



the mind of movement

# xDima 2 - workshop

Maximilian Vogel , Bernd Welter

# Agenda / Goals

- ▶ **Part 1 - concepts**
  - many (more or less independent) mechanisms?
  - DIMA lifecycle management
- ▶ **Part 2 - Discussion**
  - Feedback, Ideas, Wishes
- ▶ **Goals:**
  - Some "AHA"-moments on your side
  - Gather your requirements
- ▶ **No goals!**
  - Remote domains (mapping, routing, tour optimization)
- ▶ **Demos processed on**  
<https://xserver2-europe-eu-test.cloud.ptvgroup.com/>



# What is a DIMA?

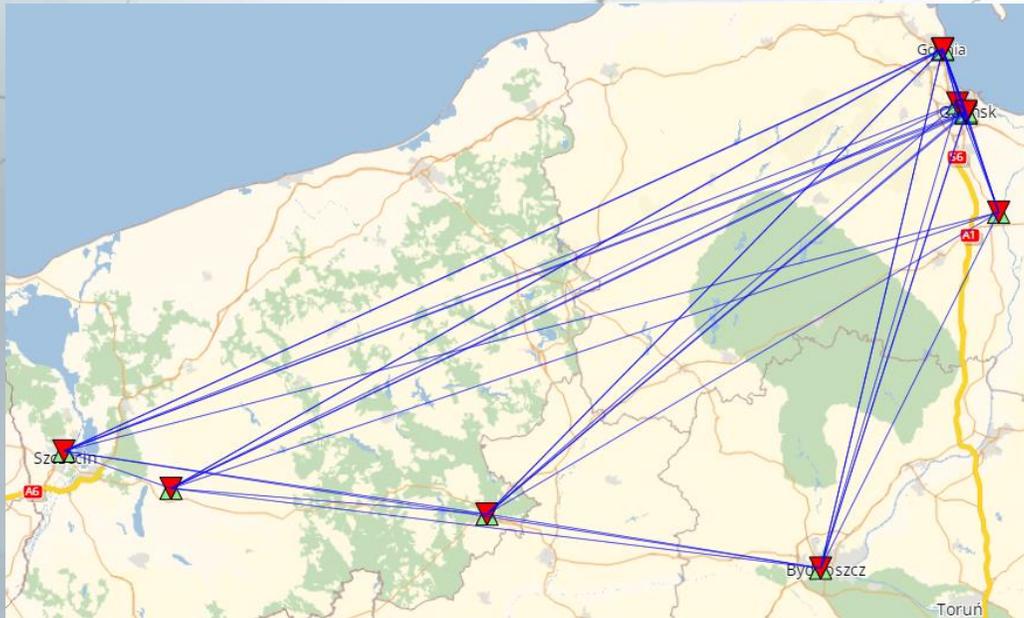
A storage

PrimaryKey:

{RouteLocation Start,RouteLocation Dest}

(supports OnRoad and OffRoad...)

- Data → **driving time & distance**  
 → **violations, routed/estimated**  
 → optional: toll, driving time over time  
 (tracks are not time dependent)



## Tenant 1

Dima 1

- Profile
- Location table
- Distance table

## Tenant 2

Dima 1

- Profile
- Location table
- Distance table

er > xserver-2.18.0 > data > dima > globaltenant > globalscope > 1cb57f50-59b8-4780-9299-de97a414cdd5

Name	Änderungsdatum	Typ	Größe
dima.ini	23.04.2020 12:16	Konfigurationsein...	1 KB
dima.lua	27.04.2020 16:55	LUA-Datei	0 KB
dima.lua.lck	23.04.2020 12:04	LCK-Datei	0 KB
dima.write.lck	23.04.2020 12:04	LCK-Datei	0 KB
disttab.dat	23.04.2020 12:04	DAT-Datei	1.288 KB
disttab.loc	23.04.2020 12:16	LOC-Datei	98 KB
RoutingProfile.xml	23.04.2020 12:04	XML-Datei	4 KB

		8,52673	50,03872	dir	vio	8,52721	50,03838	dir	vio	8,53282	50,03989	dir	vio	8,53606	50,04171	dir	vio	
1	8,52673	50,03872	0	0	f	f	228,2	1299	f	f	430,7	4138	f	f	577,5	5452	f	f
2	8,52721	50,03838	257,4	1416	f	f	0	0	f	f	457,6	2436	f	f	604,4	3750	f	f
3	8,53282	50,03989	481,3	4818	f	f	450,1	2401	f	f	0	0	f	f	204,1	1542	f	t
4	8,53606	50,04171	609	6006	f	f	577,8	3589	f	f	189,2	1436	f	t	0	0	f	f

Attention: some of these technical statements are subject to change for improved internal implementation

# What is NOT in a DIMA?

## → DETAILS

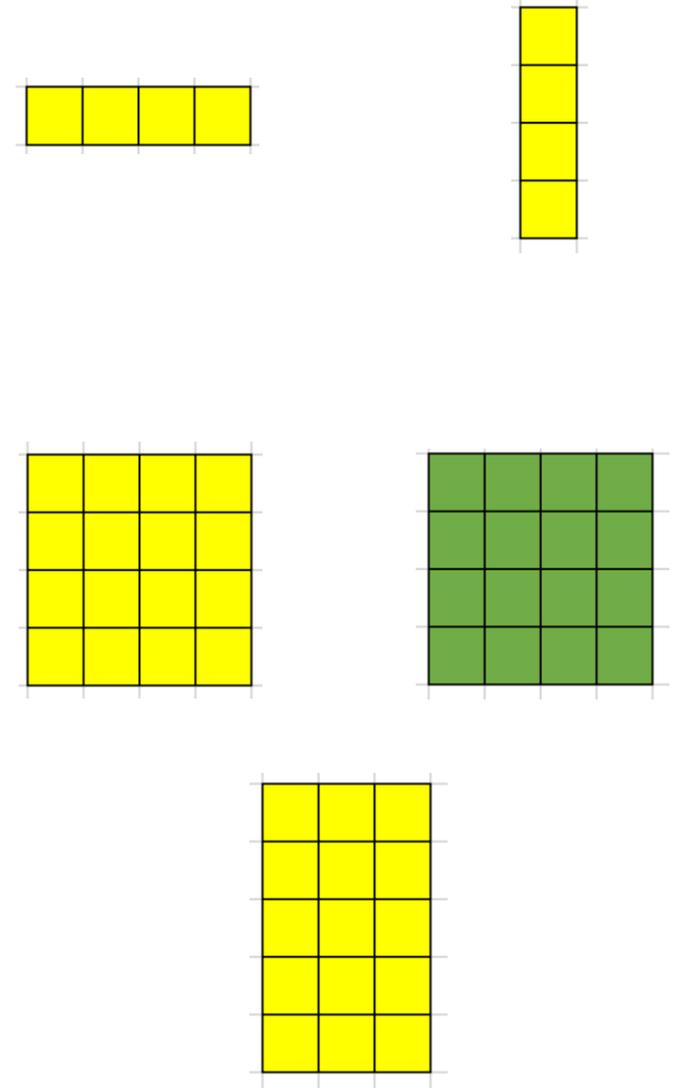
- routing polygons
- emissions
- maneuver lists
- segment lists
- further info which is returned from a regular 1:1 routing (xRoute)

