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Emanuele Adorni

Aerospace and Industrial Safety
engineer, PhD student

Modelling and simulation comparison of conventional and innovative transport for Natural Gas

Eng. E. Adorni, Eng. A. Rozhok,
PhD. Eng. L. Damiani, Prof. Eng. R. Revetria

UNIVERSITÀ DEGLI STUDI
DI GENOVA

Introduction

Natural gas reservoir can be found in several scenarios of deposits:

- Superficial layers of oil deposits
- Gas reservoirs under the surface
- Gas reservoirs under the sea-bed

Many are the extraction processes which can be used given certain conditions:

Presence of shale

Extraction of tight gas

Hazardous release of methane hydrates

Natural gas transport

Customers receive a treated product by conventional means of transport:

On water –

- **Liquified Natural Gas** carrier
- **Compressed Natural Gas** carrier

On land –

- **Pipeline**

Innovative means of transport
Airship

Aim of the research

Existing solutions for transporting natural gas have a high impact on the environment. LNG requires the construction of specific facilities for the liquefaction and regasification processes. Meanwhile, CNG does not require such measures, only specialized equipment for the compression and expansion processes that have a lower impact than LNG. Natural gas can be carried in a gaseous state as payload of airships.

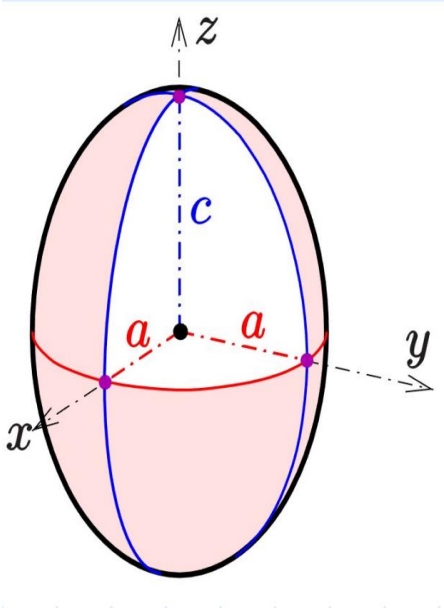
Comparison between natural gas transportation through Pipeline+CNG carrier and Airships

Research hypotheses

- The extraction of *clean* natural gas
- We created our model not taking into account
  - The costs related to the extraction tree
  - The losses due to the loading process of the airship
  - The losses of due the airship's structure and of the CNG carrier

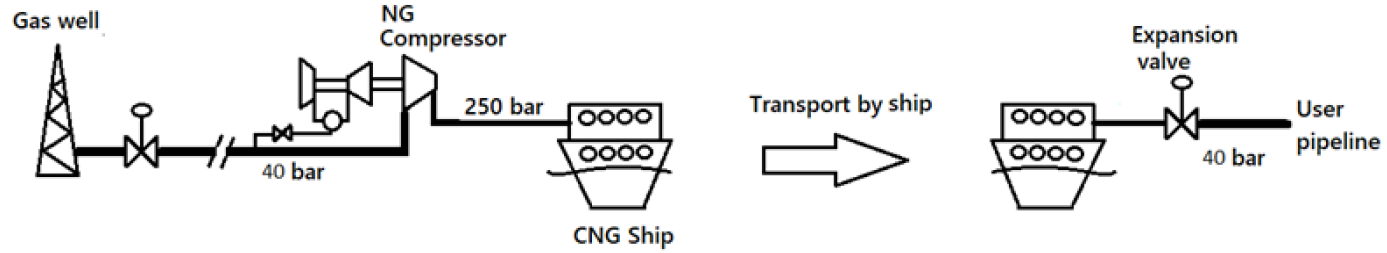
Physical characteristics

Airship	
$Volume$	$75\,000\ m^3$
$CH_4\ Volume$	$45\,000\ m^3$
c	$\approx 54\ m$
a	$\approx 18\ m$
$Resistance$	$\approx 12\ kN$
P_{engine}	$\approx 1.7\ MW$
P_{thrust}	$\approx 600\ \ kJ$

