



## Activity Report 2017

# Team DATASPHERE

## Economie des données et des plateformes

Inria teams are typically groups of researchers working on the definition of a common project, and objectives, with the goal to arrive at the creation of a project-team. Such project-teams may include other partners (universities or research institutions).

RESEARCH CENTER  
**Grenoble - Rhône-Alpes**

THEME  
**Security and Confidentiality**



## Table of contents

|   |          |
|---|----------|
| <b>1. Personnel</b>                     | <b>1</b> |
| <b>2. Overall Objectives</b>            | <b>1</b> |
| <b>3. Research Program</b>              | <b>2</b> |
| <b>4. Application Domains</b>           | <b>2</b> |
| <b>5. Highlights of the Year</b>        | <b>3</b> |
| <b>6. New Software and Platforms</b>    | <b>3</b> |
| 6.1.1. DNS data analysis                | 3        |
| 6.1.2. Advokat                          | 3        |
| 6.1.3. BGP Geopolitics                  | 3        |
| <b>7. New Results</b>                   | <b>3</b> |
| 7.1. Political economy                  | 3        |
| 7.2. Anthropocene                       | 3        |
| 7.3. Laws and digital                   | 3        |
| 7.4. Network data analytics             | 4        |
| 7.5. Data protection                    | 4        |
| <b>8. Partnerships and Cooperations</b> | <b>4</b> |
| 8.1. Regional Initiatives               | 4        |
| 8.2. National Initiatives               | 4        |
| 8.3. International Initiatives          | 4        |
| <b>9. Dissemination</b>                 | <b>4</b> |
| 9.1. Promoting Scientific Activities    | 4        |
| 9.2. Teaching - Supervision - Juries    | 5        |
| 9.2.1. Teaching                         | 5        |
| 9.2.2. Supervision                      | 5        |
| <b>10. Bibliography</b>                 | <b>5</b> |



# Team DATASPHERE

*Creation of the Team: 2017 January 01*

## Keywords:

### Computer Science and Digital Science:

A1.5. - Complex systems

A3.1. - Data

A3.5. - Social networks

### Other Research Topics and Application Domains:

B3. - Environment and planet

B8.2. - Connected city

B8.5. - Smart society

B9.5. - Humanities

B9.9. - Risk management

## 1. Personnel

### Research Scientist

Stephane Grumbach [Team leader, Inria, Senior Researcher, HDR]

### PhD Students

Robert Riemann [Inria, until Sep 2017]

Jingxiu Su [Inria, from Apr 2017 until Sep 2017]

### Administrative Assistant

Sylvie Boyer [Inria]

### External Collaborators

Jean Pascal Bassino [Ecole Normale Supérieure Lyon, HDR]

Jean Sylvestre Berge [Univ de Lyon, HDR]

Frederick Douzet [Université Paris 8 et Chaire Castex, HDR]

Olivier Hamant [INRA, HDR]

Mohammad Reza Salamatian [Université Savoie Mont-Blanc, HDR]

## 2. Overall Objectives

### 2.1. Overall Objectives

The past decade have witnessed an explosion of the amount of data produced by people and harvested through digital systems. These data are collected, analyzed, correlated and transformed to enable innovative services, which have strong, often disruptive, impact on society. The datasphere is the new space resulting from these data, considered as a whole, independently of their control. It constitutes a dynamic complex system, much like the hydrosphere, where the basic constituents are bits of data in place of water molecules. Although the date of the inception of the datasphere can be debated, it is really at the turn of the century that its role became dominant and challenged the legacy organisation of societies.

The objective of the Datasphere team is to study the transformation of socio-economic systems triggered by the diffusion of digital services. We propose a holistic view of the datasphere to apprehend global changes at a planetary scale, with a long term perspective, sometimes with a teleologic vision to understand the phenomena at play and model the interactions of the future. We also consider the digital transformation of socio-economic systems in relation with the challenges that the threats on the natural ecosystem of our planet impose on human societies. Both transformations happen contemporarily, and share parallel impact on the tension between local and global, vertical and horizontal.

From a methodological point of view, we aim (i) at interdisciplinary research with all relevant disciplines, and in particular social sciences, and (ii) when possible, analysis of large datasets, such as those from network activities, to investigate quantitatively global phenomena. The first aim raises classical difficulties of interdisciplinary research, but is carried on in a very favorable environment, namely the complex system institute, IXXI. For the second aim, we need to develop original data analysis techniques, new metrics on data flows related to social activities, as well as new visualisation methods to show the interdependencies between entities, from States to people and devices.

## 3. Research Program

### 3.1. Transformations

The research program of the Datasphere team aims at understanding the transformations induced by digital systems on socio-economic organization. It includes the following directions:

- The economy of intermediation and the progressive control of two-sided markets by digital platforms.
- The legal implication of the developments of networks, the growing global interdependencies, the collapse of territories, and the increase of digital flows beyond control.
- The geopolitics of digital systems, data flows and cyber control, the raise of new imbalances, and digital powers (US, China, Russia, etc.)
- The structural consequences of the translation of governance to digital actors, and the weakening of sovereignty over territories.
- The interdependencies of natural ecosystems and socio-economic systems, and the role of digital systems on measuring and controlling the global natural/social system.
- Developing methodologies for assessing the strategic value of data and evaluating its leverage for digital economy.

