



An Introduction to Cube 7

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CITILABS

Understanding Movement

*Florida Model Task Force Meeting
Orlando, FL
July 30, 2019*

Cube 7

Major release expected in 2020

Big changes are coming!

New Interface

- Windows 10 interface with a modern look and feel

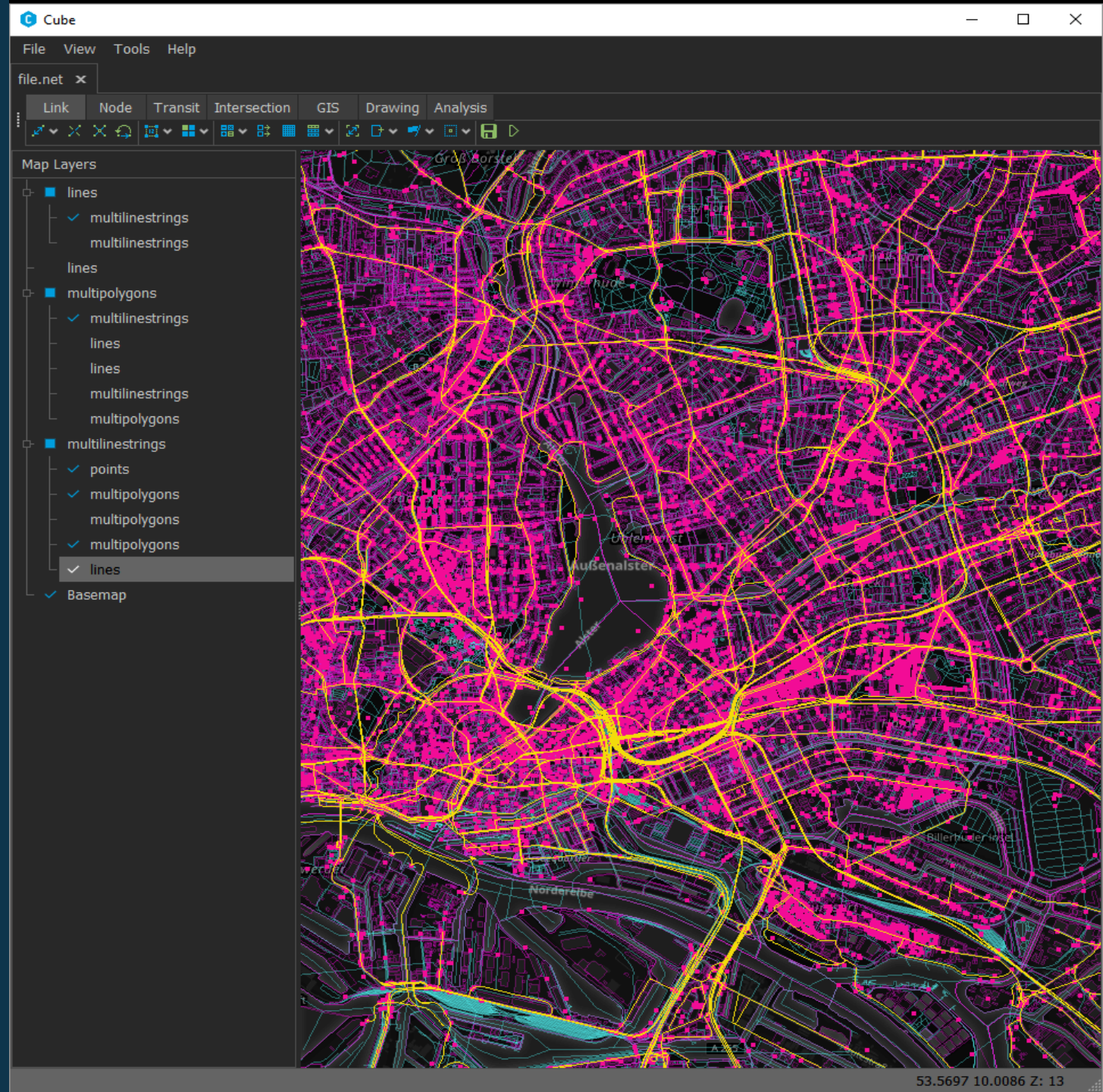
New Network Editor

- Network and GIS windows combined for better functionality and user experience.

Voyager Improvements

Major Updates to Application Manager and Task Monitor

Improvements to Cube Cluster



Cube 6 to 7 Transition

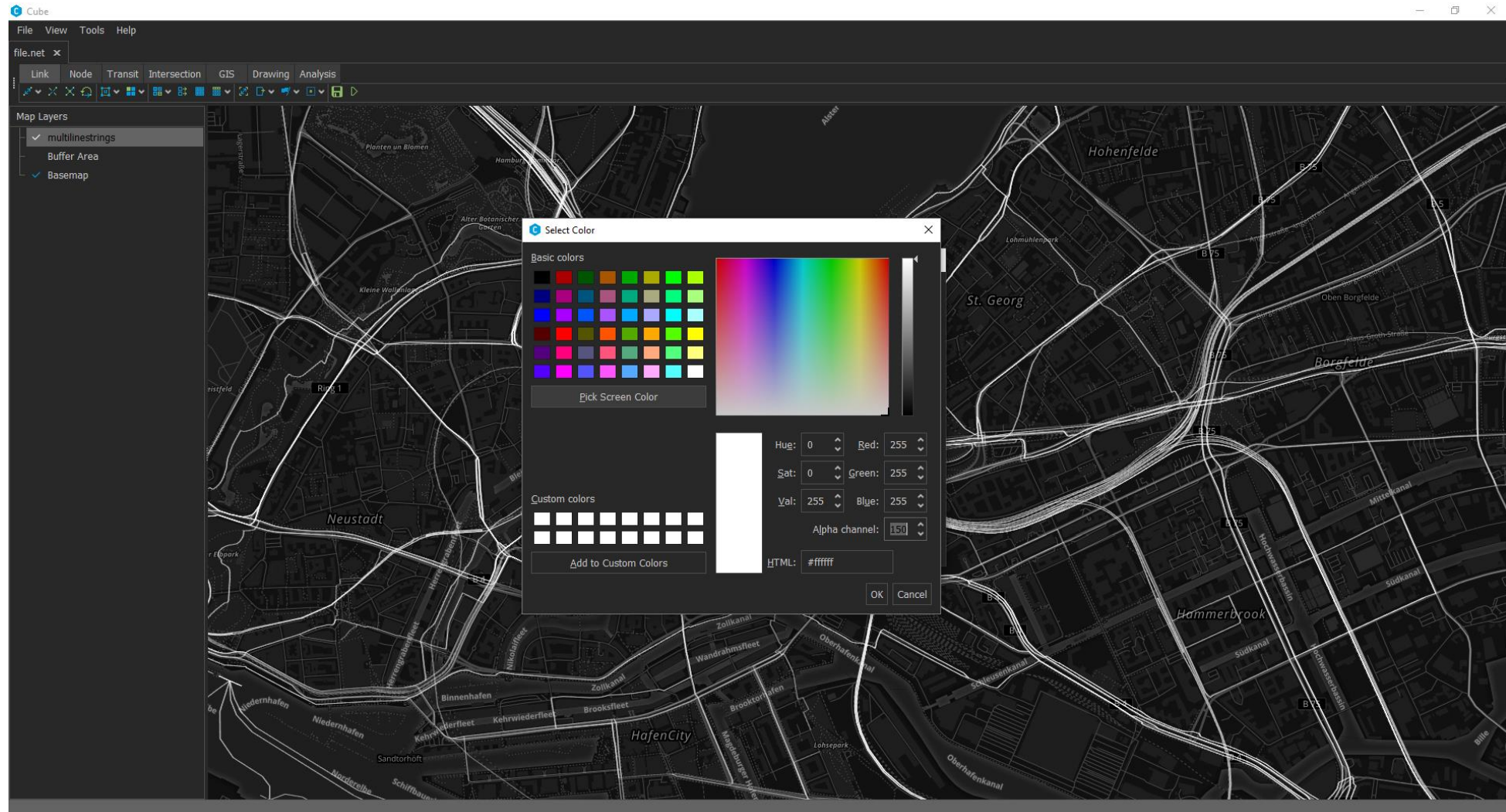
Cube 7 will be a big change from Cube 6

- To help ease in the transition to Cube 7 new releases of the Cube 6 branch will continue to be made alongside Cube 7 until it is determined that the Cube 6 branch is ready to be closed.
- A Cube 7 beta testing program will be launched to give customers under maintenance early access.
- Migration Tools for converting updated file formats from 6 to 7 will be made available.



Cube 7: New Modern Interface

- The UI will have a modern look and feel.
- Allows the user to customize many aspects of the look and organization of the system.
- The user will be able to have themes and even tie basemaps to those themes (i.e. a dark basemap along with a dark menu theme, etc).





Cube 7: Cluster

- Will have much greater usability and manageability
- Based on a robust client-server protocol system rather than file based inter-process communication
- Consolidated and centralized cluster node management; compute resources (individual computers) will be registered into the system initially and then cluster runs will be able to be started from one central machine and managed within one interfaces (no longer will you have dozens of cluster voyager windows)
- The system will not require specific assignment of cluster nodes; it will automatically determine with nodes to assign for a particular Multistep or Intrastep, but users will be able to override this behavior
- The user will be able to manage multiple Cube cluster compute pools from one interface / client (i.e., multiple model runs could be started and monitored from one user interface even if each run is occurring on a different set of computers)

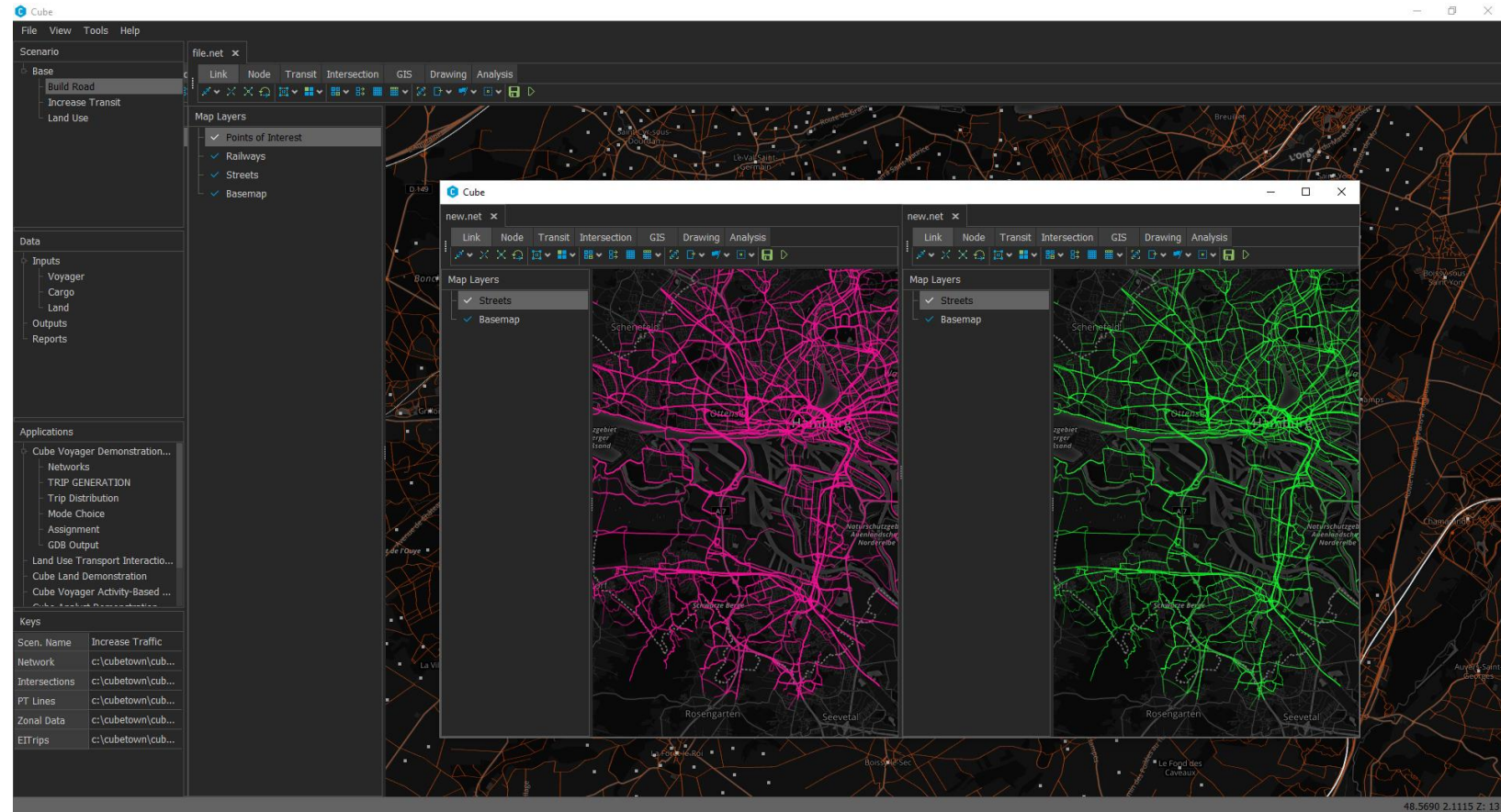
Voyager

- Natively use GIS formats for networks; currently the Network program will convert every input format to the Cube binary network format temporarily, perform the work, and then convert back to the appropriate output format (mdb, gdb, etc). There will be additional options for working with new data sources (relational databases, etc)
- The 32K zone limit will be increased to "virtually unlimited"
- Improved data formats and I/O performance
- Further Speed Enhancements for Highway, PT and other Voyager modules



