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Tsinghua University

An Approach of Performance Evaluation in Authentic Database Applications

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DB Test

Group

大学

tsinghua university

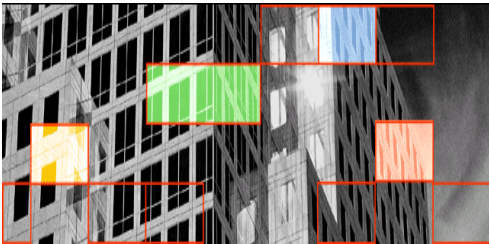
Agenda

- Background
- Motivation
- Benchmark Test Management Framework
- Workload Characteristics Modeling
- Experiment Study
- Conclusion



Background

- Worldwide DBMSs in China



- National DBMSs in China



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Background

- China national DBMSs R&D Projects ("863"Program)
 - 2001~2005 Finance support decision:
"Measurement on behalf of expert comments"
 - Undertakers of database testing
 - China Software Test Center
 - Tsinghua University
 - What metrics
 - Functionality: user-requirement driven
 - Compliance: SQL/ODBC/JDBC/OLE DB/ADO
 - Quality in use: Field research and user survey
 - Performance



Background

- Performance Evaluation
 - 2001-2005 indicators ("863" Program)
 - TPC performance in labs: TPC-C、 TPC-W
 - Performability in production systems: TPC + DBMS reliability (availability) facilities
 - 2006~2020 indicators ("HeGaoJi" Program)
 - ISO 9126:
 - **Efficiency metrics** (Internal/External quality)
 - **Productivity metrics**(Quality in use)
 - End-user requirements(in production systems):
 - Grasp detailed and authentic system status
 - Authenticity of emulating different realistic application environments (domain specific)



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Motivation

- Comparability of various testing results
 - Based on **performance benchmarks**: TPC, SPEC
 - **Configuration** of SUT and TS (user-requirements)
 - Data models and data characteristics
 - Database scale (Scale factors in TPC-H/DS)
 - Transaction types(plug-in) and mixed ratios
- Authenticity of emulated application Workloads
 - **Workload characterization**: transaction relationships
 - **Workload implementation**: SQL statement, stored procedure, Middleware(Web service), ...
- **Objective**: Open, flexible, multi-purposes performance test tools



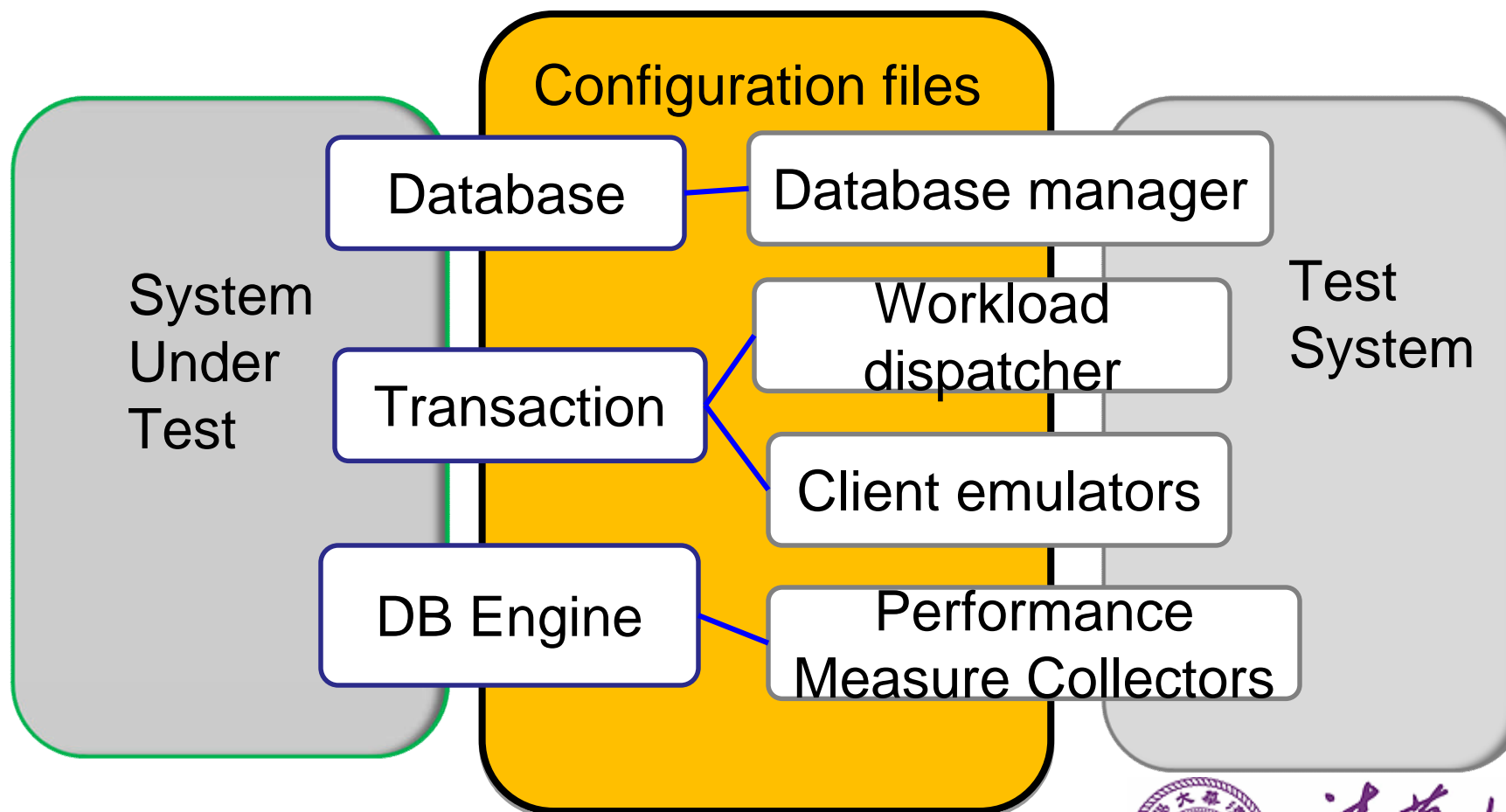
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- **Benchmark Test Management Framework**
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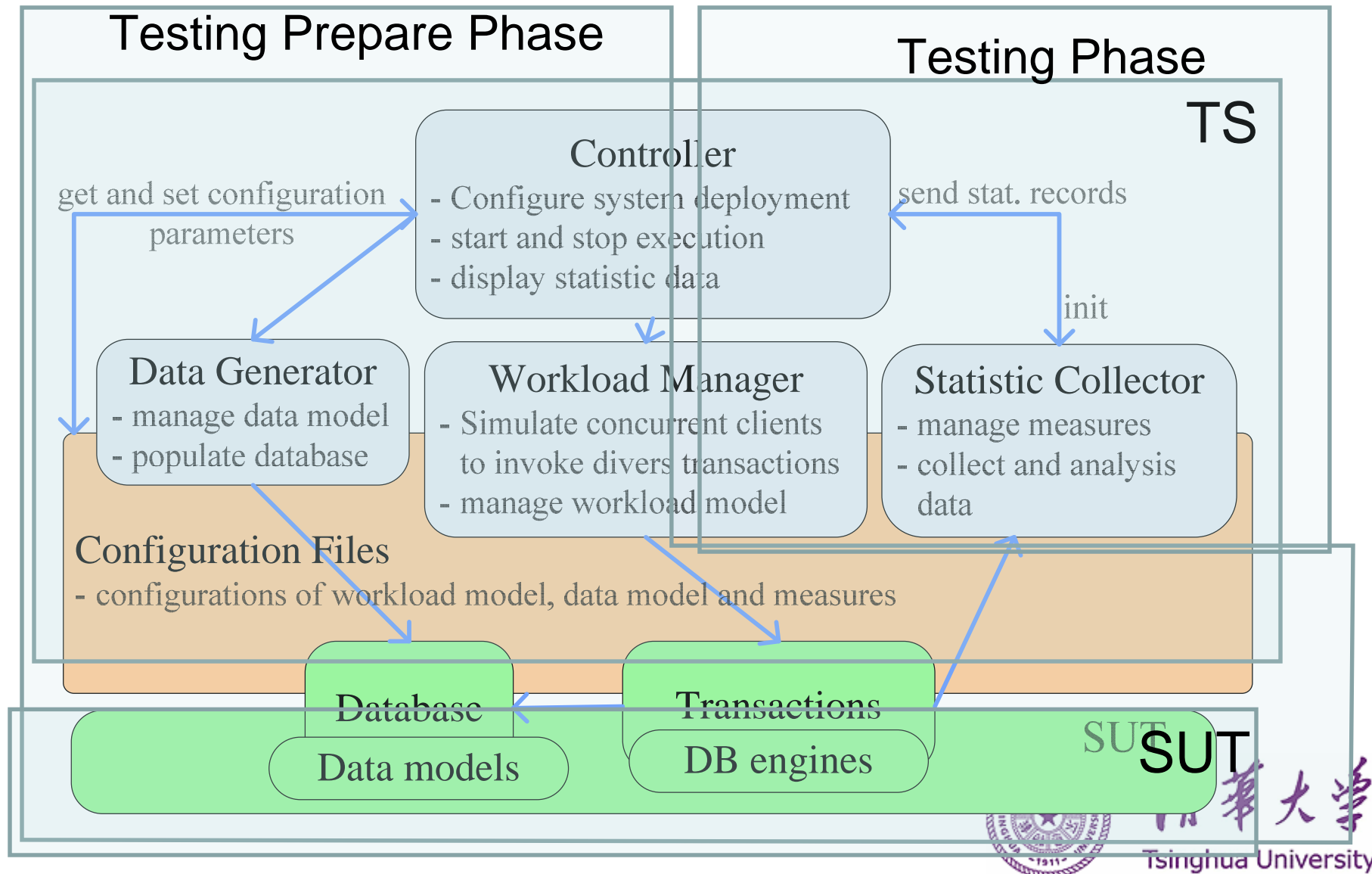


