INFRABEL
Right On Track

Communication TMS-DAS

UIC workshop

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Energy Management

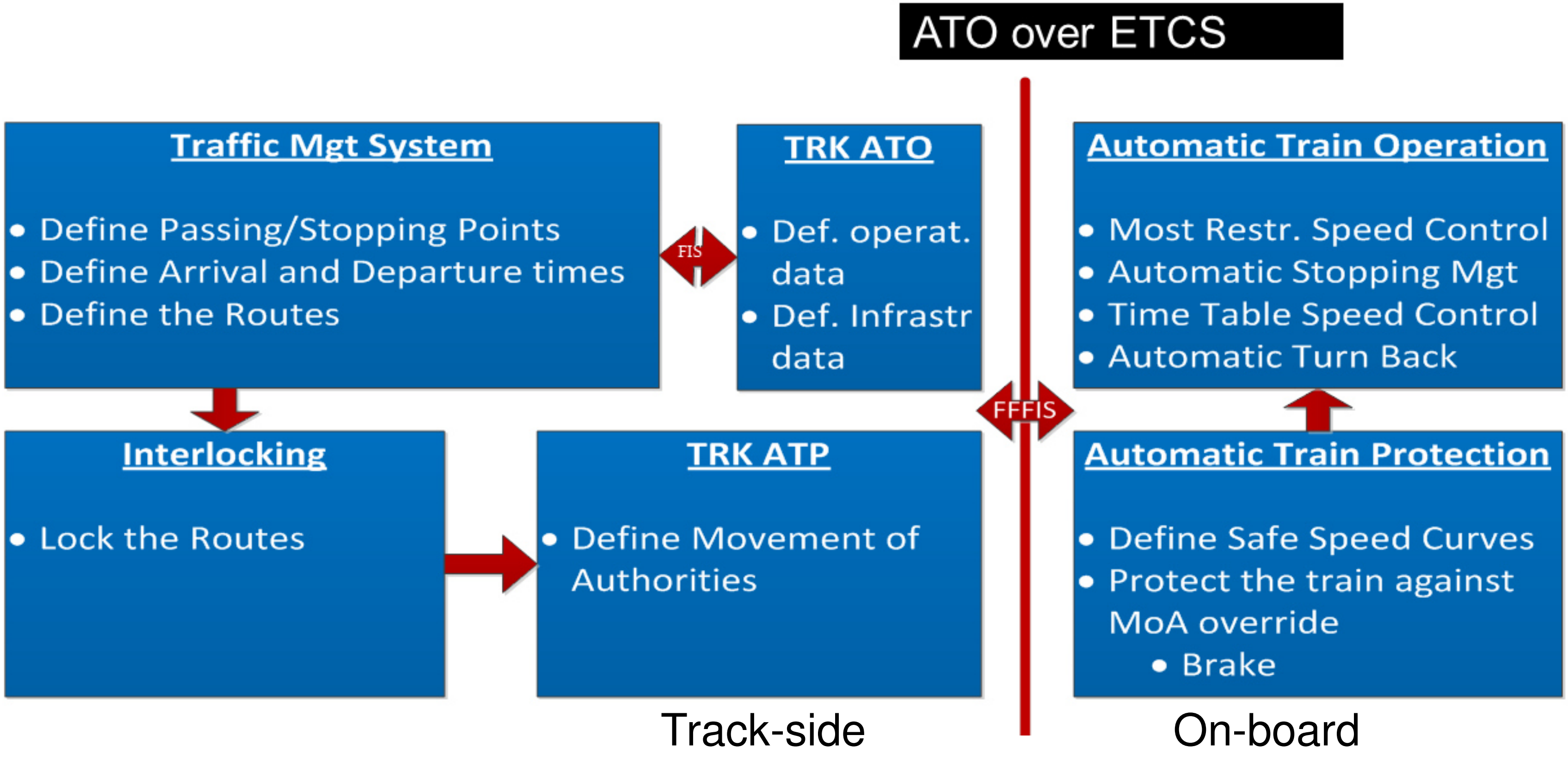
10.02.16

Communication

1. **Via ERTMS:** project ATO on ERTMS created some SUBSET's usable for the communication between TMS and DAS/ATO

2. **Via RailML:** EN 50463-4 (standard for data communication with on-board energy meters) has method to exchange XML-messages; content of data is defined in RailML

ATO over ERTMS



ATO over ETCS

Traffic Mgt System

- Define Passing/Stopping Points
- Define Arrival and Departure times
- Define the Routes

TRK ATO

- Def. operat. data
- Def. Infrastr data

Automatic Train Operation

- Most Restr. Speed Control
- Automatic Stopping Mgt
- Time Table Speed Control
- Automatic Turn Back

