The background of the slide features a large, faint watermark of the Uppsala University seal. The seal is circular with a sunburst in the center, surrounded by the Latin text "HIGRATIACADEMIA" at the top and "VERITAS NATURAE" at the bottom.

# Providing Access Control and Copy-on-Write for Content Distribution Network Assets

## Researching Copy-on-Write solutions

---

Lukas Klingsbo <luk18671@student.uu.se>

Department of Information Technology  
Uppsala University

April 4, 2016



# Outline

---

## 1 Background

- Uprise
- CDN
- BattleBinary
- Problem
- Copy-on-Write
- Related Work
- Solutions Idea

## 2 Perius

- Model
- Implementation



## Background

Uprise

CDN

BattleBinary

Problem

Copy-on-Write

Related Work

Solutions Idea

## Perius



GHOST



# Content Distribution Network (CDN)

## Background

Uprise

CDN

BattleBinary

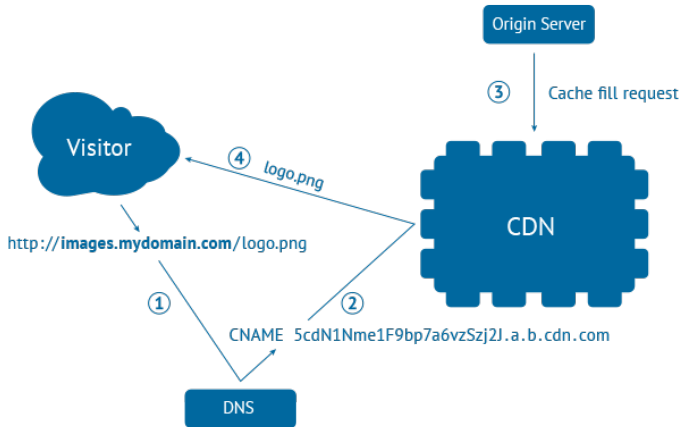
Problem

Copy-on-Write

Related Work

Solutions Idea

## Perius





# BattleBinary

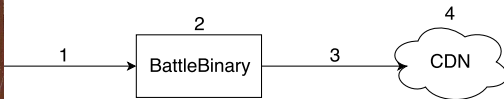
## Background

Uprise  
CDN

## BattleBinary

Problem  
Copy-on-Write  
Related Work  
Solutions Idea

## Perius



- 1. Image is uploaded to BattleBinary
- 2. Filename + Part of file's hash = Asset Identifier
- 3. Upload image to CDN
- 4. Image is available to everybody with link  
<http://ea.akamaihd.net/cat-f1ee0283b6accd6.jpg>



# BattleBinary

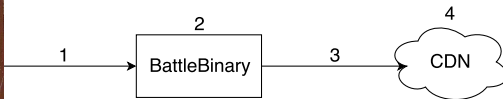
## Background

Uprise  
CDN

## BattleBinary

Problem  
Copy-on-Write  
Related Work  
Solutions Idea

## Perius



- 1. Image is uploaded to BattleBinary
- 2. Filename + Part of file's hash = Asset Identifier
- 3. Upload image to CDN
- 4. Image is available to everybody with link  
<http://ea.akamaihd.net/cat-f1ee0283b6accd6.jpg>



# BattleBinary

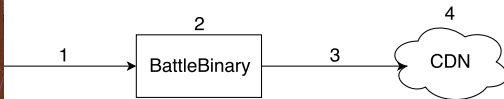
## Background

Uprise  
CDN

### BattleBinary

Problem  
Copy-on-Write  
Related Work  
Solutions Idea

## Perius



- 1. Image is uploaded to BattleBinary
- 2. Filename + Part of file's hash = Asset Identifier
- 3. Upload image to CDN
- 4. Image is available to everybody with link  
<http://ea.akamaihd.net/cat-f1ee0283b6accd6.jpg>



# BattleBinary

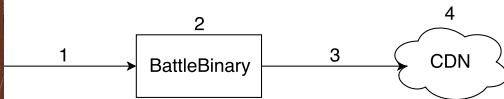
## Background

Uprise  
CDN

### BattleBinary

Problem  
Copy-on-Write  
Related Work  
Solutions Idea

## Perius



- 1. Image is uploaded to BattleBinary
- 2. Filename + Part of file's hash = Asset Identifier
- 3. Upload image to CDN
- 4. Image is available to everybody with link  
<http://ea.akamaihd.net/cat-f1ee0283b6accd6.jpg>





