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**Institut national des sciences
appliquées de Lyon**

Activity Report 2014

Team DICE

Data on the Internet at the Core of the Economy

RESEARCH CENTER
Grenoble - Rhône-Alpes

THEME
Security and Confidentiality

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Team DICE

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Creation of the Team: 2013 February 01.

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2. Overall Objectives

2.1. Overall Objectives

The DICE team has been created in February 2013 as an "action exploratoire" of Inria to initiate a multidisciplinary research on the economy of data resulting from the digital revolution and its impact on all sectors of our society including its political organization.

With the growth of Web 2.0 systems, social data constitutes a fundamental resource of the economy, much like raw materials. A resource, which is becoming as important as crude oil, and without our societies would stop working. Data are harvested and transformed by industries that grow at an unprecedented pace. Web corporations offer extremely valuable services, which attract users in the hundreds of millions. These corporations generate ecosystems, which become as essential as public utilities and support millions of developers. The new utilities also challenge societies by making obsolete fundamental aspects of their organization, and by generating new (im)balances at global scale.

The objective of DICE is to study the complex dependencies between technological, social and economic systems of the digital age, and to propose technical contributions as well as socio-political analyses. We are ambitious to further investigate the impact of the digital revolution on political systems, anticipated by the French philosopher Michel Serres as expressed in Inria's 2020 Plan.

"if the vast volume of global data [...] were to become accessible to as many people as possible [...], such an event would be liable to put political institutions and the sciences that study them on a new path, perhaps more quickly than we expect."

Michel Serres also insists on the role of computer scientists to study this revolution and its social impact.

Our contributions target both technical and theoretical aspects of the economy of personal data. Our aim is to

- study from technological as well as social, economic, political, and geopolitical points of view, the new ecosystems emerging from the services of the information society based on mediating social data, which are reshaping the very form of our organizations;
- contribute to improve the knowledge of the information society and its implications among specialists as well as non specialists, in the public opinion as well as at the political level;
- propose technological solutions that answer some of the challenges faced by our societies, such as the concentration of data, the resulting asymmetry of information, and the subsidiarity of computation, that could contribute to better distribute the knowledge among stakeholders.

3. Research Program

3.1. Introduction

Our aim is to address both

- challenges in the field of information technology, as well as
- trans-disciplinary issues emerging from the global impact of the digital revolution.

We believe that addressing both directions at the same time is an efficient way to be relevant in each of them.

We focus on intermediation platforms, which are becoming dominant systems in the Web industries. Intermediation platforms are systems which offer services to their users, which are well tuned for their expectation, thanks to the knowledge the platform has accumulated on usage. Search engines, social networks are examples of intermediation platforms. They ensure a gatekeeping function, always in direct contact to their users, providing them with the most relevant information or contact. Their economic model relies on a biface economy, with two types of users, one subsidizing the other. Their impact goes beyond the Web, and they disrupt step by step all sectors of the economy, transportation, Press, education, to name a few.

So far as IT is concerned, we focus on the technologies used for intermediation, which are at the basis of the largest online systems. For the transdisciplinary questions, we focus mostly on the new equilibrium that is resulting from the evolution of power balances due mostly to intermediation platforms.

3.2. Intermediation technologies

DICE focuses on intermediation platforms because of the central role they play in the new economy.

Intermediation platforms connect users to one another, or users to services with a very high accuracy. They rely on innovations both technological and social, which were unthinkable only ten years ago, when Facebook started. They allow communication and interaction between billions of users, gathered in the same digital space, both producers and consumers of data and services. State-of-the-art intermediation platforms include Facebook, Google, Twitter, GitHub, as well as Wikipedia, StackOverflow or Quora. These systems share a common design and their market penetration follows the same pattern. They are built around an initial minimal viable product based on a somehow naive low-tech implementation, which evolves after a few years of improvement to Web giants. Their domination now contributes to standardize the web industry, that means in particular:

- Gatekeeping, a direct relation with users together with services satisfying users' needs;
- Continuous data flows mapped to users' profiles;
- Search engines associating, in a relevant manner, producers, consumers and services.

