

### Rationale

(Reasonably) known:  
High dependability and security  
for safety-critical or availability-critical systems

Avionics, railway signalling, nuclear control, etc.

Transaction processing, back-end servers, etc.

Continuous complexity growth  
Large, networked, evolving, applications running on open systems, fixed or mobile

### Scalability of Dependability

Beyond rigorous functional design, provision of  
**Resilience for Survivability,**  
wrt accidental and malicious threats

### Logic



### Partners

- |             |                    |                    |                    |
|-------------|--------------------|--------------------|--------------------|
| Budapest U  | France Telecom R&D | LAAS-CNRS (Coord.) | Roma-La Sapienza U |
| City U      | IBM Zurich         | Lisbon U           | Southampton U      |
| Darmstadt U | IRISA              | Newcastle U        | Ulm U              |
| DeepBlue    | IRIT               | Pisa U             | Vytautas Magnus U  |
| Eurecom     |                    | QinetiQ            |                    |



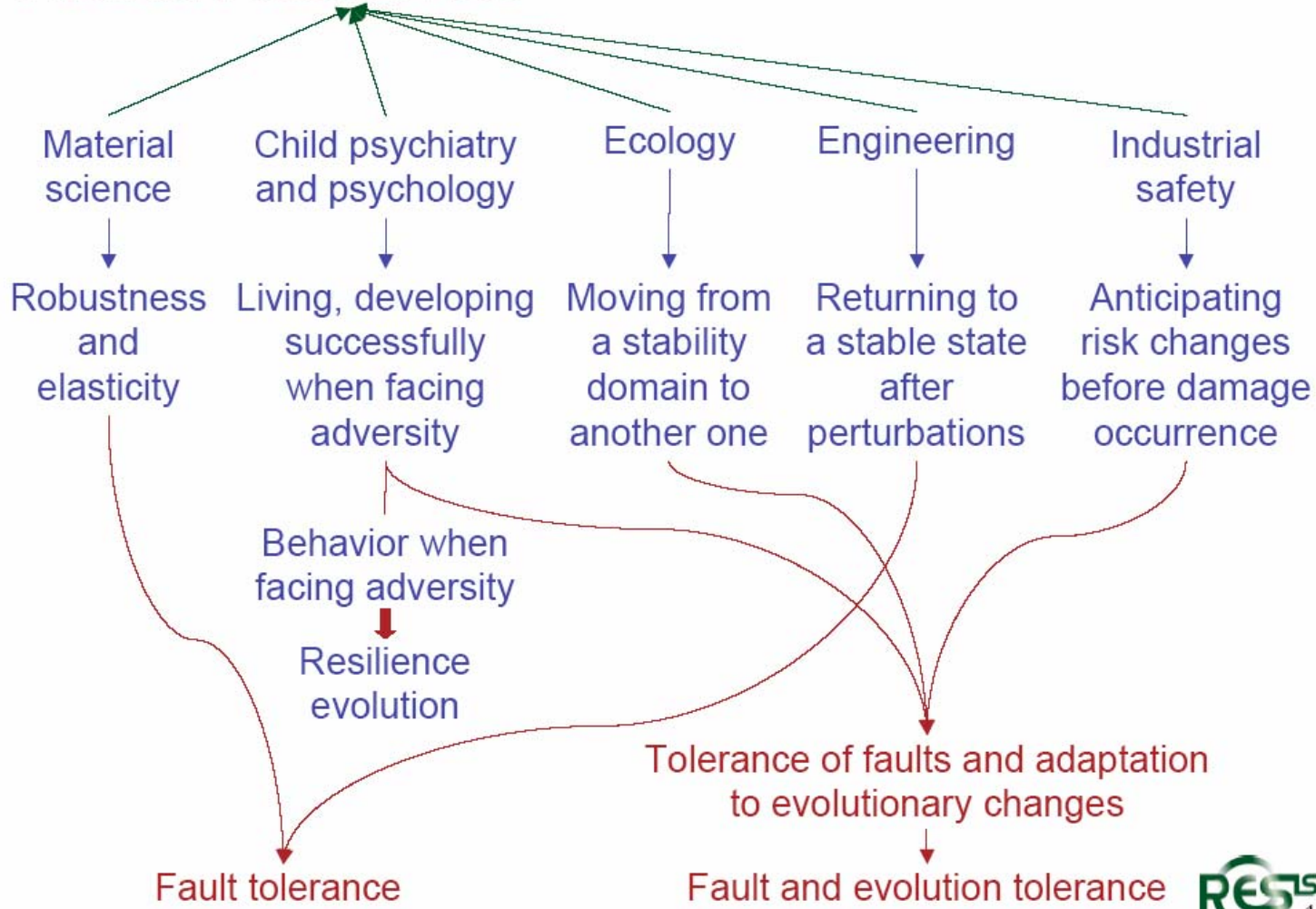
## What is “Resilience” ?

