Optimization and Implementation of Embedded Signal Processing Algorithms

Jonas Rutström
Senior Application Engineer

Two important questions in embedded design...

1. What's your algorithm?

Two important questions in embedded design...

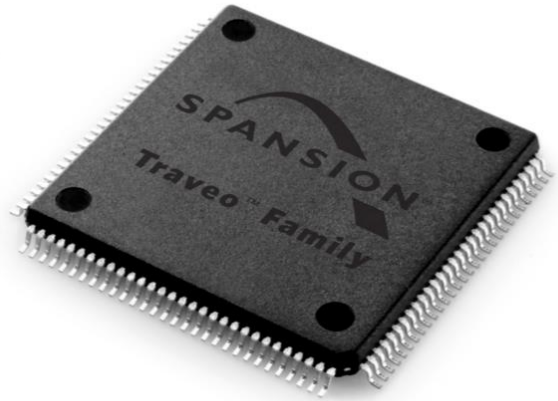
2. What's your target?

Targets are very different...

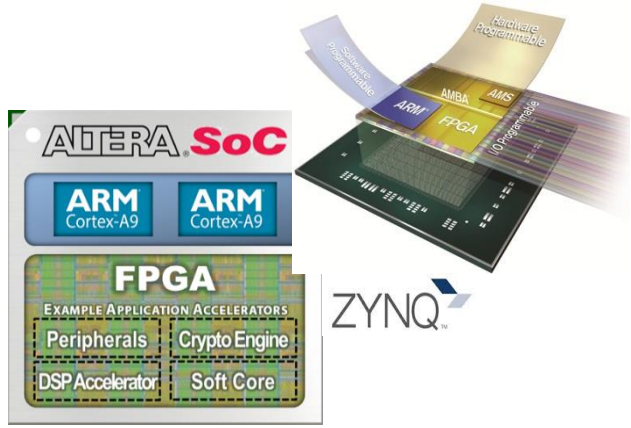
The embedded hardware might be very different...

DSP

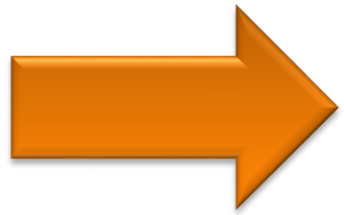
MCU



SoC/FPGA



Workflow | Idea to implementation



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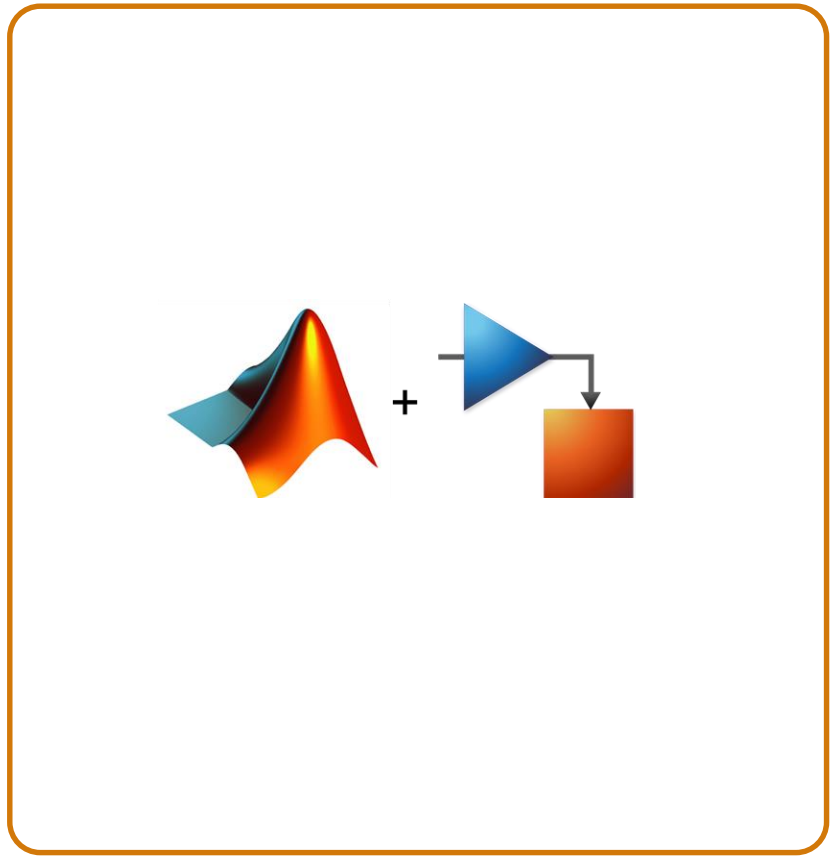
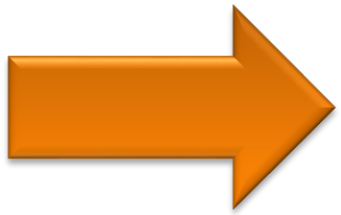
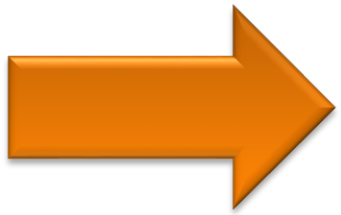




Prototyping

Workflow | Idea to implementation



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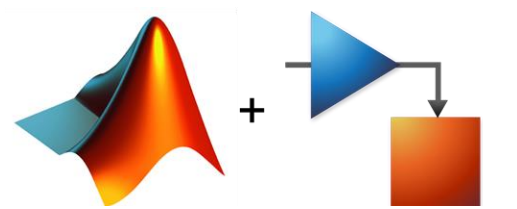


Accelerate the Design and Prototyping of Signal Processing Algorithms

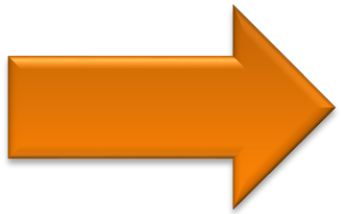
15:00–15:30

In this session we show how you can use MATLAB® for designing and prototyping an algorithm that operates on streaming data. This way of working makes simulations fast and memory efficient. We also show how to test algorithms against data coming from low-cost hardware such as a smartphone or Raspberry Pi™. In the session Optimization and Implementation of Embedded Signal Processing Algorithms, we integrate the algorithm in a larger system that is targeted for a specific hardware platform.

Daniel Aronsson, MathWorks

You will see how to:

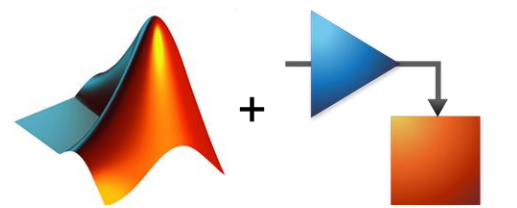
- Work with streaming data
- Accelerate simulations by keeping the memory footprint low
- Test algorithms against low-cost hardware



Prototyping

Production

Workflow | Idea to implementation



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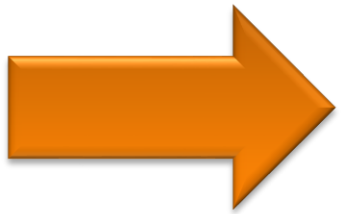
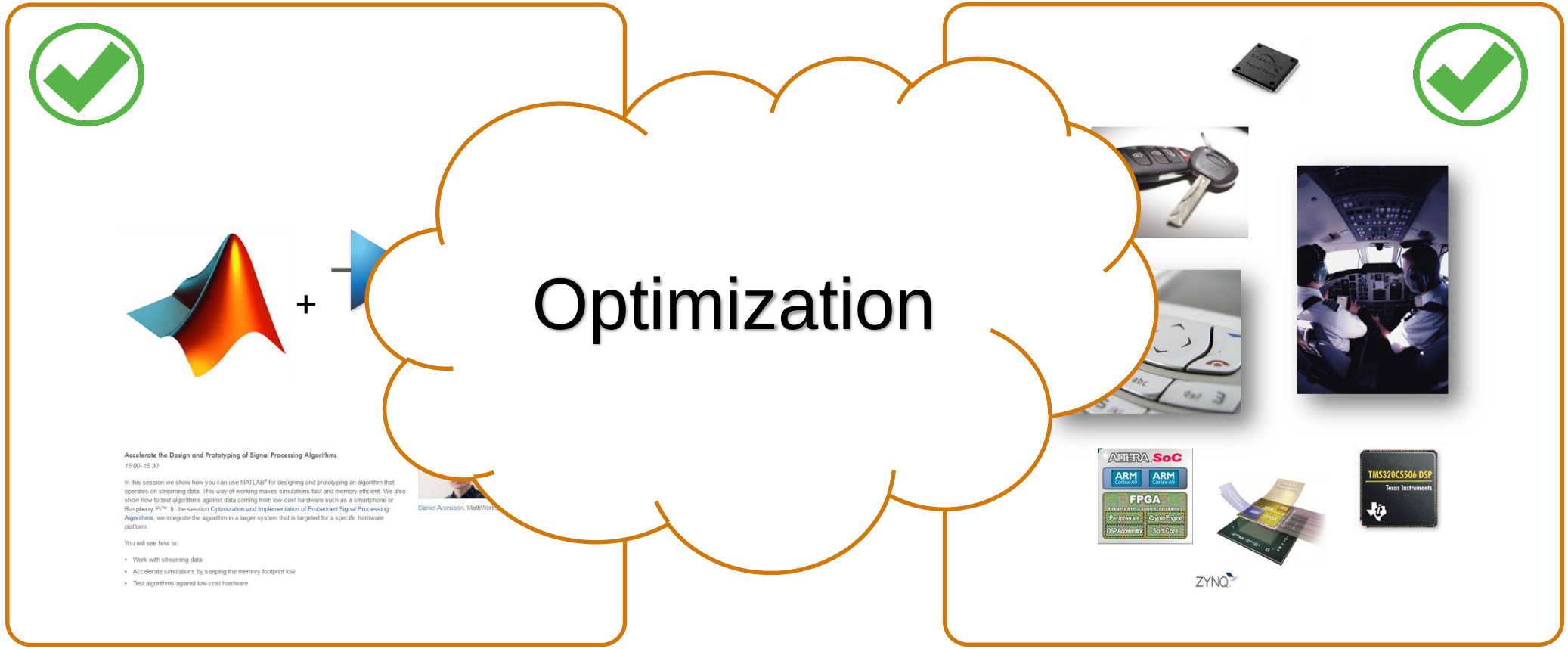


Prototyping

Production

Workflow | Idea to implementation



Prototyping

Production

Let’s take a step back...

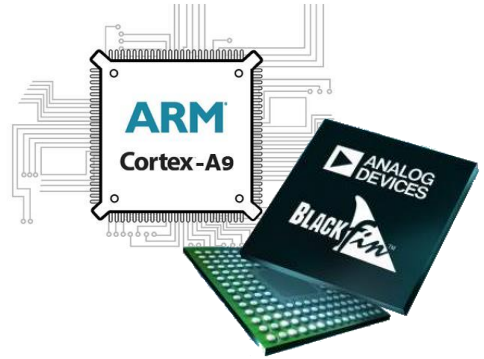
What do we mean with optimization?

