Software Assurance ITI8610-Tarkvara töökindlus

Goals and content

2015 Autumn

Why is this course needed?

- **EDS Fails Child Support (2004)**

  Software giant EDS introduced in 2004 a complex IT system to the U.K.'s Child Support Agency. Same time, the Department for Work and Pensions restructured the agency. These actions were completely incompatible.

  Result - The system overpaid 1.9 million people, underpaid 700,000, had $7 billion in uncollected child support payments, a backlog of 239,000 cases,

  In total cost the UK taxpayers over

  $1 billion to date.

LA Airport Flights Grounded (2007)

A single faulty piece of embedded software, on a network card, sends out faulty data on the U.S. Customs and Border Protection network, bringing the entire system to a halt. Nobody is able to leave or enter the U.S. from the LA Airport for over eight hours.

Result - Over 17,000 planes grounded for the duration of the outage.

The Ariane 5 Launcher Failure

- A European rocket designed to launch commercial payloads, approximately 37 seconds after a successful lift-off, lost control.
- It started to break up due to uncontrollable stress.
- Ground controllers initiated self-destruct and the rocket and payload was destroyed.

The Ariane 5 Launcher Failure

- Software failure occurred when an attempt to convert a 64-bit floating point number to a signed 16-bit integer caused the number to overflow. The lack of an associated exception handler lead to a software shutdown.
- Aggregate cost: $640 million
- Loss of life: 160

and many more...

- read https://en.wikipedia.org/wiki/List_of_software_bugs

Lessons learned

- A 2002 study commissioned by the National Institute of Standards and Technology found that software bugs cost the US economy $59.5 billion every year
- The study estimated that more than a third of that amount, $22.2 billion, could be eliminated by
  - ***improved testing,***
  - and even more by **applying systematic analysis and development techniques.**

What is software assurance?

Application of technologies and processes to achieve a required level of confidence that *software systems* and *services*

- function in the intended manner,
- are free from accidental or intentional vulnerabilities,
- provide security capabilities appropriate to the threat environment, and
- recover from intrusions and failures.

Who needs it?

- Mostly professional software security and assurance practitioners
- But to some extent all who deal with IT and SE issues
- SW assurance is already part of many Master of software engineering curricula over world.
- Main reference curriculum issued by Software Engineering Institute, Carnegie Mellon Univ. U.S.

Course differs from traditional SE and CS programs

- Special areas of emphasis:
  - Software and *services,*
  - their development and *acquisition*
  - *Security* and correct functionality: defective software isn't dependable or secure
  - *Software analytics*: the ability to analyze software to ensure that it has both the right security properties and the right functionality
  - *System operations*: monitor and assess to ensure that systems continue to have the right security properties in their operational environment
  - *Auditable evidence*: the ability to produce rigorous evidence of assurance processes and outcomes

Expected outcomes [1] (1)

Graduates will have the following ***abilities***:

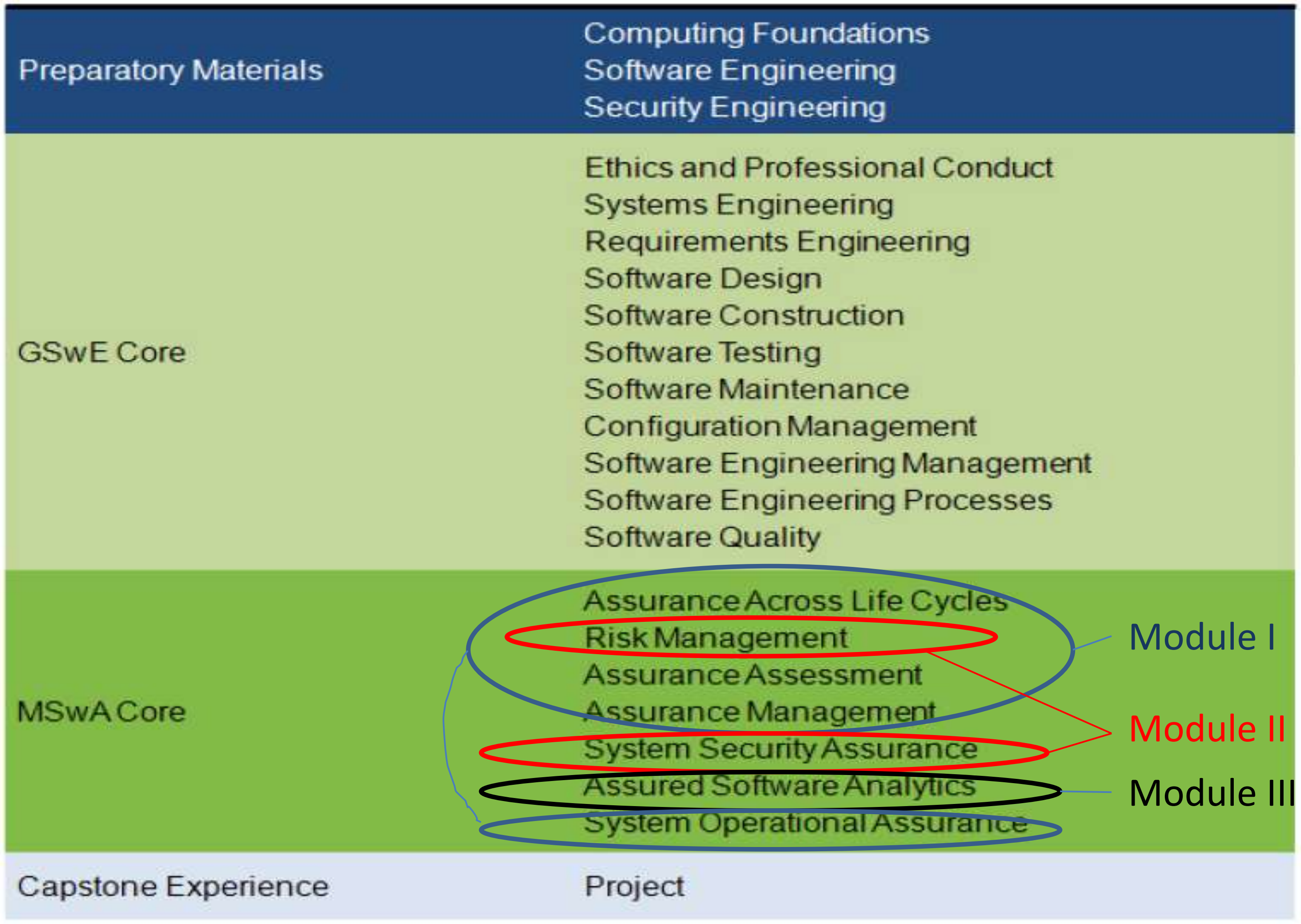
- **In Assurance Process and Management**
  - *Assurance across life cycles:* to incorporate assurance technologies and methods into life-cycle processes and development models for new or evolutionary system development, and for system or service acquisition
  - *Risk management*: to perform risk analysis, trade-off assessment, and prioritization of security measures.
  - *Assurance assessment*: to analyze and validate the effectiveness of assurance operations and create auditable evidence of security measures.
  - *Assurance management*: to make a business case for software assurance, lead assurance efforts, understand standards, comply with regulations, plan for business continuity, and keep current in security technologies.

[1] - Mead et al., 2010a

Expected outcomes (2)

- **Assurance Product and Technology**
  - *System security assurance*: to incorporate effective security technologies and methods into new and existing systems.
  - *System functionality assurance:* to verify new and existing system functionality for conformance to requirements and absence of malicious content.
  - *System operational assurance:* to monitor and assess system operational security and respond to new threats

Context of the course



Preparatory Materials	Computing Foundations Software Engineering Security Engineering
GSwE Core	Ethics and Professional Conduct Systems Engineering Requirements Engineering Software Design Software Construction Software Testing Software Maintenance Configuration Management Software Engineering Management Software Engineering Processes Software Quality
MSwA Core	Assurance Across Life Cycles Risk Management Assurance Assessment Assurance Management System Security Assurance Assured Software Analytics System Operational Assurance
Capstone Experience	Project

Course organization

- Lectures Mon 14:00-15:30
- Practical training Fri. 10:00-11:30
- 3 modules:
  - 1. module (weeks 2-4, 10 and 16), Maili Markvardt
    - Assurance Across Life Cycles
    - Assurance Assessment
    - Assurance management
  - 2. module (weeks 5-9), Aleksandr Lenin
    - Risk Management
    - System Security Assurance
  - 3. module (weeks 11-15), Jüri Vain, Jishu Guin
    - System Functionality Assurance

Requirements to pass

- *Total mark is arithmetic mean of marks collected from modules I – III*
- *Each module is evaluated separately on scale 0 – 100 points*
- *To pass a module at least 50 % points are required from max possible*
- *The points come from tests, lab assignements, home work, oral report, etc.*
- *Evaluation of results depends on the specifics of the assignment of module*

Course materials and web

- Course web page
  - (Estonian) https://cs.ttu.ee/kursused/
  - (English) https://cs.ttu.ee/courses/
- Course Moodle
- http://resources.sei.cmu.edu/asset_files/UsersGuide/2011_012_001_51607.pdf

