


Visualization in Automated Traceability

Position Paper

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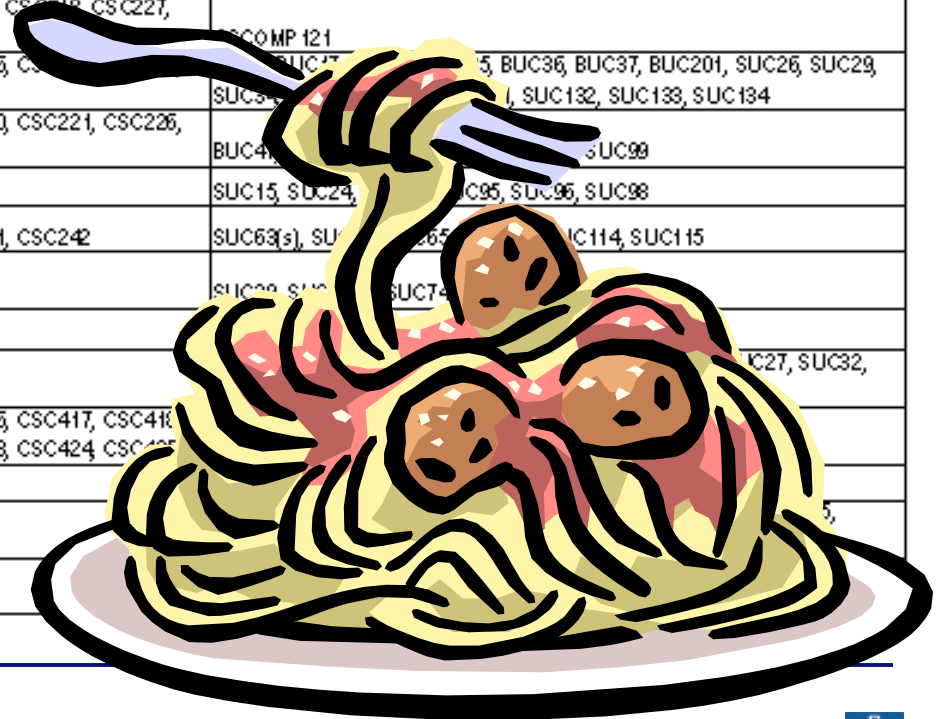
What is Traceability?

► “Requirements traceability is the ability to describe and **follow the life of a requirement**, in both a forward and backward direction, i.e. from its origins, through its development and specification, to its subsequent deployment and use, and through periods of ongoing refinement and iteration in any of these phases.”

Gotel and Finkelstein, 1994.

