Multicast Traffic Filtering for Sampled Value Process Bus Networks

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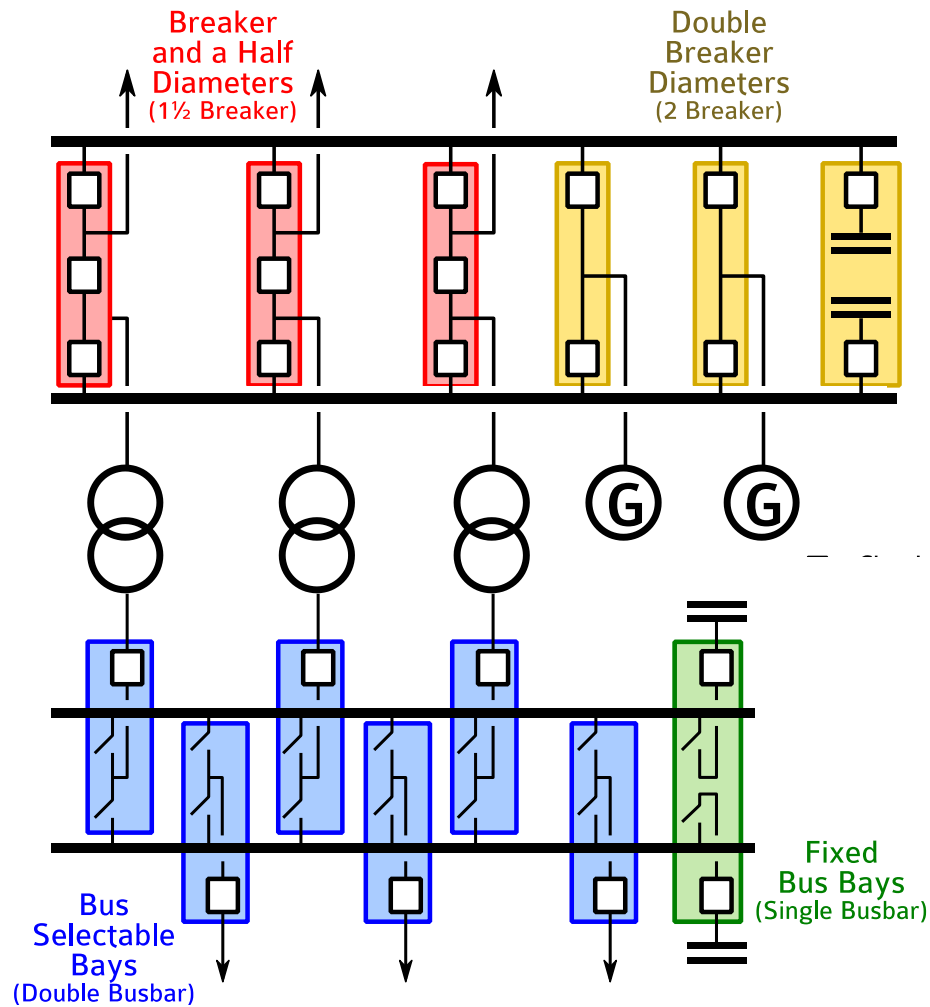
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Presentation Outline

