Architectural Thinking
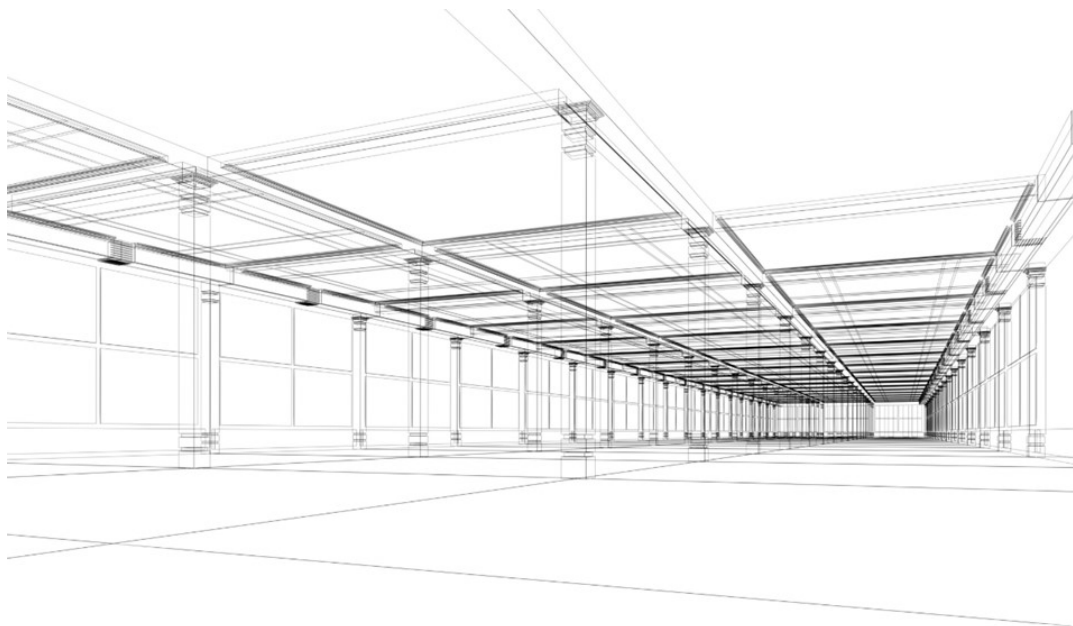
Course Exercise Model Answer - Solution Architecture Overview

Version: 7.12

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1 Introduction

1.1 Purpose of this document

This document contains the model answers for the exercises offered as part of the Architectural Thinking training course. The course uses a single case study where you as a participant play the role of Solution Architect during a proposal that has already started.

This particular document is the complete Solution Architecture Definition document and includes model answer for all the exercises.

More importantly, this document demonstrates a full example of a Solution Architecture Definition and can be used by students as a "best of breed" example in their future work.

1.2 Definitions

Table 1. List of Terms and Acronyms.

Acronyms	Meaning
AD	Architectural Decision
AJAX	Asynchronous JavaScript and XML
API	Application Programming Interface
AWS	Amazon Web Services
CDN	Content Delivery Network
CSCC	Client Standard Customer Council
COTS	Commercial Off-The-Shelf
DB	Database
DNS	Domain Name Server
DoS	Department of Statistics
DR	Disaster Recovery
ECN or eCN	Electronic Census Number
ECP	Electronic Census Processing
ECS	Electronic Census System
FW	Firewall
GUI	Graphical User Interface
HA	High Availability
HTML	HyperText Markup Language
IaaS	Infrastructure As A Service
IFP	Intelligent Forms Processing
IPS	Intrusion Protection System
LN	Logical Node

Acronyms	Meaning
LOM	Logical Operational Model
MVC	Model / View / Controller (pattern)
PaaS	Platform As A Service
PL	Physical Location
PN	Physical Node
POM	Physical Operational Model
PoP	Point Of Presence
OS	Operating System
QoS	Quality of Service
SaaS	Software As A Service
SDLC	Systems Development Lifecycle
TCO	Total Cost of Ownership
UI	User Interface
VLAN	Virtual Local Area Network
VM	Virtual Machine
VPN	Virtual Private Network
WAS	WebSphere Application Server
XML	eXtensible Markup Language

1.3   References and Related Documents

Table 2. References and related documents.

