



European Sensor Systems Cluster – ESSC

“Renaissance of chemical and biological sensors”

WG1 Environmental Sensors

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Scale of Activity Now

- In the U.S., ca. **\$250 billion of economic output stems from pollution control and monitoring** activities each year.¹
- Among **the faster-growing** segments are **sophisticated (chem-/Bio-) sensors and large-scale sensor networks**.¹
- **The European Water Sector** has a turnover of **about €100 billion p.a.**, which represents about **one third of the world water market**.²
- The **European Water Sector** includes **9000 active SME's and 600,000 direct jobs** in water utilities alone.²
- One of the key barriers to innovation in the sector has been the **'predominance of existing technological solutions (choosing existing tested technologies)'**, i.e.; it is a sector that is **stagnant in terms of ideas and adoption of new technologies**.²

¹<http://sensorsandsystems.com/global-markets-for-environmental-sensing-and-monitoring-technologies/>


²XXX [http://ec.europa.eu/environment/water/innovationpartnership/pdf/Draft Consultation Document.pdf](http://ec.europa.eu/environment/water/innovationpartnership/pdf/Draft%20Consultation%20Document.pdf)

Sensor Hierarchy and Deployment Scenarios

- **Physical Transducers** – low cost, reliable, low power demand, long life-time
 - Thermistors (temperature), movement, location, power,, light level, conductivity, flow, sound/audio,
- **Chemical Sensors** – more complicated, need regular calibration, more costly to implement
 - Electrochemical, Optical, .. For metal ions, pH, organics...
- **Biosensors** – the most challenging, very difficult to work with, die quickly, single shot (disposable) mode
 - Due to the delicate nature of enzymes, antibodies....



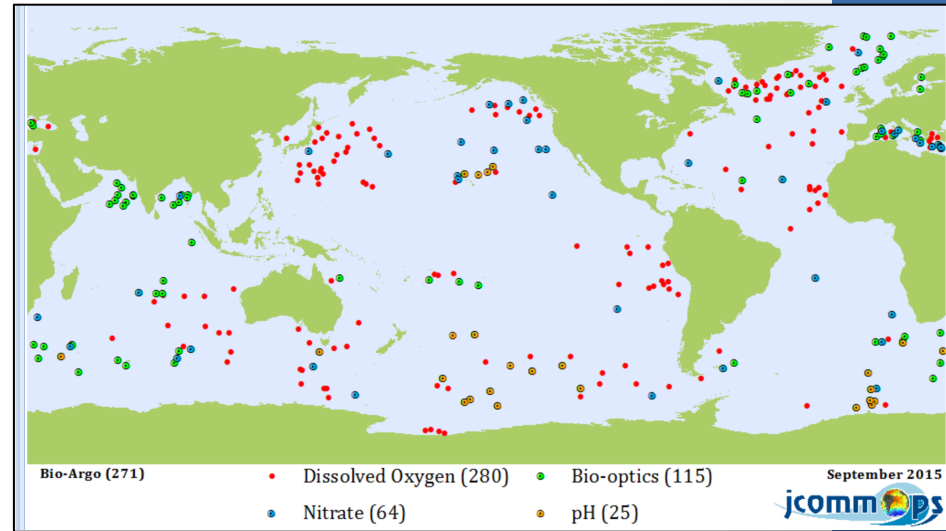
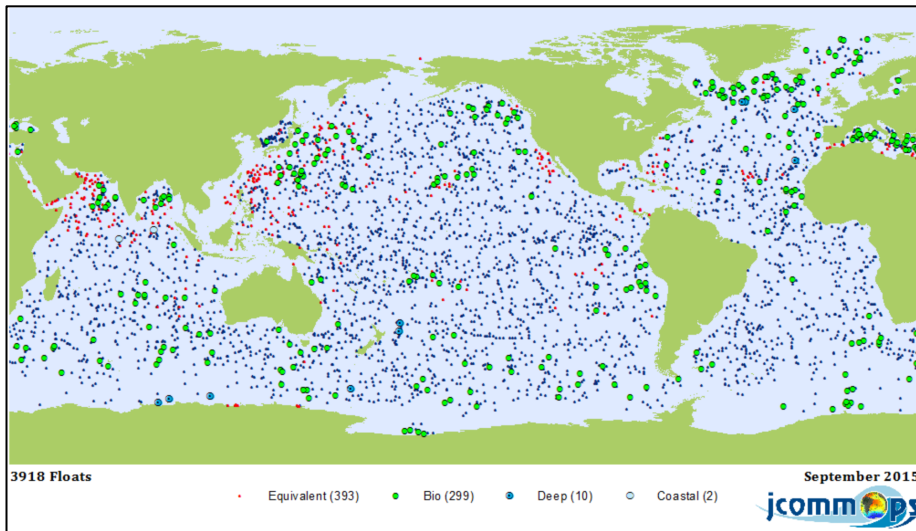
Increasing difficulty & cost



