



**End of Project Report**

**For**

**East London NHS Foundation Trust**

**Data Warehouse Management**

CONTENTS

[1 Introduction 3](#_Toc531014028)

[2 Background and Context 3](#_Toc531014029)

[3 The Solution – Utilisation of Source Group data warehouse and SQL experience to deliver a robust platform supporting the RiO upgrade. 4](#_Toc531014030)

[4 Source Group Achievements for ELFT to date: 5](#_Toc531014031)

[5 Additional Work and Benefits 10](#_Toc531014032)

[6 Summary 12](#_Toc531014033)

# Introduction

Following a successful project delivered by Source Group at East London NHS Foundation Trust (ELFT), we are pleased to submit an end of project report detailing work carried out and the benefits for the trust based on the outputs of the work.

We have detailed the technical achievements and the benefits to date for ELFT and would also like to take this opportunity to thank the staff in Information and IT for their support over the lifetime of this project.

# Background and Context

ELFT commissioned a data warehouse (HealthWare) and reporting suite from Ardentia, a supplier of SQL Datawarehouse to the NHS approx. 8- 10 years ago.

The implementation and training of staff in the use of this data warehouse was carried out by Ardentia staff, including the Source Group CTO Tom Rawley, who possesses an in-depth knowledge of the data warehouse and its construction.

The Datawarehouse has reached its limitations and is close to the end of its useful life, however needs to be maintained for a transition period whilst the Trust undergoes a procurement exercise to migrate the Datawarehouse to a cloud-based version.

Current staff members in the trust have a knowledge of the Datawarehouse, but, as with the majority of client-based instances the amount of bespoke development that has been delivered over the lifetime of the warehouse necessitates the use of external expertise, ideally one with HealthWare skills

The purpose of the project was to stabilise the current Datawarehouse on the legacy platform and support he trusts migration of RiO to SQL server 2016.

# The Solution – Utilisation of Source Group data warehouse and SQL experience to deliver a robust platform supporting the RiO upgrade.

Source Group CTO Tom Rawley, who has in depth HealthWare knowledge and SQL skills worked on this project supported by our development team and the trusts information and IT staff to stabilise the current data warehouse, optimise key processes and prepare to migrate the solution to SQL server 2016.

The key benefit was to support the upcoming RiO 2016 upgrade, but the Trust and Source Group also delivered additional benefits form optimisation of processes to reducing the volume of data and reports held within the warehouse.

The ultimate output was to be in a position to accept a RiO upgrade to SQL server 2106 in a timely and cost-effective manner – which was duly achieved, and indeed was the first successful upgrade across the RiO estate within the NHS.

# Source Group Achievements for ELFT to date:

## Migrated services away from Windows Server 2003 –

The trust had a number of servers still running Windows Server 2003 which presented a substantial security risk.

Each of these servers housed services that needed to be migrated off including a legacy PAS system that had to be rehoused and a new search facility built in SQL Server Reporting Services to enable a group of trust users to search the legacy PAS to establish where older sets of records were to be found.

The trust needed to meet Closure and migration targets set out by NHS England for Windows Server 2003 services and with the input of Source Group all remaining Windows 2003 Servers. We decommissioned and migrated successfully within the stipulated timescales.

The key benefit for the trust was to reduce the risk associated with running services on 2003 platforms and adhering to NHS England objectives

## Migrated BI Solution to SQL Server 2016 –

In order to minimise any risks or exposure of the trust’s infrastructure to external threats the trust felt that the BI solution and data warehouse needed to be migrated from current platform to SQL Server 2016.

**It is widely understood that support for SQL Server 2008 R2 stops in September 2019.This therefore poses inherent risks to any organisation that has services and processes within SQL Server 2008 R2.**

New threats, viruses and other malware etc., will no longer be catered for in maintenance releases or service packs. T

his obviously places the database platform on a level with operating systems such as Windows 2003 server, and whilst ‘WannaCry’ ransomware took advantage of outdated OS and related security patches, viruses have been released historically that attack SQL Server architecture.

Keeping these platforms current and patched is essential to maintaining their integrity.

Apart of the upgrade all platforms were migrated to SQL Server 2016, mitigating any risks to the Trust and providing a fully supported platform the will also “futureproof “the trust.

