

A MATLAB® Toolbox For ASAM MCD-3MC And ASAM MCD3 Measurement & Calibration Automation

Donn A Shull, L & D Engineering L.L.C.
Thomas G Prucha, dSPACE Inc.



Introduction

This presentation describes a new toolbox for MATLAB® implementing the ASAM standards for MCD-3MC (ASAP3), and COM/DCOM MCD3, for measurement & calibration (MC).

- ASAM Standards for Measurement & Calibration
- Using MATLAB® as an MC Client
- ASAM MC Toolbox Introduction



Standards for Measurement & Calibration

Remote monitoring & control interfaces



Test bench control
Automation/optimization

- ASAM MCD-3MC (ASAP3)
- ASAM MCD3 (COM/DCOM)

Data description formats

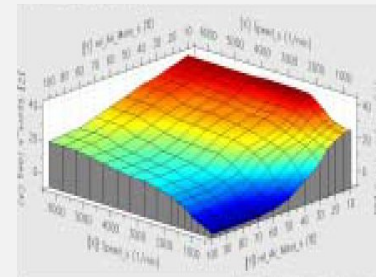
- ASAM MCD-2MC (ASAP2)
- ASAM MCD2 (FIBEX)
- DBC
- ASAM MCD-2D (ODX)



ODX: Open Diagnostic Data Exchange

Data exchange

- Calibration data
 - CDF: Calibration Data File
 - Microsoft Excel
 - DCM



- Measurement data
 - MATLAB®
 - Microsoft Excel
 - MDF, Dat

Benefits of *ASAM-MCD3* compared to *ASAP3*

ASAP3 (ASAM MCD-3MC):

- No continuous data acquisition (only polling single values)
- No single data source (separate variable lists in calibration and automation system → risk of data inconsistencies)

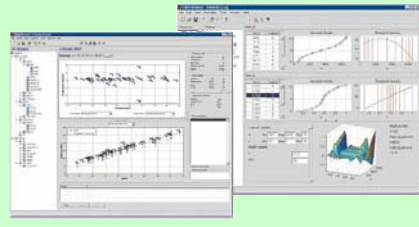
ASAM MCD3 (COM/DCOM)

- Continuous data acquisition
- Single data source: Query of available variables by automation system -> data consistency
- Standardized interface for **M**easurement, **C**alibration and **D**iagnostics supported by any OLE-capable application like MATLAB®, MS Excel®, etc.
- Integration of calibration tool with or without GUI

COM/DCOM API with CalDesk

- Calibrate parameters, curves, maps offline or online
- Switch to offline/online mode
- Activate working or reference page
- Define variables to be captured

Automation and/or optimization tool



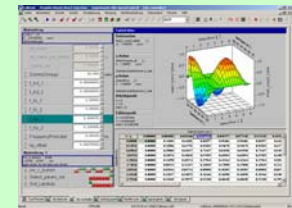
COM/DCOM

Application Programming Interface (API)

- Select experiment and device
- Check for available variables and their properties
- Capture (continuously) data

COM/DCOM (ASAM MCD3)

