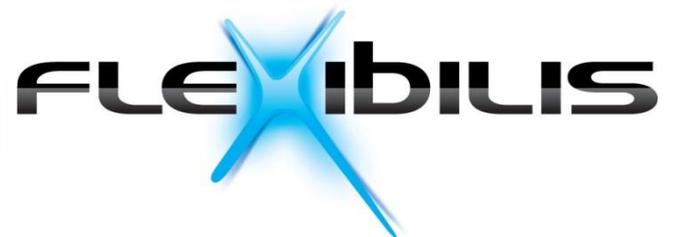


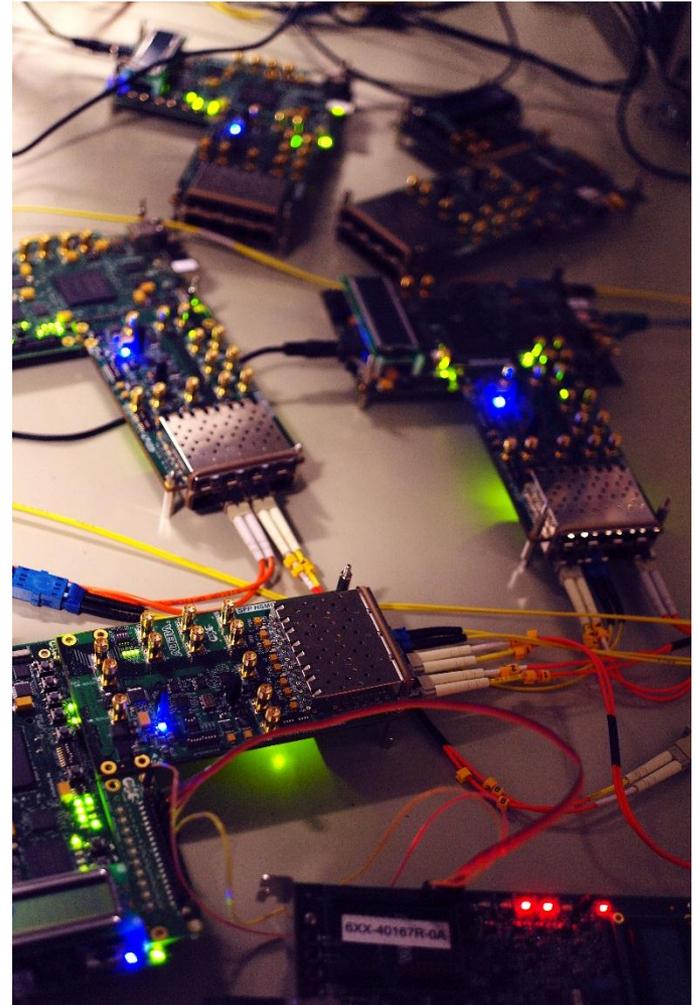
# Flexibilis

Critical Communication Solutions



# Contents

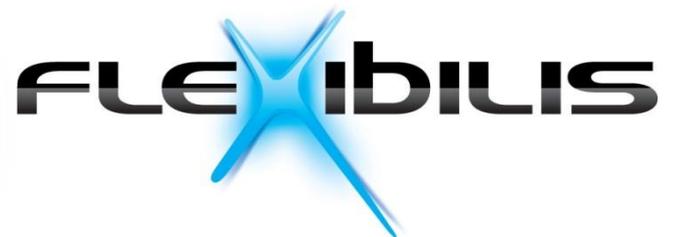
- Flexibilis
- Redundant communication
- HSR, PRP and benefits
- IEEE 1588
- FRS