**Resilience\*** and **Resilience Engineering\*** are defined as:

- **in Networks: Resilience** is the ability of the network to provide and maintain an **acceptable** level of service in the face of various faults and challenges to **normal** operation,
- **in Industrial and Organizational Safety: .....** **Resilience Engineering** looks for ways to enhance the ability of organizations to create **processes** that are **robust yet flexible**, to monitor and revise risk models, and to **use resources proactively** in the face of disruptions or ongoing production and economic pressures. .... Success has been ascribed to the ability of groups, individuals, and organizations to **anticipate the changing shape of risk** before damage occurs; failure is simply the temporary or permanent absence of that.

\* from Wikipedia and the book by Hollnagel, E., Woods, D. D. & Leveson, N. G. 2006. “Resilience engineering: Concepts and precepts”, Aldershot, UK, Ashgate.

# About Resilience



# Computing systems and information infrastructures

👉 **Resilience:** ability to deliver, maintain, improve service when facing threats and evolutionary changes

Accidental and deliberate (esp. malicious)

functional, environmental, technological (hardware and software)

— short term, e.g., dynamicity, mobility

— medium term, e.g., new versions, reconfigurations

— long term, e.g., reorganisations

👉 **Failure:** lack of adaptation to the (complexity of the) real world

Natural phenomena

Human-made features

1) Not (yet) a definition: evolutions ➡ threats

2) ⇒ « Re-visit » of the basic concepts of dependability

👉 Extension of underlying system life-cycle model



### **Task TD-T3: Resilient computing syllabus preparation**

The Syllabus, fitted for years 4 and 5 of the high education scheme 3/5/8 – that is at Master level, is intended as an organic content index, that develops a methodical path from basics to applications, through the resilience building technologies (design, verification, evaluation) up to the resilience scaling technologies (evolvability, assessability, usability, diversity).

Task TD-T3 will consist of a first release of a resilient computing syllabus to prepare the skeleton of a dependability and security curriculum, which will be used to promote dependability and security culture at university level, and will be based on interviews of the various academic partners. It will be refined in a subsequent phase of ReSIST.

This activity will be reported in Deliverable D16.

D16	Resilient Computing curriculum draft	M18
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**Activity of this task has consisted in discussions inside the T&D and the EB Committees to define the steps forward to the identification of a meaningful Curriculum of courses and their related syllabi for fitting years 4 and 5 of the high education scheme 3/5/8 – that is at Master level.**

**Proper forms for interviewing the ReSIST partners on courses offered at present in the various sites have been prepared, distributed, collected and analysed. Up to now 55 such forms have been collected, covering a total of 195 credits in ECTS system.**

**Opening to external to ReSIST persons has initiated with invitation to T&D Meetings and involvement of EWICS TC7. An **Open Workshop on “Teaching Resilient Computing”** has been organized jointly with EWICS.**

## Typical Form from ReSIST Partners

**Name of the course:** Interactive Systems Engineering

**Taught at:** University of Toulouse III

**Currently being taught:** Yes

**Description:**Development processes of interactive systems, Formal notations for dialogue description of interactive systems (IS), Verification of properties of IS, Interactive Systems testing, From specification to implementation, Development with Visual Basic prototyping tool

**Language(s) of the course:** French

**Select Author(s):** Palanque Philippe

**Select Lecturer(s):** Palanque Philippe

**Submitted by:** Philippe Palanque

**Number of credits:** 3

**Total hours of lectures:** 40

**Total hours of labs:** 15

**Total hours of personal study:** 20

**Student Interaction Type:** Group Homework, Group Project, Lectures

**Assessment methods:** Practical Examination

**Pre-requisites:** Programming languages, State based modelling

**Infrastructure Required:** Java programming environment, MicroSoft Visual Basic 6.0, Single PC, Windows XP

**Course Objectives:** Learn the specificities of the development of interactive Systems. These specificities are explained with respect to the development process, the notation and the implementation. Basic introduction to Visual Basic 6.0 is given as it proves to be a very efficient tool for high fidelity prototyping of standard interactive systems.

