EtherCAT® Product Family

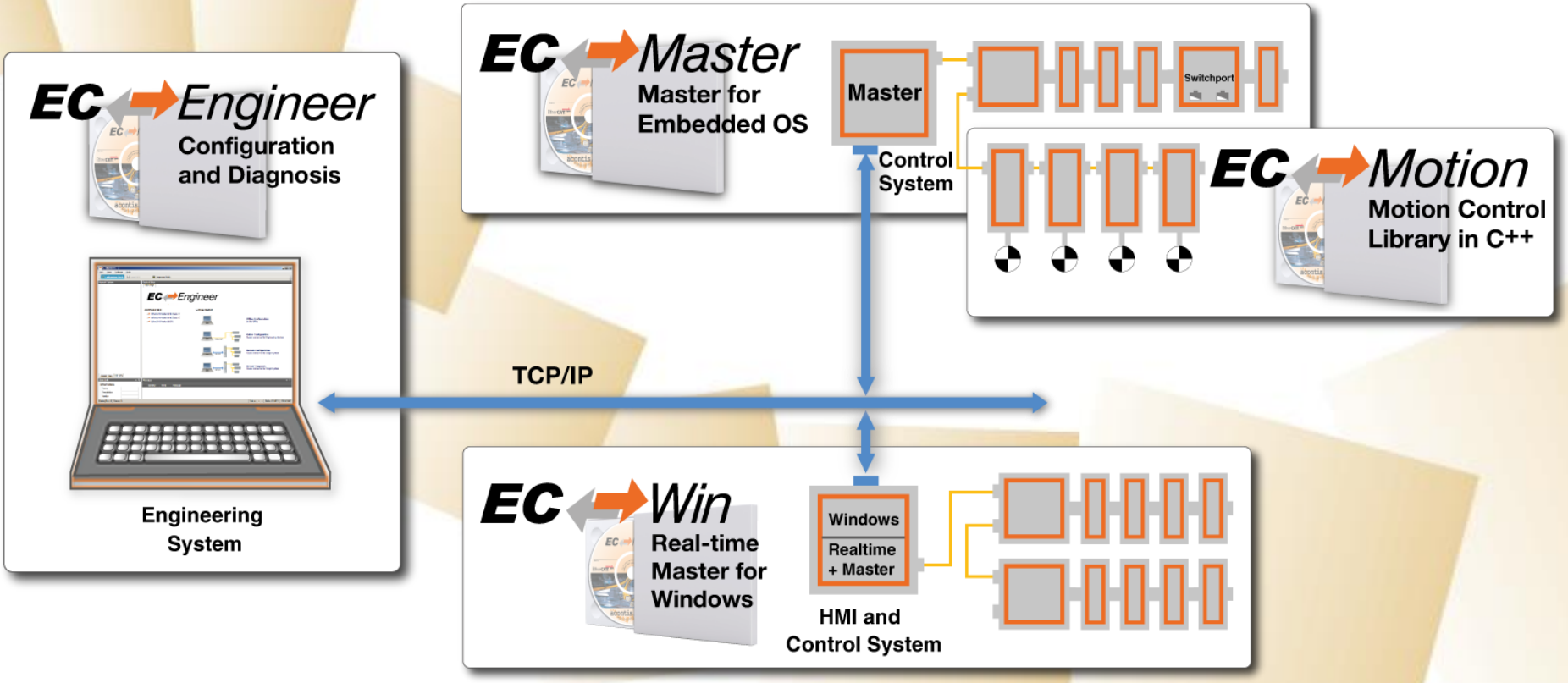
EtherCAT® Master Stack

EtherCAT® Configuration and Diagnosis Tools

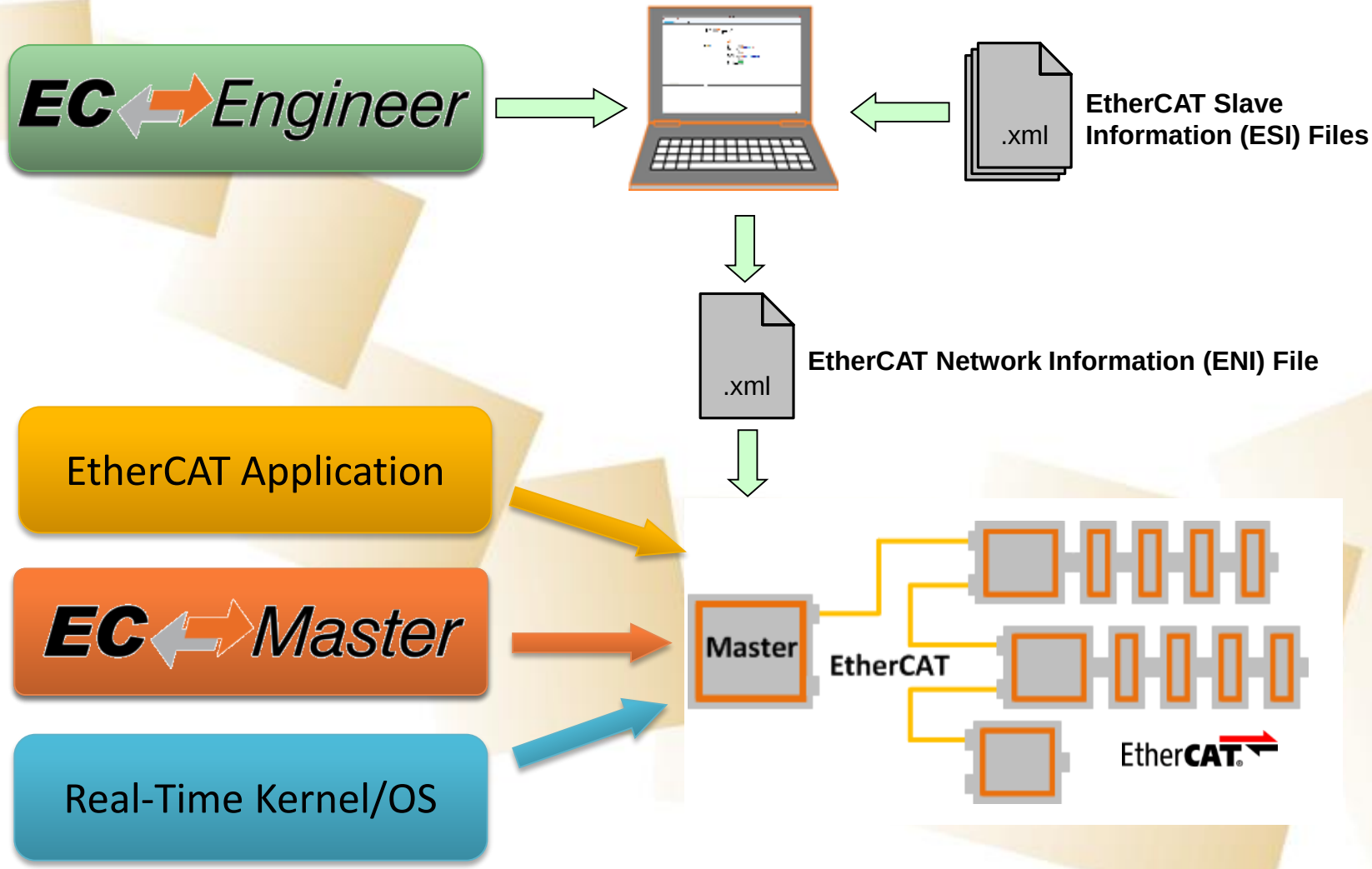
Windows EtherCAT® Real-Time Platform

Sales Presentation

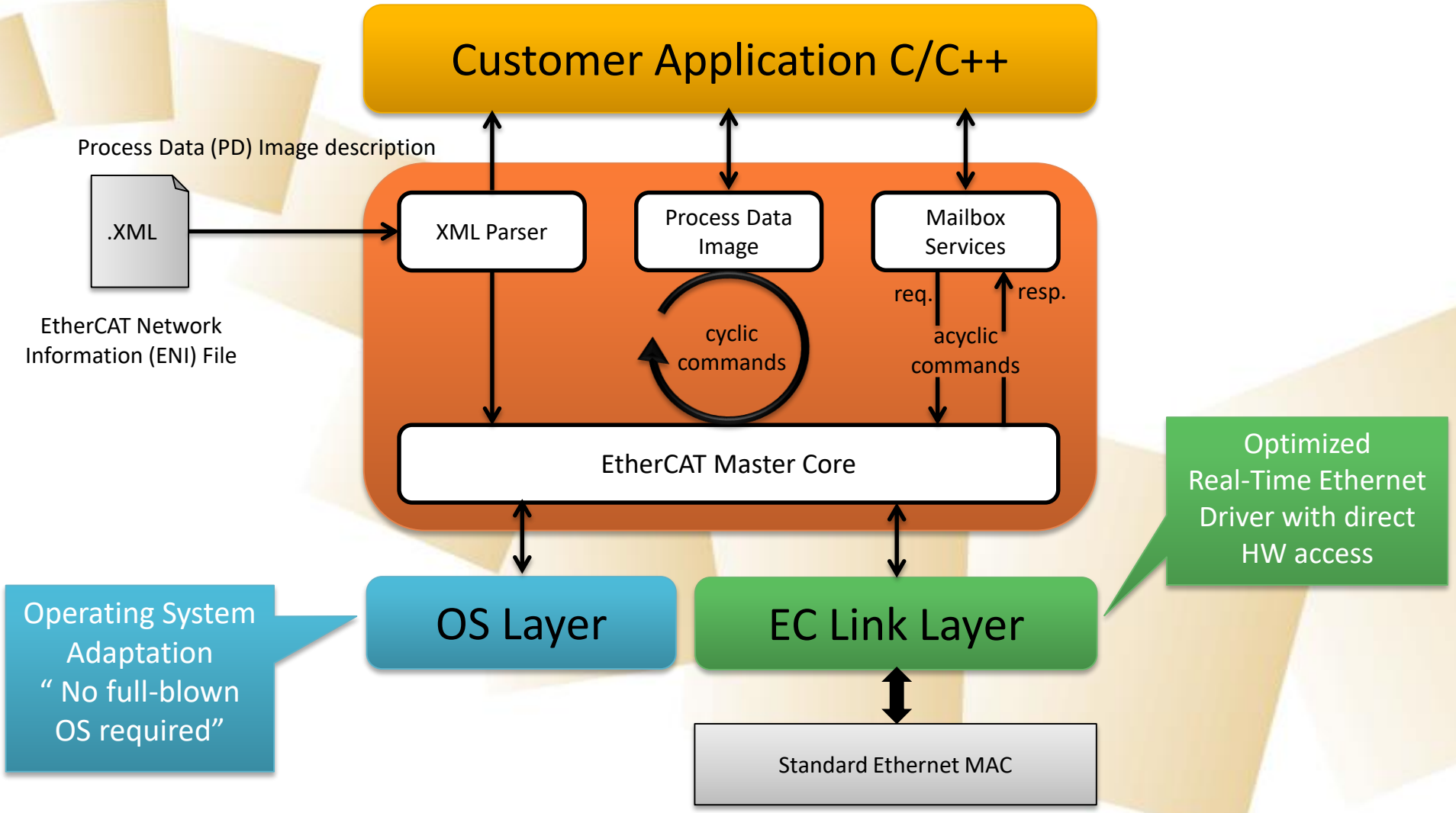
EtherCAT® Product Family



EtherCAT System Architecture



EC-Master Architecture



EC-Master SDK – Out of the box for 32-Bit Platforms

EC Master

OS Layers

Windows 10

VxWorks®
WIND RIVER

QNX

Xenomai

On Time
REAL-TIME AND SYSTEM SOFTWARE

RTX
IntervalZero

TI-RTOS

Embedded With RTEMS
www.rtems.org

INTEGRITY

INtime

µC/OS-III®
The Real-Time Kernel

T-Kernel 2.0

x86 | ARM | PowerPC

EC Link Layer

Intel Pro/1000	Xilinx GEM
Realtek Gigabit	Freescale FEC, eTSEC
Renesas RZ Family	TI Sitara CPSW, ICSS-PRU
Altera Cyclone V	SMSC 9218
Beckhoff CCAT	and more

