



**ARTEMIS JOINT UNDERTAKING**  
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## SPD Power Node ES solution in pSHIELD framework

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**ARTEMIS Call 2009 – SP6100204**





# SPD Power Node ES solution in pSHIELD framework

- Presentation shows ongoing works conducted by SESM s.c.a.r.l. company on development of **Secure-Private-Dependable (SPD) Power Node ES framework**
- The works are performed in frame of wider SPD solution prepared in **pSHIELD Project**
- pSHIELD Project is **co-funded by ARTEMIS JU**
- **16 partners from 5 European countries** are involved in project





## pSHIELD Concepts

### pSHIELD project:

- pSHIELD project approaches ESs Security, Privacy and Dependability (SPD) in pervasive computing environment to **protect people, data and infrastructures against threats.**
- pSHIELD project aims at addressing Security, Privacy and Dependability (**SPD**) in the context of Embedded Systems (**ESs**) as “**built in**” rather than as “**add-on**” functionalities.



## pSHIELD Concepts #2

### pSHIELD project:

- pSHIELD project may have a great impact on the SPD market of the ES, by addressing the **reusability** of previous designed solutions and the **interoperability** of advanced SPD technologies.
- pSHIELD project is proposing and perceiving with this strategy the first step toward SPD **standardization** and **certificability** of future **European Embedded Systems** solution.



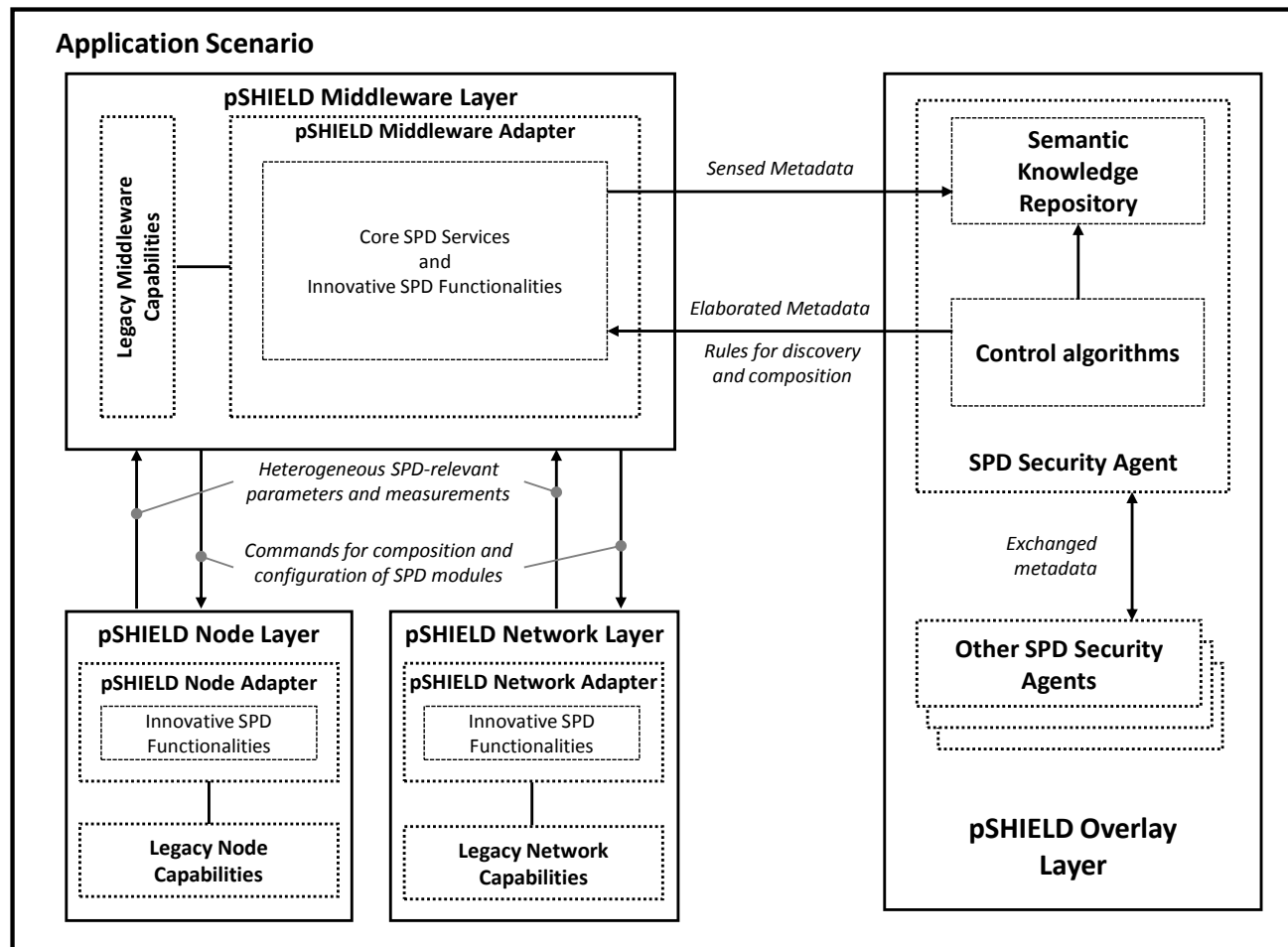
## pSHIELD Concepts #3

- pSHIELD aims to achieve its goals by a **layered** and **composable** reference infrastructure based on a set of innovative **security concepts**, technologies and **specific metrics**.
- pSHIELD will integrate SPD solutions at **Node, Network** and **Middleware** level through an **Overlay** level.
- pSHIELD project proposes and validates in application scenario a **framework of innovative** and **state of the art** SPD technologies perfectly **composable** due to an innovative **composability mechanism** and a pervasive **vision of all the layers** involved.