These common characteristics lead to new software architectural standards, which are shared by all these systems, and used in the peripheral services developed in the ecosystem around their API:

- Authentication systems: openId, OAuth, ...
- Object graphs: opengraph, follower/followee scheme, ...
- DataFlow engines: Twitter storm, Google millwheel, ...
- Databases: noSql, keyValues stores, ...
- Web Browsers: javascript, dart, MEAN (Mongo, Express, Angular, Node),...

These architectural components impact the whole digital world. DICE targets systems that use standard architecture services but preserve some aspects we consider as disruptive ones: *data concentration*, *data symmetry* and *computational subsidiarity*. Our current research activity includes the following directions:

- Peer-to-peer design for preserving users' primary data;
- Third parties based organic systems providing subsidiary data computation hosted at peer sites;
- In-Browser applications that impact mobile device and demonstrate instantaneous usability;
- Flow-based computing enabling a stream based exchange of information between peers at runtime.

3.3. Economy of the digital world

The digital revolution is impacting all sectors of our societies and organizations, education, energy, transportation, health, to name a few. This revolution results in the phenomena of Schumpeter's *creative destruction*, with the disappearance of traditional sectors and the creation of new ones. Our societies, which did not anticipate the depth of the changes, have to struggle to adapt to the pace of the development of the industry. Legal reforms in various important sectors including taxation are at stake. Some countries, more reactive than others, are clearly pulling the changes, exploiting the benefits for businesses and the capacity to generate information and value, while others are trying to catch up with the global trends.

Data form the bricks of the information society, and their flows between users and services constitute the blood of the industry. We focus in DICE on the strategic role of data in this revolution, and in particular on the systems that harvest the data and concentrate it.

We are also interested in the global political impact of this revolution, which deeply changes the relations between governments and citizens. If the privacy is the focus of considerable attention, together with the state surveillance, in Europe in particular, it is only one aspect of the new knowledge made available. Social media produce considerable knowledge not only on individuals, but on populations as well, their economic fate, their political orientation, etc. On the other hand, open data from governments allow citizens to monitor the action of their governments, as well as to contribute to it. The digital revolution, with the capacity to access information in ways unthinkable in the recent past, modifies completely the balance of powers between citizens, states and corporations.

We investigate the digital world, and more precisely the power relations, from an interdisciplinary perspective. We simultaneously quantify power relations by studying data flows and the rise of intermediation platforms and produce an economical, political and ethical analysis of this new state of affairs. Namely, we show that areas such as the US or China dominate the digital world when others, such as Europe, do not succeed in proposing widely used intermediation platforms. This situation generates several conflicts between countries and companies and prevents weak countries from promoting their values and policies.

A new trend is emerging in the humanities, around in particular the digital studies, which promote the cooperation between computer scientists and specialists of social sciences. Among them, the Berkman center for Internet and Society in Harvard, the Medialab at MIT, or the Web Science Institute in the UK have gained strong visibility. They address positive as well as negative externalities of IT for societies, that is the new potentials offered as well as their risks. The Center for Information Technology Research in the Interest of Society in Berkeley also addresses fundamental political impacts on democracy, which can be enhanced by open data as well as another philosophy of political power as currently implemented in the State of California for instance. The Open Data Institute in the UK is also a leading center for political issues in Europe. France should catch up on these research trends, at the intersection of different scientific fields.

4. New Software and Platforms

4.1. GPeer: a peer-to-peer javascript communication library

Our software development has been oriented towards systems working in browsers, with the support of an **Inria ADT project** in cooperation with the ASAP team. To answer our technological objectives, we are working on decentralized architectures, browser to browser, developed in javascript/HTML5. We rely on the WebRTC JavaScript protocol proposed by Google to develop a communication layer between peers. Many peer-to-peer protocols share common elements, that we group in a generic library for developing peer-to-peer systems. The joint library developed with the ASAP team handles any gossip based communication overlay. We design peer messages, tracker management and resilient behavior. The library is a standard bridge between complex browser to browser applications and low level networking layers such as WebRTC. With the use of our library, we can reproduce systems such as BitTorrent, but also provide new applications without the need of either native applications or identified servers.

