Research at IDT:

The **POWER** of three!

Akademin för Innovation, Design och Teknik (IDT)
## School of Innovation, Design and Engineering

Hans Hansson

Prof. in Real-Time Systems, Director of Research

Research at IDT

- By far the **strongest research unit** at MDH
- Hosts **three of four research profiles** within the faculty of Science and Engineering
- 24 profs. (8 adjoint), 44 researchers, 83 PhD students
- Total research **budget: ~75 MSEK**
- +extensive **industrial involvement** (30 industrial PhD students) and **academic network**
- **Productive research**: 9 PhD, 4 Lic, and ~180 publications (2007)
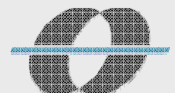
The POWER of three!
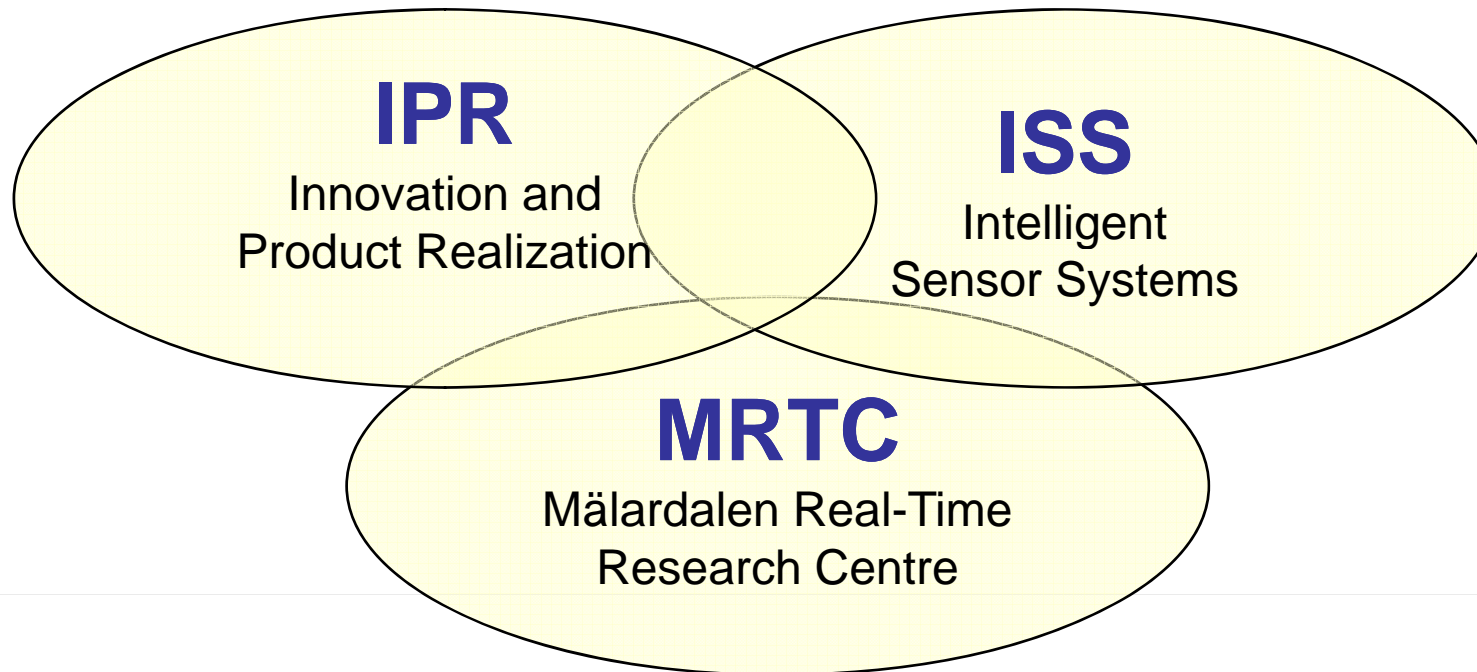
Innovation
och Produktrealisering

TRANSFORMING IDEAS INTO SUCCESSFUL PRODUCTS

Profile: Innovation and Product Realization

- Subject: Design Science
- Multi-disciplinary research
- Centre for Product Realization

Design Science						
Engineering Design	Information Design	Industrial Design	Inclusive Design	Healthcare Design	Sustainability Design	. . .
Application – Hardware, Software, Information, Service						

EXAMPLES OF RESEARCH TOPICS

Innovation & Creativity (Innovative Design and Creativity in Design)

