Example of prototyping algorithm using MATLAB/SCILAB and ECLIPSE environment

Frédéric Bard

Eclipse IoT Days - 2017

Introducing myself

WITH VEYADO COMPANY: RESEARCH ENGINEERING AND CONSULTING FOR FUNCTIONAL SAFETY, QA, CWE, DEVELOPMENT OF PROFESSIONAL TERMINAL OR IOT DEVICE, HOMOLOGATION, PRODUCTION AND MASS DEPLOYMENT TO SUPPORT VARIOUS SERVICES.

CURRENT WORK IN THE FIELDS OF ENERGY MANAGEMENT, COMMUNICATION FOR ELECTRIC DEVICES, TRANSPORTATION AN MEDICAL SERVICES.

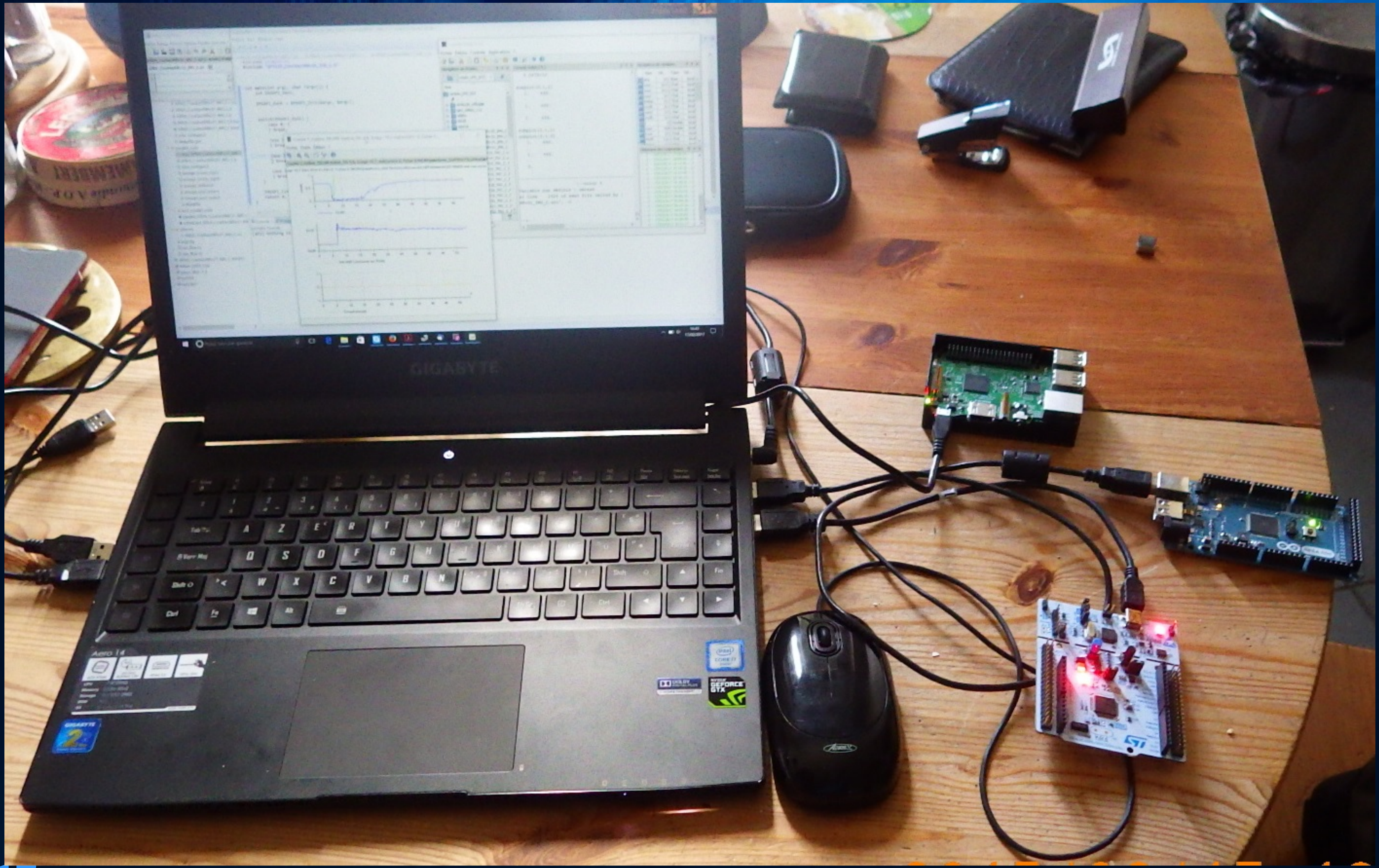
BEFORE, DEPLOYMENT OF SERVICES OVER IP/MPLS (QUADRUPLES PLAY, GEOLOCALIZATION, M2M, UC,VOIP, VOD, IPTV, TÉLÉPRÉSENCE, VISIOCONFERENCING) WITH MAJOR TELECOM PROVIDERS AND ANALYTICS OF UNIFIED COMMUNICATIONS : STATISTICS, ROI CALCULATIONS, TRANSPORTATION AND TRAVEL COSTS, GREEN HOUSE GAS (GHG) EMISSION EVALUATION AND ECO2 REDUCTIONS CALCULATION

