Cross Channel Communication Architecture
Research proposal

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Abstract. Nowadays, companies communicate with their environment through multiple communication channels. If these channels are implemented in silos, this results in frequent organisational changes, which often overlap. The Cross Channel Communication Architecture (C^3A) as proposed in this paper, is a framework that supports communication through digital bi-directional channels. This framework builds on the transaction concept of the Performance in Social Interaction theory (Ψ-theory). It supports the carrying out of transactions by means of a protocol, which comprises the complete transaction pattern, that is put between users and (legacy) applications. The protocol is modelled as a Discrete Event System (DES), in accordance with the Performance in Interaction theory (π-theory), in order to deal properly with time aspects. It will be implemented in conformity with the Normalized System (NS) theory, in order to avoid the combinatorial explosion of change effects.

Key words: multichannel, cross channel communication, single channel, Normalized Systems, DEMO, Architecture

1 Introduction

Companies have to communicate with customers. More and more communication channels become available and customers develop a preferred channel for specific subjects. Customers like to communicate on different channels at certain moments (e.g. at work customers have different channels available than at home). Because new channels pop-up regularly and as customers adopt these channels at phenomenal speed, companies have to adjust their communication[31] towards these channels (e.g. Twitter and Facebook have become important channels to reach out to customers) resulting in system change actions[24]. Companies often cannot incorporate these channels in the existing application stack because this legacy cannot cope with the new channel demands. This is where application and organisational silos emerge (multichannel[28], see figure 1). When systems within organisations are reused, dependencies between systems are created that result in combinatorial effects during the maintenance of these systems. The systems that are under maintenance change more frequent and these changes overlap more often.

These partial solutions will enable us to start solving this problem:

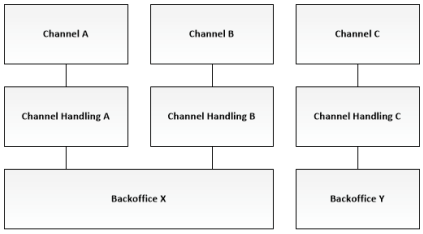

Fig. 1. Multichannel Communication

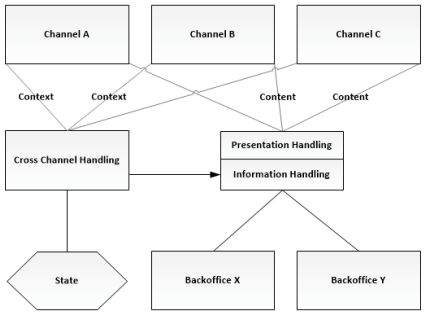

Fig. 2. Cross Channel Communication

- The combinatorial effect of changes has to be removed from the organisational and application structure of companies.
- The silos within companies must be dismantled by using all systems in an uniform way.
- Communication must be uniform throughout the company so we know what will be and has been communicated.

For architecture we will use the following definition[11]: A consistent and coherent set of design principles. For Cross Channel Communication we will use a derived definition[35]: The communication over bi-directional digital channels that take into account customer preferences and engage recipients via their preferred channel.

The Cross Channel Communication Architecture (C^3A) proposed in this paper supports implementation of communication on digital bi-directional channels within the concept of transactions defined in Performance in Social Interaction theory (Ψ-theory). The architecture contains the transaction support implemented in a protocol that is positioned between (legacy) applications and a (user)interface supporting all transaction steps. So far three theories are interesting because they have concepts that may solve different parts of this problems.

First the Normalized System (NS) theory [24] proposes a set of theorems and definitions of elements of a normalized system: data, action, workflow, connector and trigger. These elements are created from an implementation point of view and with an attempt to be generalised.

Second the Ψ-theory [10] proposes a transaction mechanism between two actor roles and therefore a uniform way of communication. This theory acts on the essence of an organisation or system without implementation suggestions. Implementation of the transactions is needed to solve the problem.

Last the Performance in Interaction theory (π-theory) describes a transaction of the Ψ-theory with a mathematical model of Discrete Event Systems (DESs).

