

Model Driven Engineering, Modularity and Re-use

3rd of October 2018



Leonardo is among the top ten global players in Aerospace, Defence and Security and Italy's main industrial company. It is organised into seven business divisions.

Listed on the Milan Stock Exchange (LDO), in 2017 Leonardo recorded consolidated restated revenues of 11.7 billion Euros and has a significant industrial presence in Italy, the UK, the US and Poland.

ITALY



UK



USA



POLAND



▪ Helicopters



▪ Aircraft



▪ Aerostructures



▪ Airborne & Space Systems



▪ Land & Naval Defence Electronics



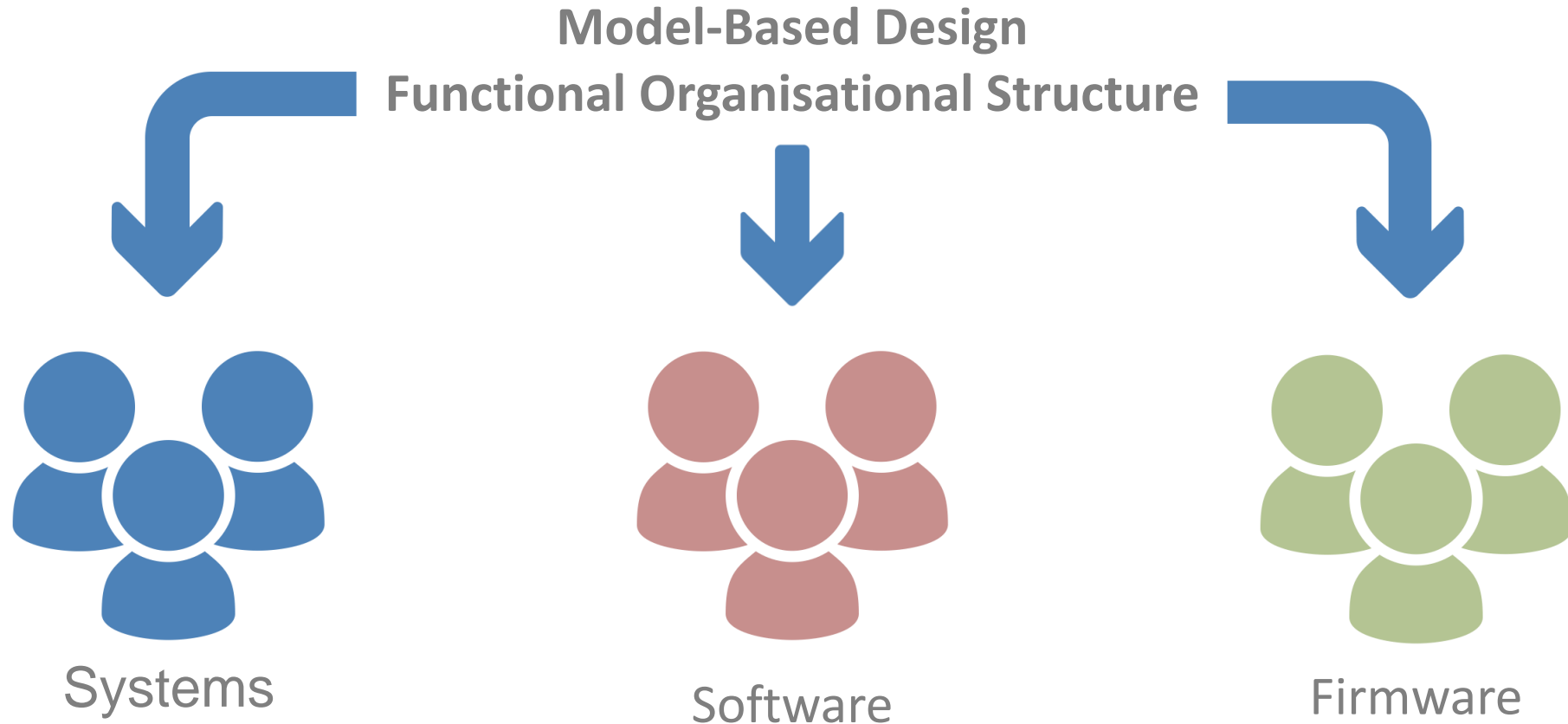
▪ Defence Systems



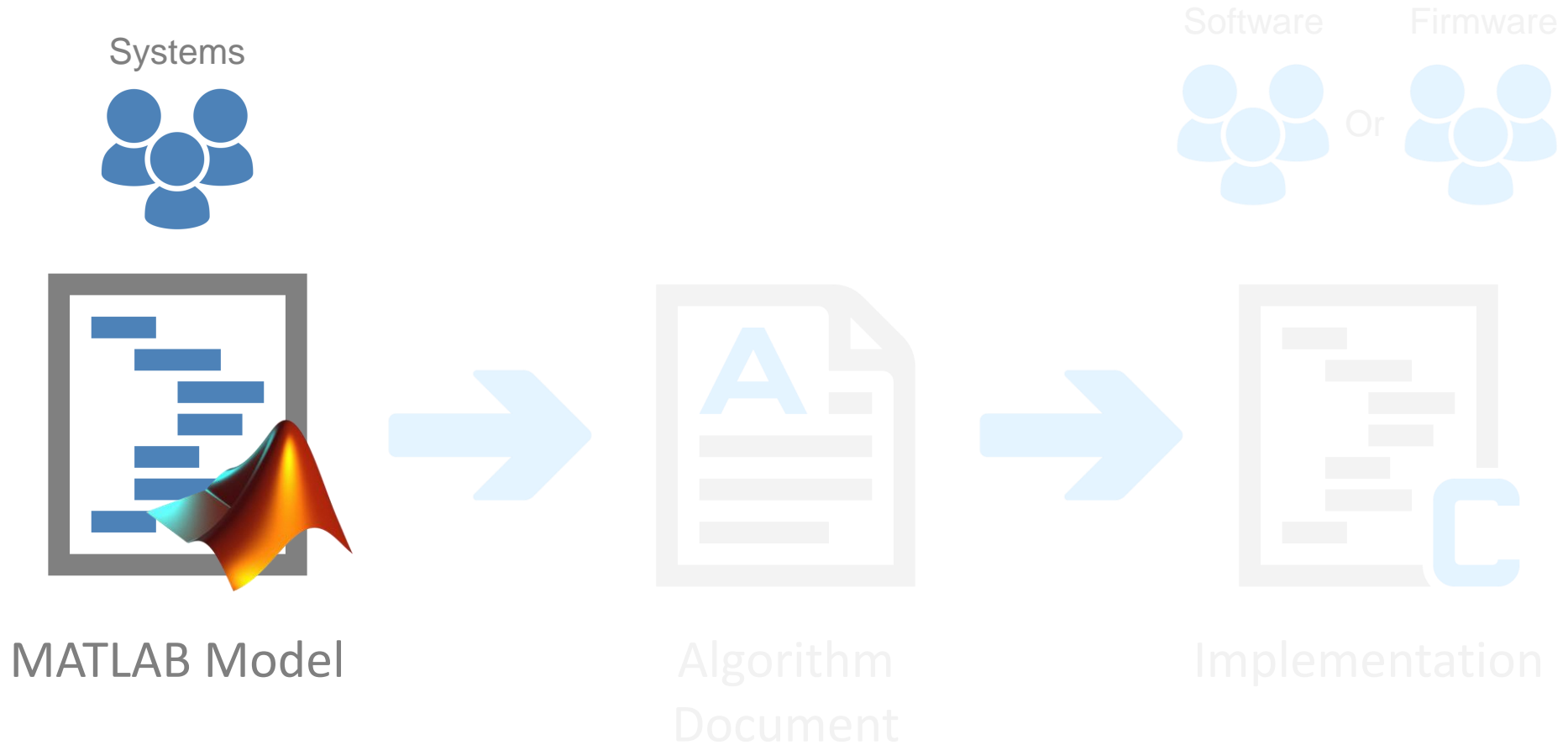
▪ Security & Information Systems



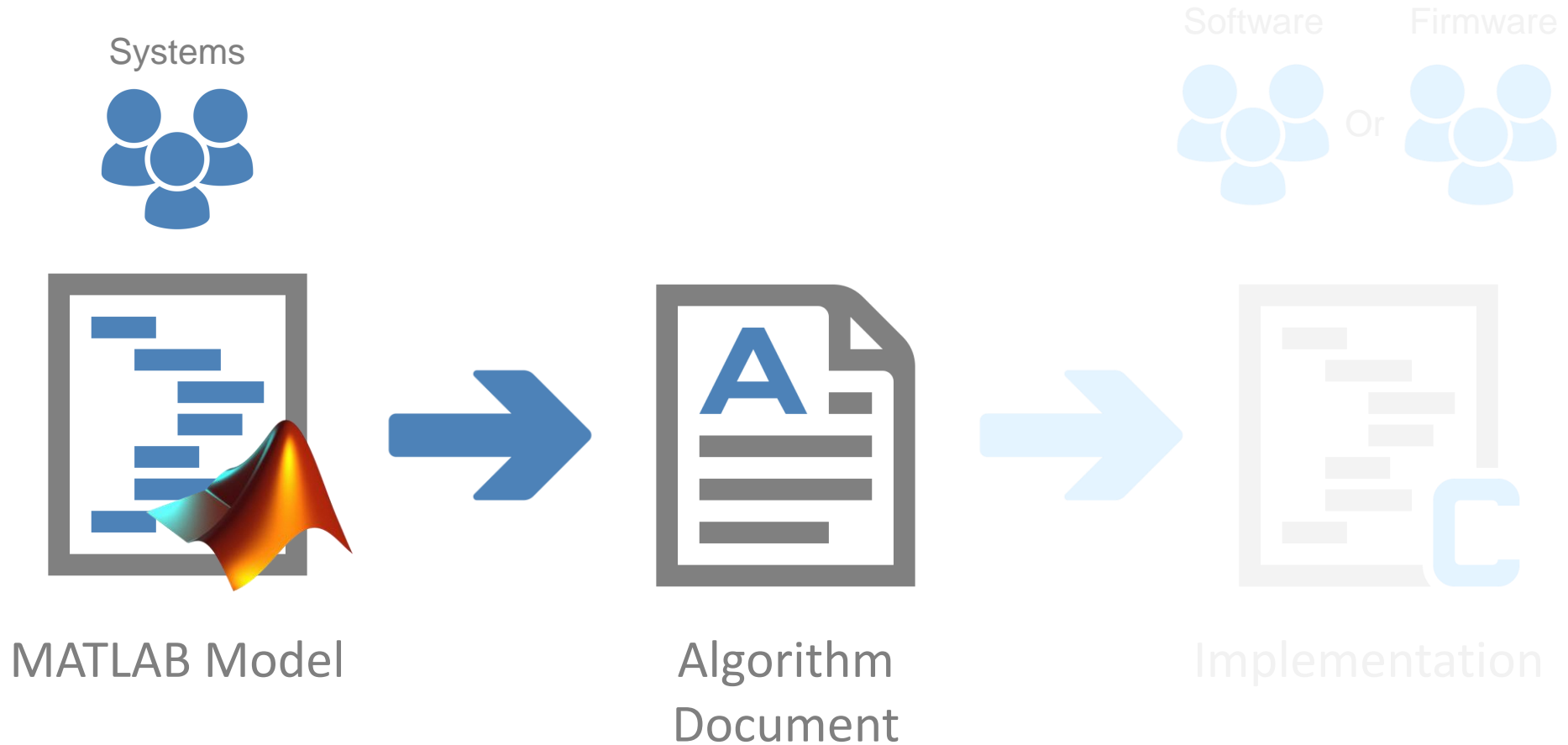
Airborne Radar & Advanced Targeting



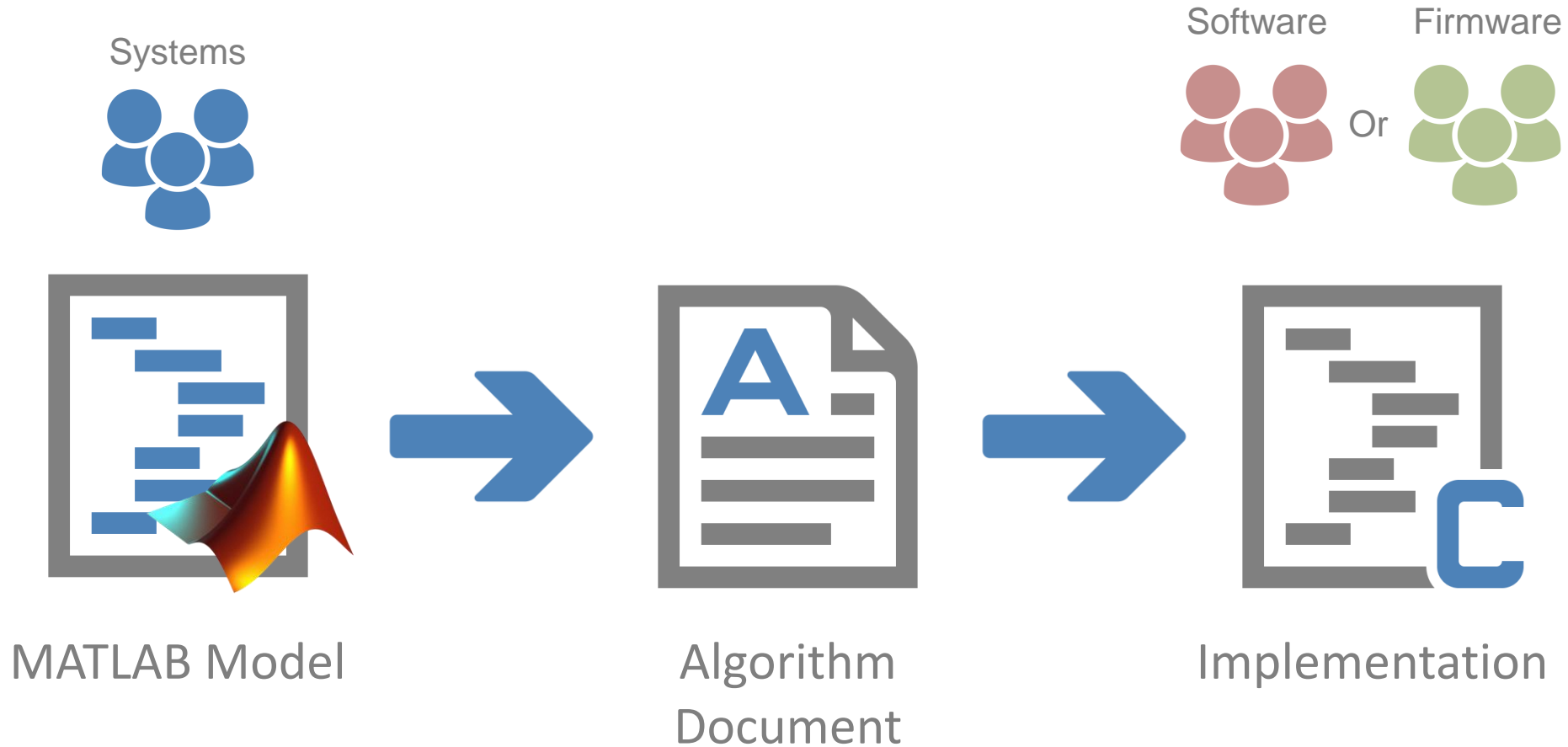
Organisational structure reflected in processes



Organisational structure reflected in processes



Organisational structure reflected in processes



Multiple points of failure

Error in MATLAB
model



Multiple points of failure

Error in MATLAB
model

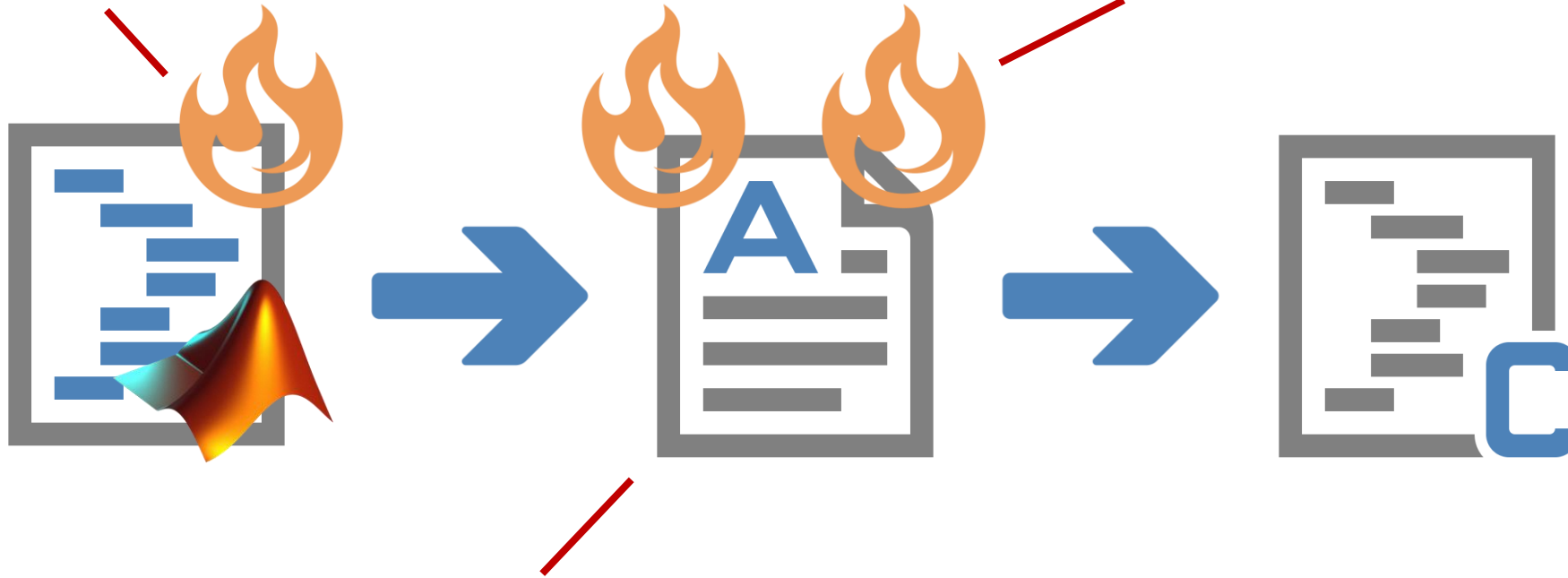


Error translating to
document

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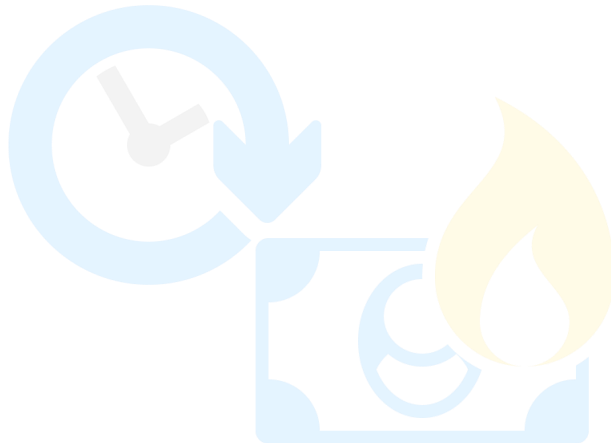
Error interpreting
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Error implementing