## 4. Application Domains

### 4.1. Governance

Application domains include:

- City governance, data and interaction with citizens.
- New voting mechanisms.
- Local governance vs global norms and control.
- Security in an unstable world.
- Adaptation to the conditions of the anthropocene, resources and homeostasis.
- Data strategy for digital economy

## 5. Highlights of the Year

### 5.1. Highlights of the Year

#### 5.1.1. Awards

Kavé Salamatian has been awarded in 2018 a President's International Fellowship of the Chinese Academy of Sciences.

## 6. New Software and Platforms

### 6.1. Platforms

The team participated to the development of the following software platforms.

#### 6.1.1. DNS data analysis

Data analytics tools for DNS data analysis were developed in a cooperation with ICT, Chinese Academy of Sciences in the frame of the thesis of Jingxiu SU [9].

#### 6.1.2. Advokat

Distributed aggregation mechanisms preserving confidentiality for application such as online voting were developed in the frame of the thesis of Robert Riemann [11].

#### 6.1.3. BGP Geopolitics

An observatory of global BGP connectivity has been developed that is used to monitor in real time BGP level attacks. In addition, a set of tools were developed to analyse the structure of information propagation over social networks.

## 7. New Results

### 7.1. Political economy

We pursued our work on digital platforms and their impact on the structure of socio-economic systems, which results from the capacity to separate data or information from the actors of the physical world. In [14], we showed how the movement above ground of the intermediation activity transforms territories. We developed further this idea in [5] to suggest that a new political grammar is necessary to understand the relationships between the actors.

### 7.2. Anthropocene

In [6], we investigated the possible similarities between biological systems and social systems facing shortage of resources, suggesting that the digital revolution might have something to do with the Anthropocene. The timing of the digital revolution was further investigated in [7], to further analyse the relationships between the two transformation affecting the contemporary period. An investigation of the world of images and photography in the time of algorithms was conducted in [4].

### 7.3. Laws and digital

The emergence of digital services affects the legal system. The law is always associated to a territory, while digital systems act remotely over large regions crossing borders to reach the population, imposing new norms. In [3], [2], we suggest that a new framework is necessary to apprehend new phenomena, such as the those resulting from the conflicts between global search engines and local rules with respect to the Right to be forgotten for instance.

## 7.4. Network data analytics

In collaboration with the Chinese Academy of Sciences, we worked on packet processing algorithmic for high speed network measurements. In [9] a packet capture archive system is developed and described. In [8] a theoretical analysis of the TCAM updates delay that is the main shortcoming of TCAM usage in high speed packet processors is presented. Quality of service for network functions were considered in [13].

## 7.5. Data protection

We developed new mechanisms to process aggregation while preserving the confidentiality of the initial data in the framework of Robert Riemann's thesis [1]. The benefits of distributed protocols for online voting was considered [12]. A distributed aggregation mechanisms preserving confidentiality of data based on Kademlia was proposed in [11]. Applications of the previous algorithms to lotteries was considered in [10].

# 8. Partnerships and Cooperations

## 8.1. Regional Initiatives

L'équipe est hébergée dans l'IXXI, l'Institut Rhônalpin des Systèmes Complexes au sein de l'ENS de Lyon, et très impliquée dans les partenariats interdisciplinaires.

## 8.2. National Initiatives

- Chaire Castex, Ecole Militaire, Paris
- AMNECYs (Alpine Multidisciplinary Network on CYber-security Studies), University of Grenoble-Alpes

## 8.3. International Initiatives

### 8.3.1. Informal International Partners

- RIHN, Research Institute on Humanity and Nature, Kyoto
- Information School, UC Berkeley
- ICT, Institute of Computing Technologies, Chinese Academy of Sciences, Beijing
- CSIRO, Sydney
- Center for CyberSecurity, University Macquarie, Sydney
- Center for Internet Human Rights (CIHR), Berlin

# 9. Dissemination

## 9.1. Promoting Scientific Activities

Stéphane Grumbach has been co-director of IXXI since 2014. He is also involved in the Anthropocene Group at ENS Lyon, which promoted interdisciplinary research and teaching activities on issues related to the adaptation to the changes of the natural ecosystem. He is involved in various initiatives to promote scientific knowledge to a wider audience, as well as in cooperation with public administrations (local and national) to face the challenges of the digital revolution.



## 9.2. Teaching - Supervision - Juries

### 9.2.1. Teaching

Stéphane Grumbach teaches a new Master course on the Economy of Data at SciPo Paris. He also teaches in several universities including, ENS Lyon, Insa Lyon, etc.

