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TestREx: A Testbed for Repeatable Exploits

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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?**



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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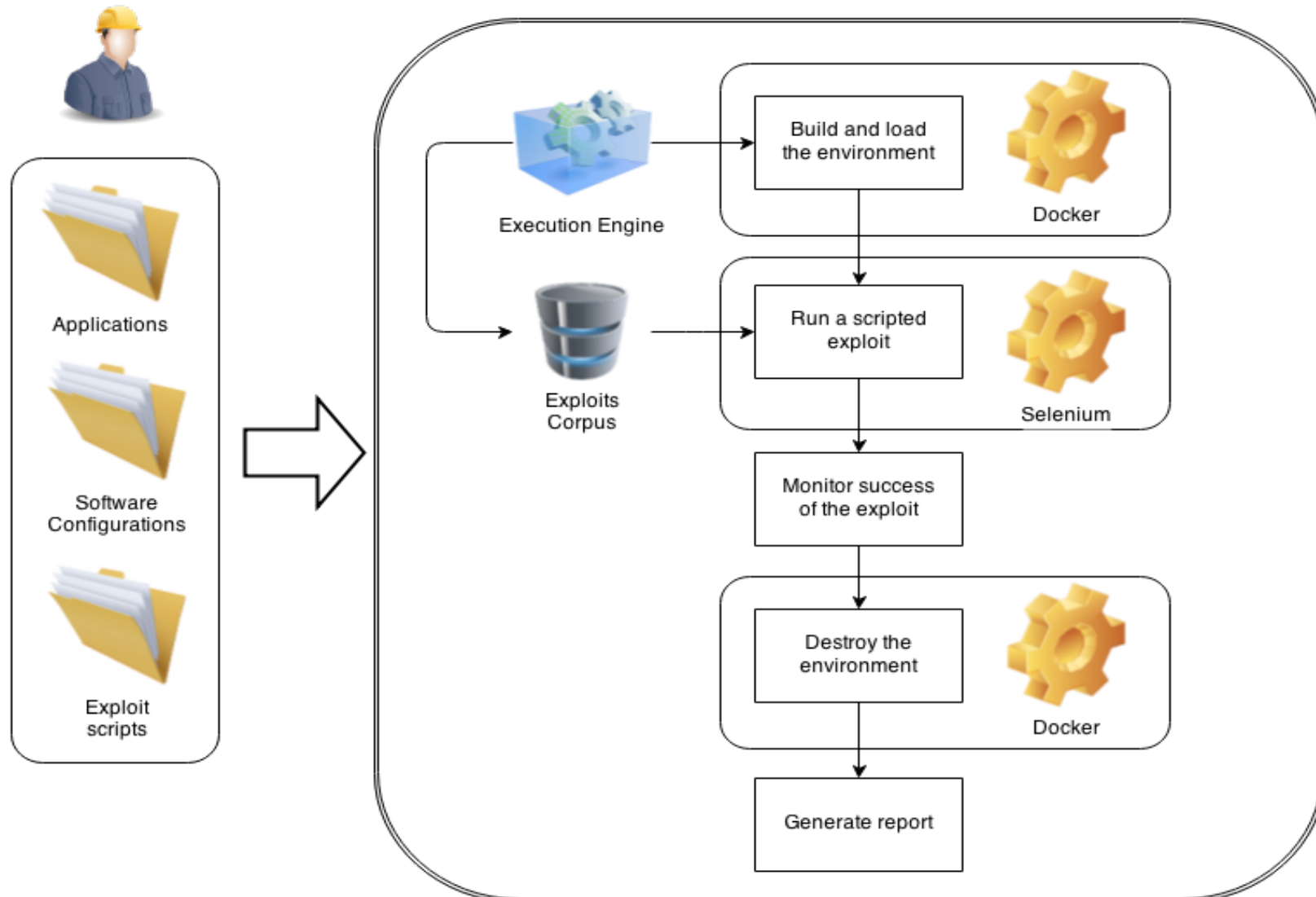
What is TestREx

- **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**



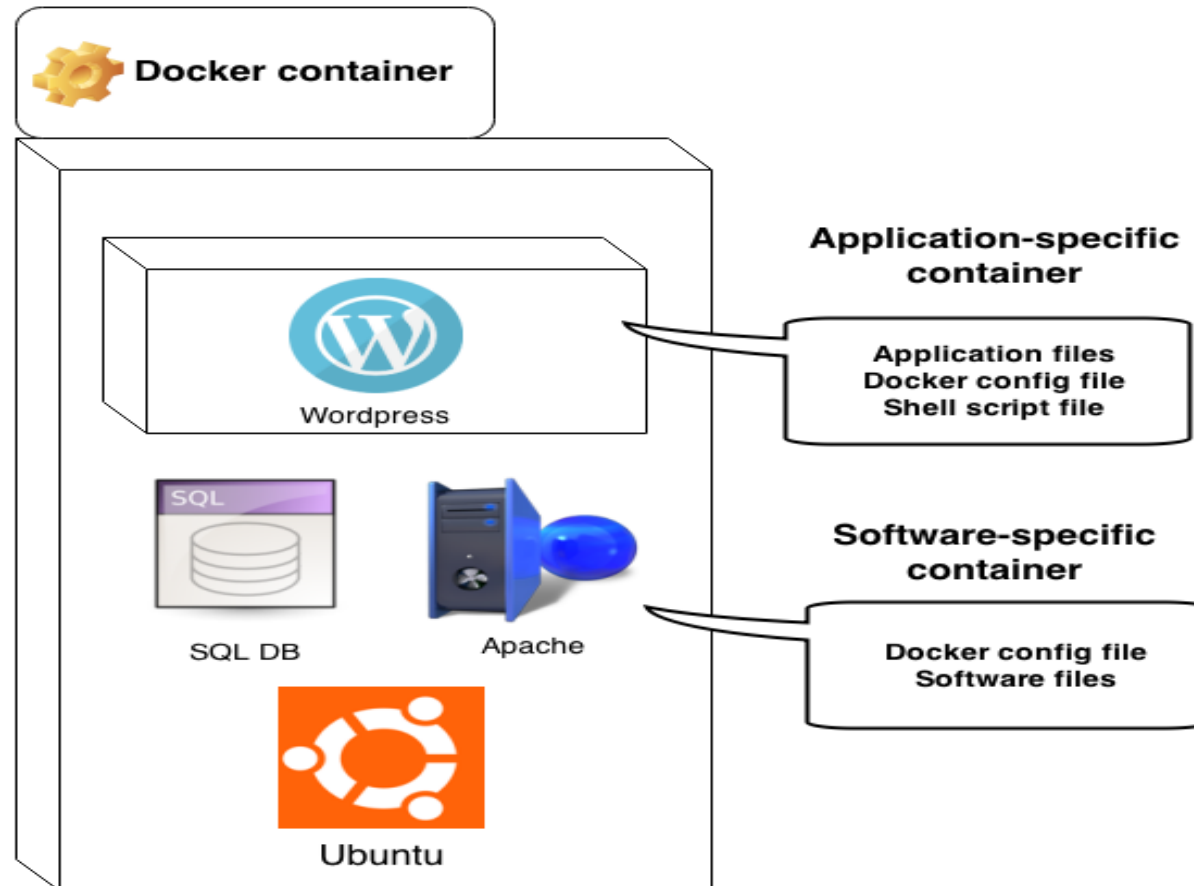
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TestREx: typical workflow



