P. J. Safarik University

Faculty of Science

OPEN ELECTRONIC SIGNATURE SOFTWARE

BACHELOR'S THESIS

Field of Study:	**Informatika**
Institute:	**Institute of Computer Science**
Tutor:	**RNDr. Viliam Kačala**

Košice 2020

Jakub Ďuraš

Acknowledgments

Thanks to the Planet!

P. J. Šafárik University in Košice
Faculty of Science

THESIS ASSIGNMENT

Name and Surname: Jakub Ďuraš
Study programme: Applied Informatics (Single degree study, bachelor I. deg., external form)
Field of Study: 9.2.9. applied informatics
Type of Thesis: Bachelor thesis
Language of Thesis: English
Secondary language: Slovak

Title: Open digital signature software

Title SK: Otvorený softvér na elektronické podpisovanie

Aims:
1. Explore the principles and global legal status of digital signatures.
2. Review current digital signature software.
3. Propose and develop open-source, cross-platform, and user-friendly software compliant with eIDAS Regulation (Regulation No 910/2014) for digital document signing.

References:
1. Christof Paar and Jan Pelzl: Understanding Cryptography - A Textbook for Students and Practitioners, Springer, 2009, ISBN 978-3-642-04100-6
2. Stephen Mason: Electronic Signatures in Law - Fourth Edition, Humanities Digital Library, 2016, ISBN 978-1-911507-01-7, http://humanities-digital-library.org/index.php/hdl/catalog/view/electronicsignatures/1/86-1
3. Mike Rosulek: The Joy of Cryptography, School of Electrical Engineering & Computer Science, Corvallis, Oregon, USA, 2019, http://web.engr.oregonstate.edu/rosulekm/crypto/crypto.pdf

Annotation: With the recent changes in the legal status of digital signatures in many parts of the world, there is a need for easily accessible solutions intended as an alternative to handwritten signatures. This may be more necessary than ever since digital communication is the preferred way of communication. This bachelor thesis aims to explore the principles and legal status of digital signatures, review current digital signature software, and explore possible obstacles the open-source community is facing to develop such specialized applications. We propose an open-source, cross-platform, and user-friendly software compliant with the eIDAS Regulation (Regulation No 910/2014). Our application should allow ordinary users to quickly sign and verify signatures of different types of documents and therefore easily use them in everyday life.

Keywords: digital signature, digital seal, qualified, open-source, XAdES, PAdES, CAdES, desktop software

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Electronic version available: unlimited

Approved: Prof. RNDr. Viliam Geffert, DrSc.

riaditeľ ústavu

Abstrakt

Abstrakt obsahuje informáciu o cieľoch práce, jej stručnom obsahu, výsledkoch a význame celej práce. Súčasťou abstraktu je 3–5 kľúčových slov. Abstrakt sa píše súvisle ako jeden odsek a jeho rozsah je spravidla 100 až 500 slov.

Kľúčové slová: *lorem ipsum, dolor, sit amet*

Abstract

With the recent changes in the legal status of electronic signatures in many parts of the world, there is a need for easily accessible solutions intended as an alternative to handwritten signatures. This may be more necessary than ever since electronic communication is the preferred way of communication. This bachelor thesis aims to explore the principles and legal status of electronic signatures, review current electronic signature software, and explore possible obstacles the open-source community is facing to develop such specialized applications. We propose an open-source, cross-platform, and user-friendly software compliant with the eIDAS Regulation (Regulation No 910/2014). Our application should allow ordinary users to quickly sign and verify signatures of different types of documents and therefore easily use them in everyday life.

Keywords: *electronic signature, electronic seal, qualified, open-source, XAdES, PAdES, CAdES, desktop software*

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Introduction

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Integer lacinia, nulla porta varius tempus, lacus metus blandit lorem, a rutrum justo wisi id sapien. Integer risus libero, feugiat eleifend, ornare ac, volutpat nec, sem. In facilisis, quam eu elementum aliquet, lorem quam euismod dui, aliquet laoreet purus ipsum ac quam.