Speed

Memory

Readability

Target

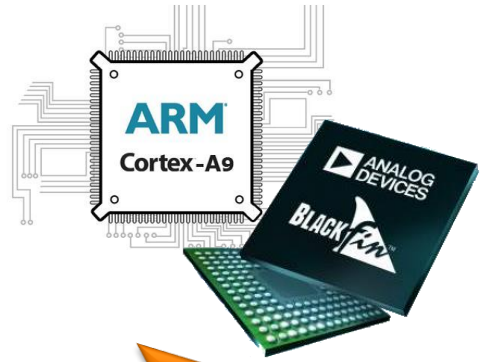


Speed

Memory

Readability

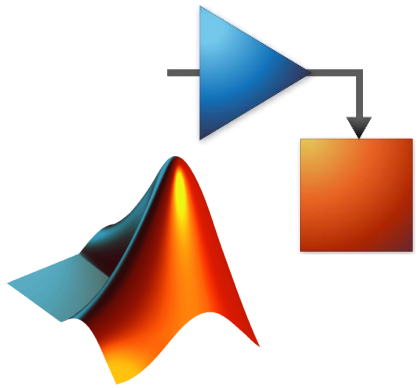
Target



Fixed point

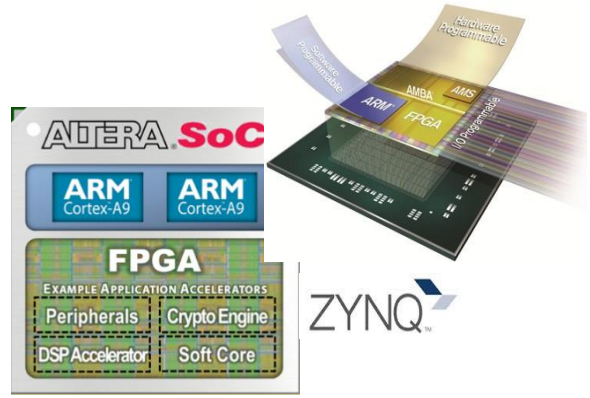
Optimization at different phases in the development...

Prototyping



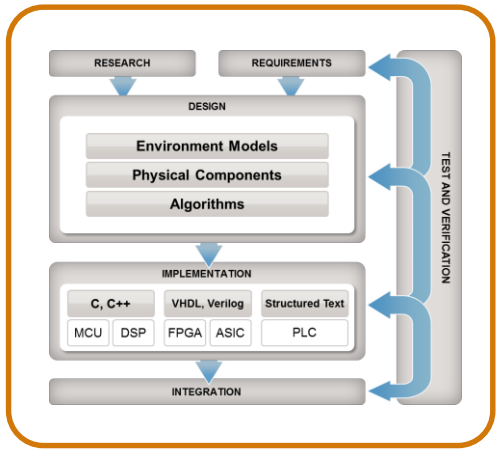
C

SoC/FPGA



Optimization at different phases in the development...

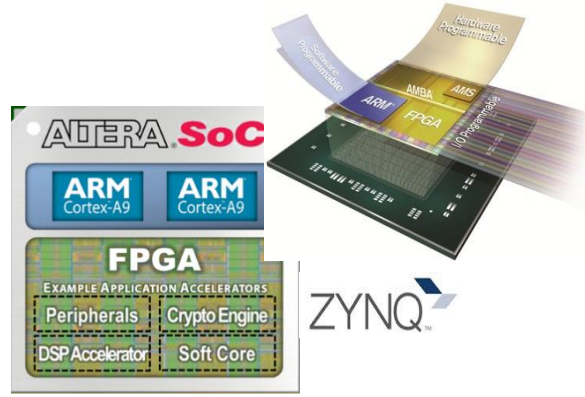
Prototyping



Model-Based Design

C

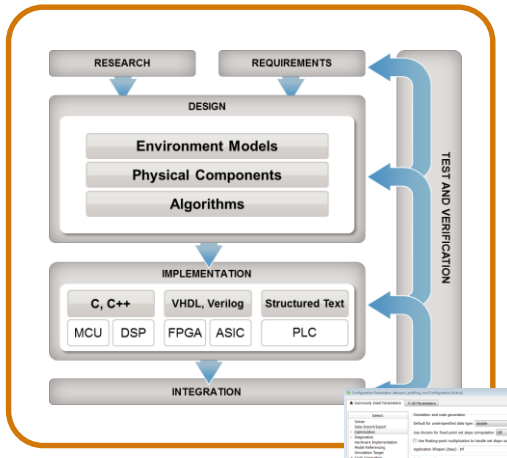
SoC/FPGA

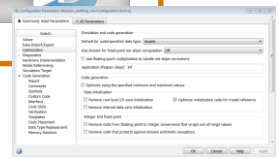


Optimization at different phases in the development...

Model-Based Design

Prototyping





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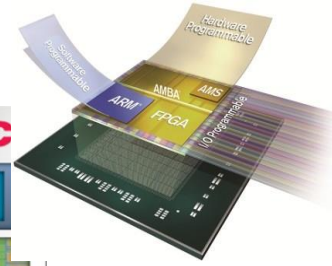
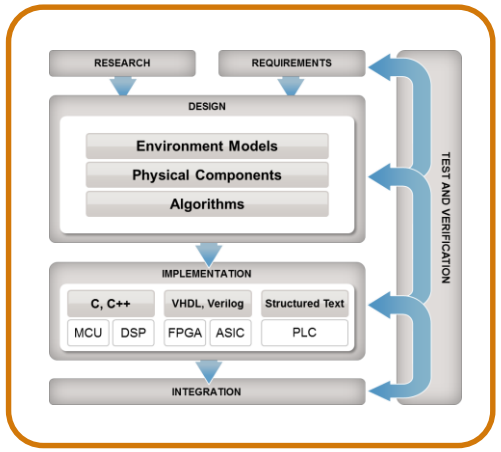


ZYNQ

Optimization at different phases in the development...

Prototyping



How can I analyze performance and optimize code in MATLAB/Simulink?

Profiling!

Profiling in MATLAB

How long did it take?

- tic/toc

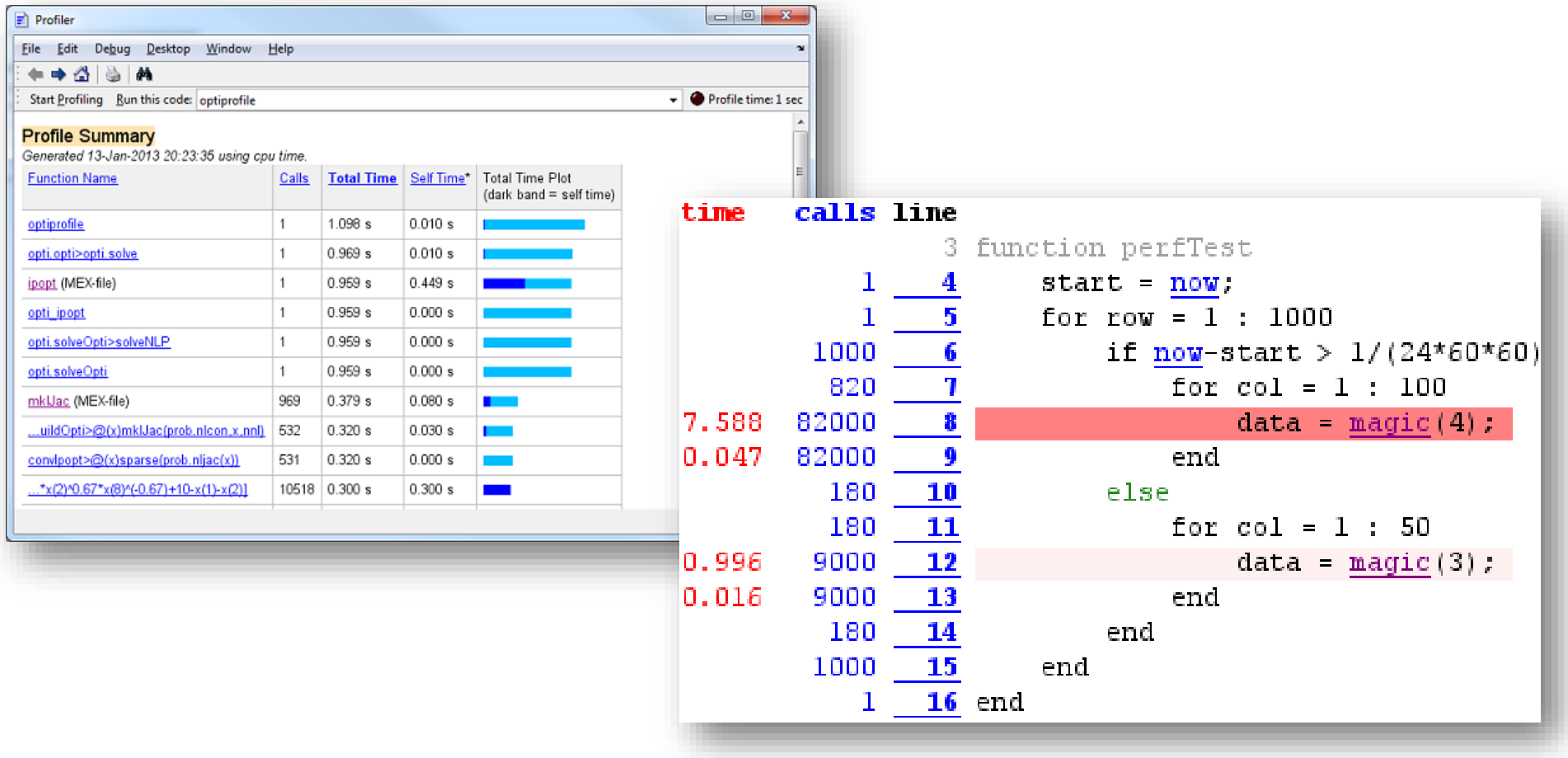
```
% start timer
tic

% execute code
out = myFunction(in);

% stop timer (and store
% elapsed time)
et = toc;
```

Where are the bottlenecks?

