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TestREx:
A *Test*bed for *R*epeatable *Ex*ploits

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http://securitylab.disi.unitn.it

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Exploits Collections

- **Systematic collection of exploits into a knowledge base**
  - Exploit DB, OVSDB, Webgoat, etc.
- **Advantages for developers *of* exploited software**
  - Provide evidence on actual risks of vulnerabilities
  - Study explicit/implicit causes of vulnerabilities, their connections
  - Insight for software analysis tools and testing approaches
- **What about developers *using* that software?**

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The 3° Party Developer Perspective

"Exploits, exploits every where. Nor a single script to run"

- T.S. Coleridge - The Rime of the Ancyent Marinere
- (Free adaptation by Fabio Massacci)

- **How to actually "repeat" the exploit in my operational environment?**
  - Applications use different platforms → SQL injection for mySQL may not work in MongoDB
  - Software changes → different exploits work for different versions
  - Software configuration does matter → exploit only works if run in a particular OS
  - Essentially it is a "non-constructive existence proof"

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Getting more value out of the corpus!

- **Apart from "documenting" an exploit, what other information do we want?**
- **Baseline Information**
  - Exploit X successfully subverts a application A that is running in environment E
- **What 3° party developers really want to know is**
  - Does X work on same A in updated E'?
  - Does X work on updated A' in same E?
  - Does X work on updated A', in updated E'?
- **Deploying and matching all possible software configurations and application versions…**
  - .. as automatically as possible…

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TestRex Baseline

- **Focus on Web-facing code (Java/JavaScript)**
- **Building on top of the existing approaches**
  - BugBox by Nilson et al.
  - MalwareLab by Allodi et al.
- **Objectives**
  - Simple and modular architecture to deploy all kind of web-based applications
  - “Actionable” information on applications, exploits, software and execution environments
  - Report successful and unsuccessful exploits

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What is TestREx

- **10.000 feet's view → Management system for software environments**
  - Provide an isolated "playground" per every application version and its corresponding software environment
- **Bird's eye view → Testbed for performing web application vulnerability experimentations**
  - Automatically, via scripted exploits
  - Manually, by giving testers the access to the requested application from within its sandbox
- **Low-level view → Test suite for managing and running scripted exploits against corresponding applications**

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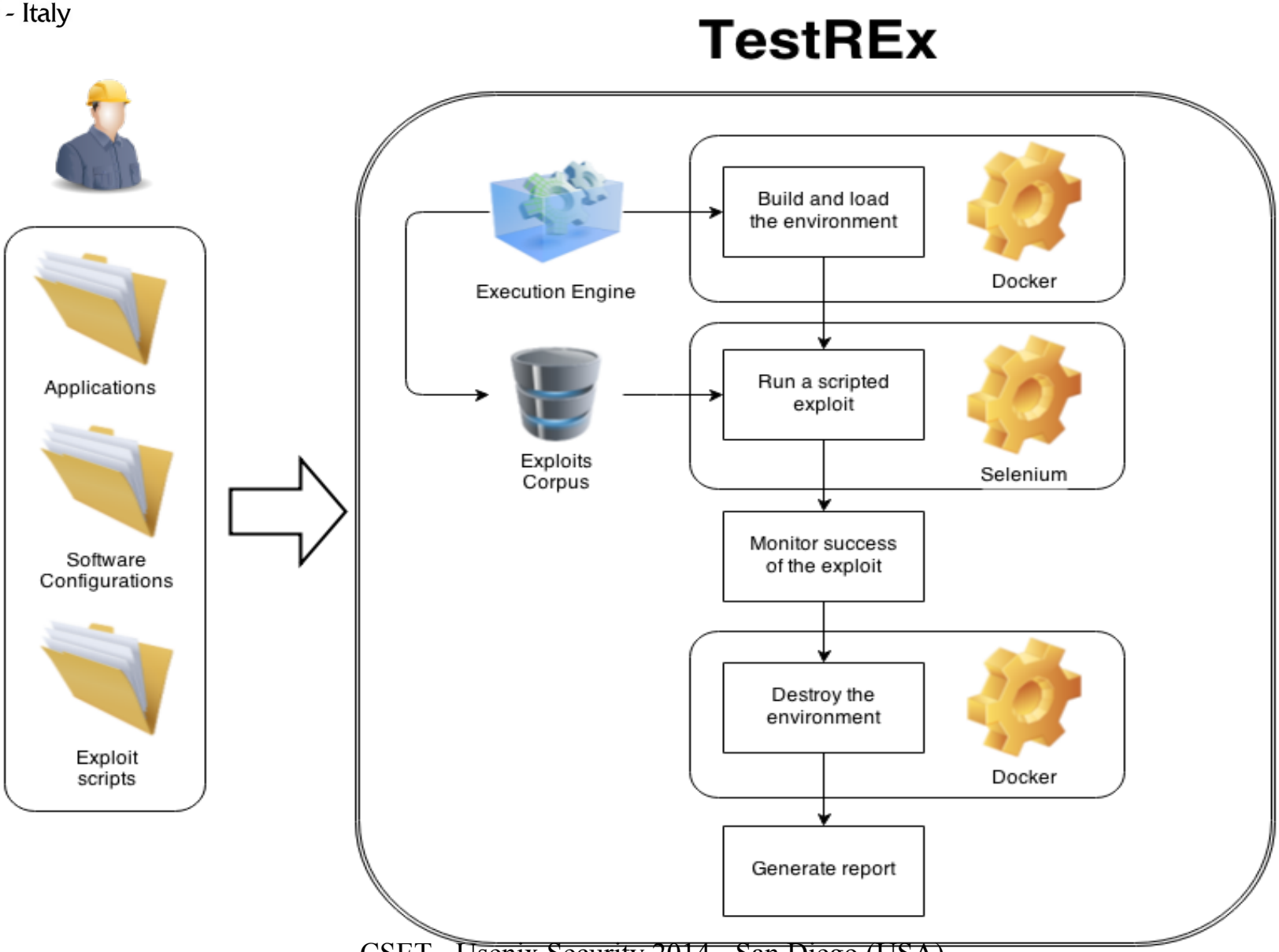
TestREx: typical workflow



