

Agile and Lean Service– Oriented Development: Foundations, Theory, and Practice

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Published in the United States of America by
Information Science Reference (an imprint of IGI Global)
701 E. Chocolate Avenue
Hershey PA 17033
Tel: 717-533-8845
Fax: 717-533-8661
E-mail: cust@igi-global.com
Web site: <http://www.igi-global.com>

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Library of Congress Cataloging-in-Publication Data

Agile and lean service-oriented development: foundations, theory, and practice / Xiaofeng Wang ... [et al.], editors.
p. cm.

Includes bibliographical references and index.

Summary: "This book explores the groundwork of service-oriented and agile and lean development and the conceptual basis and experimental evidences for the combination of the two approaches"-- Provided by publisher.

ISBN 978-1-4666-2503-7 (hardcover) -- ISBN 978-1-4666-2504-4 (ebook) -- ISBN 978-1-4666-2505-1 (print & perpetual access) 1. Computer software--Development. 2. Agile software development. 3. Lean manufacturing. I. Wang, Xiaofeng, 1971-

QA76.76.D47A379824 2013

005.1--dc23

2012023354

British Cataloguing in Publication Data

A Cataloguing in Publication record for this book is available from the British Library.

All work contributed to this book is new, previously-unpublished material. The views expressed in this book are those of the authors, but not necessarily of the publisher.

Chapter 8

Service Science: Exploring Complex Agile Service Networks through Organisational Network Analysis

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ABSTRACT

The discipline of service science encourages the need to develop alternative and more scientific approaches to conceptualise modern service network environments. This chapter identifies the opportunity to apply organisational network analysis (ONA) as a novel approach to model agile service interaction. ONA also supports the visualisation of a service infrastructure which sustains agile practice. The objective of this chapter is to demonstrate how the concept of agile service network (ASN) may be examined through an unconventional method to model service operations. ONA demonstrates the exchange of resources and competencies through an ASN infrastructure. Ultimately, this chapter provides a platform to develop an audit framework with associated metrics borrowed from ONA. ONA concepts offer a new analytical approach towards ASN (for example, structural, composition, behavioural, and functional). This has a significant theoretical contribution for software engineering performance.

DOI: 10.4018/978-1-4666-2503-7.ch008

1. INTRODUCTION

Promoting software engineering methodologies is one of the key challenges for Ireland, yet a vital one to sustain our economic competitiveness (Ryan, 2008). Agile software engineering is a methodology which continues to gain increasing levels of academic and industrial attention. Agile software development is a collaborative approach which supports iterative and incremental methods within software engineering teams (Abrahamsson et al. 2003). The key factors which foster the value of agile software development include human interactions, developing improved software solutions, customer collaborations, and responding to change (Beck et al. 2001). Thus, the composition and organisation of agile teams has a direct influence on the functionality of agile software development. While the software industry is currently undergoing a fundamental change with the transition to agile and lean methods, there is a lack of integrated research efforts towards understanding the dynamics of agile and lean methods in an effort to optimise agile capabilities (for example, Vidgen and Wang, 2009). One of the key issues within agile software is understanding how the dynamics of team collaboration impacts on service performance. The aim of this chapter is to demonstrate how we can apply organisational network analysis (ONA) as an agile software engineering modelling method which improves the visualisation of team dynamics. This will allow managers to monitor the impact of service relational structures on performance through a service network performance analytics framework (Carroll et al. 2010). The output of employing ONA is to develop a theoretical and practical approach to monitor and measure how collaborative efforts across teams can be structured to optimise agile software development outcomes. This chapter provides a theoretical foundation to develop an audit framework with associated metrics of agile practice. This research is also grounded in the emergence of service science developments to examine value co-creation across agile teams.

2. SERVICE SCIENCE

Agility has become an important service strategy to respond to the dynamic business environment. Defined by van Oosterhout et al. (2007), agility is “an innovative response to an unpredictable change”. It is concerned with taking greater “control” of unpredictable changes. Therefore, the design, management and delivery of complex service systems suggest that we need to develop a scientific understanding regarding the configuration of resources to deliver service excellence. In order to extend our understanding on service delivery, particularly within an agile environment, there is a need to establish alternative methods to examine service formation and the value propositions which connects them. Within the service-dominant environment (Normann, 2001; Vargo and Lusch, 2008), organisations are faced with increasing challenges to develop their capabilities in complex service models (Vargo et al. 2008). The emergence of “service science” as a discipline in recent years confirms the fundamental change which continues to alter the nature and application of technology within business environments. Service science is an attempt to understand the complex nature of service systems and acts as an interdisciplinary umbrella which incorporates widely diverse disciplines to construct, manage, analyse and evolve service systems (Spohrer et al, 2007). This suggests that we need a more systematic, analytical, and overarching approach to examine service co-production operations to generate knowledge regarding the overlap between the social, business, and technology factors within a service environment (i.e. bridging service management and service computing). As services become more “open”, collaborative, flexible, agile, and adaptive, there are greater pressures on business to reconfigure and meet change through strategic realignments (Carroll et al., 2010). In doing so, managers should develop an understanding as to how this impacts the “value” of the service system. A service system comprises of a provider(s) and a client(s) who collaborate to deliver (i.e. co-create)

and benefit from a service (Vargo et al. 2008). A service system may be defined as (IfM and IBM, 2007; p. 5):

...a dynamic value co-creating configuration or resources, including people, technology, organisations and shared information (language, laws, measures and methods), all connected internally and externally by value propositions, with the aim to consistently and profitably meet the customer's needs better than competing alternatives.

