

***Issues on mapping
Long Term Roadworks to DEMN***

The story so far...

- RWW had been pushed in the C-ITS corridor forerunner project as first I2V use case
- Germany and Austria (comparably similar legal/operational framework) had pushed inside the corridor for a solution for short-term roadworks by safety trailers
 - Full network coverage achievable in short time (the R-ITS-S are towed to the point where they are needed)
 - Stand alone mode without connection to the centre possible, based on ego information of the trailer
 - Incentive for operators to invest due to operational benefits (“internal use case” – trailer operational data)
- But: drivers don't understand the distinction between short-term and long-term – will they value a systems that sometimes works and sometimes not?

Characteristics of ST-RWW

- Uses DEN(M) = mature facility layer services and message set
- No dedicated implementation in vehicle
→ align with general DEN implementation
- DENM has suitable data frames/elements (in general, also dedicated roadworks container):
 - Event position (incl. trace)
 - Some classification of the problem (cause codes)
 - Lane closures and use of hard shoulder
 - Speed limit
 - Traffic flow rule
 - ...

What about Long Term?

- The ST RWW concept using only DENM does not easily extend to long term roadworks
 - Changing attributes (→ longitudinal segmentation) requires a large amount of DENMs
 - Same for different attributes laterally
 - Lane restrictions (e.g. width) are not covered
 - The use of the lane-related attributes in DENM is not self-evident in LT RW (modified lane layout with temporary markings)

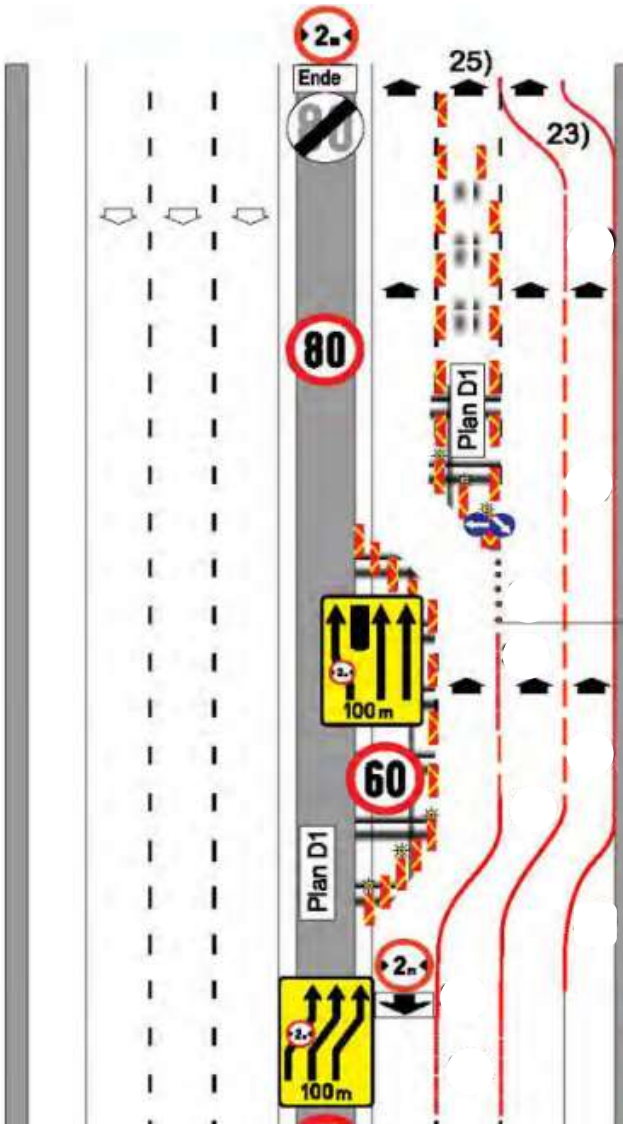
Longitudinal segmentation problem

	Number of DENMs	Lanes LanePosition	DENM DE/DF
Curve	2	2 / 1	MultipleCurvesStartingWithLeftTurn
Speed limit 80	1	(all)	SpeedLimit
Curve	1	3	MultipleCurvesStartingWithLeftTurn
Speed limit 60	1	(all)	SpeedLimit
Curve	1	(all)	MultipleCurvesStartingWithRightTurn HardShoulderStatus = closed
2m	X	3	???
Speed limit 80	1	(all)	SpeedLimit
Speed limit 100	1	(all)	SpeedLimit
Sum: 8			

No concept for lane restrictions.