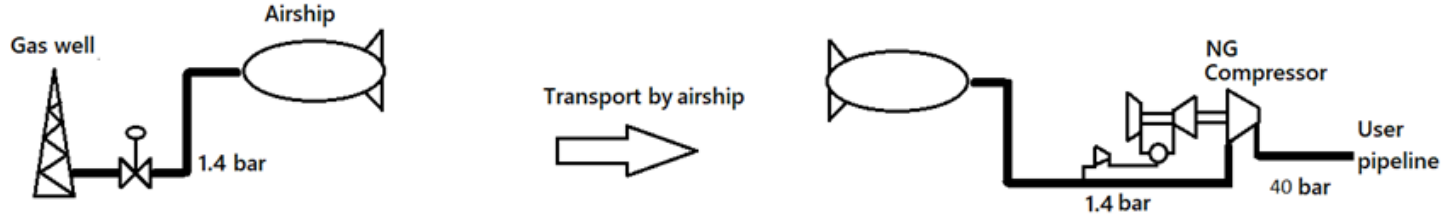


CNG carrier	
$Volume$	$10\,000\,000\ nm^3$
$P_{carrier}$	$30\ MW$

Scenarios

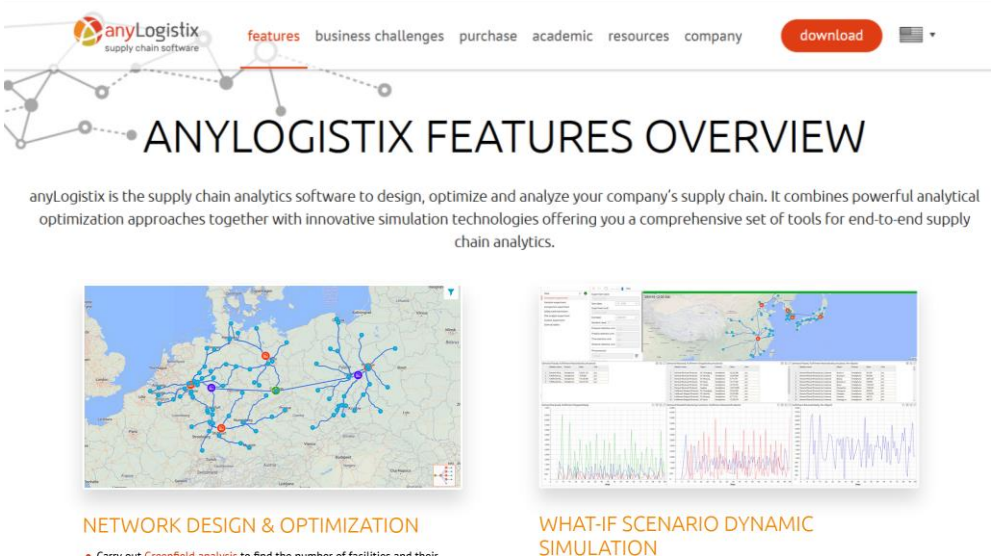


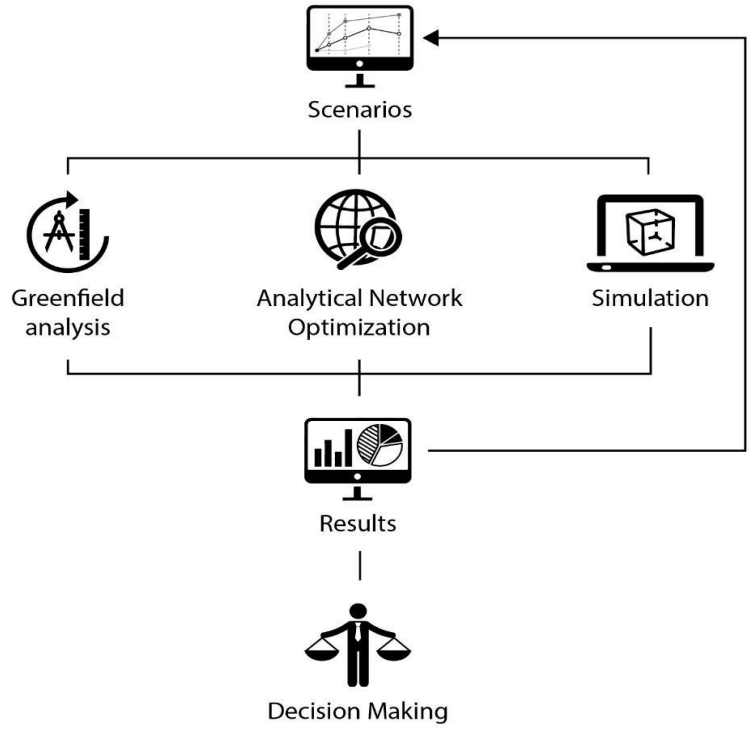
Volume, pressures and maximum payload given by literature



Envelope volume: 40% buoyancy gas + 60% natural gas

What is anyLogistix (ALX)?



