Autonomy, how much human in the loop? Architecting systems for complex contexts

by *Gerrit Muller* University of South-Eastern Norway]
e-mail: gaudisite@gmail.com
www.gaudisite.nl

Abstract

The move from today's automotive archictectures to autonomous architectures triggers many questions. Todays' architectures are federative, focused on safety through predictability, and legacy and bottom-up driven. Autonomy requires context understanding, and a fundamental discussion on the balance between humans and autonomous systems.
This presentation takes the perspective from other domains with software intensive systems, to explore the potential hurdles in the transition to autonomous systems.

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An outsiders perspective on Automotive

The speaker's background

Health care, MRI scanners 1981-1991 (and 2007-2010)
Highly integrated architecture: "Host computer" + controllers

Health care, Imaging workstations 1991-1997
Object Oriented, workstations + servers

Semiconductor equipment 1997-1999
From federated to integrated architecture

The speaker's perspective on automotive

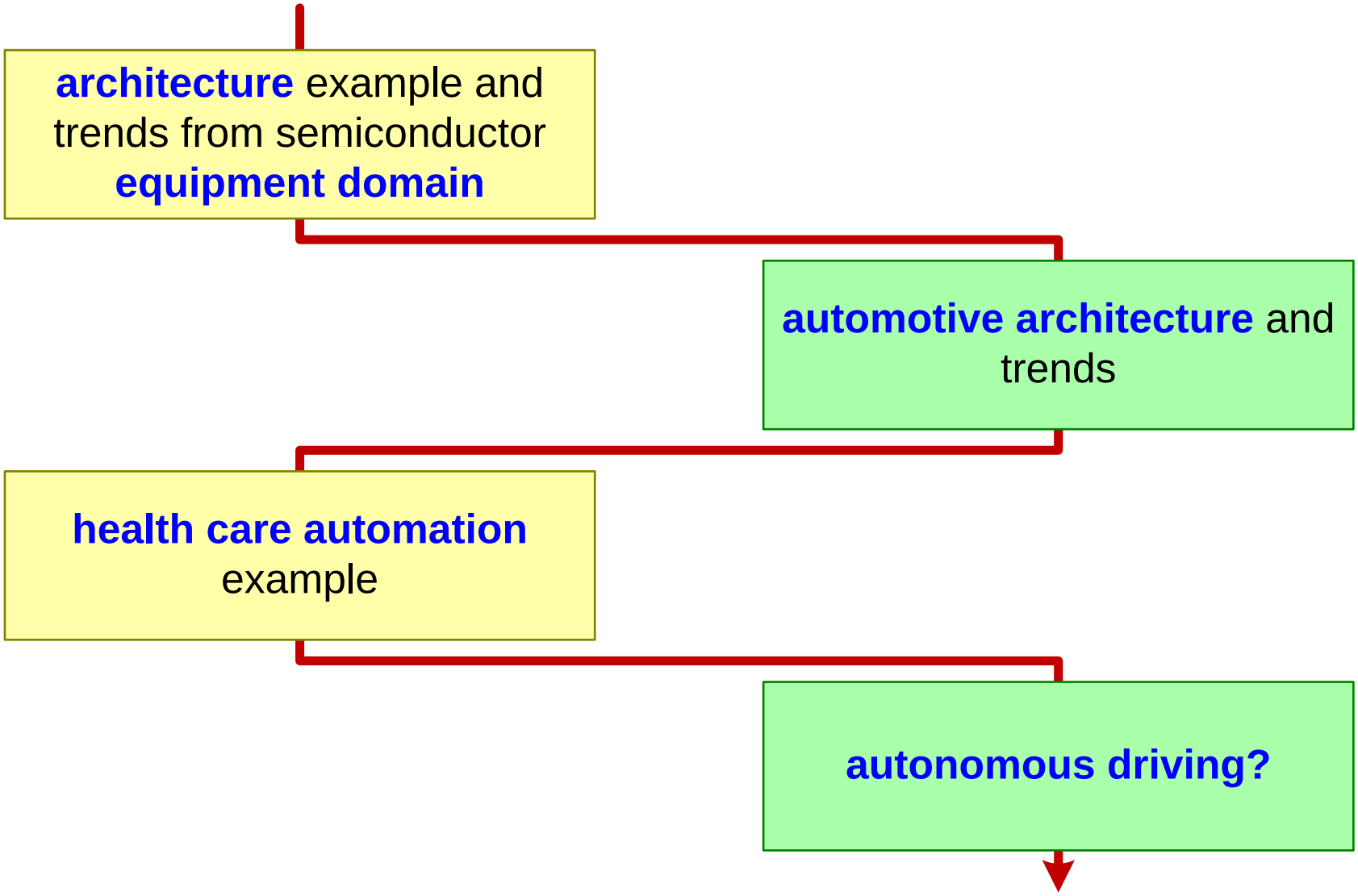
Loooong development cycles (heavy qualification, certification, verification)

Where is the "system" from control perspective?

Why do designers constrain themselves so much? (no dynamic memory management!)

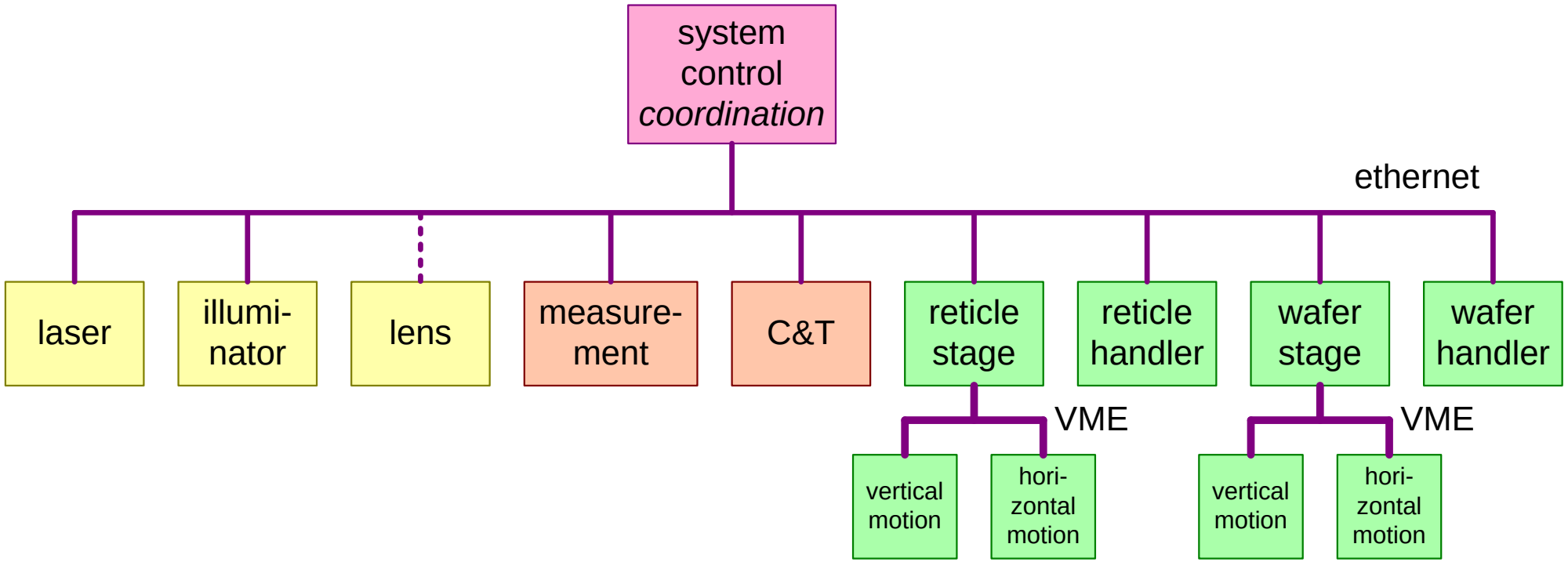
How can automotive move from such primitive state to autonomous driving?

