~~Traffic-Type-Class~~4.6.1 **Introduction**

Industrial automation applications make use of different traffic schemes/patterns for different functionalities (e.g. parameterization, control, alarming). The various traffic patterns have different characteristics and thus, impose different requirements on a TSN network. ~~When~~ To specif~~ying~~ these traffic types, a two-step approach ~~seems to be needed~~is used:

1.) First define characteristics of generic traffic type (traffic-type-~~class~~categories) and
2.) Second define instances of the generic types, i.e. the traffic types~~.~~

~~2.)~~

~~Such an approach will allow to translate the different use cases into a list of possible traffic types based on this traffic-type-classes.~~

This two-step approach allows a clear differentiation between characteristics as seen from the "~~network~~ Ethernet interface" point of view and "application" point of view. Traffic-type-~~classes~~ categories ~~would~~ allow different IEEE 802 feature selections to achieve the specified goals

~~Definitions~~

~~In order to define the traffic-type-classes we need a more precise definition of the stream traffic and the definition of the non-stream traffic.~~

~~**Stream** traffic (or Stream) is a unidirectional flow of data from a Talker to one or more Listeners, which is usually sent periodically. Network resources and/or bandwidth may be reserved in order to meet the application requirements (e.g., latency). From the system design point of view Streams are either:~~

- ~~dynamic planed configured in a network by means of (ad-hoc) stream reservation mechanisms (e.g., by using the centralized approach using the CNC and CUC or distributed approach)~~
- ~~statically planed and/or configured by means of traffic engineering tools.~~

~~**Non-stream traffic** is a flow of data from a Sender to a Receiver which is usually send sporadically and uses shared network resources which may be reserved to meet potential application requirements.~~

~~Traffic Type Classes~~

. Four traffic-types-~~classes~~ categories are identified in Industrial Automation (IA) systems:

1. IA time-aware stream
2. IA stream
3. IA traffic engineered non-stream
4. IA non-stream

IA time-aware stream

IA time-aware stream~~s~~ *are used for periodic* traffic with either deadline or latency requirements.

Characteristics		Note
~~Periodicity~~Cyclic	~~Periodic/cyclic traffic~~Yes	
Data delivery requirement	Deadline or latency	Each stream may have its individual deadline or latency value, but also multiple streams with the same period may share the same deadline or latency value
~~Configuration~~	~~traffic engineered transmission path~~	~~The network shall be configured such that the Stream configuration is not affected by the spanning tree mechanisms alone, as by selection of an alternative path for a given stream the requested application properties of that stream can be invalidated (e.g., latency requirement is not satisfied).~~
~~Frame loss and retransmission~~	~~This traffic has zero congestion los~~	~~No retransmission in case of frame loss~~
Time-triggered transmit	~~Optional ~~Yes	
~~Expected behavior of the application receive interface~~	~~Buffered communication interface~~	~~Only the latest received frame is of interest~~

IA stream

IA stream traffic are used for periodic traffic with latency requirements.

Characteristics		Note
Cyclic~~Periodicity~~	~~Periodic/cyclic traffic~~Yes	
Data delivery requirement~~Data delivery requirement~~	Latency	Each stream may have its individual deadline or latency value, but also multiple streams with the same period may share the same deadline or latency value
Time-triggered transmit~~Configuration~~	~~Learned path~~	~~The network shall be configured such that the Stream configuration is not affected by the spanning tree mechanisms alone, as by selection of an alternative path for a given stream the requested application properties of that stream can be invalidated (e.g., latency requirement is not satisfied).~~
Cyclic~~Frame loss and retransmission~~	~~This traffic has zero congestion los~~	~~No retransmission in case of frame loss~~
Time-triggered transmit~~Time-triggered transmit~~	~~No~~Optional	
~~Expected behavior of the application receive interface~~	~~Buffered or Queued communication interface~~	

IA traffic engineered non-stream

This traffic is used ~~for application that~~to send sporadic traffic ~~but have~~ with~~er~~ bounded latency ~~application requirements or require~~and requiring a certain bandwidth along the path of the traffic.

Characteristics		Note
Cyclic*Periodicity*	Aperiodic / sporadicNo	
Data delivery requirement*Data delivery requirement*	Latency ~~or bandwidth~~	~~Event traffic usually require some latency guarantee and the configuration traffic might require some bandwidth reservation.~~ Expected bandwidth usage is engineered offline, and Ethernet interfaces are configured accordingly.
Time-triggered transmitCyclicTime-triggered transmit*Configuration*	~~Learned path~~	~~Ethernet interfaces and network are configured at run-time to establish a path between a Sender and a Receiver.~~ ~~Non-stream traffic configuration may be affected by the spanning tree mechanisms.~~
Cyclic*Frame loss and retransmission*	~~Multiple Senders use the same reserved bandwidth. Frame losses are possible.~~	~~Retransmission in case of frame loss~~
Time-triggered transmit*Time-triggered transmit*	No	
Expected behavior of the application receive interface	~~Queued communication interface~~	~~All received frame are of interest.~~

IA non-stream

IA non-stream is used for the bulk traffic with no specific data delivery requirements.

Characteristics		Note
Cyclic*Periodicity*	Aperiodic / sporadicNo	
Data delivery requirement*Data delivery requirement*	None	Bulk traffic, best-effort.
Time-triggered transmitCyclicTime-triggered transmitCyclicTime-triggered transmit*Configuration*	~~Learned path~~	~~Ethernet interfaces and network are configured at run-time to establish a path between a Sender and a Receiver.~~ ~~Non-stream traffic configuration may be affected by the spanning tree mechanisms.~~
Cyclic*Frame loss and retransmission*	~~Frame losses are possible.~~	~~Retransmission in case of frame loss~~
Time-triggered transmit*Time-triggered transmit*	No	
Expected behavior of the application receive interface	~~Queued communication interface~~	~~All received frame are of interest.~~

Table 3 summarizes relevant industrial automation traffic types and their associated characteristics.

Table 1 – Industrial automation traffic types summary

Traffic type name	Cyclic	Data delivery requirements	Time-triggered transmit	Traffic-type-category
Isochronous	Yes	Deadline	Yes	IA time-aware-stream
Cyclic-Synchronous	Yes	Latency	Yes	IA time-aware-stream
Cyclic-Asynchronous	Yes	Latency	No	IA stream
Alarms and Events	No	Latency	No	IA traffic engineered non-stream
Configuration & Diagnostics	No	Latency	No	IA traffic engineered non-stream
Network Control	Yes	Latency	No	IA traffic engineered non-stream
Best Effort	No	None	No	IA non-stream
Video	No	Latency	No	IA stream
Audio/Voice	No	Latency	No	IA stream

Traffic classes to traffic-type-classes assignment

The following Table defines the usage of the following traffic classes based on the traffic type-classes:

Traffic class	Traffic type class	Traffic Type
7	IA time-aware-stream	Periodic, traffic engineered path, time-sensitive stream, zero congestion loss, defined receive deadline (engineered max latency)
6		Periodic, traffic engineered path, time-sensitive stream, zero congestion loss, engineered max latency
5	IA stream	Periodic, learned path, time-sensitive stream, defined bandwidth, engineered max latency
4	IA traffic engineered non-stream	Event-driven, learned path, defined bandwidth, network management
3		Event-driven, learned path, defined bandwidth
2		Event-driven, learned path, defined bandwidth
1	IA non-stream	Event-driven, learned path, limited bandwidth (per class)
0		Event-driven, learned path, limited bandwidth

Traffic-Type-Classes definition would allow different IEEE 802 feature selections to achieve the specified goals. Moreover it helps in identification of the traffic protection mechansims.