
ZVEI:
NAMUR
TURN EXPERTISE
INTO EXCELLENCE

Ethernet-APL Use-Cases

NAMUR & ZVEI Task Forces

Intention and Overview

The following document reflects the jointly developed use-case descriptions for Ethernet-APL by the NAMUR APL Task Force and the ZVEI APL Task Force.

Throughout the document, Ethernet-APL stands as a synonym for the whole technology stack, which includes

- Ethernet-APL;
- PROFINET or Ethernet-IP as application protocols for control for the moment, or OPC UA via TSN as a candidate for the future;
- Generic device profiles and drivers according to NE 131 (e.g., PA Profile 4.02);
- FDI (Field Device Integration) for device integration into asset management systems;
- PA-DIM (Process Automation - Device Information Model) as the standard information model for diagnostic information;
- OPC UA for diagnostic data exchange, either from the asset management system to NOA, or directly from the field device via a secondary data channel; and
- A safety protocol, such as PROFIsafe, to allow Ethernet-APL to be used in the safety domain as well.

Additional Material

This document is the detailed view on the results of the collaboration of both APL Task Forces.

A summary of one-pagers including more context can be accessed and downloaded from the NAMUR APL Task Force homepage.

- **Click here for the English version**
- **Click here for the German version**

Structure

Structure of the Sections according to lifecycle phases/applications (can be clicked):

- Engineering, procurement, and construction (EPC)
- Operations
- Maintenance
- Smart sensors

In addition, the closing Section summarizes the relevant end user requirements for each use-case

- End user requirements

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Use-Cases EPC

NAMUR & ZVEI Task Forces
Subgroup EPC

Use Cases 1/4
Engineering, Procurement, and Construction

Description:

- DCS-agnostic IO Hardware (infrastructure, field devices) -> Maint.
- Instrument configuration using generic drivers available in a centralized location
- No loop diagrams required, only assignment of IO needed
- Reduced space requirements (footprint) in rack room (no homerun cables, marshalling racks, signal conditioning, explosion protection barriers, IO cards, less system cabinets), easier expansion in future, no need for additional rack room for brownfield

Expected Value:

- Less engineering hours in IO loop documentation, commissioning, construction
- Cost savings due to simplified hardware footprint
- Faster DCS Migration projects with APL L1 installation
- Automatically Loop Check

Readiness: *Partially ready and tested*

Requirements/Pre-requisites:

- Interoperable field devices and infrastructure components
- Preconfigured instruments from factory
- Usage of Generic PA Profiles
- Central repository for FDI drivers with PA-DIM
- Device drivers and manuals available directly from the device; digital nameplates (IEC-61406)
- Training material

Baseline for Comparison of EPC Use-Case

The following cases are used for the comparison on the subsequent slides:

RIO 4..20 mA Installed in the Field

- This case serves as a baseline to reflect current „best practice“ in greenfield
- Remote I/O using standard 4..20 mA and HART, with the components installed in the field within cabinets.
- Other baselines would be possible (e.g., 4..20 mA with homerun cables) but are not the best-practice for greenfield; fieldbus is replaced by APL and therefore not considered

APL Ring-Star

- Ethernet-APL network is assumed to be ring-star topology, as trunk-spur is not ready and considered as targeted for retrofits
- Comparison is protocol-agnostic and not focused on PROFINET, Ethernet-IP, nor any other protocol

Engineering

Task	4..20 mA w/ RIOs	APL (ring-star topology)
Ex-Proofs	Calculated for every typical	Tabular with 2WISE
Field Device Specification	Required for both, no change	
IO Engineering	Comparable level of complexity and effort	
Network / Hardware Design	Distribution of RIO	Distribution of APL field switches, comparable
Hardware Detail Design (Loop Diagrams etc.)	no marshalling	no marshalling
Field Device Engineering		Minor benefits (concise way to get additional values)
Documentation		Minor benefits (channel allocation)

Procurement

Task	4..20 mA w/ RIOs	APL (ring-star topology)
Procurement of required devices and components		No major change, but different mix of components

Construction

Task	4..20 mA w/ RIOs	APL (ring-star topology)
Installation Space		Comparable
Installation Costs		Comparable
Installation Efforts		Comparable

Commissioning

Task	4..20 mA w/ RIOs	APL (ring-star topology)
Loop Checking	• Matching of device and connection port (if tag preconfigured) • Ensuring right measurement range via simulation of value etc. • Limited by data rate • High efforts in case of anomalies or issues • Standard qualifications	• Same effort when preconfigured • Not needed • Faster speed • Greatly simplified, semi-automated, tool-assisted • Additional qualification for first project required
Initial Device Parameter Synchronization	Takes long time to synchronization with AMS (minutes)	Faster synchronization (seconds)
Driver and documentation management	Lookup via website of vendor, transfer of data to DCS	Embedded directly in devices

