北京航空航天大学 计算机学院

School of Computer Science and Engineering,Beihang University

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The Future of TTCN-3 in China

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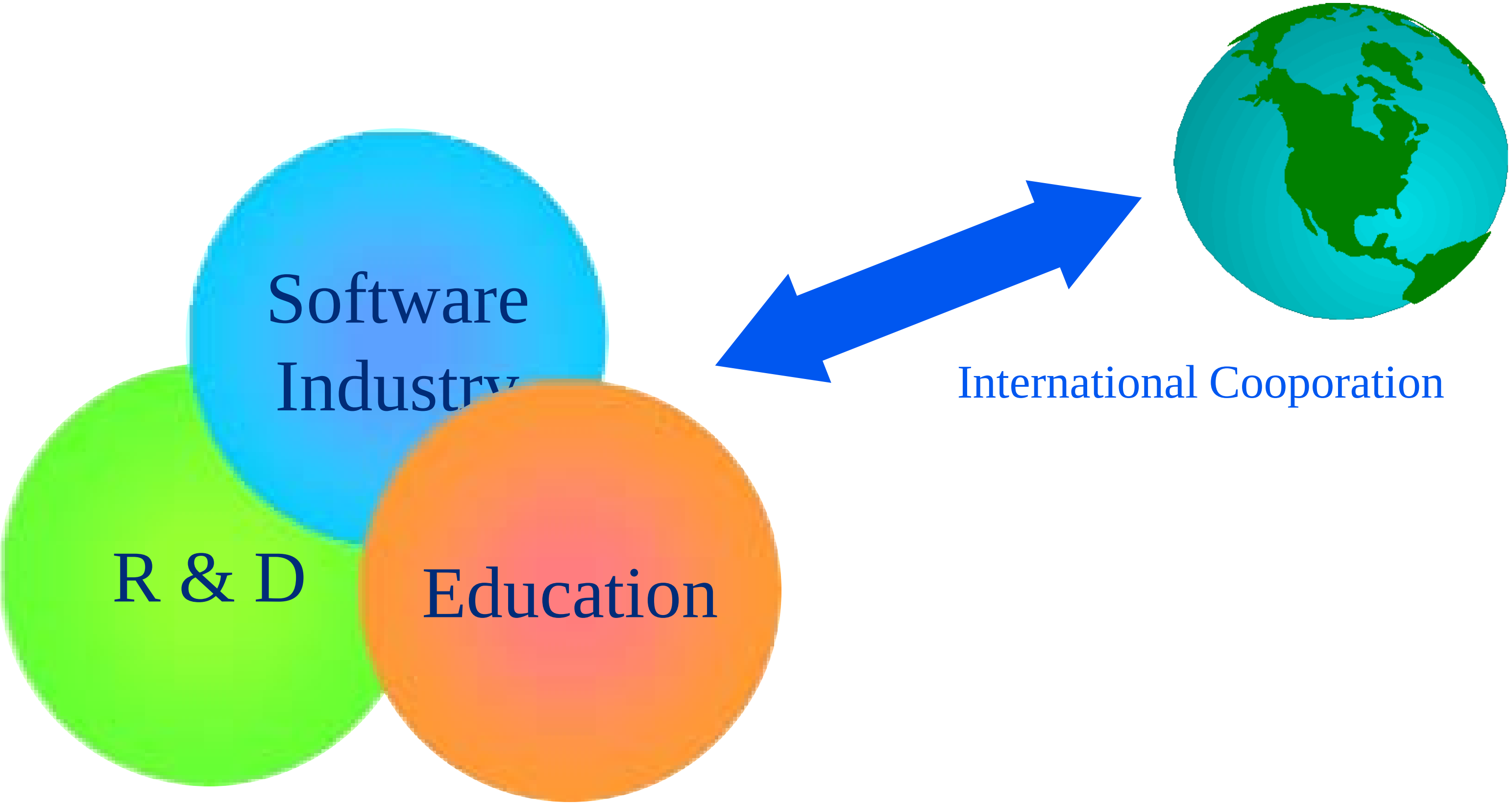
Agenda

- Why is the future a problem?
- Testing in China: State-of-art
- Test automation in China: State-of-art
- Overview of TTCN-3
- SEI/BUAA: Research and Practices on TTCN-3
- Opportunities of TTCN-3 in non-telecommunication domains
- Challenges of TTCN-3 in non-telecommunication domains
- Conclusions

Software Engineering Institute(SEI/BUAA)

- 1988-Now



Software Testing in SEI/BUAA: Look Back

- 1984-1989：
  - Software Engineering Environment
    - Software Testing Tools for C: BUAA
  - China-USA Cooperation Project, Sponsored By MOST
- 1995-2002:
  - BUAA-Lotus Software Quality Engineering Center
    - About 100 Software Testing Engineers
    - 24-hour collaboration around the world(Beijing-Boston-…)
- 2001
  - Zhong Guan Cun Software Park
    - Beijing Software Testing and Evaluation Center

- 2002-Now:
  - Code based Inspection and Testing
  - Software Test Process Management
  - Model-Driven Test(MDT)
    - TTCN-3
  - BUAA Software Testing and Evaluation Laboratory
    - Software Testing Service
      - Beijing Olympic Game-2008
      - Tests: Kinds of software & information system

TTCN-3 Contributors within China

Bii Beijing internet institute 天地互连

HUAWEI

中国移动通信 CHINA MOBILE

移动信息专家

DTT

北京邮电大学

BEIJING UNIVERSITY OF POSTS AND TELECOMMUNICATIONS

中国科学技术大学

University of Science and Technology of China

北京航空航天大學

BEIHANG UNIVERSITY

清華大學

TSINGHUA UNIVERSITY

-1911-

INNER MONGOLIA UNIVERSITY

More …

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Why is the future a problem?

- We google from the tooling view:
  - TTCN-3 测试(ce shi, testing): 4,860 items

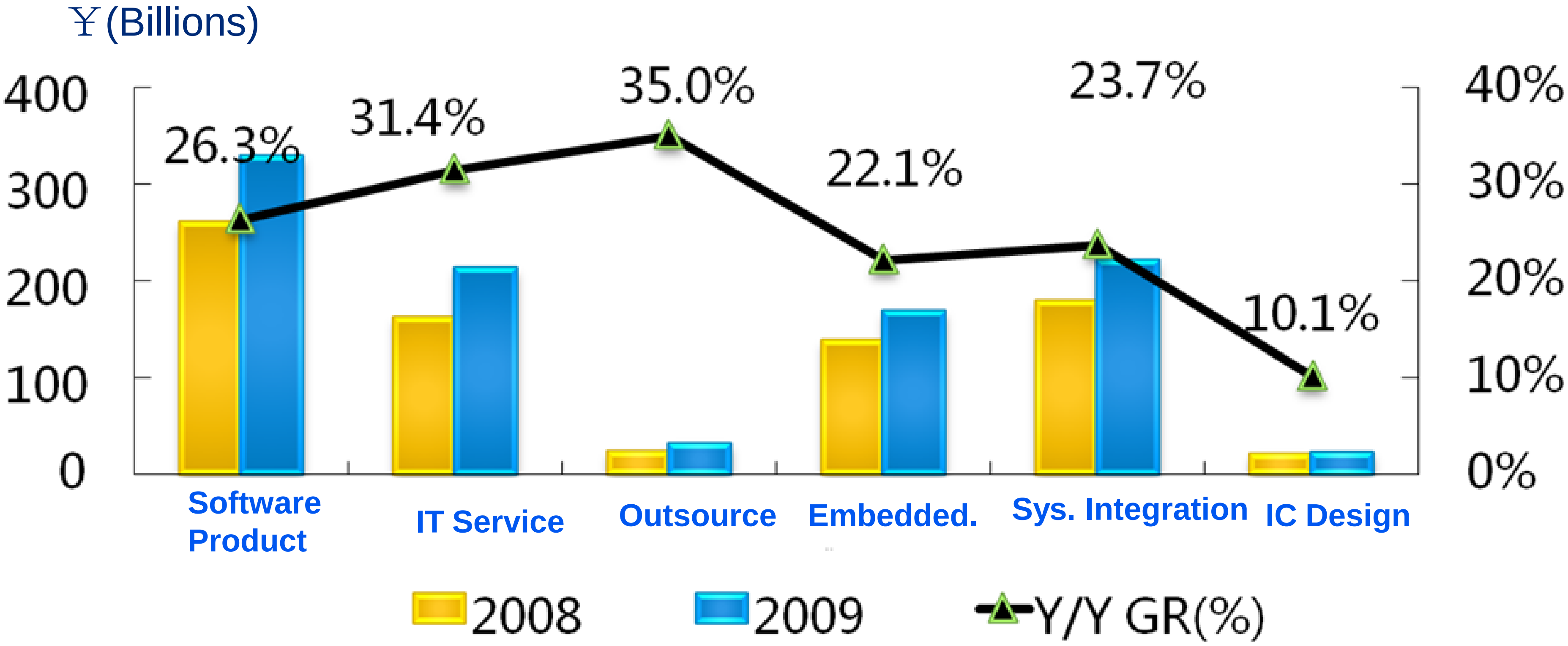
– QTP 测试:	2,050,000 items
– Loadrunner 测试:	1,850,000 items
– Rational Robot 测试:	54,500 items
– Winrunner 测试:	451,000 items
– Function Tester 测试:	624,000 items
– SilkTest 测试:	56,100 items
– TestComplete 测试:	64,000 items

Date when searching by Google：June 8, 2010

Why is the future a problem?

