TISC Suite
Connects Simulation Tools

TLK-Thermo GmbH

Why Use Tool-Coupling?

| Car | = | Passenger Compartment | + | Engine | + | Refrigeration Cycle |
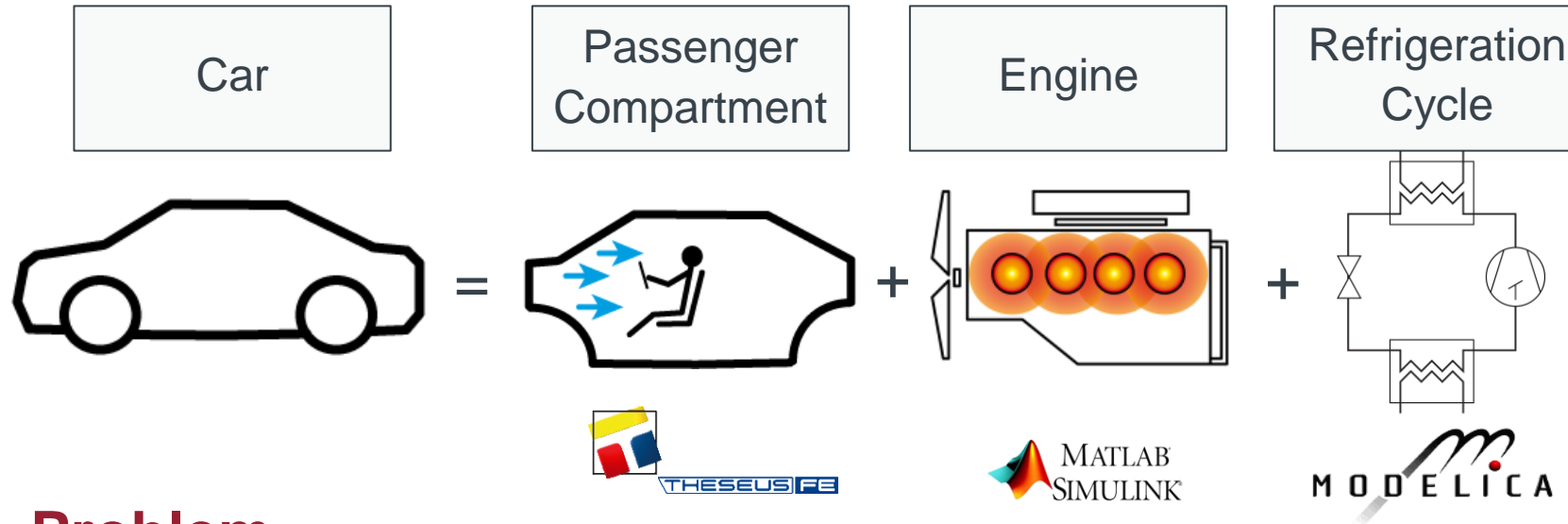
Problem

- Multiple components of a complex system are designed in different software tools

Possibilities

- Redesign of all components in one tool

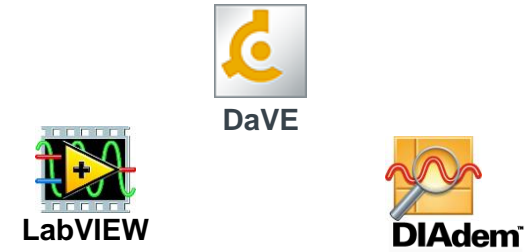- Using co-simulation to simulate different tools together

TISC Interfaces

Co-Simulation

Online Visualization

DaVE

LabVIEW

DIAdem

TISC

Measurement Setup

NI-DAQmx

ETAS INCA

CANape

Advantages of TISC

Tool-Coupling

- Usability of existing models in larger simulation compound
- Use your preferred tool for specific problems

Central Simulation Control

- Configuration, execution, post-processing using one single application
- Change simulation parameter for all models via TISC Center
- Easy model exchange in simulation compound
- Possibility of batch-simulations

Distributed Computing

- Cross-platform co-simulations possible

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Introduction of Simulation Layer
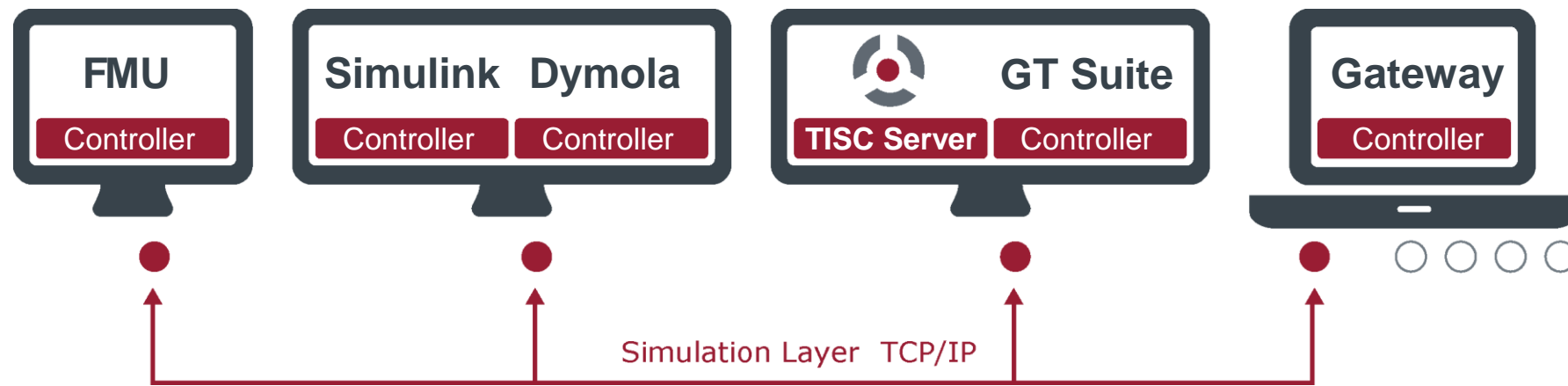
Server

