Related/previous work landscape

Deliverable 1b (short version)

Created within the OpenTC project

Bochum/Berlin, October – December 2006
(internal use only)

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Contents

Part II

Deliverable 1b

1 Introduction

The present document forms the final report of the preliminary inquiry about the related and previous work landscape in the area of *Trusted Computing* (and virtualization). The work was done by the authors within a three-month project and provides a basis for a subsequent comprehensive risk analysis within the OpenTC project.

The report should, under the terms of the contract, include the following three partial performances:[1]

1. Extended list of patent publications from *deliverable 1a* (cf. Gasmi and Stewin, 2006)

2. Improved categorization

3. Statistical evaluation of the results

The main objective was to glean the relevant patent publications concerning *Trusted Computing* (that may affect the OpenTC project) and assign them to both, functional categories and the different workpackages of the project. As the generation of an exhaustive list turned out to be too extensive to be fulfilled within the limited resources of the project, the second objective was to give a documentation of the work and the faced difficulties, to simplify future work in this field.

1.1 Important terms and definitions

To interpret the collected patent publications, it is indispensable to know the meaning of the following terms:

- *Kind code*: To distinguish between the different types of patent publications, the publication number contains an alphanumeric coding: the kind code. It indicates the level of publication (e.g. 'patent after modification'). The kind codes are assigned separately in each country and can therefore differ (in their meaning) from country to country. A complete list of existing kind codes offers The Thomson Corporation (2006*c*). Relevant for the present work is the subset of kind codes in table 1.1.

- *Patent family*: The Thomson Corporation (n.d.) defines a patent family as "a set of individual patents granted by various countries [. . .] (that includes) all the equivalent patent applications corresponding to a single invention, covering different geographical regions."

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1 The appendant DVD contains the following files:

- Related/previous work landscape (deliverable 1a)
- Related/previous work landscape (deliverable 1b, short version)
- Related/previous work landscape (deliverable 1b, full version)
- MySQL database backups
- Self-written PHP scripts
- LaTeXcode of the full version of this document
- All collected publications in portable document format (PDF)

Kind code	Meaning
European Patent Office (EPO) (EP)	
A1	Publication of application with search report
A2	Publication of application without search report
A3	Publication of search report
B1	Patent
United States (US)	
A	United States patent
A1	Patent application publication within the Trial Voluntary Protest Program (TVPP)
B1	Reexamination certificate - first reexamination
B2	Reexamination certificate - second reexamination
World Intellectual Property Organization (WIPO) (WO)	
A1	Publication of the international application with international search report
A2	Publication of the international application without international search report
A3	Subsequent publication of the international search report

Table 1.1: Meaning of kind codes in patent publications (cf. The Thomson Corporation, 2006c)

- *DW-Record*: The *Derwent World Patents Index (DWPI)*, developed by The Thomson Corporation (2005), is a database that "adds value to the information in original patent documents", basically by providing a sophisticated classification system as well as rewritten patent titles and abstracts. Furthermore the DWPI enables the identification of "non-conventional equivalents that occur when a patent is filed outside of the priority deadline", i.e. equivalent patents with different priority dates[2] are listed within the same patent family.

  A record in the DWPI (*DW-Record*) is indexed by a *Primary Accession Number* (e.g. 1996-412885) which is "a unique identification number assigned by Derwent to the first patent in each patent family, and therefore to the database record created for that family" (The Thomson Corporation, n.d.).

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2 The priority date indicates "the initial date of filing of a patent application, normally in the applicant's domestic patent office. This date is used to help determine the novelty of an invention" (cf. The Thomson Corporation, n.d.).

2 Strategy

To find patent publications, the *Delphion Research Intellectual Property Network* was utilized. Delphion is a research tool for worldwide patent publications developed by The Thomson Corporation (2006*a*). It offers an advanced search form that was used to perform more complex search queries (cf. section 2.1). Publications were collected in work files. A work file offers a mechanism to download all publications as PDF files. Thus, it was possible to analize the publications offline. When a relevant publication was found, it was entered in a MySQL database via a web form (cf. sections 2.4 and 2.5). The final results, based on the number of entered publications of each kind code (cf. table 1.1), were visualized as block diagrams (see section 5 and appendix B).

2.1 Search queries and search area

To improve the patent search, an appropriate retrieval strategie was developed,[3] which finally comprised (cf. Gasmi and Stewin, 2006, p.3):[4]

1. Patent search based on keywords

2. (Extension of the search by taking basic ideas into account)

3. (Tracing of references among patents/publications)

To facilitate the keyword-based patent search, the OpenTC website (OpenTC Consortium, 2006*b*) and several TC publications (e.g. Kuhlmann, 2006) were sifted through to identify relevant keywords and hence, to build up a list of appropriate search terms (see appendix A). Unfortunately, steps two and three of the retrieval strategy could not be performed, because of the high number of keyword-based search results. To give an example, the first two chosen search terms were *((attestation)) AND (PD>=1987-01-01)*[5] (more than 6,000 search results) and *("trusted" AND "virtualization")*[6] (number of search results: 297). Obviously, the search area defined by the list of keywords turned out to be too wide to be covered within this report. Therefore the following search queries were defined to reduce the number of search results:[7]

- *((("binding" AND "Trusted Platform Module"))) AND (PD>=1987-01-01)*

- *((("key protection" AND "Trusted Platform Module"))) AND (PD>=1987-01-01)*

- *((("logging" AND "trusted platform module"))) AND (PD>=1987-01-01)*

- *(((("public" OR "private") AND "key") AND "trusted platform module"))) AND (PD>=1987-01-01)*

- *((("sealing" AND "Trusted Platform Module"))) AND (PD>=1987-01-01)*

- *((((("secure" OR "trusted") AND ("path" OR "channel" OR "io" OR "input/output" OR "i/o")) AND "trusted platform module"))) AND (PD>=1987-01-01)*

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3   Starting point was the guidance from the European Patent Office (n.d.).

4   Related and previous work publications were ignored due to the extensive and time-consuming patent search.

5   The search term defines a full-text search for the keyword attestation among all publications since 1987. The search includes derivations of the keyword, e.g. attest.

6   The string comprises all publications that include both keywords, trusted and virtualization. Derivations are excluded by using quotation marks.

7   According to the terms of the contract

- *((("trusted computing" AND ("TCG" OR "TCPA")))) AND (PD>=1987-01-01)*

- *(((((("trusted" OR "secure" OR "authenticated") AND ("boot" OR "bootup"))*
  AND "trusted platform module"))) AND (PD>=1987-01-01)

Keep in mind that the queries mentioned above were performed in october and november of 2006. Subsequenty filed patent publications were not incorporated.

Another problem arose from large patent families and their huge amount of publications regarding the same invention. To cope with the unequal validity periods of different patent publications, the following approach was chosen:

- All publications were entered into a MySQL database. Filtering of multiple publications regarding the same invention can be performed with an appropriate database query.[8] As filtering key, the fields *Title* and *DW-Record* can be used.

- The patent search was restricted to US, EU and WO publications.

2.2 Problems with scanned patent publications

Downloaded PDF files often contained images of typewritten text that prevented keyword search (e.g. attestation) in such publications.[9] An optical character recognition (OCR) program was necessary to translate the images into machine-readable/searchable text. For this report the OCR software *OCR Shop XTR* (for Linux) which is developed by Vividata (2005) was evaluated.[10]

2.3 Entering a patent publication

Due to the time restrictions, it was not possible to read the publications completely. To decide whether or not an invention is relevant for OpenTC, the following publication parts were analized:

- "Abstract"

- "Drawings"

- "Background of the Invention"

- "Summary of the Invention" (in parts)

- "Claims" (mostly the first/main claim).

Furthermore a patent document was searched for certain keywords (e.g. attestation, binding or virtualization). Sections that contained a keyword were also taken into account. When a positive decision was made, the invention was added to the database.

2.4 Database server

This report contains a backup of the database.[11] To use the backup, the following server configuration should work:[12]

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8   Patent families of the entered publications are not complete.

9   Only US and WO patent publications were affected.

10 The software was not able to convert every PDF document. From time to time the conversion process failed with a segmentation fault.

11 The MySQL database files can be found on the DVD appendant to this document.

12 This report was generated with the help of that server configuration. Additionally, the server was placed in a virtual private network for security reasons. Requests could only be sent via a SSL connection. Furthermore, data were saved on an encrypted loop device.

- OpenSuSE 10.1
- MySQL 5.0.18
- PHP 5.1.2
- Apache 2.2.0
- PhpMyAdmin 2.8.0.3
- Self-written PHP scripts (to convert the database into LaTeXcode) and a web-based entry form

2.5 Entry form

Figure 2.1 shows the web-based entry mask. The following input fields were used to collect information about a publication:

- Publication number: The number was taken from the PDF document (without "/").
- Derwent record: The record number was copied from the *pdfindex.txt* file, that was downloaded along with the PDF documents.
- Publication date: The publication date was also fetched from the PDF file.
- Title: The publication title was adopted from the PDF file.
- Editor: The editor field was for internal use only.
- Importance: Level 3 means high importance for the OpenTC project, level 1 represents low importance. Keep in mind that the decision had to be made relatively fast and therefore should be treated with reserve.
- Brief description: To ensure basic comprehension, a brief description of the invention was written. Actually, to save valuable time, the publication abstracts were mostly cited instead of writing a new brief description.
- Search method: The search query string that was used to perform a search query using Delphion was entered in this input field.
- Related patents: This field was used to insert references to other patent publications mentioned in the publication.
- Finalized?: The finalized field was for internal use only.

The entries were rounded off by assigning the publications to both, functional categories and OpenTC workpackages (cf. OpenTC Consortium, 2006*a*). The used categories are listed in table 2.1. Keep also in mind that the assignments to the categories and workpackages were made comparatively fast, too.

Categories	Subcategories
Trusted computing	Trusted/secure bootup
	TPM basic mechanisms (with regard to its usage by OS/SW)
	Local/remote attestation
Virtualization	Trusted/secure virtualization
Trusted path/io	

Table 2.1: Used categories and subcategories

Figure 2.1: Database entry mask

3 Problems and time-consuming obstacles

As mentioned before, several difficulties had to be faced during the patent research, that had an adverse effect on the work. In the following the main problems are pointed out regarding patent publications in general as well as the patent research with Delphion.

3.1 General problems regarding patent publications

- Huge patent families (e.g. with *DW-Record* 1996-412885) with lots of members that represent the same invention, as well as up to hundreds of related publications (e.g. US6658568B1 has 104 family members and more than 300 references to patent publications) complicate the generation of a representative patent landscape. Even several patent publications may belong to the same patent (e.g. US7085935B1 and US7013484B1).

- Some publications have misspellings (e.g. US20050257048A1 describes a file locker, but mentions a 'Fire Locker' in the publication title) or inconsistencies (e.g. slight modifications) in their titles.

- The use of different terms (e.g. safer, trusted or trustworthy computing) complicates the determination of appropriate search terms and hence, has an adverse effect on the search results.

- Related patents or applications are often referred by their application or patent number instead of stating the publication number (e.g. 11/253,460 instead of US20060036851A1). Hence, a connection/link to related publications within the database (which are all indicated by their publication number) is not obvious.

- Some publications do not have a kind code that indicates the publication type (e.g. US6167521).

3.2 Problems regarding the patent search with Delphion

- Some publications have different *DW-Records* although they refer to the same invention (e.g. US20050289067A1 and US20030194094A1), some publications do not have a *DW-Record* at all (e.g. WO2006111615A1).

- When the original patent document is not available, Delphion puts a comparable publication into the PDF document without changing the file name (e.g. the file EP01384126A2.pdf contains not the expected publication EP1384126A2 but WO02086684A2).

- Not all patent family members are listed as search results. Especially when searching for keywords, the results often do not include the corresponding search reports (EP and WO publications with kind code A3), probably because of the missing description that usually contains the keywords.

4 Statistical evaluation

Due to the limited project resources and the chosen strategy (cf. chapter 2), the results of the statistical evaluation should be treated with reserve.

> *Patent family inconsistencies*
>
> Limiting the search strategy to keywords resulted in an inconsistent entry of patent family members (i.e. application and patent publications corresponding to the same invention) into the database. Using the *DW-Record* in the statistical evaluation to filter family members would not have been an appropriate solution, because some entries do not have a *DW-Record* and a differentiation between application and patent publications would still have been necessary.

Furthermore the collected publications had to be categorized and assigned to the work packages relatively fast and on the basis of very little information (cf. section 2.5).

Nevertheless, some interesting information can be extracted from the collected data, e.g. the increasing amount of patent applications during the last years, as can be seen in figure 4.2. An overview over all the collected publications is given in figure 4.1. Figure 4.3 shows the publications broken down by the used keywords whereas figure 4.4 takes the different OpenTC work packages into account. Some detailed evaluation results are listed in appendix B.
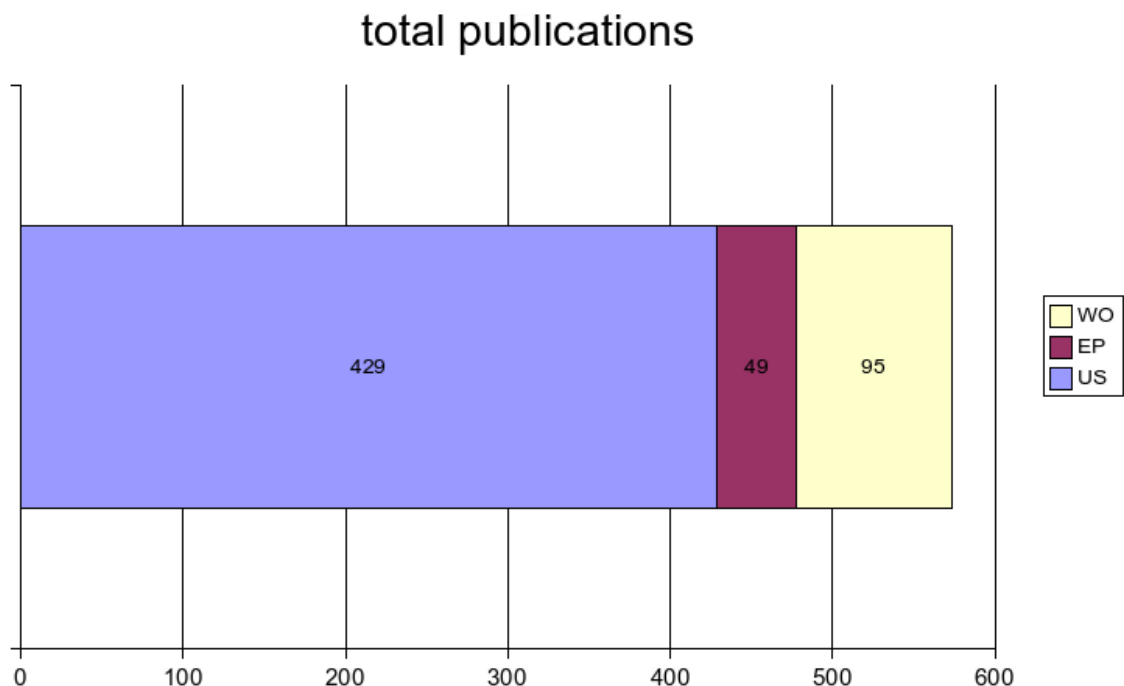

