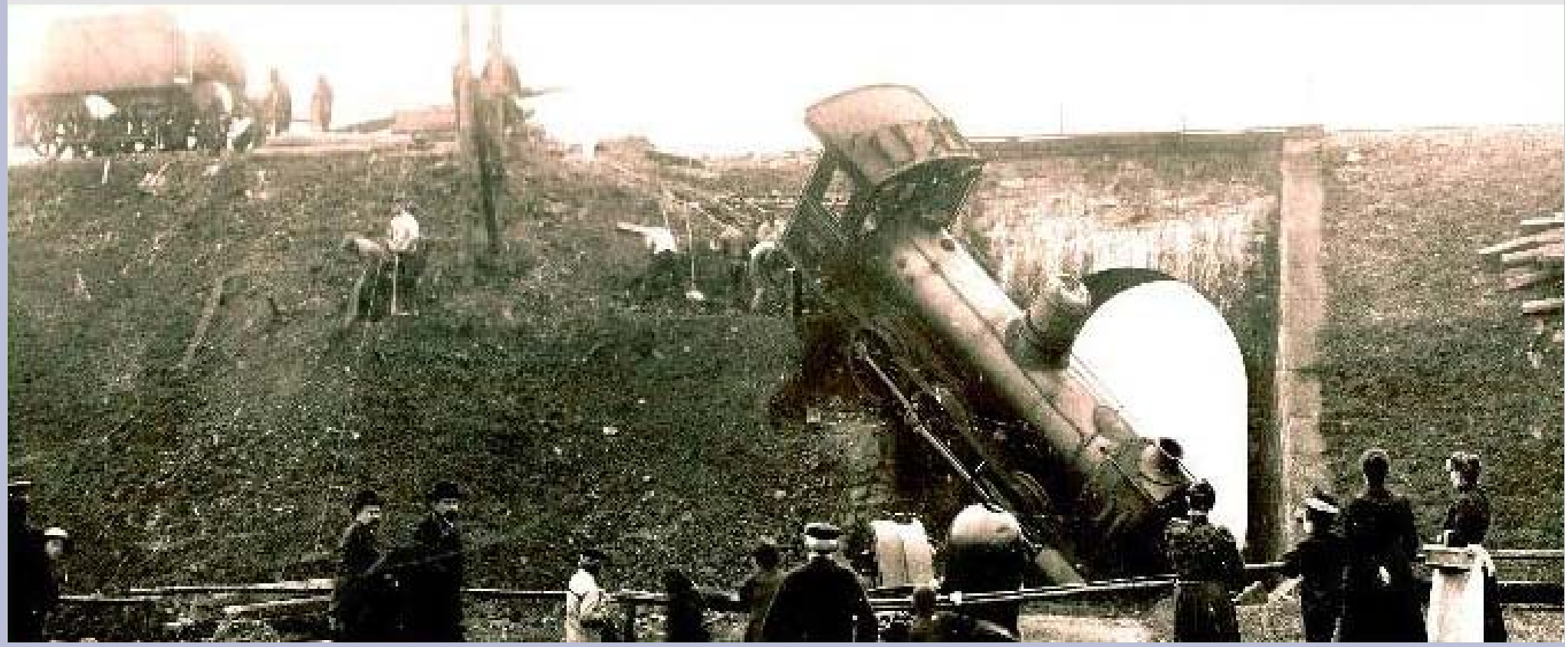
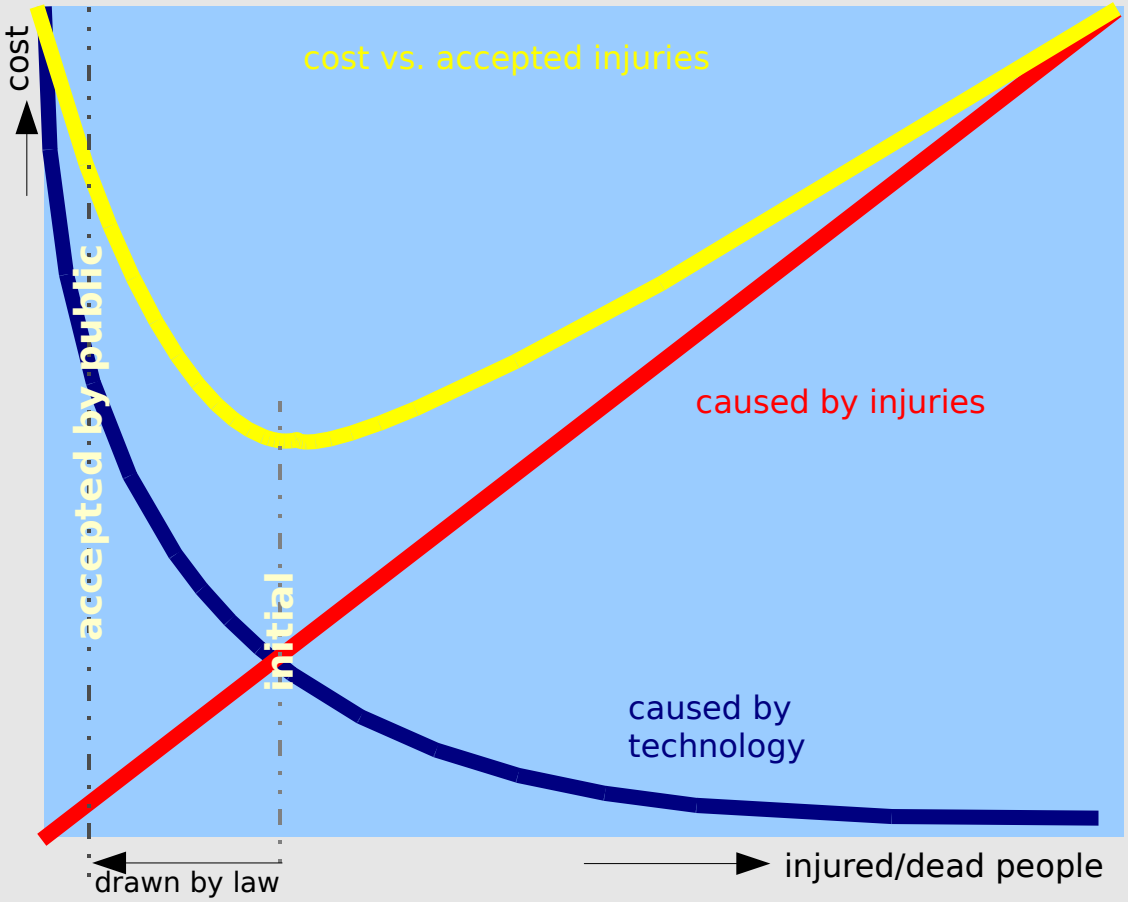
Safety Certification - FAQ