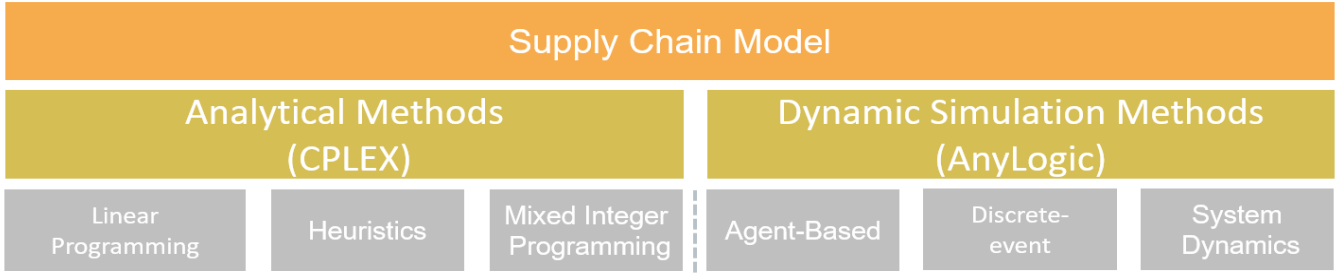


Problem inquiries:

- Where are the best locations for our Distribution centers?
- How to properly define the comparison elements between the scenarios?
- What are the best policies for replenishment, sourcing and transportation?
- What will happen if we change our inventory policy?
- What will happen if we change a distribution centers' capacities?
- What will happen if the demand of the two products changes?
- What will happen if we add more vehicles to the system?
- Will we always satisfy the demand?

Simulation and Optimization with anyLogistix

anyLogistix



#	Name	Type	Location	Inclusion Type	Additional Param...	Icon
1	Customer airship	Customer	Customer airship lo..	Include	Additional param...	
2	Customer pipeline	Customer	Customer pipeline l..	Include	Additional param...	

#	Name	Type	Location	Initially Open	Icon
1	Japan DC airship	DC	Japan DC airship..		
2	Harbour Factory	Factory	Harbour Factory .		
3	Japan DC pipeline	DC	Japan DC pipelin..		

#	Name	Type	Location	Inclusion Type	Additional Param...	Icon
1	Well pipeline	Supplier	Well pipeline loc.	Include	Additional param...	
2	Well airship	Supplier	Well airship loca..	Include	Additional param...	