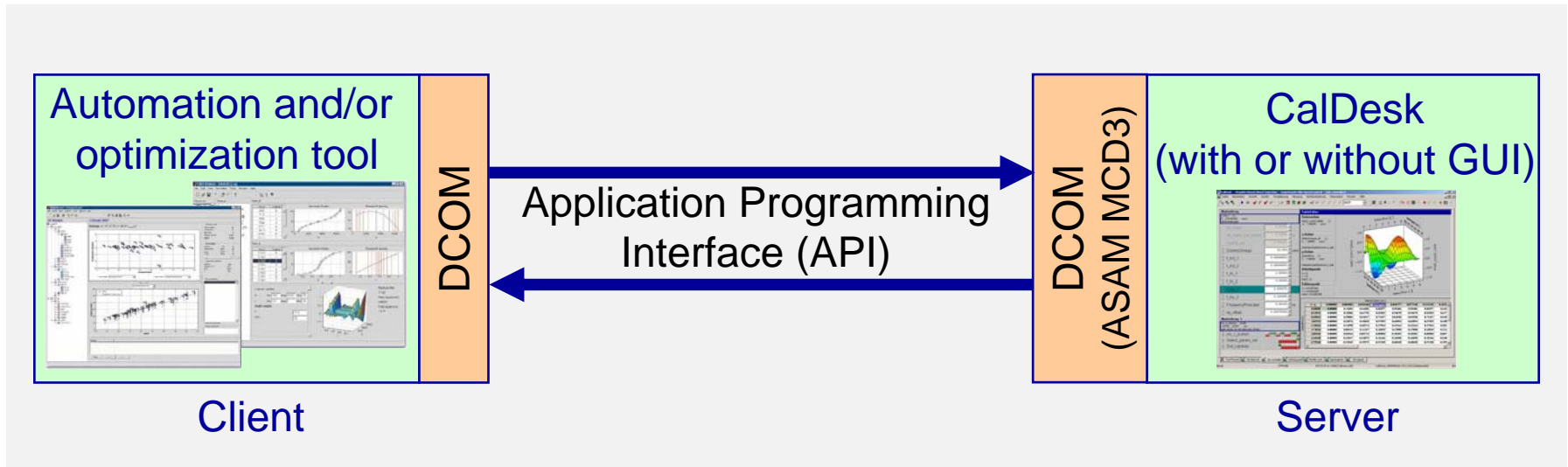
CalDesk (with or without GUI)



ECU

- Remote control of CalDesk via COM/DCOM API
- Continuous data acquisition in “real-time” raster
- Data consistency due to single data source
- Supported by any COM/DCOM-capable application, e.g., MATLAB®, MS Excel®, Automation Desk, and ControlDesk
- API standard for measurement, calibration, and diagnostics (ASAM MCD3)

COM/DCOM API with dSPACE CalDesk



Benchmark: DCOM connection

Client and server on different PCs connected via 100 Mbit/s Ethernet LAN

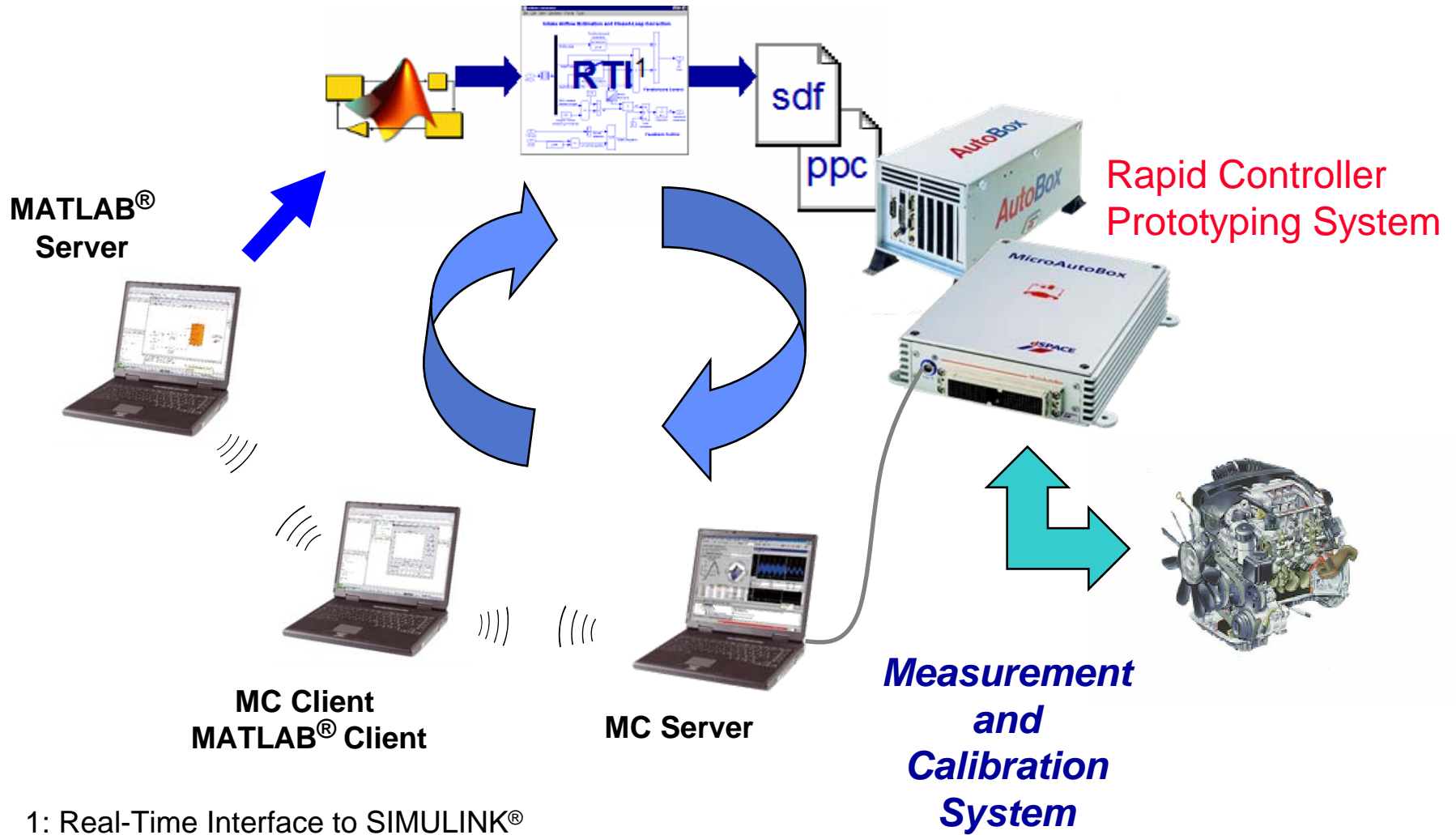
C++ test application on client system, no further computation of values