**FLEXIBILIS**

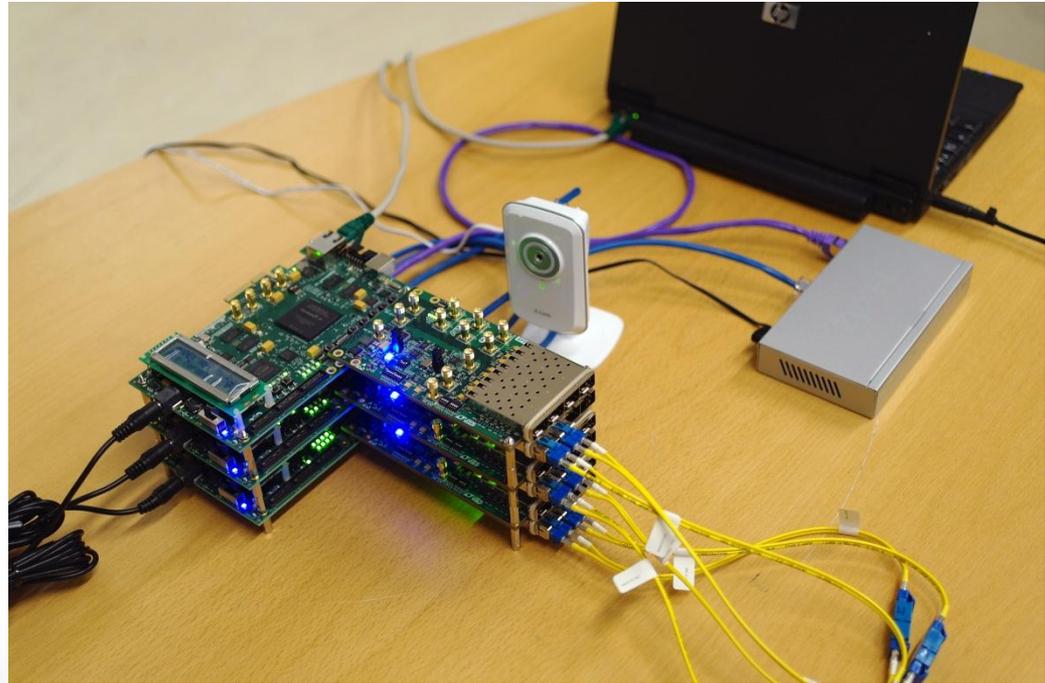
# Flexibilis in a Nutshell

- Founded in 1998
- Headquarters in Tampere, Finland
- Specialized in critical communication solutions
  - Precise, Reliable, Secure
- Core competences
  - Secure and redundant communication
  - FPGA IP cores and FPGA based solutions
  - Embedded SW consultation



# FRS

- Flexibilis' main product
- IP Core for FPGA
- Full wirespeed 10/100/1000 Mbps Ethernet Switch
- HSR, PRP and 1588 support
- Up to 8 ports



**FLEXIBILIS**

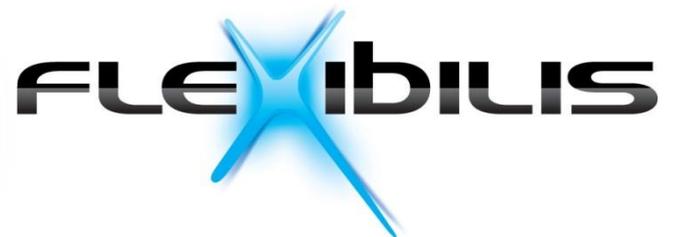
# Why Redundant Communication?

- Successful Ethernet usage in critical networks requires zero-loss redundancy
  - No single point of failure
  - Zero-time recovery = No packet loss
  - E.g. IEC 61850



