RAMS and LCC for infrastructure
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DB Netz AG

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Infrastructure Systems Interface

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Contents of the Presentation

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Contents of the presentation

- Why to use RAMS and LCC?

- Definition and Methodology of RAMS and LCC

- Practical use of RAMS and LCC

- Operational and organisational requirements

Competence areas of I.NVT 8
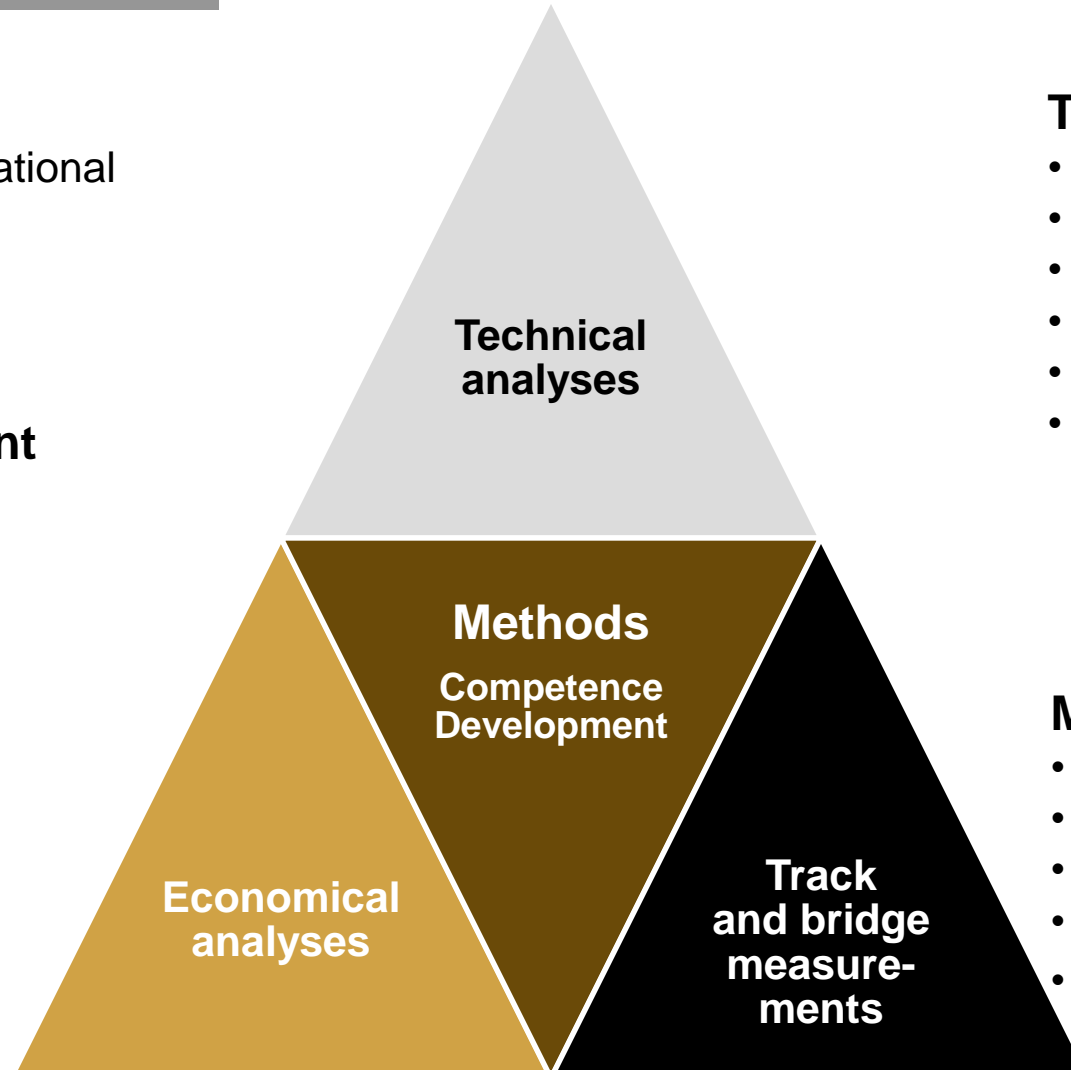# Measurements, Simulation, Analysis and Assessment

Methods
- LCC, national, international
- FMEA
- RAMS
- Data Mining

Project management
- Internal projects
- National projects
- International projects

LCC Analyses
- Analysis of variants
- Sensitivity analyses
- Potential analyses

Technical Analyses
- Simulation
- Evaluation
- Data Mining
- ABC analysis
- FMEA
- RAMS

Measurements
- Dynamic
- Long-term behaviour
- Forces
- Monitoring of vehicles
- Bridge parameter

Technical analyses

Methods
Competence Development

Economical analyses

Track and bridge measure-ments

Contents of the Presentation

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What does this all means for your daily work and decision process?

