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3^e Giornate Triestine Utenti di gvSIG

L'analisi di RETI con gvSIG

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Introduzione

- La *network extension* [1] è un'estensione di gvSIG [2] dedicata all'analisi spaziale basata su reti
- Consente di affrontare e risolvere problemi quali:
 - ♦ il cammino minimo tra due o più punti
 - ♦ il problema del commesso viaggiatore (TSP) [*]
 - ♦ l'individuazione di aree di influenza/servizio
 - ♦ la ricerca della risorsa più vicina
 - ♦ la definizione della matrice origini-destinazioni
 - ♦ l'albero ricoprente minimo
 - ♦ l'analisi di connettività

[1] <http://www.gvsig.gva.es/eng/gvsig-desktop/desk-extensiones/network-extension>

[2] <http://www.gvsig.gva.es>

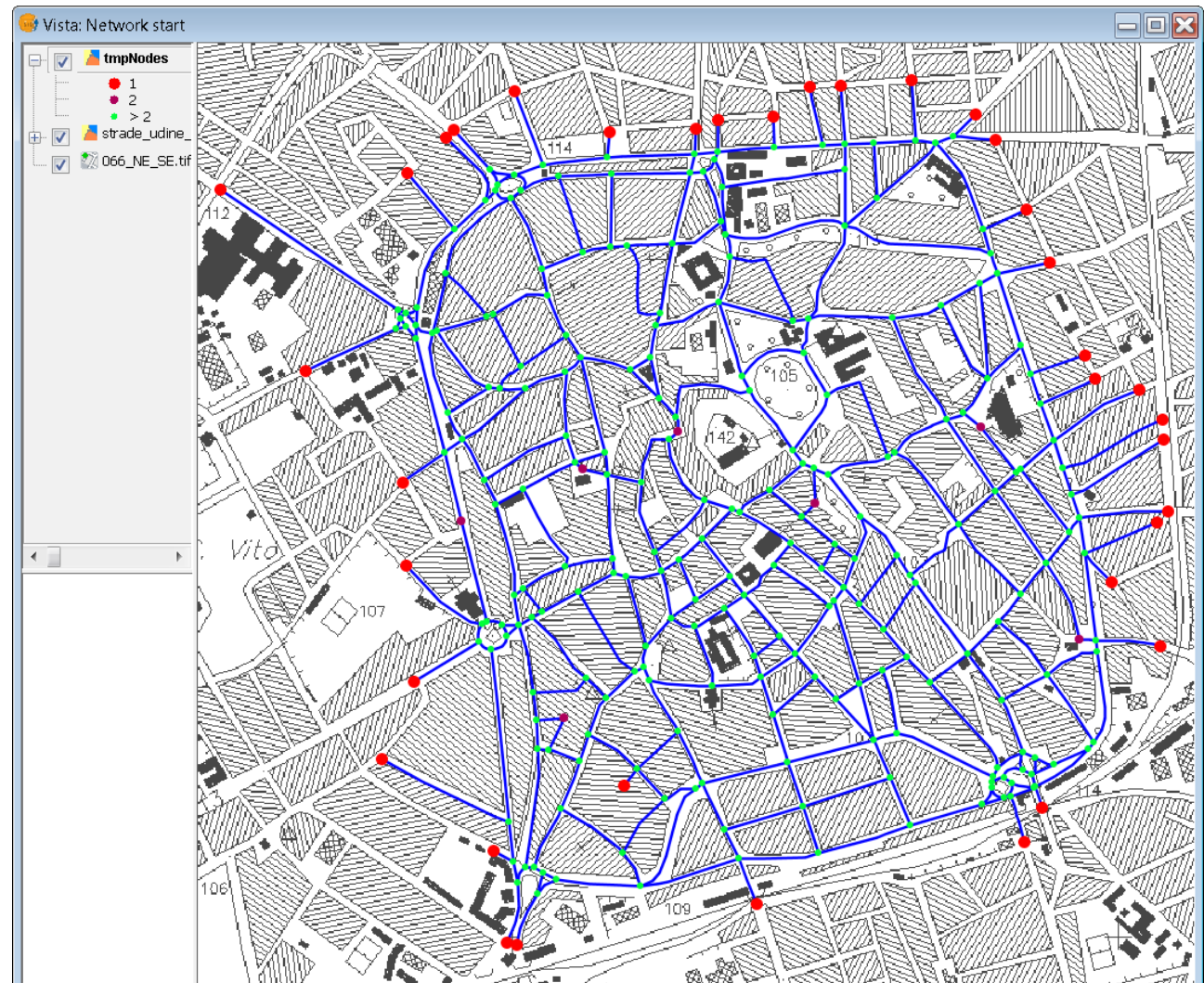
[*] non presentato in questa sede

Introduzione

- Riguarda l'analisi dei flussi su reti (*network*), rappresentate come una serie di elementi lineari (archi) e punti (nodi) interconnessi tra loro
- Queste reti spesso rappresentano oggetti come strade, ferrovie, fiumi, ecc. ma anche infrastrutture elettriche, fognarie, di distribuzione, ecc.; i nodi rappresentano tipicamente i punti di arrivo o di prelievo dei beni, i clienti del servizio, le valvole di flusso degli impianti, ecc.; persone, veicoli, acqua, gas, ecc. scorrono attraverso i nodi lungo gli archi della rete
- Gli archi e i nodi determinano come si comportano i flussi: ad esempio, alcuni archi possono consentire il flusso solo in una direzione e con un limite di velocità mentre alcuni nodi possono presentare dei vincoli al passaggio in certe direzioni
- L'analisi spaziale basata su reti aiuta quindi ad analizzare i "costi" (distanza, tempo, denaro, ecc.) di spostamento attraverso la rete stessa

