University of Luxembourg

SnT - CritiX

Towards sustainable safety and security in autonomous vehicles

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Autonomous driving – the next complexity milestone

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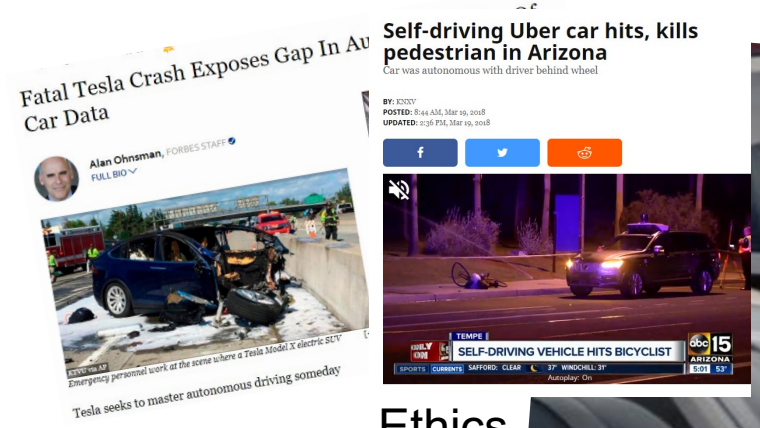
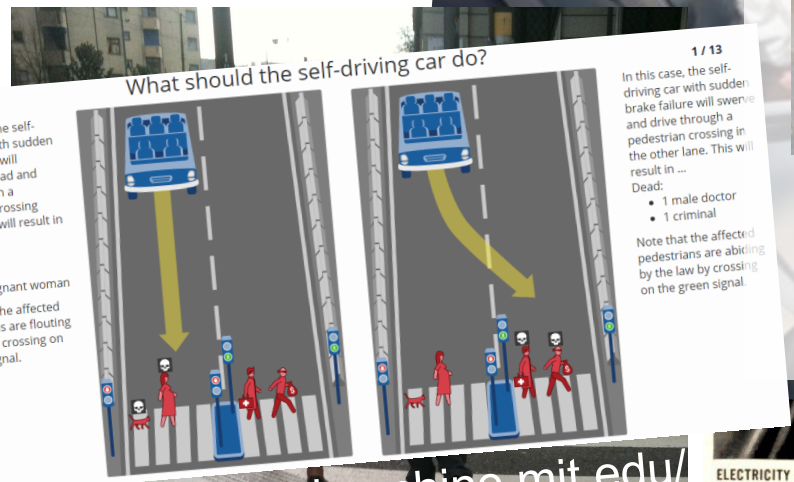
Acceptance and Reputation



Ethics



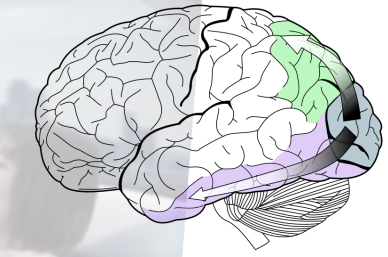
http://moralmachine.mit.edu/

1957
Level 4 autonomy => Level 5

Source: http://paleofuture.com/blog/2010/12/9/driverless-car-of-the-future-1957.html

Implicit Communication

Brain areas involved in human visual perception



Source: Wiki SelKet (CC-BY-SA-3.0)

Recognition not only of regular traffic

Source: Autobild

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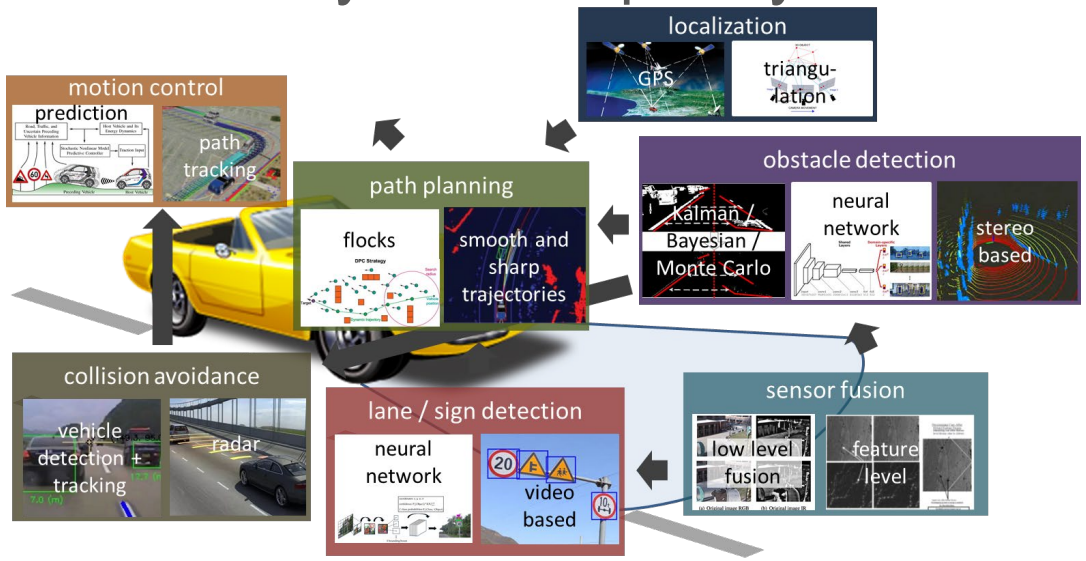
Functionality vs. Complexity



Components associated with physical control of the vehicle

Components associated with safety

Components associated with entertainment and convenience

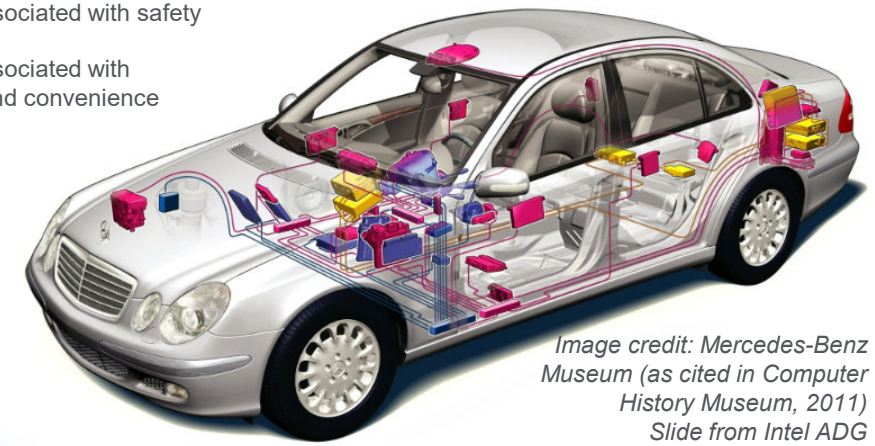


Image credit: Mercedes-Benz Museum (as cited in Computer History Museum, 2011)
Slide from Intel ADG

Complexity of autonomous driving:

- Level 3: 300 MLOC (human supervision)
- Level 5: 1 BLOC+ ?

Current Cars:

- ~ 100 MLOC (30 MLOC multimedia)
- ~ 100 ECUs

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Functionality vs. Complexity

Components associated with physical control of the vehicle

Safety Certification?

