



When every nanosecond counts

*Del CERN a DONES  
(o de los neutrinos a la vitrocerámica)  
Javier Díaz, cofundador Seven Solutions*



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- 2. El “toque CERN”**
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# Origenes y primeros pasos



# Seven Solutions

## ■ Origen

- Creado como spin-off de la Universidad de Granada
- Impulsada por la transferencia de conocimientos y tecnologías desarrolladas en el marco de los proyectos Europeos de investigación



## ■ Premios

- Premio a la Empresa Joven del Año 2008 en Granada.
- Premios Nacionales Bancaja Jóvenes Emprendedores 2008.
- Premio Emprendedor XXI 2009 a la empresa más innovadora de Andalucía

# Capacidades

*Compañía de base tecnológica especializada en:*

## ▼ **Software y hardware embebido**

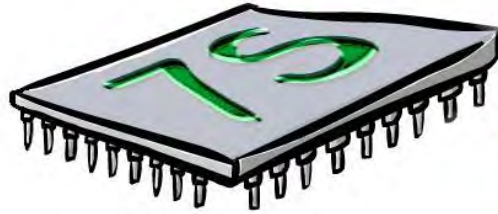
- Alta prestaciones (diseño de PCB)
- Firmware (DSP/GPU, micro-controladores y FPGAs).
- Sistemas críticos seguros (certificación)
- Sistemas de control a medida

## ▼ **Hardware Reconfigurable (FPGAs)**

- Técnica de diseño para alta prestaciones
- SoC y Codesign
- «cores IP»
- Optimización de opciones de síntesis.

## ▼ **Procesamiento de imagen y video en tiempo real**

- Análisis de video (Video vigilancia)
- Aceleración de algoritmos de visión por ordenadores
- Sistema de visión embebido



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# Los inicios ... 2006-2007

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- **Tecnología = empresa**

# Los inicios ... 2006-2007

■ ~~Tecnología = empresa~~

La tecnología es un 10% como mucho. Además hay que saber que hacer (que pide el mercado)



# Amateur ... 2008 - 2010

- ↙ Mejora en las tareas de comercialización e imagen.
- ↙ Del garaje a la incubadora
- ↙ Del diseño a medida al producto.
- ↙ Trabajadores contratados (sigue habiendo una fuerte dependencia del trabajo de los socios)



# CODE

The Elemental Didactic Computer has been designed to introduce computers and reprogrammable devices to university students. It contains a board that **integrates a basic processor implemented in reconfigurable technology**. Moreover, we provide support for modifying the system, allowing to students to develop different processors architectures and design strategies



## Features

- Reprogrammable Microcontroller.
- FPGA Xilinx Spartan XC3S400.
- 512 KB memory SRAM cy7c1041cv33.
- 6 displays of 4 digits.
- 7 general purpose programmable buttons.
- USB connector.
- Serial connector to reprogram the microcontroller.
- JTAG for programming the FPGA device.
- 4 configurable LEDs.
- Platform Flash XCF08P for FPGA configuration.
- Numeric keyboard with 16 Hexadecimal keys.
- 20 I/O general purpose pines.

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## CONTACT

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## DEVELOPMENT BOARDS

**Seven Solutions** is a spin off of the University of Granada specialized in the design of real-time processing systems for different application fields (automobile, bio-medicine, machine-vision, bio-inspired robotics, surveillance, etc.). The company also targets customized systems and platforms for research groups.

All our boards are **fully supported with hardware libraries (VHDL)** for the different peripherals as well as **EDK support** for embedded system design. Furthermore, ready to go examples are included to accelerate the design process of customer applications.

# S400

It is a **standalone platform for image processing with four independent camera inputs** that allows embedded processing. It is scalable and has the capacity of cores development and customization. It is also provided with EDK support: A processor is therefore implemented in the FPGA to execute ANSI C code.