- High voltage substations
  - Terminology
  - Field connections to the control system
- Ethernet
  - Message types
  - Addressing
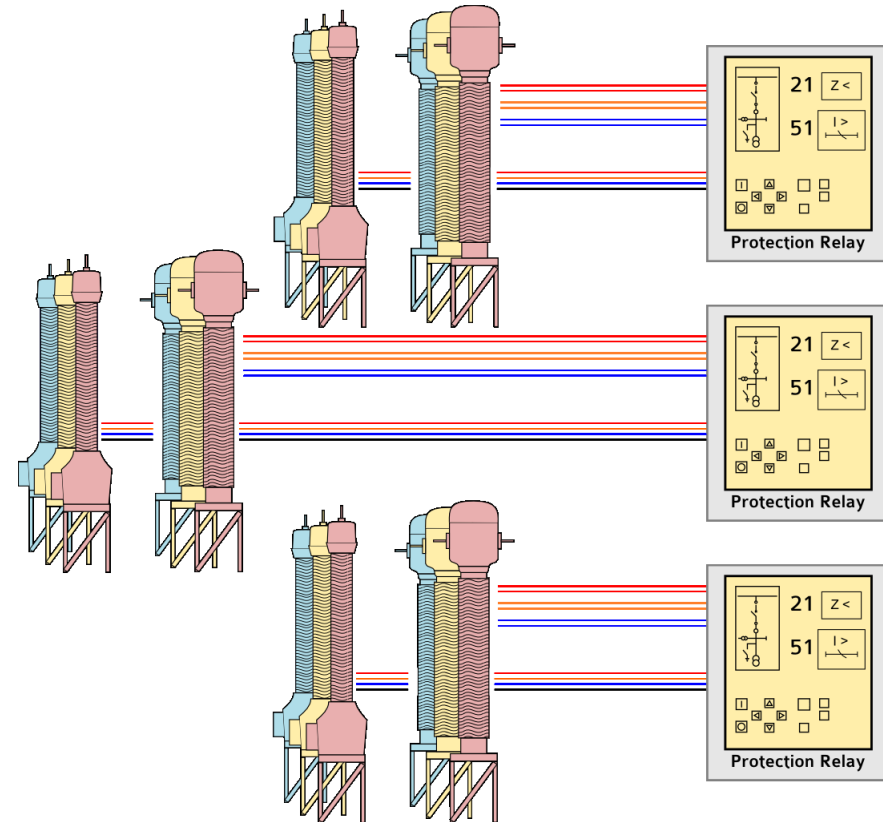- Reference Designator based addressing
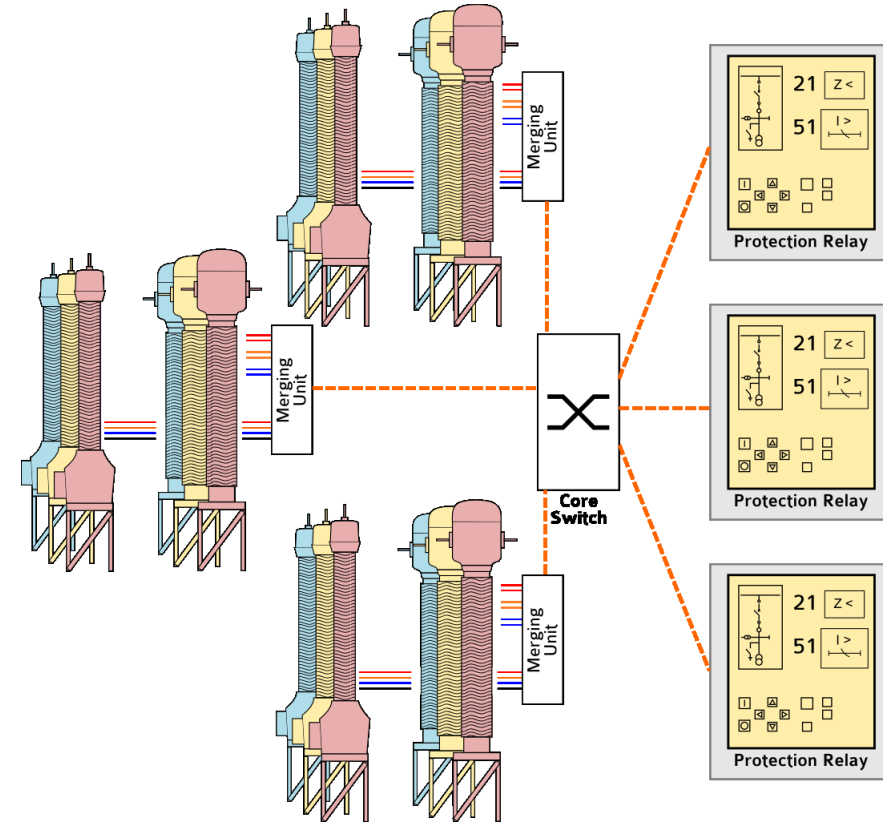 - Subscriber example

Substation 'Bays' and 'Diameters'

Process Connections

## Conventional (old)

Process Bus (new)

Ethernet Message Types

- Unicast
  - Convention **one-to-one** communication

- Broadcast
  - **One-to-all** communication
  - Cannot be filtered

- Multicast
  - **One-to-many** communication
  - Filtering can limit transmission of messages
  - Special destination addresses are used

Process Bus Protocols

- ## Sampled Values (61850-9-2)
  - – Raw currents and voltages

- ## GOOSE (61850-8-1)
  - – Digital events & alarms
  - – Transduced voltages and currents
  - – Circuit breaker tripping