[,restricted types' allows to exclude vehicle types (e.g. lorries)]

Different lane configuration coding options possible – Need to fix in Infrastructure Profile

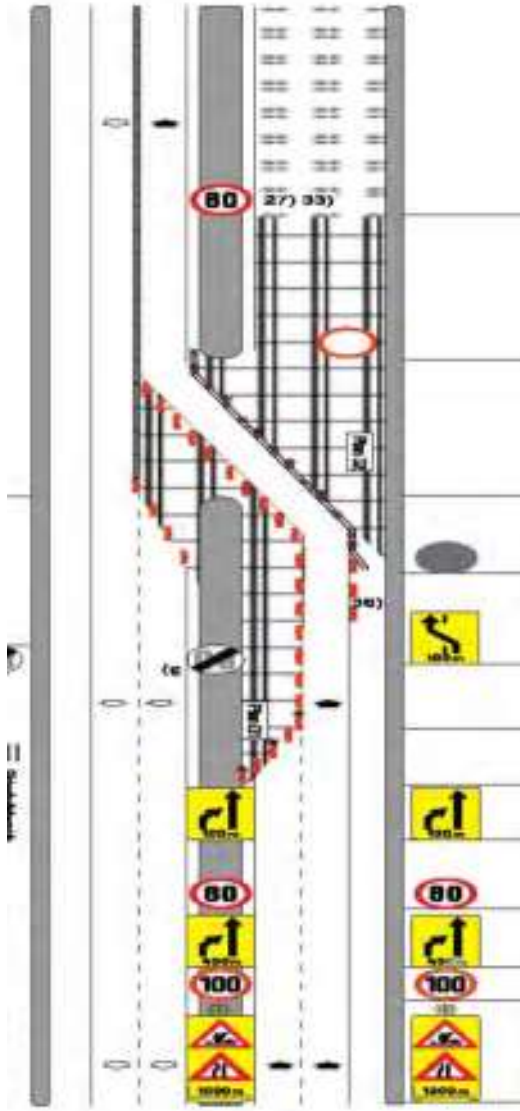


Variant A	Variant B
DrivingLaneStatus	DrivingLaneStatus
HardShoulderStatus	HardShoulderStatus
DL: { 0 - 0 - 0 } HS: closed	DL: { 0 - 1 - 0 } HS: availableForDriving
DL: { 0 - 0 - 0 } HS: closed	DL: { 0 - 0 - 1 } HS: availableForDriving
Note that in this variant the DrivingLaneStatus does not change at all	
DL: { 0 - 0 - 0 } HS: availableForStopping	DL: { 0 - 0 - 0 } HS: availableForStopping

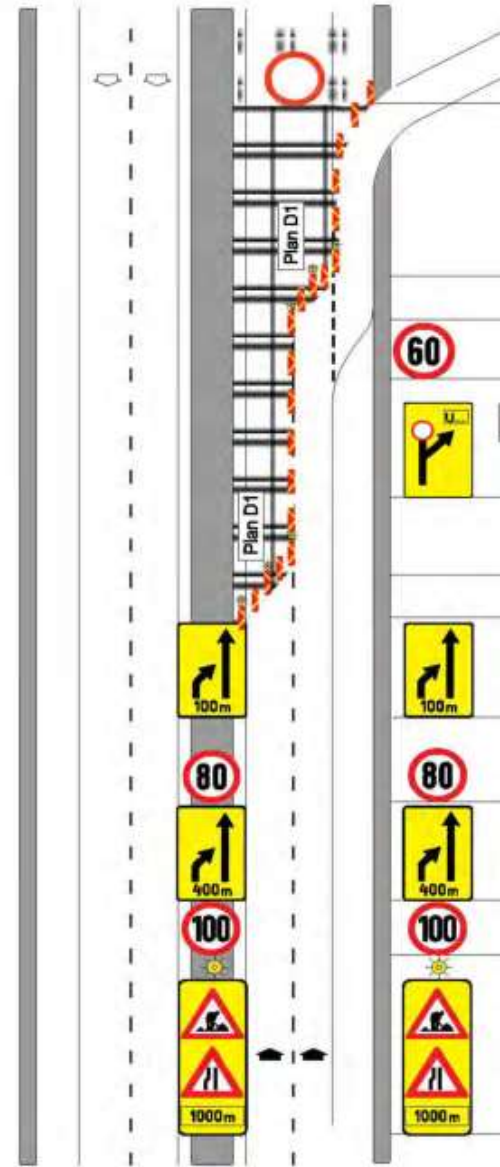
DrivingLaneStatus is depicted as first element from the left = right lane - 0 = open, 1 = closed.

Some relevant information cannot be easily coded in DENM

How to code counterflow?



How to code full closures?



Problem of long segments (using EventHistory)

Current situation:

- Release point of a segment is specified using EventHistory
→ Trace of up to 23 (*) points, last point determines the release point
- First point of trace is specified by
„offset delta position with regards to the current detected event point”
Assumption: This is meant to be the “eventPosition”
- Subsequent points are specified by
„offset delta position with respect to the previous EventPoint”
Policy: Maximum distance of 22 metres between them?
(or what are the requirements for a “trace”)?

