

EtherCAT 和 TSN



EtherCAT[®]
Technology Group

什么是TSN

ETG 和 IEEE

TSN 结合EtherCAT
的使用

总结

- 什么是Time Sensitive Networking (TSN)
- EtherCAT 与 TSN
 - 最优的结合
- 总结



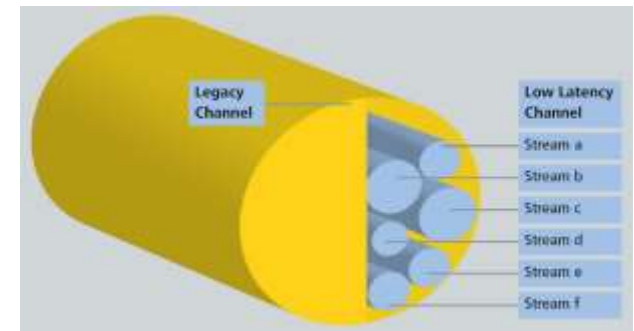
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- 时间敏感性网络 (TSN) 是IEEE桥接 (“交换技术”) 工作组的项目 (IEEE802.1)
 - 用于广泛的工业应用领域，目标是满足实时需求
 - 从“Best Effort” 方式转向到确定性的
 - 在IEEE802.1规范中数据帧需要尽可能快的被转发，避免阻塞
- 一部分带宽被预留，用于时间敏感的“高速通道”
- 剩余的带宽用于传统数据帧 (“传统通道”)



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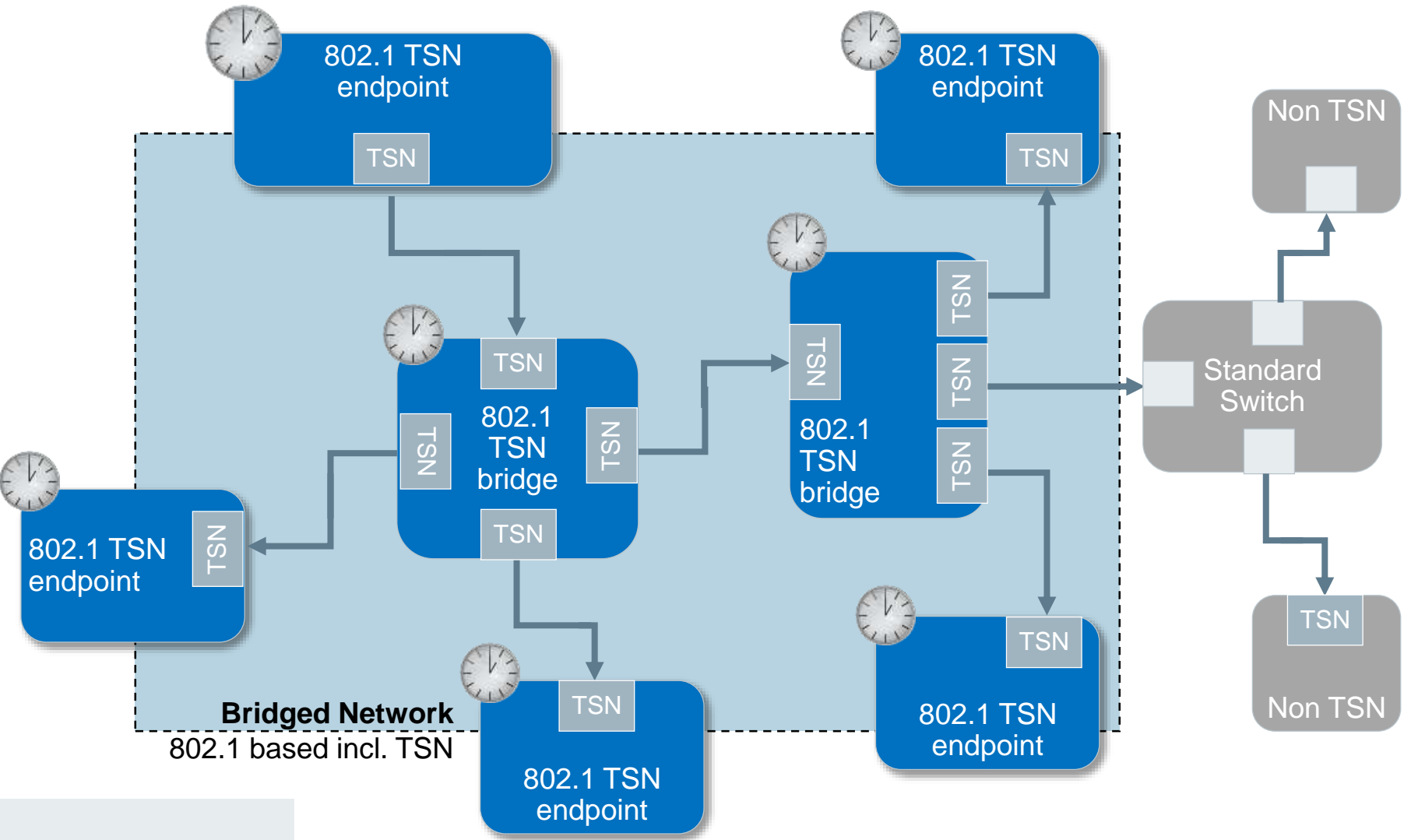
总结

- TSN是一个“工具箱”，里面非常多有用的工具
- TSN包含了一系列标准
 - 其中的工具是可以选择的
 - 没有使用手册因此，对于其中任何标准的选择和集成对于每个用户（组）或应用程序都是特定的，没有规律可循
- TSN不是一个现场总线

