Evaluation and Monitoring of Fingerprint Acquisitions for the European Visa Information System

Experiences from Austria

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Abstract: The Biometric Evaluation Authority (BEA) concept allows to evaluate and monitor fingerprint acquisitions with regard to the European Visa Information System (VIS). In Austria, a BEA implementation was installed in order to evaluate the quality of the acquired fingerprints, the duration of the fingerprint acquisition process, the number of captures conducted and the results of fingerprint record uniqueness checks. This paper introduces the concept of the BEA and presents results of the Austrian visa application process achieved in the first months of the VIS in operation.

1 Visa Applications in Austria

Since October 2011, the European Visa Information System (VIS) and the underlying Biometric Matching System (BMS) for fingerprints is in operation. Mandated by the European Regulation No. 767/2008 [EC-767-2008] all European Union member states are requested to capture a full set of fingerprints - in conjunction with a facial image and other relevant data, i.e. alphanumeric, document and personal data, for the processing of visas - of the applicant.

In order to assist member states in the fingerprint acquisition processes, the European Commission (EC) has provided a User Software Kit (USK) with four sub-kits. USK1 may be used to perform a quality check of a single fingerprint image, USK2 may be used to perform a uniqueness check of fingerprints (meaning that there are no duplicate fingerprints in the fingerprint record), USK3 may be used to segment slap fingerprint images and USK4 may be used for a quality check of a full fingerprint set (all available fingerprints of a person). All sub-kits may be used by member states in order to capture good quality fingerprints that meet the requirements of the Biometric Matching System (BMS) of the VIS.

In Austria, around 88 consular posts are needed to be adopted for fingerprint acquisition and VIS communication. All in all, this leads to around 305.000 visa applications per year. Every consular post is equipped with four-finger-scanners and fingerprint acquisition applications. The workflow for fingerprint acquisition uses the USK4 provided by the EC for quality assurance. However, the USK4 is provided with two settings. The central setting has a threshold that shall in behaviour be close to the algorithm used in the BMS of the VIS. The classic setting has a much stricter threshold that may be used to get fingerprints of even better quality.

Starting with the acquisition of the right slap (index, middle, ring and little fingers of the right hand), slap captures are repeated up to three times until the captured fingerprints meet the requirements of the USK4 using the classic (and stricter) threshold. Single finger captures may be conducted if a specific amount of fingerprint images of good quality cannot be obtained. The process is then repeated for the left slap and both thumbs, followed by a final quality check of all captured fingerprints using the central setting. This final quality check also includes a uniqueness check for duplicate fingerprints in one single record. If duplicate fingerprints are detected by the USK4, those fingerprints must be re-captured in order to ensure to have a record with unique fingerprints. Non-unique records, i.e. records that contain duplicate fingerprints, will be rejected and not be stored in the VIS.

2 Biometric Evaluation Authority (BEA)

High requirements in fingerprint quality are needed to be able to achieve good biometric performance of the BMS considering the high number of fingerprints planned to be enroled in the VIS. Hence, before storing the captured fingerprints of each member state in the central VIS database, the quality is checked. In case that fingerprints do not fulfill the defined requirements of the BMS, they are marked internally in order to be excluded when conducting a 1-to-N search. The European Commission regularly releases statistics to all member states showing the central quality rejection rate of each member state. Member states with high rejection rates are then requested to reduce it by improving their local quality assurance approaches.

However, in case that the rejection rate of a member state is considerably higher than of most other member states, the reasons causing this high rejection rate may not be known at that time. Reasons causing a high rejection rate may be different in their nature. Malfunctioning fingerprint devices may return bad quality fingerprint images, fingerprints of certain regions or of certain ethnics may be causing problems in the acquisition process, new hardware may cause unexpected problems or the roll-out in new consular posts or application offices may introduce unknown issues. Furthermore, it may be interesting to see the change of the rejection rate over time as operators in application offices may need some time to get into their new job of acquiring fingerprints of other people. All those specific statistics are not released by the EC even though they could help identifying issues that lead to a high rejection rate.