# pSHIELD Functional Component Architecture

In order to reach these ambitious objectives, the pSHIELD concept has been translated into a functional architecture and each component is addressed by a specific Task

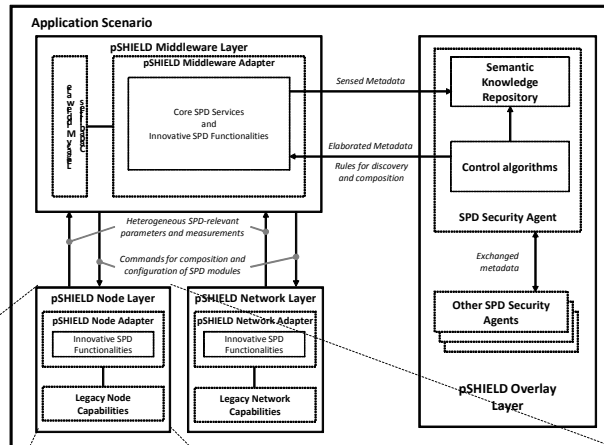


## Four SPD Layers

- **Node:** SPD hardware and firmware
- **Network:** trusted data transfer
- **Middleware:** resource management
- **Overlay:** composability and security agents system



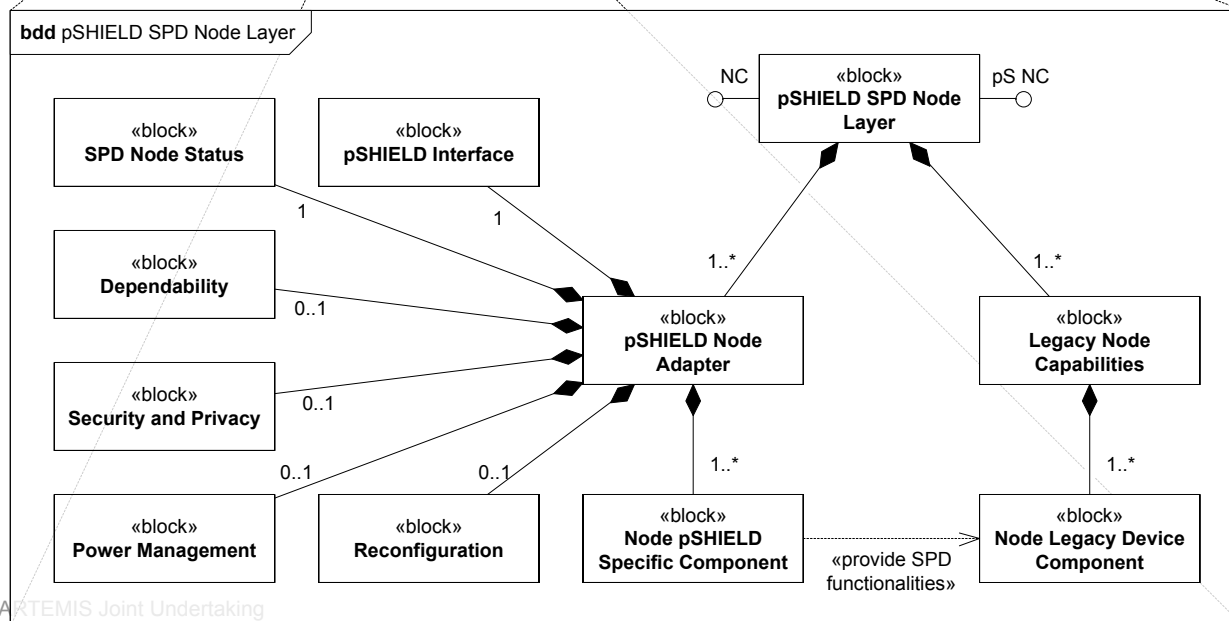
# pSHIELD SPD Node Layer Conceptual Model



