Distributed Replicated Relational Database System for Vital Event : Birth Registration

A Report Presented to:

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Department of Computer Science Master's Program

By

Natnael Makonnen, Yoseph Abebe, Robel Morka, Hanan Temam

Supervisor

Natnael Argaw (Ph.D.)

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Table Of Contents

Acronyms

CRVS : Civil Registration and Vital Statistics

ESS : Ethiopian Statistics Service

RRS : Refugees and Returnees Services

UNHCR : United Nations Human High Commissioner for Refugees

DRRDS-VEBR : Distributed Replicated Relational Database System – Vital Event Birth Registration

ICS : Immigration and Citizenship Service

OCS : Officer of Civil Status

RDBMS : Relational Database Management System

Introduction

Digitalization that applies innovations and appropriate technological solutions enables civil registration and vital statistics (CRVS) systems to perform efficiently. Digitalization would support transformation and game changer of CRVS systems from the current practice of collecting, storing, retrieving, maintaining, compiling reports, and securing primary citizen data in multiple government ministries, departments, and agencies in silos to an integrated system that generates a single digital identity for individuals.

The full CRVS end to end solution is very wide and is out of our scope. Our proposal only focuses on birth registration on a distributed replicated relational database system environment. Our team will engage with ESS, RRS, UNHCR in requirement analysis, designing and implementation of Distributed Replicated Relational Database System for Vital Event Birth Registration (DRRDS-VEBR).

The Project proposal will provide

The proposed system will be designed using the following principles:

- Scalability: The system will be designed to be scalable so that it can accommodate the growth of Birth Registration, and even additional vital event registration in future.
- Performance: The system will be designed to provide high performance for all Birth Registration operations, including data retrieval, data Insertion, and reporting.
- Security: The system will be designed to ensure the security of Birth Registration data by using industry-standard security measures.
- Reliability: The system will be designed to be highly reliable so that it can be used to support critical Birth Registration operations.

The proposed system will be implemented using the following technologies:

- Oracle Database (21C XE): The Oracle Database will be used to store Birth Registration data.
- Oracle Application Express (APEX: 23): Oracle Application Express will be used to develop the Birth Registration user interface.
- SymmetricDS: Software that will be used for replication of each distributed nodes.

The implementation of the proposed system will be phased over a period of four weeks. The first phase will involve the design and development of the system. The second phase will involve the testing and deployment of the system. The third phase will involve the presentation and demonstration of the built system. The total cost of implementing the proposed system is estimated to be $10,000. The cost will be fully funded by UNICEF.

The benefits of implementing the proposed system are expected to include:

- Improved efficiency: The proposed system will improve the efficiency of Birth Registration operations by reducing the time and effort required to access and manage Birth Registration data.
- Improved effectiveness: The proposed system will improve the effectiveness of Birth Registration operations by providing better insights into Birth Registration data.
- Increased satisfaction: The proposed system is expected to increase OCS (Officer of Civil Status) satisfaction by providing them with a more efficient and effective Birth Registration system.

Problem Statement

ICS is a federal service providing organization that supports regions and city administration with total registration offices of more than 20,000, Ethiopian shipping lines, ministry of defence, refugee and returnee service and embassy and consular services abroad Ethiopia in about 52 countries worldwide. Birth Registration data is currently stored in a variety of disparate systems, which makes it difficult to access and manage. This has resulted in the following problems.

- Inefficient Birth Registration operations: Birth Registration OCS spend a significant amount of time manually transferring data between systems. This can lead to errors and delays in processing transactions.
- Ineffective Birth Registration decision-making: The lack of a centralized Birth Registration data repository makes it difficult for CRVS ecosystem to get a complete view of Birth data. This can lead to poor decision-making about CRVS matters

A DRRDS-VEBR system would address the above problems by providing a distributed and replicated repository of Birth data that can be accessed by OCS, ICS and ESS staff across

different locations. This would improve the efficiency and effectiveness of Birth operations, and would also help to reduce security risks.

The following are some of the specific benefits of implementing a distributed and replicated Birth Registration database system:

• Improved efficiency: OCS, ICS and ESS staff would be
able to access Birth data more quickly and easily, which would reduce the time and effort required to process Birth transactions.

• Improved effectiveness: Managers would be able to get a complete view of Birth data, which would help them to make better decisions about CRVS matters.