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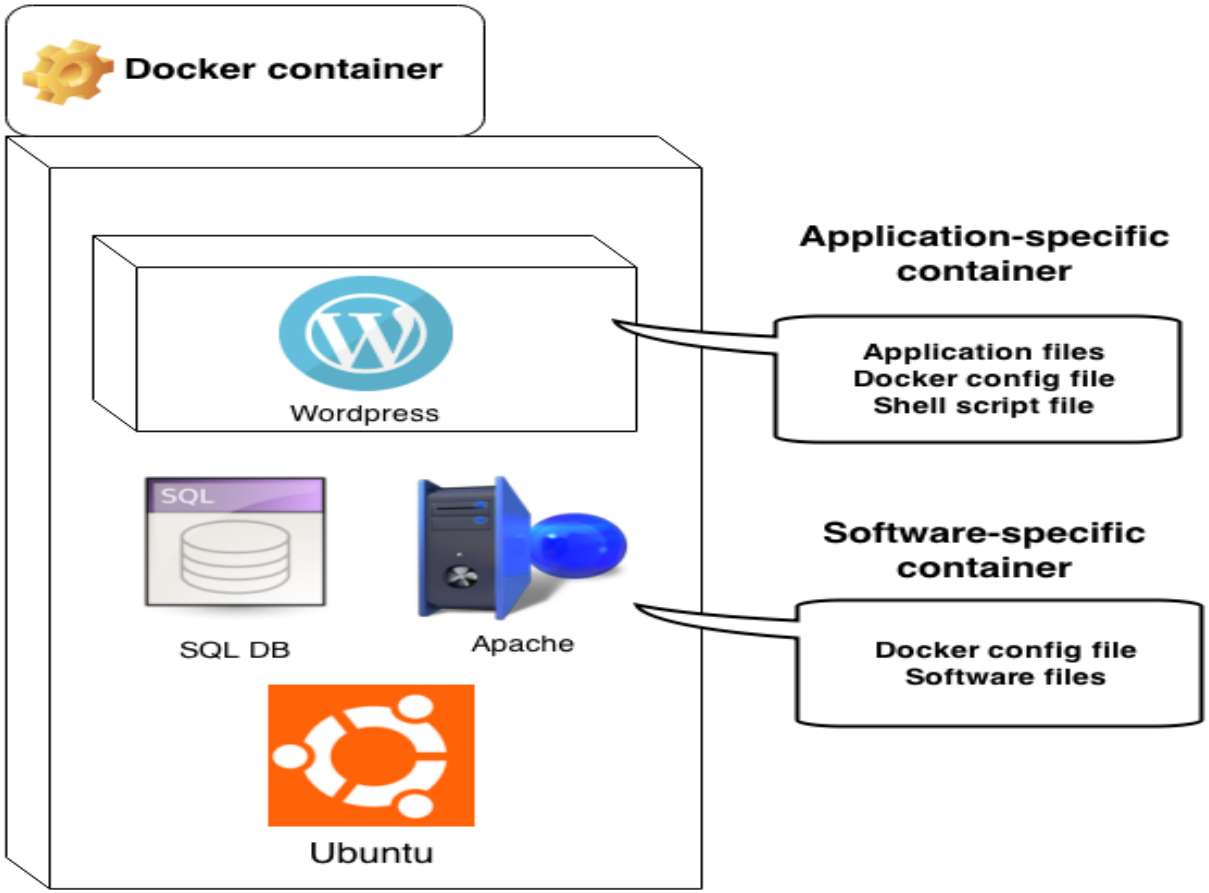
TestREx: Application Container example



