ITOS EMSIG 2015

Flemming Schmidt, SE Manager
fschmidt@gnresound.com
November 12, 2015

AGENDA

Introduction to GN Store Nord

The wireless revolution in hearing aids

Moving towards higher efficiency

Case study

Key learnings

THE HISTORY OF GN STORE NORD

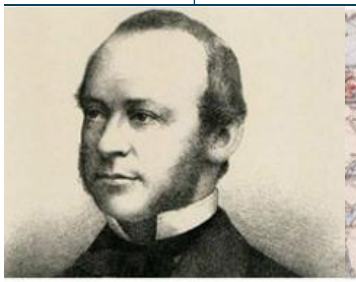
- MORE THAN 140 YEARS OF COMMUNICATION

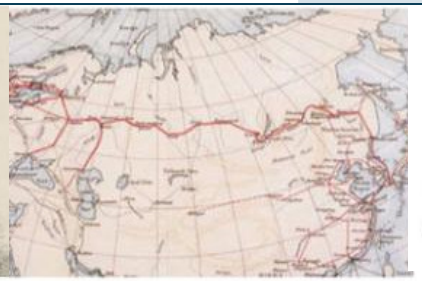
From industrial conglomerate…

1869 The Great Northern Telegraph Company was established on the initiative of C. F. Tietgen

1940-70s Diversification

2000s mid Personal communication





1872 GN opened the world's first telegraph connection between Europe and Asia

1990s from Services/products

… to focused technology leader in personal communication

GN STORE NORD GROUP STRUCTURE

GN Store Nord

GN ReSound
Hearing instruments and diagnostic equipment

GN Netcom
Hands free audio

Hearing Instruments

~54% of revenue

Otometrics

~8% of revenue

Contact Center & Offices (CC&O)

~26% of revenue

Mobile

~13% of revenue

AGENDA

Introduction to GN Store Nord

The wireless revolution in hearing aids

Moving towards higher efficiency

Case study

Key learnings

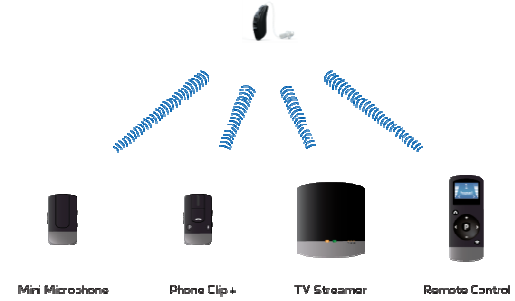
THE WIRELESS REVOLUTION IN HEARING INSTRUMENTS

Hearing aid with MFI

Hearing aid with direct wireless connection to Smartphones, Tablets etc. – connected to the internet

Hearing aid with accessories

Hearing aid with direct wireless connection to accessories



Standalone hearing aid

Standalone hearing aid with no connection to external accessories such as remote control, TV-streamer etc.

THE WIRELESS REVOLUTION IN HEARING INSTRUMENTS

- **Hearing Aids**
  - Ultra small embedded system containing:
    - Processor(s)
    - Wireless radio
    - Power management
    - Transducers
  - Ultra low power
  - Hearing aid to hearing aid (ear to ear) communication
  - Linking to the Internet through mobile devices

- **System design challenges**
  - Increasing complexity
  - Integrating technology advances from other domains
  - More partners
  - Limited resources in hearing aids:
    - Battery power
    - Memory
    - MIPS
    - Physical size

AGENDA

Introduction to GN Store Nord

The wireless revolution in hearing aids

Moving towards higher efficiency

Case study

Key learnings

MOVING TOWARDS HIGHER EFFICIENCY

Systems Engineering (SE) in GN ReSound was established in 2009 with the purpose of:

- Assisting R&D development teams in managing the increased complexity – primarily as a consequence of the wireless revolution in hearing instruments

SE is today responsible for

- Concept development
- Requirements engineering
- Definition and specifying high level systems architecture
- Systems verification

SE follows a traditional document-centric approach

- Writing product requirements documents
- Writing System design and architecture documents,
- Performing “manual” system and architecture analysis
- Writing system verification specifications and verification plans & reports

The SE function is successful but constantly challenged by:

- Escalating number of requirements
- Increasing complexity – especially within embedded systems
- Unlimited appetite for inclusion of new innovative concepts and technologies in current and future platforms
- The need for reducing cost and time to market to stay competitive

=> Challenges calling for new efficient SE work methods to stay successful
the question is just which?