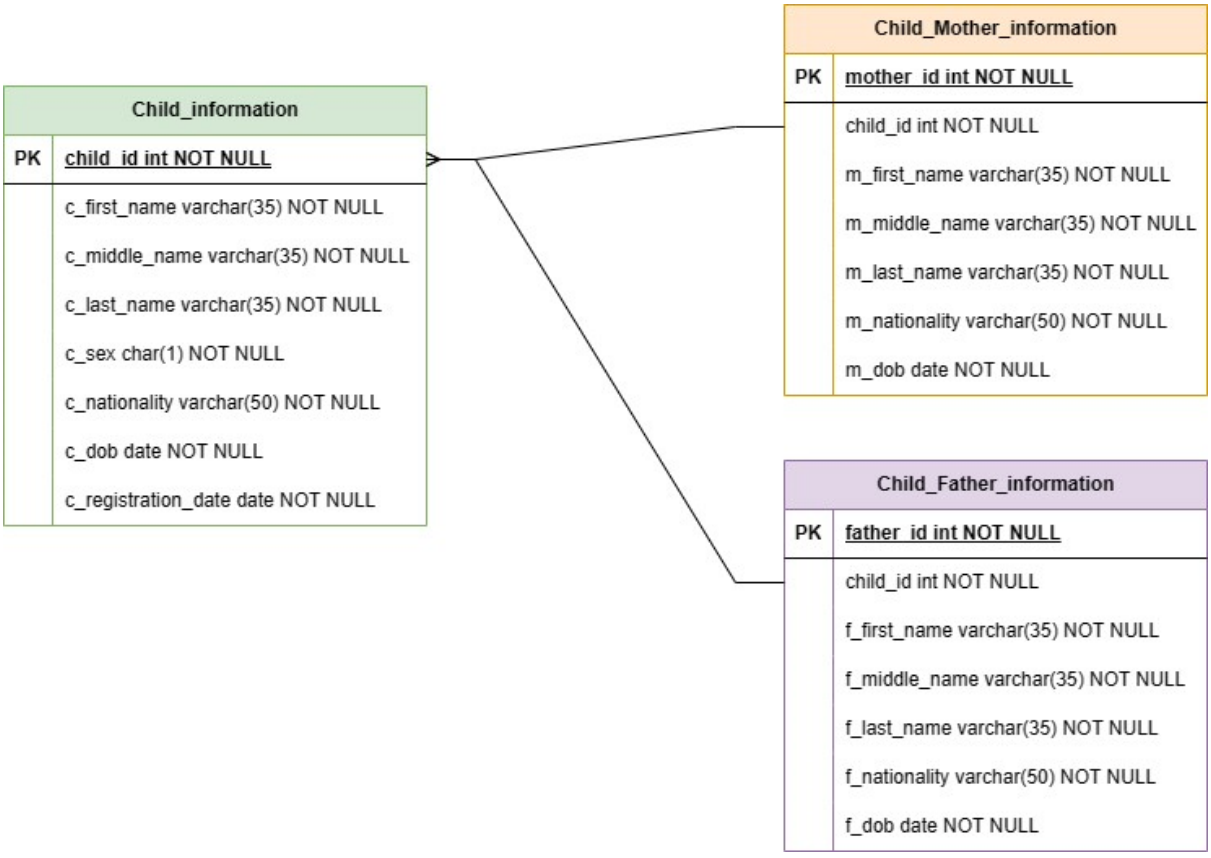
Technical Overview

Constraints and Relationships

Child_Information Table Structure					
Column	**Type**	**Null**	**Key**	**Check**	**Default**
child_id	int(18)	No	PRI		NULL
c_first_name	Varchar(35)	No			NULL
c_middle_name	Varchar(35)	No			NULL
c_last_name	Varchar(35)	No			NULL
c_sex	Char(1)	No		“M” or “F”	NULL
c_nationality	Varchar(50)	No			NULL
c_dob	Date	No			NULL
c_registration_date	Date	No			SYSDATE

Child_Mother_Information Table Structure					
Column	**Type**	**Null**	**Key**	**Check**	**Default**
mother_id	int(18)	No	PRI		NULL
child_id	int(18)	No	FRK		NULL
m_first_name	Varchar(35)	No			NULL
m_middle_name	Varchar(35)	No			NULL
m_last_name	Varchar(35)	No			NULL
m_nationality	Varchar(50)	No			NULL
m_dob	Date	No			NULL

