

WEB-BASED SYSTEM FOR MAILPIECE DIAGNOSTICS INTENDED TO USPS

Assoc. Prof. Atanasov A.

Department of Computer Science – University of Chemical Technology and Metallurgy, Bulgaria
 naso@uctm.edu

Abstract: Everyday millions of letters are redirected from old to new addresses of their recipients. It happens because people are changing their homes or job, so the companies changing their location. In order to avoid sending the letters to old and then to the new addresses, which spends lots of recourses, a new generation of Postal Automated Redirection System /PARS/ is applied in USPS. The PARS consists of more than 50 processing sorting centers /P&DC/ equipped with special optical character recognition SW which automatically redirects the letters to the new addresses. This paper presents the design and development of WEB-based Performance Diagnostic System /PDS/ intended to operative control, monitoring and diagnostics of PARS HW and SW components, as well diagnostics and analysis of sorted letters. The PDS can be used for on-line remote control of PARS and the quality and performance of the sorting process.

Keywords: AUTOMATION SOFTWARE, WEB BASED UI, REDIRECTION SYSTEMS

1. Introduction

Nowadays because of mobility many people are changing their location or jobs. The delivery of letters or parcels to their new addresses becomes of great importance and saves time and money to the postal services.

In USA more than 40 millions letters are redirected each day. During the process of sorting the letters (mailpieces) are delivered to one of the nearest Processing Distribution Centers (P&DC), forming Postal Automated Redirection Systems (PARS) of the United States Postal Services (USPS). The letters are sorted automatically and then delivered to the recipients. In case of change of addresses PARS is responsible to redirect letters to their new addressees or to return them to the senders.

Current paper describes the design of WEB-based Performance Diagnostics System (PDS) intended to collect status, monitoring and diagnostics information about PARS systems, as well to collect data regarding the redirected letters and related to them Change Of Address (COA) forms.

1.1 Process of letters sorting and redirection

- Letters are delivered to the nearest P&DC;
- The surface of each letter is scanned and the image is sent to the optical character recognition (OCR) system which finds the address data;
- Using the address a request to the national database of addresses (Address Directory) is sent and as result the sorting information is provided;
- On the base of this information the letter is directed to the special box (shoot) of the sorting machine. The box collects the letters to specific street or area of the town/village;
- From this box the letters are delivered by the carrier (postman) to the recipients.

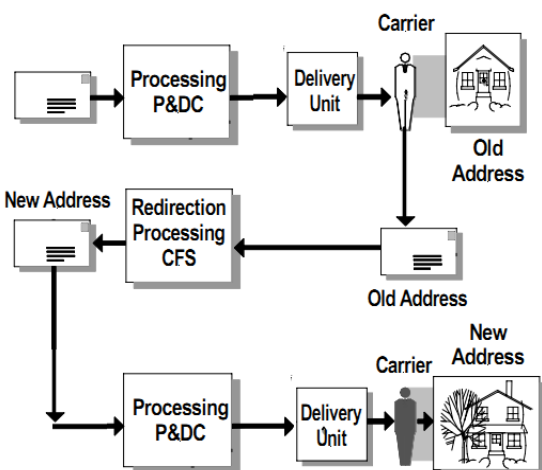


Fig 1 Delivery of letter to the new address without PARS

In case the recipient changes its address (fig 1) the postman manually delivers the letter to old address and then after finding out that the addressee is not available there he delivers the letter to the redirection unit where new address is provided by the COA Form Service (CFS) and the letter is redirected to the new or the same P&DC. Then the same sorting procedure is applied again. In order to find new address in CFS site the recipient who changed its address must provide to USPS services the COA form with its old and new address (Fig. 2).

Fig. 2 Change Of Address (COA) forms

In order to improve letters sorting in PARS system first the address found by OCR is checked both in current address directory and in CFS directory (Fig 3). If new address is reported by CFS it is printed in P&DC and stamped to the letter. Then the letter is automatically directed to the new address.

It can be seen that new approach saves lots of efforts, energy and time.