- ## PTP (IEEE Std 1588)
  - – Time synchronisation

- ## **All multicast protocols**
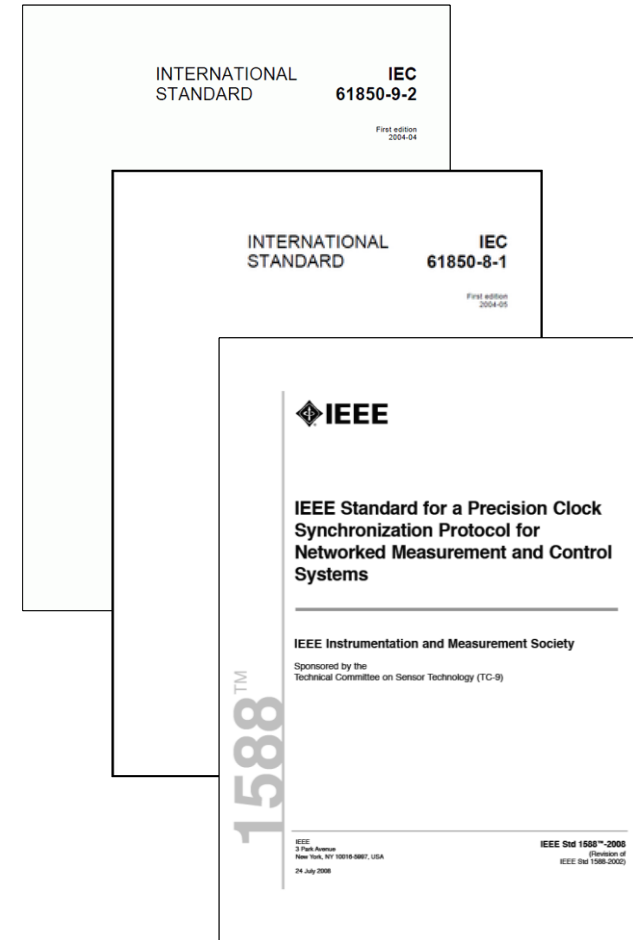
The Problem

- One 'whole of substation' process bus in China
  - Traffic not a concern for point-point process bus

- Need to develop a robust solution
  - Whole of substation process bus is the way of the future.

- No clear way to partition SV traffic into groups

- Two schools of thought: Functional & Locational
  - Locational provides clear link between source of data and the destination address

VLANs and Multicast Filtering

- ## VLANs separate classes of traffic.
  - IEEE Std 802.1Q

- ## Multicast groups separate traffic within the classes.
 - Multicast groups most important with Sampled Values.
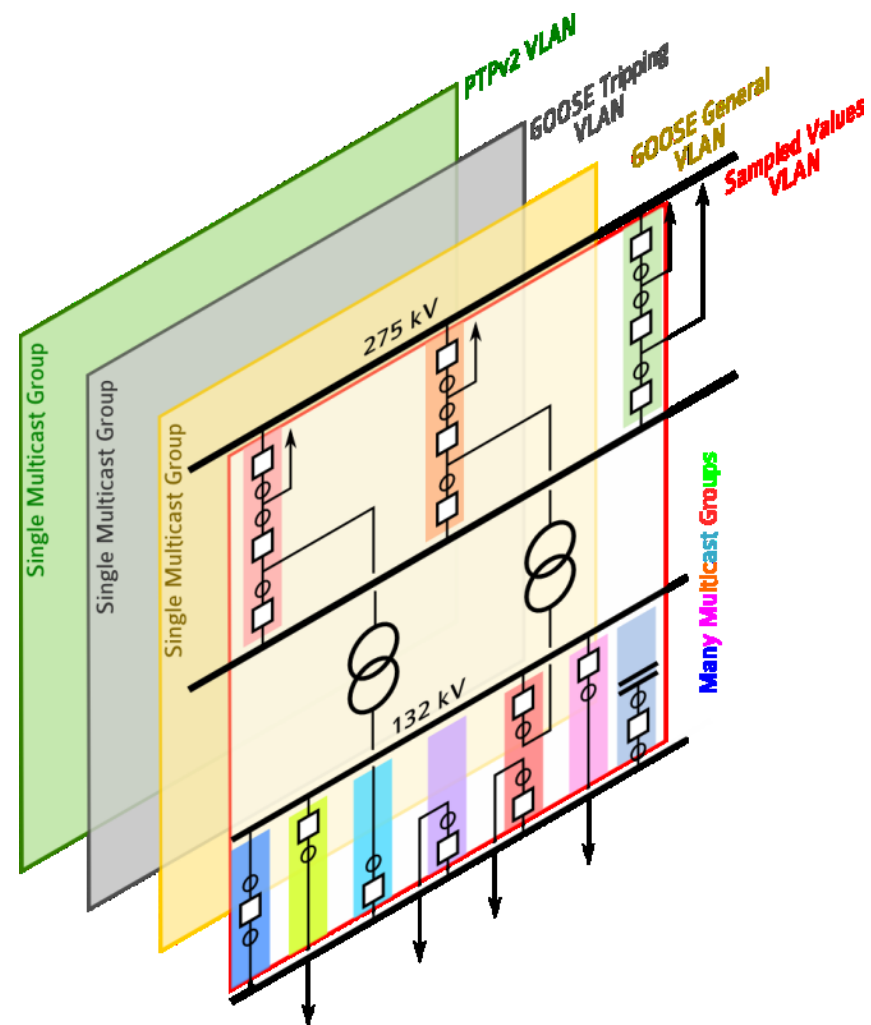
Our Proposal

