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SERVICE-ORIENTED ARCHITECTURE INITIATIVES WITH INFORMATION QUALITY: EXPLORING THE ISSUES

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Abstract

The implementation of service-oriented architecture (SOA) initiatives can help a business to leverage technology and to make it more agile and flexible to respond to rapidly changing requirements. However, enterprises cannot fully exploit its benefits, if bad information is delivered that is worthless to customers, suppliers and partners. In this context, there is a need for quality information management to build reliable SOA-based systems from the beginning. Organisations – whether engaged in work-in-progress or at the beginning of SOA initiatives – need to ensure every business process works correctly and according to business needs and requirements, by considering information quality in their initial plans. This paper reports case study research undertaken in seven organisations via semi-structured interviews. It highlights a number of information quality related issues that they encountered during implementation of their SOA initiatives, provides the reasons behind these issues and suggests possible guidelines. Consequently, dimensions of information quality associated with the issues are determined for the organisations' future reference for quality SOA initiatives.

Keywords: Information Quality, Service-Oriented Architecture, Information Governance.

1 INTRODUCTION

As organisations evolve, they often seek to seamlessly integrate and implement a number of information systems across the organisation. Gartner reports that, in recent years, CIOs in many organisations are transitioning information technology (IT) and information systems to improve business processes (MacDonald and Aron 2010). This improvement is due to the fact that they are facing rapid and radical business changes which are referred to as business agility. However, with traditional siloed and monolithic IT architecture, it is impossible to achieve business agility because of the difficulties, costly and time consuming in response to changing business conditions (Choi et al. 2010). Making business agility is a critical step to provide competitive advantage to succeed in business changing environment. In order to achieve and deliver business agility effectively in pace with dynamic business conditions include changes in legislation and policy (Gong and Janssen 2011), service-oriented architecture (SOA) offers a way to better facilitate IT integration with business objectives, to best support current and future goals and to accommodate evolving information management needs (Choi et al. 2010) and to become a service-oriented enterprise (Janssen and Joha 2008). Software Engineering Institute at Carnegie Mellon University defined SOA as "an architectural style where systems consist of service users and service providers" (Bianco et al. 2007).

Organisations that implement SOA can be referred to as having an SOA initiative. An SOA initiative is where an organisation pursuing SOA implementation through a staged approach with a reference implementation that demonstrates the recommended use of standards and best practices (Shah and Kalin 2007). The staged, step-by-step approach is suggested to give time to the organisation to embrace SOA and absorb change through extensive planning. In this paper, four phases of SOA initiative is derived from the literature; strategic planning, building architecture, services operation and continuous improvement.

Adopting, implementing and running SOA initiatives require significant attention and effort in order to deliver high-quality information and realise the full value of SOA (Pruden and Kulkarni 2007). Information quality (IQ) is commonly defined as the fitness for use of information (Juran 1992; Stiglich 2007). Aiming at identifying IQ issues in the SOA initiative, this paper adopts an interpretive paradigm with a qualitative approach through seven case studies of organisations to seek insightful understanding about their experience and view in dealing with IQ in implementing SOA initiatives. The results may guide organisations to enhance the information management aspects of SOA implementations. This research study attempts to identify specific IQ issues at the various stages of the service-oriented architecture initiatives.

This paper is structured as follows: the first part describes the background of IQ and SOA initiative based on relevant literature. The second part is the main focal point in presenting case findings of IQ issues in SOA initiatives. Finally the paper draws conclusions from the case study.

2 RELATED WORK

As SOA becomes prominent as an architectural paradigm, many organisations are rapidly moving to SOA to enhance business agility (Schwarz and Hirschheim 2006). Implementing SOA initiatives represents a substantial challenge for organisations to require detailed design and planning and is often accompanied by significant business process re-engineering (Marks and Bell 2006). SOA initiatives require a change from application-based thinking to an enterprise-wide perspective and the use of recommended standards and best practices. Unlike large monolithic IT applications, SOA allow a simple and inexpensive integration of new functionalities in response to business changes (Choi et al. 2010). Thus, a roadmap is needed to undertake as a guide to help organisations in implementing their SOA initiative.