How does Software fit in?



Ingenieurbüro
Mikroelektronik + Softwaretechnik

Who we are?



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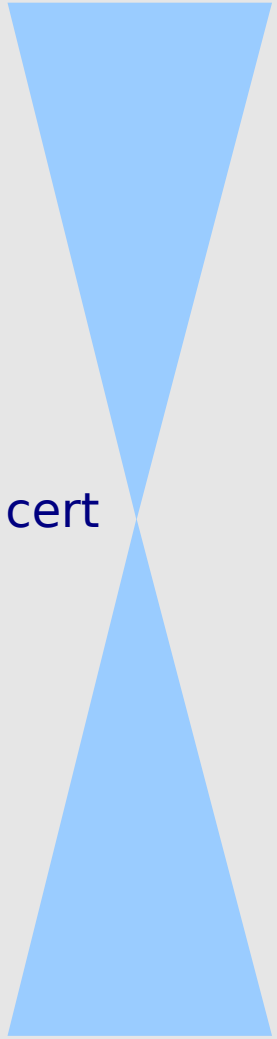
safety related RT-S/W projects since 1978
independent safety assessor since 1998

Who cares about safety?

- Vendors
  - Industries
  - Developers, Manufacturers, Operators
- Brokers / Mediators
  - Independent Safety Assossors
  - Safety Authorities
- Customers
  - Government and Public



How Does Industry Care?

- Safety Aware Development & Production
- Verification & Certified Quality Control
- Safety Management
- Certified Safety Organization
- Independent Validation
- Process Paralleled Assessment

How is Public Involved?

Eisenbahn-Bundesamt

- Safety Authority
  - Accrediting Safety Assessors
  - Releasing Certifications

Deutscher Akkreditierungs Rat

DAR

- Government
  - Converting Standards to Acceptable Laws

Deutscher Bundestag

- International Organization / EU
  - Minimal Consensus: http://www.era.eu.int/public/Safety/
  - Release of Internationally Binding Commitments based on Standards

European Railway Agency

- Standards Organizations
  - Release of Safety Aware State-of-the-Art Standards

CENELEC

IEC

How do we all Communicate?

