

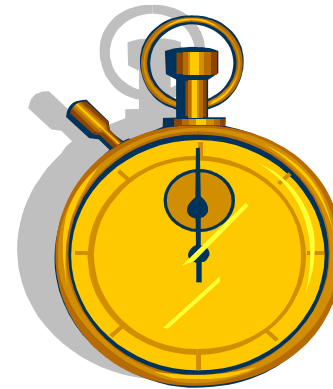
New Ways of Test Automation

MC-ST: Framework for System Test Automation with UML and LabVIEW

Costs

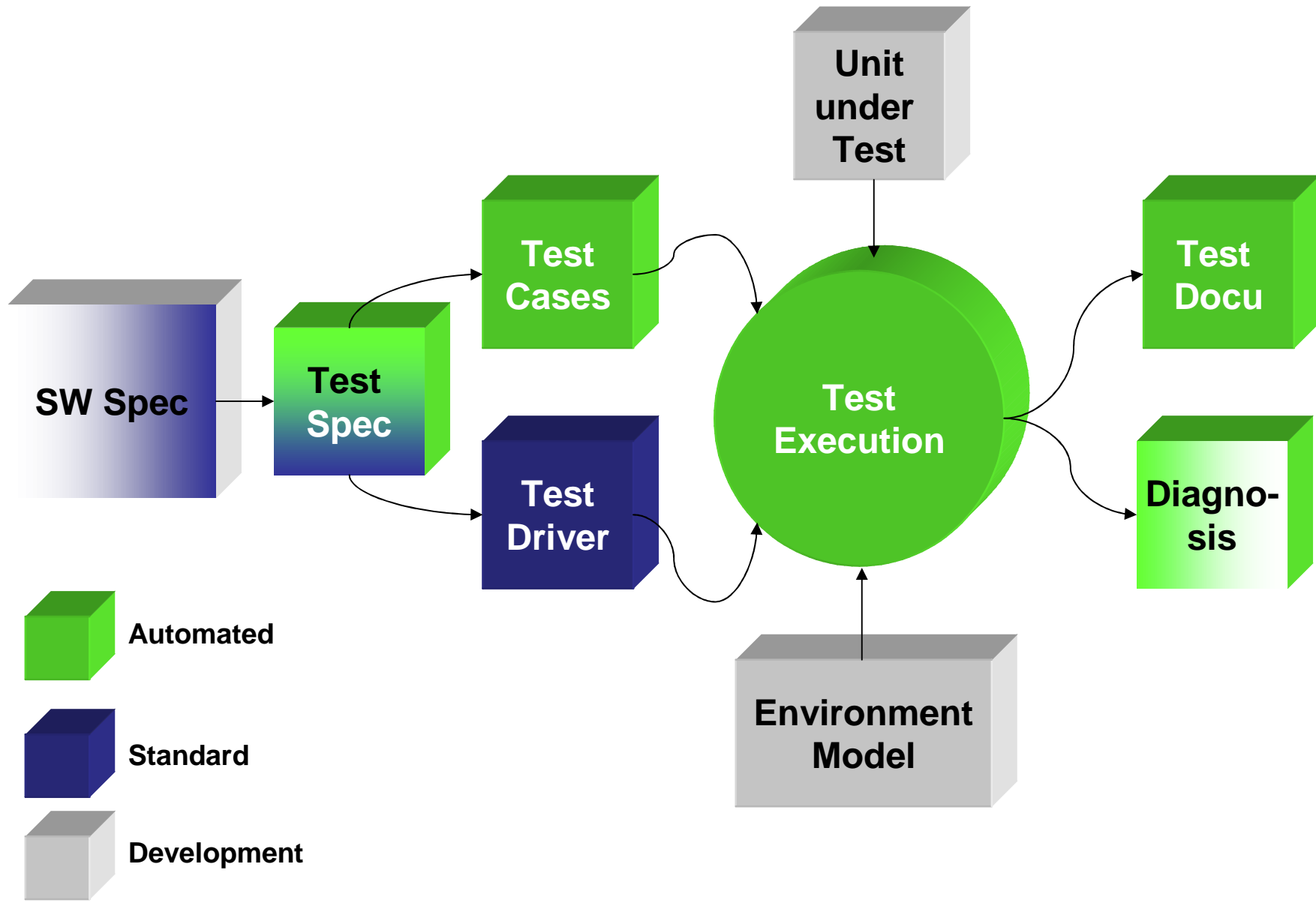


Time



Quality

Q



Automated System Tests with MicroConsult System Test, MC-ST

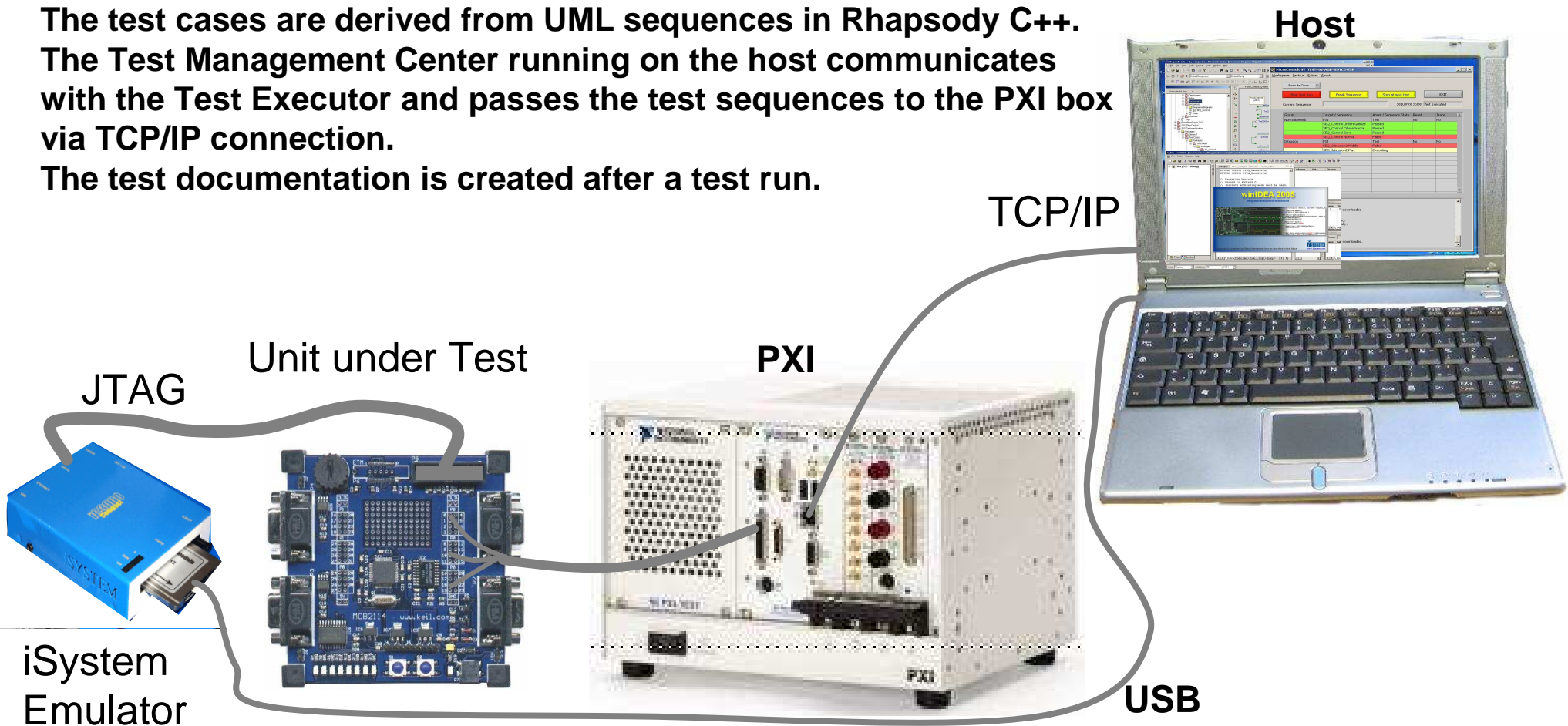
MC-ST is a framework for automated system tests with UML and LabVIEW.