Other options that have to be examined are mentioned in section 8.

When we combine the three theories in order to implement the transaction an interesting construction emerges. The π-theory describes the workflow of

the transaction. It can be expanded to describe all transactions in the model. Building the transaction using a Discrete Event in Linear Time Automaton (DELTA) from the π-theory and implementing it as an action element in NS makes it possible to implement transactions in a modular automated system. Research must confirm whether this construction is able to be implemented in an existing multichannel environment and fully complies with NS within the anticipated changes of the model.

Companies need to transform from the current multichannel organizational structure towards a C^3A which supports customer orientation based on transactions with the demanded change rate. Transactions are needed to fulfil the customer needs in his digital social behaviour. Customers want to change channel during a transaction. The core of this structure must support multiple communication channels eliminating combinatorial effects when adding channels. This structure must be supported by business and IT. Architecture is an accepted way to describe the structure for both targets. To enable companies to use this C^3A implementation within current architecture an interface is needed. The current legacy applications and (user) interfaces have to be able to cooperate within the new architecture to make this transition towards cross channel communication possible. The proposed way to integrate the existing applications with transactions is a communication protocol to let both worlds communicate.

In the next section we will elaborate on the research objective and in sections 3, 4 and 5 the research questions are stated. For question the mindset is given and thoughts are shared. In section 6 the chosen research method is elaborated. In section 7 the relevance for practise and science is mentioned. Section 8 states all read relevant papers and positions these in an organized overview. The planning in section 9 and the outlook to the rest of the research in section 10 conclude this paper.

2 Research objective

The research objective is to create a practical 'ready to use' IT communication protocol based on DELTA-processors bounded within C^3A by using formalized social transactions and bi-directional digitized communication channels while retaining the context within transactions and across channels.

This objective will support companies in installing the cross channel communication protocol between social interaction systems and technical interaction systems to support technical systems in social behaviour in and across channels. This in turn will enable companies to create social interaction systems for customers. By creating social interaction supportive systems, the gap between human social interaction and technical social interaction will become smaller when those technical systems can be adapted.

To reach this objective the following research questions need to be answered:

1. How can C^3A be defined in such a way it is an extension to existing single and multi-channel architecture?

2. How can a social transaction in the B-organisation as described in the Ψ-theory be implemented and supported by a computer program based on the π-theory and δ-theory in such a way a cross channel communication protocol can be based on Ψ-transactions?
   a) How can a high volume channel implementation be defined by creating a program that accepts, holds and exposes events with delays taking in account the architectural limitations of NS[24] and the theoretical demands of the π-theory in such a way the channel is usable in a DELTA processor implementation?
3. How can the communication context be preserved between channels during a transaction within C^3A?

3 Research question 1

1. How can C^3A be defined in such a way it is an extension to existing single and multi-channel architecture?

Although companies are using the multichannel communication concept in practice we need to use the definition of C^3A to define what steps are needed to provide results in changing the architecture. The changed architecture is available in such a way that the C^3A goal can be reached. Advanced multichannel integrated systems nowadays mostly refer to the retail branch (i.e. bricks-and-mortar shops and web shops). Companies that implement multichannel strategies that are not checked on, deliver results that are not based on best practice or available scientific evidence.

At least the following concepts play an important role in designing the C^3A.

Cross channel
When studying Cross Channel Communication in the literature the following questions still remain unanswered.

- Can cross channel communication be automated and what supporting architecture is needed to achieve this?
- Which channels exist and what properties do they have?
- Channels are digital bi-directional ways of communication. Is there a difference in social perception between the terms media and channels?

Transparency
Transparency is about communicating the anticipated path in the process that will follow and the steps that have been taken. When we create a construction model of the current organisation (using DEMO [10]) we need to communicate about the current and future steps in the model to the customer. This communication can be straight forward. A few related questions remain.

- How is transparency defined in science and does an existing definition suit the C^3A meaning of transparency?