Interlocking

- Lock the Routes

TRK ATP

- Define Movement of Authorities

Automatic Train Protection

- Define Safe Speed Curves
- Protect the train against MoA override
  - Brake

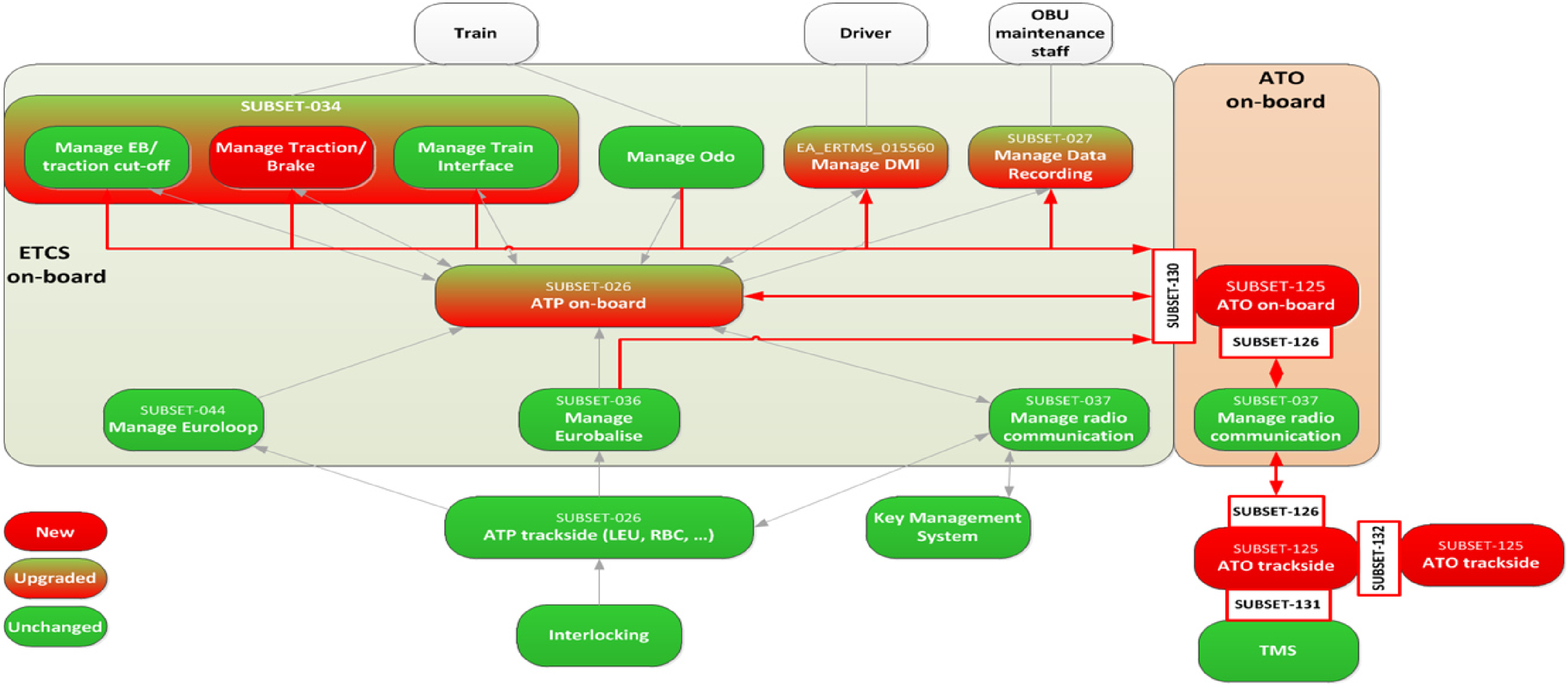
Track-side

On-board

(based on a presentation of Benoit Bienfait, UNISIG)