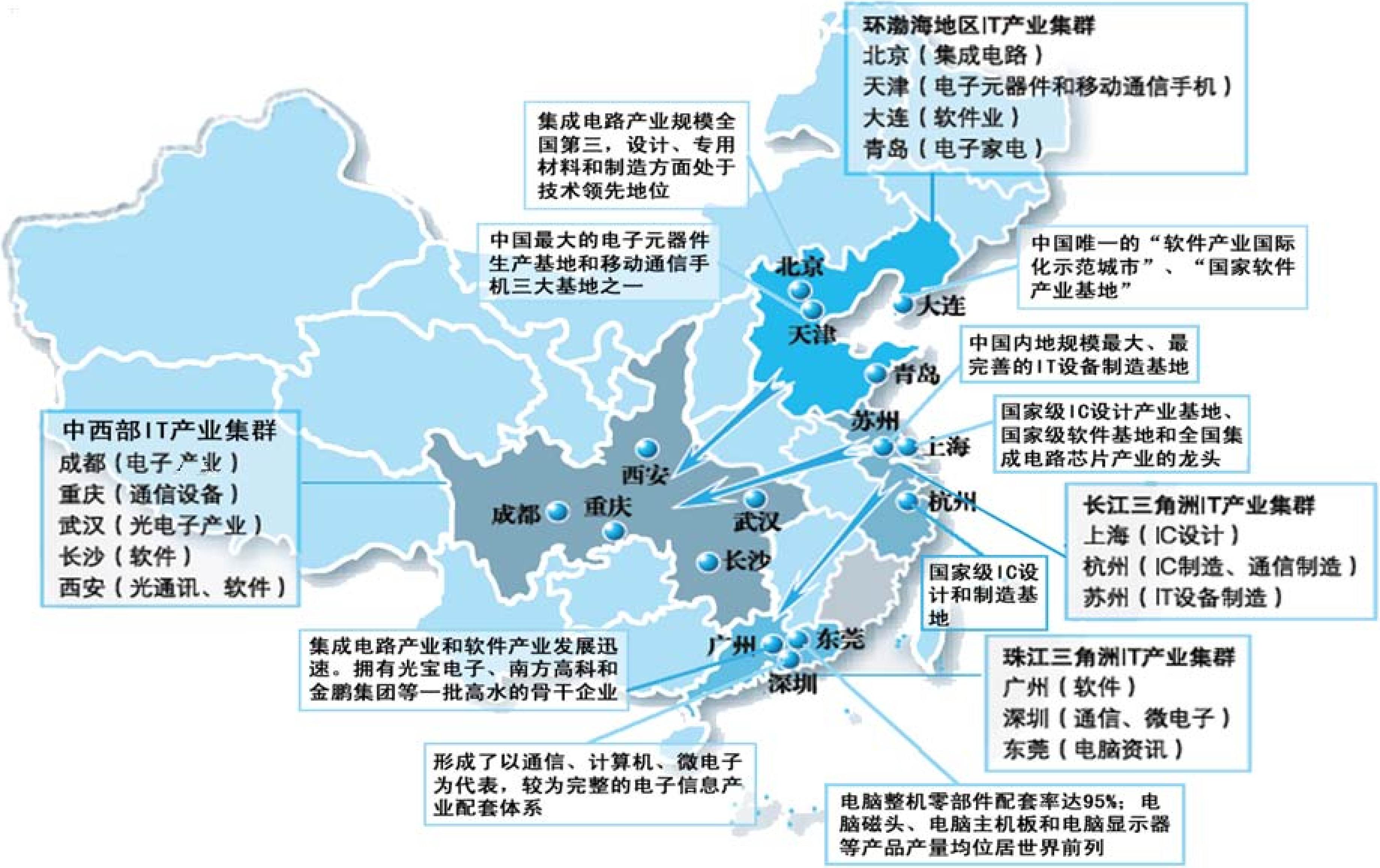
- We google from the language view:
  - TTCN-3 测试语言(ce shi yu yan, testing language)
    - 13,900 items
  - VBScript 测试语言： 1,520,000 items
  - JSP 测试语言： 1,010,000 items
  - Shell 测试语言： 3,670,000 items
  - Ruby 测试语言： 2,530,000 items
  - Python 测试语言： 4,480,000 items
  - Perl 测试语言： 4,640,000 items
  - TCL 测试语言： 1,900,000 items

Software GDP Distribution



Data source：MIIT，2010，01

China Software Parks



环渤海地区IT产业集群
北京（集成电路）
天津（电子元器件和移动通信手机）
大连（软件业）
青岛（电子家电）

集成电路产业规模全国第三，设计、专用材料和制造方面处于技术领先地位

中国最大的电子元器件生产基地和移动通信手机三大基地之一

中国唯一的“软件产业国际化示范城市”、“国家软件产业基地”

中国内地规模最大、最完善的IT设备制造基地

国家级IC设计产业基地、国家级软件基地和全国集成电路芯片产业的龙头

中西部IT产业集群
成都（电子产业）
重庆（通信设备）
武汉（光电子产业）
长沙（软件）
西安（光通讯、软件）

长江三角洲IT产业集群
上海（IC设计）
杭州（IC制造、通信制造）
苏州（IT设备制造）

国家级IC设计和制造基地

集成电路产业和软件产业发展迅速。拥有光宝电子、南方高科和金鹏集团等一批高水的骨干企业

珠江三角洲IT产业集群
广州（软件）
深圳（通信、微电子）
东莞（电脑资讯）

形成了以通信、计算机、微电子为代表，较为完整的电子信息产业配套体系

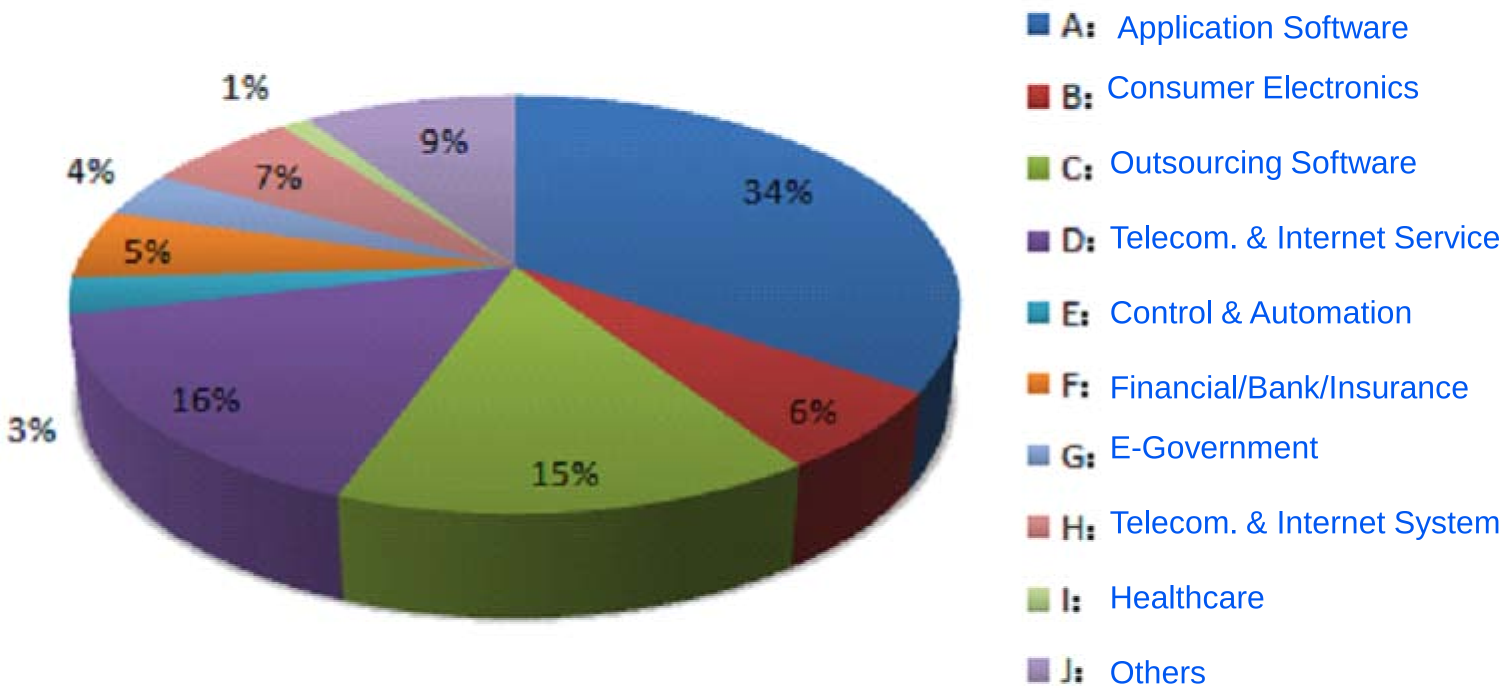
电脑整机零部件配套率达95%；电脑磁头、电脑主机板和电脑显示器等产品产量均位居世界前列

Testing in China: State-of-art

- Strong support from Government
  - Since 2001, government asked all software products MUST be registered with the evidence of testing before ship into the market
  - Since 2003, government pushes the profession certificate expanding to software testing engineer, “Software Testing Profession”
- Continuous growing of ‘IV&V Service Providers’
  - Almost every software industry park has at least one such provider
  - CCID
- The software testing master degree is popularly set in software schools at 35 universities in China since 2004