The environment in which the configuration of resources is achieved is described as a service network. A service network comprises of clear linkages which define the service structure and interactions in which it co-ordinates its tasks to achieve a certain business objective. Since it accounts for the collective effort of all service interactions to generate and realise value, co-creation is an important concept within a service network. Merging the concept of agility and co-creation together derives the concept of service networks.

2.1 Service Networks

Nowadays, through the affordance of technology, services are becoming part of a networked service environment (Carroll et al. 2010), for example, agile project management. While the literature suggests that although there are many benefits from the use of agile methods to develop service networks, there appears to be a lack of research developments on agile practice in management theory (e.g. Abrahamsson et al, 2009; Conboy, 2009). Thus, our focus here is to provide an analytical lens to examine the underlying agile service infrastructure. We envisage that this will support managers' ability to examine the service network and how its interactions align with project management activities. As we argue in this chapter, it is extremely difficult to manage and

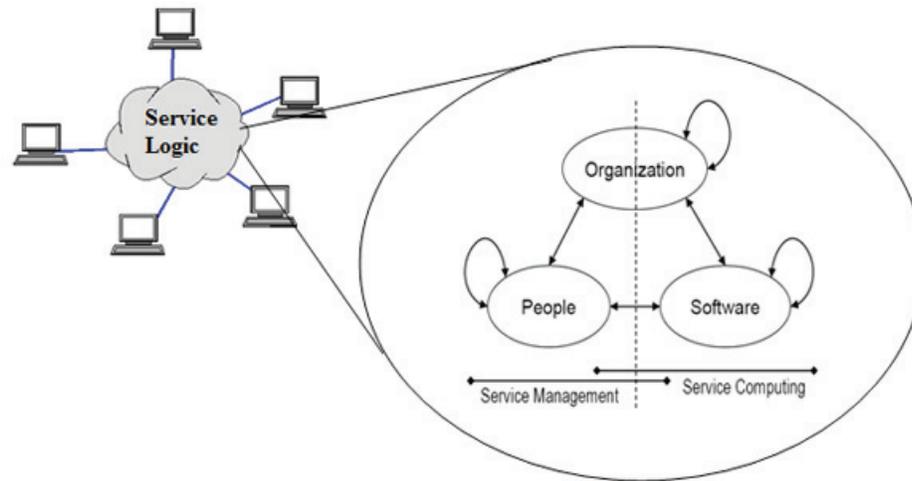
orchestrate an intangible asset, i.e., a service, and reconfigure an "invisible" service infrastructure. It is increasingly important that managers gain a scientific understanding of the service environment to optimise service operations and examine innovative strategies to evolve the service (Spohrer et al. 2007; Chesbrough, 2011). In today's service-dominant world, a service is typically part of a network which supports the co-creation of service value. Value is created through the complex and intertwining nature of services. This draws our attention to the notion of "service as a network", where a service relies on collaboration through continuous interaction executed by people, software, and service logic (see Figure 1), for example, an agile software engineering team.

The nine service relationships of an ASN illustrated in Figure 1 may be categorised as follows (Zhao et al., 2008):

1. Organisation to people;
2. Organisation to software;
3. Organisation to organisation;
4. People to organisation;
5. People to software;
6. People to people;
7. Software to organisation;
8. Software to people;
9. Software to software.

As illustrated, service computing is largely concerned with organisational and software components, while service management is mainly concerned with organisational and people components. However, both service computing and management are required to successfully deliver a service. This figure also shows the unification of these broad concepts which makes communication between service engineers and managers more effective as they are aligned with service technological initiatives. Such initiatives are central to the emergence of ASN.

Figure 1. The service network (adapted from Zhao et al., 2008)



2.2 The Concept of Agile Service Networks

Nowadays, service networks are forced to adapt their processes at a much faster pace than before. In addition, managers must also be proactive, reactive and more decisive at a faster rate than ever before. Thus, agility requires an efficient communication system to support decision-making tasks while understanding the value of the relational infrastructure of a service network. Agile practices rely on flexibility to address novel software engineering approaches, and on technologies while adapting to the service environment. In this sense, people enable the co-creation and co-production of an ASN. ASNs are networks which foster collaborative service interactions across agile teams or business applications. What is of importance here is the relational structure which stabilises the ASN, often through the reconfiguration of actors and resources. ASNs may be described as emergent and dynamic service networks which provide some form of business value by reacting to change. This suggests that ASNs are spontaneous in nature and rely on business partners' collaborative strengths to deliver service value as a network.

Thus, an ASN relies on continuous interactions and exchanges to support the co-evolution of the service environment through the mobilisation of business processes (Carroll et al. 2010).