ATO over ERTMS

A request is made to adjust these SUBSET's and also include DAS over ETCS

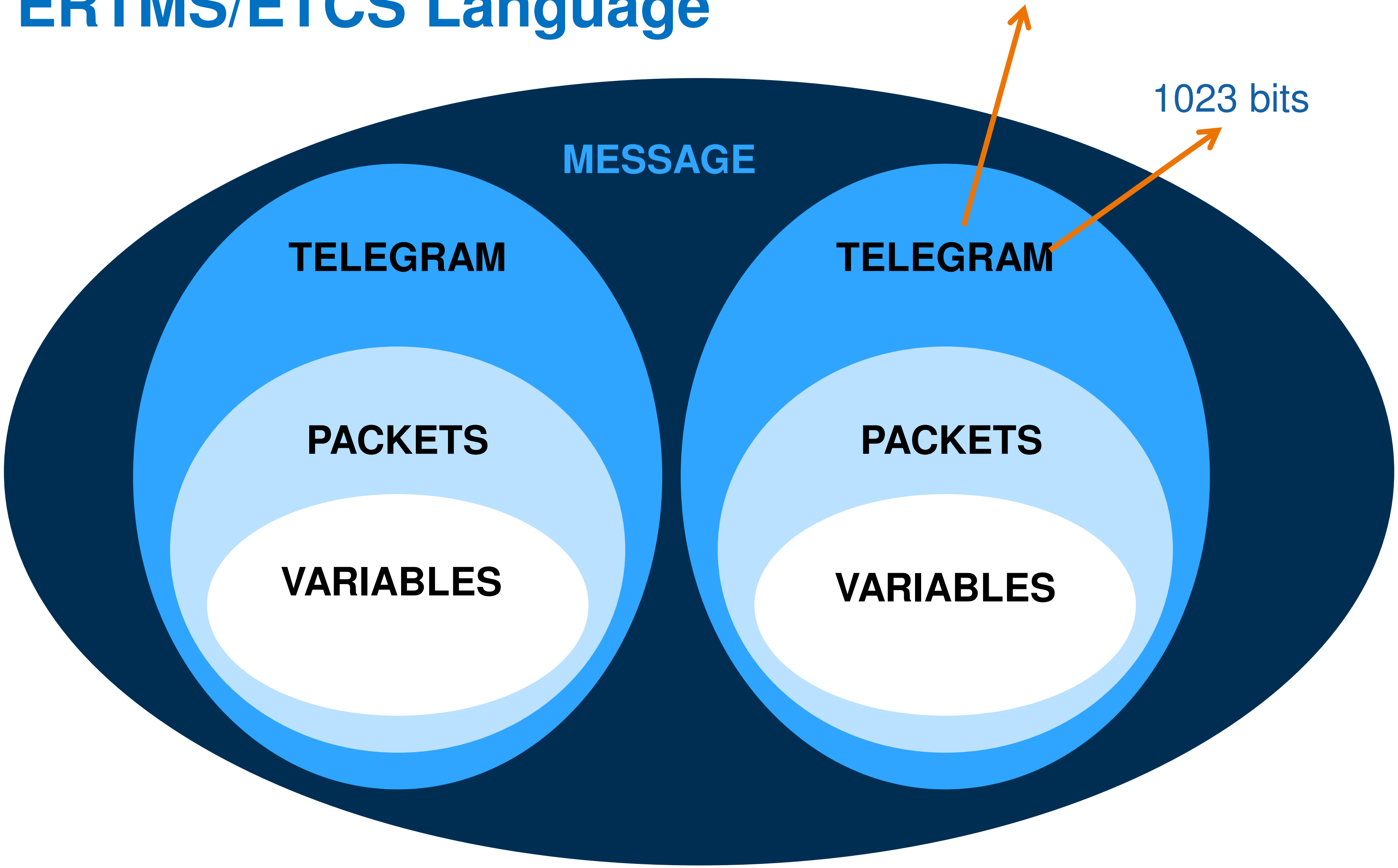


(based on a presentation of Benoit Bienfait, UNISIG)

ERTMS/ETCS Language

1. Header
2. Packets with data
3. Packet 255 (= end)

1023 bits



Packet

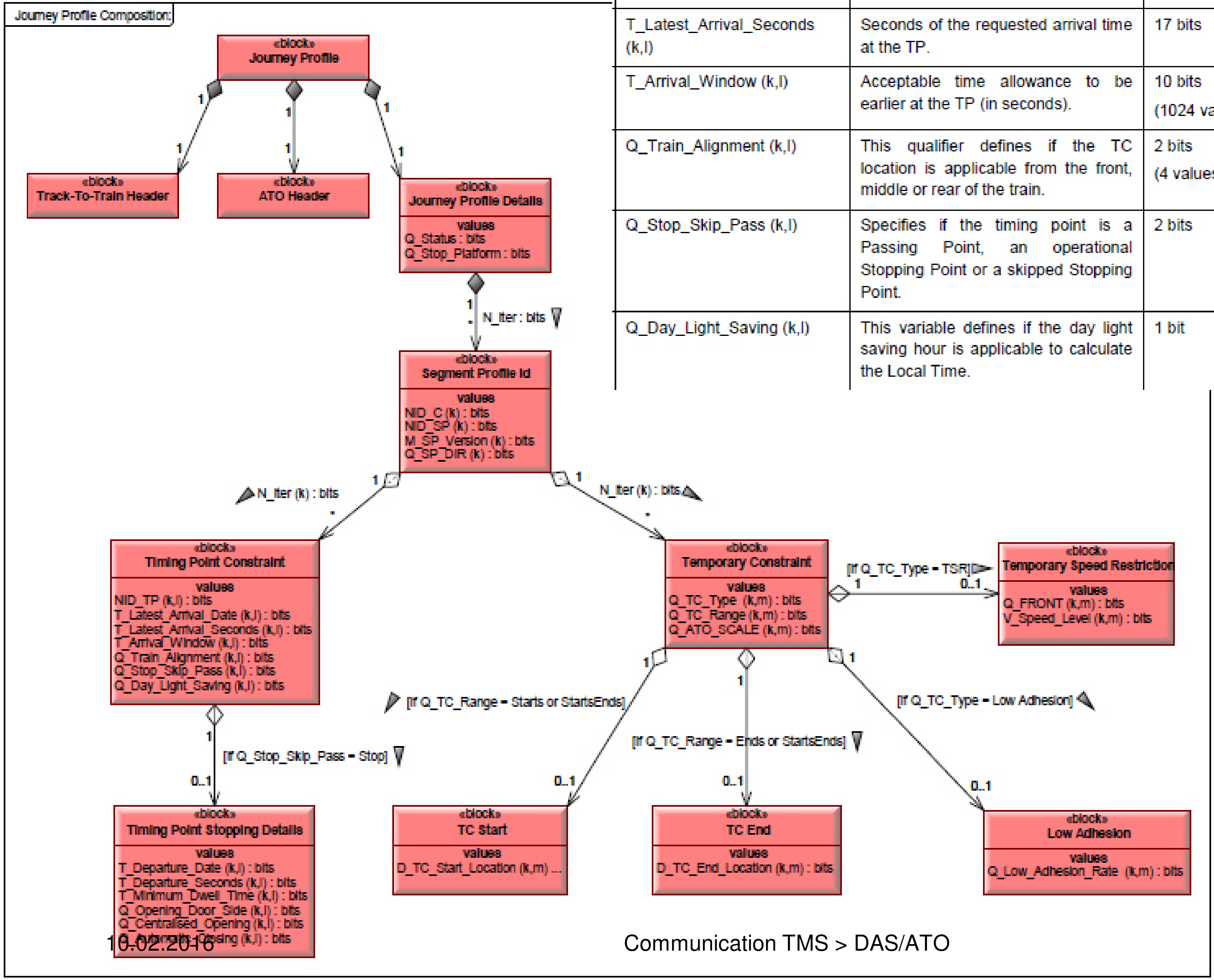
Number	NID_PACKET	Identification of the packet
Direction	Q_DIR	Indicates the driving direction to which information is applicable
Length	L_PACKET	Amount of bits in the packet
Scale	Q_SCALE	Indicates the scale uses for distances
Information	……	Fixed set(s) of variables

