# Our "success story" and some lessons learned

Jordi Portell

on behalf of Francesc Julbe (CEO)
and DAPCOM Associates

My background

≡ Electronics Engineering (UPC 2000),
opt. subject on Astronomy, **master thesis on design of SIXE data link** (incl. compression)

≡ PhD on Applied Physics and Science Simulation (UPC 2005), **thesis on Gaia payload data handling and compression**

  ○ Stages in Meudon (3 weeks) and ESTEC (3 months)

  ○ Really worth it!

≡ After PhD: from Space to Ground segment (data processing: DPAC). Still there!

≡ DAPCOM colleagues/associates:

  ○ Physics, Astronomy

  ○ Telecommunications/Electronics Engineering
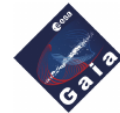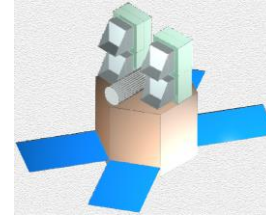
Proposal of Telemetry Model for Gaia-3

Prepared by:	Jordi Portell, Claus Fabricius, Eduard Masana, Xavier Luri
Code:	GAIA-CH-TN-UB-JP-001-1
Version:	1.2
Date:	2006/07/25
Internal code:	
Contact:	portell@ieec.fcr.es

DAPCOM background

- Since my thesis, we insisted ESA and Gaia management that Gaia's data compression was a challenge and required a careful study

  - Finally: ITT (Invitation To Tender) on **Gaia Optimum Compression Algorithm (GOCA)**, 2007, IEEC+GTD

  - Design of overall compression approach, incl. tight computing requirements onboard.

  - **Conceived PEC** (Prediction Error Coder), robust compression in front of outliers (PPEs)

  - **Its basic concept was used onboard Gaia!**

- **Conceived fully-adaptive layer** on top of PEC → **FAPEC**, presented at SPIE'09 (San Diego) and later **patented** (UB+UPC)

- Advised PhD of a student (UPC 2011) for the fine-tune calibration of FAPEC

- To commercially exploit the patent → creation of spin-off company → **DAPCOM (22-Feb-2013)**

eesa

European Space Agency
Directorate of Technical and Operational Support

Appendix 1 to AO/1-5324/06/NL/LvH

STATEMENT OF WORK

Optimum Compression for GAIA

Reference: TEC-EDP/06-002/RV

Issue: 1, Revision 0

Date:14 November 2006

Quite a long timeline!

- 1999-2000: Astronomy, satellites, compression

- 2000-2005: Gaia and its compression

- 2007: Data compression algorithm for Gaia (realistic, onboard)

- 2008-2009: FAPEC concept

- 2009-2012: fine tune, patent (ES+US, tried EU)

- 2013: DAPCOM foundation

→ ~5 years from concept through patent to spin-off

- You can only afford this if you have a job meanwhile

  - Otherwise: speedup as much as possible
  - Actually, the job (DPAC and Gaia preparations) was partially the reason for this long timeline

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- **UB/FBG + UPC offices helped a lot**

Lesson (from GOCA ITT):
You may be in a competition without knowing it.
Do NOT unnecessarily disclose your ideas or know-how to "colleagues", esp. if Industry is involved. You may get stabbed in the back.

Lesson (from FAPEC patent):
Make sure it's *really* worth to patent.
You may be imposing limitations to your own work (e.g., applications not possible anymore because of the patent).
More sense for "hardware", barely any sense for software/algorithms (plus, really difficult in the EU).

Really important lesson:
Seek advice from experts, either on patents or spin-off creation.
There are offices dedicated to this in nearly all universities.

The early times: learning to have a company

- The "founding fathers": **10 associates**!

  - 5 inventors/coinventors of FAPEC (2 UB + 3 UPC), incl. 3 Gaia/DPAC experts

  - 1 CEO / BigData expert

  - 2 "supporters" (and Gaia/DPAC experts)

  - 2 universities

- Main aim: exploit FAPEC

  - But also: exploit our know-how on massive data processing (learnt from Gaia/DPAC)

- Approach/idea:

  - Sell software licenses (of FAPEC)

  - Offer services (on massive data processing – mostly software engineering)

  - "DAPCOM" = DAta Processing and COMpression

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- Started with hand-made logo and without any actual office
  - We were just working on the same UB/ICCUB/IEEC offices of Gaia

DAPCOM

DATA SERVICES S. L.