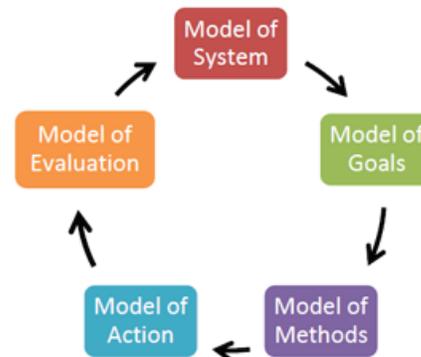
Agility within a service network is the collective ability to adapt rapidly, be as cost efficient and economical as possible, without jeopardising the quality of the product or service. Identifying changes within business processes is critical for either preventing or encouraging certain agile practice workflows. An ASN comprises of large numbers of long-running, highly dynamic complex end-to-end service interactions reflecting asynchronous message flows that typically transcend several organisations and span geographical locations (Mancioppi et al. 2008; Dubois, 2008; van den Heuvel et al. 2009). However, what is apparent across literature is that there is a significant void in understanding how the underlying relational infrastructure of service networks impacts or influences service operations and performance (Carroll et al. 2010). Kawalek and Greenwood (2000), describes an abstract model of the organisation, and how one can develop an understanding of “value” through the addition of three models when applied to a service network:

1. **A Model of the System:** A high level, structural view of actor interactions (who and/or what interacts);
2. **A Model of Goals:** Having identified patterns of interaction in the model, how can we describe the interactions (why do they take place);
3. **A Model of Methods:** Having identified what interacts and why, a model is developed to determine why and how goals are achieved.

These models also complement our understanding of ASN. Carroll et al. (2010) suggests that we should add two additional steps (Figure 2). A fourth step, from a service network perspective, is to implement a “model of action”, i.e. a model which would allow us to explore service strategic possibilities to simulate a “what-if” approach to understanding the influence of each relationship across service processes. A fifth step would include a “model of evaluation” which introduces service performance analytics to learn how interactions and ASN innovations influence performance.

We propose that while adopting this view of ASN, we can gain a better understanding of the dynamic nature of an agile environment. There is continued interest in researchers’ ability to bridge the fields of service management and service computing and explore how both fields may support business relationships across service processes (for example, Zhoa et al. 2008). Thus, it is important that managers explore “how” service networks maintain the ability to adjust relational structures within a service system to meet customer demands. In addition, network dynamics plays a central role in monitoring agile activities and allowing the service system to learn and reconfigure operations for further tasks to take advantage of future opportunities. Service science highlights the need to theorise the “modern” concept of service on a scientific level (Vargo and Lusch, 2008). The nature of service activities involve negotiated and often co-created

Figure 2. Abstract view of service network analysis (Carroll et al. 2010)



exchanges between a provider and a client in the provision of largely intangible assets, as well as the collective coordination and integration of knowledge in service delivery (Vargo et al. 2008). We need to understand service business models and service value for the organisation within the 21st century IT-enabled service economy. Service value, in this case, refers to “the adaptability and survivability of the beneficiary system” (Vargo et al., 2008, p.148) creating “opportunities for reinvestment and cross-subsidisation of activities that may potentially benefit people not involved in the original transaction” (Auerswald, 2009, p.53). ASN shares a similar logic and we introduce the need to model the dynamic ASN environment.

3. RESEARCH JUSTIFICATION

Information exchanges are a vital resource to support decision-making within agile software service teams (Abrahamsson et al. 2003). In short, there is a need for more sophisticated methods in data management and usage by agile software development teams to facilitate higher quality decision-making (Abrahamsson et al. 2003; Vidgen and Wang, 2009; Conboy and Morgan, 2011). We address this gap by introducing a novel method

which assists teams through targeted and focused decision support mechanisms by mapping service behaviour. Supporting service actions through cross-organisational organisations and teams may be described through ASN. ASN rely on message flows that typically transcend several organisations and span geographical locations (Mancioppi et al. 2008; Dubois, 2008; van den Heuvel et al. 2009). However, understanding how information is disseminated across teams and geographical locations is considered problematic, especially across agile service developments (Bruegge et al. 2006). From a management perspective it would be more practical to understand the service characteristics (Chesbrough, 2011), such as structural, compositional, and behaviour to identify (Carroll et al. 2010). For example, it would be useful to identify where bottlenecks exist or where structural holes exist across the network. Agility has therefore become an important service factor to respond to the dynamic business environment particularly to sustain innovation within the software industry. The design, management and delivery of complex service systems suggest that we need to develop a scientific understanding regarding the configuration of resources to deliver service excellence. In order to extend our understanding on service delivery, particularly within an agile environment, there is a need to establish alternative methods to examine service formation and the value propositions which connects them.

4. ORGANISATIONAL NETWORK ANALYSIS

Organisational network analysis (ONA) has been used since the mid-1930s to advance research efforts in social and behavioural sciences (Wasserman et al. 2005). In the 1980's and 1990's, ONA was employed to examine more "technical" characteristics of networks including, "reciprocity, structural balance, transitivity, clusterability, and structural equivalence" (Wasserman et al.

