



# Coastal Transport Optimization and the Future Role of USV Networks

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Hellenic Institute for Strategic Studies (HEL.I.S.S.)

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Τεχνολογικό  
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Ίδρυμα Αθήνας



ΕΛΛΗΝΙΚΟ ΙΝΣΤΙΤΟΥΤΟ  
ΕΠΙΣΤΡΑΤΗΓΙΚΩΝ ΜΕΛΕΤΩΝ

# Overview

- About Us
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- Past Solutions on Network Problems
- Current Plans for the Future of USVs
- Supporting Technologies
- Potential Uses/Applications
- Advantages over other UVs
- USVs Roles in our Seas
- Required Infrastructure
- Future Steps

# About Us

- V. C. Moussas,
  - Dipl. Electrical Eng., MSc on Data Communications, PhD on Computer & Informatics Eng., (Associate Professor)  
[vmouss@teiath.gr](mailto:vmouss@teiath.gr)
- Department of Civil Surveying & Geoinformatics Engineering, School of Technological Applications, T.E.I. of Athens
  - Civil Engineering (Specializations: Structural Eng. & Infrastructure Eng.)
  - Surveying & Geoinformatics Engineering (MSc. Geospatial Tech.)
- SOCRATES Research Laboratory
  - Society for Organization Cartography Remote sensing Road Design and Applications using Technology/Transport Engineering on Earth and Space (<http://socrates.stef.teiath.gr/>)
- HEL.I.S.S.
  - Hellenic Institute for Strategic Studies, a nonprofit organization ([www.elisme.gr](http://www.elisme.gr))



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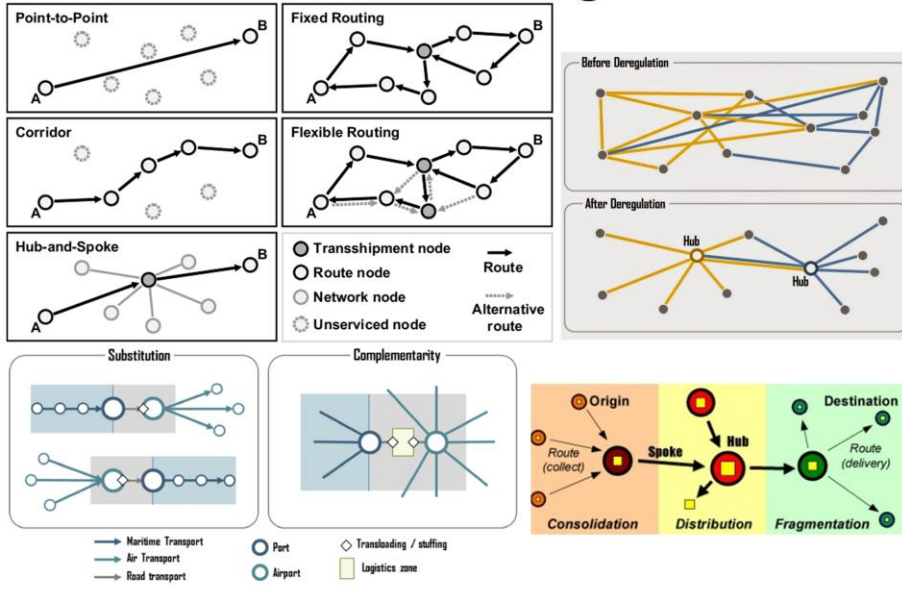


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# Motivation

- While working with SOCRATES Research Laboratory Projects, i.e.:
  - Coastal Transport Information System (Co.Tr.I.S.)
  - Smart Sustainable Islands Index ( $S^2I^2$ )
- We faced several Network Design Problems for the Aegean Sea:
  - Coastal Lines & Sea Routes planning (multi-parametric, stochastic, time varying, very complex)
  - Stake Holders (many, with different & contradicting goals)
  - Seasonally Inactive/Insufficient Lines
  - Network Plan Updating (manually, very slow, difficult to adapt)
  - Network Optimization (manual or not applied)
  - Statistics & Traffic Data Analytics (insufficient or missing)
  - Use of new ICTs (none or minimal)
  - Port Automation (none)

