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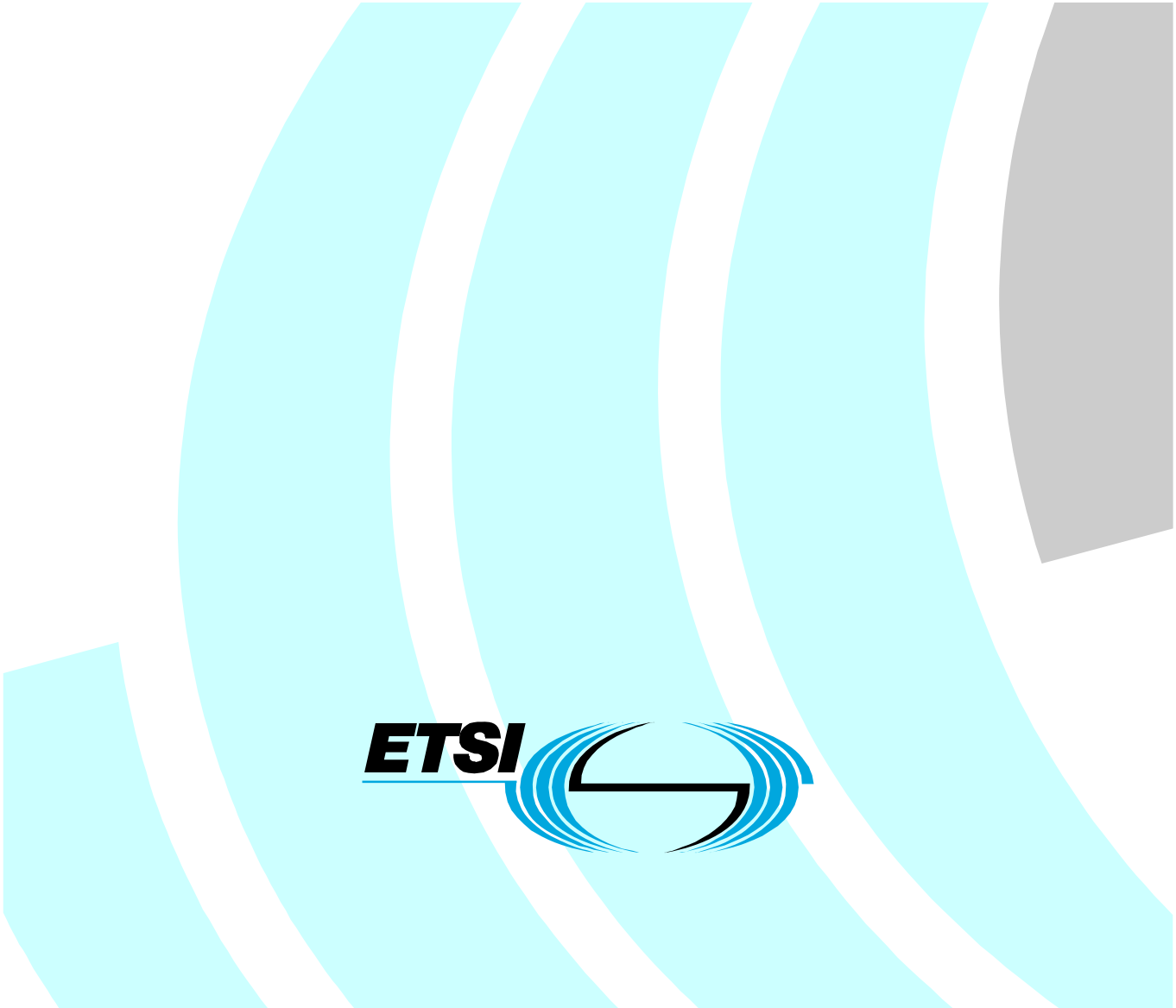
Methods for Testing and Specification (MTS); The Testing and Test Control Notation version 3; TTCN-3 Language Extensions: Configuration and Deployment Support



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Foreword

This ETSI Standard (ES) has been produced by ETSI Technical Committee Methods for Testing and Specification (MTS), and is now submitted for the ETSI standards Membership Approval Procedure.

The present document relates to the multi-part standard covering the Testing and Test Control Notation version 3, as identified below:

ES 201 873-1 [1]: "TTCN-3 Core Language";

ES 201 873-2 [i.1]: "TTCN-3 Tabular presentation Format (TFT)";

ES 201 873-3 [i.2]: "TTCN-3 Graphical presentation Format (GFT)";

ES 201 873-4 [2]: "TTCN-3 Operational Semantics";

ES 201 873-5 [3]: "TTCN-3 Runtime Interface (TRI)";

ES 201 873-6 [4]: "TTCN-3 Control Interface (TCI)";

ES 201 873-7 [i.3]: "Using ASN.1 with TTCN-3";

ES 201 873-8 [i.4]: "The IDL to TTCN-3 Mapping";

ES 201 873-9 [i.5]: "Using XML schema with TTCN-3";

ES 201 873-10 [i.6]: "TTCN-3 Documentation Comment Specification".

1 Scope

The present document defines the Configuration and Deployment Supportpackage of TTCN-3. TTCN-3 can be used for the specification of all types of reactive system tests over a variety of communication ports. Typical areas of application are protocol testing (including mobile and Internet protocols), service testing (including supplementary services), module testing, testing of CORBA based platforms, APIs, etc. TTCN-3 is not restricted to conformance testing and can be used for many other kinds of testing including interoperability, robustness, regression, system and integration testing. The specification of test suites for physical layer protocols is outside the scope of the present document.

TTCN-3 packages are intended to define additional TTCN-3 concepts, which are not mandatory as concepts in the TTCN-3 core language, but which are optional as part of a package which is suited for dedicated applications and/or usages of TTCN-3.

This package defines the TTCN-3 support for static test configurations.

While the design of TTCN-3 package has taken into account the consistency of a combined usage of the core language with a number of packages, the concrete usages of and guidelines for this package in combination with other packages is outside the scope of the present document.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

[1] ETSI ES 201 873-1: "Methods for Testing and Specification (MTS); The Testing and Test Control Notation version 3; Part 1: TTCN-3 Core Language".

[2] ETSI ES 201 873-4: "Methods for Testing and Specification (MTS); The Testing and Test Control Notation version 3; Part 4: TTCN-3 Operational Semantics".

[3] ETSI ES 201 873-5: "Methods for Testing and Specification (MTS); The Testing and Test Control Notation version 3; Part 5: TTCN-3 Runtime Interface (TRI)".

[4] ETSI ES 201 873-6: "Methods for Testing and Specification (MTS); The Testing and Test Control Notation version 3; Part 6: TTCN-3 Control Interface (TCI)".

[5] ISO/IEC 9646-1: "Information technology - Open Systems Interconnection -Conformance testing methodology and framework; Part 1: General concepts".

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI ES 201 873-2: "Methods for Testing and Specification (MTS); The Testing and Test Control Notation version 3; Part 2: TTCN-3 Tabular presentation Format (TFT)".

[i.2] ETSI ES 201 873-3: "Methods for Testing and Specification (MTS); The Testing and Test Control Notation version 3; Part 3: TTCN-3 Graphical presentation Format (GFT)".

[i.3] ETSI ES 201 873-7: "Methods for Testing and Specification (MTS); The Testing and Test Control Notation version 3; Part 7: Using ASN.1 with TTCN-3".

[i.4] ETSI ES 201 873-8: "Methods for Testing and Specification (MTS); The Testing and Test Control Notation version 3; Part 8: The IDL to TTCN-3 Mapping".

[i.5] ETSI ES 201 873-9: "Methods for Testing and Specification (MTS); The Testing and Test Control Notation version 3; Part 9: Using XML with TTCN-3".

[i.6] ETSI ES 201 873-10: "Methods for Testing and Specification (MTS); The Testing and Test Control Notation version 3; Part 10: TTCN-3 Documentation Comment Specification".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in ES 201 873-1 [1], ES 201 873-4 [2], ES 201 873-5 [3], ES 201 873-6 [4] and ISO/IEC 9646-1 [5] apply.

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in ES 201 873-1 [1], ES 201 873-4 [2], ES 201 873-5 [3], ES 201 873-6 [4], ISO/IEC 9646-1 [5] and the following apply:

MTC	Main Test Component
PTC	Parallel Test Component.

4 Package conformance and compatibility

The package presented in the present document is identified by the package tag:

`"TTCN-3:2009 Static Test Configurations"` - to be used with modules complying with the present document.

For an implementation claiming to conform to this package version, all features specified in the present document shall be implemented consistently with the requirements given in the present document and in ES 201 873-1 [1] and ES 201 873-4 [2].

The package presented in the present document is compatible to:

- ES 201 873-1 [1] version 4.2.1;
- ES 201 873-2 [i.1] version 3.2.1;
- ES 201 873-3 [i.2] version 3.2.1;
- ES 201 873-4 [2] version 4.2.1;
- ES 201 873-5 [3] version 4.2.1;
- ES 201 873-6 [4] version 4.2.1;
- ES 201 873-7 [i.3] version 4.2.1;
- ES 201 873-8 [i.4] version 4.2.1;

- ES 201 873-9 [i.5] version 4.2.1;
- ES 201 873-10 [i.6] version 4.2.1.

If later versions of those parts are available and should be used instead, the compatibility to the package presented in the present document has to be checked individually.

5 Package Concepts for the Core Language

This package defines the TTCN-3 means to define *static test configurations*. A static test configuration is a test configuration with a lifetime that is not bound to a single test case. The test components of a static test configuration may be used by several test cases. This package realizes the following concepts:

- A special *configuration function* is introduced which can only be called in the control part of a TTCN-3 module to create *static test configurations*. The configuration function returns a handle of the predefined type **`configuration`** to access an existing static test configuration.
- A static test configuration consists of *static test components*, a test system interface, *static connections* and *static mappings*. These constituents have the following semantics:
  - A *static test component* is a special kind of test component that can only be created during the creation of a static test configuration and can only be destroyed during the destruction of a static test configuration. By definition, the MTC of a static test configuration is a static test component.
  - The test system interface of a static test configuration plays the same role as the test system interface of a test configuration created by a test case.
  - A *static connection* is a connection between static test components. It can only be established during the creation of a static test configuration and only be destroyed during the destruction of a static test configuration.
  - A *static mapping* is a mapping of a port of a static test component to a port of the test system interface of a static test configuration. Such a mapping can only be established during the creation of a static test configuration and only be destroyed during the destruction of a static test configuration.
- A static test configuration can be used by several test cases. For this the test case is started on a previously created static test configuration. This means:
  - The body of the test case is executed on the MTC of the static test configuration.
  - The MTC may start behaviour on other static test components of the static test configuration.
  - Static test components may create, start, stop and kill normal and alive test components. The lifetime of these components is bound to the actual test case that is executed on the static test configuration. In case that a normal and alive test component is not destroyed explicitly by another test component, it is implicitly destroyed when the test case ends.
  - During test case execution non-static connections and non-static mappings may be established. The lifetime of non-static connections and non-static mappings is bound to the actual test case that is executed on the static test configuration. In case that a non-static connection or a non-static mapping is not destroyed explicitly by another test component, it is implicitly destroyed when the test case ends.
- Component timers and variables of static test components are not reset or reininitialized when a test case is started on a static test configuration. They remain in the same state as when they were left after the creation of the static test configuration or after the termination of a previous test case. This allows to transfer information from one test case to another.
- Ports of static test components are not emptied or restarted when a test case is started on a static test configuration. For example, this allows a delayed handling of SUT responses like e.g. repetitive status messages, during the test campaign. In addition, all port operations (i.e. **`clear`**, **`start`**, **`stop`** and **`halt`**) are disallowed for ports of static test components. All ports of a static test component remain started during the whole lifetime of a static test configuration.

- In contrast to component timers, variables and ports, the verdict and the default handling is reset. This means all activated defaults are deactiviated, all local verdicts and the global verdict are set to **none**.

5.1 The special configuration type: configuration

The special configuration type **configuration** is a handle for static test configurations. The special value **null** is available to indicate an undefined configuration reference, e.g. for the initialization of variables to handle a static test configuration.

Values of type **configuration** shall be the result of configuration functions, they can be checked for equality, e.g. to check if two variables store the same value, and they can be used in **execute** statements for starting a test case on an existing static test configuration and in **kill** configuration statements to destroy an existing static test configuration.

EXAMPLES:

```
var configuration myStaticConfig := null;   // Declaration and initialization of a
                                            // configuration variable.

myStaticConfig := aStaticConfig();          // Assigns a value to the previously declared
                                            // configuration variable. It is assumed that
                                            //aStaticConfig() is a configuration function.

myStaticConfig.kill                         // Kills the static test configuration stored in
                                            // variable myStaticConfig.
```

5.2 The configuration function

A configuration function allows the start of a static test configuration.

Syntactical Structure

```
configuration ConfigurationIdentifier
"(" [ { ( FormalValuePar | FormalTemplatePar) [","] } ] ")"
runs on ComponentType
[ system ComponentType ]
StatementBlock
```

Semantic Description

A configuration function allows the start of a static test configuration. A configuration function has to be defined in the definitions part of a TTCN-3 module and shall only be invoked in the control part of a TTCN-3 module. By definition, a configuration function returns a value of type **configuration** if the start of the configuration was successful, or **null** if the start of the configuration was not successful.

The invocation of a configuration function causes the creation of the MTC and the test system interface of the static test configuration. The types of MTC and test system interface shall be referenced in a **runs on** and a **system** clause. The **system** clause is optional and can be omitted, if the test system has exactly the same ports as the MTC and these ports are mapped one to one to each other.

The behaviour in the body of a configuration function shall be executed on the newly created MTC. During the start of a test configuration only behaviour on the MTC shall be executed and only static test components, static connections and static mappings shall be created or established. Communication with the SUT or with static PTCs is not allowed.

NOTE: The configuration function only returns a reference to a test configuration and no verdict. However, communication with the SUT might have to be checked. For this purpose, intial communication, e.g. for registration or coordination purposes, could be defined in form of a test case.

A static test configuration is successfully started if the behaviour of the corresponding configuration function has been executed till its end or if a **return** statement in the corresponding configuration function is reached. In case of a successful start, a reference to the newly created configuration is returned. The usage of a **stop** or a **kill** statement allows to specify an unsuccessful start of a static test configuration. In case of an unsuccessful start, the value **null** is returned.

Restrictions

a) The rules for formal parameter lists for the configuration function shall be followed as defined in clause 5.4 of ES 201 873-4 [2].

b) Configuration functions shall only be invoked in the module control part.

c) For the behaviour definition in the body of the configuration function the following restrictions shall hold:

- Only static test components, static connections and static mappings shall be created or established.
- Once created or established static test components, static connections and static mappings shall not be destroyed.
- It is not allowed to create and establish non-static test components, connections and mappings.
- It is not allowed to start behaviour on newly created static test components.
- Communication, timer and port operations are not allowed.

EXAMPLES:

```
// The following configuration function can be used to start a simple static test configuration
// which only consists of one MTC.

    configuration simpleStaticConfig () runs on MyMTCtype{}


// The following configuration function starts a more complex static configuration.
// Configuration information is stored in MTC component variables. Further non-static
// connections and mappings may be established by the test cases that are executed
// on this configuration.

    configuration aComplexStaticConfig (in integer NoOfPTCs) runs on MyMTCtype system MySystemType {
        var integer i;

        if (NoOfPTCs < 0) {
            log ("Negative number of PTCs");
            kill;                                   // unsuccessful termination
        }
        else if (NoOfPTCs > MaxNoOfPTCs) {      // MaxNoOfPTCs is a constant
            log ("Number of PTCs is too high");
            kill;                                   // unsuccessful termination
        }
        else {
            for (i := 1, i <= NoOfPTCs, i := i + 1) {
                PTC[i] := PtcType.create static;    // creation of static PTCs,
                                                    // Array PTC[] is a component variable
                connect (mtc:SyncPort, PTC[i]:SyncPort) static; // static connection
            }
            map(mtc:PCO, system:PCO1) static;   // static mapping of MTC.
            map(PTC[1]:PCO, system:PCO2);       // some static mappings of PTCs,
            map(PTC[2]:PCO, system:PCO3);       // further non-static mappings may be
                                                // established during test runs
        }
        return;                                 // successful termination
    }
```

5.3 Starting a static test configuration

A static test configuration is started by calling a configuration function in the control part of a TTCN-3 module. In case of a successful start, a reference to the newly created static test configuration is returned. In case of an unsuccessful start, the special value null is returned.

EXAMPLES:

```
control {
    var configuration myStaticConfig := null;   // Declaration and initialization of a
                                                // configuration variable.

    myStaticConfig := aStaticConfig();          // Assigns a value to the previously declared
                                                // configuration variable. It is assumed that
                                                // aStaticConfig() is a configuration function.

    if (myStaticConfig == null) {
        stop;                                   // Stop test campaign due to an unsuccessful start
    }
    else {
        execute(MyTestCase(),myStaticConfig)    // Successful start, continuation of test campaign
        ...
    }
}
```

5.4 Destruction of static test configurations

A static test configuration can be destroyed by executing a **kill** configuration operation.

Syntactical Structure

ConfigurationReference.**kill**

Semantic Description

The execution of a **kill** configuration operation causes the destruction of a static test configuration. The destruction is similar to stopping a test case by killing the MTC. This means, resources of all static PTCs shall be released and the PTCs shall be removed. The only difference is that no test verdict is calculated and returned. After executing the **kill** configuration operation, it is not possible to execute a test case on the killed static test configuration.

Executing the kill configuration operation with the special value **null** shall have no effect, executing a kill configuration operation with a reference to a non existing static test configuration shall cause a runtime error.

Restrictions

a) The **kill** configuration operation shall only be executed in the control part of a TTCN-3 module.

EXAMPLES:

```
control {
    var configuration myStaticConfig := null;   // Declaration and initialization of a
                                                // configuration variable.

    myStaticConfig := aStaticConfig();          // Assigns a value to the previously declared
                                                // configuration variable. It is assumed that
                                                // aStaticConfig() is a configuration function.

    myStaticConfig.kill                         // Destruction of the previously started static
                                                // test configuration.
```

5.5 Creation of static test components

The creation of static test components shall be indicated by the additional keyword **static** in the **create** operation. The extension of the **create** operation in clause 21.2.1 of ES 201 873-4 [2] required for the creation of static test components is described in the following sections.

Syntactical Structure

ComponentType "." **create** ["(" *Expression* ")"] [**alive** | **static**]

Semantic Description

The **create** operation in combination with the keyword **static** shall only be used to create static test components. Static test components can only be created by executing a configuration function and by functions directly or indirectly invoked by configuration functions. The keyword **static** in a **create** operation shall not be used in combination with the keyword **alive**.

NOTE 1: During the lifetime of a static test configuration, a static component behaves like an alive component.

Static test components are created in the same manner as normal test components that are not declared as alive components. Further details on this can be found in clause 21.2.1 of ES 201 873-4 [2].

NOTE 2: Static test components can only be created directly or indirectly by a configuration function. This may be checkable at runtime and therefore the keyword static may not be required, but for having an explicit specification of static test configurations and for keeping the feature of static test configurations extendible, the keyword **static** has been introduced.

Restrictions

a) The **create** operation in combination with the keyword **static** shall only be invoked in configuration functions and in function that may be directly or indirectly called by such a configuration function.

b) The keyword **static** in a **create** operation shall not be used in combination with the keyword **alive**.

EXAMPLES:

```
// This example declares variables of type MyComponentType, which are used to store the
// references of newly created static component instances of type MyComponentType.
// An associated name is allocated to some of the created component instances.
 :
var MyComponentType MyNewComponent;
var MyComponentType MyNewestComponent;
 :
MyNewComponent := MyComponentType.create static;
MyNewestComponent := MyComponentType.create("Newest") static;
```

5.6 Establishment of static connections and static mappings

The establishment of static connections and static mappings shall be indicated by the additional keyword **static** in **connect** and the **map** operations. The extension of the **connect** and **map** operation in clause 21.1.1 of ES 201 873-4 [2] required for the establishment of static connections and mapping is described in the following sections.

Syntactical Structure

```
connect "(" ComponentRef ":" Port "," ComponentRef ":" Port ")" [ static ]
map "(" ComponentRef ":" Port "," ComponentRef ":" Port ")" [ static ]
```

Semantic Description

The **connect** and **map** the operation in combination with the keyword **static** shall only be used to establish static connections and static mappings. Static connections and static mappings can only be established by executing the creator function of a configuration type and by functions directly or indirectly invoked by the creator functions of configuration type.

Static connections and static mappings are established in the same manner as normal connections and mappings. Further details on this can be found in clause 21.1.1 of ES 201 873-4 [2].

NOTE: Static connections and mappings can only be established directly or indirectly by a creator function of a configuration type. This may be checkable at runtime and therefore the keyword **static** may not be required, but for having an explicit specification of static test configurations and for keeping the feature of static test configurations extendible, the keyword **static** has been introduced.

Restrictions

a) The **connect** and **map** operation in combination with the keyword **static** shall only be used in configuration functions and in functions that may be directly or indirectly called by a configuration function.

b) Static connections and static mappings shall only be established to connect ports of static test components and to map ports of a static component to the ports of the test system interface of a configuration type.

EXAMPLES:

```
// The following code fragment may be part of a creator function of a configuration type.
// It is assumed that the ports Port1, Port2, Port3 and PCO1 are properly defined and declared
// in the corresponding port type and component type definitions
 :
var MyComponentType  MyNewPTC;
MyNewPTC := MyComponentType.create static;
 :
connect(MyNewPTC:Port1, mtc:Port3) static;
map(MyNewPTC:Port2, system:PCO1) static;
 :
```

5.7 Test case definitions for static test configuration

Test cases that are executed on a static test configuration have to defined in a special manner. Such test cases shall reference the configuration function that starts a static configuration on which the test case can be executed. The type of the MTC and the type of the test system interface are referenced in the configuration function and shall therefore not be specified in the test case header. The extension of the test case definition in clause 16.3 of ES 201 873-4 [2] required for the execution of a test case on a static test configuration is described in the following sections.

Syntactical Structure

```
testcase TestcaseIdentifier
"(" [ { ( FormalValuePar | FormalTemplatePar) [","] } ] ")"
( runs on ComponentType [ system ComponentType ] | execute on ConfigurationType )
StatementBlock
```

Semantic Description

A test case definition that includes an **execute on** clause will be executed on previously created static test configuration of the given configuration type. The type of the MTC and the type of the test system interface is defined in the referenced configuration type. A test case definition that includes an **execute on** clause shall not have a **runs on** or a **system** clause.

Apart from the execute on clause, the definition of test cases to be executed on a static test configuration follows the same rules as described in clause 16.3 of ES 201 873-4 [2].

Restrictions

a) A test case definition that includes an **execute on** clause shall not have a **runs on** or a **system** clause.

EXAMPLES:

```
configuration aConfiguration () runs on MyMTCtype system MySystemType {

    PeerComponent := MyPTCType.create static;   // creation of a static PTC
                                                // PeerComponent is a component variable

    connect(mtc:syncPort, PeerComponent:syncPort);      // static connection

    map (mtc:PCO1, system:PCO1)             // static mapping ot MTC
    map (PeerComponent:PCO2, system:PCO2);  // static mapping of Peer Component

    return              // successful start of test configuration
}

testcase MyTestCase () execute on aConfiguration {

    default := activate(UnexpectedReceptions()); // activate a default
```

```
        PeerComponent.start (PTCbehaviour());       // starting PTC behaviour
        SyncPort.send (Ready);                      // synchronization with PTC
        SyncPort.receive(Ready);                    // PTC ready

        PCO1.send (stimulus);                       // test starts

        ...                                         // test behaviour

    }
```

5.8 Executing test cases on static test configurations

This clause only describes the syntax extensions of the **execute** statement to allow the execution of test cases with an **execute on** clause on static test configurations and the semantics for executing such test cases. The semantics of the **execute** statement for test cases without **execute on** clause remains unchanged.

Syntactical Structure

```
execute "(" TestcaseRef "(" [ { TemplateInstance [","] } ] ")"
            [ "," TimerValue ]
            [ "," ConfigurationRef ] ")"
```

Semantic Description

A test case definition that includes an **execute on** clause shall be executed on previously started static test configuration of a given configuration function. The reference of the previously started static test configuration shall be referenced in the **execute** statement.

Trying to execute a test case on a non-existing or unfitting static test configuration shall cause a run time error. Unfitting test configuration means that the referenced static test configuration has not been created by the configuration function referenced in the test case header.

If the execution of a test case on a static test configuration causes an **error** verdict, all following usages of this static test configuration in **execute** statements shall cause a runtime error.

NOTE: It is allowed to kill the possibly erroneous static test configuration and to start a new one by invoking the configuration function again.

A test case that shall be started on a fitting static test configuration can rely on the following things:

- All static test components, static connections and static mappings created or established by the referenced configuration function shall exist.
- No non-static test components, non-static connections and non-static mappings shall exist.
- Component timers and variables of static test components shall not be reset or reininitialized when a test case is started on a static test configuration. They remain in the same state as when they were left after the creation of the static test configuration or after the termination of a previous test case. This allows to transfer information from one test case to another.
- Ports of static test components shall not emptied or restarted when a test case is started on a static test configuration. For example, this allows a delayed handling of SUT responses like e.g. repetitive status messages, during the test campaign.
- In contrast to component timers, variables and ports, the verdict and the default handling shall be reset. This means all activated defaults are deactiviated, all local verdicts and the global verdict are set to **none**.

Executing a test case on a static test configuration means that the body of the test case is executed on the MTC of the static test configuration. During test execution, all static PTCs behave like alive test components. This means, static PTCs may be stopped and started several times. During test case execution, non-static normal and alive components may be created, started, killed and stopped. In addition, non-static connections and mappings may be established and destroyed.

A test case that is executed on a static test configuration shall end when the behaviour of the MTC ends. In this case, the final test case verdict is returned. The final test case verdict shall be calculated based on the local verdicts of all static and non static test components. Furthermore, all non-static test components, non-static connections and all non static mappings shall be discarded.

Restrictions

All restrictions mentioned in clause 26.1 of the core language document apply.

EXAMPLES:

```
var verdict MyVerdict                                        // local variable

var configuration MyConfiguration := aConfiguration();  // starting a static test configuration

MyVerdict := execute(MyTestCase (),MyConfiguration);    // execution of a test case on a static
                                                         // test configuration

if (MyVerdict :== pass) {
    MyVerdict := execute MyTestCase (), 10.0, MyConfiguration); // executing the same test case
                                                                // with time guard
}

...     // further test behaviour
stop;
```

5.9 Further restrictions

Static test components, static connections and static mappings have a special semantics. Therefore, situations shall cause a runtime error:

- Applying a **`kill`** test component operation to a static test component.
- Applying port operations (**`clear`**, **`start`**, **`stop`** and **`halt`**) to a port owned by a static test component.
- Applying a **disconnect** operation to a static connection.
- Applying **unmap** operation to a static mapping.

6 Package Semantics

The complete semantics of the using the package in TTCN-3 is defined by copying the following clauses in the following manner into of ES 201 873-4 [2]: TTCN-3 Operational Semantics.