In a very recent research study has released a comprehensive roadmap for SOA management that is important for both IT and business personnel to be thorough on the whole implementation process of SOA initiative (Moeini et al. 2011). Vendors such as IBM, SAP, Oracle, Accenture, Software AG and TIBCO have also developed several different approaches to implementing SOA initiatives. In fact, they are leading SOA vendors according to two evaluation studies by Forrester research (Heffner et al. 2008; Vollmer et al. 2008); which offer SOA solutions as well as frameworks for implementing SOA. Several organisations have also developed their own SOA life cycle models for both development and operational stages, with the hope to optimise their own, policy based services (Takahashi & Ishikawa 2009). During this research several SOA approaches have been reviewed and compared. The outcome of the review exercises; four generic phases were derived for implementing of an SOA initiative as described below.

- *Phase 1: Strategic Planning* – An initial stage for an organisation to implement its SOA initiative systematically across the organisation. It is where SOA initiative is organised and defined, which is clearly different for every organisation because it all depends on meeting individual business needs. Comprehensive planning in regards to policy development and service delivery model is imperative to be enabled so that business and IT operations can be aligned in the SOA implementation. An initial plan, with actionable steps and concrete milestones, is produced and includes all the necessary requirements which should be focused on its effectiveness to start building agile SOA.

- *Phase 2: Building Architecture* – Development of services and infrastructure. It is the most important part of delivering SOA initiatives into an organisation. Building SOA means building its infrastructure and services with the support of information technology to achieve business objectives and goals. The involvement of SOA team at the early stage of SOA initiative will allow better understanding and enable them to change their way of thinking about building services. Organisations should have techniques to acquire all requirements across departments so that SOA can be built and maximise its achievements.

- *Phase 3: Services Operation* – All processes, applications and services are continuously operated. This phase requires active monitoring of all processes to check performance and to proactively solve any risks associated with SOA operation. There is also a need to monitor adherence to policies and the adequacy of performance indicators. In an SOA, the services are the equivalent of critical resources in an ordinary project. Regular reports that track the compliance of services to regulatory requirements must also be deployed at this stage.

- *Phase 4: Continuous Improvement* – Services are continuously evaluated and allow for change. This evaluation is made possible by extensive documentation of issues, faults, failures and lessons learnt in the previous three stages. The process of continuous improvement is never ending. Once deployed, the responsible staff must watch for ways to improve the service delivery as well as to optimise existing process. Improvement also requires that some policies be revised at regular intervals to ensure continuing compliance to regulatory requirements and to meet changing demands of the market.

Organisations that follow the generic phases to deliver SOA initiative often successfully return on IT investment through improved productivity and reduced cost (Benazeer et. al 2008). This is supported by jointly TechTarget and Forrester survey report that shows nearly 66% of SOA initiatives succeeded in achieving their goals (Vaughan 2010). Despite the success, many organisations fail in their SOA initiatives to realise its value; reported in the same survey report, the percentage of such failure is almost 34%. This failure caused by a lack of quality especially in the use of information (Braunstein 2009). Thus, it is important to note that having information quality is critical to effective implementing SOA initiative in an organisation.

Current literature indicates that most information quality research focuses on the actual implementation of SOA rather than the process for an organisation to implement its SOA initiative. Among the issues are:

- Integration of various external systems is crucial (Hentrich and Zdun 2006) and, with appropriate data integration strategy and techniques (White 2005), organisations can avoid data incompatible

definitions, inconsistency across the organisation, redundancy, ownership issues and update anomalies.
- During interactive services, data that is exchanged might be unclear, ambiguous, insecure and not accessible in a timely fashion (Tittel 2007), due to non-conformity with electronic data interchange (EDI) standards (Vitvar and Kotinurmi 2006).
- When it comes to security, privacy also is an important aspect, especially where impersonation and identity theft may happen (Papastergiou et al. 2007) when using services that are not in compliance with data protection principles (Ringelstein et al. 2007).
- Complexity of data in terms of data volume, latency, and multiple data formats etc. need to be addressed before feeding data into critical SOA based services (Informatica 2011).

Focusing on IQ research with an organisational perspective, therefore may avoid problems in implementing successful SOA initiatives in an organisation for business agility and flexibility. In the literature, IQ is a multi-dimensional concept (Pernici and Scannapieco 2003) and viewed differently in various contexts (Kahn et al. 2002). The most cited list of IQ dimensions in the literature is from Wang and Strong's (1996).