# Problem

---

## Background

Uprise

CDN

BattleBinary

Problem

Copy-on-Write

Related Work

Solutions Idea

## Perius

- Insecure
- Impractical
- wont scale



# Problem

---

## Background

Uprise

CDN

BattleBinary

Problem

Copy-on-Write

Related Work

Solutions Idea

## Perius

- Insecure
- Impractical
- wont scale



# Problem

---

## Background

Uprise

CDN

BattleBinary

Problem

Copy-on-Write

Related Work

Solutions Idea

## Perius

- Insecure
- Impractical
- wont scale

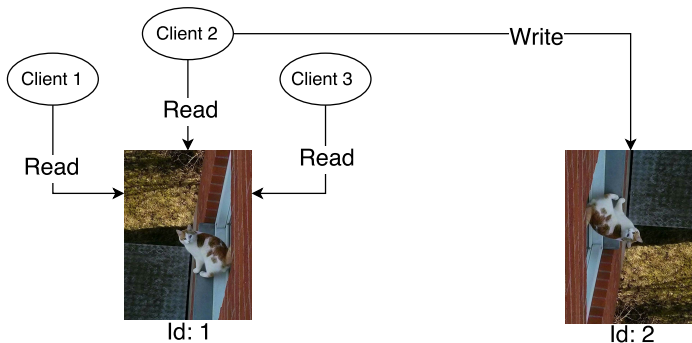


# Copy-on-Write

## Background

Uprise  
CDN  
BattleBinary  
Problem  
Copy-on-Write  
Related Work  
Solutions Idea

## Perius



\*IDs are GUIDs in real implementations



# Effects of COW

---

## Background

Uprise

CDN

BattleBinary

Problem

Copy-on-Write

Related Work

Solutions Idea

## Perius

- No accidental incremental changes or race conditions
- No locks needed → Scalability
- Take snapshots of system in constant time
- Needs some form of garbage collection/awareness



# Effects of COW

---

## Background

Uprise

CDN

BattleBinary

Problem

Copy-on-Write

Related Work

Solutions Idea

## Perius

- No accidental incremental changes or race conditions
- No locks needed → Scalability
- Take snapshots of system in constant time
- Needs some form of garbage collection/awareness



# Effects of COW

---

## Background

Uprise

CDN

BattleBinary

Problem

Copy-on-Write

Related Work

Solutions Idea

## Perius

- No accidental incremental changes or race conditions
- No locks needed → Scalability
- Take snapshots of system in constant time
- Needs some form of garbage collection/awareness



# Effects of COW

---

## Background

Uprise  
CDN  
BattleBinary  
Problem  
Copy-on-Write  
Related Work  
Solutions Idea

## Perius

- No accidental incremental changes or race conditions
- No locks needed → Scalability
- Take snapshots of system in constant time
- Needs some form of garbage collection/awareness





# Related Work

---

## Background

Uprise  
CDN  
BattleBinary  
Problem  
Copy-on-Write

Related Work

Solutions Idea

## Perius

- Mach kernel
- Btrfs
- Programming Languages



# Related Work

---

## Background

Uprise  
CDN  
BattleBinary  
Problem  
Copy-on-Write  
Related Work  
Solutions Idea

## Perius

- Mach kernel
- Btrfs
- Programming Languages



# Related Work

---

## Background

Uprise  
CDN  
BattleBinary  
Problem  
Copy-on-Write  
Related Work  
Solutions Idea

## Perius

- Mach kernel
- Btrfs
- Programming Languages



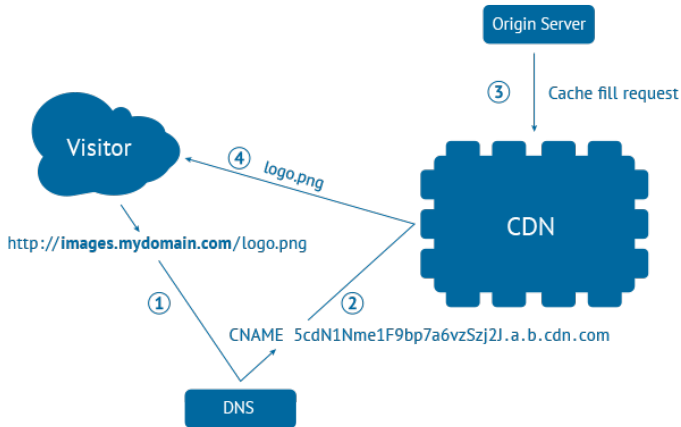
# Solutions Idea

## Background

Uprise  
CDN  
BattleBinary  
Problem  
Copy-on-Write  
Related Work

Solutions Idea

## Perius





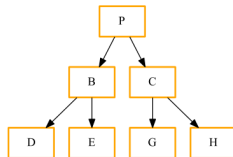
# Example Operation

## Background

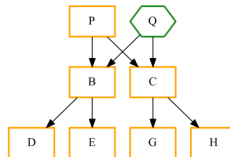
Uprise  
CDN  
BattleBinary  
Problem  
Copy-on-Write  
Related Work

