University of Applied Sciences and Arts Northwestern Switzerland
School of Architecture, Civil Engineering and Geomatics

Carolin Bronowicz (carolin.bronowicz@fhnw.ch)
Susanne Bleisch (susanne.bleisch@fhnw.ch)

# Radial network visualization

## Linking spatial and non-spatial networks in a connected circular layout

### Introduction

Networks are widely used to visualize relationships between entities, most often through force-directed or hierarchical layouts. In many real-world applications, however, both spatial and non-spatial entities need to be represented simultaneously. While spatial entities can be positioned directly on maps, integrating non-spatial elements remains challenging. Arbitrary placement risks distorting spatial perception, while separating views typically requires carefully designed transitions [1] to preserve interpretability. As a result, achieving a coherent visualization that combines spatial and non-spatial networks remains difficult across domains such as built environments, infrastructure systems, and both physical and intangible networks.

BioFabric is a network visualization technique in which nodes are depicted as parallel horizontal lines and edges as vertical connections between them (see Figure 1). Unlike traditional node–link diagrams, which often suffer from edge crossings and visual clutter in large networks, BioFabric minimizes overlap by assigning each node a dedicated row [2].

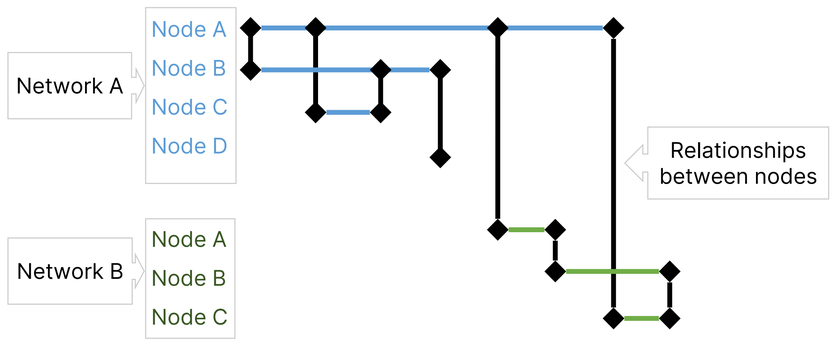


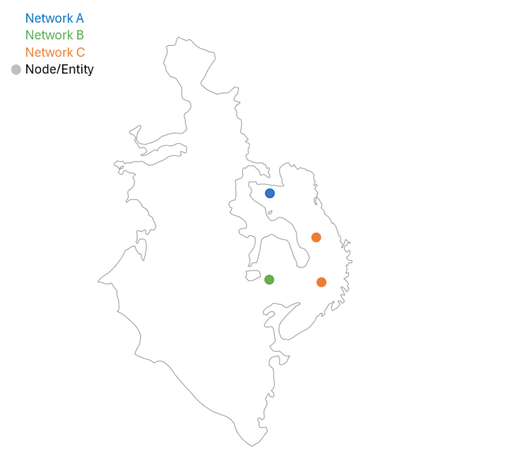

Figure 1: A schematic example of a BioFabric representation of two networks with different numbers of nodes and connections within and outside the networks. Based on [2].

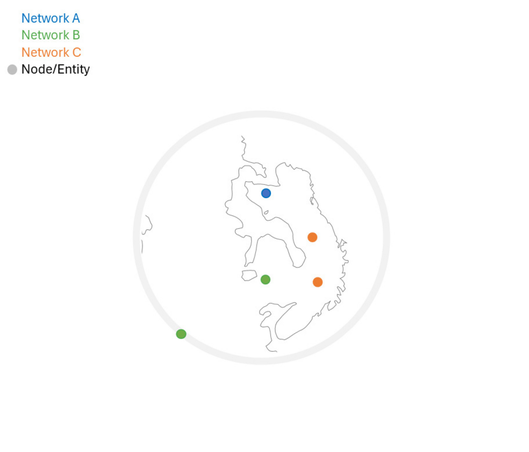
We introduce a coherent visualization approach that integrates spatial and non-spatial entities from multiple networks within a single view. The method employs a radial layout centered on a map: spatial entities preserve their geographic positions, while non-spatial entities are arranged along a circular outer boundary. This concept builds on structured node layouts such as BioFabric by extending nodes into radial leading lines, maintaining a systematic representation of relationships. Connections are encoded as circular arcs distributed across concentric layers, with markers indicating linkages, thereby reducing overlap and enhancing readability.

