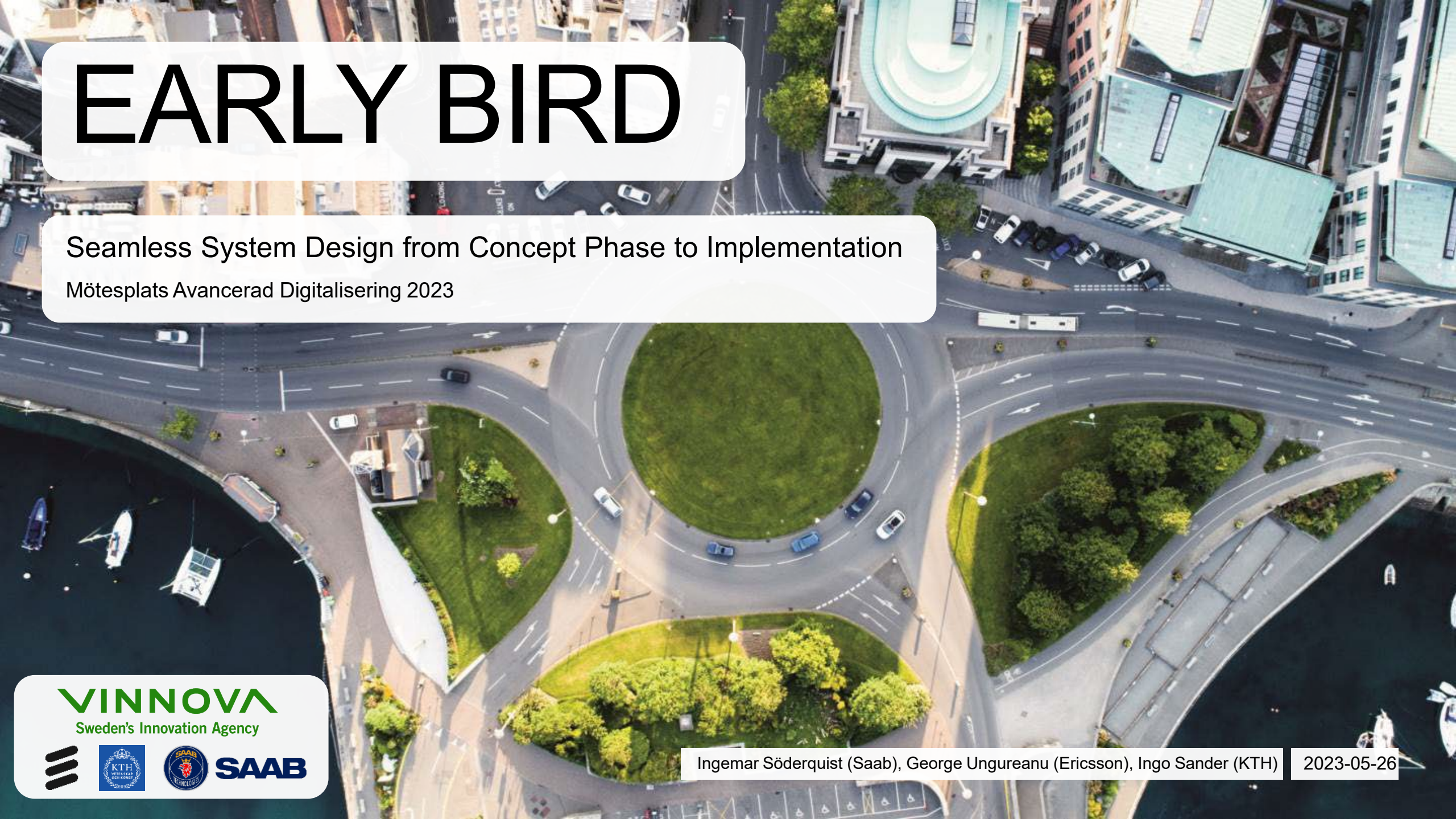
EARLY BIRD

Seamless System Design from Concept Phase to Implementation

Mötesplats Avancerad Digitalisering 2023



VINNOVA
Sweden's Innovation Agency

SAAB

Ingemar Söderquist (Saab), George Ungureanu (Ericsson), Ingo Sander (KTH)

2023-05-26

Avancerad och innovativ digitalisering – våren 2021

Projektnamn: **Early Bird – Sammanhängande systemkonstruktion från koncept till implementation**