Image credit: Mercedes-Benz Museum (as cited in Computer History Museum, 2011)
Slide from Intel ADG

Over the air updates

https://arstechnica.com/cars/2017/07/gm-to-offer-ota-software-updates-before-2020-but-only-for-a-new-infotainment-platform/

Con

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Current

- ~ 100
- ~ 100

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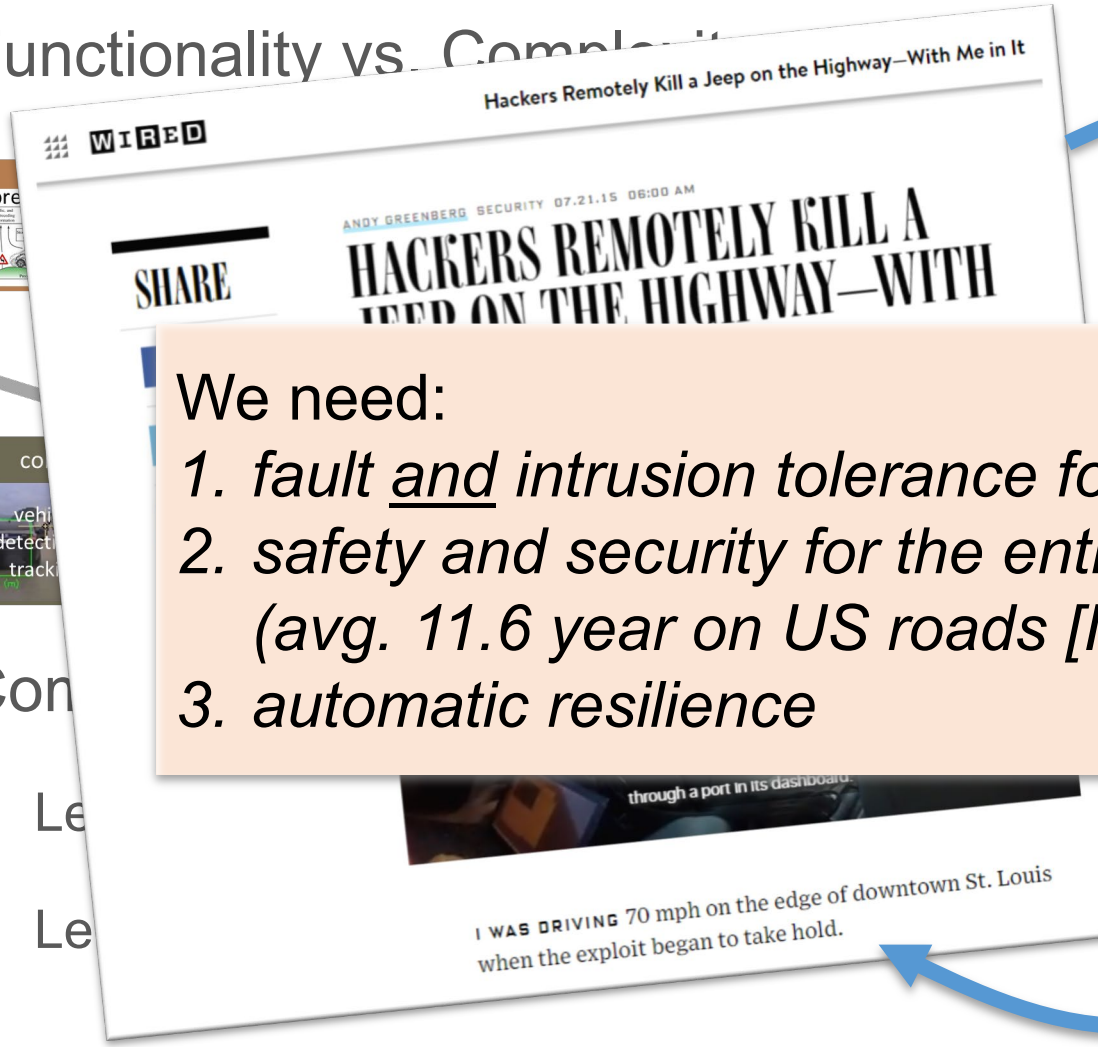
Functionality vs. Complexity



Safety Certification?

credit: Mercedes-Benz
m (as cited in Computer
History Museum, 2011)
Slide from Intel ADG

We need:

1. *fault <u>and</u> intrusion tolerance for safety critical / real-time systems*
2. *safety and security for the entire lifetime of the car*
   (avg. 11.6 year on US roads [IHS Markit Report '18])
3. *automatic resilience*

Con

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- ~ 100

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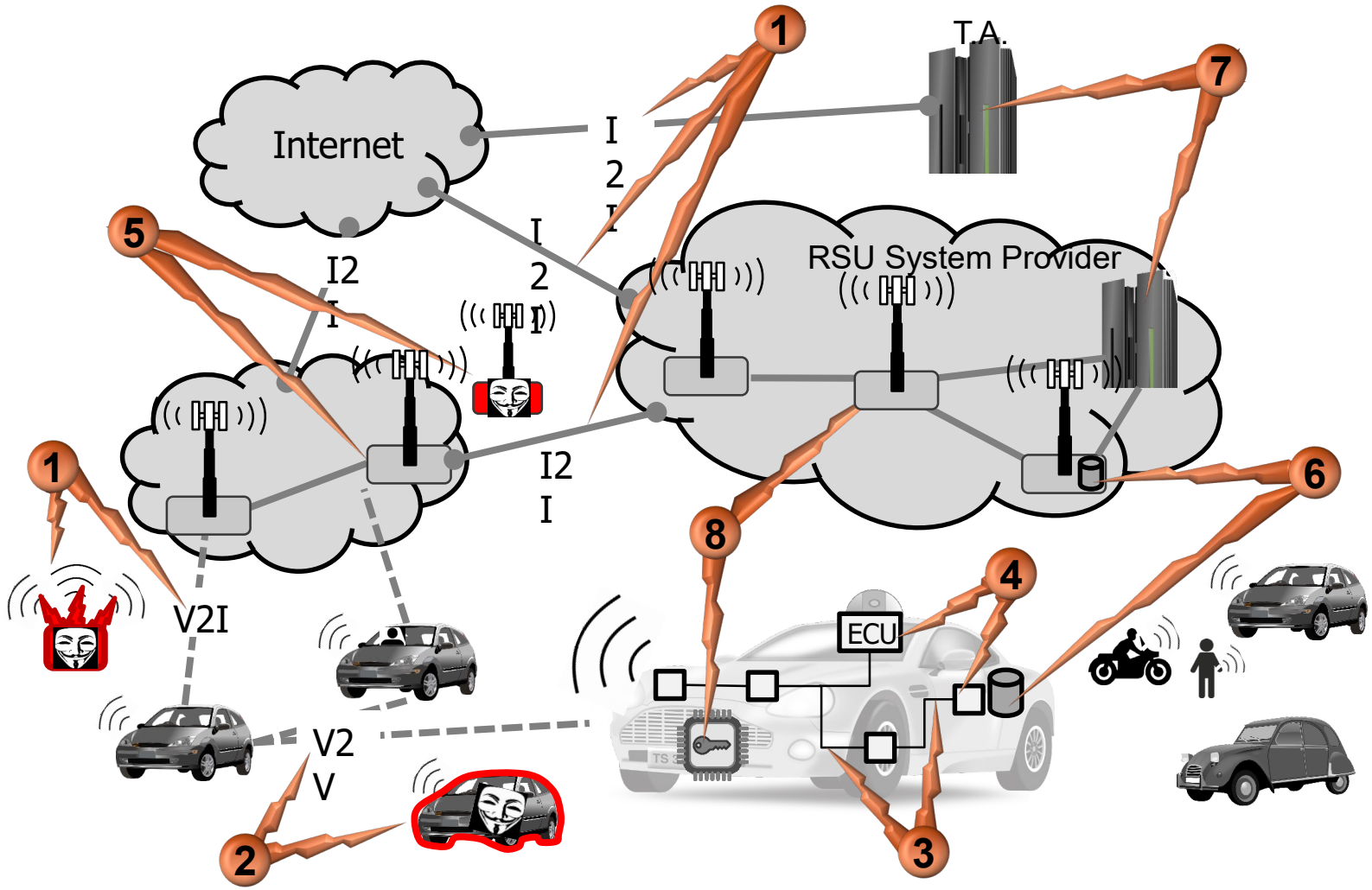
https://arstechnica.com/cars/2017/07/gm-to-offer-ota-software-updates-before-2020-but-only-for-a-new-infotainment-platform/

Threat Vectors on autonomous and cooperative vehicle ecosystems



Threat Vectors:

1. Attacks on global V2I/I2I communication infrastructure
2. Attacks on local V2V communication infrastructure
3. Attacks on in-vehicle communication infrastructure
4. Attacks on vehicle computing nodes' software
5. Attacks on road-side units'software
6. Attacks on sensors and control-sensitive data
7. Attacks on authentication mechanisms
8. Physical-level attacks

[Lima et al. “Towards Safe and Secure Autonomous and Cooperative Vehicle Ecosystems”, CPS-SPC 2016]