MOVING TOWARDS HIGHER EFFICIENCY

Transition from document-based to model based SE seems mandatory – but may be an overwhelming task, due to the tremendous number of available:

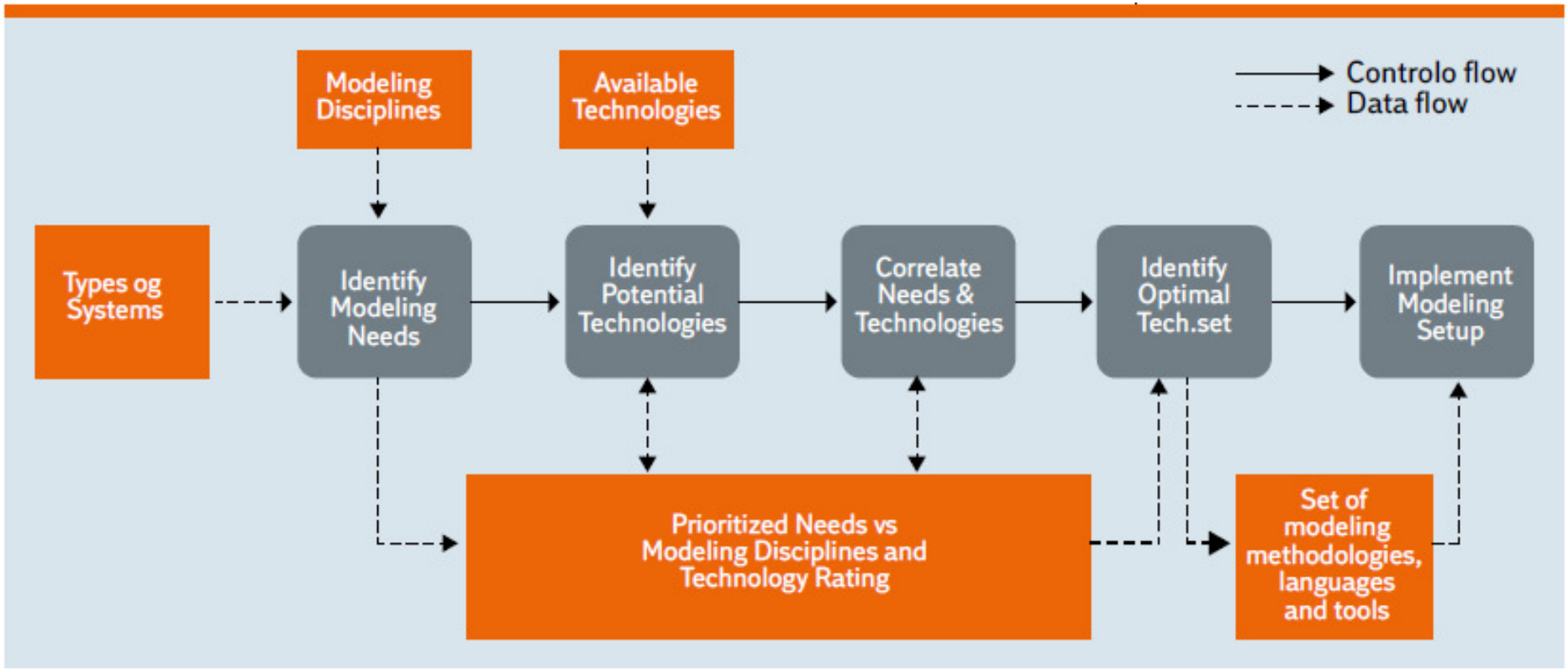
- Methodologies
- Modeling languages
- Modeling tools

Analysis of modeling needs and feasible modeling setup is workload intensive but important in getting the setup right the first time.

Choosing the wrong setup may have severe impact on the success of the organization and be costly.

A structured method for identifying modeling needs and feasible modeling setup has been developed in a research project between DTU and GNR by Allan Munck.