Figure 4.1: Collected Publications

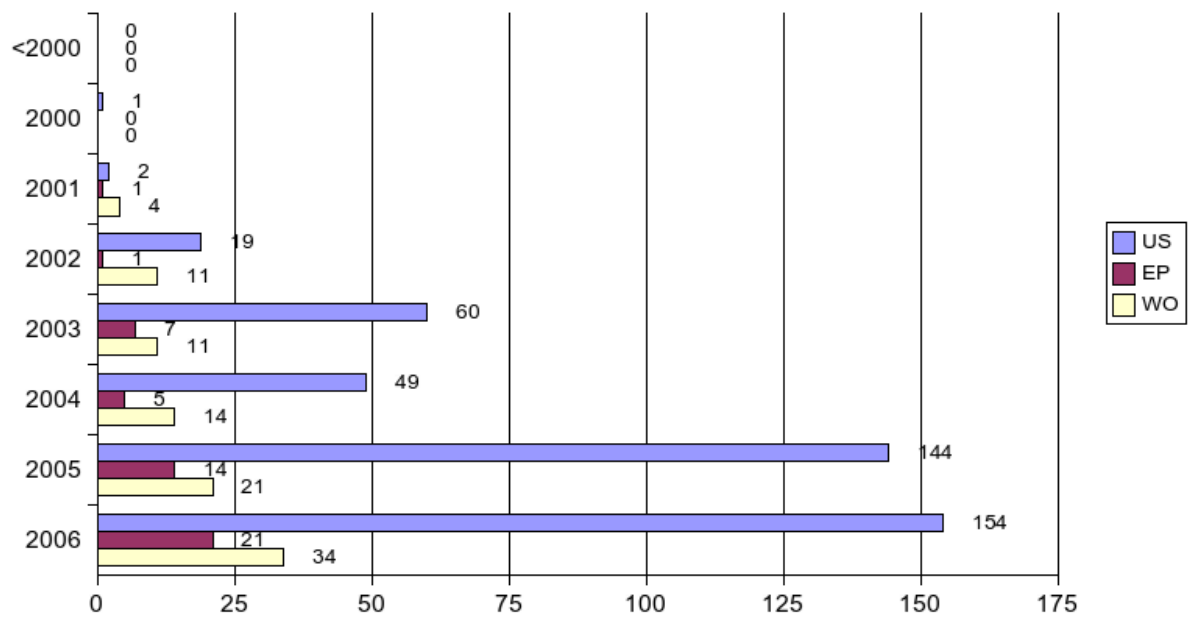## Publications assigned to publication date

Figure 4.2: Publications broken down by publication year
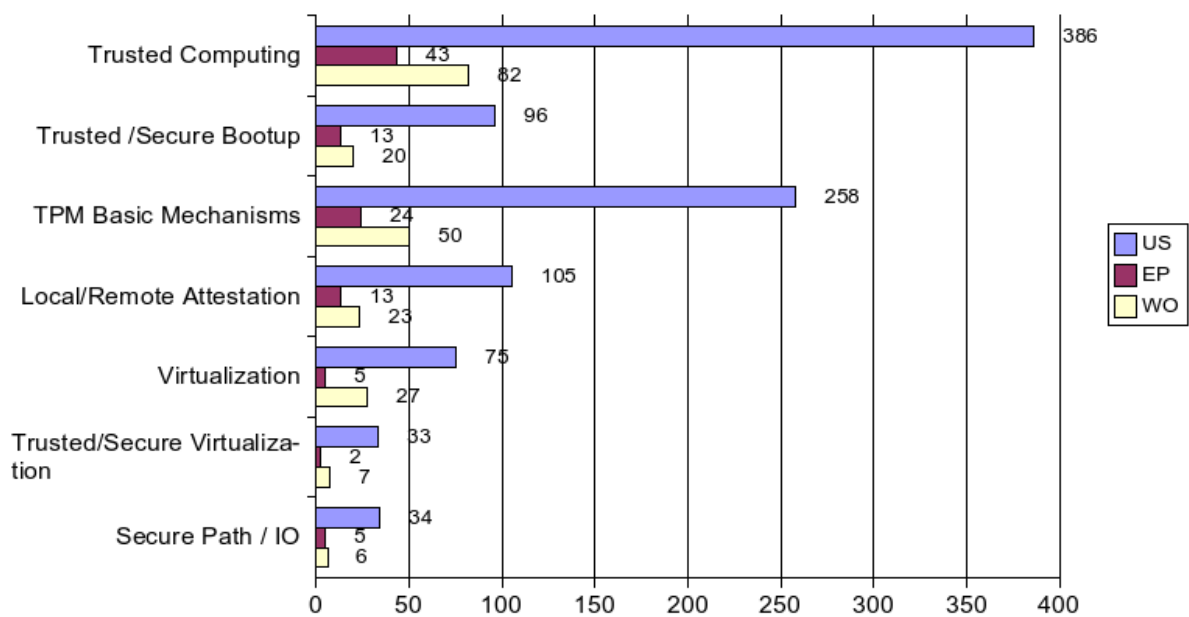
Publications assigned to keywords

Figure 4.3: Publications broken down by keywords
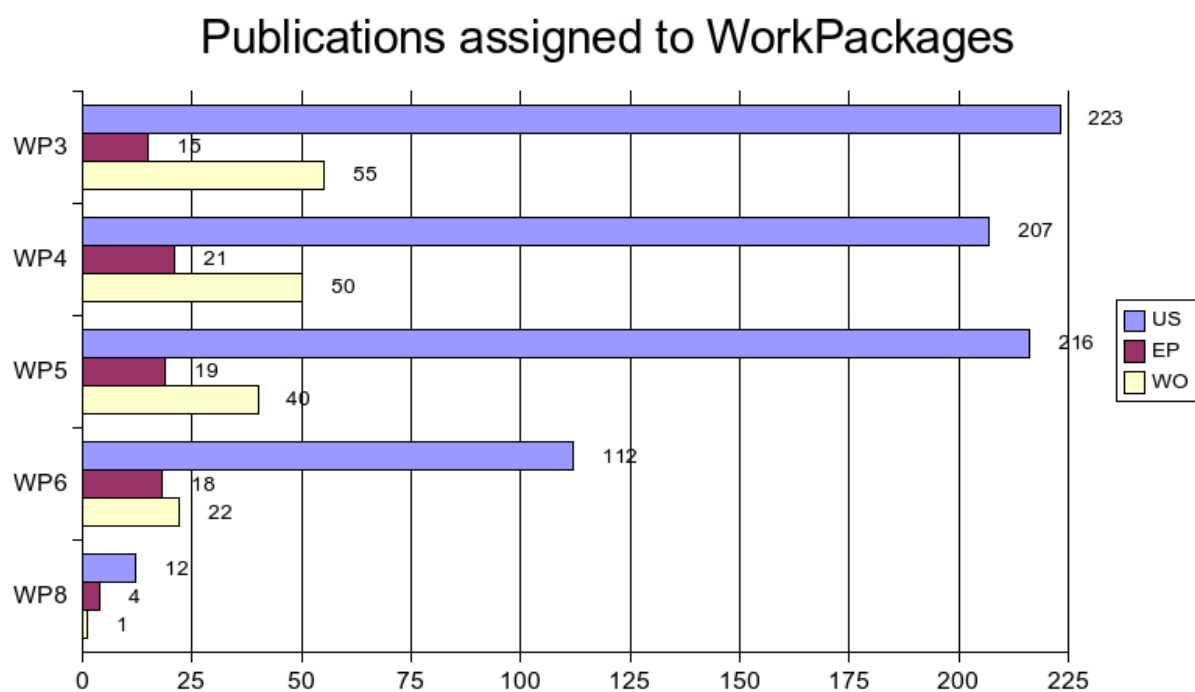
Publications assigned to WorkPackages

Figure 4.4: Publications broken down by OpenTC work packages

5 Conclusion

As described in the present final report, the limited project resources led to some weaknesses in the results:

- The search strategy was limited to keywords. A (probably more effective) search for ideas could not be performed.

- Statements on the covered search area or the percentage of identified relevant patent publications can hardly be made.

- The determination of relevance, functional category and concerned work packages had to be done relatively fast and on the basis of very little information.

- To accelerate work, the publication abstracts were mostly copied from the PDF file to the database, i.e. a future publication of the work/database should be done without the brief descriptions for copyright reasons.

- The results of the statistical evaluation should be treated with reserve because of the inconsistencies regarding patent family members.

Recommendations for future work

The use of a central server and a web frontend (if working in a team) facilitated the work a lot. To gain time when adding equivalent publications (family members) to the database, a duplicate button or the like (together with a script-based automated report generation) is very helpful.

To get better results, more time should be budgeted to analize a publication (regarding relevance, functional category and concerned work package). Deeper knowledge about the OpenTC project is necessary to improve the categorization and the assignment of publications to the OpenTC work packages.

The search strategy should not be limited to keywords but take ideas into account. Particularly when looking for ideas, the *Derwent World Patents Index* could be a powerful tool to improve the search. So far the search was limited to patent publications. To build a representative related and previous work landscape, it has to be extended to other publications (IP research).

6 Patent List

6.1 A boot process for a computer, a boot ROM and a computer having a boot ROM

- **Publication number:** EP1283464A1 / **Derwent record:** 2003-212740
- **Publication date:** 2003-02-12
- **Keywords**
  – Trusted Computing – Trusted/Secure Bootup – TPM Basic Mechanisms (with regard to its usage by OS/SW)
- **WorkPackages/SubWorkPackages**
  WP3
- **Brief description/abstract**
  A client platform receives a boot image via an internet protocol. An integrity check may be performed using a TCPA module.
- **Search method/query**
  (((("trusted computing" AND ("TCG" OR "TCPA")))) AND (PD>=1987-01-01)
- **Related patents**

- **Relevance**   ⊞☐☐
  relates to secure boot but it is different from the TCG approach

6.2 A boot process for a computer, a boot ROM and a computer having a boot ROM

- **Publication number:** US20030046529A1 / **Derwent record:** 2003-212740
- **Publication date:** 2003-03-06
- **Keywords**
  – Trusted Computing – Trusted/Secure Bootup – TPM Basic Mechanisms (with regard to its usage by OS/SW)
- **WorkPackages/SubWorkPackages**
  WP3
- **Brief description/abstract**
  A client platform receives a boot image via an internet protocol. An integrity check may be performed using a TCPA module.
- **Search method/query**
  (((("trusted computing" AND ("TCG" OR "TCPA")))) AND (PD>=1987-01-01)
- **Related patents**

- **Relevance**   ⊞☐☐
  relates to secure boot but it is different from the TCG approach

6.3 A method and apparatus for securing communications between a smartcard and a terminal

- **Publication number:** WO2006044979A1 / **Derwent record:** 2006-305190

- **Publication date:** 2006-04-27

- **Keywords**
  – Trusted Computing – TPM Basic Mechanisms (with regard to its usage by OS/SW) – Secure Path/IO

- **WorkPackages/SubWorkPackages**
  WP5 SWP5a WP6 SWP6d SWP6e

- **Brief description/abstract**
  "An approach for securing communication between a terminal and one of a smartcard and a smartcard reader. A command to initiate a local link transport layer protection protocol session between a terminal and one of a smartcard and a smartcard reader is received at the smartcard or smartcard reader. Responsive to the command, the smartcard or smartcard reader then participates in a handshake process between the terminal and one of the smartcard and the smartcard reader. The handshake process includes mutual authentication. Data is then provided from one of the smartcard and the smartcard reader to the terminal via a trusted tunnel after successful completion of the handshake process."

- **Search method/query**
  (((("binding" AND "Trusted Platform Module"))) AND (PD>=1987-01-01)

- **Related patents**

- **Relevance**   ⊞⊞☐
  mutual authentication between platform and smartcard, TPM basically used for protected storage

Appendix

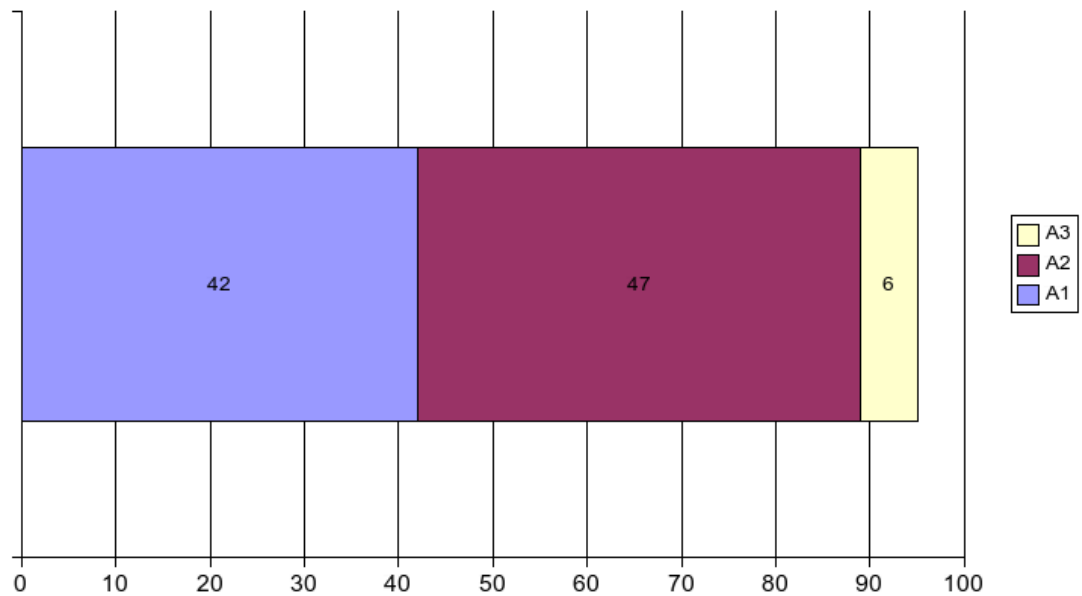# A List of appropriate search terms (in alphabetical order)

Applied trust verification, Assurance for trust properties, **Attestation**, Attestation identity, Attestation identity key, Attestation kernel, Authentication, Basic management interface, Binary attestation, **Binding**, BLOB, Boot-up measurement, Certificate extensions, Chain of authenticated software, Chain of trust, Compartment, Compartment security manager, Controlled loading, Cooperative security models, Corporate computing on home pc, Corporate virtual machine, Critical applications such as trusted banking or e-commerce software, Critical infrastructure, Cross-platform security management framework, Cryptographic interface, Cryptographic checksum, Cryptographic co-processor, Cryptographic coprocessor, Cryptographic processor, Data integrity, Data sealing, Device driver environment, Distributed policy enforcement, Domain, DRM core, Dynamic integrity checking, Encrypted file service, Endorsement Key, Enforcement mechanism, Enhanced trust, Fallback security, Fiasco, File encryption, Flow control policies, Global security framework, Guest operating system, Hardware based security, Hardware root of trust, Hardware support for virtualization, Hardware virtualization, Hardware-based security, Hardware-based security extensions, Hybrid Xen / L4 approaches, Hypervisor, Hypervisor layer, Hypervisor-based operating environments, Identity management, Insecure operating systems, Insecure systems,, software,, hardware, Integral trust and security, Integrated trust and security, Integrity, Integrity checks, Integrity checksum, Integrity constraints, Integrity measurement, Integrity methodology, Integrity of the system, IPsec, Isolated virtual machine, Isolation, Isolation and information flow control, Java integration, Java TSS, jTSS, Key management, Key management infrastructure, Key management kernel, Key storage, L4, License translation manager, Management virtual machine, Mandatory access control, Master key, Microkernel, Multi-compartment graphical user interface, Multifactor authentication, Multilateral security, Multilateral trust, Multiple hypervisors, Multiple trusted platforms, Multiple virtual personal computer instances, Mutual attestation, Negotiating policies, Network security manager, Nexus, Open security evaluation, Open trusted computing, Open trusted methodology, OpenSSH, OpenSSL, OpenTC, Operating system security, Palladium, Para-virtualization, Payload virtual machine, PCR, Personal trusted computing architecture, PET, PKCS#11, Platform authentication, Platform configuration register, Platform security, Policy domains, Policy enforcement, Privacy-enabled security verification, Privacy-preserving protocols, Private electronic transaction, Property-based attestation, Protected chip, Protected compartments, Protected environment, Protected execution environment, Protected hardware, Protected hardware environment, Protected key management, Protected storage, Protection levels, Public key BLOB, Racoon IKE, Remote attestation, Remote platform, Remote user interface, Remote verification, Remote virtual machine, Resource sharing policies, Root of trust, Scalable attestation, Scalable security, **Sealing**, **Secure channel**, Secure computer, Secure computing base, Secure core, Secure CPU initialization, Secure device, Secure device virtualization, Secure environment, Secure hardware, Secure hardware architecture, Secure kernel, Secure key management, Secure layer, Secure media player, Secure message exchange infrastructure, Secure migration, Secure migration of virtual machines, Secure operating system, **Secure path**, Secure sandboxing, Secure software, Secure SSL transaction, Secure state, Secure storage, Secure system, Secure virtual machine, Securely stored, Securing platforms and protecting data, Security architecture enhancement, Security credential, Security enforcement, Security enhanced processor, Security hardware module, Security management interface, Security policy, Security policy enforcement, Security proof, Security property, Security service layer, Security service virtual machine, Security state monitoring and management, SLB 9635 TT 1.2, SLD 9630 TT 1.1,

