

**Project Number:** IST-1999-11253-TEQUILA

**Project Title:** Traffic Engineering for Quality of Service in the Internet, at Large Scale




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## D3.3: Prototype Integration

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**Abstract:** Building on the TEQUILA system Implementation Plan, documented in Deliverable D2.2 and updated in Deliverable D2.3, this deliverable presents the project's *Integration and Experimentation Plan*.

This document should be read in conjunction with Deliverable D3.2, which specifies the set of tests to be undertaken.

**Keyword List:** Experimentation, functional validity, performance assessment, testbeds, network simulation

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IMEC	Principal Contractor	Belgium
NTUA	Principal Contractor	Greece
Global Crossing (RACAL)	Principal Contractor	United Kingdom
UCL	Principal Contractor	United Kingdom
TERENA	Assistant Contractor	The Netherlands
UniS	Principal Contractor	United Kingdom

## Executive Summary

This document presents the *TEQUILA Integration and Experimentation Plan*. It complements Deliverable D3.2, which contains the specification of the tests to be undertaken by the project during its integration, validation and experimentation phase.

The *Integration Plan* schedules the integration activities required for porting the TEQUILA system to the project's experimentation platforms. The plan specifies the set of components to be integrated to form testable subsets of the entire TEQUILA system and the platforms on which they are to be deployed, together with the time schedule for each associated activity. The plan is based on the TEQUILA Implementation Plan compiled by WP2—documented in Deliverable D2.2 and updated in Deliverable D2.3—and the specific focus of each physical testbed and simulation environment, as reported in Deliverable D3.1. In order to minimise effort and time, integration follows an incremental approach from the lower to the higher levels of the TEQUILA system hierarchy, while peer subsystems are integrated in parallel in the different platforms, according to their experimentation focus. The integration tests—specified in Deliverable D3.2—are executed as the components and subsystems are migrated to their target platforms and the successful outcome of these tests signals the completion of the integration activities.

The *Experimentation Plan* schedules the algorithm and system performance experiments specified in Deliverable D3.2 as a function of time and experimentation platform. System validation and experimentation is facilitated in terms of time and effort required by utilising the benefits of parallelism yielded by the distinct experimental focus of each platform:

- SLS Management experiments in the Greek testbed,
- MPLS-based traffic engineering and monitoring experiments in the UK testbed,
- IP-based traffic engineering experiments in the French testbed, and,
- Data plane experiments in the Belgium testbed, together with,
- Complementary intra-domain traffic engineering experiments in the NS simulator and inter-domain experiments in the OPNET simulator.

According to the presented plans, the whole system will be 'up and running' by early next year (February 2002). Experiments have already begun in the simulation platforms from September 2001 and initial tests in the physical testbeds will begin from December 2001. Experiments will continue until the end of the project in June 2002.

The plans show that the project's integration, validation and experimentation activities will be completed within the time and budget constraints of the overall project plan.

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# 1 INTRODUCTION

The overall objective of the TEQUILA project [TEQUILA] is to study, specify, implement and validate service definition and traffic engineering tools for the Internet. The TEQUILA system should provide qualitative and close to quantitative service guarantees through planning, dimensioning and dynamic control of traffic management techniques based on DiffServ.

TEQUILA addresses the following major functional areas [D1.1]

- SLS Management, for handling QoS service requests,
- Traffic Engineering (TE), for ensuring that the network (and *networks* in the case of the inter-domain TE studies undertaken) provides the required performance levels to meet the customer demands in a cost-effective manner,
- Monitoring, at network and SLS levels, for providing the above systems with the statistics required for their operation,
- Policy Management, for influencing the operation of SLS Management and TE systems on the basis of operator-defined policy parameters.

The theoretical, specification and implementation phases of the project are now close to completion. SLS Management and TE algorithms have been specified in [D1.2] and [D1.3]. The implementation architecture and design for the system as a whole as well as for each individual sub-system and component has been specified and subsequently implemented as defined in [D2.2] and [D2.3]. Now the project is entering its third phase when WP3 will take over the main focus of the project work. Experimentation platforms based on physical testbeds and simulators have initially been specified in [D3.1] and tests have been specified in [D3.2] covering sub-system level integration tests for functional validation and algorithmic and system level tests for performance assessment.

It should be stressed that is not intended for the entire TEQUILA functionality to be integrated and experimented with in each and every testbed and simulator. A distinct role is derived for each, to allow the experimentation activities to be undertaken in parallel. This has two main benefits: firstly it enables the project's integration and experimentation teams to undertake their tasks on their own premises, minimising travelling time and costs or inefficiencies implied by remotely scheduling, executing and analysing experiments. Secondly it breaks the overall system into manageable, testable subsets of the entire TEQUILA system to reduce the complexity of the validation and performance assessment exercises.