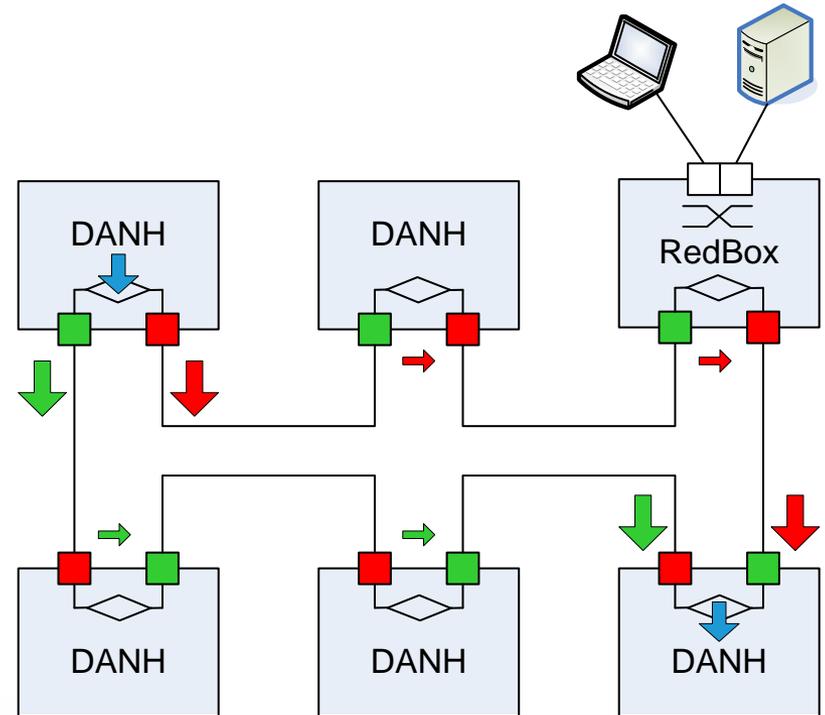
# Zero-Loss Redundant Ethernet

- There exists two protocols that can meet this requirement: HSR and PRP
  - HSR = High-availability Seamless Redundancy
  - PRP = Parallel Redundancy Protocol
  - Advantage over Rapid Spanning Tree Protocol (RSTP) and variants

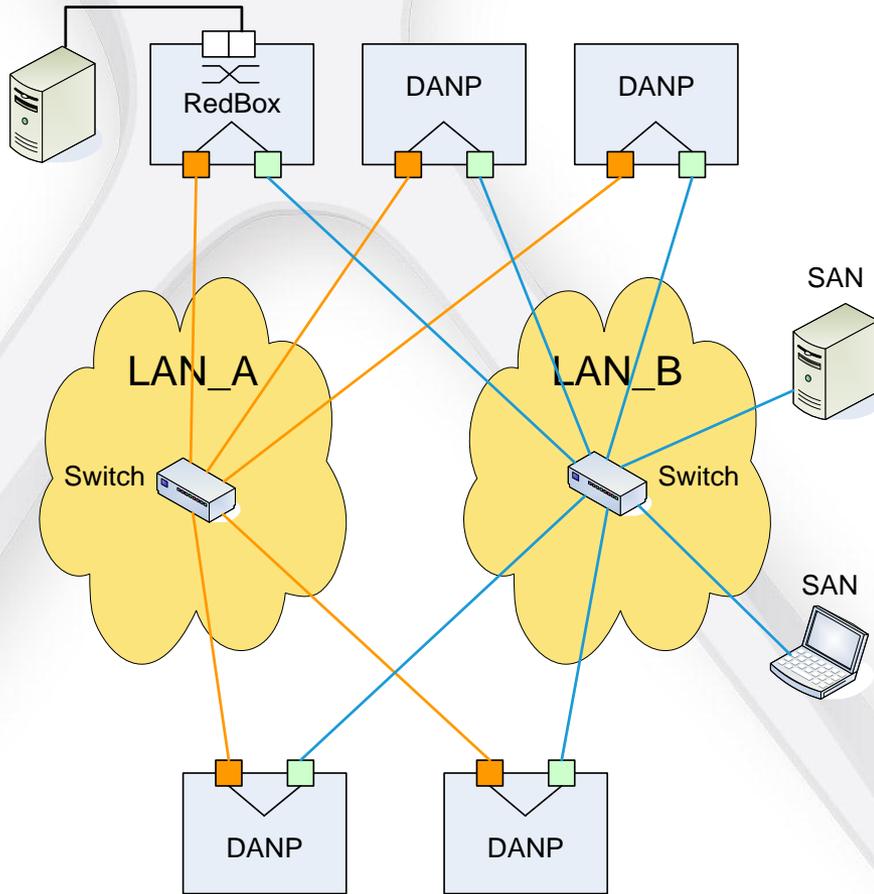


# High-availability Seamless Redundancy (HSR)

- Typically implemented in a ring topology
  - Ring of rings and other more complex topologies also possible
- Frames duplicated by the source and sent through two paths to the destination/target



