SIEMENS
Ingenuity for life

Proposal for a Resource Allocation Protocol based on 802.1CS LRP

Industrial Requirements

Feng Chen, Franz-Josef Götz
Siemens AG

IEEE 802.1 Interim Meeting
May 2017, Stuttgart, Germany

History of Stream Configuration in IEEE 802.1

1st Step – Stream Reservation Protocol (SRP) in Audio / Video Bridging (AVB)

- AVB has standardized a Stream Reservation Protocol (MSRPv0) for distributed stream configuration
  - Main focus was the audio / video applications
  - A fix set of Stream Reservation Classes (A, B) provided by Credit-based Shaper (CBS)

è Guaranteed QoS is provided by reservation and shaper

2nd Step – Enhancements for Stream Reservation for Time-Sensitive-Networking (TSN)

- Qcc focuses on the centralized configuration models driven by the need of scheduling for scheduled traffic
  - The new TSN features (e.g. pre-emption, redundancy, Scheduled Traffic, …) are currently only supported by CNC based configuration models.
  - The “fully” distributed configuration model is still restricted to CBS.

è Guaranteed QoS is provided by time based scheduling (Scheduled Traffic)

Resource Allocation Protocol

Proposal: 3rd Step – Resource Allocation Protocol (RAP)*

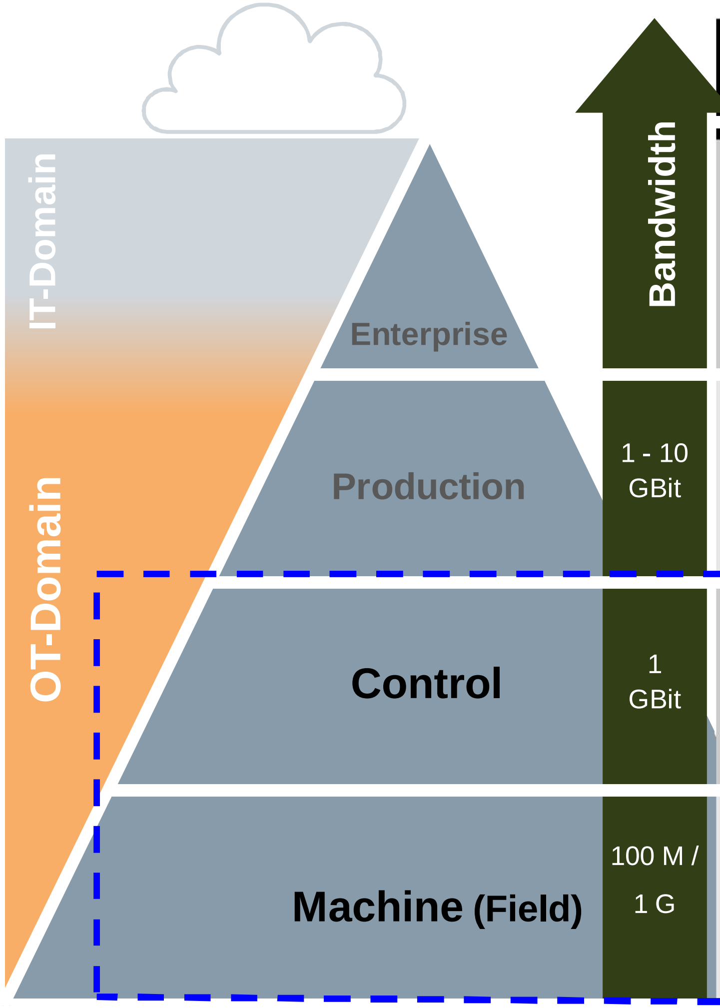
- Following the concept of MSRP for AVB, a new resource allocation protocol built on LRP is needed to provide a distributed solution for stream configuration with the following goals:
  - **improved scalability (offered by LRP)**
  - **support for TSN features**
    (e.g. configurable SRclass, transmission mechanism, redundancy)
  - **enhanced performance**
    (e.g. improved information flow, enhanced diagnostic capabilities)
- RAP as a distributed solution is NOT intended as a substitute for the centralized stream configuration model

* **Note**: instead of "Stream Reservation Protocol", a new name "Resource Allocation Protocol" is used to distinguish between two protocols that are built on different underlying registration mechanisms, i.e. RAP on LRP vs. MSRP on MRP.