The early times: learning to have a company

- Questions you should ask yourself (*before* creating the company)

  - **What am I really good at?**

  - **What do I enjoy working on?**

  - Could this interest to people / companies?

  - Could there be **enough** interest (or benefit: e.g. costs savings) to **pay for it**?

  - Is there a real (potential) **market** for this? Otherwise, could I "create" this "need"?

  - Should I "**think big**" (look for investors/funding),
    or just a **small** company would be fine (for myself and perhaps 1-2 more people)?

  - Should I really, really, REALLY look for funding, loans, etc.?
    (would it be REALLY **feasible to do enough money** to return this investment + have benefits?)

  - Do I have "**people skills**", or should I look for a salesperson?

  - Do I have enough "**economic skills**", or should I look for somebody else to handle it?
    (not talking about **management/tax/contracts company/services**: **you WILL need it anyway**)

  - Do I need a (large) **office**?

  - Do I need much **investment** on hardware, computers, instrumentation, etc.?

  - Do I need (much) **legal advisory**?

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Regardless of what you do and which experts you ask,
you'll know the *real* answer to this only after a few years. Hopefully not too late.

- ≡ You should probably **externalize** most things
  - ○ Economics + HR/contracts management, job hazards management, Legal, IT, sales, marketing / graphic design, …
  - ○ But all this has a cost, of course.

- ≡ Our first years were mostly on "DAP" (esp. **Gaia data processing**) through projects/contracts.

- ≡ Some "side project" like the "**Gaia SOC Monitor**" (right before launch: countdown, monitoring, …)

- ≡ Also **co-advising some students**
  - ○ Good "fresh blood" for FAPEC developments

- ≡ Working slowly on FAPEC improvements to make it **sellable**
  - ○ while looking for **possible customers**.
  - ○ (remember: people use to like usable, solid and professional software!)

- ≡ All this was while all of us were **still working on Gaia/DPAC**
  - ○ **Partial dedication**, not good for the company.
  - ○ Still like that nowadays!

The early times: learning to have a company

Mistake we did:

"OuR pRoDUct iS So tRaNsvErSaL tHaT aNyOnE sHouLd bE iNteReStEd iN iT"

→ NO. Focus on the 2-3 most promising, even "peculiar" sectors/market!
        (it requires a lot of thinking, investigation and time)

It may be better to find a small "niche", with few potential customers but willing to pay well, rather than the "mass market".

Mistake done / decision to be made:

Do you want to grow slowly (if at all), while working on your "main" job?

   I.e.: Is the company a kind of "side project"?

   It may be OK, but then look for at least 1 full-confidence person
   to lead the company day-by-day.

If you want a relatively quick (~2-3 years) success, go for it **full-time**

   → RISK, but it's the best way to make sure you'll move on.

In my view:

"Success" = No debts, and at least a little bit of benefit by the end of the year.

"Great success" = Slowly grow (yearly invoicing, staff).

"Dream" = No worries on being able to keep your staff during the next ~3-4 years.

Anything else is a "unicorn".

The Incubation years

- New **ESA Business Incubation Center (BIC)** in Castelldefels (UPC campus)
  - Applied, and… **success!!**
  - **Funding** (grant, not loan!) + "cheap" **office**!
  - Very interesting **ecosystem** there
  - Incubation period: **2014-2016**, but continued there afterwards

- Thanks to funding:
  - Acquisition of **server** (code+data repository)
  - Contracted some **developers** to improve FAPEC (plus my own time: refurbished FAPEC code)

- Some initial cont(r)act!
  - **First FAPEC license**! …yet merely testimonial: small amount and discontinued. But learned from their feedback.

