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Connectivity in the large –
a new challenge for us system engineers

SASG meeting 4-feb-2013

Tom Hoogenboom, ASML

Summary

- Auto Motive – from connectivity in the small
  – to connectivity in the large
- System of Systems Engineering
- A new opportunity for age-old annoyances
- A new responsibility for system engineers

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Auto Motive

AUTO = self

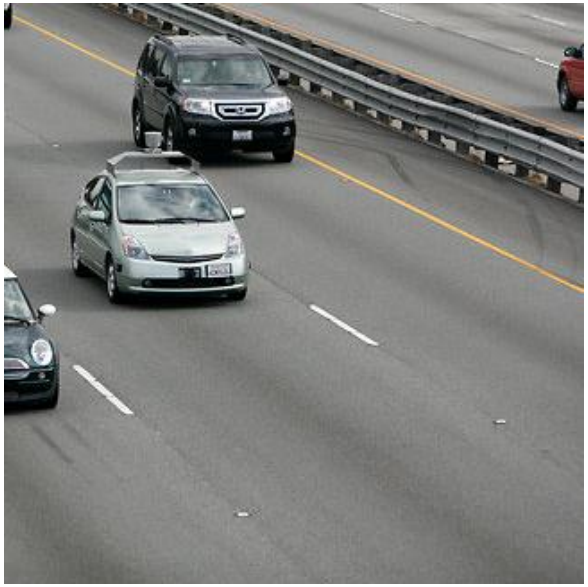
MOTIVE = moving

Automotive is not Auto Motive

- Cars do not drive themselves

Automotive can be automotive

Cars do not drive themselves?



The New York Times — October 10, 2010

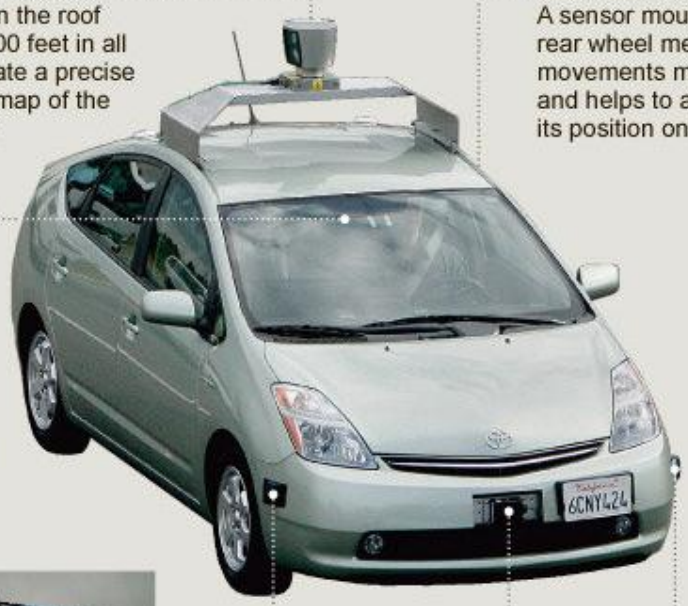
Autonomous Driving

Google's modified Toyota Prius uses an array of sensors to navigate public roads without a human driver. Other components, not shown, include a GPS receiver and an inertial motion sensor.

LIDAR
A rotating sensor on the roof scans more than 200 feet in all directions to generate a precise three-dimensional map of the car's surroundings.

POSITION ESTIMATOR
A sensor mounted on the left rear wheel measures small movements made by the car and helps to accurately locate its position on the map.

VIDEO CAMERA
A camera mounted near the rear-view mirror detects traffic lights and helps the car's onboard computers recognize moving obstacles like pedestrians and bicyclists.



RADAR
Four standard automotive radar sensors, three in front and one in the rear, help determine the positions of distant objects.

Source: Google

THE NEW YORK TIMES; PHOTOGRAPHS BY RAMIN RAHIMIAN FOR THE NEW YORK TIMES

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Connectivity in the small

- Inside
  - LIDAR
  - Front and rear cameras
  - Position sensors
  - GPS
  - RADAR
  - Etc. etc.
    - Plus engine control computer, fuel sensors
      - Plus sensor signal processing IC
        - Plus….