Consequently, the German Federal Office for Information Security (BSI) has introduced the concept of the Biometric Evaluation Authority (BEA) in their Technical Guideline TR-03121 Biometrics for Public Sector Applications [TR-03121]. Fingerprint data captured in application offices is transmitted via the National Central Authority (NCA) to the VIS / BMS. However, important information about the local fingerprint acquisition process is sent to the Biometric Evaluation Authority (BEA) for further evaluation (see Figure 1). The acquisition process data is transmitted in a specified XML (eXtensible Markup Language) format that contains the following information:

- duration of the acquisition process

- details of the acquisition process (i.e. number of captures/repetitions conducted)

- local and central quality assurance results

- results of duplicate fingerprint checks

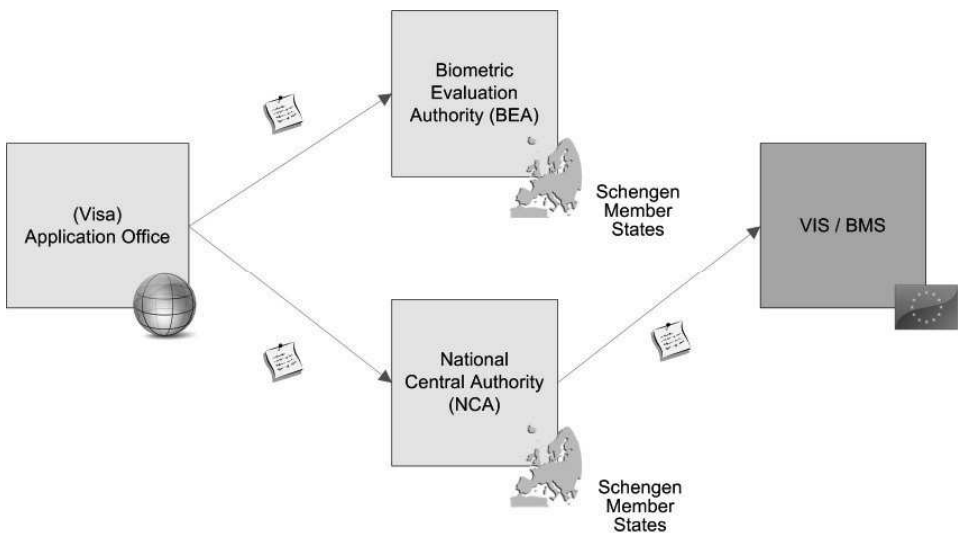- additional data for statistical reasons (i.e. demographic data, location of acquisition)

Figure 1: Instances of the Biometric Visa Application process [TR-03121]

In Austria, the concept of a Biometric Evaluation Authority was now realised and implemented as a web application by the German company secunet Security Networks AG. As part of the fingerprint enrolment process, while fingerprints are transmitted to the VIS, the process XML is parsed and the content is stored to a national evaluation database. The BEA implementation is hosted as a web application on a central web server which communicates via the ODBC interface to the evaluation

database. Via a web browser, the user interface of the BEA implementation can be displayed and evaluations may be conducted.
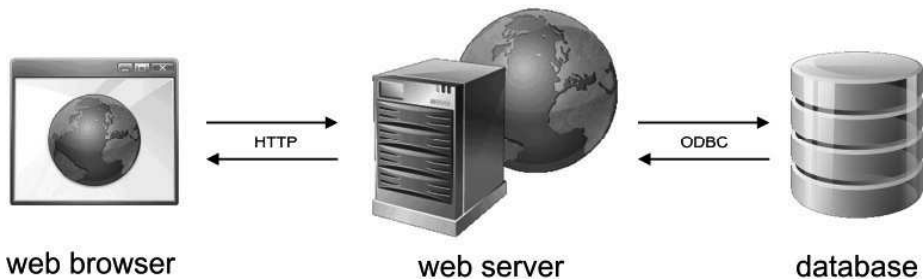

Figure 2: Architecture of BEA implementation in Austria

The BEA web application has implemented all evaluations that are defined in [TR-03121]. By selecting the according menu, diagrams are generated and displayed in the web browser. Furthermore, all evaluations may be filtered by time and location of acquisition. Hence, it is possible to generate diagrams for certain areas (e.g. Northern Africa, South East Asia, …) or even for single application offices. Additionally, every evaluation may be filtered by a chosen time-frame (e.g. all applications from 2012, all applications from the last month, …). Finally, time and location filters may be combined.