Testing in China: State-of-art

- 51testing.com made a survey in 2008

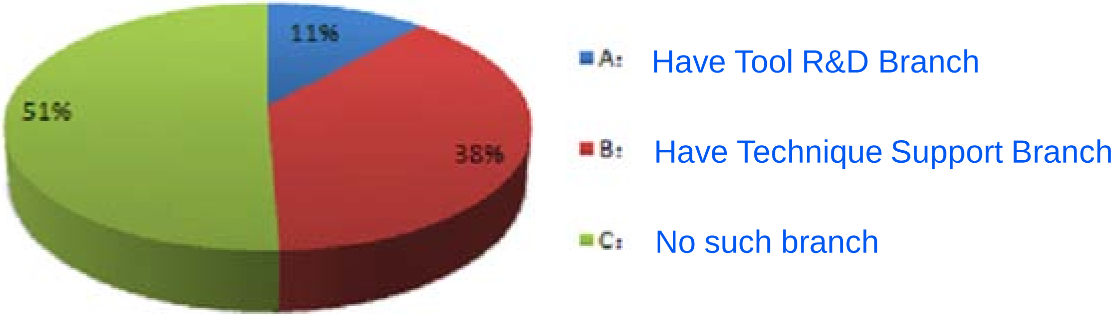


Test-Domain distribution

Sources: www.51testing.com

Testing in China: State-of-art

The ratio of having Testing Branch

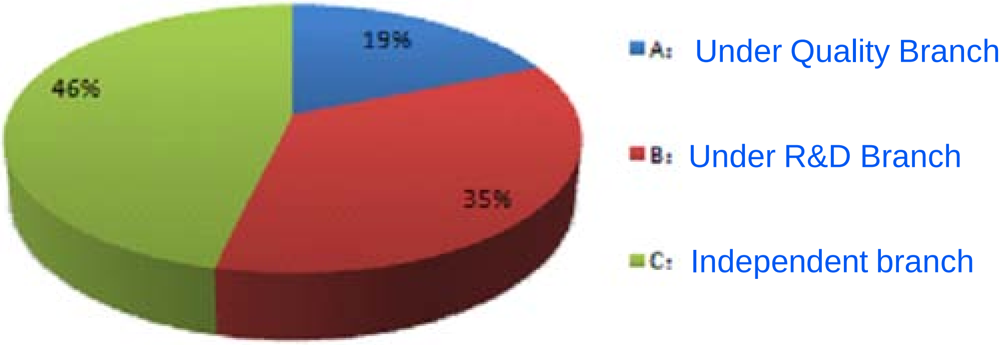


🟦A: Have Tool R&D Branch

🟥B: Have Technique Support Branch

🟩C: No such branch

The Independence of the Testing Branch



🟦A: Under Quality Branch

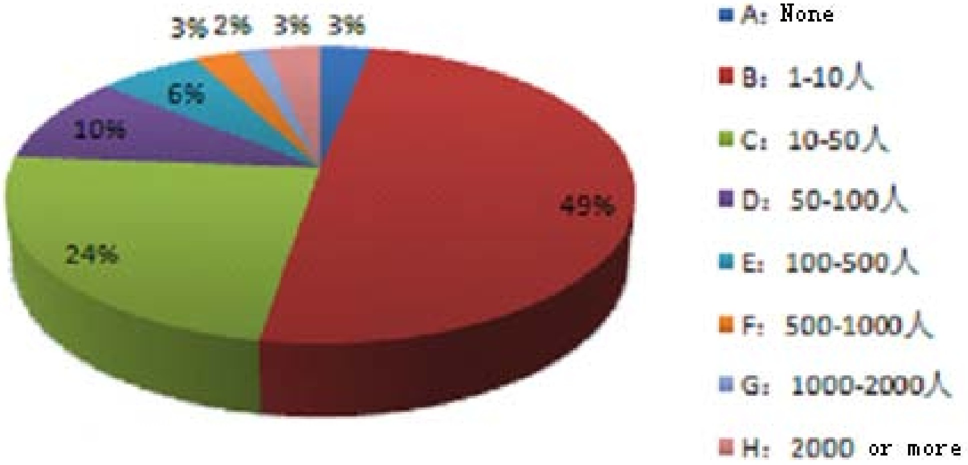
🟥B: Under R&D Branch

🟩C: Independent branch

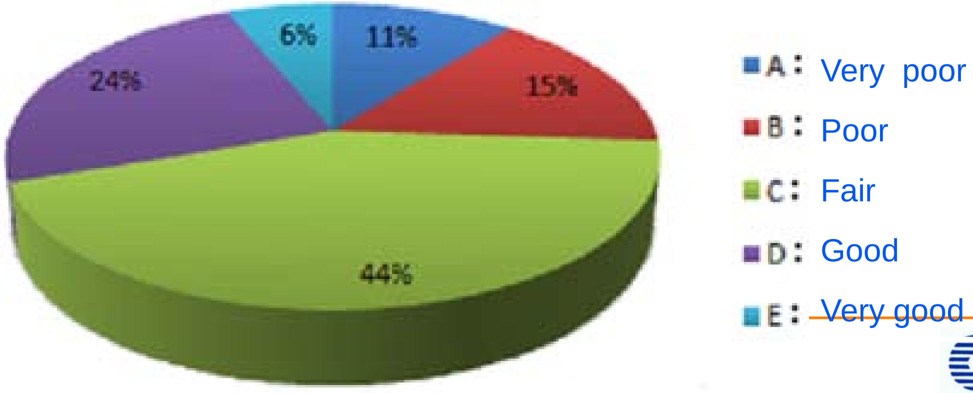
Sources: www.51testing.com

Testing in China: State-of-art

Number of Full-time Test Engineers

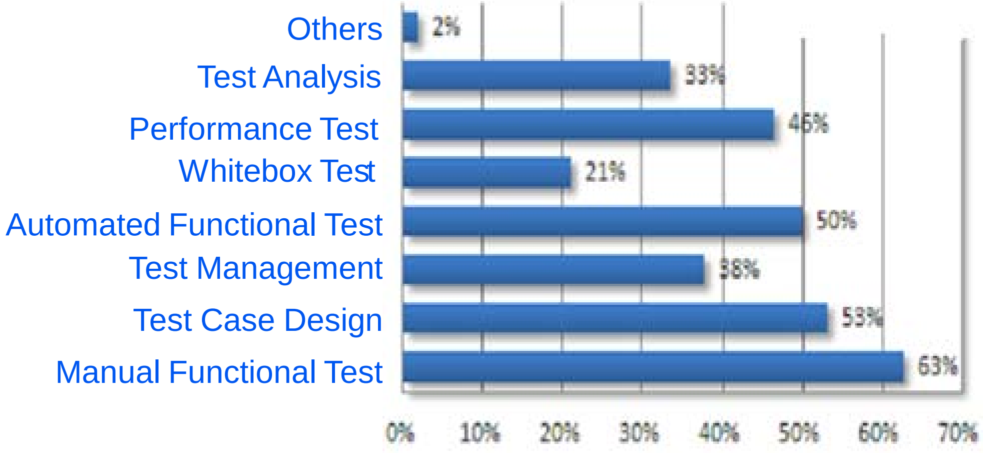


Levels of Test Process Strictness

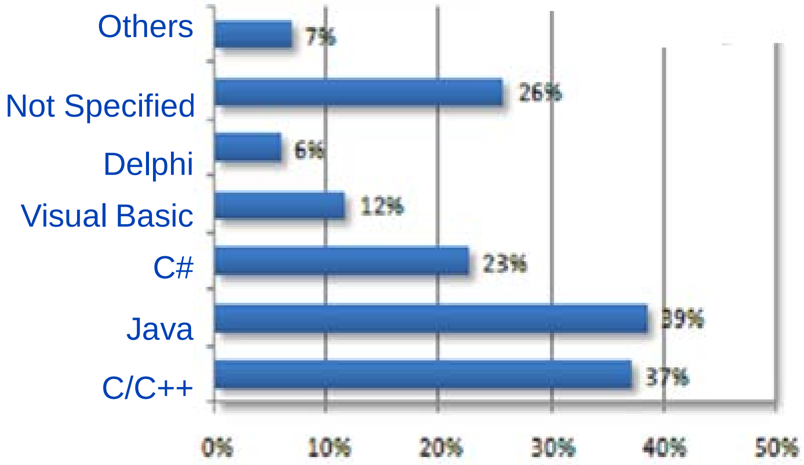


Testing in China: State-of-art

Testing Skills Expected When Hiring

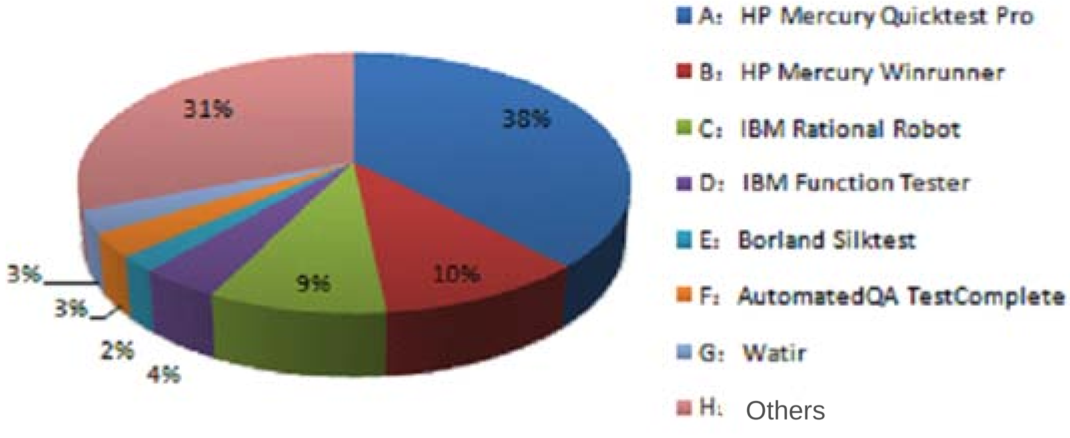


Language Skills Required When Hiring

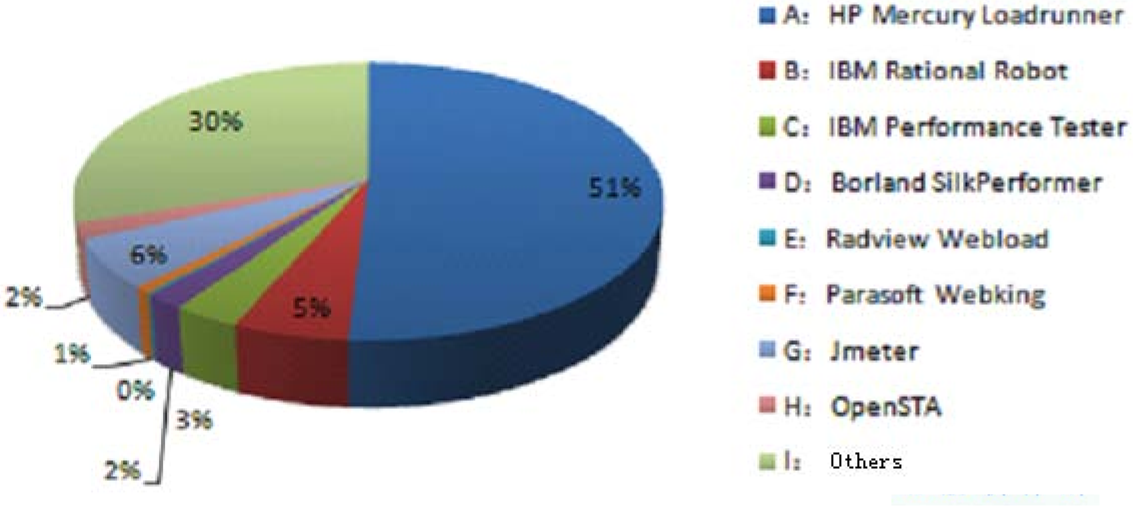


Testing automation in China

Currently used Automation Tools

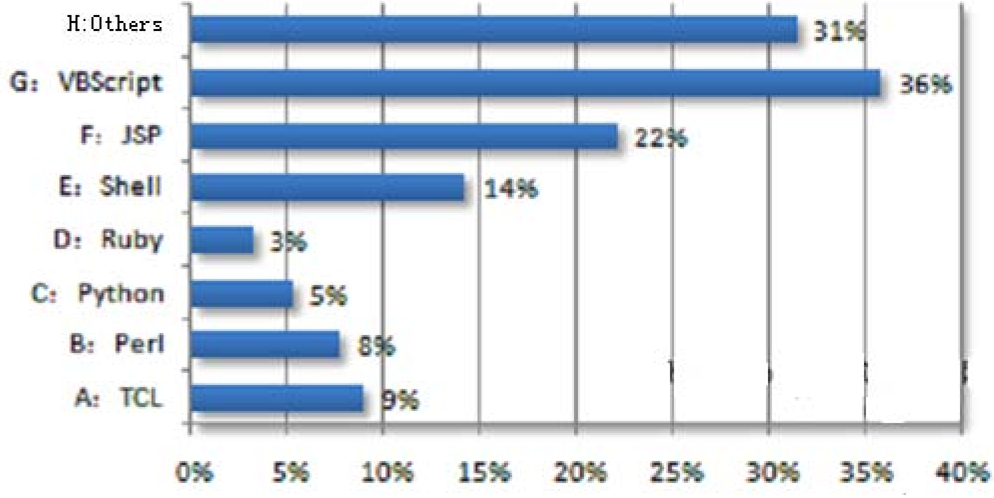


Currently used Performance Testing Tools

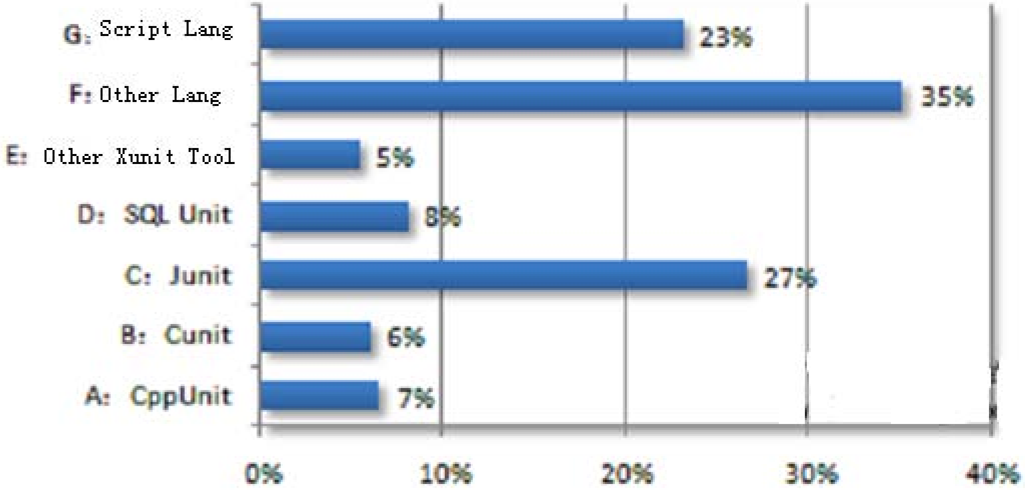


Testing automation in China

Script Language used



Framework used in Unit Testing



Evolving Techniques over 10 Years

- Model-based design
- MDA
- Web application (web service)
- Rich Web (web 2.0)
- Telecommunication
- Virtualization
- Cloud computing

Overview of TTCN-3

- The standardised (black-box) test specification and test implementation language.
