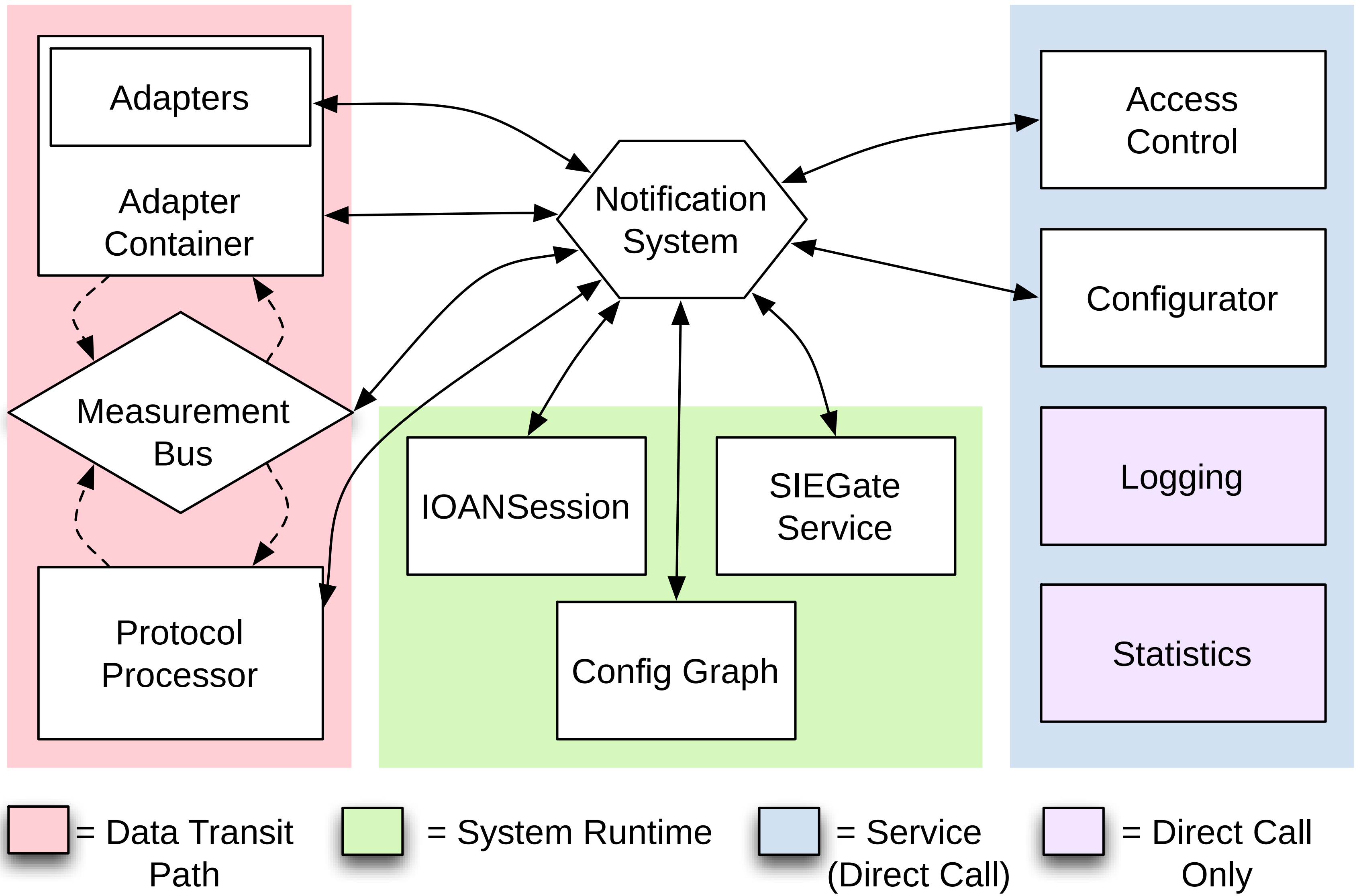
Modular Design Benefits (Development)

- **Increases flexibility**
  - Allows drop-in replacement of any component
  - Modules interface rather than intrude
- **Reduces code complexity**
  - Simplifies dependencies
  - Call graph has fewer "cycles"
  - Reduces "trampolining" between modules
- **Reduces coding errors**