## Why not?

- usually such details aren't required for each and every relation
- normally the core topic is to create an optimal result in terms of tour structures based on a dima
- Then the details are determined for a specific route with it's waypoints

# Function vs Shape

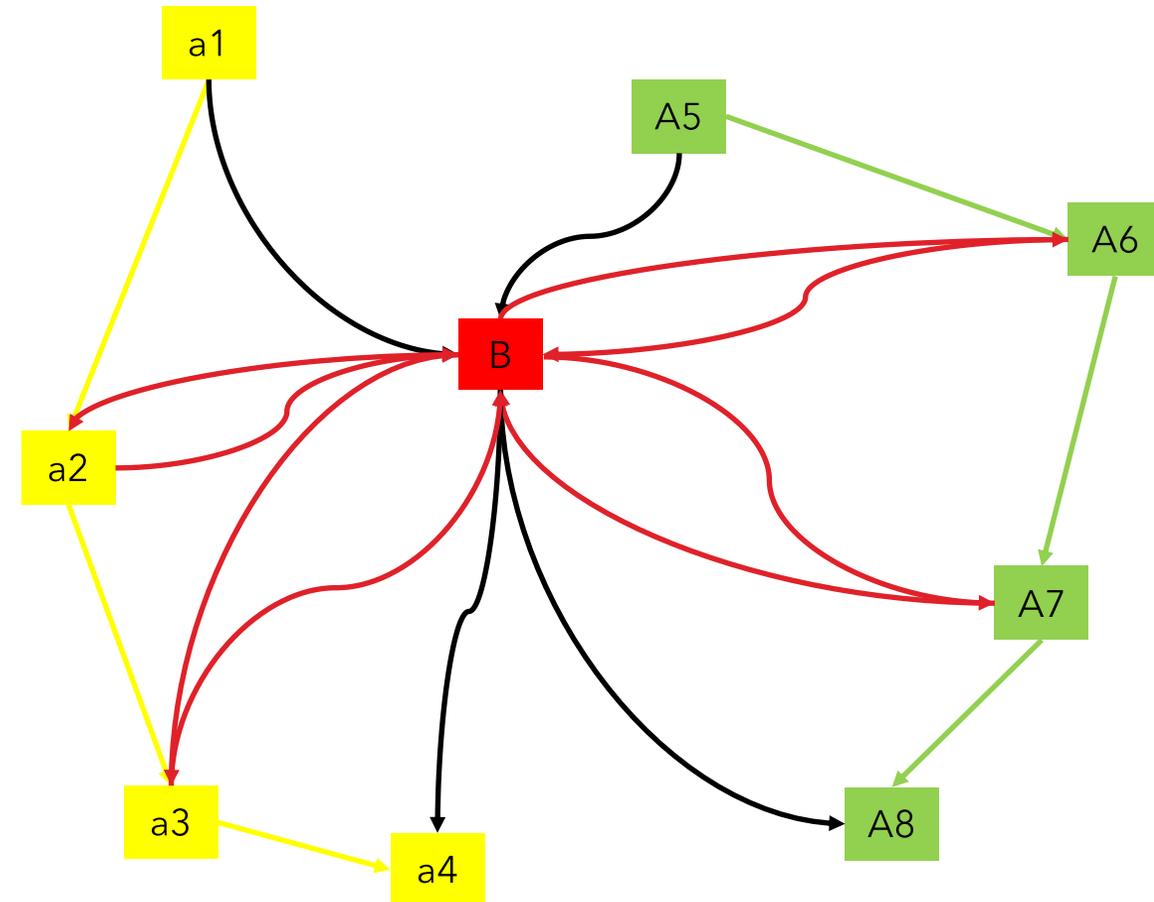
- ▶ **M:N means "M Starts, N Destinations"**
- ▶ Restaurant search  $\rightarrow$  1:M
- ▶ Pizza service, incident service level  $\rightarrow$  M:1
- ▶ Sequence Optimization (single car)  $\rightarrow$   $M^2$
- ▶ Tour optimization homogen  $\rightarrow$   $M^2$
- ▶ Tour optimization heterogen  $\rightarrow$   $M^2 + M^2\dots$
- ▶ Subsidiaries  $\leftrightarrow$  customers  $\rightarrow$  rectangular M:N



# Function vs Shape

- ▶ Appointment Scheduling:  
find best match for new appointment of B
- ▶ Has to be placed between existing stops
- ▶  $A[i] \rightarrow B \rightarrow A[i+1]$  must fulfil calendar
- ▶ Works with static routing (no time dependency)
- ▶ Example:  
2 x [3:1] + 2 x [3:1] routings
- ▶ *Mr. Yellow vs Mr. Green*
- ▶ *Monday vs Tuesday*