Social trust, Software configuration, Software trustworthiness, Specific platform state, SSH, SSL, Standard cryptographic protocols, Storage security manager, Strong isolation, System integrity state, Tamper-resistant, TBB, TC, TC based encrypted file system, TC mechanism, TC-integrated, TC-use, TCcert, TCG hardware platform, TCG platform, TCG Software Stack, Terra, Threats,, errors and malfunctions, TPM , TPM driver, TPM emulator, TPM hardware driver , TPM spec. , TPM specification , TPM version detection, TPM virtualization, TPM-based, TPM-enabled, TPM-enabling, TPM-like, Transaction security contract, TrouSerS , Trust, Trust and security , Trust and security profiles, Trust domains, Trust issues, Trust layers, Trust problems, Trusted administrator, Trusted application environment, Trusted base, Trusted boot process, Trusted browser, Trusted building block, Trusted but verify, Trusted certificate, **Trusted channel**, Trusted compartment, Trusted components, Trusted computer, **Trusted computing**, Trusted computing architecture, Trusted computing base, Trusted computing certificate, Trusted computing framework, Trusted Computing Group, Trusted computing on an embedded platform, Trusted computing system, Trusted core, Trusted core service, Trusted credential, Trusted device, Trusted device driver, Trusted environment, Trusted function, Trusted grid computing, Trusted GUI, Trusted hardware, Trusted hardware driver, Trusted hardware module , **Trusted i/o**, Trusted identity, Trusted infrastructure, Trusted input/output, *Trusted io*, Trusted Java, Trusted kernel, Trusted key, Trusted key management, Trusted layer, Trusted Linux modules, Trusted Linux operating system, Trusted Linux platform, Trusted list of users, Trusted message exchange infrastructure, Trusted mobile operating system, Trusted mobile phone, Trusted module, Trusted operating system, Trusted operating system layers, Trusted OS, Trusted party, **Trusted path**, Trusted platform , Trusted platform module , Trusted platform service, Trusted secure mobile platform, Trusted security, Trusted service provider, Trusted smartcard, Trusted software, Trusted software components, Trusted software layer, Trusted software module, Trusted software stack , Trusted state, Trusted storage, Trusted system, Trusted technologies, Trusted third party, Trusted user interface, **Trusted virtualization**, Trusted virtualization architecture, Trusted virtualization layer, TrustedOS, Trustworthy applications, Trustworthy reporting of platform states, Trustworthy system architecture, TSS , TSS-stack, TTP, Trustworthy entity, Universal virtualisation layers, Untrusted network, Untrusted systems,, software,, hardware, User credential, User security manager, Validate a given virtual machine, Verify the integrity, Virtual CPU, Virtual data center, Virtual disk space service provider, Virtual firewall, Virtual hardware, Virtual infrastructure management, Virtual IT infrastructure, Virtual machine infrastructure, Virtual machine monitor, Virtual memory, Virtual network card, Virtual network connection, Virtual storage, Virtual TPM, Virtual TPM device, Virtualisation, Virtualization cooperation, Virtualization engine, Virtualization environment, Virtualization layer, Virtualization of computers, Virtualization security mechanism, Virtualization software, Virtualization-enabled, Virtualized data center, Virtualized device, Virtualized keyboard driver, What you see is what you sign, WYSIWYS, Xen, Zero knowledge authentication
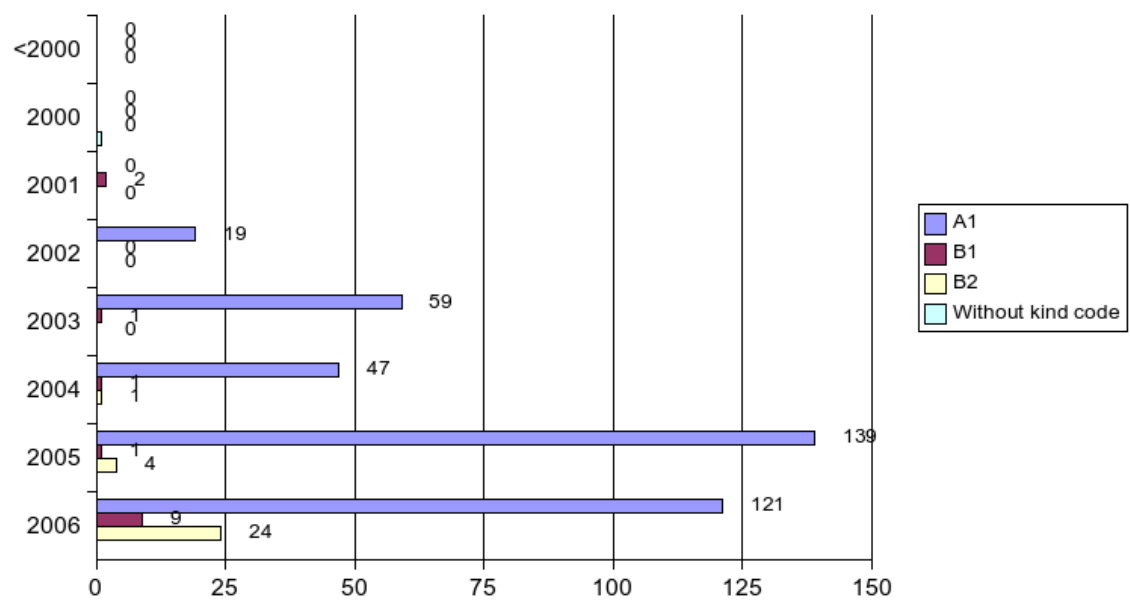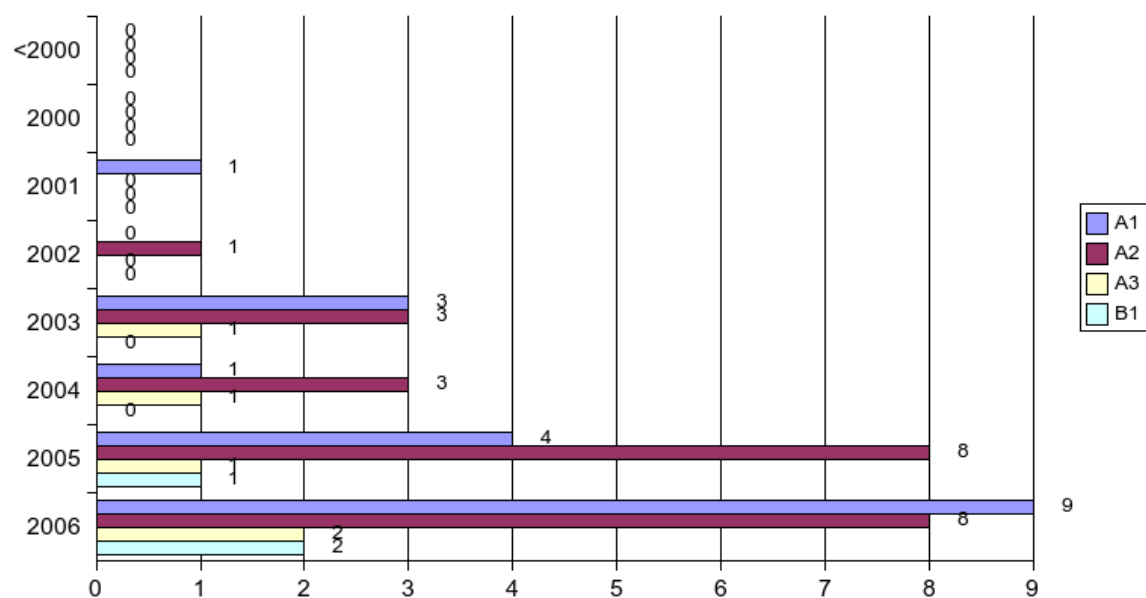
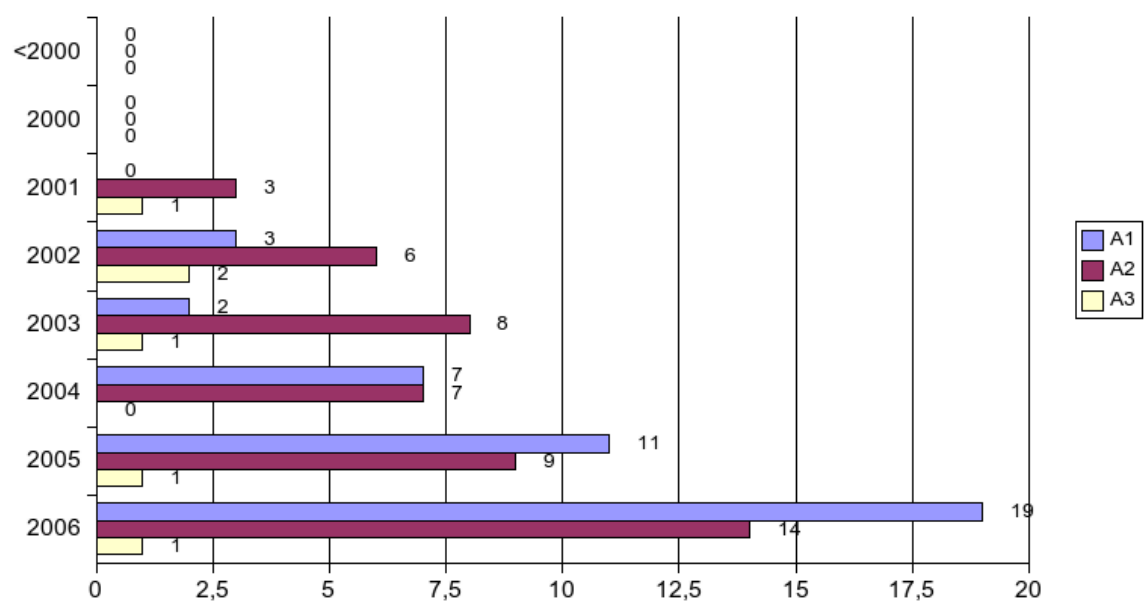# B Detailed evaluation results

Kind code breakdown (US)

Kind code breakdown (EP)
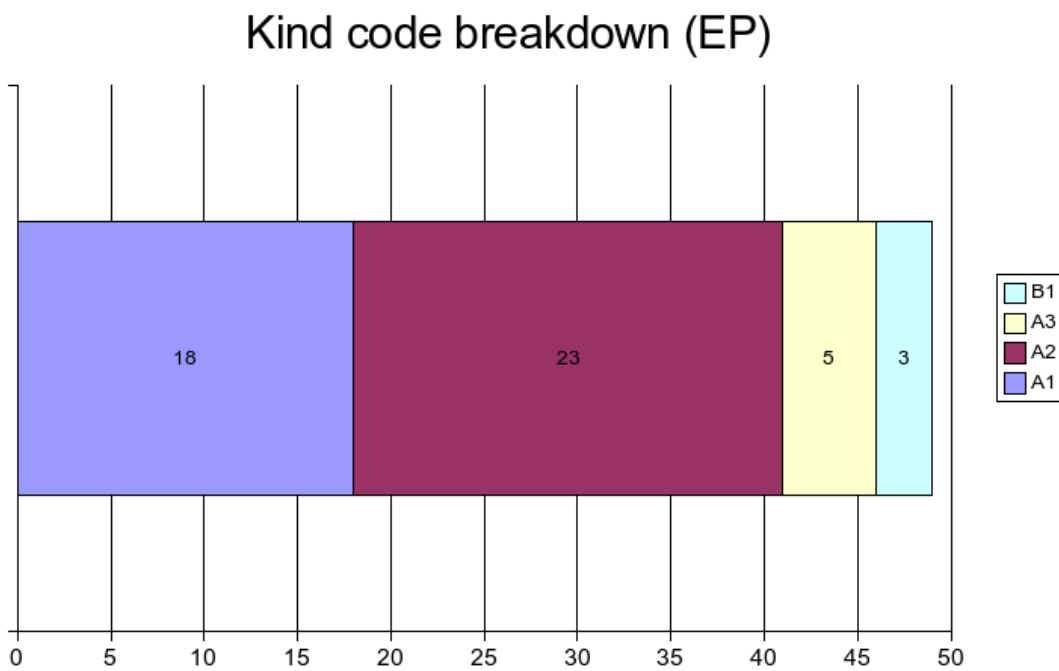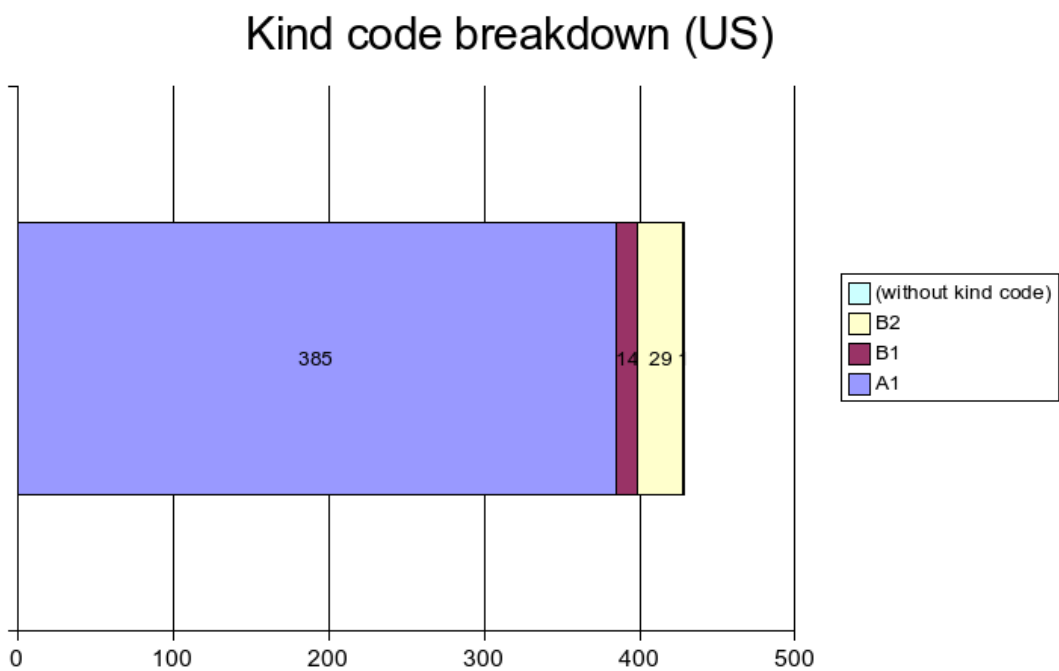
Kind code breakdown (WO)

