“Crossing the Chasm”

Today’s Gliders versus the alternatives

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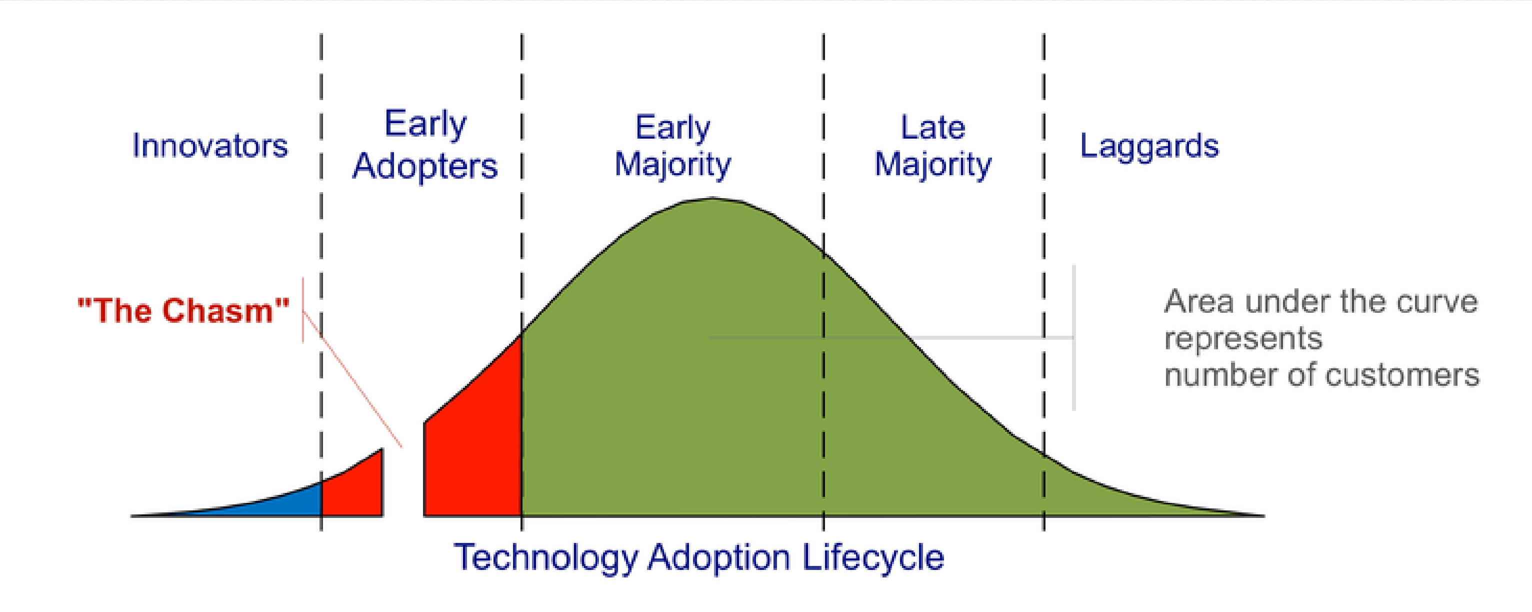
iRobot Maritime Systems

Crossing the Chasm : Rate of Technology Adoption

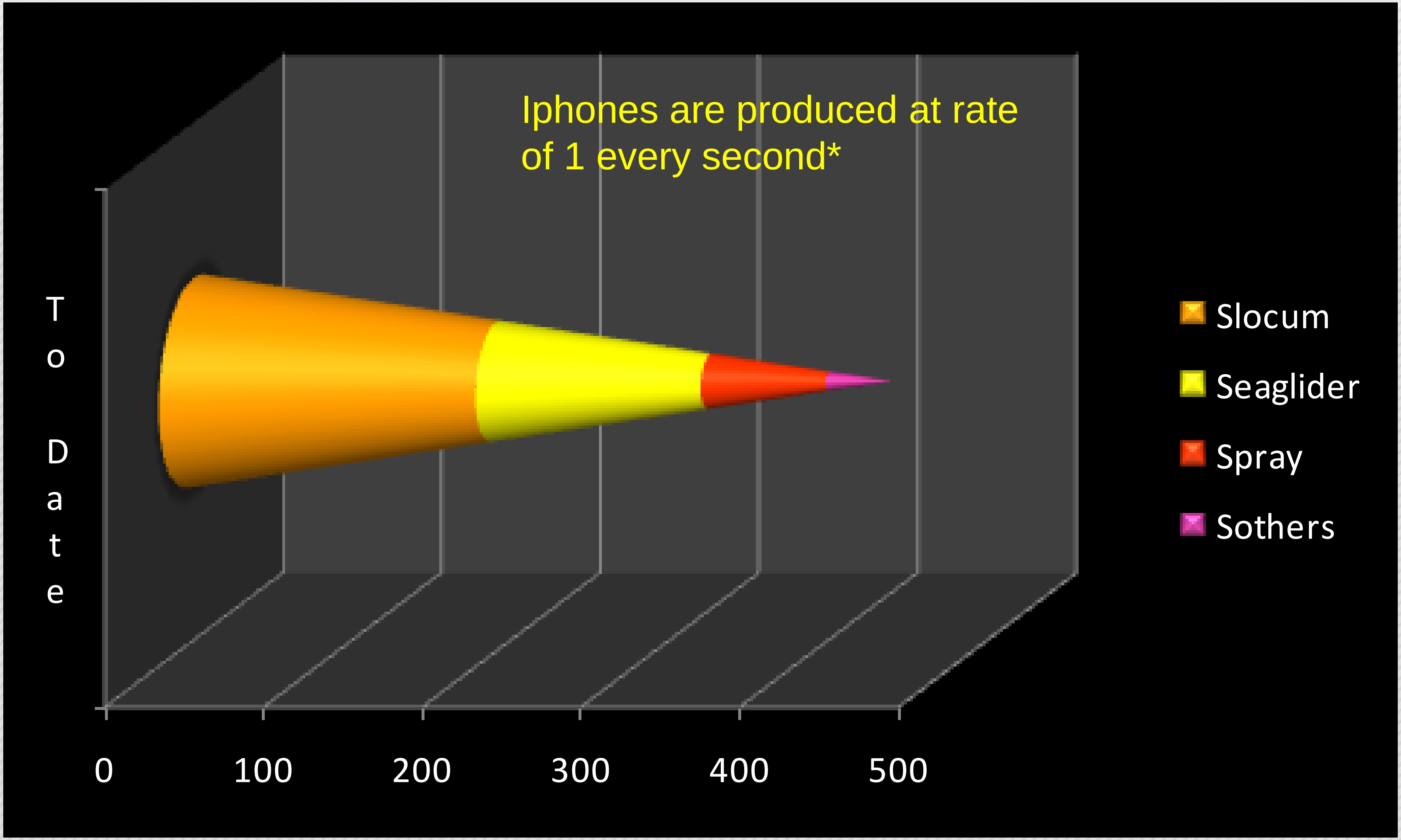


Time →

With every new technology, there exists an opportunity to lose momentum and to miss transition to the next stage.

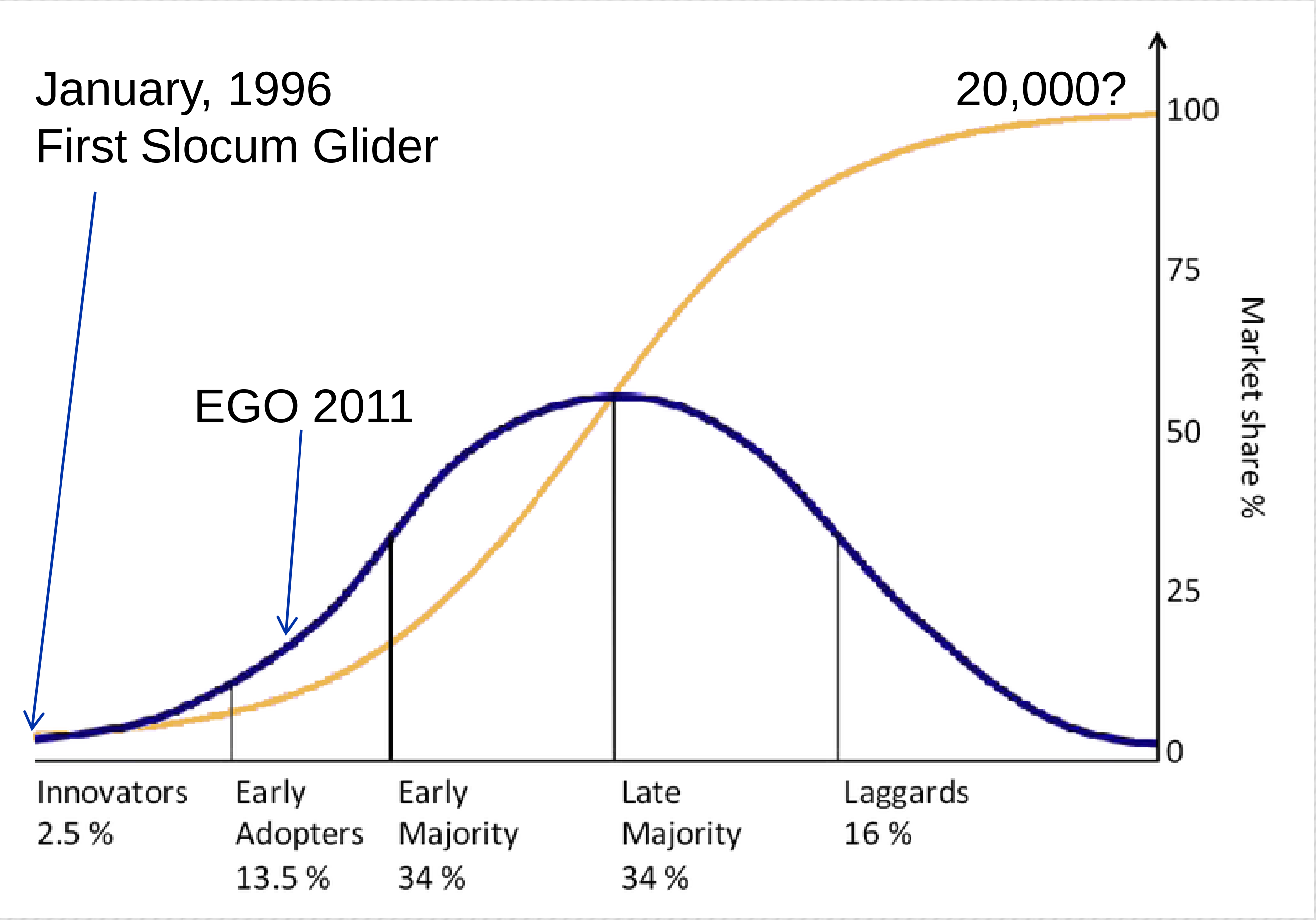
"Crossing The Chasm" by Geoffrey Moore, Harper Business Essentials, 2002

