



Welcome to

5. Web Application Security: Recon

KEA Kompetence VF1 Software Security

Henrik Kramselund he/him han/ham hlk@zencurity.com @kramse

Slides are available as PDF, kramse@Codeberg
5-web-app-hacking-recon.tex in the repo security-courses

Goals for today



Todays goals:

- Web Application Hacking – more structured knowledge about common web apps
- Do reconnaissance on web applications
- Talk about common patterns

Photo by Thomas Galler on Unsplash

Plan for today



Subjects

Web Application Security: Recon

- Structured approach to discovery, information gathering, mapping
- The Structure of a Modern Web Application
- REST APIs, JSON
- Authentication and Authorization Systems
- Finding domains, subdomains and vhosts

Exercises

- Run small programs – notice how libraries can take away complexity
- Scaning real life sites with Nikto and Whatweb, your sites, my sites and JuiceShop

Reading Summary



Web Application Security, Andrew Hoffman, 2020, ISBN: 9781492053118

Part I. Recon, chapters 1-8, very short chapters

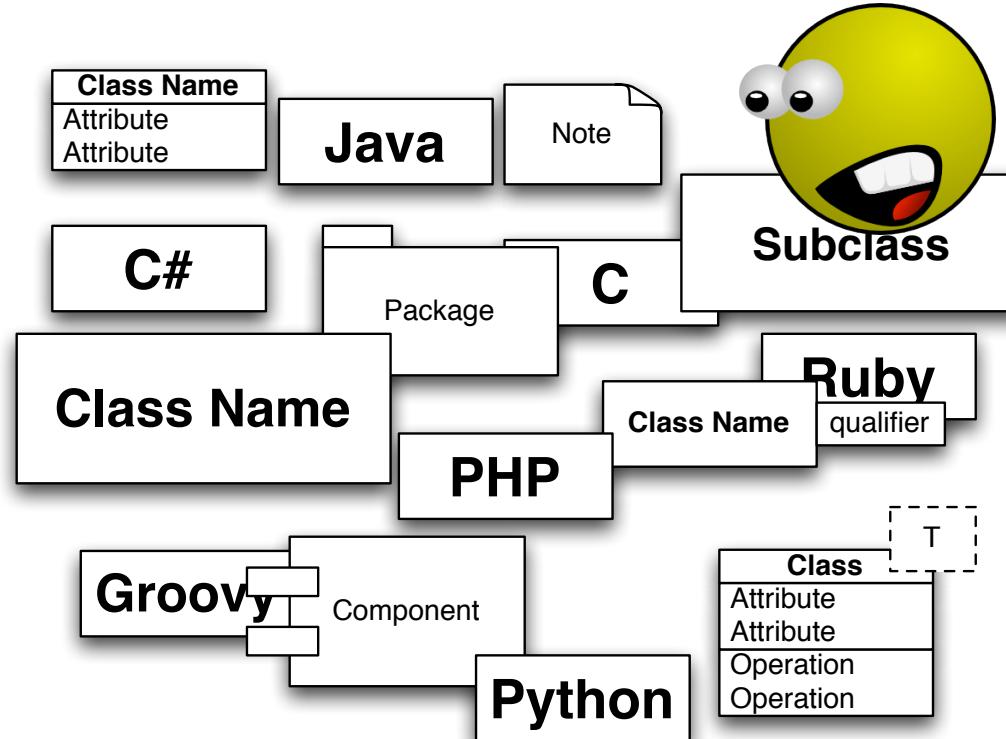
1. The History of Software Security
2. Introduction to Web Application Reconnaissance
3. The Structure of a Modern Web Application
4. Finding Subdomains
5. API Analysis
6. Identifying Third-Party Dependencies
7. Identifying Weak Points in Application Architecture
8. Part I Summary

Goals: Discovery and Reconnaissance

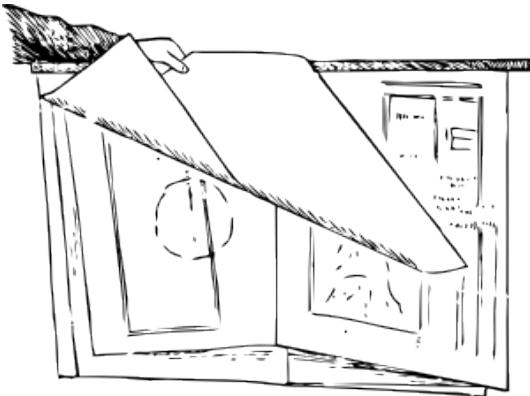


Be able to discover parts of web application environments
Perform Information Gathering Web Application Mapping

