Dynamic eHorizon with Traffic Light Information for Efficient Urban Traffic

Dr. Hongjun Pu

hongjun.pu@continental-corporation.com

Continental Automotive GmbH, Wetzlar, Germany

Continental

What can C-ITS do for Intersection Traffic?

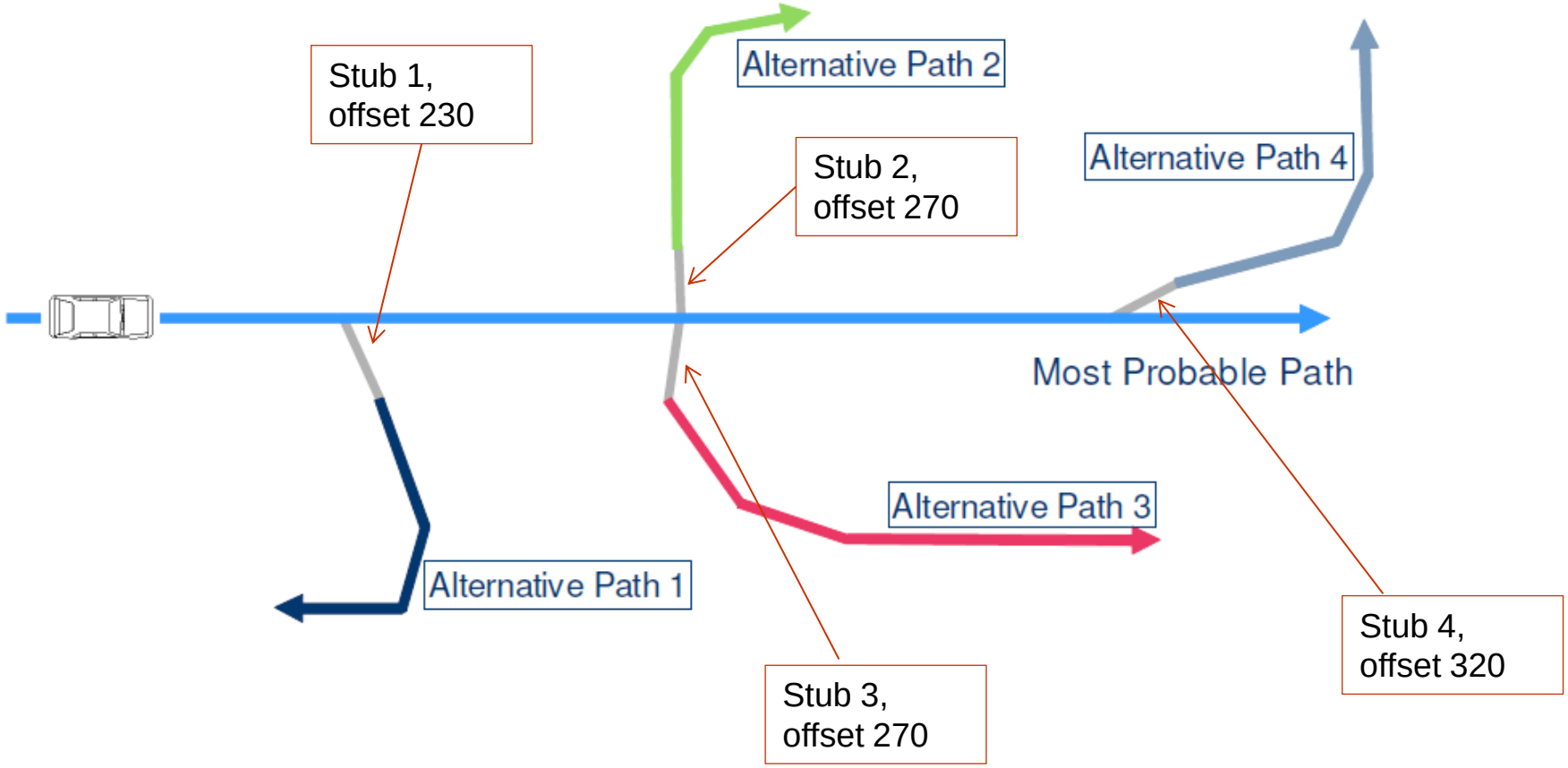
- The intersection is a known bottom-neck of the city traffic and a hotspot with respect to accident and accident potential.
- There were and are continuous efforts for increasing the traffic efficiency and safety in intersection areas
- With the increasing networking of vehicles with each other and with the infrastructure, further progresses are expected through the cooperative ITS (C-ITS).