You make daily decision like

- You react on customer requirements and makes it possible to drive more, longer or heavier trains
- You change a supplier of standard products
- You want to increase the time between two maintenance activities
- You want to improve your system regarding availability
- You want to spend your budget with highest efficiency
- You have to assess innovation provided by suppliers

- All these decision are relevant for the technical performance (RAMS) and costs (LCC)

- **Today the customers do not want the best technical solution, the customers want the solution with the highest benefit!**

➜ **In all cases you need information about the costs related to your decision**

Contents of the Presentation
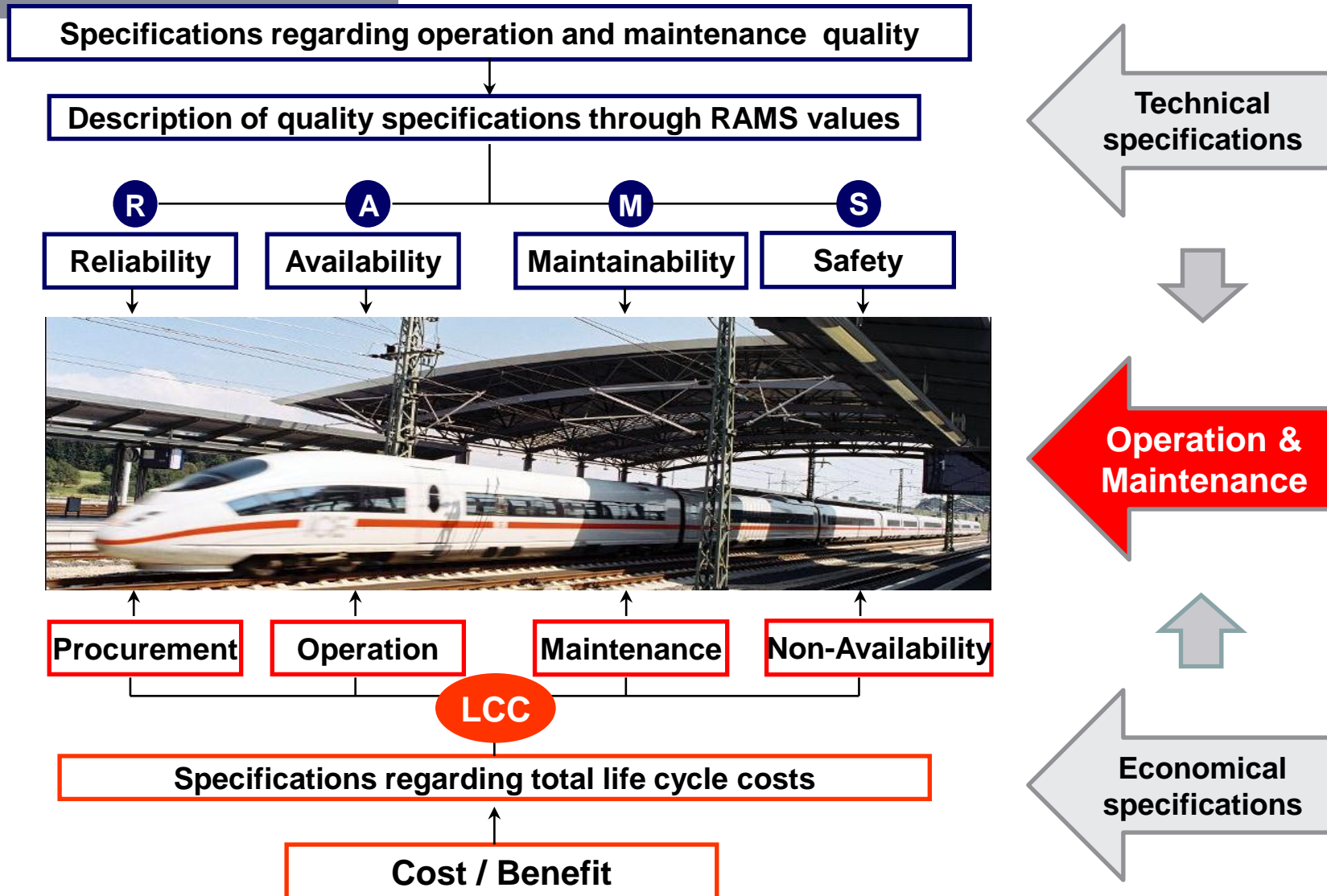
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RAMS and LCC are strongly connected. RAMS & LCC should be one part of decision criterions for the procurement & development of products

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Specifications regarding operation and maintenance quality

Description of quality specifications through RAMS values

Technical specifications

R — **A** — **M** — **S**

| Reliability | Availability | Maintainability | Safety |

Operation & Maintenance

| Procurement | Operation | Maintenance | Non-Availability |

LCC

Specifications regarding total life cycle costs

Economical specifications

Cost / Benefit

The consideration of RAM/LCC analysis ensures the development and implementation of reliable and cost-efficient system

Life Cycle Costing (LCC)

- Systematic analysis of all product-related costs from its development to operation to disposal.

- **result: „€ over time"**

Compatibility Analysis (RAM)

- Analysis of impact on the system and predictive error prevention (FMEA) to ensure system reliability.

- **result: „ Δ€ by failure prevention"**

**Technical evaluation of a workflow or system in economic, functional or procedural terms**

- Hazard identification by application of technical systems and evaluation of mitigation measures for risk control.

