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# TcFlexMeter Overview

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# What is TcFlexMeter?

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TcFlexMeter is a

**flexible**

**metering** and **data logger**

based on **TwinCAT**

**Configuration**

instead of

**programming**

# Field of application

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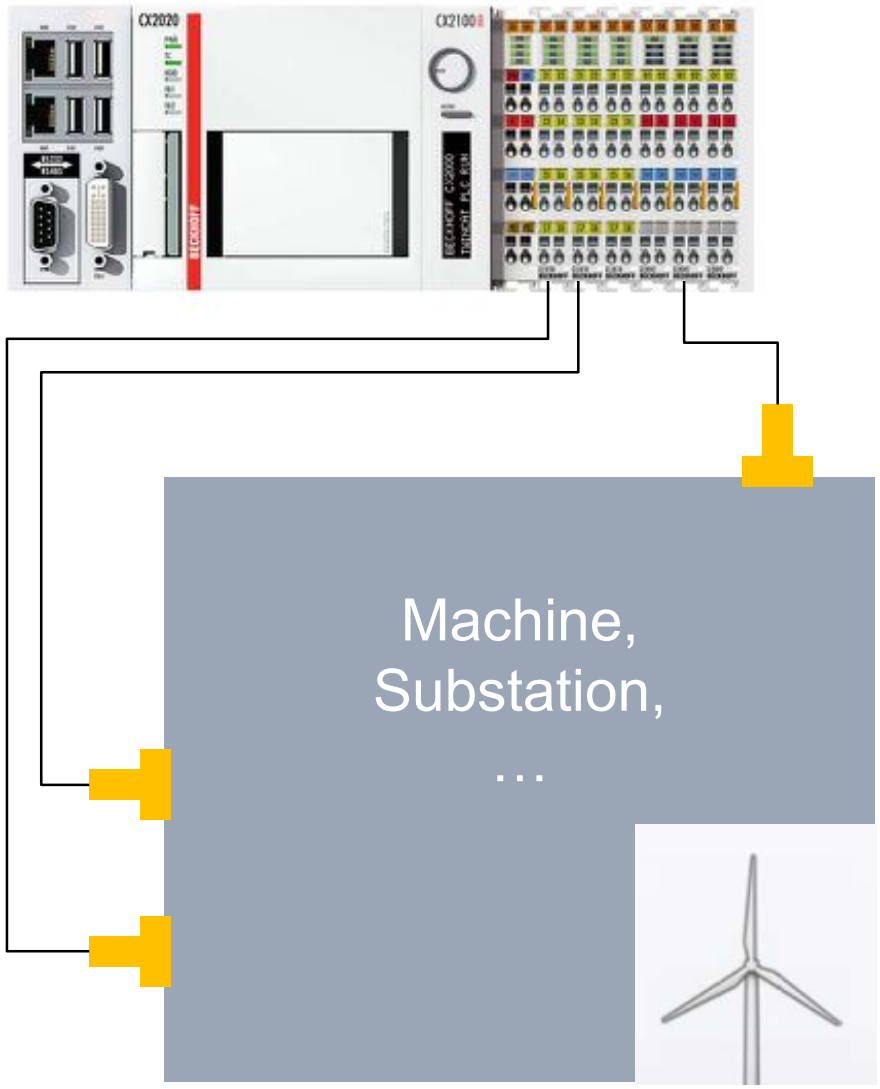
- A machine should be monitored
- measuring technicians have to equip a machine with sensors
- The data acquisition can be configured by an easy to use graphical user interface
- The Beckhoff controller processes the data and stores it on a local SQL Server



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# 1. Configuration

Network

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## 2. Data acquisition

# Key features

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Easy to use

Based on TwinCAT

Extendable

MS SQL

# One product → TcWind

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## TcFlexMeter

- TcFlexMeter is based on the TcWind Framework

## TcWind Framework

- Beckhoff product TF8310
- Used by our costumers
- Database and logging implementation
- Status codes and parameter management
- Good experience in performance and stability

# Parts of TcFlexMeter / general definitions

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Configurator

**Windows Application**

- Simplified interface for TwinCAT
- Fits perfectly to measurement requirements

Logger

**TwinCAT 3.1 RT Application**

- C++ components
- Hardware configuration of inputs
- Time sync
- Data acquisition
- Data processing

Storage

**Data storage**

- Microsoft SQL Server
  - 2014 & 2016
  - Express
  - Standard
- TcWind schema
- Data warehouse

# Example of use

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# Create Project

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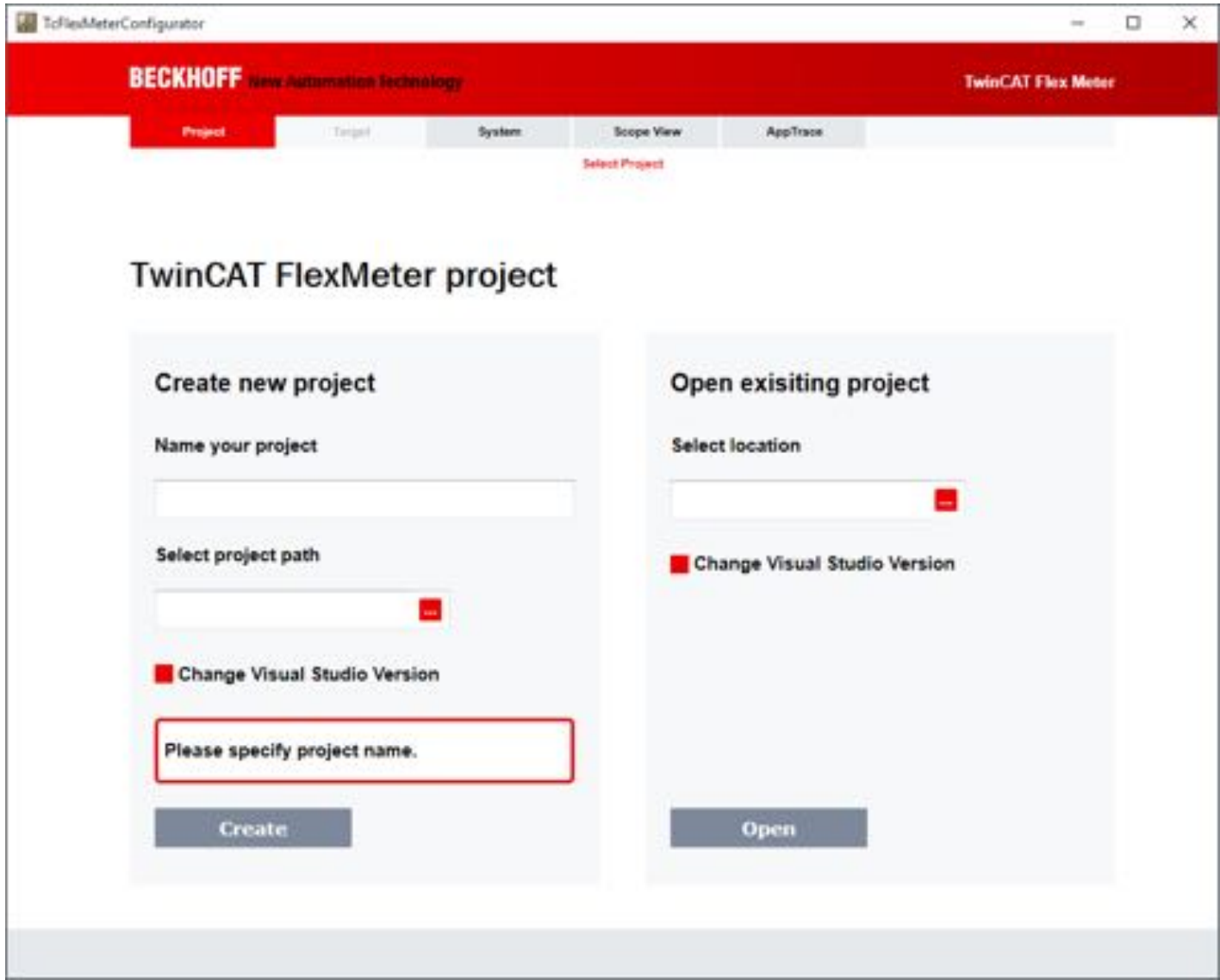
Steps:

- **Open new project**
- Add a new target
- Select route target



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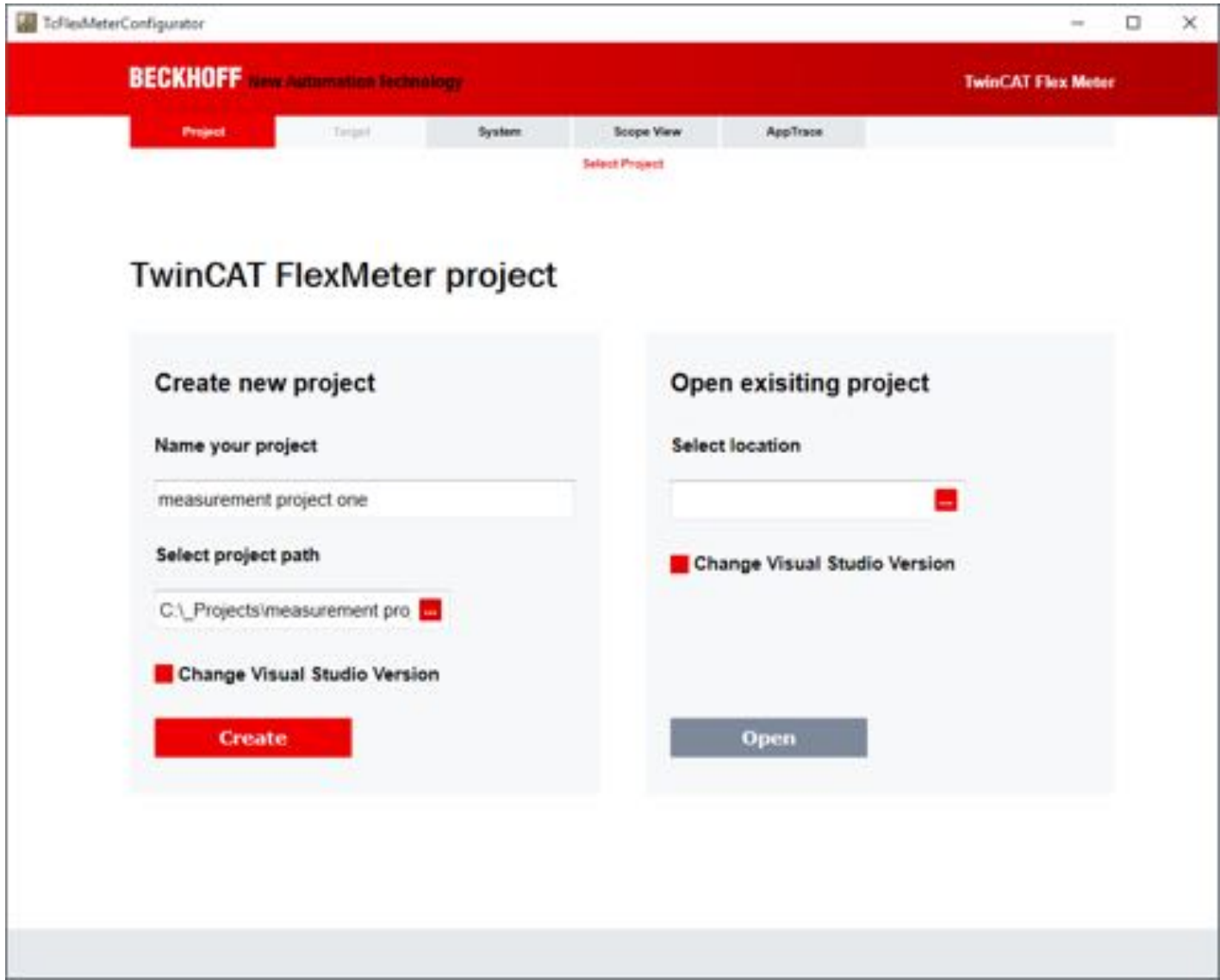

