GRUPPO TELECOM ITALIA

**BRIDGING GLOBAL COMPUTING WITH GRID**

**Sophia Antipolis, 28th – 29th November 2006**

# Autonomic Communications

## Introduction on Autonomic Communication Elements

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TELECOM ITALIA

# IST Integrated Project CASCADAS "Component-ware for autonomic, situation-aware communications and dynamically adaptable services"

- Overall Objective
  - The main objective is developing an autonomic framework for the creating, executing and provisioning situation-aware and dynamically adaptable communication services. Particularly the project will implement and demonstrate (in a test-bed) a toolkit based on distributed self-similar components characterized by autonomic features (self-configuration, self-optimization, self-healing, self-protection, self-organising, etc.).
- Consortium
  - **Telecom Italia S.p.A. (IT) (Prime)**, British Telecommunications plc (UK), Budapest University of Technology and Economics (HU), Fraunhofer Institute for Open Communication Systems (DE), Imperial College London (UK), INSTITUT EURECOM (FR), Politecnico di Milano (IT), National and Kapodistrian University of Athens (GR), Universität Kassel (DE), Université Libre de Bruxelles (BE), Università di Modena e Reggio Emilia (IT), Università degli Studi di Trento (IT), University of Ulster (UK), School of Management of Milano (IT)
- Project Data
  - Duration: 1/2006 – 12/2008 (Total Cost: € 6,92 m, EC Contribution: € 4,95 m)

# Agenda

Introduction to autonomic systems

Any applicability for commodity H/W ?

A vision on an Autonomic Service Layer

# Autonomic system

- What is an automatic system ?
  - A system, working without (or with a limited) human intervention
  - Normally it reacts to pre-defined stimuli with pre-defined outputs
- What is an autonomic system ?
  - A system, racting “automatically” even to unpredicted stimuli thus showing capabilities of adapting dynamically to variable context and situation (“mostly” independently from human operators)
  - It shows “learning" and "self-adaptation" features
  - Its self-* functions emerge as results of statistical behaviors coming from the interaction of several sub-systems

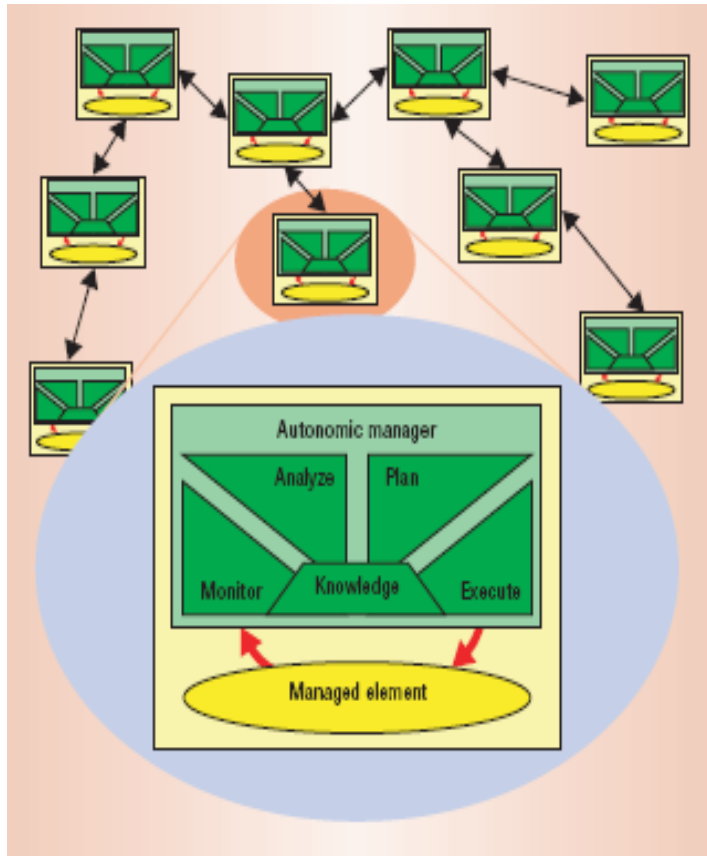
# A Manifesto on Autonomic Computing (IBM, 2001)

- Software complexity and system heterogeneity are recognized as two of the main obstacles to further developments in IT industry:
  - Individual system are increasingly complex to maintain and operate
    - large numbers of configuration/tuning parameters
  - Heterogeneous systems are becoming increasingly connected
    - integration becoming ever more difficult
  - Behaviors, execution context, interactions not known a priori
- Autonomic Computing refers to the self-managing characteristics of distributed computing resources as such capable of hiding completely its complexity to operators and users.
- Systems make decisions on its own, using high-level policies from operators. It will constantly checks and optimize its status and automatically adapt itself to changing conditions.