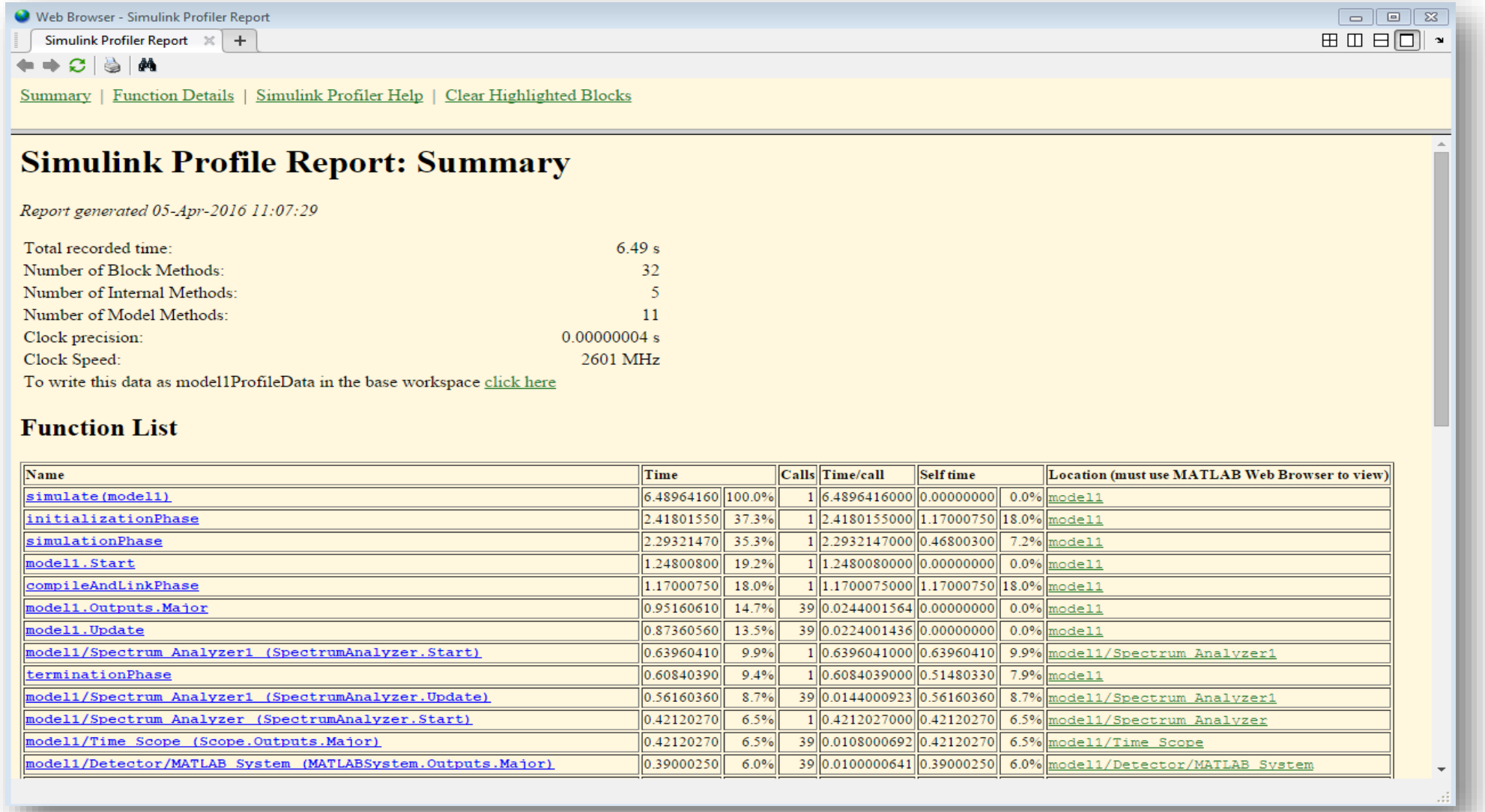
- profile

```
% turn on profiler
profile on

% execute code
out = myFunction(in);

% turn off profiler
profile off
% open html report
profile report
```

Profiling in MATLAB



Profiling in Simulink



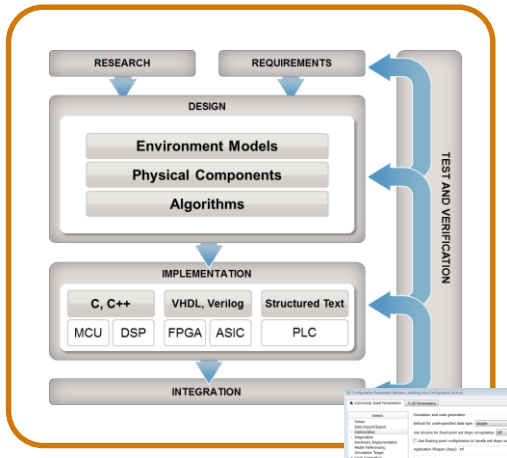
Example

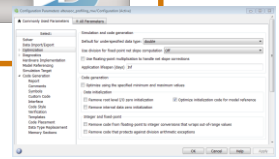
(Profiling when prototyping in MATLAB)

Optimization at different phases in the development...

Model-Based Design

Prototyping





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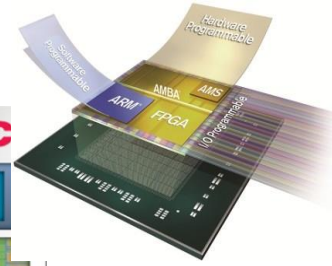
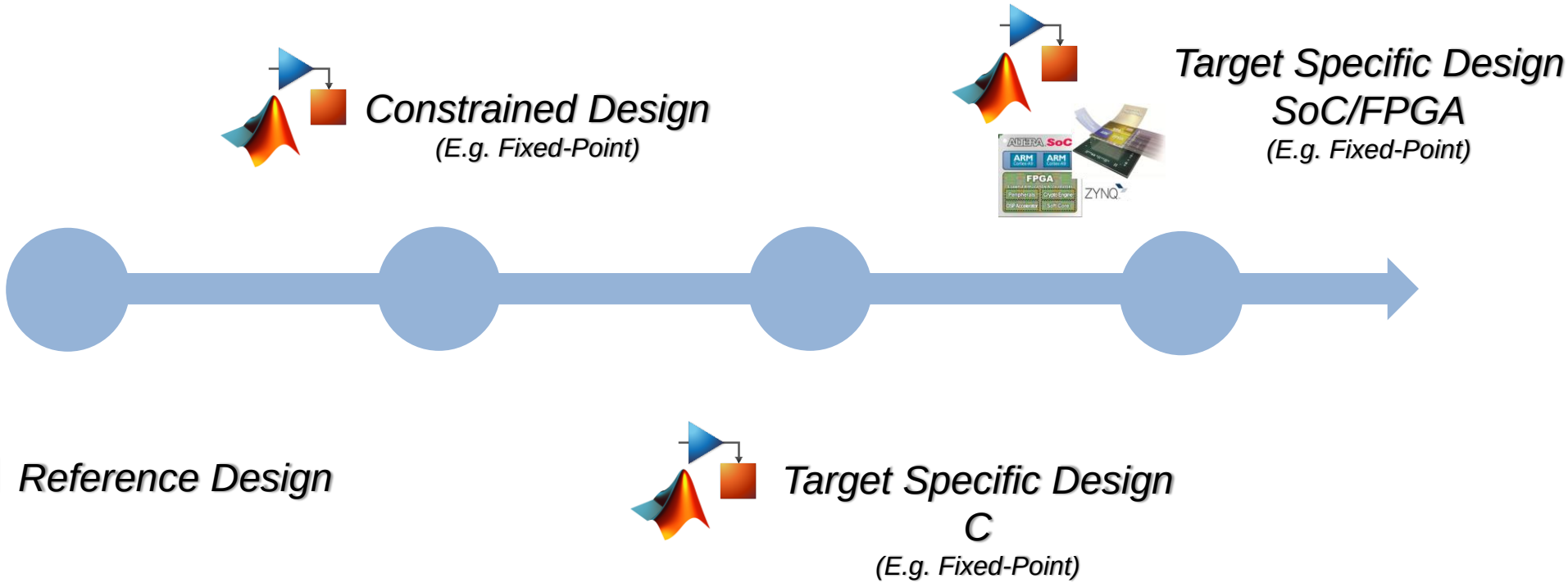


ZYNQ

Now, lets take a closer look of the workflow in embedded design!

Example: Workflow for embedded design



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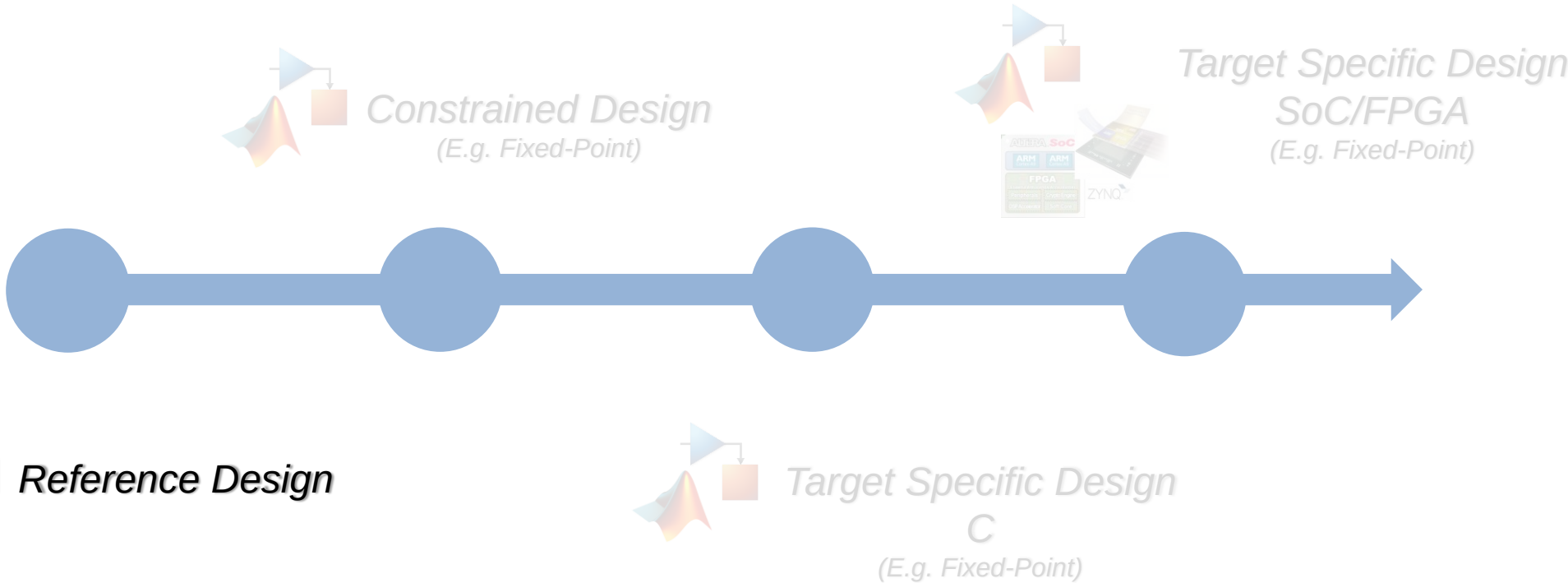