MC-ST consists of the Test Management Center, Test Executor and Test Configurator by MicroConsult.

The Test Executor runs on the PXI Box. It contains the test drivers and executes the test sequences modeled in Rhapsody C++, simulating the environment. Test cases can be parameterized and composed to test sequences using the Test Configurator.

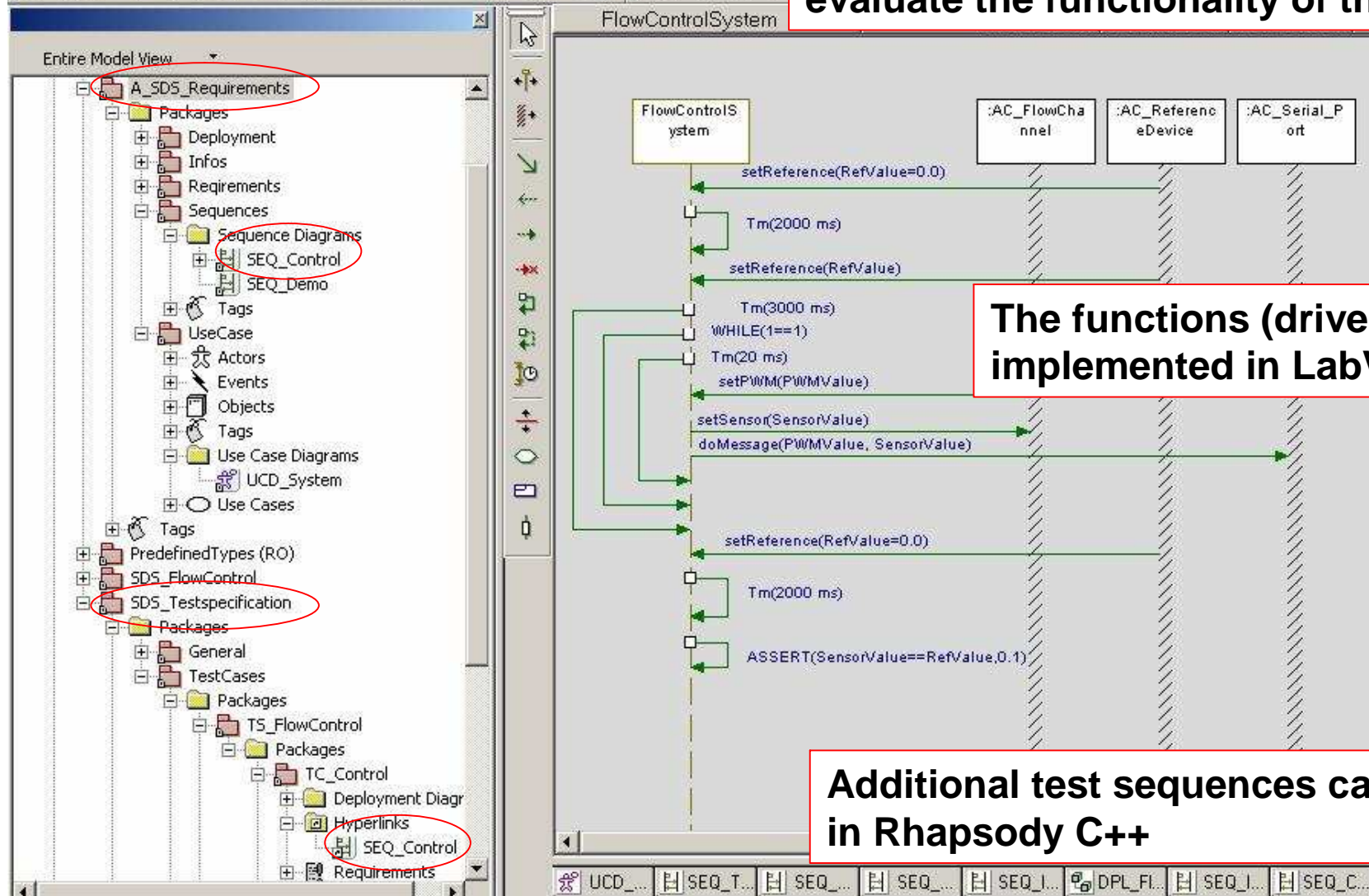
The test cases are derived from UML sequences in Rhapsody C++. The Test Management Center running on the host communicates with the Test Executor and passes the test sequences to the PXI box via TCP/IP connection.

The test documentation is created after a test run.



Rhapsody in C++ by I-Logix Inc. - FlowControl.rpy - [Sequence Diagram: SEQ_Control in A_SDS_Requirements::Sequences]

Sequences from requirements analysis describing the functionality of the system are used as test cases to evaluate the functionality of the system.

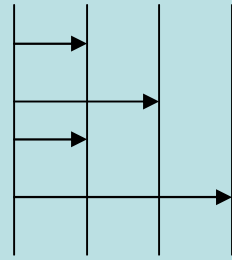


The functions (drivers) have to be implemented in LabVIEW.

