



MAPS&ADAS ADAS Interfaces

Sinisa Durekovic
NAVTEQ

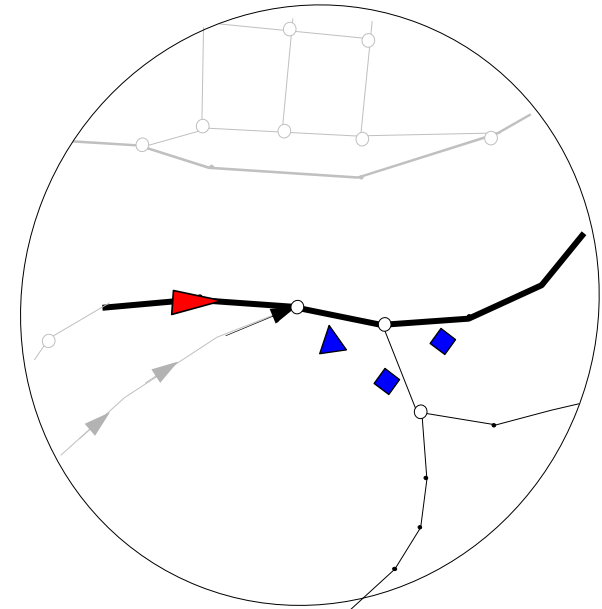


European Commission
Information Society and Media



ADAS (Electronic) Horizon

- Subset of road network map around current vehicle position up to a certain extent, including current vehicle position and movement data
- Reduced to a 'forward oriented graph' in driving direction from **vehicle position**
- Exhibiting topology, geometry, attributes



Where are ADAS Interfaces?



ADAS Horizon provider (AHP)

Module providing the ADAS
Horizon to the ADAS-
Application

ADAS Horizon Provider

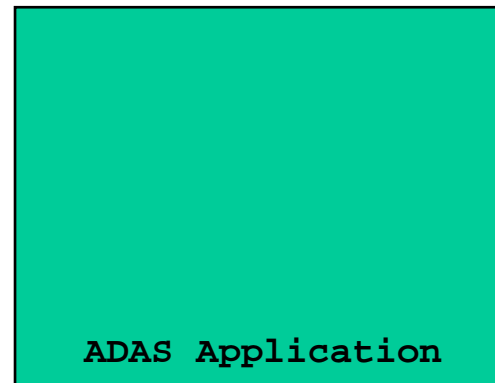
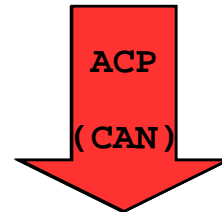
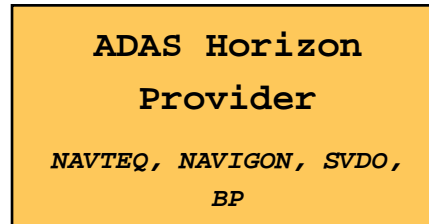
*NAVTEQ, NAVIGON, SVDO,
BP*



Where are ADAS Interfaces?

ADAS Generic Message Protocol (AGMP)

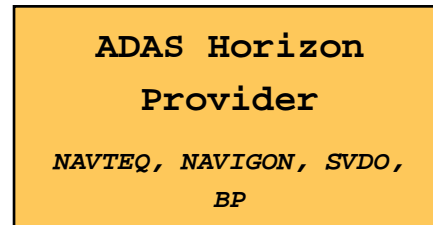
Abstract, generic message protocol to transport the ADAS interface data from AHP to AHR. This abstract protocol is independent of a particular bus specification (e.g., CAN, MOST). A bus adaptation layer is needed to adapt this generic protocol to a bus specific protocol for use with that specific bus.



ADAS Specific CAN bus protocol (ACP)

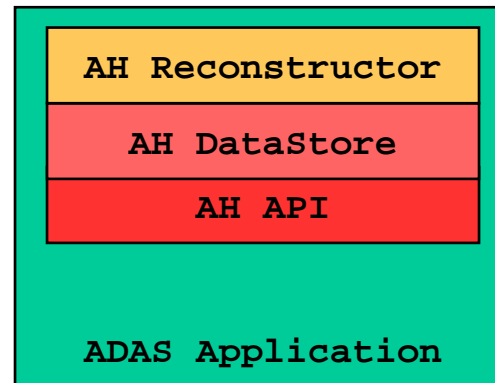
Protocol which transports the ADAS interface data packaged in CAN frames over a CAN bus from AHP to AHR

Where are ADAS Interfaces?



