Functional Open Coupling

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What is the Functional Open Coupling ?

- Allows to couple heterogeneous units functionally regardless of:
  - type of consists: train can be operated with units of different type, e.g. 2 car unit coupled with a 4-car unit and 3-car unit
  - version of consists providing upward compatibility between fleet
  - manufacturer consists providing interoperability

- Through a set of functional interfaces and physical topology description

What is the Functional Open Coupling ?

Source: Youtube Railsimu https://www.youtube.com/watch?v=yQvbYcFYcGs

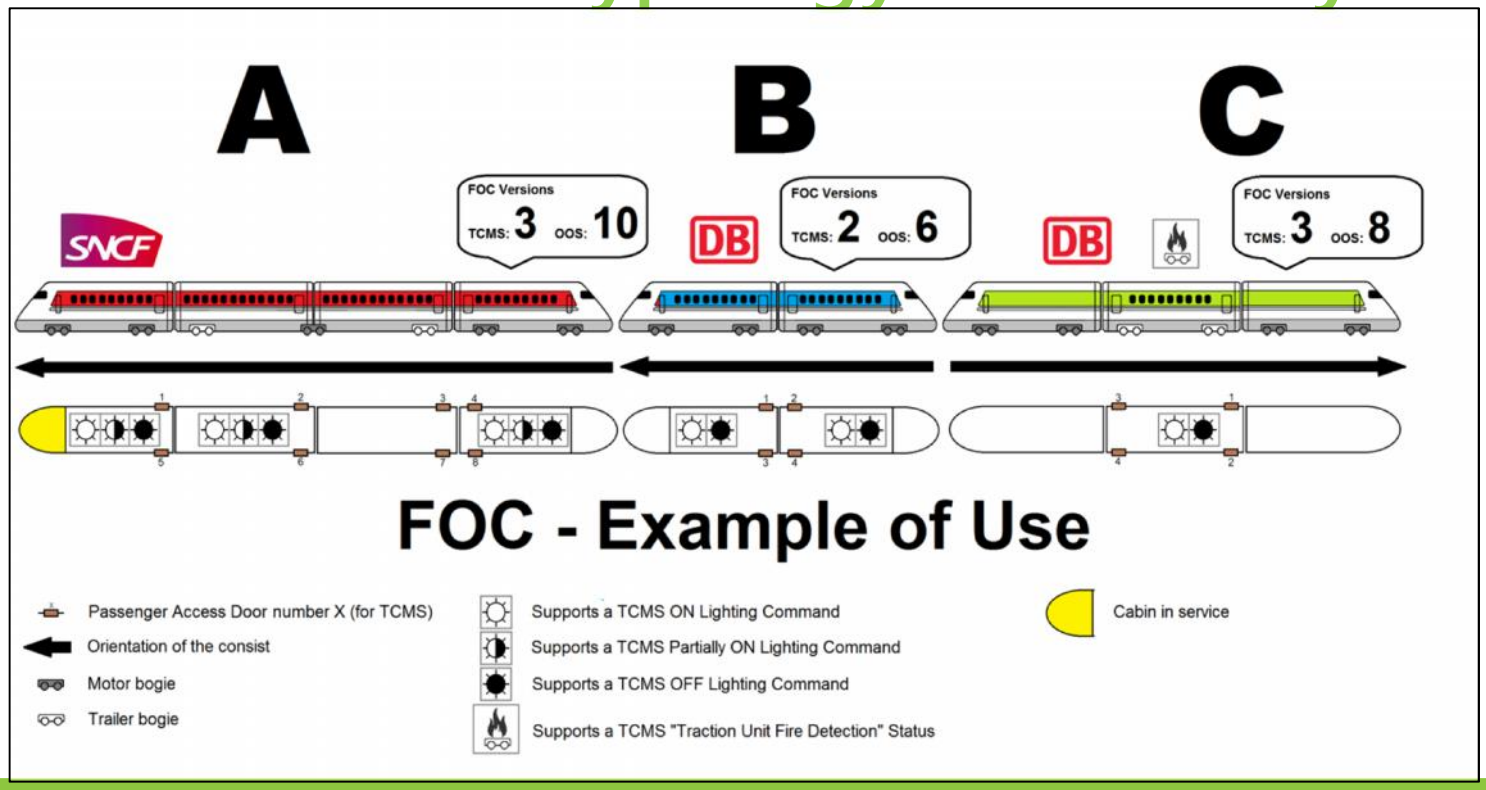
Why Functional Open Coupling ?