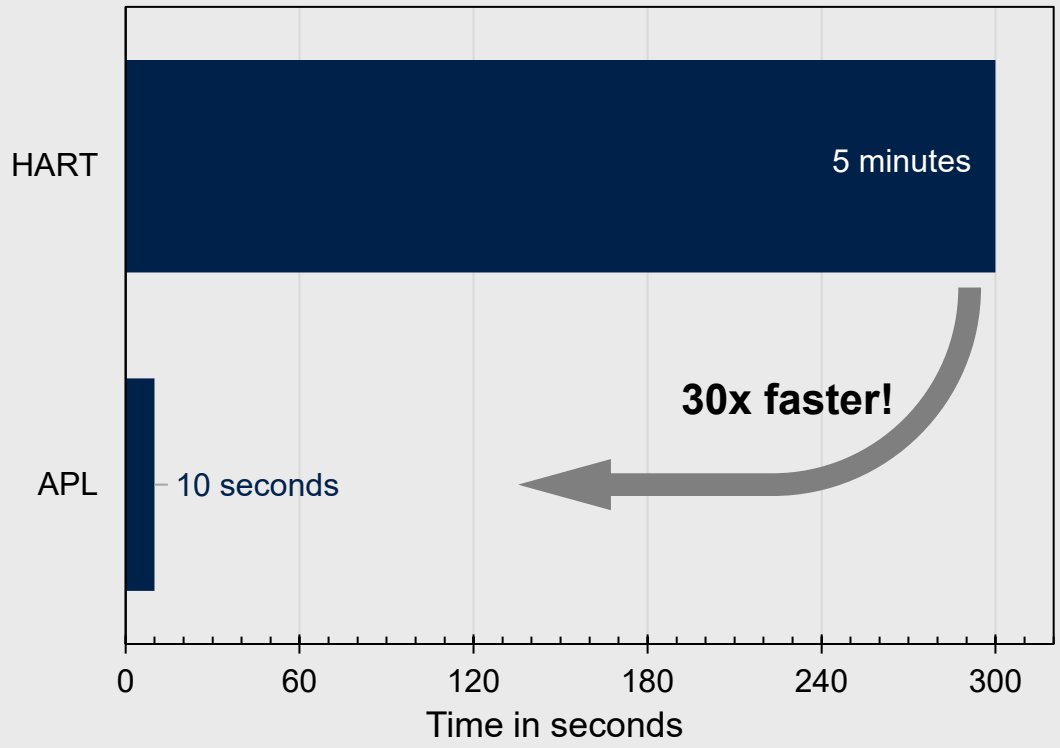
Operation

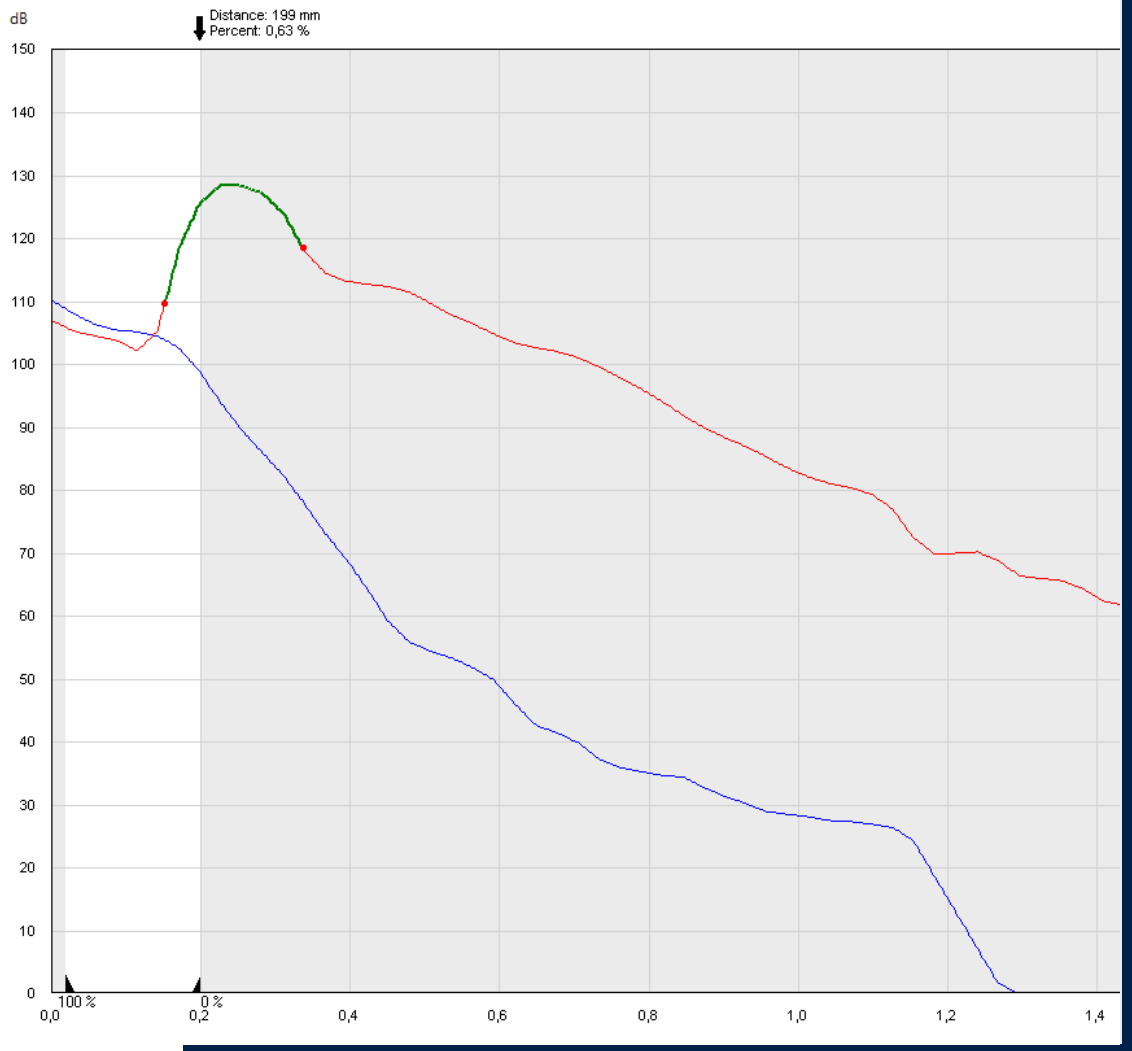
Task	4..20 mA w/ RIOs	APL (ring-star topology)
Engineering and commissioning of secondary data channel, NOA	• During operations phase • Planning of infrastructure (gateways) and commissioning, high effort for configuration • Limited to specific information	• Mostly during EPC phase • Almost no additional effort for EPC, almost zero effort during operations phase to use data • Access to all information from the field

Visual Use-Case
Influence on Device Parametrization

Massive time savings for device parametrization and parameter synchronization.