ADAS Horizon Reconstructor (AHR)

Module reconstructing the AH from the compressed data stream as prepared and transmitted from the AHP.



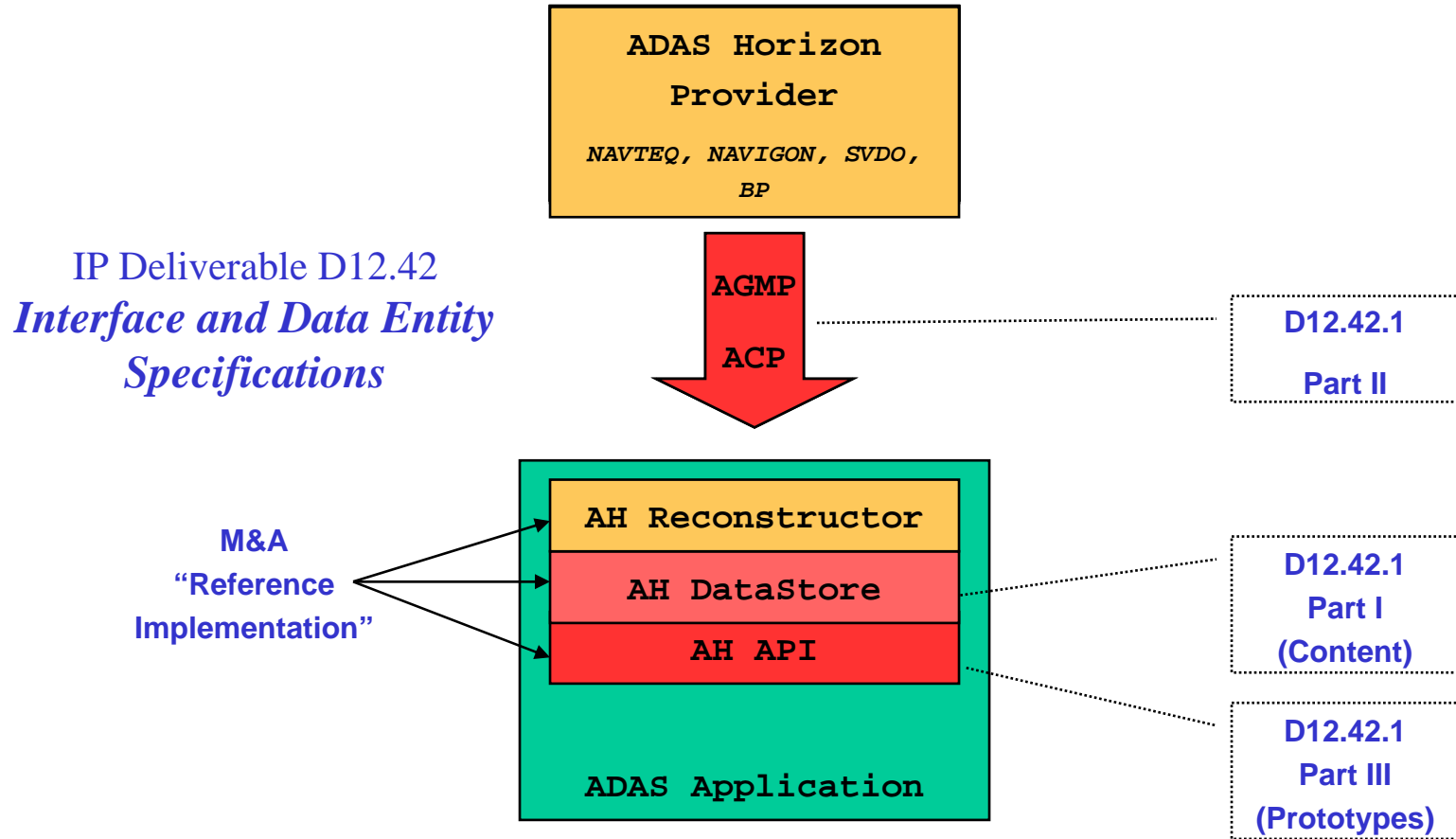
ADAS Horizon Data Store (DS)

Data structure that describes the ADAS Horizon.