EC-Master SDK – Out of the box for 64-Bit Platforms

OS Layers

Windows 10

VxWorks®
WIND RIVER

RTX
IntervalZero

x64

EC Link Layer

- Intel Pro/1000
- Beckhoff CCAT
- Realtek Gigabit

EC-Master: Building Blocks

EC Master

EC-Master according to ETG.1500 Master Classes Directive

Class A Core

- Compare network configuration
- Cyclic process data exchange
- All mailbox protocols: CoE, SoE, EoE, FoE, AoE, VoE
- Slave to slave communication
- **Distributed Clocks with master synchronization**

Class B Core

- Compare network configuration
- Cyclic process data exchange
- Mailbox protocol CoE
- Mailbox protocol SoE
- Mailbox protocol EoE
- Slave to slave communication

Feature Pack
Cable Redundancy

Feature Pack
Hot Connect

Feature Pack
Remote Access

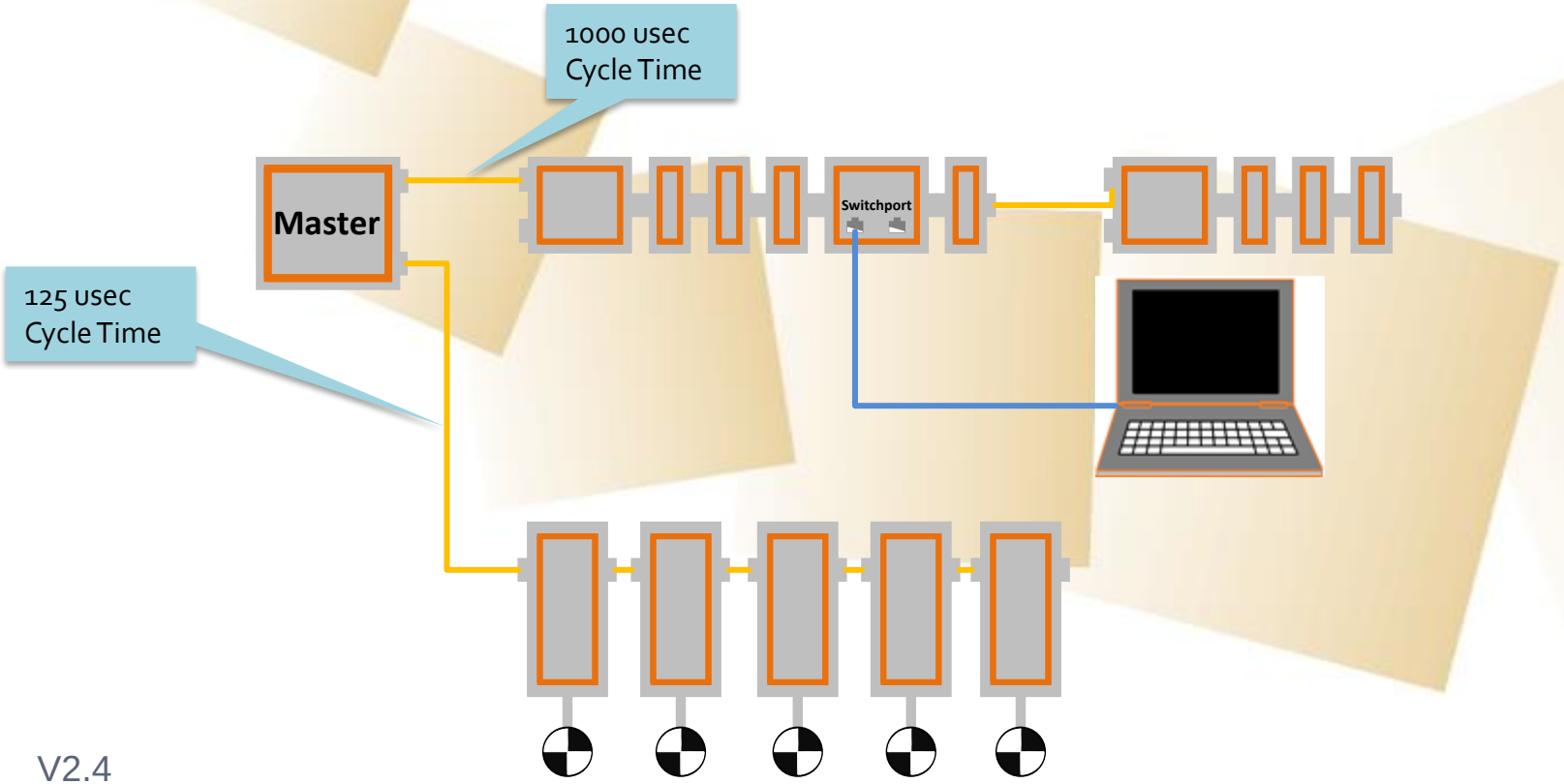
Feature Pack
Superset ENI

Feature Pack
EoE Endpoint

Feature Pack
Master Obj. Dict.

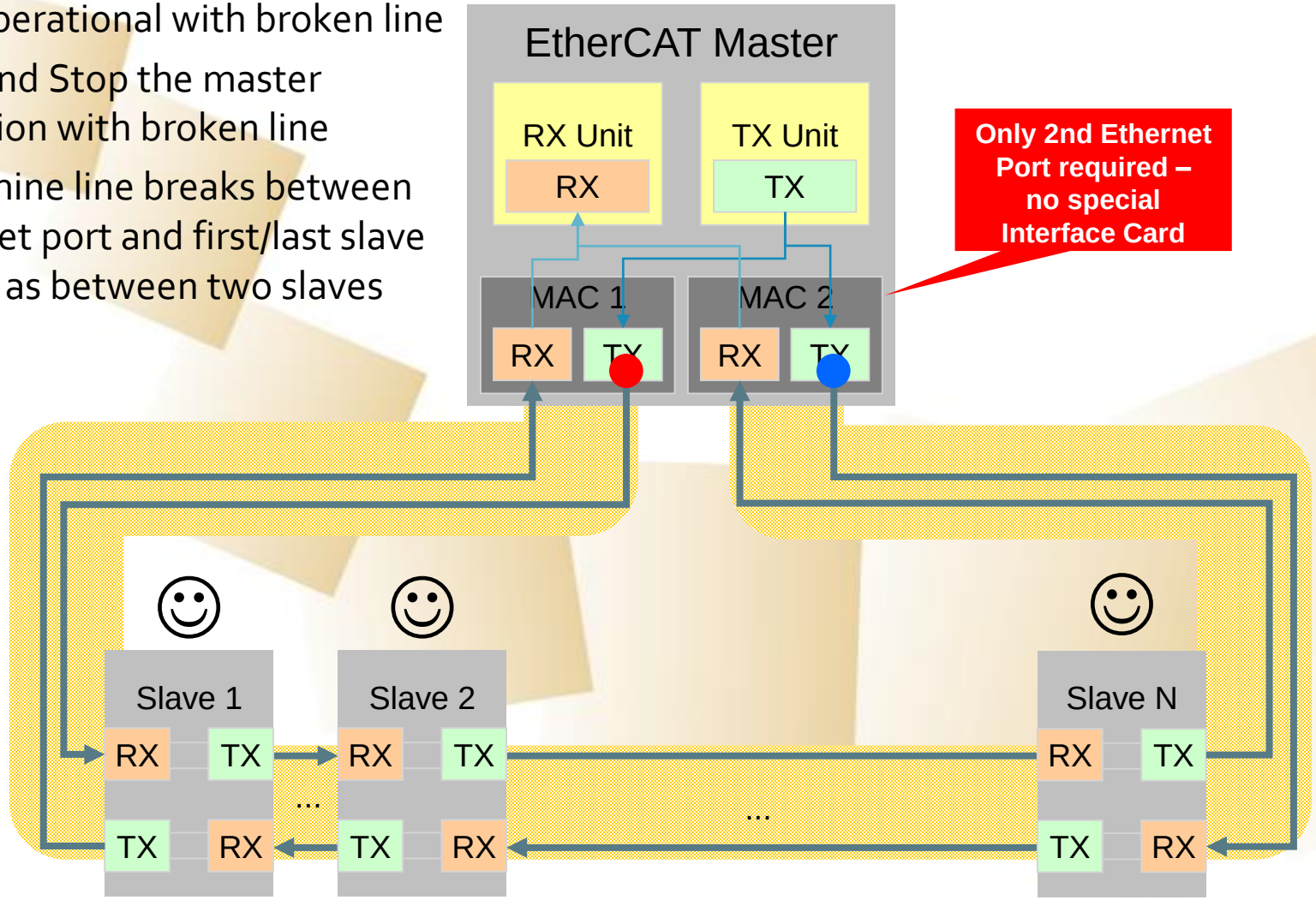
Multiple Networks (instances)

- Use Case: Control more than one EtherCAT network with one system, e. g.,
  - Network 1 (NIC 1) is used for I/O bus system
  - Network 2 (NIC 2) is used for high speed motion (drives)
- Fully independent configuration and operation
- Identical or different link layers, up to 10 networks
- Available for Class A and Class B



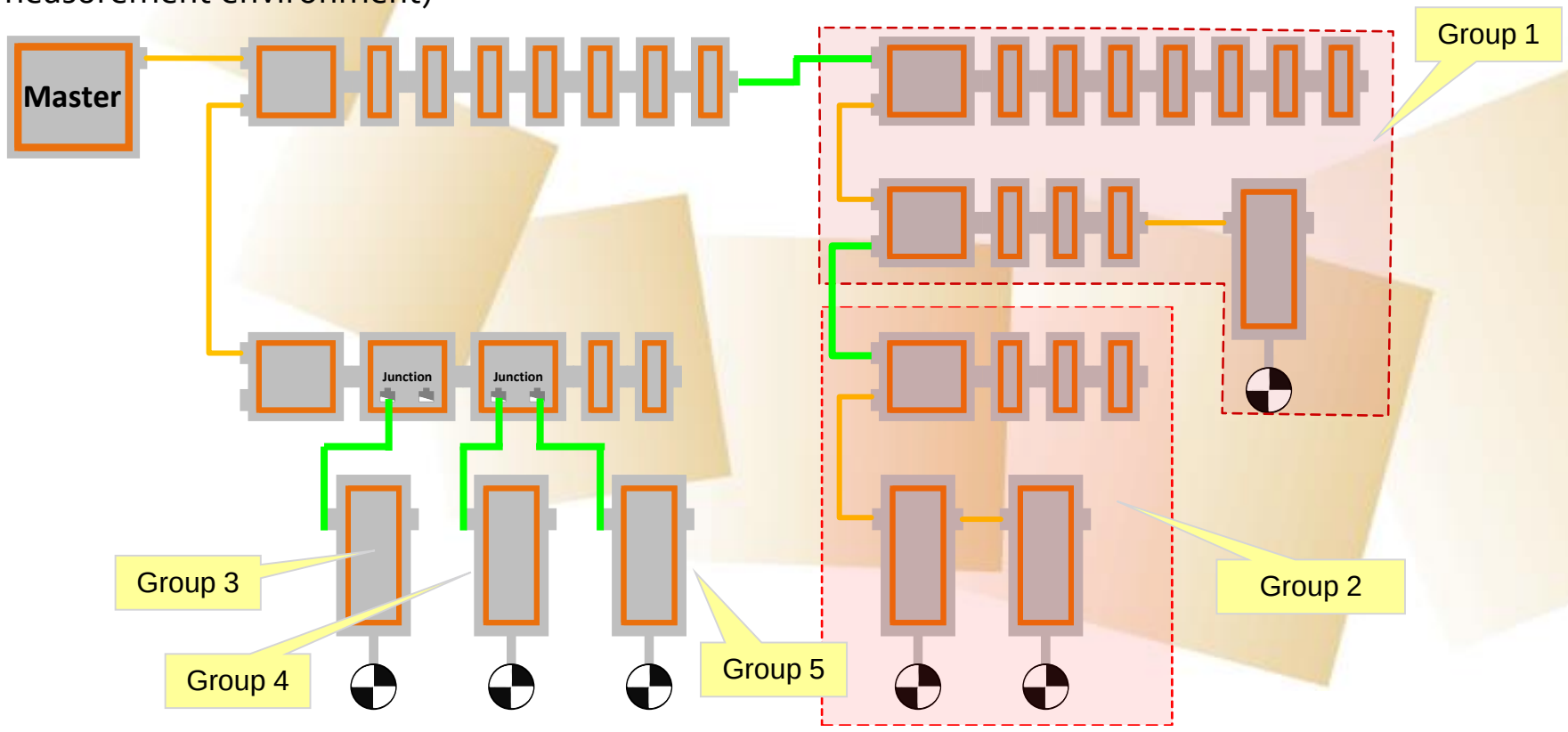
Feature Pack: Cable Redundancy

- Stay operational with broken line
- Start and Stop the master operation with broken line
- Determine line breaks between Ethernet port and first/last slave as well as between two slaves



