International Council on Systems Engineering
A better world through a systems approach

Software Defined Vehicle: behind the “Smartphone on wheels” claim, … a multidimensional system challenge!

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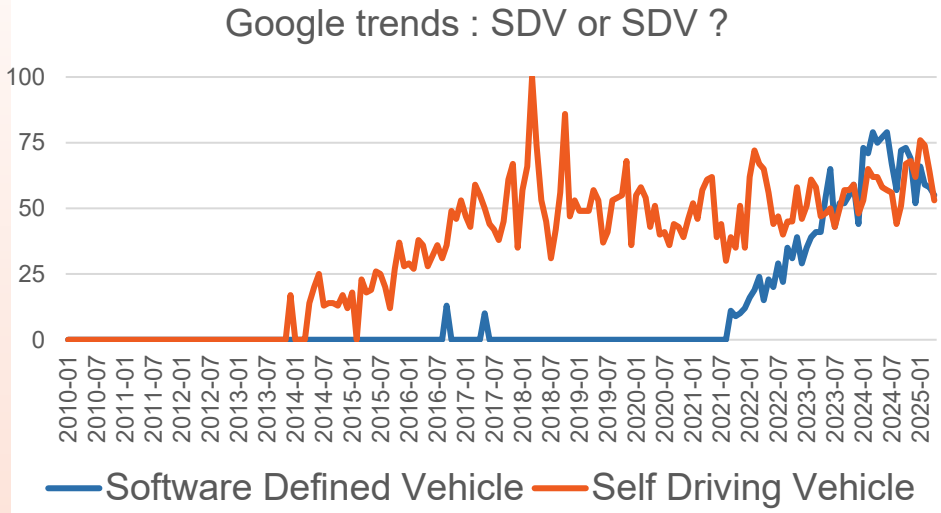
Which SDV is the most famous ;-)?

Software Defined Vehicle

vs

Self Driving Vehicle



% wrt max month, All countries, smaller numbers with S-DV

Hello.

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All five, members of the INCOSE Automotive Working Group

Our presentation's « context »

- Fully embedded in the 6 Vision 2035 Megatrends

- 2 workstreams started mid-2024 in AWG :
  - SE for Software Defined Vehicle
  - SE and Service Oriented Architecture

… « Those are not only software topics! »

INCOSE Vision 2035

exponential growth of software in the automotive industry

Software Defined Vehicle

SE4SDV | SE&SOA

INCOSE Automotive WG

Does SDV really fit to this?

3 main themes

grouping of « SDV disruptions »

… different System challenges !

More detail in appendix

SDV relies on several Software & Hardware (Electronic) advances

SDV significantly improves customer value

SDV revolutionizes business models

What even is SDV?

More than a car...

More than software...

An evolving, rolling habitat in a value-focused mobility ecosystem...

Concepts appearing in 3 definitions of SDV from Blackberry QNX, PWC and Renault

Note Terms shown in word cloud are not weighted.
Font variations are only intended to distinguish concepts.

https://blackberry.qnx.com/en/forms/wp-beyond-the-edge

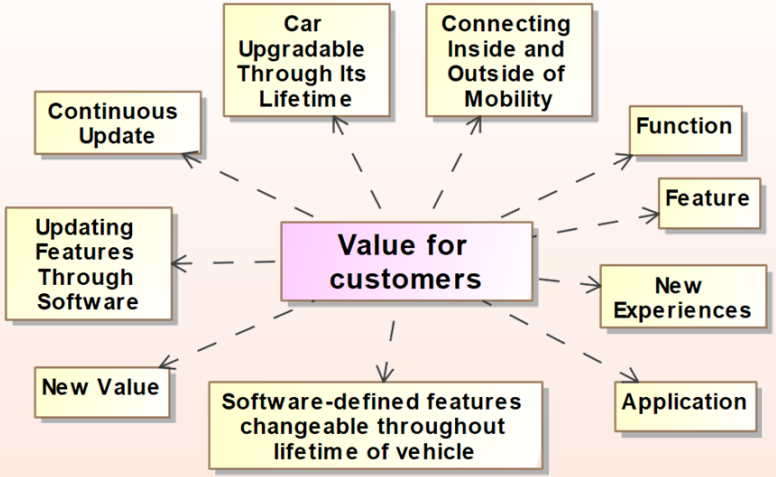
https://www.pwc.com/jp/en/knowledge/column/definition-of-sdv.html

