

# **THE SCATOL8® FOR SUSTAINABILITY: AN UPDATE ON THE REMOTE SENSING SYSTEM OF ENVIRONMENTAL, LANDSCAPE AND MANAGEMENT VARIABLES**

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## **Abstract:**

This paper describes the evolution of Scatol8®, a remote sensing system conceived and developed within the Department of Commodity Science (DCS) of the University of Torino.

The DCS developed, along the years, several projects related to Sustainable Management of economic organizations; the first part of the paper summarizes the key-elements of projects that enriched the knowledge base, providing hints that took to Scatol8®.

Scatol8®'s vision has been described in a previous paper. Its basic elements form the second part of the paper. The third part is devoted to describe several activities that have been undertaken, which display the potential of the Scatol8®'s system along directions not foreseen at the beginning; the description is splitted into Research projects and Education initiatives.

**Key words:** Sustainable Management, Remote sensing, Environmental and Landscape, Management System, Innovation, Simulation models, School Network

**JEL Classification:** I25, L66, M11, M31, O13, O31, Q56

## **1. DOCS and sustainability**

The core activities of the DCS of the University of Torino are research and teaching in sustainable development. Around fifty projects, at national and international level have been designed, launched and produced, the period...., by finding, from time to time, adequate funding.

Since the '90s, the DCS is very active in applied research, to develop methodologies and tools for environment qualification of organizations and territories. Topics covered by multidisciplinary research groups range from enhancement of typical and traditional agricultural food production,

environmental management of manufacturing and services - with an emphasis on tourist facilities -, environmental sciences and technologies, conservation and recycling of natural resources, environmental management and control as well as on the study and application of environmental management systems.

Within these issues, the following researches are worthy to be considered:

- Project CRESTA - Environmental Management System for the Rifugio Regina Margherita. Launched on 1997, it ended on 2002 with ISO 14001 certification of the highest mountain hut in Europe. It was the first research with a systemic view conducted in mountain huts, to verify the applicability of environmental management system to small tourist accommodation. After the identification of environmental significant aspects, to reach an environmental and economic optimum, a multidisciplinary team worked to adapt the European standard to the peculiar context and to draw proper operative instructions.

- Strategies of sustainable tourism developed in Aosta Valley, Piedmont and Liguria. The experimental work in mountain huts took us to involve more than 30 huts' managers whose role was helpful to write guidelines, available in four languages, to lead courses and other initiatives on environmental education in mountain refuges. This multiannual engagement took to the WWF award of the Golden Panda, for the continuing action on sustainable tourism in the Alps,

- Participation to K2 Italian alpine expedition (Pakistan), on 2004, to design and implement the Environmental management system of the expedition. This on field research assured the complete control on the environmental aspects, sharing the operative instructions

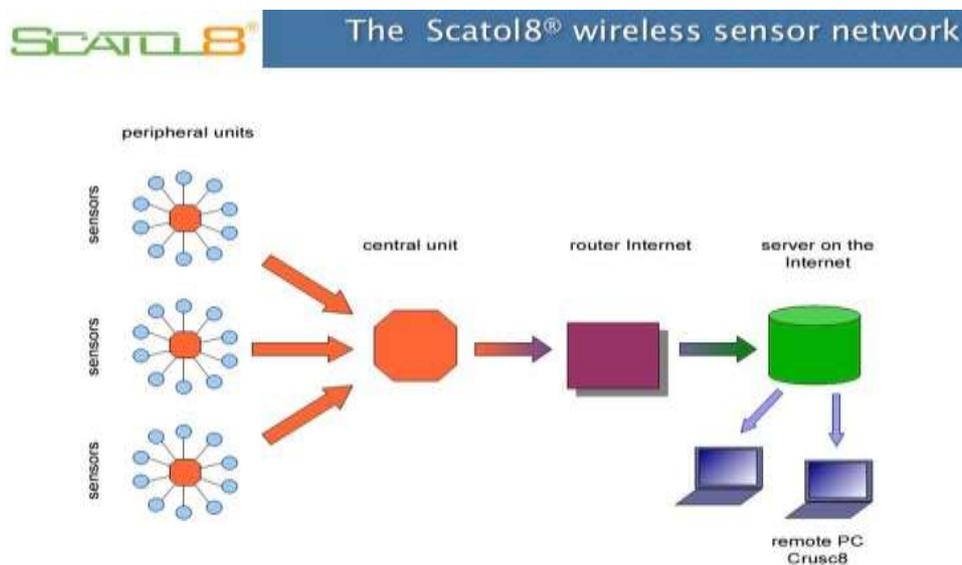
with participants of different roles and nationalities. Result of this experience were guidelines that are being spread throughout the remote mountainous areas of the world.