Outline

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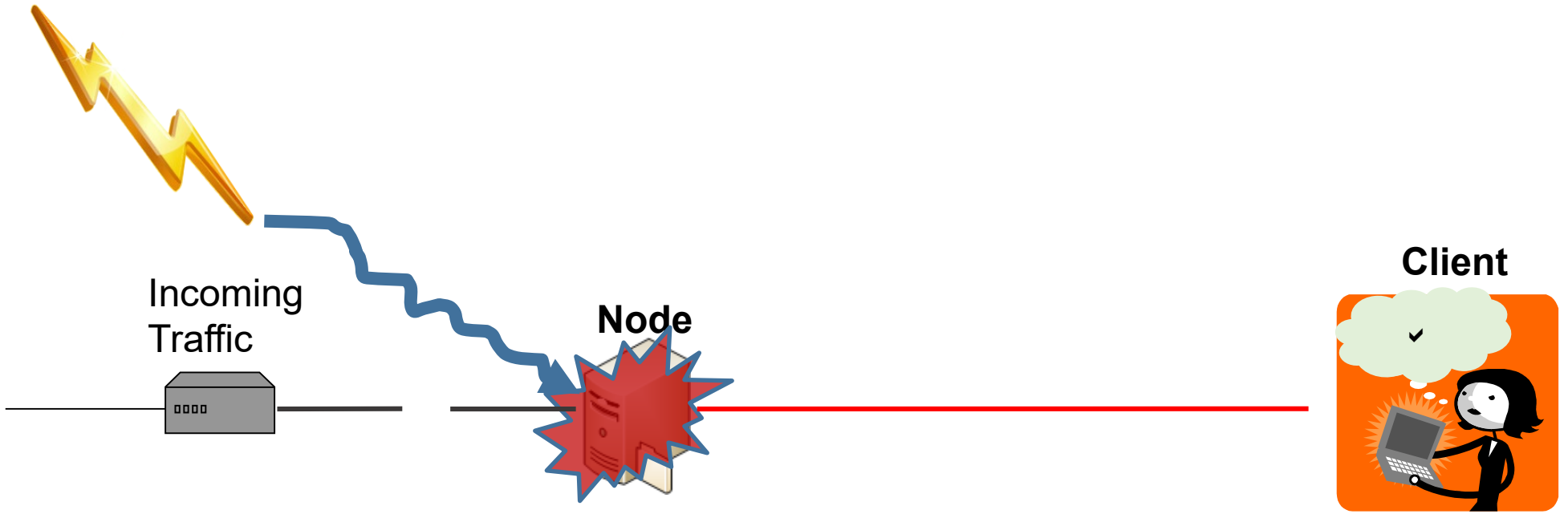
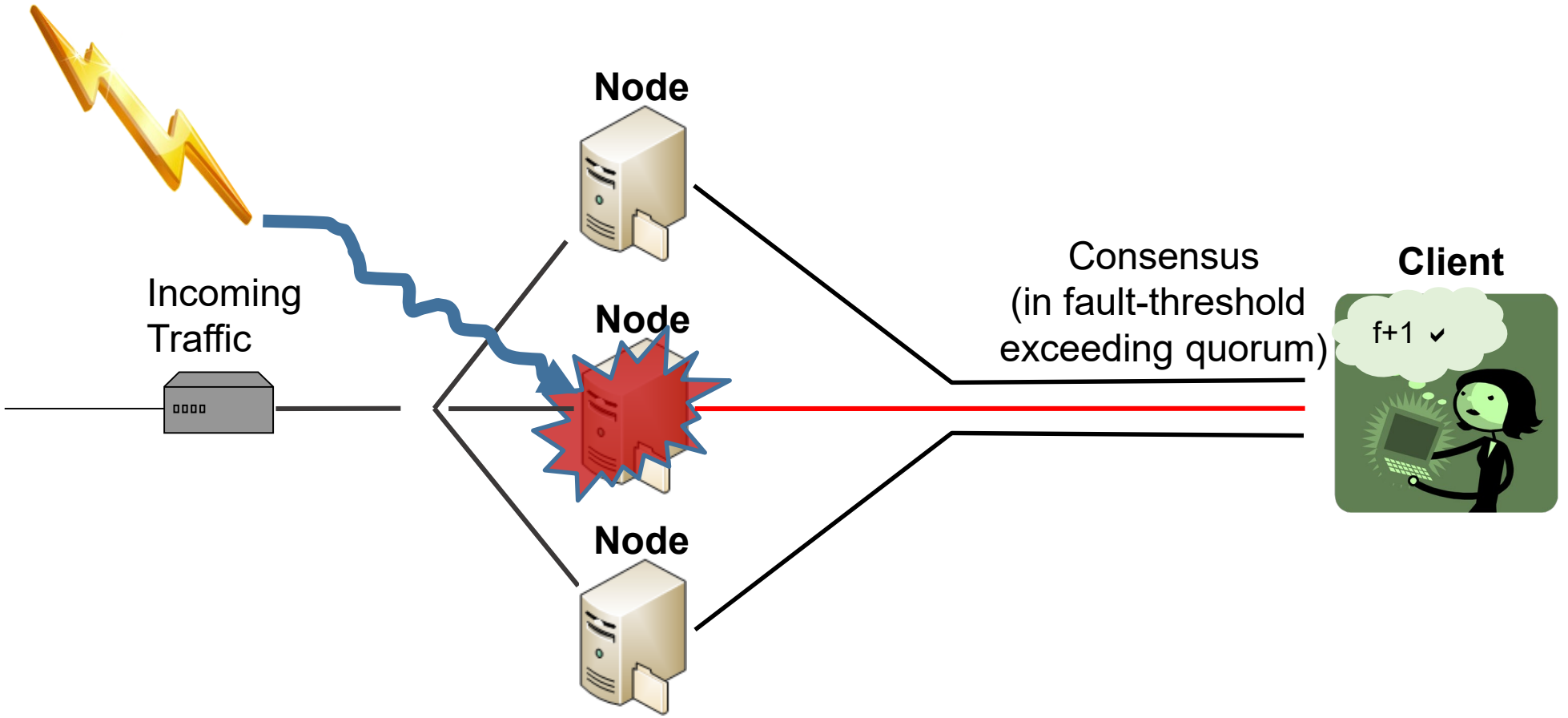
- Motivation
- What we all know: FIT / Resilience
- Full compromise of swarm individuals is intolerable
- Intra Vehicular Systems
- Towards Sustainable Safety and Security
  - Surviving perception / maneuver planning unavailabilities
  - Lifecycle for safeguarding safety and security
- Conclusions