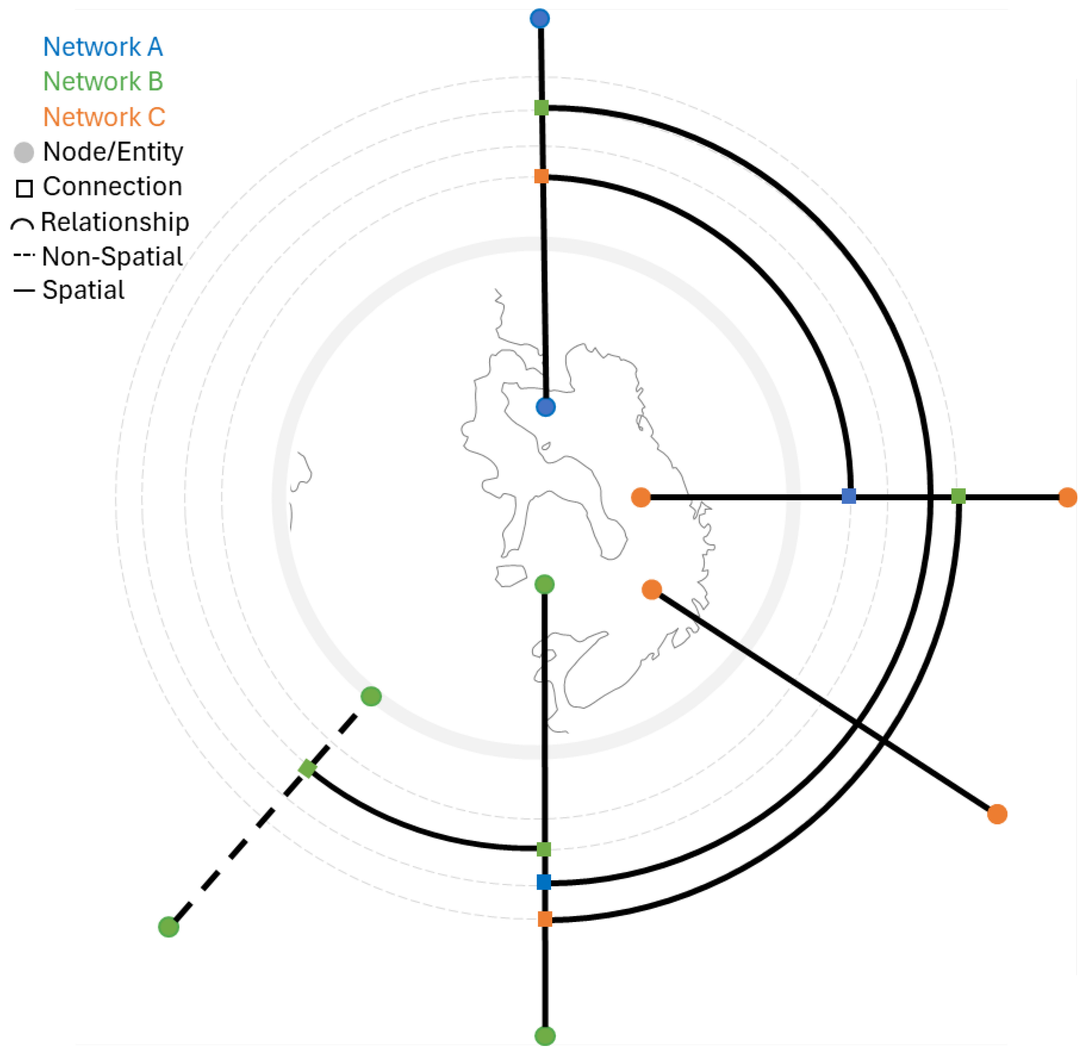
### Concept

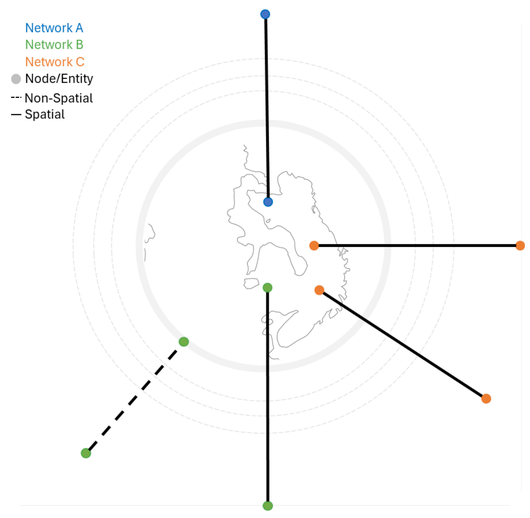
**1)** A bounded spatial region (e.g., map) defines the geographic frame with spatial nodes placed by their coordinates.

