

# PATENTS: FROM RESEARCH TO BUSINESS

## CASE STUDY: FRACTUS, S.A.

Two decades ago, mobile phones featured large antennae that needed to be pulled out before making a call. Inventor Carles Puente Baliarda revolutionised antenna design with the introduction of fractal-based antennae – small enough to fit inside a phone's body and providing powerful reception. The patenting of his inventions paved the way for the founding of Fractus, S.A.

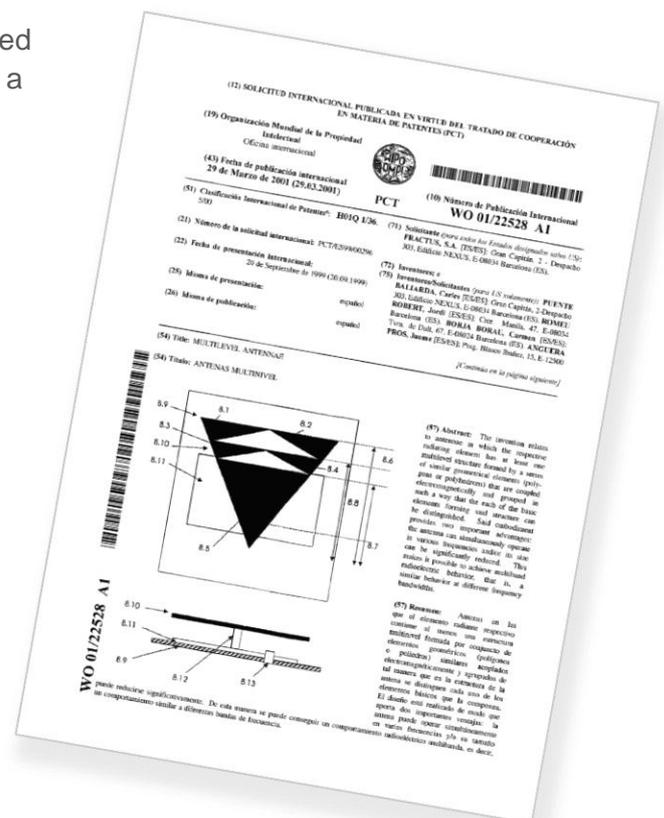
### HOW IT ALL STARTED

#### Starting points

After a number of years at the University of Illinois, in 1994 Carles Puente Baliarda joined the Universitat Politècnica de Catalunya (UPC) as Assistant Professor to continue his research on fractal-shaped antennae. Puente Baliarda very quickly became aware of the potential of this technology from a commercial point of view, and in 1995, while still at the UPC, he decided to file a patent application with the Spanish Patent Office. This application led to the first **patent** ❶ for a fractal antenna worldwide (ES2112163B1). A second Spanish patent (ES2142280B1) followed in 1998.

Together with Rubén Bonet, in 1999 he co-founded Fractus, S.A. as a **spin-off** ❷ from the UPC. With a Master's in business administration from IESE Business School, Bonet provided the ideal complement to Puente Baliarda's research background. In the same year, Fractus filed a patent application (WO01/22528A1) for a multi-level antenna which led to several patents worldwide, including the USA and Europe. A patent application for space-filling antennae (WO01/54225A1) followed in 2000. These patents became a third-generation evolution of the original fractal-shaped antennae, overcoming certain technical limitations caused by the pure fractal shape, and making them ripe for commercial application.

Soon Fractus had its first contract to develop a dual-band fractal antenna capable of operating on a second-generation (2G) cellular network. The



antenna was compact enough to be built into a phone's body and operate within the two major digital systems used across Europe: the Global System for Mobile Communications (GSM) standard, developed by the European Telecommunications Standards Institute for use in the European Union, and the Digital Cellular Service (DCS) for use in the United Kingdom.

## QUESTIONS

- Who do you think owned the IP rights for the different inventions?
- Did FRACTUS have the right to use the inventions?
- What steps would you have followed after this?

## TECHNICAL BACKGROUND

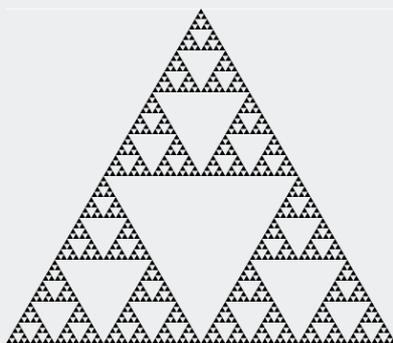
The frequency range at which an antenna emits is proportional to its size, while the radiation properties of the antenna (e.g. the direction in which it emits) are determined by its geometrical shape.

