

This is a preview - click here to buy the full publication



IEC TR 62453-42

Edition 1.0 2016-04

TECHNICAL REPORT



**Field device tool (FDT) interface specification –
Part 42: Object model integration profile – Common Language Infrastructure**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 25.040.40; 35.100.05; 35.110

ISBN 978-2-8322-3226-2

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	19
INTRODUCTION.....	21
1 Scope.....	23
2 Normative references.....	23
3 Terms, definitions, abbreviations and conventions.....	23
3.1 Terms and definitions.....	23
3.2 Abbreviations.....	30
3.3 Conventions.....	30
4 Implementation concept.....	31
4.1 Technological orientation.....	31
4.2 Implementation of abstract FDT object model.....	31
4.3 FDT Frame Application (FA).....	32
4.4 DTM Business Logic.....	33
4.4.1 General.....	33
4.4.2 Implementation of DTM, DTM Device Type, and Device Ident Info.....	34
4.4.3 Implementation of DTM device parameter access.....	35
4.4.4 Process Data Info.....	35
4.4.5 Diagnostic Data Info.....	36
4.4.6 Network Management Info.....	36
4.4.7 Function Info.....	37
4.4.8 Report Info.....	37
4.4.9 Document Reference Info.....	37
4.5 Implementation of DTM Functions.....	37
4.5.1 DTM User Interface.....	37
4.5.2 Function access control.....	38
4.5.3 Handling of standard UI elements in modeless DTM UI interfaces.....	38
4.5.4 Command functions.....	39
4.6 User management.....	39
4.6.1 General.....	39
4.6.2 Multi-user access.....	39
4.6.3 User levels.....	39
4.7 Implementation of FDT and system topology.....	42
4.7.1 General.....	42
4.7.2 Topology management.....	43
4.7.3 Data exchange between Frame Applications.....	45
4.8 Implementation of Modularity.....	45
4.9 Implementation of FDT communication.....	45
4.9.1 Handling of communication requests.....	45
4.9.2 Handling of communication errors.....	46
4.9.3 Handling of loss of connection.....	46
4.9.4 Point-to-point communication.....	46
4.9.5 Nested communication.....	47
4.9.6 Dynamic changes in network.....	47
4.10 Identification.....	48
4.10.1 DTM instance identification.....	48
4.10.2 Hardware identification.....	48
4.11 Implementation of DTM data persistence and synchronization.....	49

4.11.1	Persistence overview	49
4.11.2	Relations of DTMDataset	50
4.11.3	DTMDataset structure	51
4.11.4	Types of persistent DTM data	52
4.11.5	Data synchronization	52
4.12	Implementation of access to device data and IO information	53
4.12.1	Exposing device data and IO information	53
4.12.2	Data access control	54
4.12.3	Routed IO information	56
4.12.4	Comparison of DTM and device data	56
4.12.5	Support for multirole devices	57
4.13	Clone of DTM instances	58
4.13.1	General	58
4.13.2	Replicating a part of topology with Parent DTM and a subset of its Child DTMs	58
4.13.3	Cloning of a DTM without its children	58
4.13.4	Delayed cloning	58
4.14	Lifecycle concepts	59
4.15	Audit trail	59
4.15.1	General	59
4.15.2	Audit trail events	59
5	Technical concepts	60
5.1	General	60
5.2	Support of .NET Common Language Runtime versions	62
5.2.1	General	62
5.2.2	Rules for FDT .NET assemblies	62
5.2.3	DTM rules	62
5.2.4	Frame Application rules	62
5.2.5	FDT CLR extension concept	63
5.3	Support for 32-bit and 64-bit target platforms	63
5.4	Object activation and deactivation	64
5.4.1	General	64
5.4.2	Assembly loading and object creation	64
5.4.3	Assembly dependencies	65
5.4.4	Shared assemblies	65
5.4.5	Object deactivation and unloading	66
5.5	Datatypes	67
5.5.1	General	67
5.5.2	Serialization / deserialization	67
5.5.3	Support of XML	68
5.5.4	Optional elements	68
5.5.5	Verify	68
5.5.6	Clone	68
5.5.7	Equals	69
5.5.8	Lists	69
5.5.9	Nullable	70
5.5.10	Enumeration	70
5.5.11	Protocol-specific datatypes	70
5.5.12	Custom datatypes	72

