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Short CVs

Athena Vakali : Associate Professor at the Department of Informatics of Aristotle University, Thessaloniki, Greece, where she's leading the Web/Internet data management research group since 1997. She has a phD degree in Informatics (Aristotle University) and a MSc degree in Computer Science (Purdue University, USA) with a BSc. in Mathematics (Aristotle University). Her current research interests include Web usage mining, content delivery networks on the Web, social networks and Web 2.0 data clustering and Web data management on the cloud. Prof. Vakali has co-edited 3 books (Springer, IGI), co-authored more than 15 book chapters, and has published over than 150 papers in refereed journals and International conferences. She is in the editorial board of "Computers & Electrical Engineering" Journal (Elsevier), the International Journal of Grid and High Performance Computing (IGI publishing) and the ICST Transactions on Social Informatics (EAI Community). She has participated in more than 30 research and development projects from which she has scientifically leaded 20. Prof. Vakali has served as a PC member to many international conferences, and she has been general chair and organizer of several Workshops and tutorials (recent ones focus on Communities on the Web and evolving Web data mining).

Dr Srdjan Krčo is driving research activities in DunavNET. He was with Ericsson since 2000 where he held a number of positions (senior research engineer, system manager, project manager) and has worked in and managed a number of product development and research projects. For the last 5 years Srdjan led a research and innovation team focusing on M2M, Internet of Things and their application in various domains including the smart cities. He has participated in several FP7 projects (PROSENSE, SENSEI, SmartSantander, IOT-i) and is active in the Future Internet Assembly and IoT Forum. In 2007 he received the Innovation engineer of the Year Award in Ireland from the Institute of Engineers of Ireland. Srdjan filed more than a dozen patents and has published over 50 papers at international conferences and journals. He is serving as a PC member of a number of international conferences and is one of the editors of the Ad Hoc and Wireless Sensor Networks journal.

Leonidas Anthopoulos : Dr. Leonidas Anthopoulos is an Assistant Professor at the Department of Business Administration of the TEI of Thessaly. Dr. Anthopoulos has IT research, planning and Management experience with the development and deployment of municipal and organizational IT environments. At his previous job positions, as an Expert Counselor at the Hellenic Ministry of Foreign Affairs in e-Government and e-Diplomacy areas, as an IT researcher and manager at the Research Committee of the Aristotle University of Thessaloniki (Greece), Municipality of Trikala (Greece), Administration of Secondary Education of Trikala (Greece) and Information Society S.A. (Greece), he was responsible for planning and managing the development of multiple IT systems for Greek Government and for various Public Organizations. Among them it worth mentioning the Digital City of Trikala (e-Trikala) project, the SYZEFXIS and Police-online projects, the central portal for the Hellenic Ministry of Foreign Affairs etc. He is the author of several articles published on prestigious scientific journals, books and international conferences. His research interests concern, among others, e-Government, Enterprise Architecture, Social Networks, etc.

Acknowledgements

This work is supported by the EU FP7 SmartSantander project, its 2nd call experiment "SEN2SOC: bridging SENsor measurements and SOCial networks interactions via natural language generation for supporting smart city services", as well as by the EADIC "Developing an Enterprise Architecture for a Digital City" research project funded by the Archimedes III Greek National Research Program.

Type of the presentation proposed

This work involves both a research approach and an in-use contribution since it manages smart cities data streams with emphasis on practical and industry potential and contributors originate from academia, industrial as well as technological institutions so the presentation proposed falls in both :

- **In-use contribution**: Presentations with a practical, industry- or user-oriented focus by representatives of technology providers, adopters, and user organizations.
- **Research contribution**: Presentations with a technical focus by representatives of academia and research centres. Research contributions should summarize a broad range of techniques, methodologies or tools of relevance to Open Data, Linked Data and Big Data that have been recently developed by the presenters; papers on specific technical results or systems should be rather submitted to specialized research conferences.

Title of the presentation

Smart Cities Data Streams Integration: experimenting with Internet of Things and social data flows

Summary of the presentation (100 words)

Smart cities are nowadays expanding and flourishing worldwide with Internet of Things (IoT), i.e. smart things like sensors and actuators, and mobile devices applications and installations which change the citizens' and authorities' everyday life. Smart cities produce daily huge streams of sensors data while citizens interact with Web and/or mobile devices utilizing social networks. In such a smart city context, new approaches to integrate big data streams from both sensors and social networks are needed to exploit big data production and circulation towards offering innovative solutions and applications. The SmartSantander[1] infrastructure (EU FP7 project) has offered the ground for the SEN2SOC[2] experiment which has integrated sensor and social data streams. This presentation outlines its research and industrial perspective and potential impact.