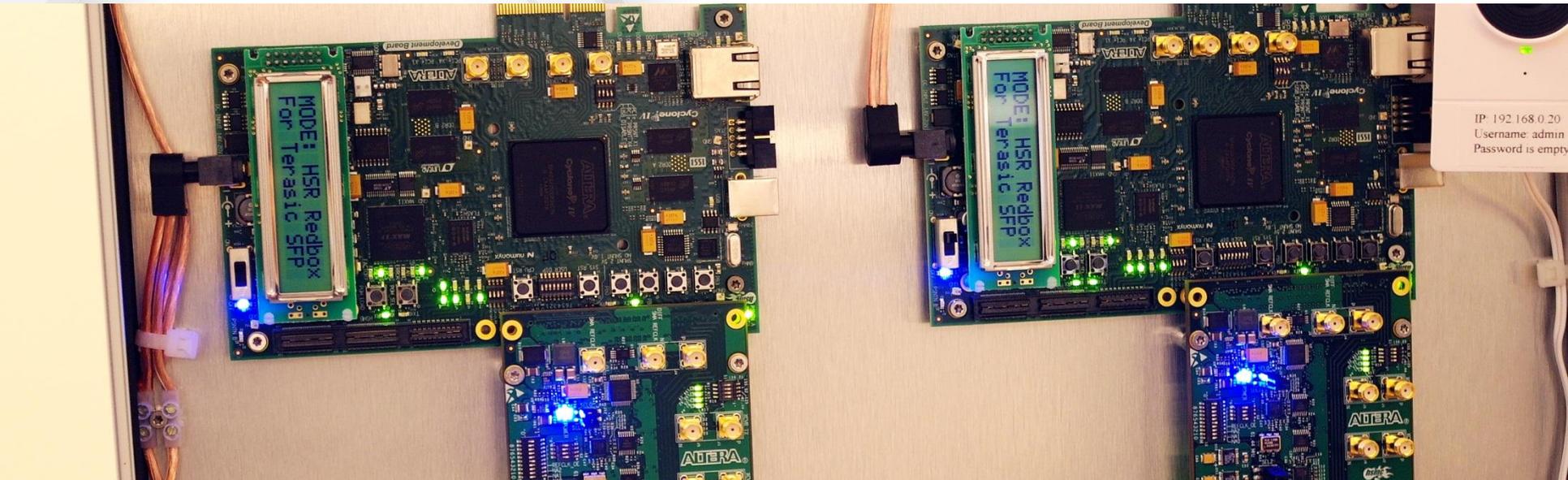
# Parallel Redundancy Protocol (PRP)



- PRP is typically implemented in a double star topology
- Frames duplicated by the source and sent through two paths to the destination/target

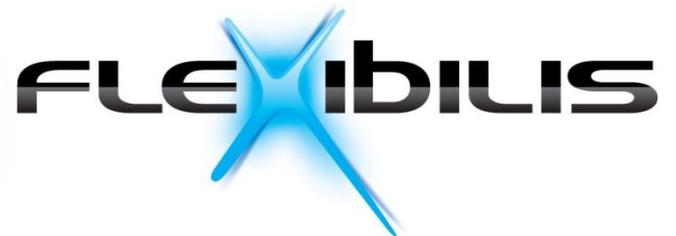
# HSR and PRP

- Target removes the duplicate
  - Delivers only the first frame to upper layers
  - Missing one of the two frames does not affect upper layers
- Does not affect higher layer protocols
  - HSR and PRP are not visible to upper layers (including the IP layer)



# Benefits of HSR and PRP

- Zero-loss, zero time to recovery
- Zero downtime during maintenance, 24/7
- Any device can be disconnected and replaced without breaking network connectivity
- Simple operation
  - Enables many different topologies without extra features
- Ring topology (low cost)
- Layer-2 Ethernet (low cost)



# Applications

- Electrical substation automation
- Industrial automation
- Transportation
- Networking equipment



# Time Synchronization - IEEE 1588

- Ethernet can be used for both data and time&frequency transfer
  - No need for separate time synchronization network, e.g. 1PPS or IRIG
- Synchronizes clocks by sending packets over a network
- Is typically needed in the same applications as HSR