5.6	General object interaction.....	73
5.6.1	General	73
5.6.2	Decoupling of FDT Objects.....	73
5.6.3	Parameter interchange with .NET datatypes	74
5.6.4	Interaction patterns	74
5.6.5	Properties	74
5.6.6	Synchronous methods.....	74
5.6.7	Asynchronous methods	75
5.6.8	Events pattern	81
5.6.9	Exception handling.....	82
5.7	Threading	86
5.7.1	Introduction.....	86
5.7.2	Threading rules.....	87
5.8	Localization support	88
5.8.1	General	88
5.8.2	Access to localized resources and culture-dependent functions.....	89
5.8.3	Handling of cultures	89
5.8.4	Switching the User Interface language.....	90
5.9	DTM User Interface implementation	90
5.9.1	General	90
5.9.2	Resizing	90
5.9.3	Private dialogs	92
5.10	DTM User Interface hosting	92
5.10.1	General	92
5.10.2	Hosting DTM WPF controls	92
5.10.3	Hosting DTM WinForms controls	93
5.11	Static Function implementation	94
5.12	Persistence.....	96
5.12.1	Overview	96
5.12.2	Data format.....	97
5.12.3	Adding / reading / writing / deleting of data	97
5.12.4	Searching for data.....	99
5.13	Comparison of DTM and device data	100
5.13.1	Comparison of datasets using IDeviceData / IInstanceData	100
5.13.2	Comparison of datasets using IComparison	101
5.14	Tracing	101
5.15	Report generation	101
5.15.1	General	101
5.15.2	Report types	102
5.15.3	DTM report data format.....	102
5.15.4	Report data exchange	103
5.16	Security	103
5.16.1	General	103
5.16.2	Strong naming of assemblies.....	103
5.16.3	Identification of origin.....	104
5.16.4	Code access security	104
5.16.5	Validation of FDT compliance certification	104
6	FDT Objects and interfaces.....	106
6.1	General.....	106

6.2	Frame Application	107
6.3	DTM Business Logic.....	109
6.3.1	DTM BL interfaces	109
6.3.2	State machines related to DTM BL	114
6.3.3	State machine of instance data.....	120
6.4	DTM User Interface	123
6.5	Communication Channel.....	124
6.6	Availability of interface methods	125
7	FDT datatypes	126
7.1	General.....	126
7.2	Datatypes – Base	127
7.3	General datatypes	127
7.4	Datatypes – DtmInfo / TypeInfo	128
7.5	Datatypes – DeviceIdentInfo.....	130
7.6	Datatypes for installation and deployment.....	135
7.6.1	Datatypes – SetupManifest.....	135
7.6.2	Datatypes – DtmManifest	136
7.6.3	Datatypes – DtmUiManifest	137
7.7	Datatypes – Communication	137
7.8	Datatypes – BusCategory	143
7.9	Datatypes – Device / Instance Data	143
7.9.1	General	143
7.9.2	Datatypes used in reading and writing DeviceData	150
7.10	Datatypes for export and import.....	152
7.10.1	Datatypes – TopologyImportExport.....	152
7.10.2	Datatypes – ImportExportDataset	153
7.11	Datatypes for process data description	154
7.11.1	Datatypes – ProcessDataInfo	154
7.11.2	Datatypes – Process Image.....	159
7.12	Datatypes – Address information	160
7.13	Datatypes – NetworkDataInfo	164
7.14	Datatypes – DTM functions.....	166
7.15	Datatypes – DTM messages	168
7.16	Datatypes for delegation of DTM UI dialog actions	170
7.17	Datatypes – CommunicationChannelInfo.....	170
7.18	Datatypes – HardwareIdentification and scanning	172
7.18.1	General	172
7.18.2	Datatypes – DeviceScanInfo.....	172
7.18.3	Example – HardwareIdentification and scanning for HART	173
7.19	Datatypes – DTM report types	174
7.20	Information related to device modules in a monolithic DTM	174
8	Workflows	176
8.1	General.....	176
8.2	Instantiation, loading and release	176
8.2.1	Finding a DTM BL object.....	176
8.2.2	Instantiation of a new DTM BL.....	178
8.2.3	Configuring access rights	180
8.2.4	Loading a DTM BL	181
8.2.5	Loading a DTM with Expert user level.....	182

8.2.6	Release of a DTM BL	183
8.3	Persistent storage of a DTM	184
8.3.1	Saving instance data of a DTM	184
8.3.2	Copy and versioning of a DTM instance	185
8.3.3	Dataset commit failed	186
8.3.4	Export a DTM dataset to file	186
8.4	Locking and DataTransactions in multi-user environments	187
8.4.1	General	187
8.4.2	Propagation of changes	188
8.4.3	Synchronizing DTMs in multi-user environments	190
8.5	Execution of DTM Functions	191
8.5.1	General	191
8.5.2	Finding a DTM User Interface object	191
8.5.3	Instantiation of an integrated DTM graphical user interface	192
8.5.4	Instantiation of a DTM UI triggered by the DTM BL	193
8.5.5	Instantiation of a modal DTM UI triggered by DTM BL	194
8.5.6	Release of a DTM User Interface	195
8.5.7	Release of a DTM UI triggered by the DTM BL	196
8.5.8	Release of a DTM User Interface triggered by itself	197
8.5.9	Release of a non-modal DTM User Interface triggered by a standard action	198
8.5.10	Progress indication for prolonged DTM actions	199
8.5.11	Starting an application	200
8.5.12	Terminating applications	201
8.5.13	Execution of command functions	201
8.5.14	Execution of a command function with user interface	201
8.5.15	Opening of documents	202
8.5.16	Interaction between DTM User Interface and DTM Business Logic	203
8.5.17	Interaction between DTM Business Logic and DTM User Interface	205
8.5.18	Interaction between DTM User Interface and DTM Business Logic with Cancel	206
8.5.19	Retrieving information about available Static Functions	207
8.5.20	Executing a Static Function	208
8.5.21	Executing a Static Function with multiple arguments	209
8.6	DTM communication	210
8.6.1	General	210
8.6.2	Establishing a communication connection	211
8.6.3	Cancel establishment of communication connection	212
8.6.4	Communicating with the device	212
8.6.5	Frame Application or Child DTM disconnect a device	213
8.6.6	Terminating a communication connection	214
8.6.7	DTM aborts communication connection	215
8.6.8	Communication Channel aborts communication connection	216
8.7	Nested communication	216
8.7.1	General	216
8.7.2	Communication request for a nested connection	217
8.7.3	Propagation of errors for a nested connection	218
8.8	Topology planning	219
8.8.1	General	219