Feature Pack: Hot Connect

- Setting up a complex control system, while parts of the system are not available, powered-off or disconnected.
- Flexibility within the wiring: slaves can be connected to different ports (e.g. analogue to CAN)
- Running a system that consists of mandatory as well as optional devices (e.g. in a test & measurement environment)



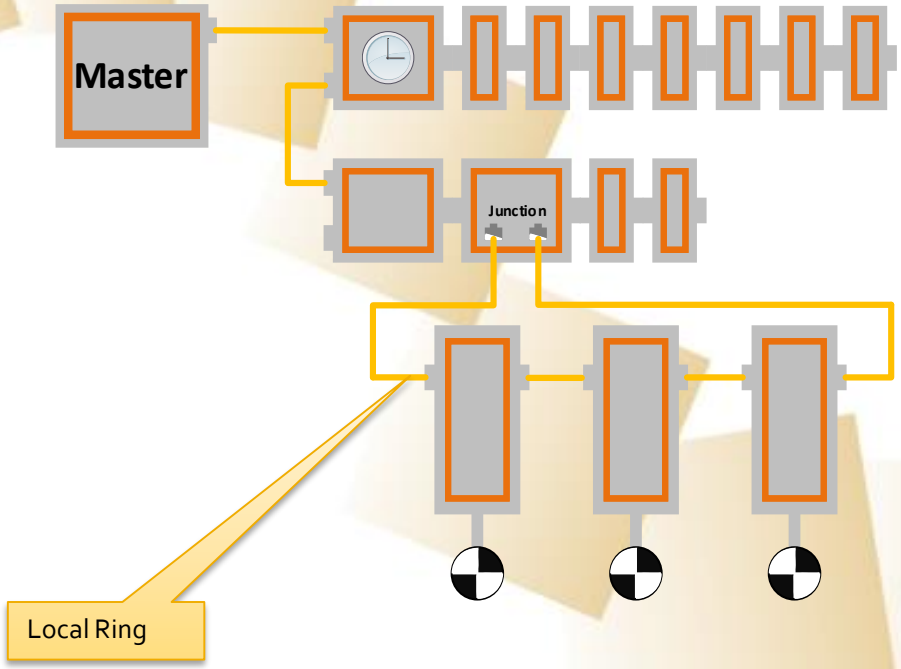
Feature Pack: Hot Connect

Functionality:

- Add or remove additional slave devices
- Differentiation of Mandatory and optional slaves
- No wrong slaves must be connected (e.g. wrong address). If a wrong slave is connected, the network stub must been cut-off at this point by the master application.
- Network can be transferred to operational state if slaves are missing which are marked as optional.
- Network may remain operational if an optional slave fails
- The network information file (ENI) contains all slaves. (Optional slave nodes may be marked there.)
- The network has to be configured in a way that all possible slaves are connected simultaneously, even if not all slaves can be connected at once.
- The cyclic commands contain the data for all slaves.

Junction Redundancy

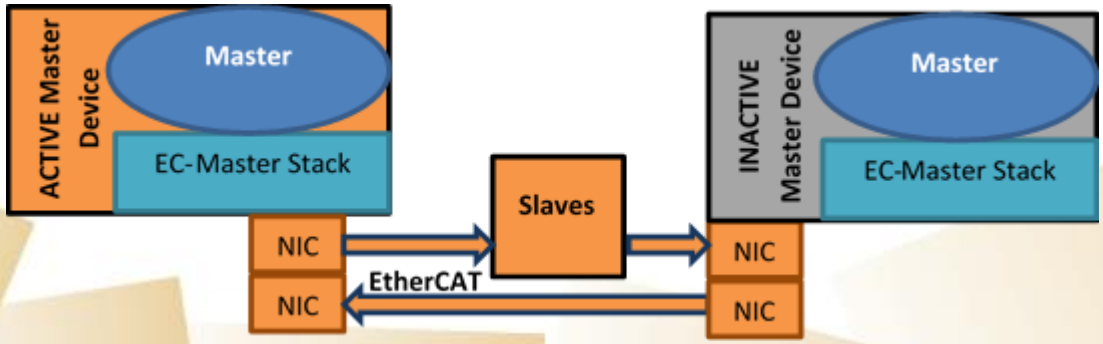
- Support Junction Redundancy with Distributed Clocks



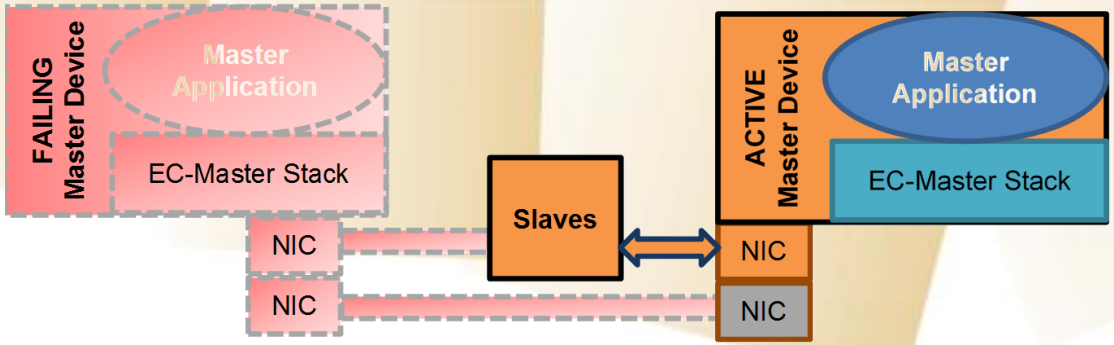
- Create local ring cable redundancy using junction devices
- Stay operational in case of a break in the local ring
- Multiple local rings supported

Feature Pack: Master Redundancy

- Cable Redundancy
  - hot plugging (or removal) of additional slaves is possible
  - Cable break: all devices are still able to work
- Hot Standby
  - inactive master takes over active master activity, devices stay in operation



- Failover: The Backup Master takes over



Feature Pack: Master Object Dictionary (1)

EC Master

- According to Modular Device Profile (MDP) Profile Number 1100
- Use Case: Application requires to access information about
  - Slaves in configuration file, slaves detected on network
  - Number of sent/received frames, slave status, …

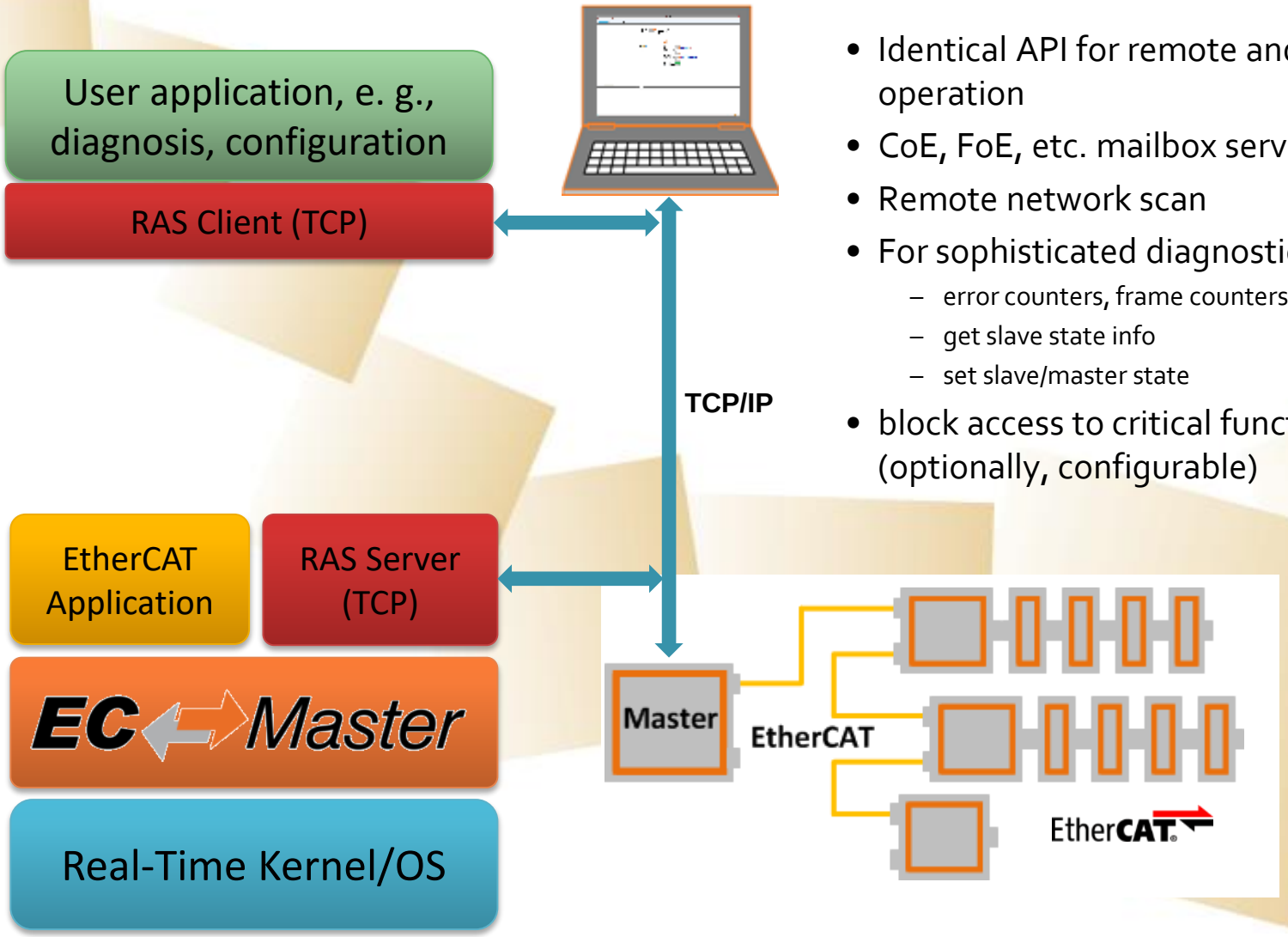
Index (hex)	Object Dictionary Area
0x0000-0x0FFF	Data Type Area
0x1000-0x1FFF	Communication Area
0x8000-0x8FFF	Configuration Area (Expected configuration of the EtherCAT slaves)
0x9000-0x9FFF	Information Area (Detected configuration of the EtherCAT slaves)
0xA000-0xAFFF	Diagnosis Area (Diagnosis of the EtherCAT slaves)
0xF000-0xFFFF	Device Area

Feature Pack: Master Object Dictionary (2) Information Data

EC Master

Index	SubIndex	Name	Data Type	Access	Description
0x9000	1	Fixed Station Address	UINT16	RO	Fixed Station Address of the first EtherCAT Slave found (same value as 0xF040:01)
	5	Vendor ID	UINT32	RO	Vendor ID of the first EtherCAT Slave found (entry 0x1018:01 of the EtherCAT slave)
	6	Product Code	UINT32	RO	Product Code of the first EtherCAT Slave found (entry 0x1018:02 of the EtherCAT slave)
	7	Revision	UINT32	RO	Revision of the first EtherCAT Slave found (entry 0x1018:03 of the EtherCAT slave)
	8	Revision	UINT32	RO	Revision of the first EtherCAT Slave found (entry 0x1018:04 of the EtherCAT slave)
	32	DL Status	UINT16	RO	DL Status (Register 0x110-0x111) of the first EtherCAT found
0x9001	1	Fixed Station Address	UINT16	RO	Fixed Station Address of the second EtherCAT Slave found (same value as 0xF040:02)
...		...			