- 50 variables can be read (polled) every 125 ms
- 50 variables can be written every 100 ms
- 25 variables can be measured at 200 Hz (5ms raster)

Client System: Pentium IV, 2.4 GHz, 512 MB RAM

Server System: Pentium IV, 2.0 GHz, 512 MB RAM

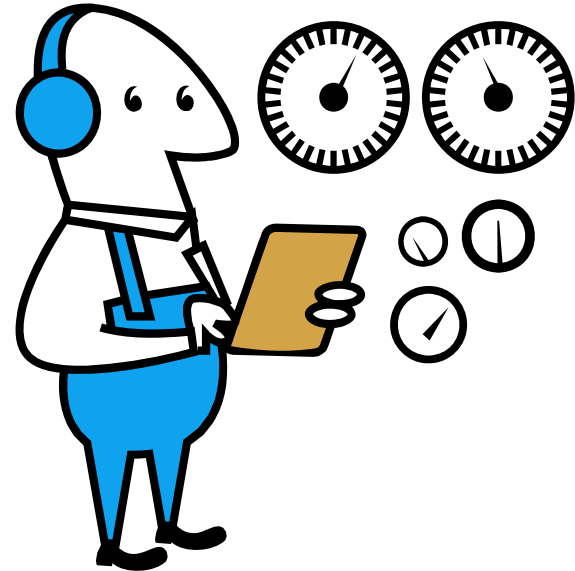
Automated Calibration – Round-Trip Back to Model



Typical Use Cases for MATLAB® MC Client

Test Bed/Dynamometer Lab

- Automated Spark ignition optimization
- Automated Fuel optimization
- Automated Cam timing optimization
- Transmission shift algorithm optimization
- Transmission line pressure optimization



Research

- Remote monitoring and control
- Time-synchronized data acquisition from distributed sources
- Real-time analysis of complex systems
- Automated Loop tuning (e.g. PI, PID)
- Automated calibration of Simulink® Models



Using MATLAB® as an MC Client

ASAM MC clients can be constructed in a variety of languages. The choice depends on how the client will be used. MATLAB® offers several unique advantages as a client environment.

- Interactive IDE eases automation development
- Built in Serial External Interfaces Support and COM/DCOM Support
- Large collection of toolboxes available for advanced data analysis
- Support for object oriented programming



MATLAB®'s Classes and Objects

The MATLAB® programming language includes object oriented programming capabilities. This allows the creation of objects which are easy to use in the scripting environment while hiding the details of interface programming.

- Function and operator overloading
- Encapsulation of data and methods
- Inheritance
- Aggregation

Basic MATLAB® Object Syntax

MATLAB® has a simple syntax for creating instances of an object and accessing its methods. These objects can be used interactively from the command line, or in programs.