Today	With Functional Open Coupling
In most of the cases, a consist can only be coupled to another one it was specifically designed for	Heterogeneous consists will be able to couple.
Operators do not have sufficient flexibility in the fleet	Operator will be able to manage their fleet with greater flexibility (e.g. in case of maintenance)
Consists that have a diversity (type of traction techno, options) cannot be coupled together	Diversity and options are managed
New software version often impose to recertify the existing fleet for multiple unit operation with new fleet	New and existing fleets will be able to couple without recertification costs on the existing fleet

Functional Open Coupling in detail

- **Use cases**
- Communication concept & data exchanges
- Example
- Next steps and conclusion

Use cases: typology of diversity



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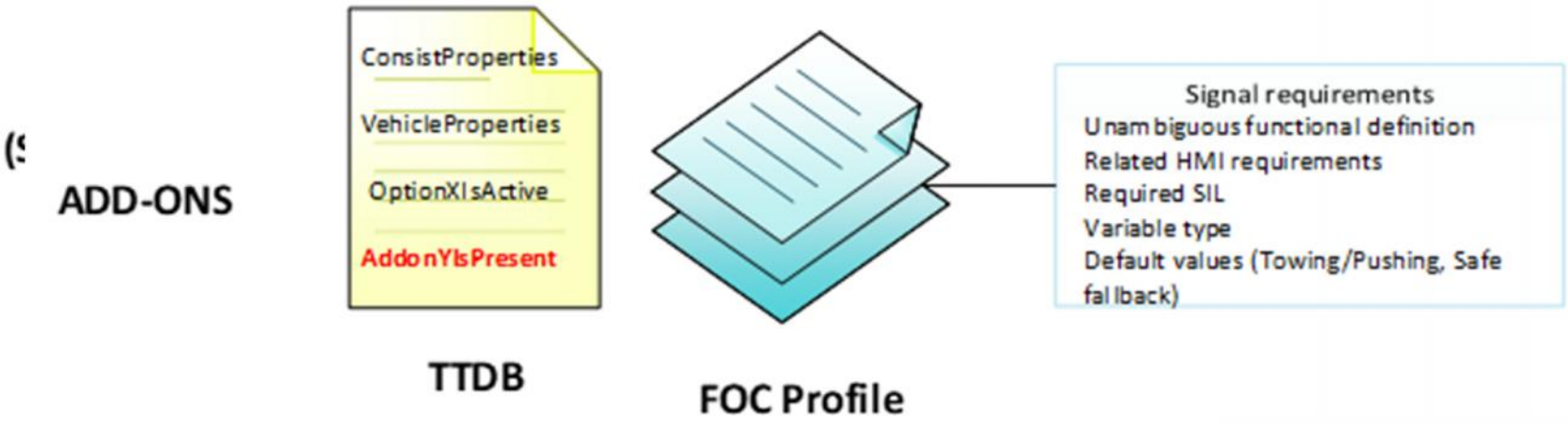
Definition of core and option functions