- Clause 6.1 replaces clause 7 in ES 201 873-4 [2].
- Clause 6.2 replaces clause 7.1 in ES 201 873-4 [2].
- Clause 6.3 replaces clause 8.2 in ES 201 873-4 [2].
- Clause 6.4 replaces clause 8.2.1 in ES 201 873-4 [2].
- Clause 6.5 is a new clause. I would become clause 8.2.6a in ES 201 873-4 [2].
- Clause 6.6 replaces clause 8.2.7 in ES 201 873-4 [2].
- Clause 6.7 replaces clause 8.3.1 in ES 201 873-4 [2].

- Clause 6.8 replaces clause 8.3.1.1a in ES 201 873-4 [2].
- Clause 6.9 replaces clause 8.3.1a in ES 201 873-4 [2].
- Clause 6.10 replaces clause 8.3.1.1a in ES 201 873-4 [2].
- Clause 6.11 replaces clause 8.3.2 in ES 201 873-4 [2].
- Clause 6.12 replaces clause 8.3.2.1 in ES 201 873-4 [2].
- Clause 6.13 replaces clause 8.3.3.1 in ES 201 873-4 [2].
- Clause 6.14 replaces clause 8.3.3.2 in ES 201 873-4 [2].
- Clause 6.15 replaces clause 8.6 in ES 201 873-4 [2].
- Clause 6.16 replaces clause 8.6.1 in ES 201 873-4 [2].
- Clause 6.17 replaces clause 8.6.1.1 in ES 201 873-4 [2].
- Clause 6.18 replaces clause 8.6.1.2 in ES 201 873-4 [2].
- Clause 6.19 replaces clause 8.6.1.3 in ES 201 873-4 [2].
- Clause 6.20 replaces clause 8.6.1.4 in ES 201 873-4 [2].
- Clause 6.21 replaces clause 8.6.2 in ES 201 873-4 [2].
- Clause 6.22 replaces clause 9.9 in ES 201 873-4 [2].
- Clause 6.23 is a new clause. It would become clause 9.9a in ES 201 873-4 [2].
- Clause 6.24 replaces clause 9.10 in ES 201 873-4 [2].
- Clause 6.25 replaces clause 9.12 in ES 201 873-4 [2].
- Clause 6.26 replaces clause 9.14.2 in ES 201 873-4 [2].
- Clause 6.27 replaces clause 9.14.3 in ES 201 873-4 [2].
- Clause 6.28 replaces clause 9.14.4 in ES 201 873-4 [2].
- Clause 6.29 replaces clause 9.14.5 in ES 201 873-4 [2].
- Clause 6.30 replaces clause 9.17 in ES 201 873-4 [2].
- Clause 6.31 is a new clause. It would become clause 9.17.0 in ES 201 873-4 [2].
- Clause 6.32 is a new clause. It would become clause 9.17.3 in ES 201 873-4 [2].
- Clause 6.33 is a new clause. It would become clause 9.17.4 in ES 201 873-4 [2].
- Clause 6.34 is a new clause. It would become clause 9.17.5 in ES 201 873-4 [2].
- Clause 6.35 replaces clause 9.22 in ES 201 873-4 [2].
- Clause 6.36 replaces clause 9.28a in ES 201 873-4 [2].
- Clause 6.37 replaces clause 9.29a in ES 201 873-4 [2].
- Clause 6.38 replaces clause 9.29a.1 in ES 201 873-4 [2].
- Clause 6.39 replaces clause 9.29a.3 in ES 201 873-4 [2].
- Clause 6.40 replaces clause 9.29b in ES 201 873-4 [2].
- Clause 6.41 is a new clause. It would become clause 9.29c in ES 201 873-4 [2].

- Clause 6.42 replaces clause 9.32 in ES 201 873-4 [2].
- Clause 6.43 replaces clause 9.47 in ES 201 873-4 [2].
- Clause 6.44 replaces clause 9.49 in ES 201 873-4 [2].
- Clause 6.45 replaces clause 9.49.1 in ES 201 873-4 [2].
- Clause 6.46 is a new clause. It would become clause 9.49.4 in ES 201 873-4 [2].
- Clause 6.47 is a new clause. I would become clause 9.49.5 in ES 201 873-4 [2].
- Clause 6.48 replaces clause 9.51 in ES 201 873-4 [2].
- Clause 6.49 replaces clause 9.56.1 in ES 201 873-4 [2].
- Clause 6.50 replaces clause 9.56.2 in ES 201 873-4 [2].
- Clause 6.51 replaces clause 9.56.3 in ES 201 873-4 [2].

6.1 Replacement of short forms

Short forms have to be expanded by the corresponding complete definitions on a textual level before this operational semantics can be used for the explanation of TTCN-3 behaviour.

TTCN-3 short forms are:

- lists of module parameter, constant and variable declarations of the same type and lists of timer declarations;
- stand-alone receiving operations;
- stand-alone altsteps calls;
- **`trigger`** operations;
- missing **`return`** and **`stop`** statements at the end of function, configuration function and test case definitions;
- missing **`stop`** execution statements;
- **`interleave`** statements;
- **`select-case`** statements;
- **`break`** and **`continue`** statements;
- **`disconnect`** and **`unmap`** operations without parameters; and
- default values of missing actual parameters.

In addition to the handling of short forms, the operational semantics requires a special handling for module parameters, global constants, i.e. constants that are defined in the module definitions part, and pre-processing macros. All references to module parameters, global constants and pre-processing macros shall be replaced by concrete values. This means, it is assumed that the value of module parameters, global constants and pre-processing macros can be determined before the operational semantics becomes relevant.

NOTE 1: The handling of module parameters and global constants in the operational semantics will be different from their handling in a TTCN-3 compiler. The operational semantics describes the meaning of TTCN-3 behaviour and is not a guideline for the implementation of a TTCN-3 compiler.

NOTE 2: The operational semantics handles parameters of and local constants in test components, test cases, functions and module control like variables. The wrong usage of local constants or **`in`**, **`out`** and **`inout`** parameters has to be checked statically.

6.2 Order of replacement steps

The textual replacements of short forms, global constants and module parameters have to be done in the following order:

1) replacement of lists of module parameter, constant, variable and timer declarations with individual declarations;
2) replacement of global constants and module parameters by concrete values;
3) replacement of all **`select-case`** statements by equivalent nested **`if-else`** statements;
4) embedding stand-alone receiving operations into **`alt`** statements;
5) embedding stand-alone altstep calls into **`alt`** statements;
6) expansion of **`interleave`** statements;
7) replacement of all **`trigger`** operations by equivalent **`receive`** operations and **`repeat`** statements;
8) adding **`return`** at the end of function and configuration function definitions without **`return`** statement, adding **`self`**.**`stop`** operations at the end of testcase definitions without a **`stop`** statement;
9) adding **`stop`** at the end a module control part without stop statement;
10) expansion of **break** statements;
11) expansion of **continue** statements;
12) adding default parameters to **`disconnect`** and **`unmap`** operations without parameters; and
13) adding default values of parameters.

NOTE: Without keeping this order of replacement steps, the result of the replacements would not represent the defined behaviour.

6.3 Flow graph representation of TTCN-3 behaviour

The operational semantics assumes that TTCN-3 behaviour descriptions are provided in form of a set of flow graphs, i.e. for each TTCN-3 behaviour description a separate flow graph has to be constructed.

The operational semantics interprets the following kinds of TTCN-3 definitions as behaviour descriptions:

a) module control;
b) test case definitions;
c) function definitions;
d) altstep definitions;
e) component type definitions;
f) configuration functions.

The module control specifies the test campaign, i.e. the execution order (possibly repetitious) of the actual test cases. Test case definitions define the behaviour of the MTC. Functions structure behaviour. They are executed by the module control or by the test components. Altsteps are used for the definition of default behaviour or in a function-like manner to structure behaviour. Component type definitions are assumed to be behaviour descriptions because they specify the creation, declaration and initialization of ports, constants, variables and timers during the creation of an instance of a component type. Configuration functions specify the creation of static test configurations.

6.4 Flow graph construction procedure

The flow graphs presented in the figures 18 to 22 and the flow graph segments presented in clause 8 are only templates. They include *placeholders* for information that has to be provided in order to produce a concrete flow graph or flow graph segment. The placeholders are marked with "<" and ">" parenthesis.

The construction of a flow graph representation of a TTCN-3 module is done in three steps:

1) For each TTCN-3 statement in module control, test cases, altsteps, functions and component type definitions a concrete flow graph segment is constructed.

2) For the module control and for each test case, altstep, function, component type and configuration function definition a concrete flow graph (with reference nodes) is constructed.

3) In a stepwise procedure all reference nodes in the concrete flow graphs are replaced by corresponding flow graph segment definitions until all flow graphs only include one start node, end nodes and basic flow graph nodes.

NOTE 1: Basic flow graph nodes describe basic indivisible execution units. The operational semantics for TTCN-3 behaviour is based on the interpretation of basic flow graph nodes. Clause 8.6 presents execution methods for basic flow graph nodes only.

The replacement of a reference node by the corresponding flow graph segment definition may lead to unconnected parts in a flow graph, i.e. parts which cannot be reached from the start node by traversing through the flow graph along the flow lines. The operational semantics will ignore unconnected parts of a flow graph.

NOTE 2: An unconnected part of a flow graph is a result of the mechanical replacement procedure. For the construction of an optimal flow graph representation the different combinations of TTCN-3 statements also has to be taken into consideration. However, the goal of the present document is to provide a correct and complete semantics, not an optimal flow graph representation.

6.5 Flow graph representation of configuration functions

Schematically, the syntactical structure of a TTCN-3 test case definition is:

```
configuration <identifier> (<parameter>) <testcase-interface> <statement-block>
```

The <testcase-interface> above refers to the (mandatory) **runs on** and the (optional) **system** clauses in the configuration function definition. The flow graph description of a configuration function describes the behaviour of the MTC when establishing a new static configuration. Variables, timers and constants defined and declared in the component type definition are made visible to the MTC behaviour by the **runs on** clause in the <testcase-interface>. The **system** clause is not relevant for the MTC and is therefore not represented in the flow graph representation of a configuration function.

The scheme of the flow graph representation of a configuration function is shown in figure 22a. The flow graph name <identifier> refers to the name of the represented configuration function. The nodes of the flow graph have associated comments describing the meaning of the different nodes. The reference node <return-with-value> covers the case where no explicit **return** operation for the MTC is specified, i.e. the operational semantics assumes that a **return** operation is implicitly added. After a successful termination, a configuration function always returns a handle to the newly created static test configuration.

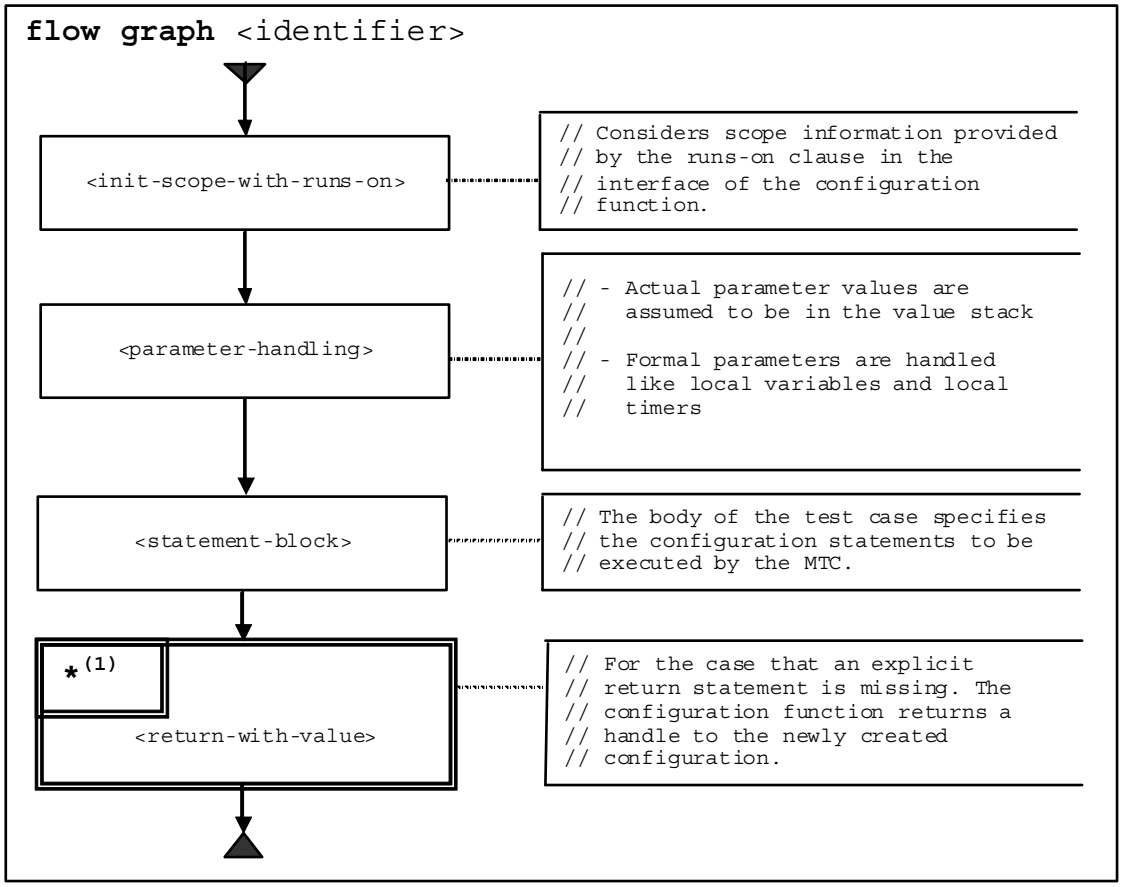


Figure 22a of ES 201 873-4 [2]: Flow graph representation of configuration functions

6.6 Retrieval of start nodes of flow graphs

For the retrieval of the start node reference of a flow graph the following function is required:

The GET-FLOW-GRAPH function: GET-FLOW-GRAPH (flow-graph-identifier)

The function returns a reference to the start node of a flow graph with the name *flow-graph-identifier*. The *flow-graph-identifier* refers to the module name for the control, to test case names, to function names, to altstep names to component type names and configuration function names.

6.7 Module state

As shown in figure 23 a module state is structured into a *CONTROL* state and an *ALL-CONFIGURATIONS* state. The *CONTROL* state describes the state of the module control. Module control is handled like a test component, i.e. *CONTROL* is an entity state as defined in clause 8.3.2. *ALL-CONFIGURATIONS* is a list of configuration states representing test configurations that are instantiated during the execution of module control.

CONTROL	ALL-CONFIGURATIONS		
	$CONFIG_1$	...	$CONFIG_n$

Figure 23 of ES 201 873-4 [2]: Structure of a module state

6.8 Accessing the module state

The *CONTROL* state and the *ALL-CONFIGURATIONS* state of the module state can be addressed by using their names, i.e. *CONTROL* and *ALL-CONFIGURATIONS*. Configurations can be accessed by using the dot notation, e.g. *ALL-CONFIGURATIONS*.$CONFIG_1$, or by using the list operations defined in clause 8.3.1.1a of ES 201 873-4 [2].

6.9 Configuration state

As shown in figure 23a the configuration state is structured into *ALL-ENTITY-STATES*, *ALL-PORT-STATES*, *TC-VERDICT*, *DONE* and *KILLED*. *ALL-ENTITY-STATES* represents the states of all instantiated test components during the execution of a test case. The first element of *ALL-ENTITY-STATES* is the reference to the MTC of the configuration. *ALL-PORT-STATES* describes the states of the different ports. *TC-VERDICT* stores the actual global test verdict of a test case, *DONE* is a list of all currently stopped test components during test case execution and *KILLED* is a list of all terminated test components during test case execution.

NOTE 1: The number of updates of *TC-VERDICT* is identical to the number of test components that have terminated.

NOTE 2: An alive-type test component is put into the *DONE* list each time when it is stopped and removed from the DONE list each time when it is started. It is put into the *KILL* and the *DONE* list when it is killed.

NOTE 3: Port states may be considered to be part of the entity states. By **`connect`** and **`map`** ports are made visible for other components and therefore, this operational semantics handles ports on the top level of the configuration state.

Figure 23a of ES 201 873-4 [2]: Structure of a configuration state

6.10 Accessing the configuration state

The *TC-VERDICT* and the lists *ALL-ENTITY-STATES*, *ALL-PORT-STATES*, *DONE* and *KILLED* can be accessed like variables by their name and the dot notation, e.g. *CONFIG*.*TC-VERDICT* for accessing the test verdict of configuration *CONFIG*.

For the creation of a new configuration state the function *NEW-CONFIGURATION* is assumed to be available:

- *NEW-CONFIGURATION*();

creates a new configuration state and returns its reference. The components of the new configuration state have the following values:

- *ALL-ENTITY-STATES* is an empty list;
- *ALL-PORT-STATES* is an empty list;
- *TC-VERDICT* is set to none;
- *DONE* is an empty list;
- *KILLED* is an empty list.

For the handling of lists, e.g. *ALL-ENTITY-STATES*, *ALL-PORT-STATES*, *DONE* and *KILLED* in module states, the list operations *add*, *append*, *delete*, *member*, *first*, *last*, *length*, *next*, *random* and *change* can be used. They have the following meaning:

- *myList*.*add*(*item*) adds *item* as first element into the list *myList* and *myList*.*add*(*sublist*) adds the list *sublist* to list *myList*, i.e. *add* can be used to add single elements or lists to lists;
- *myList*.*append*(*item*) appends *item* as last element into the list *myList* and *myList*.*append*(*sublist*) appends the list *sublist* to list *myList*, i.e. *append* can be used to append single elements or lists to lists;
- *myList*.*delete*(*item*) deletes *item* from the list *myList*;
- *myList*.*member*(*item*) returns **`true`** if *item* is an element of the list *myList*, otherwise **`false`**;
- *myList*.*first*() returns the first element of *myList*;

- *myList*.*last*() returns the last element of *myList*;
- *myList*.*length*() returns the length of *myList*;
- *myList*.*next*(*item*) returns the element that follows *item* in *myList*, or **NULL** if *item* is the last element in *myList*;
- *myList*.*random*(<*condition*>) returns randomly an element of *myList*, which fulfils the Boolean condition <*condition*> or **NULL**, if no element of *myList* fulfils <*condition*>;
- myList.change(<operation>) allows to apply <operation> on all elements of myList.

NOTE: The operations random and change are not common list operations. They are introduced to explain the meaning of the keywords **all** and **any** in TTCN-3 operations.

Additionally, a general *copy* operation is available. The *copy* operation copies and returns an item instead of returning a reference to an item:

- *copy*(*item*) returns a copy of *item*.

6.11 Entity states

Entity states are used to describe the actual states of module control and test components. In the module state, *CONTROL* is an entity state and in the configuration state, the test component states are handled in the list *ALL-ENTITY-STATES*. The structure of an entity state is shown in figure 24.

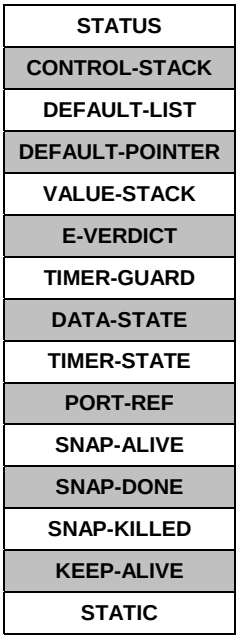


Figure 24 of ES 201 873-4 [2]: Structure of an entity state

The *STATUS* describes whether the module control or a test component is **ACTIVE**, **BREAK**, **SNAPSHOT**, **REPEAT** or **BLOCKED**. Module control is blocked during the execution of a test case. Test components are blocked during the creation of other test components, i.e. when they call a **create** operation, and when they wait for being started. The status **SNAPSHOT** indicates that the component is active, but in the evaluation phase of a snapshot. The status **REPEAT** denotes that the component is active and in an **alt** statement that should be re-evaluated due to a **repeat** statement. The **BREAK** status is set when a **break** statement is executed for leaving altstep. In this case, the **alt** statement in which the altstep was directly or indirectly (i.e. by means of the default mechanism) called is immediately left.

The *CONTROL-STACK* is a stack of flow graph node references. The top element in *CONTROL-STACK* is the flow graph node that has to be interpreted next. The stack is required to model function calls in an adequate manner.

The *DEFAULT-LIST* is a list of activated defaults, i.e. it is a list of pointers that refer to the start nodes of activated defaults. The list is in the reverse order of activation, i.e. the default that has been activated first is the last element in the list.

During the execution of the default mechanism, the *DEFAULT-POINTER* refers to the next default that has to be evaluated if the actual default terminates unsuccessfully.

The *VALUE-STACK* is a stack of values of all possible types that allows an intermediate storage of final or intermediate results of operations, functions and statements. For example, the result of the evaluation of an expression or the result of the **`mtc`** operation will be pushed onto the *VALUE-STACK*. In addition to the values of all data types known in a module we define the special value **`MARK`** to be part of the stack alphabet. When leaving a scope unit, the **`MARK`** is used to clean *VALUE-STACK*.

The *E-VERDICT* stores the actual local verdict of a test component. The *E-VERDICT* is ignored if an entity state represents the module control.

The *TIMER-GUARD* represents the special timer, which is necessary to guard the execution time of test cases and the duration of call operations. The *TIMER-GUARD* is modelled as a timer binding (see clause 8.3.2.4 and figure 28).

The *DATA-STATE* is considered to be a list of lists of variable bindings. The list of lists structure reflects nested scope units due to nested function and altstep calls. Each list in the list of lists of variable bindings describes the variables declared in a certain scope unit and their values. Entering or leaving a scope unit corresponds to adding or deleting a list of variable bindings from the *DATA-STATE*. A description of the *DATA-STATE* part of an entity state can be found in clause 8.3.2.2.

The *TIMER-STATE* is considered to be a list of lists of timer bindings. The list of lists structure reflects nested scope units due to nested function and altstep calls. Each list in the list of lists of timer bindings describes the known timers and their status in a certain scope unit. Entering or leaving a scope unit corresponds to adding or deleting a list of timer bindings from the *TIMER-STATE*. A description of the *TIMER-STATE* part of an entity state can be found in clause 8.3.2.4.

The *PORT-REF* is considered to be a list of lists of port bindings. The list of lists structure reflects nested scope units due to nested function and altstep calls. Nested scope units for ports are the result of port parameters in functions and altsteps. Each list in the list of lists of port bindings identifies the known ports in a certain scope unit. Entering or leaving a scope unit corresponds to adding or deleting a list of port bindings from the *PORT-REF*. A description of the *PORT-REF* part of an entity state can be found in clause 8.3.2.6.

NOTE: The TTCN-3 semantics administrates ports globally in the module state. Due to port parameterization, a test component may access a port by using different names in different scopes. The *PORT-REF* part of an entity state is used to identify port states uniquely in the module state.

The *SNAP-ALIVE* supports the snapshot semantics of test components. When a snapshot is taken, a copy of the *ALL-ENTITY-STATES* list of the module state will be assigned to *SNAP-ALIVE*, i.e. *SNAP-ALIVE* includes all entities (test components and test control) which are alive in the test system.

The *SNAP-DONE* supports the snapshot semantics of test components. When a snapshot is taken, a copy of the *DONE* list of the module state will be assigned to *SNAP-DONE*, i.e. *SNAP-DONE* is a list of component identifiers of stopped components.

The *SNAP-KILLED* supports the snapshot semantics of test components. When a snapshot is taken, a copy of the *KILLED* list of the module state will be assigned to *SNAP-KILL*, i.e. *SNAP-DONE* is a list of component identifiers of terminated components.

The *KEEP-ALIVE* field indicates whether the entity can be restarted after its termination or not. It is set to true if the entity can be restarted. Otherwise it is set to false.

The *STATIC* field indicates whether a test component is part of a static test configuration or not. It is set to **true** if the test component is created during the execution of configuration function. During the execution of a configuration function the *STATIC* field of the entity representing test control is also set to **true**. In all other cases, the *STATIC* field is set to **false**.

6.12 Accessing entity states

The *STATUS*, *DEFAULT-POINTER*, *E-VERDICT* and *TIMER-GUARD* parts of an entity state are handled like variables that are globally visible, i.e. the values of *STATUS*, *DEFAULT-POINTER* and *E-VERDICT* can be retrieved or changed by using the "dot" notation, e.g. *myEntity*.*STATUS*, *myEntity*.*DEFAULT-POINTER* and *myEntity*.*E-VERDICT*, where *myEntity* refers to an entity state.

NOTE: In the following, we assume that we can use the "dot" notation by using references and unique identifiers. For example, in *myEntity*.*STATUS*, *myEntityState* may be pointer to an entity state or be the value of the <*identifier*> field.

The *CONTROL-STACK*, *DEFAULT-LIST* and *VALUE-STACK* of an entity state *myEntity* can be addressed by using the "dot" notation *myEntity*.*CONTROL-STACK*, *myEntity*.*DEFAULT-LIST* and *myEntity*.*VALUE-STACK*.

CONTROL-STACK and *VALUE-STACK* can be accessed and manipulated by using the stack operations *push*, *pop*, *top*, *clear* and *clear-until*. The stack operations have the following meaning:

- myStack.push(item) pushes item onto myStack;
- myStack.pop() pops the top item from myStack;
- myStack.top() returns the top element of myStack or **`NULL`** if myStack is empty;
- myStack.clear() clears myStack, i.e. pops all items from myStack;
- myStack.clear-until(item) pops items from myStack until item is found or myStack is empty.

DEFAULT-LIST can be accessed and manipulated by using the list operations *add*, *append*, *delete*, *member*, *first*, *length*, *next*, *random* and *change*. The meaning of these list operations is defined in clause 8.3.1.1.

For the creation of a new entity state the function *NEW-ENTITY* is assumed to be available:

- *NEW-ENTITY* (*flow-graph-node-reference*, *keep-alive*, *static*);

creates a new entity state and returns its reference. The components of the new entity state have the following values:

- *STATUS* is set to **`ACTIVE`**;
- *flow-graph-node-reference* is the only (top) element in *CONTROL-STACK*;
- *DEFAULT-LIST* is an empty list;
- *DEFAULT-POINTER* has the value **`NULL`**;
- *VALUE-STACK* is an empty stack;
- *E-VERDICT* is set to **`none`**;
- *TIMER-GUARD* is a new timer binding (see clause 8.3.2.4) with name GUARD, status **IDLE** and no default duration;
- *DATA-STATE* is an empty list;
- *TIMER-STATE* is an empty list;
- *PORT-REF* is an empty list;
- *SNAP-ALIVE* is an empty list;
- *SNAP-DONE* is an empty list;
- *SNAP-KILLED* is an empty list;
- *KEEP-ALIVE* is set to the value of the *keep-alive* parameter;
- *STATIC* is set to the value of the *static* parameter.