Information System & Knowledge Management in Design

Design Management and Product Development Processes
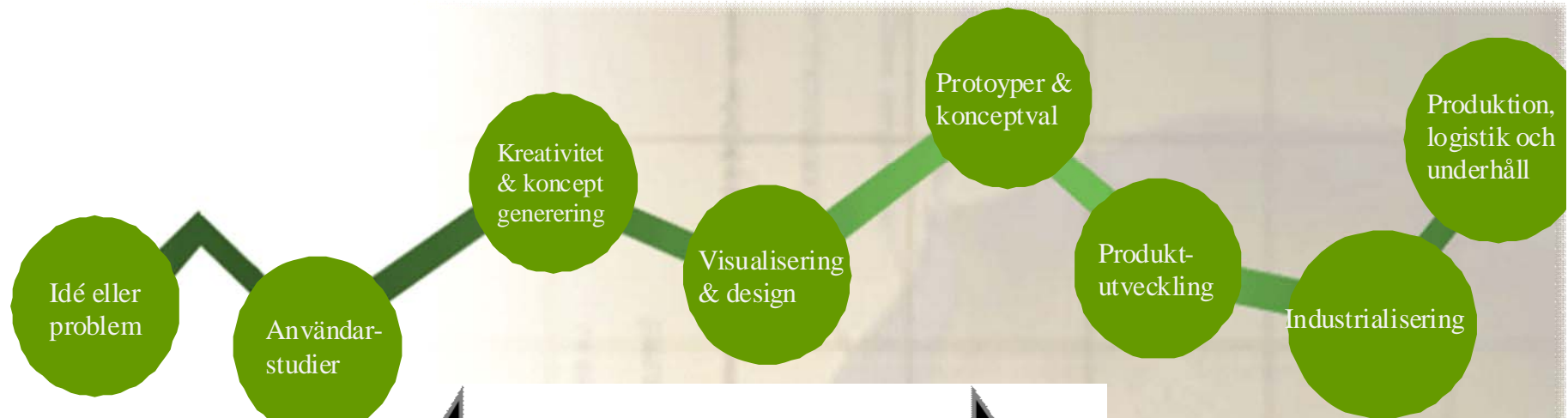
Requirements & Functional/Value Analysis

Design for X (Design for Recycling, Design for Safety, Design for Manufacturing)

Design of Production Systems, Logistics, Automation and Robotics

Maintenance

…

A unique cross-functional competence within product realization

The combination of Information design, Innovation technology and Product & Process development

Sten Ekman (Mats Jackson)

• Ideation and creativity
• Innovation and
  change management
• Entrepreneurship

• Product development
• Production development
• Logistics
• Maintenance

**Sven Hamrefors
Anders W. Johansson**

Innovation
technology

Product &
process
development

Mats Jackson

An Arena for co-production between industry and MDH
Centre for Product realization
Magnus Wiktorsson

Information
design

Yvonne Eriksson

• Graphical design
• Text design
• Room embodiment

• Interaction design
• Information strategy

Innovation and Product Realization (IPR)

- Staff
  - 3 full professors,
  - 3 adjunct professors,
  - 18 additional senior researchers, and
  - 30 PhD-students.
- Three mutually supportive research groups
  - Innovation and Entrepreneurship,
  - Information Design, and
  - Product and Process Development
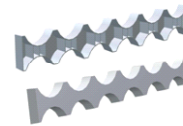- The Centre for Product Realization

Sportrulle
Mobility Design for Body & Mind and The Project "Multisport Wheelchair/Sportrulle"

Design for Recycling och Recycling Design

Produktframtagning, utveckling av produkt och process
- Mälarplast
- Idesta
- Bonaj
- X-ponent
- Södergrens metallindustri
- Eskilstuna elektronikpartner

MÄLARDALENS HÖGSKOLA
ESKILSTUNA VÄSTERÅS

Automation i framtidens verkstad
- "Lean" Robotik

Factory-in-a-Box
- Cooperation Chalmers, Jönköping and Linköping
- 5 Demonstrators in industrial environment