Module 1: Assurance processes & risk management

WE COULD DESIGN THE PRODUCT WITH A SIMPLE POINT-AND-CLICK INTERFACE . . .
OR WE COULD REQUIRE THE USER TO CHOOSE AMONG THOUSANDS OF POORLY DOCUMENTED COMMANDS, EACH OF WHICH MUST BE TYPED EXACTLY RIGHT ON THE FIRST TRY
BEAR IN MIND, WE'LL NEVER MEET A CUSTOMER OURSELVES.
MAKE IT SO THEY HAVE TO REBOOT AFTER EVERY TYPO.
E-Mail: SCOTTADAMS@AOL.COM
S. Adams
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Assurance processes and requirements

SW Risk management

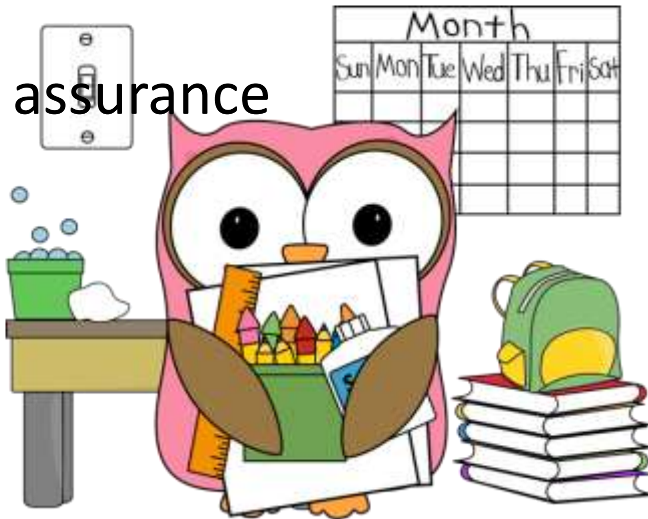
Tool considerations

Learning outcomes for module I

- After completing module I, student is able to
  - Analyse and objectively describe SW system's context in terms of assurance
  - Document non-functional requirements in controlled manner as a basis for assurance
  - Conduct and document risk analysis depending on SW system's context
  - Implement tool support for SW assurance in an organisation

Topics timeline & mandatory assignments

- Week 2: Requirements engineering considerations in assurance
  - Excercise on non-functional requirements
- Week 3: Risk management: Concept and preparations
  - Risk analysis preparations excercise for SW system
- Week 4: Risk management: Risk analysis
  - Risk analysis excercise for SW system
- Week 10: Tool support for analysis
  - Practical exercise in example of quality assurance management tool
  - Week 16: TBA



Conditions

- All assignments are mandatory
  - Solving the assignment itself
  - Reviewing another group's solution
- My assignments are usually done in groups
- Deadline for each practice assignment is usually following week's Friday
  - Assignment & review – plan your timing with care
  - Don't be late if you have not agreed another deadline in advance!
- Submitted via e-learning environment

Module II: Security Assurance

IT – business enabler or a threat?

Module II: Security Assurance

Module II: Security Assurance

The course is about:

- Designing reliable secure and trustworthy systems
- Critical/weak spots in software. Typical attack vectors
- Vulnerability and threat identification
- Security patterns, best practices, security testing
- Security vs usability
- Security fallacies

The course is **not** about:

- Designing security systems
- Cryptography
- Reliability, fault tolerance and safety

Module II: Security Assurance

Practice hands-on assignments:

1. Threat identification, control and mitigation
2. Vulnerability identification
3. Secure software design

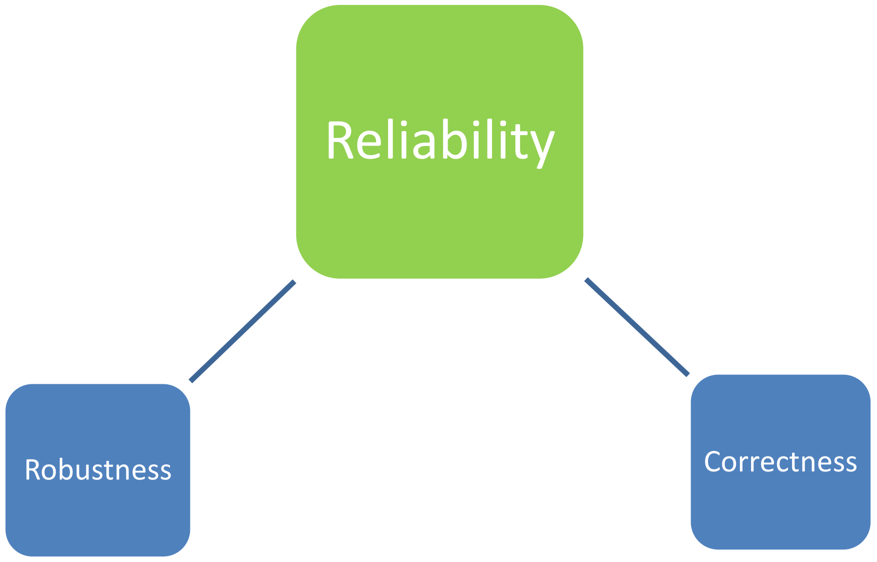
The structure of the course is subject to possible changes due to the audience background.

