The Benefits of Using InterSystems Ensemble within the Saint Pierre Hospital

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Agenda

• St Pierre Hospital and the IRIS Group
• History of middleware in St-Pierre
• The choice of Ensemble
• Implementation
• Short term evolution
• Conclusion
CHU Saint-Pierre at a glance

• Major Hospital in Brussels Center:
  – 600 beds
  – Member of the IRIS Group with 5 hospitals spread over 11 sites with 9000 employees
CHU St-Pierre hospital challenges

- Major Hospital in Brussels Center with **Emergency Services:**
  - 24/7 is compulsory
  - Fast and accurate access to patients data is critical

- Tight interaction between different services:
  - ER: interaction with Administration (SIS, medical history)
  - Labs: blood sample, pathology
  - Radiology: X-rays, CT/PET Scan, Ultra-Sound, MRI
  - Surgeons and operational staff (anesthetics, nurses, assistants)
  - Pharmacy

- IT is playing a fundamental role in the complete chain → infrastructure and application must follow the same pattern of modern healthcare
St-Pierre IT Environment

• Heterogeneous applications:
  – Covering multiples functionalities:
    • Patient administration, accounting, planning
    • Medico-technical departments: Labs, imaging
    • Electronic medical records: general or specialized (ophthalmology, oncology, gynecology,…)
    • Logistic: pharmacy, patients transport,…
  – On several platforms: Windows, Linux, Solaris,…
  – Based on databases from different types and different versions: Oracle, MS-SQL, Progress,…
  – Hosted on many servers (>200)
Middleware history in St-Pierre

- Exchange of data between systems plays a major role to provide users with accurate information in order to treat patients in the most appropriate way.

- Early need of a middleware layer for the transmission of information between systems.
  - 1998: Implementation of DataGate
    - Sending of administrative data to/from medico-technical systems (labs, pharmacy) for an exhaustive accounting
    - Sending of administrative data to the appointments scheduler and the online billing application for the outpatient clinic
    - TCP/IP or FTP
    - Proprietary messages
Middleware history in St-Pierre

- 2002: DataGate replaced by E-gate
  - Set up of a results server: Necessity to transmit medical information from Medico-technical applications (imaging, labs, anapathology).
  - HL7 messages / TCP/IP
- But:
  - Not scalable without additional expensive modules
  - Heavy maintenance
  - Complex development abilities for transforming incoming messages and adapt them to several receptors
Middleware history in St-Pierre

• Need of a more intelligent tool, more flexible in order to achieve real interoperability between systems and able to:
  – Exchange information in different formats (HL7, xml, flat records, …) with different protocols (TCP/IP, FTP, MLLP, …)
  – Transform incoming messages following the requirements of different receiving applications
  – Integrate calls to external applications or stored procedures in databases during message processing
  – Allow us to develop our own interfaces, avoiding specific and expensive development cost from applications providers
  – Allow us to evolve in the future toward a more service-oriented architecture
The choice of Ensemble

- 20 years of experience with Mumps and Caché databases:
  - High reliability of Intersystems products
  - Very good performance
- Appreciable quality of service, which led to a real relationship of trust with the company
- Guarantee to help us not only in installing the product but also in providing us the knowledge to move forward in an independent manner
The choice of Ensemble

- Product answering all our requirements at once:
  - Numerous adaptors allowing to process information coming in a large variety of formats & protocols: flat records, database tables, HL7 messages, e-mails, files..., TCP sockets, FTP, HTTP
  - Efficient internal database (Relational/Hierarchical/Object) allowing persistence of messages along processing
  - Development Studio with graphical interface for the creation of business processes and data transformation, in an object oriented language.
  - Scalable dashboard and monitoring tools
First step: transposing the existing data flow to Ensemble.
First step

- Implementation done in a few days in 2008 with help of CHU Brugmann team by importing and adapting classes already created in their environment

- 2 Instances (Productions):
  - TCP transmission
  - FTP transmission

- Archives of all messages

- Alert system in case of problems in transmission
Medical Data Aggregation Layer

- 2008:
  - Iris project to aggregate medical data from all the hospitals of the IRIS network (Dbmotion project)
  - Clinical data coming from the different hospitals must be stored in 4 nodes (repositories) with identical structure
  - Data from the nodes are federated on the fly when they are requested by the user. A virtual patient object is instantiated and can be used by other applications.
  - Federation of patients identification is made by an EMPI application (Initiate)
**Aggregation process**

![Diagram showing the Aggregation process with various components and data flows.](image)

- **Clinical Data Repository (CDR)**
- **Document Cache Repository (DCR)**: Medical document collector
- **Aggregation Layer**
- **Middleware Ensemble**
- **Applicative Layer**
- **Data consultation platform**
- **Independent storage**
- **Production Servers**

**Document Cache Repository**
- Patients demographic data & encounters
- Structured clinical data: medications, diagnosis, immunizations, allergies
- Clinical Documents Indexes
- Images indexes

**Structured clinical data** includes medical history, medications, diagnoses, immunizations, and allergies.
A new challenge