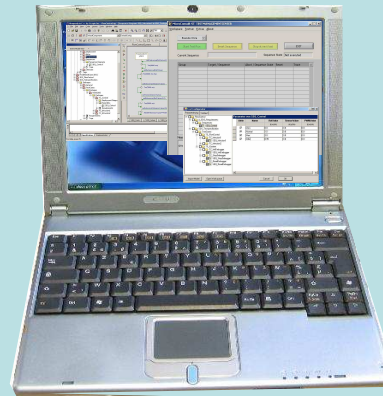
Additional test sequences can be modeled in Rhapsody C++

Software Specification -> Test Specification -> Test Cases

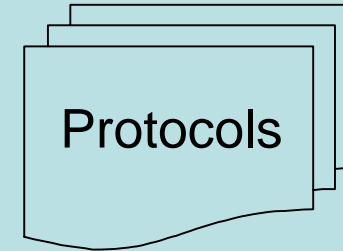
Host



Test Sequence:

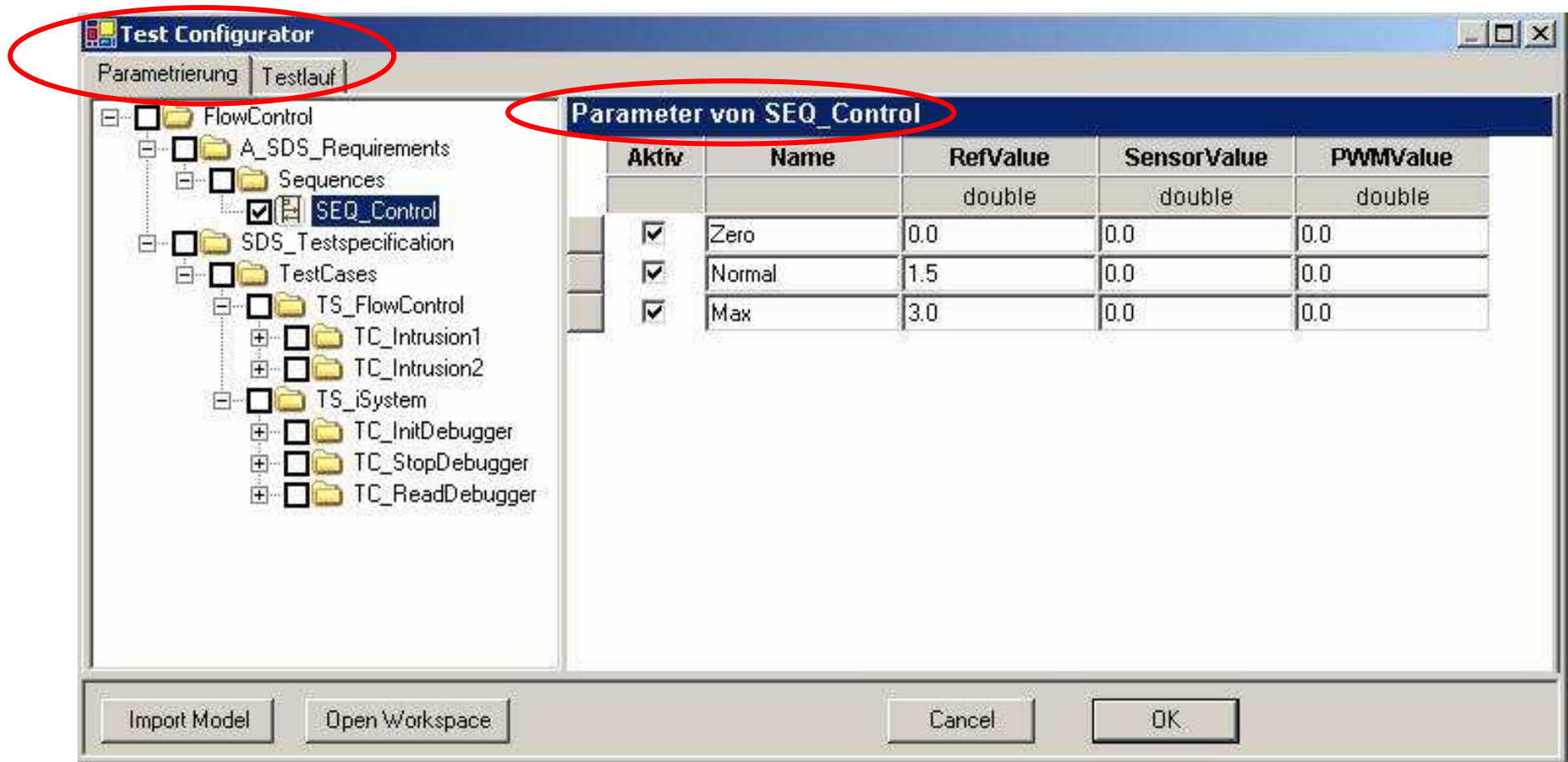


Test Management Center



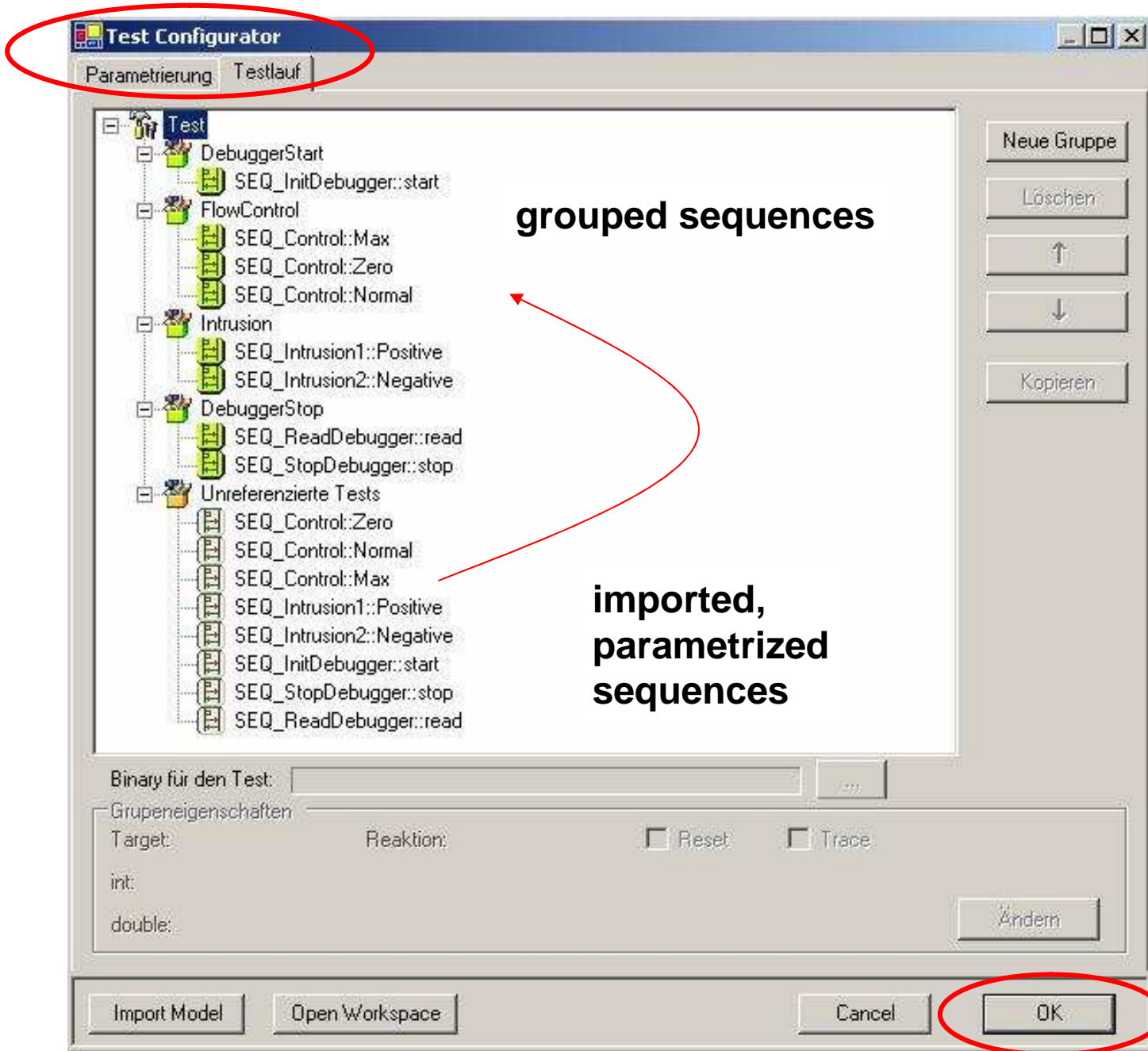
The screenshot shows two windows side-by-side. The left window is Rhapsody in C++ displaying a sequence diagram for 'SEQ_Control'. The right window is the 'MC-ST TestConfigurator' showing a tree view of test cases. A red arrow points from the 'SEQ_Control' element in the Rhapsody tree to the 'SEQ_Control' element in the TestConfigurator tree. Another red arrow points from the 'Import Model' button in the TestConfigurator to the 'SEQ_Control' element in the Rhapsody tree. A red box labeled 'Requirements' points to the 'A_SDS_Requirements' package in Rhapsody. A red box labeled 'Test Spec' points to the 'SEQ_Control' element in Rhapsody. A red box labeled 'Link' points to the 'SEQ_Control' element in Rhapsody. A red box labeled 'Sequences from Rhapsody C++ are imported into the MC-ST Test Configurator.' points to the 'Import Model' button in the TestConfigurator.

