Conflation Tools and Workflows:

An Introduction

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Agenda

- What is Conflation?
- Geoprocessing Conflation Tools
- Conflation Workflows
  - Conceptual workflow
  - Single task workflows
    - Demo 1: Detect Feature Changes workflow
    - Demo 2: Transfer Attributes workflow
  - Real world scenarios
- Conclusions and Future Work
- Q&A

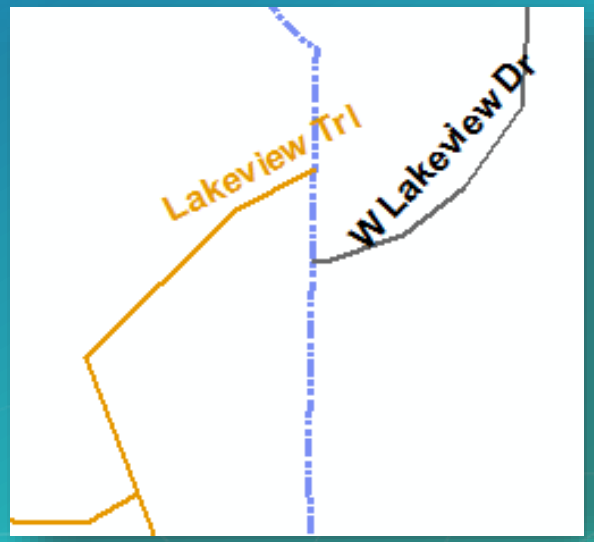
What is conflation?

When using multi-source spatial data together

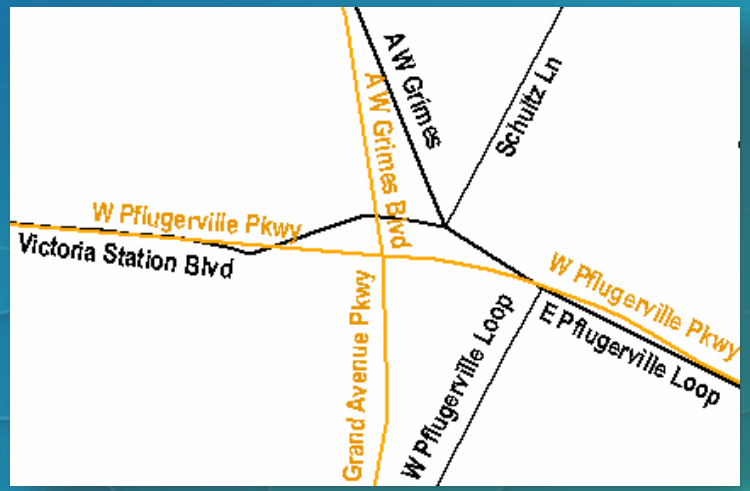
Common obstacles in analysis and mapping:

- Spatial and attribute inconsistency caused by differences in data collection and modeling
- High cost to fix the problems

Adjacent datasets



Overlapping datasets



Conflation reconciles multi-source datasets and optimizes data quality and usability

Between overlapping datasets:

- Detect feature changes (differences) through feature matching
- Make spatial adjustment and attribute transfer

Between adjacent datasets:

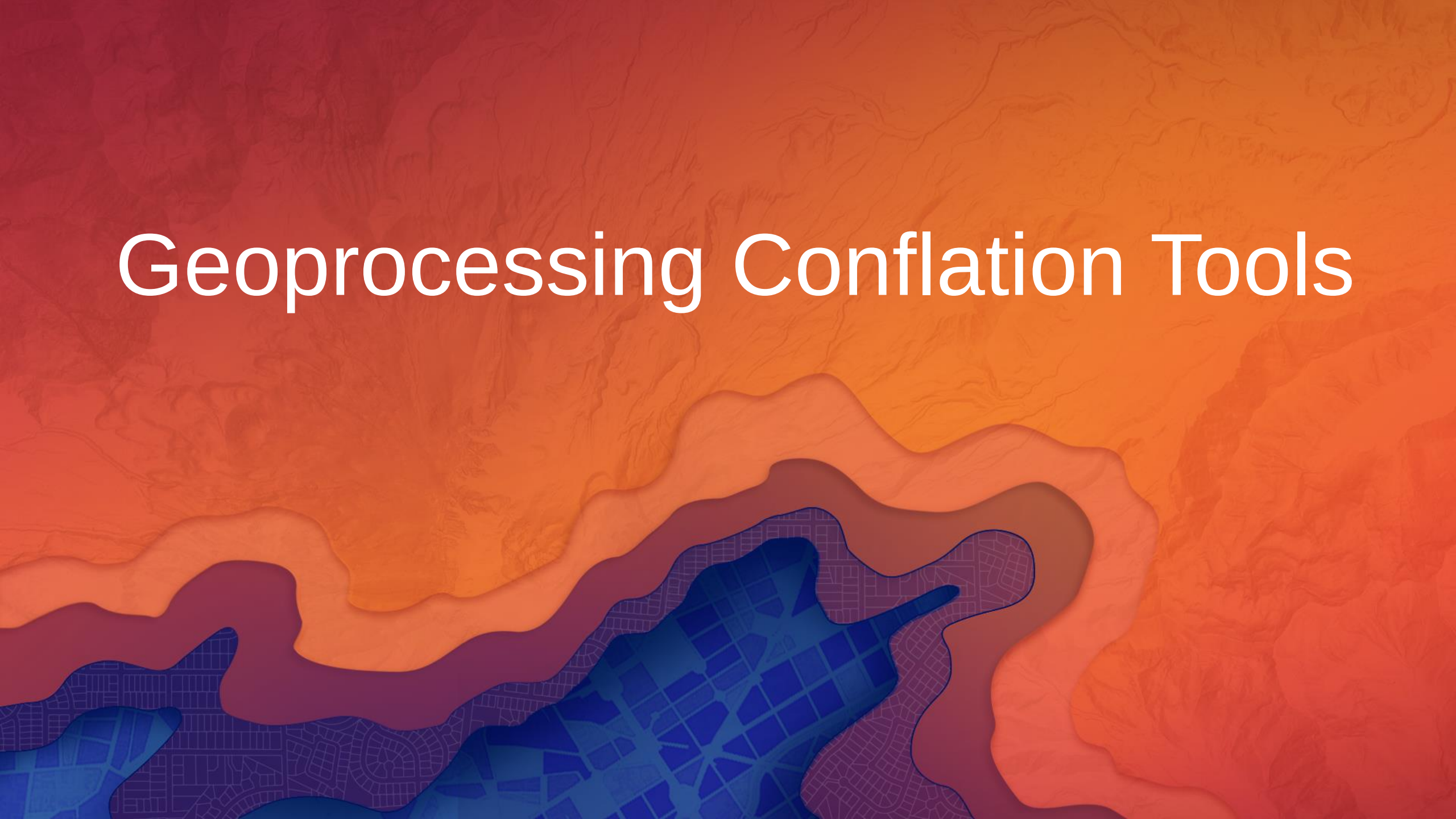
- Detect and resolve feature conflicts and disconnections through edge matching and alignment

Ultimately:

- Maintain an unified and seamless dataset – enriched and up-to-date
- No longer live with various imperfect datasets
- Rely on the data to perform analysis and quality mapping with confidence

What does it take to achieve the goals?

Geoprocessing Conflation Tools



Our initial focuses

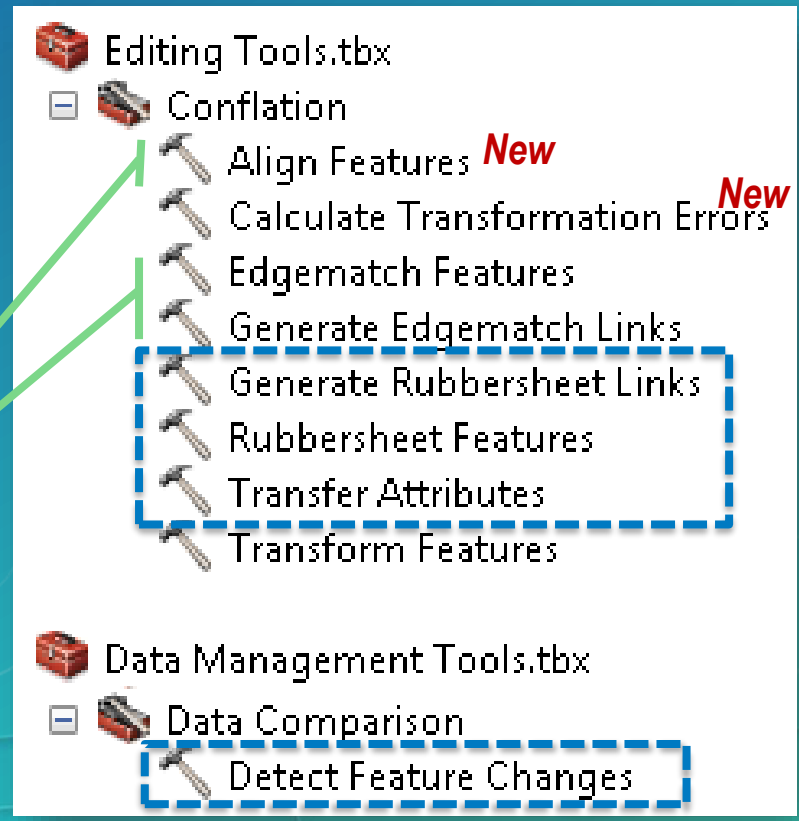
Develop highly automated tools in Geoprocessing framework

- Starting with linear features (roads, parcel lines, etc.)
- Aiming at high accuracy (not promising 100%)
- Providing information to facilitate post-processing

Build workflows

Have you used these tools in ArcMap?

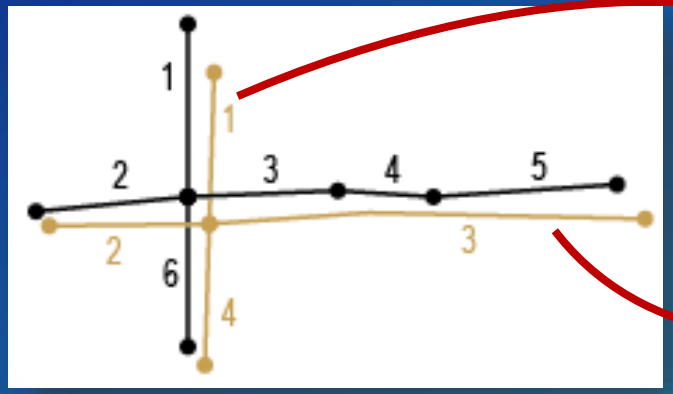
In ArcGIS 10.5.1 and Pro 2.0



Conflation: Edgematching tools and workflows
2:30 – 3:15pm, Tuesday
Demo Theater 07 – Spatial Analysis

Feature matching (FM) for overlapping datasets

Based on proximity, topology, pattern, and similarity analysis, as well as attributes information

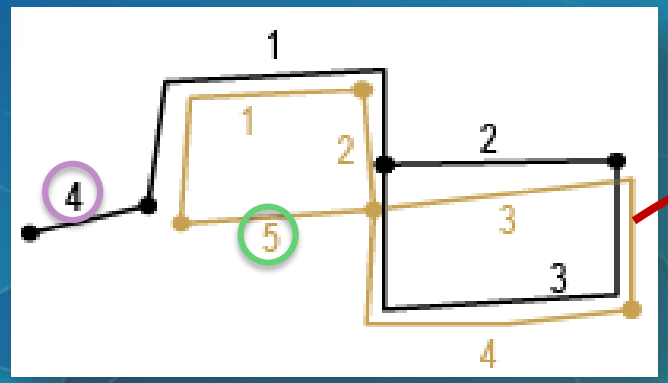


Source feature

Target feature

1:1 and 1:m matches

OBJECTID *	SRC_FID	TGT_FID	FM_GRP	FM_MN	FM_CONF
1	1	1	1	1:1	100
2	2	2	2	1:1	100
3	3	3	3	1:3	100
4	3	4	3	1:3	100
5	3	5	3	1:3	100
6	4	6	4	1:1	100



m:1 and m:n matches

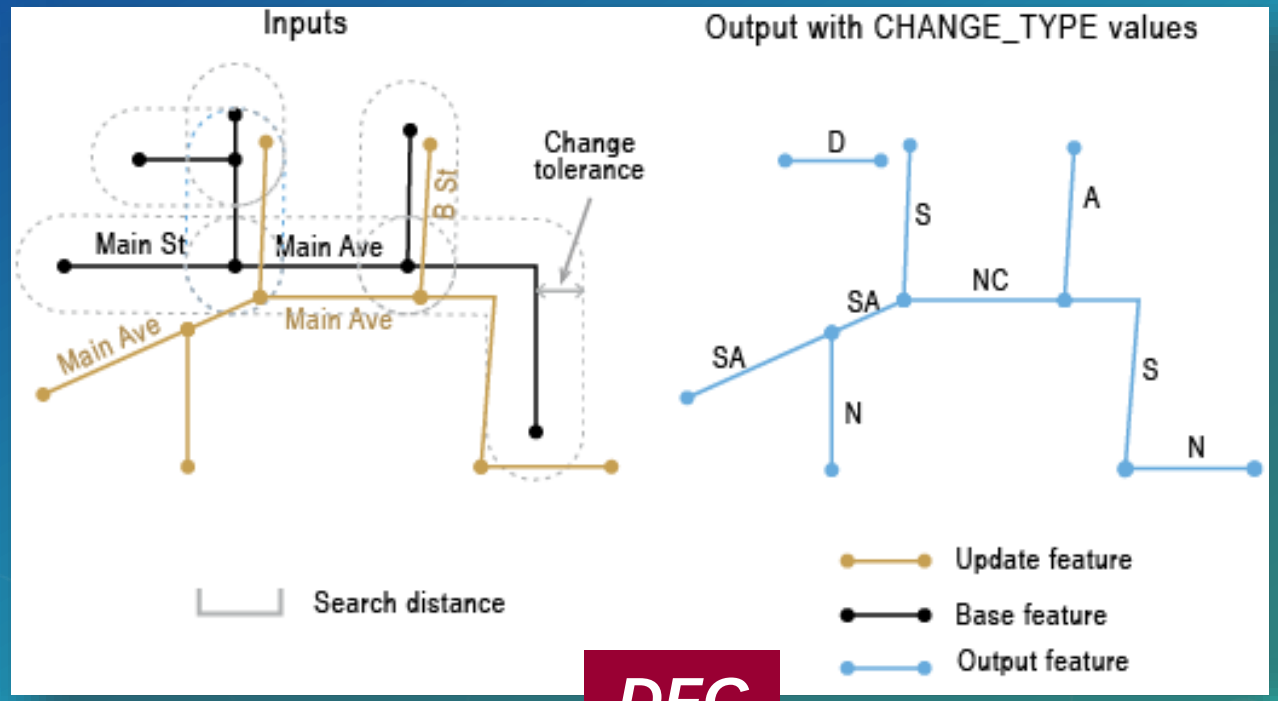
OBJECTID *	SRC_FID	TGT_FID	FM_GRP	FM_MN	FM_CONF
1	1	1	1	2:1	100
2	2	1	1	2:1	100
3	3	2	2	2:2	100
4	3	3	2	2:2	100
5	4	2	2	2:2	100
6	4	3	2	2:2	100
7	5	-1	-1	N/A	0
8	-1	4	-1	N/A	0

FM-based tool #1 - Detect Feature Changes (DFC)

Finding feature differences

Output CHANGE_TYPE

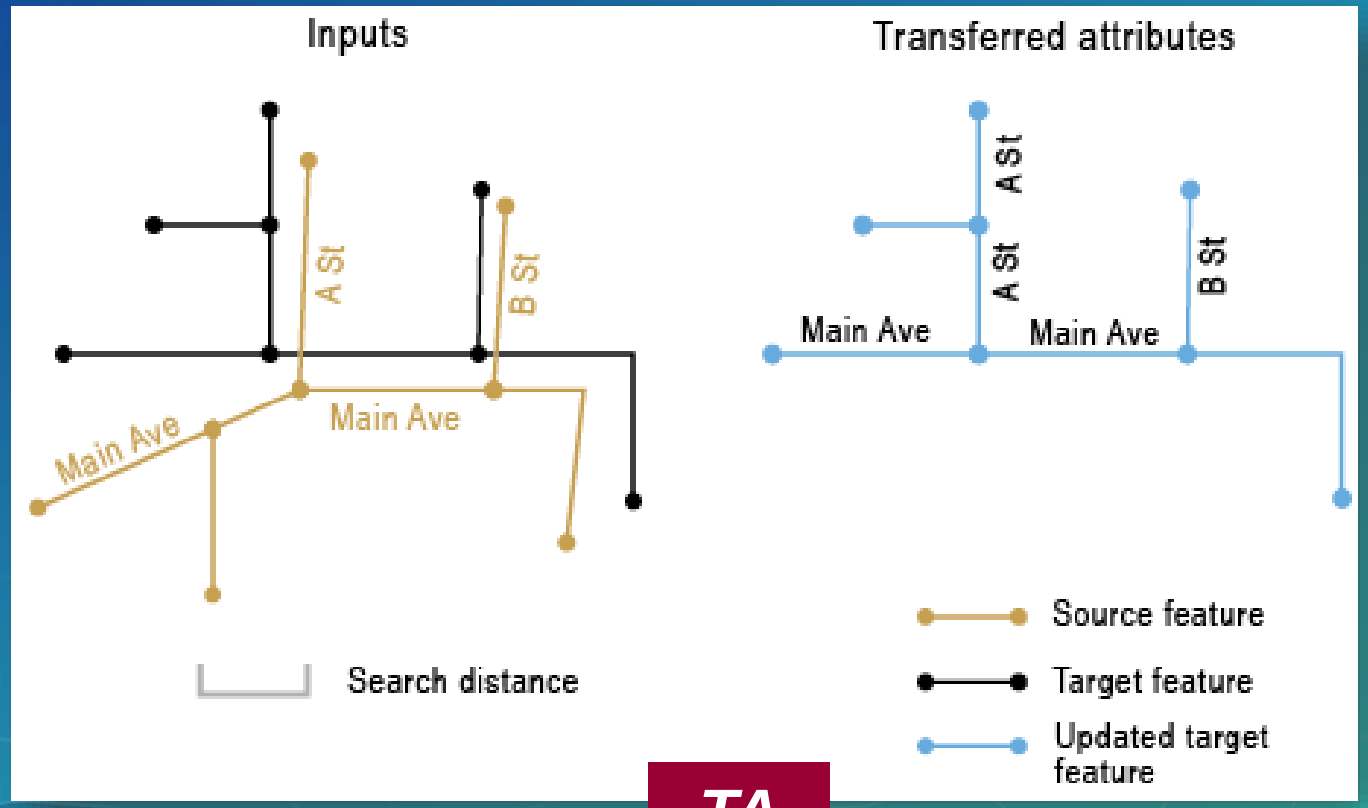
- Spatial change (S)
- Attribute change (A)
- Spatial & attribute change (SA)
- Spatial and line direction change (S_LD)
- Spatial, attribute, and line direction change (SA_LD)
- No change (NC)
- New update feature (N)
- To-be-deleted base feature (D)