Always 2 bits:

- 00 = 10 cm scale
- 01 = 1 m scale
- 10 = 10 m scale
- 11 = spare combination

Timing point constraints

T_Latest_Arrival_Date (k,l)	Date of the requested arrival time at the TP.	15 bits	Value from 0 (01/01/2010) to 32.767 (18/09/2099)
T_Latest_Arrival_Seconds (k,l)	Seconds of the requested arrival time at the TP.	17 bits	Value from 0 (00:00:00) to 86.399 (23:59:59)
T_Arrival_Window (k,l)	Acceptable time allowance to be earlier at the TP (in seconds).	10 bits (1024 values)	Binary to numeric (in seconds). The value is 0 for Stopping Points.
Q_Train_Alignment (k,l)	This qualifier defines if the TC location is applicable from the front, middle or rear of the train.	2 bits (4 values)	0 = Front, 1 = Middle, 2 = Rear, 3 = Spare
Q_Stop_Skip_Pass (k,l)	Specifies if the timing point is a Passing Point, an operational Stopping Point or a skipped Stopping Point.	2 bits	0 = Stopping point, 1 = Stopping point to be skipped (with symbol shown to driver), 2 = Passing Point, 3 = Spare
Q_Day_Light_Saving (k,l)	This variable defines if the day light saving hour is applicable to calculate the Local Time.	1 bit	0 = No saving hour, 1 = Saving hour



Journey Profile Composition:
«block» Journey Profile
«block» Track-To-Train Header
«block» ATO Header
«block» Journey Profile Details
values
Q_Status : bits
Q_Stop_Platform : bits
N_Iter : bits
«block» Segment Profile Id
values
NID_C (k) : bits
NID_SP (k) : bits
M_SP_Version (k) : bits
Q_SP_DIR (k) : bits
N_Iter (k) : bits
N_Iter (k) : bits
«block» Timing Point Constraint
values
NID_TP (k,l) : bits
T_Latest_Arrival_Date (k,l) : bits
T_Latest_Arrival_Seconds (k,l) : bits
T_Arrival_Window (k,l) : bits
Q_Train_Alignment (k,l) : bits
Q_Stop_Skip_Pass (k,l) : bits
Q_Day_Light_Saving (k,l) : bits
«block» Temporary Constraint
values
Q_TC_Type (k,m) : bits
Q_TC_Range (k,m) : bits
Q_ATO_SCALE (k,m) : bits
[If Q_TC_Type = TSR]
«block» Temporary Speed Restriction
values
Q_FRONT (k,m) : bits
V_Speed_Level (k,m) : bits
[If Q_TC_Range = Starts or StartsEnds]
[If Q_TC_Range = Ends or StartsEnds]
[If Q_TC_Type = Low Adhesion]
[If Q_Stop_Skip_Pass = Stop]
«block» Timing Point Stopping Details
values
T_Departure_Date (k,l) : bits
T_Departure_Seconds (k,l) : bits
T_Minimum_Dwell_Time (k,l) : bits
Q_Opening_Door_Side (k,l) : bits
Q_Centralised_Opening (k,l) : bits
Q_Automatic_Closing (k,l) : bits
«block» TC Start
values
D_TC_Start_Location (k,m) ...
«block» TC End
values
D_TC_End_Location (k,m) : bits
«block» Low Adhesion
values
Q_Low_Adhesion_Rate (k,m) : bits
1
1
1
1
1
1
1
1
1
1
1
1
1
0..1
0..1
0..1
0..1
0..1
*
*
*