**Support courseware used**

**(Textbooks, slides, notes, etc. with their corresponding links when available):** [Interactive Systems](#)

[Engineering Slides \(in French\)](#)

**Freely Available:** Yes

**Copyright or Restrictions:** Yes

## Links to Universities and Research Centers offering courses in Dependable and/or Secure Computing :

- 1) EWICS: <http://www.ewics.org/docs/curricula-subgroup>
  - 2) Newcastle: <http://www.ncl.ac.uk/postgraduate/taught/subjects/computing/courses/458>, <http://www.cs.ncl.ac.uk/pg/csr/>, <http://www.cs.ncl.ac.uk/degrees/pg/csr/2006CSR.html>
  - 3) Universitat Saarlandes: <http://depend.cs.uni-sb.de/index.php?id=169>
  - 4) Aachen University: <http://lufgi4.informatik.rwth-aachen.de/general/page/about.html>
  - 5) EPFL: <http://dslab.epfl.ch/courses/pods/winter06-07/index.html> (with downloadable slides)
  - 6) Dresden Technische Universitat: <http://wwwse.inf.tu-dresden.de/index.php?language=English&site=courses&file=index>
  - 7) Eurecom: <http://www.eurecom.fr/teaching/engineering/curriculum.en.htm>
  - 8) Chalmers: <http://www.chalmers.se/en/sections/education/masterprogrammes/programme-descriptions/secure-dependable>
  - 9) Darmstadt: <http://www.deeds.informatik.tu-darmstadt.de/teaching/index.html>
  - 10) BUTE: <http://www.inf.mit.bme.hu/FTSRG/Education/index.html>
  - 11) Madrid: <http://lsd.ls.fi.upm.es/lzd/distribuidos.htm>
  - 12) Lancaster: <http://www.comp.lancs.ac.uk/postgraduates/distsyseng.html>
  - 13) Vrije: <http://www.cs.vu.nl/masters/compsys/program.html>
  - 14) Antwerp: <http://www.pats.ua.ac.be/courses>
  - 15) Mannheim: <http://pi1.informatik.uni-mannheim.de/index.php?pagecontent=site/Teaching.menu/Current%20Courses.menu/Principles%20of%20Dependable%20Systems.page>
  - 16) IBM Zurich: <http://www.zurich.ibm.com/~cca/sft06/>
  - 17) LAAS: <http://www.laas.fr/TSF/courses>
  - 18) U. Roma: <http://www.dis.uniroma1.it/%7Ealberto/didattica/critto.html>, <http://www.dis.uniroma1.it/%7Ebaldoni/SD.html>
  - 19) Cornell U.: <http://www.cs.cornell.edu/ken/book/>
  - 20) FME-Formal Methods Europe: <http://www.di.uminho.pt/FME-SoE/index.html>
  - 21) Indiana U. on FM: <http://www.cs.indiana.edu/formal-methods-education/xxiec/statements/mjcg-slides.ps>
- also:
- OpenSeminar: <http://openseminar.org/se/modules/44/index/screen.do>,  
<http://openseminar.org/se/modules/45/index/screen.do>,  
<http://openseminar.org/se/courses/41/modules/206/index/screen.do>  
<http://www.intute.ac.uk/sciences/cgi-bin/browse.pl?limit=75&id=25926&type=%25&sort=record.title>

# Curriculum organization

The curriculum is structured in 4 semesters (tentatively 30 ECTS each) over two years:

## 1<sup>st</sup> Year

### **1<sup>st</sup> semester: Basics and Fundamentals (30 ECTS)**

Courses:

- **Advanced Probability and Statistics (6 ECTS)**
- **Cryptology and Coding Theory (6 ECTS)**
- **Mathematical Logic and Formal Modelling (6 ECTS)**
- **Human Factors, Human and Organisational Behaviour (3 ECTS)**
- **Graph Theory (3 ECTS)**
- **Fundamentals of Real-Time Systems (3 ECTS)**
- **Fundamentals of Dependability (3 ECTS)**

### **2<sup>nd</sup> semester: Methods, Techniques and Tools (30 ECTS)**

Courses:

- **Computer Systems Security (6 ECTS)**
- **Fault Tolerant Distributed Systems and Algorithms (6 ECTS)**
- **Dependability Evaluation of Computer Systems (6 ECTS)**
- **Testing, Verification and Validation (6 ECTS)**
- **Dependability of Socio-technical Systems (6 ECTS)**