Example: Time required for downloading envelope curve from radar sensor





Quantitative Use-Case
Ex-Proofs

Assumptions

- 30 device types
- 30 minutes for ex-proof per typical

4..20 mA w/ RIO

- 15 h total effort

APL

- 30 minutes for documentation

<u>14.5 h (2 work days) less effort</u>

Use-Cases Operations

NAMUR & ZVEI Task Forces
Subgroup Operations

The roles in operations

- Control Room Operator
- Reliability Manager
- Operations Engineer
- Improvement Engineer
- Process Automation Manager
- Process Safety Manager
- Security Manager

Summary

Technol.	Feature	Generic Benefit	Control Room Operator	Reliability Manager	Operations Engineer	Improvement Engineer	Prcs-Automat. Manager	Prcs-Safety Manager	Security Manager
APL	Digital	Data-Accuracy	X			X			
	Datatransmission	Data-Reliability	X					X	
		Fast Transmissionrate				X			X
		Device Data Memory				X			
	Security	NOA		X	X				X
	Standard Ethernet	IPv4+IPv6		X			X		
		No termination resistors							
	Net instead of Trunk-cable	Scalability							
		Expansion of the Network							
		ess cabeling efforts							
	Universal Connection	device unspecific				X		X	
	2-wire for data and power.	polarity independent		X					
		efficient wiring							
	standardized	utureproof		X					
	Conformance Testing	nteroperability		X					
	Ex-Zone 2 / 1	Galvanic isolation							
		2-wise		X		X	X		
PROFINET	RealTime-Communication	TSN							
	additional Data	Maintenance / Diagnostic	X	X			X	X	
		Optimisation				X			
		Infrastructure Monitoring	X						
		instrumentation values					X		
	Redundancy	Topology (Ring, 2oo3)							X
		Controller							
	Coexistence with other Prot	unified infrastructure							
		device update							
	Security	Plant Availability							
		Integrity (reliability)							
	generic device drivers (PA4)	reduced vendor lock in							
	reconfiguration in runtime	Plant adaption							
	Topology detection	simple device replacement				X			
		simple device enhancement				X			
	Conformity Testing	Device Compatibility							
PROFIsafe	safe communication (SIL3)	All values valid						X	
		loopcheck							
		test automation							
		prooftest							
	generic device drivers (PA4)	under development							
	central management	simple device enhancement							
	Conformity Testing	Device Compatibility							
FDI									

Operations Role: Control Room Operator

Main Advantage:
Better instrument malfunction identification. Operator can identify and take action before the instrument fails (contacting instrumentation, generating work order, bypassing the instrument in the control system, etc.)

Needs from the Technology:

- APL field devices generating extra status data
- APL field switches and network transmitting the data
- PROFINET
- DCS system ability to identify and alarm on new diagnostics

Value:
Downtime reduction by avoiding Unplanned Events (UPE)

T.	Feature	Generic Benefit	Ctrl. R. Operator
APL	Digital Datatransmission	Data-Accuracy	X
		Data-Relaibility	X
		Fast Transmissionrate	
		Device Data Memory	
	Security	NOA	
	Standard Ethernet	IPv4+IPv6	
		No termination resistors	
	Net instead of Trunk-cable	Scalability	
		Expansion of the Network	
		less cabeling efforts	
	Universal Connection	device unspecific	
	2-wire for data and power.	polarity independent	
		efficient wiring	
	standardized	futureproof	
	Conformance Testing	Interoperability	
	Ex-Zone 2 / 1	Galvanic isolation	
		2-wise	
PROFINET	RealTime-Communication	TSN	
	additional Data	Maintenance / Diagnostic	X
		Optimisation	
		Infrastructure Monitoring	X
		instrumentation values	
	Redundancy	Topology (Ring, 2oo3)	
		Controller	
	Coexistence with other Prot	unified infrastructure	
		device update	
	Security	Plant Availability	
		Integrity (reliability)	
	generic device drivers (PA4)	reduced vendor lock in	
	reconfiguration in runtime	Plant adaption	
	Topology detection	simple device replacement	
		simple device enhancement	
	Conformity Testing	Device Compatibility	
PROFIsafe	safe communication (SIL3)	All values valid	
		loopcheck	
		test automation	
		prooftest	
	generic device drivers (PA4)	under development	
	central management	simple device enhancement	
	Conformity Testing	Device Compatibility	
FDI			

Operations Role: Reliability Manager

Main Advantage:
NOA concept, easier/faster plant data in the enterprise/cloud. Access to dashboards, AI/ML to enable proactive instead of reactive maintenance

Needs from the Technology:

- APL field devices needs to support a second channel and PA DIM.
- APL field switches to support a second channel and PA DIM.
- End users will decide how to do the ‘second channel’,
  use native Ethernet components and technology or completely segregate the second channel. No system engineering efforts necessary
  (security considerations will be taken into account)
- With APL devices we will get more information, more data, faster, increase integrity

Value:
Currently we extract the data from DCS through different jumps and software to bring data into the Cloud. Access data will be easier and it will be more likely to be used. The Apps used in the Cloud to optimize the plants will increase.