Figure of Contents™

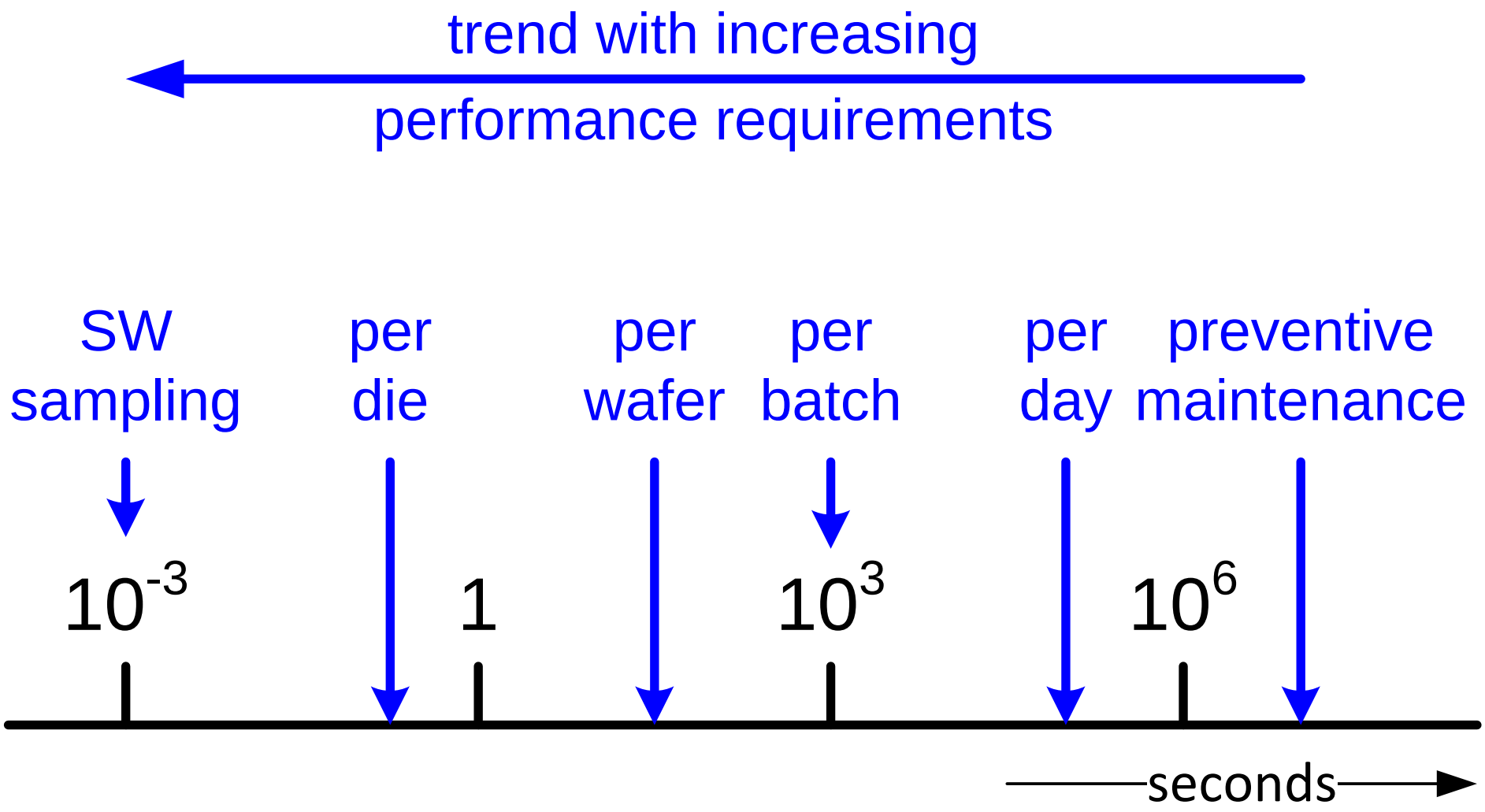


Example ASML Waferstepper

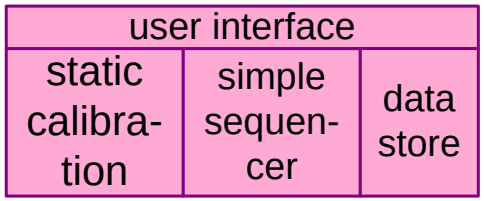
Control Hierarchy of a Waferstepper



Trend: Increased Frequency of Control Actions

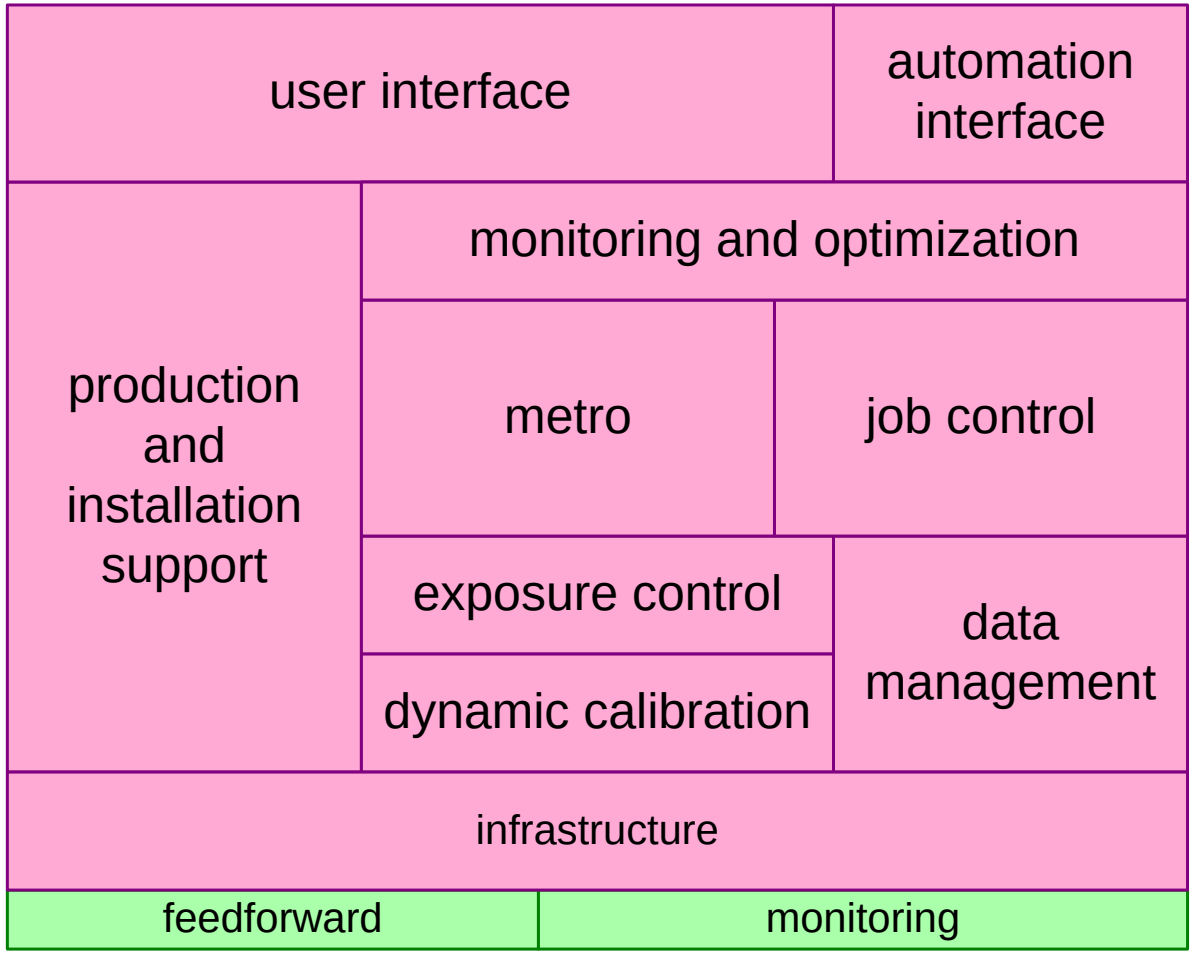


