Simulation of Activity Stream inside Energy Social Business Environment using Assemblage Theory and Simplicial Complex Tool

Eddie Soulier, Philippe Calvez, Florie Bugeaud, Francis Rousseaux, Jacky Legrand

***Abstract*—**Social, mobility and information aggregation inside business environment need to converge to reach the next step of collaboration to enhance interaction and innovation. The following article is based on the “Assemblage” concept seen as a framework to formalize new user interfaces and applications. The area of research is the Energy Social Business Environment, especially the Energy Smart Grids, which are considered as functional and technical foundations of the revolution of the Energy Sector of tomorrow. The assemblages are modelized by means of mereology and simplicial complexes. Its objective is to offer new central attention and decision-making tools to end-users.

***Keywords*—**Activity Streams, Assemblage, Energy Social Business Environment, Simplicial Complex, Smart Grid

I. Introduction

THE concept of «Smart Grids» is closely connected to the Energy sector especially electricity and the way to produce, transport and deliver it. Smart Grids are going beyond the classical backbone or value chain between Electricity Producer, Transporter, Provider and Customer.

Information and Communication Technologies (ICT) are playing a critical role in these new networks and infrastructure. In fact, all these technologies give existing networks some kind of «intelligence» and transform passive networks in flexible, resilient Smart Grids. George W. Arnold, National Coordinator for Smart Grid Interoperability from the National Institute of Standards and Technology of US Department of Commerce defines ICT impacts in Smart Grids as « […] is the integration of information and communication technologies (ICT) into the power system to make it more cost effective, efficient, reliable and cleaner and provide customers with actionable information about their energy use so they can control their costs. » These new infrastructures are able to anticipate and adapt themselves to new user’s usages and sustainable production technologies such voltaic or wind energies which offer customers (private home, building, cities,…) to produce and use electricity in a multiple connected layers digital business ecosystem instead in a typical top bottom system (energy produced exclusively by companies electricity plants towards customers).

Eddie Soulier, Tech-CICO Laboratory, Université de Technologie de Troyes Troyes, France, (e-mail: eddie.soulier@utt.fr).

Philippe Calvez, CRI Laboratory, Université Paris 1 - Panthéon Sorbonne, Paris, France, (e-mail: philippe.calvez@malix.univ-paris1.fr).

Florie Bugeaud, Tech-CICO Laboratory, Université de Technologie de Troyes, Troyes, France, (e-mail: florie.bugeaud@utt.fr).

Francis Rousseaux, CRéSTIC Laboratory, Université de Reims Champagne-Ardenne, Reims, France, (e-mail: francis.rousseaux@univ-reims.fr).

Jacky Legrand, CERSA, Laboratory, Université Panthéon-Assas, Paris, France, (e-mail : jacky.legrand@u-paris2.fr).

Everyone could now be a part of these Smart Grids, as electricity producer or electricity consumers. « The «Smart Grid» is the integration of an electric grid, a communication network, software and hardware to monitor, control and manage the creation, distribution, storage and consumption of energy. The «Smart Grid» of the future will be distributed, it will interactive, it will be self-healing and it will communicate with every device, […] an advanced Smart Grid enables the seamless integration of utility infrastructure, with buildings, homes, electric vehicles, distributed generation, energy efficiency, renewable energy use and customer satisfaction, while reducing capital and operating costs. » [3].

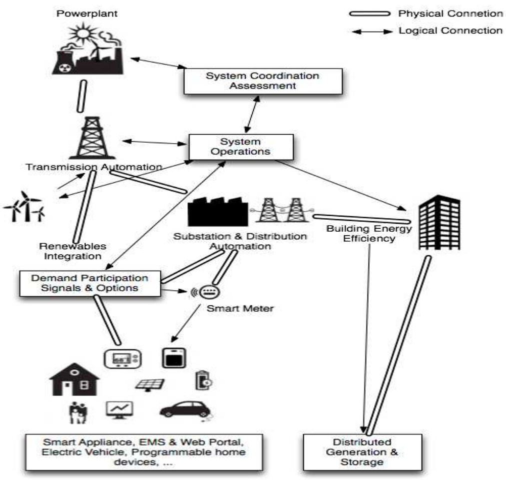


Fig. 1 Smart Grid Global Overview

We notice that Energy Sector particularly electricity, is confronted with an extraordinary revolution, due mainly to the fact that primary energy resources such oil decrease and more important because of environmental problems, all these problems are becoming critical in a sustainable global economy and society. Energy Sector is facing many problems and need to advance towards new business models as well to implement new technologies, processes, and tools to manage this transformation. Energy Smart Grids as intelligent networks are considered as one of the main opportunity to offer functional and technical structures to support these challenges. How these Smart Grids will really help all actors of energy sectors (humans, non human) to evolve inside new type of Social Distributed Networks is a critical point that concepts such Activity Streams, Social Digital Business Environment could help to carry out. A large amount of different type of information will be centralized and analysed in dedicated Information System and applications to support data management in Smart Grids and especially to provide new oriented user services.

