**IEEE 802.24**

**Vertical Applications TAG**

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# Describe why TSN is needed in a utility

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

# 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

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).

DETNET works over a routed network.

What is the opportunity for wireless standards to leverage?