## pSHIELD SPD Functional Component Architecture

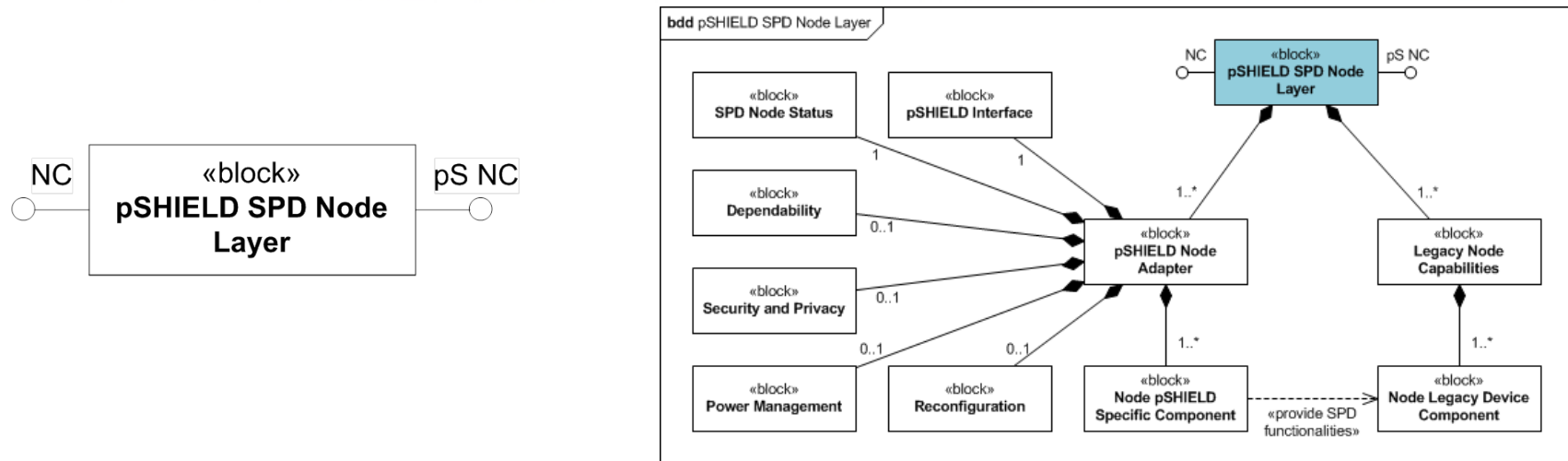
and exploding:

## pSHIELD SPD Node Layer Conceptual Model





# pSHIELD SPD Node Layer: Interfaces

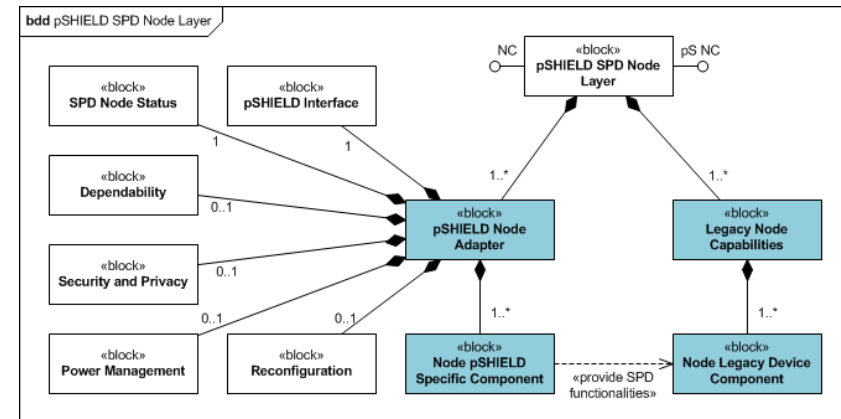
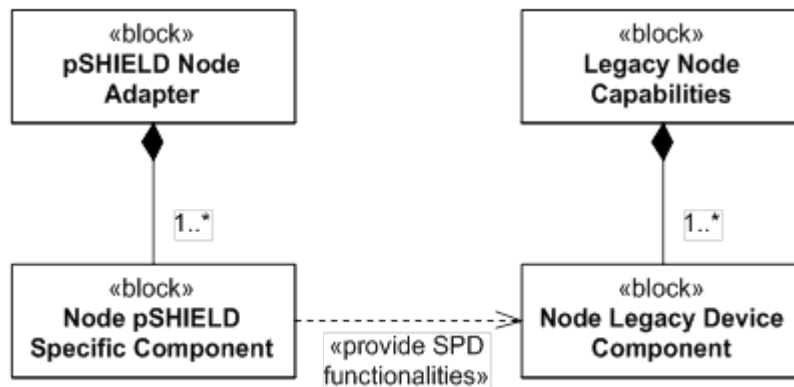


- **pS-NC** - pSHIELD Node Capabilities interface with the Middleware Layer:
  - To enable the SPD composability
  - To provide Node pSHIELD-specific functionalities
  - To provide access to legacy Node capabilities
- **NC** - legacy, technology-dependent, Node Capabilities