Koordinator: Saab AB

Projektledare: Ingemar Söderquist

Projektperiod: 2021-10-01 – 2024-09-30

Projektaktörer: Saab AB, Ericsson AB, Kungliga Tekniska Högskolan, KTH

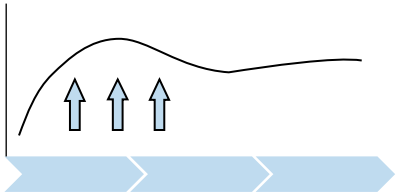
Presentatörer:

Ingemar Söderquist
Saab

George Ungureanu
Ericsson

Ingo Sander
KTH

Agenda



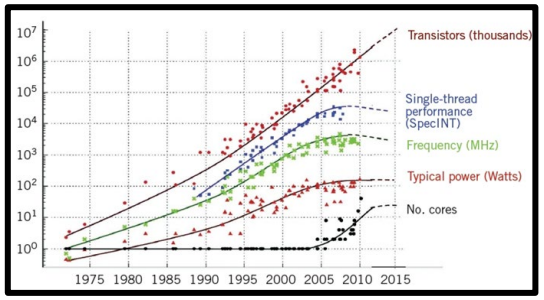
Handle … increased complexity and a large design space at the concept phase

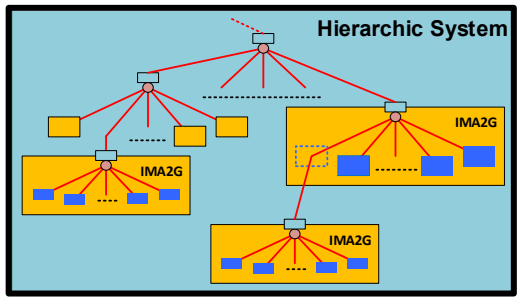
… with the uncertainties expressed as part of a formal model.

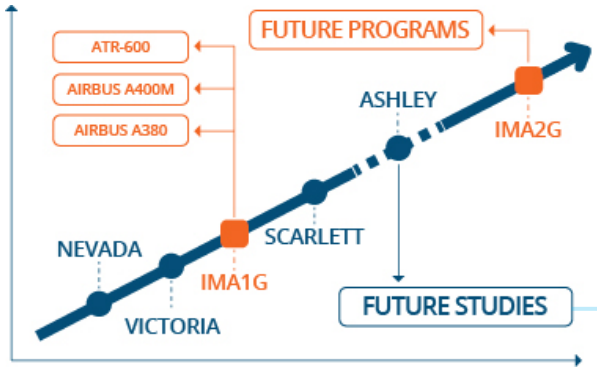
- Background
  - Aerospace industry needs
  - Telecom Industry needs
- Project idea
- Research challenges
- Questions …

Background → Early Bird

Application of IMA







EARLY BIRD – 3 Year / 14 MSEK

PANORAMA

TRANSFORM

NFFP7

CORRECT

COMPUTE

CLASSIC

CASTOR Software Research Centre → CASTOR 2.0

Seed:

- Correct-by-Construction Design of Embedded and Cyber-Physical Systems
- Design Space Exploration of Mixed-Criticality Applications on Predictable Multi-Processor Platforms
- Towards Zero-Overhead Solutions for Heterogeneous Architectures
- Early Stage Design Space Exploration of Heterogeneous Multiprocessor Systems on Distributed Platforms

.... NFFP 6

VICTORIA SCARLETT ASHLEY

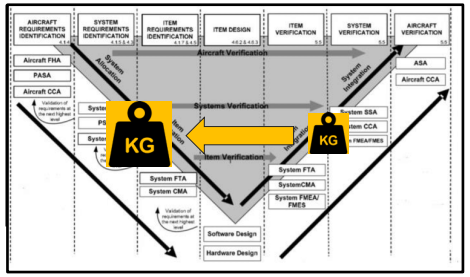
2001 2008 2013 2017 2018 2019 2020 2021 2022 2023 2024

Aerospace industry needs

Well-established system development methodology exists within avionics community.

- But product complexity increases.
- Need to express uncertainties.
- More automated methodology needed, valuable especially in early design phases to explore the design space and capture human thinking.