- Believability
- Accuracy
- Objectivity
- Reputation
- Value-added
- Relevancy
- Timeliness
- Completeness
- Appropriate amount of data
- Interpretability
- Ease of understanding
- Representational of consistency
- Concise representation
- Accessibility
- Access security

In this list; timeliness, accuracy, completeness and consistency, are the four of the most significant dimensions identified by several experts include the majority of researchers in the IQ literature (Caro et al. 2007; Tongchuay and Praneetpolgrang 2008). Thus, by considering these issues and dimensions, but not limited to, this study requires a deep understanding of SOA initiative context through a case study to identify IQ related issues with associated dimensions. The term 'information quality' and 'data quality' are used interchangeably in this paper as both terms are used for such purpose by most researchers.

3   RESEARCH METHODOLOGY

This research investigates the IQ issues emerged during the process of SOA initiative in organisations. The research therefore, focused on the real case scenarios of SOA initiative implementation in seven large organisations (identified as Banking A, Banking B, Banking C, Defence, Retail, Public, and Utility); by investigating how different organisations address IQ in SOA implementation. This research study therefore, adopts a qualitative approach which uses an interpretive research paradigm where the interactions between the phenomenon and context are analysed and interpreted. It is explanatory by nature and requires effective understanding of detailed real-life behaviour (Yin 2009).

Managers, architects and developers that are involved in implementing SOA initiative in their respective organisation were interviewed using a semi-structured approach. Through such interviews, an understanding of quality of information in SOA initiative is important rather than the explanation where it engages human to human relationship and provides dynamism and flexibility in conversation (Fontana and Frey 2000). Participants from different organisations in diverse settings have allowed deeper understanding, description and explanation of the SOA initiative by obtaining in-depth insights of different aspects of identifying IQ problems.

Analysis of the seven cases under review allowed the researcher to capture the viewpoints of participants with respect to how they perceived IQ would be embedded within the SOA

implementation. The analysis involved multiple processes by first having the interview transcriptions, next categorising them using thematic approach and then the most critical process is the interpretation of interview transcripts. The interpretation turns up new information and findings based on the interview questions that were progressively focused towards the research framework. Having themes in a useful manner would ease the process of interpretation and reporting of interviews as a whole. The researcher used computer-assisted analysis software, Nvivo™ (Lewins and Silver 2007) to categorise and analyse the data upon transcription.

The participating organisations that have deployed SOA were the main data collection sources. The reason was that experienced organisations that have deployed SOA might share valuable information on IQ issues throughout implementing SOA initiatives. Table 1 illustrates the background of participating organisations and their SOA initiatives.

Case	Background	SOA Initiative
Banking A	One of the largest financial institutions in Australia with it's headquarters located in Sydney; It has a nationwide network of 857 branches with approximately 39,000 staffs worldwide; Its business model is customer centricity, comprising five key area of businesses through which serves around 11.8 million customers.	SOA program was initiated in 2009 and will deliver about 150 services by end of 2011; The SOA program is applied to the consumer systems for integration across the enterprise; Using an SOA vendor's technology and framework that also include information data modelling to develop necessary services.
Banking B	Among the largest banks in Australia and its head office is in Victoria; Has a strategy to drive competitive advantage to lead super regional bank with around 48,000 employees around the world; Delivers customers solutions to around 8 million customers worldwide through specialised businesses.	Has started the IT transformation since for the past 10 years and in 2010, has initiated SOA; The transformation was to deliver IT solutions and infrastructure globally using SOA approach; An SOA vendor as the core technology delivery in realising the SOA value and all the services by using a framework to improve around the level of reuse.
Banking C	A merger of two banks in 2007 owned more than 82,000 shareholders provides banking and wealth management services to customers and businesses; Represented with 465 branches nationwide and headquartered in Victoria.	Began as hub services in 2005 and continue to have the SOA initiative; Allow centralised control of its payroll system combined with distributed access throughout the country; Fitted in with SOA to deliver services using portals and XML programs.
Retail	An internationally recognised retailing business in Australia; Serving millions of customers every day with 95% of fresh food from domestic sourcing; Employs more than 191,000 people in which 40,000 are shareholders.	A part of their business strategy was to introduce SOA in 2007; A strategic initiative with a business driver to implement SOA in their customer, retail and financial systems; The SOA journey is well under way with two leading SOA vendors by using their products and technology; A consulting organisation, an SOA expert, was involved to assist in the SOA matter.
Public	Located in South Australia and is a state government-owned enterprise; Managing one of the most valuable resources to ensure it is sufficient and sustainable for long-term future supplies; Successfully developed and launched a plan that provides 94 actions to diversify the sources.	Started the SOA implementation in June 2009 and has completed in July 2010; It was a federal funded project to complete within a certain timeframe; Technology from a SOA vendor was used for implementing SOA specifically in GIS systems for natural resource data; The SOA implementation was actually carried out by contractors from an Indian company.
Defence	One of the leading defence organisations which is headquartered in South Australia; Has approximately 6,000 employees across the	Taken SOA journey in 2008 with a need of flexible, scalable IT infrastructure to rapidly link together disparate systems; Use a leading