• Need to build a more sophisticated middleware layer to extract data from the productions servers and send them to the aggregation layer through HL7 V2.x messages by:
  – Duplicating and transforming the existing messages flow
  – Creating new interfaces when needed
  – Avoiding development of new dedicated interfaces by applicative providers
Focus on some developments

1. Transforming ADT proprietary messages (sequential) to HL7 (Event – Based)
   - Transposition of Business rules into Ensemble Business process and data Transformation with Ensemble HL7 library

2. Adding Information to incoming HI7 messages by querying production database

3. Dealing with clinical documents and clinical documents meta-data
Decision table

<table>
<thead>
<tr>
<th>SEQ</th>
<th>DESCRIPTION</th>
<th>QUESTION</th>
<th>ANSWER</th>
<th>INPUT TYPE</th>
<th>TYPE/REV. CODE/MVT</th>
<th>HL EVENT</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The patient is coming with his ID card and or SS card</td>
<td>Yes</td>
<td>Creation of the demographic data</td>
<td>SEQ/NC.</td>
<td>GC</td>
<td>A08</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Update of the demographic data</td>
<td>Y</td>
<td>Creation of the demographic data</td>
<td>SEQ/NC.</td>
<td>GC</td>
<td>A08</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Create or update insurability Insurability exists? Yes</td>
<td>Creation of the demographic data</td>
<td>SEQ/NC.</td>
<td>GC</td>
<td>A08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Update insurability</td>
<td>Y</td>
<td>Creation of an hospitalization in a care unit</td>
<td>SEQ/NC.</td>
<td>GC</td>
<td>A08</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Color of the patient in a room</td>
<td>Update of hospitalization</td>
<td>PAT-H</td>
<td>HC</td>
<td>A08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Transfer of the patient in a room</td>
<td>Update of hospitalization</td>
<td>PAT-H</td>
<td>HC</td>
<td>A12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>&quot;Weekend&quot; Discharge</td>
<td>Update of hospitalization</td>
<td>PAT-H</td>
<td>HC</td>
<td>A02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Patient coming back after WE</td>
<td>Update of hospitalization</td>
<td>PAT-H</td>
<td>HC</td>
<td>A12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Patient discharge</td>
<td>Close hospitalization</td>
<td>PAT-H</td>
<td>HC</td>
<td>A03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Cancel a transfer</td>
<td>Delete a movement</td>
<td>PAT-H</td>
<td>HD</td>
<td>A12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Cancellation of patient discharge</td>
<td>Delete a movement</td>
<td>PAT-H</td>
<td>HD</td>
<td>A13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Cancel an admission</td>
<td>Cancel an admission</td>
<td>PAT-H</td>
<td>HD</td>
<td>A12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Business process

if (Request_TYPE = "A") {
    if (Request_OCCUPATION = "C") {
        if (Request_DATE = "31.12.9999") {
            return "SendRequestAsync("TcbAdmHSPCpout",vrasbo_00010),01701X\t"
            return "SendRequestAsync("AdmHSPFileInout",vrasbo_00010),01701X\t"
            return "SendRequestAsync("AdmHSPFileInout",vrasbo_00010),01701X\t"
            return "SendRequestAsync("AdmHSPFileInout",vrasbo_00010),01701X\t"
            return "SendRequestAsync("AdmHSPFileInout",vrasbo_00010),01701X\t"
        } else if (Request_DATE = "31.12.9999") {
            return "SendRequestAsync("TcbAdmHSPCpout",vrasbo_00010),01701X\t"
            return "SendRequestAsync("AdmHSPFileInout",vrasbo_00010),01701X\t"
            return "SendRequestAsync("AdmHSPFileInout",vrasbo_00010),01701X\t"
            return "SendRequestAsync("AdmHSPFileInout",vrasbo_00010),01701X\t"
            return "SendRequestAsync("AdmHSPFileInout",vrasbo_00010),01701X\t"
        } else {
            return "SendRequestAsync("TcbAdmHSPCpout",vrasbo_00010),01701X\t"
            return "SendRequestAsync("AdmHSPFileInout",vrasbo_00010),01701X\t"
            return "SendRequestAsync("AdmHSPFileInout",vrasbo_00010),01701X\t"
            return "SendRequestAsync("AdmHSPFileInout",vrasbo_00010),01701X\t"
            return "SendRequestAsync("AdmHSPFileInout",vrasbo_00010),01701X\t"
        }
    } else if (Request_DATE = "31.12.9999") {
        return "SendRequestAsync("TcbAdmHSPCpout",vrasbo_00010),01701X\t"
        return "SendRequestAsync("AdmHSPFileInout",vrasbo_00010),01701X\t"
        return "SendRequestAsync("AdmHSPFileInout",vrasbo_00010),01701X\t"
        return "SendRequestAsync("AdmHSPFileInout",vrasbo_00010),01701X\t"
        return "SendRequestAsync("AdmHSPFileInout",vrasbo_00010),01701X\t"
    } else {
        return "SendRequestAsync("TcbAdmHSPCpout",vrasbo_00010),01701X\t"
        return "SendRequestAsync("AdmHSPFileInout",vrasbo_00010),01701X\t"
        return "SendRequestAsync("AdmHSPFileInout",vrasbo_00010),01701X\t"
        return "SendRequestAsync("AdmHSPFileInout",vrasbo_00010),01701X\t"
        return "SendRequestAsync("AdmHSPFileInout",vrasbo_00010),01701X\t"
    }
}
Transforming HL7 messages

- Most of the time, HL7 messages provided by the source systems were incomplete and/or not properly formatted.
- In general, these messages were not sent through Ensemble but directly to the result servers.