We focused in this article in the relation between Electricity providers and Electricity consumer/client. Lot of aggregated information, technical as well social, will help to describe people activities patterns, then evaluate it in order to calculate potential impacts on energy client's consumption, offer decision tools and to go further, helping the consumers to adapt their use of energy to their way of life.

II. Energy social Business environment as assemblage, or actor-network

"Assemblage" is a term used in systems and network theories by authors of philosophy and the sciences to characterize to varying degrees the non-unified, non-hierarchical, non-linear, hybrid, flat, and complex nature of systems. We refer here especially to the seminal metaphysic work of Whitehead [18], enrich by some postmodern philosophy stances in favour of apparatus (Foucault, [9]), 'agencement' (Deleuze and Guettari, [7]) and, in sociology, actor-network (Çalışkan and Callon, [2]; Latour, [13]), continued by new continental philosophies of Manuel DeLanda [4], Theodore R. Schatzki [16] or Graham Harman [10], latters trying to define a new social ontology in a materialist and realist ways which challenges either reductionisms (individualisms) and holisms ('society as a whole'). *An assemblage refers therefore to the heterogeneous components which are ordered in any domain of entities, assemblage itself being the system of relations that can be established between these elements*. [15]. Assemblages are non-essentialist (they are historically contingent actual entities – singular individuals - not instances of ideal forms) and non-totalizing (assemblages are not seamless totalities but collections of heterogeneous components that should be analysed as such) phenomena's. An assemblage is a "multiplicity", a whole made of elements (or parts) [17] like actors, things, objects (artifacts) and discourses [6]. Unlike organic totalities an assemblage is a by-product of interactions between components, an emergence.

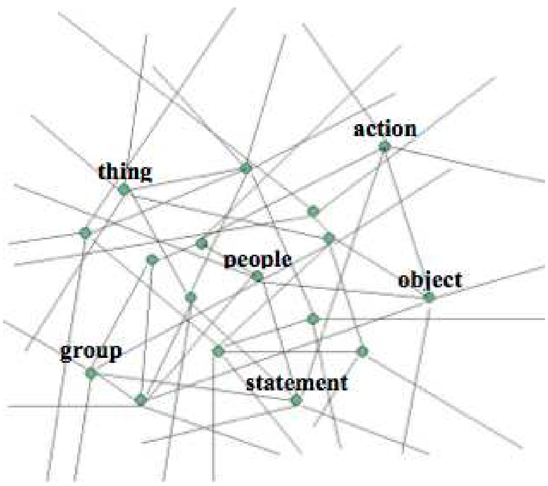


Fig. 2 A representation of an assemblage

Each component which composes an assemblage is first at all an active entity and, as such, it must be connected to come to any existence: any entity has "capacities to interact" with others entities. What we call a 'thing' is for Whitehead a set of agitations of force, a group of activity or energy, a configuration of process or motion, and he calls such a bit of process an 'actual occasion'. In some sense, "existence precedes essence" as existentialism claimed. The identity of every component must not be defined before they enter in an assembly process (or process of assemblage). Indeed, as the "game" or process progresses, all the things (at large) that it collects (people, statements, objects…) come to define them. Latour pushes these intuitions to the limit in the Actor-Network Theory [13]. Here, an active entity (an agent or actant) is defined neither by itself (identity, essence) nor by its relations (its network). This apparent paradox is possible because the question of the actors and their network is always empirically untied, during trials in which agents, and mediations on which they rely on, operate translations enabling them at the same time (or not) to enter in relation, and to be defined as acting individual and collective entities. The dynamic "mediation-translation-trial" associates (according to dimensions which are themselves heterogeneous) and stabilizes an initial plurality of heterogeneous entities according to a certain trajectory.