Evolution of System Control



1990

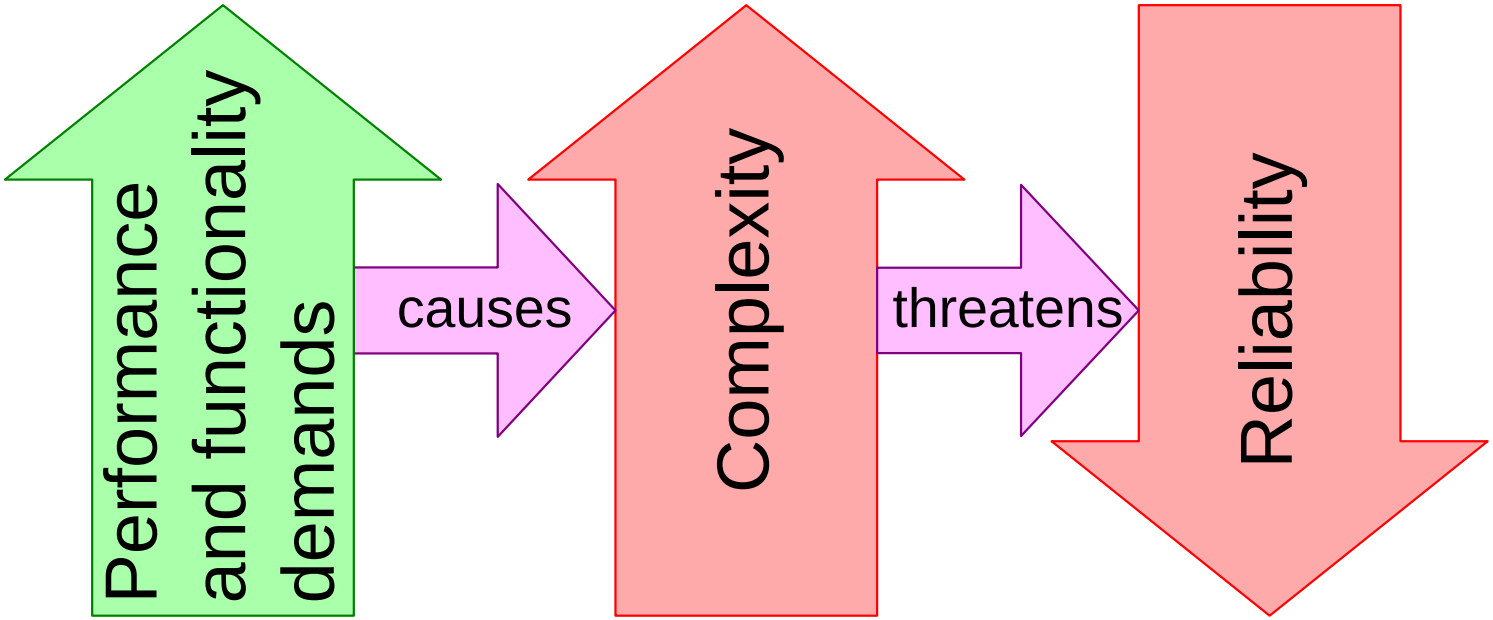
150 kloc



2000

2000 kloc

Consequences of Evolution

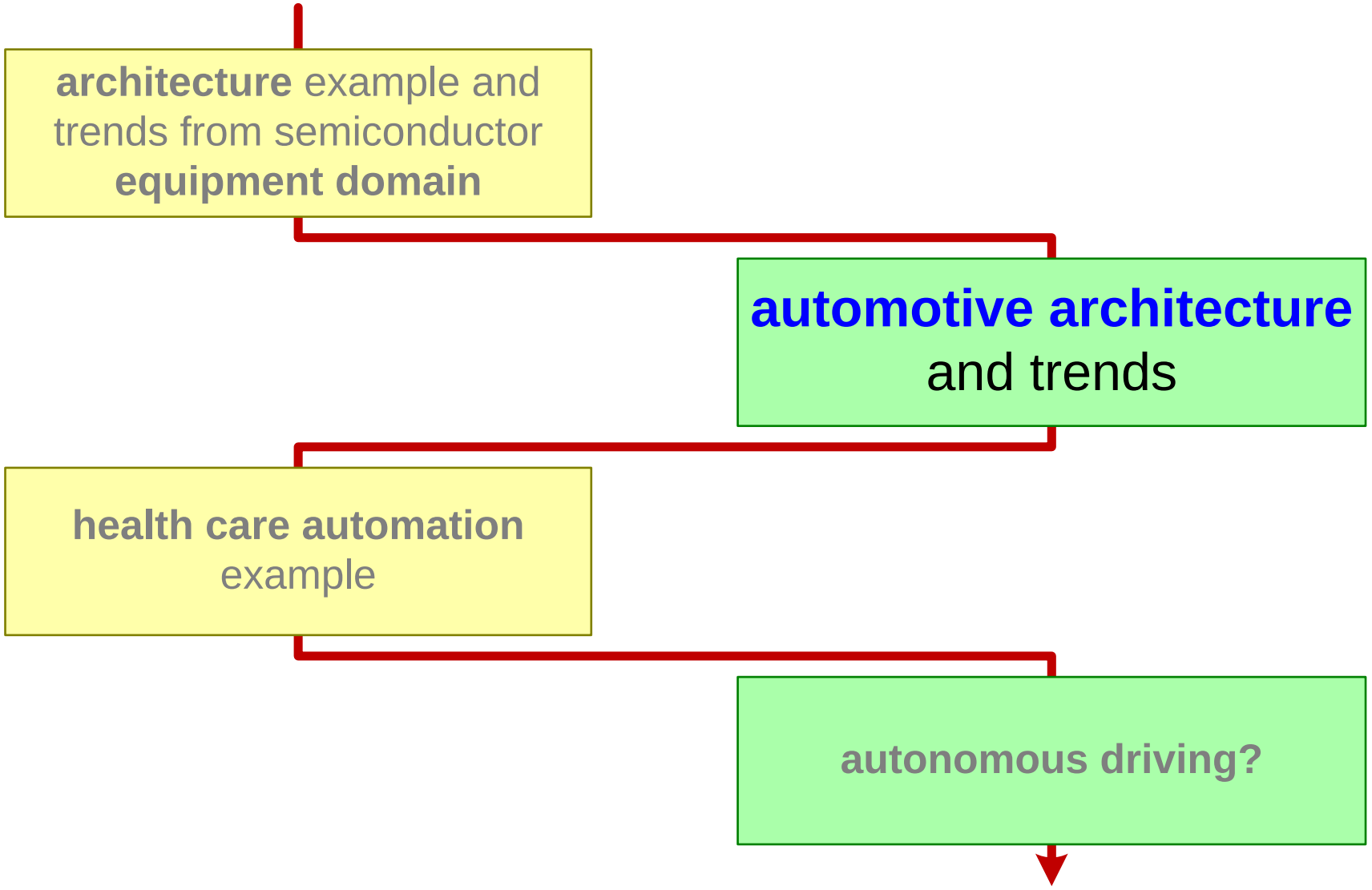


loss of overview (150kloc fits in 1 mind, 2Mloc not)

