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New RFID-apps:

HF-based stock management by mobile solution and producing usage statistics on non-lending collections (f.e. periodicals)

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abstract

With this contribution we will provide an outline on new applications of RFID-utilization which go beyond the typical applications such as self-check service to clients and security tasks and may give a perspective of new ideas.
The German market of RFID-related tenders in the library context has an annual value of estimated at ten million Euro on average. It is our belief that innovative ideas and insights from within the library world itself are needed to advance the technological support and improve our goals, services and workflows in the small and smart world of the internet of things.
Against the background that our University of Applied Sciences is not so far from the Funkerberg where the first radio programme was transmitted in Germany in the year 1920 and that some RFID-related degree courses like Telematics, Logistics and Informatics are offered, it is proud to maintain the only RFID-task group in Germany which is strongly connected with the library-matters[1] and can present two contributions during this conference.

At first we will describe our inventory workflow with mobile RFID-devices, wands and software to get real time information about the existing holding and its position, which is important for every library to monitor its asset and all visualisations and indications of online-catalogue information like the location of each copy.[2]
We have different ways of reaching this goal, e.g. through the Unique Identifier (UID) as serial numer of each tag which identifies the transponder and has under the point of view of security aspects further advantages. Our team has achieved with this method a detection rate of 98 percent. Through scanning the media shelves with an RFID working mobile device (which includes antenna and reader) we got in a relatively short time (average of less than 10 minutes for 1.500 RFID-tags or items) a good part of the library sock. The UID is deposited within the Integrated Library System (ILS) or Library Management System (LMS) of the public libraries in Berlin with almost hundred locations. In a broader audience we would like to discuss and share our experience.

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[1] It concerns the annually happens two-day RFID-conference (see http://www.th-wildau.de/rfidsymposium), two-day-workshops, projects like iCampus (http://server01.tm.th-wildau.de/wcv2/pc/#/lang=2&page=home), BiblioScan to produce smart-baskets (www.biblioscan.org/), to set standards and guidelines like VDI 4478 about test procedure for standardising the definition of performance of RFID gates for use in libraries (http://www.th-wildau.de/autoidrfid).

[2] See the results of the first global RFID-survey by Mick Fortune: http://www.libraryrfid.co.uk/reasons2.html

As a second example we will present our solution to measure the usage of RFID-tagged printed-journals on a movable shelf. This shelf is fitted with an RFID-Reader, adapted single-loop antenna and some other smart units, a rechargeable battery, also a bluetooth transmitter to deliver all data to bluetooth-receiving personal computer. In this notebook a special unique software is used as middleware with a program that produces different charts about the usage of each shelved current journal. The electromagnetic field near this shelf enables recording how often the journal has been removed and replaces. With this solution as a first step we hope to get more information about the usage of non-lending materials within a library, not only journals.

Keywords: RFID-based inventory, RFID-based usage-statistics

Stock Management in the library

In our library with approximately 100000 volumes we have organised the three floors endowed with metlalic shelves as free access to the stacks. This arrangement offers a nice and direct access as service between the client and the desired media, but also increases the opportunity to disturb the shelf classification and media shelved by subjects through misplacing that media. The consequences have a great impact because not one library in Germany organizes regularly a complete or entire inventory procedure to get an overview of lost, missed and misplaced printed materials.
With our services of lending and return of media or using it into the library as part of the non-circulation part we manage a closed circuit or rotation of this good and to administrate supply chain of outgoing and coming goods with thousands of patrons is more ambitious than to conduct a storehouse.
Only the partial inventories that we are carrying out while we replace books in a tidy shelf or random samples take place. The reasons to avoid a whole library inventories are high staff expenditures, it is time consuming and inconvenient through closing the library while carrying out this process. Therefore it is obvious to look for technological solutions to provide support by automation-chains to keep track of library stock.