**FLEXIBUS**

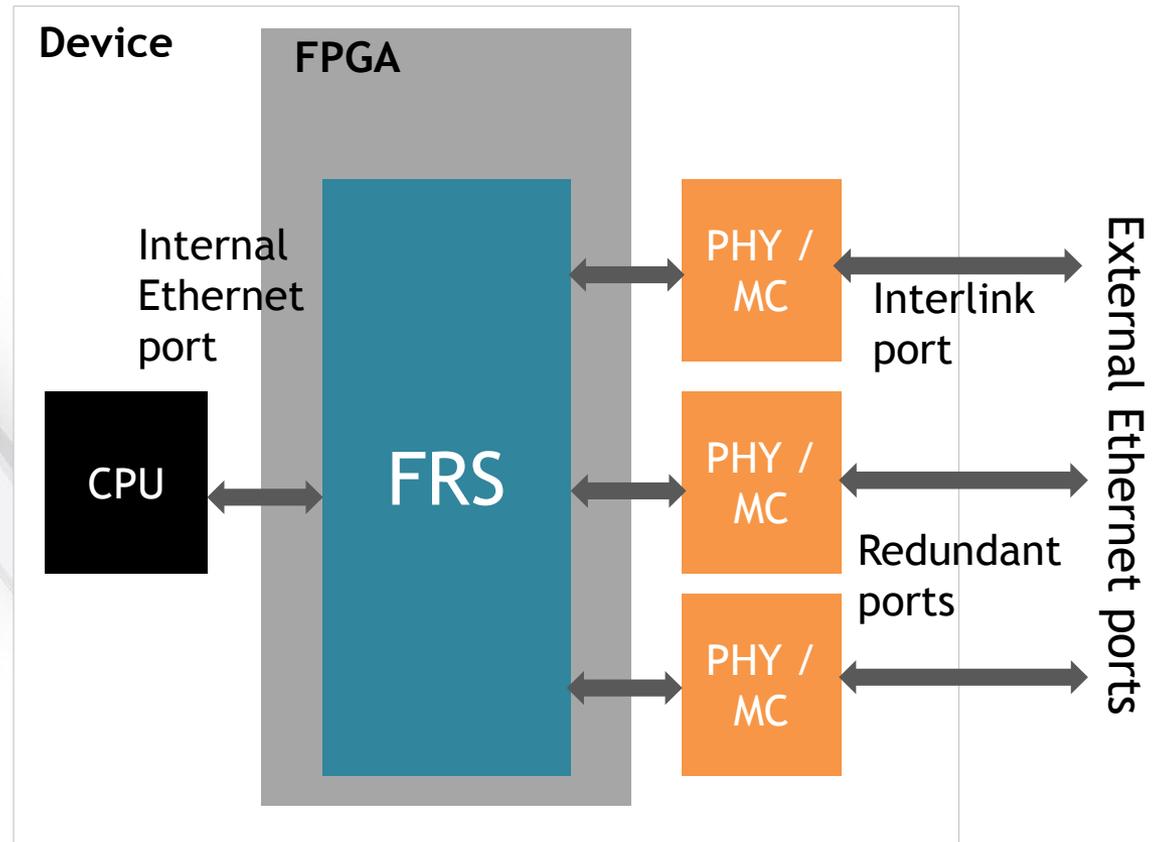
# Time Synchronization - IEEE 1588

- Time synchronization accuracy of  $1\mu\text{s}$  can be achieved easily
  - $1\mu\text{s}$  accuracy is enough for most of the power and industrial automation applications
- FRS supports IEEE1588
  - Transparent clock
  - Boundary clock
  - Ordinary clock
  - Reference design available for NIOS II