4.2. Fluxion: a software plugin for flows in AngularJS

The **joint project with Worldline** aims at managing mobile code in complex Web architectures. Load variation in data-centers is currently poorly resolved. Most of the time, systems overestimate resource consumption in order to absorb burst usage. These consumption overestimation has a cost both in terms of the SLA negotiated with the client and the non-availability of reserved resources. With Wordline we focus on code mobility for high performance Web architectures and design a fast and reactive framework, transparently moving functions between running systems. The Fluxion model is our approach to design mobile application modules that are a mix of functional programming and flow based reactive systems.

4.3. BitBallot: a decentralized voting protocol

The BitBallot voting protocol is designed to target large scale communities. The protocol allows users to share only restricted amounts of their data and computation with central platforms as well as other peers. Convinced by the need of new election mechanisms, to support emerging forms of more continuous democracy, we are developing BitBallot, to allow elections to be organized independently of any central authority. The protocol guarantees the following properties, anonymity of the data sources, non interruptible run-time, global access to results, and non predictability of results through partial communication spying.

4.4. Odin: an intermediation platform

Odin is a middleware framework for building intermediation platforms. It is build over a kernel that stores users data and activities on a noSQL database and a full client/server JavaScript communication stack. The kernel is used to build intermediation platforms for any kind of project management systems, and where projects peculiarities are handled through a plugin architecture. Plugins are used to define dedicated crawlers over the Web that gather information and push recommendation toward users. The framework maintains an internal currency used to trigger a subset of agents used for recommendation. These recommendations must be mapped to the project keywords and user profile. Each user project is associated to a specific amount of money in our currency, and project users may use this currency to drive their virtual agents. If agents are correctly driven, projects may gain more money used to obtain better recommendations or used on other projects. Our goal is to gather a huge amount of users in order to study system scalability in a real life application. We use odin to test and validate search engines, recommendation engines, external resource crawling, and social network user experiences.

4.5. C3PO: Collaborative Creation of Contents and Publishing using Opportunistic Networks

Social networks put together individuals with common interests and/or existing real-life relationships so that they can produce and share information. There is a strong interest of individuals towards those networks. They rely on a stable, centralized network infrastructure and a user will always be provided with the same services no matter what their current context is. By contrast, the C3PO project aims at promoting “spontaneous and ephemeral social networks” (SESN), built on top of a peer-to-peer distributed architecture leveraging ad-hoc mobile networks and the resources and services offered by mobile devices. As with traditional social networks, SESN can put together nomad individuals based on their affinities and common interests so that they can collaboratively work on tasks as part of a SESN. In C3PO, we strive for incitation in collaborating through a SESN. Several application domains have been anticipated for SESN, especially those involving gathering information and producing content as part of cultural or sport events. In such types of SESN, photo sharing, collaborative document edition and sport results spreading services can be used for building structured digital contents that relate the events of sports gatherings. Generated contents can be consulted through the multiple production sources. They can then be replicated on dedicated servers or published to traditional, centralized social networks and made available to Internet users beyond the lifespan of the SESN where they were initially produced. The C3PO project aims at investigating the problems posed by SESN, and especially those induced by the dynamic and unreliable nature of the ad-hoc mobile networks. It will offer innovative scientific and software solutions for services provision with intermittent connectivity, the definition of an infrastructure for the collaborative management of services in the context of SESN, and an analysis of the value adapted to this context. C3PO is a 3 years ANR industrial research project involving 4 academic research groups and an industrial partner. The proposed contributions will be validated by experimentation in real-world conditions.

5. New Results

5.1. The economy of intermediation

We have presented in [6] an introductory panorama on the disruption of the intermediation revolution. Our efforts to measure data flows in the world, have been pursued [2] to estimate the concentration of the data industry. It is well known that the main platforms of the Web are concentrated in a few countries, mostly in the USA. Some countries, mostly in Asia, such as China, Russia, Korea or Japan have successfully developed their own Web 2.0 industry, while others, such as European countries, have failed to do so. We have explored in [7] the strategy of China, which has the largest Web industry behind the US and has made a priority of keeping its data at home, with systems in all activity sectors developed in general only one or two years after their main American counterparts. The innovation strategy of China aims in all fields to achieve technological independence, with at most 30% of foreign IP.