- **result: „proof of safety"**

- Service testing and certification to ensure system integration and acceptance

- **result: „equipment in line with the design intent & contractual obligations"**

Risk Analysis (Safety)

Integration & Asset Management

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Milestones of a LCC-Calculation standardised within DB
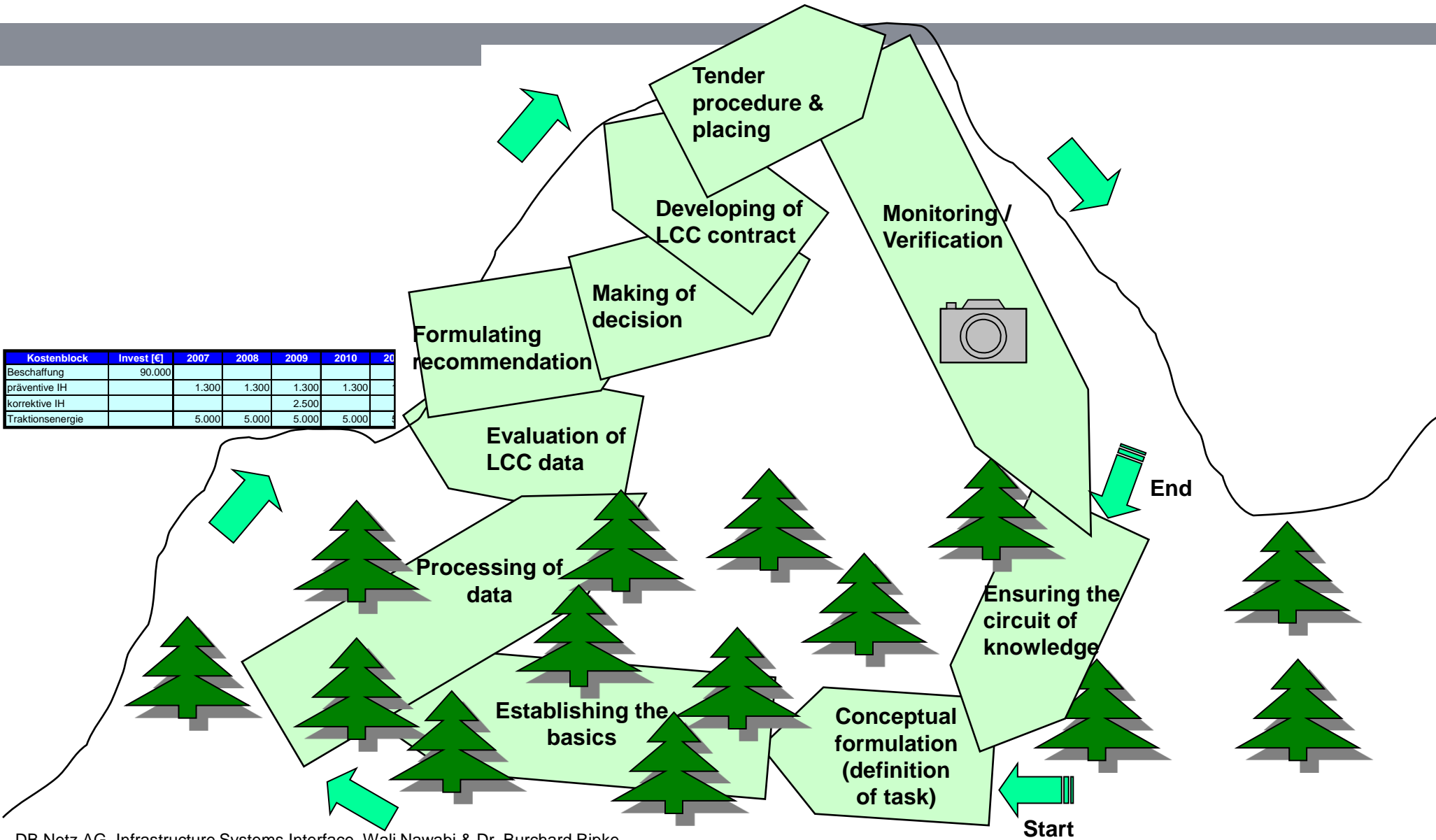
Kostenblock	Invest [€]	2007	2008	2009	2010	20
Beschaffung	90.000					
präventive IH		1.300	1.300	1.300	1.300	
korrektive IH				2.500		
Traktionsenergie		5.000	5.000	5.000	5.000	

Tender procedure & placing

Developing of LCC contract

Monitoring / Verification

Making of decision

Formulating recommendation

Evaluation of LCC data

Processing of data

Ensuring the circuit of knowledge

End

Establishing the basics

Conceptual formulation (definition of task)

Start

Contents of the Presentation

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Contents of the presentation

Why to use RAMS and LCC?

Definition and Methodology of RAMS and LCC

Practical use of RAMS and LCC (first example)

