



# IEC 61375 Interoperability Test Summary

Jon-Olov Vatn, Westermo, jon-olov.vatn@westermo.com

Miles Chen, Moxa, miles.chen@moxa.com

Interoperability Test Session, September 10-12 2019, Västerås, Sweden



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# IEC-61375 Tests

- Interoperability tests of the IEC 61375 implementations have been performed between Moxa and Westermo
- The purpose was to ensure that ETBNs provided by both partners are interoperable which will facilitate successful collaboration during development of Next-Generation Train Communication Network (NG-TCN) in the Drive-by-Data WP of Safe4Rail-2
- The tests were conducted in two parts:
  - ◆ Offline - Sept. 1<sup>st</sup> 2019
  - ◆ Face-to-face meeting - Sept. 10-12<sup>th</sup> 2019
- The devices used during testing:
  - ◆ Moxa ETBN (temporary engineering sample)
  - ◆ Westermo ETBN (Viper-208-T8G-TBN), software for IEC 61375-2-3 was work in progress (not yet released)

# IEC-61375 Test Scope

**Offline** these control packets were evaluated:

- TTDP HELLO frame
- TTDP TOPOLOGY frame
- CSTINFO / CSTINFOCTRL request telegram
- ETBCTRL telegram

During the **F2F meeting** these parts were evaluated:

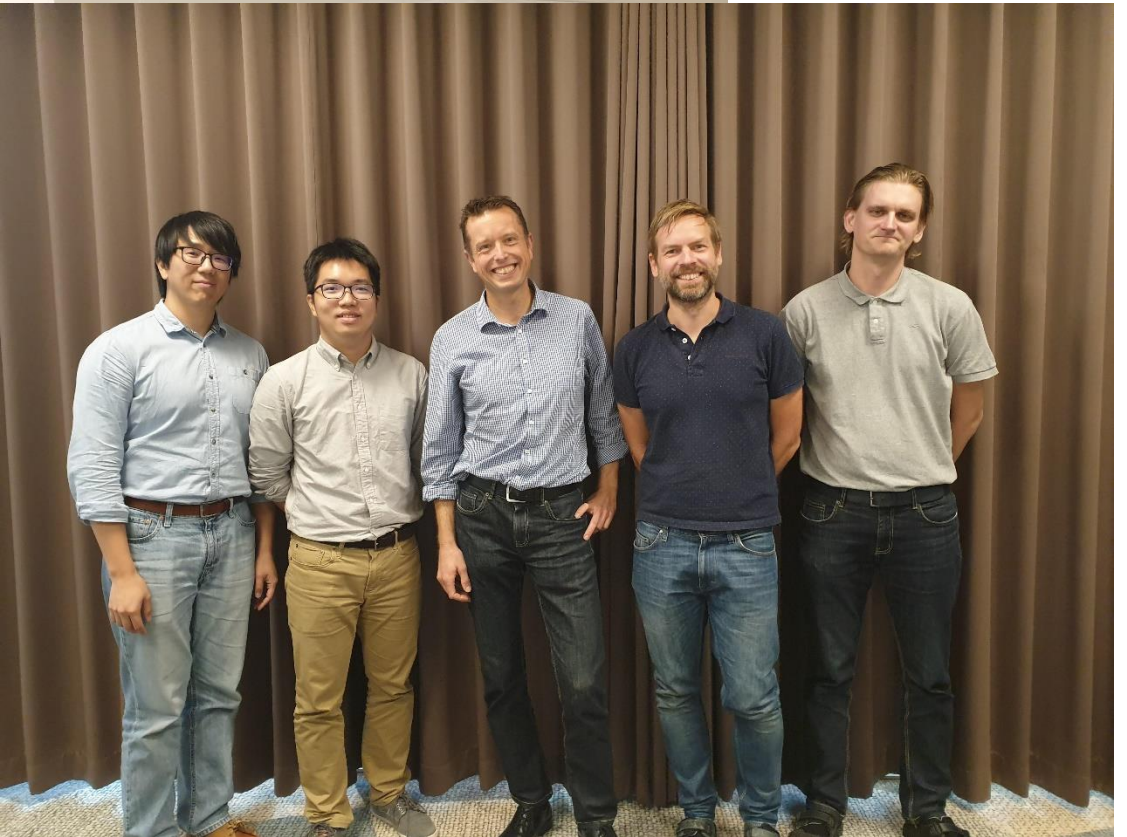
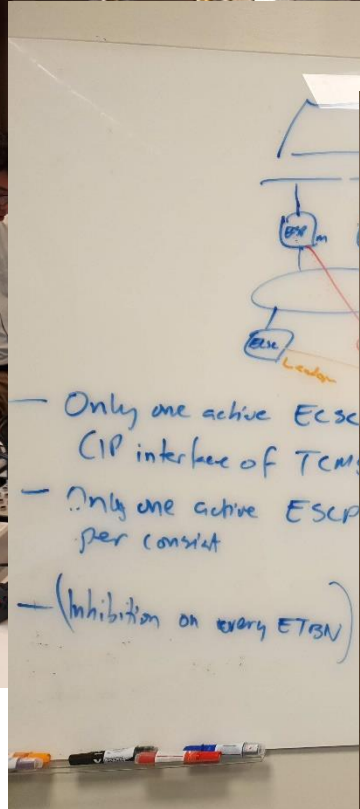
- ETB Port Interoperability Test
- ETB Inauguration with 1 ETB Line
- ETB Inauguration with 2 ETBN Redundant Consists
- ETB Inhibition
- Node recovery
- End Node recovery
- Unicast Addressing and Routing
- Multicast Addressing and Routing
- ECSP Operational Train Directory / TopoCnt
- Leading
- Leading Conflict
- Confirm
- Mapping TCN-URI to Unicast IP Address
- Mapping TCN-URI to Multicast IP Address and Multicast Routing
- ECSP Redundancy