T.	Feature	Generic Benefit	Reliability Man.
APL	Digital Datatransmission	Data-Accuracy	
		Data-Relaibility	
		Fast Transmissionrate	
		Device Data Memory	
	Security	NOA	X
	Standard Ethernet	IPv4+IPv6	X
		No termination resistors	
	Net instead of Trunk-cable	Scalability	
		Expansion of the Network	
		less cabeling efforts	
	Universal Connection	device unspecific	
	2-wire for data and power.	polarity independent	X
		efficient wiring	
	standardized	futureproof	X
	Conformance Testing	Interoperability	X
	Ex-Zone 2 / 1	Galvanic isolation	
		2-wise	X
PROFINET	RealTime-Communication	TSN	
	additional Data	Maintenance / Diagnostic	X
		Optimisation	
		Infrastructure Monitoring	
		instrumentation values	
	Redundancy	Topology (Ring, 2oo3)	
		Controller	
	Coexistence with other Prot	unified infrastructure	
		device update	
	Security	Plant Availability	
		Integrity (reliability)	
	generic device drivers (PA4)	reduced vendor lock in	
	reconfiguration in runtime	Plant adaption	
	Topology detection	simple device replacement	
		simple device enhancement	
	Conformity Testing	Device Compatibility	
PROFIsafe	safe communication (SIL3)	All values valid	
		loopcheck	
		test automation	
		prooftest	
	generic device drivers (PA4)	under development	
	central management	simple device enhancement	
	Conformity Testing	Device Compatibility	
FDI			

Operations Role: Operations Engineer

Main Advantage:
NOA concept, easier/faster plant data in the enterprise/cloud. Access to dashboards, AI/ML to enable proactive instead of reactive maintenance

Needs from the Technology:

- APL field devices needs to support a second channel and PA DIM.
- APL field switches to support a second channel and PA DIM.
- End users will decide how to do the ‘second channel’,
  use native Ethernet components and technology or completely segregate the second channel. No system engineering efforts necessary
  (security considerations will be taken into account)
- With APL devices we will get more information, more data, faster, increase integrity

Value:
Currently we extract the data from DCS through different jumps and software to bring data into the Cloud. Access data will be easier and it will be more likely to be used. The Apps used in the Cloud to optimize the plants will increase

T.	Feature	Generic Benefit	Operations Eng.
APL	Digital Datatransmission	Data-Accuracy	
		Data-Relaibility	
		Fast Transmissionrate	
		Device Data Memory	
	Security	NOA	X
	Standard Ethernet	IPv4+IPv6	
		No termination resistors	
	Net instead of Trunk-cable	Scalability	
		Expansion of the Network	
		less cabeling efforts	
	Universal Connection	device unspecific	
	2-wire for data and power.	polarity independent	
		efficient wiring	
	standardized	futureproof	
	Conformance Testing	Interoperability	
	Ex-Zone 2 / 1	Galvanic isolation	
		2-wise	
PROFINET	RealTime-Communication	TSN	
	additional Data	Maintenance / Diagnostic	
		Optimisation	
		Infrastructure Monitoring	
		instrumentation values	
	Redundancy	Topology (Ring, 2oo3)	
		Controller	
	Coexistence with other Prot	unified infrastructure	
		device update	
	Security	Plant Availability	
		Integrity (reliability)	
	generic device drivers (PA4)	reduced vendor lock in	
	reconfiguration in runtime	Plant adaption	
	Topology detection	simple device replacement	
		simple device enhancement	
	Conformity Testing	Device Compatibility	
PROFIsafe	safe communication (SIL3)	All values valid	
		loopcheck	
		test automation	
		prooftest	
	generic device drivers (PA4)	under development	
	central management	simple device enhancement	
	Conformity Testing	Device Compatibility	
FDI			

Operations Role: Improvement Engineer

Main Advantage 1:
Faster data, better data accuracy, more data from instruments to follow up on plant performance: mass/energy balance, optimization software, etc

Needs from the Technology:

- APL field devices
- APL field switches
- Any Ethernet Network
- TCP/IP Protocol

Value:
Improve the optimization of our plants by having more data, more accuracy and more inputs from one instrument. Timely troubleshooting as data is more synchronized and ‘easily’ available.

T.	Feature	Generic Benefit	Improvement Eng.
APL	Digital Datatransmission	Data-Accuracy	X
		Data-Relaibility	
		Fast Transmissionrate	X
		Device Data Memory	X
	Security	NOA	
	Standard Ethernet	IPv4+IPv6	
		No termination resistors	
	Net instead of Trunk-cable	Scalability	
		Expansion of the Network	
		less cabeling efforts	
	Universal Connection	device unspecific	X
	2-wire for data and power.	polarity independent	
		efficient wiring	
	standardized	futureproof	
	Conformance Testing	Interoperability	
	Ex-Zone 2 / 1	Galvanic isolation	
		2-wise	X
PROFINET	RealTime-Communication	TSN	
	additional Data	Maintenance / Diagnostic	
		Optimisation	X
		Infrastructure Monitoring	
		instrumentation values	
	Redundancy	Topology (Ring, 2oo3)	
		Controller	
	Coexistence with other Prot	unified infrastructure	
		device update	
	Security	Plant Availability	
		Integrity (reliability)	
	generic device drivers (PA4)	reduced vendor lock in	
	reconfiguration in runtime	Plant adaption	
	Topology detection	simple device replacement	X
		simple device enhancement	X
	Conformity Testing	Device Compatibility	
PROFIsafe	safe communication (SIL3)	All values valid	
		loopcheck	
		test automation	
		prooftest	
	generic device drivers (PA4)	under development	
	central management	simple device enhancement	
	Conformity Testing	Device Compatibility	
FDI			