Key Detection Algorithm

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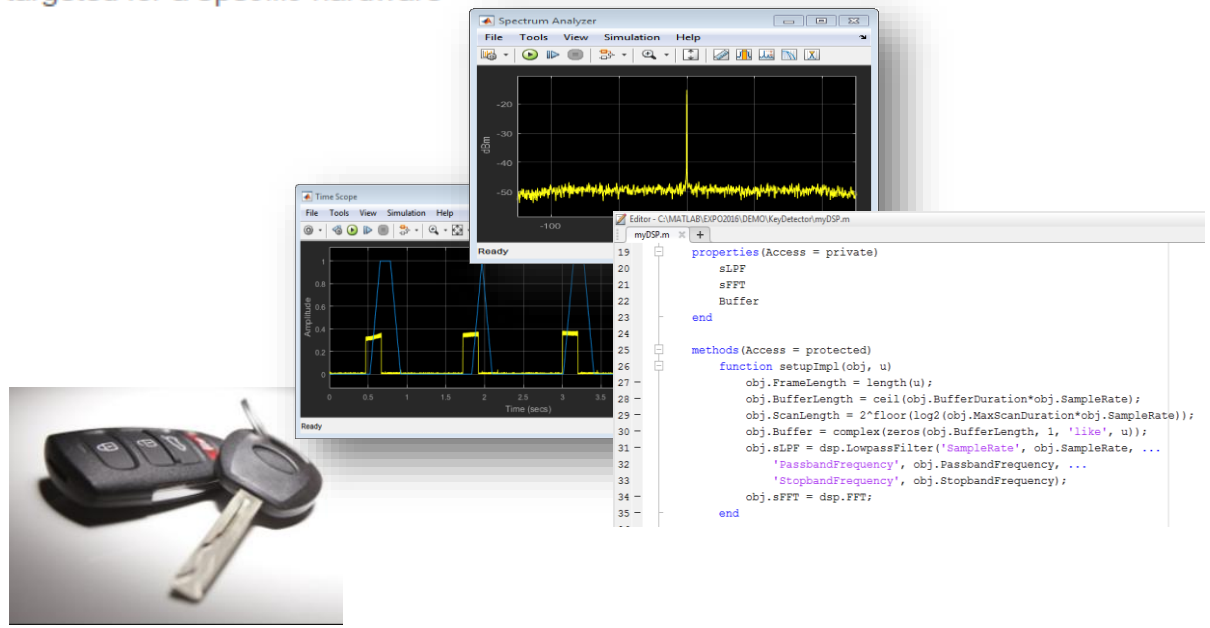
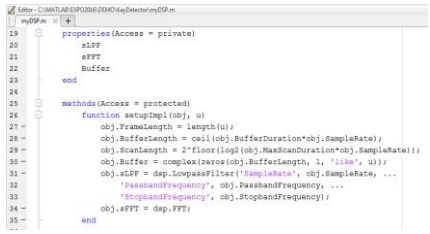
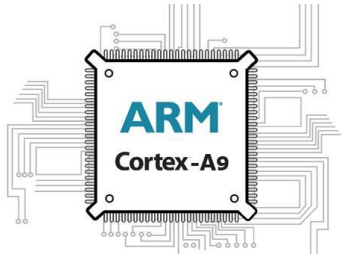


Component Integration

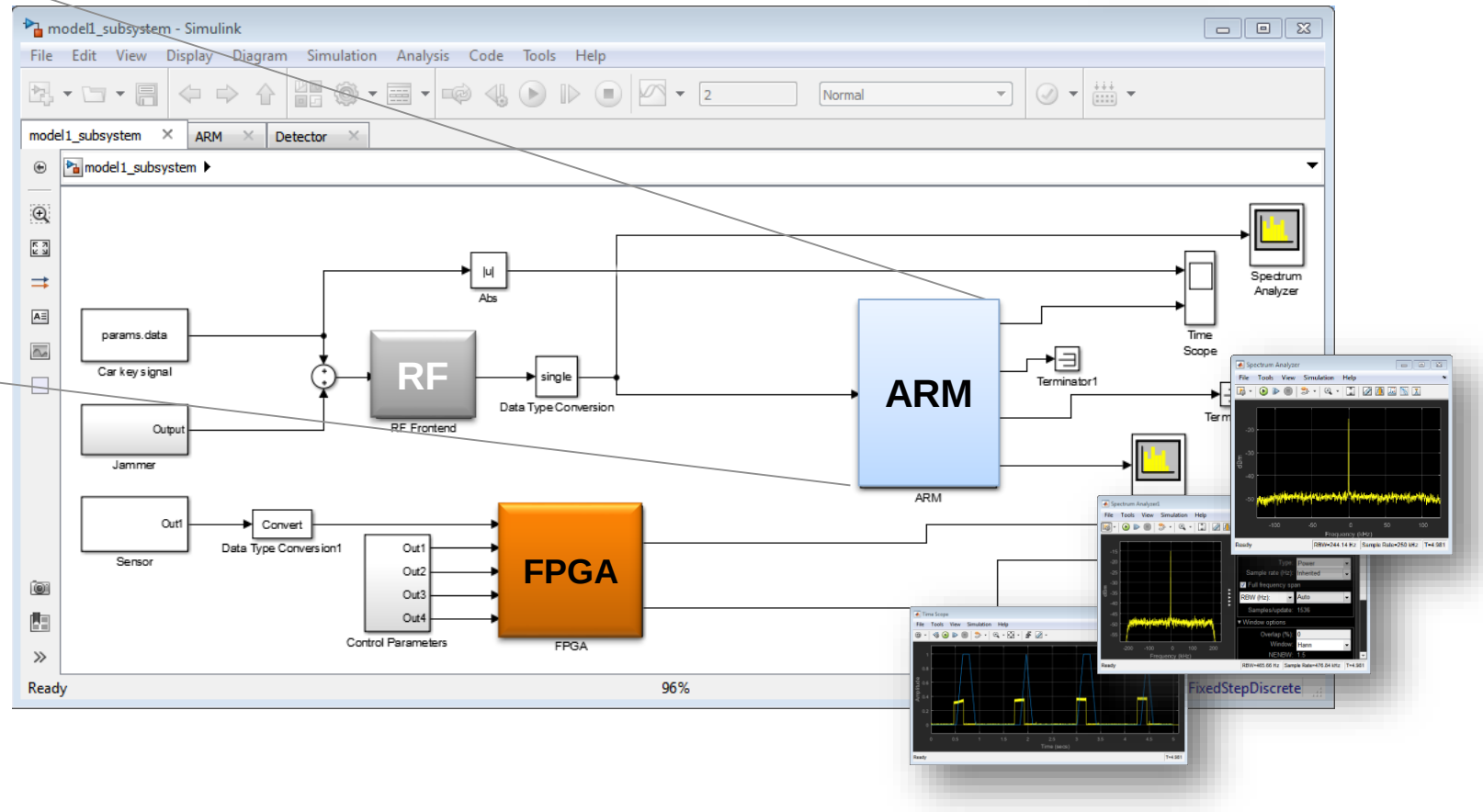
System Object
(Reference Design)





Optimize

System Design



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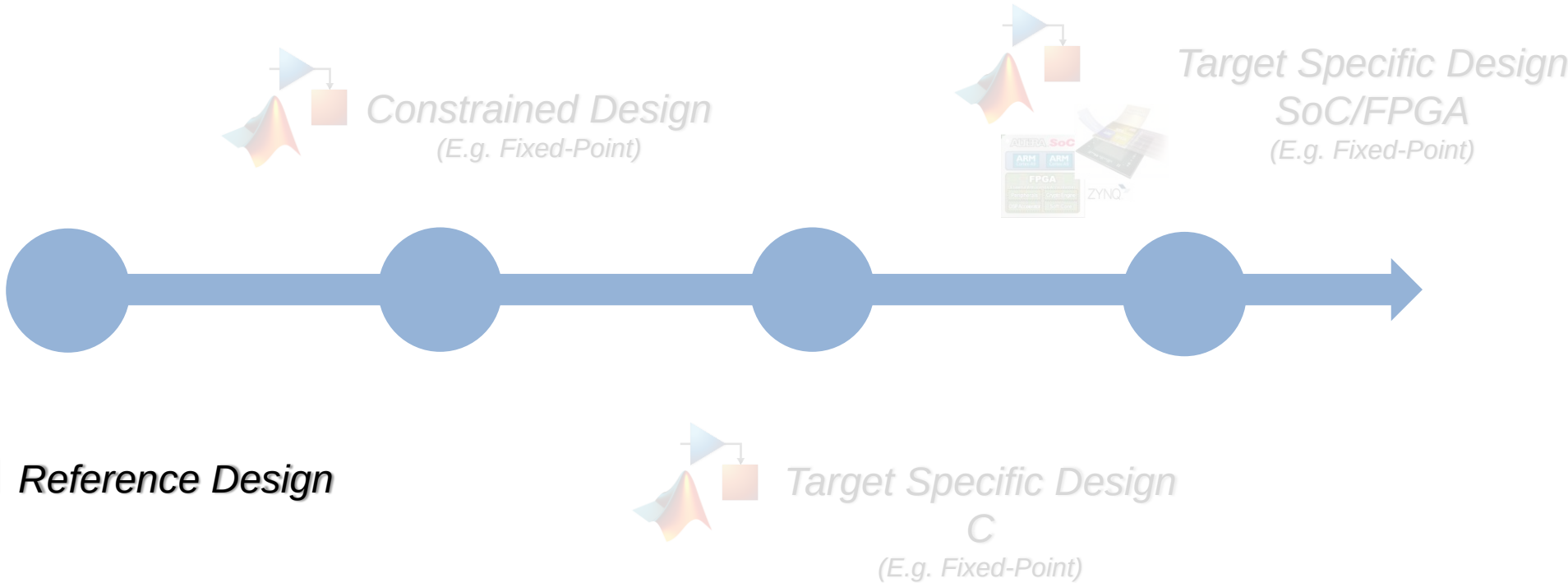

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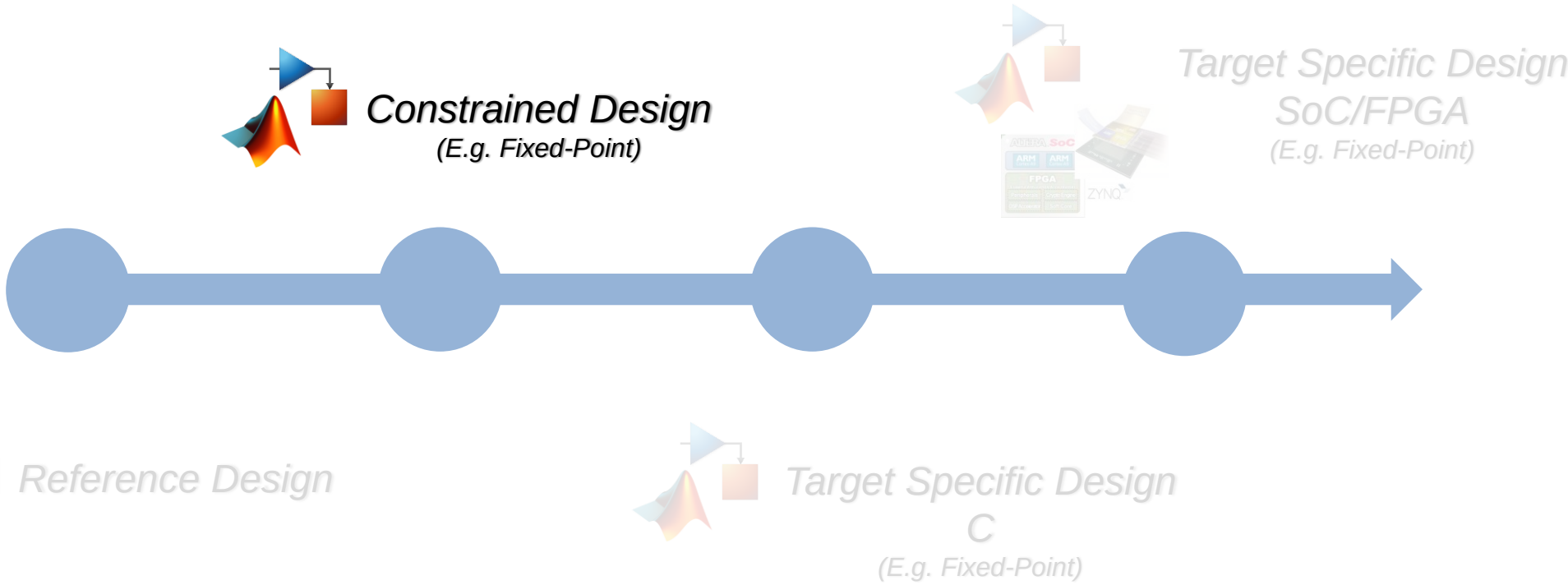

