# TESI
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The **Web and Internet Science (WAIS)** group with more than 100 people researches large scale systems, exemplified by the Web and Internet, that combine computational, data and human components. Research activities ranges from Semantic Web, Linked and Open Data, Social Machines and Crowd Sourcing to Internet of Things and Cyberphysical Systems.

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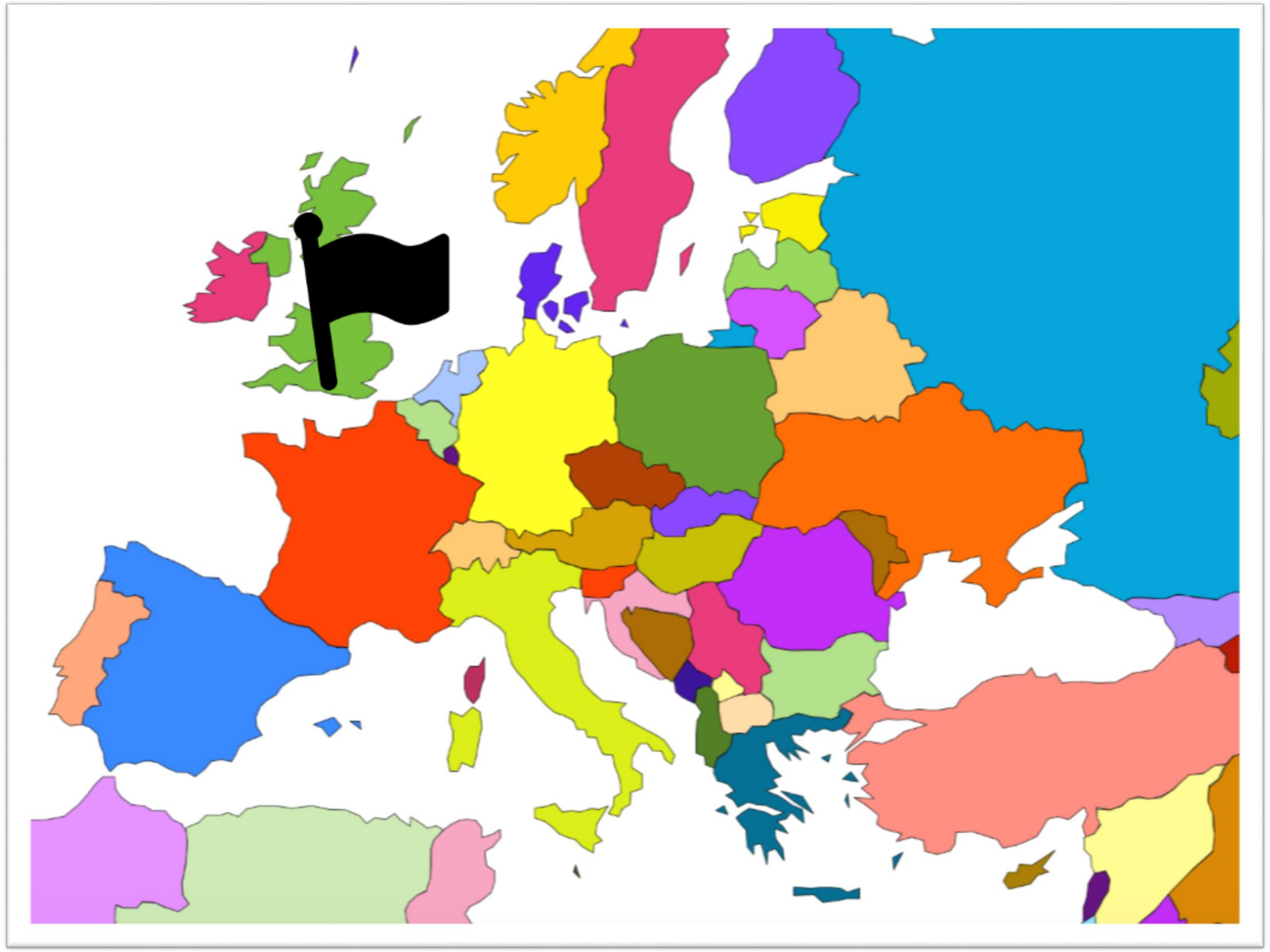
Prof. Thanassis in numbers: H-Index: 17; Citations: 1028

**Required Skills for the thesis**:

Semantic Web and Big Data

Machine Learning e Big Data Analytics

*Give a look to the Lab Website*



UNIVERSITÀ DEGLI STUDI DI SALERNO

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# SEMANTIC WEB ANALYTICS OF AN IOT SENSOR-BASED SYSTEM FOR MANAGING NATURAL DISASTERS

# Abstract

The ability to predict the occurrence of conditions that promote forest fires, allow fire prevention teams to timely respond and to manage targeted evacuations. This same concept applies equally to the smarter detection of and reaction to mudslides, avalanches, earthquakes, and other natural disasters. Natural disasters cannot be predicted well in advance but it is still possible to decrease the loss of life and mitigate the damages, exploiting some peculiarities that distinguish them. The weather condition can also be a problem or an advantage for rescuers after an earthquake. Therefore, after an earthquake, the communication are typically difficult due to power outages caused by broken cables, antennas or other issues.