- We Share a Common Language
- Industry Releases *Safety Cases*
- Project Attendant Assessment
  - Access to Resources and People
  - Checks against Standards, Fully Documented
  - Independently Released Final Judgement
- Safety Authority gets *Assessments*
  - Releases Certification based upon Assessments
  - Gives Allowence to Operate in Public

Key Terms of Safety Language?

- ***Safety Integrity***
  - Probability to adhere to Safety Functions
    - Complexity increases problems to give evidence for Safety Integrity
- ***Tolerable Hazard Rate***
  - caused by residual undetected ***Dynamic*** *Hardware* ***Errors***
  - e.g. not more than 10^{-9}/h, or 1 hazardous failure in 100000 product-years
- ***Safety Target***
  - Harzard Rate that can be/shall be demonstrated to hold, upfront
- ***Safety Integrity Levels***
  - Mapping of Hazard Rate Ranges to the State-of-the-Art in Avoidance of ***Systematic Errors***

Essentials of a Safety Case?

(1) Determine the System or Product

(2) Give Evidence for Quality Management

(3) Give Evidence for Safety Management

(4) Demonstrate Technical Safety

(5) Refer to Related Safety Cases

(6) Give Concluding Summery

Impact on Software Lifecycle?

- Give Evidence for Safety-Rq-Completness
  - ... and trace requirements at all stages
- Demonstrate Software-SIL
  - how did you avoid systematic errors?
  - at any phase, involve the assessor
- Detect any Single Random Hardware Fault
  - implement detection algorithms in software
- Communicate / Interact with Safe Systems
  - across unsafe channels by means of safe protocols
- provide *Safety Application Conditions*

What's more to Know about Safety Case?

- testing, error classes, the Validation Report
- detailed
  - Quality Management and its Report
  - Safety Management and its Report
  - Technical Safety and its Report
  - Impact of Safety Application Conditions
- examples
  - redundant/diverse processor architecture
  - communicating safe systems
  - systems covering different SIL
  - safety case of compatibility
- re-use modules that had been part of a safe product
- considre the prove-in-use approach
  - SIL2 and then SIL4
- ...

What Classes of Errors to Find? In what Test Phase?

- module test:
  - (1) programming errors like ±1, true/false, array bounds
  - **(2) random errors in code (checksums, per module under test?)**
- s/w integration:
  - (3) incomplete interface specs between modules
  - (4) diff. in interpretation of interface specs between modules
- hw/sw integration:
  - (5) incomplete lower layer interface spec (e.g. TAS Platform)
  - (6) differences in interpretation of lower layer interface specs
  - (7) unexpected, unforeseen behavior of hardware/system-software
  - (8) performance issues
  - (9) unexpected behaviour in functionality, esp. safety
- independent validation
  - (10) differences in interpretation of requirements
  - (11) doubts about functionality, esp. safety (give evidence)
  - (12) doubts about non-func. requirements (give evidence)
  - (13) incomplete module-, s/w-, hw/sw-integr. tests
- system tests, field trials, qualification periods
  - (14) incomplete external interface specs
  - (15) differences in interpretation of external interface specs
  - **(16) unexpected behavior or reaction to faults of real external hard-/software**

How is Testing Related to Safety?

- Testing: just another 4-Eyes-Principle
  - Risk Mitigation of Design, Implementation Errors
- one Test Coverage Statement by Error Class
- No Evidence on Fault Absense by Testing
- Quality and Safety are Build-In *not Tested-In*
- Safety Management Separate from Testing

What's in Validation Report

- Statement of Independence, including Safety Management
- Evidence for Configuration Management
- Evidence for each Verification Step
- Evidence for each Single Requirement
- with Emphasis on Safety Requirements
- Justification
  - for each Open Issue
  - of Manuals, Installation, Operation, Maintenance
- Final Justification for taking Safety Responsibility by the Product

What's in Quality Management Report?