Appendix

Kind code breakdown publication date (US)
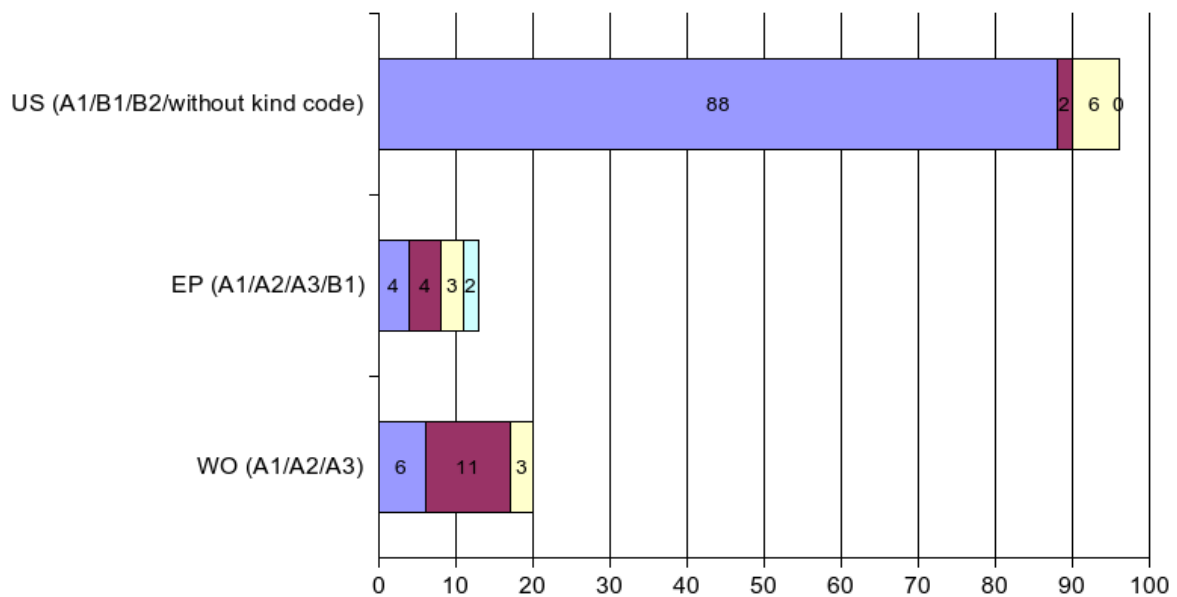
Kind code breakdown publication date (EP)

Legend: A1, A2, A3, B1

Year	A1	A2	A3	B1
<2000	0	0	0	0
2000	0	0	0	0
2001	1	0	0	0
2002	0	1	0	0
2003	3	3	1	0
2004	1	3	1	0
2005	4	8	1	1
2006	9	8	2	2

Kind code breakdown publication date (WO)

Legend: A1, A2, A3

Year	A1	A2	A3
<2000	0	0	0
2000	0	0	0
2001	0	3	1
2002	3	6	2
2003	2	8	1
2004	7	7	0
2005	11	9	1
2006	19	14	1

Kind code breakdown keyword Trusted Computing

US (A1/B1/B2/without kind code): 351, 11, 23
EP (A1/A2/A3/B1): 17, 18, 8
WO (A1/A2/A3): 35, 41, 6

Kind code breakdown keyword Trusted/Secure Bootup

US (A1/B1/B2/without kind code): 88, 2, 6, 0
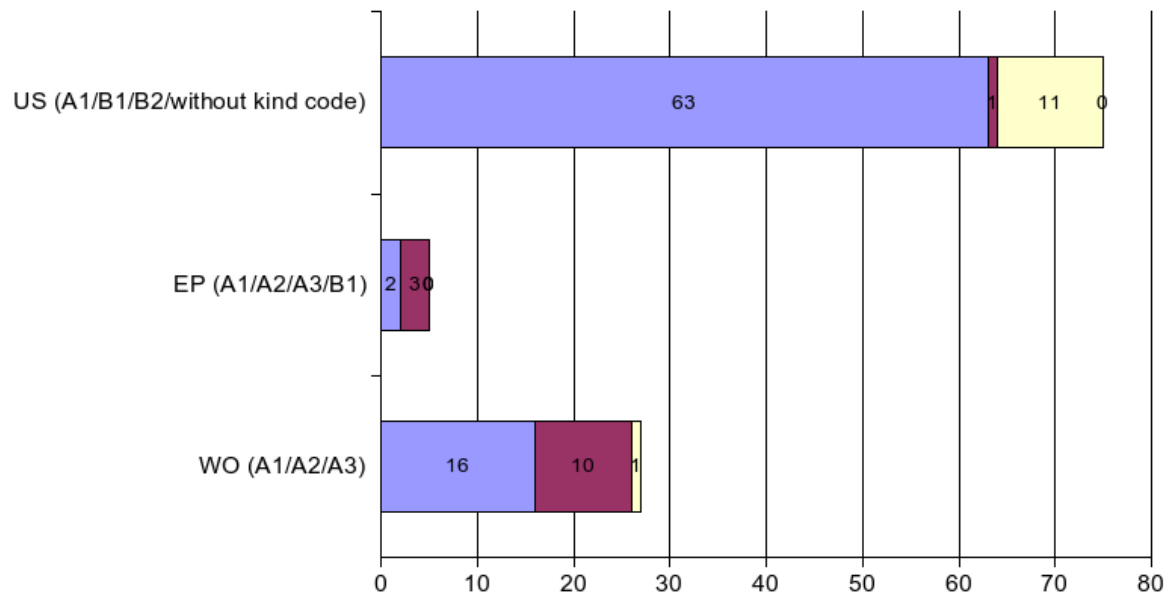EP (A1/A2/A3/B1): 4, 4, 3, 2
WO (A1/A2/A3): 6, 11, 3
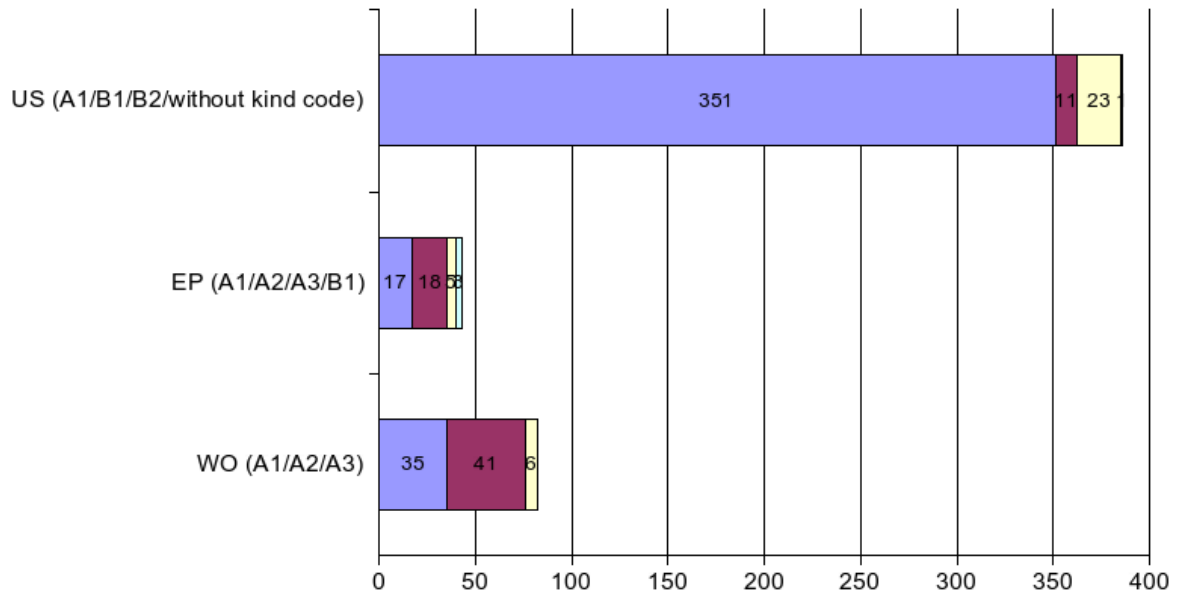
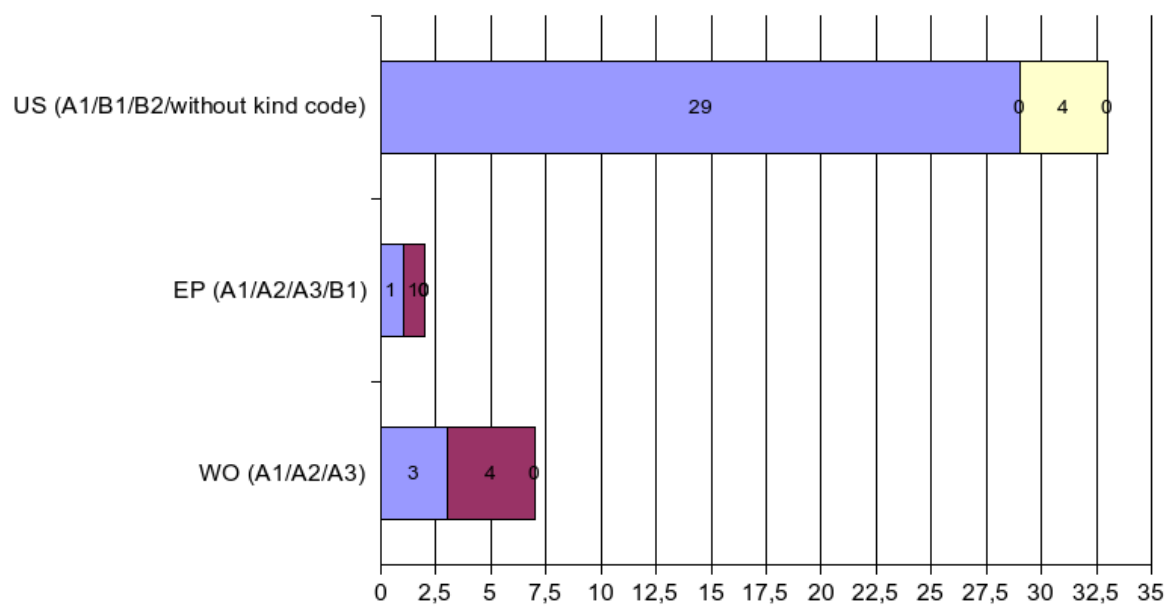## Kind code breakdown keyword TPM Basic Mechanisms
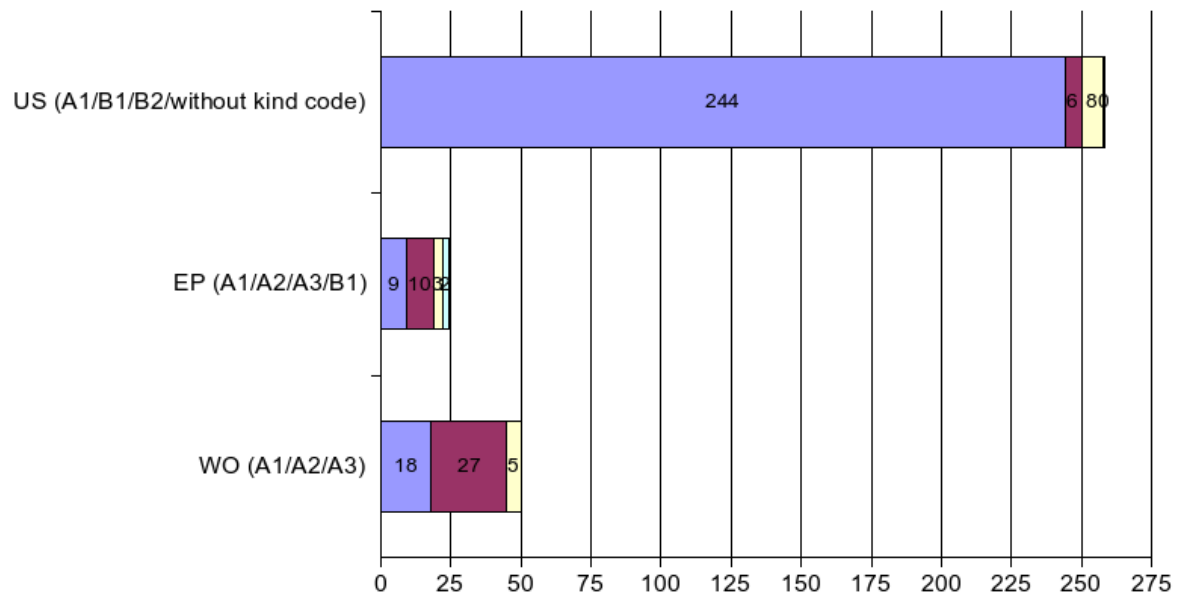
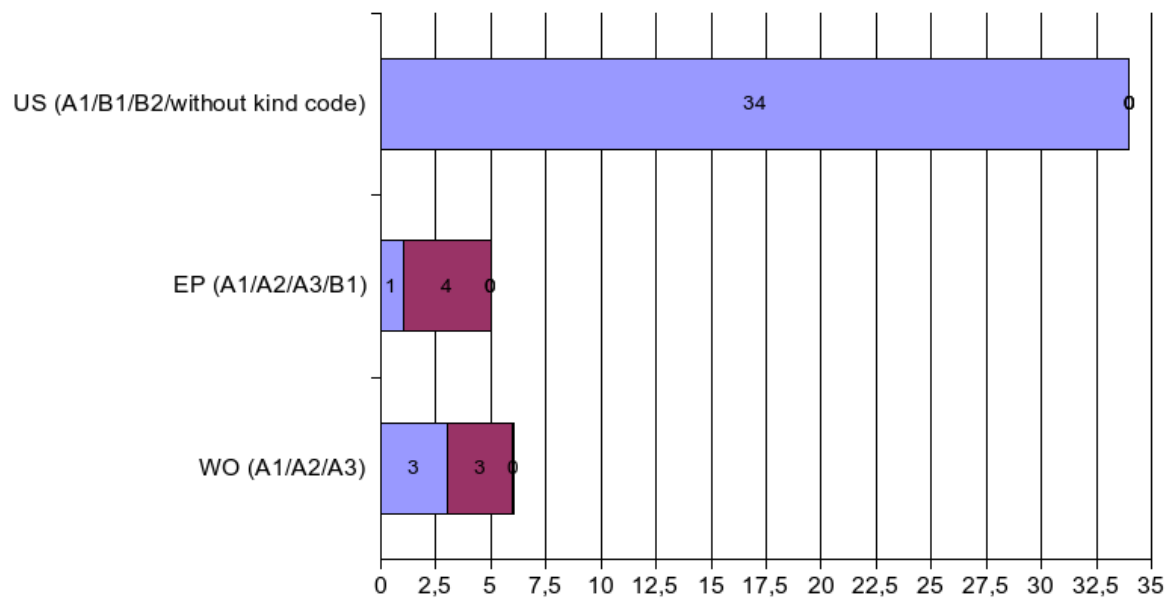## Kind code breakdown keyword Local/Remote Attestation
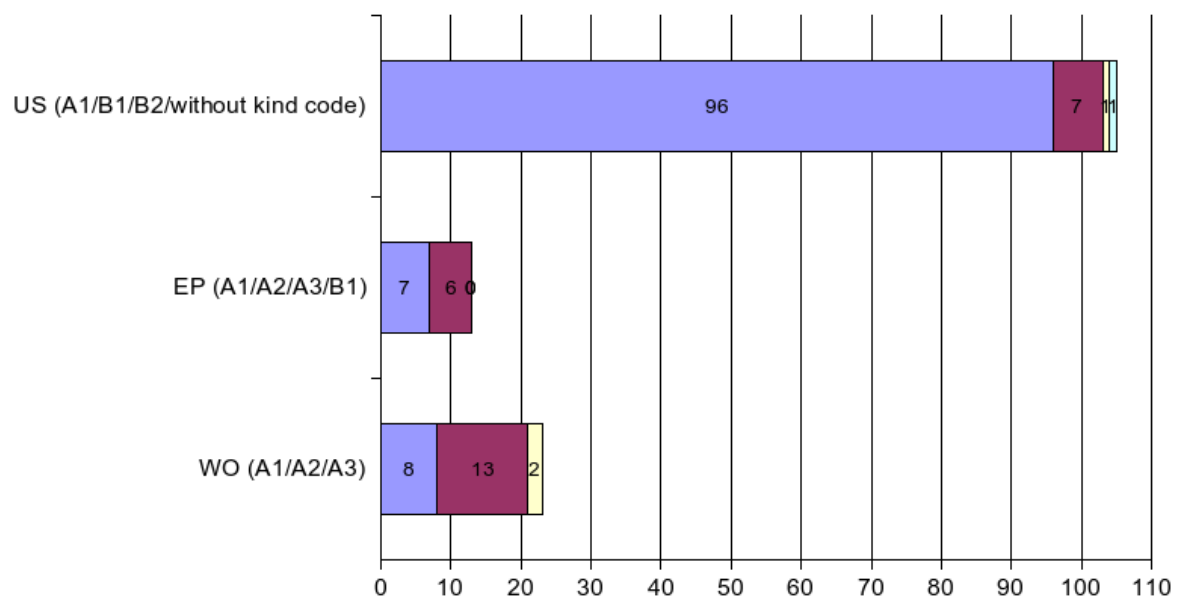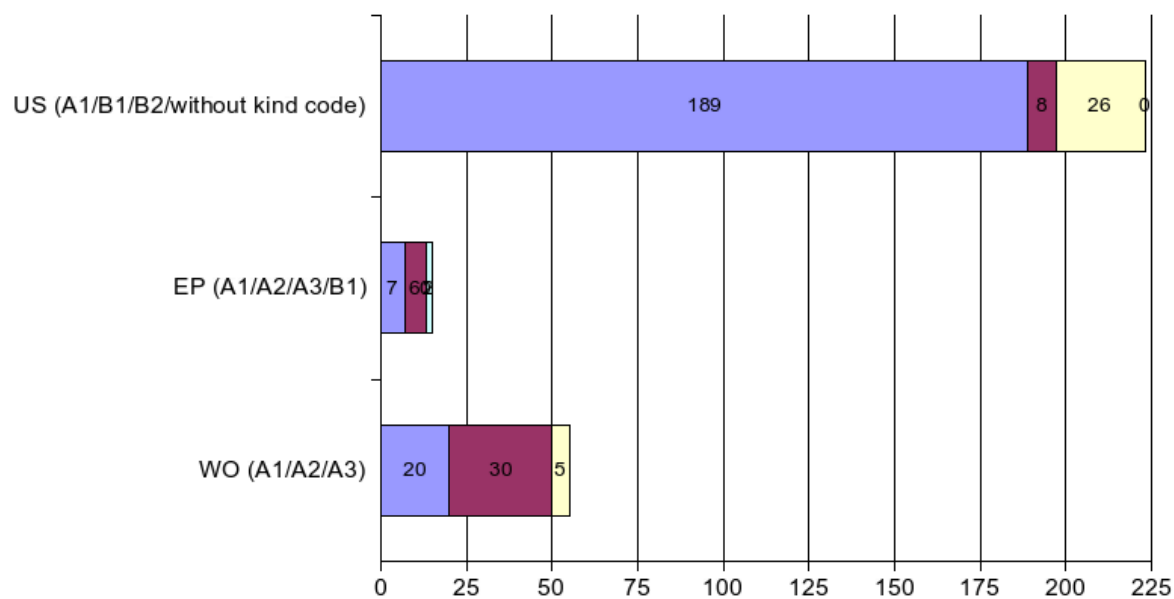
Kind code breakdown keyword Virtualization

