GIS, SOCIAL MEDIA AND SIMULATION IN INTEGRATED ICT SOLUTIONS FOR URBAN FUTURES

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ABSTRACT

ICT tools and their methods to support the policy lifecycle in urban planning have drastically changed with the emergence of social media, advanced simulation techniques, open government data, big data, opinion mining, advanced text analytics and visualization. All those components should be combined with GIS. Current ICT solutions supporting e-participation and collaborative urban planning are focused on solving a specific problem. They are not integrated neither on the conceptual nor on the technical level. The conceptual level referring to the policy lifecycle, the technical level to data integration and user interface. This paper describes a new integrated approach to policy design and implementation. It consists of an advanced policy lifecycle and an IT-solution with features supporting all phases of the proposed lifecycle. The concept as well as the technical architecture as implemented in the Future Policy Modelling Project (FUPOL) to achieve such a complete integration with separate applications is outlined.

KEY WORDS

Urban policy lifecycle; E-Participation; FUPOL; GIS; Integrated approach; Integration architecture

INTRODUCTION

ICT tools and their methods to support the policy lifecycle in urban planning have drastically changed with the emergence of social media, advanced simulation techniques, open government data, big data, opinion mining, advanced text analytics and visualization. All those components should be combined with GIS, since most of the policy issues in a city are linked to a location.

In this context the definition of processes and lifecycles of the urban policy creation plays an essential role. In particular, the aspect of active participation in the policy modelling can be supported by technologies.

Current ICT solutions supporting e-participation and collaborative urban planning are focused on solving a specific problem. They are not integrated neither on the conceptual nor on the technical level. The conceptual level referring to the policy lifecycle, the technical level to data integration and user interface.

The research in policy modelling addresses the process of the policy creation process (Macintosh, 2004, Howlett, 2009). It has never been attempted to develop a policy lifecycle, which is detailed enough to allow an alignment of various ICT-technologies. Consequently a more detailed definition of the alignment of ICT-tools or their features to the policy creation process is not given.

In this paper we present a new ICT-based policy modelling process in a detailed form. The process is based on established, but just abstractly defined ICT-based policy modelling process and traditional but well elaborated works for non-ICT based policy modelling process descriptions. Different ICT-features were assigned to this process outlining the benefits.

POLICY MODELLING PROCESSES: AN OVERVIEW

The process of Policy Modelling (PM) is a complex challenge, which includes various tasks with a predefined order to ensure the creation of an effective policy. To face this challenge the structure of the accruing tasks were investigated by several existing process definitions. The processes enable the definition of process-tasks and supporting tools for an efficient task-solving. In particular the supporting tools are nowadays brought by the Information and Communication Technologies (ICT), with the rising role of internet, social web and further ICT-based technologies. The definition of PM-processes was often defined in existing works by setting goals for their categorization.

The conventional PM processes are the most established definitions and primary used and implemented at public authorities. They have been researched since decades, but unfortunately they lightly consider the ICT-tools and their opportunities. Novel approaches for eParticipation and eGovernment cannot be reconciled with the conventional PM-processes. The most advantage of such conventional PM-process definitions is their accurate documentation. No other category of PM-process definition provides such a well described definition of each process step. Most of the

conventional defined PM-process, i.e. in (Jones, 1984), Hupe, 2006), are not equal, but they describe the most necessary steps in a similar way according to (Howlett, 2009) and (Hupe, 2006). Therefore they are using a three to seven stage model and cover with the diverse stage-numbers the same issues. This fact allows the grouping of these approaches into a generalized five-stage model:

(1) Agenda Setting
(2) Policy Making
(3) Policy Decision
(4) Policy Implementation
(5) Policy Evaluation.

A more recent approach to define the PM-process is the inclusion of ICT-tools in the entire process. In particular the involvement of citizens and their opinions can be supported in a more sufficient way. These process models adapt the conventional PM-process to include ICT-tools. There are two established and equal PM-process definitions that investigate ICT in the process model: The well-known definition of Macintosh (Macintosh, 2004) and published model proposed by the OECD (OECD, 2003) to reinforce e-Democracy. Both processes define a five-stage PM-process: (1) Agenda Setting, (2) Analysis, (3) Policy Creation, (4) Policy Implementation, and (5) Policy Monitoring.