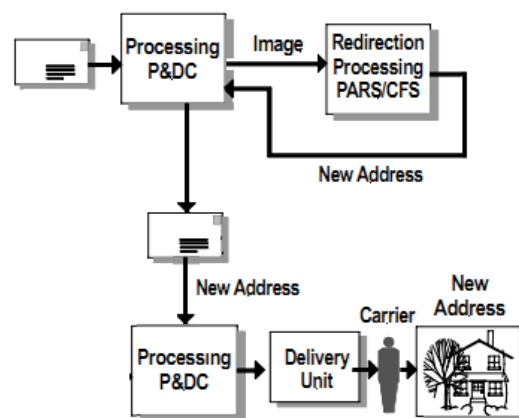


Fig 3 Delivery of letter to the new address with PARS

In case the customer did not provide its new address the mail is returned to the sender.

1.2. Providing the COA information

The customer who changes its address must provide new address by:

- sending a mail to USPS;
- filling manually the COA form (at post office);
- filling the same form to the WEB site of USPS.

In paragraphs above the automatic recognitions of the addresses in P&DC sites was discussed. In some cases of handwritten address the OCR algorithm could not find the whole address of the letter. In this case to solve the problem the image of the letter is sent to Remote Encoding Center (REC) where the address is resolved by human help. There on video-terminal the address is completed by the operator. As soon the address is completed it is returned from REC to P&DC and the letter is sorted.

1.3. The main HW and SW systems involved to letters processing

The main hardware system are sorting machines equipped with cameras and barcode readers. Next are transportation subsystems. The sorting machine has specific software for on-line OCR of the sender and the receiver addresses and post stamps types and their price.

The main OCR related subsystems are:

- RIC - redirection image controller – subsystem managing images from the cameras by the following components:
 - o IH/ - image handler which is converting the images from the cameras to the image file formats used by the readers
 - o IC - image controller, controller managing the IH
 - o SC system controller
 - o CDB - data bases for statistical and other data
- AFR – address forwarding reader – subsystem for OCR address recognition (AFR-I) and for post stamps recognition (AFR- II)
- CFR – change of address (COA) forms reader – subsystem responsible for COA forms with new addresses (forms filled by the people changed their addresses or by the postman)

Each sorting machine is capable to process up to 50000 letters per hour. In order to do that it uses lots of IHS, ICs, AFRs, CFRs running in parallel on tens of PCs.

All mentioned above subsystems and components are forming the Image Management System (IMS) of the P&DC or of the REC. The diagnostics, monitoring and control of the SW subsystems of the sorting machines of each P&DC or REC is provided via internet on the base of the current PDS. The PDS is running as a specialised server on a Tomcat Apache WEB server installed on each P&DC or REC.

2. PDS systems' requirements

The following functional requirements derive from the general P&DC, REC and PDS system requirements [1,2,4] and can be summarized as:

- Authentication of logging of up to 60 users.
- Monitoring permanently of the IMS hardware and software components and providing real-time maintenance diagnostics for the verification of the operational status of the whole IMS.
- Providing the possibility to start/stop the IMS and each of its subsystems and components.
- Monitoring of the connections between current P&DC and other P&DC (named REC, NTSC , etc)
- Providing IMS statistics (for mails site performance, AFR , CFR, Benchmark, etc.)
- Monitoring the Network status
- IMS diagnostics including network diagnostics and performance
- Computer diagnostics (HDD info and system logs)
- Software diagnostics (shared memory and processes view)

- Providing capability to install, update backup and restore the system software or firmware
- Letters (mailpiece) diagnostics
- COA forms diagnostics
- VDT diagnostics (related to manually coded COA forms using video terminals).
- Address Directory diagnostics.
- Number of saved (processed) letters/COA forms is up to 300000 per day and must be collected for one month period.

3. Architecture of the System

As a result of the analysis of the requirements and taking into account similar solutions in postal automation systems [1,2,3] the architecture (Fig. 4) of the WEB-based PDS server was developed. The server is executed within the Apache Tomcat Server container. It is a servlet container [4] that is used in the official Reference Implementation [5] for the Java Servlet and Java Server Pages technologies, as well Ajax and Struts Technologies.

The components forming the the systems are:

- PDS Web UI including UI Framework – base of the IMS Diagnostics UI, Statistics UI, RTE UI, OS/HW and HDD Diagnostics UI and Backup/Restore UI
- PDS Server including:
 - o IMS Monitoring and Diagnostics component
 - o Statistics component
 - o OS/HW and HDD Diagnostics component
 - o Backup/Restore component
 - o RTE server processing real-time events
 - o Message layer component
 - o Mailpieces and COA forms Diagnostics component
 - o Directory Diagnostics component

They are described in the next sub-sections.