- Standardised VLANs provide prioritisation
  - Consistent across an enterprise
- Multicast groups are site specific
- Multicast traffic groups based on diameter/bay.
  - Location based approach
- Relays need 2-4 CTs for 1½CB and 2CB
  - Reduces number of groups required

275/132 kV Substations (Transmission)
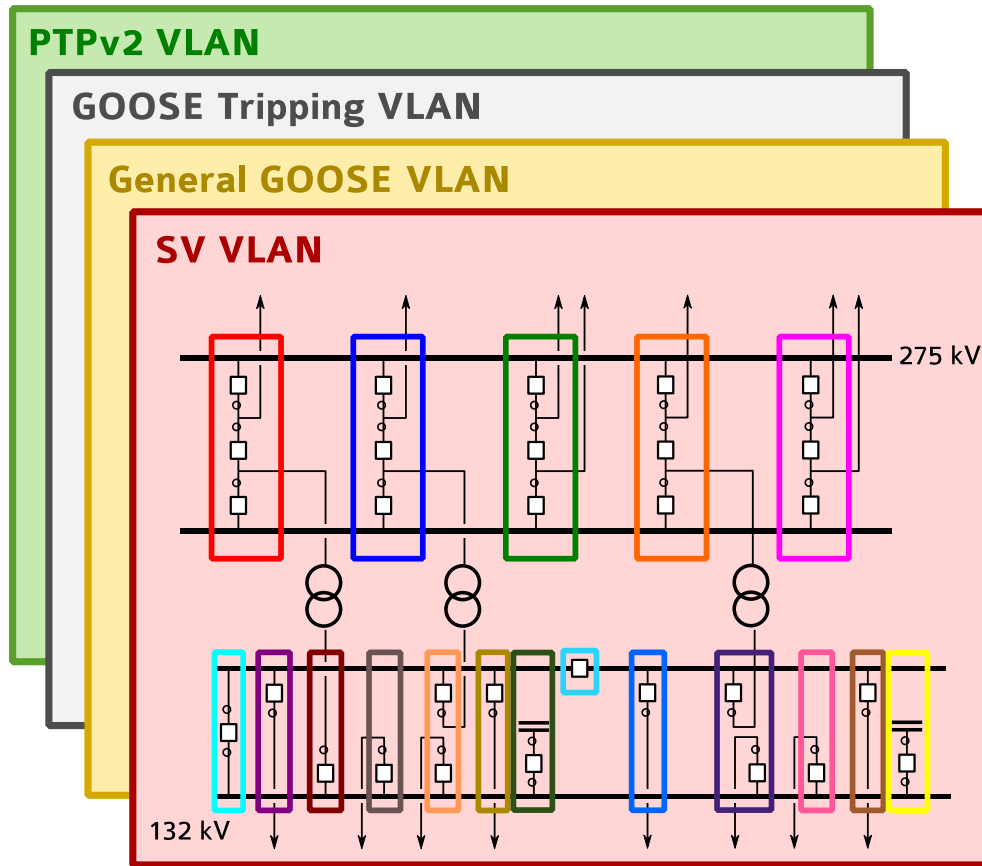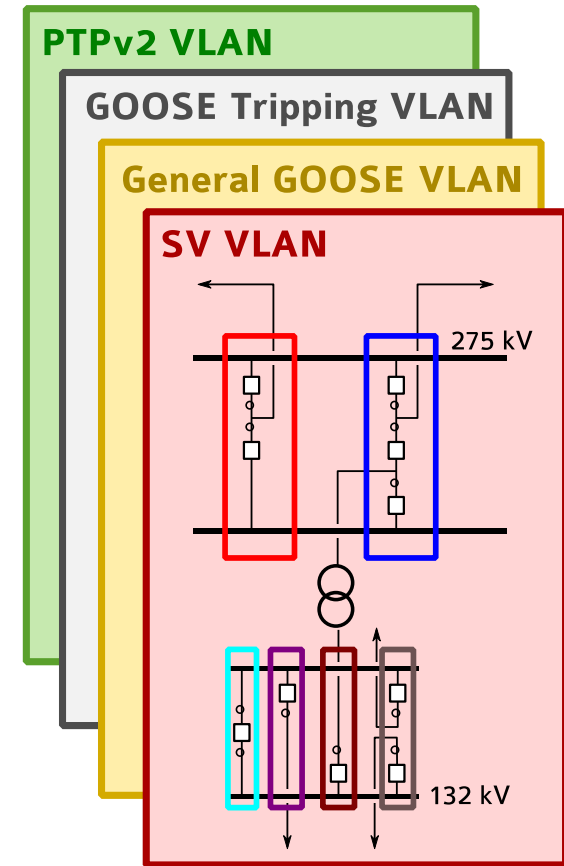
IEC 61346 and Voltage Levels