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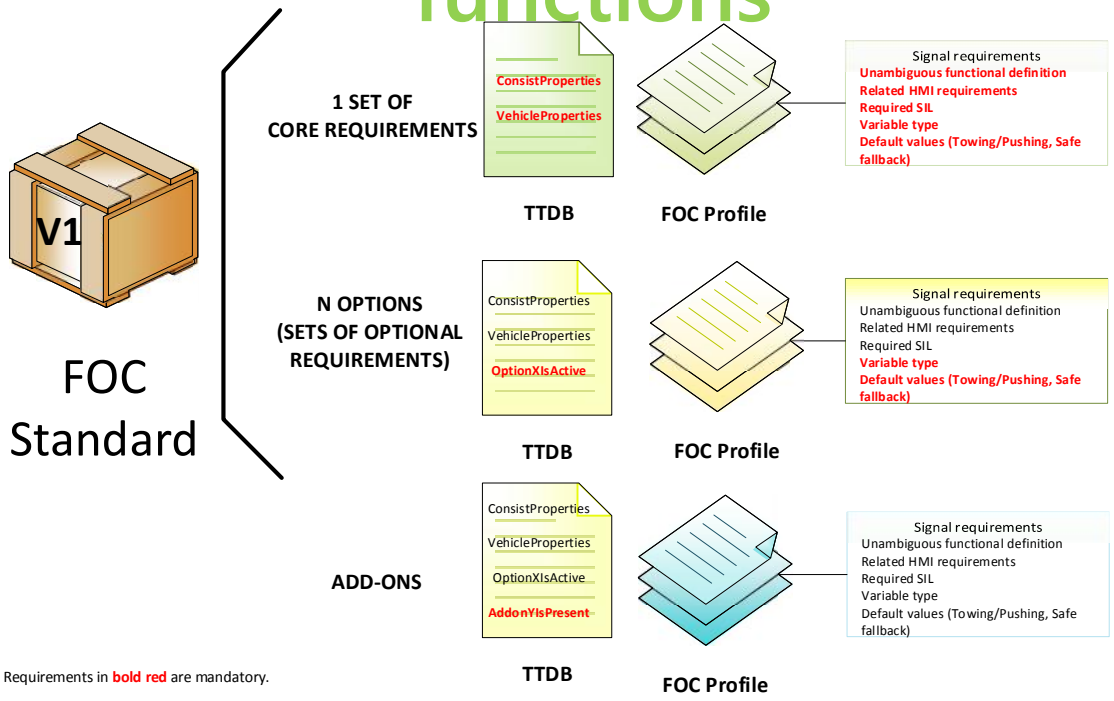
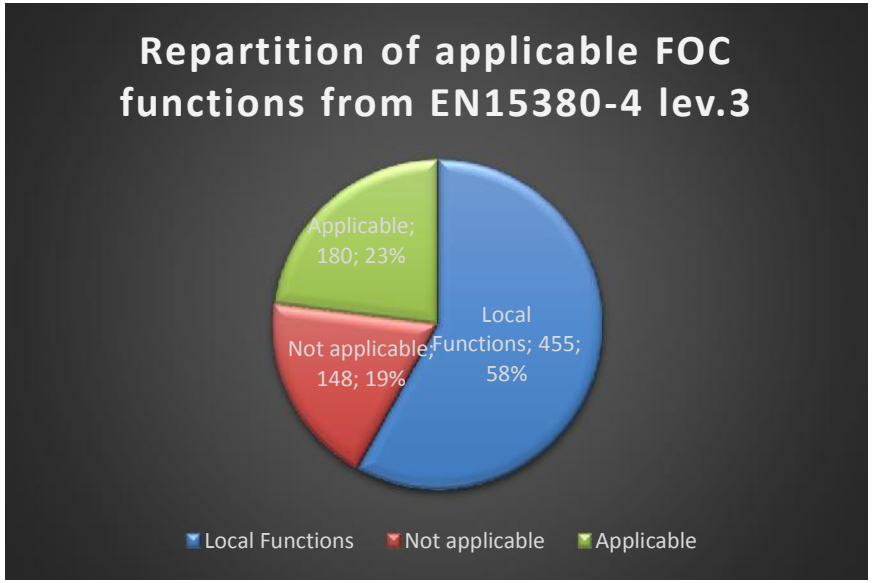
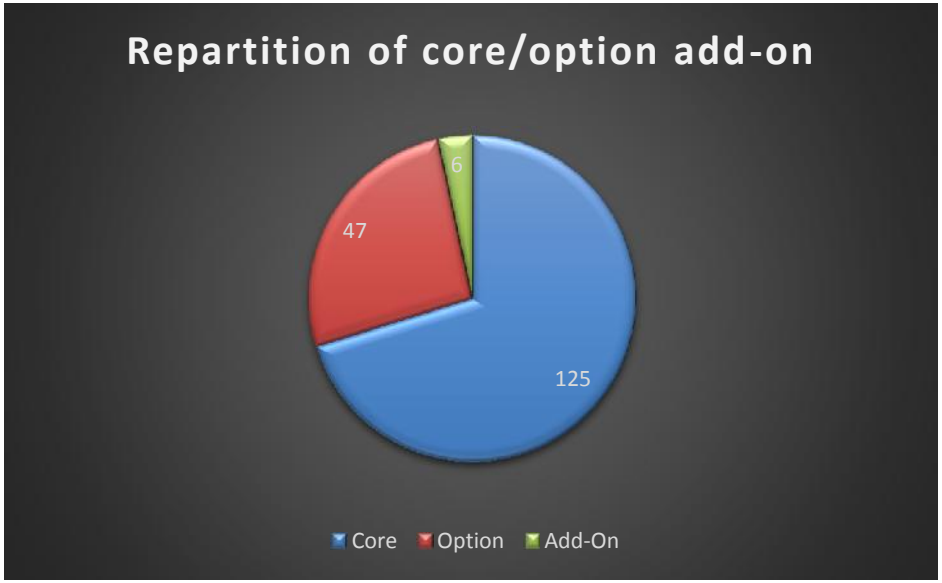


