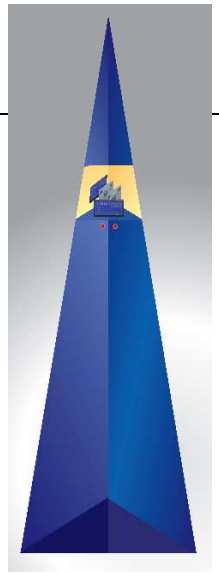
Dependable and Embedded Systems @ Fraunhofer FIRST

Sergio Montenegro

sergio@first.fhg.de

Fehlertoleranz



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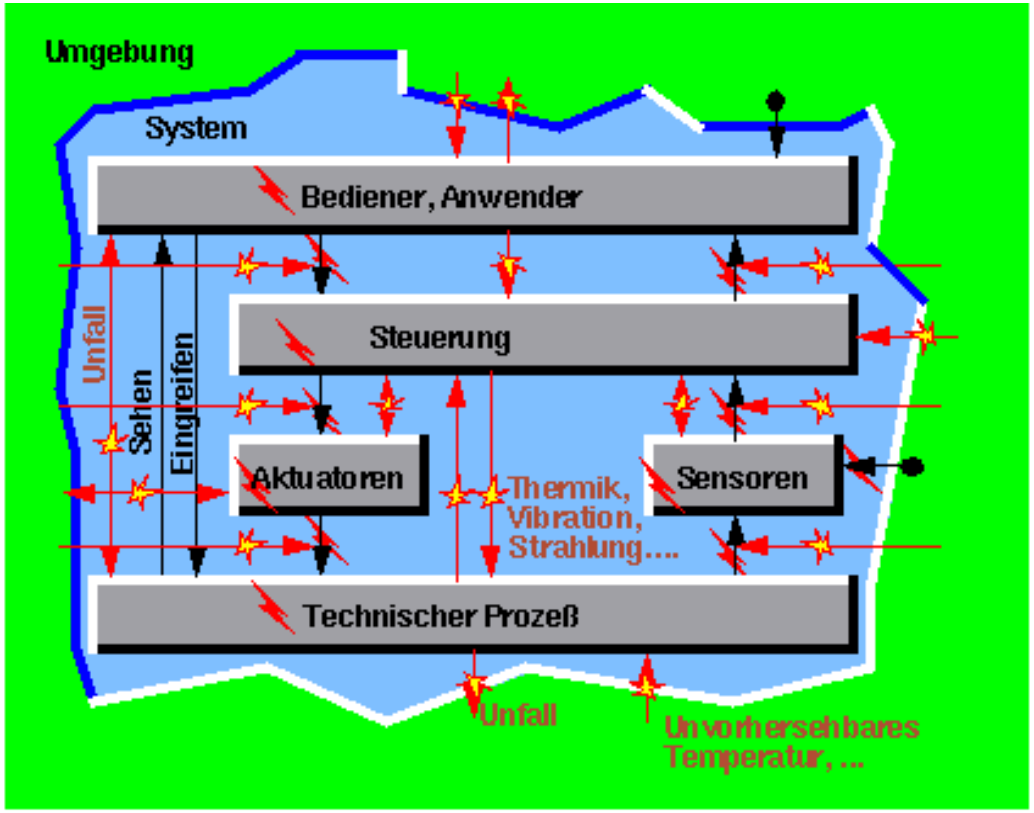
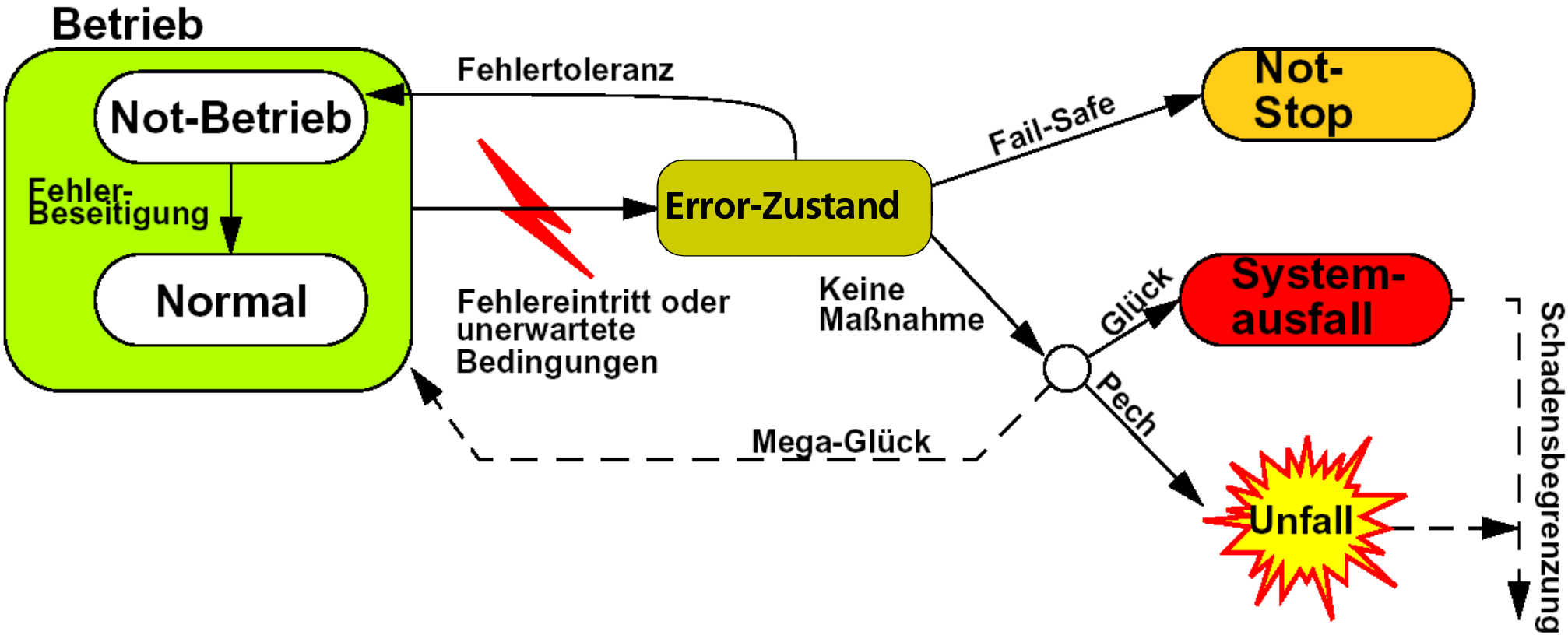
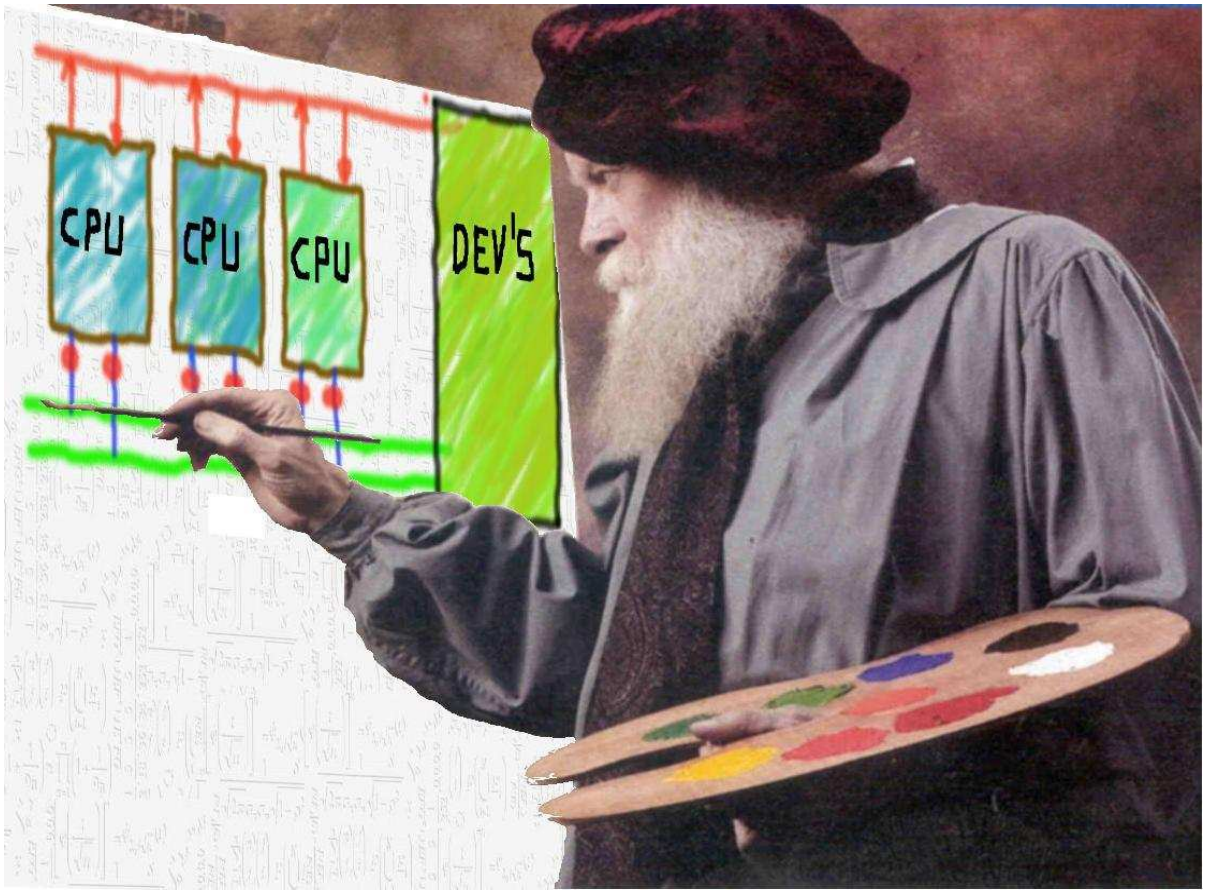
Warum Fehlertoleranz?





Der direkte Weg vom Fehler zum Unfall

The art of fault tolerance



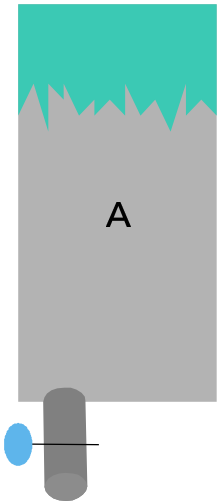
The art of fault tolerance

Gemeinsam ein Beispiel...

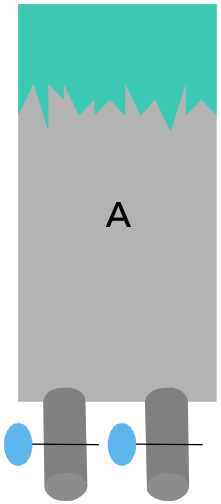
Was soll man duplizieren?

Die Tanks einer Rakete?

Was soll man duplizieren?

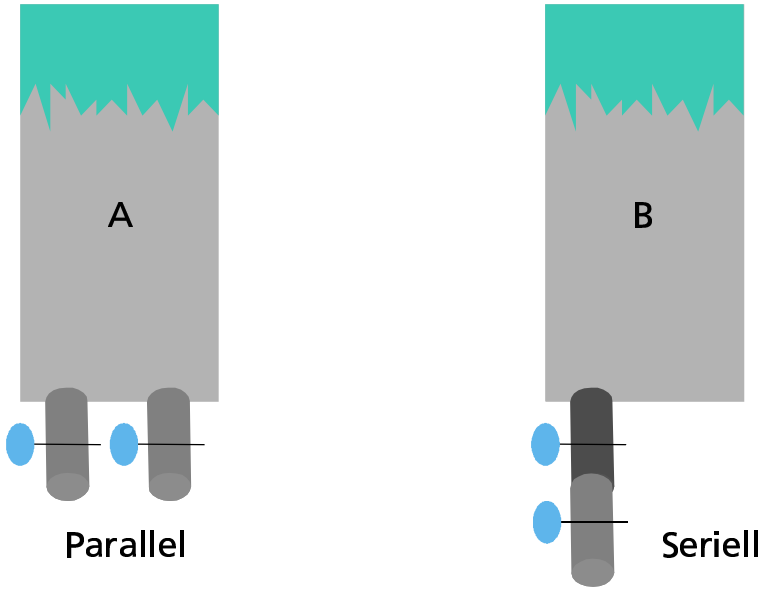


Was soll man duplizieren?