A Typical Matrix

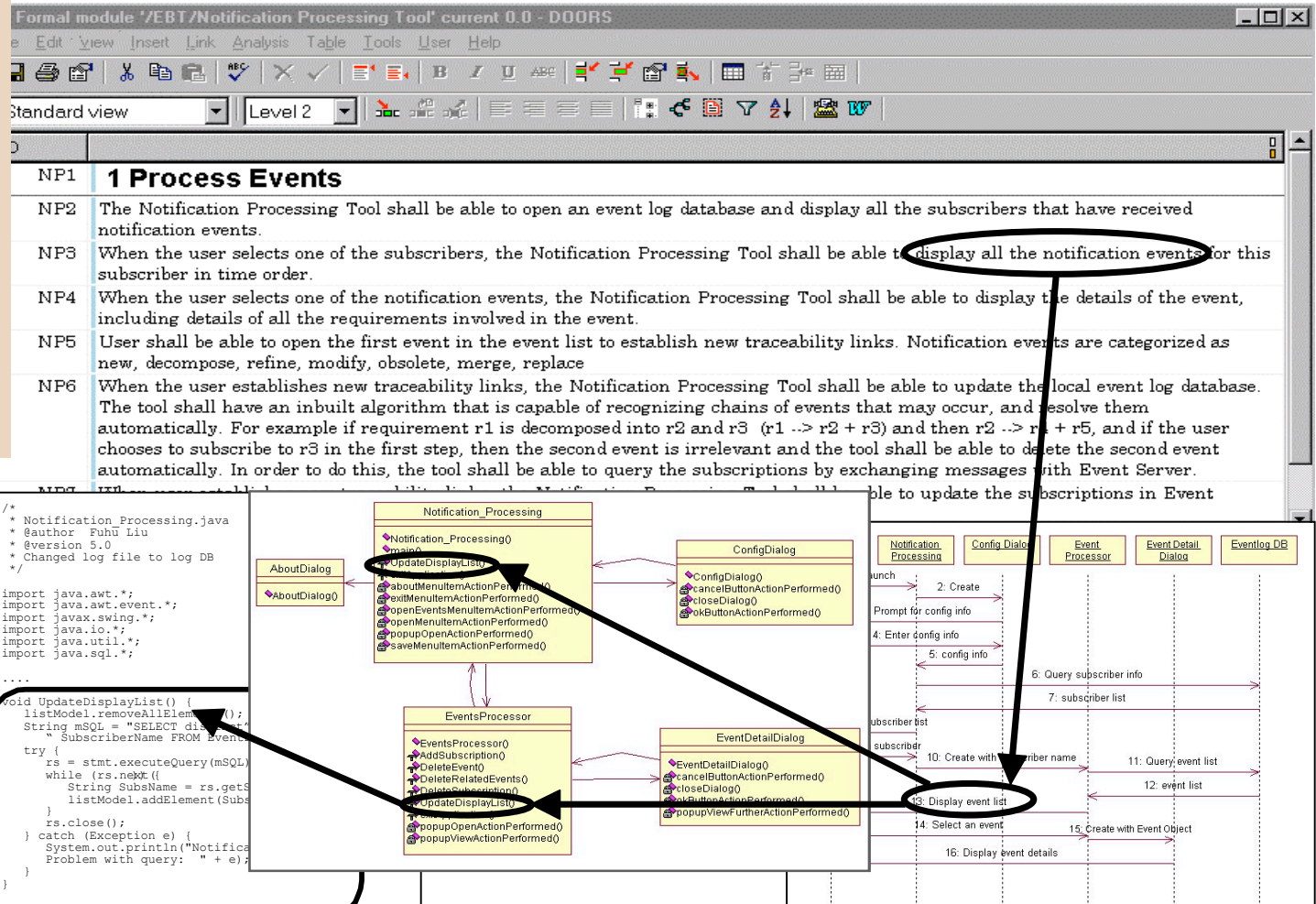
Tag	Name	TracedFrom	Traced-to
SUC101	Filter View in IET Central	CSC396, CSC397, CSC153, CSC154, CSC155, CSC241, CSC297, CSC378, CSC379, CSC380, CSC381, CSC382, CSC383, CSC484	BUC17, BUC18, BUC22, BUC201
SUC107	Change Active Project in MSD	CSC29, CSC40, CSC189, CSC190, CSC191, CSC248, CSC244, CSC302	BUC196, BUC201
SUC111	View Concepts in MSD	CSC44, CSC195, CSC284, CSC387, SUC116, SUC121	BUC17, BUC18, BUC22, BUC201
SUC112	View Drawing in MSD	CSC236, CSC269, CSC338, CSC340, SUC120, SUC121	BUC6, BUC18, BUC23, BUC25, BUC124, BUC125, BUC131, BUC135, BUC145, BUC146, BUC201, BUC202
SUC113	View Material Flow Diagram in IET Central	CSC230, CSC231, CSC242, SUC122	BUC3
SUC114	View Projects in IET Central	CSC298, CSC305, SUC122	BUC17, BUC18, BUC22, BUC201
SUC115	View Properties in IET Central	CSC74, CSC101, CSC102, CSC156, CSC158, CSC218, CSC227, CSC228, CSC300, CSC385, SUC122	COMP121, SUC127, SUC128, SUC129, SUC130, SUC131, SUC132, SUC133, SUC134
