Enabling Technologies for Distributed Energy Resources

An Evaluation of Alternative Telemetry Communication Technologies

A Report by the New York Independent System Operator

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Introduction

The NYISO utilizes real-time telemetry data to ensure the safe and reliable operation of the New York State Transmission System. Telemetry data exchanged through direct connections with New York's Transmission Owners (TOs) and certain Resources allow the NYISO to balance Load and Generation throughout the New York Control Area (NYCA) and with neighboring Control Areas.

The NYISO currently utilizes Inter-Control Center Communications Protocol (ICCP) over Multi-Protocol Label Switching (MPLS) on dedicated Tier 1 (T1) circuits to send and receive telemetry data. This telemetry infrastructure has historically proven reliable, and the NYISO expects it to continue to meet established performance standards in the future. However, alternatives to an MPLS-based communication path may be available at lower cost and with quicker installation and set-up times, providing benefits to market participants with small MW portfolios.

Recent NYISO market design initiatives have developed participation models and market rules to accommodate the operating characteristics of Energy Storage Resources (ESR) and Distributed Energy Resources (DER). While these new participation models reduce barriers to ESR and DER market entry, the NYISO is also evaluating whether existing processes and procedures will need revision, and if so, what changes can be made. As part of that evaluation, the NYISO undertook a review of the existing telemetry communication requirements and framework, and investigated whether new telemetry technology may be available to help facilitate ESR and DER integration.

As a result of this investigation, the NYISO determined that a public internet based Software-Defined Wide Area Network (SD-WAN) is a viable alternative that meets the NYISO's operational needs. The NYISO also investigated the use of Distributed Network Protocol Version 3 (DNP-3) for a telemetry data encryption alternative to the existing ICCP, as this is an industry-standard protocol that New York's TOs already support.

The NYISO's study examined security, reliability, and regulatory significance of utilizing SD-WAN technology. This report presents an overview of the NYISO's approach to evaluating new telemetry solutions, performance considerations, and characteristics of the SD-WAN and DNP-3 telemetry technologies that the NYISO examined in order to determine the most viable alternatives.

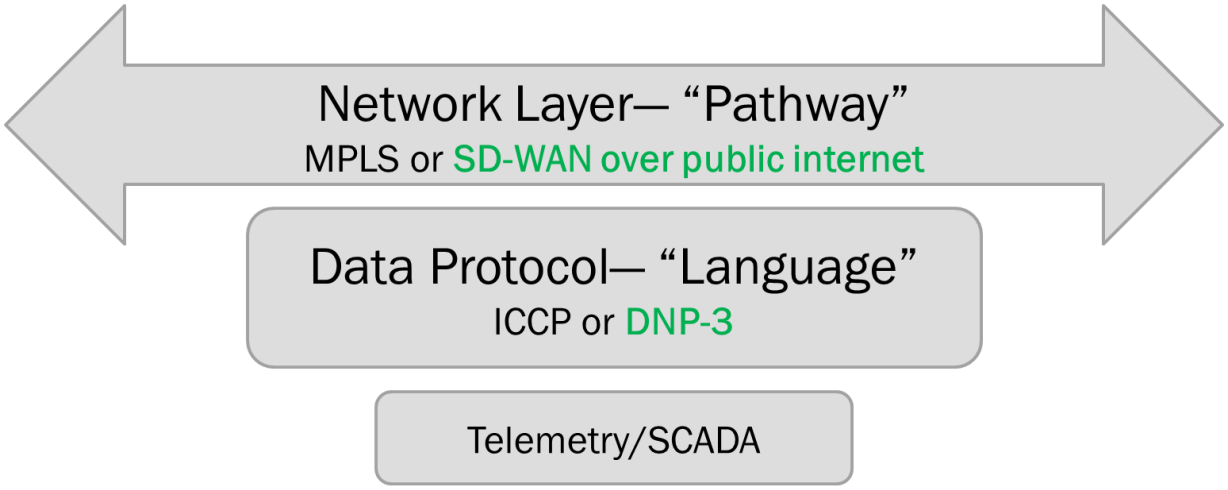
Telemetry in the NYCA

The NYISO uses telemetry signals to efficiently and accurately dispatch Resources to meet load and reliably operate the New York State electricity grid. The NYISO's telemetry framework is comprised of

three components: a network layer, an application layer (data protocol), and telemetry data. This evaluation did not address the characteristics of telemetry data (and the associated operational requirements) and Supervisory Control and Data Acquisition (SCADA). Rather, the NYISO evaluated alternatives to the network layer and data protocol components of the telemetry framework.