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Advantages:

- + Optimised Software/Firmware implementations
- + Established process supported by experienced engineers

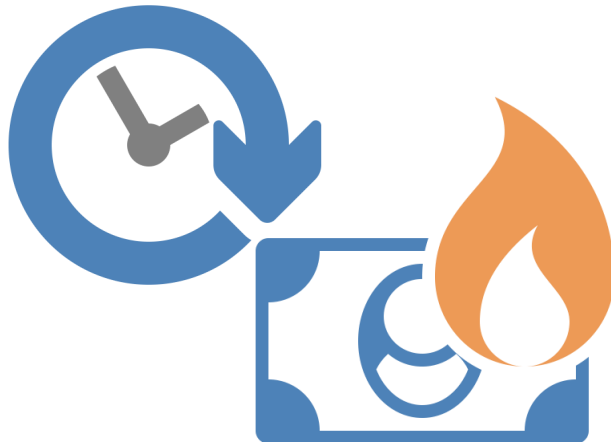


Disadvantages:

- Extensive multi stage reviews
- Slow multi-function iteration cycles
- Independent multi stage testing
- Extensive documentation
- Limited collaboration of solution
- Targeting hardware late in lifecycle

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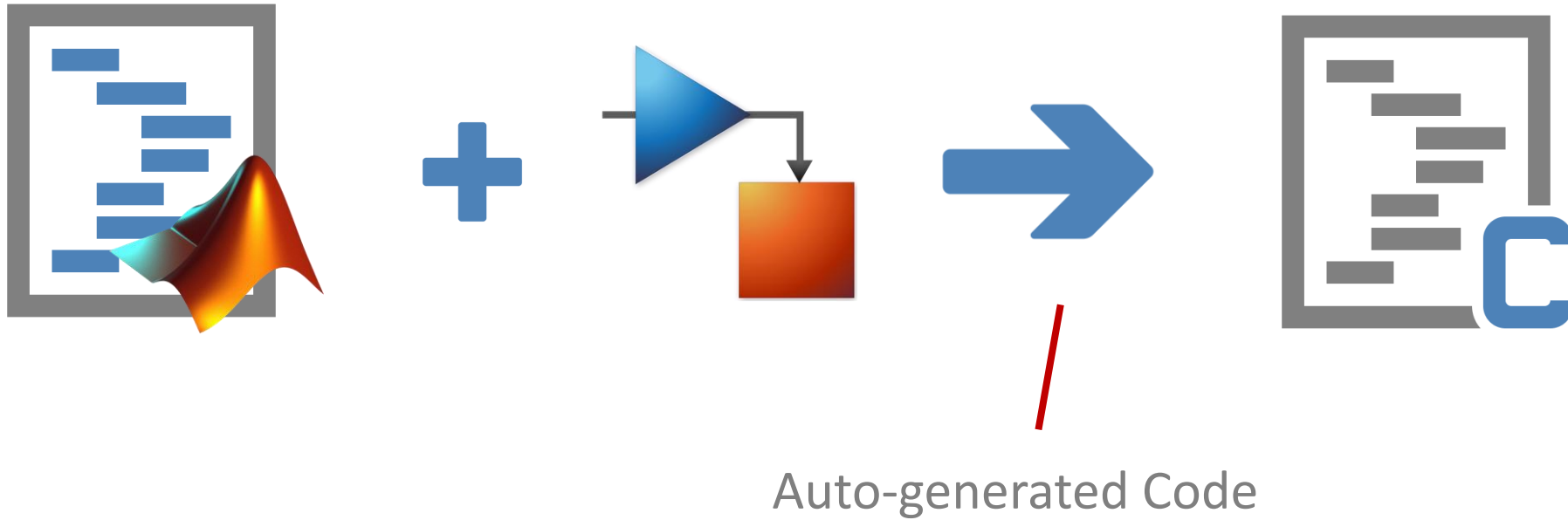


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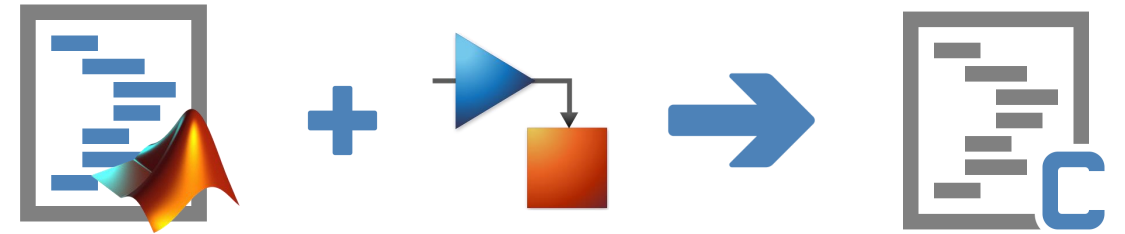
Reduced points of failure

Model-Based Design in Simulink



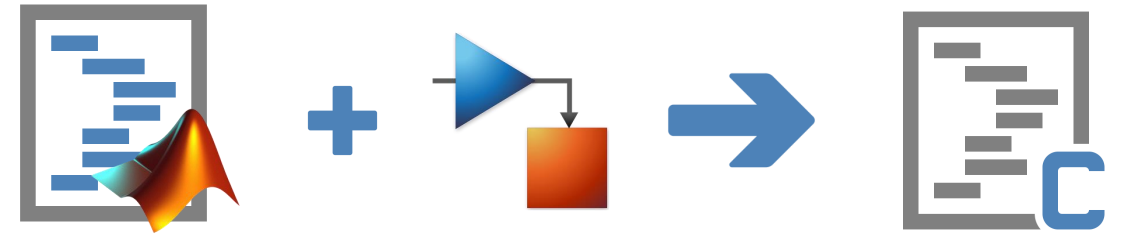
Model Based Design is not new at Leonardo Edinburgh and has been used for over 10 years although technology and design toolset advances present new opportunities:

- Dynamic and intuitive engineering process updates
- Expansion of advanced infrastructure
- Knowledge sharing leading to widespread adoption
- Increase cross-functional collaboration at model level (Systems/Software/Firmware)



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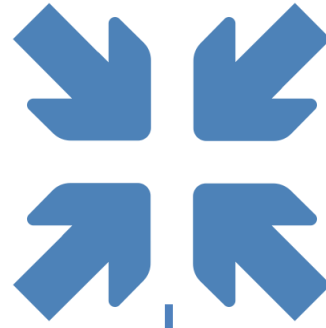


Challenge: How do we **scale** Model-Based Design to realise these opportunities?