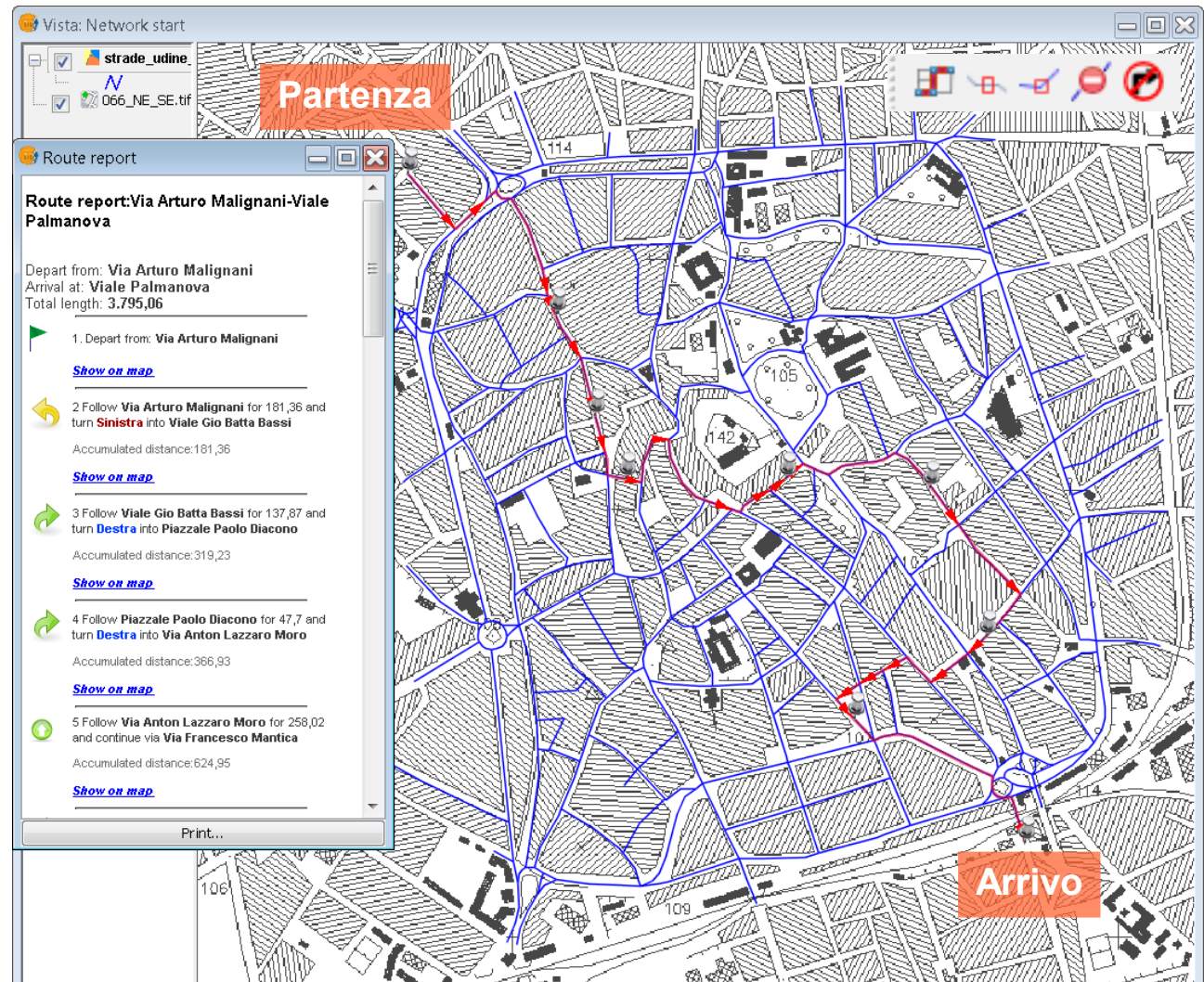
La creazione della topologia della rete

- L'estensione richiede un layer di elementi lineari da cui generare la topologia della rete
- La creazione della rete può avvenire per coordinate esatte o determinando la corrispondenza dei nodi all'interno di un intervallo di tolleranza
- Principali parametri impostabili sugli archi per la costruzione e la successiva ricerca sul grafo:
 - ◆ tipologia (codifica associabile, ad esempio, alla velocità di percorrenza)
 - ◆ lunghezza
 - ◆ costo di percorrenza (lunghezza, tempo, ecc.)
 - ◆ direzione di percorrenza (concorde o discorde alla digitalizzazione)



Il cammino minimo tra due o più punti

- Questa funzionalità trova applicazione nella ricerca automatica di percorsi tra diverse localizzazioni fisiche, quali i classici problemi di “navigazione” stradale
- I vincoli sul percorso (partenza/passaggio/arrivo) possono essere specificati sia sui nodi che sugli archi della rete
- La ricerca del cammino minimo impiega algoritmi classici di risoluzione
- Viene generato anche un “foglio di viaggio” che consente di seguire il cammino minimo attraverso una lista *turn by turn*



Il cammino minimo tra due o più punti

- È possibile inserire “barriere” sulla rete per rappresentare archi della stessa che devono essere evitati
- È possibile specificare “turn cost” (“costi di svolta”) sui nodi della rete per rappresentare differenti criteri di scelta negli archi da percorrere (es. il più veloce da imboccare, quello con il minore angolo di svolta)
- È possibile assegnare velocità di percorrenza diverse alle differenti tipologie di archi della rete
- I risultati possono essere resi persistenti salvandoli in *layer* fisici (es. *shapefile*)