- The greatest potential of C-ITS lies on the extended information horizon of the vehicles and drivers
- The C-ITS enables new kinds of driver information and assistance applications, e.g. cooperative speed management based on predictive traffic light information at intersections
- The provision of traffic light information to the in-vehicle applications becomes an important feature in cooperative ITS
- In this paper we present a solution based on the electronic eHorizon (eH)

The electronic Horizon and It's Applications

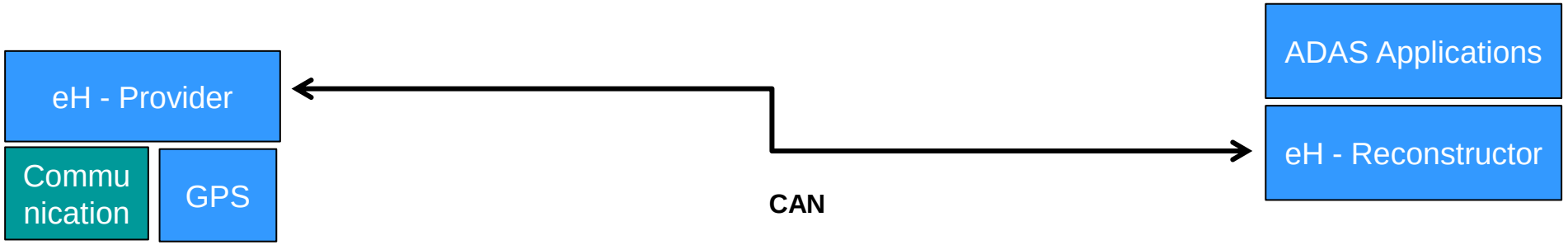
- The electronic horizon (eH) extract road attributes like road segments, intersection, slope, curvature, etc. from a geo-database and provide them over a well specified CAN-interface-
- In this way, nearly all ECUs can get the road information for improving their own functionality
- For example, a vehicle cruise control adapted to road attributes can reduce fuel consumption compared to an usual cruise control

Basic Elements of the electronic Horizon: Paths, Stubs and MPP



- Paths and stubs are the basic elements of eHorizon describing the road segments and the branch-points
- The ADAS attributes, which support the driver assistance applications, are provided to the paths