8.8.2	Adding a DTM to the topology	219
8.8.3	Removing a DTM from topology.....	220
8.8.4	Frame Application creates topology	221
8.8.5	DTM generates sub-topology.....	222
8.8.6	Physical Layer and DataLinkLayer.....	224
8.9	Instantiation, configuration, move and release of Child DTMs.....	224
8.9.1	General	224
8.9.2	Instantiation and configuration of Child DTM BL.....	224
8.9.3	Interaction between Parent DTM and Child DTM.....	225
8.9.4	Interaction between Parent DTM and Child DTM using IDtmMessaging	227
8.9.5	Parent DTM moves a Child DTM.....	227
8.9.6	Parent DTM removes Child DTM	228
8.10	Topology scan.....	229
8.10.1	General	229
8.10.2	Scan of network topology	229
8.10.3	Cancel topology scan.....	230
8.10.4	Scan based DTM assignment.....	231
8.10.5	Manufacturer-specific device identification.....	232
8.11	Configuration of communication networks	234
8.11.1	Configuration of a fieldbus master	234
8.11.2	Integration of a passive device	235
8.12	Using IO information	235
8.12.1	Assignment of symbolic name to process data	235
8.12.2	Creation of Process Image	237
8.12.3	Validation of changes in process image while PLC is running.....	238
8.12.4	Changing of variable names using process image interface.....	239
8.13	Managing addresses	240
8.13.1	Set DTM address with user interface	240
8.13.2	Set DTM addresses without user interface.....	241
8.13.3	Display or modify addresses of all Child DTMs with user interface.....	242
8.14	Device-initiated data transfer.....	243
8.15	Reading and writing data.....	244
8.15.1	Read/write instance data.....	244
8.15.2	Read/write device data.....	246
8.16	Comparing data	248
8.16.1	Comparing device dataset and instance dataset	248
8.16.2	Comparing different instance datasets.....	248
8.17	Reassigning a different DtmDeviceType at a device node	249
8.17.1	General	249
8.17.2	DTM detects a change in connected device type.....	250
8.17.3	Search matching DtmDeviceTypes after incompatible device exchange.....	252
8.17.4	Reassign DtmDeviceType after incompatible device exchange.....	253
8.18	Copying part of FDT Topology	255
8.18.1	Cloning of a single DTM without Children.....	255
8.18.2	Cloning of a DTM with all its Children	256
8.19	Sequences for audit trail.....	256
8.19.1	General	256
8.19.2	Audit trail of parameter modifications in instance dataset.....	256
8.19.3	Audit trail of parameter modifications in device dataset.....	257

8.19.4	Audit trail of function calls	258
8.19.5	Audit trail of general notification	259
9	Installation.....	259
9.1	General.....	259
9.2	Common rules.....	259
9.2.1	Predefined installation paths	259
9.2.2	Manifest files	262
9.2.3	Paths in manifest files	263
9.2.4	Common command line arguments	263
9.2.5	Digital signatures of setup components.....	264
9.3	Installation of FDT core assemblies	264
9.4	Installation of communication protocols.....	264
9.4.1	General	264
9.4.2	Registration	264
9.4.3	Protocol manifest	264
9.5	Installation of DTMs	265
9.5.1	General	265
9.5.2	Registration	266
9.5.3	DTM manifest	267
9.5.4	DTM User Interface manifest.....	268
9.6	DTM setup	269
9.6.1	Structure.....	269
9.6.2	DTM setup manifest	270
9.6.3	DTM device identification manifest	271
9.6.4	Setup creation rules	273
9.7	DTM deployment.....	274
9.8	Paths and file information.....	276
9.8.1	Path information provided by a DTM.....	276
9.8.2	Paths and persistence.....	276
9.8.3	Multi-user systems	276
10	Life cycle concept.....	276
10.1	General.....	276
10.2	Technical concept.....	277
10.2.1	General	277
10.2.2	DtmManifest / DtmInfo.....	278
10.2.3	TypeInfo	278
10.2.4	Supported DataSet formats	279
10.2.5	DeviceIdentInfo.....	279
10.2.6	Dataset.....	280
10.2.7	DeviceScanInfo.....	280
10.3	DTM setup	280
10.4	Life Cycle Scenarios	281
10.4.1	Overview	281
10.4.2	Search for device type in DTM setups.....	282
10.4.3	Search for installed DTMs	283
10.4.4	Dataset migration for reassigned DTM.....	285
11	Frame Application architectures	286
11.1	General.....	286
11.2	Standalone application	286

