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[1] Google has published an Oxera report that estimates the revenues from global Geo services at $150 billion to $270 billion per year (http://www.oxera.com/Latest-Thinking/News/January-2013/Oxera-quantifies-the-benefits-of-Geo-services-to-g.aspx). In the 2014 State of the Satellite Industry Report published by the Satellite Industry Association, the revenue from remote sensing activities are valued at $1.5 billion.

[2] See Capgemini Consulting publication https://www.capgemini-consulting.com/rebooting-the-business-model-for-the-digital-age

[3] Google owns and operate EO satellites through Skybox. See http://www.skyboximaging.com/

[4] Amazon has made Landsat 8 data freely available on S3 so that anyone can create new products using AWS.

[5] See http://www.cesbio.ups-tlse.fr/index_us.htm

Tech4Earth: Capgemini's platform to foster the digital transformation of the Earth Observation ecosystem

Digital Transformation is now a key topic at the top of the agenda for CxOs in every line of business. The Earth Observation (EO) ecosystem is no exception, and this ecosystem is not limited to the Space sector: almost every line of business can benefit from new EO digital services to come.

People matter, results count.

We have identified four main drivers for the upcoming digital transformation of the Earth Observation ecosystem:

- **A downstream extension of the image processing value chain in the digital world**, opening new markets through new business models. The traditional, product-based, "remote sensing" B2B market will evolve towards downstream digital application for business, consumer and local authorities markets. Completely new ways of consuming and leveraging imagery will generate demand and will have a huge economic impact[1]. Rebooting the business model is a "common" practice when entering the digital world[2]!
- **Newcomers among the key actors of imagery value stream**. Google[3] and Amazon[4] already have moved towards these huge opportunities of the future Earth Observation market.

A platform-centric approach brings disruptive capabilities and a more agile culture for developing ecosystems and creating new services

New imagery and more generally information coming from new sensors is becoming available all the time. For example, the European Commission Copernicus program with Sentinel satellites provides free and open imagery. The goal is to stimulate the emergence of new markets and actors, including startups that will disrupt the value that can be extracted from imagery and other open data.

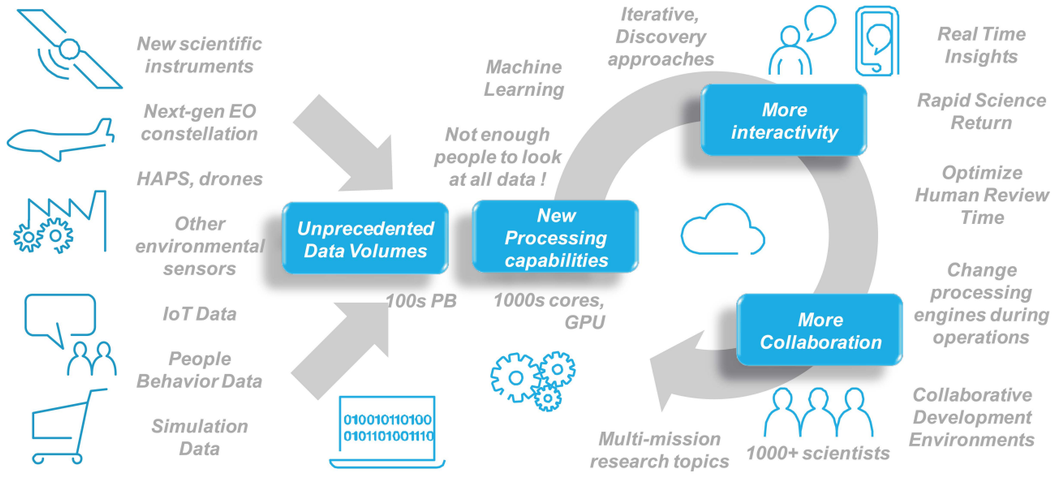
- **The use of Platforms that bring scalability and flexibility to boost creativity, increasing business agility while controlling risks and reducing time-to-market**. These platforms combine all required state-of-the-art capabilities (storage, processing, large-scale collaboration, mobile access, connectivity with sensors and end-users, etc) that have emerged from the digital transformation in the pioneer sectors. The same platform can be used for developing new services as well as for operating them, thus drastically reducing the time to market for new services.
- **A more open, collaborative culture reshaping organizations and developing ecosystems** with Spatial Agencies, Satellite manufacturers, Storage & Processing platform providers, Research labs, scientific communities, startups and even end-users.