FM-based tool #2 – Transfer Attributes (TA)

From source features to target features

- Transfer fields (e.g. ROAD_NAME, UniqueID)
- Target features are modified with the transferred fields

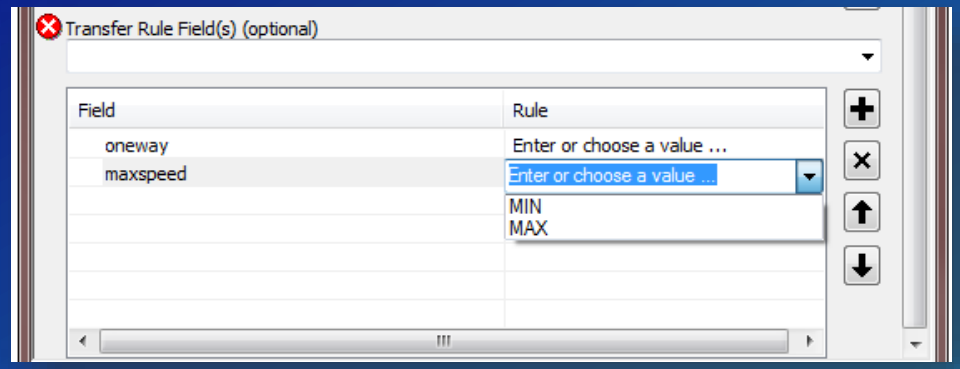


TA

Added a new parameter …

Transfer Rule Field(s) - for Transfer Attributes (TA)

To control m:n (m > 1) transfers based on source attribute information



Without rules (default):

- **Transfer from the longest source**

Ranked rules:

- **Field 1, rule value 1**
- **Field 2, rule value 2**
- **…**

3:1 match

Source feature

Target feature

Source attributes

OBJECTID	ROAD_NAME	TRAVEL_DIRECTION	SPEED_LIMIT	Shape_Length
1	East Ave	One way	40	100.3
2	Central Ave	One way	30	200.7
3	West Ave	Both way	45	300.2

Target attributes

OBJECTID	ROAD_CLASS	Shape_Length
1	A	600.9

(a). Transfer by default

OBJECTID	ROAD_CLASS	Shape_Length	ROAD_NAME
1	A	600.9	West Ave

Fields and values of transfer rules:

TRAVEL_DIRECTION: One way

SPEED_LIMIT: MAX

(b). Transfer by rules

OBJECTID	ROAD_CLASS	Shape_Length	ROAD_NAME
1	A	600.9	East Ave

FM-based tool #3 – Generate Rubbersheet Links (GRL)

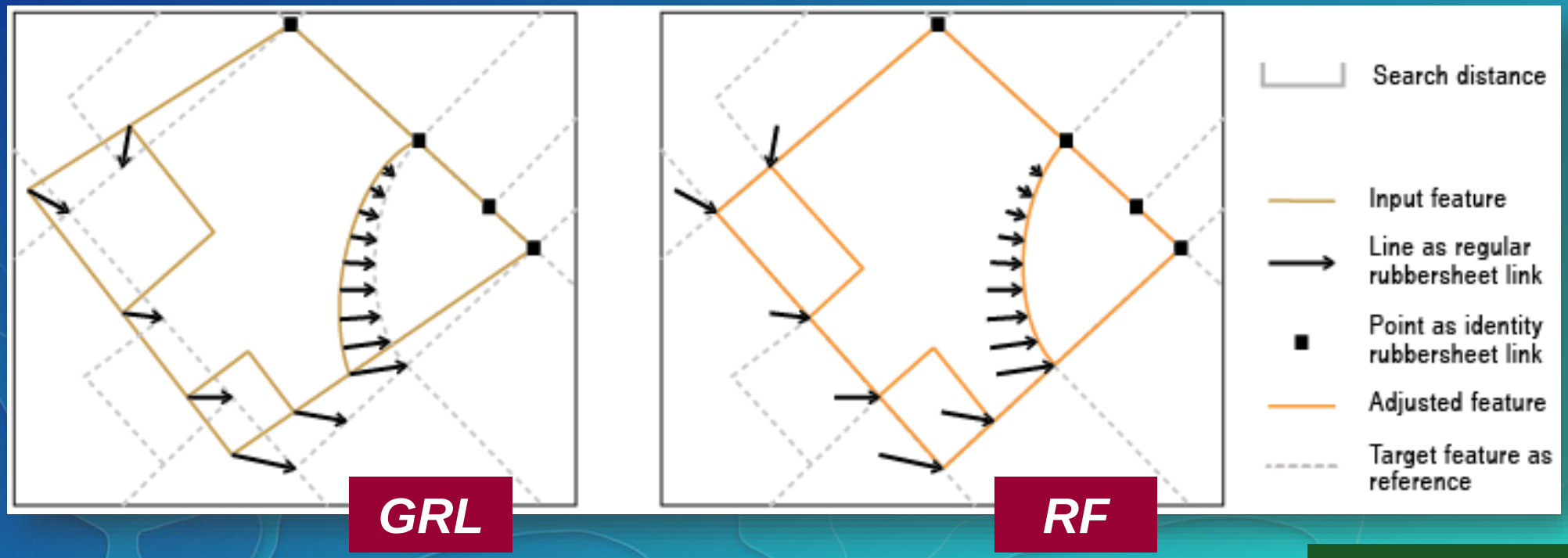
Rubbersheeting moves source locations towards target locations based on established links

Generate Rubbersheet Links (GRL)

- From source features to target features

Followed by Rubbersheet Features (RF)

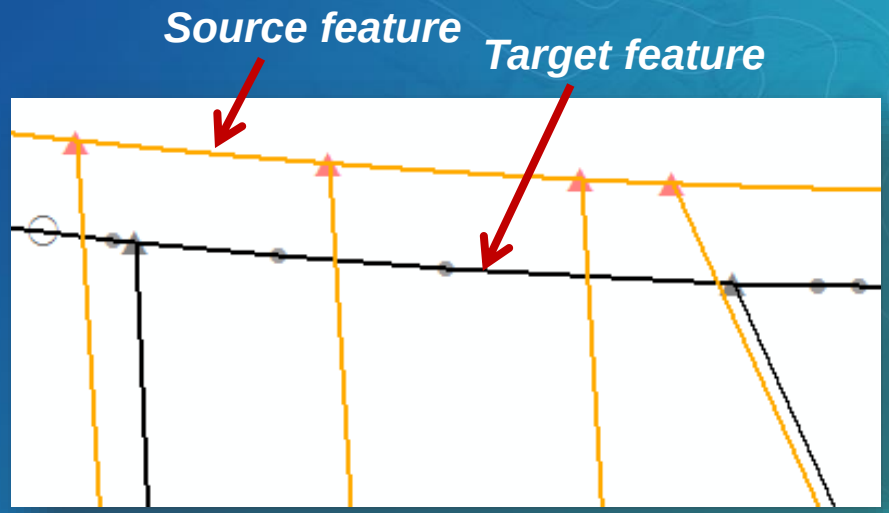
- Adjusting input features



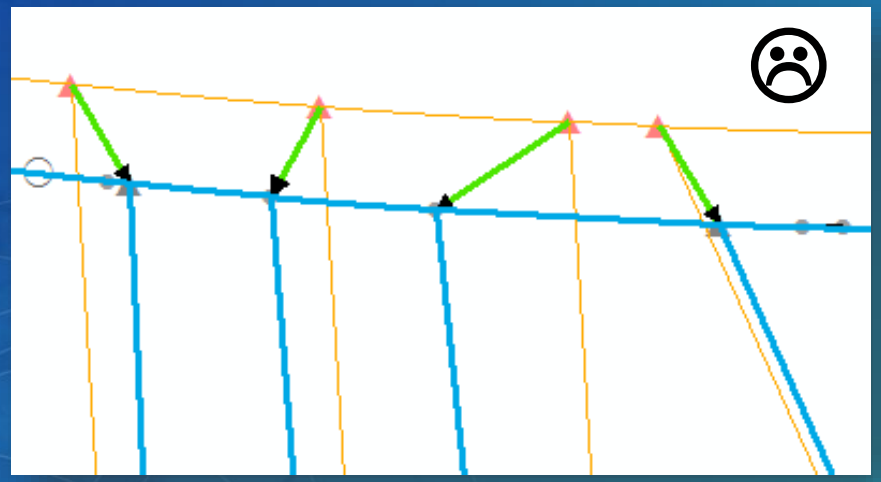
Link improvements …

Improved rubbersheet links

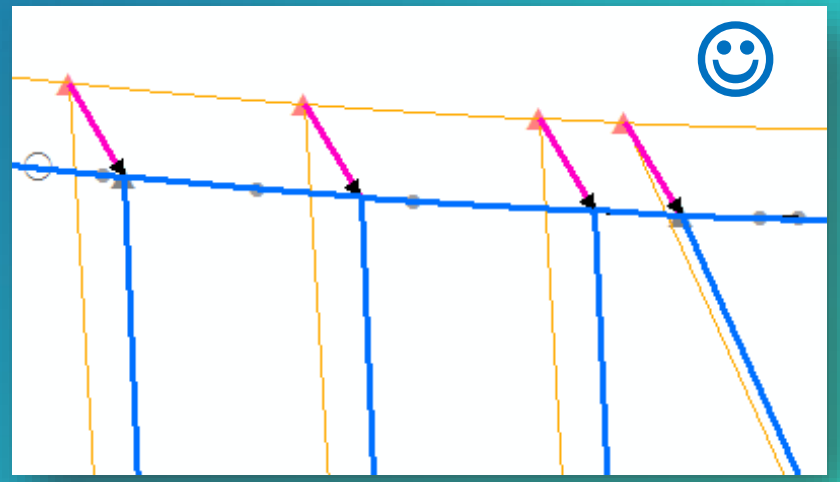
- Minimized intersecting, missing, improperly oriented links
- Made adjusted result better
- Reduced post-processing time



Previous links and rubbersheeting result



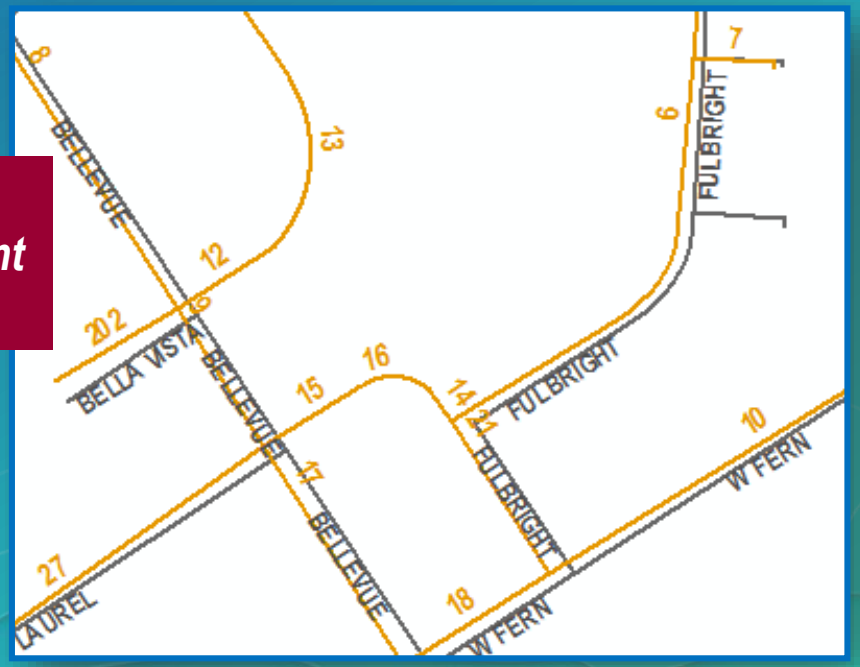
Improved links and rubbersheeting result



Conflation Workflows

Conceptual workflow
- for a common scenario

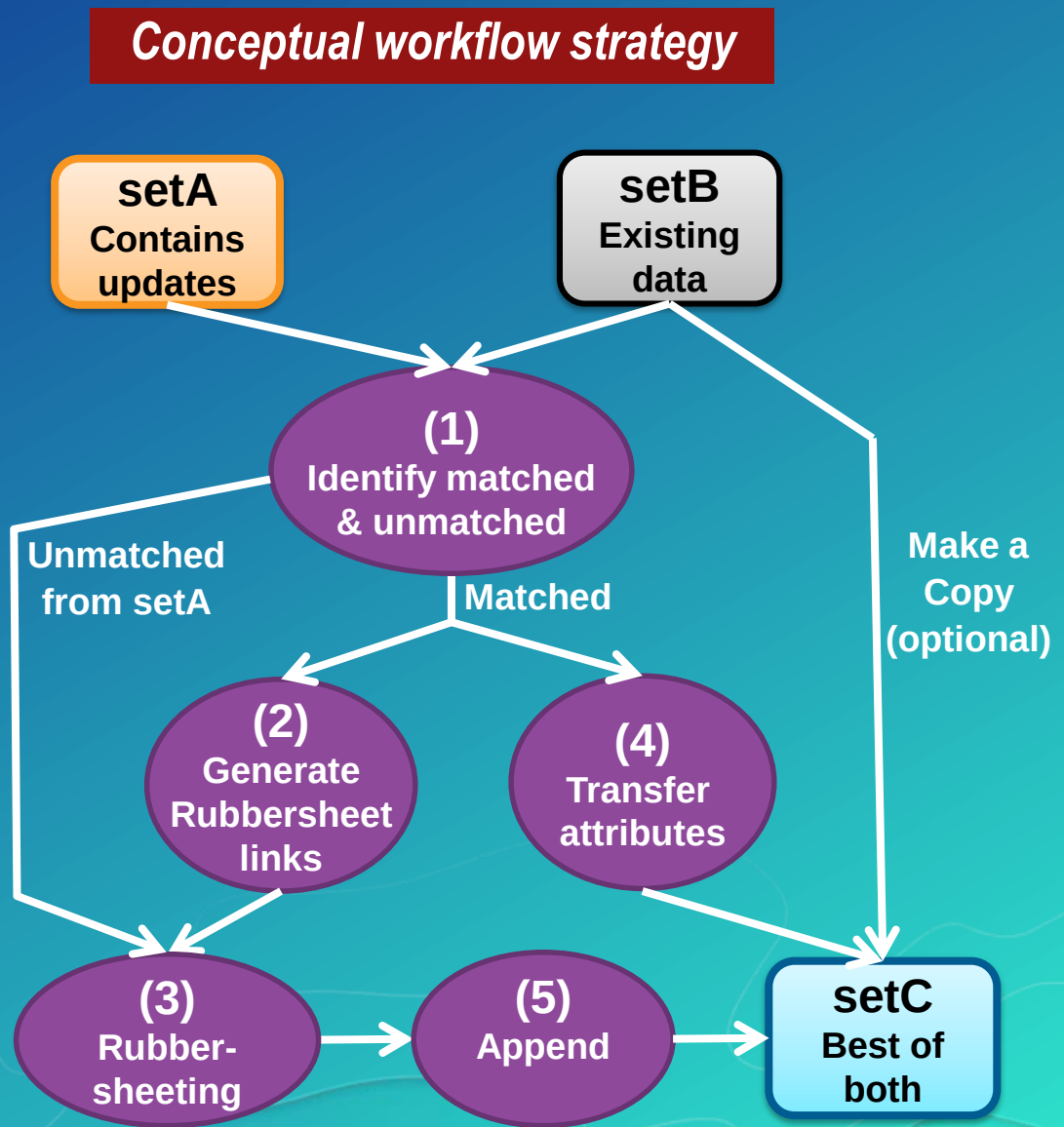
Unification of two overlapping, inconsistent datasets