Glider Production noses forward

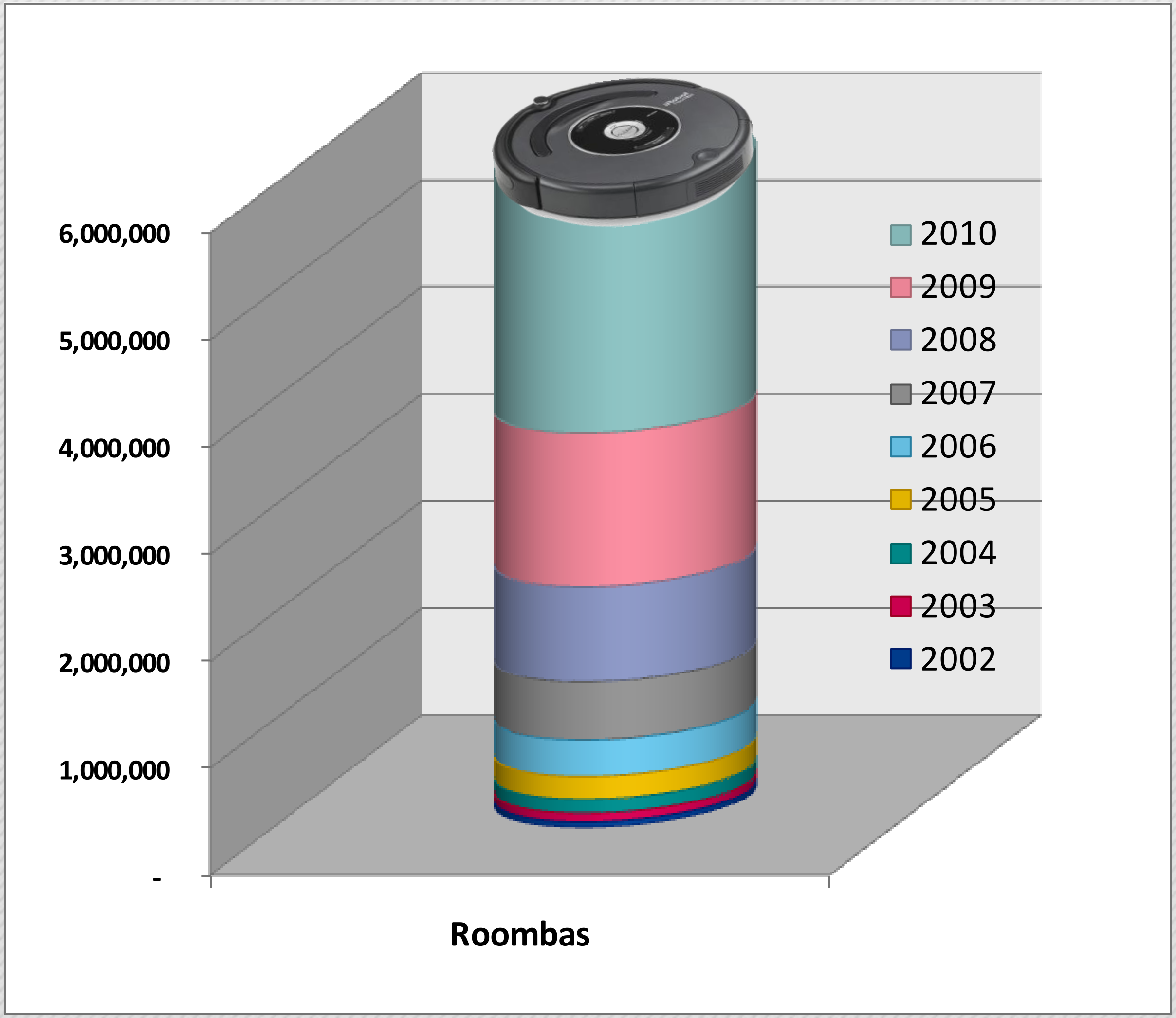


Iphones produced: 31.5 m in 2010, 25.1 m units sold in 2009, 13.7 m in 2008, 2.3 m in last quarter 2007

The Product Life Cycle : From Innovation to Market Saturation



Robots that Crossed the Chasm



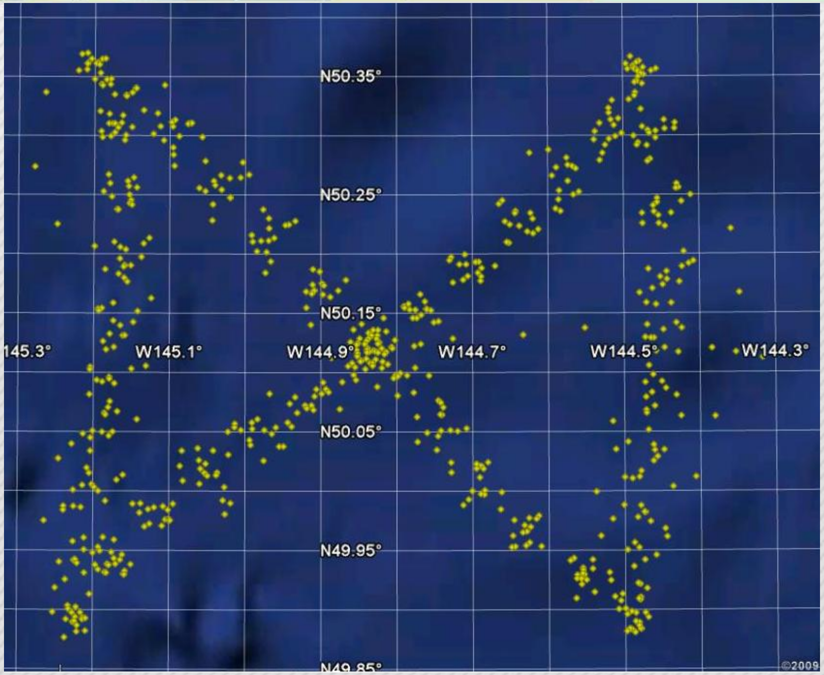
World Record Distance- TransAtlantic Crossing

Over 7000 km covered in 7.3 mos by Rutgers University modified Slocum RU27

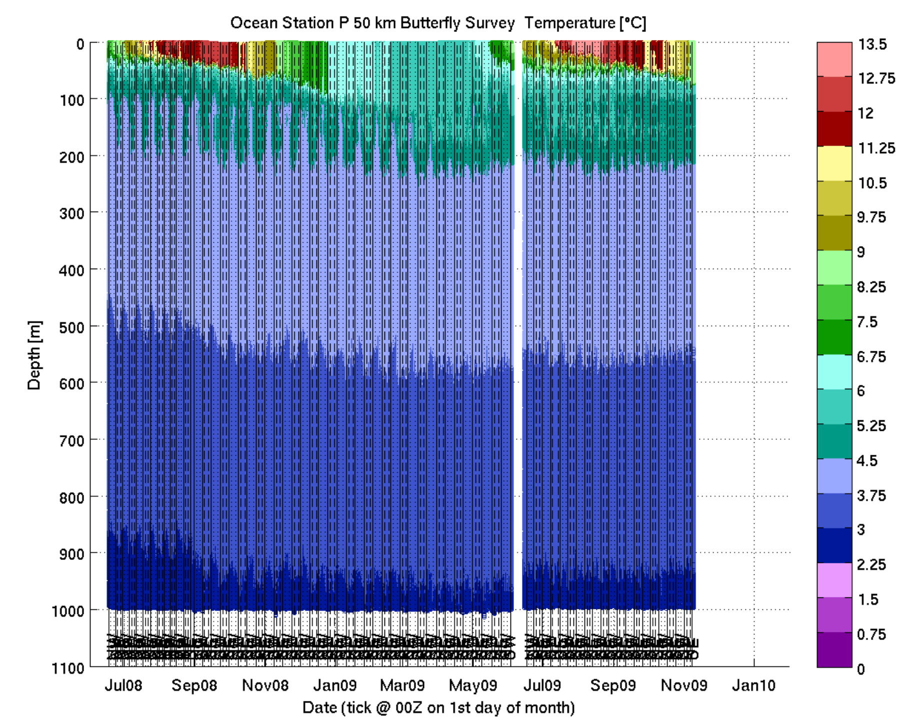
Equivalent to 21,700-mpg!