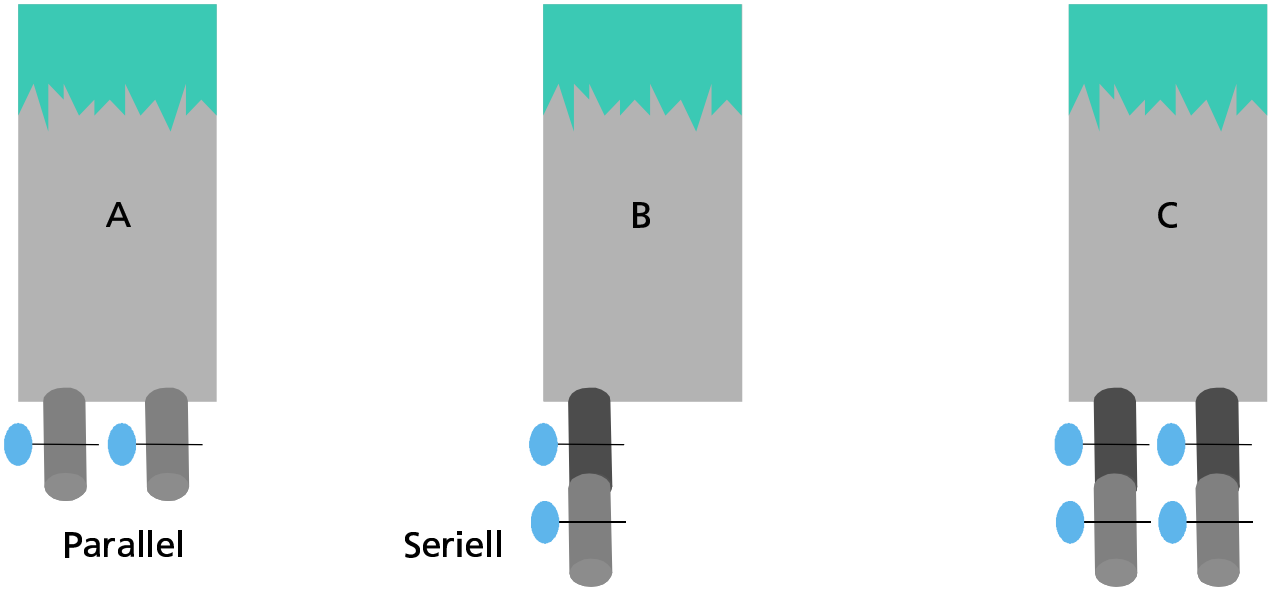


Parallel

Was soll man duplizieren?



Was soll man duplizieren?

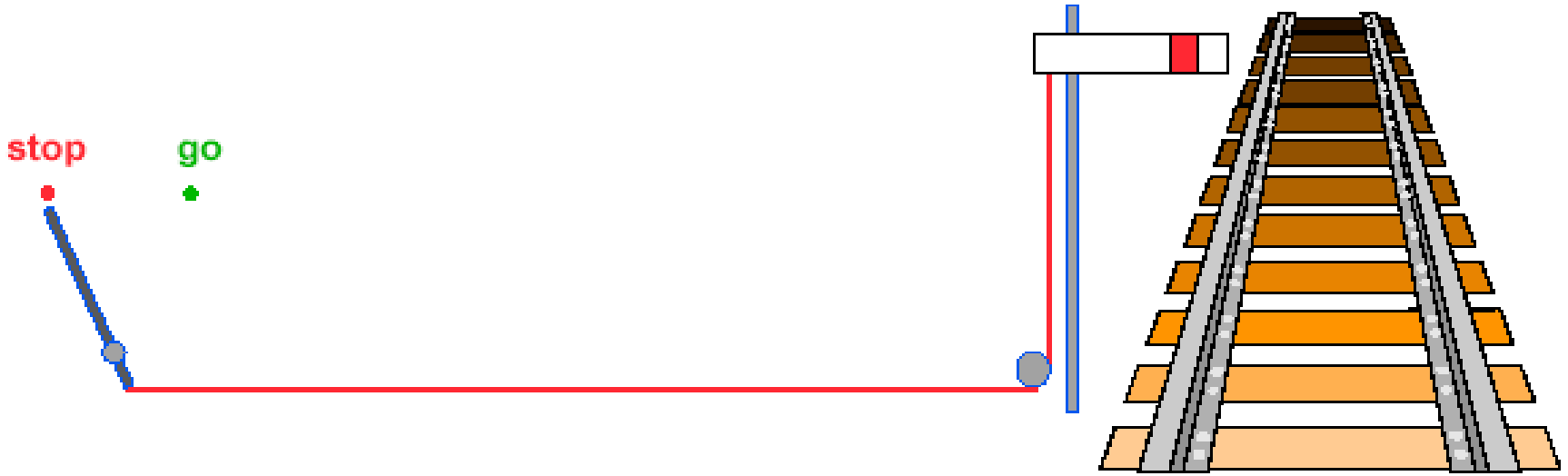


Ventile
Ausfall: Zu

Ventile
Ausfall: Auf

An Early Example of Fail-Safe Design

David Powel



An Early Example of Fail-Safe Design

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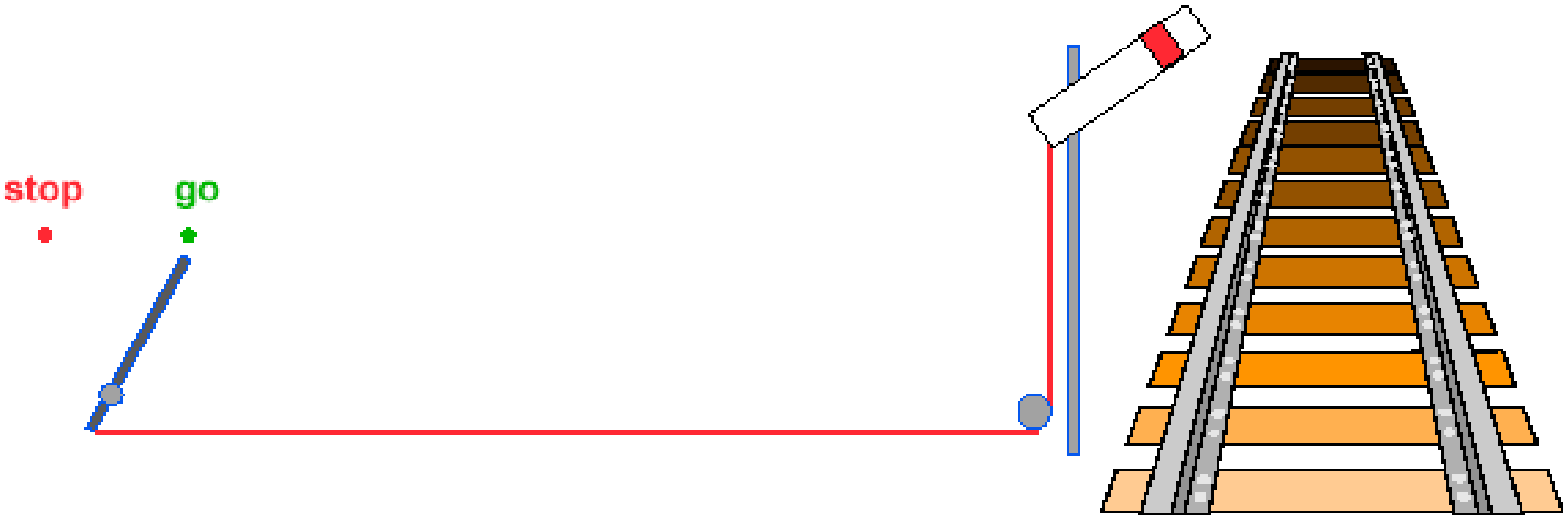
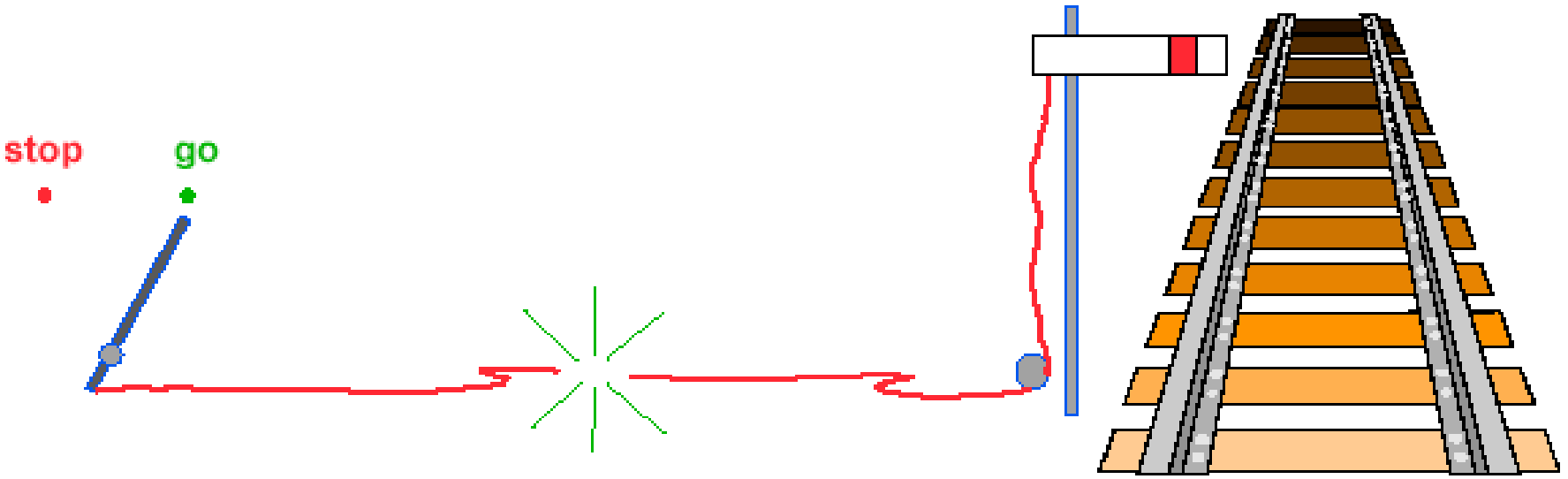