No	ID	Document Title
[1]	AT_CS00	Case Study Background
[2]	AT_CS01	Requirements Specification

2   Overview of requirements

2.1   Summary of functional requirements

The government of the Republic of Bolumbia, a prosperous country with a population of over 23 million people, has a Department of Statistics (DoS) which collects and analyses information about various aspects of the country including its population, society, health and the economy to name the key areas. The department has been running a Population and Housing Census for over 100 years and in recent history the Census has run every 5 years, the next census being three years from now. The government is looking for an IT partner to deliver the complete Electronic Census System (ECS) solution including implementation, hosting and support.

The following diagram is the System Context for ECS showing ECS as a *black box*, the external actors that interact with ECS and what they do. Note that the use case model provides more detail about the nature of the interaction between the actors and ECS.
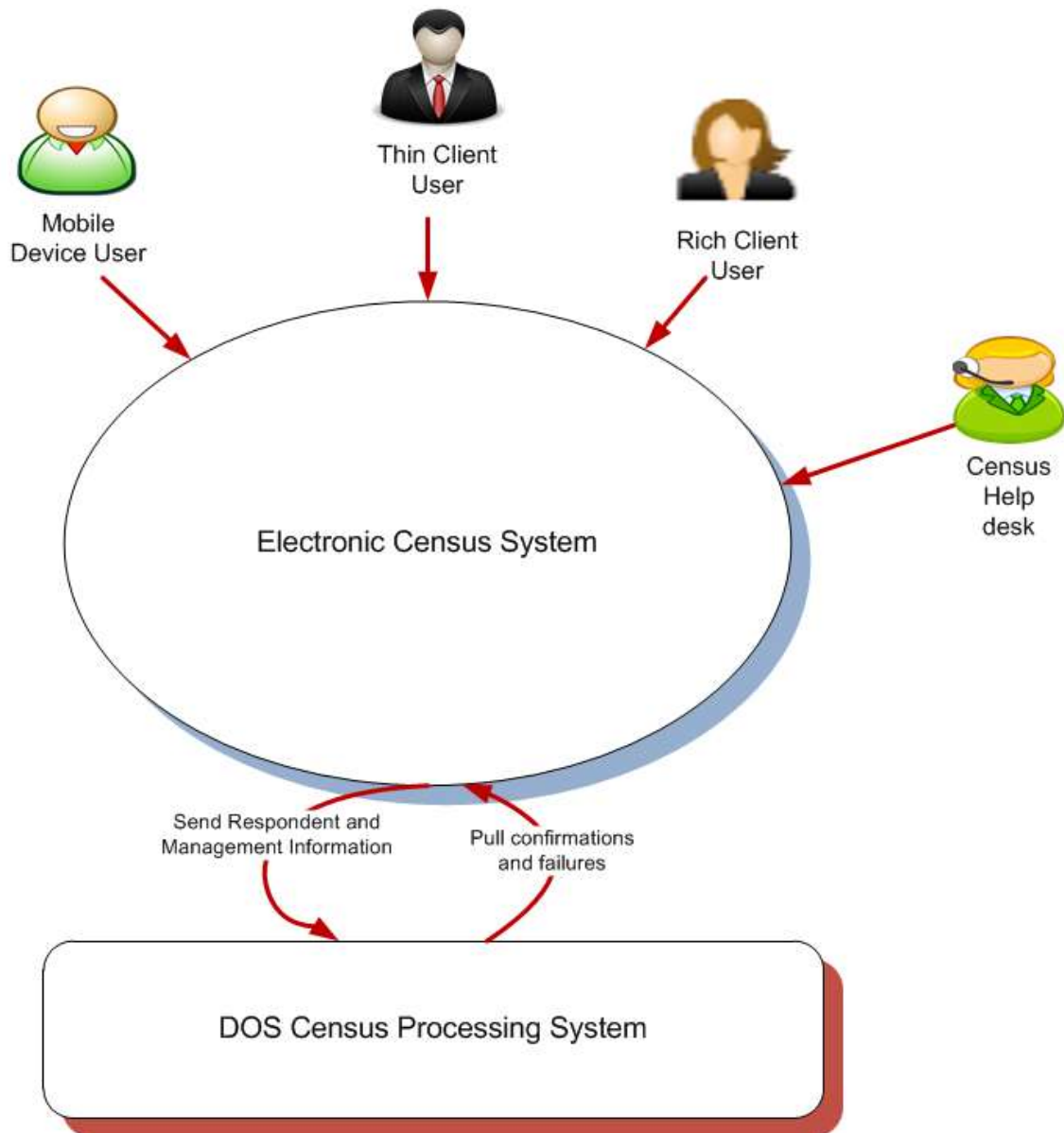
Figure 1 - System Context