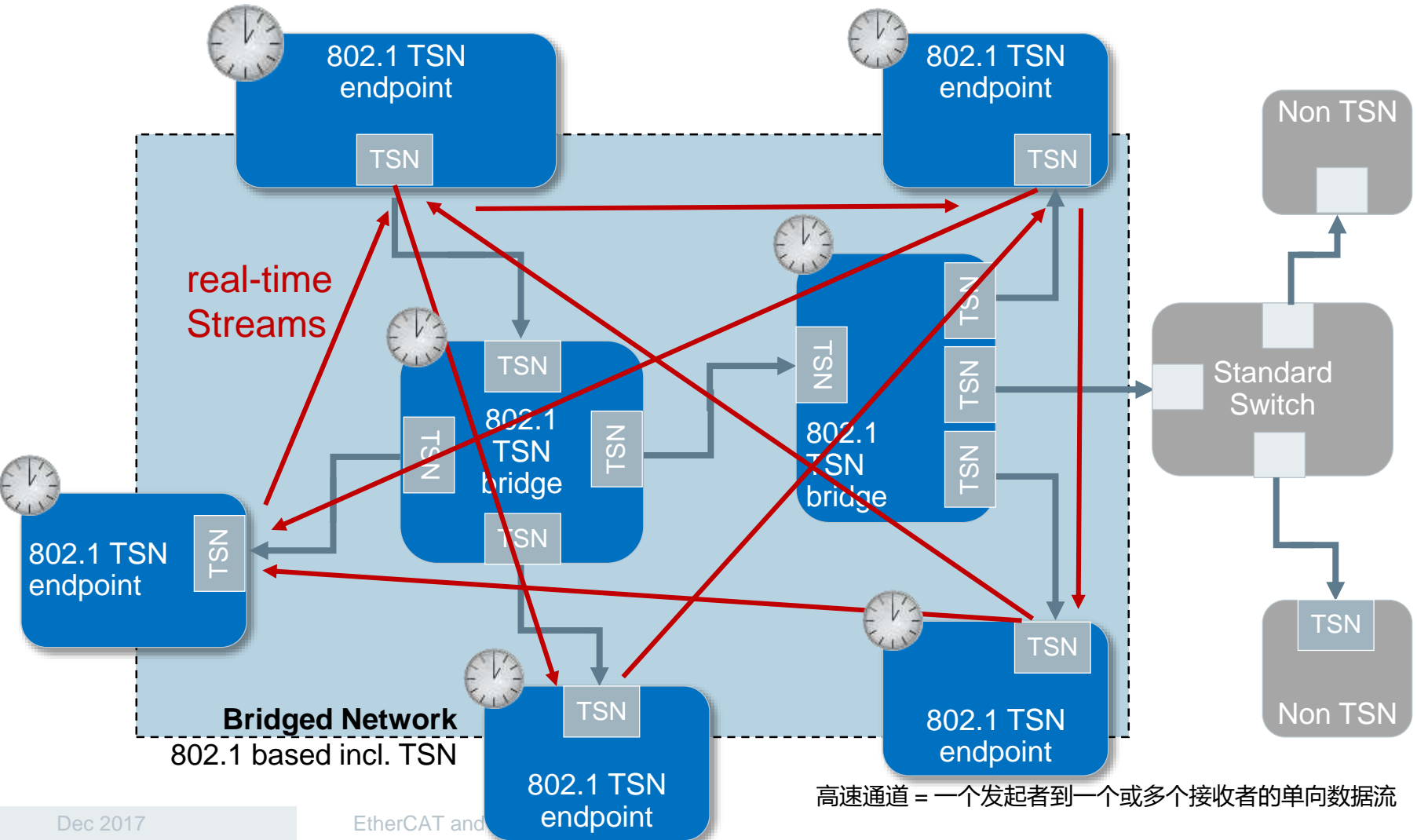


1. 802.1Qbu
2. 802.1Qbv
3. 802.1Qca
4. 802.1CB
5. 802.1Qcc
6. 802.1AS-REV
7. 802.1Qch
8. 802.1Qci
9. 802.1Qcj
10. 802.1CM
11. 802.1Qcp
12. 802.1Qcr
13. 802.1CS

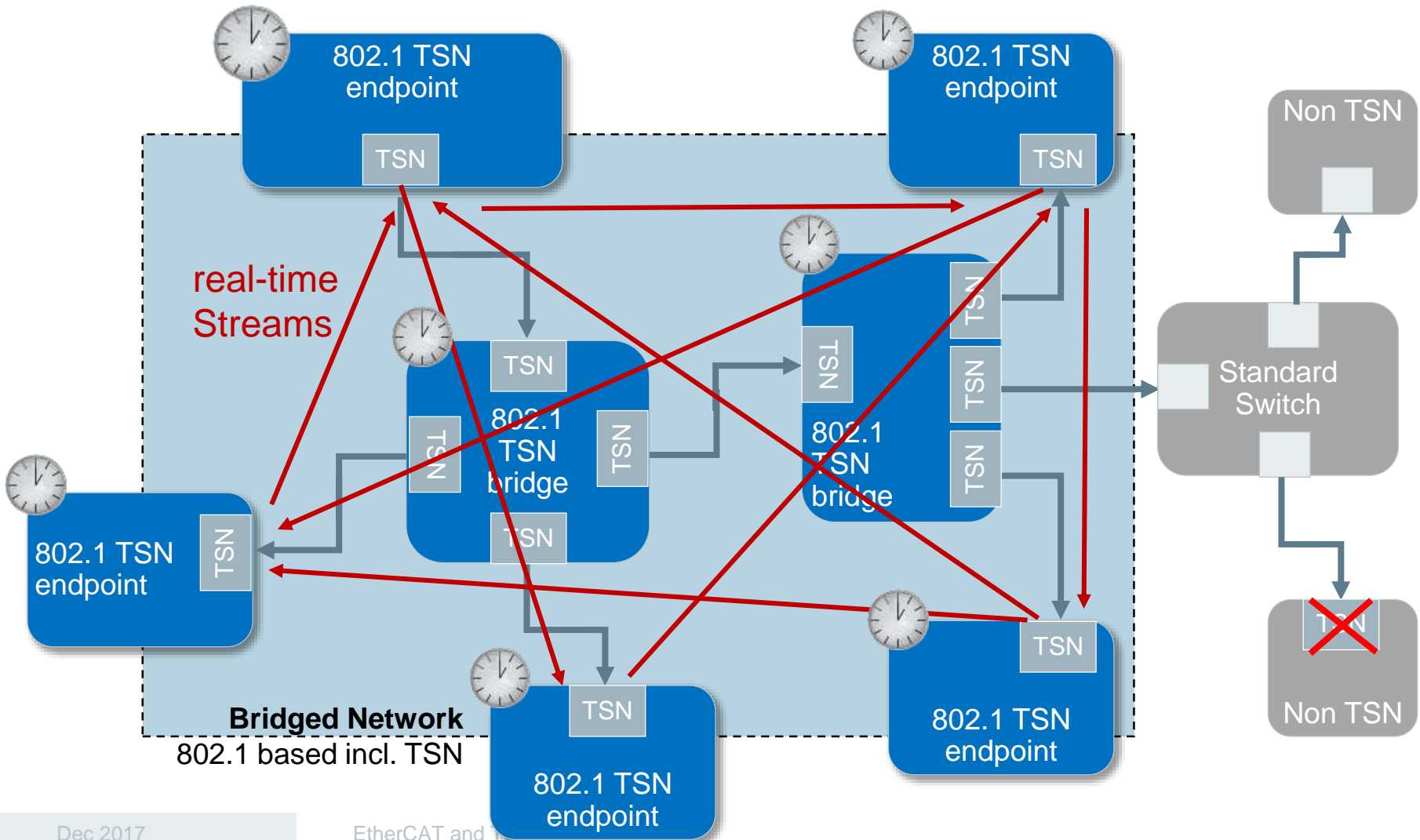
- 分布时间 (IEEE 802.1AS-Rev, IEEE 1588 规范) ...