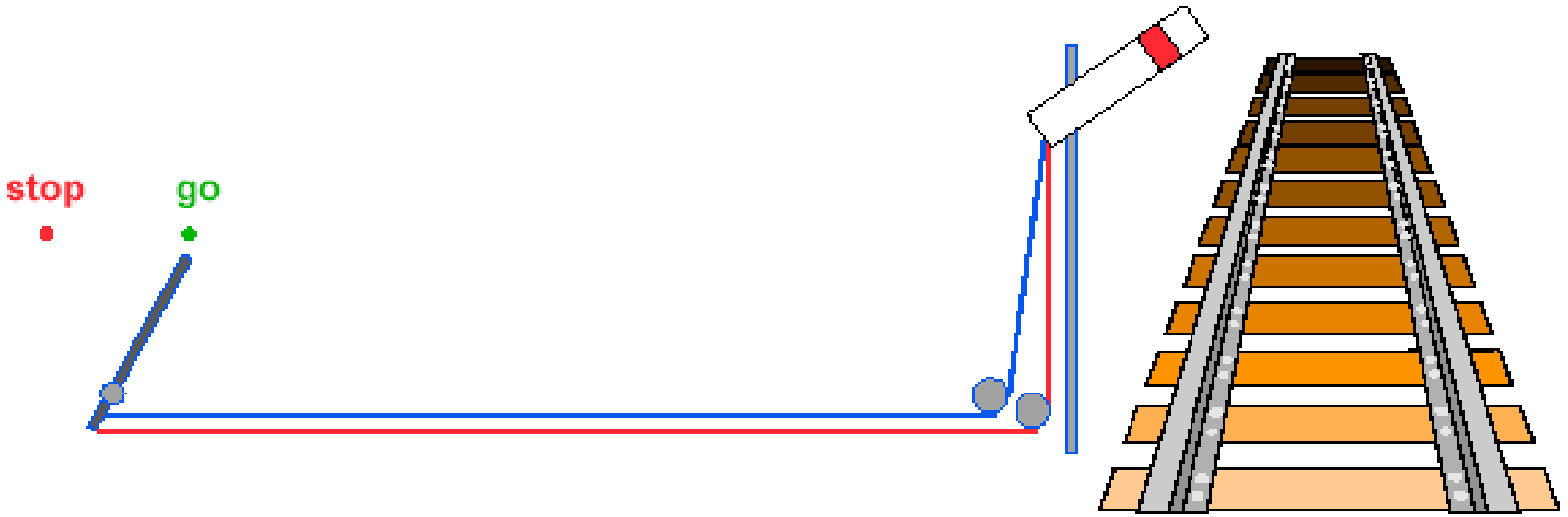
An Early Example of Fail-Safe Design

David Powel



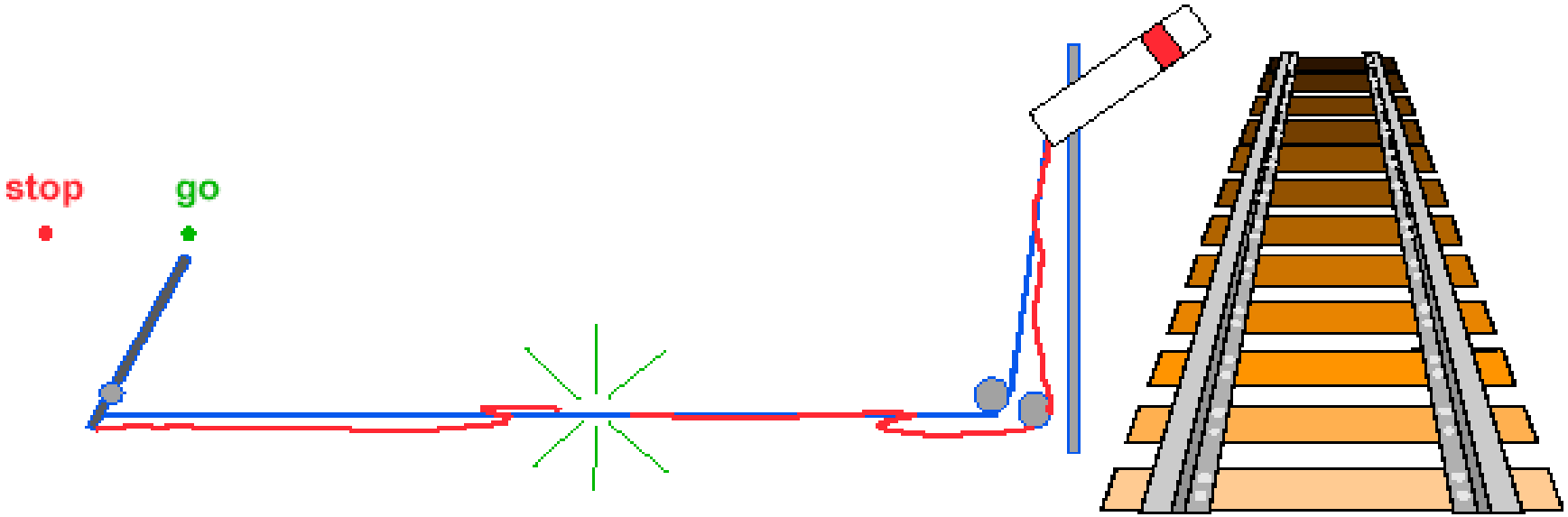
Fault-Tolerant Fail-Safe Design?

David Powel



Fault-Tolerant Fail-Safe Design?

David Powel



Fault-Tolerant Fail-Safe Design?

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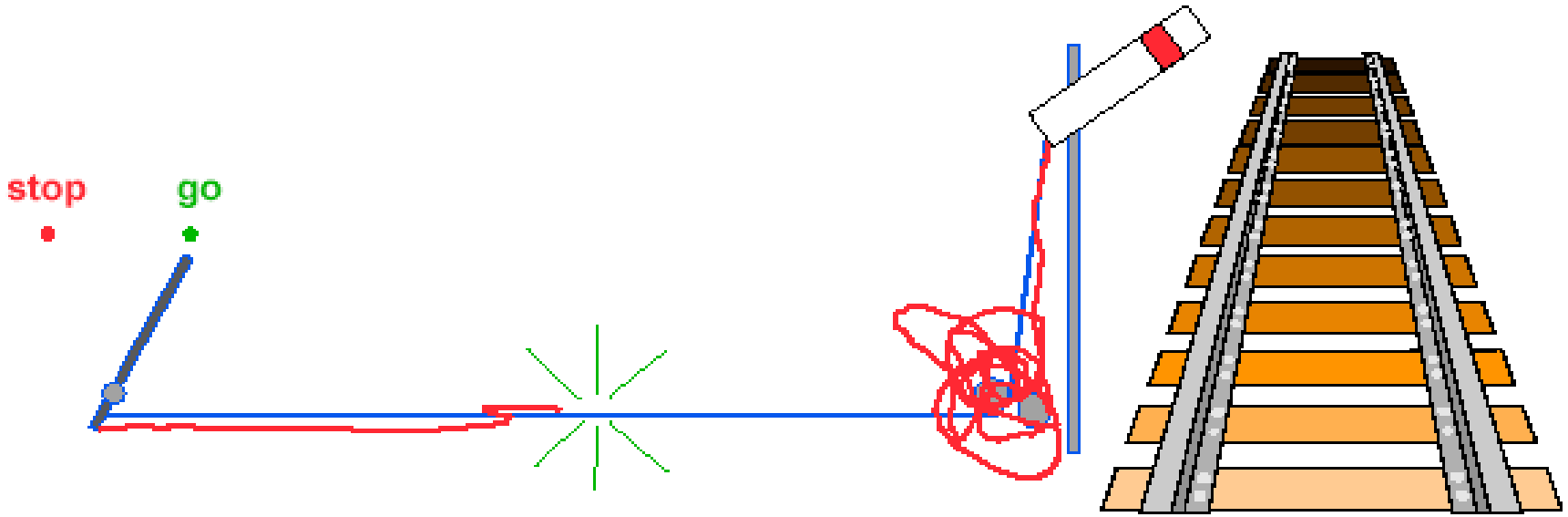

Fault-Tolerant Fail-Safe Design?

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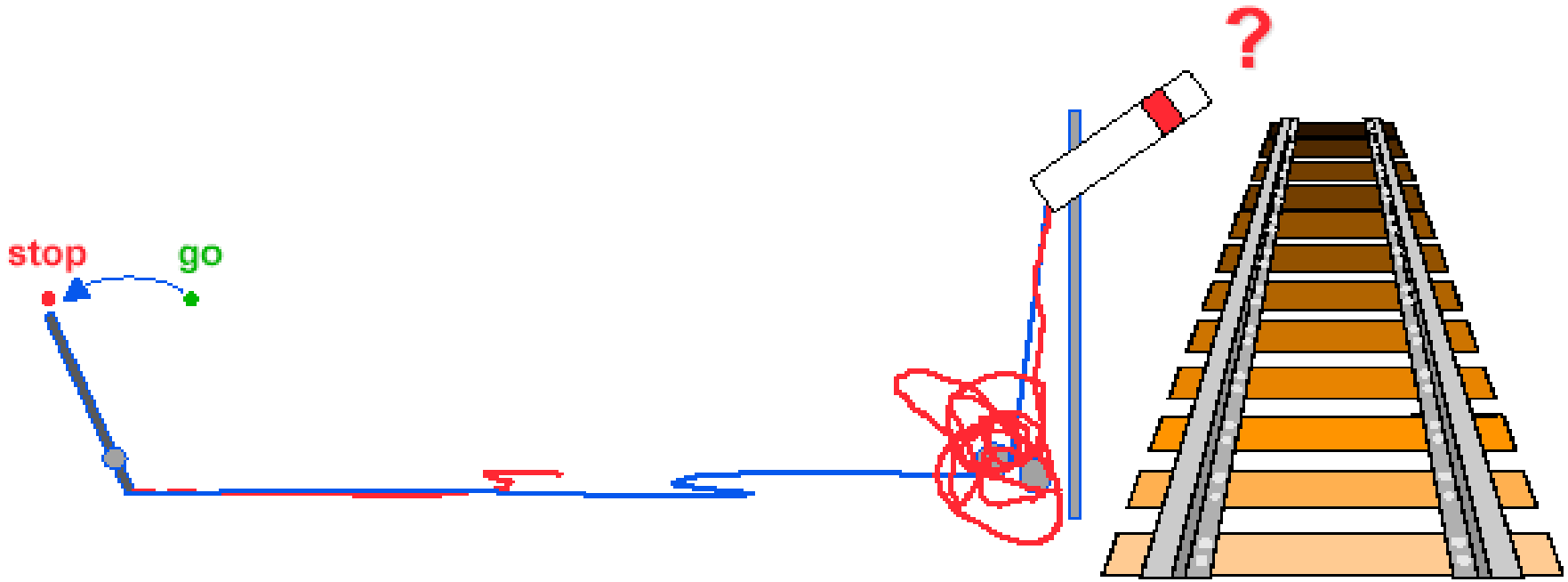

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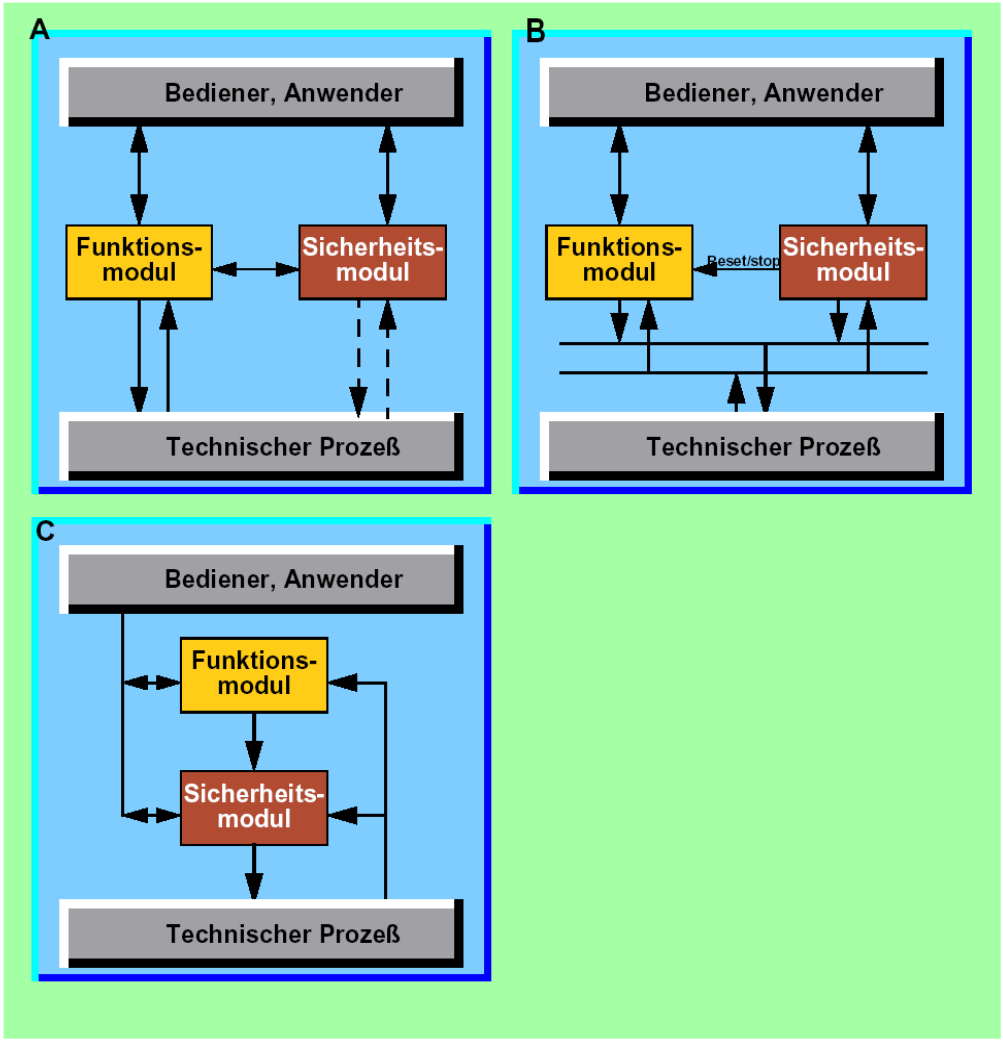
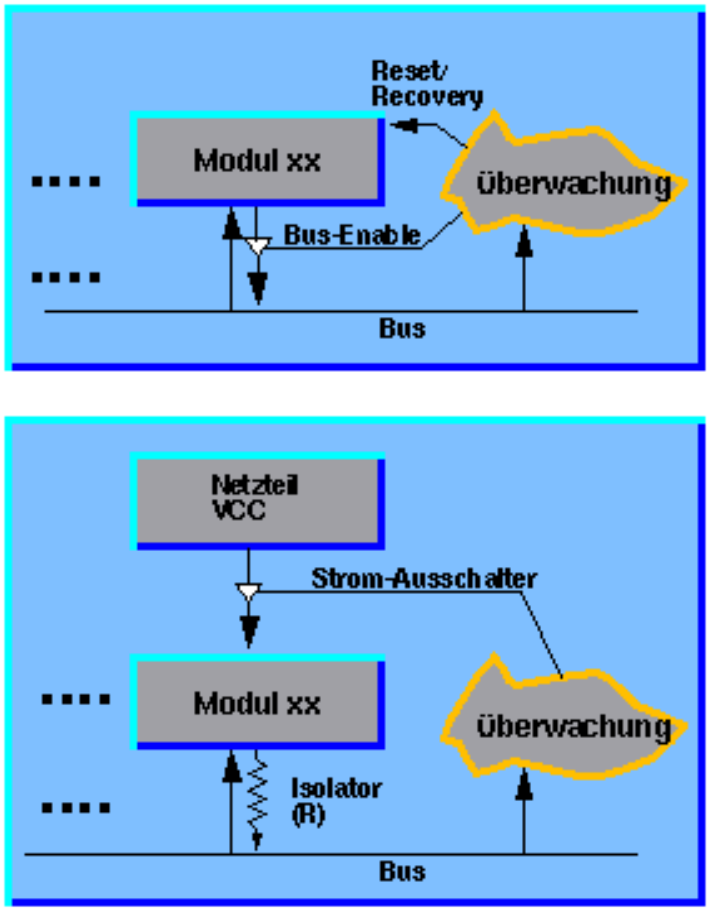
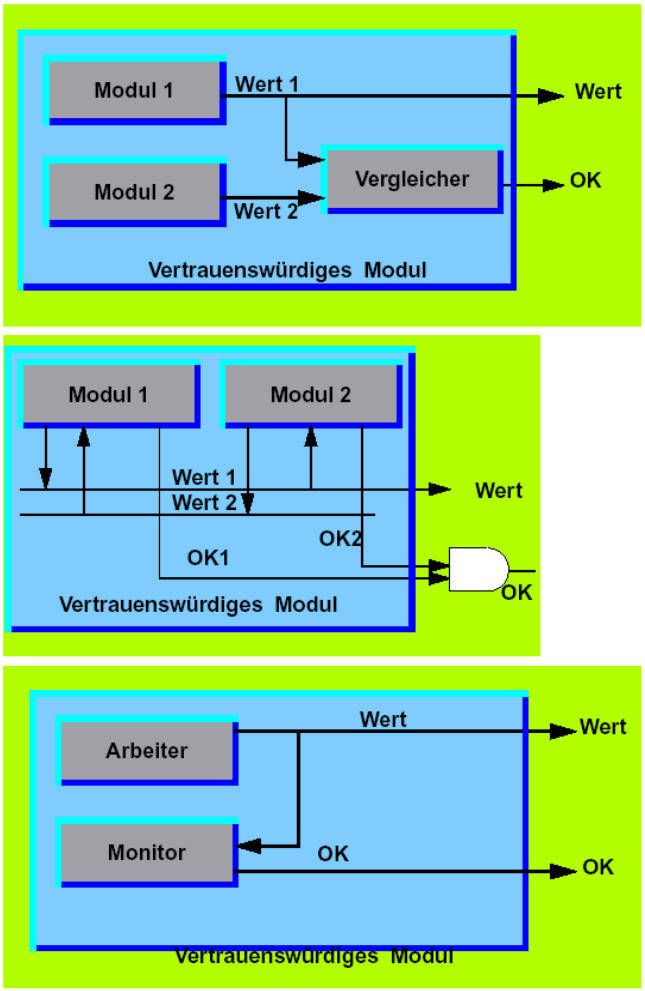
Überwachung / Prüfung