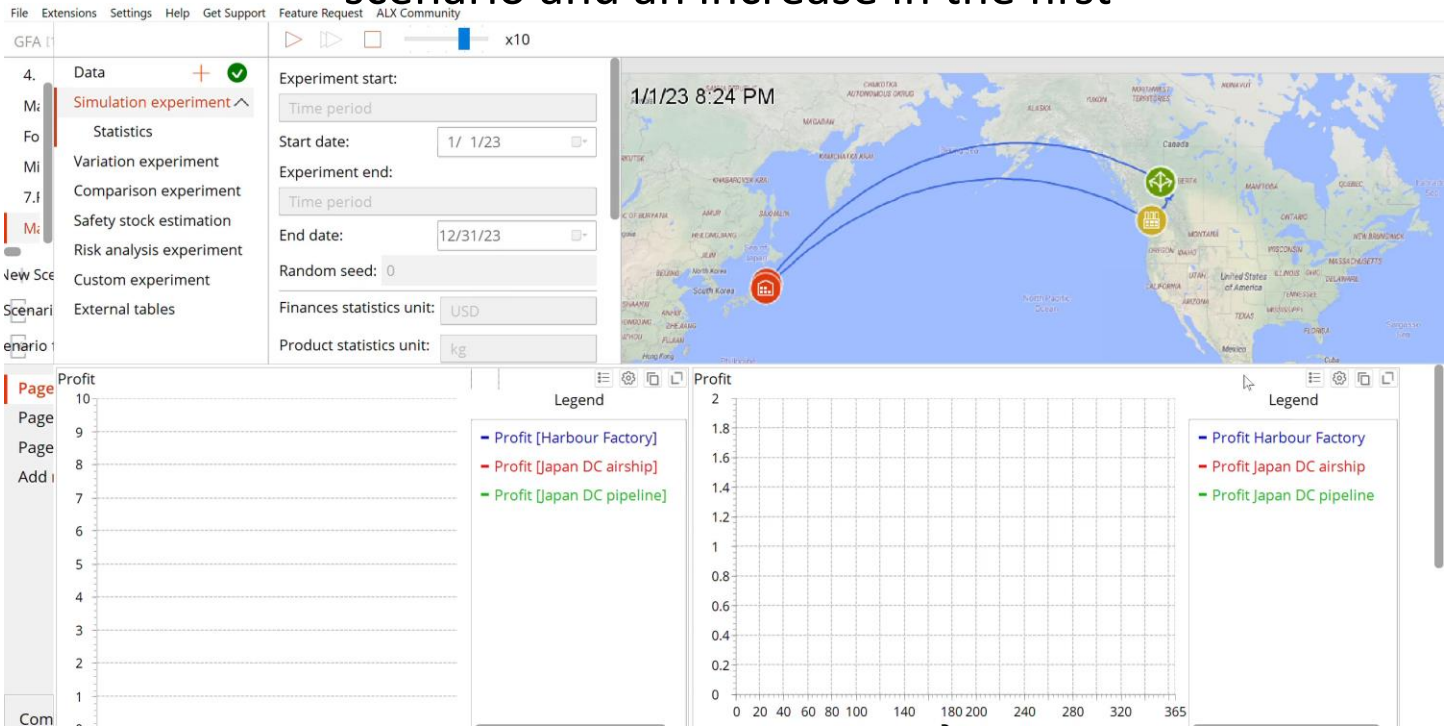
Similarities between scenarios

- The natural gas well used for both scenarios is unlimited
- It is located in a gas rich region of Canada
- The customers to whom the natural gas will be delivered are in Japan. One distribution centre is assigned to the customers of the “airship scenario” and one distribution centre is assigned to the customers of the “pipeline scenario”.
- The demand for both scenarios is the same

Results

Initially the second scenario showed better results than the first scenario.

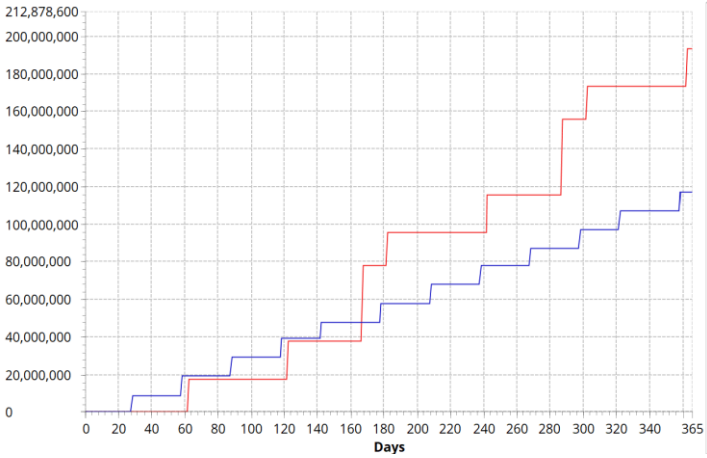
However, throughout the year we observe a decrease in profits of the second scenario and an increase in the first