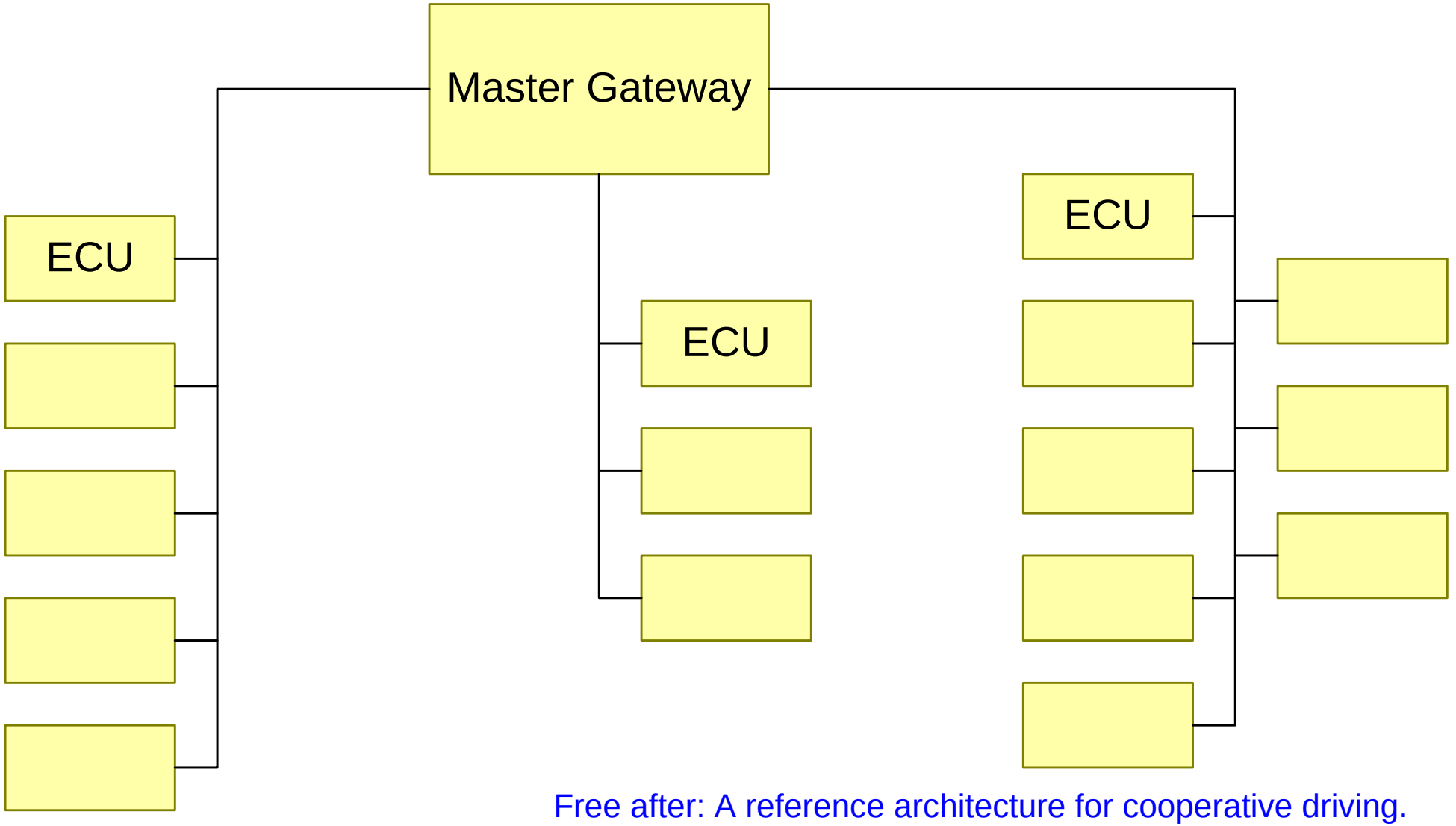
(more than?) exponential increase of coupling