Überwachung -> Fehlertoleranz Modelle

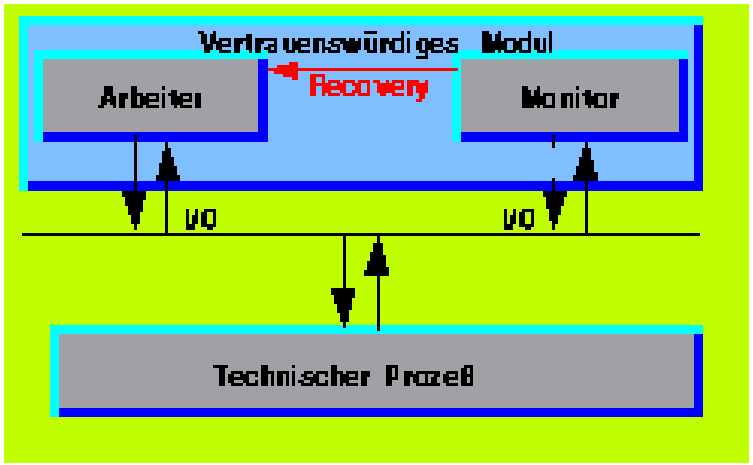


Fehlertoleranz Modelle.. Self checking par

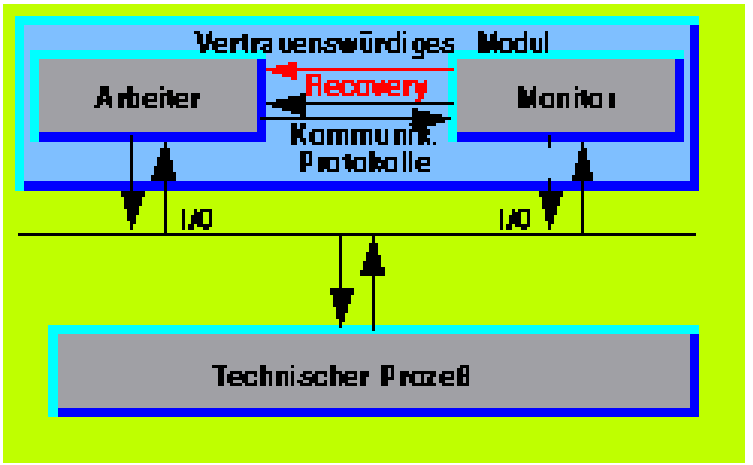


Vertrauenswürdige Module

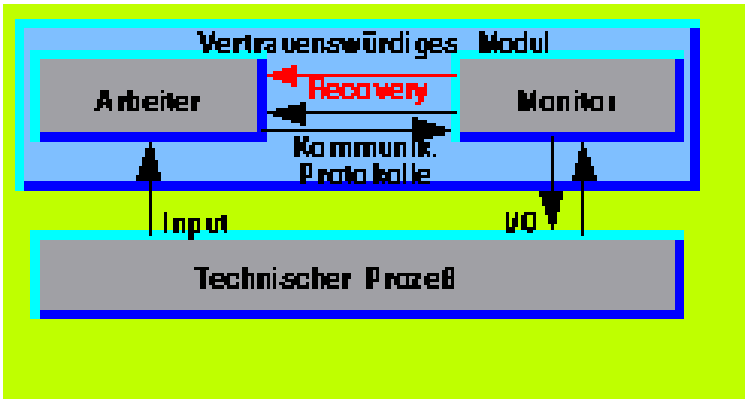
Fehlertolernaz Modelle... Und nach dem Fehler?



A

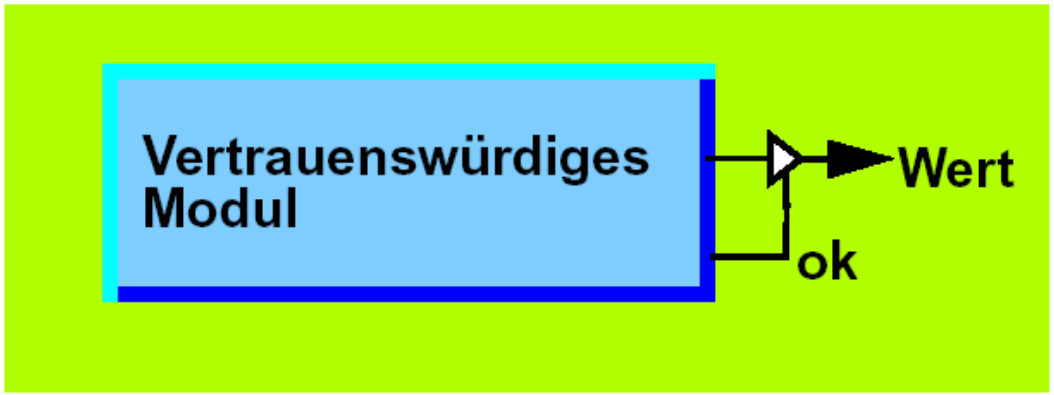


B



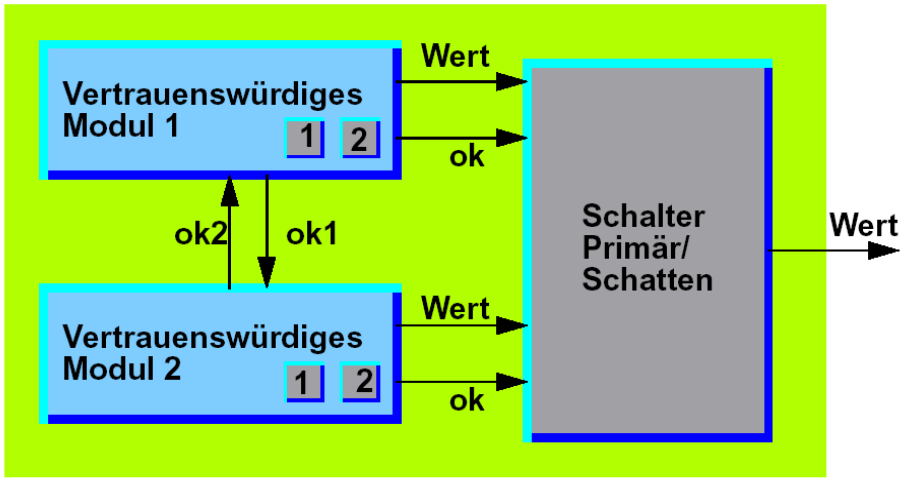
C

Fehlertoleranz Modelle.. Self checking par : Fail silent



Autoisolation bei Fehlern

Fehlertoleranz Modelle.. Self checking par : Fail silent



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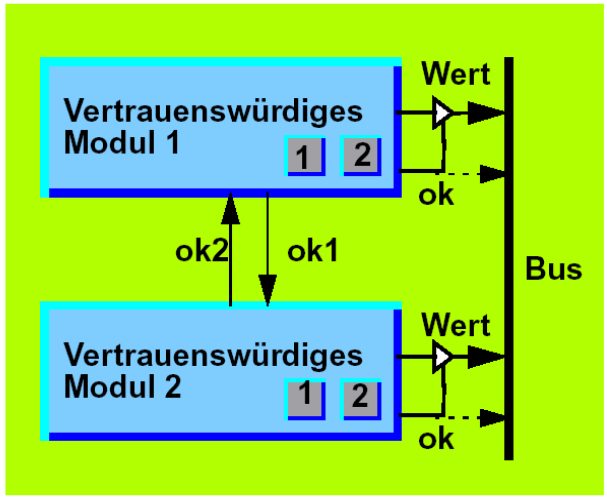
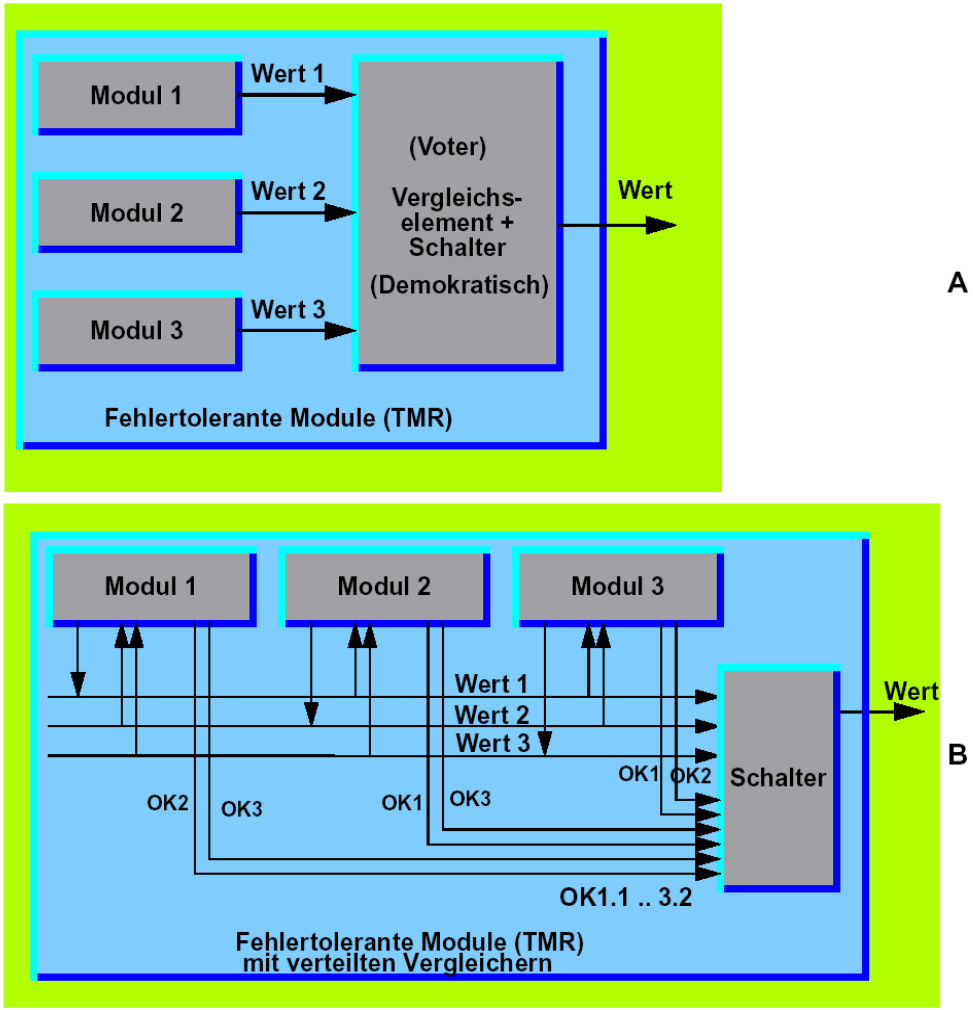