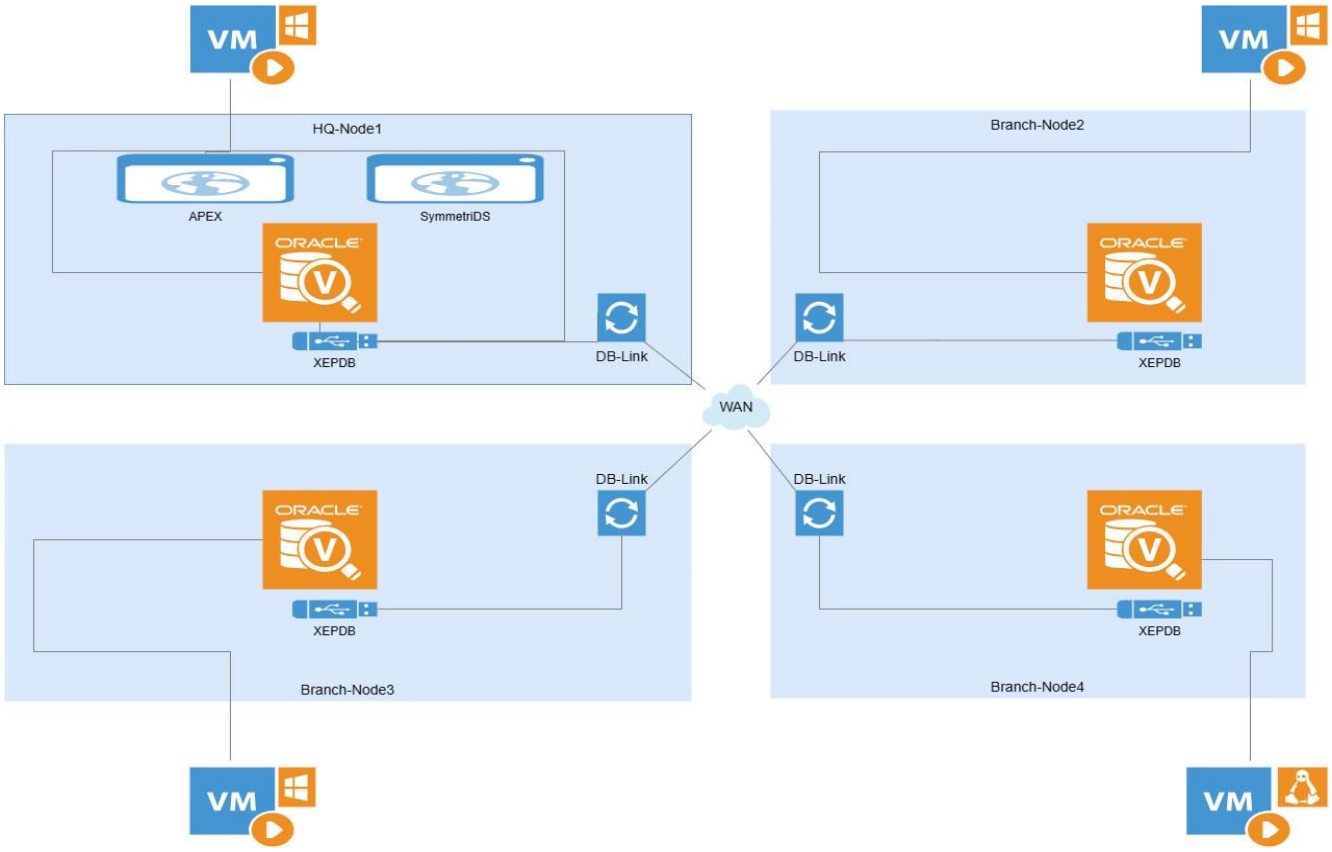
Child_Father_Information Table Structure					
Column	**Type**	**Null**	**Key**	**Check**	**Default**
mother_id	int(18)	No	PRI		NULL
child_id	int(18)	No	FRK		NULL
f_first_name	Varchar(35)	No			NULL
f_middle_name	Varchar(35)	No			NULL
f_last_name	Varchar(35)	No			NULL
c_nationality	Varchar(50)	No			NULL
c_dob	Date	No			NULL



Data Model

The data model will be implemented using the Oracle Database. The Oracle Database is a relational database management system (RDBMS) that is widely used for storing and managing large amounts of data.

The data model will be designed to be scalable so that it can accommodate the growth of Birth Registration data and user base. The data model will also be designed to be secure so that it can protect the confidentiality and integrity of Birth Registration data.



Data Partitioning Strategy

The data partitioning strategy for the DRRDS-VEBR will be based on the following factors:

Data volume: The project has a large volume of data. The child information table has over 10,000 rows, Child Mother information table has 10,000 rows and the Child Father information table has over 10,000 rows.

Data access patterns: The data access patterns for the DRRDS-VEBR project are varied. Some common data access patterns include:

- Current Birth from Child Information: Child registered before 90 days of birth occurred which is getting the result of the child birth date and registration date of the birth.