Design philosophy

- BTMF: model-driven + configurable

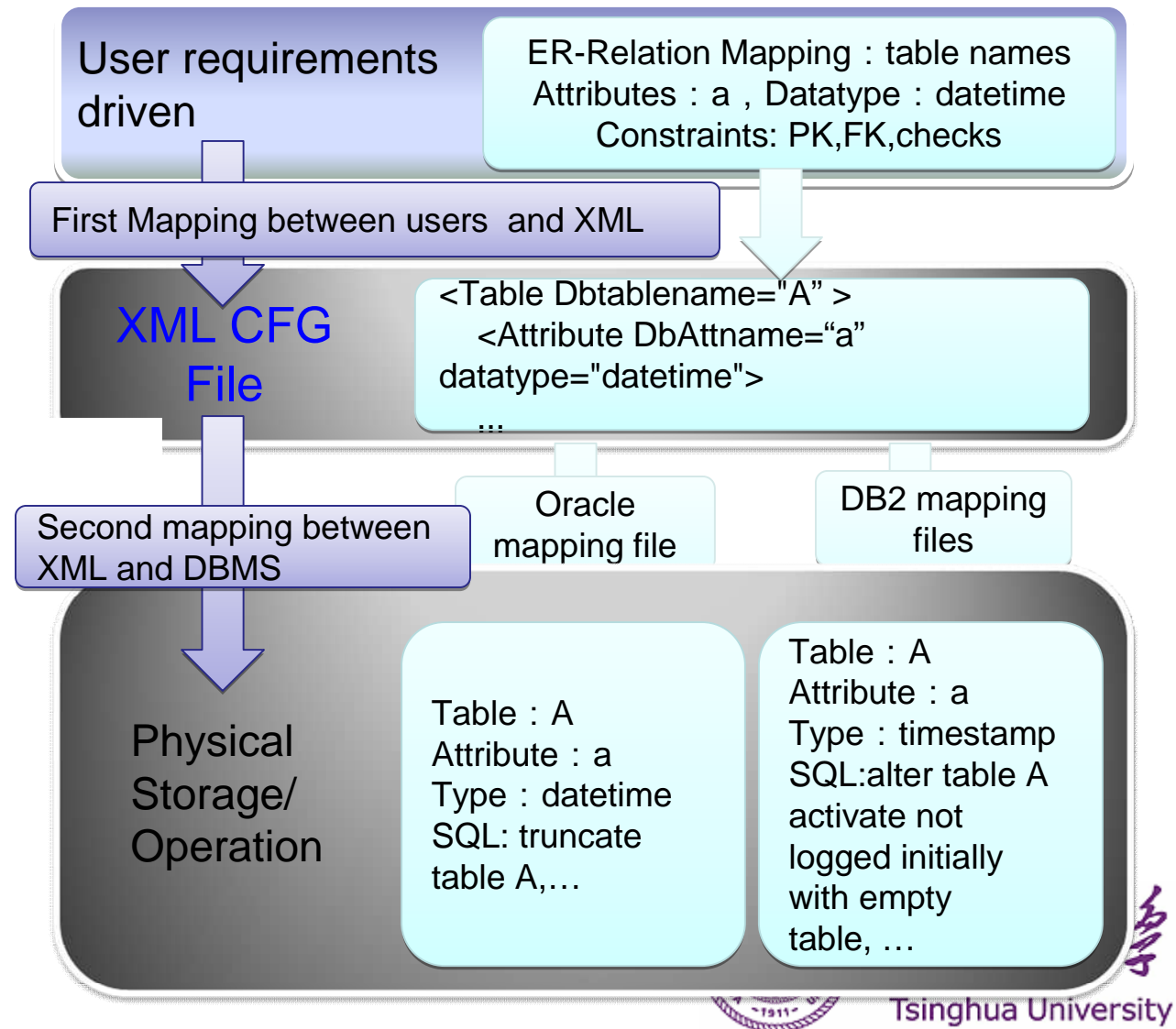


BTMF Prototype Implementation



Test Database Management

- Data manager in CFG files(two mapping)