a1		a2	a3	a4	A5	A6	A7	A8
a2					A6			
a3					A7			



# Filled vs Empty

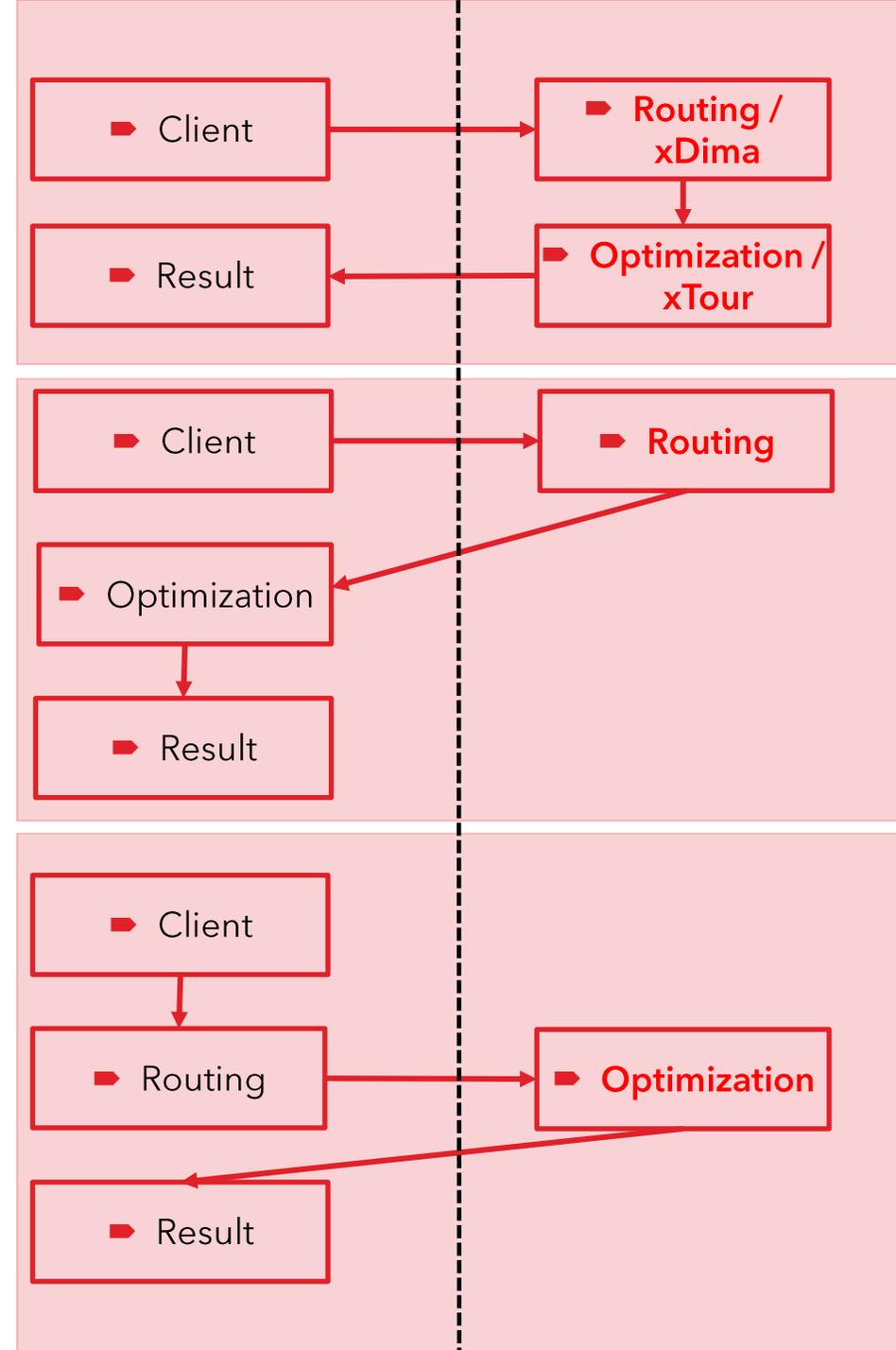
- ▶ Not each and every cell of a DIMA contains routed KPIs
- ▶ Some cells could remain estimated. This depends on whether a routing was successful for a relation or not.

	A	B	C	D	E
A	1st routed			2nd routed	
B					
C					
D					
E					
	1st call	(A,B,C)x(A,B,C)	create		
	2nd call	(D,E)x(D,E)	update		

# Who requires a DIMA?

The usecases shown before are applied in these contexts

- ▶ I want PTV to optimize a usecase on routing level
  - use xDima to create DIMA
  - use xTour and refer to DIMA
- ▶ I want PTV to provide routing info required by my own optimization algorithm (e.g. SAP based TMS)
  - use xDima to create content
  - use xDima to download content
  - use your own engine to perform optimization
- ▶ I have my own routing engine and I want PTV to optimize based on my own info
  - use your engine to create routing info
  - upload routing info to PTV cloud (n.a. so far)
  - perform optimization with xTour



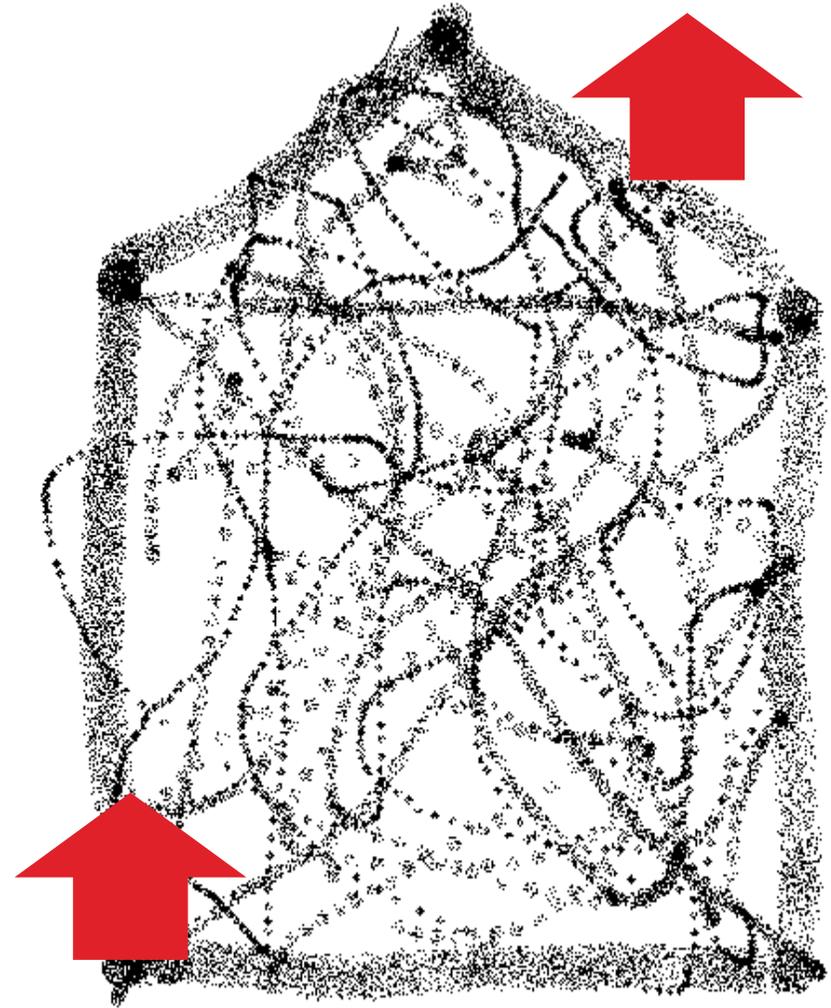
# Routing from a META perspective

double price(200 routing options)