B

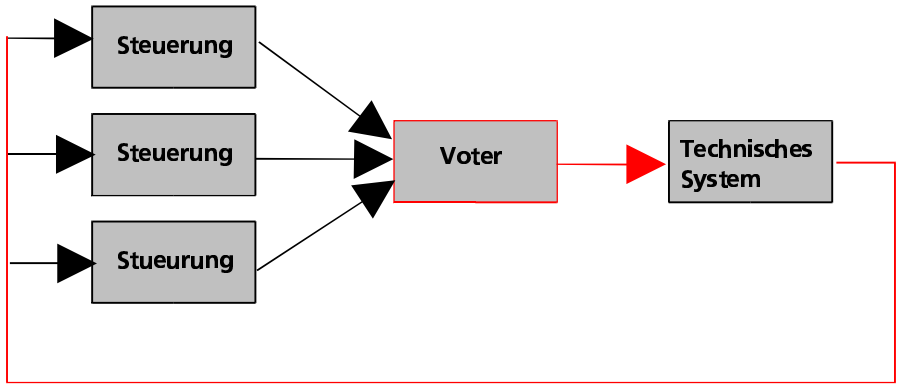
Fehlertolerante Module mit vetrauenswürdigen Modulen

Fehlertoleranz Modelle.. TMR

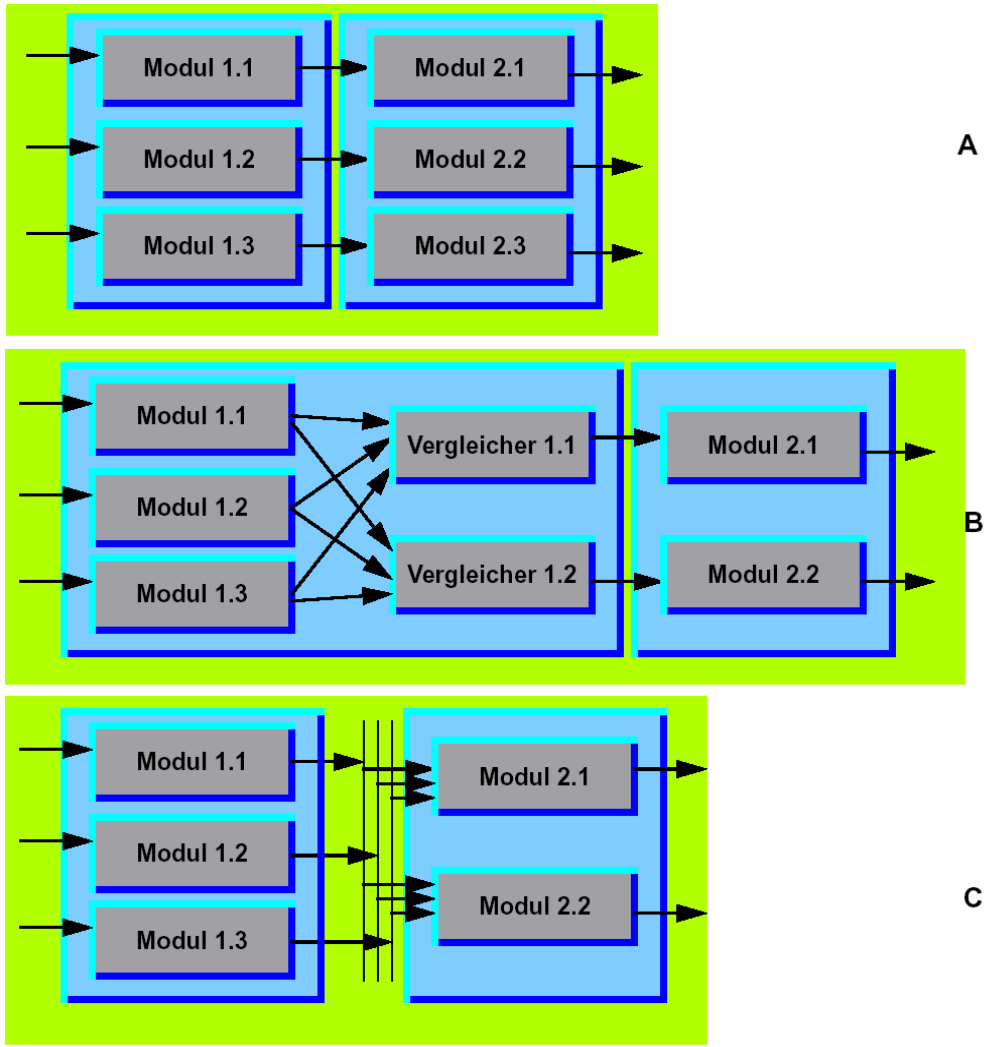


TMR: Dreifache Modulredundanz

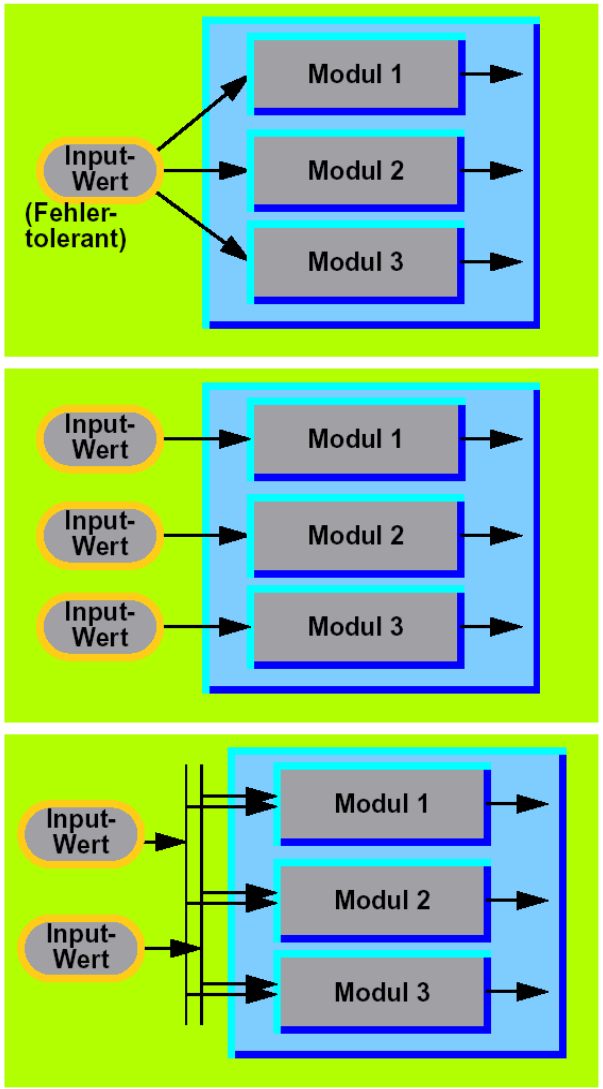
Fehlertoleranz Modelle.. TMR: Ist es sicher?



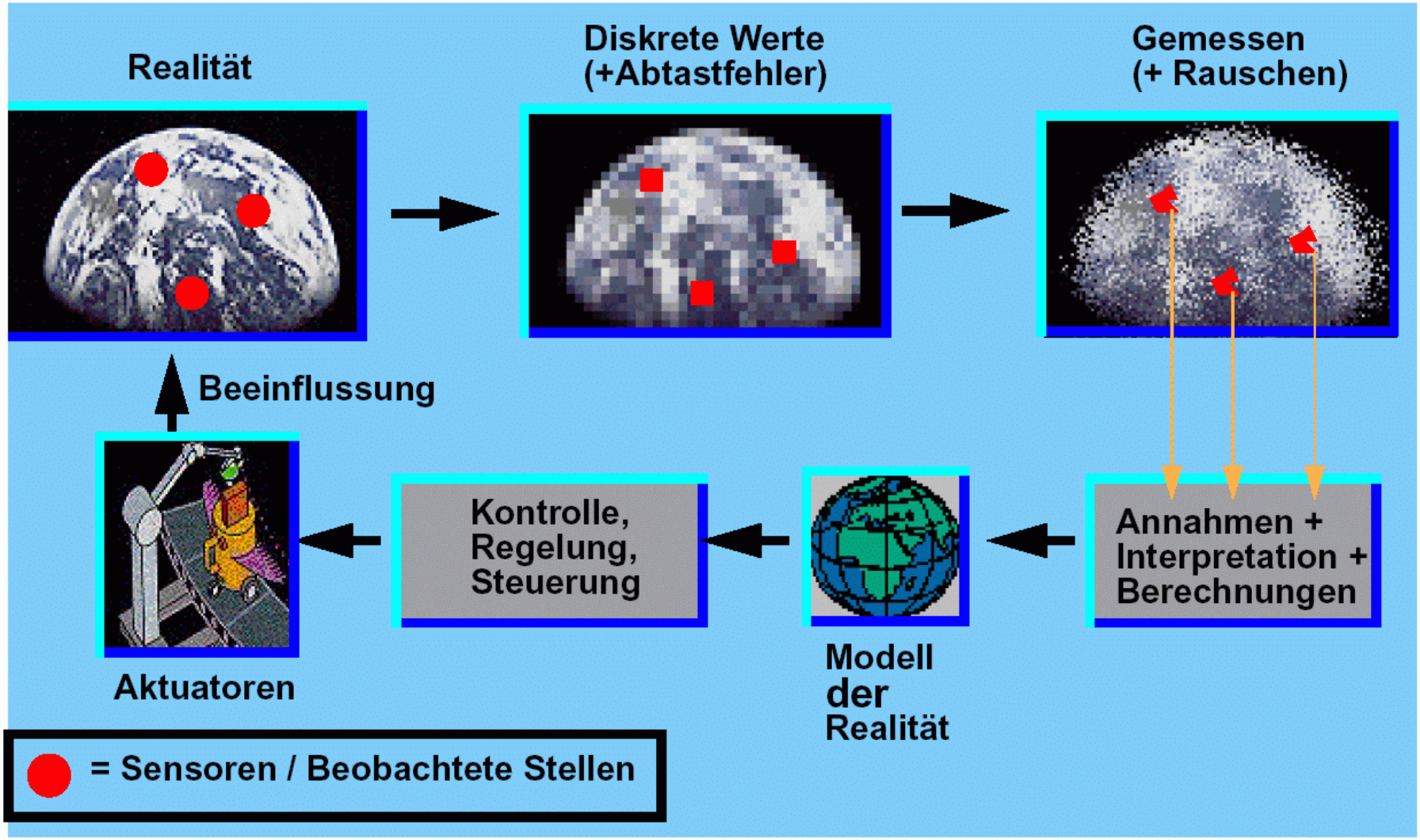
Fehlertoleranz Modelle.. TMR: Ist es sicher?



Fehlertoleranz Modelle.. TMR: Und die Inputs?