Creating an Instance of an object

```
obj = objectName(objectParameters);
```

Using an objects methods

```
methodResult = methodName(obj, methodParameters);
```

ASAM MC Toolbox Introduction

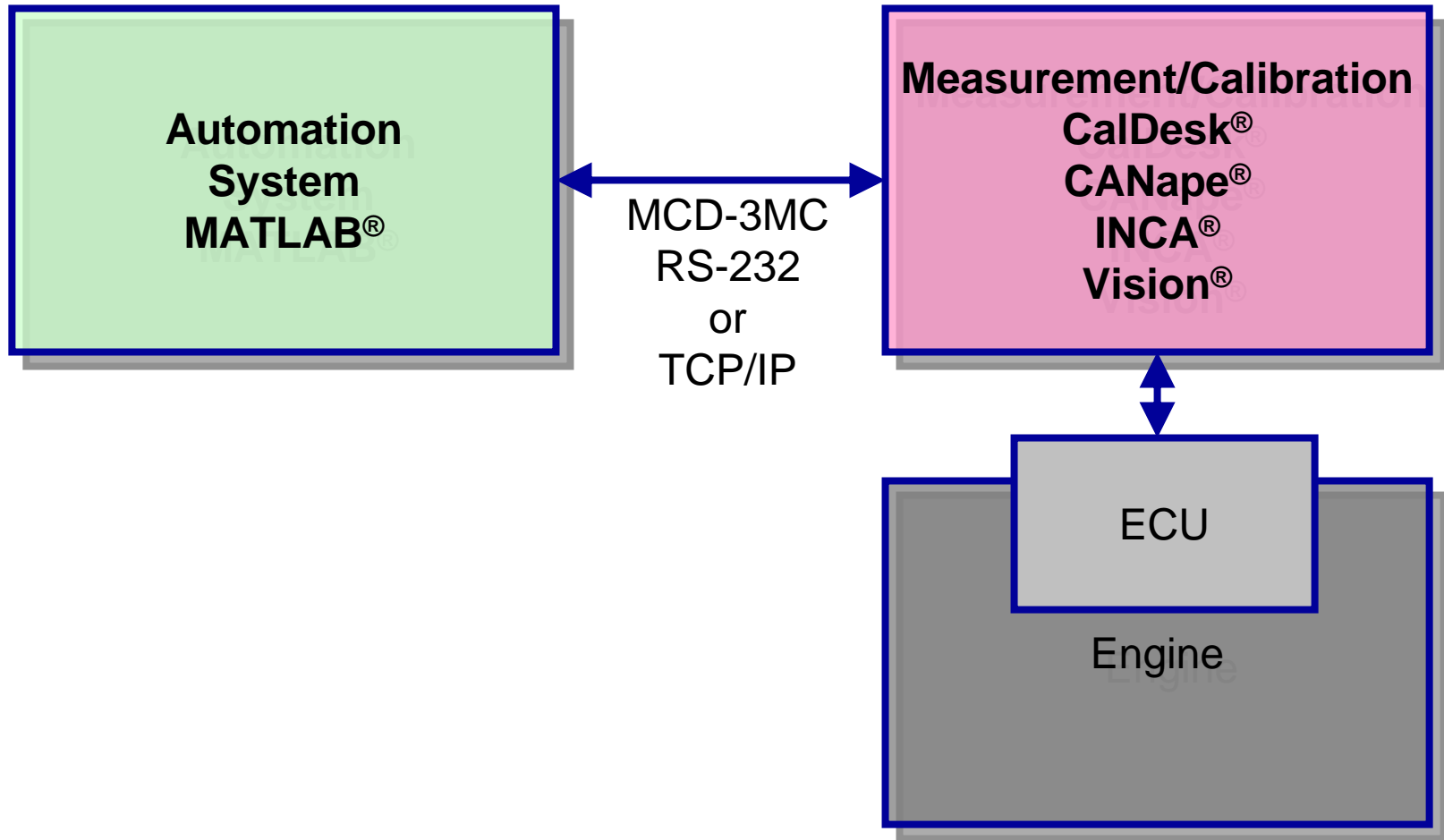
The ASAM MC Toolbox core functionality is provided by two MATLAB® objects. One object supports ASAP3 communication. The other object handles the ASAM_MCD3_V2.00 COM/DCOM standard.