{

freaking complex calculation

}



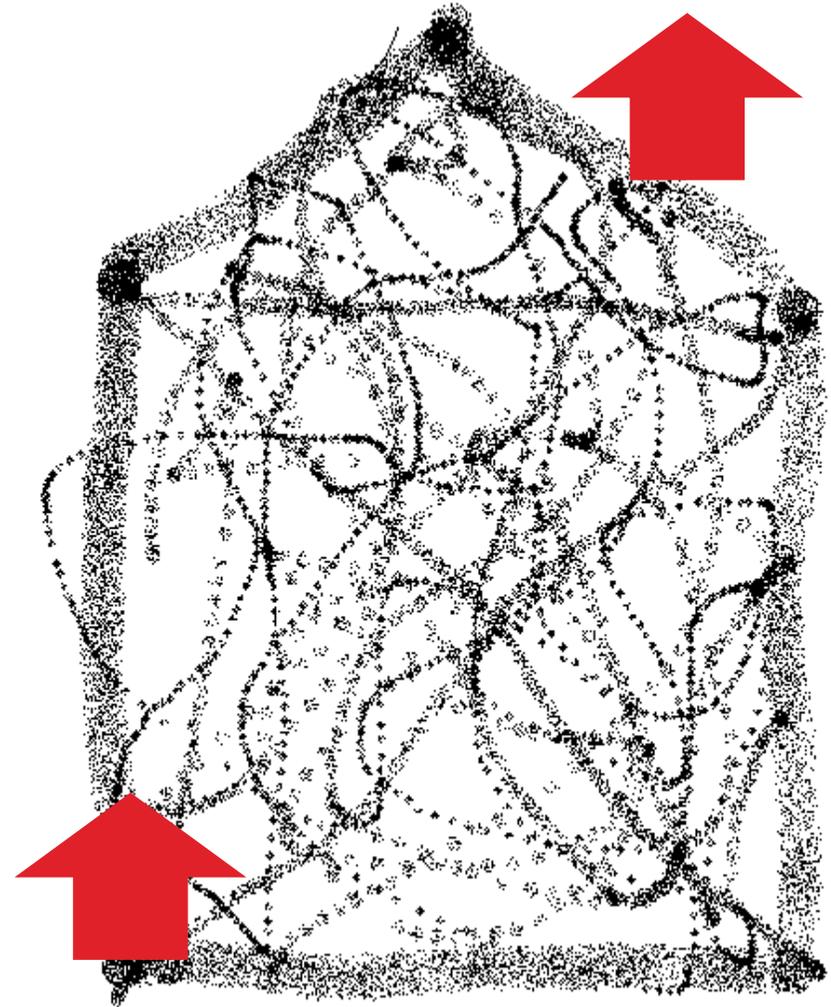
# Routing from a META perspective

```
double price()
```

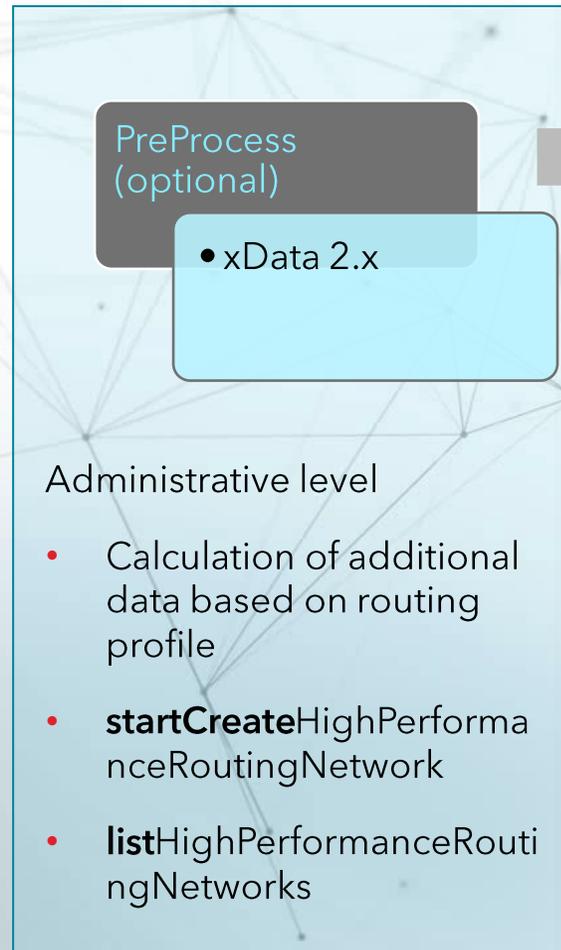
```
{
```

```
    preprocessed values!
```

```
}
```

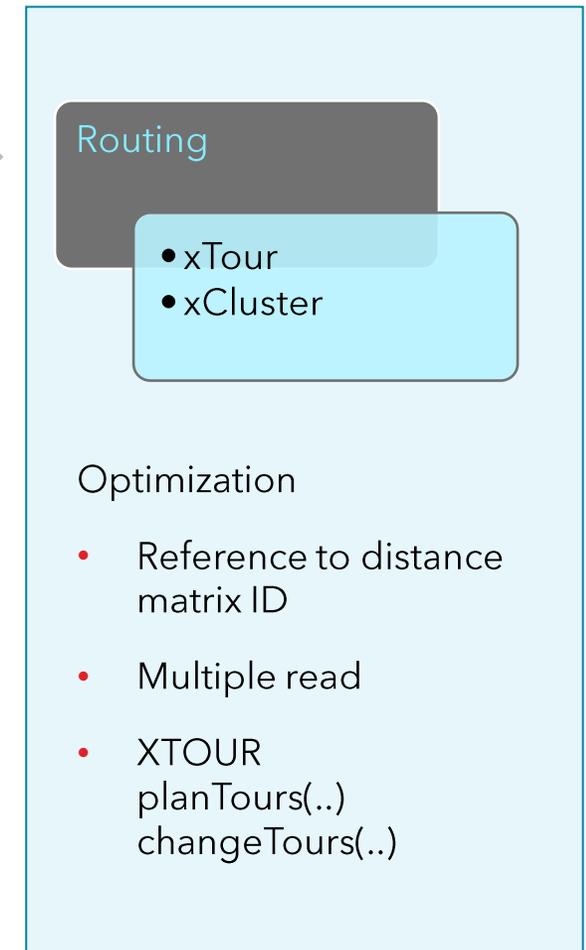
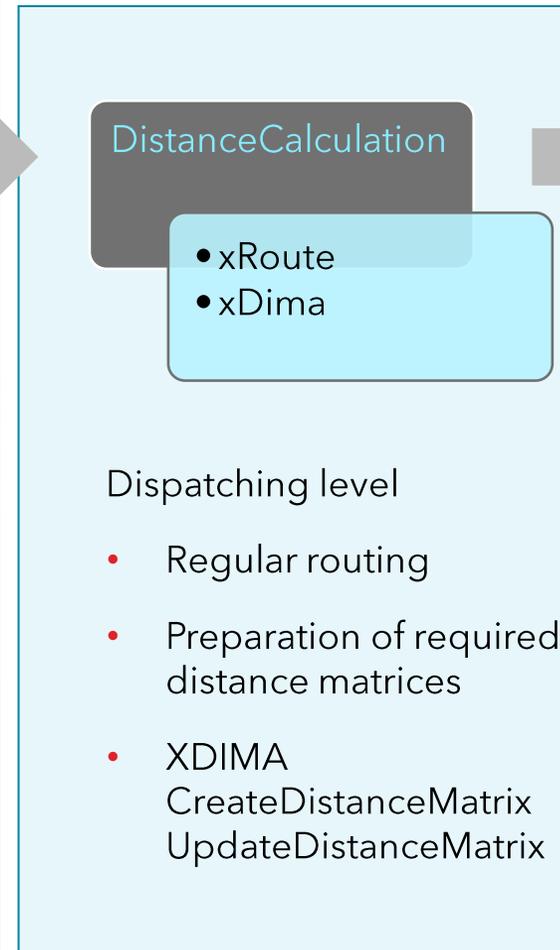