Operations Role: Improvement Engineer

Main Advantage 2:
Easier/faster modifications adding new devices and changes (interoperability, Ethernet connectivity, explosion protection standardized, support by IT specialists)

Needs from the Technology:

- APL switches with spares available in the field
- Protocol, technology and tools
- APL device with it's own documentation and subscriptions. At least one version in the device and in a central location

Value:
Less configuration needed to add a new APL instrument in the process and not affection to current instruments

T.	Feature	Generic Benefit	Improvement Eng.
APL	Digital Datatransmission	Data-Accuracy	X
		Data-Relaibility	
		Fast Transmissionrate	X
		Device Data Memory	X
	Security	NOA	
	Standard Ethernet	IPv4+IPv6	
		No termination resistors	
	Net instead of Trunk-cable	Scalability	
		Expansion of the Network	
		less cabeling efforts	
	Universal Connection	device unspecific	X
	2-wire for data and power.	polarity independent	
		efficient wiring	
	standardized	futureproof	
	Conformance Testing	Interoperability	
	Ex-Zone 2 / 1	Galvanic isolation	
		2-wise	X
PROFINET	RealTime-Communication	TSN	
	additional Data	Maintenance / Diagnostic	
		Optimisation	X
		Infrastructure Monitoring	
		instrumentation values	
	Redundancy	Topology (Ring, 2oo3)	
		Controller	
	Coexistence with other Prot	unified infrastructure	
		device update	
	Security	Plant Availability	
		Integrity (reliability)	
	generic device drivers (PA4)	reduced vendor lock in	
	reconfiguration in runtime	Plant adaption	
	Topology detection	simple device replacement	X
		simple device enhancement	X
	Conformity Testing	Device Compatibility	
PROFIsafe	safe communication (SIL3)	All values valid	
		loopcheck	
		test automation	
		prooftest	
	generic device drivers (PA4)	under development	
	central management	simple device enhancement	
	Conformity Testing	Device Compatibility	
FDI			

Operations Role: Process Automation Manager

Main Advantage:
More instrument data, less calculations in the control system (for example, convert volumetric to mass flow, heat duty calculations). Less control system downloads in production to improve code. Failure reduction.

Needs from the Technology:

- APL instruments with more data available and ability to perform calculations (flow totalizer, etc.)
- DCS should support NE 107
- Not critical at this point: Network traffic versus DCS load will have to be evaluated

Value:
CPU load decreased in the DCS, less DCS changes reduces the code downloads

T.	Feature	Generic Benefit	Prcs-Autom. Man.
APL	Digital Datatransmission	Data-Accuracy	
		Data-Relaibility	
		Fast Transmissionrate	
		Device Data Memory	
	Security	NOA	
	Standard Ethernet	IPv4+IPv6	X
		No termination resistors	
	Net instead of Trunk-cable	Scalability	
		Expansion of the Network	
		less cabeling efforts	
	Universal Connection	device unspecific	
	2-wire for data and power.	polarity independent	
		efficient wiring	
	standardized	futureproof	
	Conformance Testing	Interoperability	
	Ex-Zone 2 / 1	Galvanic isolation	
		2-wise	X
PROFINET	RealTime-Communication	TSN	
	additional Data	Maintenance / Diagnostic	X
		Optimisation	
		Infrastructure Monitoring	
		instrumentation values	X
	Redundancy	Topology (Ring, 2oo3)	
		Controller	
	Coexistence with other Prot	unified infrastructure	
		device update	
	Security	Plant Availability	
		Integrity (reliability)	
	generic device drivers (PA4)	reduced vendor lock in	
	reconfiguration in runtime	Plant adaption	
	Topology detection	simple device replacement	
		simple device enhancement	
	Conformity Testing	Device Compatibility	
PROFIsafe	safe communication (SIL3)	All values valid	
		loopcheck	
		test automation	
		prooftest	
	generic device drivers (PA4)	under development	
	central management	simple device enhancement	
	Conformity Testing	Device Compatibility	
FDI			

Operations Role: Process Safety Manager

Main Advantages:

- Re-purpose from operations to safety functions. Easy change/reconfiguration of instruments for Non Safety/Safety applications
- Enhance the runtime of the system by doing eg: partial stroke test with the sensors running. Testing can be automated and more efficient.

Needs from the Technology:

- APL instruments with Safety/Non Safety capability
- APL switches with spares
- Digital communication: Faster loop check

Value:

- Reduce wiring, less effort for commissioning, less plant downtime.
- Extend the Proof test interval and eventually increase the running time of your plant

T.	Feature	Generic Benefit	Prcs-Safety Man.
APL	Digital Datatransmission	Data-Accuracy	
		Data-Relaibility	X
		Fast Transmissionrate	
		Device Data Memory	
	Security	NOA	
	Standard Ethernet	IPv4+IPv6	
		No termination resistors	
	Net instead of Trunk-cable	Scalability	
		Expansion of the Network	
		less cabeling efforts	
	Universal Connection	device unspecific	X
	2-wire for data and power.	polarity independent	
		efficient wiring	
	standardized	futureproof	
	Conformance Testing	Interoperability	
	Ex-Zone 2 / 1	Galvanic isolation	
		2-wise	
PROFINET	RealTime-Communication	TSN	
	additional Data	Maintenance / Diagnostic	X
		Optimisation	
		Infrastructure Monitoring	
		instrumentation values	
	Redundancy	Topology (Ring, 2oo3)	
		Controller	
	Coexistence with other Prot	unified infrastructure	
		device update	
	Security	Plant Availability	
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	Topology detection	simple device replacement	
		simple device enhancement	
	Conformity Testing	Device Compatibility	
PROFIsafe	safe communication (SIL3)	All values valid	X
		loopcheck	
		test automation	
		prooftest	
	generic device drivers (PA4)	under development	
	central management	simple device enhancement	
	Conformity Testing	Device Compatibility	
FDI			