During the traversal of a flow graph the *CONTROL-STACK* changes its value often in the same manner: the top element is popped from and the successor node of the popped node is pushed onto *CONTROL-STACK*. This series of stack operations is encapsulated in the *NEXT-CONTROL* function:

```
myEntity.NEXT-CONTROL(myBool) {
    successorNode := myEntity.CONTROL-STACK.NEXT(myBool).top();
    myEntity.CONTROL-STACK.pop();
    myEntity.CONTROL-STACK.push(successorNode);
}
```

6.13 Handling of connections among ports

A connection between two test components is made by connecting two of their ports by means of a **connect** operation. Thus, a component can afterwards use its local port name to address the remote queue. As shown in figure 30, *connection* is represented in the states of both connected queues by a pair of *REMOTE-ENTITY* and *REMOTE-PORT-NAME*. The *REMOTE-ENTITY* is the unique identifier of the test component that owns the remote port. The *REMOTE-PORT-NAME* refers to the port name that is used to declare the port in the component type definition of the test component *REMOTE-ENTITY*. *STATIC* is a Boolean which is true if connection is a static connection of a static test configuration. TTCN-3 supports one-to-many connections of ports and therefore all connections of a port are organized in a list.

NOTE 1: Connections made by **map** operations are also handled in the list of connections. The **map** operation: **map**(*PTC1*:*MyPort*, **system**.*PCO1*) leads to a new (non static) connection (**system**, *PCO1*, **false**) in the port state of *MyPort* owned by *PTC1*. The remote side to which *PCO1* is connected to, resides inside the SUT. Its behaviour is outside the scope of this semantics.

NOTE 2: The operational semantics handles the keyword **system** as a symbolic address. A connection (**system**, *myPort*, **false**) in the list of connections of a port it indicates that the port is mapped onto the port *myPort* in the test system interface. The **false** indicates that the mapping is not static.

REMOTE-ENTITY	REMOTE-PORT-NAME	STATIC

Figure 30 of ES 201 873-4 [2]: Structure of a connection

6.14 Handling of port states

The queue of values in a port state can be accessed and manipulated by using the known queue operations *enqueue*, *dequeue*, *first* and *clear*. Using a *GET-PORT* or a *GET-REMOTE-PORT* function references the queue that shall be accessed.

NOTE 1: The queue operations *enqueue*, *dequeue*, *first* and *clear* have the following meaning:

- *myQueue*.*enqueue*(*item*) puts *item* as last item into *myQueue*;
- *myQueue*.*dequeue*() deletes the first item from *myQueue*;
- *myQueue*.*first*() returns the first item in *myQueue* or **NULL** if *myQueue* is empty;
- *myQueue*.*clear*() removes all elements from *myQueue*.

The handling of port states is supported by the following functions:

a) The *NEW-PORT* function: *NEW-PORT* (*myEntity*, *myPort*)

creates a new port and returns its reference. The *OWNER* entry of the new port is set to *myEntity* and *COMP-PORT-NAME* has the value *myPort*. The status of the new port is **STARTED**. The *CONNECTIONS-LIST* and the *VALUE-QUEUE* are empty. The *SNAP-VALUE* has the value **NULL** (i.e. the input queue of the new port is empty).

b) The *GET-PORT* function: *GET-PORT* (*myEntity*, *myPort*)

returns a reference to the port identified by *OWNER myEntity* and *COMP-PORT-NAME myPort*.

c) The *GET-REMOTE-PORT* function: *GET-REMOTE-PORT* (*myEntity*, *myPort*, *myRemoteEntity*)

returns the reference to the port that is owned by test component *myRemoteEntity* and connected to a port identified by *OWNER* *myEntity* and *COMP-PORT-NAME* *myPort*. The symbolic address **SYSTEM** is returned, if the remote port is mapped onto a port in the test system interface.

NOTE 2: *GET-REMOTE-PORT* returns **NULL** if there is no remote port or if the remote port cannot be identified uniquely. The special value **NONE** can be used as value for the *myRemoteEntity* parameter if the remote entity is not known or not required, i.e. there exists only a one-to-one connection for this port.

d) The *STATUS* of a port is handled like a variable. It can be addressed by qualifying *STATUS* with a *GET-PORT* call:

GET-PORT(*myEntity*, *myPort*).*STATUS*

e) The *ADD-CON* function: *ADD-CON* (*myEntity*, *myPort*, *myRemoteEntity*, *myRemotePort*, *myStatic*)

adds a connection (*myRemoteEntity*, *myRemotePort*, *myStatic*) to the list of connections of the port identified by *OWNER* *myEntity* and *COMP-PORT-NAME* *myPort*.

f) The *DEL-CON* function: *DEL-CON* (*myEntity*, *myPort*, *myRemoteEntity*, *myRemotePort*)

removes a connection (*myRemoteEntity*, *myRemotePort*, ?) with any *STATIC* value from the list of connections of the port identified by *OWNER* *myEntity* and *COMP-PORT-NAME* *myPort*.

g) The GET-CON function: GET-*CON* (*myEntity*, *myPort*, *myRemoteEntity*, *myRemotePort*)

retrieves a connection (*myRemoteEntity*, *myRemotePort*, ?) with any *STATIC* value from the list of connections of the port identified by *OWNER* *myEntity* and *COMP-PORT-NAME* *myPort*.

h) The *SNAP-PORTS* function: *SNAP-PORTS* (*myEntity*)

updates *SNAP-VALUE* for all ports owned by *myEntity*, i.e.

```
SNAP-PORTS (myEntity) {
    for all ports p          /* in the module state */ {
        if (p.OWNER == myEntity) {
            if (p.STATUS == STOPPED) {
                p.SNAP-VALUE := NULL;
            }
            else {
                if (p.STATUS == HALTED && p.first() == HALT-MARKER) {
                    // Port is halted and halt marker is reached
                    p.SNAP-VALUE := NULL;
                    p.dequeue();         // Removal of halt marker
                    p.STATUS := STOPPED;
                }
                else {
                    p.SNAP-VALUE := p.first()
                }
            }
        }
    }
}
```

NOTE 3: The *SNAP-PORTS* function handles the **HALT-MARKER** that may be put by a **halt** port operation into the port queue. If such a marker is found, the marker is removed, the *SNAP-VALUE* of the port is set to **NULL** and the status of the port is changed to **STOPPED**.

6.15 The evaluation procedure for a TTCN-3 module

6.16 Evaluation phases

The evaluation procedure for a TTCN-3 module is structured into:

(1) *initialization phase*;

(2) *update phase*;

(3) *selection phase*; and

(4) *execution phase*.

The phases (2), (3) and (4) are repeated until module control terminates. The evaluation procedure is described by means of a mixture of informal text, pseudo-code and the functions introduced in the previous clauses.

6.17 Phase I: Initialization

The initialization phase includes the following actions:

a) **Declaration and initialization of global variables:**

- *INIT-FLOW-GRAPHS*(); // Initialization of flow graph handling. *INIT-FLOW-GRAPHS* is
  // explained in clause 8.6.2.
- *Entity* := **NULL**; // *Entity* will be used to refer to an entity state. An entity state either
  // represents module control or a test component.
- *MTC* := **NULL**; // MTC will be used to refer to the entity state of the main test component of
  // a test case during test case execution.

NOTE 1: The global variable *CONTROL* form the control state of a module state during the interpretation of a TTCN-3 module (see clause 8.3.1).

- *CONTROL* := **NULL**; // CONTROL will be used to refer to the entity state of module control a

NOTE 2: The global variable *CONFIGURATION* is used to store the reference to a configuration state in the Module state, i.e. a member of ALL-CONFIGURATIONS (see clause 8.3.1).

- *CONFIGURATION* := **NULL**;

NOTE 3: The following global variables *ALL-ENTITY-STATES*, *ALL-PORT-STATES*, *TC-VERDICT*, *DONE*, and *KILLED* are used to store references to a test configuration state of a module state during the interpretation of a TTCN-3 module (see clause 8.3.1).

- *ALL-ENTITY-STATES* := **NULL**;
- *ALL-PORT-STATES* := **NULL**;
- *TC-VERDICT* := **none**;
- *DONE* := **NULL**;
- *KILLED* := **NULL**.

b) **Creation and initialization of module control:**

- *CONTROL* := *NEW-ENTITY* (*GET-FLOW-GRAPH* (<*moduleId*>), **false**, **false**);
  // A new entity state is created and initialized with the start node of
  // the flow graph representing the behaviour of the control of the
  // module with the name <*moduleId*>. The Boolean parameters
  // indicate that module control cannot be restarted after it is
  // stopped and that it is not a static component in a test configuration.
- *CONTROL*.*INIT-VAR-SCOPE*(); // New variable scope
-
- *CONTROL*.*VALUE-STACK*.*push*(**MARK**); // A mark is pushed onto the value stack

6.18 Phase II: Update

The update phase is related to all actions that are outside the scope of the operational semantics but influence the interpretation of a TTCN-3 module. The update phase comprises the following actions:

a) **Time progress:** All running timers are updated, i.e. the *TIME-LEFT* values of running timers are (possibly) decreased, and if due to the update a timer expires, the corresponding timer bindings are updated, i.e. *TIME-LEFT* is set to 0.0 and *STATUS* is set to **`TIMEOUT`**.

NOTE 1: The update of timers includes the update of all running *TIMER-GUARD* timers in module states. *TIMER-GUARD* timers are used to guard the execution of test cases and call operations.

b) **Behaviour of the SUT:** Messages, remote procedure calls, replies to remote procedure calls and exceptions (possibly) received from the SUT are put into the port queues at which the corresponding receptions shall take place.

NOTE 2: This operational semantics makes no assumptions about time progress and the behaviour of the SUT.

6.19 Phase III: Selection

The selection phase consists of the following two actions:

a) **Selection:** Select a non-blocked entity, i.e. an entity that has not the *STATUS* value **`BLOCKED`**. The entity may be *CONTROL*, i.e. module control, or a test component in a test configuration that is executing a test case.

b) **Storage:**

- Store the identifier of the selected entity in the global variable *Entity*.
- If *Entiy* is *CONTROL*, set *CONFIGURATION* to **NULL**.
- If *Entiy* is not *CONTROL*, store the identifier of the configuration of which *Entity* is part of in the global variable *CONFIGURATION* and do the following assignments:
  - ALL-ENTITY-STATES := CONFIGURATION.ALL-ENTITY-STATES;
  - MTC := CONFIGURATION.ALL-ENTITY-STATES.first();
  - ALL-PORT-STATES := CONFIGURATION.ALL-PORT-STATES;
  - TC-VERDICT := CONFIGURATION.TC-VERDICT;
  - DONE := CONFIGURATION. DONE;
  - KILLED := CONFIGURATION.KILLED;

6.20 Phase IV: Execution

The execution phase consists of the following three actions:

a) **Execution step of the selected entity:** Execute the top flow graph node in the *CONTROL-STACK* of *Entity*.

b) **Update of the module state:** This includes an update of the configuration state of the executed *Entity*.

c) **Check termination criterion:** Stop execution if module control has terminated, i.e. *CONTROL* is **NULL**. Otherwise continue with Phase II.

6.21 Global functions

The evaluation procedure uses the global function *INIT-FLOW-GRAPHS*:

a) *INIT-FLOW-GRAPHS* is assumed to be the function that initializes the flow graph handling. The handling may include the creation of the flow graphs and the handling of the pointers to the flow graphs and flow graph nodes.

The pseudo-code used the following clauses to describe execution of flow graph nodes use the functions *CONTINUE-COMPONENT*, *RETURN*, *****DYNAMIC-ERROR*****:

b) *CONTINUE-COMPONENT* the actual test component continues its execution with the node lying on top of the control stack, i.e. the control is not given back to the module evaluation procedure described in this clause.

c) *RETURN* returns the control back to the module evaluation procedure described in this clause. The *RETURN* is the last action of the "*execution step of the selected entity*" of the *execution* phase.

d) *****DYNAMIC-ERROR***** refers to the occurrence of a dynamic error. The error handling procedure itself is outside the scope of the operational semantics. If a dynamic error occurs all following behaviour of the test case is meant to be undefined. In this case resources allocated to the test case shall be cleared and the **error** verdict is assigned to the test case. Control is given to the statement in the control part following the execute statement in which the error occurred. This is modelled by the flow graph segment <dynamic-error> (clause 9.18.5).

NOTE: The occurrence of a dynamic error is related to test behaviour. A dynamic error as specified by the operational semantics denotes a problem in the usage of TTCN-3, e.g. wrong usage or race condition.

e) *APPLY-OPERATOR* used as generic function for describing the evaluation of operators (e.g. +, *, / or -) in expressions (see clause 9.18.4).

6.22 Clear port operation

The syntactical structure of the **clear** port operation is:

```
<portId>.clear
```

The flow graph segment <clear-port-op> in figure 59 defines the execution of the **clear** port operation.

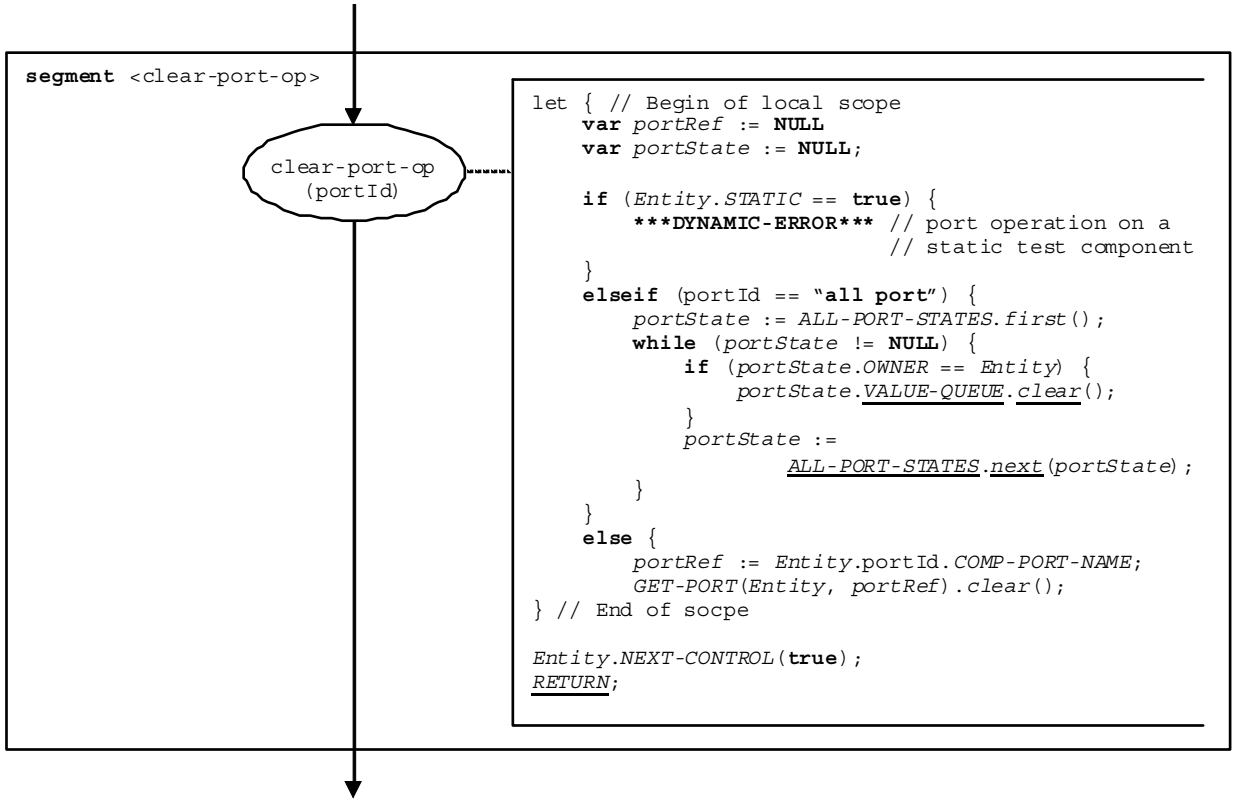


Figure 59 of ES 201 873-4 [2]: Flow graph segment <clear-port-op>

6.23 Configuration function call

The invocation of a configuration function starts with the creation of the MTC. In a static test configuration the MTC is modelled as a static alive component. Then the MTC is started with the behaviour defined in the configuration function. Afterwards, the module control waits until the configuration function terminates. The creation and the start of the MTC can be described by using **create** and **start** statements:

```
var mtcType MyMTC := mtcType.create alive static;
MyMTC.start(ConfigurationFunctionName(P1…Pn));
```

The flow graph segment <config-func-call> in figure 59a defines the execution of a configuration function by using the flow graph segments of the operations **create** and the **start**.

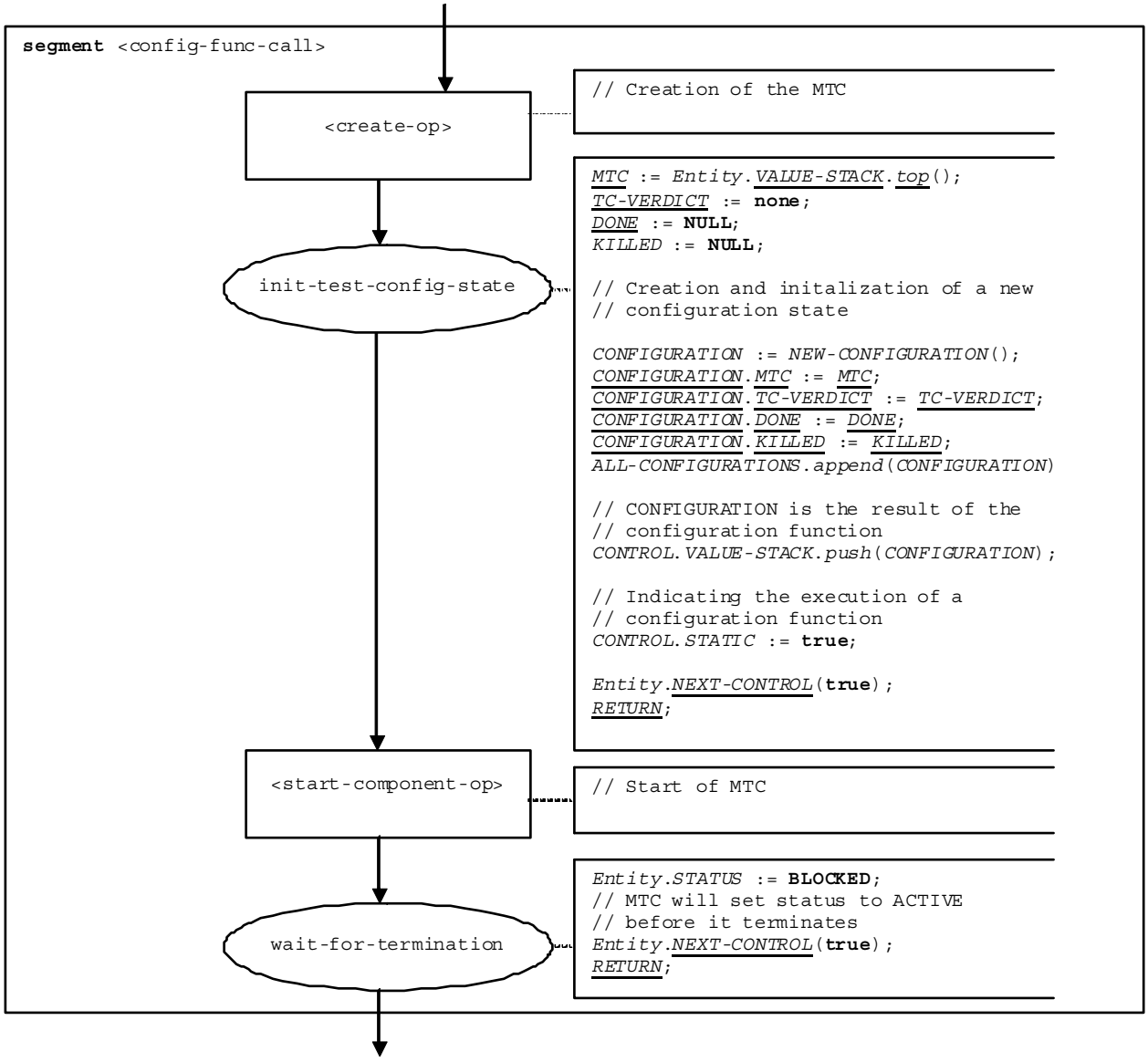


Figure 59a of ES 201 873-4 [2]: Flow graph segment <config-func-call>

6.24 Connect operation

The syntactical structure of the **connect** operation is:

connect(<component-expression$_1$>:<portId1>, <component-expression$_2$>:<portId2>) [**static**]

The identifiers <portId1> and <portId2> are considered to be port identifiers of the corresponding test components. The components to which the ports belong are referenced by means of the component references <component-expression$_1$> and <component-expression$_2$>. The references may be stored in variables or is returned by a function, i.e. they are expressions, which evaluate to component references. The value stack is used for storing the component references.

A present **static** clause indicates that the new connection is static, i.e. established during the execution of a configuration function. Presence and absence of the **static** clause is handled as a Boolean flag in the operational semantics (see static parameter of the basic flow graph node connect-op in figure 60).

The execution of the **connect** operation is defined by the flow graph segment <connect-op> shown in figure 60. In the flow graph description the first expression to be evaluated refers to <component-expression$_1$> and the second expression to <component-expression$_2$>, i.e. the <component-expression$_2$> is on top of the value stack when the connect-op node is executed.

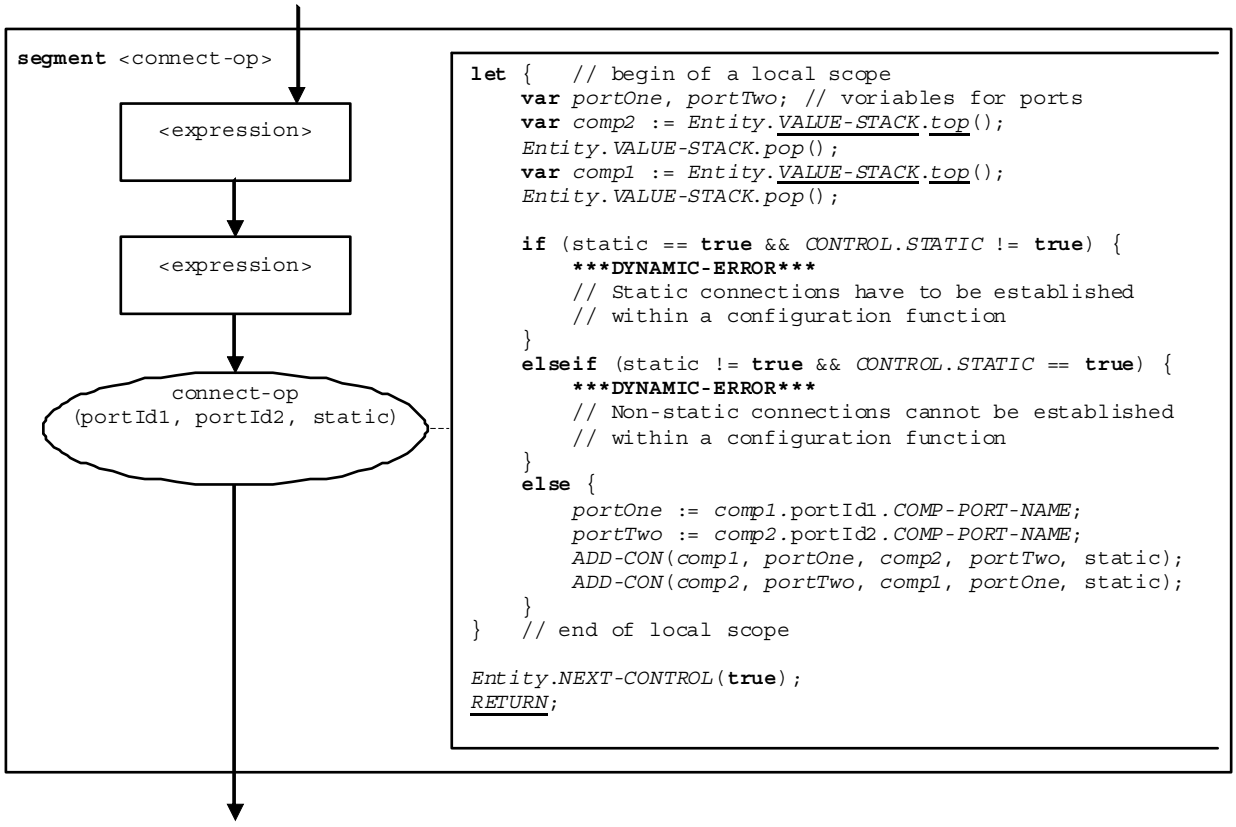


Figure 60 of ES 201 873-4 [2]: Flow graph segment <connect-op>

6.25 Create operation

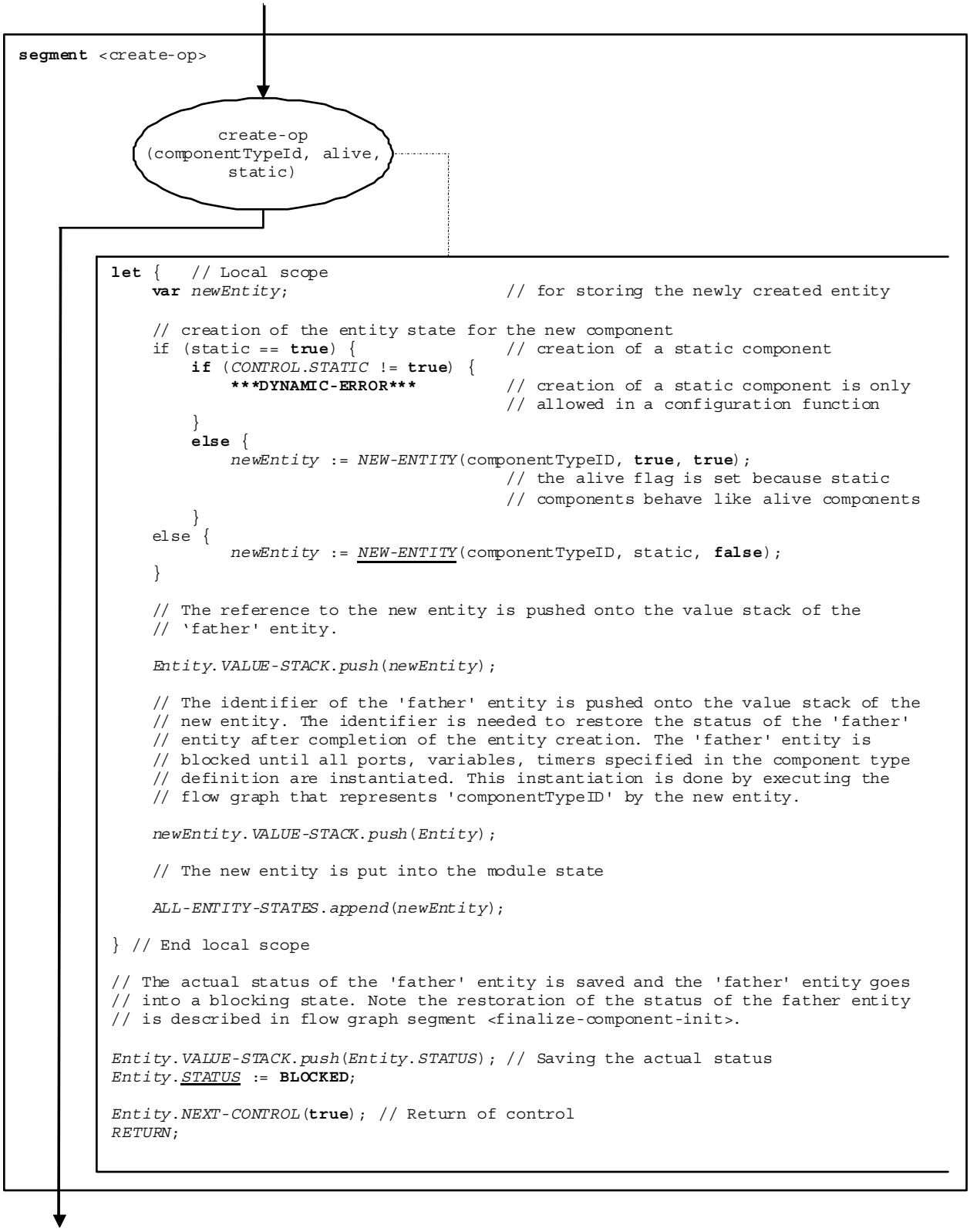
The syntactical structure of the **create** operation is:

```
<componentTypeId>.create [alive] [static]
```

A present **alive** clause indicates that the created component can be restarted after it has been stopped. Presence and absence of the alive clause is handled as a Boolean flag in the operational semantics (see `alive` parameter of the basic flow graph node `create-op` in figure 62).