Code	Voltage Range	Code	Voltage Range
B	**> 420 kV**	H	30 kV .. < 45 kV
C	**380 kV .. 420 kV**	J	20 kV .. < 30 kV
D	**220 kV .. < 380 kV**	K	10 kV .. < 20 kV
E	**110 kV .. < 220 kV**	L	6 kV .. < 10 kV
F	**60 kV .. < 110 kV**	M	1 kV .. < 6 kV
G	45 kV .. < 60 kV	N	< 1 kV

IEC 61346 Example

275 kV
→ "D"

=D1-QA2
Specific circuit
breaker
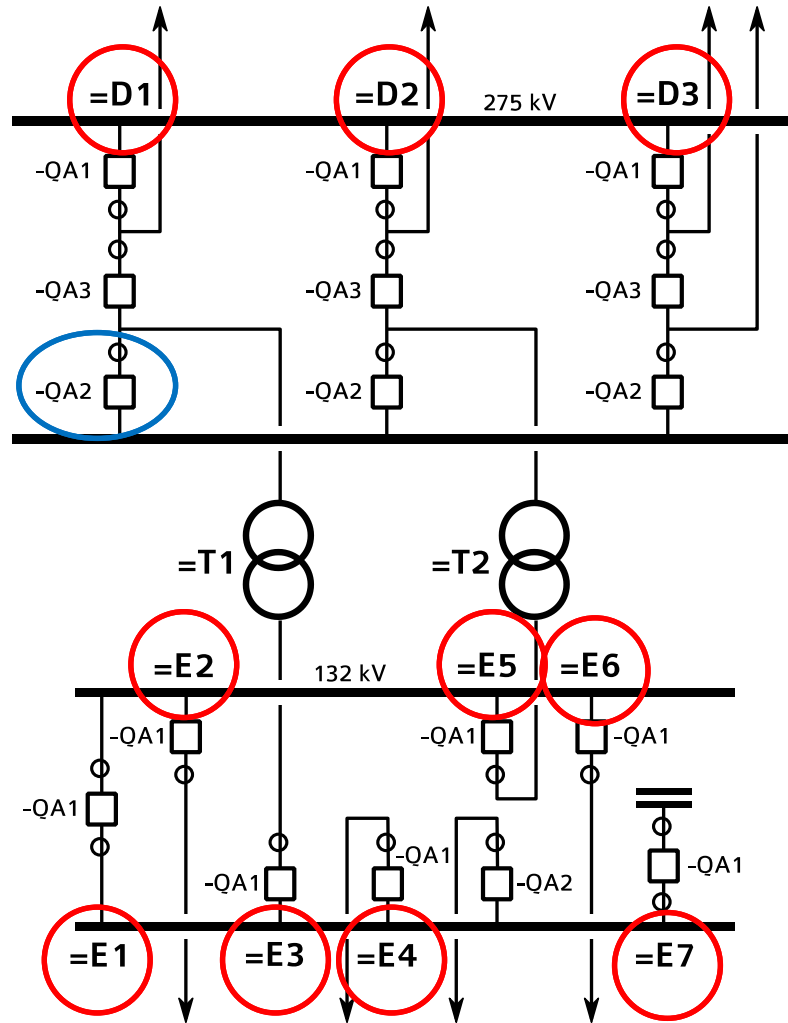
132 kV
→ "E"