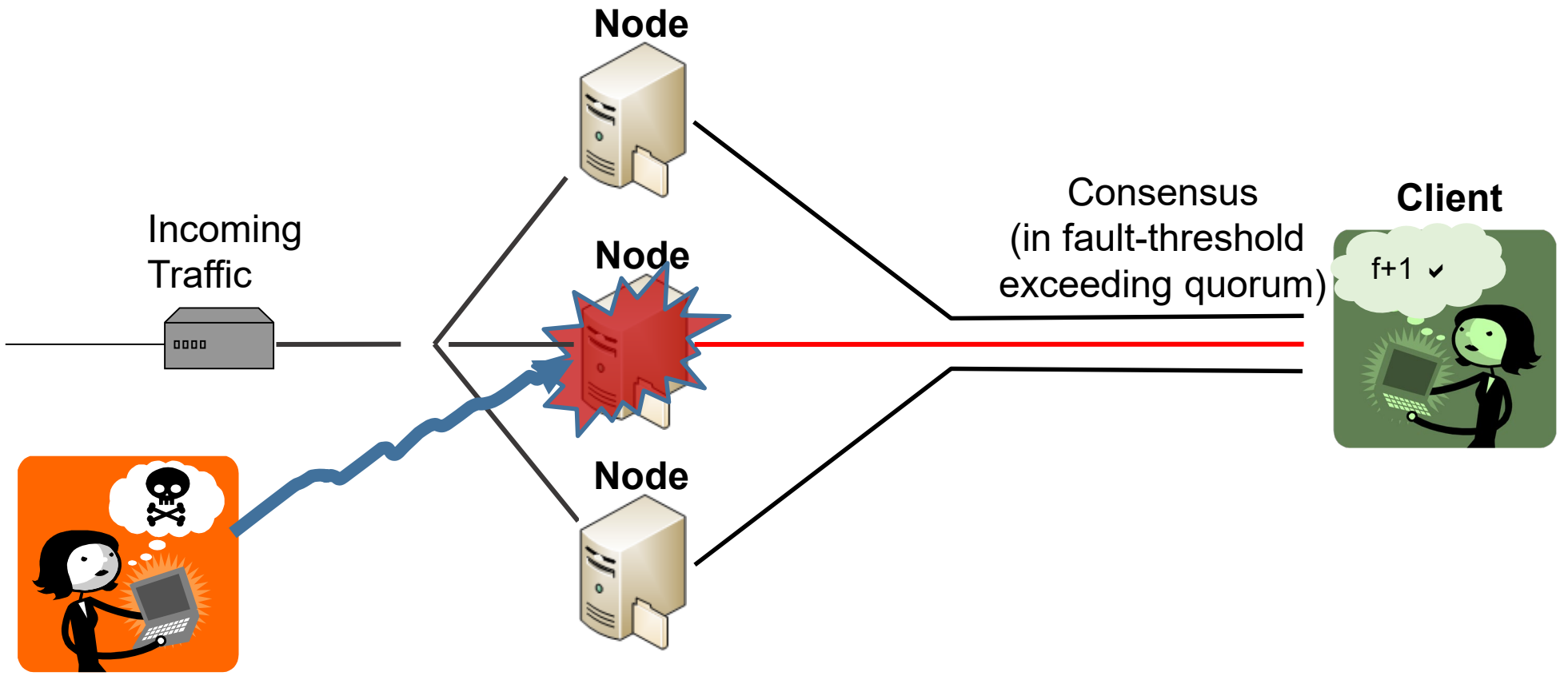
Fault and Intrusion Tolerance



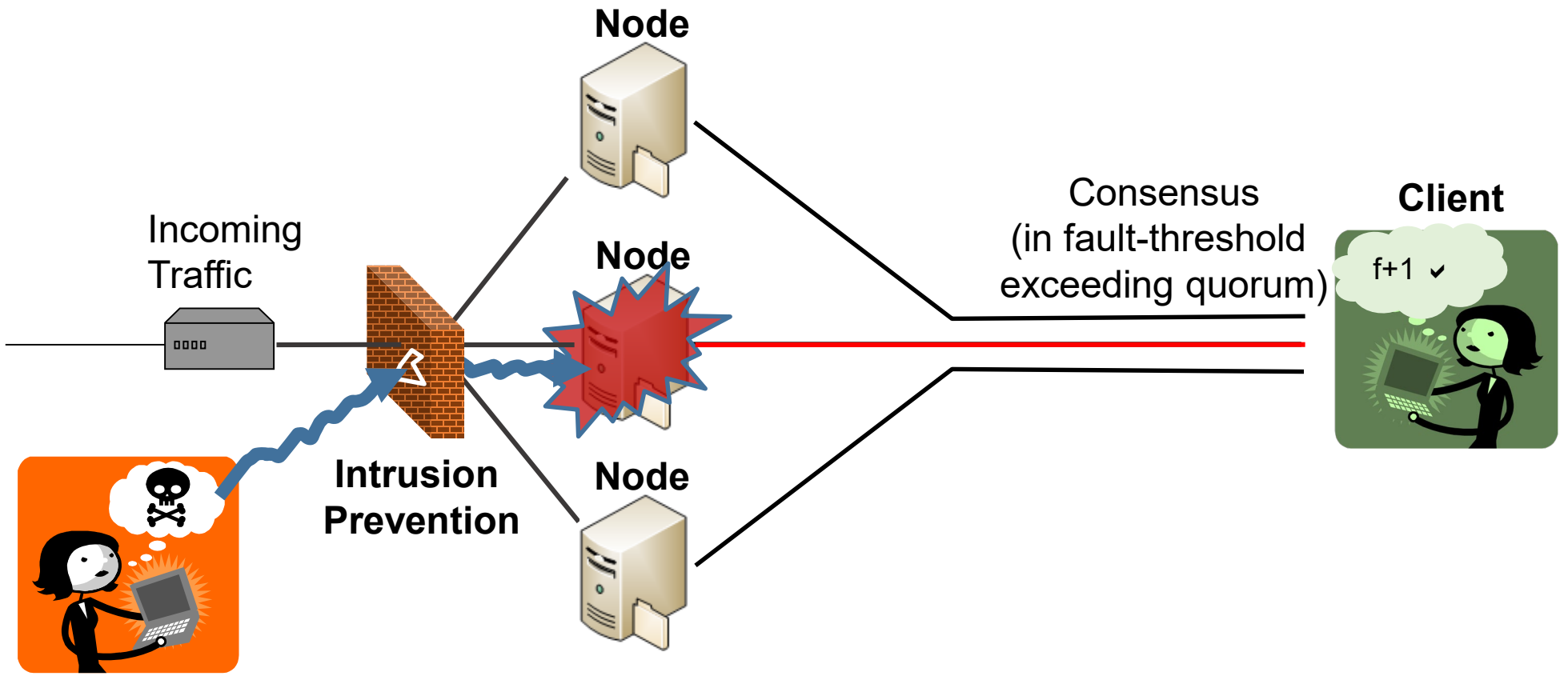
Fault and Intrusion Tolerance



Fault and Intrusion Tolerance

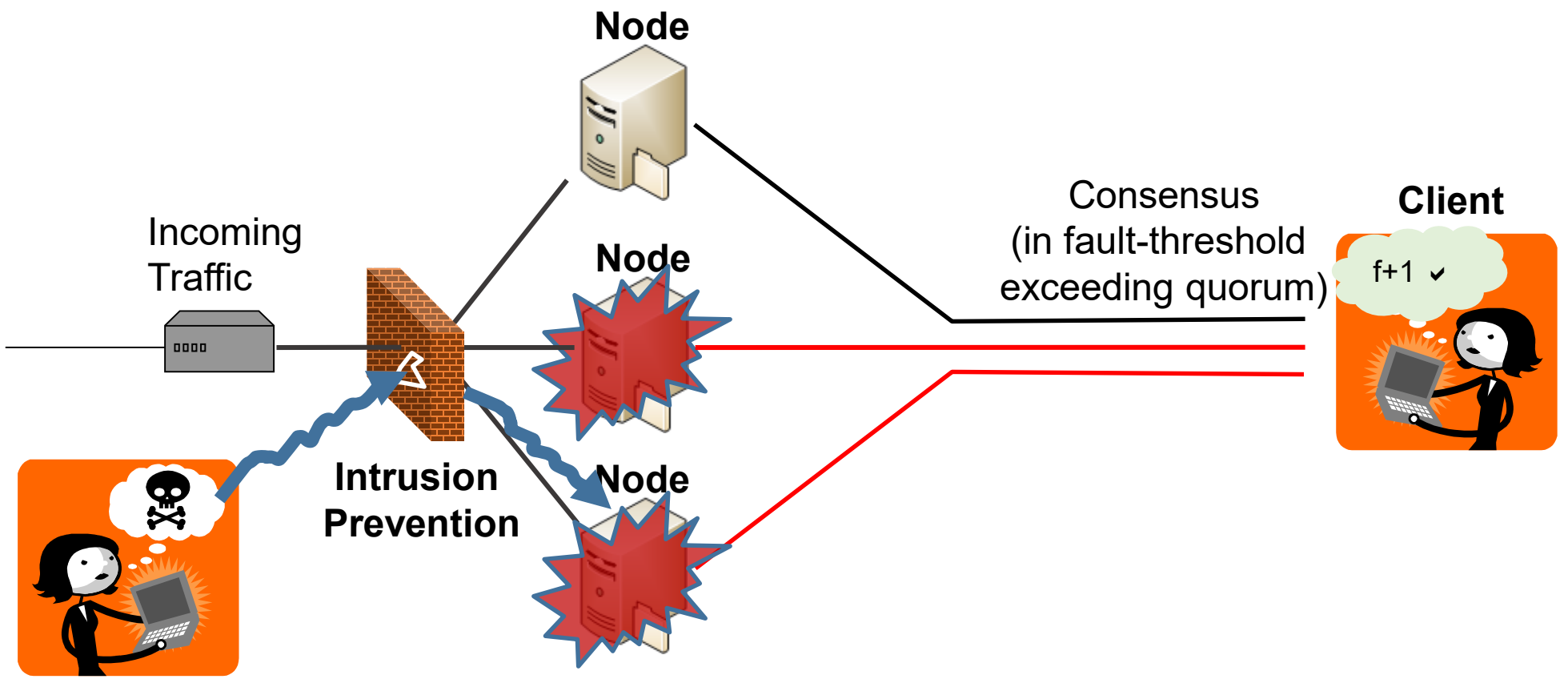


Fault and Intrusion Tolerance



Fault and Intrusion Tolerance

