SECURITY IN THE MICROSERVICE ARCHITECTURE

SR - SEMINAR

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AGENDA

- Introduction to microservices
- Security problems in microservices
- Security-as-a-Service approach for microservices
- Conclusions

BASIC DEFINITIONS

A **monolithic application** is a software composed of modules that are not independent from the application to which they belong.

A **microservice** is a minimal independent process interacting with others via messages.

A **microservice architecture** is a distributed application where all modules are microservices.

MICROSERVICE ARCHITECTURE

Communication is performed through **RESTful API** or **message brokering** services.

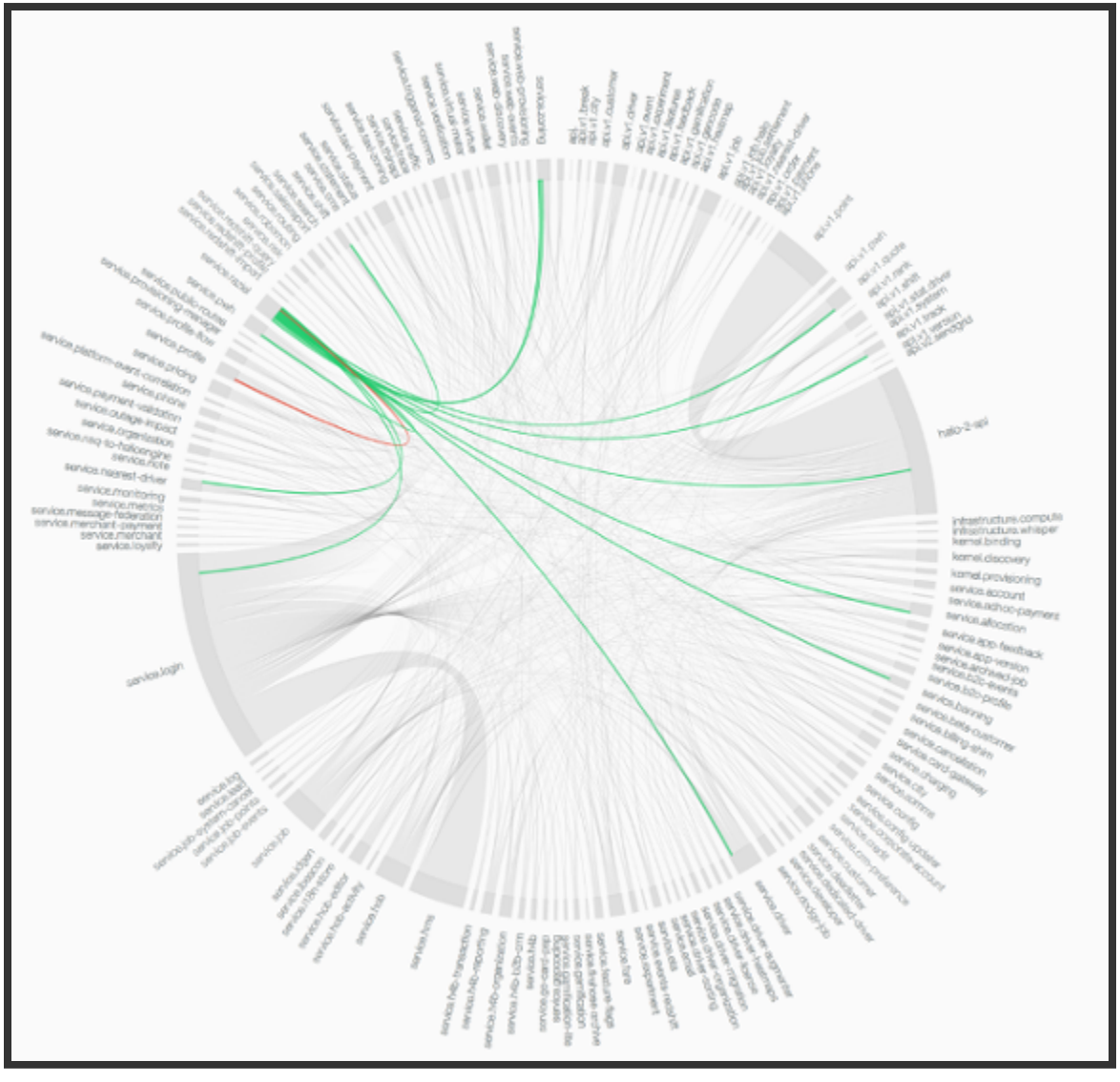
Each microservice is **autonomous** and **domain specific**.