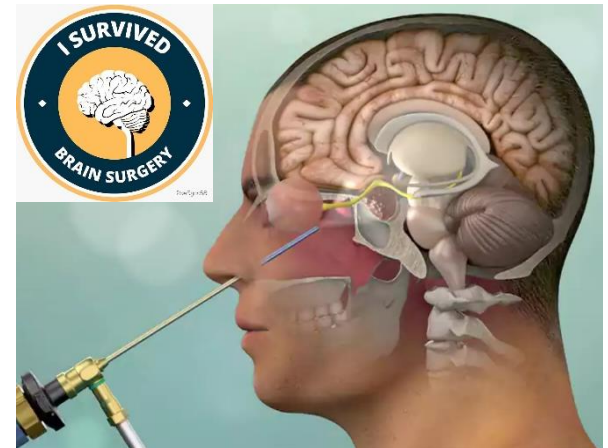# The Incubation years

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- **Shit happens #1:**
  - **April'2015, my 2nd birthday**

Lesson:
Clearly document everything (incl. procedures) if you don't want your hard work to be lost, in case worse comes to worst.

- Meanwhile, continued offering services to Gaia data processing.

  - Remarkably: **Contract with ESA for the main Gaia Cross-Matching!** (XM), with some extensions for a few years.

  → Consolidating DAPCOM as
  products (our hope) +
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Adapt to what people/companies demand. Even if that topic wasn't your goal, if it gives money and you know how to do it well, go for it.

A company is continuous learning + adaptation.

Use your contacts. Learn to find needs, identify weaknesses in other projects, and **sell yourself as the solution**.

Proactively look for possible contracts, grants, public calls, etc. Don't sit and wait for others to seek you!

Try to find somebody in the "middle". Not too high/boss (they won't understand you), not too low (no decision power).

Forget about "academic writing" in proposals or quotations. Be **concise**, focus on improvements/**results**.

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≡ Attempt of getting **public funding** (NEOTEC)

- Failed due to some administrative bullshit

Never ever submit a proposal too close to its deadline. Have a **margin** of at least ~24 hours, and double-check that you have everything: certificates, signatures, paperwork, blood of your first-born child, dark deity invocation verses, etc.

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Lift off: FAPEC flies!

- Spire Global Inc. (through a former IEEC contact) approached us to adapt+use FAPEC in their nanosatellites constellation

- New algorithm development
  → **licenses + services**

- **End'2017: FAPEC deployed in their first satellites. Success!**

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Try to do your product (and service) as good as possible, so that it won't require much post-sale support from your side.

Try to go beyond requirements, so the client is impressed.
It's the best publicity (and it helps in sales continuity).

Don't follow the "it's good enough" approach – but find the balance, to avoid delays and long development-to-market times.

Life & Death, departures, pandemic...

- ≡ (Big) Shit happens #2:
  Demise of Enrique García-Berro.

- ≡ (Big) Shit happens #3:
  Demise of Jordi Torra.

- ≡ Shit happens #4:
  Cornerstone worker leaves, and
  salesforce/projects worker not performing well.
  - ○ ESA-BIC office became quite empty
    → **move office to Vic**

Adapt. Don't be scared to move your office if that helps (costs, work-life balance)

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≡ Shit happens #5: **pandemic**.

  ○ Severe problems for some customers,
    incl. out-of-business for 2 of them.

Adapt. Don't be scared to move your office if that helps (costs, work-life balance)

You may never get some of the envisaged income, so be careful when estimating your benefit margin, real costs, when do you actually devote the effort or buy things, etc.

Think about possible "force majoeure" situations. From time to time, imagine the worst situations and take measures to survive it. E.g.: off-site backups, insurance…
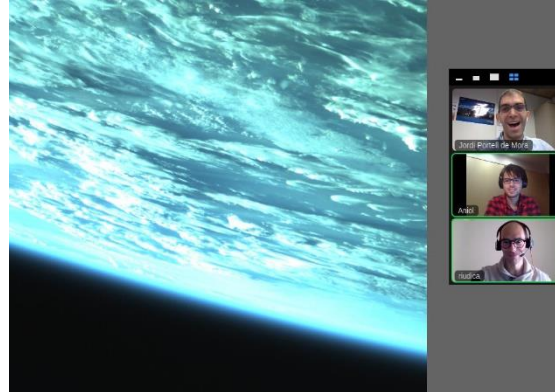
New projects

- ≡ Presentations in some **workshops** (e.g. ESA OBPDC), publication of some **papers**.