Another functionality is the possibility to generate reports. By selecting the desired locations, a report is generated that contains sub-reports of the last month, the last three months and the last year. This functionality gives the Austrian Federal Office for European and International Affairs the possibility to have a summary of the fingerprint acquisition process of any desired application office, area or time-frame.

3 Analysis of Fingerprint Acquisitions

Fingerprint acquisitions in terms of visa applications were conducted from October 2011 on in Austrian consular posts of the first two VIS roll-out regions, North Africa and Near East. From the following consular posts data is available from October 2011 until June 2012, representing the first nine months of VIS in operation. All in all, more than 7400 fingerprint acquisitions have been taken within this time-frame.

- North Africa
    - Tunis (Tunisia)
    - Algiers (Algeria)
    - Cairo (Egypt)
    - Rabat (Morocco)
    - Tripoli (Lybia)

- Near East
    - Amman (Jordan)
    - Beirut (Lebanon)
    - Tel Aviv (Israel)
    - Ramallah (Palestinian territories)
    - Gaza City (Palestinian territories)

3.1 Monitoring Fingerprint Quality

Using the quality assurance evaluations of the BEA implementation, diagrams of local and central quality assurance results can be generated. The diagram of Figure 3 shows a pie chart of the overall local quality assurance. As denoted earlier, the local quality is assured by the use of USK4 with the stronger, classic threshold setting. For the period from October 2011 until June 2012, results of the mentioned consular posts show that around 11.27 percent of all applications contain fingerprint images that do not meet the requirements of the local quality assurance mechanisms.

However, talking about the rejection rate from the BMS of the European VIS, the results of the central quality assurance algorithm (USK4 with central threshold setting) have to be considered. The according diagram from the BEA implementation is shown in Figure 4. It shows that the central rejection rate is slightly above 3 percent.
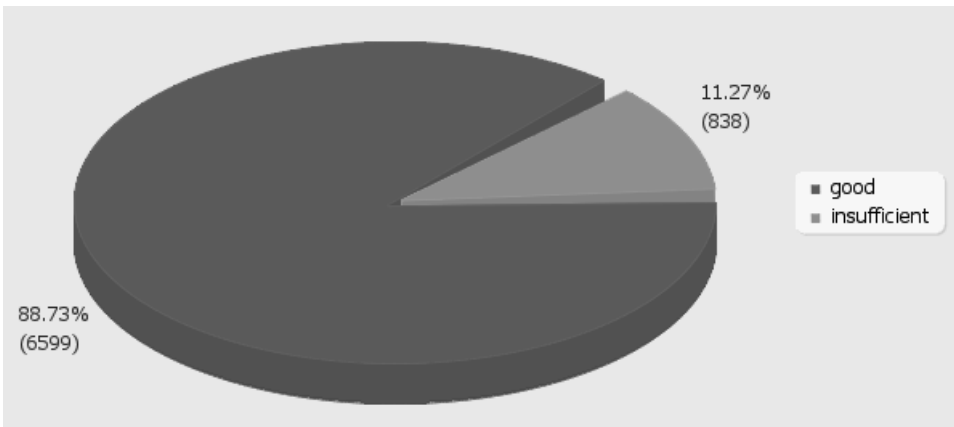

Figure 3: Local quality assurance results (USK4 with classic threshold)
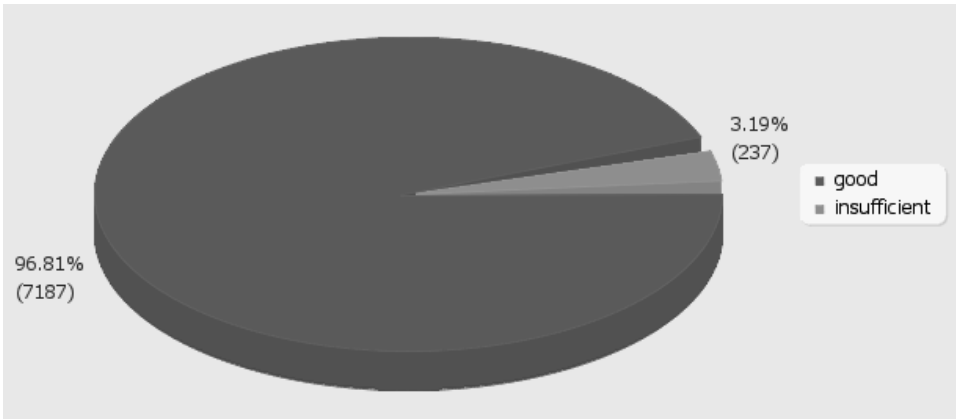
Figure 4: Central quality assurance results (USK4 with central threshold setting)