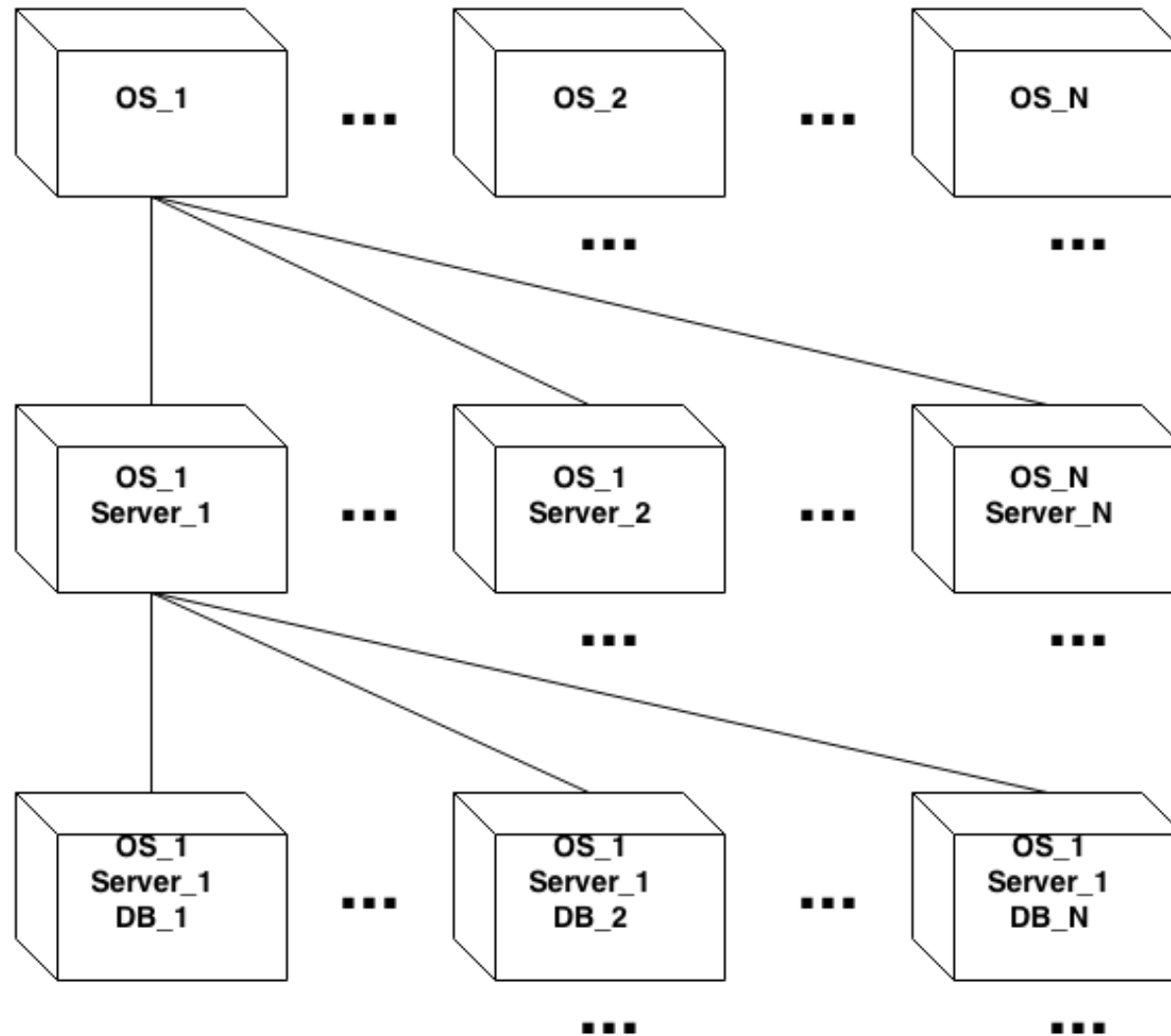


TestREx: Application Container example





TestREx: Software Containers hierarchy





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



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
```



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 through 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)