World Record Endurance – SG144 achieves 9.6 months (April 2, 2010)

iRobot Seaglider



Back to back glider missions for 18 Months sampling at a single locaion unveils mesoscale structure



SG144 – Ocean Station Papa Mission*
6/14/2009 – 4/2/2010

Dives: 878
Duration at Sea: 9.6 months
Vertical Distance through Water: 1734 km
Horizontal Distance over Ground: 5076 km
Horizontal Distance through Water: 6798m
Velocities through Water:
Max Horizontal: 39.9 cm/s
Average Horizontal: 21.6 cm/s
Max Vertical: 9.3 cm/s
Average Vertical: 6.25 cm/s
Total Battery Remaining after Mission: 13%

Sensor Payload :
Seabird CTD, 2 x O2 (Aannderaa + Seabird),
Wet Labs ECO Triplet
1 M resolution sampling over ascent / descent to 1000 m

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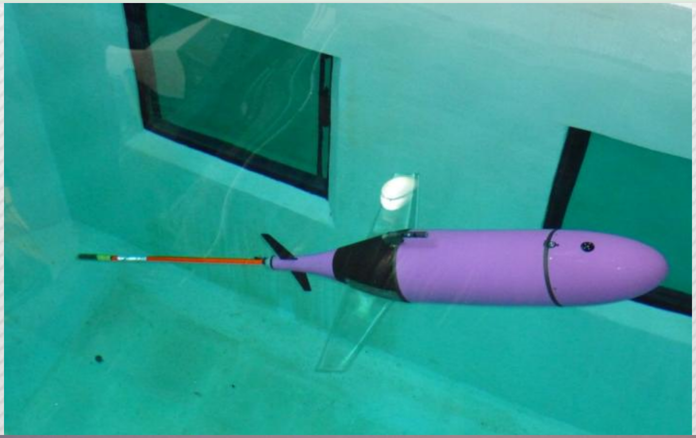
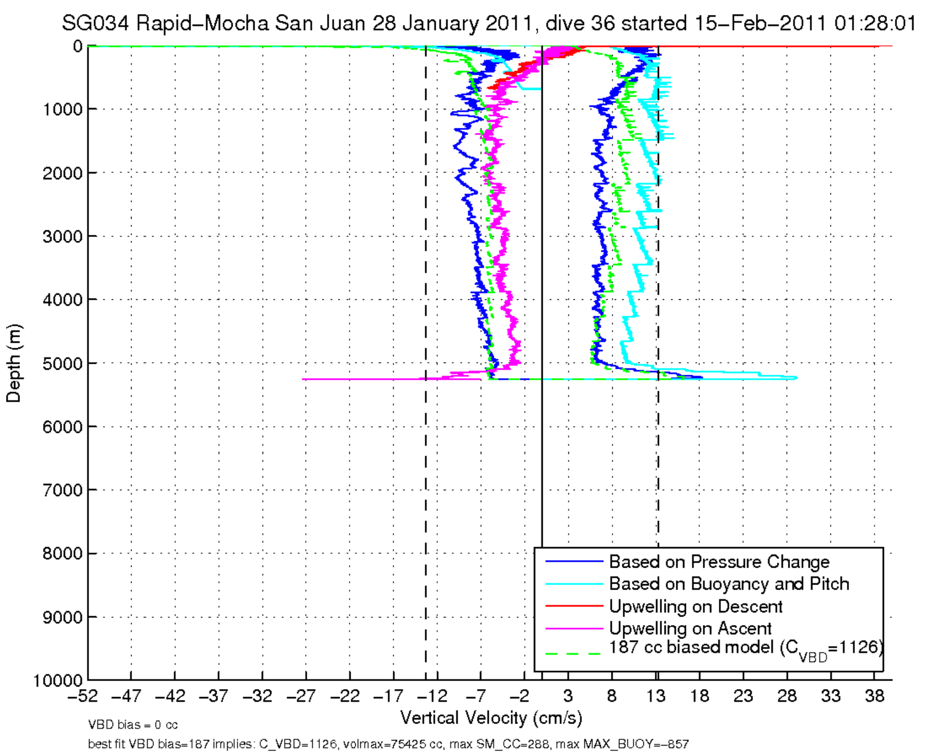
Record Glider Depth – 6,000 meters!

iRobot Seaglider

August 6, 2010, the "Deepglider" version of Seaglider developed by Professor Charlie Eriksen and team at UW has achieved 6000 m dives off coast of Puerto Rico.

This depth milestone means that gliders can now cover 98% of Earth's Oceans





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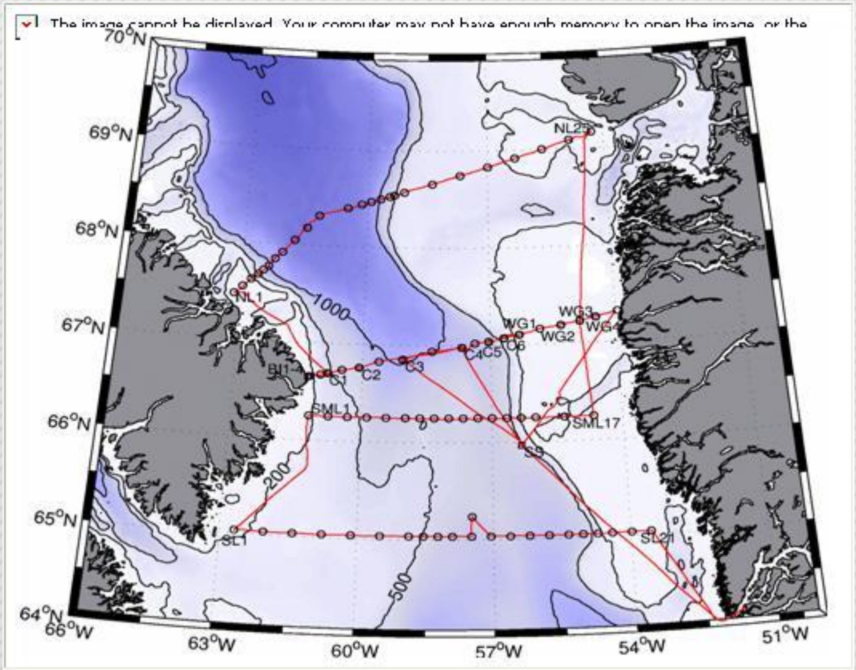
Under the Antarctic Ice – Ross Sea (December 2010)

Dr Vernon Asper of University of Southern Mississippi's (U.S.M.) Department of Marine Science at the NASA Stennis Space Centerand a diverse team of colleagues from U.S.M., the University of Washington in Seattle, Old Dominion University in Norfolk, Va., the Virginia Institute of Marine Sciences, and the U.K.'s University of East Anglia

http://www.scientificamerican.com/article.cfm?id=antarctica-seaglider-phytoplankton-study

And in the Arctic for many years already

Professor Craig Lee of APL - University of Washington has used Seagliders extensively in the arctic – see:



Davis Straits
Under ice runs using RAFOS

http://www.youtube.com/watch?v=ajbQhb-LITE&feature=player_profilepage - t=208

Gliders in the Gulf:
Responding to the Deep Water Horizon accident

iRobot Seaglider

What other *good* can Gliders do?

iRobot Seaglider

Anyone know of a good underwater scintillation counter (radiation)?

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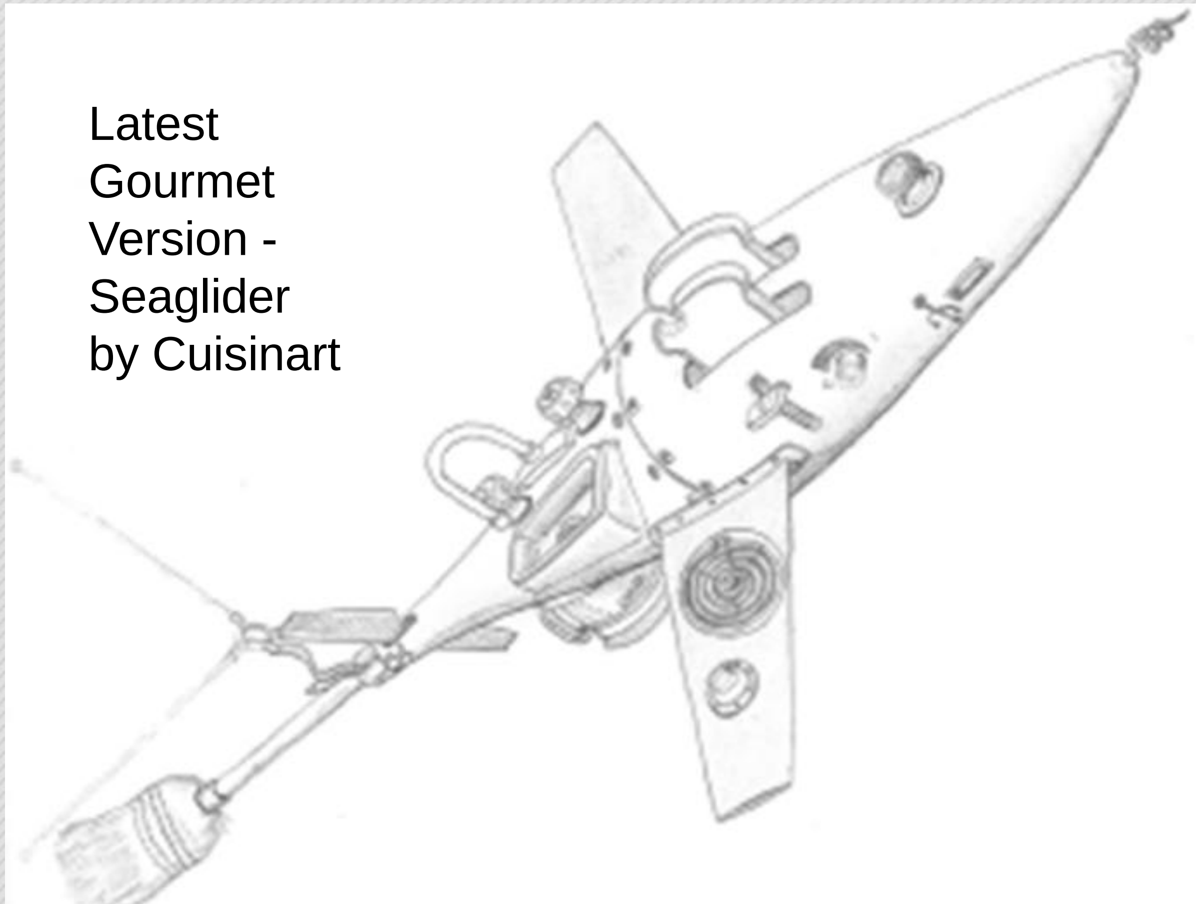
Oil companies, Navies are concerned about regulations on impacts to mammals

iRobot and Duke University Marine Lab are integrating acoustic mammal tracking on Seagliders