[1] http://www.smartsantander.eu/
[2] http://oswinds.csd.auth.gr/SEN2SOC/

Extended abstract of the presentation

1. Sensor and Social data monitoring at SEN2SOC experiment

SEN2SOC experiment aligned to smart people, smart environment and smart government dimensions of the smart city environment (Giffinger et al., 2007; Anthopoulos and Vakali, 2012). It has promoted the interaction between sensor and social networking platforms in an effort to offer beneficial exploitation of data produced under the SmartSantander platform, while addressing needs of citizens and authorities. The sensor-to-social interaction is established through the combination of both sensor and social data into meaningful services or functions. Social network behavior regarding the city of Santander is analyzed and the respective results are offered to users of the SEN2SOC applications, whereas, SmartSantander environmental sensor measurements are processed and displayed via alerts generation which updates citizens about the extreme environmental conditions. At the same time, human sensing is activated and SEN2SOC applications users are enabled to express their sensing on their environment (i.e., "users as sensors") or to share environmental alerts in real time on the social network of their preference. Thus, along with sensor or social information provision, the SEN2SOC experiment accommodates input from the community (A. Vakali et al 2013, C. Samaras et al 2013).

Sensor and social data flows converge in the SEN2SOC experiment via Web and mobile application prototypes such that:

- Web application essentially constitutes a monitoring tool for the SmartSantander sensor network and offers functions such as: environmental conditions' monitoring; visualization of current or historic sensor data; comparison of data graphs for nearby sensors; and statistical analysis results related to sensor measurements.
- Mobile application presents to its users chromatic maps of various environmental parameters; suggests routes based on favorable environmental conditions; shows alerts regarding extreme environmental values; and informs about trending topics around Santander resulting from the social media content analysis.

Designing an architecture for integrating two different and heterogeneous (sensor and social) data streams required a tailored architecture, depicted in Figure 1, with a component-based approach which has been organized around: the Sensor Data Monitoring, the Social Data Observer, the Interface, the Statistical Analysis, the Web Application, and the Mobile Application components ().

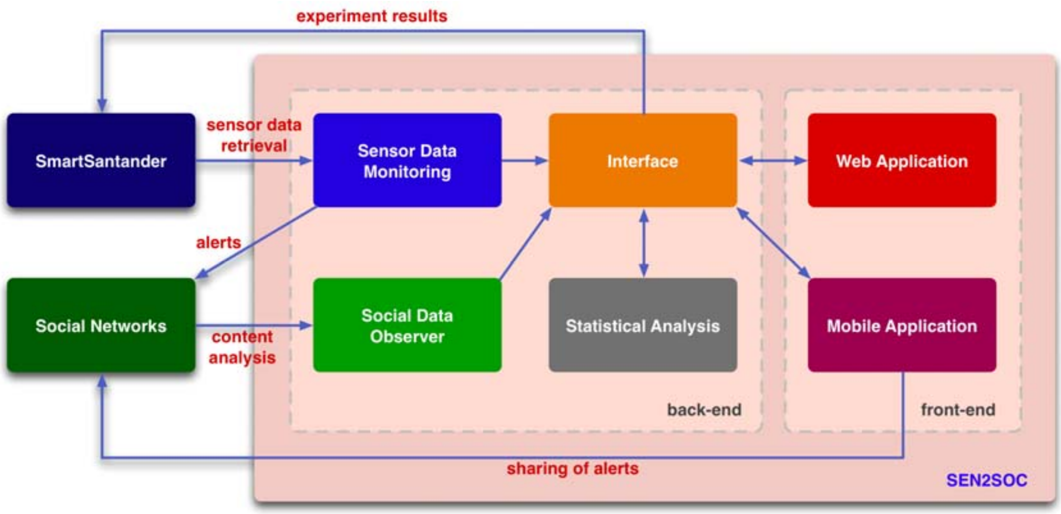

Figure 1 : The SEN2SOC architecture

These components were proposed in order to meet challenges posed by the two different data streams management and in particular their role is highlighted next:

- The **Sensor Data Monitoring** component retrieves sensor data from the SmartSantander platform with primary tasks: data retrieval, data cleansing, data aggregation, and data storage. Sensor data is spatially aggregated in order to construct the so-called virtual nodes that correspond to various geographic areas that Santander is divided into. Moreover, the Sensor Data Monitoring component implements the alerts generation whenever environmental sensor values exceed certain predefined thresholds (i.e., detection of extreme environmental conditions). Alerts are published to the SEN2SOC social media accounts and are forwarded to the SEN2SOC Mobile Application users in real time.
- The **Social Data Observer** component collects Santander geo-located social media content and implements mining on social networks user-generated content (Twitter, Flickr, and Foursquare). Social Data Observer aggregates social media posts and photos based on time and geographic location, and identifies popular topics and photo clusters under semantic similarities and geographic proximity.
- The **Interface** essentially constitutes the intermediary module of the SEN2SOC platform, which: lies in between all components; specifies services that other components can utilize; and allows data communication among SEN2SOC components.
- The **Statistical Analysis** component correlates and analyzes sensor data supporting sensor data mining, statistical analysis, sensor data anomalies detection, and it reports results to the SEN2SOC Web Application. Statistical analysis methods or models applied pertain to: data smoothing; prediction; correlation between two or more sensors; and autocorrelation for detection of repeating patterns.
- The **Web Application** forms a monitoring tool for the SmartSantander sensor network and supports the visualization of real-time and historic sensor data. Other features include the following: detection of closest sensors to the sensor node selected by the user and comparison of the respective data using line charts; prediction models for various environmental parameters; alerts regarding user-configurable thresholds for the desired time period and parameter type.
- The **Mobile Application** offers various services such as: chromatic maps illustrating Santander environmental conditions in real time; route recommendations based on favorable environmental conditions; alerts on extreme environmental conditions; suggestion of areas and points of interest to city citizens and visitors; analysis results of social media users' activity. Furthermore, the Mobile Application implements a mechanism that allows users to express their perception on the present environmental parameters of their current location, thus in a way “validating” SmartSantander sensor measurements.

2. Applications utilizing Sensor and Social data integration

The SEN2SOC Web Application has facilitated results summarization and via a user-friendly interface format, selection of a specific feature triggers data collection and analysis from three different sources:

i. the Sensor data monitoring database which collects information for real-time and historic sensor data measured by individual sensor nodes and virtual nodes;
ii. Statistical Analysis process outcome;
iii. Social data database.

An experimentation case study with Heat map representation for all Santander areas is depicted in Figures 2 and 3. Figure 2 has results for the CO measurements, with the red area indicating high level of CO, while Figure 3 has similar heat measurements for temperature.