- Research on Environmental and Landscape Management System (ELMS). The four years research, which was implemented in the municipalities of Langa and the Barolo, took to a proposal for an evolution of the European Regulation EC n. 761/2001 (EMAS II), which sees its integration with the principles of the European Landscape Convention (ELC). This new method increases the benefits of EMAS and visibly the declination of the principles on a regional scale, promoting the value of the landscape, its conservation and enhancement, through the active involvement of population and economic actors.

- Interreg Project (2007-2013) "VETTA, Enhancement experiences of Transboundary Tours and products of high and medium altitude", with the involvement of 52 mountain huts. These accommodations have environmental aspects related to the most popular organizations, including domestic reality and landscape aspects of excellence, which help to make them the attractors of a growing number of tourists.

Sustainability is not just a matter of business, but it is associated with everyone's daily life, with consumers's choices and behavior. Internalize this principle and to adjust accordingly, their decision-making models is possible if you have data that express the pressure on resources and the environment. The Scatol8<sup>®</sup> was born for this!

## 2. Scatolo 8<sup>®</sup> in short



The Scatol8<sup>®</sup> is a remote sensing network of environmental, landscape and management variables, created at the DCS, entirely based on free and open technology (hardware and software) (Open Source), with a view of controlling costs, of openness and ease of access. The choice of the name Scatol8<sup>®</sup> conveys the idea of a friendly device, handmade, easy to understand and easy to use, so affordable.

As described in Fig. 1, Scatol8® consists of a central unit and of peripheral (end) units, connected in a network. Numerous sensors, able to detect the monitored variables, are connected to peripheral units which transmit the data to a central unit, connected with a server. Sensors and peripheral units change in type and numbers depending on customers' requirements.

Collected data are transmitted to a personal computer, where they are stored, processed and displayed by an instrument digital panel, called the Cruse8. Thus, you can create a real-time monitoring of each measured variable, as well as evaluate their performance over time, thanks to the display of time series.

In turn, the personal computer is able to upload data on a server on the Internet; the server collects and organizes them in a collective database. Data can be input for environmental management systems and/or for actuators (i.e. a wide range of devices, from leds to motors).

The part list is the following:

END NODE	
Main parts	Brief
Arduino uno	The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins and 6 analog
Wireless sd shield	Shield that acts like a socket for the bees modules and that contains an SD to store data in if the coordinator node is temporarily unavailable
xBee	XBee and XBee-PRO ZB ZigBee modules from digi provide cost-effective wireless connectivity to devices in ZigBee mesh networks
Rtc	The real time clock DS1307 is used to add a timestamp to every sample
Brick shield	This shield replies the power supply, the ground and other signals from the ATmega many times. It is used to easily connect all the sensors and the RTC to the microcontroller

COORDINATOR NODE	
Main parts	Brief
Arduino MEGA	The Arduino Mega is a microcontroller board based on the ATmega2560. It differs for the one used in the end node basically because it offers more memory to run programs
Ethernet shield	It connect the microcontroller to the internet using the TCP protocol to send data to the server
xBee	XBee and XBee-PRO ZB ZigBee modules from digi provide cost-effective wireless connectivity to devices in ZigBee mesh networks
Wireless shield	It interfaces the Xbee radio to the microcontroller

Until now, the set of variables the system is capable of monitoring is illustrated in the following table:

variable	unit of measurement
Outdoor temperature	°C
Relative humidity	%
Snowfall level	m
Precipitation level	m
Wind speed	m/s
Wind direction	degree
Illumination level	Lux
Air emission quality	Presence of LPG, butane, smoke, propane, methane, alcohol, hydrogen
Water consumption	l/s
Electric energy consumption	W/h
Solid waste quantity	Kg
Waste water quality	pH, ORP
Presence	number
Landscape view	