Was kann der Computer sehen? (dies ist noch kein Fehler, aber falsch)



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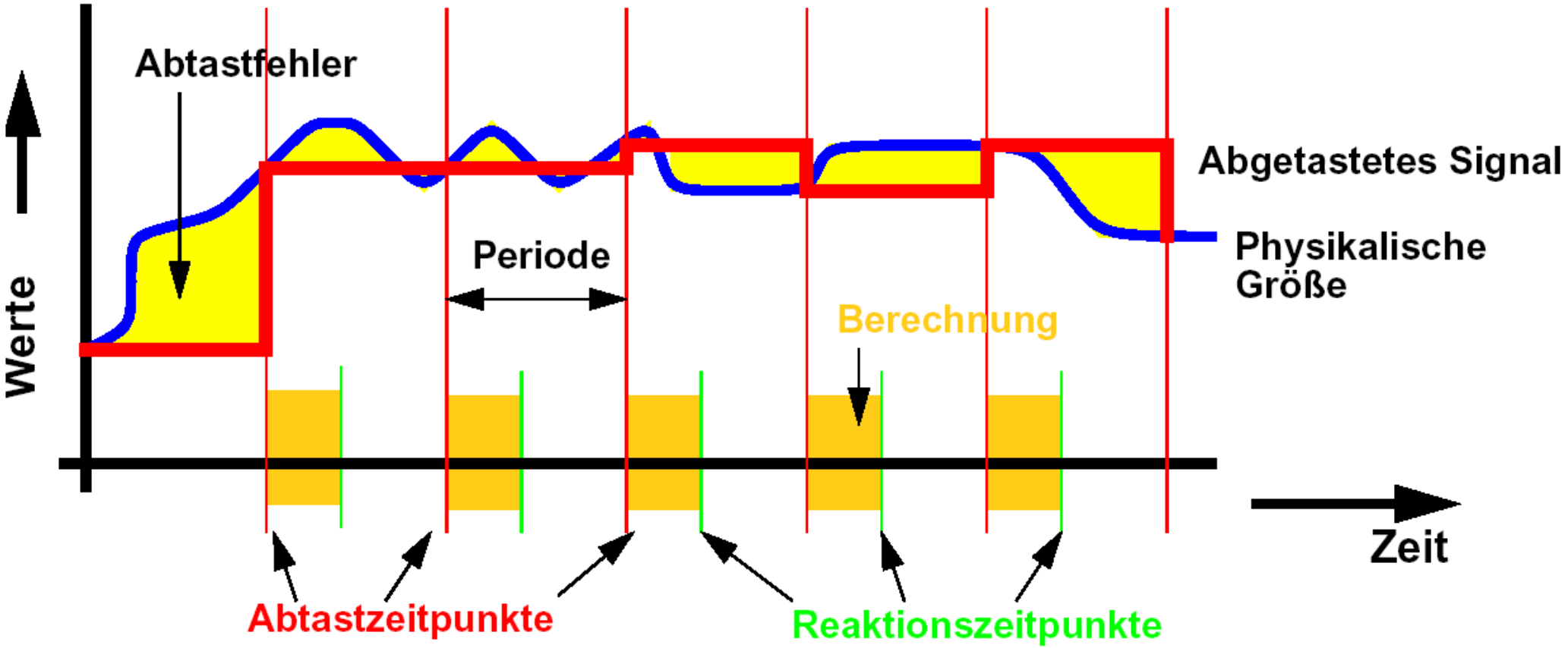
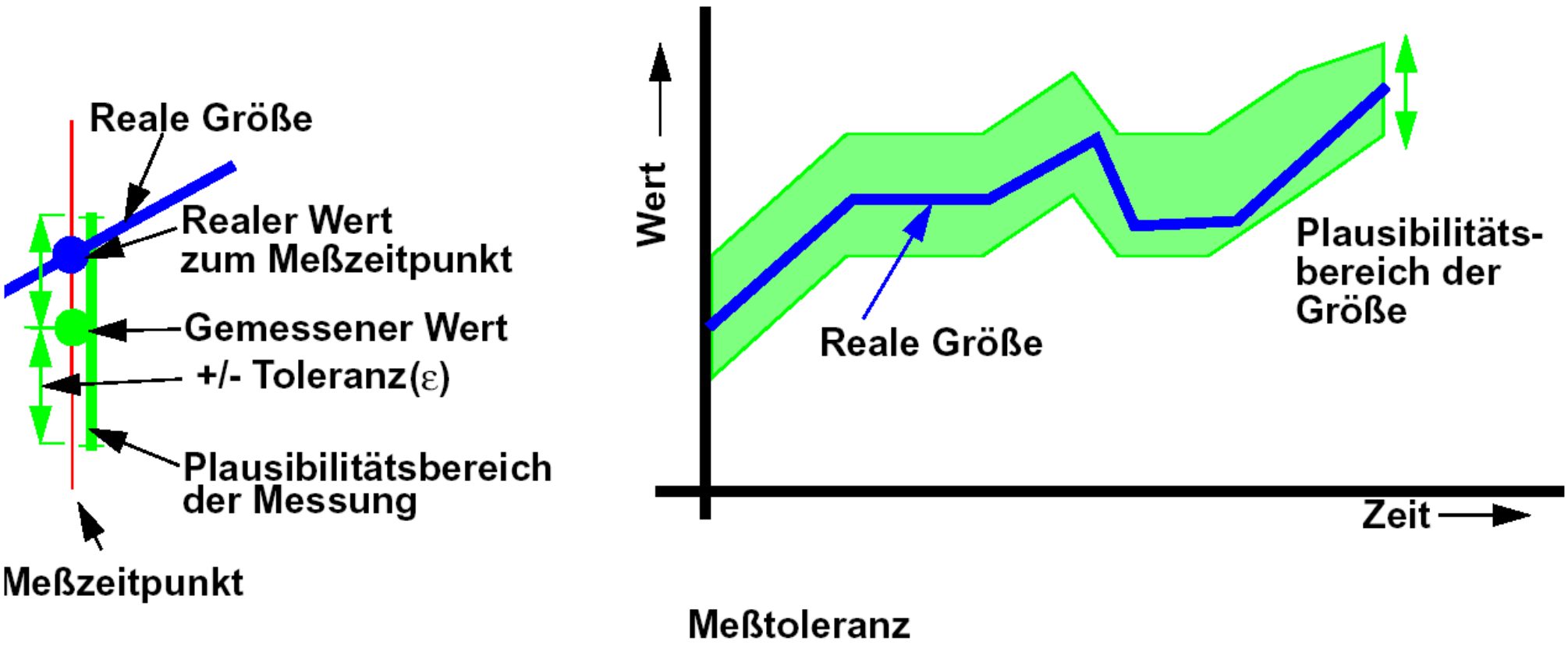
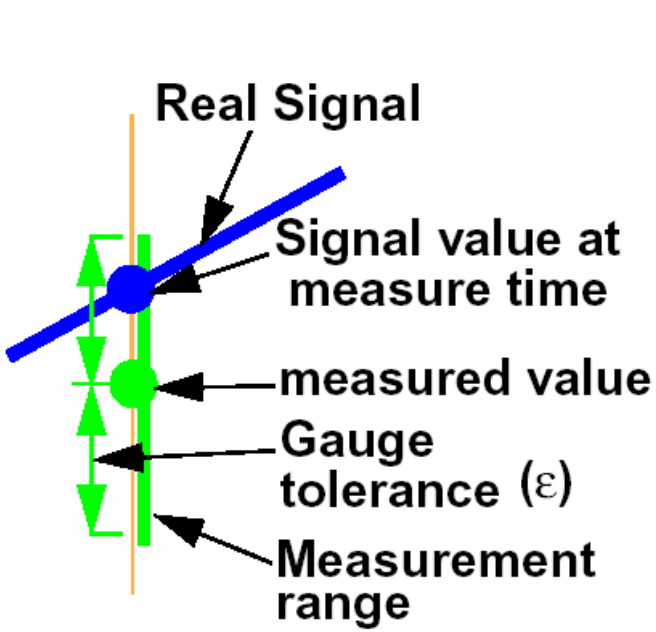
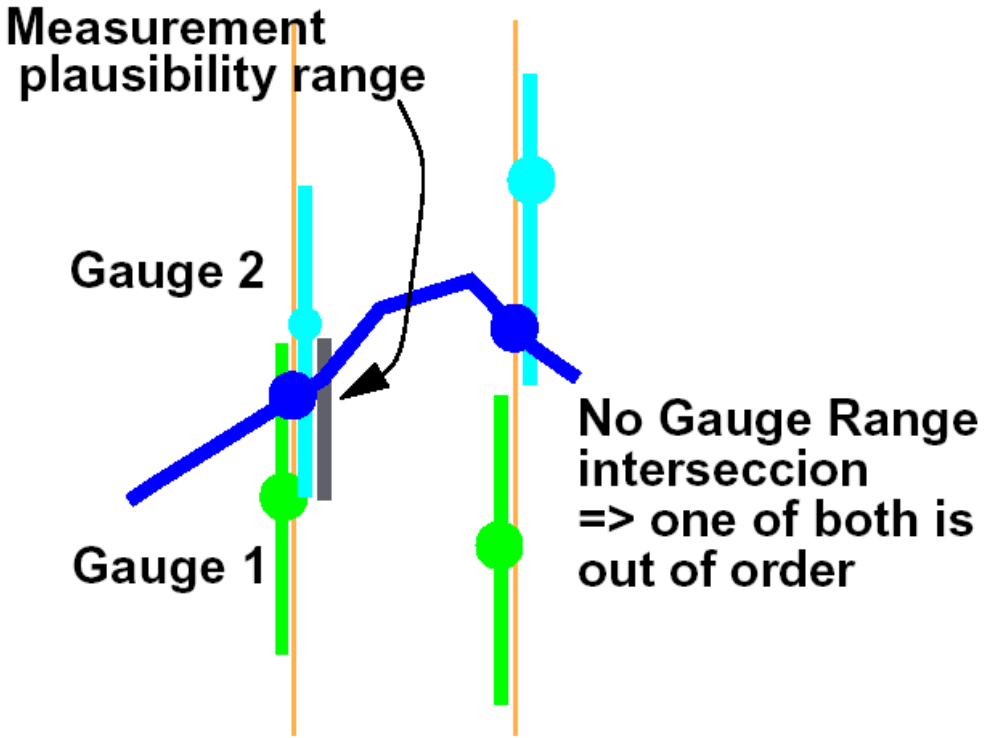


Sensor Toleranz..



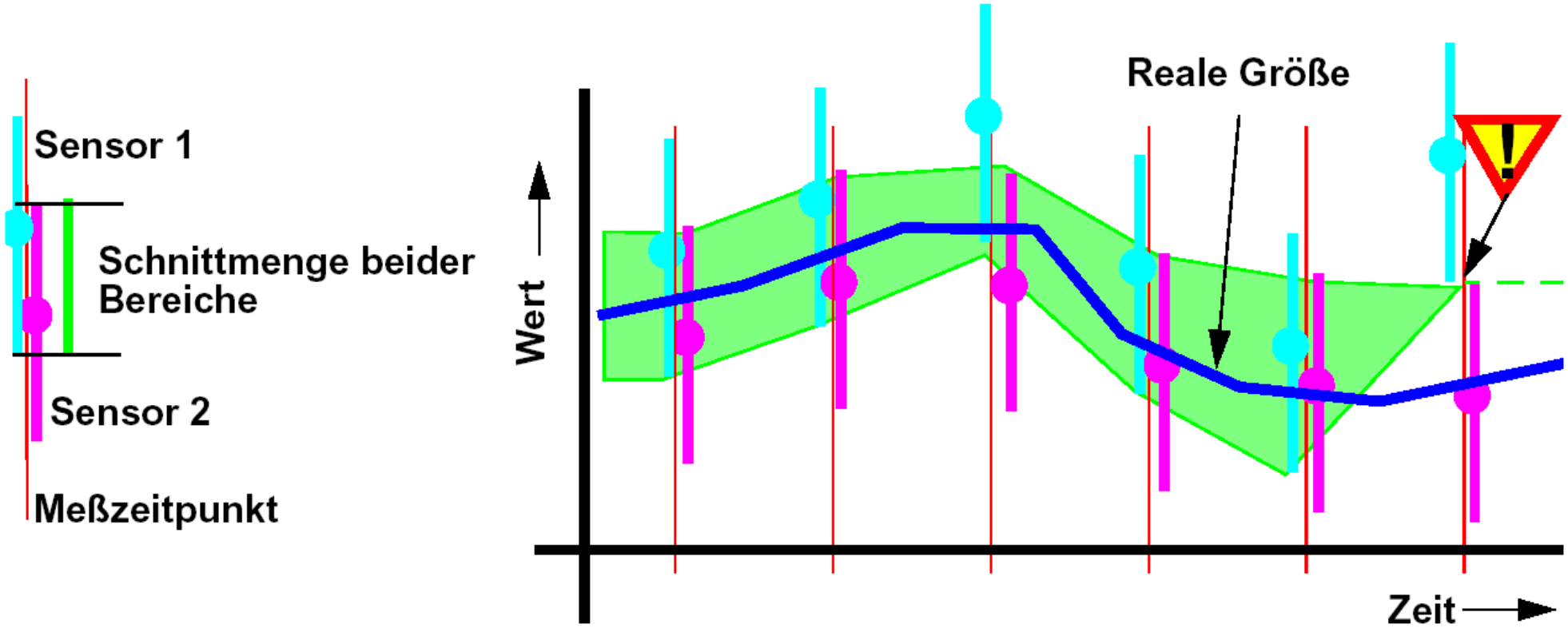
Sensor Toleranz..