Parameterization of Test Cases with the Test Configurator



One sequence diagram can be used for several test cases with different parameters.

Import of Test Sequences from Rhapsody into the Test Configurator



The test sequences can be grouped and sorted.

grouped sequences

imported,
parametrized
sequences

Test Management Center

MicroConsult ST TESTMANAGEMENTCENTER

workspace Testrun Extras About

Execute Once

Start Test Run

Break Sequence

Stop at next test

EXIT

Current Sequence

Sequence State Not executed

Group	Target / Sequence	Abort / Sequence State	Reset	Trace
FlowControl	PXI	Test	No	No
	SEQ_Control Max	Not executed		
	SEQ_Control Zero	Not executed		
Intrusion	PXI	Test	No	No
	SEQ_Intrusion1 Positive	Not executed		
	SEQ_Intrusion2 Negative	Not executed		

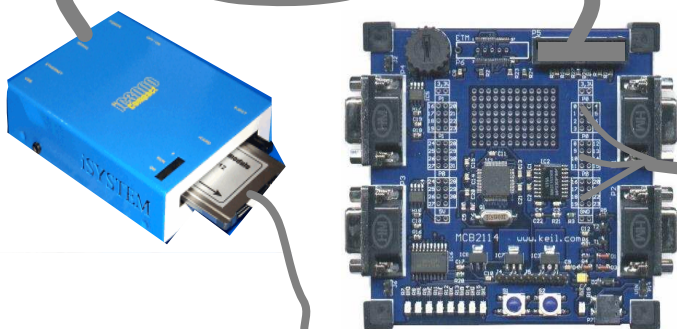
The sorted and parameterized tests are loaded into the Test Management Center.

Host

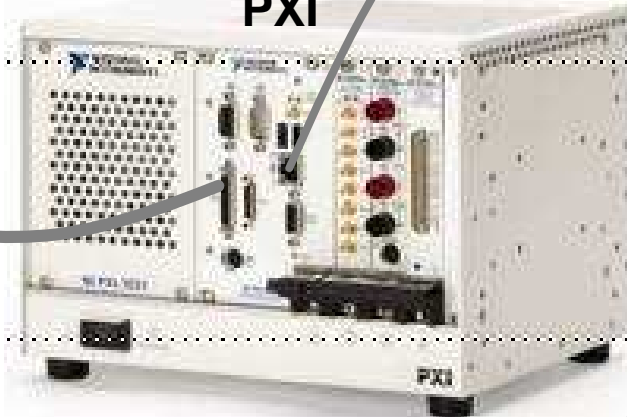


TCP/IP

JTAG



PXI

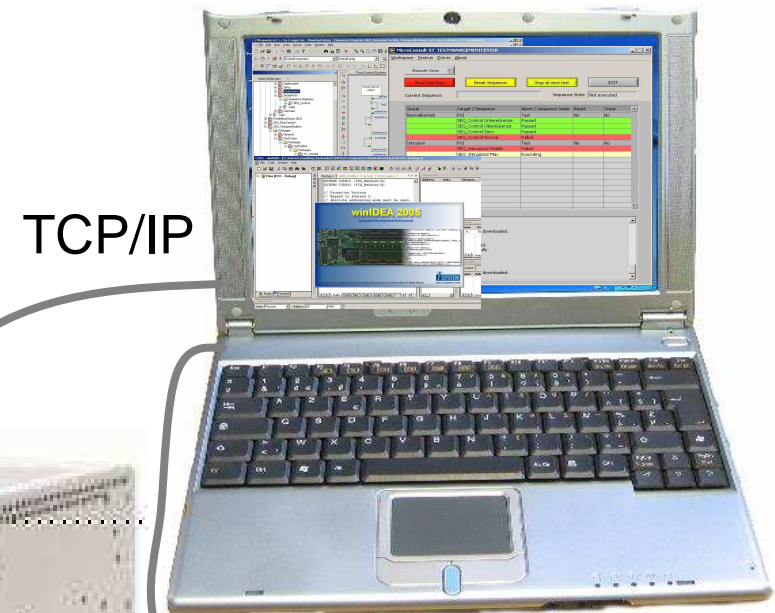


USB

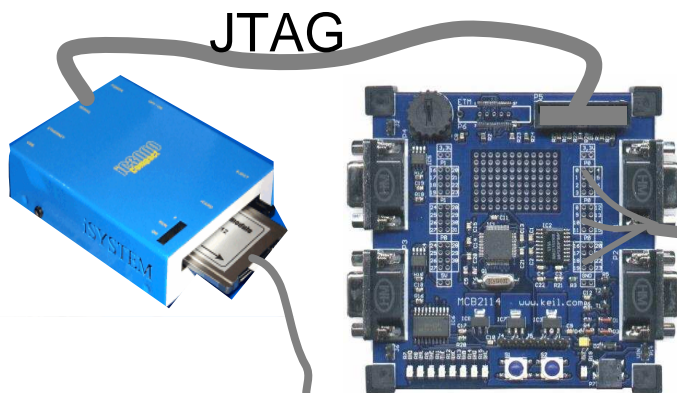


The Test Executor and the drivers are loaded down into to the PXI Box.