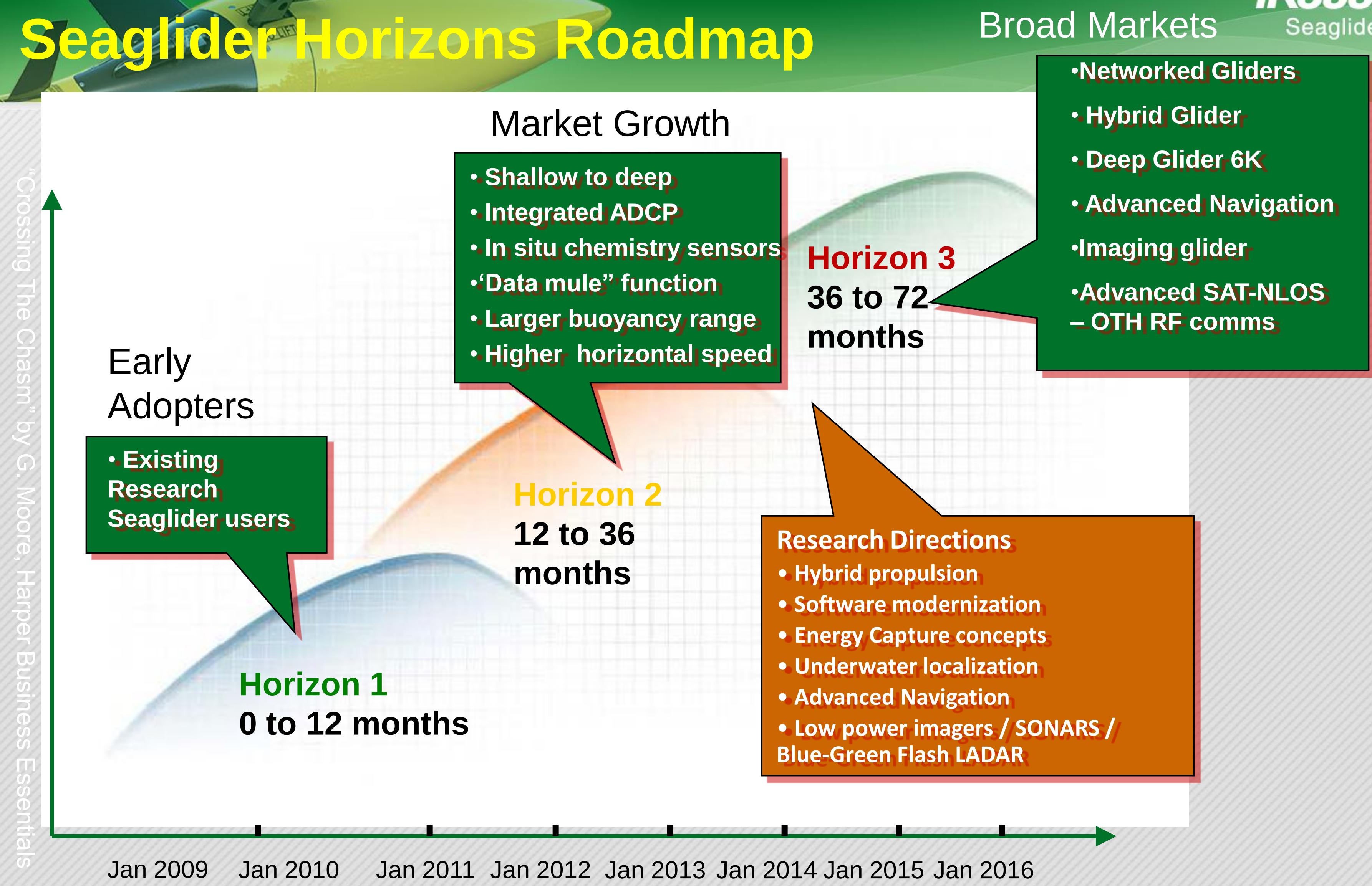
How does the glider market continue organic growth and cross the chasm?

Everything Glider?

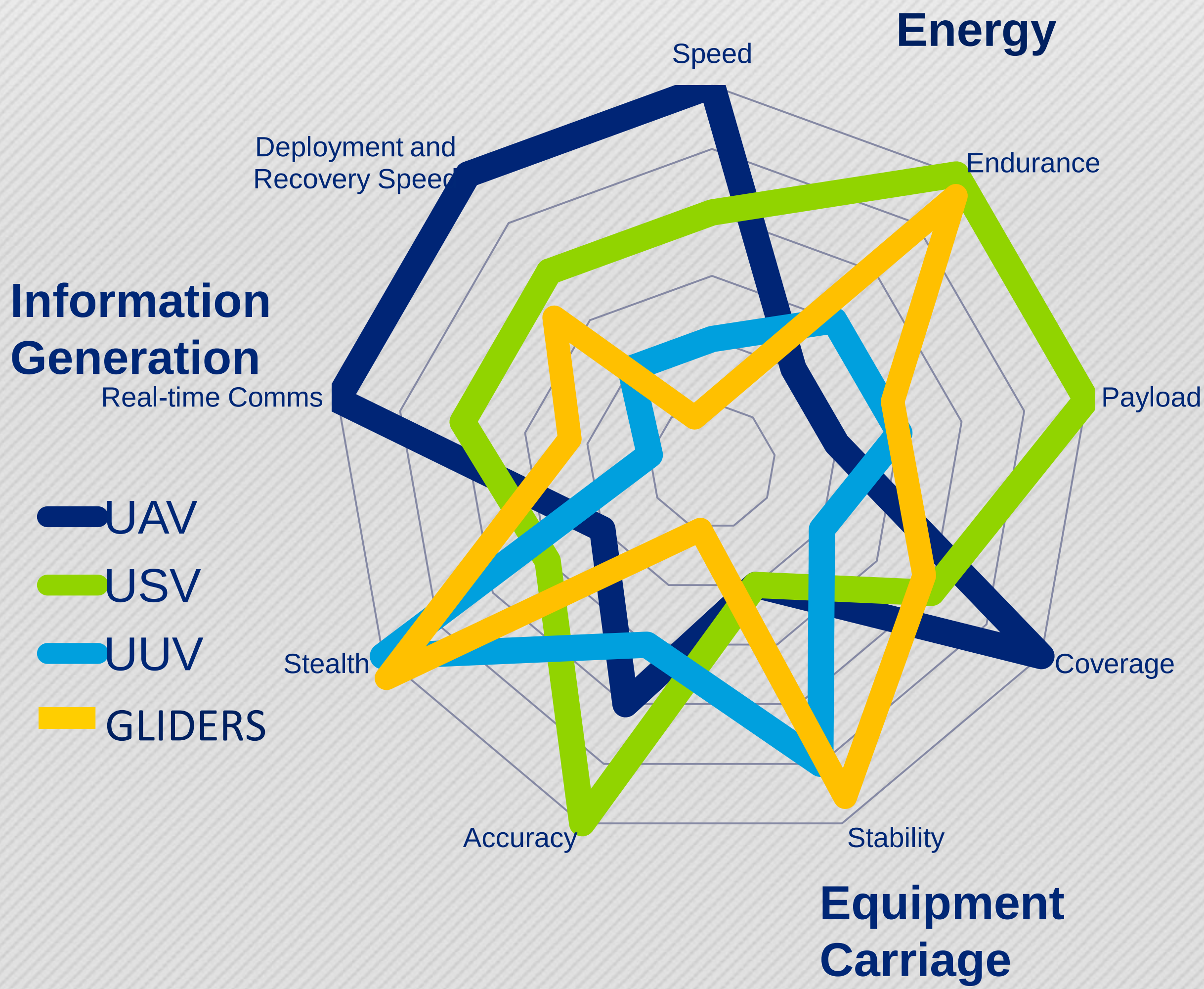
- **Empathic design** is a *<u>user-centered design</u>* approach that pays attention to the user's feelings toward a product (McDonagh and Lebbon, 2000; Fulton-Suri, 2003; Crossley 2003).
The foundation of empathic design is observation, the goal is to identify latent customer needs.
- Latent needs are product requirements that customers don't even know they desire, or in some cases are solutions that customers have difficulty envisioning due to lack of exposure to new technologies or being locked in the mindset of working with existing products and services.



Seaglider Horizons Roadmap



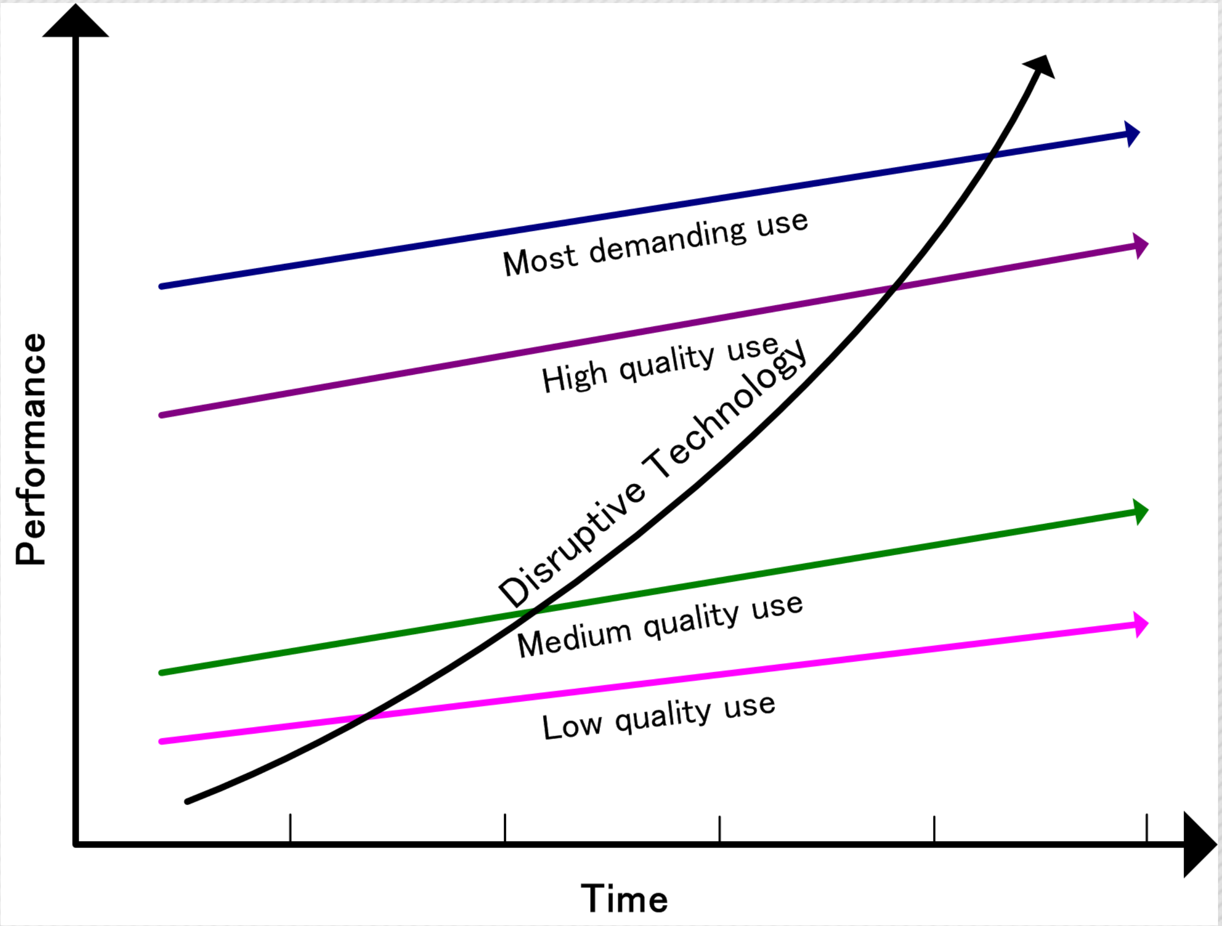
Gliders have plenty of Unmanned competition