# Create Project

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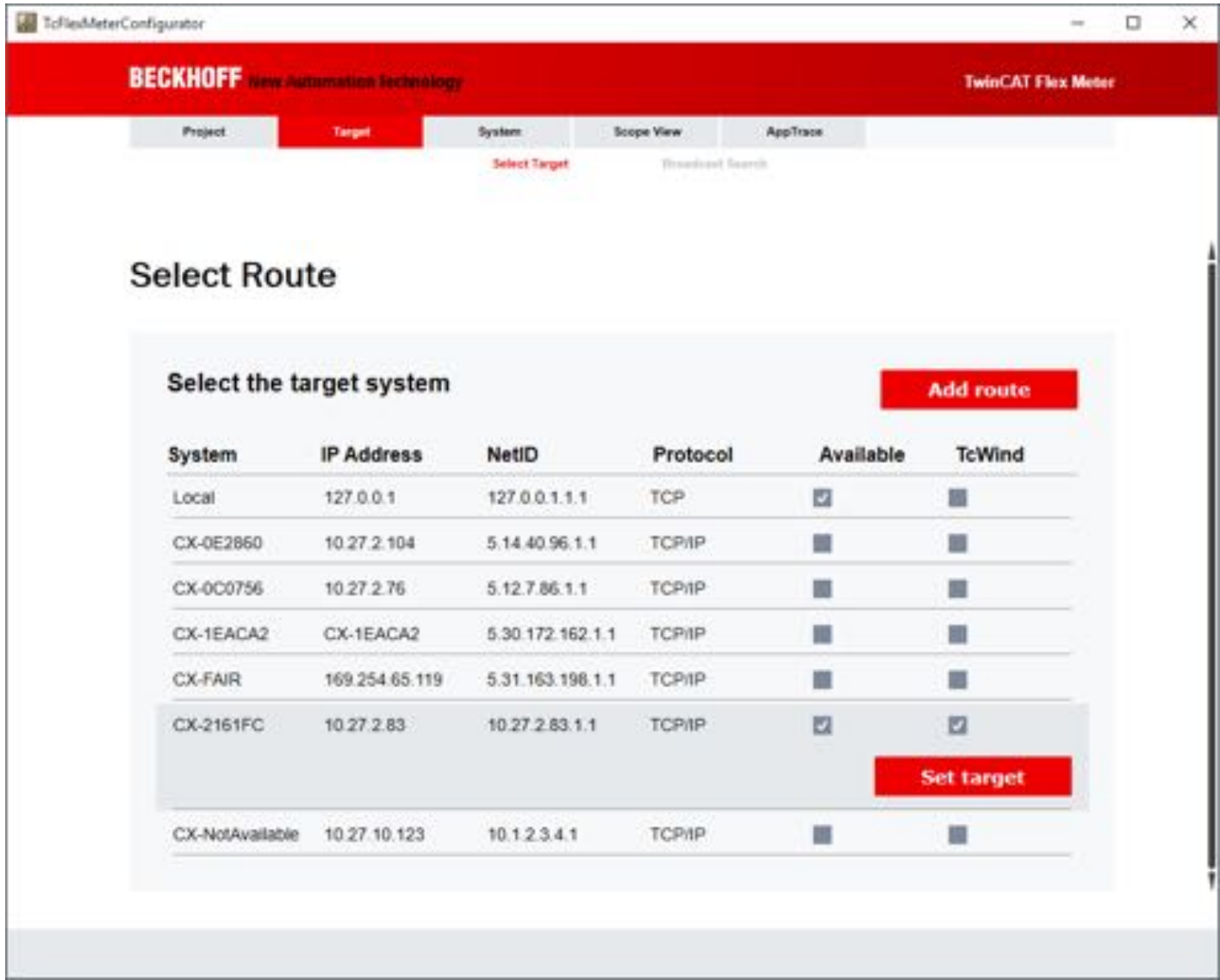
Steps:

- Open new project
- Optional:
  Broadcast Search target
- Select Route



# Scan Hardware

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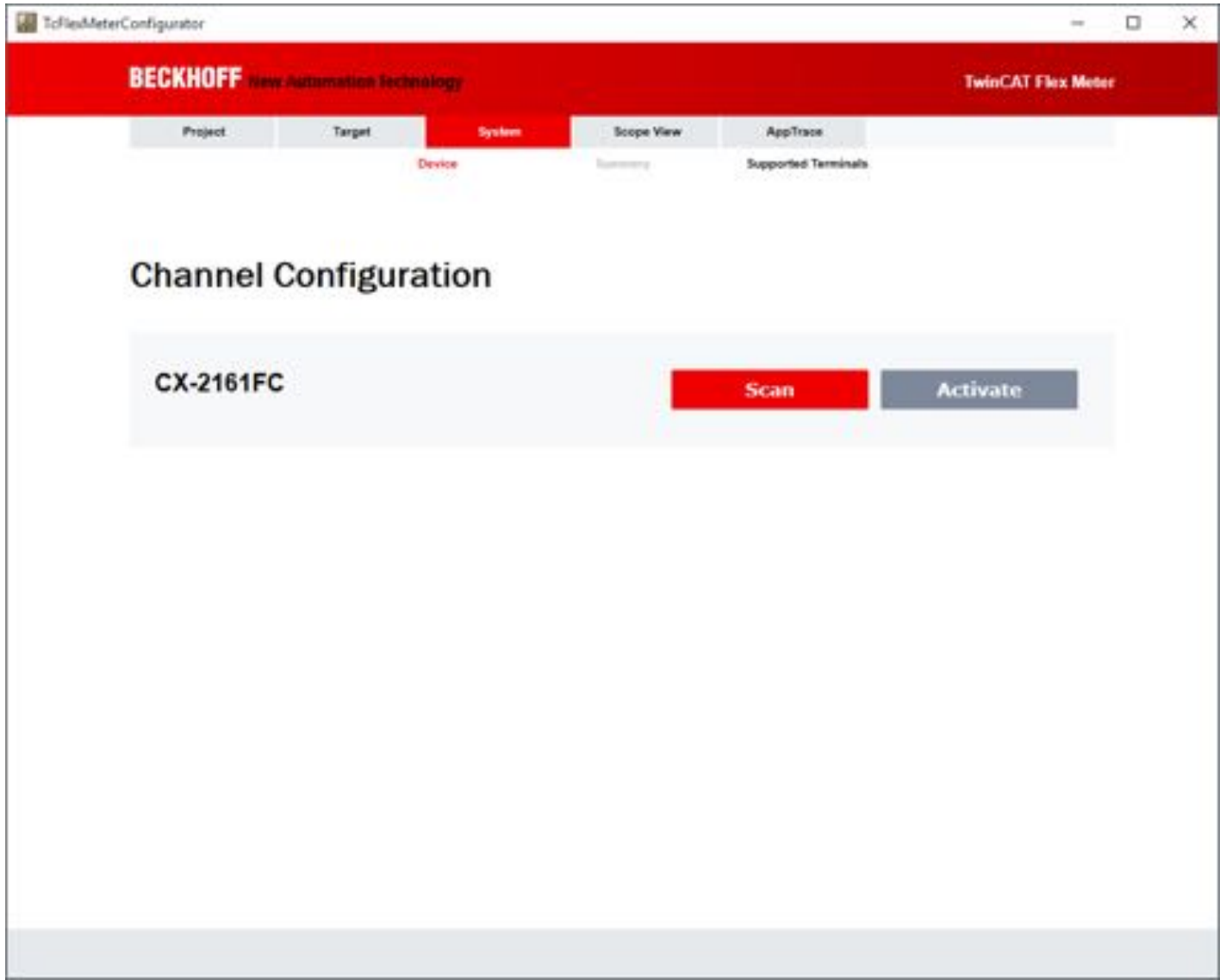
Steps:

- **Scan for terminals**



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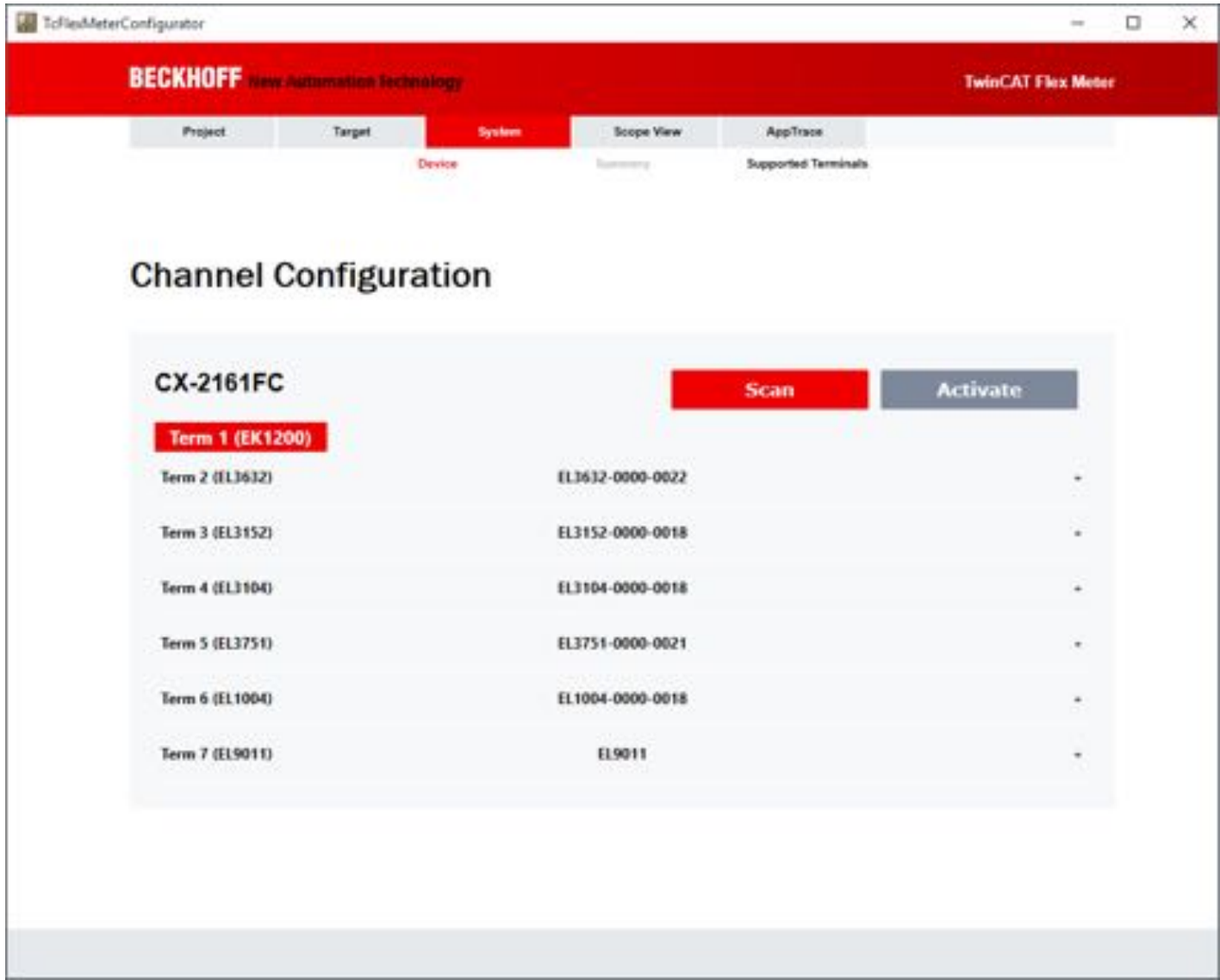