Selecting Technologies for your enterprise



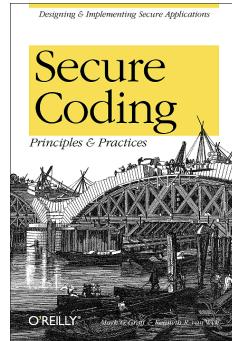
Why talk about selecting technologies



- A big part of systems integration it to make sure applications can work together
- Data interchange
- Running systems require skills, many different technologies, many humans needed
- Managing complexity with many systems become harder

Later today we will discuss this subject more with the hand-in assignment

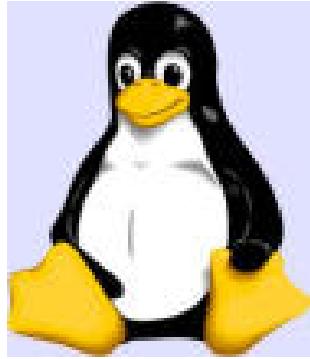
Secure Infrastructures starts with architecture and design



Secure Coding: Principles and Practices af Mark G. Graff, Kenneth R. Van Wyk 2003

- Architecture and design while you are thinking about the application
- Implementation while you are writing the application
- Operations After the application is in production
- Approx. 200 pages, but very dense with information.

Operating Systems



- Applications need to run within some controlled system
- What is an operating system today?
- Is Docker an operating system? What is Docker?

Use the Modern Operating Systems



Newer versions of Microsoft Windows, Mac OS X and Linux

- Buffer overflow protection
- Stack protection, non-executable stack
- Heap protection, non-executable heap
- *Randomization of parameters* stack gap m.v.

Note: these still have errors and bugs, but are better than older versions

Check end-of-life and when updates will stop for each version

OpenBSD has shown the way in many cases

<http://www.openbsd.org/papers/>

Always try to make life worse and more costly for attackers



Technologies used in enterprises

The following tools and environments are examples that are used in enterprises today:

- Programming languages and frameworks Java, Spring, Python
- Development environments IDE NetBeans / Eclipse / IntelliJ, Atom
- Systems for running Java: TomCat / GlassFish
- Networking and network protocols: TCP/IP, HTTP, DNS
- Formats XML, JSON, WSDL, GRPC, msgpack, protobuf, apache thrift
- Web technologies and services: REST, API, HTML5, CSS
- Tools like cURL, Git and Github
- Integration tools Camel
- Message queueing systems: MQ
- Aggregated example platforms: Elastic stack, logstash, elasticsearch, kibana, grafana
- Cloud and virtualisation Docker, Kubernetes, Azure, AWS, microservices

This list is not complete, but what was discussed in System Integration course!

What about dependencies



- Are you using some special software, or hardware
- Does your application depend on some tools, library that needs help

Data overview XML data, JSON



Photo by Chris Lawton on Unsplash

XML data



Extensible Markup Language (XML) is a markup language that defines a set of rules for encoding documents in a format that is both human-readable and machine-readable. The World Wide Web Consortium's XML 1.0 Specification[2] of 1998[3] and several other related specifications[4]—all of them free open standards—define XML.[5]

The design goals of XML emphasize simplicity, generality, and usability across the Internet.[6] It is a textual data format with strong support via Unicode for different human languages. Although the design of XML focuses on documents, the language is widely used for the representation of arbitrary data structures[7] such as those used in web services.

Source: <https://en.wikipedia.org/wiki/XML>

- We have seen XML used for configuration in Apache Tomcat and Camel
- Perfect for computers, less for humans

XML data example - Nmap output



```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE nmaprun>
<?xmlstylesheet href="file:///usr/bin/../share/nmap/nmap.xsl" type="text/xsl"?>
<!-- Nmap 7.70 scan initiated Sat Feb 22 23:35:53 2020 as: nmap -oA router -sP 10.0.42.1 -->
<nmaprun scanner="nmap" args="nmap -oA router -sP 10.0.42.1" start="1582410953">
  startstr="Sat Feb 22 23:35:53 2020" version="7.70" xmloutputversion="1.04">
  <verbose level="0"/>
  <debugging level="0"/>
  <host><status state="up" reason="echo-reply" reason_ttl="62"/>
    <address addr="10.0.42.1" addrtype="ipv4"/>
    <hostnames>
    </hostnames>
    <times srtt="2235" rttvar="5000" to="100000"/>
  </host>
  <runstats><finished time="1582410953" timestr="Sat Feb 22 23:35:53 2020" elapsed="0.32"
    summary="Nmap done at Sat Feb 22 23:35:53 2020; 1 IP address (1 host up)
    scanned in 0.32 seconds" exit="success"/><hosts up="1" down="0" total="1"/>
  </runstats>
</nmaprun>
```