Source: IBM, "Autonomic Computing: IBM's Perspective on the State of Information Technology"

# A Manifesto on Autonomic Computing (IBM, 2001)

- Managed Element could be a hardware resource, such as storage, a CPU, or a software resource, such as a database, a directory service, or a large legacy system.
- An Autonomic Manager (AM) will typically manage (i.e. represent and control) one or more Managed Elements according to the MAPE-K model. AM are communicate each other to get the overall control.
- Autonomic Manager will relieve Operators of the responsibility of directly managing the managed element by monitoring it (and its external environment) and executing actions plans based on an analysis of this information.



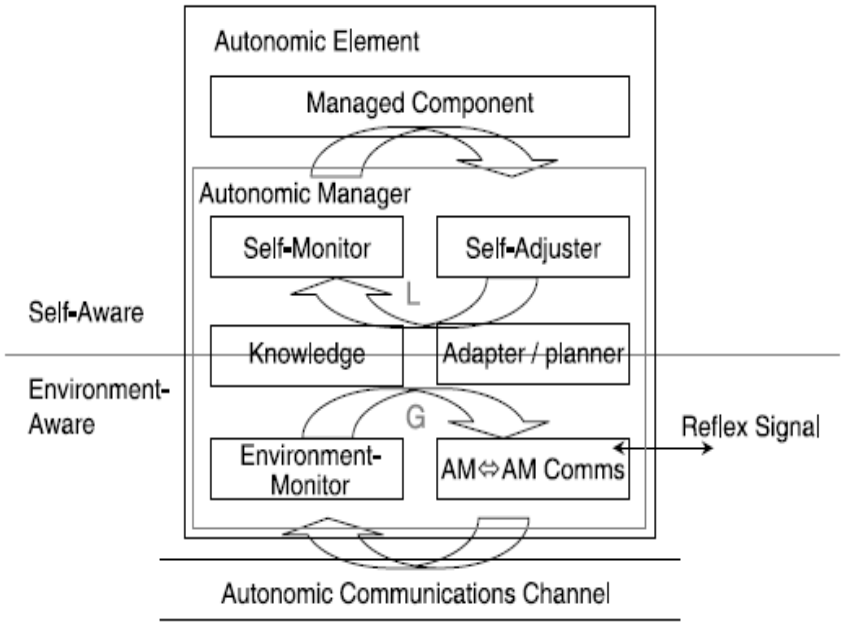

Source: IBM, "Autonomic Computing: IBM's Perspective on the State of Information Technology"

# Goal of Autonomic Computing (vs Grid)

- Distributed (and parallel) computing has evolved to provide specialized solutions to satisfy very stringent requirements in isolation
  - security, dependability, reliability, availability, performance, throughput, efficiency, pervasive, automation, reasoning, etc.
- However, in pervasive Grid environments requirements and objectives are dynamic and not know a priori
  - requirements, objectives and choice of specific solutions (algorithms, behaviors, interactions, etc.) depend on runtime state, context, and content
- The goal of autonomic computing is to use optimize solutions dynamically based on state/context/content given specified policies

# Autonomic Communication Element

- An Autonomic Communication Element is the atom of an autonomic system
- It is self-aware and capable of self-management
  - Thanks to control loops with sensors (self-monitoring) and effectors (self-adjustment) together with system knowledge and planning/adapting policies (local (L) and global (G) control loops)
  - A local (L) control loop for components self-awareness
  - A global (G) control loop facilitates environment awareness, allowing if necessary, to change the environment — this is effected through communication with other autonomic managers that have the relevant influence through reflex or event messages.
- In this scheme, every component in a system, and every system within systems of systems, is self-managing with management communications between components