Solutions Idea

## Perius



(a) Tree  $T_p$



(b)  $T_p$  cloned to  $T_q$

BTRFS: The Linux B-Tree Filesystem, O. Rodeh et al



# Virtual Filesystem

Background

Perius

Model

Implementation

ProjectsSearchAbout

▼ Sparta

▼ avatars

DefaultAvatar

NonDefaultAvatar

▼ backgrounds

▼ wallpaper

high def

Elephant

buttons

logos

UI

bluepeoplemovieavatar

mr beanbluepeoplemovieavatar

hdwallpaperelephant

Filename: Elephant

Filename:	Elephant
Dimensions:	3840x2400
Size:	900100KB
Date uploaded:	2015-10-18 12:15
Tags:	<div>elephantwallpaperhd</div>

CloudFront


https://wallpaperscraft.com/image/elephant\_large\_grass\_walk\_ears\_trunk\_166f

Akamai

https://wallpaperscraft.com/image/elephant\_large\_grass\_walk\_ears\_trunk\_166f

S3

https://wallpaperscraft.com/image/elephant\_large\_grass\_walk\_ears\_trunk\_166f



Elephant

Edit content

Download

Delete

Dept. of Information Technology

- 12 -

Lukas Klingsbo | lukl8671@student.uu.se



# Model

---

Background

Perius

Model

Implementation

- Describes the system that is to be implemented
- Model informally checked through JPF
- Inspired by Biba. et al



# Model

---

Background

Perius

Model

Implementation

- Describes the system that is to be implemented
- Model informally checked through JPF
- Inspired by Biba. et al





# Model

---

Background

Perius

Model

Implementation

- Describes the system that is to be implemented
- Model informally checked through JPF
- Inspired by Biba. et al



# Stack

Background

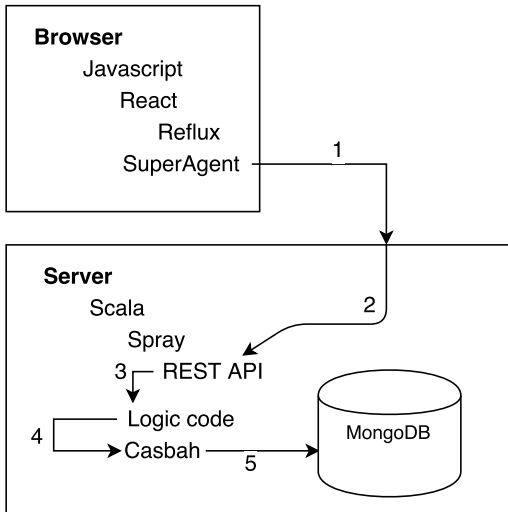
Perius

Model

Implementation

**Front-end  
(Perius-front)**

**Back-end  
(Perius)**





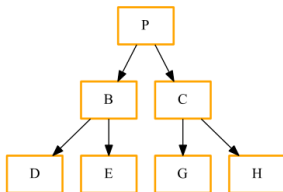
# Snapshots (and branching)

Background

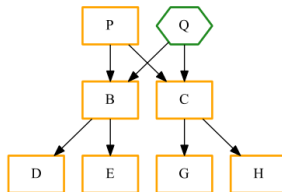
Perius

Model

Implementation



(a) Tree  $T_p$



(b)  $T_p$  cloned to  $T_q$



# Scalability

---

Background

Perius

Model

Implementation

- Unlimited scaling on width
- Optional Non-Blocking I/O with Reactive Mongo
- Some heavy operations can be solved with caching



# Scalability

---

Background

Perius

Model

Implementation

- Unlimited scaling on width
- Optional Non-Blocking I/O with Reactive Mongo
- Some heavy operations can be solved with caching



# Scalability

---

Background

Perius

Model

Implementation

- Unlimited scaling on width
- Optional Non-Blocking I/O with Reactive Mongo
- Some heavy operations can be solved with caching