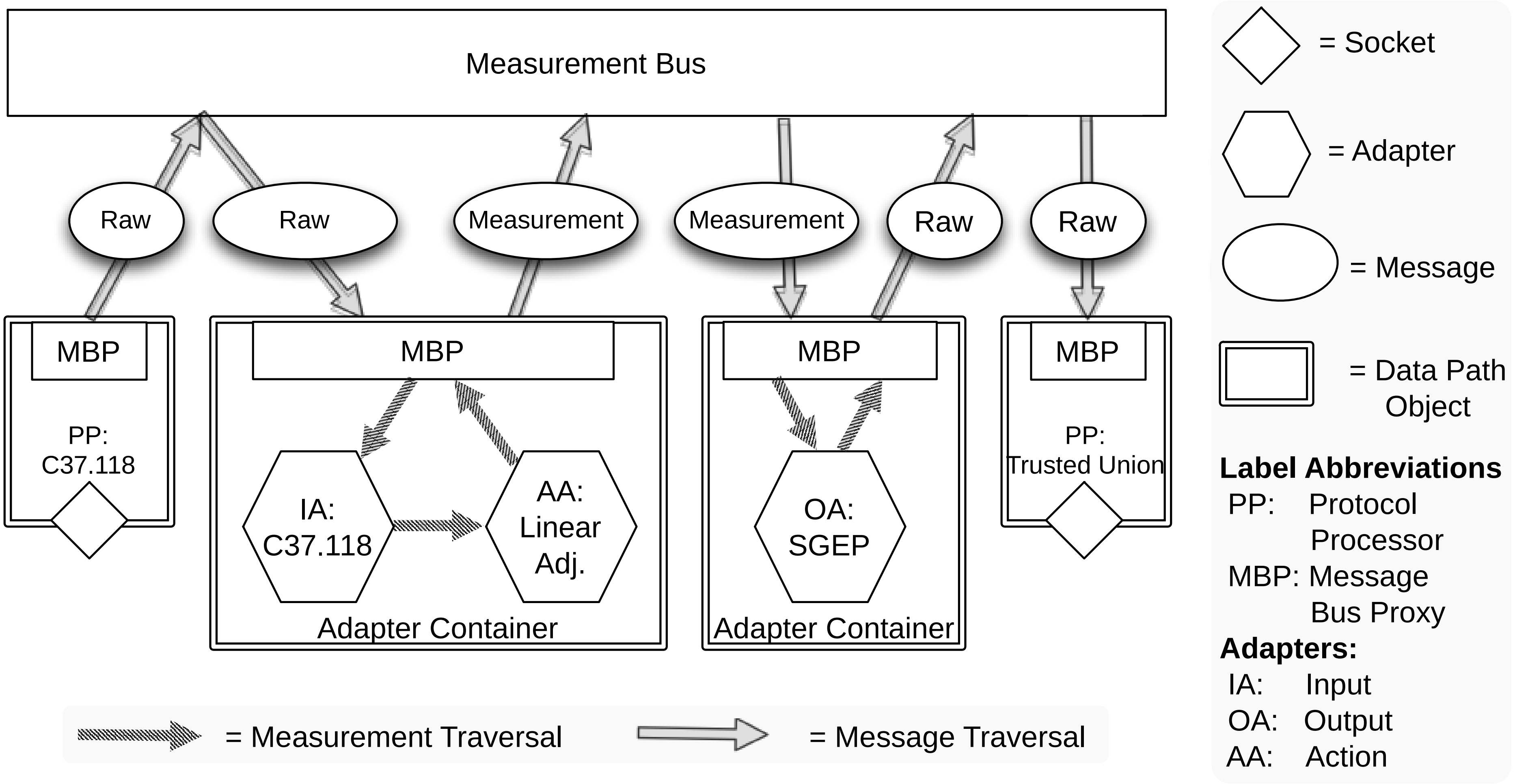
Modular Design



Decoupling the Data Path from Internal Messaging



Modular Data Path



Modular Design Benefits (Security)

- **Allows consistent policy application**
  - Access control is handled by a single service
  - No inconsistencies between how rules are applied
  - General credential service allows system wide revocation
- **Single Responsibility Principle**
  - Any defect occurs in only one code location
  - Any new security feature can be applied to everything immediately
- **Carefully restricted API to limit access**
  - Isolates functionality to minimize attack surface
  - Minimizes information leakage

Furthering Security via Modularity: Going forward with Engine Development

- **Assembly Separation**
  - Per assembly security capabilities
  - Limit code available to the runtime to reduce attack surface
- **Composability for deployment specific security choices**
  - Public vs. private transport considerations
  - Computation speed vs. data security
- **Extensible security modules for enterprise integration**
  - Corporate credential managers
  - Network access rules