P. Sousa et al. – Exhaustion Failure



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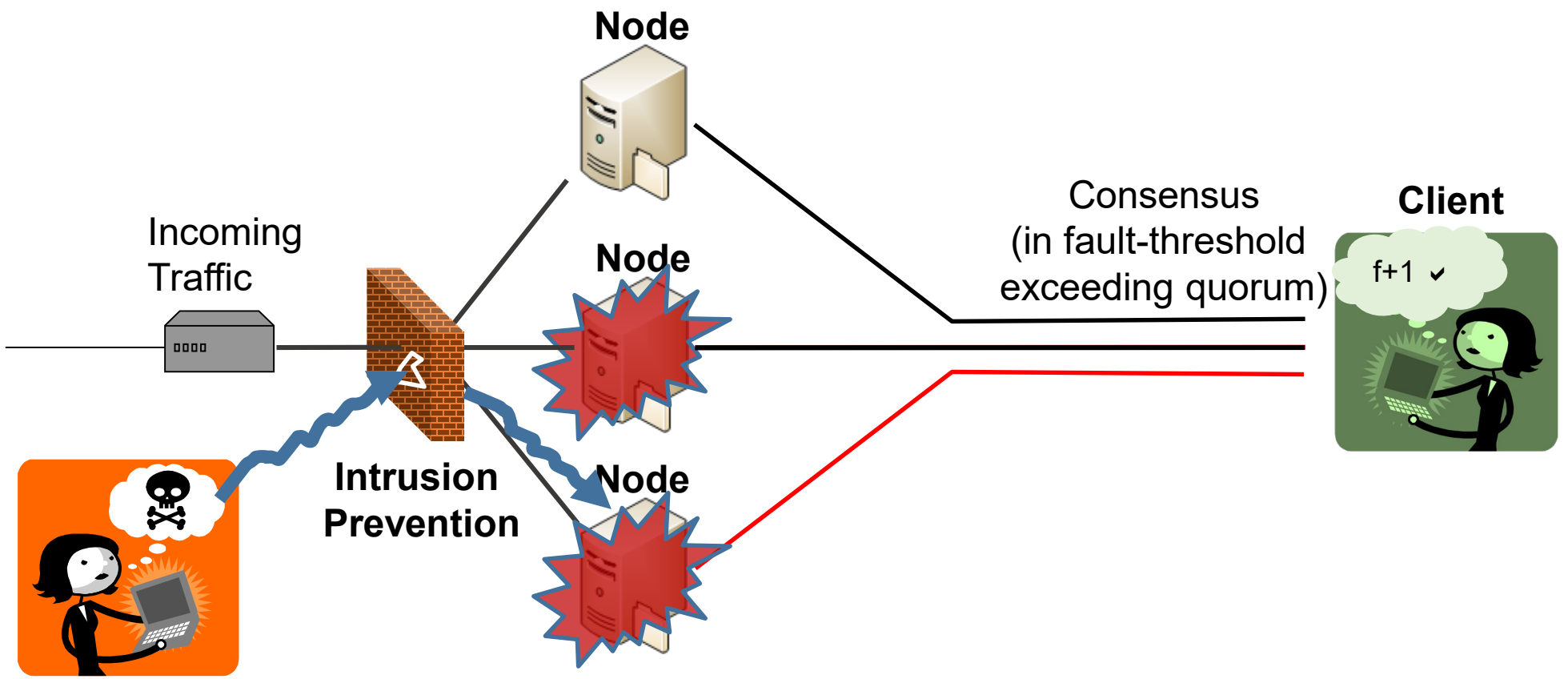

Fault and Intrusion Tolerance

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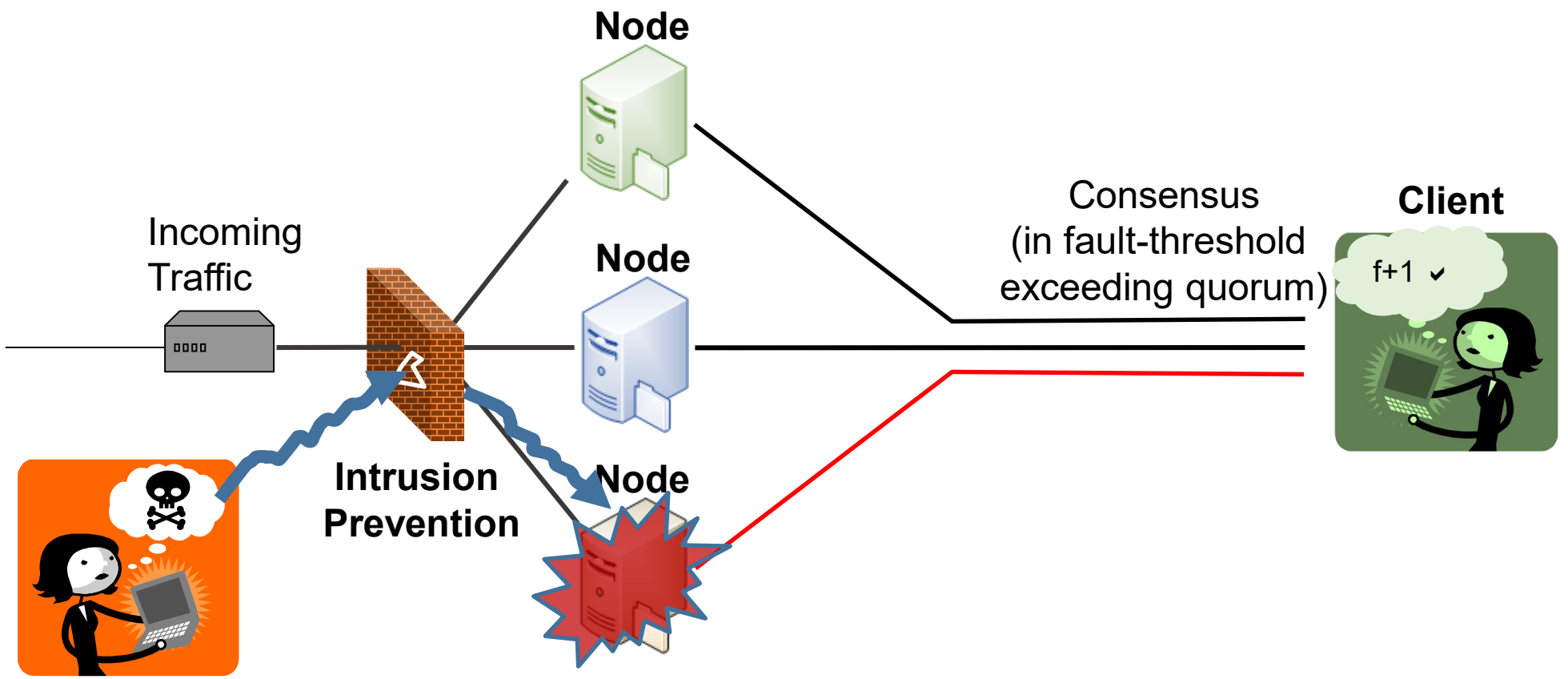