- ASAP3 object inherits from Serial or TCP/IP object
- Data for transmit and receive telegrams
- Private methods for telegram handling
- Public methods implement ASAP3 functions

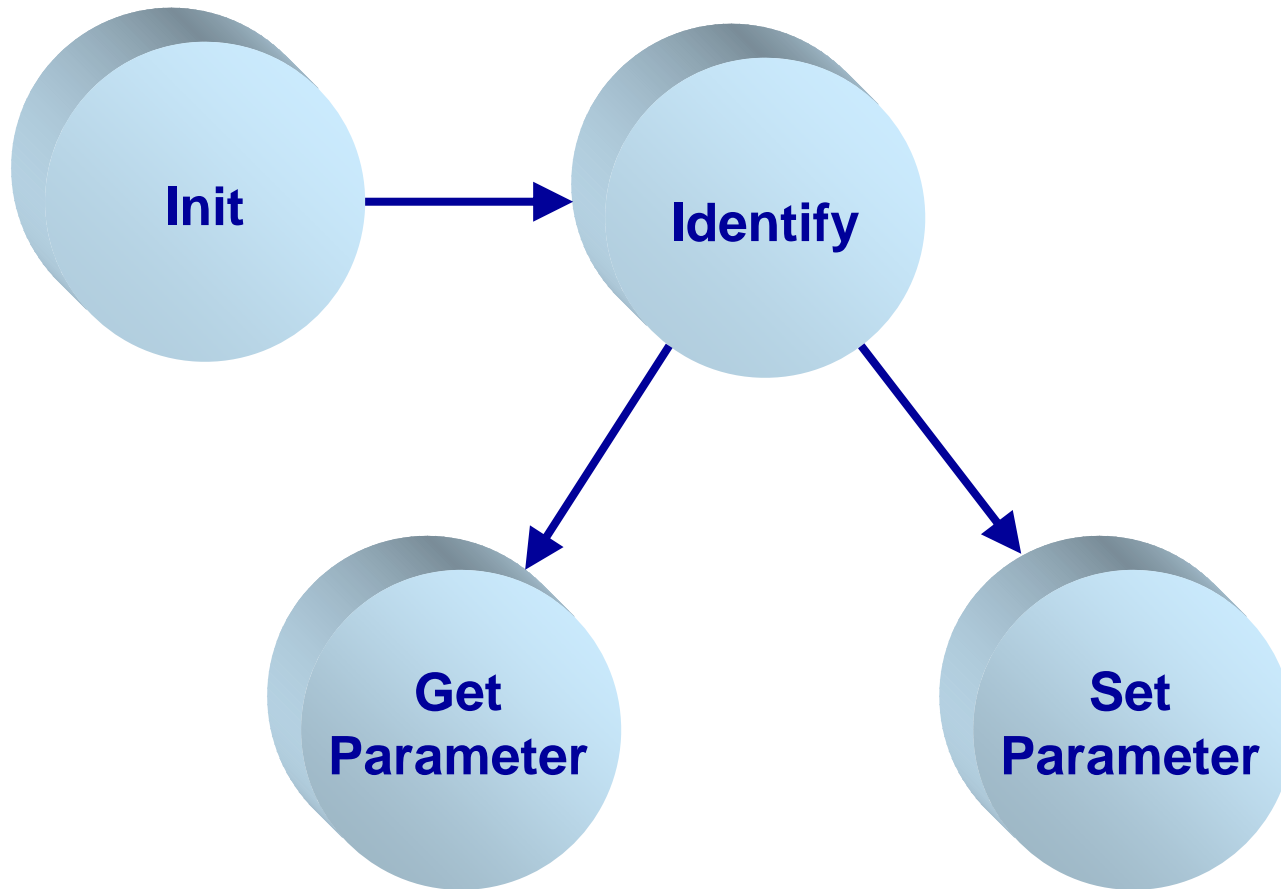
- MCD3 object encapsulates COM/DCOM component
- Methods facilitate component use