SAE ARP 4754 for overall system design
RTCA/DO-297 for IMA development guidelines

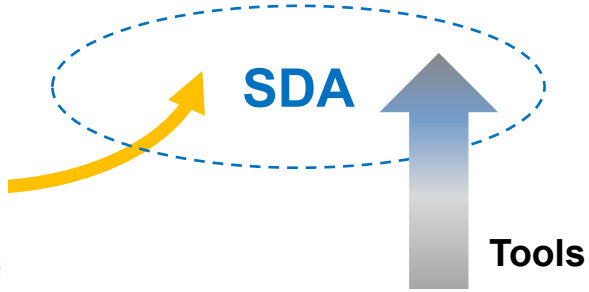


Early Bird stress new methodology for concept phase

- Tools supporting System Design Automation (SDA)
- Early Design Space Exploration
- Engineering rules and judgement
- Computer system sizing

Double added value expectations

- Decrease (flatten) system development and verification cost, in the view of increased complexity.
- Enabler to offer more complex products, e.g. new Systems of Systems solutions.



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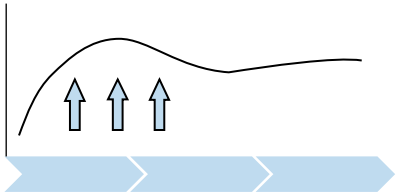

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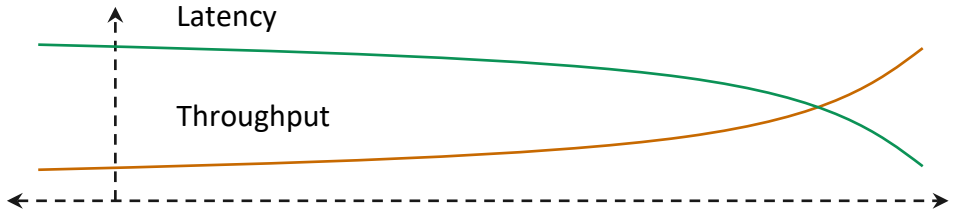
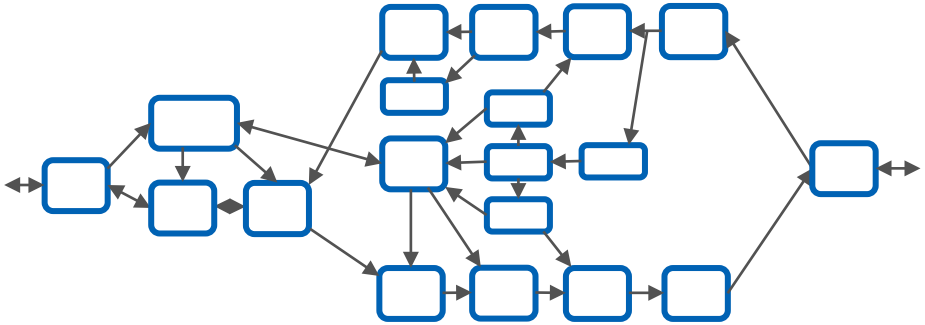
Telecom industry needs
(focus on RAN)



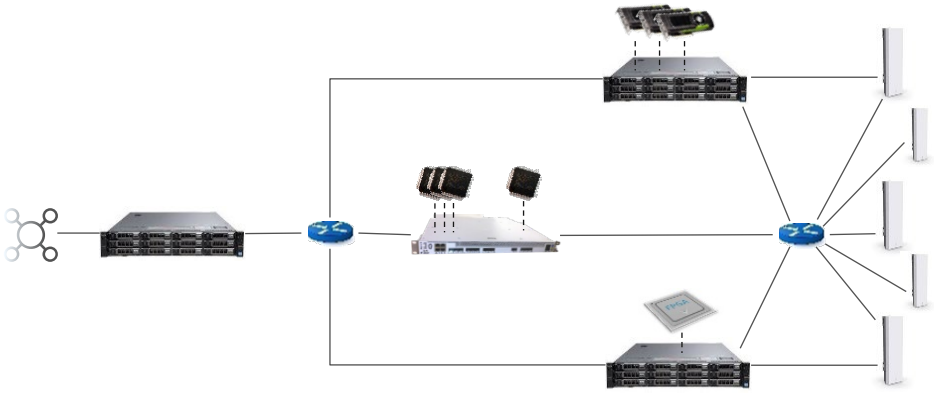
Increasingly complex ecosystem

- Very tough requirements on Radio Access Network (RAN)
- SW needs to make the most of available HW
- Larger feature set → more complex SW/HW
- HW diversity increases, as does functional distribution