## Features

- 2 Million gates Spartan 3 device.
- 2 ZBT SRAM memory chips of 1Mb word x36 bits (each).
- Ethernet Gigabit.
- Platform Flash XCF08P for FPGA configuration.
- VGA and composite video output.
- 4 composite video inputs.
- One buzzer, some general purpose buttons and LEDs.
- JTAG programmable.
- Several built in clock oscillators (100 and 125 MHz).
- Stand-alone power supply.

# XIRCA V4

It is an **advanced co-processing accelerator and prototyping platform**. It includes a high performance Virtex-4 FPGA and high bandwidth communication interfaces as **PCI-Express and Gigabit ethernet connectors** that make ideal for high performance applications. Moreover, this platform **can work as a standalone platform** for embedded systems **or as coprocessing board** using the PCI Express interface.



## Features

- VIRTEx-4 FPGA (from XC4VFX60 to XC4VFX100) including two hardcore Power-PC processors.
- 2 independent banks of DDR SDRAM (512Mb).
- 4 Pipelined SRAM memory chips 72-Mbit (2M x 36).
- 1 lane PCI Express port 1x.
- 2 tri-speed Ethernet PHY transceivers 10/100/1000.
- 8 SMA connectors connected to 2 Rockets IO.
- 20 IO expansion pins.
- 1 RS-232 Serial port.
- 2 user clocks at frequencies, 100 MHz and 125 MHz.
- 2 LEDs y 2 push buttons.
- 2 Flash memories (32MB) connected to CPLD.
- CPLD to arbitrate the local bus.
- 4-Kb IIC EEPROM.
- 1 JTAG configuration port.
- 1 LCD display: 2 lines x 8 characters.
- 1 Buzzer.
- IIC Fan Controller.

# SB

SB is a **portable standalone platform for portable image processing applications**, with autonomy of 10 h, with the included batteries. It provided with multiple imaging devices that make it ideal for development of augmented vision reality projects or robotics vision based systems.



## Features

- XILINX Spartan III FPGA: 2000 K gates.
- Platform Flash XCF32P for FPGA configuration.
- 36 Mbit (1 Mb x 36) pipelined SRAM Bank.
- Input Video decoder, Composite video.
- DAC (Digital to Analog Converter) with an 8-bits colour-map.
- Output Video decoder, composite video.
- VGA and composite video output.
- LEDs, Joystick, Button, Switch.
- JTAG port interface.
- Lithium Polymer (LIPO) batteries with up to 5000 mA.

# Madurando ... 2008 - 2010

- ↙ Conseguimos capital semilla.
- ↙ Sabemos como e identificamos que hacer
  - Inversión en desarrollo de un sistema propietario de videovigilancia
  - Nuestro propio producto en un sector con un alto volumen de mercado!
  - **Y usando nuestra tecnología FPGA!**

# Amateur ... 2008-2010

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- **Producto= empresa**

# Amateur ... 2008-2010

■ ~~Producto = empresa~~

El producto es un 30% como mucho. Además hay que saber venderlo. Tener clientes!

# Amateur ... 2008 - 2010

- ❯ **Fracaso de la línea de solución general basado en producto propietario → válida en mercados nicho.**
  - Más se aprende de tus errores...
- ❯ **Que poco sabemos de comercialización, ventas, posicionamiento, etc..!**
- ❯ **Una cosa es tener una tecnología, otra saber que hacer con ella y otra muy diferente hacer un producto.**

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**El toque CERN**







## Desarrollo de tecnologías de sincronización para aceleradores de partículas

- Se alinéan capacidad y oportunidad.
- Llamada CDTI en el marco de la Industria de la Ciencia. Búsqueda del grupo BE-CO de empresa experta en FPGAs + diseño electrónico.
- CERN proporciona
  - Especificaciones
  - Tecnología disruptiva (sincronización)
  - Difusión internacional
  - ~ Financiación
  - Monitorización y formación continua de los procesos de calidad, estándares internacionales, etc.. (CERN es un cliente MUY exigente).