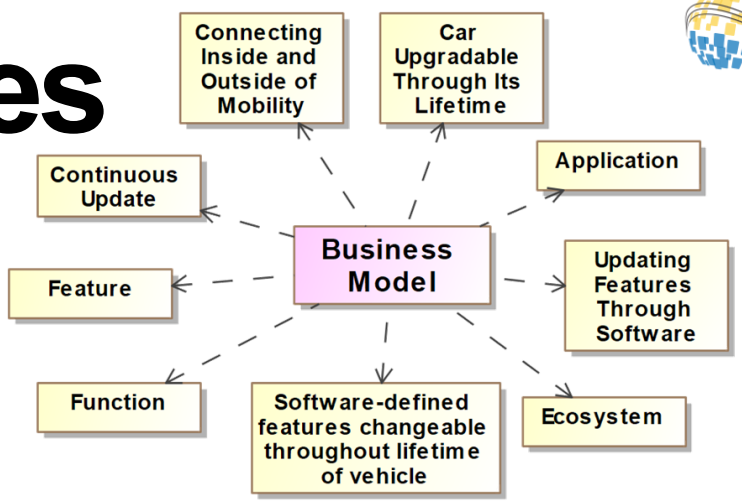
https://www.renaultgroup.com/en/magazine/technology/all-about-software-defined-vehicle/

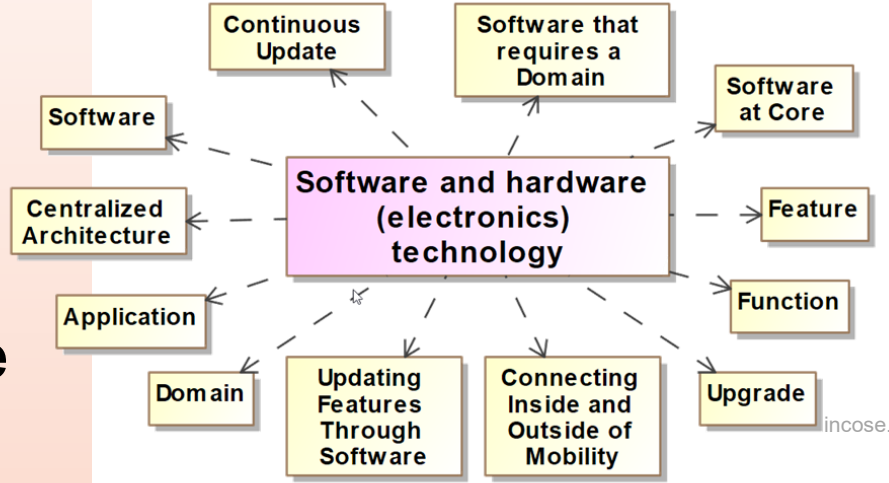
https://web.archive.org/web/20240716201926/https://www.bosch-mobility.com/media/global/mobility-topics/mobility-topics/software-defined-vehicle/download/231019_sdv_ebook.pdf

More detail in appendix

Concepts-themes







Mapping **concepts** from definitions to the 3 identified SDV **themes** in the literature review

Other elements in appendix

Anything to learn from other « SDx » ?

we looked at 3 other « Software Defined something » that occurred in the past

SD Radio

SD Wristwatch (Smartwatch)

SD Architecture

Other elements in appendix

Smart (SD) Wristwatch

Smart watches squashed the middle of the market.

Seiko is a conspicuous example of a company that used to be famous for *"Nice, high-quality product at a reasonable price."* Rather than go out of business, they scrambled to rebrand as luxury jewelry.

Apple can command $400. Most of the market is now down around $100 with some examples as cheap as $21.59.

Patek Philippe
Worldtimer *Guilloché* Ref. 2523/1:

$5.5 million

Luxury (*Mechanical!*)

Grand Seiko Japan Four Seasons Special Edition Shunbun Spring Dial SBGA413:

$6,600

$6000

Rapidly Disappearing Market Segment!!

$400

Apple Watch Series 9 [GPS + Cellular, 41mm]:

$393.03

Software Defined

Generic Smartwatch

$21.59

https://luxe.digital/lifestyle/watches/most-expensive-watches/#Patek-Philippe-Worldtimer-Guilloche

Software Defined xxx … learnings for the Auto Industry?