Such multiplicity is a structure of a possibility space (DeLanda, [5]). As assemblages result from the "gluing together" process, we need an associated combinatorial structure to follow, represent, analyse and, maybe, "amend" in some ways the traces it has left. The structural description of linkage among components may be tackle with a simplicial complex (Legrand, [14]) and hypernetworks [11], which helps us to explore the multidimensionality of every components of any assemblage. Assemblage's identity as possibility space may be "parameterized" (or restricted) along three primary axes (DeLanda, [5]). A first axis defines the variable roles a component may play: expressive or material. A 'territorializing'/'deterritorializing' axis indicating processes in which a component is involved. These components are defined by *relations of exteriority*, i.e. their 'role' within a larger assemblage is not what defines them (this would be a relation of interiority). This means that a component is self-subsistent and may be 'unplugged' from one assemblage and 'plugged' into another without losing its identity. Whereas in organic totality the linkages between its components form logically necessary relations which make it what whole it is, in an assemblage these relations may be only contingently obligatory. This second axis specifies the stability of an assemblage according to the state of its boundaries (sharp and fixed or fuzzy and fluctuating) and the degree of internal homogeneity of its components. The degree of mobility (behavioral factors) of an assemblage may also determine its identity. A third axis defines processes in which specialized information constraints intervene in 'coding'/'decoding' the assemblage.

A high degree of territorialization and codification means for an assemblage a weak ability to change. And vice versa an assemblage may be said (relatively or absolutely) decoded and deterritorialized if it is be able to decontextualize a set of relations that partially fixed it (and, thus, destabilized it), rendering them virtual (immanent) and preparing them for more distant actualizations (like communication technology does). Thus the parts of an assemblage are analysable and assemblage itself has irreducible properties to its parts, without being a 'totality'.

So assemblages are also defined by their tendencies and capacities (DeLanda, [5]). Tendencies can make the properties of a whole vary, as when a seed is growing up and changes its own identity, becoming a young plant: here the tendency of any seed is to grow (if nothing prevents it). On the other hand, capacities make a whole exhibits aspects of their identity that were previously hidden, as when an apparently neutral plant turns out to possess unexpected medicinal powers. But tendencies and capacities cannot be listed before they appear due to the relationship between entities component the whole and the all different ways in which they can affected and by affected each other's and by other wholes.

Assemblage theory makes it also possible to posit social entities on all scales, from sub-individual to transnational, making the problem of the link between micro- and macro-levels of reality non relevant in this 'flat ontology' perspective (Marston and al., 2005). Finally, assemblages necessarily exist in heterogeneous populations, which forms there context. The relationship between an assemblage and its components is complex and non-linear: assemblages are formed and affected by heterogeneous populations of lower-level assemblages, but may also act back upon these components, imposing restraints or adaptations in them.

We reframe here all these fragmented insights in a coherent framework – called theory of assemblage ontology – and operationalize it with some relevant mathematical techniques, called simplicial complex theory, as it was first applied by Ron Atkin to the realm of social affairs (Atkin, [1]) to solve the problem of multidimensionality of any entity. Then, we have applied it in a Computer Science and Software Engineering perspective to smart grid ecosystem, which is a digitally enabled electrical grid that gathers, distributes, and acts on information about the behaviour of all participants (suppliers and consumers) in order to improve the efficiency, importance, reliability, economics, and sustainability of electricity services.

III. Towards Personal Energy Consumption Management with Activity Streams

Activity Streams may help weave together business processes, collaborative tasks and social networking, while retaining decentralization and individuality. The basic idea of activity stream concept is to take existing streams of content, which represent all of the activities coming out of networks, web sites, applications, repositories, emails, tweets and so on, and provide the metadata necessary to differentiate all the distinct activities coming from these different sources.

Conceptually, the idea of activity stream comes to us from the idea of "life stream", originated as a concept in 1996 as a project at Yale by Eric Freeman [8] and David Gelernter [19]. "Well, Lifestreams was already my idea that instead of keeping my information in separate pieces of digital Tupperware with some of it in this app, and some of it in that app, and some of it in the file system, and some of it in my Web brower, and some of it on my laptop, and some in my palm, and some in my cell, … — I didn't want to do that. I wanted every information object I owned arranged in an electronic diary or journal or narrative. Or 'Lifestream' is what I call it.". In his doctoral dissertation, Gelernter define lifestream as further: "A lifestream is a time-ordered stream of documents that functions as a diary of your electronic life; every document you create or other people send you is stored in your lifestream. The tail of your stream contains documents from the past (starting with your electronic birth certicate, perhaps). Moving away from the tail and toward the present, your stream contains more recent documents | papers in progress or new electronic mail; other documents (pictures, correspondence, bills, movies, voice mail, software) are stored in between. Moving beyond the present and into the future, the stream contains documents you will need: reminders, calendar items, to-do lists". Lifestreams are also referred to as social activity streams or social streams. We generalized Lifestream concept to any activity - social activities, shopping on line as well as workplace contexts and also interactions between "things" (in a sense of Internet of Things), in order to capture the fluence nature of the life.