Connectivity in the large

- Outside
  - Pedestrians
  - Road marking
  - Traffic lights
    - Traffic control systems
      - GPS satellites
        - plus…

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Systems engineering

- Optimize 1 system
  - For 1..n environments
  - To sell 1..n copies

System of Systems Engineering (SoSE)

- SoSE goal:
  - optimize network of various interacting systems
    - Both legacy and new
    - brought together to satisfy multiple objectives
    - Including evolution of the SoS over time

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Consider multiple ‘automotive’ cars

Model, say, The Netherlands as one big network

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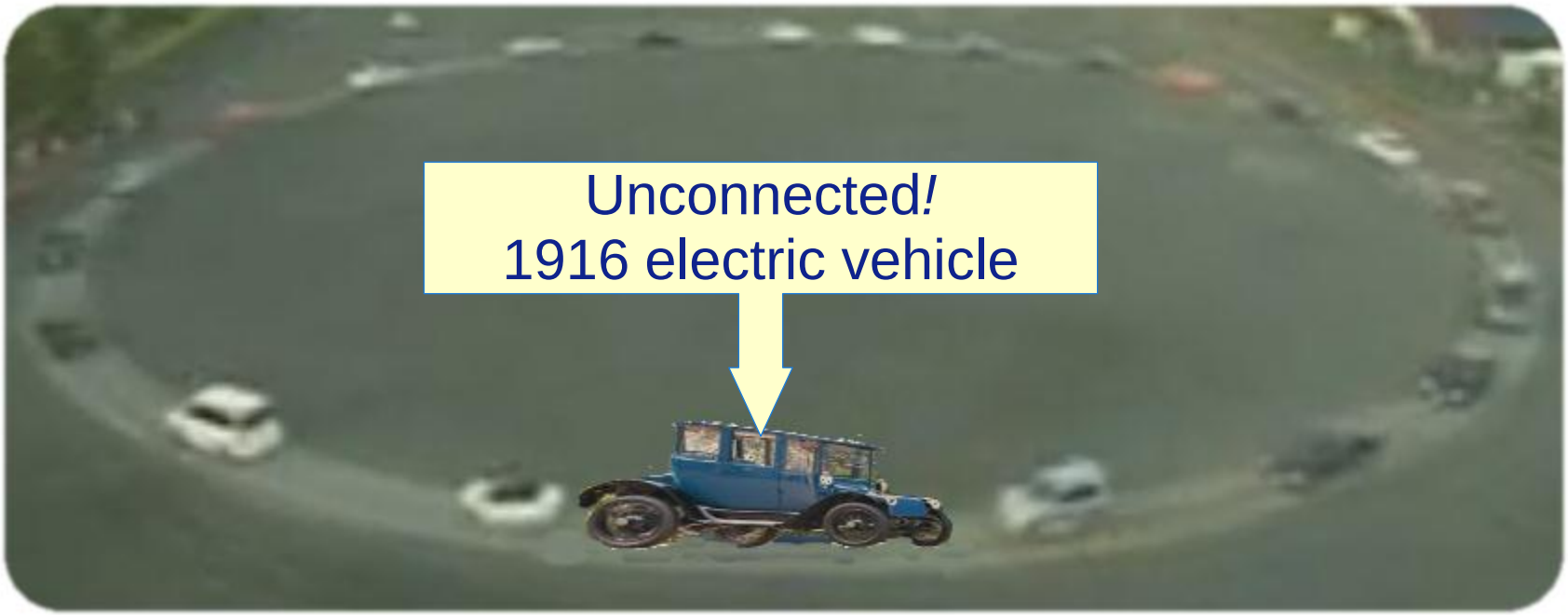
→ new reliablility issues emerge