– How does transparency relate to customer experience?
– Which transparency implementations already exist to serve customers in current multichannel communication environments?
– Do the current transparency mechanisms work according to customers?
– Which architecture currently exist behind the transparency mechanisms?

Transparency is all about communication both internally and externally. When discussing transparency within communication the question arises whether companies have any idea whether they do communicate in a transparent way. The conditions and strategic choices in transparent customer communication have been considered [8] to make the change possible. Referenced articles need to be researched to complete the definition within the C^3A.

Consistency
Consistency in communication is about the semantics of the message on various channels. This raises the following supporting questions.

– What is needed to communicate consistently along channels?
– How is a customer able to notice that consistent communication is being used?
– What shall be the influence of consistent communication on customer experience?
– What is the relevance of consistency for semantics and knowledge bases?
– Does consistency translate into context criteria?

Knowledge bases support people with different backgrounds but still need to provide the same knowledge to all readers. A method to accomplish this [9] is described and can be used as a starting point for the definition.

4 Research question 2

2. How can a social transaction in the B-organisation as described in the Ψ-theory be implemented and supported by a computer program based on the π-theory and δ-theory in such a way a cross channel communication protocol can be based on Ψ-transactions?
   a) How can a high volume channel implementation be defined by creating a program that accepts, holds and exposes events with delays taking in account the architectural limitations of NS[24] and the theoretical demands of the π-theory in such a way the channel is usable in a DELTA processor implementation?

To automate a transaction the processing of transaction states and events is needed. The DELTA forms the basis of the π-theory describing a finite automata with time capabilities. Because the Ψ-theory describes the universal social transaction between humans and the DELTA is the base of these transactions we assume that the technical implementation of the DELTA forms the basis of the technical implementation of social communication. The answer to this research

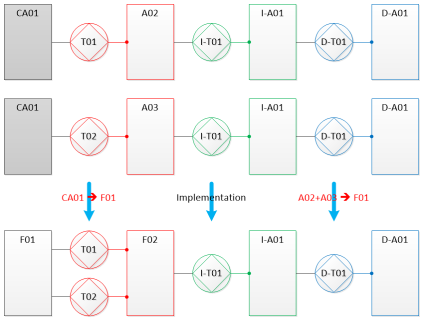

Fig. 3. The Normalized implementation of PSI transactions

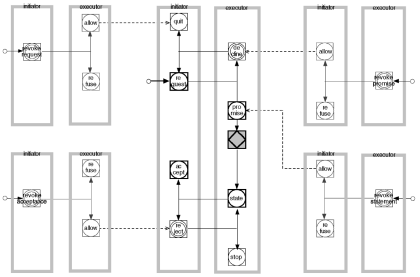

Fig. 4. Transaction to be written as DES

question involves an implementation of a DELTA-processor and a protocol to make this processor 'ready to use' for other applications.

The DELTA processor (see figure 5) executes a DES and feeds the DES with decision information from a bank storing internal and external information. The DES can write into the banks and has interstriction links with the banks. The automate defined in the DES can create events in a specific channel that will emerge at the end of the channel after a, in the event specified, delay.

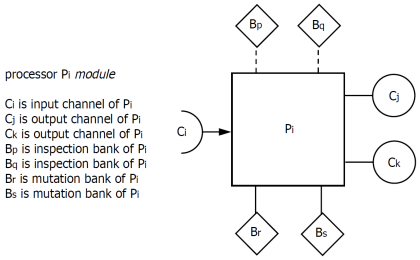

Fig. 5. The DELTA processor as described in the π-theory

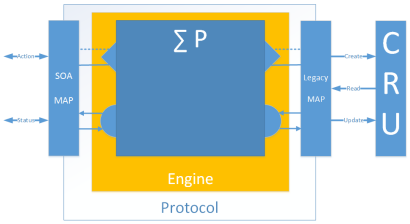

Fig. 6. The Communication Protocol and the DELTA Processor Engine

The communication between the DES or DELTA processor is configured in the engine combining several processors in a specific structure or completely independent. On the left side (see figure 6) the Service Oriented Architecture (SOA) defines two endpoints that supports the full transaction communication and production acts/facts. The action entry can also be used in a legacy or traditional call ignoring the social status entry. The legacy map supports the resulting status and event translation towards legacy systems. Every possible state translates to either create, read, or update action. The delete action is skipped because this is assumed to be done using garbage collection if information has to be deleted permanently. Other delete actions are considered to be updates of existing data.

