

The Multimedia Multi-Channel Infrastructure Platform

— Scope and Definition —



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Peter Holmes
Håkon Steinbakk
Arve Larsen

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Forfatter/Authors:

Peter Holmes, Håkon Steinbakk, Arve Larsen

Sammendrag/Abstract:

Norsk Regnesentral (NR) is currently working upon a five-year, nationally-funded Research Programme addressing “Service Architecture and Service Channeling in the Personal and Professional Information Society”.

The long-term focus of the Programme is two-fold. First, a set of major research areas are targeted for investigation within the Programme. In addition, a research and development platform shall be established. This platform is called the Multimedia Multi-Channel Infrastructure (M3Ci) Platform.

The purpose of this document is to describe the scope and definition of the M3Ci Platform, as currently envisioned within the Programme. It also describes the research areas to be investigated during the development effort.

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Peter Holmes
Håkon Steinbakk
Arve Larsen

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Table of Contents

1. INTRODUCTION.....	1
1.1 BACKGROUND.....	1
1.2 GLOBAL TRENDS.....	1
1.3 SERVICE USE.....	1
1.4 SERVICES AND CHANNELS.....	2
2. M3CI VISION AND APPROACH.....	3
2.1 VISION.....	3
2.2 APPROACH	3
3. PURPOSE OF THE PLATFORM	3
3.1 NR PERSPECTIVE	3
3.2 CHANNEL S PERSPECTIVE.....	3
3.3 RESEARCH AND DEVELOPMENT PERSPECTIVE	4
4. SCOPE AND DEFINITION OF THE PLATFORM EFFORT	4
4.1 SERVICE CREATION.....	4
4.2 CONTENT PRODUCTION.....	5
4.3 RESEARCH AREAS.....	6
4.3.1 <i>Channel-independent service interaction models</i>	6
4.3.2 <i>Service session management</i>	6
4.3.3 <i>Adaptation and Quality of Service</i>	7
4.3.4 <i>Service creation and user interface</i>	7
4.3.5 <i>Service personalization and usability</i>	7
4.3.6 <i>Interoperability</i>	8
4.3.7 <i>Multi-channel content and service production</i>	8
4.3.8 <i>Interactivity</i>	8
4.3.9 <i>Synchronization</i>	8
5. PRELIMINARY ARCHITECTURAL ELEMENTS.....	8
5.1 M3Ci CLIENT FRAMEWORK	9
5.2 M3Ci SERVER	9
5.2.1 <i>MM Streaming Server</i>	9
5.2.2 <i>Context Server</i>	10
5.2.3 <i>Portal</i>	10
5.3 CONTENT AND SERVICE PRODUCTION ENVIRONMENT	10
REFERENCES.....	10

1. Introduction

1.1 Background

At the close of 1999, Norsk Regnesentral (NR) was awarded a Strategic Institute Programme (SIP) by the Research Council of Norway (Norges forskningsråd). This SIP is a five-year, nationally-funded Research Programme addressing “Service Architecture and Service Channeling in the Personal and Professional Information Society”; its working title is **channel S** [1].

The SIP has a superior objective of developing knowledge, methods and technological building blocks for net-based, multi-platform information and service solutions — solutions which enable information and services to be tailored and channeled to variegated target groups in different work and life situations. The overall effort is characterized by work aimed to delineate, develop and evaluate how multi-platform services and information can and should be:

- channeled *to* specific target groups through multiple technology platforms and end-user technologies;
- channeled *through* heterogeneous kinds of network infrastructures; and,
- organized as a service architecture enabling flexible use and updating.

The long-term focus of the Programme is two-fold. First, a set of major research areas are targeted for investigation within the Programme. In addition, a decision has been made to establish a research and development platform. In channel S, this platform is called the **Multimedia Multi-Channel Infrastructure (M3Ci) Platform**.

The purpose of this document is to describe the scope and definition of the M3Ci Platform, as currently envisioned within the Programme. It also describes the research areas to be investigated during the Platform development effort.

1.2 Global Trends

In many parts of the world today, there has developed a widespread expectation amongst business professionals, consumers and citizens that electronic information and services should be available wherever and whenever they are wanted or needed. In parallel, there is an ever-increasing proliferation of electronic equipment and devices in our everyday environment which have some greater or lesser capacity of making available such information and services. Both the realized and latent economic value inherent in the supply of electronic information and services has thereby generated an unprecedented momentum amongst powerful actors in this market sector — actors which are desperate not only to attract new customers, but to keep from losing their existing customers, as well.