- Data exchange
- Synchronization

Clients

- Interfaces integrate TISC into the simulation tools
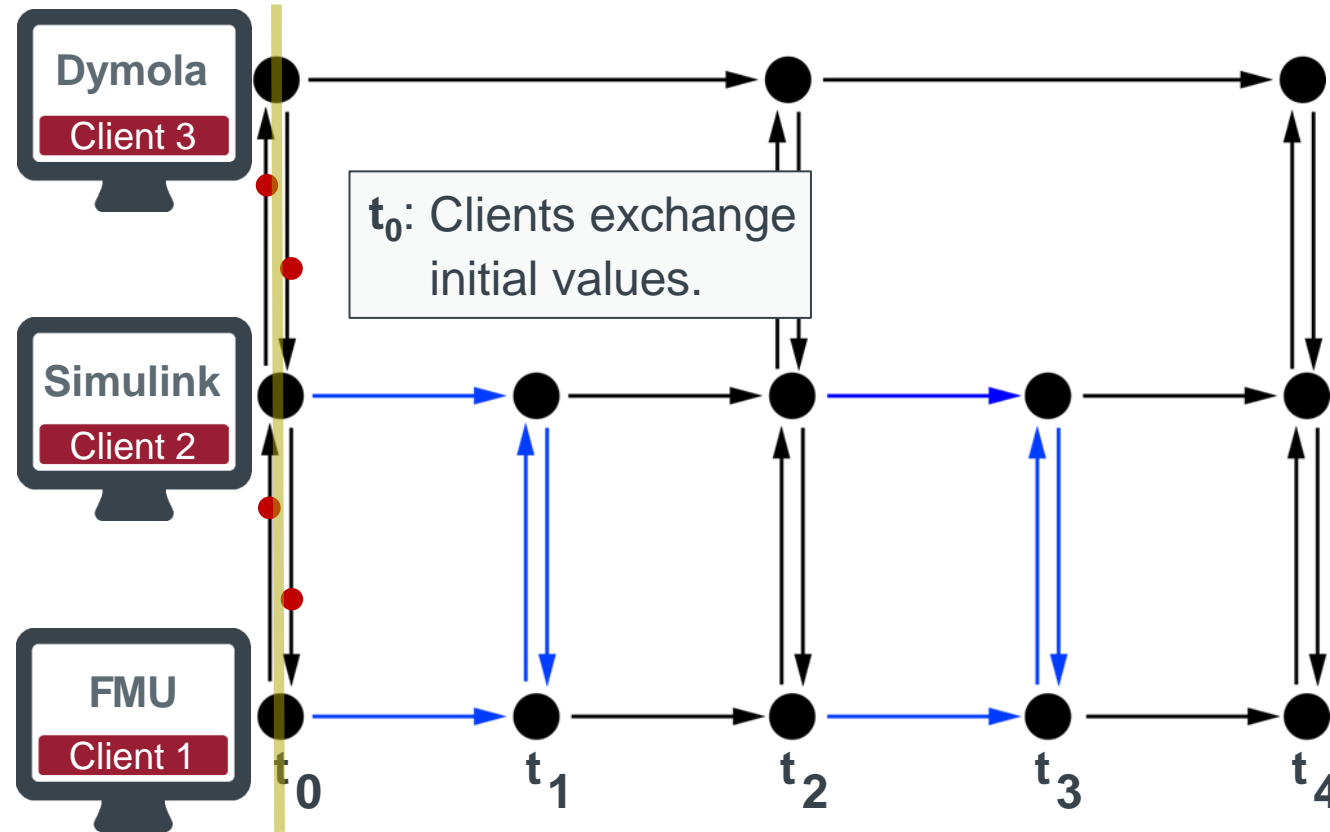- Clients communicate with the server only

Communication

- Using TCP-sockets
- Platform independent
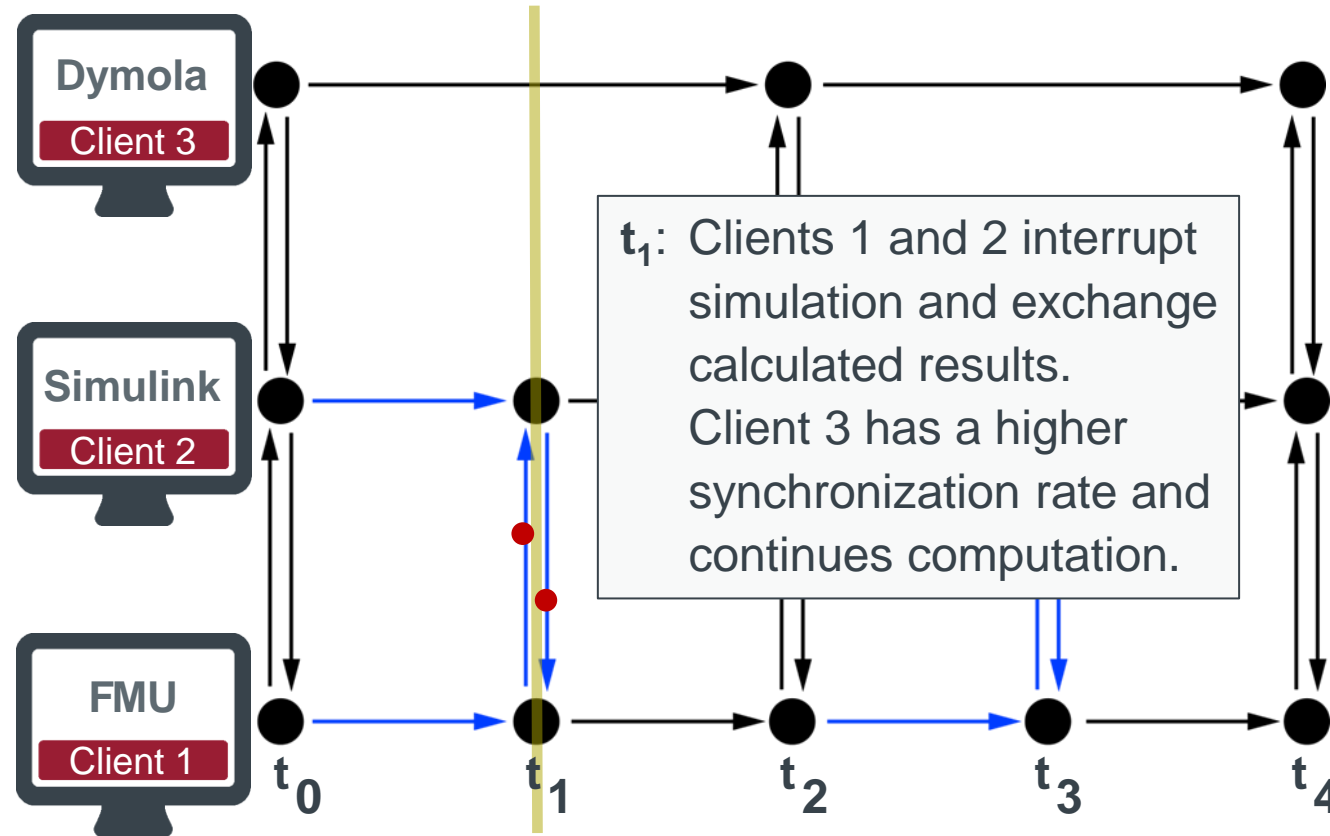- Distribution of a simulation on multiple computers is possible

FMU
Controller

Simulink Dymola
Controller   Controller

GT Suite
TISC Server   Controller

Gateway
Controller

Simulation Layer TCP/IP

Introduction of Simulation Layer

Synchronization

t_0: Clients exchange initial values.