# WRS-3/18

## White Rabbit Switch v3

Standalone version with 18 SFP ports

White Rabbit Switch (WRS) is the key component of the White Rabbit Protocol that provides precision timing and high synchronization over an Ethernet-based network.

The WRS can be configured as master and sends its clock to all the nodes in the network using cascade architecture.

The WRS-3/18 version is a standalone version using 18 SFP connectors to synchronize the different nodes

- Time precision: sub-nanosecond timing.
- Scalability: 2000 nodes in the network
- Distance range: over 10km using fiber
- PTPv2, Sync-E
- Robustness configuration.
- RS-232 and USB debug.



## Modelo de negocio basado en colaboración público-privada y open hardware como proyección internacional

**Open**

Winning combination.  
Best of both worlds.

Whole support burden  
falls on developers.  
Not scalable.

**Proprietary**

Vendor lock-in.

Dedicated non-reusable  
projects.



(CERN OHL &  
GPL licenses)

**IFMIF**



## Triple spin-off: UGR, CERN, IFMIF

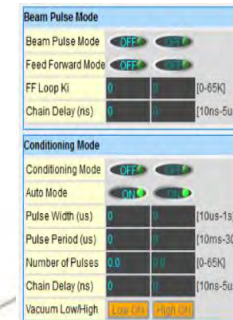
- Inicio en 2014, LLRF
- Framework contract F4E, 2017
- BPMs, 2018.
- Extensin a otras acelardores: 2020 en adelante.
- Otros mercados -→ tecnologías RADAR ....

# Experiencia en IFMIF / EVEDA

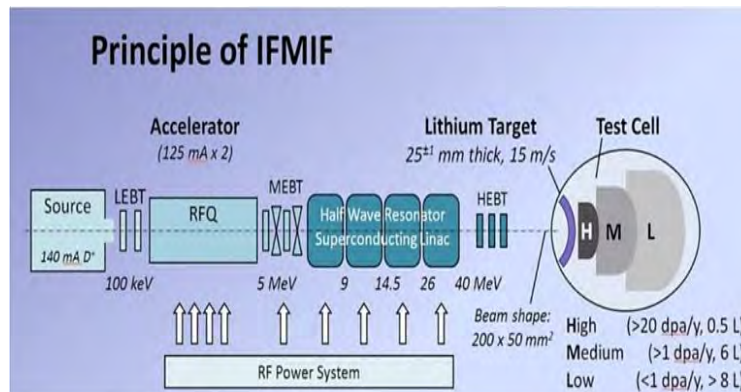
- The LIPAc is a fully representative of the IFMIF low energy (9 MeV) accelerator and will be completed at Rokkasho (Japan) in June 2017.
- Granada is the European candidate to host the next generation of IFMIF accelerator (**DONES**). It will have an overall budget of more than 600M€.

## Seven Solutions Main Tasks on LIPAc:

- Control software for acquisition, interlocks and data logger through **EPICS** platform & **CSS/BOY**.
- Integration of White Rabbit synchronization.
- Implementation of Low-Level RF equipment.



LLRF Main Parameters Setup		Write Def.
<b>Amplitude &amp; Phase Setup</b>		
Cavity Voltage (mV)	446.68 mV	(0-1400)
Cavity Volt. (dBm)	3.000 dBm	
Cav Volt. Limit (mV)	800.00 mV	
Cavity Phase	95.00	(0-360)°
Amp. Ramp Rate	0.06r	mV/s
Phase Ramp Rate	0.5 d	%
Amp Reflim (mV)	300.00 mV	(0-1400)
Amp Reflim (dBm)	-0.458 dBm	
Phase Reflim	45.00	(0-360)°
PI Limit	800.00 mV	(0-1k)
KI	850	(0-1M)
Kp	0.05	(0-16)
En AmpPh Loops	<input checked="" type="checkbox"/>	
Gain K	1.00	(0.01-4.0)
Look MO Ref.	<input checked="" type="checkbox"/>	
Quadrant	1	
En Vcav PhShift	<input checked="" type="checkbox"/>	
Phase Shift Vcav	135.00	(0-360)°
Enable Vcvt PhShift	<input checked="" type="checkbox"/>	
Phase Shift Vcvt	0.00	(0-360)°
# Samples to Avg	2	
Filter Stages	0	