Model **D**riven **E**ngineering, **M**odularity & **R**e-use

Cross Functional



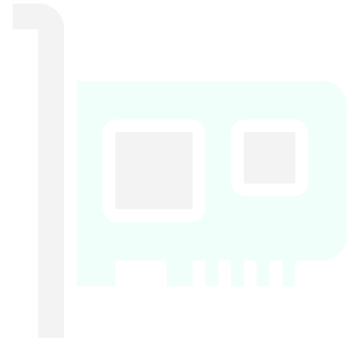
Development Tools



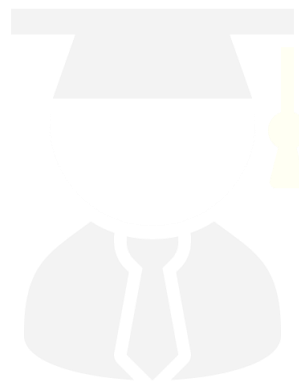
MDE Process



Reference Designs



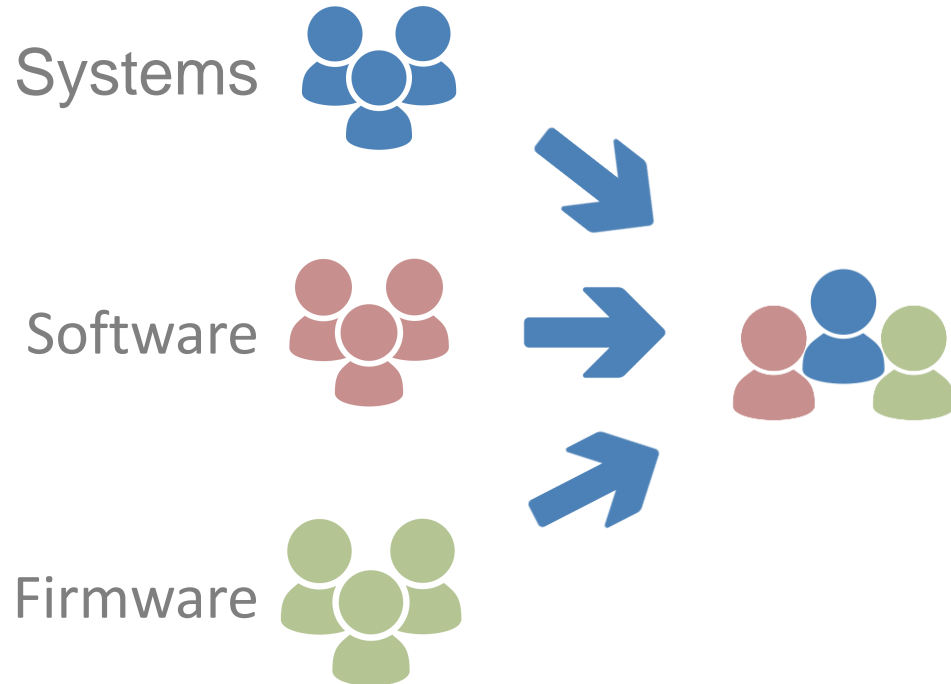
New Technology



Academic Placements

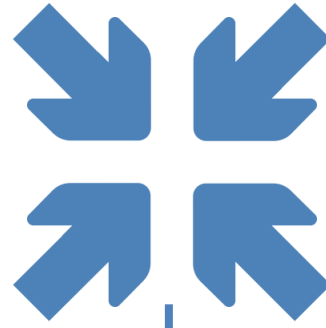


Cross-functional team containing **specialist engineers** dedicated to addressing Model-Based Design capability at Leonardo.



- Working with Systems, Software and Firmware to ensure MBD is not counter to
 - Existing processes
 - Development environments
- Leverages the **full lifecycle** capability of the MathWorks toolset
- Drive continuous improvement and best practice

Cross Functional



Development Environment



MDE Process

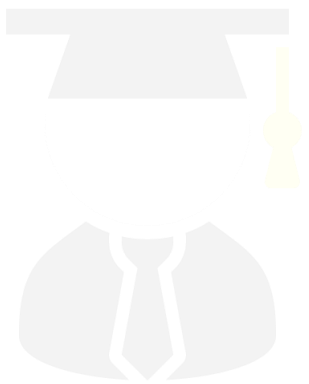


Reference Designs

New Technology



Academic Placements



Infrastructure for Model-Based Design

Fundamental to developing complex multi-functional models is to have a development environment capable of supporting **high integrity** designs in **collaboration**.



Common MATLAB & Simulink Workflows:

- Issue Management
- Source Control
- Test Automation

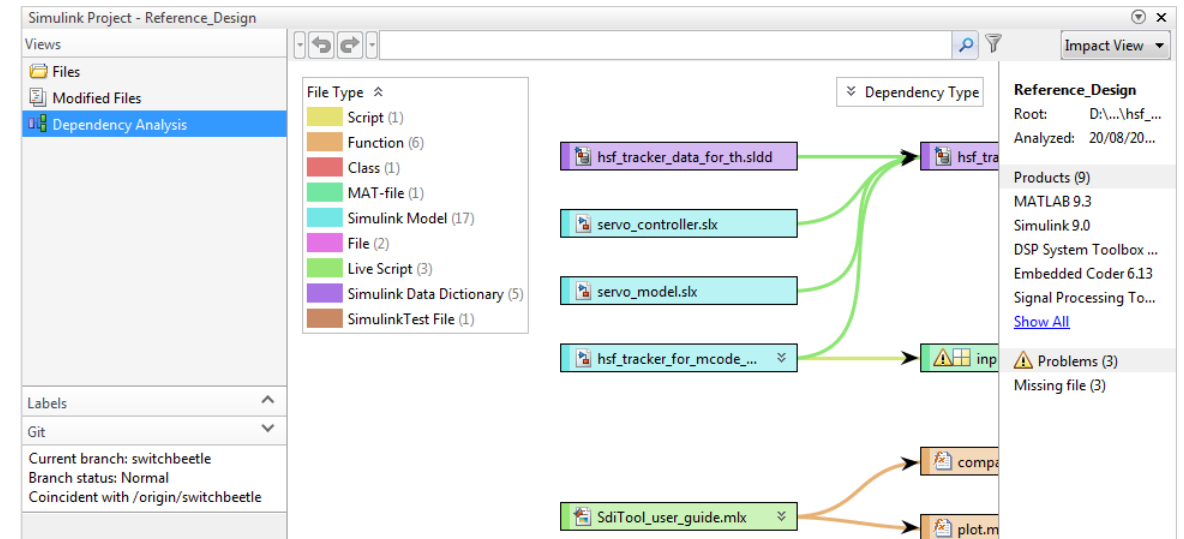


Common Environment

Mandate the use of **Simulink Projects** for both MATLAB and Simulink designs

- Standardised environment setup
 - No more *'add all to path... then load this file... but not that one'*
- Use project **Templates** to **distribute** standardised projects
- Reflect model architecture using **Referenced Projects**
- Source Control integration

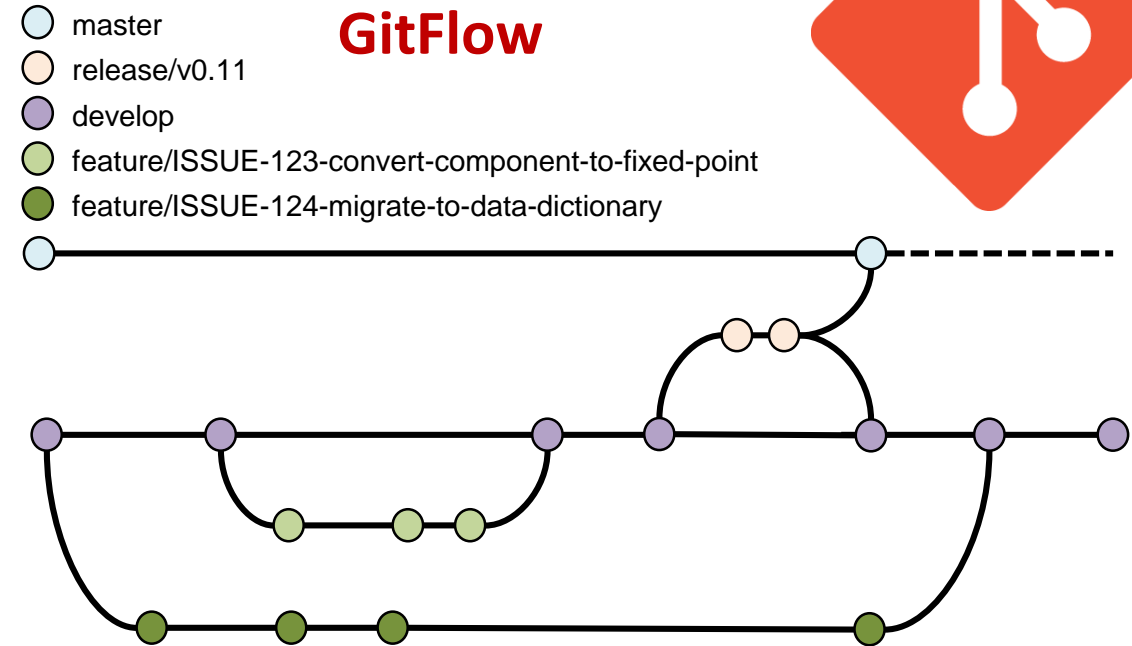
Simulink Projects



Source Control

Migrated to **GIT** from legacy source control solution

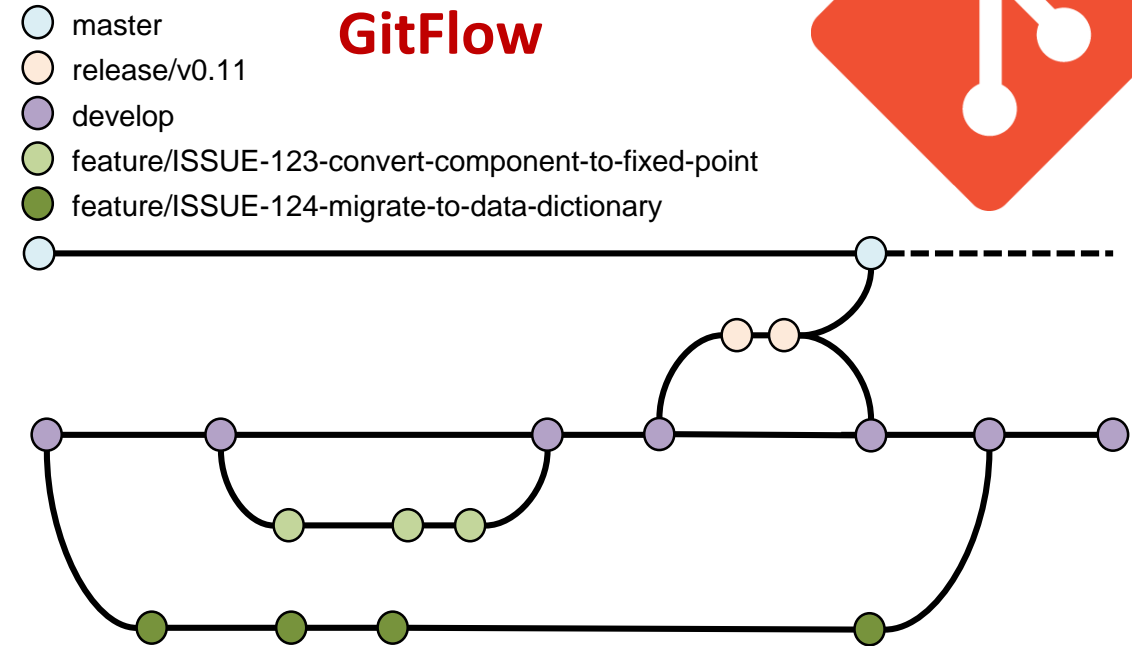
- Enables collaborative branching workflows which are **not** file locking based
- **GitFlow** for its scalability and traceability



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How does a branching workflow work for Simulink?