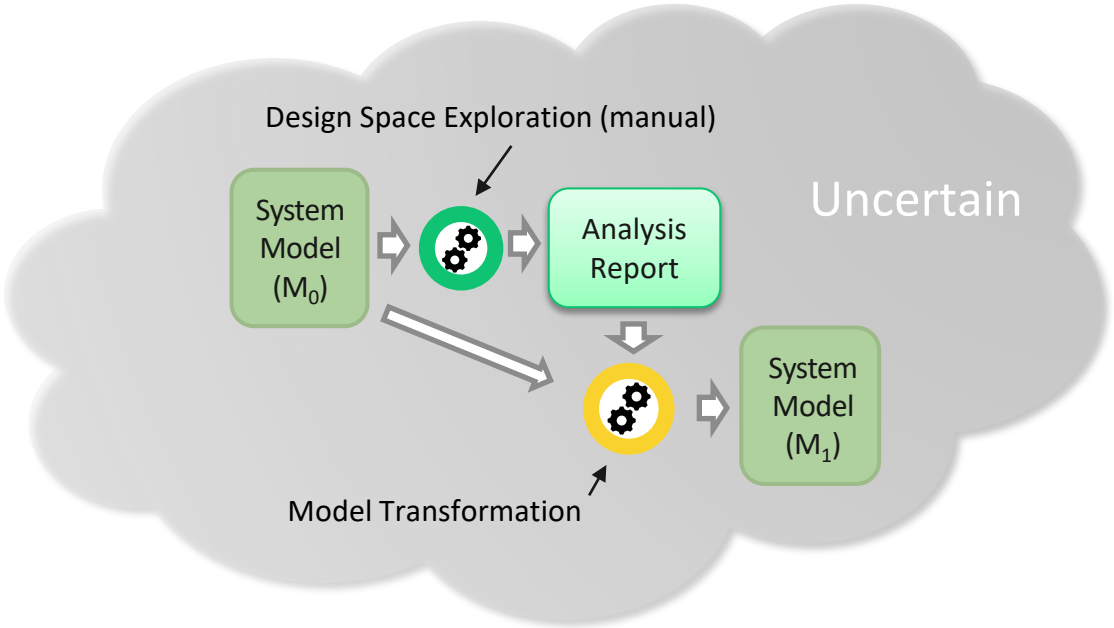


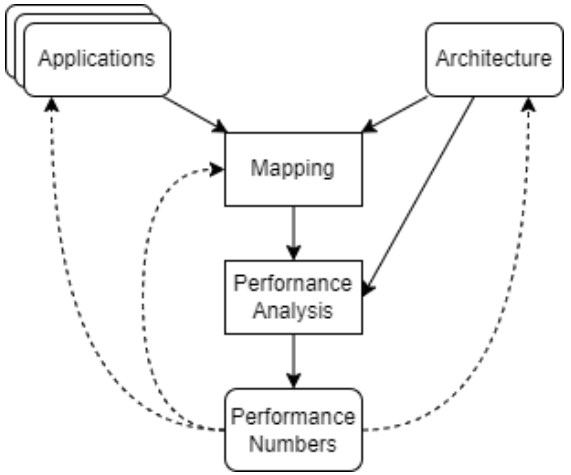
A cohesive design process

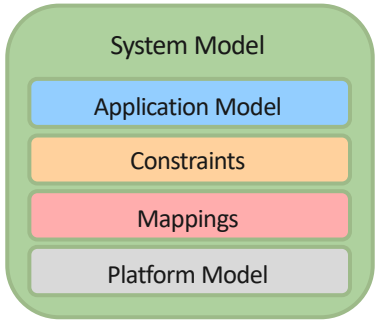
- Balance programmability with requirement satisfiability
- Resource-conscious design
- Purpose-built: develop SW/HW in tandem
- Early design decisions weigh (increasingly) much