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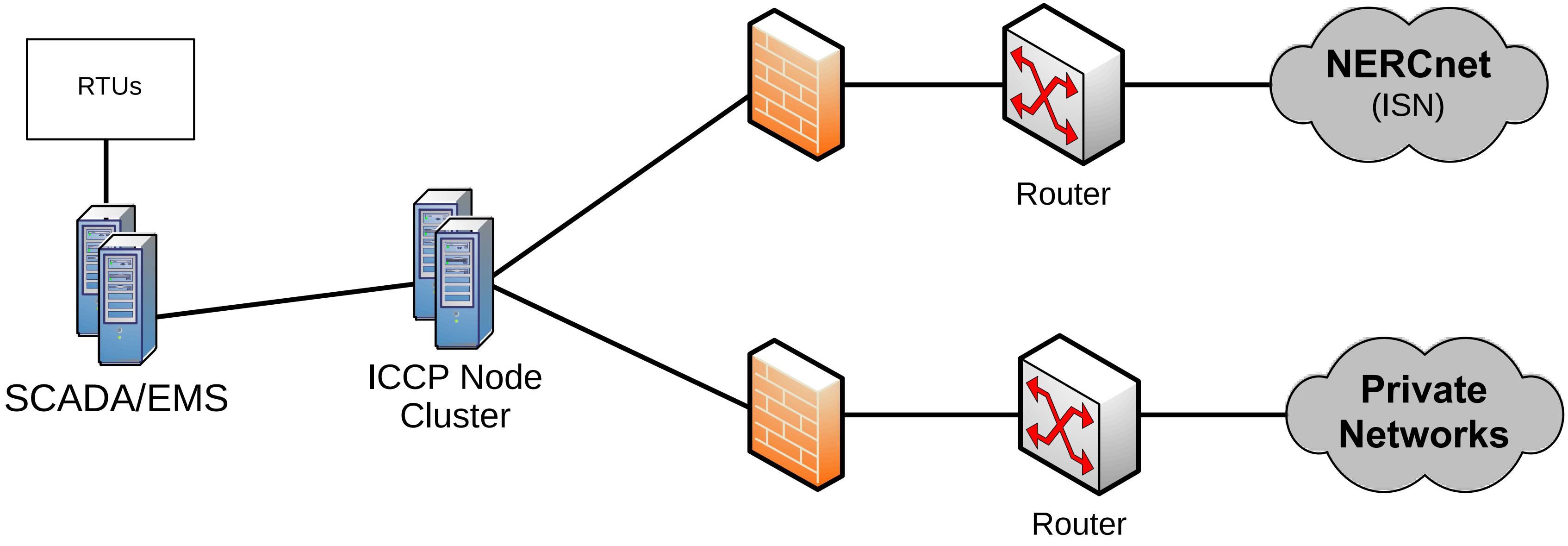
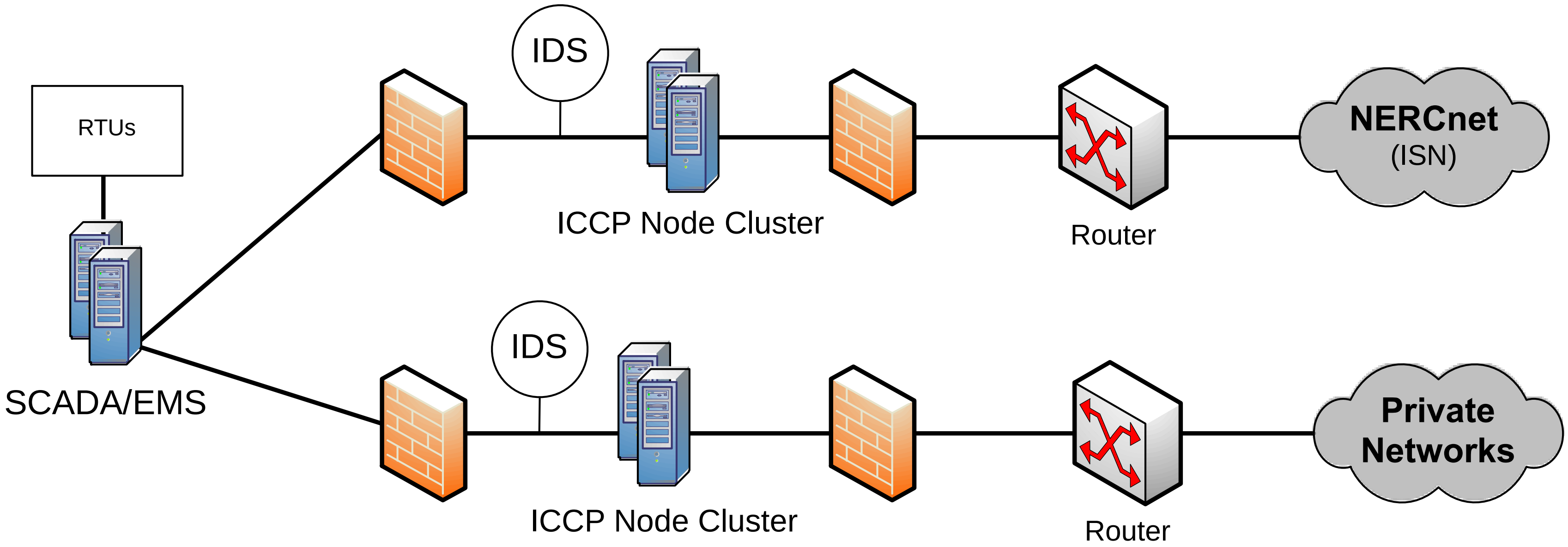
Deployment Architecture Discussion