Not All Industrial Real-Time applications require Lowest Latency with Scheduled Traffic

SIEMENS

Classical Automation Pyramid



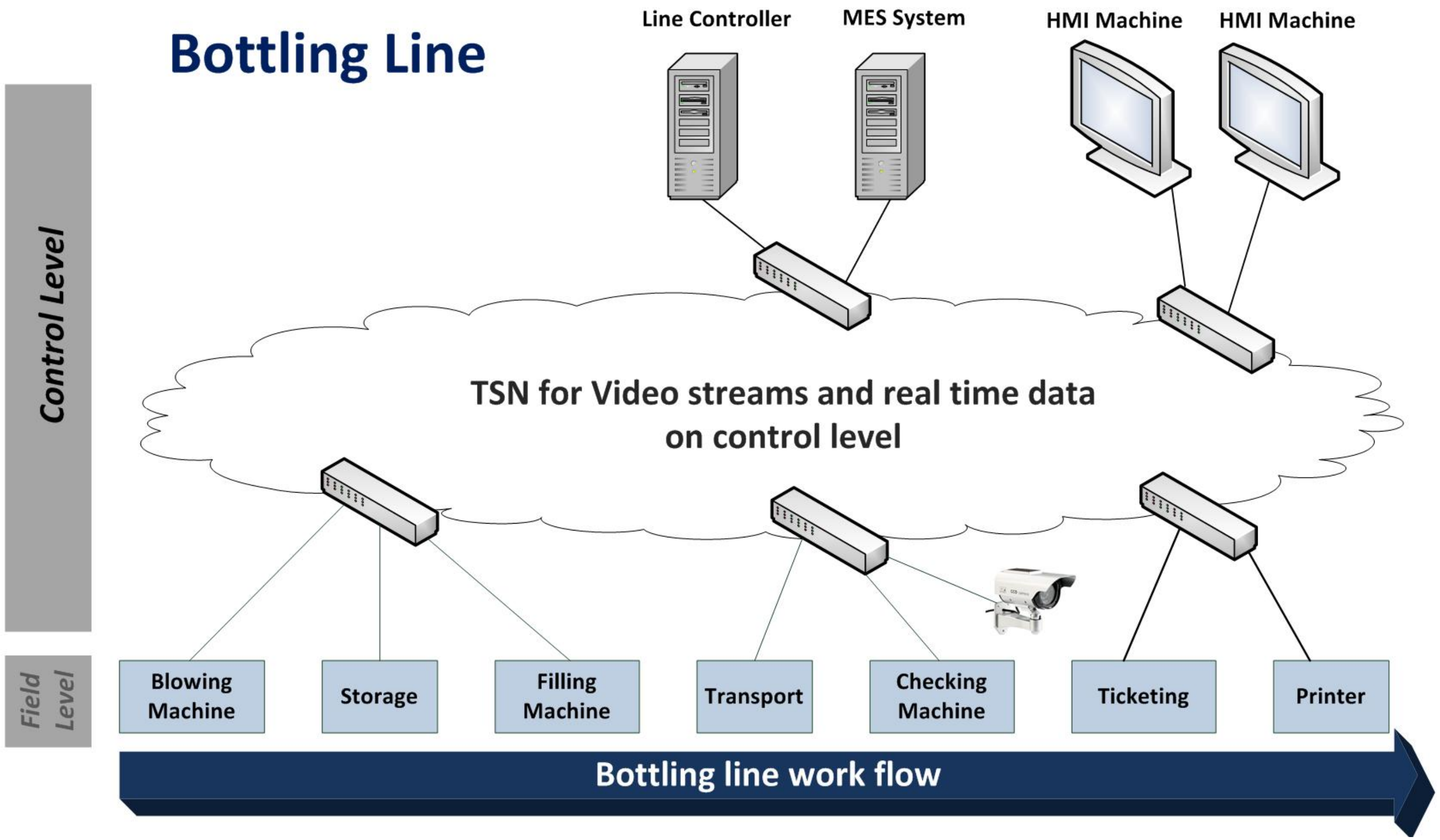
Level	Bandwidth	Main Features	Typical Applications	Latency
Enterprise		▪ Universal time ▪ Strict separation between end stations and network → network infrastructure	ERP All IP based protocols	seconds ↕ 100 ms
Production	1 - 10 GBit	▪ High precision time sync ▪ Strict separation between end stations and network ▪ → network infrastructure	MES, SCADA Condition Monitoring High diversity of Layer 3 protocols	1 s ↕ 100 ms
Control	1 GBit	▪ Dynamic allocation of network ressources ▪ Seamless redundancy	Control, M2M, HMI Time Sync, Safety, Multiple real-time applications	200 ms ↕ 1 ms
Machine (Field)	100 M / 1 G	▪ High cost pressure ▪ Devices with integrated switches ▪ isochronous working clock ▪ Seamless redundancy	PLC Safety Time Sync Individual real-time applications	16 ms ↕ 31.25 µs