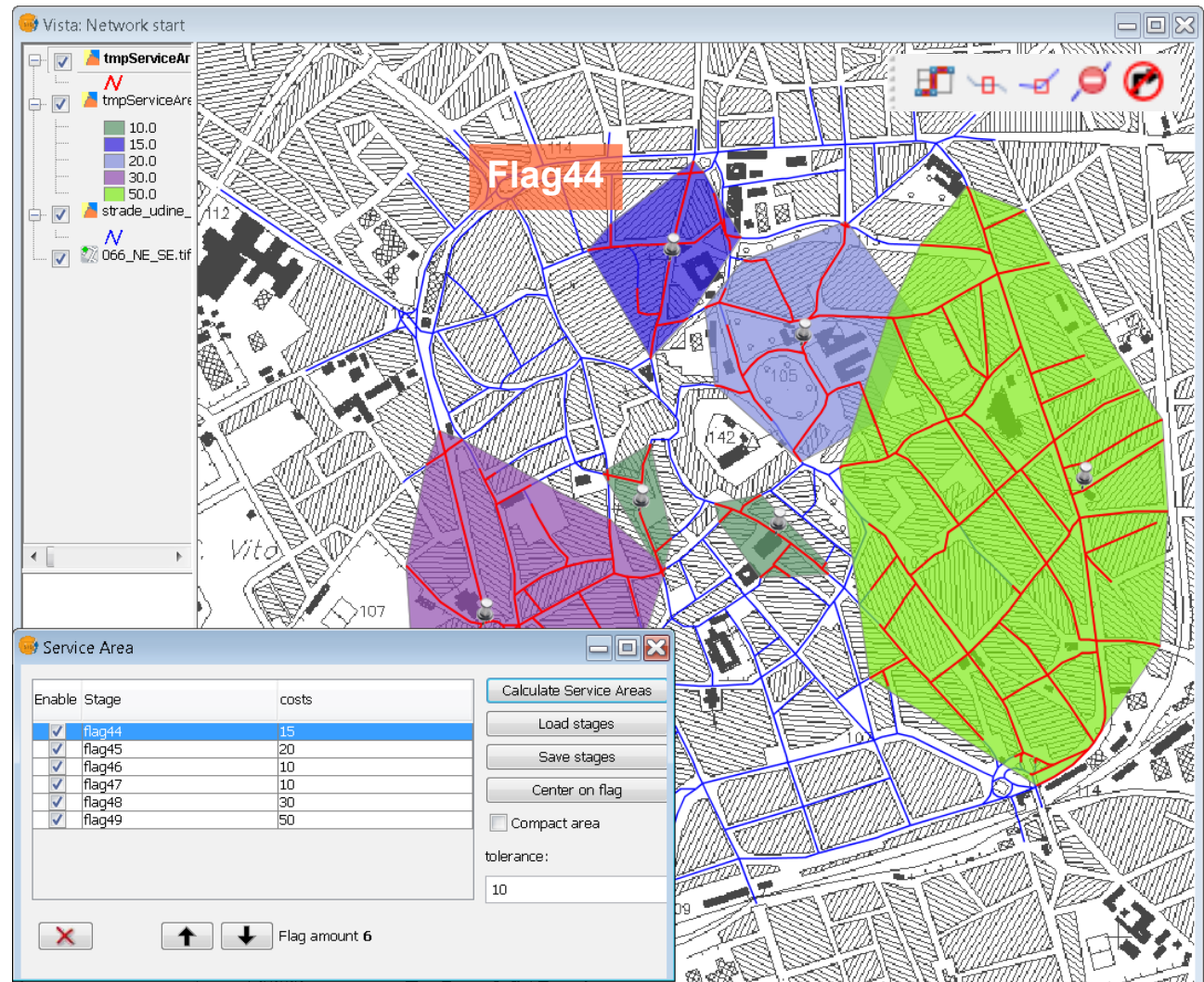
The screenshot shows the 'Route control panel' window with the following data:

Enable	Stage	Cost
<input checked="" type="checkbox"/>	flag27	0
<input checked="" type="checkbox"/>	flag28	672,307
<input checked="" type="checkbox"/>	flag29	1.318,205
<input checked="" type="checkbox"/>	flag30	1.514,145
<input checked="" type="checkbox"/>	flag31	2.135,995
<input checked="" type="checkbox"/>	flag32	2.554,685
<input checked="" type="checkbox"/>	flag33	3.162,092
<input checked="" type="checkbox"/>	flag34	3.691,957
<input checked="" type="checkbox"/>	flag35	4.370,017

Additional controls in the panel include: Total route cost: 4.370,02; buttons for Load stages, Save stages, Save route, Center on flag, Set speeds; tolerance: 10; checkboxes for Order Stops and Return to origin.