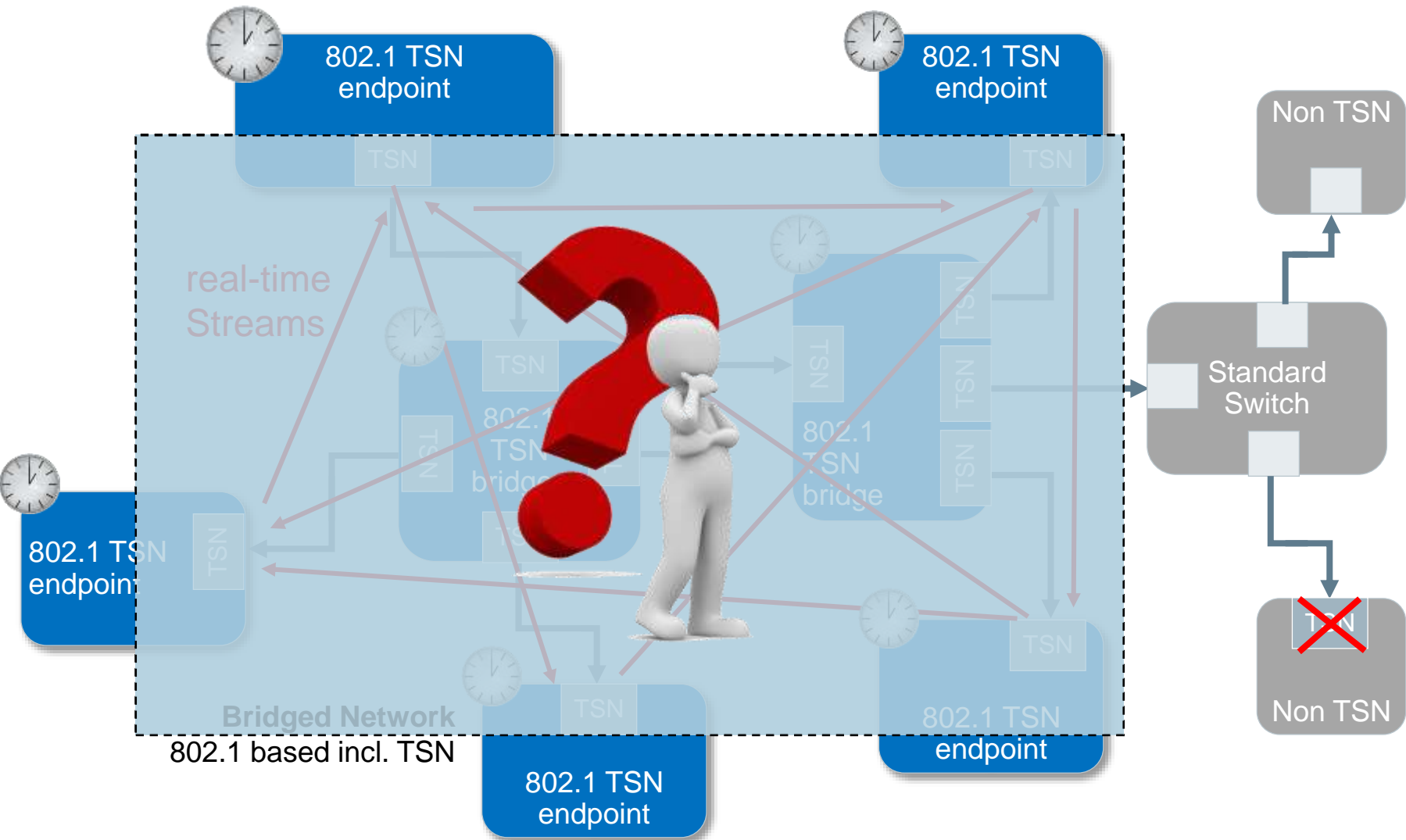
- 用于同步转发的实时数据通道 (IEEE802.1Qbv)



- 在TSN区域中要保持一致，需要支持TSN



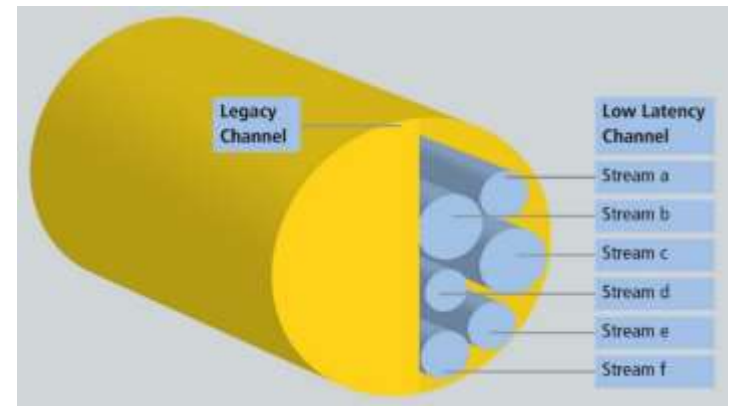
- IEEE802.1还没有制定配置定义



- TSN是IEEE 802世界中的范式转移
 - 处理多种行业的实时需要
 - 摆脱**best effort**模式
- 一部分带宽预留用于时间敏感的高速通道
- 剩余带宽用于传统数据帧（更高丢包率，更高的延时）

→ TSN打算为时间敏感的高速通道预留一部分带宽，
例如，TSN高速通道不会占用100%的带宽

→ 主要存在的问题：
所有网络组件的统一配置



Standard	Title	Status	
IEEE 802.1AS-Rev	Timing and Synchronization for Time-Sensitive Applications	Performance improvement, support of multiple time domains and redundancy included. Can synchronize Layer 3 networks. (2019)	W
IEEE 802.1Qbu	Frame Preemption	Use of Ethernet Mechanism, requires new MAC	P
IEEE 802.1Qbv	Enhancements for Scheduled Traffic	So called Time Aware Shaper (TAS) = mainstream technology.	P
IEEE 802.1Qca	Path Control and Reservation	Not longer in scope as too much data and service interaction needed to specify a schedule	P
IEEE 802.1CB	Frame Replication and Elimination for Reliability (Seamless Redundancy)	Support of seamless media redundancy. Allows multiple paths for streams.	P
IEEE 802.1Qcc	Stream Reservation Protocol (SRP) Enhancements and Performance Improvements	SRP is not suited to run a schedule with several hundreds of streams. New config model selected as a result. (2017?)	W
IEEE 802.1Qch	Cyclic Queuing and Forwarding	Streams received in previous cycle forwarded in next cycle	P
IEEE 802.1Qci	Per-Stream Filtering and Policing	Packets accepted if the port-, time- and rate-constraints met	P
IEEE 802.1CM	Time-Sensitive Networking for Fronthaul	Telecom TSN profile	T
IEEE 802.1Qcr	Asynchronous Traffic Shaping	Shaper that operates on non synchronized streams	T
IEEE 802.1Qcj	Auto Attach to PBB	Provider bridging configuration using LLDP	T
IEEE 802.1Qcp	802.1Q YANG data model	Needed for .1Qcc services. YANG textual encoding should replace MIB/SNMP. (2019)	W
IEEE 802.1CS	LRP (new link-local registration protocol)	Procedures to replicate a registration database and changes to parts from one end to the other of a point-to-point link. (2021)	E