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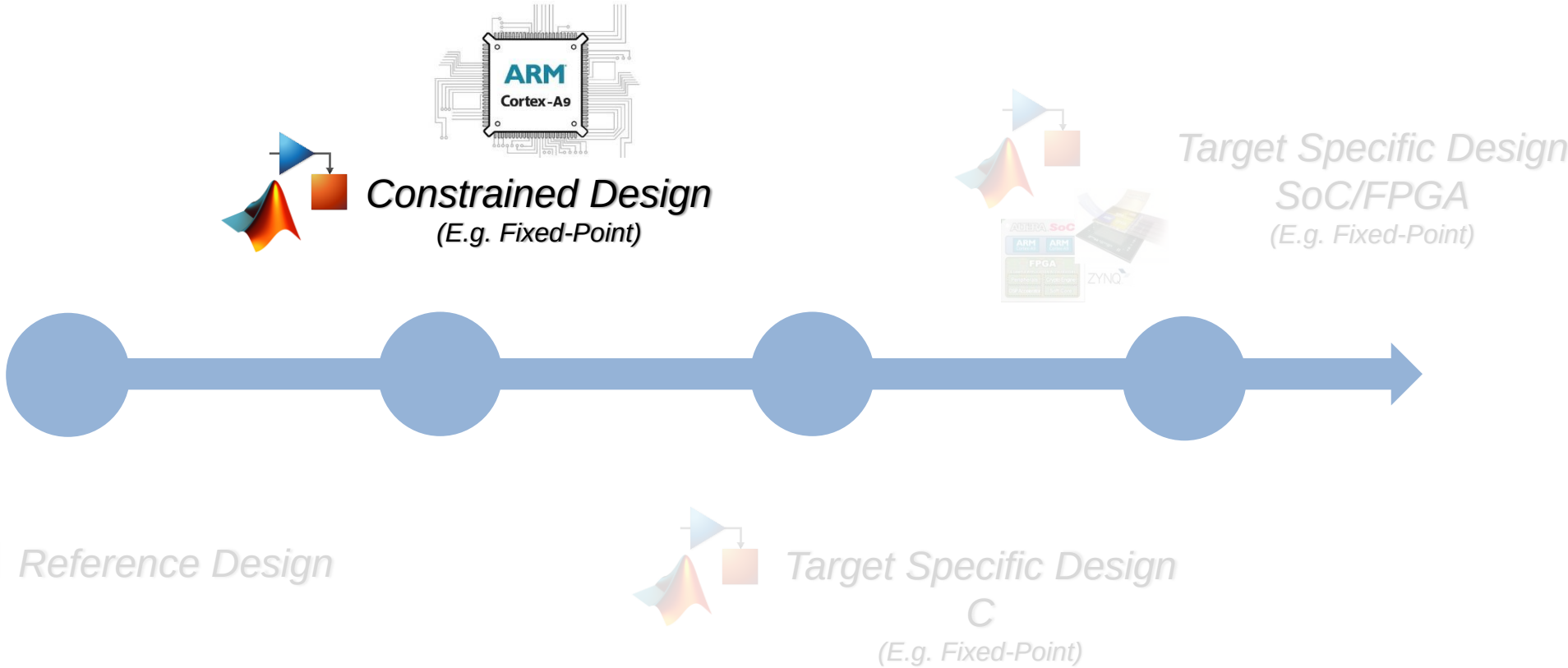

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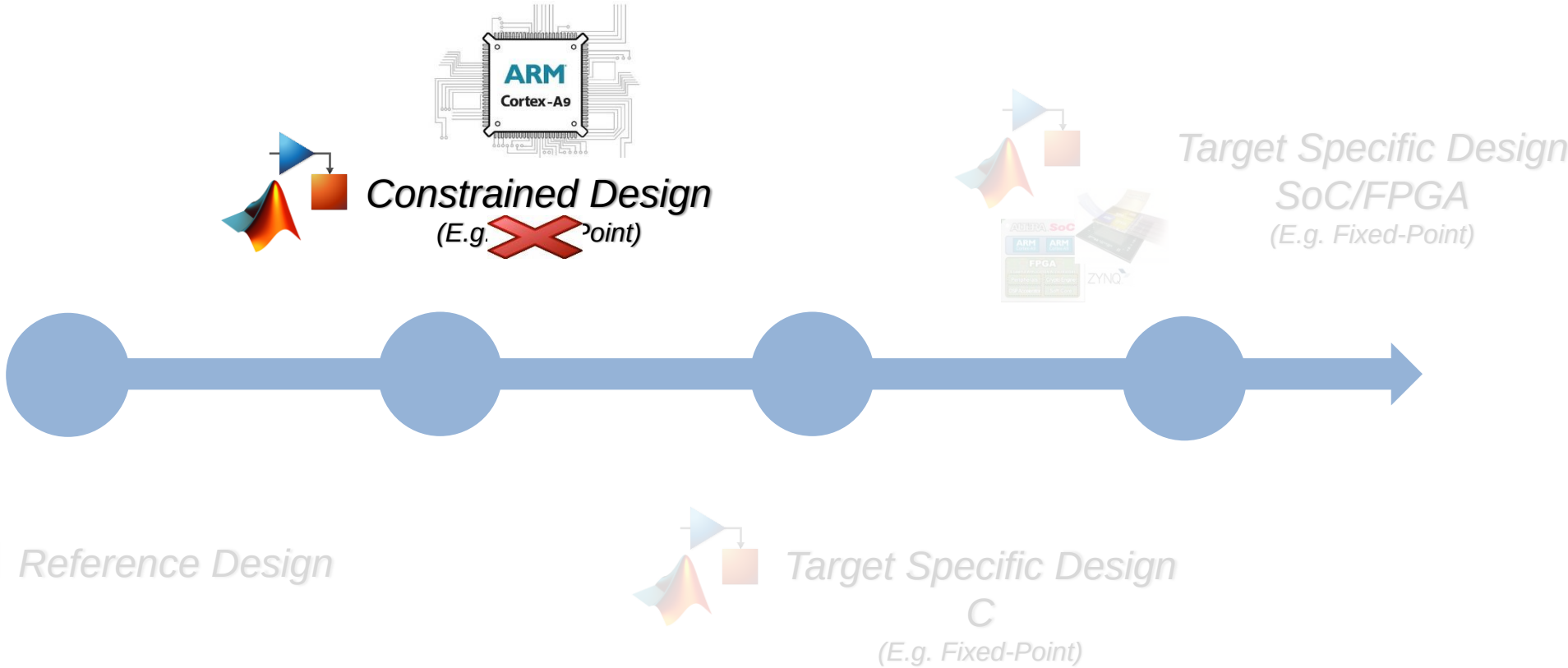

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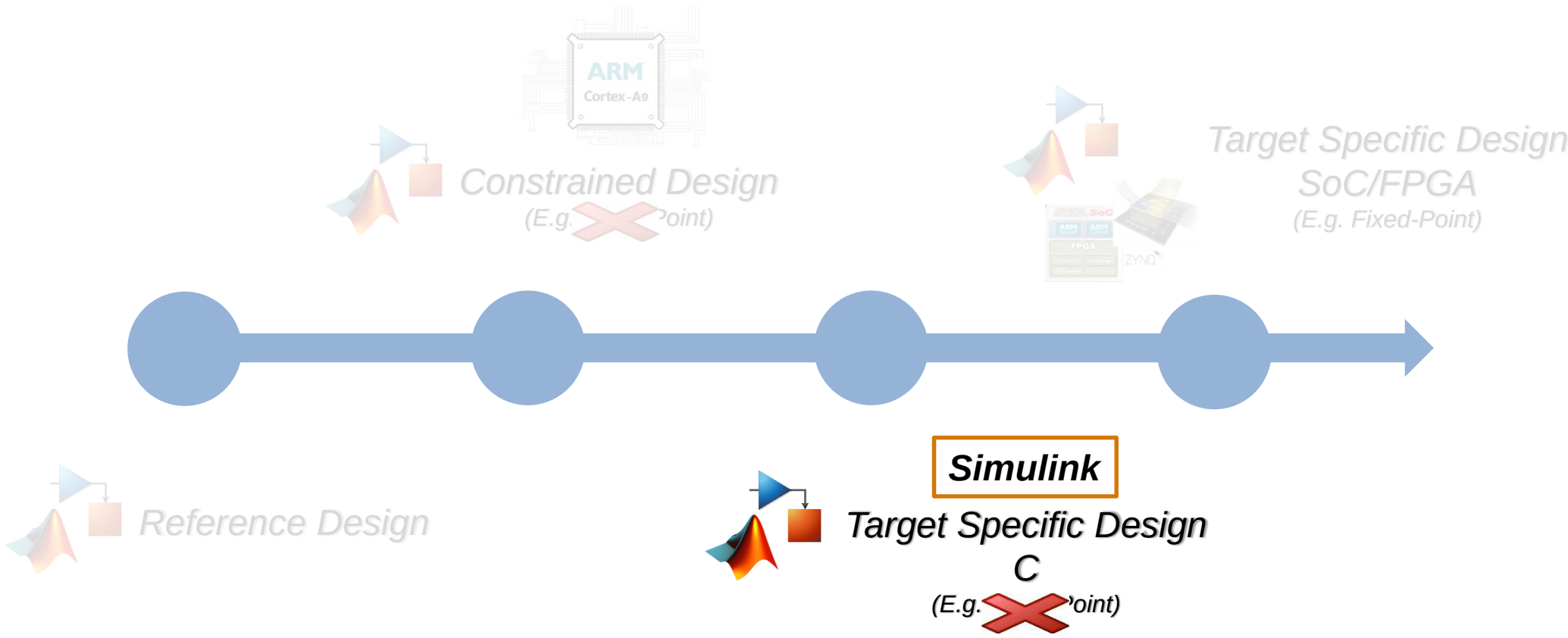
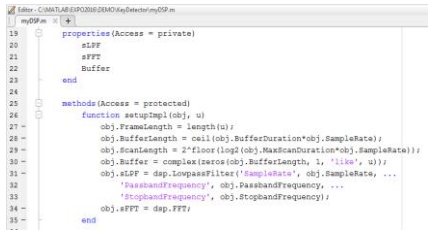