11.3	Remoted user Interface	286
11.4	Distributed multi-user application.....	287
11.5	OPC UA.....	287
Annex A (normative) FDT2 Use case model		289
A.1	Use case model overview.....	289
A.2	Actors	289
A.3	Use cases	290
A.3.1	Use case overview	290
A.3.2	Observation use cases	291
A.3.3	Operation use cases	292
A.3.4	Maintenance use cases	294
A.3.5	Planning use cases	299
A.3.6	Main Operation	301
A.3.7	OEM Service.....	302
A.3.8	Administration.....	302
Annex B (normative) FDT interface definition and datatypes		303
Annex C (normative) Mapping of services to interface methods.....		304
C.1	General.....	304
C.2	DTM services	304
C.3	Presentation object services.....	308
C.4	General channel services	308
C.5	Process channel services	308
C.6	Communication Channel Services	309
C.7	Frame Application Services	310
Annex D (normative) FDT version interoperability guide.....		313
D.1	Overview.....	313
D.2	General.....	313
D.3	Component interoperability.....	314
Annex E (normative) FDT1.2.x / IEC 62453-42 Backward-Compatibility.....		315
E.1	Overview.....	315
E.2	Parallel FDT topologies	315
E.3	Mixed FDT topologies.....	316
E.4	FDT1.2.x / IEC 62453-42 Adapters	318
E.5	FDT1.2.x XML / IEC TR 62453-42 Datatype Transformers.....	319
E.5.1	General	319
E.5.2	Installation and Registration of Protocol-specific Transformers.....	320
E.5.3	Interaction between FDT2 and FDT1.2 components using Transformers.....	321
E.6	Sequences related to backward compatibility	322
E.6.1	General	322
E.6.2	Dataset migration from FDT1.x DTM to FDT2.x DTM.....	322
Annex F (informative) Implementation Hints		324
F.1	IAsyncResult pattern	324
F.2	Threading Best Practices	325
Annex G (informative) Trade names		326
Annex H (informative) UML Notation		327
H.1	General.....	327
H.2	Class diagram.....	327
H.3	Statechart diagram.....	330

H.4	Use case diagram	331
H.5	Sequence diagram	332
H.6	Object diagram.....	336
Annex I (informative) Physical Layer Examples.....		337
I.1	General.....	337
I.2	Interbus S	337
I.3	PROFIBUS.....	337
I.4	PROFINET.....	337
Annex J (informative) Predefined SemanticIds.....		339
J.1	General.....	339
J.2	Data	339
J.3	Images.....	339
J.4	Documents.....	339
Bibliography		341
Figure 1 – Relation of IEC 62453-42 to the IEC 62453 series		21
Figure 2 – IEC 62453-42 Object Model.....		32
Figure 3 – Frame Application		32
Figure 4 – DTM Business Logic.....		34
Figure 5 – DTM, Device Type and Device Ident Info		35
Figure 6 – Process Data Info.....		36
Figure 7 – Logical topology and physical topology		43
Figure 8 – FDT and logical topology		43
Figure 9 – DTMs and physical topology		44
Figure 10 – Point-to-point communication		46
Figure 11 – Nested communication		47
Figure 12 – Identification of connected devices		49
Figure 13 – FDT storage and synchronization mechanism.....		50
Figure 14 – Relation between DTMDataset, DTM instance, and device.....		50
Figure 15 – DTMDataset structure		51
Figure 16 – Data Synchronization.....		53
Figure 17 – Routed IO information.....		56
Figure 18 – Multirole Device.....		57
Figure 19 – FDT .NET Assemblies		60
Figure 20 – FDT Object implementation.....		61
Figure 21 – FDT CLR extension concept		63
Figure 22 – Example: Assembly.LoadFrom().....		64
Figure 23 – Example: Assembly dependencies		65
Figure 24 – Example: Datatype definition		67
Figure 25 – Example: Data cloning.....		69
Figure 26 – Example: Methods without data cloning.....		69
Figure 27 – Protocol-specific datatypes		70
Figure 28 – Protocol manifest and type info attributes.....		71
Figure 29 – Example: Protocol assembly attributes.....		72

