

Real-Time Testing  
Automotive Testing Expo 2008 - North  
America



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- Hardware-in-the-Loop (HIL) testing
- Large number of automated test cases
- Increased testing efficiency
- Stimulate-Capture-Evaluate-Decide vs. Stimulate-Evaluate-Decide
- Test flexibility
- Reproducibility
- Time-precise signal stimulation
- Test execution control
- Plant model optimization



## Test Execution – Host PC

Stimulate → Capture → Evaluate → Decide

Test Script

DATA

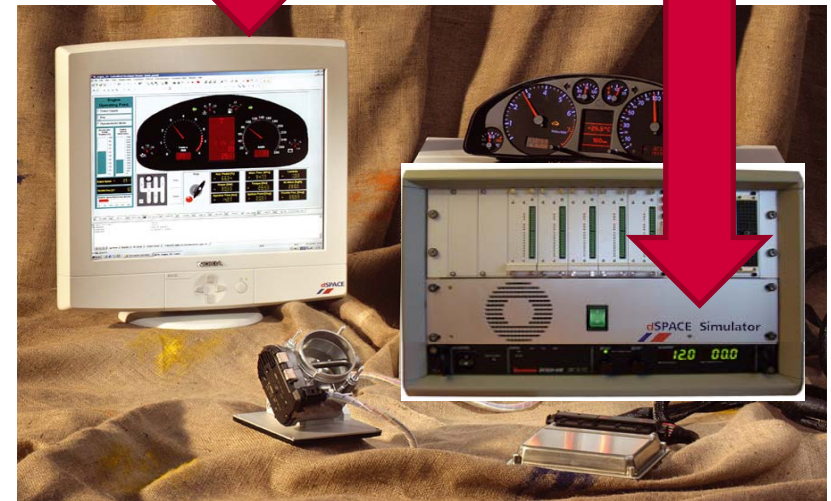


## Test Execution – Real-Time System

Stimulate → Evaluate → Decide

Test Script

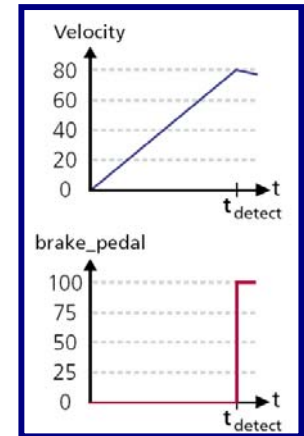
Test Results/Tests



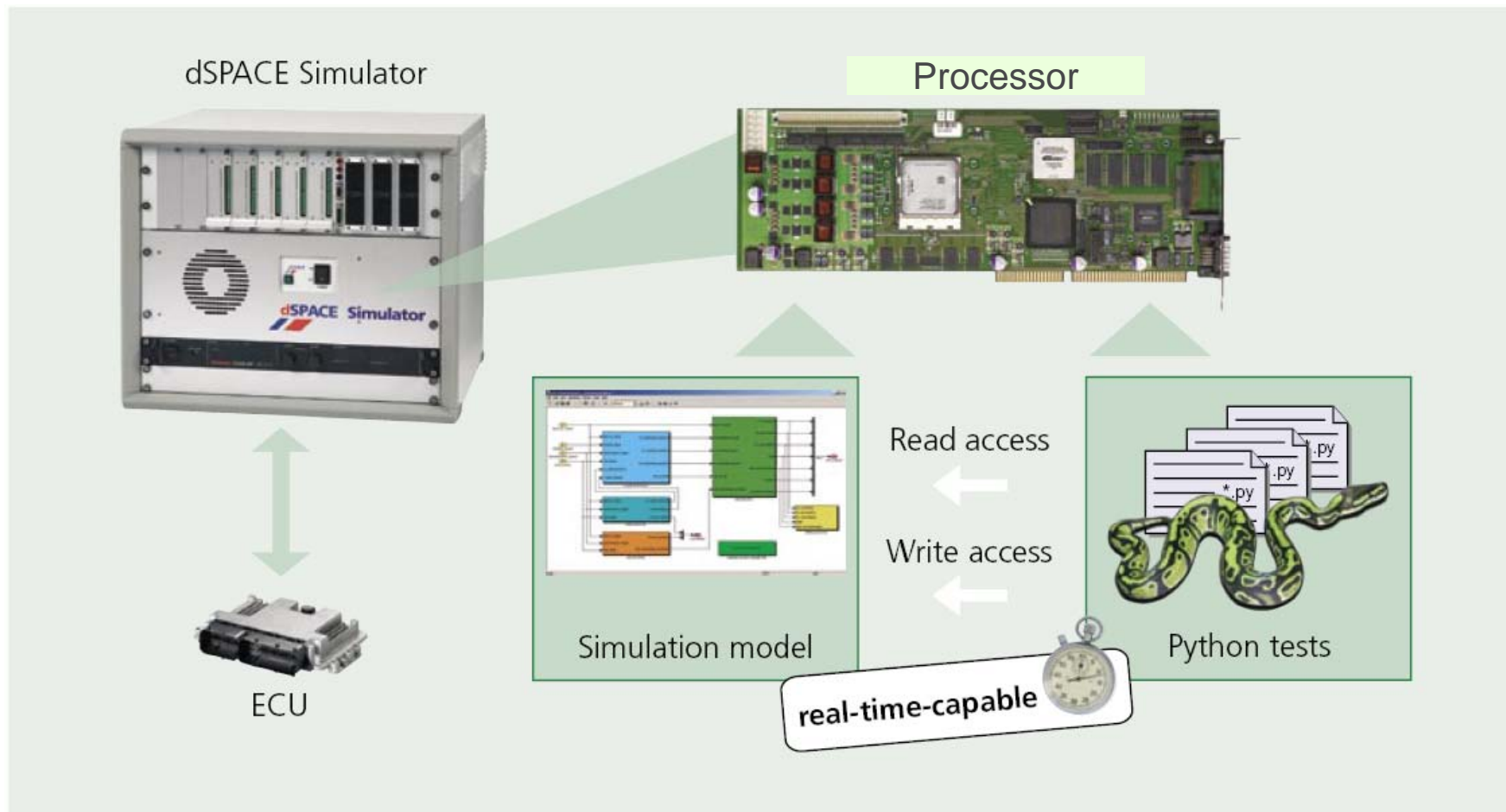
- What is Real-Time Testing?
  - Execution of embedded software validation and verification tests in a real-time environment
  - Test execution is synchronous to plant model simulation in the HIL environment
  - Test execution maintaining real-time simulation integrity