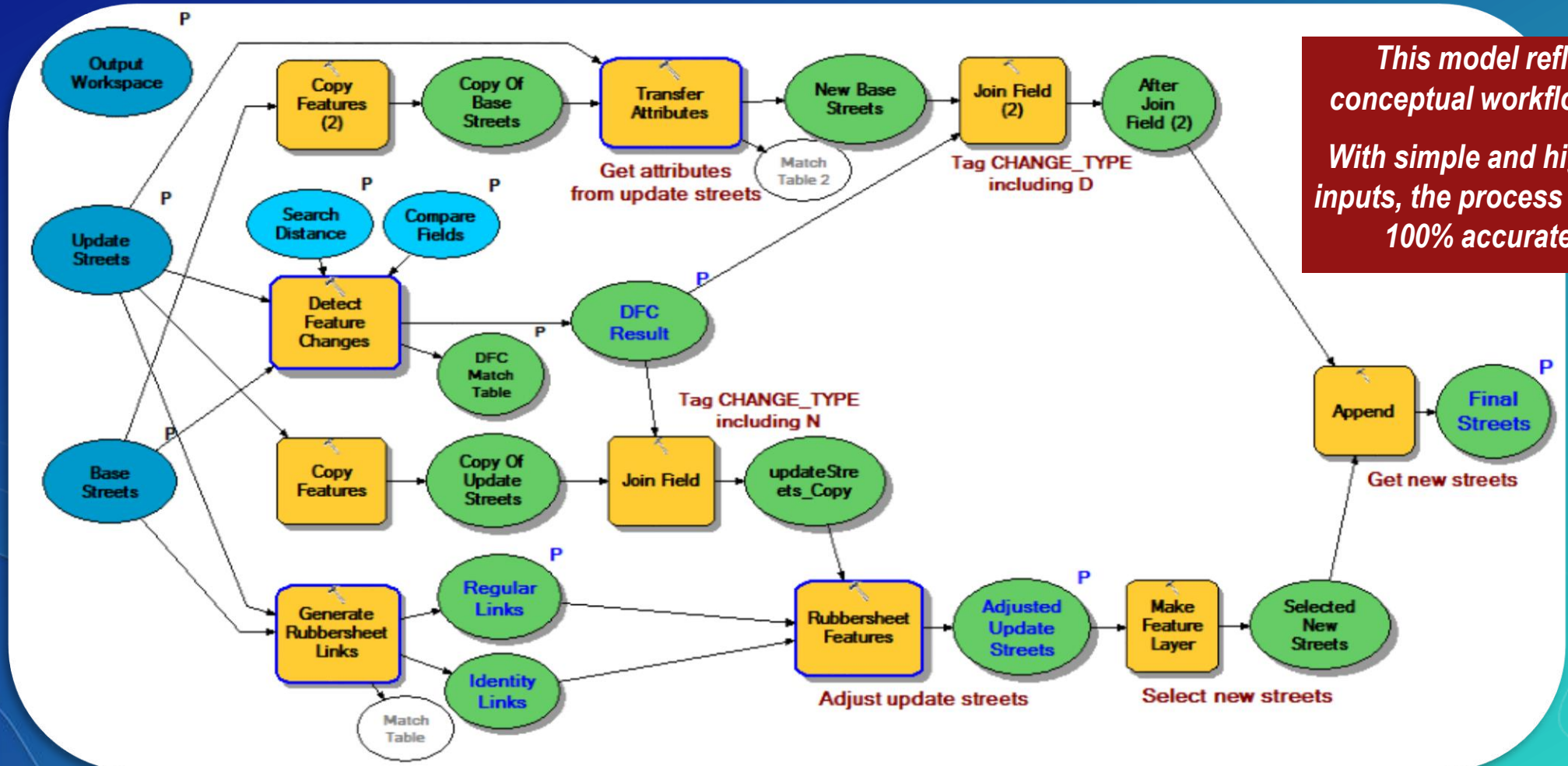
Unification of overlapping datasets

Key processes:

- Identify feature differences
- Make spatially adjustment
- Transfer attributes for matched features
- Add new features; delete old features if necessary



Conflate overlapping datasets



This model reflects the conceptual workflow strategy.

With simple and highly similar inputs, the process can produce 100% accurate result.

Quick demo …

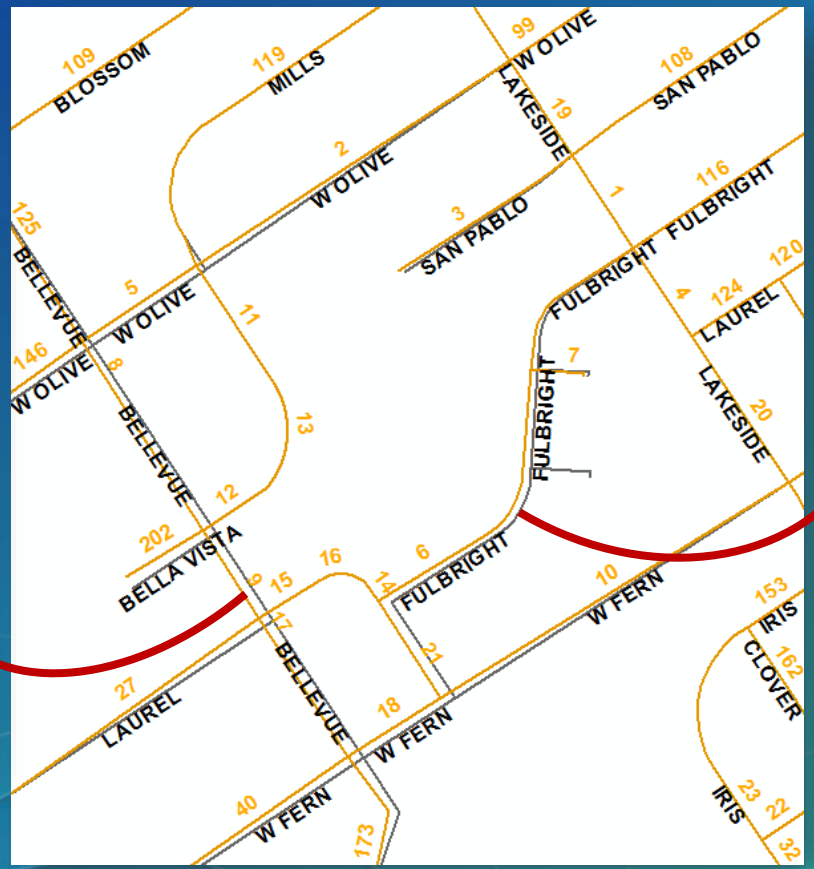
Simple and highly similar input streets

Together

Update features with new streets and attributes

UpdateStreets

OBJECTID *	Shape	UniqueID	Priority	Shape_Length
1	Polyline	1	<Null>	88.544127
2	Polyline	2	L	298.351168
3	Polyline	3	L	166.198499
4	Polyline	4	L	83.759794
5	Polyline	5	L	109.060742
6	Polyline	6	L	378.689485
7	Polyline	7	L	44.406315
8	Polyline	8	M	178.995089
9	Polyline	9	M	82.505747
10	Polyline	10	M	326.699698
11	Polyline	11	<Null>	113.142624
12	Polyline	12	<Null>	59.711738
13	Polyline	13	<Null>	90.582727
14	Polyline	14	<Null>	18.331248



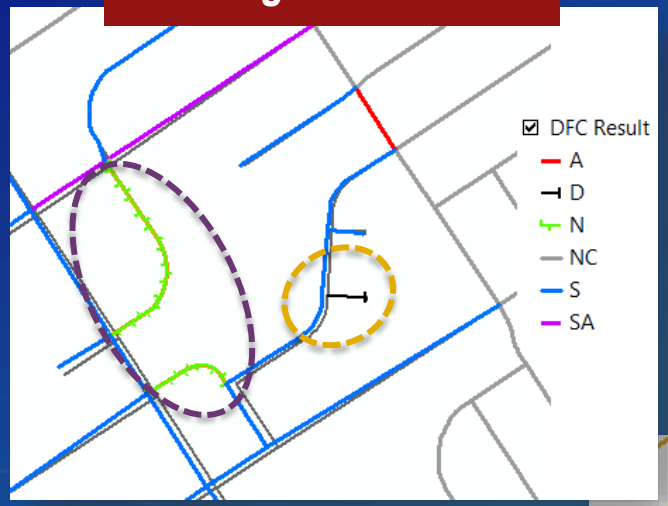
Base features with spatial accuracy and attributes

BaseStreets

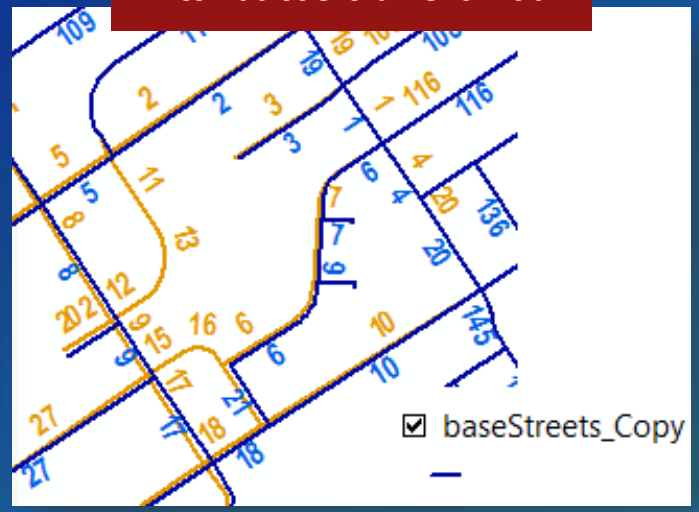
OBJECTID *	Shape *	NAME	Priority	Shape_Length
130	Polyline	W FERN	M	82.64188
149	Polyline	W FERN	M	316.419224
156	Polyline	W FERN	M	87.413082
106	Polyline	SHERWOOD	L	138.32864
129	Polyline	SHERWOOD	L	154.974493
73	Polyline	SAN RAFAEL	L	94.960556
82	Polyline	SAN RAFAEL	L	86.952636
87	Polyline	SAN PABLO	L	259.025112
102	Polyline	SAN PABLO	L	162.609722
114	Polyline	NOTTINGHAM	L	138.470439
140	Polyline	NOTTINGHAM	L	217.51654
66	Polyline	MILLS	L	90.060797
69	Polyline	MILLS	L	91.095418

Results

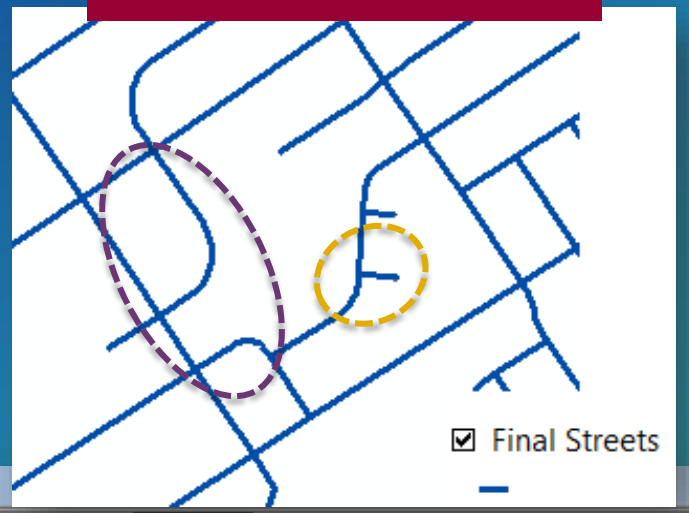
Changes detected



Attributes transferred



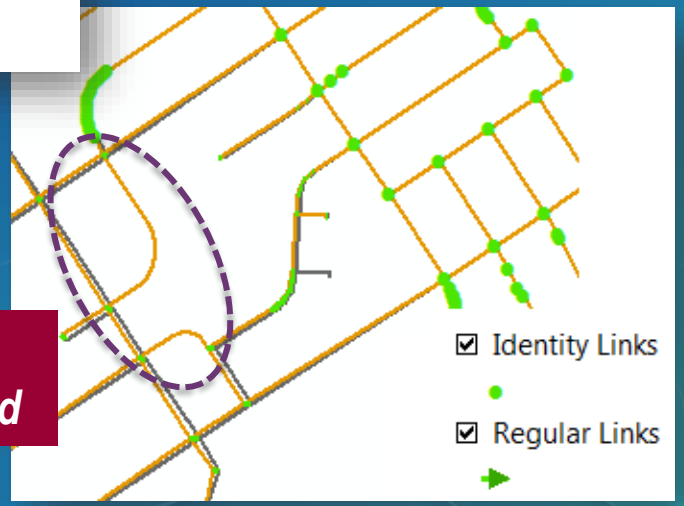
New features adjusted and added to base



Final Streets

OBJECTID *	Shape *	NAME	Priority	Shape_Length	UniqueID	CHANGE_TYPE
100	Polyline	W OLIVE	M	293.577825	2	A
109	Polyline	W OLIVE	M	109.071651	5	A
128	Polyline	<Null>	L	51.455286	<Null>	D
200	Polyline	<Null>	M	112.706047	11	N
201	Polyline	<Null>	M	59.242967	12	N
202	Polyline	<Null>	M	90.29932	13	N
203	Polyline	<Null>	M	18.383534	14	N
204	Polyline	<Null>	M	58.252814	15	N
205	Polyline	<Null>	M	37.23	16	N
6	Polyline	LAUREL	L	384.916164	27	NC
19	Polyline	W FERN	M	340.788763	40	NC
66	Polyline	MILLS	L	90.060797	87	NC
67	Polyline	KATHL	L	173.068809	88	NC
69	Polyline	MILLS	L	91.095418	90	NC

Rubbersheet links generated



The reality is more complicated …

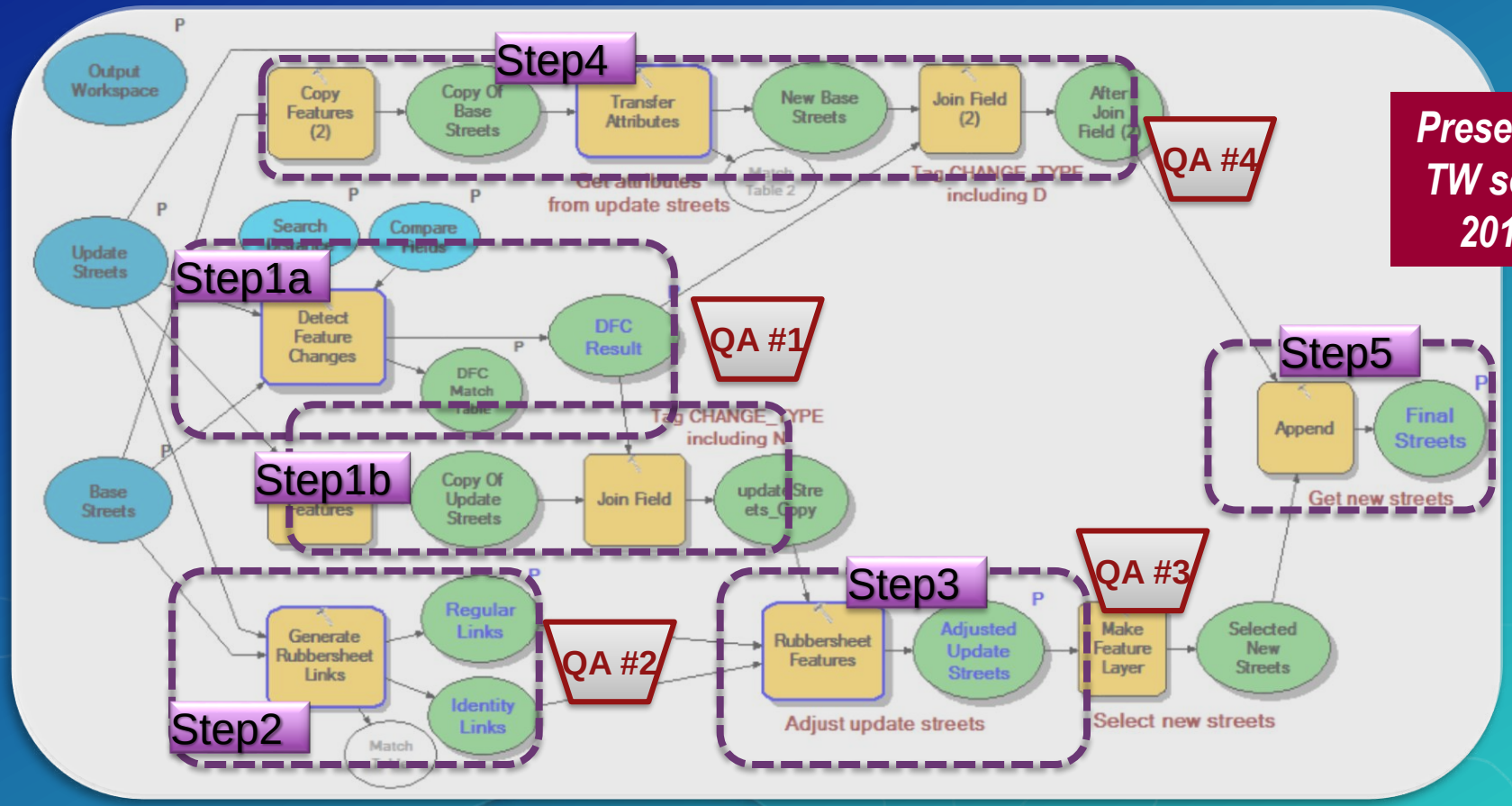
Conflation workflow in real world scenarios