Test Database Management

Each attribute has a data generation method according to data characteristics predefined in test system ([generation constraints: plug-in functions](#))

- **Data generator**

- Row dependencies
- Column dependencies

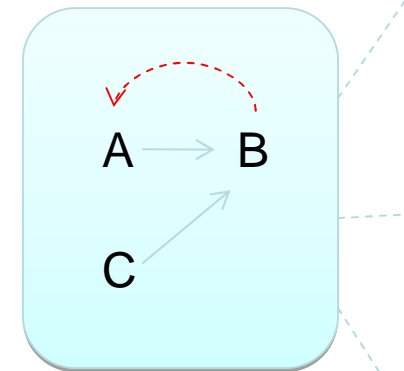
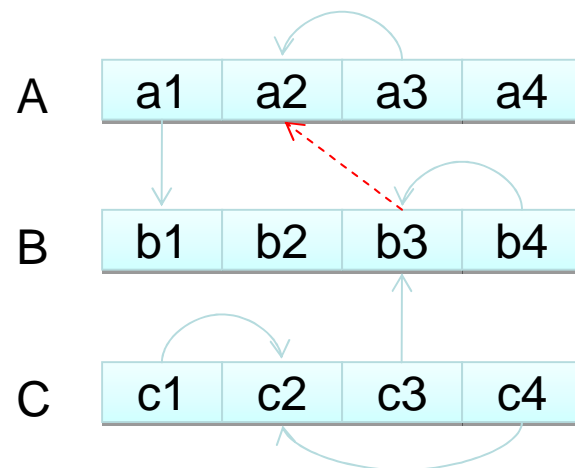
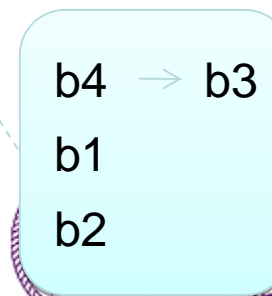
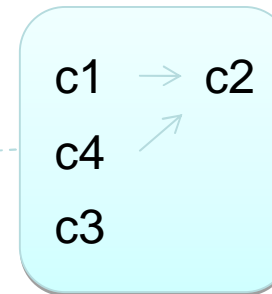
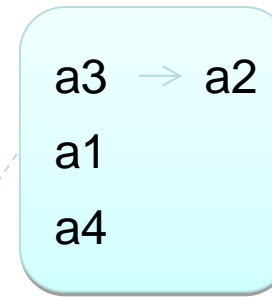