As the central rejection rate is regularly reported to the member states by the European Commission and it may indicate on issues during the fingerprint acquisition process, a diagram of the development of it over time can be displayed in the BEA implementation. Figure 5 shows the development from October 2011 until June 2012. While the average rejection rate of this time-frame is around 3 percent, the central rejection rate of each month shows the deviation from the average. An interesting fact is the growth of the rejection rate in March 2012. This could be an indication of issues appearing in the visa application process. In fact, the significant increase results from the new installation of the acquisition software in some consular posts of the Near East region where operators are not yet familiar with the fingerprint acquisition process. Applying filters in the BEA implementation, it can be found out that the central rejection rate in March 2012 for the consular posts of Ramallah, Gaza City, Tel Aviv, Beirut and Amman is around 11 percent. Figure 6 shows the development of the central rejection rate for these consular posts only. It can be clearly identified that in the first two months of using fingerprint acquisitions in these consular posts the rejection rate is significantly higher than the average. Furthermore, the diagram shows that there is a strong decrease until June 2012. This indicates that operators get used to the new processes and, hence, the fingerprint quality increases. Reasons for such a high rejection rate during the introduction of these new processes may be wrong handling of the fingerprint devices, missing information for the applicants, or the lack of experience of the operators in both acquiring satisfying fingerprints and avoiding common usage errors.

However, having evaluated the rejection rate of each month, the results are inline with the results returned by the European Commission.
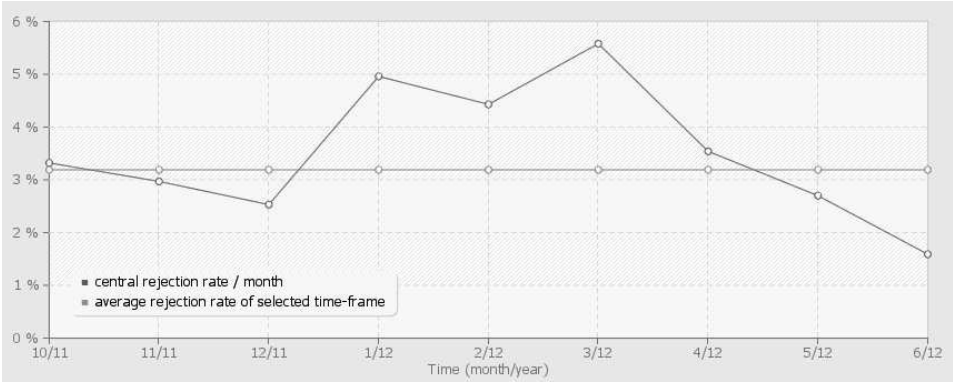
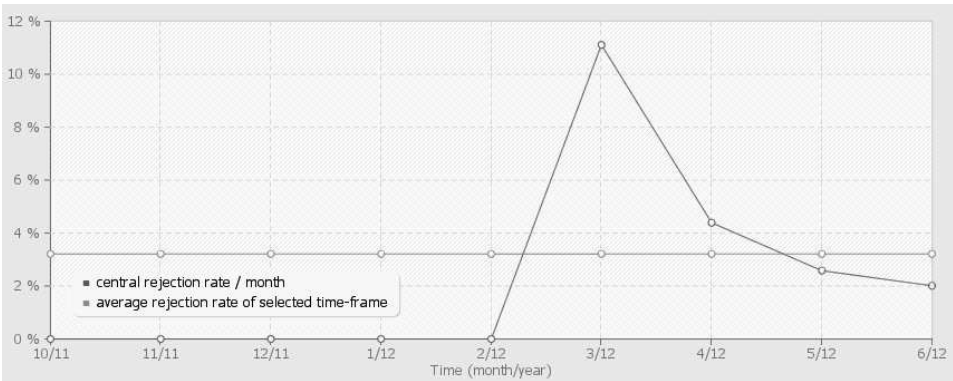Figure 5: Development of central rejection rate over time