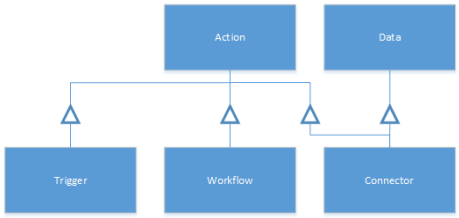

Fig. 7. NS elements

Implementing the processor within the C^{3}A and within the NS theory requires the definition of the data and action element. For now we consider the data and action element the only necessary elements for the implementation of the transaction protocol. The anticipated changes that the system should support are additions of data and action elements as well as new versions of existing elements. Other mentioned anticipated changes [24] are considered to be part of the changes that are taken into account (e.g. an added field can be considered as a new version of a data element). The four theorems that will be taken into account are the separation of concerns(1), version transparency(2,3) and separation of states(4). The separation of concerns can be found in data and action elements as well as cross cutting concerns like logging, security and persistence.

5 Research question 3

3. How can the communication context be preserved between channels during a transaction within C^{3}A?

To have just a protocol supporting the technical implementation of a social transaction is not enough to fully implement the C^{3}A. For this implementation to work, the transaction has to be able to be used across all bi-directional digital channels. The only way to switch channels and stay within the social transaction is to maintain the context of the transaction. To make the protocol usable it is necessary to find the context preservation criteria and to create the automated preservation of context across channels.

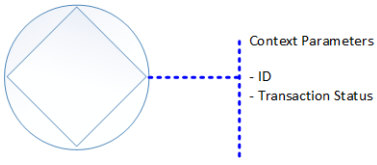

Fig. 8. Transaction Context Parameters

For each channel the context criteria need to be found and an overall list of needed context criteria needs to be created. Channels have two options when

they are added to the C^{3}A. Either the channel has the ability to provide the context criteria and blend in or the channel is not able by nature to provide all criteria. The channel provides a mechanism to use another channel to provide the information or use an extra technique to add the context criteria to the C^{3}A.

6 Approach

This study will be carried out by using the Design Science Research methodology[15]. According to this methodology artefacts are created based on available knowledge and are validated by application in an appropriate environment. Because not all definitions within the architecture are available these have to be created and matched per category to existing supporting literature.

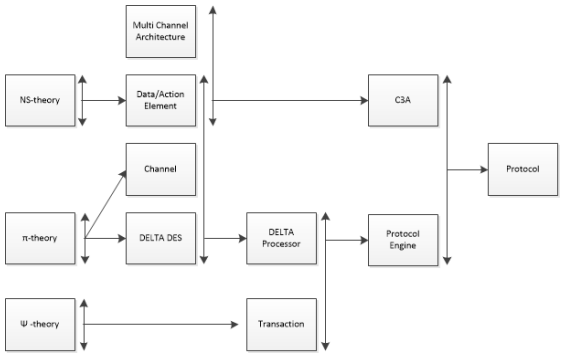

Fig. 9. Research Framework

The Ψ-theory describes the organization as a social system. This theory describes the elements and the influence bonds between these elements which stand for actor roles and transactions. Business actors perform coordination acts and production acts, using different abilities in order to create coordination facts and production facts. Business actors need these facts, or derivations of these facts, to decide on the acts to perform. The Ψ-theory describes the generic process of deriving an object system from a using system (e.g. the derivation of the infological organization from the business organization). From the using system the underlying function model of the object system is defined. Subsequently the implementation-independent construction model of the object system, also known as the ontological model, is designed. Many alternative implementation models could be produced from the ontological model. One implementation on infological level will be the use of the transaction protocol based on the DELTA processor.