# Network Designs



Many candidate network configurations

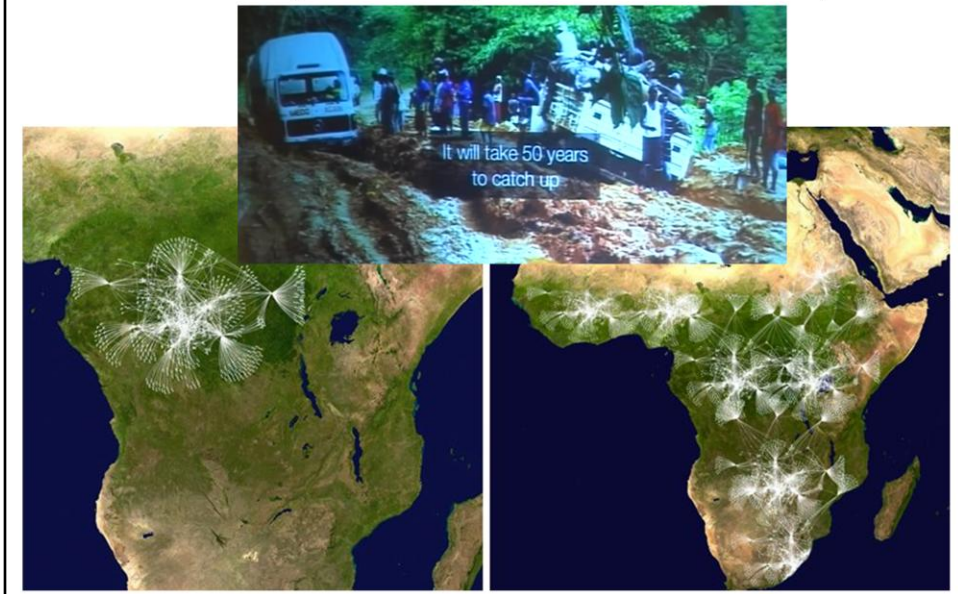
Network solutions can be found by an optimization technique, but, it is not easy to implement when the traffic is not automated.

Rigid and difficult to adapt networks often are replaced or complemented by a more flexible network

# Solutions on Network Problems

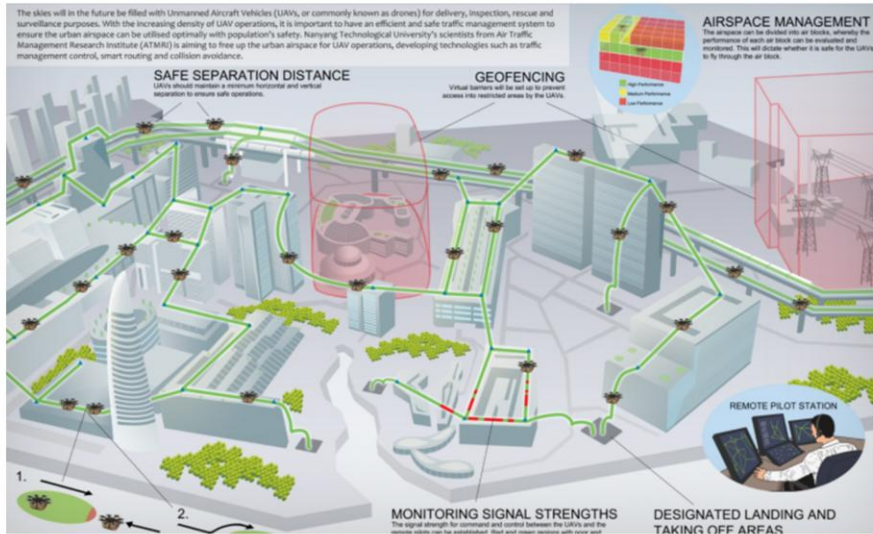
- Absence of Cable Telephone Network (Africa)
  - → Mobile Phone Network
- No Surface Network (Remote or Isolated Places)
  - → Satellite Network
- Absence of Roads (Mountain, Jungle, Desert)
  - → UAVs Delivery Network
- Existing but Congested Roads (Big Cities)
  - → UAVs Delivery Network
- Expanding the above experience to solve Coastal/Sea Lines problems
  - → USVs Delivery Network

## Africa (missing road network)



Matternet proposed a UAVs delivery network to replace the seasonally destroyed road networks

# City (congested network)



A city UAV network complements the city's congested road network





Proposed solutions for ground transportation (UGVs)



Proposed aerial delivery systems (UAVs) from small parcels to containers

## Current Plans for the Future of USVs

- Unmanned Surface Vessels
- Unmanned Cargo Ships
- Autonomous Routing
- Fleets of USVs
- Automated Load/Unload



Smaller unmanned vessels, using solar & wind power (green & sustainable). Useful for research and environmental monitoring but not for transportation.