Chapter 1

A Traditional Lipsum

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Integer lacinia, nulla porta varius tempus, lacus metus blandit lorem, a rutrum justo wisi id sapien. Integer risus libero, feugiat eleifend, ornare ac, volutpat nec, sem. In facilisis, quam eu elementum aliquet, lorem quam euismod dui, aliquet laoreet purus ipsum ac quam.

$$\iint x^y \,\mathrm{d}x\,\mathrm{d}y = \iint (1+x) - (\sin^2 x + \cos^2 x)^y \,\mathrm{d}x\,\mathrm{d}y$$

Donec dolor arcu, posuere at, vehicula vitae, accumsan ut, lacus. Nulla tristique eros eu diam. Vivamus nec tortor vel ligula elementum lacinia. Curabitur euismod eros adipiscing ipsum. Donec sed quam at felis suscipit egestas. Morbi faucibus libero sit amet libero. Nullam laoreet ipsum eu eros. Donec in diam. Ut facilisis eros vel leo. Nunc vitae mauris. Donec leo erat, luctus porttitor, laoreet eget, facilisis non, erat. Integer nec elit.

1.1 Dolor sit amet

Turabitur condimentum. Quisque ut risus. Vestibulum non arcu a est feugiat porttitor. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis in metus.

$$\forall \epsilon > 0 \exists \delta > 0 : \forall x \in (-\delta, \delta) : |f(x) - \epsilon| < \delta$$

Integer ligula sapien, rutrum et, pulvinar ac, viverra a, neque. Suspendisse hendrerit lectus id ante. Fusce mattis nunc non ipsum. Praesent tristique hendrerit lorem. Morbi risus erat, euismod quis.

1.2 Sit transit gloria mundi

Definícia 1.1 *Definíciou* nazývame každý pojem uzavretý v prostredí `df`.

Autorom predchádzajúcej definície je František Taraba, ktorý už v roku fusce elit enim, commodo eget, blandit eu, faucibus sed, nisl. Maecenas adipiscing. Proin non risus in erat dapibus hendrerit. Sed nonummy, velit sit amet dictum eleifend, arcu lacus molestie mauris, a sollicitudin felis lacus eget velit. Vivamus imperdiet. Vivamus accumsan sollicitudin leo. Morbi et orci. Sed at sem. Vestibulum mattis augue. Nam sit amet wisi. Donec vel est. Praesent vehicula. Nunc convallis hendrerit nisl.

$$m^2 = n_1^2 + n_2^2$$

Veta 1.2 (Cauchy's Integral Theorem) *Let U be an open subset of C which is simply connected, let $f : U \to C$ be a holomorphic function, and let γ be a rectifiable path in U whose start point is equal to its end point. Then*

$$\oint_\gamma f(z)\,dz = 0.$$

.

Dôkaz.
Dôkaz prenechávame na pozorného čitateľa.

□

Dôkaz.
A teraz:

$$\begin{pmatrix} 3 & 3 \\ 1 & 2 \end{pmatrix} \cdot 3$$

□

Dôkaz prenechávame na pozorného čitateľa. Už [**?**] ukázal použitie tejto metódy. Na druhej strane, [**?**] použil alternatívny prístup.[1]

Suspendisse lobortis. Donec ornare elit sit amet nibh. Mauris nec augue. Sed dignissim dictum mauris. Morbi tincidunt leo at est. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Etiam eu ante in

[1] Donec venenatis rutrum odio. Fusce porta. Curabitur a ipsum sit amet arcu semper posuere. Donec orci felis, auctor sit amet, semper non, suscipit vel, tellus. Sed eu ipsum nec mi egestas ultrices. Sed mauris. Aliquam purus.

Level	Requirement
1	0
2	1000
3	3000
4	6000

Table 1.1: Requirements of XP for given level.

sem dictum eleifend. Nunc eget odio. Sed vitae elit at justo tristique dapibus. Quisque sit amet urna at velit faucibus cursus, ako bolo ukázané v [**?**].

Aliquam commodo wisi sed ipsum. Donec quis ligula. Ut porttitor, nibh nec interdum fringilla, risus est nonummy nibh, at rutrum massa odio molestie dolor. Morbi metus. Nulla nec velit vitae elit nonummy lobortis. Phasellus facilisis, urna ac viverra tristique, tellus turpis commodo dui, id pharetra erat nibh et mi. Mauris iaculis nisl sit amet tellus molestie fringilla.

