



the mind of movement

# Daytime Dependent Routing xServer2

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the mind of movement

# Daytime Dependent Routing xServer2

(today Sparring) Partners



Volker Lauterfeld

Developer

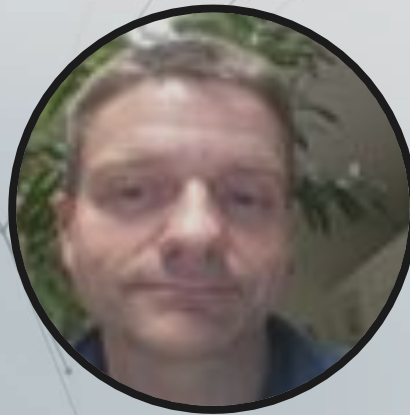
COS Oberkirch

Partner of PTV > 10 years

Strategic Planning / Dispatching Solution

xServer Key user

Active Forum User



Rolf Manzke

Senior Consultant


ABAT (Bremen)

Partner of PTV since >10 years

Integrator of xServers / SAP

xServer Key user

Active Forum User



# Goals


**Today we want to give answers to the following questions / enable you to**

1. What is routing?
2. How can I parametrize routing?
3. Distinguish between the usage scenarios
4. Decide about how to use our components in the best way

If an answers are missing → check [the xServer forum](https://xserver.ptvgroup.com/forum)  
<https://xserver.ptvgroup.com/forum>

Access is free of cost!

Partners can get access to further resources (let me know)



# Goals

## In other words


1. We want you to understand the potential of the interface for your use cases  
→ extend your application
2. Understanding the necessary parameters and configuration settings for correct and optimal usage  
→ **quality** of output  
→ **performance**



# NO Goals

## Not in the focus today

1. Documentation of the various feature layers
2. How to install feature layers
3. How to activate



# Agenda

1. Basics about routing ( TC )
2. Extensions about routing ( TC )
3. Technical Overview ( DEV )
4. Live Demo ( DEV )
5. Discussion ( TC,PM,DEV, Partner)



## Routing in a nutshell

1. In the context of a routing calculation each street segment has a **specific cost value** (described later)
2. The optimal route is the sequence of segments that
  - **connects two waypoints** and
  - **minimizes the aggregated costs** of the segments
3. Once the route is calculated further info can be determined (via the lister)
  - emissions
  - toll
  - manoeuvres
4. In fact there's an initial step called Linking

The next slides will describe routing on a very rough level. Detailed routing is much more flexible and supports about 200 parameters





## Cost calculation

1. The core cost value is computed based on  
→ segment length & required driving time  
(incl. OPTIMIZATION, distTimeWeight)
2. In a next step the core value could be increased/decreased due to malus mechanism, e.g. due to NC, attributes (isTollTruck)
3. If “violations are allowed with a penalty of XXX” this means a forbidden segment (e.g. based on not matching TruckAttributes) is treated as allowed with additional costs (e.g. 50000).
4. Depending on the geometry in the region this could lead to “segment appears in the route because the detour would cause too many additional costs”



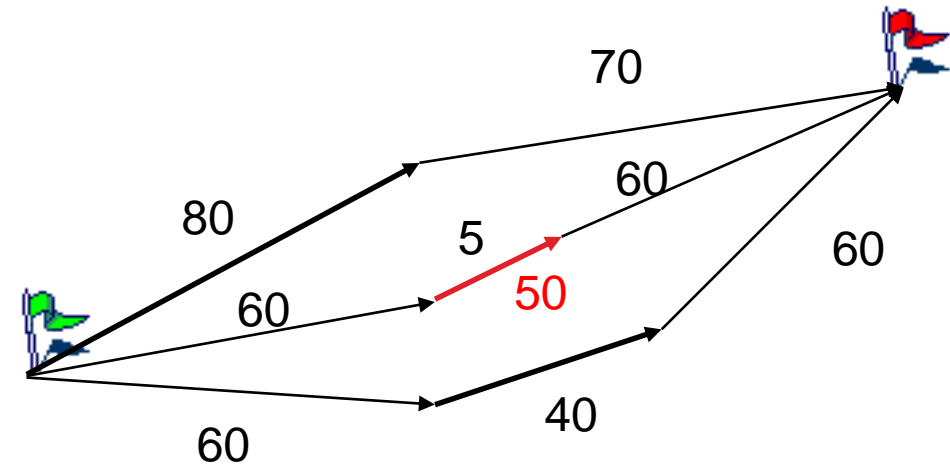
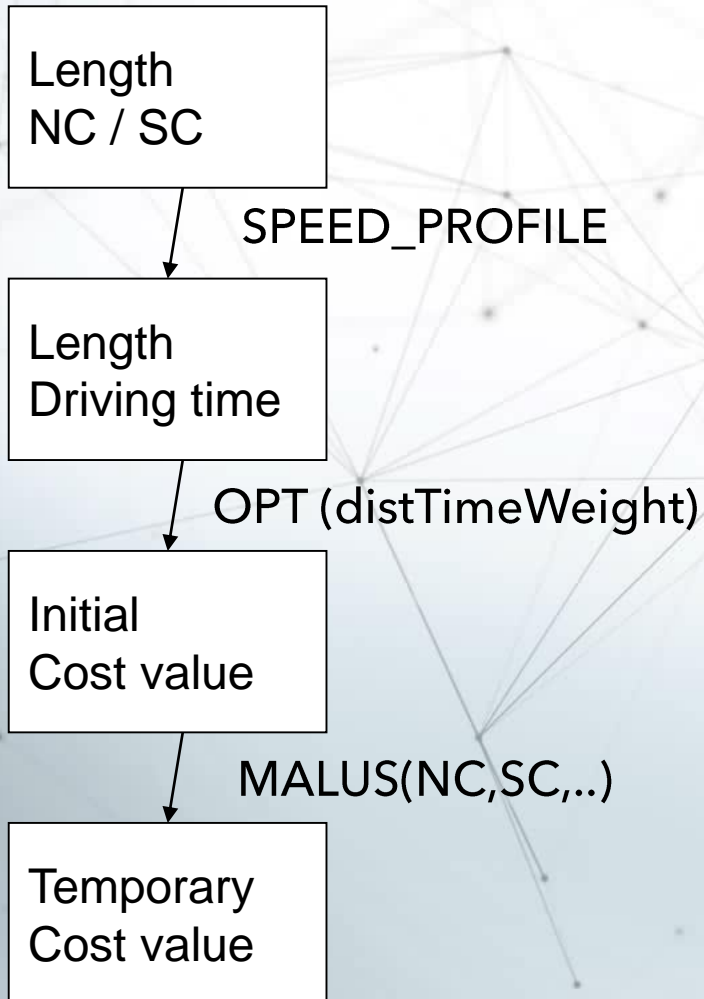


## Speed on a segment

The speed on a segment depends on various factors

- **Live Traffic Incidents** could set a temporary speed value  
(PTV\_TrafficIncidents)
- Historical **Speed patterns**  
(PTV\_SpeedPatterns, PTV\_TruckSpeedPatterns)
- **TruckAttributes** could cause blockings or violations on segments:category or values  
(PTV\_TruckAttributes)
- **Static speeds**  
→ finally there are also static speed values define by the user / profile

# Routing in general: segment costs



## approximation formula

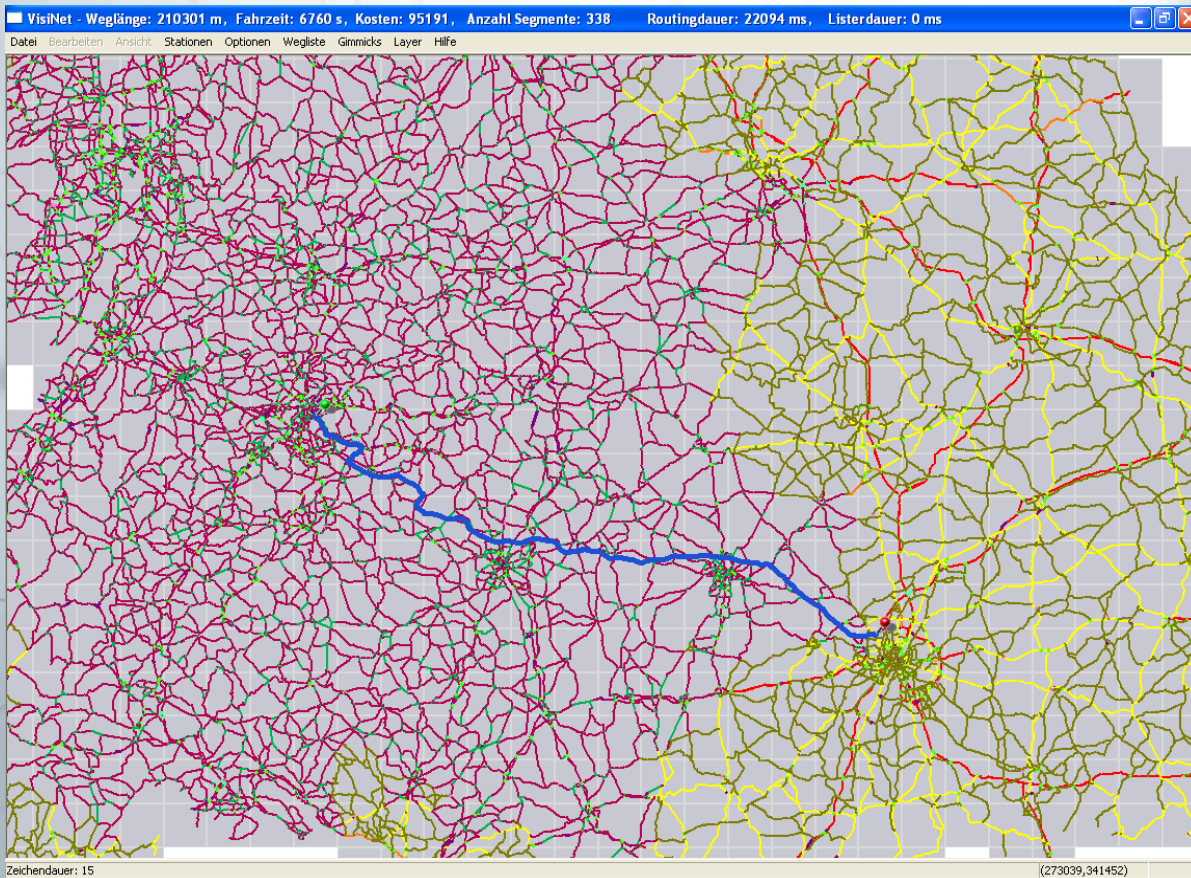
$$\frac{\text{OPT} \times \text{TIME} \times 10 + (100 - \text{OPT}) \times \text{DIST}}{100}$$