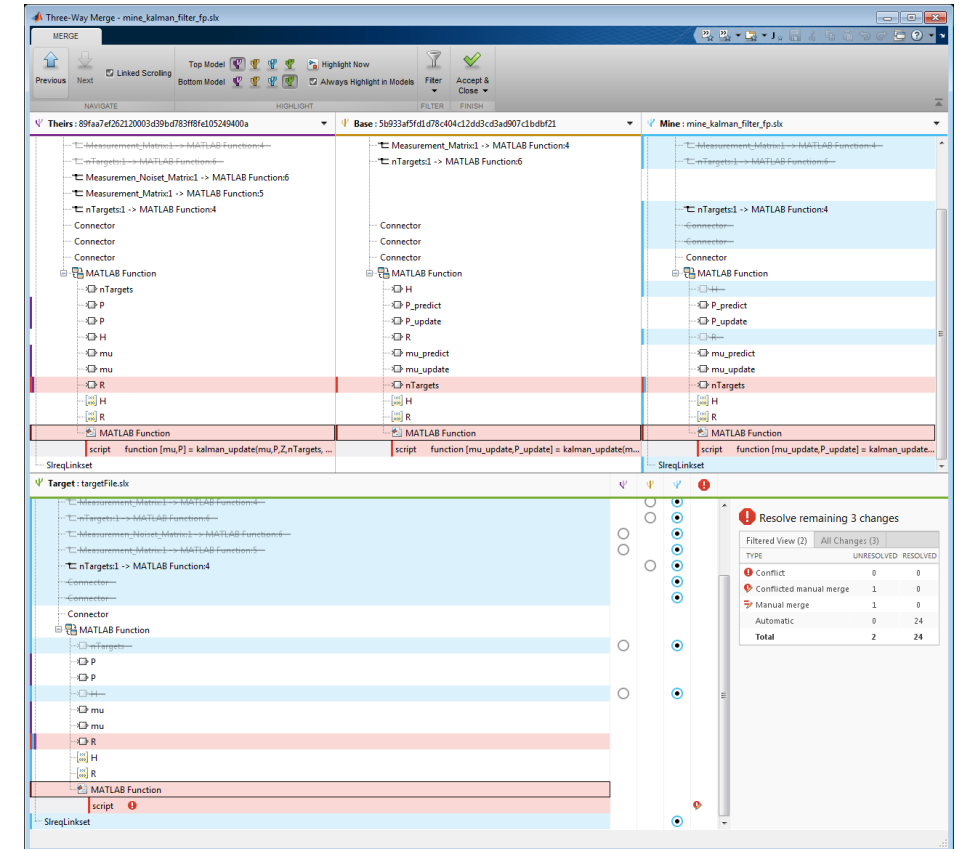
Three-Way Model Merge

GitFlow for Model-Based Design

Only possible due to the excellent advancements in **merge** and **diff** tool capability of Simulink models.

Fundamental to success is **communication** and model **componentisation**.

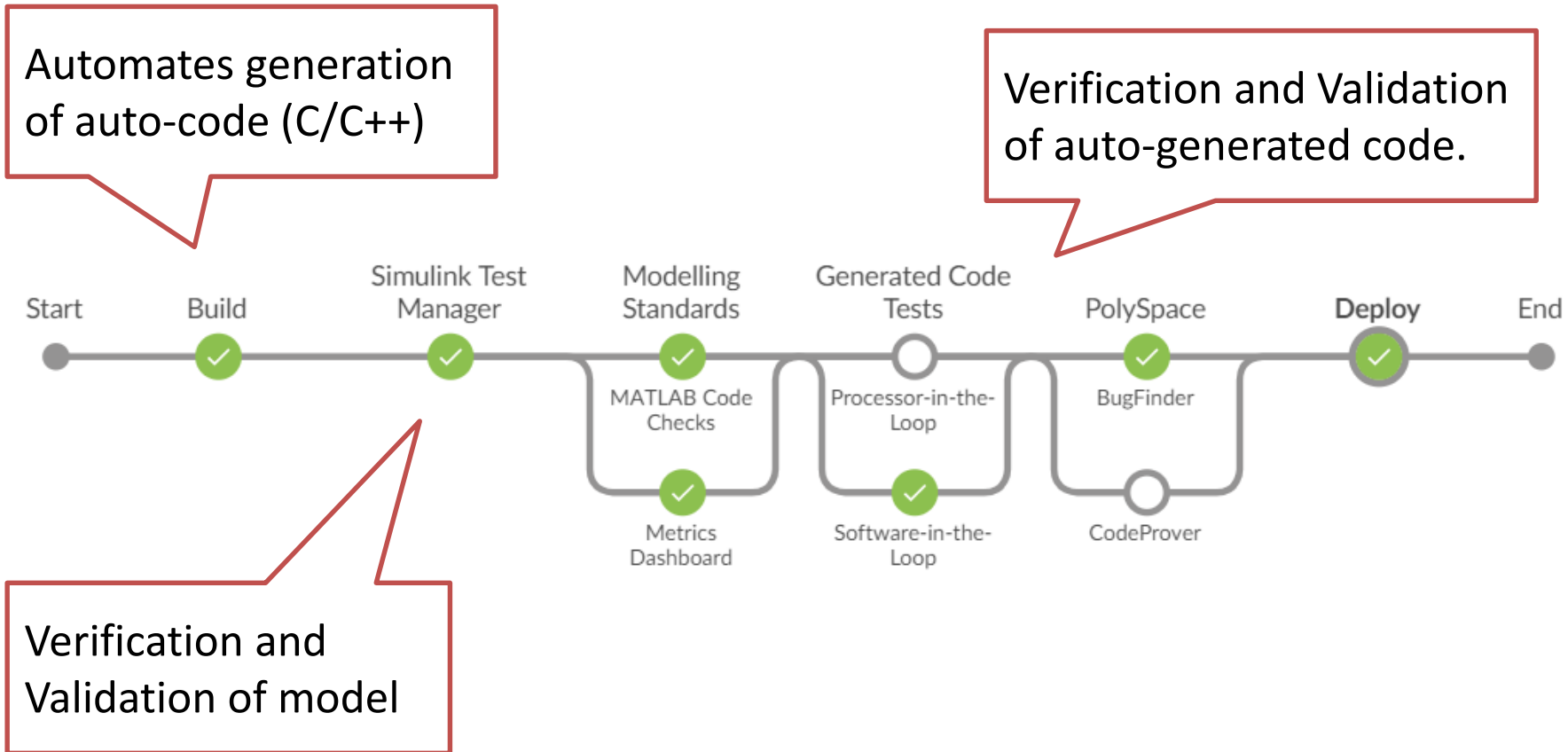
- Model updates must be planned and scoped - branch cannot be open indefinitely
- Model must be well structured: Referenced Models and Libraries



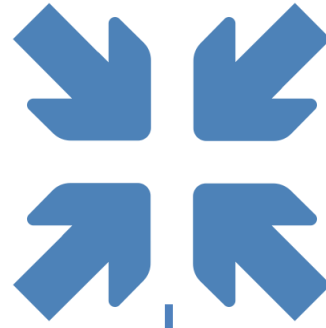
How does a branching workflow work for Simulink?

Automated Testing

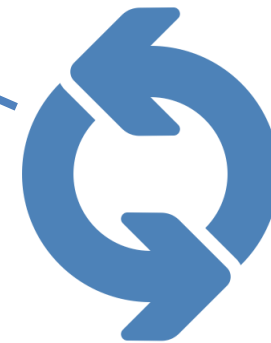
Investing in automated **build** and **test** pipelines for Simulink



Cross Functional

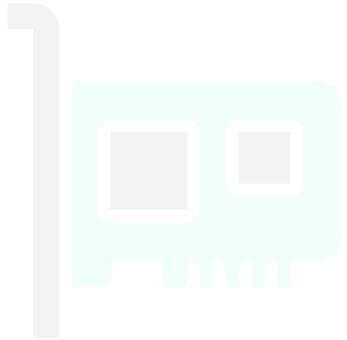


Development Environment

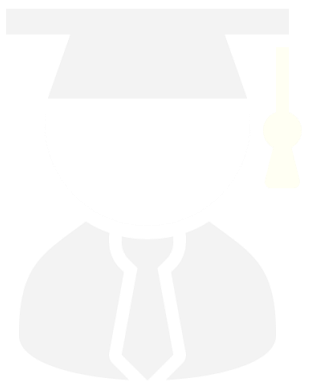


MDE Process

New Technology



Academic Placements



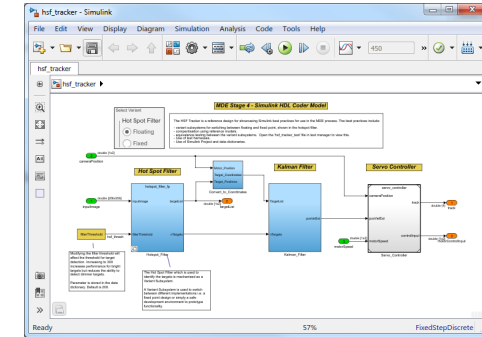
Reference Designs



Dynamic Model-Driven Engineering (MDE) Process

Process that defines how to develop Model-Based Designs in Simulink

- Rapid prototyping
- Main development and modelling
- Partitioning to Software/Firmware (Fixed Point)
- Targeting representative hardware through PIL, FIL and SysIL testing



Partition Model

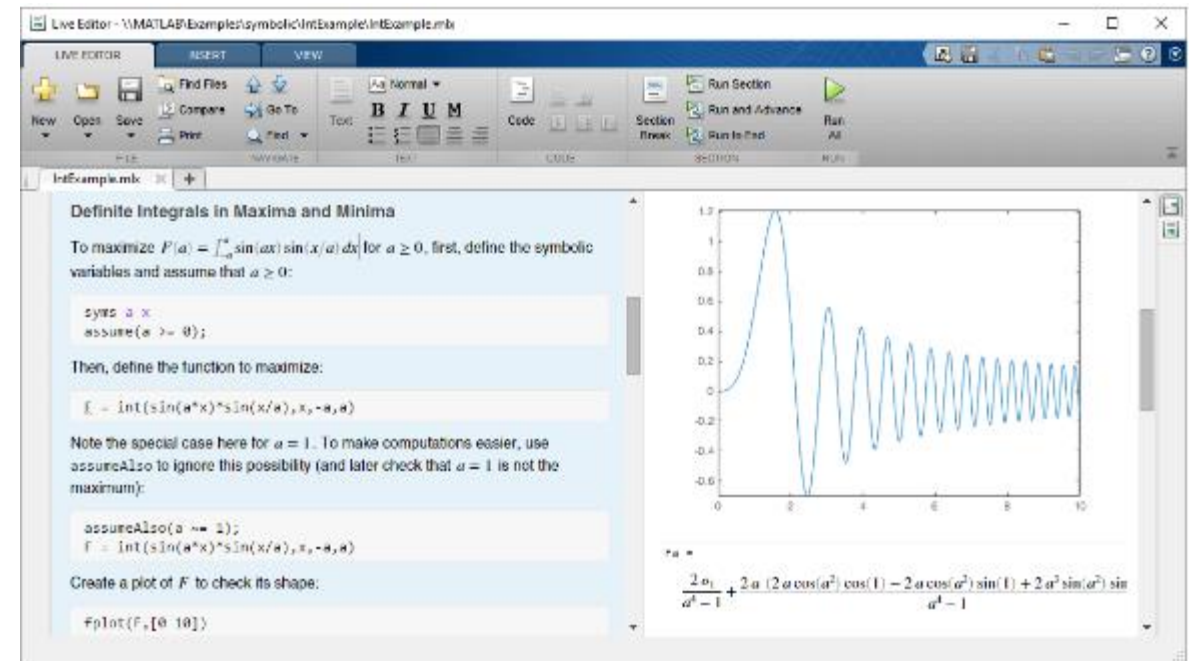
Leverage the cross-discipline expertise.

Model-Driven Engineering Process

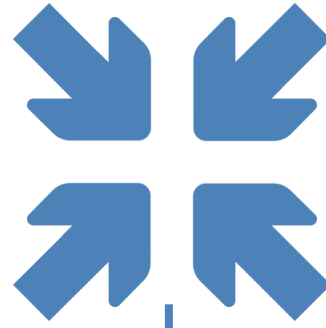
Uses **Live Editor** to give interactive examples on each step that leverage internal referenced designs e.g.

- How to use Test Manager for SIL/PIL/FIL equivalence testing of requirements?
- How to setup environment? e.g.
 - GIT repo
 - Simulink Projects
 - Jenkins
- How to deploy?