XML data - documents



Hundreds of document formats using XML syntax have been developed,[8] including RSS, Atom, SOAP, SVG, and XHTML. XML-based formats have become the default for many office-productivity tools, including Microsoft Office (Office Open XML), OpenOffice.org and LibreOffice (OpenDocument), and Apple's iWork[citation needed]. XML has also provided the base language for communication protocols such as XMPP. Applications for the Microsoft .NET Framework use XML files for configuration, and property lists are an implementation of configuration storage built on XML.[9]

Source: <https://en.wikipedia.org/wiki/XML>

- Document formats using XML may still be proprietary!
- Documents using XML can be validated, are they well-formed according to the Document Type Definition (DTD)

Transforming XML using XSLT



XSLT (Extensible Stylesheet Language Transformations) is a language for transforming XML documents into other XML documents,[1] or other formats such as HTML for web pages, plain text or XSL Formatting Objects, which may subsequently be converted to other formats, such as PDF, PostScript and PNG.[2] XSLT 1.0 is widely supported in modern web browsers.[3]

Source: <https://en.wikipedia.org/wiki/XSLT>

- Can be seen as a mapping between formats, different XML schemas
- Also is Turing complete, is a programming language



XSLT example

```
<?xml version="1.0" encoding="UTF-8"?>
<xsl:stylesheet xmlns:xsl="http://www.w3.org/1999/XSL/Transform" version="1.0">
  <xsl:output method="xml" indent="yes"/>
  <xsl:template match="/persons">
    <root> <xsl:apply-templates select="person"/> </root>
  </xsl:template>
  <xsl:template match="person">
    <name username="{@username}"> <xsl:value-of select="name" /> </name>
  </xsl:template>
</xsl:stylesheet>
```

- XSLT uses XPath to identify subsets of the source document tree and perform calculations. XPath also provides a range of functions
- XSLT functionalities overlap with those of XQuery, which was initially conceived as a query language for large collections of XML documents

Source: <https://en.wikipedia.org/wiki/XSLT>



xsltproc example using Nmap

```
$ su -  
# apt install nmap xsltproc  
# nmap -sP -oA /tmp/router 91.102.91.18  
# exit  
$ xsltproc /tmp/router.xml > /tmp/router.html  
$ firefox /tmp/router.html
```

- We can use the command line tool xsltproc for transforming documents
- apt install xsltproc
- Its part of the package Libxslt <https://en.wikipedia.org/wiki/Libxslt>
- Try installing the tools Nmap and xsltproc and reproduce the above
- This is an easy tool to try, and very useful too

Data overview JSON



JavaScript Object Notation (JSON, pronounced /dəsən/; also /dəsən/[note 1]) is an open-standard file format or data interchange format that uses **human-readable text** to transmit data objects consisting of attribute–value pairs and array data types (or any other serializable value). It is a very common data format, with a diverse range of applications, such as serving as replacement for XML in AJAX systems.[6]

Source: <https://en.wikipedia.org/wiki/JSON>

- I like JSON much better than XML
- Many web services can supply data in JSON format

JSON example



```
{  
  "first name": "John",  
  "last name": "Smith",  
  "age": 25,  
  "address": {  
    "street address": "21 2nd Street",  
    "city": "New York",  
    "state": "NY",  
    "postal code": "10021"  
  },  
  "phone numbers": [  
    {  
      "type": "home",  
      "number": "212 555-1234"  
    },  
  ],  
}
```

- This is a basic JSON document, new data attribute-value pairs can be added
Source: <https://en.wikipedia.org/wiki/JSON>

Note about frameworks and libraries



```
import xml.etree.ElementTree as ET
tree = ET.parse('testfile.xml')
root = tree.getroot()

print(root.tag)
print('Nmap version: \t\t{:s}'.format(root.attrib['version']))
print('Nmap started: \t\t{:s}'.format(root.attrib['startstr']))
print('Nmap command line: \t{:s}'.format(root.attrib['args']))

hosts = tree.findall('.//host')
for host in hosts:
    print(host.tag)
    print(host.attrib)
    for hostvalues in host:
        print(hostvalues.tag)
        print(hostvalues.attrib)
```