Next to these very established process definitions, there are very similar definitions with a deviation in the number of stages. They address the same issues, similar to the parallel existing process definition for the conventional PM-processes. The process definition of Mashinini (Mashinini, 2008) consists of four phases. His model combines the first two stages of Agenda Setting and Analysis in one stage. Another PM-process definition was proposed by the World Bank (World Bank 2010). It describes a more structured PM-process with an assessing and coordination responsibility within the governments. All of these ICT-driven process definitions do not describe the process in a detailed form. Neither the concrete tasks are named or described, nor are the possibly useful ICT-tools defined for supporting the tasks. Nevertheless the mentioned processes are for many e-Democracy project-ideas a well foundation, even if they are just defined on a very abstract level. The lack of a detailed description makes it difficult to use such a PM-process definition in ICT supported implementations.

ADVANCED POLICY LIFECYCLE

In order to address the linkage between policy process and ICT, a new model developed in the FUPOL project (Sonntagbauer P. et al., 2013). It uses the existing models as a base, but enriches them with a more detailed breakdown of tasks and with a linkage to ICT technologies.

It consists of the following steps, which are broken down further into subtasks:

AGENDA SETTING

1. Policy Problem identification

This means to identify policy issues. Policy issues can be divided into two categories: those already on the public policy agenda, and those that are not. If an issue is already on the public-policy agenda, it

has a sufficiently high profile, and a formal process to elaborate further on it is likely to be in place. If an issue is not on the public-policy agenda electronic tools (among other channels) can be used to identify them quickly, namely

a) Objective construction: This refers to identification through analysis of statistical data. Issues are identified through deviations of indicators from predefined thresholds.

b) Subjective construction: This refers to the identification of topics from social media.

2. Policy problem validation

In this stage it is checked, whether the problem identified is a real problem and should be taken further to an analysis stage. Objective Validation through experts means that the problem identified in the step subjective policy problem identification are checked again by experts, whether they are a real problem. Subjective validation means that the problem identified in the step objective policy problem identification are checked again by a subjective analysis whether they are a real problem for the citizens and stakeholders.

ANALYSIS

1. Identification of challenges and opportunities

This refers to the identification of challenges and opportunities associated with an agenda item. In the analysis-phase knowledge and evidence has to be collected from a broad variety of sources such as research-based knowledge, project and policy implementation knowledge and statistics. In order to facilitate policy goals they must be measured and their influencing factors must be determined from the very beginning. Already at this stage opinions can be collected actively from stakeholders as a preparation of the next phase.

2. Determine Solution Approaches and Strategies

The objective is to develop a range of options refers allows the stakeholders (citizens, civil servants, companies, etc.) to determine the range of options under review. In addition it is proposed to simulation the options. This step is not mandatory and means that the impact of the policy is simulated. Social Media can also be used to collect opinions of stakeholders concerning the goals and objectives. Option Analysis includes various characteristics of the options such as impact, costs, efforts, risks etc. involved.

POLICY FORMULATION AND CREATION

1. Dialogue phase

The dialogue phase aims at establishing a dialogue, reaching a consensus and finally chose among the various policy alternatives. Discussion and deliberations can be enabled through various channels such

as social media, expert groups meetings, meetings with interest groups, public hearings etc. The results are summarized and published so they are available to the public.

2. Formulation

During the formulation phase the creation of a good policy document based on formal consultations, risk analysis and pilot studies is ensured. Active participation is limited in this phase [Ma04a]. The evaluation of options in the current context refers to the evaluation and fine-tuning of the intended policy in the current legal, organizational and political context. At the end one or more alternative fine-tuned policy proposals are drafted for ratification in the decision making bodies.

DECISION MAKING

In this phase a decision is made by the relevant decision making body. This could be for example an assembly of representatives, a politician or a decision maker in the civil service.