ASAM MCD-3MC (ASAP3) 16.12.1999

MCD-18-3MC-SP-R-020101-E.pdf



ASAP3 Get and Set Parameter Sequence



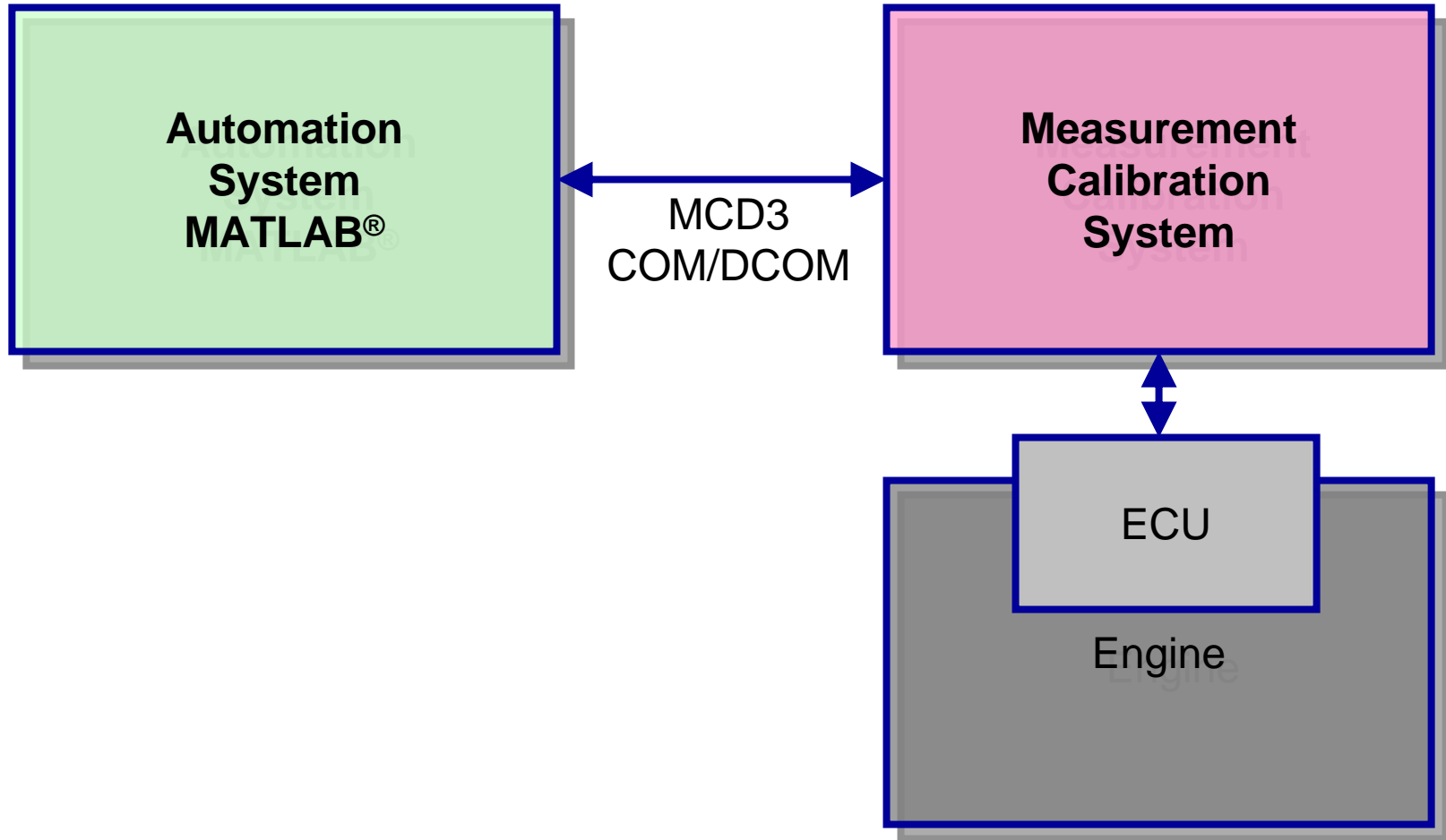
MATLAB® ASAP3 Object

Example asap3 object code for passing calibration data between MATLAB® and a calibration tool.