- Dont import JSON or XML using home made programs
- Example uses `xml.etree.ElementTree` from Python
<https://docs.python.org/3.7/library/xml.etree.elementtree.html>

Convert XML to JSON



```
import xml.etree.ElementTree as ET
import json
def etree_to_dict(t):
    d = {t.tag : map(etree_to_dict, t.getchildren())}
    d.update((('@' + k, v) for k, v in t.attrib.items()))
    d['text'] = t.text
    return d

tree = ET.parse('testfile.xml')
root = tree.getroot()
mydict = etree_to_dict(root)
print(type(tree))
print(type(root))
print(type(mydict))

print(mydict)

with open('testfile.json', 'w') as json_file:
    json.dump(mydict, json_file)
```

Converting using Python is easy

Web services SOAP, WSDL

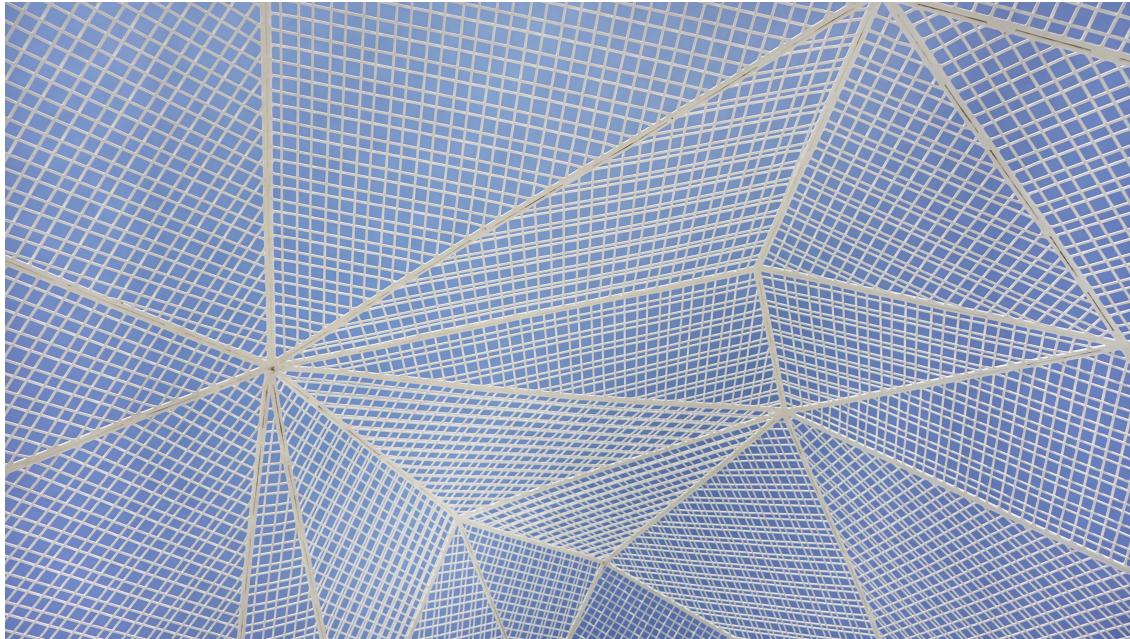


Photo by Josefina Di Battista on Unsplash

Web Services



The term Web service (WS) is either:

- a service offered by an electronic device to another electronic device, communicating with each other via the World Wide Web, or
- a server running on a computer device, listening for requests at a particular port over a network, serving web documents (HTML, JSON, XML, images), and creating web applications services, which serve in solving specific domain problems over the Web (WWW, Internet, HTTP)

Source: https://en.wikipedia.org/wiki/Web_service

- Today a generic name for services using the internet
- Web servers such as Apache HTTPD, Nginx etc. provide a service to the internet allowing access using HTTP
- Source for some parts on this slide, https://en.wikipedia.org/wiki/Web_service



A web service is a software system designed to support interoperable machine-to-machine interaction over a network. It has an interface described in a machine-processable format (specifically WSDL). Other systems interact with the web service in a manner prescribed by its description using SOAP-messages, typically conveyed using HTTP with an XML serialization in conjunction with other web-related standards.