OPT = 0 → DIST  
OPT = 20 → 2 x TIME + 0.8 x DIST  
OPT = 80 → 8 x TIME + 0.2 x DIST  
OPT = 100 → 10 x TIME

North = 80 x 1.50 + 70 = 190  
South = 60 + 40 x 1.50 + 60 = 180

**The „best“ route depends  
therefore on the malus value!**

# Leveling



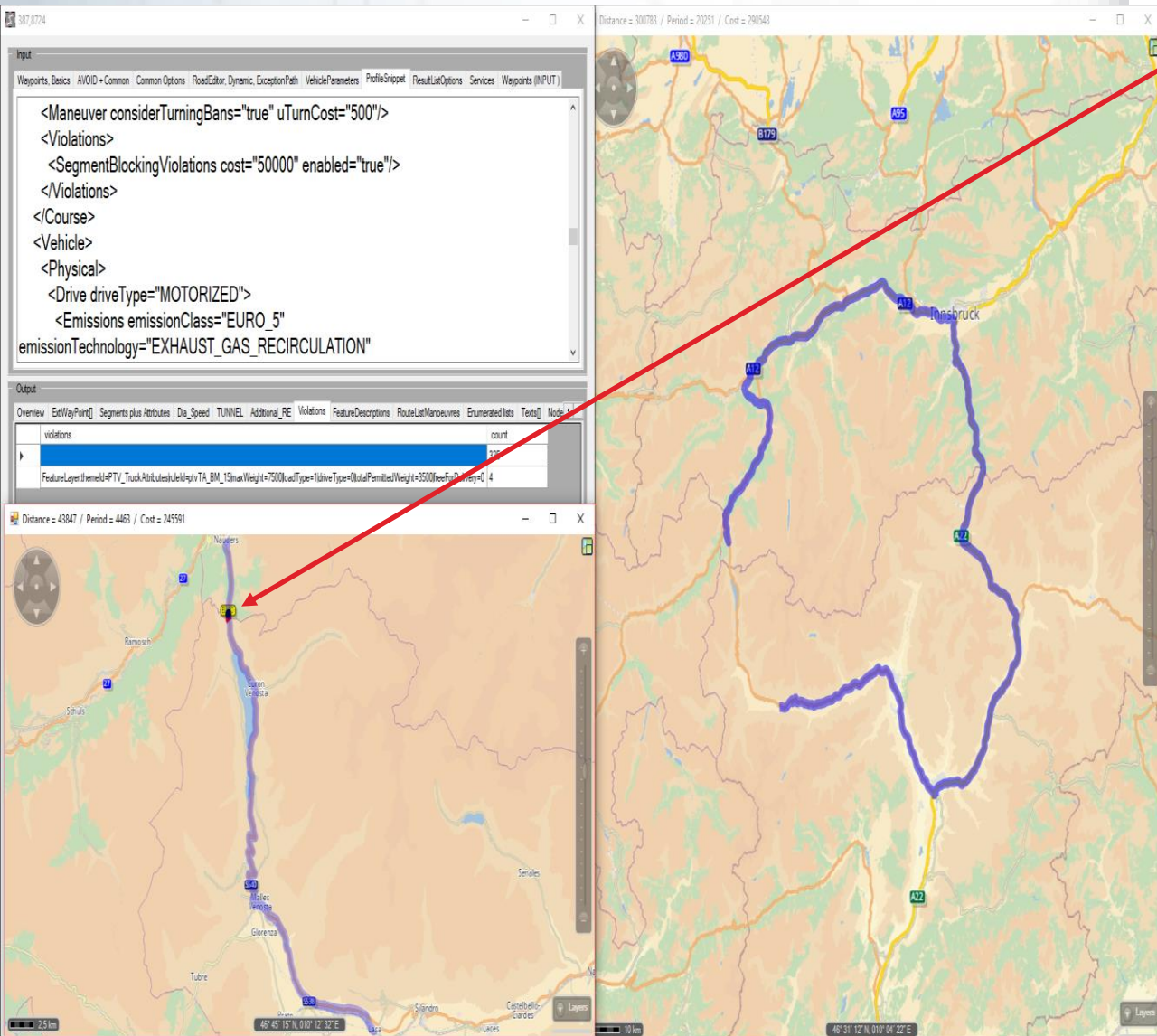
Leveling means to reduce the total number of segments based on a simple strategy

1. Segments which are too far away from an involved waypoint are removed temporarily
2. Usually this filter applies to lower network classes (NC3 – NC7)  

```
<Algorithm AStarAggressiveness="1.3">  
<LevellingScopeByNetworkClass searchSpace="-1"/>  
<LevellingScopeByNetworkClass searchSpace="-1"/>  
<LevellingScopeByNetworkClass searchSpace="-1"/>  
<LevellingScopeByNetworkClass searchSpace="200"/>  
<LevellingScopeByNetworkClass searchSpace="50"/>  
<LevellingScopeByNetworkClass searchSpace="20"/>  
<LevellingScopeByNetworkClass searchSpace="10"/>  
<LevellingScopeByNetworkClass searchSpace="10"/>  
</Algorithm>
```
3. Leveling is applied to increase performance within traditional routing but it also reduces quality (and sometimes causes routing errors)
4. High Performance Routing is so fast that it doesn't need Leveling – it is therefore exact

# Violations

Violated segments get an additional temporary cost value (usually 50'000)

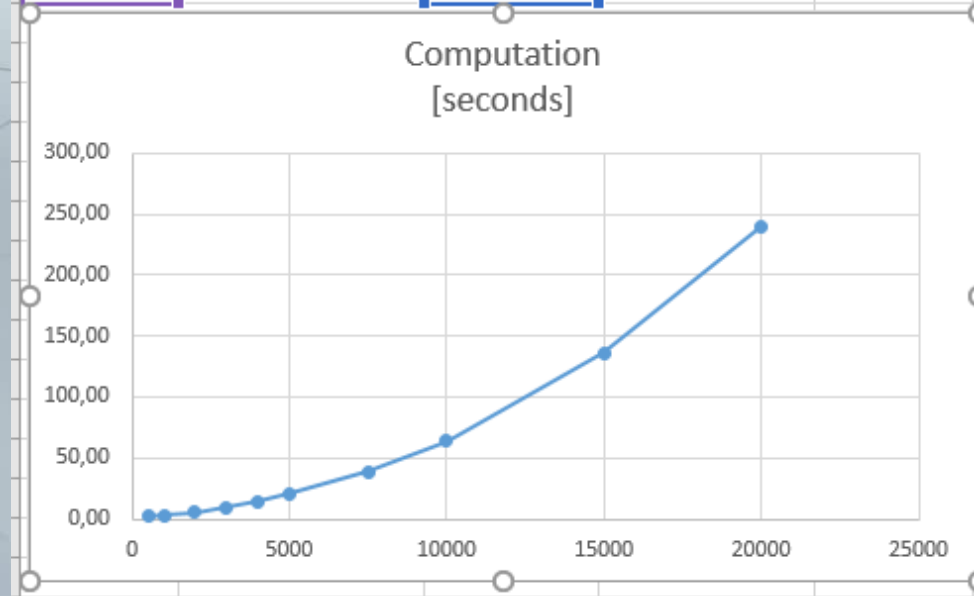


1. Left (via Reschenpass, forbidden for trucks):  
dist = 43847 ; time = 4463 ; 4 violations  
→ cost = 245.xxx
2. Right (no violations):  
dist = 300783 ; time = 20251 ; no violations  
→ cost = 290.xxx
3. If VIOLATIONS are allowed the left track is returned, otherwise the right track is returned



# High Performance Routing

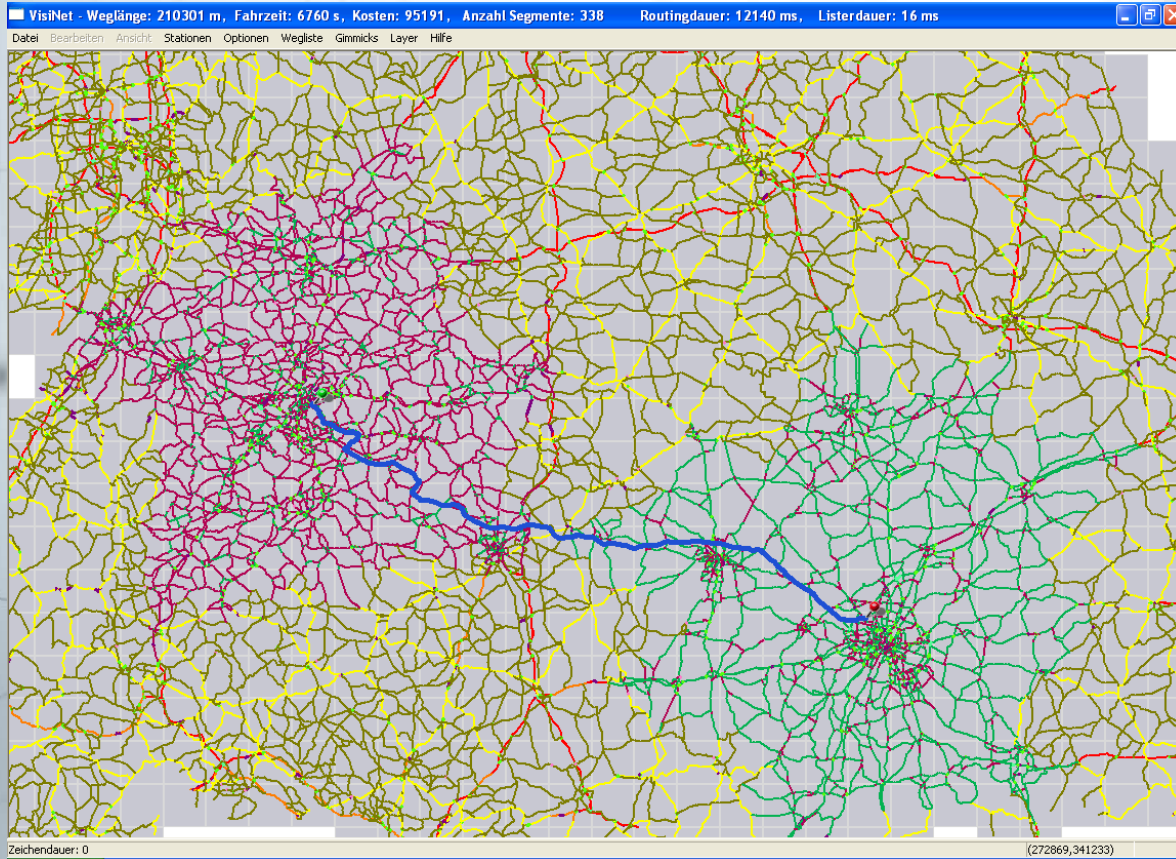
Rows	Relations	Computation [seconds]	Filesize [Bytes]	Filesize
500	250.000	2,00	1.500.000	1.50 MB
1000	1.000.000	3,00	6.000.000	6.00 MB
2000	4.000.000	5,50	24.000.000	24.00 MB
3000	9.000.000	9,50	54.000.000	54.00 MB
4000	16.000.000	14,50	96.000.000	96.00 MB
5000	25.000.000	21,00	150.000.000	150.00 MB
7500	56.250.000	39,00	337.500.000	337.50 MB
10000	100.000.000	64,00	600.000.000	600.00 MB
15000	225.000.000	136,00	1.350.000.000	1.35 GB
20000	400.000.000	240,00	2.400.000.000	2.40 GB



Some years ago PTV invented so-called HPR

- Depends on pre-processing a HPR network (aka SearchGraph) which is then used to improve routing performance within A→B and DistanceMatrix
- Doesn't speed up listing
- Network is based on
  - map data
  - additional content (FL, TA)
  - profile
  - **strategies**
- If one of those factors changes → recalc required
- HPR network is hungry for memory!  
Preprocessing is even more hungry