The role of each platform depends on the major functional areas to be investigated and the implementation task allocation per partner [D2.2]. Table 1 and Table 2 depict the focus of the project testbeds and simulation platforms respectively.

Testbed	Partners involved	Experimentation focus (per major functional area of the TEQUILA system)
UK	GCX	Intra-domain MPLS-based traffic engineering and Monitoring functionality
French	FTR&D	Intra-domain IP-based traffic engineering functionality
Belgian	IMEC	Data plane functionality to support SLS management and traffic engineering functions
Greek	ALGO, NTUA	SLS management (TEQUILA SLS-based service subscription and invocation) functionality and interactions with traffic engineering

**Table 1: Experimentation Focus of the Testbeds**

Simulator	Partners involved	Experimentation focus
NS	UCL, UniS	Intra-domain traffic engineering functionality
OPNET	ALCATEL	Inter-domain traffic engineering aspects

**Table 2: Experimental Focus of the Simulators**

## 2 INTEGRATION PLAN

The integration plan, developed in this section, schedules the integration activities required for porting the TEQUILA system to the project's experimentation platforms. The plan is based on the TEQUILA implementation plans compiled by WP2 [D2.2], [D2.3] and the specific focus of each physical testbed and simulation environment [D3.1], also see Table 1 and Table 2.

While the *software* integration activities, specified and scheduled in [D2.3], will deliver working sets of components, the WP3 integration activities have the task of integrating the delivered sets of components into whole sub-systems (SLS Management or MPLS-based TE sub-systems, for example) in the target experimental platforms.

The essence of our integration approach, in order to minimise the required effort and time, is two-fold:

- It follows an incremental approach from the lower to the higher levels of the TEQUILA system hierarchy, while peer subsystems are integrated in parallel in the different platforms, thanks to the distinct experimentation focus of each platform.
- Integration tasks are allocated close to and are executed locally by the implementers.

During integration, the *integration tests* specified in [D3.2] are executed as the components and sub-systems are migrated to their target platforms. A successful outcome of these tests signals the completion of the integration activity and the commencement of the system performance assessment activities (see next section).

Figure 1 depicts the integration tasks in time, which are analysed in Table 3.