	nation; Approximate annual sales AUD $1.8 billion; Main challenges are designing, integrating and maintaining systems for defence at lower cost.	SOA vendor's suite to support the acquisition strategy to older legacy applications for future integration requirements arising from new acquisition.
Utility	A leading Australasian integrated energy provider and Sydney is where the company headquarter is located; Supplying energy to around 4.6 million customers across Australia; Has more than 4,400 employees and 150,000 plus shareholders.	In 2004, with a consulting company, a full SOA plan was put in place to develop sophisticated enterprise software applications to meet specific business requirements; Has implemented 30 top level business exposed services in retail systems to connect with CRM; To obtain ongoing cost savings and business efficiencies and to increase its return on future IT investments.

Table 1.   Participating organisations and its SOA initiatives

A total of 28 interviews were conducted with SOA professionals from the above seven organisations. Semi-structured interview were conducted through one-to-one interview which averaged approximately one hour each. The interview questions were sent in advance, giving them the opportunity to reflect on the research. The participants were grouped into three teams: management team, architectural team and delivery team as shown in Table 2, according to their roles and responsibilities. To preserve the participants' confidentiality and in-line with the university's ethics guidelines on conducting research, the participants were identified only by their job position.

Case	Management Team	Architectural Team	Delivery Team
Banking A	Head of SOA; Head of Architecture and Strategy	Lead Architects (3); Solution Architects (2); Service Modelling & Design	Engagement Manager
Banking B	Head of Architecture	Solution Architect	Head of Integration Services; Delivery Manager Integration
Banking C	–	Solution Architect; Team Lead Solution Design	Manager Application Development
Defence	Project Manager	Solution Architect	Integration Program Manager
Public	Chief Information Officer	–	Operations Manager; GIS Administrator
Retail	–	Integration Design Manager	Senior Development Manager; Development Manager
Utility	–	Enterprise Architects (2); Solution Architect	–

Table 2.   SOA team within case studies; ( ) – denotes number of interviewees.

4   RESEARCH FINDINGS

By analysing interviews data, we gained interesting insights into the focus area of SOA initiative with information quality. The analysis revealed a number of IQ issues with affected IQ dimensions in each phase of SOA initiative, which we will present some of them in the following section.

4.1   Strategic Planning

With any business-information technology implementation, in which SOA initiative is not exceptional in this case, the organisations are keen to emerge and integrate their legacy systems through SOA approach due to the widespread of the SOA architecture. More often the starting point for implementing SOA initiative to the entire organisation across most, if not all, departments involving business functions, documents and processes; is strategic planning. This planning is usually carried out

by the administrative management-level of an organisation and they are truly driven by business objectives. But it almost never goes smoothly and the direction often misleading. Table 3 shows some key IQ issues found through case studies during strategic planning.

Issue	Cause	Dimension Affected	Interviewee
Information for business case development is incomplete; leads to poor time performance.	Architects do not know all the information but they coordinate the planning process which takes longer time.	Completeness; Timeliness	Head of Architecture and Strategy (Banking A)
Information about the necessity of implementing SOA was vague leading to that implemented SOA cannot be sustained.	At the time when having a large amount of money to spend, SOA were built in a flurry of activity.	Clarity	GIS Administrator (Public)
Information about IQ/DQ program is not presented by SOA vendor for consideration in selection process.	The vendor claims to have quality in its information that is being exposed as web services.	Availability	Solution Architect (Utility)

Table 3.   IQ Issues in Strategic Planning.