A present **static** clause indicates that the new component is static, i.e. part of a static test configuration and created during the execution of a configuration function. Presence and absence of the **static** clause is handled as a Boolean flag in the operational semantics (see `static` parameter of the basic flow graph node `create-op` in figure 62).

The flow graph segment `<create-op>` in figure 62 defines the execution of the **create** operation.




```
let {   // Local scope
    var newEntity;                      // for storing the newly created entity

    // creation of the entity state for the new component
    if (static == true) {               // creation of a static component
        if (CONTROL.STATIC != true) {
            ***DYNAMIC-ERROR***         // creation of a static component is only
                                        // allowed in a configuration function
        }
        else {
            newEntity := NEW-ENTITY(componentTypeID, true, true);
                                        // the alive flag is set because static
                                        // components behave like alive components
        }
    else {
            newEntity := NEW-ENTITY(componentTypeID, static, false);
    }

    // The reference to the new entity is pushed onto the value stack of the
    // 'father' entity.

    Entity.VALUE-STACK.push(newEntity);

    // The identifier of the 'father' entity is pushed onto the value stack of the
    // new entity. The identifier is needed to restore the status of the 'father'
    // entity after completion of the entity creation. The 'father' entity is
    // blocked until all ports, variables, timers specified in the component type
    // definition are instantiated. This instantiation is done by executing the
    // flow graph that represents 'componentTypeID' by the new entity.

    newEntity.VALUE-STACK.push(Entity);

    // The new entity is put into the module state

    ALL-ENTITY-STATES.append(newEntity);

} // End local scope

// The actual status of the 'father' entity is saved and the 'father' entity goes
// into a blocking state. Note the restoration of the status of the father entity
// is described in flow graph segment <finalize-component-init>.

Entity.VALUE-STACK.push(Entity.STATUS); // Saving the actual status
Entity.STATUS := BLOCKED;

Entity.NEXT-CONTROL(true); // Return of control
RETURN;
```

Figure 62 of ES 201 873-4 [2]: Flow graph segment <create-op>

6.26 Flow graph segment <disconnect-all>

The flow graph segment <disconnect-all> defines the disconnection of all components at all connected ports. Static connections will not be disconnected. Their lifetime is bound to the lifetime of the static test configuration.

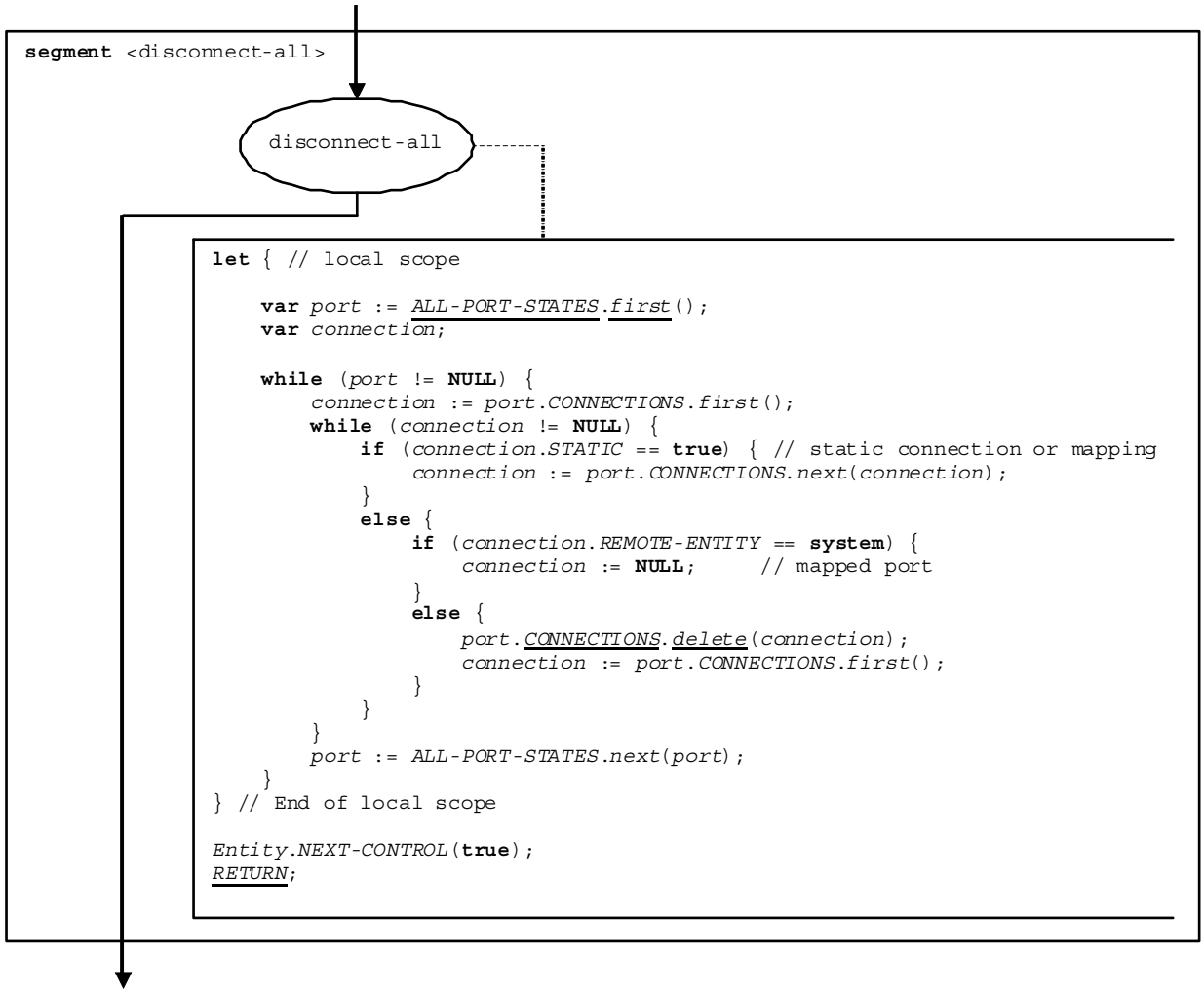


Figure 64b of ES 201 873-4 [2]: Flow graph segment <disconnect-all>

6.27 Flow graph segment <disconnect-comp>

The flow graph segment <disconnect-comp> defines the disconnection of all ports of a specified component. Static connections will not be disconnected. Their lifetime is bound to the lifetime of the static test configuration.

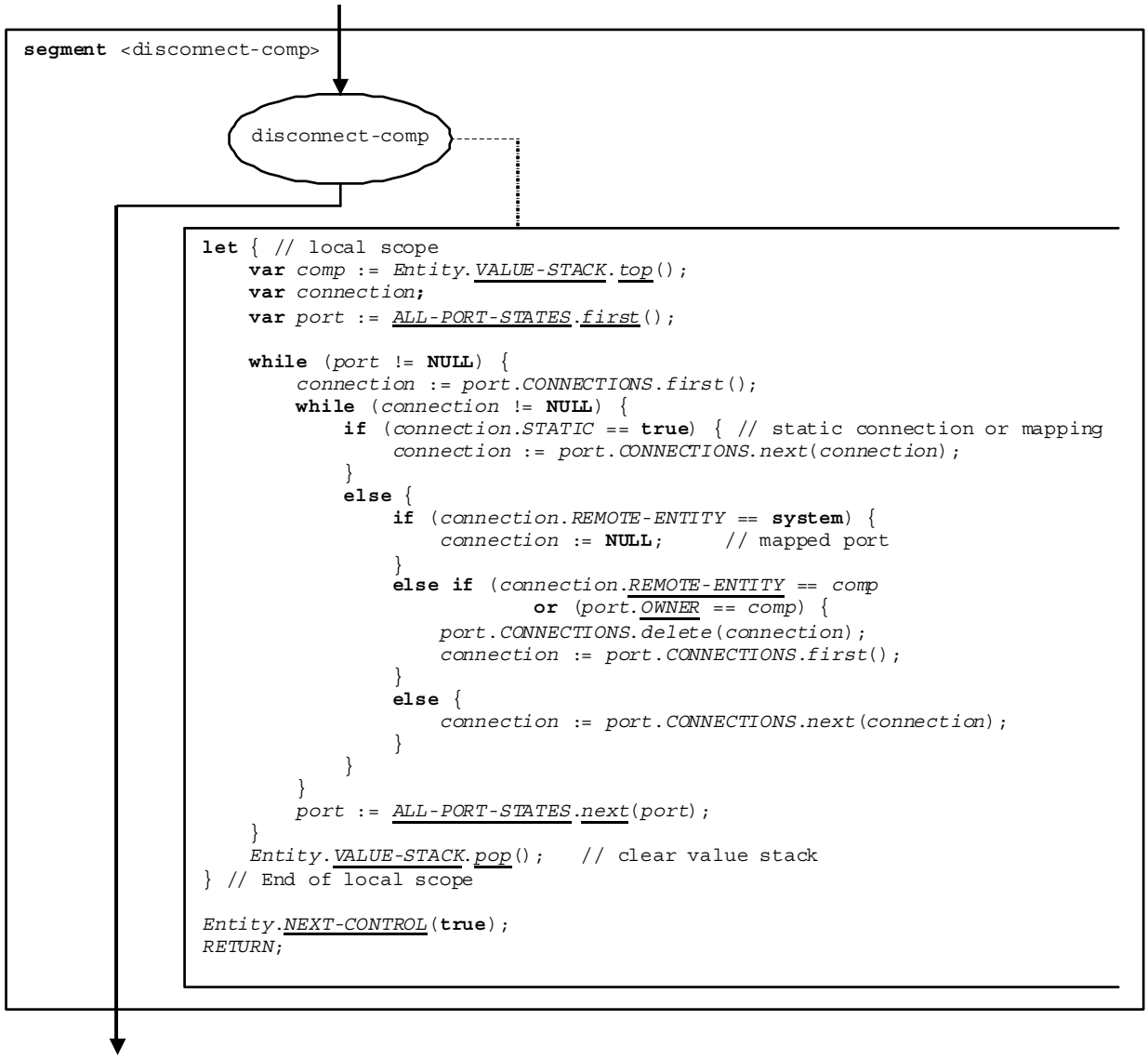


Figure 64c of ES 201 873-4 [2]: Flow graph segment <disconnect-comp>

6.28 Flow graph segment <disconnect-port>

The flow graph segment <disconnect-port> defines the disconnection of a specified port. Static connections will not be disconnected. Their lifetime is bound to the lifetime of the static test configuration.

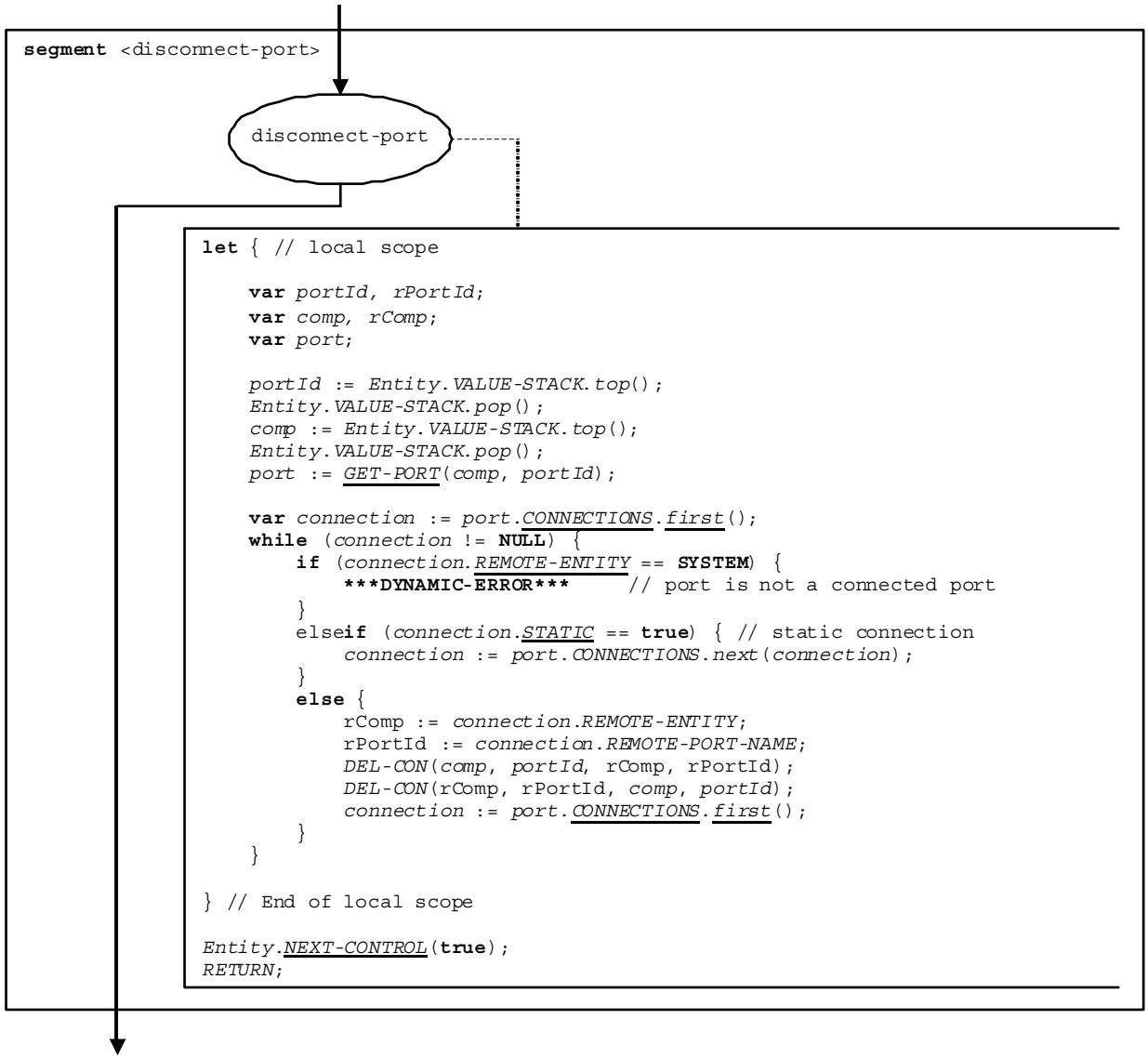


Figure 64d of ES 201 873-4 [2]: Flow graph segment <disconnect-port>

6.29 Flow graph segment <disconnect-two-par-pairs>

The flow graph segment <disconnect-two-par-pairs> shown in figure 64e defines the execution of the **disconnect** operation with two parameter pairs which disconnects specific connections. In the flow graph segment the first expression to be evaluated refers to <component-expression$_1$> (see syntactical structure of the **disconnect** operation in clause 9.14) and the second expression to <component-expression$_2$>, i.e. the <component-expression$_2$> is on top of the value stack when the disconnect-two node is executed. Applying the **disconnect** operation to a static connection leads to a dynamic error.

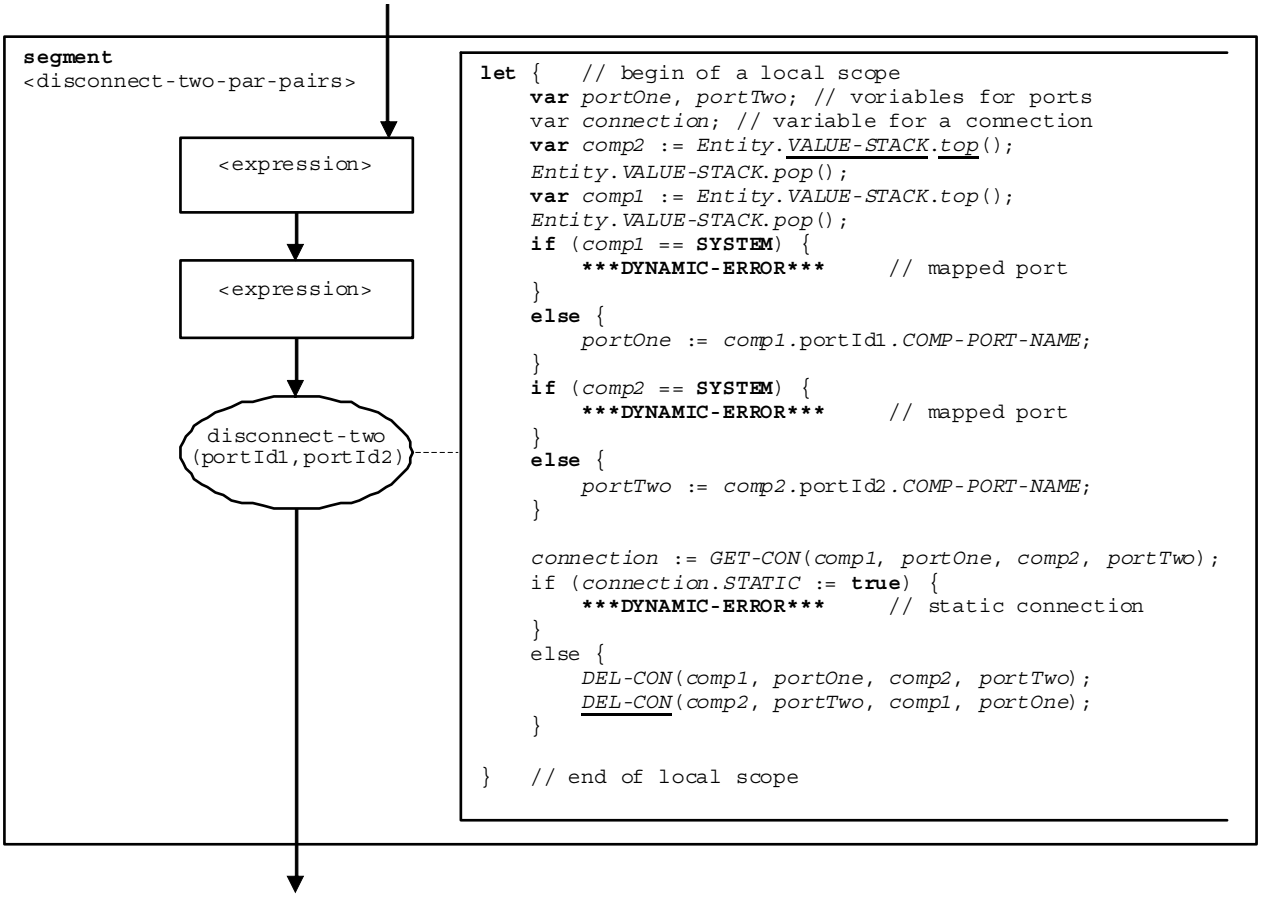


Figure 64e of ES 201 873-4 [2]: Flow graph segment <disconnect-two-par-pairs>

6.30 Execute statement

The syntactical structure of the **execute** statement is:

execute(<testCaseId>([<act-par$_1$>, … , <act-par$_n$>)]) [, <float-expression>] [, <config-expression>])

The **execute** statement describes the execution of a test case <testCaseId> with the (optional) actual parameters <act-par$_1$>, … , <act-par$_n$>. Optionally the execute statement may be guarded by a duration provided in form of an expression that evaluates to a **float**. If within the specified duration the test case does not return a verdict, a timeout exception occurs, the test configuration is destroyed and an **error** verdict is returned.

If a test case is executed on an existing static test configuration, the configuration shall be provided in form on an expression that evaluates to a configuration reference.

If no timeout exception occurs, the MTC is created or started, the control instance (representing the control part of the TTCN-3 module) is blocked until the test case terminates, and for the further test case execution the flow of control is given to the MTC. The flow of control is given back to the control instance when the MTC stops its execution.

The flow graph segment <execute-stmt> in figure 67 defines the execution of an **execute** statement. The operational semantics distinguishes the cases where a test case is executed on an existing static test configuration and where not.

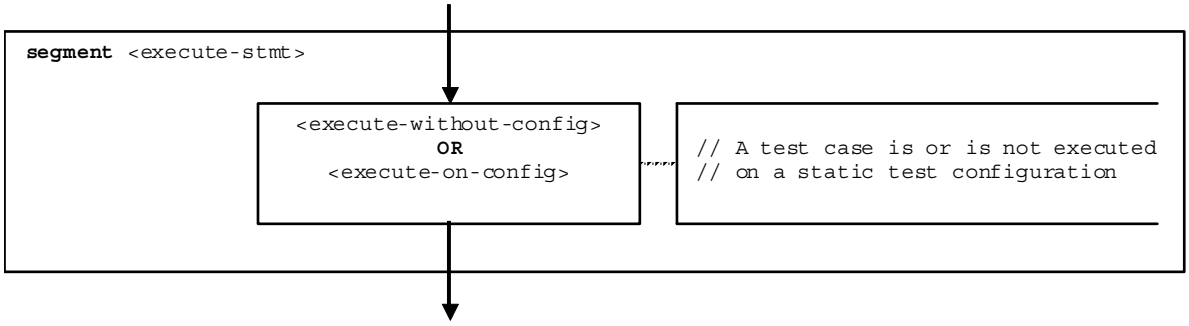


Figure 67 of ES 201 873-4 [2]: Flow graph segment <execute-stmt>

6.31 Flow graph segment <execute-without-config>

The flow graph segment `<execute-without-config>` in figure 67a distinguishes between the case where the execution is guarded by a timeout and the case where the statement is not guarded.

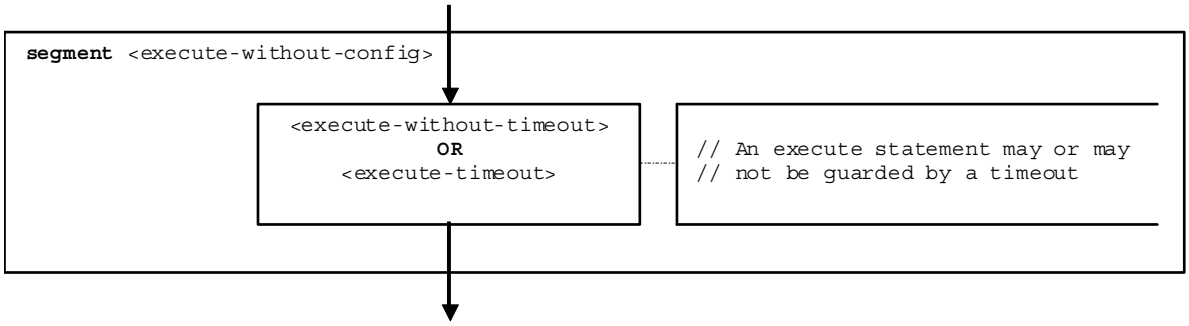


Figure 67a of ES 201 873-4 [2]: Flow graph segment <execute-stmt>

6.32 Flow graph segment <execute-on-config>

The flow graph segment `<execute-on-config>` in figure 69a distinguishes between the case where the execution of a test case on a configuration is guarded by a timeout and the case where the execution is not guarded.

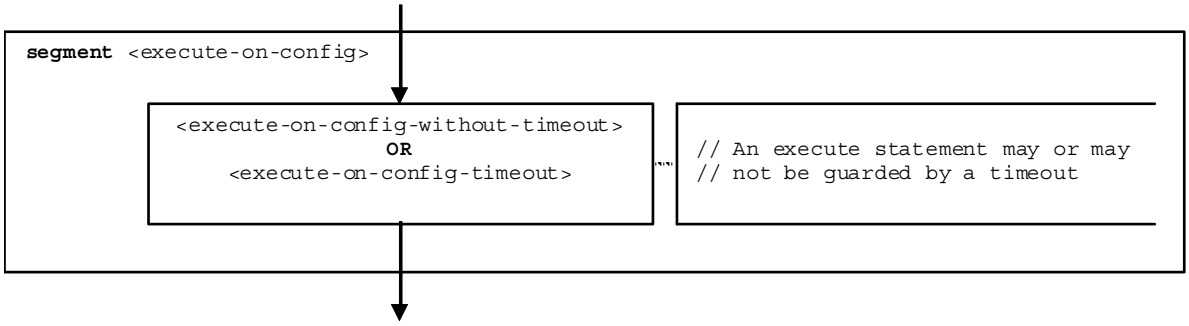


Figure 69a of ES 201 873-4 [2]: Flow graph segment <execute-on-config>

6.33 Flow graph segment <execute-on-config-without-timeout>

Executing a test case on a static configuration means to start the behaviour of the test case on the MTC of the test configuration, i.e. `MyMTC.`**`start`**`(TestCaseName(P1…Pn)).`

- In addition the following parts of the configuration state have to be reset to the following values:
  - the global test case verdict and all local component verdicts are set to **none**;

- the local default lists of all components of the test configuration are emptied;
- the global lists DONE and KILLED are emptied. These lists are used for storing the test components that stopped their execution or have been killed during test execution.

The flow graph segment <execute-on-config-without-timeout> in figure 69b specifies the execution of a test case on a static configuration where the execution is not guarded by a timer. It makes use of the **start** component operation.