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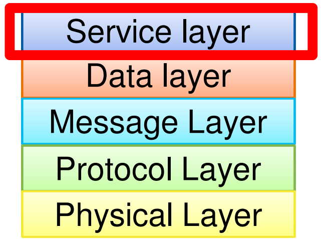
Communication

1. **Via ERTMS:** project ATO on ERTMS created some SUBSET's usable for the communication between TMS and DAS/ATO

2. **Via RailML:** EN 50463-4 (standard for data communication with on-board energy meters) has method to exchange XML-messages; content of data is defined in RailML



Service layer

Data layer

Message Layer

Protocol Layer

Physical Layer

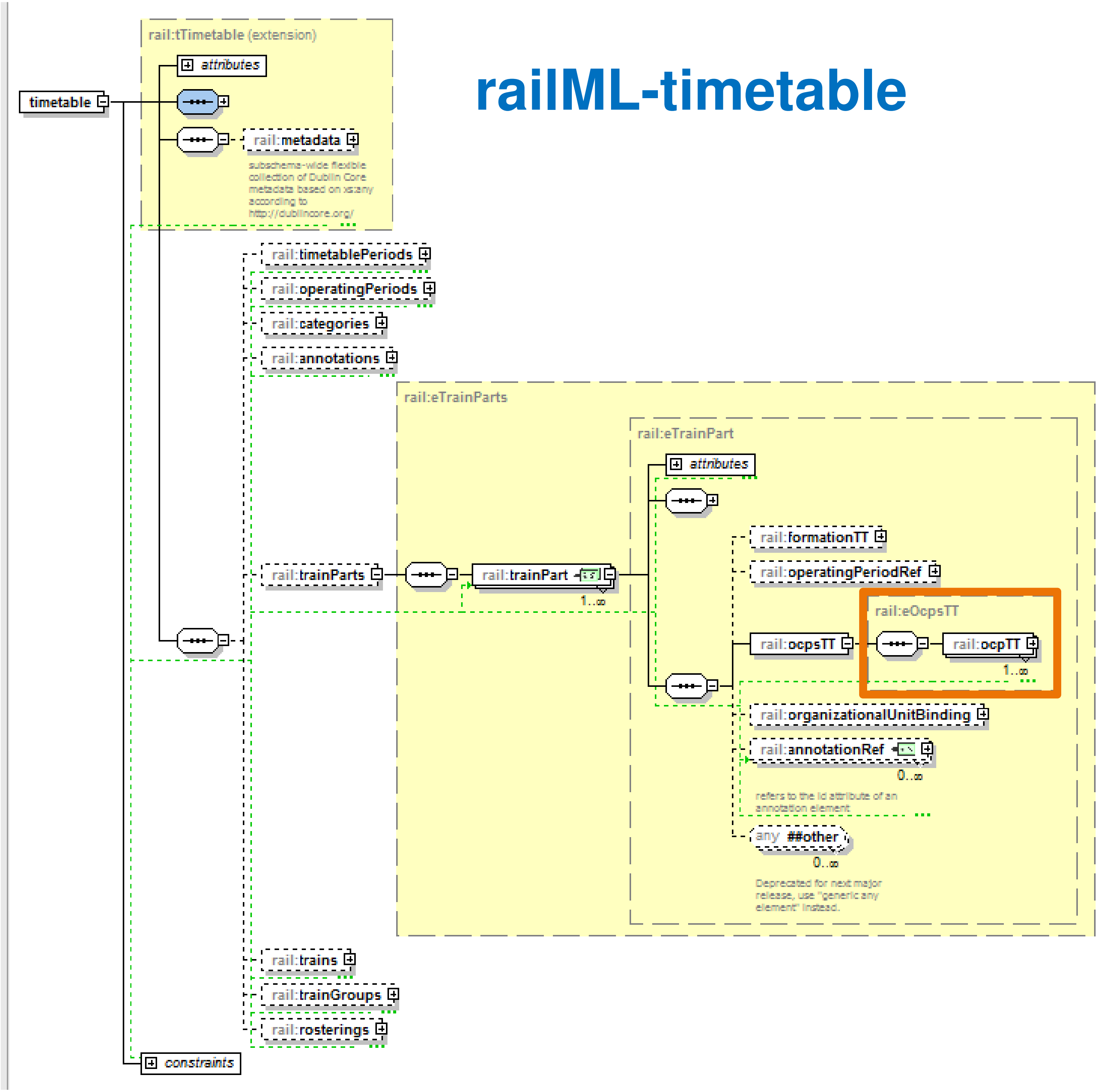
Service layer

EN 50463-4 defines the services for the communication to an on-board Energy Measuring System to ground Data Collection Services. Similar services need to be defined for the application services between DAS/ATO on-board of the train and a user on ground connected to Traffic Management