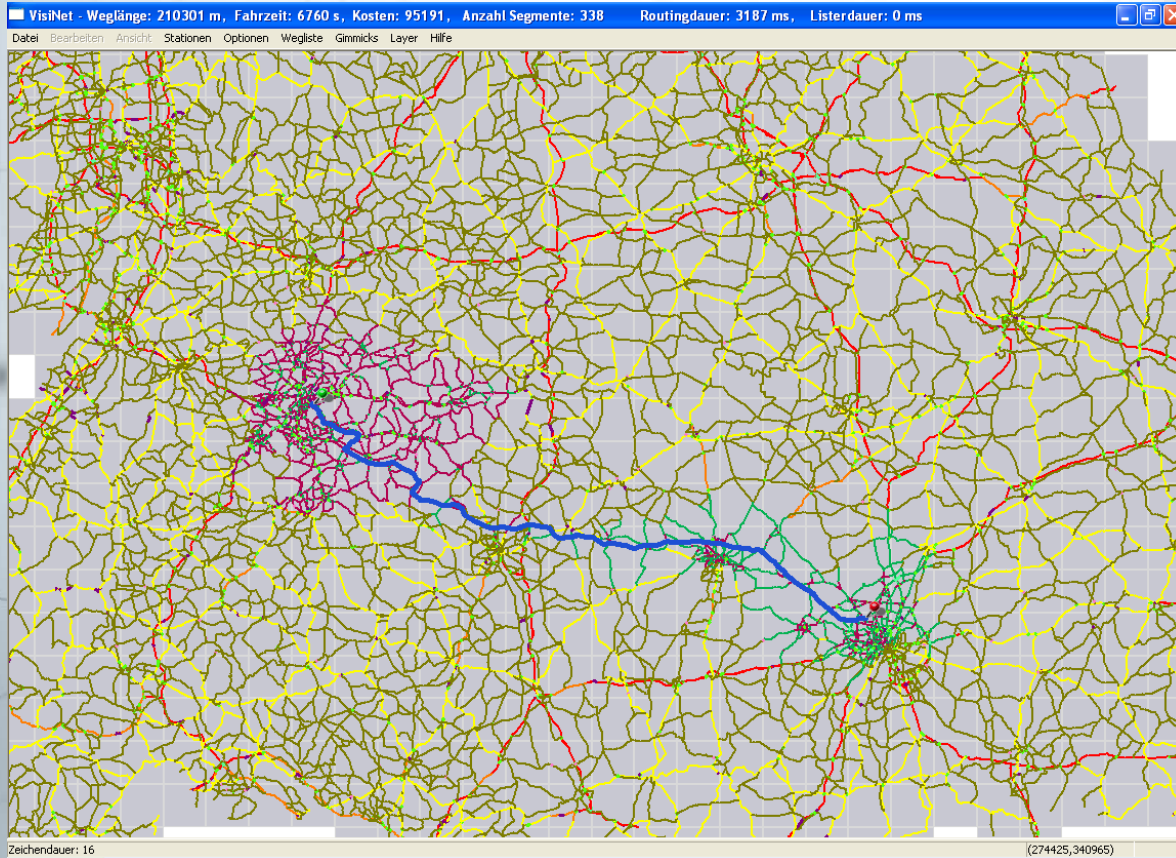
# Symmetric routing Bidirectional



If the speed of a segment is NOT derived by a timewise context (e.g. 100% static speed values) the routing is performed from two waypoints.

E.g. we flood the street network starting from both sides.

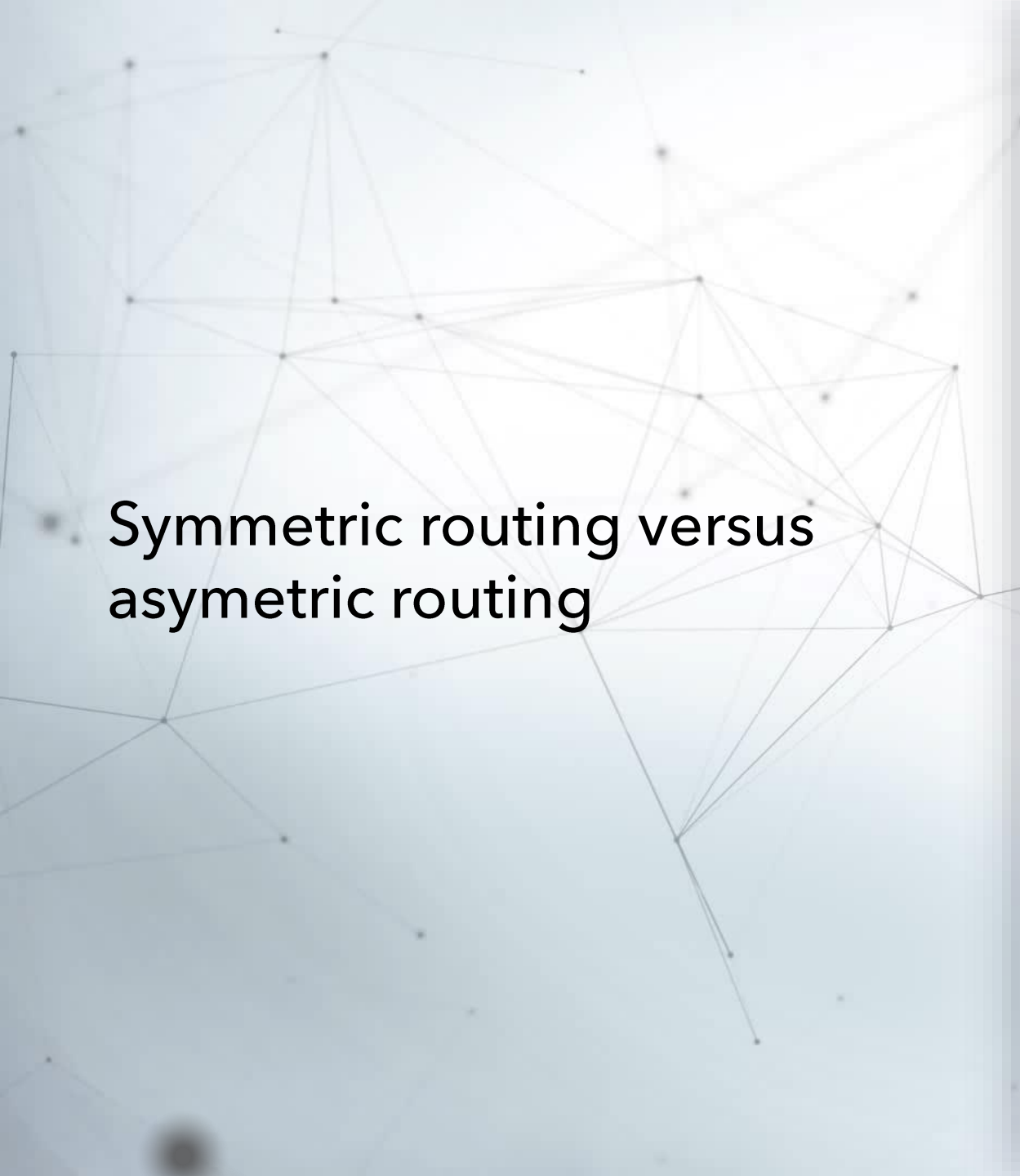
# Bidirectional $\rightarrow$ A\*



It is even possible to apply an additional target oriented algorithm which is some heuristic named A\* (= "a star")

This reduces the data set even more and has a positive impact on performance.





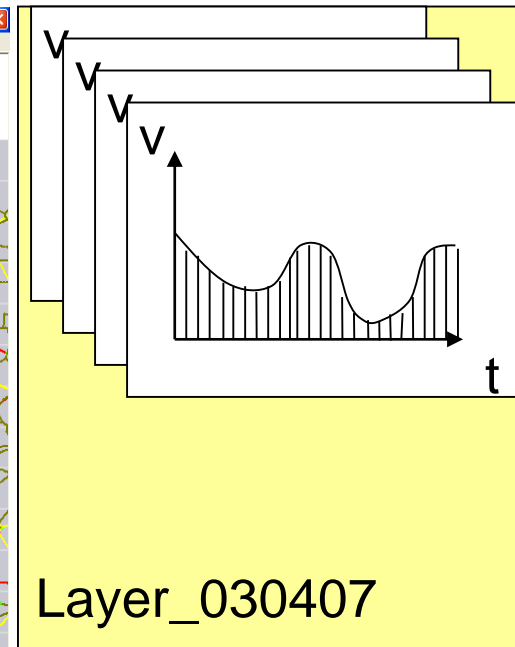
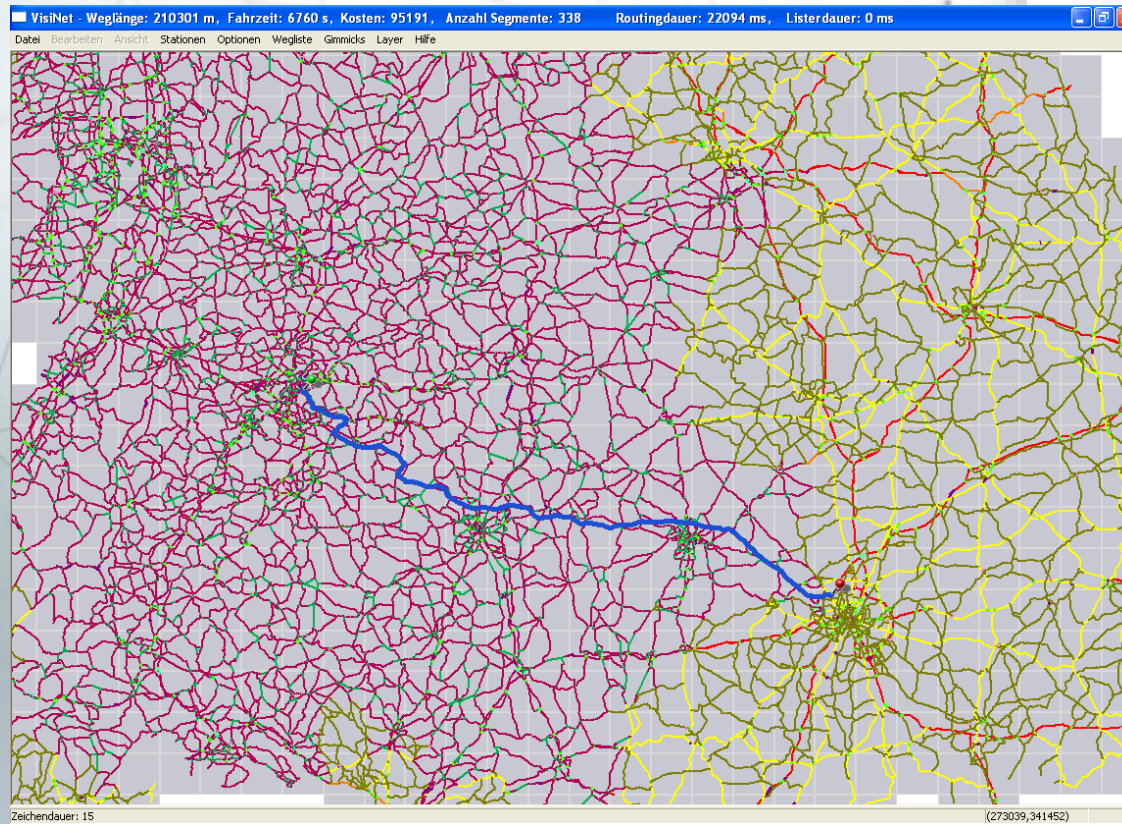
## Symmetric routing versus asymmetric routing

If the speed of a segment is derived by a timewise context (e.g. speed patterns) the routing is performed from a single waypoint.