- Developed
  - by the European Telecommunications Standards Institute (ETSI) from 1999 to 2001.
  - based on the experiences from previous TTCN versions.
- Standards
  - ES 201 873-1 (Z.140): TTCN-3 Core Language
  - ES 201 873-2 (Z.141): TTCN-3 Tabular Presentation Format (TFT)
  - ES 201 873-3 (Z.142): TTCN-3 Graphical Presentation Format (GFT)
  - ES 201 873-4 (Z.143): TTCN-3 Operational Semantics
  - ES 201 873-5: TTCN-3 Runtime Interface (TRI)
  - ES 201 873-6: TTCN-3 Control Interfaces (TCI)
  - ES 201 873-7: import ASN.1, XML, IDL, C/C++ to TTCN-3
  - …

TTCN-3 Language

ASN.1 Types & Values

IDL

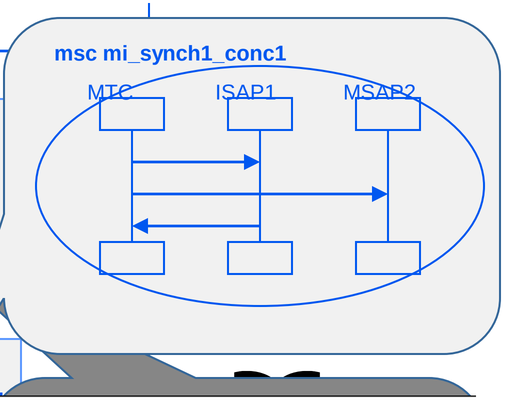
TTCN-3 Core Language

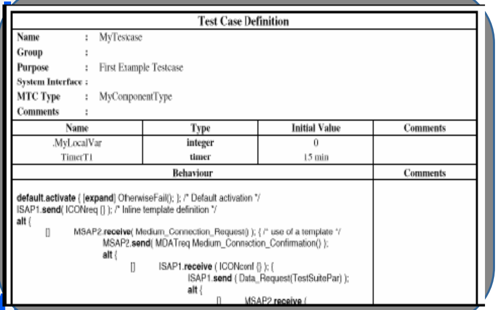
Tabular Format

Graphical Format

Presentation Format

```
:
testcase myTestcase () runs on MTCType system TSIType
{               mydefault := activate (OtherwiseFail);
                verdict.set(pass);
                :
                connect(PTC_ISAP1:CP_ISAP1,mtc:CP_ISAP1);
                :
                map(PTC_ISAP1:ISAP1, system:TSI_ISAP1);
                :
                PTC_ISAP1.start(func_PTC_ISAP1());
                PTC_MSAP2.start(func_PTC_MSAP2());
                Synchronization();
                all component.done;
                log(.Correct Termination.);
}
:
```





Test Case Definition

Name : MyTestcase
Group :
Purpose : First Example Testcase
System Interface :
MTC Type : MyComponentType
Comments :