SUC116	Manage Concepts in MSD	CSC192, CSC193, CSC194, CSC195, CSC196, CSC283	BUC36, BUC37, BUC201, SUC26, SUC29, SUC132, SUC133, SUC134
SUC117	Manage Concepts in IET Central	CSC216, CSC217, CSC218, CSC219, CSC220, CSC221, CSC226, CSC295, CSC296, CSC297, CSC309	BUC4, SUC99
SUC119	Manage Groups in IET Central	CSC52, CSC54, CSC56	SUC15, SUC24, SUC95, SUC96, SUC98
SUC122	View Objects in IET Central	CSC213, CSC226, CSC227, CSC230, CSC231, CSC242	SUC63(s), SUC265, SUC114, SUC115
SUC123	Manage Collections (Dashboards) in IET Central		SUC29, SUC74
SUC124	Promote Objects in IET Central	CSC75, CSC308, CSC309	C27, SUC32,
SUC125	Manage System Elements in MSD	CSC391	
SUC131	Manage Drawing Content in MSD	CSC412, CSC413, CSC414, CSC415, CSC416, CSC417, CSC418, CSC419, CSC420, CSC421, CSC422, CSC423, CSC424, CSC425	
SUC136	Refresh Drawing in MSD	SUC120	
SUC137	Open Drawing in MSD	SUC120	
SUC138	Check in Drawing in MSD	SUC120	