# IEC-61375 F2F Test Result Summary

Test	Result
ETB Port Interoperability Test	OK
ETB Inauguration with 1 ETB Line	OK
ETB Inauguration with 2 ETBN Redundant Consists	OK
ETB Inhibition	OK
Node recovery	Partial success
End Node recovery	OK
Unicast Addressing and Routing	OK
Multicast Addressing and Routing	OK
ECSP Operational Train Directory / TopoCnt	Partial success
Leading	Not tested
Leading Conflict	Not tested
Confirm	Not tested
Mapping TCN-URI to Unicast IP Address	Partial success
Mapping TCN-URI to Multicast IP Address and Multicast Routing	Partial success
ECSP Redundancy	Not tested

# Overview of IEC-61375 Test Results

- The overall result were positive; the most difficult parts work and are interoperable
  - ◆ IEC 61375-2-5: Correct computation of Train Network Directory (TND). Computation based on TTDP TOPOLOGY message exchange is essential for interoperable establishment of IP routes, R-NAT rules, etc. Both unicast and multicast communication worked as expected!
  - ◆ IEC 61375-2-3: Correct computation of Operational Train Directory. Computation based on TND and CSTINFO exchange is the basis for several ECSP services. Of these services, the TCN DNS service was verified to work interoperably. Thus, train-wide communication can be initiated based domain names rather than IP addresses.
- Interoperability tests prove valuable both to verify the implementations of the involved vendors, but also to discover ambiguities in the associated standards.
  - ◆ IEC 61375: There were some issues raising the need for clarification in the IEC 61375-2-5:2014 and IEC 61375-2-3:2015 standards, as well input to the associated PICS work (WG43 SGT11).
  - ◆ Some implementation flaws and missing parts were discovered, with the result that all functionality could not be tested for interoperability. Detecting them at this stage makes it possible to fix them before following Safe4Rail interoperability and integration tests.