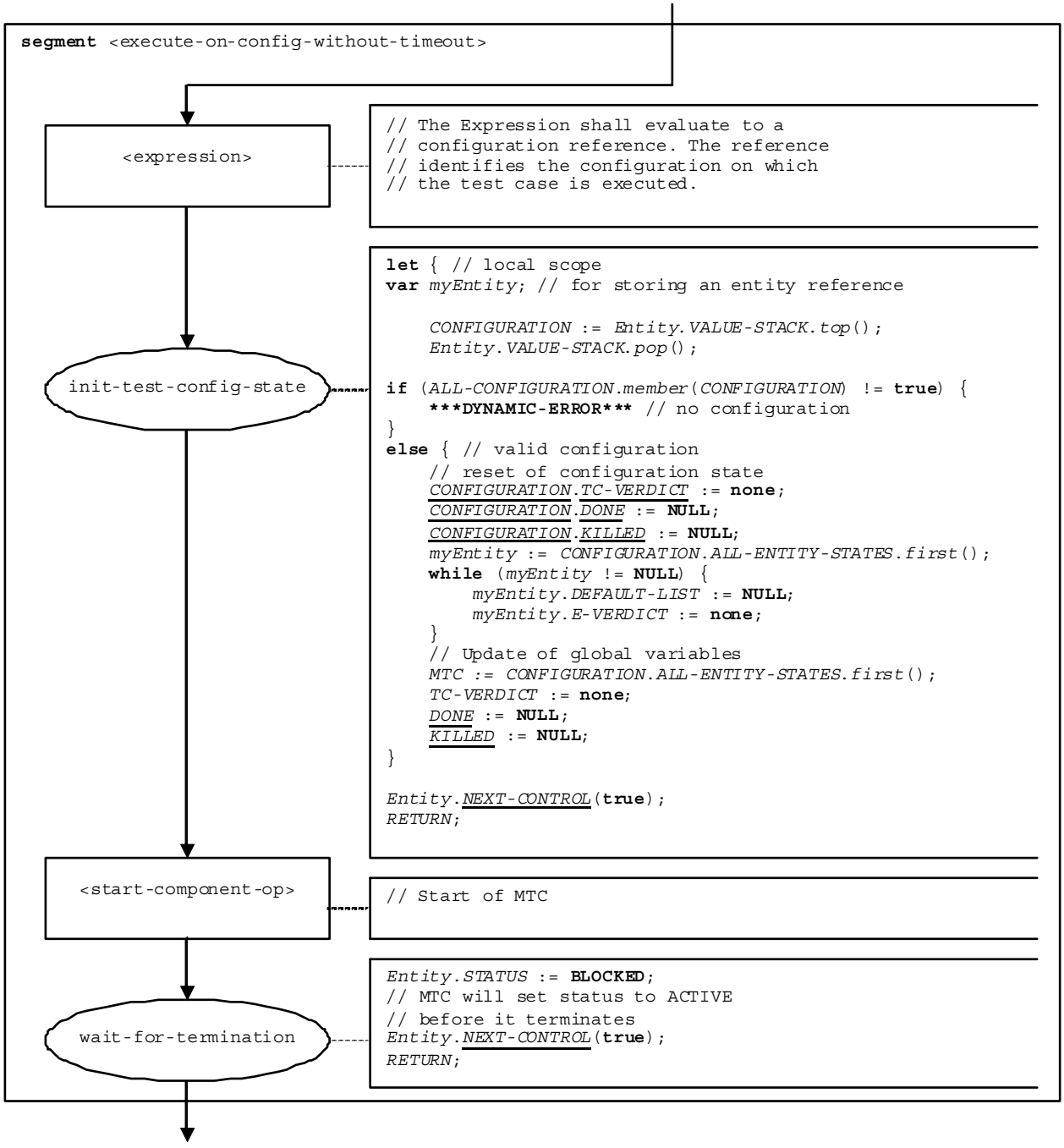


Figure 69b of ES 201 873-4 [2]: Flow graph segment <execute-on-config-without-timeout>

6.34 Flow graph segment <execute-on-config-timeout>

The flow graph segment `<execute-on-config-timeout>` in figure 69c defines the execution of a test case on a configuration that is guarded by a timeout value. The flow graph segment also models the execution of the test case by starting the behaviour of the test case on the MTC on an existing static test configuration. In addition, *TIMER-GUARD* guards the termination.

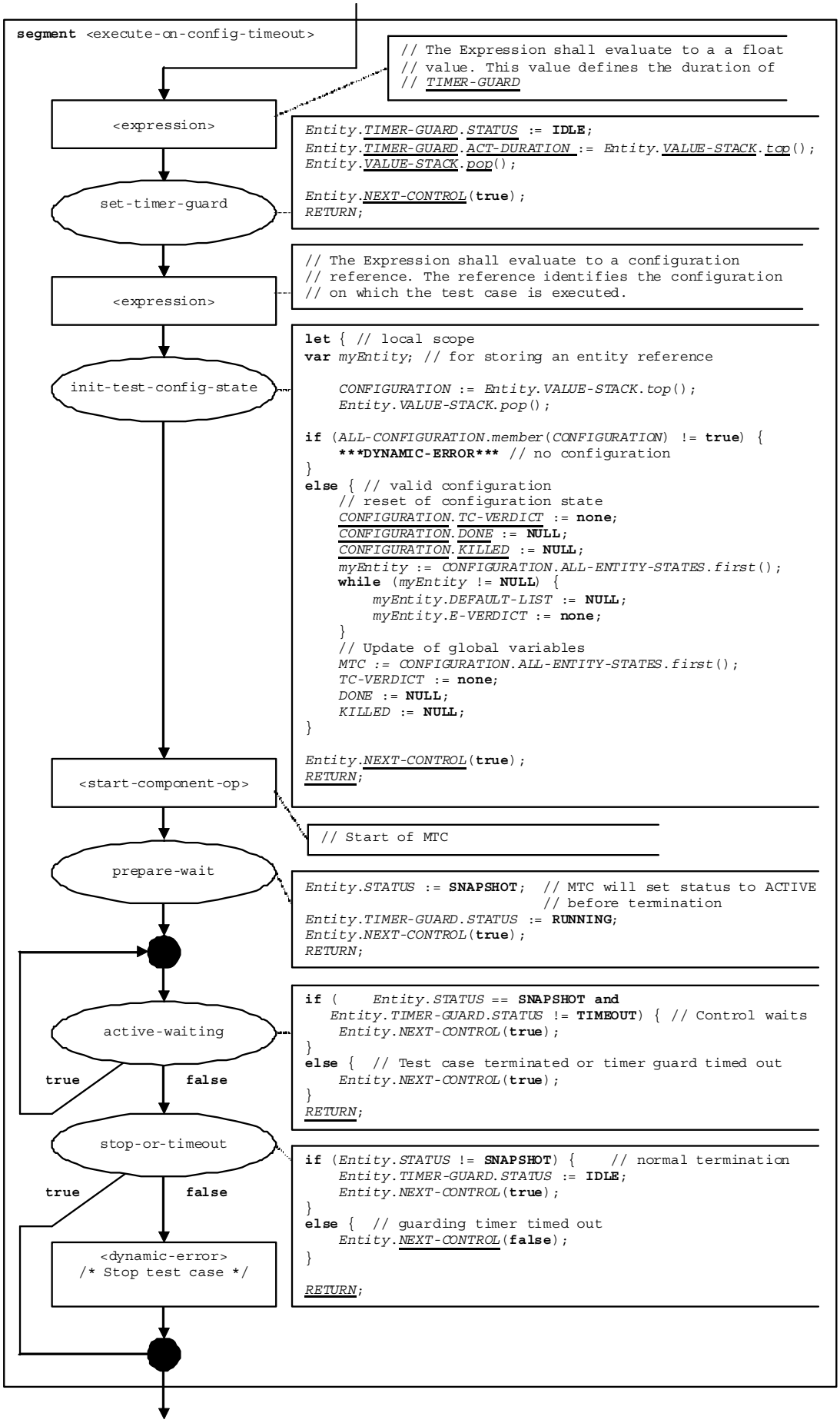


Figure 69 of ES 201 873-4 [2]: Flow graph segment <execute-timeout>

6.35 Flow graph segment <statement-block>

The syntactical structure of a statement block is:

{ <statement$_1$>; … ; <statement$_n$> }

A statement block is a scope unit. When entering a scope unit, new scopes for variables, timers and the value stack have to be initialized. When leaving a scope unit, all variables, timers and stack values of this scope have to be destroyed.

NOTE 1: A Statement block can be embedded in another statement blocks or can occur as body of functions, altsteps, test cases and module control, and within compound statements, e.g. **`alt`**, **`if-else`** or **`do-while`**.

NOTE 2: Receiving operations and altstep calls cannot appear in statement blocks, they are embedded in **`alt`** statements or **`call`** operations.

NOTE 3: The operational semantics also handles operations and declarations like statements, i.e. they are allowed in statement blocks.

NOTE 4: Some TTCN-3 functions, like e.g. **`system`** or **`self`**, are considered to be expressions, which are not useful as stand-alone statements in statement blocks. Their flow graph representations are not listed in figure 78.

The flow graph segment `<statement-block>` in figure 78 defines the execution of a statement block.

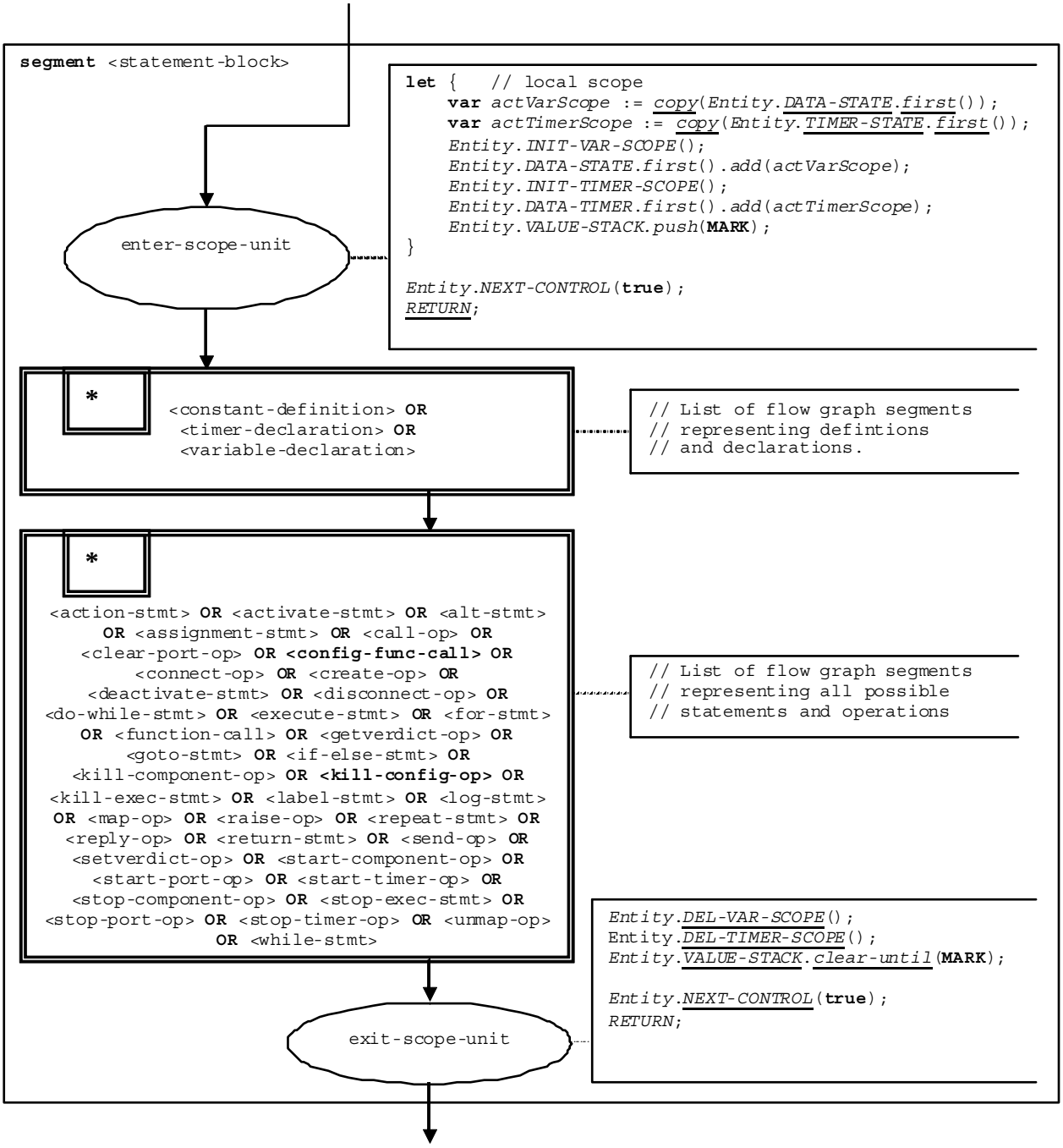


Figure 78 of ES 201 873-4 [2]: Flow graph segment <statement-block>

6.36 Halt port operation

The syntactical structure of the **halt** port operation is:

```
<portId>.halt
```

The flow graph segment <halt-port-op> in figure 89a defines the execution of the **halt** port operation.

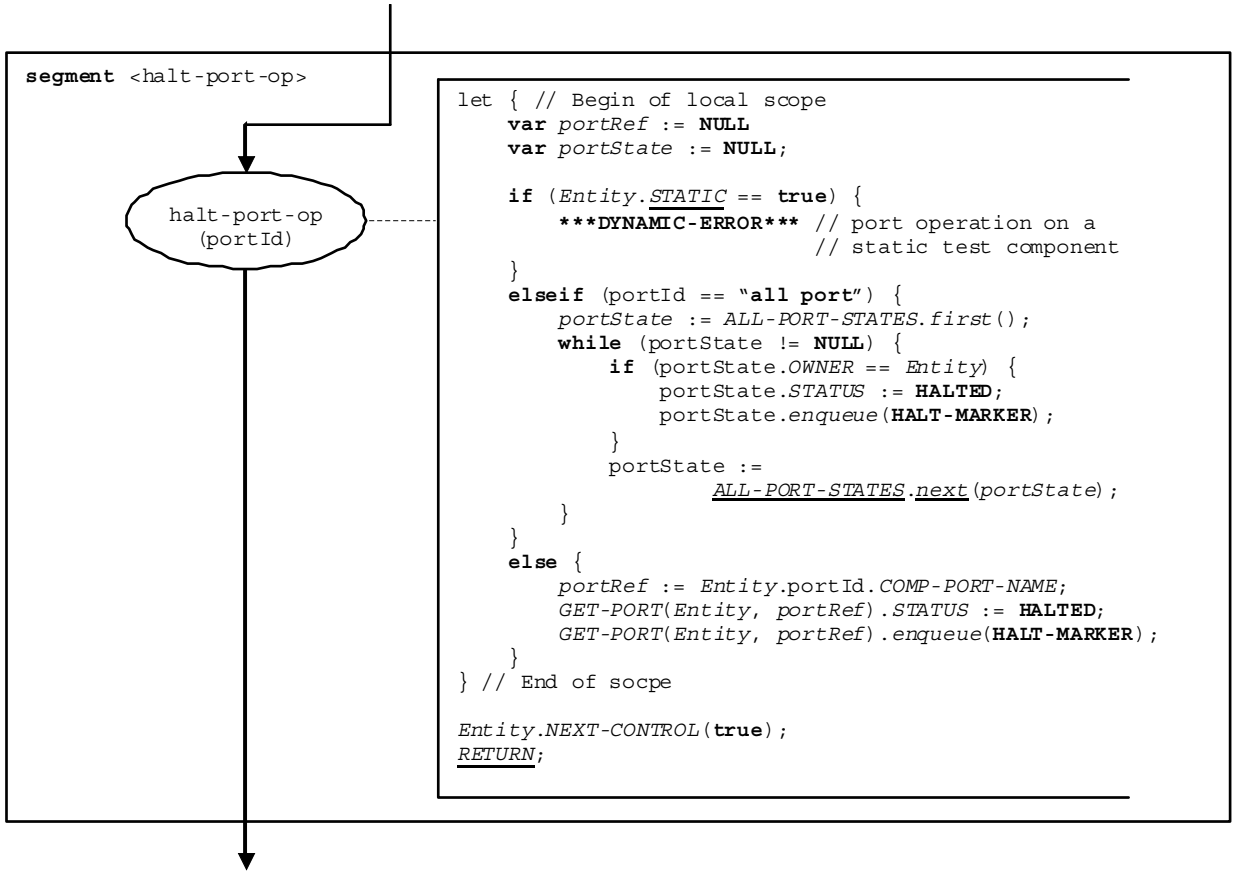


Figure 89a of ES 201 873-4 [2]: Flow graph segment <halt-port-op>

NOTE: The **HALT-MARKER** that is put by a **halt** operation into the port queue is removed by the *SNAP-PORTS* function (see clause 8.3.3.2) when the marker is reached, i.e. all messages preceding the marker have been processed. The *SNAP-PORTS* function is called when taking a snapshot.

6.37 Kill component operation

The syntactical structure of the **kill** component statement is:

<component-expression>.**kill**

The **kill** component operation stops the specified component and removes it from the test system. All test components will be stopped and removed from the test system, i.e. the test case terminates, if the MTC is killed (e.g. **mtc**.**kill**) or kills itself (e.g. **self**.**kill**). The MTC may kill all parallel test components by using the **all** keyword, i.e. **all component**.**kill**.

Special rules apply for using the **kill** component operation in static test configurations: Applying the **kill** component operation to a static component leads to a dynamic error. The lifetime of all static components (including the MTC) is bound to the lifetime of the test configuration. However, the MTC may kill all non-static parallel test components by using the **all** keyword, i.e. **all component**.**kill**.

A component to be killed is identified by a component reference provided as expression, e.g. a value or value returning function. For simplicity, the keyword "**all component**" is considered to be special values of <component-expression>. The operations **mtc** and **self** are evaluated according to clauses 9.33 and 9.43.

The flow graph segment <kill-component-op> in figure 90a defines the execution of the **kill** component operation.

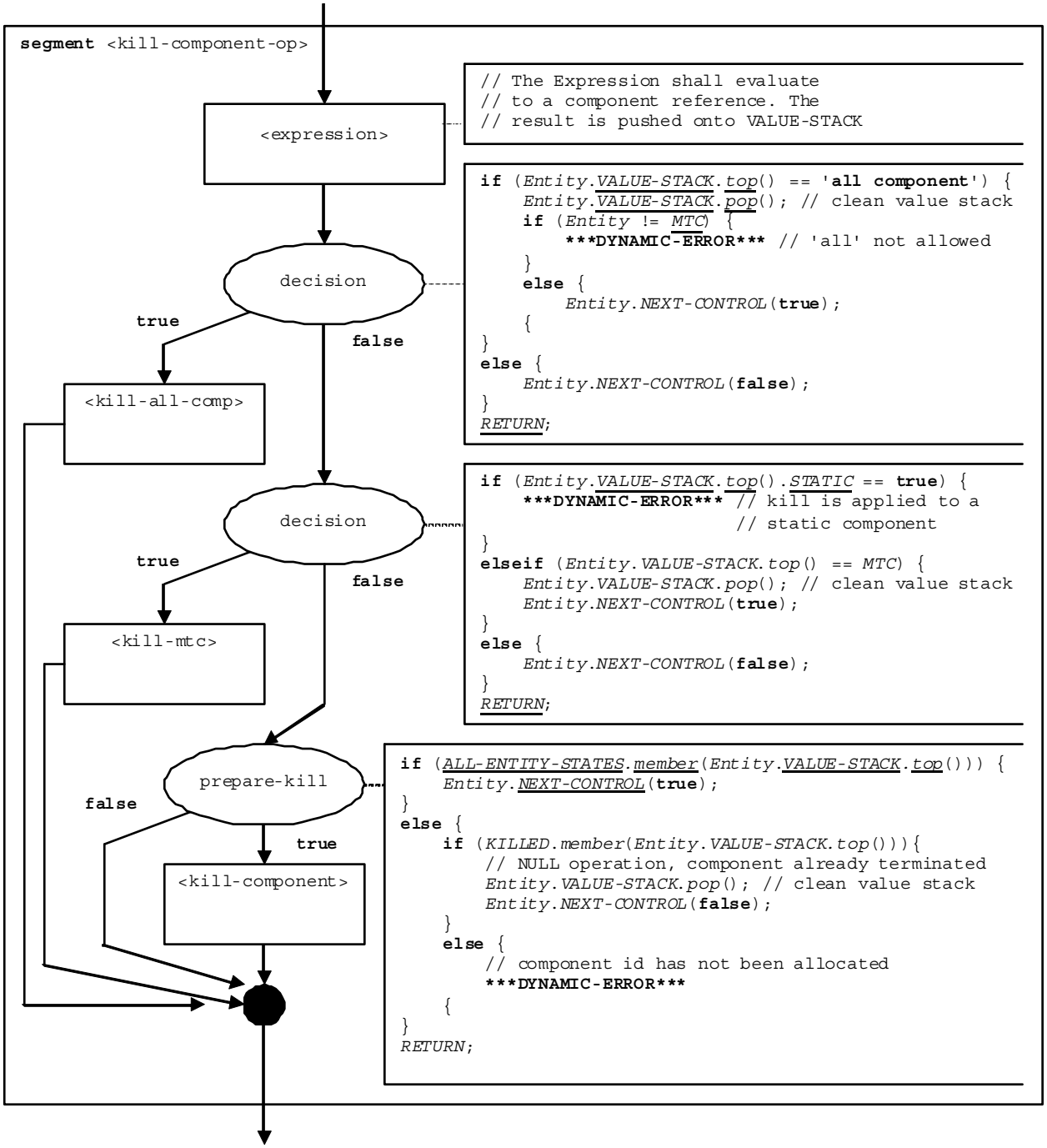


Figure 90a of ES 201 873-4 [2]: Flow graph segment <kill-component-op>

3.38 Flow graph segment <kill-mtc>

The <kill-mtc> flow graph segment in figure 90b describes the killing of the MTC. The effect is that the test case terminates, i.e. the final verdict is calculated and pushed onto the value stack of module control. The release of all resources are released is modelled by deleting the test configuration from the ALL-CONFIGURATIONS list.

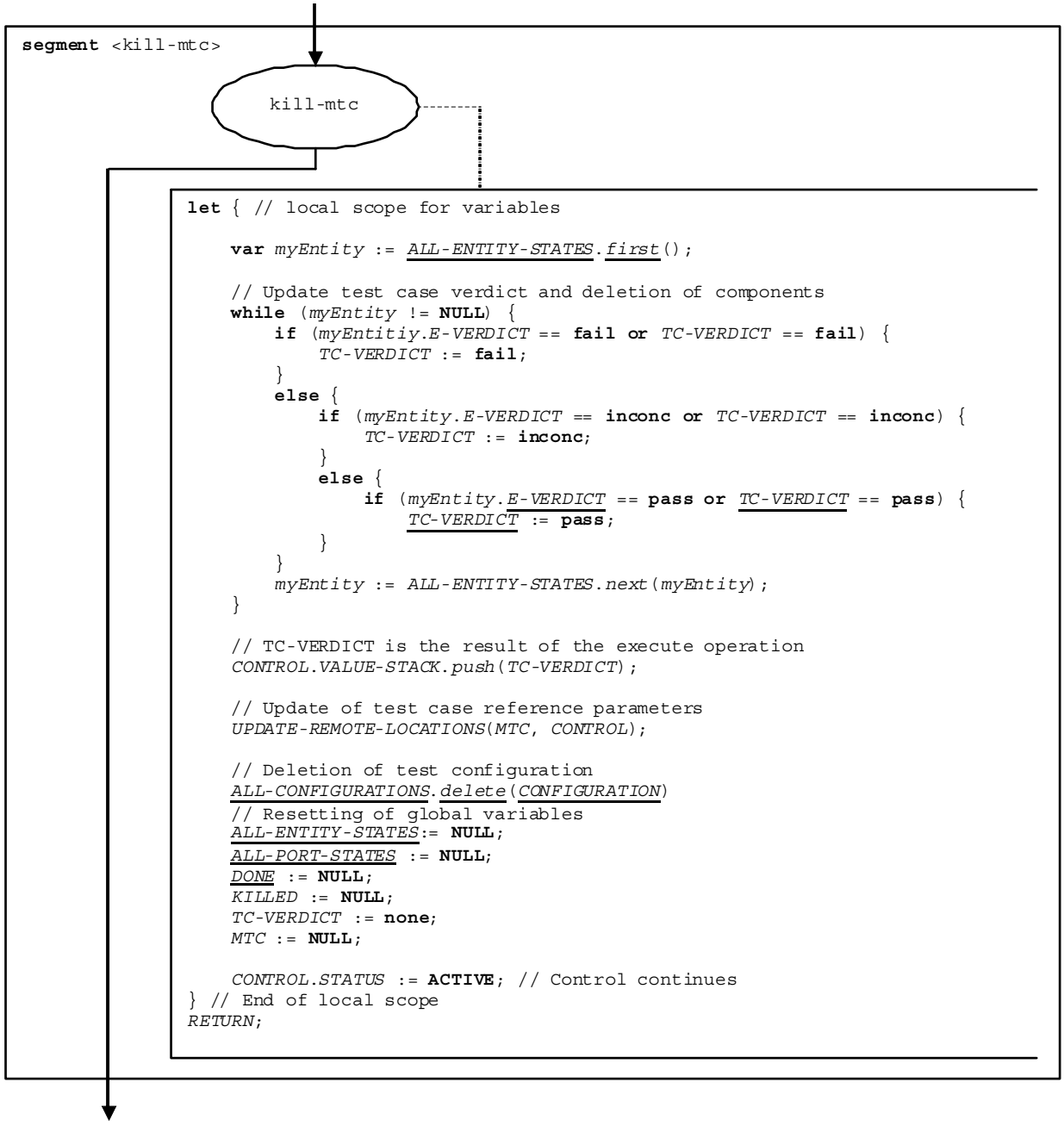
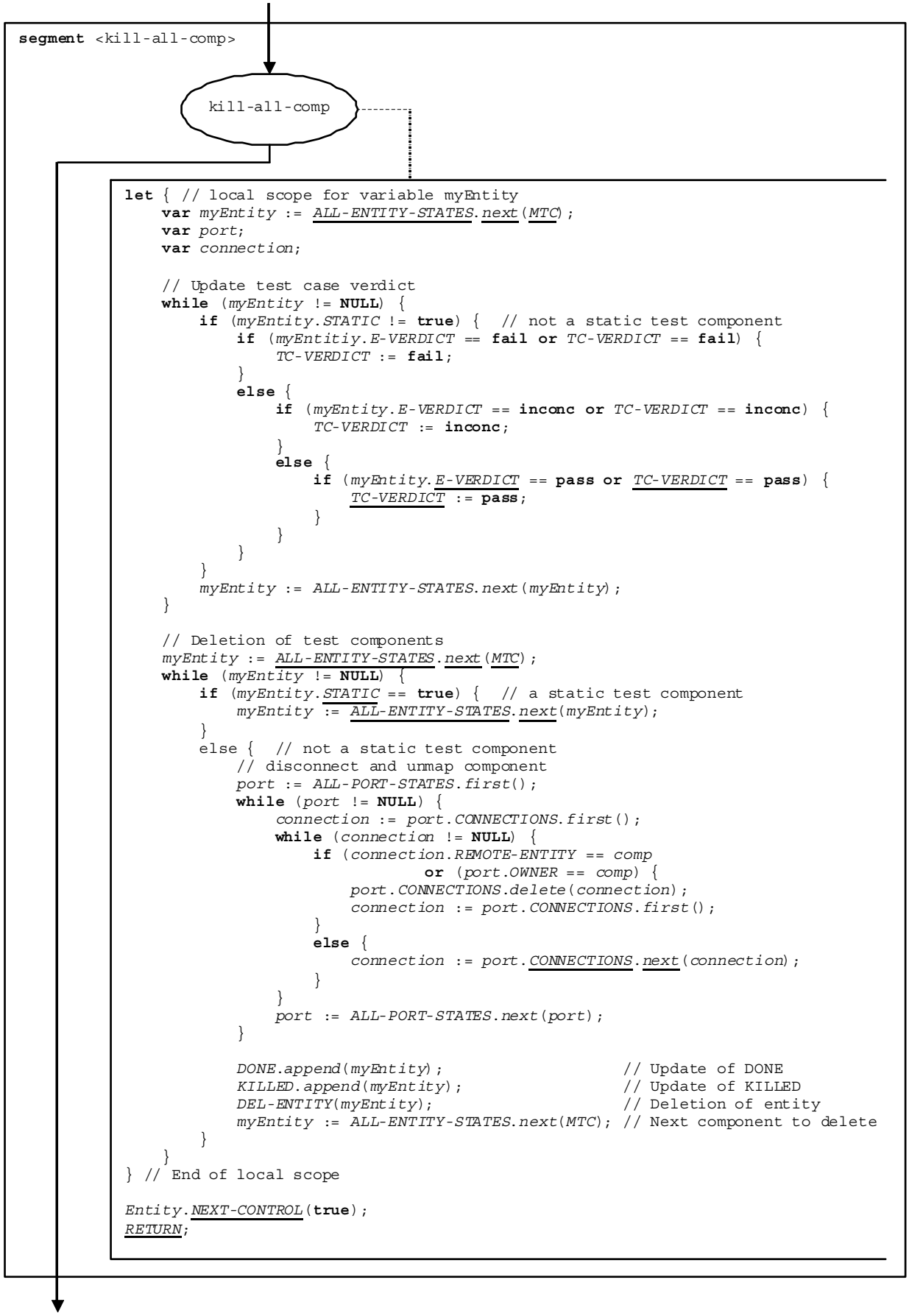