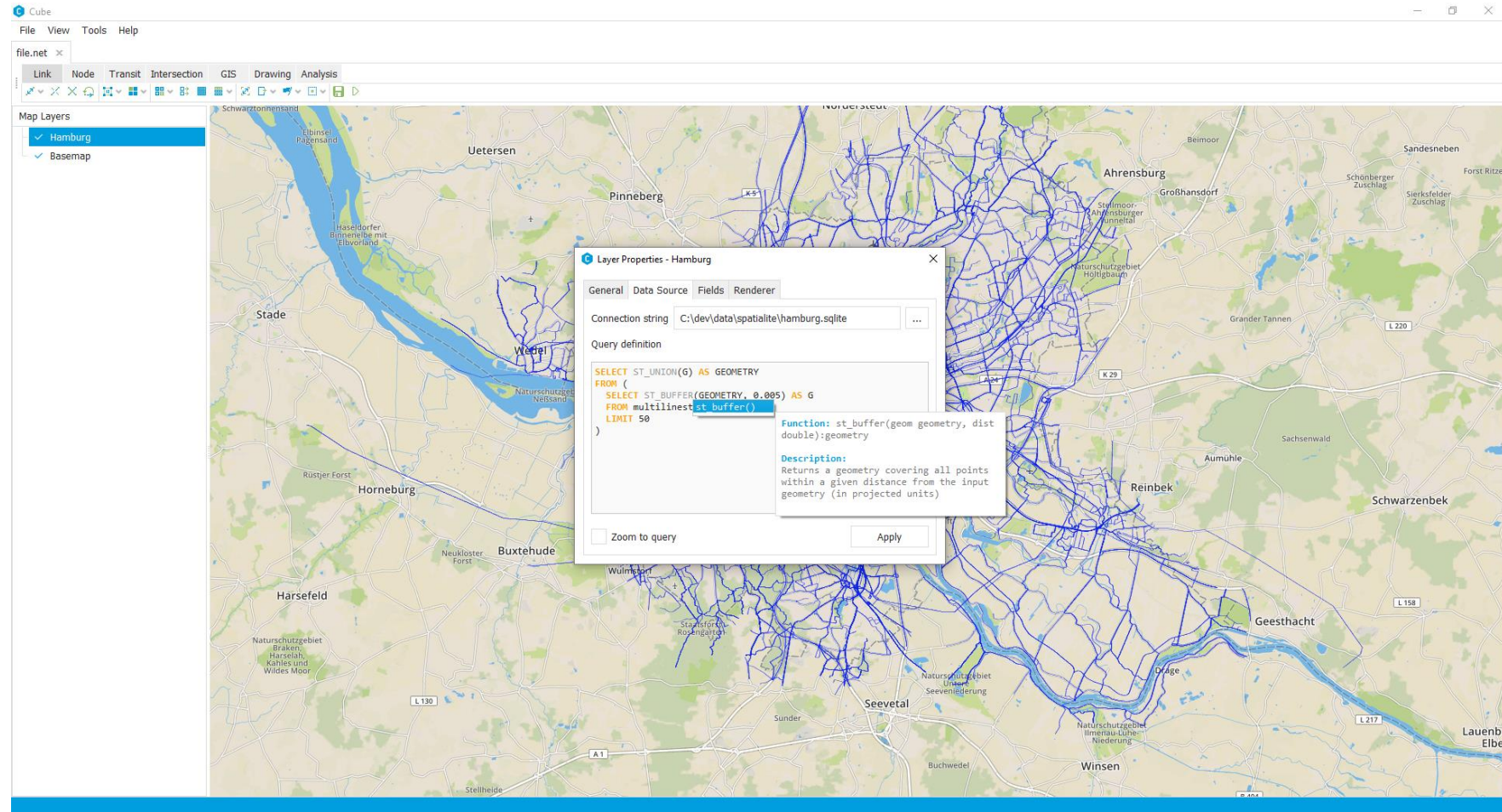
Cube 7: New Network Editor and GIS Tool

- High performance visualizations with better support for much larger datasets.
- A single interface for Network / GIS data (no distinction between Cube Network Window and GIS Window).
- Greater data flexibility with native support for a wide variety of modern GIS data sources, particular database systems implementing OpenGIS Simple Features or SQL/MM, such as Spatialite, PostGIS, Oracle, Microsoft SQL Server, and more!
- New collaboration opportunities. Cube 7 will support true relational database management systems and thus users may collaborate on the same data concurrently within Cube just as they would with any other database application



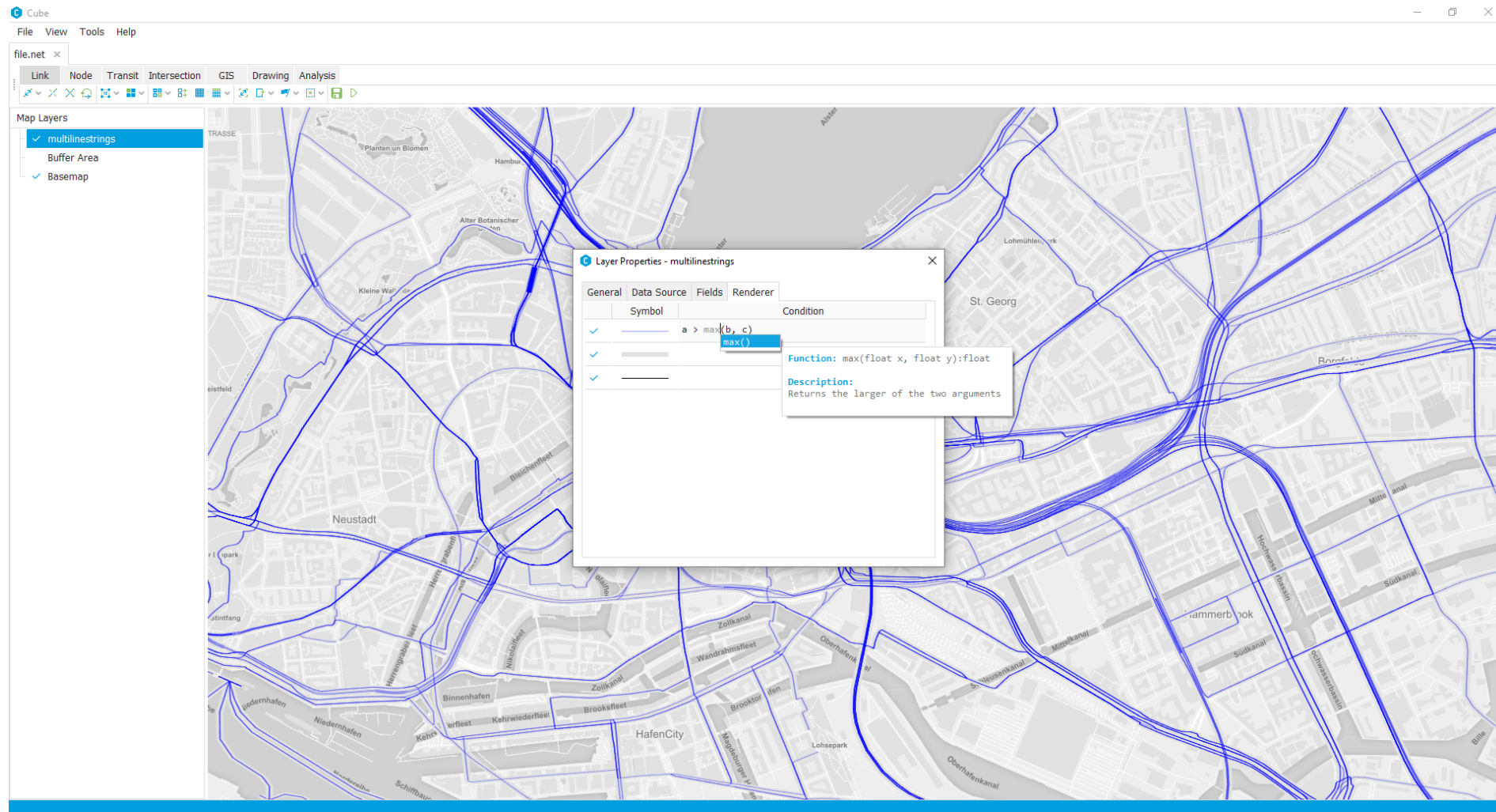
Cube 7: New Network Editor and GIS Tool

- Powerful query capability that allows vector data layers to be updated dynamically based on standard spatial queries in a very low friction interface; this query capability allows for very powerful geoprocessing tasks through a standard SQL interface (query templates will be provided for common types of tasks to make things even easier)
- Cube Networks will be more robust and provide better data validation
- Modifying highway networks within a Cube network databases will automatically update and ensure consistency across all transit networks in the same database



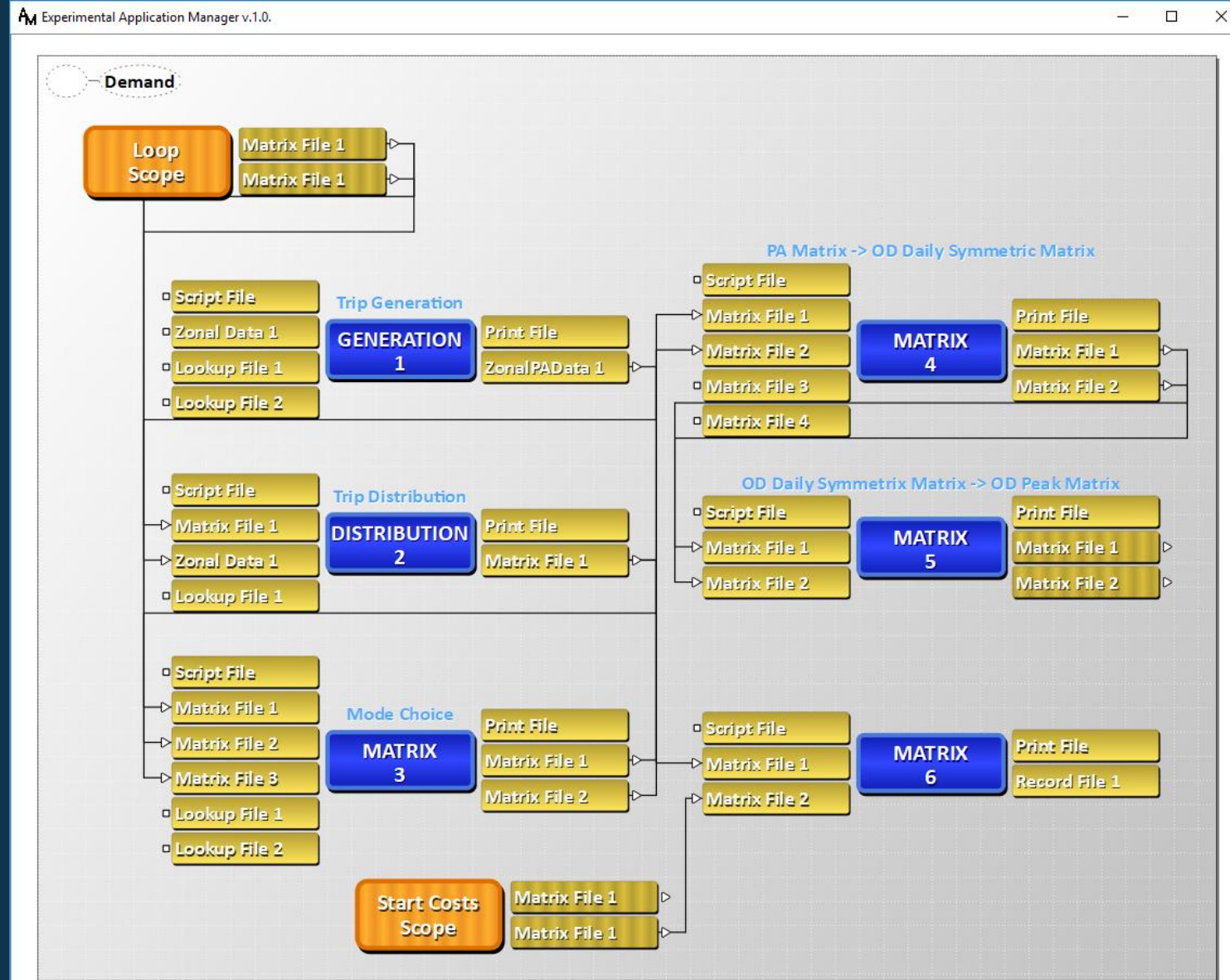
Cube 7: New Network Editor and GIS Tool

- Support for multiple basemap sources, ArcGIS Online, Open Street Map data, etc
- Full support for WMS/WMTS
- Foundation for much more complex visualizations and potentially animations to be added into the system on a regular basis (some examples may be GPS path animations, or a 2.5D desire line visualization, etc); the new system will be much more flexible allow quicker implementation of these and other capabilities