2005). ONA developments stem from the network science and social science disciplines. Lewis (2009) defines network science as the study of the theoretical foundations of network structure/dynamic behaviour and its application to many subfields, such as ONA. In addition, to incorporate the dynamic nature of networks, one must avail of the information which informs us how the service interaction results in a specific outcome. Using ONA, we can define the structure of a system in terms of vertices (nodes) and edges (links) to represent a "real world" environment. In addition, Lewis (2009) suggests that the best way to describe a network is by what it does, i.e. "the study of the structure of the collection of nodes and the links that represent something real", and the "study of dynamic behaviour of the aggregation of nodes and links" (p. 6). Using ONA, we can study the exchange of resources and competencies (for example, information) among actors. We can identify patterns of relations among nodes such as people, groups, organisations, or information systems and visualise the value of ties and relationships between each node. Consequently, OSA provides us with an approach to detect, describe, and analyse relationships which support ASN. Another benefit of ONA is its ability to provide a methodology to gain deeper insight of how structural regularities influence behaviour. Structures may be altered to optimise service network outcomes. Therefore, ONA is a very fitting technique to deploy to uncover more "truths" as to ASN activities, interaction, and exchanges.

ONA focuses on pairs or groups of individuals who share some kind of relational tie such as within ASN. ONA typically begins with one specific community and examines the relational infrastructure which stabilises the network, for example, an organisation. Adopting ONA is a significant contribution within the agile research domain. There are many difficulties in modelling the intertwining complexity and dynamic service configuration (IfM and IBM, 2008) of people, knowledge, activities, interactions, and decisions

which create and deliver value. This presents a starting point upon which this research explores how to model an ASN and supports how we describe an ASN as “the exchange of resources or competencies”. There is a large body of literature which suggests that ONA can present us with a unique method to model and monitor the dynamics of ASN (for example, Berkowitz, 1982; Wellman and Berkowitz, 1988; Scott, 1991; Wasserman and Faust, 1994; Tichy, et al., 1979; Hansen, 1999; Watts, 2004, Hassan, 2009; Carroll et al. 2010). It is claimed that managers have ignored the “dynamic characteristics of networks and the ways that dynamic qualities of networks affect organisations’ flexibility and change” (Cross and Parker, 2004). This has unavoidably led to organisations failing to capture the “health” of their service networks dynamics and performance (for example, behavioural, functional, compositional, and structural) and the overall contributory value of service linkages (relational structures). ONA focuses on exchange patterns of relations among actors (Freeman et al., 1992) and presents an opportunity to model the relational ties between each node to model service network behaviour. To understand the dynamic nature of ASN and its impact on service performance, it is critical to explore the underlying principles in service behaviour and analyse both how and why services perform in a specific manner from the socio-technical viewpoint. This is necessary as Spohrer et al., (2007) posit that the success of service science will be achieved through the introduction of general theories of service interaction and co-creation of value. Mapping a representation of an ASN is important as managers realise that the key to continued success is within their understanding of how workflows and business processes can be optimised (e.g. Linder and Cantrell, 2000).

4.1 ONA Methodology

ONA is an approach and set of techniques which can assist us study the exchange of resources and competencies (for example, information) among

actors. ONA focuses on patterns of relations among nodes such as people, groups, organisations, or information systems. ONA also demonstrates the value of ties and relationships between each node to provide a visual and mathematical representation of interaction. Mapping representation of ASN interaction is important to support the development of an audit framework with associated metrics and training materials. Therefore, ONA offers a powerful modelling technique for ASN. Marsden (2005) explains that, as a technique, ONA data collection practices throughout literature typically involve survey methods. A common method of analysis has been to use implicit or explicit snowball sampling. To develop an understanding of service networks, we had to undertake a rigorous description of the relationship patterns of the network population as the starting point of analysis. Investigating the relationships which exist within a service network is a tedious task, for example, data gathering, analysis, manipulation, and calculation using matrices to record data and represent interactions. ONA software is vital to support these tasks and to provide a visualisation which represents the relational descriptions. There are a number of software packages available to support ONA, for example, UCINET, Pajek, and NetMiner. Adopting formal methods allows us to mathematically represent the network data and learn of structural characteristics of the ASN environment. Formal methods also provide graphing rules and mathematical notation which presents further insights on network data which may not be clear in descriptive text form.

The majority of social network studies apply either “whole-network” research design where a set of interrelated actors which are considered for analytical purposes or “egocentric” research design where the focus is on a focal actor and the relationships in their loyalty (Marsden, 2005). In matrix terms, a study may examine one set of actors which are linked through one set of relationships at a specific period of time which provides a sociomatrix (i.e., one-mode data). Data which examines more than one set of relationships at

various periods of time (i.e., to examine change) is described as one-mode (Wasserman and Faust, 1994). Deciding on which actors lie within the network is a difficult task for whole-network studies (Marsden, 2005). Laumann et al. (1989) list three possible approaches to adopt as network boundary specification strategies:

1. **Positional Approach:** Based on characteristics of network membership, e.g. employment;
2. **Event-Based Approach:** Participation in a certain class of activity, e.g. meeting specific goals;
3. **Relational Approach:** Based on social connectedness, e.g. social network (professional and/or friendship).

In this chapter we introduce service network analytics to model service network behavioural changes. We achieve this by monitoring the impact of change on service relational structures using ONA. For example, we can examine the cohesion of a network by examining the density and distance of relational structures. If, for example, we want to examine the impact of implementing technology on a service network, we can re-examine the relational structure post-technological implementation to determine the effect of technology on the service relational structure. We use UCINET6 to generate ONA measures, and by comparing pre- and post-IS measures, we can generate metrics to determine the impact on the service structure. As a simple example of gathering data, and examining an ASN, the next section provides an overview of the main concepts which support ASN.