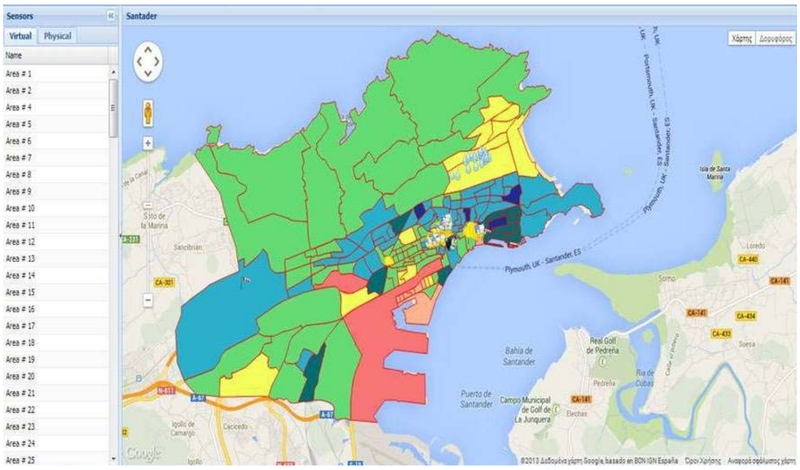

Figure 2: Heat map for CO metric

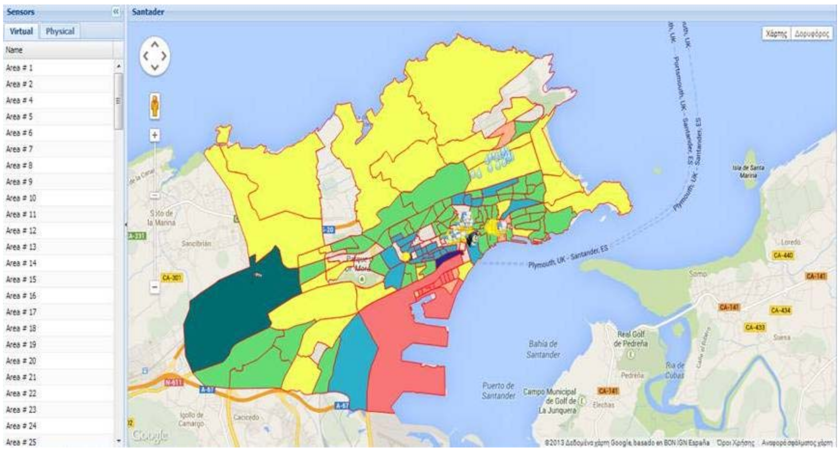

Figure 3: Heat Map for Temperature metric

A data summarization example highlights the Social Data Observer functionality with an indicative example (Figure 4) for a Santander virtual node which depicts photos collected (Flickr) for this area with capabilities given in the applications for social networks users to verify environmental conditions as they emerge in the different Santander city areas.

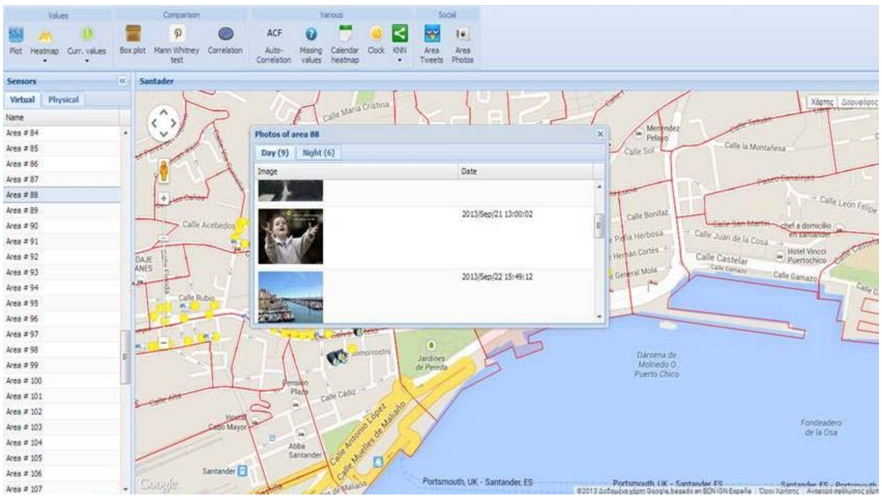

Figure 4: Santander area statistics out of Flickr activity

3. Sensor and Social data integration : industrial exploitation

Over the last several years smart cities have gained significant attention in both academia and industry. Seen as complex systems, combined with the requirement to continue to grow in a sustainable manner, the cities represent an excellent ground for deployment and utilization of various ICT based solutions and hence an excellent commercial opportunity.

The SmartSantander is one of the prime examples of the benefits of deployment ICT solutions in general, and in particular of deployment of IoT based solutions. In the course of the project, a number of services were deployed not just for the benefit of the research community, but also for the benefit of the citizens and the city administrations. Real-time monitoring of on-street parking space utilization, environment monitoring (air quality and noise), adaptable street lighting, control of watering schemes in public parks are examples of applications that were made available in collaboration with the participating cities. Further to this, services that enable citizens to report on various events taking place in the city (overfilled waste bins, illegal parking, damaged road and road signs etc.) and thus facilitate faster reaction of the relevant utility companies as well as augmented reality based services to support sightseeing represent further examples of smart city services that were embraced by the city administrations and the citizens.

The commercial exploitation potential of these services is huge and the companies are approaching it from different perspectives. In SmartSantander, large companies like Telefonica and Ericsson provided the key components of the platform enabling storage and semantic annotation of the sensor data (Telefonica’s IDAS) and a repository of semantic descriptions of all available sensors in the system thus enabling their dynamic discovery (Resource Directory). Ericsson collaborates actively with the cities on promotion of smart city solutions and has already deployed the ekobus service, a combination of public bus fleet management and environment monitoring service in the city of Pancevo where the Resource Directory is used as one of the key enablers. In collaboration with the city of Novi Sad, a participatory sensing application has been released. A number of small companies are specializing in development and deployment of various hardware components that can be used in the cities, while large companies like Intel and ARM are creating the enablers for development of small, cost and energy efficient hardware components that can be used in IoT systems. At the same time, several cloud based platforms are being developed and deployed as standalone solutions or in collaboration with the mobile operators aiming to facilitate faster deployment and adoption of smart city services. As the social networks have become a mainstream media for interaction and collaboration, the IoT solutions are increasingly focusing on integration of social networks features thus making the smart things social and at the same time enabling fast and efficient information sharing between the members of a community.

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