WiSys Ref: T200045

# Precision Delay Monitoring Protocol

## Market and Background

The growth of digital transformation, with a focus on centralized automation and cloud services, has led to an increased demand for high-throughput and ultra-reliable low-latency network standards. This is particularly essential for critical applications like substation protection networks and aviation control that require stringent delay requirements. This requirement is met by Time-Sensitive Networking (TSN), a set of network protocols designed to prioritize and redirect data packets based on their time sensitivities, thereby reducing network congestion and delays.

The TSN technology utilizes scheduling and traffic shaping strategies to efficiently regulate network traffic, guaranteeing that time-critical operations have access to the required network resources for optimal performance. The Time-Sensitive Networking products market has seen considerable growth over the past couple of years. A Markets and Markets report estimates that the global market for time-sensitive networking will reach over $1.1 billion by 2026. Communication interfaces will account for $84.85 million of the overall market during the same period.

Despite the numerous benefits offered by TSN technology, the current TSN implementation faces many challenges, such as, the high cost for dedicated channels/timeslots utilizing specialized hardware and software, the complexity of configuration, interoperability among multi-vendor devices, scalability, real-time monitoring and maintaining during the real-world events like cyber-attacks, and especially integration with legacy network devices. Therefore, there is an opportunity to develop a networking protocol capable of monitoring and estimating delays in real-time, with easy scalability, automatic global traffic optimization, and compatibility with legacy devices and multi-vendor devices.

## Technology and Commercialization Needs

Research from the University of Wisconsin – Platteville has resulted in the development of a Precision Delay Monitoring (**PDM**) protocol which provides an Internet map with real-time delay information to be utilized within the TSN system. The PDM offers a cost-effective method to continuously monitor delays among active nodes in a TSN system with microsecond level precisions. The real-time delay measurements map generated globally can be used to identify bottlenecks in a data communication network, and in turn, improve network performance through dynamic routing/switching. Additionally, the delay information can be utilized by intermediate devices for early drop decisions, reducing network traffic load in congested areas and expediting feedback. The PDM provides a new perspective of network performance visualization and analysis, enabling customers and service providers to validate service-level agreement in an application-specific yet accurate manner and possibly facilitating the development of new services utilizing delay-performance information. By integrating with the network calculus algorithm, the Estimated Time of Arrival (**ETA**) can be obtained before the packet is sent, hence improving the communication task prioritization in local application.

The proposed Precision Delay Monitoring (PDM) protocol offers innovative approaches to continuously monitor the real-time end-to-end delay among all the active nodes in the TSNs with high precision. The PDM protocol includes two approaches, Passive Precision Delay Monitoring (PPDM) protocol, and Active Precision

Delay Monitoring (APDM) protocol. Development and real-world testing of the two protocols is ongoing. The PPDM requires only a firmware update. The APDM requires minimal new hardware.

WiSys is seeking a strategic partner in the time-sensitive networking industry who can provide a route to market for the commercialization and use of these Precision Delay Monitoring protocols.

## Applications and Key Benefits

- Real-time precise delay measurement over the entire time-sensitive network
- Requires none (PPDM) or minimal (APDM) packets injected
- Does not require modification to the original message and is fully compatible with the current network equipment
- Protocol can be widely used in IP-based network-interface-chip firmware
- Accurately estimate the delay performance of large-scale systems using data collected from a small yet representative testbed
- Monitor network latency and dynamically adjust the QoS
- Builds a measurement-based delay baseline profile for the entire network to detect cyber intrusions or maliciously delayed operation
- Offers a new set of measurement capabilities for newly emerging networking technologies, such as software-defined networks

## Intellectual Property

A US patent is pending for this technology. For more information, please contact WiSys at licensing@wisys.org.