### 9.2.2. Supervision

PhD : Robert Riemann, Towards Trustworthy Online Voting: Distributed Aggregation of Confidential Data, Université de Lyon, 18 décembre 2017, directeur de thèse Stéphane Grumbach

PhD in progress : Jingxiu Su, DNS data analysis, 2016, directeur de thèse Kave Salamatian

## 10. Bibliography

### Publications of the year

#### Doctoral Dissertations and Habilitation Theses

- [1] R. RIEMANN. *Towards Trustworthy Online Voting: Distributed Aggregation of Confidential Data*, Ecole normale supérieure de Lyon, December 2017, <https://hal.inria.fr/tel-01675509>

#### Articles in International Peer-Reviewed Journals

- [2] J.-S. BERGÉ, S. GRUMBACH. *The Datasphere and the Law: New Space, New Territories*, in "Revista Brasileira de Políticas Públicas", 2017, vol. 7, n<sup>o</sup> 3, forthcoming, <https://hal.inria.fr/hal-01669292>
- [3] J.-S. BERGÉ, S. GRUMBACH, V. ZENO-ZENCOVICH. *Data Flows beyond Control: Challenges for Law and Governance*, in "European Journal of Comparative Law and Governance", January 2018, forthcoming, <https://hal.inria.fr/hal-01669305>
- [4] S. GRUMBACH. *Dans les griffes des algorithmes*, in "Infra-minces: revue de photographie", 2017, forthcoming, <https://hal.inria.fr/hal-01669290>
- [5] S. GRUMBACH. *Digital Platforms: A New Grammar for Territories?*, in "Ethics-in-Progress", 2017, vol. 1, n<sup>o</sup> 1, forthcoming, <https://hal.inria.fr/hal-01669287>
- [6] S. GRUMBACH, O. HAMANT. *Digital Revolution or Anthropocenic Feedback?*, in "The Anthropocene Review", December 2017, pp. 1-12 [DOI : 10.1177/2053019617748337], <https://hal.inria.fr/hal-01227303>
- [7] S. GRUMBACH, O. O. HAMANT. *Pourquoi "maintenant" ? Le cas de la révolution de l'intermédiation algorithmique*, in "Revue Multitude", 2017, forthcoming, <https://hal.inria.fr/hal-01669278>
- [8] P. HE, W. ZHANG, H. GUAN, K. SALAMATIAN, G. XIE. *Partial Order Theory for Fast TCAM Updates*, in "IEEE/ACM Transactions on Networking", December 2017, vol. PP, n<sup>o</sup> 99, pp. 1 - 14 [DOI : 10.1109/TNET.2017.2776565], <https://hal.archives-ouvertes.fr/hal-01666244>
- [9] G. XIE, J. SU, X. WANG, T. HE, G. ZHANG, S. UHLIG, K. SALAMATIAN. *Index-Trie: Efficient archival and retrieval of network traffic*, in "Computer Networks", September 2017, vol. 124, pp. 140 - 156 [DOI : 10.1016/J.COMNET.2017.06.010], <https://hal.archives-ouvertes.fr/hal-01617171>

### International Conferences with Proceedings

- [10] S. GRUMBACH, R. RIEMANN. *Distributed Random Process for a Large-Scale Peer-to-Peer Lottery*, in "Proc. of 17th IFIP Distributed Applications and Interoperable Systems", Neuchâtel, Switzerland, L. Y. CHEN, H. P. REISER (editors), LNCS - Lecture Notes in Computer Science, Springer, June 2017, vol. 10320, pp. 34-48, <https://arxiv.org/abs/1709.05122> [DOI : 10.1007/978-3-319-59665-5\_3], <https://hal.inria.fr/hal-01583824>
- [11] S. GRUMBACH, R. RIEMANN. *Secure and Trustable Distributed Aggregation based on Kademia*, in "32th IFIP International Conference on ICT Systems Security and Privacy Protection (SEC)", Rome, Italy, S. D. C. DI VIMERCATI, F. MARTINELLI (editors), ICT Systems Security and Privacy Protection, Springer International Publishing, May 2017, vol. AICT-502, pp. 171-185, <https://arxiv.org/abs/1709.03265> - Part 3: Private Queries and Aggregations [DOI : 10.1007/978-3-319-58469-0\_12], <https://hal.inria.fr/hal-01529326>
- [12] R. RIEMANN, S. GRUMBACH. *Distributed Protocols at the Rescue for Trustworthy Online Voting*, in "3rd International Conference on Information Systems Security and Privacy (ICISSP 2017)", Porto, Portugal, February 2017, pp. 499 - 505, <https://arxiv.org/abs/1705.04480> [DOI : 10.5220/0006228504990505], <https://hal.inria.fr/hal-01501424>
- [13] Y. WANG, Z. LI, G. XIE, K. SALAMATIAN. *Enabling automatic composition and verification of service function chain*, in "2017 IEEE/ACM 25th International Symposium on Quality of Service (IWQoS)", Vilanova i la Geltru, Spain, June 2017, <https://hal.archives-ouvertes.fr/hal-01617175>

### Scientific Books (or Scientific Book chapters)

- [14] S. GRUMBACH. *Les nouvelles médiations hors des territoires*, in "L'ère du numérique", J.-P. CHAMOIX (editor), ISTE éditions, 2017, vol. Vol. 2: L'économie politique à l'épreuve, forthcoming, <https://hal.inria.fr/hal-01669282>