Live Editor



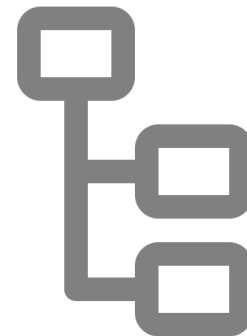
Cross Functional



Development Environment



MDE Process

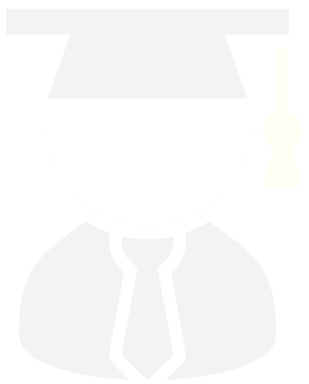


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New Technology



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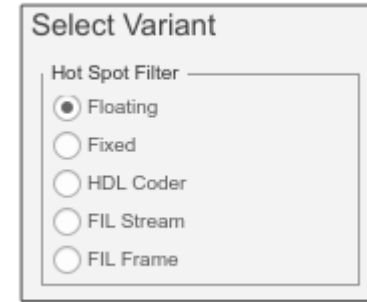


Referenced Designs

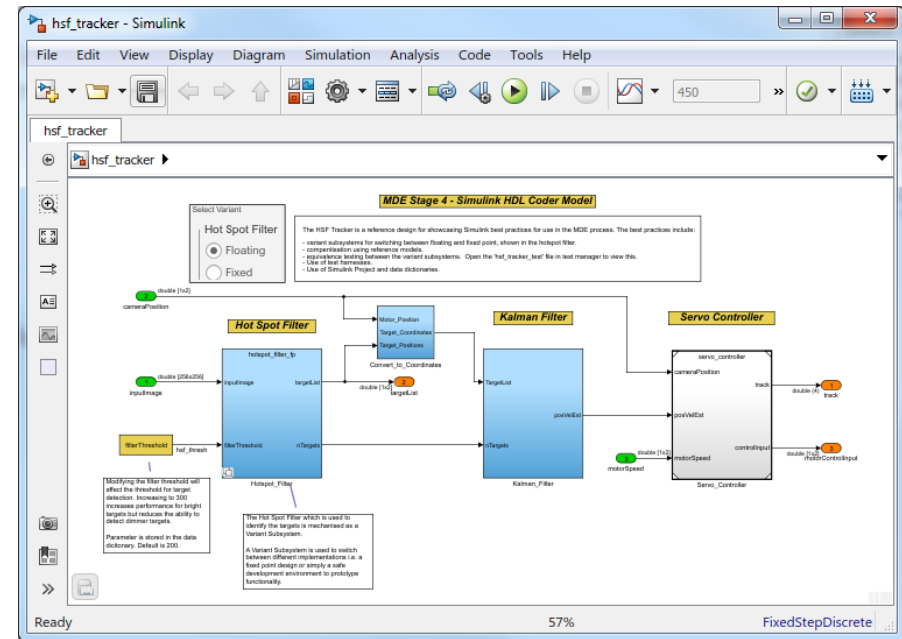
A key factor in scaling and promoting **best practice** to the Leonardo engineering community is through referenced designs which are **published** internally

Referenced designs are relevant to **Leonardo products** to better engage with user base e.g. Radar and tracking algorithms

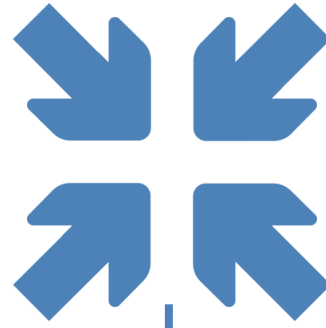
Referenced designs are used to **investigate new technologies** and promote **re-use**



Referenced designs are configured to showcase stages of MDE Process and lifecycle

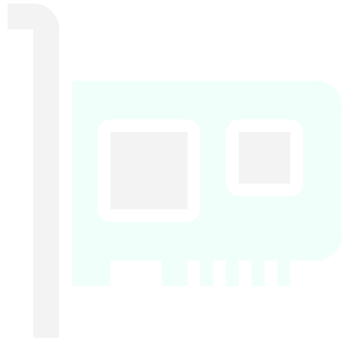


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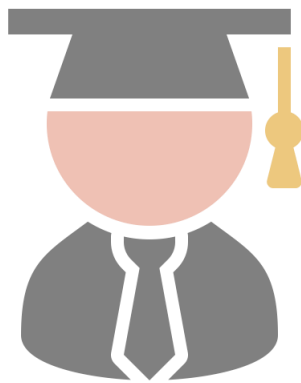


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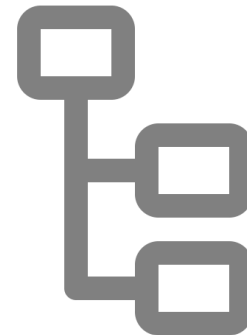
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MDE Process

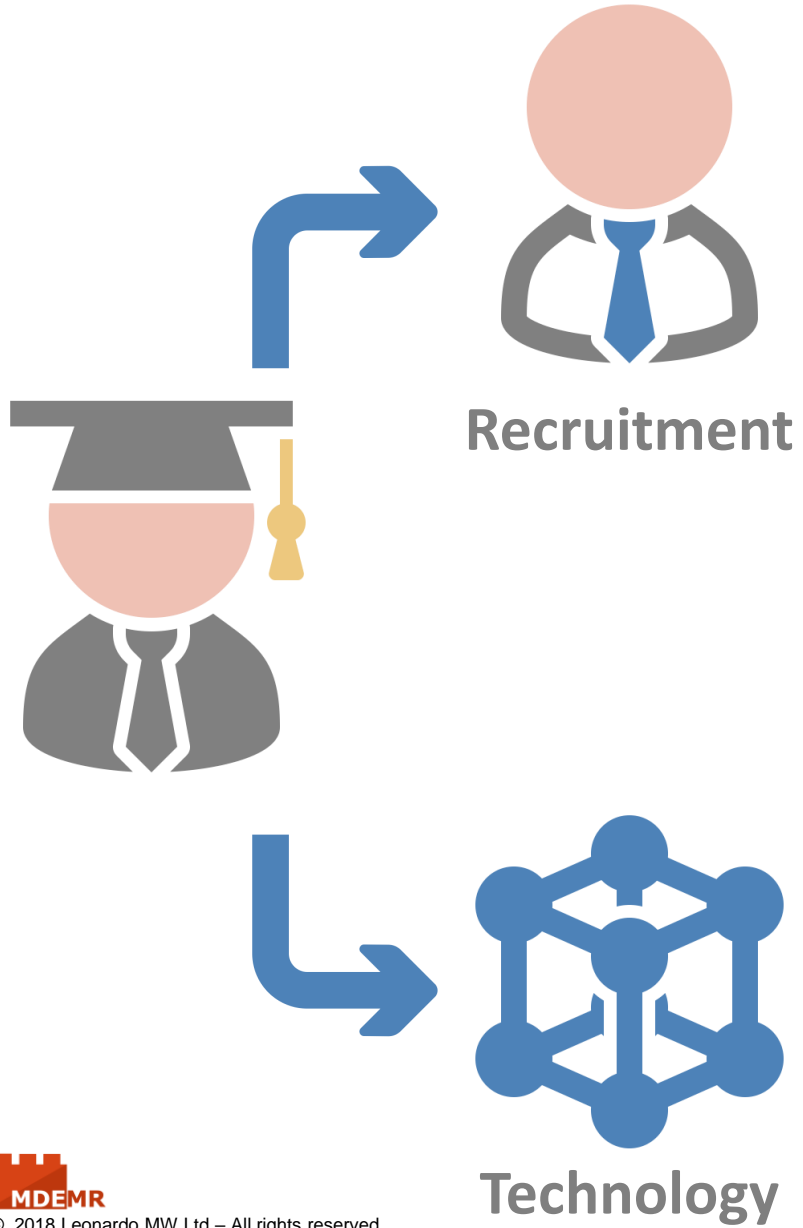


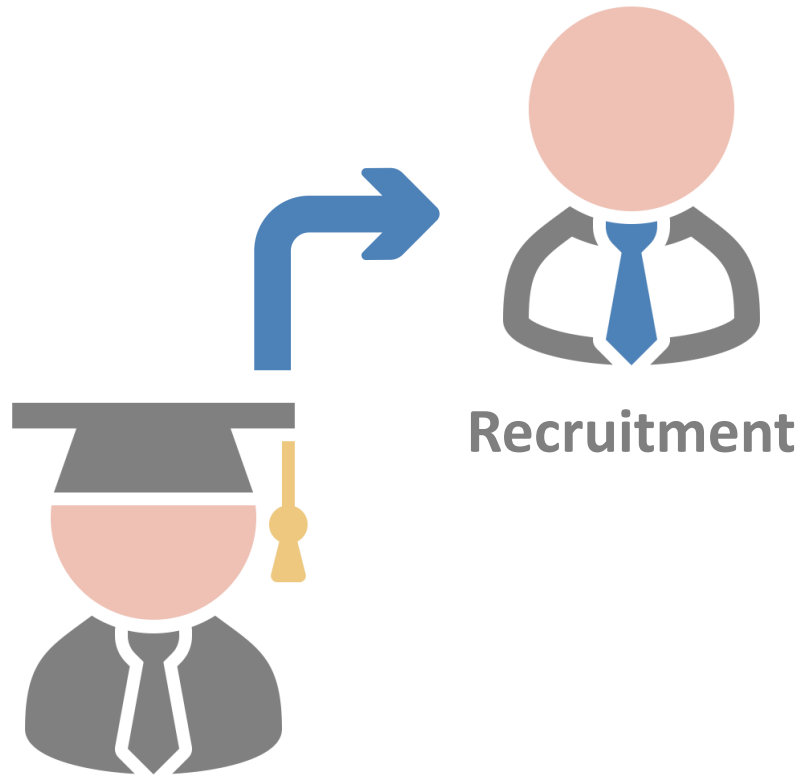
Academic Placements



Reference Designs



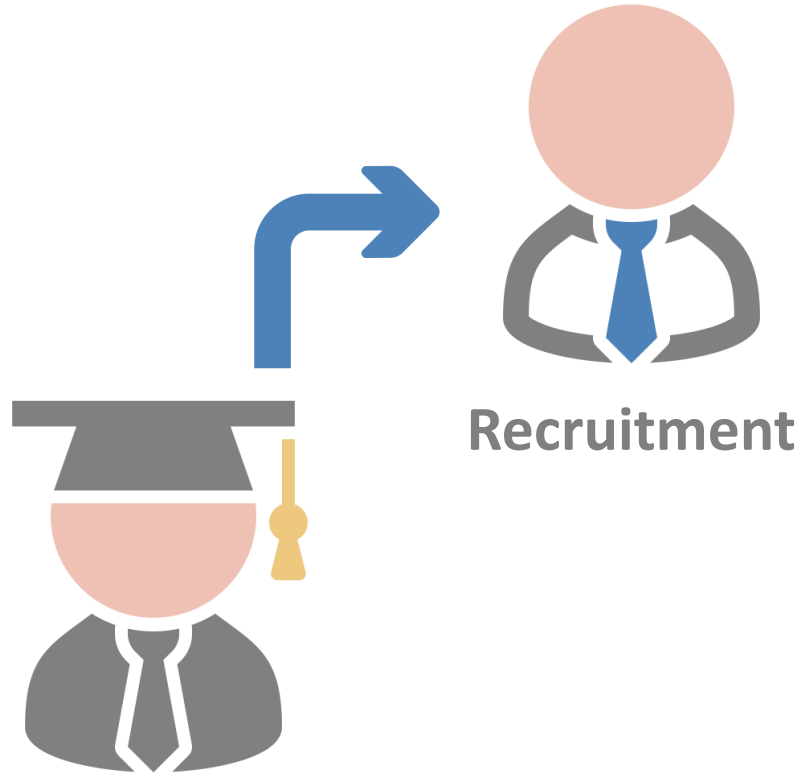




Recruitment

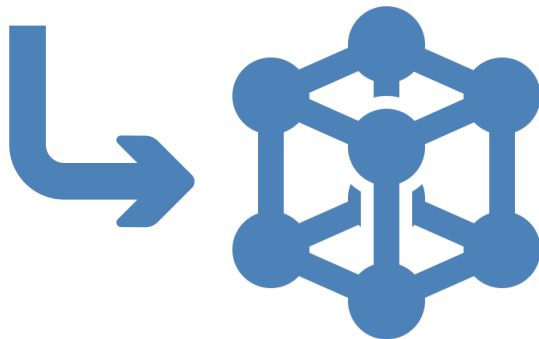
- Offer **exciting** 3, 6 and 12 month placements
- Individual deliverable projects that ties in with **MDE strategy**
- Wider business exposure
- Pave the way for future work and employment

Technology



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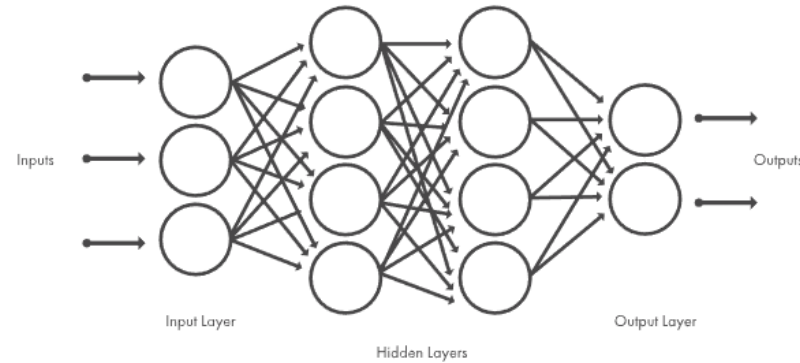