The DELTA processor will be developed as an artefact and will be used to execute the generic transaction. The transaction will be described in a DES. The processor will use another artefact, the channel, to communicate to itself and other processors. These two artefacts (the channel and the processor) will be validated using automated testing where predefined use cases are used. A protocol

will be created as an artefact using the tested processor environment and will be available for integration in third party programs. This protocol will be validated in a case study. In this case study an Organisation Construction Diagram (OCD) will be created for a specific problem area of the organisation where the protocol is believed to improve multichannel communication. The C^3A definitions and the protocol will be presented in an architecture that is suitable to be used for customer facing services. The whole will be tested in a limited number of case studies. These case studies will try to implement the protocol in an existing environment in a pilot case to show the improvement of customer communication. Possible improvement measurements can be Net Promoter Score, number of complaints or a direct measure of the customer satisfaction of the transaction.

7 Relevance

7.1 Integration of automation in the industry

Automation in the industry is getting larger. People need to communicate more and more with technical systems. The general acceptance level of systems that mimic social behaviour is higher than old legacy systems that were build from a technical point of view.

7.2 Scientific

Incorporating social behaviour into technical applications is a road that scientist have already taken for a long time. More and more systems are designed to support humans within social environments. No system has currently been defined to support the interaction from social systems to technical systems using transactions as a fundamental basis.

The revocation patterns of DEMO have not yet been documented implemented. This research adds to the knowledge of implementing automated DEMO transactions in organisations. The feasibility of implementation of the π-theory is tested.

8 Preliminary research

The papers found about the subject can be sorted into a matrix. On one axe the focus, on the other axe the cross channel properties used to describe an aspect. This matrix has to be refined and adjusted to represent all properties relevant to cross channel.

8.1 Focus: Channel

Architecture
The fragmentation of the architecture when implementing a new channel towards customers is a big problem [18]. By identifying components and evaluating the

		Channel properties			
		Channel	Web Services	CRM	Customer Experience
Focus	Architecture	[18], [4], [23], [34]	[14], [21], [19], [5]	[2], [13]	
	Marketing	[6], [16], [7], [20], [33], [32]		[28],[39], [12]	[38], [22], [1], [36]
	Customer	[3], [40]		[37]	[27], [30]

Table 1. Papers ordered by focus and channel properties

components using simulation the author tried to create a more flexible architecture. A generic e-services architecture has been proposed [4]. This is mainly business to consumer (B2C) for marketing purposes and not consumer to business (C2B) for service purposes. Patterns and structures for designing technical and organisational multichannel systems are described [23]. This is applied in a government environment.

Marketing
From a marketing channel perspective the study [6] looks promising for a channel design. Further study on this subject can be useful. This paper builds on [4]. A practical framework for integrating channels for a bank exists [16]. This framework segments customers and products and adapts channels for customer groups. Accordingly it also enables the transfer over channels.
To create an optimal channel mix from the perspective of cost and channel, conflicts arise according to the provided framework [33]. The framework is tested on a software firm. Various complex issues in channel management regarding cross channel and process transparency are reviewed [32]. This list of problems raise questions.

Customer
Transparency between channels [3] is needed and influences the customers behaviour. Pros and cons of retailing multichannel constructions are described [40]. Cross channel synergies and strategies are created.

8.2 Focus: Web services/web sites

Architecture
For the retail industry a SOA architecture regarding multichannel customer facing has been proposed [14]. A different approach on channels has been done in an e-learning project [5]. Here the context of the interaction is saved. Also a channel independent language is used to make the channels independent of

the interaction. A solution for the performance issue on multichannel web service architectures is given in [21]. The construction and cost calculation of these web services is explained. Another study on web services [19] focusses on the re-engineering of services to provide access to and from mobile systems. This is a review of described re-engineering methods that suit this purpose.