Obviously software and connectivity are becoming of paramount importance in many domains (SDx, “Smart”, “IoT”, …)

Any more precise learning?

No consensus!!

"any similarity is purely coincidental”?

vs

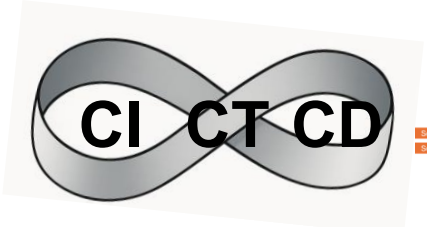
“maybe something, need to go deeper”?

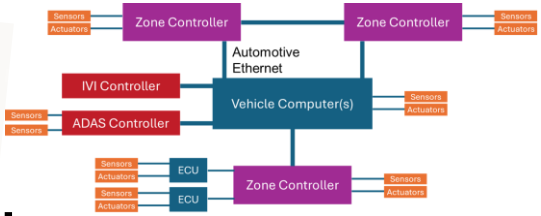
	Auto Industry similarity ?
SD Radio	*Transition to zonal architecture and digital cockpit displays are similar?*
Smart (SD) Wristwatch	*(no room for purely mechanical highend trend in the Automotive area)* *Low-cost trend?* *No similarity because of other product/market characteristics?*
SD Architecture	*Possible model for the auto industry?* *But SDV technologies are neither fully mature nor deployed…*

1) SE challenges associated to SW & HW breakthrough

Redefine EE and Software…
… skills, jobs, jobshare,
… processes, development environment,
… architectures, deliveries,
… interaction with the other Engineering teams, both Vehicle & Off-board

HW here means Electric-Electronic, not "physical" in general





Service Oriented,

Agile,

…

Zonal EE archi.

SoC

Cybersecurity

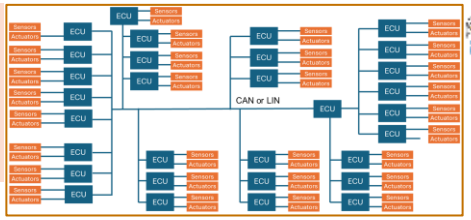
1) SE challenges associated to SW & HW breakthrough

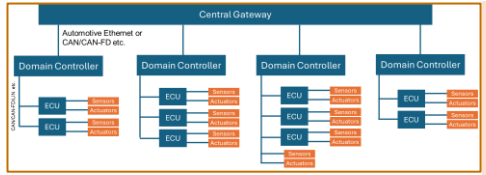
Zoom on EE Architecture:

3 steps towards “Pure zonal” ➔

=> Enriched areas management,
from:
Vehicle / ECUs
to:
Vehicle / Central area / Single Computers / legacy ECUs

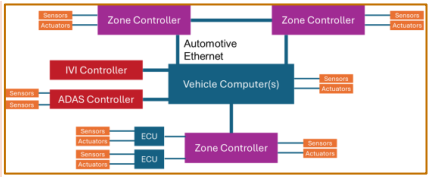
1) Classical (#ECU ⇧)
Individual software dev.
CAN network (messages)





2) Structured, Domain oriented, CAN & Aut. Ethernet

3) Zonal (full, partial), Automotive Ethernet in central area, supporting unified software dev, Service Oriented, …



But still…
« legacy ECUs »,
Power management,
Failure management,
…

2) SE challenges associated to enriched value

Complexity, often high safety and cyber-security content, with new:

- End to end scopes (including SW, HW, multi-physics, off-board, multi-partners)
- Stakeholders (perspectives on value),
- Life-cycle phases, Use-Cases, …

Explosion of functionalities,

Over the air updates,

« App stores »,

Selling services, data,…

AND OFTEN:

Mechatronics,

Safety intensive

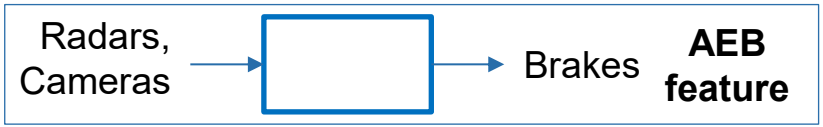
2) SE challenges associated to enriched value