- ≡ Tests & developments for **ESA OPS-SAT** (for free)

    - ○ **FAPEC flies again!**
    (now on nice Earth Observation images)
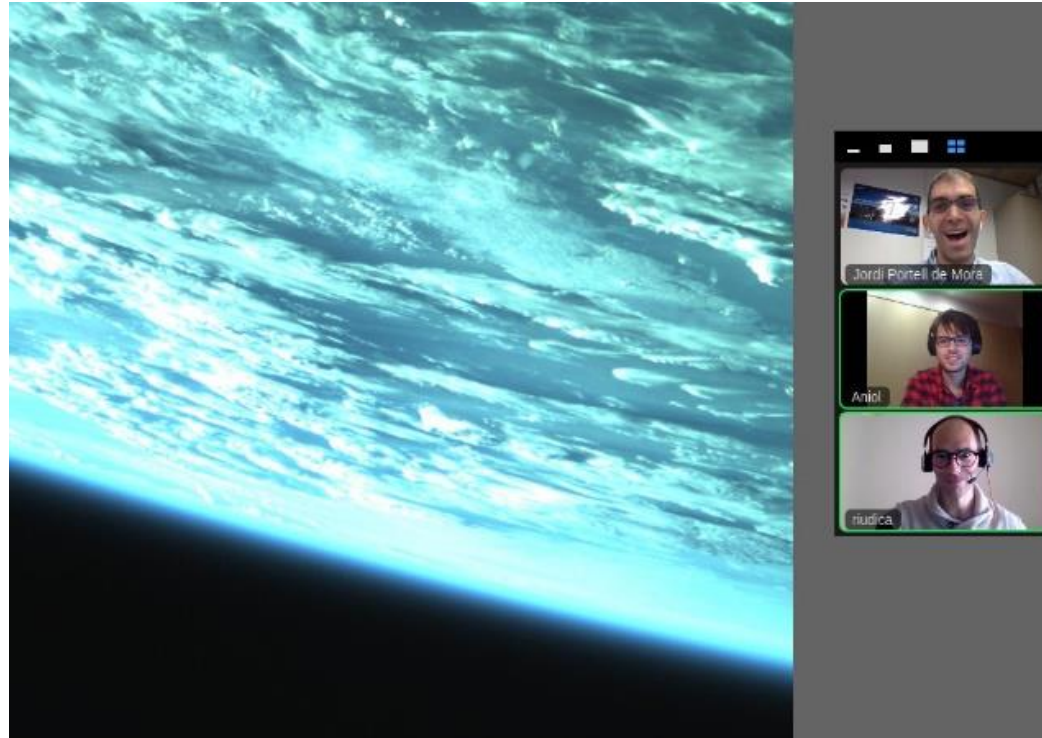
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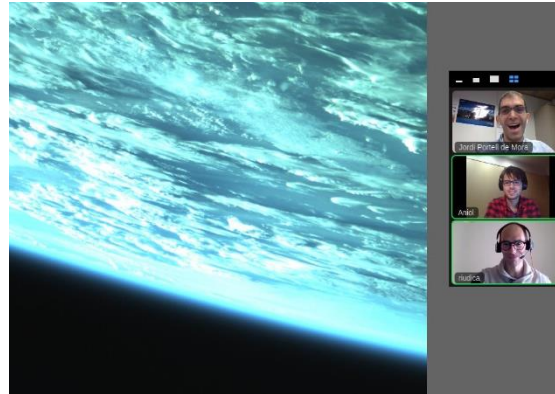
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  - **FAPEC flies again!**

    (now on nice Earth Observation images)

- Some "side projects"
  - FAPEC on UPC students nanosatellite
    → *platform failure…*
  - Hardware-less timing for athletic runners
    → *later out-of-business due to pandemic…*
  - Automatization of meteorological predictions for astronomical observatories
    → *later continued with a 2nd project*

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Dare to accept out-of-your-expertise projects: you may take students (and even university support) to do those.

Estimate carefully your benefits margin: far enough to cover costs (but not too high).