Introduction of Simulation Layer

Synchronization

t_1: Clients 1 and 2 interrupt simulation and exchange calculated results.
Client 3 has a higher synchronization rate and continues computation.

Introduction of Simulation Layer

Synchronization

t_2: All Clients interrupt simulation after reaching this time step and exchange the calculated results.
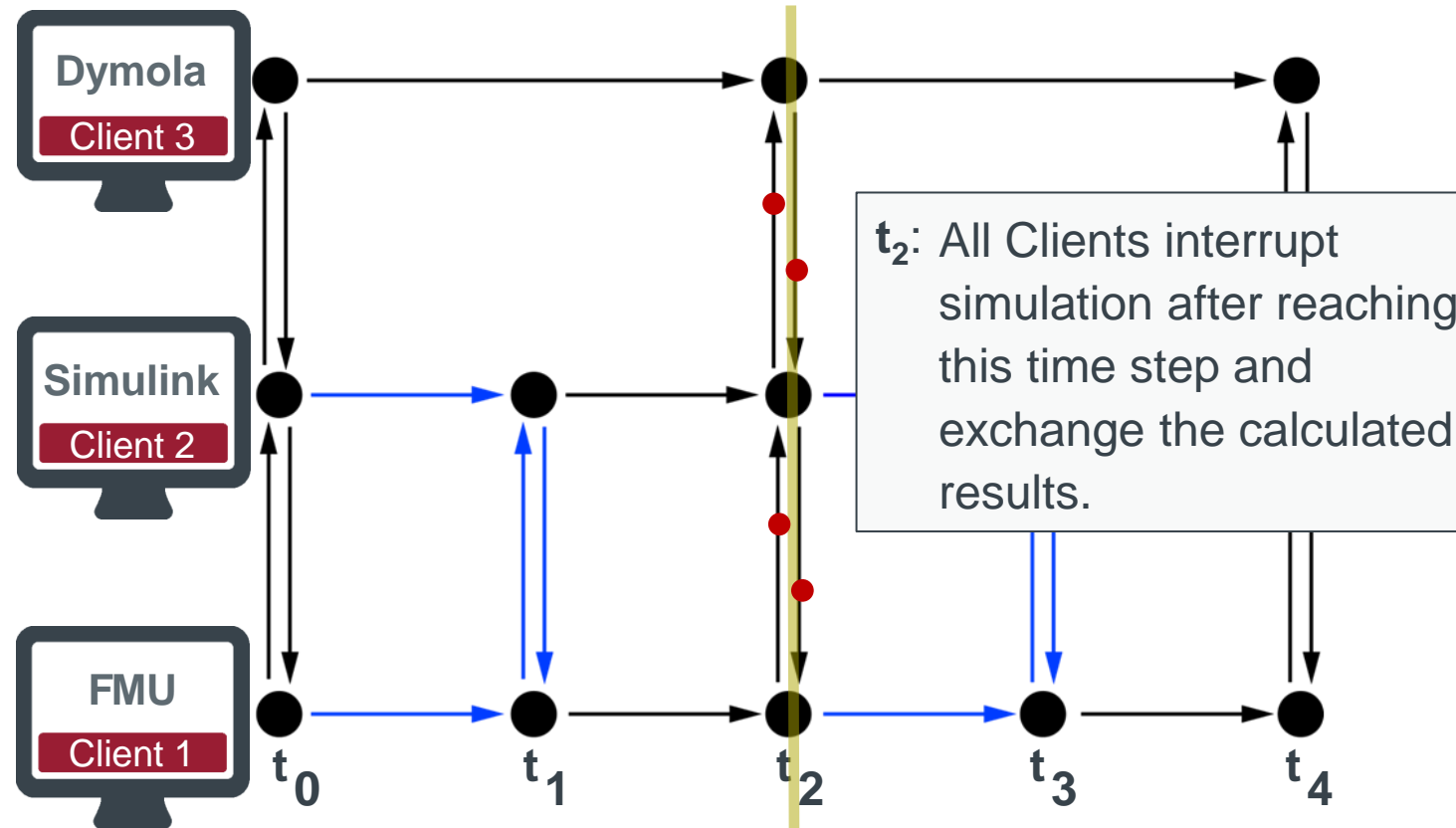
TISC Connection – Example Simulink