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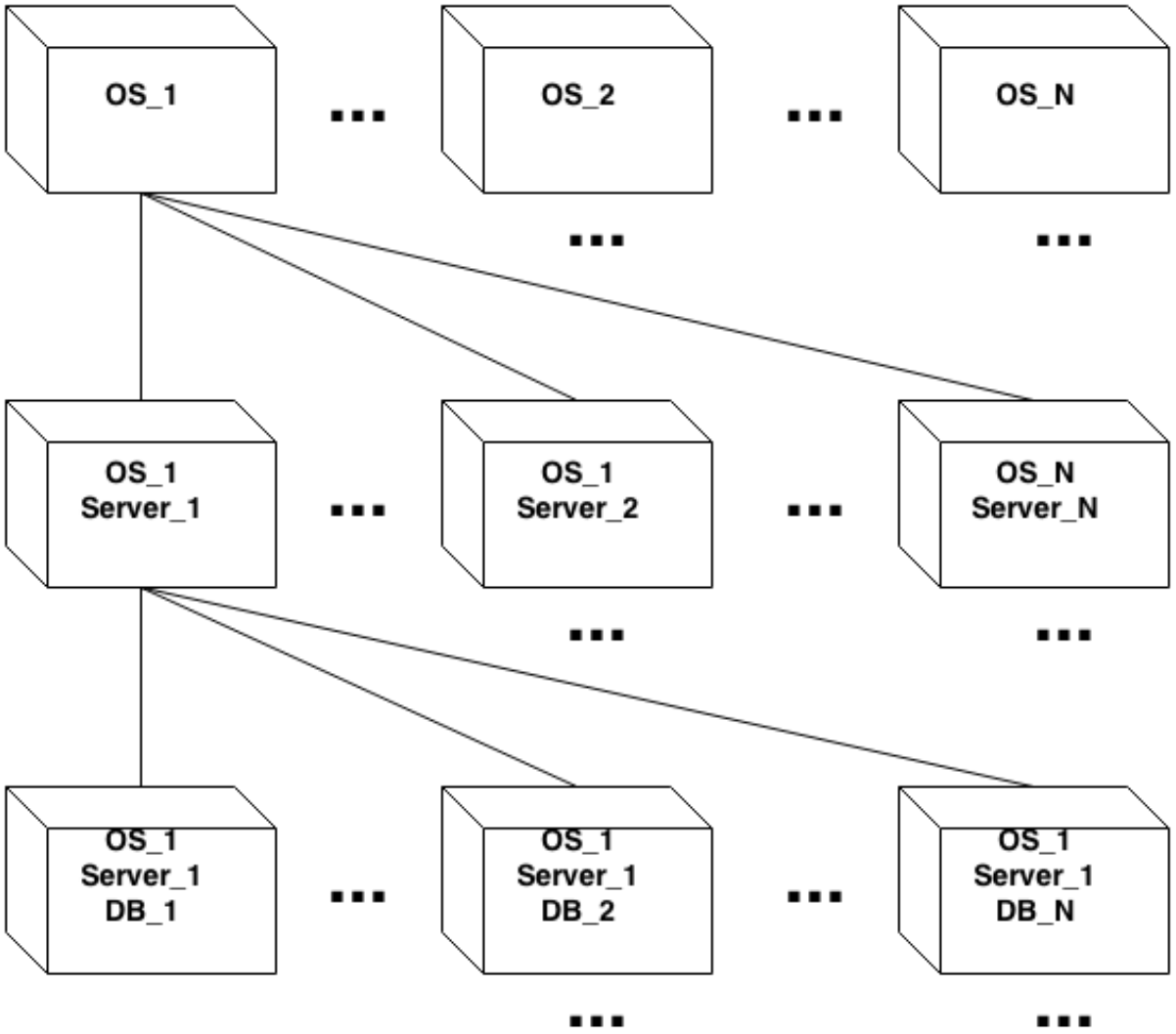
TestREx: Software Containers hierarchy