1.3 Service Use

When utilizing electronic services, end-users may employ their own personal devices (e.g., mobile phones and PDAs), company-owned equipment (e.g., PCs and laptops) and/or public equipment (e.g., electronic kiosks, bank terminals, TV-based solutions, etc.). When utilizing services, end-users are necessarily involved in different contexts and situations, such as working, shopping, learning, etc. One condition is universal, however: end-users tend to prefer and accept services which are *suited for* the device

with which they are interacting with the service; services which are clumsy, slow, disorganized, etc. may be used "once-but-never-again". In addition, end-users tend to accept services which take into account their own knowledge, understanding and preferences.

1.4 Services and Channels

When in use, *electronic services* necessarily involve some form of *interaction*. Here, one part of the interaction involves some kind of service receiver, which could either be some person (e.g., an *end-user*), or instead with some other (possibly automated) actor. As part of the interaction, information (or *content*) is exchanged between the service receiver and the service; the exchange may be uni- or bi-directional.

A *channel* (or 'service channel') is here said to consist of all hardware and software elements utilized in the provision of and/or interaction with a service. Here, a service channel is said *not* to include the end-user nor the explicit content delivered or exchanged within a service.

In a nutshell, every electronic service is characterized by interaction, where interaction concerns the exchange of content through one or more channels. The manifestation of every service is dependent upon the channel(s) through which it is delivered. In contrast, the configuration of a channel is *not* dependent upon any service.

2. M3Ci Vision and Approach

2.1 Vision

The vision of the Multimedia Multi-Channel Infrastructure Platform effort is to establish a software platform which helps address the expectations and preferences of end-users, as well as a number of requirements faced by service providers. The vision is to establish a software platform which enables:

- the rapid creation and delivery of new services and new content to end-users
- the rapid creation of services which perform well, are easily understood and simple to use
- single-process production of content which can be used within different services, as well as through channels and upon devices having varying characteristics
- the creation of services which can adapt their functionality and interface to best suit different kinds of end-user devices
- the creation of services which can adapt their presentation and content to individual users or classes of users.

In addition, the M3Ci Platform should be easy to set-up and rapidly deploy within new environments. It should allow simple updating of both content and components over its life-cycle. The Platform should also offer a straight-forward approach and well-defined interfaces by which to integrate legacy content and services.

2.2 Approach

It is important to emphasize that the M3Ci Platform is being established, not designed and constructed from scratch. Therefore, the approach begins with the careful review, evaluation and utilization of existing designs, products and components where possible. The ultimate aim, however, is to develop the architecture of the M3Ci Platform such that it is *product-independent* — it must always be possible to substitute improved products and components in place of old or inferior ones. Such substitution shall be enabled through the use of international and de-facto standards, as well as the development of *open interfaces and protocols* within the Platform.

3. Purpose of the Platform

3.1 NR Perspective

The aim in establishing the M3Ci Platform is to contribute to the strategic positioning of Norsk Regnesentral within the area of *Service Architecture and Service Channeling*, with respect to both national and international research centers and customer bases.

3.2 channel S Perspective

In regard to the channel S Programme [1], the M3Ci Platform shall serve as a focus by which to meet explicit Programme goals, that is, to produce innovative research and solutions, and to provide technological building blocks which can serve as a basis for commercial products or services involving Service Architecture and Service Channeling. The M3Ci Platform shall be one of the most significant results delivered from the channel S Programme.

3.3 Research and Development Perspective

The M3Ci Platform shall be a platform for both research and development. The research work performed in the process of establishing the M3Ci Platform shall create possibilities for the publication of new results. This work and its results shall also help gain the focussed attention of significant customers — customers which will likely have interest in evaluating, field testing and/or deploying Platform components. Such relationships help yield clear sets of functional requirements — requirements which in turn help serve to refine and articulate the objects and components within the Platform. Through such software development cycles, new generalizations and improvements to the Platform and its architecture can be discovered and implemented.

4. Scope and Definition of the Platform Effort

The objective of the M3Ci Platform is twofold. On the one hand, the final result of this effort is ideally a platform which is both a multi-channel service creation environment (SCE), as well as a content and service production environment; that is, a platform with which it is possible:

- to rapidly develop new *types* of services
- to rapidly accommodate new devices
- to rapidly produce and maintain *content* for those services, and
- to produce concrete, end-user services by associating specific content with an instance of a service type.