Technically, the implementation of lifestream documents comes from the success of feeds, like in RSS (Really Simple Syndication) which is a family of web feed formats used to publish frequently updated works—such as blog entries, news headlines, audio, and video—in a standardized format. So we can say that RSS is like an ancestor of activity stream mechanism: Web feed formats is a technology enabler for activity stream protocol, which aims to syndicate activities across social Web applications. But RSS are too poor: the only mandatory fields in RSS are title, link, and description — which makes it an extremely flexible format. The only problem is that aggregators have to do a lot of guesswork about what's in it, complicated by the various flavors of RSS. In 2005, a group of people got together to create a better-specified syndication format called Atom. Atom specification adds to RSS (title, link, summary) a unique way to identity a feed entry, the author, and when it was last changed (author, id, updated). This format was really still designed for the case of syndicating articles into portals. Sites only publish the information as RSS or Atom, so no matter what, to sites like Facebook or Google, all these activities all look the same: as people are performing more and more activities online it is difficult to differentiate all these different feeds when you only have one basic format which focuses on *content*. Activity Stream approach shifts RSS-Atom focus from static content, documents and other temporary artifacts to the source of the energy, creativity, and decision making, people-centric approach, where *activity* is at the beginning. It was time to had a format as rich as people's social activities are diverse, at the moment where people subscribes and adds to their profile so many services so that services like FriendFeed are unable to really aggregate real-time feeds and consolidates their updates from social media and social networking websites, social bookmarking websites, blogs and micro-blogging updates, as well as any other type of RSS/ Atom feed, disregard that they are services that no longer exist (or got acquired) while new ones comes to light. So, one of the solution was a universal format for (social) activities and hence ActivityStreams

The ActivityStreams model, as in Activity Based Schema, presents an “actor verb object” tuple, with an optional “target” parameter. For example, someone sharing a link (person share link), or someone following someone else (person started following person), or someone modify his or her profile on Facebook, or if a developer forks a project (developer fork project-name), someone tags photos on Flickr, and so on. So in its simplest form, an activity consists of an actor, a verb, and an object, and a target. It tells the story of a person performing an action on or with an object -- "Eddie posted a photo to her album" or "Philippe shared a video". As Chris Messina [20] [12] noticed, this model is compatible with all social theory which place “activity” as its pivotal conceptualization, especially – but not exclusively - Activity Theory as theoretical framework with its roots in Lev Vygotsky's cultural-historical psychology, extended by Engeström, Y.

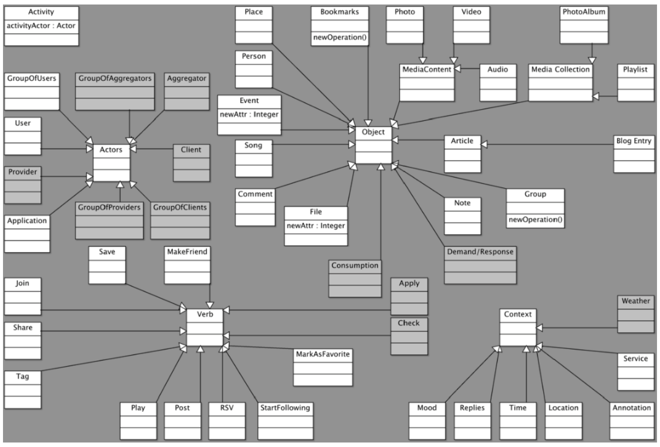


Fig. 3 ActivityStreams Data Model oriented Energy Digital Business Ecosystem [12]

It is a goal of activity stream specifications to provide sufficient metadata about an activity such that a consumer of the data can present it to a user in a rich human-friendly format. An object is a thing, real or imaginary, which participates in an activity. It may be the entity performing the activity, or the entity on which the activity was performed. An object consists of properties. Actor category describes the entity that performed the activity. An activity must contain one actor property whose value is a single object. Target describes the target of the activity. The precise meaning of the activity's target is dependent on the activities verb, but will often be the object the English preposition "to". For instance, in the activity, "Eddie saved a movie to his wish list", the target of the activity is "wish list". The activity target must not be used to identity an indirect object that is not a target of the activity.