1:1 relation HW:SW becomes n:m relation

autonomous subsystems — paradigm shift! — *integrated system*

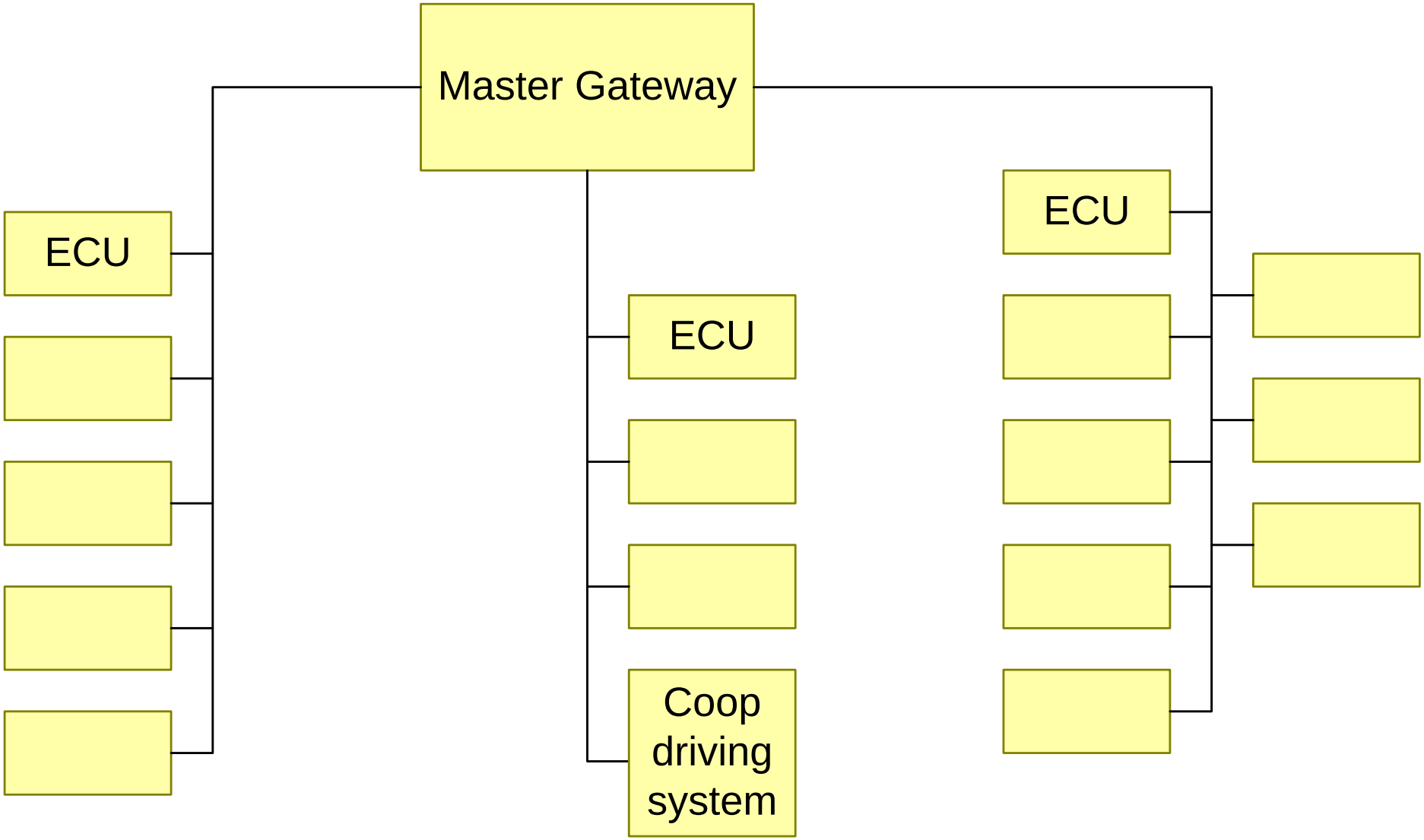

architecture example and trends from semiconductor **equipment domain**
automotive architecture and trends
health care automation example
autonomous driving?

Conventional Vehicle Network



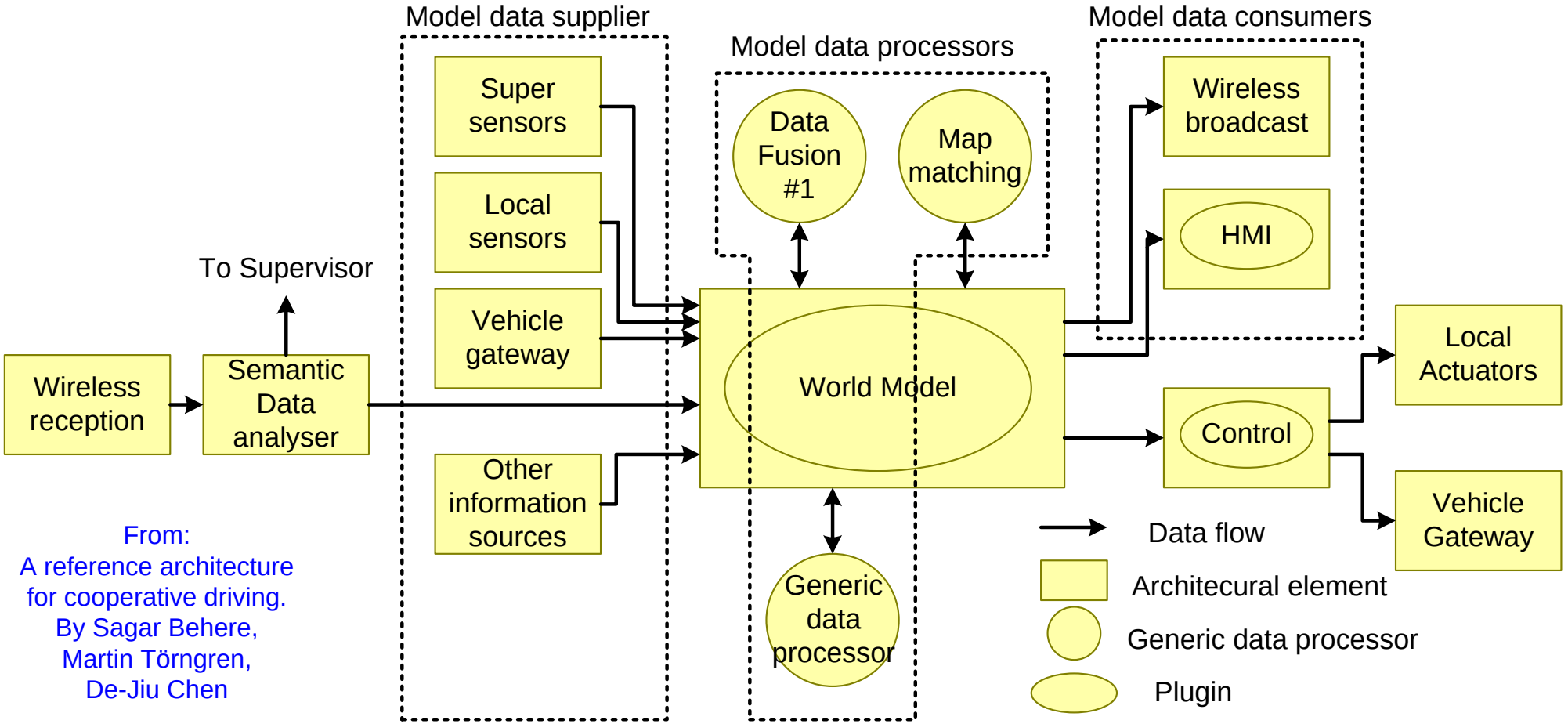
Free after: A reference architecture for cooperative driving.
By Sagar Behere, Martin Törngren, De-Jiu Chen