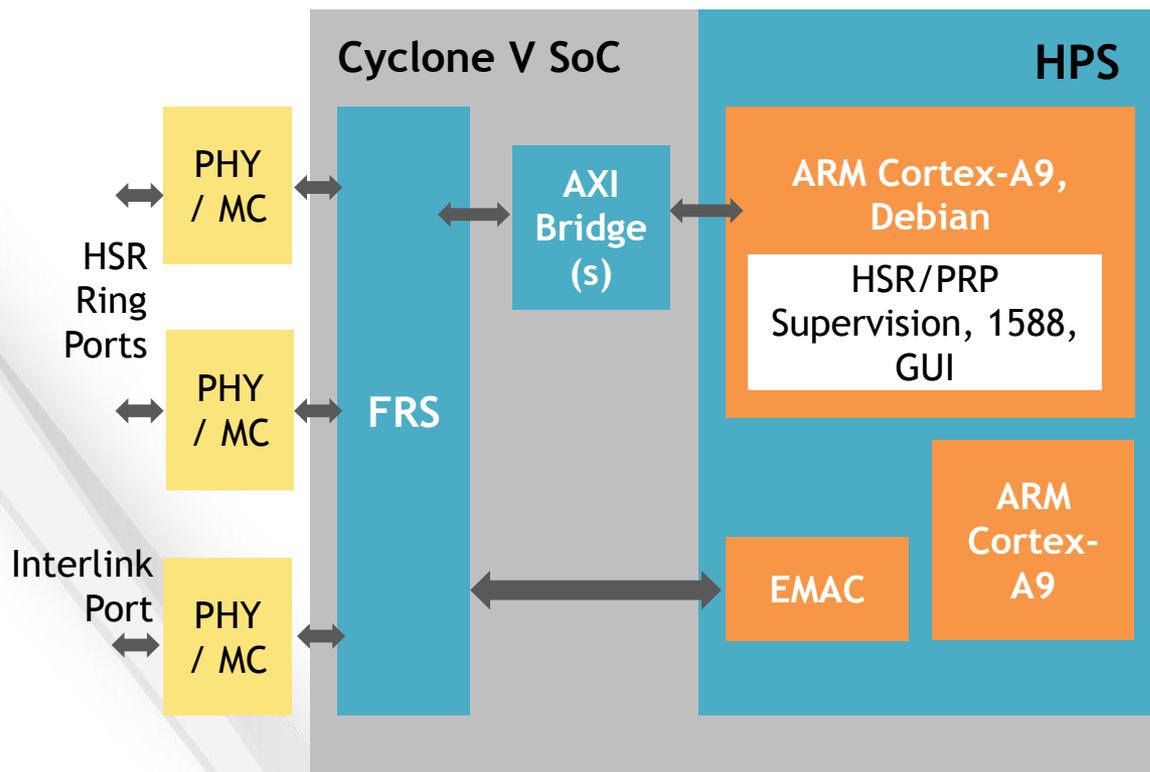
# 4-port FRS Example

- Can be used in
  - RedBox
  - End-node
  - QuadBox (2 x RedBox)
- LEs: 44-46k
- M9K: 240
- Suitable devices for example:  
Altera EP4CGX50, EP4CE55, 5CEA4, 5CGXC4