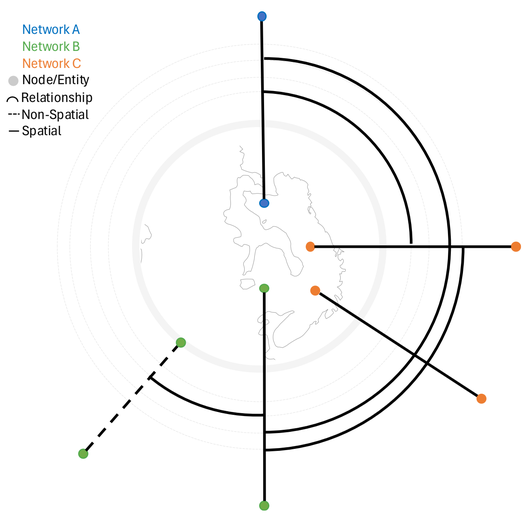
**2)** Non-spatial nodes are placed and evenly distributed along a circular boundary.



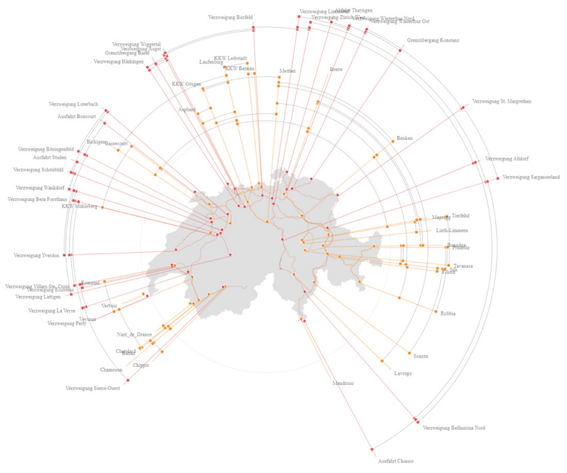

**3)** From all nodes, radial leader lines extend outward and encode connectivity through markers that indicate the presence, number, and type of relationships.

**4)** Connections are drawn as continuous curves combining radial segments and multiple circular arcs for clear separation, centered on the global origin.

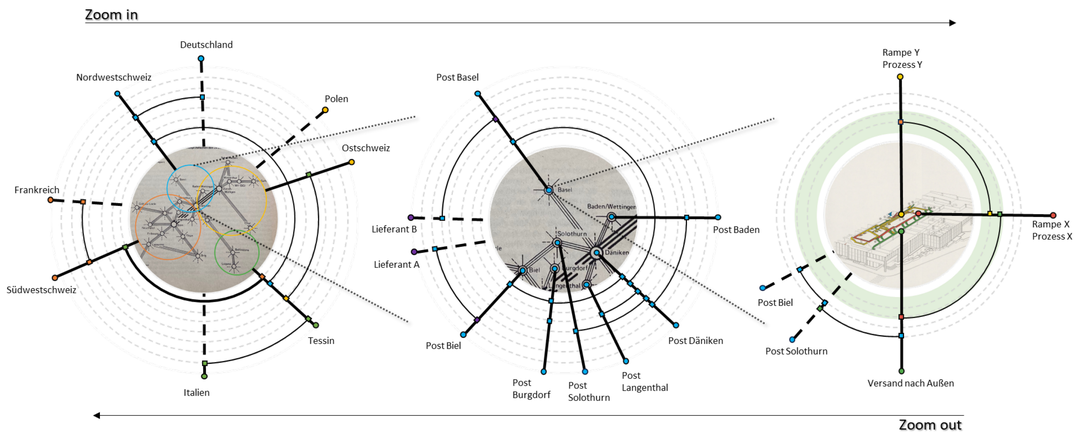
**5)** Crossings without connections remain identifiable due to missing markers, and isolated nodes are recognizable by the absence of markers along their leaders.

### Implementation

See implemented prototypes:
https://go.fhnw.ch/kUXoUD



### Next steps

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**References**
[1] Tominski, C., Andrienko, G., Andrienko, N., Bleisch, S., Fabrikant, S., Mayr, E., Miksch, S., Pohl, M., Skupin, A., (2021) Toward Flexible Visual Analytics Augmented through Smooth Display Transitions. Visual Informatics, 28–38. ISSN: 2468-502X. DOI: 10.1016/j.visinf.
[2] Longabaugh, W. J. (2012). Combing the hairball with BioFabric: A new approach for visualization of large networks. *BMC Bioinformatics*, *13*(1), 275. DOI: 10.1186/1471-2105-13-275