As far as we know about different discussions and publications, none of 600 RFID-run German libraries with little exceptions use an technically mature system of established workflows for mobile RFID-inventory of its stacks and holdings. One example are ambitious tests in the library of the University of Bielefeld which will be published soon in the german journal *B.I.T.-online* his results. Another example is a processing in the Westminster libraries in UK, which takes for 1500 till 2000 items one hour[3]. The small art library Sitterwerk with around 20000 items in Switzerland is uses a robot-fully-automized-system for the two-tiered wall-mounted shelves and gives the technical support to manage by chaos-principle the user-centered media collection.[4]
This analysis has been for us unexpected because in Germany we estimate that companies sold more than one hundred mobile devices (PDA, reader, antenna, rechargeable battery) to be utilized for RFID-inventories. The reason has been that the detection rate of 60 till 80 percent is still not acceptable to support efficiently and sustainably our stock management to monitor it.

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[3] see http://www.th-wildau.de/fileadmin/dokumente/bibliothek/dokumente/4._RFID_2011/RFID_Stock_Management_slides.pdf

[4] Use the online-catalogue to see the result, http://www.sitterwerk-katalog.ch/

HF-test in the year 2008 by accession number following the Danish data model

In the year 2008 colleagues of our library compared two RFID mobile-devices (provided by the German company FEIG) to manage an inventory from the same company. Correspondent to the Danish data model (ISO 28560-3:2011) the reader read the accession number as reference information of each copy or multimedia package. Both devices attained the same results in the detection rate. We went along the book-spine in the shelf with a speed of one metre in five seconds and reached detection rates of almost 95 percent. But these results fluctuated by an average of 60 to 80 percent as detection rate and could not be stabilized. So we decided in that year to manage our stocktaking by the classical way to compare printed lists of non-borrowed media with its existence amid the shelves. It was the first stocktaking since the foundation of our Technical University of Applied Sciences. For all this procedures we required half a year and got the information of 920 missing items.

Figure 1 Example of an inventory setting

In further tests we got better results this year by following this method to measure in the frequency of 13,56 MHz and using the Danish data model and there inscripted information about the accession number of medias as only reading out information. Tests on the university library Bielefeld with a proprietary solution (smartstock 100 by Tagsys and bibliotheca as responsible companies) promise to open a next generation of RFID-support in stocktaking. The reason for the optimisation are improved RFID tags (SLI-X), improved design of antenna also for handling and the power of reader.

UHF test in the year 2010 using the tag-UID

The unsatisfactory results of the 2008 tests provided the impulse to utilize another open frequency or industrial, scientific and medical (ISM) radio band, Ultra-high frequency (UHF). Most libraries in the Germany and in the world use HF with 13,56 MHz[5] but some use and test UHF-solutions too. We tried in 2010 to use UHF with 868 MHz and fitted 300 volumes and multimedia packages with UHF-tags. Using UHF the tags have not enough memory to storage all data-lines concerning the Danish data model. Therefore we tried with devices and SDK (Service Development Kit) by the German company FEIG to detect the Unique Identification Number as hardcoded and unchangeable read-only data-term into each UHF-tag. The same we organised for HF-tags which have also UID-information on each tag.

For both scenarios, HF and UHF-tags with detectable UID-informations, we reached an average recognition rate of approximately 90 percent. The reading time to detect 300 UHF-tags took four minutes and to recognise 300 HF-tags by UID eight minutes.
Another test with the UHF-technology and based on UID-detection some months later in the same year for the background of first experiences produced better results. 329 UHF-tagged volumes have been recognised in four and a half minutes at a detection rate of 99 percent.