New projects

≡ Another company building a **nanosatellites constellation** – and they also want FAPEC, yay!

- ◌ …but: perfect (shit)storm.
  Launch site in the worst pandemic epicenter of India. Maiden launch scheduled ~mid2020. Huge delays. **Bankrupt**.

Define milestones and downpayments, so that you get paid progressively. The customer may operate in completely good faith, but some things are out of anyone's control.

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- ESA's Open Space Innovation Platform (OSIP): Call for ideas related to OPS-SAT
    - **Applied 2 proposals, 1 granted** – yay!
    - **Funding** → hired 2 developers (one still there!)
    - RICSDAC: Radio-frequency and Image data Compression Software for Demanding Applications in Cubesats
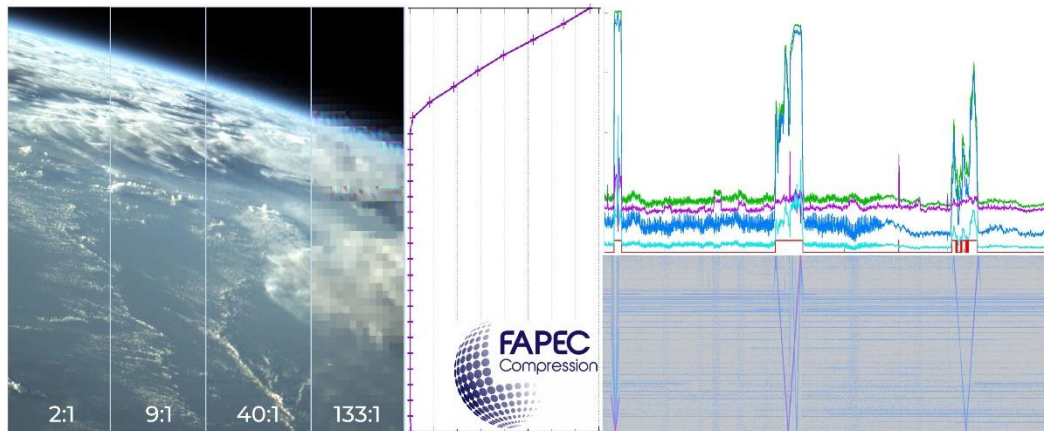
    > If you have time and feel strong to implement it (and/or the proposal is "easy" to prepare) apply as much as possible. You'll increase the chances to get it.

    > Remember the previous lesson, on accepting some work for free?
    > That was worth it!
    > You can create **solid confidence** on your work.
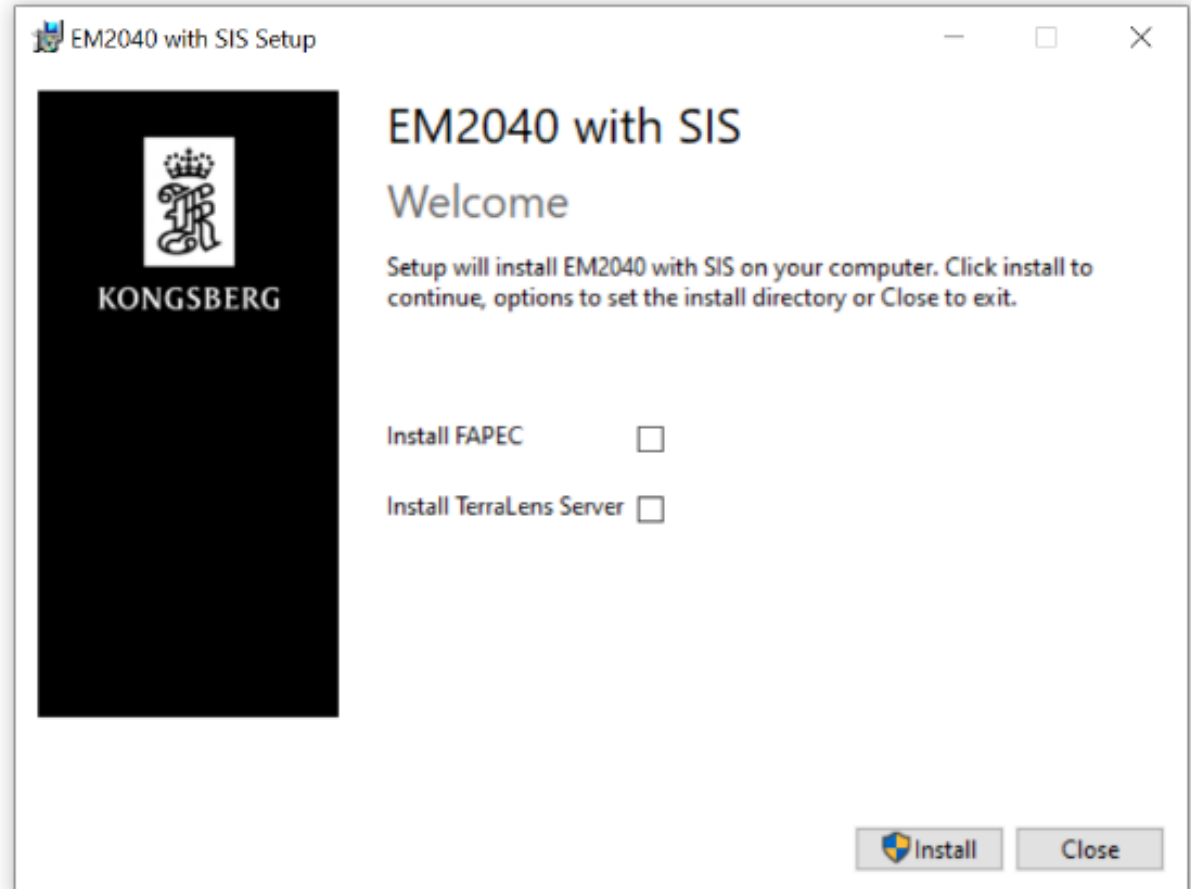