Source: “A concise introduction to Autonomic Computing”, R.Sterrit, M Parashar, et alii

# Autonomic Communications

- Autonomic solutions may offer interesting advantages:
  - Optimization of resource
    - *Server utilization rates could be "massively optimized" rising to an average of 80% from the 20% that's typical today (Source: Forrester Research Inc.);*
  - Reduction of management complexity (Self-management and self-chop)
    - *Introducing autonomics in data center means reducing operating costs: one systems administrator can manage 10 or 20 times the number of servers that could be managed in a traditional environment (Source: SUN);*
    - *Approximately 70% of today's IT budget is labor. Human errors currently account for nearly 80% of database problems (Source IDC);*
  - Info-ware management (management of huge amounts of data and information)
  - Enabling new services related to state/context/content and based on specified policies
    - *creation and execution of innovative and pervasive situation-aware (communication and content) services using pervasively distributed resources, enablers, info-ware and data*

# Commodity H/W and smart S/W

Google

**Network-Centric Principles (Google)**

1. Build & operate protected information network;
2. Offer universal connectivity for:
   - Collection, processing and storing of information;
   - Provide secured communications.
3. Maintain shared data models;
4. Require continued upgrading & innovation.

- Architecture based on:
  - Commodity Hardware
  - Smart Software
  - … and an effective business model

**Google Infrastructure: Key to Growth (1)**

- >200,000 custom-built commodity servers;
- Acting as one parallel supercomputer;
- Fault tolerant hardware.

*Source: Prof. P.A. Straussman "Google"– George Mason University (5/12/2005)*

# Commodity H/W and smart S/W

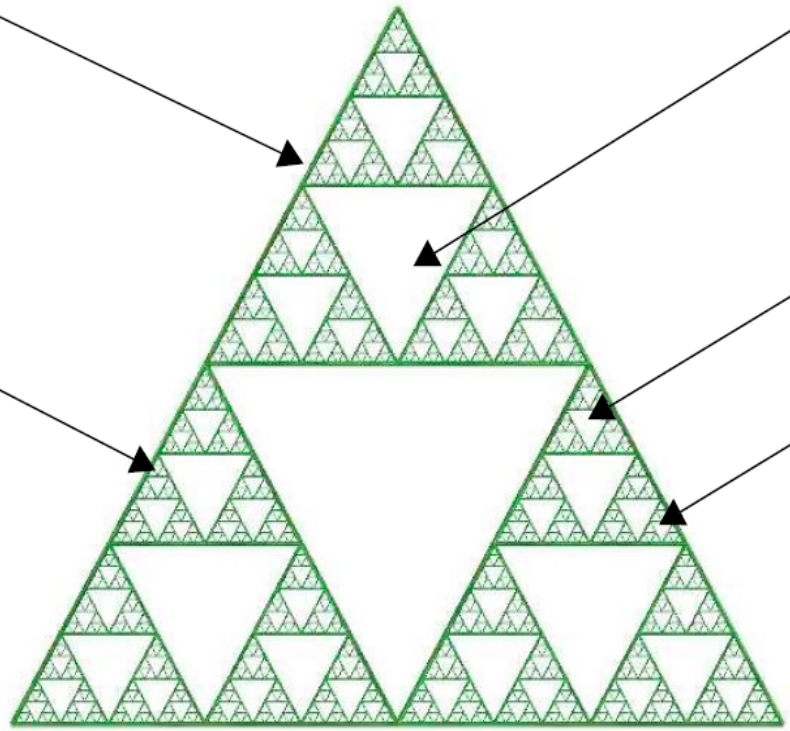
The Googleplex is a larger instance of the organization of a single pizza box server.

A data centre uses the same design and is composed of racks.