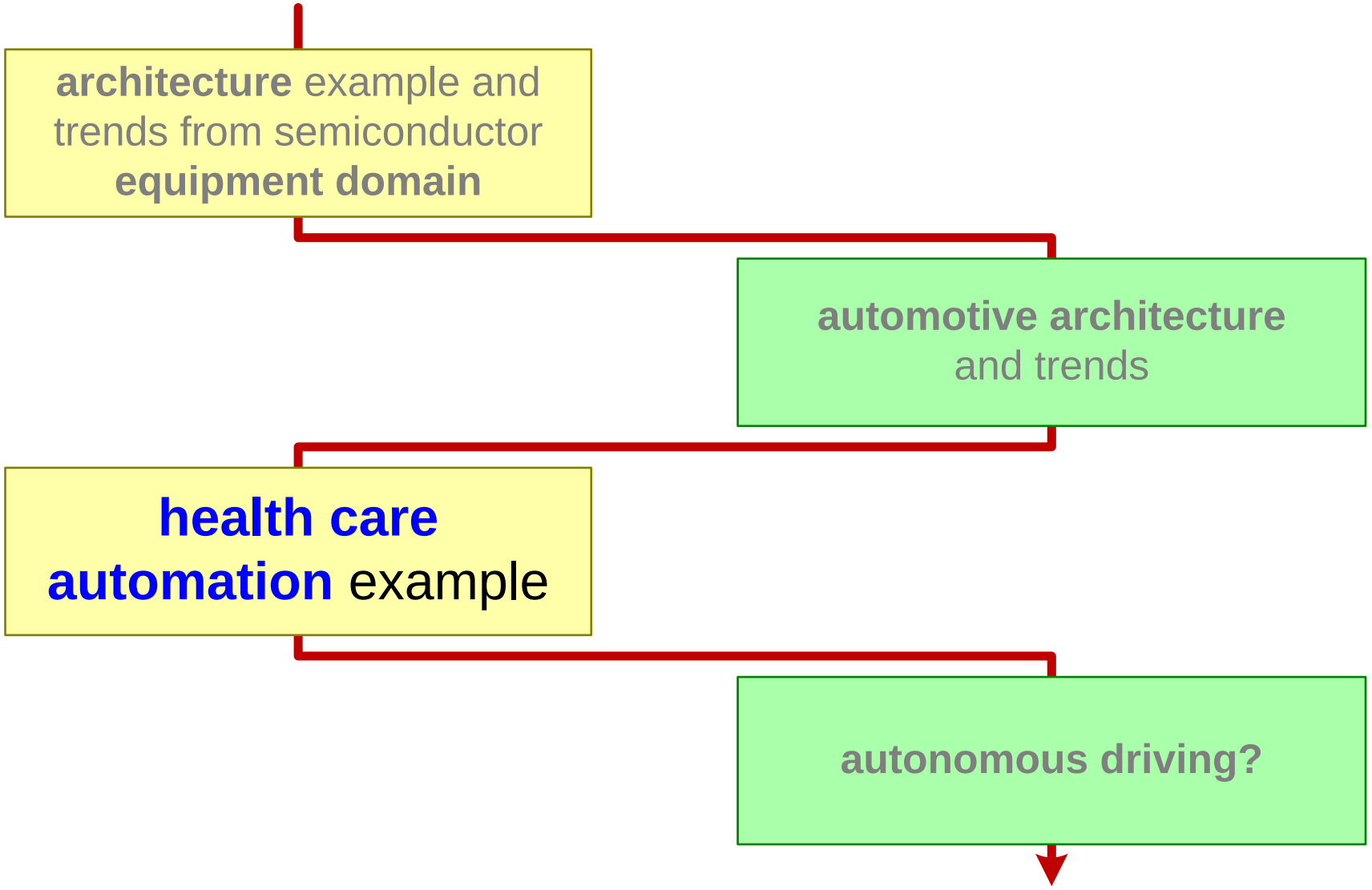
Cooperative Driving Vehicle Network



From: A reference architecture for cooperative driving by Sagar Behere, Martin Törngren, De-Jiu Chen

Conceptual view of the reference architecture

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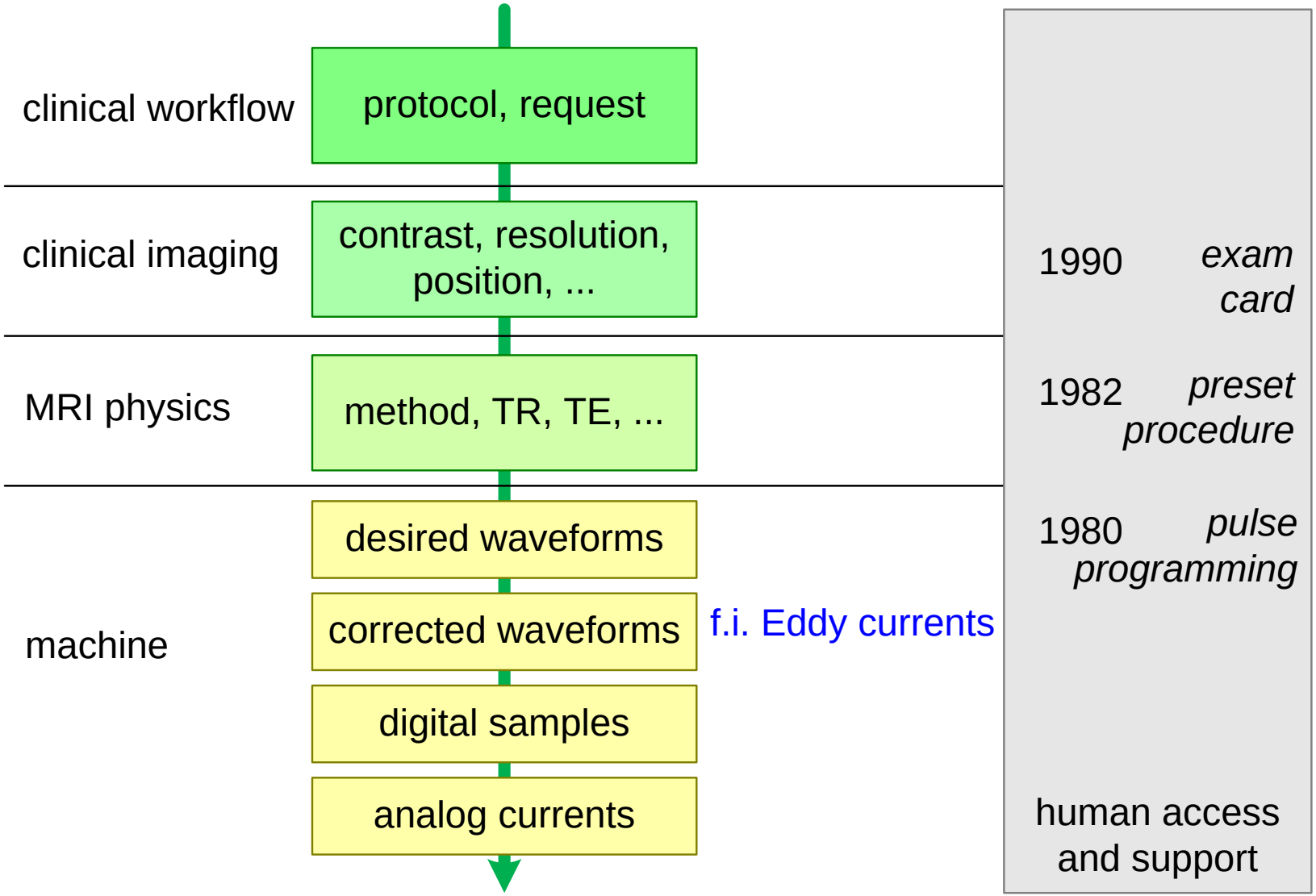
MRI: From Human Intent to Technical Realization