2:1   9:1   40:1   133:1

FAPEC Compression

From Space to Oceans

≡ Again, contacts & friends:
Discovered strong need for data compression in
one of those "niche": **maritime echosounders**.

⟳ Developments,
discussions, and finally:
**Agreement with
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  Discovered strong need for data compression in one of those "niche": **maritime echosounders**.

  - Developments, discussions, and finally: **Agreement with Kongsberg Maritime**

- First customer on the maritime sector:
  2023-2024, 2 licenses + software engineering

- **Agreement with Fugro**

  - to use FAPEC in their vessels

- Side development: **FARSHY Viewer**

  - We needed a tool to better understand the data to be compressed, so we developed it
    …and it became a new commercial product

- Commercial article in an important magazine

Consider attending specific, professional workshops and congresses; the cost may be really worth it – but make sure there will be potential customers. And **don't be shy!**

Make sure to have a legal advisor to revise agreements/contracts, esp. on IPR, license terms, support, liabilities…

Get used ASAP to task management and planning tools (e.g. Trello, Project), and use it often.

If you, as expert, need a tool that doesn't exist, consider creating it; it may become a new nice product

Don't hesitate to spend some money on "publicity" when possible – but only if it has real potential to attract new customers

☐ **Sponsored article**

Efficient data compression and visualization software for multibeam echosounders
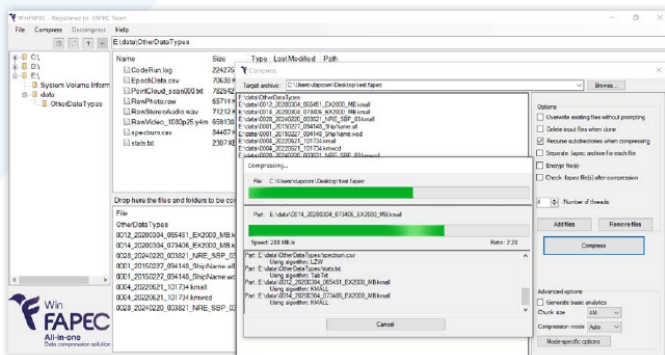
Surfing the big data wave