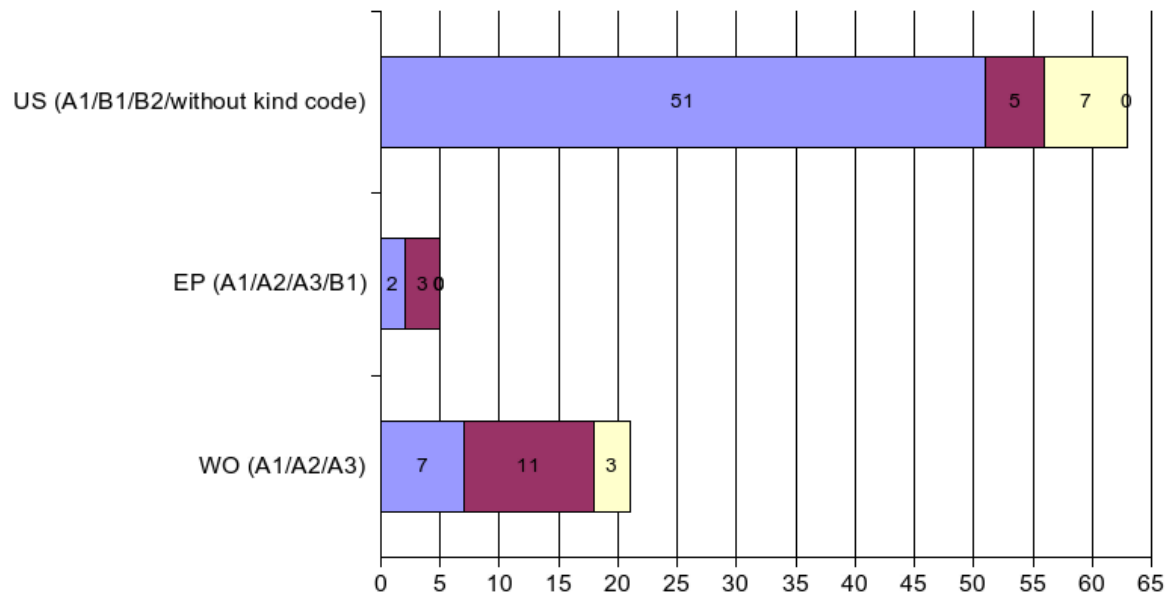## Kind code breakdown keyword Trusted/Secure Virtualization

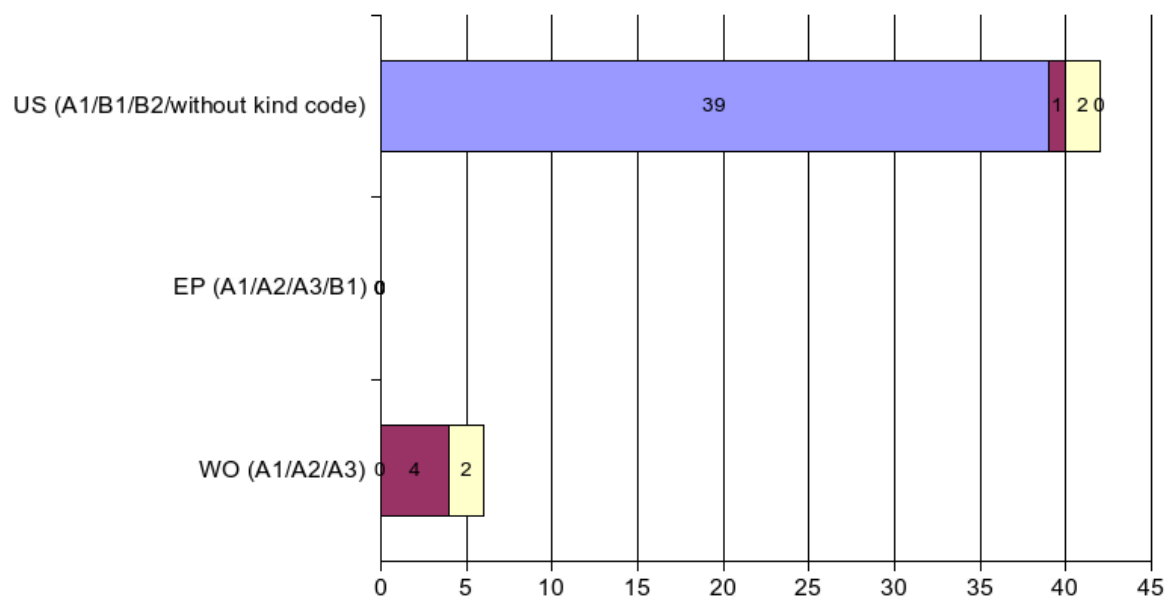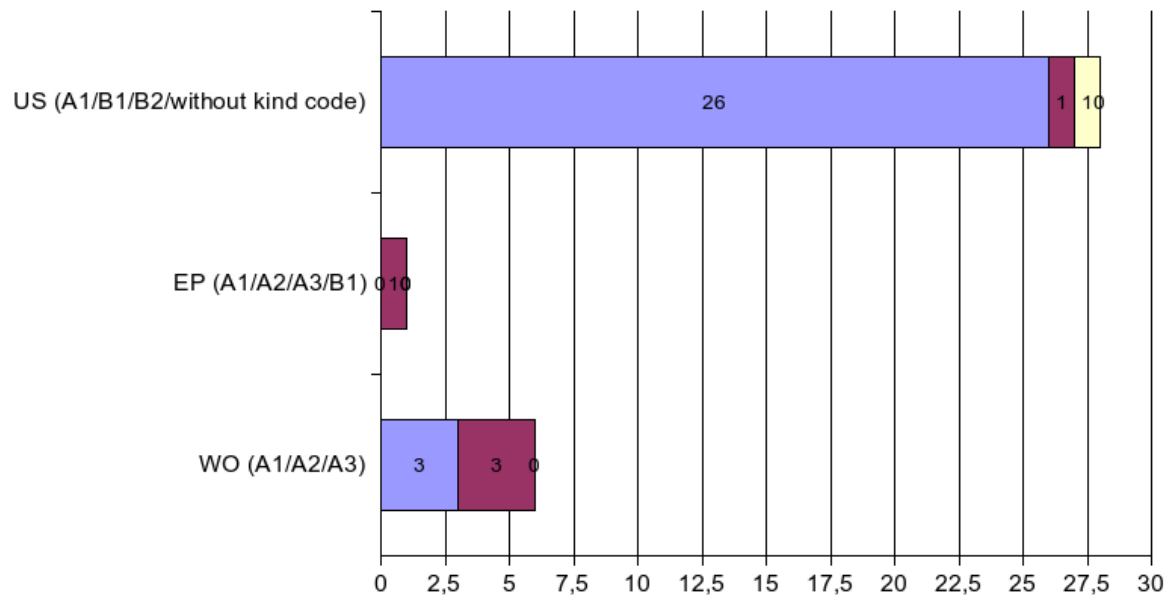## Kind code breakdown keyword Secure Path / IO

Kind code breakdown WP3

Kind code breakdown SWP3a

Kind code breakdown SWP3b

Kind code breakdown SWP3c

Kind code breakdown SWP3d

Kind code breakdown WP4

US (A1/B1/B2/without kind code) | 186 | 6 | 14 |
EP (A1/A2/A3/B1) | 9 | 7 | 3 | 2 |
WO (A1/A2/A3) | 22 | 24 | 4 |

0 25 50 75 100 125 150 175 200 225

Kind code breakdown SWP4a

US (A1/B1/B2/without kind code) | 39 | 1 | 10 |
EP (A1/A2/A3/B1) | 2 | 1 | 0 |
WO (A1/A2/A3) | 6 | 10 |

0 5 10 15 20 25 30 35 40 45

Kind code breakdown SWP4b
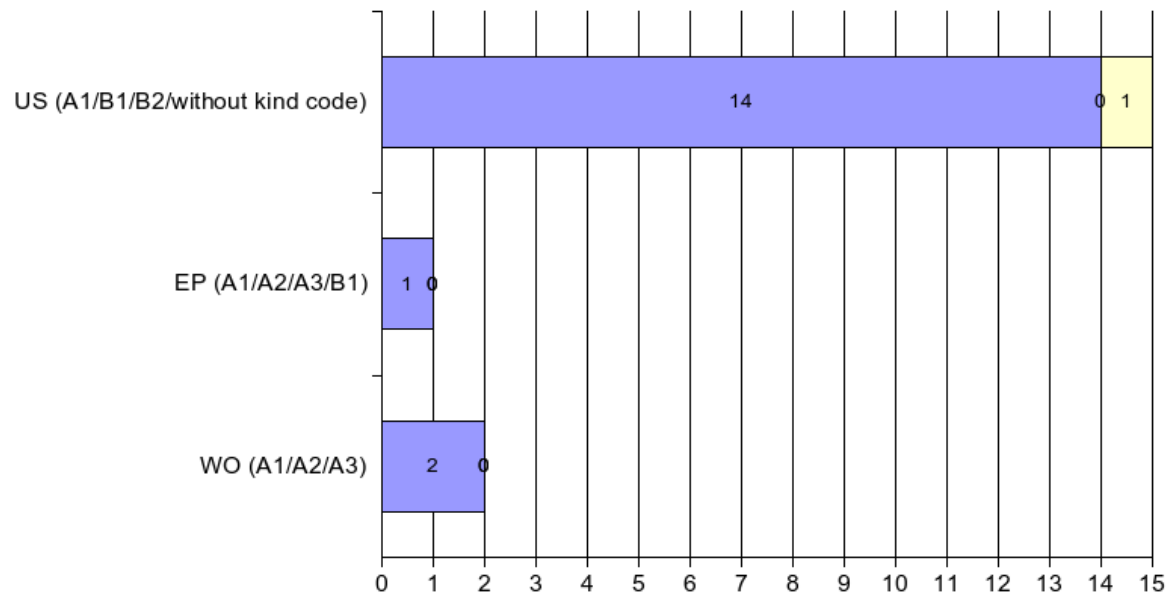
Kind code breakdown SWP4c