Medium vessels that may carry a payload. Currently under development, most projects started recently (Netherlands, Norway, etc).

May work/collaborate as fleets.

Promising size and capabilities for our case



Containerships of the future. Proposals from various companies and researchers  
(Oceanic transportation not applicable in the Aegean islands)





Port Automation required by USVs.

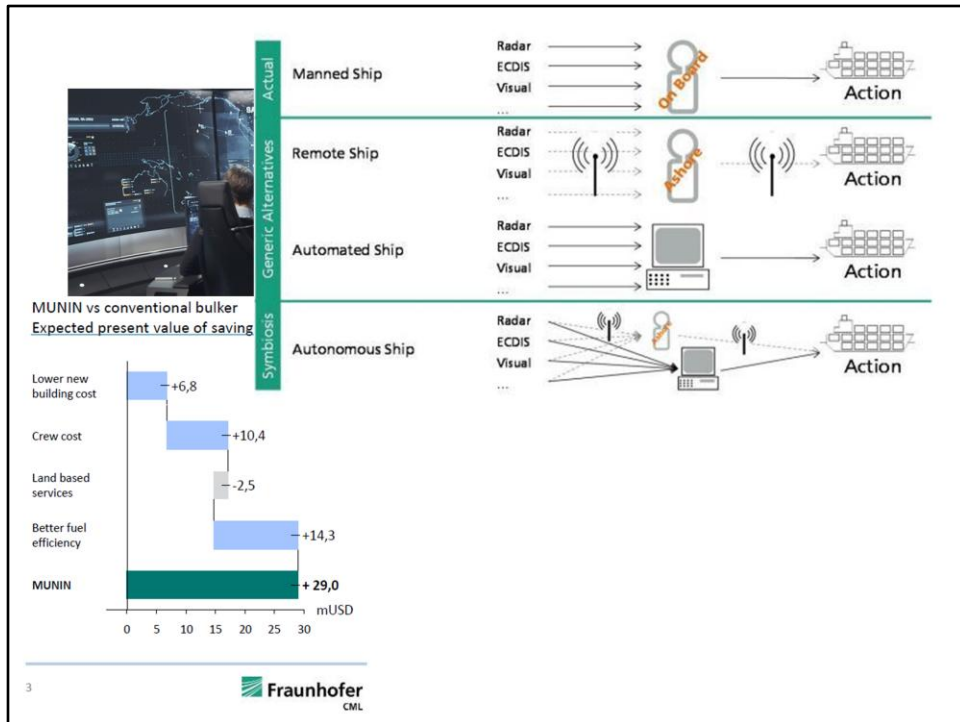
Magnetic, Suction or Gripping mechanisms, as well as, Refueling and Recharging mechanisms should be developed to serve the USVs

## Supporting Technologies

- UAV/USV Navigation & Control
- UAV fleet control
- Unmanned (Remote Control)
- Autonomous Function
- Auto Routing/Re-routing (Hub & Spoke, etc.)
- Automatic Load/Unload,
- Automatic Refueling/Charging

A large number of mature technologies is already available.





Autonomous ships will provide onboard automation and ashore control.  
Several projects estimate big savings by using unmanned vessels

## Potential Uses/Applications

- Package Delivery (small, light) network
- Goods Transportation network (containers)
- Environmental Monitoring (pollution, weather, fish, oil, etc.) network
- Surveillance Network

And also,

- Emergency Cases (medical, replacement parts)
- Rescue Missions

We can only imagine the potential applications.

Every new network creates new applications once installed and functioning.

(The applications I had in mind while installing backbones in 95 (email, ftp, web) have nothing to do with the recent explosion on network based applications (cloud services, social nets, media, etc.)