Name	Type	Initial Value	Comments
.MyLocalVar	integer	0	
TimerT1	timer	15 min	

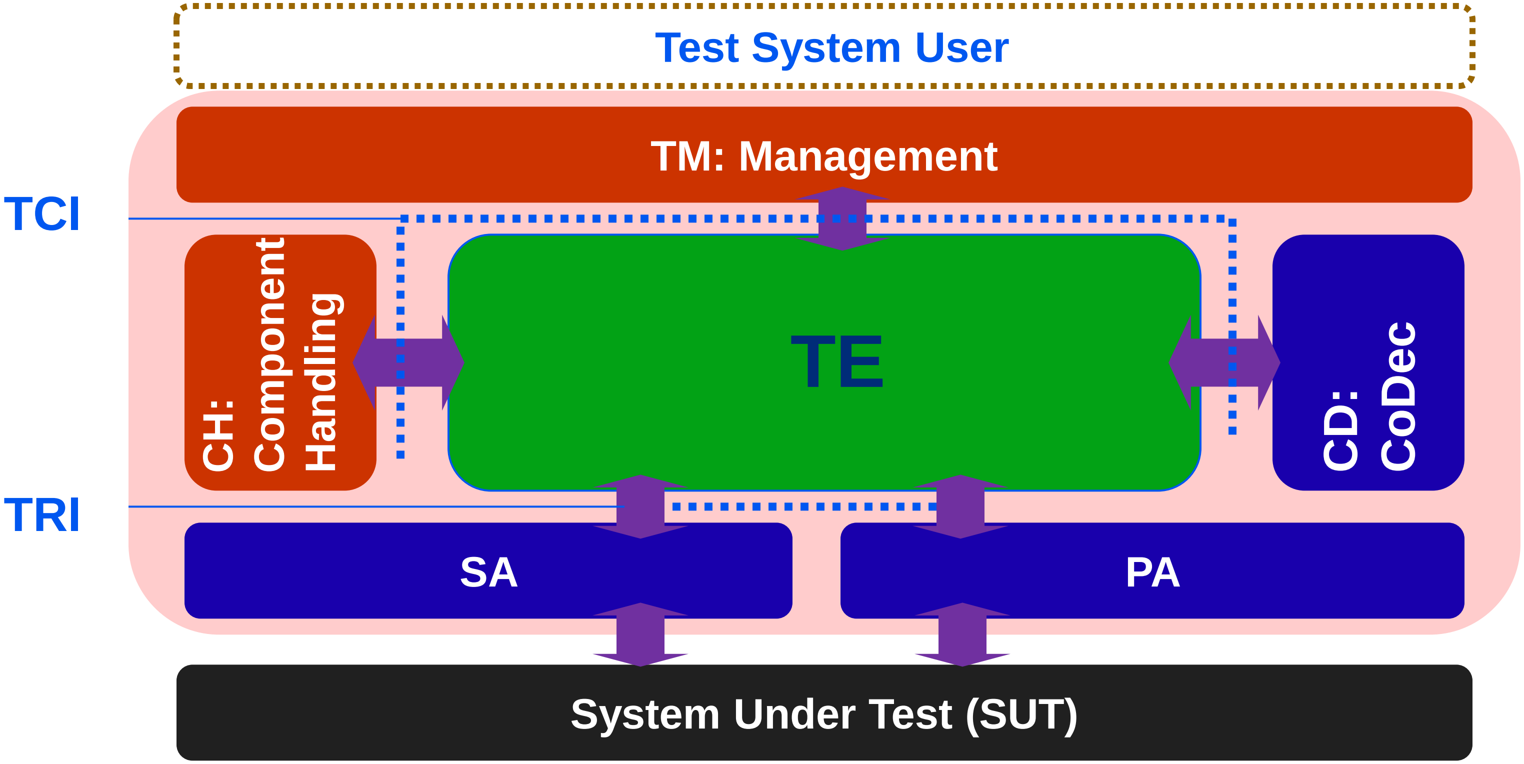
Behaviour	Comments

```
default.activate ( [expand] OtherwiseFail(); ); /* Default activation */
ISAP1.send( ICONreq [] ); /* Inline template definition */
alt {
    []      MSAP2.receive( Medium_Connection_Request() ); { /* use of a template */
                MSAP2.send( MDATreq Medium_Connection_Confirmation() );
                alt {
                    []      ISAP1.receive ( ICONconf {} ); {
                                ISAP1.send ( Data_Request(TestSuitePar) );
                                alt {
                                    []      MSAP2.receive (
```

TTCN-3 Language

- It is the standardized test language
  - Not tied to a particular application or its interface(s)
  - Not tied to any specific test execution environment, compiler or operation system
- Powerful language features
  - Rich type system and namespace
  - Template matching mechanism
  - Snapshot semantics on event queue
  - Concept of verdict
  - Concurrent test behaviour
  - Structured decomposition (data and behavior)
  - …