Full compromise of swarm individuals is intolerable

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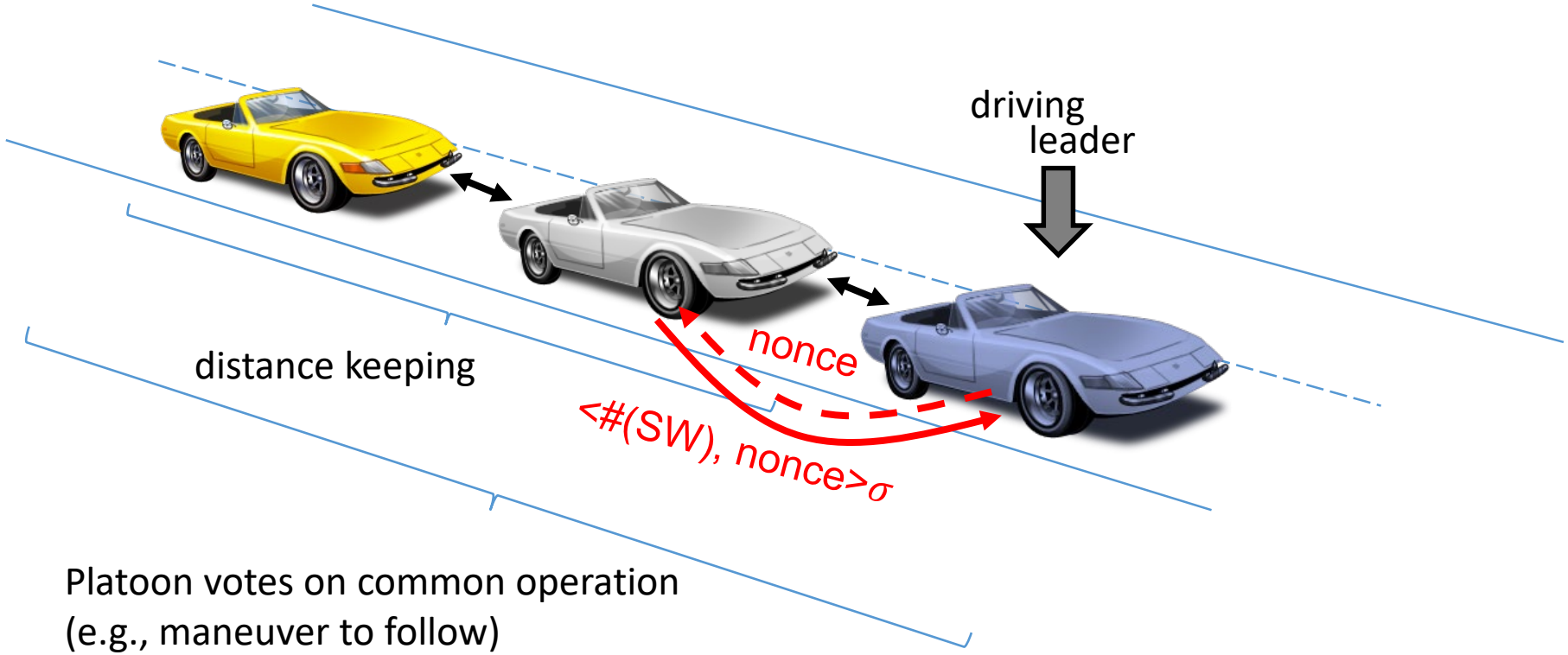
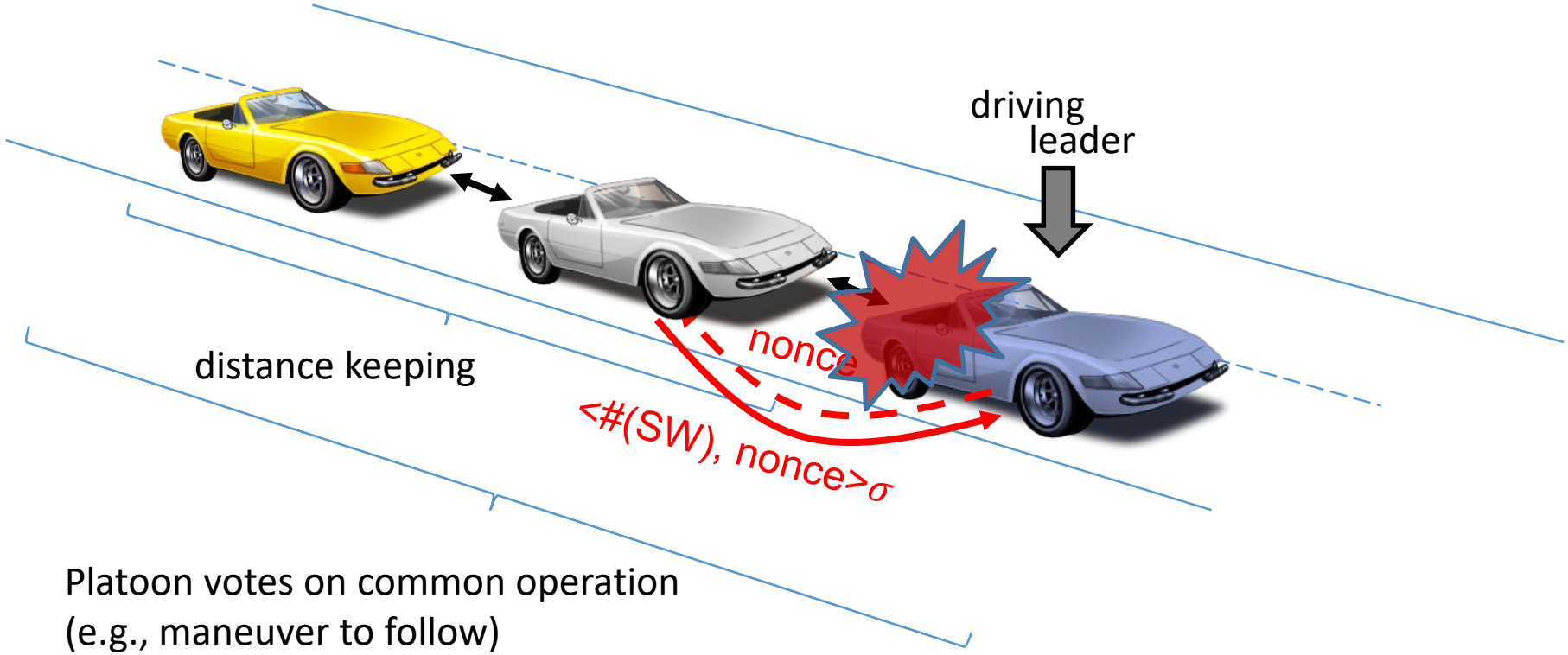
- Platoon of Cars



Platoon votes on common operation
(e.g., maneuver to follow)

Full compromise of swarm individuals is intolerable

- Platoon of Cars

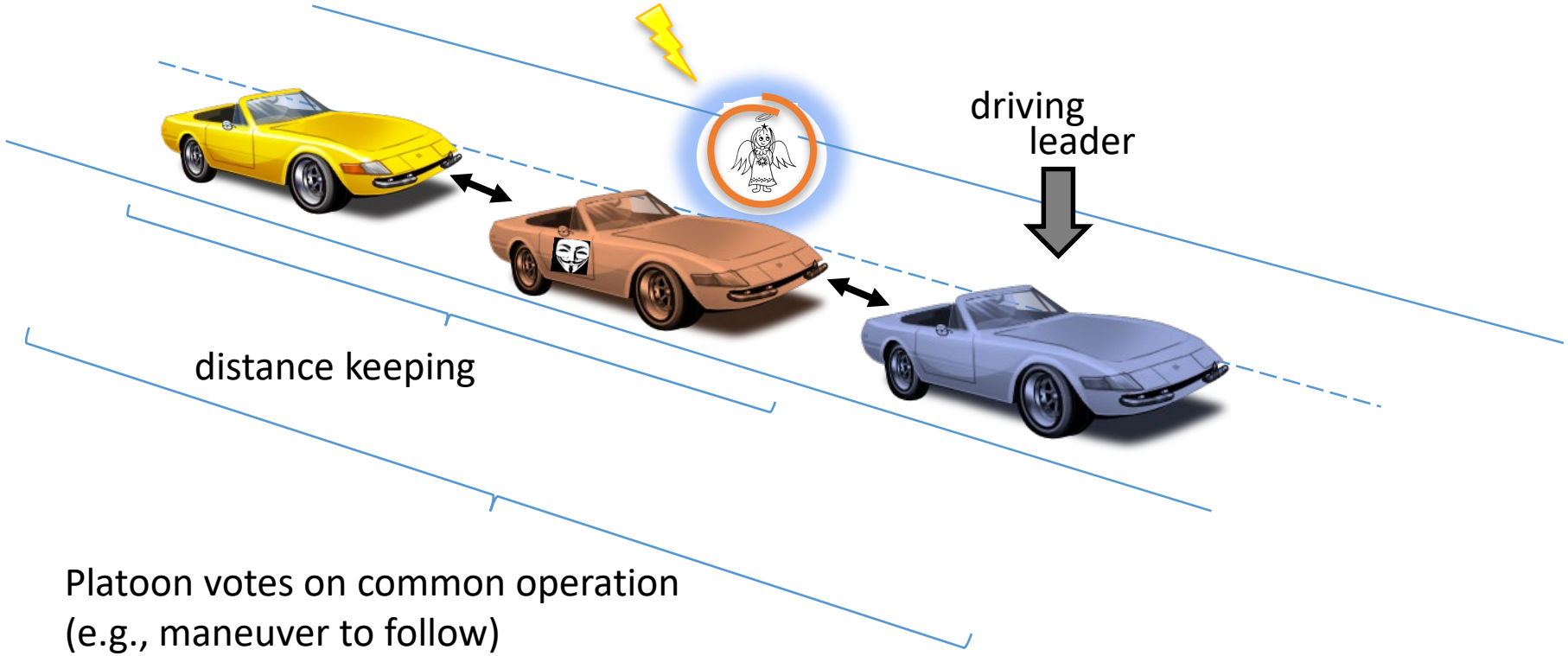


Platoon votes on common operation
(e.g., maneuver to follow)