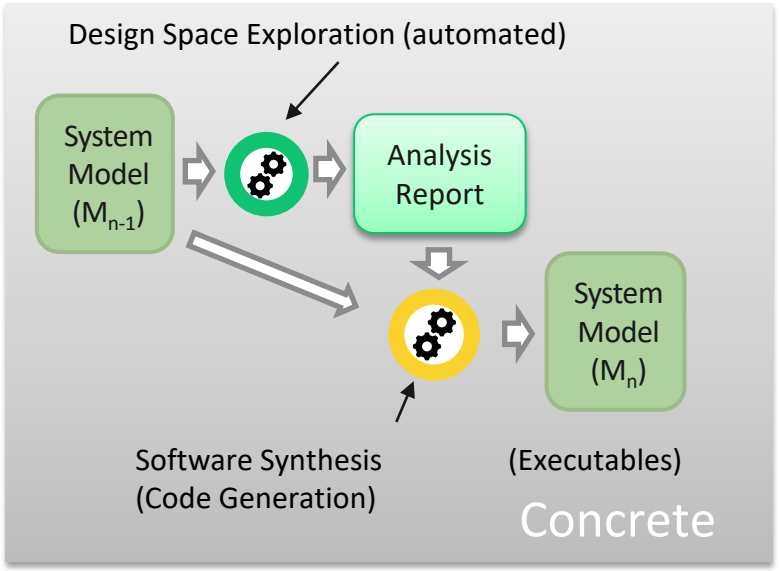


System Design Flow









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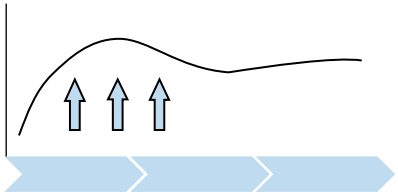

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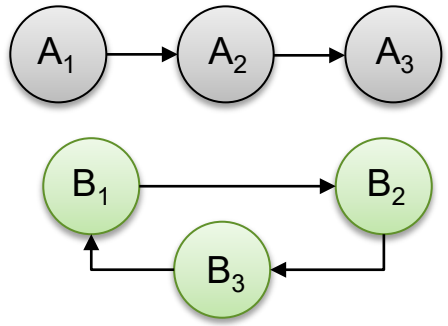
ForSyDe Design Methodology
Vision: Correct-By-Construction Design

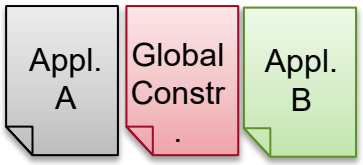
System Modelling

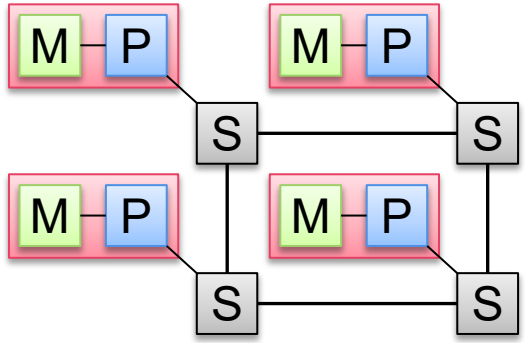
ForSyDe Modelling Libraries
- supporting several MoCs
- compliant to ForSyDe modelling paradigm



Application Models
- Formal Base (MoCs)
- Executable

Design Constraints
- Real-Time
- Power/Energy
- …



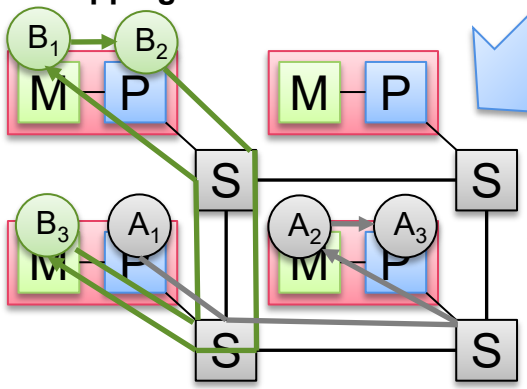


(Flexible) Platform
- Multiprocessor, Hardware Accelerators
- Predictable Performance
- …

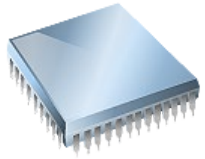
Design Space Exploration
(based on formal model and predictable architecture)

Performance Metrics
(WCET, Memory, Power, …)