IMPLEMENTATION

1. Implementation Tasks: Implementation has many facets and therefore cannot be described extensively It includes tasks such as budgetary measures, public relation actions, organizational changes, staffing etc.

2. Policy enforcement: An important aspect is the selection of the policy enforcement instrument. Policies can be implemented in a number of ways, means by various policy tools / policy instruments. A policy statement describes what is being sought; the tool or instrument is the method by which the desired outcome is pursued, for example self-regulation, persuasion, subsidies, incentives or regulation.

POLICY MONITORING AND EVALUATION

The aim of the monitoring evaluation is to determine whether an implemented policy is doing what it is supposed to. Monitoring the policy - and the values and goals defined in the analysis phase - enables a determination of positive or negative effects for the target group. Changes should be suggested in this phase. At this point the process can loop back into stage 1 (agenda setting) as the policy may be modified on the basis of experience with implementation [Ma04a]. In this phase the simulation can be used to forecast future impact at any time using actual figures and as such contribute to the evaluation of the implemented policy. Monitoring means to use quantifiable indicators to measure the policy implementation progress. It should help stakeholders to verify that targets are being met and policy makers to know whether the policy is working. It certainly involves the development of methods for effective data-collection and management.

TECHNOLOGY FEATURES

This section describes the technology features that are assigned to the policy modelling lifecycle in Figure 4.

1. Full Data Integration and Storage: A central repository is indispensable to integrate data from multiple source systems. It ensures data consistency across all steps of the policy lifecycle and it provides a single common data model for all data of interest regardless of the data's source. Technically it is implemented using a Service Oriented Architecture (SOA) architecture and an Enterprise Service Bus (ESB).

2. Full GUI Integration: Applications have the same “Look and Feel” from a user’s point of view. A single sign on to all applications simplifies the use of the system and improves security through a centralized authentication.

3. Policy Indicator Dashboard: The policy indicator dashboard visualizes various indicators and flags them if they are below / above thresholds or certain conditions are fulfilled. It is an efficient tool to monitor policies on the management level.

4. Social network aggregation and Single Window Display: This is the process of collecting content from multiple services such as Facebook, Twitter, Blogspot or the FUPOL opinion map and pulling them together into a single location. The postings are displayed “single window”, which means postings from various sources are displayed on the same screen. The feature saves a lot of time, which is typically required to log into all the different sources and read the postings.

5. Hot Topic Sensing and Summarization: Hot Topic Sensing is a web and social network analytics tool that analyses data from social networks, newspapers, forums, blogs, etc. and identify relevant topics. Also a summary of postings is created, which reflects the opinions of the postings in brief.

6. Community Feedback Platform (CFP): The Community Feedback Platform is inspired by crowdsourcing platforms and is designed to enhance cognitive processes in a similar vein as traditional Idea Management Systems. The purpose of the system is to facilitate the idea analysis and selection processes. The Community Feedback Platform enhances the capabilities of Social Network, namely aggregation and Single Window Display with additional features such as commenting/voting and an analytics toolkit (i.e. computing: trends, topics, sentiments)

6. Visualization of Statistical Data: In the described process of policy modelling, the aspect of problem identification plays a key-role for the whole policy design process. The need for getting valid information about certain topics and policy indicators is essential for setting the agenda for a new possible policy. Visualizing these valid and proved data provides a more useful instrument to gather information by comparing, associating, correlating and identifying various data, data-attributes or indicators. The standard which is used to visualise statistical data on a map are Chloropleth maps.
Figure 1 illustrates the internet users per 100 population in 2005 as an overlay on an Openstreetmap.