Operations Role: Security Manager

Main Advantages:
Inventory/Asset management: Easier sensor overview, as build information will ease identifying specific devices and versions when an update is needed

Needs from the Technology:

- APL instruments
- APL switches
- PROFINET
- APL devices will transmit the software version, switches will transmit what sensors are connected. The functionality will be a combination of APL + PROFINET

Value:

- Complete inventory to know what Security actions need to be taken. Reduce vulnerabilities and reduce potential downtime due to a device manipulation / cyberattack.
- Reduce the amount of work keeping the list of devices/version updated (it can be automated)

T.	Feature	Generic Benefit	Security Man.
APL	Digital Datatransmission	Data-Accuracy	
		Data-Relaibility	
		Fast Transmissionrate	X
		Device Data Memory	
	Security	NOA	X
	Standard Ethernet	IPv4+IPv6	
		No termination resistors	
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		efficient wiring	
	standardized	futureproof	
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PROFINET	RealTime-Communication	TSN	
	additional Data	Maintenance / Diagnostic	
		Optimisation	
		Infrastructure Monitoring	
		instrumentation values	X
	Redundancy	Topology (Ring, 2oo3)	
		Controller	
	Coexistence with other Prot	unified infrastructure	
		device update	
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PROFIsafe	safe communication (SIL3)	All values valid	
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		test automation	
		prooftest	
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	central management	simple device enhancement	
	Conformity Testing	Device Compatibility	
FDI			

Use-Cases Maintenance

NAMUR & ZVEI Task Forces
Subgroup Maintenance

Use Case: Simplified and Faster Device Replacement

Description:
A simple and fast workflow for device replacement, even if an instrument from supplier 1 is replaced through an instrument from supplier 2. Therefore, the new device has just to be connected at the same port, like the former one. Even the configuration of the former instrument can be used and downloaded to the new device.

Please refer to next slide to get more information and a comparison between 4 to 20 mA / HART and PROFINET.

Expected Value:
- faster and easier workflow for device replacement, which is as well less sensitive for errors
- reduced downtime of plants, since no subject matter expert required for device replacement
- approach for supplier independent device replacement
- cost savings in asset management through more efficient field device replacement

Requirements/Pre-requisites (per component group):
PROFINET over APL field devices with PA Profile 4

Use Case: Simplified and Faster Device Replacement

Description (field device from supplier 1 will be replaced through field device from supplier 2):

4/20 mA with HART	PROFINET over APL with PA Profile 4 devices
Check and calculate intrinsic safety parameters for measuring loop*	Check label for 2-WISE approval*
Check polarity of 2 wires at the transmitter	
Check if the same mode (active/passive) is required	
Connect device in the right way to the DCS/PLC	Connect 2-wires (not polarity sensitive), device will be detected, and measuring value communicated automatically
Get trained on new device (menus and parameter names)	
Search and download DD of new transmitter	
Install DD for new transmitter	
Check configuration of the measuring range in the control system	
Check configuration of the measuring range in the transmitter	
Configure parameter 1	
Configure parameter 2	
Configure parameter 3	
Configure parameter ….	
Download parameter (approx. 15 min for dedicated field instruments)	Download former parameter set with FDI package** for PA Profile 4 device (already installed) within seconds
Read transmitter related documents for displayed diagnostic information	
Solve issue based on transmitter specific remedies	Use harmonized remedy information (from PA Profile 4 device) to solve the issue

* in case of hazardous area applications, **to be provided through PI

Use Case: Faster Instrument Configuration and Diagnostics

Description:

- High transmission rates are helpful for acyclic services
- HART: 1,2 kbit/sec; Profibus PA 31,25 kbit/sec; Profinet over APL 10 mbit/sec
- Parameter upload Coriolis: HART (via Profibus RIO) 8 min ; (Profibus PA: 3 min ;) APL: 10sec
- Upload Echo curve takes few minutes via HART. With APL the upload happens in real time

Expected Value:

- Diagnosis messages /safety loop check / proof test = enhanced availability)
- Uniform profile diagnostics / less training in relation to different devices => higher efficiency
- Uniform configuration via the profiles

Requirements/Pre-requisites (per component group):

- Device Profinet over APL ready
- APL Field Switch
- Controller, Engineering Station, Asset Management

Use Case: Automated as Built
Live network layout

Description:

- Process and **vital data are standardized from the field.**
- **Uniform data room** (**Manufacturing X / Process X**) to enrich engineering tools with further data, to enable predictive maintenance or to increase the efficiency of production.
- Maintenance, component and infrastructure **information are in real time available.**

Requirements/Pre-requisites (per component group):

- Further development of the NOA concept for Ethernet APL, PA-DIM, …
- AAS, Digital Identifier (Nameplates) must be read automatically directly from the field device
- Concept for existing field devices is to be considered. Integration/ migration of 4...20mA / HART, PA, FF into the new APL infrastructure.

