

# ***Persistent Presence and Open Networks Undersea***

## ***New Technologies for Ocean Observing***

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# Big Picture: Networked Systems

- Circa 2003, ashore
  - Palm Pilot (data)
  - GPS (location)
  - Cell Phone (connectivity)



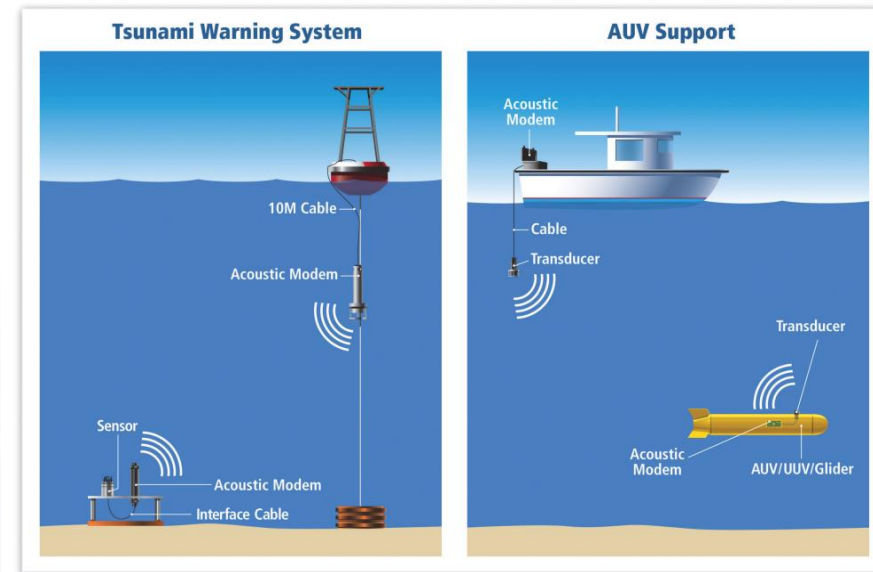
- Today, 2013
  - Smartphones and apps
- Without effective RF signals undersea this transformation has not yet come to ocean explorers, research and industry
- Teledyne is driving this transition in the ocean
  - Ubiquitous platforms
  - Reliable acoustic connectivity
  - Open protocols
  - Dedication to a connected subsea community



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# Subsea acoustic communications

- Present Capabilities (5 kHz band, 11.5, 18, 25 kHz center frequencies)
  - Multi-channel, MFSK: 140, 300, 600, 800, 1200 bps
  - MPSK: 2560, 5120, 10K bps
  - Differential OFDM (binary, quadrature) : 950, 1850, 3700 bps
  - Range, frequency and condition dependent ~1000m to beyond 6000m
  - Range measurement (0.5 m resolution) with every transmission



Streaming videos under sea, not so much, moving 144 character messages, definitely

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# Big Picture: Ocean Observing

- Global Ocean
  - 36,614,237,300,000,000,000,000 gallons of water
  - $\frac{3}{4}$  of the planet
  - Majority of the biosphere
  - Corrosive
  - Cold
  - Immense pressure
- Impacts
  - Climate
  - Commerce
  - Quality of life
- Demands
  - Extended observation in time and space
  - Without breaking the bank
  - At a high level of technical and scientific quality