- Give Evidence of
  - Configuration Management
  - ISO 9001, 9000-3 Processes
  - Competent Professionals
  - Verification, Reviews, and Inspections
  - Defect and Change Management
  - Known Open Issues

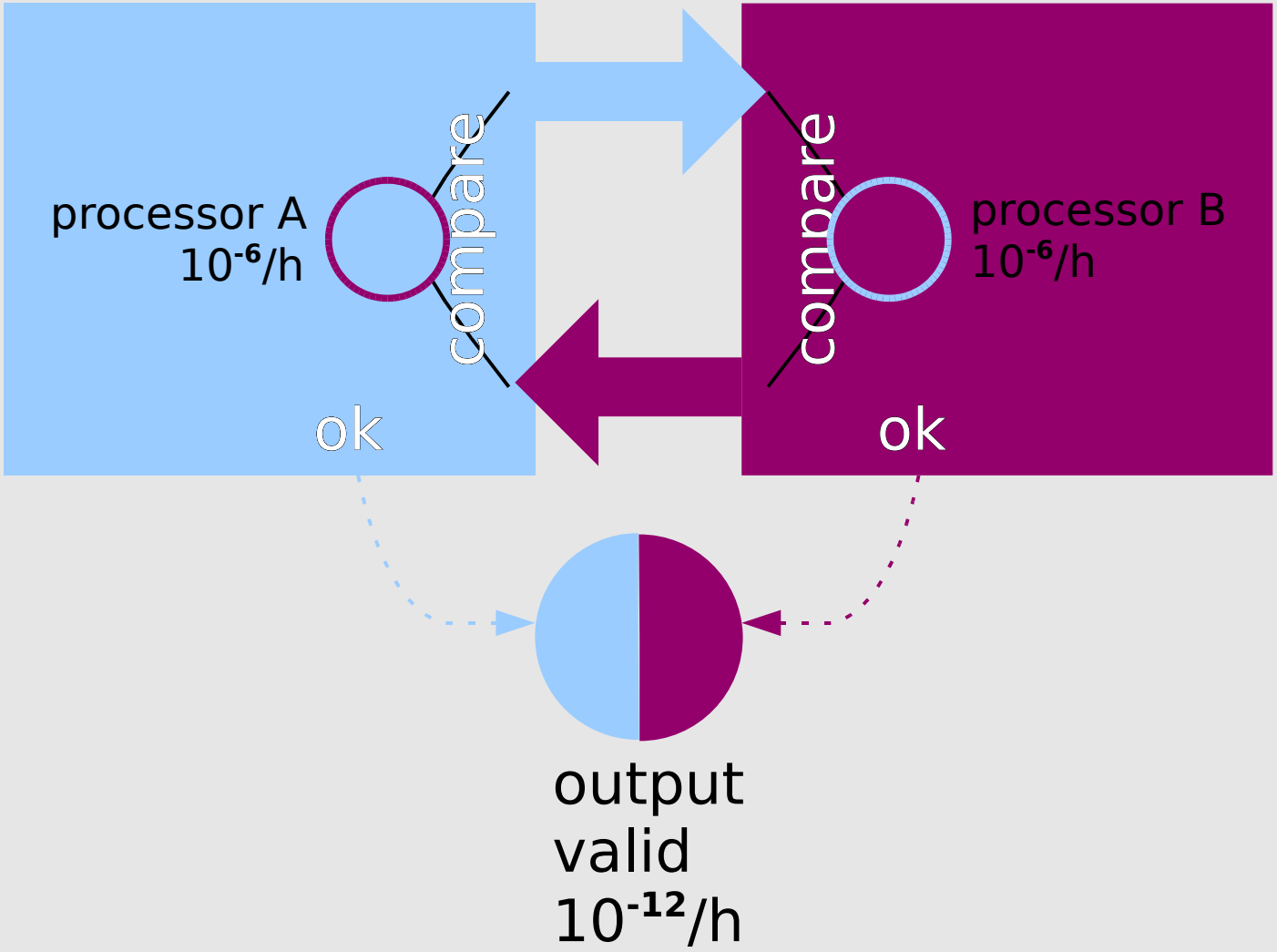
What's in a Safety Management Report?

- Evidence of
  - Hazard Log and Analysis, Safety-Rq-Verification
  - (Software) Failure Mode and Effect Analysis
  - Audits on
    - Technical Safety Concept, State-of-the-Art
    - Adherence to Chosen Techniques and Measures
      - including Software-Maintenance
    - Rules for Operation and Maintenance
  - Achieved Safety and Availability Targets

What's in a Technical Safety Report?