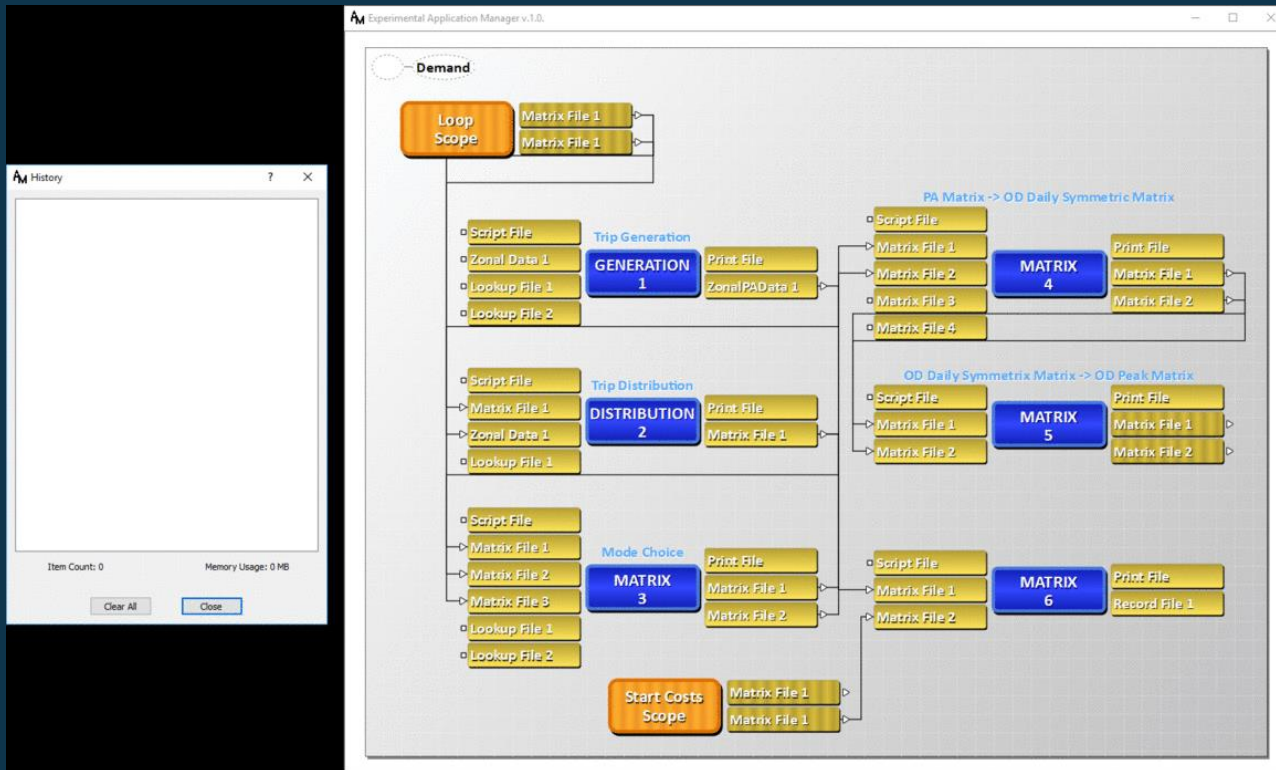
Cube 7: Application Manager

- Application Manager will have a new look and have more powerful visual capabilities such as:
 - Zooming / scaling,
 - An overhead mini-view of the current flowchart,
 - Hover over group box displays preview of that group's flowchart
 - Ability to view the entire application group tree hierarchy and navigation
- Users may specify how far up a group hierarchy that an input file may be "public"
- Model run mode; AM will allowing running of an application and all of its subgroups in a read-only view that highlights the currently running program and various statistics about the current run (similar to Task Monitor but more detailed)

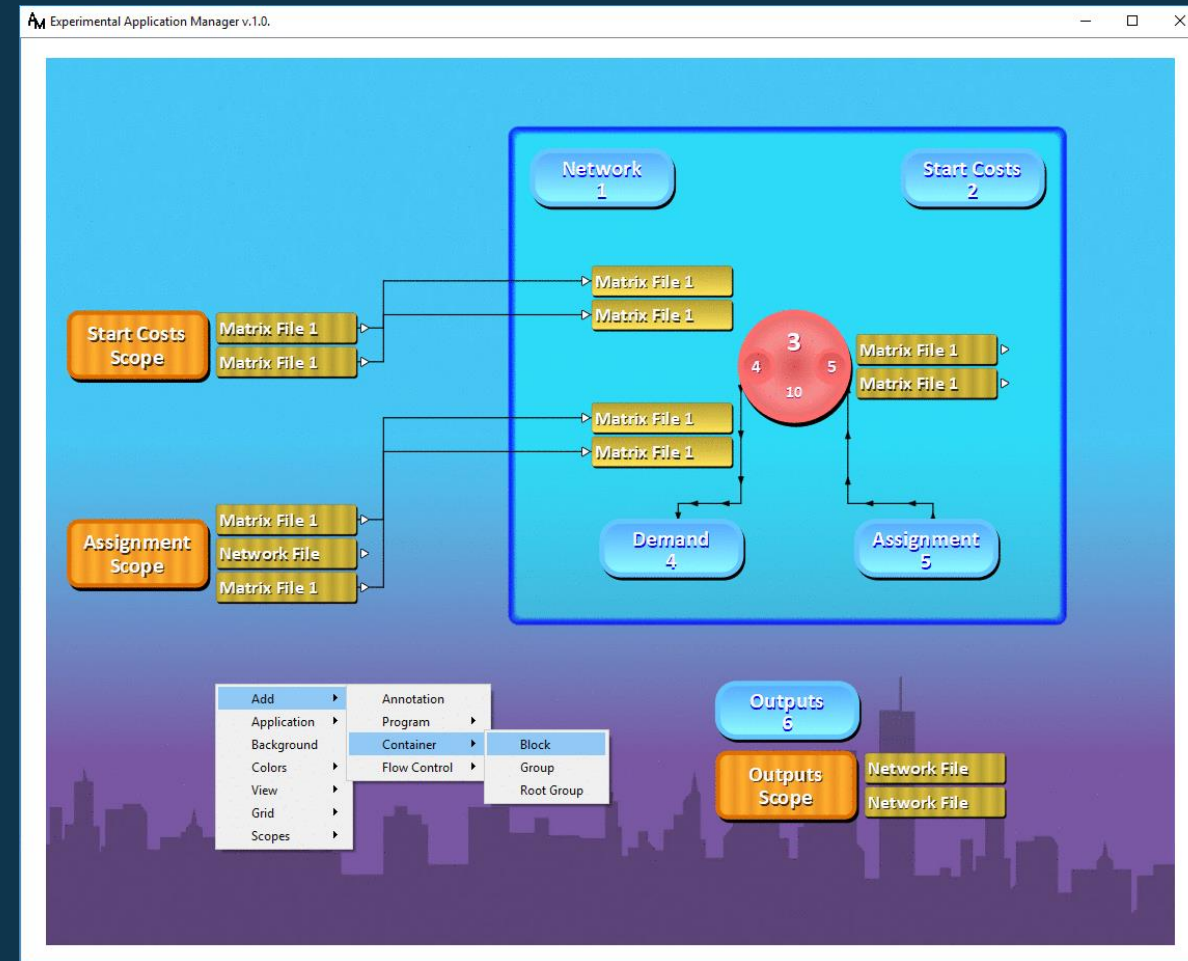


Cube 7: Application Manager

- History allows for undoing changes



- Grouping Control





Introduction of CubePy

New Cube Library for Python

- A next generation alternative model scripting system based on Voyager technology
- Utilizes Python, for an easy-to-learn and integrate experience
- Greatly enhanced flexibility in the assignment algorithm processes with more control over individual phases
- Powerful capabilities for manipulating matrices and networks
- Able to perform GIS analyses directly within CubePy
- Interoperate between popular Python libraries such as scipy and numpy, as well as other libraries callable from Python



Version Control

- In Cube 7, we are committed to creating an experience that works very well with industry standard version control systems
- Full support for relative paths throughout Cube (Scenario Manager, Application Manager, Voyager, etc) and relative paths will be the default behavior for file paths when possible, which will mean that no updates are needed when the root directory of a model is moved, for instance
- Provide updated configuration file formats, such as the catalog file, so that version control systems may easily track modifications to scenarios and keys
- We will provide guidance on how best to utilize Cube with version control systems

New GPU Computing in Cube 7

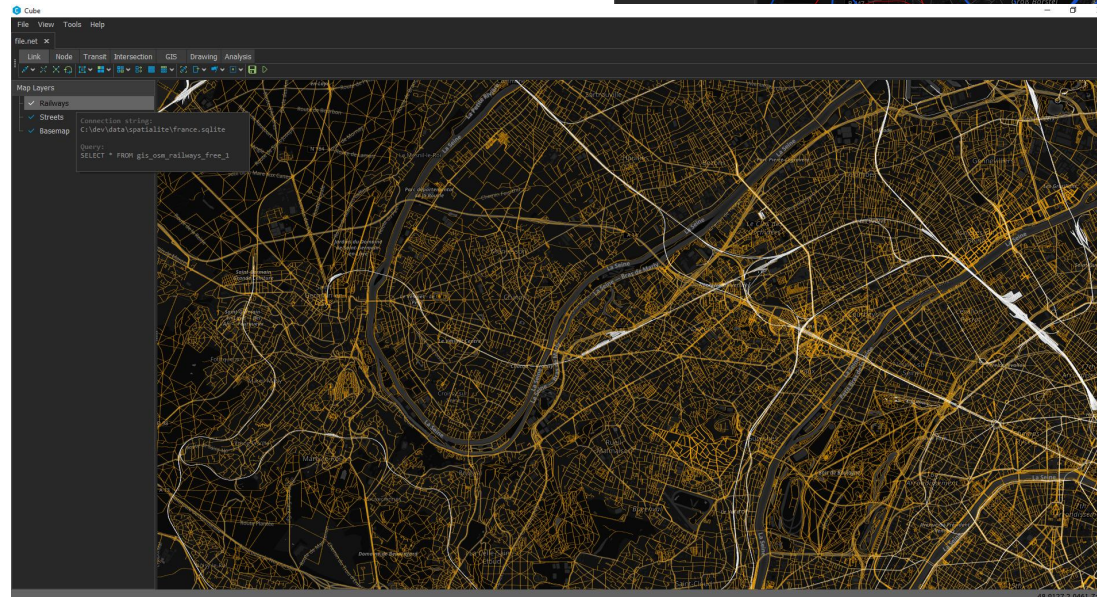
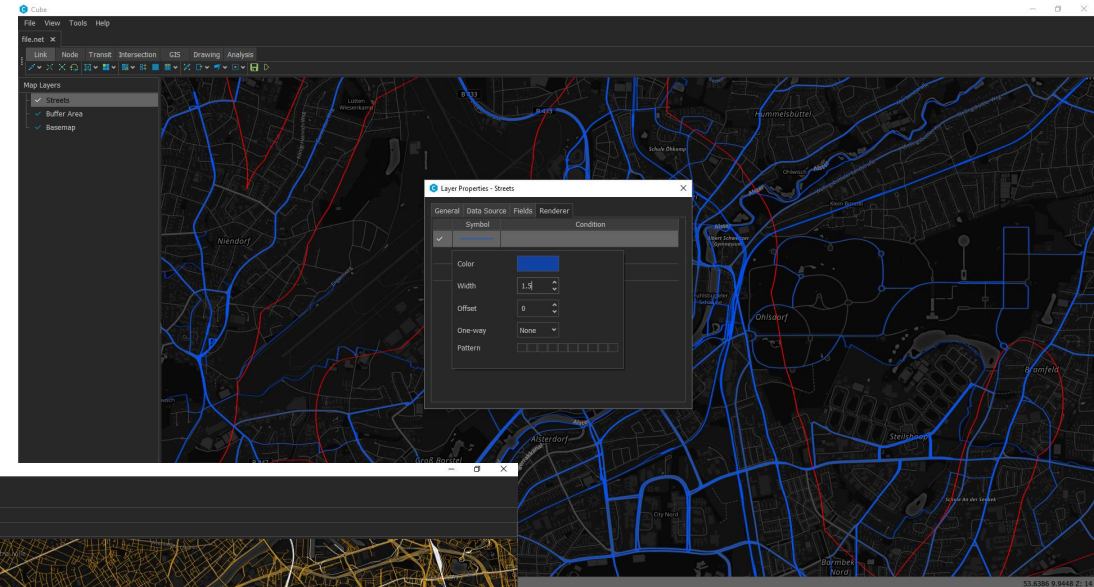
- Cube 7 will be the first version of Cube to make use of GPU co-processors for both Visualization and Computation.
- Current Analyst Drive GPU version slashes runtimes for large problems. A single class Chicago model time was reduced from over 7 hours on an Intel i7-8700 to under 12 minutes on an Nvidia RTX 2070.
- A Florida Statewide Model (circa 2012) AD test reduced runtimes from 5 hours 21 minutes to just 24 minutes, a 13X speedup

Florida Statewide Model – CPU vs GPU AD runs. nzA=non-zero route choice matrix entries, nzX= non-zero OD matrix entries, nzb=total counts with non-zero initial volume. Gradient computation is entirely done on GPU and is the most computationally significant piece of each iteration.