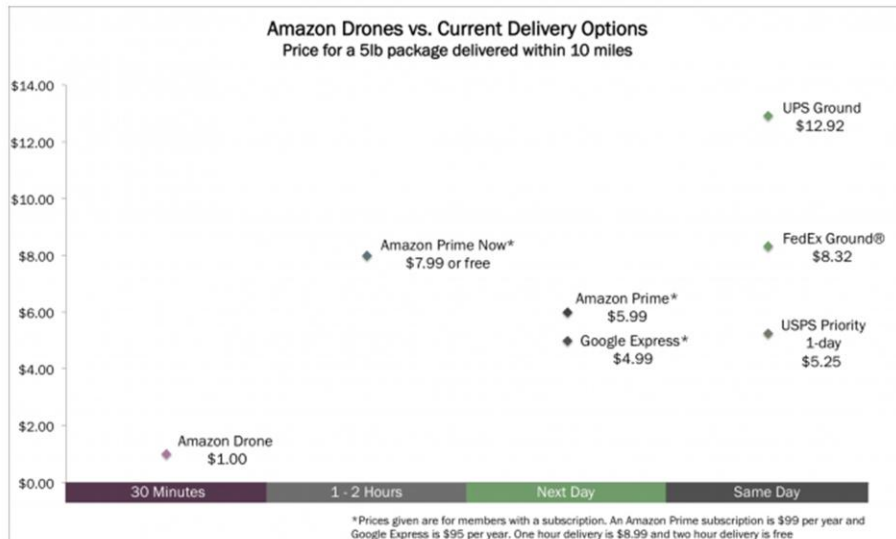
The above is just an initial list...

## Advantages of USVs over other UVs

- Greener, Safer, Stronger
- Solar, Wind, LPG (can wait for recharging)
- Obstacle Avoidance easier (larger space, lower speed)
- Engine may fail without risk (wait for repair or pickup)
- Can be unsinkable (no humans → no need for empty hull)
- Etc.

USVs have many advantages: Zero consumption, Fail Safe, Faster first response to incidents, Temporary loss of Control is not critical, etc.

# Delivery Cost reduction (Amazon)



According to Amazon: Transportation and delivery using drones (UAVs) is faster and cheaper.

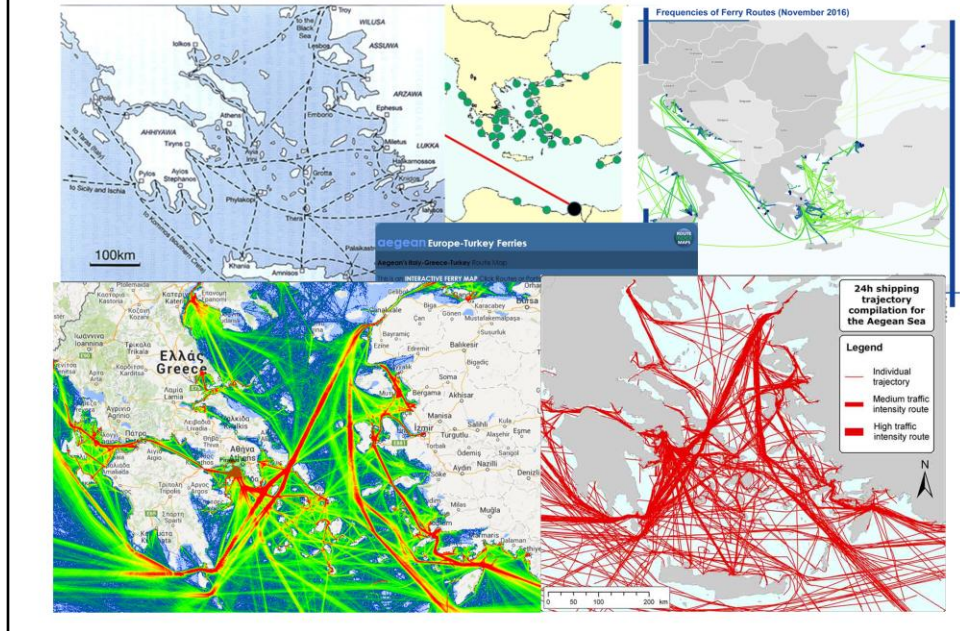
We expect the same to hold for the USVs in the near future.

## USVs Roles in our Sea networks (Aegean, Ionian, etc.)

- Connections between a Hub island and local smaller islands
- Connections between Mainland and closest islands
- Coastal connections between adjacent places/ports
- Coastal tour of islands (post, deliveries, goods, surveillance, environmental)
- 24/7 available on demand connection to any port
- Persistent connections during bad weather conditions
- Environmental periodic inspections
- Etc...