ProViking   Factory in a Box

VOLVO   ABB   robot dalen   MÄLARDALENS HÖGSKOLA ESKILSTUNA VÄSTERÅS

Strategisk Underhållsutveckling i Tillverkningsindustrin

Ett samarbetsprojekt Volvo CE, MDH, ABB Cewe-Control och Leax-gruppen

I SAMARBETE MED
KK·stiftelsen

Intelligenta Sensorsystem
Akademin för Innovation, Design och Teknik

Core Competence Areas
ISS

Sensor Systems

Wireless Communication

ISS

Artificial Intelligence
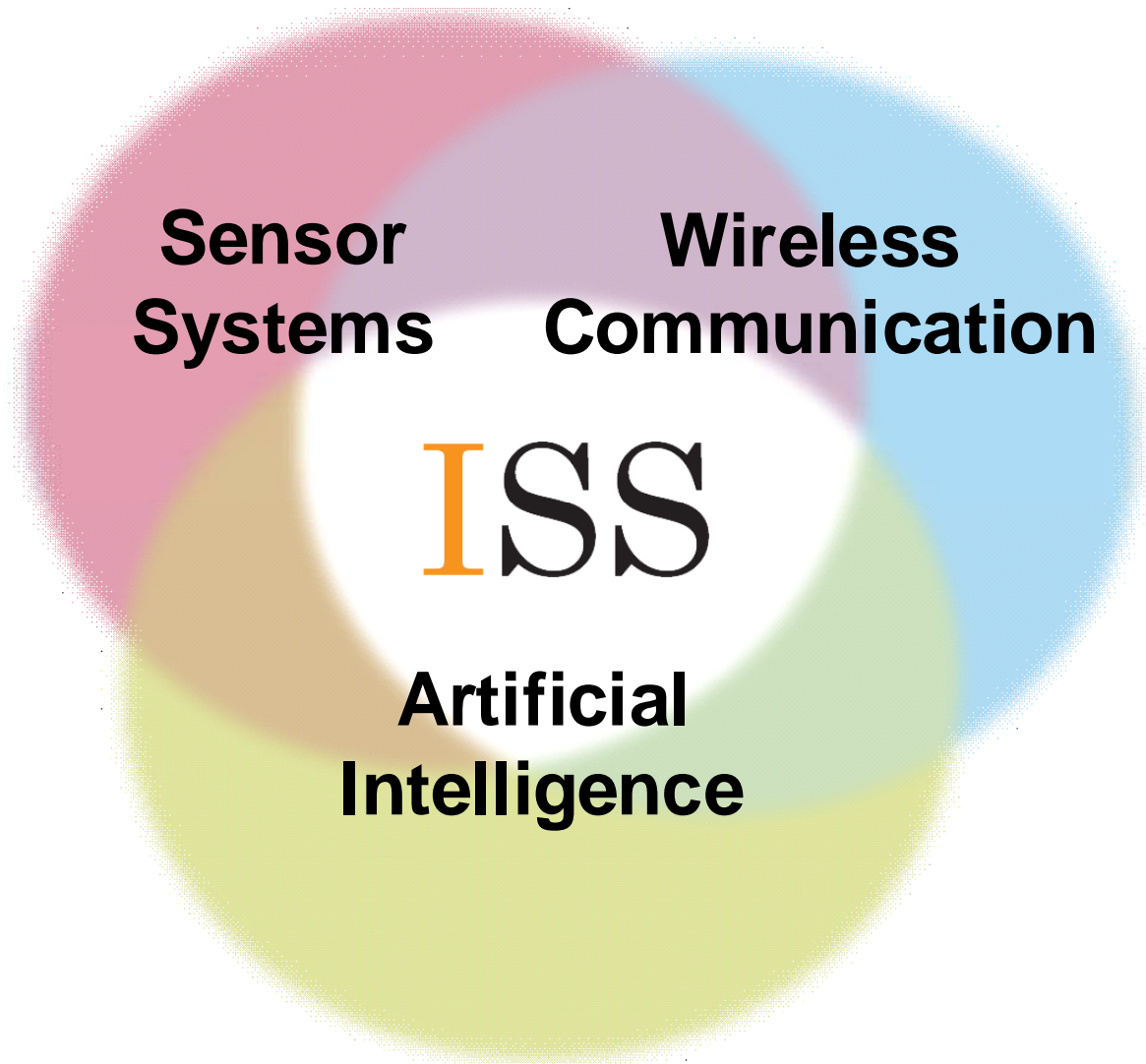
Research profile
Intelligent Sensor Systems
Profile coordinator: Maria Lindén