4.2 Analysing ASN: Main Concepts

The major characteristics of ASN analysis are that the unit of analysis to describe the behaviour of the ASN is the network which unites actors (person, group, organisation, etc.) and its variables (i.e. values associated with interaction). Normann

(2001) suggests that co-ordinating efforts by different actors towards a common whole is not new, for example, he explains how economics describes the logic leading to complementary specialisation as that of “competitive advantage”. However, Normann (2001) adds that what is new is the way it now expresses itself in terms of role patterns and modes of interactivity and organically reshapes co-productive roles and patterns. This is true in the case of ASN. Therefore, understanding the main principles of network structures is critical towards our quest to model ASN. We apply Lewis’s (Lewis, 2009; p. 20-21) list of the key characteristics of network science which are applicable in ASN (see Table 1).

An analysis of ASN may be simply described as an x-ray of a service network structure which highlights the importance of relational structures to support service performance. According to Tichy et al., (1979), network analysis is concerned with the structure and pattern of these relationships and seeks to identify both their causes and consequences. Therefore, an ASN can be viewed on an abstract level as social groupings with relatively stable patterns of interactions over time. ONA allows us to explore techniques to model the system relational structures through a coherent framework and methods of analysis which capture both emergent process patterns between a specific set of linkages and their properties among a defined set of actors. Tichy et al. (1979) provides an overview of network concepts and network properties as listed in Table 2.

The transactional content explores what is exchanged by actors (e.g. information) during the formation and evolution of the ASN. The nature of the links considers the strength and qualitative nature of the relation between two or more nodes, while the structural characteristics examine the overall pattern of relationships between the actors. For example, clustering, network density, and special nodes on the network are all structural characteristics. Watts and Strogatz (1998) report that real-world networks are neither completely

Table 1. General principles of an ASN

Characteristic	Description
Structure	A collection of nodes and links that have a distinct format or topology which suggests that function follows form.
Emergence	Network properties are emergent as a consequence of a dynamic network achieving stability.
Dynamism	Dynamic behaviour is often the result of emergence or a series of small evolutionary steps leading to a fixed-point final state of the system.
Autonomy	A network forms by the autonomous and spontaneous action of interdependent nodes that “volunteer” to come together (link), rather than central control or central planning.
Bottom-Up Evolution	Networks grow for the bottom or local level up to the top or global level. They are not designed and implemented from the top down.
Topology	The architecture or topology of a network is a property that emerges over time as a consequence of distributed – and often subtle – forces or autonomous behaviours of its nodes.
Power	The power of a node is proportional to its degree (number of link connecting to the network), influence (link values), and betweenness or closeness; the power of a network is proportional to the number and strengths of its nodes and links.
Stability	A dynamic network is stable if the rate of change in the state of its nodes/links or its topology either diminishes as time passes or is bounded by dampened alternations within finite limits.

Table 2. ONA properties

Property	Explanation
Transactional	
Transactional Content	Four types of exchanges: 1. Expression of effect (e.g. initiate a transaction) 2. Influence attempt (e.g. negotiating a SLA) 3. Exchange of information (e.g. terms and conditions) 4. Exchange of goods and services (e.g. payment)
Nature of Links	
Intensity	The strength of the relations between individuals (i.e. intensity of service interactions)
Reciprocity	The degree to which a relation is commonly perceived and agreed on by all parties to the relation (i.e. the degree of symmetry)
Clarity of Expression	The degree to which every pair of individuals has clearly defined expectations about each other’s behaviour in the relation, i.e. they agree about appropriate behaviour between one another (i.e. SLA)
Multiplexity	The degree to which pairs of individuals are linked by multiple relations. Multiple roles of each member (e.g. consumer, supplier, negotiator, etc) and identifies how individuals are linked by multiple roles (the more roles, the stronger the link).
Structural Characteristics	
Size	The number of individuals participating in the network (i.e. service eco-system)
Density (Correctedness)	The number of actual links in the network as a ratio of the number of possible links
Clustering	The number of dense regions in the network (i.e. network positioning, structural holes)
Openness	The number of actual external links of a social unit as a ratio of the number possible external links
Stability	The degree to which a network pattern changes over time (i.e. level of innovation)
Reachability	The average number of links between any two individuals in the network.
Centrality	The degree to which relations are guided by the formal hierarchy
Star	The service with the highest number of nominations
Liaison	A service which is not a member of a cluster but links two or more clusters
Bridge	A service which is a member of multiple clusters in the network (linking pin)
Gatekeeper	A star who also links the social unit with external domains (i.e. knowledge diffusion and service network analyst)
Isolate	A service which has uncoupled from the network.