The network layer can be likened to the transport 'pathway' by which encrypted data may travel from one control center to another. The NYISO currently uses MPLS circuits to link the NYISO and Transmission Owners and certain Resources participating in the NYISO demand response programs. The telemetry data is encrypted and packaged using the Inter-Control Center Communications Protocol (ICCP).

Figure 1: Telemetry and SCADA information remaining unchanged, there are two additions to the NYISO telemetry framework. A new network layer will be SD-WAN, and a new application layer protocol will be DNP-3.



The current telemetry framework is a reliable solution, enabling the NYISO and Transmission Owners to have grid visibility, respond to disturbances, and efficiently meet demand at all times. The telemetry framework enables system operators to manage data and execute reliability functions as needed. Reliable telemetry encryption and communication supports current NYISO initiatives, and will continue to serve a key role in NYISO operations going forward.

Reasons for Study

The NYISO and its stakeholders identified potential concerns with applying the existing telemetry framework to ESRs and DER: the time required to establish a telemetry connection, and the cost to establish and maintain that connection (*i.e.* special construction costs). This study outlines the NYISO's approach to evaluating new telemetry technology alternatives that provide reliable and economic communication access to market participants, and that address the identified concerns.

Market participant ESR and DER portfolios are expected to be Aggregations of comparatively smaller sizes (MW) than the central station Resources or Transmission Owners utilizing MPLS and ICCP today. While the NYISO is not aware that the current requirements are a material concern for central station Resources and TOs, ESRs and DER are likely to operate on smaller budgets and with less time required to enter the market. Therefore, telemetry costs and connection timelines take on added significance and may affect ESR and DER market penetration.

The objective of the study was to identify alternatives to the current telemetry framework technologies (*i.e.* MPLS & ICCP) that will provide lower cost options to market participants and maintain reliability in the NYCA. Once the NYISO identifies alternatives the technology will be available to all market participants with small MW portfolios, not just ESR and DER.

Considerations for Evaluation

To appropriately evaluate alternatives to the current telemetry framework, the NYISO first identified mandatory requirements regardless of solution type. These criteria reflect the NYISO's operational requirements:

- A scan rate of 6-seconds or faster;
- No greater than a 10-second one-way latency (From NYISO to Resource[1] or Resource to NYISO); and
- No greater than a 20-second round-trip latency (From NYISO to Resource and back to NYISO).

These criteria represent the minimum requirements of telemetry data, and illustrate the NYISO's expectation for the performance of any new telemetry technology alternative. The NYISO also considered:

- Minimization of business and customer impacts.
    - Additional resource burden for the NYISO and market participants to utilize an alternative;
    - Ease of integration into existing NYISO telemetry framework; and
    - Ease of installation and operation for market participants, including installation and configuration time and scalability.
- The range of cost impacts for market participants and for the NYISO to support alternatives, as well as NYISO resourcing to support both MPLS and the alternative.

[1] Telemetry communication from individual facilities to the NYISO.

Beyond operational and business criteria considerations, the NYISO also evaluated alternatives for impacts pertaining to the New York Transmission Owners and applicable regulatory entities. The NYISO and TOs work cooperatively to operate the New York State Transmission System. This report is focused on telemetry requirements for communication between resources and the NYISO, but a telemetry solution should meet both the operational and market needs of the NYISO and TOs.