Feature Pack: Remote Access - Overview



- Identical API for remote and local operation
- CoE, FoE, etc. mailbox services
- Remote network scan
- For sophisticated diagnostics
  - error counters, frame counters (OD)
  - get slave state info
  - set slave/master state
- block access to critical function calls (optionally, configurable)

Feature Pack: Remote Access – Use Cases

EC Master

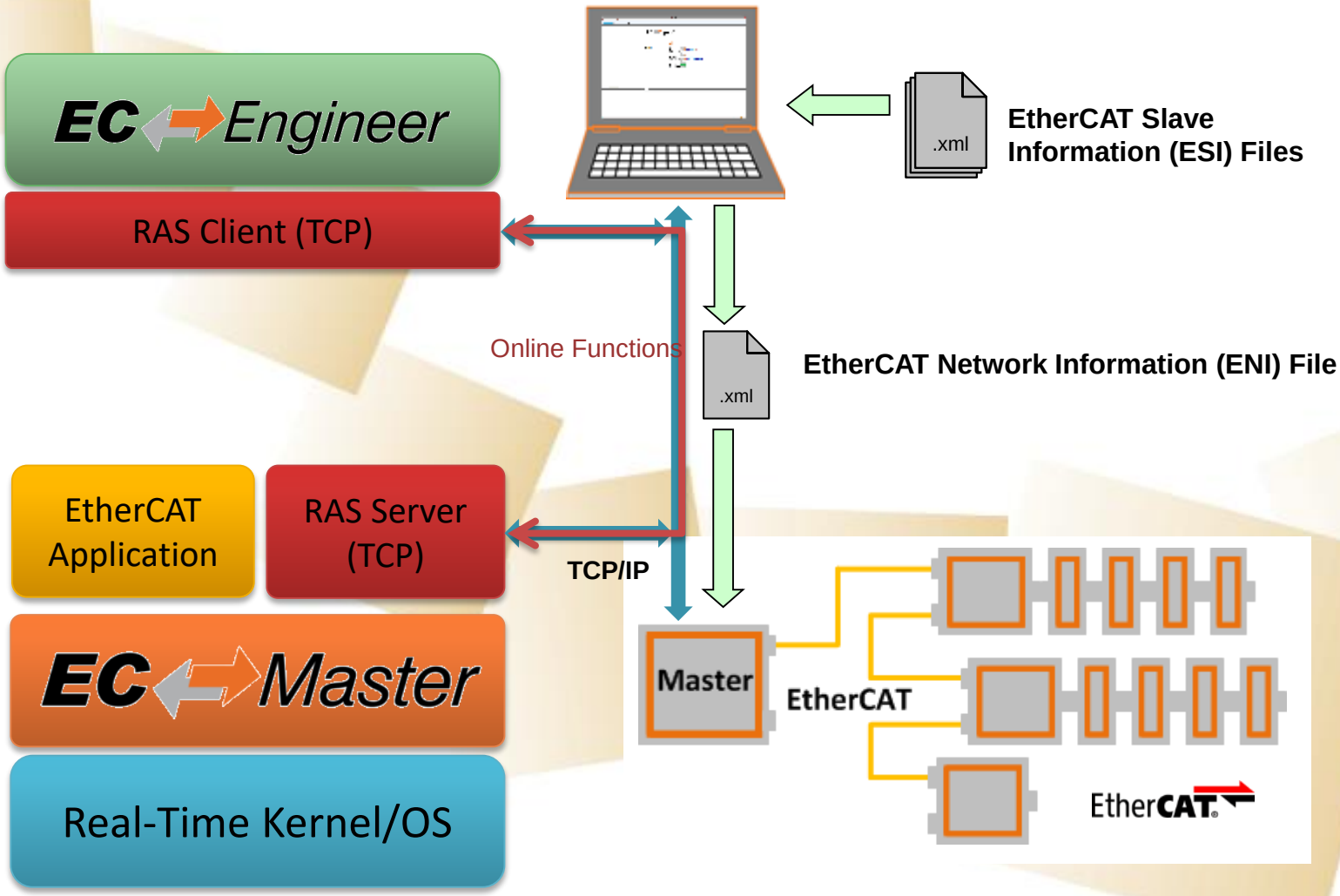
- Access EC-Master (use the API calls) from a remote system
  - Example: Access EC-Master which is running in VxWorks control system from a Notebook that is running Windows XP (e.g. read master or slave status)
- Access EC-Master (use the API calls) from a second Windows process or executable
  - Example: Access EC-Master which is running inside a Windows CE controller process (control.exe) from a second Windows CE diagnostics process (diag.exe)
- Very useful in combination with the Master Object Dictionary feature pack for diagnostics

Key benefits

- Out-of-the-box for the most popular operating systems
  → Get it running on your system in one day!
- High scalability
  → small footprint embedded systems: remove features
  → high end systems: all ETG.1500 features available
- Reliable and robust implementation
  → Field proven in several 10000 systems!
- Sophisticated diagnosis functions
  → Detect state change problems and frame loss errors easily
- High performance and hard real-time
  → Low CPU load due to optimized link layers
- Easy to integrate
  → Various example applications and comprehensive user manuals
- No runtime license activation required
  → License sticker

ETHERCAT CONFIGURATION AND DIAGNOSIS TOOL

EtherCAT System Architecture

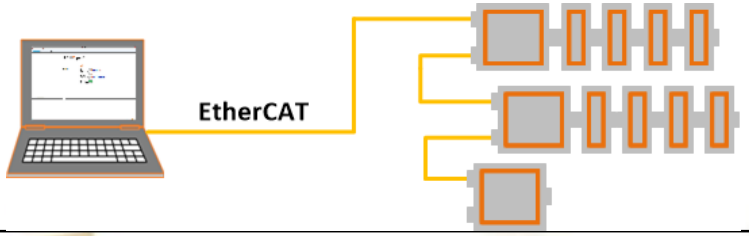


Operating Modes

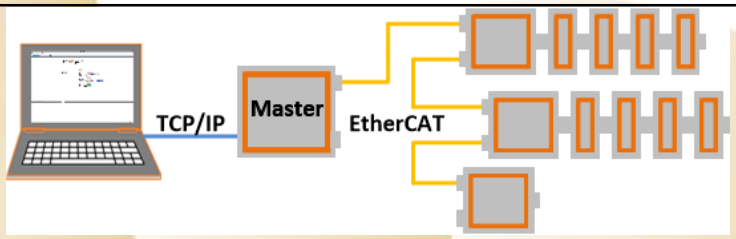
EC Engineer

*Offline **Configuration**:*
(In the Office)

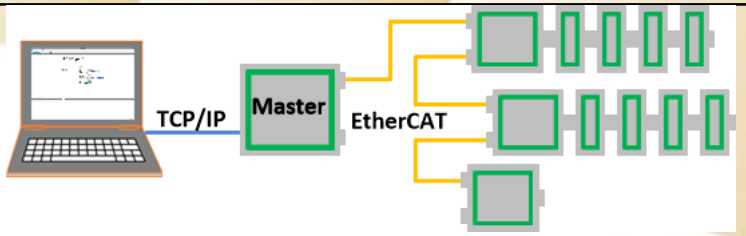
*Online **Configuration**:*
Slaves connected to
Engineering System