E=EditorDraft, T=TSNballot, W=802.1ballot, S=sponsorBallot, R=RevCom, P=published

TSN: 系列标准 与EtherCAT高速通道相关的标准

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- IEEE 802.1AS-REV

时钟同步

- Profile of 1588

- IEEE 802.1Qbv:

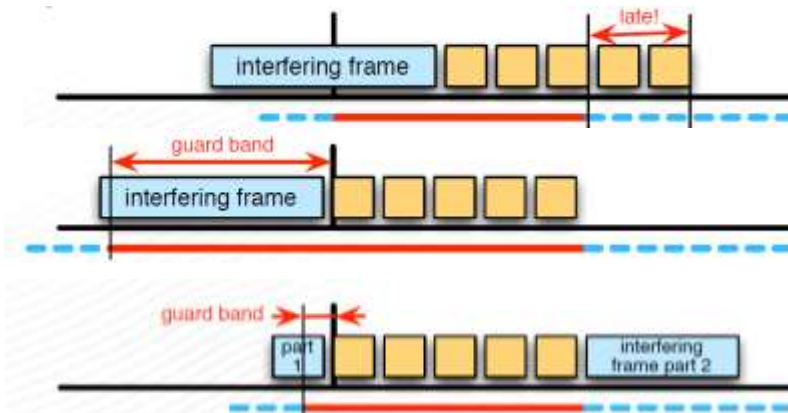
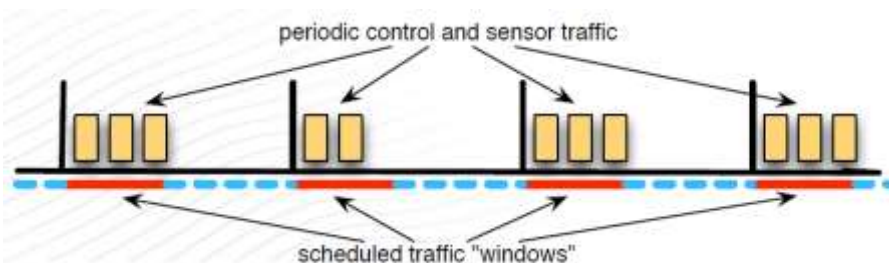
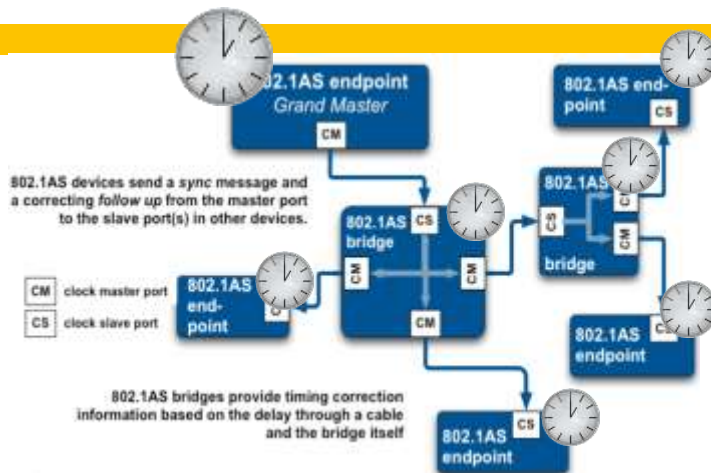
预订数据帧队列窗口

- 时间感知整形
- 有效的数据帧规划**
- 保护频带

- IEEE 802.1Qbu:

数据帧优先权

- To reduce Guard band



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ETG 积极参与到TSN 工作组中: Dr. Karl Weber是 IEEE 802.1的正式会员



3. Imtiaz, Jahanzaib; Jasperneite, Jürgen; **Weber, Karl**: Approaches to reduce the Latency for High Priority Traffic in **IEEE 802.1 AVB Networks**. In: 9th **IEEE** International Workshop on Factory Communication Systems (WFCS 2012) Lemgo, Germany, May 2012.
4. Imtiaz, Jahanzaib; Jasperneite, Jürgen: Performance impacts of different models. **IEEE 802.1 AVB** Task Group Real Time communication Symposium, Munich, Germany, Jan 2012.
5. Imtiaz, Jahanzaib; Jasperneite, Jürgen; Schriegel, Sebastian: A Proposal to Integrate Process Data Communication to **IEEE 802.1 Audio Video Bridging (AVB)**. In: 16th **IEEE** International Conference on Emerging Technologies and Factory Automation (ETFA 2011) Toulouse, France, Sep 2011.
6. Imtiaz, Jahanzaib; Goetz, Franz-Josef; **Weber, Karl**: Reduction of Impacts of Legacy Traffic on Stream Latency. In: **IEEE 802.1 AVB** Task Group Interim Meeting Santa Barbara, CA, May 2011, May 2011.
- Jasperneite, Jürgen; **Weber, Karl**: Redundant Structures for a Real-time Ethernet System. In: 15th **IEEE** International Conference on Emerging Technologies and Factory Automation, Bilbao, Spain Sep 2010.
- Wisniewski, Lukasz; Jasperneite, Jürgen; **Weber, Karl**: A Forwarding Policy for a Generic Real-time Ethernet System. In: 10th International Workshop on Factory Communication Systems COMET 2010 (WFCS 2010) Nancy, France, May 2010.

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ETG Team Worldwide

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- EtherCAT技术和IEEE 802.1工作组就技术方面进行和深入合作
- 这个联系包括开放IEEE802.1文档的访问权限，尽管这些文档还没有被发布。
- 这将确保TSN标准可以通过ETG设备行规定义，以正确方式并尽早的被使用
- 随便说一下：

并不是每一个声称知道TSN和知道如何使用它的组织（公司）都可以访问TSN的标准草案，也不代表他们参加了任何一个IEEE 802.1工作组...