Frédéric Bard
VEYADO SAS

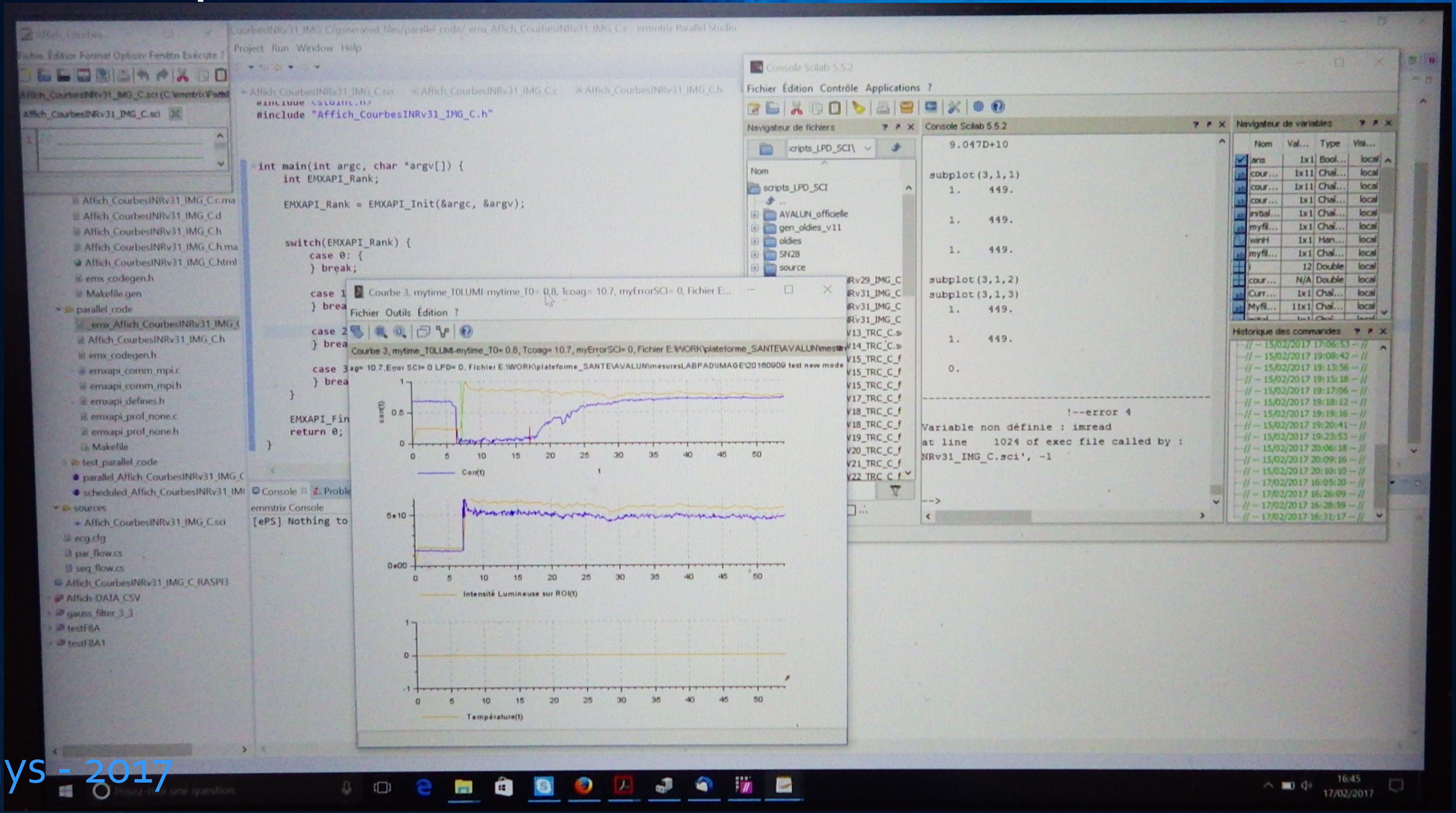
Email: bardf@veyado.fr
Cél: 0689821845

15 years in DSP and electronics
15 years in services over IP and network
PARISTECH graduated engineer
Mastère ParisX – IFG ICG – Management
CEE/IEEE auditor
ISEP lecturer

Developing an IoT system is so simple :on your kitchen table



Eclipse allows to prototype in MATLAB/SCILAB , to generate and validate C/C++ code and debug on embedded platform



IoT devices development

Laboratory

Functional Tests
Uses Cases

Proof concept, breadboard
Research Equipment
Tools: Labview

Product Design

Unitary, Integration,
Loading Tests

System model and manual testing , first non regression tests
Development processes, patent
Tools: Matlab

Proto 1

Bluetooth,
ISO13485 Certification,
Field Usage

Choice of an embedded platform, SW partitioning 1st choice
HW : PCB routing, components choice
SW: drivers, application code
Tests : unitary ,functional,integration
QA referential and tools
Tools: SDK, C language