ISS

MÄLARDALEN UNIVERSITY
SWEDEN

Sensor
Systems

Wireless
Communication

ISS

Artificial
Intelligence
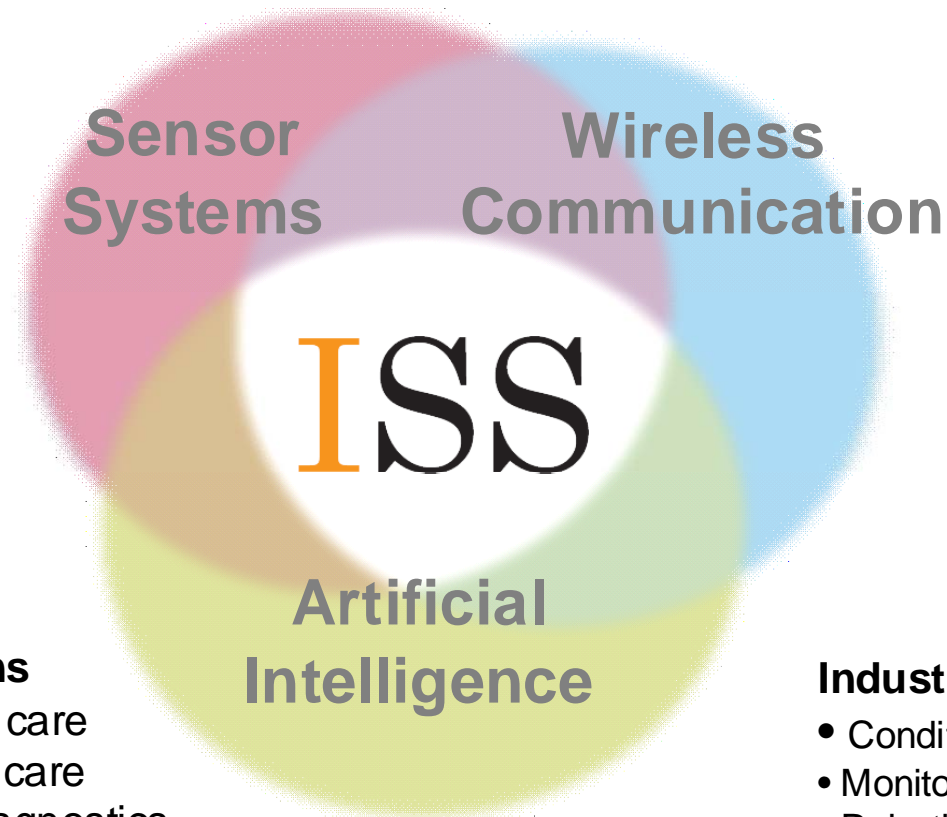
Health care applications
- Distributed health care
- Preventive health care
- Monitoring and diagnostics
- Wearable monitoring systems
- Sports medicine

Industrial applications
- Condition based maintenance
- Monitoring and diagnostics
- Robotics
- Production and automation systems
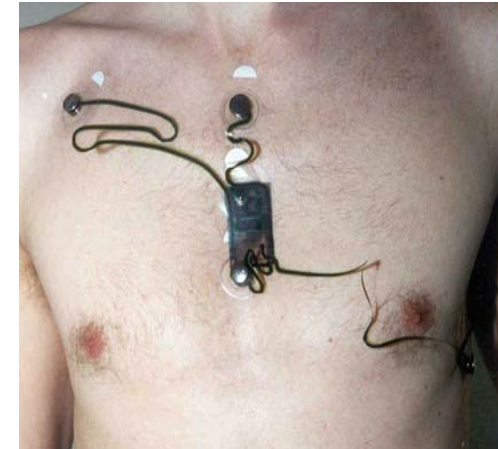- Process industry

Examples of projects

- **IPOS, Integrated Personal Health Optimizing System**

Combines physiological sensors for health care and sports medicine with AI
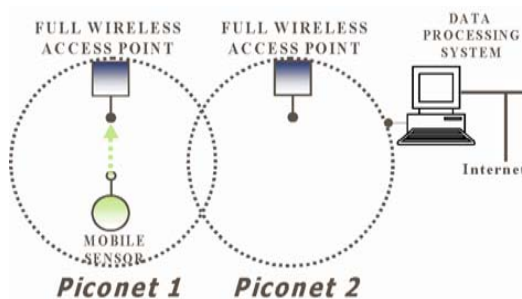

- **Wireless ECG-sytem**

- AROS - Asymmetric Routing in Sensor Systems
- Wireless Ad-hoc Sensor Network

Combines simulations with real sensor networks

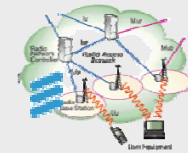
- **Robotic vision**

Sensors to interpret the environment

MRTC

MÄLARDALEN REAL-TIME RESEARCH CENTRE

- Research focus: **"IT-inside"**

- **Internationally competitive research in**
  - **Real-Time Systems**
  - **(Component-based) Software Engineering**

- **Extensive industrial co-operation**

Bombardier Transportation

...for challenging mobile applications

CC SYSTEMS

PROGRESS

MRTC

"Applied academic research in Industrial Software Engineering and Real-Time Embedded Systems with strong industrial links."