Deployment of eHorizon in Vehicle System

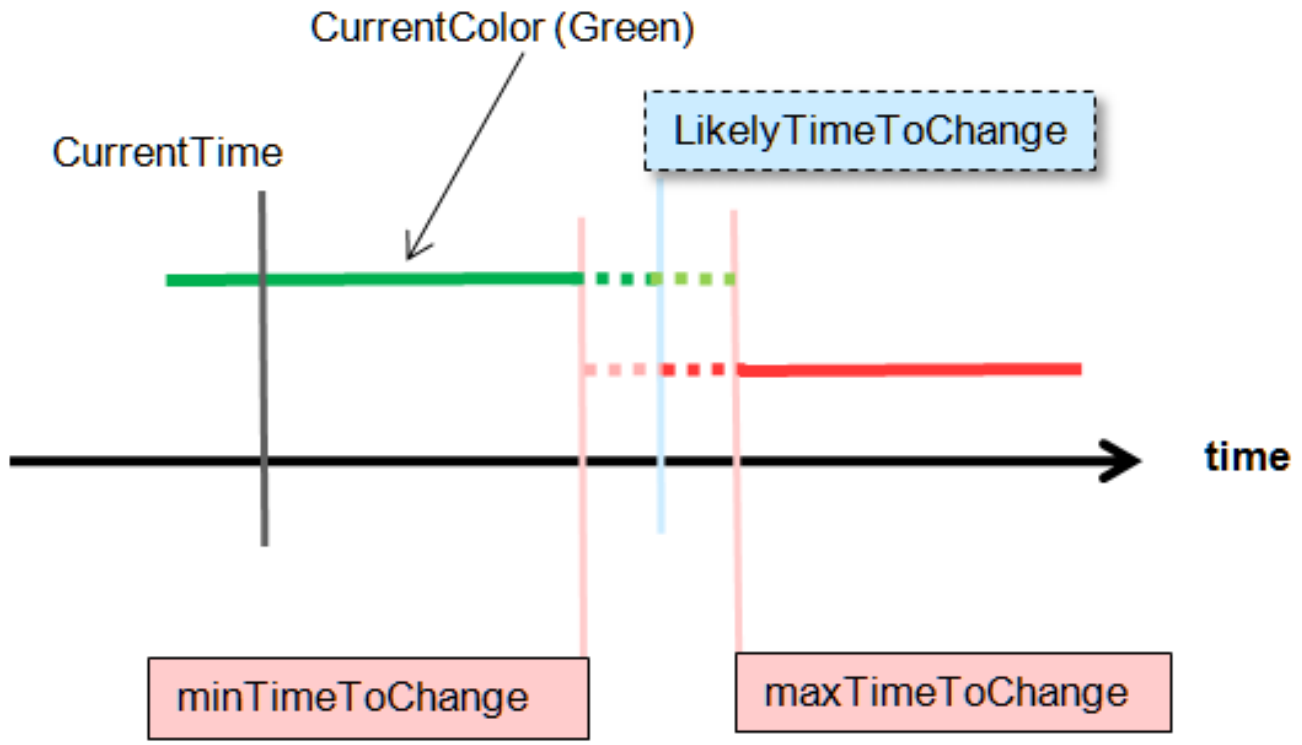


- Diverse eH messages are defined for the provision of road data
- All eH messages are contained in 64 bit CAN frame
- Profile-Long message depicted right has the biggest payload
- Our dynamic.extension of eH uses different Profile-Long messages (depicted right) for traffic light signals

	7	6	5	4	3	2	1	0
7	Message Type			Offset				
6								
5	Cyclic Count		Path Index					
4	Profile Type					Control Point	Retrans mission	Update
3	Value							
2								
1								
0								