Class	nzA	nzX	nzb	CPU Gradient time (s)	GPU Gradient Time (s)	Gradient Computation Speedup (X)	CPU Iter Time (s)	GPU Iter Time (s)	Total Iter Speedup (X)	Per Iteration Time Savings (s)
1	78026272	2363837	10818	32	0.3	106.6666667	63	1.6	39.375	61.4
2	166380269	1558394	10720	56	0.58	96.55172414	77	2.9	26.55172414	74.1
3	74617942	551040	10606	25	0.3	83.33333333	33	1.5	22	31.5
4	214592	17622	2821	0.35	0.04	8.75	0.4	0.3	1.333333333	0.1
5	4311412	57592	7964	1.4	0.06	23.33333333	1.8	0.38	4.736842105	1.42
6	43455642	3020901	10695	23	0.2	115	61	1.1	55.45454545	59.9
7	30690138	2035163	10700	16	0.16	100	41	0.9	45.55555556	40.1
8	112736160	3034003	10829	45	0.41	109.7560976	85	2.12	40.09433962	82.88
9	30563354	630061	10238	11	0.17	64.70588235	17.5	0.9	19.44444444	16.6

Cube 7: Other Anticipated Features

- CubePy library for running Cube from Python scripts.
- GPS Processing Tools.
- New and Improved Database and Matrix Editors.
- Improved Cube reports
- New tools for Mobility Services modeling
- A powerful data format API for integration with various processes and workflows
- Migration tools for moving from Cube 6 to 7



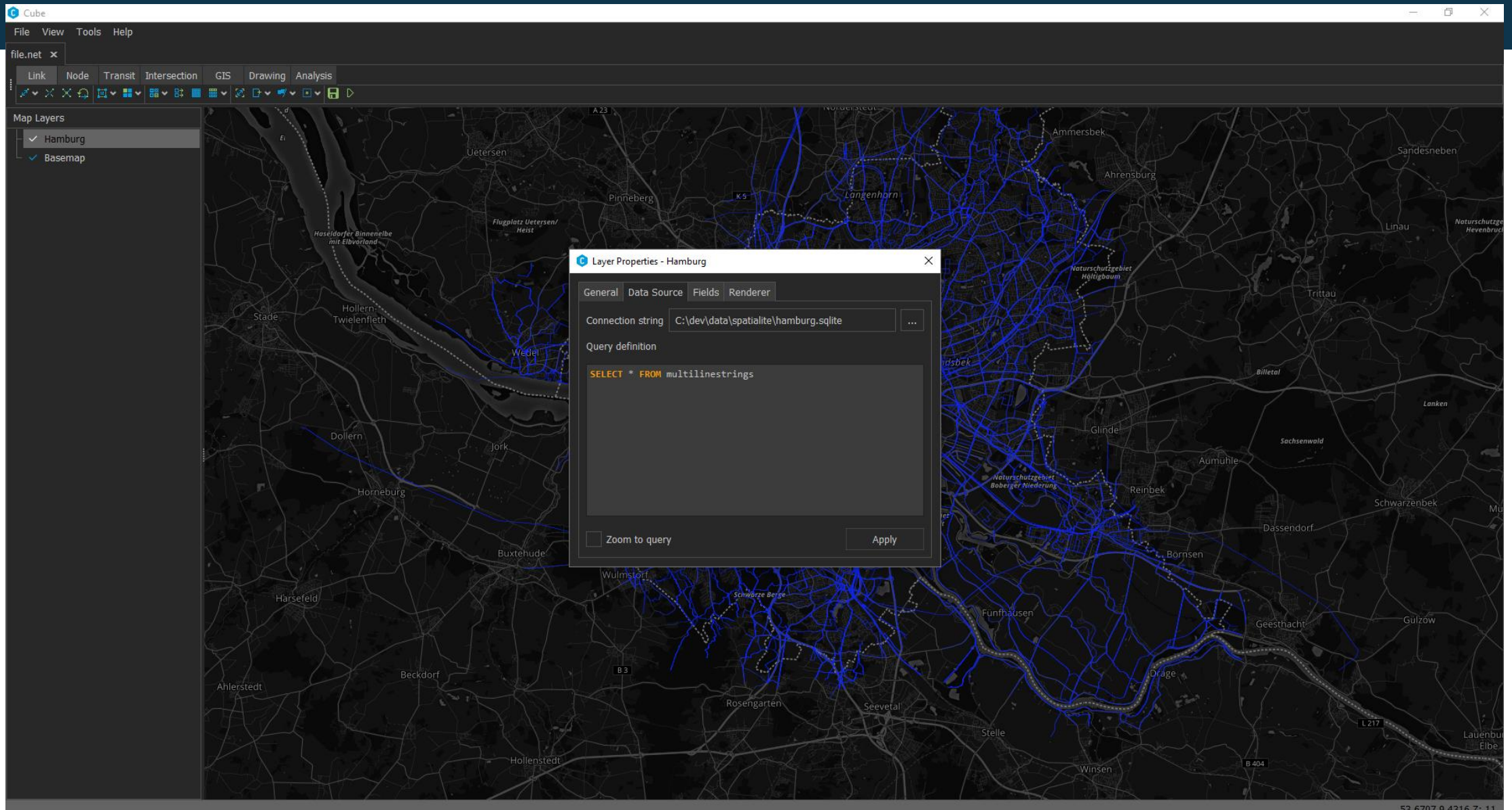


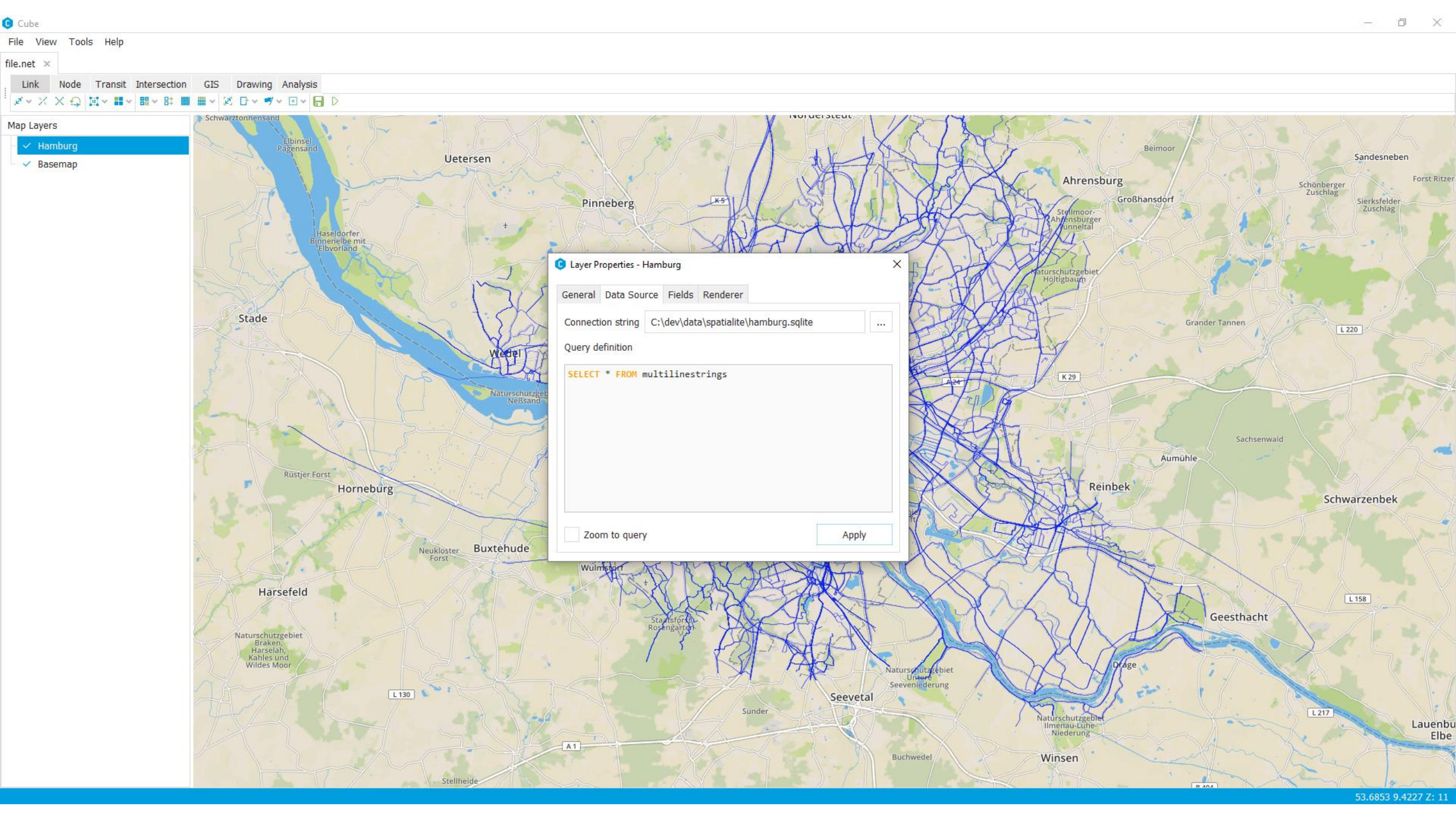
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THANK YOU

Cube 7 Gallery





Layer Properties - Hamburg

General Data Source Fields Renderer

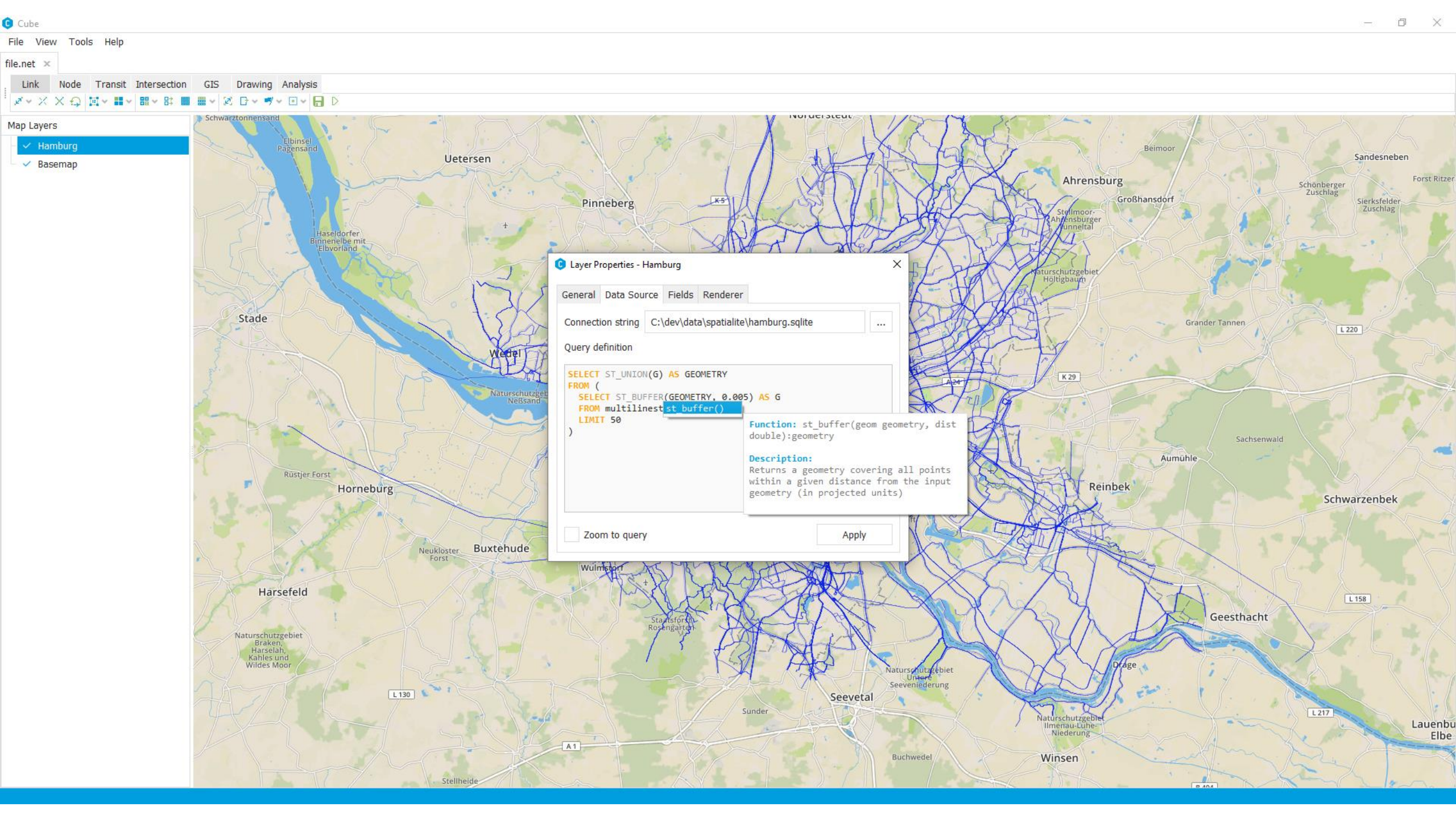
Connection string C:\dev\data\spatialite\hamburg.sqlite ...

Query definition

SELECT * FROM multilinestrings

☐ Zoom to query

Apply



Layer Properties - Hamburg

General Data Source Fields Renderer

Connection string C:\dev\data\spatialite\hamburg.sqlite ...