- 10 Full Professors
- 3 Adjunct Professors
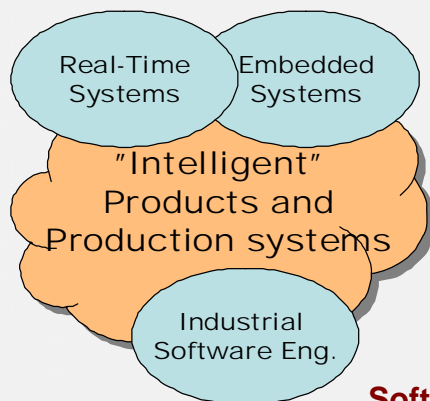- 20 Senior Researchers
- 50 PhD students

Västerås
Stockholm

Mälardalen University
Västerås, Sweden
www.mrtc.mdh.se

Industrial partners include:

ERICSSON
ABB
BOMBARDIER
VOLVO
SCANIA

Research areas at
Mälardalen **R**eal-**T**ime Research **C**entre

Real-Time Systems

Embedded Systems

"Intelligent" Products and Production systems

Industrial Software Eng.

Software Engineering
Computer Science
Computer Engineering
(Embedded Systems)

The M**R**T**C** research groups

Industrial Software Engineering group
Prof. Ivica Crnkovic; Adj. Profs. Heinz Schmidt, Magnus Larsson, Dr Frank Lüders; 6 graduate students; **Software Engineering for industrial systems**

Embedded Systems Software Engineering group
Prof. Christer Norström; Adj. Prof. Jakob Axelsson Drs. Kristian Sandström, Anders Wall; 6 graduate students; **Embedded Systems Software Engineering**

SE

The Programming Languages group
Prof. Björn Lisper; Drs. Jan Gustafsson, Andreas Ermedahl; 7 graduate students
Worst-case execution time analysis, and design and analysis of languages for real-time and embedded systems

CS

Dependable Software Enginnering group
Profs. Sasikumar Punnekkat, Kristina Lundqvist; Dr Radu Dobrin, 4 graduate students
Methods and processes for engineering dependable software systems

RT Modelling and Analysis group
Prof. Paul Pettersson, Dr. Cristina Seceleanu; **Formal modeling, analysis, and testing of real-time systems**

ES

Real-Time Systems Design group
Profs. Hans Hansson, Mikael Nolin, Drs. Jukka Mäki-Turja, Thomas Nolte, Dag Nyström, Insik Shin; 6 graduate students; **Design methods, architectures and communication for real-time systems**

Communication Performance Predictability and Analysis group
Prof. Mats Björkman; Drs. Bob Melander, Svante Ekelin, 5 graduate students; **Small embedded devices; traffic measurement and analysis; sensor networks**

Predictably Flexible Real-Time Systems group
Dr. Damir Isovic (Prof. Gerhard Fohler); 2 graduate students; **combining static and dynamic real-time scheduling, multimedia**

Scalable Architecture for Real-time Applications group
Prof. Lennart Lindh; 5 graduate students; **Scalable multiprocessor systems, system-on-chip, and moving software functions into hardware**

Monitoring and Testing group
Dr. Henrik Thane; 4 graduate students; **Monitoring, testing, and debugging of real-time systems**

PROGRESS

MRTC has put MDH on the Map

	CTH	GU	KI	KTH	LiU	LU	LTU	MDH	SU	SLU	UmU	UU
VR och Formas Linnéstöd, 2006	1	1	2	2	1	8			2	1	1	1
VR Starka forsknings-miljöer, 2005	1		2			2			2		1	2
SSF 17 Forskningscentrum, 2005	2	2	1	2	2,5	4		1	1	1		0,5
SSF Forskningscentrum i livsvetenskap och mikroelektr. 2002-2003	2		3	1	3	1					1	1
Formas Starka forsknings-miljöer, 2005									1	2	1	1
Vinnova Excellence center	4	1		5	1	1	1		1			1
Totalt:	10	4	8	10	7,5	16	1	1	7	4	4	6,5

CTH= Chalmers tekniska högskola
GU= Göteborgsuniversitet
KI= Karolinska institutet
KTH= Kungliga Tekniska högskolan

LiU= Linköpings universitet
LU= Lunds universitet och tekniska högskola
LTU= Luleå tekniska högskola
MDH= Mälardalens högskola

SU= Stockholms universitet
SLU= Sveriges lantbruksuniversitet
UmU= Umeå universitet
UU= Uppsala universitet

Örebro?   Karlstad?   MittUniv?   Växjö?