# Products for Particle Accelerators

## CONTROL AND DIAGNOSTIC FOR PARTICLE ACCELERATORS

Contact us and get started >



### Services

Seven Solutions offers its customers a wide range of services to collaborate with the most demanding and more challenging scientific facilities .

[Learn more...](#)



### LLRF CompactPCI Serial

As a reliable and accurate solution, the LLRF controls and tunes the RF accelerating field in the cavities of the accelerator.

[Learn more...](#)



### Beam Positioning Monitor (BPM)

The BPM system is an accurate and fully programmable solution which provides information on the horizontal and vertical position, beam intensity and beam phase.

[Learn more...](#)



### White Rabbit-Based Timing System



### uTCA / Stand-alone LLRF



### Master oscillator 10 MHz reference

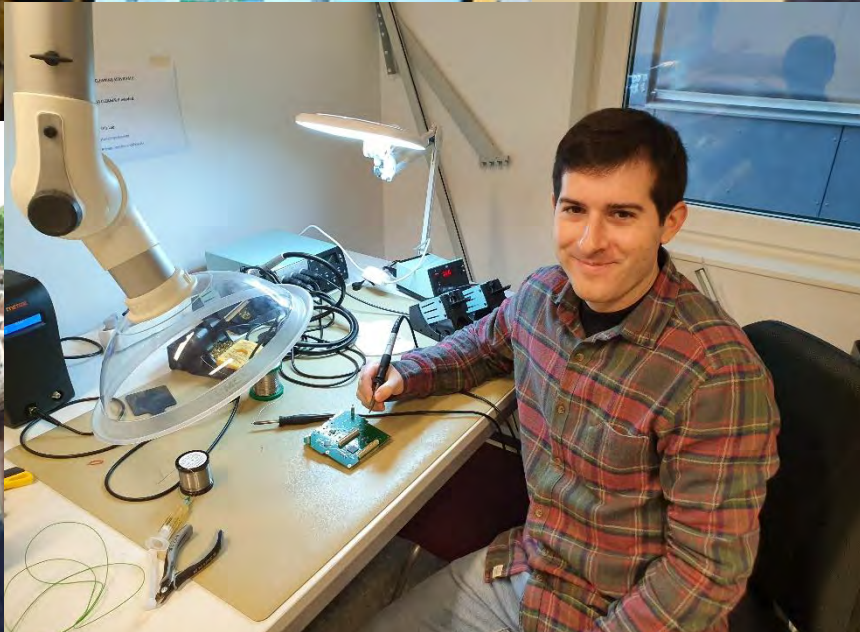