Source: After ACTUV Brief, Rob McHenry, AUVSI Program Review 2010, data based on an analysis of published UxS characteristics

Disruptive Glider Technologies?

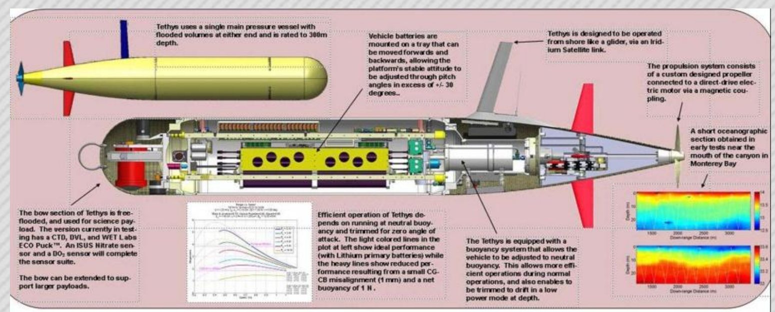
- Advanced batteries
- Energy Capture
- Hybrid propulsion
- Miniature Sensors
- Increased Depth?
- Low cost expendable gliders
- All of the above?



• Quasi Gliders – are they disruptive?

NOC – UK Long Range AutoSub
-By travelling rather slowly (0.4 metres per second), and keeping a tight rein on the power available to its sensors, it will be capable of missions of up to six months duration and ranges of 6,000 kilometres.
- It can dive to a depth of 6,000 m

Liquid Robotics – Wave Glider
- Wave Glider concept brings
Year long endurance by capturing
Wave power and station keeping with GPS
-Limited to measurements near surface



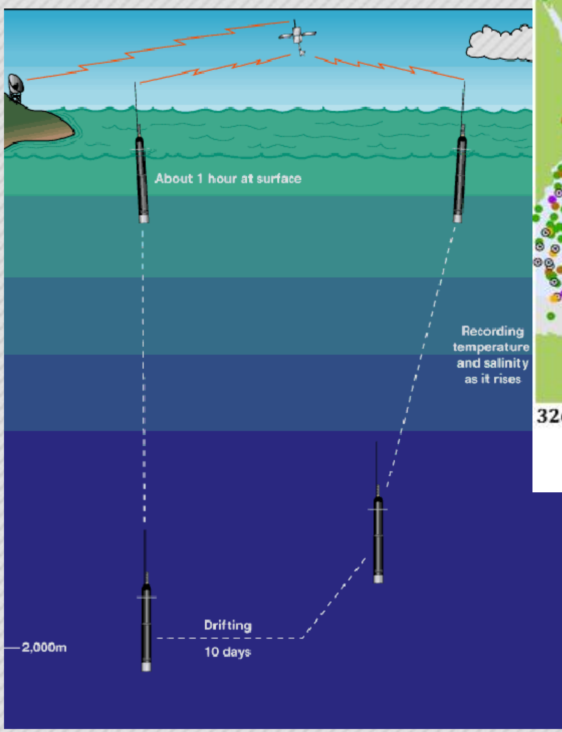
MBARI Tethys LRAUV Goals
-Travel over 1,000 kilometers at approximately one meter per second with sensors drawing eight watts
-Cover more than 3,000 kilometers with minimal sensors and slow speeds (0.5 meters per second).

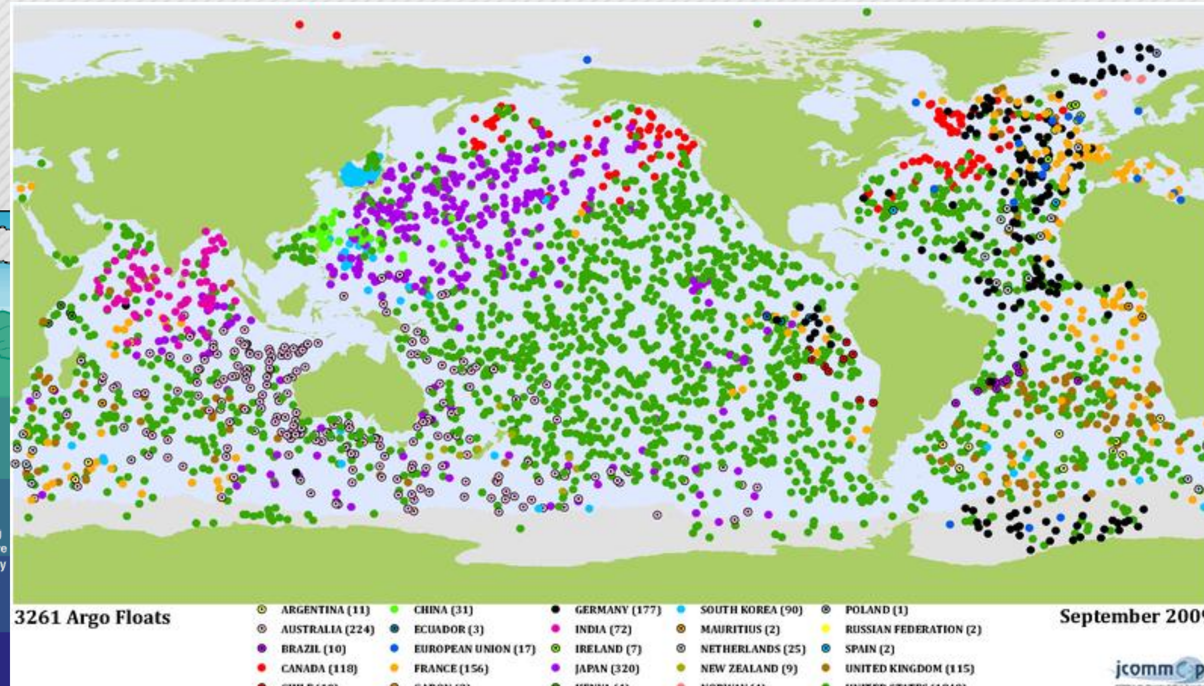
So Many 'APPS' –but also many alternatives

Platform	Mode of Operation	Typical Deployment Duration	Spatial Scales	Sensor Payload
Surface Drifter	Floats on surface, sometimes drogued at depth	Weeks to years	Regional to global	Moderate, power-limited
Float	Neutrally buoyant, sometimes profiling	Weeks to years	Regional to global	Moderate, power-limited
Glider	Profiles, controls horizontal position by gliding	Weeks to months	Regional	Light, power and size-limited
Autonomous Underwater Vehicle (AUV)	Powered horizontally through water, e.g., by propeller	Hours to days	Local	Heavy

Rudnick, D.L. and M.J. Perry, eds., 2003, ALPS: Autonomous and Lagrangian Platforms and Sensors, Workshop Report,

ARGO Floats– More than 5000 deployments





Next generation floats may be able operate for years in some parts of the mid latitudes oceans

Whole product is a generic product augmented by everything that is needed for the customer to have a compelling reason to buy. The core product is the tangible product that the customer experiences. The whole product typically augments the core product with additional elements required for the product to have compelling value to a customer. For example, if a personal computer is the core product, then whole product would include software applications, training classes, peripheral devices (mouse, keyboard, printer, etc), and internet service. Without these additional product components, the core product would not be very useful.