# Configure Terminals

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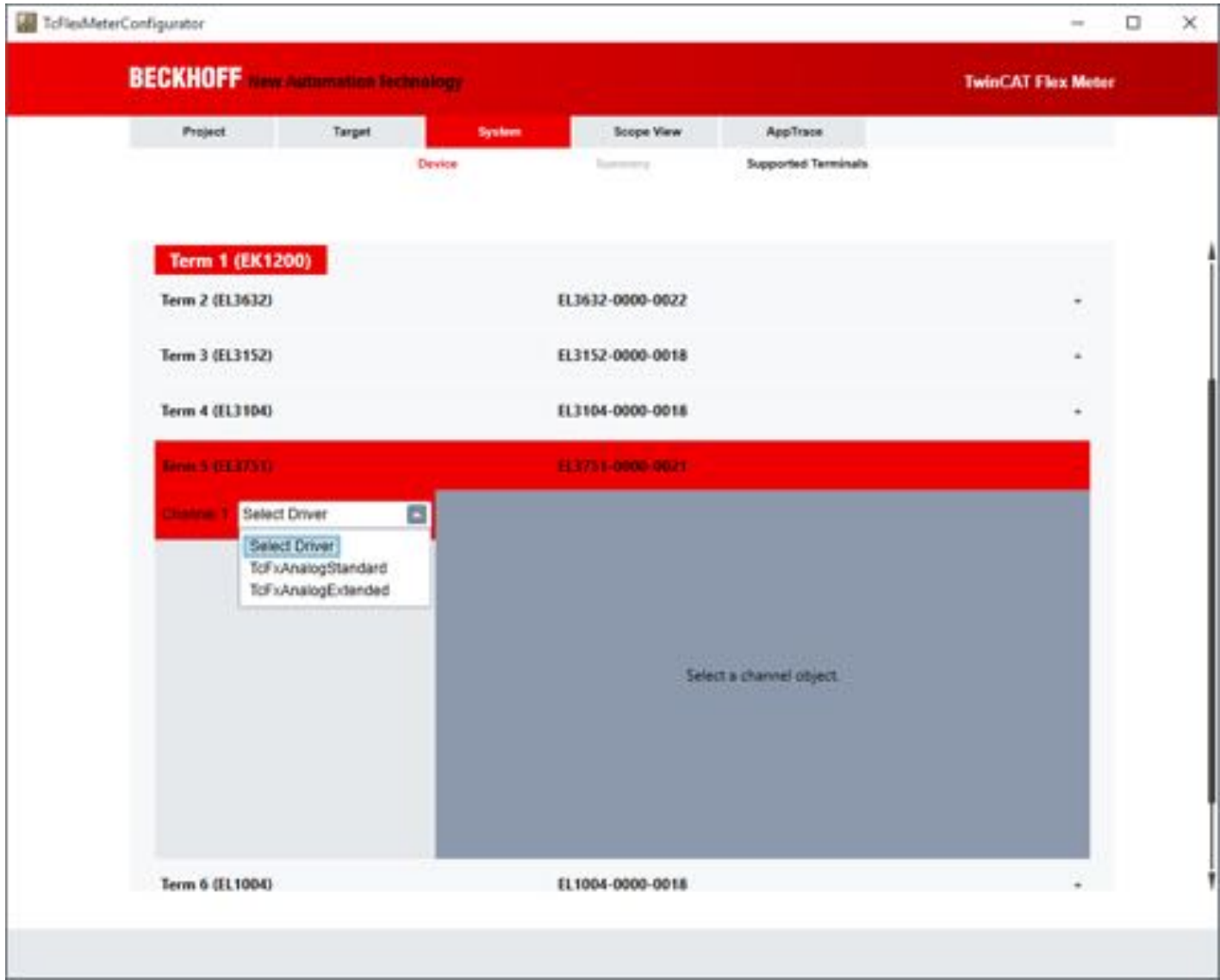
Steps:

- **Select input type**
- Configure object
  - Channel Name
  - Sample Time
  - …
- Activate configuration



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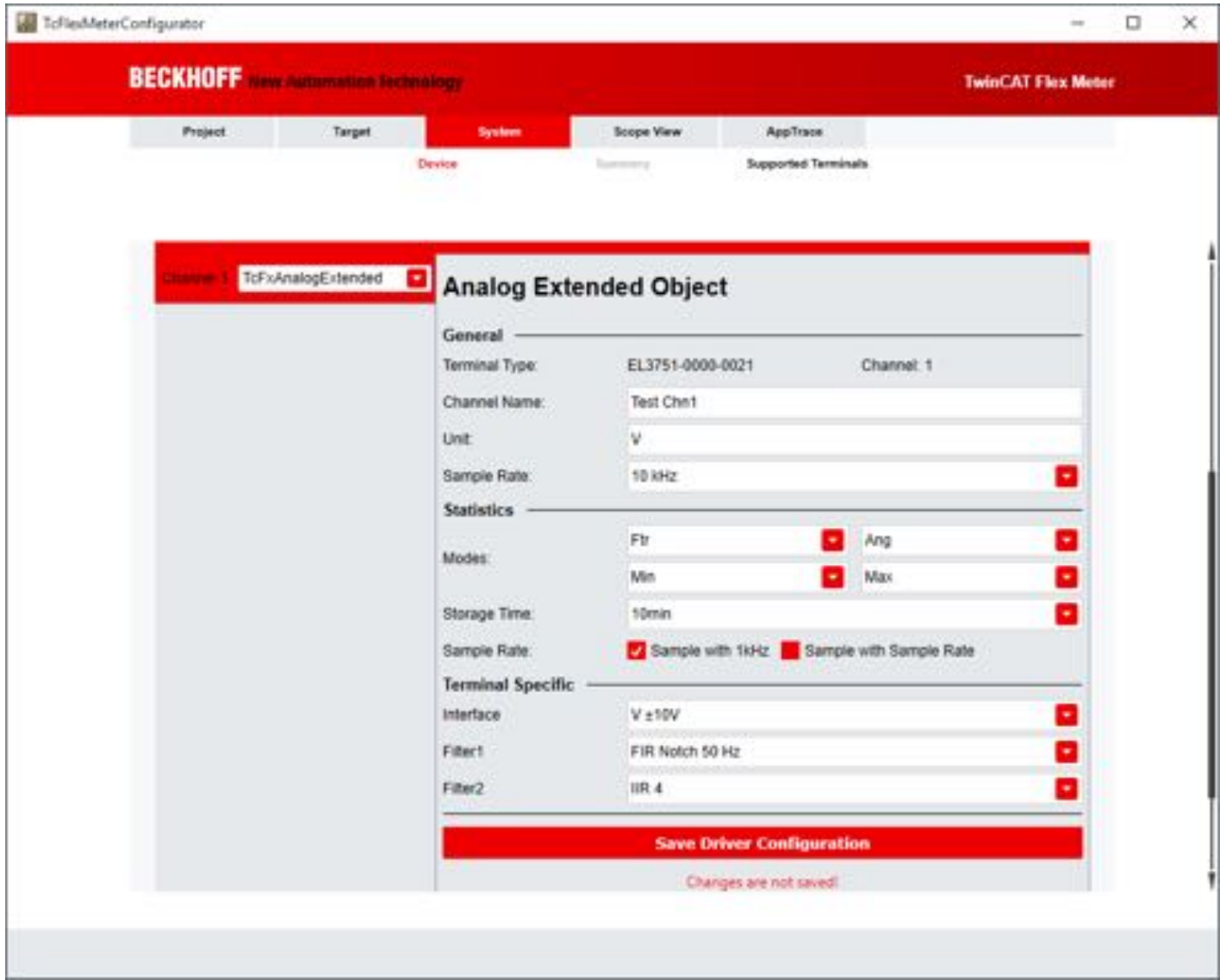

