


## Abstract

Over 2 million pilgrims were expected to arrive in Turin for the Ostension of the Holy Shroud. To manage such a volume of visitors, the event organising Committee assigned the control over access to Reply, specifically Concept Reply, the research and development centre for Machine to Machine (M2M) solutions.

The innovative solution proposed by Reply was based around installing measurement points (sensors and thermal cameras) for controlling the flow of pilgrims in a given area and, where necessary, timely intervention to activate the necessary control procedures. The system was not only able to count the number of persons accessing an area; it also estimated their speed and direction, providing corrective indications to prevent the creation of bottlenecks.



## People flow management to access to the Holy Shroud assigned to Concept Reply

### Scenario

The Internet of things (also known as Web 3.0) is not far away. After the Internet of systems (Web 1.0) and the Internet of people (Web 2.0), the coming years will see the proliferation and the penetration of the web into all of the key objects commonly used in daily life. The exploitation of innovative technologies on systems that manage the flow of people and that utilise counting, tracking, and localisation devices, acquires an enhanced value thanks to the feasibility of communication between objects of a different nature, featuring traits such as portability, flexibility, sensitivity to context, and self-adaptability.

Applications capable of measuring the data of the external world and displaying them using web services represent a new opportunity for various sectors, from health care (localisation and guidance in hospitals) to retail (tracking of customers' paths through supermarkets), to large public events (temporary installations). Sensors of various natures can be used in these contexts: starting with simple infrared checkpoints all the way to thermal cameras able to sense warm moving objects, Bluetooth presence detectors, biometric sensors, etc.

### The event: the Ostension of the Holy Shroud

The faithful multitudes were expected to arrive in the city for the Ostension of the Holy Shroud, a unique event affecting the city of Turin for about forty days (April 10 – May 23, 2010.)

An impressive security system was set up to manage the visitors, with special attention paid to controlling access to the points along the route approaching the Holy Shroud. The path wound its way through areas where transit needed to be regulated and a maximum number of people in the zone at the same time could not be exceeded.

The flow of pilgrims therefore needed to be suitably regulated, avoiding jams and minimising as far as possible physical barriers, which often cause hold-ups and discomfort. For this reason, in addition to the traditional control systems, Concept Reply was assigned the task of implementing an application capable of measuring, using specific sensors, the number of pilgrims present in a given area, assessing the flow, and where necessary, intervening in a timely fashion with the necessary control procedures.

## The solution

Concept Reply, Reply's Research and Development Centre focused on Machine to Machine (M2M) solutions, designed and developed a service platform for exchange of information and **interaction between devices linked in a wireless network**.

The platform developed includes innovative services, devices, and middleware. Its primary characteristics are pervasiveness, transparency and portability, flexibility, sensitivity to context, self-adaptability and self-configurability.

Sensors for the detection of human physiological/biological parameters are at the heart of Concept Reply's platform. The solution implemented by Concept Reply for the Ostention of the Holy Shroud was based around the installation of **measurement points** aimed at controlling the huge flow of moving pilgrims.

Specifically the system, via the use of thermal cameras, was able not only to count anonymously – and therefore **respect privacy** - with accuracy **greater than 99%**, the number of pilgrims entering a given area, but also to estimate their speed and direction.

In the areas that made up the path for approaching the Holy Shroud, the application was set out as follows:

- At the start, in addition to the conventional mechanical turnstile installed as required by the safety authorities, an **electronic gate** was installed with *sensory Reply*. This system collected information on the number of persons entering the area subject to control. The sensor provided the official count of the number of pilgrims and provided **predictive indications** on the degree of congestion in the controlled zone.

- Thermal cameras** detected the flow of pilgrims entering the area of interest and sent the information to the control software; this made it then possible to visualise the number of people present in the so-called "Infernotti" [basement level] corridor, manage the virtual traffic light located on the sensors, and generate the intervention thresholds governing the traffic light itself.

- Via the recording of the passage of people, the control software also returned a **statistical analysis** of the flow of pilgrims, comparing the transit data with that of the entry and exit gates of the controlled area via a **calculation algorithm**. When the number of pilgrims was found to be approaching the maximum number allowed, the volunteers assigned to managing the flow could be alerted.

Concept Reply also installed a people counting system in the area of the orientation halls - the halls near the Duomo [Cathedral], where they were able to see a projection of an introductory video on the Shroud. These halls had a maximum capacity of 250 people. The system, again based around thermal cameras, counted the people entering the halls, while a **virtual traffic light** gave a visual and audible warning when the preset threshold had been reached.

Over a span of about **forty days** (the duration of the event) the solution developed by Concept Reply made it possible to manage, in an orderly way and while respecting the safety constraints, access to over **1,200,000** people, with a daily average of **30,000**.

## Reply value

The choice of the event's organisers to rely on Concept Reply's expertise for a world scale occasion has confirmed the faith in the professional approach that the company offers its clients. Indeed, Concept Reply possesses a leading platform and develops innovative solutions within the physical Internet of Things.

The solution implemented by Concept Reply was installed in a non-invasive way, as is demanded by a site of special historic interest: indeed, the video cameras communicated with the processing system through a wireless connection. Despite the project's technological complexity, Concept Reply's experience made it possible to develop an easy to use system that could be managed entirely by the volunteers working at the event.

Concept Reply is Reply's Research and Development Centre focused on Machine to Machine (M2M) solutions. Concept Reply implements innovative service, device, and middleware platforms having the key features of pervasiveness, transparency and portability, flexibility, sensitivity to context, self-adaptability and self-configurability. Under the framework of the Internet of Things (IoT), Concept Reply offers solutions capable of supporting specific vertical applications such as info-mobility, advanced logistics, environmental safety, remote medical assistance, "contactless" payments, and product traceability.

For further information: [www.reply.eu](http://www.reply.eu)