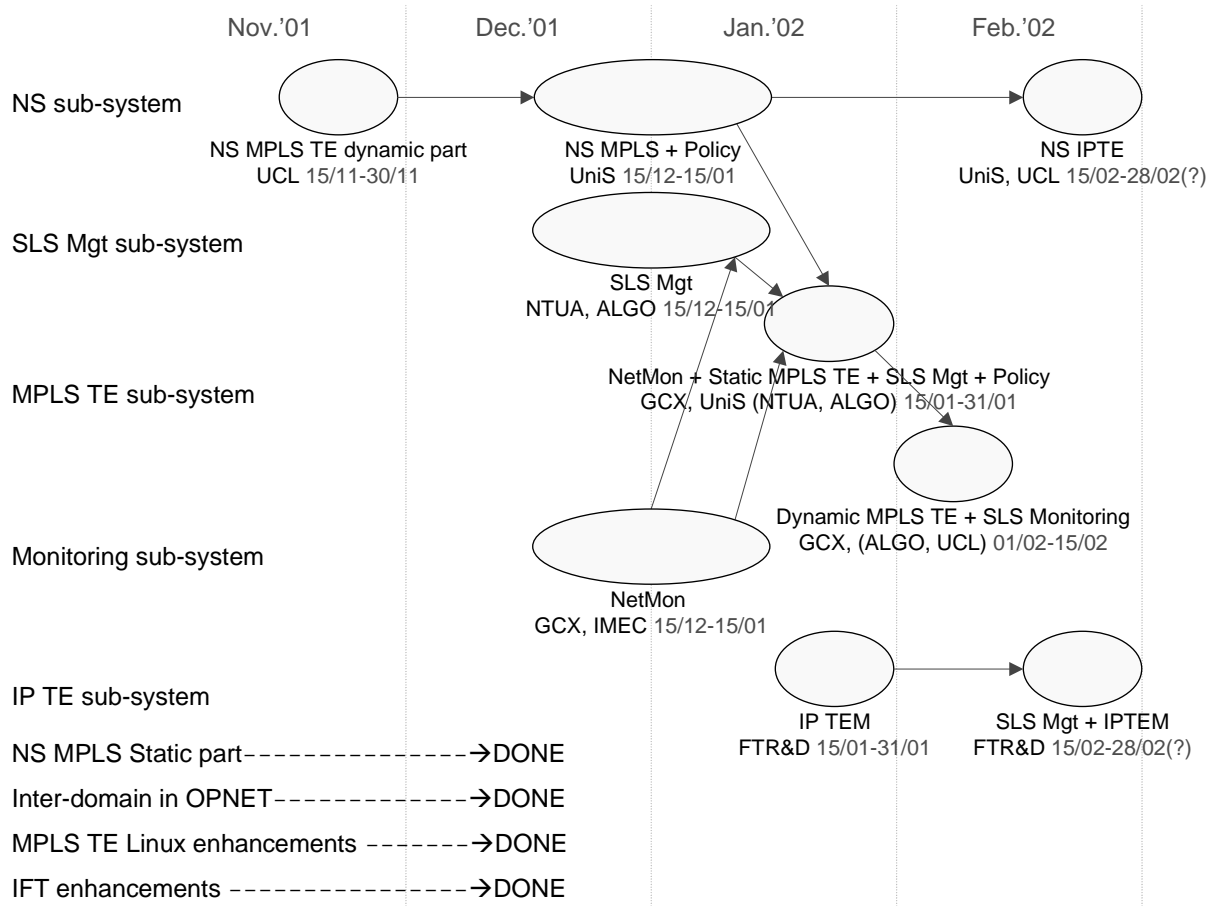


Figure 1: Integration Plan

Task	Partner(s)	Location	Tests, see [D3.2]	Due Date
NS MPLS Static Part	UniS	NS sim., UK	N/A	DONE
Inter-domain in OPNET	Alcatel	Belgium	N/A	DONE
MPLS TE Linux Enhancements	IMEC	Belgian testbed	N/A	DONE
IFT Enhancements	FTR&D	French testbed	N/A	DONE
NS Dynamic Part	UCL	NS sim., UK	suite1_0	30/11
NS MPLS + Policy	UniS	NS sim., UK	suite1_7	15/01
SLS Mgt	NTUA,ALGO	Greek testbed	suite1_1	15/01
NetMon (Network Monitoring)	GCX, IMEC	UK testbed	suite1_2	15/01
NetMon + Static MPLS + SLS Mgt + Policy	GCX (ALGO, NTUA, UniS)	UK testbed	suite1_4/.../mpls/[d-plane, slsm]	31/01
Dynamic MPLS + SLS Monitoring	GCX (ALGO, UCL)	UK testbed	suite1_4/.../mpls/[slsm,comp] suite1_7 (in the real system)	15/02
IP TEM	FTR&D	French testbed	suite1_5*, suite1_6	31/01

\* excluding the protocol behaviour verification aspects of suite1\_5 (see Table 5)

Table 3: Integration Task Allocation

### 3 EXPERIMENTATION PLAN

This section defines the TEQUILA experimentation plan which schedules the algorithm and system performance experiments specified in Deliverable D3.2 as a function of time and experimentation platform.

As for the integration activities in the previous section, this plan has been compiled taking into account the experimentation focus of each platform. Figure 2 shows the experimentation tasks in time and identifies a set of Integration Milestones (IM3.\*) for project planning purposes, which are also listed in Table 4. For completeness, the chart also shows the schedule of the integration tests defined in the previous section.

<b>Integration Milestone (IM)</b>	<b>Description</b>	<b>Date</b>
IM3.1	SLS Management System integrated in the testbed	15/01
IM3.2	Monitoring System integrated in the testbed	15/01
IM3.3	MPLS TE System integrated in the testbed	15/02
IM3.4	IP TE System integrated in the testbed	31/01
IM3.5a	Policy Management System integrated in NS	15/01
IM3.5b	Policy Management System integrated in the testbed	15/02

**Table 4 Integration and Experimentation Milestones**

Table 5 maps the subject of the experiments (the testable subsets of the TEQUILA system according to major functional area) to the experimentation platforms, it identifies the partners who will undertake the tests and it provides a reference to the specific tests to be executed as defined in [D3.2].