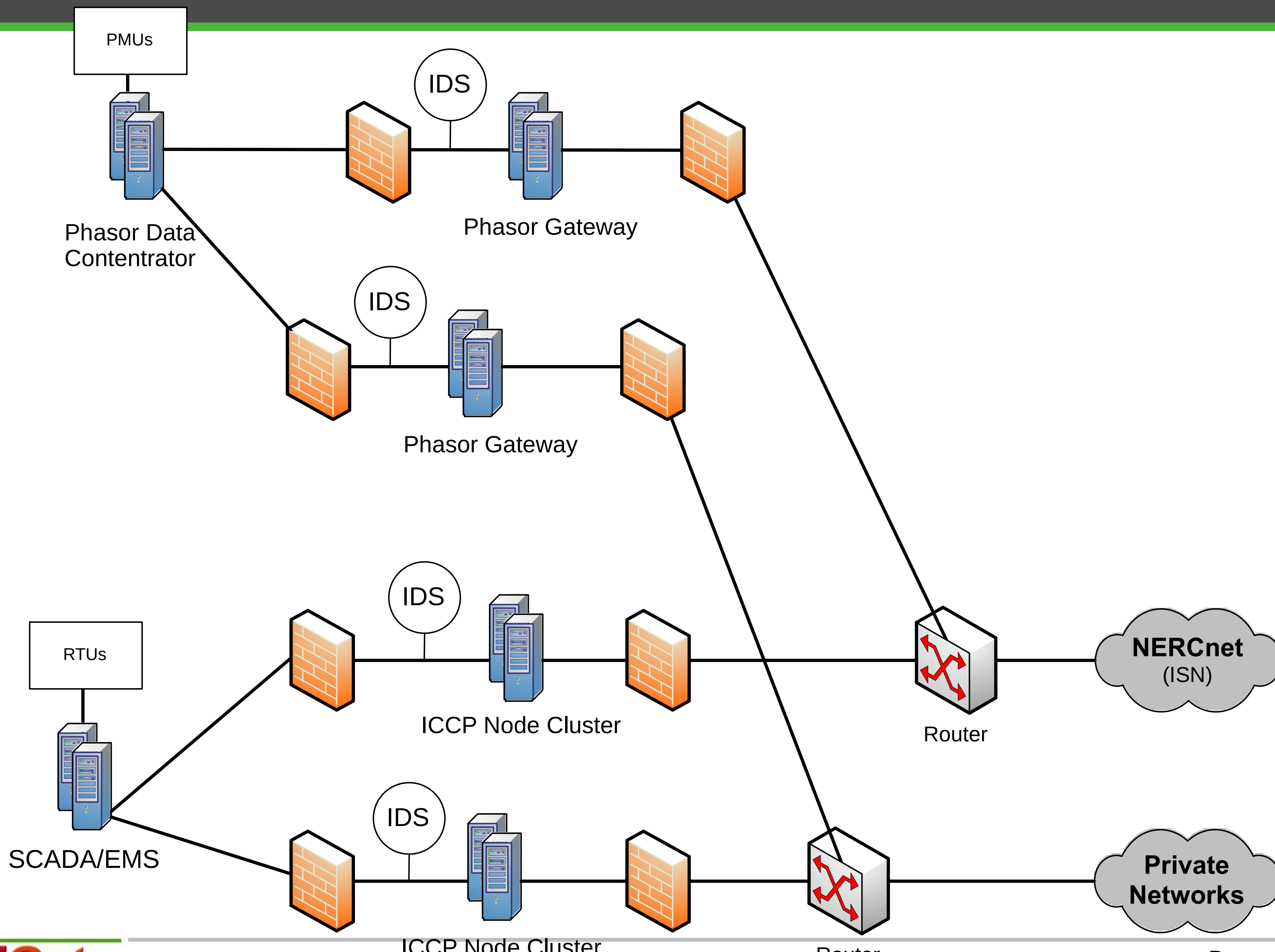
Legacy SCADA Architecture



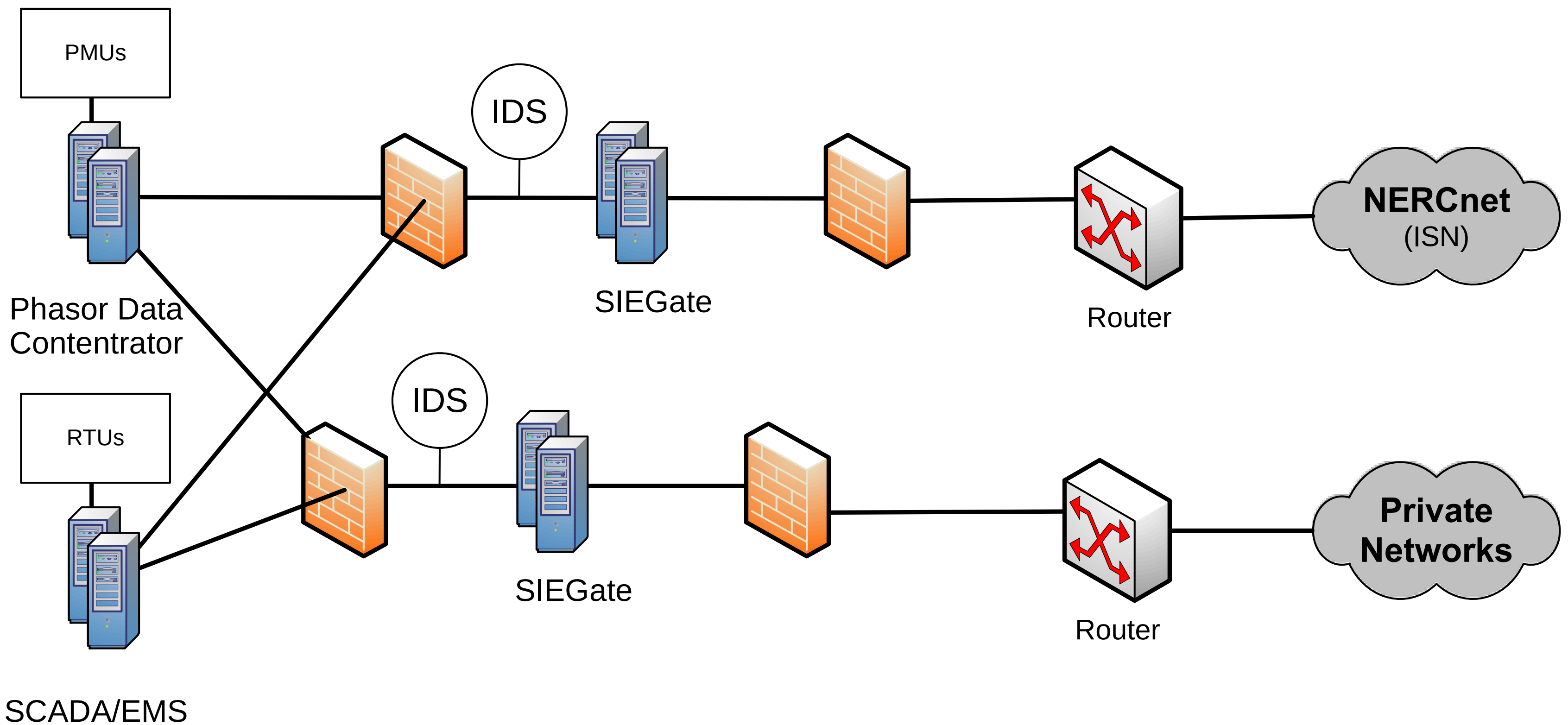
Modern SCADA Architecture



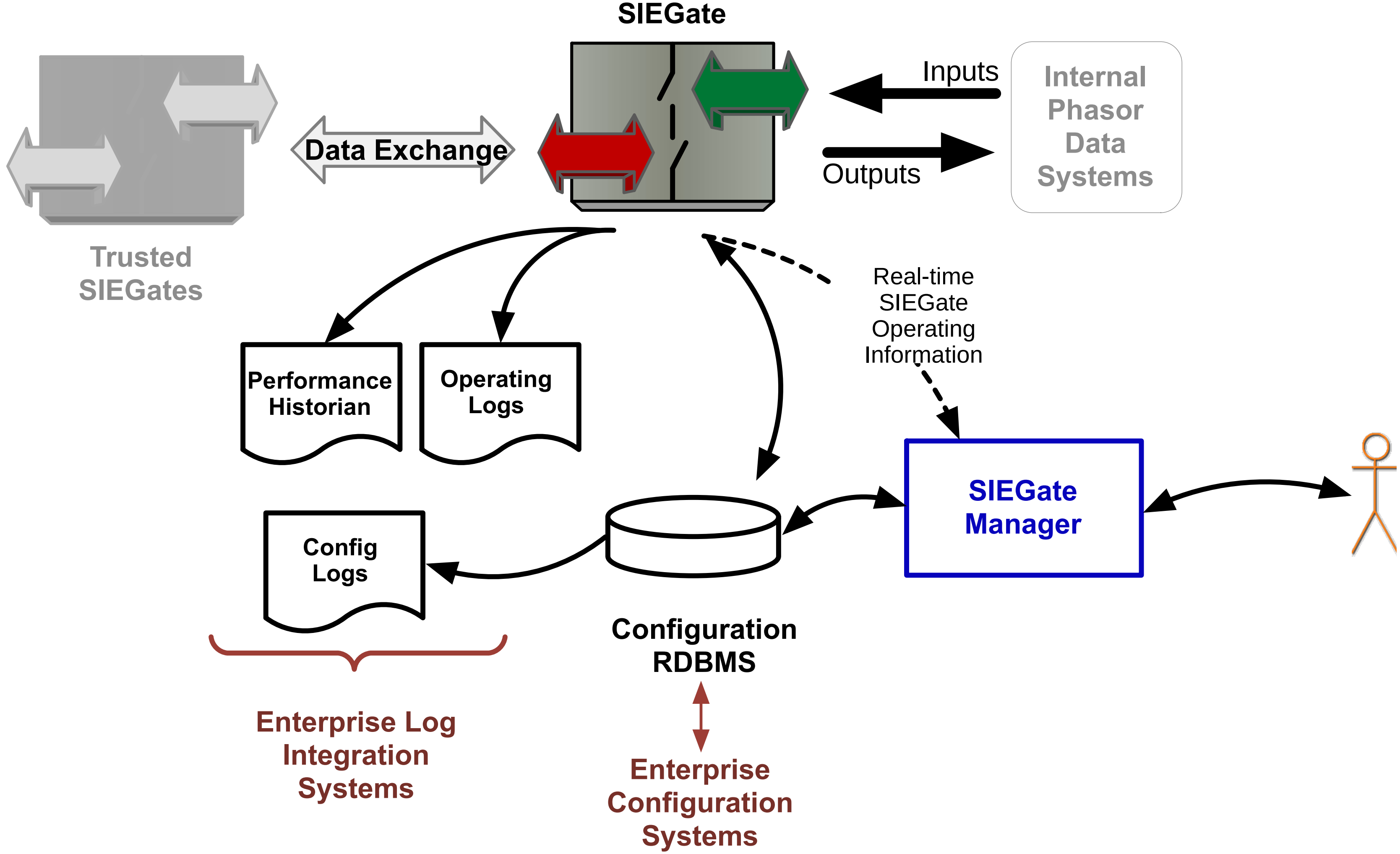
Incorporating Phasors