4.2   Building Architecture

SOA provides a way of building architecture that involves infrastructure and services. This building begins once the SOA implementation has initiated by the top management in the organisations. The different that SOA approach compared to the conventional development methodology is the way of thinking on how the systems work better in the service environment rather than the siloed monolithic environment. Despite that, there are issues in the area of information either provided to the architects or developers, shared among them or used by them. Few of such issues are presented in Table 4.

Issue	Cause	Dimension Affected	Interviewee
Mapping the information to the wrong services; Incorrect service definition in back-end system.	New people do not have perfect knowledge of back-end interfaces.	Accuracy	Solution Architect (Banking A)
Templates for business and solution requirements that are used are inconsistent which cause information inaccurate and incomplete.	Due to a merger of two banks, business analysts and service designers of each bank were focused differently where review of the templates is not completed.	Accuracy; Completeness	Team Lead Solution Design (Banking C)
Information about planning to develop services was incorrect leads to improper development of services.	Lack of maturity of the market and that is why planning was done by self-reading and discovering what developing a service mean.	Accuracy	Integration Program Manager (Defence)
Information missing in the requirements leads to release a service that is not yet end-to-end finished.	Problems with the decision about what the granularity of the service is or data should be in the requirements.	Completeness; Comprehensiveness	Integration Design Manager (Retail)

Table 4.   IQ Issues in Building Architecture.

4.3 Services Operation

In order to secure services operation in SOA environment which is able to adapt business changes, it is important to make sure the architecture is well tested in all case scenarios. This include enterprise service bus, services registry and communication channel that allow accessibility for clients use. However, such operations are not usually operated according to operation guidelines. The issues of information quality in services operation could create substantial risks for organisations. Table 5 provides some of such issues found in the case study.

Issue	Cause	Dimension Affected	Interviewee
Customers do not understand integration and thus provide unclear integration requirements.	Poor level of understanding for integration and commitment around trying to solve some of the integration issues.	Understandability; Clarity	Head of Integration Services (Banking B)
A service could not handle an extremely large immediate increase of some of the transactions.	The integration of the service was made when the two banks came together cause a volume spike to that service,	Appropriate amount of data	Manager Application Development (Banking C)
Services were not working due to data integrity check did not pass an incorrect invoice data during transaction.	Account personnel made a mistake that enter an incorrect invoice data into the system.	Accuracy	Operations Manager (Public)
Customer data is not available at back-end system during data mapping activities.	Service level agreement (SLA) is violated; Service has terminated unexpectedly.	Availability	Development Manager (Retail)

Table 5.   IQ Issues in Services Operation.

4.4 Continuous Improvement

While the services are being operated, continuous improvement is necessary to ensure its continuous suitability, adequacy and effectiveness. Monitoring the change of business conditions and process flows will foresee either to upgrade the current services or create new services. In addition, during this phase, all processes throughout the SOA journey have been refined to a level of good practice. Although this can be achieved, there is still lack of quality information underlies the continuous improvement efforts as shown in Table 6.

Issue	Cause	Dimension Affected	Interviewee
Multiple information of the same customer is difficult to identify.	Inaccurate rules in customer matching; The customer information is not completely viewed in the system.	Accuracy; Completeness	Head of Architecture (Banking B)
Financial data in maritime business may not be exactly up to date which incurs a cost to the business.	A service of a program in maritime business did not process the financial data for update due to the service has stopped provisionally.	Timeliness	Project Manager (Defence)
In one stream of a project, customer data was incorrect when assessing its data quality.	Assumption was made in the use of a standardised environment that the data was of better quality.	Accuracy	Enterprise Architect (Utility)

Table 6.   IQ Issues in Continuous Improvement.

Some of the issues addressed in the literature, presented in section 2, were focused on the actual implementation of SOA which are generally occurred during the services operation i.e. the execution of SOA applications and services. However, the findings in the case study show that there are more issues in regard to IQ in other areas of SOA initiative include management strategy towards implementing SOA, design and development of SOA applications and services, and improvement of the policies and standards throughout the SOA journey. These issues are likely quite distinctive to the area of IQ research in the context of SOA architected environment.