- In same projection
- Data validation
- Selection of relevant features

- Conflation tools
- Workflow tools

- Queued review
- Interactive editing

Breakdown of conceptual workflow into sub-workflows



Presented at UC TW sessions in 2014 - 2016

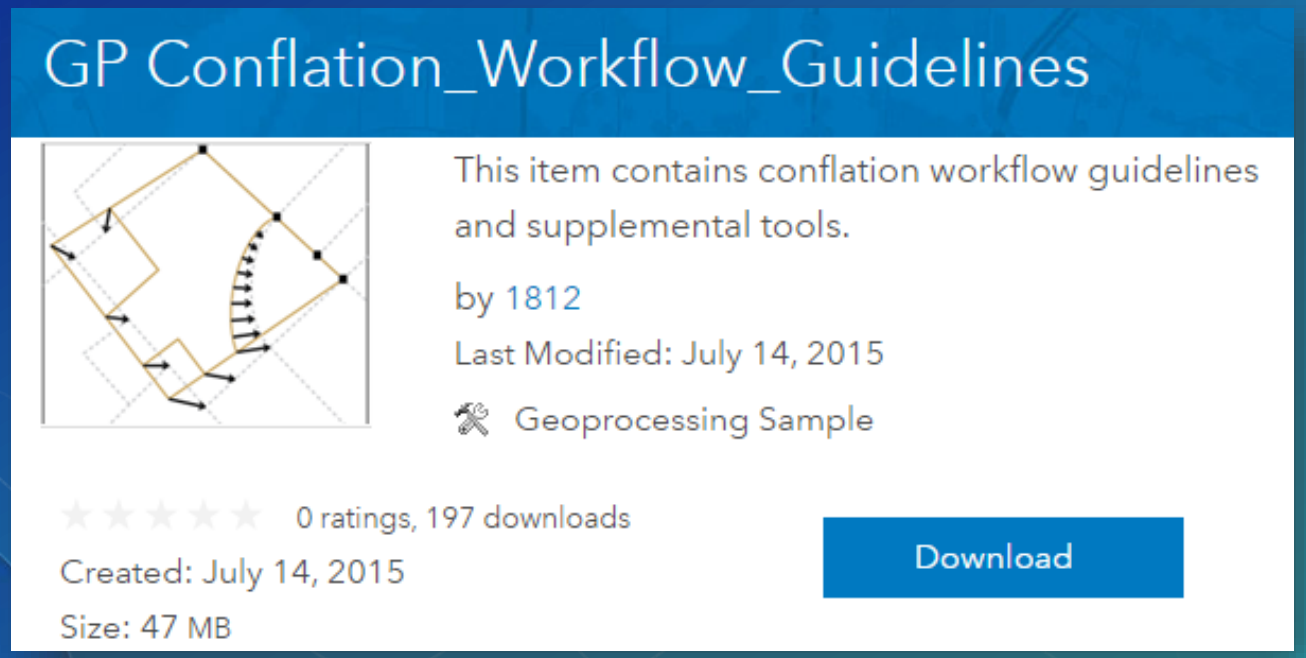
http://proceedings.esri.com/library/userconf/proc16/tech-workshops.html

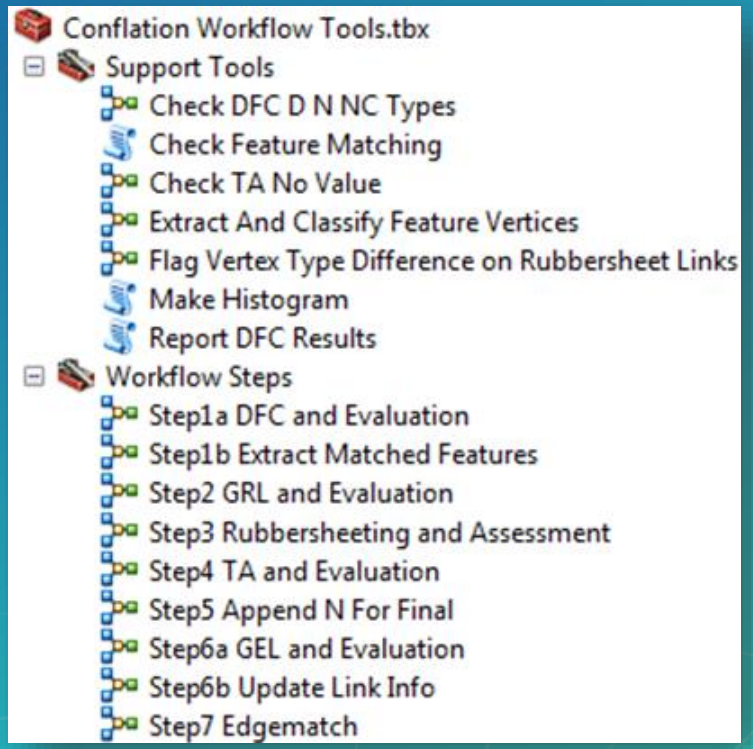
Google search by "Esri UC technical workshop presentations"

Supplemental tools and guidelines for download

http://www.arcgis.com/home/item.html?id=36961cde1b074f1f944758f6abec87cc

You can also search by "conflation" at arcgis.com to find the download.





We are improving the add-in toolbar and workflow tools.

This time, let's focus on single task workflows …

Demo 1:
Detect Feature Changes workflow

Road datasets from two sources

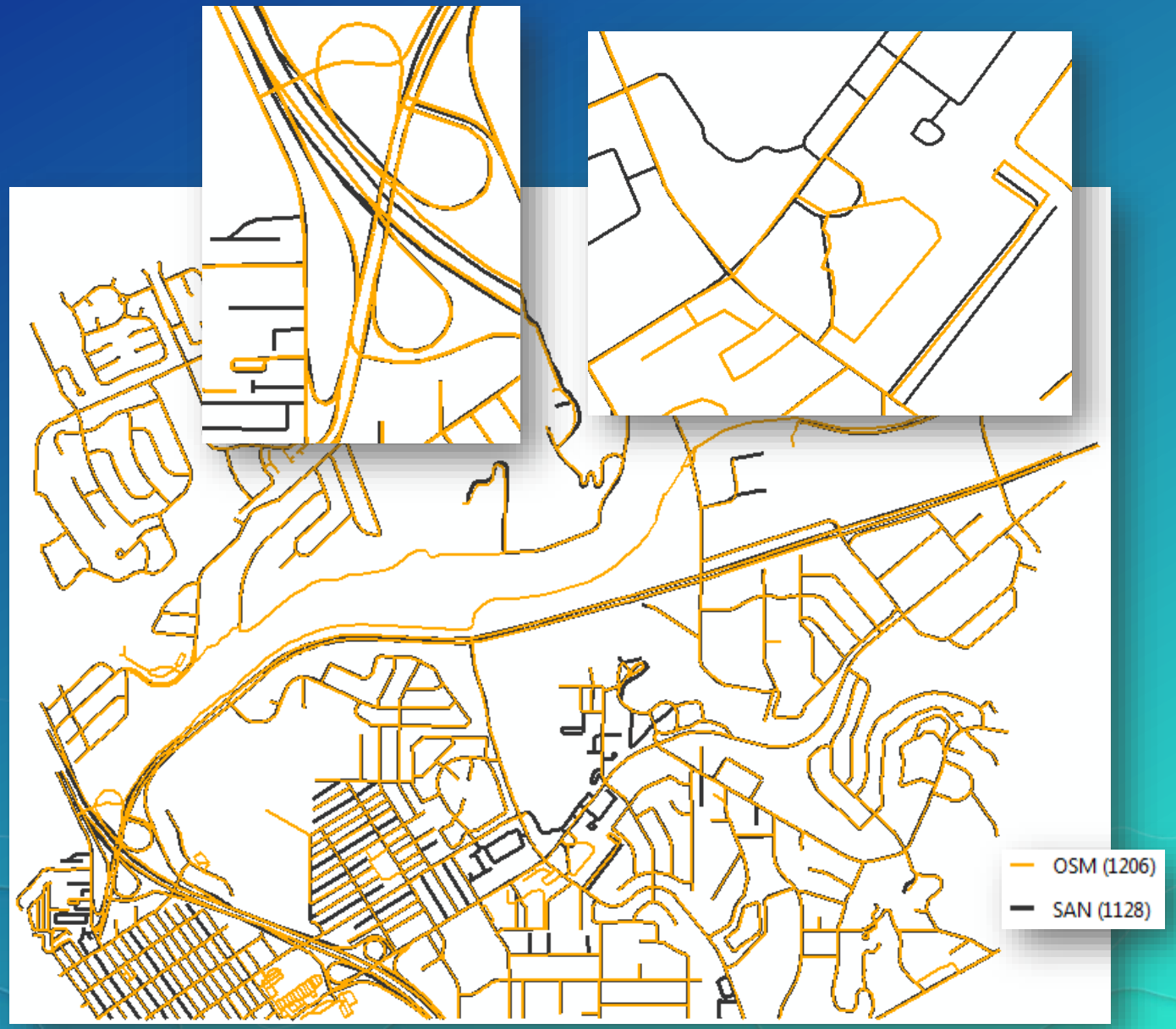
Data overview

Two road datasets (northwest of San Diego, CA):

- OSM – 1206 features
- SAN – 1128 features

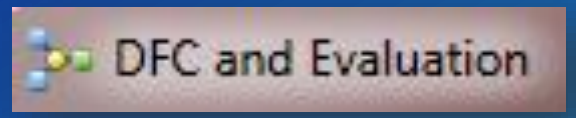
Both datasets:

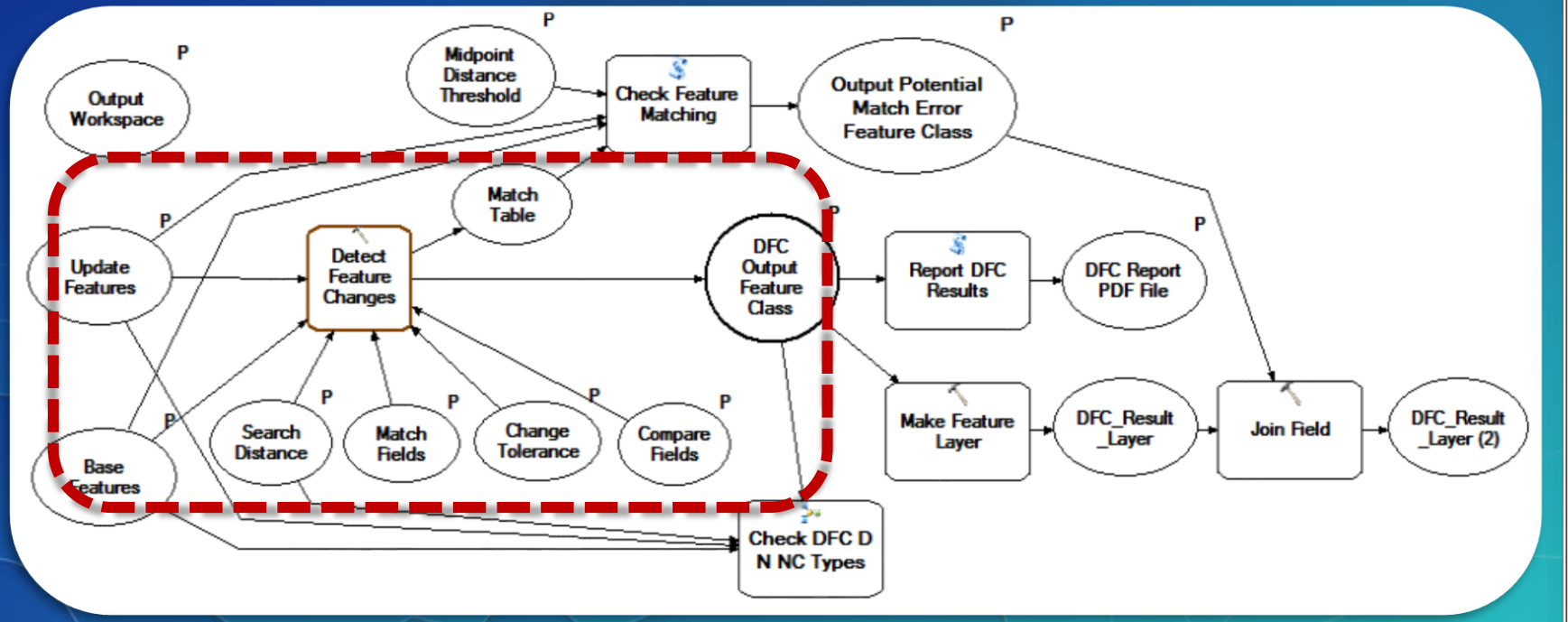
- Have common and uncommon features and attributes
- Are well pre-processed

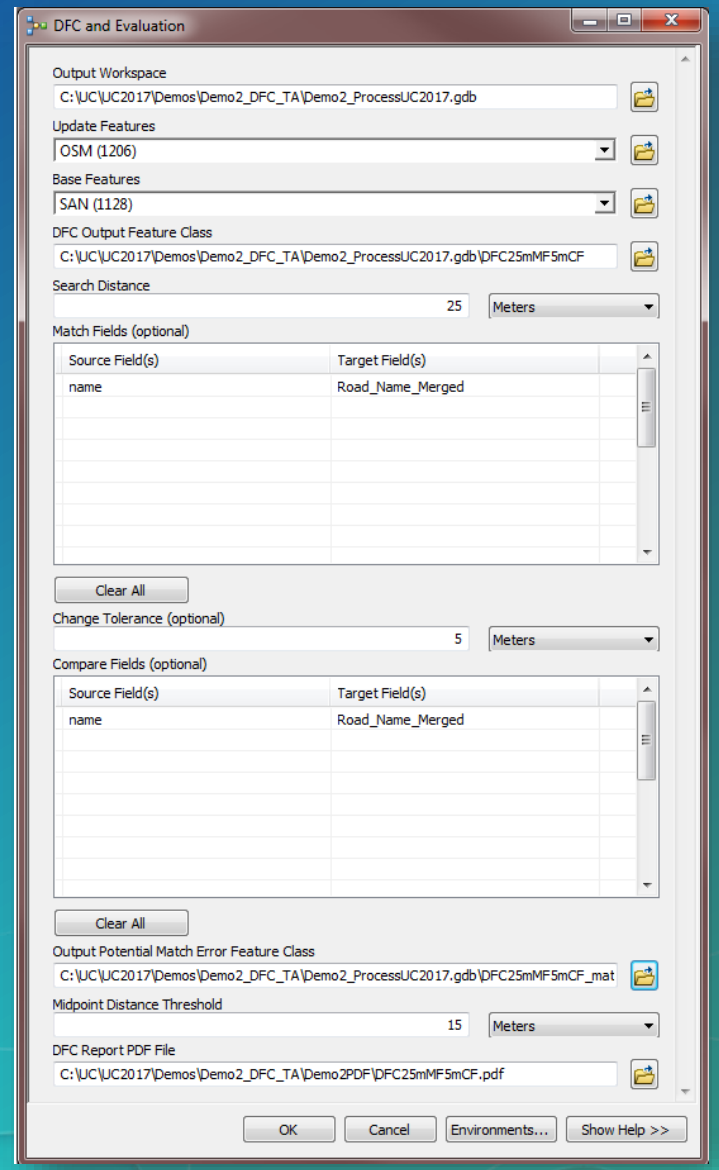


DFC and Evaluation

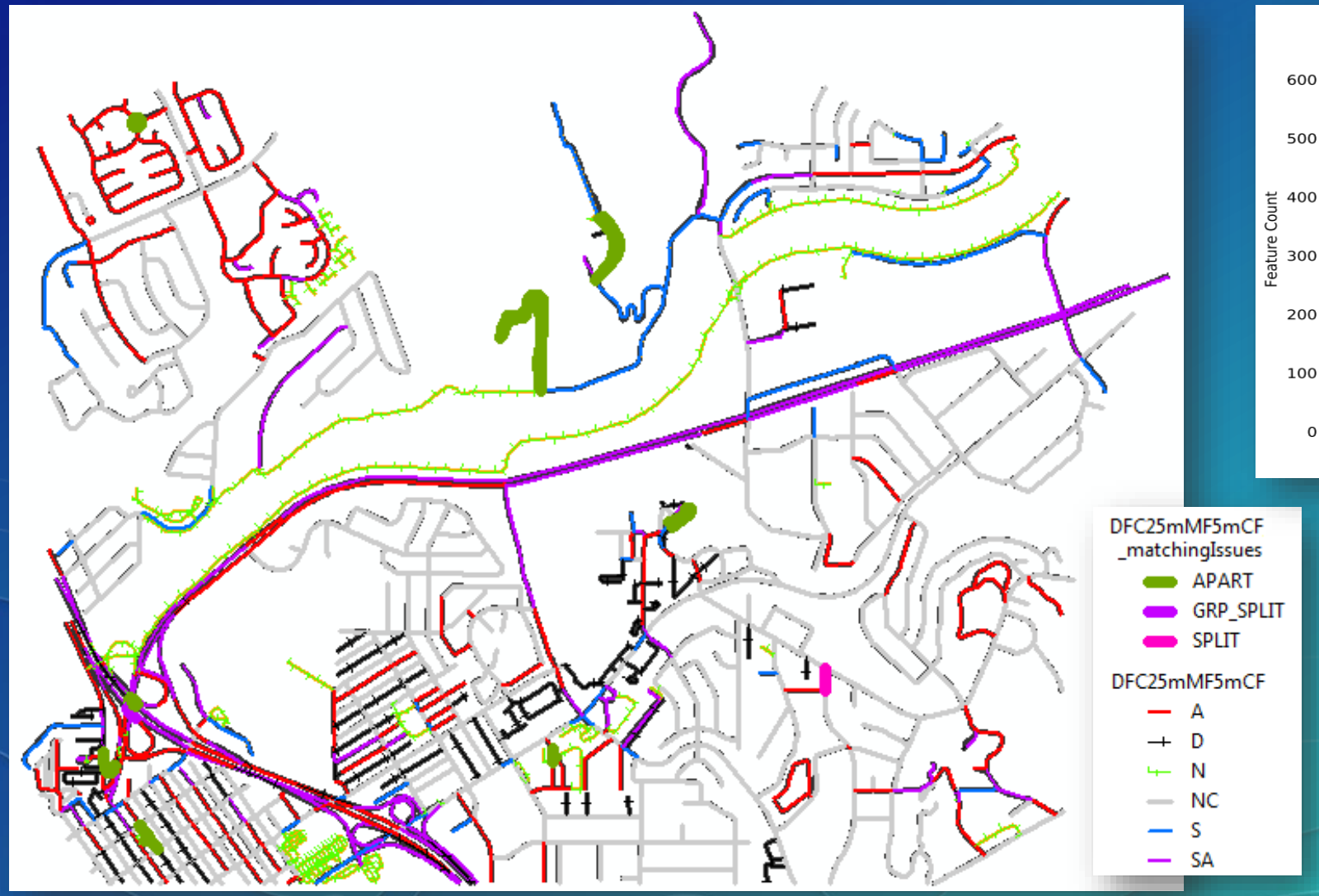
Potential issues are flagged in the DFC output

