NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

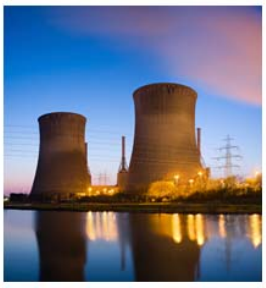
DRAFT

Cyber Security – Communications Between Control Centers

Implementation Guidance for CIP-012-1

~~November~~March~~,~~ 2018~~7~~

RELIABILITY | ACCOUNTABILITY

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Introduction

~~The Commission issued Order No. 822 on January 21, 2016. Order 822 approved seven CIP Reliability Standards and new or modified definitions, and directed modifications be made to the CIP Reliability Standards. Among other items, the Commission directed NERC to "develop modifications to the CIP Reliability Standards to require responsible entities to implement controls to protect, at a minimum, communication links and sensitive bulk electric system data communicated between bulk electric system Control Centers in a manner that is appropriately tailored to address the risks posed to the bulk electric system by the assets being protected (i.e., high, medium, or low impact)." (Order 822, Paragraph 53)~~

~~In response to the directive in Order No. 822, the Project 2016-02 standard drafting team (SDT) drafted Reliability Standard CIP-012-1 to require Responsible Entities to implement controls to protect sensitive Bulk Electric System (BES) data and communications links between BES Control Centers. Due to the sensitivity of the data being communicated between Control Centers, the standard applies to all impact levels (i.e., high, medium, or low impact).~~

~~The SDT drafted requirements to provide Responsible Entities the latitude to protect the communication links, the data, or both, to satisfy the security objective consistent with the capabilities of the Responsible Entity's operational environment. Requirement R1 requires Responsible Entities to document one or more plans that protect Real-time Assessment and Real-time monitoring and control data while being transmitted between Control Centers. The plan(s) must address how the Responsible Entity will mitigate the risk of unauthorized disclosure or modification of the applicable data. Requirement R2 covers implementation of the plan developed according to Requirement R1.~~

The Project 2016-02 SDT drafted this Implementation Guidance to provide example approaches for compliance with CIP-012-1. Implementation Guidance does not prescribe the only approach, but highlights one or more approaches that would be effective in achieving compliance with the standard. Because Implementation Guidance only provides examples, entities may choose alternative approaches that better fit their individual situations[1].

Responsible Entities may find it useful to consider this Implementation Guidance document along with the additional context and background provided in the SDT-developed Technical Rationale and Justification for CIP-012-1 document.

Background

The Commission issued Order No. 822 on January 21, 2016. Order 822 approving ~~approved~~ seven CIP Reliability Standards and new or modified definitions, and directed modifications be made to the CIP Reliability Standards. Among other items, the Commission directed NERC to "develop modifications to the CIP Reliability Standards to require responsible entities to implement controls to protect, at a minimum, communication links and sensitive bulk electric system data communicated between bulk electric system Control Centers in a manner that is appropriately tailored to address the risks posed to the bulk electric system by the assets being protected (i.e., high, medium, or low impact)." (Order 822, Paragraph 53)

In response to the directive in Order No. 822, the Project 2016-02 standard drafting team (SDT) drafted Reliability Standard CIP-012-1 to require Responsible Entities to implement controls to protect sensitive Bulk Electric System (BES) data and communications links between BES Control Centers. Due to the sensitivity of the data being communicated between Control Centers, the standard applies to all impact levels (i.e., high, medium, or low impact).

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[1] NERC's Compliance Guidance Policy

Requirements

R1. *The Responsible Entity shall ~~develop~~ implement one or more documented plan(s) to mitigate the risk of unauthorized disclosure or modification of Real-time Assessment and Real-time monitoring ~~and control~~ data while being transmitted between any Control Centers. This requirement excludes oral communications. The plan shall include: [Violation Risk Factor: Medium] [Time Horizon: Operations Planning]*

1.1. Identification of security protection used to mitigate the risk of unauthorized disclosure or modification of Real-time Assessment and Real-time monitoring ~~and control~~ data while being transmitted between Control Centers;

1.2. Identification of where the Responsible Entity applied ~~demarcation point(s) where~~ security protection ~~is applied~~ for transmitting Real-time Assessment and Real-time monitoring and control data between Control Centers; and

1.3. If the Control Centers are owned or operated ~~Identification of roles and responsibilities of each Responsible Entity for applying security protection to the transmission of Real-time Assessment and Real-time monitoring and control data between Control Centers, when the Control Centers are owned or operated~~ by different Responsible Entities, identify the responsibilities of each Responsible Entity for applying security protection to the transmission of Real-time Assessment and Real-time monitoring data between those Control Centers.