Traffic Light Data in Vehicle: Status and next change

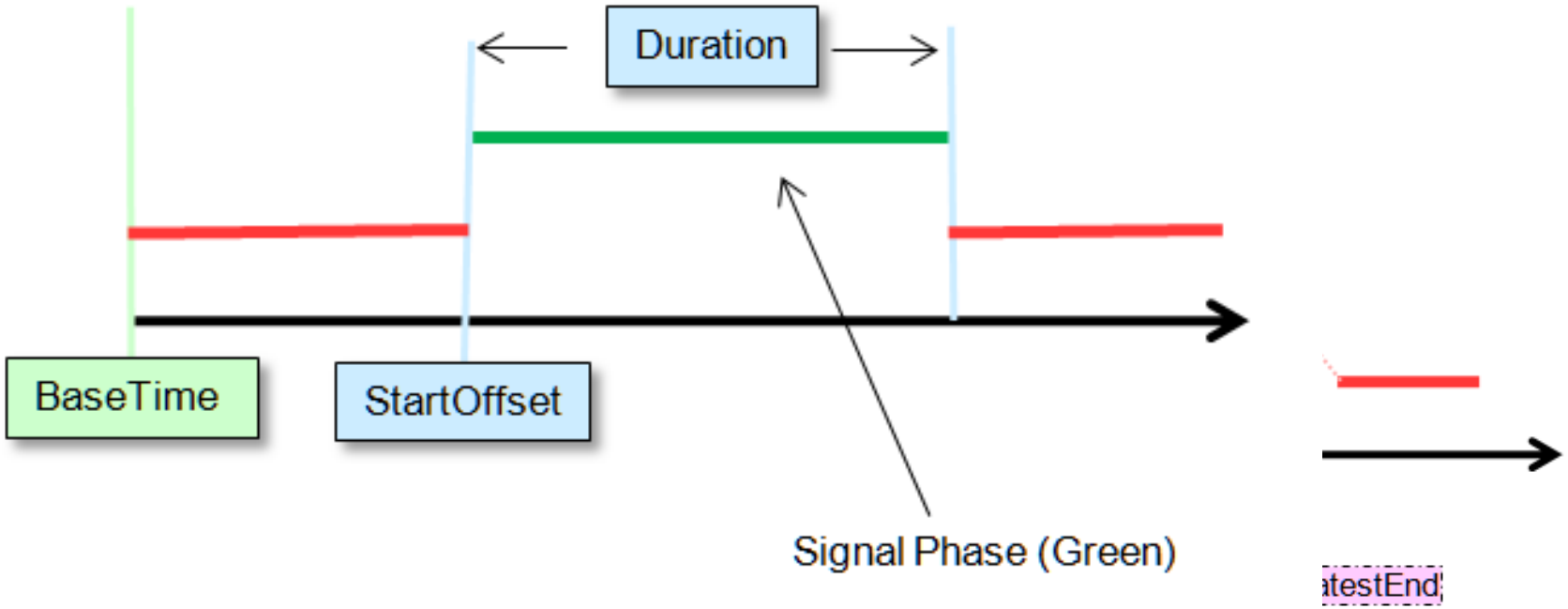
Via C2X communication (ITS-G5/IEEE802.11p), the traffic light control unit can directly send a message named “Signal Phase and Timing” (SPAT) to the vehicles in a range of some hundreds of meters.



Traffic Light Data in Vehicle: full phase information

Traffic light information can also be presented in a dedicated TPEG-message, e.g. Traffic Signal Information (TSI). Like other TPEG-messages, the TSI may be transmitted via different channels, e.g. Internet, DAB, etc.

Because of the almost unlimited range of transmission over Internet and DAB Broadcasting, a TPEG-TSI message about an intersection may be received by vehicles far from this intersection.



CAN-messages for Traffic Light Signals I

Tag	Bit	Content and Format
		Head
Message Type	3	
Profile Type	5	= 16
Cyclic Count	2	
Path Index	6	ID of the path, on which the stop line is
Offset	13	Position of the stop line as offset to the origin of the path
Value		
Current Color	3	0-7 for green, red, amber, amber-blinker, red + green arrow right, red + green arrow left, dark green and not available.
MinTimeToChange	10	The earliest time of next switch; Resolution 0.1s; Range 0 – 1021; 1022 for all greater values; 1023 for not available.
IntervalTimeToChange	5	Max. time to change after MinTimeToChange; Resolution 0,1s; Range 0–29; 30 for all greater values; 31 for not available.
LikelyTimeToChange	5	Likely time to change after MinTimeToChange; Resolution 0,1s; Range 0–29; 30 for all greater values; 31 for not available.
Confidence	4	Probability of LikelyTimeToChange; Range 0-15; The value 15 means 100%.
GreenWaveSpeed	5	Reference speed for remaining in green wave; Optional; Range 0-30 m/sec (0–108 km/h); 31 for not available.