A single Google cluster embodies the same organizing principle as a single pizza box server

A single replicated Google file reflects the controllling organizing principle

A single Google pizza box server



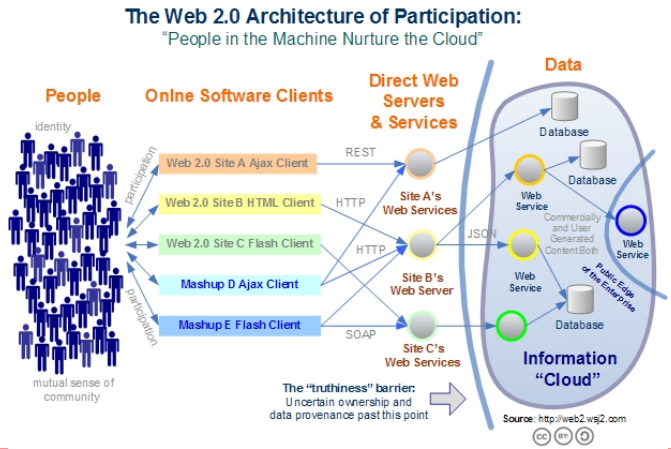
**Architecture for Reliability**

- Replication (3x+) for redundancy;
- Replication for proximity and response;
- Reliability with software and architecture, not with hardware.

*Fonte: Prof. P.A. Straussman "Google"– George Mason University (5/12/2005)*
*Fonte: Google Technology - www.infonortics.com/publications/google/technology.pdf*

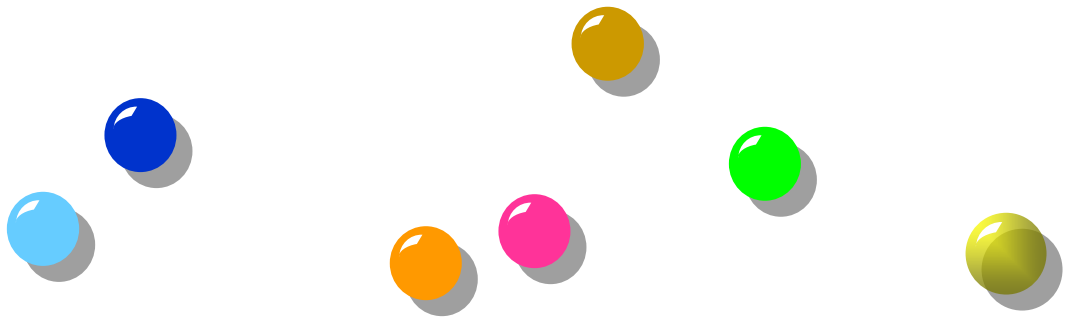
# … and an effective business model

- Google
  - Vision: network is a *pipe* for communications between end-points
  - Services: for free to Users
  - Advertisers: → €
- Telco Providers
  - Vision: network is a platform where introducing new services/functions
  - Services (mostly voice and data): paid by Users
  - Users: → €
- …Web 2.0 brings a shift of business models
  - Service Brokering of personalized service
  - Advertising in the value-chain