~~**R2.** *The Responsible Entity shall implement the plan(s) specified in Requirement R1, except under CIP Exceptional Circumstances.*~~

General Considerations

Plan Development

~~General Considerations for R1~~

As noted in the Technical Rationale and Justification for CIP-012-1, the focus of Requirement R1 is ~~on developing~~ implementing ~~a~~ a documented plan to protect information that is critical to the real-time operations of the Bulk Electric System while in transit between applicable Control Centers. The number of plan(s) and their content may vary depending on a Responsible Entity's management structure and operating conditions. The Responsible Entity may document as many plans as necessary to meet its needs. For instance, a Responsible Entity may choose to document one plan per Control Center or ~~it may~~ choose an all-inclusive, single plan for its Control Center communication environment. ~~to document everything in a single plan.~~ A Responsible Entity may choose to document one plan for communications between Control Centers it owns and a separate plan for communications between its Control Centers and the Control Centers of a neighboring Entity. The number and structure of the plans is at the discretion of the Responsible Entity as long as the plan(s) include the required elements described in parts 1.1, 1.2, and 1.3 of Requirement R1.

Identification of Security Protection

Entities have latitude to identify and choose ~~determine~~ which security protection~~s~~ ~~are~~ is used to mitigate the risk of unauthorized disclosure or modification of Real-time Assessment and Real-time monitoring ~~and control~~ data while being transmitted between Control Centers ~~and should identify those protections accordingly~~.

This security protection could consist of logical protection, physical protection, or some combination of both. To determine security protection, the requirement specifies that it must mitigate the risk of unauthorized disclosure or modification of applicable data.

Security protection implementation can be demonstrated in many ways. If a Responsible Entity uses physical protection, it may demonstrate implementation through review of an applicable Control Center floor plan~~,~~ with details subsequently confirmed through visual inspection, which identifies the physical security measures in place protecting the communication link. If the Responsible Entity uses logical protection, it may demonstrate implementation through an export of the device configuration which applies the security protection. Alternatively, a Responsible Entity may demonstrate implementation through security control monitoring, using an automated monitoring tool to generate reports on the encryption service used to protect a communications link.

Identification of ~~Demarcation Point(s)~~ Where Security Protection is Applied by the Responsible Entity

A Responsible Entity should consider its environment ~~to determine an effective solution~~ when identifying ~~the demarcation points~~ where security protections ~~are~~ should be applied. One approach ~~to identifying a demarcation point~~ is to implement security ~~place the demarcation point~~ within the Control Center ~~so the confidentiality and integrity of the data is protected throughout the transmission~~itself to ensure that data confidentiality and integrity is protected throughout the transmission. The Responsible Entity can ~~choose either a physical or logical demarcation point~~ identify where security protection is applied using a logical or physical location~~. Demarcation points identified by the Responsible Entity do not add additional assets to the scope of the CIP Reliability Standards. The demarcation point identification ensures that each Responsible Entity identifies clear demarcation of where the protection is applied to the in-scope data. Demarcation points~~ The application of security in accordance with CIP-012 requirements does not add additional assets to the scope of the CIP Reliability Standards. Locations of applied security protection may vary based on many factors such as impact levels of the Control Center, different technologies, or infrastructures.

Identification of where a Responsible Entity applies security protection could be demonstrated with a list or a Control Center diagram showing either physical or logical security controls. Physical diagrams may require visual confirmation of these controls. These diagrams or a list could be included within the plan developed for R1. A Responsible Entity could also use labels to identify on-site devices where CIP-012 security protection is applied.