The PDS communicates to the external IMS subsystems via messages sent/received over TCP/IP sockets. On each external system (PC) the PDS client DLL or PDS service is running. They are providing API from the specific system and PDS.

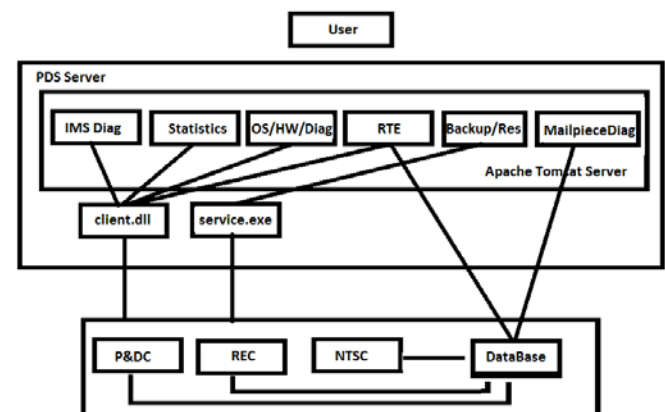


Fig. 4 PDS Architecture

Users are connected over secure HTTP to the PDS server using Internet Explorer browser.

3.1. WEB UI component

This component is responsible for preparing all jsp (java server pages) provided to the user. It deals also with the actions that can be triggered by the user (clicking different buttons in Browser). It provides servlets manipulations and tables' decorations. It takes info about the status, statistics, diagnostics and other data from other PDS components which are provided to the user. The component is sending periodically auto refresh messages in order to keep the status data presented on the user browser up to date.

3.2. IMS monitoring and diagnostics component

This component ensures the monitoring, diagnostics and control of entire IMS and all its SW and HW systems and components. The component has to provide:

- Reporting Logical Status Change of SW subsystems and components;
- Reporting of Physical Status Change of IMS Computers;
- Monitoring of the IMS Status and reporting Overload of certain Subsystem;
- Monitoring the Storages Status and Computer Storage Status
- Monitoring the Network Status
- Controlling IMS System (Start, stop restarts shutdown of IMS)
- Monitoring the Connections
- Monitoring SW Processes
- Reporting SW Component Versions
- View or Download of Log and Configuration Files

3.3. Run Time Event Server

The Run Time Event (RTE) Server deals with the special messages (info, warning errors, fatal errors) produced by the all SW components of the IMS. The RTE messages are stored permanently on the data base server and are available on request to the PDS. In some case information about this message has to be sent by mail to the IMS operators, technicians or managers. These activities are done by the RTE server component. It is responsible also for:

- Presenting of All RTEs
- Presenting of RTE Detailed info for one selected RTE
- Adding or Modifying RTE Filter
- Update of RTE Note Field
- Create/ Delete RTE Mailing List
- Add/ Delete Member to Mailing List
- Add /Remove Filter to Mailing List
- Add Filter to UI Notification 12
- Remove Filter from UI Notification
- Export RTE List
- Delete RTE older than
- Delete RTE mails older than 25 days.

The flow of action when some option is activated in RTE menu includes query to the RTE component which send the query to the data base and when the result is available it parses it and presents it to WEB UI screen

Other PDS components as HW/OS/HDD diagnostics and Backup and Restore component are using the same flow of actions when communicating to the corresponding IMS subsystems. The difference is that HW/OS/HDD diagnostics component is using Windows API for getting OS, BIOS and hard disk data, instead of the client API (see Fig. 4).

Backup and Restore component is using COOL command scripts which are activated by the PDS service (service.exe on Fig 4). Only the names of the scripts are different then those used to start/stop computers, etc.

3.4. Mailpieces and COA forms diagnostics

This component is responsible to send queries to the database to extract data regarding processed by the P&DC or REC mails or COA forms. Each query can be with variable number of fields describing lots of letter/COA form attributes as ZIP code , type of mail (firs class, military, foreign, etc.), city, state, names of sender/recipient, etc. As a result series of letters ' or COA forms images are presented for diagnostics or analysis to the user.

4.PDS WEB UI structure and views

The following figure (Fig 5) gives the structure of the menu items of the PDS WEB UI, as well some of the UI pages representing most of the features of the PDS. The menu items are grouped into five general groups (IMS Monitoring IMS Diagnostics, Run Time Events, Backup and Restore and Administration).

