Frankfurt University of Applied Sciences

–Faculty of Computer Science and Engineering–

Using Non-Fungible Tokens to Track User Data Across Websites

What this paper is for (Abschlussarbeit zur Erlangung des ...)

Forschungsprojekt Winter Semester 22/23

Submitted by

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Hendrik Gruber

ABSTRACT

Lorem ipsum ...

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ACRONYMS

NFT	Non-Fungible Token

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1.1 MOTIVATION

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2 BACKGROUND

This chapter introduces ...

2.1 MY NAME SECTION

The term ...

3

STATE OF THE ART

Several research groups [**frankl:1959**][**postman:2005**] have presented ...

4

THE METHOD

In order to communicate through the **NoC!** (**NoC!**), a common **IPA!** (**IPA!**) sending an incomplete packet.

5 EIN WEITERES KAPITEL

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5.1 LISTEN

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1. Enumeration with small numbers
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A. Enumeration with small caps (alpha)

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5.2 GRAFIKEN

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5.2.1 *Einfache Grafiken*

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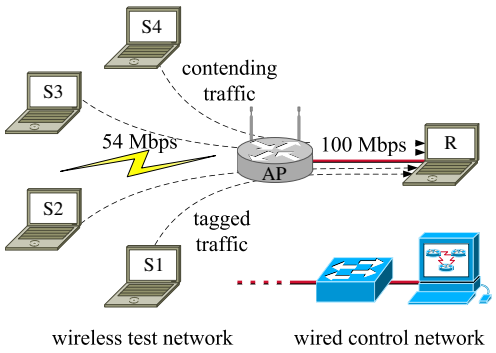

Figure 5.1: Dies ist eine einfache Grafik

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5.2.2 *Grafiken mit Subfloat*

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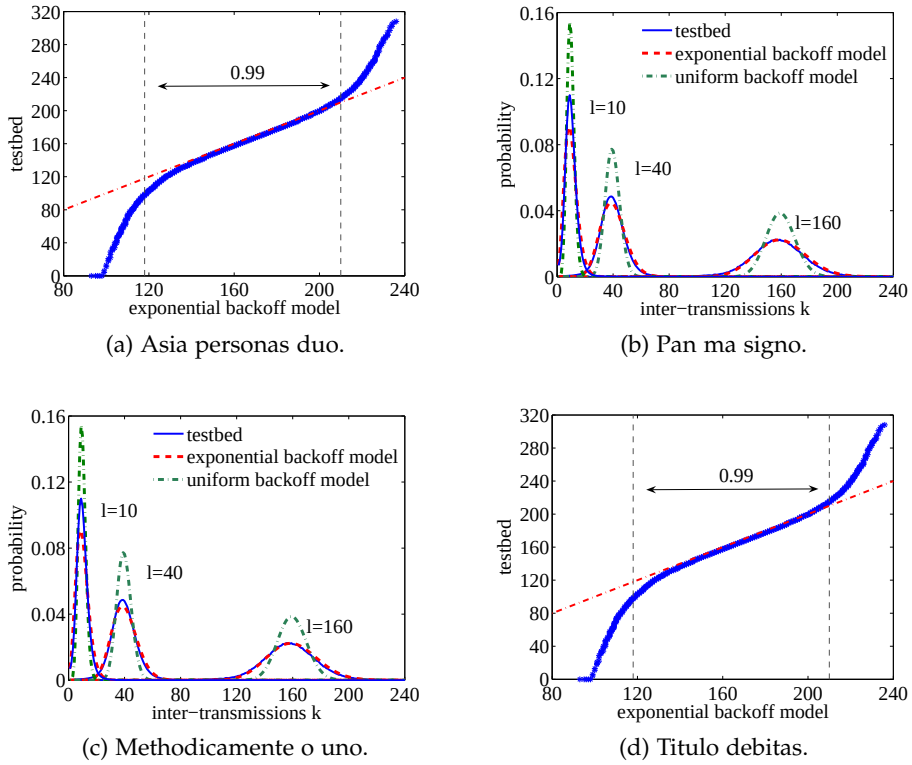

(a) Asia personas duo.

(b) Pan ma signo.

(c) Methodicamente o uno.

(d) Titulo debitas.

Figure 5.2: Mit Subfloat lassen sich mehrere Grafiken neben- und untereinander darstellen. Jeder Figure kann dabei mit einem eigenen Text versehen werden.