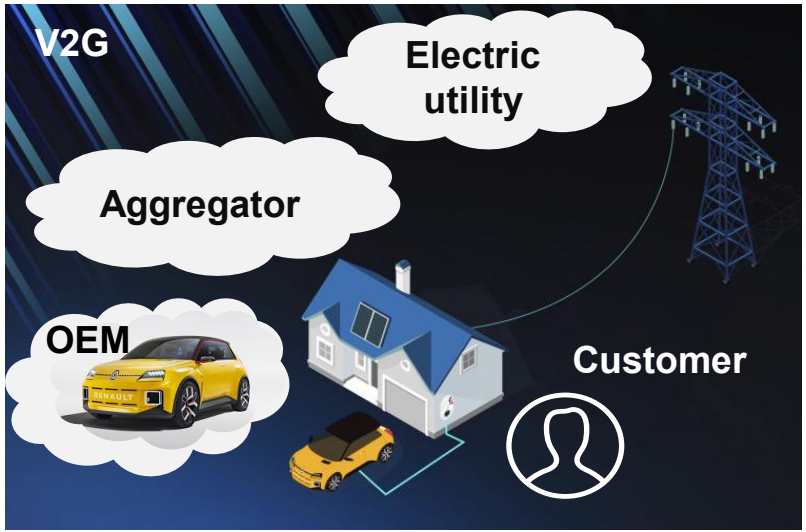
Two examples:

- ADAS function with critical safety:
  Autonomous Emergency Braking

- Wide System of Systems:
  Vehicle to Grid

Also Bicycles, pedestrians, …





https://media.renault.com/mobilize-v2g-where-the-future-electric-renault-5-becomes-a-source-of-energy/

3) System challenges associated to Business Model breakthroughs

Huge systemic complexity:

Multiple and intertwined timescales,

Multiple business domains (incl. value ownership question),

Uncertain context

Sell “Fully equiped Vehicles” then “Features as a Service”

New OEM-Tier1 jobshare

“Make, or Buy, or Partner?” for mid-layer and applications SW

Open source growing role

Room for “Product+Service” platforms for B2B? (“Skateboard”)

SDV scope & deployment speed? (Full or partial? Evs only?...)

3) System challenges associated to Business Model breakthroughs

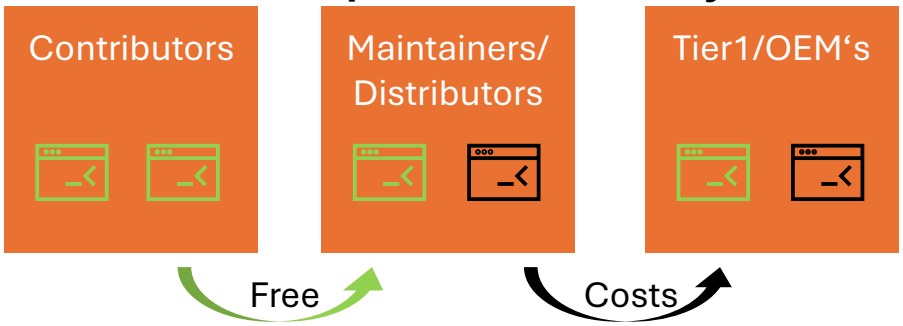
One example:
the Differentiating / Non-differentiating software components, and the potential of Open-source growth with new actors

Non-differentiating building blocks: Middleware, API Framework, Hardware Abstraction Layer & OS, ...

Differentiating Building Blocks: ADAS/AD, Infotainment, Chassis and Powertrain Control, Cockpit User Interface, ...

"Coopetition" (Cooperation + Competition):
- **Coop**eration by sharing of development costs for non-differentiating building blocks
- Comp**etition** on Differentiating Building Blocks

Room for an Open-Source eco-system ?



Telecom did similar revolution !

Next steps…

… for SDV:

… for the INCOSE Automotive WG SDV & SOA workstreams:

- Ongoing survey about “SOA” in Automotive,
- 2 topics among many just selected,
- Opportunity tbc with HAL4SDV* European project
- Continued exchange with the System & Software Interface WG, with JCOSE Automotive WG, …

=> you’re welcome onboard!