Query definition

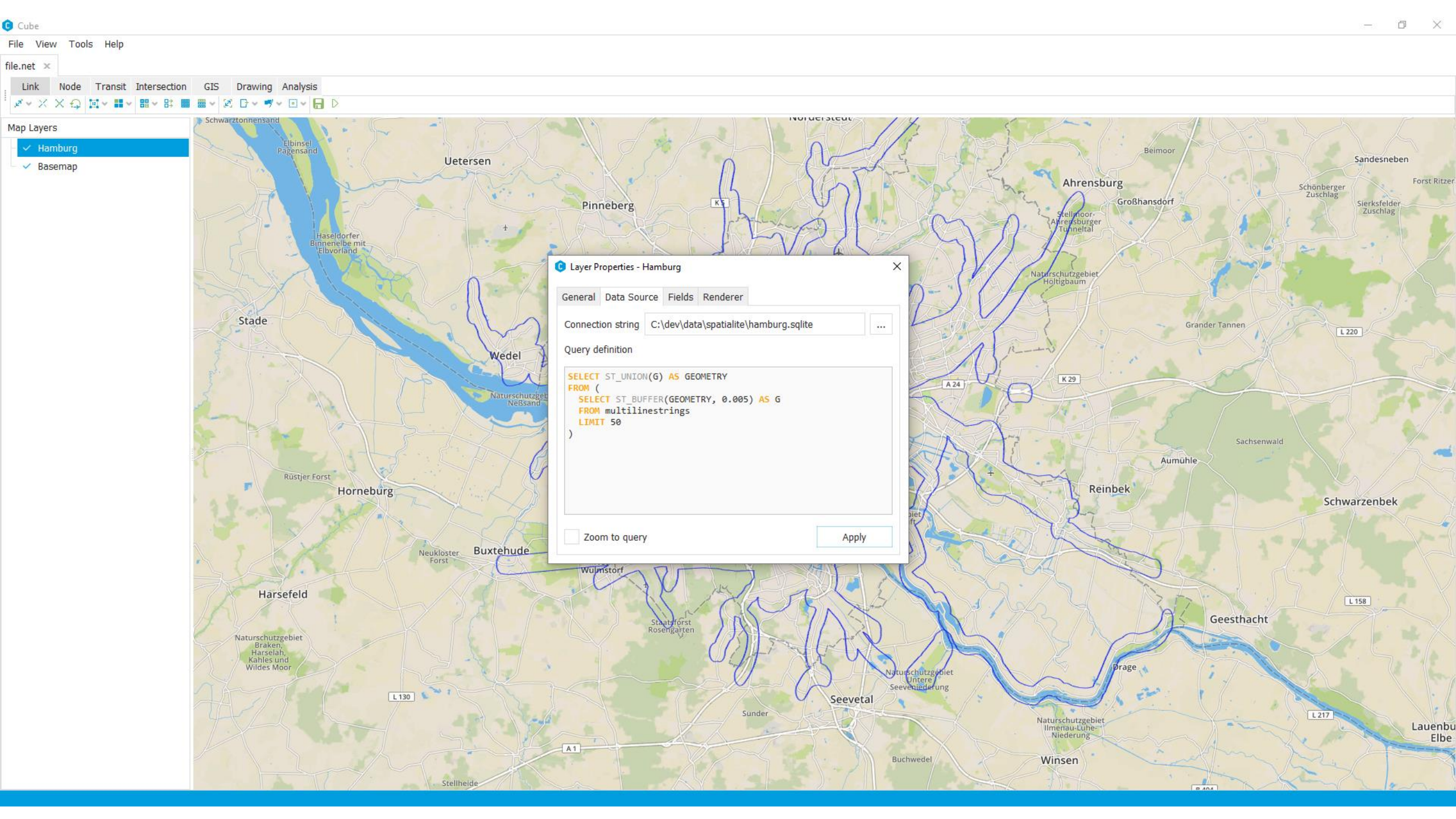
```
SELECT ST_UNION(G) AS GEOMETRY
FROM (
  SELECT ST_BUFFER(GEOMETRY, 0.005) AS G
  FROM multilinet st buffer()
  LIMIT 50
)
```

Function: st_buffer(geom geometry, dist double):geometry**Description:**

Returns a geometry covering all points within a given distance from the input geometry (in projected units)