L'individuazione di aree di influenza/servizio

- Questa funzionalità permette di determinare aree di influenza/servizio a partire da punti della rete in base a costi di percorrenza specificati
- Trova applicazione, ad esempio, in analisi di *geomarketing* o per valutare l'accessibilità di servizi sul territorio
- È possibile assegnare costi di percorrenza differenti ai diversi punti di valutazione ed inserire "barriere"
- I risultati includono sia gli archi della rete percorribili entro i parametri di costo specificati che le aree sottese (eventualmente "compattate" su tutti gli archi percorribili)



La ricerca della risorsa più vicina

- Questa funzionalità permette di trovare la risorsa più vicina ad un punto della rete (evento) sulla base dei costi dei percorsi di tutte le coppie evento-risorse
- Trova applicazione, ad esempio, nella pianificazione delle risorse in situazioni di emergenza o di incidente
- È possibile specificare un numero massimo di risorse su cui effettuare la ricerca e un limite di costo per i percorsi
- È possibile determinare il percorso *da/per* l'evento *verso/a partire* dalla risorsa più prossima
- I risultati includono i percorsi individuati e i “fogli di viaggio” di tali percorsi

The screenshot shows the 'Closest facility' dialog box in gvSIG. The map background displays a network of roads with a red dot labeled 'Evento' and several blue dots labeled 'Risorsa'. Green arrows indicate routes from the event to the resources. The dialog box has the following sections:

Facilities: chiese_udine_centro.... (Only use the selected points checkbox is unchecked)

Number of facilities to search: 6

Maximum limit of cost: <units>

Events: Route to the event (unchecked), Route from the event (checked)

Id	Description
0	flag13

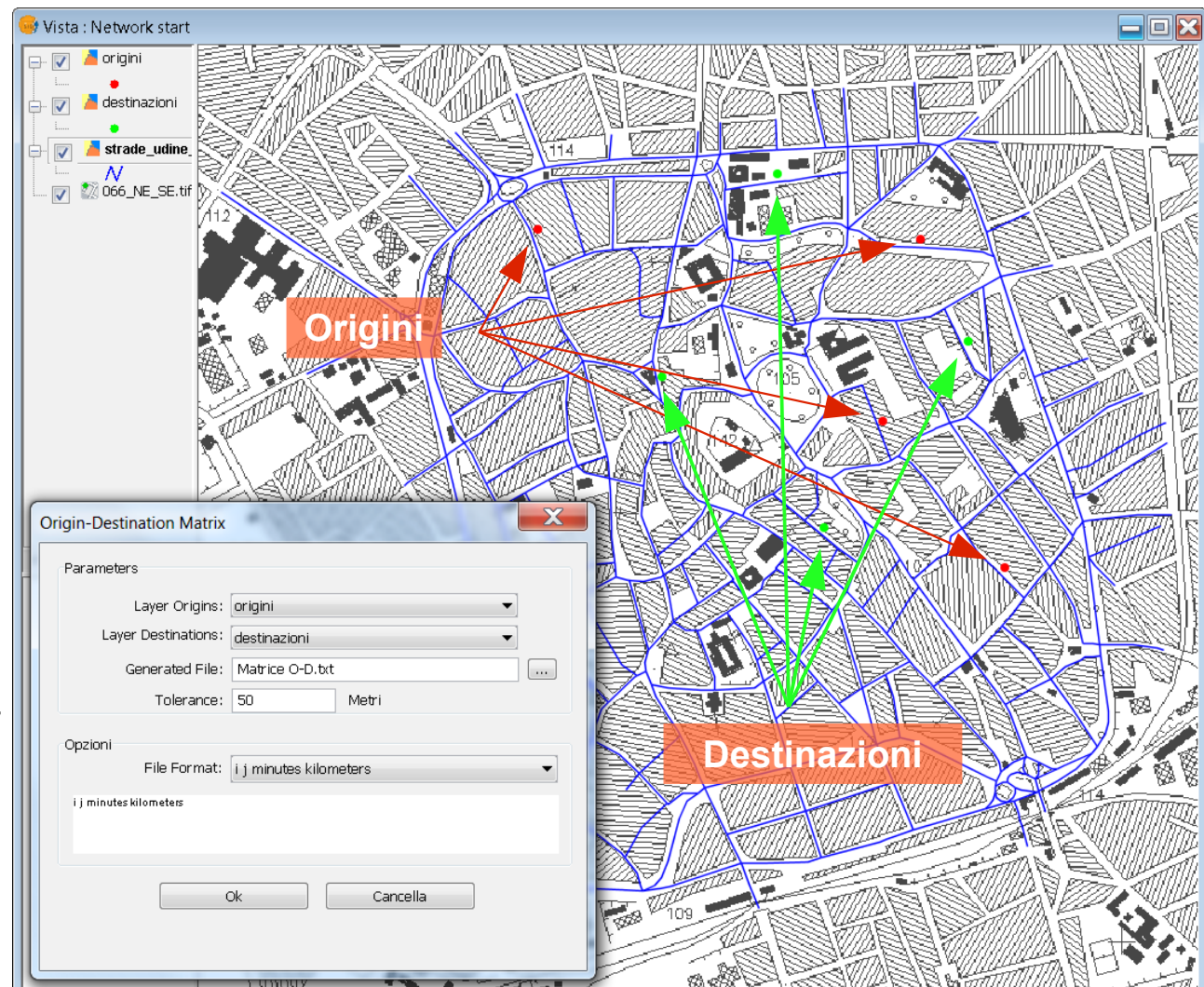
Solution:

Facility position	Description	Cost
1	Facility 4	584,259
2	Facility 3	605,616
3	Facility 2	666,471
4	Facility 1	946,962
5	Facility 5	1.154,419
6	Facility 0	1.338,079

Buttons: Instructions, Draw the route, Zoom to route, Solve

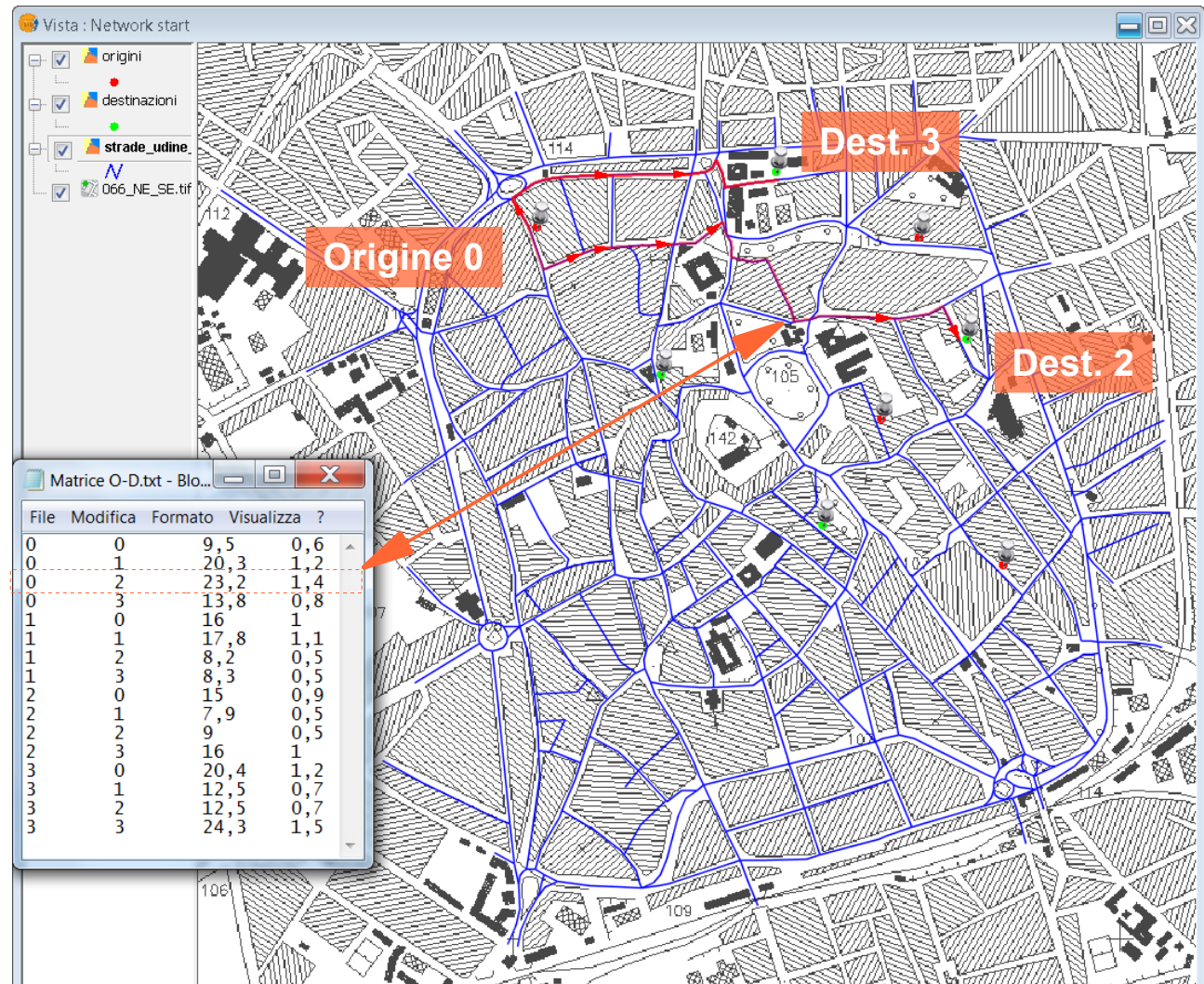
La definizione della matrice origini-destinazioni

