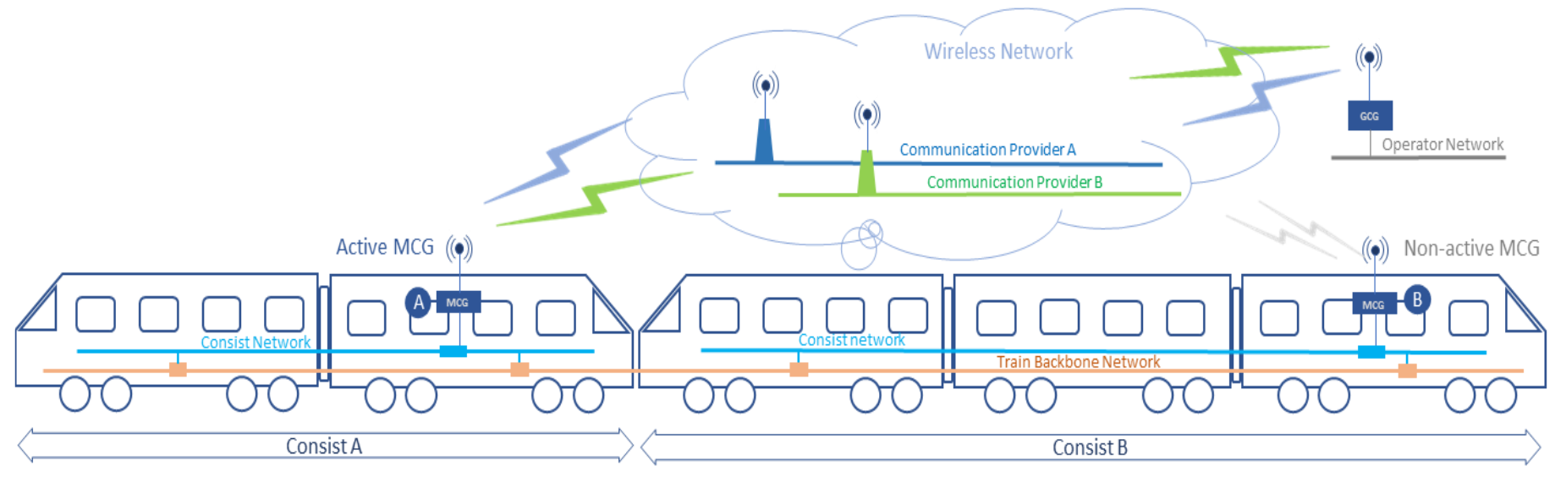
Railway System use case

Overview

Our goal with the Railway System Use Case is to exploit ADMORPH tools to create robust and reliable communication between the train and the ground part of the railway system.