The Test Management Center passes the tests on to the Test Executor running on the PXI Box. Tests are executed.



TCP/IP

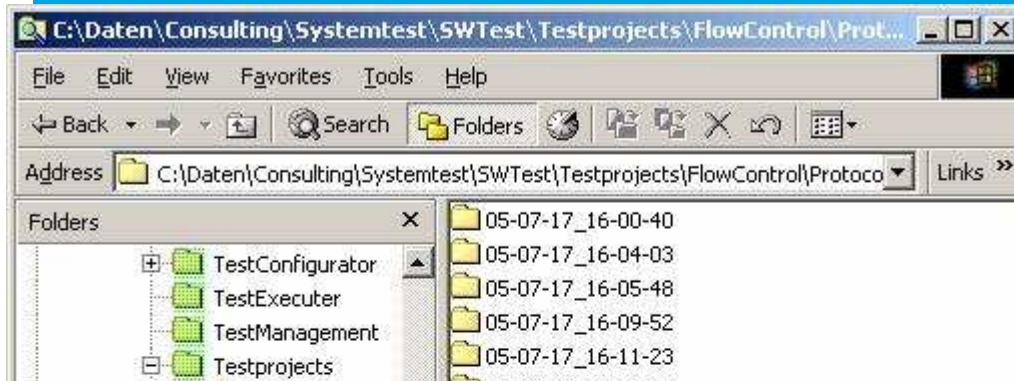


JTAG



USB

After a test run, protocols are filed in a protocol directory.



```

=====Sequence State=====
SEQUENCE: SEQ_Intrusion2 Positiv
STATE: Passed
MESSAGE:
  executed till 15
TRACE:
09:32:30.922 IT      0  Flow Control started.
09:32:31.509 IT      1  A_SDS_Requirements::UseCase::FlowControlSystem.FlowControlSystem.setReference
09:32:31.509 IT      1  No return,0.000000
09:32:31.512 FL      2  wait-Initial 2000, ID 1
09:32:31.512 FL      2
09:32:31.513 IT      3  Timer wait/RST, ID 1
09:32:33.493 IT      3
09:32:33.494 IT      4  A_SDS_Requirements::UseCase::FlowControlSystem.FlowControlSystem.setReference
09:32:33.494 IT      4  No return,1.500000
09:32:33.495 IT      5  wait-Initial 3000, ID 2
09:32:33.495 IT      5
09:32:33.496 IT      6  Timer wait/RST, ID 2
09:32:36.467 IT      6
09:32:36.468 FL      7  A_SDS_Requirements::UseCase::AC_FlowChannel.AC_FlowChannel.setIntrusion2
09:32:36.468 FL      7  No return,0.700000
09:32:36.469 IT      8  wait-Initial 7000, ID 3
09:32:36.469 IT      8
09:32:36.470 IT      9  Timer wait/RST, ID 3
09:32:43.407 IT      9
09:32:43.407 FL     10  A_SDS_Requirements::UseCase::AC_FlowChannel.AC_FlowChannel.setsensor
09:32:43.424 IT     10  No return,1.499108
09:32:43.427 FL     11  A_SDS_Requirements::UseCase::FlowControlSystem.FlowControlSystem.setReference
09:32:43.427 FL     11  No return,0.000000
09:32:43.427 IT     12  wait-Initial 2000, ID 4
09:32:43.427 IT     12

```

The trace protocol shows each step of the test run.

Testprotokoll		lfd. Nr.:	Default Workspace Name_86
		Datum:	17.07.2005 17:23:13
Projekt:			
Projekt-Nr.:	Flow Control 001		
Projektname:	Flow Control Test Project		
Beschreibung:			
Test project for flow control. Test driver with data management.			
vorgelegt von			
Name/Abt.:	Rosenthal	Telefon:	+49(0)89 450617 62
		E-Mail:	rosenthal@microconsult.de
Ausgeführte Testfälle:			
Beschreibung der Testfälle	- SEQ_Control: Standard Use Case for controller - Countinous test		
Testfälle Statistik:	Klassifikation:	Absolut	% bezogen auf Anzahl
	Anzahl:	244	100
	Ausgeföhrt:	243	100
	Passed	243	100
	Failed	0	0
	Execution Error	1	0
Ausführung:			
Testobjekt:	Flow Channel Control		
Testumgebung: (Konfiguration, Test- umgebung, Hardware)	HIL, PXI, PXI-6221 MDAQ		

```

Debugger.log - Notepad
File Edit Format Help
[[variables]
k=0
[Registers]
R13=5F676B
[PWM_val_array]
PWM_val_array(0)=0
PWM_val_array(1)=0
PWM_val_array(2)=0
PWM_val_array(3)=0
PWM_val_array(4)=0
PWM_val_array(5)=0
PWM_val_array(6)=0
PWM_val_array(7)=0

```

The debugger log file contains the read-out register and variable values. The values are read out using the JTAG emulator.

A test protocol according to IEEE 829 is created.

SEQ_Control.tst - Notepad

```

[sequence]
Name=SEQ_Control Norma

[parameters_int]
2000 const
20 const
1 const
3000 const

[parameters_double]
1.5 RefValue
0 sensorvalue
0 PWMValue
0.0 const
0.1 const

[parameters_string]

[steps]
1 1 2 2 0 40000004
7 0 3 4 1 80000001 3 3
8 0 4 1 1
1 1 5 2 0 40000001
7 0 6 4 3 80000004 3 d
4 0 7 4 80000003 0 80000003 d
7 0 8 4 2 80000002 3 b
1 2 9 2 0 40000003
1 3 a 2 0 40000002
1 4 b 3 0 40000003 40000002
8 0 c 1 2
0 0 6 0
8 0 e 1 3
1 1 f 2 0 40000004
7 0 10 4 4 80000001 3 10
8 0 11 1 4
6 0 12 4 40000002 0 40000001 400
        
```