Dynamic Retrieval of Traces

Query =
Requirement
or Change
proposal

Document =
Retrievable
artifact such
as code, test
case, design
document.



Estimating the Probability of a Link

Frequency of term t_i in respect to the size of the document.

$$\text{prob}(d_j|t_i) = \text{freq}(d_j, t_i) / \sum_k \text{freq}(d_j, t_k)$$

Frequency of term t_i in respect to the size of the query.

$$\text{prob}(q|t_i) = \text{freq}(q, t_i) / \sum_k \text{freq}(q, t_k)$$

$$\text{Prob}(d_j|q) = \frac{\sum_i \text{prob}(d_j|t_i) \text{prob}(q|t_i) \text{prob}(t_i)}{\text{prob}(q)}$$

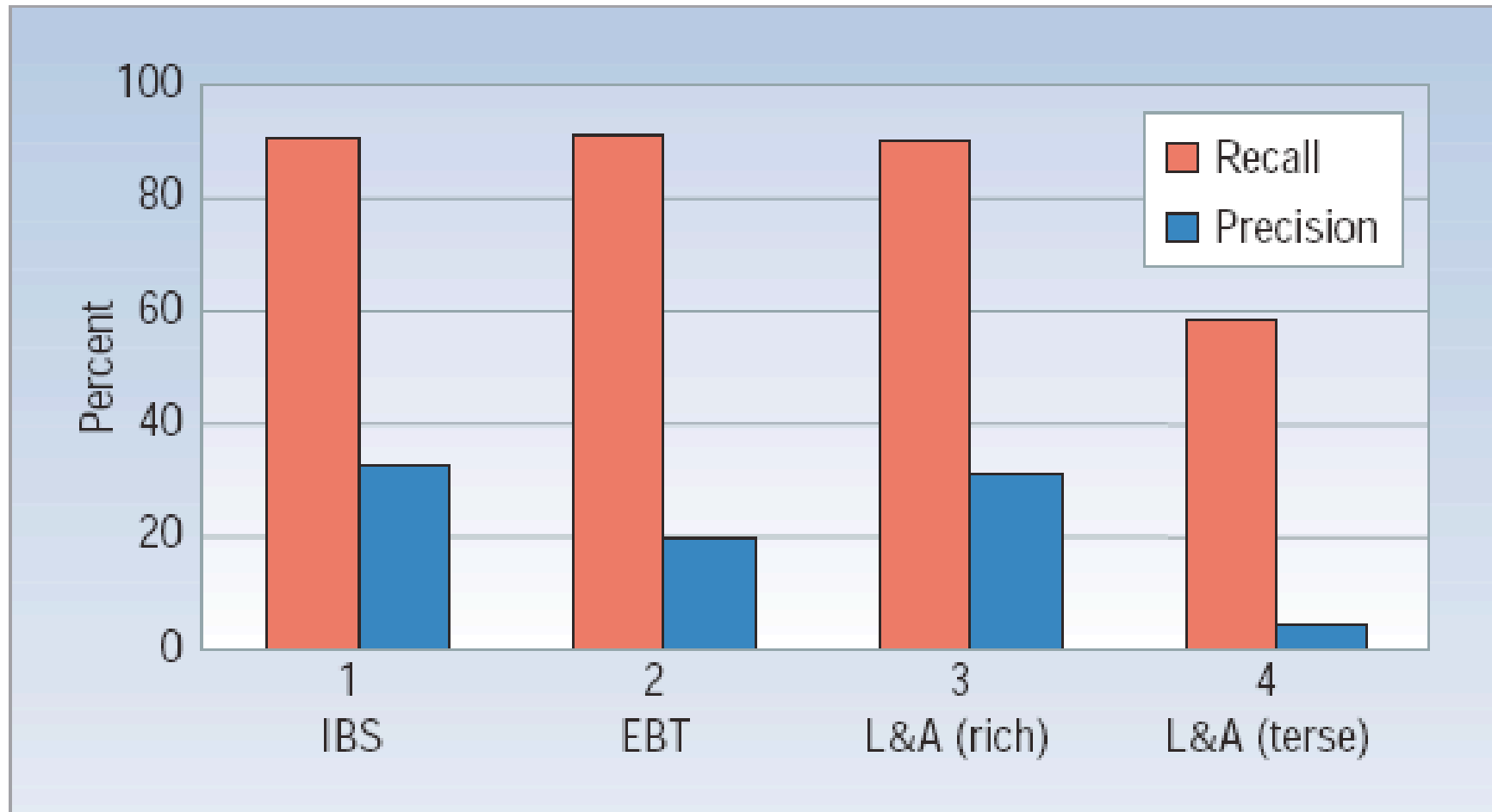
Probability of a link between a query and document.

$$\sum_i \text{prob}(q|t_i) \text{prob}(t_i)$$

Measures the rarity/commonality of the term.
 $\text{prob}(t_i) = \eta(1/n_i)$
where $n_i = \#$ of docs containing t_i .
 η = normalizing factor

tf-idf: term frequency–inverse document frequency

Overview of results



Poirot: *TraceMaker*

[Open Project](#)[Query](#)[Administrative Tools](#)[Resources](#)[Help](#)

IDLG Sqlserver

Query:

Trace requirement # 9014 " Data received from weather stations shall be updated regularly"

Enter Document ID :

Find

Report

<<>> **Class Diagram**

CANDIDATE LINKS

UNLIKELY LINKS

1 - 10 of 21 [Next](#) [Last](#)

Document ID:	Document Description:	Confidence Level	Accept
138	Receive shipment	<div><div></div><div></div><div></div><div></div><div></div></div>	<input type="checkbox"/>
83	FailedWeatherStationGUI (379)	<div><div></div><div></div><div></div><div></div><div></div></div>	<input type="checkbox"/>
12	Weather Station Manager	<div><div></div><div></div><div></div><div></div><div></div></div>	<input checked="" type="checkbox"/>
3	Weather Station Directory		
6	Weather Station Input Proxy		
53	Scheduler (308)		
5	Weather Station GUI		
9	Weather Station Maintenance		
7	Weather Station Report		
119	DatabaseManager (313)		

1 - 10 of 21 [Next](#) [Last](#)

Export Data

Visualize

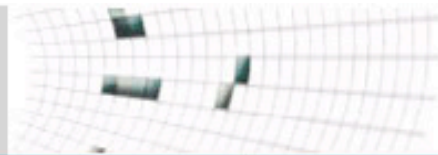
Class Diagram for Weather Station Manager - Microsoft I...