The following diagram and associated table provide an overview of the system functionality required.
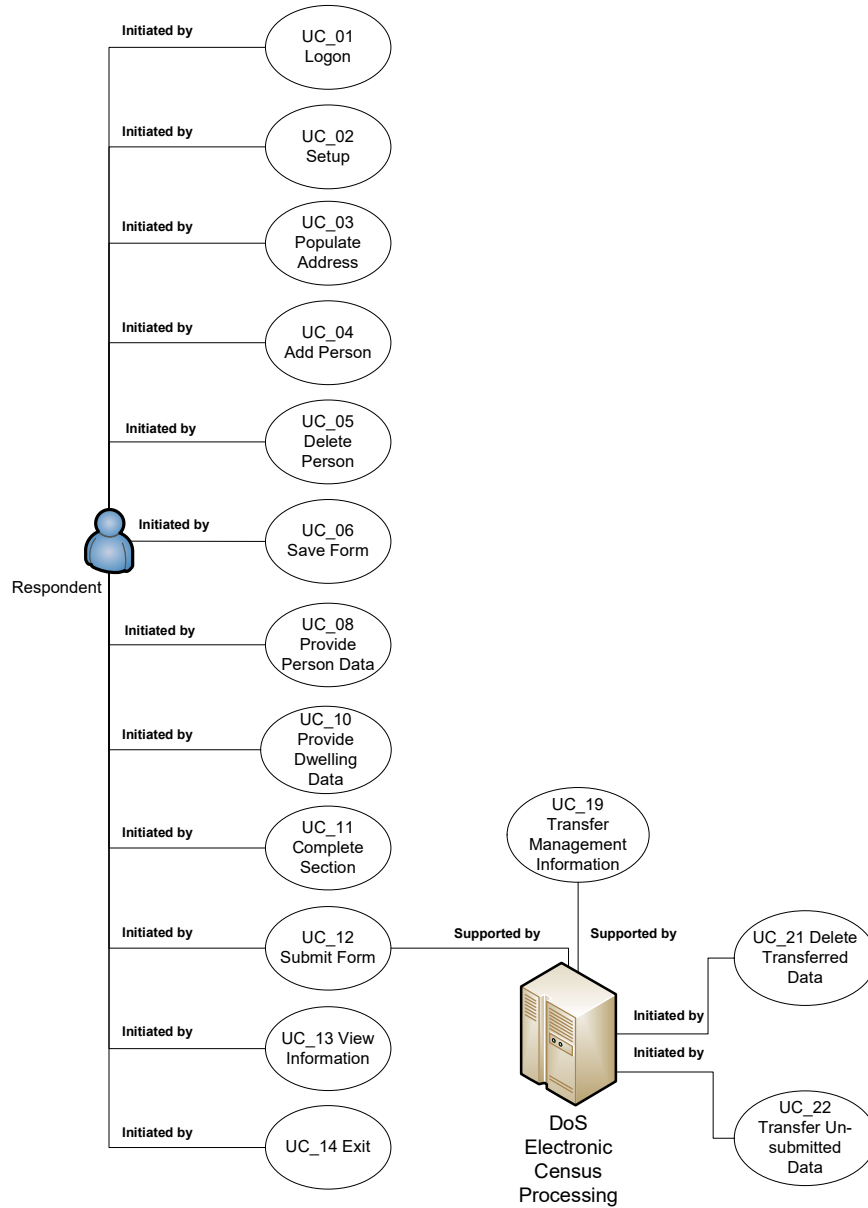
Figure 2 - Use Case Model Diagram

Table 3 - Use Case Overview

User Case ID	Use case name	Description
UC_01	Logon	The Respondent logs onto the System using a Census Form Number (CFN) and Electronic Census Number (ECN) which constitute logon credentials. Following successful logon, the Respondent is presented with the ECS Census Form.
UC_02	Setup	The Census Form can contain a list of up to 10 people residing in the dwelling on Census night. Setup is used to capture the number of persons present on Census night to configure the person section.
UC_03	Populate Address	Addresses must be completed for all dwellings.