Test Configurator

Parametrierung | Testlauf

FlowControl

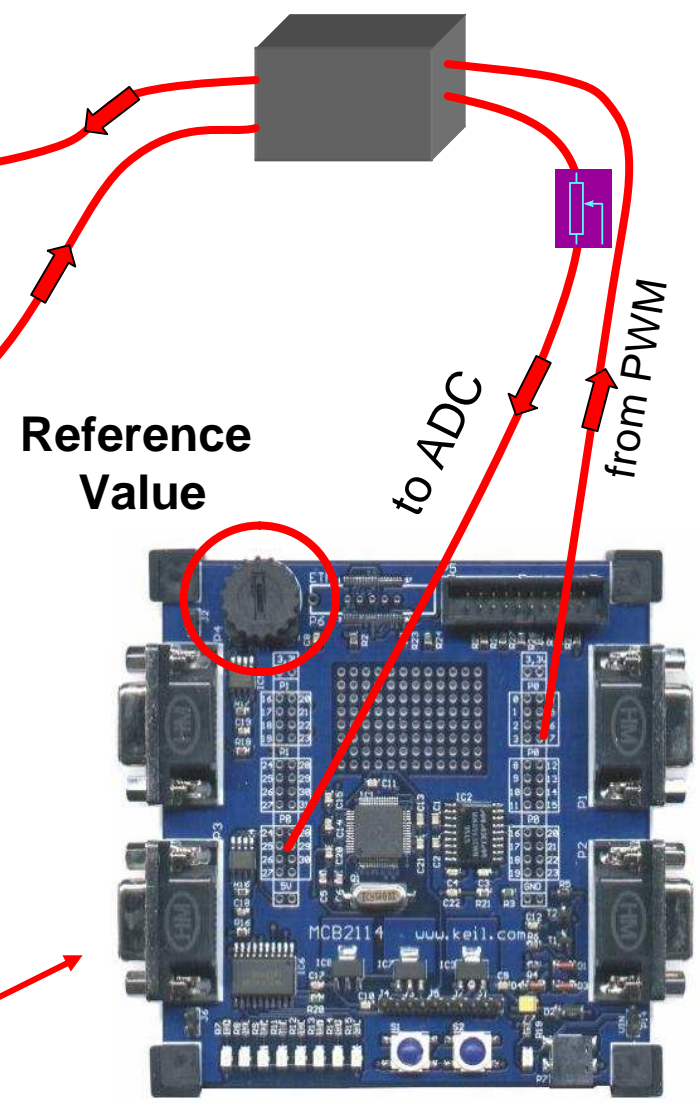
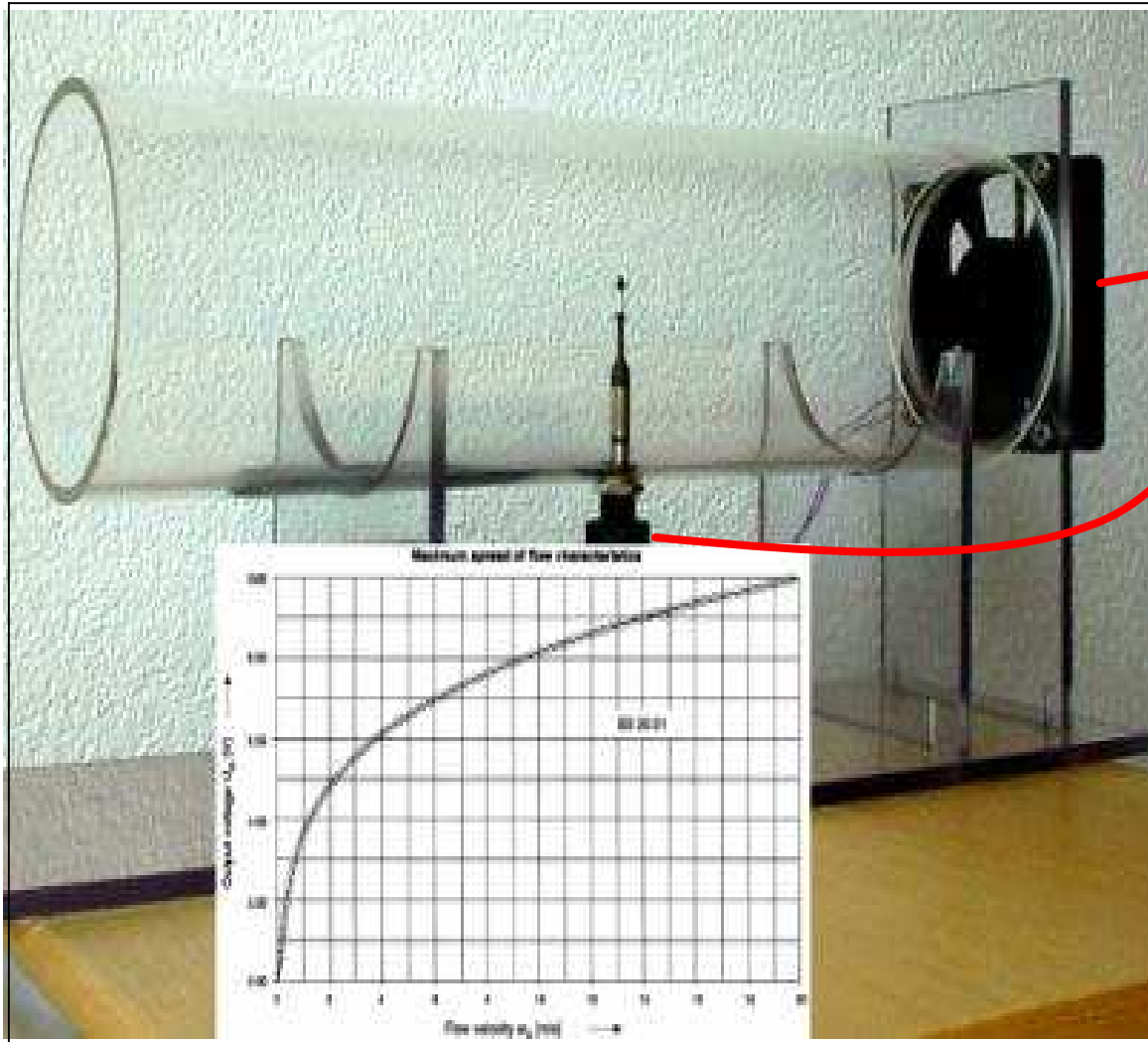
- A_SDS_Requirements
 - Sequences
 - SEQ_Control
- SDS_Testspecification
 - TestCases
 - TS_FlowControl
 - TC_Intrusion1
 - TC_Intrusion2
 - TS_System
 - TC_InitDebugger
 - TC_StopDebugger
 - TC_ReadDebugger

Parameter von SEQ_Control

Aktiv	Name	RefValue	SensorValue	PWMValue
		double	double	double
<input checked="" type="checkbox"/>	Zero	0.0	0.0	0.0
<input checked="" type="checkbox"/>	Normal			
<input checked="" type="checkbox"/>	Max			

Test Driver setReference(RefValue)