Figure 30 – Example: Handling of protocol-specific assemblies in Frame Application.....	72
Figure 31 – Decoupled FDT Objects in IEC 62453-42	73
Figure 32 – IAsyncResult pattern: blocking call.....	76
Figure 33 – Example: Blocking use of asynchronous interface	76
Figure 34 – IAsyncResult pattern (simplified): blocking call	77
Figure 35 – IAsyncResult pattern: non-blocking call	77
Figure 36 – Example: Non-blocking use of asynchronous interface	78
Figure 37 – IAsyncResult pattern (simplified depiction): non-blocking call	78
Figure 38 – IAsyncResult pattern: canceling an operation	80
Figure 39 – IAsyncResult pattern: providing progress events	81
Figure 40 – Frame Application's host window providing scroll bars.....	91
Figure 41 – Control using internal scrollbars.....	91
Figure 42 – Example: Hosting a DTM WPF control in a WPF Frame Application	93
Figure 43 – Example: Hosting a DTM WPF control in a WinForms Frame Application	93
Figure 44 – Example: Hosting DTM WinForms controls in a WinForms Frame Application	94
Figure 45 – Example: Hosting a DTM WinForms control in a WPF Frame Application	94
Figure 46 – Relation of StaticFunctionDescription to Static Function	95
Figure 47 – DTMDataset structure.....	96
Figure 48 – Example: Initialization of DTMDataset with DTM data	98
Figure 49 – Example: Writing of DTM data in DTMDataset.....	98
Figure 50 – Example: Reading of DTM data from a DTMDataset	99
Figure 51 – Example: Creation of a BulkData.DTMDataset with descriptor	100
Figure 52 – Example: Searching for DTMDatasets with specific descriptor	100
Figure 53 – Skeleton of a DTM-specific report fragment.....	103
Figure 54 – Example: Authenticode check	104
Figure 55 – Example: Conformity record file	105
Figure 56 – Example: checking conformity record file	106
Figure 57 – Frame Application interfaces.....	107
Figure 58 – DTM Business Logic interfaces (Part 1)	110
Figure 59 – DTM Business Logic interfaces (Part 2)	111
Figure 60 – State machine of DTM BL	115
Figure 61 – Online state machine of DTM.....	117
Figure 62 – Modifications of data through a DTM.....	120
Figure 63 – ModifiedInDtm: State machine of instance data	121
Figure 64 – ModifiedInDevice: State machine related to device data	122
Figure 65 – DTM UI interfaces	123
Figure 66 – Communication Channel interfaces	124
Figure 67 – FdtDatatype and FdtList	127
Figure 68 – DtmInfo / TypeInfo – datatypes	129
Figure 69 – DeviceIdentInfo – datatypes.....	131
Figure 70 – DeviceIdentInfo – Example for HART	132
Figure 71 – Example: DeviceIdentInfo creation	134

Figure 72 – Example: Using DeviceIdentInfo	135
Figure 73 – Example: DeviceIdentInfoTypeAttribute	135
Figure 74 – SetupManifest – datatypes	135
Figure 75 – DtmManifest – datatypes	136
Figure 76 – DtmUiManifest – datatypes	137
Figure 77 – Communication datatypes – Connect	138
Figure 78 – Communication datatypes – Transaction	138
Figure 79 – Communication datatypes – Disconnect	139
Figure 80 – Communication datatypes – Subscribe	139
Figure 81 – Communication datatypes – Scanning	140
Figure 82 – Communication datatypes – Address setting	140
Figure 83 – Example: Communication – Connect for HART	142
Figure 84 – Example: Communication – CommunicationType for HART	143
Figure 85 – BusCategory – datatypes	143
Figure 86 – Device / Instance data – datatypes	144
Figure 87 – Example: Providing information on data of a HART device	146
Figure 88 – Example: Providing information on module data of a PROFIBUS device	147
Figure 89 – Example: Providing information on data	148
Figure 90 – Example: Providing information on structured data	149
Figure 91 – EnumInfo – datatype	150
Figure 92 – Read and Write Request – datatypes	150
Figure 93 – ResponseInfo – datatype	151
Figure 94 – TopologyImportExport – datatypes	152
Figure 95 – ImportExportDataset – datatypes	153
Figure 96 – ProcessDataInfo – datatypes	154
Figure 97 – IOSignalInfo – datatypes	155
Figure 98 – Example: ProcessDataInfo for HART (UML)	157
Figure 99 – Example: ProcessDataInfo creation for HART	158
Figure 100 – Example: Using ProcessData for HART	159
Figure 101 – Example: IOSignalInfoType attribute	159
Figure 102 – ProcessImage – datatypes	160
Figure 103 – AddressInfo – datatypes	161
Figure 104 – Example: AddressInfo creation	162
Figure 105 – Example: Using AddressInfo	163
Figure 106 – Example: DeviceAddressTypeAttribute	163
Figure 107 – NetworkDataInfo – datatypes	164
Figure 108 – Example: NetworkDataInfo creation example	165
Figure 109 – Example: NetworkDataInfo using example	166
Figure 110 – Example: NetworkDataTypeAttribute example	166
Figure 111 – DTM Function – datatypes	167
Figure 112 – DTM Messages – datatypes	169
Figure 113 – ActionItem – datatypes	170
Figure 114 – CommunicationChannelInfo – datatypes	170