The Joint Utilities of New York are also evaluating the requirements necessary to allow the use of alternative technologies for telemetry communication, and have developed a draft communications and coordination manual that defines operational coordination requirements, including data and information exchanges, between the TO/DSP, NYISO, individual DER, and DER Aggregators to facilitate DER wholesale market participation.[2] The manual also outlines processes for telemetry exchange between the TO/DSP and DER/Aggregator. The NYISO has and will continue to work with the Joint Utilities in the development and testing of new alternative telemetry communication technologies, and will consider feedback provided by the Joint Utilities. The NYISO will include feedback received from the Joint Utilities and all other Transmission Owners in the NYCA to capture appropriate considerations as it continues to evaluate telemetry solutions.

The NYISO assessed the current regulatory landscape as well as standards that are currently being developed as part of its evaluation. For example, proposed NERC reliability standard CIP-012-1, addressing cybersecurity for data communication between control centers, may affect future telemetry communication solutions. Any new alternative telemetry solution will comply with all applicable regulatory standards.

Alternatives to be Deployed

Software-Defined Wide Area Network

The NYISO has determined that a public internet-based SD-WAN is a viable network layer alternative to MPLS. The NYISO evaluated current telemetry technologies, including the benefits, risks, and mitigation strategies associated with those technologies, and the investigation supports SD-WAN's utilization in the NYISO-administered markets.

SD-WAN does not have the same pedigree for ISO/RTO applications as MPLS, but the NYISO believes that it can sufficiently perform all necessary functions to securely and efficiently communicate telemetry

[2] Joint Utilities of New York. *Draft DSP Communications and Coordination Manual*. 2018. https://jointutilitiesofny.org/wp-content/uploads/2018/07/JU-DSP-Communications-and-Coordination-Manual-DRAFT-2.pdf.

among the NYISO, TOs, and market participants. The NYISO has tested one SD-WAN application as part of the Pilot Program, and has successfully utilized the application to exchange simulated telemetry data in a test environment. The NYISO expected to have similar successes in the production environment with an SD-WAN solution.

The SD-WAN technology and applicable software can be installed and connected in a matter of weeks, making it more dynamic than MPLS installation and connection. The NYISO believes that an SD-WAN solution would cost significantly less to install and maintain than MPLS connections. Based on the limited information reviewed, the NYISO believes the utilization of SD-WAN technology avoids the special construction costs and network maintenance fees associated with MPLS over a dedicated T1 line. As described in the Appendix, an SD-WAN solution has been operational in a different ISO/RTO for a number of years, highlighting some valuable industry experience and use for telemetry communication.

The NYISO does not have experience with SD-WAN applications outside of its Pilot Program, and anticipates the potential for new and different risks with widespread adoption. Identification of these risks help with the assessment of new potential telemetry communication solutions. SD-WAN risks (that may not exist with MPLS) include Internet Service Provider disruptions, loss of public internet infrastructure, and vendor viability risk.

The NYISO continues to evaluate what risks use of public internet may cause, and has developed processes to appropriately integrate this alternative telemetry framework, including assessing business risks, reliability, and security. First, the NYISO anticipates engaging two SD-WAN vendors, which will provide redundancy and mitigate some business risks and enable market participants to establish connections across vendors for added reliability. Additionally, the NYISO has defined an initial set of redundancy thresholds with corresponding requirements for connections using SD-WAN and conventional MPLS technologies. The redundancy thresholds are intended to provide more reliable and secure connections. Finally, the NYISO proposes to establish a simultaneous connection threshold for market participants with portfolios of certain sizes in order to prevent critical losses.

A portfolio or resource must maintain connection to the NYISO through the proposed redundancies as described in Figure 2. These redundancy thresholds are based on the NYISO's initial evaluation of existing public internet-based telemetry solutions in other ISOs and review of potential MW contingencies. The redundancy requirements will limit the potential of losing significant MW operations due to the failure of a single endpoint connection failure. These thresholds may be reevaluated on an ongoing basis, depending on the SD-WAN solution(s) utilized, stakeholder engagement, and performance quality of technology types selected.

