



The XtratuM Hypervisor as Key Enabling Technology for New Space: A Success Story

www.fentiss.com

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ECRTS 2021 Space Session, 5th July 2021

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- **fentISS**, the company
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fentISS, the Company (I): History

- This story starts 20 years ago when the **Real-Time System Group** of the Technical University of Valencia (UPV) created a virtualizer for embedded systems called **XtratuM**.
- The group enhanced XtratuM through research activities in different projects of the EC Framework Programmes: OCERA, FRESCOR,...
- Customer's interest showed the need to create a company: make XtratuM **more stable, maintainable** and **qualify** it for critical environments, organize customer's relationships, and give continuity to the product.

“Genius is 1% inspiration and 99% perspiration”

Thomas Edison (1847-1931)

fentISS, the Company (II): who we are

- **Spin-off** from the real-time embedded systems group of the Technical University of Valencia.
- It started in **2010** as an independent company.
- Strong connection with the **real-time research** group at the University.

A decorative background on the left side of the slide. It features a dark blue, abstract network diagram with glowing white nodes and connecting lines. A thick, solid orange diagonal bar is positioned over the network diagram, extending from the bottom left towards the top right.

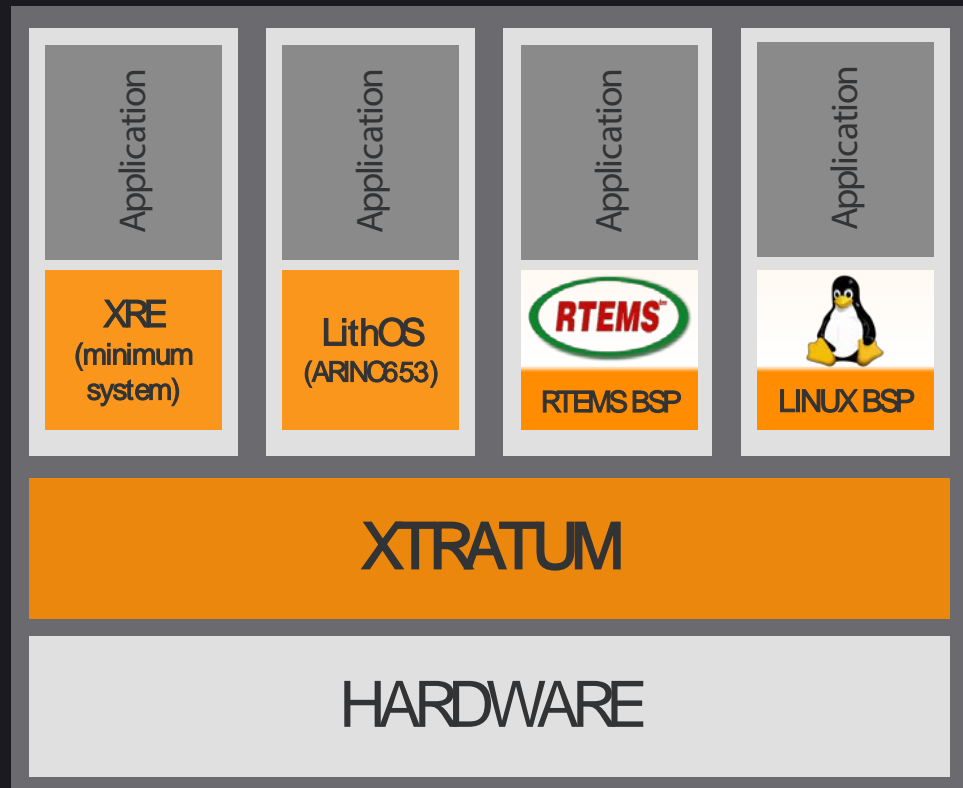
fentISS, the Company (III): what we do

- We enable **critical** and **non-critical** applications to share a common (multicore) hardware platform without interfering with one another (**virtualization**)
- fentISS presence is consolidated in the **Space** market.

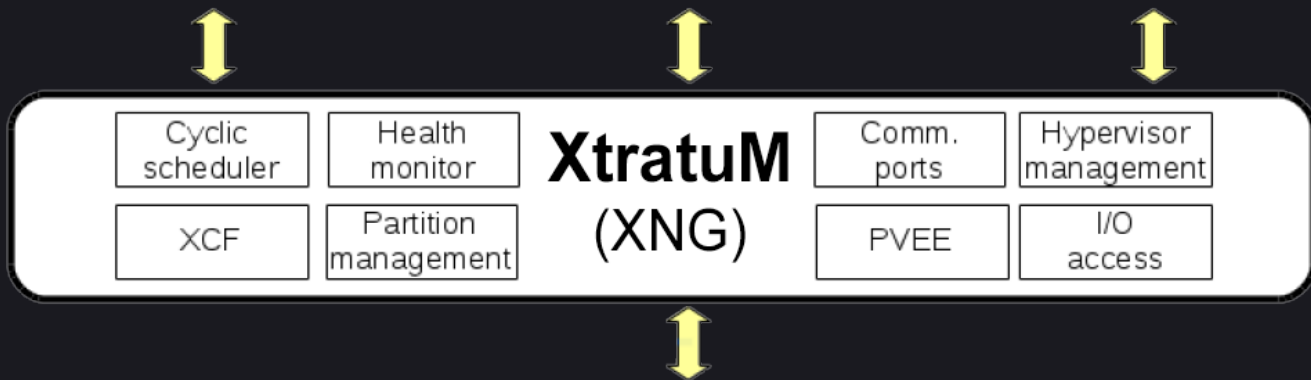
Company products (I)