The key benefit delivered through this piece of work is migration to a futureproofed platform and minimising of any key virus/ malware risks that could cost time money and potentially impact on patient care.

## Provision of the capability to migrate Servelec

As part of the ongoing support for the Servelec RiO PAS all trusts in the NHS using this PAS will be upgraded to SQL Server 2016 by June 2019 and consequently all trusts will need to ensure that the supporting infrastructure is capable of maintaining this environment.

It was obvious that the skills and resources within ELFT were not readily available to deliver the infrastructure upgrade in the timescales required and ELFT, stated as being seen as a key innovator and leading trust in the MH field wanted to be the first site migrated required the support of Source Group to achieve this on time and to budget

The key benefit for the trust is that ELFT maintain their position as a leading innovator within the MHT arena and other organisations are looking to ELFT for guidance and support in going through this upgrade. This can only benefit in terms of external PR and staff retention and attraction.

## SQL Server 2016 brings with it a number of benefits.

For a full list please see Appendix 1 However, we will summarise the key points.

### Performance Improvement

The Trust has seen a dramatic improvement in performance has improved compared to SQL server 2008R2.

There have been considerable advances in hardware platform technology since SQL 2008R2 was released and whilst service packs were released until September 26th, 2014 (service pack 3) these were aimed at solving ongoing problems rather than catering for, and augmenting, advances in technology.

This performance improvement has been realised already. - The daily processing for the ELFT BI Reporting Solution was running between 1 am and 3pm the following day. **taking 13 hours**

The upgrade and optimisation work carried out by Source Group has initially reduced this to **9 hours**

The key benefits are both to the trust in allowing their teams an additional 4 hours of extra data access for reporting and analysis, but also externally now ELFT can offer this access to its community clients, delivering much needed analysis time.

### Platform Stability

SQL Server 2016 is very much more stable than 2008R2 with uptime (time achieved between service restart) averages recorded far outstripping its older counterpart.

This historically has proved to be a challenge for the trust, increasing downtime and reducing output whilst serving to decrease morale and confidence in the platform with the internal staff.

Upgrading to SQL Server 2016 has negated these issues, increasing predictivity, morale and support for the informatics service in general.

### Security Improvements

Security and role-based access has been improved considerably with the Source Group delivered upgrade including row level security. T

his will enable many reports that have been duplicated for different teams to be amalgamated into one with row level security set against user accounts on the team field in the data.

This will cut down on processing time because where multiple tables may have been used to cater for each of the different reports for each team, only one table with one set of derivation routines will be needed.

The key benefits are within the performance times and increased access to the data, hopefully delivering an improvement in output from the user community

### Programmability Advances

Many advances in programmability have been added including additional functions in TSQL, support for connective technologies such as JSON (very important for elements such as custom charts, for example SPC charts, required by the trust recently.

Other elements such as user defined data types are now accessible which have the potential to improve performance and security by leaps and bounds.

The key benefits are improved output in terms of reports and charts for the senior teams and end users, creating clearer and easier to understand dashboards, supporting critical business discussions made at board.

The capability to make solid evidence-based decisions sing easy to interpret data and dashboards will reduce costs and the timeliness of key decision-making processes delivery clarity to senior team sand those who report to the teams

### Futureproofing

Support for On-Premise to Cloud moves has been introduced. This allows ELFT to migrate its platform to a hosted Cloud solution with the obvious benefits that Cloud Hosting brings

* Host ensures latest releases are implemented
* Host responsible for security layer
* Trust does not have hardware maintenance costs
* Trust can free up space by the removal of hardware
* Less customisation, a key challenge currently in ELFT

### Improvement in Reporting Services performance

As a direct result of discussions with ELFT and the process and configuration by Source Group of the reporting services layer the performance of the presentation layer has improved.

By undergoing discussions and configuration of the BI layer staff who previously have relied on excel, pivot tables etc are now much more comfortable using reporting services, driving the trust to a commonality of approach and a single version of the truth, adopted by all.

The key benefits are that reports, and dashboards presented at board level for critical decision-making processes will be consistent in look feel and interpretation, allowing security for the key decision makers.