# WP1 NG-TCN Interoperability Test Summary

Khawar Naeem, Westermo, khawar.naeem@westermo.com

Roland Chan, Moxa, roland.chan@moxa.com

Interoperability Test Session, December 17-18 2019, Västerås, Sweden



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## NG-TCN Tests

- The purpose was to ensure that NG-TCN ETBNs provided by both partners are interoperable which will facilitate successful collaboration in CTA-2/S4R-2 DbD integration workshop
- The difference as compared to previous interop test is to use new NG-TCN ETB topology while the previous used current IEC 61375 ETB Topology
- The date and place where the tests were conducted:
  - ◆ Dec 17-18, 2019
  - ◆ Västerås, Sweden
- The devices used during testing:
  - ◆ Moxa ETBN (temporary engineering sample)
  - ◆ Westermo ETBN (Viper-208-T8G-TBN)

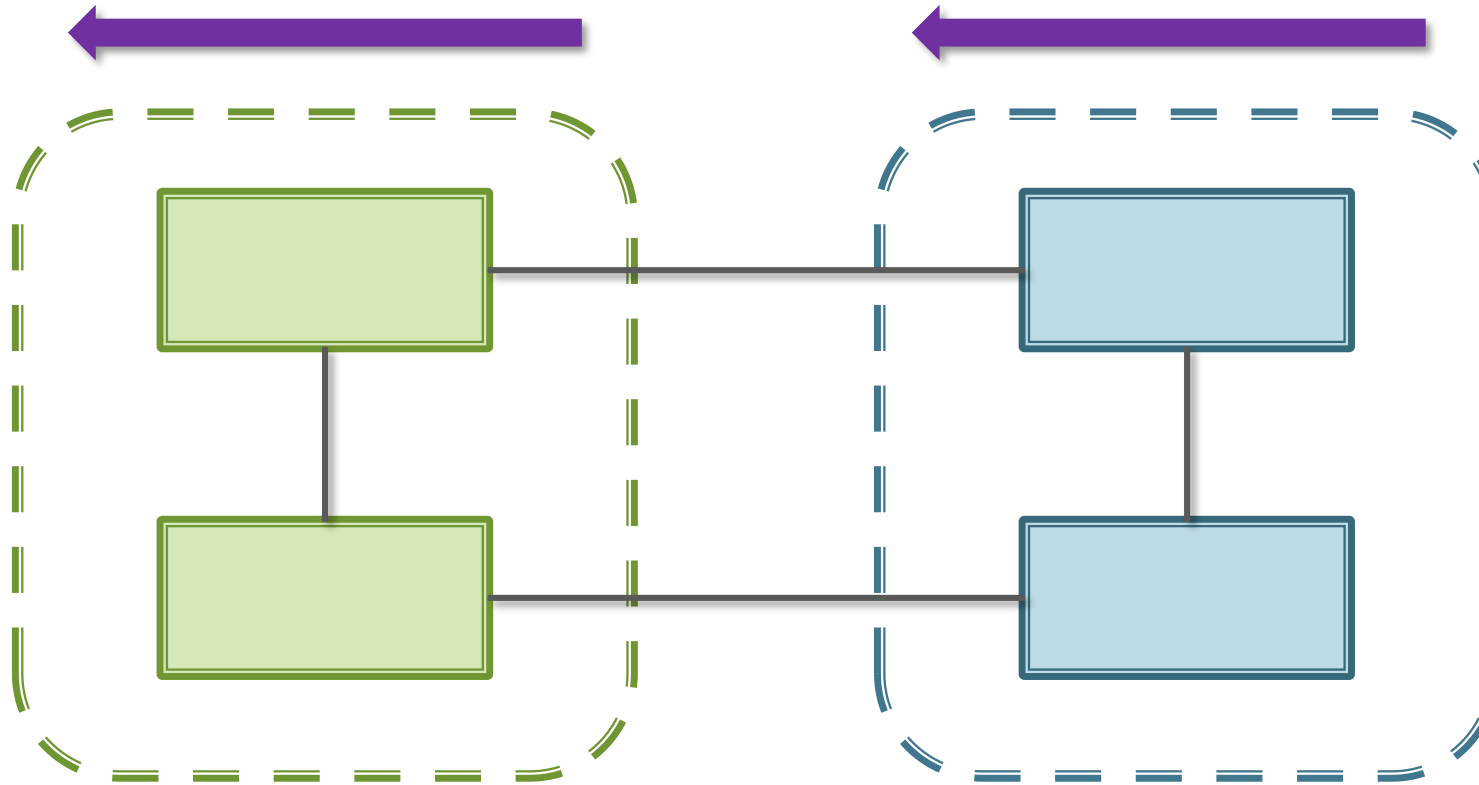


# NG-TCN Test Scope

- ETB Inauguration
  - ◆ Hello Relay
  - ◆ VLAN Reconfiguration
    - Failure on ETB line
    - Failure on ECN line
- Operational Inauguration
  - ◆ Inhibit
  - ◆ Leading
  - ◆ Train Network Directory
  - ◆ Operational Train Directory
  - ◆ Lengthening / Shortening
- Packet routing
  - ◆ Unicast
  - ◆ Multicast