TISC Connection Block

For coupling simulation tools TISC Connection blocks are integrated into each model to exchange data with the simulation server.
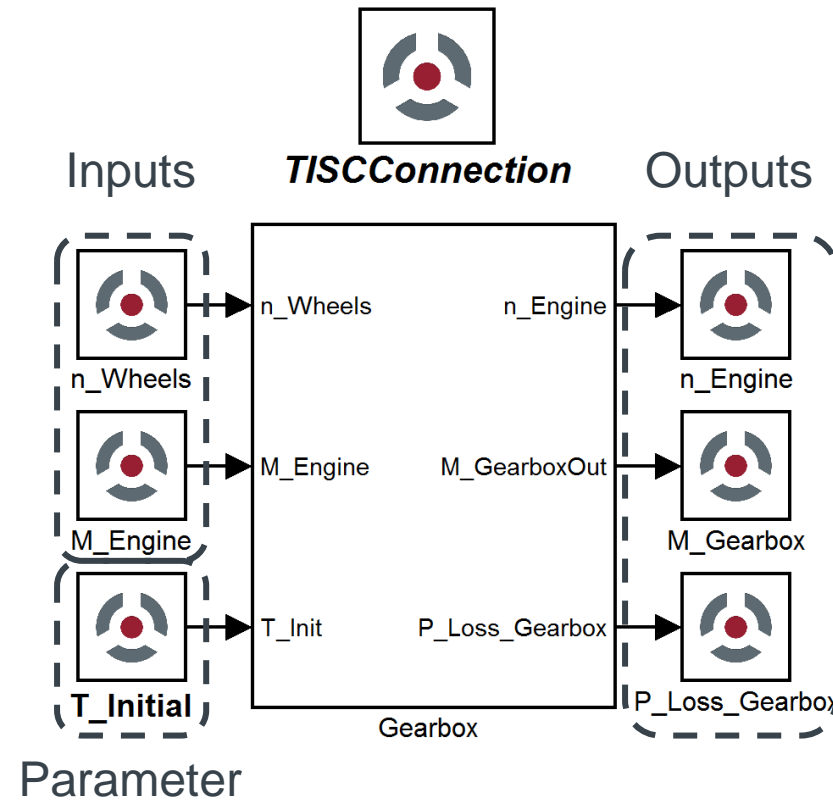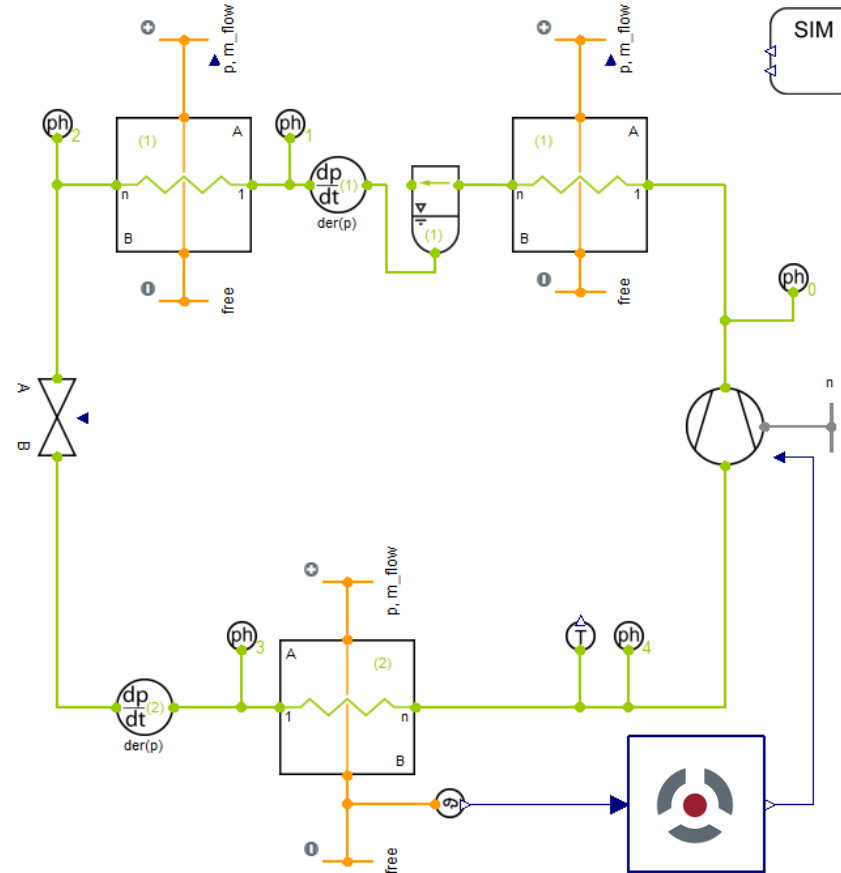
TISC Connection – Example Modelica/TIL

TISC Connection Block

For coupling simulation tools TISC Connection blocks are integrated into each model to exchange data with the simulation server.

TISC Connection – Variable Matching

Variables are matched automatically by TISC Name

- Green – received variable is connected, send variable is calculated and available on the server
- Yellow – variable is not connected and keeps its start value
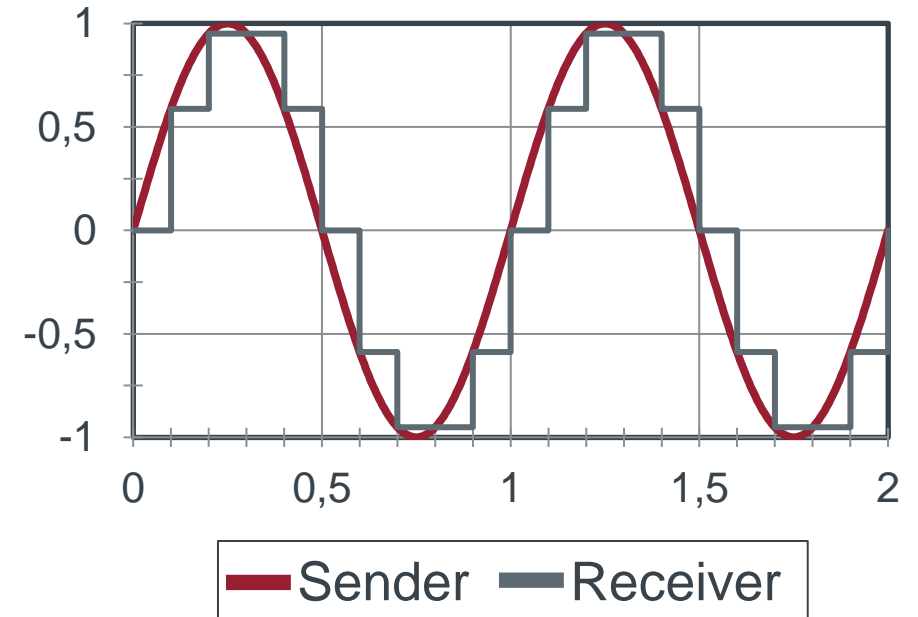
Numerical Aspects of Coupling

