**IEEE 802.24**

**Vertical Applications TAG**

|  |  |  |
| --- | --- | --- |
| Project | IEEE 802.24 Vertical Applications Technical Advisory Group  IEEE 802.1 Time Sensitive Networking Task Group  IEEE 802.3br past TG on Interspersing express traffic (IET) | |
|  | Utility Applications of Time Sensitive Networking White Paper | |
| Date Submitted | 10-July-2017 | |
| Source | 802.1 802.24 | Ruben Salazar, Tim Godfrey, Ludwig Winkel, Norm Finn, Clint Powell, Ben Rolfe |
| Re: | White Paper Development | |
| Abstract | TSN White Paper | |
| Purpose | TSN White Paper | |
| Notice | This document has been prepared to assist the IEEE P802.24. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein. | |
| Release | The contributor acknowledges and accepts that this contribution becomes the property of IEEE and may be made publicly available by P802.24. | |

# Describe why TSN is needed in a utility

In the context of this white paper, the utility is considered the entity (or entities) that manage the distribution of electricity from the transmission grid, to the distribution grid, to the customers. The power distribution network involves substations, and various protective and control devices that communicate over communications networks.

Typical utility terminology is a “low latency network”

Define what “realtime” means in the context of specific grid use cases and applications.

Real-time behavior of Ethernet based communication networks is defined in IEC 61784-2. There are 6 (plus one technology specific) consistent sets of parameters described to define the requested and achieved Real-time Ethernet behavior of end-to-end stations.

For the network components using TSN is an effort ongoing in IEC SC 65C.PT61784-6, dealing with a TSN profile for industrial automation applications.

Teleprotection – differential protection schemes require very low (<10ms) end to end latency, which must be highly consistent and predictable.

Teleprotection – differential protection schemes require very low (<10mS) end to end latency, which must be highly consistent and predictable.

Type of connection – typically fiber

Intra-substation LAN. Support for IEC 61850 Generic Object Oriented Substation Event (GOOSE) messages for controlling relays and switches within the substation. TR61850-90-13 addresses this

Type of connection – typically Ethernet (copper or fiber)

GOOSE and MMS traffic.

TSN could be a help on the process bus -

Shared IT/OT networks over a common medium. The OT networks require a controlled, predictable latency, and freedom from dropped or lost packets. This behavior is required regardless of the loading or overloading of the IT network.

How does TSN affect this? The important benefit is providing a converged multi-service architecture. Critical services can have guaranteed performance and bounded latency. This saves cost by converging several networks into one.

But not all TSN behaviors can be built in one network component without a difficult engineering. A profile for Utilities is needed to reduce the effort of engineering. IEC TC57 is looking for such a profile and is collaborating with the IEC SC65C/MT9.PT61784-6 project team.

IEEE 802.3br provides the best basis for this instead of using only shapers.

Critical voice services from field or substation. Ensuring voice traffic is unaffected by other data flow on common network.

Field Area Network Applications – Fault Location Identification and Service Restoration (FLISR) requires predictable low latency to re-route distribution power grids to isolate faulted areas and restore power to customers so quickly that they don’t notice an interruption. TSN capabilities in the FAN could enable FLISR to operate on shared medium networks. The same low latency communication with a Distributed Energy Resources Management System (DERMS) will allow local DER devices to participate in the restoration. The DERMS may be located at a central location (away from the DER equipment). End to end connectivity between the DERMS and the DER equipment may require multiple networks, each able to support low latency applications.

Similar requirements exist with MicroGrids. Dynamic protection, reverse power flows, etc.

Potential use cases around wind farms – there may be situations where TSN is needed – protection algorithms are the main driver.

# Describe how TSN works

Don’t focus on the standards themselves, but focus on basic capabilities.

Goal of low latency vs maximum worst case latency, and leading to zero congestion loss.

A new optimization, compared to best-effort packet world.

It is not just low latency, but bounded, deterministic worst case latency. That enables the application.

Shifting paradigm from acting on the packet to acting when the packet says to act.

Secondarily, ability to guard against equipment failure.

Informational material: 802.1Qbu, 802.3br, 802.1Qbv, 802.1Qat, 802.1Qca, CB, Qcc, Qch, Qci, Qcn, Qcr, AEcg

Discuss 802.1CM and BA, as an example of industry profiles for the use of TSN

# Understand IEC 61850 activities and relationships

How standardized APIs are integrated into 61850

What is the set used for grid applications? Relate to IEC TC57 Profiles

Harmonization of TC65 (automation) with TC57 profiles

# Explain relationships to time synchronization in 802.1AS

Power Profiles of IEEE 1588

# Relationship to IETF DETNET and RTCWEB

DETNET works over a routed network.

RTCWEB is focused on video and audio mostly, but supports it over the Internet.

What is the opportunity for wireless standards to leverage?

The work of the IETF DETNET working group targets the same network “quality of service” (QoS) properties as TSN, namely bounded, deterministic worst-case latency that enables certain classes of applications. However, the IETF work will apply these properties to network operation at layer 3, which is the traditional purview of the IETF. The key goal of the IETF DETNET work is to utilize the common themes of congestion control and traffic scheduling to offer bounded latency to applications with these requirements.

**Wired vs. Wireless**

In addition to the common obstacles to bounded latency faced by wired networks (congestion control, resource reservation), wireless networks have additional problems not faced by wired topologies, including:

* **RF interference**: even if the issues of congestion control and resource reservation are solved, local RF interference can cause packets to be lost and/or require packets to be re-transmitted, causing increased latency.
* **Bandwidth**: many wireless mesh networks (802.15.4, LPWANs, etc.) have limited bandwidth, and operate at speeds in kilobits-per-second, as opposed to megabits-per-second or higher.
* **Resource constraints**: on wireless mesh networks, network devices will be constrained in their resources and have limited buffer space to manage congestion control.
* **Mobility**: for wireless networks supporting mobility, the potential for variances in RF interference are higher than wireless topologies that are configured statically, with no mobility support.
* **Low**-**Power**: In some wireless mesh topologies, there are battery-powered devices that need to limit their packet transmission rates, which add additional latency.

**Example Use-Cases**

The use-case examples enumerated below apply to existing wireless 802.15.4 mesh network scenarios

**Network-wide Firmware Download**

When functional or security issues are found in deployed devices, it is critical to remediate the situation as quickly as possible. Many of these situations require an entire network to be updated with new firmware. Since these networks often are associated with critical infrastructure, some measure of bounded latency will be required so that operations can be reestablished in a predictable fashion.

**Ad-Hoc communications**

Many wireless mesh applications have “automated” network traffic patterns that periodically occur, without human intervention. However, there are applications that allow operators to manually generate ad-hoc queries to network equipment. For these “interactive” applications, there is a desire for network response times to be “user friendly”, since there is a human operator awaiting response information.

**Mesh Network “Boot”**

After systemic power loss, or firmware upgrade of large portions of a wireless mesh, there is a need to “reboot” the mesh. In large wireless mesh networks, there is a “joining process” whereby each node in the network must perform a set of roundtrip packet transactions across the mesh with a network “controller”. These network transactions effectively comprise the joining process. Once joined, the devices enter their normal functional state. Operators need to be able to predict when the network is fully up and operational (all nodes joined).