# Introduction



## Workflow

### 1. Routing 2.0



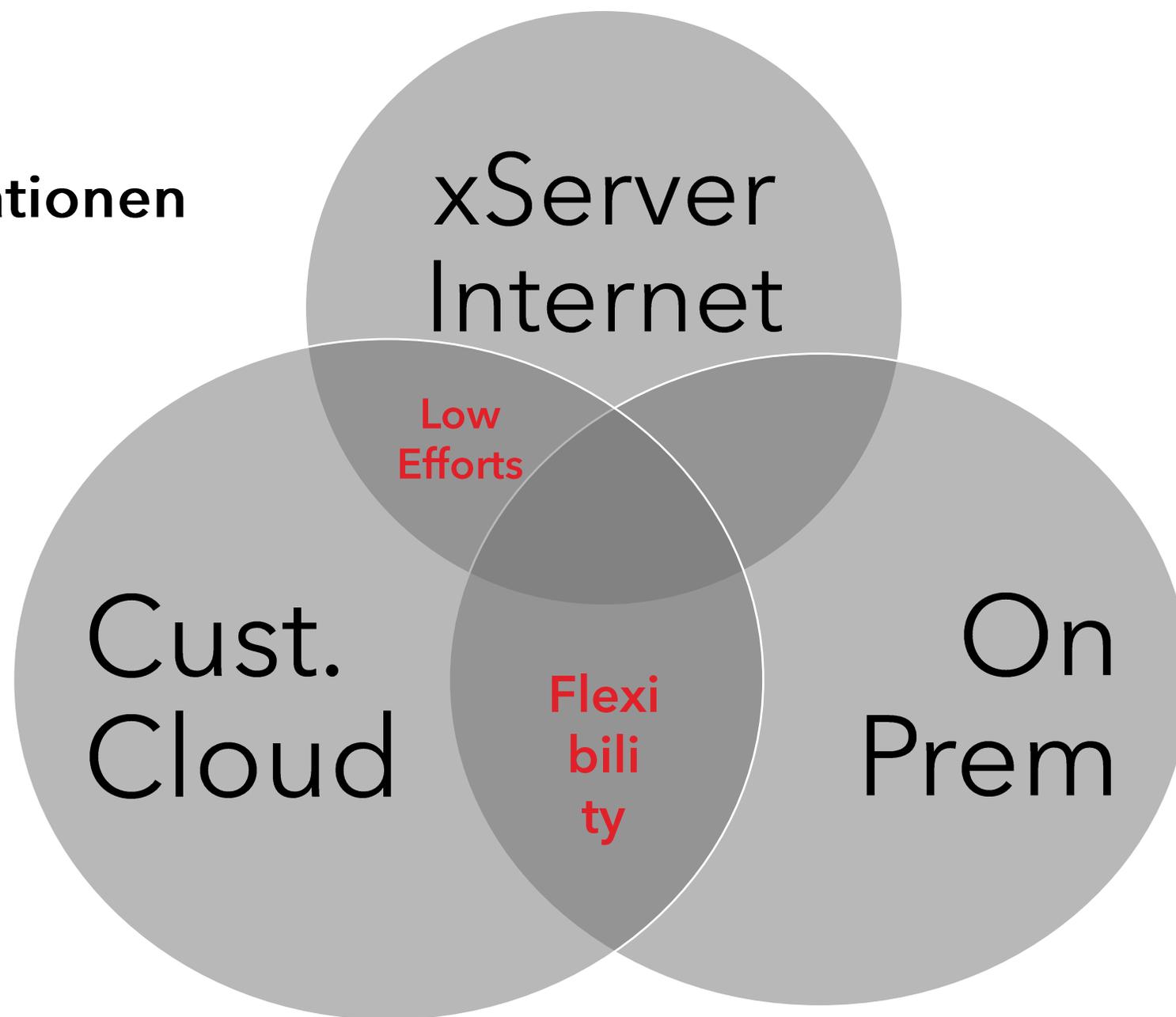
# Usecase scenario „last mile“



## Parcel delivery

- **B2B**  
Parcel delivery companies have daily delivery routine with static coordinates  
→ create (and extend dima)  
→ extension is fast enough for CONVENTIONAL
- **B2C**  
Parcel delivery companies have dynamic workload and destinations  
→ recreation of dima each planning cycle required  
→ HIGH\_PERFORMANCE recommended

# Die Motivationen



# xDima - methods / requests

- ▶ createDistanceMatrixRequest
- ▶ createAndGetDistanceMatrixRequest
- ▶ extendDistanceMatrixRequest
  
- ▶ listDistanceMatrices
- ▶ deleteDistanceMatrixRequest
  
- ▶ getDistanceMatrix --> consume on client

- ▶ Like a SQL INSERT
- ▶ Like a SQL INSERT and SELECT and DELETE
- ▶ Like a SQL INSERT (and not UPDATE!)
  