- Testing reactivity in a range of milliseconds
- Time-precise stimulation of several model signals
- Time-precise measurement of model changes
- Reliable determination of minimum and maximum values of model variables
- Dynamic execution of a Python-based CAN restbus simulation
- Exact replay of recorded bus communication (like CAN or FlexRay log files)
- Parallel execution of several independent ECU tests

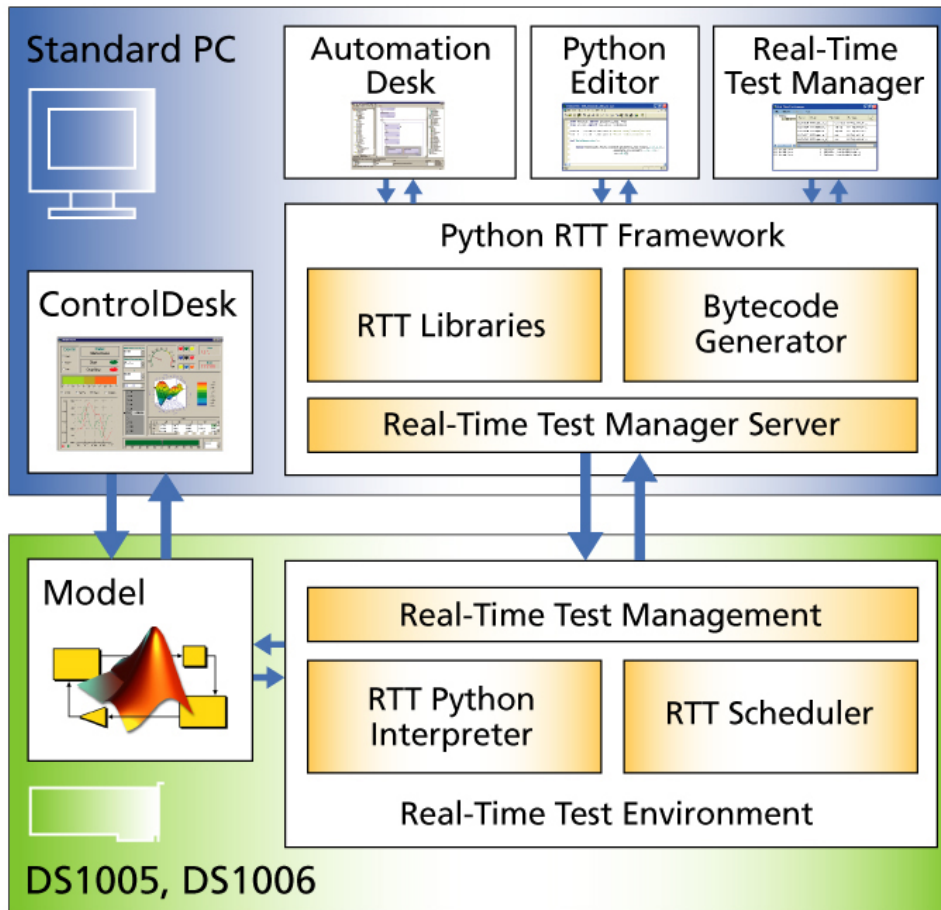


- Simple yet powerful high-level programmability
- Reproducible
- Simultaneous test execution
- Dynamic test execution management
- Flexible data exchange between Test -> Model, Test -> User Interface, test reports
- Small footprint on execution time
- Plant model independent
- API for tool and process integration