Figure 90b of ES 201 873-4 [2]: Flow graph segment <kill-mtc-op>

6.39 Flow graph segment <kill-all-comp>

The <kill-all-comp> flow graph segment in figure 90d describes the termination of all parallel test components of a test case.




```
let { // local scope for variable myEntity
    var myEntity := ALL-ENTITY-STATES.next(MTC);
    var port;
    var connection;

    // Update test case verdict
    while (myEntity != NULL) {
        if (myEntity.STATIC != true) {  // not a static test component
            if (myEntitiy.E-VERDICT == fail or TC-VERDICT == fail) {
                TC-VERDICT := fail;
            }
            else {
                if (myEntity.E-VERDICT == inconc or TC-VERDICT == inconc) {
                    TC-VERDICT := inconc;
                }
                else {
                    if (myEntity.E-VERDICT == pass or TC-VERDICT == pass) {
                        TC-VERDICT := pass;
                    }
                }
            }
        }
        myEntity := ALL-ENTITY-STATES.next(myEntity);
    }

    // Deletion of test components
    myEntity := ALL-ENTITY-STATES.next(MTC);
    while (myEntity != NULL) {
        if (myEntity.STATIC == true) {  // a static test component
            myEntity := ALL-ENTITY-STATES.next(myEntity);
        }
        else {  // not a static test component
            // disconnect and unmap component
            port := ALL-PORT-STATES.first();
            while (port != NULL) {
                connection := port.CONNECTIONS.first();
                while (connection != NULL) {
                    if (connection.REMOTE-ENTITY == comp
                              or (port.OWNER == comp) {
                        port.CONNECTIONS.delete(connection);
                        connection := port.CONNECTIONS.first();
                    }
                    else {
                        connection := port.CONNECTIONS.next(connection);
                    }
                }
                port := ALL-PORT-STATES.next(port);
            }

            DONE.append(myEntity);                    // Update of DONE
            KILLED.append(myEntity);                  // Update of KILLED
            DEL-ENTITY(myEntity);                     // Deletion of entity
            myEntity := ALL-ENTITY-STATES.next(MTC); // Next component to delete
        }
    }
} // End of local scope

Entity.NEXT-CONTROL(true);
RETURN;
```

Figure 90d of ES 201 873-4 [2]: Flow graph segment <stop-all-comp>

6.40 Kill execution statement

The syntactical structure of the **kill** execution statement is:

```
kill
```

The effect of the **kill** execution statement depends on the entity that executes the **kill** execution statement:

a) If **kill** is performed by the module control, the test campaign ends, i.e. all test components and the module control disappear from the module state.

b) If the **kill** is executed by the MTC, all parallel test components and the MTC stop execution. The global test case verdict is updated and pushed onto the value stack of the module control. Finally, control is given back to the module control and the MTC terminates.

c) If the **kill** is executed by a test component, the global test case verdict *TC-VERDICT* and the global *DONE* and *KILLED* lists are updated. Then the component disappears from the module.

The execution of the **kill** execution statement by any static test component (including the MTC of a static test configuration) is not allowed. It leads to a dynamic error.

The flow graph segment <kill-exec-stmt> in figure 90e describes the execution of the kill statement.

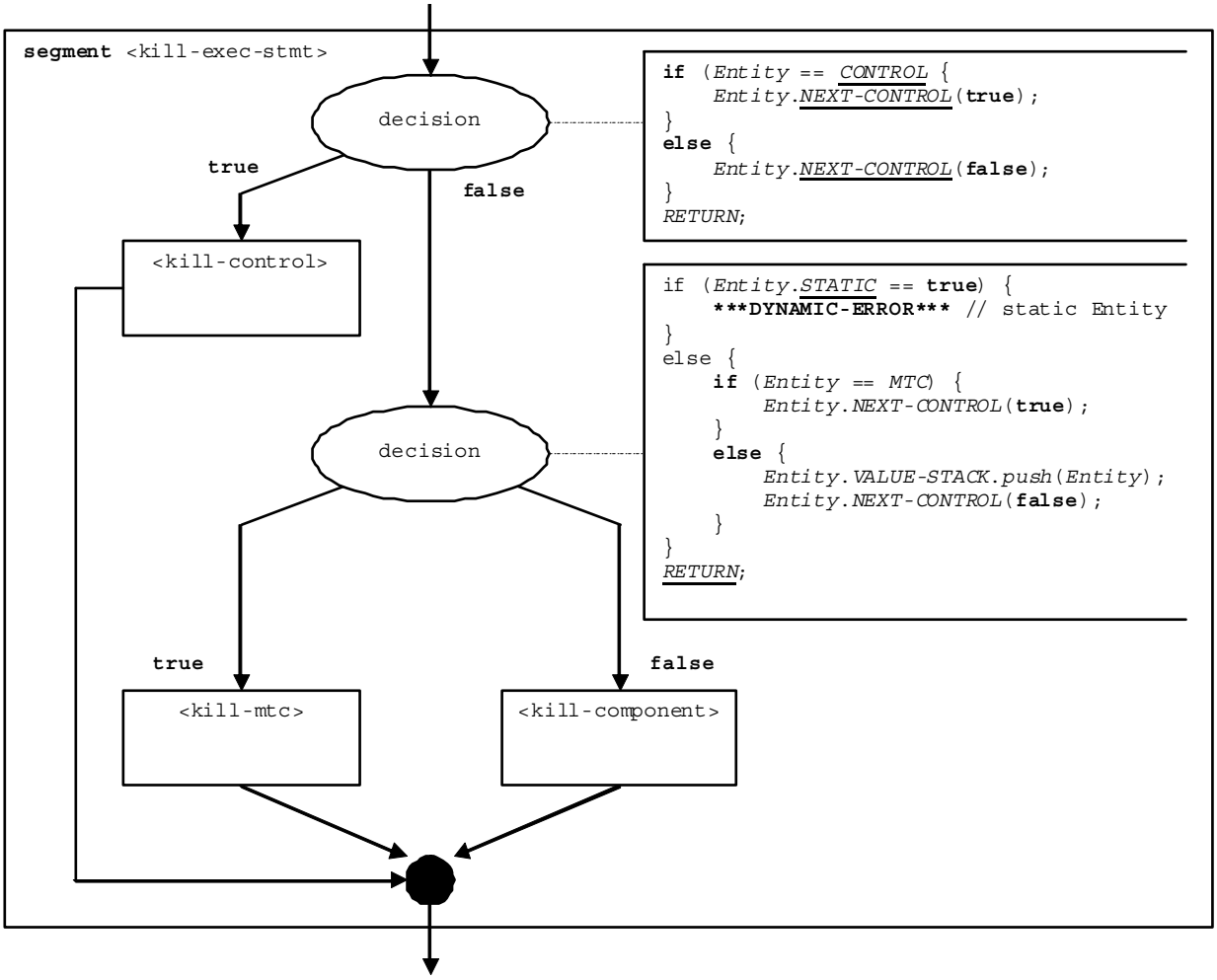


Figure 90e of ES 201 873-4 [2]: Flow graph segment <kill-exec-stmt>

6.41 Kill configuration operation

The syntactical structure of the **kill** configuration operation is:

```
<configuration-expression>.kill
```

The **kill** configuration operation destructs the specified test configuration and removes it from the test system. The kill configuration operation shall only be executed by module control. The configuration to be killed is identified by means of a <configuration-expression>., i.e. an expression that evaluates to a reference to a configuration.

The flow graph segment <kill-config-op> in figure 90f defines the execution of the **kill** configuration operation.

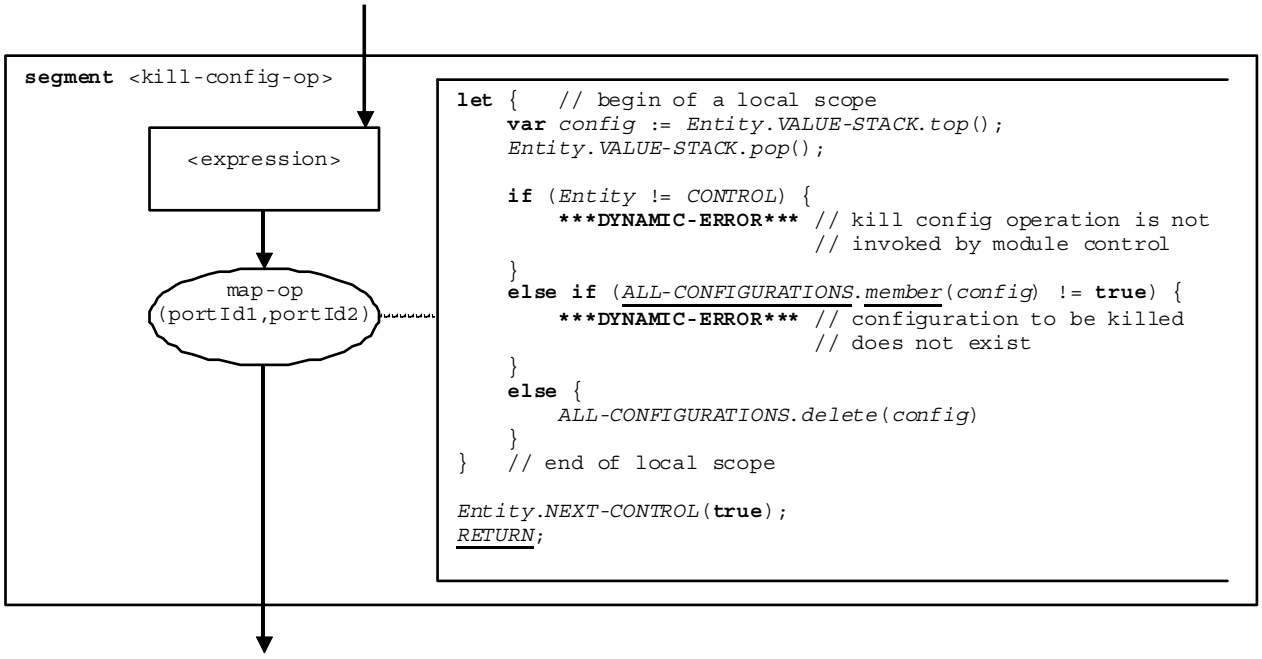


Figure 90f of ES 201 873-4 [2]: Flow graph segment <kill-config-op>

6.42 Map operation

The syntactical structure of the **map** operation is:

```
map(<component-expression>:<portId1>, system:<portId2>) [static]
```

The identifiers <portId1> and <portId2> are considered to be port identifiers of the corresponding test component and test system interface. The component to which the <portId1> belongs is referenced by means of the component reference <component-expression>. The reference may be stored in variables or is returned by a function, i.e. it is an expression, which evaluates to a component reference. The value stack is used for storing the component reference.

A present **static** clause indicates that the new mapping is static, i.e. established during the execution of a configuration function. Presence and absence of the **static** clause is handled as a Boolean flag in the operational semantics (see static parameter of the basic flow graph node map-op in figure 93).

NOTE: The **map** operation does not care whether the **system**:<portId> statement appears as first or as second parameter. For simplicity, it is assumed that it is always the second parameter.

The execution of the **map** operation is defined by the flow graph segment <map-op> shown in figure 93.

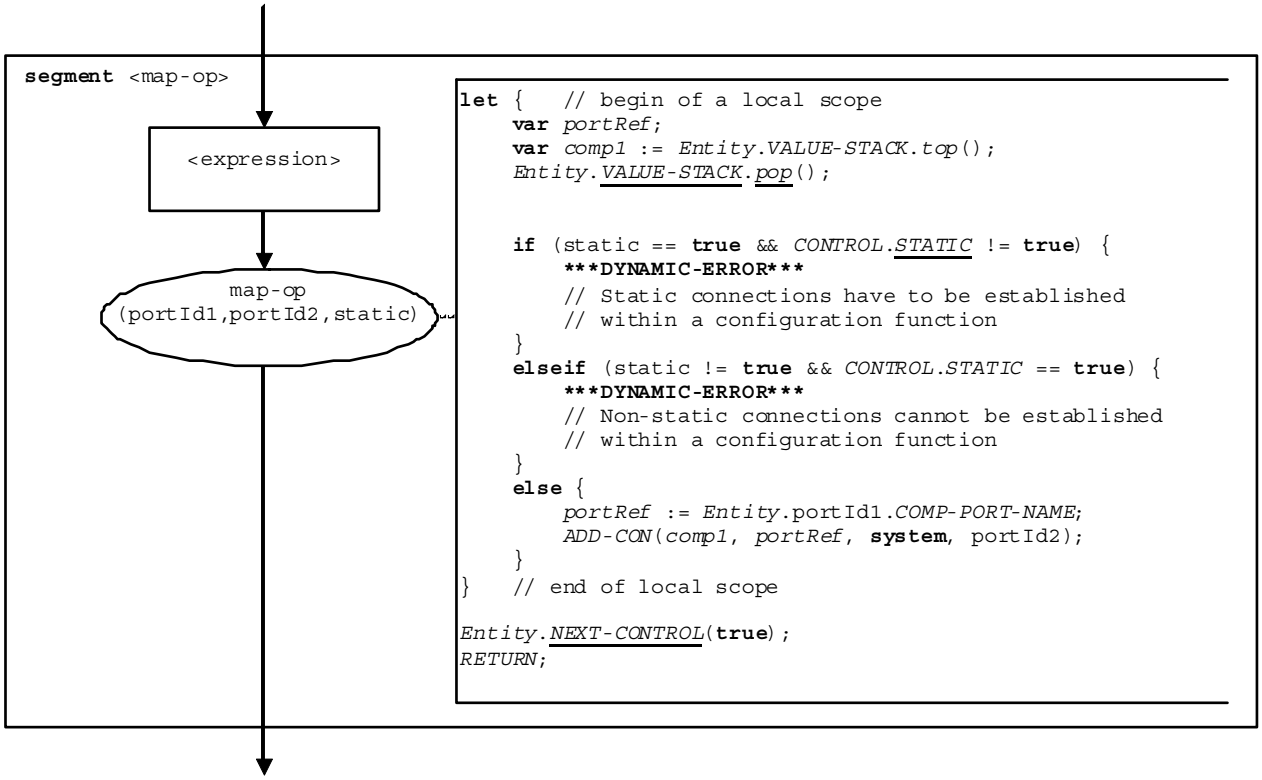


Figure 93 of ES 201 873-4 [2]: Flow graph segment <map-op>

6.43 Start port operation

The syntactical structure of the **start** port operation is:

```
<portId>.start
```

The flow graph segment <start-port-op> in figure 121 defines the execution of the **start** port operation.

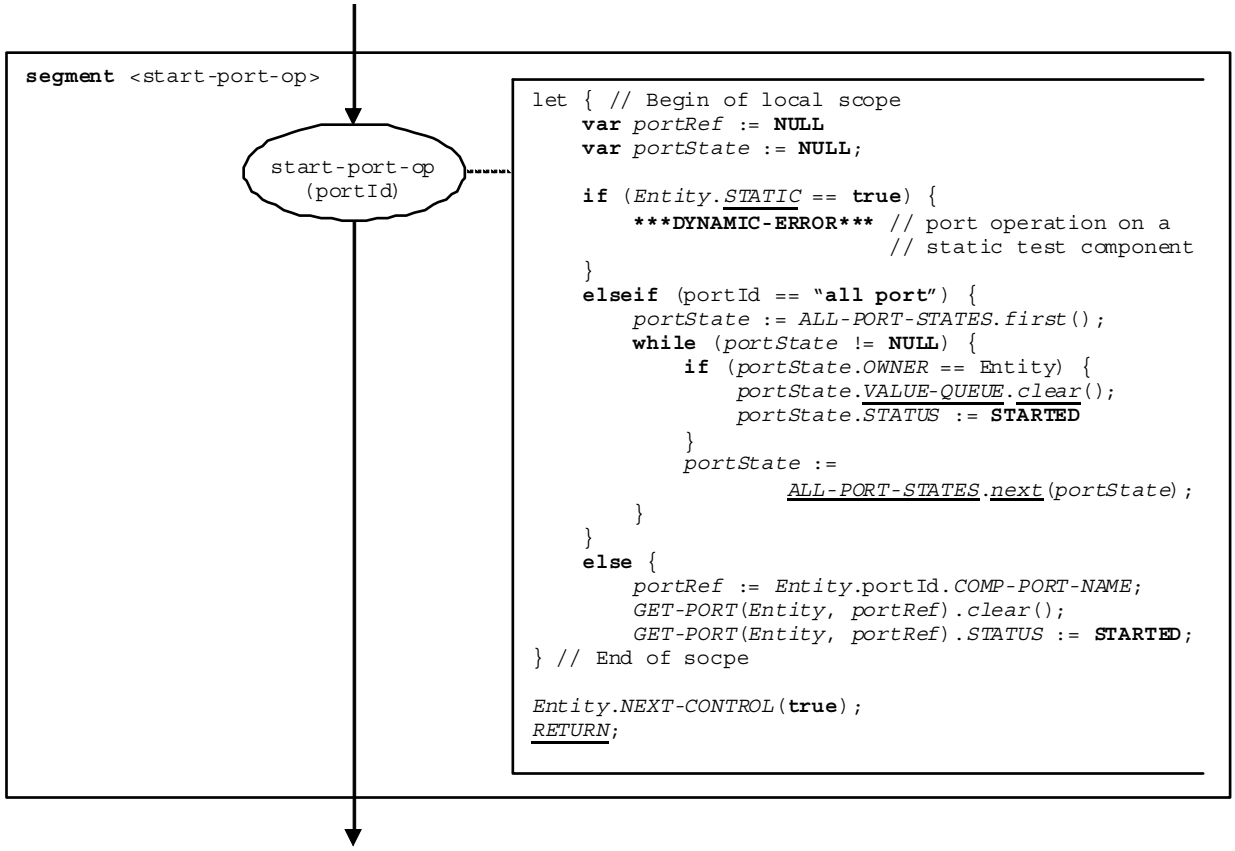


Figure 121 of ES 201 873-4 [2]: Flow graph segment <start-port-op>

6.44 Stop component operation

The syntactical structure of the **stop** component statement is:

<component-expression>.**stop**

The **stop** component operation stops the specified component. All test components will be stopped, i.e. the test case terminates, if the MTC is stopped (e.g. **mtc**.**stop**) or stops itself (e.g. **self**.**stop**). The MTC may stop all parallel test components by using the **all** keyword, i.e. **all component**.**stop**.

Stopped components created with an **alive** clause in the **create** operation are not removed from the test system. They can be restarted by using a **start** statement. Variables, ports, constants and timers owned by such a component, i.e. declared and defined in the corresponding component type definition, keep their status. A **stop** operation for a component created without an **alive** clause is semantically equivalent to a **kill** operation. The component is removed from the test system.

A component to be stopped is identified by a component reference provided as expression, e.g. a value or value returning function. For simplicity, the keyword "**all component**" is considered to be special values of <component-expression>. The operations **mtc** and **self** are evaluated according to clauses 9.33 and 9.43.

The flow graph segment <stop-component-op> in figure 125 defines the execution of the **stop** component operation.

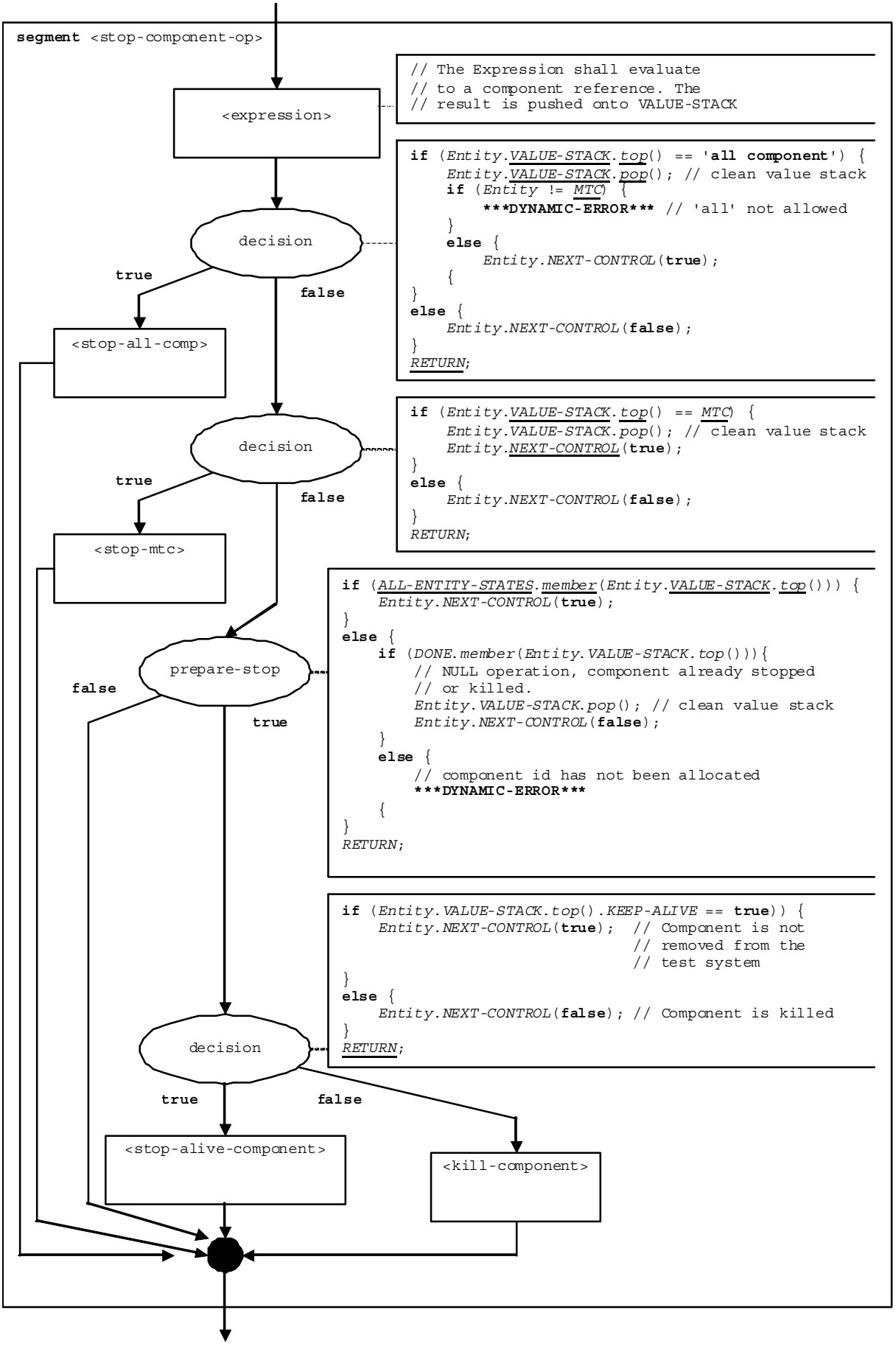


Figure 125 of ES 201 873-4 [2]: Flow graph segment <stop-component-op>

6.45 Flow graph segment <stop-mtc>

The flow graph segment <stop-mtc> in figure 125a describes the stopping of an MTC. The effect of stopping an MTC is that a test case or a configuration function terminates. Depending on where and how an MTC has been executed, three cases have to be distinguished:

1) The MTC stops the behaviour of a test case that has not been executed on a static test configuration.
2) The MTC stops the behaviour of a test case that has been executed on a static test configuration.
3) The MTC stops the execution of a configuration function.