When exchanging data between two entities, if a Responsible Entity only manages one end of a communication link, the Responsible Entity is not responsible for identifying where the security protection is applied by the neighboring entity with whom it is exchanging data. However, if a Responsible Entity has taken responsibility for both ends of the communication link (such as by placing a router within the neighboring entity's data center), then the Responsible Entity shall identify where the security protection is applied at both ends of the link. Similarly, if a Responsible Entity owns and operates both Control Centers which are exchanging data (such as in the case of a primary and backup Control Center), then the Responsible Entity shall identify where security protection is applied at both ends of the link.

Identification of ~~Roles and~~ Responsibilities when the Control Centers are Owned or Operated by Different Responsible Entities

The Technical Rationale and Justification for CIP-012-1 identifies key considerations in the Control Center Ownership section when communicationsing between Control Centers with different owners or operators. ~~Most if not all of the m~~Many operational relationships between Responsible Entities are unique. Consequently, there is no single way to identify ~~roles and~~ responsibilities for applying security protection to the transmission of Real-time Assessment and Real-time monitoring ~~and control~~ data between Control Centers.

Implementation of ~~Responsible Entities may consider identifying the roles and~~ responsibilities could also be demonstrated in many ways. ~~for the following situations: (1) configuration of security protocols, (2) responding to communication failures, and (3) responding to Cyber Security Incidents.~~ Some examples include a joint procedure, a memorandum of understanding, or meeting minutes between the two parties where responsibilities are ~~discussed~~defined.

~~General Considerations for R2~~

~~Given the format of the requirements, the majority of the documentation is required under R1 while R2 requires the implementation of the plan developed for R1. Compliance with R2 is established by implementing the protection identified in a Responsible Entity's R1 plan. The sections below outline examples of evidence that may be provided in order to demonstrate the implementation of Entity Alpha's CIP-012-1 R1 plan.~~

~~Identification of Security Protection~~

~~Implementation of the security protection can be demonstrated in many ways. If physical protection is used, a Responsible Entity may demonstrate implementation through a floor plan which identifies the physical security measures in place protecting the communication link. If logical protection is used, a Responsible Entity may demonstrate implementation through an export of the device configuration which applies the security protection. Alternatively, a Responsible Entity may demonstrate implementation through monitoring of the security control such as a report generated from an automated tool that monitors the encryption service used to protect a communications link.~~

~~Identification of Demarcation Point(s)~~

~~Identification of demarcation point(s) could be demonstrated with a diagram (physical or logical) or a list. This diagram or list could be included within the plan developed for R1. A label could also be used to identify a device as a demarcation point.~~

~~Identification of Roles and Responsibilities when the Control Centers are Owned or Operated by Different Responsible Entities~~

~~Implementation of roles and responsibilities could also be demonstrated in many ways. Some examples include a joint procedure, a memorandum of understanding or meeting minutes between the two parties where roles and responsibilities are discussed.~~

Reference Model~~s~~

For this Implementation Guidance, the SDT uses a basic reference model of Primary and Backup Control Centers (Entity Alpha) to illustrate approaches ~~concepts necessary~~ to demonstrating~~e~~ compliance. These Control Centers communicate to each other and to a neighboring entity's Control Center (Entity Beta) in configurations outlined by the diagrams in this section. The SDT recognizes that the reference model~~s~~ does not contain many of the complexities of a real Control Center. For this Implementation Guidance, the registration or functions performed in the reference model Control Center are also not considered. A high level block diagram of the basic reference model is shown below in Figure 1. This Implementation Guidance is developed from the perspective of Entity Alpha.