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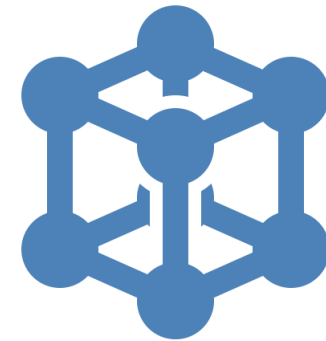
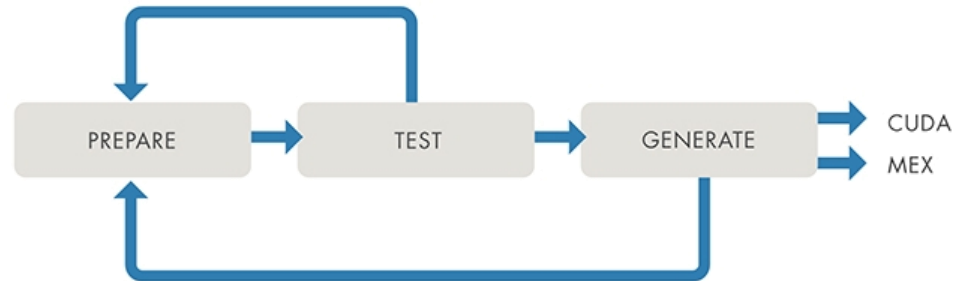
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- Trial and feedback on MATLAB and Simulink pre-releases
- Develop reference designs showcasing **best practice**

Examples of Summer placement work with MATLAB

Deep Learning for Object Detection

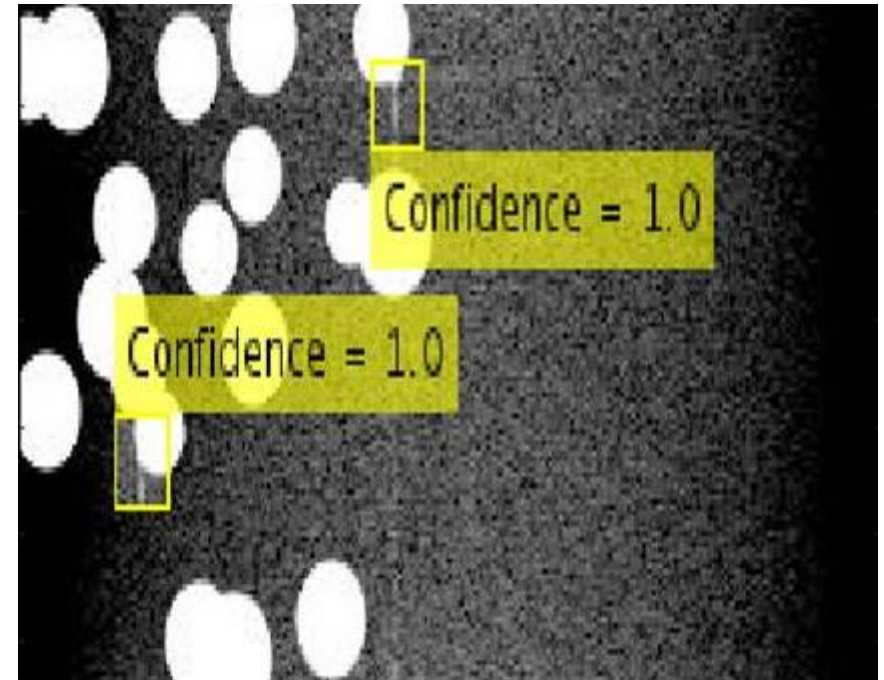
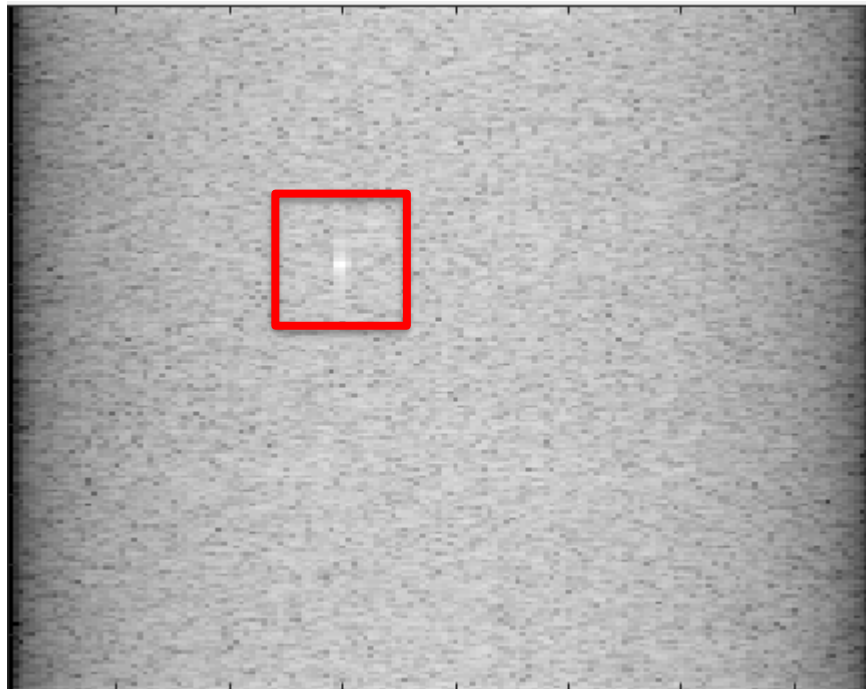
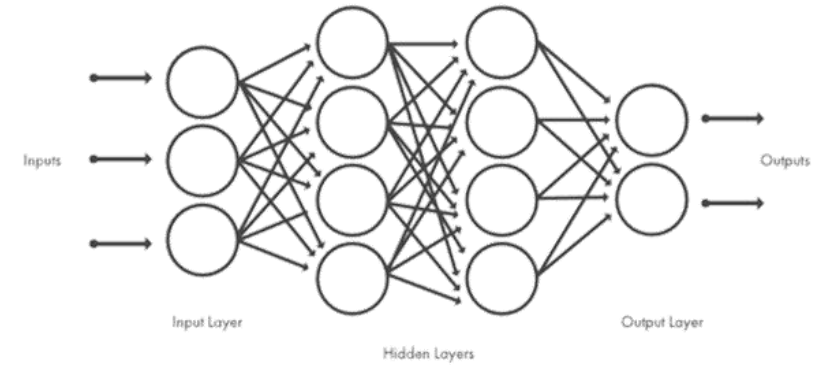


Targeting embedded GPUs with GPU Coder



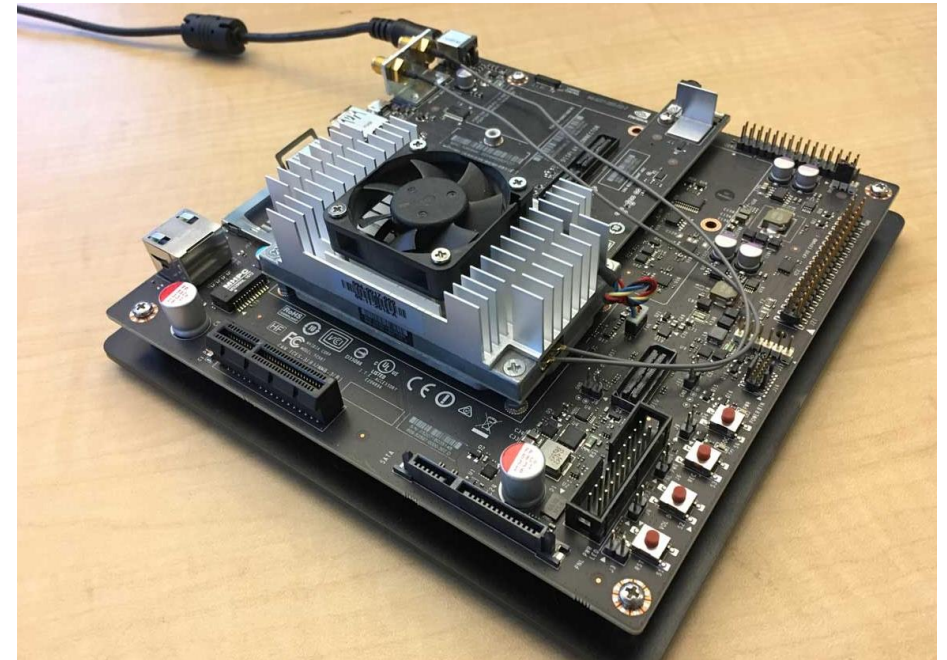
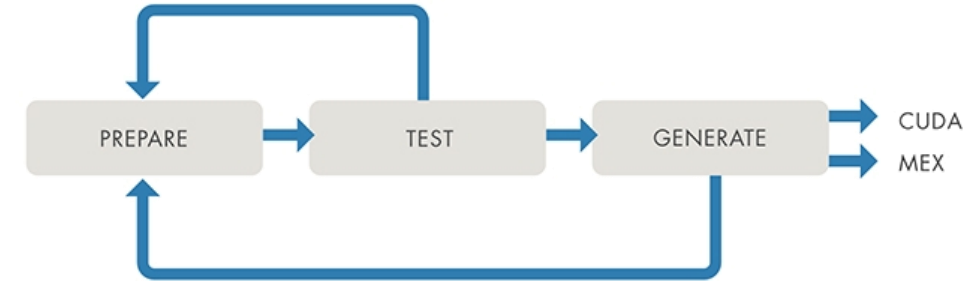
Deep Learning for Object Detection

- Trained on 5000 'simple' target images
- Uses FasterRCNN MATLAB implementation
- Accurately predicts targets in cluttered environment



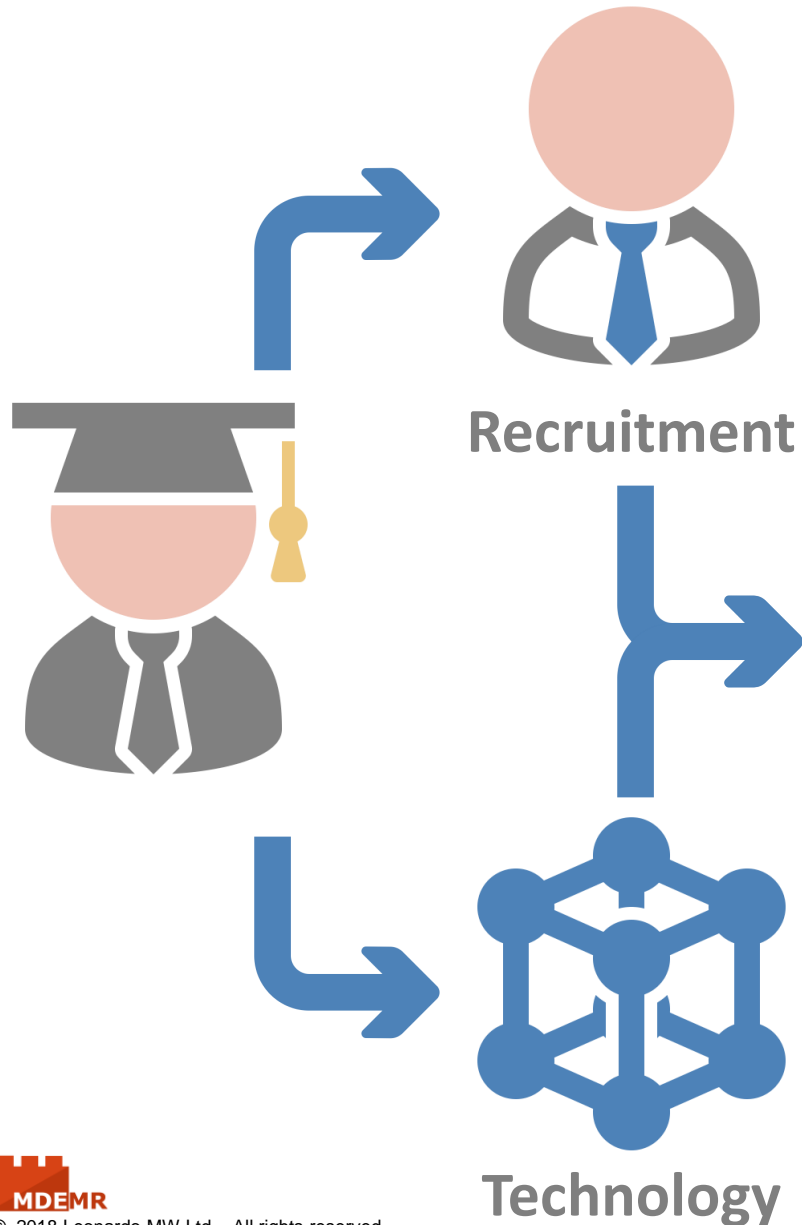
Targeting embedded GPUs with GPU Coder

- Auto generates CUDA from m-code using GPU Coder
- Runs on target Jetson TX2 embedded hardware
- Closer to a real-world implementation