User Case ID	Use case name	Description
UC_04	Add Person	The Respondent must be able to add, and modify a person at any time prior to submission. For those persons added, where the Respondent indicates that they are to be included in the Census, a new person record is also created for them.
UC_05	Delete Person	The Respondent must be able to delete a person at any time prior to submission.
UC_06	Save Form	A Save of Census data may be requested at the completion of a page, section, on exit or at submission whilst logged onto the System with a current session. The data is stored for later retrieval by the Respondent.
UC_08	Provide Person Data	The Respondent provides answers to the questions contained in the person section.
UC_10	Provide Dwelling Data	The Respondent provides answers to the questions contained in the dwelling section.
UC_11	Complete Section	The Respondent may request completion of a Census section once mandatory questions have been answered. The completion process entails an implicit save initiated by the System. When all sections have a status of complete, the Respondent may request submission of their data to the DoS.
UC_12	Submit Form	The Respondent may submit their Census data only once to the DoS, after completing all sections. After successful submission, the System issues the Respondent with a receipt number. Any subsequent access to the System will provide the Respondent with their receipt number. Respondent is prevented from making changes or resubmitting their Census form.
UC_13	View Information	The Respondent may at any point request a viewing of extra information. This includes links such as Copyright, Conditions of Use, Privacy and Security and Contextual Help.
UC_14	Exit	The Respondent may exit the System at any time with or without saving their Census data. If the Respondent exits without first saving any changes, the System provides the opportunity to save before exiting. The Respondent may decline this opportunity, which results in unsaved data being discarded.
UC_19	Transfer Management Information	The System transfers management information data to the DoS.
UC_21	Delete Transferred Data	The System receives confirmation from the DoS of Respondent Census data that can be deleted, identified by ECN. For each ECN received, the System deletes the corresponding Respondent data.
UC_22	Transfer Un-submitted Data	The System transfers un-submitted Respondent data to the DoS on request.

2.2 Summary of non-functional requirements

Table 4 – NFR Summary

ID	Category	Requirement statement

ID	Category	Requirement statement
1	Volumetric	Capacity to support up to 9.5 Million households during the census enumeration period.
2	Volumetric	Peak system load on the first Census night after 5pm
3	Volumetric	Population of Bolumbia is approximately 23 Million people so that many person records need to be accounted for.
4	Performance	The transaction processing time (under ECS control) should be under 3 seconds on average
5	Performance	The target overall response time should be less than 10 seconds on average
6	Hours of Operation	Respondents must be able to logon, complete and submit census responses 24 hours a day during every day of the enumeration period.
7	Availability	The ECS must be available 98% of the time during the hours of operation.
8	Security	Audit trails must be provided as part of the security arrangements for the solution.
9	Accessibility	Support for Chrome, Firefox and Internet Explorer.
10	Accessibility	Support for Android, iOS7 or later and Microsoft Surface.

2.3 Out of scope statements

The ECS proposal does not include:

- System(s) that analyse Census information collected.
- Non-private dwellings: These responses will be paper based for this first release of ECS.