# pSHIELD SPD Node Layer: Legacy capabilities



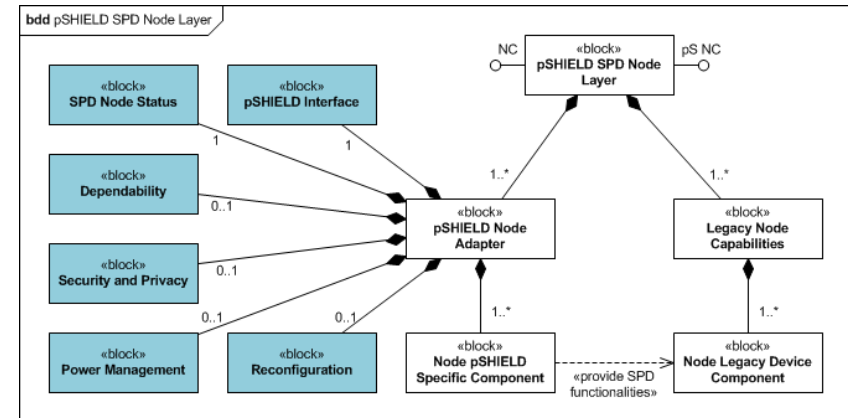
- **Legacy Node Capabilities** – consist of one or more **Legacy\* Device Components**, such as CPU, I/O Interfaces, Memory, Battery, etc.
- **pSHIELD Node Adapter**, composed of **Specific Components** – the innovative SPD functionalities provided to each of the Legacy Device Components, such as status, metrics, or checkpoint-recovery

\* By Legacy means any third-party or of-the-shelf device



# pSHIELD SPD Node Layer: Innovative SPD

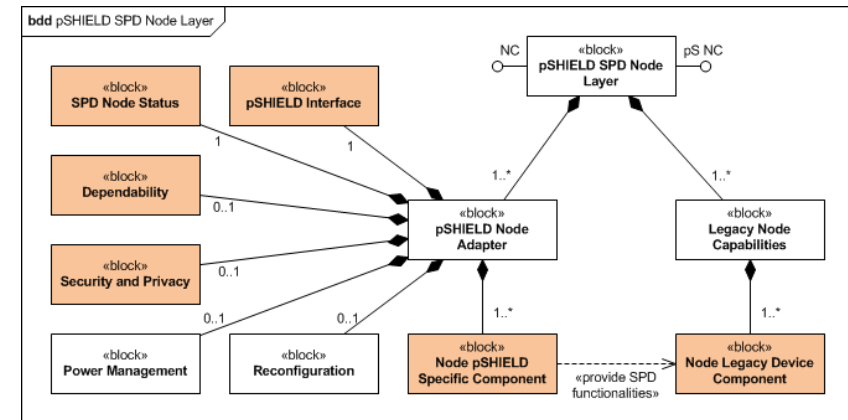
- **pSHIELD Interface** – physical interface to the pSHIELD Network.
- **SPD Node Status** – collection and disclosure of SPD-relevant parameters and measurements. Checks on system health status for self-recovery, self-reconfiguration and self-adaptation.
- **Reconfiguration** – module or system reconfiguration for recovery or new functionalities.
- **Dependability** – self-dependability at node layer: error detection and system recovery. Checkpointing service provider.
- **Security and Privacy** – hardware and software security and privacy service provider.
- **Power Management** – power sources management.





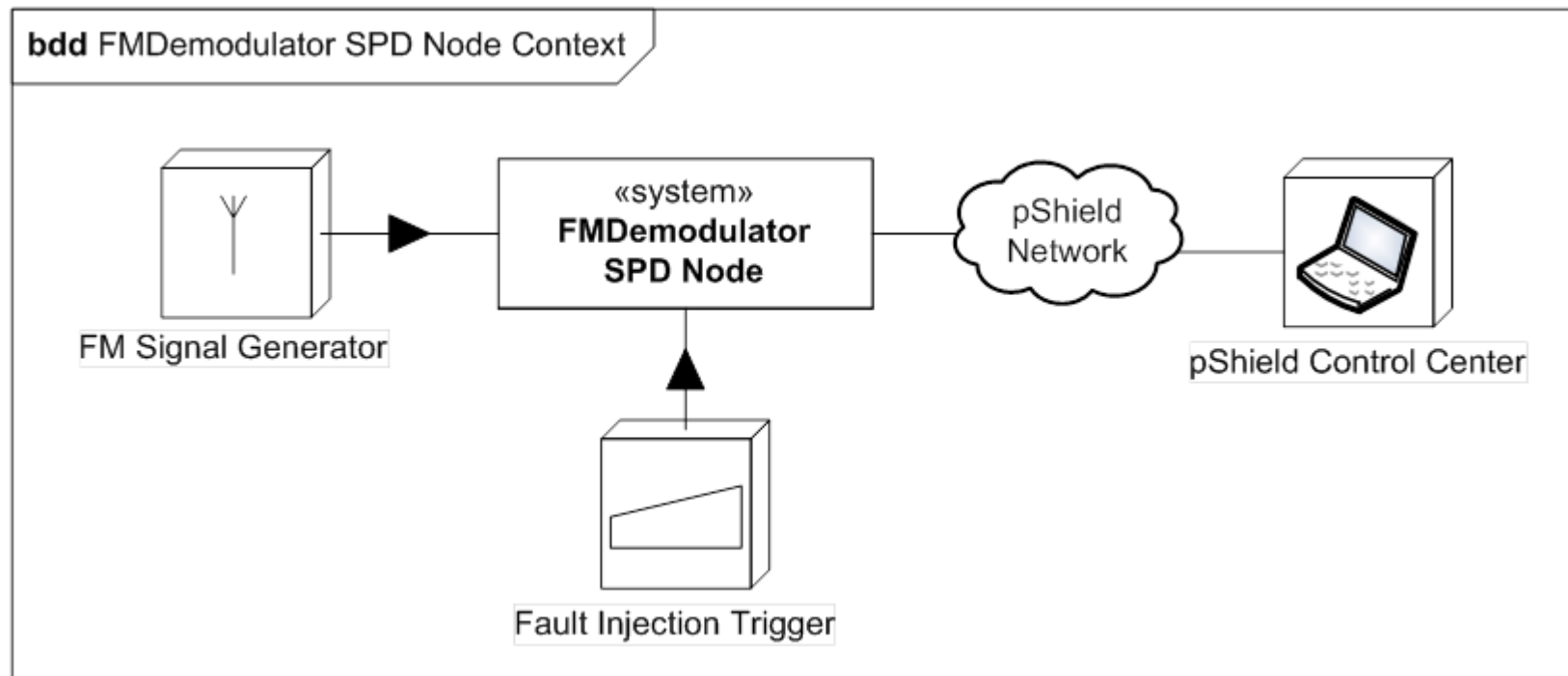
# pSHIELD Power Node Demonstrator: FMDemodulator