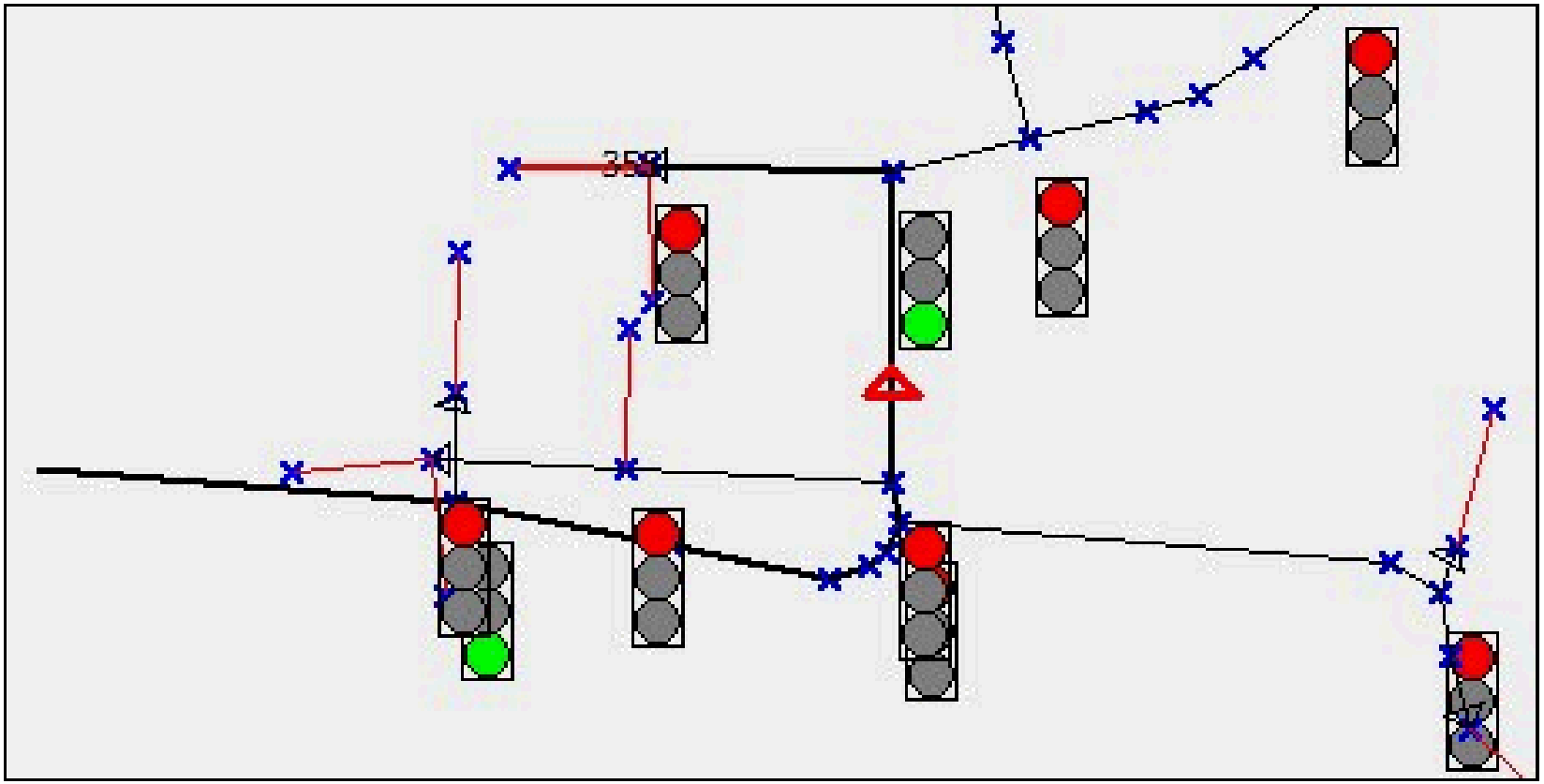
CAN-messages for Traffic Light Signals IIa

Tag	Bit	Content and Format
	Head	
Message Type	3	
Profile Type	5	= 17
Cyclic Count	2	
Path Index	6	ID of the path, on which the stop line is
Offset	13	Position of the stop line as offset to the origin of the path
	Value	
ControlStatus	1	0=fixed time; 1=Dynamic time.
NextStartGreen	17	Start of the next green phase within a day (24h); Resolution 1s.
GreenPhase	7	Range 0-125s; Duration of the green phase; 126 for values ≥ 126; 127 for not available.
NoGreenPhase	7	0-125s; Duration of the non-green phase; 126 for values ≥ 126; 127 for not available.