File Edit View Favorites Tools Help

```
WeatherStation Manager 375
get WeatherStation ID ( )
set WeatherStation ID ( WeatherStation ID )
check Station Transmissions ( )
issue Transmission Alert ( )
All stations functioning ( )
```



Poirot : *TraceMaker*

[Project](#)[Query](#)[Artifacts](#)[Options](#)[Help](#)[IBS > Query > Report](#)**Query : Document ID # 12**

"Temperature, wind chill, and precipitation data will be received from external weather stations and roadside sensors."

Dominant Cluster

Cross-cutting Cluster

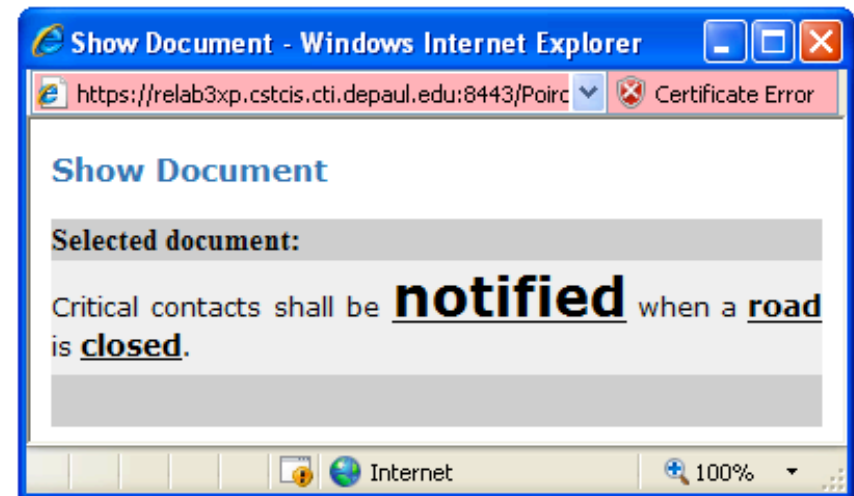
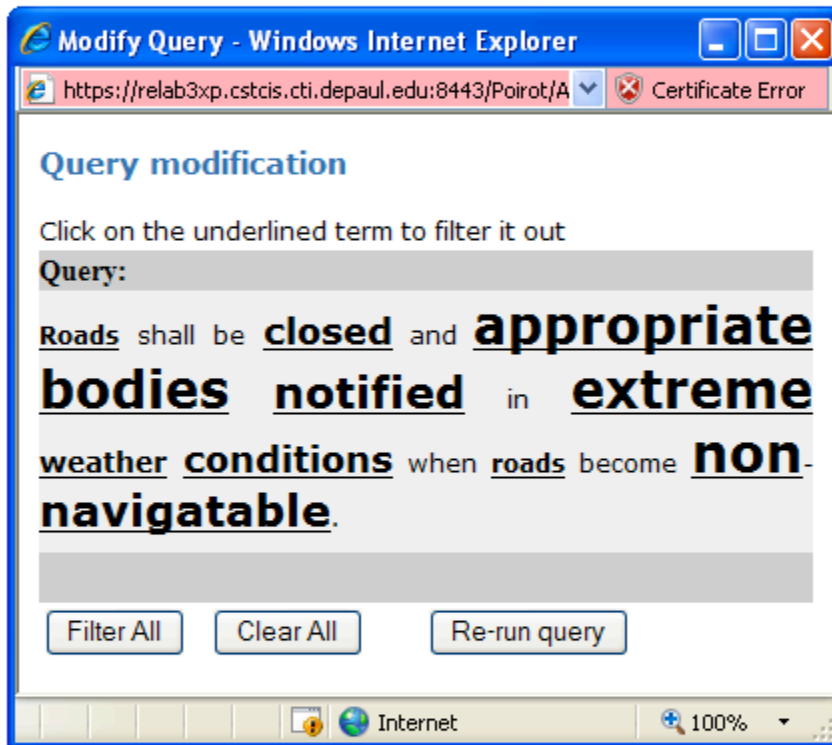
ID :