35

Appendix

Kind code breakdown SWP4d

Kind code breakdown SWP4e

Kind code breakdown WP5
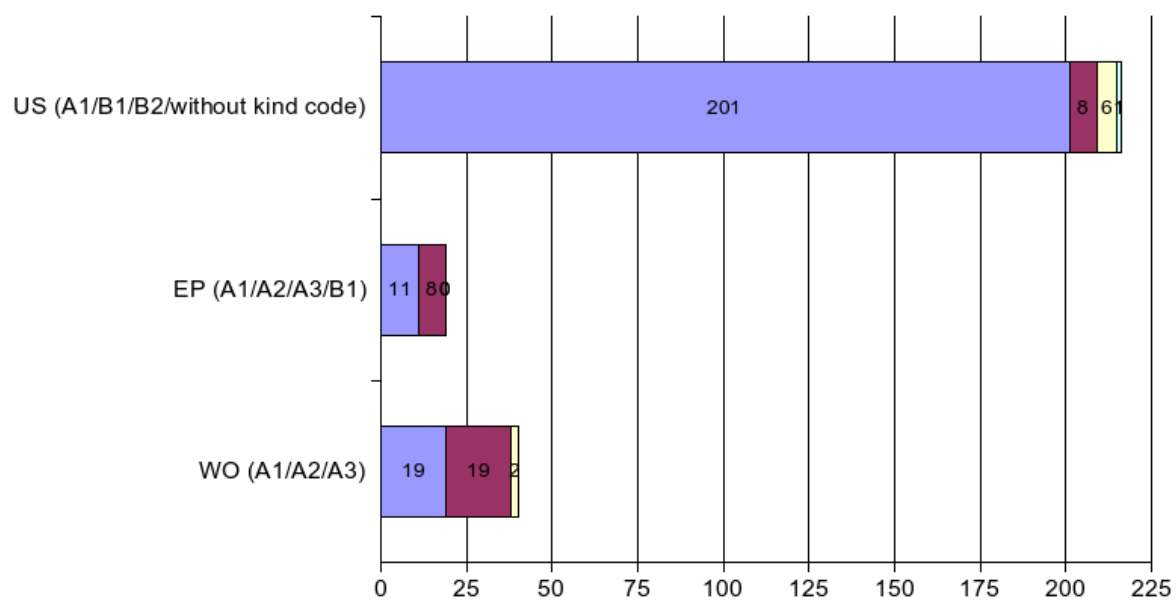
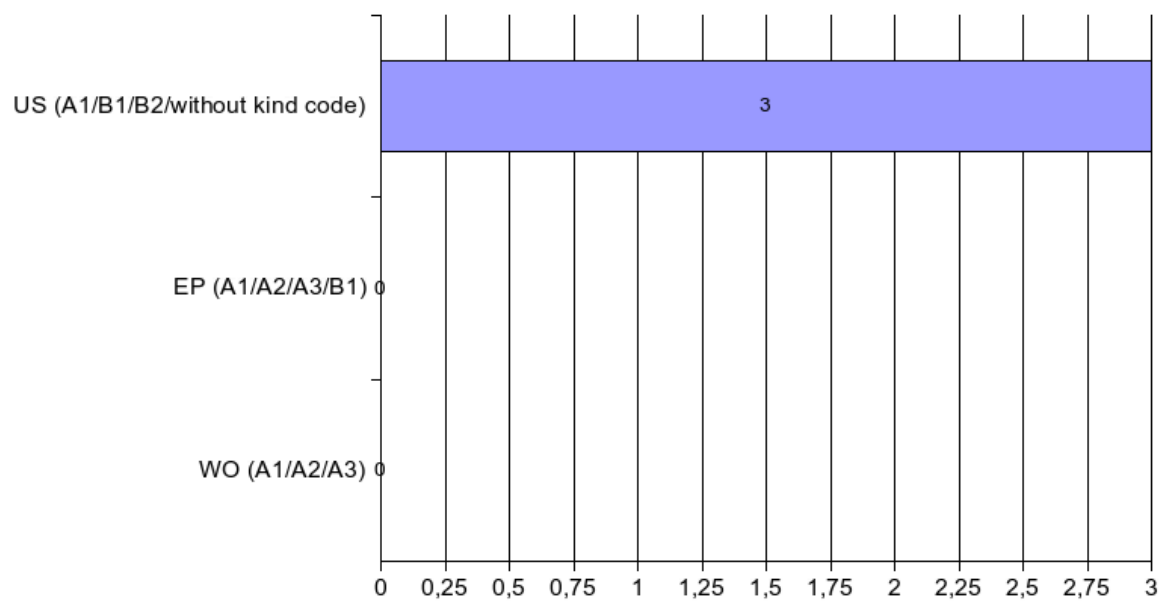## Kind code breakdown SWP5a
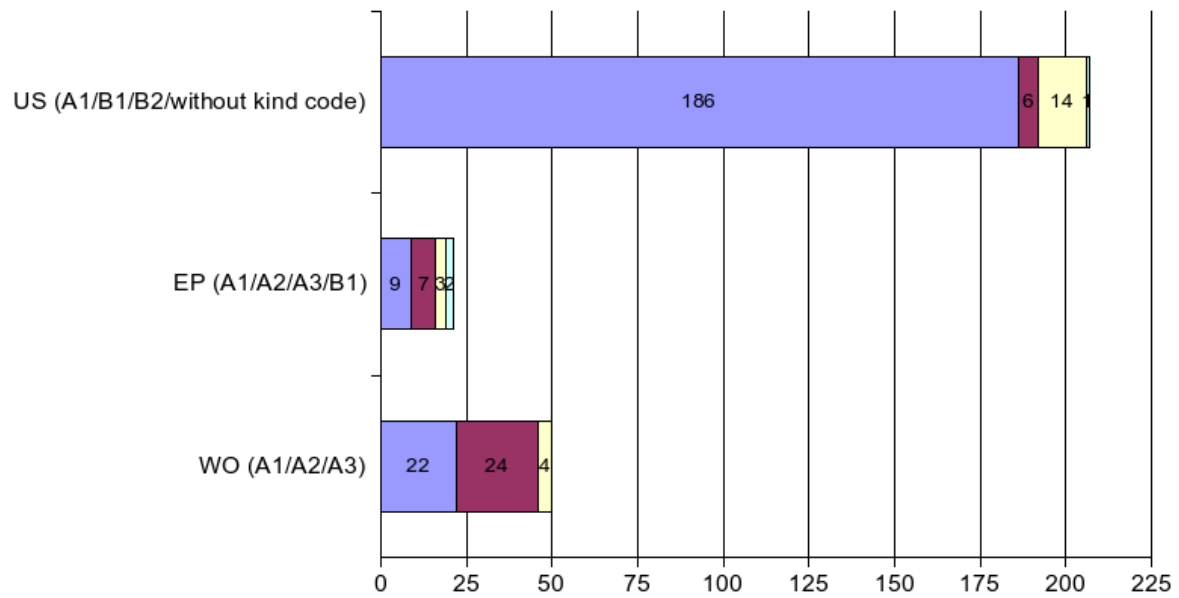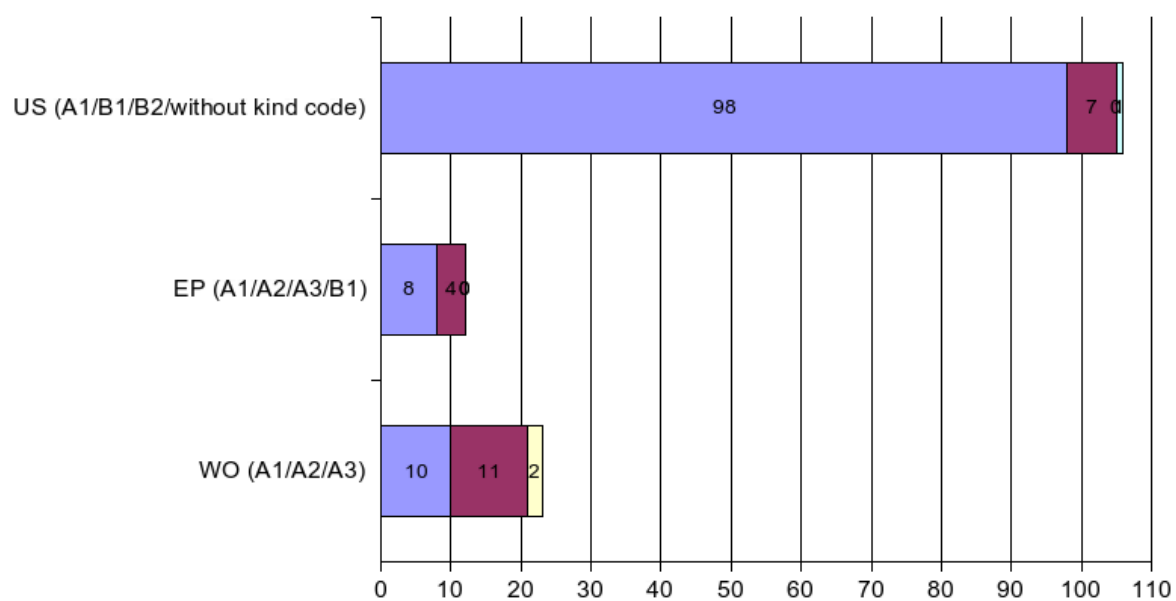
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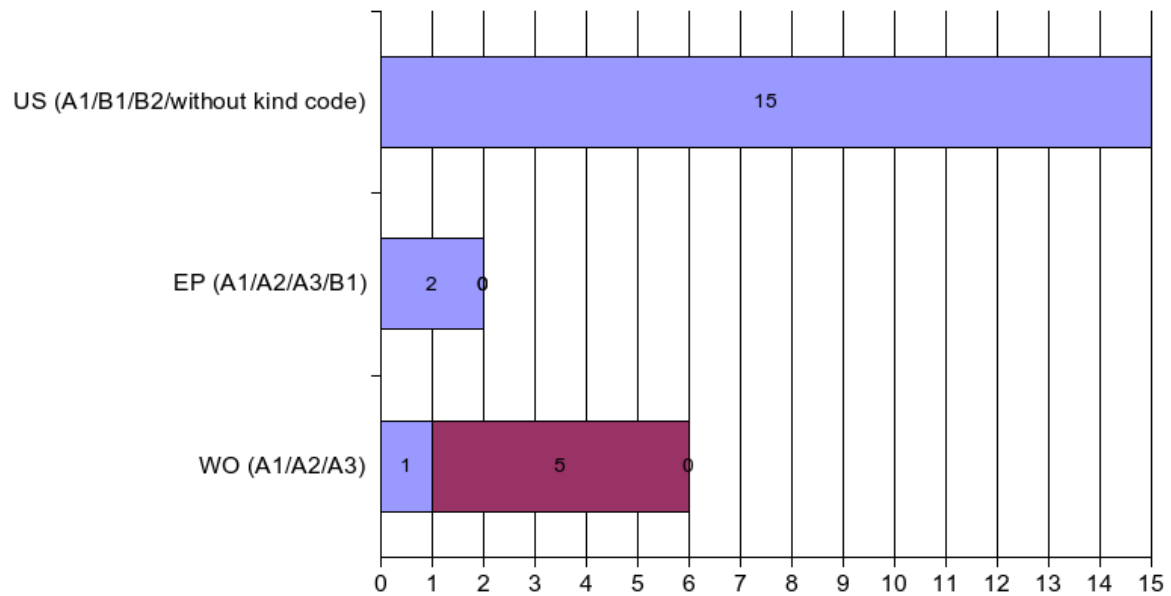
Kind code breakdown SWP5c
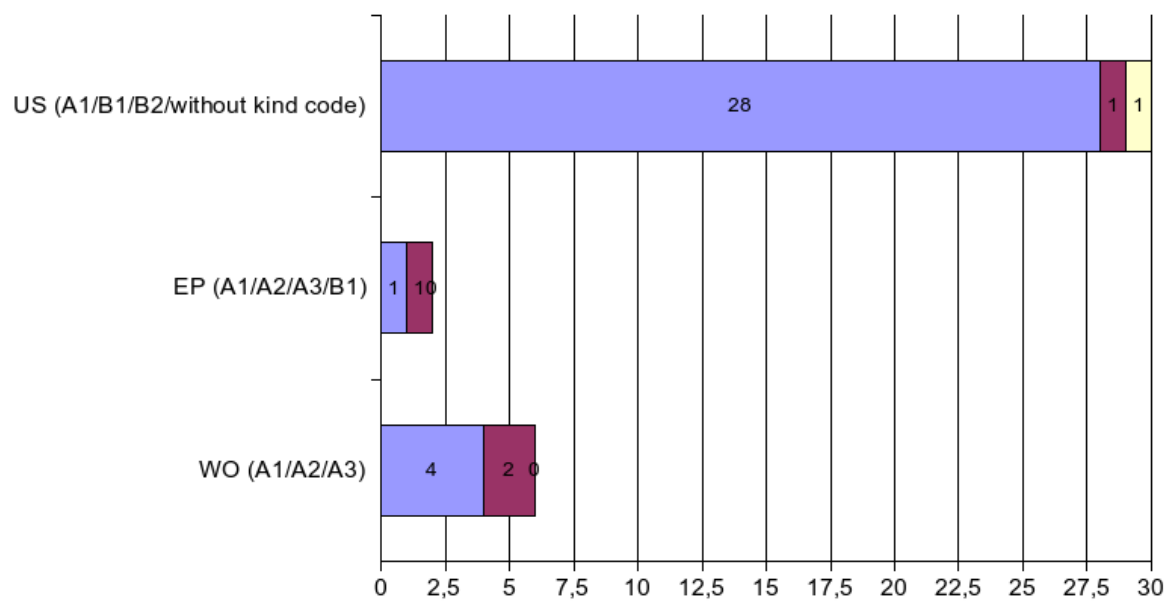
Kind code breakdown SWP5d
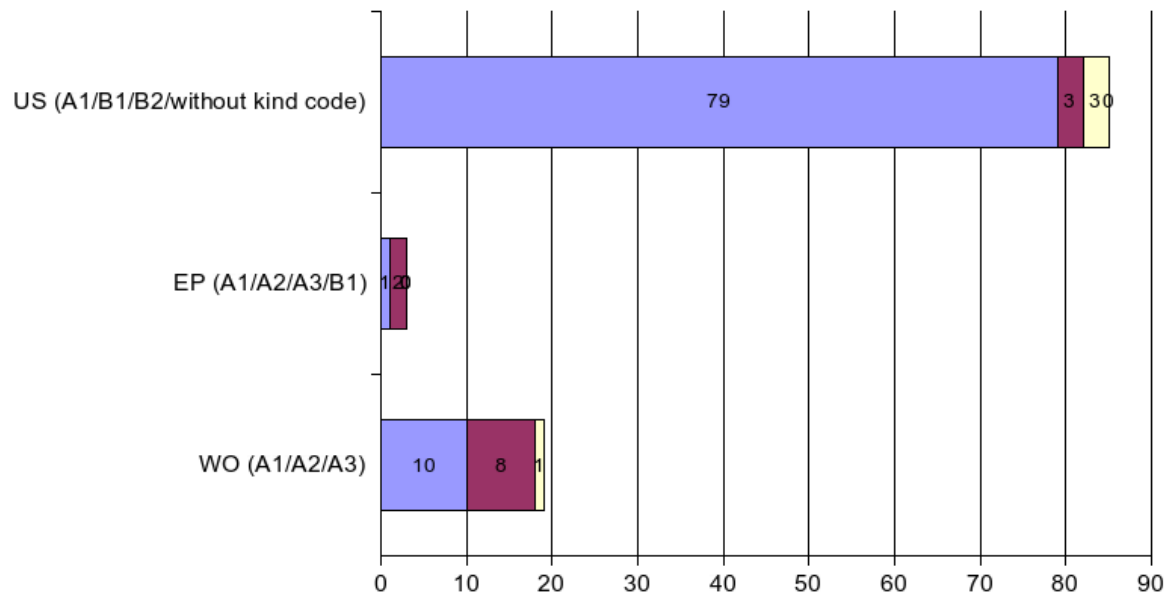
Kind code breakdown WP6

Kind code breakdown SWP6a

US (A1/B1/B2/without kind code): 25, 2, 0

EP (A1/A2/A3/B1): 3, 6, 0

WO (A1/A2/A3): 3, 5, 2

(x-axis: 0, 2,5, 5, 7,5, 10, 12,5, 15, 17,5, 20, 22,5, 25, 27,5)