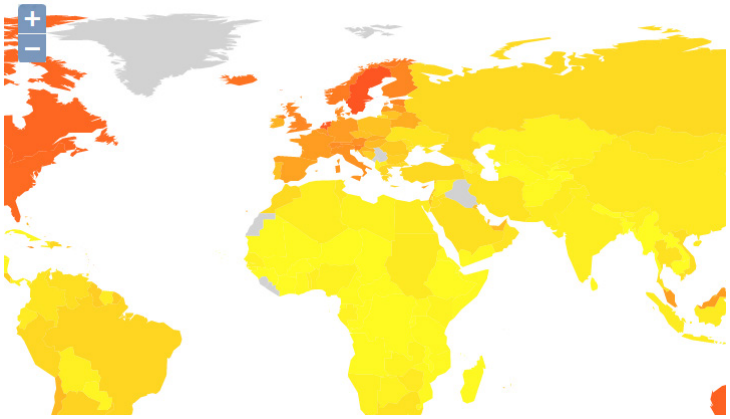

Figure 1: Chloropleth maps (Thematicmapping, 2013)

7. Visual Social Data Analysis: Besides valid and objective data, the investigation of "subjective values" is important for identifying problems and gathering information about the "social impact". The method of choice to analyse based on ICT-tools the social impact is Social Network Analysis (SNA). SNA enables analysing social networks and identifying opinion leaders by measuring and mapping the relationships and flows between people, groups, organizations and other connected information or knowledge entities.

An important aspect of visual social analysis are "Heat Maps". This refers to the visualization of social media postings on a map. Figure 3 shows some sample data as an overlay on Openstreetmap.

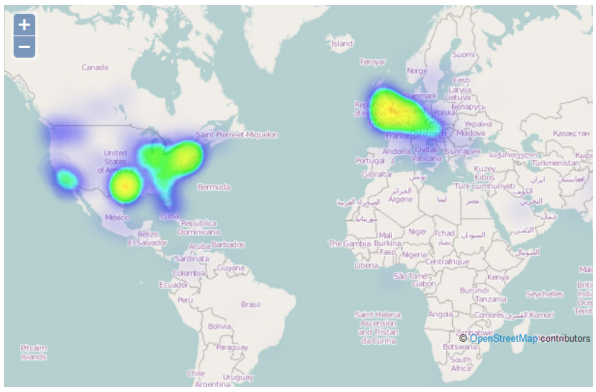

Figure 3: FUPOL Heat Map (Heatmaps)

8. Knowledge Database and Visualization: This refers to a multiple interlinked databases with policy related information. The visual knowledge database provides a visual search ability for proving the given information and compare to the web-knowledge.

9. Outgoing Multichannel Social Media Single Window Messaging: The capability of posting messages to various channels (social media targets) at the same time without the need to manually post to each site separately.

10. Opinion Maps: Opinion maps are interactive electronic maps that can be integrated into almost any internal or external web site and allow the posting of comments on a GIS based map.