Figure 2: There are unique redundancies associated with SD-WAN and MPLS based on market participant portfolio size. 100 MW or greater may not be managed using an SD-WAN — less than 100 MW of a market participant's portfolio may be managed using SD-WAN. One MPLS connection implies redundancy to both NYISO control centers via one vendor.

Market Participant Portfolio	SD-WAN	MPLS
X<25MW	Single Internet Service Provider supporting one gateway for one SD-WAN	One MPLS circuit
25MW≤X<100MW	Two Internet Service Providers supporting two gateways for one SD-WAN vendor i. Market participant may elect to also establish a connection with a secondary SD-WAN vendor	One MPLS circuit
X≥100MW	SD-WAN not available option for communication with NYISO	Two MPLS circuits

Distributed Network Protocol Version 3

The NYISO's evaluation also determined that Distributed Network Protocol Version 3 (DNP-3) is a viable alternative to ICCP for the application layer data protocol. DNP-3 is an industry standard application layer protocol, and the viability of DNP-3 has been demonstrated through the current and historic use of the protocol by the New York TOs to communicate with Resources. Going forward, the NYISO will support the DNP-3 protocol use by market participants beginning after the implementation of the NYISO's DER participation model. DNP-3 will expand the options available to the market for telemetry communication, and will align with a protocol that is currently used by the TOs.

Summary and Conclusions

Telemetry communication serves a crucial role in the reliable operation of the New York State electric system. The NYISO has historically used MPLS and ICCP, but as the markets evolve, so too should the communication infrastructure.

The NYISO believes that public internet-based SD-WAN will provide adequate performance, security, and reliability, and will help mitigate the initial installation costs and timeline challenges of MPLS for certain wholesale market participants, reducing barriers to entry while maintaining acceptable levels of reliability. The NYISO will also support the integration of the DNP-3 protocol as an option for market participants.

The SD-WAN solution is expected to meet the established security, latency, availability, and data

quality requirements. The NYISO will work with market participants to implement telemetry infrastructure consistent with any future regulatory requirements and/or reliability standards. However, and in light of the NYISO's limited experience with the technology, market participant use of SD-WAN will be limited based on portfolio size as described in Figure 2. Further, the NYISO anticipates identifying and supporting two vendors of SD-WAN in the market to provide opportunities for market participants seeking added reliability through more than one connection. The SD-WAN and DNP-3 alternatives will be available options to all market participants, not just ESR and DER.

References

These materials are intended to provide background and additional information on matters discussed in this report

California Independent System Operator. *Business Practice Manual for Direct Telemetry*. 2018. https://bpmcm.caiso.com/Pages/BPMDetails.aspx?BPM=Direct Telemetry

Cisco. "What is SD-WAN?" 2019. https://www.cisco.com/c/en/us/solutions/enterprise-networks/sd-wan/what-is-sd-wan.html

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*Federal Energy Regulatory Commission. Technical Conference Regarding Reliability of the Bulk-Power System, Docket No. AD19-13-000. June 27th, 2019. http://ferc.capitolconnection.org/

*Visit video specific to this date located at the web address provided

ISO/RTO Council June 24th 2019 Comments, Docket No. RM18-20-000 https://nyisoviewer.etariff.biz/ViewerDocLibrary//Filing/Filing1486/Attachments/RM18-20%20Comments%20of%20the%20ISO%20RTO%20Council.pdf

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New York State Department of Public Service. *New York State Standardized Interconnection Requirements and Application Process for New Distributed Generators and Energy Storage Systems 5 MW or Less Connected in Parallel with Utility Distribution Systems*. 2018. http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/dcf68efca391ad6085257687006f396b/$FILE/October%20SIR%20Appendix%20A%20-%20Final%2010-3-18.pdf

North American Electric Reliability Corporation. *Critical Infrastructure Protection-012-1- Cyber*

Security- Communications between Control Centers. (Draft Standard)