# Configure Terminals

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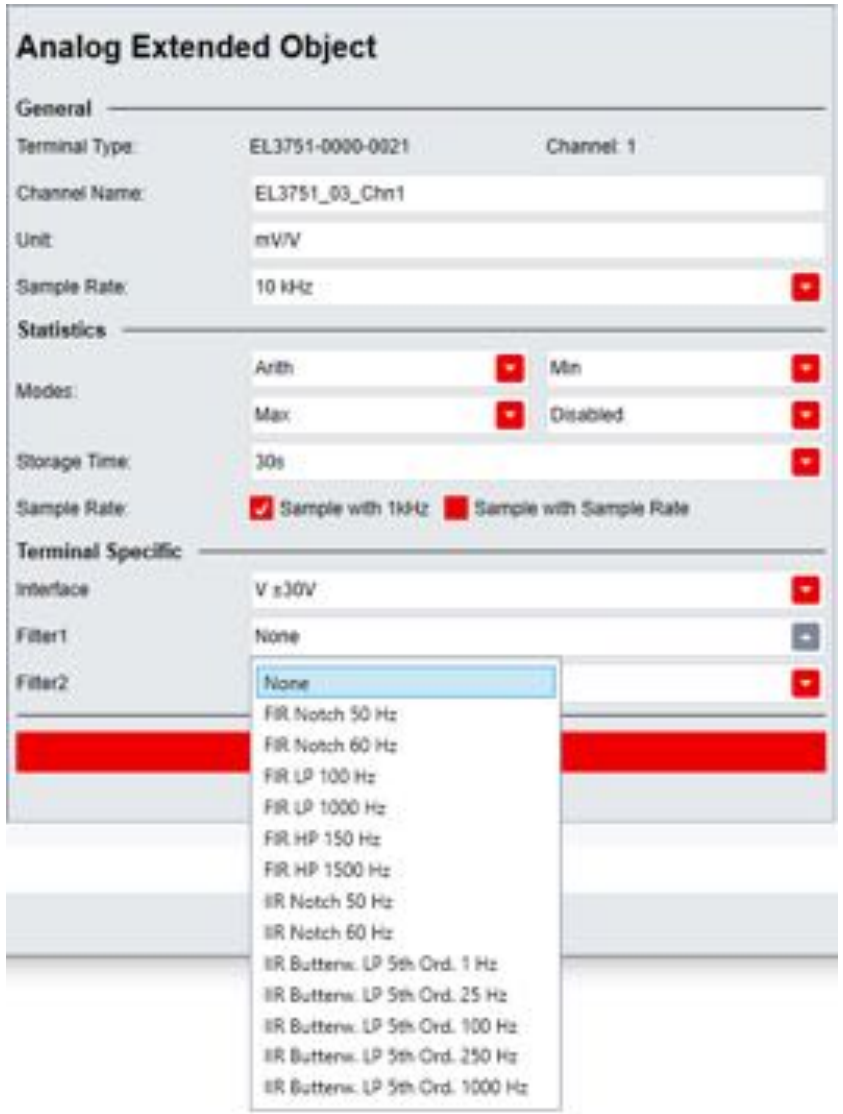
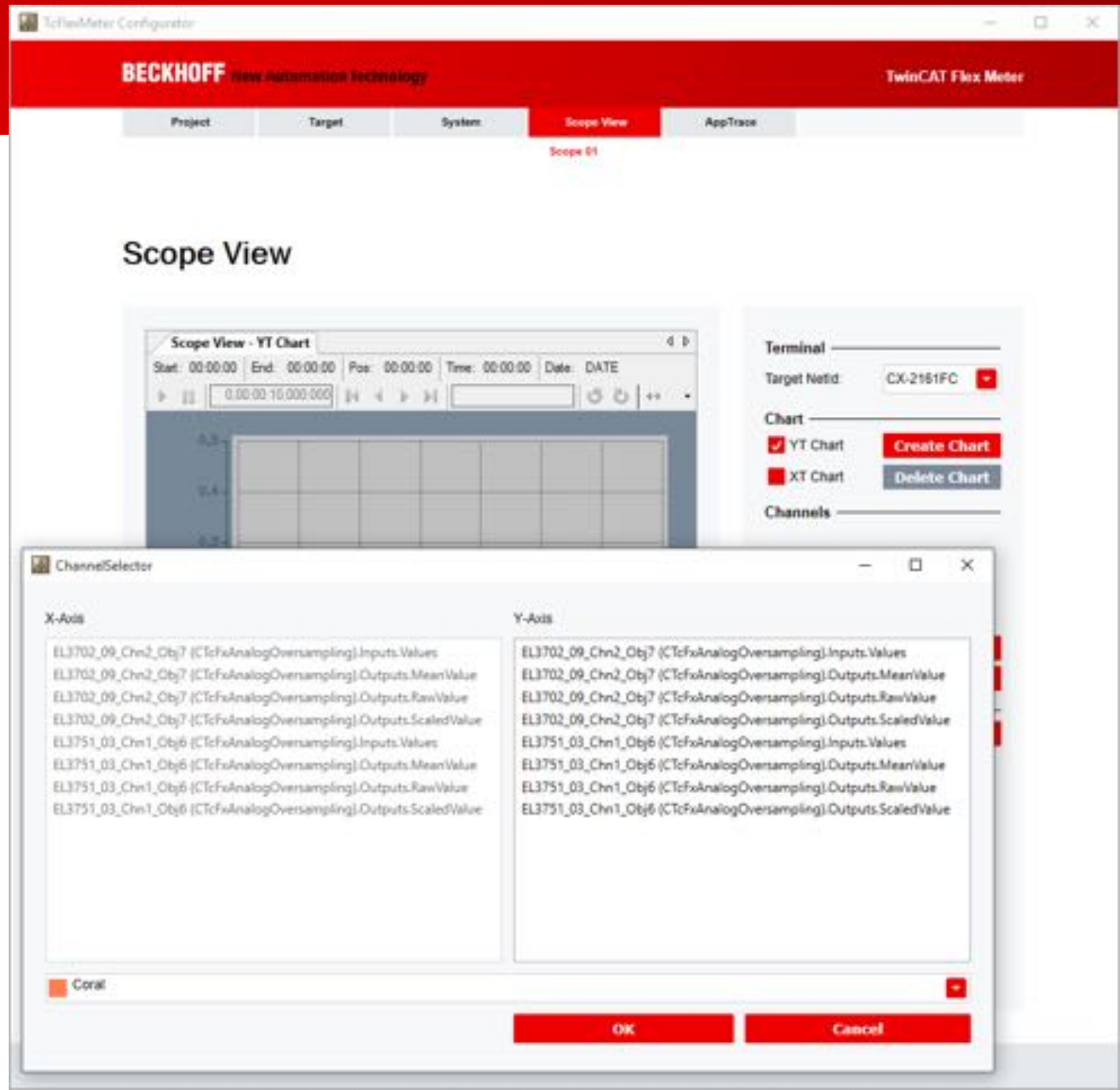


# Features – Configuration Process

Live Data:

- TwinCAT ScopeView integration
- Online monitoring of signals



# Features – Configuration Process

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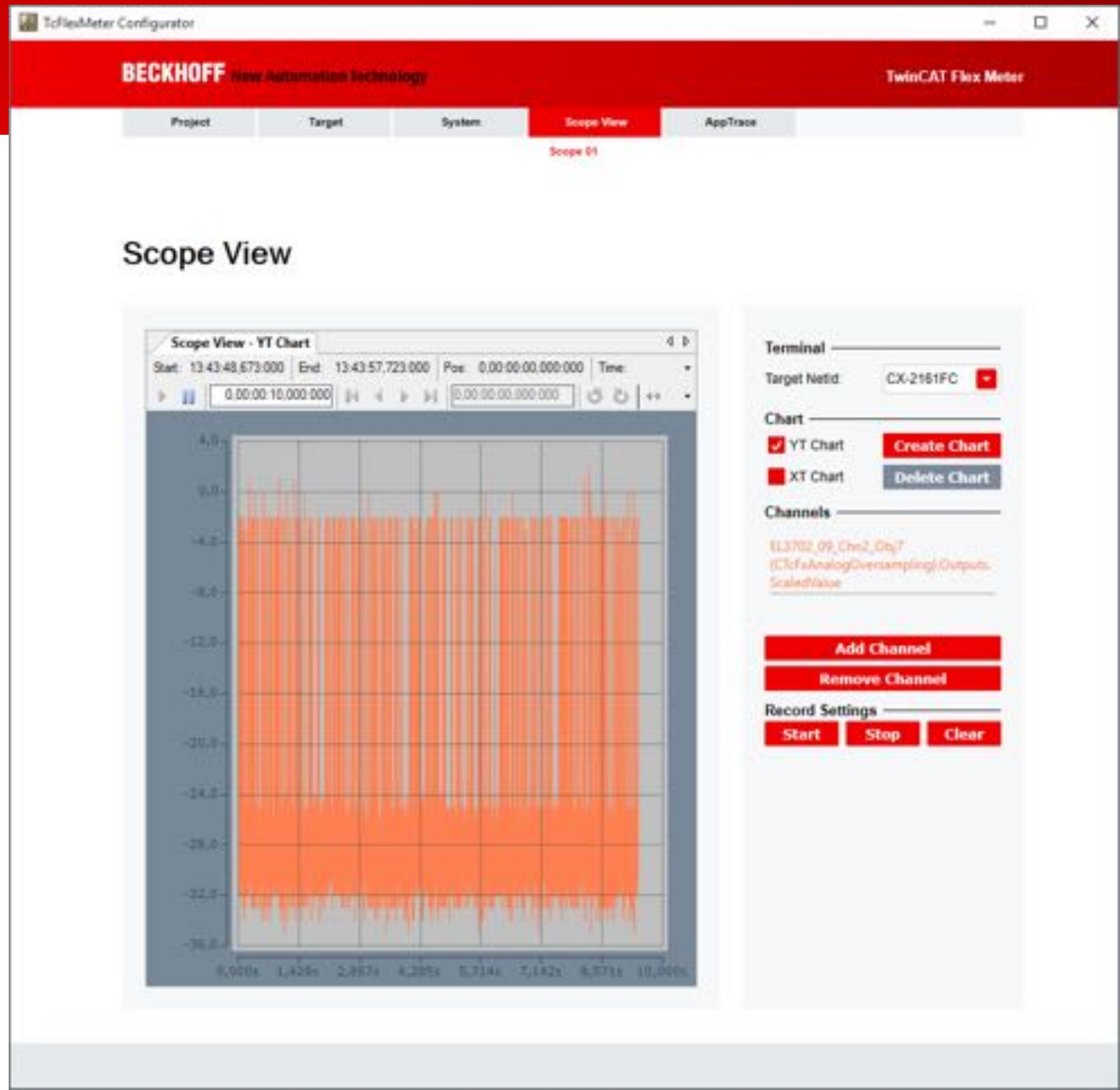

# Configuration process

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# Configuration process

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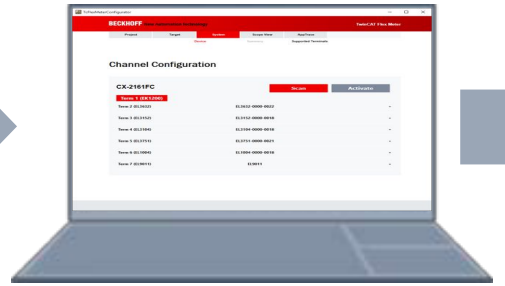
- Easy to use
- No programming experience required
- One stand alone application for the configuration process
- Configurator on engineering system

User input




Activate project on logger

Create TwinCAT project

The TwinCAT project is hidden from the users

# Configuration process – remote

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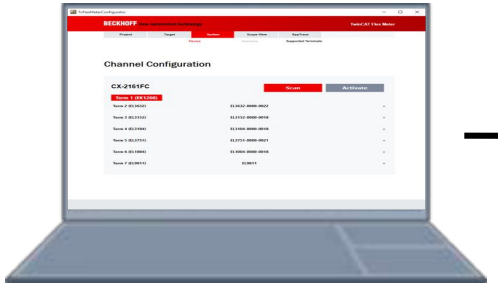
**Engineering System**
- TwinCAT 3.1 XAE
- TcFlexMeter Configurator

**Beckhoff System**
- TwinCAT 3.1 Runtime
- TwinCAT Wind Framework
- SQL Server




ADS Route / Network


Independent from engineering **after** configuration

# Configuration process – local

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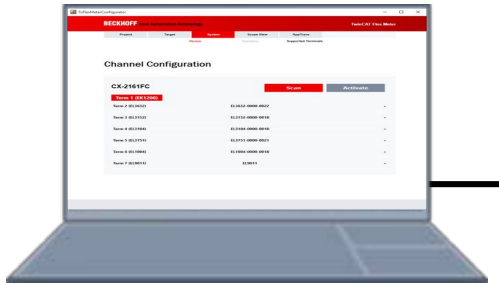
## Input devices

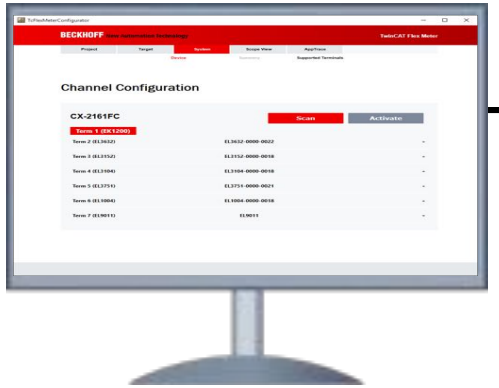
- Computer with remote desktop
- Monitor with keyboard and mouse

## Beckhoff system

- TcFlexMeter Configurator
- TwinCAT 3.1 XAE
- TwinCAT 3.1 Runtime
- TwinCAT Wind Framework
- SQL Server