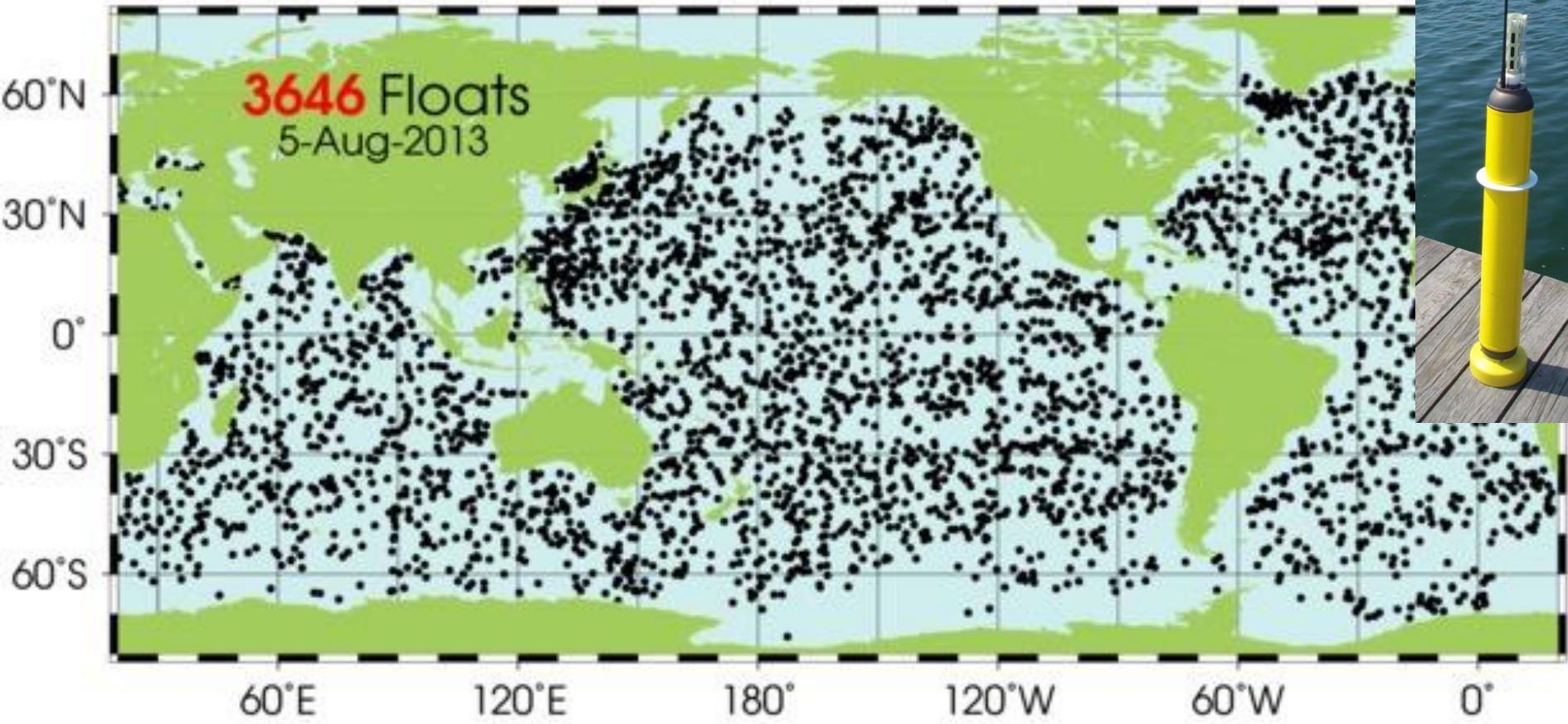
**Big Ocean**

**Small Budgets**

**Huge Data Gaps**

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# Ubiquitous Ocean Platforms



**Are these our ocean cell towers?**

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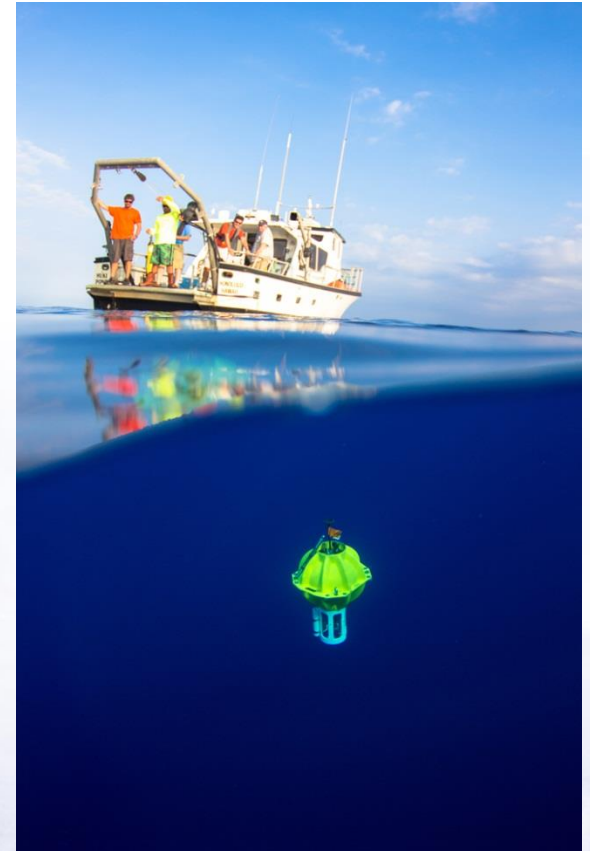