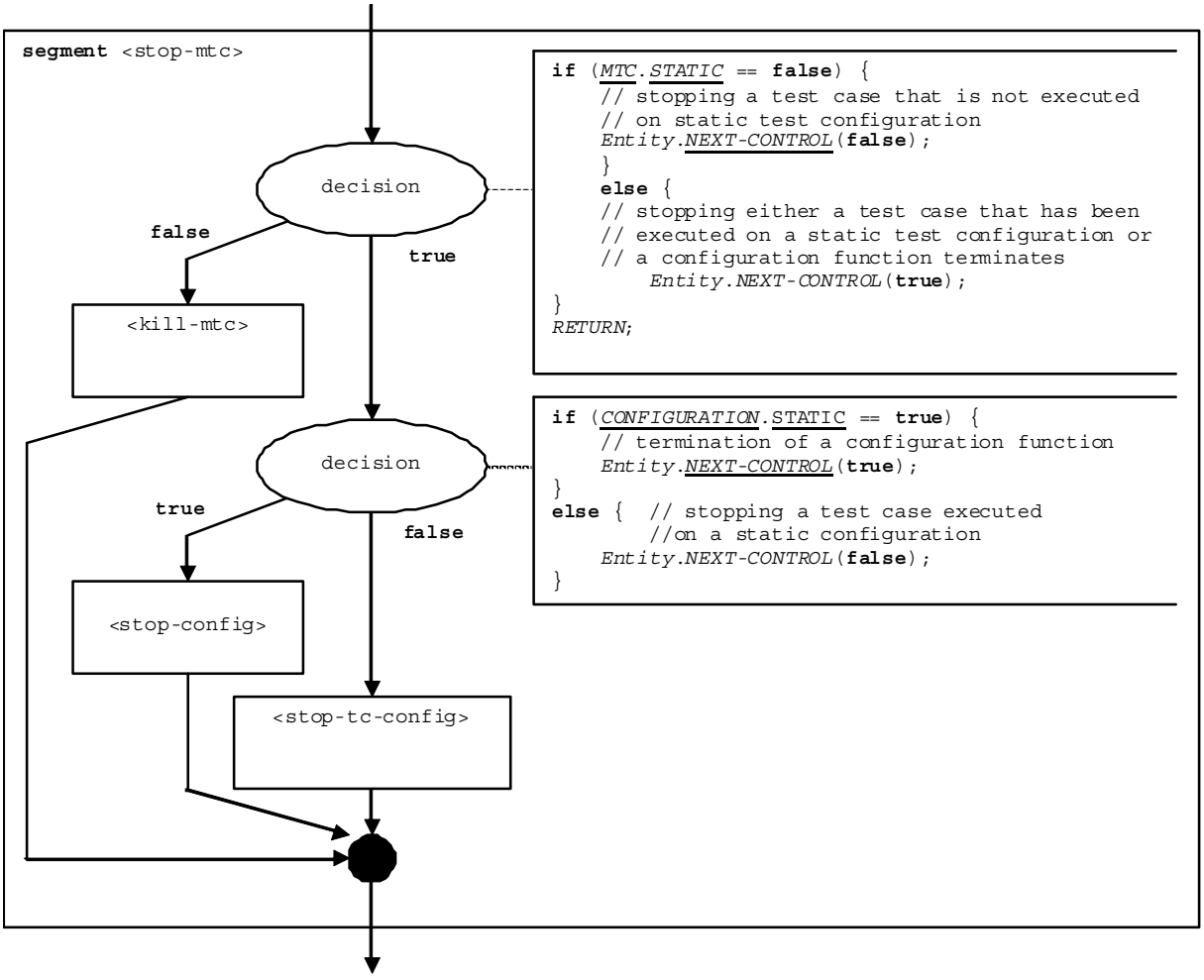


Figure 125a of ES 201 873-4 [2]: Flow graph segment <stop-mtc>

6.46 Flow graph segment <stop-config>

The <stop-config> flow graph segment in figure 127a describes the stopping of an MTC that has executed a configuration function.

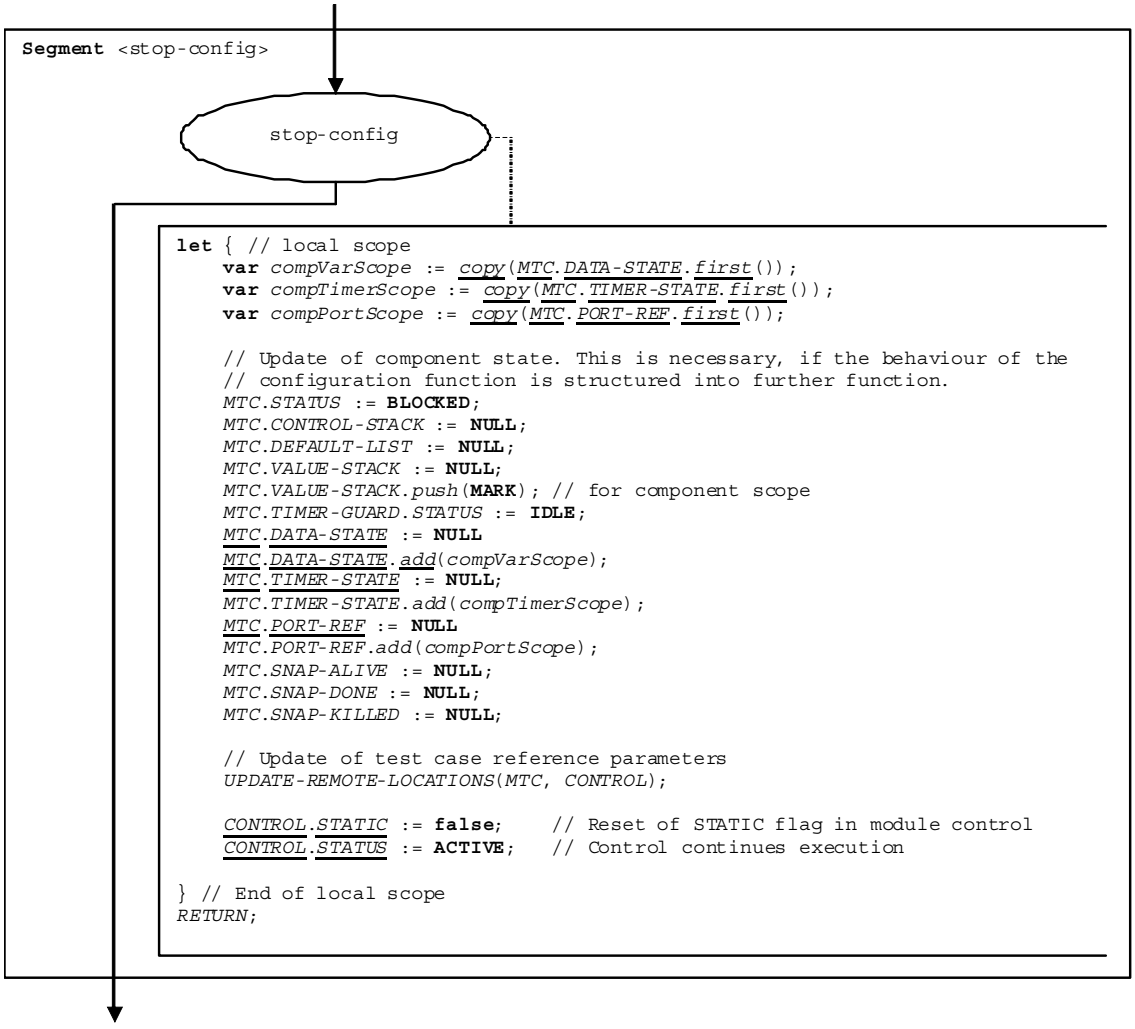


Figure 127a of ES 201 873-4 [2]: Flow graph segment <stop-config>

6.47 Flow graph segment <stop-tc-config>

The <stop-tc-config> flow graph segment in figure 127b describes the termination of a test case that is executed on a static test configuration.

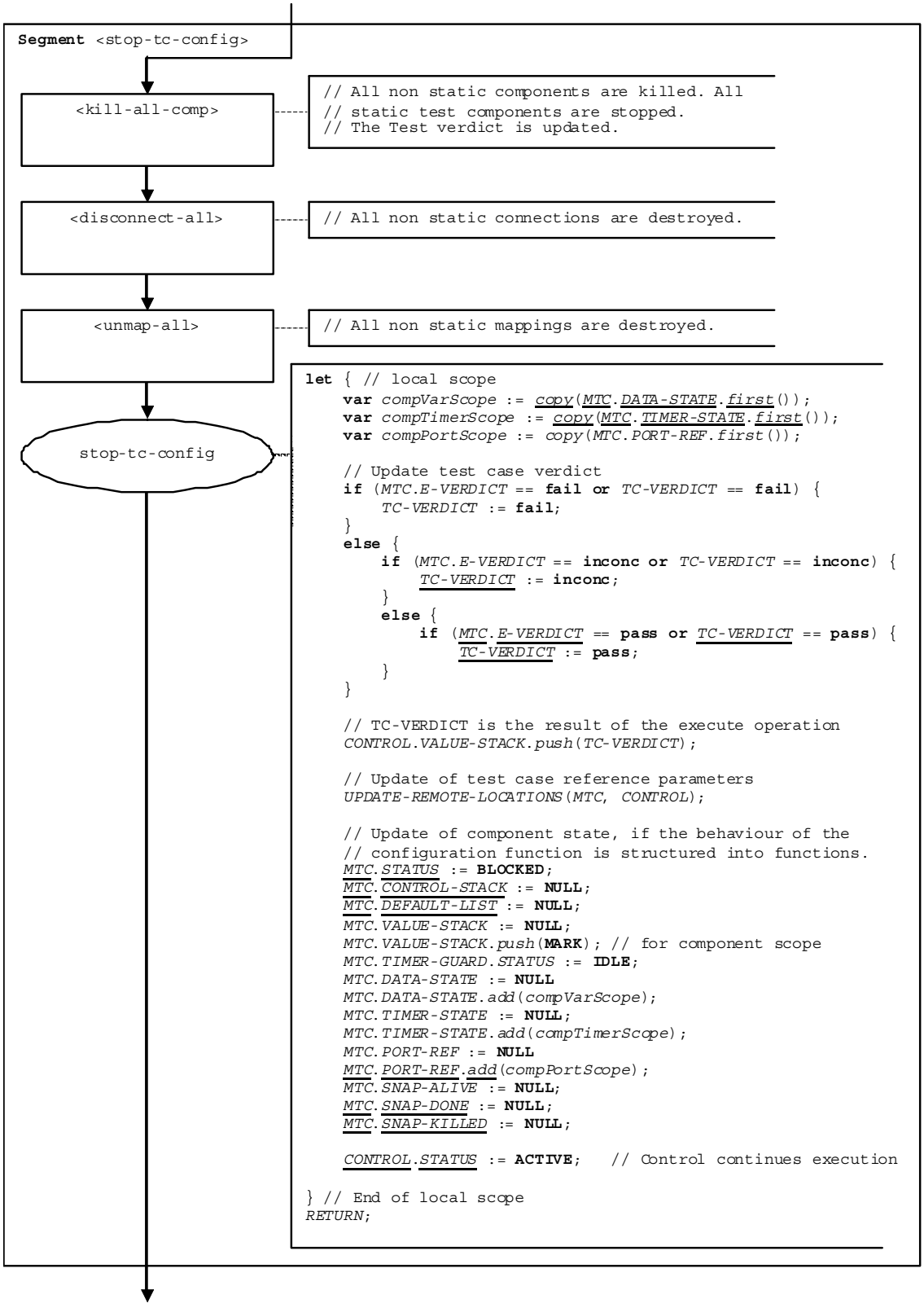


Figure 127b of ES 201 873-4 [2]: Flow graph segment <stop-tc-config>

6.48 Stop port operation

The syntactical structure of the **stop** port operation is:

```
<portId>.stop
```

The flow graph segment <stop-port-op> in figure 129 defines the execution of the **stop** port operation.

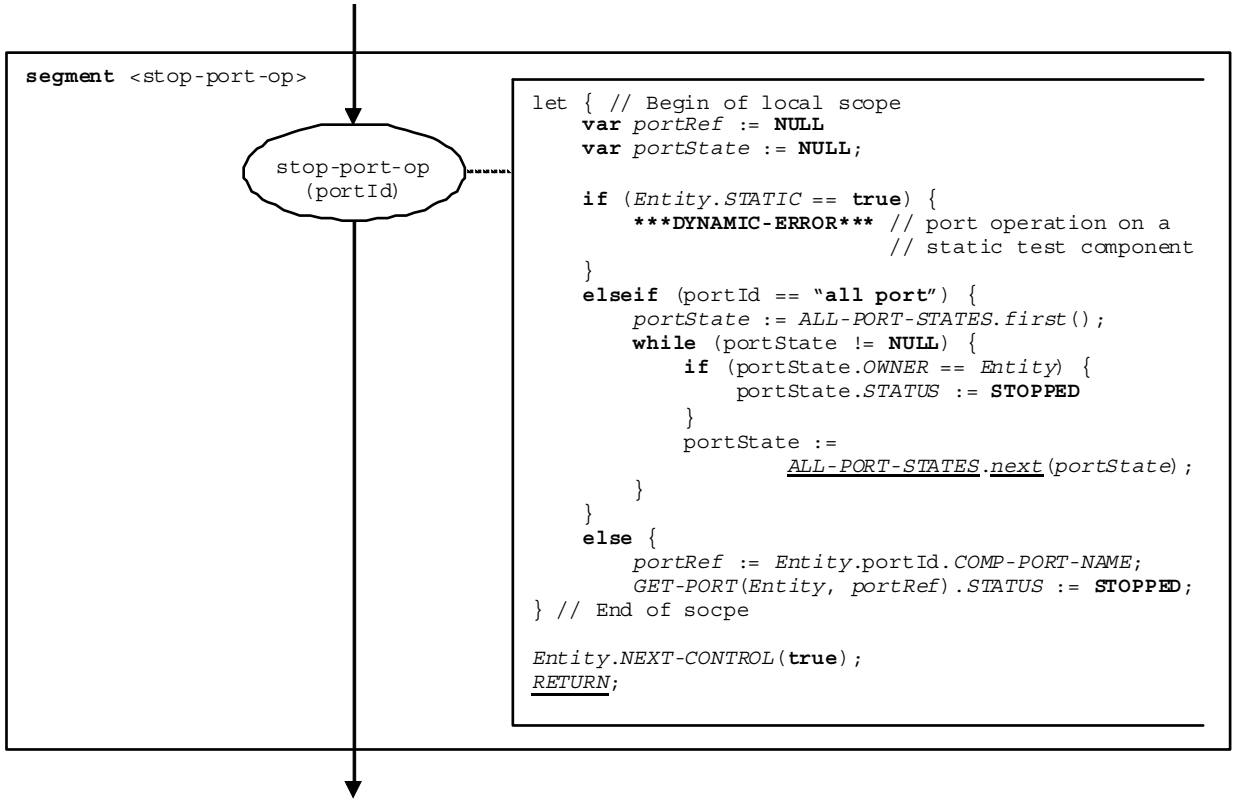


Figure 129 of ES 201 873-4 [2]: Flow graph segment <stop-port-op>

6.49 Flow graph segment <unmap-all>

The flow graph segment <unmap-all> defines the unmapping of all components at all mapped ports. Static mappings will not be unmapped. Their lifetime is bound to the lifetime of the static test configuration.

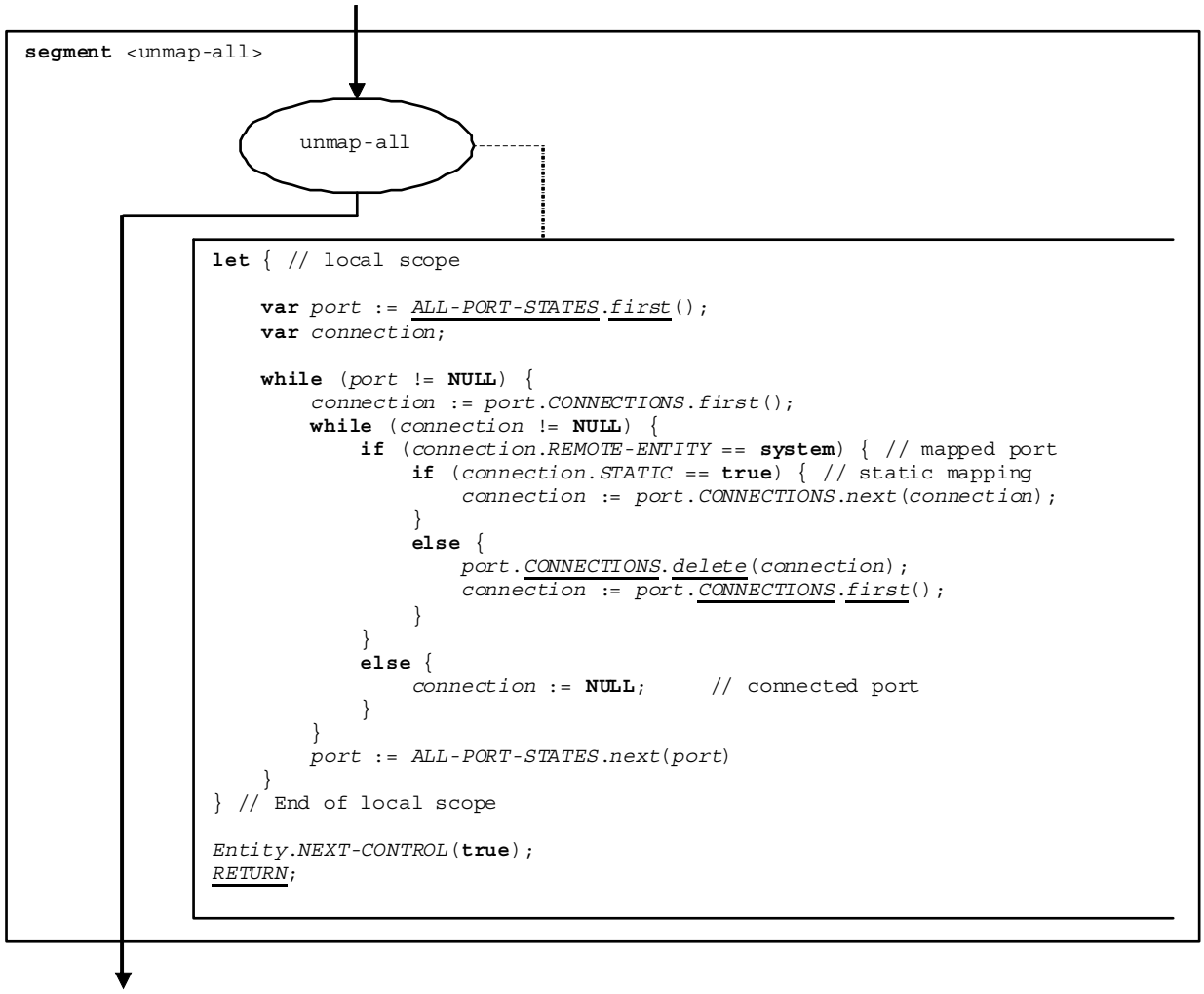


Figure 136a of ES 201 873-4 [2]: Flow graph segment <unmap-all>

6.50 Flow graph segment <unmap-comp>

The flow graph segment <unmap-comp> defines the unmapping of all mapped ports of a specified component. Static mappings will not be unmapped. Their lifetime is bound to the lifetime of the static test configuration.

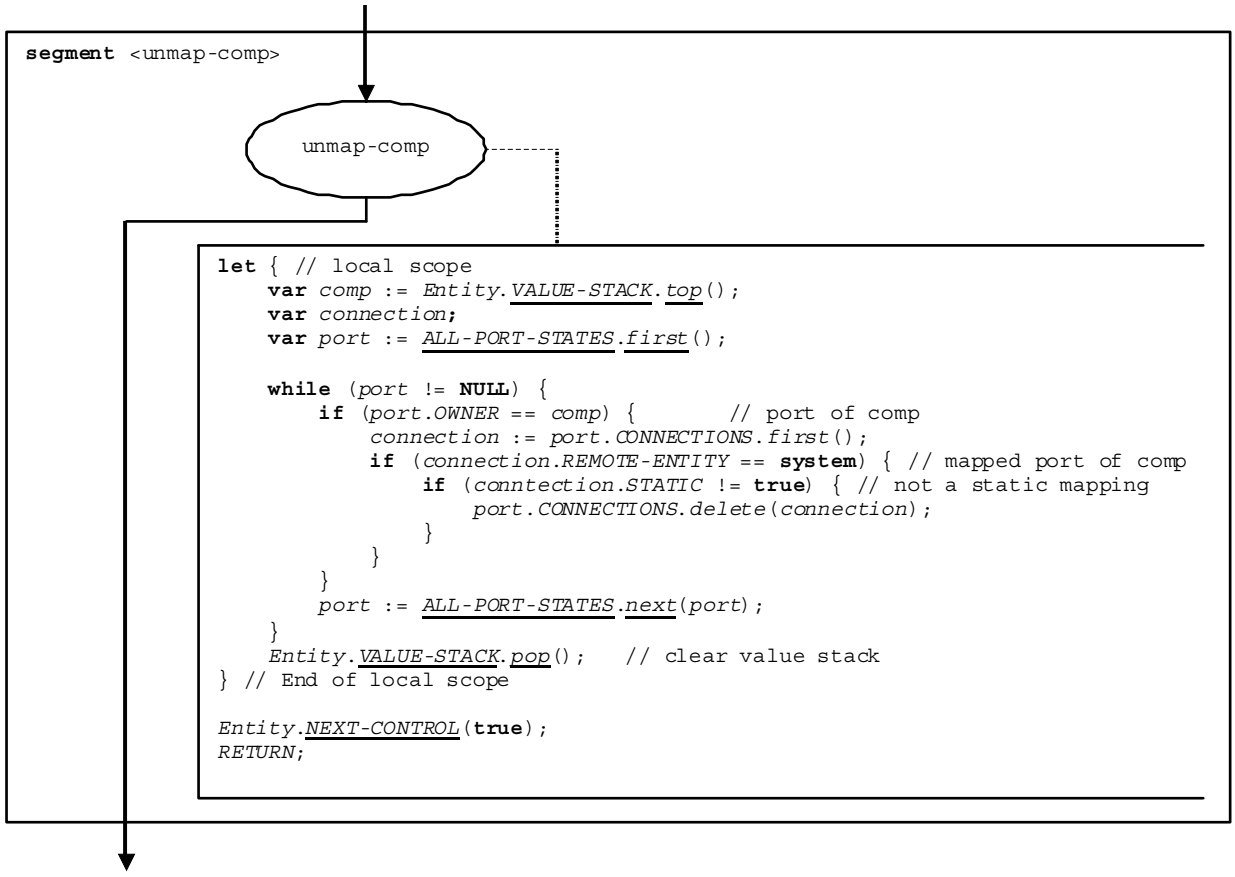


Figure 136b of ES 201 873-4 [2]: Flow graph segment <unmap-comp>

6.51 Flow graph segment <unmap-port>

The flow segment <unmap-port> defines the **unmap** operation for a specific mapped port.

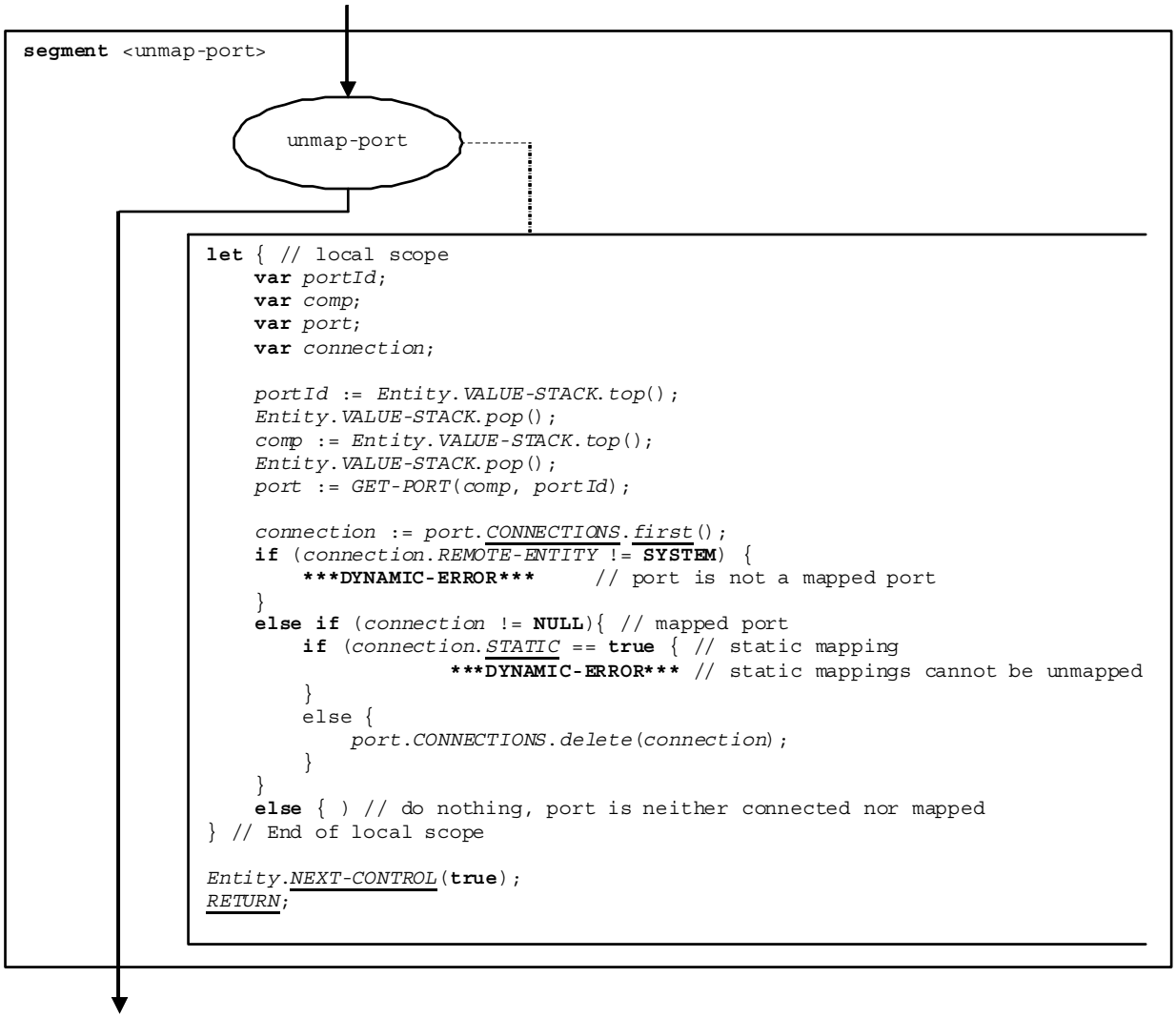


Figure 136c of ES 201 873-4 [2]: Flow graph segment <unmap-port>

7 TRI Extensions for the Package

7.1 Changes and extensions to clause 5.5.2 of ES 201 873-5 [3] Connection handling operations

If this package is being used, the TriExecuteTestCase operation shall be used only for initialization purposes of the SA, but not for the establishment of static connections. In order to establish static connections, the TriStaticMap operation shall be used instead. The TriUnmap can be used for closing dynamic and static connections.

Clause 5.5.2.1 triExecuteTestCase (TE → SA)

This clause is changed as follows.

Signature	`TriStatusType triExecuteTestCase(`
	`in TriTestCaseIdType testCaseId,`
	`in TriPortIdListType tsiPortList)`

In Parameters	`testCaseId` identifier of the test case that is going to be executed `tsiPortList` a list of test system interface ports defined for the test system
Out Parameters	n.a.
Return Value	The return status of the `triExecuteTestCase` operation. The return status indicates the local success (***TRI_OK***) or failure (***TRI_Error*)** of the operation.
Constraints	This operation is called by the TE immediately before the execution of any test case. The test case that is going to be executed is indicated by the `testCaseId`. `tsiPortList` contains all ports that have been declared in the definition of the system component for the test case, i.e. the TSI ports. If a system component has not been explicitly defined for the test case in the TTCN-3 ATS then the `tsiPortList` contains all communication ports of the MTC test component. The ports in `tsiPortList` are ordered as they appear in the respective TTCN-3 component declaration.
Effect	The SA can initialize any communication means for TSI ports. The `triExecuteTestCase` operation returns ***TRI_OK*** in case the operation has been successfully performed, ***TRI_Error*** otherwise.

Clause 5.5.2.3 triUnmap (TE → SA)

This clause is changed as follows.