#### **Guidelines of Scatol8<sup>®</sup>**

Designed in the perspective of sustainability, Scatol8<sup>®</sup> is inspired in its creation and implementation to various criteria, such as:

- **Open Source.** Hardware and software are fully based on open technologies and software (Open Source) in view of cost containment, openness and ease of access, even for training purposes;
- **Modularity.** The system is constituted from time to time, according to the requirements and specifications of each application;
- **Environmental compatibility.** All collection and processing devices are placed in recycled containers, coming mainly from food and electronics industry, transformed and adapted to their new function, or in containers made of wood (a renewable resource), or even cardboard.
- **Knowledge dissemination.** The Scatol8<sup>®</sup> is not only a product, but also an initiative to spread knowledge, which aims to involve young people in the creation of technology (and not only in its use), which is accompanied by information tools on the relationship between observed variables and sustainability and proposes the reuse of components through the concrete realization of the active systems.

The **implementation of hardware and software** is entrusted to Ing. Paolo Cantore who takes part in the definition of the technical specifications of the circuits, designed them and takes care of selecting sensors and microprocessors, conducting tests in DCS Lab to verify accuracy and reliability, within the economic constraints.

When the testing phase reaches satisfactory results, Scato18<sup>®</sup> is packed in customized packaging. Finally, systems are installed and tested by Scato18<sup>®</sup> 's Team in real conditions. Afterwards, the phase of writing technical documentation and reports begins.

**Communication** plays a key role in the Scato18<sup>®</sup>. It presents a number of problems because there are different subjects to which it is addressed (teachers, students, entrepreneurs of various productive sectors) and the means (website, social networks, brochures, research reports). A multilayer communication is carried out continuously, providing news updates to stimulate reflections and to keep the attention, to arouse curiosity in the potential of the system and to encourage involvement in the project proposals. Given the importance of these instances, in the organizational structure of the team Scato18<sup>®</sup> has been inserted the "Communication" function, assigned to the Architect Camilla Botto Poala. As noted above, a great importance is given to the packaging that plays a role in communicating the values associated to Scato18<sup>®</sup>. For this reason, she is also entrusted with the responsibility of the trials conducted on packaging recovery that must meet functional and communicational requirements that change depending on to the context.

### **3. Scato18<sup>®</sup>'s in Research projects**

Scato18<sup>®</sup> makes it possible to simultaneously monitor different variables and multiply the number of these variables as necessary: the configuration of a network in a domestic unit is similar to the needs satisfied in mountain huts, that despite their structural peculiarities, exemplify application Scato18<sup>®</sup> inside a building.

Being able to store and view the captured data in real time and compare, thanks to the series, the environmental performance of a building (including not only the technological characteristics of the building and the materials used, but also plant components) together with the temperature and humidity characteristics of the interior, put the remote sensing system as a useful tool for understanding and monitoring of building in question.

In addition to displaying the data collected continuously, also be carried out remotely, the system can convey a subsequent processing and analysis of the historical data collected in order to build maintenance actions or, where necessary, to improve the management of activities carried out in the domestic unit.

#### **3.1. Scato18<sup>®</sup> 's indoor applications**

##### **Scato18<sup>®</sup> 's in accommodations**

The sparks that took to Scato18<sup>®</sup> has been the EU funded Interreg Project (2007-2013) "VETTA, Exploitation of Transboundary Tourist Experiences and products of medium and High altitude". Within the actions assigned to the DCS, there is a pilot project aimed to design and carry out three Wireless Sensor Networks (WSN) in as many mountain huts of Verbania province. In the summer of 2011 and 2012 Scato18<sup>®</sup> systems were first tested and then installed permanently.

### Scatol8® 's in manufacturing companies

The DCS is engaged, with the University of Gastronomic Sciences and the Polytechnic of Torino in the project POLIEDRO - Pollenzo Index Environmental and Economics Design whose aim is the developing of a sustainability index for agro-industrial production in Piedmont.

In particular, the DCS is committed to design the index, through the application and execution of Life Cycle Analysis on food products typical of our region. The need to overcome the reference data, often lacking or so generic to be meaningless, through an accurate measurement suggested to place a Scatol8® systems on the machines. Attention has been devoted to energy consumption of the main production stages. The monitoring system is used for the acquisition and management of environmental data and to provide a database from which to draw for the preparation of a quality index of food production based on aspects of environmental, social and economic sustainability. The project is in the final phase and the outcome will be a prototype of a dedicated system to start the production.