An activity may contain a target property whose value is a single object.

More important, an Activity Stream is a collection one or more individual activities. A *stream* is a collection of activities, providing general information about the activities it contains. In particular, a stream has a subject, which can be either a digital artifact or an agent, and is the common feature between all the activities of the stream. But the relationship between the activities within the collection is undefined by activity stream specifications. It is precisely why we need something like an assemblage theory to analyze, observe or even simulate how numerous activity streams emerge from many interactions of many heterogeneous components. Activity theory reduces social systems to human power and don’t take enough account of that systems as emergences from the interactions between components, as assemblage theory does. We can thus define an assemblage as a multidimensional relationship between the activities within the collection. Assemblages are social systems of any sizes and natures, understand as activity networks (and fueled by activity data) that grow up as these life streams or activity streams start to accrue and build up value over time.

Several major websites with activity stream implementations have already opened up their activity streams to developers to use, including Facebook and MySpace. More generally, the tendency for editors is to add activity streams to their social software platform or web portal like Liferay or Drupal. Facebook finally launched its new format for the profiles: Timeline (which more or less replace the Wall) is a chronological “history” which makes it possible to see all its activity present and last on the social network. Timeline permit to share and highlight our most memorable posts, photos and life events on our timeline. This is where we can tell our story from beginning, to middle, to now. We also begin to find mobile applications, which propose “social network aggregators” services available through application distribution platforms such as the Apple App Store or Android Market, like Lifestream form WordPress. And finally activity stream tend to be a new framework component for most technology and consulting corporations like IBM which make it a central capability of its present and future strategy in what it has be called “social business”. Thus, Activity Streams provide a personalized, aggregated view of events, notifications and relevant action items across a range of enterprise systems, collaborative tools and social media. The activity stream is a personal view of relevant updates and events that have been aggregated from multiple sources, similar to a news feed on a social but applied to enterprise data and data sources, as well as any Internet services, including “things” of the Internet of Things, which is particularly important in a smart grid context. This in turn provides a central location for attention management - viewing and acting on personally relevant events and content across one's network and relevant services. The goal of the Activity Stream is to provide a standards-based capability enabled by an aggregation service, which can be linked into any enterprise application. In addition Activity Streams is a convenient and consistent way to syndicate social activities around the web.

To sum up, we now have an activity vocabulary for social activity where we could create new roles for people, with social objects that they care about, and collect around, with rules that are fair and reasonable, in order to connect the individual to a community through shared goals.

So now we can propose a new model of data processing. In this model, data does not take the form of persistent relations, but rather arrives in multiple, continuous, rapid, time-varying data streams. Activity Stream is a conceptual model while assemblage theory is a theoretical framework and simplicial complex is a topologic and data processing technic which allows us to calculated some optimal or meaning order starting from the order in which data elements arrive to be processed.

IV. Modeling and Simulation of User's Activities Streams Using Simplicial Complexes

In order to test our theories, we developed an example based on a user scenario. This scenario describes a person preparing a fishing trip. Within this scenario, a number of materialized data are identified and extracted. The sample of the scenario in the figure below highlits some of data from activities streams.

Loic ***lives*** in Brest; west coast in France ***(Geographical location data)*** and it is Saturday morning ***(days / hours data).*** He decides to go fishing and for this, he wants to organize this event. He gets local weather ***(Weather Local data)*** and tides ***(Tides data)*** Information, weather should be great between 13pm and 18pm on this Saturday ***(Local Weather data)*** […] He decided to start charging his electric car ***(Battery level data)*** with house's solar panels because it would be a sunny day and better use solar to load car's battery ***(Monitoring solar output data)*** rather than doing it via his electricity provider and his specific electricity energy contract ***(Provider data)*** […].

Fig. 4 User's Activities Streams Scenario Sample.

The figure below provides for example some data information which typically be used in our research to reach this activities modelling.