Source – W3C, Web Services Glossary[3]

WSDL - Web Services Description Language



The Web Services Description Language (WSDL / w z dəl/) is an XML-based interface description language that is used for describing the functionality offered by a web service. The acronym is also used for any specific WSDL description of a web service (also referred to as a WSDL file), which provides a machine-readable description of how the service can be called, what parameters it expects, and what data structures it returns. Therefore, its purpose is roughly similar to that of a type signature in a programming language.

The current version of WSDL is WSDL 2.0. The meaning of the acronym has changed from version 1.1 where the "D" stood for "Definition".

Source: https://en.wikipedia.org/wiki/Web_Services_Description_Language

WSDL XML



```
<?xml version="1.0" encoding="UTF-8"?>
<description xmlns="http://www.w3.org/ns/wsdl"
    xmlns:tns="http://www.tmsws.com/wsdl120sample"
    xmlns:whttp="http://schemas.xmlsoap.org/wsdl/http/"
    xmlns:wsoap="http://schemas.xmlsoap.org/wsdl/soap/"
    targetNamespace="http://www.tmsws.com/wsdl120sample">

<documentation>
    This is a sample WSDL 2.0 document.
</documentation>
```

Source: https://en.wikipedia.org/wiki/Web_Services_Description_Language



WSDL XML types

```
<!-- Abstract type -->
<types>
  <xsschema xmlns:xs="http://www.w3.org/2001/XMLSchema"
    xmlns="http://www.tmsws.com/wsdl120sample"
    targetNamespace="http://www.example.com/wsdl120sample">

    <xselement name="request"> ... </xselement>
    <xselement name="response"> ... </xselement>
  </xsschema>
</types>
```

Source: https://en.wikipedia.org/wiki/Web_Services_Description_Language

Types Describes the data. The XML Schema language (also known as XSD) is used (inline or referenced) for this purpose.



WSDL XML interfaces

```
<!-- Abstract interfaces -->
<interface name="Interface1">
  <fault name="Error1" element="tns:response"/>
  <operation name="Get" pattern="http://www.w3.org/ns/wsdl/in-out">
    <input messageLabel="In" element="tns:request"/>
    <output messageLabel="Out" element="tns:response"/>
  </operation>
</interface>
```

Source: https://en.wikipedia.org/wiki/Web_Services_Description_Language

Interface Defines a Web service, the operations that can be performed, and the messages that are used to perform the operation.



WSDL XML the binding

```
<!-- Concrete Binding Over HTTP -->
<binding name="HttpBinding" interface="tns:Interface1"
    type="http://www.w3.org/ns/wsdl/http">
    <operation ref="tns:Get" whttp:method="GET"/>
</binding>

<!-- Concrete Binding with SOAP-->
<binding name="SoapBinding" interface="tns:Interface1"
    type="http://www.w3.org/ns/wsdl/soap"
    wsoap:protocol="http://www.w3.org/2003/05/soap/bindings/HTTP/"
    wsoap:mepDefault="http://www.w3.org/2003/05/soap/mep/request-response">
    <operation ref="tns:Get" />
</binding>
```

Source: https://en.wikipedia.org/wiki/Web_Services_Description_Language

Binding Specifies the interface and defines the SOAP binding style (RPC/Document) and transport (SOAP Protocol).
The binding section also defines the operations.



WSDL XML the Service

```
<!-- Web Service offering endpoints for both bindings-->
<service name="Service1" interface="tns:Interface1">
    <endpoint name="HttpEndpoint"
        binding="tns:HttpBinding"
        address="http://www.example.com/rest/" />
    <endpoint name="SoapEndpoint"
        binding="tns:SoapBinding"
        address="http://www.example.com/soap/" />
</service>
```

Source: https://en.wikipedia.org/wiki/Web_Services_Description_Language

Service Contains a set of system functions that have been exposed to the Web-based protocols.

SOAP - Simple Object Access Protocol



SOAP (abbreviation for Simple Object Access Protocol) is a messaging protocol specification for exchanging structured information in the implementation of web services in computer networks. Its purpose is to provide extensibility, neutrality, verbosity and independence. It uses XML Information Set for its message format, and relies on application layer protocols, most often Hypertext Transfer Protocol (HTTP), although some legacy systems communicate over Simple Mail Transfer Protocol (SMTP), for message negotiation and transmission.

Source: <https://en.wikipedia.org/wiki/SOAP>

Utilizes UDDI (Universal Description, Discovery, and Integration)

Web Service Explained



The term "Web service" describes a standardized way of integrating Web-based applications using the XML, SOAP, WSDL and UDDI open standards over an Internet Protocol backbone. XML is the data format used to contain the data and provide metadata around it, SOAP is used to transfer the data, WSDL is used for describing the services available and UDDI lists what services are available.