Requirements in **bold red** are mandatory.

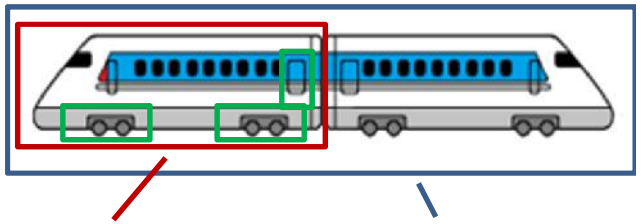
Communication concept





Definition of a FOC layer

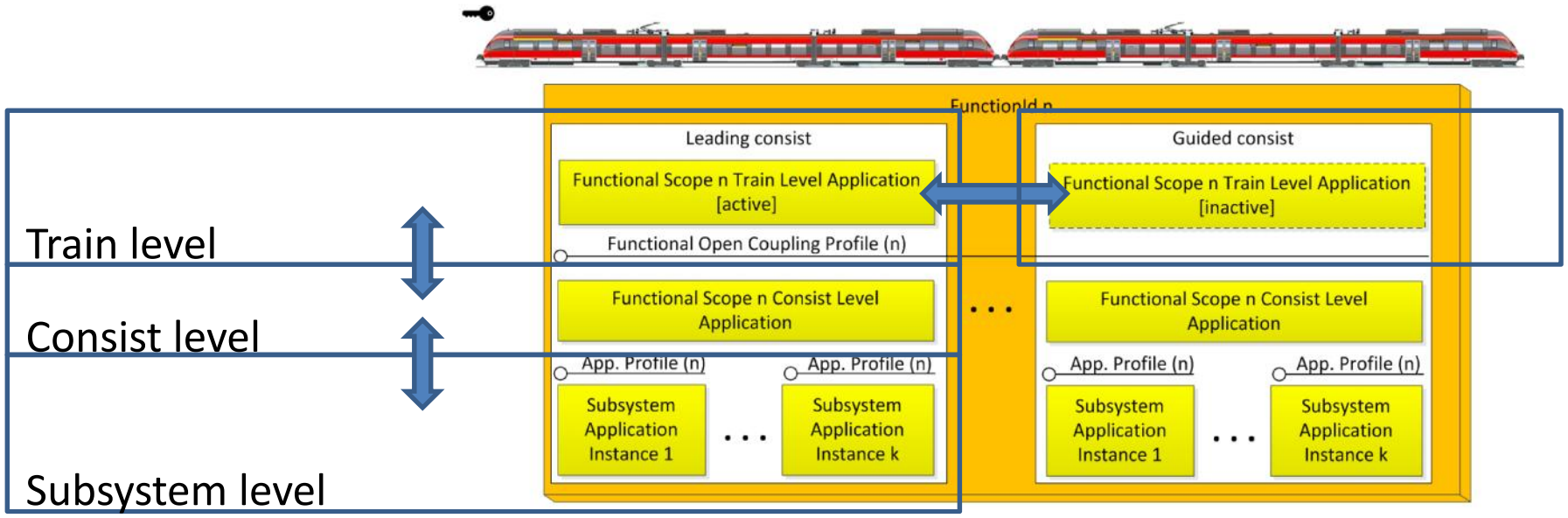
- a set of **organic information** aimed at being shared by the consists using the FOC included in the TTDB