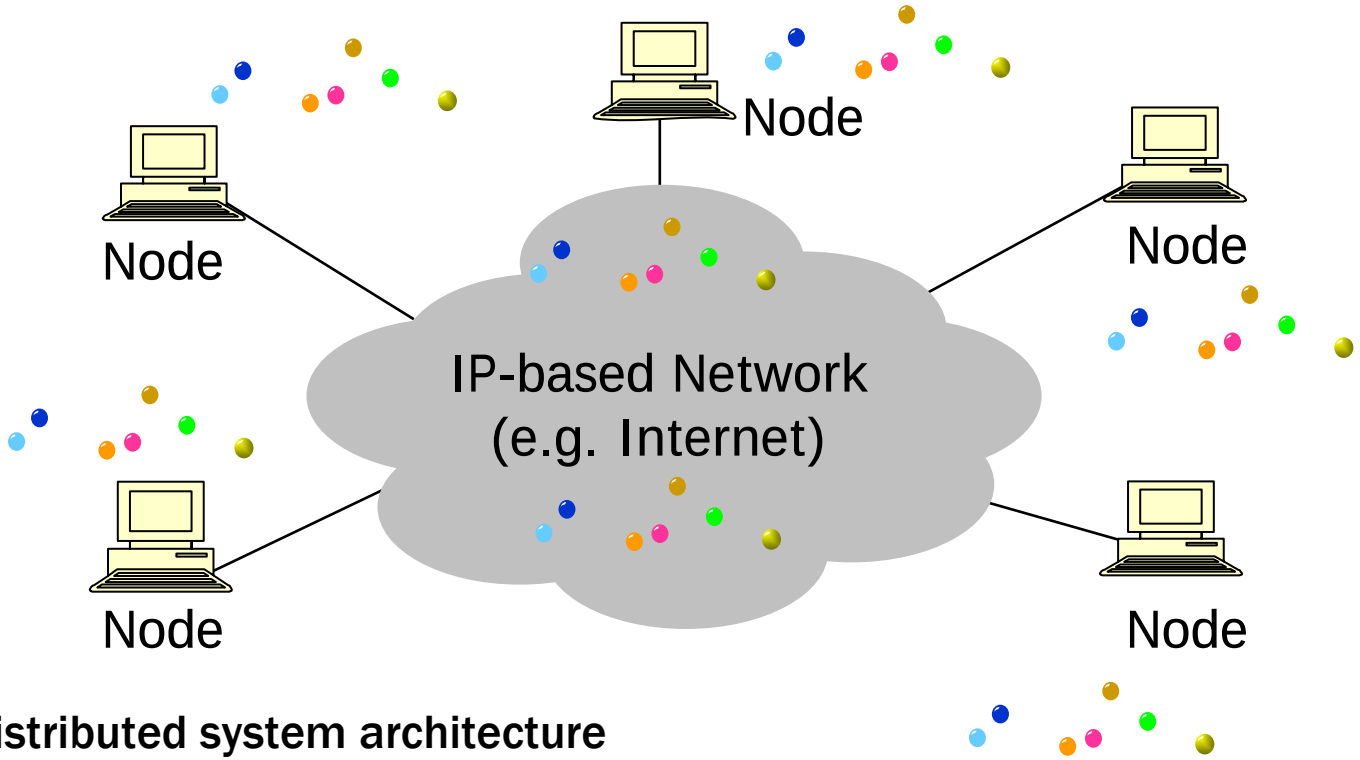


# Drivers

- Telco Providers have the need to explore innovative way to provide services economically, flexibly and quickly… service may have a short-life !
- An autonomic component-based approach is likely to increase efficiency:
  - services may be created and executed starting from the dynamic self-aggregation of distributed basic components
- Info-ware management: search, communications, data and contents
  - lightweight components also for handling global knowledge and data



# ...distributing autonomic resources (self-similar architectures)




- A distributed system architecture
  - No centralized control
  - Nodes are symmetric in function
- Large number of (even unreliable) nodes → commodity H/W and smart S/W