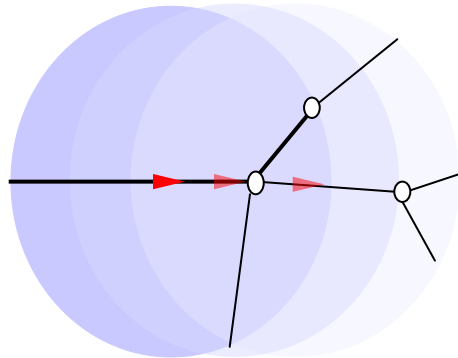
ADAS Horizon Application Programming Interface (AH API)

Programmers interface used to access ADAS Horizon in the Data Store.

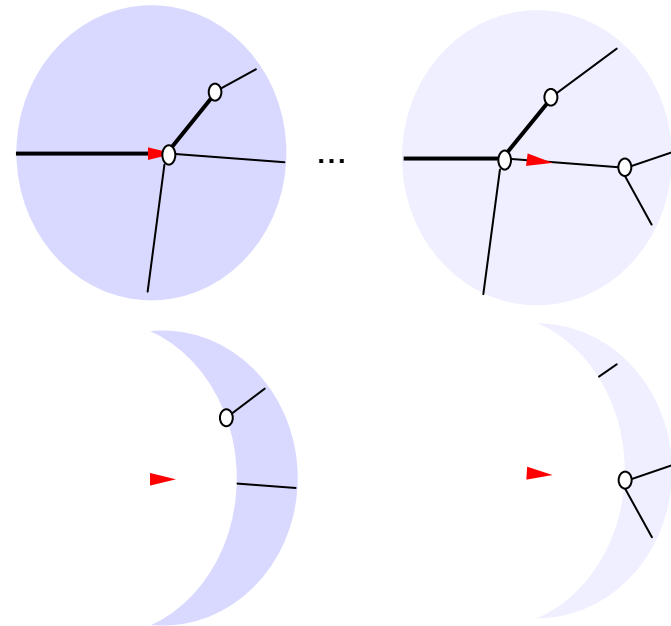
Where are ADAS Interfaces?



Transmit map horizon as incremental data stream of delta-information



instead of
redundant
transmission . . .