Increasing scalability

- **Gas/Air Sensing** – easiest to realise
 - Reliable sensors available, relatively low cost
 - Integrate into platforms, develop IT infrastructure, GIS tools, Cloud Computing
- **On-land Water/ Monitoring**
 - More accessible locations
 - Target concentrations tend to be higher
 - Infrastructure available
- **Marine Water**
 - Challenging conditions
 - Remote locations & Limited infrastructure
 - Concentrations tend to be lower and tighter in range

Argo Project (accessed March 20 2016)



- Ca. 4,000 (3918) floats: temperature and salinity
- Bio/Chem: Nitrate (64), DO (280), Bio-optics (115), pH (25)

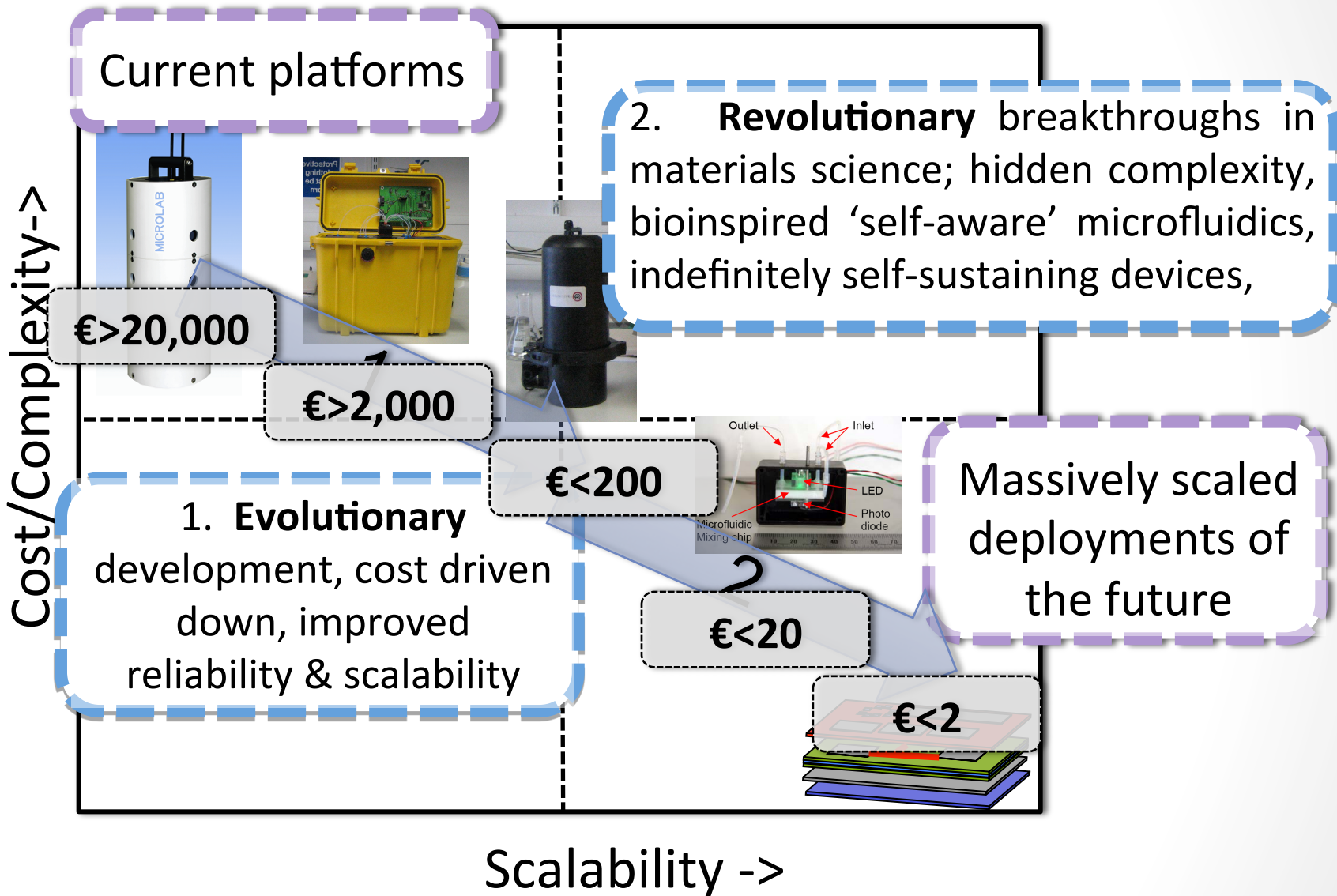
DO is by Clark Cell (Sea Bird Electronics) or Dynamic fluorescence quenching (Aanderaa)