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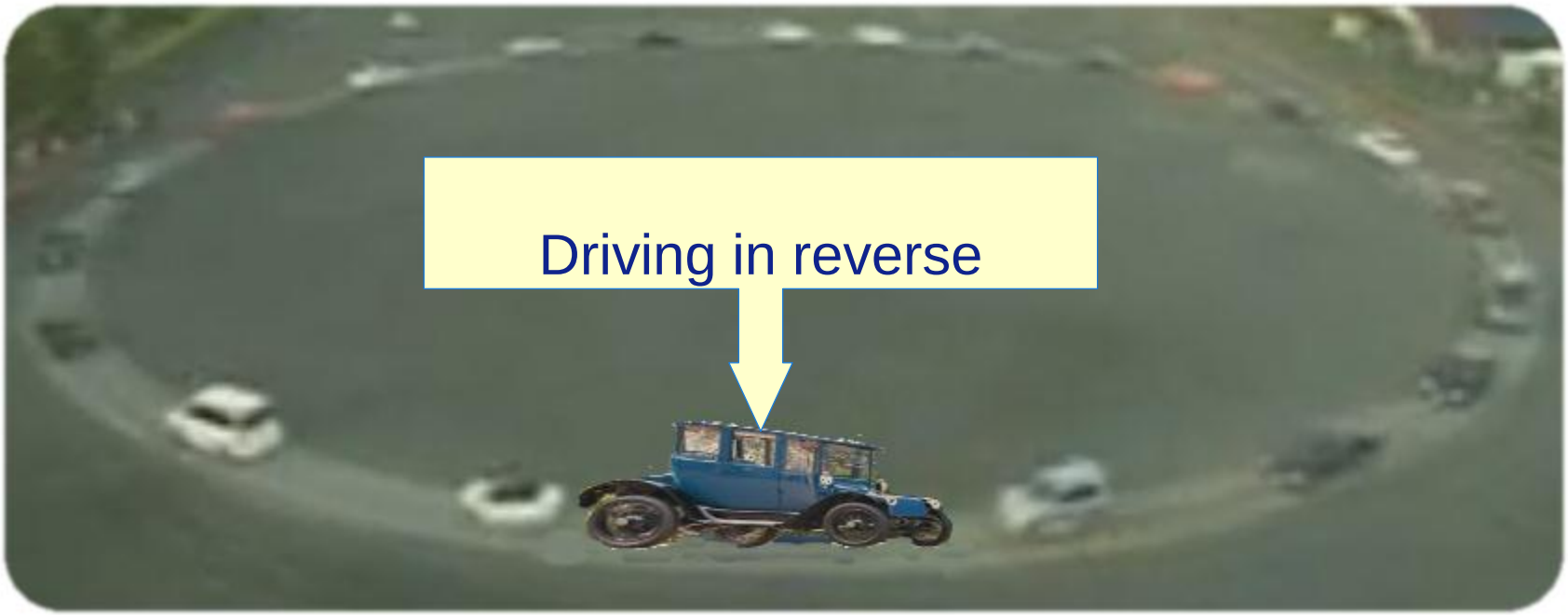
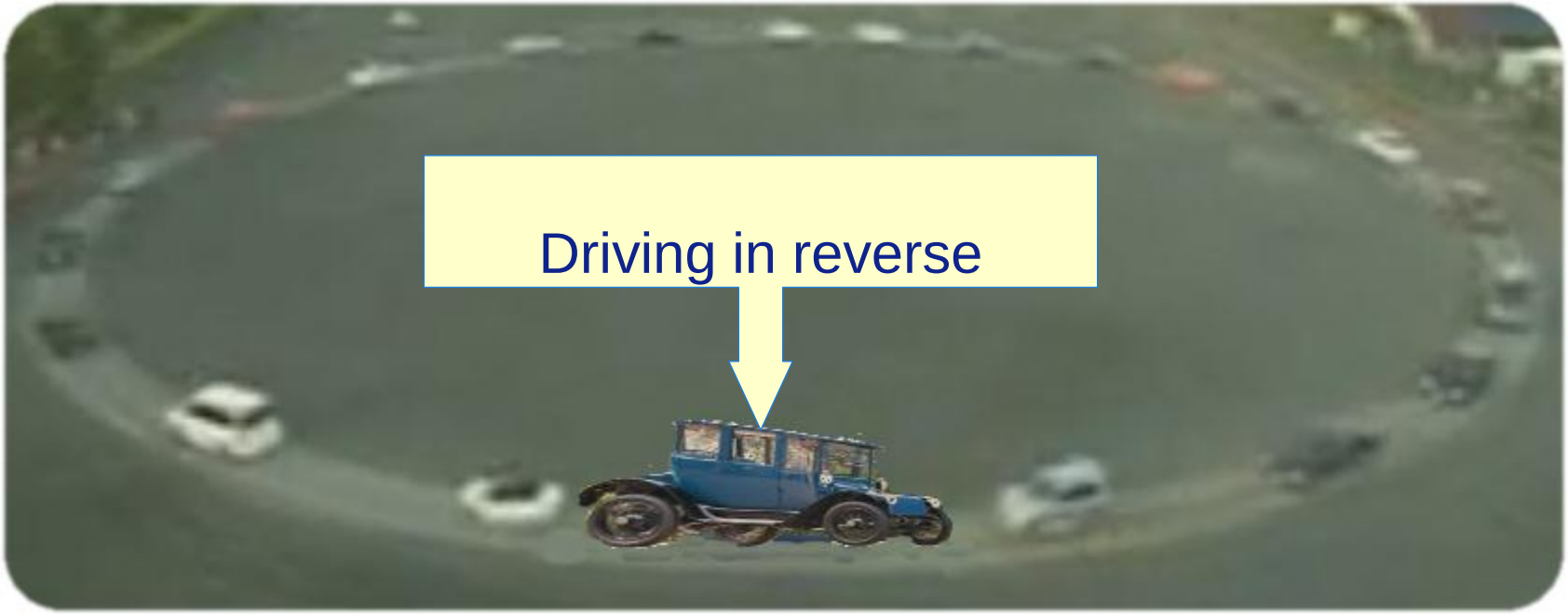
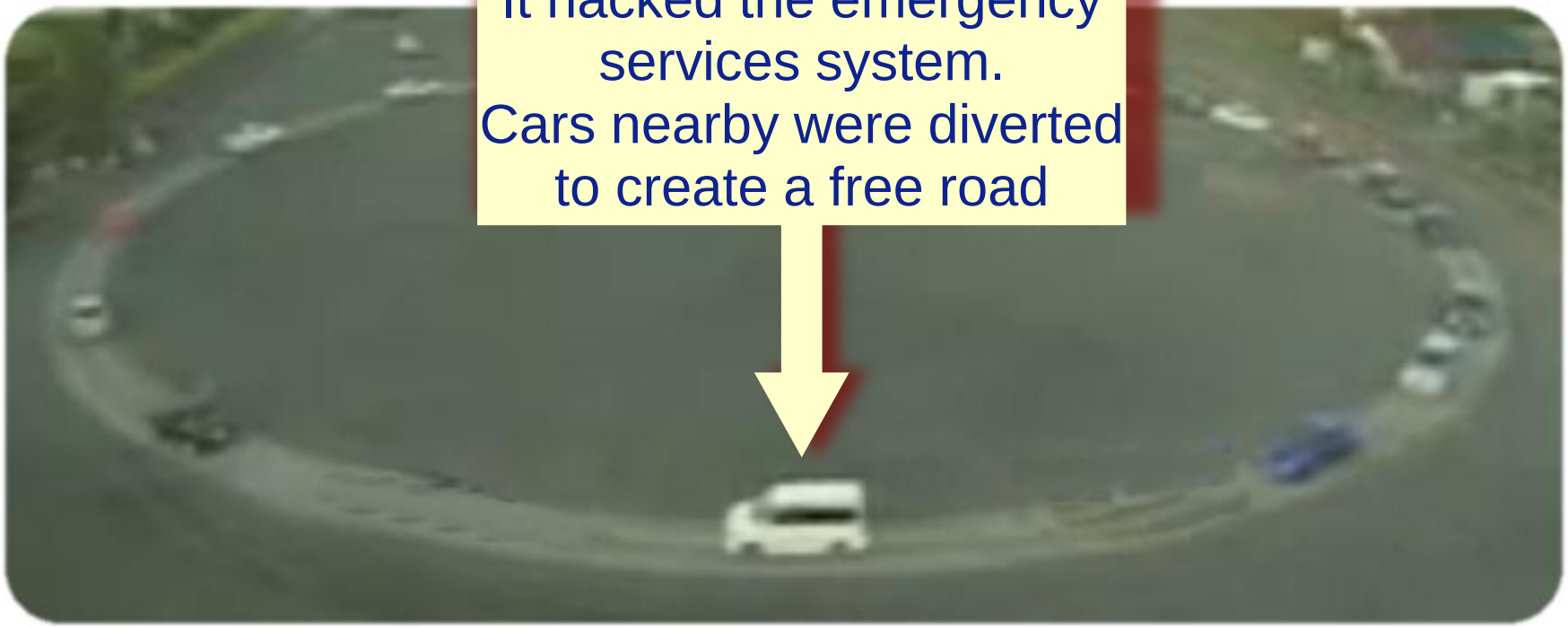




→ System-of-systems must cope with legacy components


It hacked the emergency services system.
Cars nearby were diverted to create a free road

→ System-of-systems must cope with security issues

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So we must consider a complex environment which evolves over time

- Reliability for an ensemble of N systems

  with N > 1000000.

- Protect privacy and prevent hacking

- Address security issues that could affect a whole country

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Final Summary

- Auto Motive – from connectivity in the small
  – to connectivity in the large
- System of Systems Engineering is a new discipline
- A new opportunity for age-old annoyances like reliablility
- A new responsibility for system engineers:
  integration of systems evolving over time

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To trigger discussions – 4 statements

1- small scale connectivity,

e.g. canBus,

reliability spec must have N cars in mind, not 1
→ reduced risk of traffic jams in The Netherlands

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e.g. Tom Tom networks
must prevent hijacking of system functionality

→ engineers must consider new failure modes

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4- System-of-system integration must be coordinated

across all levels of connectivity

by a body with sufficient authority to enforce security, privacy and reliablility.

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