Expected Value:

- Online image of the field devices is possible in real time and significantly reduces the engineering effort for plant maintenance and documentation.
- Online monitoring of the CO2 emissions of the production plant
- Proof of intrinsic safety or functional safety testing can also be implemented automatically.
- Internal device fault and diagnostic functions can be easily made usable for maintenance.
- The greatest benefit lies in the **reduction of the engineering effort required for the necessary documentation and maintenance of the systems** and thus also a reduction in personnel costs for standard activities.

Use Case: Centralized and Faster Device Update

Description:
Für Ethernet APL soll eine einfache und zentrale Geräteupdate Möglichkeit geschafft werden.

Expected Value:
-device update via central tool
-update data via manufacturer independent online service
-exchange via FDI package
-implementation of NAMUR traffic light (NE107) for critical or functional update

Requirements/Pre-requisites (per component group):
-Vendor shared server
-AMS connection
-Uniform certificate structure

Use Case: Network Commissioning, Maintenance and Troubleshooting

Network diagnostics definition/description:

- Non-intrusive online monitoring and alarming of relevant communications statistics and physical layer characteristics to avoid developing faults becoming destructive
  - Ethernet statistics counters
  - Relevant physical layer values as e.g. voltage, current, SNR
- Auto trial function to trace events which lead to an abnormal condition or failure
- Root cause analyses provides instructions to resolve faults

Network diagnostics for legacy technologies:

- 4-20 mA
  - Manual, scheduled testing with dedicated tools on site required
  - Time consuming as each loop needs to be tested individually
- Fieldbus
  - Automatic test equipment is widely used and proven
  - Test equipment are dedicated devices, requiring dedicated maintenance budget

Use Case: Network Commissioning, Maintenance and Troubleshooting

Description:

- Continuous monitoring and testing of communication quality and physical layer provided by infrastructure devices
- Covers project lifecycles commissioning, maintenance and troubleshooting
- Detection of network performance degradation before it becomes critical for plant operation

Expected Value:

- Simplified and faster network commissioning due to automatic testing and documentation
- Preventive instead of reactive maintenance leads to minimized plant downtime and reduced maintenance cost
- Simplified and faster root cause finding for trouble shooting

Requirements/Pre-requisites:

- Network diagnostics support of infrastructure components
- User knowledge of Ethernet network statistics and Ethernet-APL physical layer
- Provision of training and services

Use-Cases Smart Sensing

NAMUR & ZVEI Task Forces
Subgroup Smart Sensing

HUMAN SENSORS APPLICATIONS

Create a sub working group to find effective applications for Human Sensors:

- **Hearing:**
- **Smelling:**
- **Watching:**
- **Feeling:**

(- Tasting:)

Everyone interested to join the sub working group please contact Ralf.Kueper@Emerson.com until 23.6.2023

Remote AI signal processing

- Configuration and diagnostic faster than other technologies
- With better measurement (e.g. acoustic with FFT) we could use AI-based algorithms to identify failures easier (and the algorithm improves over time by self-learning)
- For level measurement the raw signal could be used in a AI software to optimize the measurement
- Bulk raw data processing

Multi Sensor (1/2)

- Multi sensor transmitter with same output signal e.g. rotating equipment with vibration monitoring, bearing temperature, noise monitoring
- Less cabling for more information
- Reducing loops, engineering, hardware (cf. Engineering use case)
- Multi-variable sensors could send all the information (secondary data like density of coriolis)

Multi Sensor (2/2)

ROI example:

- **Multipoint temperature measurement with multiple (example: 10) temperature measurements could be reduced to a single APL transmitter**
- **One measurement point complete with engineering in chemical industry:**
- **3.000€ x 10 measurement points = 30.000€**
- **4.000€ x 1 with APL = 4.000€**

HUMAN SENSORS APPLICATIONS Hearing

Hearing:

- Microphone network for plant acoustics, e.g. recognition of cavitation, leaks, call for help by staff detection etc.
- Acoustic fence monitoring, noise emission detection (internal vs. external source) e.g. flare noise monitoring
- Acoustic measurement for frequency outside of human hearing range
- Noise monitoring of rotating equipment
- Blockage of pipes
- Acoustic localization

HUMAN SENSORS APPLICATIONS Smelling

Smelling:

- Leak detection
- Early Fire / Smoke detection
- Quality monitoring in process
- Toxic gas detection
- Oxygen measurement
- Lubrication smelling (when oil is too hot)

HUMAN SENSORS APPLICATIONS Watching

Watching:

- Camera signal
- Broadband video broadcast
- Thermal cameras
- Camera to read (with AI) local pressure/temperature/level/position gauges
- Dust monitoring
- Particle monitoring
- Smoke detection 3D/localization
- Loading of big bag/tanks to detect if they are connected correctly

HUMAN SENSORS APPLICATIONS Feeling

Feeling:

- Surface temperature monitoring with themal camera
- One transmitter with multi temperature sensors
- Vibration monitoring
- Structure-borne sound of steel infrastructure
- Plugging of pipes

End User Requirements

NAMUR APL Task Forces

APL Task Force – End user requirements
Use Case “EPC”

Simplified, cost-effective engineering

- Easy setup of an APL based communication network. No loop drawings required.
- Same devices available for safety and non-safety applications
- Availability of simple interface modules, (two-wire devices, modular mini I/O, etc.) for binary signals
- Easy setup and commissioning of secondary data channel with almost no additional effort.
- Fast automated ex-protection calculation/confirmation (2-WISE)
- Faster execution of DCS Migration projects

Easy and fast commissioning

- Easy, fast and as much as possible automated commissioning (registration and integration of devices into the network, fast parameter upload/download, access to all parameters) with no effects on already established communication.
- Detailed monitoring of communication, field and network devices. Fast reporting of any issues discovered.
- Easy, fast and as much as possible automated loop check