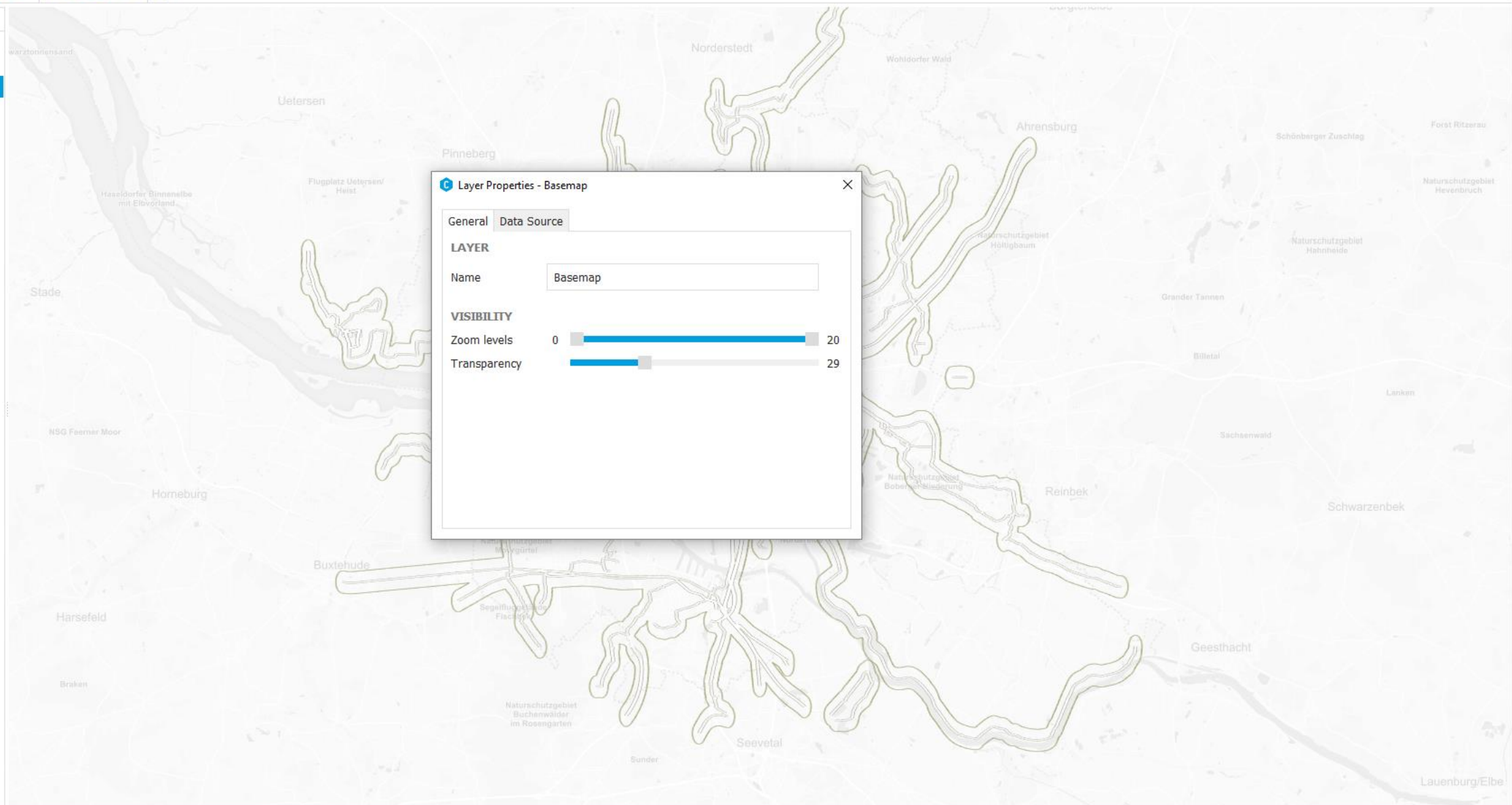
☐ Zoom to query

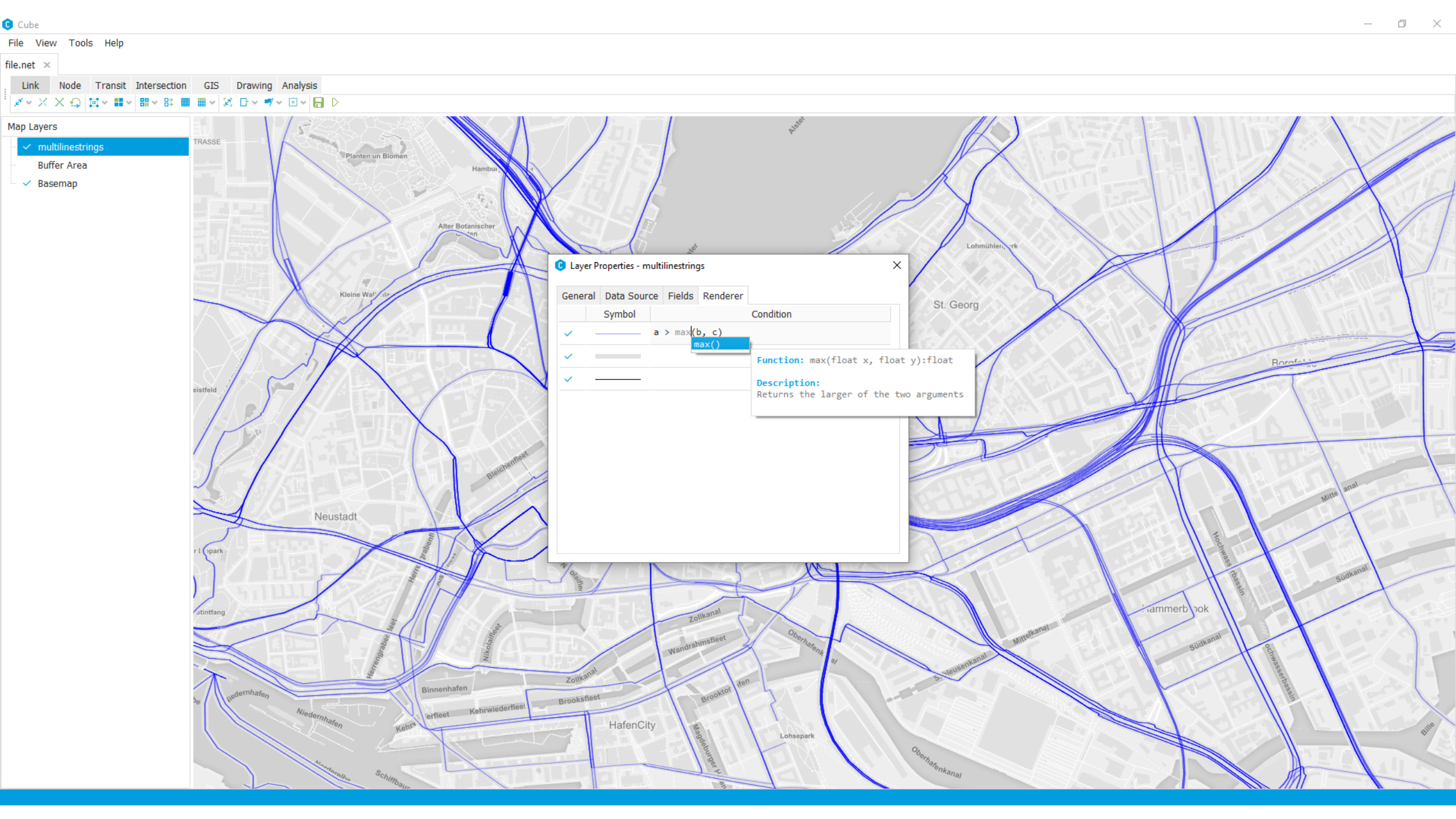
Apply



Map Layers




- ✓ multilinestrings
- ✓ Buffer Area
- ✓ Basemap





Layer Properties - multilinesstrings

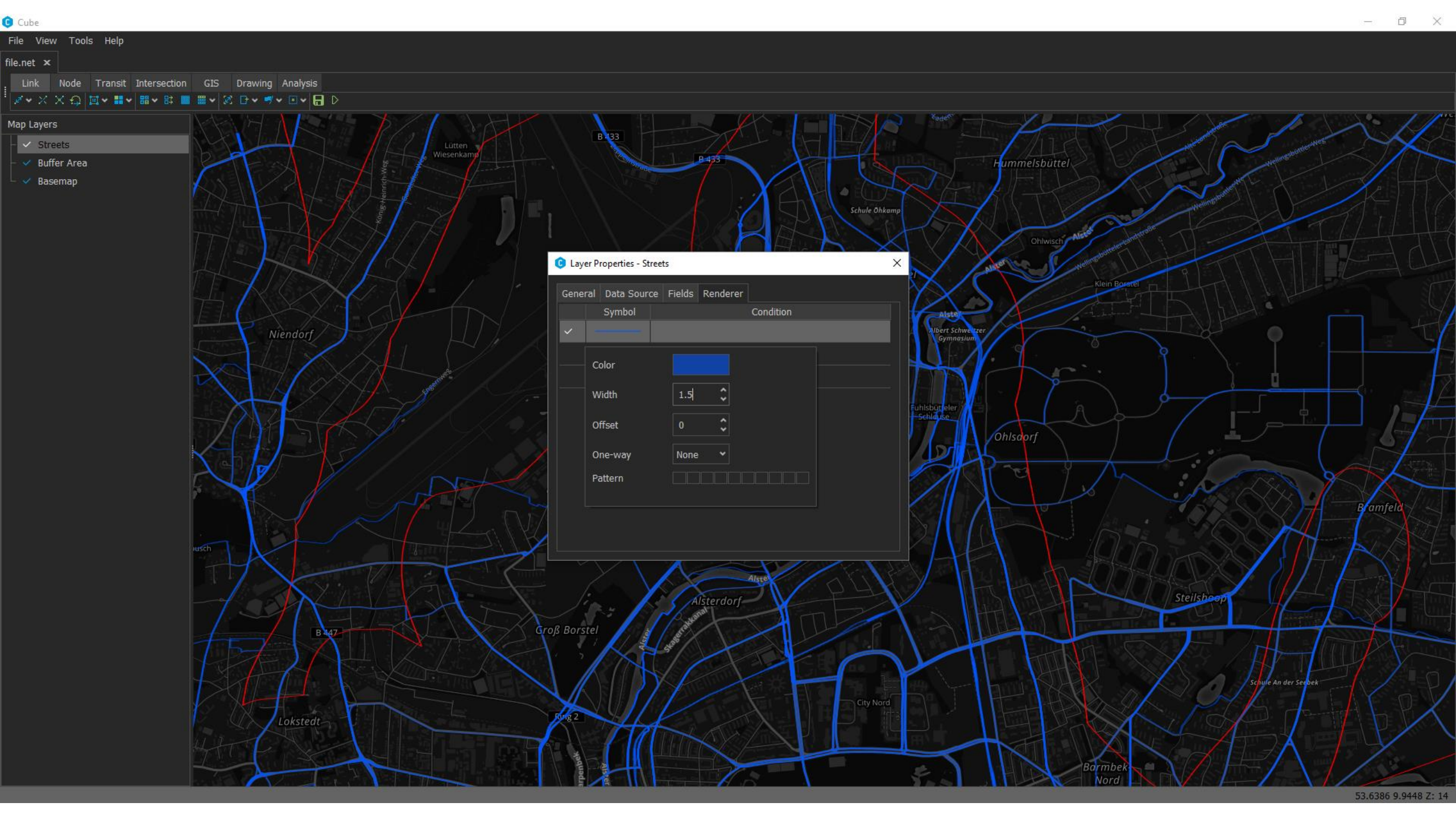
General Data Source Fields **Renderer**

	Symbol	Condition
✓		a > max(b, c)
✓		
✓		

Function: max(float x, float y):float

Description:
Returns the larger of the two arguments






Layer Properties - Streets

General


Data Source

Fields

Renderer

	Symbol	Condition
✓		

Color



Width

1.5

↑

↓

Offset

0

↑

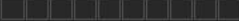
↓

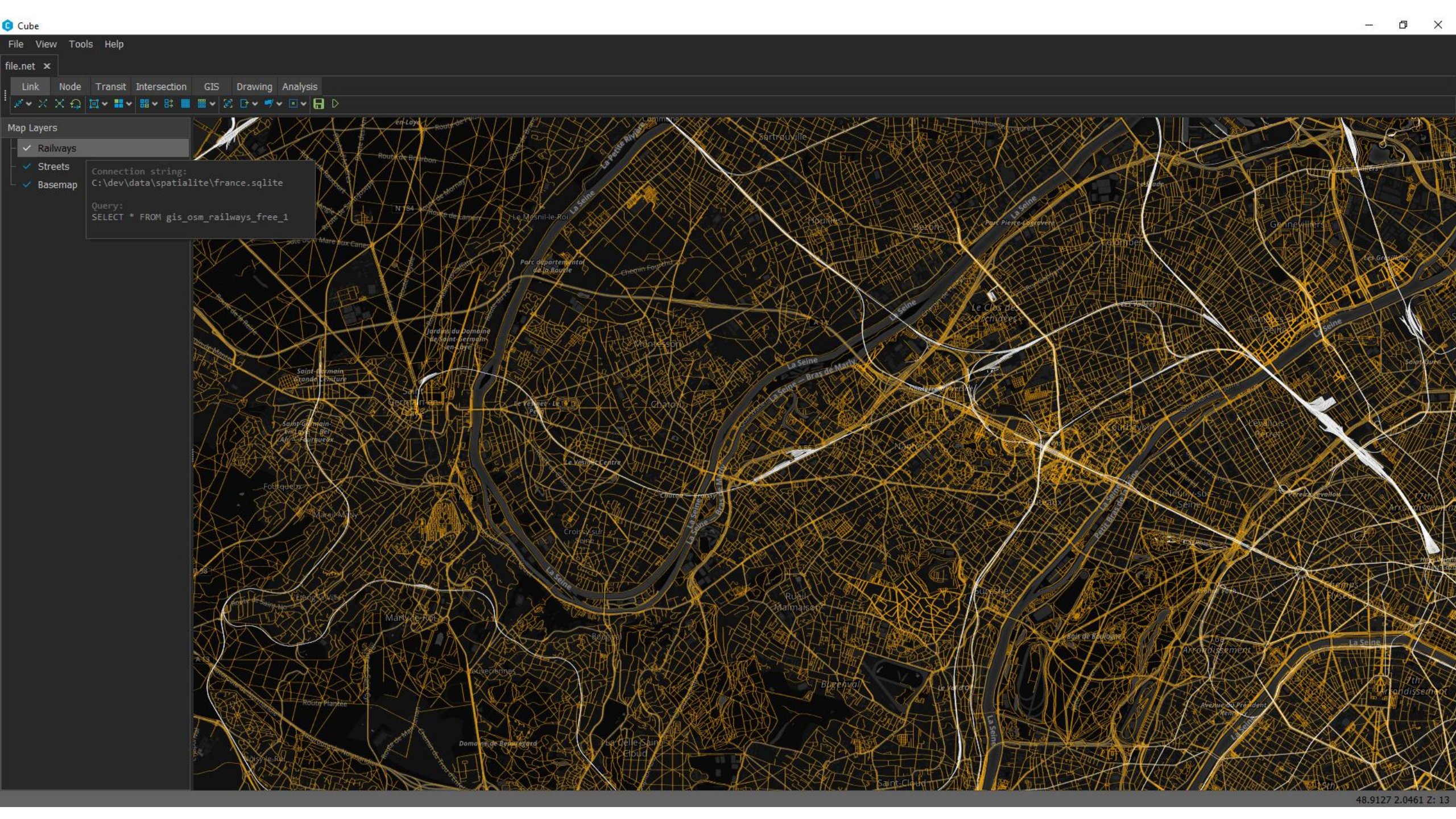
One-way

None

▼

Pattern





Connection string:
C:\dev\data\spatialite\france.sqlite

Query:
SELECT * FROM gis_osm_railways_free_1



ATMAT00LS x

```

1  ;;<<Default Template>><<MATRIX>><<Default>>;
2  ; Do not change filenames or add or remove FILEI/FILEO statements using an editor. Use Cube/Application
   Manager.
3  ■ RUN PGM=MATRIX PRNFILE="C:\Cubetown\MODEL\ATMAT00D.PRN" MSG='Unified Activity & Travel Simulator'
4
5  FILEI DBI[1] = "{SCENARIO_DIR}\SYNTHETIC.DBF",
6         SORT = hrzone,hhldid,persid
7  FILEI ZDATI[2] = "{SCENARIO_DIR}\ACCESSIBILITY.DBF"
8  FILEI ZDATI[1] = "{Zonal Data}"
9
10 FILEI MATI[2] = "{SCENARIO_DIR}\PT_LOS.MAT",
11      AUTOMDARRAY=MATIFT MI=1-20
12 FILEI MATI[1] = "{SCENARIO_DIR}\HWY_LOS.MAT",
13      AUTOMDARRAY=MATIHW MI=1-24
14
15 FILEO RECO[3] = "{SCENARIO_DIR}\ABM_PATTERNS.DBF",
16      FIELDS= HHID(8.0),PERSON(2.0),HHCARS(2.0),NTOURS(2.0),PRIMARY(2.0),STOURS(2.0)
17 FILEO RECO[2] = "{SCENARIO_DIR}\ABM_TOURS.DBF",
18      FIELDS= HHID(8.0),PERSON(2.0),NTOURS(2.0),PRIMARY(2.0),STOURS(2.0),
19      TOUR(2.0),TORIG(5.0),TDEST(5.0),TPURP(2.0),TMODE(2.0),STOPS1(2.0),STOPS2(2.0)
20 FILEO RECO[1] = "{SCENARIO_DIR}\ABM_TRIPS.DBF",
21      FIELDS= HHID(8.0),PERSON(2.0),NTOURS(2.0),PRIMARY(2.0),STOURS(2.0),
22      TOUR(2.0),TORIG(5.0),TDEST(5.0),TPURP(2.0),TMODE(2.0),STOPS1(2.0),STOPS2(2.0),
23      THALF(2.0),TRIPN(3.0),I(5.0),J(5.0),orgPurp(2.0),dstPurp(2.0),period(2.0),Mode(2.0),
24      ADIST(8.2),TTIME(8.2),TCOST(8.2),Trips(1.0)
25
26 ; - INPUT FILES FIELDS AND NOTATION: -
27 ; synthetic.dbf           : di.1.hhldid, di.1.persid, di.1.hhsize, di.1.income, di.1.gender,
   di.1.age, di.1.employ, di.1.hrzone, di.1.pumsid
28 ; cubetown.mdb\Demographics : zi.1.taz, ..., zi.1.sf_du, zi.1.mf_du, zi.1.hhl, zi.1.hh2, ...,
   zi.1.incl, zi.1.inc2, ..., zi.1.total_emp, zi.1.service, zi.1.retail, zi.1.other
29 ; accessibility.dbf       : zi.2.zone, zi.2.amwaccl, zi.2.mdwaccl, ...
30 ; los matrices            : MATIHW[table][i][j] MATIFT[table][i][j]
31
32 ; - Initialize random seed: -
33 _Seed = RANDSEED(12345) ;note this is re-initialized for every implicit I-Loop
34
35 ; - ARRAYS DEFINITION: -
36 array gendertab=20 agetab=20 employtab=20
37 array tpurp=20 torig=20 tdest=20 tmode=20 stopsout=20 stopsret=20 tourdur=20 startperiod=20 returnperiod=20
38 array carownutil=4 todutil=13 pattutil=51 pattprob=51
39 array zoneutil=zones sovutil=zones hovutil=zones trnutil=zones walkutil=zones msumutil=zones
40
41
42 ; - LOOKUP FUNCTIONS DEFINITION: -
43
44 ; lookup table for periods
45 ;   startperiod[tour] = periodlookup(1,periods)
46 ;   returnperiod[tour]= periodlookup(2,periods)
47 Lookup name=periodlookup,
48         lookup[1]=1, result=2,
49         lookup[2]=1, result=3,
50         ; TOD      Start Return
51 R= ' 1      1      1',
52    ' 2      1      2',
53    ' 3      1      3',

```


Cube

FileViewToolsHelp

Scenario

Base

- Build Road
- Increase Transit
- Land Use

Data

Inputs

- Voyager
- Cargo
- Land

Outputs

Reports

Applications

Cube Voyager Demonstration...

- Networks
- TRIP GENERATION
- Trip Distribution
- Mode Choice
- Assignment
- GDB Output

Land Use Transport Interactio...

Cube Land Demonstration

Cube Voyager Activity-Based ...

Cube Activity Demonstration

Keys

Scen. Name	Increase Traffic
Network	c:\cubetown\cub...
Intersections	c:\cubetown\cub...
PT Lines	c:\cubetown\cub...
Zonal Data	c:\cubetown\cub...
EITrips	c:\cubetown\cub...

file.net x

LinkNodeTransitIntersectionGISDrawingAnalysis

Map Layers

Points of Interest

Railways

Streets

Basemap

ATMAT001S x

1234567891011121314151617181920212223242526272829303132333435363738394041424344454647484950

```
;;<<Default Template>><<MATRIX>><<Default>>;
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15 FILEO RECO[3] = "{SCENARIO_DIR}\ABM_PATTERNS.DBF",
16     FIELDS= HHID(8.0),PERSON(2.0),HHCARS(2.0),NTOURS(2.0),PRIMARY(2.0),STOURS(2.0)
17 FILEO RECO[2] = "{SCENARIO_DIR}\ABM_TOURS.DBF",
18     FIELDS= HHID(8.0),PERSON(2.0),NTOURS(2.0),PRIMARY(2.0),STOURS(2.0),
19     TOUR(2.0),TORIG(5.0),TDEST(5.0),TPURP(2.0),TMODE(2.0),STOPS1(2.0),STOPS2(2.0)
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22     TOUR(2.0),TORIG(5.0),TDEST(5.0),TPURP(2.0),TMODE(2.0),STOPS1(2.0),STOPS2(2.0),
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24 ),Mode(2.0),
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27 ; - INPUT FILES FIELDS AND NOTATION: -
28 ; synthetic.dbf          : di.1.hhldid, di.1.persid, di.1.hhsize, di.1.income,
29 ; cubetown.mdb\Demographics : zi.1.taz, ..., zi.1.sf_du, zi.1.mf_du, zi.1.hhl, zi.1.hh2,
30 ; ..., zi.1.incl, zi.1.inc2, ..., zi.1.total_emp, zi.1.service, zi.1.retail, zi.1.other
31 ; accessibility.dbf       : zi.2.zone, zi.2.amwaccl, zi.2.mdwaccl, ...
32 ; los matrices            : MATIHW[table][i][j] MATIPT[table][i][j]
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40 returnperiod=20
41 array carownutil=4 todutil=13 pattutil=51 pattprob=51
42 array zoneutil=zones sovutil=zones hovutil=zones trnutil=zones walkutil=zones msumutil=zones
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51     lookup[2]=1, result=3,
52     : TOD, Start, Return
```