Kind code breakdown SWP6b

US (A1/B1/B2/without kind code): 9

EP (A1/A2/A3/B1): 1, 0

WO (A1/A2/A3): 0

(x-axis: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9)
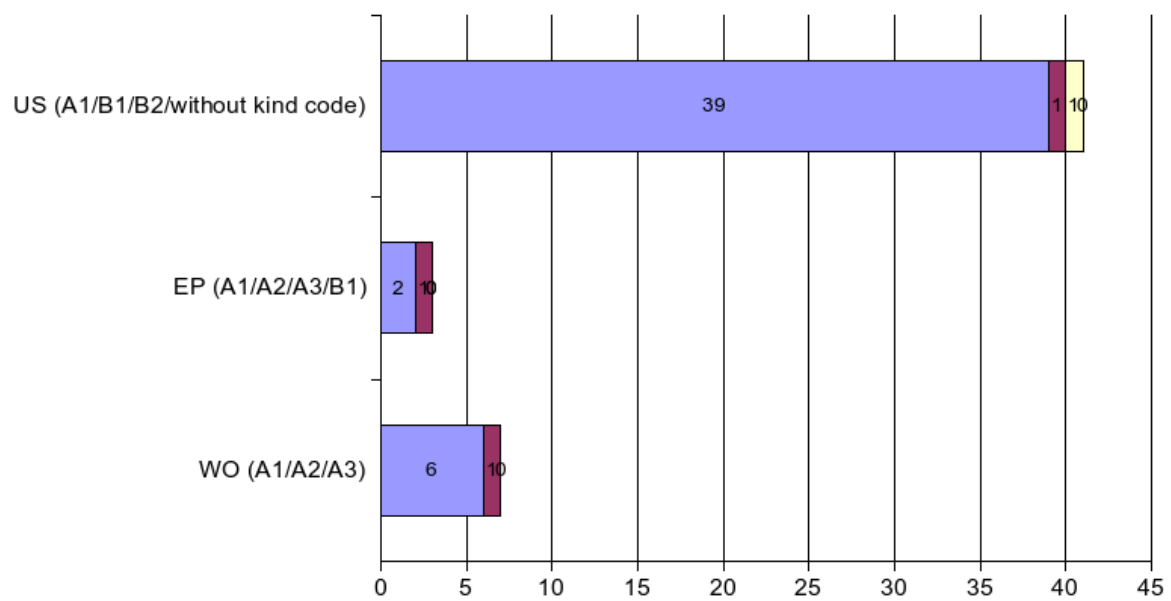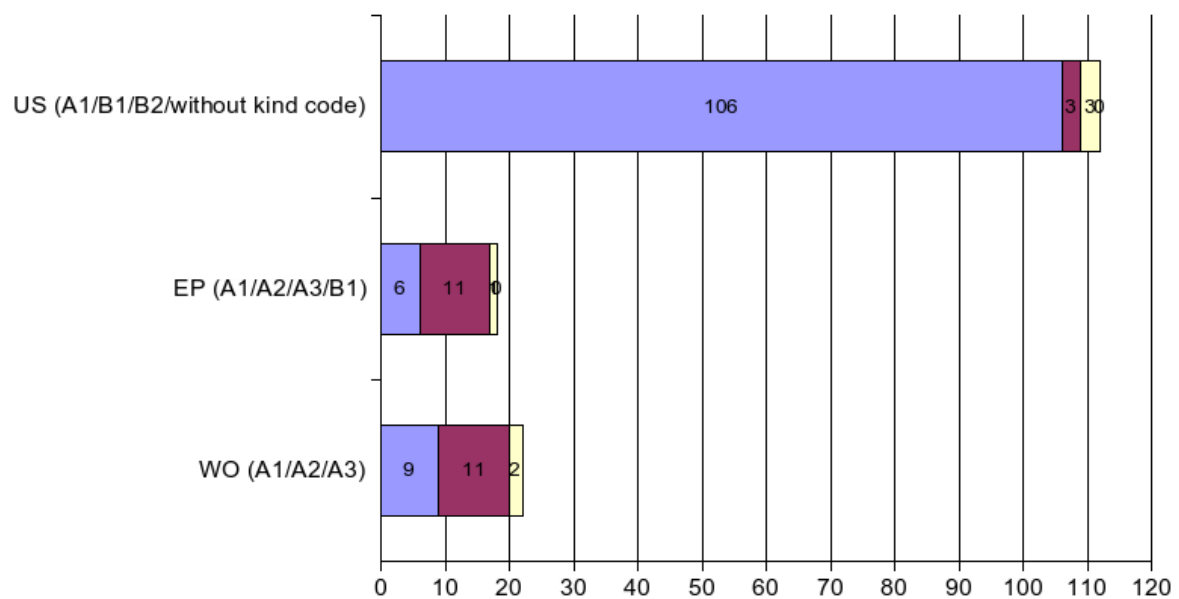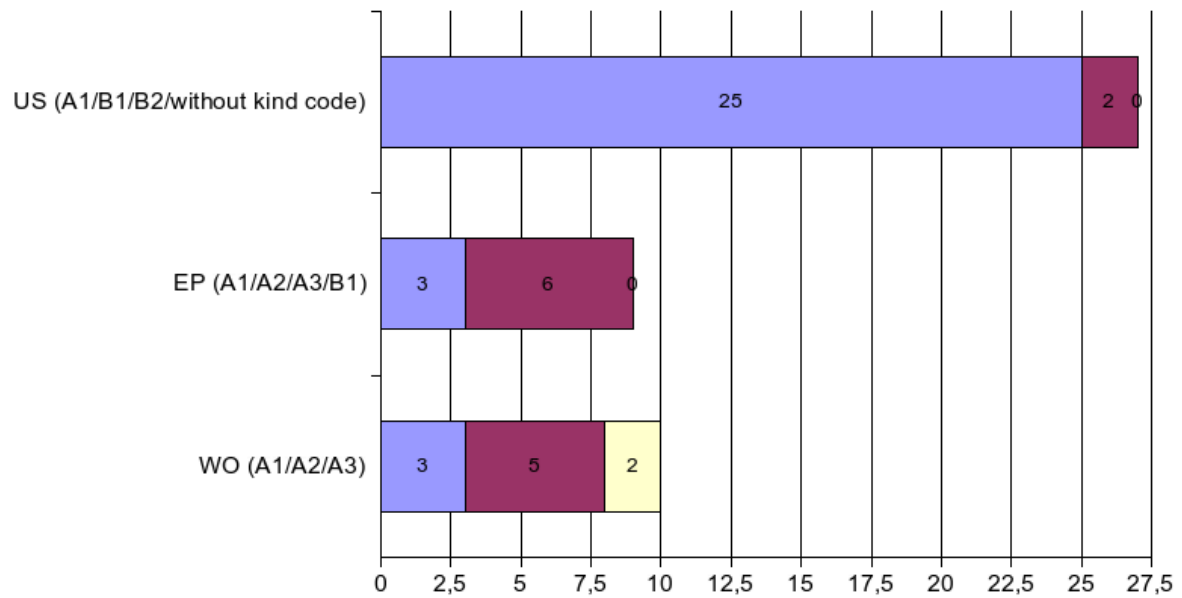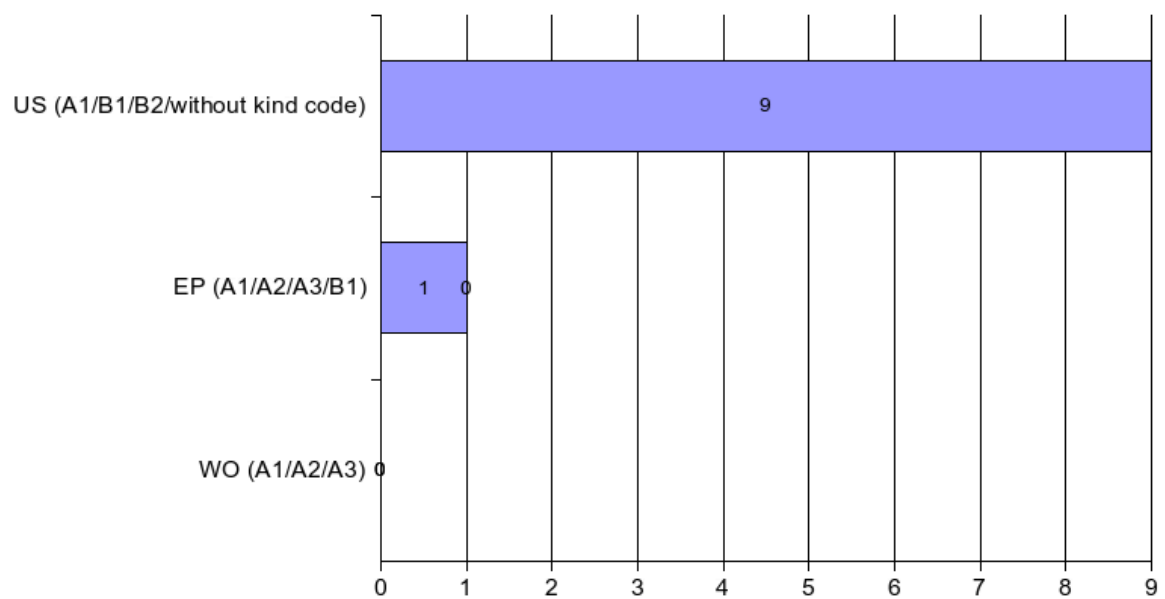
Kind code breakdown SWP6c
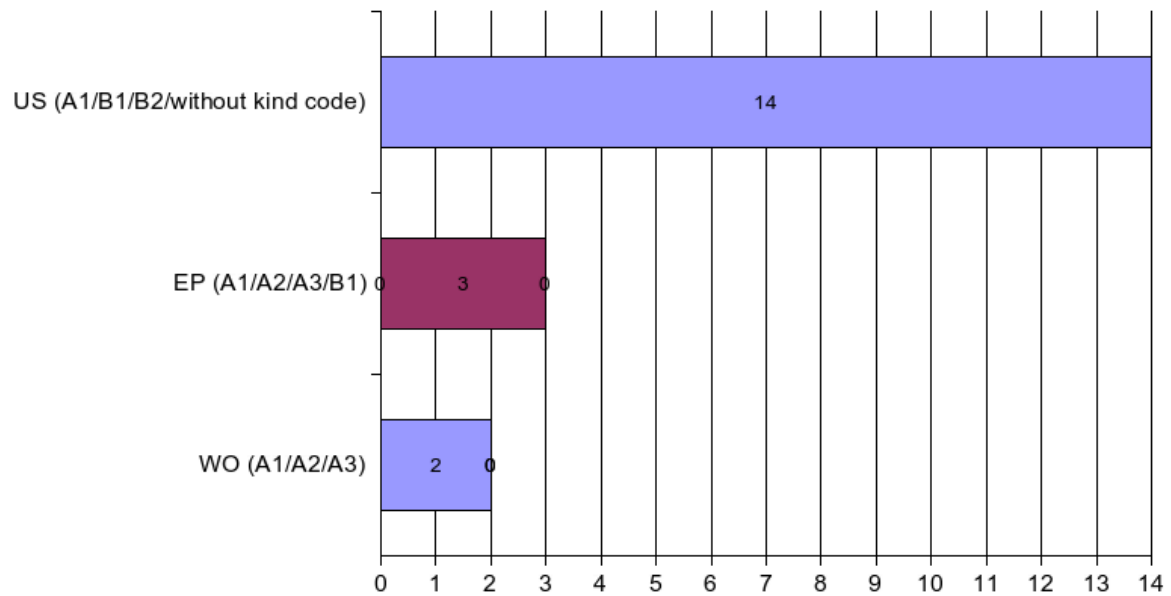
Kind code breakdown SWP6d
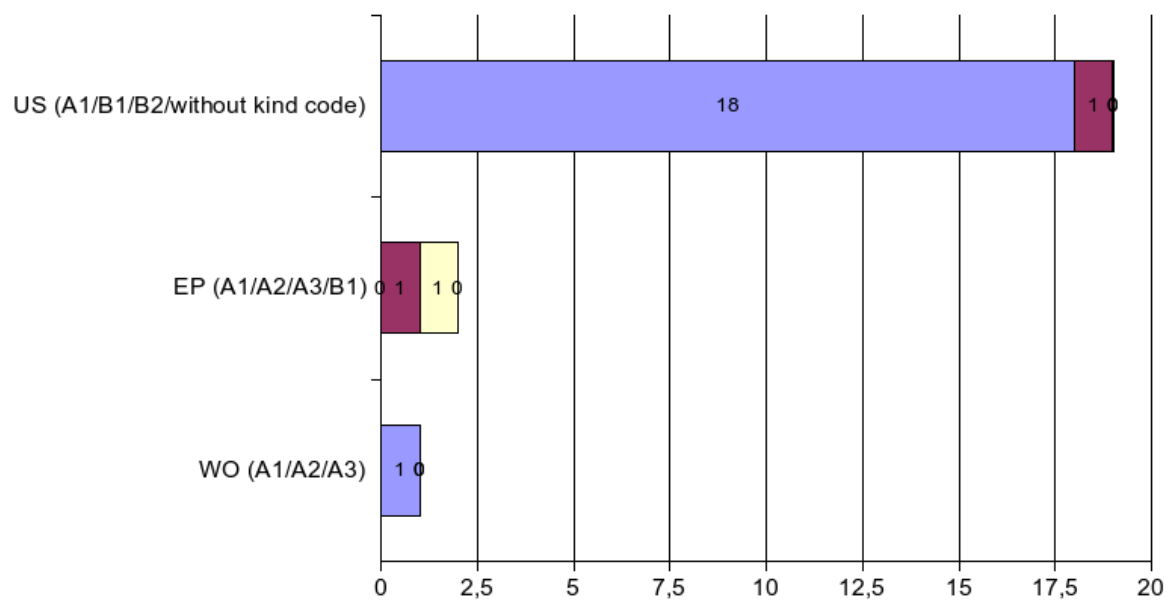
Kind code breakdown SWP6e