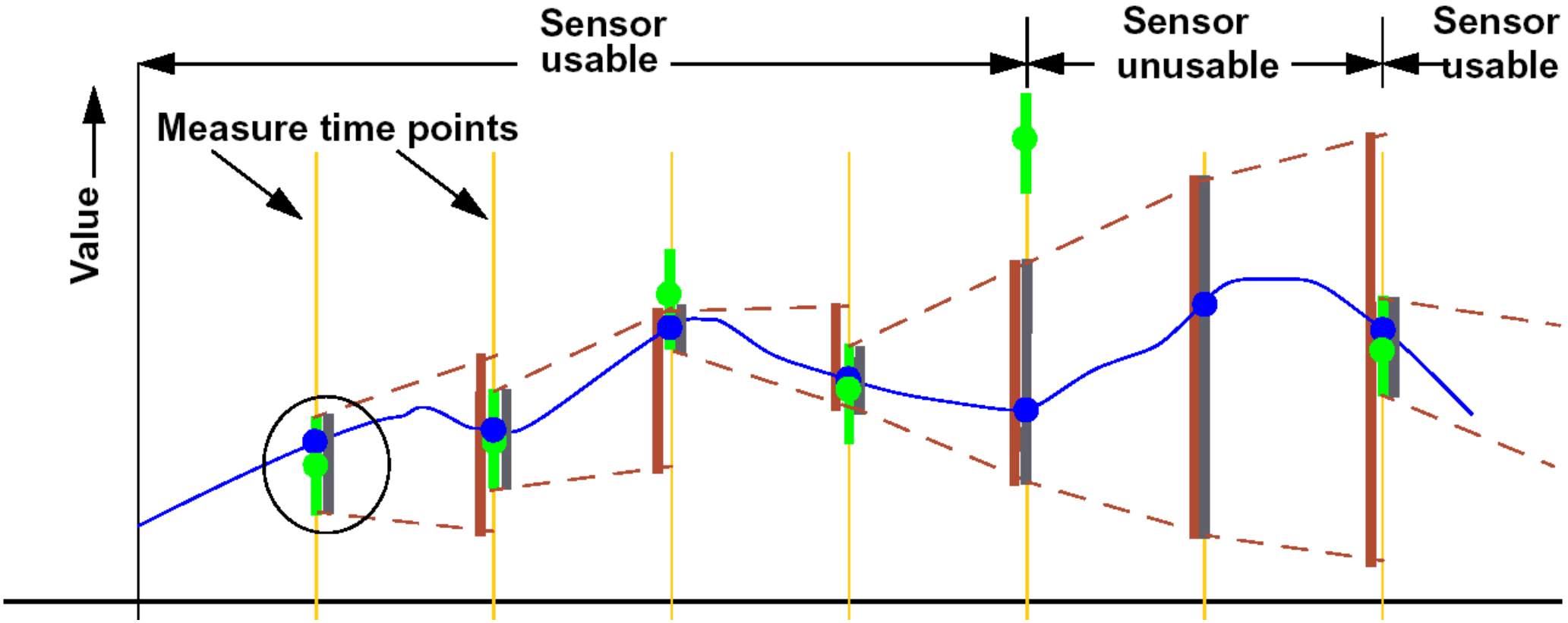
Gauge tolerance and the use of 2 or more Gauges

Sensor Toleranz..

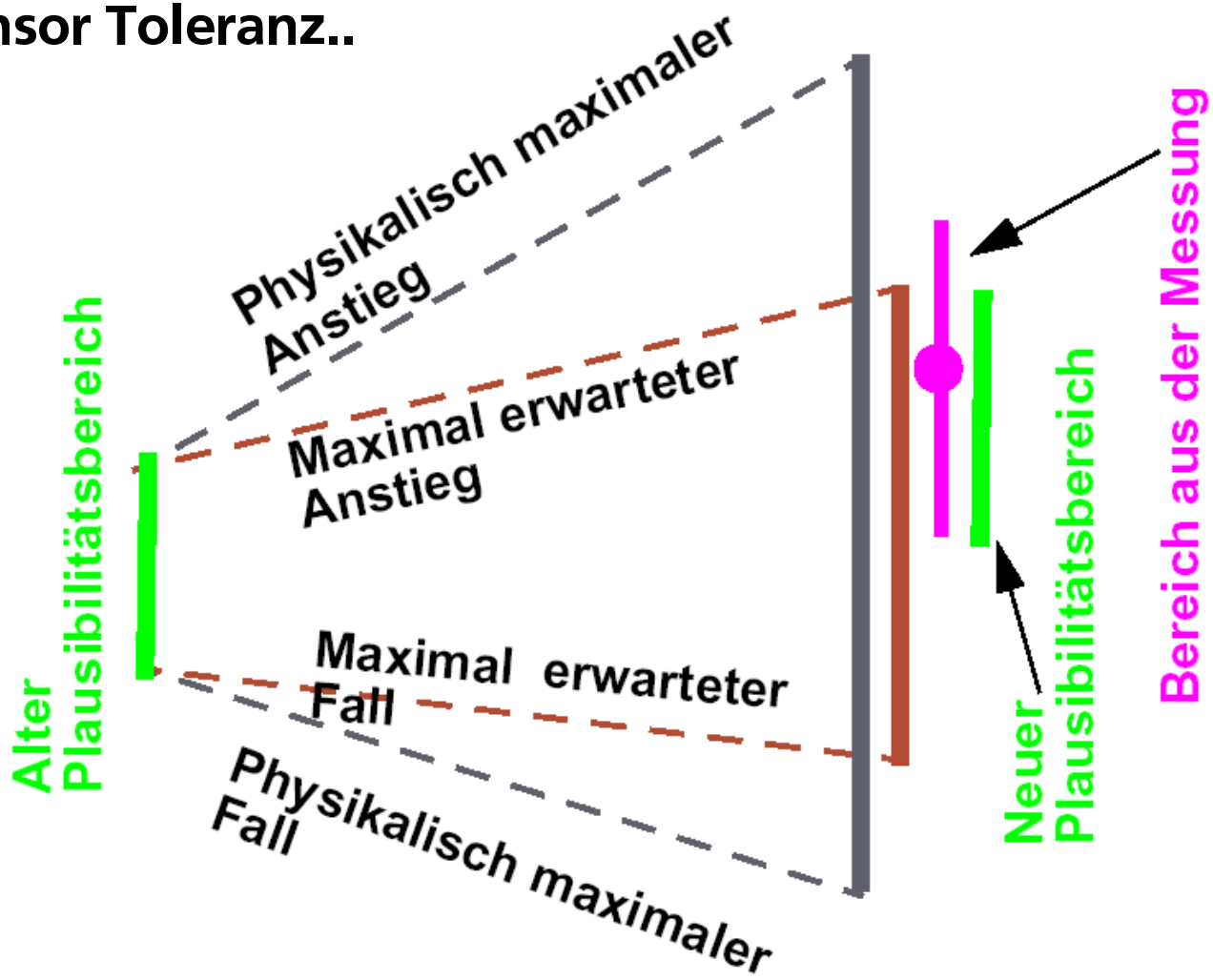


Direkte Redundanz engt den Plausibilitätsbereich ein

Sensor Toleranz..

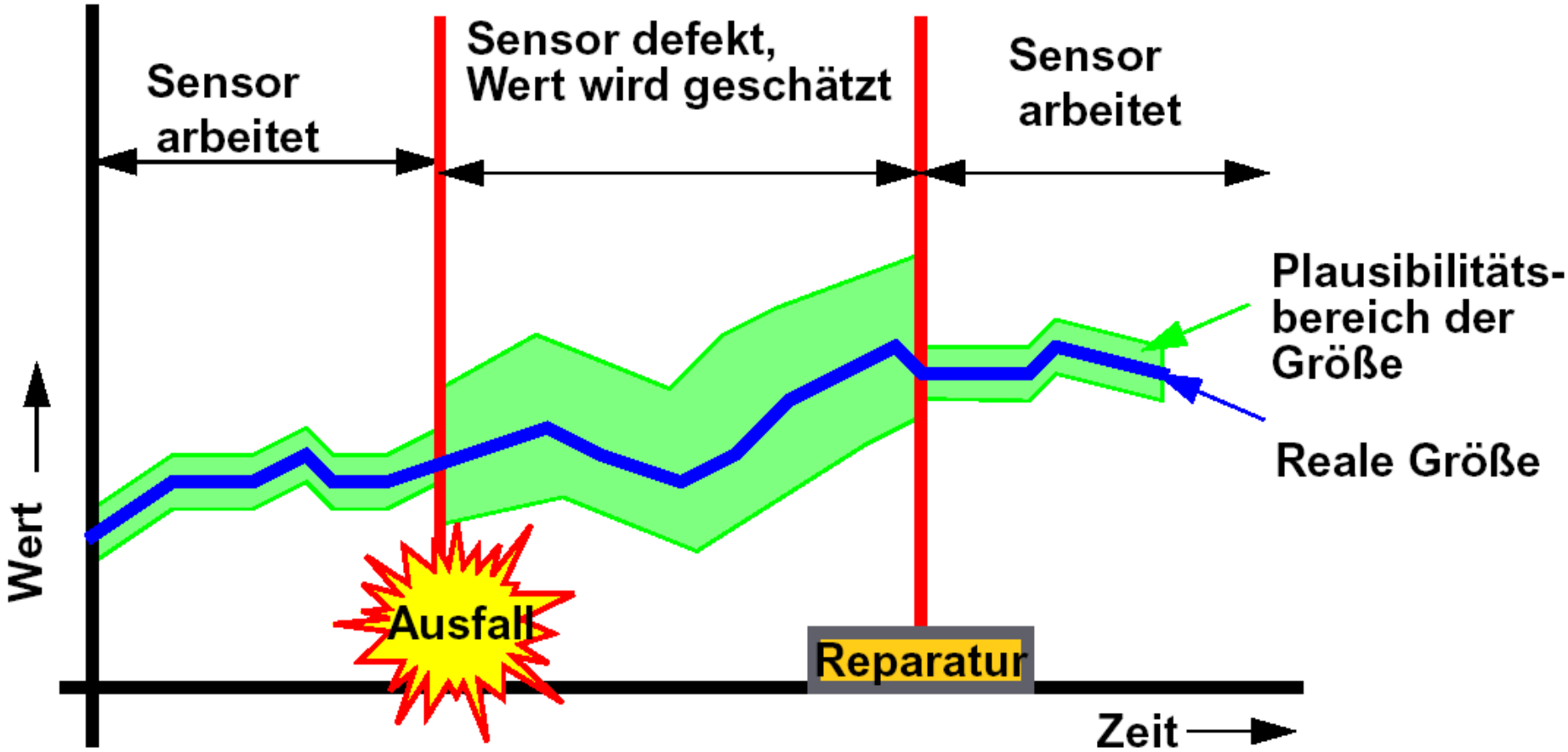


Sensor Toleranz..



Indirekte Redundanz engt den Plausibilitätsbereich ein

Sensor Toleranz..