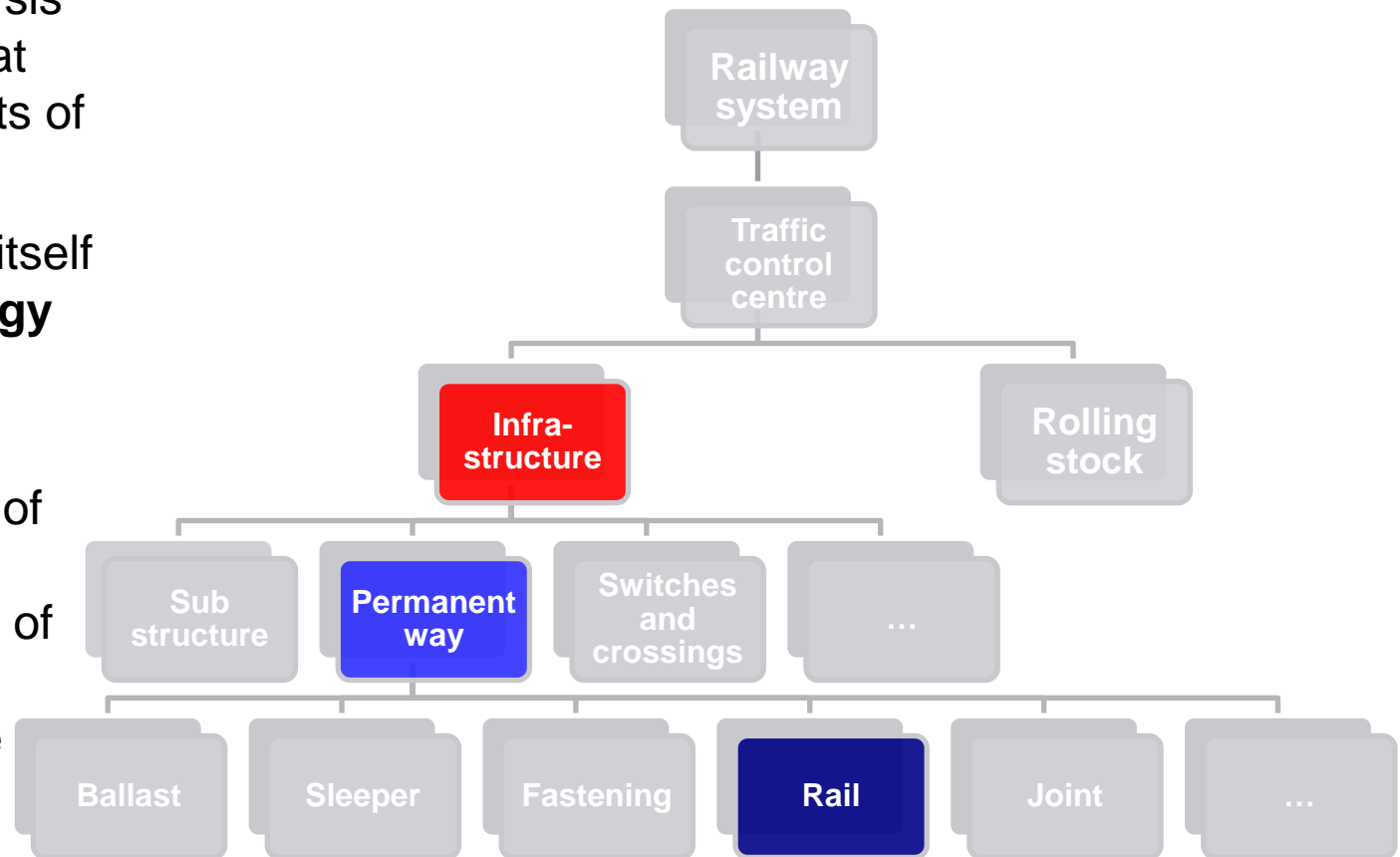Operational and organisational requirements

RAMS and LCC analysis for Economical use of heat treated rails
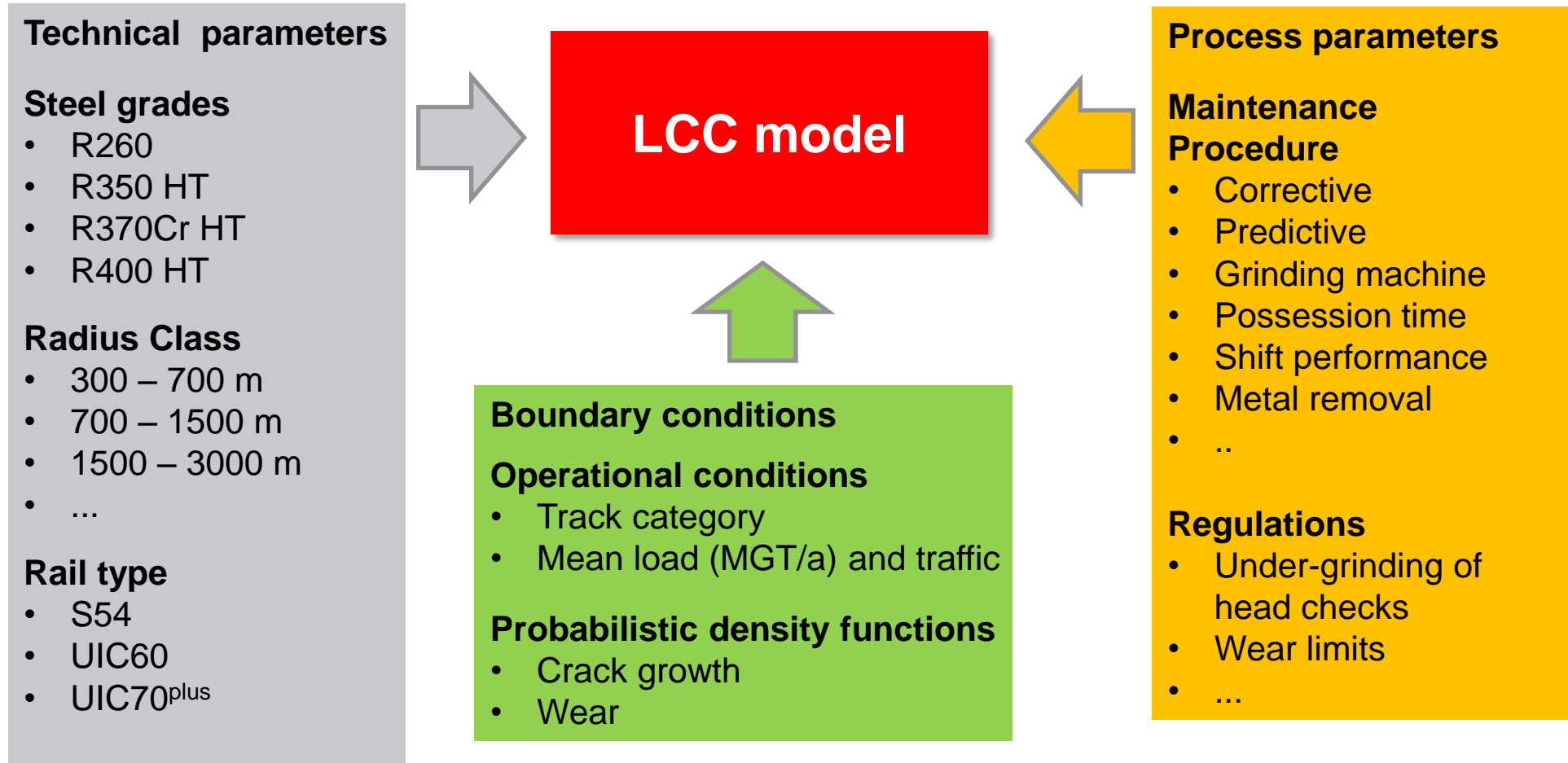
System description