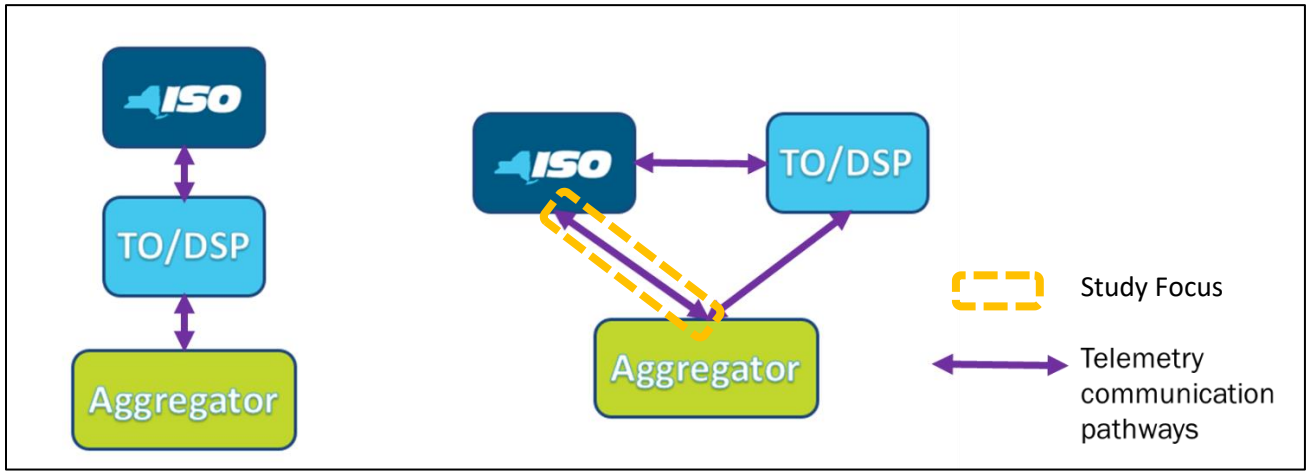
https://www.nerc.com/_layouts/15/PrintStandard.aspx?standardnumber=CIP-012-1&title=%20Cyber%20Security%20%c3%a2%c2%80%c2%93%20Communications%20between%20Control%20Centers&jurisdiction=null

Appendix: Additional Background and Technical Information

Study Scope & Background

The NYISO telemetry communication framework is essential to reliably operating the electric grid. The NYISO's proposed DER participation model will provide additional flexibility to Aggregators providing telemetry to the NYISO.

Figure 1: NYISO telemetry signals will always be received by the corresponding Transmission Owner with the option of additional direct connection between the market participant and the NYISO.



The NYISO's study focused on two broad concepts: (i) the coordination of data exchange between the market participant and the NYISO, and (ii) the economic and operational implications of utilizing an alternative to the MPLS/ICCP framework. The DER participation model will require market participants to provide a telemetry signal from the Aggregation (as opposed to the individual facilities) to the TO and NYISO. The NYISO's proposed rules will not require the Aggregator and individual facilities to utilize any specific telemetry communication framework within the Aggregation. The NYISO communicating with the Aggregator, rather than the individual facilities, will require less administrative oversight, fewer connections, and more efficient operation. Aggregators may elect a uniform telemetry solution to also communicate with the TO for additional streamlining and potential cost savings. NYISO coordination with New York's TOs may result in additional future efficiencies, as many of the same considerations identified in this report will also be relevant for TO implementation of new telemetry solutions.

It is important to note that the NYISO is not proposing to change the content of telemetry data itself. Rather, the NYISO is proposing to offer alternative network layer and data protocol options. The "network layer" can be thought of as the channel, and is currently MPLS. The "data protocol," or application layer, can

be thought of as the language, and is currently ICCP.

One alternative network layer, as described in the Report, is SD-WAN, and could be used to create a virtual private network controlled primarily by the NYISO. SD-WAN uses public internet or a broadband cloud-based service to connect Resources (or Aggregations) to the TO and NYISO's control centers. The NYISO may use a vendor to manage data on its network and monitor resources, if doing so reduces costs and administrative oversight of a SD-WAN application for the NYISO and market participants.