- late Birth (less than one year): calculating from date of the birth of the child and the registration date of the birth.

- Delayed Birth (more than one Year Birth registration) from Child Information table: extracted by calculating from birth date and registration date of the birth. Details for partitioning strategy for the DRRDS-VEBR project should take into account the data volume, data access patterns, and performance requirements.

Here is a possible data partitioning strategy:

- The child information table: The child information table could be partitioned by calculating the difference of registration date and date of birth. This would improve performance for queries that search for child information by active, late and delayed.

This data partitioning strategy would improve performance for the most common data access patterns in the DRRDS-VEBR project.

Replication Strategy

The replication strategy for the DRRDS-VEBR database will use a master-slave or master-master replication model. The master node will be located in the ICS headquarters, and the slave nodes will be located at branch offices around the world.

The following tables will be replicated:

- Child Information Table: This table stores data about Child, such as name, sex, date of birth, and nationality.

- Child Mother Information Table: This table stores data about the child's Mother name, nationality, and , date of birth.

- Child Father Information Table: This table stores data about the child's Father Name, Nationality and date of birth.•

Benefit: This table stores data for statistics, legal and policy making.

Transaction Management Strategy

Security

The security objectives for the distributed CRVS database are as follows:

- Confidentiality: The data in the DRRDS-VEBR database must be kept confidential from unauthorized users.
- Integrity: The data in the DRRDS-VEBR database must be kept accurate and up-to-date.
- Availability: The data in the DRRDS-VEBR database must be available to authorized users when they need it.

Security Controls

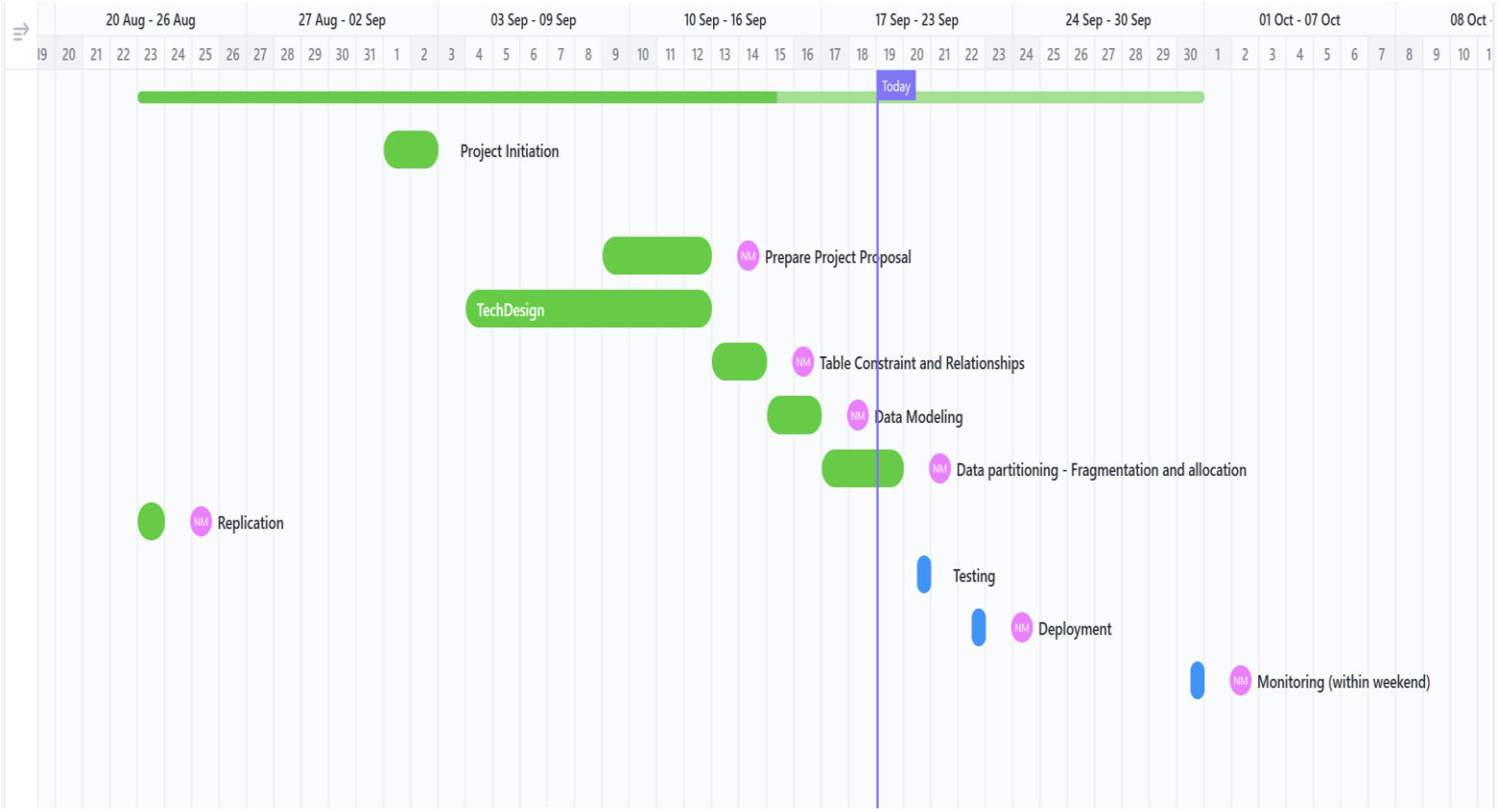
The following security controls will be implemented to achieve the security objectives for the distributed DRRDS-VEBR database:

- Physical security: The physical security of the data centre where the DRRDS-VEBR database is stored will be maintained to prevent unauthorized access to the data.
- Logical security: The logical security of the DRRDS-VEBR database will be maintained using access control lists, encryption, and auditing.
- Application security: The application that accesses the DRRDS-VEBR database will be secured using input validation, output sanitization, and session management.
- Network security: The network that connects the DRRDS-VEBR database to the rest of the organization will be secured using firewalls, intrusion detection systems, and data loss prevention.
- User education: Users will be educated on security best practices and how to identify and report security threats.

Monitoring and Testing

The security of the distributed DRRDS-VEBR database will be monitored on a continuous basis. The security controls will be tested regularly to ensure that they are working properly.

Implementation Planning



Conclusion

As of CRVS registration started on paper-based registration might be good initiation to commence on the registration in Ethiopia. However, there are many disadvantages in terms of efficiency of the registration process and cost effectiveness. Furthermore, the coverage and quality of registration is expected to improve with the use of electronic registration. This project exercise will be scaled up nationally upon successful accomplishment and will give a highlight on all aspects of improvement ranging from efficiency and effectiveness of using the technology to its impact on the overall CRVS quality and coverage improvement. Accordingly, ICS as collaboration with stakeholders to implement such projects and conduct quality and coverage survey on such the projects, findings are a baseline to make CRVS Digitization undoubtedly has an impact on an institution's performance and level.

Sample Code

```
-- Database Links
CREATE DATABASE LINK "HQ"
  CONNECT TO "SYSTEM" IDENTIFIED BY VALUES ':1'
  USING '(description = (address_list =(address =(protocol =tcp)(host=LOCALHOST)
(port=1521)))(connect_data=(service_name=XEPDB1)))';

CREATE PUBLIC DATABASE LINK brpdb
   CONNECT TO system IDENTIFIED BY password
USING '(description = (address_list =(address =(protocol =tcp)(host=192.168.77.90)
(port=1521)))(connect_data=(service_name=XEPDB1)))';


--Select Statement
select * from vital.child_information@hq
select * from vital.child_information@brpdb
-- Create  view
CREATE OR REPLACE VIEW vital.hrz_child_information_vw AS
   SELECT
      *
   FROM
      vital.child_information@hq
   UNION
   SELECT
      *
   FROM
      vital.child_information@brpdb;
```

```
-- Trigger
CREATE OR REPLACE TRIGGER horz_trigger INSTEAD OF
   INSERT ON vital.hrz_child_information_vw
   FOR EACH ROW
BEGIN
   IF ( :new.c_registration_date - :new.c_dob <= 90 ) THEN
      INSERT INTO vital.child_information@hq (
         c_first_name,
         c_middle_name,
         c_last_name,
         c_sex,
         c_nationality,
         c_dob,
         c_registration_date
      ) VALUES (
         :new.c_first_name,
         :new.c_middle_name,
         :new.c_last_name,
         :new.c_sex,
         :new.c_nationality,
         :new.c_dob,
         sysdate
      );

   ELSE
      INSERT INTO vital.child_information@brpdb (
         c_first_name,
         c_middle_name,
         c_last_name,
         c_sex,
```

```
            c_nationality,
            c_dob,
            c_registration_date
        ) VALUES (
            :new.c_first_name,
            :new.c_middle_name,
            :new.c_last_name,
            :new.c_sex,
            :new.c_nationality,
            :new.c_dob,
            sysdate
        );

    END IF;
END;
```