Examples:

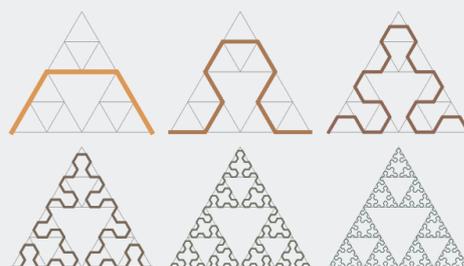
- Radio FM antennae (approx. 90 MHz) → typical length: 0,75 m
- GSM (2G) mobile phones (approx. 900 MHz) → typical length: 7,5 cm

For this reason, short and stubby antennae were a fixture on early mobile phones, visibly protruding several centimetres from the phones' bodies – a limiting factor for slimming down the size and shape of the first generation of mobile phones.

A fractal is a mathematical concept which can be used to describe a structure which is self-similar, meaning that the structure is formed by repetitions of its geometrical shape at smaller scales. Thanks to this property, fractal structures allow multiple long paths to be compacted in a small and contained area.



**Fig. 1** Repetition of triangle at smaller scales (Sierpinski triangle with 7 scales).  
[<https://de.wikipedia.org/wiki/Sierpinski-Dreieck>]



**Fig. 2** Long paths in a small and contained area (Sierpinski triangle).  
[[https://en.wikipedia.org/wiki/Sierpinski\\_triangle](https://en.wikipedia.org/wiki/Sierpinski_triangle)]

From the antenna theory point of view, repetition of its geometrical shape at different scales would imply the same radiation properties at different frequencies, and compacting long paths in a small and contained area would reduce the size of the antenna for a given frequency range. By using these two properties of fractals, Puente Baliarda found that it was possible to design antennae which could be used to operate at different frequency ranges and would be small enough to fit into the body of a mobile phone without sacrificing function.

## Limitations of fractal antennae and Fractus' breakthrough

When designing antennae which can emit at different frequency bands with similar radiation properties, it is crucial to be able to choose the frequency bands flexibly. For example, a dual-band mobile phone working in the mobile networks of two different countries might need to operate in two bands, e.g. 900 MHz and 1800 MHz. However, pure fractal structures do not provide sufficient flexibility for this.

Fractus' first two patents (patent applications WO01/22528A1 and WO01/54225A1) are the basis of its technology and represent a third generation of antennae, which deviate from the ideal fractal shape to achieve flexibility in the choice of frequency ranges (multi-level antennae) and/or improve their miniaturisation properties (space-filling antennae).

In multi-level antennae (WO01/22528A1), the building elements can use the same type of polygon (or polyhedron in the case of a three-dimensional antenna) as in fractal-shaped antennae, but the aspect ratios of the elements can be different, and the antenna itself does not need to have the same shape as the building elements. As a result, these antennae allow much greater flexibility in the choice of the frequency bands in which they operate.

**Fig. 3 a)** Fractal-shaped vs.  
**b)** multi-level antenna  
[<http://www.fractal-explorer.com/picture.php?pictitle=STri2>]

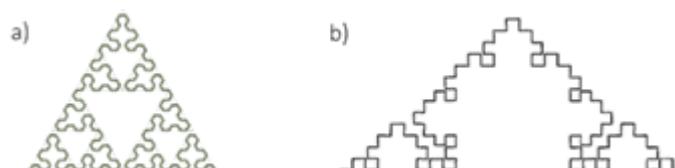
[WO01/22528A1]



Space-filling antennae (WO01/54225A1) are based on the second property of fractal geometry mentioned above: compacting long paths in a small and contained area. As shown in Figure 2, fractal shapes contain or define long curves which are confined in a small area. These kinds of curves do not, however, need to underlie a self-similar fractal shape. The idea behind the concept of space-filling antennae is that at least part of the antenna has the form of a space-filling curve, said space-filling curve not necessarily having to be strictly self-similar (see Figure 4). Eliminating the requirement of the fractal shape provides much more flexibility in the design of the antenna geometry, which allows a greater reduction in the size of the antenna for a given emission frequency.