Table 3. Example of employing ONA as service network analytics

Metric	Explanation of it Measure
Betweenness	Examines the connectivity of node between two other nodes in a network and determines the number of actors a particular node connects other nodes indirectly.
Bridge	Is the link which, if it was removed, it would move the nodes to an alternative structural position in the socio-gram/graph.
Centrality	Provides an indication of the 'power' of actors based on their overall connection with other actors.
Centralisation	Identifies the difference between all of links for each nodes divided by maximum available links.
Closeness	Determines how resources may flow from one actor to another, i.e. it measures how close actors are to one another in a network.
Clustering coefficient	Examines the likelihood that two associates of an actor are associates themselves. The higher the value the greater the clique.
Cohesion	Measures the degree to which actors are connected to one another, for example, the strength of cliques.
Degree	Counts the number of ties to other actors across a network.
Eigenvector centrality	Measures the importance of actors within a network based on their connectivity.
Path length	Measures the distance between two nodes in the network.
Radiality	Examines the degree of an actors 'reach' into the network which is informs and influences.
Reach	Measures the degree in which an actor within the network can reach another actor in the network.
Structural equivalence	Examine which nodes have a common set of link connections to other actors within the network.
Structural hole	Identifies network holes which may be strategically filled by connecting one or more actors. This may, for example, improve communication within a network.

ordered nor completely random, but rather exhibit properties of both. In addition, they claim that the structure of network can have dramatic implications for the collective dynamics of a system, whose connectivity the network represents, and that large changes in dynamic behaviour could be driven by even subtle modifications to the network structure. Therefore the orchestration of structural relations (emergent property of the connection, the exchange process) or attributes (intrinsic characteristics, e.g. value of an exchange) becomes a central concept to analyse an ASN structural properties. ONA assumes that actors are interconnected, with real consequences for behaviour and performance. Thus, structures may be altered to optimise the networks outcomes which present an opportunity to model service network analytics (i.e., offers us a blueprint of ASN).

Table 3 summarises how we can borrow ONA concepts as service metrics to examine ASN. In the next section, we examine some of these to demonstrate how they may be applied in an ASN scenario.

5. ASN SCENARIO

This scenario examines the impact of service technology on the relational infrastructure of a service network. In our research, we examine how we could develop an audit framework with associated metrics and training materials which will have significant contributions towards software engineering performance. A fictitious agile organisation, Agile Inc., wishes to examine their ASN in the hope to gain a better understanding of the relational structure which supports their agile activities. Agile Inc. are interested in learning about ASN characteristics (as listed in Tables 1 and 2) in order to gain a deeper understanding of how their agile practice performance may be improved. They also want to examine how technological innovation may influence their service structure and consequently, team performance. The organisation wishes to foster an interactive agile environment between the international software engineering teams and is interested in learning how agile leaders across an international service network interact with other team leaders across

the team. Management are particularly interested in understanding the exchange of resources and competencies among actors. This scenario demonstrates how the organisation can examine how performance is influenced by the relational structure of the agile team.

6. MAPPING THE ASN

An ASN typically comprises of numerous entities in the form of organisations, groups, or teams. The actors distributed across Agile Inc. are represented as nodes within a network. Between each node, interaction is facilitated by the exchange of resources and/or competencies in various agile practices. The organisational headquarters is represented by the yellow node (see Figure 3). The exchanges between nodes are represented as edges or links within the graph. This links are vital as they represent the value of the relational infrastructure which supports the co-creation of service “value”. It is critical to understand that each node in the network is not fixed, but rather, represents its position within a given time (i.e. a snapshot). Interaction involves at least two

nodes within any exchange which represents their reaction to specific business processes. These exchanges may comprise of a number of factors, for example, knowledge diffusion through various ASN partners in a decision-making problem. Modelling the ASN may highlight who is the greatest influence, who emerges as a leader within the ASN, or where “structural holes” exist across the network. Therefore, ONA concepts and measures (Table 3) allow us to examine the relational structure of the ASN to uncover truths of service interactions (i.e. compare the differences between Figures 3 and 4). For the purpose of this study, we provide an abstract representation of the ASN. Node identifications have been removed from both Figures 3 and 4 as this example scenario is employed for demonstrative purposes.

Figure 3 illustrates the relational structure of ten main agile teams which interact on a regular basis during various software engineering practices. These teams are dispersed across Europe in various locations, all of which are linked to the headquarters office (i.e. yellow node). The yellow node illustrates the position of the organisational headquarters and the blue nodes represent the managers of each organisation while the red nodes

Figure 3. ONA map of ASN (before IT-innovation)