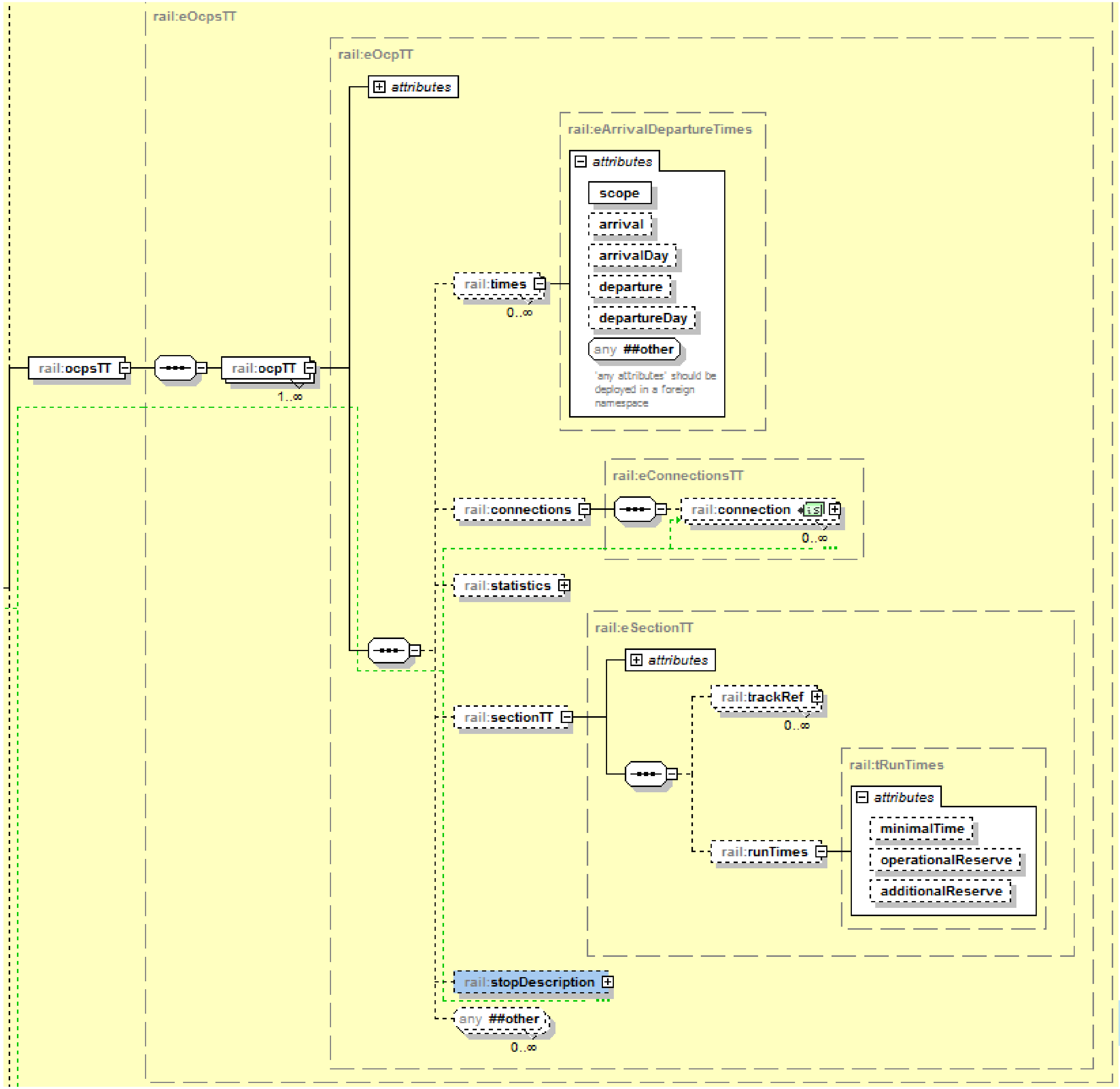
- Request infrastructure data (on-board)
- Send infrastructure data (ground)
- Request time table data (on-board)
- Send time table data (ground)
- Automatic transfer time table data (ground)
- …

railML-timetable

- Service layer
- Data layer
- Message Layer
- Protocol Layer
- Physical Layer



Operational Control Points



Service layer

Data layer

Message Layer

Protocol Layer

Physical Layer

Service layer
Data layer
Message Layer
Protocol Layer
Physical Layer

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Example of an railML-timetable