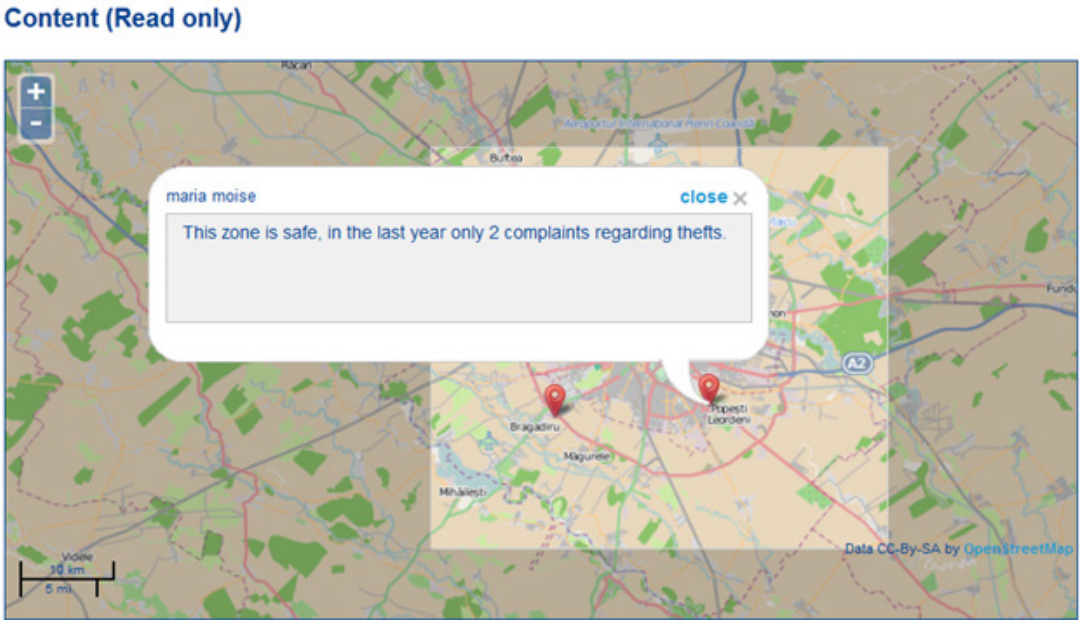

Figure 3: GIS based FUPOL opinion map

11. Simulation and Impact Visualization: Policy simulation enables a virtual evaluation of policies. Therefore the statistical history of indicators is used to generate forecast based on mathematical models, in dependency of identified influencing indicators which can be addressed with a policy. To provide a better comprehension and transparency, some outcomes of the calculated simulation are visualized. This includes statistical visualization to analyse the impact based on the quantitative data, GIS (map based) visualization to illustrate the impact on a map, the “Policy Indicator Dashboard” to provide a simplified impact overview of the key indicators

12. Visual Fuzzy Cognitive Map: Modern systems are complex and they are usually comprised of a large number of interacting and coupling entities that are called subsystems and/or components. A fuzzy cognitive map represents a system as a network showing the directed causal relations between its elements through arrows. The relations between the elements can be used to compute the "strength of impact" of these elements. (Stylios, 2004)

An overview of the advanced policy model and the technology assignment is provided below:

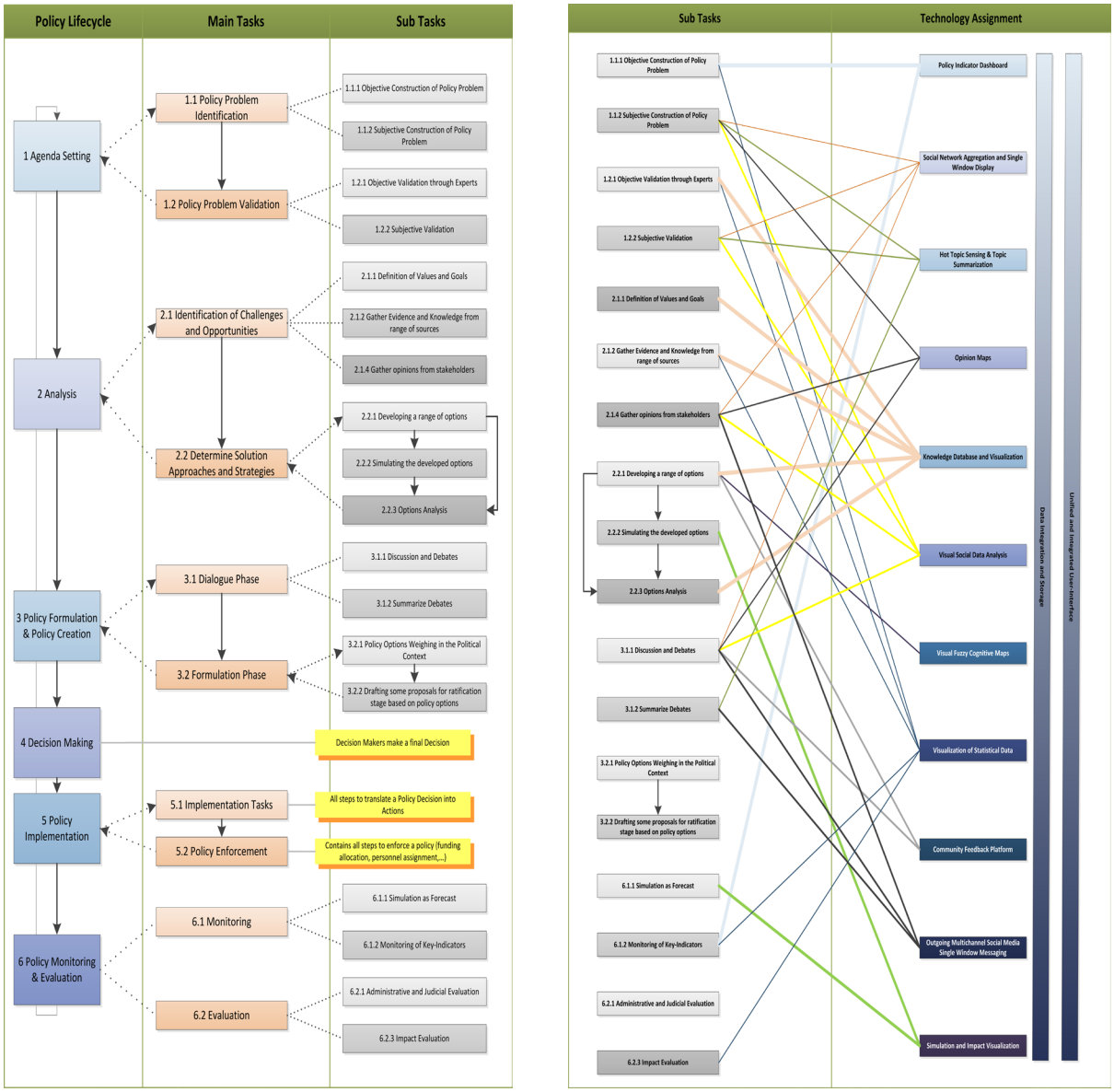

Figure 4: Advanced Policy Model

(a) The enhanced ICT-based policy modelling lifecycle with tasks and subtasks on the left, and (b) the technology features assigned to the policy modelling lifecycle on the right.

TECHNICAL INTEGRATION

This section describes the technical architecture, how to integrate different software building blocks. This architecture is already implemented in the FUPOL project (FUPOL, 2012) and tested in pilots.

INTEGRATION ARCHITECTURE

The integration architecture is based on a service oriented architecture using an enterprise service bus (ESB) as the communication backbone. Note that most connections between the modules will be (logically) point-to-point, but technically all communication is routed through the ESB. This architecture allows the exchange of data and transactions between the different components.