### Local Oscillator Distributor (LOD)

IFMIF



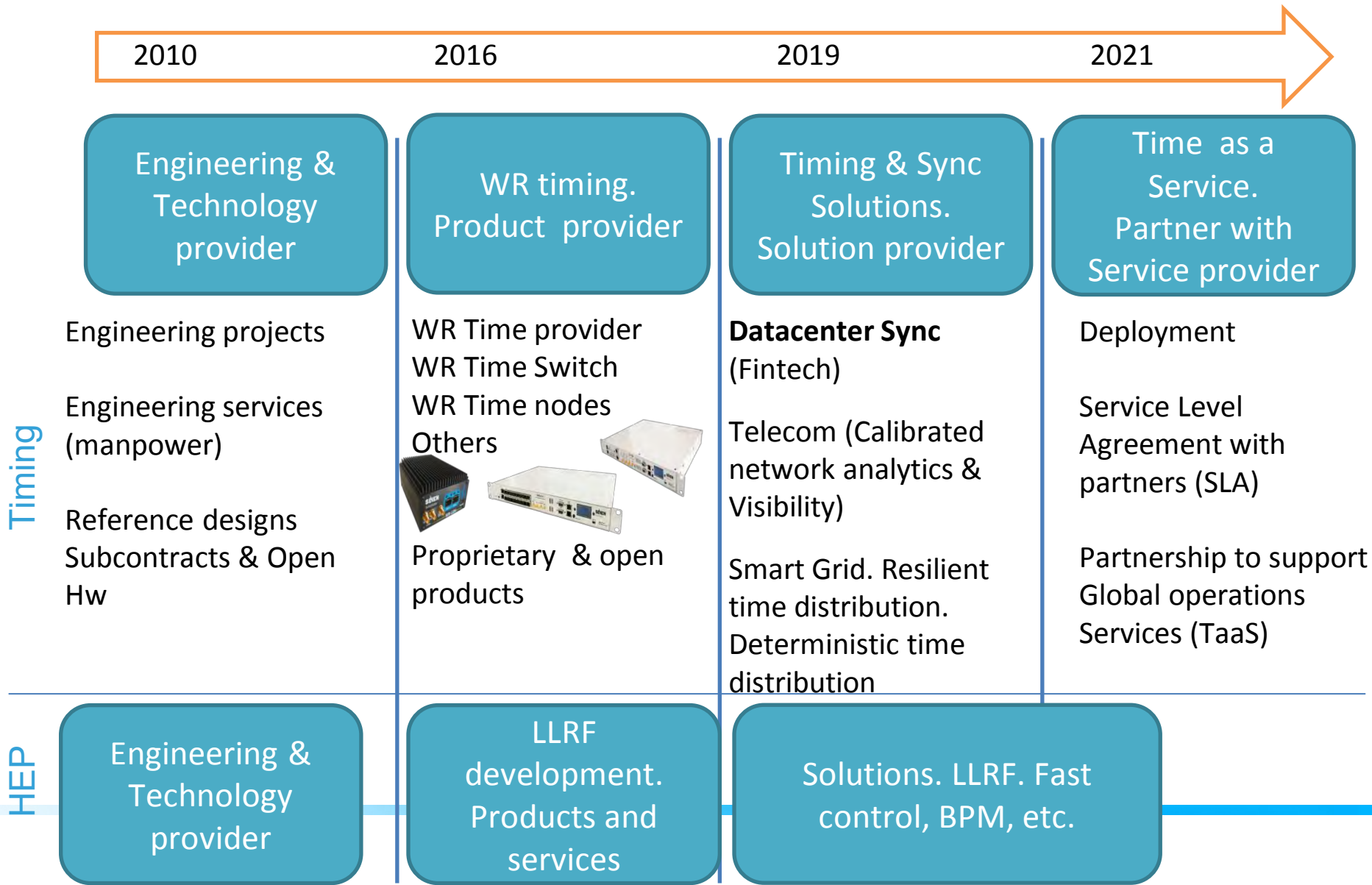
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# Seven Solutions actualmente

# Roadmap



## Experts in timing and synchronization

Seven Solutions has built its reputation as **accurate timing providers** contributing to the development of the **White Rabbit technology (WR)** in close collaboration with **CERN** and other scientific institutions, to bring **sub-nanosecond** time precision to distributed scientific and industrial instrumentation.

Part of our success has been our ability to adapt WR to multiple infrastructures as KM3NeT, CTA or IFMIF-EVEDA as well as to industrial facilities, avionics, radar or telecommunications.