The rise of the economy of data disrupts values, such as privacy, and the way we think about our visibility. In [9], we investigate the digital world from an ethical perspective and a computer science viewpoint. We assess the structure and the dynamic of digital visibility and propose a model-driven approach to handle visibility in service compositions.

5.2. Architecture design for intermediation platforms

During our joint work with Worldline we built a JavaScript compiler for generating dataflow program from plain standard JavaScript sources. In an ACM Middleware conference poster session we raised the question of extracting a dataflow design from JavaScript callback hell. The compiler <https://github.com/etnbrd/due-compiler> is used to help JavaScript standard developers generate their equivalent dataflow scheme without the need of external libraries such as Promises, Async or Q. With this tool, developer may migrate their javascript legacy code towards a new flow based design. Our due npm module <https://github.com/etnbrd/due> is a first step towards a dynamic flow based architecture studied in Etienne’s project.

The C3PO project provides a browser based application for interacting with other nearby participants in chat mode. The client architecture runs exclusively in the browser over a DTN layer and listens to posts sent through a dedicated spontaneous and ephemeral social network (SESN) [5]. The client is organized around a display canvas hosting plugins. Each plugin registers for some tags it wishes to handle. The local DTN manager receives posts and propagates them to the plugins.

We have used intermediation technologies for voting systems. A brief presentation of our motivations has been made in [4]. A patent on the BitBallot protocol is on its way.

6. Bilateral Contracts and Grants with Industry

6.1. Bilateral Contracts with Industry

DICE has bilateral contracts with two large companies.

Worldline Worldline is a leader in B2B applications development, and is in the front line to provide new technical solution in the Web 2.0 era. We have a CIFRE partnership contract on the study of flow based architectures both at the data centers and at the Web browser level.

BullSA BullSA is producing and designing next generation Many-Core architecture. Although most of the time these calculators are used in real-time, closed environment such as military equipment, the dynamic, adaptability, and upgradable nature of systems is a real issue. We participate in a joint project to design a management layer for handling dynamic data flow application in a soft real-time context.

7. Partnerships and Cooperations

7.1. Regional Initiatives

DICE is involved in a regional project of the Rhône-Alpes region, ARC6 "Innovative Services for Social Networks", with Telecom Saint Etienne.

7.2. National Initiatives

7.2.1. ANR

DICE is involved in two ANR projects, to start at the end of 2013,

- C3PO, on Collaborative Creation of Contents and Publishing using Opportunistic networks, with LT2C Telecom Saint-Etienne, INSA LYON, IRISA, ChronoCourse, et Ecole des Mines de Nantes.
- Socioplug, Social Cloud over Plug Networks, Enabling Symmetric Access to Data and Preserving Privacy, with LINA / Université de Nantes, Université de Rennes 1, INSA Lyon.

7.3. European Initiatives

7.3.1. FP7 & H2020 Projects

DICE is involved in the CSA project "Big data roadmap and cross-disciplinary community for addressing societal Externalities (BYTE)", Objective ICT-2013.4.2 Scalable data analytics (c) Societal externalities of Big Data roadmap.

7.4. International Initiatives

7.4.1. Inria International Labs

DICE is involved in the Inria IPL citylab project headed by Valerie Issarny.

7.4.2. Participation In other International Programs

DICE has a joint project on BigData and intermediation "Promises of intermediation platforms for services frugal in resources" that is carried out within the cooperation framework JORISS between ENS Lyon and ECNU Shanghai.

DICE is starting a cooperation with CERN for the design of a new Javascript 2D/3D architecture for LHC event display experiments.

7.5. International Research Visitors

7.5.1. Visits of International Scientists

7.5.1.1. Internships

In 2014, the team DICE supervised three internships of master students, including two international students.

8. Dissemination

8.1. Promoting Scientific Activities

8.1.1. Scientific events selection

Stéphane Grumbach is a member of a Scientific Committee on journalism and public welfare in the digital age at the College des Bernardins in Paris.