### Maintaining key financial flows

IQVia had not updated their architecture to be able to work completely with SQL 2016. However the expertise and understanding of the HealthWare (Data Warehouse)build meant that we could carry this out independent of IQVia reducing time to migrate and also reducing any costs associated with contracting to IQVia for this work ( much of which would have been duplicated already and therefore superfluous).

This led to a speeding up of time to migrate and ensuring that commissioner reports and data extracts could be produced post migration.

This will ensure the Trust’s financial flows are not interrupted as some of these will be used for invoice validation by the commissioners themselves.

The key benefit is a financial position is maintained, but more importantly, seamless transition is achieved for the commissioners, enhancing the provider / commissioner relationship

### Improved BI performance

A key reason for the poor and ever degrading performance of the legacy 2008R2 based BI solution has already been explained to some degree, but much of this decrease in performance was down to outdated OS architecture.

The virtual OS platform that supported the solution (Windows Server 2008) only allowed for a finite amount of processing power and RAM to be harnessed to support the service.

This was limited to four core processors and 8 Gigabytes of RAM. So, when the service had harnessed the maximum availability and had been at that maximum for some years, as data and processing requirements increased month on month the capability to deliver this remained static reducing performance.

Upgrading improved speed and performance of the BI solution, allowing users to create reports in a relatively short period of time compared to previous report creation.

Whilst this is a technical benefit– the outcome was lack of faith in the architecture by the trust staff and therefore lack of productivity and reduced outputs as well as decreased morale and lack of belief in the platform. All of which should be reduced with the upgrade.

### Could based future

Viable disaster recovery and a setup to enabled move to the cloud has now been positioned to allow ELFT to move in that direction.

As part of the migration and support work Source Group advised the halting of the move of the platform onto physical hardware which is very much more difficult to get back up and running in the event of disaster.

Physical architecture needs to be mirrored and replicated in order to cater for disaster whereas virtual architecture (especially where BI requirements as opposed to transactional databases recording data hour on hour minute on minute are concerned – BI data updates once incrementally at agreed timepoints) needs only a backup or a snapshot to be restored.

Virtual platforms can take advantage of newly available technologies by simply moving them, whereas physically based platforms require migration. Overall physical architecture costs a great deal more money in the long run.

By working with Source Group ELFT have been available to have VM DR, reducing hardware costs and support costs and ensuring stability and uptime

### Multiple outage recoveries –

On several occasions, where the legacy architecture could no longer support the levels of processing and caused service outages, Source Group have worked on the solutions to ensure the services restoral.

For example, when the clocks went forward just prior to last Easter and the creation of two log files caused the daily load to break, team members from Source Group spent the bank holiday weekend working on restoring the nightly data refresh.

Similarly, when Windows updates brought the service down Source Group worked late into the night investigating the route of the problem and then offered the solution.

The trust benefits from a seamless service as a result of the efforts Source Group have delivered.

# Additional Work and Benefits

### KPI Audit Investigation –

Source Group have thoroughly documented all supporting objects used in the production of the outputs for the commissioner KPIs.

As part of the project we set about documenting all the technical dependencies for each of the KPIs.

We are set to put forward a proposal for the second phase after we have discussed each of the KPIs with the team that put them together.

This is the first time the trust has a documented list of technical dependencies for trust KPIs – see attached



### Documentation –

Source Group have been through all the reporting services reports and thoroughly documented all of the dependencies all the way back through all databases to the base Rio\_Reporting (copy of the Rio backend database which is updated daily).

This was a in depth ad resource heavy task that resulted in a completely new comprehensive document which we saw as entirely necessary for the roadmap to a stable and performant BI solution.

The simple fact is that there are several hundred reports that are being used regularly and a number of commissioner extracts that are fulfilling their purpose.

The underlying structures have fundamental weaknesses that have caused issues to manifest to the users, primarily around length of daily process and as a result the availability of accurate and timely data during the working day, service outages, and the overall performance of the reports themselves (time taken to open and load etc.) as well as overall look and feel of the solution (which is a secondary consideration but still one that user populations tend to feel strongly about).