TTCN-3 Test System Framework

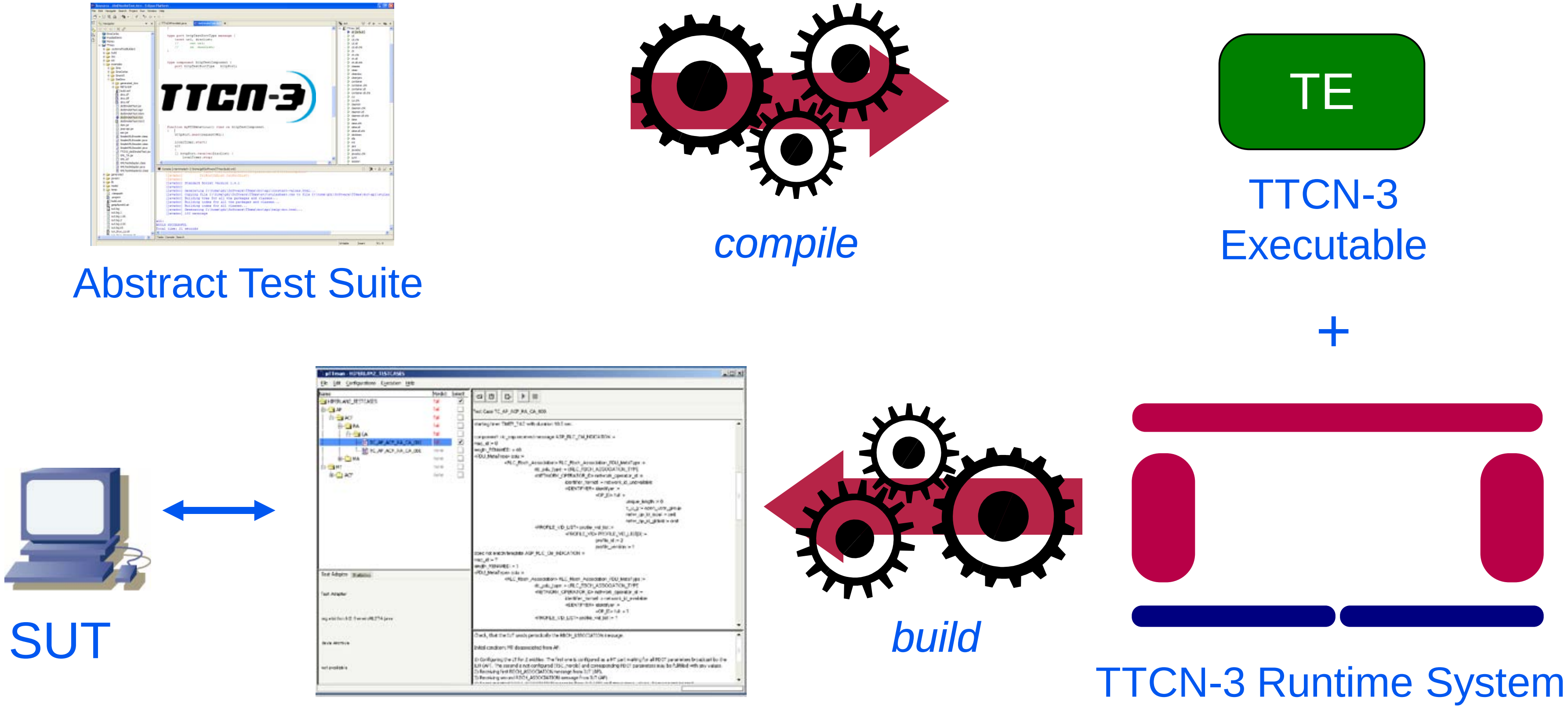


🟥 Vendor Provided

🟦 Tester Developed

🟩 Tester Developed

Implementation of TTCN-3 System



Abstract Test Suite

compile

TE

TTCN-3 Executable

+

SUT

build

TTCN-3 Runtime System

Executable Test Suite

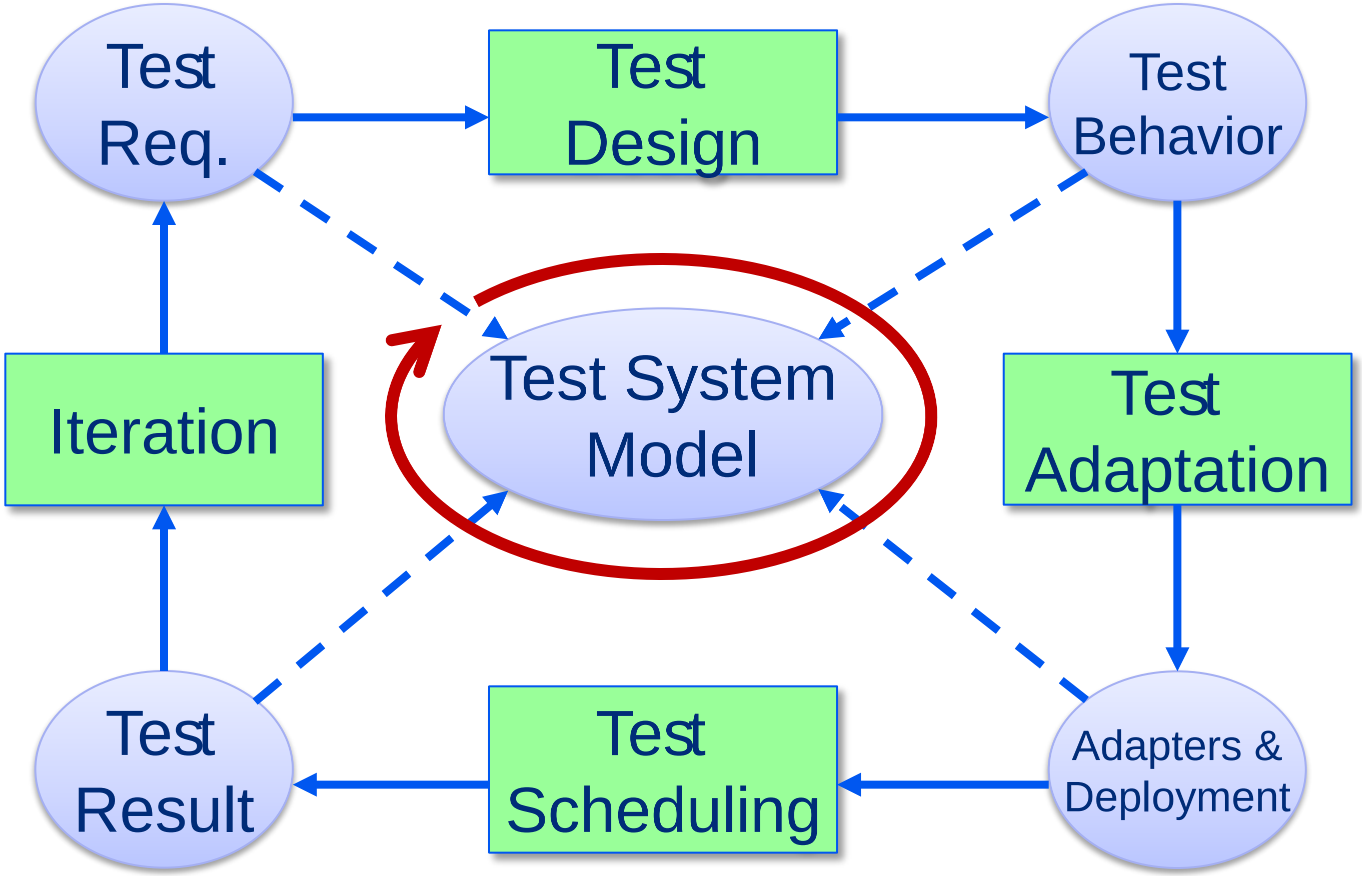
TTCN-3 Applications

- Applicable for all kinds of black-box testing for reactive and distributed systems
  - Telecom systems (ISDN, ATM);
  - Mobile (telecom) systems (GSM, UMTS, 3G, LTE);
  - Internet (has been applied to IPv6, SIP, Wimax);
  - CORBA based systems;
  - Java, XML, ...
- Wider scope of application
  - not just conformance, also for development, system, integration, interoperability, scalability... testing
  - applicable in the telecom and datacom domain
  - used both for standardized test suites…

TTCN-3 Activities in Beihang Uni.

- Researches
  - Model driven testing
  - Test distribution
  - Robustness testing
  - Supported by NSF, MOST, MIIT, etc.
- Engineering Projects
  - Banking system testing in TTCN-3
  - Operating system interoperability testing in TTCN-3
  - Large scale web app. Testing in TTCN-3
  - Web-based Office interface testing in TTCN-3

MDT Methodology Framework



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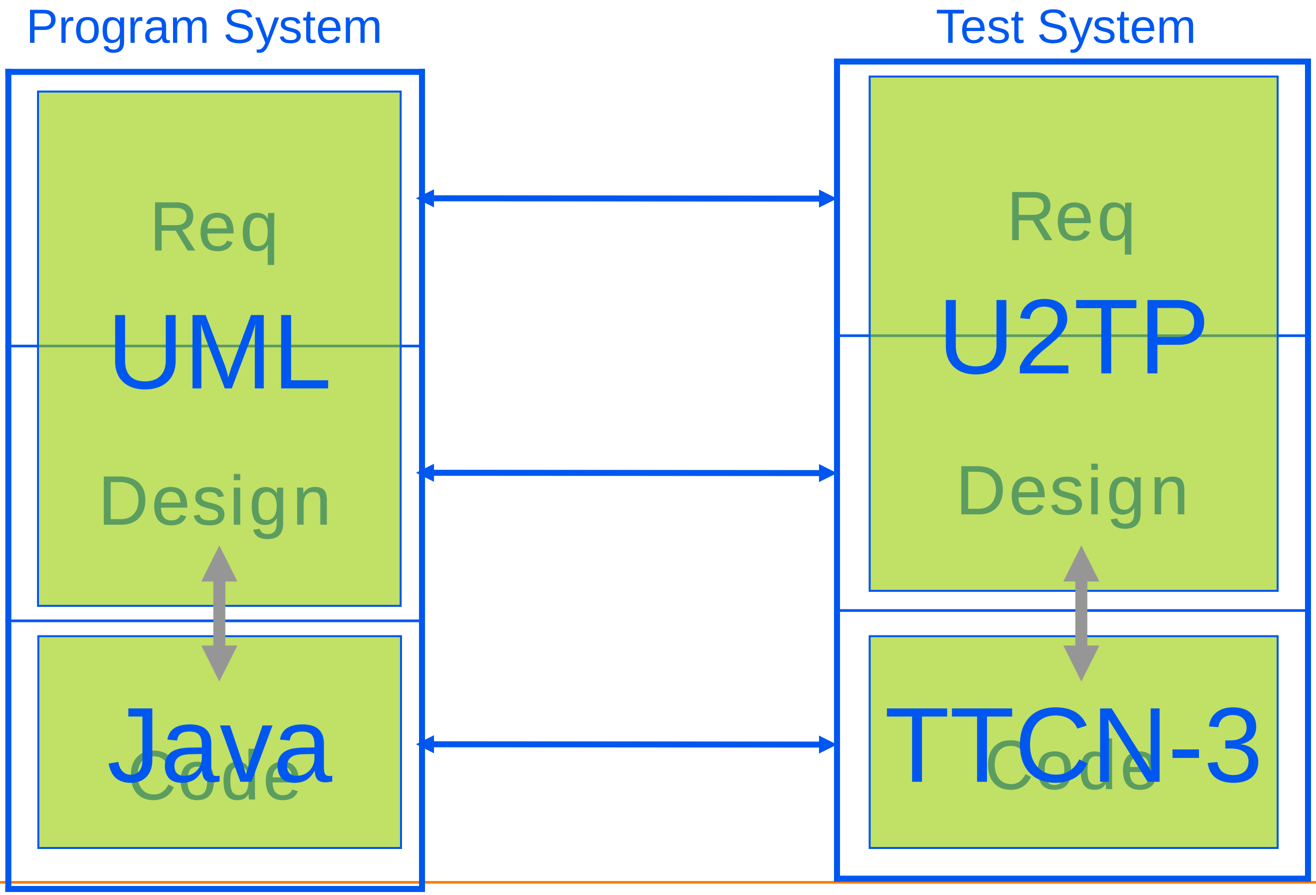
Model-driven Testing (cont.)

- Test system model language
  - Meta-model definition based on U2TP
- Transformation is the key
  - Stepwise transformation from Test Req to executable test system
- Test iteration
  - Adjust test requirement and test design strategy

MDT Methodology Framework

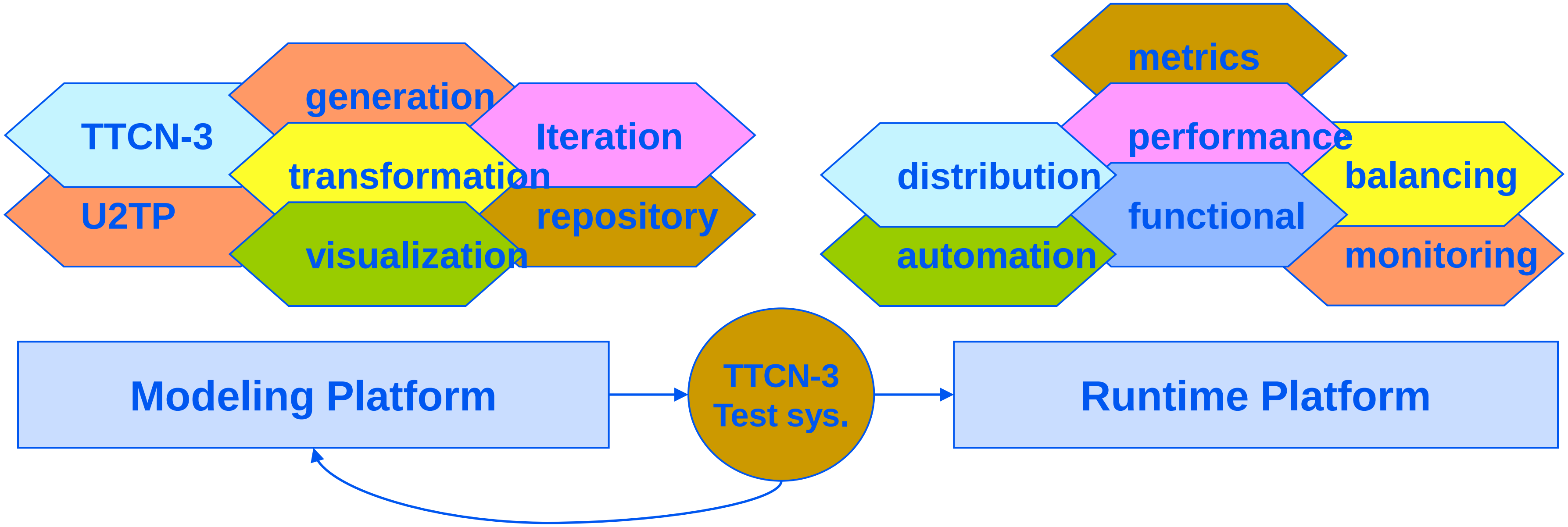
- Test Req.
  - SUT Model + Testing concerns
- Test Behavior
  - Test data, test case, test component
- Adapters & Deployment
  - Test adapters, test component deployments
- Test results
  - Test verdict, test trace