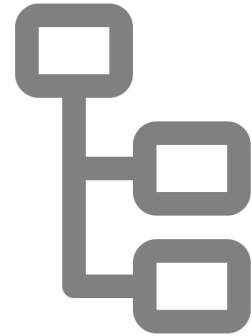


SAR image formation

Jetson TX2



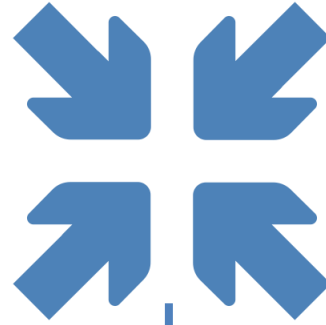
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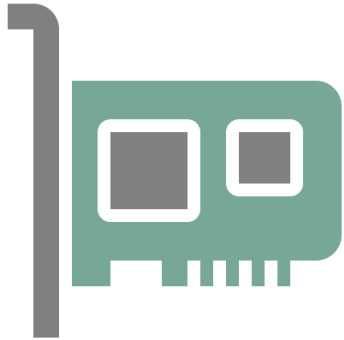
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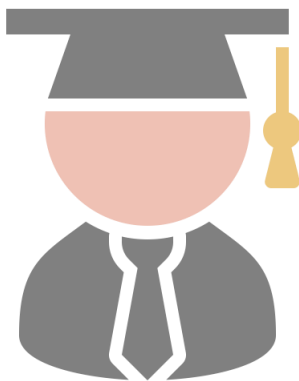


Development Environment

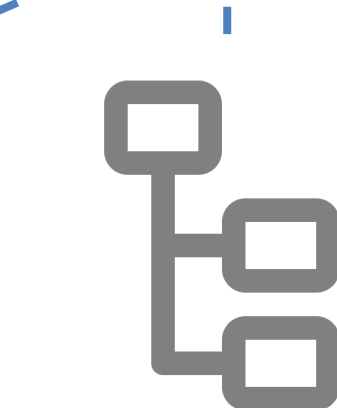
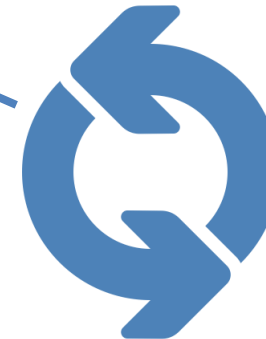
New Technology



Academic Placements



MDE Process



Reference Designs





Graphical Processing Unit (GPU)

- Originally for graphical processing for video and games

Highly Parallel Architecture

- Many thousands of computing cores
- Capable of spawning many threads
- Allows for massive parallelism in code

Plug and Play

- Cards can be inserted into the PCIe slot on most motherboards

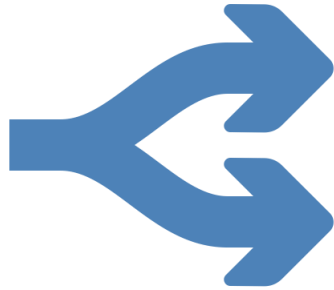
Simulation Acceleration

- Powerful for tackling compute intensive mathematical modelling
- Can provide order of magnitude speedups over CPU implementations