PROGRESS

The competitiveness of products is implemented in software
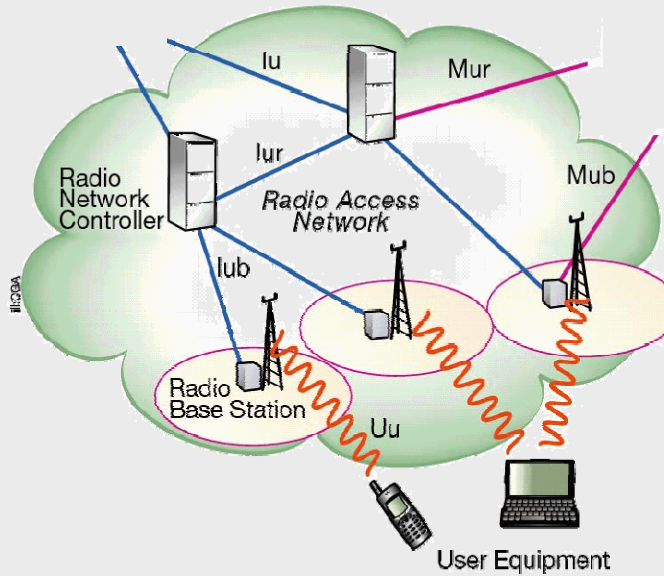
"IT-inside" – challenges

- **Complexity**

- **Integration**

- **Quality assurance**
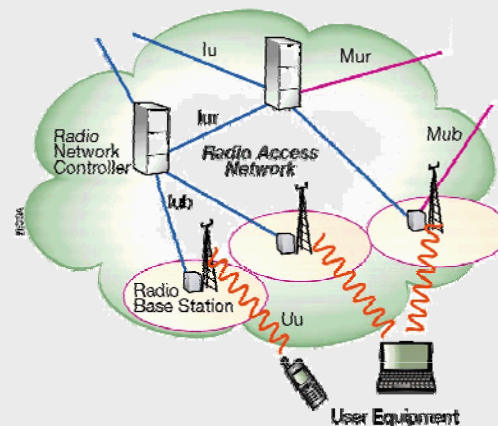
(Our) **Hypothesis**

- By building embedded software (and systems) from reusable components
  - complexity,
  - integration, and
  - quality assurance
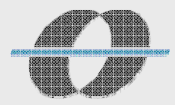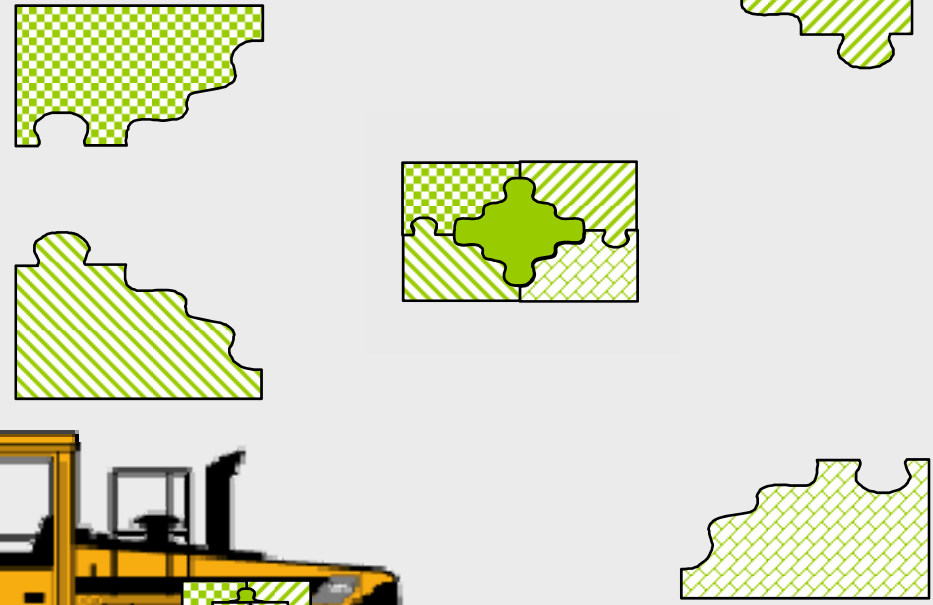- can be handled in a more cost efficient and scalable way