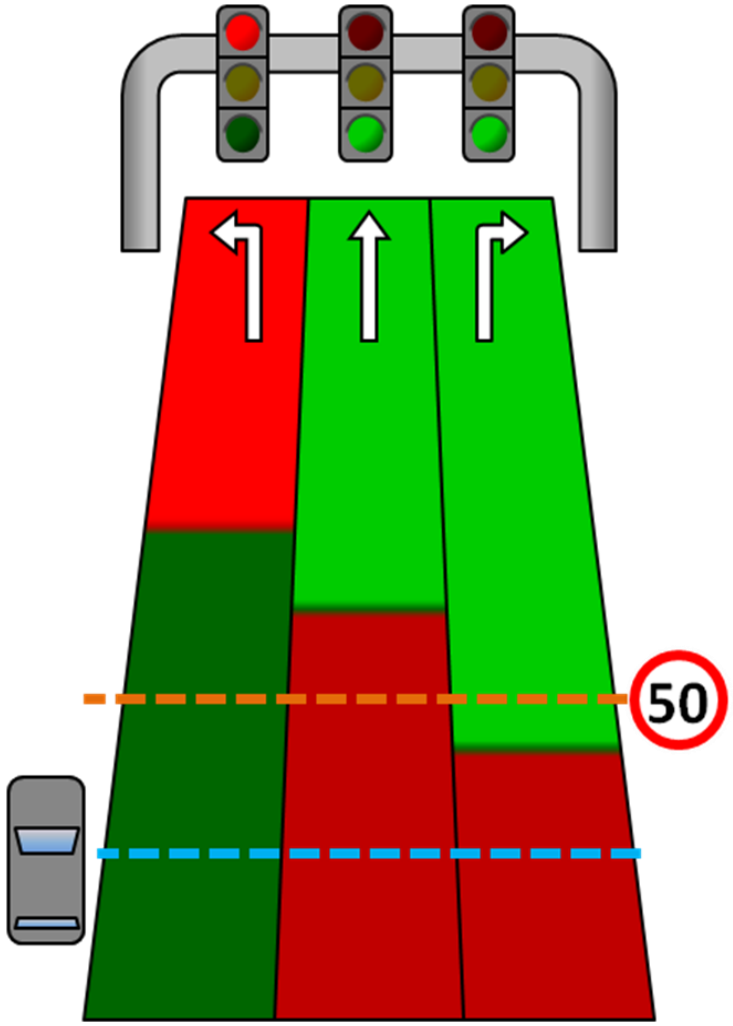
CAN-messages for Traffic Light Signals IIb

Tag	*Bit*	*Content and Format*
	Head	
Message Type	3	
Profile Type	5	= 18
Cyclic Count	2	
Path Index	6	ID of the path, on which the stop line is
Offset	13	Position of the stop line as offset to the origin of the path
	Value	
SignalDirection	4	Bit string
MostLikelyStart	7	Most likely start as delta before NextStartGreen; Resolution 0.1s.
MostLikelyEnd	7	Most likely end as delta after NextStartGreen + GreenPhase; Resolution 0.1s.
EarliestStart	7	Earliest start as delta before NextStartGreen; Resolution 0.1s.
LatestEnd	7	Latest end as delta after NextStartGreen + GreenPhase; Resolution 0.1s.

eHorizon with Traffic Light



An Example of Traffic Light Assistant [1]



Presents the signal phase in real time with constant geometrical form

The movement of ego-vehicle is synchronized with the signal phases in a natural way

Acceleration and deceleration of the ego-vehicle can be directly mapped to the signal phases and with respect to the speed limit

Provides also information for a tactic lane change maneuver

[1] H. Pu, *Ein neues Konzept zur Darstellung prädiktiver Ampelinformation für die kooperative Kreuzungsassistenz*, Innteract Conference, 7.-8. May 2015, Chemnitz, Germany

Thanks a lot for your attention !

Your questions are welcome

Or per e-mail to hongjun.pu@continental-corporation.com