The second aim of the effort concerns the development and dissemination of specialized competence, through the performance of research into the requirements and issues entailed in the work towards a platform of this kind.

Typical applications/application areas where the platform may be used, are:

- Distributed interactive learning
- Intranetworking
- Knowledge management
- Entertainment
- Public information access
- Security enhancements (VOD from surveillance cameras)
- Professional inspections of limited-space work environments
- Distributed collaborative work

Sections 4.1 and 4.2 which follow characterize the kinds of support which could be provided within the M3Ci Platform, while section 0 describes some of the kinds of research areas to be encountered.

4.1 Service Creation

Service creation concerns the creation of *types* (or *classes*) of services, rather than specific *instances* of services. Central aspects of the service creation process include the design and implementation of service functionality, interaction model and service

interfaces for the end user. Almost always, the design of a service is significantly influenced by the characteristics of the device(s) upon which it is intended to operate; other characteristics of the channel may also impact service design to a greater or lesser extent.

To simplify design of service interfaces, the multi-channel SCE should enable the specification of client device constraints, including screen size, color depth, keypad or other input mechanisms, etc. It should also enable the rapid specification and reconfiguration of layout templates for different client devices, including content fields, names, background graphics, etc. In cases where device characteristics are quite similar, the SCE could enable the specification of a single layout template for a given service, along with a set of transformation operators by which to tailor service appearance to each of the (similar) devices. An analogous approach might also be used to create services which can adapt their presentation and content to individual users or classes of users.

The SCE should also enable the specification of a channel-independent interaction model for a given service, as well as any specializations of that model which may be necessary for specific target devices. Definitions of layout templates and interaction models should be represented independently of one another, wherever possible.

Finally, the multi-channel SCE must ease service testing and debugging, as well as deployment into a live, online environment.

4.2 Content Production

In an *ideal* realization, the M3Ci Platform should enable — in a single, integrated process — the production of content which can be used within different services, as well as through channels and upon devices having varying characteristics. With such content available, the M3Ci Platform should enable the production of concrete services through *substantiation*; that is, through selection and instantiation of a service type, and association of specific content with that service instance.

The first phase of the content production process often begins with creation (or selection) and preliminary editing of content; this phase in the process may also be called *content authoring*. At this stage of the process, the goal is often the creation of content which can be used — with some further minor raffinement, editing and preparation — in a variety of services and contexts. Sometimes, content authoring is carried out with the substantiation of a specific service in mind, and sometimes not. In fact, the reusability of content can often be lessened when knowledge of target service is applied within early stages of content creation and editing.

The second phase of the content production process concerns the preparation and tailoring of content for a specific service. At this stage of the process, the service type to be substantiated is known and taken fully into account during content preparation. This phase of the process involves the raffinement and final editing of each *individual* piece of content (e.g., text, images, icons, graphics, audio and video segments, etc.) to be included within the service¹. This aspect of content production is tightly interwoven with the service production process.

¹ The original version of each piece of content may be saved for later reuse, if applicable.

The service production process concerns the association or assignment of specific content with some selected instance of a service type. When substantiating multimedia services, service producers will need to be able to rapidly compose and synchronize content and special effects. Since specific channels and devices may affect the final appearance and performance of the service, service producers must have at least some basic support by which to gain an appreciation as to how the service may be transformed or influenced.

Thus, the M3Ci Platform should include real-time production tools which include functionality for viewing the kinds of effects different channels have upon service presentation and performance in real-time. For instance, video may be omitted when multimedia content is delivered through low bandwidth connections and/or onto devices having small screens or little processing power. Graphic layouts may be rearranged on a handheld in comparison to a palmtop. The M3Ci Platform should also demonstrate the effects of delay upon service usability. Furthermore, all production processes and tools must be open to accommodate new content and channel types as these emerge.

4.3 Research Areas

There exists a wealth of research subjects which shall be encountered in working to realize the M3Ci Platform. These subjects generally involve one aspect or another in the more encompassing area of service and information architectures. Some of the research subjects to be addressed are briefly elaborated upon below.