Proto 2

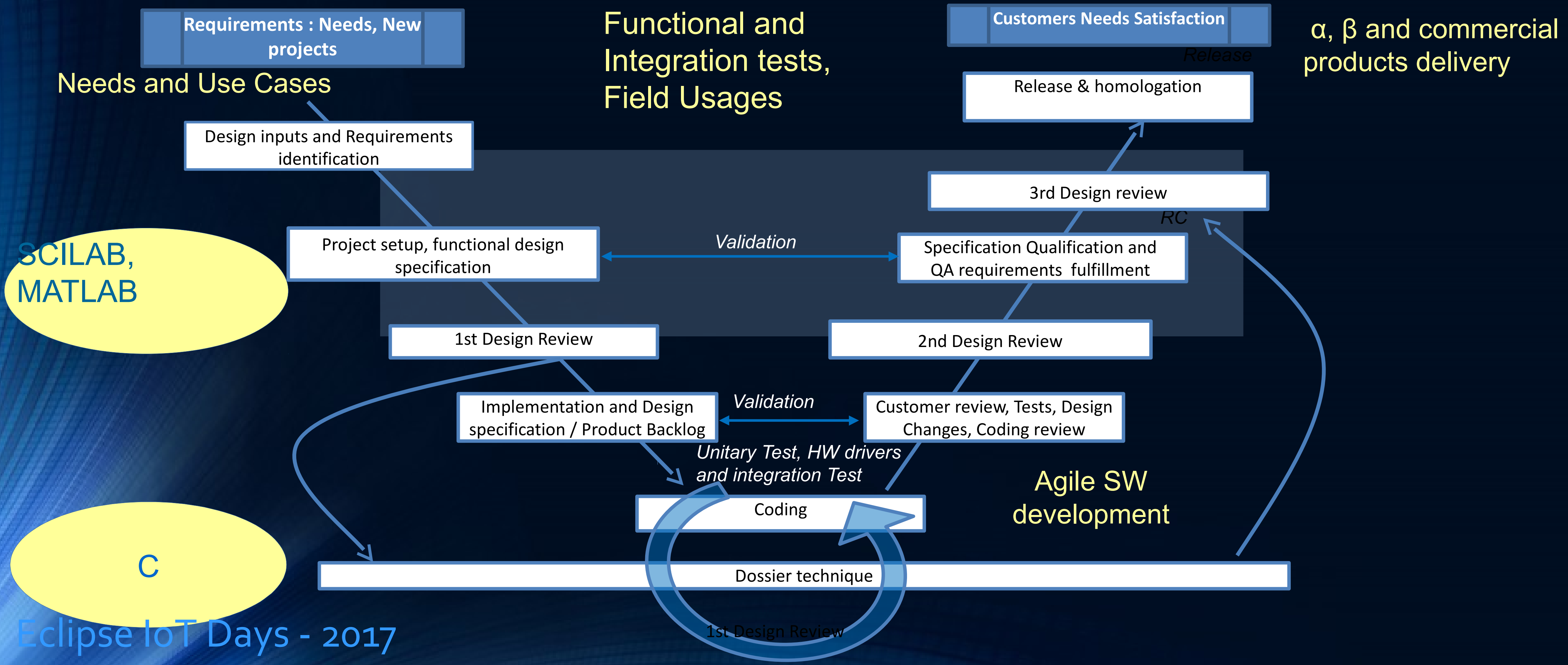
Add of communication chip, SW partitioning 2nd choice
HW : PCB routing, components choice
SW: drivers, application code
Tests : unitary ,functional,integration, network and server testing
QA referential and tools
Tools: SDK, C language, JAVA, C#

Proto 3

HW rework, SW partitioning 3rd choice
HW : PCB routing, components choice
SW: drivers, application code
Tests : unitary ,functional,integration, network and server testing
QA referential and tools
Tools: SDK, C language, JAVA, C#

Product developement : a stairway with many challenges

Importance of Quality Control , testability during the Life Cycle : from Use cases to Product assessment



Passing from the Lab demo to an embedded POC , translating Signal Processing Model to C code

Basics for simplicity :

Have an simple HIM to develop and signal processing validation (Scilab, Labview, MatLab, Octave)

Distribute it to all users (cheap license)

Use open standard for code generation

Run laboratory and process (ex medical , biological , optics, ...) , tune lab device and functional tests that will serve to tune end products

If needed, compliance to standard EN62304 (medical), ISO26262 (vehicle)

Simulating on a Model (SCILAB) on core I7 PC with Windows 10 , improving performances can have strange outcome

SCILAB parallel_run : parallel calls to a SCILAB function

```
timer();
for i = 1:nCourb
//    waitbar(i/nCourb,winH);
   myfile_bin = MyfilesDIR(i,1)+'\correl_data.bin';
   courbes_dispos = [courbes_dispos string(i)];
   courbe_desc = 'courbu('+string(i)+');';
   courbes_o = [courbes_o courbe_desc];
   corr_plot(i,myfile_bin,myfile_txt);;
end
Temps_calcul_boucle = timer();
```

------ critical loop (in sec.) :

2402.921875

Regular to parallel loop SCI
97,4 %

```
function corr_PAR_plot(i)
 //   waitbar(i/nCourb,winH);
   myfile_bin = MyfilesDIR(i,1)+'\correl_data.bin';
   courbes_dispos = [courbes_dispos string(i)];
   courbe_desc = 'courbu('+string(i)+');';
   courbes_o = [courbes_o courbe_desc];
   corr_plot(i,myfile_bin,myfile_txt);
Endfunction

timer();
//for i = 1:nCourb
   PAR_test = parallel_run(1:nCourb, corr_PAR_plot);
Temps_calcul_boucle = timer();
```