- ▶ Like a SQL ???
- ▶ Like a SQL DROP
  
- ▶ Like a SQL SELECT

## xDima - simple statements

- ▶ Computes / maintains / stores rectangular structures (used to be squared in xServer1)
- ▶ All relations within a DIMA are based on the same routing profile
- ▶ It is impossible to alter the profile of a DIMA  
→ recreate the DIMA instead
- ▶ Not possible to delete rows or columns
- ▶ Upload of own relations isn't possible at the moment

## ▶ HighPerformanceRouting HPR ↔ CONVENTIONAL

- ▶ **Required space:**  
at least 8 bytes/relation, even more if toll and multiple travel times are required
- ▶ Multiple travel times:  
geometry is not time dependent

# Important !

- ▶ Currently the standard cloud does not provide access to custom search graphs  
→ requires Custom Cloud / On Premise
- ▶ 7.2020: As off today PTV offers 4 standard graphs in the Cloud (IDs available through xData)
- ▶ Ensure not to **HARDCODE** the IDs of the search graphs:  
→ the IDs on TEST are not equal to PROD  
→ after a map update the IDs will change

- ▶ **listDistanceMatrices:**  
Performance depends on resultFields...  
As always: do not request what you don't need (e.g. coordinates of starts/destinations)
- ▶ **Touch your DIMA...**  
→ we delete DIMAs based on the lastUsed timestamp (2 weeks)

# Triggers - when should we read/write a DIMA

- ▶ **New locations in your horizon → update dima**

Whenever your master data is updated, e.g. depots, customers are inserted/deleted

- ▶ **Map update → recreate dima**

At least once per year we update the cloud map data. Improved data means improved routing info.

- ▶ **Profile update → recreate dima**

Imagine your organization decides to change some shared parameters such as "speed on highways" or "prio of distance versus period"

# Errors

- ▶ Relations which are requested but not contained  
xserver1 → create an error  
xserver2 → always returns KPIs (estimated)
- ▶ Relations which are contained and but not successfully routed contain airline replacement

- ▶ Use the Asynchronous protocol (framework topic)  
→ AZURE timeout !  
→ requires full qualified hosting center  
<https://xserver2-eu-test.cloud.ptvgroup.com/service>

```
jobId = startRunLong(request).id
do
  jobStatus = watchJob(jobId).status
while jobStatus not in [ FAILED, SUCCEEDED, DELETED, UNKNOWN ]

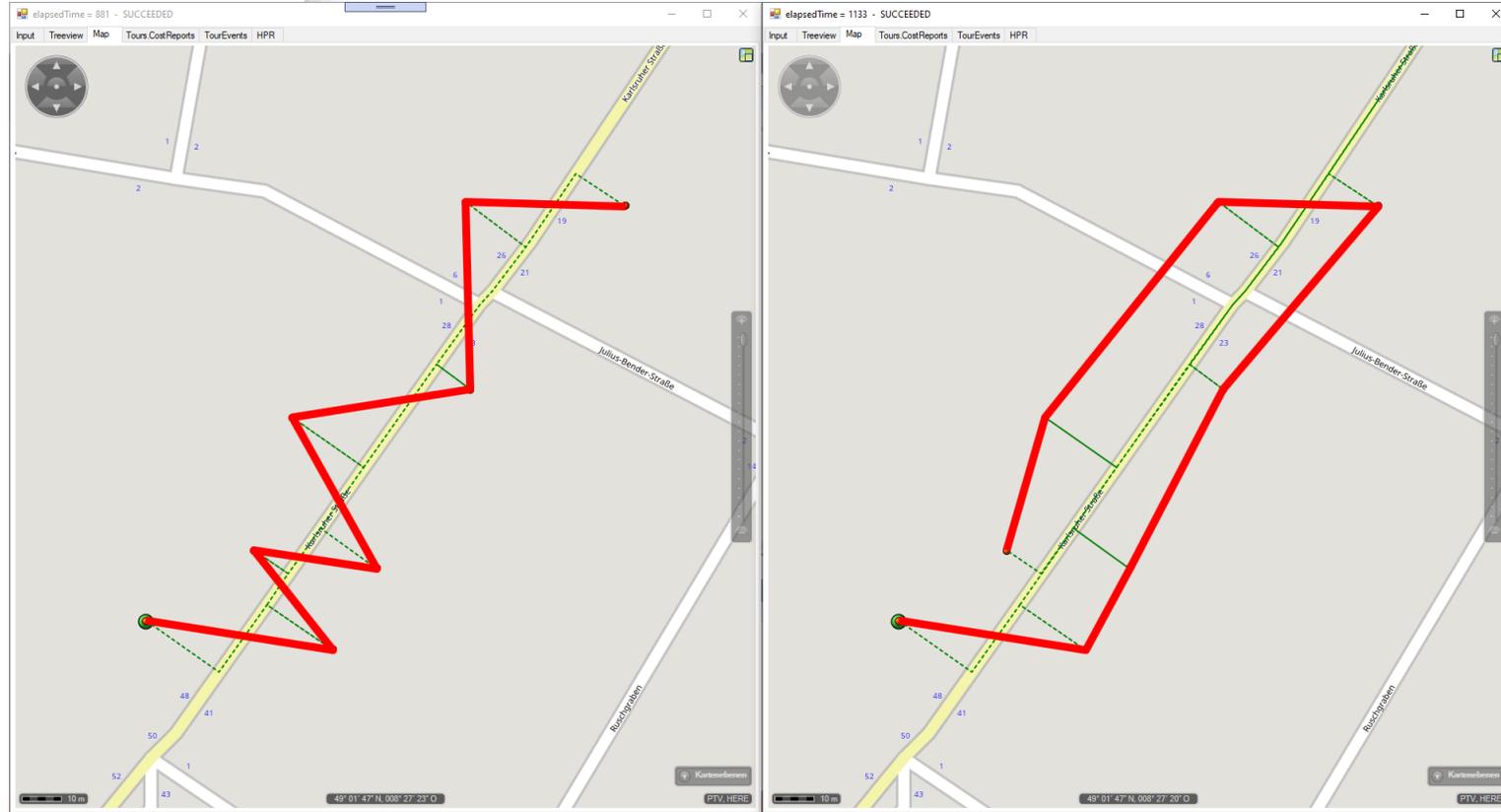
if jobStatus in [ FAILED, SUCCEEDED ] then
  response = fetchResponseType(jobId)
end
```

# Performance

- ▶ Time dependent FeatureLayers such as TruckAttributes have an impact on routing performance in general
- ▶ Consider geographic restrictions
  - auto, bounding rect
  - positive/negative country list
- ▶ Session handling:  
Use "update if possible", don't recreate
- ▶ Use HPR (HIGH\_PERFORMANCE) instead of CONVENTIONAL if possible
- ▶ xDima2.listDistanceMatrices → only request info you really need, otherwise poor performance

# New features 2.19

- ➔ OffRoadRouteLocation  
→ considerDrivingSide  
(Demo xTour2 Client)