8.2. Teaching - Supervision - Juries

8.2.1. Teaching

Licence : Stéphane Frénot, Stéphane Grumbach: Twitter, Facebook et le Web2.0, Module INSA Lyon, automne 2014

Master : Stéphane Grumbach, L'intermédiation et l'économie des ressources, cours dans le cadre du Master Biosciences, UE Sciences et Société, ENS Lyon, décembre 2014

INSA, Stéphane Frénot, Agility: A 32 hours optional course on agile software development presenting both iterative (SCRUM) and stream based approaches (LEAN IT). M1. (since 2011)

INSA, Stéphane Frénot, Innovating Project: Supervising 250 hours student project aim at managing innovating projects. Each student group leads its own subject during one semester. All projects and organizational details are publicly available here: <http://tc-pi.fr> M1 (Since 2006)

INSA, Stéphane Frénot, Learn Other Languages: The aim of the course is to improve one's skills in current state-of-the-art programming and discover different ways to develop using mainly web-oriented programming languages. M1 (Since 2013)

Stéphane Grumbach, L'Economie des données, Webinaire, as part of the lecture Economie du Web, ENS Lyon, Université de Montréal, Enssib, Nov 2014

8.2.2. Supervision

Robert Riemann, decentralized voting, Sept 2014

Etienne Brodu, DataFlow compilation from JavaScript, Jan 2013

Manuel Selva, Dynamic dataflow for embedded system, Nov 2011, with Lionel Morel (Socrate Inria team)

Marie-Ange Lebre, Service oriented computing in cars, Jan 2011, with Frederic Le Mouel (Dynamid CITI team)

Rocha Goya, Smart OS for smart ambient devices, Sept 2011, with Frederic Le Moueil (Dynamid CITI team)

8.2.3. Juries

Hu Zeng, Auto-configuration, Supervision et Contrôle d'Entités Physiques par l'intermédiaire de Réseaux de Capteurs et Actionneurs, Advisor, Jan 2014

Dan Yufang, Security and self-healability enforcement of dynamic components in a service-oriented system, Advisor, may 2014

Nicolas Haderer, APISENSE : une plate-forme répartie pour la conception, le déploiement et l'exécution de campagnes de collecte de données sur des terminaux intelligents, examiner, 5 nov 2015

Jigar Solanki, Approche générative conjointe logicielle-matérielle au développement du support protocolaire d'applications réseaux, reviewer, 27 Nov 2014

8.3. Popularization

- Stéphane Frénot and Stéphane Grumbach have been invited speakers to the BlendWebMix conference in Lyon end of October. This event of two days unites actors from different fields in the web domain, i.e. programmers, entrepreneurs, designers and scientists. Two contributions have been programmed for DICE to speak about digital and geographical territories, and about big data and intermediation platforms.
- The annual German-speaking conference DNP14 in Vienna (Austria) is a two-day event to discuss topics related to data, networks and politics and has taken place this year in September. Robert Riemann was giving a talk to introduce the concept of the C3PO project and illustrate its possibilities of application.
- Metroscope aims at being a leading Internet Observatory. It holds an annual workshop. Aurélien Faravelon presented DICE's works on intermediation at the 2014 edition.
- Séminaire Pint Of Science, Lyon, Google, Twitter, BitTorrent et BitCoin : les données, objets de toutes les convoitises <http://www.pintofscience.fr/#!lyon/ci18>, 21 Mai 2014
- Rencontres CNRS Journées citoyen CNRS, poitiers, invitation to a seminar at school about Big Data, 17-19 Oct 2014, <http://www.cnrs.fr/sciencesetcitoyens/>
- Panel Big Data, Open Data : enjeux démocratiques, colloque Le monde après Snowden, Assemblée nationale, Paris, 13-14 mars 2014
- La France dans le paysage mondial de l'intermédiation, Audition publique au Sénat, Mission commune d'information "Nouveau rôle et nouvelle stratégie pour l'Union européenne dans la gouvernance mondiale de l'Internet", Paris, 11 Febr 2014
- Les enjeux du numérique présentés aux députés, avec la délégation Inria, et le groupe d'études Internet et société numérique de l'Assemblée nationale, Paris, 21 janvier 2014