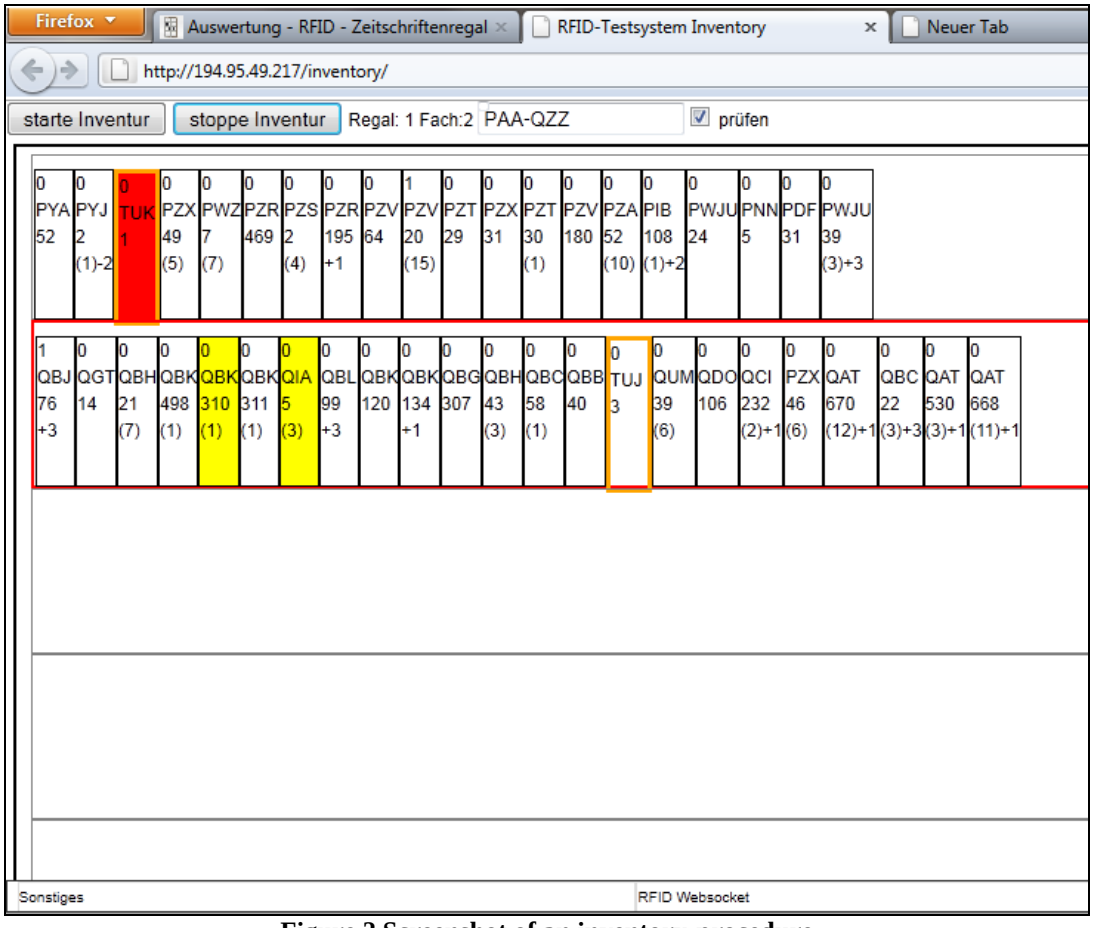

Figure 2 Screenshot of an inventory-procedure

As a first conclusion we have to reflect the good results to support inventory-procedures by using UHF as frequency and by reading the UID as tag-identification. The crucial question here is whether HF-running RFID-libraries change the running system for this “inventory”

[5] see http://www.libraryrfid.co.uk/frequencies.html

reason? Could be the inventory-workflow be the tipping-point to convert the implemented RFID-system? Also we have the issue that many Library Management Systems (LMS) or Integrated Library Systems (ILS) have not the opportunity to get and write in the UID-information in the database and backend.
Another remarkable consideration not linked to the choosen frequency is that the procedure after the RFID-detection is more time-consuming. The preparation of stocktaking by producing shelf selected lists and the correlation of RFID-based information with the LMS/ILS requires much manual support and rework than to pass the book-spines with the antenna or wand.
But one important spin-off result has been, that the reading time of UID run faster than of the accession number following the Danish data model. This effect has its technological reason because the identification as a first contact between the RFID-antenna and reader of one site, and the RFID-tag of the other runs directly with the UID. An inventory-command (ISO15693) of the RFID-reader must be send and result a short UID-answer as an identification-action. This means that this first contact gives the sufficient information of the UID and no more contact (reading operation) is required (e.g. to ask the tag about the accession number and more, concerning the Danish data model). Every reading operation requires more time consuming.
Our tests to compare the reading operations after UID-detection and accession-number detection provided the following results: The operation time after reading multiple blocks command to read the nine-character of accession number of one HF-tag took 24 milliseconds, for 14 tags in all 540 milliseconds.
If we would like to read more in the storage of a tag like the accession number, we need for 14 tags 24 milliesconds more for each tag, in summary 336 milliseconds or nearly 60 percent more time to get the for the LMS/ILS tailored information (accession number).