### SCATOL8® The Scatol8® wireless sensor network in Winery of Carema (TO, Italy)



One of Scatol8®'s installation was in Winery of Carema, in the province of Torino. The harvest of grapes and production of wine took place during the first weekend of last October. Scatol8® monitored the production process of wine-making, via a specially crafted network of remote sensing. Five peripheral units have detected the electrical consumption of the machines that make up the production line: roller conveyor, destemmer, crusher, pump and press, for the entire duration of their use. The purpose of monitoring is to measure and record the power consumption of each device, and on a technical level, this is done by means of clamp meters, prepared to work on a three-phase voltage, such as the one in the Winery.

The picture illustrates the positioning of the nodes and of the central unit.

The timely detection and display of power consumption have multiple utilities:

- to control the operating conditions of the equipment;

- to ease a prompt intervention with maintenance operations, should they occur abnormal absorption conditions;
- to provide a reliable picture of energy requirements in order to assess costs and benefits of installation of production of electricity;
- to prepare an initial energy analysis, useful to develop an energy management system,
- to calculate the carbon footprint of a product, in order to raise consumer awareness on the contribution of consumer goods to greenhouse gas emissions.

Winery of Carema can be considered a pilot-project from which other applications originated: a furniture firm and a home applications.

### **3.2. Scatol8<sup>®</sup>'s Outdoor applications**

The system, its features and architecture, allow outdoor applications, for the monitoring of environmental variables. In this framework, the DCS is working on ProGeo, in collaboration with the Faculty of Geology of the University of Torino. The project aims to develop a tourism offer focused on geological sites of relevant interest, such as quarries and mining sites. This conversion process is fostered by multimedia devices, able to make natural signs readable and, in general, to turn environmental data into stage effects, increasing visitors' emotional involvement.

Scatol8<sup>®</sup>'s task in this project concerns environmental quality data acquisition (air temperature, relative humidity, lighting) and communication with a wide range of sensors and actuators already installed in the sites.

In addition, data will be used to feed an Integrated Management System (Environment, Safety and Social Responsibility) developed by the DCS.

### **3.3 Scatol8<sup>®</sup>'s in other initiatives**

#### **Cooperation with Italian Association of Landscape Architects (AIAPP)**

As previously mentioned, DCS has invented ELMS and then gave rise to ELWSMS, which considers the possibilities opened up by the Internet.

Though designed for local authorities, ELMS can be applied to all initiatives that seek to promote the environment and the landscape, sharing the principles of sustainability and enhancement of the landscape and by controlling the impacts resulting from its activities. Such a large-scale management system will be tested in the organization of an international event, the 2016 International Federation of Landscape Architects (IFLA) Congress, to be held in Turin. In this contest, data access through the Internet is particularly important and ELWSMS has the chance to be tested. The AIAPP is the entity that adheres to IFLA, and it is responsible for organizing the event at the national level. Through a Memorandum of Understanding, being formalized, the DCS is in charge of identifying ways to verify the applicability of the ELWSMS to events that, over three years, will accompany the international congress, where some 3000 landscape specialists are expected. The ELMS will be tested from the planning of events, to predict and monitor its multidimensional impacts along the life cycle. The ELC leads to emphasize the dimension of knowledge sharing, which is already present in EMAS, and to direct it towards the landscape, not just the physical, perceptible by the senses, but also to the cultural landscape.

The Scatol8<sup>®</sup> will be used to detect a number of variables that are at the basis of the assessment of the sustainability of events and to make available the environmental and landscape profile event. Other variables attaining the social and institutional side of sustainability will be added to complete an on line Sustainability Report. Our commitment has been formalized in the application dossier, presented in Cape Town, September 4, 2012 which led Italy to win the race for hosting the Congress.

#### **4. Scatol8<sup>®</sup> 's in Education activities**

##### **Scatol8<sup>®</sup>'s in University Courses provided by DCS**

The teaching of the DCS has had for many years two courses: Commodity Science and Technology of Production Cycles. Commodity Science presented the methods for chemical and physical characterization of goods; the Technology of Production Cycles dealt with transformations from raw materials and all auxiliary services to production.