* : https://www.hal4sdv.eu/

Conclusion

Automotive products & services are facing **tremendous challenges**, SDV is a buzz-word with many facets,

=> don't imagine:

- the solution is "software only"
- vehicles are becoming "smartphones on wheels"

=> System thinking will help!

Thanks for your attention,

Any remark, question?

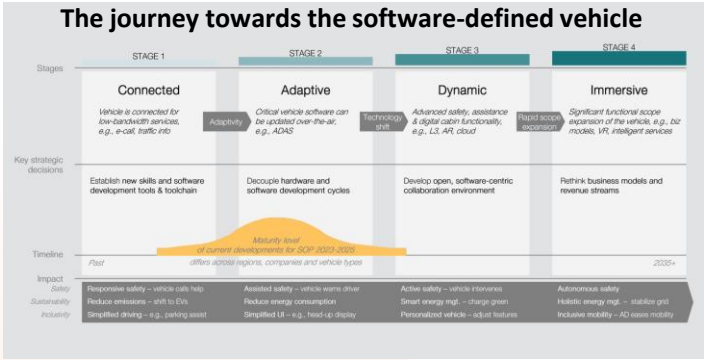
Appendix

Several complements not compatible with the presentation duration

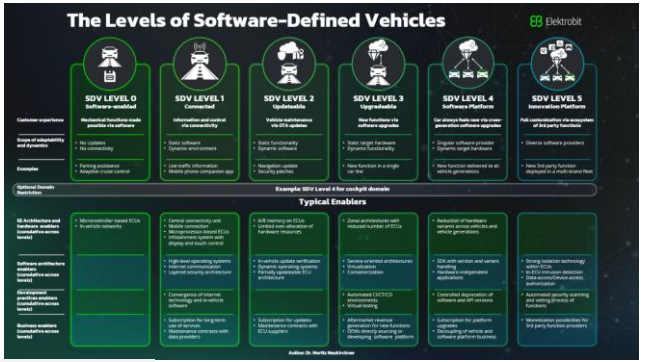
- Several "SDV scales“ used to describe progression and maturity towards “full SDV”
- Other view about relations between SDV Themes and concepts used in the definitions
- Modelling tentative based on the concepts expressed in one definition
- Another SDx : Software Defined Radio
- Another SDx : Software Defined Architecture

Several "SDV scales"

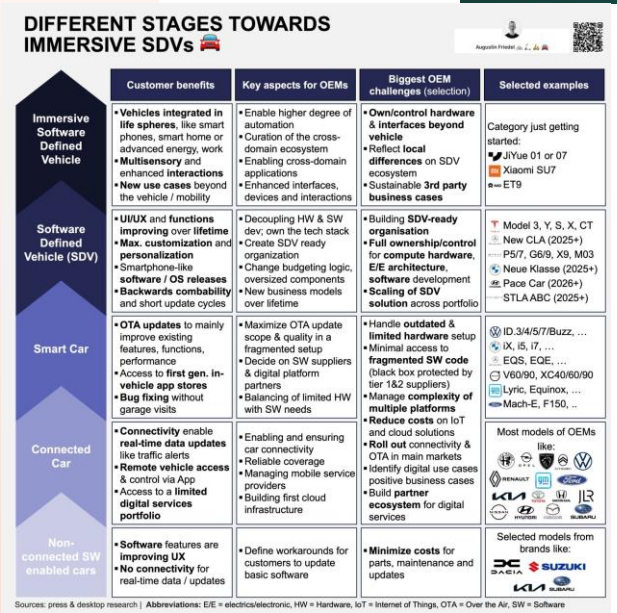
Implementation / maturity « non official », similar ideas