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应用情况:

- 在交换机网络中提升EAP的实时性能
- EtherCAT主站和EtherCAT网段的链接是通过异构的交换机网络

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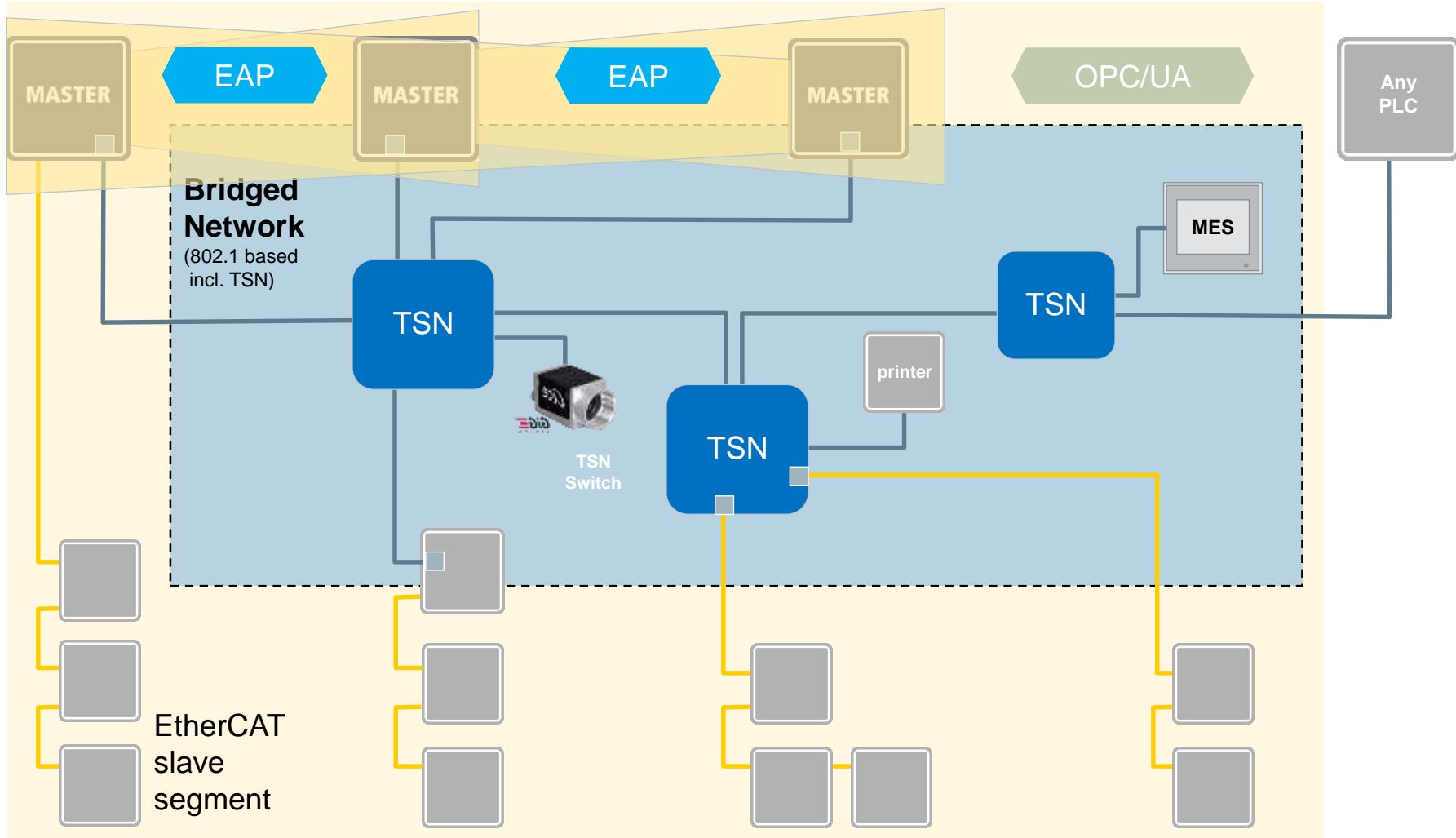
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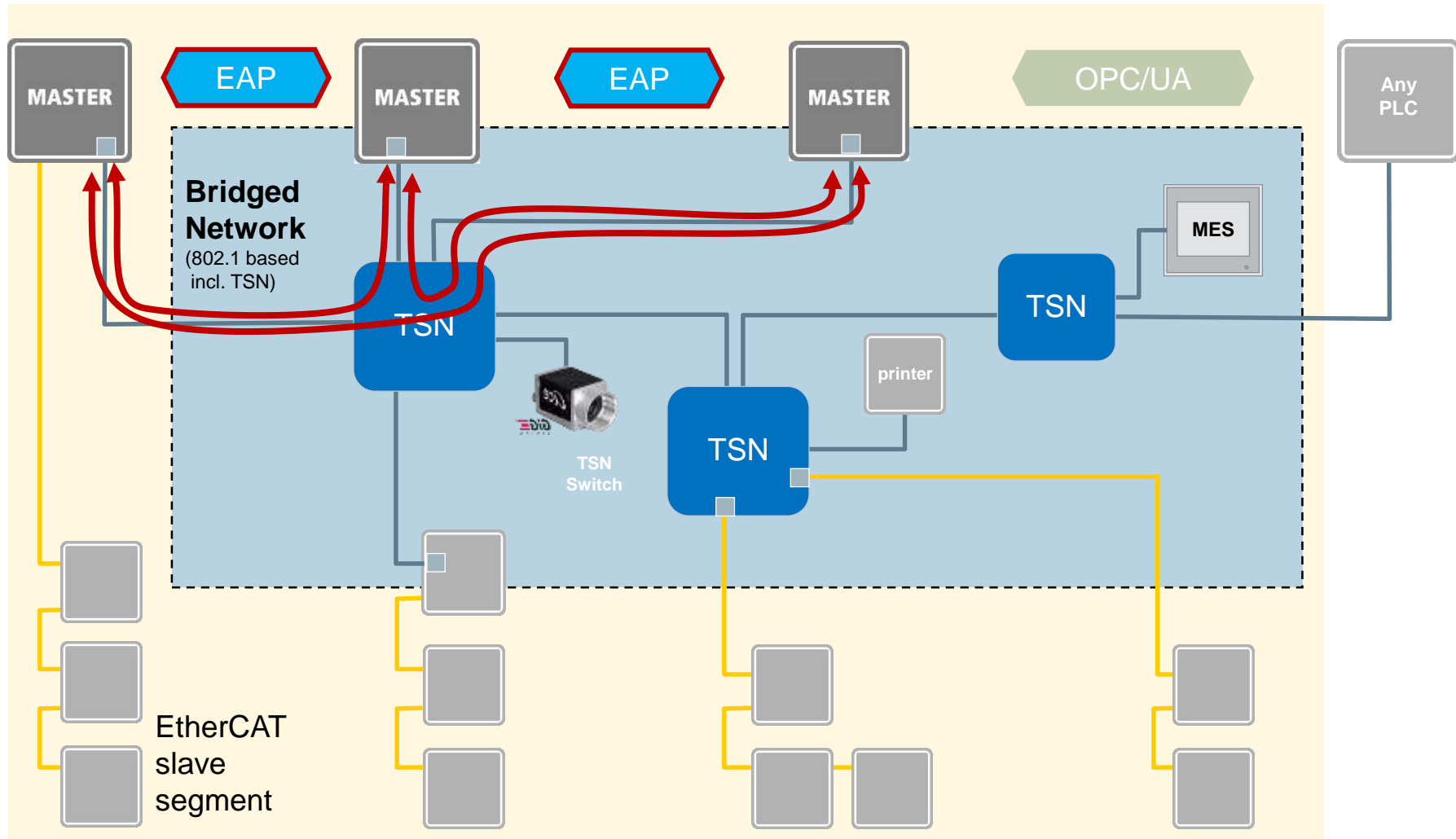
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EtherCAT 主站之间通过TSN访问