Duis ligula lectus, condimentum in, lacinia eget, pellentesque sit amet, mi. Aliquam convallis euismod arcu. Aliquam erat volutpat. Fusce erat elit, congue eu, pretium in, congue non, neque. Vestibulum non massa eu nisl condimentum blandit. Integer pretium wisi id metus. Donec venenatis rutrum odio. Fusce porta. Curabitur a ipsum sit amet arcu semper posuere. Donec orci felis, auctor sit amet, semper non, suscipit vel, tellus. Sed eu ipsum nec mi egestas ultrices. Sed mauris. Aliquam purus. In hac habitasse platea dictumst. Phasellus ut urna. Etiam sit amet ligula ultrices massa iaculis suscipit. Integer odio lacus, interdum eget, tempor eu, aliquam nec, elit.

Suspendisse lobortis. Donec ornare elit sit amet nibh. Mauris nec augue. Sed dignissim dictum mauris. Morbi tincidunt leo at est. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Etiam eu ante in sem dictum eleifend. Nunc eget odio. Sed vitae elit at justo tristique dapibus. Quisque sit amet urna at velit faucibus cursus. Morbi metus. Nulla nec velit vitae elit nonummy lobortis. Phasellus facilisis, urna ac viverra tristique, tellus turpis commodo dui, id pharetra erat nibh et mi. Mauris iaculis nisl sit amet tellus molestie fringilla. Sed nonummy mollis dui. Sed fermentum suscipit metus. Curabitur quis wisi. In condimentum pellentesque ante. Integer in odio. Curabitur arcu metus, convallis eu, euismod in, ultricies nec, felis. Suspendisse hendrerit ipsum ac neque pretium consectetuer. Vestibulum et diam vitae nulla faucibus mattis.

Chapter 2

Contemporary Pseudo-Random Texts

Nullam neque felis, accumsan a cursus at, fringilla a massa. Praesent suscipit purus eget enim volutpat, bibendum imperdiet odio convallis. Vivamus congue ultricies dapibus. Sed eu pretium mauris, consequat scelerisque ex. Vestibulum ut sem venenatis, pharetra orci eu, tempus metus. Ut auctor porta tincidunt. Interdum et malesuada fames ac ante ipsum primis in faucibus. Sed eget risus fringilla, volutpat mauris non, cursus ex. Donec faucibus ante et nisl sodales, vel venenatis turpis rhoncus. Nunc eget congue elit. In placerat leo in libero hendrerit maximus. Vestibulum efficitur aliquet sapien blandit semper. Nulla est diam, fermentum a commodo id, ullamcorper vitae tellus. Aenean scelerisque fringilla velit id condimentum. Ut vel libero turpis.

$$P(X_n = x_n | X_{n-1} = x_{n-1}, X_{n-2} = x_{n-2}, \ldots, X_0 = x_0) = P(X_n = x_n | X_{n-1} = x_{n-1}) \tag{2.1}$$

Sed ornare ac mauris semper efficitur. Aenean id sollicitudin augue. Quisque at efficitur libero, at scelerisque arcu. Suspendisse consectetur luctus posuere. Cras vel nisl non neque feugiat tempor. Aliquam dapibus, mi eget fringilla rutrum, ligula nulla mattis sem, in pharetra augue neque quis ipsum. Cras bibendum quis lacus eget interdum. Pellentesque facilisis auctor magna, vitae mattis metus fringilla in. Ut tempor vel tellus sed ultricies. Donec accumsan mi ac fermentum cursus. Donec congue, arcu et scelerisque ornare, velit leo placerat augue, in laoreet velit odio quis odio. Proin tempor gravida mauris. Nulla facilisi. Nam pellentesque porttitor enim non malesuada.