Next page (Fig. 6) represents combined IMS system status view. With green bar graphs are presented the IMS subsystems that are in Ready state, with yellow the Not Ready subsystems and with red those in Malfunction state. Below the bar graphs tin the table the current number of those subsystems (IH, RIC, AFR, etc.) is given. In the upper part the tabs of all available IMS statistics ate given. By selecting tabs the needed statistics can be seen. By the use of the buttons the entire IMS can be Restarted or Shutdown.

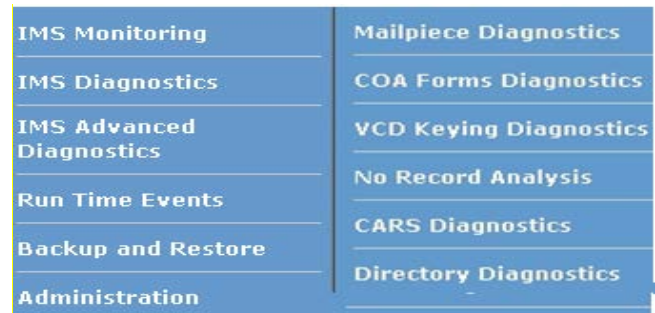


Fig.5 PDS WEB UI Menu Items

Below the bar graphs tin the table the current number of those subsystems (IH, RIC, AFR, etc.) is given. In the upper part the tabs of all available IMS statistics ate given. By selecting tabs the needed statistics can be seen. By the use of the buttons the entire IMS can be Restarted or Shutdown.

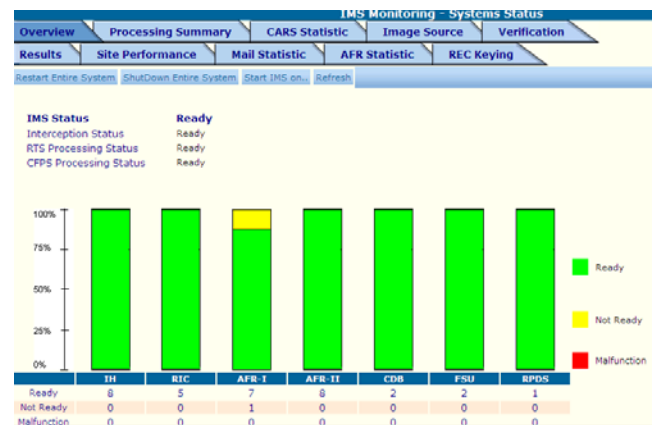


Fig. 6Monitoring the IMS System Status

The Status of the all IMS computers is given on Fig. 7. From this web page the user is able to access the status of SW subsystems/components (Fig. 8) running on the selected computer.

IMS Monitoring - Computer Status				
Select all	IP Address	Hostname	Subsystems	Status
<input type="checkbox"/>	10.10.16.186	SCLACAMRIC0	➡	● Ready
<input type="checkbox"/>	10.10.16.187	SCLACAMRIC1	➡	● Ready
<input type="checkbox"/>	10.10.16.188	SCLACAMRIC2	➡	● Ready
<input type="checkbox"/>	10.10.16.189	SCLACAMRIC3	➡	● Ready
<input type="checkbox"/>	10.10.16.190	SCLACAMRIC4	➡	● Ready

Fig. 7 Computers Status Page

IMS Monitoring - Subsystem Status					
IP Address	Hostname	Subsystem	Component	Status	Overload
10.10.16.186	SCLACAMRIC0	RIC 01	FSU 01	● Ready	
10.10.16.186	SCLACAMRIC0	RIC 01	CDB 01	● Ready	
10.10.16.187	SCLACAMRIC1	RIC 02	FSU 02	● Ready	
10.10.16.187	SCLACAMRIC1	RIC 02	CDB 02	● Ready	
10.10.16.188	SCLACAMRIC2	RIC 03	IC 01	▲ Warning	■
10.10.16.189	SCLACAMRIC3	RIC 04	IC 02 (master)	● Ready	
10.10.16.189	SCLACAMRIC3	RIC 04	SC 01	● Ready	

Fig. 8 Subsystems Status Page

On the page below (Fig. 9) the diagnostics page – Hard disk info can be seen, available via Diagnostics/Hardware/HDD.