------ critical loop (in sec.) :

2481.625000

SCILAB parallel_run : calls to a SCILAB or C compiled function

```
link_name = "CalCorr_FindCoagTime";    // to the call table
exec loader.sce;
...
[Test_retour] =call("CalCorr_FindCoagTime",mydata,1,"d",lengthC,2,"i",myTcoagSCI,3,"d","out",[1,3],4,"d");
```

--------------- critical loop (in sec.): 82.140625

C to SCI ratio
3,65 %

```
function [Tcoag,Error] = Coag_FindCoagTime_EOLANE(Corr,T)
...
Endfunction

[myTcoagSCI,myErrorSCI] = Coag_FindCoagTime_EOLANE(mydata,mytime);;
```

--------------- critical loop (in sec.): 2402.921875

SCILAB parallel_run : parallel calls to a function + compiled C code call

```
timer();
for i = 1:nCourb
//   waitbar(i/nCourb,winH);
   myfile_bin = MyfilesDIR(i,1)+'\correl_data.bin';
   courbes_dispos = [courbes_dispos string(i)];
   courbe_desc = 'courbu('+string(i)+');';
   courbes_o = [courbes_o courbe_desc];
   corr_plot(i,myfile_bin,myfile_txt);;
end
Temps_calcul_boucle = timer();
```

----- critical loop duration:
82.140625

Regular to parallel loop C
98,8 %

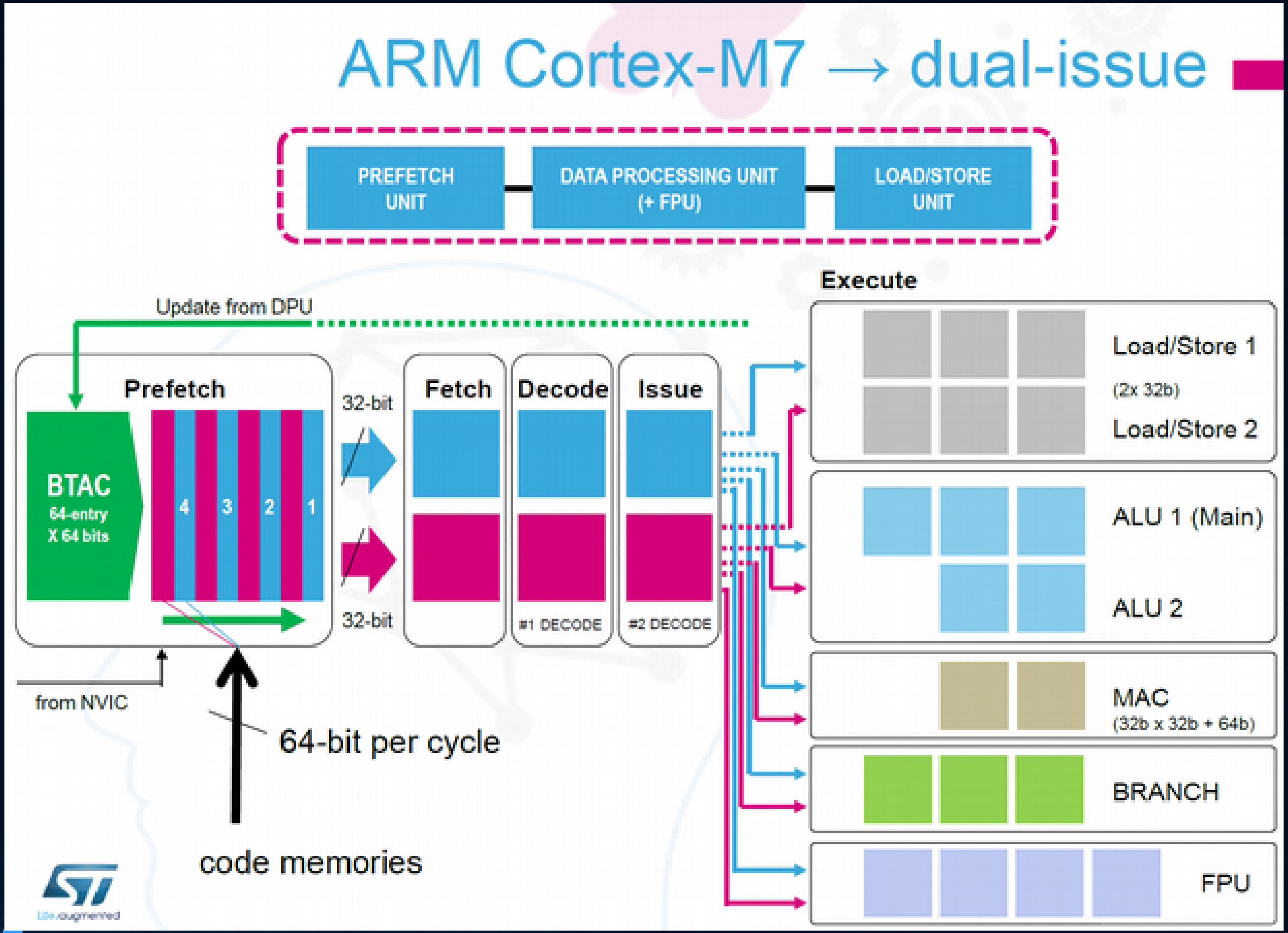
```
function corr_PAR_plot(i)
 //   waitbar(i/nCourb,winH);
   myfile_bin = MyfilesDIR(i,1)+'\correl_data.bin';
   courbes_dispos = [courbes_dispos string(i)];
   courbe_desc = 'courbu('+string(i)+');';
   courbes_o = [courbes_o courbe_desc];
   corr_plot(i,myfile_bin,myfile_txt);
Endfunction

timer();
//for i = 1:nCourb
   PAR_test = parallel_run(1:nCourb, corr_PAR_plot);
Temps_calcul_boucle = timer();
```