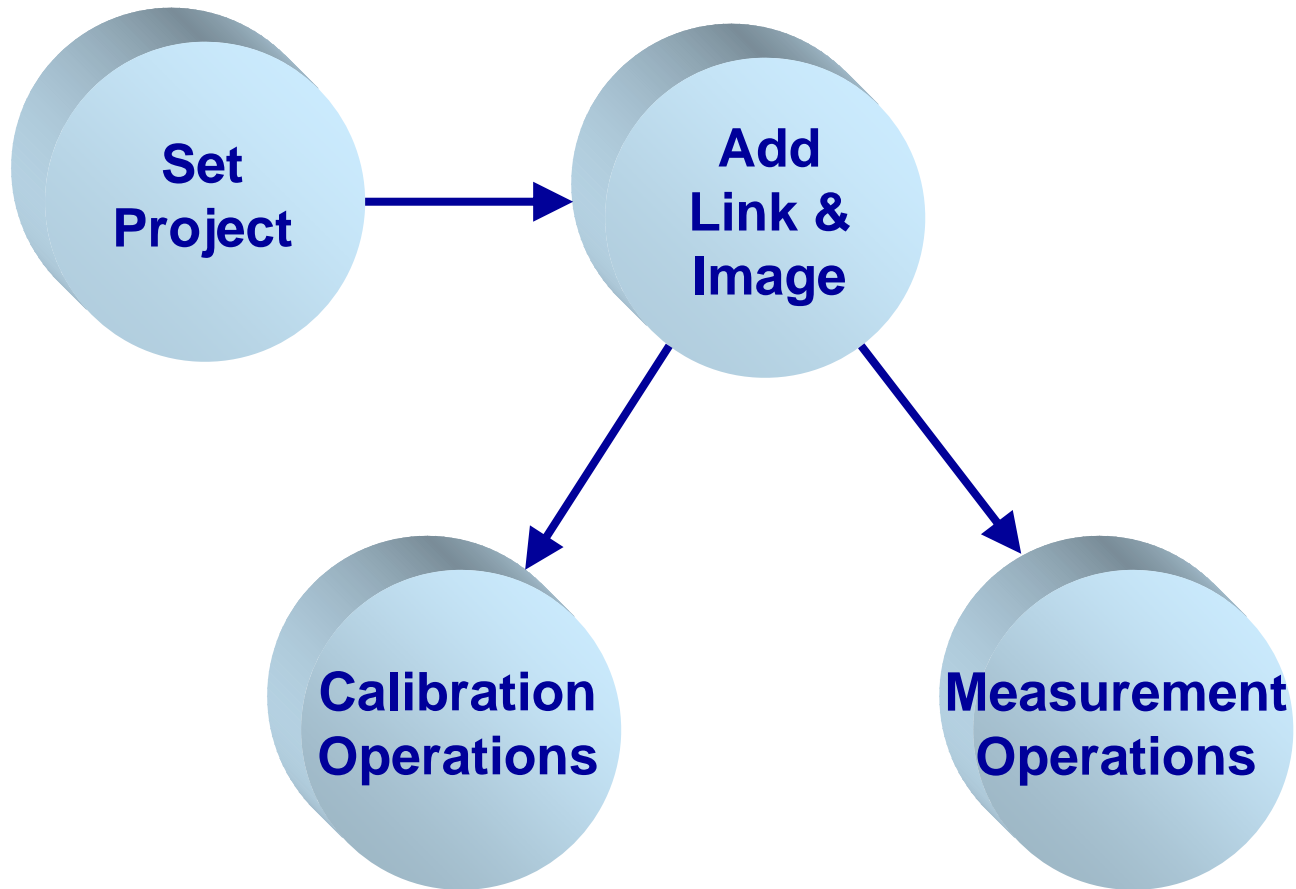
```
x = asap3;  
fopen(x);  
init(x);  
identify(x, version, 'ASAMToolbox');  
value = get_parameter(x, lun,  
    'characteristicName');  
...  
set_parameter(x, lun,  
    'characteristicName', newValue);
```