EAP 通过TSN扩展802.1网络传输



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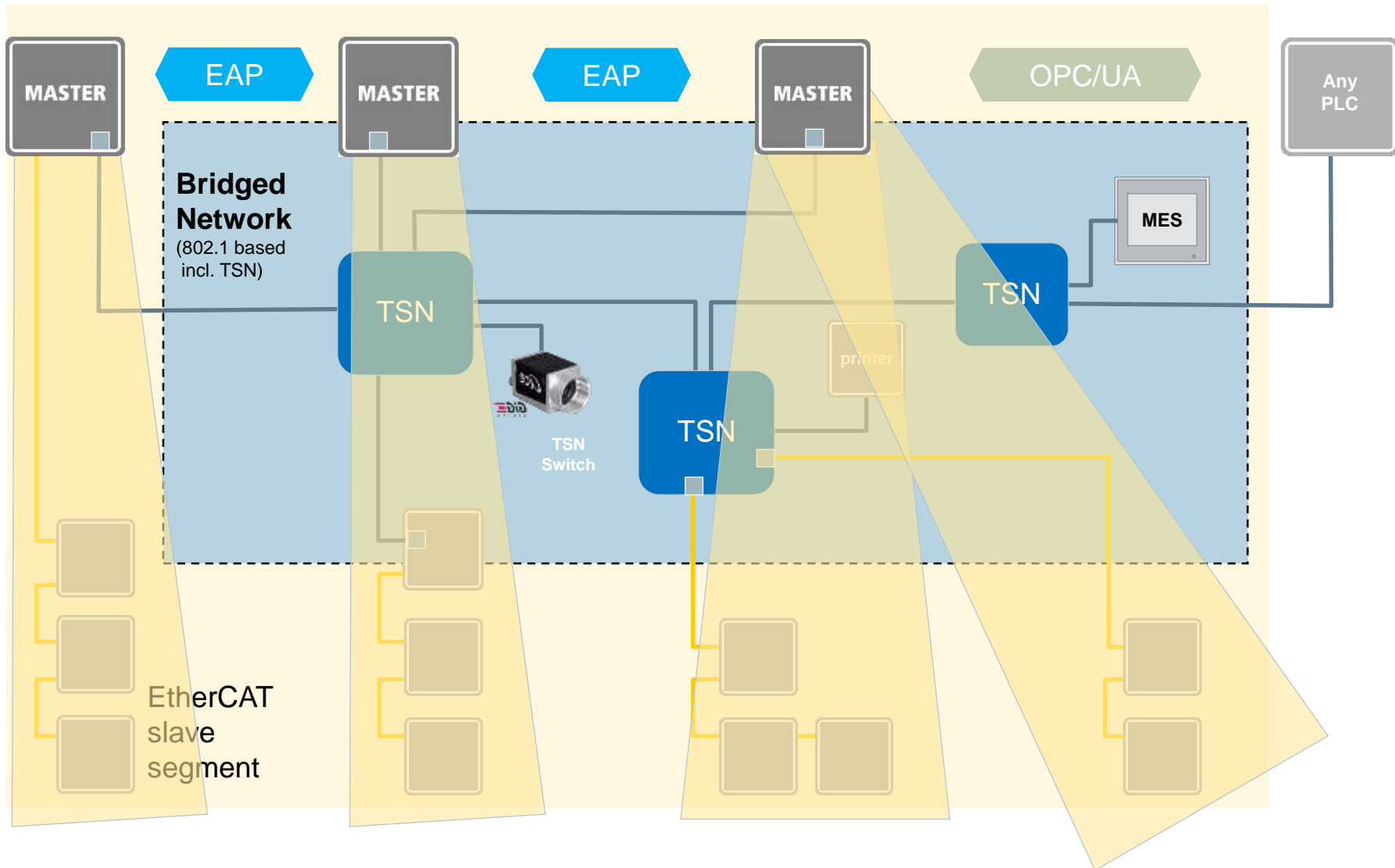
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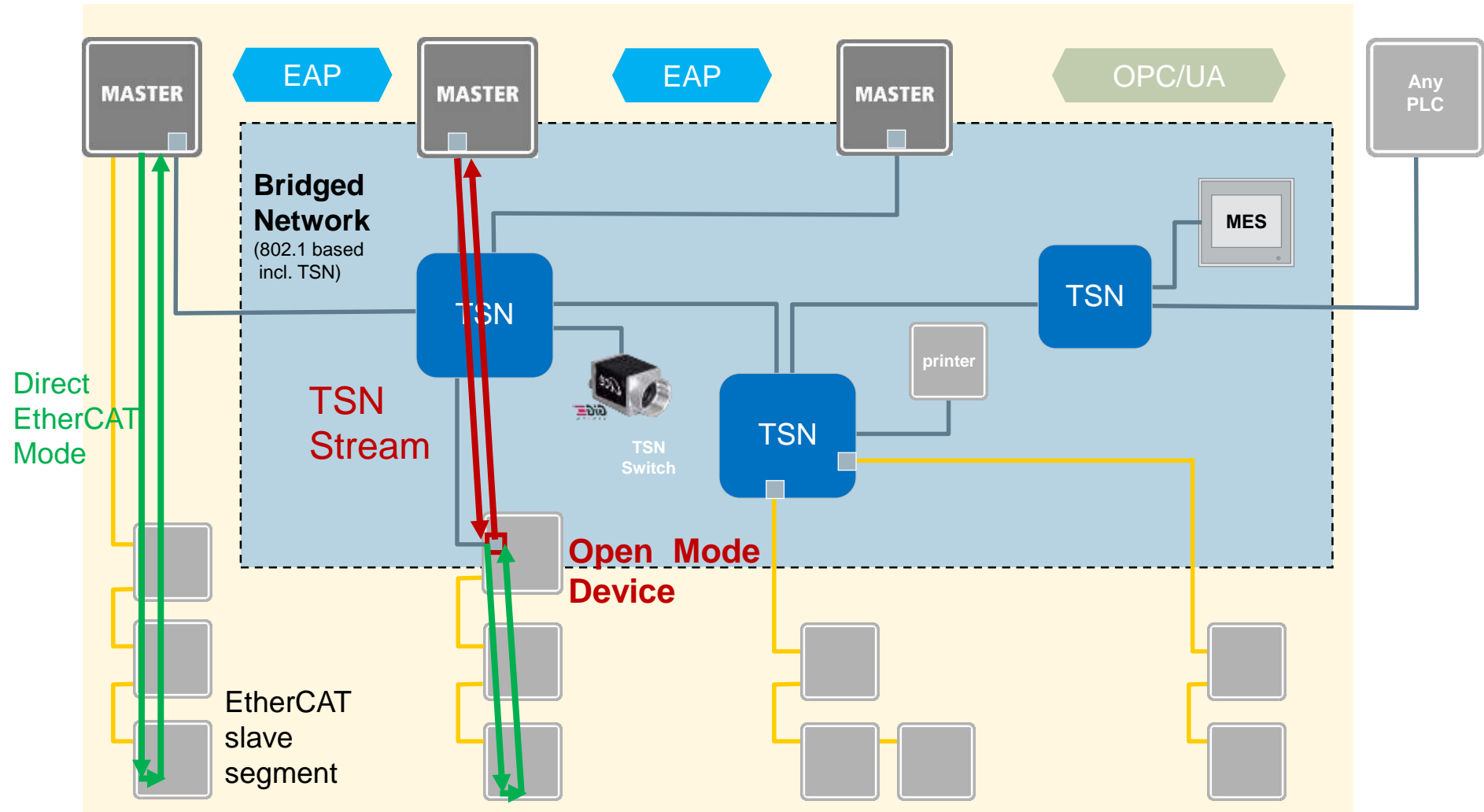