Constant air flow in the flow channel



Control Device

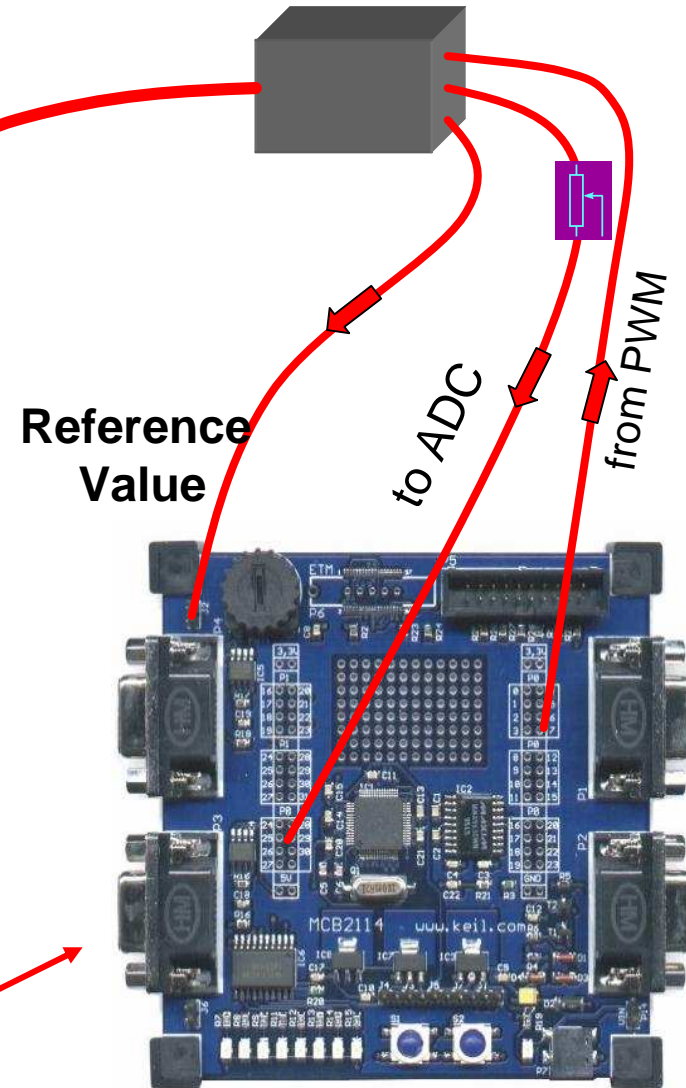
Constant air flow in the flow channel

PXI



Environment Model

Control Device



Constant air flow in the flow channel

PXI



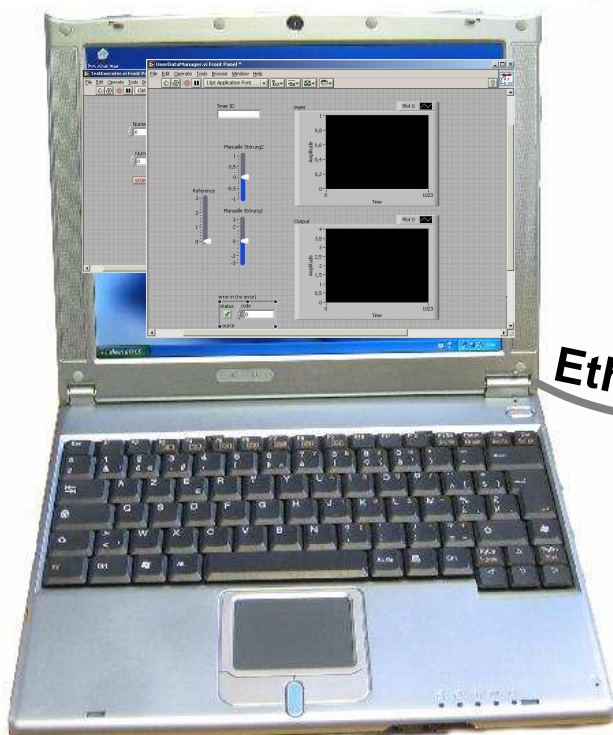
Environment Model

PXI



Control Device

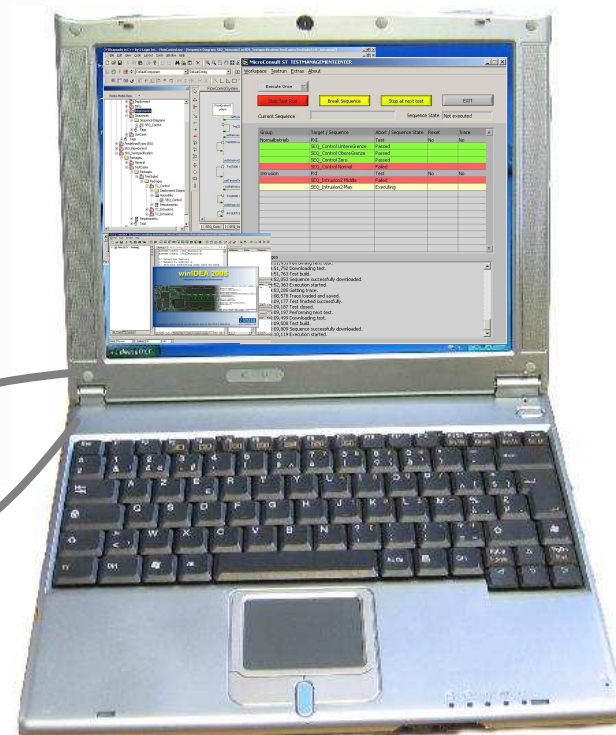
Visualization



PXI

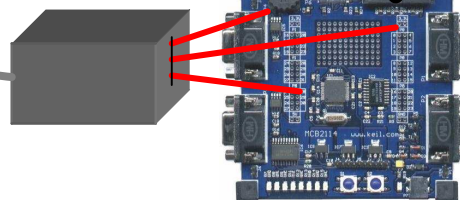
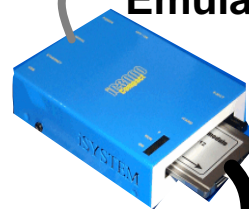