Signature	`TriStatusType triUnmap(in TriPortIdType compPortId,` `in TriPortIdType tsiPortId)`
In Parameters	`compPortId` identifier of the test component port to be unmapped `tsiPortId` identifier of the test system interface port to be unmapped
Out Parameters	n.a.
Return Value	The return status of the `triUnmap` operation. The return status indicates the local success (***TRI_OK***) or failure (***TRI_Error***) of the operation.
Constraints	This operation is called by the TE when it executes any TTCN-3 unmap operation.
Effect	The SA shall close a dynamic or static connection to the SUT for the referenced TSI port. The `triUnmap` operation returns ***TRI_Error*** in case a connection could not be closed successfully or no such connection has been established previously, ***TRI_OK*** otherwise. The operation should return ***TRI_OK*** in case no connections have to be closed by the test system.

Clause 5.5.2.5 triStaticMap (TE → SA)

This clause is to be added.

Signature	`TriStatusType triStaticMap(in TriPortIdType compPortId,` `in TriPortIdType tsiPortId)`
In Parameters	`compPortId` identifier of the test component port to be mapped in a static connection `tsiPortId` identifier of the test system interface port to be mapped in a static connection
Out Parameters	n.a.
Return Value	The return status of the `triStaticMap` operation. The return status indicates the local success (***TRI_OK***) or failure (***TRI_Error***) of the operation.
Constraints	This operation is called by the TE when it executes a TTCN-3 static map operation.
Effect	The SA can establish a static connection to the SUT for the referenced TSI port. The `triStaticMap` operation returns ***TRI_Error*** in case a connection could not be established successfully, ***TRI_OK*** otherwise. The operation should return ***TRI_OK*** in case no static connection needs to be established by the test system.

7.2 Extensions to clause 6 of ES 201 873-5 [3] Java language mapping

Clause 6.5.2.1 triCommunicationSA

The `triCommunicationSA` interface mapping is to be extended with the definition for `TriStaticMap`:

```
// TriCommunication
// TE -> SA
package org.etsi.ttcn.tri;
public interface TriCommunicationSA {
    :
    // Connection handling operations
    :
    // Ref: TRI-Definition 5.5.2.5
    public TriStatus triStaticMap(TriPortId compPortId, TriPortId tsiPortId);
    :
```

7.3 Extensions to clause 7 of ES 201 873-5 [3] ANSI C language mapping

Clause 7.2.4 TRI operation mapping

The table is to be extended with the definition for `TriStaticMap`:

IDL Representation	ANSI C Representation
…	

`TriStatusType triStaticMap`
`(in TriPortIdType compPortId,`
`in TriPortIdType tsiPortId)`
	`TriStatus triStatic Map`
	`(const TriPortId* compPortId,`
	`const TriPortId* tsiPortId)`

…	

7.4 Extensions to clause 8 of ES 201 873-5 [3] C++ language mapping

Clause 8.6.1 TriCommunicationSA

The `triCommunicationSA` interface mapping is to be extended with the definition for `TriStaticMap`. In addition, the description of `TriUnmap` has to be changed to handle also the closing of static connections:

```
class TriCommunicationSA {
public:
   :
  //To establish a static connection between two ports.
   virtual TriStatus triStaticMap (const TriPortId *comPortId, const TriPortId *tsiPortId)=0;

  //To close a dynamic or static connection to the SUT for the referenced TSI port.
   virtual TriStatus triUnmap (const TriPortId *comPortId, const TriPortId *tsiPortId)=0;
   :
```

8 TCI Extensions for the Package

8.1 Extensions to clause 7.2.1.1 of ES 201 873-6 [4] Management

The management type `TciTestComponentKindType` has to be extended with constants for static test components:

`TciTestComponentKindType` A value of type `TciTestComponentKindType` is a literal of the set of kinds of TTCN-3 test components, i.e. `CONTROL`, `MTC`, `PTC`, `SYSTEM`, `PTC_ALIVE`, `MTC_STATIC`, `PTC_STATIC`, and `SYSTEM_STATIC`. This abstract type is used for component handling.

8.2 Extensions to clause 7.3.1.1 of ES 201 873-6 [4] TCI TM required

In order to handle static configurations via TCI-TM, the operations `tciStartConfig` and `tciKillConfig` are defined as follows.

Clause 7.3.1.1.11 tciStartConfig

This clause is to be added.

Signature	`void tciStartConfig (in TciBehaviourIdType configId, in TciParameterListType parameterList)`	
In Parameters	`configId`	A configuration function identifier as defined in the TTCN-3 module.
	`parameterList`	A list of `Values` where each value defines a parameter from the parameter list as defined in the TTCN-3 configuration function definition. The parameters in `parameterList` are ordered as they appear in the TTCN-3 signature of the configuration function. If no parameters have to be passed either the `null` value or an empty `parameterList`, i.e. a list of length zero shall be passed.
Return Value	`void`	
Constraint	Shall be called only if a module has been selected before. Only `configId` for test cases with static configurations that are declared in the currently selected TTCN-3 module shall be passed – see `tciStartTestCase`.	
Effect	Starts a static configuration of the selected module as described in the TTCN-3 configuration function. A static configuration started from TCI-TM will be used by test cases that reference the static configuration and are executed from TCI-TM.	

Clause 7.3.1.1.12 tciKillConfig

This clause is to be added.

Signature	`void tciKillConfig(in Value ref)`	
In Parameters	`ref`	The reference to the static configuration.
Return Value	`void`	
Constraint	Shall be called only if a module has been selected before.	
Effect	`tciKillConfig` causes the destruction of the static test configuration `ref`. If `ref` is currently not started, the operation will be ignored.	

8.3 Extensions to clause 7.3.1.2 of ES 201 873-6 [4] TCI TM provided

In order to enable the indication of static configuration start and destruction at TCI-TM, the operations `tciConfigStarted` and `tciConfigKilled` are defined as follows.

Clause 7.3.1.2.7 tciConfigStarted

This clause is to be added.

Signature	`void tciConfigStarted(in Value ref)`	
In Parameters	`ref`	The reference to the static configuration.
Return Value	`void`	
Constraint	Shall only be called after the static configuration has been started either using the *required* operations `tciStartConfig` or internally by the TE.	
Effect	`tciConfigStarted` indicates to the TM that static configuration `ref` has been started. It will not be distinguished whether the static configuration has been started explicitly using the *required* operation `tciStartConfig` or implicitly while executing the control part.	

Clause 7.3.1.2.8 tciConfigKilled

This clause is to be added.

Signature	`void tciConfigKilled(in Value ref)`	
In Parameters	`ref`	The reference to the static configuration.
Return Value	`void`	
Constraint	Shall only be called after the static configuration has been killed either using the *required* operations `tciKillConfig` or internally by the TE.	
Effect	`tciConfigStarted` indicates to the TM that static configuration `ref` has been destructed. It will not be distinguished whether the static configuration has been started explicitly using the *required* operation `tciKillConfig` or implicitly while executing the control part.	

8.4 Extensions to clause 7.3.3.1 of ES 201 873-6 [4] TCI CH required

In order to establish static connections, the `tciStaticConnect` and `tciStaticMap` operations shall be used at TCI-CH. The `tciDisconnect` and `TciUnmap` can be used for closing static connections.

Clause 7.3.3.1.21 tciStaticConnect

This clause is to be added.

Signature	`void tciStaticConnect(in TriPortIdType fromPort, in TriPortIdType toPort)`	
In Parameters	`fromPort`	Identifier of the test component port to be connected from.
	`toPort`	Identifier of the test component port to be connected to.
Return Value	`void`	
Constraint	This operation shall be called by the CH at the local TE when at a remote TE a *provided* `tciStaticConnectReq` has been called.	
Effect	The TE shall statically connect the indicated ports to one another.	

Clause 7.3.3.1.21 tciStaticMap

This clause is to be added.

Signature	`void tciStaticMap(in TriPortIdType fromPort, in TriPortIdType toPort)`	
In Parameters	`fromPort`	Identifier of the test component port to be mapped from.
	`toPort`	Identifier of the test component port to be mapped to.
Return Value	`void`	
Constraint	This operation shall be called by the CH at the local TE when at a remote TE a *provided* `tciStaticMapReq` has been called.	
Effect	The TE shall statically map the indicated ports to one another.	

8.5 Extensions to clause 7.3.3.2 of ES 201 873-6 [4] TCI CH provided

In order to establish static connections, the `tciStaticConnectReq` and `tciStaticMapReq` operations shall be used at TCI-CH. The `tciDisconnectReq` and `TciUnmapReq` can be used for closing static connections.

Clause 7.3.3.2.29 tciStaticConnectReq

This clause is to be added.

Signature	`void tciStaticConnectReq(in TriPortIdType fromPort, in TriPortIdType toPort)`	
In Parameters	`fromPort`	Identifier of the test component port to be connected from.
	`toPort`	Identifier of the test component port to be connected to.
Return Value	`void`	
Constraint	This operation shall be called by the TE when it executes a TTCN-3 static connect operation.	
Effect	CH transmits the static connection request to the remote TE where it calls the `tciStaticConnect` operation to establish a logical static connection between the two indicated ports. Note that both ports can be on remote TEs. In this case, the operation returns only after calling the `tciStaticConnect` operation on both remote TEs.	

Clause 7.3.3.1.30 tciStaticMapReq

This clause is to be added.

Signature	`void tciStaticMapReq(in TriPortIdType fromPort, in TriPortIdType toPort)`	
In Parameters	`fromPort`	Identifier of the test component port to be mapped from.
	`toPort`	Identifier of the test component port to be mapped to.
Return Value	`void`	
Constraint	This operation shall be called by the TE when it executes a TTCN-3 static map operation.	
Effect	CH transmits the static map request to the remote TE where it calls the `tciStaticMap` operation to establish a logical static connection between the two indicated ports.	

8.6 Extensions to clause 7.3.4 of ES 201 873-6 [4] TCI-TL provided

In order to log the handling of static connections and of static components, the operations are `tliCStaticCreate`, `tliPStaticConnect`, and `tliPStaticMap` are defined. For the logging of the starting and destruction of static configurations, the operations `tliConfigStarted` and `tliConfigKilled` are defined.

Clause 7.3.4.1.106 tliCStaticCreate

This clause is to be added.

Signature	`void tliCStaticCreate(in TString am, in TInteger ts, in TString src, in TInteger line, in TriComponentIdType c, in TriComponentIdType comp, in TString name)`	
In Parameters	`am`	An additional message.
	`ts`	The time when the event is produced.
	`src`	The source file of the test specification.
	`line`	The line number where the request is performed.
	`c`	The component which produces this event.
	`comp`	The component which is created.
	`name`	The name of the component which is created.
Return Value	`void`	
Constraint	Shall be called by TE to log the create component operation. This event occurs after component creation.	
Effect	The TL presents all the information provided in the parameters of this operation to the user. The kind of the created component (see TciTestComponentKindType) can be logged in `am`. How this is done is not within the scope of the present document.	

Clause 7.3.4.1.107 tliPStaticConnect

This clause is to be added.

Signature	`void tliPStaticConnect(in TString am, in TInteger ts, in TString src, in TInteger line, in TriComponentIdType c, in TriPortIdType port1, in TriPortIdType port2)`	
In Parameters	`am`	An additional message.
	`ts`	The time when the event is produced.
	`src`	The source file of the test specification.
	`line`	The line number where the request is performed.
	`c`	The component which produces this event.
	`port1`	The first port to be connected.
	`port2`	The second port to be connected.
Return Value	`void`	
Constraint	Shall be called by CH or TE to log the connect operation. This event occurs after the connect operation.	
Effect	The TL presents all the information provided in the parameters of this operation to the user. The kind of the connection (i.e. dynamic or static) can be logged in `am`. How this is done is not within the scope of the present document.	

Clause 7.3.4.1.108 tliPStaticMap

This clause is to be added.

Signature	`void tliPStaticMap(in TString am, in TInteger ts, in TString src, in TInteger line, in TriComponentIdType c, in TriPortIdType port1, in TriPortIdType port2)`	
In Parameters	`am`	An additional message.
	`ts`	The time when the event is produced.
	`src`	The source file of the test specification.
	`line`	The line number where the request is performed.
	`c`	The component which produces this event.
	`port1`	The first port to be mapped.
	`port2`	The second port to be mapped.
Return Value	`void`	
Constraint	Shall be called by SA or TE to log the map operation. This event occurs after the map operation.	
Effect	The TL presents all the information provided in the parameters of this operation to the user. The kind of the connection (i.e. dynamic or static) can be logged in `am`. How this is done is not within the scope of the present document.	

Clause 7.3.4.1.109 tliConfigStarted

This clause is to be added.

Signature	`void tliConfigStarted (in TString am, in TInteger ts, in TString src, in TInteger line, in TriComponentIdType c, in TciBehaviourIdType configId, in TciParameterListType tciPars, in Value ref)`	
In Parameters	`am`	An additional message.
	`ts`	The time when the event is produced.
	`src`	The source file of the test specification.
	`line`	The line number where the request is performed.
	`c`	The component which produces this event.
	`configId`	The static configuration function being started.
	`tciPars`	The parameters of the started configuration function.
	`ref`	The resulting static configuration reference.
Return Value	`void`	
Constraint	Shall be called by TE to log the starting of a static test configuration. This event occurs after static configuration start.	
Effect	The TL presents all the information provided in the parameters of this operation to the user, how this is done is not within the scope of the present document.	

Clause 7.3.4.1.110 tliConfigKilled

This clause is to be added.

Signature	`void tliConfigKilled (in TString am, in TInteger ts, in TString src, in TInteger line, in TriComponentIdType c, in Value ref)`	
In Parameters	`am`	An additional message.
	`ts`	The time when the event is produced.
	`src`	The source file of the test specification.
	`line`	The line number where the request is performed.
	`c`	The component which produces this event.
	`ref`	The static configuration reference that has been destructed.
Return Value	`void`	
Constraint	Shall be called by TE to log the kill configuration operation. This event occurs after configuration kill.	
Effect	The TL presents all the information provided in the parameters of this operation to the user, how this is done is not within the scope of the present document.	

8.7 Extensions to clause 8 of ES 201 873-6 [4] Java language mapping

Clause 8.2.2.5 TciTestComponentKindType

This clause is to be extended.

```
// TCI IDL TciTestComponentKindType
public interface TciTestComponentKind {
    :
    public final static int TCI_MTC_STATIC_COMP     = 5;
    public final static int TCI_PTC_STATIC_COMP     = 6;
    public final static int TCI_SYSTEM_STATIC_COMP  = 7;
}
```

Clause 8.4.1.1 TCI TM provided

This clause is to be extended.

```
// TCI-TM
// TE -> TM
package org.etsi.ttcn.tci;
public interface TciTMProvided {
    :
    public void tciConfigStarted(Value ref);
    public void tciConfigKilled(Value ref)
}
```

Clause 8.4.1.2 TCI TM required

This clause is to be extended.

```
// TCI-TM
// TM -> TE
package org.etsi.ttcn.tci;
public interface TciTMRequired {
    :
    public void tciStartConfig
                (TciBehaviourId configId, TciParameterList parameterList)
    public void tciKillConfig(Value ref)
}
```

Clause 8.4.3.1 TCI CH provided

This clause is to be extended.

```
// TciCHProvided
// TE -> CH
package org.etsi.ttcn.tci;
public interface TciCHProvided {
    :
    public void tciStaticConnectReq(TriPortId fromPort, TriPortId toPort);
    public void tciStaticMapReq(TriPortId fromPort, TriPortId toPort);
}
```

Clause 8.4.3.2 TCI CH required

This clause is to be extended.

```
// TciCHRequired
// CH -> TE
package org.etsi.ttcn.tci;
public interface TciCHRequired extends TciCDRequired {
    :
    public void tciStaticConnect(TriPortId fromPort, TriPortId toPort);
    public void tciStaticMap(TriPortId fromPort, TriPortId toPort);
}
```

Clause 8.4.4.1 TCI TL provided

This clause is to be extended.

```
// TCI-TL
// TE, TM,CH,CD, SA,PA -> TL
package org.etsi.ttcn.tci;
public interface TciTLProvided {
    :
    public void tliCStaticCreate(String am, int ts, String src, int line, TriComponentId c,
            TriComponentId comp, String name);
    public void tliPStaticConnect(String am, int ts, String src, int line, TriComponentId c,
            TriPortId port1, TriPortId port2);
    public void tliPStaticMap(String am, int ts, String src, int line, TriComponentId c,
            TriPortId port1, TriPortId port2);
    public void tliConfigStarted (String am, int ts, String src, int line, TriComponentId c,
            TciBehaviourId configId, TciParameterList tciPars, Value ref);
    public void tliConfigKilled (String am, int ts, String src, int line, TriComponentId c,
            Value ref);
}
```

8.8 Extensions to clause 9 of ES 201 873-6 [4] ANSI C language mapping

Clause 9.5 Data

The table is to be extended.

TCI IDL ADT	ANSI C representation (Type definition)	Notes and comments
:		

TciTestComponentKindType	typedef enum
	{
	  :,
	  TCI_MTC_STATIC_COMP,
	  TCI_PTC_STATIC_COMP,
	  TCI_SYSTEM_STATIC_COMP
	} TciTestComponentKindType;	

:		

Clause 9.4.1.1 TCI TM provided

This clause is to be extended.

```
    :
    void tciConfigStarted(Value ref);
    void tciConfigKilled(Value ref)
```

Clause 9.4.1.2 TCI TM required

This clause is to be extended.

```
    :
    void tciStartConfig(TciBehaviourIdType configId, TciParameterListType parameterList)
    void tciKillConfig(Value ref)
```

Clause 9.4.3.1 TCI CH provided

This clause is to be extended.

```
    :
    void tciStaticConnectReq(TriPortId fromPort, TriPortId toPort);
    void tciStaticMapReq(TriPortId fromPort, TriPortId toPort);
```

Clause 9.4.3.2 TCI CH required

This clause is to be extended.

```
    :
    void tciStaticConnect(TriPortId fromPort, TriPortId toPort)
    void tciStaticMap(TriPortId fromPort, TriPortId toPort)
```

Clause 9.4.4.1 TCI TL provided

This clause is to be extended.

```
    :
    void tliCStaticCreate (String am, int ts, String src, int line, TriComponentId c,
            TriComponentId comp, String name)
    void tliPStaticConnect (String am, int ts, String src, int line, TriComponentId c,
            TriPortId port1, TriPortId port2)
    void tliPStaticMap (String am, int ts, String src, int line, TriComponentId c,
            TriPortId port1, TriPortId port2)
    void tliConfigStarted (String am, int ts, String src, int line, TriComponentId c,
            TciBehaviourIdType configId, TciParameterListType tciPars, Value ref);
    void tliConfigKilled (String am, int ts, String src, int line, TriComponentId c,
            Value ref);
```

8.9 Extensions to clause 10 of ES 201 873-6 [4] C++ language mapping

Clause 10.5.2.13 TciTestComponentKind

This clause is to be extended.

```
class TciTestComponentKind {
public:
    :
    static const TciTestComponentKind MTC_STATIC_COMP;
    static const TciTestComponentKind PTC_STATIC_COMP;
    static const TciTestComponentKind SYSTEM_STATIC_COMP;
    :
}
```

Clause 10.6.1.1 TciTmRequired

This clause is to be extended.

```
    :
    virtual void tciStartConfig (const TciBehaviourId *configId, TciParameterList *parameterList)=0;
    virtual void tciKillConfig(const Value *ref)=0;
```

Clause 10.6.1.2 TciTmProvided

This clause is to be extended.

```
    :
•   //Indicates the start of a static configuration
    virtual void tciConfigStarted(const TciValue *ref) =0;
    virtual void tciConfigKilled(const TciValue *ref)=0;
```

Clause 10.6.3.1 TciChRequired

This clause is to be extended.

```
    :
    virtual void tciStaticConnect(const TriPortId *fromPort, const TriPortId *toPort)=0;
    virtual void tciStaticMap(const TriPortId *fromPort, const TriPortId *toPort)=0;
```

Clause 10.6.3.2 TciChProvided

This clause is to be extended.

```
    :
    virtual void tciStaticConnectReq(const TriPortId *fromPort, const TriPortId *toPort)=0;
    virtual void tciStaticMapReq(const TriPortId *fromPort, const TriPortId *toPort)=0;
```

Clause 10.6.4.1 TciTlProvided

This clause is to be extended.

```
    :
    virtual void tliCStaticCreate (const Tstring &am, const timeval ts, const Tstring src,
    const Tinteger line, const TriComponentId *c, const TriComponentId *comp,
    const Tstring &name)=0;

    virtual void tliPStaticConnect (const Tstring &am, const timeval ts, const Tstring src,
    const Tinteger line, const TriComponentId *c, const TriPortId *port1, const TriPortId *port2)=0;

    virtual void tliPStaticMap (const Tstring &am, const timeval ts, const Tstring src,
    const Tinteger line, const TriComponentId *c, const TriPortId *port1, const TriPortId *port2)=0;

    virtual void tliConfigStarted (const Tstring &am, const timeval ts, const Tstring src,
    const Tinteger line, const TriComponentId *c, const TciBehaviourId *configId,
    const TciParameterList *tciPars, const TciValue *ref)=0;

    virtual void tliConfigKilled (const Tstring &am, const timeval ts, const Tstring src,
    const Tinteger line, const TriComponentId *c, const TciValue *ref)=0;
```

8.10 Extensions to clause 11 of ES 201 873-6 W3C XML mapping

Clause 11.4.2.1 TCI TL provided

This clause is to be extended.

```
    <xsd:complexType name="tliCStaticCreate">
        <xsd:complexContent mixed="true">
            <xsd:extension base="Events:Event">
                <xsd:sequence>
                    <xsd:element name="comp" type="Types:TriComponentIdType"/>
                    <xsd:element name="name" type="SimpleTypes:TString"/>
                </xsd:sequence>
            </xsd:extension>
        </xsd:complexContent>
    </xsd:complexType>

    <xsd:complexType name="tliPStaticConnect">
        <xsd:complexContent mixed="true">
            <xsd:extension base="Events:PortConfiguration"/>
        </xsd:complexContent>
    </xsd:complexType>

    <xsd:complexType name="tliPStaticMap">
        <xsd:complexContent mixed="true">
```

```
        <xsd:extension base="Events:PortConfiguration"/>
    </xsd:complexContent>
</xsd:complexType>

<xsd:complexType name="tliConfigStarted">
    <xsd:complexContent mixed="true">
        <xsd:extension base="Events:Event">
            <xsd:sequence>
                <xsd:element name="configId" type="Types:TciBehaviourIdType"/>
                <xsd:element name="tciPars" type="Types:TciParameterListType" minOccurs="0"/>
                <xsd:element name="ref" type="Values:Value"/>
            </xsd:sequence>
        </xsd:extension>
    </xsd:complexContent>
</xsd:complexType>

<xsd:complexType name="tliConfigKilled">
    <xsd:complexContent mixed="true">
        <xsd:extension base="Events:Event">
            <xsd:sequence>
                <xsd:element name="ref" type="Values:Value"/>
            </xsd:sequence>
        </xsd:extension>
    </xsd:complexContent>
</xsd:complexType>
```

Clause B.5 TCI TL XML Schema for Events

The five additional events defined for clause "11.4.2.1 TCI TL provided" have to be added to the events schema definition given in clause B.5.

Annex A (normative): BNF and static semantics

A.1 Additional TTCN-3 terminals

Table A.1 presents all additional TTCN-3 terminals which are reserved words when using this package. Like the reserved words defined in the TTCN-3 core language, the TTCN-3 terminals listed in table A.1 shall not be used as identifiers in a TTCN-3 module. These terminals shall be written in all lowercase letters.

Table A.1: List of additional TTCN-3 terminals which are reserved words

configuration	**static**		

A.2 Modified TTCN-3 syntax BNF productions

This clause includes all BNF productions that are modifications of BNF rules defined in the TTCN-3 core language document [1]. When using this package the BNF rules below replace the corresponding BNF rules in the TTCN-3 core language document. The rule numbers define the orespondence of BNF rules.

```
11. ModuleDefinition ::= [Visibility] (TypeDef |
                         ConstDef |
                                        TemplateDef |
                         ModuleParDef |
                         FunctionDef |
                         SignatureDef |
                         TestcaseDef |
                         AltstepDef |
                         ImportDef |
                         GroupDef |
                         ExtFunctionDef |
                         ExtConstDef |
                         FriendModuleDef |
                         ConfigurationDef) [WithStatement]


197. TestcaseDef ::= TestcaseKeyword TestcaseIdentifier
                     "("[TestcaseFormalParList] ")" ConfigSpec | ExecuteOnSpec
                     StatementBlock

205. TestcaseInstance ::= ExecuteKeyword "(" TestcaseRef "(" [TestcaseActualParList] ")"
                          ["," TimerValue] ["," ConfigurationReference] ")"

294. ControlStatement ::= TimerStatements |
                          BasicStatements |
                          BehaviourStatements |
                          SUTStatements |
                          StopKeyword |
                          KillConfigStatement

316. CreateOp ::=   ComponentType Dot CreateKeyword ["(" SingleExpression ")"]
                    [AliveKeyword | StaticKeyword]

330. ConnectStatement ::= ConnectKeyword SingleConnectionSpec [StaticKeyword]
342. MapStatement ::= MapKeyword SingleConnectionSpec [StaticKeyword]

452. PredefinedType ::= BitStringKeyword |
                        BooleanKeyword |
                        CharStringKeyword |
                        UniversalCharString |
                        IntegerKeyword |
                        OctetStringKeyword |
                        HexStringKeyword |
                        VerdictTypeKeyword |
```

```
                        FloatKeyword |
                        AddressKeyword |
                        DefaultKeyword |
                        AnyTypeKeyword |
                        ConfigurationKeyword

610. OpCall ::= ConfigurationOps |
                VerdictOps |
                TimerOps |
                TestcaseInstance |
                FunctionInstance [ ExtendedFieldReference ] |
                TemplateOps [ ExtendedFieldReference ] |
                ActivateOp |
                ConfigurationInstance
```

A.3 Additional TTCN-3 syntax BNF productions

This clause includes all additional BNF productions that needed to define the syntax introduced by this package. Additional BNF rules that have a relation to modified BNF rules defined in clause A.2, will have the rule number of the modified rule followed by a lower case letter, e.g. number of modified rule 316, number of related additional rule 316a. The numbering of other new rules start with number 900.

```
197a. ExecuteOnSpec ::= ExecuteKeyword OnKeyword ConfigurationRef

316a. StaticKeyword ::= "static"


900. ConfigurationDef ::= ConfigurationKeyword ConfigurationIdentifier
                          "("[TestcaseFormalParList] ")" ConfigSpec
                          StatementBlock
901. ConfigurationKeyword ::= "configuration"
902. ConfigurationIdentifier ::= Identifier
903. ConfigurationInstance ::= ConfigurationRef "(" [TestcaseActualParList] ")"
904. ConfigurationRef ::= [GlobalModuleId Dot] ConfigurationIdentifier


905. KillConfigStatement ::= ConfigurationReference Dot KillKeyword
906. ConfigurationReference ::= VariableRef | FunctionInstance
```

History

Document history			
V0.0.4	May 2010	Membership Approval Procedure	MV 20100730: 2010-05-31 to 2010-07-30