Since 1983, the course of Social technology has been entered in the learning process, whose program included considerations on the environmental impacts from the production of goods and the study of technologies and methods for clean-up interventions.

Since then, the course has changed its name (Technology of production cycles - address environmental, Environmental technology, Environmental management systems and certification, Integrated management systems) and programs included new feelings and new tools to reflect changes that have constitute the cultural heritage of graduates in Economics. In addition to a technical approach, the share of organizational and methodological aspects has been expanded, providing students with technical tools such as Life Cycle Assessment, and organizational tools, such as management systems ISO9001: 2001, ISO14001: 2004, ISO26000: 2010, ISO 50001:2011.

Recently it has been realized a course in Industrial Ecology and Integrated Certification within which the "physical records" allow you to develop hypotheses of integration among firms located in Ecologically Equipped Productive Areas.

Partnerships with companies for educational purposes have formed a significant part of the didactic and were appreciated by students who, in many cases, have developed their thesis within enterprises.

Now Scatol8<sup>®</sup> is an integral part of didactics. The ebook "Scatol8<sup>®</sup>: A Path To Sustainability", downloadable on <http://scatol8.net>, can be a useful support in different teaching methods and to different students. It is possible to prepare tailor-made releases of the book, combining parts of it in relation to teachers and students' needs.

The issue of sustainability is linked to the availability of natural resources for future generations, a requirement influenced by the concepts of intra-and intergenerational fairness.

Future generations are prepared to sustainability from the present.

The message must be addressed right through the school, with motivated teachers and through engaging educational proposals, instilling in students concepts that form the foundation of sustainability, the environment, in order to form individuals who incorporate this value in their decision-making models. The interactive didactics made possible thanks to Scatol8<sup>®</sup> can do a lot to attract young people to concepts that may appear abstract or too complicated.

### SCATOL8® WIRELESS SENSOR NETWORK PROTOTYPE



The funny side of teaching has been tested by DCS thanks to the participation at the 6th Edition of the "Researchers' Night" on September 2011. At our booth, set up in Turin, there have been various classes of primary school who participated with enthusiasm to the trail that Scatol8® has made it possible: the different games related to the monitoring of certain environmental variables have created a virtuous competition, which has stimulated the logical capacity, creativity and team spirit of the students, allowing you to reflect together on consumptions and on the concept of environmental sustainability.

This year, the experience has been renewed, with new games. On September 2012, students had the chance to see the system in operational conditions, variables displayed on Crusc8 and clips on the experiences in the mountain huts. Interactive games have been organized.

A new proposal for teaching-oriented capabilities of today's students, benefits from the potential offered by new technologies. New technologies very often allow the creation of gadgets that not only have a very short life cycle, are likely to be confined in the environment, very limited, the experimenters. But new technologies can also accompany a customized learning path. Therefore, at the basis of Scatol8® 's proposal there is the idea that new technologies are capable of imparting a tremendous impetus to training, if make it possible to understand important concepts in a fun way and if this process occurs in large numbers.

From our experience with regard, in particular, to students of the Faculty of Economics, the values of Scatol8® led us to dialogue with other educational institutions to enrich and decline the initial concept, according to the wishes expressed by the new categories of users to which we refer.

### **Scatol8's in Primary schools**

Primary schools "Sant'Anna" and "Santa Teresa" of Chieri are the first schools involved, since last year, in a positive competition on sustainability. After a meeting with the teachers, from the month of October 2012 will be organized educational activities with proper cultural association of science for children Ar:kid:lab, coordinated by the Architect Simona Gallina.

Besides this initiative, whose costs are totally funded by pupils' families, the Piedmont Region has started, in the school year 2011-2012, a project to promote energy savings in public buildings, with specific attention to the schools, was carried out a project for environmental education in primary schools in Piedmont. In the school year 2012-2013, two schools, respectively located in Torino and Vercelli join the initiative "Everybody in the race for Energy with the Scatol8<sup>®</sup>", which includes meetings with teachers to arrange the competition, installation and monitoring of two remote sensing networks, and a closing event. In autumn 2012, a network of remote sensing of environmental and management variables will be installed in two classes of each school. Around the monitored variables they will build a learning path based on the reading of the monitored data. From the operational involvement of students in the design and manufacture of containers of Scatol8<sup>®</sup> to be installed within the school walls, the game will run through analysis, comparisons, comments and use of good environmental practices. Pupils and teachers will work on data of waste production, energy consumption and temperature. The schools will be "virtually" connected thanks to their display on Crusc8.