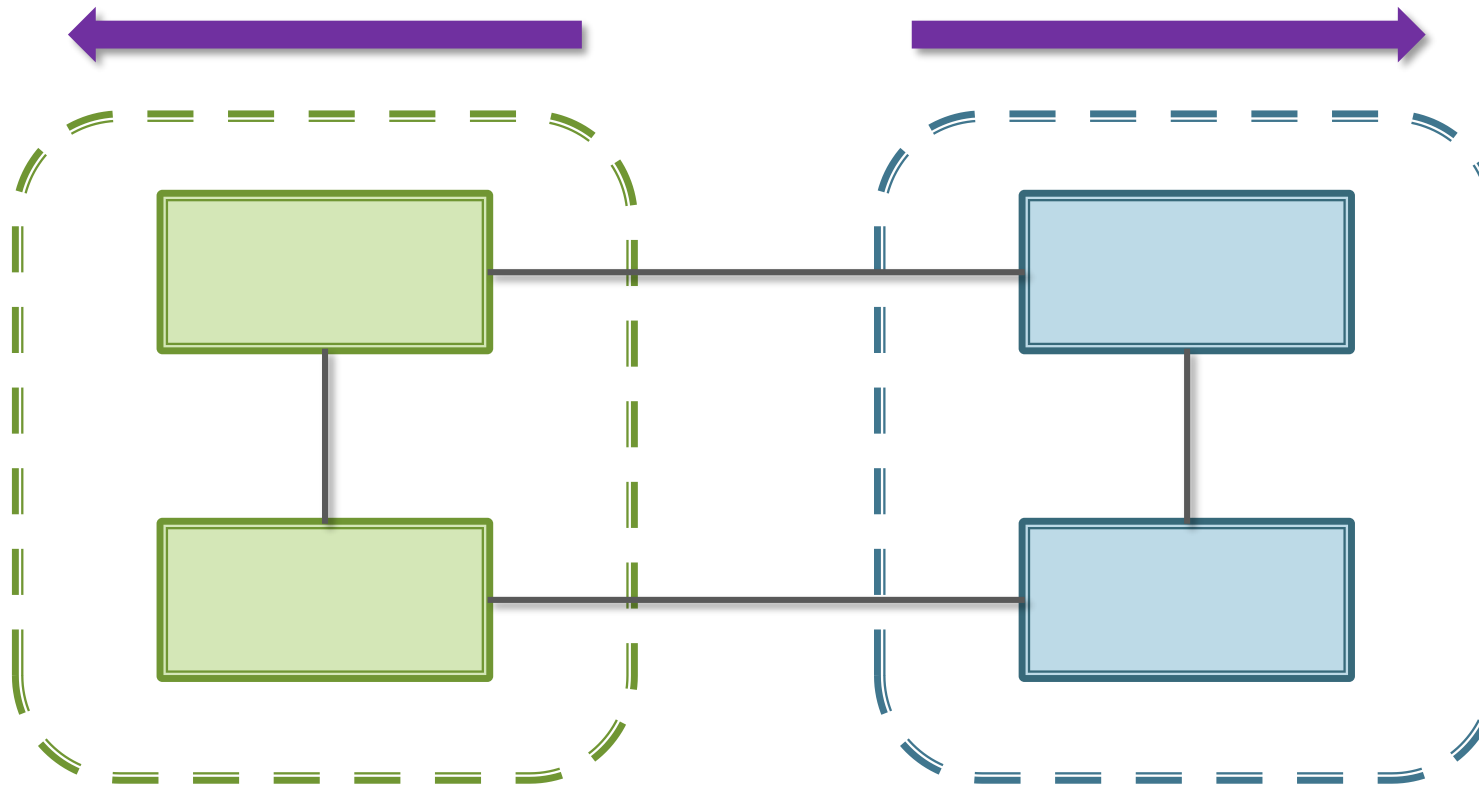
# NG-TCN Test Scenario

- One MOXA consist + One WMO consist in the same direction



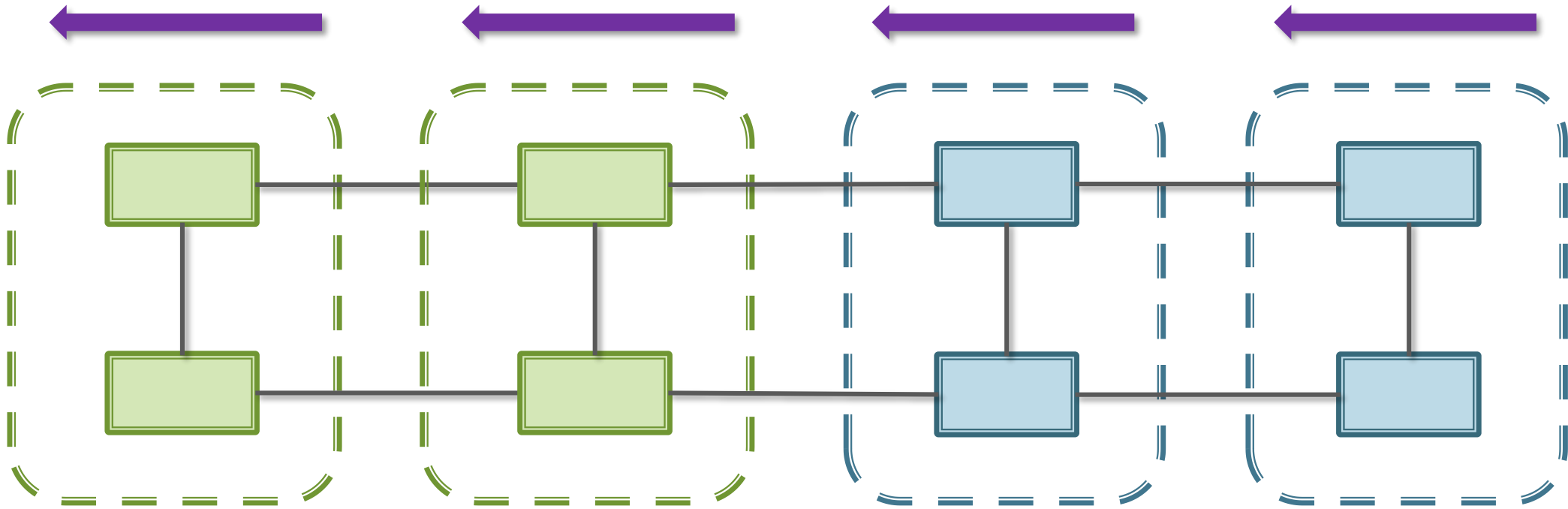
# NG-TCN Test Scenario

- One MOXA consist + One WMO consist in the different direction



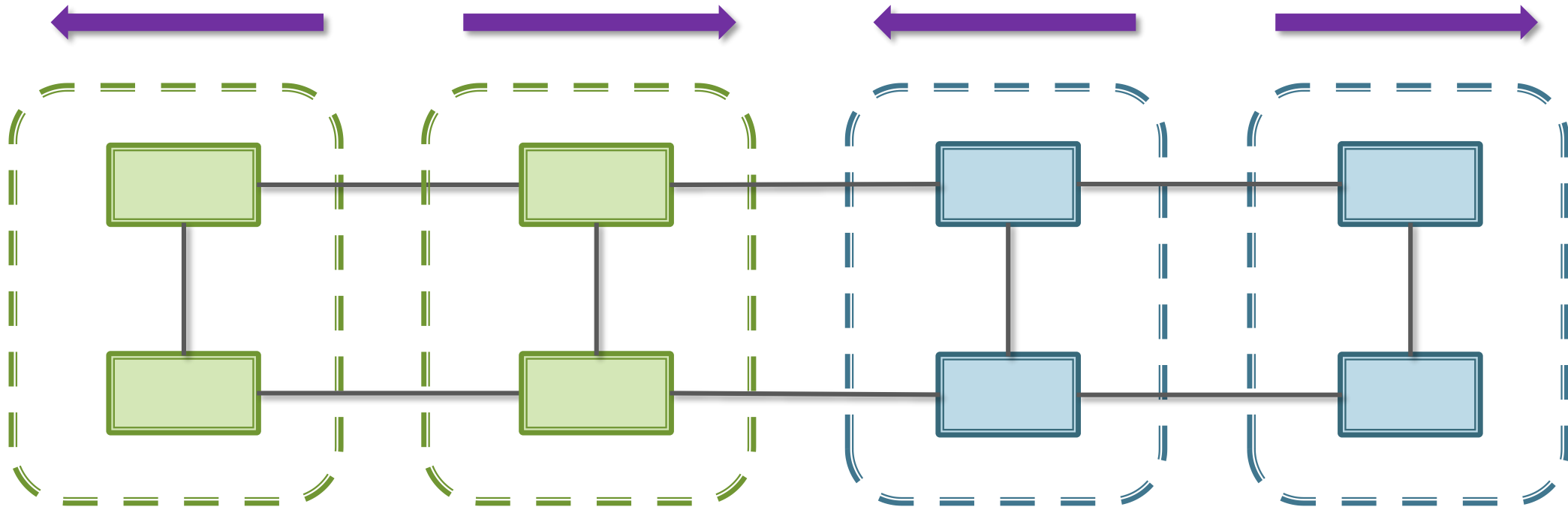
# NG-TCN Test Scenario

- Two MOXA consists + Two WMO consists in the same direction



# NG-TCN Test Scenario

- Two MOXA consists + Two WMO consists in the different direction



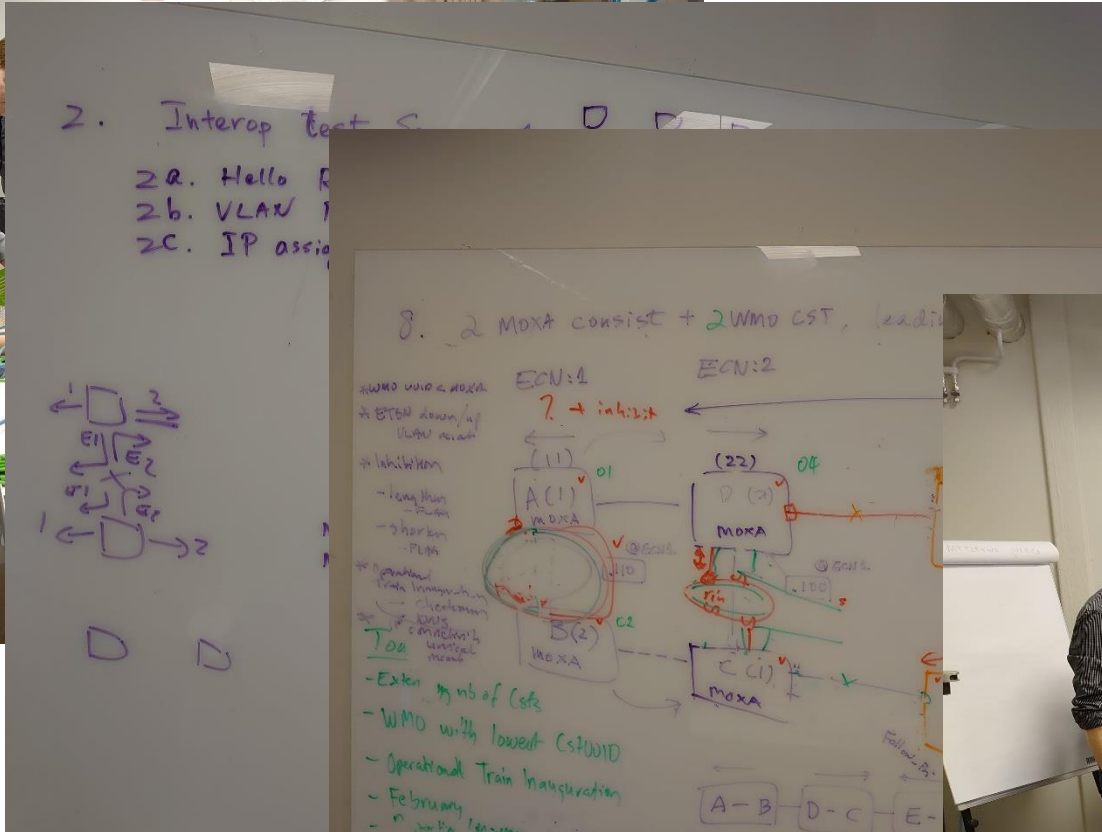
# NG-TCN Test Result Summary

Test	Result
Hello Relay	Passed
VLAN Reconfiguration	Passed
VLAN Reconfiguration with failure on ETB line	Passed