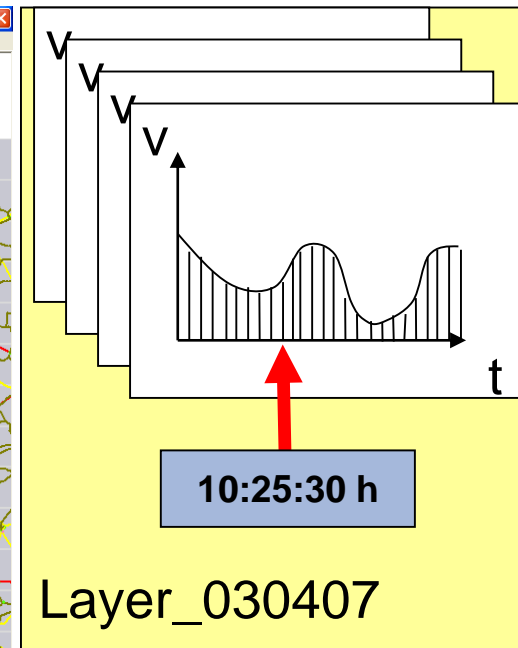
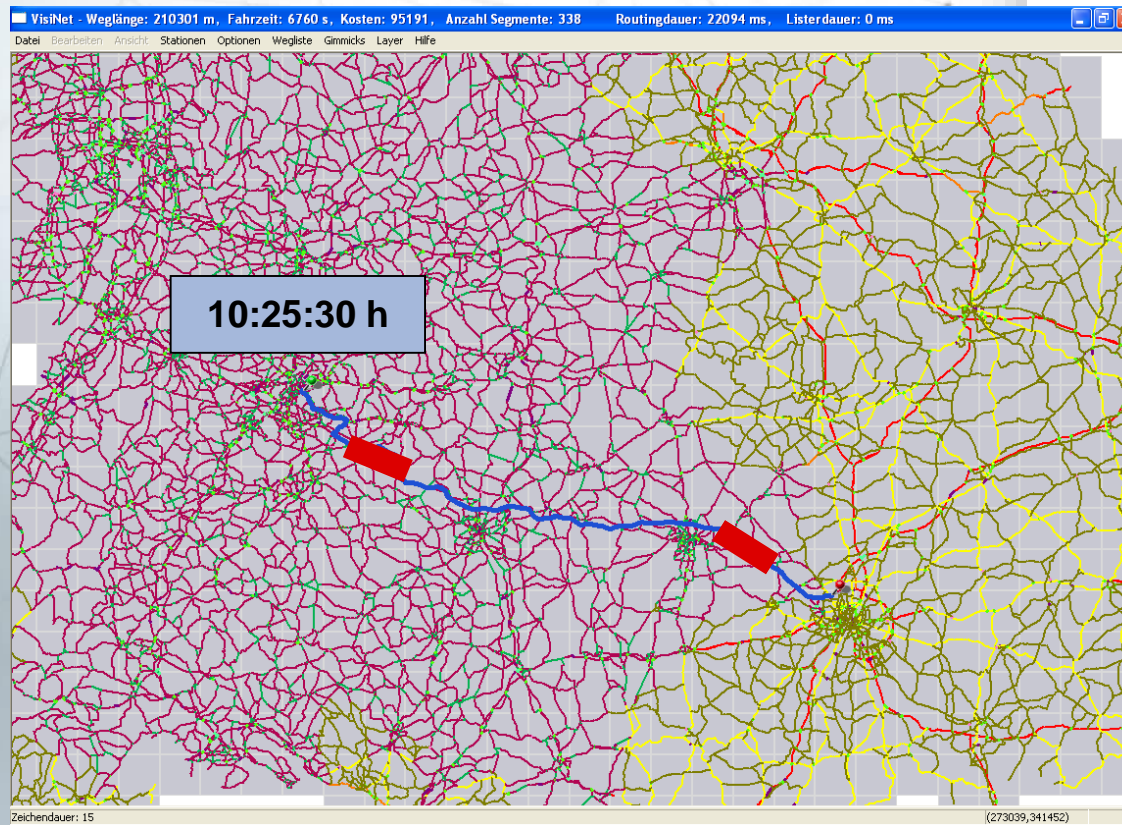
E.g. we flood the street network starting from START (requires a START\_TIME)

The mechanism is almost the same if TIME OF ARRIVAL is set (flood just starts from the opposite direction)

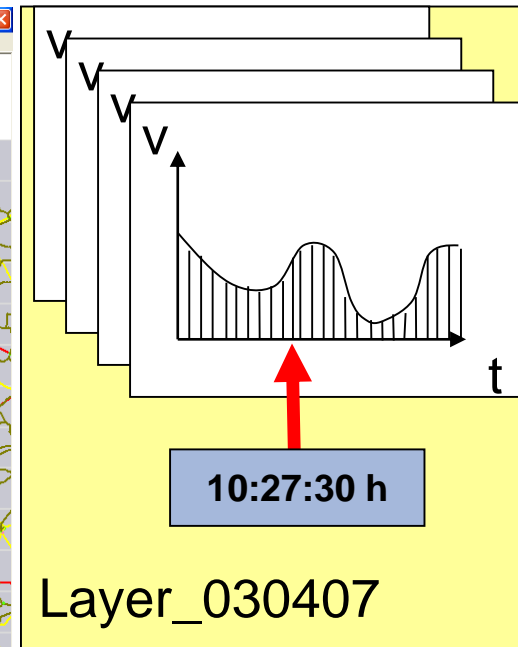
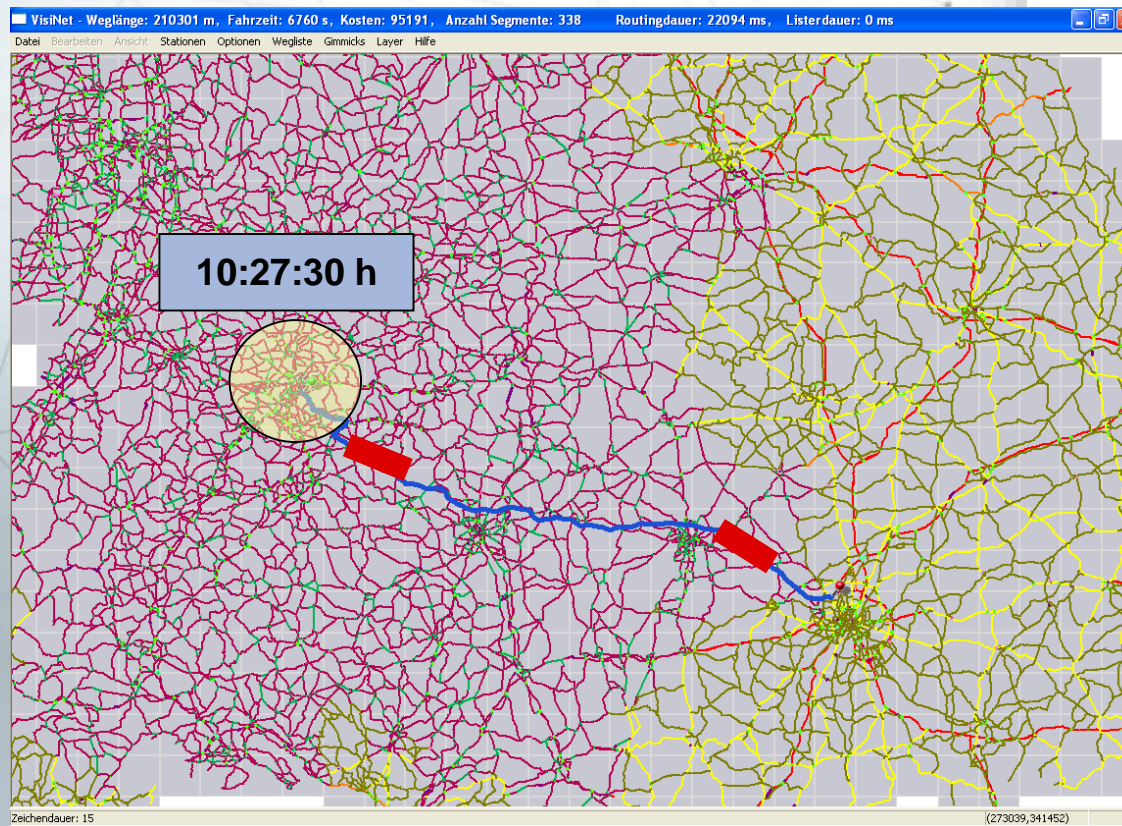
# PTV Dynamic Routing - Approach



# PTV Dynamic Routing - Approach

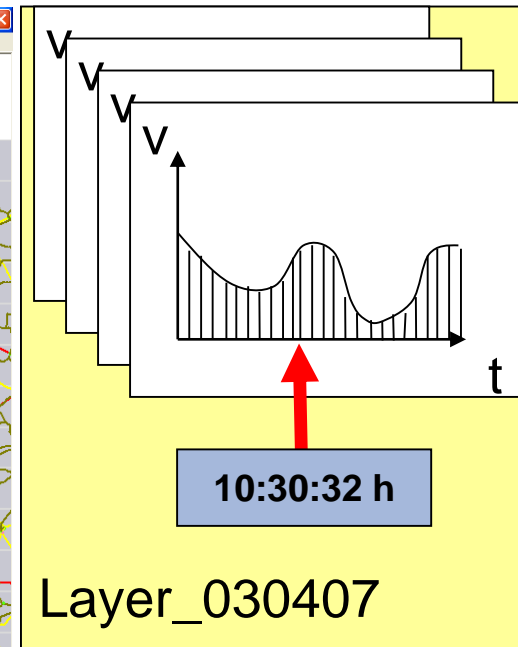
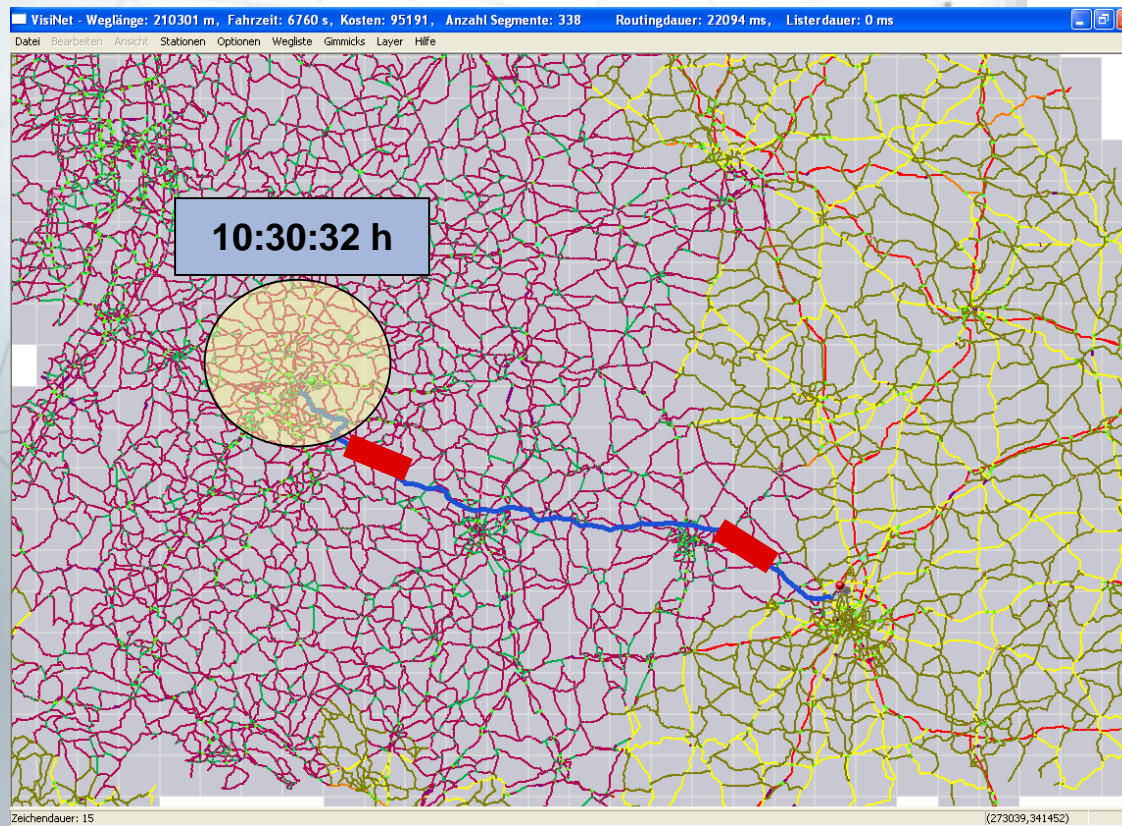