Alternatives are negotiable.

Module III: Assured Software Analytics

❑ Focus area

- System functionality assurance



Module III: Assured Software Analytics

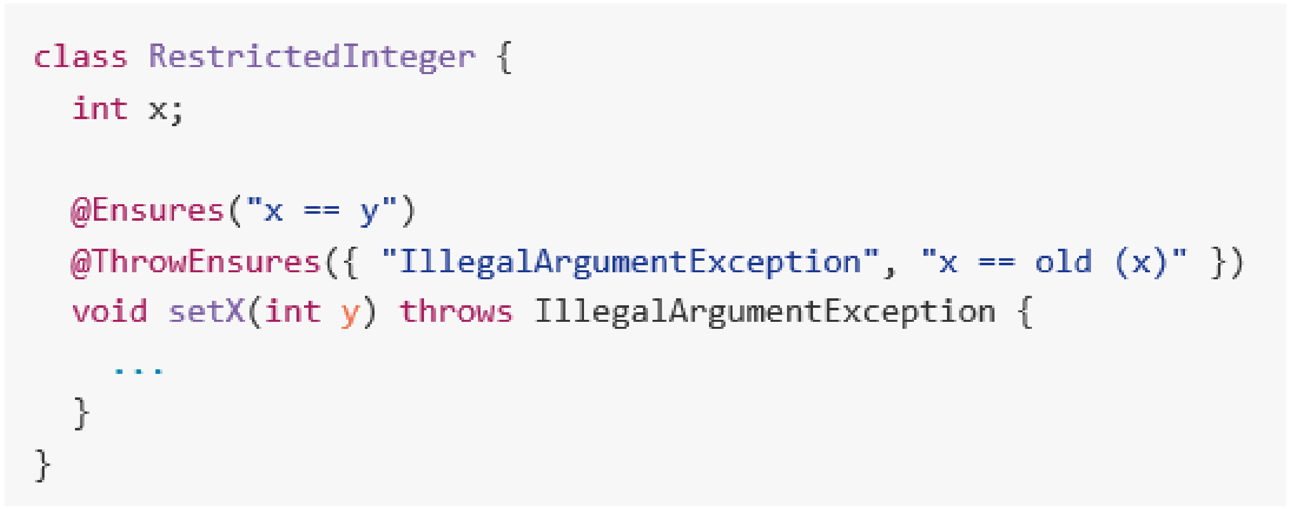
❑ Method

- Design by contracts
  - Correctness - Adherence to contracts
  - Robustness - Handle violation of contracts

Module III: Assured Software Analytics

❑Practise Environment

- Contracts for Java (Cofoja) - A **contract programming** framework and **test tool** for Java, which uses annotation processing and bytecode instrumentation to provide run-time checking.



```
class RestrictedInteger {
  int x;

  @Ensures("x == y")
  @ThrowEnsures({ "IllegalArgumentException", "x == old (x)" })
  void setX(int y) throws IllegalArgumentException {
    ...
  }
}
```

Module III: Assured Software Analytics

❑Pre-requisites

- Basic knowledge of Java programming language.
- Familiarity with basic data structures (List, Map, etc.)

Module III: Assured Software Analytics

- After completing module III, student is able to
  - specify functional and non-functional requirements as contracts and use contracts in software processes and development increments
  - analyse and verify contracts
  - easily adapt to new contract based development tools.

Module III: Assured Software Analytics

- ❑Assignments
  - The module has two assignment.
    - Short class assignment - 40% grade for Module III
    - Take home assignment - 60% grade for Module III

If bridges were built like software...

MEIL POLE AEGA EGA RAHA, ET KORRALIKULT TEHA
AGA MEIL ON AEGA JA RAHA, ET ÜMBER TEHA
DIY.DESPAIR.COM

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