- There exist a number of industrial applications on both control and field levels with different real-time requirements in the range from **hundreds of µs to tens of ms**.
- For many of such applications, guaranteed QoS with **bounded max. latency and zero packet loss** can be achieved by TSN **without using scheduled traffic.**

bounded max. latency and zero packet loss

highest determinism with lowest latency

Example of Control-Level Applications

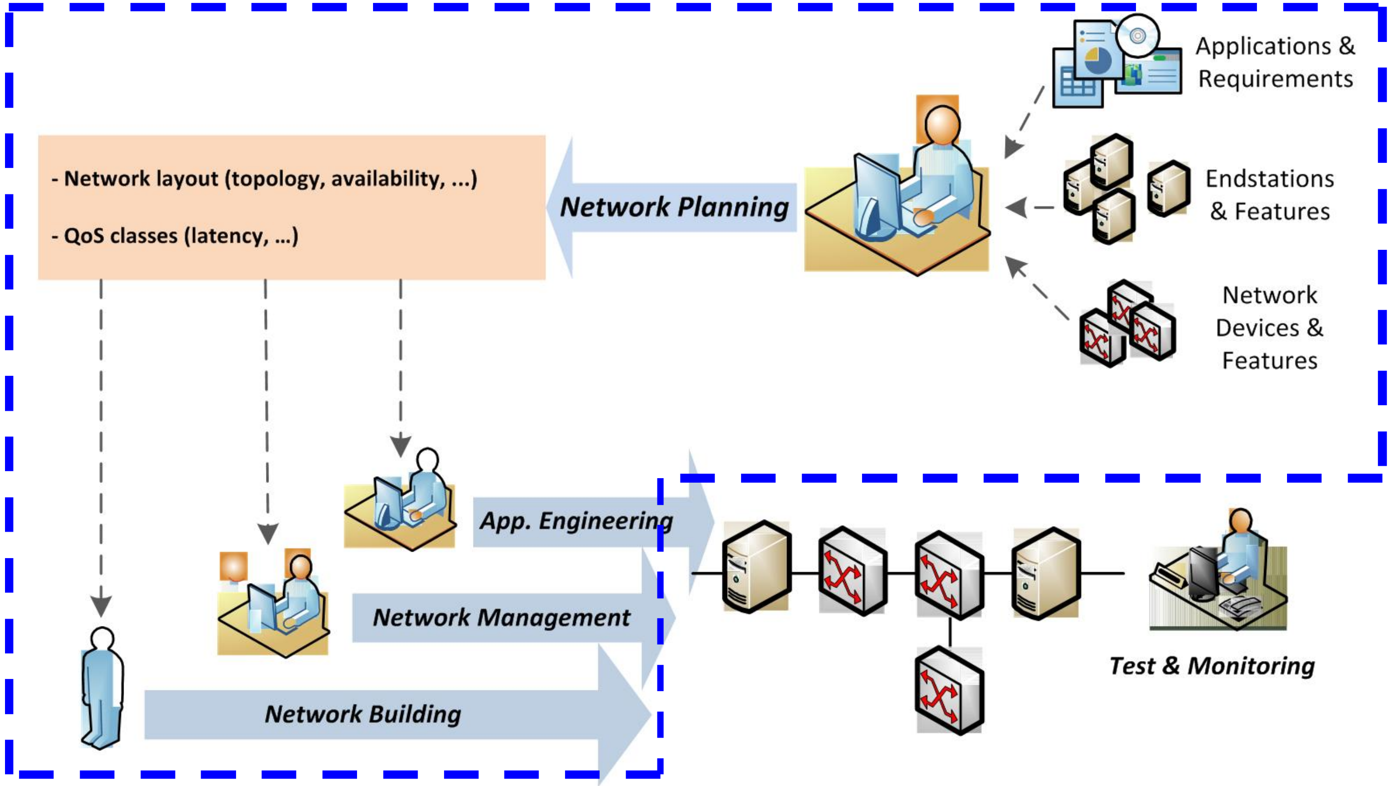


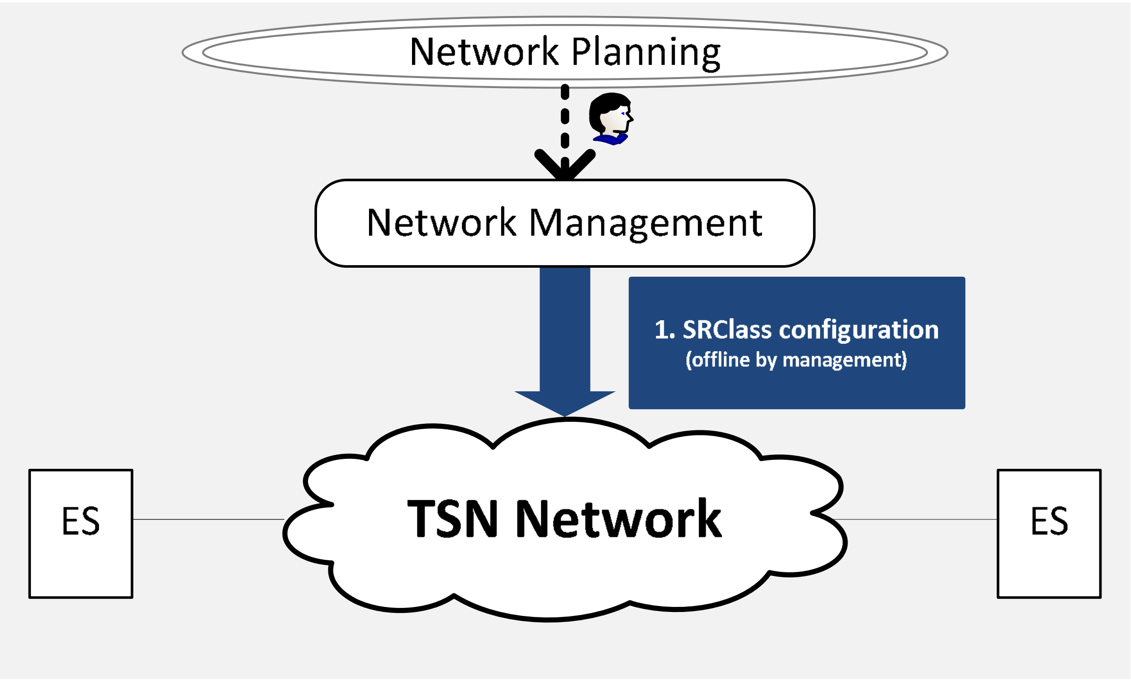
Traffic Types	QoS Requirements
Video streams	• max bandwidth of 5 Mbps per stream • bounded max latency of **200 ms**
Real-time data	• 1-to-1 or 1-to-N relation • bandwidth in range of 1 to 10 Mbps • bounded max latency **2.5 ms** • zero packet loss
…	