4.3.1 Channel-independent service interaction models

In order to distinctly separate service (or business) logic from the specifics of the channel, it may become necessary to create layered forms of service interaction. Work of this kind demands a clear interaction model. Over time, work upon instances of various interaction models may lead to the eventual definition of a *meta-level service interaction framework*. Using such a framework, instances of service interaction models can be generated from a common interaction framework. This kind of approach can yield more common forms of interaction across channels, a condition for the end user which yields a greater sense of recognizability and familiarity across different services.

4.3.2 Service session management

Session management which deals with multiple channels is a highly complex task. Some of the more complex issues include:

- management of non-contiguous service sessions
- management of multi-user / multi-device service sessions.

As new, more complex services must be devised, there is a need for managing services sessions which may be non-contiguous in time. That is, one may initiate a service, enter information, etc., then suddenly need to pause and/or terminate work with the service before completion. Alternatively, the connection may be interrupted or lost inadvertently. When resuming work with the service, one wishes to begin where one left off, rather than starting from the beginning again. In addition, flexible session management requires other complex functionality such as conferencing, application sharing, "handing off" service sessions to a co-worker, merging two or more ongoing sessions, etc.

New, advanced services will also require that a user can be *logged into the same service session* from more than one terminal at a time. Interactions with the service on one terminal must be reflected within the user-interface of the other terminal, as soon as the channel-dependent factors permit. This area of research must also address conditions where different users are logged into the same service session, in order to coordinate their work². Again, interactions with the service on one user's terminal must be reflected within the user-interface of the other user's terminal, as soon as possible.

4.3.3 Adaptation and Quality of Service

The usability of a service ultimately depends upon all aspects of the channel through which it is being delivered. This fact has led to a great deal of work in the area of adaptation and Quality of Service (QoS). There are many ways in which to construct solutions which aim to optimize service and application performance, given an operating environment which may often be subject to unpredictable, dynamic changes. It is of value to study the relations between the aspects of various channels, the manner in which they may vary over time and how variations in these aspects impacts the performance of *classes* of applications. Understanding these relations makes possible the appropriate selection and application of adaptation mechanisms across use contexts which are characteristically different.

4.3.4 Service creation and user interface

Many if not all choices affecting service interface design are made during the service creation process. This includes both service layout and interaction model. It is therefore crucial that investigations address the relationship between device input/output characteristics and service interaction models. In addition, the aspects of service protocol design which eventually affect functionality available in the user interface (e.g., protocol features which limit service flexibility and functionality) must also be identified and made explicit.

4.3.5 Service personalization and usability

Today, a large number of WWW sites selling common products utilize certain knowledge about their customers — knowledge either captured “behind-the-scenes” or submitted explicitly by the user — in an effort to adapt (or personalize) their services and thereby increase sales.

In many cases, it can be favorable to the user that services are personally tailored, but is at least equally important that the every user's legal right to privacy is not trespassed.

Research topics in this area include:

- understanding of the suitability of different channels with respect to the services they should deliver
- developing an understanding and guidelines as to which service personalization is necessary and useful in different contexts
- developing an understanding and guidelines as to how privacy concerns should be treated in user modeling.

² This situation can also be conceived as a specialized form for conferencing.

4.3.6 Interoperability

For problems involving service architecture and service channeling, achieving interoperability is the most fundamental requirement. The nature of the problem itself is defined by the need to deliver services across heterogeneous kinds of networks, often utilizing information from a diverse variety of information resources.

Today's requirements in this area already demands the aggregation and composition of information drawn from geographically distributed information resources. Another basic requirement is that of preserving existing infrastructure investments, in other words, the need to integrate service channeling solutions with legacy systems and applications. A need also exists to identify and address possible forms of service interactions which degrade or even disable one or more of the involved services.

4.3.7 Multi-channel content and service production

Some of the requirements for multi-channel content and service production have been described above in section 4.2. Research goals in this area include the creation of methodologies, processes, techniques and tools which offer an integrated approach by which to produce content and substantiate services.

4.3.8 Interactivity

An important aspect of many services is the interactivity it is capable of providing. The degree of interactivity, may in many cases be an important success criteria of a commercial service, and the user may choose to keep or reject the service based upon the interaction possibilities. While the services provide interactivity possibilities to the user, it is important that the interactivity matches the service, and vice versa.

The research in this area should focus on establishing requirements and suitable models for solving interaction between the user and a) the client; b) the server, and c) the content production line.