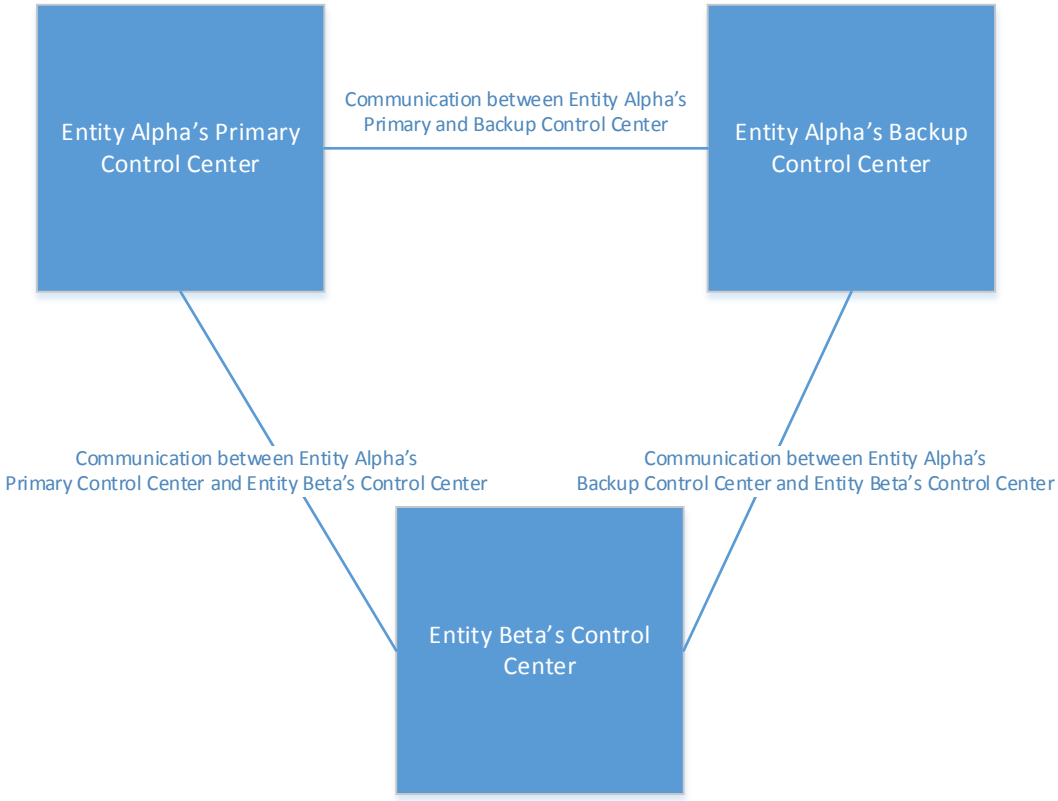

Figure 1: High Level Block Diagram of Reference Model Control Centers

Reference Model Discussion

Requirement R1 requires the implementation of a documented plan. To comply with requirement R1, one approach to a plan is to first determine which communications ~~require protection under~~ are in scope of CIP-012-1. There are multiple ways to identify an entity's scope in R1. For example, Entity Alpha in the reference model may first identify the Control Centers with which it communicates. Entity Alpha would determine that there are three: Entity Alpha's Primary Control Center, Entity Alpha's Backup Control Center, and Entity Beta's Control Center. Entity Alpha does not need to consider whether Entity Beta further shares its data with another Entity. That is the responsibility of Entity Beta and is outside of Entity Alpha's purview. Additionally, Entity Alpha does not need to consider any communications to other non-Control Center facilities such as generating plants or substations. These communications are out of scope for CIP-012-1.

Now that Entity Alpha has identified the Control Centers with which it communicates, Entity Alpha identifies either: (1) the Real-time Assessment and Real-time monitoring data; or (2) communication links which are used to transmit Real-time Assessment and Real-time monitoring data between Control Centers. In either case, Entity Alpha should refer to the data specification for Real-time Assessment and Real-time monitoring data identified

in TOP-003-3 and IRO-010-2. For this reference model scenario, identifying the communication links used to transmit Real-time Assessment and Real-time monitoring data may be the most straightforward approach. Through an evaluation of communication links between Control Centers and an evaluation of how it transmits and receives Real-time Assessment and Real-time monitoring data, Entity Alpha determined that it communicates applicable data between its primary and backup Control Centers across a single communication link. Entity Alpha also determined that it communicates applicable data to and from Entity Beta's Control Center across one of two links that originate from either Entity Alpha's primary or backup Control Center using the Inter-Control Center Communications Protocol (ICCP).

With an identified scope of communications links, Entity Alpha now considers the three required elements of its required communications between Control Centers for its plan.