Table dependence

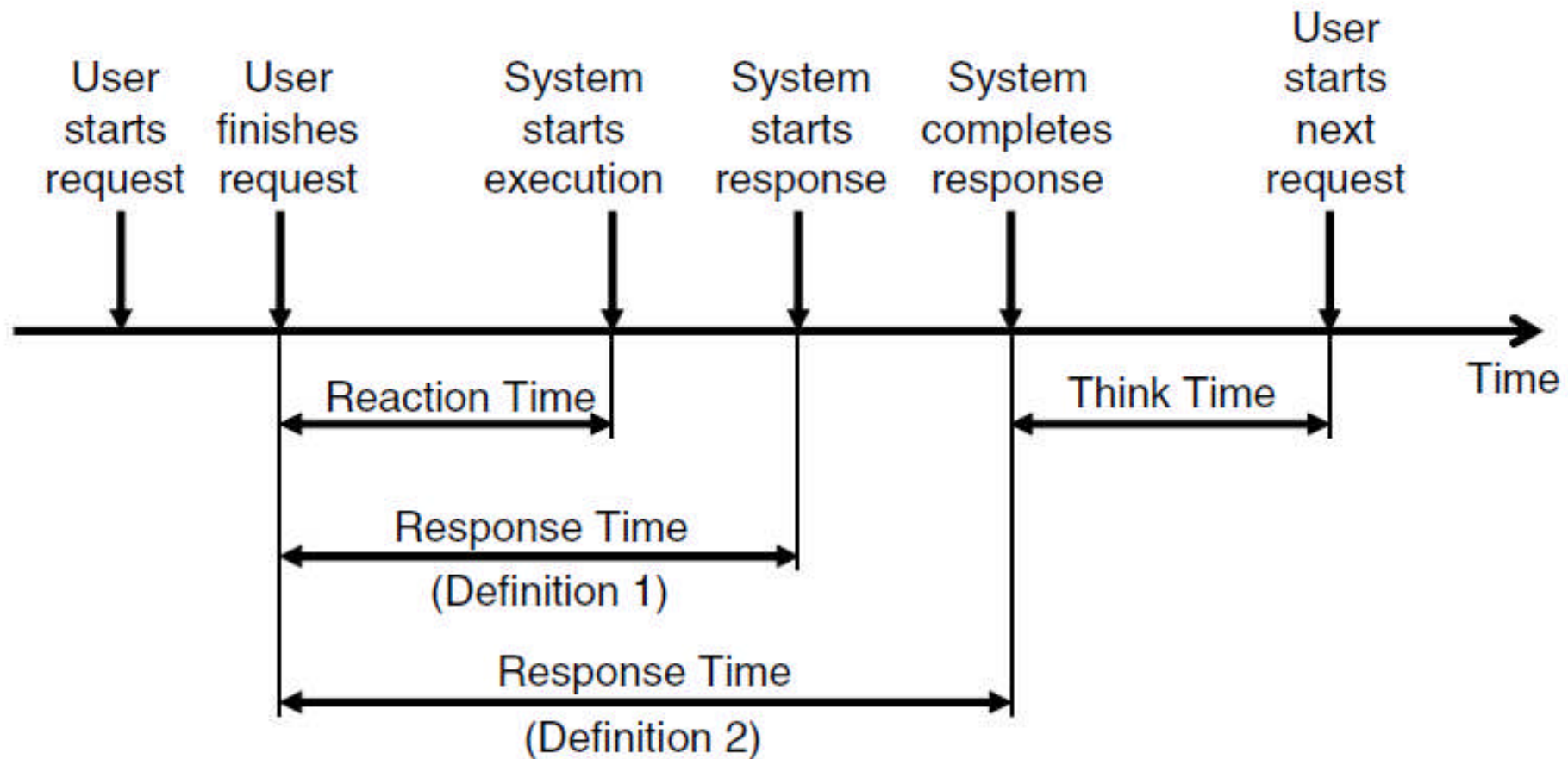
Attribute dependence



➔ Multi-thread database population

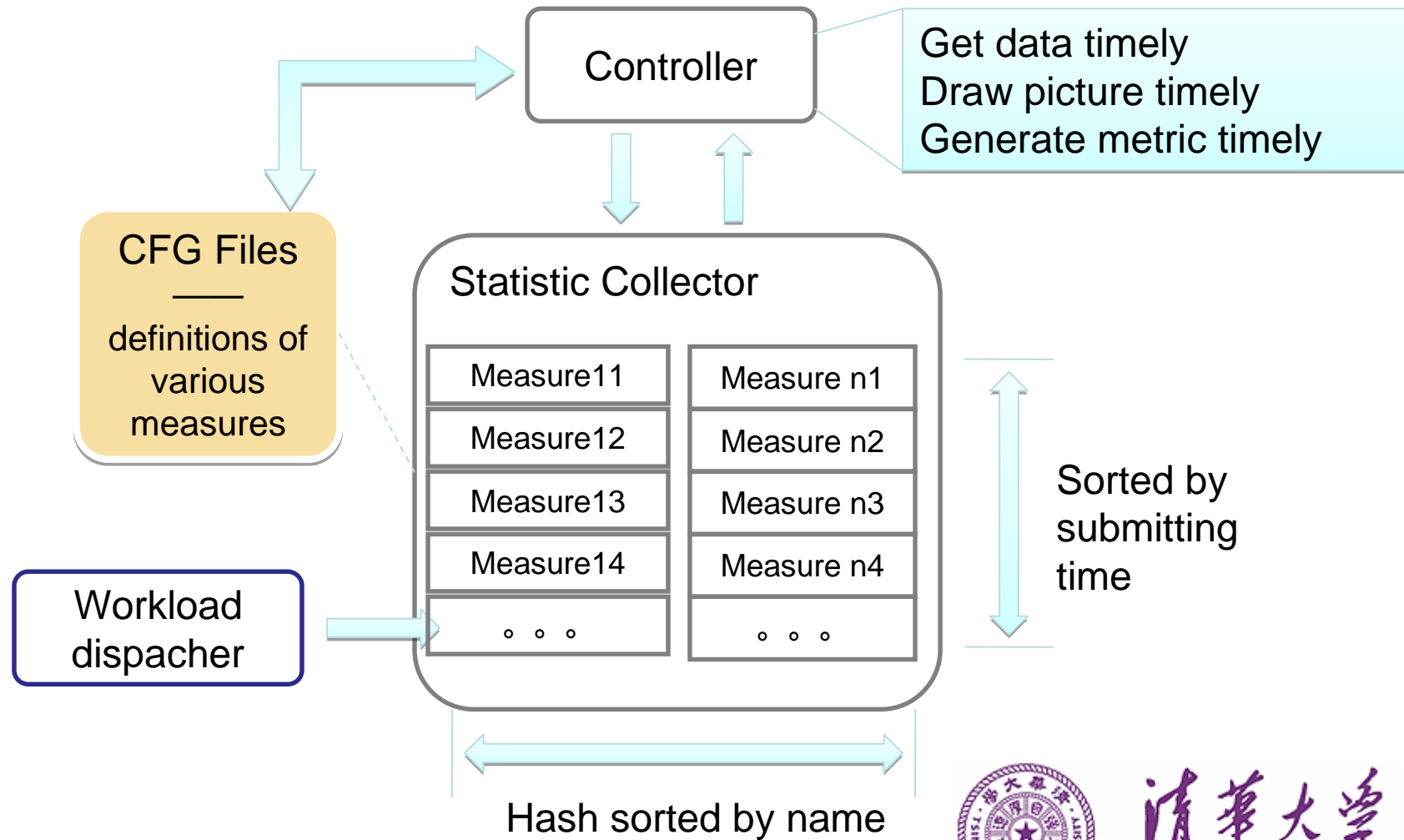
Performance Metric Management

- Measures:



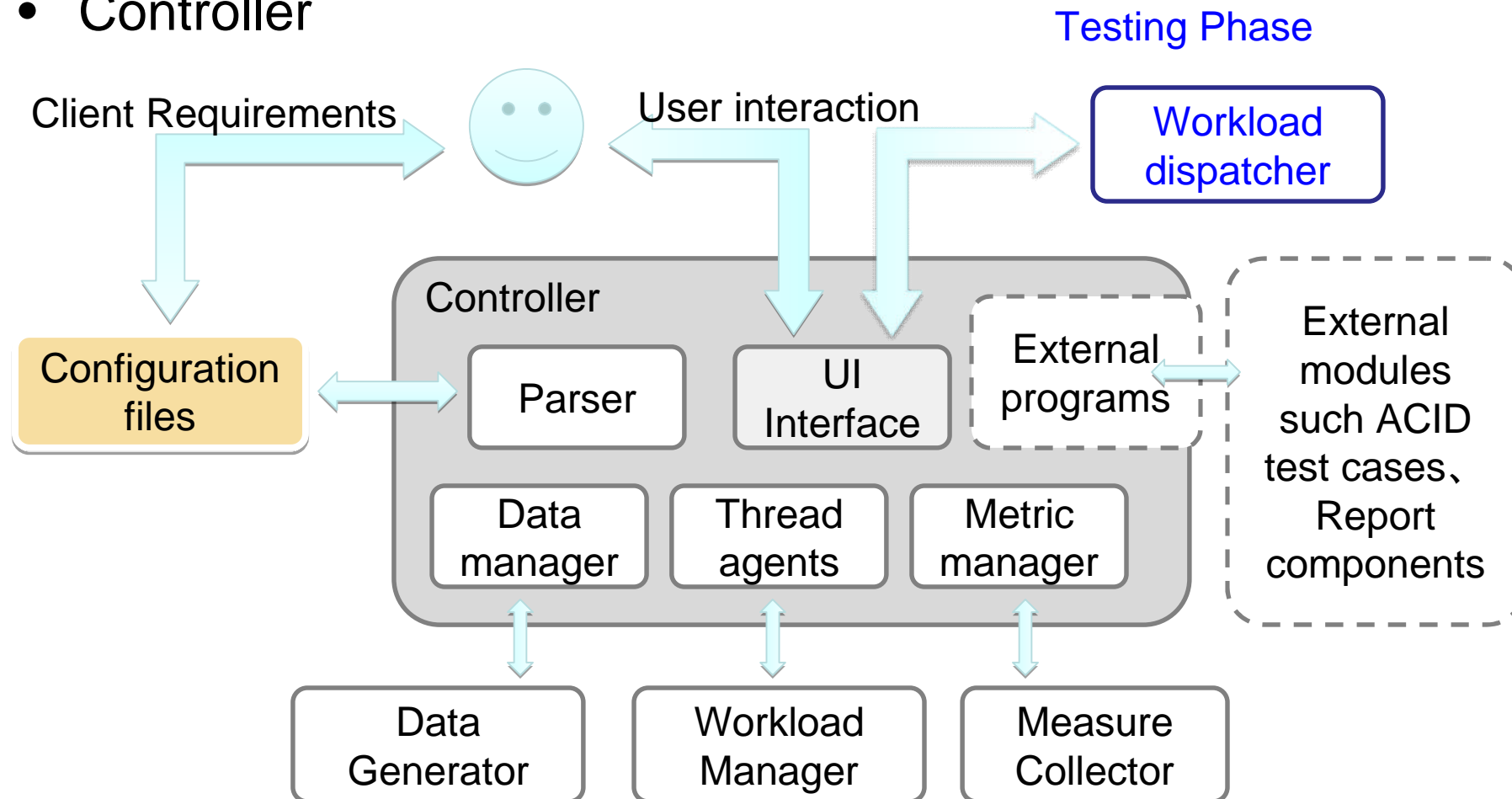
Performance Metric Management

- Measure collector



User Interface: Controller

- Controller



BTMF Implementation Tool

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The screenshot shows the '应用系统测试_TPCAppOracle - [模式定制]' window. The '数据准备' (Data Preparation) menu is selected. A dialog box titled 'Test Database Characteristics' is open, displaying a table of database fields:

字段名称	数据类型	长度	允许空值
i_id	decimal	9	False

Other callouts in the image include 'Database Scale' pointing to the '长度' column, 'Database Initialization' pointing to the '数据准备' menu, and 'Test Database Management' pointing to the '确定' button.



BTMF Implementation Tool

Prototype

The screenshot displays the '应用系统测试_TPCAppOracle - [模式定制]' window. The main area shows a table structure for '测试用表' with columns: i_id, i_titl, i_publisher, i_subject, i_desc, i_image, i_srp, and i_cost. The '属性编辑' dialog is open for the 'i_id' column, showing '字符型取值范围' with '值串长度最小' set to 14 and '字符集' set to 'a b c d e'. The '自定义方法' section is also visible.

字段名称	数据类型	长度	是否主键
i_id	varchar	60	True
i_titl	varchar	60	True
i_publisher	varchar	60	True
i_subject	varchar	60	True
i_desc	varchar	500	True
i_image	varchar	40	True
i_srp	decimal	17,2	True
i_cost	decimal	17.2	True

Table structure

Test Database Data Characteristics

User defined Plugin function

General constraints, e.g. Min/max Distribution



BTMF Implementation Tool

The screenshot displays the BTMF Implementation Tool interface, which is used for configuring and monitoring performance tests. The main window is titled "应用系统测试_TPCAppOracle - [压力测试]" (Application System Test_TPCAppOracle - [Stress Test]).

The interface includes a navigation pane on the left with the following menu items:

- 项目管理 (Project Management)
- 系统设置 (System Settings)
- 数据准备 (Data Preparation)
- 性能测试 (Performance Test)
- 正确性验证 (Correctness Verification)
- 日志管理 (Log Management)
- 系统帮助 (System Help)

The main configuration area is divided into several sections:

- 参数设置 (Parameter Settings):** Includes a dropdown for "测试方案" (Test Plan) set to "TPCAPP2", "预热时间 (秒)" (Warm-up Time (s)) set to 800, and "测试时间 (秒)" (Test Time (s)) set to 7200.
- 交互 (Interaction):** Includes a dropdown for "交互" (Interaction) set to "修改商品" (Modify Goods) and "图形种类" (Graph Type) set to "每秒交互个数监控图" (Per-second interaction count monitoring graph).
- 运行监控 (Run Monitoring):** Includes a table for monitoring test results and summary statistics.

The "运行监控" (Run Monitoring) section contains a table with the following data:

Web交互	成功	失败	运行时间 (秒)
修改商品	0	0	0
新用户	0	0	
修改支付方式	0	0	
商品详单	0	0	
新商品	0	0	
订单状态	0	0	
创建订单	0	0	
全部交互	0	0	
			总请求数
			0
			有效请求数
			0

The bottom status bar shows the following log entries:

- [2009-6-17 8:59:14] 执行菜单命令: 集群参数
- [2009-6-17 8:59:34] 执行菜单命令: 模式定制
- [2009-6-17 8:59:44] 执行菜单命令: 模式定制

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Database Workload Modeling

- Database transactions with the following characteristics(TPC workload)
 - Mix of transactions with timing constraints:
 - TPC-C/TPC-W/TPC-E (SQL->procedure)
 - Stream of transactions: TPC-H/DS(QGEN)
- Configuration of database workload
 - Customized transactions: SQL scripts/user defined plug-in functions(DLL, Web service)
 - Configurable mix of transactions and their timing constraints



Business Workload Modeling

- Why we need workflow workload?
 - ✓ Workflow patterns exist in real system.
- ✓ How will the workflow workload (customer access patterns) will affect the performance?
 - ✓ model the **relationship between transactions** in OLTP systems
 - ✓ for designing or modifying the OLTP performance test benchmark
 - ✓ Model the **relationship between workflow and transactions** in OLTP systems