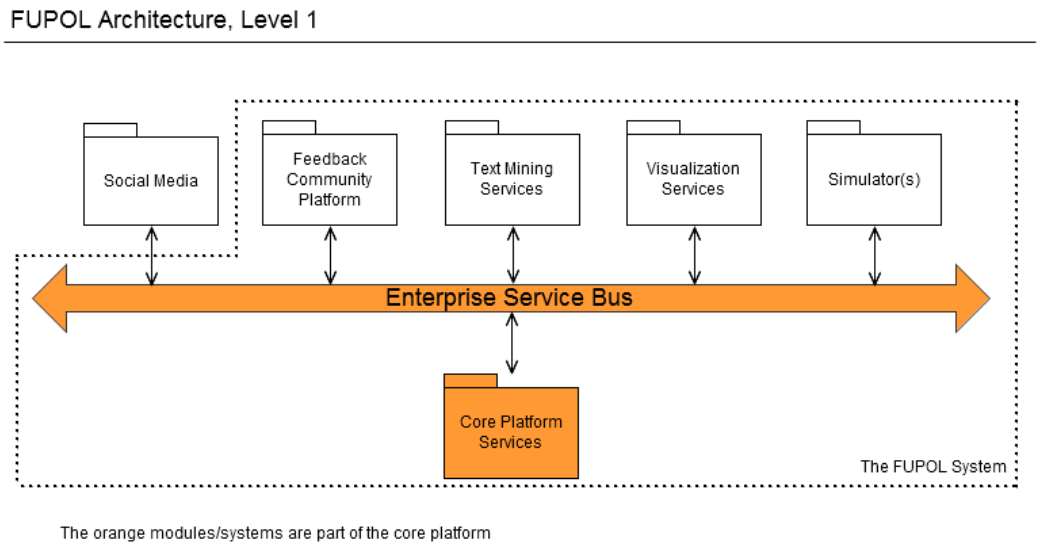

Figure 5: Technical Architecture Level 1

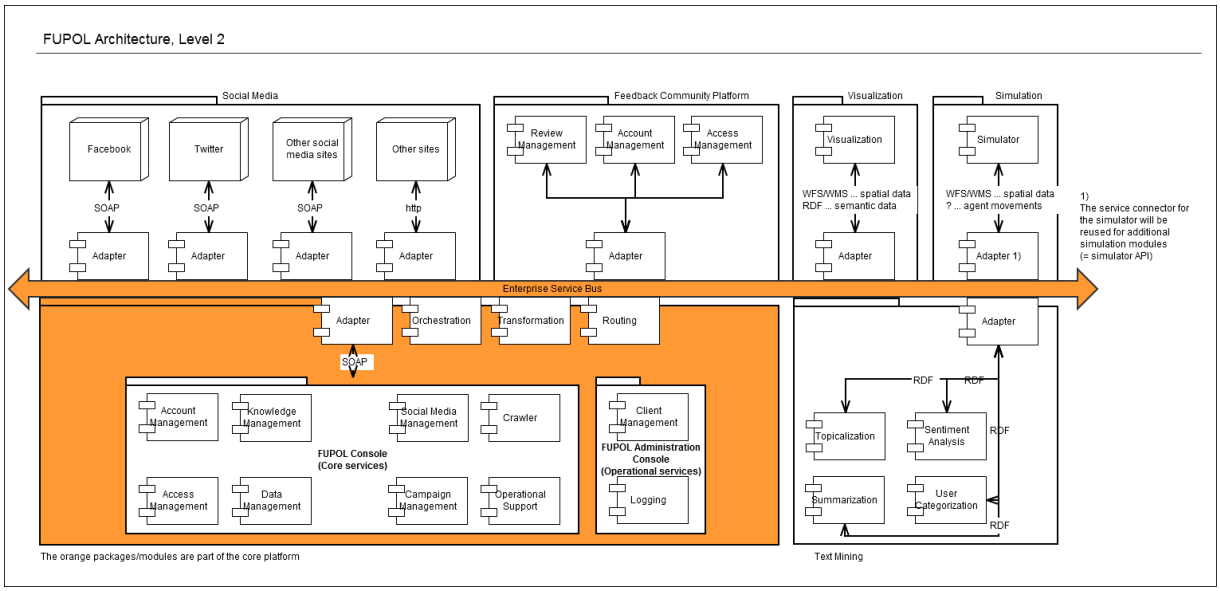

Figure 6: Architecture Level 2

The SOA architecture has some key principles that allow for business agility and scale. The key focus is to decouple systems from each other while allowing them to communicate in a consistent and manageable way.

This means:

- The "bus" concept decouples applications from each other. This is usually achieved using a messaging server like MULE or AMQP.
- The data that travels on the bus is represented in a canonical format and is almost always some XML dialect.
- There is an "adapter" between the application and the bus that marshals data between the two parties.
- The adapter is responsible for talking to the backend application and for transforming data from the application format to the bus format. The adapter can also perform a host of other activities such as message routing transaction management, security, monitoring, error handling, etc.
- ESBs are generally stateless; the state is embedded in the messages passing through the bus.

The canonical message format and the API functions are the contract between the different components. The canonical format means that there is one consistent message format traveling on the bus and that all application on the bus can communicate with each other. Whenever possible existing protocols/encodings (WFS/WMS, SDMX, RDF/SparQL) based on web services are used.

CONCLUSION

A new integrated approach to policy design and implementation has been outlined.

The novelty is

a) the enhancement of the policy lifecycle with detailed tasks and its alignment with various technologies.

b) The flexible conceptual approach and the open architecture, which allows future expansion with additional applications supporting the policy lifecycle.

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