https://initiatives.weforum.org/drive-a/sdv



https://www.linkedin.com/pulse/sdv-yet-dr-moritz-neukirchner-uuyxf/

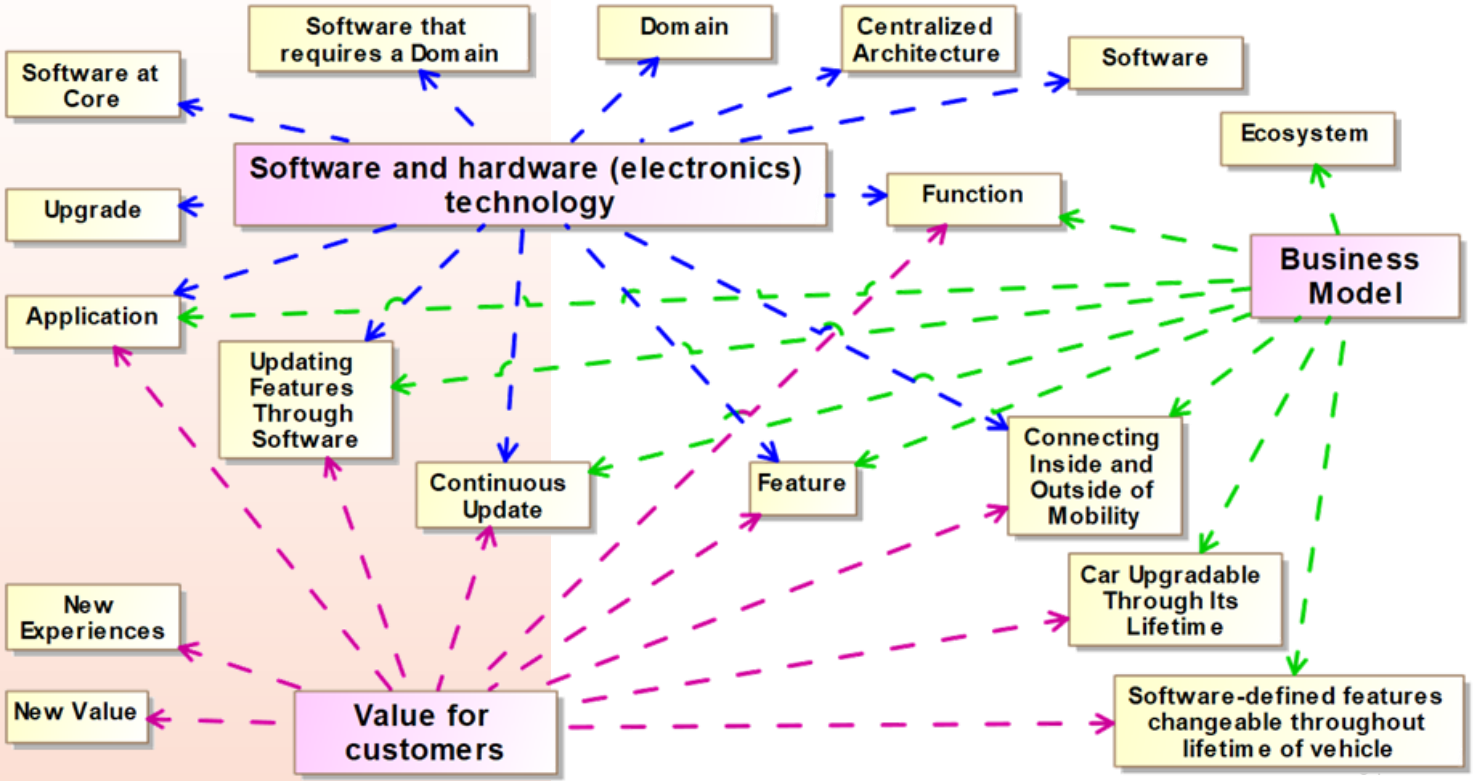


https://www.linkedin.com/posts/friedel_sdv-mobility-automotive-activity-7235561097280290816-5PG7?utm_source=share&utm_medium=member_desktop&rcm=ACoAAAaYzpwBhnSMFXtB8La3t49RAhRpbNvsRVs