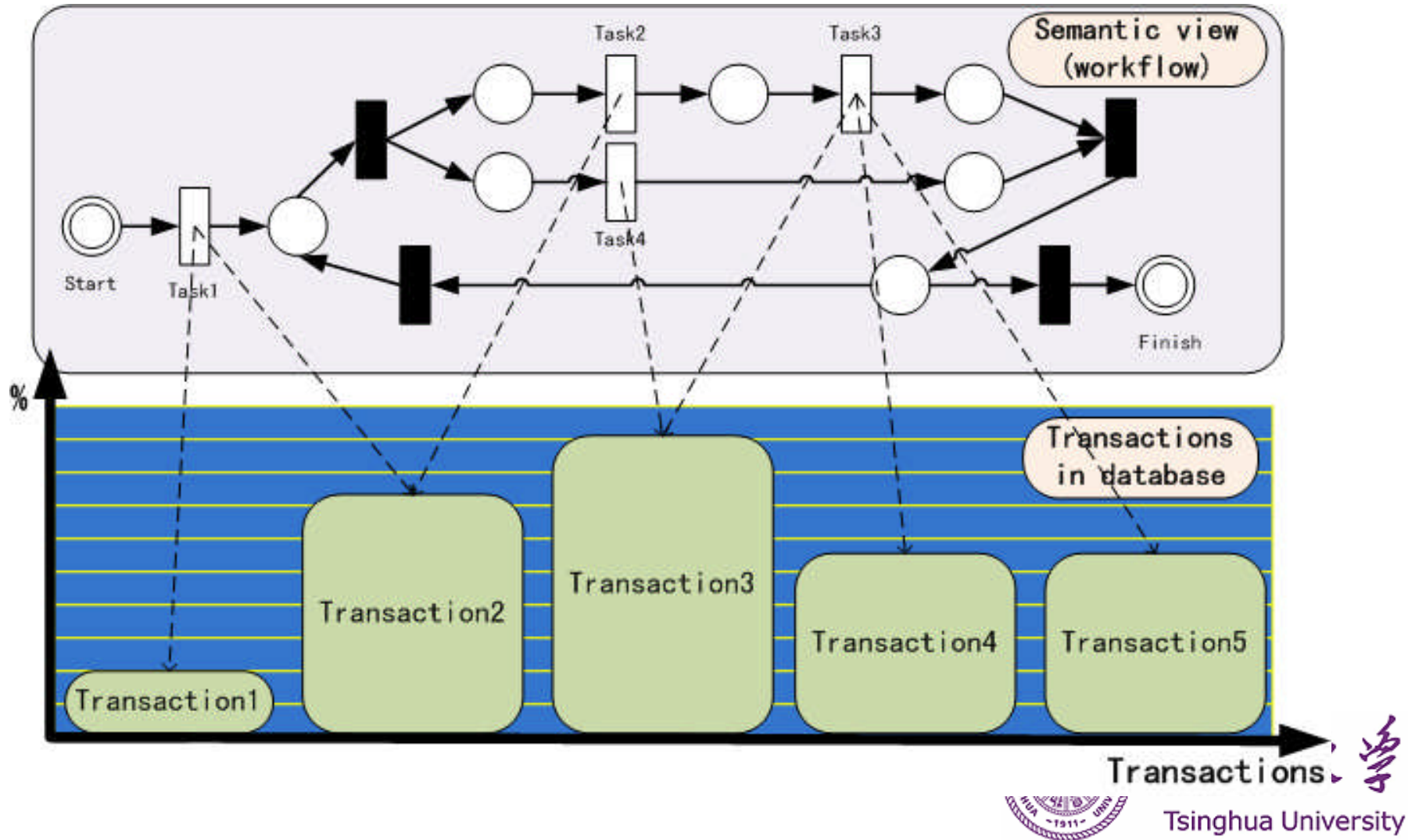
Dbtest 2009: Towards Workflow-Driven Database System Workload Modeling



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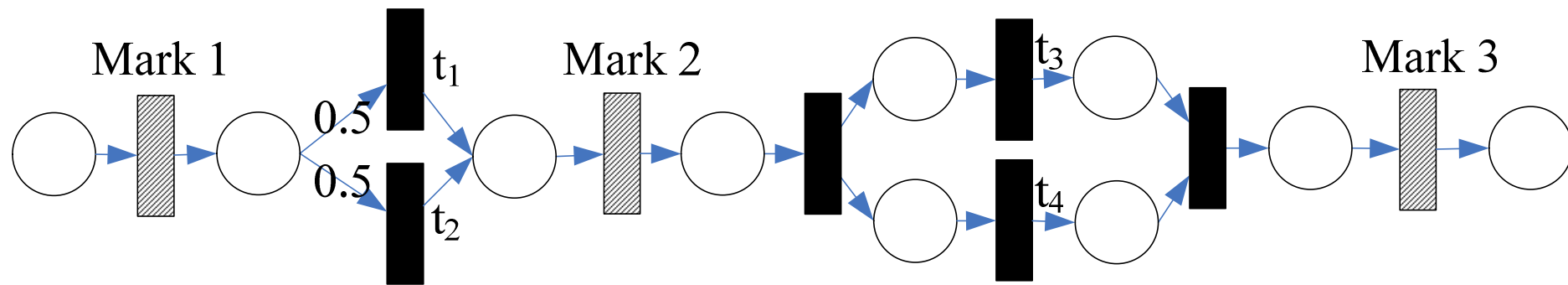
Workload Modeling

- Mapping between business and database workload



Workload Modeling

- Workflow/Transaction Workload Modeling with Granularity Measures



- benefit for designing or modifying the OLTP performance test benchmark.