# Ecosistema productos

## Time references

### DOWR & ZENs

#### Time reference receiver

- ✓ Calibrated time receiver
- ✓ High accuracy time transfer
- ✓ Traceable to UTC reference
- ✓ Built-in Fail over
- ✓ Best network switchover



## Enablers (partnerships)

OEM modules & IP  
cores

## Software & services



- ✓ Support
- ✓ Auditing . Remote Monitoring
- ✓ Calibration of metro & Long-haul links
- ✓ Turn-key QoS & SLA

**Ecosystem for  
TaaS providers  
and timing  
consumers**



## Distribution devices

### Z16

#### Time Fan out

- ✓ High accuracy time transfer
- ✓ High accuracy Fan Out



### ZEN TP32

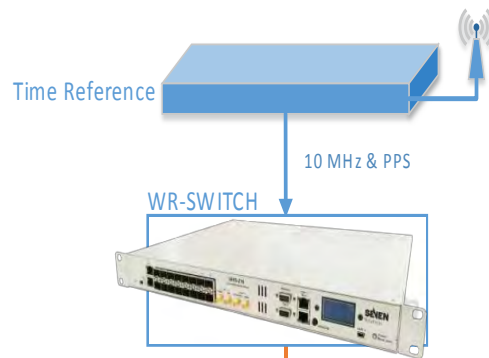
#### Analog Time Fan out

- ✓ High accuracy local time transfer
- ✓ High accuracy analog Fan Out

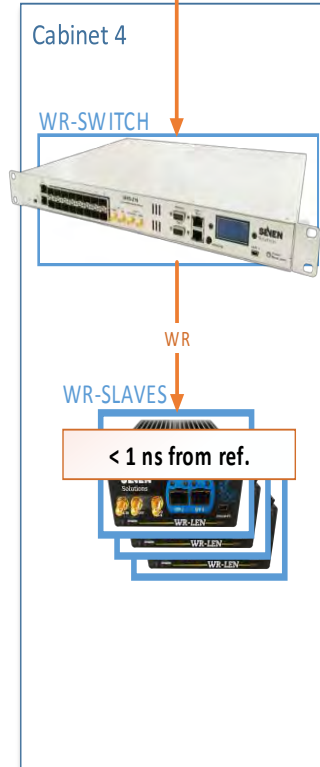
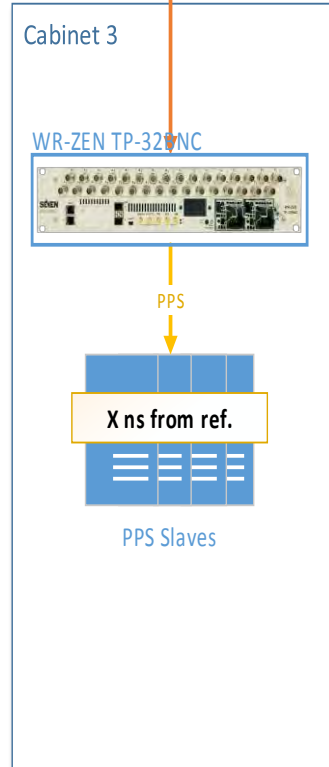
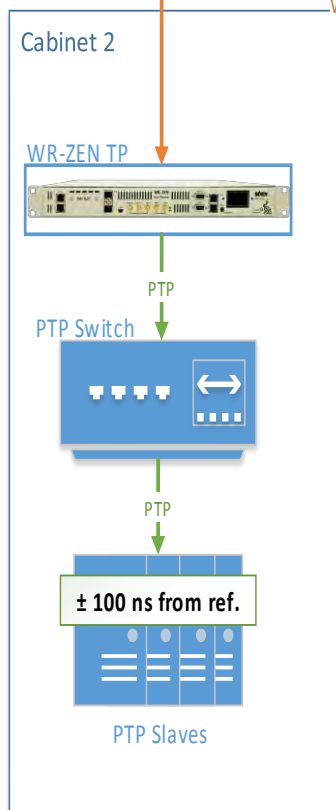
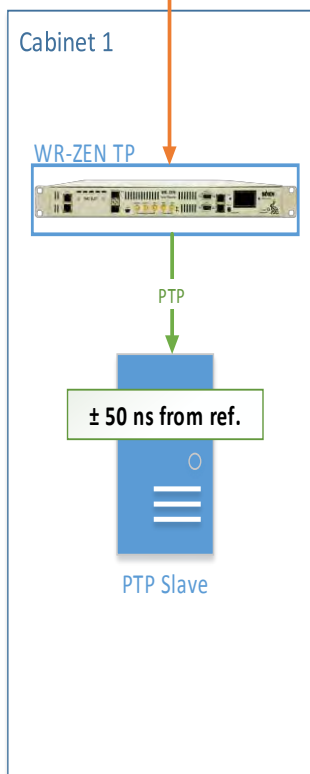