3   Architecture Overview

This section provides the Architecture Overview work product. It contains the solution architecture that facilitates understanding of the detailed solution elements and their mutual relationships described in the remainder of the document. The latter sections provide progressively more detailed views of the solution.
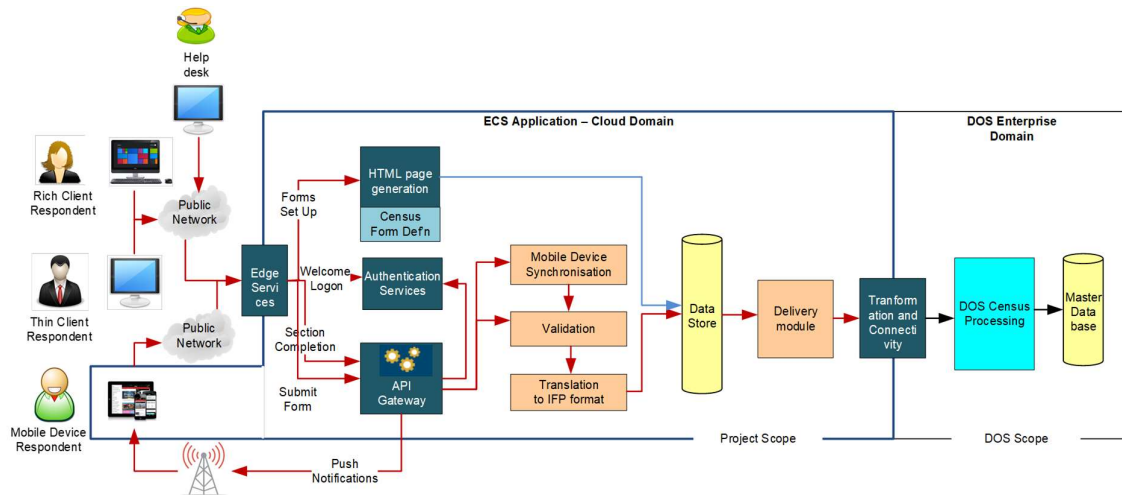

Figure 3 - Architecture Overview Diagram

The following major architectural components of the ECS solution are illustrated in Figure 3 above.

a)   Thin client user interface - must meet the accessibility requirements including operation with JavaScript disabled and support for screen readers. ECS application running on the server generates all HTML pages displayed to the respondent and performs all field validation, business rule and mandatory question checks, and subsequent processing. The browser performs the pure presentation layer function, and thus every individual page transition requires interaction with the server.

b)   Rich client user interface – given expected high load during peak hours usage (the first day of census period after business hours), thin client user interface is likely to generate substantial performance load on the server. A more efficient approach is to develop a rich ECS client separate from the thin ECS client. The rich AJAX client application runs within the browser and generates all of the HTML pages displayed to the respondent based on definition data, locally. The respondent interacts with the displayed pages and the client performs all field and business rule validations, collecting the respondent and management information within the browser memory. The client application posts the collected respondent and management information to the server at each form completion point and when the respondent submits their data, or creates feedback or a technical help request.

c)   Mobile device application – must be available for Android, iOS and Windows mobile devices. The functional of the mobile device application will be like that offered by the Rich client browser application. Additionally, the solution will support "offline" mode of operation

whereby census can be filled in by the mobile device user while the device is not connected to any network. The data is temporarily stored on the device and replicated back to the servers as soon as connection to a network is established. The data is removed from the mobile device once it is replicated to the server.

In summary the ECS solution will support; HTML-only client for approximately 2% of web users without Javascript, AJAX client that will provide a richer and more responsive client for the 98% of web users who have Javascript enabled and a mobile device application that allows users to submit their census forms via their mobile devices.

d) Edge Services - provide network capability to deliver content through the Internet (DNS, CDN, firewall, load balancer).

e) API Gateway – Invokes APIs (exposed by Microservices), routes and connects requests from the front-end applications.

f) Authentication – ECS is secured using a combination of Census Form Number (CFN), and ECS Number (ECN). The Authentication module implements the required ECN authentication algorithms and security rules related to number of logins per ECN, IP Lockout and other security features. Validation and authentication of the user-provided CFN and ECN is performed with algorithms provided by the DoS but implemented as part of the ESC.

g) Census Form Definition – all question information (question type, question text, help text, message content), in fact all text information displayed within the census form is defined within XML definition file(s). Thus the ECS application is a relatively generic mass scale internet based questionnaire solution that is configured to fulfil the specific DoS requirements. The configuration data has the following elements:

- Census Page Definition – is an XML file that specifies the overall information for the Navigation panel, and the set of pages that make up the census, and various overall parameters such as the core application button labels (Next, Previous etc.). The census form is composed of multiple sections with questions; each section requires one or more pages to respond to the questions.