More on requirements of industrial control-level applications for Time Sensitive Networks in Manufacturing are presented in

http://www.ieee802.org/1/files/public/docs2015/tsn-munz-requirements-for-tsn-in-manufacturing-0515-v01.pdf

Design Flow of Industrial Networks for Distributed Stream Configuration (1)

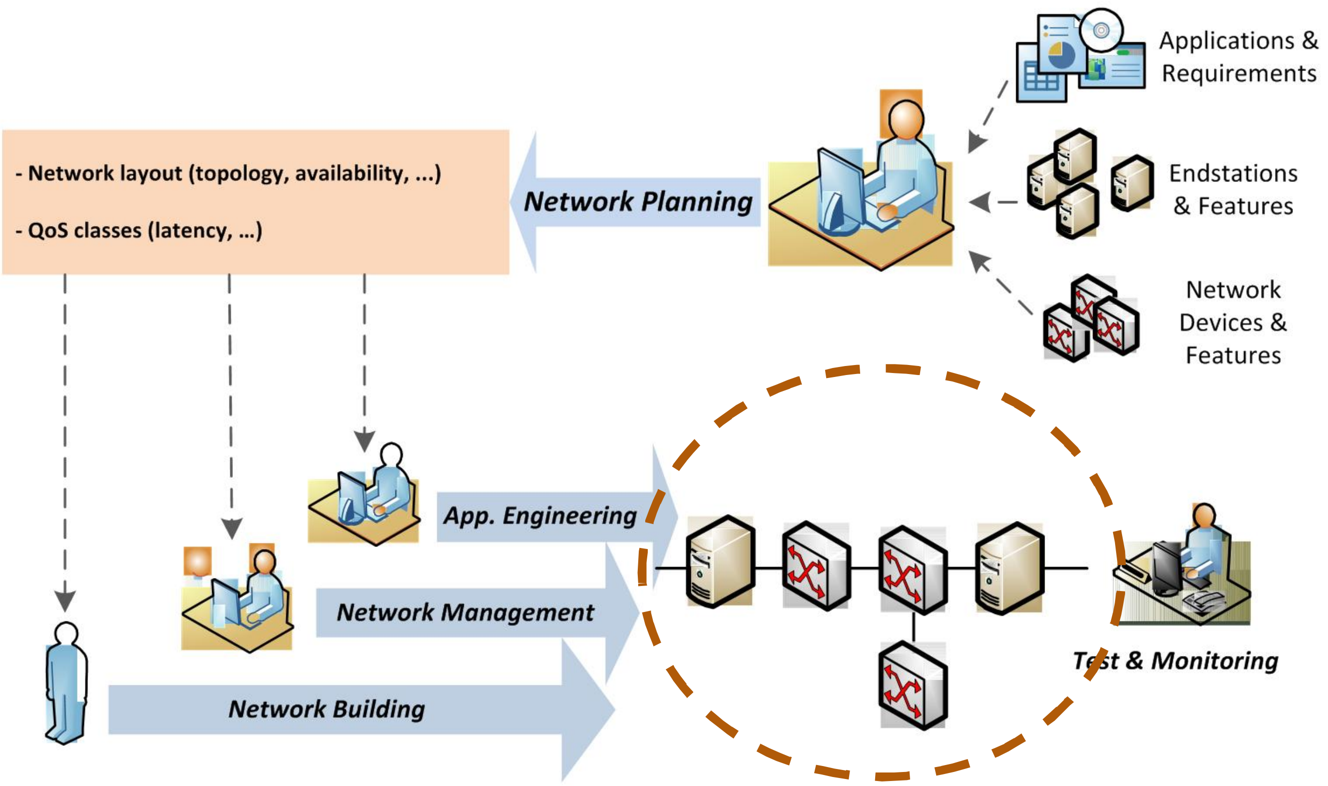