The system for the analysis of economical use of heat treaded rails only consists of the component rail.

Besides the component itself the **maintenance strategy** (grinding) is taken into account.

The technical behaviour of the **component rail** influences the behaviour of the **sub-system permanent way** and the **system infrastructure.**

```
                    Railway
                    system
                       |
                    Traffic
                    control
                    centre
              _____|_____
             |                                   |
         Infra-                              Rolling
        structure                            stock
      _____|_____
     |        |         |         |
    Sub    Permanent  Switches   ...
 structure   way       and
                     crossings
      _____|_____
     |       |        |        |       |      |
  Ballast  Sleeper Fastening  Rail   Joint   ...
```

Parameters for LCC model

Technical parameters

Steel grades
- R260
- R350 HT
- R370Cr HT
- R400 HT

Radius Class
- 300 – 700 m
- 700 – 1500 m
- 1500 – 3000 m
- ...

Rail type
- S54
- UIC60
- UIC70^{plus}

LCC model

Boundary conditions

Operational conditions
- Track category
- Mean load (MGT/a) and traffic

Probabilistic density functions
- Crack growth
- Wear

Process parameters

Maintenance Procedure
- Corrective
- Predictive
- Grinding machine
- Possession time
- Shift performance
- Metal removal
- ..

Regulations
- Under-grinding of head checks
- Wear limits
- ...

Documentation of boundaries is essential
In/Out-frame for heat treated rails

R 260 and R350HT	Cost for investment and non-availability	Identical grinding performance for HT rails
Grinding	Wear and RCF	Maintenance – fault clearance
Corrective maintenance	Service life of rails	Variable load of track
Mixed traffic Radius 700–1500 m 20-30 MGT/a	Load dependent grinding costs	Reference to test sites and experiments

Individual regulations

Interactions with other SPs

Outside

welding quality and costs

Grinding performance for HT grade

Documentation of used cost items is essential
Cost matrix – top level

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I. Procurement

I.1 Preparation
one-time / generic/ product-specific (product family)

I.2 Preparation
recurrent / project-specific (single product)

I.3 Investment

I.4 Imputed residual value

I.5 Decommissioning / retraction / sale / removal (tasks)

I.6 Disposal / recycling (material)

II. Operation

II.1 Service
II.1.2 Energy

II.1.9 Other costs

III. Maintenance

III.1 Inspection and service (track)

III.2 Maintenance - preventive (track)

III.4 Maintenance - corrective (track)

III.7 Design and system support

IV. Non Availability

IV.1 Planned
IV.1.1 Rail grinding
IV.1.2 Rail renewal
IV.1.3 Less Serviceability

IV.2 Unplanned
IV.2.1 Malfunctions
IV.2.2 Delays
IV.2.3 Less Serviceability

V. Social Economics

V.1 Energy consumption

V.2 Environment

V.3 Delay

Documentation of important parameters is essential
Economical parameters

*) Tm = Track meter

Cost block	Data structure	Reference case R260 (standard rail grade)	Innovation R350 HT (hard rail grade)
Investment	Euro Cycle Source Quality	215 €/Tm*) load dependent, nom. 20 year DB intern Experts / Analysis	225 €/Tm load dependent, nom. 40 year DB intern Experts / Analysis
Operation	Euro Cycle Source Quality	N/a	N/a
Maintenance Rail renewal	Euro Cycle Source Quality	188 €/Tm load dependent, nom. 20 year DB intern Experts / Analysis	198 €/Tm load dependent, nom. 40 year DB intern Estimation / Experts / Analysis
Maintenance Rail grinding	Euro Cycle Source Quality	5-12 €/m per shift load-, radius dependent , 1 year DB intern Experts / Analysis	5-12 €/m per shift load-, radius dependent , 3 year DB intern Experts / Analysis
Non-Availability	Euro Cycle Source Quality	Track Category dependent load dependent DB Intern Analysis	Track Category dependent load dependent DB Intern Analysis