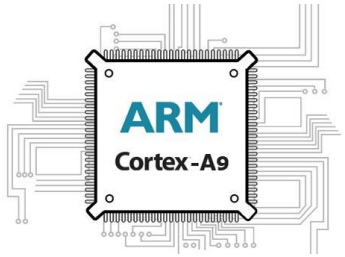
DEMO

(System Integration and Generating Code for ARM Cortex A9 from Simulink)
(Including verification with PIL)

Component Integration

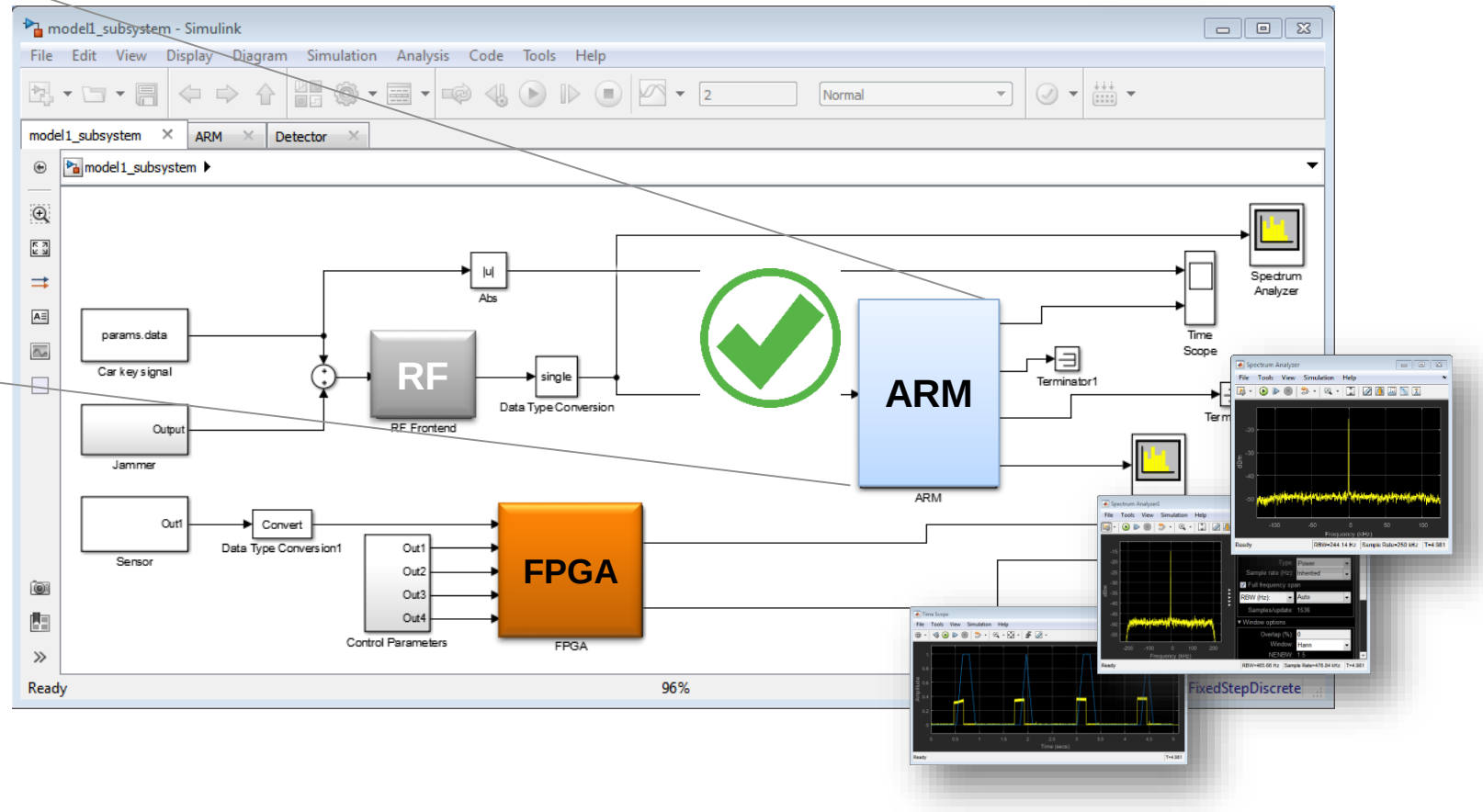
System Object
(Reference Design)





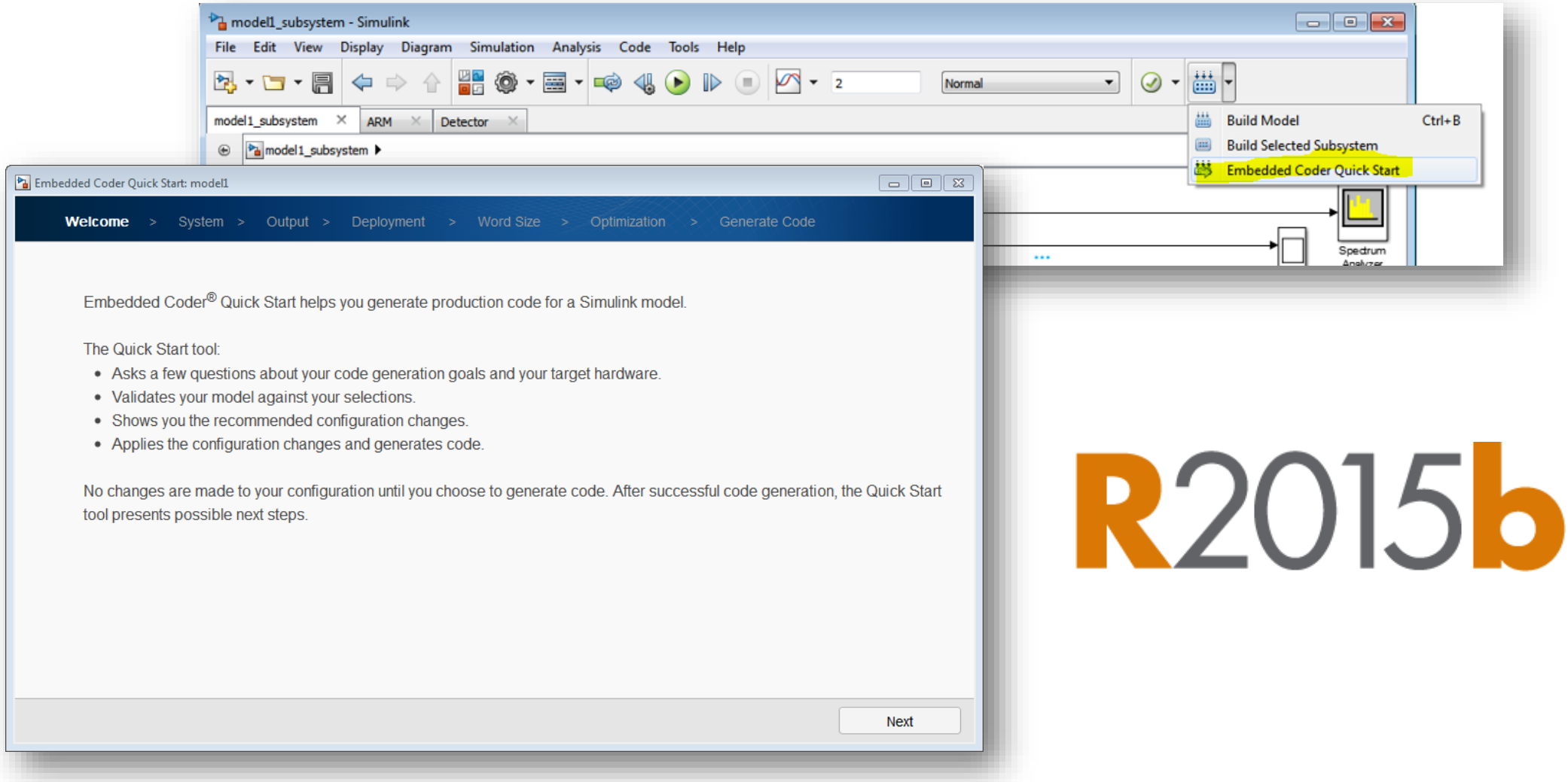
Optimize

System Design



A few words about Embedded Coder...

Embedded Coder Quick Start



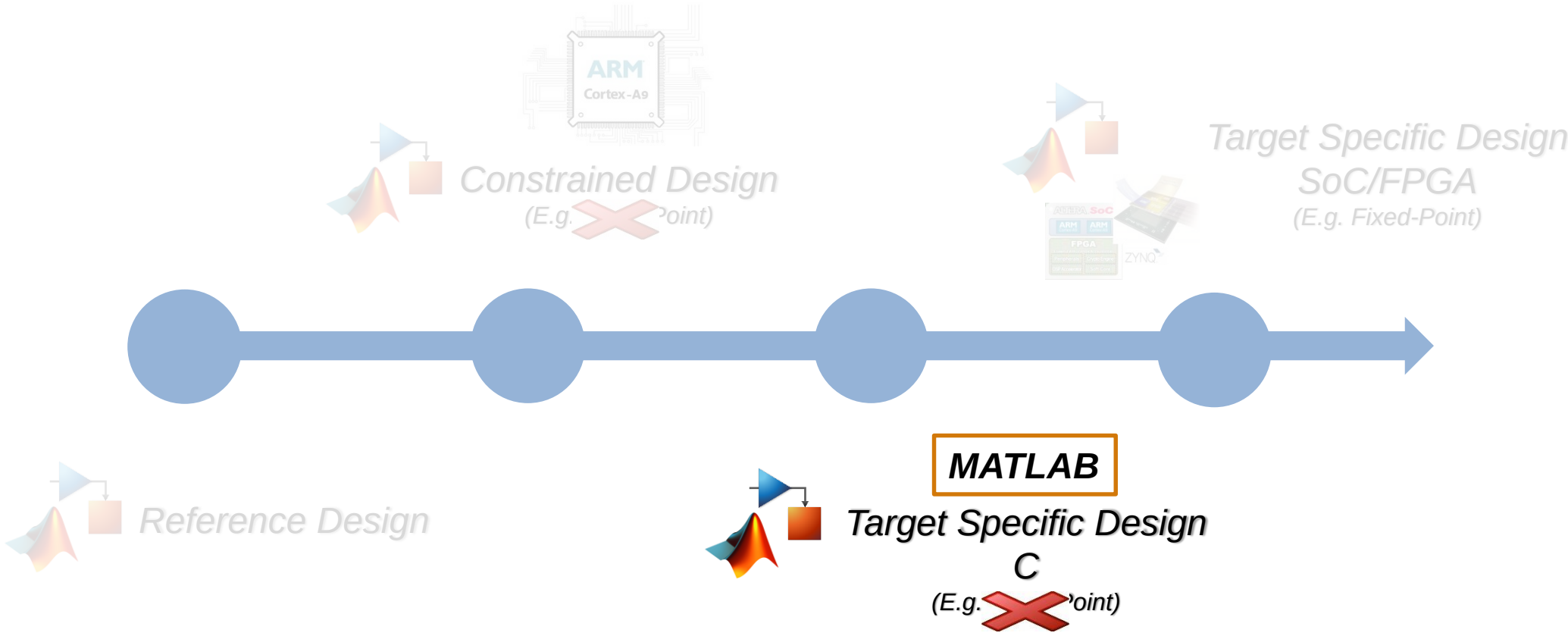
R2015b

DEMO

(Embedded Coder Quick Start)

Another use case...