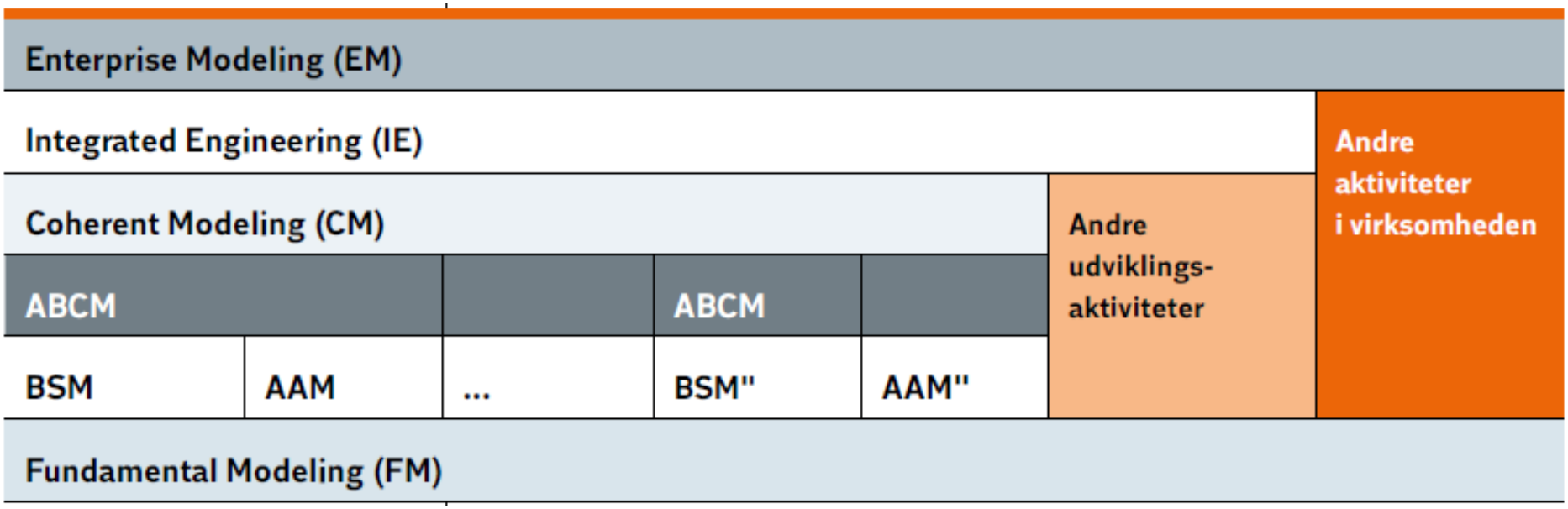
MOVING TOWARDS HIGHER EFFICIENCY



Method for identifying modeling setup.

MOVING TOWARDS HIGHER EFFICIENCY

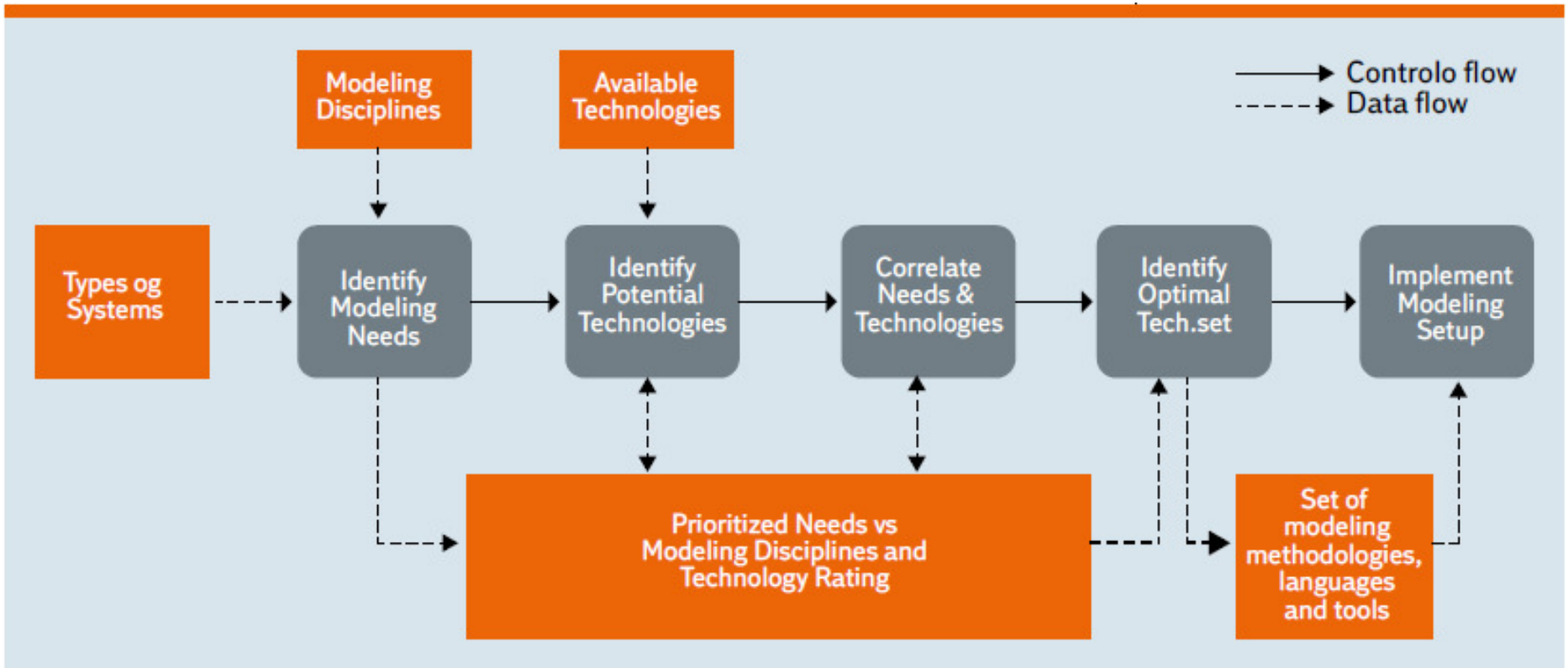
Knowledge and understanding of the modeling disciplines shown below is essential for using the proposed method.