Figure 115 – Example: Channel information	171
Figure 116 – DeviceScanInfo – datatypes.....	172
Figure 117 – Example: HARTDeviceScanInfo – datatype	173
Figure 118 – DTM Report – datatypes	174
Figure 119 – Information related to device modules	175
Figure 120 – Finding a DTM BL object.....	177
Figure 121 – Instantiation of a new DTM BL	179
Figure 122 – Configuration of user permissions	181
Figure 123 – Loading a DTM BL.....	182
Figure 124 – Loading a DTM with Expert user level	183
Figure 125 – Release of a DTM BL.....	184
Figure 126 – Saving data of a DTM	185
Figure 127 – Dataset commit failed	186
Figure 128 – Export a DTM dataset to file.....	187
Figure 129 – Propagation of changes	189
Figure 130 – Synchronizing DTMs in multi-user environments.....	190
Figure 131 – Finding a DTM User Interface	192
Figure 132 – Instantiation of a DTM User Interface	193
Figure 133 – Instantiation of a DTM UI triggered by DTM BL.....	194
Figure 134 – Instantiation of a modal DTM UI triggered by DTM BL.....	195
Figure 135 – Release of a DTM User Interface	196
Figure 136 – Release of a DTM UI triggered by the DTM BL	197
Figure 137 – Release of a DTM User Interface triggered by itself.....	198
Figure 138 – Release of a non-modal DTM UI triggered by a standard action	198
Figure 139 – Progress indication for prolonged DTM actions.....	199
Figure 140 – Starting an application	200
Figure 141 – Execute a command function	201
Figure 142 – Execute a command function with user interface	202
Figure 143 – Opening a document.....	203
Figure 144 – Interaction triggered by the DTM User Interface	204
Figure 145 – Interaction triggered by the DTM Business Logic	205
Figure 146 – Interaction triggered and canceled by the DTM User Interface	206
Figure 147 – Retrieving information about available Static Functions	207
Figure 148 – Example: Information about available Static Functions	208
Figure 149 – Executing a Static Function.....	209
Figure 150 – Executing a Static Function with multiple Arguments	210
Figure 151 – Establishing a communication connection	211
Figure 152 – DTM cancels ongoing Connect operation	212
Figure 153 – Communicating with the device.....	213
Figure 154 – Child DTM disconnects	214
Figure 155 – Child DTM terminates a connection.....	215
Figure 156 – Child DTM aborts a connection	215
Figure 157 – Communication Channel aborts a connection	216

Figure 158 – Example: Nested communication behavior	217
Figure 159 – Example: Nested communication data exchange	218
Figure 160 – Add DTM to topology	220
Figure 161 – Removing a DTM from topology	221
Figure 162 – Frame Application creates topology	222
Figure 163 – DTM generates sub-topology	223
Figure 164 – Instantiation and configuration of Child DTM BL	225
Figure 165 – Interaction between Parent DTM and Child DTM	226
Figure 166 – Interaction using IDtmMessaging	227
Figure 167 – Parent DTM moves a Child DTM	228
Figure 168 – Parent DTM removes Child DTM	229
Figure 169 – Scan of network topology.....	230
Figure 170 – Cancel topology scan	231
Figure 171 – Scan based DTM assignment.....	232
Figure 172 – Manufacturer-specific device identification	233
Figure 173 – Configuration of a fieldbus master.....	234
Figure 174 – Integration of a passive device.....	235
Figure 175 – Assignment of process data	236
Figure 176 – Creation of process image	238
Figure 177 – Validation of changes while PLC is running	239
Figure 178 – Changing of variable names using process image interface	240
Figure 179 – Set DTM address with UI	241
Figure 180 – Set DTM addresses without UI.....	242
Figure 181 – Display or modify child addresses with UI.....	243
Figure 182 – Device-initiated data transfer	244
Figure 183 – Read/write instance data	245
Figure 184 – Read/write device data	247
Figure 185 – Comparing device dataset and instance dataset.....	248
Figure 186 – Compare instance data with persisted dataset.....	249
Figure 187 – DTM triggers ActiveTypeChanged event.....	251
Figure 188 – Find matching DtmDeviceTypes after incompatible device exchange	253
Figure 189 – Reassign a DtmDeviceType after incompatible device exchange.....	254
Figure 190 – Clone DTM without children	255
Figure 191 – Clone DTM with all children	256
Figure 192 – Audit trail of parameter modifications in instance dataset.....	257
Figure 193 – Audit trail of parameter modifications in device.....	258
Figure 194 – Audit trail of function calls.....	258
Figure 195 – GAC and FDT_Registry	261
Figure 196 – Installation paths (with example DTM).....	262
Figure 197 – Example: Protocol manifest.....	265
Figure 198 – Search for installed DTMs.....	266
Figure 199 – Example: DtmManifest.....	268
Figure 200 – Example: DtmUiManifest.....	269

Figure 201 – DTM setup structure	270
Figure 202 – Example: DtmSetupManifest	271
Figure 203 – Example: DeviceIdentManifest	273
Figure 204 – DTM deployment	275
Figure 205 – Overview DTM identification.....	277
Figure 206 – Identification attributes in DTM setup	281
Figure 207 – Check DTM Setup for list of supported types	283
Figure 208 – Scan installed DTMs	284
Figure 209 – Dataset migration to a reassigned DtmDeviceType	285
Figure 210 – Client / Server Application	286
Figure 211 – Example for distributed multi-user application.....	287
Figure 212 – OPC UA server based on IEC TR 62453-42	288
Figure A.1 – Main use case diagram	289
Figure A.2 – Observation use cases	291
Figure A.3 – Operation use cases	293
Figure A.4 – Maintenance use cases	295
Figure A.5 – Planning use cases	299
Figure E.1 – Example: IEC TR 62453-42 Frame Application with FDT1.2.x backward- compatibility support	315
Figure E.2 – IEC TR 62453-42 Frame Application with FDT1.2.x Device DTM	316
Figure E.3 – IEC TR 62453-42 Frame Application with FDT1.2.x Comm. and Gateway DTM	317
Figure E.4 – IEC TR 62453-42 Frame Application with FDT1.2.x Gateway DTM	317
Figure E.5 – IEC TR 62453-42 – FDT1.2 interaction using transformer.....	322
Figure E.6 – Dataset migration from FDT1.x DTM to FDT2.x DTM.....	323
Figure H.1 – Note	327
Figure H.2 – Class	327
Figure H.3 – Association	327
Figure H.4 – Navigable Association	328
Figure H.5 – Composition.....	328
Figure H.6 – Aggregation	328
Figure H.7 – Dependency.....	328
Figure H.8 – Association class	328
Figure H.9 – Abstract class, Generalization and Interface	329
Figure H.10 – Interface related notations	329
Figure H.11 – Multiplicity.....	330
Figure H.12 – Enumeration datatype	330
Figure H.13 – Elements of UML statechart diagrams.....	330
Figure H.14 – Example of UML state chart diagram	331
Figure H.15 – UML use case syntax	331
Figure H.16 – UML sequence diagram.....	332
Figure H.17 – Empty UML sequence diagram frame	332
Figure H.18 – Object with life line and activation.....	333
Figure H.19 – Method calls	333