8.4. Invited talks

- Introduction aux algorithmes, Séminaire Journalisme et bien commun à l'heure des algorithmes, Collège des Bernardins, Paris, 16 Dec 2014
- Les données et la sécurité, Panel Les villes intelligentes, Universités de la sécurité, AN2V, Lyon, 4-5 Dec 2014
- L'intermédiation et l'économie des ressources, cours dans le cadre du Master Biosciences, UE Sciences et Société, ENS Lyon, Dec 2014
- Data is power, Panel The power of data and the internet of things, Global Forum, Geneva, 17-18 Nov 2014

- L'Economie des données, Webinaire, dans le cours Economie du Web, ENS Lyon, Université de Montréal, Enssib, Nov 2014
- "Big Data as a Resource – Political And Geopolitical Issues At Stake", Conference on Smart Data for Government, London, 23-24 Sept, 2014
- Les enjeux de l'information, Congrès de l'Union Française des Métiers de l'Événement, UNIMEV, Lille 2-4 Jul 2014
- Panel "Data Centers, Open Data, Big Data", 5th European Summit on the Future Internet, Luxembourg, 12-13 June 2014
- "The Power of Intermediation and the Geopolitical Challenge", The Diplomacy and Diversity Fellowship, a Humanity in Action program, Paris, 11 Jun 2014
- L'économie de l'intermédiation, Les grandes conférences du LIG, Grenoble, 15 May 2014
- Les données, nerf de la guerre, Journée IXXI sur la révolution numérique et la gouvernance, Lyon, 4 Apr 2014
- Les grandes plateformes de données, enjeux politiques et géopolitiques ? Institut des sciences de la communication, ISCC, Paris, 25 Mar 2014
- Panel on Big Data, Swiss STS meeting, Collecting, Organizing, Trading Big Data, University of Lausanne, 20-22 Febr 2014

9. Bibliography

Publications of the year

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Articles in National Peer-Reviewed Journals

- [2] S. FRÉNOT, S. GRUMBACH. *Les données, objets de toutes les convoitises*, in "Hérodote", February 2014, <https://hal.inria.fr/hal-00908894>

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- [3] Y. DAN, N. STOULS, S. FRÉNOT. *An OSGi Monitoring System with Dynamicity Resilience enhancing Fault Tolerance*, in "International Conferences on Software and Computing Technology", Lijiang, China, August 2014, <https://hal.inria.fr/hal-01009780>
- [4] S. FRÉNOT, S. GRUMBACH, D. REIMERT. *E-Voting, the Case for Decentralised Systems*, in "COOP 2014", Nice, France, Workshop on Cooperative Technologies in Democratic Processes - Beyond e-Voting, May 2014, 3 p. , <https://hal.inria.fr/hal-01097479>
- [5] F. LAFOREST, N. LE SOMMER, S. FRÉNOT, F. DE CORBIÈRE, Y. MAHÉO, P. LAUNAY, C. GRAVIER, J. SUBERCAZE, D. REIMERT, E. BRODU, I. DAIKH, N. PHELIPPEAU, X. ADAM, F. GUIDEC, S. GRUMBACH. *C3PO: a Spontaneous and Ephemeral Social Networking Framework for a collaborative Creation and Publishing of Multimedia Contents*, in "International conference on selected topics in Mobile and Wireless Networking (MoWNet 2014)", Rome, Italy, Procedia Computer Science, Elsevier, September 2014, pp. 1-6, <https://hal.archives-ouvertes.fr/hal-01069778>

Scientific Books (or Scientific Book chapters)

- [6] S. FRENOT, S. GRUMBACH. *Des données à l'intermédiation, une révolution économique et politique*, in "Big data : nouvelles partitions de l'information", De Boeck, December 2014, <https://hal.inria.fr/hal-01091812>
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Other Publications

- [8] E. BRODU, S. FRÉNOT, F. CELLIER, F. OBLÉ. *A compiler providing incremental scalability for web applications*, December 2014, Middleware [DOI : 10.1145/2678508.2678526], <https://hal.archives-ouvertes.fr/hal-01076857>
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