5.2.3 *Grafiken mit Minipage*

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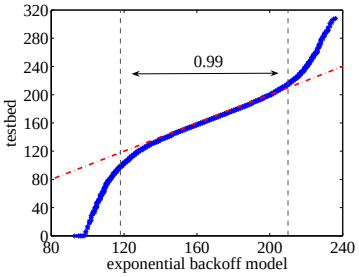

Figure 5.3: Minipage-Grafik Nummero uno

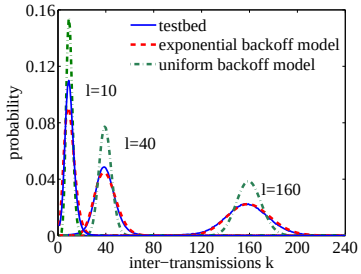

Figure 5.4: Minipage-Grafik Nummer zwei

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5.3 TABELLEN

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5.4 LISTINGS

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5.5 EQUATIONS

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$$U = R * I \tag{5.1}$$

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$$I = \frac{U}{R} \tag{5.2}$$

In the following we use probability theory to derive closed-form expressions for the fairness that is achieved among M contending stations. We tag station M and denote K_i the inter-transmissions of station $i = 1 \dots M-1$ and let $K = \sum_{i=1}^{M-1} K_i$. The conditional probability $P[K=k|l]$ can be defined for $M \geq 2$ as

$$\mathsf{P}[K=k|l] = \mathsf{P}\left[\sum_{i=1}^{M-1} K_i = k \middle| l\right] \tag{5.3}$$

where the random variables K_i are the integers that satisfy

$$\sum_{j=1}^{K_i} b_i(j) \leq \sum_{j=1}^{l} b_M(j) \quad \text{and} \quad \sum_{j=1}^{K_i+1} b_i(j) > \sum_{j=1}^{l} b_M(j).$$

5.6 THEOREM AND PROOF

We use the central limit theorem to derive the long-term fairness. In the sequel, we denote normal random variables $N(\mu, \sigma^2)$ where μ is the mean and σ^2 the variance.

Theorem 1 (Gaussian approximation) *Let the $b_i(j)$ be i.i.d. random variables with mean μ and variance σ^2 and let $M = 2$. For $k, l \gg 1$ (5.3) is approximately Gaussian where*

$$\mathsf{P}[K \leq k|l] \approx \mathsf{P}\left[N(0,1) \leq \frac{\mu\,(k-l)}{\sigma\sqrt{k+l}}\right].$$

Proof For $M = 2$ we have from (5.3) that

$$\mathsf{P}[K<k|l] = \mathsf{P}\left[\sum_{j=1}^{k} b_1(j) > \sum_{j=1}^{l} b_2(j)\right]$$

and after expansion and some normalization this equals

$$= \mathsf{P}\left[\frac{\sum_{j=1}^{l} b_2(j) - l\mu}{\sigma\sqrt{l}} - \frac{\sum_{j=1}^{k} b_1(j) - k\mu}{\sigma\sqrt{l}} < \frac{\mu(k-l)}{\sigma\sqrt{l}}\right].$$

Using the central limit theorem it follows that

$$\mathsf{P}[K<k|l] \approx \mathsf{P}\left[N(0,1) - N\left(0, \frac{k}{l}\right) < \frac{\mu(k-l)}{\sigma\sqrt{l}}\right].$$

Since the normal distribution with zero mean is symmetric we can replace the subtraction of $N(0, k/l)$ by addition. Furthermore, the sum of two normal random variables $N(\mu_1, \sigma_1^2)$ and $N(\mu_2, \sigma_2^2)$ is normal with $N(\mu_1 + \mu_2, \sigma_1^2 + \sigma_2^2)$ such that

$$\mathsf{P}[K<k|l] \approx \mathsf{P}\left[N\left(0, \frac{k+l}{l}\right) < \frac{\mu(k-l)}{\sigma\sqrt{l}}\right].$$

Finally, we use that if X is $N(a\mu, a^2\sigma^2)$ then $Y = X/a$ is $N(\mu, \sigma^2)$ with $a^2 = (k+l)/l$ to standardize the result. ∎

Th. 1 assumes i.i.d. random countdown values. It does, however, not make any assumption about their distribution.

6

EXPERIMENTS AND RESULTS

The experiments chapter demonstrates the methods of verification that were taken in order to test the functionality of the **IPA!**.

7

CONCLUSION AND FUTURE WORK

As it was shown in Chapter 6, it is possible to ...

APPENDIX