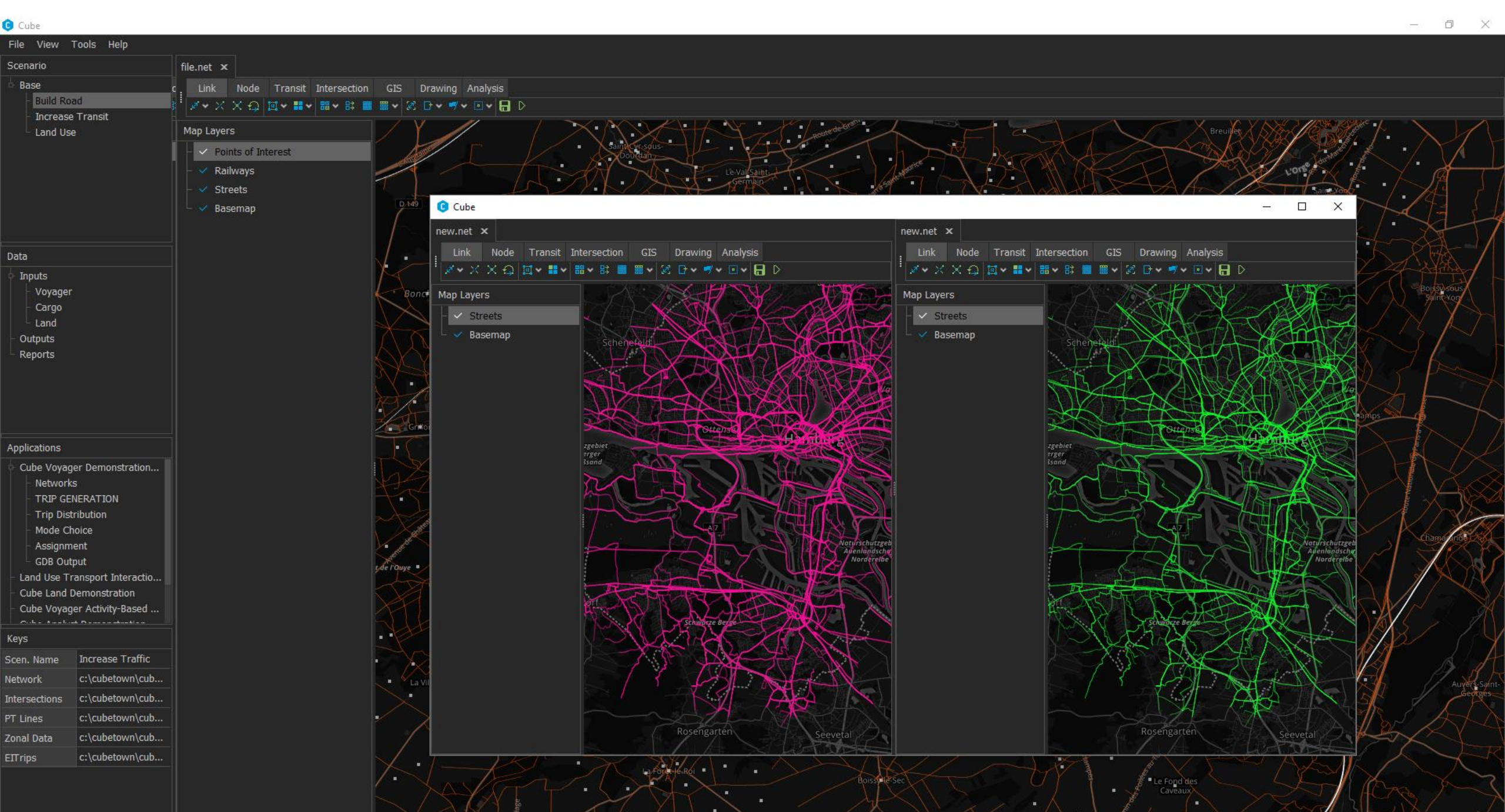
Ready

ROW: 1

COL: 1

VOYAGER

48.5727 1.9771 Z: 13



- Build Road
- Increase Transit
- Land Use

- ✓ Points of Interest
- ✓ Railways
- ✓ Streets
- ✓ Basemap

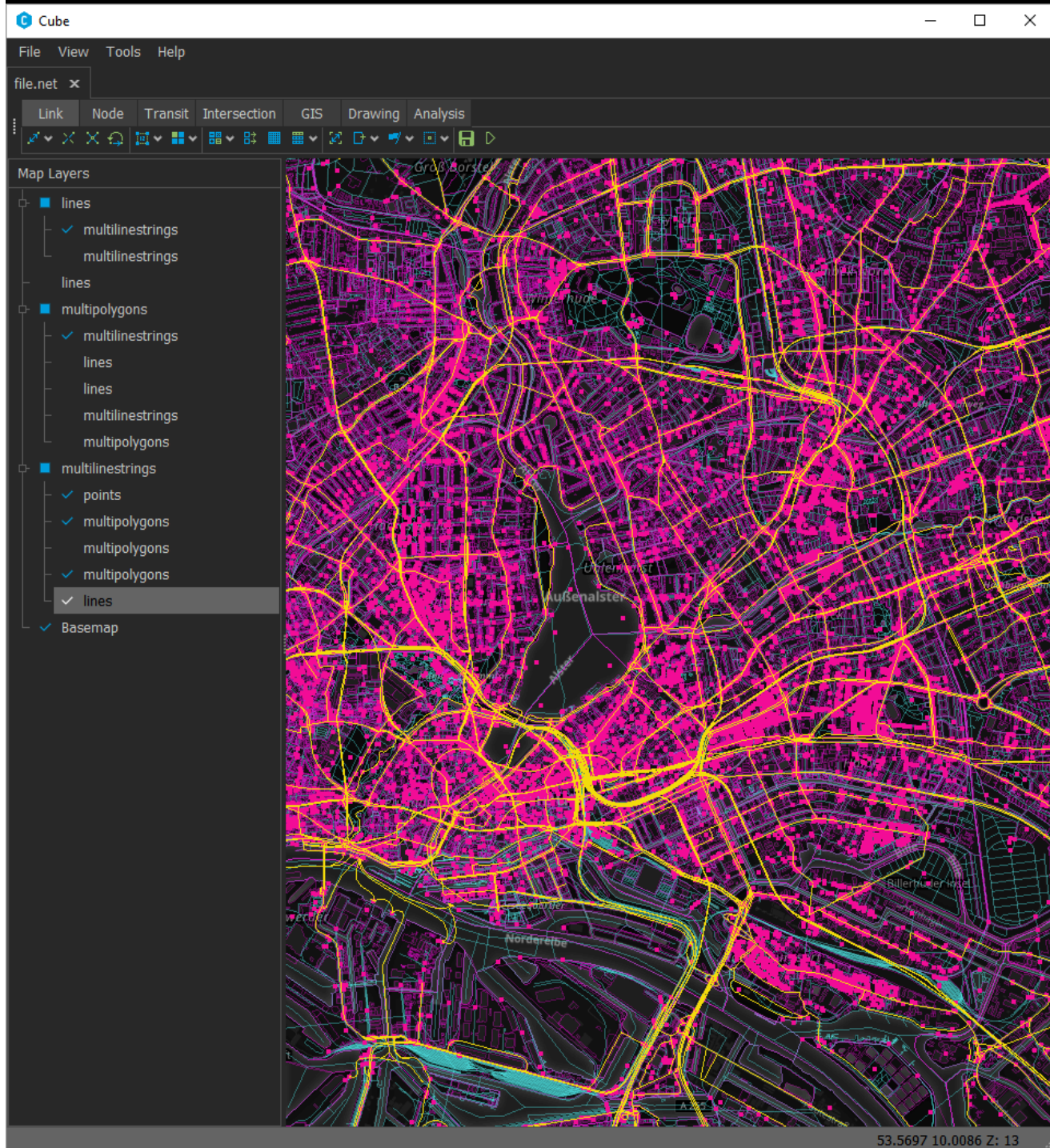
- Voyager
- Cargo
- Land
- Outputs
- Reports

- Cube Voyager Demonstration...
 - Networks
 - TRIP GENERATION
 - Trip Distribution
 - Mode Choice
 - Assignment
 - GDB Output
- Land Use Transport Interactio...
- Cube Land Demonstration
- Cube Voyager Activity-Based ...
- Cube Activity Demonstration

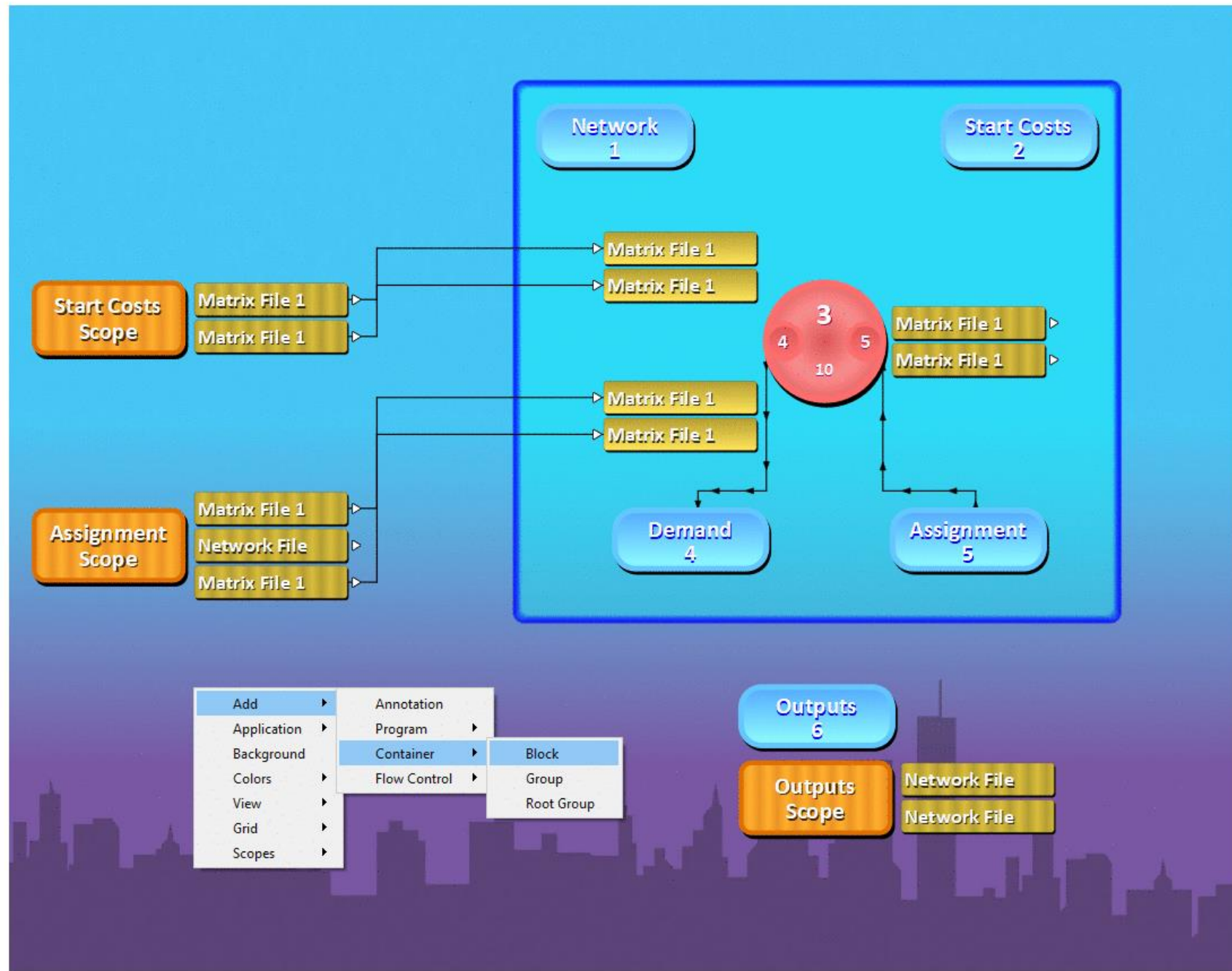
Scen. Name	Increase Traffic
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PT Lines	c:\cubetown\cub...
Zonal Data	c:\cubetown\cub...
EITrips	c:\cubetown\cub...