# PTV Dynamic Routing - Approach

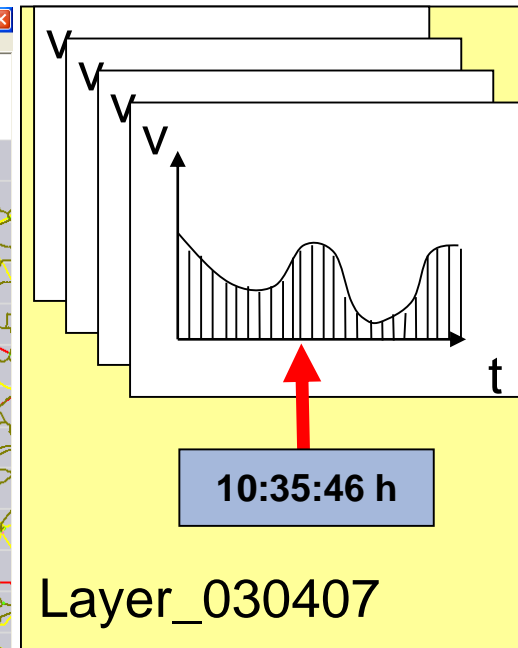
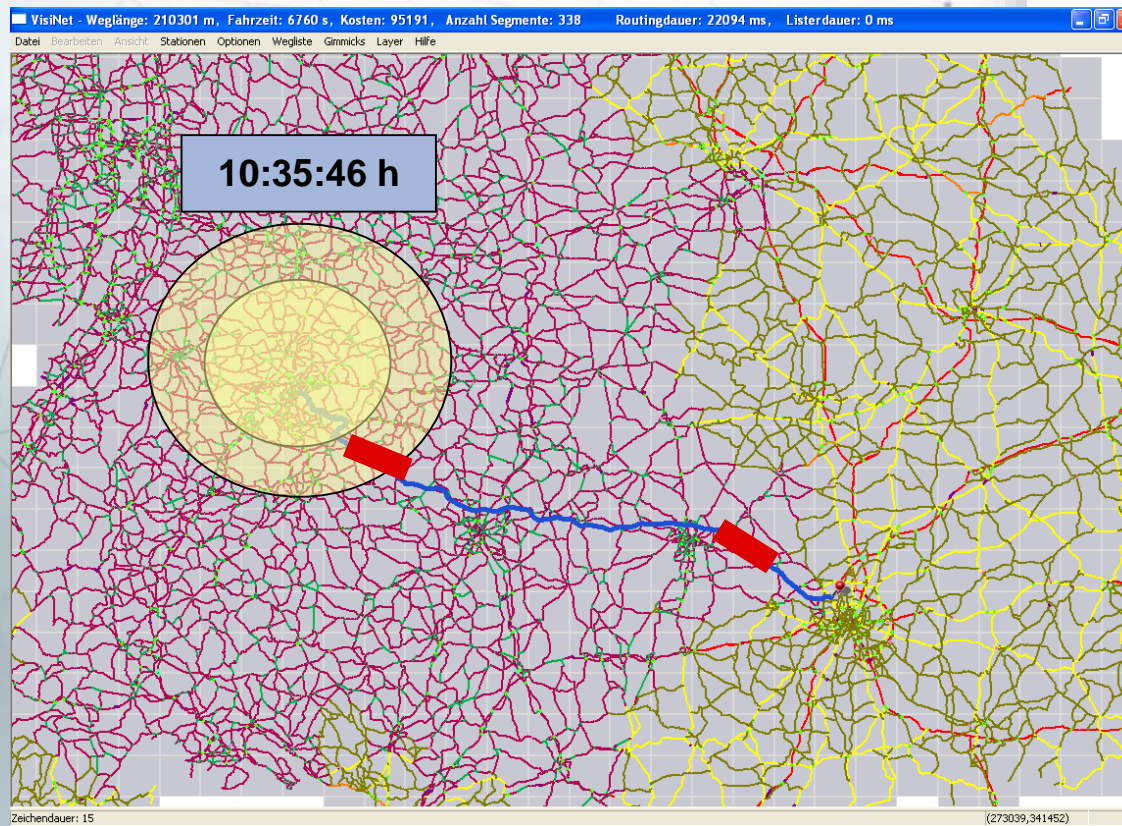




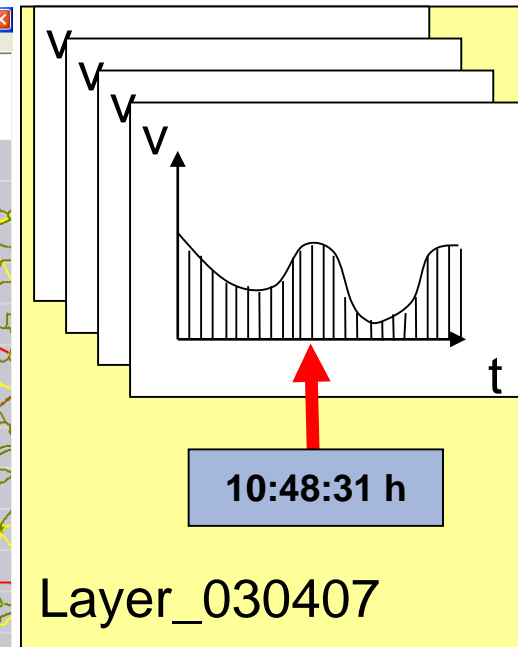
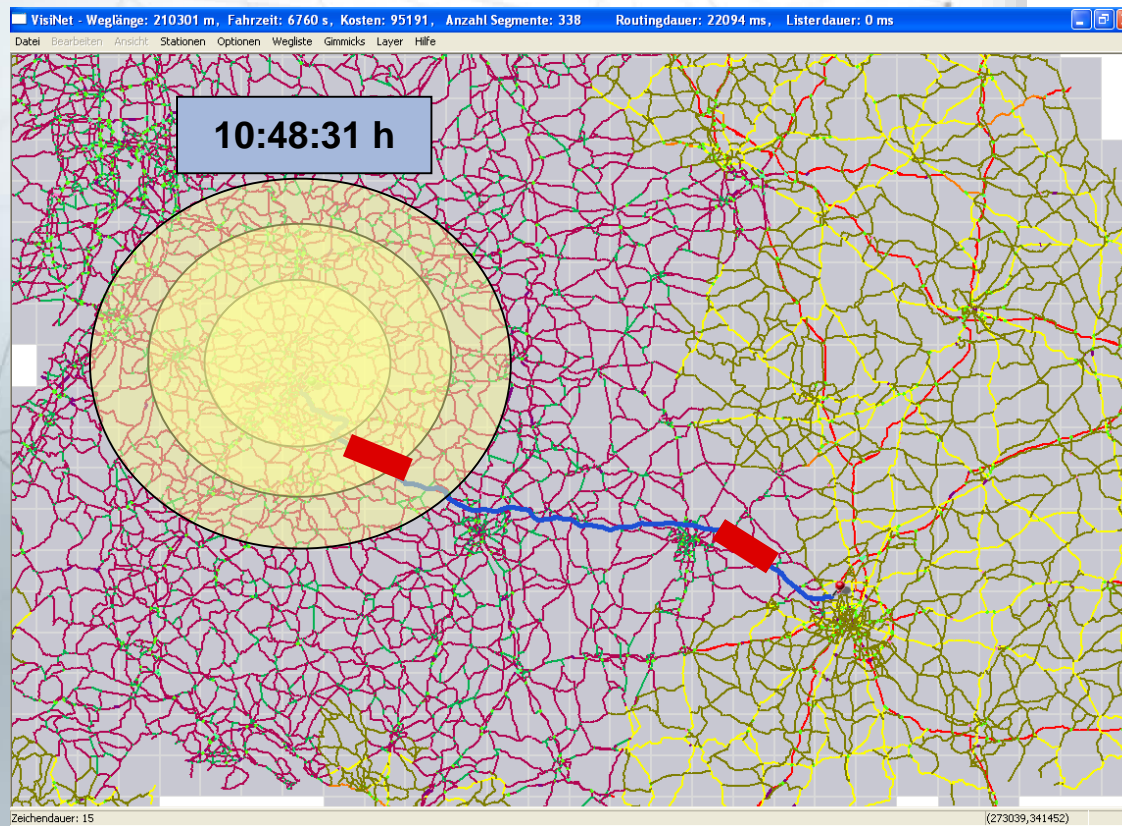
# PTV Dynamic Routing - Approach



# PTV Dynamic Routing - Approach

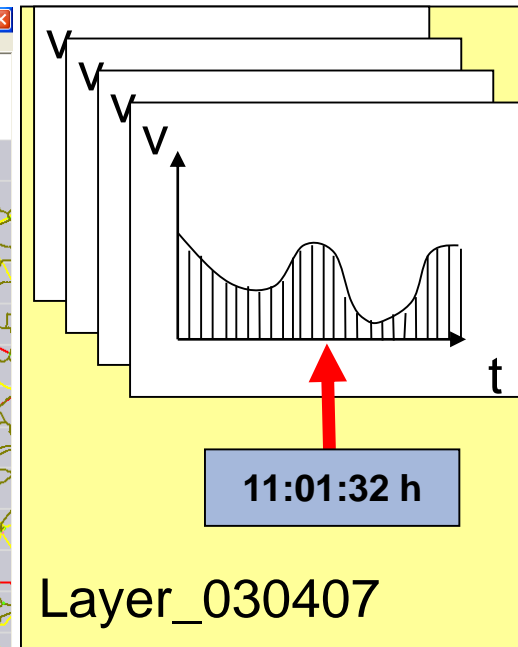
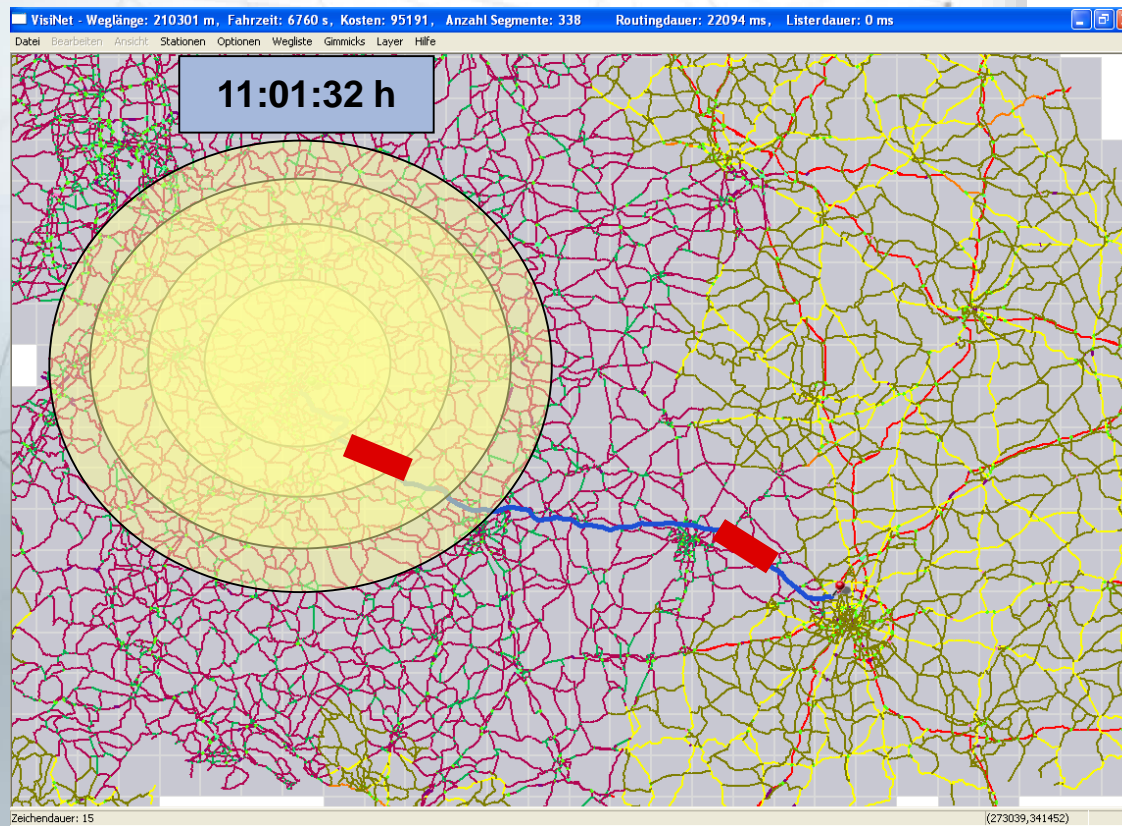