Local Performance Diagnostic System	
IMS Diagnostic - Harddisc	
HDD Info	SCLACAMRICO
Drive C:	Physica (System)
File System	NTFS
Volume serial No	2001-FFDD
Total Size	80 GB
Partition size	38.4 GB
Free Size	29.5 GB
% Free	67%
Driver Description	SAMSUNG SP0411N
Driver Date	2001-07-01
Driver Version	5.1.2535.0
Drive D:	Logical
File System	NTFS
Volume serial No	FA01-FABC
Partition Size	38.4
Free Size	29.3 GB
% Free	60%
Driver Description	SAMSUNG SP0411N1
Driver Date	2001-07-01
Driver Version	5.1.2535.0

Fig. 9 Hardware- Hard Disk Info Page

Next two pages (Fig. 10 and 11) present the Mailpiece diagnostics screen of WEB UI and search criteria related to different letter's attributes, as well the one of the results of the search. The attributes of the letters or the COA forms are too many and their explanation exceeds the volume of current paper. For example when the OCR algorithm tries to find the recipient address or the sender address different approaches (using barcode, ZIP codes (3, 5, 11 digits) including city, state codes, recipient name abbreviations) are applied. So the diagnostics of mailpieces can include variations of these or others attributes, as well the attributes that are related to the ID of sorting machine, time of sorting, type of the mail (first class, ordinary, military mail, etc).

Fig. 10 Mailpiece Diagnostic search screen

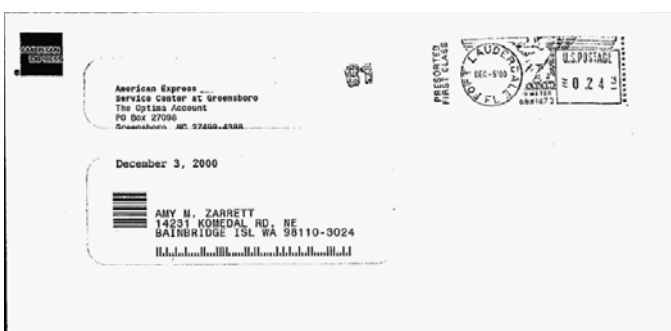


Fig. 11 One of the found results (mailpiece) matching the search criteria

Similar to the figures 10 and 11 above are the search screens for analyzing COA forms. The differences in them are related to the structure and the information of the COA form, given on Fig. 2.

Search criteria related to VCD keying diagnostics include how many steps (keys pressed) are used by the operator in REC site to complete letter's or COA forms' address.

5. Conclusion

Presented in the paper WEB based PDS system was developed on request by Siemens PA [7] and was intended to USPS. The author of the paper was a project manager of one of the significant part of the system and was involved in PDS requirements analysis, SW architecture development, coding and testing of SW components.

Implemented PDS system provides abilities for on-line remote control, monitoring and diagnostics of IMS systems working in all P&DC and REC sorting centers of USPS. PDS ensures detailed information and statistics to users of different levels – operators, technicians or managers that can be used for taking operative and strategic decisions, in the field of postal automation.

Abilities for mailpiece and COA diagnostics can be used for further software improvement of the OCR readers (AFR and CFR)

Developed PDS Web Based architecture was already modified and applied successfully in the area of Automatic Number Plate Recognition (ANPR) systems [1,2]. In this case it was used for a remote control and tuning of the parameters of a new generation ANPR cameras used for traffic control, tolling or parking access, etc.

5. References

- Atanassov A, Controlling An Automatic Number Plate Recognition System Via Web-Based Component, международна конференция автоматика и информатика'10, 3-7 октомври 2010 г., София, България
- Atanassov A., Tomova. F., Web-Based Subsystem For Tuning Of An Automatic Plate Number Recognition System, Sixth International Conference, Challenges In Higher Education And Research In 21st Century, June 4 – 7, 2008 Sozopol, Bulgaria
- Atanassov, A., Parallel Software Solutions In Automated Parcel's Processing, Third International Bulgarian -Turkish Conference, Computer Science'06, 12 - 15 Oct., 2006, Istanbul, Turkey
- Cavaness C., Programming Jakarta Struts, Second Edition, O'Reilly, 2004
- Husted T., Struts in Action Building web applications with the leading Java framework, Manning Publications Co.,2003
- <http://www.apwu.org/dept/clerks/clkpars.htm> Postal Automation Redirection System (PARS)
- http://www.siemens.com/innovation/en/publikationen/publication_s_pof/pof_fall_2003/editorial/postal_automation.htm