*Remote **Configuration**:*
Slaves connected to
Target System

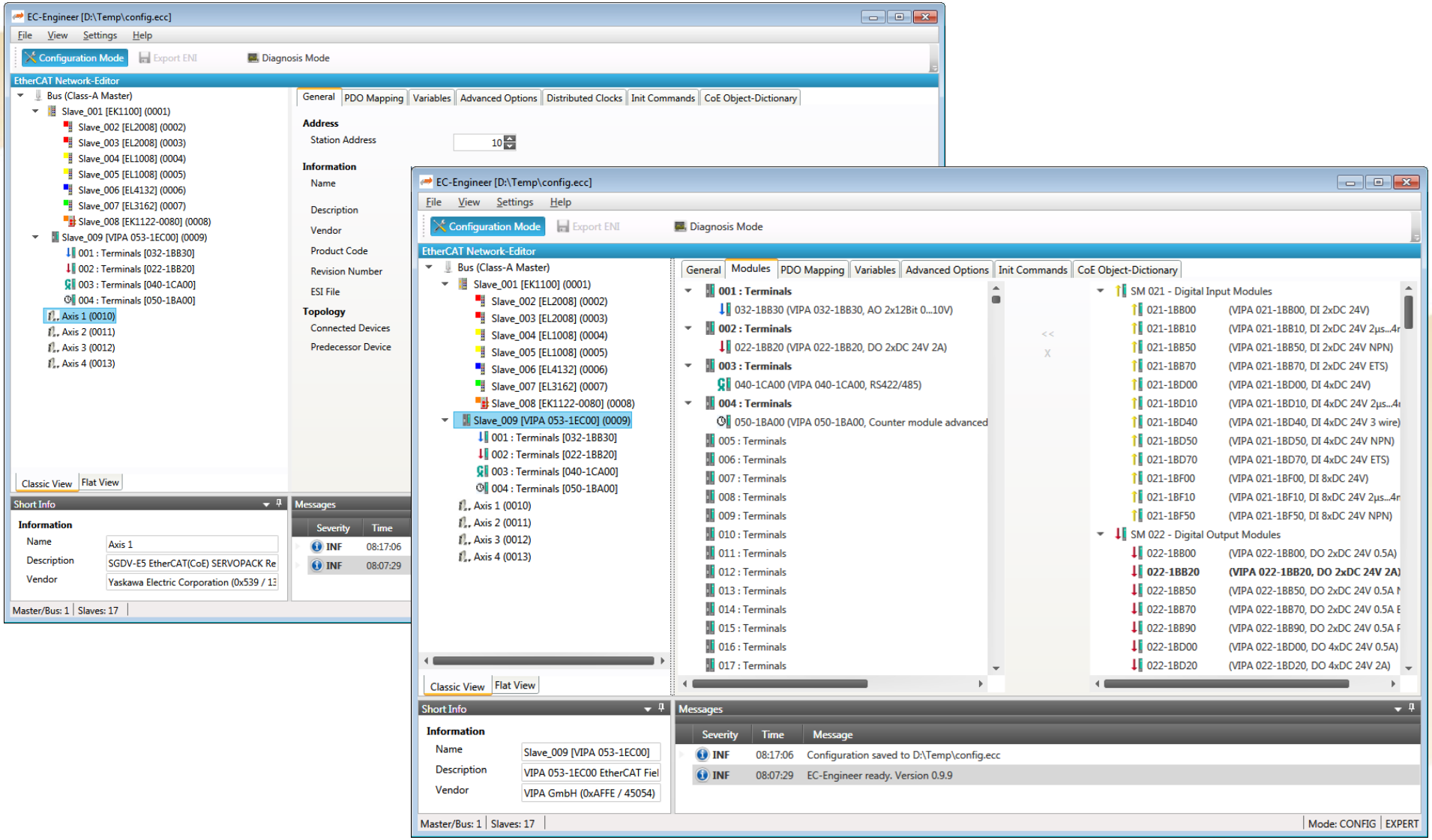


*Remote **Diagnosis**:*
Slaves connected to
Target System



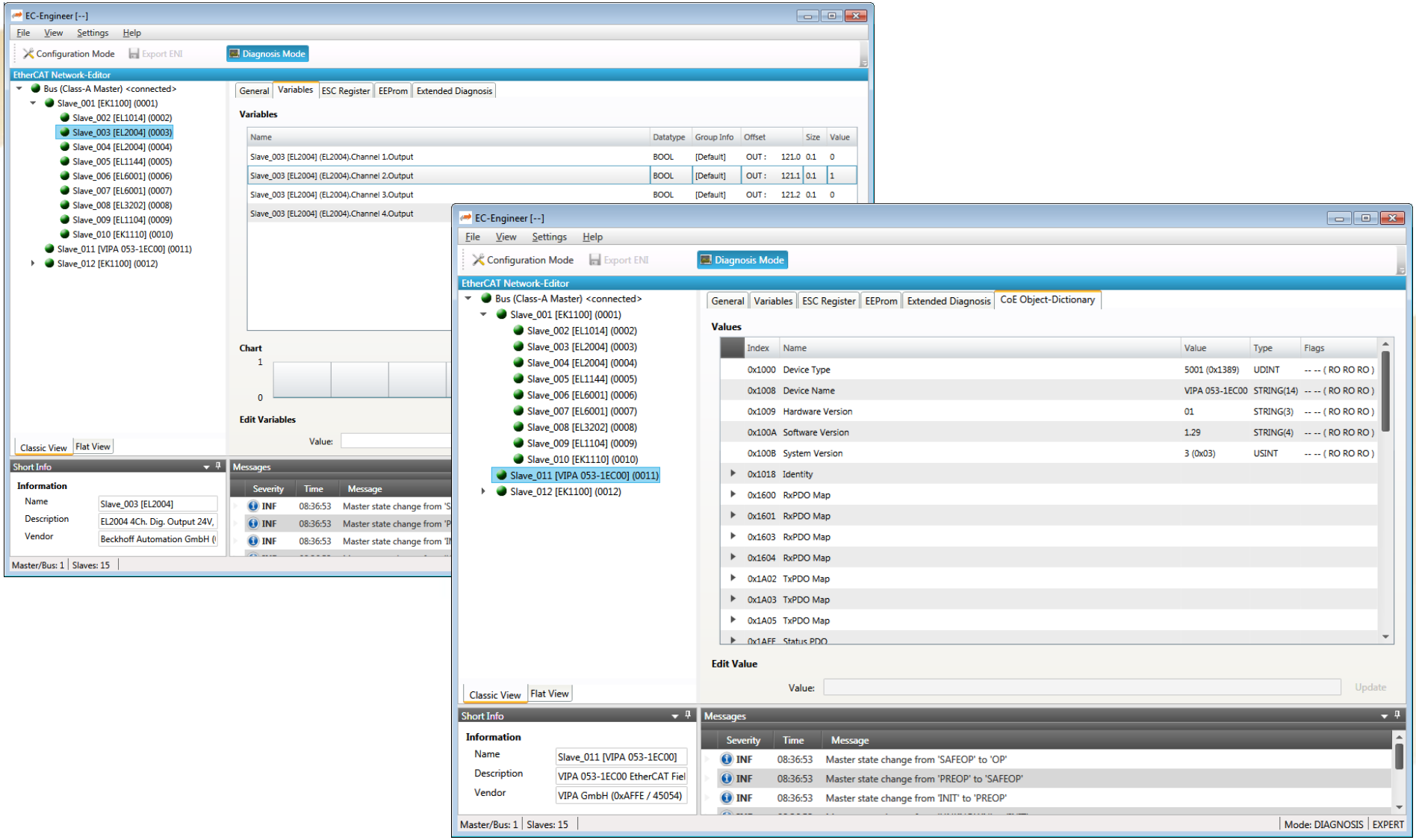
Build an configuration in less steps

EC Engineer

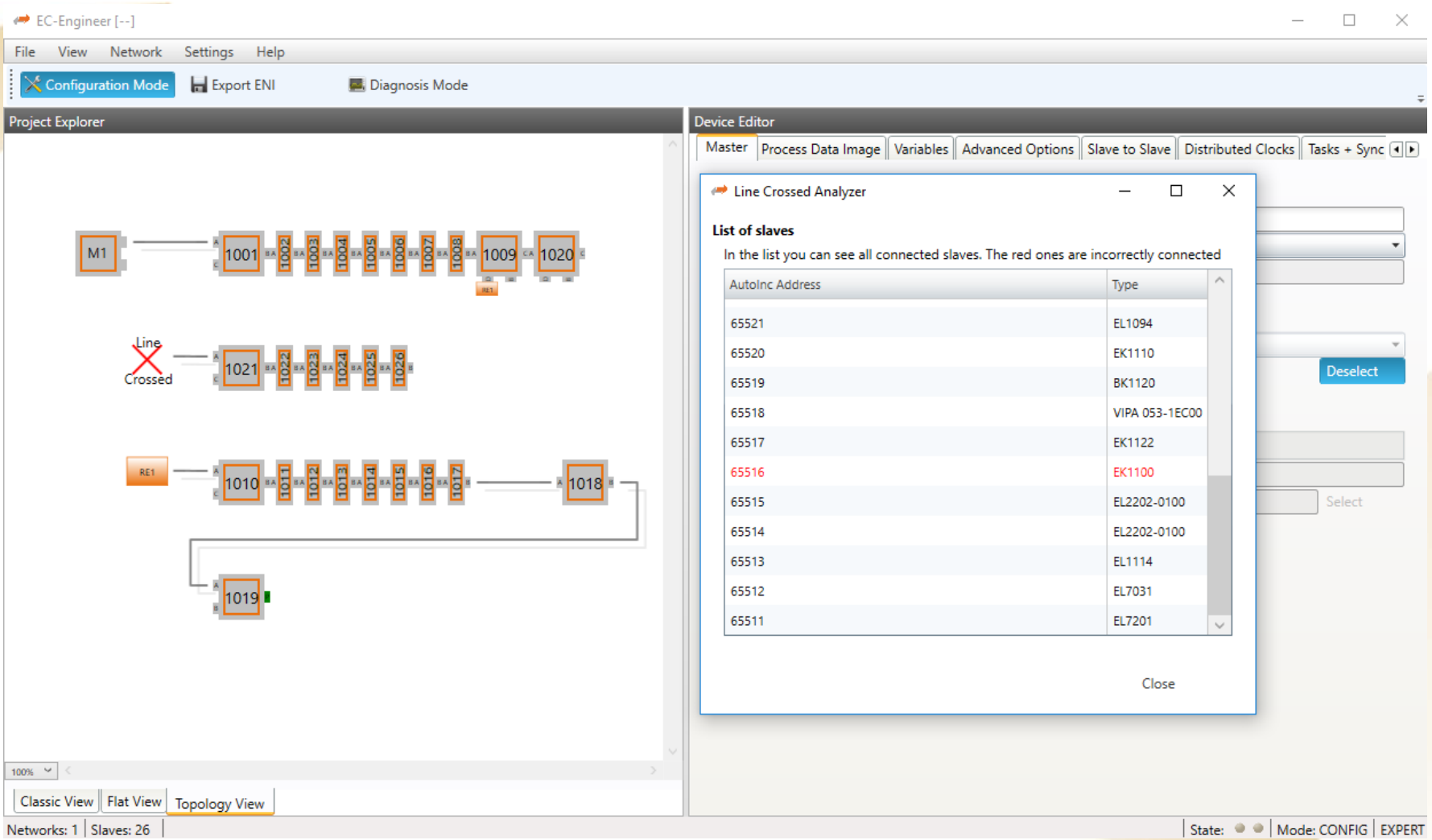


Comprehensive diagnostic

EC Engineer

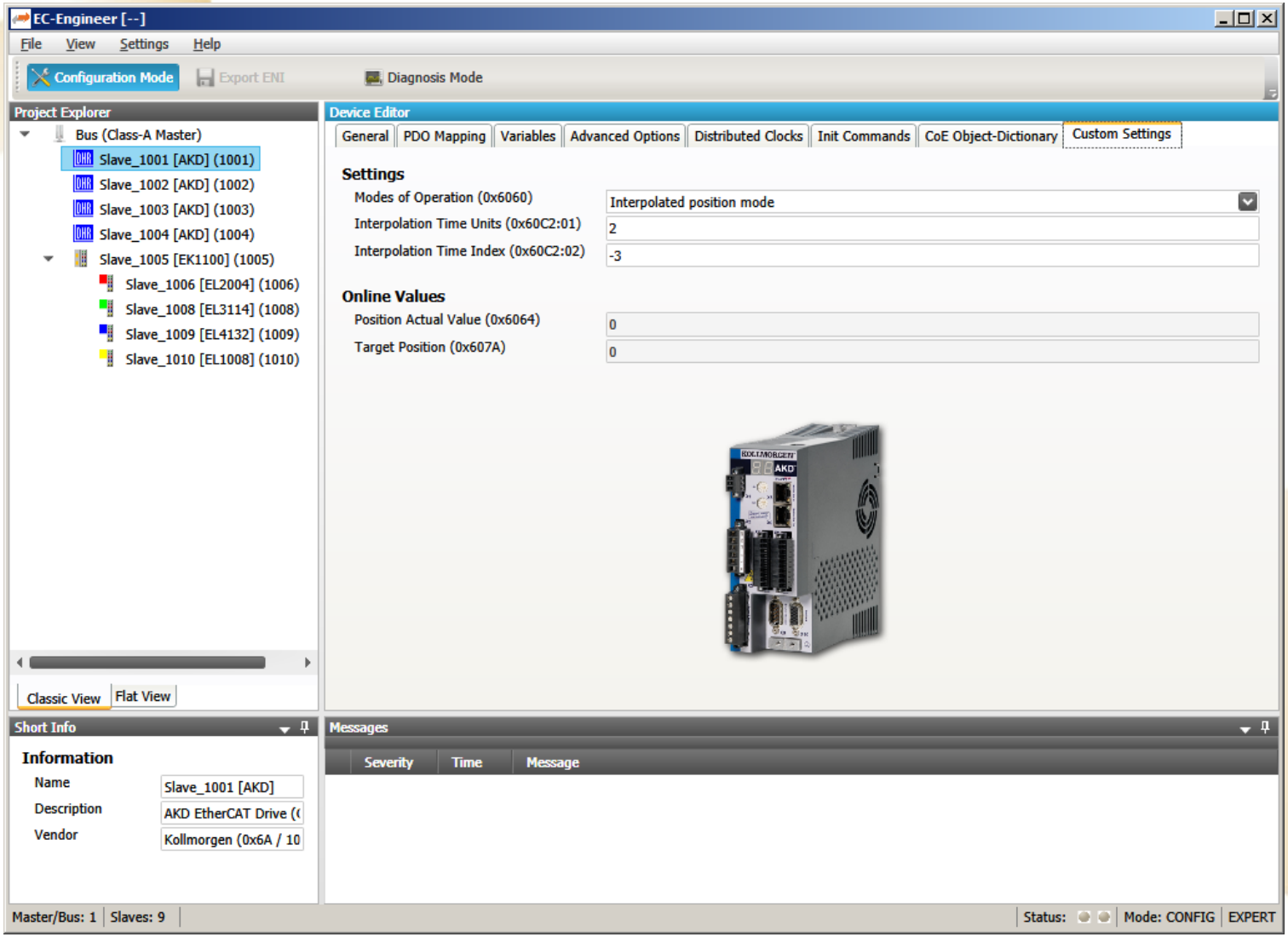


Powerful “Line crossed” detection



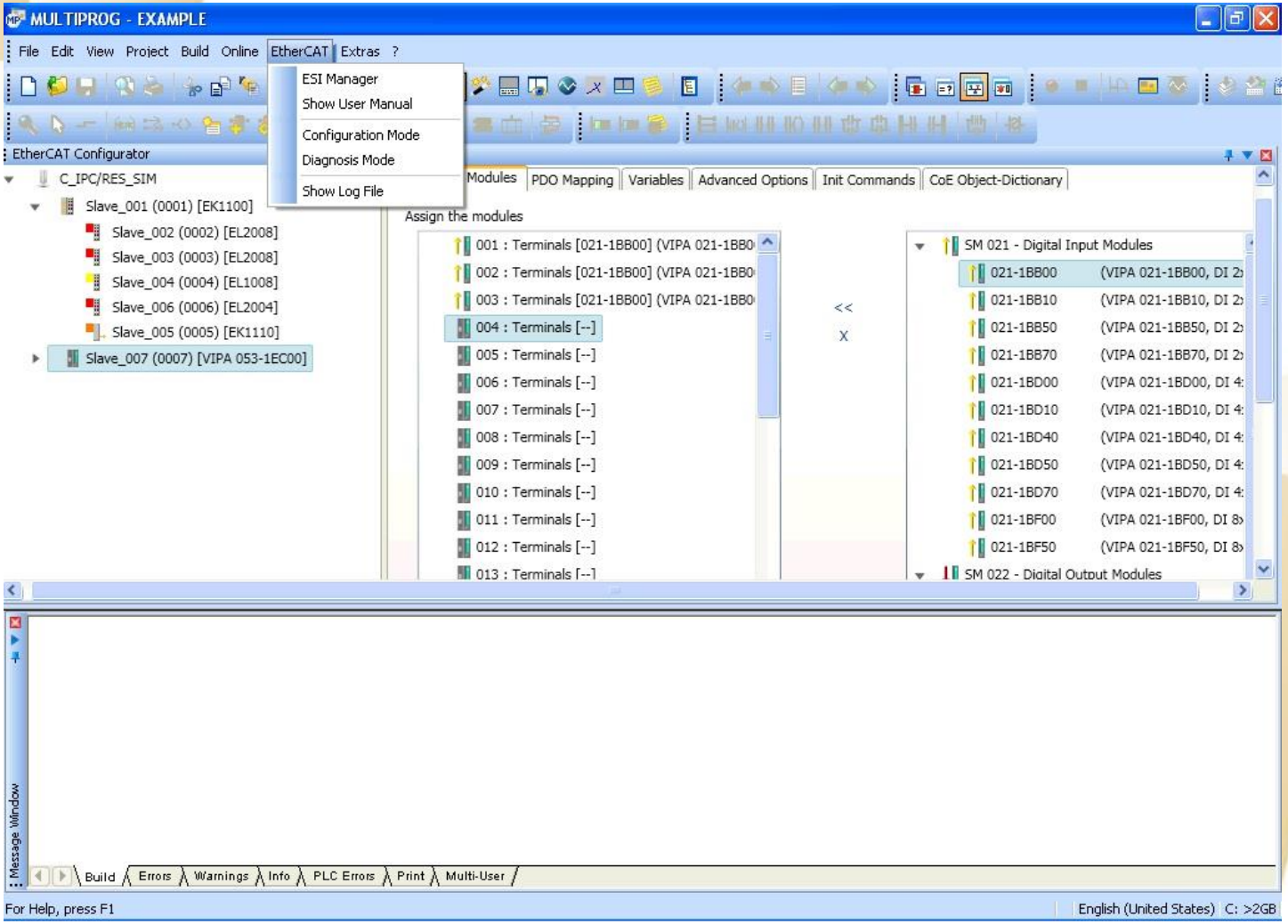
EC-Engineer SDK

- Customer enhancements of EC-Engineer (e.g. special EtherCAT slave handling)