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- edited with OpenTrack (http://www.opentrack.ch) -->
<railml xmlns:xsi="http://www.w3.org/2000/10/XMLSchema-instance"
xsi:noNamespaceSchemaLocation="timetable.xsd">
    <timetable version="0.95" scheduleformat="hh:mm:ss"periodformat="s">
                <train trainID="RX 100.2" type="planned"  source="opentrack">
                         <timetableentries>
                                <entry posID="ZU" departure="06:08:00" type="begin"></entry>
                                <entry posID="ZWI" departure="06:10:30" type="pass"></entry>
                                <entry posID="ZOER" arrival="06:16:00“ departure="06:17:00"
                                                                    minStopTime="9" type="stop"></entry>
                                <entry posID="WS" departure="06:21:00" type="pass"></entry>
                                <entry posID="DUE" departure="06:23:00" type="pass"></entry>
                                <entry posID="SCW" departure="06:27:00" type="pass"></entry>
                                <entry posID="NAE" departure="06:29:00" type="pass"></entry>
                                <entry posID="UST" arrival="06:34:30" type="stop"></entry>
                        </timetableentries>
                </train>
    </timetable>
</railml>
```

Train code

Departure time

Stop

End of a train information

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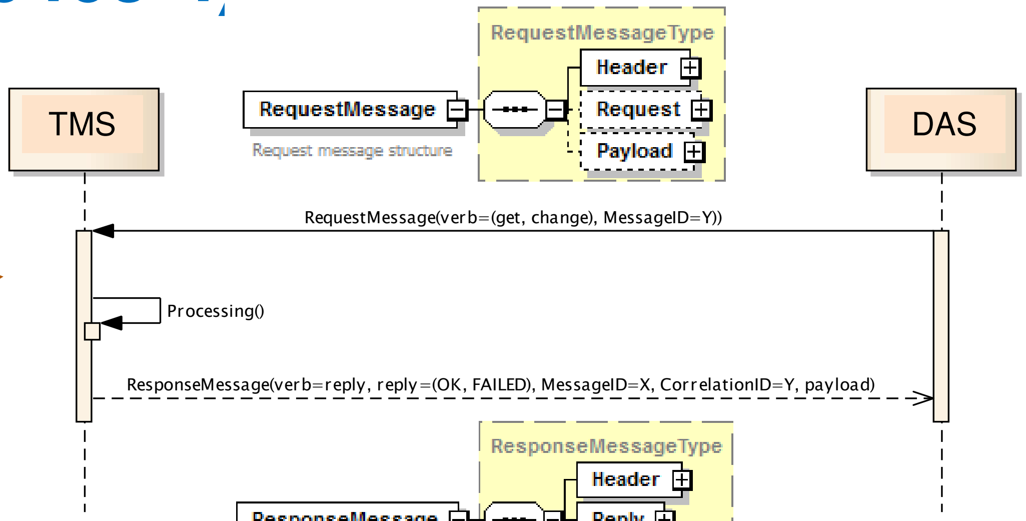
Service layer
Data layer
Message Layer
Protocol Layer
Physical Layer

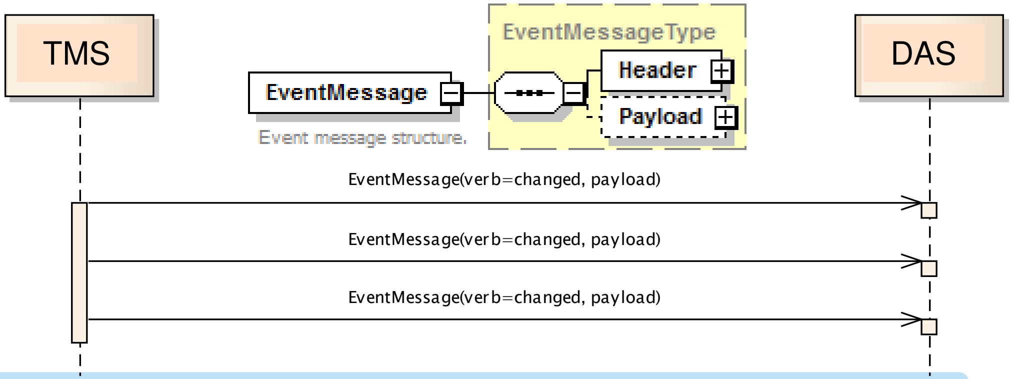
Message Layer (EN 50463-4)

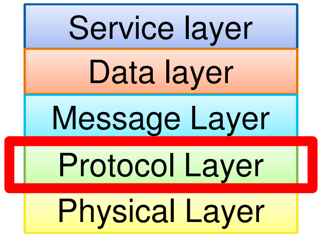
The message mechanism uses two methods for supporting the services

- Simple request/reply
  → User on ground request data
- Event
  → Ground automatically sends corrected time table data

Based on IEC 61968-100


TMS
RequestMessage
Request message structure
RequestMessageType
Header
Request
Payload
DAS
RequestMessage(verb=(get, change), MessageID=Y))
Processing()
ResponseMessage(verb=reply, reply=(OK, FAILED), MessageID=X, CorrelationID=Y, payload)
ResponseMessage
Response message structure
ResponseMessageType
Header
Reply
Payload


TMS
EventMessage
Event message structure.
EventMessageType
Header
Payload
DAS
EventMessage(verb=changed, payload)
EventMessage(verb=changed, payload)
EventMessage(verb=changed, payload)



Application protocol for supporting the message mechanism

EN 50463-4 defines 3 possible methods

- XML-RPC
- FTP with mailbox
- HTTP

If low layer does not provide enough security using standard solutions, the original message shall be encrypted

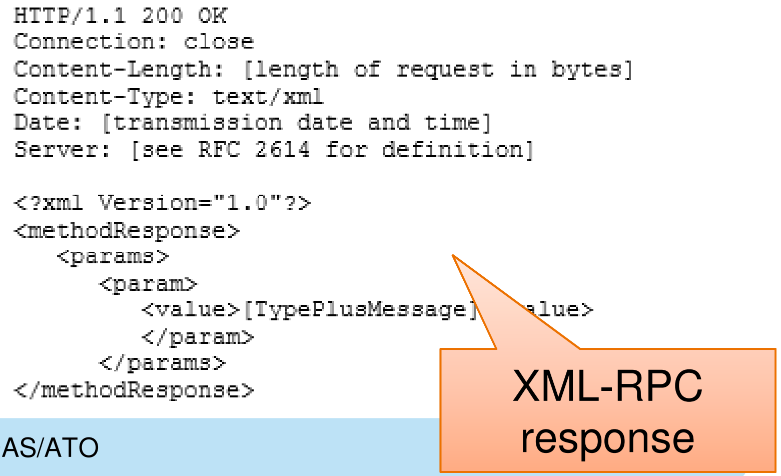
- Symmetrical encryption

  → AES-128-CTR with IV = 0