=D1, =D2, =E2 …
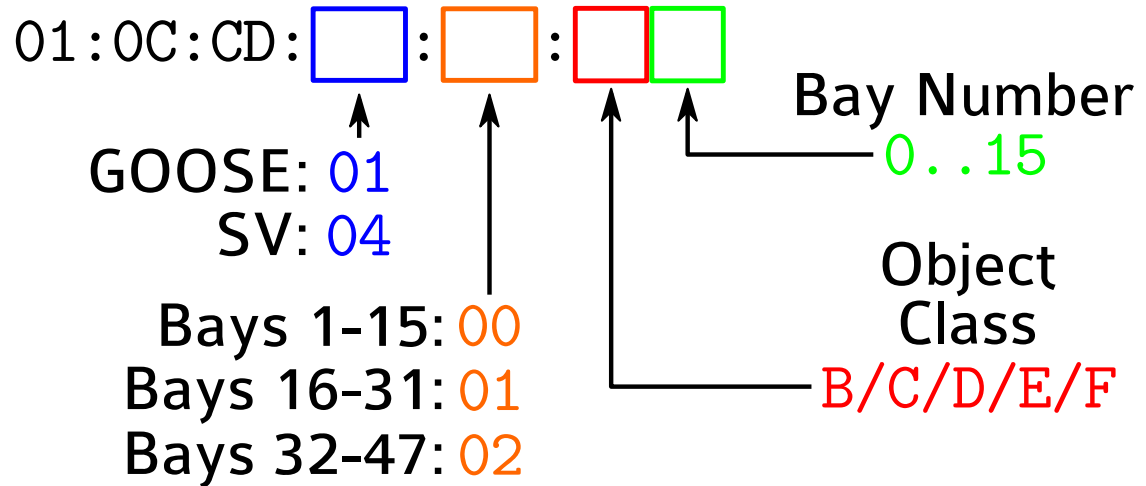Diameter or Bay
Designators

Designator → Address Mapping

Multicast Destination   01:0C:CD:☐:☐:☐☐

Bay Number
0..15

GOOSE: 01
SV: 04

Object Class
B/C/D/E/F

Bays 1–15: 00
Bays 16–31: 01
Bays 32–47: 02

Bay	GOOSE	SV
=C2	01:0C:CD:01:00:C2	01:0C:CD:04:00:C2
=D12	01:0C:CD:01:00:DC	01:0C:CD:04:00:DC
=D40	01:0C:CD:01:02:D8	01:0C:CD:04:02:D8
=E20	01:0C:CD:01:01:E4	01:0C:CD:04:01:E4