Test System Dev. Metaphor

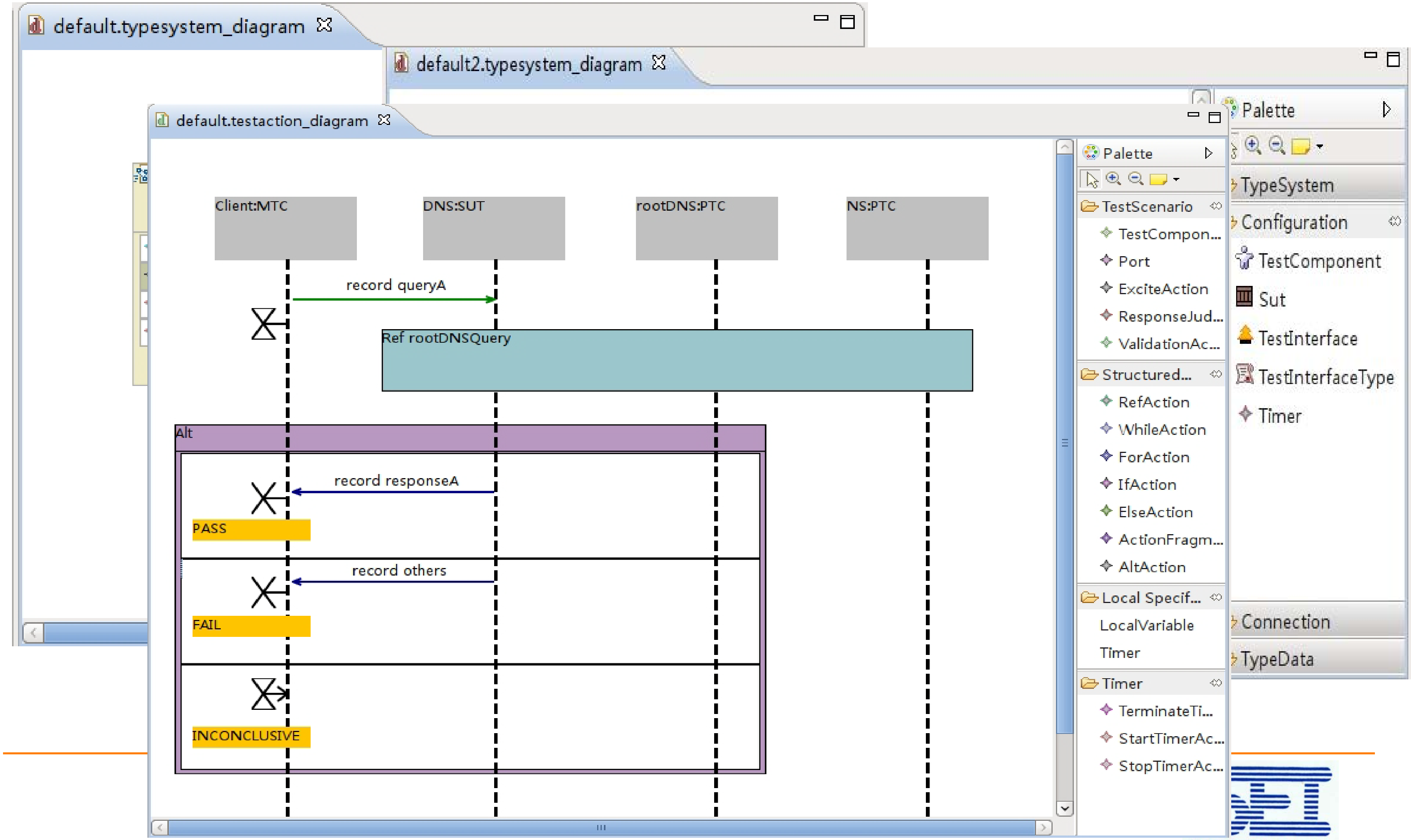


Test System Dev. Platform

- Focus on domain specific research based on the essential MDT features
  - Modeling platform
  - Runtime platform



Visualized Modeling



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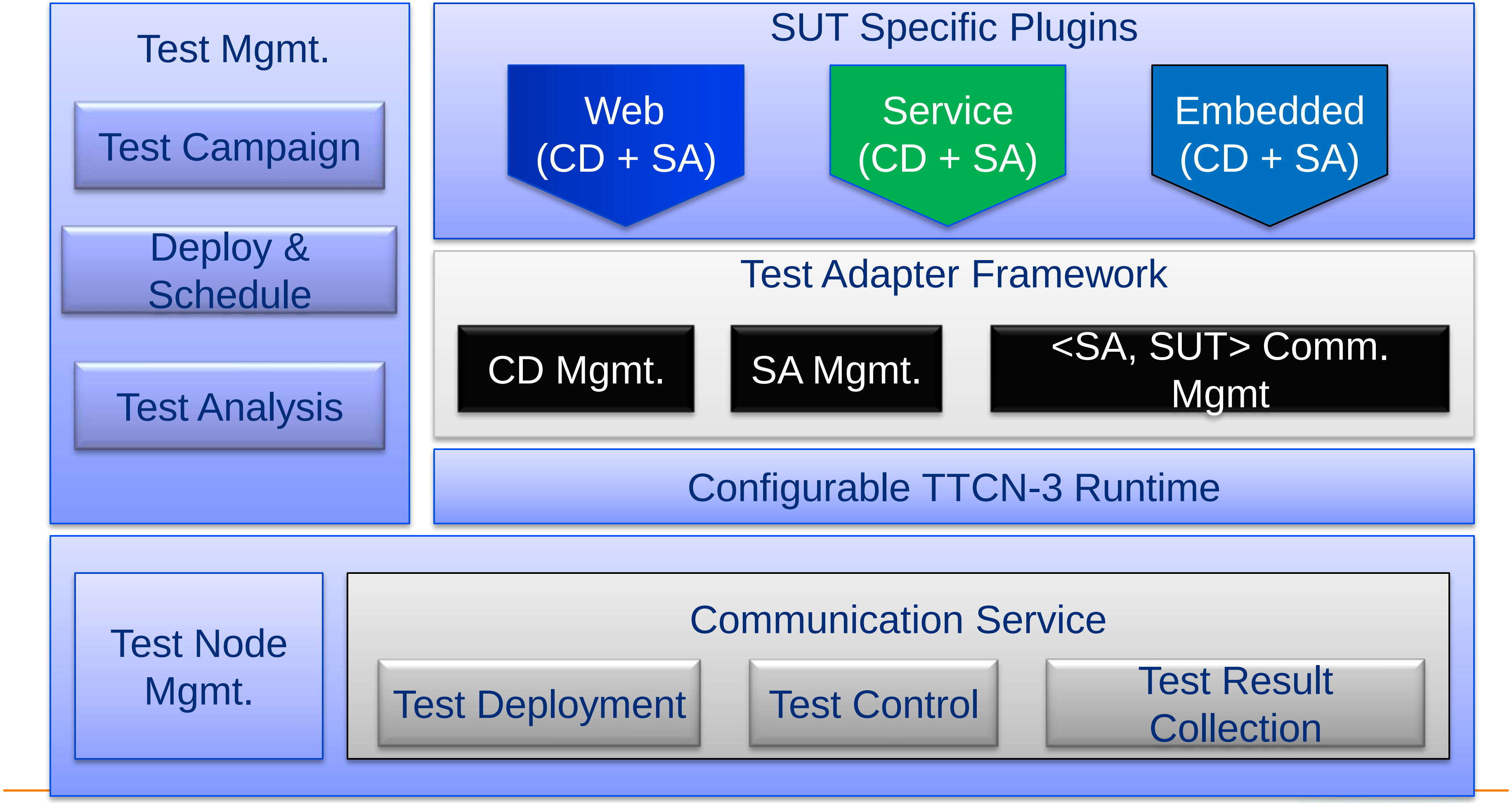
Test Distribution