ASAM MCD3 Object Oriented Specification 31.03.2005

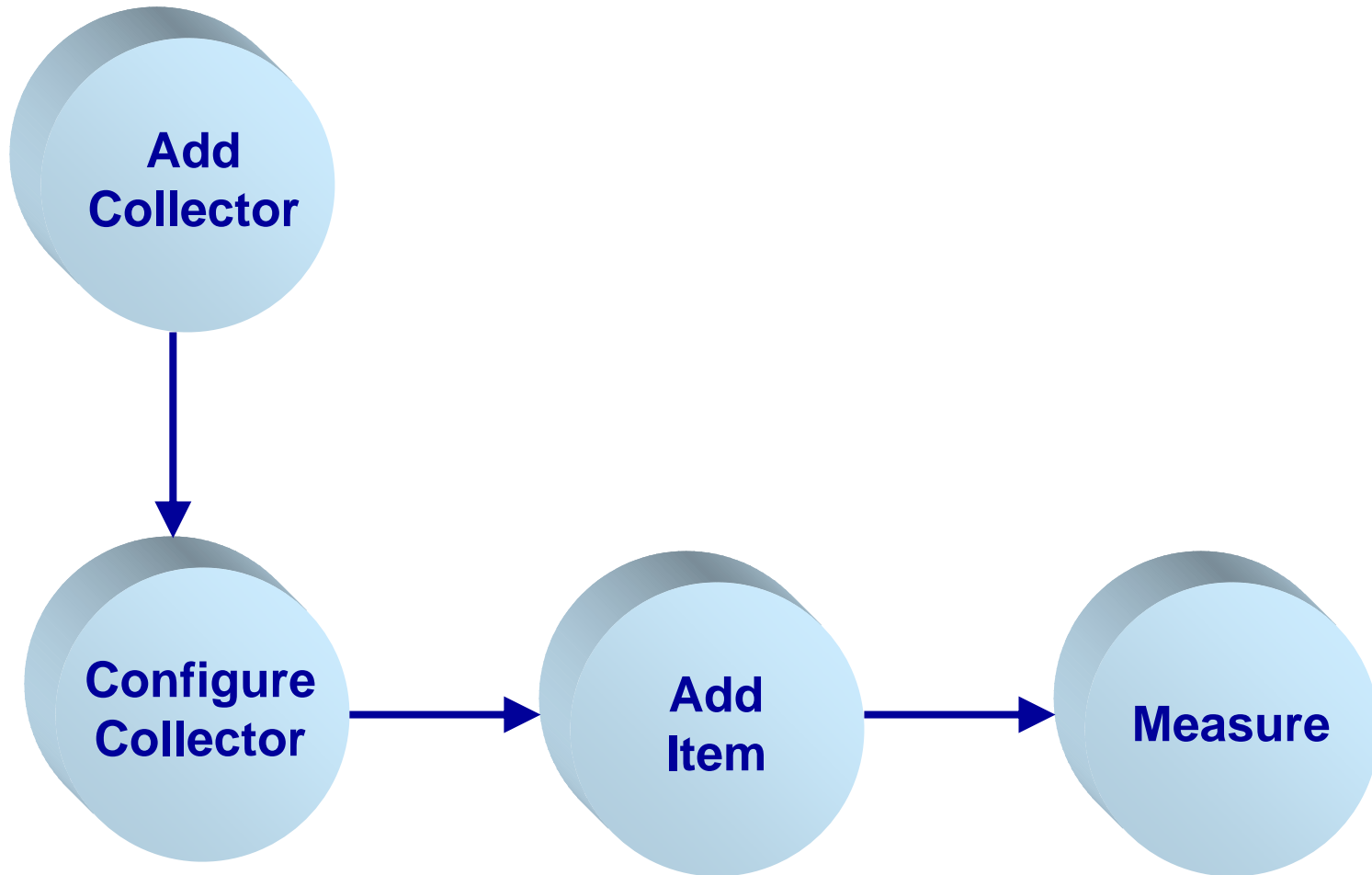
ASAM_MCD3_V2.00.02_Specification.pdf



ASAM MCD3 General Operations



ASAM MCD3 Measurement Sequence



MATLAB® MCD3 Object

Example mc3 object code for bringing measurement data into MATLAB®.

```
x = mc3('dSPACE', 'remoteHost');
set_project(x, projectName);
add_logical_link(x, logicalLink, linkImage);
add_collector(x, logicalLink);
configure_collector(x, logicalLink, collectorIndex, ...
    bufferSize, rateIndex);
add_measurement(x, {'varName'});
sig = measure(x);
```

CalDesk 1.2 With XCP on CAN Demo With ASAM MC Toolbox

- *RCP Bypass and Calibration using XCP on CAN*
- *ASAM MC Toolbox using DCOM for Remote Control*