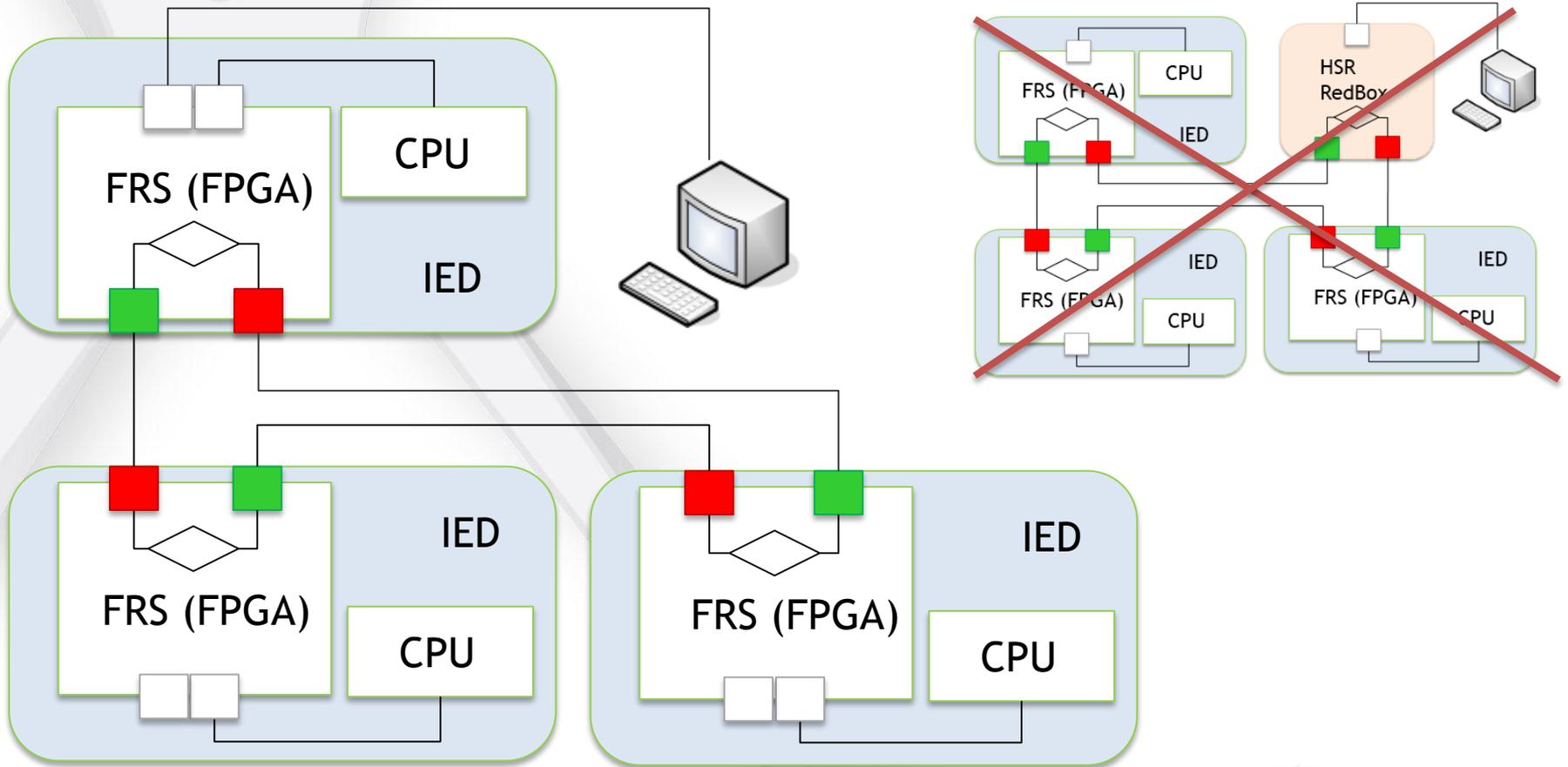


# Cyclone V SoC Example

- 4-port with ARM
  - LEs: 44-46k
  - M9K: 240
  - Suitable devices for example: 5CSEA5, 5CSXC5



# No Separate RedBox Needed $\Rightarrow$ Cost Savings



# FRS Highlights and Benefits to Customers

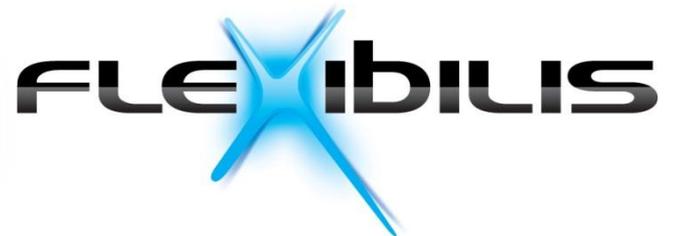


- Field proven and verified
- Only vendor with field proven 1 Gbit solution
  - Link speed is essential when ring size increases
- Full wirespeed switch functionality - can be also used as an ordinary switch
- Intelligent switching architecture, up to 8 ports

**FLEXIBILIS**

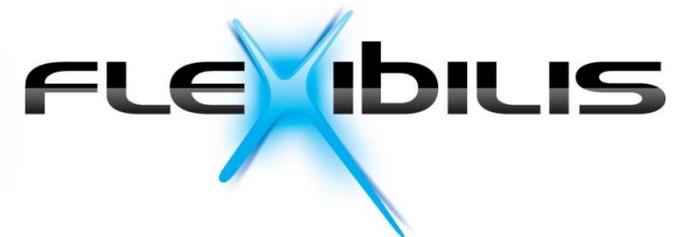
# Hassle-free business model

- No up-front licensing fees
- Reduce development risk
- Faster time to market
- Support and maintenance are included in the royalty price
- HSR/PRP Supervision as well as PTP Protocol Stack are free of charge for royalty customers
  - <http://www.flexibilis.com/products/hsr-prp-supervision/>
  - <http://www.flexibilis.com/products/ptp-protocol-stack/>



# Contact

For more information, please visit  
<http://www.flexibilis.com> or contact  
[contact@flexibilis.com](mailto:contact@flexibilis.com)



Thank you!