Example: Workflow for embedded design

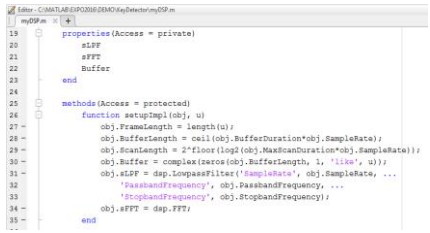


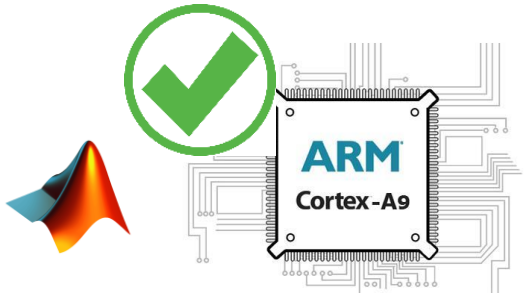
Example

(Generating Code ARM Cortex A9 from MATLAB)

Component Integration

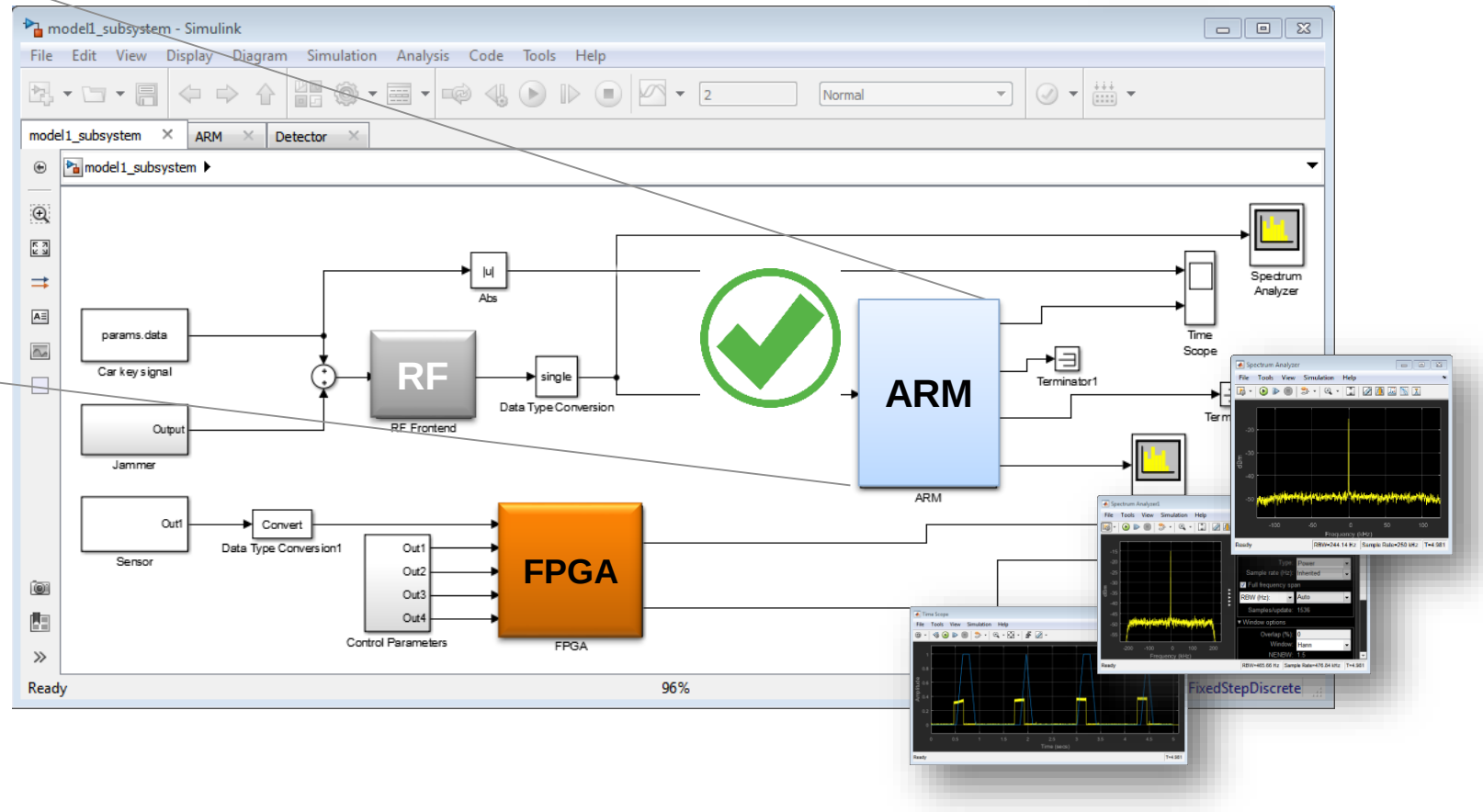
System Object
(Reference Design)





Optimize

System Design



Example: Workflow for embedded design

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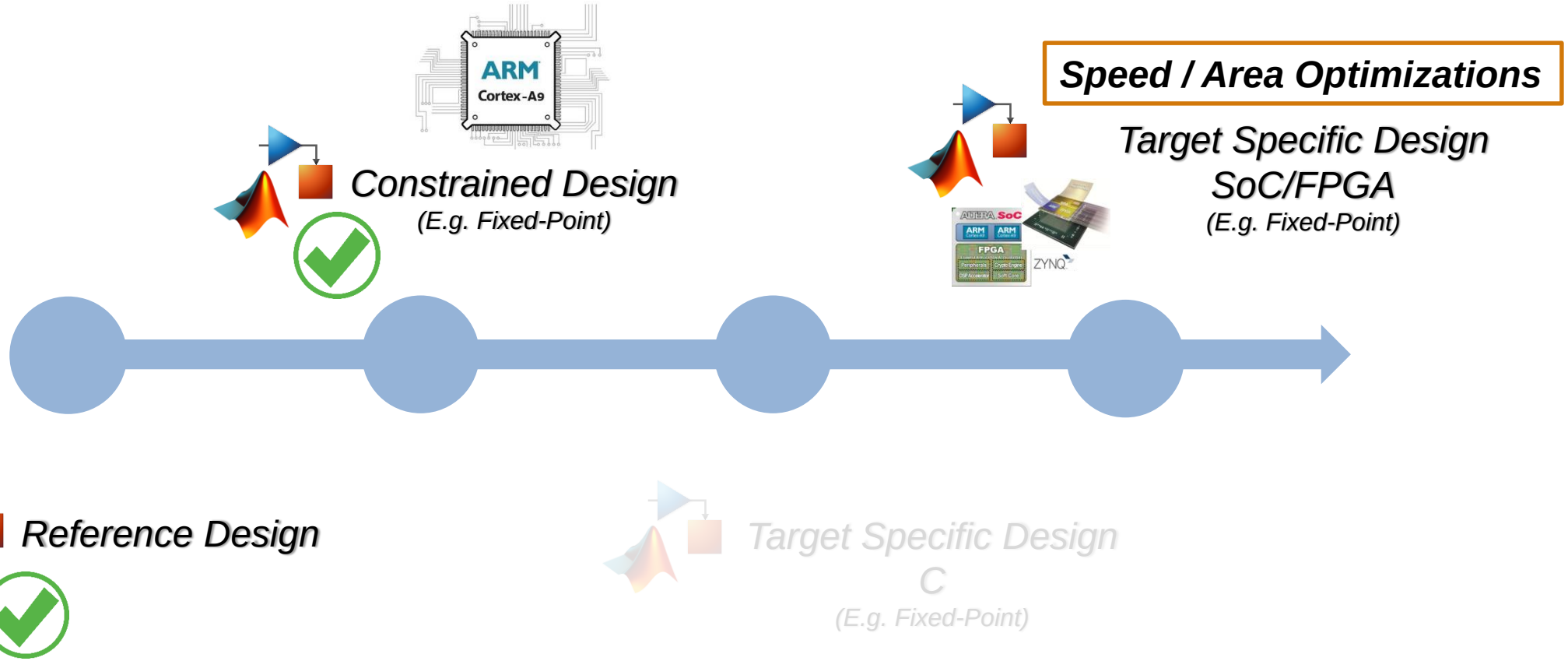
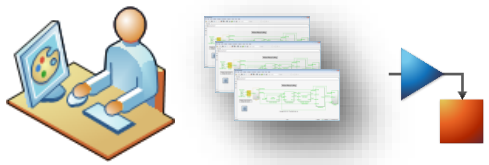
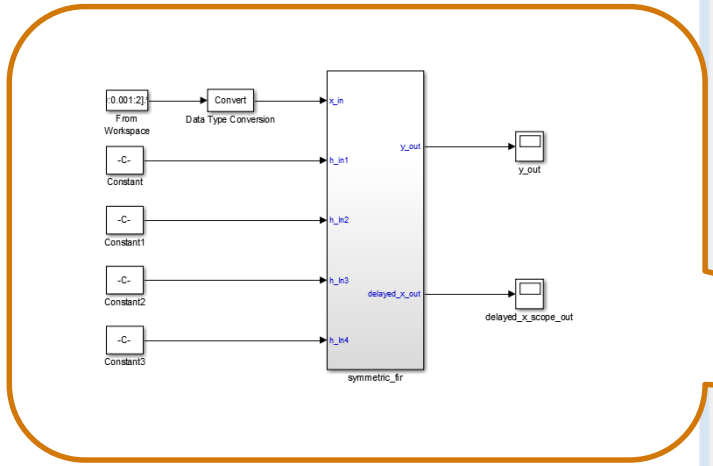
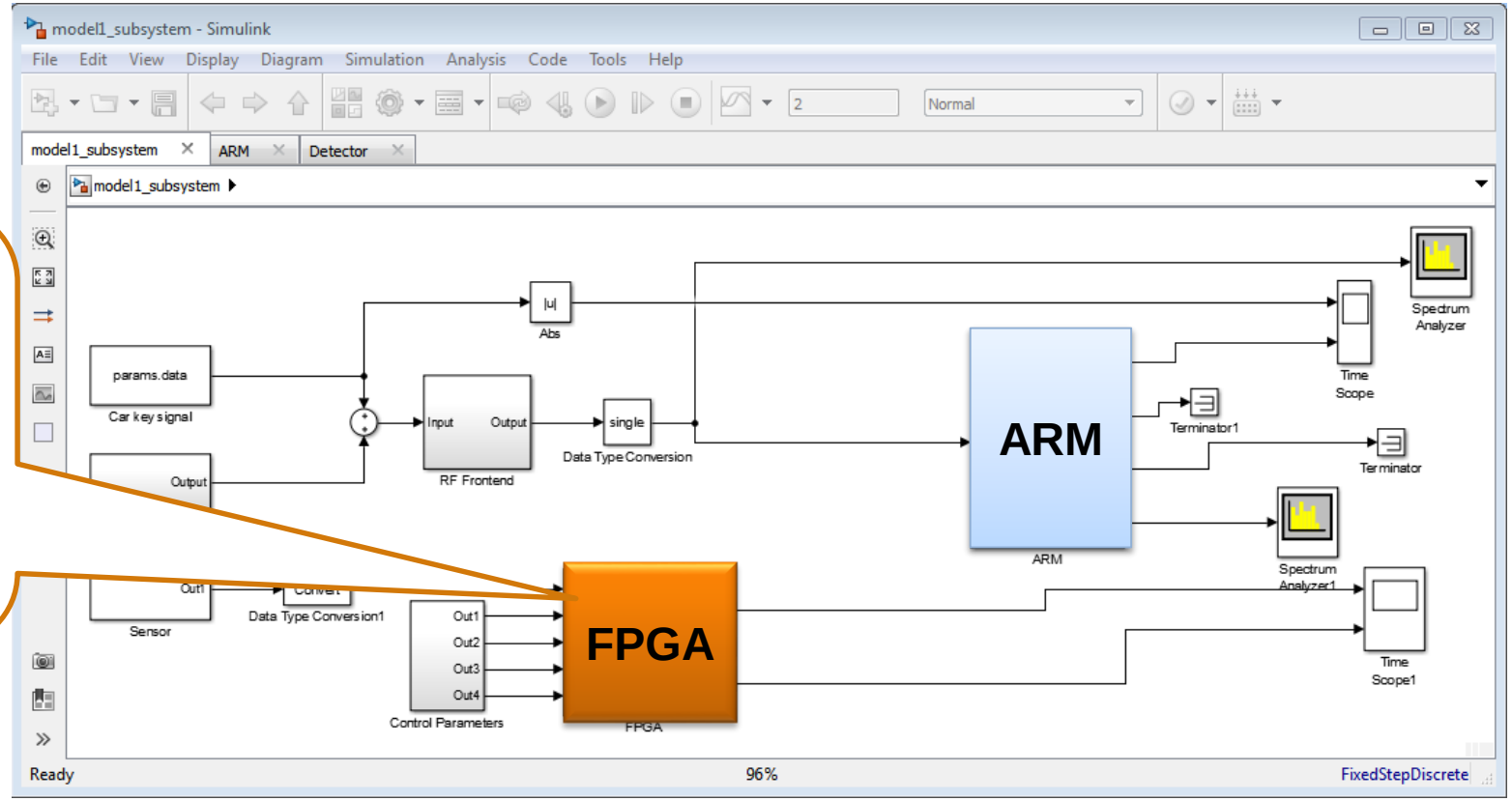