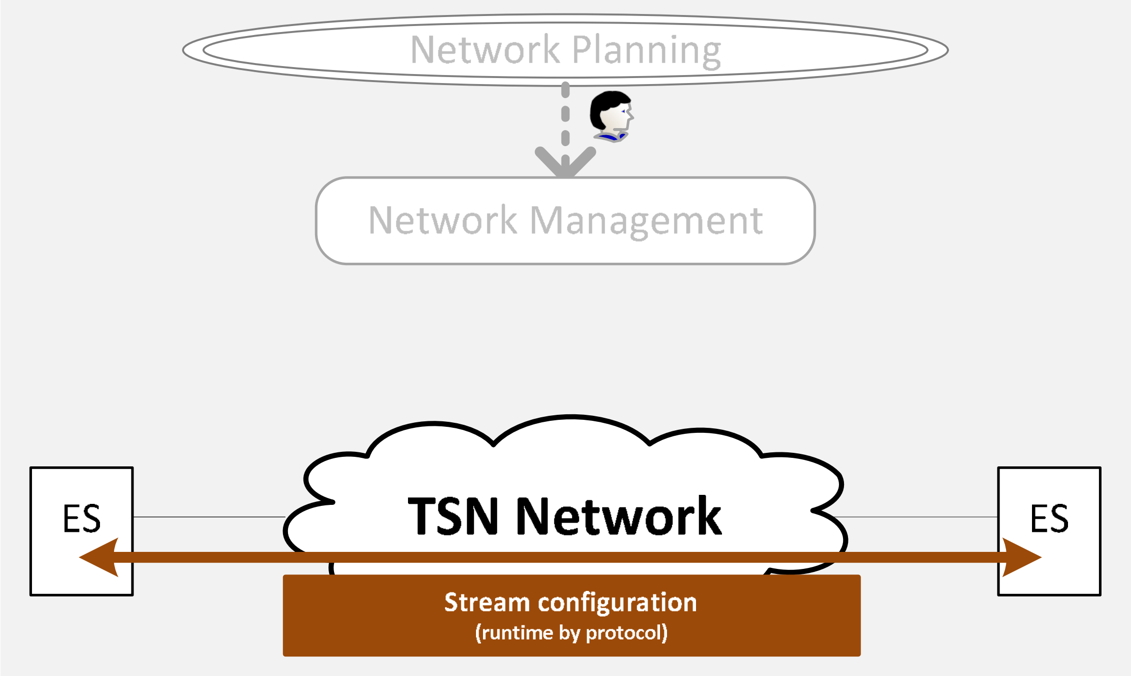


Step 1 . Offline network planning and engineering

A set of SRclasses are pre-configured by network management, where each SRclass represents a given level of QoS provided by the network.

Design flow of Industrial Networks for Distributed Stream Configuration (2)