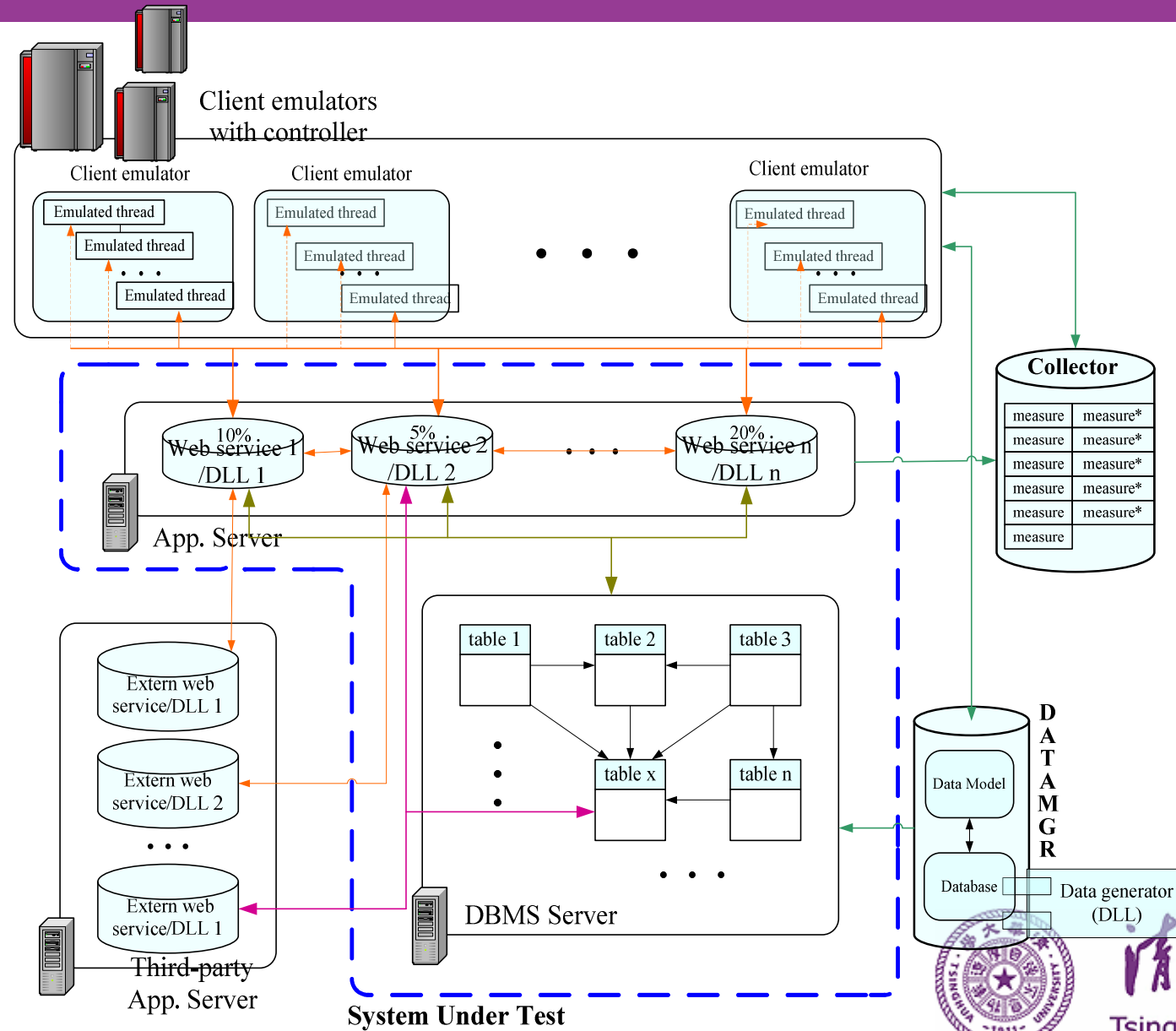


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Experiment Study



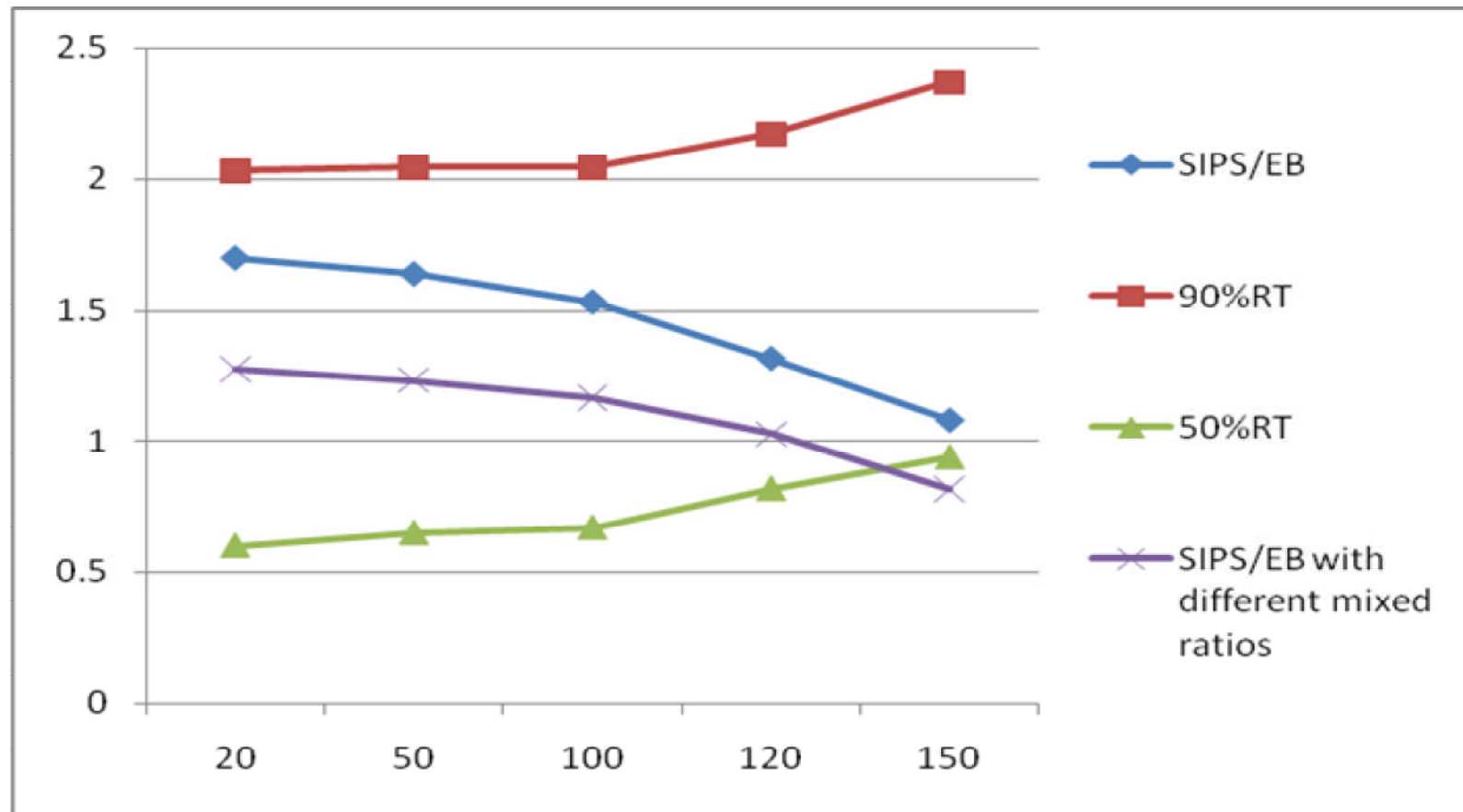
Experiment Study

Environments		Configurations
Test system (TS)	Controller Machine (Controller and Web Server 1)	Intel® Core™2 Quad CPU Q6600 2.40GHz
		8G memory , 1T hard disk
		Microsoft Windows Server 2003 R2
	Web Server 1 (for Statistics)	Internet Information Server (IIS) 6.0
System Under Test (SUT)	Web Server 2 Machine	Intel® Core™2 Quad CPU Q6600 2.40GHz
		8G memory , 1T hard disk
		Microsoft Windows Server 2003 R2
	Web Server 2 (for Transactions)	Internet Information Server (IIS) 6.0
	Database Server Machine	Intel® Xeon® CPU E5420 2.50GHz
		8G memory , 1T hard disk
		Microsoft Windows Server 2003 R2
Database Server	Oracle Database 10g home1 v10.2.0	
Platform	Development Platform	Microsoft Visual Studio 2005 , C#
		Microsoft .NET Framework SDK v2.0