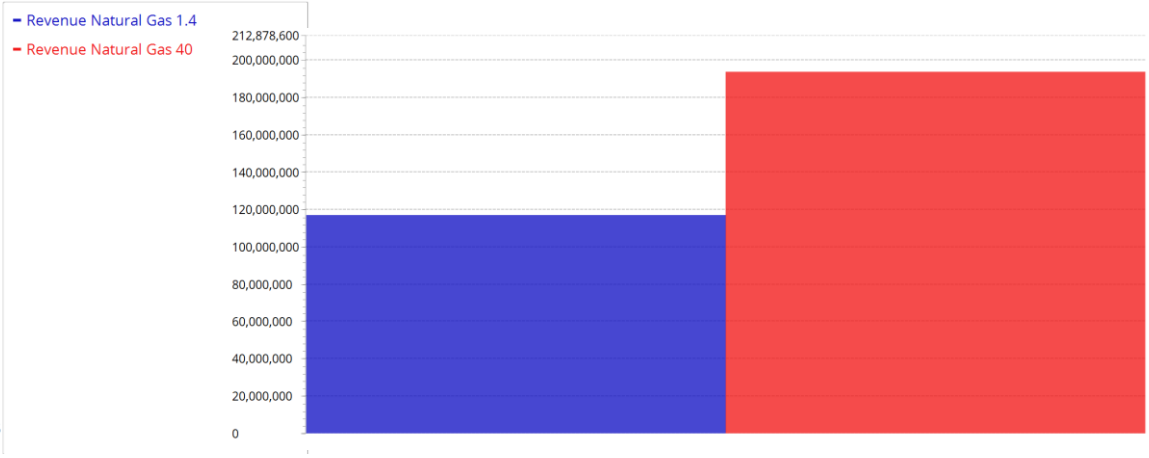


Results

These two graphs represent the profits of the products delivered by the two transport systems

In the long term the profits of traditional means of transport are greater than the innovative since a better development of the infrastructure