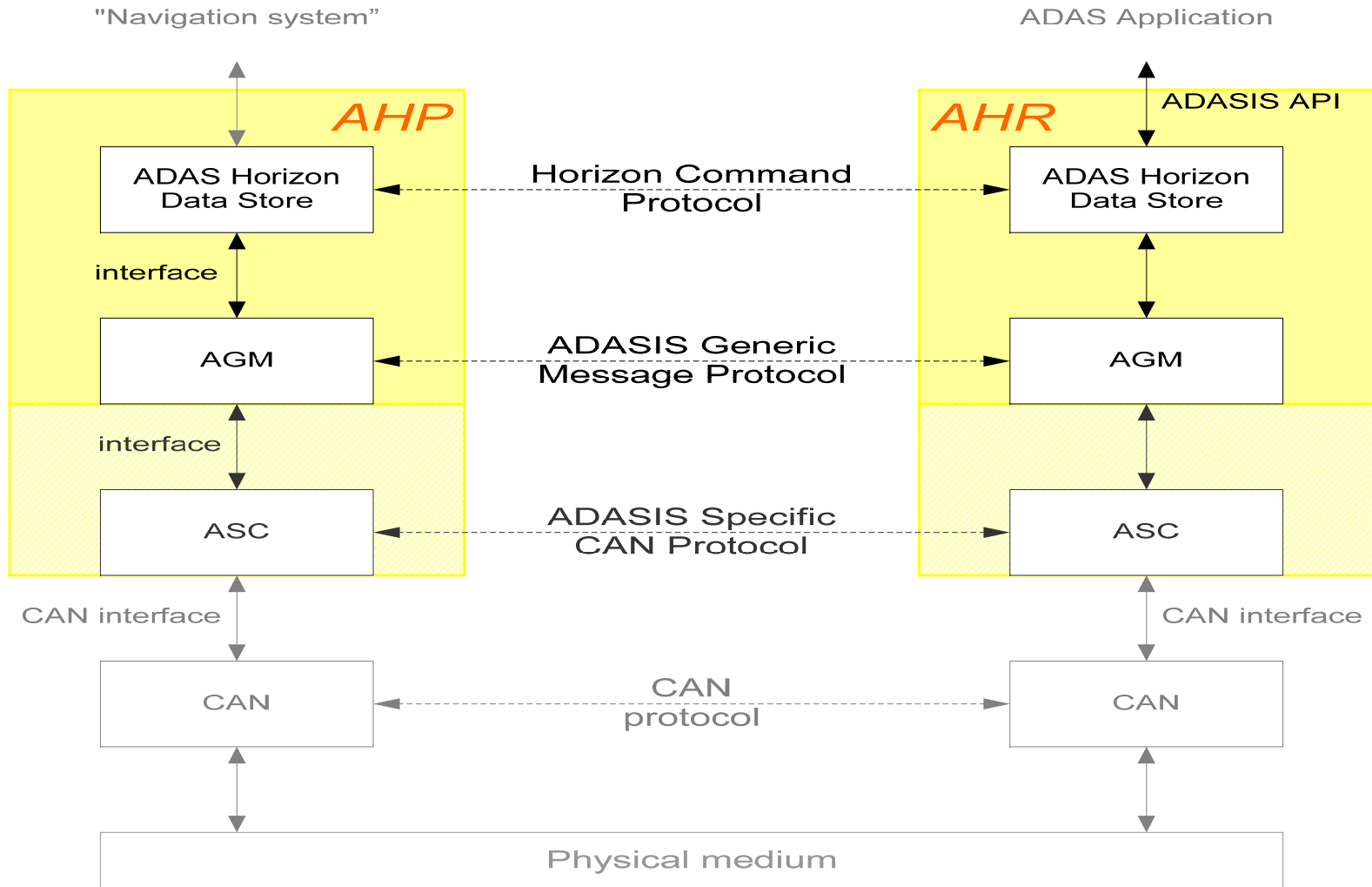
... use an
incremental
scheme

- static content
- position within horizon

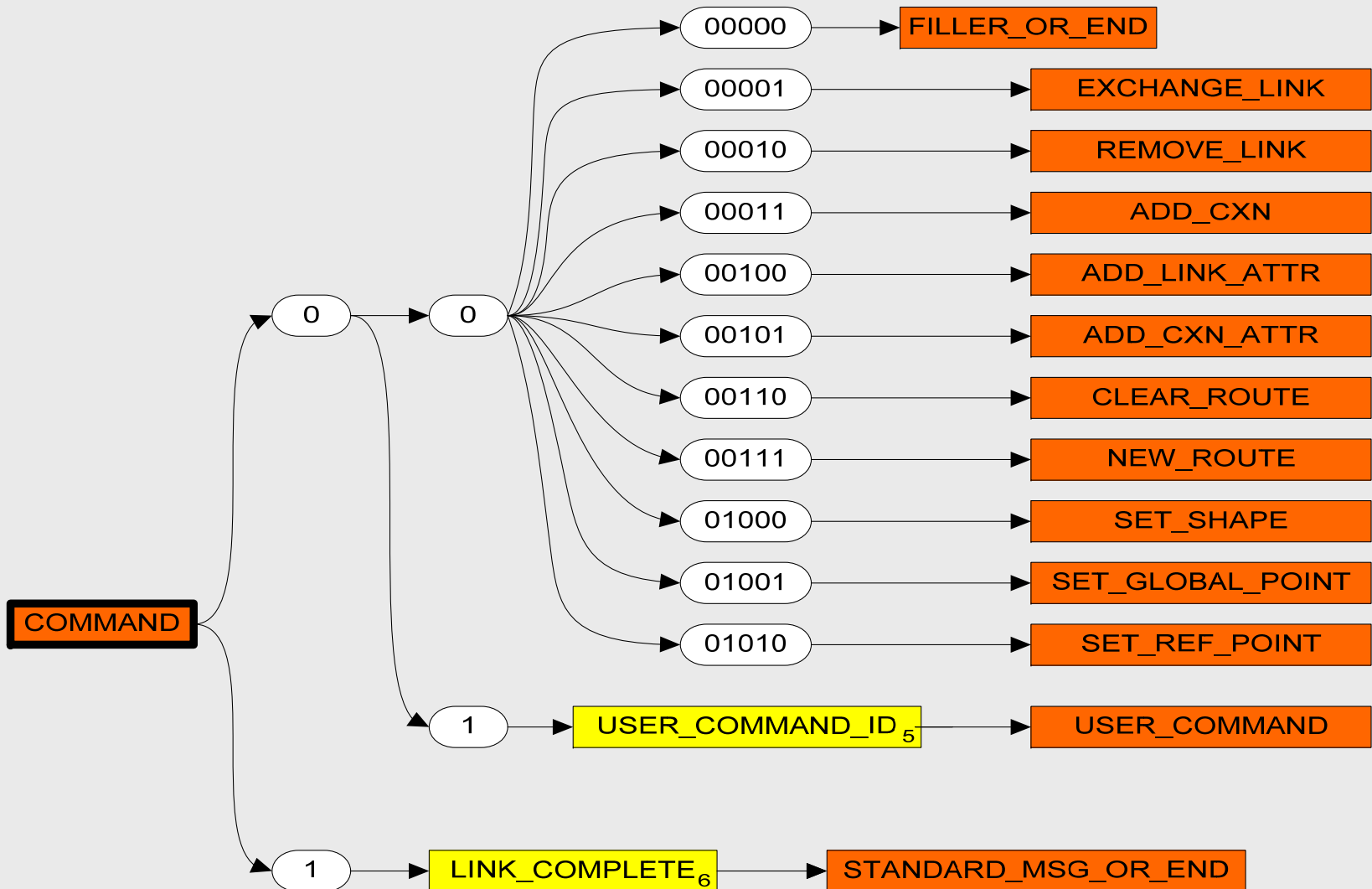
transmitted once
updated periodically

- low frequency
- high frequency

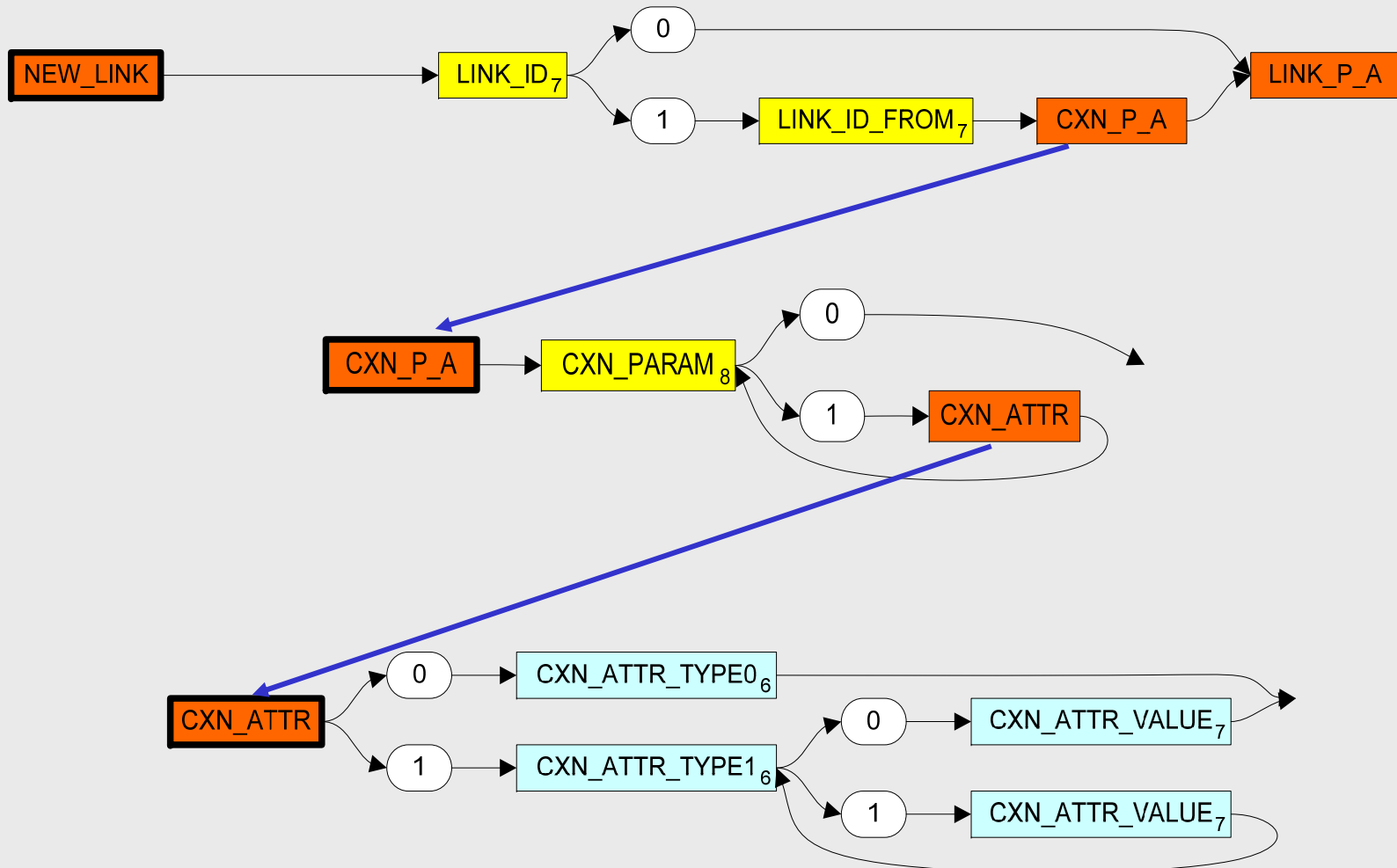
ADAS Protocol Layers



AGMP Protocol



AGMP Protocol



AGMP Bits & Bytes

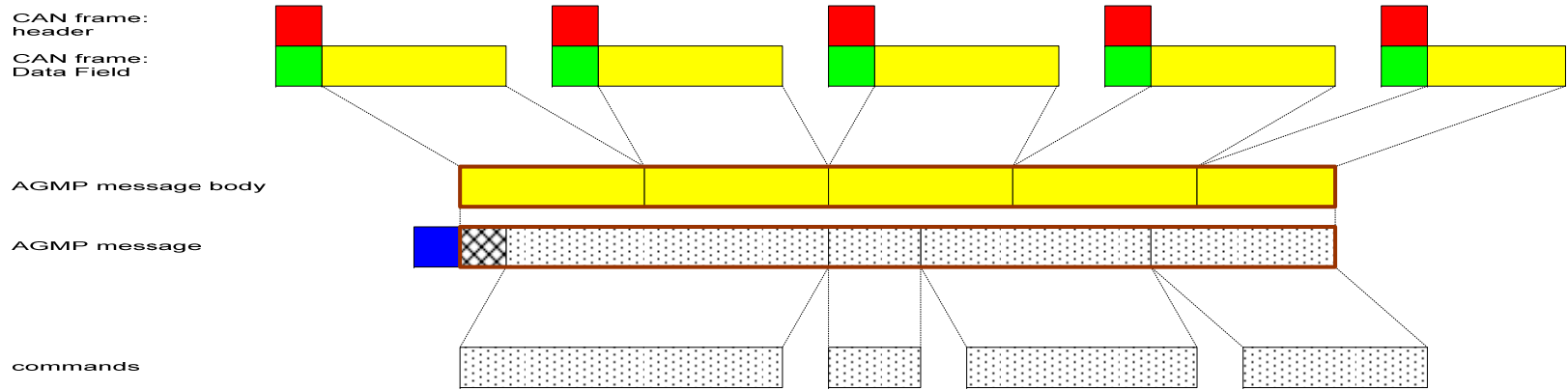








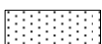
```
#[MESSAGE: CAT_EST_POS CAT_EST_POS_EXT CAT_TOPOLOGY CAT_BASIC_ATTRS CAT_HEADING MSG_SIZE=8,
#  [STANDARD_MSG:
#    [NEW_LINK: LinkId=2, LinkIdFrom=1,
#      [CXN_P_A:
#        [CXN_PARAM: JunctionComplete=true, UTurn=false, ProbabilityOfTravel=20],
#        [CXN_ATTR: GiveWay=1, Type=6],
#        [CXN_ATTR: Heading Change=-1],
#        [LINK_P_A:
#          [LINK_PARAM: Route=false, DrivingDirection=3, Length=115, Lanes=0, Type=19]]
#      ]
#    ]
#  ]
#]
```

e408828194ae9f307313



From AGMP to ACP



CAN frame: header		Message-type (CAN-ID) Size (Byte count of CAN data field)
CAN frame: data field: sync-byte		Retransmission (1 bit) Sequence-number (3 bits) First-frame-of message (1 bit) Frames-still-to-come (3 bits)
CAN frame: data field: message		Contents of AGMP message body
AGMP message header		Message-type Size (of AGMP message body)
AGMP message body		
AGMP message body: control		Version CRC check
Command		Command content