They can be deployed on a single server, virtual machine, container or process.

ADVANTAGES

- Composability
- Scalability
- Resilience
- Technology agnostic
- Ease of deployment

REAL-WORLD EXAMPLES: HAILO



SECURITY ISSUES

- Greater surface attack area
- Heterogeneity
- Network complexity
- Authentication and authorization
- Communication security
- Trust

GREATER SURFACE ATTACK AREA

In the microservice infrastructure all services expose API that are independent from the programming language.

These services can in principle be **accessed by the external**.

HETEROGENEITY

The application can be made out of a very **large number of services** that can also be unknown in advance.

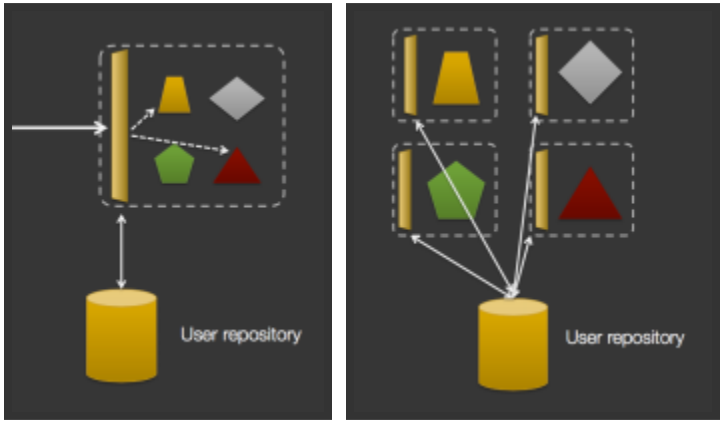
No common security infrastructure, different *Trusted Computing Base*.

NETWORK COMPLEXITY

The architecture bring difficulties in debugging, monitoring, auditing, and forensic analysis of the entire application.

Attackers could **exploit this complexity** to attempt attacks against applications.

AUTHENTICATION AND AUTHORIZATION



Each micro-service has to ensure that the request comes from an authenticated client with the correct rights.

To avoid repeated work an **SSO Gateway** can be used, to login and check users authorization.

DETAILS

There is no actual standard, but the main idea is to use a **token system**.

The most used technologies are:

- JWT, a token system.
- OpenID, decentralised authentication protocol.
- OAuth, a delegation protocol.

COMMUNICATION SECURITY

The communication between the services should be **secure**.

Adopted technology:

- HTTPS
- HMAC Over HTTP

TRUST

We can't assume a microservice trustworthy.

Encrypt and certificate the communication is not enough, so that a compromised service can't act against us.

CONFUSED DEPUTY PROBLEM

When a malicious party can trick a deputy service into making calls to a downstream service on his behalf that he shouldn't be able to.

A NETFLIX VULNERABILITY

A subdomain of Netflix was **compromised** so that an adversary:

- can serve any content in the context of netflix.com.
- was able to tamper authenticated Netflix subscribers and their data.

SECURITY-AS-A-SERVICE

In the paper "Security-as-a-Service for Microservices-Based Cloud Applications" a solution is proposed to monitor and analyse microservice requests to ensure some **communication policy**.

MONITOR THE NETWORK

The solution must have these characteristics:

- Completeness
- Tamper resistance
- Flexibility
- Efficiency

DESIGN

Put the monitoring part outside the business logic.

Create a **security VM** that can analyse and monitor the flow coming from the application VM.

All the network events of the application VM can be **redirected** by the SDN of the cloud infrastructure.

FLOWTAP PRIMITIVE

To avoid custom network configuration it is possible to define a new primitive:

```
FlowTap (SRC, DST, Flow_Syntax, Action)
```

- **SRC**, the port of the source VM
- **DST**, the port of the destination VM
- **Flow_Syntax**, identifies a specific flow to tap
- **Action**, forwarding or redirect

Flow_Syntax Example (Monitor incoming HTTP requests):

```
nw_src = 0.0.0.0/0; nw_proto = TCP; tp_dst = 80
```

FTC COMPILER

A tool to translate the policies written in Datalog to a set of FlowTap call.

It can dynamically compile the policies into different sets of FlowTap calls to **maximise the efficiency** of the system based on CPU usage and network loads.

IMPLEMENTATION

FlowTap is implemented on the **OpenStack Icehouse** release.