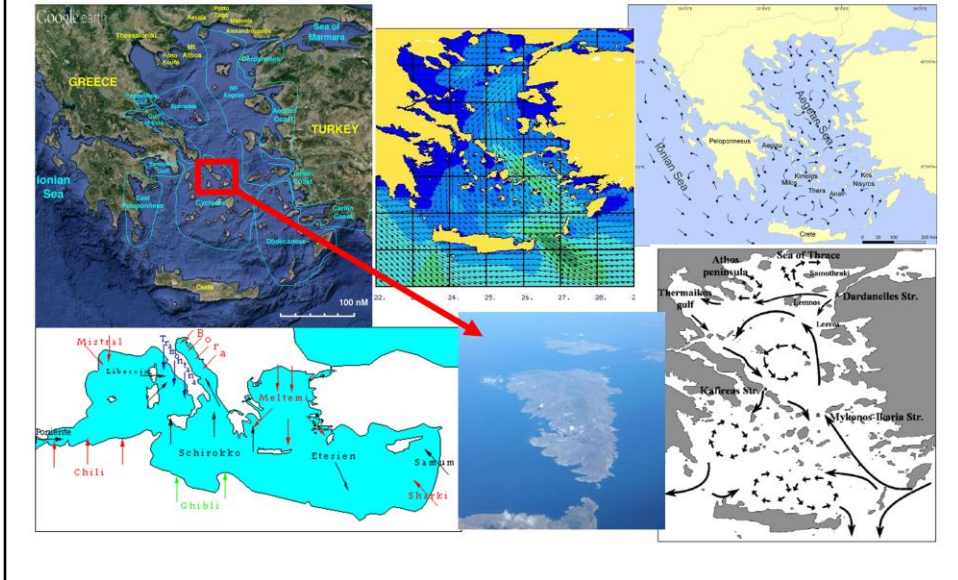
More roles will emerge upon installation and functioning.

## Coastal/sea Lines in Greece



The very dense transportation network in the Greek seas offers an ideal test-bed for USVs solutions.

# Sea/Weather Data



USVs network can also be local and serve specific areas: Cyclades, Saronikos gulf, Sporades, etc.

Water currents, Seasonal Winds and Waves height in the Aegean sea, all will be part of the automated navigation system in order to optimize time, consumption, safety, etc.

## Requirements - Infrastructure

- USV boats (convert or build)
- USV Test Sites (e.g., Univ. of Aegean, Cyclades)
- USV ports (civil infrastructure - port works)
- USV control sites (static on Hub Islands, Portable, Central on Mainland, etc.)
- USV network optimization (on-demand rearrangement, rerouting)
- USV assignment automation (ordering web site)

Practically all required techniques & infrastructure is available/exists in Greece.



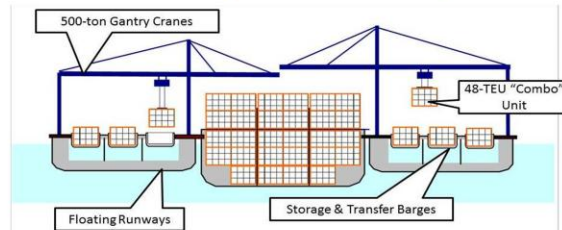


Trondheim: A test area for USVs was just established last month (March 2017)  
 Many companies offer equipment for easy conversion of existing vessels to USVs.  
 (e.g. MAP control installation package)

# Port Automation



## 4th Revolution – Specialized Floating Terminal



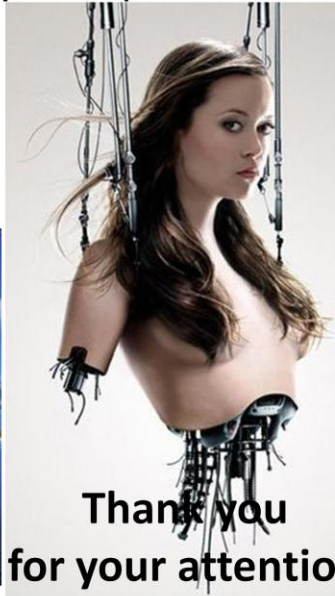
Port automation will complement the automated USV networks.  
USVs will be the floating version of the above automatic container movers.  
Floating terminals can approach containerships and unload containers to USVs

## Future Steps

- Build/convert low cost USVs
- Build/acquire reliable Control System
- Select/approve USV test area
- Design/Build a USV auto-port facility (load/unload/charge/refuel)
- Test with a Pilot network
- Design/Implement the full USV network (optimally reconfigurable upon request)

Next steps required to start implementing this approach

Are we ready to replace them by...drones?



Thank you  
for your attention



Smart Mermaids ?

# Thank you for your attention

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