AGMP/ACP Bits & Bytes



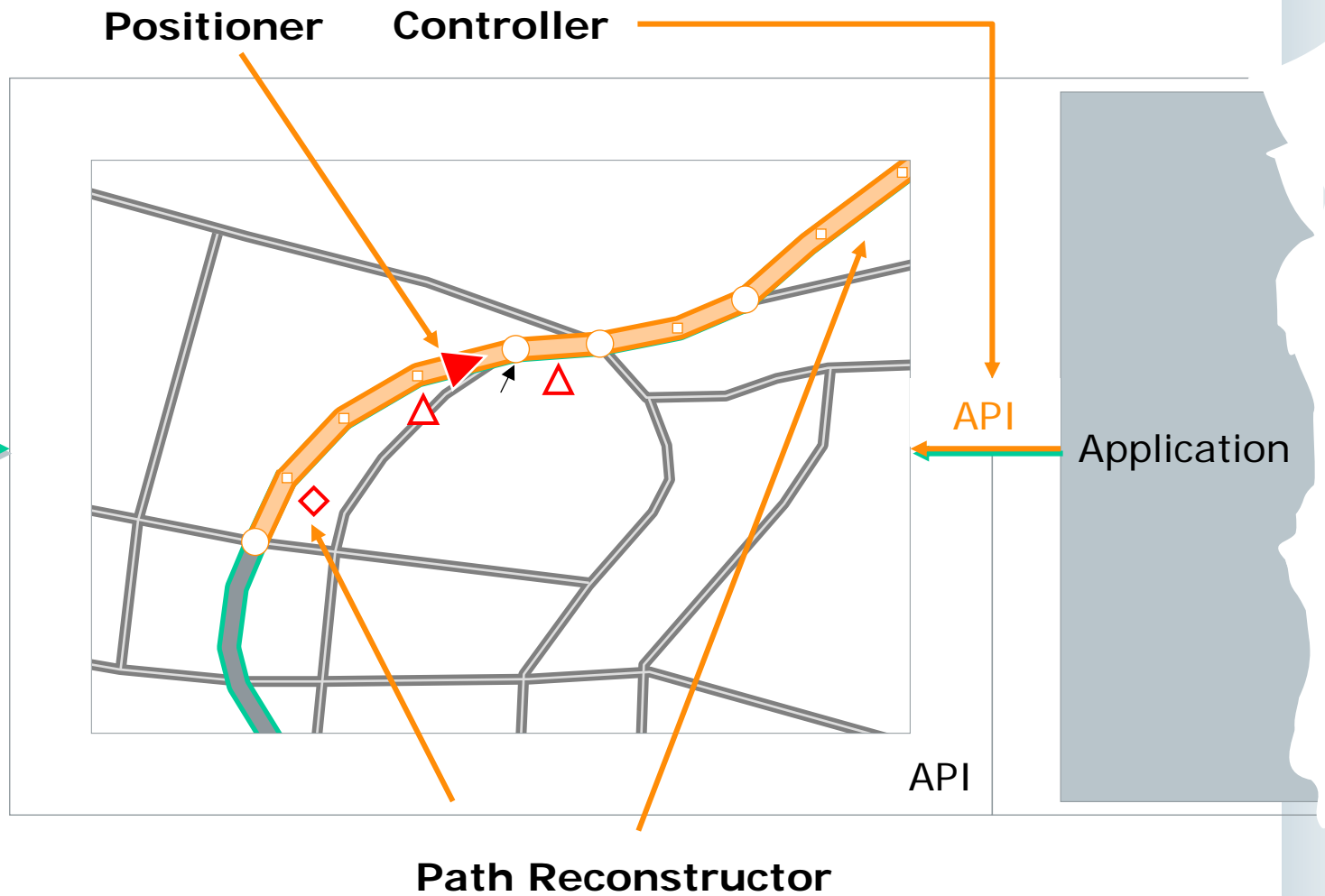
```
#[MESSAGE: CAT_EST_POS CAT_EST_POS_EXT CAT_TOPOLOGY CAT_BASIC_ATTRS CAT_HEADING MSG_SIZE=8,  
# [STANDARD_MSG:  
# [NEW_LINK: LinkId=2, LinkIdFrom=1,  
# [CXN_P_A:  
# [CXN_PARAM: JunctionComplete=true, UTurn=false, ProbabilityOfTravel=20],  
# [CXN_ATTR: GiveWay=1, Type=6],  
# [CXN_ATTR: Heading Change=-1],  
# [LINK_P_A:  
# [LINK_PARAM: Route=false, DrivingDirection=3, Length=115, Lanes=0, Type=19]]  
# ]  
# ]  
# ]  
#]
```

e408828194ae9f307313

**44 82 81 94 ae 9f 30 73
28 13**



AH API: C programming language



AH API: Example



```
AH_COUNTER    i            = 0;
AH_ERROR_CODE err        = GetPath(pathIndex);
AH_DISTANCE   offset     = 0;
AH_COUNTER    capacity   = *size;
*size = 0;
for(; i < nLinks  &&  err >= AH_SUCCESS  &&  capacity > 0;  i++)
{
    AH_DISTANCE length = 0;
    AH_COUNTER  s      = capacity;
    err = AH_GetLinkLength(path[i], &length);
    if (err >= AH_SUCCESS)
    {
        err = AH_GetLinkAttachments(path[i], type, &s, att+ *size);
        if (err >= 0)
        {
            // etc.
        }
    }
}
```



NAVTEQ ADAS Horizon Provider



The screenshot displays the ADAS RP software interface. The main window shows a map with a vehicle icon and a route. The interface includes several plug-in status windows and a log window.