RDP




USB + DVI


Independent from engineering **any** time

# From programming to parametrizing

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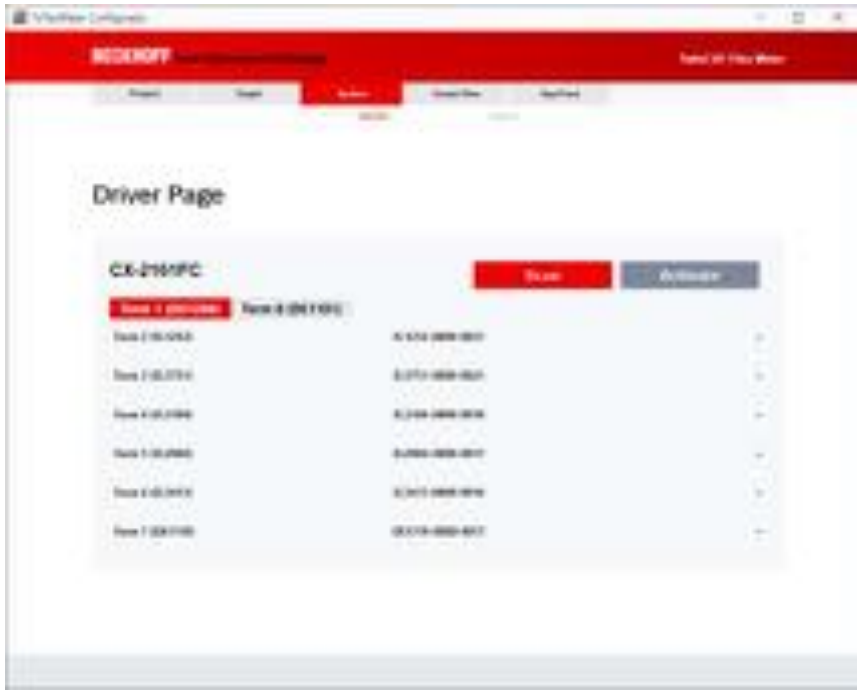
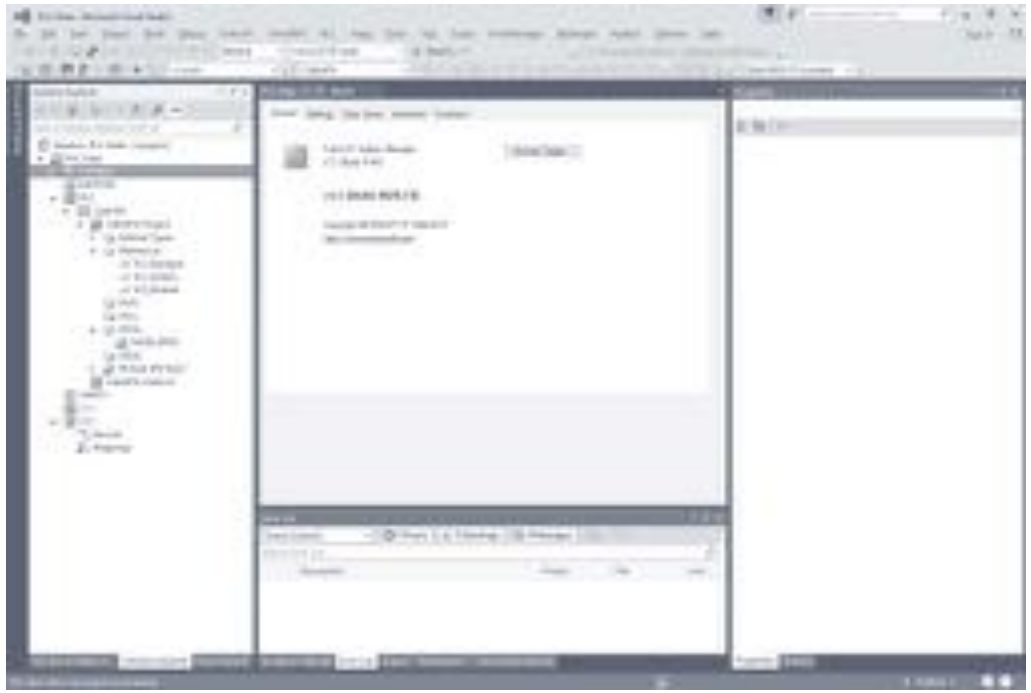
TcFlexMeter Configurator is a simplified frontend for TwinCAT 3.1 and Visual Studio



**Configuration and parametrizing**
Specialized application for measuring and logging

**Configuration and programming**
Flexibly not limited

# Data Acquisition

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# Logger Modules

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## Base functions

- EtherCAT Diagnostics
- Database Interface
- Time Synchronisation

## Input types

- Digital
- Analog
- Custom

## Instances for input channels

- Digital 0..n
- Analog 0..n
- Custom 0..n

n → Software Limit

# TcFlexMeterObjects and IO

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EL3208 – 8 Channel


Analog

0..8

EL3751 – 1 Channel


Analog

0..1

EL1252 – 2 Channel


Digital

0..2

# Recording Modes

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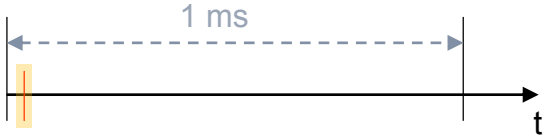
## Cycle Time

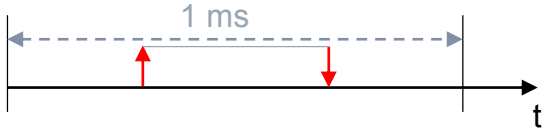



EtherCAT Communication Frame

## Oversampling


Sampling in sync

## Timestamping




64 Bit timestamp (R) 64 Bit timestamp (F)

## EL3208 – 8 Channel


## EL3751 – 1 Channel


## EL1252 – 2 Channel

# EtherCAT Measurement Modules

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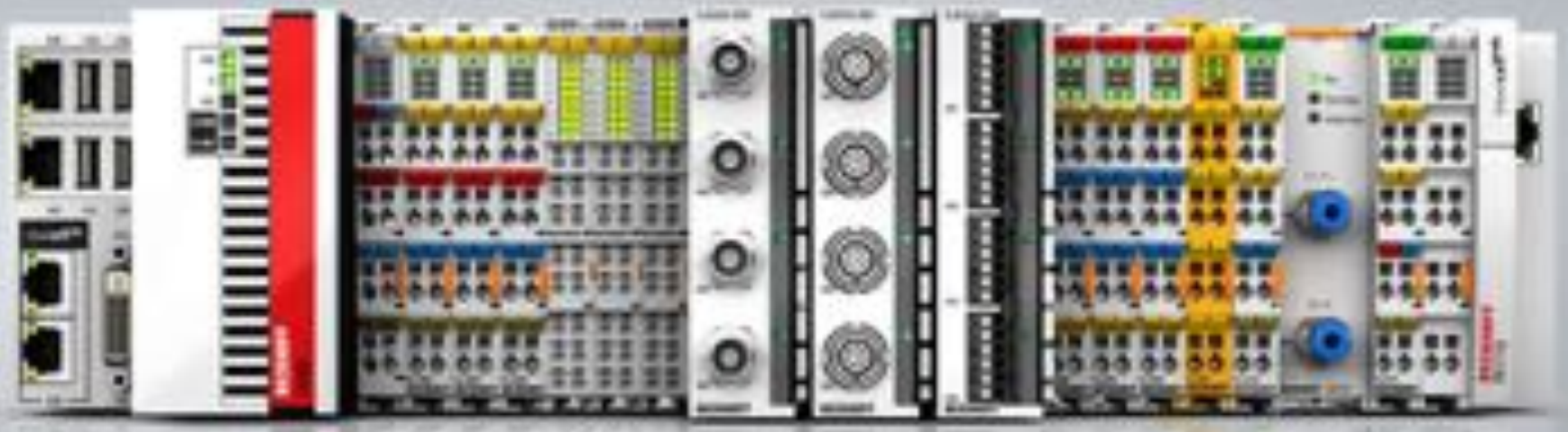

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## DIN rail-mountable IP 20 modules

EtherCAT measurement modules in connector-compatible metal housings

# Signal processing in the EtherCAT measurement modules

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Analog electrical signal → High-quality, stable and robust input electronics → Analog-to-digital conversion in 24-bit resolution → 2 freely parameterisable filters up to the 39th order → Decimation unit → TrueRMS Integrator/ Differen-tiator → Scaler → PDO transport via EtherCAT

# ELM3xxx series – 24bit, 10 kSps and diagnostic

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| | ELM3704-0001 | ELM3704 | ELM3702 | ELM3004 | ELM3002 | ELM3104 | ELM3102 | ELM3504 | ELM3502 | ELM3604-000x | ELM3602-000x |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Multi Multi functional input | | | U Voltage measurement | | I Current measurement | | Measuring bridges analysis SG | | IEPE analysis | |
| Channels | 4 | 4 | 2 | 4 | 2 | 4 | 2 | 4 | 2 | 4 | 2 |
| Resolution | 24 bit | | | | | | | | | | |
| Max. sampling rate | 10 kSps | 10 kSps | 10 kSps | 10 kSps | **20 kSps** | 10 kSps | **20 kSps** | 10 kSps | **20 kSps** | 20 kSps | **50 kSps** |
| Connection techn. | LEMO 1B 8p. | Push-In 6 pole | | | | | | | | BNC, Push-In | |
| U (±20 mV … ±60 V) | x | X | x | x | x | | | | | x | x |
| I (±20 mA) | x | x | x | | | x | x | | | | |
| Meas. bridge SG | x | x | x | | | | | x | x | | |
| IEPE | x | x | x | | | | | | | x | x |
| Resistance 5kΩ | x | x | x | | | | | | | | |
| Potentiometer | x | x | x | | | | | x | x | | |
| Temperature RTD | x | x | x | | | | | | | | |
| Temperature TC | x | x | x | | | | | | | | |

# Data calculation chain

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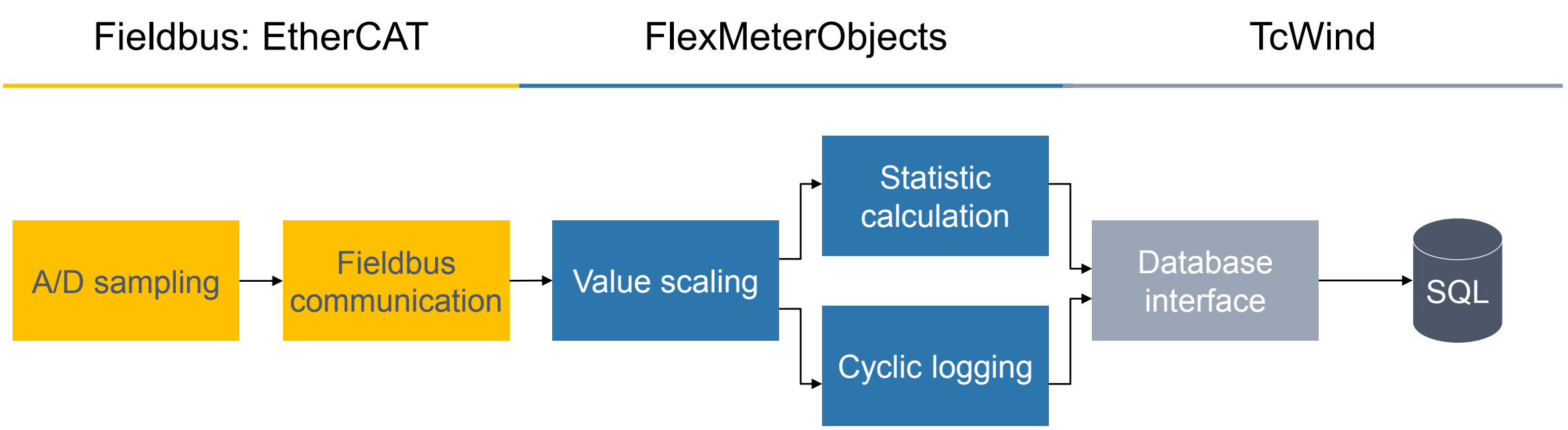