# Only when we can get deep . . .

Conventional Argo floats are limited to 2,000m depth

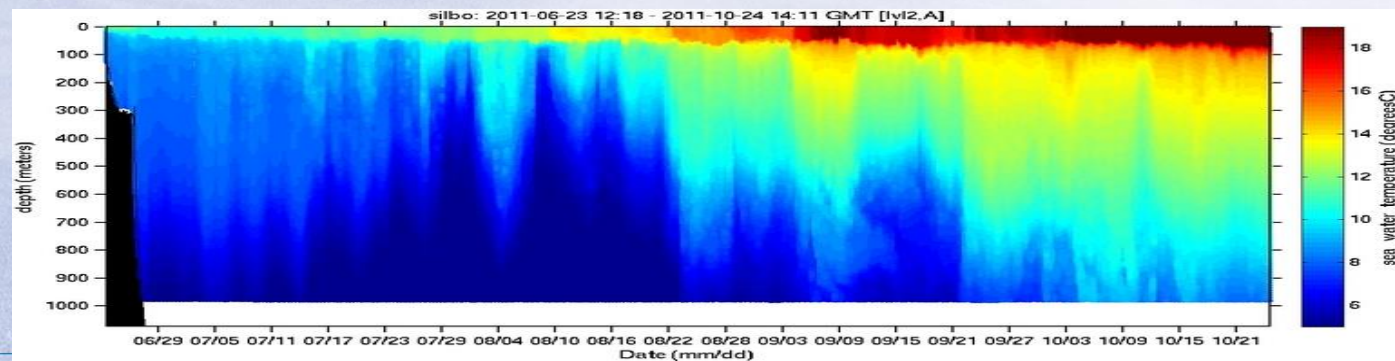
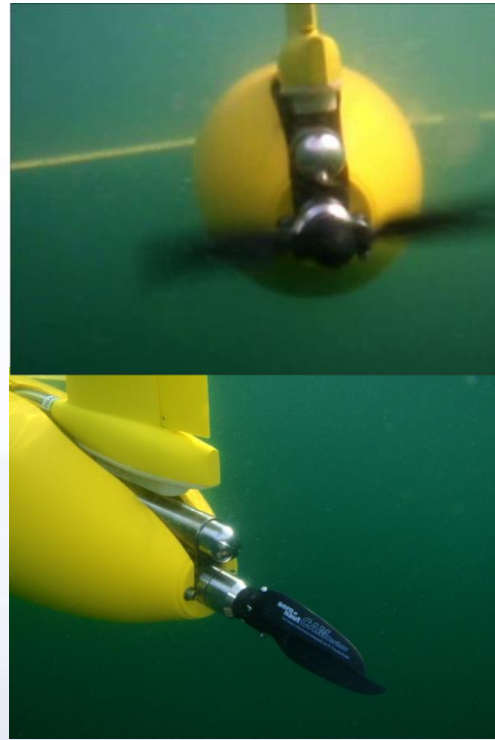
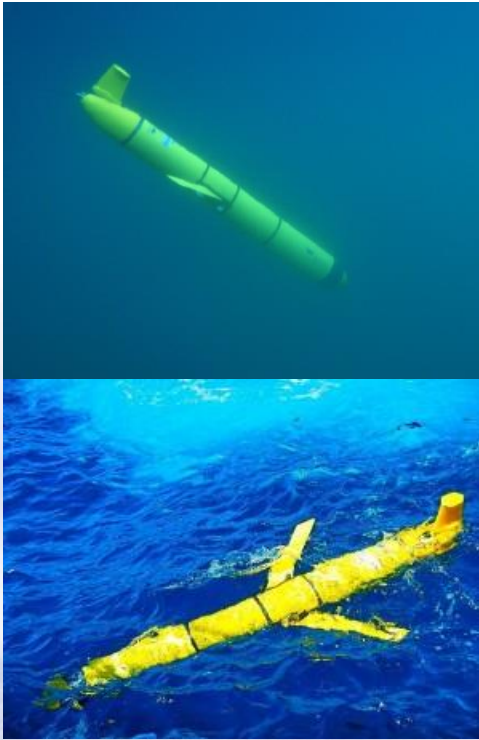
New Teledyne APEX Deep reaches 6,000m – demonstrated in Feb 2013