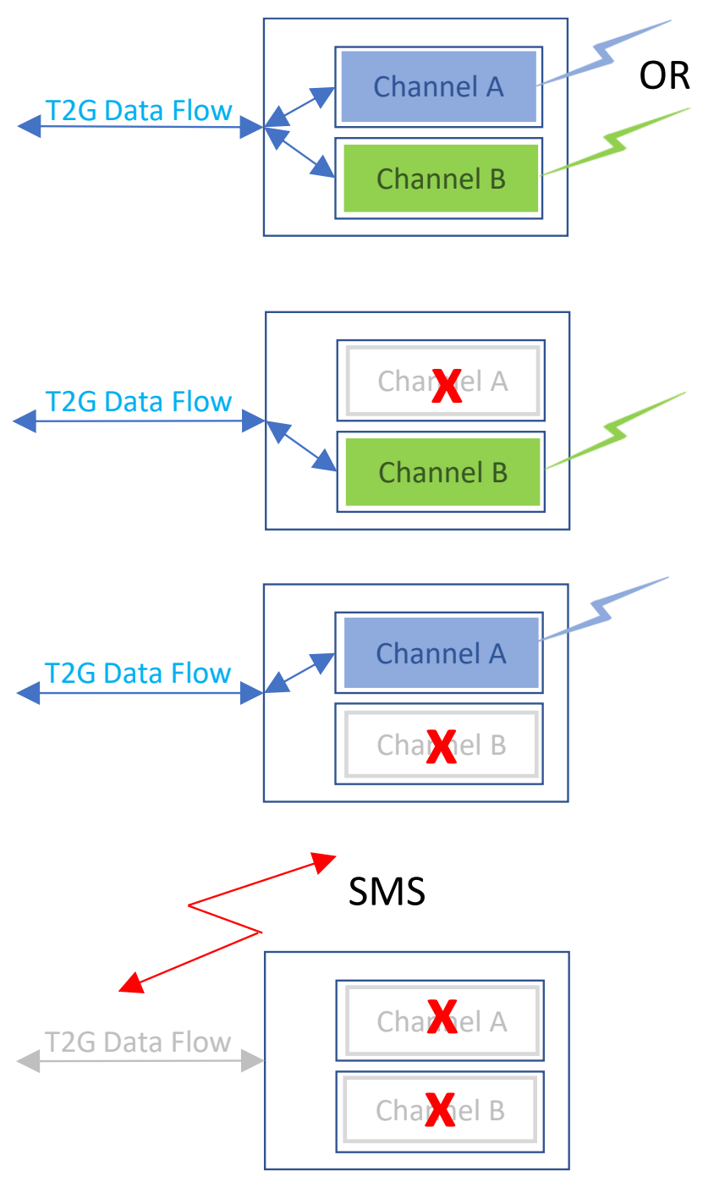
The data transmission system between the train and the ground part of the operator's system consists of a pair of MCG-GCG communication units (Mobile Communication Units and Ground Communication Unit), as shown in the figure. The purpose of these units is to interconnect the trusted parts of the on-board system with the trusted parts of the ground system through an untrusted wireless network environment.



Mode A: ***Quality of service***
A higher quality channel is selected

Mode B: ***Channel corrupted***
Backup communication established