back

SDV Themes - concepts

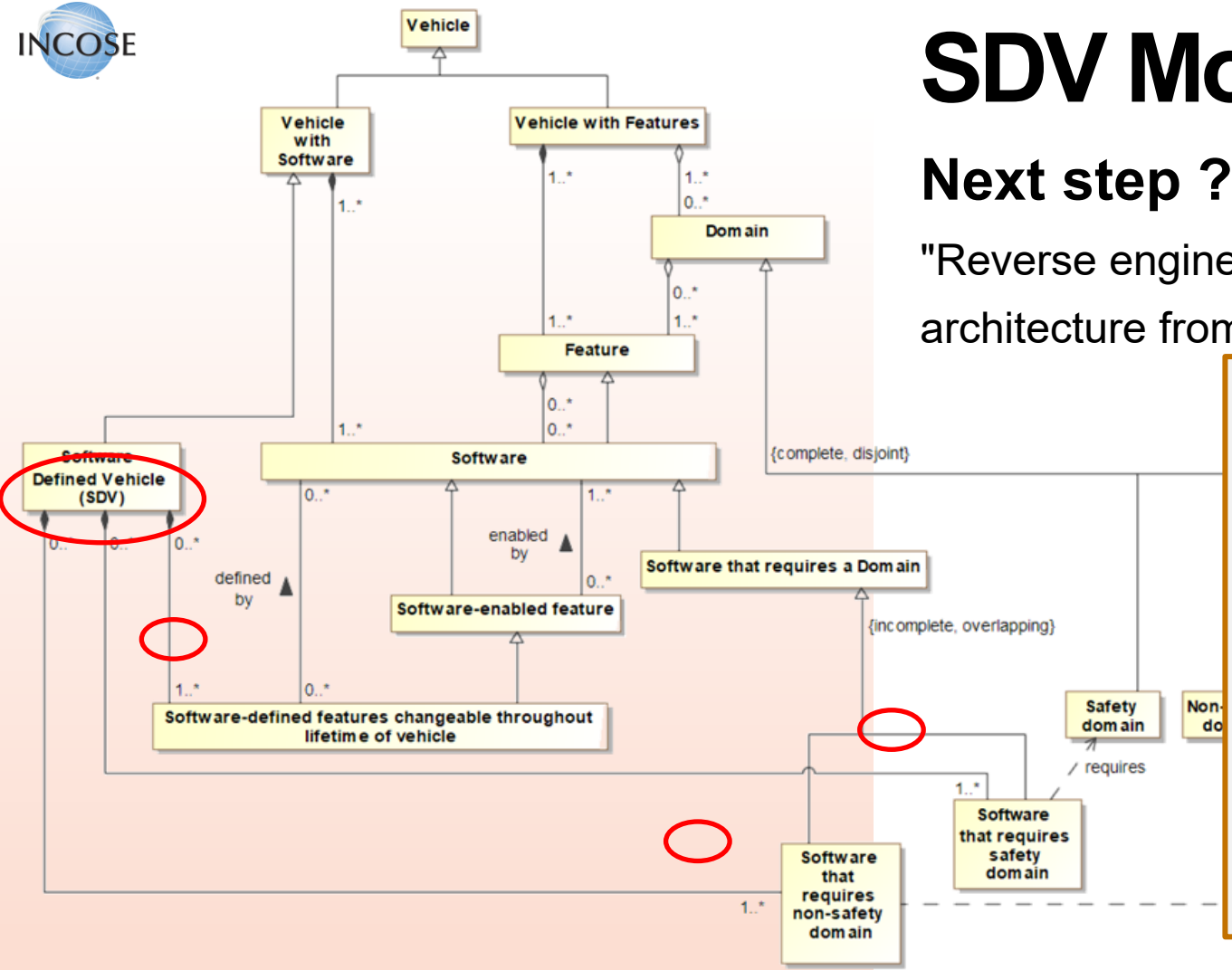
Mapping concepts from definitions to themes identified by literature review



SDV Model

Next step ?

"Reverse engineering" of reference architecture from SDV definitions



Example – Blackberry QNX

"A vehicle where many features are enabled by software, the software requires both safety and non-safety domains, and the software-defined features are changeable throughout the lifetime of the vehicle"

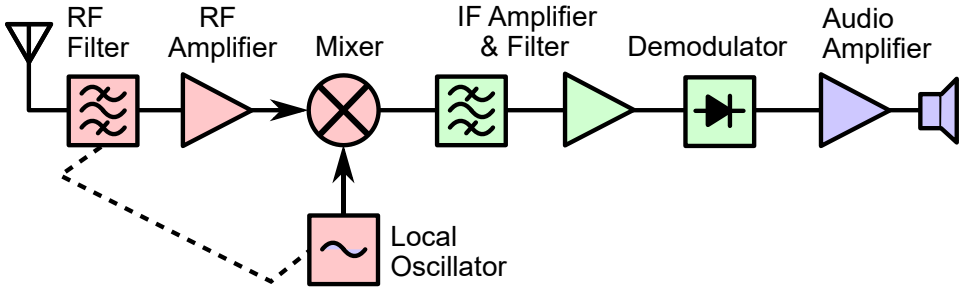
Software Defined Radio

Hardware Tuners Replaced with Digital Signal Processing

Analog radios contained many components whose frequency characteristics were determined by their physical dimensions.