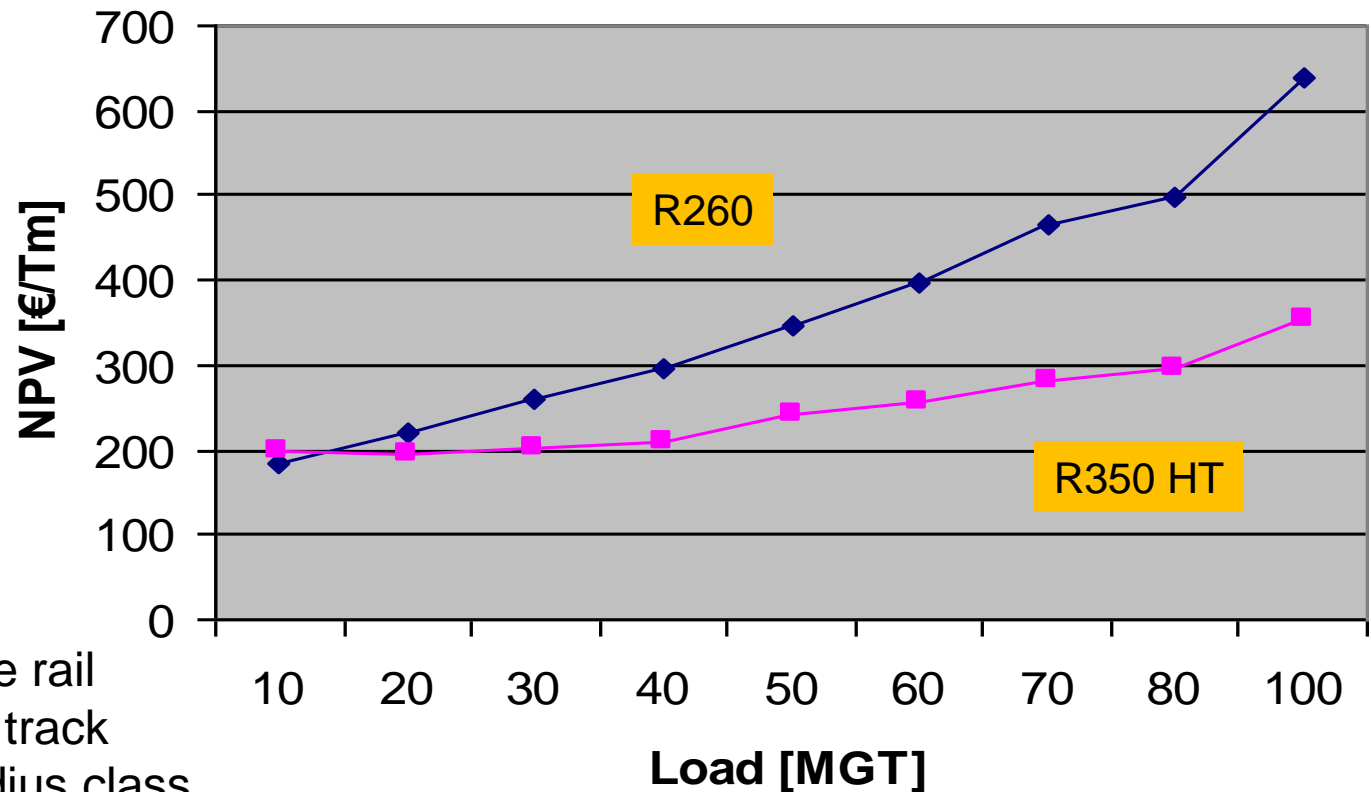# The heat treated rail shows a good technical and economical performance in curves up to 1500 m

Results

Life cycle costs

For higher loading the LCC of R350HT is relevant lower than for R260:

LCC savings

☺ Up to **50%** regarding the rail
☺ Up to **7%** regarding the track system for selected radius class
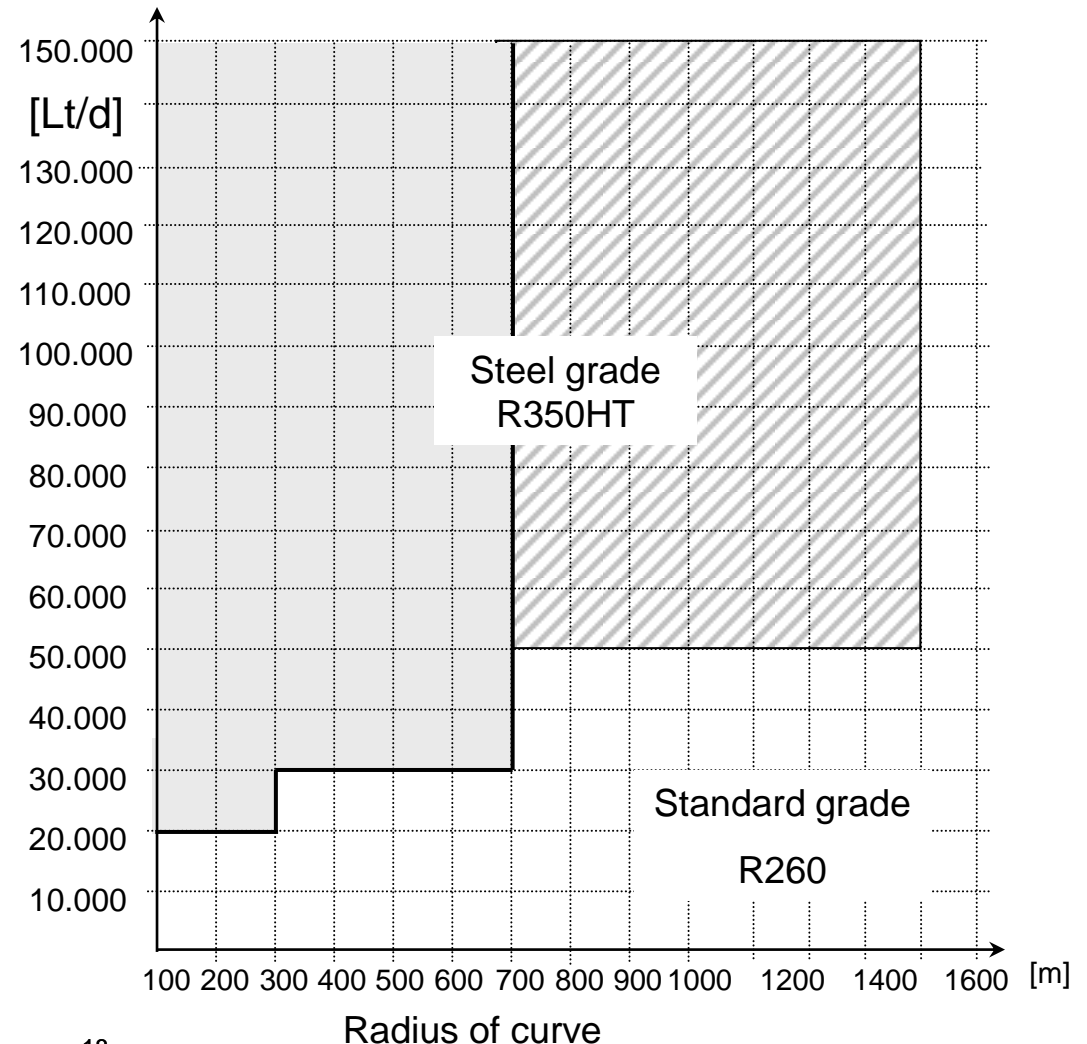

Radius class 700 – 1500 m

How to use the results of RAMS and LCC analysis?

Implementation of results

The LCC analysis shows, that the use of heat treated rails with grade R350HT reduce the life cycle costs in curves with radius up to 1500m.
This result is *valid under all operational condition*s for a mean load above 50.000 Lt/d.

The specifications of DB were updated.

Are efforts and benefits in good correlation?

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Effort

- Installation of heat treated rails for testing under real conditions
- Measurement of crack depth at fixed intervals depending on actual load validation and evaluation of measurements
- Definition of system and boundaries
- Development of LCC model
- LCC analysis including sensitivity analysis for several boundary conditions
- Documentation of parameters, boundaries and results

Management

Frame work

Processes

Ressources
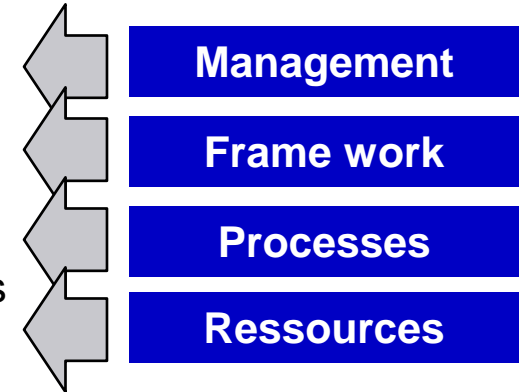
Benefits

- Traceable and valid decision by LCC for implementing heat treated rails
- Clear boundary conditions for economic use of heat treaded rails
- System improvement in shorter times
- Reduction of LCC of rail about 10%- 50%
- Increase reliability and availability of track
- Increase of knowledge and updated standards

Reduced LCC

Increased RA

Implementation

Ressources
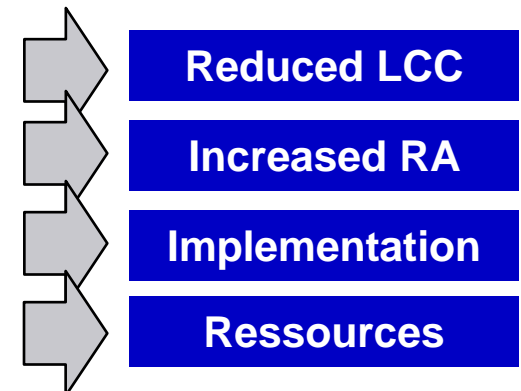
☺ **The benefit of the analysis is much higher than the effort**