Step 2: run-time stream configuration

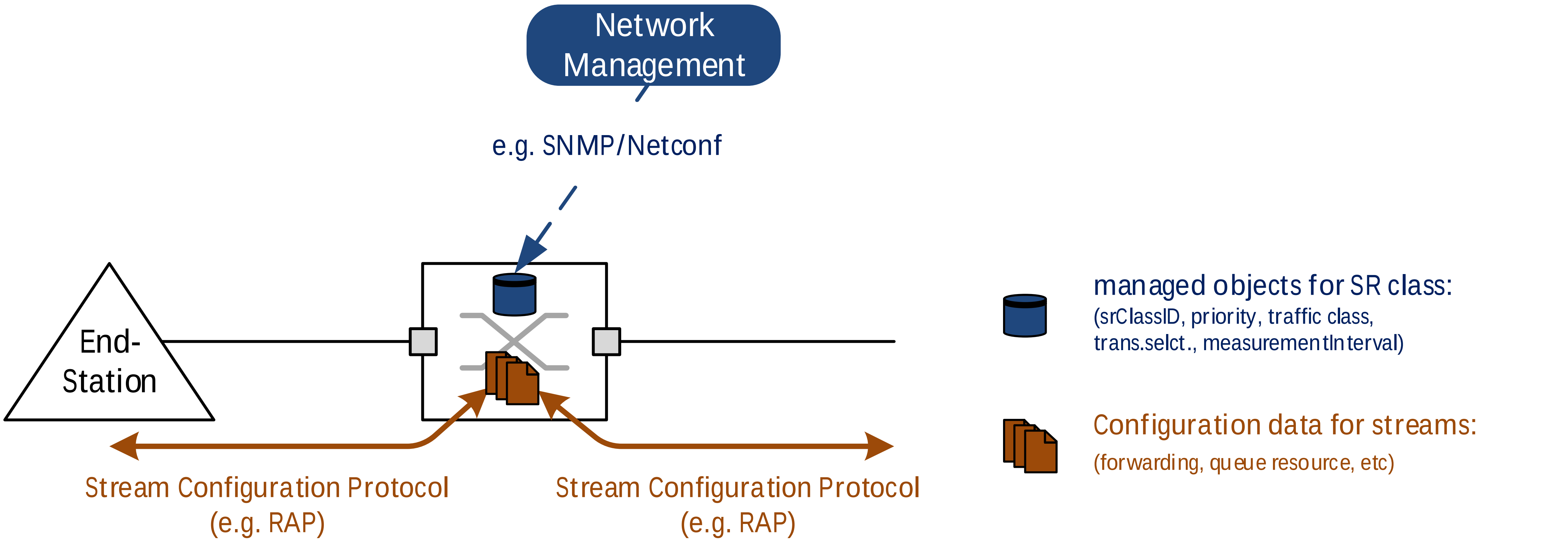
A stream configuration protocol (initiated by end-stations) performs bandwidth reservation and resource allocation for each stream on the network.

Industrial End-Stations have the capability of initiating stream configuration on the Network

SIEMENS

Example: End-station triggers distributed stream configuration on a time sensitive network

(comparable to MSRP in AVB)



Summary

Why Distributed Stream Configuration for Industrial?

- A new stream configuration protocol based on LRP is needed to provide a distributed solution for those industrial real-time applications that
  - do not require lowest latency, which is typically realized by applying centralized scheduling for scheduled traffic
  - but still desire TSN benefits such as bounded max latency and zero packet loss

- The design flow of industrial automation networks is able to support the concept of distributed stream configuration
  - SR classes are preconfigured using management offline
  - Stream configuration is executed by a protocol at run-time