***The Whole Product will also be of higher economic value relative other alternatives**

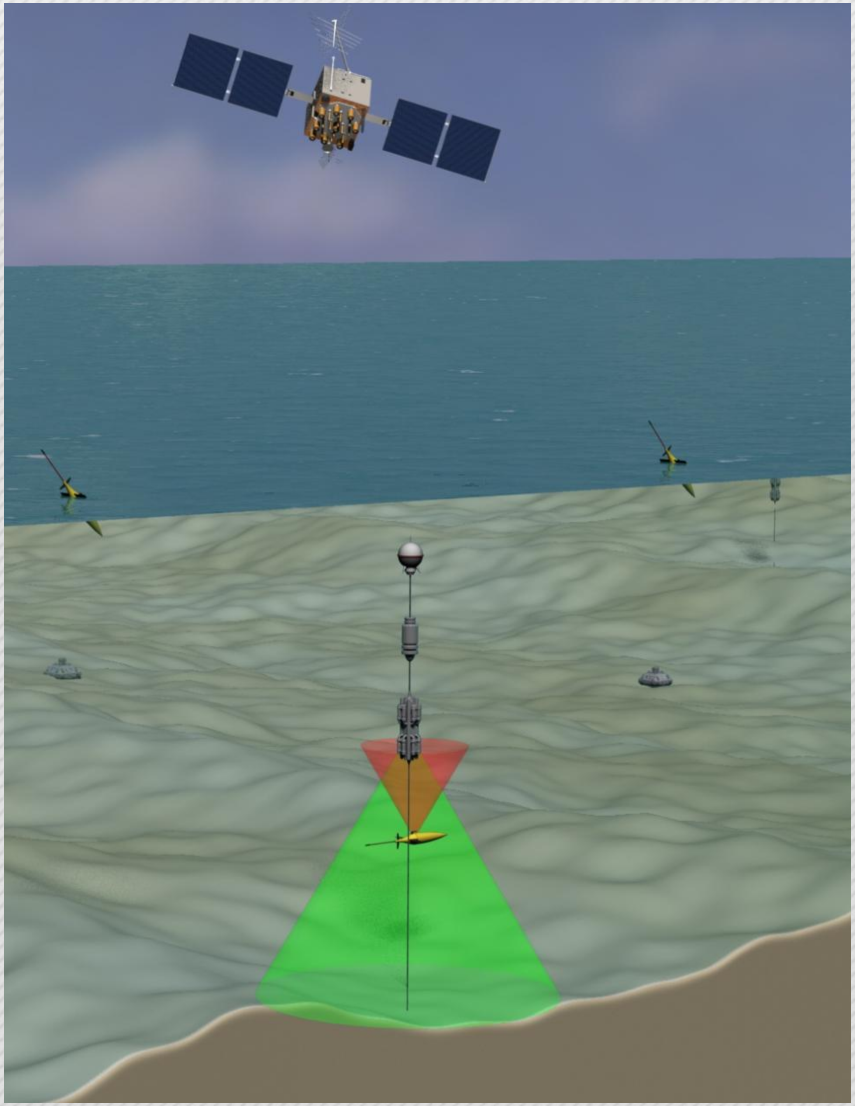
Enabling economic comprehensive underwater assessment –

- Seagliders sample 7/24, for months without manual intervention
- GUMBO Seaglider fleet operating costs projected operating costs including satellite link, piloting services and vehicle depreciation amounts to less than $400 / day
- NOAA reports that the costs to deploy a research ship is more than $44,000 / day, while fleet of 20 Seagliders as in GUMBO – about $4,200 day

U.S. Coast Guard Petty Officer 2nd Class Dave Martin, a specialist in hazardous material and oil spill response, lowers a fluorometer into the Gulf of Mexico May 27. The device collects water samples and field data, which help environmental scientists determine the effectiveness of dispersants used to break down oil. U.S. Coast Guard photo by Petty Officer 2nd Class Luke Pinneo

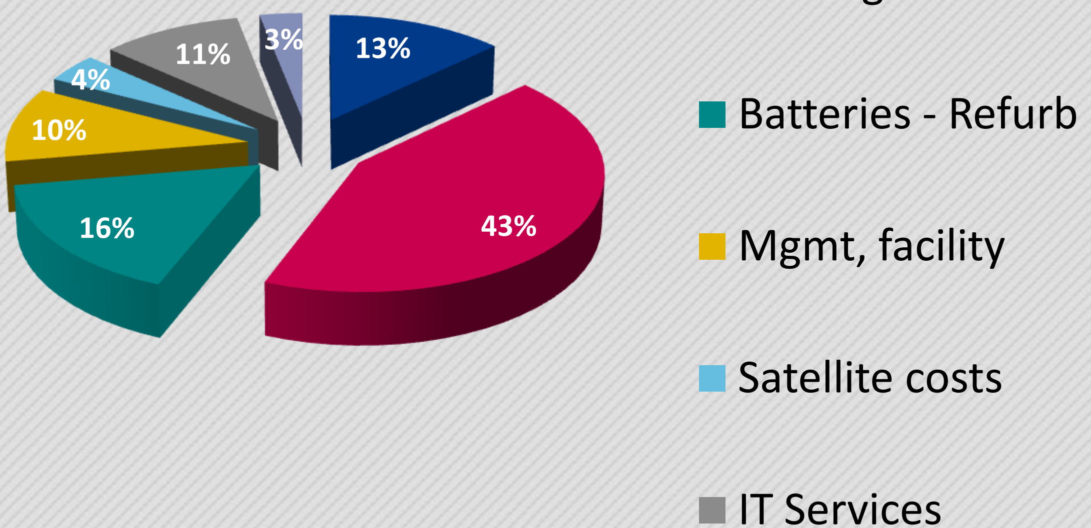
Glide Mailman for Moorings without surface expressions

Vulnerable to vandalism, fishing,
Storms, and collisions, moorings have
High costs of ownership

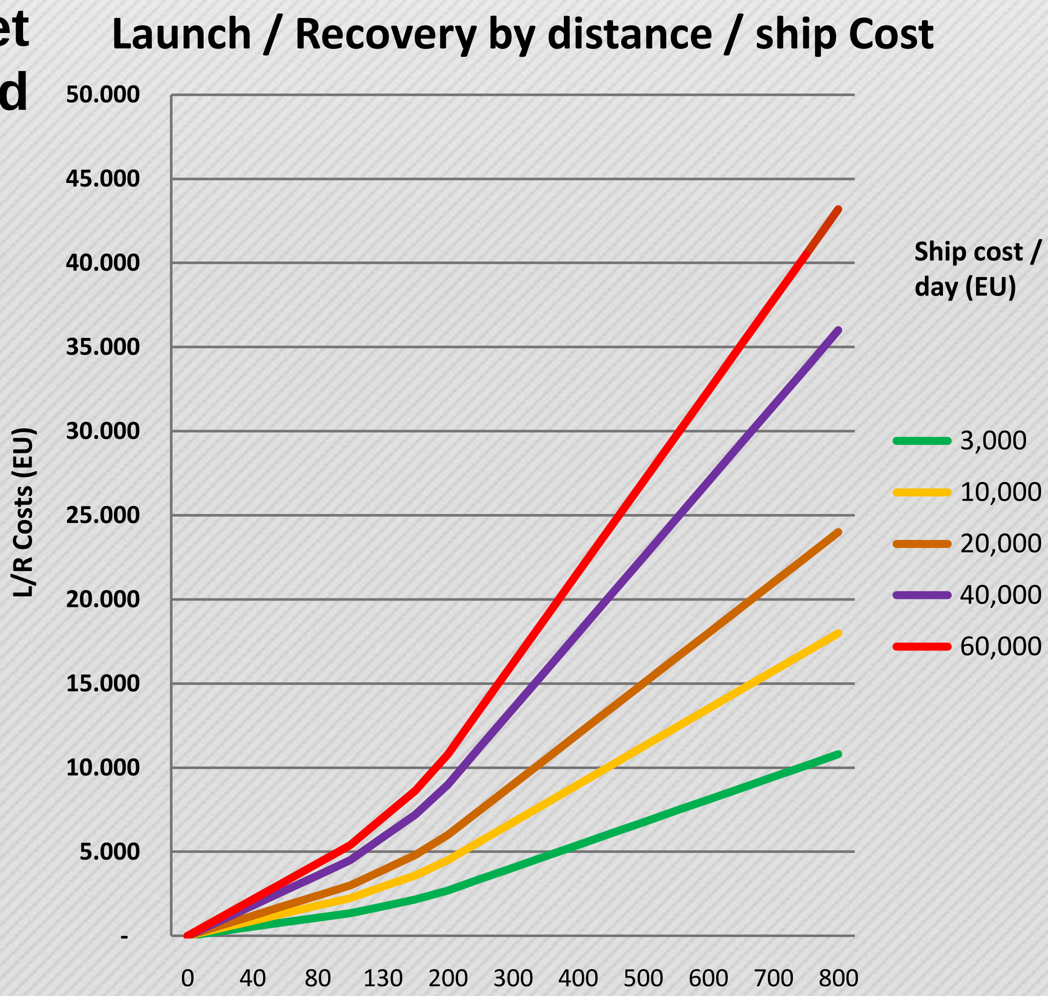


The Whole Product will address the true Cost of Owning and operating gliders

Glider Operating Cost / Week
(not including Launch / recovery / ship cost)