Data	Data Type
48.39172; 48.65109;48.64808; …	Localisation Service GPS Latitude
-4.46025; 4.31552; -4.46025;…	Localisation Service GPS Longitude
78;70; …	Data Maree SHOM High/Low Tide
15;18,5;21; …	Date Temperature Home HESM
1stfish.jpeg; boat.jpeg;…	Social Photo Service
10,45; 14,37; 18,56; …	Data Battery Auto HESM
4,58; 5,31; 6,39; …	Data Budget Provider
5,1; 12,7; 14,7; …	Wind Strenght
0.0322; 0,0522; 0,0822; …	Data Live Feed Energy Cost Provider
… [Data]	… [Data Type]

Live
refer
Should be
Share
Get
Calculate
… [verb]

Fig. 5 Example of Energy Data Set based on Activity Streams

Data sets are extracted from a typical user's day activities scenario that describe an event or a group of activity, in this case the fishing event. We based our description and data extraction to the Activity Stream Meta Data Model (exposed in page four of this document, and we match the Activity Streams Data with our Energy digital business ecosystem data structure, which we describe in the figure below, to identify data we needs.

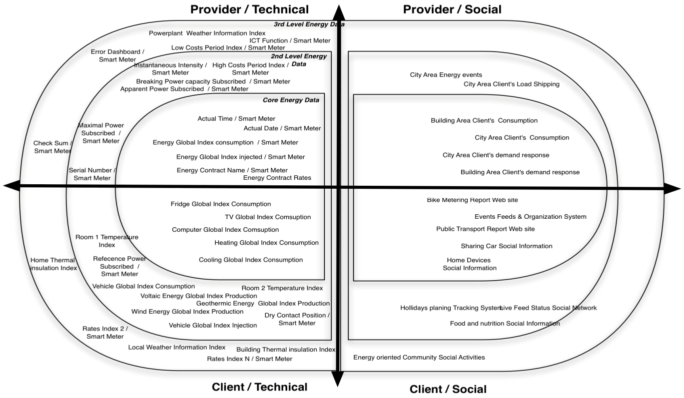


Fig. 6 Energy digital business ecosystem Data Structure – Client/Provider

In the next step, we calculate an example of Simplicial Complex to illustrate our scenario and multiple possible trajectories based User's on five different optimizations axes such actor's electric consumption, actor's home automation, actor's mobility, actor's global energy uses and actor's life style. These axes aggregate many decision paths, which represent activities, monitored with our system.

The figure below illustrates these results and allows us, to visualize different decision paths, such possible, unreal paths, new paths, and unidentifiable paths.

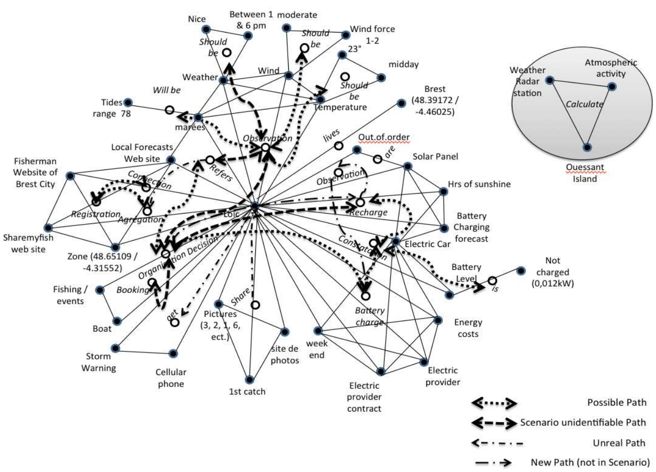
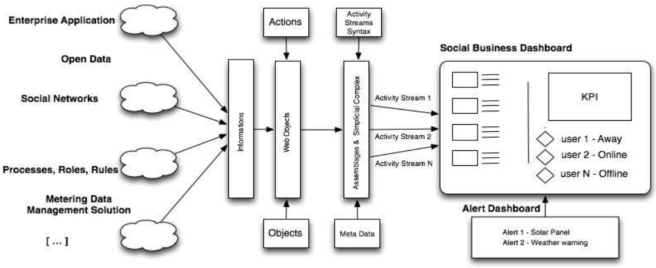


Fig. 7 Scenario Data represented as Simplicial Complex with trajectories

All these paths in the Complex are build with data (actor, verbs and objects) from the scenario (localization service GPS Service Data, Loic, Charge, Share, …) and will be use first to verify the calculation engine and algorithms with existing paths already in scenario then check if the calculation engine can purpose us new paths and secondly to build an Energy Digital Business Ecosystem User Interface to help him to decide between multiple possibilities. The figure below outlines the big picture of this interface.