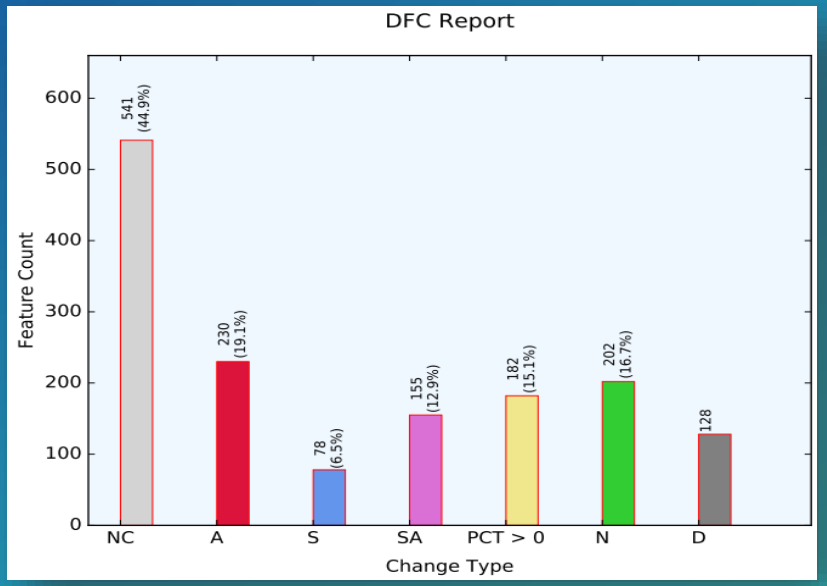






DFC result with flags on potential issues





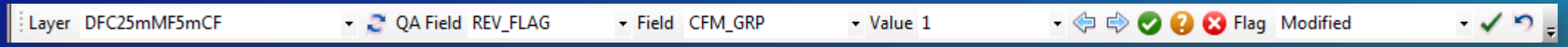
QA

- Review potential match issues (CFM_GRP)
- Review potential no-match issues (Ns and Ds)

Demo of DFC QA …

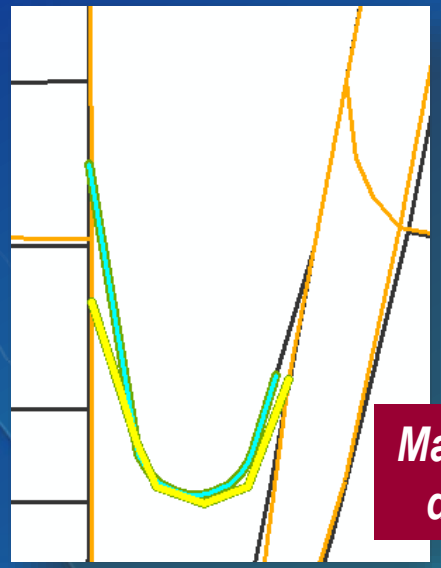
Review potential incorrect matches

Conflation QA toolbar (Esri Add-in)



Total 12 CFM_GRPs were flagged

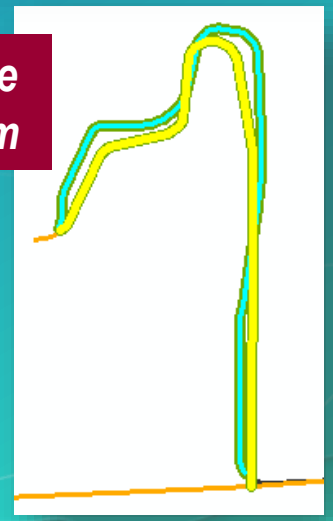
- **8 were either true match issues or data issues due to data complexity and dissimilarity**
- **4 were false alarm (ignorable)**



Match issue due to data complexity

	OBJECTID *	Shape *	Shape_Length	SRC_FID	TGT_FID	FM_MN	FM_GRP	CFM_GRP	CFM_FLAG	CFM_DIST	REV_FLAG
	26	Polyline	715.674065	1004	-1	1:1	777	10	APART	27.714693	Correct
	27	Polyline	744.797553	-1	484	1:1	777	10	APART	27.714693	Correct

False alarm



	OBJECTID *	Shape *	Shape_Length	SRC_FID	TGT_FID	FM_MN	FM_GRP	CFM_GRP	CFM_FLAG	CFM_DIST	REV_FLAG
▶	4	Polyline	86.966385	401	-1	2:1	363	2	APART	20.894693	Recheck
	5	Polyline	28.514848	402	-1	2:1	363	2	APART	20.894693	Recheck
	6	Polyline	148.179803	-1	970	2:1	363	2	APART	20.894693	Recheck

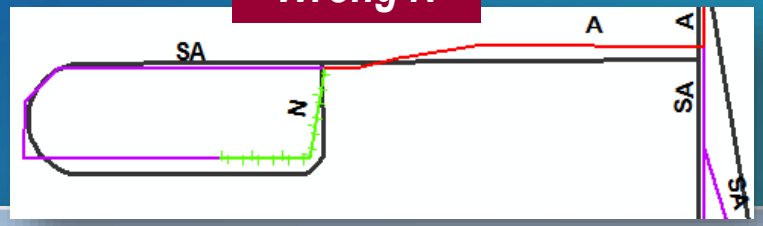
Review potential no-match issues: (Ns and Ds)

((CHANGE_TYPE = 'N') OR (CHANGE_TYPE = 'D')) AND (NEAR_DIST > 0)

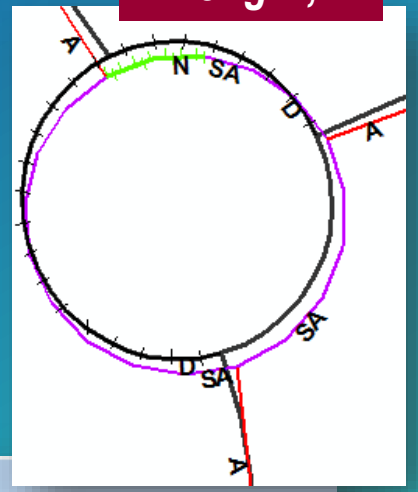
Inspect records with high potential for errors:

- **116 reviewed**
- **15 wrong Ns or Ds flagged**

Wrong N



Wrong D, N



DFC25mMF5mCF

OBJECTID *	Shape *	UPDATE_FID	BASE_FID	CHANGE_TYPE	LEN_PCT	LEN_ABS	Shape_Length	FM_MN	FM_GRP	CFM_GRP	CFM_FLAG	CFM_DIST	NEAR_FID	NEAR_DIST	REV_FLAG
1317	Polyline	-1	956	D	-1	-1	43.071085	<Null>	<Null>	<Null>	<Null>	<Null>	726	5.306041	Correct
1220	Polyline	-1	145	D	-1	-1	56.928144	<Null>	<Null>	<Null>	<Null>	<Null>	729	11.183812	Correct
1225	Polyline	-1	187	D	-1	-1	132.847559	<Null>	<Null>	<Null>	<Null>	<Null>	730	8.253837	Wrong
1258	Polyline	-1	401	D	-1	-1	40.03363	<Null>	<Null>	<Null>	<Null>	<Null>	731	9.641416	Wrong
635	Polyline	153	-1	N	-1	-1	28.431826	<Null>	<Null>	<Null>	<Null>	<Null>	738	14.585656	Correct
649	Polyline	170	-1	N	-1	-1	27.048795	<Null>	<Null>	<Null>	<Null>	<Null>	740	13.60104	Correct
1284	Polyline	-1	613	D	-1	-1	49.007339	<Null>	<Null>	<Null>	<Null>	<Null>	790	23.833544	Correct
1326	Polyline	-1	1076	D	-1	-1	38.881254	<Null>	<Null>	<Null>	<Null>	<Null>	790	20.235574	Correct
1257	Polyline	-1	393	D	-1	-1	95.801864	<Null>	<Null>	<Null>	<Null>	<Null>	804	3.667978	Correct
1191	Polyline	1186	-1	N	-1	-1	12.511227	<Null>	<Null>	<Null>	<Null>	<Null>	816	2.369617	Wrong
1096	Polyline	1061	-1	N	-1	-1	34.727105	<Null>	<Null>	<Null>	<Null>	<Null>	821	19.313911	Correct
1080	Polyline	1043	-1	N	-1	-1	39.061351	<Null>	<Null>	<Null>	<Null>	<Null>	823	23.220141	Correct

0 (116 out of 1334 Selected)

Feature matching accuracy estimates

Matched groups:

- **Total: 975 groups**
- **Correct: 967 groups**
- **Incorrect: 8 groups**

Accuracy = 967/ 975 => 99.18%

Unmatched:

- **Total: 330 (202 Ns + 128 Ds)**
- **Correct: 315 (193 Ns + 122 Ds)**
- **Incorrect: 15 (9 Ns + 6 Ds)**

Accuracy = 315 / 330 => 95.45%

(biased by the total count)

Overall feature matching accuracy

(average of matched and unmatched)