# Input Objects: Internal structure

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## Analog

| | |
|---|---|
| Terminal diagnostics | Over rage |
| | Under range |
| Scaling | Unit |
| Statistics | Maximum |
| | Average |
| | Deviation |
| | Minimum |
| RAW values | *To data storage* |
| Data storage | *Interface* |

## Speed (EL1252)

| | |
|---|---|
| Terminal diag | Terminal state |
| Value calc. | *Flags to RPM* |
| Scaling | Unit |
| Statistics | Maximum |
| | Average |
| | Deviation |
| | Minimum |
| RAW values | *To data storage* |
| Data storage | *Interface* |

# Channel options

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## Generic

- Channel Name
- Sample Time (10kHz, 1kHz, …, 25 Hz, 1Hz)
- Different statistic calculations

## Object specific (analog/digital/…)

- Analog → Scale and offset
- Speed → Pulses per revolution, modulo, …

## Terminal specific

- Interface types for EL3751
- Hardware filter

# Cyclic RT Application

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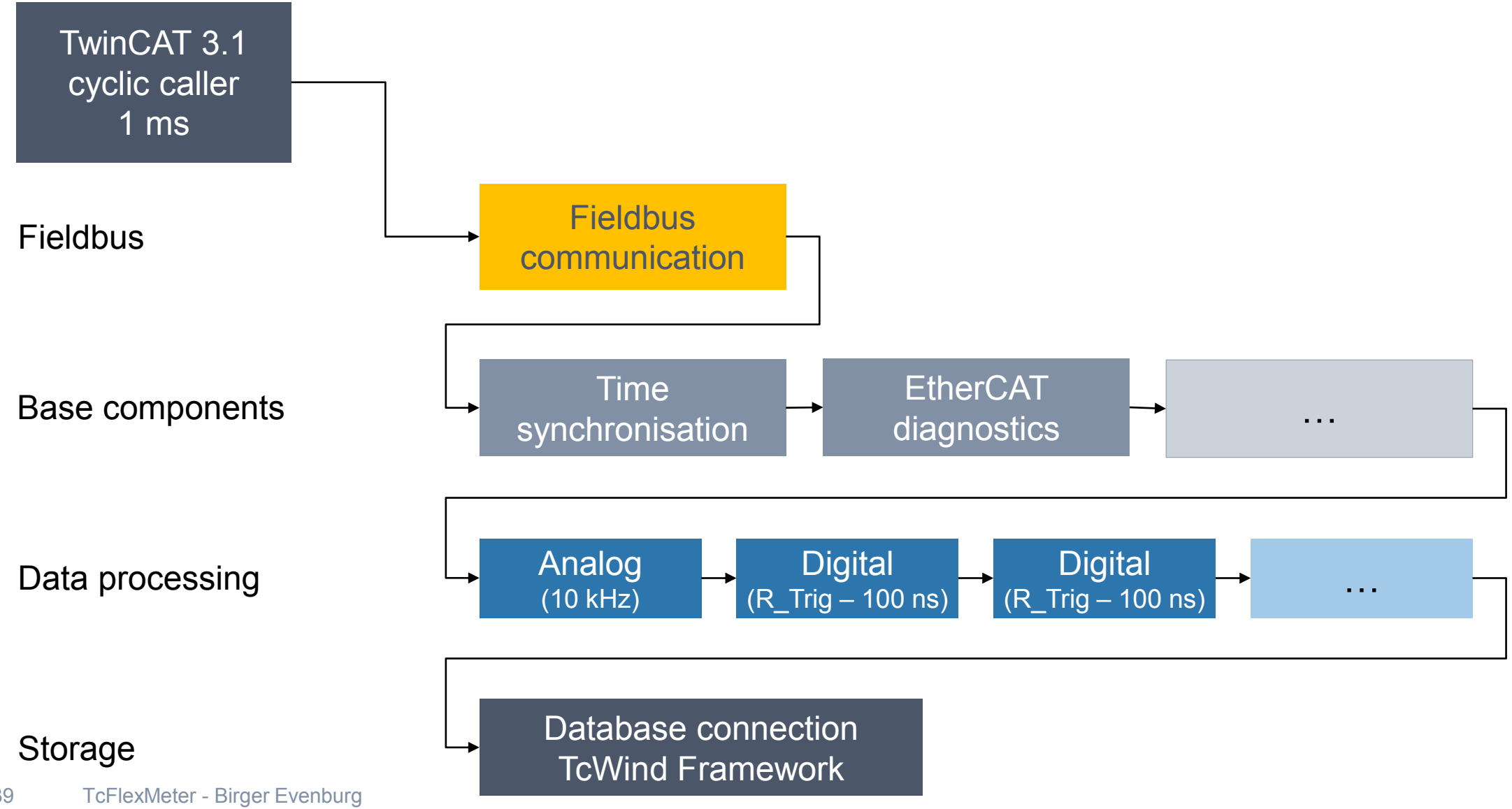

# Data Processing

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# TcFlexMeter/TcWind – Statistic

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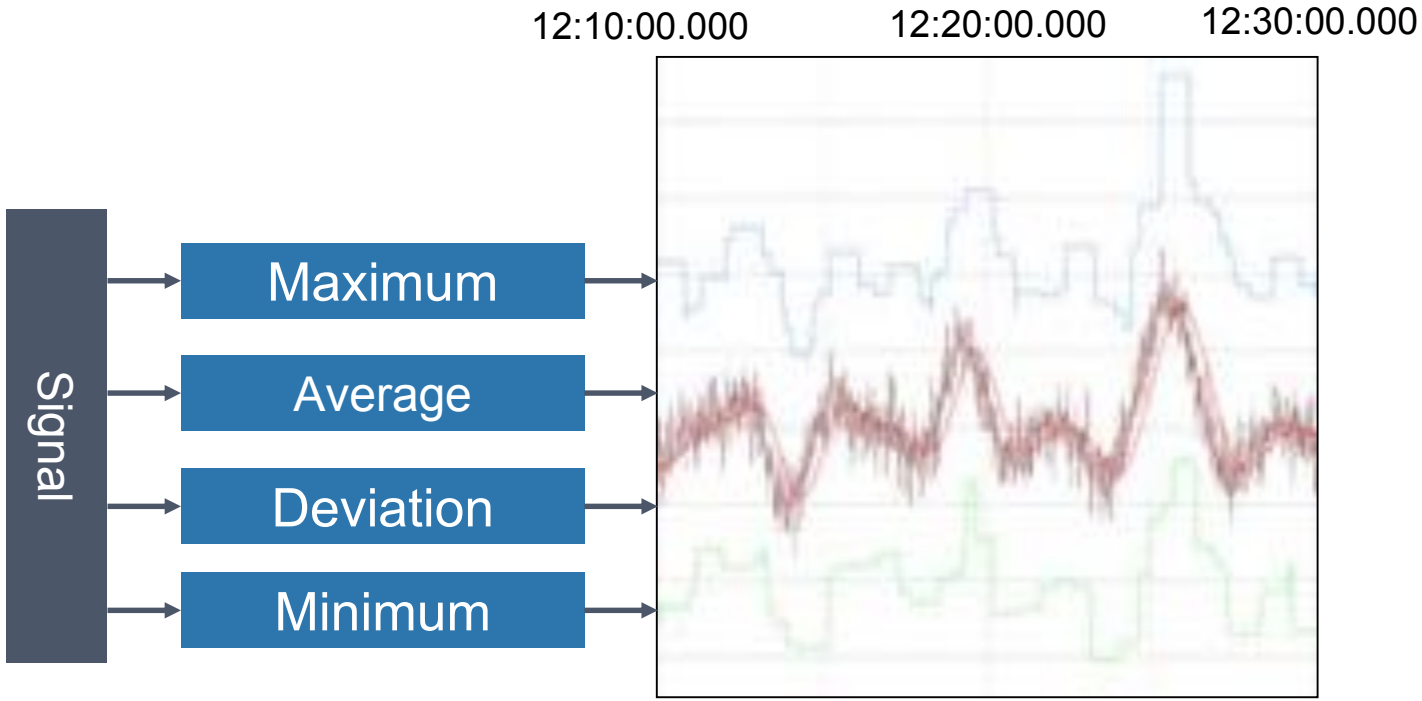
- Mean calculation, long-term evaluation
- Statistical treatment of signals
- Computation of arithmetic, root mean square, …
- Free configuration of mean computation steps
- Free configuration of storage intervals
- Simultaneous storage cycles



# TcFlexMeter / TcWind – Capture

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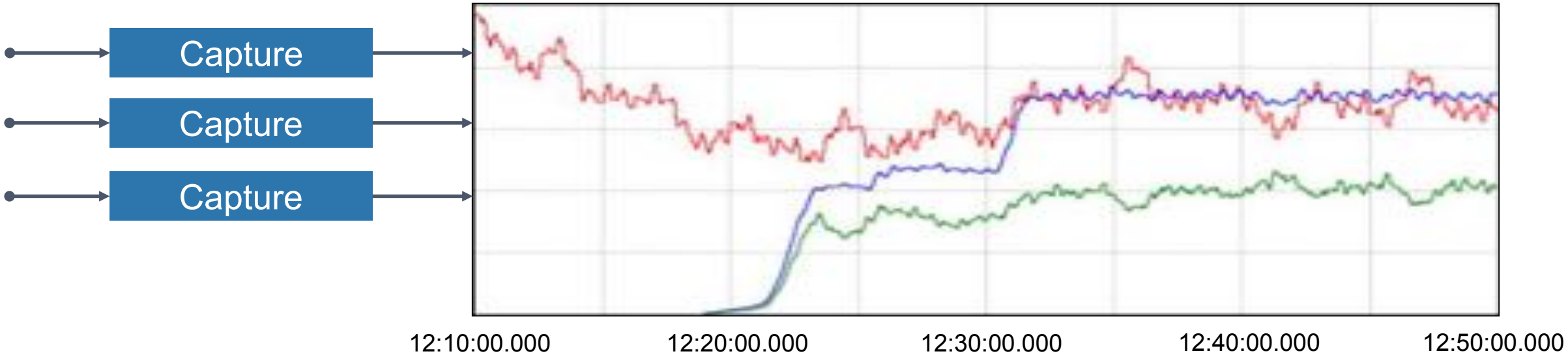
- Capturing of process signals
- RAW scaled values
- Continuous long-term recording and storage
- Storing digital, analog, cyclically, on change, …
- Count and time chronology
- Simultaneous storage cycles