Figure 6: Development of central rejection rate over time in Near East consular posts

3.2 Impact of Duplicate Records

As already mentioned, the visa application workflow in Austria uses the USK4 (with central threshold setting) to determine if a record contains duplicate fingerprints or not. In the first version of the client software, detected duplicates were displayed to the operator in order to re-acquire these fingerprints. However, it turned out that numerous records were rejected by the VIS due to detected duplicates. Those duplicate fingerprints were not re-captured by the local operators at the consular posts. Thus, the Austrian Federal Ministry for European and International Affairs changed the software to force operators to repeat finger captures if duplicates were detected by the final USK4 check. Nevertheless, many records were still rejected by the VIS. In Austria, around 1 percent of all visa applications contain records with duplicate fingerprints. To solve this issue, the European Commission suggests to use the USK2 (after a USK4 quality check) to determine if a record contains duplicate fingerprints.

However, secunet and the Austrian Federal Ministry for European and International Affairs have conducted a small evaluation in order to know if the usage of USK2 will improve the situation. In general, USK2 comes with three possible threshold settings to use:

- Quite Secure: corresponds to a False Acceptance Rate of 0.1 %

- Secure: corresponds to a False Acceptance Rate of 0.01 %

- Very Secure: corresponds to a False Acceptance Rate of 0.001 %

Evaluating all the records created in Austrian consular posts that were refused by the VIS due to detected duplicates, showed that none of the duplicate records could be detected by using USK4. But when using USK2 for uniqueness checks, all records, regardless of the chosen threshold, are detected as containing duplicate fingers. However, there is a difference in the number of detected duplicates per record. Results are shown in Figure 7. Using the threshold Quite Secure, most records contain between 2 and 6 duplicates. Applying thresholds Secure or Very Secure, however, most records are rated having only 2 to 4 duplicates.

As a result, it seems that using USK2 is the best option in order to reliably detect duplicate fingerprints in records. Furthermore, the usage of the threshold settings Secure or Very Secure seem to be the best choice. Due to the fact that records with duplicate fingerprints are fully rejected by the BMS, it is necessary to integrate USK2 into the enrolment application. This will also reduce the need for applicants to come back to the consular posts in case duplicate fingerprints were detected in the acquired record set. However, the additional usage of USK2 for uniqueness checks comes at cost of time during visa applications. The evaluation of the process data acquired during the next few months will show if the duration has increased significantly and if no more records will be rejected by the central BMS.
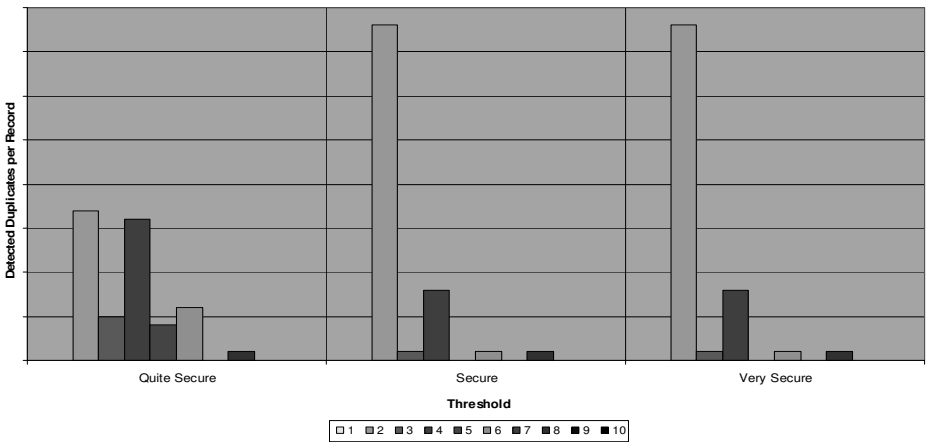

Figure 7: USK2 evaluation results (detected duplicates per record / chosen threshold)