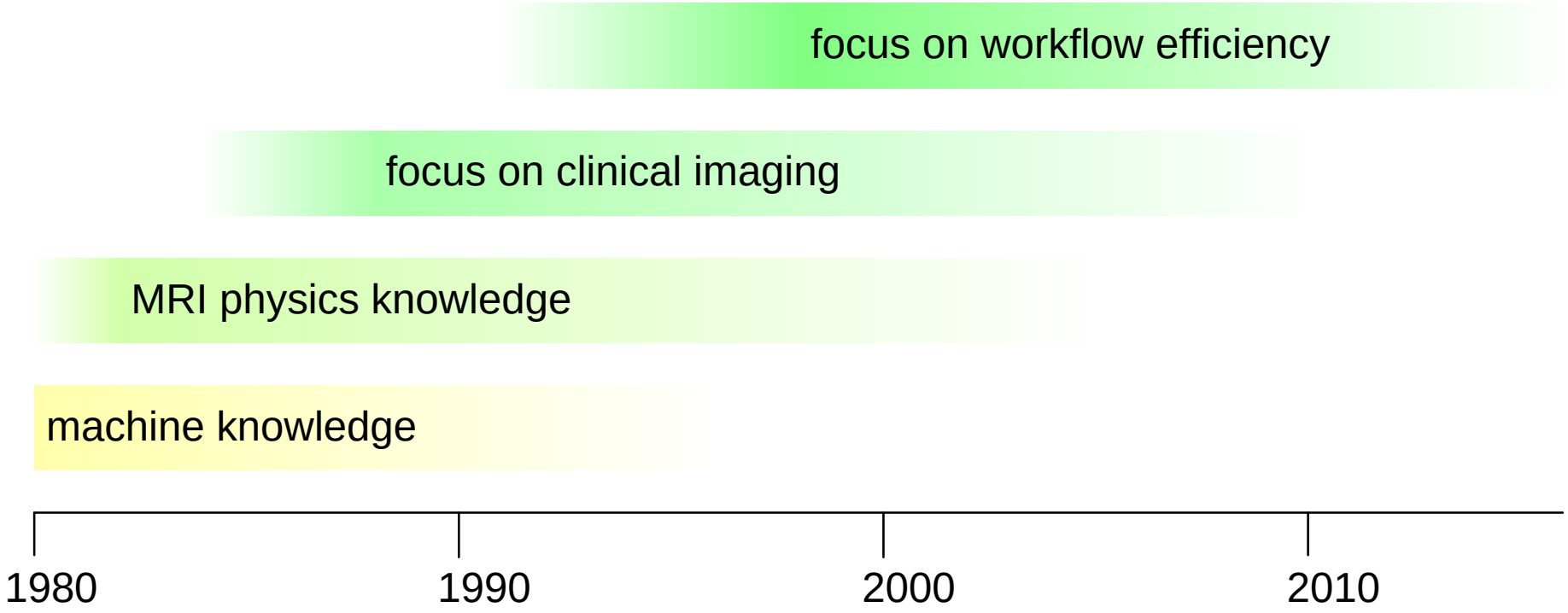
Evolution in Operation of MRI

operator knowledge and focus: from technical to application to workflow

scope: from system to examination (including humans) to department or hospital

positive: result orientation

How robust is this set-up for more exceptional cases?



What are the Consequences of Automation

Benefits

Focus on patient and clinical aspects

Less errors for routine cases, due to protocolized way of working

Concerns

How much do clinical users know and understand the imaging system?

Will they understand and be able to cope with technical opportunities and constraints?

Will they be able to operate the system for non-routine cases?

Challenge of automating

How can clinical users build up and maintain technical competence?

Symptom of Problematic Automation

Alarm Fatigue

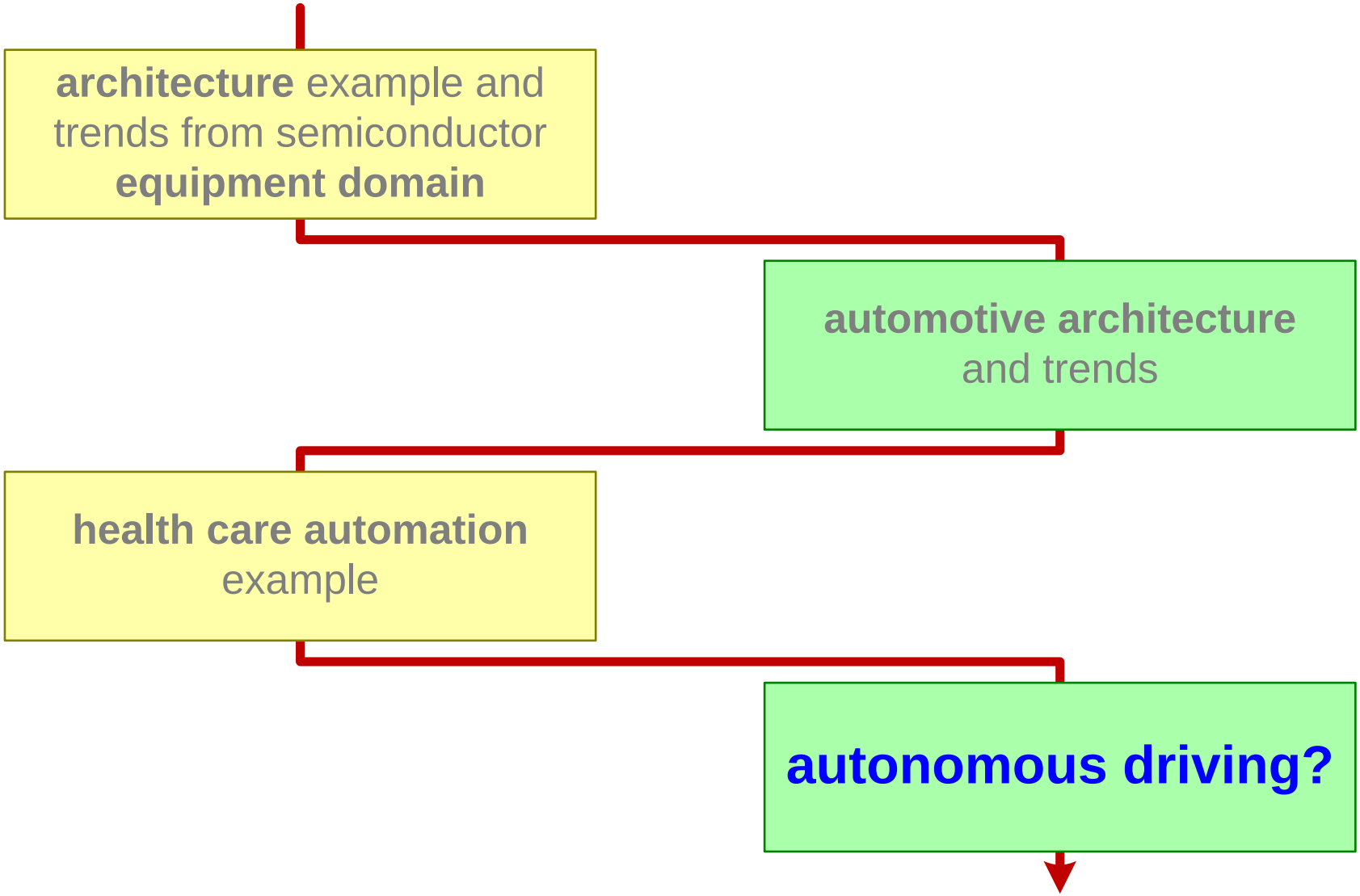
Ignoring or switching off alarms that occur too often.

Typical pattern

When designers do not know how to handle an exception, then they make a configurable alarm, delegating the problem to the next person in the chain.

Have you been in Critical Care Units or any control room? How many alarms are ignored?

Deepwater Horizon, Gulf of Mexico
The alarms in the crew cabins
were switched off,
since the alarm sounded too often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Should Cars Ignore the Law?

Date: Fri, 18 Dec 2015 07:18:52 -0800 Subject: Driverless cars: too safe at any speed?

Keith Naughton, 18 Dec 2015

Accident rates are twice as high for driverless cars as for regular cars, but the driverless cars have never been at fault.

https://www.autonews.com/article/20151218/OEM11/151219874/humans-are-slamming-into-driverless-cars-and-exposing-a-key-flaw