# TaaS in Datacenters

TaaS Provider



TaaS end-user





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-  Fusion
-  Particle Physics
-  Industry
-  Metrology
-  Astrophysics & others

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## White Rabbit equipment for ultra-accurate time transfer at Deutsche Börse

Seven Solutions announces successful deployment of White Rabbit equipment for ultra-accurate time transfer in ultra-accurate time distribution and synchronization announced today that Deutsche Börse deploys and monitoring infrastructure for the trading network. Seven Solutions provided the White Rabbit technology, The White Rabbit technology was developed in collaboration with leading scientific organizations such as C. Seven Solutions now provides industrial-grade solutions to address time synchronization requirements for uses Seven Solutions' products to synchronize their packet capture and timestamping devices across the en. Accurate time distribution is necessary to make meaningful statements about the relative order of all event ultra-accurate time distribution can be deployed and used in an exchange...



# Un día típico en Seven





# Participation on R&D projects



## SINCRONET

SINCRONET: Synchronization Devices For Electrical Infrastructures, 5G And Ethernet (TSI-100102-2017-10). This Project Has Been Co-Financed By The Spanish Ministry Of Energy, Tourism And The Digital Agenda, In The Framework Of The Spanish National Plan For Scientific And Technical Research And Innovation 2013-2016. This Project Focuses On Researching New Mechanisms



## World Timing

Worldtiming (Ultra Accurate World Timing Services) Is An EU SME INSTRUMENT Grant (SME Instrument Phase I Number 673403 And SME Instrument Phase II Number 725490) Awarded To Seven Solutions. The Projects Aims At Distributing Ultra-Accurate And Traceable Timing Through Optical Fibres. The Goal Is To Provide Timing Information For...



## BIG DATA, High Temporal Precision

BIG DATA, High Temporal Precision  
BIG DATA, High Temporal Precision For The Optimization In The Integrated System Of Positioning Beam At Particle Accelerators (RTC-2016-5009-3). Co-Financed By FEDER Funds (Fondo Europeo De Desarrollo Regional). The Main Objective Of The Project Is To Develop A Set Of Synchronization And Industrial Control Techniques That...



## CLONETS

What Is A CLONETS Project? A Scientific And Technological Paradigm Change Is Taking Place, Concerning The Way That Very High Performance Time And Frequency Reference Signals Are Distributed, Moving From Radio Signal Broadcasting To Signal Transport Over Optical Fibre Networks. The Latter Technology Demonstrates Performance Improvements By Orders Of Magnitude,...



## EMC2

EMC2 - 'Embedded Multi-Core Systems For Mixed Criticality Applications In Dynamic And Changeable Real-Time Environments' Is An ARTEMIS Joint Undertaking Project In The Innovation Pilot Programme 'Computing Platforms For Embedded Systems' (AIP5). EMC2 Project Is A 3-Years Project (April 2014 - March 2017) Co-Funded By ARTEMIS Joint Undertaking And National...



Happy  
2021

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# Reflexiones finales

# Reflexiones finales

- Industria de la ciencia es una gran oportunidad de desarrollo tecnológico e innovación
- IFMIF-DONES es hoy una realidad con requisitos de productos y servicios para todos los sectores TIC
- Seven Solutions colabora desde 2014, apoya la candidatura y estaría encantada de colaborar con otras empresas interesadas.
- **Energía y entusiasmo. Adelante!**

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**Thanks for your attention!**