Fundamental modeling (FM).
Behavioral simulation modeling (BSM).
Architectural analyses modeling (AAM).
Architecture/behavior co-modeling. (ABCM)

Coherent modeling (CM).
Integrated engineering (IE).
Enterprise modeling (EM).

MOVING TOWARDS HIGHER EFFICIENCY



Method for identifying modeling setup.

MOVING TOWARDS HIGHER EFFICIENCY

Discilpines and needs		Technology rating					
	Need Priority	SysML Tool #1	AADL Osate2	UPPAAL + SMC	SystemC +TLM/AMS	PLM Tool #2	Plugins 4 Tool #1
Architectural analyses modeling							
- Interactive analyses	Maybe	***	*	*	***	NA	NA
- Automated analyses	Yes	***	*****	*	*	NA	NA
- Sensitivity analyses	Yes	***	**	*****	**	NA	NA
- Dynamic architecture modeling	Maybe	*	*****	*	***	NA	NA
- Easy standard analyses	Maybe	*	*****	***	*	NA	NA
- Customized analyses	Yes	*****	**	****	***	NA	NA
- Fault propagation and impact analyses	Later	*	****	**	**	NA	NA
- Easy architecture overview	Yes	******	*	*	*	NA	NA
Architecture/Behavior co-modeling							
- Homogeneous systems simulations	Yes	*****	*	*	****	NA	*****
- Heterrogeneous systems similations	Yes	**	*	*	***	NA	**
- Code generation	No	-	-	-	-	-	-
Cohenerent modeling							
- Master model needed	Yes	****				NA	*****
- Slave models needed	Maybe		*	****	**	NA	*****
Integrated engineering							
- Integrate modeling and requirements tools	Later	***	*	*	*	*****	*****
- Integrate different modeling tools	Later	***	?	?	?	*****	*****
- Integrate modeling with other R&D artifacts	Later	***	?	?	****	*****	***
- Enterprise modeling	No	-	-	-	-	-	-
Beyound modeling							
- Software in the loop	No	-	-	-	-	-	-
- Hardware in the loop	No	-	-	-	-	-	-
- virtual reality scenarios	No	-	-	-	-	-	-
General questions							
- Affordability	Yes	**	****	**	*****	*	**
- Predefined libraries available	Maybe	*	**	*	**	NA	NA
- Traceability	Yes	*****	*	*	*	NA	NA
- Tool availablity, trustworthiness, etc	Yes	*****	**	***	****	*****	*****
Verdict	NA	Yes	Maybe	Yes	Later	Later	Yes

Correlation table

MOVING TOWARDS HIGHER EFFICIENCY

By following the proposed method and the results shown in the correlation table the following set of technologies were identified for GN ReSound:

- SysML or MARTE

- (UPPAAL or SystemC or Ptolemy-II or VHDL-AMS) and PLM and Plugins

We found SysML more attractive due to the steep learning curve using MARTE

Also – UPPAAL was found more attractive than the alternatives due to its unique formal and statistical model checking features.

AGENDA

Introduction to GN Store Nord

The wireless revolution in hearing aids

Moving towards higher efficiency

Case study

Key learnings

CASE STUDY

Purpose:

- Try the identified set of technologies

- Try the TD-MBSE approach on real SE architecture analysis task
  - Is the TD-MBSE able to handle the complexity and solve the task?
  - Compare TD-MBSE results with results obtained using classic approach
  - Identify the modeling effort

- To get some “hands-on” experience on using a modeling tool
  - Ease of use / learning curve
  - Tool capabilities / performance
  - Tool limitations

AGENDA

Introduction to GN Store Nord

The wireless revolution in hearing aids

Moving towards higher efficiency

Case study

Key learnings

KEY LEARNINGS

- A modeling setup for GN ReSound could be identified using the proposed method
- TD-MBSE / TD-DSE methodology was used for architectural analysis with success
- Results show that TD-MBSE/TD-DSE methodologies have no problems handling the complexity
- Results also show that all use cases executed on the changed architecture passes without dead locks or data being lost - in fact plenty or margin was identified
- Compared with the classical approach, results from the modeling approach provides more accurate and complete information on system performance
- The case study work was time consuming. Much of the effort went into understanding and defining use cases and tool hands on
- The modeling task was relatively small for an experienced modeller.

KEY LEARNINGS

- Next steps:
  - Introduce MBSE in SE (small scale)
  - MBSE training of systems engineer(s)
    - Modeling techniques
    - Tool training
  - FM and BSM of new module for future product

Q&A