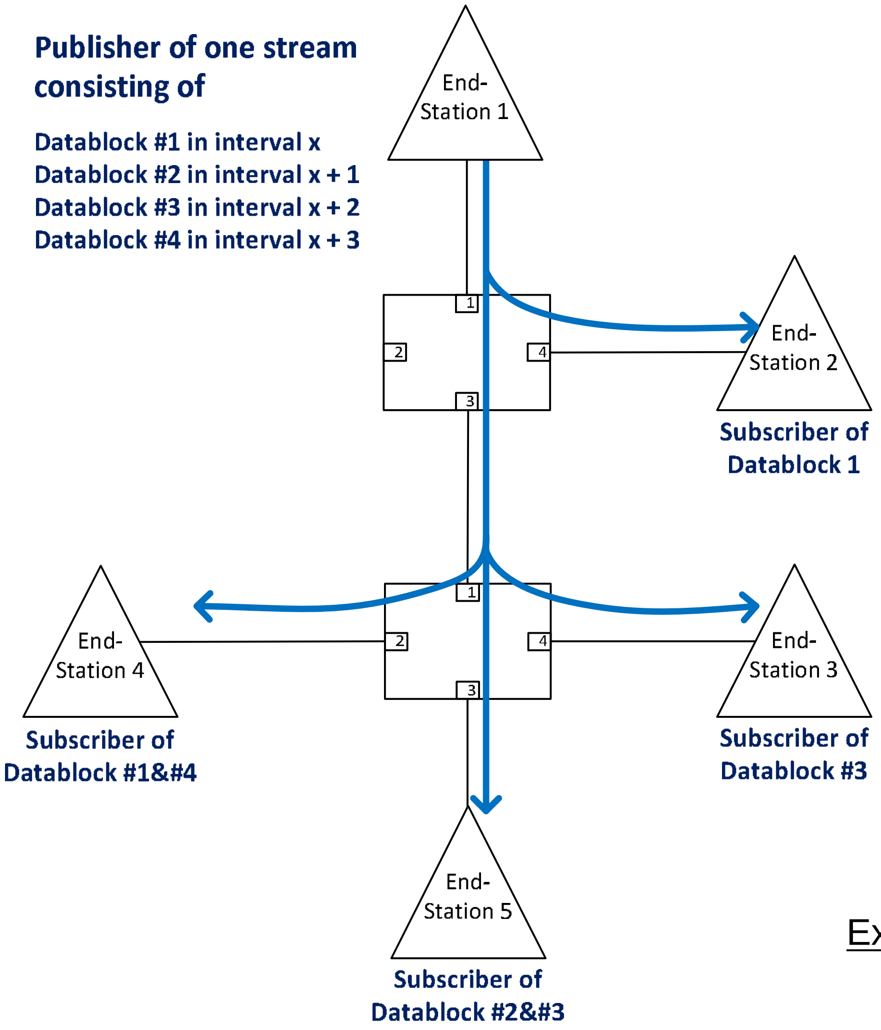
- Industrial End-Stations have the capabilities of initiating stream configuration onto the network

Thank You!

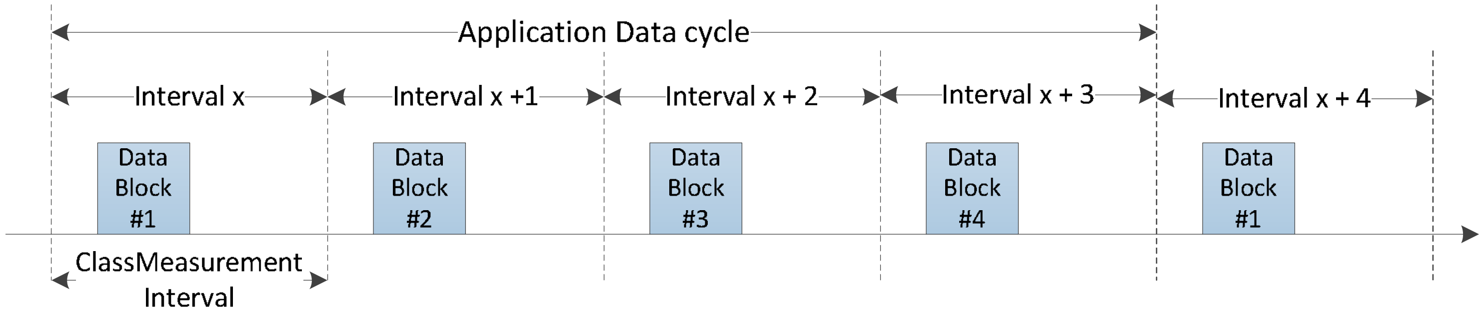
Questions?

Industrial End-Stations have the capability of adapting application data cycles to intervals provided by SR Classes

SIEMENS



Type	Attribute	Value
Application	Datablock cycle	• 1 ms
	Max. data size (including header)	• 128 Bytes
Network	SRclass measurement interval	• 250 µs
	Max. Frame Size	• 152 Bytes



Example: adaption of application data cycles to network class measurement intervals at end-stations using “reduction-ratio”