- Assurance of Safety Coverage in Application
  - show Architecture together with Safety Cases to be Applied to Parts of Application
- Assurance of Correct Functional Operation
- Effects of Faults, including Multiple Faults
- Operation with External Influences
- Detailed Safety Application Conditions

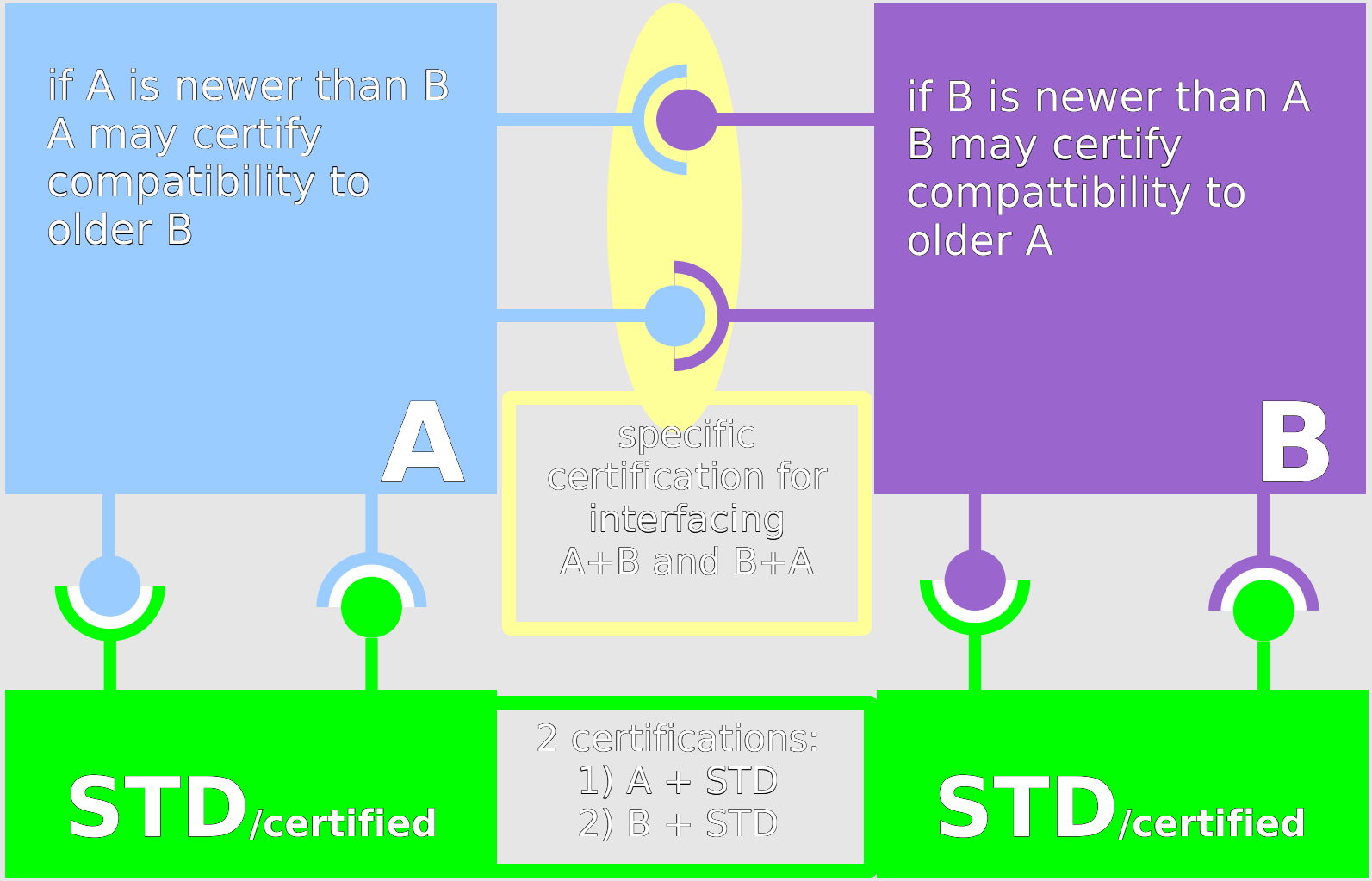
Example Redundant/Diverse Architecture



- communicating safe systems

- systems covering different SIL

safety case for compatibility



re-use modules

- ... that had been part of a safe product

consider the proven-in-use approach

- SIL2
  - independent validation
  - no need for evidence of systematic failure avoidance
- ... and then SIL4
  - 100 product-year long continuous logging
    - varity of operations
    - not a single near-safety critical event
- you may persuade ISA and safety authority