Source:https://en.wikipedia.org/wiki/Web_service

Again frameworks and libraries



A simple “Hello World” http SOAP server:

```
import SOAPpy
def hello():
    return "Hello World"
server = SOAPpy.SOAPServer(("localhost", 8080))
server.registerFunction(hello)
server.serve_forever()
```

And the corresponding client:

```
import SOAPpy
server = SOAPpy.SOAPProxy("http://localhost:8080/")
print server.hello()
```

- Dont process SOAP manually using home made programs
- <https://pypi.org/project/SOAPpy/>

SOAP Request



```
// HTTP here
POST / HTTP/1.0
Host: localhost:8080
User-agent: SOAPpy xxx (pywebsvcs.sf.net)
Content-type: text/xml; charset=UTF-8
Content-length: 340
SOAPAction: "hello"
// SOAP start here
<?xml version="1.0" encoding="UTF-8"?>
<SOAP-ENV:Envelope
    SOAP-ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
    xmlns:SOAP-ENC="http://schemas.xmlsoap.org/soap/encoding/"
    xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"
>
<SOAP-ENV:Body>
<hello SOAP-ENC:root="1">
</hello>
</SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

SOAP Response



```
// HTTP here
HTTP/1.0 200 OK
Server: <a href="http://pywebsvcs.sf.net">SOAPpy xxx</a> (Python 2.7.16)
Date: Mon, 24 Feb 2020 13:29:44 GMT
Content-type: text/xml; charset=UTF-8
Content-length: 510
// SOAP start here
<?xml version="1.0" encoding="UTF-8"?>
<SOAP-ENV:Envelope
    SOAP-ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
    xmlns:SOAP-ENC="http://schemas.xmlsoap.org/soap/encoding/"
    xmlns:xsi="http://www.w3.org/1999/XMLSchema-instance"
    xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"
    xmlns:xsd="http://www.w3.org/1999/XMLSchema"
>
<SOAP-ENV:Body>
<helloResponse SOAP-ENC:root="1">
<Result xsi:type="xsd:string">Hello World</Result>
</helloResponse>
</SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

REST Service



Figure 9.1

An entity service based on the Invoice business entity that defines a functional scope that limits the service capabilities to performing invoice-related processing. This agnostic Invoice service will be reused and composed by other services within the same service inventory in support of different automated business processes that need to process invoice-related data. This particular invoice service contract displays two service capabilities based on primitive methods and two service capabilities based on complex methods.



- Very typical REST URL/method `GET /invoice/{invoice-id}`
- See also https://en.wikipedia.org/wiki/Representational_state_transfer

Source:

Service-Oriented Architecture: Analysis and Design for Services and Microservices, Thomas Erl, 2017

10.1 RESTful services



Table 10.1 The RESTful API for the Rider Auto Parts order web service

Verb	http://rider.com/orders	http://rider.com/orders/{id}
GET	Retrieves a list of all the orders	Retrieves the order with the given ID
PUT	N/A	Updates the order with the given ID
POST	Creates a new order	N/A
DELETE	Cancels all the orders	Cancels the order with the given ID

RESTful services, also known as REST services, has become a popular architectural style used in modern enterprise projects. REST was defined by Roy Fielding in 2000 when he published his paper, and today REST is a foundation that drives the modern APIs on the web. You can also think of it as a modern web service, in which the APIs are RESTful and HTTP based so they're easily consumable on the web.

Small Source:

Camel in action, Claus Ibsen and Jonathan Anstey, 2018

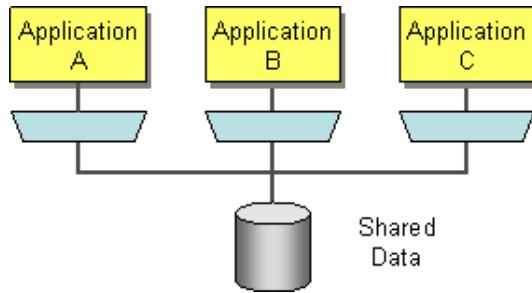
Python and REST



```
#!/usr/bin/env python
import requests
r = requests.get('https://api.github.com/events')
print (r.json());
```

- Lets try to use some Python to access a REST service.
- We will use the JSONPlaceholder which is a free online REST API: <https://jsonplaceholder.typicode.com/>
- Start at the site: <https://jsonplaceholder.typicode.com/guide.html> and try running a few of the examples with your browser
- Then try using the same URLs in the Requests HTTP library from Python,
<https://requests.readthedocs.io/en/master/>