- Questa funzionalità permette di calcolare i costi di percorrenza tra tutte le coppie di punti *Origine* di un insieme e di punti *Destinazione* di un secondo insieme
- Viene impiegata, ad esempio, per l'analisi dei flussi di traffico, per stime della domanda di mobilità, ecc.
- È possibile definire i punti che partecipano all'analisi entro una distanza di tolleranza dagli archi della rete
- Per il calcolo dei tempi di percorso, è possibile stabilire le velocità di percorrenza per le differenti tipologie di archi della rete



La definizione della matrice origini-destinazioni

- Il risultato è una matrice che, per ogni coppia di punti *Origine-Destinazione* valida, attribuisce il tempo di percorrenza (in base alla velocità assegnata alla tipologia di arco) e la relativa distanza sulla rete
- I percorsi possono essere visualizzati attraverso la ricerca del cammino minimo tra due punti



L'albero ricoprente minimo

- Questa funzionalità consente di selezionare gli archi che formano un albero ricoprente minimo a partire da punti predefiniti della rete (con costi di percorrenza massimi specificati)
- Viene impiegato, ad esempio, per creare configurazioni di rete a costo minimo collegando tutti i nodi con un solo percorso a partire da un'origine comune (es. pianificazione di infrastrutture a rete)
- È possibile specificare un insieme di punti da cui calcolare l'albero ricoprente minimo ed inserire "barriere"
- I risultati includono i costi cumulativi a partire da ciascuna origine specificata

Input

Please, input max cost to calculate Minimum Spanning Tree:

350

OK Annulla

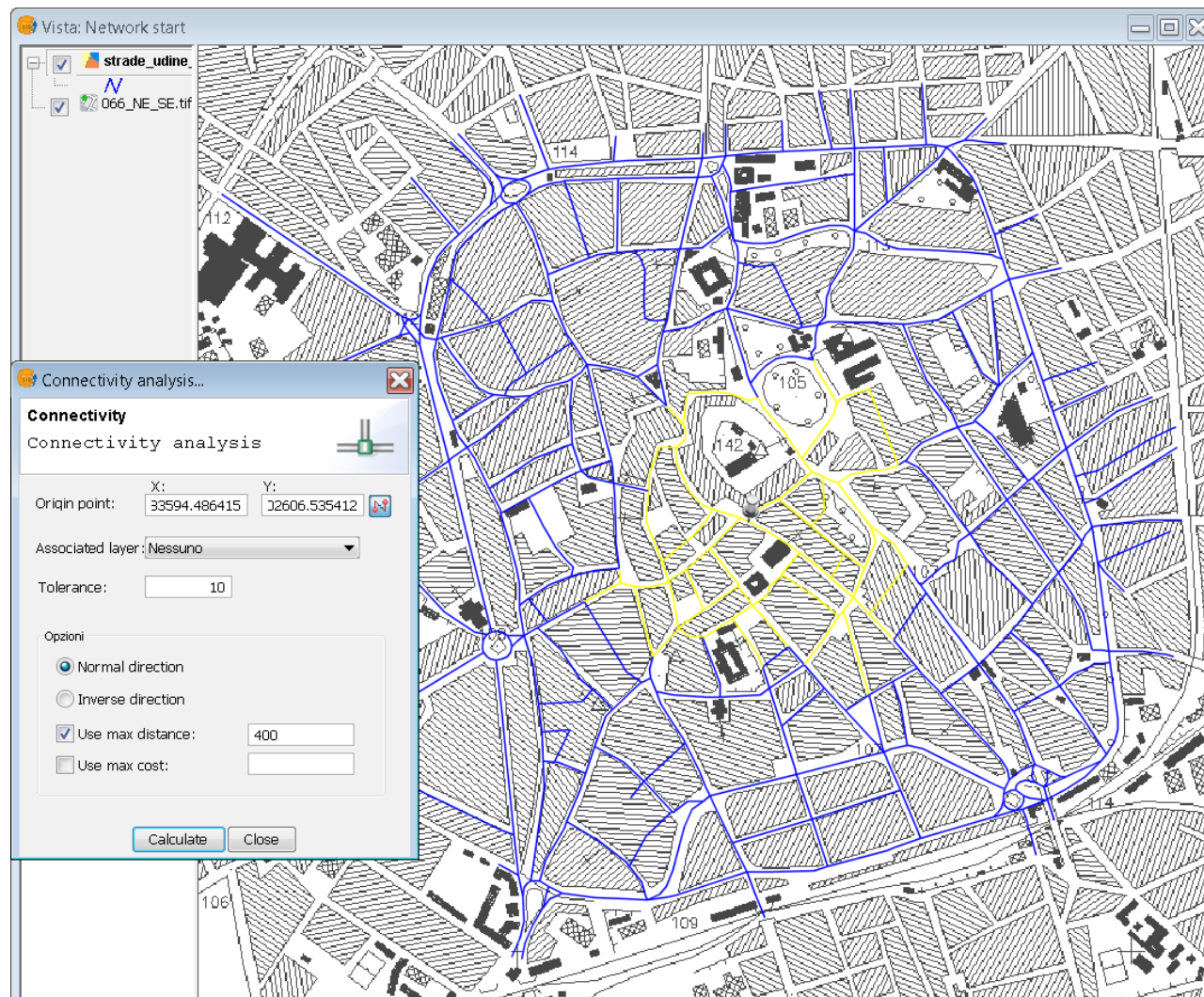
Tabella: Tabella degli attributi: MST_tmpShp17.shp

IDARC	IDEDGE	COSTORIG	DISTORIG	COSTEND	DISTEND	IDFLAG
799	799	0.0	0.0	29.72133	29.72133	0.0
797	797	0.0	0.0	39.74066	39.74066	0.0
202	202	39.74066	39.74066	79.87174	79.87174	0.0
153	153	29.72133	29.72133	137.95563	137.95563	0.0
630	630	79.87174	79.87174	193.22595	193.22595	0.0
157	157	137.95563	137.95563	203.85737	203.85737	0.0
204	204	39.74066	39.74066	219.19081	219.19081	0.0
256	256	29.72133	29.72133	225.539	225.539	0.0
407	407	79.87174	79.87174	308.85451	308.85451	0.0
483	483	203.85737	203.85737	314.1406	314.1406	0.0

1 / 37 Totale registri selezionati.

L'analisi di connettività

- Questa funzionalità verifica se una rete è connessa a partire da un nodo prescelto
- Viene impiegata, ad esempio, per valutare la "robustezza/vulnerabilità" di una configurazione che varia nel tempo
- È possibile limitare l'analisi ad un valore massimo di distanza o di costo
- È possibile estendere la ricerca ad un *layer* di punti associati connessi alla rete (utile, ad esempio, per valutare un taglio del grafo)
- È possibile eseguire la ricerca in ordine diretto o inverso (utile, ad esempio, in una rete di distribuzione per trovare la valvola più prossima da chiudere in modo da eliminare una perdita)



Conclusioni

- La *network extension* è un'estensione di gvSIG che si inserisce in un settore dominato da soluzioni commerciali e proprietarie
- Impiega algoritmi di risoluzione "classici", ben conosciuti e largamente utilizzati per la risoluzione di problemi sulle reti
- Adattabile a soluzioni verticali nell'ambito del *geomarketing*, logistica, gestione di infrastrutture a rete, gestione delle emergenze, ecc.
- Attualmente è disponibile come versione "stabile"

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