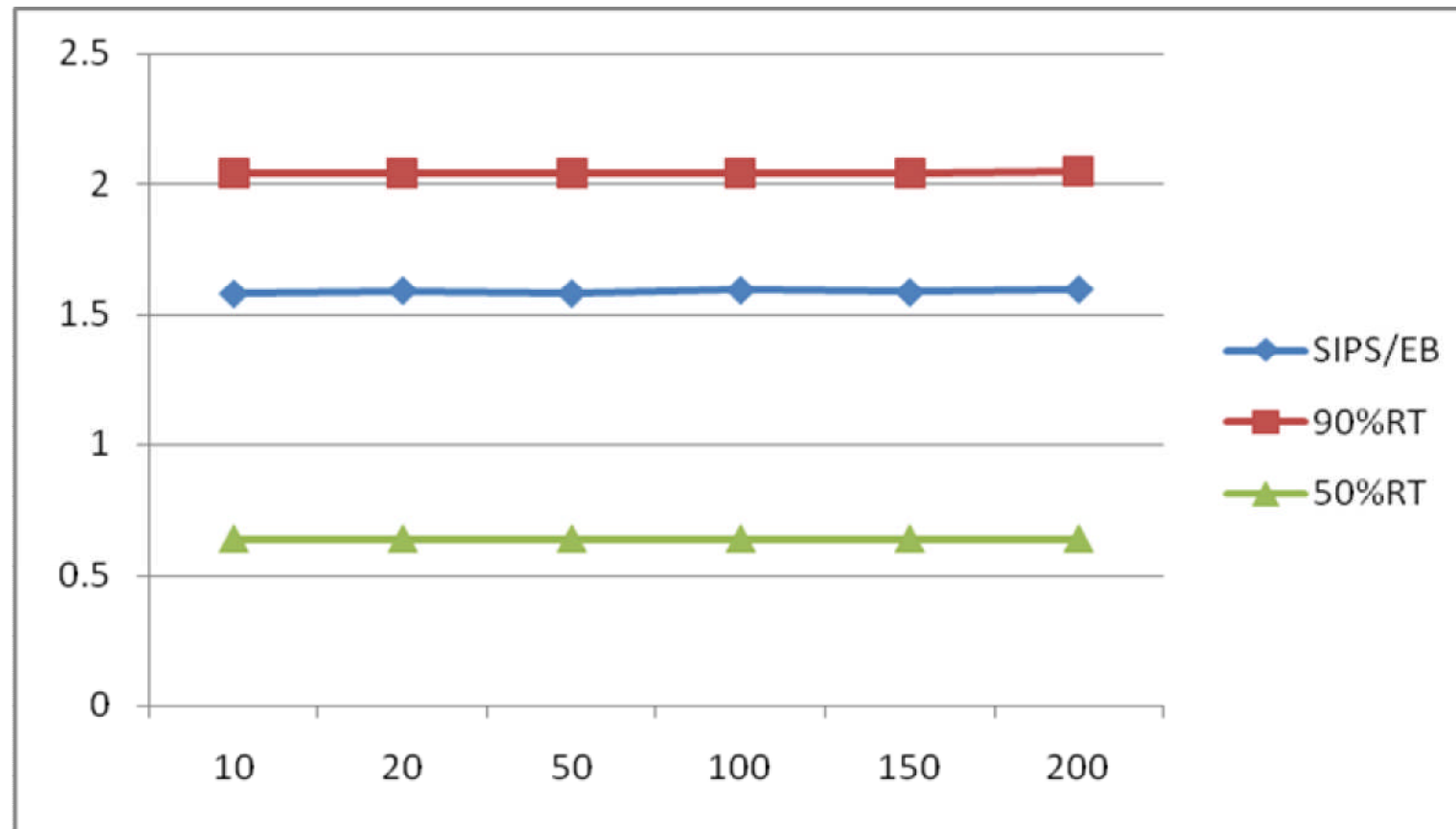
Experiment Study

- BTMF Usability Test Analysis



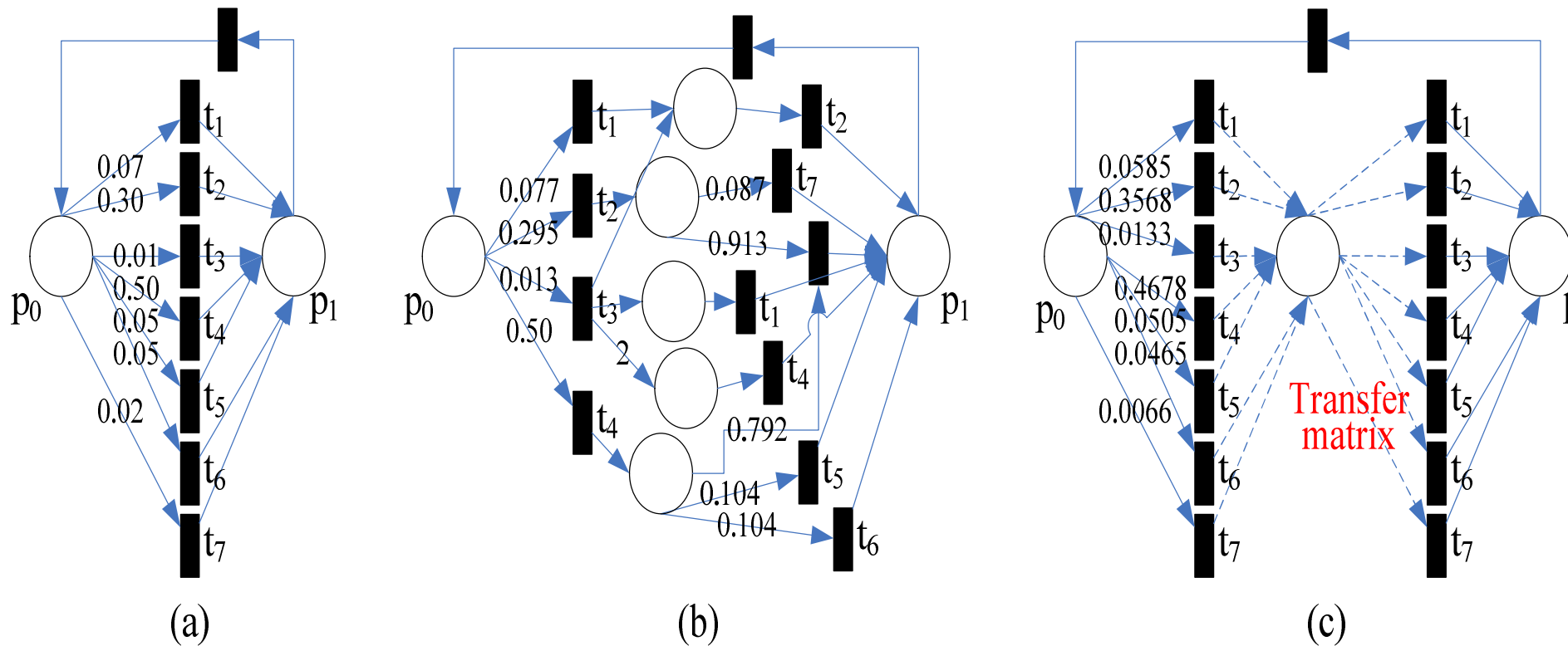
Experiment Study

- BTMF Usability Test Analysis



Experiment Study

- Workload Characterization Test Analysis



Experiment Study

- Results with different transaction workflows

Workload models	Scenarios in TPC-App benchmark	Scenarios described by Petri net	Scenarios with transfer matrix
Configured EBs	10	10	10
Active EBs	100	100	100
SIPS	157.97	159.19	161.11
SIPS/EB	1.5797	1.5919	1.6111
90%RT(s)	2.04	2.05	2.05
50%RT(s)	0.64	0.64	0.65



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Conclusions

- Proposed a model-driven benchmark test management framework
 - applicable for standard benchmarks and authentic applications performance evaluation
 - Petri net and transfer matrix used to describe workload characteristics
- models for performability and analytical methods for performance prediction will be invested in the future





Q & A

QUESTIONS
ANSWERS



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