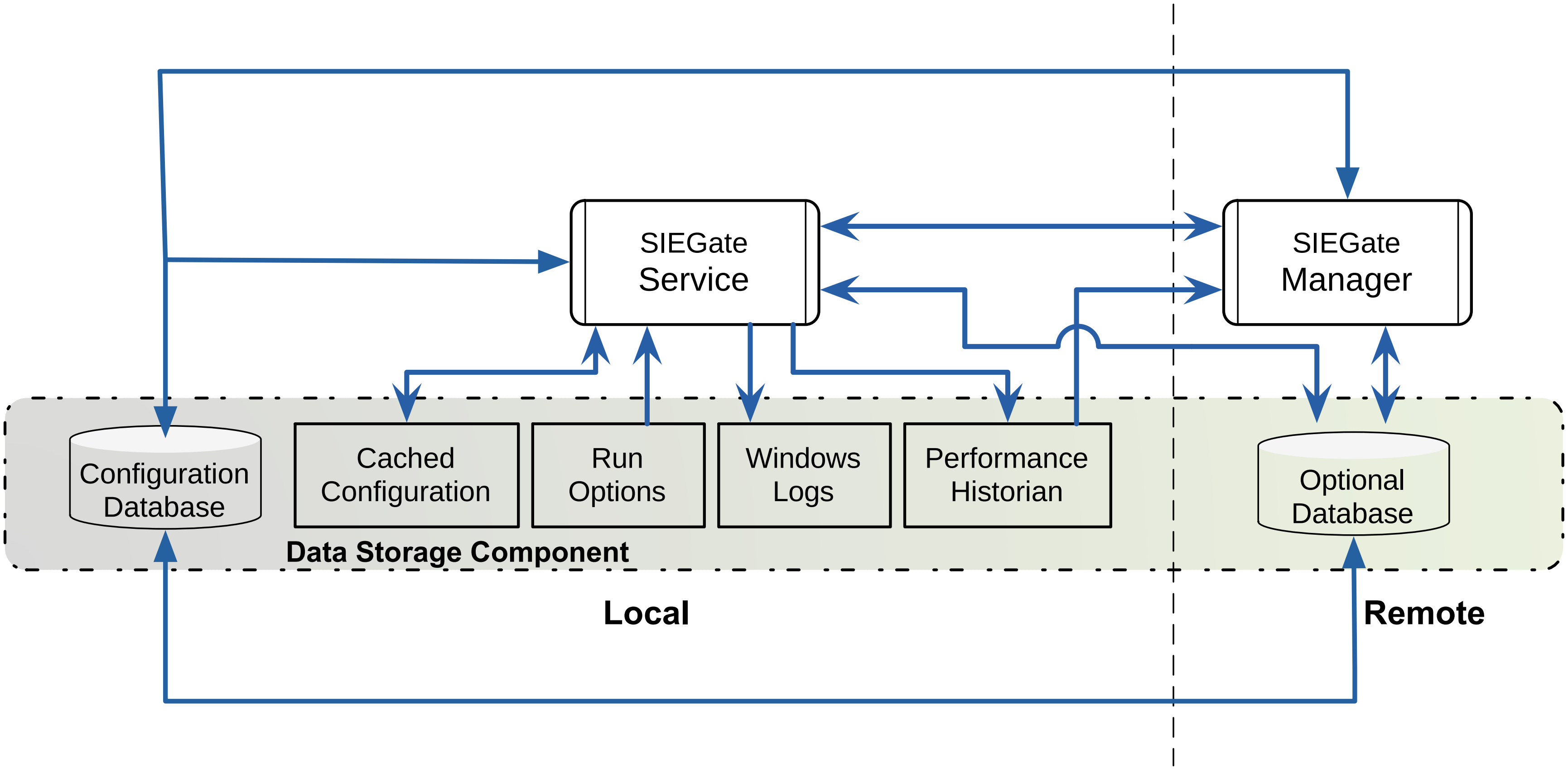
Simplifying with SIEGate



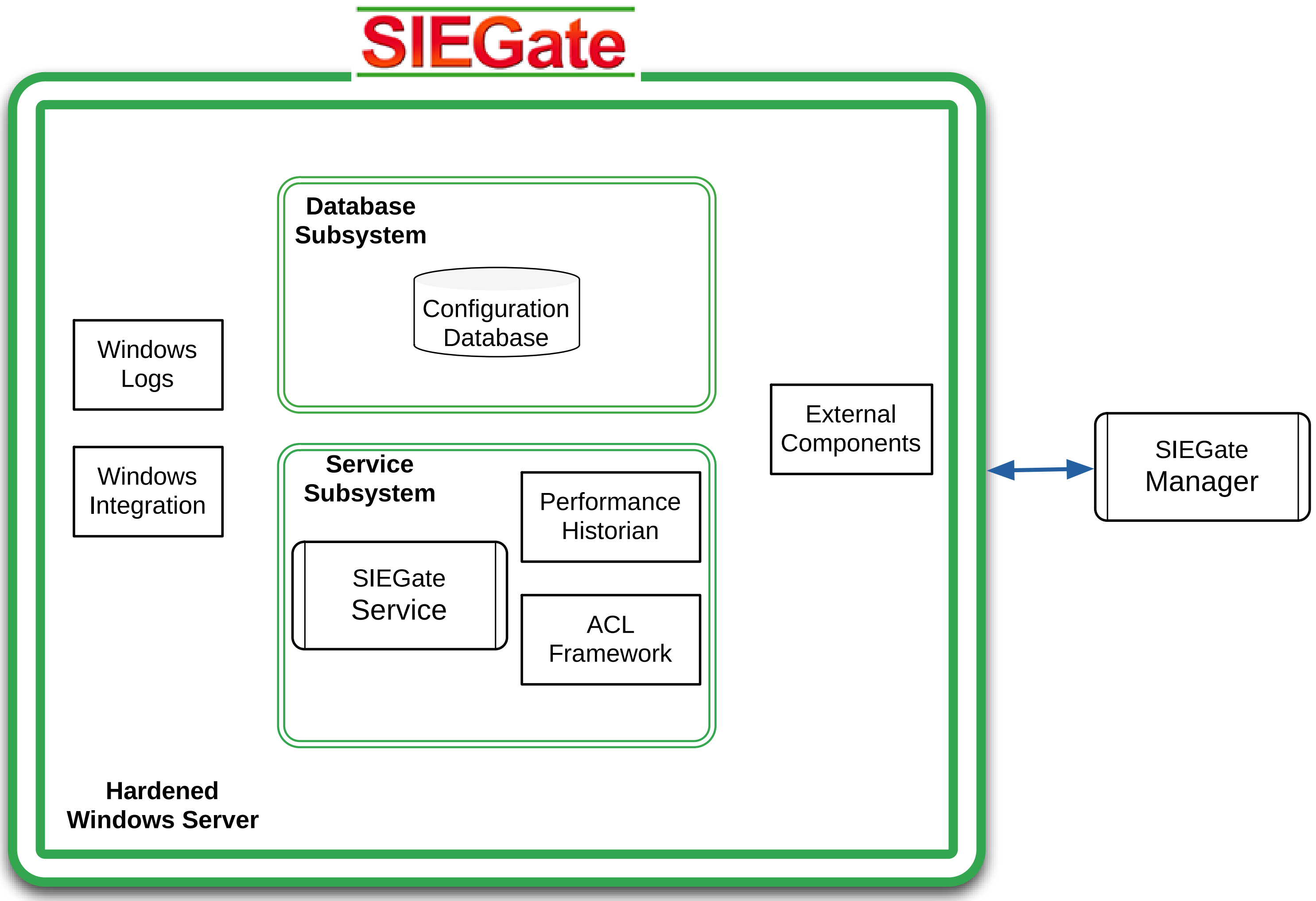
Basic Overview



System Breakdown

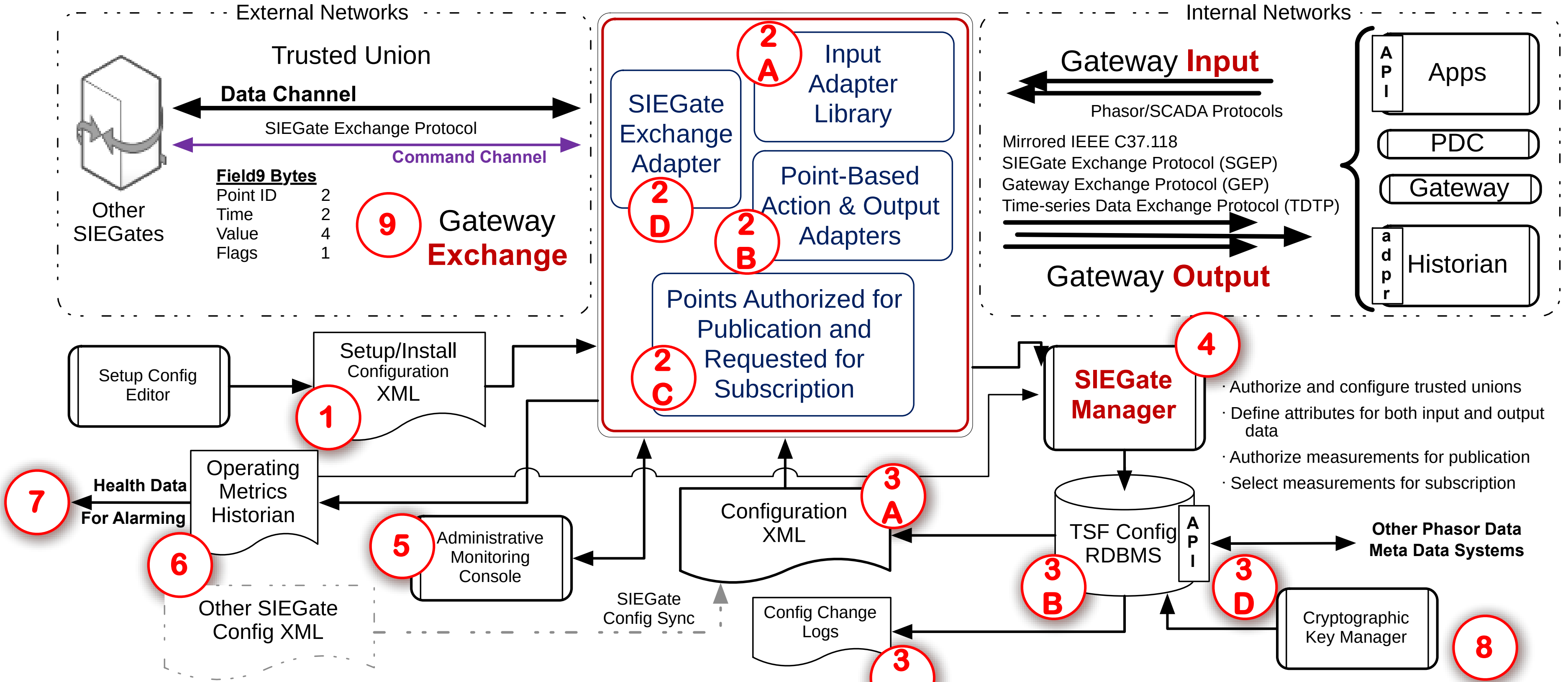


SIEGate Appliance



Detailed Architecture

SIEGate Service



SIEGate

Deployment Improvements

- **OpenPG**
  - Application-based install
  - Normal user privs.
  - Monolithic architecture
- **SIEGate**
  - Hardened OS
  - Composible components
  - User account restrictions
  - Application and Appliance installations
  - Windows Server 2008 R2 (standard and core)
  - Security policies for enterprise integration and audit

Future: Best Practice Guides

- **Coming soon…**
  - More granular security policies
  - Representative typical architectures
  - Guide on security related settings and what they mean for system security

… more (stay tuned)!