@€60K ea!

See <https://picasaweb.google.com/JCOMMOPS/ArgoMaps?authuser=0&feat=embedwebsite>

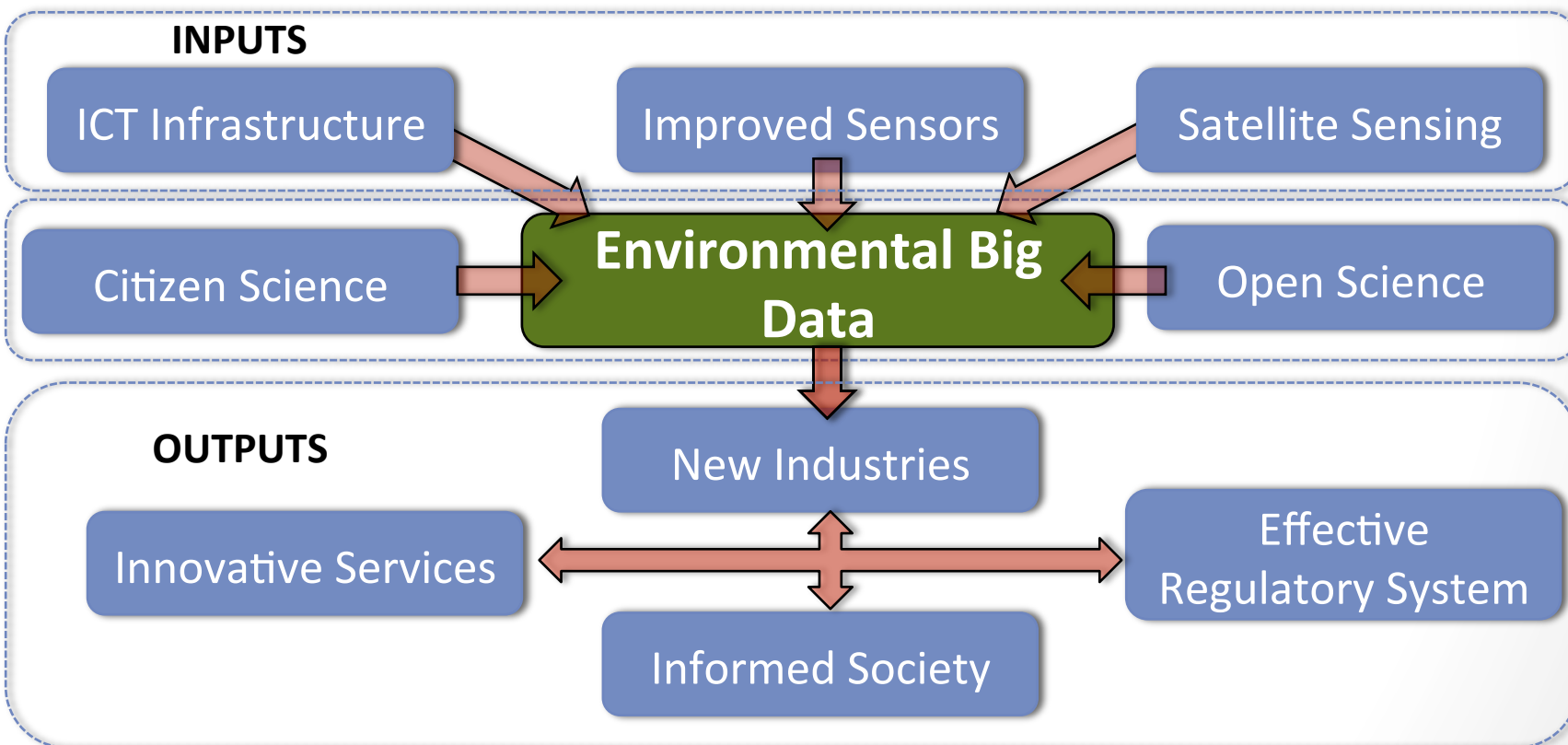
‘calibration of the DO measurements by the SBE sensor remains an important issue for the future’, Argo report ‘Processing Argo OXYGEN data at the DAC level’, September 6, 2009, V. Thierry, D. Gilbert, T. Kobayashi

Achieving Scale-up



Overview – Environmental Sensors

- Huge Span of scenarios and activities
- Heavily cross-linked with other Working Group Topics
- Major Trends and Opportunities



Ubiquitous Chem-/Bio-Sensing

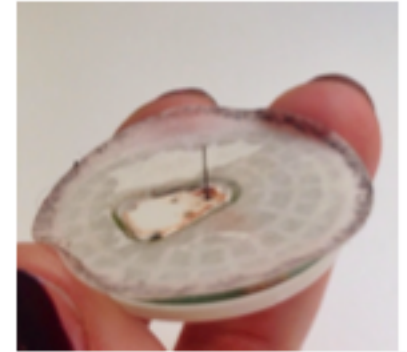
Major Drivers

- Big data and Cloud Computing
- IOT dominated by transducers (temperature, location, light, movement,
- Already realising multiple applications and major societal impact
- Next big opportunity to leverage digital capacity???

Ubiquitous Chem-/Bio-Sensing

Issues

- **Scalability:** Reliability, Cost, Stability.....
- **Requirement for Intimate Interaction** with Sample Medium (often extremely hostile)



Topic: Integrated Approaches to Outdoor Air Quality Monitoring

Call timing: 2018-2019

Instrument: RIA

Challenge description: To develop **scalable deployments of low cost accurate in-situ sensor networks** targeting specific components in the atmosphere, and to **integrate this data with complementary information generated by satellite remote sensing** and mobile platforms.

Possible solutions: Activities involving **close integration of in-situ gas sensor networks, mobile sensors and satellite remote sensing data**, with the goal of demonstrating the power of this multi-modal approach **to leverage the strongest attributes of each, for the benefit of the citizen**; e.g. **City air quality indexing** for real-time **and predictive modeling of air status and management of adverse environmental events** (e.g. industrial fires, natural disasters).