 Find[Next](#) [Last](#)

Document ID:	Document Description:	Confidence Level:	Accept
⊕ Temperature readings			
⊖ Updates			
9404	Road maps shall be updated by importing data from an external source.	<div><div></div><div></div><div></div><div></div><div></div></div>	<input type="checkbox"/>
9016	Data received from the road sensors shall be updated regularly	<div><div></div><div></div><div></div><div></div><div></div></div>	<input checked="" type="checkbox"/>
9012	Weather forecasts shall be updated as received by the weather bureau.	<div><div></div><div></div><div></div><div></div><div></div></div>	<input type="checkbox"/>
9140	When new road sensors are added, the thermal map shall be updated to reflect the new weather data.	<div><div></div><div></div><div></div><div></div><div></div></div>	<input type="checkbox"/>
9007	Weather forecast update	<div><div></div><div></div><div></div><div></div><div></div></div>	<input type="checkbox"/>

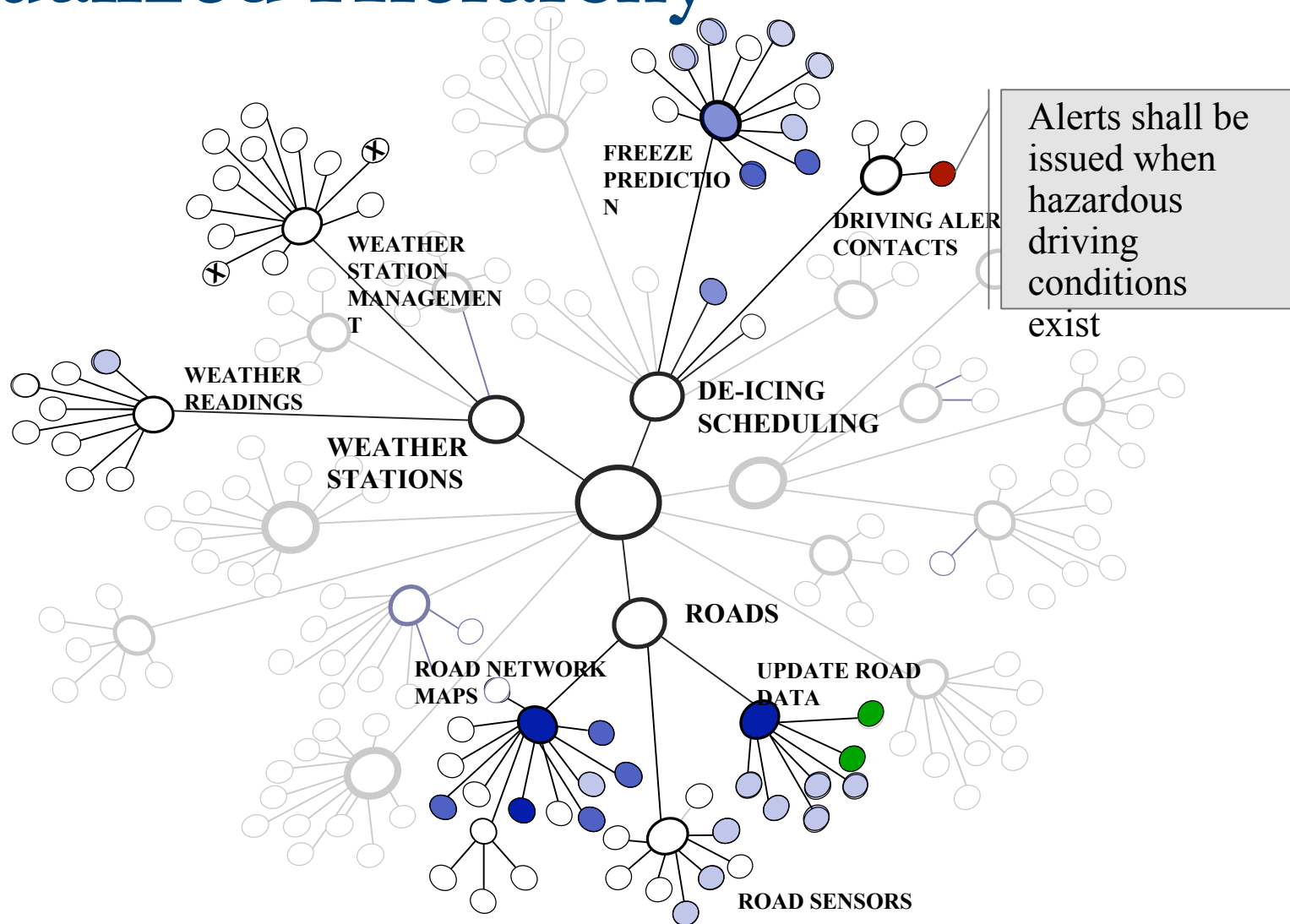
[Show Context](#)[Select All](#)[Clear All](#)⊕ [Transmission](#)⊕ [Weather data](#)[Next](#) [Last](#)[Export Data](#)[Save](#)[Report](#)