- Standard object-oriented scripting language with various standard libraries out of the box (see. [www.python.org](http://www.python.org))
- Predefined data structures (lists, tuples, dictionaries) with corresponding operations and operators for high-level programming
- Continuous development process by Python community (new libraries)
- Functionality can easily be extended by user
- Same programming language for host and real-time test scripts
- Tailored for HIL testing by specific libraries delivered by dSPACE
- Python objects can easily be passed between target and host





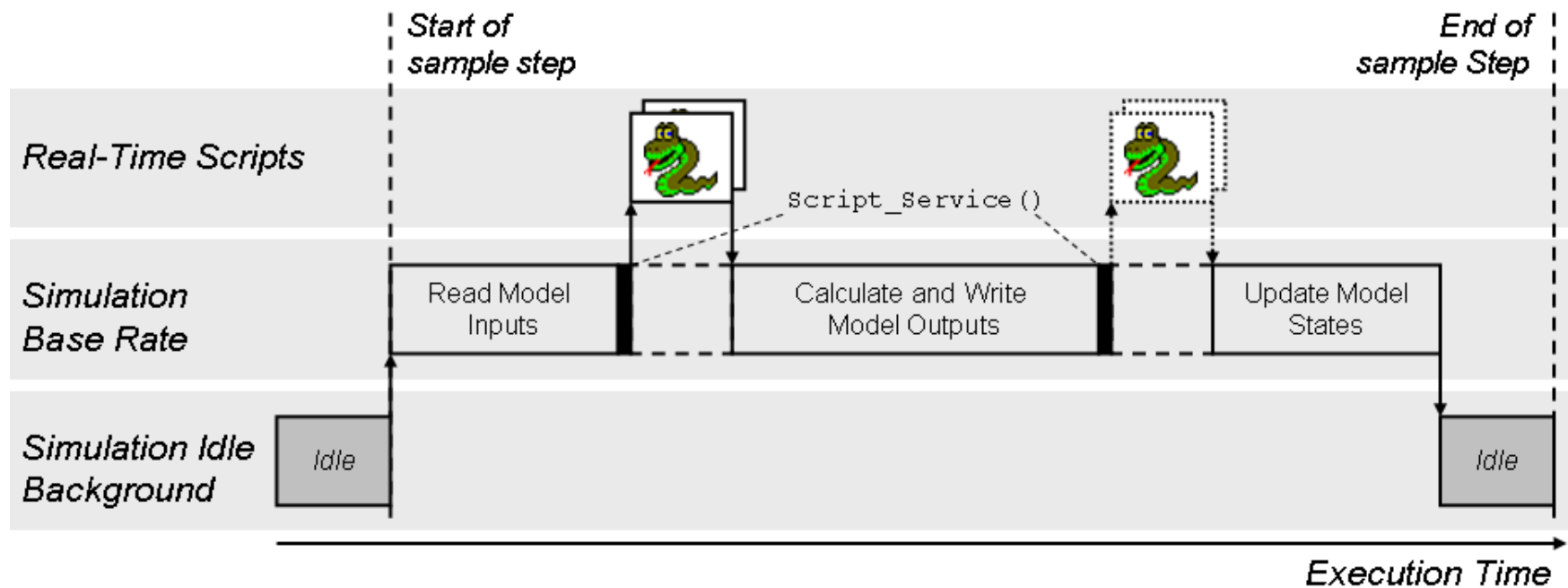
## Standard PC

- Real-time test programming via Python scripts (with use of specific RTT libraries)
- Bytecode generation
- Real-time test management (download, start, stop, pause...)