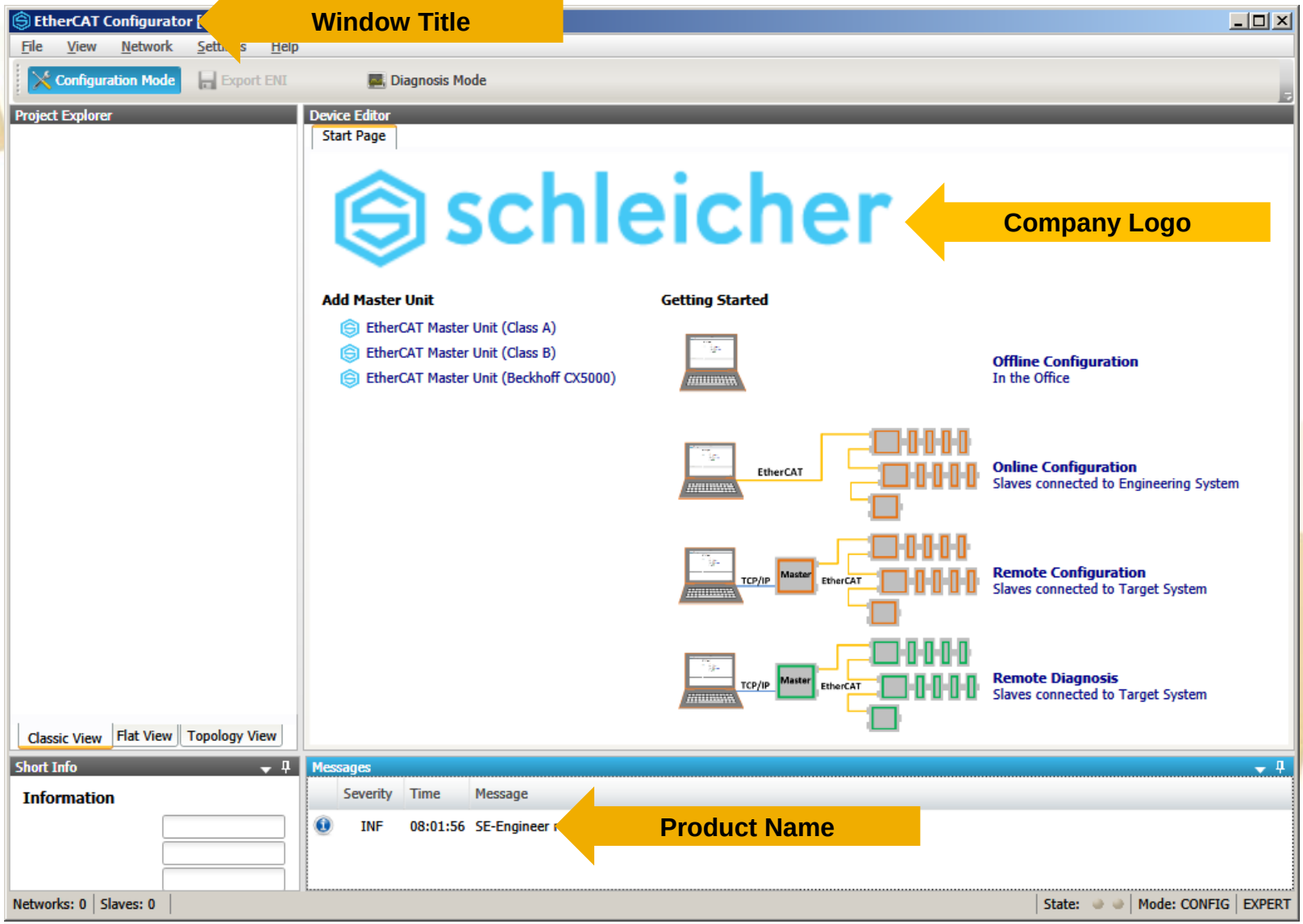


EC-Engineer SDK

- Integration into existing tools
- Example: Phoenix Contact Software Multiprog PLC programming environment



EC-Engineer Brand Labeling Kit



Key benefits

EC Engineer

- Powerful online functions together with EC-Master
  - Network scan local and remote, compare configured and found slaves (network mismatch view)
  - Access to states, variables, object dictionary, ESC register, EEPROM, etc.
- Easy to use - modern design
  - Build an configuration in less steps
  - Only reasonable settings and options are visible
  - Hide expert settings if not required
- Restriction to the essentials
  - Options and dialogs can be restricted to those features which the control system supports, e. g. available cycle times, support of mailbox protocols, DC synchronization or Hot Connect.
  - Predefined EMI (EtherCAT Master Information) files for Class A and Class B are included and will serve as templates to enhance or restrict the function according to the customer needs
- Fixed process data memory layout
  - Define a group of slaves or a single slave with fixed offsets in the process image. The layout don't change if new devices are added.
- CSV export for process data variable layout
- Adjustable/Extensible (Software Development Kit available)
  - Adjust to customer needs or integrate into customer engineering environment

ETHERCAT DIAGNOSIS TOOL

Feature overview

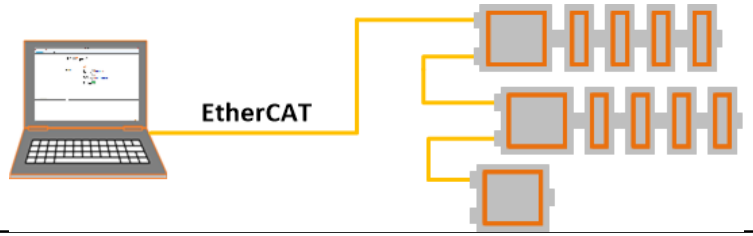
EC Lyser

- Analyze EtherCAT networks operated by EC-Master
- Find out the possible reasons for transmission errors due to
  - bad cables and connectors
  - vibrations that cause transmission interruptions
  - system degradation caused by high temperatures, oxidation, mechanic failure
  - electromagnetic fields, electrostatic discharge
- Sophisticated diagnosis functions (according to EC-Engineer)
  - Graphical display of the network topology
  - Compare actually connected slaves with configured slaves
  - Edit and view master state, slave states and process data
  - Access to master and slave object dictionaries (SDO Up- and Download)
  - Display Slave Error Register 0x300 ff.
  - Edit EtherCAT Slave Controller (ESC) Registers
  - And more

Operation Modes

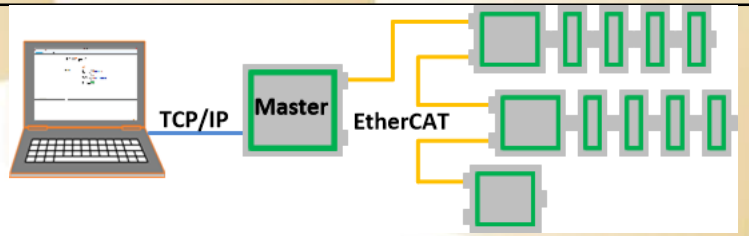
1. Local: Based on integrated EtherCAT master
   - Connect all slaves to notebook/PC, normal control system is stopped
   - Provide ENI file to set network into OP state

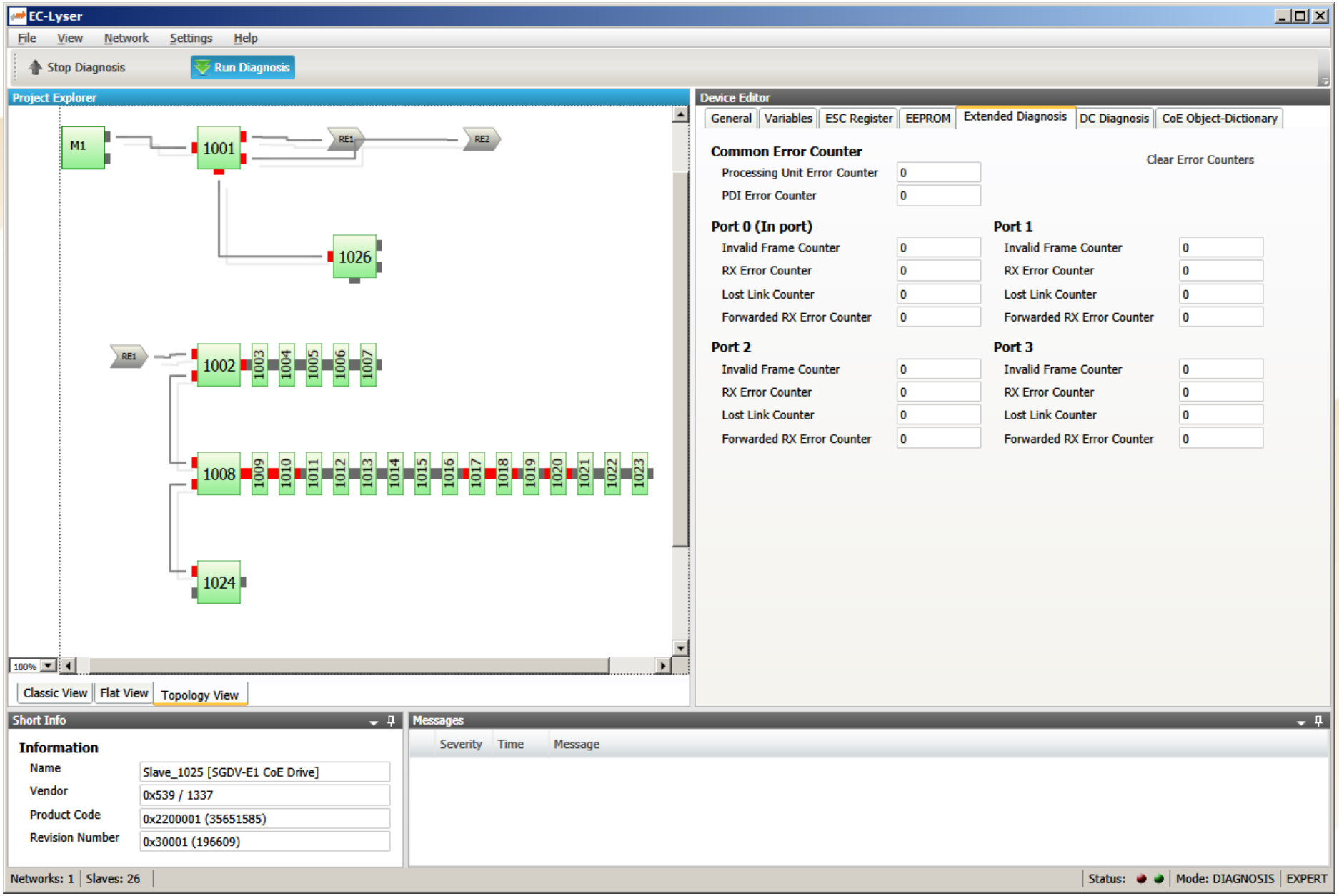
Local Diagnosis:
Slaves connected to Notebook/PC