# Datastorage

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# TcFlexMeter / TcWind database

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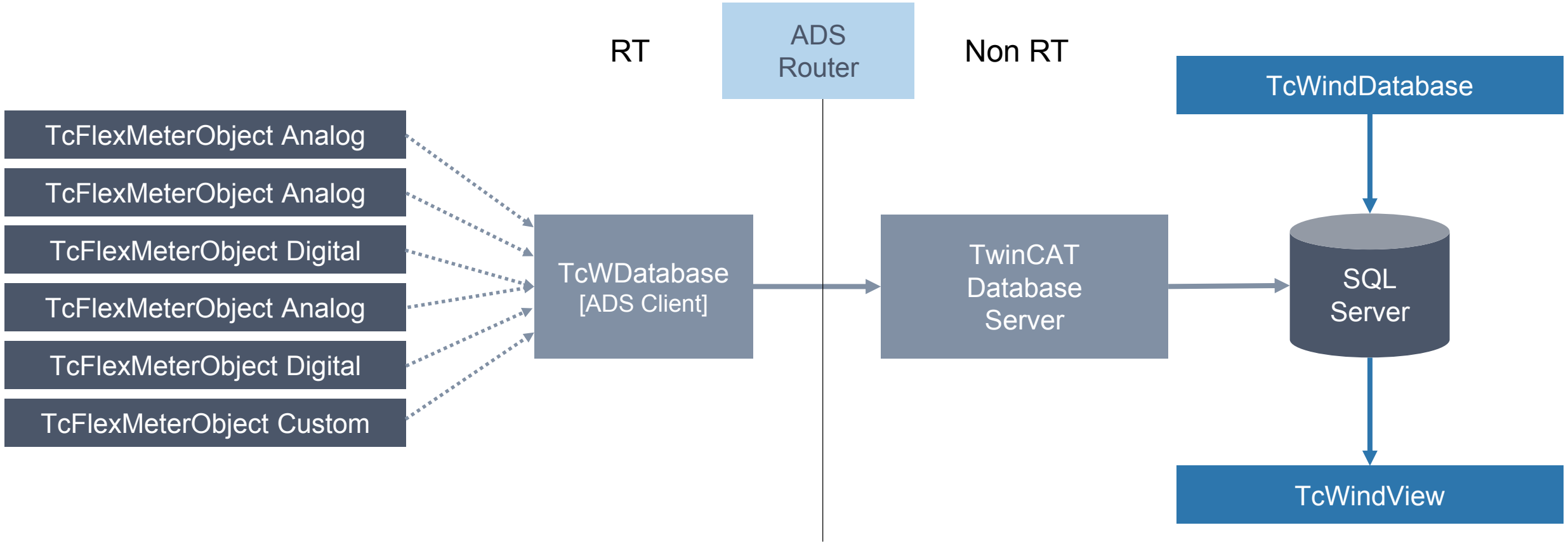

# TcFlexMeter / TcWind – Data Warehouse by merge procedures

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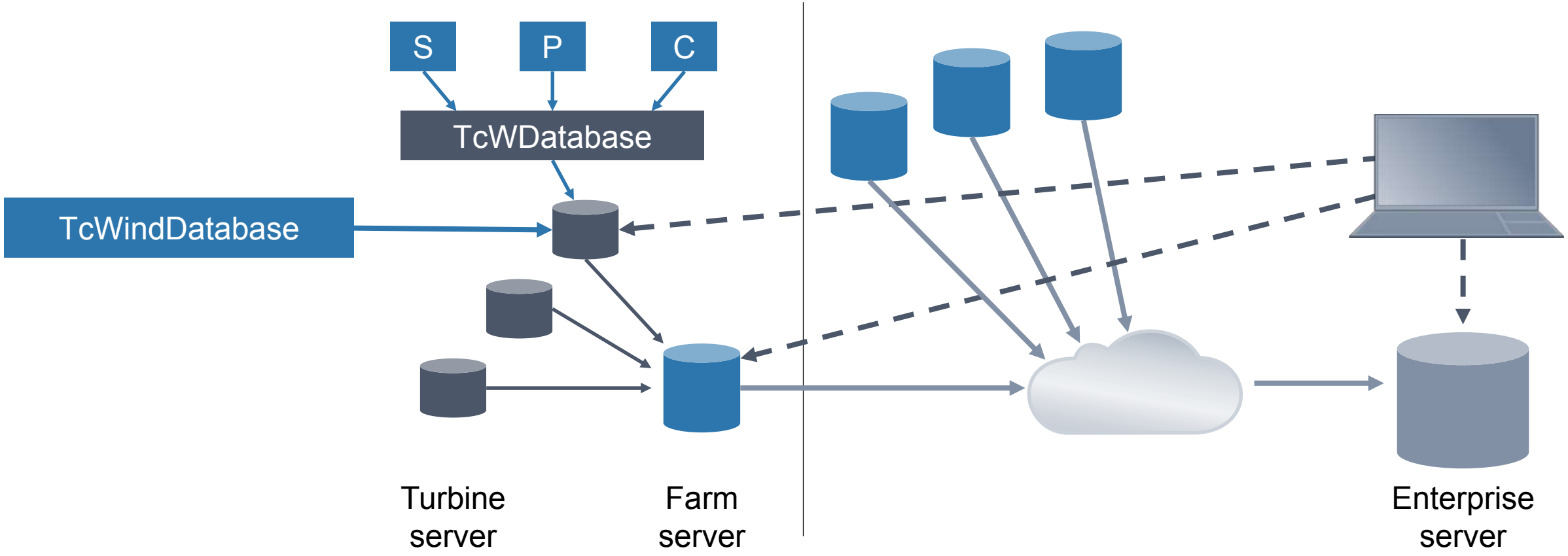


Congregate data from multiple sources into a single database so a single query engine can be used to present data.
(https://en.wikipedia.org/wiki/Data_Warehouse)

# Extensibility

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# Plugin System

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Base Application

TcFlexMeter Configurator

TwinCAT 3.1 XAE

Extensions

Driver
Analog Standard

Driver
Analog ELM

Driver
Digital Standard

Driver
etc…

Driver
etc…

Driver

*.dll
Layout of options

*.xml
Supported terminals

TcCom
RT data acquisition

# Data Calculation Chain – Extensions

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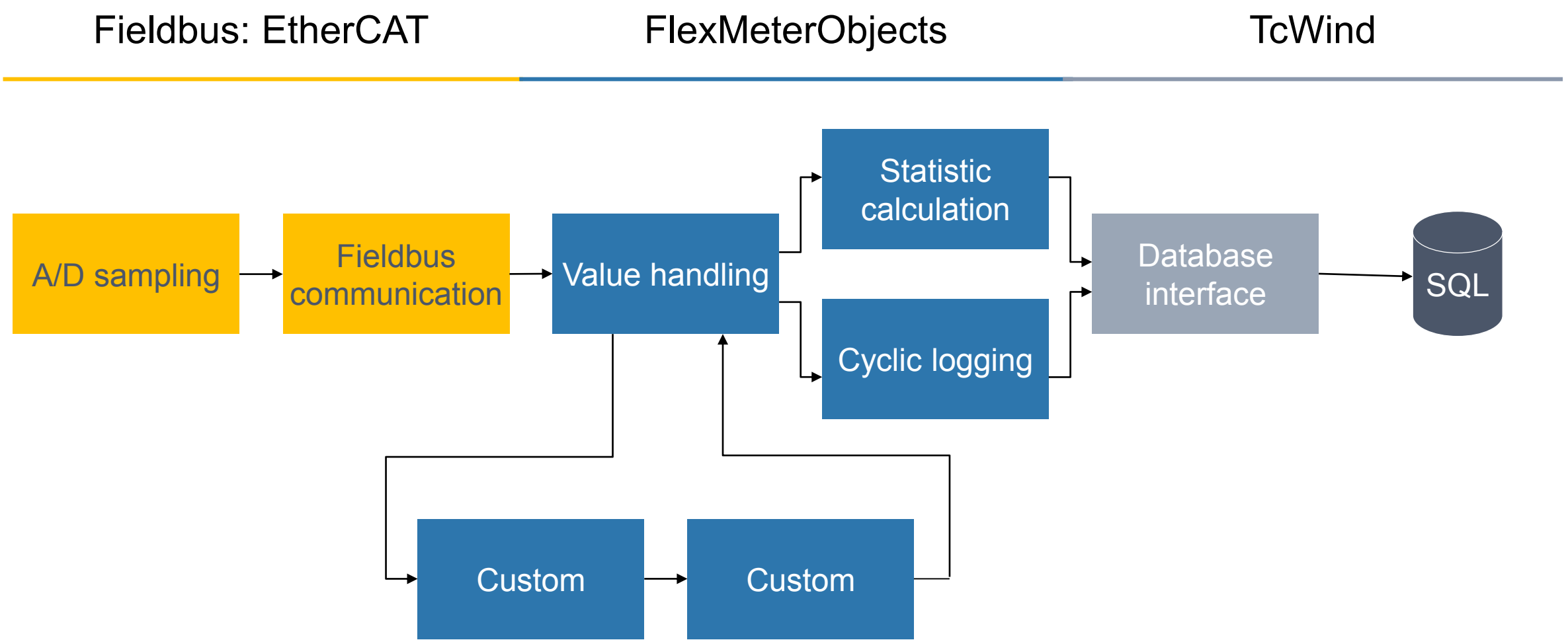