- AGMP Test Plug-In:** Shows status for Link 9 with various parameters like AH_GetLinkLength, AH_GetLinkOnRoute, AH_GetLinkDriveDir, AH_GetLinkPoints, AH_GetLinkProfiles, AH_GetLinkAttachments, and AH_GetLinkConnection.
- AGMP Server Plug-in:** Shows status for AGMP Server, AGMP Stat, VP Trace, and VP Sensor, including position and heading data.
- AGMP Dumper Plug-In:** Shows log messages for position and message data.
- AGMP to ACP Converter Plug-In (hidden):** A hidden plug-in window, indicated by a blue box and an arrow.

The log window contains the following messages:

```
# [POSITION_MSG:
# [EST_POS_BASIC: RelLon=129, RelLat=-840, RefPtIdx=0, PosInt=0, Speed=155, RelAlt=0, TSOrAge=1356]
# ]
757379,4008819efcb8009b054c
#[MESSAGE: CAT_MM_POS CAT_EXT_ATTRS MSG_SIZE=8,
# [POSITION_MSG:
# [MM_POS: Index=0, LinkId=8, Offset=5, Lane=0, Speed=155, RelHeading=0, Intensity=0, Prob=30, TSOrAge=1361]
# ]
757379,100802001426c000f551
#[MESSAGE: CAT_EST_POS_EXT CAT_BASIC_ATTRS MSG_SIZE=8,
# [POSITION_MSG:
# [EST_POS_EXT: Accel=0, AbsHdg=943, YawRate=0, TSOrAge=1361]
# ]
AGMP Dumper Plug-In
757379,2008c075e003fffffd51
```



ACP in the car



Test drive	ASCP Position msg/s	ASCP Network msg/s	Total ASCP msg/s	Band width usage	Comments
BMW2 urban	3.00	0.72	3.72	0.08% @500kBd	NAVTEQ AHP with single path set up – see BMW1.3 test in Table 4-1
BMW2 rural	3.00	0.60	3.60		
BMW2 highway	3.00	0.56	3.56		
DC1 urban	3.00	1,58	4.58	0.11% @500kBd	
DC1 rural	2.99	1,70	4.69		
DC1 highway	2.99	1,58	4.57		
DC2 urban	2.03	2.16	4.19	0.08% @500kBd	Tests of 1/20ms vs. 10/200ms - burst mode gave equal results, because no difference with respect without effect on to mean average message frequencies!
DC2 rural	2.02	2.17	4.19		
DC2 highway	1.94	1.62	3.56		
Ford1 urban full content	3.00	1.04	4.04	≈0.1% @500kBd	
Ford1 rural full content	2.93	1.44	4.37		
Ford1 highway full content	2.71	1.25	3.96		



ACP Test Results



- Test drives have been performed on different vehicles in different environments and the resulting data streams been mixed off-line while varying several transmission parameters. The whole variety of performed tests, even the most challenging set ups have shown the following results:
 - Transmission errors have not been recorded on the test equipment on the final mixed test set-up.
 - **Bandwidth requirement** for the horizon data stream is normally around 0.1% of the total bus capacity, reaching **up to 1.7%** for very demanding set ups.
 - The maximum **added latency** charged to the background traffic (lower priority CAN frames) keeps below 0.37ms for normal conditions and **below 0.53ms** for more challenging set ups.
 - The **total latencies** experienced for the MAPS&ADAS data stream are around 0.25ms average and 0.5ms maximum for normal conditions, reaching up to 0.5ms average and **1ms maximum** for more demanding test conditions.



- Current protocol does not include error correction mechanism.
- Protocol highly compressed
→ non-trivial extensions
- Only 2 CAN identifiers used
→ polymorphic CAN frames
 - Unacceptable for some car manufacturers

Will be solved in version 2 of the protocol.



Thank you for your attention!

Sinisa Durekovic, NAVTEQ
sinisa.durekovic@navteq.com