UID-reading HF-test with the public libraries of Berlin

To recapitulate the UID-results by using HF-technology on a broader basis we decided to cooperate with the public libraries of Berlin, because they are using as a big exception a LMS/ILS, the name of this German softwar is aDIS/BMS, which offers to add UID-data deluge in the system for each copy.
To implement RFID-technology in all public libraries in Berlin a big project is running which will be completed in the next year. The web of Berlin public libraries comprises more than 80 different branches, ten mobile libraries and more than six million of items in different collections. To introduce in the LMS/ILS the tag-UID has the reason to manage in the future, so far unspecified more services maybe permanently stocktaking.

Our one test with this material runs with 1580 volumes (only books and no media packages) of 35 linear metres amid the subject field of biology. Each linear shelf metre comprises on average 45 volumes. Out of the LMS/ILS we selected by SQL-command a list of not-borrowed volumes in this subject field with his UID-numbers. This list involved to examine invisible UID-information by a librarian also some bibliographic data such as title and the signature or shelf number.
As hardware-units we were using a laptop, a RFID-reader of the German company FEIG (Feig ID ISC.MR101-USB) and a mobile, handheld antenna of the same provenience (ID ISC.ANTH200/200-A). As software we used a Java-based own inventory program. This program communicate with the Java-Software-Development-Kit (SDK) of the FEIG

company. We do not want to describe in detail the different interfaces, adaption of two systems to visualize the results of mis-shelfed and missed media in a comfortable way, because the main focus here goes to RFID-procedures.

To sum up 41 volumes of 1.580 we did not have detected after a runtime or detection period of seven minutes without error handling for e.g. thin volumes and metallic bookends. The detection rate with 98 percent is very high and opens the view to use this workflow in stable and productive operation as a next step into the context of multimedia packages.
In this year some own developments of antenna-design, software-adoption by two colleagues of our RFID-task force in Wildau optimized the detection rate of recognising UID-information on HF-tags more, so that we will hope to utilize in our 100000 volumes counted library soon RFID-inventory equipement to carry out a full stocktaking during the quiet time of term-vacations in less than one month. We will excitedly observe the developments of optimization of reading-time and detection rate by using the accession number on tags.

One other aspect which supports our UID-intention and attitude comes from the smart phone applications of Near Field Communication, another form of RFID by the same frequency (13,56 MHz). Using e.g. Android as a Linux-based operating system for mobile devices some tests in Wildau have shown that it easy to use the open standards and interfaces (ISO 15693 and ISO 18000) to manipulate and change the security part of each tag. The Application Family Identifier (AFI) bit for security follows this standard like the Danish data model and protects the attached volume to go out with them. The UID-number is not changeable, nor rewritable, only readable. To set up with this number other performances like anti-theft protection could be a valuable and considerable contribution for further developments.

Usage statistics with a mobile smart shelf

Since the digital age crossed the library way we are spoilt by usage statistics of download another counter compliant information from our providers of digital collections like e-journals, e-books and databases. Before the customer could lend a book for e.g. four weeks therefore a borrowing-rate of twelve times a year was peak usage. Now current users can read the same source at the same time and give us as digital footprints logfiles with the number of downloads. To make a decision about any subscription and to license offers comprises this usage-statistic is the base.
Why could we not measure the usage of non-lending collections? We think that the initiative of internet of things offers this opportunity. As a first step our main focus runs on the highly demanded printed newspapers and journals which as current issues are not borrowable. The reason is that we observe that many clients and visitors like some titles as their favourits by online-survey and so on, but the observable usage-rate is less than expected.