⇒ We concentrated these interfaces in Ensemble and duplicated messages in order to transform them and add content.
| MSH | ^^^& | WEB1000HSP | 00025 | HL7RAD | SHB | 20100520104726 | ORM^&O01 | 127434524654359 | D | 2.3.1 | || ||
| PID | || 1000000000 | RE^&M | 19690502 || || || || 10113356
| PV1 | || || || || || || ||
| ORC | ^& | 10113356 | IO | || || || || UNKNOWN

| OBR | || 10113356 | Panorex | || 20100520094300.000000 || || || || 10113356 | || IMG | || Online || || || ||

| MSH | ^^^& | WEB1000HSP | 00025 | HL7RAD | SHB | 20100520104726 | ORM^&O01 | 127434524654359-158880502 | D | 2.3.1 | || ||
| PID | || 1000000000 | ^^^HSP_AD_T_SNI | ^^^RE^&M | 19690502 || || || || 10113356
| PV1 | || IO | || || || || || || ||
| ORC | ^& | 10113356 | IO | || || || || 12798555520^&LOEB^&Isabelle^&^&^&INAMI-RIZAV

| OBR | || 10113356 | Panorex | HSP_RIS | 20100520094300 | 20100520094300 || || || || 10113356 | || IMG | || Online | O | || || 12798555520^&LOEB^&Isabelle^&^&^&INAMI-RIZAV | || || || || ^^^0025
| OBX | | CE | IMG | | Online | http://WEB1000.stpierre-bru/agfa/StudyViewer.html?patient_id=100898628\password=%USER%\T
\password=%PASSWORD% http://WEB1000.stpierre-bru/agfa/TransferStudy.html?patient_id=100898628\password=%USER%\T
\password=%PASSWORD% http://WEB1000.stpierre-bru/agfa/QueryForStudies.html?whereclause=patientid='100000000'\password=%USER%\T
\password=%PASSWORD% || || A | || ||
Clinical Data Repository

Document Cache Repository: Medical document collector

All documents stored in a repository (oracle database) and converted in PDF.
A WebService allows retrievies and displays documents when requested by the user

Data consultation platform

Independant storage

Production Servers
Production Databases with documents: Doc, tif, rtf,...

Events on documents

Doc To Treat

Document Extractor & PDF convertor

ENSEMBLE

Transforms XML to HL7

Imports PDF related to xml

Codes PDF in Base 64

Transforms XML & Includes PDF (base 64 coded)

Updates « Doc To Treat » table in the DB

HL7

Clinical data repository

XML

Documents repository

Doc metadata

XML

PDF

Document

CHU Saint-Pierre

iris
• Production Environment:
  – Windows server 4-core - 16 Gb Ram
  – HD: 500 Gb

• Development Environment:
  – PC 2-core - 1 Gb RAM
  – HD: 700 Gb
### Average Daily Load

<table>
<thead>
<tr>
<th>Messages</th>
<th>In</th>
<th>Out</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADT</td>
<td>23500</td>
<td>354000</td>
</tr>
<tr>
<td>Pharmacy</td>
<td>4000</td>
<td>4000</td>
</tr>
<tr>
<td>Labs (HL7-OUL)</td>
<td>10000</td>
<td>312000</td>
</tr>
<tr>
<td>Documents (HL7-ORU)</td>
<td>4400</td>
<td>4400</td>
</tr>
<tr>
<td>Pathology (HL7-ORU)</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>Imaging (HL7-ORM)</td>
<td>750</td>
<td>750</td>
</tr>
<tr>
<td>Other HL7 (HL7: A60, VXU, PRB, ORM)</td>
<td>750</td>
<td>750</td>
</tr>
<tr>
<td>TOTAL</td>
<td>44050</td>
<td>676550</td>
</tr>
<tr>
<td>FTP files</td>
<td>300</td>
<td>300</td>
</tr>
</tbody>
</table>
Short term evolution

- Need for an “ultraflow” abstraction level
  - Between production and aggregation layer
  - Leveraged independently from existing application and hardware technologies and tools
- Based on intelligent interoperability capacities of existing middleware
- Performing complex logical workflows handling data extracted from parallel software sources at production layer as provided by independent vendors
- Intelligent messaging between “ultraflow” and production layer assumed and assured by Ensemble
Conclusions

• Ensemble a flexible tool which allowed us
  – To centralize the messages flow in one place
  – To perform complex transformations on incoming messages avoiding the implementation of new interfaces and reducing costs in development and maintenance
  – To develop an aggregation layer for medical data independent of production applications

• Will in the future help us to create decision and operational processes fed by adequate data coming from our different systems