2. Remote: Network operated by original target system
   - Based RAS protocol, RAS server has to run on control system
   - Collect information while machine is running

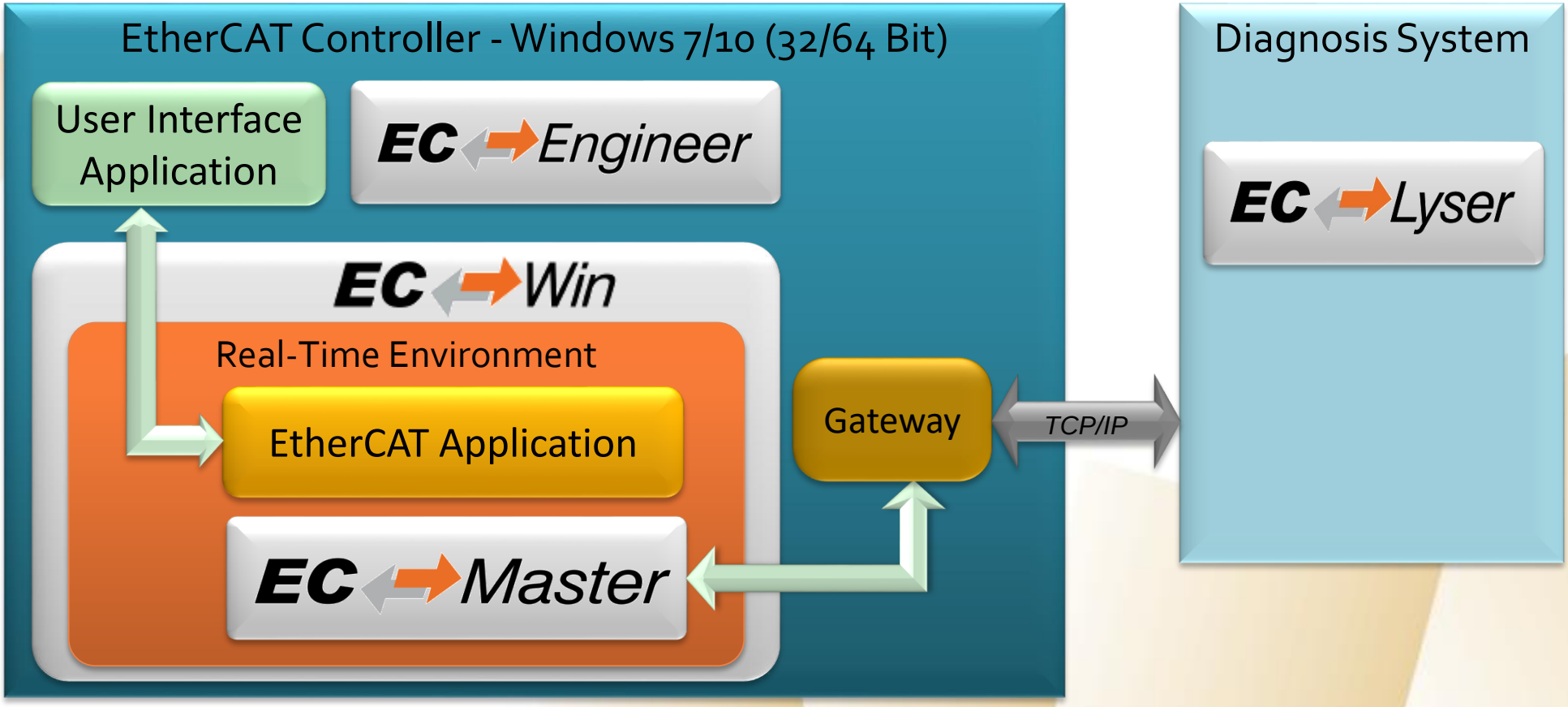
Remote Diagnosis:
Slaves connected to Control System




EC-Lyser
File
View
Network
Settings
Help
Stop Diagnosis
Run Diagnosis
Project Explorer
M1
1001
RE1
RE2
1026
RE1
1002
1003
1004
1005
1006
1007
1008
1009
1010
1011
1012
1013
1014
1015
1016
1017
1018
1019
1020
1021
1022
1023
1024
100%
Classic View
Flat View
Topology View
Device Editor
General
Variables
ESC Register
EEPROM
Extended Diagnosis
DC Diagnosis
CoE Object-Dictionary
Common Error Counter
Clear Error Counters
Processing Unit Error Counter
PDI Error Counter
Port 0 (In port)
Invalid Frame Counter
RX Error Counter
Lost Link Counter
Forwarded RX Error Counter
Port 1
Port 2
Port 3
Short Info
Information
Name
Slave_1025 [SGDV-E1 CoE Drive]
Vendor
0x539 / 1337
Product Code
0x2200001 (35651585)
Revision Number
0x30001 (196609)
Messages
Severity
Time
Message
Networks: 1
Slaves: 26
Status:
Mode: DIAGNOSIS
EXPERT

WINDOWS ETHERCAT REAL-TIME PLATFORM

EC-Win System Architecture



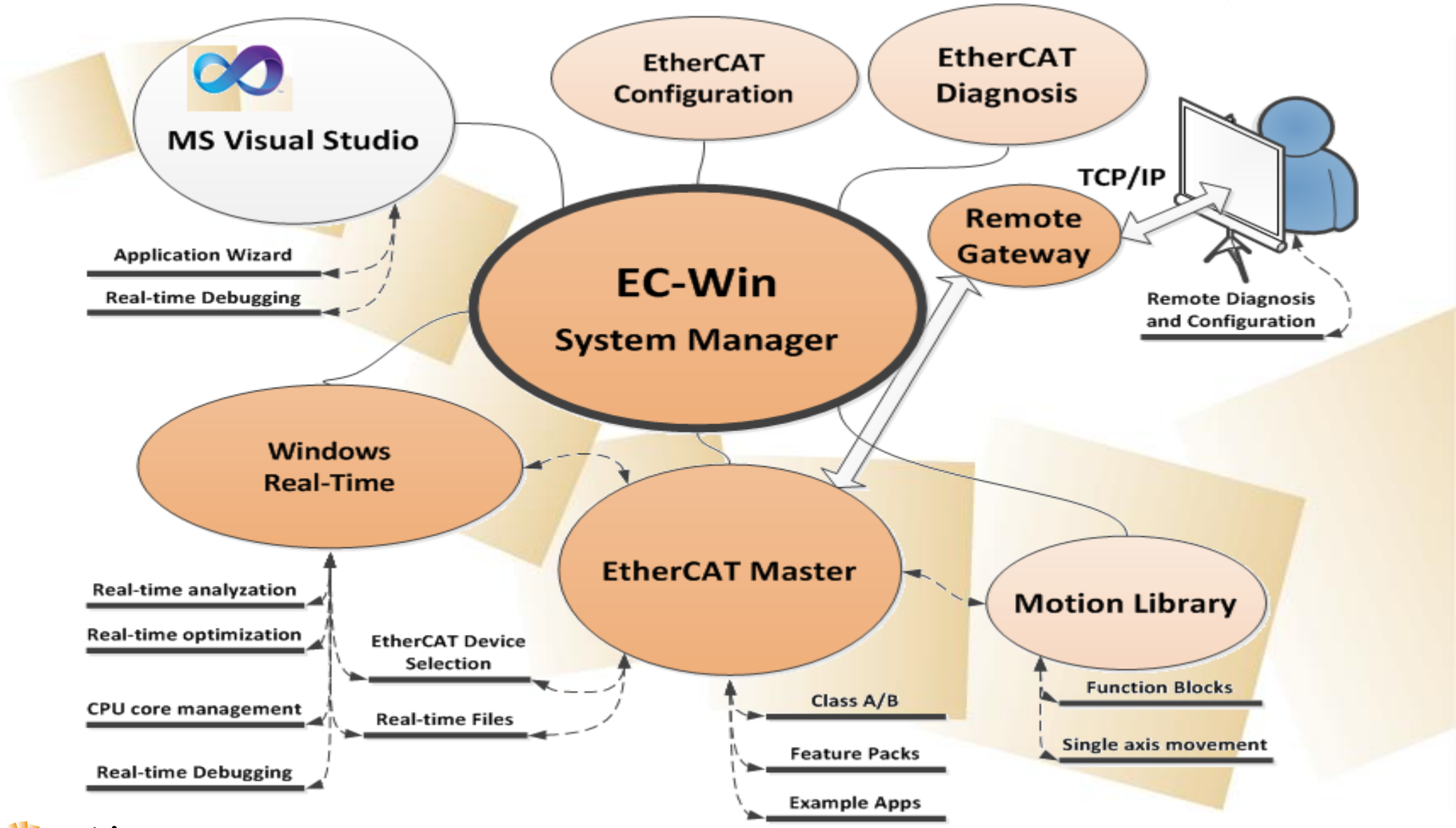
- Windows: All applications are non deterministic
- Real-time part runs on separate real-time environment

EC-Win – Core Components

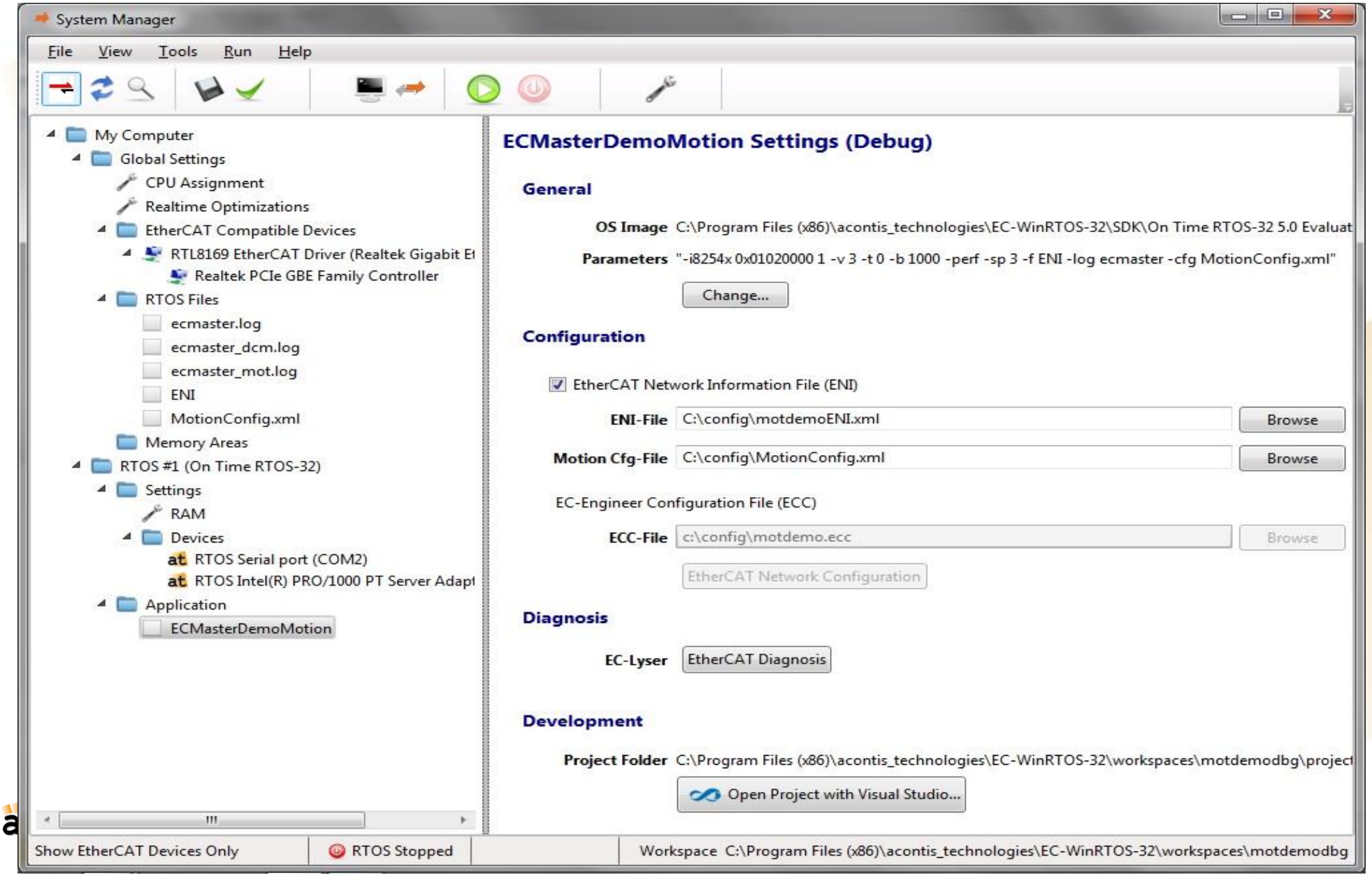
- Windows Real-time extension (standalone product: RT-Win)
- EtherCAT Master Stack (standalone product: EC-Master)
  - Running in the real-time environment