Nullam lacus turpis, tempus et nisi non, dignissim tincidunt urna. Praesent vehicula dui urna, ac ullamcorper justo laoreet in. Pellentesque at arcu id risus ultricies consequat ut in dolor. Duis posuere, enim at ullamcorper facilisis, dolor erat auctor augue, vitae congue ipsum velit vitae nibh. Maecenas tincidunt magna luctus felis tempus blandit. Pellentesque mattis lorem lacus, pretium egestas tellus maximus in. Donec ligula felis, laoreet non tortor id, ultrices lobortis arcu. Proin in fermentum libero, vitae ultricies nibh. In non euismod sapien, ullamcorper luctus tellus. Donec nibh massa, malesuada a metus ac, molestie consectetur purus. Morbi elementum molestie libero, quis condimentum ipsum.

Ut lobortis semper risus, non condimentum dui convallis ut. Nulla eget volutpat tellus. Vestibulum lobortis tincidunt massa eu rhoncus. Suspendisse luctus eu dui non vehicula. Vivamus elementum auctor felis, placerat maximus magna lobortis ut. Donec placerat sem a mi sagittis blandit. Maecenas pellentesque laoreet mauris, dictum viverra ante sodales sed. Nullam non ligula quis ante ultricies finibus non quis ex. Ut tempor vitae ipsum sed imperdiet. Fusce aliquam nisl sit amet nunc tempor convallis. Vivamus vehicula magna sit amet purus commodo, et tincidunt purus accumsan. Nulla velit dolor, lacinia nec scelerisque a, euismod a sapien.

Conclusion

Ut lobortis semper risus, non condimentum dui convallis ut. Nulla eget volutpat tellus. Vestibulum lobortis tincidunt massa eu rhoncus. Suspendisse luctus eu dui non vehicula. Vivamus elementum auctor felis, placerat maximus magna lobortis ut. Donec placerat sem a mi sagittis blandit. Maecenas pellentesque laoreet mauris, dictum viverra ante sodales sed. Nullam non ligula quis ante ultricies finibus non quis ex. Ut tempor vitae ipsum sed imperdiet. Fusce aliquam nisl sit amet nunc tempor convallis. Vivamus vehicula magna sit amet purus commodo, et tincidunt purus accumsan. Nulla velit dolor, lacinia nec scelerisque a, euismod a sapien.

Bibliography

[1] Beck, G., 2007. *Zakázaná rétorika: 30 manipulatívních technik.* Preklad Pomikálová, M.. Praha: Grada Publishing. ISBN 978-80-247-1743-2.

[2] Vojčík, P., 2010. *Občianske právo hmotné II.* 3. prep. a dopl. vyd. Košice: UPJŠ v Košiciach. ISBN 978-80-7097-817-7.

[3] Šoltés, M. a Radoňák, J., 2013. *Základné princípy laparoskopickej chirurgie.* Košice: UPJŠ v Košiciach. ISBN 978-80-8152-074-7.

[4] Guzanin, Š., Sabovčík, R. a Kačmár, P., 2004. *Selected Chapters of Plastic and Reconstructive Surgery: vysokoškolské učebné texty.* Košice: Univerzita Pavla Jozefa Šafárika v Košiciach, Lekárska fakulta. ISBN 80-7097-557-1.

[5] Nagyová, I. et al. 2009. *Measuring health and quality of life in the chronically ill.* Košice: Equilibria. ISBN 978-80-892-8446-7.

[6] Speight, J. G., 2005. *Lange's Handbook of Chemistry* [online]. London: McGraw-Hill. [cit. 2009.06.10.] ISBN 978-1-60119-261-5. Dostupné na: `http://www.knovel.com/web/portal/basic_search/display?_EXT_KNOVEL_DISPLAY_bookid=1347&_EXT_KNOVEL_DISPLAY_fromSearch=true&_EXT_KNOVEL_DISPLAY_searchType=basic`

[7] Bačkor, M. a Mihaličová, S., zost., 2013. *Zborník príspevkov z konferencie 11. dni doktorandov experimentálnej biológie rastlín a 13. konferencie experimentálnej biológie rastlín* [online]. Košice: Univerzita Pavla Jozefa Šafárika v Košiciach, Prírodovedecká fakulta [cit. 2009-06-10]. ISBN 9788081520327. Dostupné na: `http://www.upjs.sk/public/media/5596/PF-Zbornik-prispevkov-konferencie-11-dni-doktorandov.pdf`

[8] *Thaiszia: Journal of Botany.* Košice: P.J.Safarik University, Botanic Garden, 1990– . ISSN 1210-0420.