The NYISO also evaluated an Internet Service Provider Secure Sockets Layer (ISP SSL) option, which is also public internet-based. The NYISO determined that the ISP SSL alternative does not have the same scalability potential as SD-WAN, and presents additional overhead and maintenance concerns. The NYISO decided not to conduct further analysis of this option.

As described in the Report, the NYISO evaluated an alternative telemetry data protocol. DNP-3 is already in use by the New York TOs, and in other regions. As this study focuses primarily on the potential for an alternative network layer (*e.g.,* SD-WAN) the NYISO does not have detailed analysis of additional data protocols.

Resources utilizing an SD-WAN solution will be required to provide telemetry data every six seconds, which is the same granularity provided by existing generators, and to meet the established data security requirements.

Other ISO/RTOs Telemetry Frameworks

As part of the study, the NYISO reviewed the telemetry frameworks employed by other ISO/RTOs. Like the NYISO, the California Independent System Operator (CAISO) and Pennsylvania Jersey Maryland Interconnection (PJM) have DER participation initiatives that are either in effect or in an advanced stage of development. The information presented in the table below is current as of December 2019, and represents ISO/RTO the requirements for telemetry communication, gathered over a number of years before publication in March 2019.[3]

The table below contains telemetry accuracy, availability, and scan rate requirements for the NYISO, CAISO and PJM. The information used to develop the table was obtained from a technical update published by the Electric Power Research Institute (EPRI), based on interviews and assessments of public materials

[3] Electric Power Research Institute. "Low-Cost Telemetry for Mass Market Demand Response." 2019. https://www.epri.com/#/pages/product/000000003002015273/?lang=en-US

for each ISO/RTO.[4] The intent of the technical update is the same as the NYISO's study: to identify low-cost alternative telemetry mechanisms for performance in the wholesale electric markets.

The information presented by EPRI allows for comparison of scan rate, availability, and accuracy requirements for telemetered data for each ISO/RTO, as well as insight into respective telemetry frameworks utilized.

CAISO and PJM's applicable telemetry requirements indicate that public internet-based telemetry can be a viable alternative to traditional frameworks. Both ISO/RTOs utilize public internet-based telemetry and require more precise data than the NYISO's requirements. The NYISO understands that CAISO currently utilizes a SD-WAN application developed by Dispersive. The Dispersive product supports CAISO's performance requirements, including a four-second scan rate, which is stricter than the NYISO-required scan rate of six seconds. PJM's *Jetstream* is a public-internet based solution (it is not SD-WAN technology) that operates similarly to the CAISO Dispersive network. PJM's *Jetstream* communication framework supports a scan rate of two seconds, which scan rate is more granular than both CAISO and NYISO. In addition to supporting scan rates that are more granular than the NYISO's, the CAISO and PJM alternatives must have a telemetry accuracy requirement of +/- 2%, as compared to the NYISO telemetry accuracy requirement of +/- 5%.

[4] Electric Power Research Institute. "Low-Cost Telemetry for Mass Market Demand Response." 2019. https://www.epri.com/#/pages/product/000000003002015273/?lang=en-US

Telemetry Requirements in CAISO, PJM, and NYISO[5]

ISO/RTO	Network	Operational Telemetry Requirements
California Independent System Operator	(1) Generator-leased T1 connection to the ECN from AT&T, requiring a digital certificate; or (2) AT&T-installed AT&T Network Based IP VPN Remote Access (ANIRA) VPN gateway at the generator site to backhaul data over the public internet to the ECN; or (3) Public internet SSL (4) Dispersive CISDN SD-WAN	Scan rate: 4 seconds Accuracy: Load (+/- 2%)
New York Independent System Operator	(1) T1 connections for both primary and backup capabilities	Scan rate: 6 seconds Accuracy: Load (+/- 5%)
Pennsylvania Jersey Maryland Interconnection	(1) PJM*net* or *Jetstream* (ISP) at internet capability	Scan rate: 2 seconds Accuracy: Load (+/- 2%)

Additional Technical Information – Network Layer Solution Types

ICCP over MPLS Private Network

The NYISO utilizes Multiprotocol Label Switching (MPLS) and Inter-Control Center Communications Protocol (ICCP) for all external telemetry data transfers. The NYISO requires all Resources and TOs to provide redundant pathways through two separate communications carriers. Redundancy mitigates the risk of any potential single points of failure for telemetry communication. Currently, TO and resource

[5] Electric Power Research Institute. "Low-Cost Telemetry for Mass Market Demand Response." 2019. https://www.epri.com/#/pages/product/000000003002015273/?lang=en-US

telemetry exchange utilizes unique data protocols and direct connections that may vary depending on TO.