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TestREx: Exploits

- **Exploit – "TestREx Definition"**
  - sequence of [automated] actions required to subvert a vulnerability in an application and verify its success
- **Low Level Technicality**
  - Self-contained unit test + description metadata
  - Python script + Selenium driver (automate browser)
  - Script passes results of its run to Execution Engine
- **Which exploits are present?**
  - Adapted corpus of exploits taken from BugBox
  - Created own example exploits (17) with WebGoat and server-side JavaScript

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Exploit example

```
1  from data.exploits.framework.BasicExploit import BasicExploit
2
3  class Exploit(BasicExploit):
4
5      attributes = {
6        'Name' :         'SQLInjectionExploit',
7        'Description' : "SQL injection in MongoDB + node.js application.",
8        'References' :  [["empty"]],
9        'Target' :       "SQLInjection",
10       'Container': 'ubuntu-apache-mysql',
11       'TargetLicense' : '',
12       'Plugin' : '',
13       'VulWikiPage' : "None",
14       'Type' : 'SQL injection'
15     }
16
17     def runExploit(self):
18         w = self.wrapper
19         w.navigate("http://localhost:49160/insecureLogin.html")
20         w.find("userid").keys("pwned' OR 'a'='a")
21         w.find("submit").click()
22         element = w.find("body")
23         self.assertIn("Hello, Batman!", element.raw.text)
24
```

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Running an Experiment

- **Modular way to run exploits and applications**
  - All exploits are independent scripts that can be supplied by anyone
  - An application can be started in either “clean” or “infected” state
- **Sample scenarios → regression testing and configuration testing**
  - Deploy multiple versions of an application and understand what was fixed though the version history
  - Deploy an application on different platforms and see the correlation between third-party software and vulnerabilities
- **Report generation**
  - A .csv file with exploit run results and exploit metadata

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TestREx Business Applications

- **Executable documentation for software companies**
  - "document an exploit" = "write a TestREx script"
  - Automated security + configuration testing
  - Automated regression testing suite
  - Penetration testing support tool
- **Aid for security-unaware developers**
  - Part of training toolkit for studying web app security
  - Benchmark for code analysis tools evaluation
- **Patent Pending for SAP Labs**

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Future Work

- **Engage UNITN students**
  - Extension of the exploit/vulnerability corpus
  - Implement a number of attack scenarios and countermeasures for JavaScript
  - Use TestREx as a part of a toolchain for scanning Node.js
- **Build a hierarchy of exploits similarly to what we did with containers**
- **Semi-automatic generation of test cases for security vulnerabilities**
  - Use TestREx for JavaScript static analysis tools evaluation (to eliminate false positives)

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Conclusions

- **We envision a scripted exploit is an executable documentation that can facilitate testing and bug fixing in software development**
- **Getting TestREx?**
  - **http://securitylab.disi.unitn.it/doku.php?id=software**
  - **https://github.com/standash/TestREx**
  - Use for research is free but commercially there is a patent pending for SAP Labs
- **Finally**

> "Farewell, farewell! but this I tell
> To thee, thou Usenix-Guest!
> He codeth well, who exploith well
> Both app, environment and test"
>
> T.S. Coleridge - The Rime of the Ancyent Marinere
> (Free adaptation by Fabio Massacci)