- Demonstration of:
  - Node Legacy Device with SPD functionalities:
    - pS-NC interface
    - SPD metrics
    - Self-recovery from hardware transient faults (through fault-injection)
    - Auto-reconfiguration
    - Data encryption
  - Provision of security and privacy services – hardware data encryption/decryption
- Node function
  - Dependable, secure and reconfigurable FM Demodulation



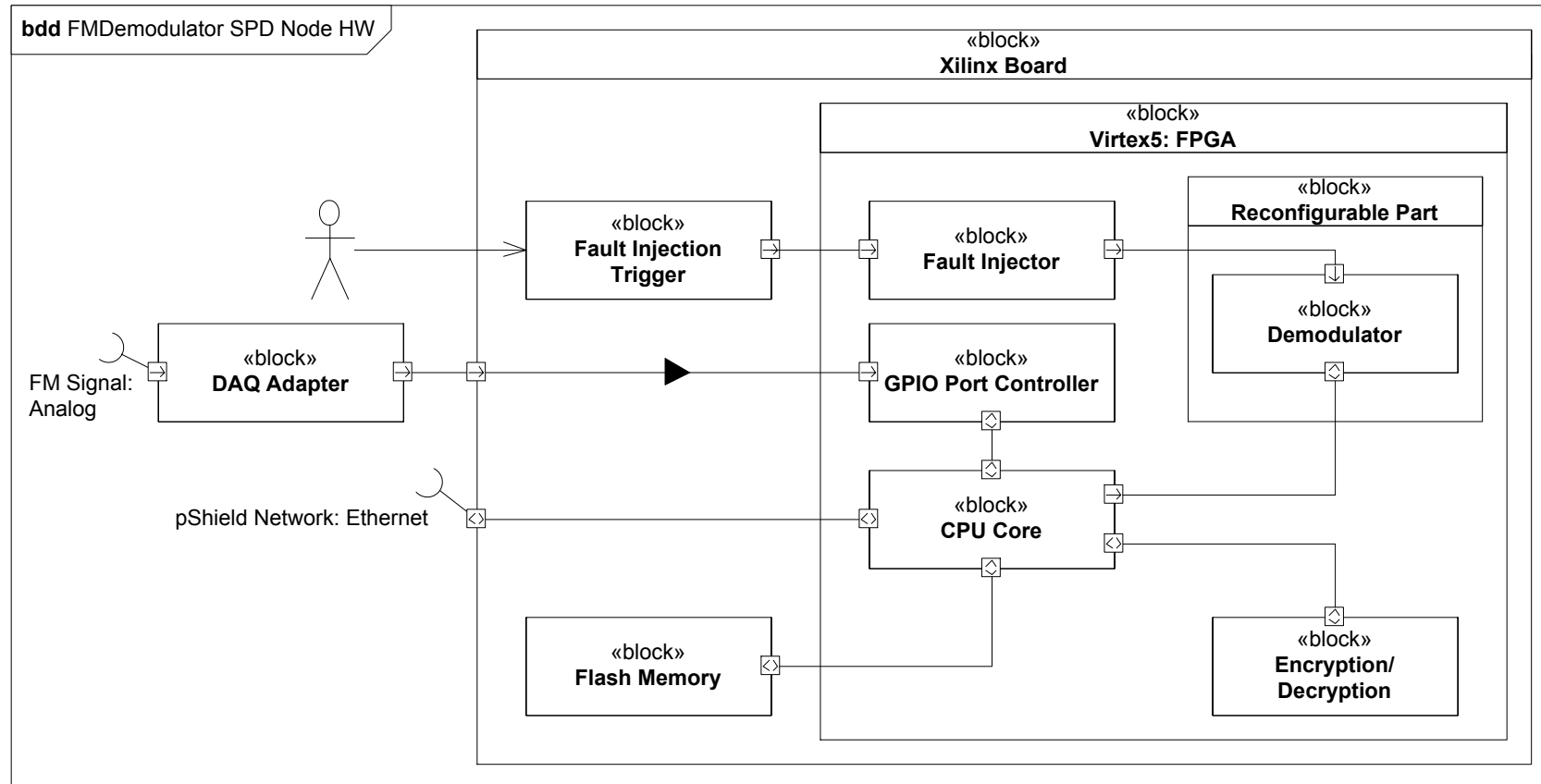