# DEMOS – all on XSI

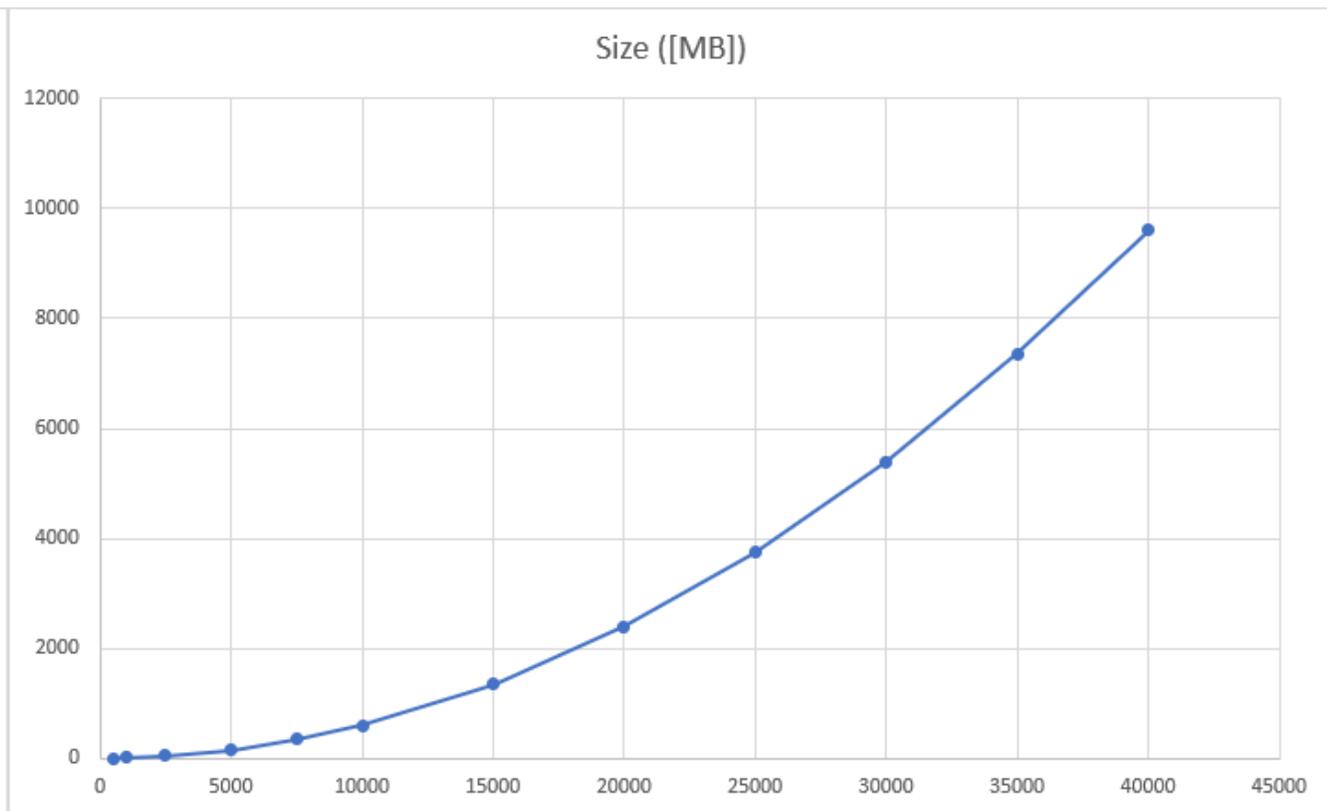
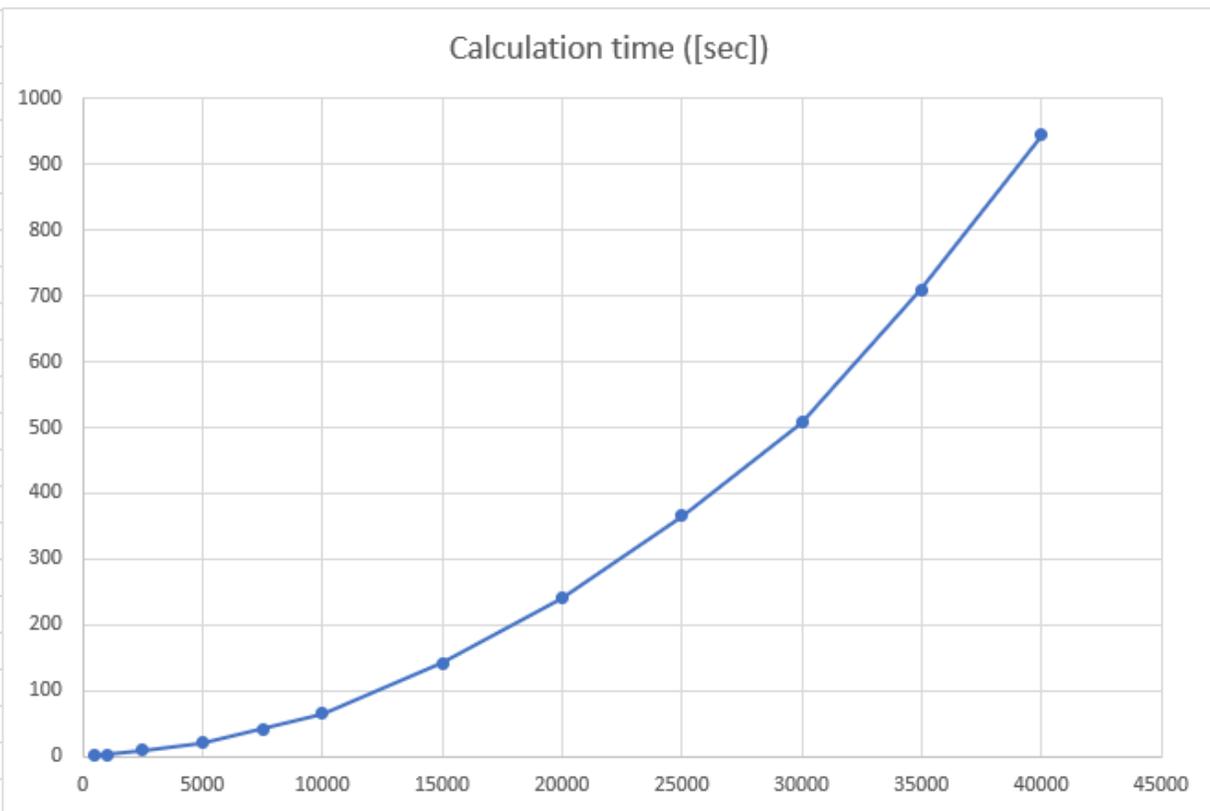
- List Searchgraphs
- List dima
- Sample data: german zip5...
- Square 500x500 dima with HPR
- Square 20 x 20
- Square 20 x 20 / DE
- Square 20 x 20 + FL TruckAttributes
- Rectangular dima (1-10)x(6-15)
- GetDistanceMatrix