In order to remedy these problems, Source Group put together a statement of works that set out to highlight the main issues and put forward solutions at a number of levels to help transform the ELFT BI offering:



A fundamental part of this plan was to backwards engineer all the outputs (reports and extracts) of the BI solution that were being used regularly, as well as those that were not being used in order to be able to quickly identify any redundant architecture. This would then be archived, and the remaining structures optimised to reduce the daily processing time and improve the performance of those regularly used objects.

We have completed this documentation.

Please see the ‘MostViewedReports - Report Dependencies.xlsx’ spreadsheet. Unfortunately, it is too large to embed within this document.

Should you wish for a copy please email [helpdesk@source-group.uk](mailto:helpdesk@source-group.uk) quoting the name of the document etc.

This piece of work has resulted in the delivery of consistency and order reducing processing time and minimising the amount of excess and redundant reports being generated

### Source Control and Configuration Management

Part of the plan to revamp the Trust’s BI solution involved ensuring that future development was managed in a professional manner with appropriate levels of configuration management and source control.

This will help prevent a recurrence of the situation the Trust found itself in at the beginning of this financial year, where daily processing times were running as long as 14 hours, services outages were occurring regularly, users were getting as little as an hours access to the data and reports daily, and algorithms were being lost due to deployment of new developments over the top of existing ones without any version control.

These issues were undoubtedly the result of little or no controls on who develops what where and when. To this end Source Group have provided Redgate SQL Toolbelt, a suite of SQL Server management tools including SQL Source Control, a configuration management and version control system that helps the management of the development of SQL server data objects in conjunction with Team Foundation Server (the storage mechanism).

We have installed and configured both on the new server. It must also be pointed out that many of the requirements of pursuing the migration at the pace that we did and within the timescales that we did simply would not have been possible were it not for some of the other tools provided in the Redgate SQL Toolbelt, such as SQL Compare and SQL Data Compare.

These tools enabled us to reduce the risk of the migration by keeping the legacy SQL 2008R2 server running, providing a fall back should the migration server encounter issues.

For example, once Servelec had updated the backend of Rio to SQL 2016, the data feeds to update the data daily in the data warehouse came through in that format and at a point the legacy database could not be updated because the data update (log) files were no longer being produced in the SQL 2008R2 format.

SQL Data Compare enabled us to take the data from the new SQL 2016 version of the Rio\_Reporting database and write all the differences back to the legacy data warehouse on a daily basis. T

his not only reduced the risk of missing the bold timescales, but enabled commissioner reports to continue to be produced from the legacy system when NetTransform (IQVia Product) could not be enabled in time for the SUS submission on the new architecture.

Again, the benefits are in timeliness of access to data – financial flow stability and performance uptime

# Summary

ELFT had a creaking – over engineered , undermanaged data warehouse supporting the RiO PAS and providing data for in house analysts and community customers at a pace that was “ accepted “ as “what it is “ which led to performance issues, creation of an excessive amount ( in excess of 1900 ) of reports , and put strain on both information team and their capability to deliver , as well as the relationship with external clients in the provision of accurate data in a timely manner.

By working with Source Group over a period of 6-8 months, performance has improved, financial flows maintained, data analysis time is improved, delivery of services to external customers has also seen an improvement.

Ultimately, by creating a platform capable of supporting RiO upgrade to SQL Server 2106 the combined efforts of ELFT informatics IT teams and Source Group expertise, patient care will improve via the first deployment in the NHS of Servelec upgrade.

Appendix 1

BENEFITS OF USING SQL 2016 OVER SQL 2008R2 (This takes into account all of the changes through SQL versions 2012,2014,2016)