Remains to be proven!
(at least for the application domains we consider)

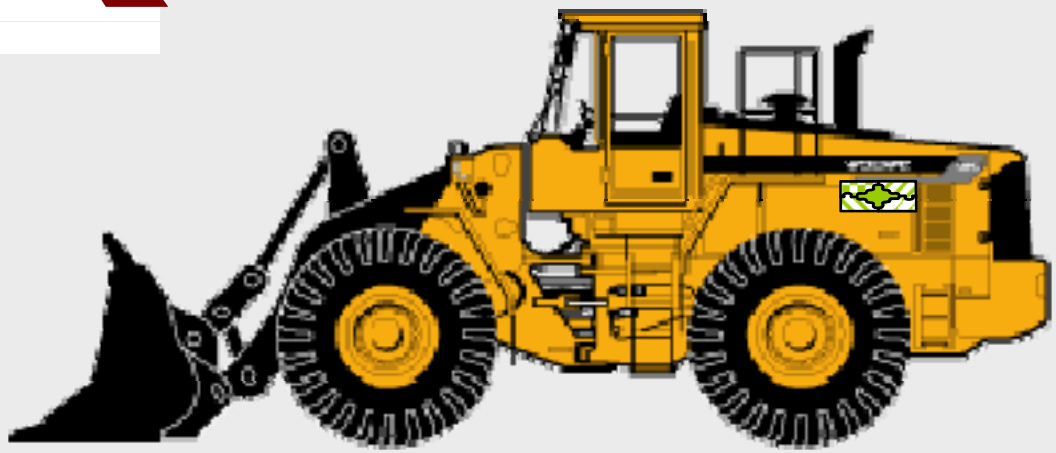# Component-based SW development

- Build SW systems from existing SW components

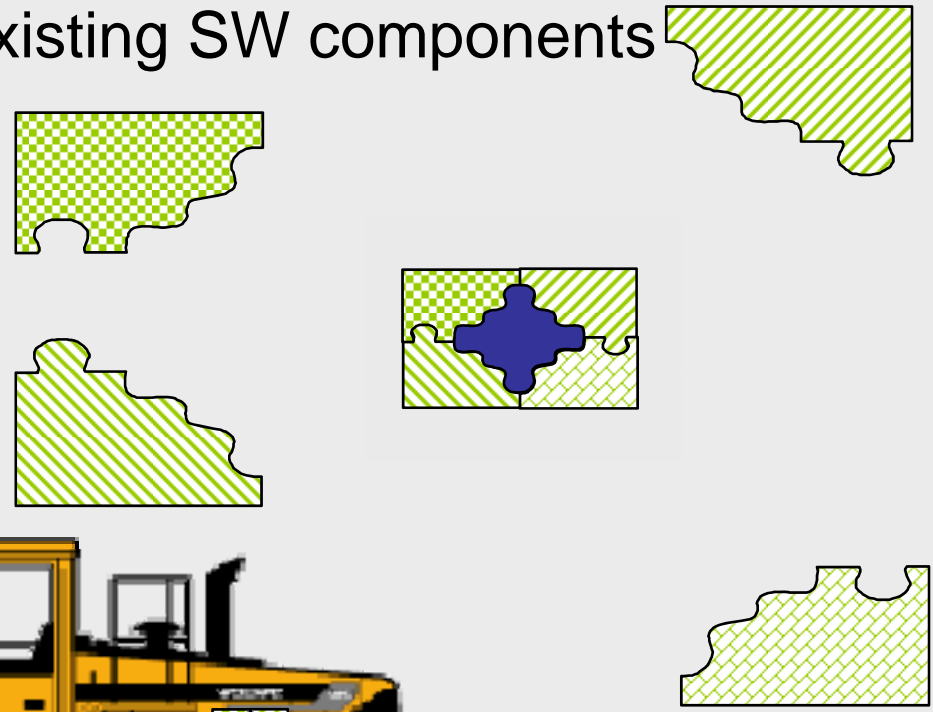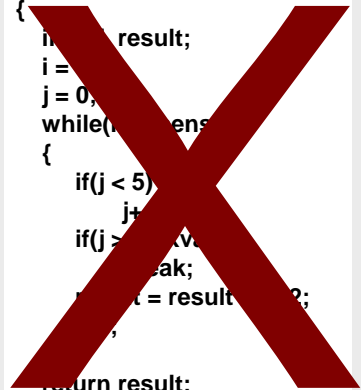# Component-based SW development