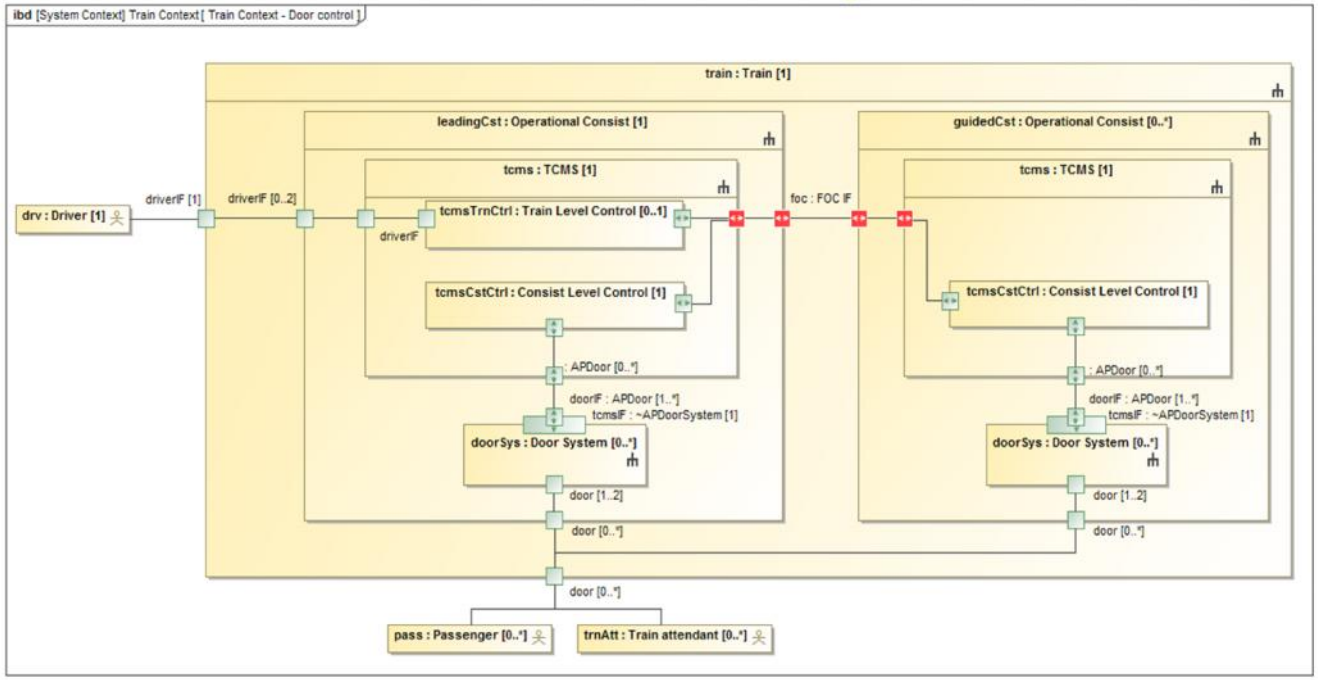
- a set of **signals** to be exchanged called "**FOC profile**" taking into consideration **Application Profile** Methodology

Flow property *Name : Type [Multiplicity]*	**Attributes** *Name : Type [Multiplicity]*	Leading	Guided	Classification
statusAllCstExtDrsClosedLockedTrnSide : StatusCstAllExtDrsClosedAndLockedTrnSide [1]	◇ allCstDrsClosedAndLocked : TrainSideKind [1] Status which consist doors are closed and locked based on train side. All consist doors on the given train side are closed and locked. • **none** - No side of the train. • **left** - Only the left side of the train. • **right** - Only the left side of the train. • **both** - Both sides (left and right) of the train.	in	out	core