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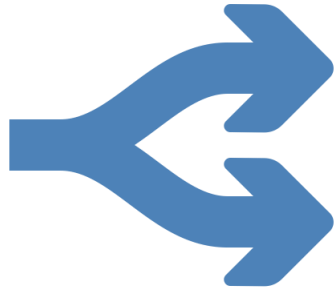
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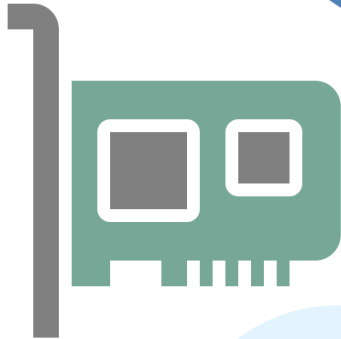
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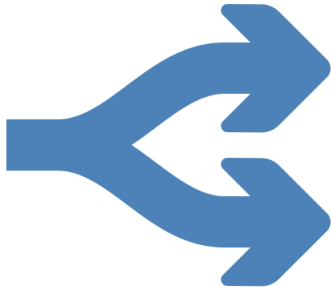
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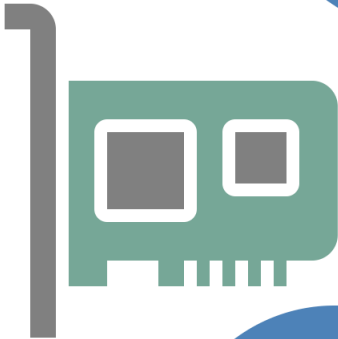
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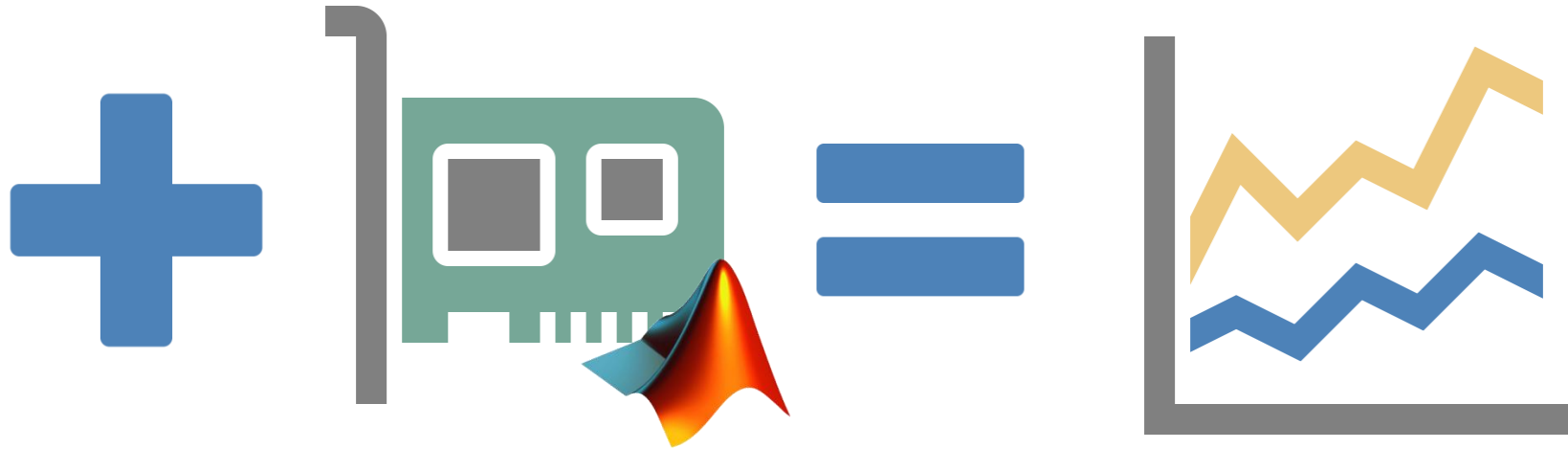
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```
1 % Filthy elementwise multiply  
2 - X = A.*B;  
3  
4 % Nasty matrix inversion  
5 - Y = inv(X);  
6  
7 % Disgusting fft  
8 - fft_y = fft(Y);
```



Parallel Computing Toolbox

Aircraft radome antenna modelling

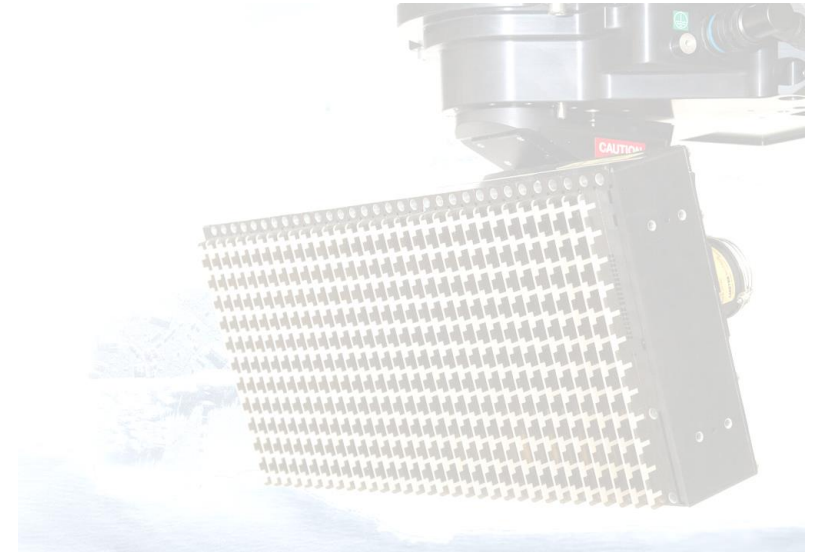


**20x
speedup**

Radar beam forming



Synthetic Aperture Radar (SAR)



Aircraft radome antenna modelling



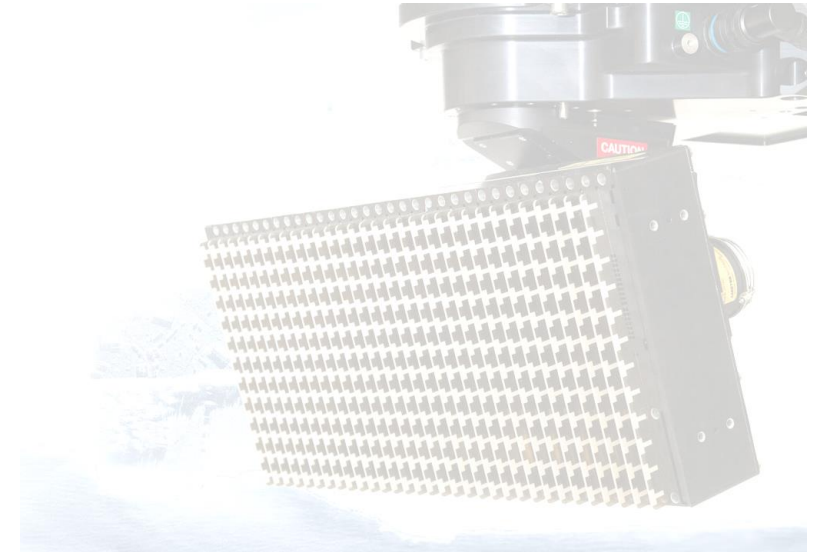
**20x
speedup**

Radar beam forming



**50x
speedup**

Synthetic Aperture Radar (SAR)



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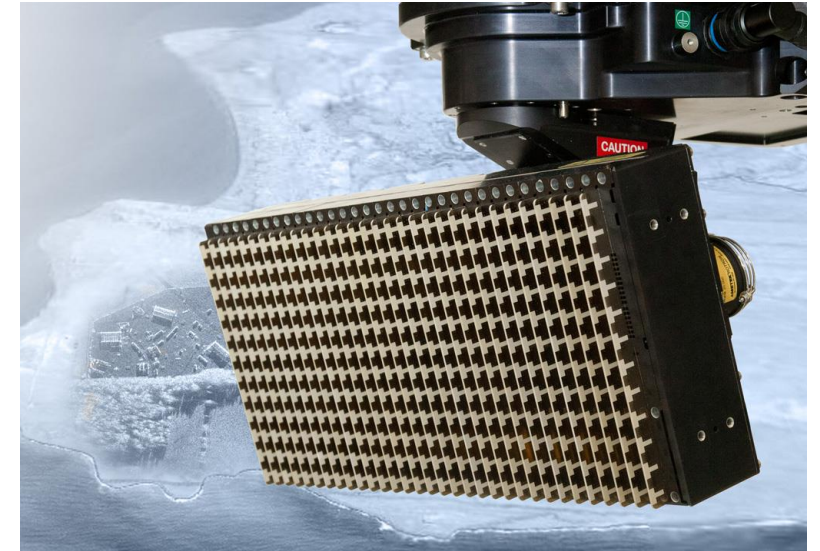
**20x
speedup**

Radar beam forming



**50x
speedup**

Synthetic Aperture Radar (SAR)



**100x
speedup**

Aircraft radome antenna modelling



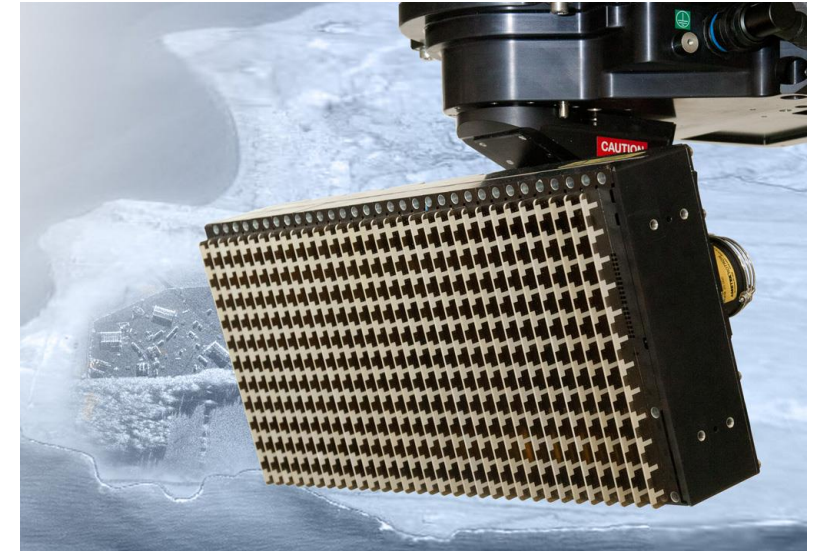
**20x
speedup**

Radar beam forming



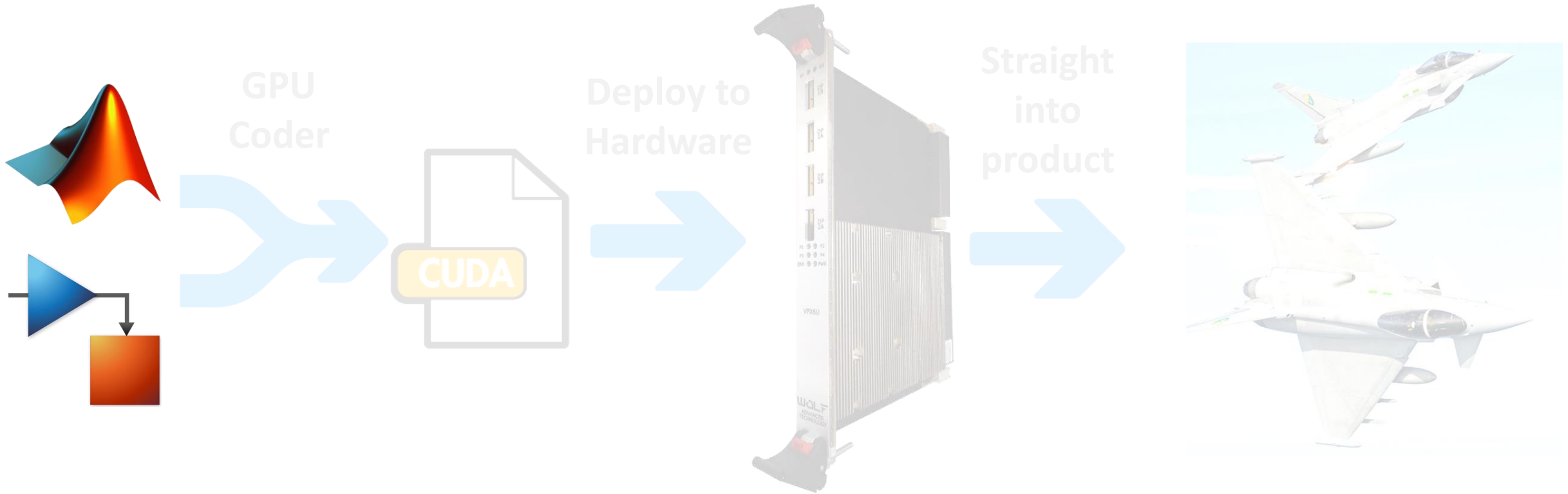
**50x
speedup**

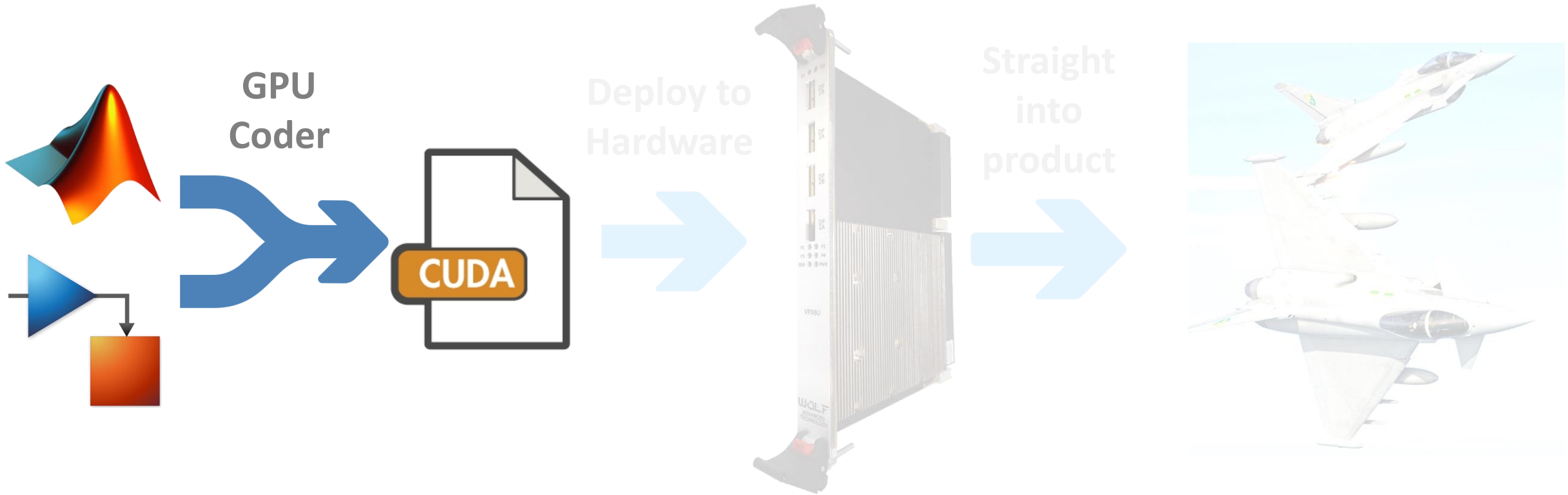
Synthetic Aperture Radar (SAR)

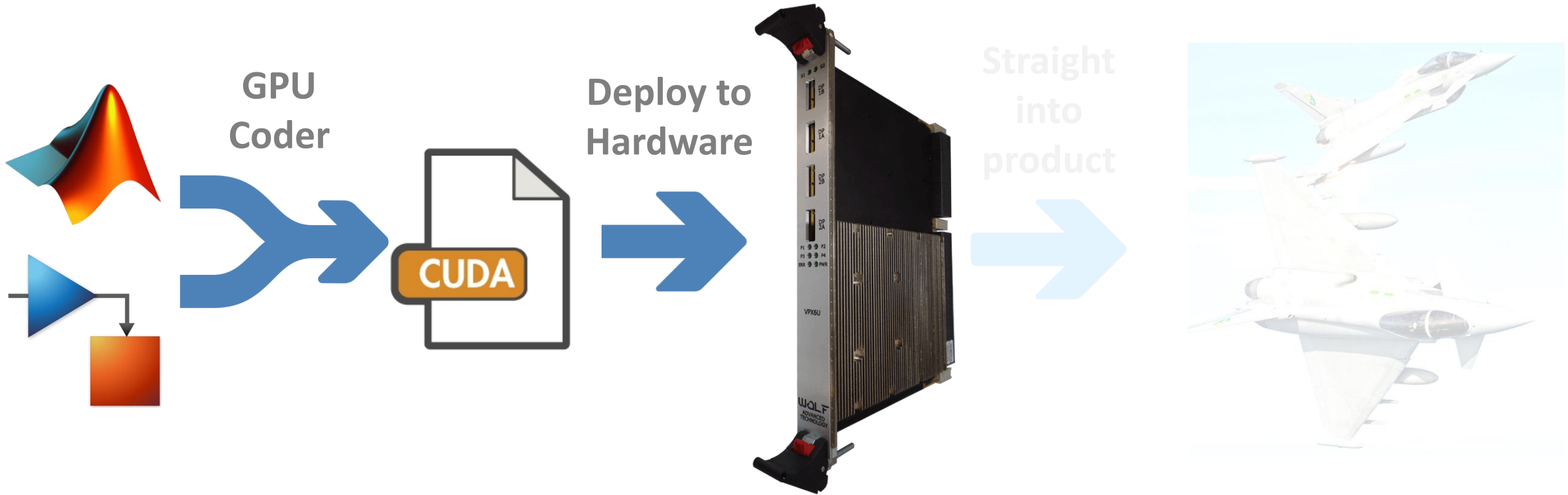


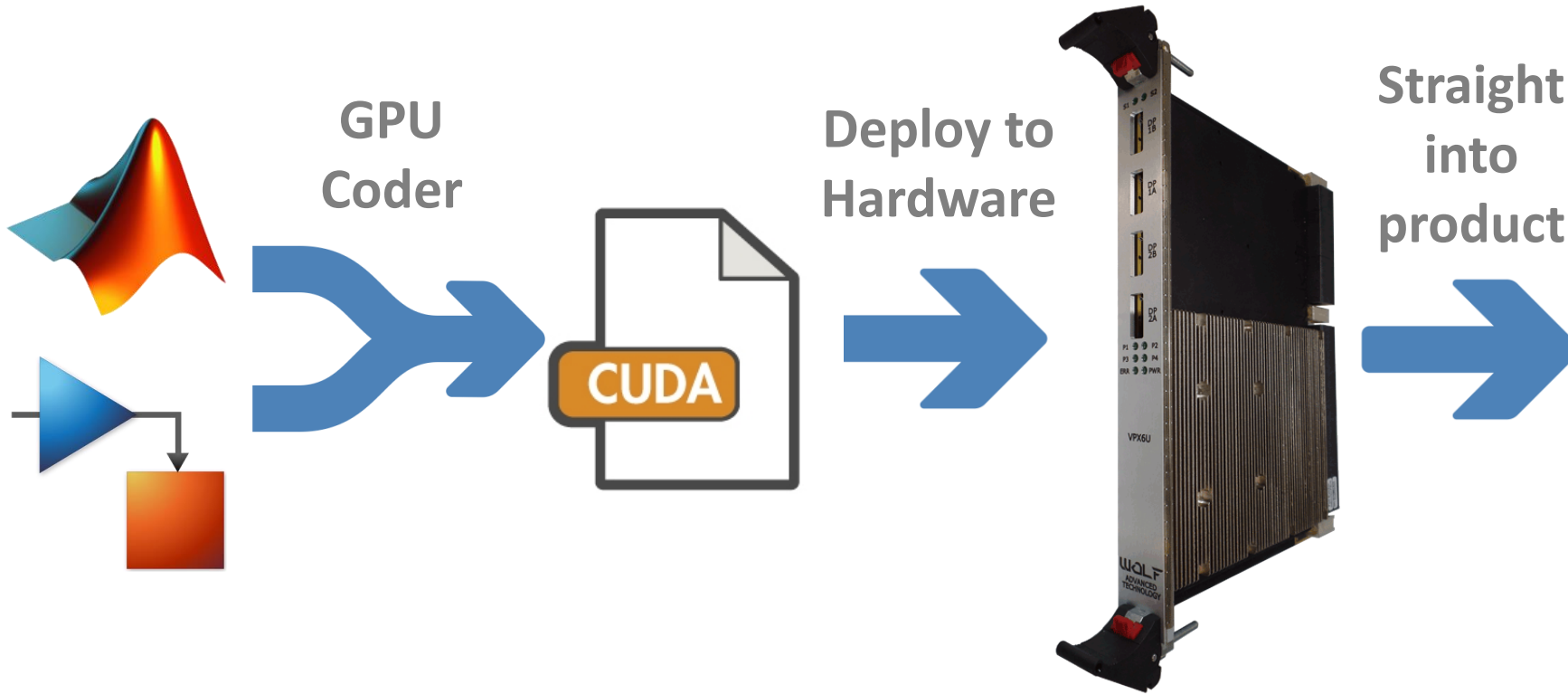
**100x
speedup**

How do we use a GPU in a real-world environment?



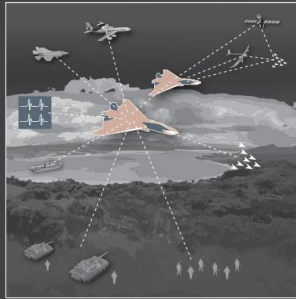






Connected & Co-operative

Communications and Interoperability

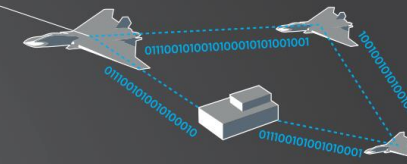


Capable

Integrated Intelligent System of Systems
Science and Innovative Technology

Flexible

Advanced Mission Data



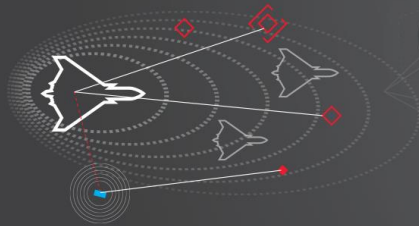
Attack

Directed Energy
Electronic Warfare
Support to Kinetic Weapons



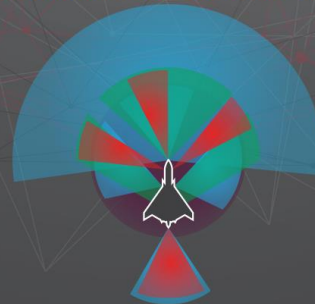
Protect

Team Survivability in a High Threat Environment

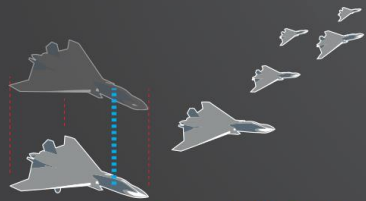


Sense

Multi Spectral Integrated Sensor System



Open Mission System



Through Life Solution

Affordable



Upgradeable

THANK **YOU** FOR YOUR ATTENTION