DEVELOPMENT TOOLS

- XPM (Eclipse plugin Project Manager)
- Xoncrete (schedule analysis)
- Xcparser (hypervisor configuration)
- Xtraceview (observability support)
- SKE (XtratumM simulator on servers)



Company Products (II): XtratuM internals



- **Partition Management:** partitions control and time and space isolation
- **PVEE:** Virtual representation of underlying hardware (vCPU, vIRQCtrl, vSysClock,...)
- **Comm Ports:** Interpartition communication mechanism
- **Cyclic scheduler:** Partition scheduling
- **XCF:** hypervisor configuration
- **Health Monitor:** fault detection and reporting
- **I/O access:** peripheral devices management (delegation to partitions...)
- **Hypervisor Management:** hypervisor state control (system partitions)

Company Products (III): Others

- Three guest OS supported in XtratuM:
 - **LithOS**: intrapartition ARINC-653 API
 - **RTEMS**: third-party open source real-time system (Board Support Package, BSP)
 - **Linux kernel**: version 5.4.0 (Board Support Package)
- Supporting Tools:
 - Xoncrete: configuration and scheduling analysis tool
 - Xtraceview, xci, xcon: debugging and observability
- Special versions of XtratuM:
 - Radiation tolerance using transparent software modular redundancy (XtratuM/DMT)

XtratuM and New Space (I)

The wide availability of powerful MPSoCs chips enables space systems with lower **Cost**, **Size**, **Weight** and **Power** Consumption by integrating all subsystems in the same on-board computer platform...

... but many applications sharing the same computer require mechanisms to **guarantee isolation** (in time and space), a perfect match for the solution offered by hypervisors

New Space requires smaller satellites (<300kgs) in large quantities (constellations of **tens** to **tens of thousands**) leading to industrial production in large series

In addition hypervisors:

- reduce the number of on-board computers and associated cabling
- simplify manufacturing with less different devices
- reduce expensive (re)certification cost
- allow easier upgrade to new and more powerful devices



XtratuM in Space (II): Low-Earth Orbit Missions

254
currently orbiting

2019-2022



Constellation with 600+ satellites

XtratuM with RTEMS (OBC)

2019

EYESAT

XtratuM with LithOS (OBC)

2021

N3SS

XtratuM with LithOS (OBC)

2019

ANGELS

XtratuM with LithOS (OBC)

2021

MERLIN

XtratuM with RTEMS (mass memory)

2022

SVOM

XtratuM with LithOS (ECALIRS & MXT)

2022

SWOT

XtratuM with RTEMS (mass memory)

2022

CO3D

4 satellites (expandable to 20)
XtratuM with RTEMS (OBC)

2022-2023

KINEIS

Constellation with 25 nano-satellites

XtratuM with LithOS (OBC)

2022-....

PLATiNO

XtratuM with RTEMS (OBC)

XtratuM in Space (III): Deep Space Missions



2024
MMX
ROMA and CROW
XtratuM with
LithOS

This circular callout features an illustration of the MMX spacecraft with its solar panels and instruments. It is connected by a white line to the orbit of Mars in the background solar system diagram.



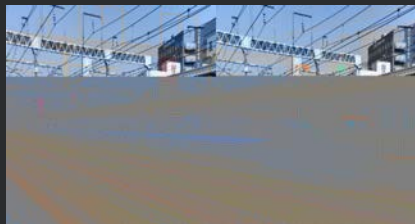
2022
JUICE
MAJIS
XtratuM with
LithOS

This circular callout features an illustration of the JUICE spacecraft with its large blue solar panels. It is connected by a white line to the orbit of Jupiter in the background solar system diagram.

Other Opportunities



UAVs



RAILWAYS



AUTOMOTIVE



IOT



MEDICAL EQUIPMENT

Conclusions

- Research inspired in **user's needs** is the first step to innovation (Tom Kelley, IDEO: *"Innovation starts with an eye"*)
- Time and Space partitioning can be a convenient solution for real-time embedded systems in different markets:
 - When **mixed-criticality** applications are present in shared powerful hardware platforms
 - When **(re)certification** cost is high
 - When hardware updates are frequent requiring **portability**
- Convergence in real-time system requirements across different markets presents an opportunity for cross-market solutions (aeronautics, automotive, IoT, railways,...)

Special Thanks to Prof. Crespo, Prof. Balbastre and Dr. Masmano for starting this challenging endeavour

THANKS!

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