[9] *Ikaros: elektronický časopis o informační bezpečnosti* [online], 2002. [Praha]: Ikaros. 1997– [cit. 2002-03-08]. Dostupné na: `http://www.ikaros.cz/`. ISSN 1212-5075.

[10] *CHIP: magazín informačních technologií*, 2013. Praha: Burda Praha, roč. 23, říjen. ISSN 1210-0684.

[11] Sabol, J., 2000. Jazyk ako ľudské posolstvo: (namiesto doslovu). In: *O jazyku a štýle kriticky aj prakticky*. Prešov: Náuka, s. 149–159. ISBN 809676022X.

[12] Tóthová, E. a kol., 2013. A rare t(9,22,16)(q34,q11,q24) translocation in chronic myeloid leukemia for which imatinib mesylate was effective: a case report. In: *XXVII. Olomoucké hematologické dny s mezinárodní účastí, 12.–14.5.2013, Olomouc: sborník abstrakt*. Olomouc: Univerzita Palackého v Olomouci, s. 75–76. ISBN 9788024434803.

[13] Beňačka, J. et al., 2009. A better cosine approximate solution to pendulum equation. In: *International Journal of Mathematical Education in Science and Technology*. Vol. 40, no. 2, p. 206–215. ISSN 0020-739X.

[14] Dubayová, T. et al., 2010. The impact of the intensity of fear on patient's delay regarding health care seeking behavior: a systematic review vyhľadaní zdravotníckej starostlivosti. In: *International Journal of Public Health*. Vol. 55, no. 5, p. 459–468. ISSN 1661-8556.

[15] Steinerová, J., 2000. Princípy formovania vzdelania v informačnej vede. In: *Pedagogická revue*. Roč. 2, č. 3, s. 8–16. ISSN 1335-1982.

[16] Hoggan, D., 2002. Challenges, Strategies, and Tools for Research Scientists. In: *Electronic Journal of Academic and Special Librarianship* [online]. Vol. 3, no. 3 [cit. 2013-01-10]. ISSN 1525-321X. Dostupné na: `http://southernlibrarianship.icaap.org/content/v03n03/Hoggan_d01.htm`

[17] Srbecká, Gabriela, 2010. Rozvoj kompetencí studentů ve vzdělávání. In: *Inflow: information journal* [online]. Roč. 3, č. 7 [cit. 2013-08-06]. ISSN 1802-9736. Dostupné na: `http://www.inflow.cz/rozvoj-kompetenci-studentu-ve-vzdelavani`

[18] Zemánek, P., 2001. The machines for "green works" in vineyards and their economical evaluation. In: *9th International Conference: proceedings. Vol. 2. Fruit*

Growing and viticulture [CD-ROM]. Lednice: Mendel University of Agriculture and Forestry, p. 262–268. ISBN 80-7157-524-0.

[19] MIKULÁŠIKOVÁ, M., 1999. *Didaktické pomôcky pre praktickú výučbu na hodinách výtvarnej výchovy pre 2. stupeň základných škôl*: diplomová práca. Nitra: UKF.

[20] URDZÍK, P., 2007. *Predikcia intrauterinnej rastovej retardácie a preeklampsie pomocou biochemických a ultrazvukových markerov*: dizertačná práca. Košice: UPJŠ v Košiciach.

[21] BAUMGARTNER, J. a kol., 1998. *Ochrana a udržiavanie genofondu zvierat, šľachtenie zvierat*: výskumná správa. Nitra: VÚŽV.

[22] STN ISO 690: 2012. *Informácie a dokumentácia. Návod na tvorbu bibliografických odkazov na informačné pramene a ich citovanie.*

[23] VKÚ, 2003. *Košice: mapa okolia.* [1:15000]. 3. vyd. Harmanec: VKÚ. ISBN 80-8042-223-0.

[24] *Zákon č.131/2002 Zb. o vysokých školách a o zmene a doplnení niektorých zákonov.*

[25] *Zákon č. 313/2001 o verejnej službe.*