# FMDemodulator: Node Context





# FMDemodulator: Hardware





# FMDemodulator: Hardware

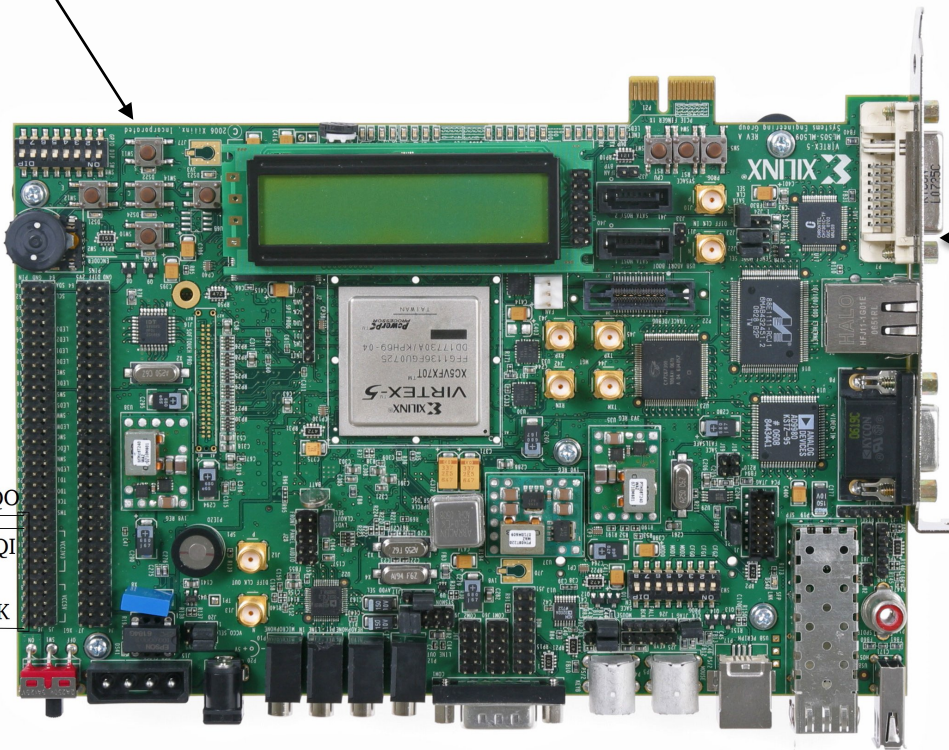
*Fault injection trigger*

*Xilinx ML507 evaluation board*

*FM signal*

*Ethernet  
(pShield Network)*

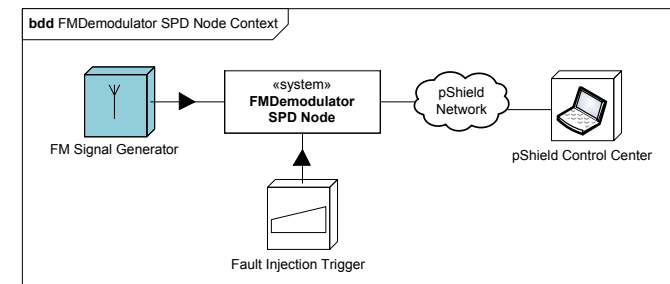
IRQO  
IRQI  
CLK





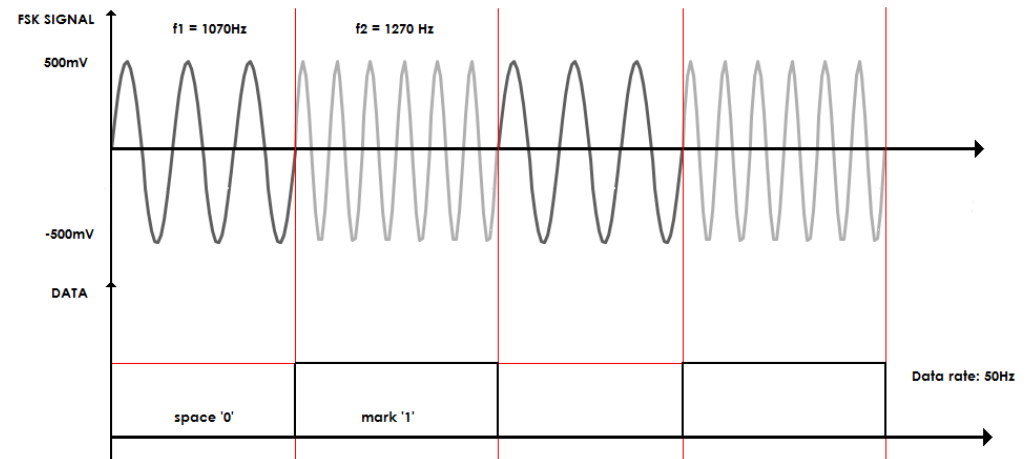
# FM Signal Generator

- Implemented using specially developed board broadcasting signal.  
The signal features are contained in a wave file.