Tag Clouds



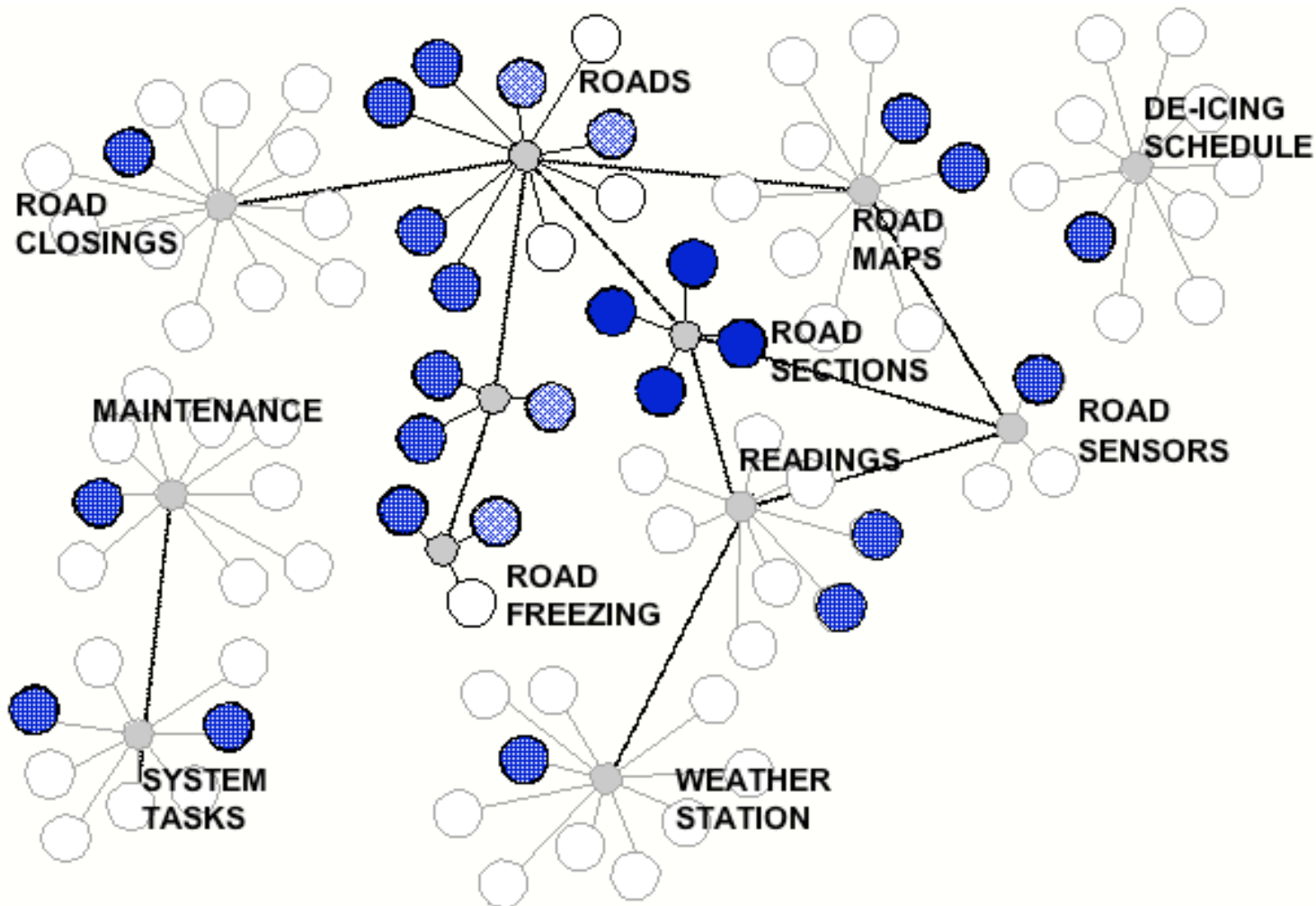
- ▶ Help analyst to understand WHY a link was generated.
- ▶ Help with filtering decisions.

