VOLKSWAGEN

AKTIENGESELLSCHAFT

Developing a Cloud Computing Based Approach for Forensic Analysis using OCR

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Outline

1. Motivation
2. Background
3. Developing a Cloud-based Framework
4. Implementing Our System
5. Conclusion

Motivation

- Digital forensic tools to extract information
- Criminals: Information hiding in files
- Embedding screenshot of text in PDF files

↓

This text could be extracted!

Processing different file types

	Before OCR	With OCR
→	Plain text of the file	Text and images of the file
→	Plain text of the file	Text and images of the file
→	Plain text of the file	Plain text of the file
→	nothing	Information of the picture
→	nothing	nothing

Advantage Optical Character Recognition (OCR)

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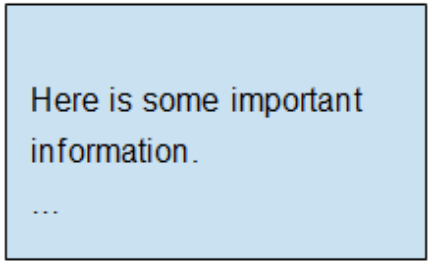

Figure 1: Example figure

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Here is some important information.

…

Figure 1: Example figure

With OCR

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- Embedded in standalone tools like FTK (with Version 3.1)
- Performance is the bottleneck
- Problems with system scalability

Our aims

1) Cloud-based approach to perform OCR jobs for forensic purposes;
2) Clearly defined communication protocol between the job controller and each virtual machine;
3) Analytical solution for setting up multiple virtual machines

Challenges

1) Most cloud-based systems do not naturally support OCR
2) Standard operating systems available on cloud are unnecessarily large
3) Current cloud-based solutions lack a centralized management tool to organize the jobs

Deriving the number of virtual machines

Probability of each incoming job is delayed

$$P_d = \frac{P_0 (m\rho)^m}{m!(1-\rho)}$$

with

$$P_0 = \left[\sum_{k=0}^{m-1} \frac{(m\rho)^k}{k!} + \frac{(m\rho)^m}{m!\,(1-\rho)} \right]^{-1}$$

Time to complete a job

$$T = \frac{P_d}{m\mu - \lambda} + \frac{1}{\mu}$$

p: utilization rate $\rho = \frac{\lambda}{m\mu} < 1$

m: number of VMs

μ: average engaging rate of each VM

λ: average incoming rate of each job

Example for the calculation

Convert 10 pages in 100 seconds

$\mu = 10/100 = 0.1$

Process 12 pages per minute

$\lambda = 12/60 = 0.2$

Probability of delay (for three VMs)