Mapping and Schedules



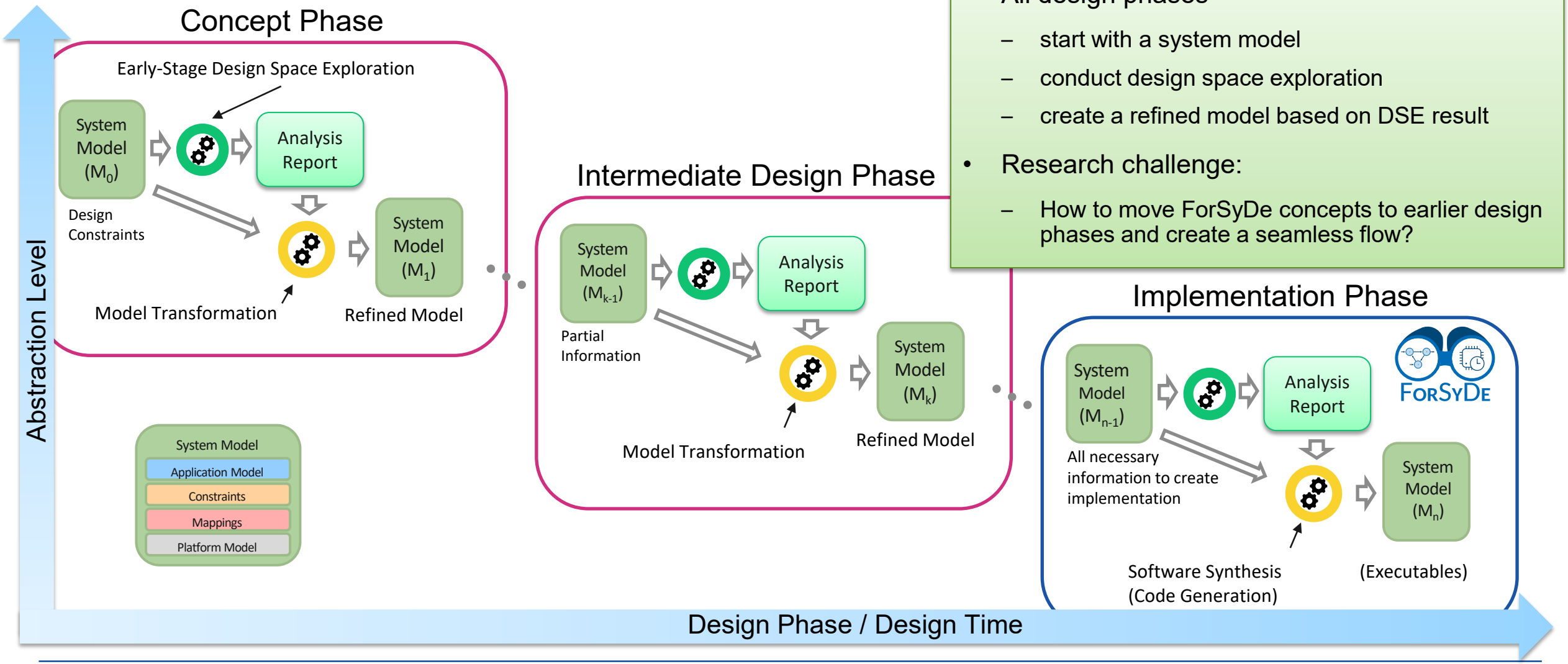
Synthesis and Compilation



Implementation
- Customized Hardware
- Efficient Software

ForSyDe
https://forsyde.github.io/

EARLY BIRD: A generalization of ForSyDe



- All design phases
  - start with a system model
  - conduct design space exploration
  - create a refined model based on DSE result
- Research challenge:
  - How to move ForSyDe concepts to earlier design phases and create a seamless flow?

Research Challenges

- System Model
  - How to express uncertainties or incomplete information at the early design stages?
  - To what extent can incomplete models be simulated?
- Design Space Exploration
  - How can design space exploration be conducted with partial information?
  - How can designers' knowledge be integrated into the design flow to enable better decisions?
  - How can information about the confidence of the DSE results be produced?
  - How can the confidence of the DSE be increased?
- Model Transformation / Synthesis
  - How to formulate and apply model transformations to create a refined model based on the analysis results of the design space explorations?
  - How to decide which of the possible results of the DSE should be used for synthesis?

EARLY BIRD will utilize results of the previous projects CORRECT, and PANORAMA, and the ongoing project TRANSFORM.