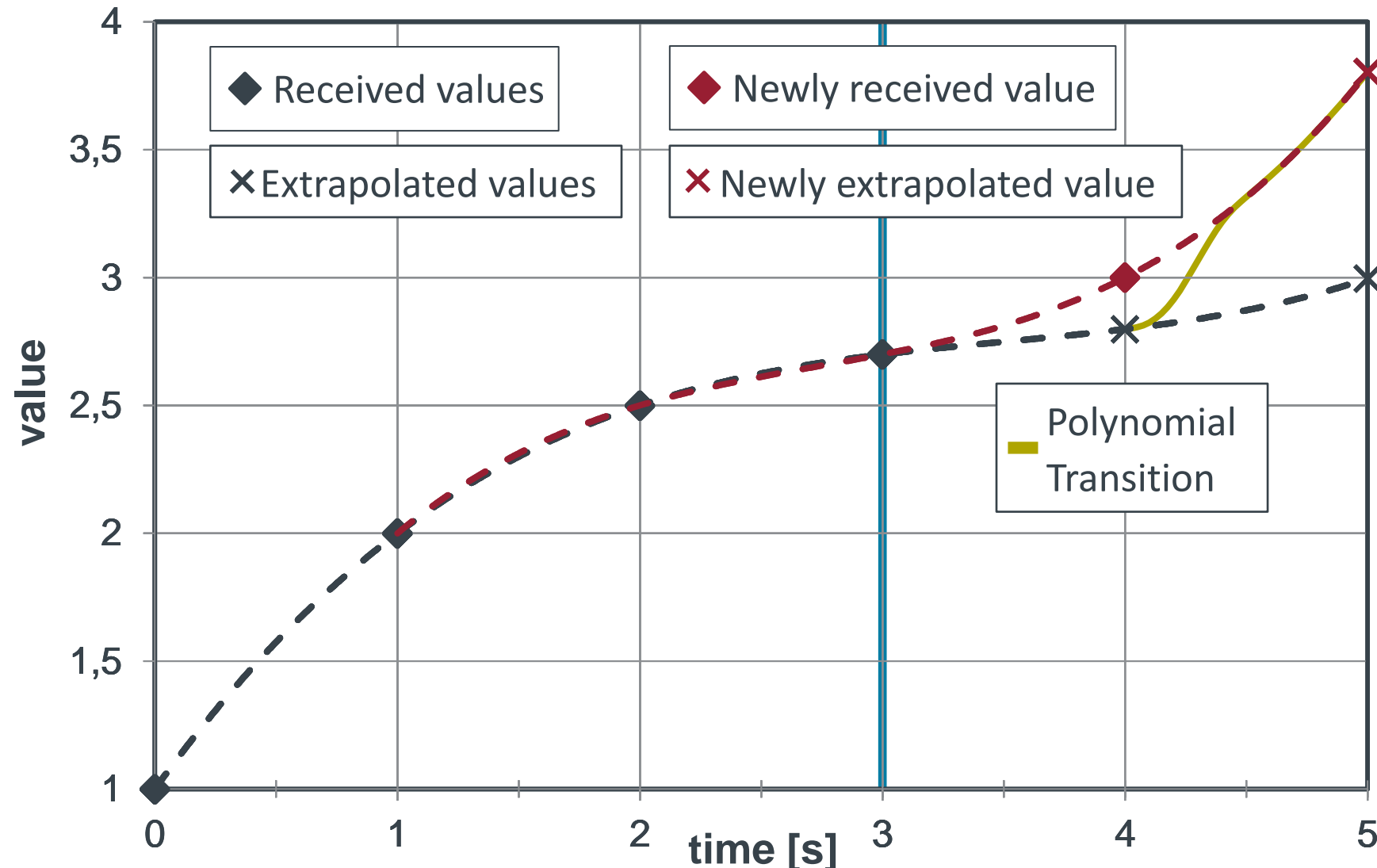## Transmitting time discrete values

Challenges

- Deviation
- Handicapped re-initialization
- Not differentiable
- Delayed event detection

Solution

- Synchronization with different time intervals
- Special handling of time series
- Extrapolation

Numerical Aspects - Extrapolation

Introduction of Control Layer
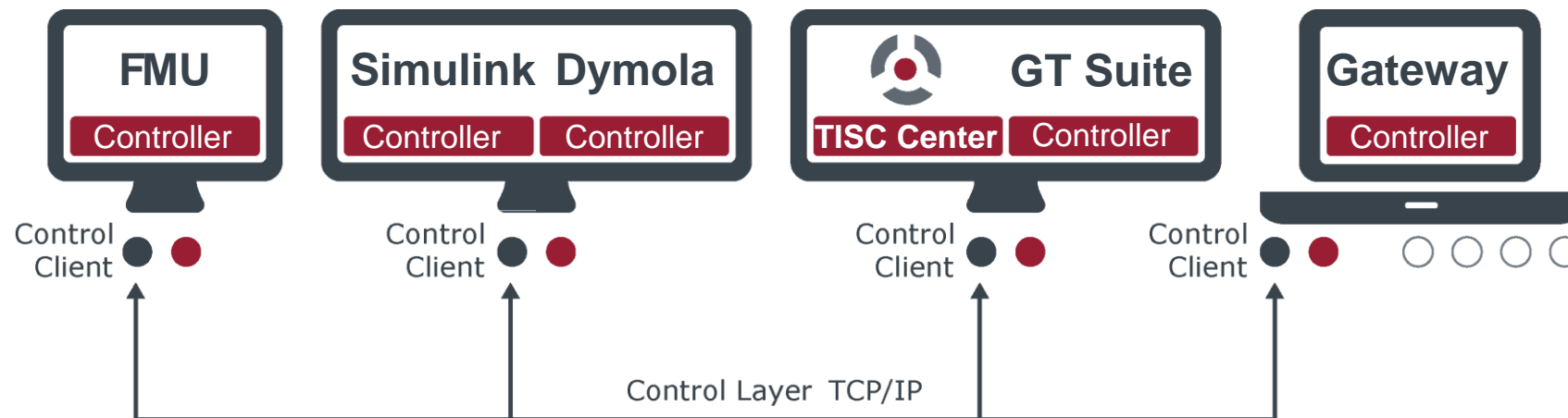
Configuration

- Model selection
- Parameterization

Execution

- Starting and stopping of simulation
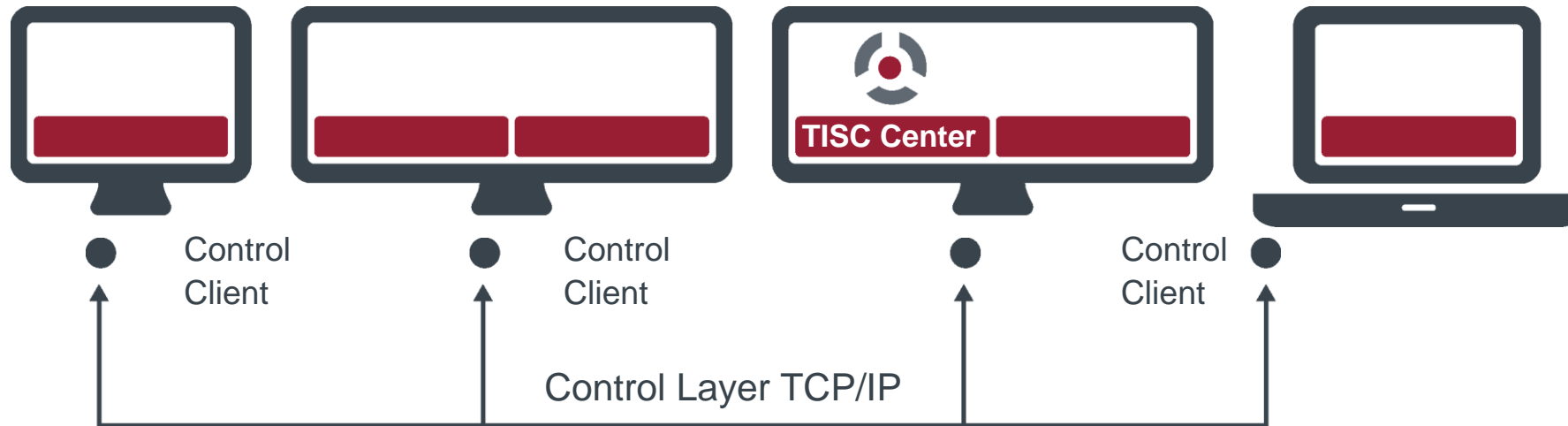- Display and processing of status messages

Batch

- Possibility to run batch simulations over night

Control connection: Process management and control

TISC – Communication Structure 1/4

TISC Center

Control Client

Control Client

Control Client

Control Layer TCP/IP

Initial situation

- A coupled simulation shall be started on multiple computers.