EU positioning: Europe has a strong position and has all the elements required to advance this area rapidly. This ranges across gas sensor manufacturers, specialist services providers based on gas sensing, satellite based informatics (e.g. EU SatCen) and research capacity and industry related to geospatial informatics/intelligence/services.

Companies interested: EU NETAIR (ca. 30 companies), **IBM, INTEL, AlphaSense, Skytek, Ambisense.**

Topic: Improved Platforms for Marine and Freshwater/ Wastewater Monitoring

Call timing: 2018-2019

Instrument: RIA

Challenge description: Current platforms are too expensive to purchase and maintain. A key objective could be to **reduce the unit cost by at least one order of magnitude, and preferably more** (e.g. commercial target price of €1,000; current systems typically cost €20K+ and for Marine deployments considerably more).

Possible solutions: Analytical targets in the initial phase could encompass **pH, COD, DO, nutrients, metal ions**; for which there are **well-established (but expensive) reagent based analyser methods and/or electrochemical methods**. Particularly important will be **low cost, fully integrated, scalable approaches to incorporating components like detectors, pumps and valves into multifunctional microfluidic platforms fabricated using polymer rapid prototyping (e.g. 3D printing technologies) and materials science (e.g. stimuli-responsive polymer actuators)**.

EU positioning: There has been **significant research activity through FP7 and H2020** projects, and this must be further strengthened and supported. The US has used **targeted global challenges very effectively to drive developments in the sector**.

Companies interested: European Association of Remote Sensing Companies (EARSC- 74 companies), **TELLAbs, IBM, INTEL, HACH, HENKEL, VEOLIA**

Topic: Migrating Analytical Instruments to the Field

Call timing: 2020-2021

Instrument: RIA

Challenge description: Currently, it is not possible to do in-situ measurements for many species listed under regulatory directives like the WFD. Consequently, enforcement of legislation is difficult, as these targets are not monitored with acceptable temporal frequency and spatial coverage.

Possible solutions: Mobilise the tremendous potential of **micro/nanofabrication technologies and new materials fabrication technologies (e.g. 3D printing, 2Photon polymerization)** to create sophisticated field deployable platforms that **integrate separation technologies, and information rich MS and optical detectors and biodetectors**. Couple advanced functional materials with emerging fabrication technologies to **reduce the impact of biofouling** through control of materials characteristics like surface micro/nanostructure and hydrophobic/hydrophilic nature.

EU positioning: While Europe is quite strong, the US is also very active, particularly in the development of miniaturized MS detectors. **This could be an excellent topic for 'open science' and collaborative alliances focused on a 'global challenge'.**

Companies interested: European Association of Remote Sensing Companies (EARSC- 74 companies), Dionex, **TELLAbs, IBM, HACH, VEOLIA,**

The European Sensor Systems Cluster (ESSC) 19th April 2016

Topic: Environmental Sensor Informatics and Forecasting

Call timing: 2020-2021

Instrument: RIA

Challenge description: Environmental 'Big Data' will increase exponentially as the diversity of sensed sources expand and become integrated. **Data must conform to standards** so that data from diverse sources can be accessed and searched using standard tools.

Possible solutions: Initiate actions to **demonstrate the power of aggregating data from multiple sources such as in-situ sensor networks** (initially gas/air sensing, but extending to fresh water, marine water as devices become increasingly deployed), citizen focused activities, **and satellite remote sensing towards the ultimate goal of predictive modeling services.**

EU positioning: Europe can lead the development of data standards (including quality indexing) vital for large scale data sharing and modeling. **Environmental Big Data will clearly contribute significantly to 'open Science' initiatives with other major global players e.g. USA and China.**

Companies interested: Siemens Environmental, Deltares, European Association of Remote Sensing Companies (EARSC- 74 companies), IBM, HACH, GOOGLE, Health Services e.g. related to allergenic and respiratory issues, travel industry.

Thank You