The NYISO requires router-to-router encryption on the MPLS. Encryption standards are periodically reviewed to maintain applicable industry standard(s). Connection to the private NYISO WAN requires installation and maintenance of TCP-IP addresses recognizable by NYISO infrastructure. Interconnection with the NYISO WAN is established through verification, testing, and documentation of the resources connecting to the NYISO network. Resources are responsible for maintenance of direct connections to the NYISO.

Software Defined Wide Area Network (SD-WAN)

The primary public internet-based technology that the NYISO examined in this study is SD-WAN. SD-WAN is an internet network similar to the MPLS network, but based in a series of servers that allow for rerouting of information and avoidance of disruptions. With existing communication from resources to TOs and the NYISO, there is interest in exploring potential alternatives to simply adding dedicated private MPLS connections for each new Resource directly connected to the NYISO, such as a DER Aggregator. The NYISO's Pilot Program testing has thus far indicated that SD-WAN architecture would effectively meet the reliability and performance standards met by a dedicated MPLS connection, but does not require each Aggregator establish a new dedicated MPLS, and uses the more readily-accessible public internet for expedient and appropriately encrypted secure connections to the NYISO and TOs. SD-WAN is compatible with cellular, satellite, and broadband networks.

Additional Technical Information – Application Layer Telemetry Protocols

Establishing telemetry communication with Resources requires the standardization and adoption of appropriate protocols. The NYISO evaluated alternatives to find a cost effective, technologically scalable solution capable of upholding performance requirements for telemetry. The NYISO currently utilizes, and will continue to support ICCP for existing and future resource telemetry connections. The NYISO has also identified DNP-3 as a viable alternative to ICCP. ICCP is a control center-specific telemetry protocol, and is designed for grid-based communications, while DNP-3 is a protocol more commonly utilized by TOs for telemetry exchange with Resources.

ICCP

The ICCP protocol is commonly utilized for metering system communication, energy management system applications, and general inter-control center communications. From a technical perspective, ICCP implements quality attributes that specify the source of data received, whether entered manually, estimated, telemetered, or calculated. Additionally, ICCP specifies the quality of data received as valid, invalid, held, or suspect, with configurations and parameters developed based on specific needs. Generally,

ICCP does not have some SCADA features necessary for substation to control center communication, and is mostly used only for inter-control center telemetry.[6] The ICCP protocol is currently being tested through a public internet-based SD-WAN in the NYISO Pilot Program.

DNP-3

Distributed Network Protocol Version 3 is used by CAISO and PJM in conjunction with public internet-based telemetry communication frameworks, and is an alternative to the ICCP protocol. DNP-3 is commonly utilized by the New York TOs for telemetry with resources operating in the NYCA, and is commonly used for communications between substations, SCADA, EMS, feeder devices, and consumer portals. DNP 3 utilizes a simple object model based on basic data types, allowing for definition of new data types and mixing of data types.[7] Further, DNP-3 is a standardized mechanism for carrying original serial protocol over internet provider networks. One limitation identified in an EPRI assessment of data protocols is that while DNP-3 is supportive of objects, it does not have a method to flexibly access structured data within objects.

6 Electric Power Research Institute. "The Communication Networks Guidebook for Intelligent Transmission Systems." 2009. https://www.epri.com/#/pages/product/000000000001017848/?lang=en-US

7 Electric Power Research Institute. "The Communication Networks Guidebook for Intelligent Transmission Systems." 2009. https://www.epri.com/#/pages/product/000000000001017848/?lang=en-US