- TISC Center is used for central simulation management.

- TISC searches for available Control Clients on used computers.

- Control layer is established.
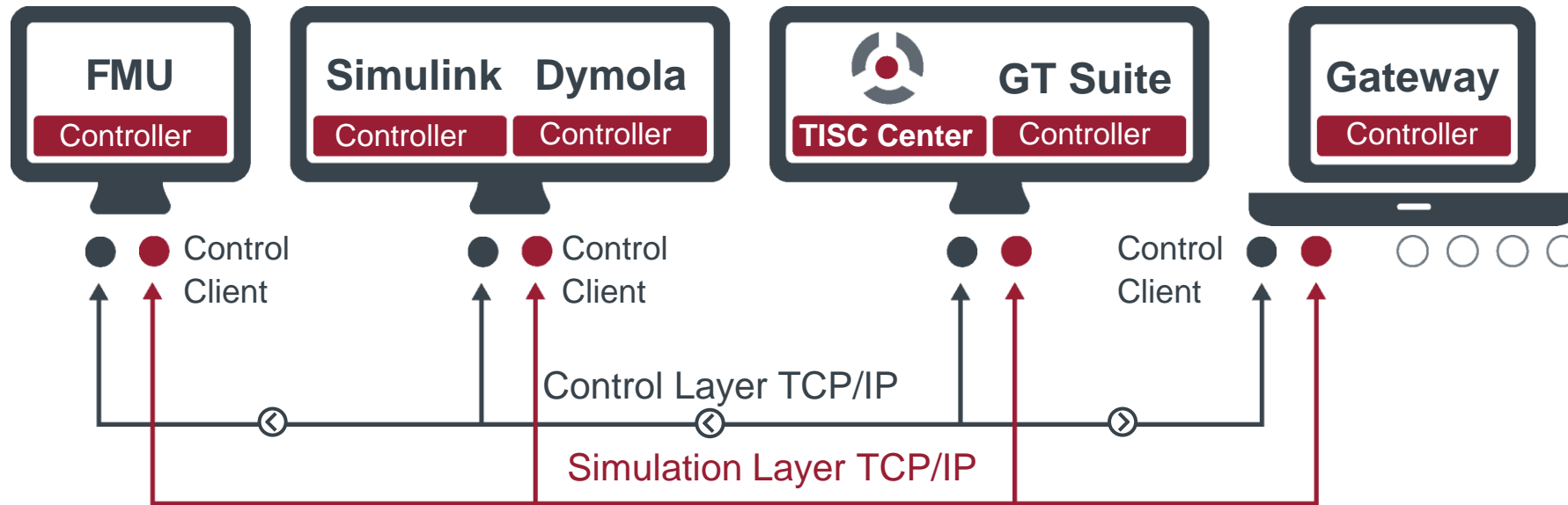
TISC – Communication Structure 2/4
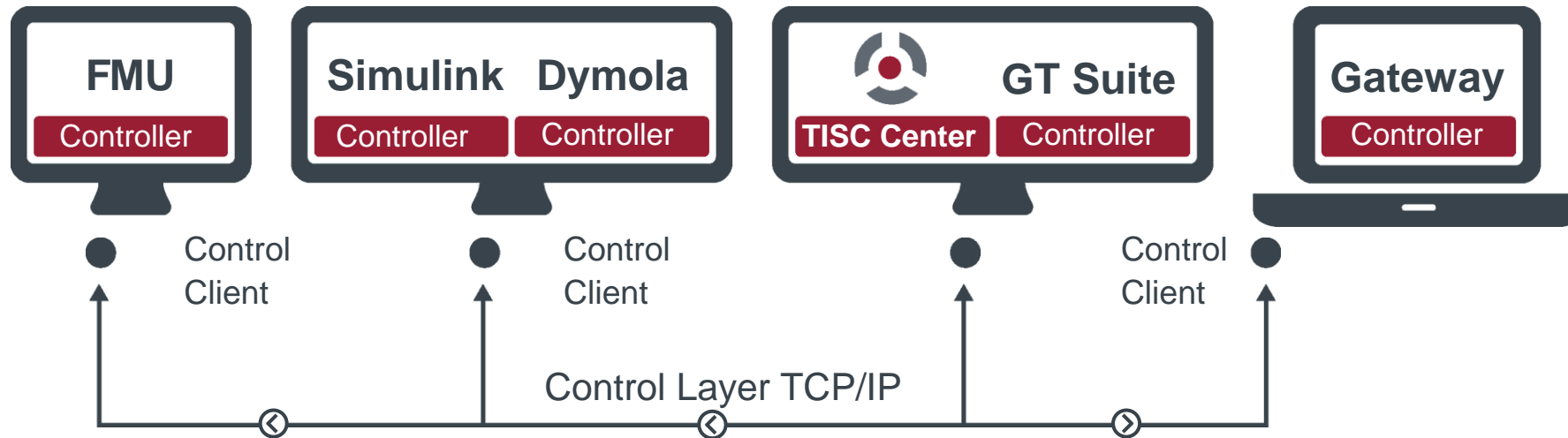
Initialization

- TISC Center sends startup signals to Control Clients.