3.3 Monitoring Acquisition Duration

A very important factor is the duration needed for the additional fingerprint acquisitions in consular posts. The average duration for the fingerprint acquisition is around 64 seconds. However, as shown in Figure 8 about 40 percent of the acquisitions can be finished within 40 seconds, nearly 70 percent within one minute. Only few applicants need much longer than one minute.
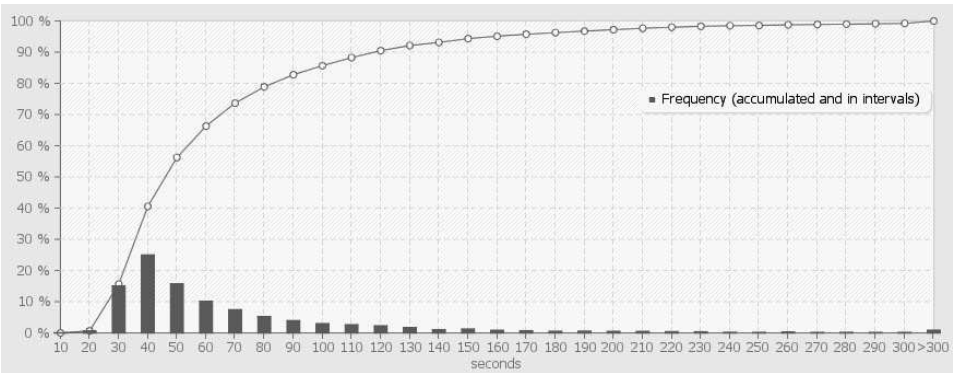

Figure 8: Duration of fingerprint acquisition

Applying filters in the BEA implementation, a distinction in the average duration of every consular post can be made. The following table shows the differences between consular posts.

Consular post	Average fingerprint acquisition duration
Tunis	79.8 seconds
Cairo	58 seconds
Rammalah	67.6 seconds
Algiers	76.8 seconds
Tel Aviv	69.3 seconds
Amman	67 seconds
Rabat	64.3 seconds
Tripoli	65 seconds
Beirut	57.7 seconds
Gaza City	45.6 seconds

Table 1: Average fingerprint acquisition duration in consular posts

Although the average fingerprint acquisition duration of each consular post is more or less similar considering the full time-frame from October 2011 until June 2012, it can be seen from Figure 9 that the average duration for fingerprint acquisition in Near East consular posts somehow correlates to the rejection rate of this region (see Figure 6) - fingerprints have much poorer quality with regard to the central USK4 check and the acquisition process takes much longer than the average. Again, this is an indication for the need of proper and thorough operator training before new processes like fingerprint acquisitions are introduced at consular posts. This information will for sure help during the roll-out of the acquisition software in the next VIS regions.
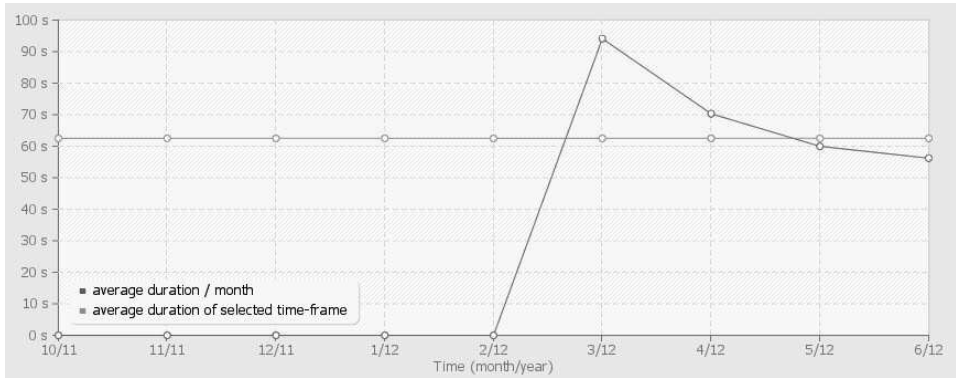

Figure 9: Development of average duration in Near East consular posts

However, the average duration of all consular posts shows that the process for fingerprint acquisitions in Austrian consular posts is rather fast. This fact can also be accompanied by the number of acquisitions conducted during enrolment (see next section and Figure 10).

3.4 Number of Acquisitions

Another interesting statistics is the evaluation of the number of acquisitions conducted in consular posts. Figure 10 shows that, in average, in more than 90 percent of all visa applications only one acquisition per slap is conducted. Especially for the thumbs slaps the value is even higher (about 98 percent). This is another indication for a fast process of acquiring fingerprints as in most cases the first acquisition already satisfies the needs for a central fingerprint matching system.