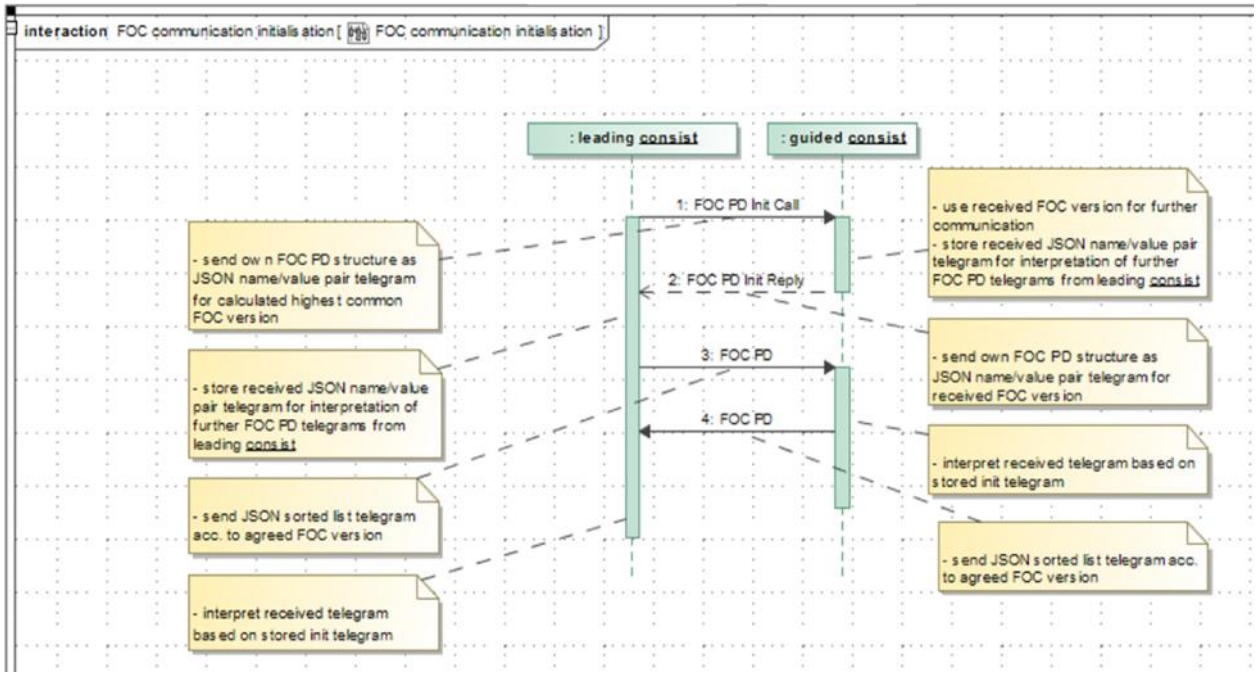
Data exchanges



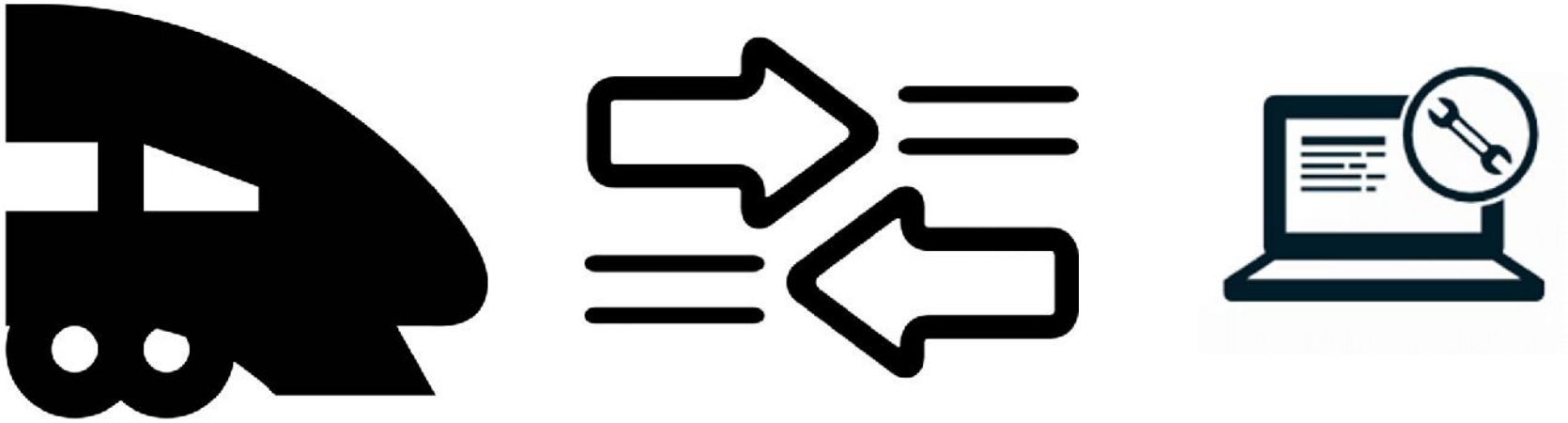
Data exchanges



Function Telegram Structure Initialisation



Certification of a consist type towards FOC standard



A consist type tested OK with the certified simulator shall operate successfully with any other consist that has passed the same test.

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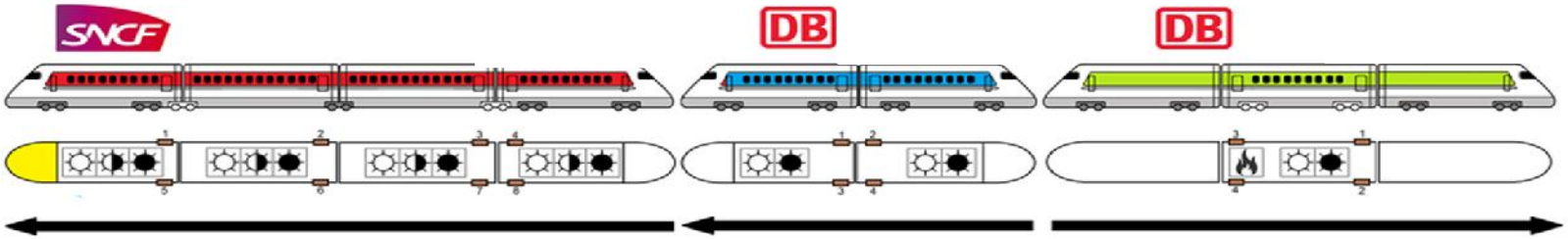
Example for traction effort capacity



Mass+ rotation inertia at full speed = 400 tons, Maximal effort 500kN	M+i 100 tons, Max 100kN	M+i 300 tons, Max 250kN
2 motor blocks OK 2 motor blocks Isolated	2 motor block OK 0 motor block Isolated	3 motor block OK 1 motor block Isolated
In case an average of consist is made : (50%+100%+75%)/3 = **75%** In case a fraction by motor block counting is made : "7/10 = **70%** of perf is available" In reality (2*125kN+2*50kN+3*62,5kN)/ 850kN = **63%** of force is available		

Need for specific definition of some interfaces with the right abstraction level

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Next station is

- Completion of Function Open Coupling regarding **DMI visualization**
- Design and implementation of Functional Open Coupling **protocol**
- Definition of a certification strategy and definition of a conformance/interoperability test
- Definition of test cases, test scenarios, implementation and test execution

Quite a dense program for Connecta 2!

Conclusions

- The Functional Open Coupling allows a better **flexibility** in fleet management for operators (interoperability)
- A **FOC standard is necessary** to ensure compliancy:
  - Interface signals and their SIL Level
  - Physical description and specific abstraction level
- For some functions, due to diversity among consists, a specific level of abstraction has to be define
- With the **cumulative effects** of other new technologies such as **Application Profiles**, **Drive-by-Data** and **Wireless Coupling**, it is paving the way towards **Open Coupling**