- Consists of a Audio Frequency-Shift Keying (A-FSK) modulated signal:

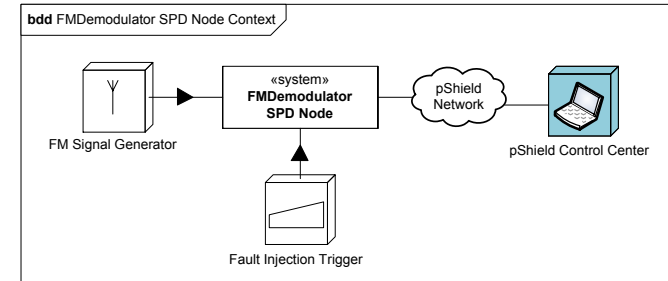
- FSK Rate: 50 Hz
- “Space” freq.: 1070 Hz
- “Mark” freq.: 1270 Hz
- Amplitude: 1 Vpp





# pSHIELD Control Center

- A remote PC, connected to the pSHIELD network via ethernet.
- A server/client application running on the PC allows a remote user to:
  - receive and store the data samples sent by FMDemodulator;
  - receive and analyze the metrics of the system
  - send the commands (reconfigure/recover) to the system

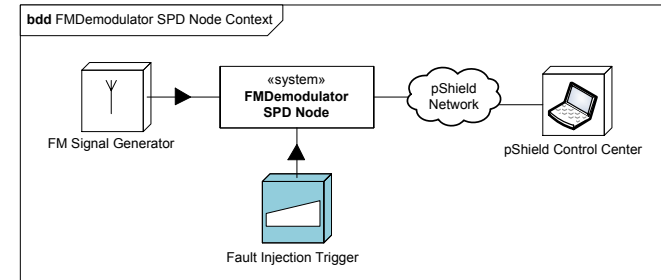






# Fault Injector

- The Fault Injector emulates a hardware fault, by changing a register cell that corresponds to a parameter of the processing algorithm.
- The result of the fault should be a fatal error of the FM Demodulation application.
- The fault is triggered by pushing a button.





# FMDemodulator Metrics

<b>Device:</b>	<i>SESM pSHIELD SPD Power Node Demodulator</i>
<b>Function</b>	
<i>Name:</i>	<i>FMDemodulation</i>
<i>Inputs:</i>	<i>Analog Audio FSK signal (Data Rate: 50 Hz; Mark:1020 Hz; Space: 1070 Hz; Amplitude: 1Vpp)</i>
<i>Outputs:</i>	<i>Digital demodulated signal (Data Resolution: 8 bit)</i>
<b>SPD Status</b>	
<i>SPD Level:</i>	<i>0-3(TBD)</i>
<i>Status:</i>	<i>Halted / Initialized / Running-full / Running-degraded / Error</i>
<b>Description</b>	
<i>In Port:</i>	<i>DAQ Adapter IN</i>
<i>Out Port:</i>	<i>TCP/IP Port 80</i>
<i>Key Length:</i>	<i>64 bit</i>
<i>Key Length range:</i>	<i>32 to 448 bit</i>
<i>Data encrypted length</i>	<i>64 bit</i>
<b>Measurements</b>	
<i>Demodulated frames:</i>	<i>20</i>
<i>Demodulation errors:</i>	<i>2</i>
<i>Function recovery:</i>	<i>0</i>
<i>Device recovery failures:</i>	<i>1</i>
<i>Encrypted Bytes</i>	<i>1000</i>



# FMDemodulator SPD Node Function

- **Dependable, secure and reconfigurable FM Demodulation functions:**

- 1. FM signal demodulation**

- Demodulates incoming FM Signal
- Processes & analyzes the characteristics of the sampled signal
- Provides all the valid samples to the pShield Network

- 2. Dependability**

- Rejects the invalid samples
- Recovers from device failure: FPGA reprogramming

- 3. Metrics**

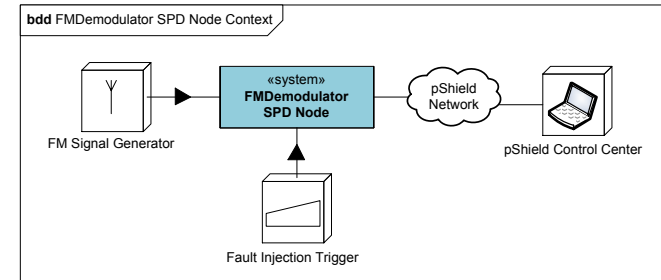
- Collects performance results
- Collects dependability and security measurements