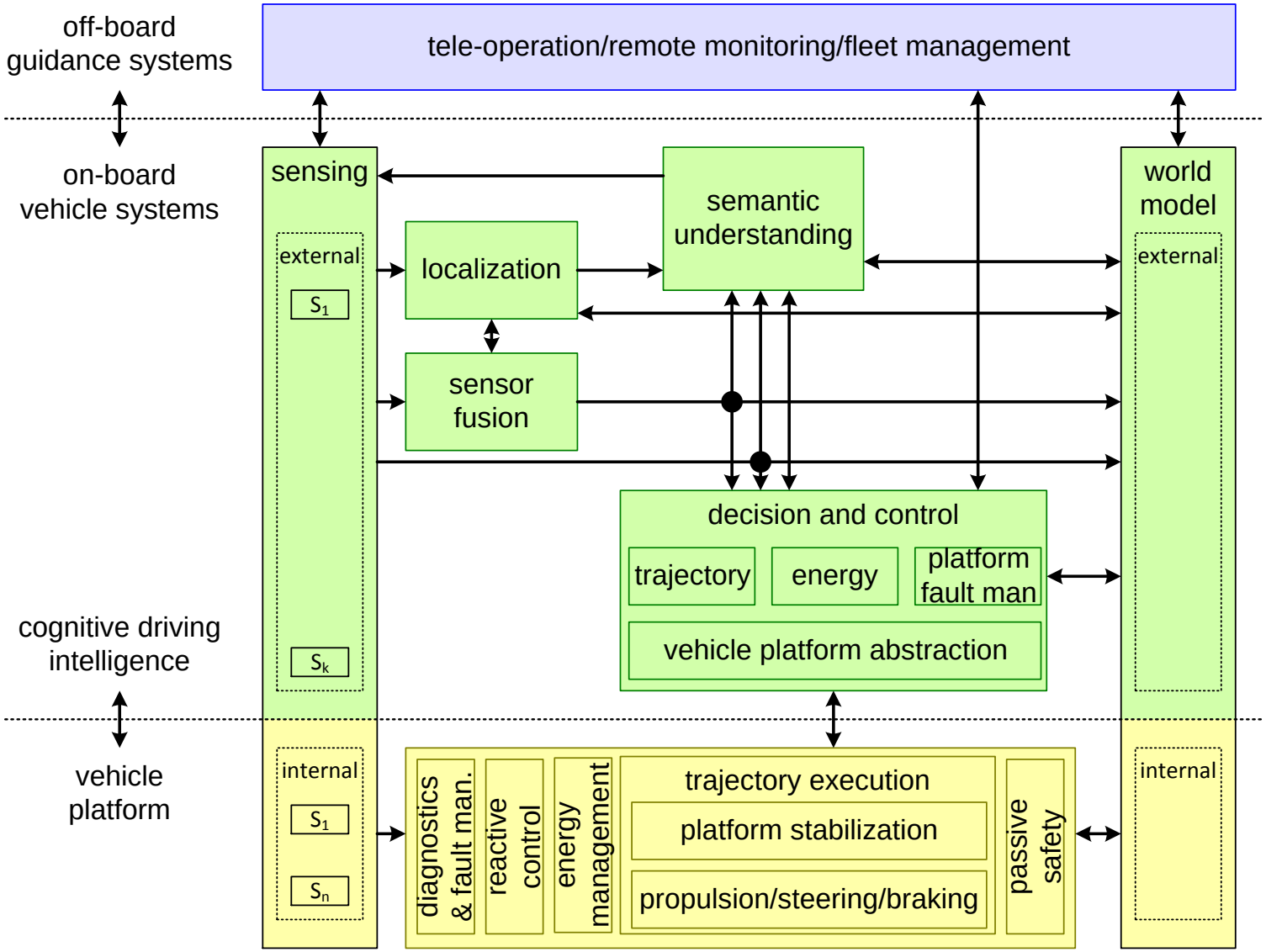
DETROIT (Bloomberg) -- The self-driving car, that cutting-edge creation that's supposed to lead to a world without accidents, is achieving the exact opposite right now: The vehicles have racked up a crash rate double that of those with human drivers.

The glitch?

They obey the law all the time, as in, without exception. This may sound like the right way to program a robot to drive a car, but good luck trying to merge onto a chaotic, jam-packed highway with traffic flying along well above the speed limit. It tends not to work out well.

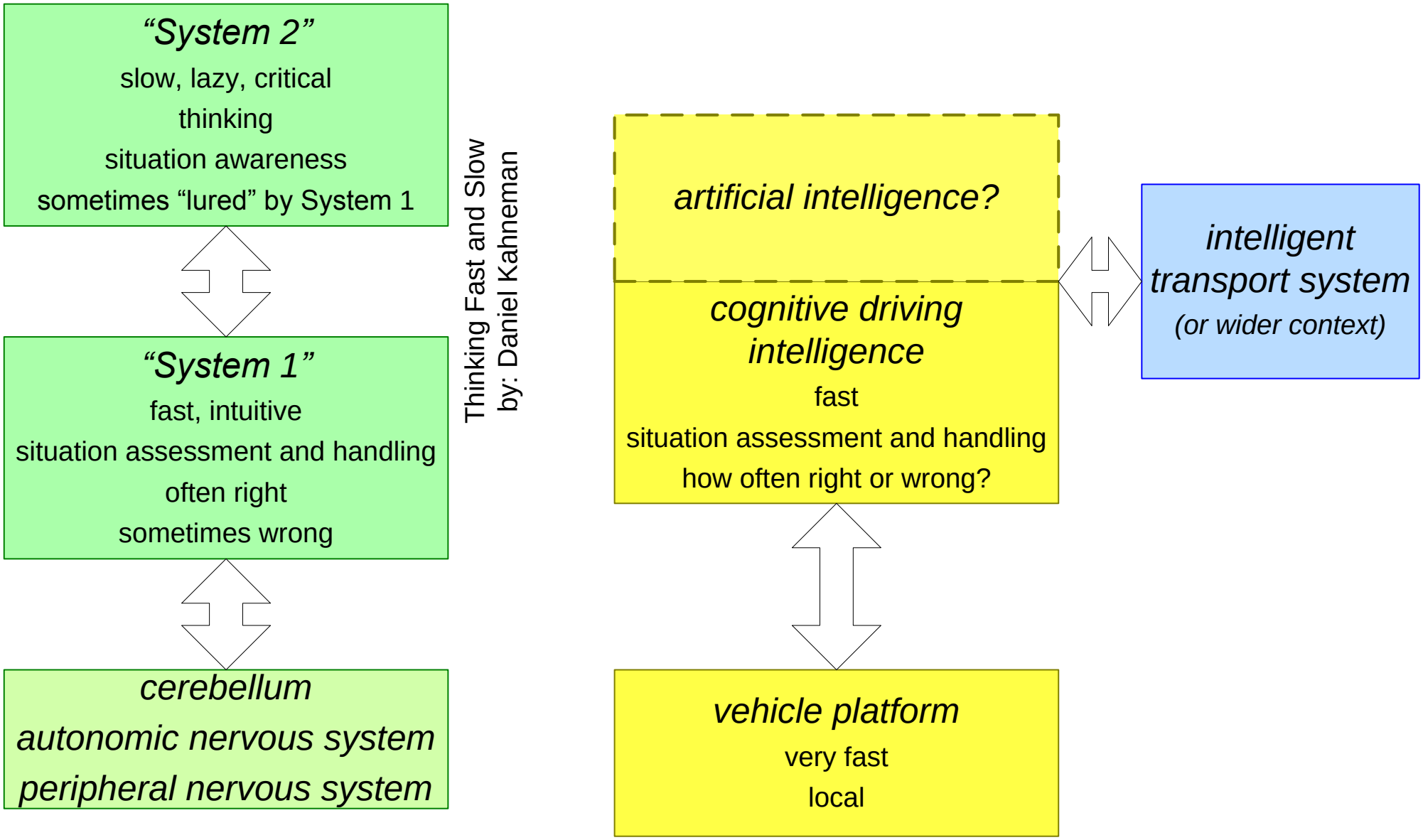
As the accidents have piled up -- all minor scrape-ups for now -- the arguments among programmers at places like Google Inc. and Carnegie Mellon University are heating up: Should they teach the cars how to commit infractions from time to time to stay out of trouble? [...]

A functional architecture for autonomous driving



from: *A Functional Architecture for Autonomous Driving*, by Sagar Behere, Martin Törngren

Human and Automotive Minds



What is your Conclusion?

When and why do we benefit from full autonomous driving?

Will we have time and energy for new developments?

Will we lose our own capabilities?