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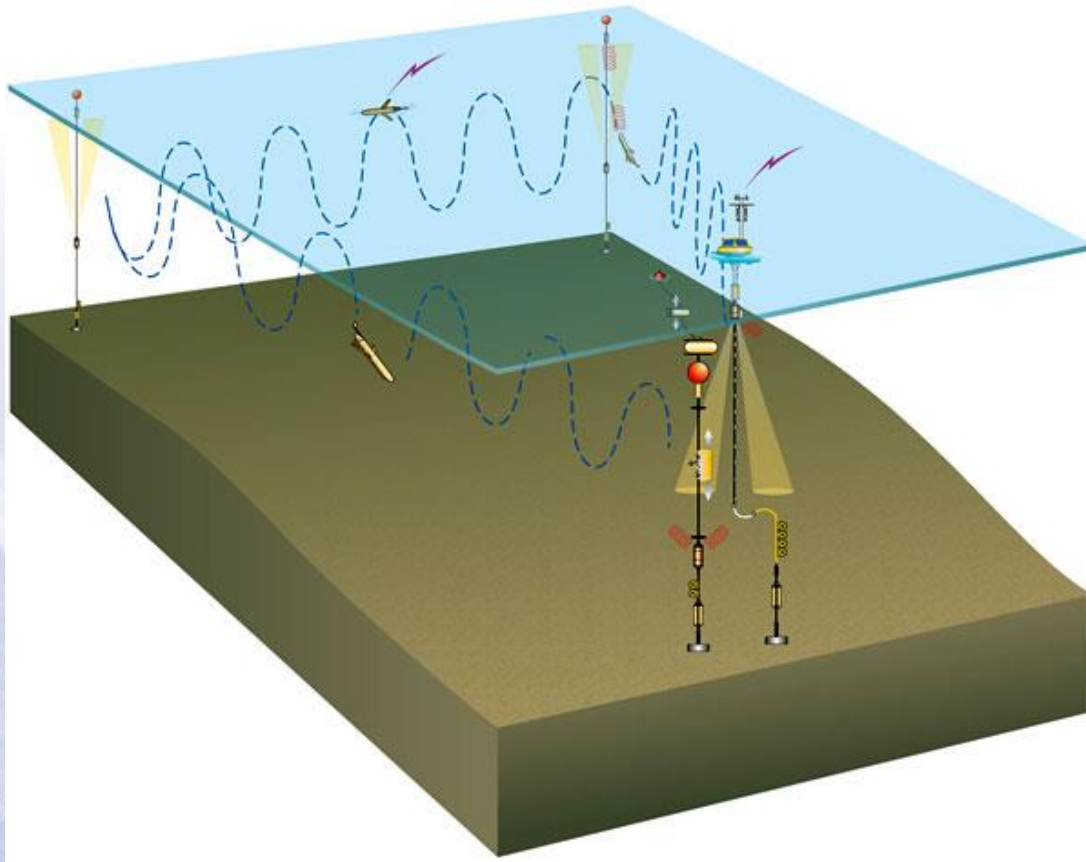
# Gliders bring mobility in all three dimensions





# Bringing it all together

## Ocean Observatories Initiative - OOI



Gateway gliders began delivery in 2013

**This is real not sci-fi**



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# So where are we today?