----- critical loop duration:
87.890625

Embedded computing bring other constraints, an example with of STM32 (Cortex Mx core) :

- floating point and fixed point calculation optimization (FPU and CPU)
- No MMU but faster memory access through data cache or local memory(compare to flash RAM)

Smart use of a « simple » architecture



Correlation critical loop

Calculs en float :

```
///  long int SumAA;* Sum des A² */
//  SumAA = SumAA + ( ((float)(pI1[(iIn*m) + iIm])) - val_moy_1 ) *
( ((float)(pI1[(iIn*m) + iIm])) - val_moy_1 );

    LDRB    R0,[R0, R11]
    VMOV    S1,R0
    VCVT.F32.U32 S1,S1
    VSUB.F32 S1,S1,S17
    VMLA.F32 S19,S0,S1
```

Calculs en int :

```
//  long int SumAA;
/* Sum des A² */
//  SumAA = SumAA + (((pI1[(iIn*m) + iIm]*Konst_Kernel) - val_moy_1 )^2);  //KK2 = 11^2
= 121 donc 8b de dynamique perdue, mais (28b)^2 on sature la dynamique 32b
    LDR     R0,[SP, #+16]
    LDR     R1,[SP, #+844]
    LDR     R2,[SP, #+852]
    MLA     R2,R2,R4,R10
    LDRB    R1,[R2, R1]
    LDR     R2,[SP, #+8]
    MULS    R1,R2,R1
    LDR     R2,[SP, #+20]
    SUBS    R1,R1,R2
    EORS    R1,R1,#0x2
    MULS    R1,R2,R1
    ADDS    R0,R1,R0
    STR     R0,[SP, #+16]
```

Ideally , direct generation of C/C++/C# from the Model Language AND optimization for the embedded/multicore platform.