Mode C: Data ***communication corrupted***
Emergency SMS sended



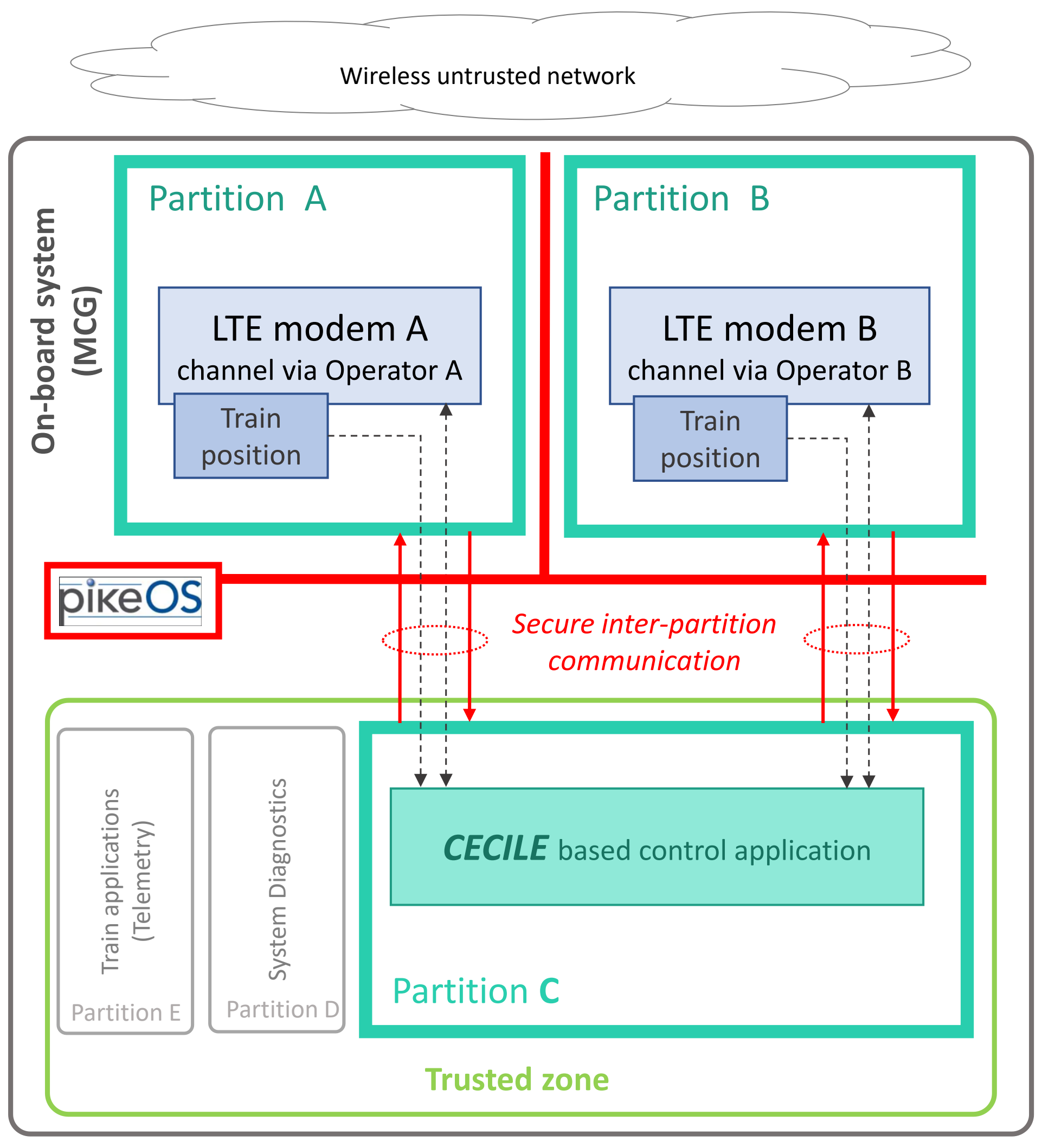
The robustness of the system (security and availability of the service) is achieved by the redundancy of communication channels (optimally managed by the systems of various telecommunications operators) and the use of an application that continuously evaluates the status and parameters of transmission channels. Based on the set criteria (security, transmission quality, etc.), the application will adapt the operating mode of the data connection, as illustrated in the figure.