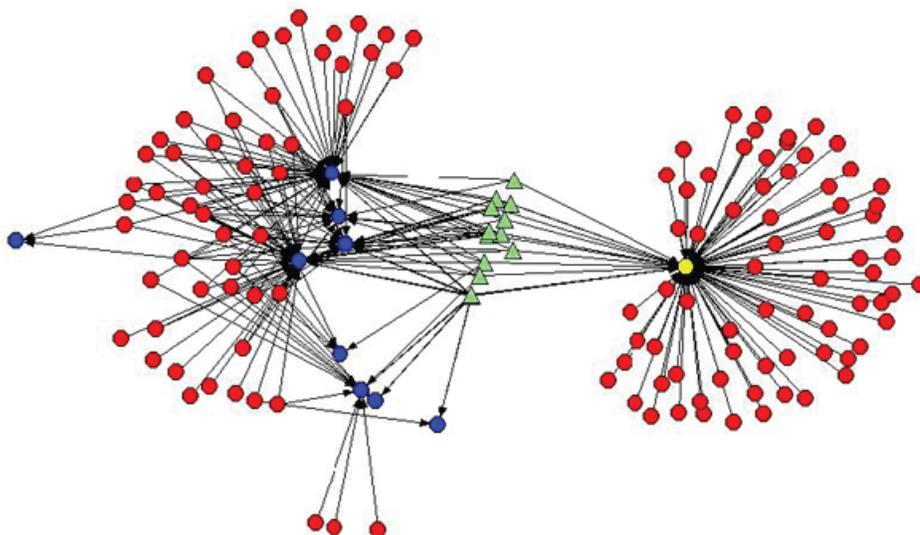
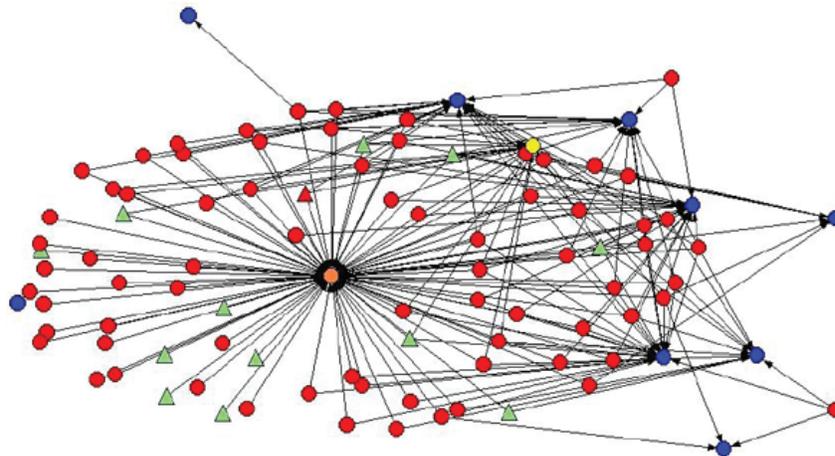


Figure 4. ONA map of ASN (after Web-based system)



represent the software developers. The links illustrate the connection or relationship each actor has with other team members within the environment. This data may be gathered through the distribution of a survey to all staff members within this ASN. Each staff member may be asked to indicate their level of interaction with employees across the ASN for various tasks.

Upon further inspection, Agile Inc. notices that there is a lack of network cohesion across the ASN. They suspect that this may hamper agile practices, for example, it becomes more difficult to transmit information which threatens service quality. As a result, this can have a negative impact on their service reputation. Ultimately, this prevents them from optimising performance. The organisation also identifies that there are 13 nodes (triangle nodes) which appear to be dominant within the centre of the network as they occupy a powerful position. This would be known as a bridge or a broker between service providers. Agile Inc. are considering innovative methods to centralise agile practice through a more united application of agile practices. They implement a central communication forum which allows actors exchange resources and competencies with other actors for agile software practices. While the implementation of service innovation is often considered to

be beneficial, the organisation wishes to employ a method which would examine how service relations have altered as a result of the service communication forum. Figure 4 demonstrates the impact of implementing service innovation technology on the service structure, highlighting how the service has become more centralised by removing service bottlenecks through the service. This approach supports the diffusion of innovation across the network and enhances the exchange of information to support decision-making tasks. In addition, one can clearly see how the headquarters has been relieved of decision-making tasks which optimise efficiency and performance of the network. The service brokers have also become more integrated in the ASN which provides greater support to various international organisations.

To examine how this change impacts on the ASN, Table 4 lists some of the ONA concepts and summarises the impact of implementing technology on a service network relational structure. This examines the impact of service technology on the relational infrastructure of the service network. It also demonstrates how ONA concepts may be introduced as service network analytics to examine change to service dynamics within an ASN and develop service network performance analytics for technological innovation.

Table 4. Examples of service network analytics metrics

Metrics	Old ASN	New ASN	Difference explained
No. of Ties	254	208	Reduced number of structural ties to deliver a service.
Density	0.061	0.072	Increased density of network making the network more connected.
Distance	Average: 1.97 Cohesion: 0.514 Fragmentation: 0.49	Average: 1.13 Cohesion: 0.73 Fragmentation: 0.28	Distance reduced as a result of technological innovation and improved the cohesiveness of the ASN.
Krackhardt GTD Measures	Connectedness: 1.00 Hierarchy: 0.00 Efficiency: 0.97 LUB ¹ : 1.00	Connectedness: 1.00 Hierarchy: 0.38 Efficiency: 0.10 LUB: 0.95	The “horizontal differentiation” of the service structure have reduces to improve ‘connectivity’.
Hybrid Reciprocity:	0.0031	0.00	The reciprocity of ties has reduced which suggests greater service efficiency.
Degree (Centralisation)	Outdegree: 0.54% Indegree: 25.34%	Outdegree: 5.48% Indegree: 94.88%	IT service innovation introduces greater cohesion and efficiency and is less dependent on other individuals.
Eigenvector Centrality	55.02%	8.31%	IT innovation provides more equal service structures as it adopts the central position.
Distance-Weighted Fragmentation	0.486	0.28	Reduces the distance between all nodes of a service through increased cohesion.
2-Mode Cohesion Measures	Density: 0.03 Avg Dist: 2.48 Radius: 3.00 Diameter: 4.00 Fragmenta: 0.00 Transitiv: 0.56 Norm Dist: 0.60	Density: 0.68 Avg Dist: 1.62 Radius: 2.00 Diameter: 4.00 Fragmenta:0.23 Transitiv: 0.98 Norm Dist: 1.18	Service IT innovation increases the service density, and transitivity, while it reduces the average distance, radius, diameter, fragmentation, and normalised distance across the network. Interestingly, the diameter remains the same in both networks suggesting that there was no significant impact on the actor-network boundary.