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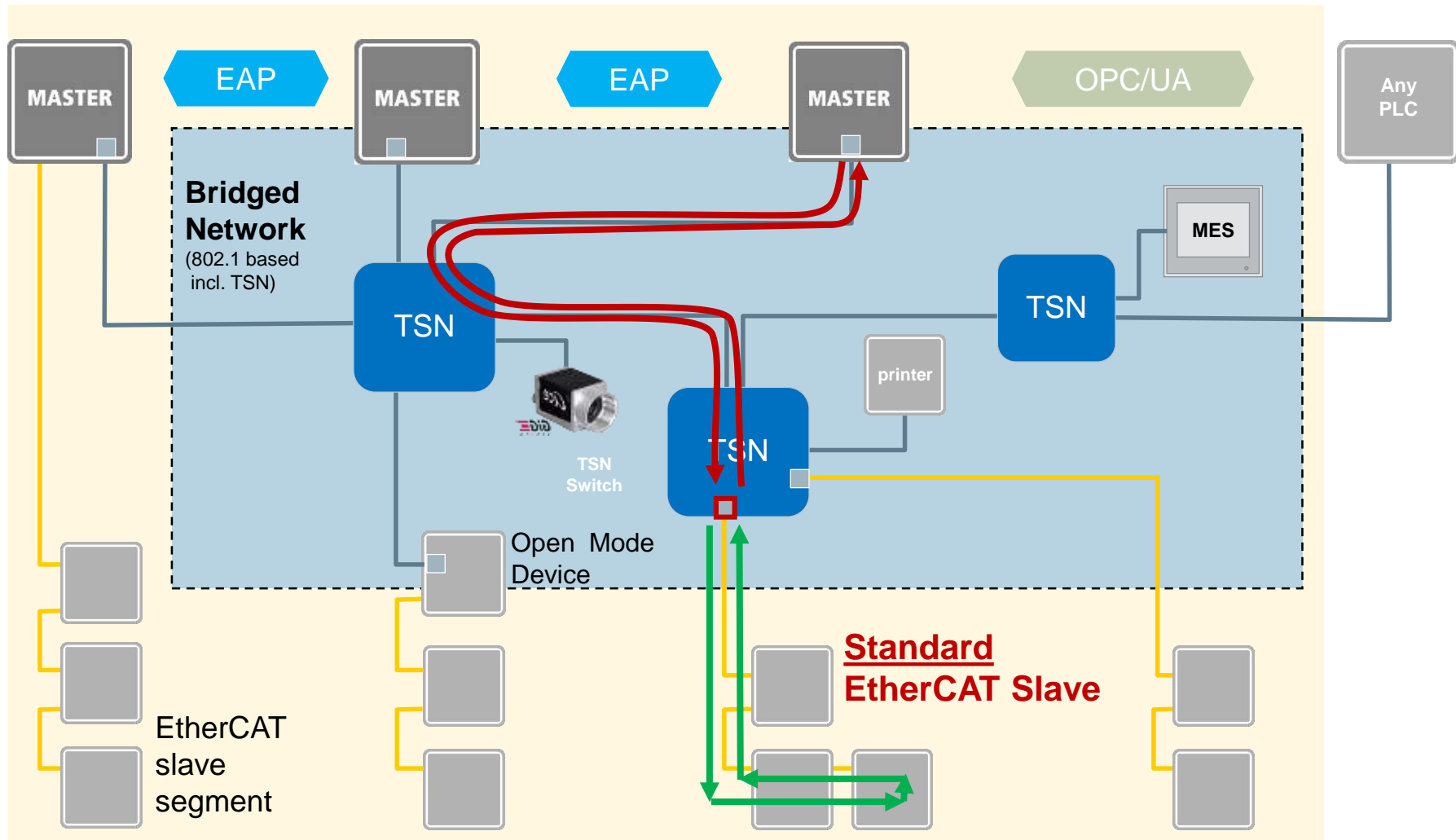
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TSN 网络连接EtherCAT主站和EtherCAT网段