Figure H.20 – Modeling guarded call and multiple calls.....	333
Figure H.21 – Call to itself.....	334
Figure H.22 – Continuation / StateInvariant	334
Figure H.23 – Alternative fragment.....	335
Figure H.24 – Option fragment	335
Figure H.25 – Loop combination fragment	335
Figure H.26 – Break notation	335
Figure H.27 – Sequence reference	336
Figure H.28 – Objects	336
Figure H.29 – Object association.....	336
Table 1 – FDT User levels.....	40
Table 2 – Role dependent Access Rights and User Interfaces for DTMs.....	41
Table 3 – Description of properties related to data access control.....	55
Table 4 – Supported CLR versions	62
Table 5 – Frame Application interfaces.....	108
Table 6 – DTM Business Logic interfaces	112
Table 7 – Availability of interfaces depending of type of DTM.....	113
Table 8 – Definition of DTM BL state machine	116
Table 9 – Definition of online state machine	118
Table 10 – Description of instance dataset states	121
Table 11 – Description of dataset states regarding online modifications	122
Table 12 – DTM UI interfaces.....	124
Table 13 – Communication Channel interfaces	125
Table 14 – Availability of DTM BL methods in different states	125
Table 15 – FDT base datatypes.....	127
Table 16 – FDT General datatypes.....	128
Table 17 – DtmInfo datatype description.....	129
Table 18 – DeviceIdentInfo datatype description.....	131
Table 19 – DeviceIdentInfo – Example for HART	133
Table 20 – SetupManifest datatype description.....	136
Table 21 – DtmManifest datatype description	136
Table 22 – DtmUiManifest datatype description	137
Table 23 – Communication datatype description	141
Table 24 – BusCategory datatype description	143
Table 25 – DeviceData datatype description	145
Table 26 – Reading and Writing datatype description.....	150
Table 27 – Reading and Writing datatype description.....	151
Table 28 – TopologyImportExport datatype description	153
Table 29 – ImportExportDataset datatype description	153
Table 30 – ProcessDataInfo datatype description	155
Table 31 – IOSignalInfo datatype description.....	156
Table 32 – ProcessImage datatype description.....	160

Table 33 – AddressInfo datatype description	161
Table 34 – NetworkDataInfo datatype description	165
Table 35 – DTM Function datatype description	168
Table 36 – DTM Messages datatype description	169
Table 37 – ActionItem datatype description	170
Table 38 – CommunicationChannelInfo datatype description.....	171
Table 39 – DeviceScanInfo datatype description.....	172
Table 40 – Example: HARTDeviceScanInfo datatype description	173
Table 41 – Reporting datatype description.....	174
Table 42 – Predefined FDT installation paths	259
Table 43 – Predefined setup properties	263
Table 44 – Setup command line parameters	263
Table 45 – DTM identification.....	278
Table 46 – DtmType – user readable description of supported types	278
Table 47 – TypelInfo identification.....	279
Table 48 – DtmType – Dataset support identification	279
Table 49 – Dataset identification	280
Table 50 – DeviceScanInfo – scanned device identification.....	280
Table 51 – Setup information	281
Table 52 – Changing DTM-- overview	282
Table A.1 – Actors	290
Table A.2 – Observation use cases	291
Table A.3 – Operation use cases.....	293
Table A.4 – Maintenance use cases	296
Table A.5 – Planning use cases	299
Table C.1 – General services	304
Table C.2 – DTM services related to installation	304
Table C.3 – DTM service related to DTM Information.....	304
Table C.4 – DTM services related to DTM state machine	305
Table C.5 – DTM services related to function	305
Table C.6 – DTM services related to documentation	306
Table C.7 – DTM services to access the instance data	306
Table C.8 – DTM services to access diagnosis	306
Table C.9 – DTM services to access to device data	306
Table C.10 – DTM services related to network management information	307
Table C.11 – DTM services related to online operation	307
Table C.12 – DTM services related to FDT-Channel objects.....	307
Table C.13 – DTM services related to import and export.....	308
Table C.14 – DTM services related to data synchronization	308
Table C.15 – DTM UI state control	308
Table C.16 – General channel service.....	308
Table C.17 – Channel services for IO related information.....	309
Table C.18 – Channel services related to communication	309