# Autonomic Service Layer

*Self-* for hiding complexities to humans* +

*Commodity H/W* +

*Smart S/W* +

*Decentralisation and resource distribution* +

*Access to shared resources, services and data* =

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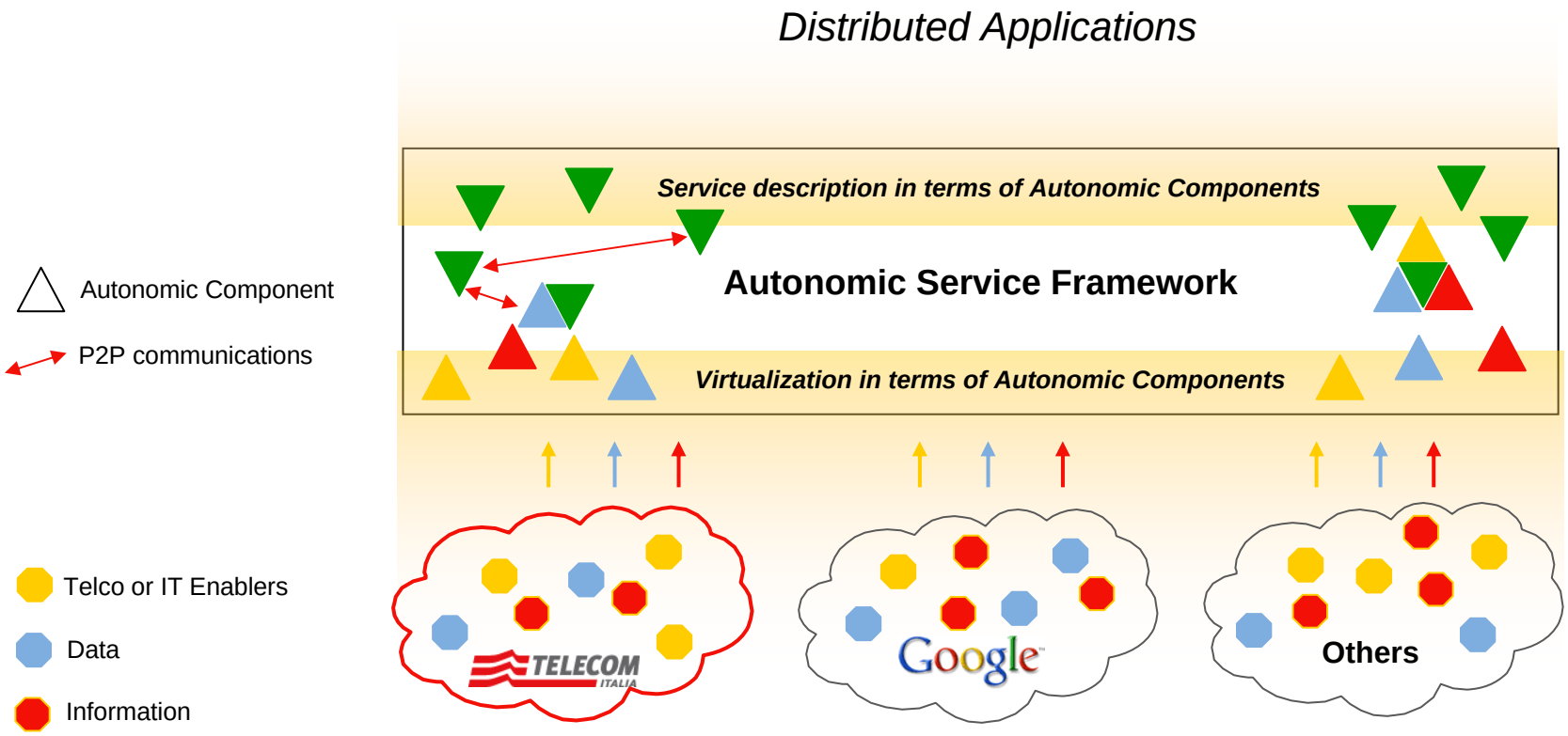
*Autonomic Service Layer*

*over*

*All-IP Networks*

# Autonomic Service Layer

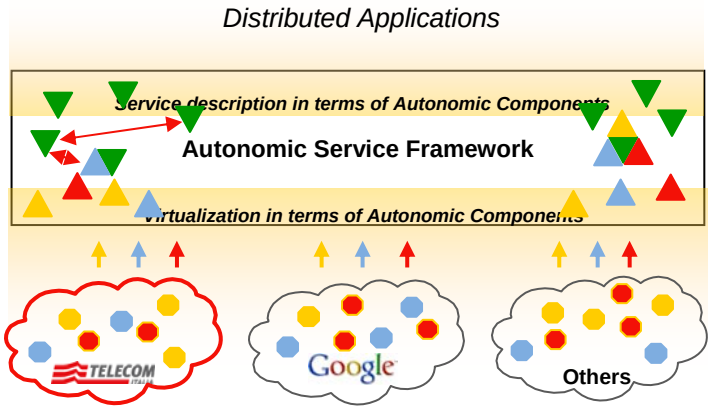


# Conclusions

- Autonomic system
  - A system showing self-* functions as emergence of statistical behaviors coming from the interaction of several sub-systems
  - Potential advantages
    - Optimization of resource
    - Reduction of management complexity
    - Info-ware management (management of huge amounts of data/info
    - Enabling new pervasive and situated services
- An autonomic component-based approach is likely to increase efficiency in providing services:
  - services may be created and executed starting from the dynamic self-aggregation of distributed basic components

# Conclusions

- Commodity H/W and smart S/W
  - Self-similar architectures
- Autonomic Service Layer
  - Self-* for hiding complexities to humans
  - Commodity H/W & Smart S/W
  - Decentralisation and resource distribution
  - … for new business models




*Resources, data and functionalities highly distributed*

# Thanks !

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