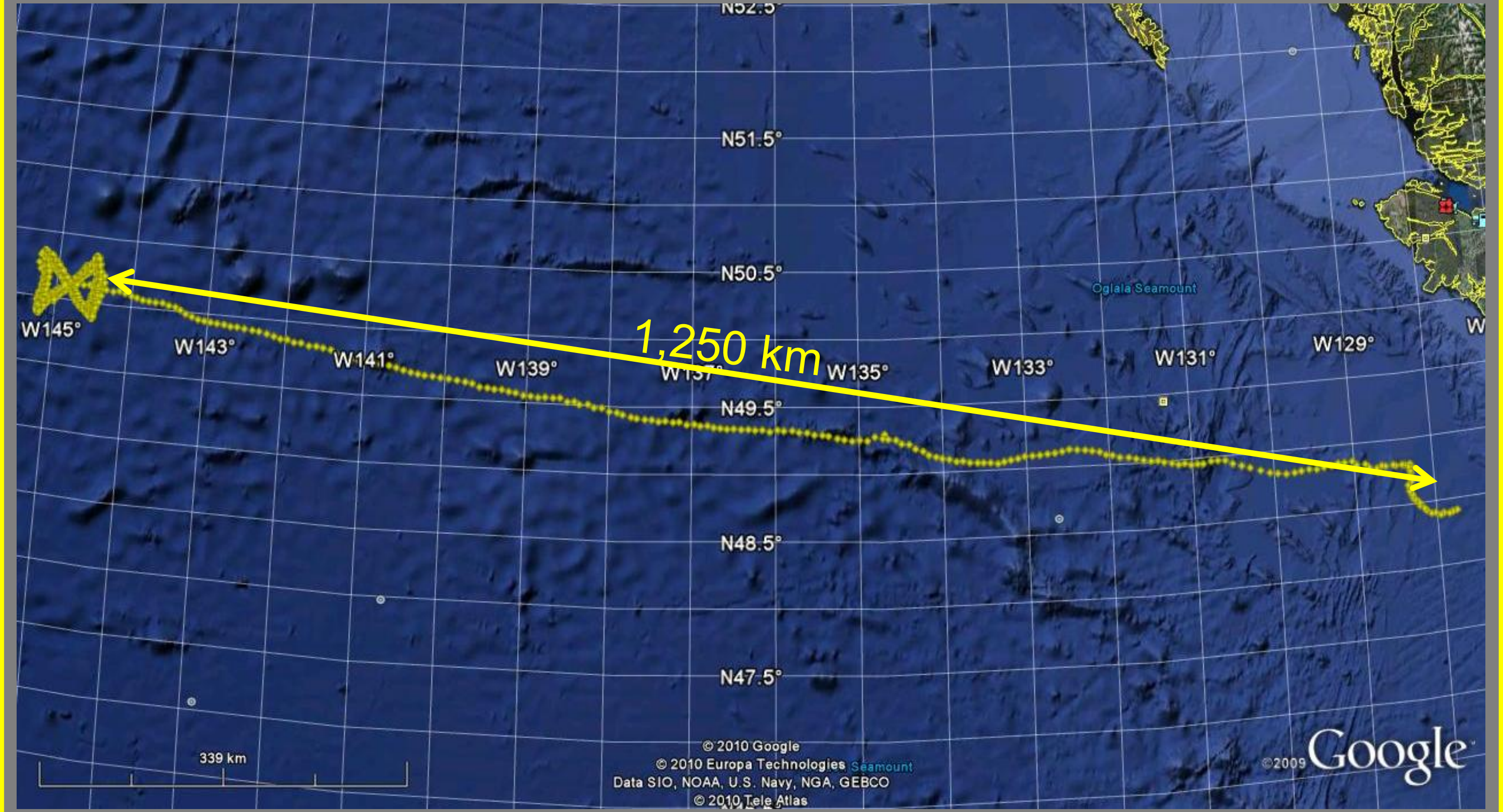


Launch / Recovery costs are driven by distance to target location / ship size & speed

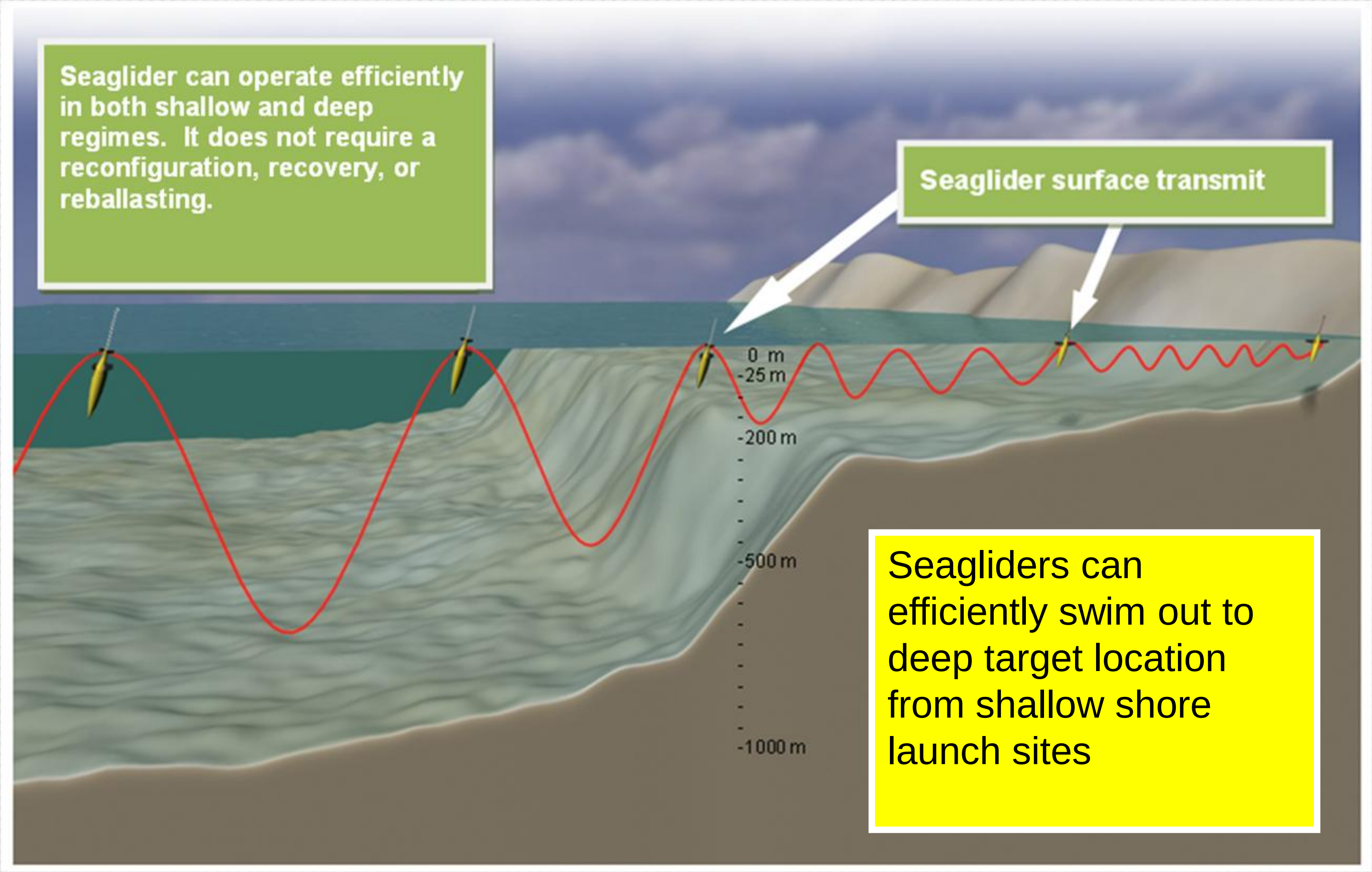


Seaglider can swim to location

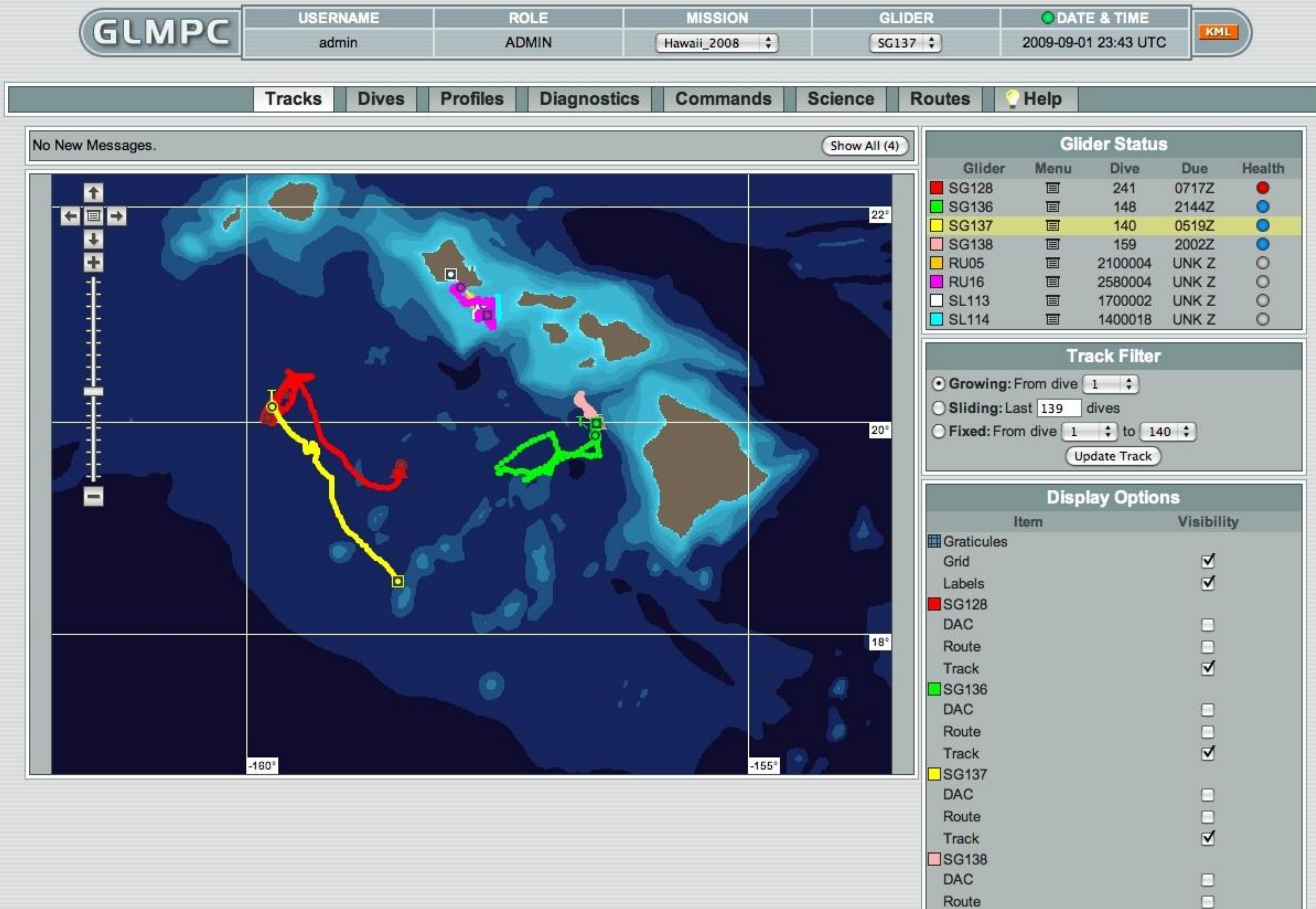
SG144 – Entire Ocean Station Papa Mission