Identification of Security Protection

- Entity Alpha must ensure that protection is applied where identified in its CIP-012-1 plan. The protection must also meet the security objective of mitigating the risk of unauthorized disclosure or modification of applicable data while in transit between Control Centers. The identification of security protection could be demonstrated by a network diagram similar to that shown in Figure 2 or Figure 3.
- In a simple case where the security protection is applied sufficiently close to the Control Center, such as within the Physical Security Perimeter of the Control Center, Entity Alpha may use a single security protection method to meet the security objective. For this case, shown in Figure 2, Entity Alpha implements a Virtual Private Network (VPN) connection across a private leased communication circuit for each of its three in-scope communication links. To meet the security objective, Entity Alpha further states that its VPN uses Internet Protocol security (IPsec) with encryption.
- For more complex scenarios, Entity Alpha may need to use a combination of security controls. For instance, in Figure 3, Entity Alpha uses a combination of physical security controls (physical access control) and logical security controls (encrypted communications consistent with the first scenario above) to meet the security objective.
- While these scenarios are all specific to communication links, it is possible that Entity Alpha and Entity Beta achieve the security objective by applying protection to the data rather than the communication links. In this scenario, the application enabling the data exchange between Control Centers may be capable of applying security controls directly to the data. These security controls mitigate the risk of unauthorized disclosure or modification of applicable data rather than relying on lower level network services to provide this security. For instance, Entity Alpha and Entity Beta may apply security protection at the application layer by using Secure ICCP to exchange applicable data. According to a report released by Sandia National Labs[2], Secure ICCP provides "data integrity indirectly by providing a cryptographic checksum. ~~...~~Secure ICCP provides data confidentiality by encrypting ICCP data exchanges." Methods other than Secure ICCP could also be used to apply security protection to the data at the application layer.
- It is theoretically possible that Entity Alpha and Entity Beta could exchange Real-time Assessment data between Control Centers by email. In that scenario, one approach may be for Entity Alpha to email the applicable data to Entity Beta's Control Center in a protected container such as an encrypted zip file. Entity Alpha and Entity Beta can then exchange the password to that encrypted container through another method, such as by phone. While the notional example of protecting data exchanged by email is a useful illustration of how to achieve the security objective of CIP-012-1, it is extremely unlikely to be used in practice. The characteristics of email communication are inconsistent with the requirements of Real-time data exchange.

[2] https://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/19-Secure_ICCP_Integration.pdf

-Identification of Where Security Protection is Applied by the Responsible Entity

Similar to the identification of security protection above, the identification of where security protection is applied can also be demonstrated by a network diagram similar to those found in Figures 2 and 3.

- Figure 2 shows the identification where CIP-012-1 security protection is applied for the Entity Alpha reference model when a single encrypted tunnel is used to implement the required protection. Entity Alpha has identified that security protection is applied at each of its Control Centers on the external Ethernet interface on the WAN router. While the diagram depicts where Entity Beta has applied security protection for illustrative purposes, Entity Alpha is not responsible for identifying where Entity Beta has applied security protection.

- In ~~some cases~~ order to understand the application of security protection in context of who controls the communication link, it may be helpful to identify both where CIP-012-1 security protection is applied and the location of the telecommunications carrier (telco) demarcation point. Figure 3 provides such an example where the telco demarcation point may not be within the Control Center and based the facts and circumstances surrounding this scenario, Entity Alpha has implemented a combination of security controls to comply with CIP-012-1. In this scenario, Entity Alpha identifies that it has applied physical security protection for its PSP and continuing for its WAN router and that it has applied logical security protection (encryption) at the WAN router. Entity Alpha has also identified the telco demarcation point at a point in the telecommunications cabling connecting to Entity Alpha's WAN router, perhaps at a punch down block for example. In Figure 3, the telco demarcation point is inside the same room as the WAN router. The telco demarcation points are referenced in the drawing for clarity, but are not part of the plan.

- The data-centric scenario described above is less intuitive for identifying where security protection is applied by Entity Alpha. If security protection is applied at the application layer (such as Secure ICCP), Entity Alpha could reasonably identify the application or service applying the security (such as the Secure ICCP service) as the location of where security protection is applied.

Identification of Responsibilities when the Control Centers are Owned or Operated by Different Responsible Entities

Entity Alpha and Entity Beta may determine they each are responsible for one end of the VPN configuration on their respective WAN routers. Entity Alpha and Entity Beta have agreed to a 30 character pre-shared key for IPSec authentication.