Subscriber Configuration
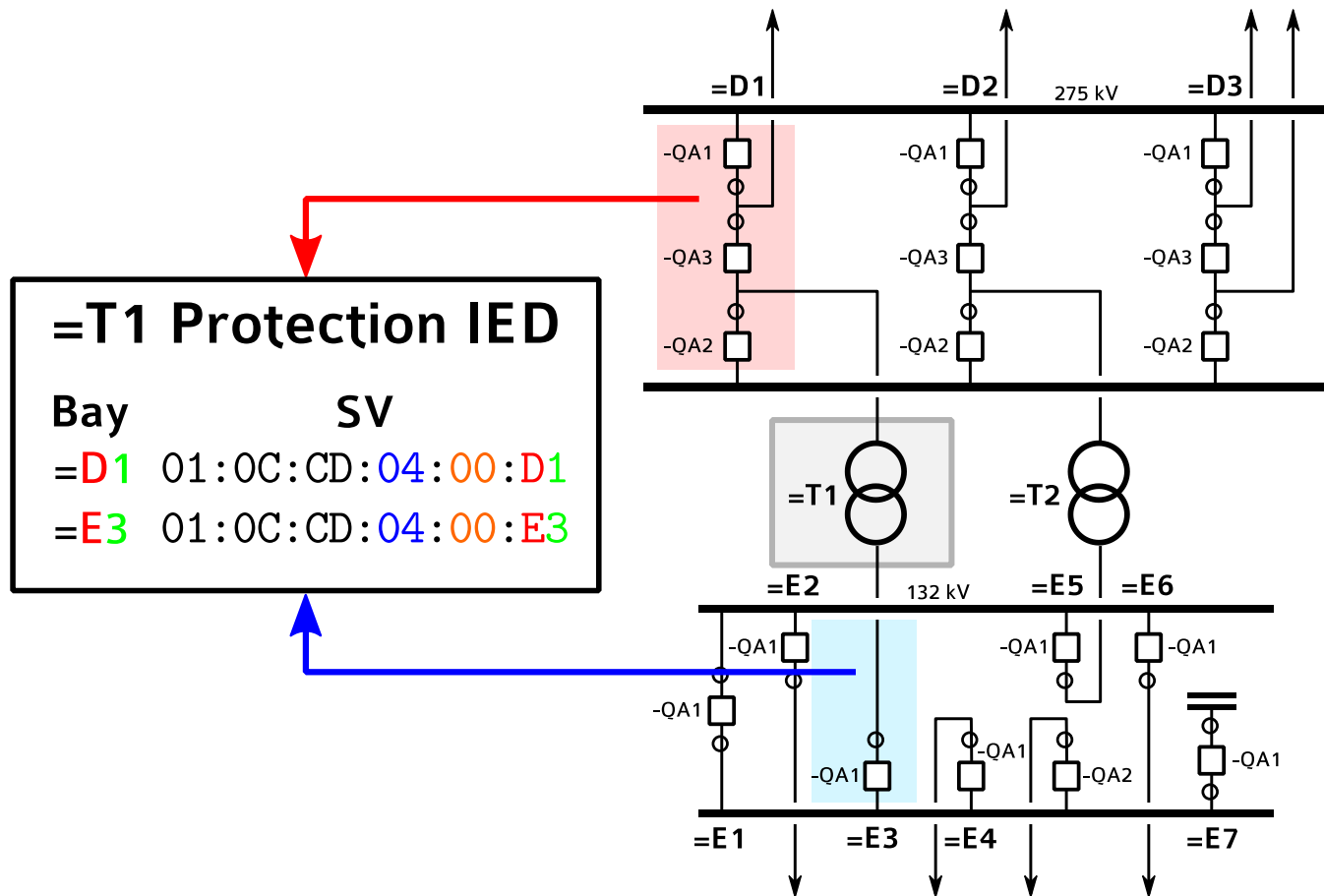
Sample Switch Configuration

VID	VLAN Name	Forbidden Ports
1	Management	1-23
81	GOOSE Trip	18-24
82	GOOSE General	18-24
92	Sampled Values	12-24
1588	PTPv2	18-23

MAC Address	VID	CoS	Ports	Comment
01-0C-CD-04-00-D1	9	High	1,6	=D1 Fdr & =T1 Tfmr Prot
01-0C-CD-04-00-D2	9	High	2,9	=D2 Fdr & =T2 Tmfr Prot
01-0C-CD-04-00-D3	9	High	3	=D3 Feeder Protection
01-0C-CD-04-00-E1	9	High	4	=E1 Bus Coupler Protection
01-0C-CD-04-00-E2	9	High	5	=E2 Feeder Protection
01-0C-CD-04-00-E3	9	High	6	=T1 Transformer Protection
01-0C-CD-04-00-E4	9	High	7	=E4 Feeder Protection
01-0C-CD-04-00-E5	9	High	8,9	=E5 Fdr & =T2 Tfmr Prot
01-0C-CD-04-00-E6	9	High	10	=E6 Feeder Protection
01-0C-CD-04-00-E7	9	High	11	=E7 Capacitor Protection

Summary

- Process buses have many protocols sharing the one network.

- Prioritisation/segregation by function uses VLANs.

- Addresses based on reference designators are 'human readable'.

- Filtering minimises network load for individual devices.

- Consistent network design will simplify commissioning, testing and fault finding.

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