Area Optimization for FPGA implementation





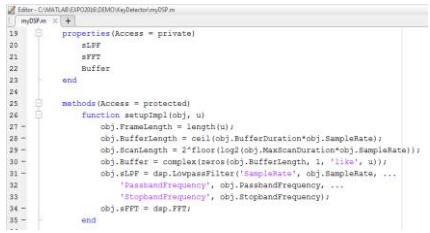


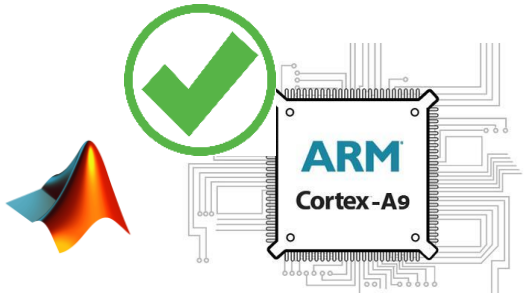
Example

(Area Optimization for FPGA Implementation)

Component Integration

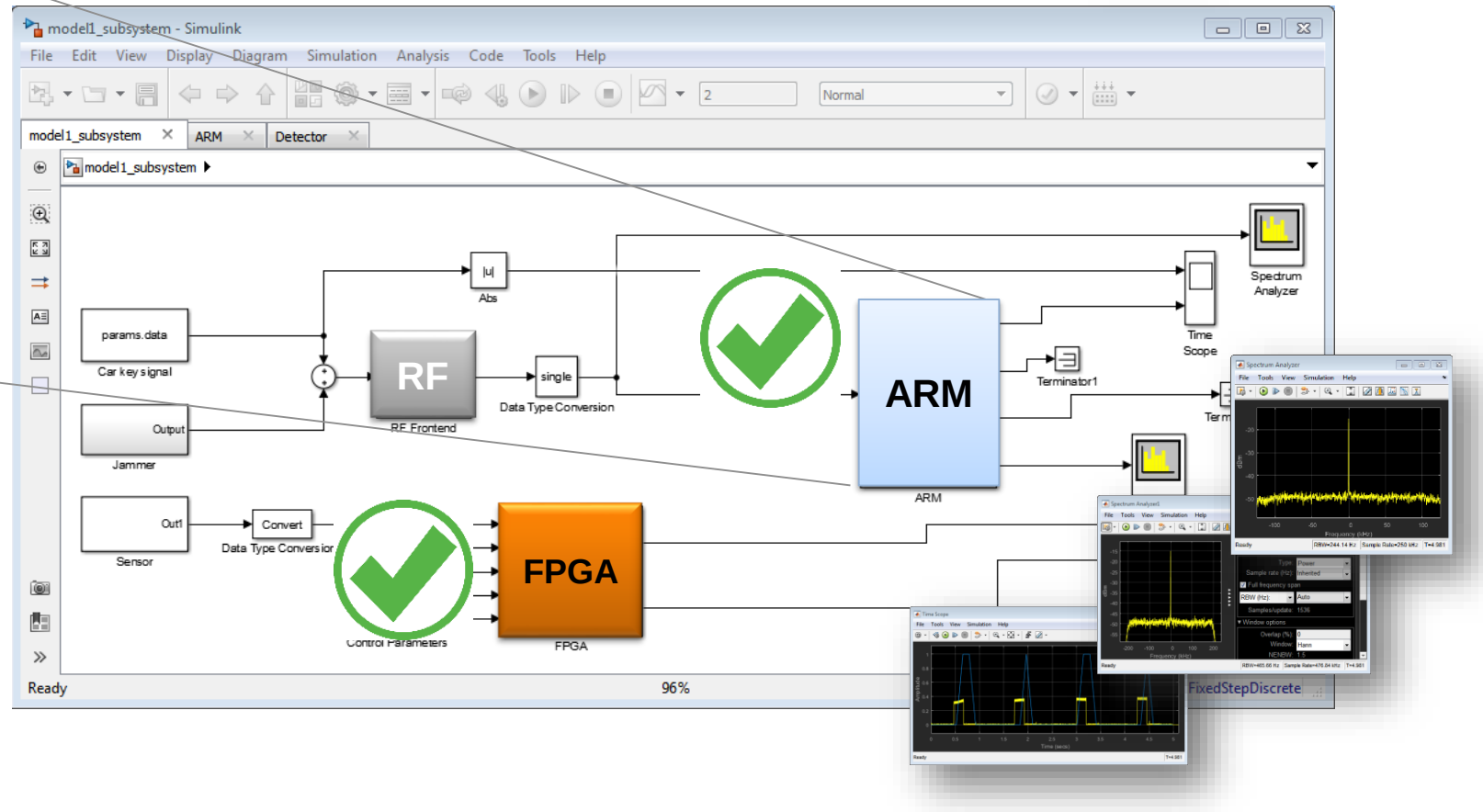
System Object
(Reference Design)





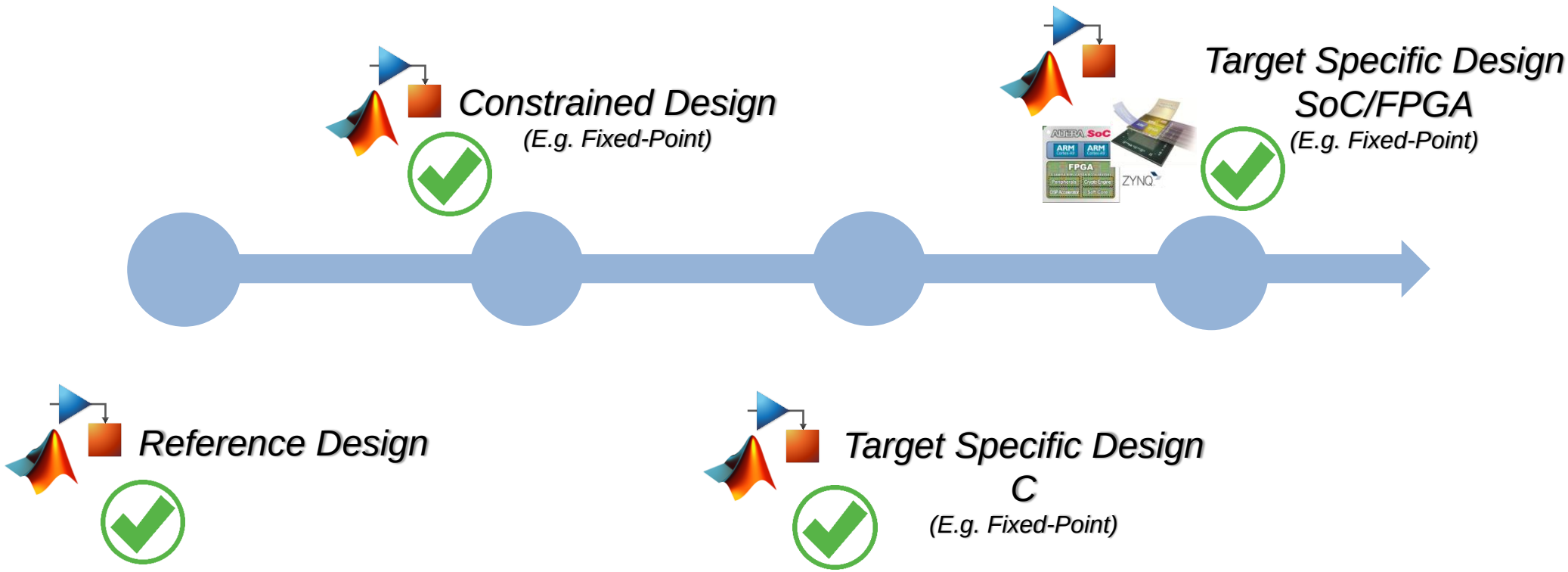
Optimize

System Design



Summary

Optimization and Implementation of Embedded Signal Processing Algorithms



Questions?