To manage natural disasters, we need to integrate data coming from several sources (sensors and services) using lightweight computers. The importance of a lightweight computer is due to power consumption and bandwidth usage during a disaster scenario to avoid waste of time to act as quickly as possible to put out fires, save lives, etc. The Internet of Things technologies have been analyzed because of its peculiarity to encourage the communication between devices, also famously known as Machine-to-Machine (M2M) communication. The physical devices can stay connected and hence the total transparency is available with lesser inefficiencies and greater quality. Devices can interact and communicate with the potentiality of low power consumption and using low bandwidth. The protocols of IoT have been analyzed with a comparison with their pros and cons. Further, two embedded systems have been analyzed and compared: Cubietruck and Raspberry Pi 2.

Semantic Web is an extension of the World Wide Web and not a separate Web. With the Semantic Web, information and content on the Web gets a well-defined meaning that computers facilitate understanding of the meaning, semantics and information. Semantic technologies have been effectively used in various domains, particularly, to address the heterogeneity challenge to ease the interconnection of such data, deduce new knowledge to build smart applications and maintain interoperability at data processing, management and storage.In this project, Internet of Things and Semantic Web technologies have been applied for analytics of a hypothetic system to be applied in areas affected by disasters. The data used are about weather and earthquakes and are retrieved using web services streams. The streams come from two different web services: World Weather Online and INGV, respectively for the weather and the earthquakes. Starting from the streams, triples have been created and stored into a triple store, according to a structure defined to describe them. The properties describe information about date and time, weather condition, latitude and longitude, city, magnitude of an earthquake, precipitation, wind, temperature, and humidity. The architecture of the system has been developed using an approach for the IoT that presents 4 stages during the development of the system. In particular, because the streams come from web services, it hasn't been necessary to use sensors for the purpose of the thesis.  After storing of the triples, the system performance has been evaluated to measure the response times making a comparison between a client hosted on a PC and a client hosted on a Raspberry Pi 2 Model B. The analyses have highlighted the potentiality of the system using lightweight computers to perform operations that usually involve PC, because the differences between the response times is negligible, with an average difference of the order of one second. For the testing part, an application has been developed. The application presents two components: the client send the SPARQL queries and show results pto the user; the server elaborates the queries retrieving the answer from the triple store and send it to the client. The response times take account of the process from when the queries sent until the answer received. The achieved results are encouraging for the use of the system in disaster scenario, either natural or caused by humans. Furthermore, the system developed can be used also in different ambit that doesn't necessary concern disaster scenario, such as monitoring of a sewer system to avoid water pollution.

UNIVERSITÀ DEGLI STUDI DI SALERNO

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# DESIGN OF AN IOT TECHNOLOGY INFRASTRUCTURE FOR MONITORING AND MANAGING A SEWER SYSTEM

# Abstract

The sewer systems managers encourage to have an efficient monitor system to manage correctly and efficiently the downstream depuration process. In order to close the water's cycle, they must follow some law constrains, which sometimes it's not so easy due to external agents that alter the flow, causing additional costs. Therefore, water managers want to optimize the whole process to limit the costs, preserving the parameters required by law. The Sewerage is the infrastructure of the collecting ducts, typically in the underground, to receive and drain, far from civil places, the waste water, which are produced by human activities. The main sources are usually houses, popular places (e.g. schools, offices, and hospitals), but also factories, industries and commercial offices, that can produce highly polluting substances, which need particular treatments to be purified.

A sewer system can be long several kilometres and have many access points and several factors can contribute to the alteration of the content and normal flux. The flux has to be controlled by someone or something, sensing with a certain frequency, depending on the system status, the volumetric flow rate, the flow composition, and external unauthorized input. The cheapest solution to achieve this goal is having some remote sensors, which can sense regularly and easily these parameters. Introducing a high amount and different kind of sensors, we have to face several problems mainly related to: Power Management, Communication, Data Management, and Sensor Type.

The goal of this project is to design an infrastructure which is able to answer the daily questions that a manager asks for the resources management. Real time information about the network status may be given by the system. With this capability the manager will can control all the parameters. The good effect of more control is more efficiency and less management costs.

A wide sensors network needs a right setup to work properly. Recent research has introduced many improvements in cheap sensors and actuation technologies.

We have to choose a network model, a sensors management model, and physical environments to design an efficient system which is helpful to our purpose. We have found a solution in a mixed architecture of Cloud and Fog Computing and in LoRaWAN technology. LoRaWAN is a promising technology for our application because using it we can build a wide and cheap network in a simple way. The costs depend also on what we want to do, if we want to sense something particular the cost can raise because the sensor type to be used. We can build a simple monitor system using cheap device like Raspberry Pi, ST Microelectronics boards, and Libelium solutions. The resulting architecture is a three layers structure composed by: end-devices, which sense the real world and send the data using LoRaWAN technology, gateways, which in LoRAWAN architecture are also servers receiving and filtering the information, and Central Server, which receive all the network data, store and analyse them. Being a mixed of Cloud and Fog Computing, we have some computation near the end-devices, on the gateway, and some heavy computation on the Cloud or Central Server.

To validate the architecture, we have built our network using a Raspberry Pi as Gateway with iC880A LoRa concentrator shield and some ST P-NUCLEO-LRWAN1 pack as nodes. The Gateway intercepts the nodes' radio transmissions and forwards them to a server. An application on the server is able to decode these messages and send them to a MQTT broker creating topics, which other clients can subscribe to. In this way, a client ca choose the topics and so what kind the information streams receive.

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