# PTV Dynamic Routing - Approach

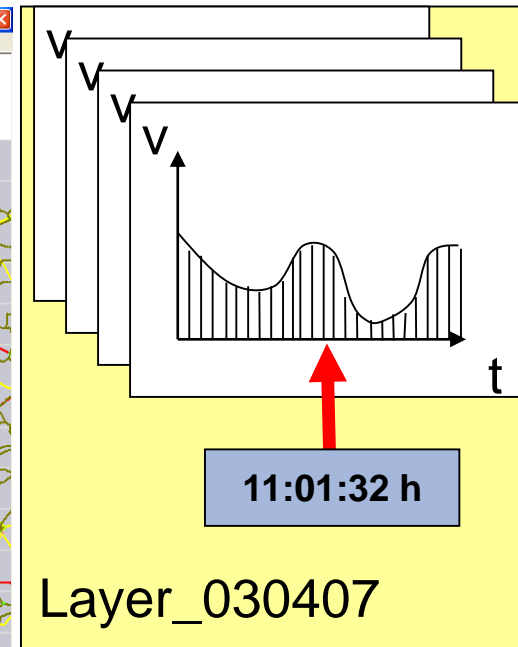
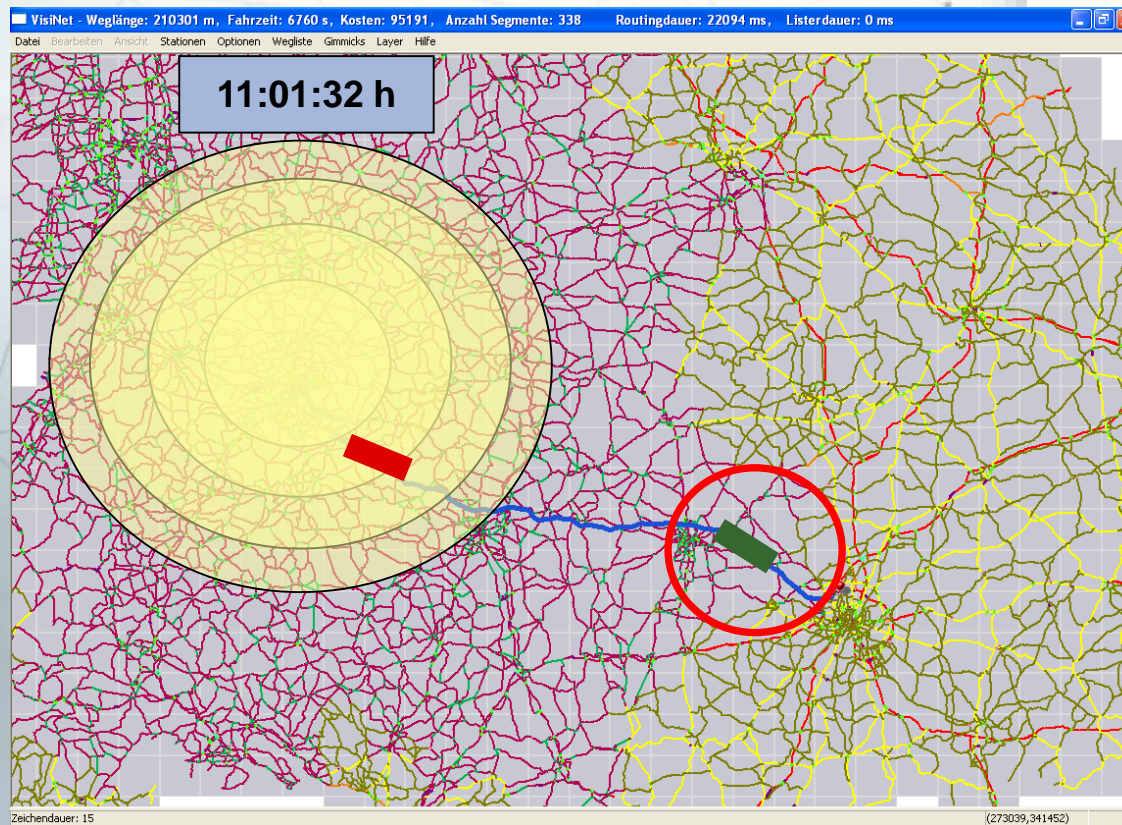




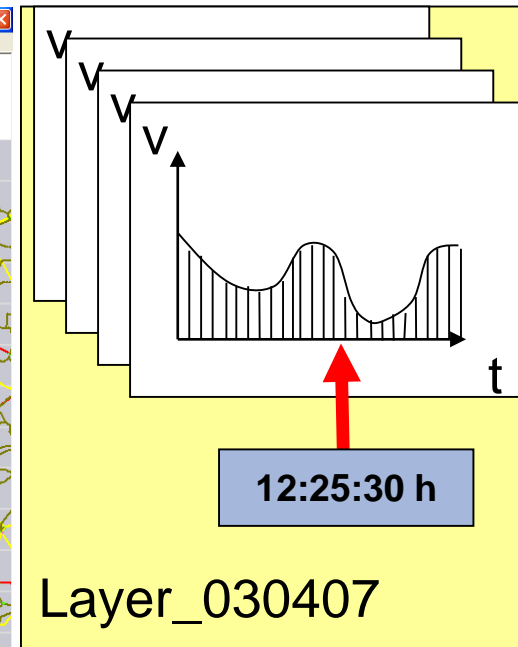
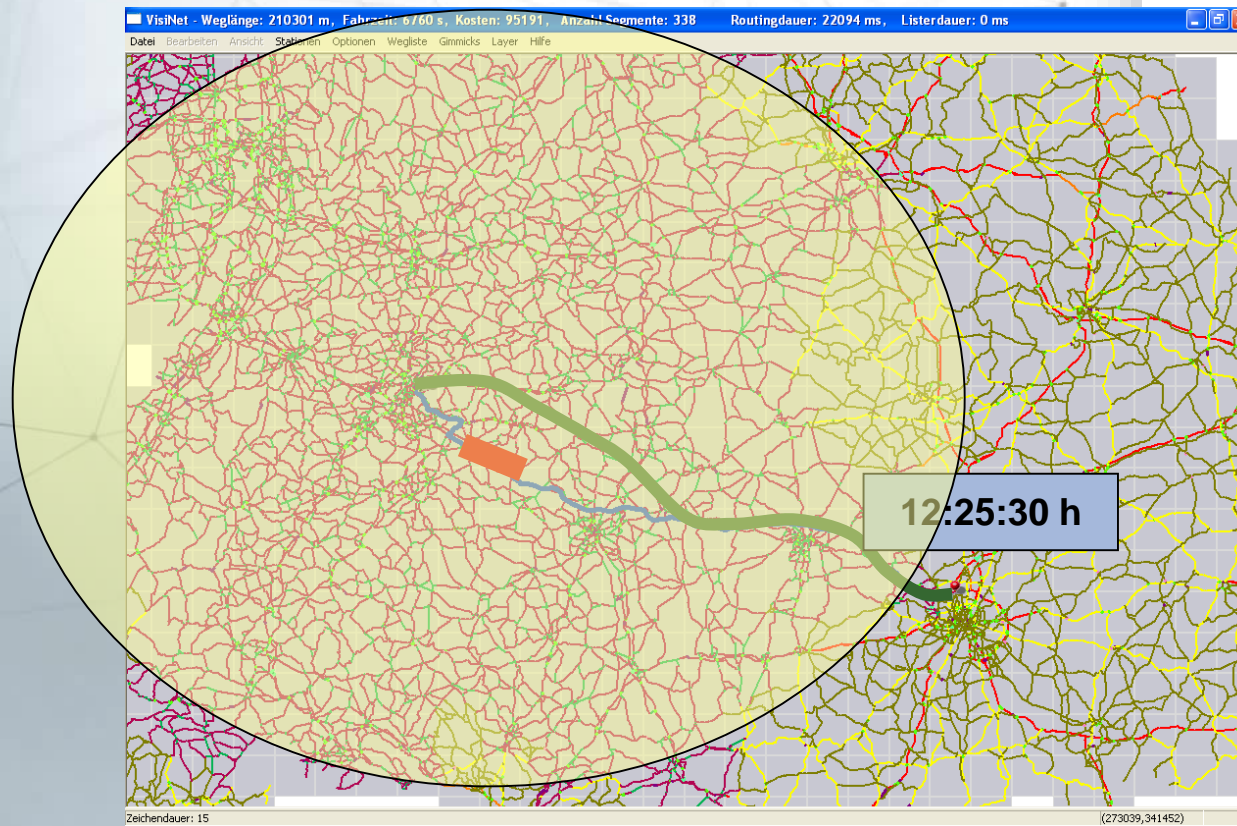
# PTV Dynamic Routing - Approach



# PTV Dynamic Routing - Approach

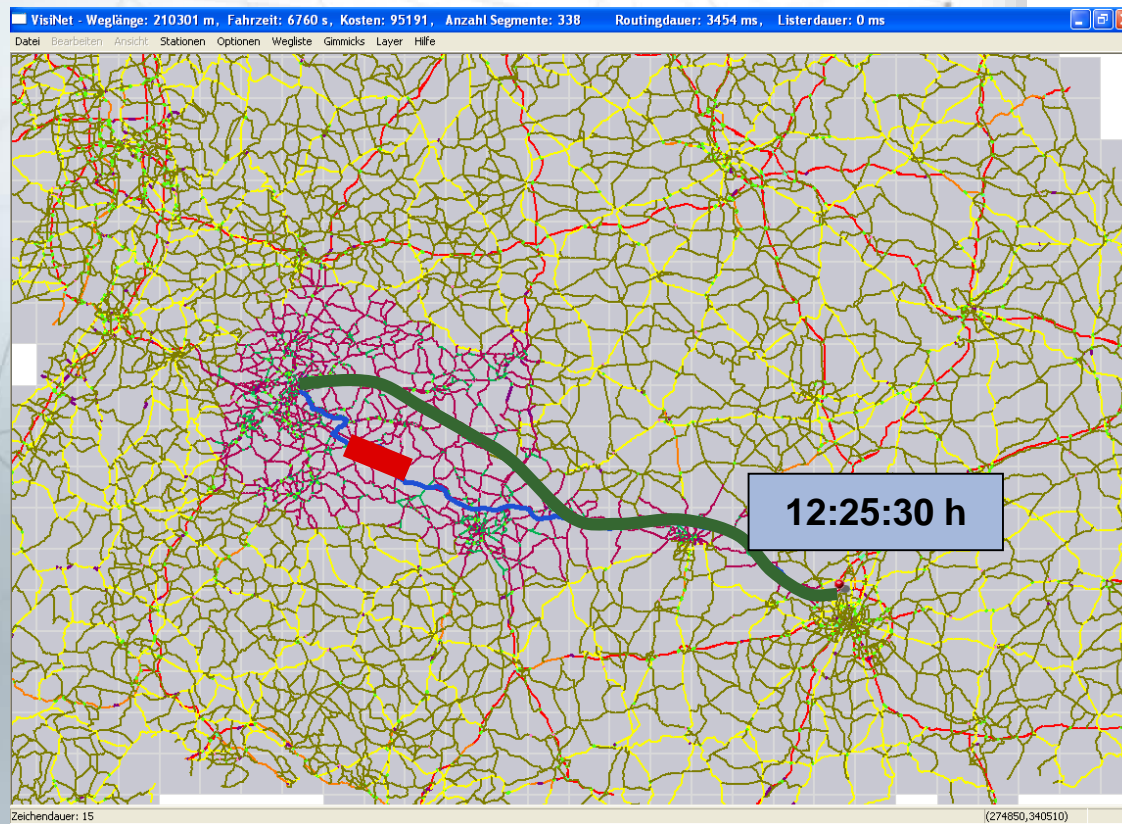


# PTV Dynamic Routing - Approach





>A\* approach with levelling is applicable to prune the search space,  
but no bidirectional search