## 2<sup>nd</sup> Year

### 3<sup>rd</sup> semester: Projects (in cooperation with industry on specific application fields) (30 ECTS)

Courses (common to all application tracks)

- **Management of Projects** (3 ECTS)
- **Fault Tolerant Middlewar- based Systems** (3 ECTS)
- **Software Reliability Engineering** (3 ECTS)

Application track: **Telecom**

Courses (specific for this track):

- **Dependability of Protocols and Architecture** (3 ECTS)
- **Dependability of Mobile Applications** (3 ECTS)

Application track: **Safety critical Systems**

Courses (specific for this track):

- **Development Process and Standards for Safety critical Applications** (3 ECTS)
- **Architectural Issues and Examples of Systems** (3 ECTS)

Application track: **e-Business**

Courses (specific for this track):

- **Dependability of SOA and Web-based Applications** (3 ECTS)
- **Damage Tolerance in Large scale Systems** (3 ECTS)

Common to all Application tracks:

- **Project in cooperation with Industry** (10 ECTS)
- **Space for additional Courses** (5 ECTS)

### 4<sup>th</sup> semester:

#### **Master's Thesis and Dissertation (30 ECTS):**

- **Specific Courses and Seminars** (3 ECTS)
- **Preparation and Presentation of the Thesis** (27 ECTS)

## **Advanced Probability (9 ECTS)**

The purpose of this course is to provide a methodical advanced background of probability, stochastic processes, and statistics needed to the students to address modelling and assessment issues in resilient computing.

### **Contents**

- Introduction
- Discrete Random Variables
- Continuous Random Variables
- Expectation
- Conditional Distribution and Expectation
- Stochastic Processes
- Discrete-Time Markov Chains
- Continuous-Time Markov Chains
- Networks of Queues
- Statistical Inference
- Regression and Analysis of Variance

### **Suggested textbook:**

Kishor S. Trivedi: **Probability and Statistics with Reliability, Queuing, and Computer Science Applications, Second Edition, John Wiley & Sons, 2002**

### **Suggested Courseware:**

Slides from the same author, available at <http://www.ee.duke.edu/~kst/>



QuickTime™ and a  
TIFF (Uncompressed) decompressor  
are needed to see this picture.

**Call for Contributions  
One-Day Workshop on  
“Teaching Resilient Computing”  
Erlangen, Germany - May 2, 2007**

EWICS-TC7, the European Workshop on Industrial Computer Systems, Technical Committee on Reliability, Safety and Security, and ReSIST NoE, the EU Network of Excellence on Resilience for Survivability in IST, organize a one-day workshop on “Teaching Resilient Computing”.

EWICS-TC7 has established a curriculum subgroup to identify curriculum requirements both for academic education and for industrial training, which are necessary to effectively cover the complete life cycle of dependable software-based systems applied in industrial sectors (<http://www.ewics.org/docs/curricula-subgroup>). ReSIST NoE has an activity on Training and Dissemination, whose aim, among others, is the identification of an academic curriculum, fitted for years 4 and 5 of the high education scheme 3/5/8 – that is at Master level. It is intended as an organic set of courses and related content indexes (syllabi), that develops a methodical path from basics to applications, to train students on resilient computing, so that they can be readily productive in an informed and expert way in industrial and research work (<http://www.resist-noe.org>).

**Why a Workshop on “Teaching Resilient Computing”**

There is today a lack of unified educational programmes for dependability engineers: at the very best, professionals are offered academic curricula and industrial training courses focused on specific technologies required during the life-cycle of software-based systems. These are mostly tailored to specific background disciplines, such as computer science or single application domain engineering sciences. Typically, this situation results in communication problems across project members with different technical background, as they miss a common education concerning terminology and techniques, and it increasingly tends to endanger effective design of dependable complex systems.

## Aims of the Workshop

- **To review experiences made in European Universities**
- **To identify the topics to be taught and their allocation to semesters**
- **To identify the pre-requisites for a MSc curriculum in Resilient Computing**
- **To identify the right level of mix between theoretical methods and practical techniques to prepare students to be productive in both industry and/or research**
- **To identify the application fields that needs expertise in Resilient Computing**
- **To discuss the courseware needed in support to the courses**
- **To discuss the liaison with EC DG on Education to have the curriculum approved at European level**