Full compromise of swarm individuals is intolerable

Towards Sustainable Safety and Security

- Safeguard safety through trusted trustworthy components



Platoon votes on common operation
(e.g., maneuver to follow)

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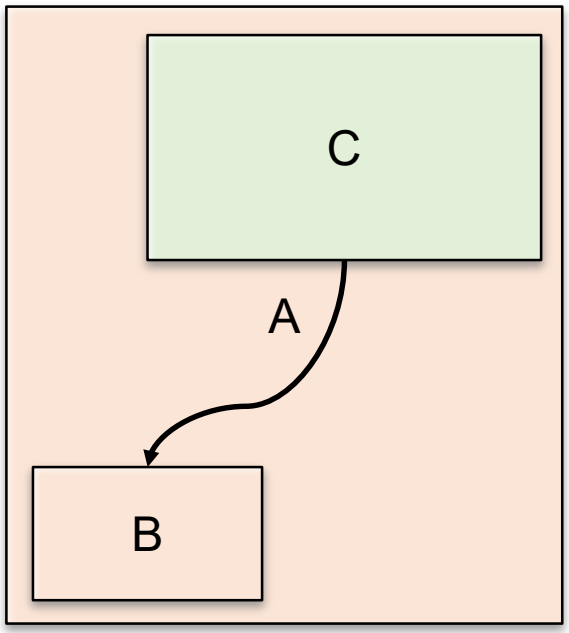
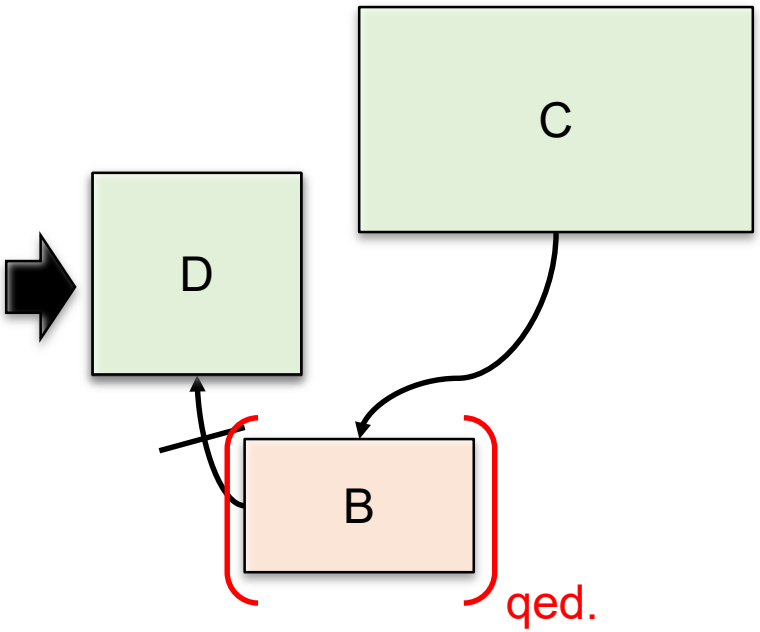
- Known Strategies for TCB Reduction

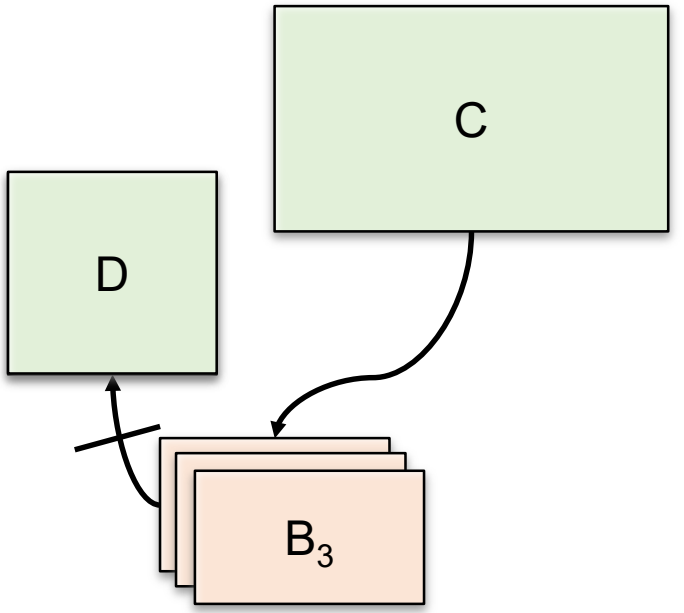
split applications: trusted / untrusted



reuse untrusted



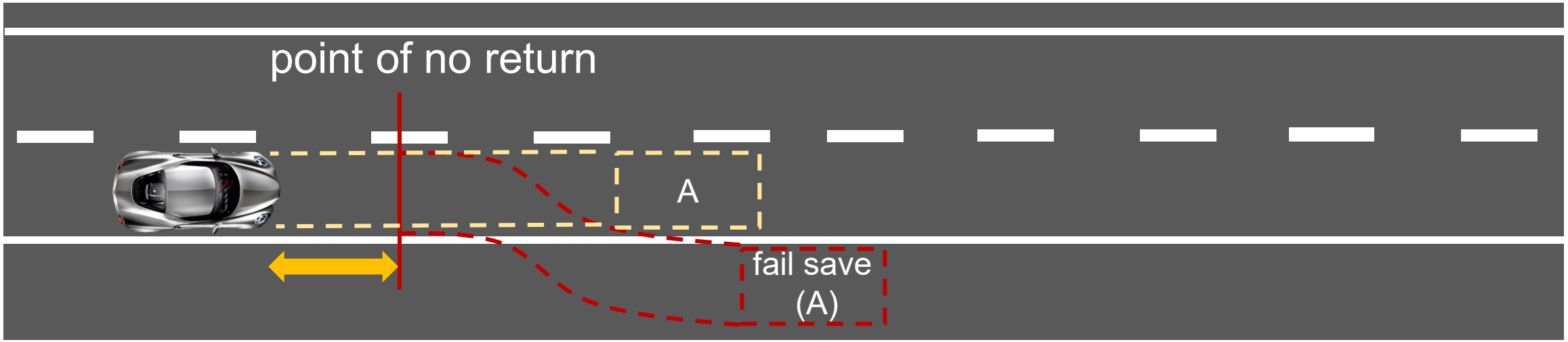
replication (trust majority; not individual)



e.g., C. Weinhold: JVPFS
(also Inktag, SGX)

Towards Sustainable Safety and Security

- Reusing potentially unavailable maneuver planning



Towards Sustainable Safety and Security

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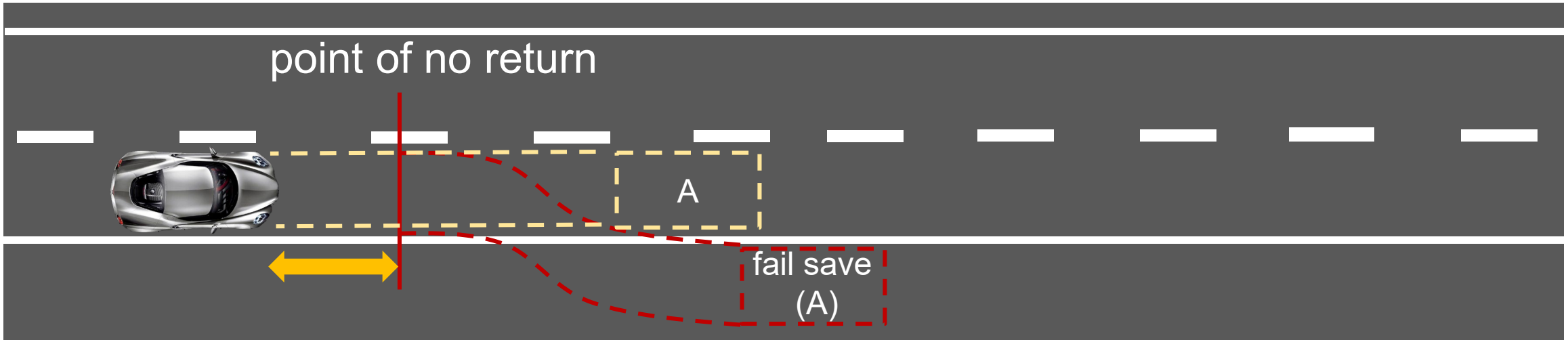