Rather than use a pre-shared key, Entity Alpha and Entity Beta may decide to use digital certificates for the IPSec authentication using a trusted certificate authority. In that scenario, Entity Alpha and Entity Beta would agree on who is the party responsible for managing the certificate authority.

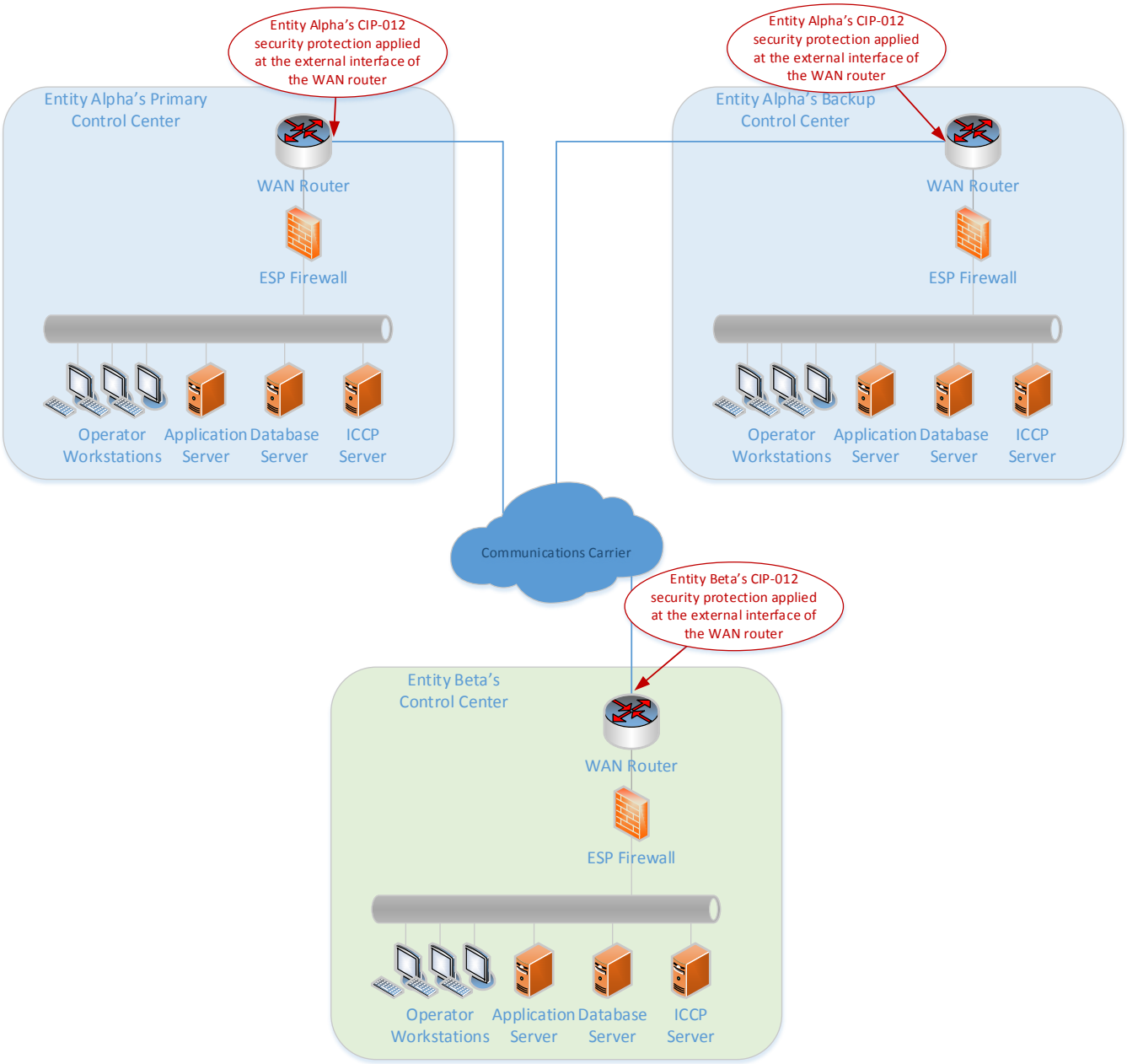

Figure 2: Network diagram and identification of where security protection is applied