Simple closed networks being deployed

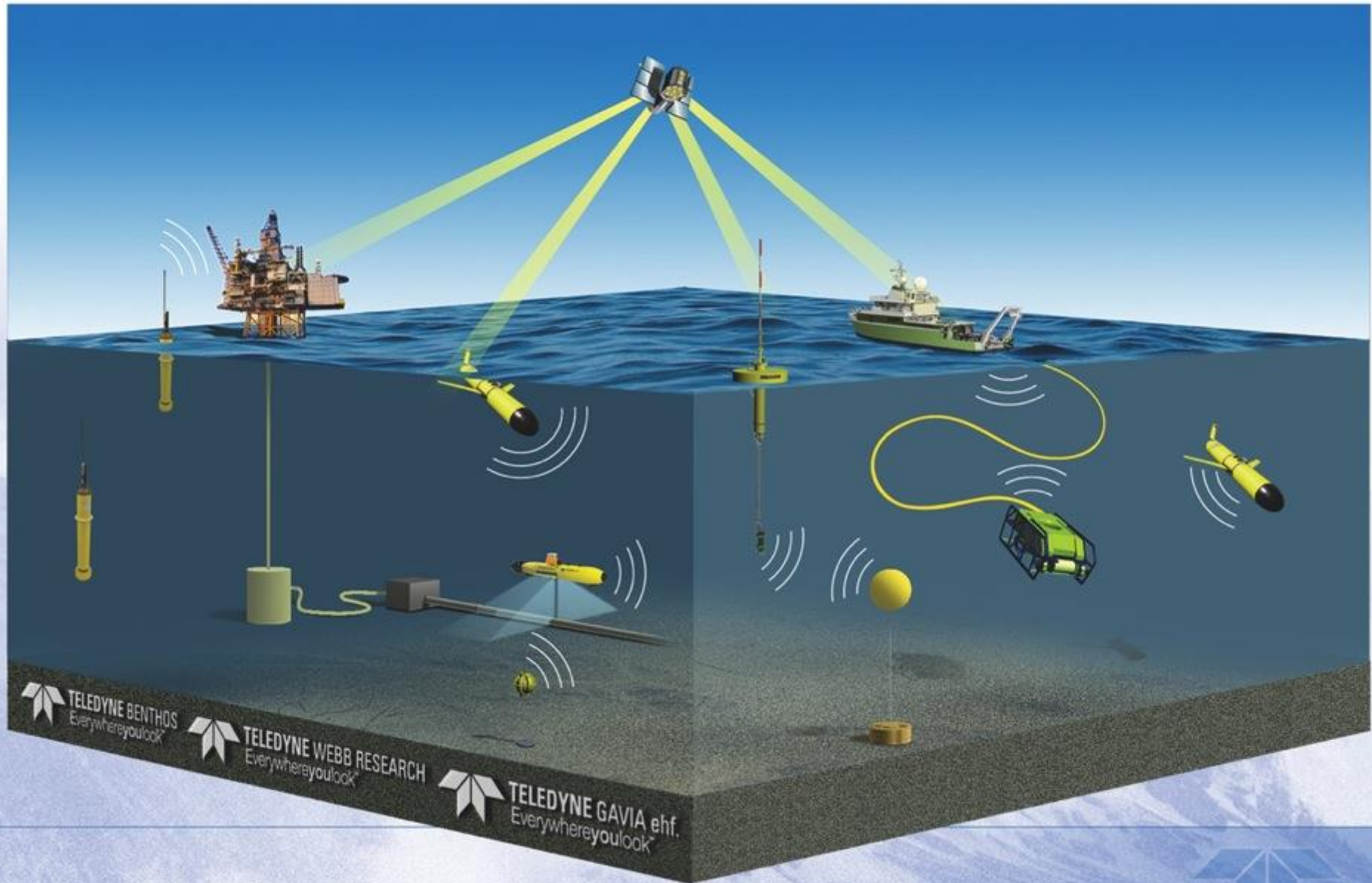
- Like early “bulletin boards” or AOL
- Only connect “members” using proprietary mechanisms
- Limited number of “nodes” and offerings

Awaiting key enablers of networked systems

- Ubiquitous coverage (cell towers, wifi)
- Open protocols (www, html)