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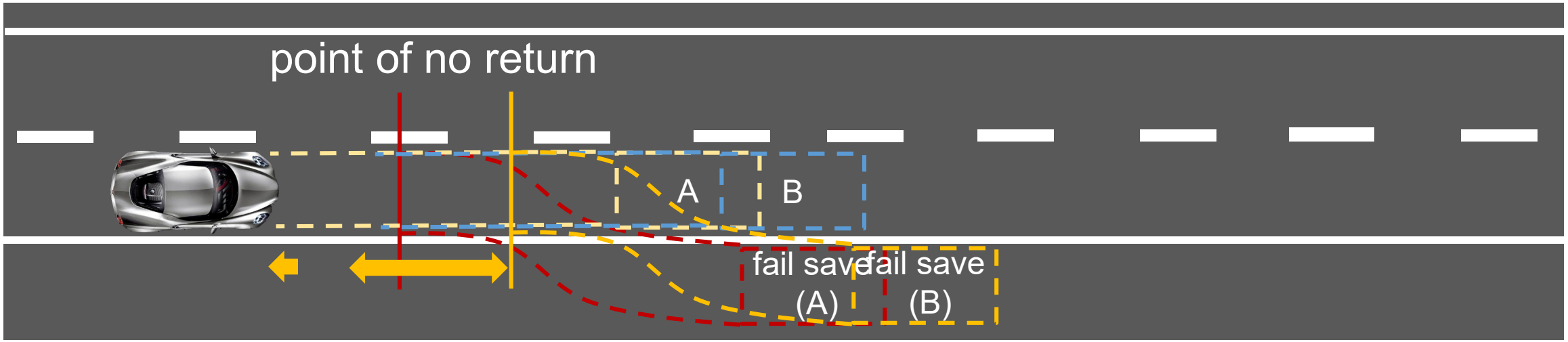
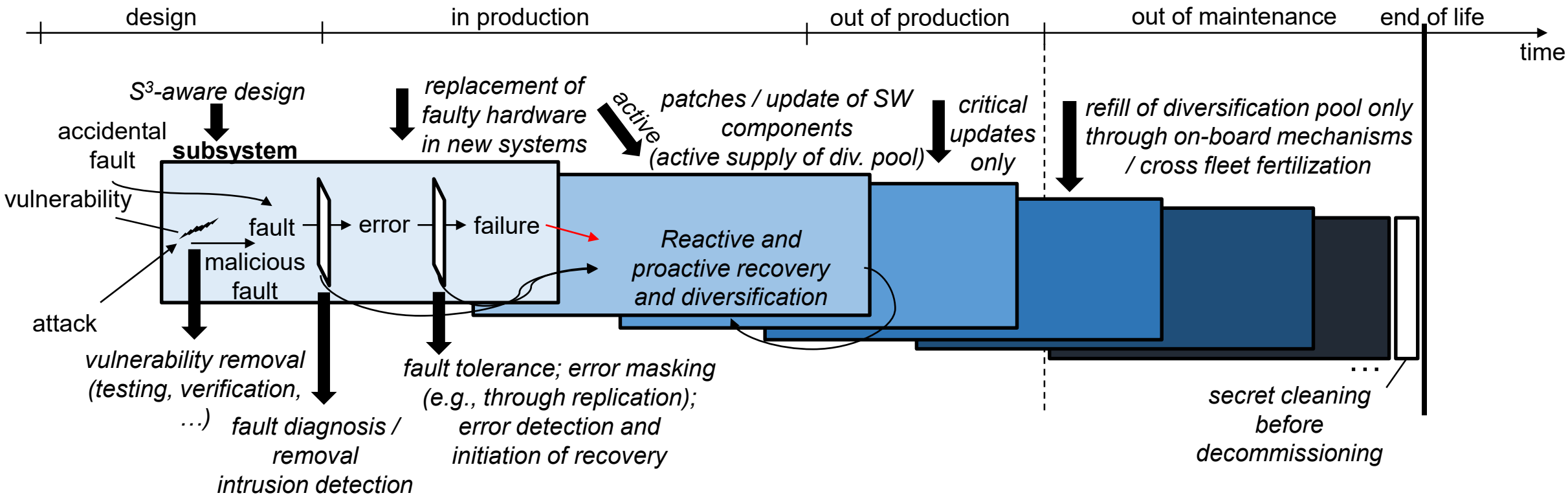


Towards Sustainable Safety and Security

- Lifecycle for safeguarding safety and security



This Talk in one Slide

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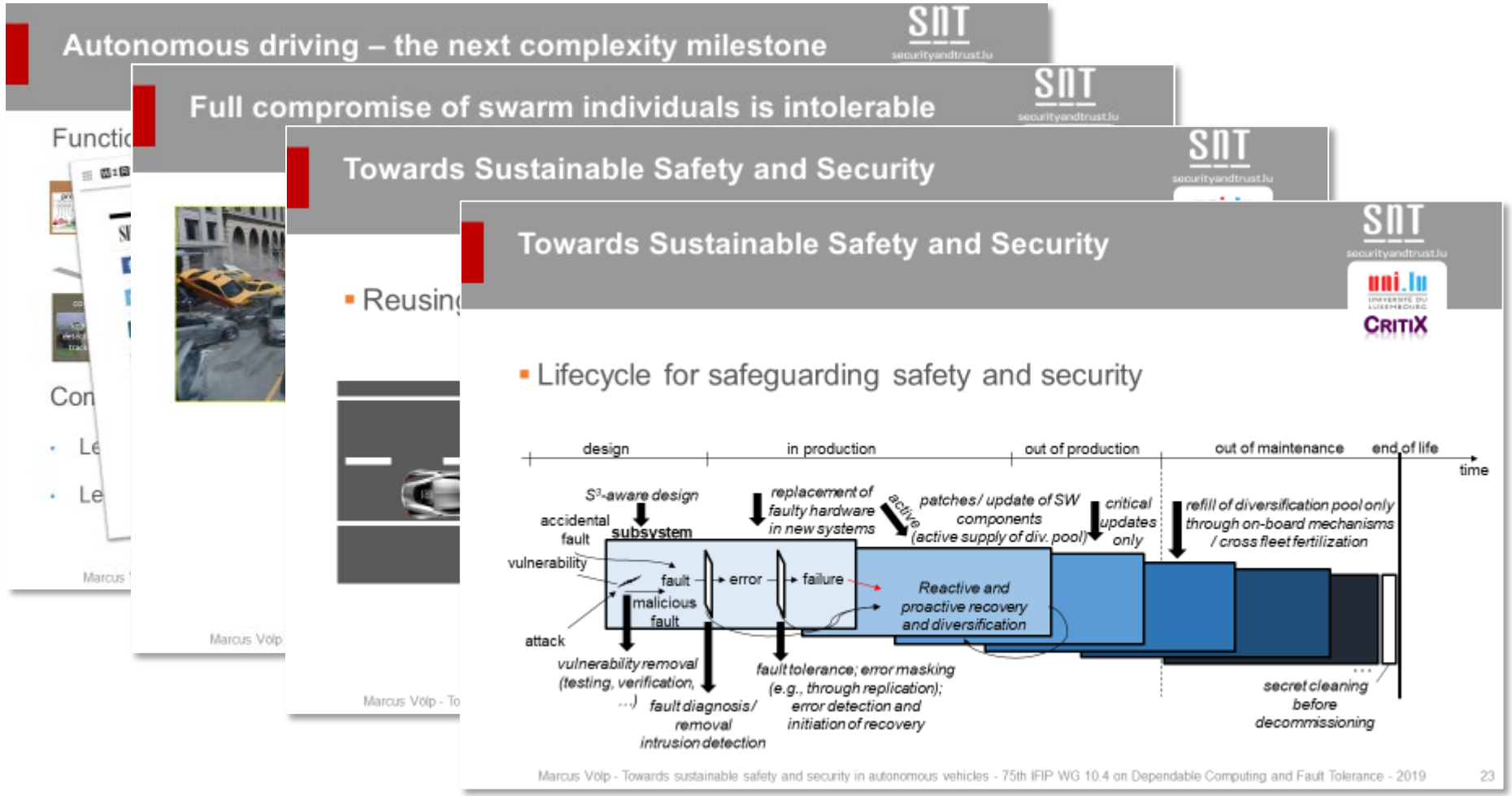

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