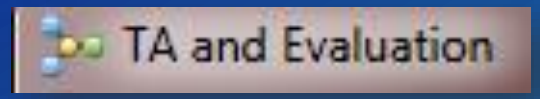
97.32%

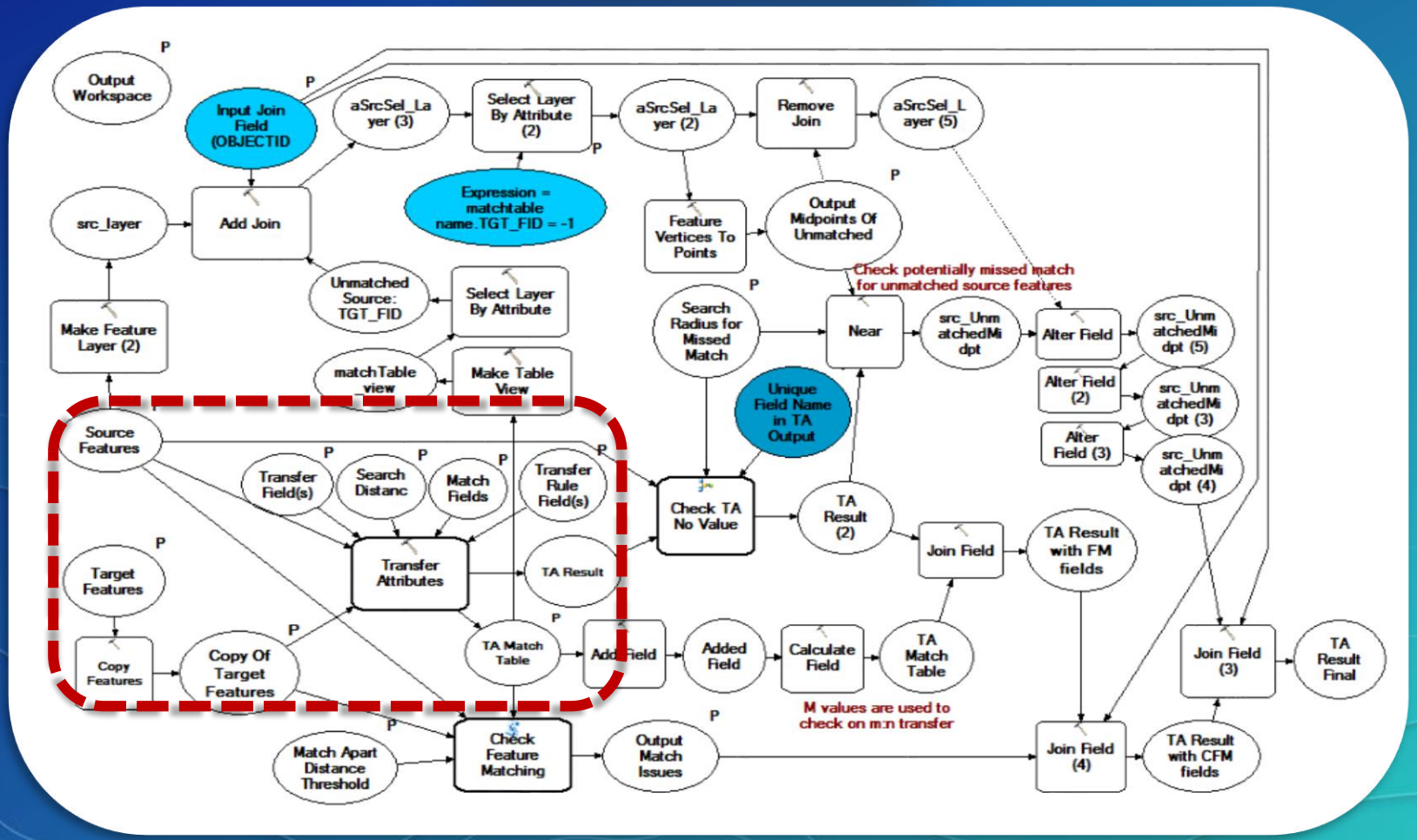
Demo 2:
Transfer Attributes workflow

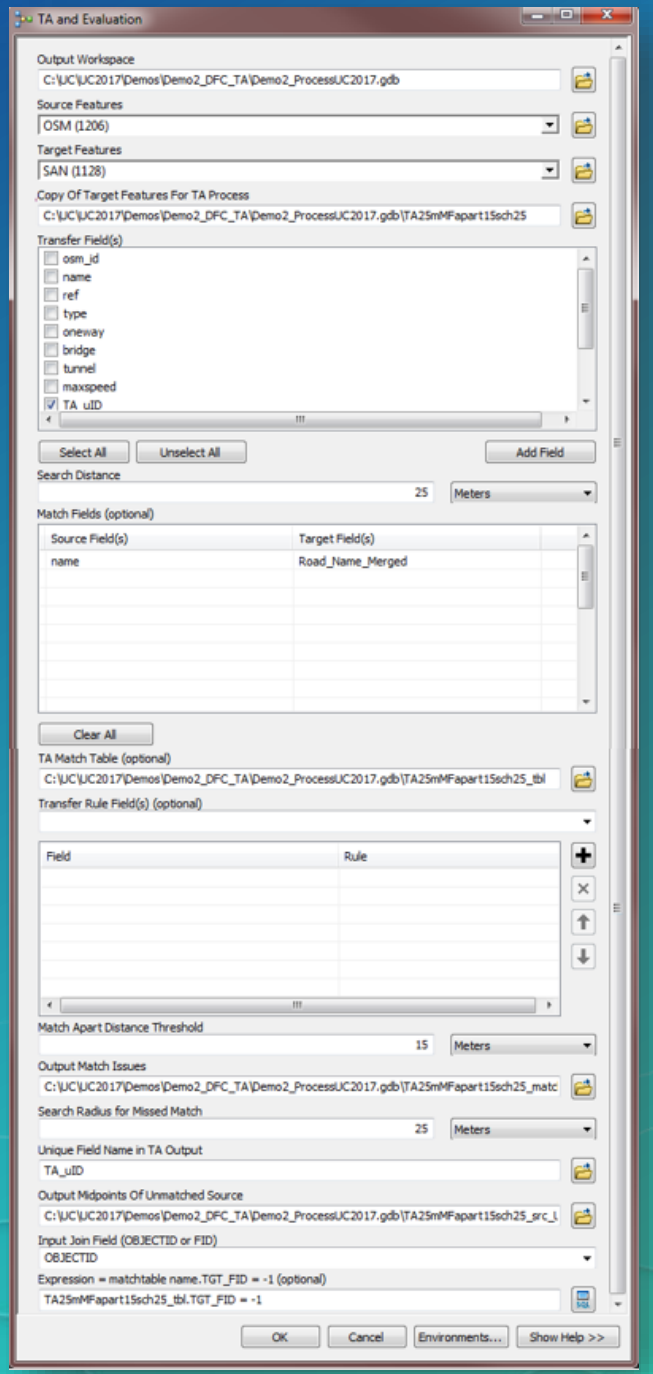
Road datasets from two sources

TA and Evaluation

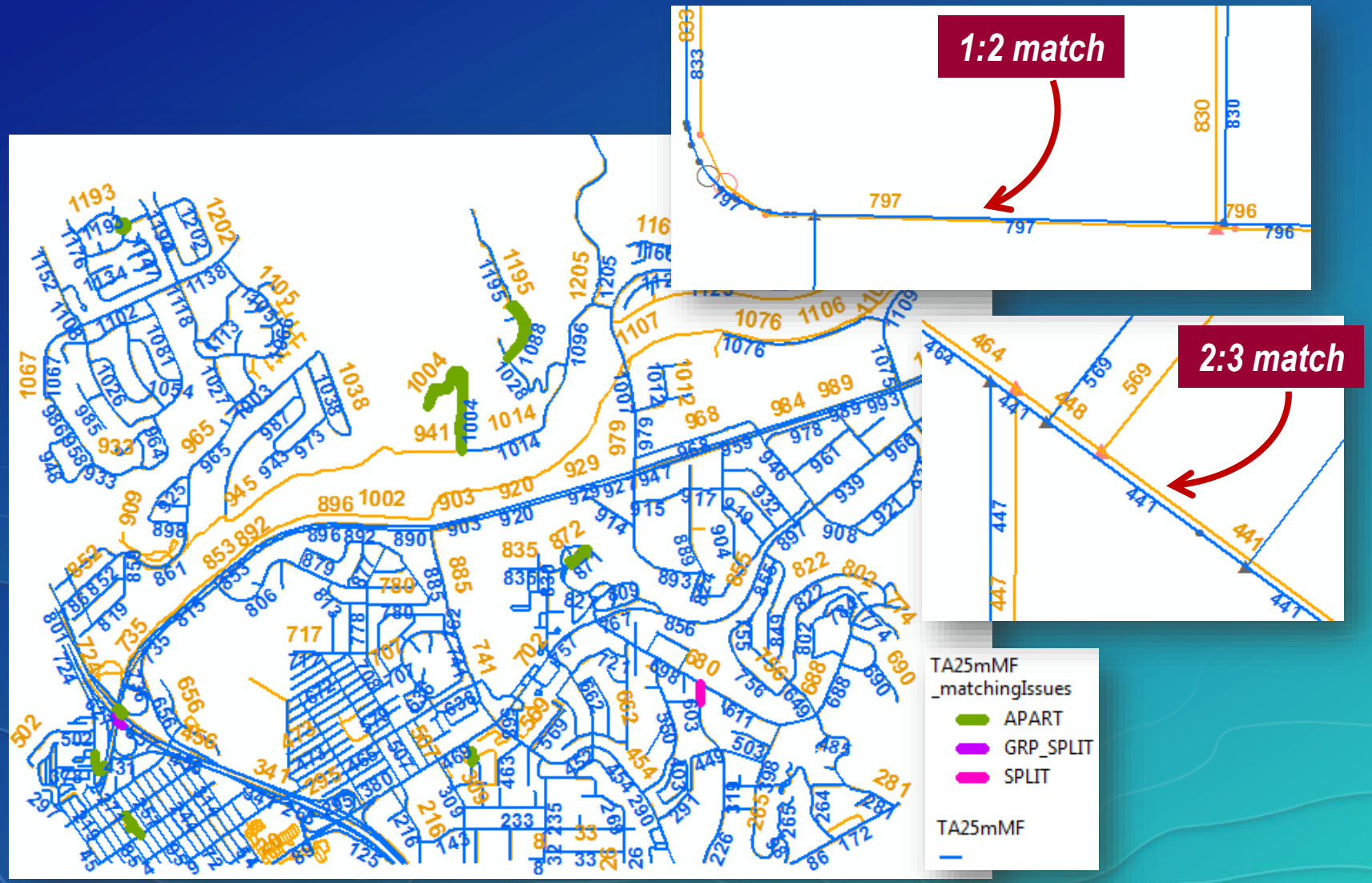
Potential issues are flagged in a copy of the target







TA result and flags on potential issues



QA

- **Review potential wrong transfers**
- **Review potential missed transfers**
- ***Multi-source transfers (m:n) are noted in srcM_inMN***

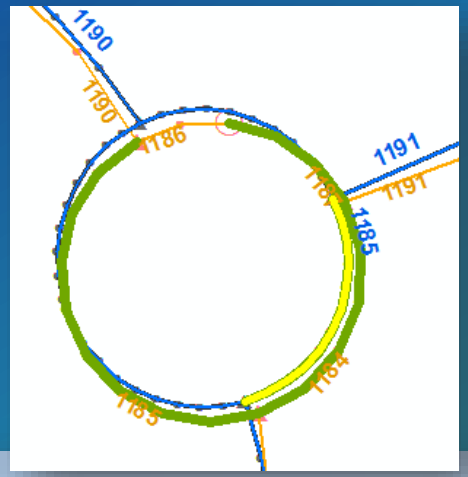
Demo of TA QA ...

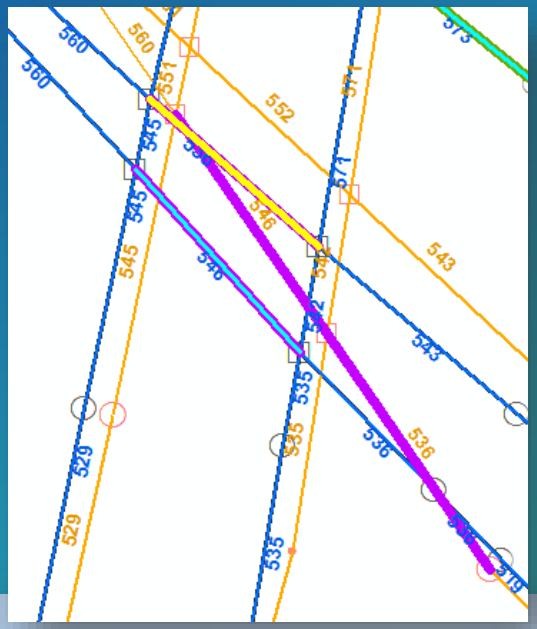
Review transfers with potential match issues

CFM_GRP >=0

13 records were reviewed:

- **2 TA_uID values were corrected**





TA25mMF

OBJECTID	Shap	TBMG	RD20NA	RD	RD20FU	Road_N	Shape_L	TA_uID	NEAR_FID	NEAR_DIS	FM_GRP	FM_MN	srcM_in	CFM_	CFM_FL	CFM_DI	srcORIGFID	srcNearFID	srcNearDis	REV_FLAG	rev_TAuID
664	Polyli	A3	PRIVATE	RD	PRIVAT	Private R	32.98117	1185	<Null>	<Null>	884	3:1	3	5	APART	17.7133	<Null>	<Null>	<Null>	Wrong	1184
147	Polyli	A6	I-5 SB		I-5 SB	Interstate	24.82510	536	<Null>	<Null>	462	2:1	2	3	GRP_SP	-1	552	147	6.838031	Wrong	552
275	Polyli	A6	I-5 NB		I-5 NB	Interstate	23.79797	585	<Null>	<Null>	234	2:1	2	1	APART	18.1100	<Null>	<Null>	<Null>	Correct	<Null>
400	Polyli	A6	I-5 NB		I-5 NB	Interstate	23.62526	573	<Null>	<Null>	233	1:1	1	6	APART	16.8328	<Null>	<Null>	<Null>	Correct	<Null>
458	Polyli	C4	BENET HIL	RD	BENET	Benet Hill	275.3343	1088	<Null>	<Null>	810	1:1	1	11	APART	19.3391	<Null>	<Null>	<Null>	Correct	<Null>
484	Polyli	B4	PRIVATE	RD	PRIVAT	Private R	744.7975	1004	<Null>	<Null>	777	1:1	1	10	APART	27.7146	1005	484	12.868726	Correct	<Null>
611	Polyli	D6	CROUCH	ST	CROUC	Crouch S	101.9074	643	<Null>	<Null>	527	2:1	2	4	SPLIT	-1	<Null>	<Null>	<Null>	Correct	<Null>
752	Polyli	A7	ALLEY		ALLEY	Alley	138.9000	208	<Null>	<Null>	238	1:1	1	7	APART	18.5957	<Null>	<Null>	<Null>	Recheck	<Null>
890	Polyli	C5	ECCLESIA	DR	ECCLES	Ecclesia	133.4632	871	<Null>	<Null>	667	1:1	1	9	APART	20.6245	<Null>	<Null>	<Null>	Recheck	<Null>
897	Polyli	C6	PRIVATE	RD	PRIVAT	Private R	58.41161	420	<Null>	<Null>	373	1:1	1	8	APART	15.5651	<Null>	<Null>	<Null>	Recheck	<Null>
961	Polyli	A6	I-5 SB OF	RA	I-5 SB O	Interstate	27.39497	546	<Null>	<Null>	457	1:1	1	3	GRP_SP	-1	<Null>	<Null>	<Null>	Correct	<Null>
970	Polyli	J7	SR-76 WB		SR-76	State Ro	148.1798	401	<Null>	<Null>	363	2:1	2	2	APART	20.8946	<Null>	<Null>	<Null>	Correct	<Null>
1061	Polyli	C3	BENET HIL	RD	BENET	Benet Hill	91.54481	1089	<Null>	<Null>	811	1:1	1	12	APART	16.9071	<Null>	<Null>	<Null>	Correct	<Null>

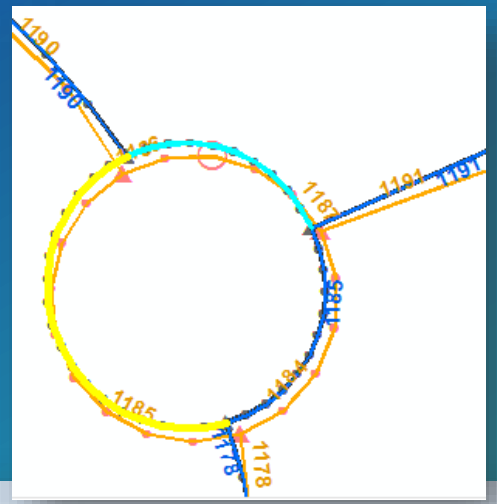
0 (13 out of 1128 Selected)

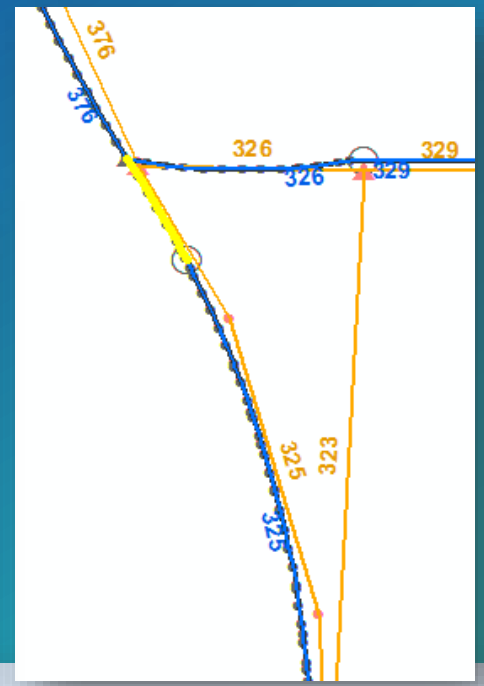
Review potential missed transfers

TA_uID IS NULL AND (NEAR_FID >0 OR srcNearFID >0)

48 records were reviewed:

- **6 transferred TA_uID values were incorrect**





TA25mMF

OBJECTID	Shap	TBMG	RD20NA	RD	RD20FU	Road_N	Shape_L	TA_uID	NEAR_FID	NEAR_DIS	FM_GRP	FM_MN	srcM_in	CFM_	CFM_FL	CFM_DI	srcORIGFID	srcNearFID	srcNearDis	REV_FLAG	rev_TAuID
401	Polyli	J6	I-5 NB		I-5 NB	Interstate	40.03363	<Null>	731	9.641416	-1	N/A	-1	<Null>	<Null>	<Null>	731	401	9.630519	Wrong	731
419	Polyli	C5	ECCLESIA	DR	ECCLES	Ecclesia	21.15319	<Null>	871	0.288407	-1	N/A	-1	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Correct	<Null>
421	Polyli	J3	PRIVATE	RD	PRIVAT	Private R	57.36360	<Null>	1185	0.214332	-1	N/A	-1	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Wrong	1185
553	Polyli	B7	I-5	RA	I-5 RA	Interstate	35.14299	<Null>	165	1.88825	-1	N/A	-1	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Recheck	<Null>
554	Polyli	B7	I-5	RA	I-5 RA	<Null>	38.92028	<Null>	197	12.469526	-1	N/A	-1	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Recheck	<Null>
566	Polyli	B7	I-5	RA	I-5 RA	<Null>	24.05586	<Null>	213	4.873462	-1	N/A	-1	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Recheck	<Null>
593	Polyli	C6	PRIVATE	DY	PRIVAT	<Null>	29.27072	<Null>	613	12.225035	-1	N/A	-1	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Correct	<Null>
609	Polyli	B7	MCNEIL	ST	MCNEIL	Mcneil St	16.74027	<Null>	358	9.022339	-1	N/A	-1	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Correct	<Null>
625	Polyli	E7	MACDON	ST	MACDO	Macdona	11.06622	<Null>	325	0.525794	-1	N/A	-1	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Wrong	325
703	Polyli	B6	PRIVATE	RD	PRIVAT	Private R	29.63157	<Null>	541	12.521015	-1	N/A	-1	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Correct	<Null>

0 (31 out of 1128 Selected)

Attribute transfer accuracy estimates

- **Total target features: 1128**
- **Correct: 1120**
- **Incorrect: 8**

Accuracy = 1120/ 1128 => 99.29%

- **Remaining no transfer features (TA_uID IS NULL AND REV_FLAG IS NULL): 80**

All correct

Post transfer if necessary

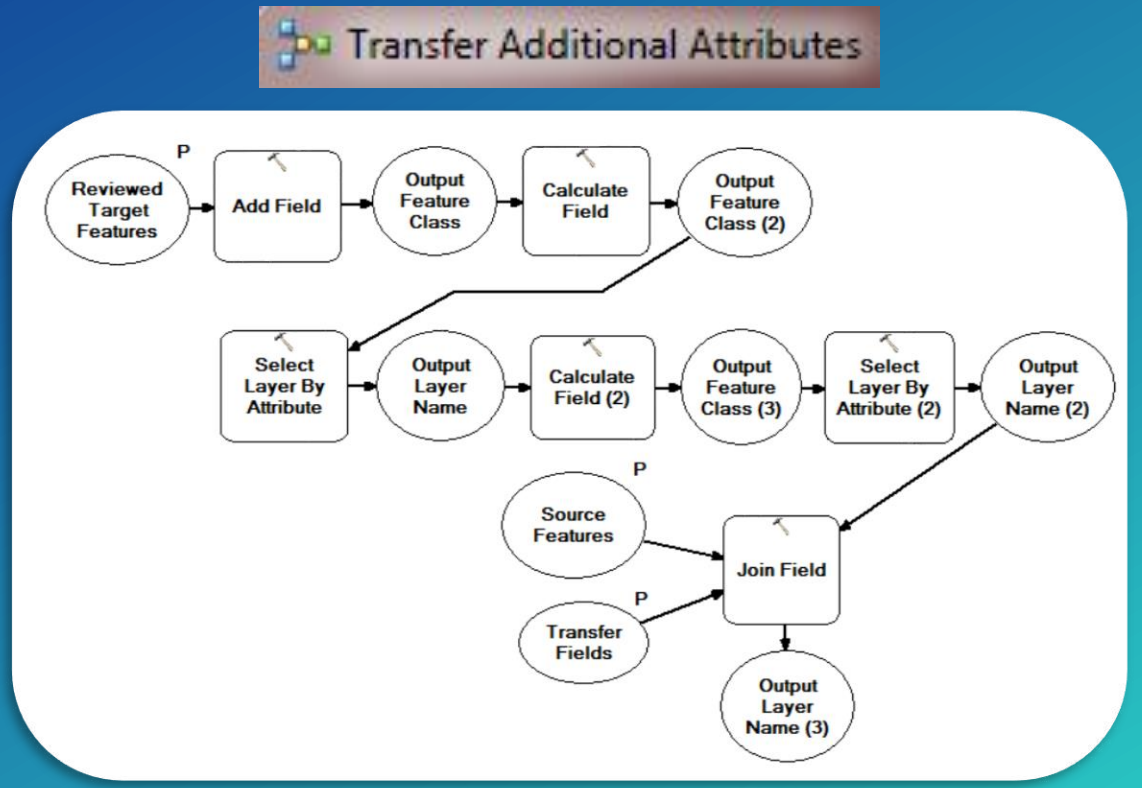
Based on updated final_TA_uID

Calculate final_TA_uID

- Add a field final_TA_uID
- Calculate final_TA_uID = TA_uID
- Select rev_flag = 'Wrong'
- Calculate final_TA_uID = rev_TA_uID

Transfer additional attributes

- Use Join Field on source TA_uID and target final_TA_uID to transfer additional attributes



RD20FU	Road_	Shape_Len	TA_uID	NEAR_FID	NEAR_DIS	FM_GRP	FM_MN	srcM_in	CFM_	CFM_FL	CFM_DI	srcORIGFID	srcNearFID	srcNearDis	REV_FLAG	rev_TAuID	final_TAuID	oneway	bridge
PRIVAT	Private	30.400859	<Null>	1187	1.463928	-1	N/A	-1	<Null>	<Null>	<Null>	1186	816	1.876831	Wrong	1187	1187	1	0
PRIVAT	Private	57.363602	<Null>	1185	0.214332	-1	N/A	-1	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Wrong	1185	1185	1	0
PRIVAT	Private	32.981175	1185	<Null>	<Null>	884	3:1	3	5	APART	17.7133	<Null>	<Null>	<Null>	Wrong	1184	1184	1	0
CAPIST	Capistr	0.069553	<Null>	850	0.02129	-1	N/A	-1	<Null>	<Null>	<Null>	850	1018	3.947928	Wrong	861	861	1	0
I-5 NB	Intersta	40.03363	<Null>	731	9.641416	-1	N/A	-1	<Null>	<Null>	<Null>	731	401	9.630519	Wrong	731	731	1	1
I-5 SB	Intersta	24.825103	536	<Null>	<Null>	462	2:1	2	3	GRP_SP	-1	552	147	6.838031	Wrong	552	552	1	1
MACDO	Macdon	11.066227	<Null>	325	0.525794	-1	N/A	-1	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Wrong	325	325	0	0
PRIVAT	<Null>	10.550205	<Null>	-1	-1	-1	N/A	-1	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>
I-5 SB	Intersta	28.867189	543	<Null>	<Null>	8	1:1	1	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	543	1	1
I-5 SB	Intersta	9.015739	534	<Null>	<Null>	7	1:2	1	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	534	1	0
I-5 SB	Intersta	283.923776	534	<Null>	<Null>	7	1:2	1	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	534	1	0