- System Manager
  - The whole development process is controlled from within this easy-to-use tool
- Visual Studio Application Wizard
  - Easily create own EtherCAT projects based on shipped demos
- Remote TCP/IP Gateway to connect external tools with master
  - No extra IP address or network bridging required!
  - Available for acontis tools (EC-Engineer, EC-Lyser) and for customer's own tools

Fully integrated Windows EtherCAT platform



System Manager: Configuration/Development Console

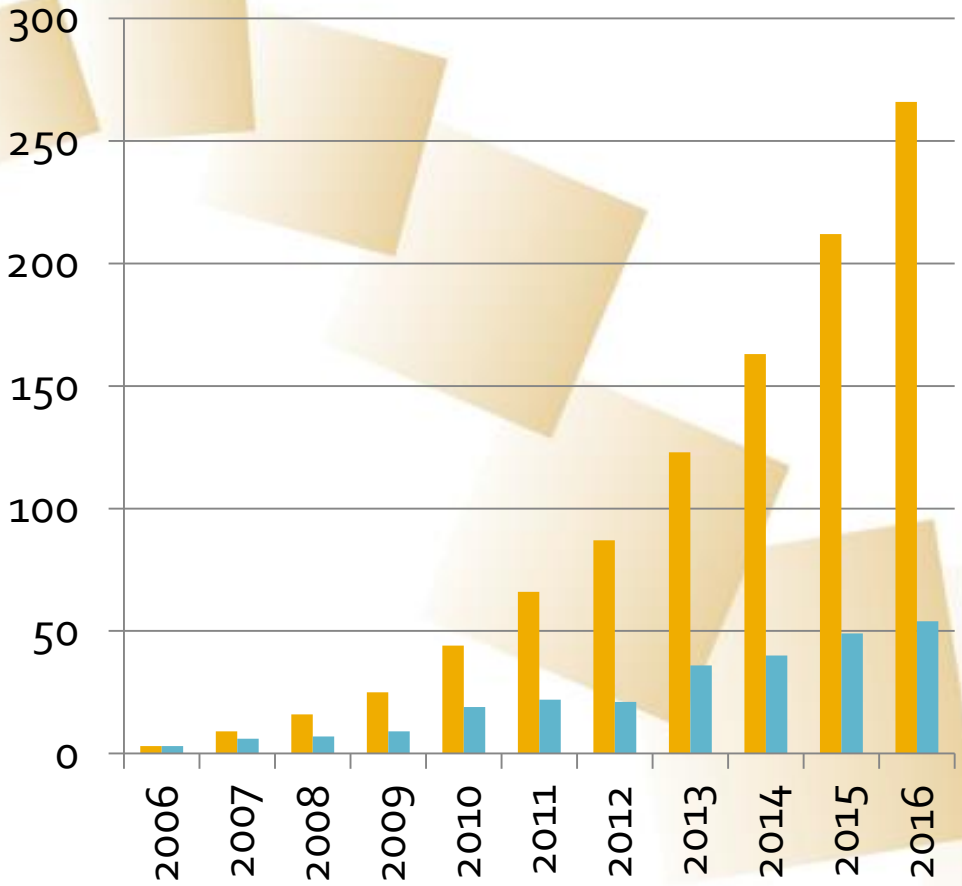


Key benefits

- Fully integrated EtherCAT real-time solution
  - one vendor, one support contact
  - Acontis has expertise for Windows real-time extensions back to 1994 and is leading provider for EtherCAT software since 2005
  - System Manager tool: One-stop tool for the whole product
- Hypervisor based real-time extension
  - full isolation between Windows and real-time part
- Support for symmetric multiprocessing (SMP)
  - use more than one CPU core for the real-time part
- Extreme fast Windows real-time Extension
  - Includes On Time RTOS-32 license, the fastest RTOS on the market
- Development and debugging with Visual Studio 2005 .. 2013
- External TCP/IP Gateway
  - Remote connection for EC-Lyser/EC-Engineer using the Windows IP address
- Licensing: No software activation or USB dongle

ACONTIS MARKET ACCEPTANCE

EtherCAT OEM Software Customers



- 2016: in total 54 new OEM customers
- 2016: specifically strong growth in Asia
  - 50% from Asia
  - 25% from China

EtherCAT Products – Markets and Customers

Industrial Automation

Omron (JP)
Yaskawa (JP/US/DE)
Kollmorgen (US)
Bosch/Rexroth (DE)
Panasonic SUNX (JP)
Adlink (TW)
Hanwha Techwin (KR)
Shanghai Electric (CN)
Lenze (DE)
Delta Electronics (TW)
Bachmann elect. (AT)
Prima Electro (IT)
fscut (CN)
Krones (DE)
ACS Motion Control (IL)
Bobst Group (CH)
Precitec (CH, DE)
Ricoh (JP)
ITRI/MSL (TW)

Semiconductor

No. 1 Equipment Provider (US)
No. 1 Wafer Fabrication Provider (US)
No. 1 Lithography Provider (US/NL)
Zeiss SMT (DE)
Varian Semiconductor (US)

Robotics

KUKA Roboter (DE)
Cloos (DE)
Yaskawa (JP/US)
energid (US)
ABB (CN), Panda (CN), HIT Robot (CN)
Turin (CN), Jari (CN)

Energy

GE/Alstom (ES)
AREVA (FR)
Enerflow (CA)
Mitsubishi Heavy Industries (JP)

Test/Measurement

No. 1 HIL Provider (US)
No. 1 MsrmtEquip (US)
Jenoptik (DE)
MKS Instruments (US)
Leica Geosystems (CH)
Formula 1 team (UK)
Brooks Instruments (NL)
JUMO (DE)
Instron (DE)
Toyota (JP)
ABB (SE)
Weiss Umwelt (DE)

Others

No. 1 Agric Mobiles (US)
No. 1 Show Biz. (US)
No. 1 Smart Phone (US)
MEN (DE)

Aerospace

No. 1 US Gov. Organization
No. 1 US Airplane vendor
CAE (CA)
Clemessy (FR)
IHI Aerospace (JP)

Medical

“Under NDA” (NL)
Curexo/Robodoc (US)
Medtronic (US)
Hocoma (CH)
Cascination (CH)

CNC

Hurco (US)
ISG (DE)
Prima Electro (IT)
ESAB/ATAS (DE)
GSK (CN)

Markets using Real-time and EtherCAT products from acontis

KUKA Roboter (GER)

Robotics

EC Win

Under NDA (USA)

Semiconductor

EC Win

ACS Motion Control (ISR)

CNC

EC Win

Markets using EtherCAT products from acontis

VIPA (GER)

Industial Automation

HURCO (USA)

CNC

Kristl & Seibt (AUT)

Test & Measurement

EC Master

EC Master

EC Master

Markets using Real-time and EtherCAT products from acontis

Alstom / Ikerlan (ESP)

Energy

EC Master

Under NDA (USA)

Semiconductor

EC Master

Under NDA (NLD)

Medical

EC Win

Why use acontis Products?

- Used by >200 OEM customers world-wide: de-facto standard besides TwinCAT
- Feature richness
  - All ETG defined features and feature-packs supported in real-world projects
  - Excellent diagnosis capabilities
- Scalability
  - Start with small solution (e.g. Class B master stack)
  - Grow with your requirements (feature packs, complementary products)
- Reliable long-term partnership
  - our customers are global leaders in different market segments
  - we are obliged for long-term support
- Your EtherCAT solution will be fast time-to-market
  - Out-of-the box for many operating systems
  - Get in running on your system in one day
- Get support from our agents in your local language
- Your EtherCAT solution will be more competitive than your competitors!

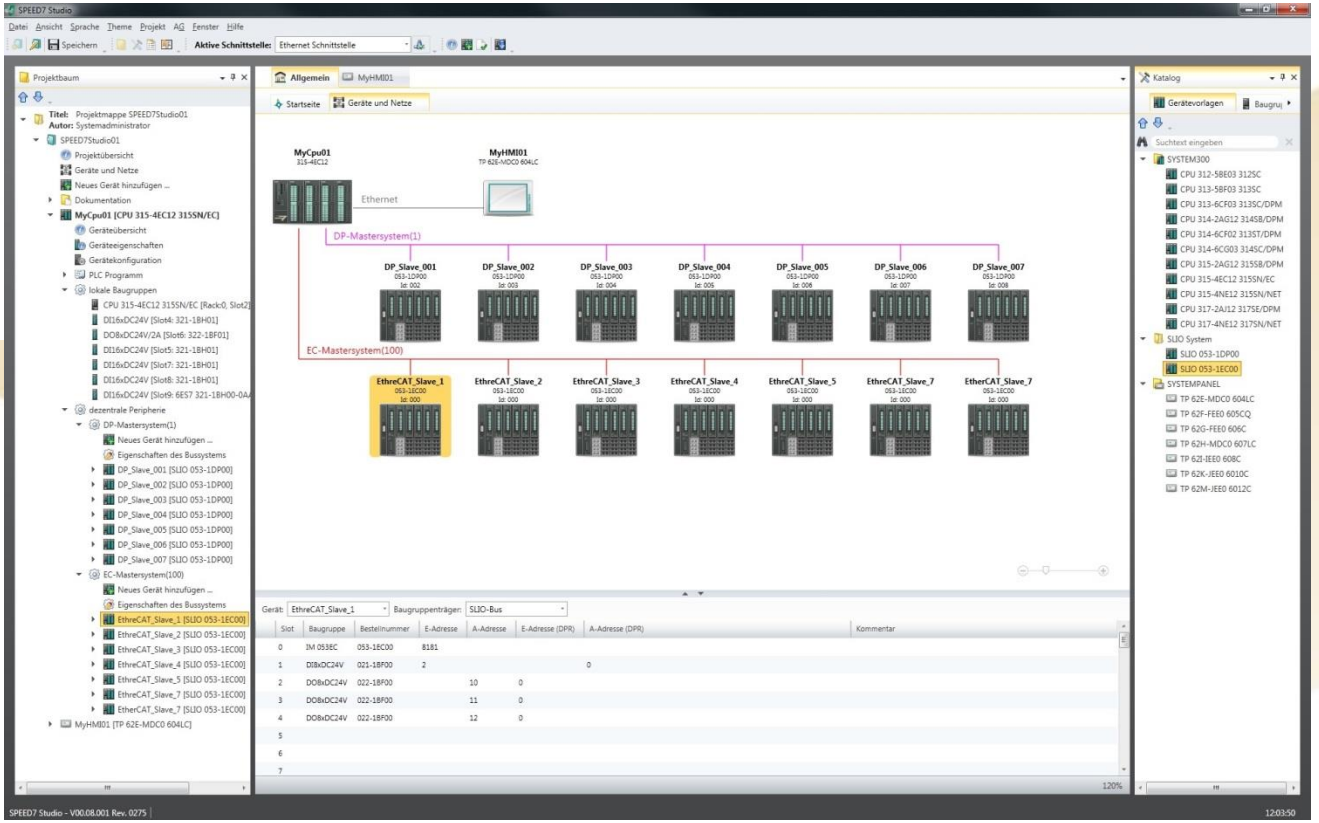
KUKA Roboter (GER)

- Application:
  - New Generation Industrial Robot Controller
  - Integrated Safety Controller
- Acontis Products
  - EC-Master Class A Master Stack
  - FPs: Hot Connect, Remote API
  - VxWin
- Challenges
  - Symmetric Multiprocessing
  - High Performance
  - Remote Diagnosis and Configuration

VIPA (GER)

PLC with EtherCAT fieldbus

- EC-Master Class A Master Stack
- FPs: Hot Connect, Master OD, EoE Endpoint, Remote API
- ARM with embedded OS



Engineering Suite

- Integration of EC-Engineer with own design/theme
- Online functions using RAS client

acontis technology – behind the stage!