1. PERFORMANCE & SCALE
   * 1. In-Memory OLTP
     2. Enhanced In-Memory Column-Store for DW
     3. Support for 640 logical proc. & 4 TB memory
     4. Support to 15,000 partitions
     5. Resource Governor IO governance
     6. Buffer Pool Extension to SSDs
     7. Query optimization enhancements
     8. Sys-Prep at cluster level
     9. Predictable performance with tiering of compute, network, and storage with Windows Server 2012 R2
2. HIGH AVAILABILITY
   * 1. SQL Server Always-On
     2. Delayed Durability
     3. Recovery Advisor
     4. Windows Server Core
     5. Live Migration
     6. Online Operations enhancements
     7. Clustered Shared Volume support, VHDX support (Windows Server 2012 R2)
     8. Manage on-premises and cloud apps (System Center 2012 R2)
3. SECURITY
   * 1. User-Defined Server Roles
     2. Default Schema for Groups
     3. SQL Server Audit
     4. SQL Server Fine-grained Auditing
     5. Enhanced separation of duty
     6. CC certification at High Assurance Level
     7. Backup encryption support
4. PROGRAMMABILITY
   * 1. SQL Server Data Tools
     2. Local DB runtime (Express)
     3. Data-tier Application Component project template
     4. Data-Tier Application Framework (DAC Fx)
     5. Query optimization enhancements
     6. Interoperability support (ADO.NET, ODBC, JDBC, PDO, ADO APIs and .NET C/C++, Java, Linux, and PHP platforms)
5. T-SQL ENHANCEMENTS
   * 1. Enhanced support for ANSI SQL standards
     2. Transact-SQL Static Code Analysis tools
     3. Transact-SQL code snippets
     4. Intellisense
     5. Unstructured & Complex Data Support
     6. FileTable built on FILESTREAM
     7. Remote Blob Storage with SharePoint 2010
     8. Statistical Semantic Search
     9. Spatial features, including Full Globe & arcs
     10. Large user-defined data types
6. MANAGEABILITY
   * 1. Distributed Replay
     2. Contained Database Authentication
     3. System Center Management Pack for SQL Server 2012
     4. Windows PowerShell 2.0 support
     5. Multi-server Management with SQL Server Utility Control Point
     6. Data-Tier Application Component
7. ACCESS ANY DATA
   * 1. Power Query
     2. Windows Azure HDInsight Service
     3. Analytics Platform System (PDW V2)
     4. Mash up data from different sources, such as Oracle & Hadoop
8. INSIGHTS WITH FAMILIAR TOOLS
   * 1. Power BI in Office 365
     2. Power Map for Excel
     3. Mobile interfaces for Power BI
9. COMPLETE BI SOLUTION
   * 1. SQL Server BI Edition
     2. HA for Stream Insight, complex event processing
     3. BI Semantic Model
     4. SQL Server Data Tools support for BI
     5. Change Data Capture for Oracle
10. ANALYSIS SERVICES
    * 1. Import PowerPivot models into Analysis Services
      2. Enhancements on productivity, performance
11. REPORTING SERVICES
    * 1. Power View
      2. Configurable reporting alerts
      3. Reporting as SharePoint Shared Service
      4. Report Builder 3.0
12. DATA QUALITY SERVICES
    * 1. Build organizational knowledge base
      2. Connect to 3rd party data cleansing providers
13. MASTER DATA SERVICES
    * 1. Master Data Hub
      2. Master Data Services Add-in for Microsoft Excel
14. INTEGRATION SERVICES
    * 1. Graphical tools in SSIS
      2. Extensible object model
      3. SSIS as a Server
      4. Broader data integration with more sources; DB vendors, cloud, Hadoop
      5. Pipeline improvements
15. HYBRID CLOUD SOLUTIONS
    * 1. Simplified backup to Windows Azure
      2. Support for backup of previous versions of SQL Server to Windows Azure
      3. Cloud back-up encryption support
      4. Simplified cloud Disaster Recovery with AlwaysOn replicas in Windows Azure VMs
16. EASY ON-RAMP TO THE CLOUD
    * 1. New Windows Azure Deployment UI for SQL Server
      2. Larger SQL Server VMs and memory sizes now available in Windows Azure
      3. DAC enhancements: Import/export with Windows Azure SQL Database
17. COMPLETE AND CONSISTENT
18. FROM ON-PREM TO CLOUD
    * 1. SQL Server Data Tools
      2. License Mobility (with SA)
      3. Resource Governor enhancements
      4. Snapshot backups to Windows Azure via SQL Server Management Studio
19. CHANGES IN THE LATEST UPDATE (2016)
    * 1. Always Encrypted
      2. JSON Support
      3. Dynamic Data Masking
      4. Poly-Base
      5. Row Level Security
      6. Stretch Database
      7. Multiple Temp DB
      8. Query Store