Use of Transfer Rule Field(s)

To control m:n transfers based on field values

Rule #1:

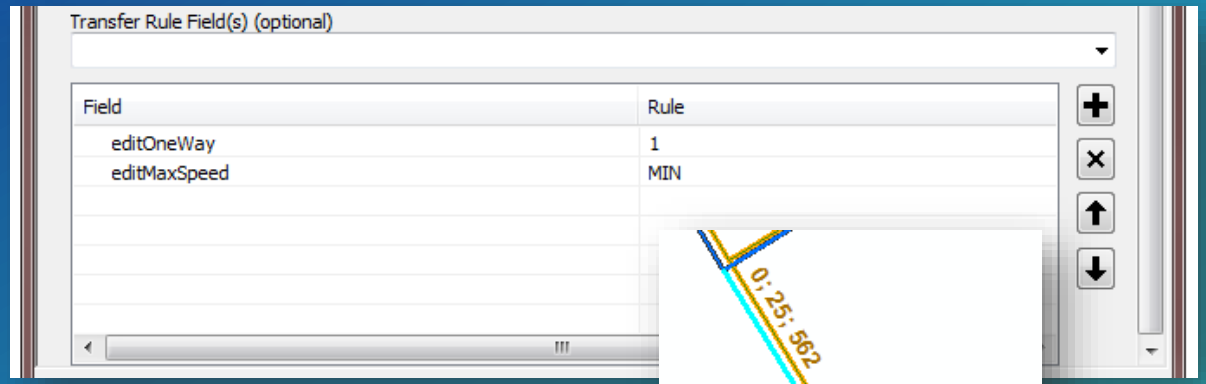
- **Transfer from the source feature if it has value 1 in field “editOneWay”.**

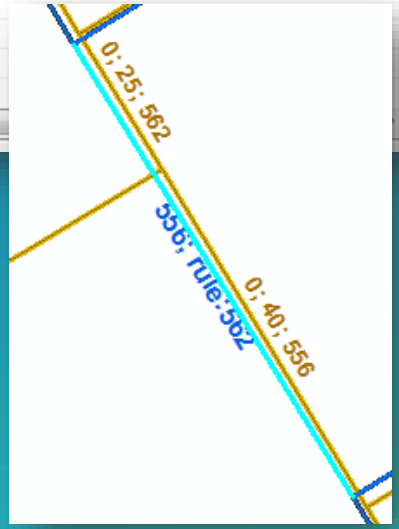
Rule #2:

- **If more than one source features meets Rule #1, then transfer from the one that has the minimum value in field “editMaxSpeed”.**

Rule #3 (default):

- **If both rules are not met, then transfer from the longest source.**





TA25mMF

Road_N	Shape_L	TA_uID	NEAR_FID	NEAR_DIS	FM_GRP	FM_MN	srcM_in	CFM_	CFM_FL	CFM_DI	srcORIGFID	srcNearFID	srcNearDis	REV_FLAG	rev_TAuID	copyTA_uID
San Dieg	48.80705	556	<Null>	<Null>	318	2:1	2	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	562
Interstate	233.2520	427	<Null>	<Null>	952	2:1	2	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	426

Real world scenarios

User story 1: Enhancing county roads by spatially more accurate city roads

County centerline attributes and direction must be retained.

Original_county_centerlines
Temecula_city_centerlines

Updated_county_centerlines
Original_county_centerlines

Updated_county_centerlines
Temecula_city_centerlines

- Use DFC to find matching features and line direction differences
  - For 1:1 matches, flip city centerlines of opposite direction (Flip Line)
  - For m:n matches, merge/split city or county centerlines to get 1:1 matching segments, recalculate address ranges for county roads as needed, and flip city centerlines of opposite direction (tools + scripts)
- Transfer city centerline geometry to county centerlines (script)

~ 98%+ accuracy

Data/information source: RCTLMA (Riverside County Transportation and Land Management) CA, USA
Acknowledgement: Thanks to Richard Fairhurst, for providing the information and screenshots.

User story 2: Combining electoral roads and topographic roads

There is no “most accurate” dataset.

Electoral roads

Topographic roads

Conflation workflow

Land Information New Zealand
Toitū te whenua

Feature matching
- many to many (ArcGIS tool)

~ 90% accuracy

Segmentation
(script)

Feature matching
& Spatial Differencing
- one to one (ArcGIS tool)

~ 99% accuracy

Select best spatial alignments against imagery
(custom plugin)

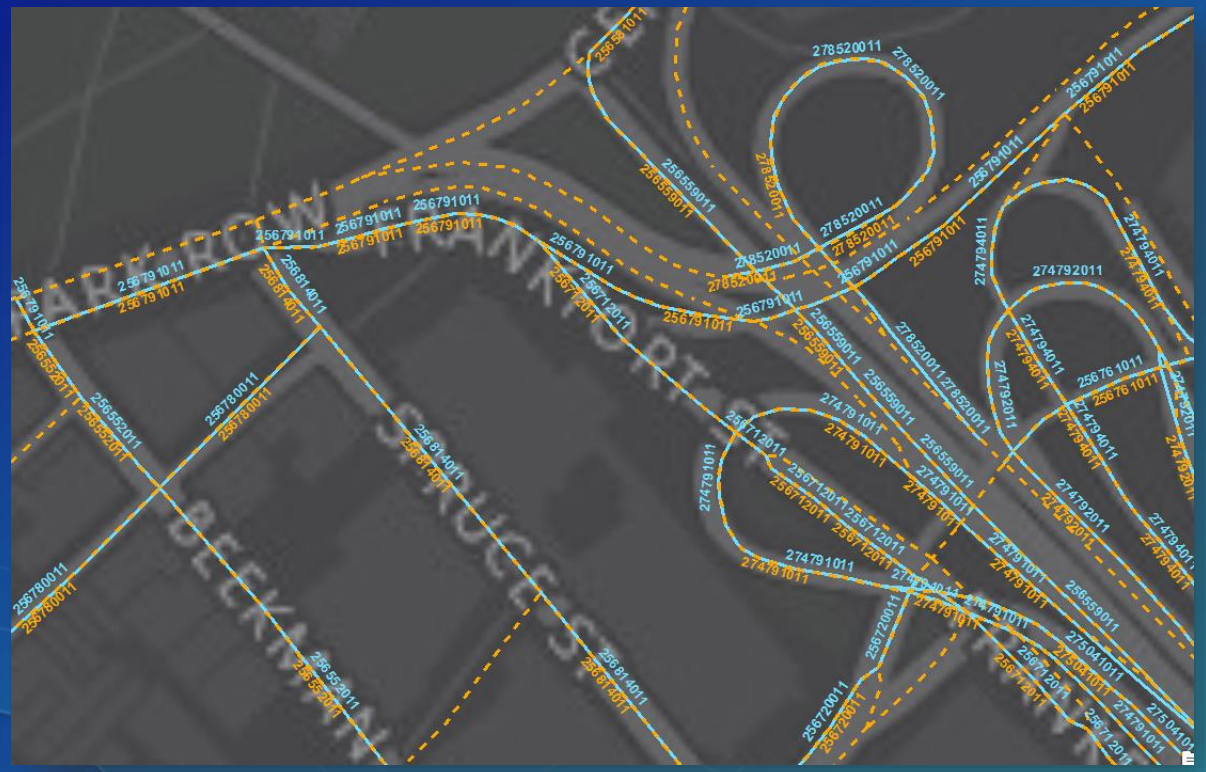
Merge datasets
- snap, rubbersheet, merge attributes (script)

Information source: Land Information New Zealand (LINZ)

Acknowledgement: Thanks to Douglas Kwan, LINZ, for providing the information.

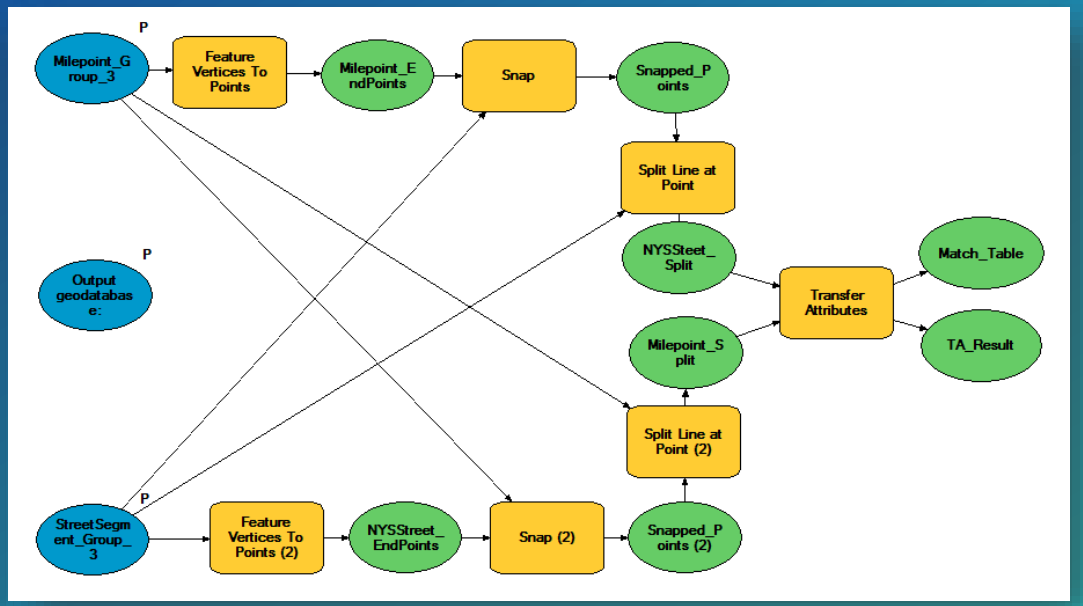
User story 3: Transferring attributes from State routes to Street segments

Segmentation for the datasets was different



State routes

Street Segments



- **State Routes and Street segments were split by end points to provide a more similar segmentation between the two datasets.**

~99.5% matching rate

Data/information source: NYSDOT, USA

Acknowledgement: Thanks to Kevin Hunt, for giving us the opportunity to work with him and share his data.

Conclusions and Future Work

Thanks to:

- Department of Public Works (DPW), Los Angeles County, USA.
- Institut Cartogràfic i Geològic de Catalunya (ICGC), Barcelona, Spain.
- Kevin Hunt, New York State Department of Transportation, USA.
- Richard Fairhurst, Riverside County Transportation and Land Management) CA, USA RCTLMA,
- National Institute for Water and Atmospheric Research (NIWA) and Land Information New Zealand (LINZ) - Crown Copyright Reserved.
- Resource Management Service, LLC, Birmingham, AL, USA.
- All others who supported us along the way.

Conflation can be done more efficiently now

It takes a workflow:

- Use the best practice in pre-processing.
- Run automated tools to obtain highly accurate results and evaluation information.
- Interactively review and edit the results. The time is worth-investing.

Consider conflation a higher priority

Study the tools and understand the results

- Start with small test areas

Customize the workflows for your goals

- Improve data quality and usability
- Bring new value and potential to your data

Work with broader communities

- Data sharing and collaboration
- Seamless analysis and mapping

Please send us your feedbacks and share your stories … ☺

Future work

New tools and enhancements

- Split Line By Match tool
- Better feature matching
- Better rubbersheet links
- Tools for other feature types

Integrated processing and inspections

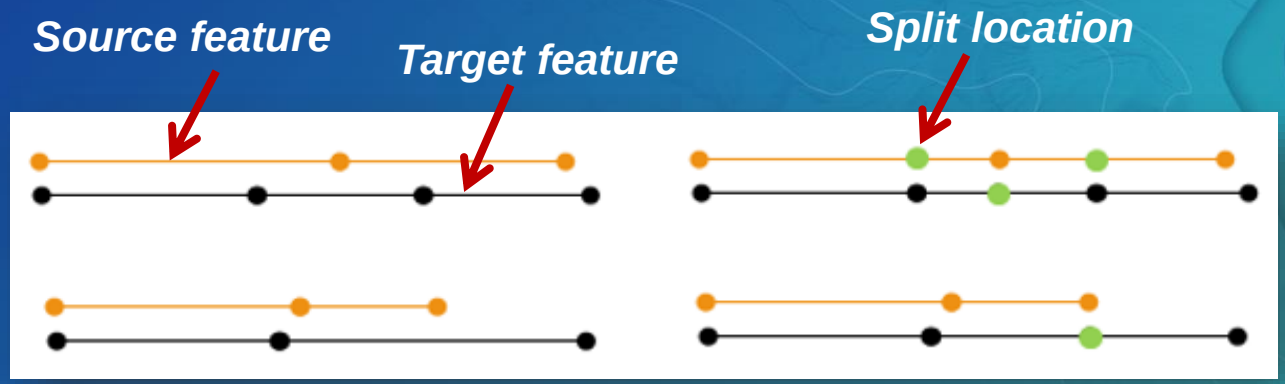
- Design of Conflation Manager is underway

Formalization of workflows

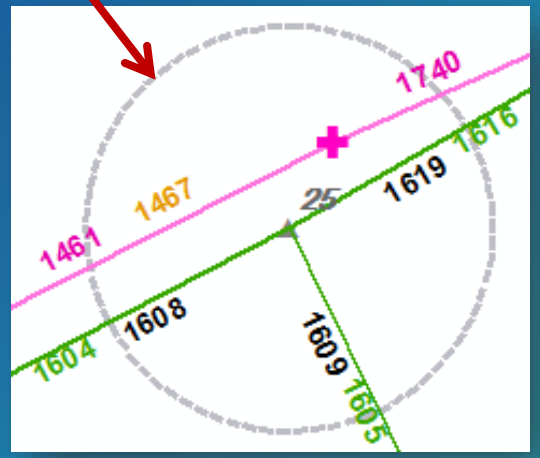
- Common scenarios (e.g. multi-scale data updating, linking buildings of different scale)
- Incorporation of other data sources (imagery, lidar, GPS)
- Contextual conflation (spatially related features)

Split Line By Match – proposed tool

- Applies a search radius from each source or target node
- Produces more 1:1 correspondences
- Improves matching

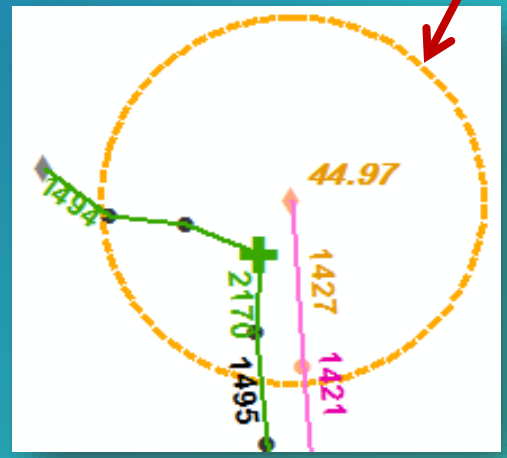


Search radius from target node



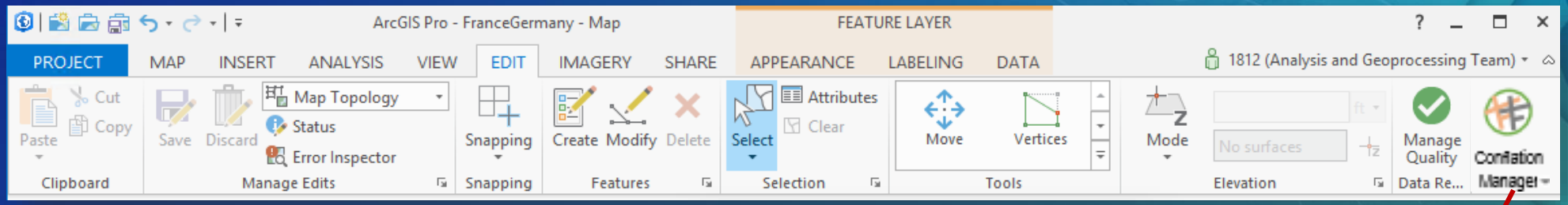
Split source at the only vertex

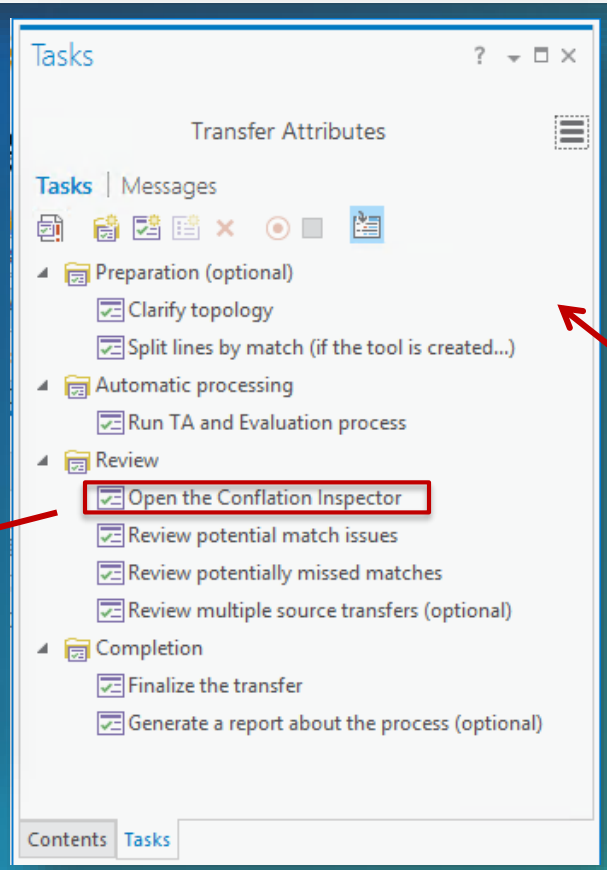
Search radius from source node

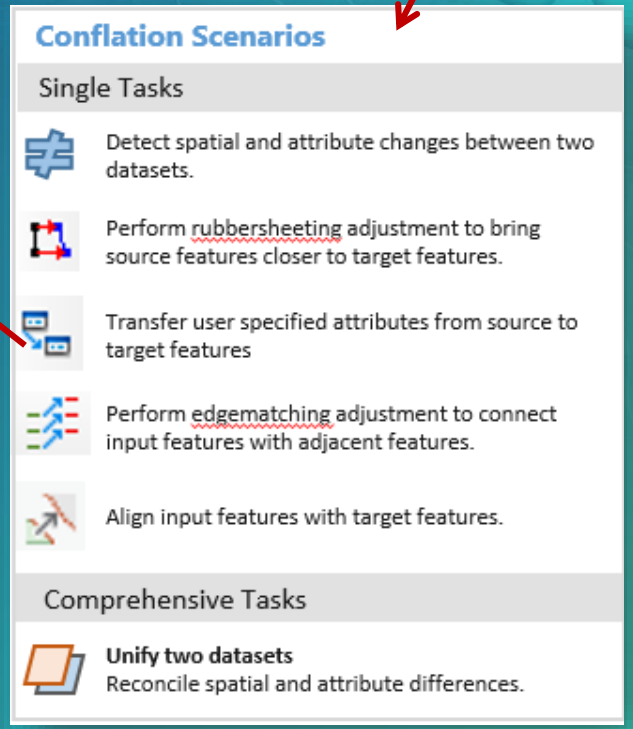


Split target at the nearest vertex

Conflation Manager (ConfMgr)