However, in a quarter of all applications, the operator switches to the single-finger mode where single fingerprints are captured instead of slaps. In more than 80 percent of these cases, the captured single fingerprints meet the quality requirements of the USK4. As a conclusion, it means that using single finger captures may help in many situations to acquire good quality fingerprints of visa applicants whereas it may not be possible to obtain the same quality by using a slap capture.
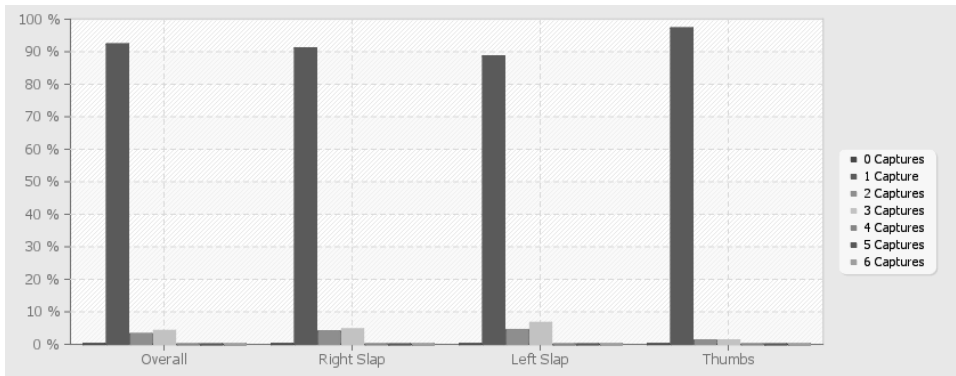
Figure 10: Number of slap acquisitions

4 Summary and Outlook

With the help of the BEA concept, an extensive evaluation of the visa application process is possible. By simply extending the enrolment application with a process logging functionality and a communication link to a central evaluation database, it is possible to evaluate and monitor the visa application process from a central location. In Austria, the BEA implementation is already in use to detect abnormalities and issues occurring in consular posts.

Evaluations from October 2011 until June 2012 with data from consular posts of North African and Near East regions have shown, that the central quality rejection rate is in a good range but could still be improved. However, looking at the good average fingerprint acquisition duration of slightly more than one minute, the implemented workflow seems to be a good trade-off between acquisition duration and fingerprint quality. Especially the short visa application time satisfies visa applicants as well as operators in consular posts.

The uniqueness check evaluation has shown that detecting duplicate fingerprints by the local acquisition application needs to be improved. It seems that using USK2 with threshold Secure or Very Secure adds much more reliability to the detection of duplicate fingerprints than just using the results of the USK4 check. However, this will come at cost of enrolment time. Given the fact that records containing duplicate fingerprints will be completely rejected by the VIS, it seems reasonably to invest more time in duplicate checks within the enrolment application. Hence, the USK2 check was added to the enrolment application. Future evaluations will show how much the duration will increase in average.

The last months since the VIS is in operation have shown that operators have to be forced by software mechanisms to re-acquire fingerprints that were detected as duplicates by the used uniqueness check algorithms. If not, operators will not re-capture these fingerprints resulting in a high number of rejections by the VIS.

Nevertheless, the fingerprint acquisition workflow for visa applications in Austria has many advantages as it is very fast and reduces the time needed for a visa applicant in consular posts. This is one of the major outcomes of using the BEA concept in Austria. Looking at profiles of the BSI Technical Guideline TR-03121 Biometrics for Public Sector Applications [TR-03121], further profiles for facial image acquisition with regard to the visa application process, as well as profiles for visa border control using fingerprints are already available. The BEA implementation by secunet Security Networks AG and the Austrian Federal Ministry for European and International Affairs already supports those profiles. Especially for visa border control the concept of the Biometric Evaluation Authority may be very interesting in order to have the possibility to quickly react on anomalities or issues occurring on international borders.

References

[EC-767-2008]   Regulation (EC) No. 767/2008 of the European Parliament and of the council of 9 July 2008 concerning the Visa Information System (VIS) and the exchange of data between Member States on short-stay visas (VIS Regulation).

[TR-03121]   Federal Office for Information Security (BSI): Technical Guideline TR-03121 Biometrics for Public Sector Applications, Version 2.3, 2011.