Shared Database

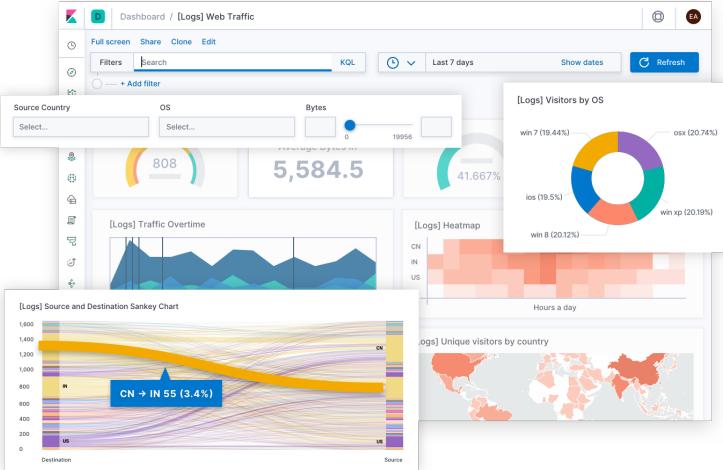


Shared Database — Have the applications store the data they wish to share in a common database.

Common systems and technologies used:

- database management system (DBMS) using Structured Query Language (SQL), relational database examples:
 - PostgreSQL, Oracle DM, Microsoft SQL, MySQL <https://en.wikipedia.org/wiki/SQL>
 - NoSQL databases has been a new input with examples like: MongoDB, CouchDB, Redis, RIAK <https://en.wikipedia.org/wiki/NoSQL>

Elastic stack Kibana



Screenshot from <https://www.elastic.co/kibana>

Elasticsearch is a search engine and document store used in a lot of different systems, allowing cross application integration.

Getting started with Elastic Stack



Easy to get started using the tutorial *Getting started with the Elastic Stack* :

<https://www.elastic.co/guide/en/elastic-stack-get-started/current/get-started-elastic-stack.html>

Today Elastic Stack contains lots of different parts.

- Elasticsearch - the core engine
- Logstash - a tool for parsing logs and other data.

<https://www.elastic.co/logstash>

"Logstash dynamically ingests, transforms, and ships your data regardless of format or complexity. Derive structure from unstructured data with grok, decipher geo coordinates from IP addresses, anonymize or exclude sensitive fields, and ease overall processing."

- Kibana - a web application for accessing and working with data in Elasticsearch

<https://www.elastic.co/kibana>

TCP/IP and External Data Representation 1987



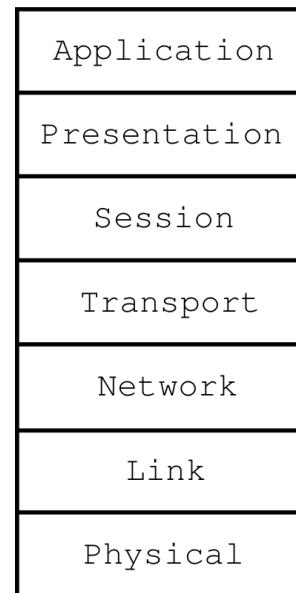
External Data Representation (XDR) is a standard data serialization format, for uses such as computer network protocols. It allows data to be transferred between different kinds of computer systems. Converting from the local representation to XDR is called encoding. Converting from XDR to the local representation is called decoding.

Source:

https://en.wikipedia.org/wiki/External_Data_Representation

<https://tools.ietf.org/html/rfc1014>

OSI Reference Model



Internet protocol suite

Applications	NFS		
HTTP, SMTP, FTP, SNMP,	XDR		
	RPC		
TCP UDP			
IPv4	IPv6	ICMPv6	ICMP
ARP	RARP	MAC	
Ethernet token-ring ATM ...			

Designing and Standardizing HTTP Response Codes



- 100-199 are informational codes used as low-level signaling mechanisms, such as a confirmation of a request to change protocols
- 200-299 are general success codes used to describe various kinds of success conditions
- 300-399 are redirection codes used to request that the consumer retry a request to a different resource identifier, or via a different intermediary
- 400-499 represent consumer-side error codes that indicate that the consumer has produced a request that is invalid for some reason, example 404 file not found
- 500-599 represent service-side error codes that indicate that the consumer's request may have been valid but that the service has been unable to process it for internal reasons. Elasticsearch exposes REST APIs that are used by the UI components and can be called directly to configure and access Elasticsearch features.