4.3.9 Synchronization

Timing and synchronization of content within multimedia services is a difficult problem, and involves many different parameters and trade-offs to establish a sufficient QoS for the service. Research into this area may investigate the different characteristics of the media, different trade-off strategies, and different strategies for providing a graceful degradation of the service.

An interesting research area that may also be investigated is the interaction and synchronization between several devices/clients in a multiple device session, or several users in a multiple user session.

5. Preliminary Architectural Elements

The M3Ci Platform is currently planned to include a number of major software elements. These are:

- the M3Ci Client Framework
- the M3Ci Server (presently includes MM Streaming Server, Context Server and Portal modules) and
- a Content and Service Production Environment.

Within the period of the effort, these elements shall be investigated, further developed and closely integrated. It is intended that most of these elements be field tested with Partners within the channel S Programme; furthermore, it is a secondary aim that the software quality reaches such a level that certain third party actors may ultimately wish to license the Platform, or individual components, for experimental purposes or productification.

During the course of the work, new elements may be added (e.g., gateways), and other Server modules will likely be integrated (e.g., a server module which handles real-time conferencing protocols).

In the sections which follow, each of the M3Ci Platform elements is briefly described.

5.1 M3Ci Client Framework

The main activities for this platform element are the design and implementation of an M3Ci Client Framework with which it is possible to create *instances* of clients. Thus, the framework must enable the interchange of information and content with the M3Ci Server, as well as deliver and present it in a consistent manner. Effort will be directed to make the framework platform-independent and, as such can be easily utilized on new/other platforms. One part of the effort here will be to investigate how existing third party components can be utilized advantageously in the framework.

5.2 M3Ci Server

The M3Ci Server element of the Platform is responsible for establishing connections with clients, negotiating the service content and interchanging information and content with clients. The M3Ci Server is designed to be able to serve multiple clients on multiple platforms and to provide multiple formats of the same media, while at the same time being scalable and easy to maintain. Currently, three major modules are planned for the M3Ci Server. These are the MM Streaming Server, the Context Server and the Portal.

5.2.1 MM Streaming Server

The Multimedia (MM) Streaming Server is a module of the M3Ci Server that simultaneously delivers media content to multiple clients on multiple platforms. The MM Streaming Server is designed to be versatile and flexible with respects to content types (e.g., audio, video, text, images, etc.), content formats (e.g., different audio/video formats) and transfer modes (e.g., file transfer, stream transfer, or "broadcast" fashion).

For clients with bandwidth or hardware limitations, the MM Streaming Server is capable of easing the load on the client by pre-processing the content, optimizing bandwidth usage, synchronization-optimization and other similar functionality.

As part of this overall effort, certain research work will be directed towards *introspective metaobject protocols* (see e.g., [2]) and *declarative protocol programming*. Employing introspective metaobject protocols enables the system to examine its own internal workings during operation. Creation of a declarative protocol programming language will allow the automatic implementation of protocols from formal protocol specifications, thereby reducing the overall protocol development cycle time.

5.2.2 Context Server

The Context Server is a module which enables the delivery of context-dependent and personalized content to end-users. The Context Server is currently designed to acquire context- and user-specific information through a "dialogue" with the user. Information acquired in this manner can thereafter be used by other server modules in order to tailor content and services.

The Context Server module is based upon original design work carried out in the EU project called SPACE [3]. In that design, a Unified Dialogue Architecture was created which enables distributed dialogue systems to deliver unified dialogues [4]. A unified dialogue allows the user to conduct an orderly and consistent discourse with the system even though the dialogue is controlled by several independent components. Of equal significance is the condition that the dialogue itself is not known by the client until run-time. The distributed dialogue system approach enables the different server components' owners to modify their own parts of the dialogue — within the bounds imposed by the established semantic framework — without necessitating change or re-configuration of other parts of the system.

5.2.3 Portal

The Portal module of the M3Ci Server embodies features such as secure transactions, copyright issues, web-customizations and other functionality which is well understood and implemented in WWW environments. It is perhaps this module which utilizes the greatest degree of off-the-shelf technology.

5.3 Content and Service Production Environment

The Content and Service Production Environment embodies a set of methodologies, processes and tools designed to streamline the overall content and service production process. Process activities include the production/retrieval of content; format editing and format conversions; and the organization of the media in a cohesive, synchronized and structured manner. The focus here is to provide tools and methods for the general cases, while at the same time enabling content production line to suit the requirements of specific target services.

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