Host



Ethernet

iSystem Emulator



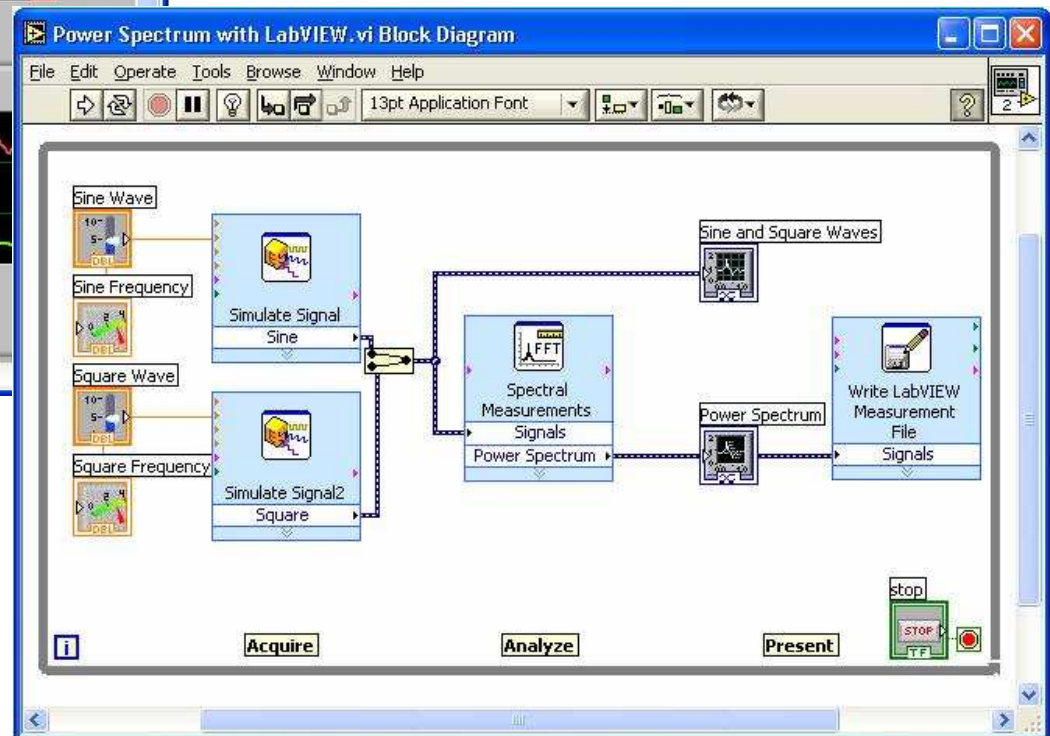
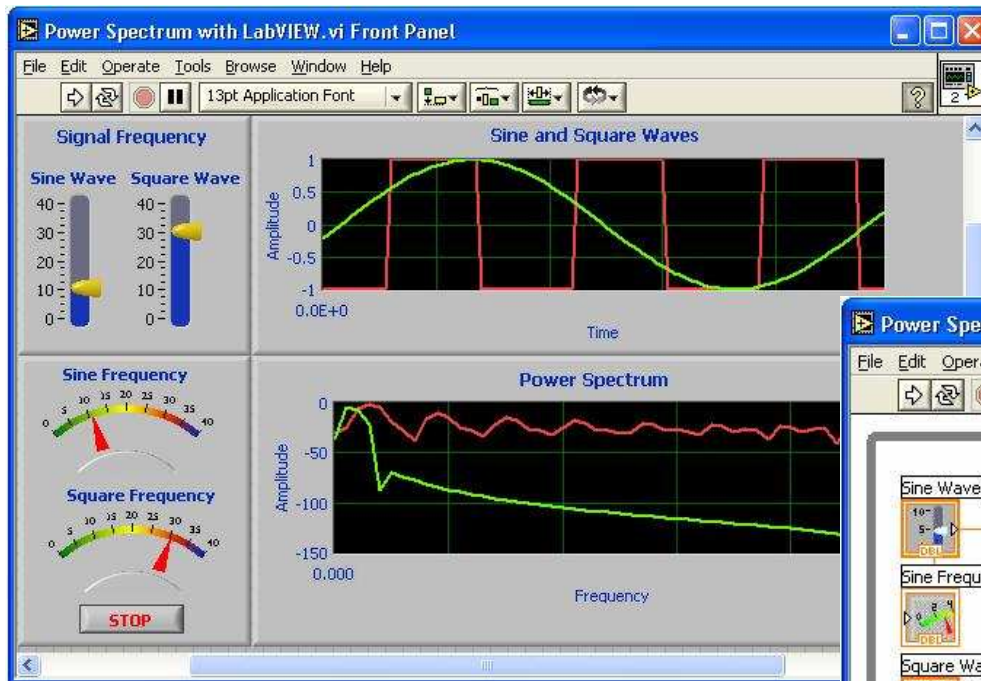
Rhapsody in C++
Test Management Center
iSystem winIDEA

PXI offers a standardized, open hardware platform for generating, measuring and displaying signals with more than 1000 I/O-cards from **many different manufacturers**.



With LabVIEW, you can program a test environment for generating, measuring and displaying signals graphically.

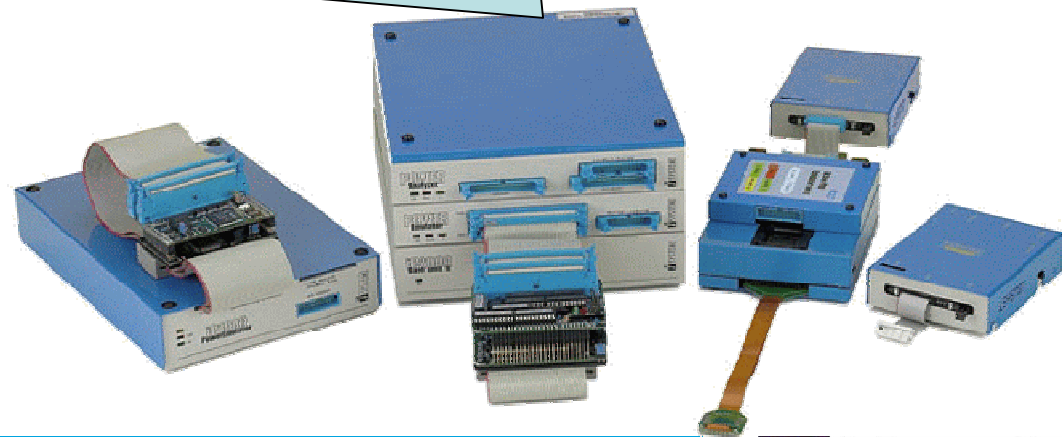
User Interface

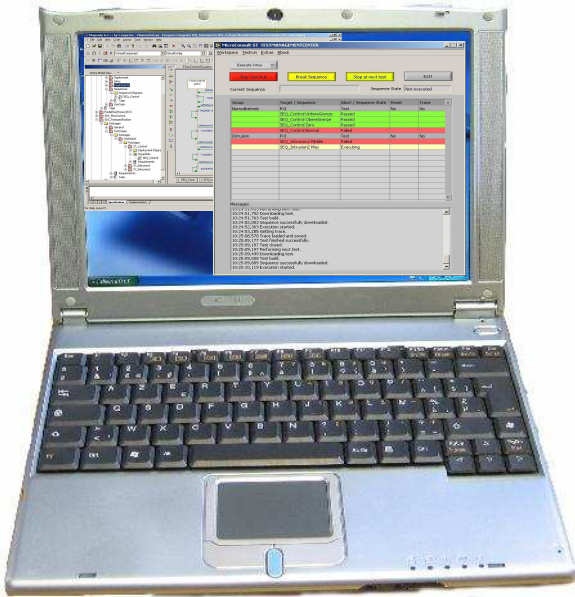




- Download
- Flash programming
- Program start/stop
- Variable read/write
- Register read/write
- Profiling

LabVIEW controls Debugger



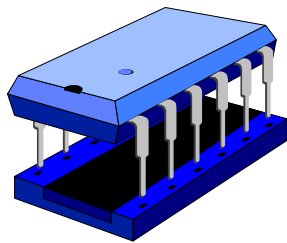


PC Sequencer as SIL

- no real-time

PXI System as HIL

- ≥ 1 ms



FPGA as HIL

- ≥ 25 ns