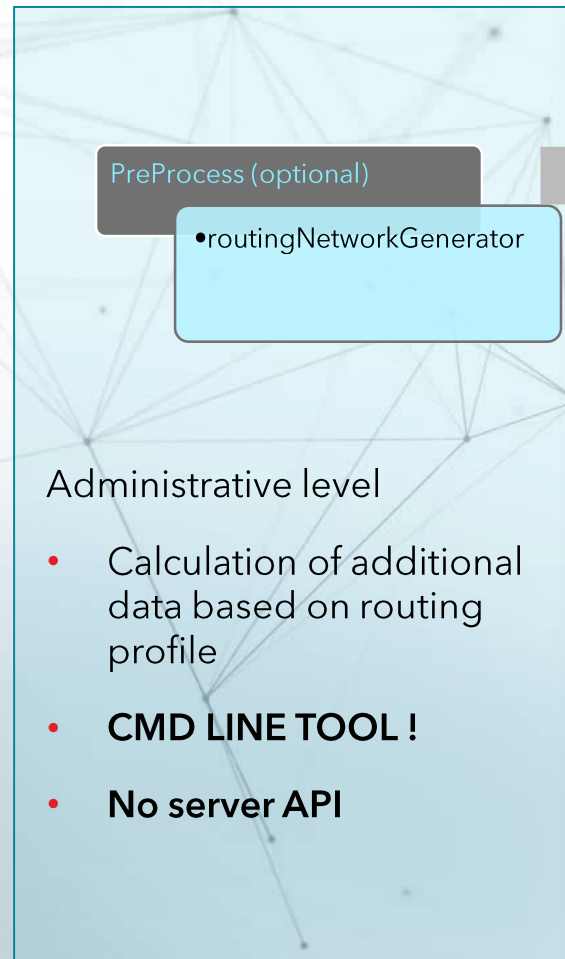
# TimeConsiderationMode

## Overview

This table shows when it is possible (meaningful) to apply the specific mechanisms.

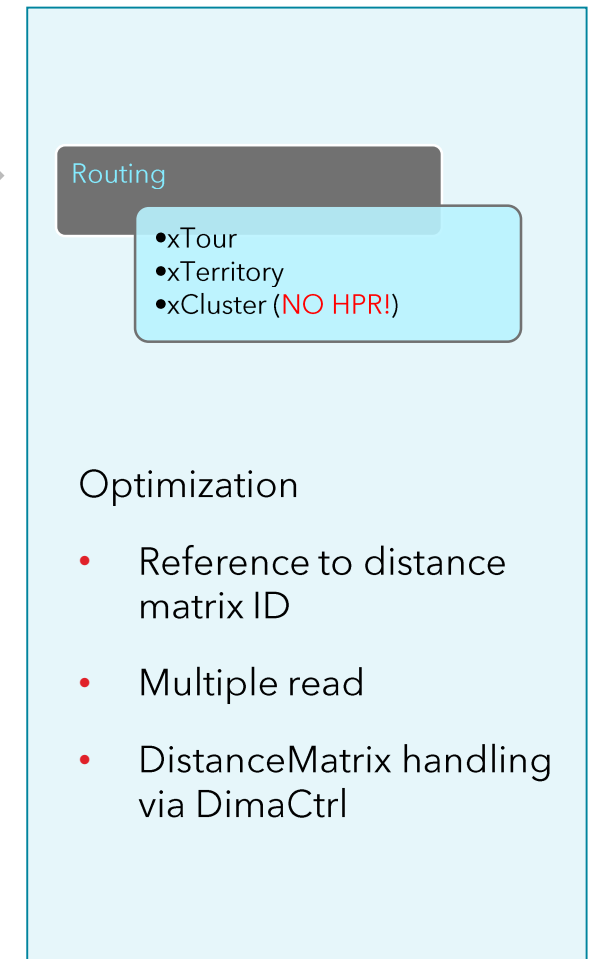
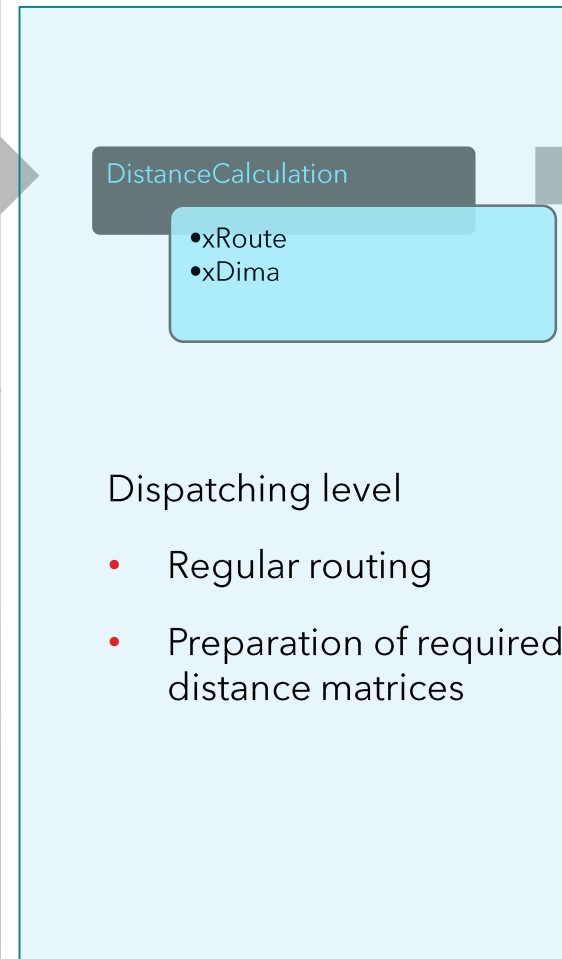
Mode	1:1	Dima	HPR
NO TIME	Yes	Yes	Yes
SNAPSHOT	Yes	Yes	Yes
TIME SPAN	Yes	Yes	Yes
EXACT	Yes	No	No
OPTIMISTIC	Yes	Yes	Yes
MULTIPLE TRAVEL TIMES	No	Yes	No

# Introduction

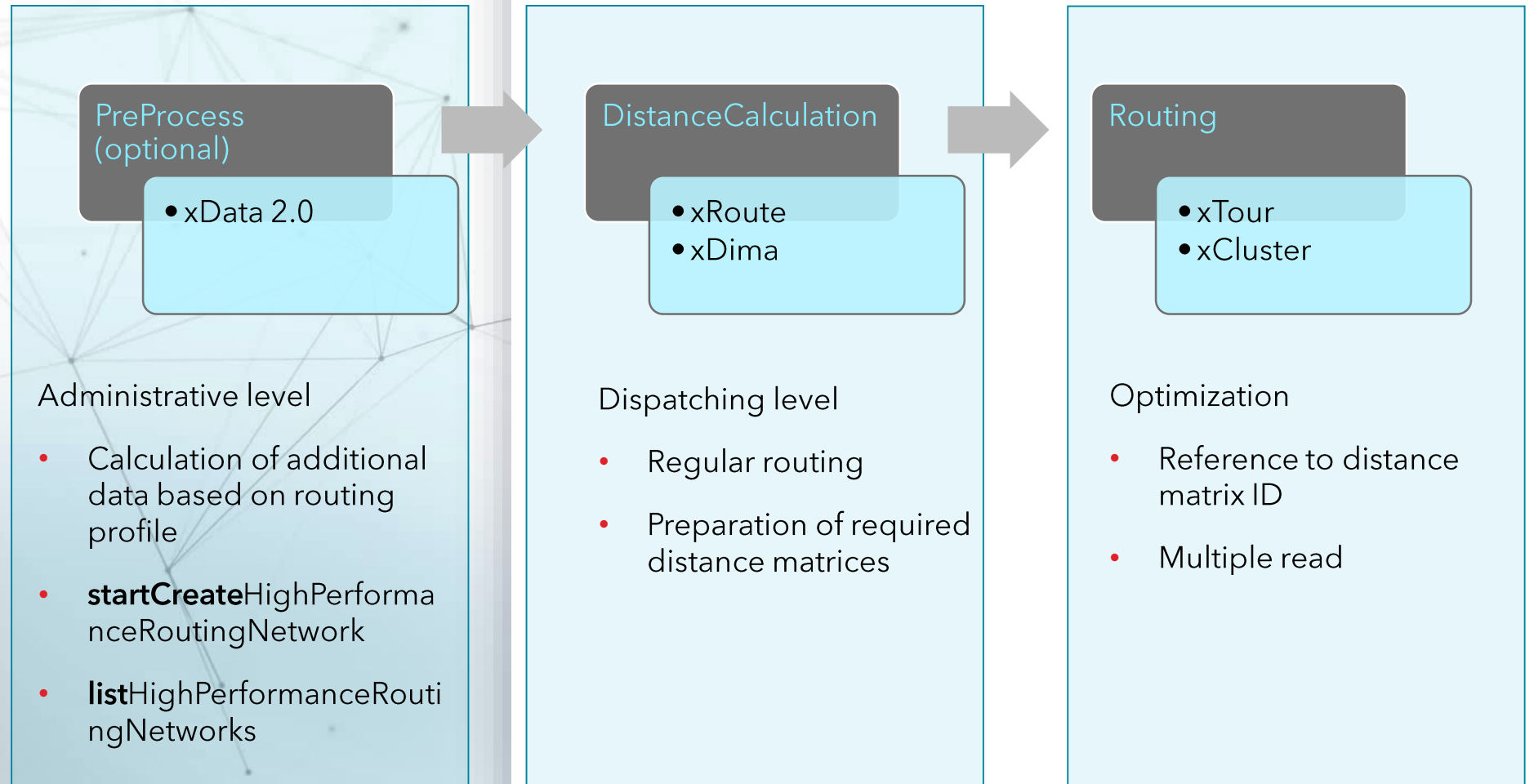


## Workflow

### 1. Routing 1.0



# Introduction



## Workflow

### 1. Routing 2.0





## Use cases

## Constraints

1. A search graph based routing can't override relevant options via API  
→ this level of flexibility requires a new SG
2. Search graphs have to be updated if underlying  
→ routing options change (XML profile)  
→ custom data has changed (xServer1)  
→ base data has changed (e.g. map update)
3. xServer 1 (CMD)  
routingNetworkGenerator.bat truckfast
4. xServer 2 (xData-API)  
→ several time consideration modes  
→ several filter modes (geo bounds, countries)