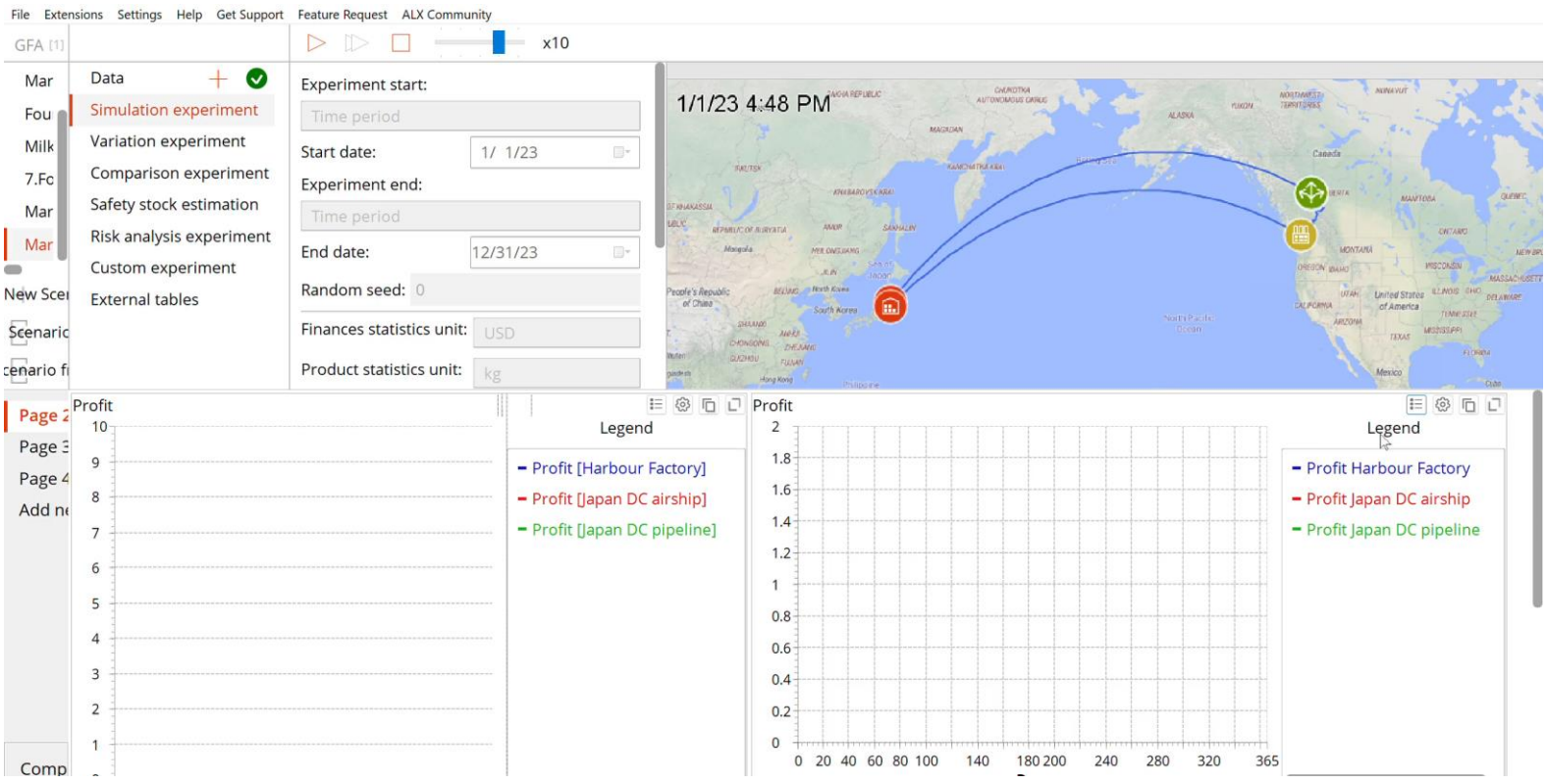


Conclusions

Very little amount of information on the employment of airships as means of transport is available in the literature. However, we were able to develop a model representing two delivery systems of natural gas: through land and sea, and by flight. The model results gave us a greater profit with the employment of the traditional means of transport.

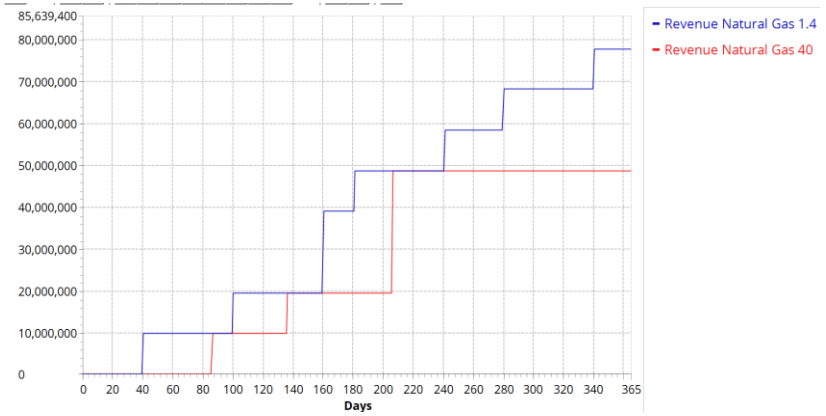
Future studies will focus on the possibility on creating a fleet of airships and developing an enhanced design of the logistic whilst employing a greater number of airships.

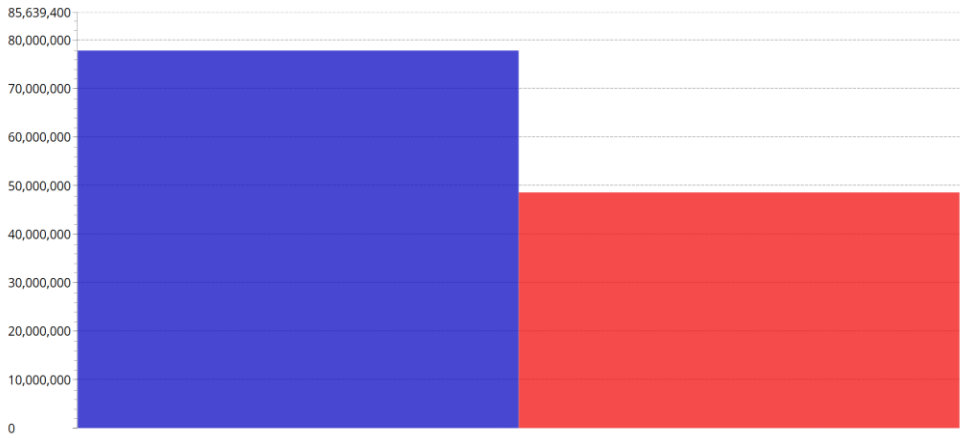
Further research



Further research

Further research considering a fleet of airships involved in transportation system results in an increase in profit in the second scenario.





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