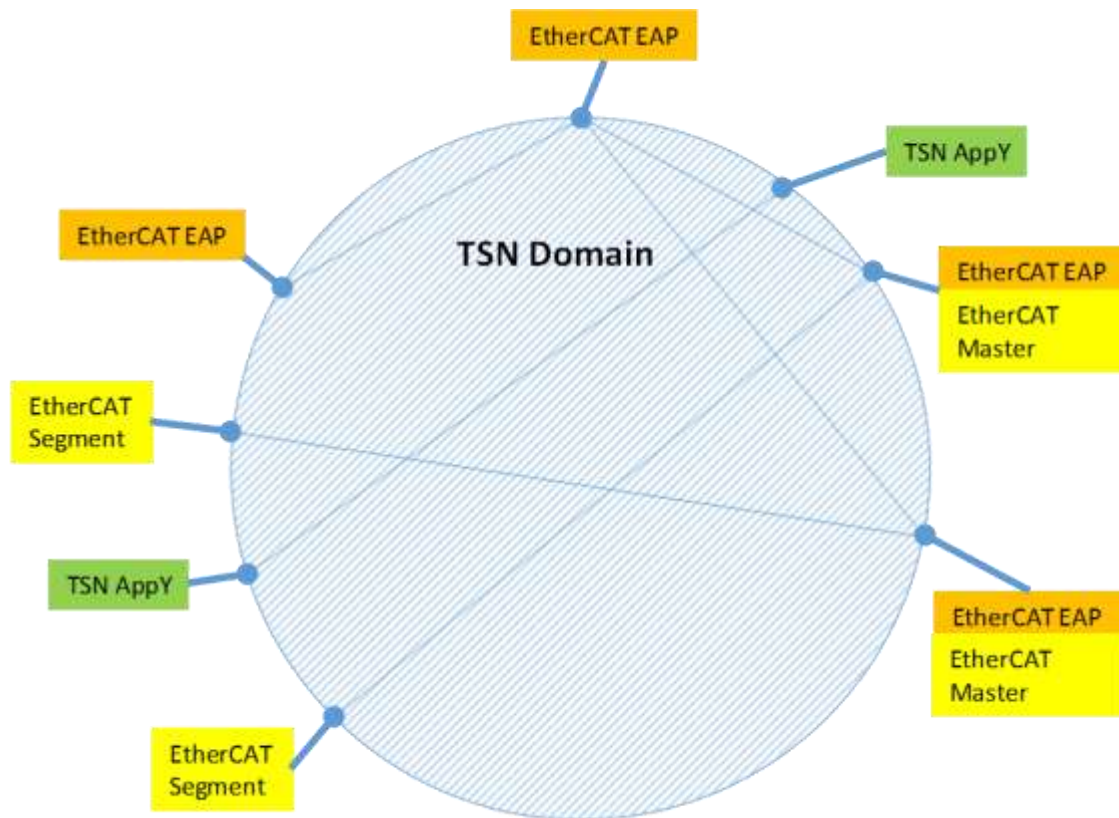


- ETG定义了行规规范用与EtherCAT和TSN的使用
 - 基于时间的发送
 - 同步

- 第一版（草案）已经发布



- 如果您需要选择，两个都使用！
- 适配高速通道使用了TSN技术，但并没有改变TSN！
- 适配高速通道使用了EtherCAT，但并没有改变EtherCAT！



行规在圆形区域外面.

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- EtherCAT很好的匹配了TSN高速通道----EtherCAT网段可只使用**唯一的数据帧传递数据**
- 新的行规---而不是新的协议
- EtherCAT还是之前的技术:
 - 没有改变,包括在EtherCAT从站设备中
 - 精益的通道配置功能可以实施到TSN交换机中
 - 这样EtherCAT网段可以和TSN区域直接相连

- EtherCAT 协议 IEC61158-12 (2008) 中定义的“open mode 开放模式”

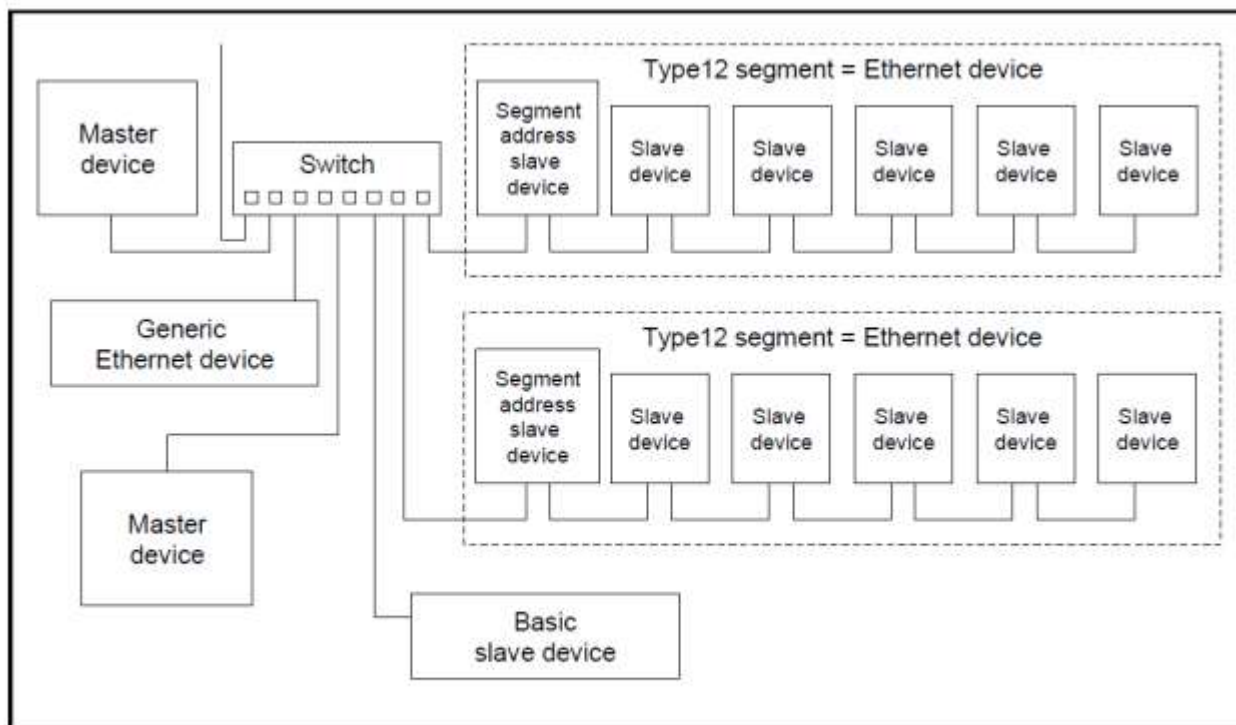


Figure 3 – EtherCAT segments in open mode

- EtherCAT 早在10年之前就定义的远程寻址EtherCAT网段的模式-TSN 是今天实施它的很好的选择