Water column data acquired by multibeam echosounders (MBES) imposes large requirements on disk storage and data transfer, so it is typically logged only during specific times, a practice that poses the risk of missing interesting targets. Furthermore, huge data volumes from both bathymetry and water column data can lead to considerable burdens for the operators during long surveys. MBES data is often compressed using standard solutions such as Zip or 7-Zip, but these can be computationally heavy for a relatively modest size reduction. To overcome this, we developed FAPEC, a high-performance data compression software, now supporting MBES data. We also present FARSHY, a fast visualization and analysis tool to streamline quick checks on the heavy water column files.
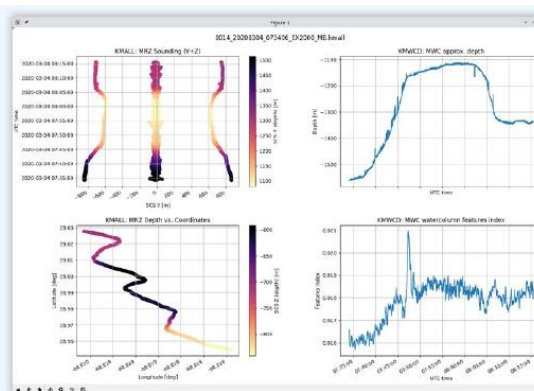
Space technology for marine echosounders

DAPCOM's FAPEC data compression software was originally designed for satellites such as ESA's Gaia, the billion-star surveyor, where onboard computing, storage and downlink capabilities are extremely limited. Later, FAPEC was enhanced with improved performance and additional algorithms to better adapt to a wide variety of file formats and data characteristics. In collaboration with Kongsberg Discovery and the Marine Geosciences Research Group of the University of Barcelona (UB), FAPEC was adapted to accommodate the *.all*, *.wcd*, *.kmall* and *.kmwcd* (KMall) formats from Kongsberg's

EM MBES systems, and more recently it has been integrated into Kongsberg's Seafloor Information System (SIS) to provide automated file compression once the logging files have closed. FAPEC is being further extended to other formats and vendors.

FAPEC runs on Windows (including a graphical user interface, WinFAPEC), as well as on macOS and Linux, and it supports ARM processors. Its C, Python (*fapyc* package) and Java API allows for integration in third-party software. FAPEC rapidly examines the files to be compressed, determining the best algorithm and configuration for each of them. It supports tabulated text files (such as CSV or point clouds), multidimensional time series and multispectral images, to name a few. Therefore, rather than a *universal* data compressor, FAPEC is adaptive and versatile, allowing a much more efficient use of resources.

Figure 1: Screenshot of WinFAPEC while compressing several files on a standard laptop.

to keep most of the features in the water column (including sub-bottom data) while vastly improving the compression ratio. In the specific example shown in the FARSHY screenshots, the combined bathymetry and water column KMall file is 933MB, which is reduced to 410MB in lossless mode, and just 154MB with these lossy options. When adequately adjusted, water column files can become even smaller than bathymetry files while retaining most of the relevant information.

FAPEC achieves these results by knowing the data format and examining the values. It can provide *basic data analytics* on the fly, namely small CSV-like text files with a digest of the file contents. For example, it generates a *water column features index*, which aims to indicate sudden changes in the scene such as those created by gas seeps, fish shoals or

Figure 2: Plots obtained with Python from on-the-fly basic data analytics provided by FAPEC, from soundings (left: beam width, depth and coordinates) and water column data (right: depth and features index).

On MBES datasets kindly provided by Kongsberg and Fugro (who have started using FAPEC on their vessels), FAPEC demonstrated superior performance: it achieved better compression than *7-Zip*, while running 50 times faster and using 30 times less memory. Depending on the echosounder and scenario, FAPEC further reduced the file sizes (compared to 7-Zip) up to 10% for water column data, and up to 23% for combined bathymetry and water column data.
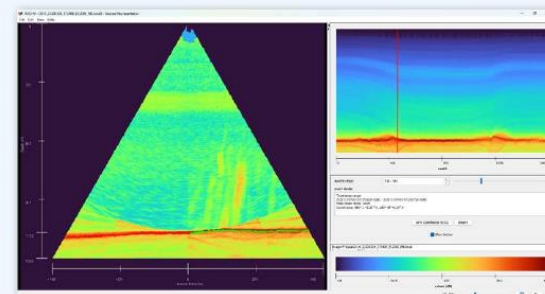
Beyond data compression