# Calculation Times (HPR)

Calculated on a DELL Precision 5530, Intel i7-8850H (2.6 GHz),  
32.0GB, Windows 10-64bit

Rowcount	Required time [sec]	Size [MB]
500	1	1,5
1.000	2	6
5.000	20	150
10.000	65 = 1:05	600
20.000	240 = 4:00	2400
30.000	507 = 8:27	5400
40.000	945 = 15:45	9600

# Calculation Times (HPR)



# General approaches

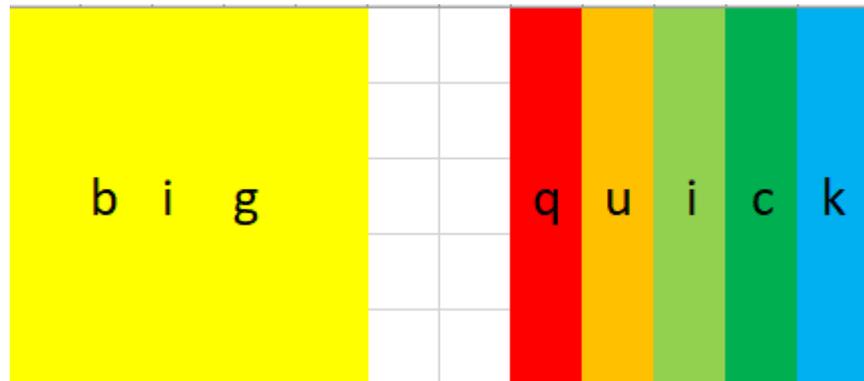
## Tasks:

- ▶ Calculation of DIMA content on server
  - based on starts / destinations
  - CONVENTIONAL - explicit routing profile (at runtime)
  - HIGH\_PERFORMANCE - through search graph
  - HIGH\_PERFORMANCE\_FALLBACK
- ▶ Maintaining DIMA
  - extend / overwrite content
- ▶ Listing of DIMA's
  - included coordinates, metadata
- ▶ Delete DIMA
  - clean up space (based on last usage)
- ▶ Download DIMA content on client side either
  - plain
  - binary encoded arrays



# Download aspects

- ▶ Download of content  
→ needed for on premise optimization algorithms
- ▶ Size of a single download is limited  
→ partitioning recommended  
→ consider encoded arrays to save performance
- ▶ Check licensing conditions: r u allowed to download and use DIMA content on clientside?



# Pro's and con's

## Cloud

### Pro

- Price
- Performance
- No efforts

### Contra

- Reduced flexibility

## Custom Cloud

### Pro

- Performance
- Flexibility

### Contra

- TCO

## On Premise

### Pro

- Performance
- Flexibility

### Contra

- TCO

# Questions and Answers (from the chat / experience)

**Question: Are the results (distances and driving times) of a DIMA based optimization comparable to a post-processed routing if we use the same routing parameters?**

- ▶ Answer: There may be some gaps (few meters or seconds) between the xDima / DIMA based approach and the xRoute / sequential routing - even if you use the same routing profiles on the same instance (implicit: same map version). The cause for such gaps is the way temporary data structures are created. If you use CONVENTIONAL routing we usually apply levelling (filtering of lower prio segments which are too far away from any waypoint). Remember: a „NxM“ DIMA is filled with N times „1:M“ routing results. So within such a single backend C++ call the distance between „1“ and all the M's considers all the detailed zones around all the Ms while the post processing of a single AB route ownly knows details around A and B. If you use HIGH\_PERFORMANCE\_ROUTING in both steps the results will be equal because HPR is EXACT and does not apply a heuristic or leveling.

Fancy videos: [https://www.youtube.com/watch?v=psSUvbxrObo&list=PLtcAJ\\_IPSDBafyyyVo\\_DuNiNSn-KPfS7R](https://www.youtube.com/watch?v=psSUvbxrObo&list=PLtcAJ_IPSDBafyyyVo_DuNiNSn-KPfS7R)

Here are some forum posts that deal with this question:

<https://xserver.ptvgroup.com/forum/viewtopic.php?f=6&t=1224#p3537>

<https://xserver.ptvgroup.com/forum/viewtopic.php?f=7&t=911>

<https://xserver.ptvgroup.com/forum/viewtopic.php?f=7&t=1187>

**DO NOT HESITATE TO GET BACK TO THESE TOPICS IN THE FORUM** <https://xserver.ptvgroup.com/forum>

# Questions and Answers (from the chat / experience)

**Question: Is it possible to create a dima through an xTour2 call**

- Nope - the responsibility of creation, update and deletion of a DIMA is based on xDima 2. Other components such as xTour or xCluster are then accessing the DIMA through it's ID.

**Question: is xDima 2 compatible to xTour 1?**

- Answer: short answer: no.

**DO NOT HESITATE TO GET BACK TO THESE TOPICS IN THE FORUM <https://xserver.ptvgroup.com/forum>**

# Questions and Answers (from the chat / experience)

**Question: Is it possible to combine HIGH PERFORMANCE with Dynamic Data such as Traffic Incidents or Speed Patterns?**

➤ Answer: no, this is not possible. The traversing context of segments is not known during the preprocessing phase of the search graphs.

From a technical perspective it could be meaningful to create search graph based on a SNAP SHOT or TIMESPAN consideration mode but this would require the graphs to be recreated too often. In an OnPremise system you could discuss about createing a WEEKLY search graph but we won't apply such a strategy in the cloud.

**Question: is it possible to set a DIMA to ReadOnly Mode?**

➤ Answer: no, if you have access to a DIMA through a TOKEN you also have the access to manipulating it.

# Questions and Answers (from the chat / experience)

**Question: Why would I use a shared DIMA instead of on own?**

- Answer: The advantage of using 1 dima for multiple process calls is that there is less time wasted double the same route calculation multiple times. The disadvantage is that you to make sure that request are properly queued etc. Overall I usually stick to 1 dima per specific optimization task.

**Question: Is the considerDrivingSide available on the DiMa (xDima) response? Or just in the xRoute module?**

- Answer: considerDrivingSide is part of the location object you as input, and thus also part of the location if you request them by listDistanceMatrix, There's a boolean field named "considerDrivingSide" in the RouteLocation object in the dima request. (Side note: with the xServer2 API we improved the concept of shared data types. So a type such as RouteLocation is unique within xCluster, xRoute, xDima...)

<https://xserver2-europe-eu-test.cloud.ptvgroup.com/dashboard/Default.htm#API-Documentation/routing.html#com.ptvgroup.xserver.routing.OffRoadRouteLocation>

# Merci beaucoup!

- Thanks for watching!
- Thanks for your feedback!
- <https://xserver.ptvgroup.com/forum>