- Control Clients start the controllers (remote execution clients) for each program which in turn open the models in their simulators.
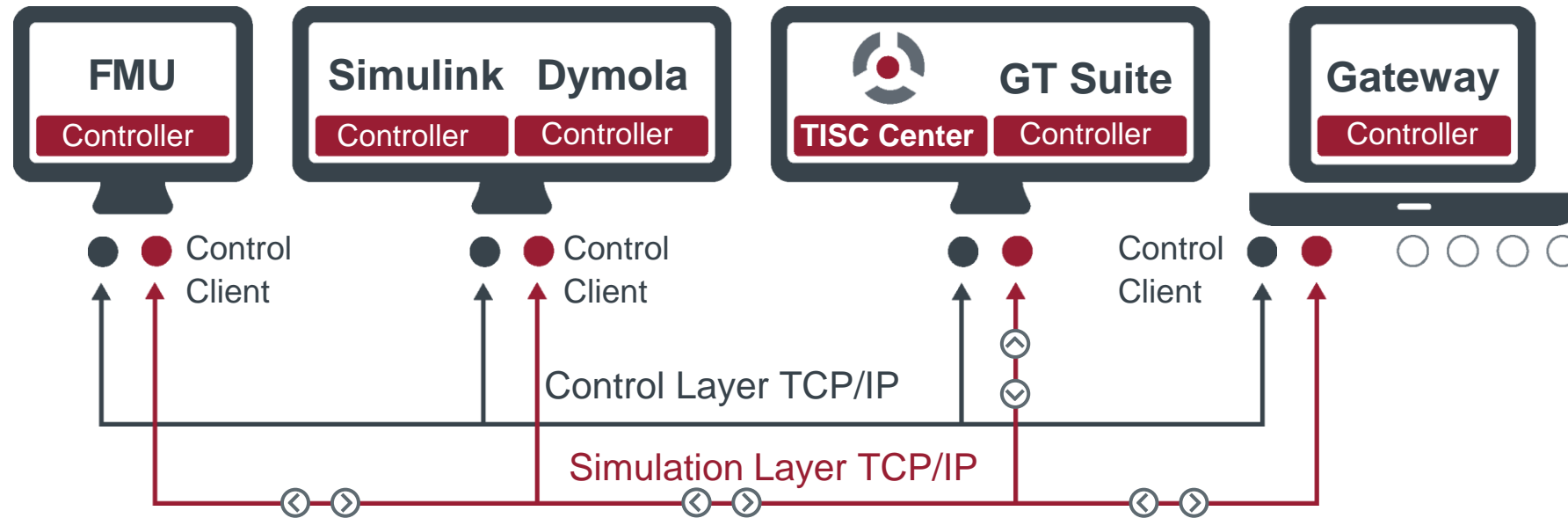
TISC – Communication Structure 3/4

Start Simulation

- Each simulator opens a connection to TISC Center via Simulation Layer to exchange simulation data.
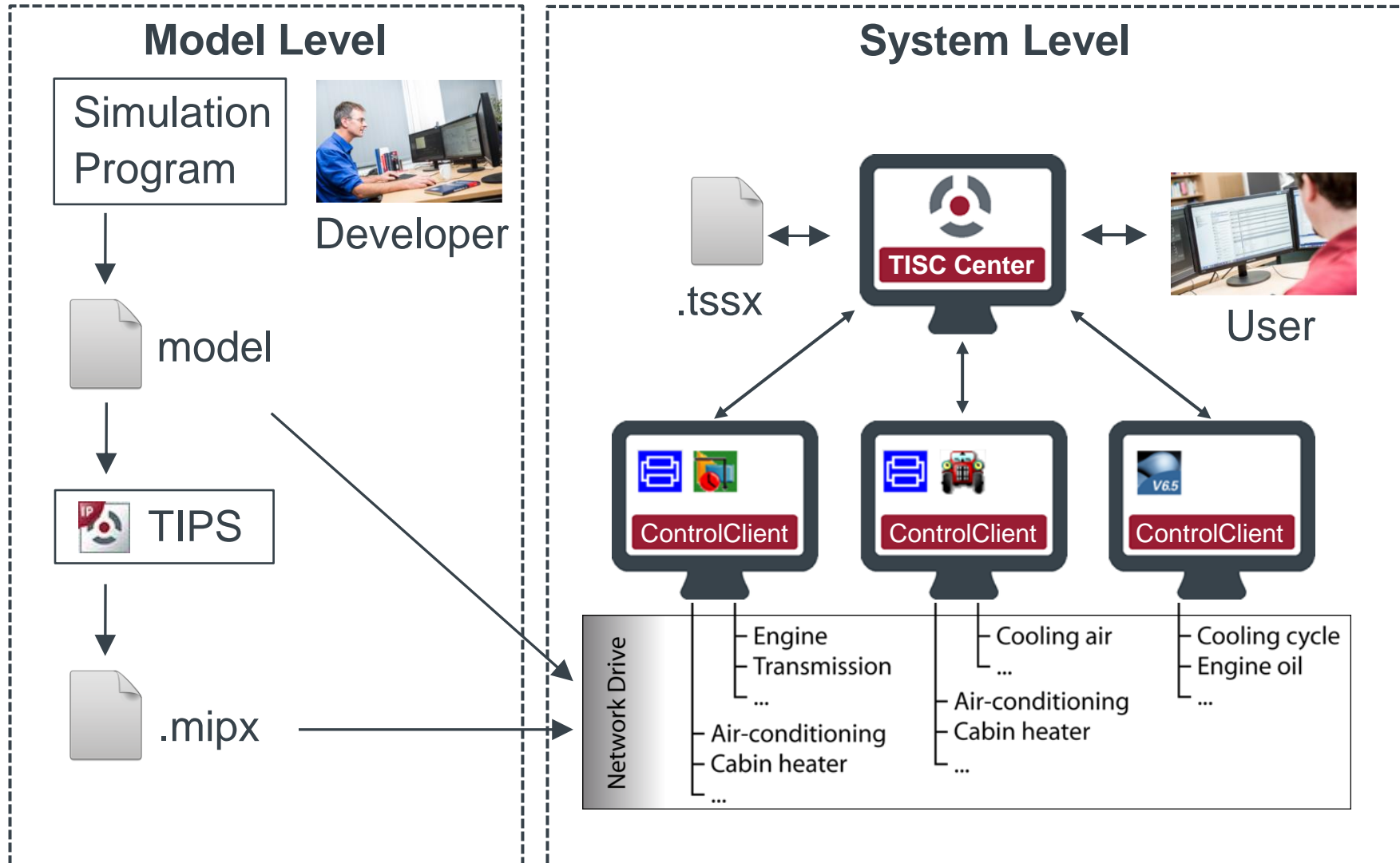
TISC – Communication Structure 4/4

Execute Simulation

- Clients and TISC Center exchange computated results during simulation.

- When finished the simulation will be terminated through Control Layer and simulators closed by controllers.