While some of the metrics we incorporate to examine the impact of technological innovation on ASN are listed in Table 4, we can also incorporate the use of key performance indicators in agile software development through predefined service performance targets. These are ONA measures which are employed in the context of ASN metrics. There are many measures (see Table 3) which a manager may apply to an ASN to examine various factors of a service network. The example provided here generates many measures to inform management of the service structure and how ONA provides insights on the ASN dynamics. The metrics employed in this chapter are for demonstration purposes to explain how we can develop service network analytics metrics to examine agility across software engineering teams. The metrics compare the impact of technology on the service relational structure to allow managers determine the “value” and “success” of

ASN change. From such insights, it becomes evident that ASN are not engineered and but rather become the emerging product of collaboration to co-create and co-stabilise an ASN. Although, the purpose of this scenario is to provide an example of how one might demonstrate the application ONA to model ASN, while using large data sets it becomes more obvious as to the power of ONA as an analytics method.

7. CONCLUSION AND FUTURE WORK

Agile software development is a collaborative approach which supports iterative and incremental methods within software engineering teams. The key factors which foster the value of agile software development include human interactions, developing improved software solutions,

frequent customer collaborations, and the ability to rapidly respond to change. Thus, the composition and organisation of agile teams has a direct influence on the functionality of agile software development. Decision-making plays a critical role within a complex service environment to stabilise software development teams. Thus, information exchanges are therefore a vital resource to support decision-making within service teams. The material used to guide decisions on service actions is influenced by socio-technical factors. Understanding how information is disseminated across teams is considered problematic, especially across agile service developments. Technology is often implemented to enhance service efficiency and enhance performance. However, in many cases, managers have little insights as to “how” technology influences service relational structures. This chapter introduces an agile software engineering modelling method which improves the visualisation of team dynamics through using ONA graphs. This method allows managers to monitor the impact of service relational structures on performance. This may be achieved through a service network performance analytics framework which is supported by the application of ONA. ONA is a novel approach to model ASN interaction and visualise the agile service infrastructure. This chapter discusses the importance of developing greater insights into ASN and examining alternative methods to visualise the relational structure which stabilises networks. The scenario highlights that the ONA method of studying service patterns is critical to examining service systems. We explain how ONA offers a fitting technique to study relational patterns which support ASN infrastructures. This chapter provides a significant platform to extend theoretical developments on ASN and developing additional methods to map agility within the service environment.

As part of our future work, we will build on this approach from both a theoretical and practical approach through numerous case studies in agile software development. We anticipate that

this work will lead to the construction of an audit framework which will assist the process of monitoring ASN and provide significant contributions to the emergence of service science. Our work will pay particular attention towards the foundation of performance analytics for ASN and continue to test the application of ONA in developing ASN performance indicators within the audit framework. We anticipate that this approach will harness more open innovation within agile software engineering developments.

ACKNOWLEDGMENT

The research leading to these results has received funding from the European Community’s Seventh Framework Programme FP7/2007-2013 under grant agreement 215483 (S-Cube). This work was supported in part by Science Foundation Ireland grant 03/CE2/I303_1 to Lero – the Irish Software Engineering Research Centre (www.lero.ie).

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KEY TERMS AND DEFINITIONS

Agile Service Network (ASN): An emergent and dynamic service networks which provide some form of business value by reacting to change which is spontaneous in nature and rely on business partners collaborative strengths to deliver service value as a network.

Agility: An innovative response to an unpredictable change.

Business Agility: The ability of a service environment to decide how to react to change by exploiting its relational infrastructure to execute actions which optimise on resource and competence exchanges across a service network to meet specific service goals.

Organisational Network Analysis (ONA):

An approach and set of techniques which examines the exchange of resources (for example, information) among actors. ONA also demonstrates the value of ties and relationships between each node to provide a visual and mathematical representation of interaction and exchanges which influence behaviour.

Service Network: A service network may be defined as a set of complex interactions which co-create value through the support of a socio-technical relational infrastructure to stabilise a service environment through the exchange of resources, competencies and capabilities to benefit the performance of another actor though the generation and realisation of value.

Service Science: An interdisciplinary umbrella which incorporates widely diverse disciplines to construct, manage, analyse and evolve service systems through systematic and overarching approaches to examine service co-production operations between business and technology (i.e. service management and service computing).

Service System: A service system is defined as a dynamic value co-creating configuration or resources, including people, technology, organisations and shared information (language, laws, measures and methods), all connected internally and externally by value propositions, with the aim to consistently and profitably meet the customer’s needs better than competing alternatives.

Service Value: Concerned with the adaptability and survivability of the beneficiary system creating opportunities for reinvestment and cross-subsidisation of activities that may potentially benefit people involved in the service network.

ENDNOTES

¹ Least Upper Bound