Source:

Service-Oriented Architecture: Analysis and Design for Services and Microservices, Thomas Erl, 2017



Exercise: Communicate with HTTP

Try this - use netcat/ncat, available in Nmap package from Nmap.org:

```
$ netcat www.zecurity.com 80  
GET / HTTP/1.0
```

```
HTTP/1.1 200 OK  
Server: nginx  
Date: Sat, 01 Feb 2020 20:30:06 GMT  
Content-Type: text/html  
Content-Length: 0  
Last-Modified: Thu, 04 Jan 2018 15:03:08 GMT  
Connection: close  
ETag: "5a4e422c-0"  
Referrer-Policy: no-referrer  
Accept-Ranges: bytes  
...
```

Basic test tools TCP - Telnet and OpenSSL



Telnet used for terminal connections over TCP, but is clear-text

Telnet can be used for testing connections to many older protocols which uses text commands

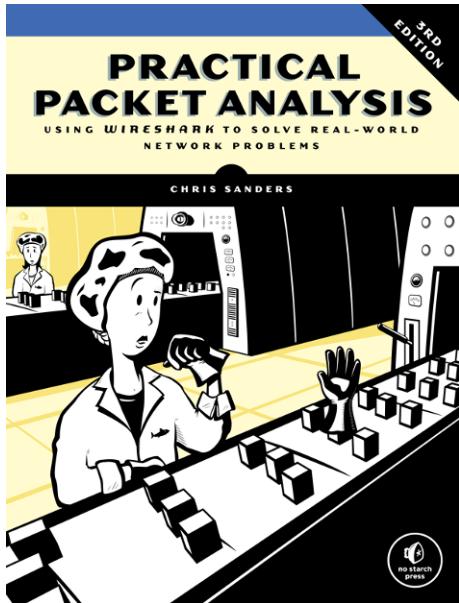
- telnet mail.kramse.dk 25 create connection to port 25/tcp
- telnet www.kramse.dk 80 create connection to port 80/tcp

Encrypted connections often use TLS and can be tested using OpenSSL command line tool
`openssl`

- `openssl s_client -host www.kramse.dk -port 443`
create connection to port 443/tcp with TLS
- `openssl s_client -host mail.kramse.dk -port 993`
create connection to port 993/tcp with TLS

Using OpenSSL in client-mode allows the use of the same commands like Telnet after connection

Book: Practical Packet Analysis (PPA)



Practical Packet Analysis, Using Wireshark to Solve Real-World Network Problems by Chris Sanders, 3rd Edition April 2017, 368 pp. ISBN-13: 978-1-59327-802-1

<https://nostarch.com/packetanalysis3>

Git intro



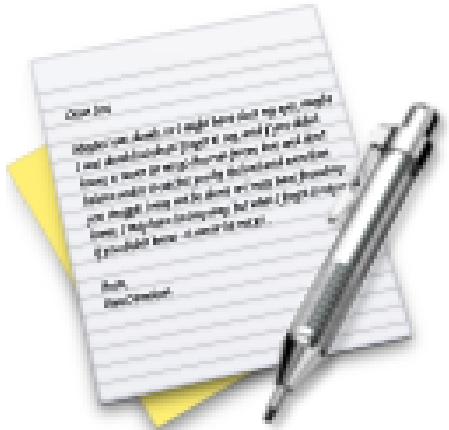
Git (/ t/)[7] is a distributed version-control system for tracking changes in source code during software development.[8] It is designed for coordinating work among programmers, but it can be used to track changes in any set of files. Its goals include speed,[9] data integrity,[10] and support for distributed, non-linear workflows.[11]

Source: <https://en.wikipedia.org/wiki/Git>

- We will introduce Git and Github - commercial Git hosting company
<https://en.wikipedia.org/wiki/Git>
- Try creating a Git repository, remember to add a README
- Checkout the repository
- Edit a file
- add and commit it

Read the Github Hello World example: <https://guides.github.com/activities/hello-world/>

Exercise

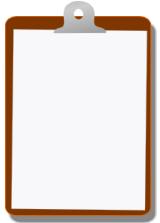


Now lets do the exercise

i Postman API Client 20 min

which is number **18** in the exercise PDF.

For Next Time



Think about the subjects from this time, write down questions

Check the plan for chapters to read in the books

Visit web sites and download papers if needed

Retry the exercises to get more confident using the tools