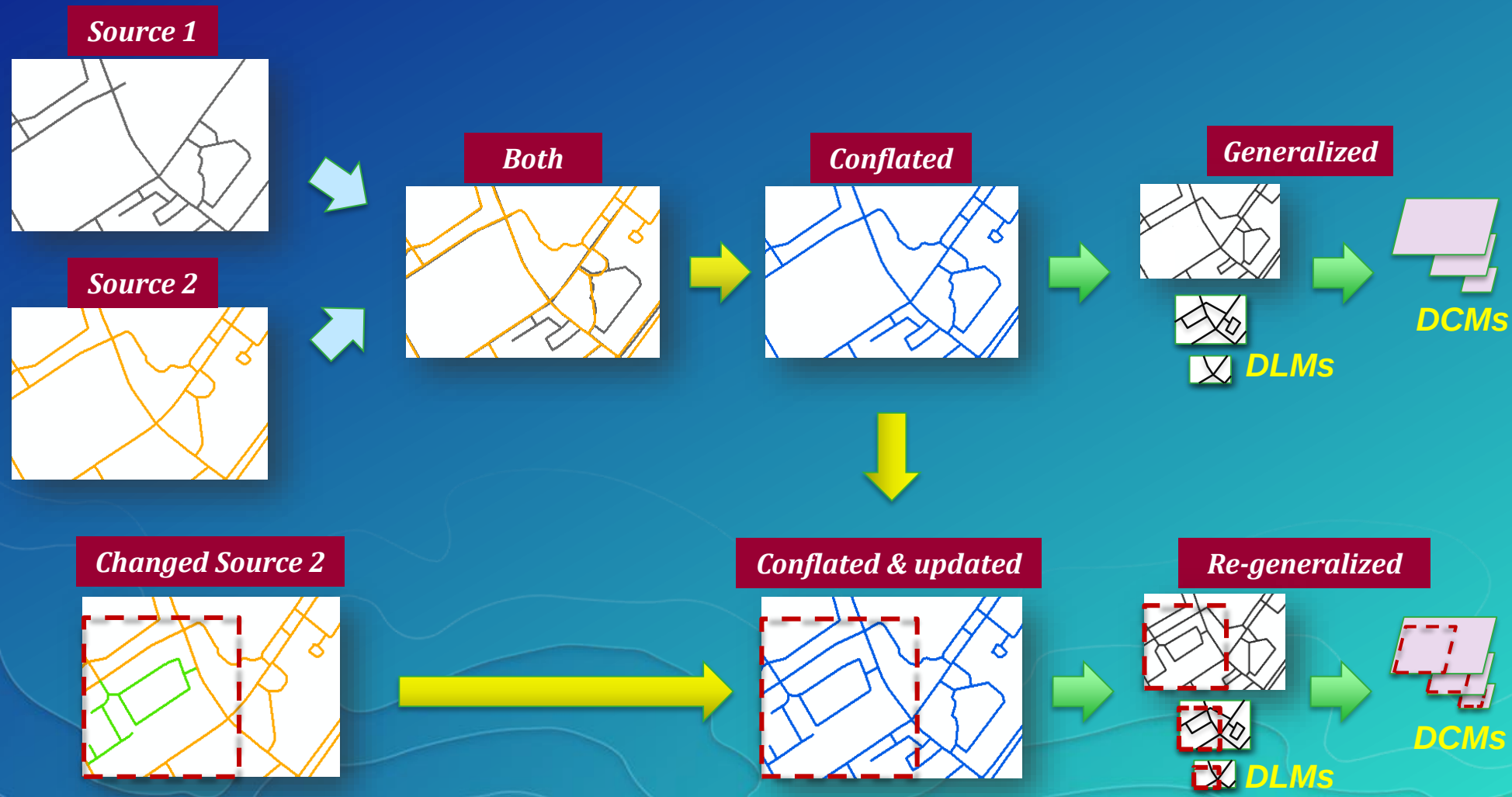




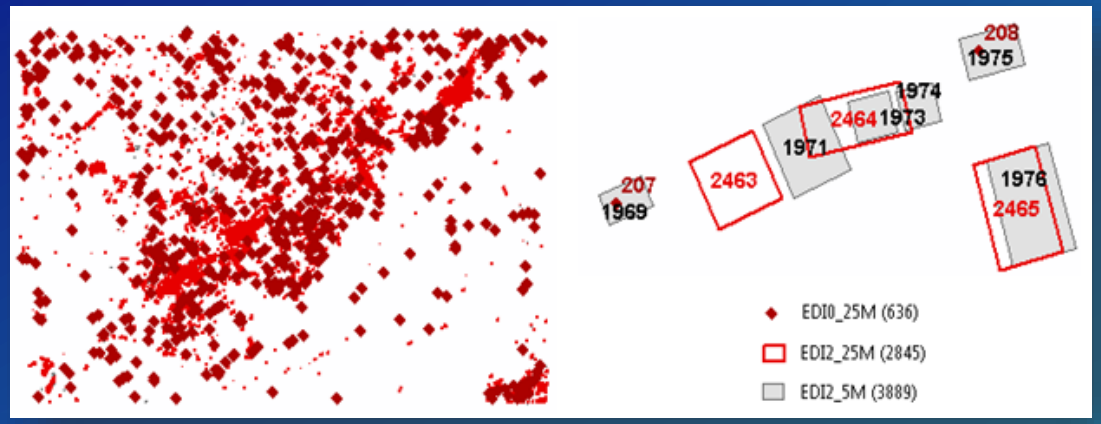


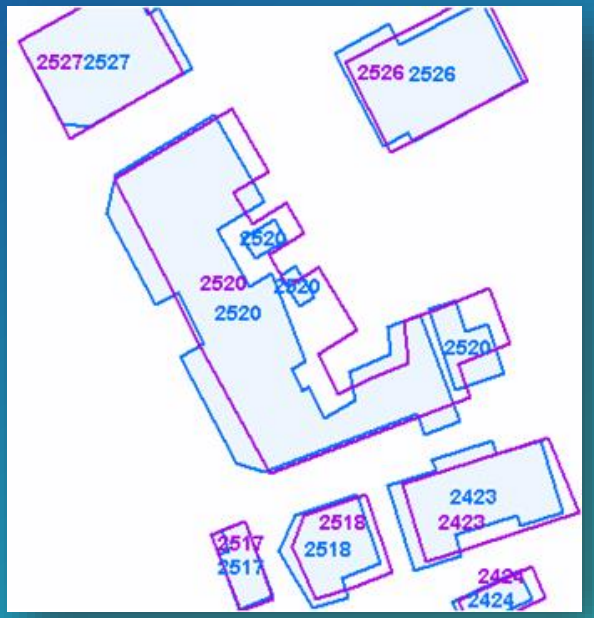
Conflation in multi-scale data updating and mapping

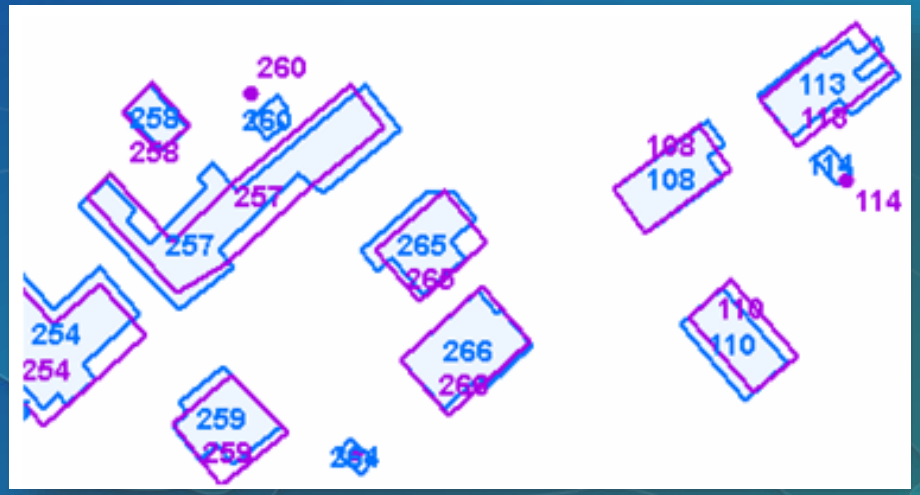
DLM – digital landscape model; DCM – digital cartographic model

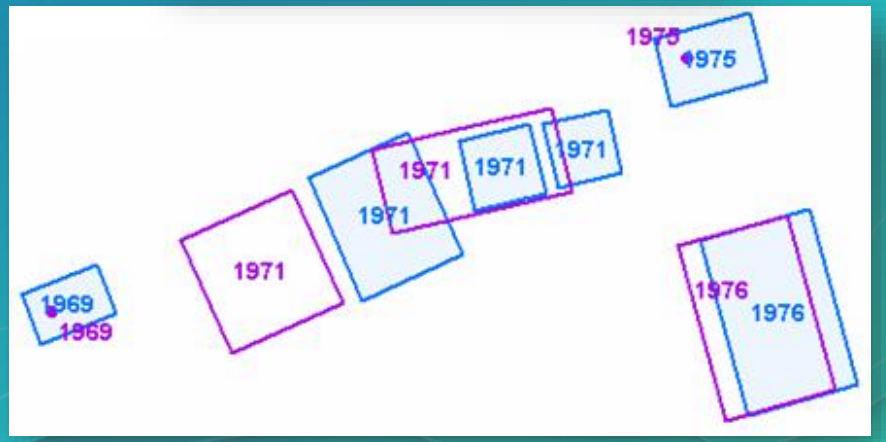


Case study – linking ICGC 1:5k and 1:25k buildings









Recent papers

- Baella B, Lee D, Lleopart A, Pla M (2014) ICGC MRDB for topographic data: first steps in the implementation, The 17th ICA Generalization Workshop, 2014, Vienna, Austria.
  https://kartographie.geo.tu-dresden.de/downloads/ica-gen/workshop2014/genemr2014_submission_8.pdf
- Lee D, Yang W, Ahmed N (2017), Road data conflation – the key step to geospatial data enhancement, The 27th International Cartographic Conference, 2017, Washington DC, USA.
- Lee D (2015), Using Conflation for Keeping Data Harmonized and Up-to-date, ICA-ISPRS Workshop on Generalisation and Multiple Representation, 2015, Rio de Janeiro, Brazil.
  https://kartographie.geo.tu-dresden.de/downloads/ica-gen/workshop2015/genemr2015_submission_8.pdf
- Lee D, Yang W, Ahmed N (2015) Improving Cross-border Data Reliability Through Edgematching, to be presented at The 27th International Cartographic Conference, 2015, Rio de Janeiro, Brazil. http://www.icc2015.org/abstract,670.html
- Lee D, Yang W, Ahmed N (2014) Conflation in Geoprocessing Framework - Case Studies, GEOProcessing, 2014, Barcelona, Spain. http://goo.gl/iOoSGV
- Yang W, Lee D, and Ahmed N, "Pattern Based Feature Matching for Geospatial Data Conflation", GEOProcessing, 2014, Barcelona, Spain. http://goo.gl/JKGJbo

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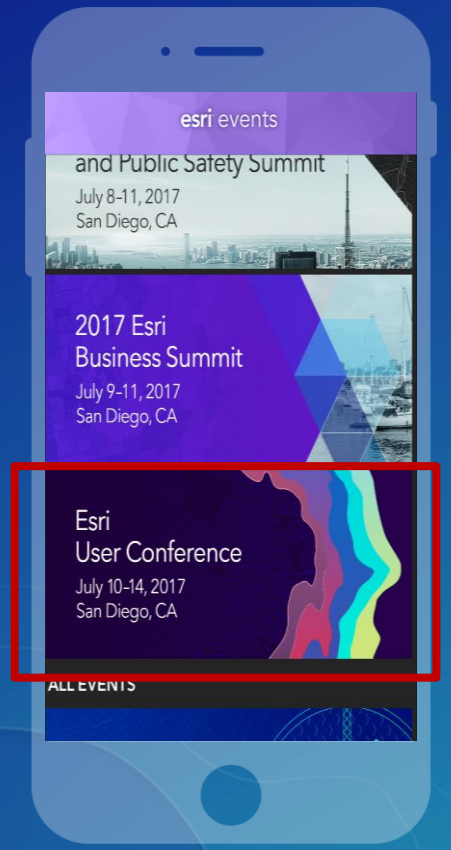

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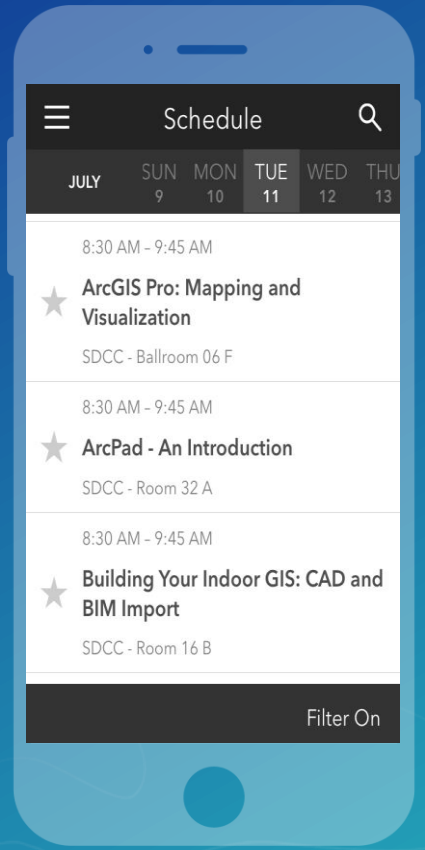

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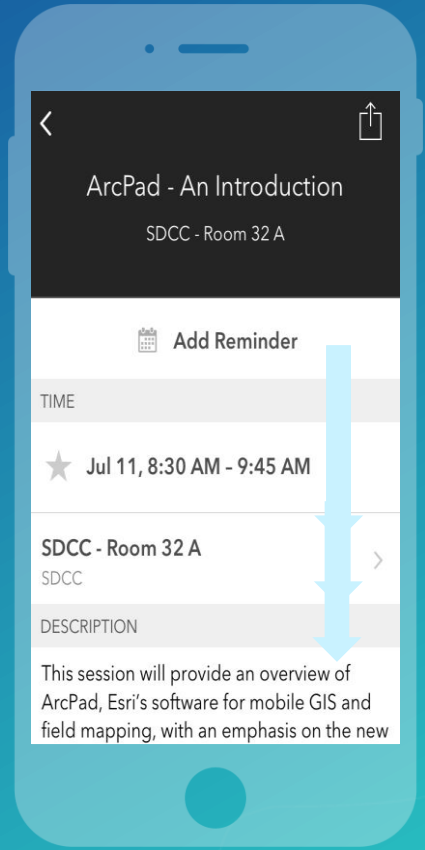

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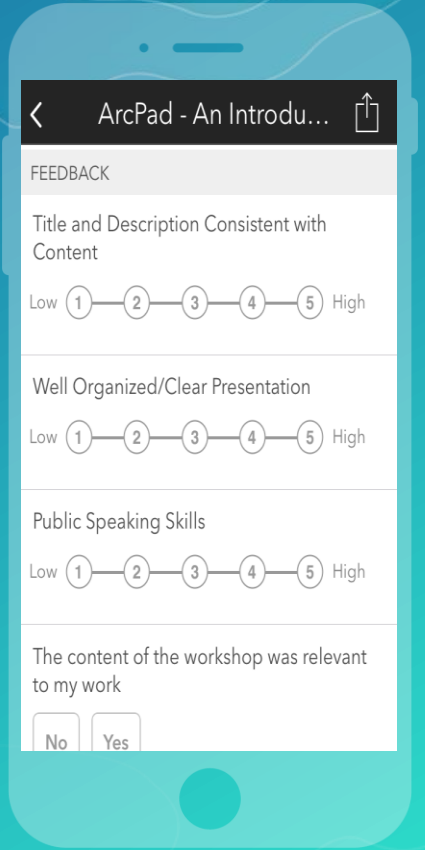

Thank you for attending!

Q & A


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