- Build SW systems from existing SW components

```
int foo(int sensor)
{
    int    result;
    i =
    j = 0;
    while(    sens
    {
        if(j < 5)
            j+
        if(j        v
            eak;
        t = result     2;

    return result;
}
```

Essentials

-Industrial requirements
-"Deployable" CBSE process

Life-cycle processes (development/maintenance/modifications)

Legacy systems

Componentisation

Validation

Componentisation of legacy SW

Requirements

Predictable and efficient mapping from model to implementation level

Env

Model-based framework
for
Component-based software development

Komporent-modell

System modell

Komponent-modell
Komponent-modell
Komponent-modell

Predictable and efficient execution of CBSW

- Component models
- Framework for reasoning and modelling of functional and extra-functional properties

Analys-modell
modell
modell

Flexible platform

Jobb ... Jobb
Middleware
Distribuerat delsystem

Jcbb ... Jobb
Middleware
Distribuerat delsystem

Platform properties

Execution environment

Network Nods

"Komponentdatabas"

Integration of results and demonstration of applicability

PROGRESS

Framework of **component models,** the basis on which (essentially) all PROGRESS activities build on.

Tool infrastructure – set of basic tools and support for integration of other tools Component based development **processes** and how such development can be integrated in existing processes.

Methods and techniques that assist in **integrating legacy code** in the component-based development

Component-based development cluster
Ivica Crnkovic

Legacy cluster
Christer Norström

Component model RD

Ivica Crnkovic
Jan Carlson

Predictability assurance RD

Paul Pettersson

Integrated development environment and process RD

Ivica Crnkovic

Deployment RD

Mikael Nolin

Componentization of legacy RD

Thomas Nolte

Legacy property prediction RD

Christer Norström
Johan Kraft

Theories, **methods**, **algorithms** and **tools** for reasoning about **predictability** attributes.

Mappings and **translations** from the SW design to code executing on particular target platforms.

Methods for analysis and **model extraction.**

Industrial Embedded Systems Processes

MRTC
MÄLARDALEN REAL-TIME
RESEARCH CENTRE

Senior researchers

- Prof. Christer Norström, MDH
- Adjunct prof. Jakob Axelsson, Volvo Car
- Prof. Ivica Crnkovic, MDH
- Dr Rikad Land, MDH
- Dr Anders Wall, ABB
- Dr Joakim Fröberg, Volvo CE
- Dr Stig Larsson, ABB

Industrial PHD students

- Håkan Gustafsson, Scania
- Pia Stoll, ABB
- Markus Lindgren, ABB
- Joakim Fröberg, Volvo CE
- Stefan Johnsson, Level21

PHD students

- Peter Wallin
- Ylva Boivie

Goal

Increasing efficiency in product development of industrial complex software intensive systems by applied research in close collaboration with industry

Approach

- Start from a common problem understanding
- Formulate hypotheses
- Strengthen hypotheses by case studies
- Prototype development

Projects

- **Release planning – balancing cost and quality** - with ABB

- **Performance metrics in product development** – with ABB, Ericsson, Volvo, Saab and Level21

- **Engineering Automotive Electronic Systems – Decision Support for Successful Integration** – with Volvo CE

- **PASAS - Prioritizing Business Goals and System Quality Attributes in Software Architecture Solutions** – with ABB

- **Open Innovation in product development of industrial complex systems** – with Ericsson

Christer Norström

- **Key Elements of Software Product Integration Processes** – with ABB

Ivica Crnkovic

- **Business Oriented Concept Development of Electronic System Architecture and Platforms in Vehicles** – with Volvo Car, Volvo Truck and Volvo CE

- **Methods for development of E/E-systemarchitectures in early phases** – with Scania

Jakob Axelsson

Extensive involvements of industrial researchers and industrial PhD-students

Research at IDT:

The **POWER** of three!

Many synergies possible!
- existing cooperations
- KK environment application

"Low hanging fruits":
- Focus on areas of obvious overlap
- Creative idea stimulating seminars

Research at IDT:

The **POWER** of three!

Many synergies possible!
- existing cooperations
- new organization
- new joint initiative (KK environment application)

We are always interested in cooperation!!