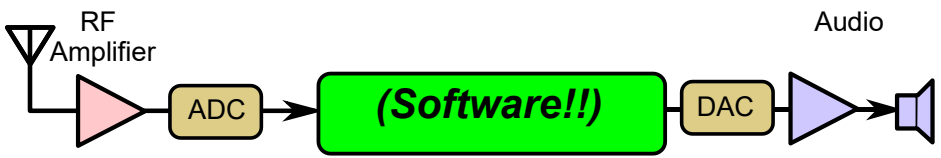
With the advent of digital signal processing, many of these could be eliminated or replaced with simpler, broader band versions. Size, weight, power were reduced, and flexibility was improved.

Analog Superheterodyne Receiver



By Chetvorno - Own work, CC0, https://commons.wikimedia.org/w/index.php?curid=46222556

Software Defined Radio (Conceptual)



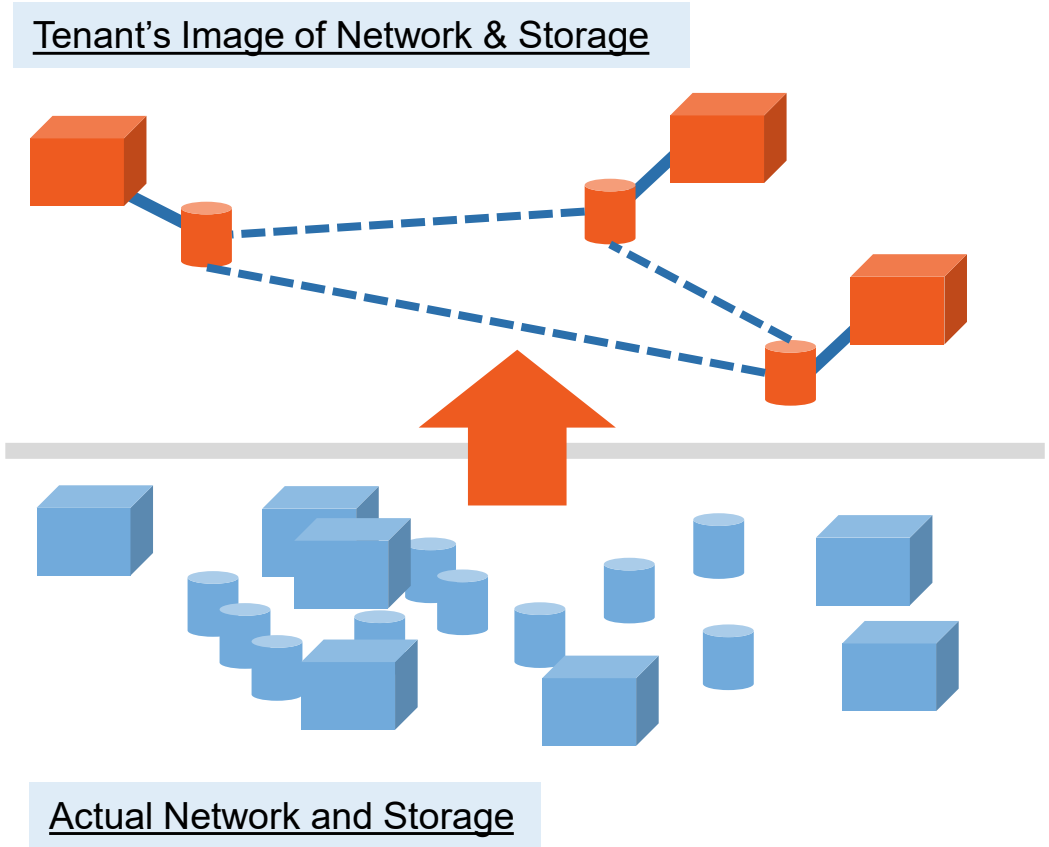
back

Software Defined Architecture

Simulation of Dedicated Networking and Storage for Multiple Tenants

A service provider presents a reduced complexity image of storage systems and networks to an end-user organization using virtualization features.

Unlike software defined radio, not much actually changed in the underlying products (which already had such features).



back