V. CONCLUSION

This approach based on Simplicial formalism, Assemblage and Activity Streams presents many perspectives, especially in area such Energy Management interface and application development.

We hypothesize first that Assemblage theory is relevant to model a Home Energy Management System, second point of view is that Simplicial Complex techniques are very powerful to calculate trajectories and relationships structures and third point of view that Activity Stream is a useful semantic framework to aggregate different type of data. To summarize and describe the different steps of our work in frame of this article, we aggregated different sources of information and extracted data to build a specific data set. After that we use Assemblage theory and calculate with Simplicial Complex theory to get a graphic visualization of possible trajectories and finally we analyse these results to define decision paths which help user in his ecosystem and energy's uses.

At this time some limitations still exist and we need to continue with our research. The upstream of our information aggregation process is not totally automatized principally due to the Activity Streams implementation. Then we have an actual visualization limitation of Simplicial Complex results when lot of data are involved. The last limitation is that actually our system is focused on Data & Alert aggregation in order to provide user key information through a end user interface. We are trying to implement Ecosystem process, visualisation axes and new decision algorithms to provide integrated intelligent application as a Global Energy Home Decision & Management Application.

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Eddie Soulier was born in Savoy, France, in 1962. He received his PhD degree in Artificial Intelligence from Université Pierre et Marie CURIE (UPMC), France, in 2003, and is Habilitation degree in Computer Science from the "Université de Technologie de Compiègne" (UTC), in 2010. In 1999, he joined the Cooperative Technologies for Collective Interaction and Knowledge Laboratory (Tech-CICO) of the University of Technology of Troyes (UTT). Since 2000, he belongs to the Department of Informatics and Information Systems (ISI), University of Technology of Troyes. He is Professor since 2011. He is also Associate Professor at Paris Dauphine, Paris, and Paris Descartes University, France. His current research interests include Computer-Supported Cooperative Work (CSCW), Knowledge engineering (KE), Social web and, more recently, simulation of dynamics complex social systems. Prof. Soulier is since 2000 member of Système d'Information et Management (SIM), as the leading journal in the French speaking world in Information System Management area.

Philippe Calvez was born in 1977, Berlin, Germany. he received his Master of Science degree in Computer Science from University of Technology of Troyes. He worked during many years in Consulting Firms especially in Web Technologies.He is actually PhD student at University of Paris 1 Sorbonne (CRI Laboratory) and Business Analyst at GDF SUEZ, French multinational energy company (the world's largest utility). His current research interests include Smart Grid, Digital Business Ecosystem, Enterprise Social Semantic Networks, Social Web.

Florie Bugeaud was born in 1984, Evry, France. She received her PhD degree in Computer Science, in collaboration with the University of Technology of Troyes (ICD/Tech-CICO), as she was Research Engineer at France Télécom Orange - Research and Development.She is actually Research Engineer at Nekoe, Orléans Area, France, Nonprofit and Civic & Social Organization industry since November 2011.Her current research interests include Service science, management, and engineering (SSME) discipline, Ontology and in particular Mereology, Modeling, Simulation, Process-oriented paradigm.

Francis Rousseaux was born in 1961, Reims, France. He received his PhD degree in Computer Science - University of Paris VI (Paris) Multimedia applications and groupware applied to music, in 1990. During 1986-1990 he was Associate professor at the University of Paris IV - Sorbonne - Paris Information highways, culture economics, and information technologies. He received is Habilitation in 1992. Between 1998 – 2001 he was Director of the research team associated to the International Philosophy College - Paris on the theme of strategic-political decision. He is Full Professor of Computer Science at the University of Reims Champagne-Ardenne (URCA) since fall 1997 and member of the Research Lab in Computer Science (LERI), then member of CRéSTIC (EA 3804), Université de Reims (URCA), France, and currently at IRCAM (UMR 9912) on behalf of CNRS, France. His current research interests include Computing and decision making, Music & new technologies, Epistemology & computational location.In 2005 he was President of the "Computer Society" chapter of the French Section de l'IEEE.

Jacky Legrand is assistant professor in Computer Science at the Université Panthéon-Assas. His current research interests include Algorithmic analysis, knowledge management, Database theory, and decision theory.