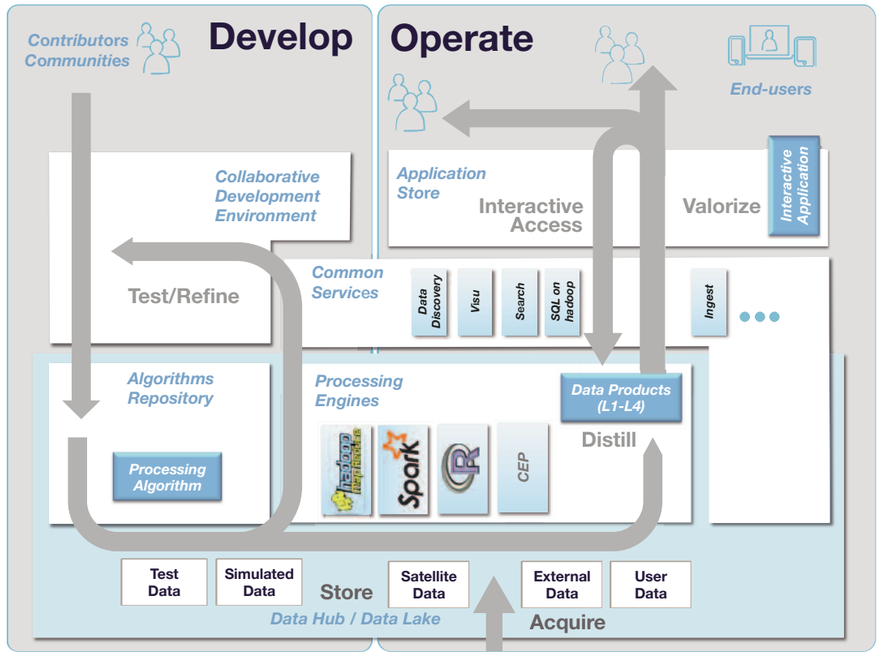
New technologies for new usages, from dark matter to smart cities

It's a revolution that comes from Technology. We believe that the EO processing chains that used to be designed, then developed, and then operated in a fixed-everything context are completely outdated. Even their layered structure (Level 0 to Level 4) is to be challenged.

It's a revolution that also comes from usages. To make scientific discoveries (dark matter, gravitational waves) or to invent new services for the consumer market (smart cities), space scientists actually have to address new challenges:

- Space scientists will have to deal with **unprecedented data volumes** coming from next-generation instruments and sensors, and also simulation data that will be used to develop and refine next-gen processing chains. Several hundreds of petabytes will be common in the next decade for a single space mission. Moreover, to get more insights from space data, scientists will combine data from multiple space missions or instruments with additional, "common" data.
- Space scientists will also design **new kinds of processing chains**, not limited to image processing at pixel level, but also using machine learning or statistical algorithms, much like "big data" enterprises are doing.
- The operation of these new processing chains will also significantly change, moving towards **more collaboration and more interactivity, real-time insights** and **"test & learn" approaches** involving automatic, "artificial intelligence" analyses as well as interactive, "human" ones. It can also mean systematically processing all observations to find out which ones are relevant for further analysis steps.





Tech4Earth key features and benefits

For the last 4 years, Capgemini Aerospace & Defense teams have explored multiple ways to address the drivers and challenges of the upcoming EO digital transformation mentioned previously by leveraging new disruptive Big Data and Digital technologies. This experience has led to several Proof-of-Concepts, an overall Vision and more recently to our operational Cloud platform:Tech4Earth.

As of today, we have running applications in the following business domains:

- Flooding Risk Forecast (partnership with the CESBIO[5] French lab), integrated into a Disaster Management digital application we're developing
- Rice crop monitoring
- Ocean pollution and lifeform analysis

Our Tech4Earth platform is designed for building "vertical" applications, to foster the discovery and the emergence of new usages in specific business domains. We have been developing multiple "flavours" of all the components that are required: data storage, processing engines, collaborative development environment, digital "application store":

- At the "core", a **Data Hub** or **Data Lake** that stores all data. Its key characteristics are to be scalable and open to both structured and non-structured data. It's powered by hadoop 2.0 that sets up a "Data Operating System" combining multiple processing engines: Map/Reduce for "simple" batch jobs on disk-resident data, Spark for in-memory processing to drastically increase processing speed, R for statistical analysis and Complex Event Processing frameworks like Storm to process streams of data in an event-oriented way.
- The **Collaborative Development Environment** and the Algorithms Repository are a set of services that enable scientific communities to collaboratively and iteratively develop small processing capabilities that enable the "distillation" of input data into higher level information. From a technology point of view it relies on notebook environments (Jupyter), continuous integration, automated testing, packaging and deployment solutions (Jenkins, Sonar, Nexus).

Tech4Earth addresses the complete value chain from scientific processing to digital applications for end-users. All services are available on a single platform!

- **Common services** are split up into 2 layers: on the one hand, platform-attached services on top of the core data hub (eg: search and sql-on-hadoop services) and on the other hand, context-specific "toolbox" services that customize the platform to your needs.
- **Interactive Applications** hold the business logic and the user experience. The objective is to go beyond simply displaying images (eg: flooding forecast visualized in a heat map), to help end-users make faster and more relevant decisions (eg: combine images with information gathered from the field into a fully-featured disaster management application).