- Census Form Definition – is an XML file that specifies each of the questions belonging to a section. This includes the question response type (Text, Date, Address and Selection), the question text, alternate question text, help text, labels, field sizes, field validation rules, question dependency rules, business rules, and all other presentation and functional aspects of each question on the form.

h) HTML page generation – page generation after the Welcome and Login page is performed on the server and rendered on the client side.

i) Validation – this component performs all field (data type/length) validation, mandatory question checking, and business rule error and warning checks. Server side validation is performed on all incoming data submitted by every HTML interface page. The server side

validation component is also used to validate all completed form data received from the client at the time of submission. Field and page level validation is performed upon each page submission (from the thin client), while the section and form level validation (cross-page validation) is performed at the time of form submission (from any client).

j) Translation – this component translates the respondent data from the input format to the IFP format required for delivery to DoS. The IFP labels required for the answer data are specified in the Form Data definitions. Translation occurs after validation and prior to the data being stored to the database. Translation from IFP back to the client format is required when a respondent has saved their data on exit and subsequently logs back onto the system.

k) Data Store – the temporary (store and forward) data store contains the respondent's data which is subsequently sent to the DoS' Electronic Census Processing system using asynchronous 'store & forward' pattern.

l) Delivery module – this module runs periodically and performs three distinct flows:

- Extracts the respondents' data from the database and transfers it to DoS.

- Retrieves acknowledgment files from DoS and deletes census records that are positively acknowledged by DoS.

- Retrieves re-submission requests from DoS where respondent's data has not been successfully processed by DoS. These respondent records will be included in the first sub-sequent extraction and delivery to DoS.

m) Transformation and Connectivity - enables and connects securely between modules running in the cloud and applications running in the DoS enterprise data centre.

n) DoS Census Processing system – this component receives data files, separates out the different data types (collector notifications, technical help requests, respondent data and feedback) processing each as appropriate, and generates acknowledgement and resend request files if required.

4   Summary of key Architectural Decisions

This section documents critical choices that have been made during creation of the solution architecture.

Table 5: Summary of key Architectural Decisions

ID	Problem Statement	Decision	Stage	Comments
AD005	How should the ECS client web application be implemented?	Implement two types for web clients: • HTML-only client • AJAX Web 2.0 style application	Architecture Overview	Most respondents will use AJAX web client thereby minimising server traffic, while HTML client is required to meet the accessibility requirements.
AD010	Interaction model between AJAX web client and the server.	The AJAX web client application posts the collected respondent and management information to the server at each form completion point and when the respondent submits their data, or creates feedback or a technical help request.	Architecture Overview	
AD015	Flexibility of the Census page and form definitions and validation rules	The ECS application is to be a generic mass scale internet based questionnaire solution that is configured to fulfil the specific DoS requirements.	Architecture Overview	Page and form definitions and validation rules externalised and defined within XML definition file(s).
AD020	Way of storing respondents' data in the ECS database	The respondents' data is stored in the ECS database using IFP format.	Architecture Overview	The respondents' data is required to be sent to DOS in the IFP format.
AD025	Lifecycle of the respondents' data on the mobile device	The data is temporarily stored on the mobile device and replicated back to the servers as soon as connection to a network is established. The data is removed from the mobile device once it is replicated to the server.	Architecture Overview	

While in this section we present architectural decisions in a summary form, one should indeed have each decision elaborated as per templates presented in the lecture materials. The table below should be used as an example of one such elaboration.

Table 6: Example of an architectural decision elaboration

Issue or Problem	How should the ECS client web application be implemented?
Alternatives	1. HTML-only client 2. AJAX Web 2.0 style application

Decision	Both:
	1. Implement the application as a Web 2.0 style application with most of the presentation logic running within the browser and copy all question, help and other text to definition/configuration files that can be rendered into HTML pages by the client locally. 2. HTML only interface to meet the accessibility requirements
Justification	• Much more responsive application with all actions occurring locally within the browser. • Substantial reduction in server end infrastructure • Ability to change question, help and message text without application changes. • Use only the core AJAX mechanism, avoiding the GUI presentation widget sets as these are more likely to have browser dependencies. • Substantial increase in application scalability.
Implications	Additional UI development effort.

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