Table C.19 – Channel services related sub-topology management.....	309
Table C.20 – Channel services related to functions	310
Table C.21 – Channel services related to scan	310
Table C.22 – FA services related to general events	310
Table C.23 – FA services related to topology management.....	311
Table C.24 – FA services related to redundancy.....	311
Table C.25 – FA services related to storage of DTM data	311
Table C.26 – FA services related to DTM data synchronization	311
Table C.27 – FA related to presentation	312
Table C.28 – FA services related to audit trail	312
Table D.1 – Interoperability between components of different versions.....	314
Table E.1 – Adapter interface mappings	319

INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIELD DEVICE TOOL (FDT) INTERFACE SPECIFICATION –

Part 42: Object model integration profile – Common Language Infrastructure

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC TR 62453-42, which is a technical report, has been prepared by subcommittee 65E: Devices and integration in enterprise systems, of IEC technical committee 65: Industrial-process measurement, control and automation:

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
65E/439/DTR	65E/486/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 62453 series, under the general title *Field Device Tool (FDT) interface specification*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This Part of IEC 62543, which is a technical report, is an interface specification for developers of FDT (Field Device Tool) components for function control and data access within a client/server architecture. The specification is a result of an analysis and design process to develop standard interfaces to facilitate the development of servers and clients by multiple vendors that need to interoperate seamlessly.

With the integration of fieldbuses into control systems, there are a few other tasks which need to be performed. In addition to fieldbus- and device-specific tools, there is a need to integrate these tools into higher-level system-wide planning or engineering tools. In particular, for use in extensive and heterogeneous control systems, the unambiguous definition of engineering interfaces that are easy to use for all those involved is of great importance.

A device-specific software component, called DTM (Device Type Manager), is supplied by the field device manufacturer with its device. The DTM is integrated into engineering tools via the FDT interfaces defined in this specification. The approach to integration, in general, is open for all kind of fieldbusses and thus meets the requirements for integrating different kinds of devices into heterogeneous control systems.

Figure 1 shows how IEC TR 62453-42 is related to the IEC 62453 series.

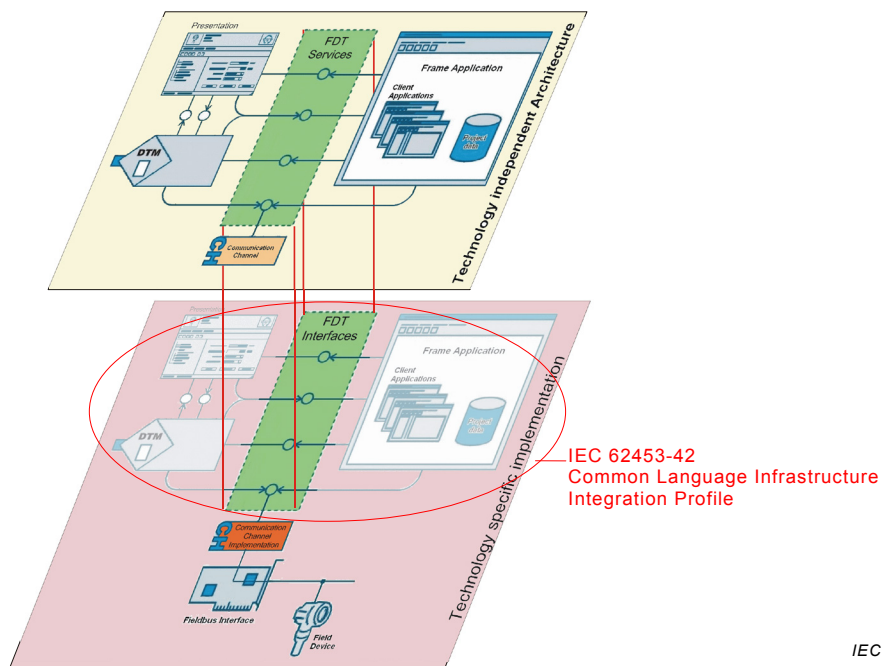


Figure 1 – Relation of IEC 62453-42 to the IEC 62453 series

The document structure is:

- Clause 3 explains the used terms, definitions and conventions
- Clause 4 introduces the general concepts of IEC 62453-42
- Clause 5 describes the technical concepts used to implement IEC 62453-42 and how FDT concepts are mapped to .NET Framework
- Clause 6 provides an overview of the FDT Objects, their interfaces and behavior
- Clause 7 presents an overview of the IEC 62453-42 datatypes
- Clause 8 shows the interaction of FDT Objects at runtime
- Clause 9 explains rules related to installation and deployment of DTMs

- Clause 10 explains how FDT life cycle concepts are implemented
- Clause 11 shows examples for Frame Application architectures

FIELD DEVICE TOOL (FDT) INTERFACE SPECIFICATION –

Part 42: Object model integration profile – Common Language Infrastructure

1 Scope

This part of IEC 62453, which is a technical report, defines how the common FDT principles are implemented based on the .NET technology, including the object behavior and object interaction via .NET interfaces.

This document specifies FDT version 2.0.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62453-1:—¹, *Field Device Tool (FDT) interface specification – Part 1: Overview and guidance*

IEC 62453-2:—¹, *Field Device Tool (FDT) interface specification – Part 2: Concepts and detailed description*

¹ To be published concurrently with this technical report.