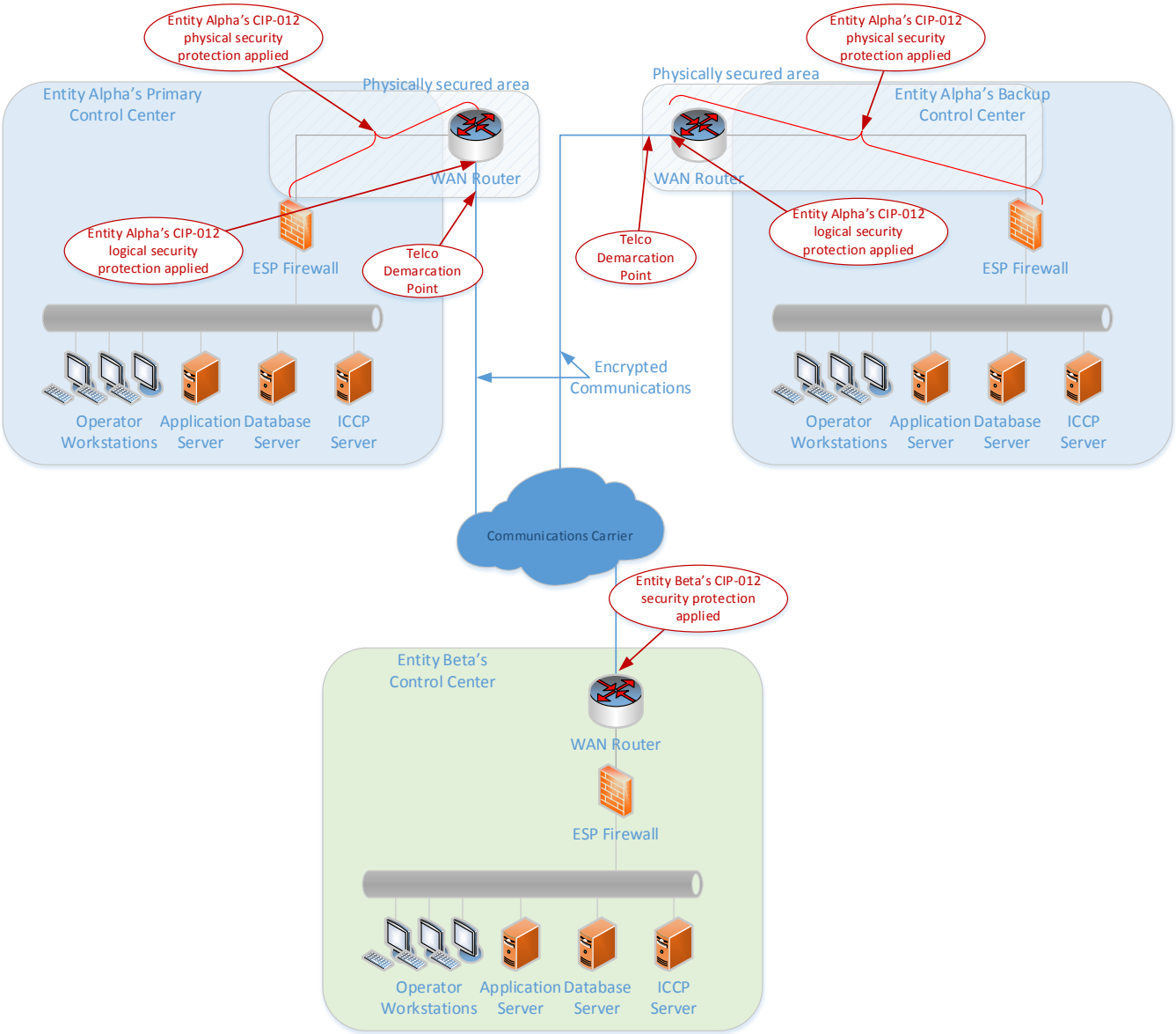

Figure 3: Network diagram using a combination of controls for CIP-012-1

References

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https://cwe.mitre.org/data/definitions/327.html

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Guide to Cryptography
https://www.owasp.org/index.php/Guide_to_Cryptography#Symmetric_Cryptography