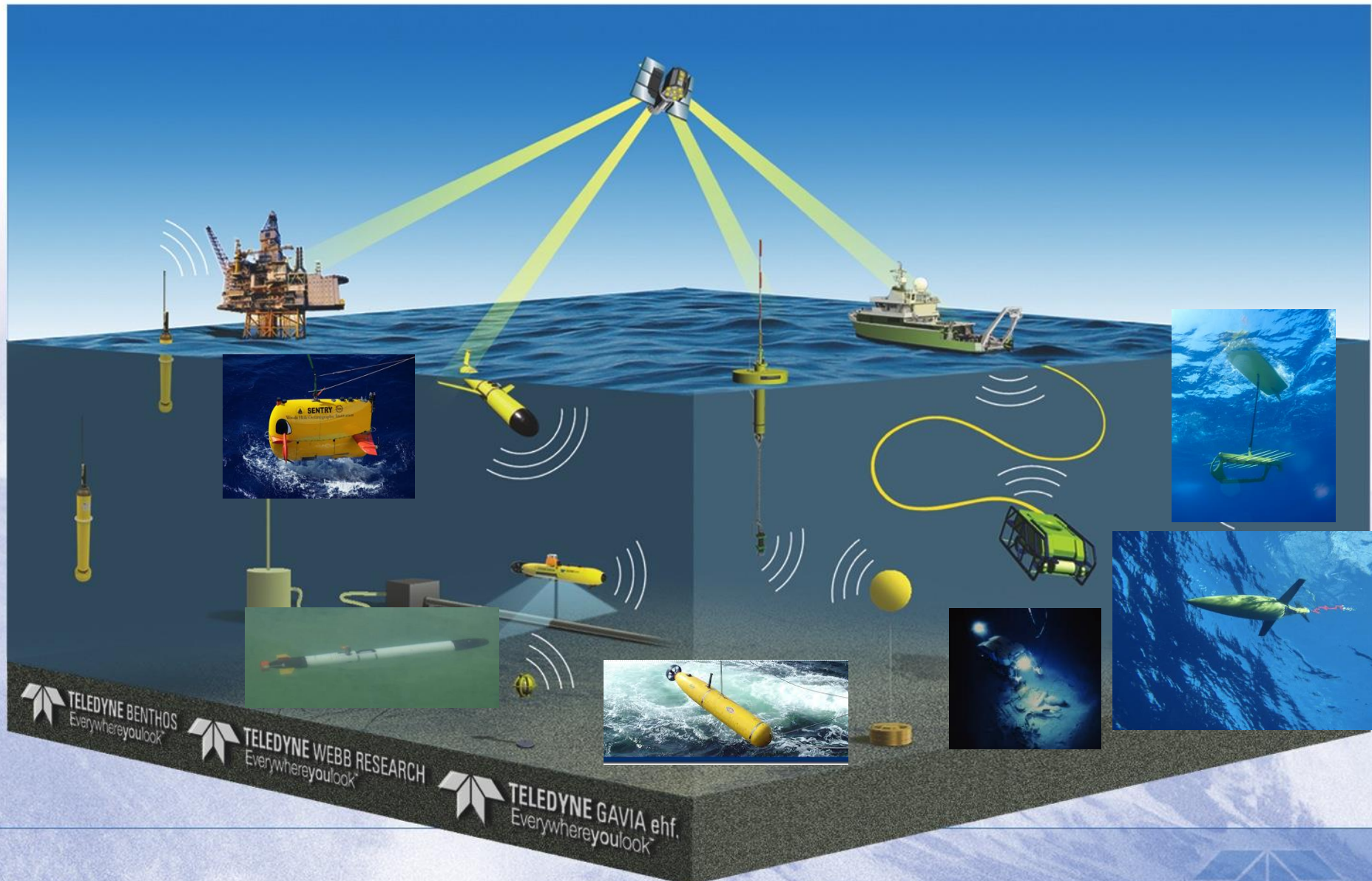
# The Networked Future

(Teledyne can build a closed network today)





# The Networked Future, once open to all, will it yield a “smartphone era” for ocean operations? We say yes!



Images courtesy WHOI, OceanServer Technologies, Bluefin Robotics, iRobot and Liquid Robotics

# ***Questions***

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