$P_d = 0.2353$

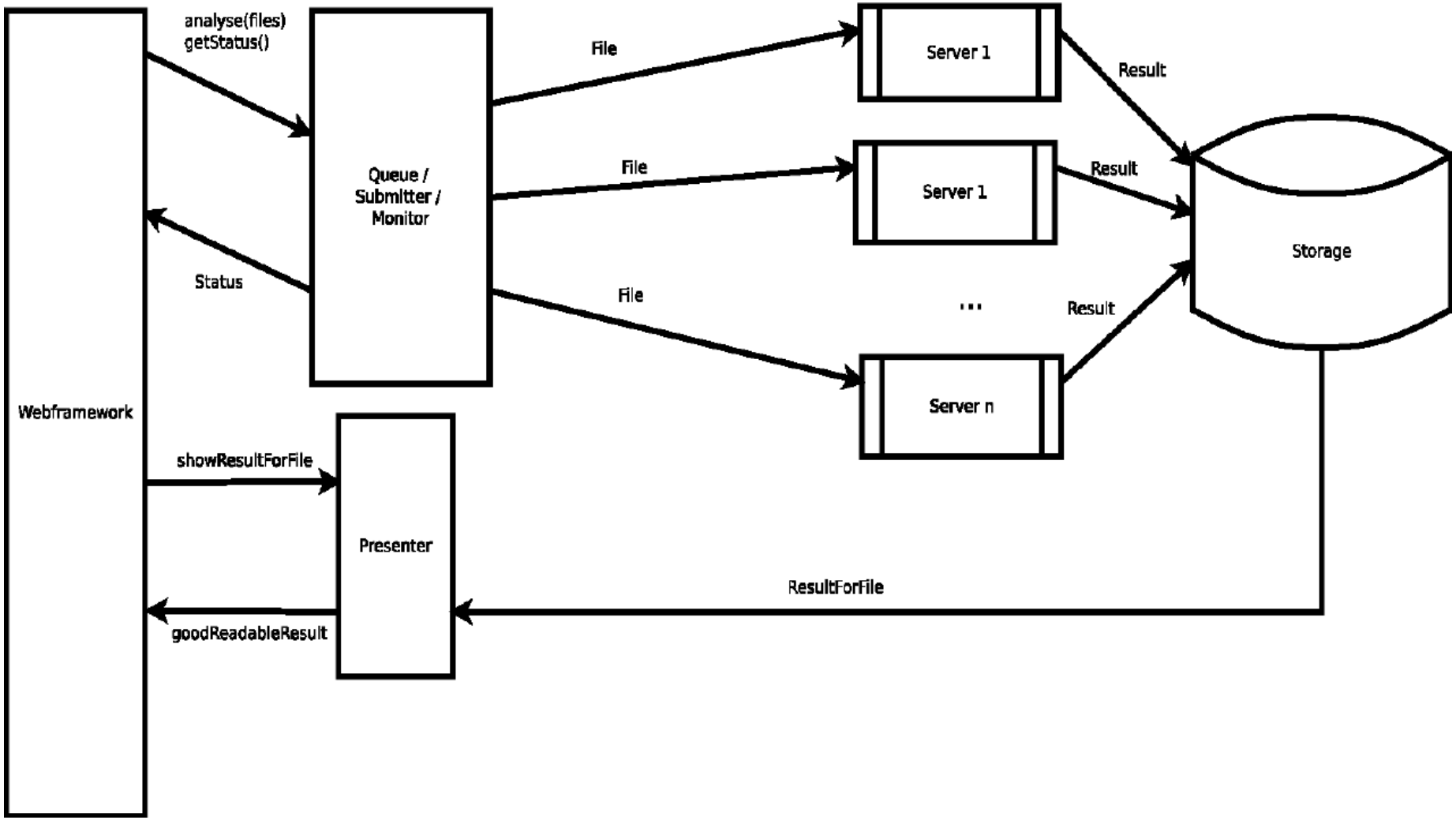
<u>Result:</u>

$T = 12.353$ sec → Processing 17,280 PDF pages per day

Why processing the whole page?

- No context information get lost

Implementing Our System - Architecture



Implementing Our System

Forensic tool

Please upload a pdf file or a zip-file

select

Start to compute

Currently working processes

id	hash	status	download
1	zna7M...	finished	download
2	KwcN1...	finished	download
3	BFUQe...	running	-
4	RXjRD...	running	-
5	XpTz9...	running	-
6	n94gl...	running	-
7	8fklZ...	not started	-

ImageMagick

“convert -sharpen 2 -type Grayscale" + density + "-units PixelsPerInch - depth 8" + input + " " + tempfile + "%d.tif“

Tesseract (for all files)

“tesseract " + file + str(i) + “.txt >>"+output

Conclusion

- Proposed a cloud based system for forensic analysis (open-source)
- Scalable system (cloud based system using virtual machines)
- Framework improves scalability, performance, flexibility and upgradability

- Future studies on breaking CAPTCHA by using our OCR

Thank you for your attention!

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Developing a waiting policy

- All pages have to be processed before showing

Probability of saturation the system with *s* jobs:

$$P_S = \frac{\left(1-\frac{\lambda}{\mu}\right)\left(\frac{\lambda}{\mu}\right)^S}{1-\left(\frac{\lambda}{\mu}\right)^{S+1}} = 0.0009837$$

S=5

Number of blocked jobs:

$$N = \sum_{k=0}^{S} kP_k = \frac{\frac{\lambda}{\mu}}{1-\frac{\lambda}{\mu}} - \frac{\frac{\lambda}{\mu}}{1-\frac{\lambda}{\mu}}(S+1)P_S = 0.6615$$

Time that a job spends in the system:

$$T = \frac{N}{\lambda(1-P_S)} = 3.3105 \text{ sec}$$

More jobs then machines

$$m\mu P_k = \lambda P_{k-1}$$

$$\begin{aligned} P_k &= \frac{\lambda}{m\mu} P_{k-1} \\ &= \left(\frac{\lambda}{\mu}\right)^{k-m} \left(\frac{1}{m}\right)^{k-m} P_m \\ &= \frac{(m\rho)^{k-m}}{m^{k-m}} \left(\frac{m\rho^m}{m!} P_0\right) \\ &= \frac{m^m \rho^k}{m!} P_0 \end{aligned}$$