Conclusions

- Current state:
  - Demonstration of the basic ForSyDe concepts in an avionics IMA context
  - ForSyDe modeling libraries and initial set of design tools available as open source
- Project goals:
  - Establish a seamless system design methodology from early concept to implementation
  - Extend ForSyDe modeling and simulation framework to express avionics and telecom applications and platforms, and uncertainties at different stages of the design flow
  - Develop concepts and tools for DSE at different levels of abstraction with emphasis on the early stages of the design process
  - Develop a general concept and tools for model transformation (synthesis) across different design stages from concept phase to the final implementation
  - Demonstrate and evaluate the methodology with relevant industrial use cases from the avionics and telecom domain

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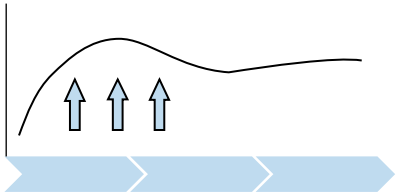

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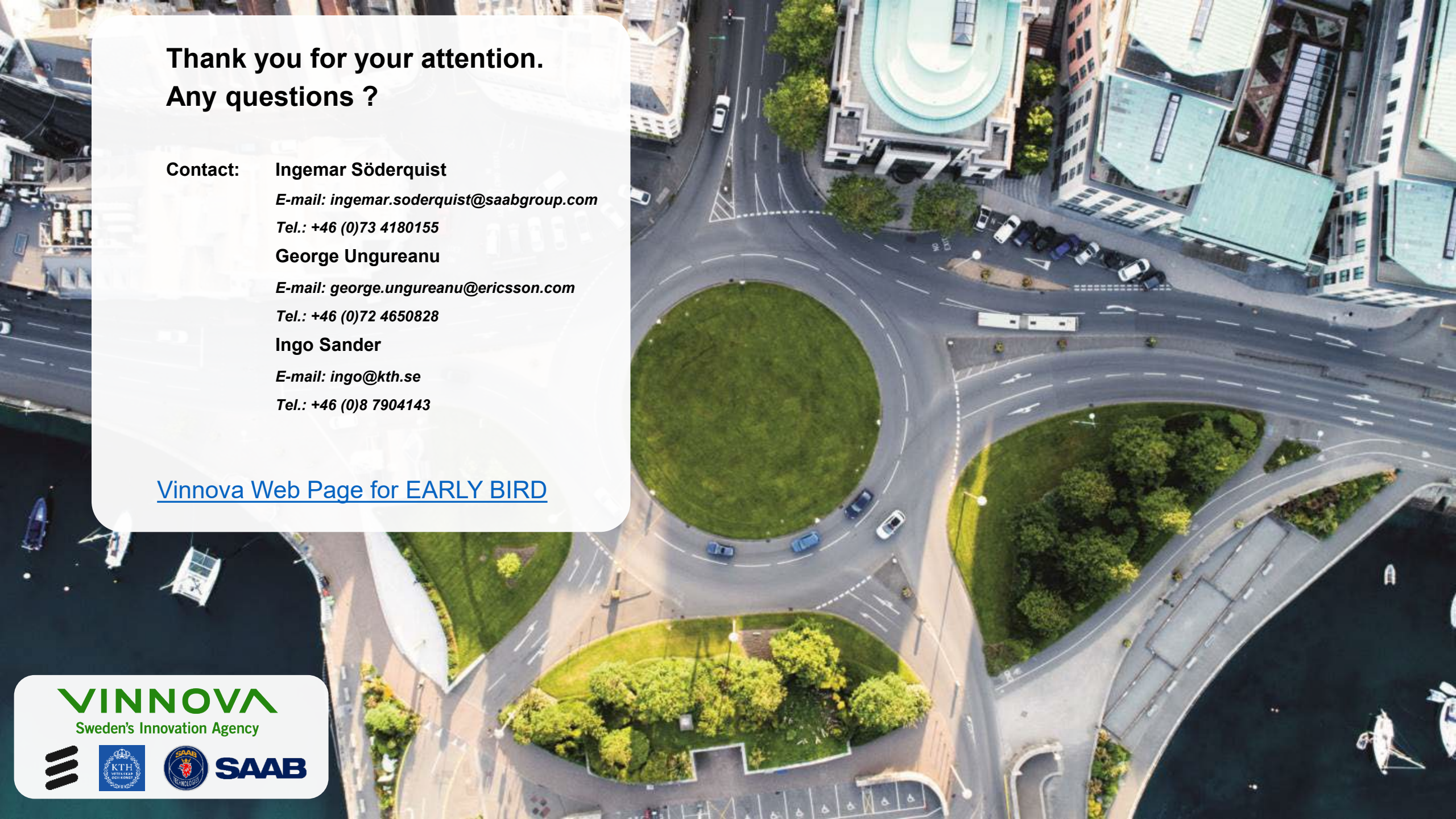

Thank you for your attention.
Any questions ?

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