## HIL processor board

- Execution of Python real-time tests
- Synchronization between real-time tests and simulation model
- Scheduling of all real-time tests

- Programmable test execution



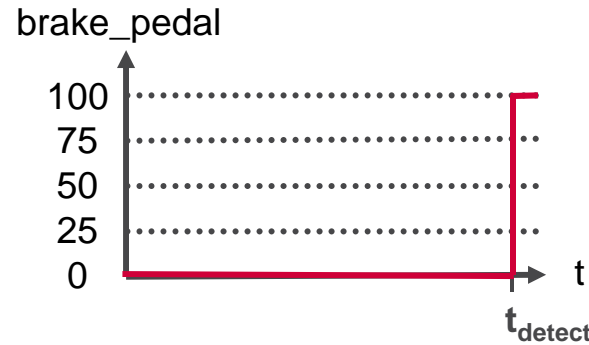
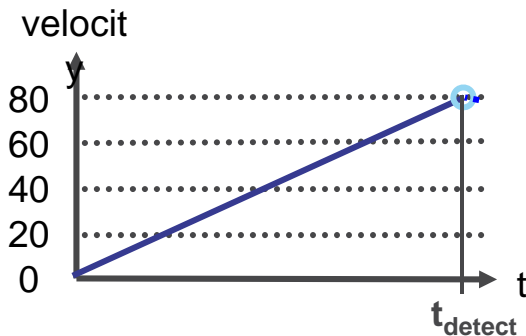
```
from rttlib import variable
velocity      = variable.Variable(r'Model Root/Velocity/Out1')
brake_pedal  = variable.Variable(r'Model Root/Brake/Value')

def MainGenerator():
    while(velocity.Value <= 80.0):
        yield None

    brake_pedal.Value = 100.0

    yield None
```

Execution waits as long as the condition is true



- Reaction is done in the same sample step of event occurrence ( $t_{detect}$ ).

## Option 1: Automated via Test Manager API

## Option 2: Interactive use of the Real-Time Test Manager

**Real-Time Test Manager**

File Platform Sequence Help

Platforms  
ds1006 (RTT)

Handle	Name	Priority	State	File Name	Last Error	Channel	Description
0x27f...	RTTSequence_0	1	Paused	C:\dSPACE\Wor...		scPre...	This is my first RTT Sequence!
0x27f...	RTTSequence_2	1	Running	C:\dSPACE\Wor...		scPre...	my second sequence
0x27f...	RTTSequence_4	1	Error	C:\dSPACE\Wor...	File "C:\dSPAC...	scPre...	third sequence ...
0x27f...	RTTSequence_5	1	Error	C:\dSPACE\Wor...	File "C:\dSPAC...	scPost...	sequence description ...
0x27f...	RTTSequence_6	1	New	C:\dSPACE\Wor...		scPost...	RTT Sequence Description ...
0x27f...	RTTSequence_7	1	Running	C:\dSPACE\Wor...		scPre...	
0x27f...	RTTSequence_8	1	Stopped	C:\dSPACE\Wor...		scPre...	My RTT Sequence 'testing ...
0x27f...	RTTSequence_9	1	Termin...	C:\dSPACE\Wor...		scPost...	a short test sequence
0x27f...	RTTSequence_10	1	Running	C:\dSPACE\Wor...		scPre...	
0x27f...	RTTSequence_11	1	New	C:\dSPACE\Wor...		scPre...	This Sequence is running for a long time.
0x27f...	RTTSequence_12	1	Error	C:\dSPACE\Wor...	File "C:\dSPAC...	scPre...	

File "C:\dSPACE\Work\MyRTTSequences\MyThirdRTTSequence.py", line 32, in MainGenerator  
exceptions.Exception: invalid parameter

RTT Manager Server (RTTSequence\_8) state changed to Stopped  
RTT Manager Server (RTTSequence\_9) state changed to Terminated  
RTT Manager Server (RTTSequence\_10) state changed to Running  
Real-Time Test Manager Byte code generator file 'C:\dSPACE\Work\MyRTTSequences\MyThirdRTTSequence.bcg' cr...  
RTT Manager Server (RTTSequence\_12) created.  
RTT Manager Server (RTTSequence\_12) state changed to Running  
RTT Manager Server (RTTSequence\_12) Start of Name: MyThirdRTTSequence\_12  
RTT Manager Server (RTTSequence\_12) Start of File: rtsequence.zip/MyThirdRTTSequence.pyc  
RTT Manager Server (RTTSequence\_12) state changed to Error  
RTT Manager Server (RTTSequence\_12) throws an Exception.

Platform Handling

Managing of RTT Sequences

Log Viewer

Embedded Success **dSPACE**

**Real-Time Test Manager**  
Version 1.4

- Full real-time model access with 100% reproducible test execution
- Execution of test scripts is synchronous to real-time model
- Read and write model variables within the simulation step
- Test programming in Python
- Established in the dSPACE tool chain
- Extensibility by user (import userlib)
- High test flexibility
- Independent from real-time model (no rebuild, no model stopping)
- Multiple scripts at a time
- Data exchange between PC and RT platform
- Easy integration into existing customer test frameworks

# Accelerate Your Testing!



- Accelerate Test Execution
- Improve Test Coverage
- Improve Test Results



Thanks for Listening!



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