```
POST /RPC2 HTTP/1.1
User-Agent: [see RFC 2614 for definition]
Host: [DestinationAddress]
Date: [transmission date and time]
Content-Type: text/xml
Content-length: [length of request in bytes]

<?xml Version="1.0"?>
<methodCall>
   <methodName>[MethodName]</methodName>
   <params>
      <param>
         <value><string>[OriginAddress]</string></value>
      </param>
      <param>
         <value>[TypePlusMessage]</value>
      </param>
   </params>
</methodCall>
```

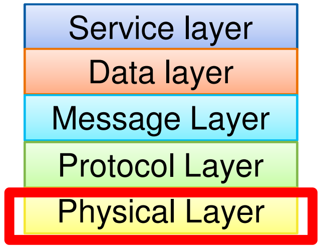
XML-RPC call



```
HTTP/1.1 200 OK
Connection: close
Content-Length: [length of request in bytes]
Content-Type: text/xml
Date: [transmission date and time]
Server: [see RFC 2614 for definition]

<?xml Version="1.0"?>
<methodResponse>
   <params>
      <param>
         <value>[TypePlusMessage]   alue>
         </param>
      </params>
</methodResponse>
```

XML-RPC response



Service layer

Data layer

Message Layer

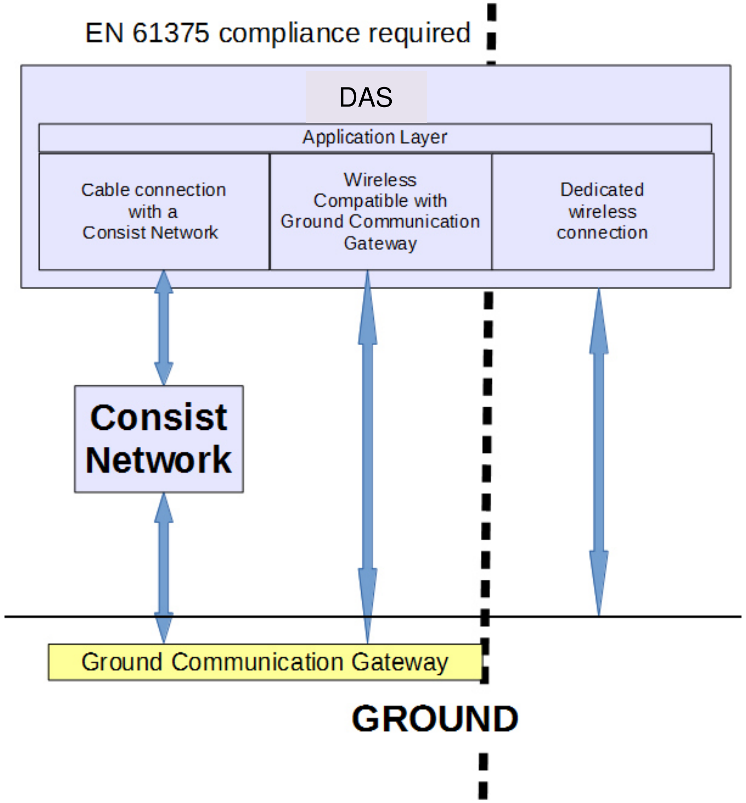
Protocol Layer

Physical Layer

Communication profile

EN50463-4 uses 3 communication profiles

- Dedicated wireless connection.
- Shared wireless connection compatible with an EN 61375 ground communication gateway.
- Consist network connection based on EN 61375.



EN 61375 compliance required

DAS

Application Layer

Cable connection with a Consist Network

Wireless Compatible with Ground Communication Gateway

Dedicated wireless connection

Consist Network

Ground Communication Gateway

GROUND

Communication

1. **Via ERTMS:** project ATO on ERTMS created some SUBSET's usable for the communication between TMS and DAS/ATO
   1. SUBSET's are defined but not officially approved
   2. Adjustment of existing ERTMS-baselines needed for full integration
   3. Ergonomic workgroup for integration in DMI not started yet
   4. Binary language (only understandable for computers)

2. **Via RailML:** EN 50463-4 (standard for data communication with on-board energy meters) has method to exchange XML-messages; content of data is defined in RailML
   1. Applications on service layer not yet defined
   2. Train-data, infrastructure data and time table data defined in RailML
   3. Message layer and protocol layer defined in EN 50463-4
   4. Physical layer based on EN 50463-4 and IEC 61375-series

QUESTIONS