# Plugin System – Dependency

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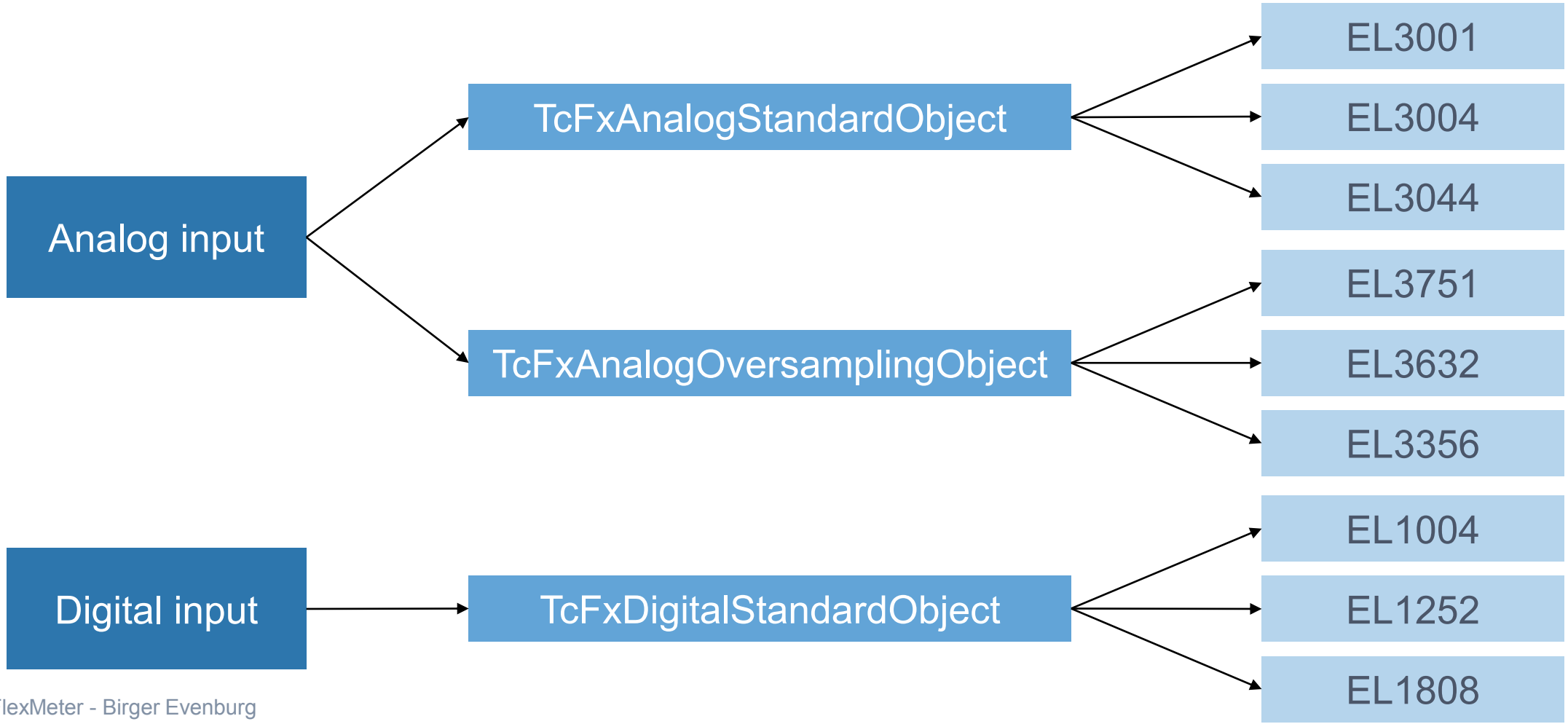
Configurator Plugin (.dll) | TcFlexMeterObject (.sys / TcCom) | Terminal (.xml)



# Components

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# Plugin System – DLL

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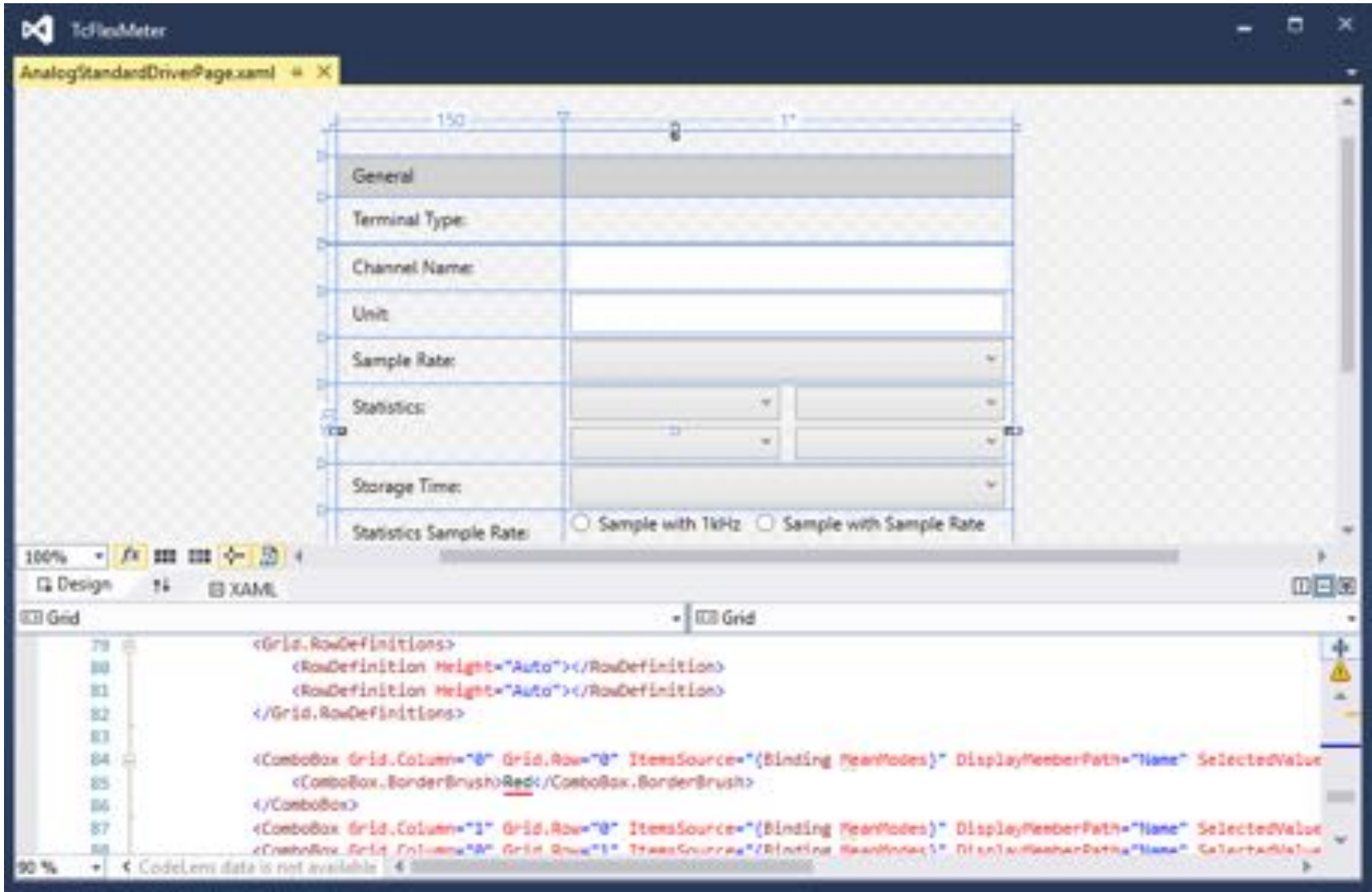
- Layout for driver depended options
- Logic for TwinCAT 3.1 configuration
- Collect user inputs



# Plugin System – xml

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- Link between terminal and TcComObject
- Define terminal revisions
- Mapping information
- CoE information

→New Terminal can be added in XML

```
<Drivers>
  <Driver Name="Analog Standard">
    <Channels>1</Channels>
    <GUID>70012bf5-71e5-404c-b82d-d6d14eec9bba</GUID>
    <PlugInPath />
    <TerminalTemplates>
      <TerminalTemplate Name="EL3751">
        <Channels>1</Channels>
        <TerminalDescription VendorId="2" ProductCode="245837906" Revision="1376256" />
        <OversamplingFactors>
        <LinkTemplates>
          <LinkTemplate>
            <Link1>PAI Samples 1^Samples[{0}]</Link1>
            <Link2>Inputs^Input[{0}]</Link2>
          </LinkTemplate>
          <LinkTemplate>
          <LinkTemplate>
          <LinkTemplate>
        </LinkTemplates>
        <CoEDefaultOptions>
          <CoEDefaultOption Name="TerminalFactoryReset">
            <CoEIndex>4113</CoEIndex>
            <CoESubIndex>1</CoESubIndex>
            <CoEEntry Name="Reset Code" Value="1684107116" />
          </CoEDefaultOption>
        </CoEDefaultOptions>
        <CoEUserOptions>
          <CoEUserOption Name="Interface">
            <CoEIndex>32768</CoEIndex>
```

# Plugin System – TcCom

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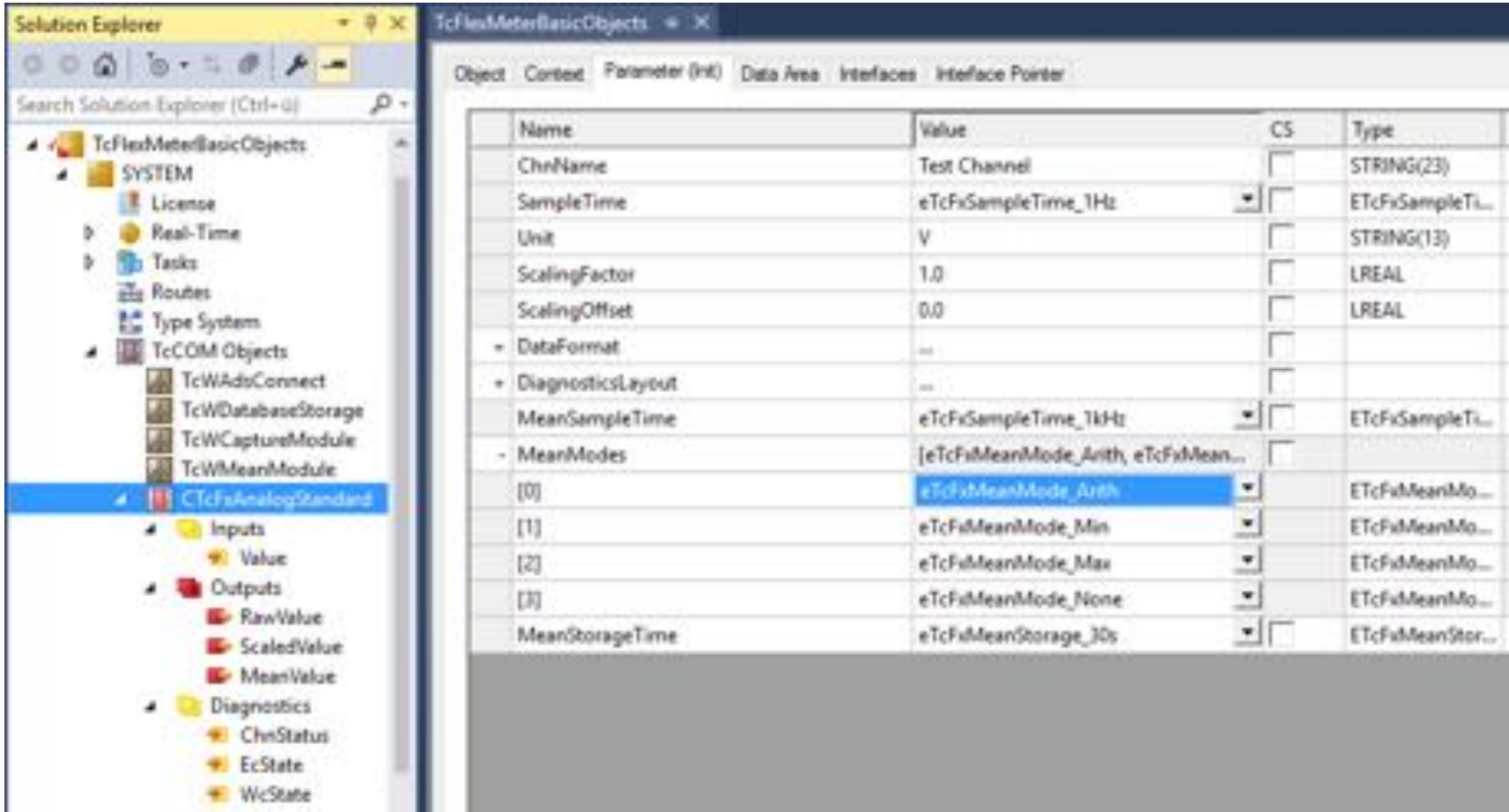
- Configuration with parameter
- Data processing logic in C++
- No code generation while configuration process
- Integration in automation project possible



# Questions?

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# Contact

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