Figure 3 The described wood shelf for journals

Our team of two colleagues build as a prototype into a moveable both-sided and two-leveled wood-shelf an adapted and self-developed loop-antenna. Furthermore are embedded as invisible parts an RFID-Reader (Feig IDISC101), a microcontroller, a bluetooth receiver and a rechargeable battery. The idea with this equipment is to detect as permanently (three time per ten seconds) inventory-workflow every HF-tag by his UID and access number near this shelf. The command to read constantly during our opening hours both data from the HF-tag comes from the microcontroller. The RFID-reader transmits energy to receive feedback from each contactable tag. The detectable electromagnetic field is small space near the wood-shelf. When someone is sitting near this shelf the tag is too far away to be contactable. If the RFID-reader could not receive one excepted signal this information has the value of one usage of exactly this on the tag and his numbers attached journal. A condition to count one usage is that the detection procedure must miss this tag more than one time. After some repeated inventory workflows of this system in which one tag could not contacted one usage will be counted. No more tasks than to count the contactable and non-contactable tags runs by the shelf to reduce the energy consumption. The daily results will after the opening-hours transmitted by the bluetooth device (the distance limit is 30 meters) on the computer to analyse the counter statistics. A self-developed middleware, based on Java as software-context, analyses the data deluge, which correlates different data from the wood-shelf with the LMS/ILS and produce a visualisation as summary of the usage statistic. The visualisation program based on PHP as web-application and analysed by the Javascript-library Highcharts (http://www.highcharts.com/) and a lot of point of views are scalable or chooseable. We could offer usage statistics by day, week and month, also for every title of journal or as best of statistic. You could observe our usage below the link http://194.95.49.222/smartshelf/ but with explanations only in German.

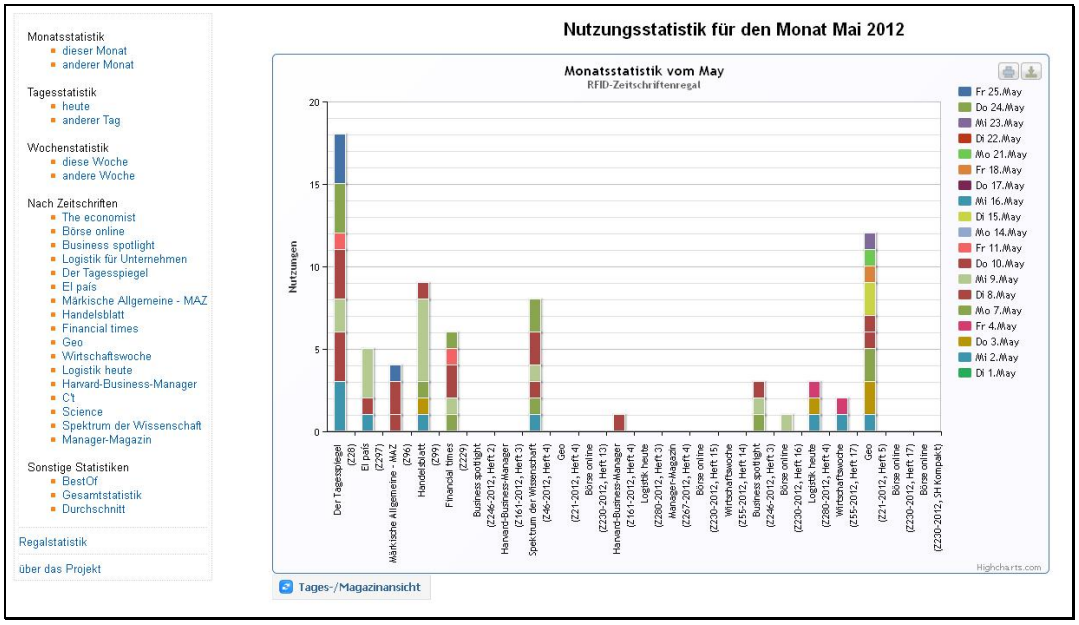

Figure 4 Usage statistic

To summarize my intention we hope to have showed new chances to augment opportunities to use a well known technology and to see it in a new conquerable light and we hope that we all RFID-users and early-adopters will come together to consider other solutions with this not fully-exhausted technology.