Automated documentation

- The system shall be capable to create a network drawing automatically
- The AMS shall be capable to document all relevant field device settings automatically

APL Task Force – End user requirements
Use Case “Maintenance”

Systems (DCS and AMS) shall support:

- Enhanced monitoring of communication (transmission failures, outages, unexpected traffic, degrading), field and network devices (like APL field switches). Fast reporting / alarming of any issues discovered, even to higher level entities.
- Reduced plant downtime due to easy, fast and almost automated replacement of defective devices, even by devices from different vendors, including automated registration/verification/integration of the new device into the network, including fast take-over of the configuration data of the failed device. Device replacement shall not require engineering skills and shall not disturb the network communication.
- Same devices available for safety and non-safety applications
- Automated update of the network drawing.
- Easy, almost automated integration and configuration of new field devices without affecting the existing communication.
- Availability to manage components such as switches, routers, access points, centrally and locally. Corresponding devices must prevent unauthorized device access via access control.
- Simple software update via AMS with information available in a central, vendor independent location

APL Task Force – End user requirements
Use Case “Operations”

Expectations are

- Highly, long term reliable (redundant) network
- Lifetime of devices and components for >20 years
- Fast provision of process data to plant operators
- Accurate time-tagging of messages, status information etc.
- Early field device malfunction identification before the instrument fails
- Easier/faster access to plant data in the enterprise/cloud for reliability management.
- Faster/more data with better accuracy from instruments to monitor plant performance for improvement
- Support of asset management by an almost automatically created asset inventory
- Easy repurpose of field instruments from operation to safety functions and vice versa
- Fast and secure interface to upper-level software tools (data mining for equipment monitoring etc.)

APL Task Force – End user requirements
Use Case “Human Sensing”

Expectations are

- Availability of multi-point / multi-variable sensors (multi-point temperature measurement, multi-variable sensors to monitor rotating equipment via vibration, bearing temperature, noise, temperature, etc.)
- Availability of sensors capable to
  - Watch: cameras capable to read local pressure/temperature/level/position gauges, to indicate dust/particles, to detect and localize smoke/fire, to monitor loading of big bag/tanks to detect if they are connected correctly, etc.
  - Hear: microphones to recognize cavitation, leaks, call for help by staff detection, to monitor plant fences and flare noise, to measure frequencies outside of human hearing range, to indicate pipe blockage etc.
  - Smell: sensors for leak detection, early fire/smoke/toxic gas detection, lubrication smelling etc.
  - Feel: surface temperature, vibration monitoring, pipe plugging etc.
- Fast and simple integration/configuration of above-mentioned sensors
- Availability of evaluation tools capable to process the data delivered by human sensing devices

APL Task Force – End user requirements
Generic Requirement from the NE 168*

- "Protocols IEC 61784-2 CPF2/2 ‘Ethernet/IP‘ and IEC 61784-2 CPF3/5 ‘PROFINET IO CC B‘ shall be available. Minimum requirements are:
  - All devices in the network must be able to communicate to controllers other in an interoperable manner without any interference.
  - TCP/IP protocols other than mentioned above shall run simultaneously on the same system without interferences/disturbances.
  - The same protocol shall be used regardless of the physical layer used, i.e. also for wireless or fiber optical solutions.
  - Both Protocols must support real time applications.
  - The bus infrastructure should indicate overload situations, especially when real time communication is jeopardized."
- The communication system and network participants should support IPv4 and IPv6 addresses in the same network.
- Network transmission mechanisms as well as the ones for filtering & blocking shall comply with the state-of-the-art security technology. Device and vendor independent authentication mechanisms capable of verifying the authenticity of software and devices must be available and in place. NA 135 and NE 153 must be followed.
- Central network components (SIS, DCS, network infrastructure, etc.) must fully support the two protocols already specified before.
- Grounding and shielding must be aligned with existing explosion protection standards. Single and multi-point grounding shall be supported.
- Vendor/DCS agnostic solutions

** Please note that an updated version of NE 168 is under revision at the moment and that the contents of this list may change*

APL Task Force – End user requirements
Generic Requirement from the NE 168*

- EMC requirements as per NE 21 shall apply to all devices and components
- Two-wire cables for signals and energy supply should be used to connect field devices. The physical layer shall be available for explosive and nonexplosive atmospheres.
- The device name plate shall have a marking that identifies it as an Ethernet device. Devices shall be clearly identified via an electronic TAG (≥32 char.) & the MAC address.
- Preferred means to manage field devices should be the Field Device Integration (FDI) tool. The device packages required integration shall be available in the devices itself and capable of being transmitted to central device management tools.
- As per default, web servers should be “OFF”, and default for web servers and apps shall be “Read only”. Any other interfaces (WLAN, Bluetooth etc.) must be disabled.
- The system must prevent device data sets from becoming inconsistent between the tools utilized.
- Automation security requirements must be fully followed. Field devices itself must provide access control mechanism to prevent unwanted and unauthorized device access.
- Bulk download during device commissioning must be supported.
- Status signals as per NE 107 shall be consistently supported by devices, systems and components. In general, devices should be delivered with defaults as per NE 131 and NE 107.
- Certification to ensure the conformity of systems, devices and components must be available. It must be manufacturer–independent by authorized service providers.
- Transparent transitions must be created for existing fieldbus applications, providing at least the same functionality as current fieldbus masters.
- Life cycle costs of Ethernet based field communication systems should be less than corresponding 4-20mA HART installations.

** Please note that an updated version of NE 168 is under revision at the moment and that the contents of this list may change*