By default, FAPEC runs in lossless mode, meaning that the original files can be exactly recovered. However, for .wcd and KMall files, it also provides several lossy compression options, meaning that the quality of the data is slightly degraded to achieve a better compression. For KMall bathymetry (soundings), it allows for an instrumentally lossless operation, just removing the measurement noise. The seabed image samples can be quantized at a level indicated by the user, and can even be mostly removed if not needed. A similar approach is provided for older (.wcd) water column files.
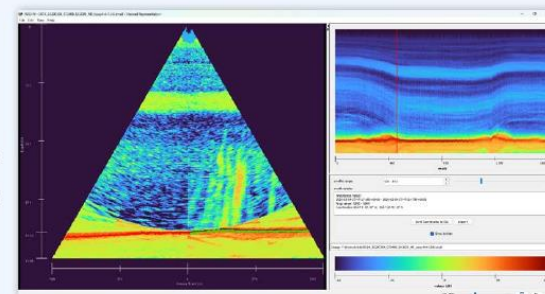
For KMall water column data, besides sample quantization, FAPEC also provides a *smart lossy* mode, which examines the sample values and removes those below a given percentile. This makes it possible

Figure 3: Screenshot of FARSHY showing gas seeps in the water column (left) and the along-track view (top right). (Data courtesy: Fugro)

Figure 4: Same water column file as in Fig. 3 after lossy compression by FAPEC, reaching a compression ratio of six while showing an even clearer view of the gas seeps.

Consolidating our Gaia contributions

- ≡ ESA contract on Gaia/DPAC Close Pairs!

  - ○ 2020-2023 (incl. 2 extensions)

  - ○ Mainly in CU3-IDU XM

- ≡ ESA PRODEX on Gaia/DPAC developments!

  - ○ 2024-2026 (2.5 years)

  - ○ CU3-IDU, DPCB and CU9-Validation

  - ○ Again, thanks to contacts and confidence on the capabilities of our team

This kind of projects can require **a lot** of "side" work: proposal preparation, tasks/progress monitoring, meetings, reports, documentation…
Don't underestimate it.

Try to progressively grow, at least a bit, with reliable, efficient and trustworthy **workers**.
The company is nothing without them.

Consolidating our Gaia contributions

- ≡ ESA contract on Gaia/DPAC Close Pairs!
  - ○ 2020-2023 (incl. 2 extensions)
  - ○ Mainly in CU3-IDU XM

- ≡ ESA PRODEX on Gaia/DPAC developments!
  - ○ 2024-2026 (2.5 years)
  - ○ CU3-IDU, DPCB and CU9-Validation
  - ○ Again, thanks to contacts and confidence on the capabilities of our team

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Don't be economically ambitious.
Don't look for large benefits (at least during the first years).
Try to devote most of your incomes to salaries, and pay attention to the Economics situation: try to pay "enough" for their profiles.

Once everything starts to look stable, you may consider earning more. But don't put your company or your workers at risk because of your ambition.

Most probably, you will NOT get rich with your company.
If you and your workers can get reasonably good salaries, and esp. if you don't have debts, that's a big success.

So… where are we?

- We have 2 main **software products**:
  - FAPEC compressor: CLI, GUI (WinFAPEC) and Python (fapyc)
  - FARSHY viewer (Java)

- FAPEC **customers**
  - For Space (e.g. Spire) and Oceans (e.g. Fugro)

- Strong **software engineering expertise** on Gaia/DPAC
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- Looking ahead:
  - Get ready for a new PRODEX call: 2027+ funding for our Gaia developers
  - Proactively look for more maritime customers of FAPEC: try to grow our FAPEC+FARSHY team
  - Look for further Space customers: possible incorporation of a **third-party technology** in FAPEC to become even more competitive in that sector
  - Try to hire a projects manager / salesperson / secretary, and at least one more developer (obviously depending on income)
  - By the end of this year: **expected workforce of 9 people**

- **12 years and counting!**

Thanks!

Jordi Portell (jordi.portell@dapcom.es)

on behalf of Francesc Julbe (CEO)
and DAPCOM Associates

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