Meßtoleranz und Abschätzungstoleranz

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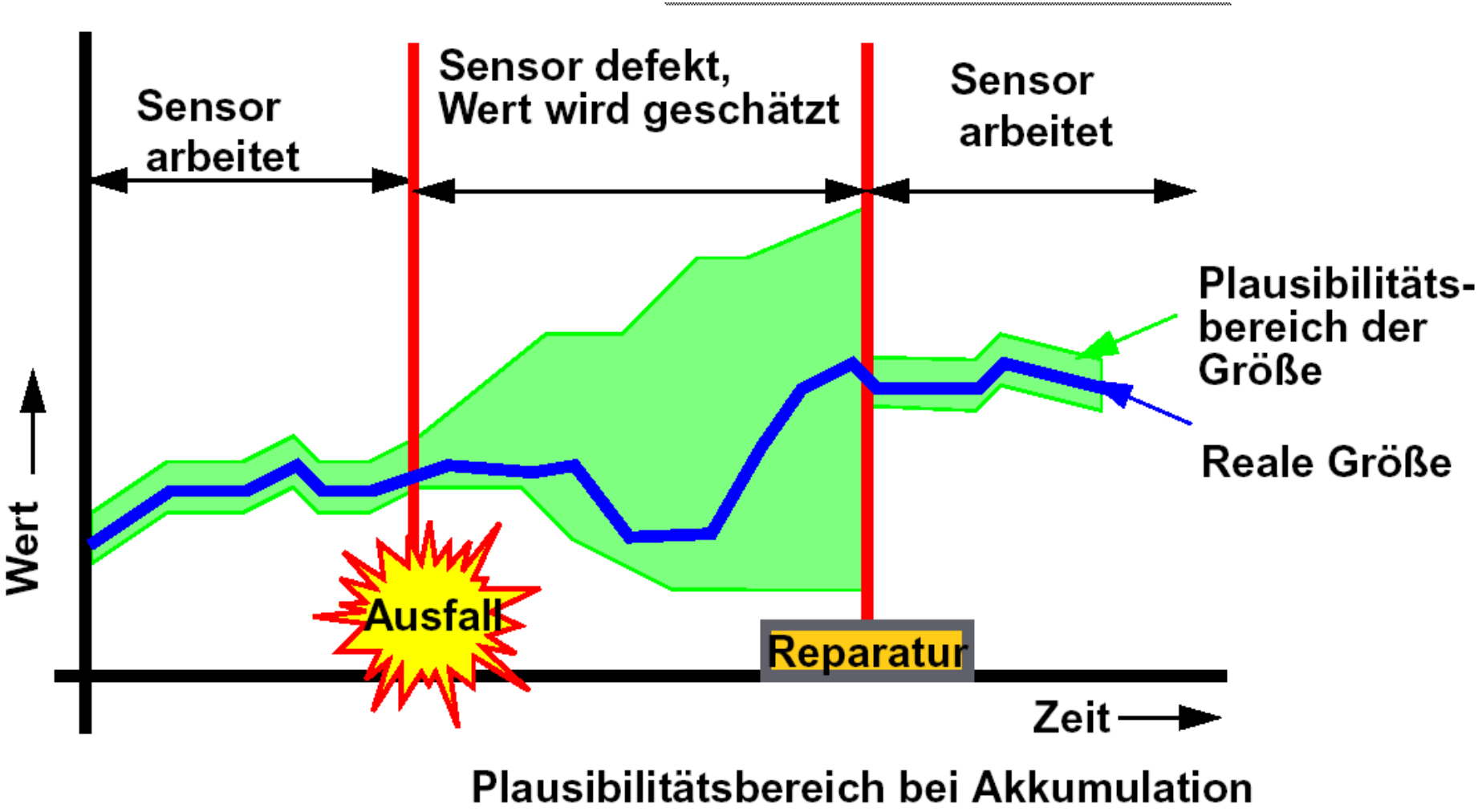
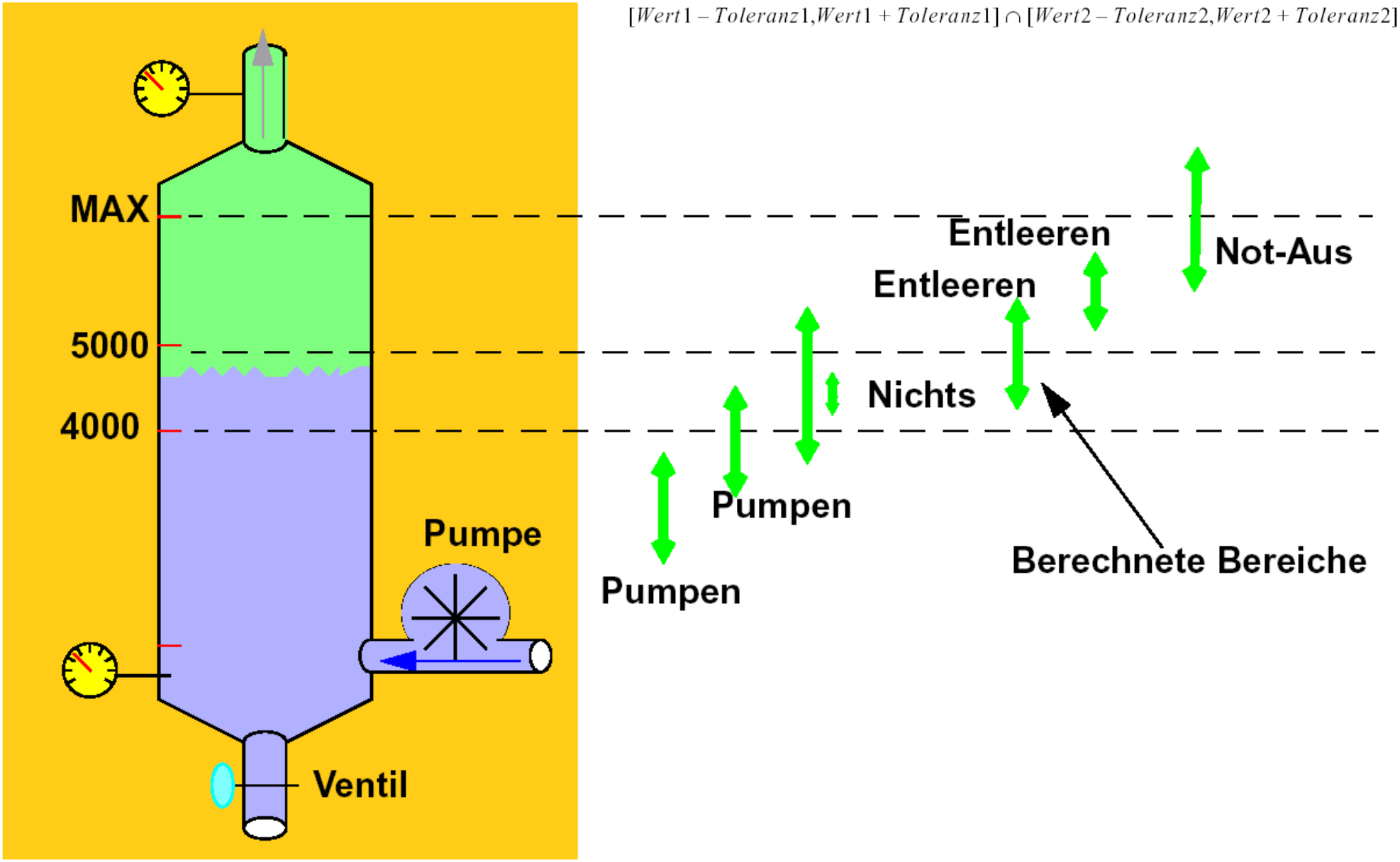
Sensor Toleranz..



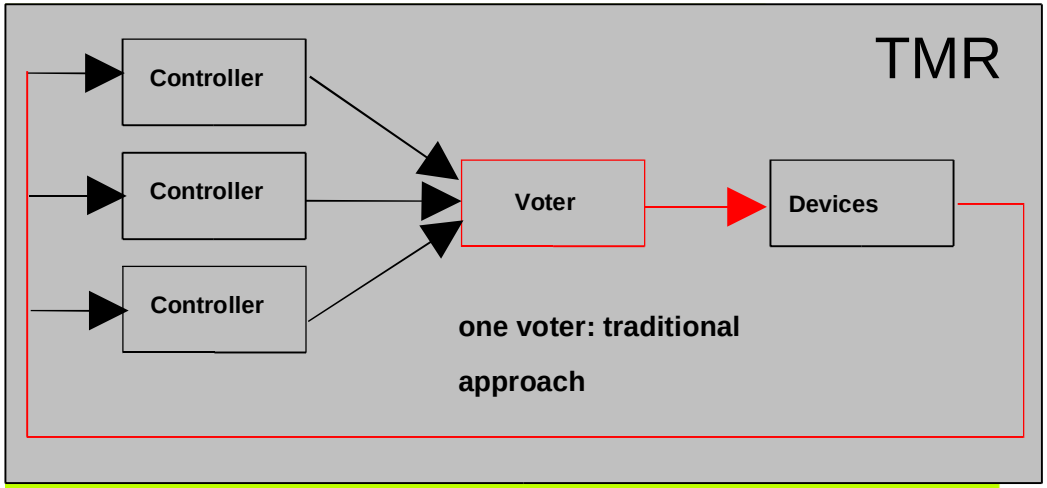
Plausibilitätsbereich bei Akkumulation

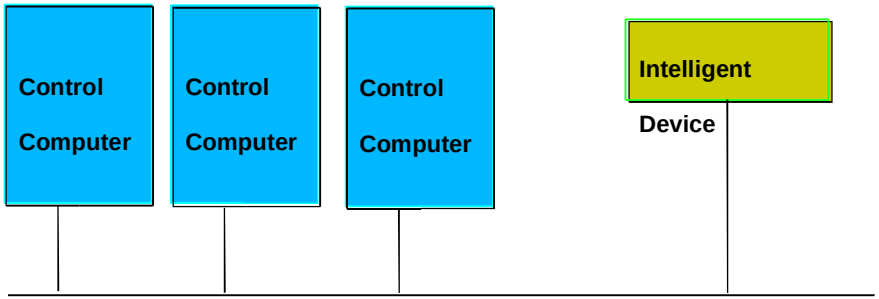
$$[Wert1 - Toleranz1, Wert1 + Toleranz1] \cap [Wert2 - Toleranz2, Wert2 + Toleranz2]$$



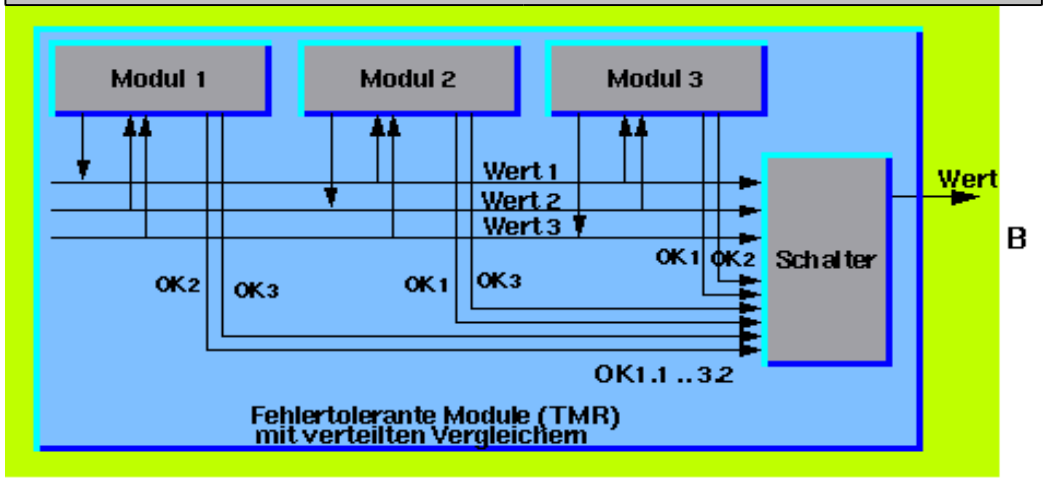
Steuerungsbeispiel

Alternativen





software voter, identification using
authentification



distributed voter, simple switch

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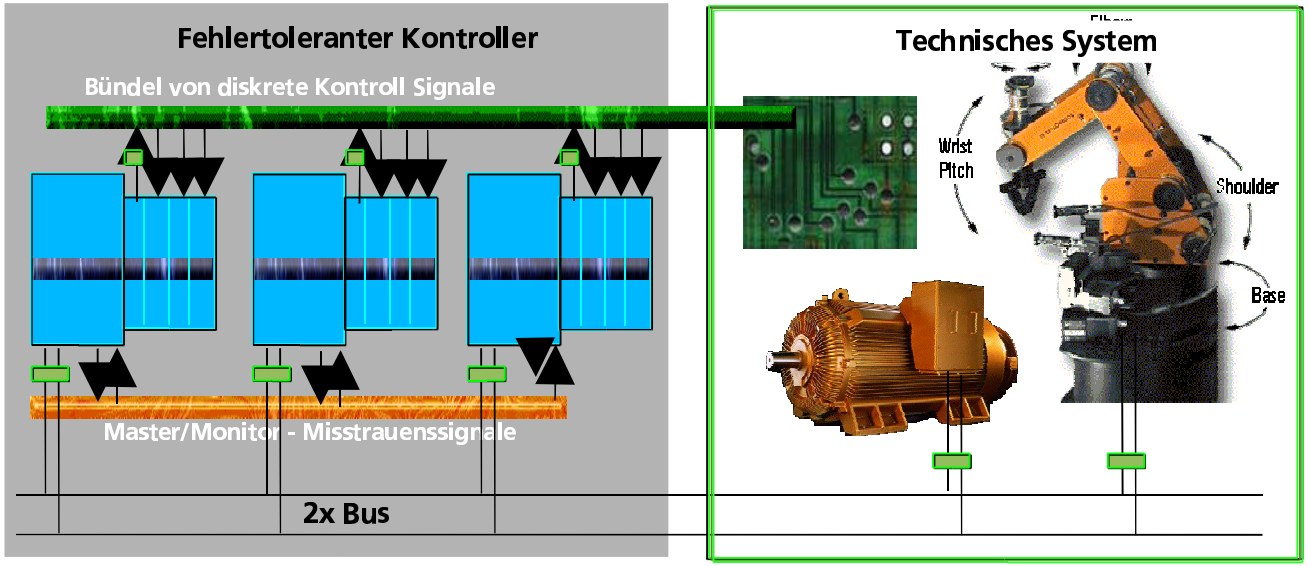
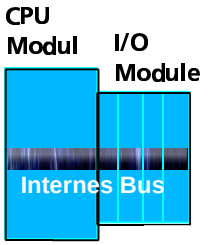
EverControl: demonstrator for fault tolerance in real time





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