TISC-Center – Operating Process

Hardware Interfaces

Connection of hardware and software

Live data exchange for:

- Test benches

- HiL Systems (i.e. dSpace)

- Control systems (i.e. PLC)

- Measurement Software
  (i.e. CANape, LabVIEW)

- Gateway/Controller for several communication types like

  - SPSGateway (for example ET 200S) over LAN

  - CANGateway (for example Vector CANCase) over CAN

  - ASAMController (for example dSpace HIL API)

Hardware Interfaces

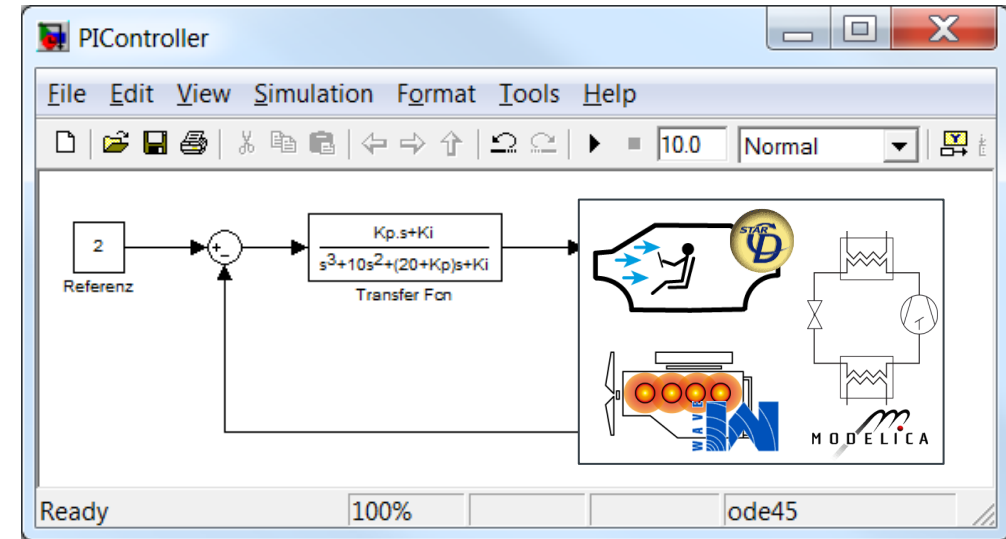## Connection of hardware and software
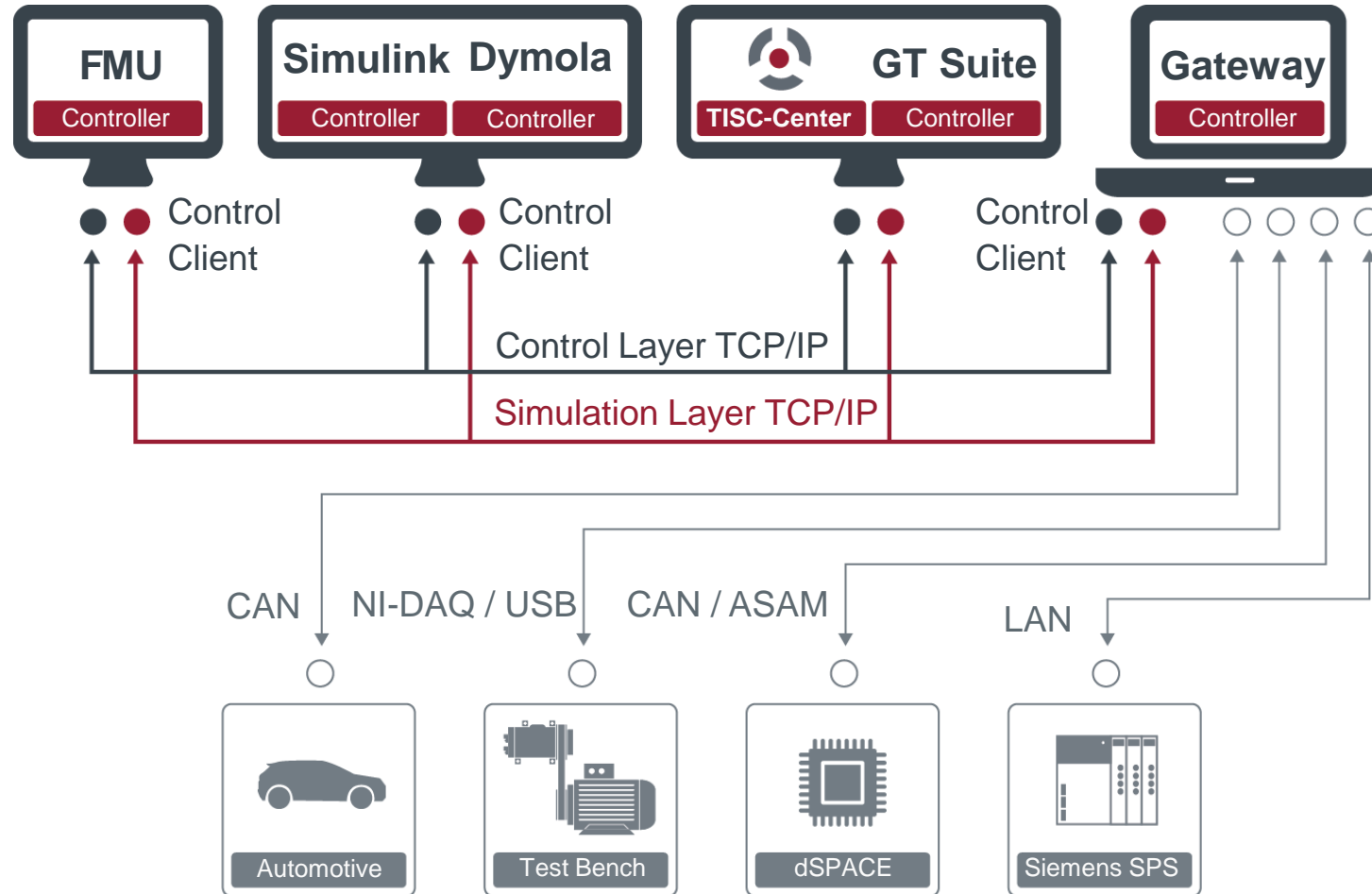
Advanced Features

Embedded TISC

- Integrate different models into one application
- Master/Slave configuration
- No distributed computing on several computers

Source Code Interfaces

- Call TISC functions direct in your source code
- Supported for C/C++, Java, Python and Fortran


```
1    #include "tiscslibc.h"
2
3    #include <iostream>
4    #include <sstream>
5
6    int main () {
7        std::cout << "configure\n";
8        tiscConfigureClient("127.0.0.1", 2000, "TISClibc Tester", 2);
9        tiscSetSyncRate(1000000);
10
11       std::cout << "sendVariable1\n";
12       int sId1(tiscSendVariable("dValue", "Double")),
13           sId2(tiscSendVariable("iValue", "Integer")),
```

Thank you

TLK-Thermo GmbH

If you have any questions,
please don't hesitate to contact us at
tisc@tlk-thermo.com

Or your contact person
Hinnerk Fischer

h.fischer@tlk-thermo.com

TLK-Thermo GmbH
Rebenring 31
38106 Braunschweig
www.tlk-thermo.com

Tel.: +49/531/390 76 - 253
Fax: +49/531/390 76 - 29