Efforts and benefits of RAMS and LCC analysis

Benefits	Efforts
■ Assessment and comparison of alternative strategies and solutions and prediction of costs ■ Identification of cost driver and reduction of costs ■ Transparency of the costs and decision making process ■ Security of the decision making, to plan annual expenses, clear financial business plan for expenses ■ Risk prediction & reduction, increase life cycle of assets ■ Optimisation of Maintenance strategy ■ Optimisation of Reliability and Availability by ensuring of quality at the same time ■ Ensuring and increase of business success (through quality and customer satisfaction	■ Organisational framework (quality management system, process, responsibilities, resources etc.) ■ Knowledge of the reliability of system and process ■ Adapted organisational structure and workflows, systematisation ■ Experts with knowledge and experience in the field of RAMS and LCC ■ RAMS and LCC data in a appropriate quality, quantity and accurate form and appropriate tools ■ Holistic approach ■ Appropriate environment for implementation (suppliers, government, infrastructure managers) ■ Motivation and staying power

organisational requirements
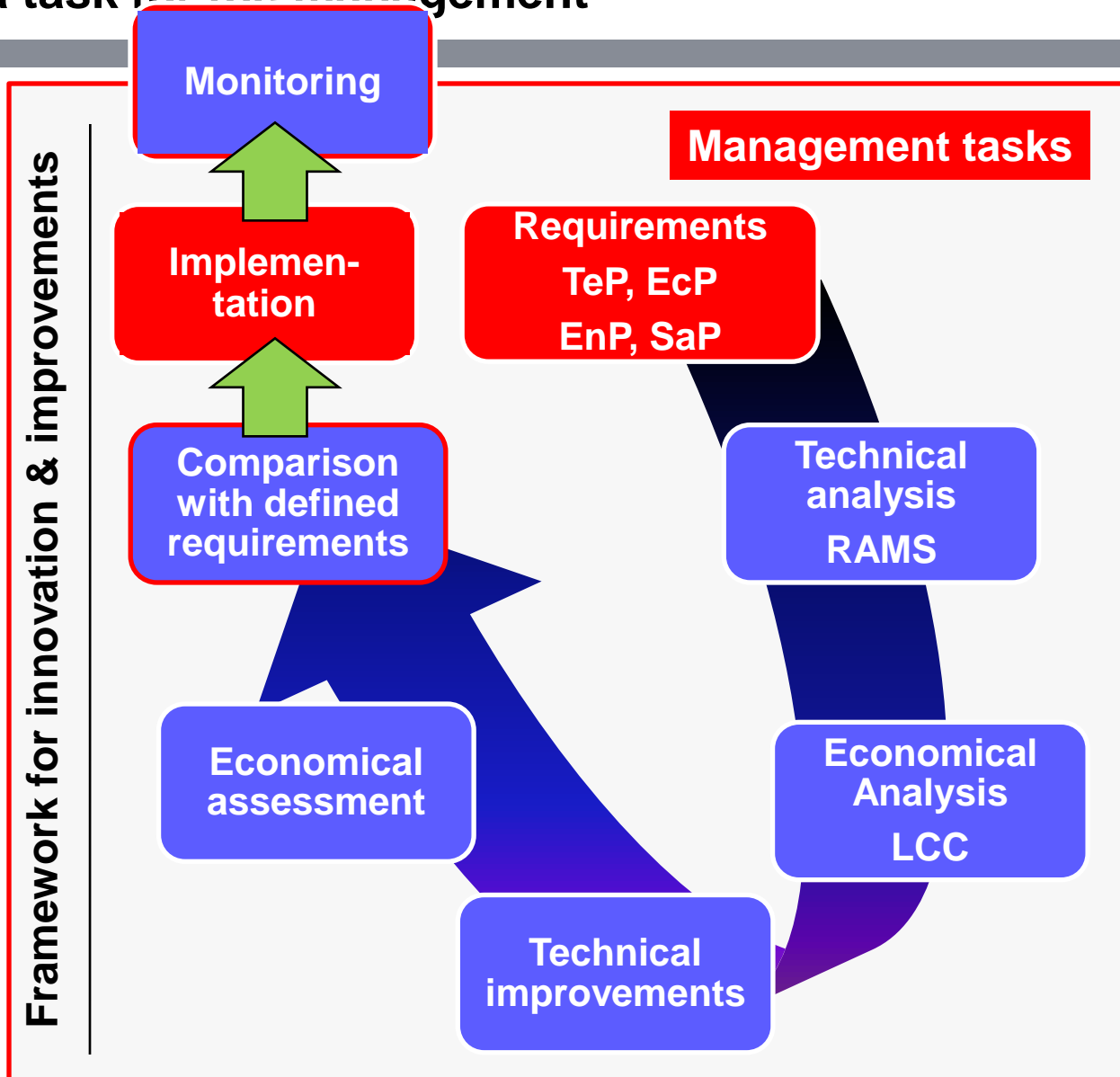## Framework for Innovation is a task for the management

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The **management** has responsibility for

- the *general frame work*
  - processes,
  - boundaries,
  - responsibilities and
  - resources

- *requirements*
  - technical performance
  - economical performance
  - environmental performance
  - safety

- *implementation strategy*

Only a consequent *LCC-* and *RAMS-management* ensures technical and economical improvements at a short time.

Framework for innovation & improvements

Monitoring

Implemen-tation

Comparison with defined requirements

Management tasks

Requirements TeP, EcP EnP, SaP

Technical analysis RAMS

Economical Analysis LCC

Economical assessment

Technical improvements

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In case of any questions please contact

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