- 4. Security**

- Encrypts demodulated data

- 5. Reconfiguration**

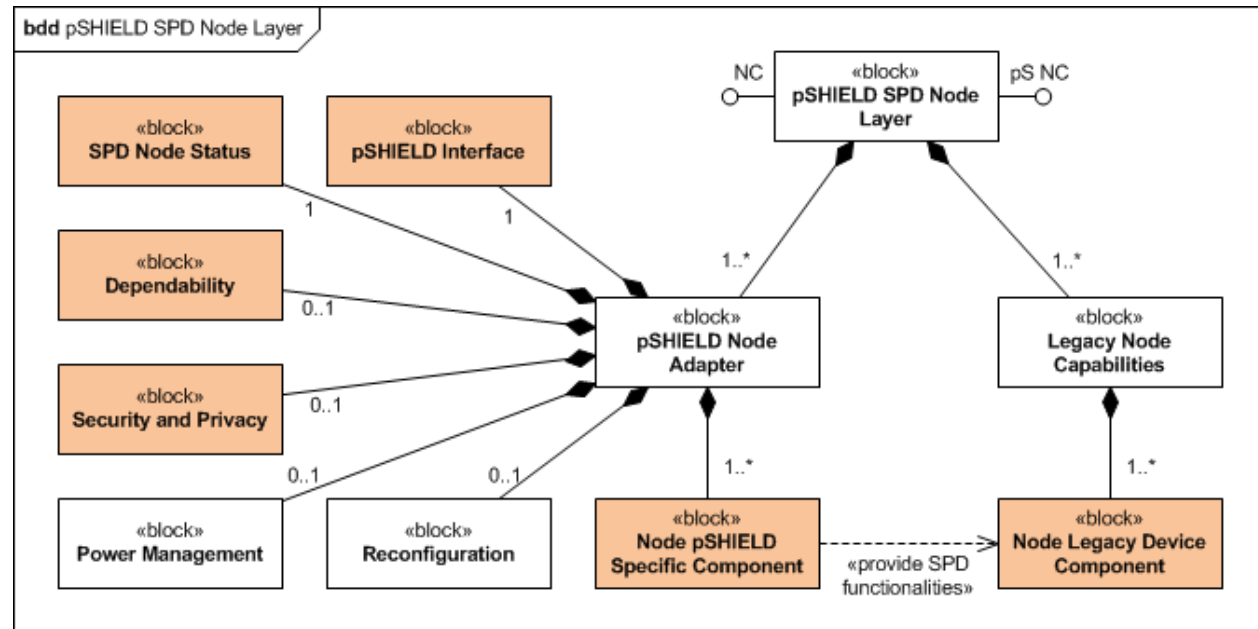
- Self-adaptation for improved performance: FPGA partial reconfiguration (only demodulation module)





# Conclusions

- Developed Node Layer represents the base components of the pSHIELD SPD pervasive system
- Development of SPD Node Layer framework should result in standardization and certifiability of future European ESs solution

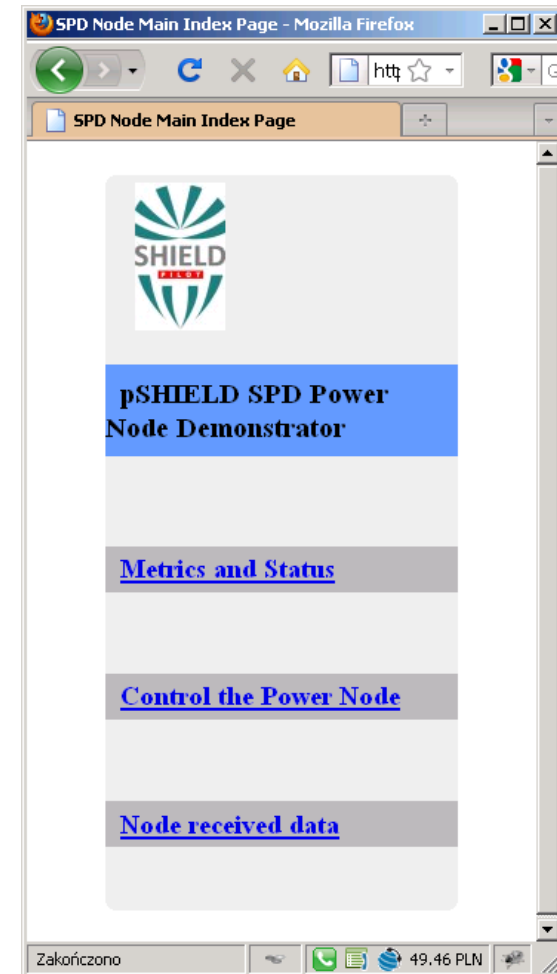


- In developed of pSHIELD SPD Node Layer Framework architecture:
  - Several blocks (filled pink in diagram) were already tested by implementation in prototype
  - Some blocks will be implemented during future works in company or by partners



# Controlling Power Node

- WiFi: pshield
- Pass: nodelayer
  
- url: <http://192.168.100.229/>





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