8.3 Focus: CRM

Architecture
Ten problems and solutions are provided to improve the use of Customer Relationship Management (CRM) [13]. CRM is a key feature of multichannel communication. CRM connected to the internet is used as basis to create a multichannel environment [2]. The customer experience is important. A framework for creation of this strategy is proposed. The use of CRM in a company can be evaluated using an integrated framework [12]. The assessment is not complete and focusses specifically on the CRM system.

Marketing
Multichannel integration as a cross functional perspective of CRM is described [28]. The strategic use of CRM and channels are reviewed. Research options are described. CRM retail specific data collections for marketing purposes are discussed [39]. They are used for predicting customer reactions.

Customer
Multichannel customer management is defined [37]. Strategic and tactical hints are given but the problem is not solved. A check list on this subject is provided as completion of the paper from a marketing perspective.

8.4 Focus: Customer Experience

Marketing
The relationship between searching and buying on the on-line channel is described [38]. Improvements for buying are stated. A framework for closed loop marketing from a customer view [22] is described. A customer experience on quality is presented [36]. Quality perspectives on the levels of virtual physical and integration are discussed. The different channel choices customers make in the financial sector have been investigated [1]. The investment of companies in channels is implied.

Customer
The Service Experience Blueprint is a method for designing service experience in multichannel environments [27]. Going through customer service experience, service interfacing and interface choices are used as a multidisciplinary tool. For the organisational design from a customer point of view, multichannel design is

studied [30]. The more channels available the higher the chance that the customer chooses a channel that he thinks will solve his need. Customers start to play the role of employee on various channels.

8.5 Focus: Basic Theories

The best parts of the three theories founding this C^3A come together in the implementation. The Ψ-theory forms the fundamental basis for the essence of the organisation where the roles and transactions within an organisation are formalized. The transactions take place on the ontological, infological and datalogical level. This research focusses on the infological and/or datalogical level in the implementation. The π-theory models the coordination and production acts of the transaction. It describes the necessary steps within a transaction and can be implemented using a DES. The architecture of implementation of the DES will be created using the NS elements. Therefore the resulting C^3A architecture supporting the Ψ-theory will be a Normalized System. Other theories may be necessary on implementation but cannot be foreseen now.

9 Planning

This table shows the past and future planning of this research.

2013		**2014**	
Jan-Aug	Orientation and literature	Jan-May	Pre-promotion Seminars
Sep-Dec	Pre-promotion Seminars	Feb-May	Design Science college
Nov-Dec	Research proposal	Feb-Mar	Research proposal
		Mar	Thesis paper for EEDC
		Apr	Channel Paper
		Apr	Presentation prep EEDC
		May	Presentation at EEDC
		Jun	DELTA processor architecture preparation
		May-Jul	Definition paper
			With students of HU
		Aug-Dec	DELTA processor implementation based on π-theory
2015			
Jan-May	practical usage: case 1	Aug-Dec	DELTANET implementation based on π-theory
May-Jun	case 1 paper		
Jul-Nov	practical usage: case 2	Aug-Dec	protocol implementation based on DELTANET
Aug-Dec	case 2 paper		
2016			**Writing**
Jan-May	practical usage: case 3	Jul-Aug	DELTA processor paper
May-Jun	case 3 paper	Sep-Okt	DELTANET paper
Aug-Dec	dissertation	Nov-Dec	protocol paper

10 Outlook

To enable customers to switch channels during communication, allowing new communication channels and avoiding combinatorial effects in IT an architecture has to be developed. Three theories have been chosen as starting point to create this architecture and build a communication protocol. The goal is to implement the protocol in three case studies and prove that the theories hold during implementation. Where needed other theories or best practises will be added to complete the artefacts. Based on the preliminary research some addition can be made on de architecture from those papers.

According to the planning the next steps this year are to design the artefacts to an usable level and to run the protocol in a test environment. Then the case studies can be defined and the protocol can be implemented in a real organisation.

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