### **5.Scatol8's improvement Technical Highschool "Ettore Majorana"**

On school year 2010-2011, DCS started a collaboration with the Technical Highschool Ettore Majorana - Grugliasco (TO) - to organize traineeships periods on technical issues (choice of sensors, electronic circuits production, ...). Some students were involved in the installation of Scatol8<sup>®</sup>'s in the huts participating to the project VETTA. The school is still actively working on the system.

### **Polytechnic University of Turin - Faculty of Architecture**

In the academic year 2011-2012, the Scatol8<sup>®</sup> was presented to the students of Communication and Visual perception. It has been the theme for 8 working groups that have developed full proposals for games, videos, websites for an educational offer for the primary School. The results, some of which have appreciable effect and completeness, can be seen at the following link: <http://scatol8.net/?p=639>  
In addition, the system has been presented in the course of Industrial Design (Prof. Claudio Germak) and is expected to carry out laboratory activities during the academic year 2012-2013.

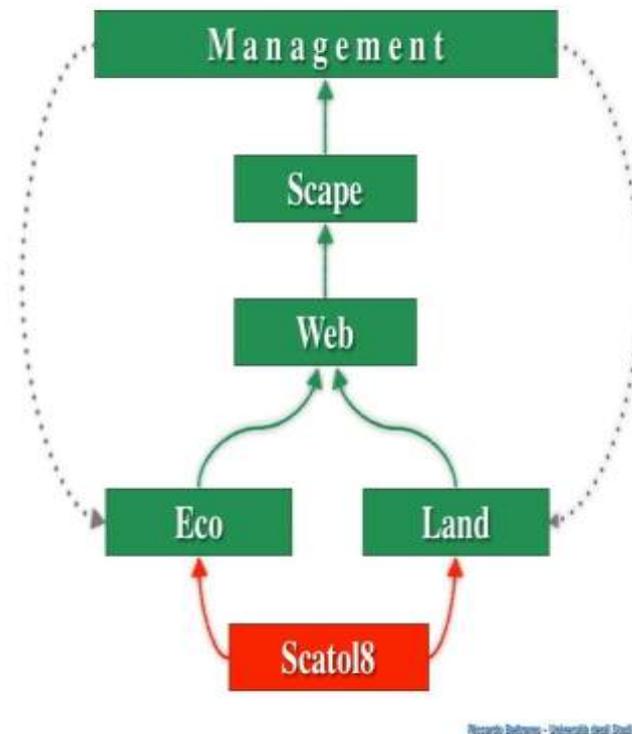
### **School network**

In our region, it has been set up a School Network for the Scatol8<sup>®</sup>'s dissemination in training activities. The following highschools joined the network: Institute "A.Monti" and "B. Vittone" of Chieri, Institute "N. Bobbio" of Carignano (TO), Institute "Plana" of Turin. The network is open to national and international schools. This initiative has been promoted by the Italian Association of Teachers of Natural Sciences -

ANISN. The strong environmental characterization of Scatol8<sup>®</sup> has made it possible to meet the ANISN, the Italian Association which links teachers of Natural Sciences, an Association strongly engaged in EU funded projects for the dissemination of scientific culture. On last May, Scatol8<sup>®</sup> was presented to the National Assembly and it was decided to explore ways to spreading the system and creating initiatives to teaching support. The first result was the formalization of a Memorandum of Understanding to create a Schools Network, which took place on July 31, 2012. Through the protocol, it has been planned a competition on Sustainability among the schools linked in the School network and decided to applicate to a national Call for proposals with a multi-year project.

## 6. Conclusion

The following diagram was drawn at the time of the invention of Scatol8<sup>®</sup>.



It represents the initial structure has been followed in the development of the project. All the initiatives that, since then, have been dropped give an idea of the potential of Scatol8<sup>®</sup>'s system. Although they stand for a wide range of existence, we are still at the beginngin of our exploration of the pervasive concept of Sustainability. On the website <http://scatol8.net> we provide an upgrade of the project, on a concept map.

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