Visualized Hierarchy



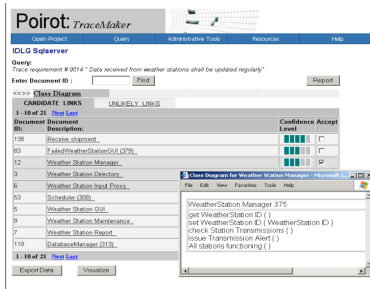
● Candidate link ● Accepted link ● Current link ⊕ Rejected link

Visualized Clusters

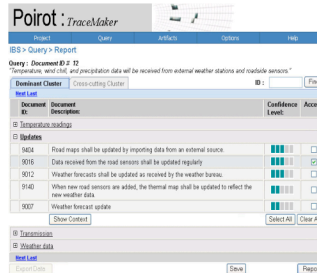


Which do you prefer?

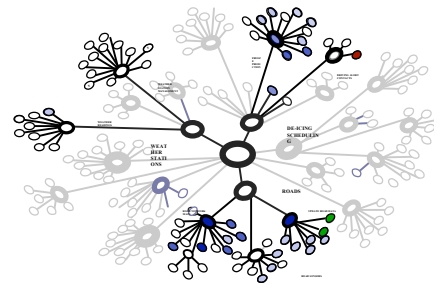
- ▶ You are the users and you have to ‘vote’ for which method you think would best support analysis of traces.
- ▶ Vote for your favorite.



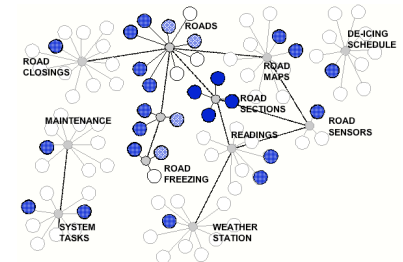
Traditional



Clustered-text



Physical hierarchy



Visual clusters

More seriously

- ▶ Usability study planned that utilizes eye-tracker technology to try and understand which approach best supports analysts in their traceability tasks.
 - ▶ These visualizations are as yet untested but may provide means to help analysts filter lists of candidate links, and interpret trace results.
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