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# Daytime Dependent Routing Developers

Frank Schulz  
(DEV)



Stefan Hug  
(DEV)



Maximilian Vogel  
(DEV)





# TimeConsiderationMode

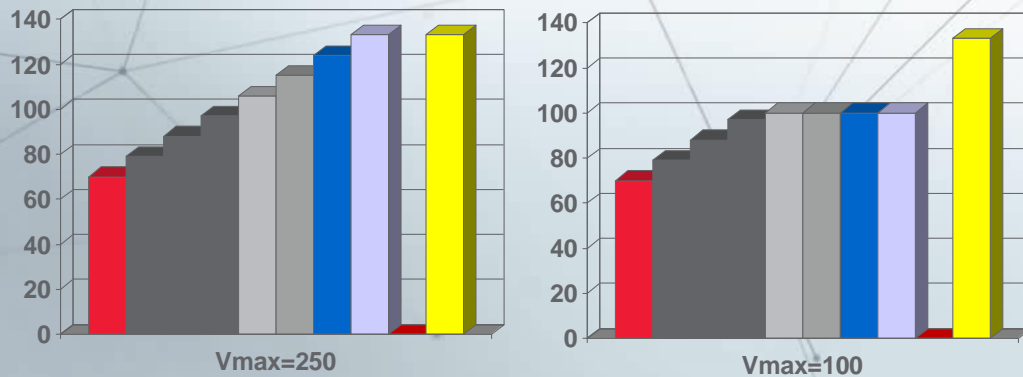
## xServer 2 supports several modes

1. **NO TIME** CONSIDERATION
2. **SNAPSHOT** TIME CONSIDERATION  
→ requires snapshot reference time
3. **TIME SPAN** CONSIDERATION  
→ requires reference interval
4. **EXACT TIME** (only AB-routing, no Dima)  
→ requires reference time + AS START / AS ARRIVAL
5. **OPTIMISTIC**  
→ only time independent blockings apply  
→ speed values derived by "best speed" available
6. **MULTIPLE TRAVEL TIMES** (only Dima, no AB-routing)

# TimeConsiderationMode

## NO TIME

1:1 routing → YES  
DIMA routing → YES



## Story behind the usecase

1. Imagine a static street network where the speed on a segment does not depend on time but is simply derived by the speed profile
2. This is more or less the traditional approach of routing based on a matching table of NC→Speed
3. E.g. car fast profile

```
<Speed maximumSpeed="80">
<SpeedRangeByNetworkClass minimumSpeed="70" maximumSpeed="135"/>
<SpeedRangeByNetworkClass minimumSpeed="38" maximumSpeed="122"/>
<SpeedRangeByNetworkClass minimumSpeed="30" maximumSpeed="105"/>
<SpeedRangeByNetworkClass minimumSpeed="25" maximumSpeed="100"/>
<SpeedRangeByNetworkClass minimumSpeed="20" maximumSpeed="95"/>
<SpeedRangeByNetworkClass minimumSpeed="10" maximumSpeed="50"/>
<SpeedRangeByNetworkClass minimumSpeed="5" maximumSpeed="20"/>
<SpeedRangeByNetworkClass minimumSpeed="4" maximumSpeed="9"/>
</Speed>
```
4. No matter what time it is:
  - each NC\_0 segment with speed class SP\_0 applies 135km/h
  - each NC\_0 segment with speed class SP\_7 applies 70km/h
  - further speed classes are interpolated

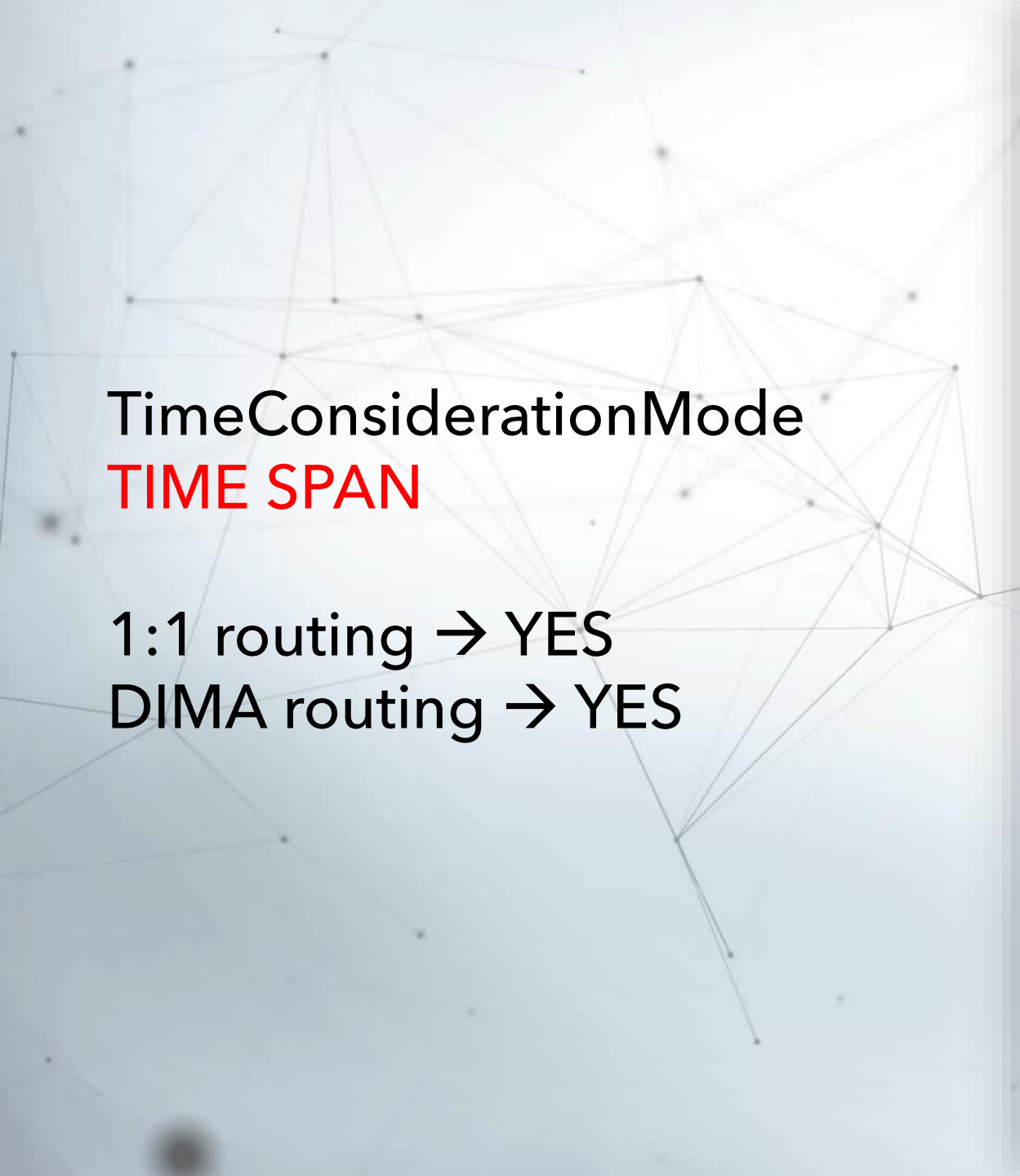
A background graphic consisting of a network of interconnected nodes and lines, resembling a graph or a map, in a light blue and grey color scheme.

## TimeConsiderationMode SNAPSHOT

1:1 routing → YES  
DIMA routing → YES

### Story behind the usecase

1. Works fine both with 1:1 and DIMA routing at least is the interval of the dima application is rather short (e.g. morning shift) and there's a representative state of the street
2. Simply applied all speed values derived by the time
3. All blockings that apply at the SNAPSHOT reference time are used



## TimeConsiderationMode

### TIME SPAN

1:1 routing → YES  
DIMA routing → YES

### Story behind the usecase

1. Comparable to snapshot but the filter criteria is weaker.
2. Could be used to capture all long term blockings (e.g. construction, long term road works) which have the same condition during the whole interval
3. E.g. "six weeks of reduced lanes due to bridge reconstruction"
4. Therefore also works fine with both 1:1 and DIMA

A faint, light blue background image showing a complex network of interconnected nodes and lines, resembling a street network or a data graph.

## TimeConsiderationMode

### EXACT TIME

1:1 routing → YES  
DIMA routing → NO

### Story behind the usecase

1. Imagine you want to apply the segments speed and blocking state at a precise point in time → the moment when the routing traverses the segment
2. This is possible if you flood the street network from a single waypoint (forward or backward) as described on previous slides
3. Best approach for single “linear” route
4. Doesn’t work with DIMA routing because DIMA would require a static segment state for all waypoints scopes





TimeConsiderationMode  
**OPTIMISTIC**

1:1 routing → YES  
DIMA routing → YES

## Story behind the usecase

### 1. Imagine

A background graphic on the left side of the slide featuring a complex network of thin grey lines connecting various points, resembling a graph or a map's connectivity. The lines are more dense in some areas and sparser in others, creating a web-like structure.

## TimeConsiderationMode **MULTIPLE TRAVEL TIMES**

1:1 routing → **NO**

DIMA routing → YES

### Story behind the usecase

1. Imagine you'd like to approximate speed and blocking conditions by slicing the day into pieces
2. Each piece is then treated as SNAPSHOT
3. Not meaningful for 1:1 routing
4. Special feature which is then useful in DIMA routing e.g. in combination with day time dependent tour optimization



## Discussion

## Discussion

- **Availability**  
Can we calculate our own SG in xServer Internet?
- **Persistency**  
**How long will my custom data be available in the cloud?**  
My own HPR?  
My own Distance Matrix?  
My own storedRequestId?

# Ressources

Further info is available at

- **Show cases xServer2**  
[https://xserver2-europe-eu-test.cloud.ptvgroup.com/dashboard/Default.htm#Samples/Samples.htm%3FTocPath%3DShowcases%7C\\_\\_\\_\\_0](https://xserver2-europe-eu-test.cloud.ptvgroup.com/dashboard/Default.htm#Samples/Samples.htm%3FTocPath%3DShowcases%7C____0)
- **PTV xRoute Server Forum**  
<https://xserver.ptvgroup.com/forum/viewforum.php?f=7>
- **Use case documentation  
Time Consideration**  
[https://xserver2-europe-eu-test.cloud.ptvgroup.com/dashboard/Default.htm#TechnicalConcepts/Basics/DSC\\_TimeConsideration.htm%3FTocPath%3DTechnical%2520Concepts%7CBasics%7C\\_\\_\\_\\_12](https://xserver2-europe-eu-test.cloud.ptvgroup.com/dashboard/Default.htm#TechnicalConcepts/Basics/DSC_TimeConsideration.htm%3FTocPath%3DTechnical%2520Concepts%7CBasics%7C____12)

# Generic RESSOURCES and ...

1. DevComp **Consulting**  
→ bernd.welter@ptvgroup.com  
larsnorman.moritz@ptvgroup.com
2. DevComp **Support**  
→ support.de@xServer.ptvgroup.com
3. Our **Forum** (free of cost - english)  
→ <http://xserver.ptvgroup.com/forum>
4. Developer **Blog**  
→ <http://devblog.ptvgroup.com/>
5. Youtube Channel Bernd Welter  
→ <https://www.youtube.com/channel/UCgkUli9yGf0gwTDdxbMZ-Kg>
6. PTV xServer **INTERNET**  
<http://xserver.ptvgroup.com/en-uk/cookbook/content-and-services/general-information/>
7. Further **questions?**  
→ **SALES!**





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