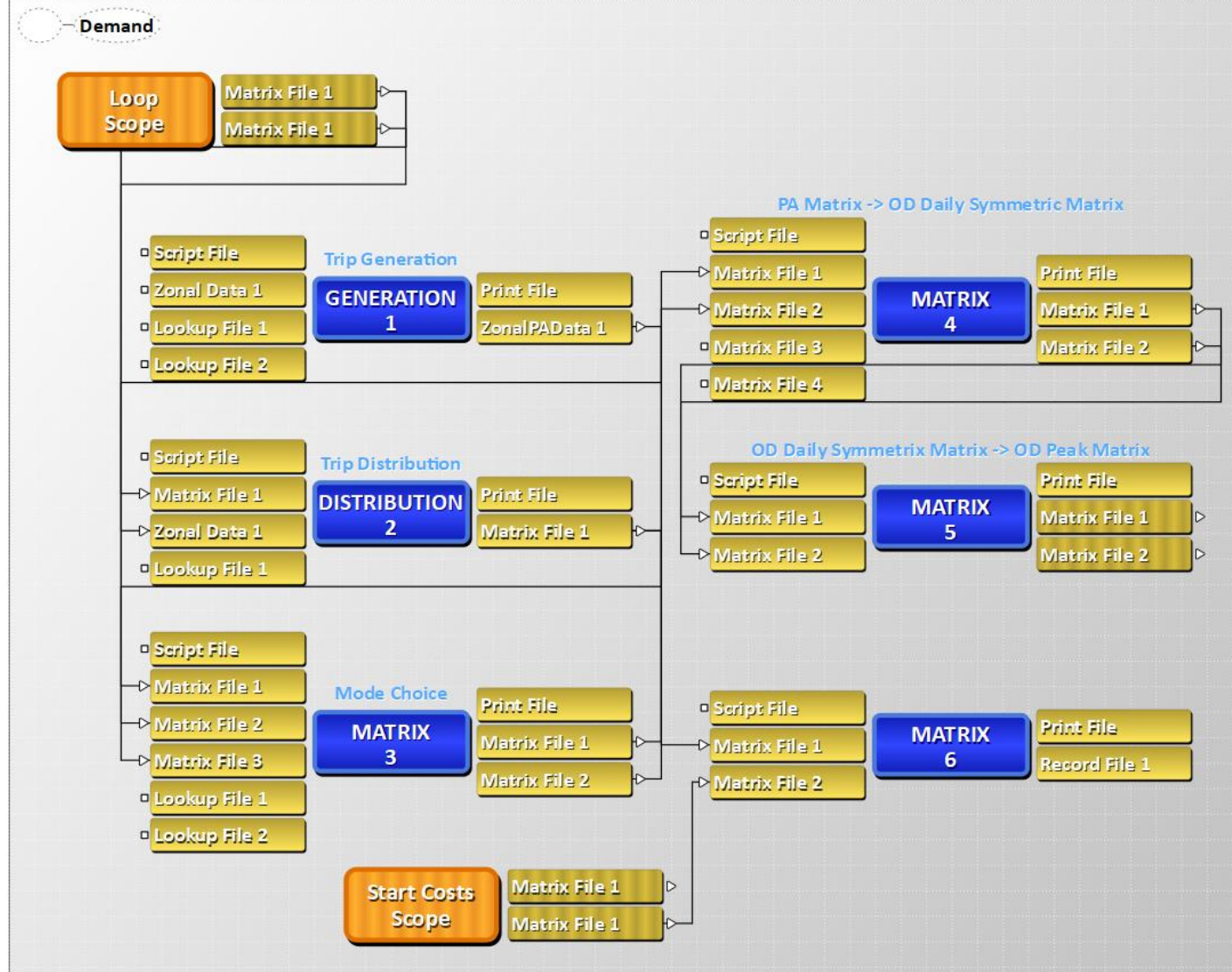
- ✓ Streets
- ✓ Basemap

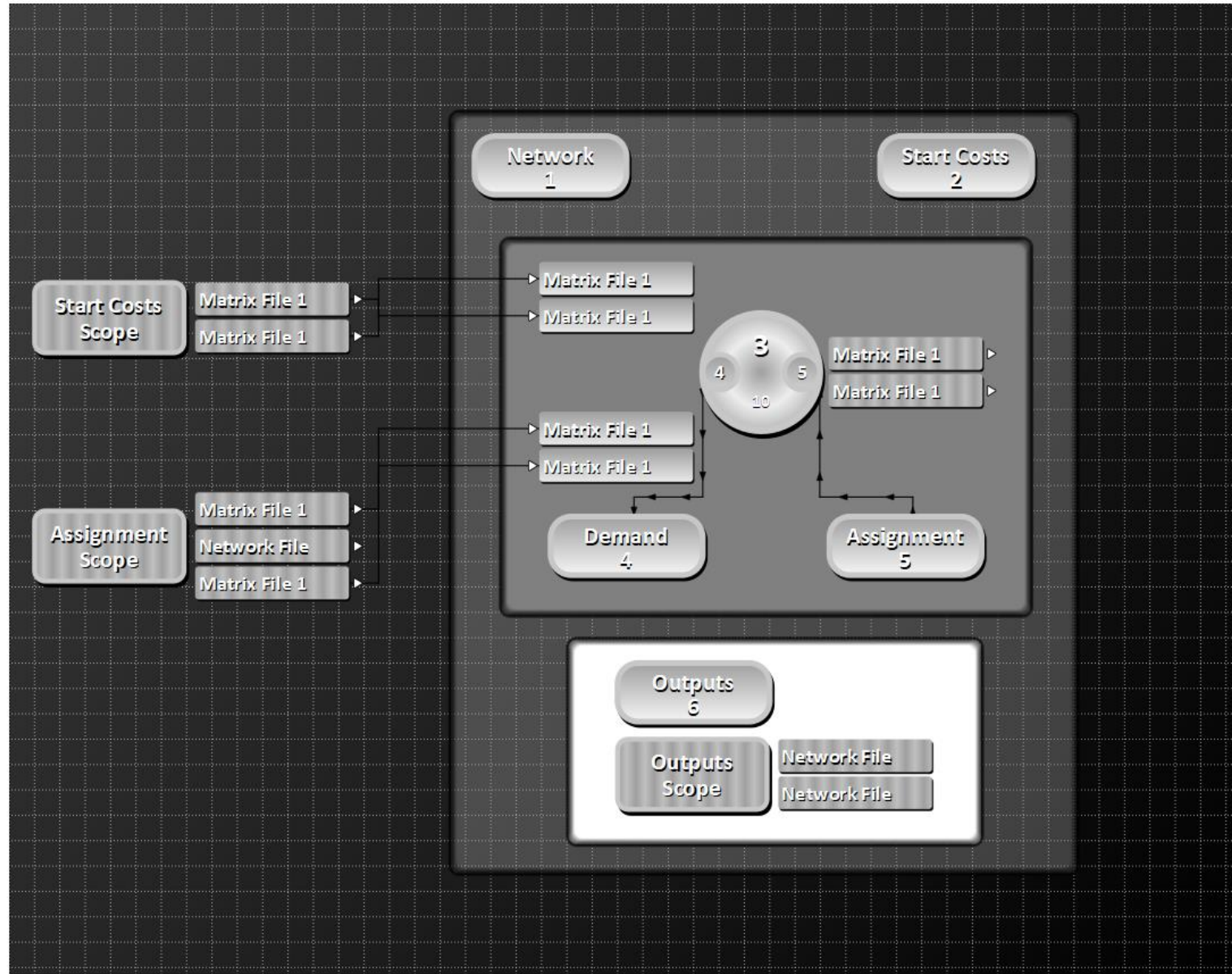
- ✓ Streets
- ✓ Basemap

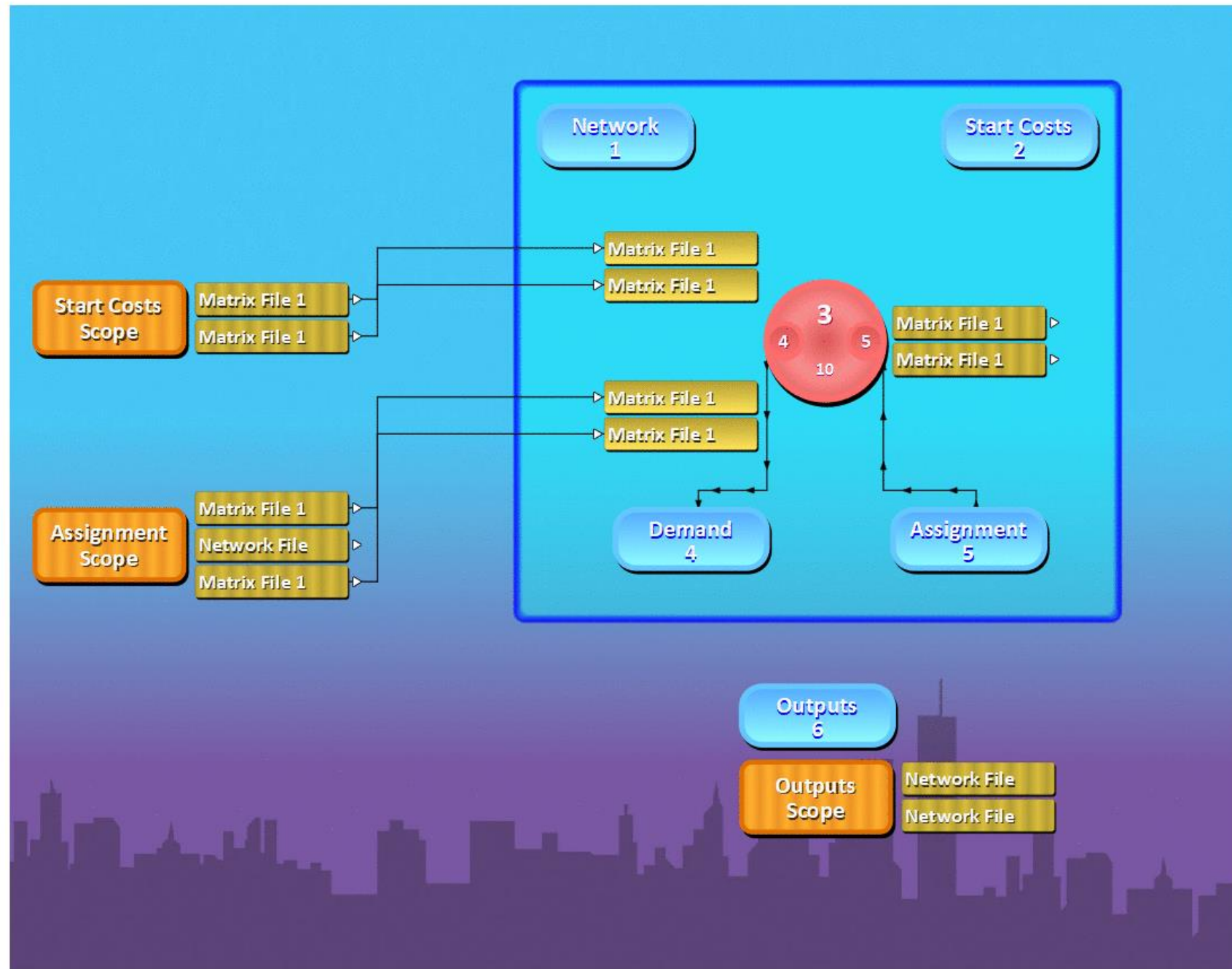








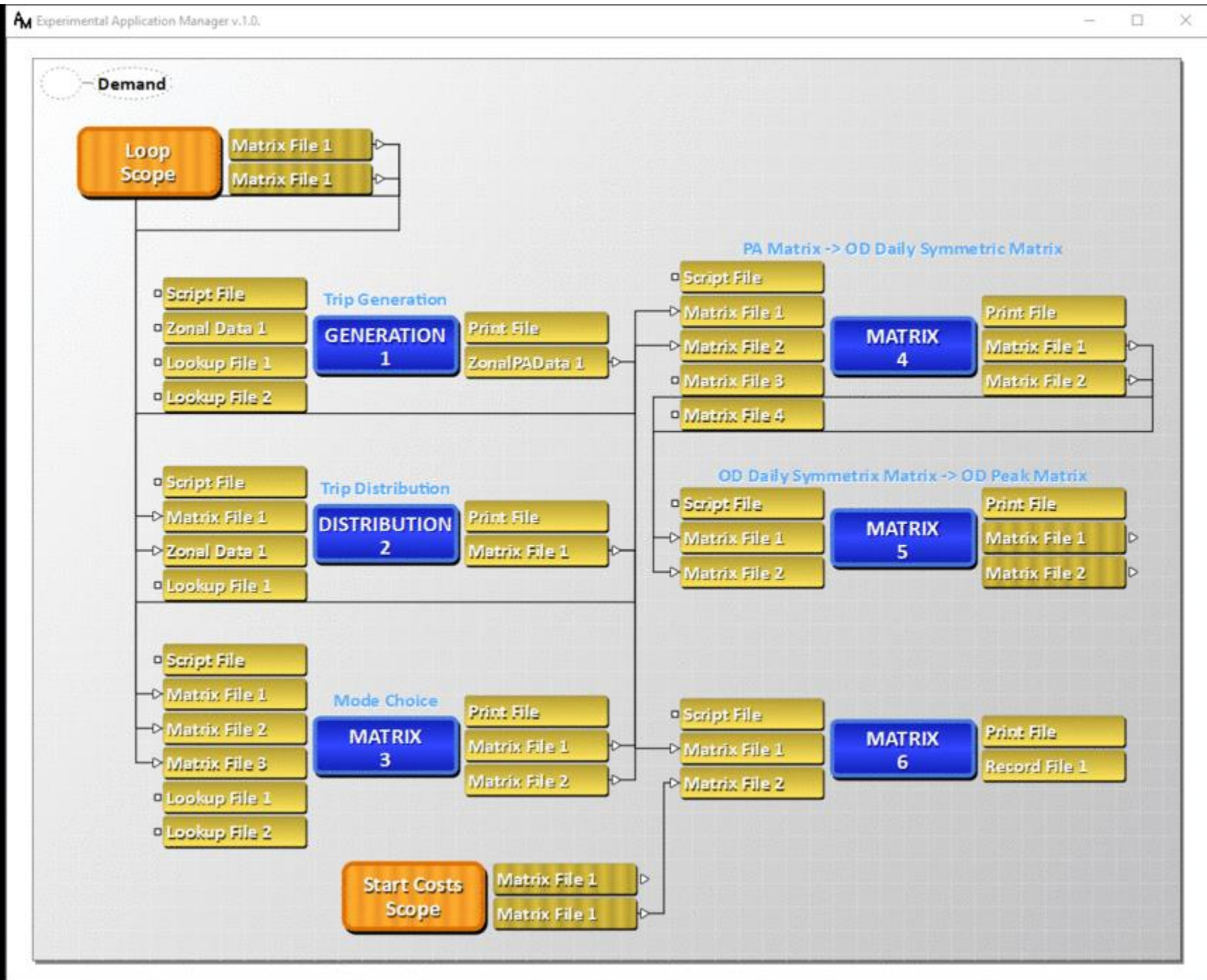




AM History ? X

Item Count: 0 Memory Usage: 0 MB

Clear All Close



Settings

Display

Color

Night light

Night light settings

Scale and layout

Change the size of text, apps, and other items

100% (Recommended)

Advanced scaling settings

Resolution

1920 × 1080 (Recommended)

Orientation