VLAN Reconfiguration with failure on ECN line	Partially passed
Inhibit	OK
Leading	Partial success
Train Network Directory / etbTopoCnt	OK
Operational Train Directory / opTrnTopoCnt	Partially passed
Lengthening / Shortening	Partial success
Unicast Routing	OK
Multicast Routing	Not tested



# Overview of NG-TCN Test Results

- The overall result of NG-TCN over ETB were positive
  - ◆ ETB inauguration (Hello Relay and VLAN Reconfiguration) was successful between both parties under normal operation, and also the failure of one ETB line. There were some issues in the failure of one ECN line, and the root cause could easily be identified during the workshop.
  - ◆ Operational Inauguration was successful in exchanging inhibition flags, but failed in exchanging leading flags the root cause could easily be identified during the workshop.
  - ◆ All the issues will be fixed before CTA-2/S4R-2 integration workshop.



## Next Steps for NG-TCN

- CTA-2/S4R-2 integration workshop by February 2020
- Provide hardware and integrate software (ETB Inauguration, Operation Inauguration, ...)
- Continue to work closely to committees, feed inputs for next standardization version

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If you need further information, please contact the coordinator:

**IK4-IKERLAN, Aitor Arriola**

✉ [aarriola@ikerlan.es](mailto:aarriola@ikerlan.es)

☎ +34 943 712 400 / +34 607 603 847

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# Acronym

NG-TCN	Next-Generation Train Communication Network
DbD	Drive-by-Data
ETB	Ethernet Train Backbone
ETBN	Ethernet Train Backbone Node
ECN	Ethernet Consist Network
TTDP	Train Topology Discovery Protocol
ECSP	ETB Control Service Provider
TCNURI	Train Communication Network Uniform Resource Identifier
R-NAT	Railway-Network Address Translation
TND	Train Network Directory
DNS	Domain Name Service
TopoCnt	Topology Counter
PICS	Protocol Implementation Conformance Statement