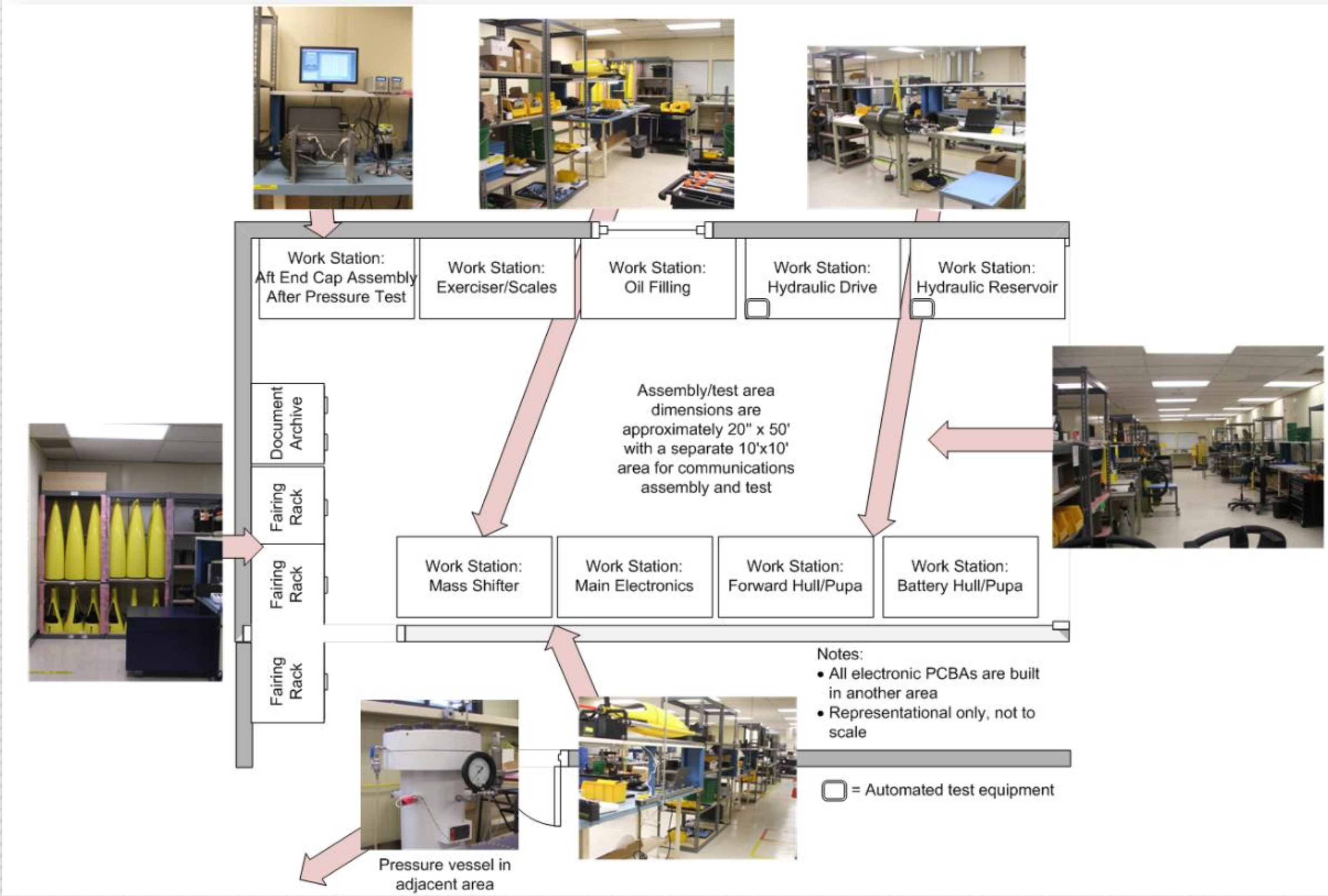
Seagliders now efficiently perform "shallow to deep" in a single mission



For glider technology to flourish – making piloting easier is vital

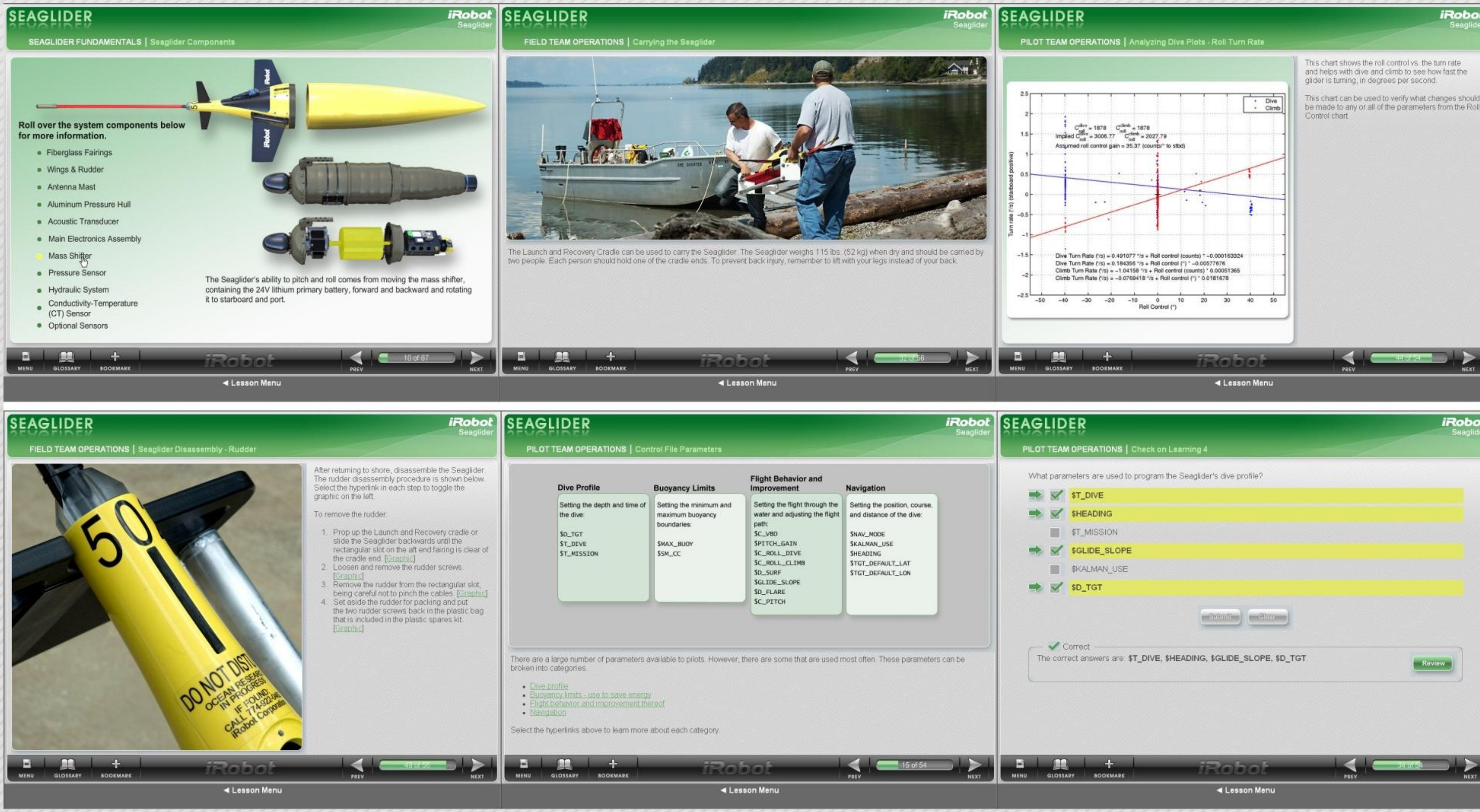


Quality Production Systems are in integral part of the Whole Product at iRobot



iRobot Seaglider

The ‘Product’ is the support and engagement by the whole team



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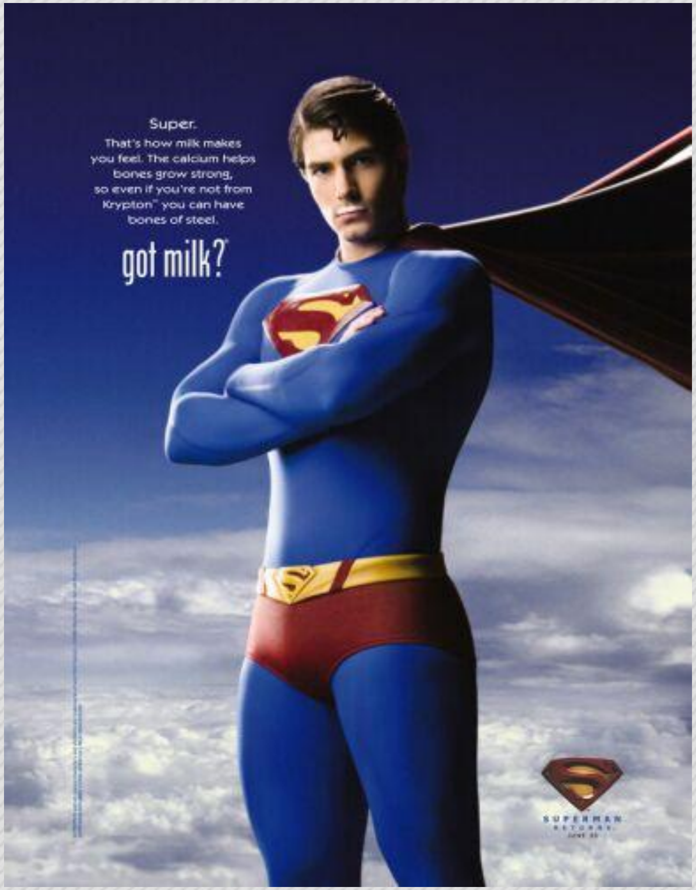
Got Glider?



Gotta give those gliders some love…

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Early Adopters:

Visionaries that match technology to strategic opportunity

- **Looking for a fundamental breakthrough for a business goal: order-of-magnitude return**
- **Least price sensitive segment-a source of capital on early projects**
- **Easy to sell, hard to please (dream vs. reality)**
  - Need to carefully manage expectations
- **Project oriented, structure each phase so:**
  - It can actually be accomplished quickly
  - Results in a marketable product
  - Provides a concrete return on investment to be celebrated
- **They find you through innovator referrals**