**Fig. 4 a)** Fractal shape and underlying space-filling curve vs.  
**b)** space-filling curve not part of a fractal shape.  
[[https://en.wikipedia.org/wiki/Sierpinski\\_triangle](https://en.wikipedia.org/wiki/Sierpinski_triangle)]

[WO01/54225A1]



## THE STORY CONTINUES

### Fractus' business model

Fractus' vision was that developments in mobile communications technology would lead to smaller devices with new functionalities that would operate in an increasing number of frequency bands (2G, 3G, 4G, etc.). This vision has been confirmed: nowadays, mobile devices are not only capable of transmitting data over a cellular network but they use multiple data transmission technologies such as Wi-Fi, Bluetooth and GPS which render multi-band antennae indispensable. This perspective was a decisive factor in helping the company raise funds from venture capital to set the project in motion.

Fractus started designing and producing its own antennae, and approached the major vendors of mobile phone equipment to offer its technology. Remaining true to its founding philosophy, it dedicated a large part of its budget to R&D, and in doing so managed to extend the application of the principles of multi-level and space-filling antennae to other fields and create a significant patent portfolio.

In 1998, Fractus' development of multi-triangular dual-band fractal antennae for cellular telephony GSM and DCS technology was awarded the Grand Prize at the European Union IST Awards. In 2002, the company was selected as supplier to Telefonica for its UMTS base station antennae rollout, and in 2004 it launched its standard Bluetooth and Wi-Fi chip antenna technology.

However, the company soon noticed that there were limitations to its business model. Each phone has a different form factor and a specific geometry, so each one requires an individual antenna design, and the revenue generated per antenna hardly compensated for the re-design effort. This effect was substantially magnified by the dynamic nature of the consumer electronics market, where products are short-lived and continuously superseded.

### QUESTION

What do you think they could change in their business model?

### Re-inventing itself

After some research on the markets of its technology fields, in 2006 Fractus decided to take on a new direction and change its business model. Instead of producing its own antennae for mobile devices, it would shift from direct to indirect exploitation of its inventions for mobile devices, i.e. from manufacturing antennae to licensing its patents to third parties, restricting its own production to products for less rapidly changing markets. Thus, after a *due diligence*  procedure, Fractus opted for a dual business model: revenue from its own products and revenue via licensing of its patents.

## QUESTION

Which steps do think they had to follow to do this?

As a result of its continuous investment in R&D and a consistent strategy of protecting its IP, Fractus had built up a strong portfolio. As part of its new licensing strategy, in May 2009 it decided to file a complaint for patent infringement against ten handset OEMs in the Eastern District of Texas, relying on the quality of its IP.

## QUESTION

How did their patents help them with infringement cases?

It finally settled with most of the companies in the field, including LG, Research In Motion Ltd. (makers of BlackBerry), HTC, Motorola and Sanyo, for up to US\$ 70 million. In May 2011, a federal jury in Texas found that Samsung had infringed four Fractus patents and ordered the electronic giant to pay US\$ 41 million, and Fractus subsequently settled with Samsung on a further pending suit. The change of business model caused the company's turnover to go from US\$ 3.6 million in 2009 to a cumulative revenue of over US\$ 100 million in 2014.

Today, Fractus is regarded as an early pioneer in the development of internal antennae for smartphones, tablets and wireless Internet of Things devices. It holds an intellectual property rights portfolio of more than 40 inventions protected by over 120 patents and patent applications in the United States, Europe and Asia. Among the numerous awards and honours the company has received for its innovative work, Fractus was named a 2005 Davos World Economic Forum Technology Pioneer and has been recognised by the European Patent Office for its award-winning inventions. The company has a proven track record in innovation and licensing its award-winning geometry-based antenna technology to wireless device manufacturers in the USA, Europe and Asia.

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❶ **Patent:** The grant of an exclusive right to exploit an invention. [...] An applicant for a patent must show that the invention is new, not obvious and capable of industrial exploitation. [...] A patent remains valid for 20 years from the date of publication (known as priority date) provided that the patentee continues to pay the appropriate fees. [...] During this time, the patentee may assign his patent or grant licenses to use it. [...] If anyone infringes his monopoly, the patentee may sue or an injunction and damages or an account of profits. (Jonathan Law and Elizabeth A. Martin (2014) A Dictionary of Law. Oxford University Press)

❷ **Spin-off:** The situation that arises when a parent corporation organizes a subsidiary corporation, to which it transfers a portion of its assets in exchange for all of the subsidiary's capital stock, which is subsequently transferred to the parent corporation's shareholders (<http://legal-dictionary.thefreedictionary.com/Spin-Off>).

❸ **Due diligence:** The process of investigating all facts, conditions, rules, laws, regulations, financial considerations, or any other such matters as would affect one's decision to purchase property. The various types of investigations as would comprise due diligence will vary from property to property. (<http://financial-dictionary.thefreedictionary.com/due+diligence>)