The following component have been modified:

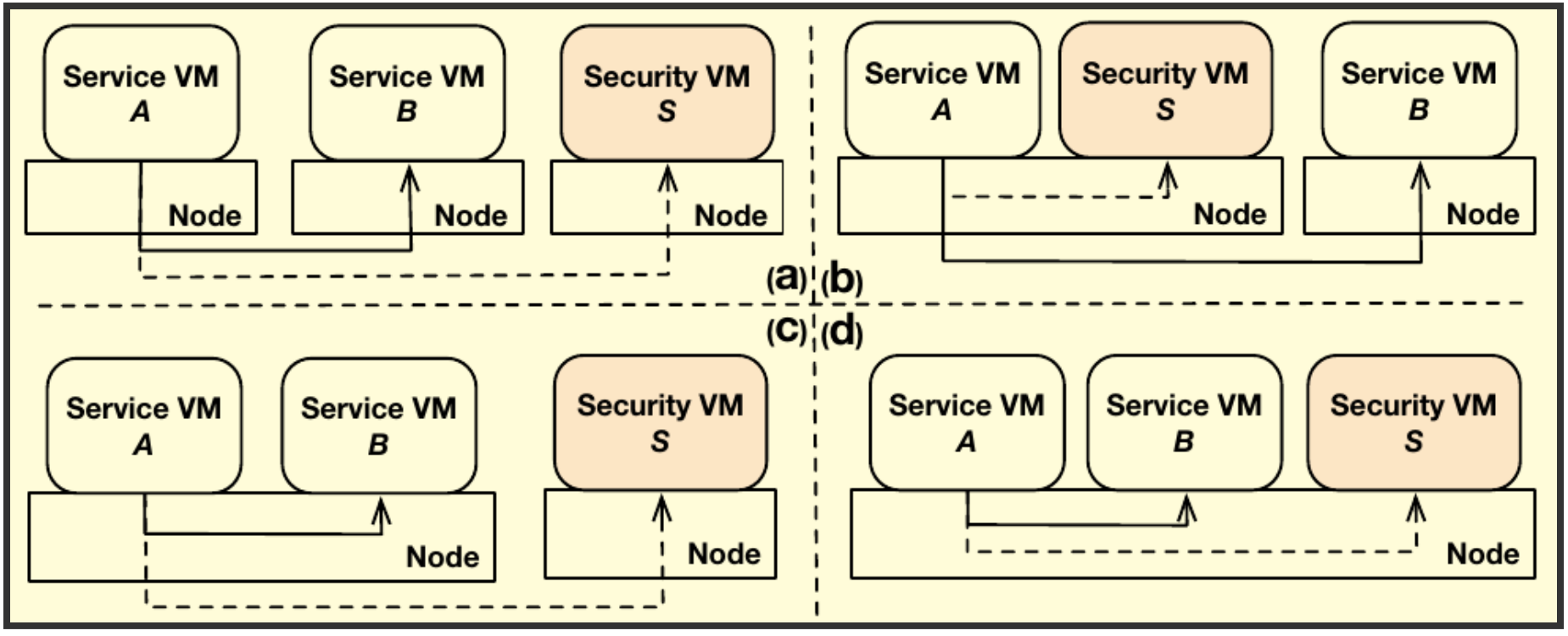
- The integration bridge (`br-int`) that connects to VMs
- The tunneling bridge (`br-tun`) that tunnels the VM traffic across cloud nodes.

HOW IT WORKS

The modified `br-int` processes each packet in the following way:

1. It compares the flow with the flow syntax
2. If it matches, the flow is duplicated or taken as is
3. Change the original MAC address with the security VM one
4. re-submit to the `br-int` if the security VM is on the same node, or to the `br-tun` for tunnelling.

EVALUATION



Scenario	(a)	(b)	(c)	(d)
Baseline (Mbps)	2600	2600	12000	12000
FlowTap (Mbps)	2100	2600	5100	9100
Throughput reduction	19%	0%	57%	24%

PROBLEMS OF THIS APPROACH

- It generates a lot of additional network traffic and work.
- It needs an infrastructure implementation *(cloud providers have to adopt it)*.
- Difficulties to deploy the security VM machine in the optimal nodes.
- It cannot tap a specific flow at the Application layer *(reduce check performance)*.
- The management of the security VMs can becomes more complex.

CONCLUSION

The microservice architecture is a style that is increasingly gaining popularity both in academia and in the industrial world.

Standardization and research should work to create a more robust infrastructure to build secure and scalable microservices.

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