Problem:

- Delta specification can have a max. capacity of 959 m in Austria (worst case)
→ max. length of a segment can be $959 \text{ m} + (22 \text{ points} * 22 \text{ m}) \approx 1,4 \text{ km}$

(*) additional contradiction: Common data dictionary ETSI TS 102 894-2 V1.2.1 (2014-09) specifies 23 points (ASN.1), whereas DEMN specification ETSI EN 302 637-3 V1.2.2 (2014-11) textually describes up to 40 points.

Problem of long segments (using EventHistory): Calculation of max. Delta specification

- Length of a degree in kilometres for longitude and latitude depends on the specific latitude in question:

Latitude	54 (northern Germany)	49 (northern Austria)	46,5 (southern Austria)	0 (Equator)
1 degree lat	111,304 km	111,209 km	111,161 km	110,574 km
1 degree long	65,575 km	73,171 km	76,762 km	111,319 km

For Austria:

- 1 **microdegree** would correspond to **11,11 Centimetres lat** and **7,31 centimetres long** (minimum values)
- By definition, the DEMN EventPosition can cover at max 13.107,1 microdegrees (lat as well as long)
- For a straight road from West to East, the maximum delta long which can be specified is $13.107,1 \times 7,3171 \text{ cm} = \mathbf{959 \text{ m}}$ (worst case scenario; even lower value for Germany)

Links:

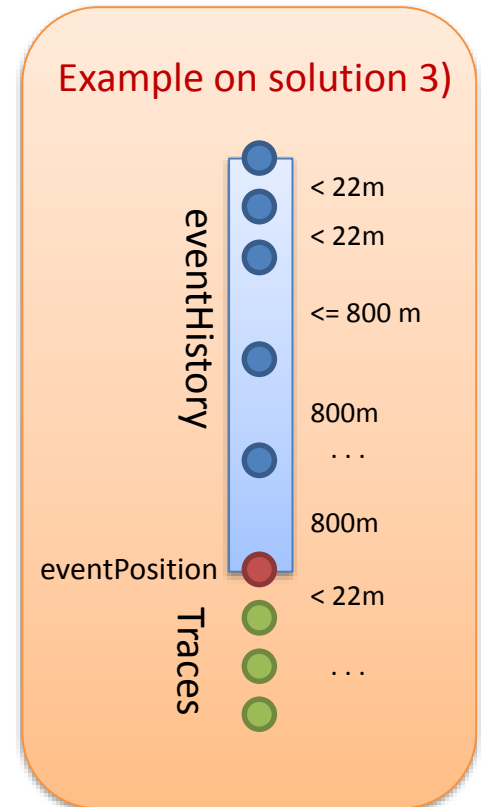
- Calculation of length of a degree: <http://www.csgnetwork.com/degreeenllavcalc.html>
- Geomap: <http://gps0.de/maps/>

How to code long segments (using EventHistory)?

Possible solutions:

1. Defining a maximum segment length (900m for example)
Add additional (nearly identical) DENMs with eventPosition = releasePoint of predecessor DENM, when needed (i.e. kind of repetition)
2. Omit releasePoints, i.e. the EventHistory
New DENMs overrule the previous ones.
Disadvantage: How to clarify, that DENMs for multiple lanes should not overrule each other?

3. **Drop the policy of 22m max. between two points for a few “interpolation points”; allow distances of 800 m**



Summary of options

Can be phrased in DENM:

- RWW type
- Position ('eventPosition')
- Speed limits, also per lane
- Lane closures
- Hardshoulder usage or closure
- Sharp curve warning (i.e. lane deviations)
- Slow or stationary vehicles
- Works related or environmental warnings (steam, dust, noise etc.)
- EndOfQueue warning possible

Can be phrased in DENM with limitations:

- Length of work (release point by 'EventHistory') – limitation see extra slides

Can NOT be phrased in DENM:

- Width-restrictions
- Lane topology, Carriageway split, lane deviation to counterflow carriageway
- Lane geometry and specific restrictions, especially restricted width (narrow lanes) and weight, height)
- Route choice advise (e.g. 'off-ramp not available')
- Full closure and deviating traffic off the motorway (junction closure)
- Short entry/exits ramps

Not considered for DENM:

- Signs only valid for roadwork vehicles (most likely within the roadworks-area)
- Right of way signs (esp. STOP on a dangerous on-ramp)
- Prohibition signs (e.g. a prohibition sign for all vehicles within the marked roadworks area)
- Destination signs or changes on those signs

Conclusion

- The proposed way to advance in short term is to use different message sets at the same time
 - DENM as a basic danger warning
 - IVI for subtle regulation (by coding the signs implementing the regulation)
 - MAP (in the future) to provide roadwork geometry and topology information at high granularity
- Vehicles can decide which layers they want to process, but the messages can (currently) not refer to each other
- We still have to agree (amongst ourselves, but also with in-vehicle applications) and fix (in the infrastructure profile) which DENM features to use and which to drop (information will then only be available in IVI/MAP)