5 DISCUSSION AND CONCLUSION

All interviewees reported specific IQ related issues in which they had discovered the errors in information associated with SOA initiative implementation. These results provide a different perspective to earlier research suggesting that organisations do too have IQ issues in the process of implementing SOA initiative. This research identified a large number of IQ issues in the implementation of SOA initiatives in these organisations. The IQ issues were come from within the SOA environment that involves the information flow and delivery of services. In other cases, in the communications and sharing of resources between and among SOA team would results low quality of information.
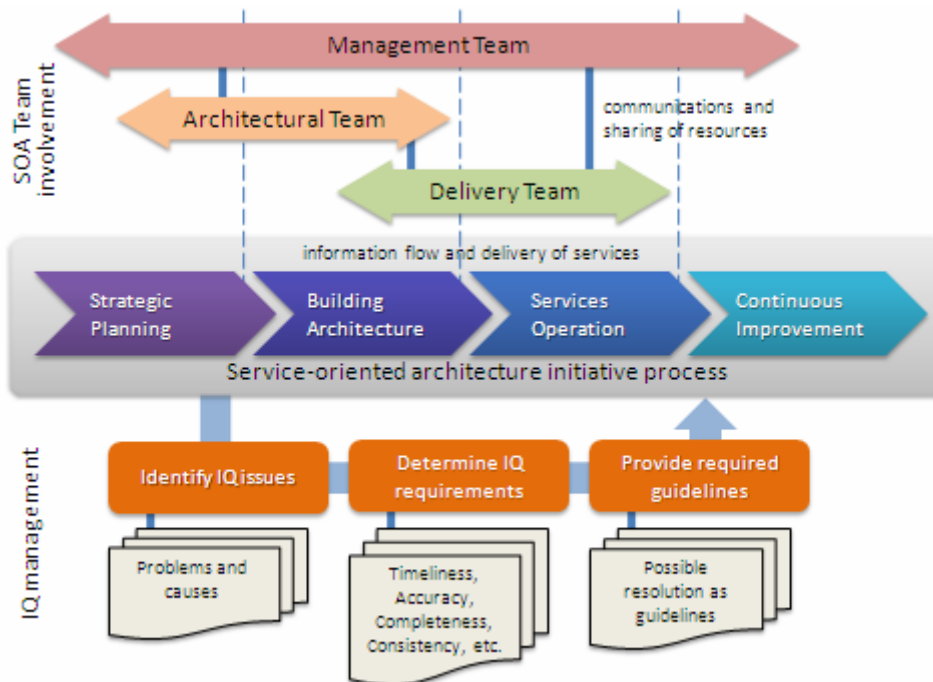

Figure 1.   Framework for SOA initiative with IQ management (developed for this research)

It is found that, in general, all seven organisations realise the importance of information quality in their SOA initiative implementation as one of the interviewees, the head of SOA at banking A, noted that "information quality is a very important issue in SOA initiative". Moreover, these organisations are interested in reducing the impact of poor IQ on services and decision making. The following guidelines are suggested by this study.

- SOA team should understand and recognise the meaning and value of SOA as well as the commitment of their organisations to have SOA initiative implemented in their organisations. This behaviour will allow the team to think and design information systems as services and to ensure the level of information quality within SOA initiative is at a satisfactory level.

- Organisations should come up a comprehensive IQ program for their SOA initiatives in order to effective implementing SOA architecture include infrastructure and services. This program should provide training for managers, architects and developers to recognise IQ issues; identify root causes and construct possible resolutions and embed this process as part of their jobs.

The close review of the study reveals that by implementing SOA initiative in an organisation that embeds IQ dimensions, it can improve SOA initiative and make it more agile and flexible. This study also indicates that understanding and mapping the processes in SOA phases and associated information would be critical. With this understanding, a framework is proposed (in Figure 1) allowing the SOA team to be able to define better standards and guidelines with best practices to determine what solutions to use in order to gain optimum benefits from SOA.

The study was motivated by the observation that the failure and success of SOA initiative in many organisations are often attributed to IQ issues. The affected dimensions of IQ emerged from case study should be taken into consideration by any organisation that wishes to implement SOA initiatives to ensure enhanced processes in SOA initiative implementations.

Acknowledgement

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