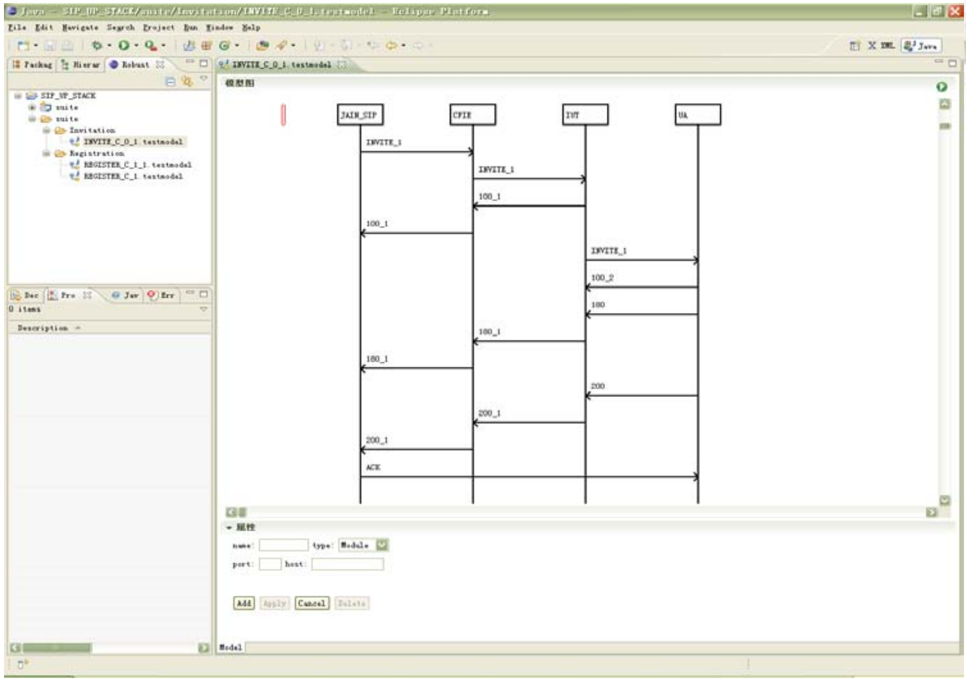


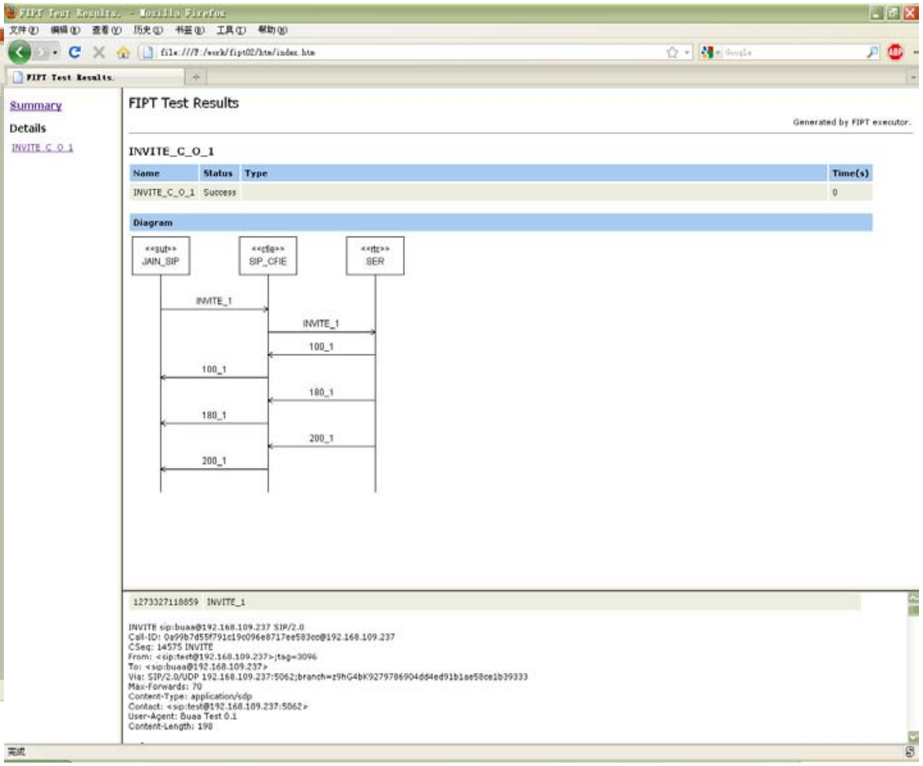
Robustness Testing

- Apply model driven methodology on robustness testing
  - Focus on abnormal messages
- Provide visualized fault model designer based on sequence model
- Tester can inject typical message faults into the communication scenario
  - Message loss
  - Message re-order
  - Message delay
  - Message content falsify

Robustness Testing

- Fault Model Designer & Visualized Result Viewer




FIPT Test Results. - Mozilla Firefox
文件(F) 编辑(E) 查看(V) 历史(S) 书签(B) 工具(T) 帮助(H)
file:///F:/work/fipt02/htm/index.htm
FIPT Test Results.
Summary
Details
INVITE_C_0_1
完成

FIPT Test Results

Generated by FIPT executor.

INVITE_C_0_1

Name	Status	Type	Time(s)
INVITE_C_0_1	Success		0

Diagram

```
1273327118859  INVITE_1

INVITE sip:buaa@192.168.109.237 SIP/2.0
Call-ID: 0a99b7d55f791c19c096e8717ee583cc@192.168.109.237
CSeq: 14575 INVITE
From: <sip:test@192.168.109.237>;tag=3096
To: <sip:buaa@192.168.109.237>
Via: SIP/2.0/UDP 192.168.109.237:5062;branch=z9hG4bK9279786904dd4ed91b1ae58ce1b39333
Max-Forwards: 70
Content-Type: application/sdp
Contact: <sip:test@192.168.109.237:5062>
User-Agent: Buaa Test 0.1
Content-Length: 198
```

Engineering in TTCN-3

- Banking system testing in TTCN-3
  - Supported by MOST 863 Projects
  - Co-worked with Shandong Computer Science Center
- OS interoperability testing in TTCN-3
  - Supported by MIIT Key Project
  - Co-worked with the Software Test Center at China Electronics Standardization Institute
- Large scale web app. Testing in TTCN-3
- Web-based Office testing in TTCN-3
  - Supported by MOST 863 Projects

Opportunities of TTCN-3 in non-telecommunication domains

- Why only non-telecom domains?
  - Simply because TTCN-3 already takes the telecom!
  - Non-telecom is opening its bigger market in China
- Typical non-telecommunication domains in China
  - Avionics Electronics : big plan pushed by government
  - Automobile Electronics: very active
  - Web applications (service): very popular

Aviation and Auto

- Embedded
- Net-centric
  - Bus: CAN or 1553B
  - Protocol: TCP/IP
- Strict real-time behavior
- High dependability requirement
- Model-based development

Opportunities

- For embedded software, TTCN-3 show be outperformed in
  - Testing the standardized interface & protocol
  - Testing the real time behavior
  - Supporting multiple platforms efficiently
  - Integrating with testing device
  - Importing data types in C/C++

Web Applications (Service)

- Rapid development
- Protocol intensive
- Performance sensitive
- Quick evolving of techniques
  - Web 2.0, HTML 5, AJAX, Javascript, cloud,…
- Rapid requirement evolving

Opportunities

- For web application, TTCN-3 should be outperformed in
  - Testing the protocols
  - Testing the workflows/collaborations among distributed modules
  - Testing SOA or cloud computing

Challenges (1)

- TE can be easily handled, while adapters (SA and CD) development are tightly coupled with the platform techniques
  - Requires wealth of platform knowledge & experience, even tricks
  - Most testers in China will have difficulties
- For example, web application testing
  - QTP enables direct data object + html tag access and evaluation
  - The CD development has to consider the data schema, the local script like java script, ajax, etc…

Challenges (2)

- Models are massively involved in developing aviation and auto applications
- If TE+SA+CD can be automatically (or partially) generated from the models, TTCN-3 will have more chances to win
- But, how to generate tests from the heterogeneous models?
  - TE generation: maybe coverage based
  - CD+SA generation: ?
  - Correlation btw TE and CD+SA: ?

Challenges (3)

- There still do not have a methodology and tools on the development of TTCN-3 test system.
  - Requirement
  - Design
  - Coding
  - Deployment
  - Optimization

Challenges (4)

- No technique meets all the testing requirements.
- TTCN-3 system needs also to collaborate with other system and techniques.
  - SUT artifacts
    - import not only data types, but the platform knowledge
  - Tools to work with
    - XMI-based integration and interoperability

Challenges (5)

- Some SUT input is implicit, like database or configuration file.
    - How to make such input explicitly?
    - How to make the implicit data input consistent with the input selected in TTCN-3 code?

Challenges (6)

- On performance testing
  - How to generate the required load easily and effectively?
  - How to collect the massive logs efficiently?

Challenges (7)

- GUI is the key interface for black-box testing.
- GUI data objects are platform dependent.
  - How to deal with it?

Challenges (8)

- TTCN-3 solution is labor-intensive compared with QTP or Robot
- How to provide smart solution by quickly developing test data and test evaluation(Verdicts)?

Challenges (9)

- How to manage the evolving of TTCN-3 languages?
  - Testers have to keep learning, …

Challenges (10)

- Should we maintain the pureness of TTCN-3 as a general language, or provide calibrated domain specific x-TTCN-3 when dealing with those challenges?

China Specific Challenges

- The cost
  - Support tools and services
  - Training
  - Solution cost compared with manual testing
- Localization
  - Need success stories in non-telecommunication domains
  - Support tools and services
  - Tools from local vendors
- Sell to the IV&V testing service providers
  - Not only business behavior, need government support
  - Professional test development education

Conclusions

- TTCN-3 is successfully adopted in telecom and datacom domains
- Testing in China is still in its developing stage
  - Strong need of test automation
  - Non-telecommunication domains open its big market
  - But, TTCN-3 is not well known
- There are opportunities
  - In Web and Embedded application domains
  - Government encourage standardized solution
- Need more collaborations among
  - Academies
  - Tool vendors
  - Users

谢谢！

Thanks!

- Any Questions?