<b>Subject of Performance Assessment Task</b>	<b>Partner(s)</b>	<b>Location</b>	<b>Tests. See [D3.2]</b>	<b>Period</b>
SLS Management Algorithm	ALGO	Greek testbed	suite2_0	01/01-31/03
SLS Management System	NTUA, ALGO	Greek testbed	suite3_0	15/01-31/05
MPLS TE Algorithm	UniS, UCL	NS sim., UK	suite2_1	30/09-31/05
MPLS TE System	GCX	UK testbed	suite3_1	15/02-31/05
Monitoring System	GCX, IMEC	UK testbed	suite3_2	15/01-15/04
Policy Management System	UniS	NS sim., UK	suite3_4	15/01-31/05
IP TE Algorithm	FTR&D	French testbed	suite2_2*	01/02-31/05
IP TE System	FTR&D	French testbed	suite3_3	01/02-31/05

\* including the protocol behaviour verification aspects of suite1\_5 (see Table 3)

**Table 5: Performance Assessment Experimentation Activities**





The original milestones for system integration, M3.2 and M3.3, were defined in the WP3 plans at the time of the project negotiation and documented in Annex 1 of the TEQUILA contract. As explained in the latter document the precise nature and timing of these milestones was subject to change, depending on the implementation plan of WP2 [D2.2]. An update to the original integration and experimentation milestones is given in this deliverable (Figure 2) and the mapping between the two sets of milestones can be summarised as follows:

- Original milestone M3.2 (due end July 2001), “SLS User-Network Components Integrated in the Testbed”, corresponds to milestone IM3.1. The first set of TEQUILA User-Network Components was actually released in April 2001, with emphasis on service negotiation through the SrNP (service negotiation protocol). As far as user-network components are concerned, IM3.1 includes improved subscription, negotiation and invocation components, which could not be predicted at the time of project negotiation (as the necessary theoretical work and specification tasks had not yet started).
- Original milestone M3.3, “Intra-domain Components Integrated in Testbeds”, corresponds to milestones IM3.2, IM3.3, IM3.4 and IM3.5.

## 4 RESOURCE PLAN

Table 6 depicts the required resources for undertaking integration and experimentation activities per partner, per month.

	Nov-01	Dec-01	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Total
<b>Alcatel</b>	0.9	1.0	0.9	1.0	0.9	1.0	0.9	1.0	<b>7.6</b>
<b>Algo</b>	1.3	1.2	1.3	1.2	1.3	1.2	1.3	1.2	<b>10.0</b>
<b>FTR&amp;D</b>	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.6	<b>4.9</b>
<b>IMEC</b>	0.4	0.4	0.4	0.3	0.4	0.3	0.4	0.3	<b>2.9</b>
<b>NTUA</b>	1.3	1.4	1.3	1.4	1.4	1.4	1.4	1.4	<b>11.0</b>
<b>GCX</b>	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	<b>11.2</b>
<b>UCL</b>	0.8	1.0	0.7	1.5	1.4	1.5	1.8	1.9	<b>10.6</b>
<b>TERENA</b>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<b>0.0</b>
<b>UniS</b>	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.3	<b>10.7</b>
<b>Total</b>	<b>8.0</b>	<b>8.3</b>	<b>7.9</b>	<b>8.7</b>	<b>8.9</b>	<b>8.8</b>	<b>9.2</b>	<b>9.1</b>	<b>68.9</b>

**Table 6: Resource Plan for Integration and Experimentation**

Partners are committed to providing the effort specified in the above table, therefore guaranteeing the resources necessary for the successful implementation of the experimentation plan.

## 5 CONCLUSIONS

This report has detailed the integration and experimentation plan for the third and final phase of TEQUILA—integration, validation and experimentation—which sees the main focus of the project work moving to WP3. The plans show that the project's integration, validation and experimentation activities will be completed within the time and budget constraints of the overall project plan.

The full set of prototypes comprising the entire TEQUILA system will be ‘up and running’ by early next year (February 2002). Experiments have already begun in the simulation platforms from September 2001 and initial tests in the physical testbeds will begin from December 2001. Experiments will continue until the end of the project in June 2002.

The project is confident that by following the plans in this deliverable to conduct the tests specified in [D3.2] a set of meaningful experiments can be undertaken, within available time and resources, to validate the developed functionality and draw conclusions on its performance, thus fulfilling the overall objectives of TEQUILA.

## 6 REFERENCES

- [D1.1] TEQUILA project Deliverable D1.1, “Functional Architecture Definition and Top Level Design”, July 2000
- [D1.2] TEQUILA project Deliverable D1.2, “Protocol and Algorithm Specification”, January 2001
- [D2.1] TEQUILA project Deliverable D2.1, “Selection of Simulators, Network Elements and Development Environment and Specification of Enhancements”, May 2000
- [D2.2] TEQUILA project Deliverable D2.2, “System Design and Implementation Plan”, Version 1, February 2001
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- [ISO-9646-7] ISO/IEC 9646-7: 1992, Information Technology – Open Systems Interconnection – Conformance Testing methodology and framework – Part 7: Implementation Conformance Specification.
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