

# Title: Urban Intelligence Networks for Smarter Cities

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Although most cities in developed countries function well, changes in population distribution patterns will make provision of services, accommodation, and transport a nightmare. This is largely because of population increase estimated to reach eight billion by 2025. Out of these, two billion will be seniors living longer due to advances in medicine and better healthcare. Currently, the world is home to 841 million seniors. People around the world are gradually moving from rural areas to work and live in cities. For instance, 82.3% of Europeans today live in urban centers. As the number of commuters increases across major European cities, public transport systems will start to collapse. Another major challenge is diminishing freshwater resources. Currently, a staggering 89% of global population relies on improved water supply systems that lose about 32 billion cubic meters of precious water via physical leakage. As a result, up to 50% of the world's population (four billion) will reside in water stressed areas by 2025. A growing global population will increase energy demand by 56% by 2040.

One way to address these issues and improve the people's quality of life is to develop new Internet of Things (IoT) applications that leverage ubiquitous connectivity, big data and analytics to make cities more "intelligent" and more connected. These new applications introduce tremendous new capabilities such as the ability to remotely monitor, manage and control devices, and to create new insights and actionable information from massive streams of real-time data. The challenges discussed above can be addressed effectively and efficiently through smart city technology. Big data analytics will produce insights that city authorities could use to improve road and rail transport, reduce crime, improve healthcare, improve public service delivery, and reduce environmental pollution.

Urban centers can also benefit greatly by installing and using energy-efficient IoT systems. Since urban transport systems are prone to bottlenecks such as traffic jams, technology would come in handy to improve efficiency. This would require GPS systems, cameras, and traffic light coordination systems connected via IoT to keep traffic moving. Players in the food production sector would also benefit from technologies such as IoT and big data. Some farmers in the Europe and US use machinery that rely on data analysis and GPS guidance systems to manage fertilizer application, watering, weeding, and harvesting.

Supporting this new approach requires the adoption of new paradigms. In this paper, agent technology is combined with the emergent concept of *Edge computing* to design control systems based on the decentralization of control functions over distributed autonomous and cooperative entities that are running at the edge of the network. We describe the Rainbow platform that is designed to bring computation as close as possible to the physical part. Multi-agent systems running

on top of Rainbow create smart services using adaptive and decentralized algorithms which exploit the principles of collective intelligence.

In the context of the Res-Novae project[1], a smart street environment has been designed and implemented in the city of Cosenza (Italy), exploiting the features of the Rainbow platform. This smart environment is called *Smart Street Cosenza*. The goal is to furnish the city with an IT infrastructure which provides services to the citizens, and which can be further extended over time, either covering new areas or providing new features and functionality. The target areas for a first deployment are shown in Fig. 1(a) and are located in the centre of the city.

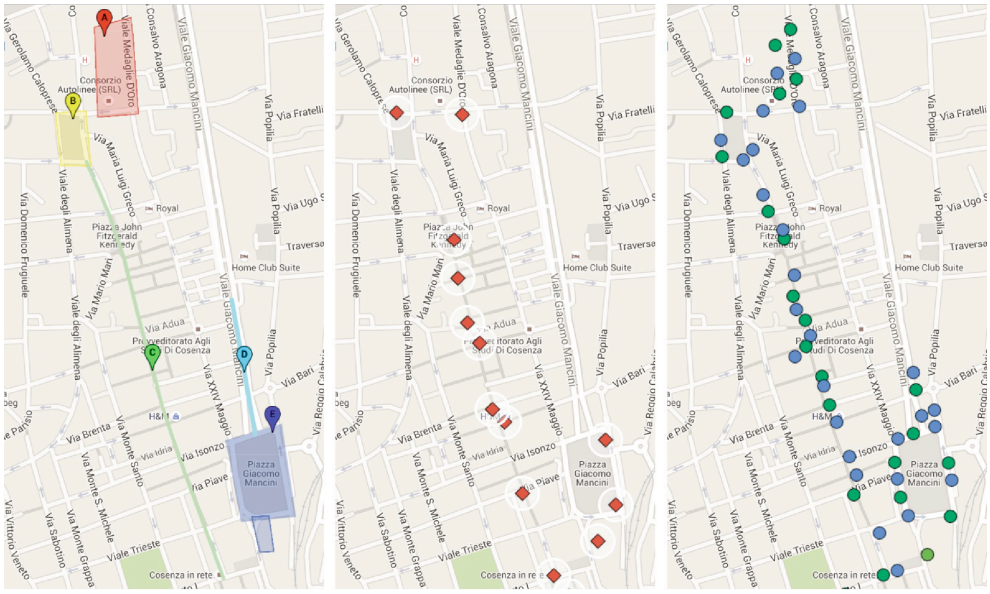



Fig. 1. Smart Street Cosenza. (a) Target areas; (b) Computational Nodes; (c) Sensors nodes. Green locations host one *type A* node and one *type B* node, blue locations hosts only a *type A* node.

Specifically, the infrastructure covers: (A) a Bus Station, (B) a square, (C) the main commercial street of the city, (D) part of one of the main driveways and (E) the area around a commercial centre. Over the chosen areas, a set of thirteen computational nodes (Fig. 1 (b)) and seventy wireless sensors nodes (Fig. 1(c)) are deployed. Each computational node consists of a Raspberry Pi mod.2 board, is mains powered, and hosts the Rainbow middleware. Each sensor node has a battery embedded and is powered by a solar panel. Sensor nodes can be of two types: type A nodes host noise, temperature, relative humidity and luminosity sensors, and type B nodes host air quality sensors, measuring the concentration of CO, $CO_2$, NO and $O_3$. All the sensor and computation nodes are connected using a wi-fi network infrastructure, also deployed in the same areas.
Currently, the described cyber-physical infrastructure hosts an application devoted to real-time monitoring the status of the areas involved. Raw measures are collected by the computational nodes, then filtered and aggregated and finally sent to a remote server that stores the data in a DBMS. A web portal is available showing geo-referenced sensor measures as well as aggregated information indexes such as Simmer Summer Index (SSI), Humidex and Air Quality Index (AQI). This information is available to the citizens, who can use it to figure out how much the different areas are comfortable and healthy, to the city administrator, who can monitor critical climatic or pollution events, and the research community, who can use it for further investigations and analysis. Both the cyber-physical infrastructure and the monitoring application are up and running since December 2015, with only a few sensors failures.

## References


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**Biography**

**Giandomenico Spezzano** received his Laurea degree in Engineering from University of Calabria. He is currently a Research Director at CNR-ICAR, Institute of High Performance Computing and Networking of the Italian National Research Council. He is also an adjunct professor of Informatics at the University of Calabria in Italy. He has led various research projects in the distributed and pervasive computing area. His current research interests cover tools for parallel computers, gpu computing, internet of things, real-time data analytics, swarm intelligence, pervasive computing, urban computing, smart city. He has published about 200 papers and two books.


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