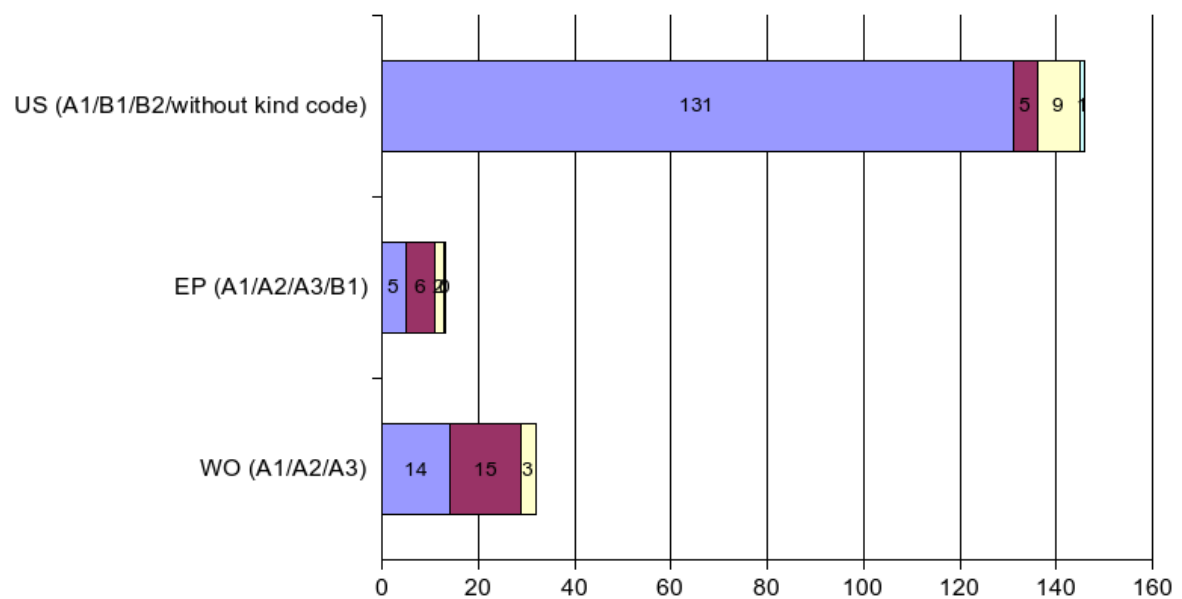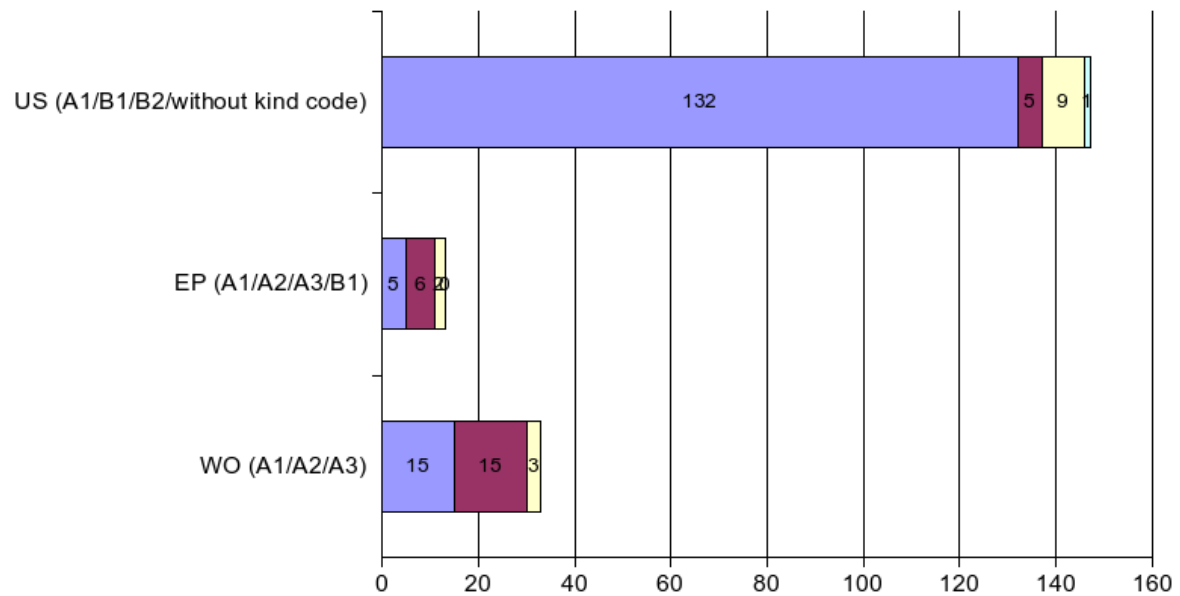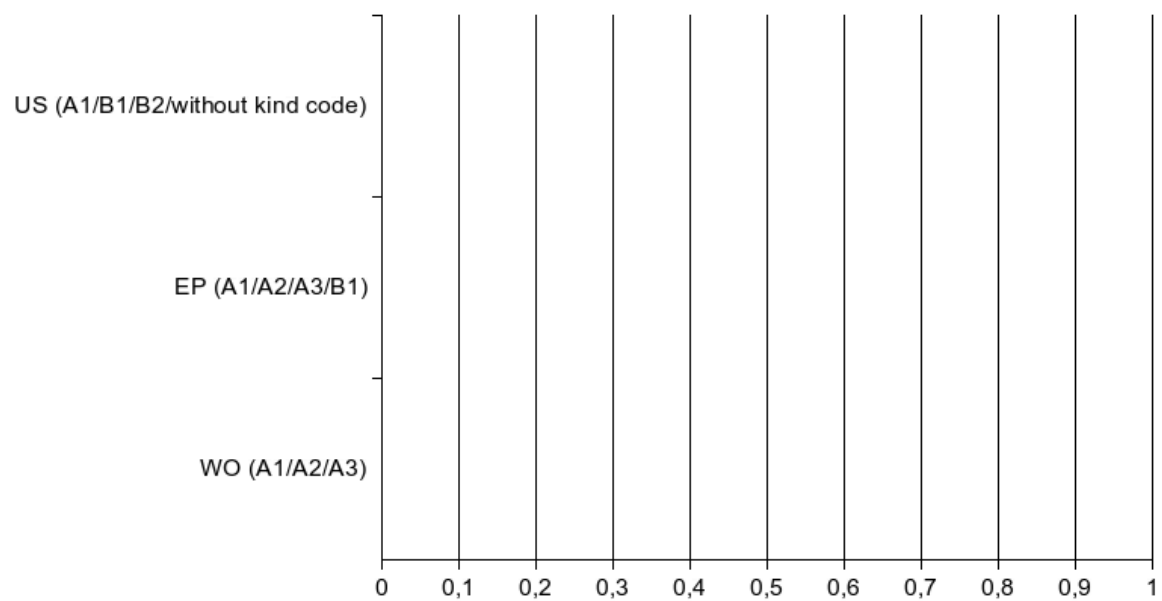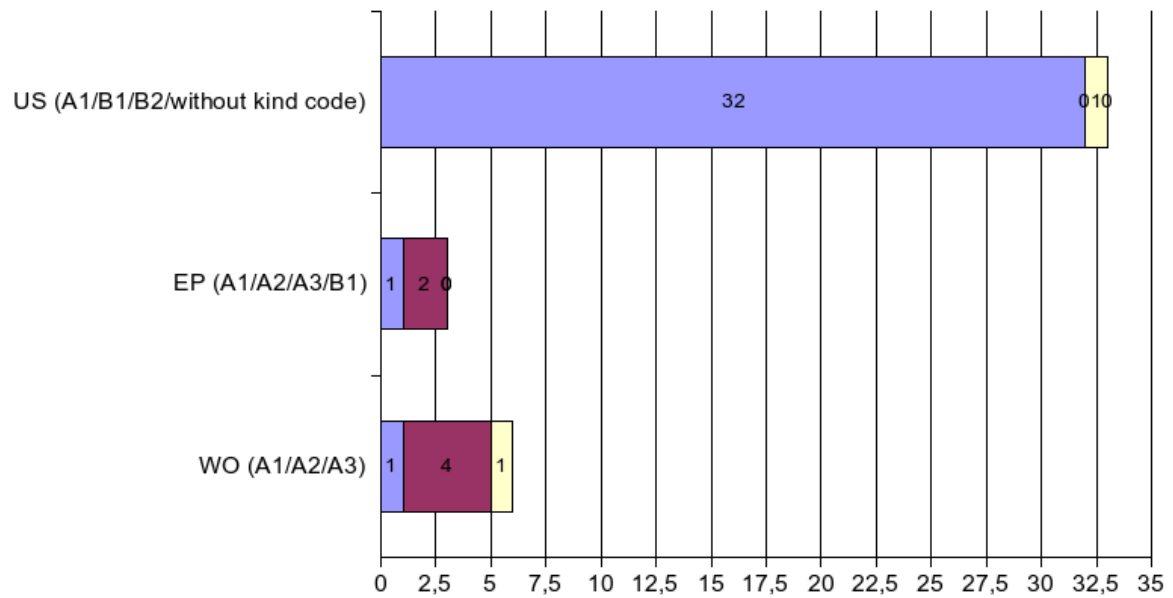## Kind code breakdown WP8
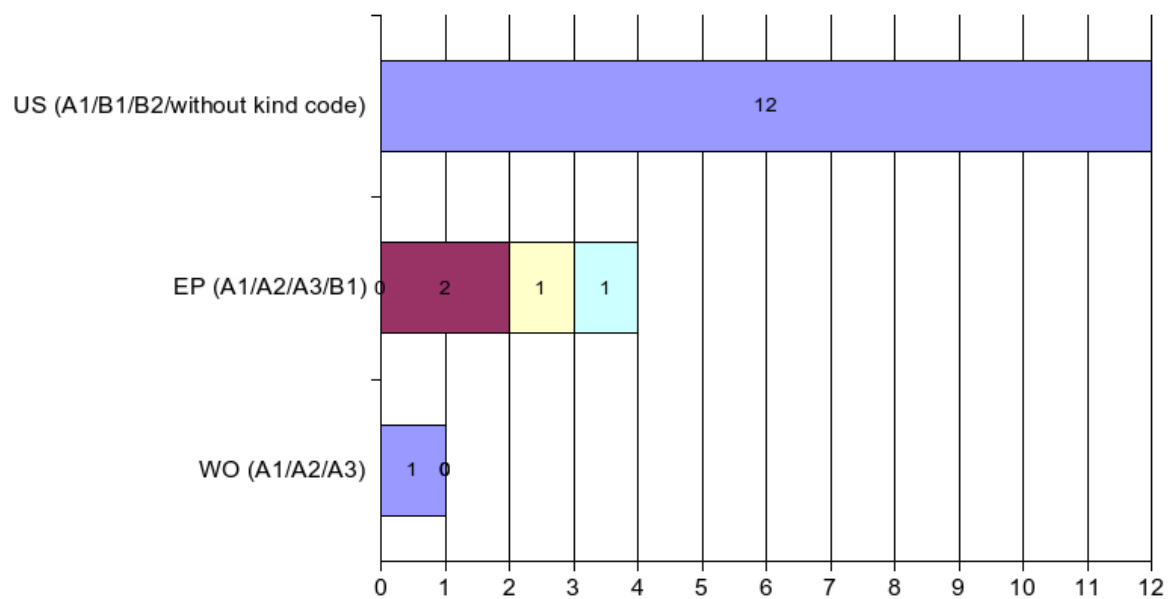
Kind code breakdown SWP8a.1
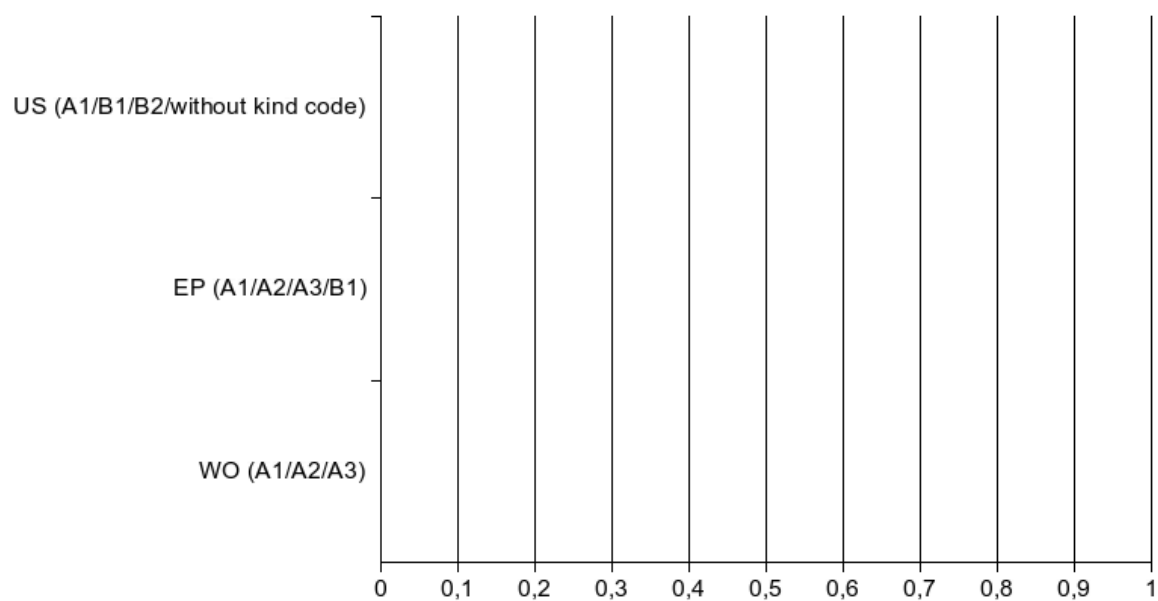
Kind code breakdown SWP8a.2

Kind code breakdown SWP8b

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EP (A1/A2/A3/B1)

WO (A1/A2/A3)

0   0,1   0,2   0,3   0,4   0,5   0,6   0,7   0,8   0,9   1

Kind code breakdown SWP8c

US (A1/B1/B2/without kind code)

EP (A1/A2/A3/B1)

WO (A1/A2/A3)

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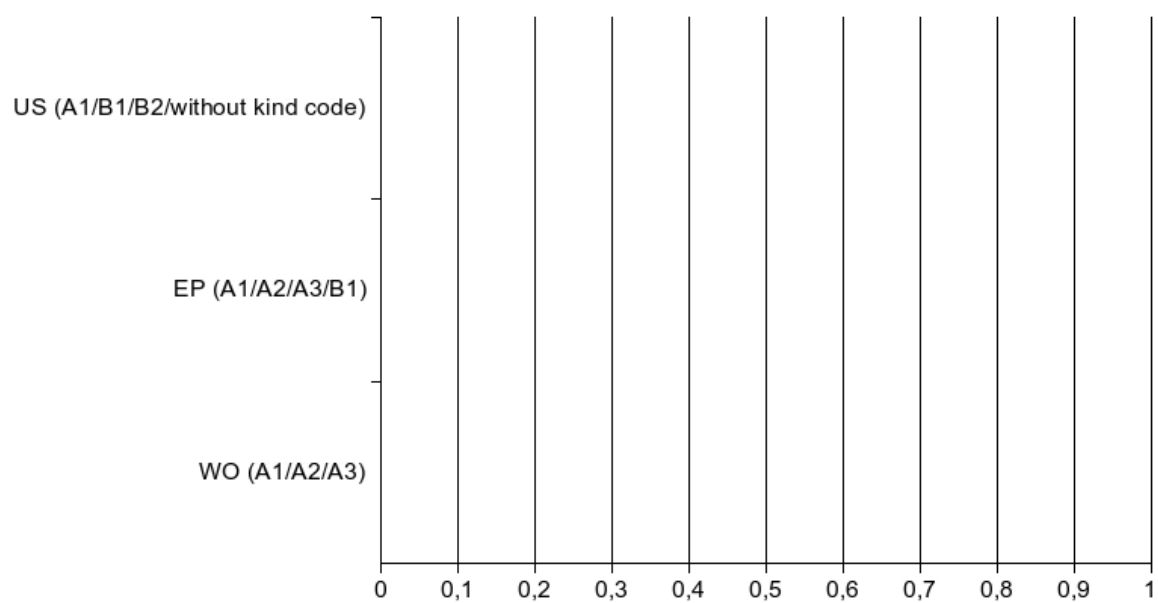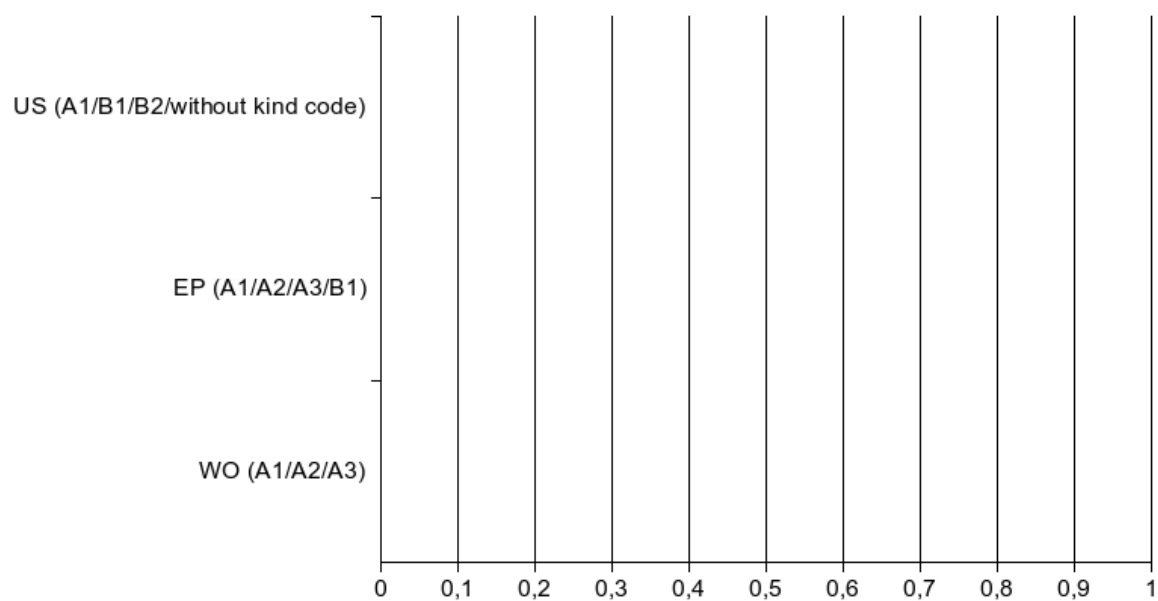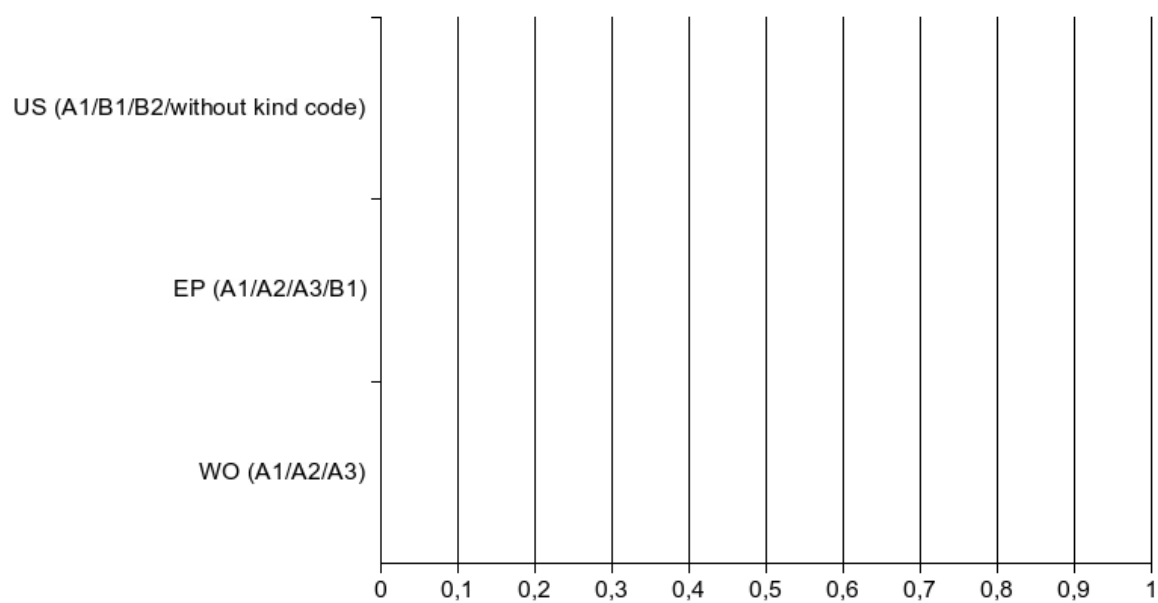
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