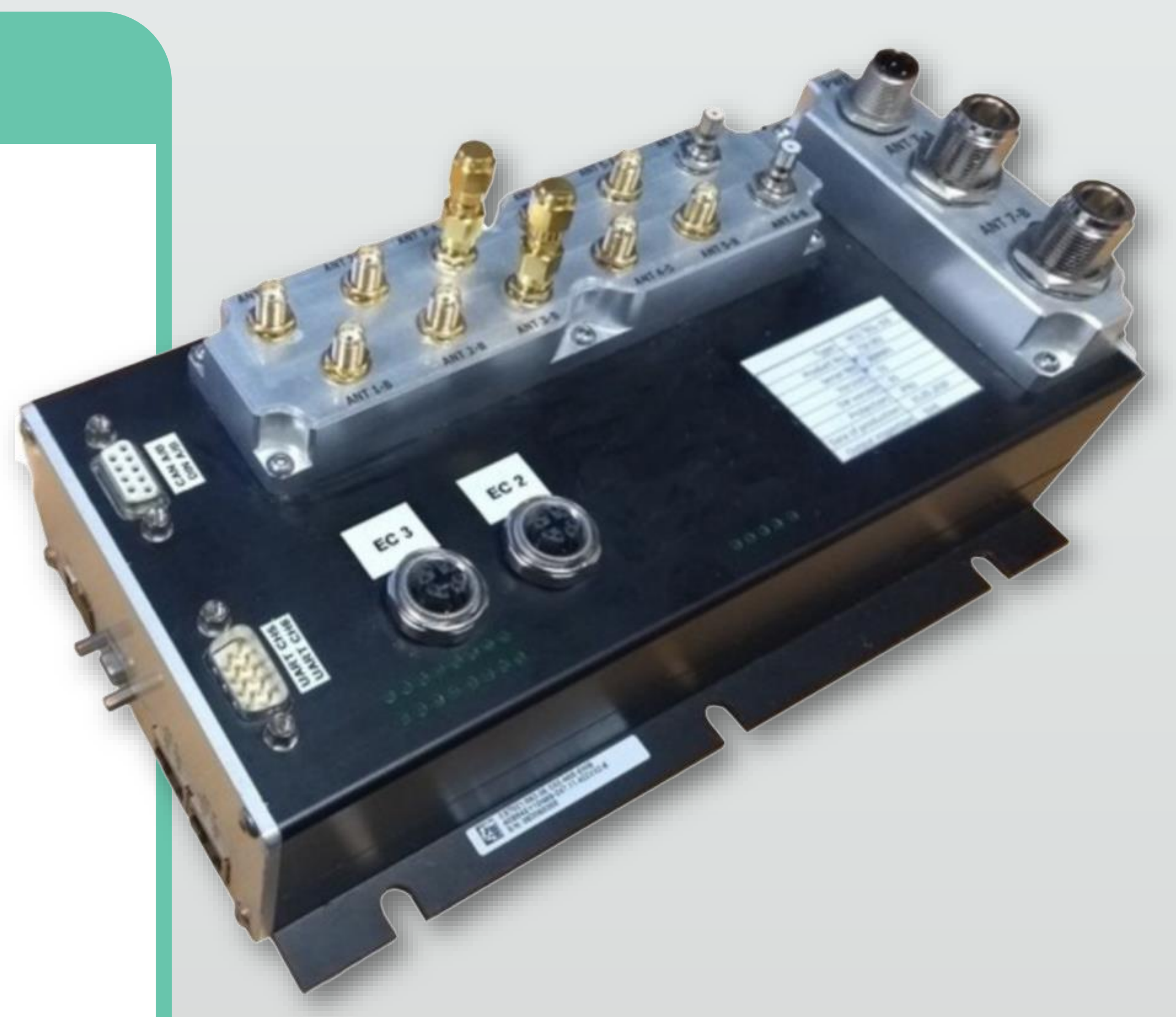
Use of project tools

To achieve a sufficient level of protection for the trusted part of the MCG and the mutual separation of communication channels A and B, the PikeOS hypervisor is used, allowing the physical device to be divided into several independent logical parts. For the needs of the use case, the HW of the commercial communication unit (see images) was configured to create three independent parts:

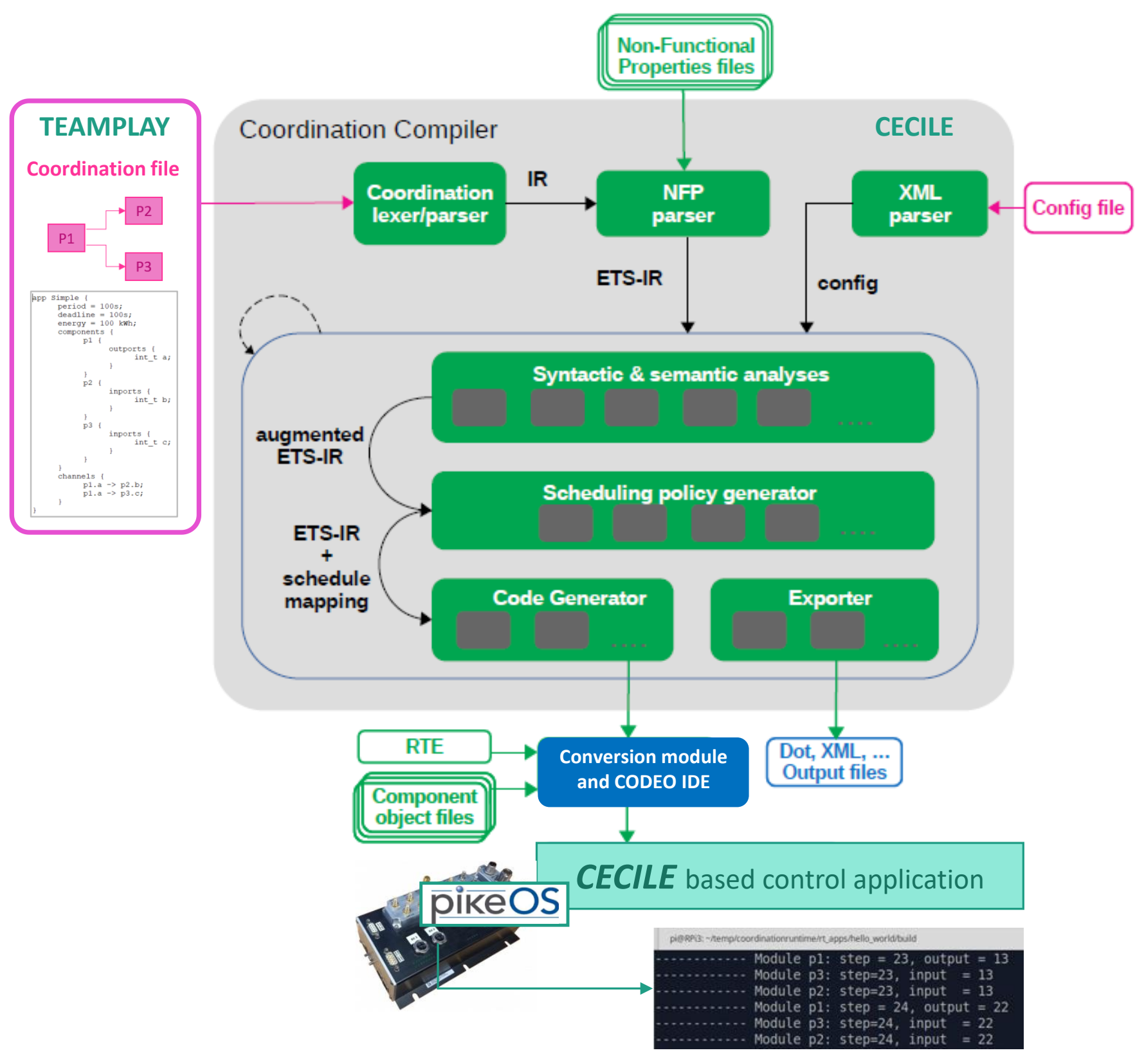
- two mutually isolated communication parts for Channel A and Channel B (partitions A and B)
- a part for the needs of the control application (partition C)

Linux OS is installed in partitions A and B, which allows to easily integrate commercial peripherals. Partition C is without an OS (so-called native PikeOS partition), configured for the needs of the static scheduler CECILE.





Application development toolset


Non-Functional Properties files
TEAMPLAY
Coordination file
P1
P2
P3
Coordination Compiler
CECILE
Coordination lexer/parser
IR
NFP parser
XML parser
Config file
ETS-IR
config
Syntactic & semantic analyses
augmented ETS-IR
Scheduling policy generator
ETS-IR + schedule mapping
Code Generator
Exporter
RTE
Component object files
Conversion module and CODEO IDE
Dot, XML, ... Output files
CECILE based control application
pikeOS

```
app Simple {
      period = 100s;
      deadline = 100s;
      energy = 100 kWh;
      components {
            p1 {
                  outports {
                        int_t a;
                  }
            }
            p2 {
                  inports {
                        int_t b;
                  }
            }
            p3 {
                  inports {
                        int_t c;
                  }
            }
      }
      channels {
            p1.a -> p2.b;
            p1.a -> p3.c;
      }
}
```

```
pi@RPi3: ~/temp/coordinationruntime/rt_apps/hello_world/build
------------ Module p1: step = 23, output = 13
------------ Module p3: step=23, input  = 13
------------ Module p2: step=23, input  = 13
------------ Module p1: step = 24, output = 22
------------ Module p3: step=24, input  = 22
------------ Module p2: step=24, input  = 22
```

The TeamPlay coordination language and the CECILE static scheduler will be used to create the control application. Therefore, a tool was created to convert the output of the CECILE coordination compiler to a format suitable for the Target Compiler and Linker CODEO (Sysgo's IDE), which generates binary code for the native PikeOS partition. The figure shows a test application written in TeamPlay and its console output when running on a PikeOS partition.

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