Wireless Sensor Networks

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CoNe Freiburg

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Options for topology control

Topology control

Control **node** activity – deliberately turn on/off nodes

Control **link** activity – deliberately use/not use certain links

Topology control

Flat network – all nodes have essentially same role

Hierarchical network – assign different roles to nodes; exploit that to control node/link activity
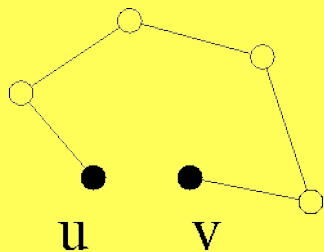
Power control

Backbones

Clustering
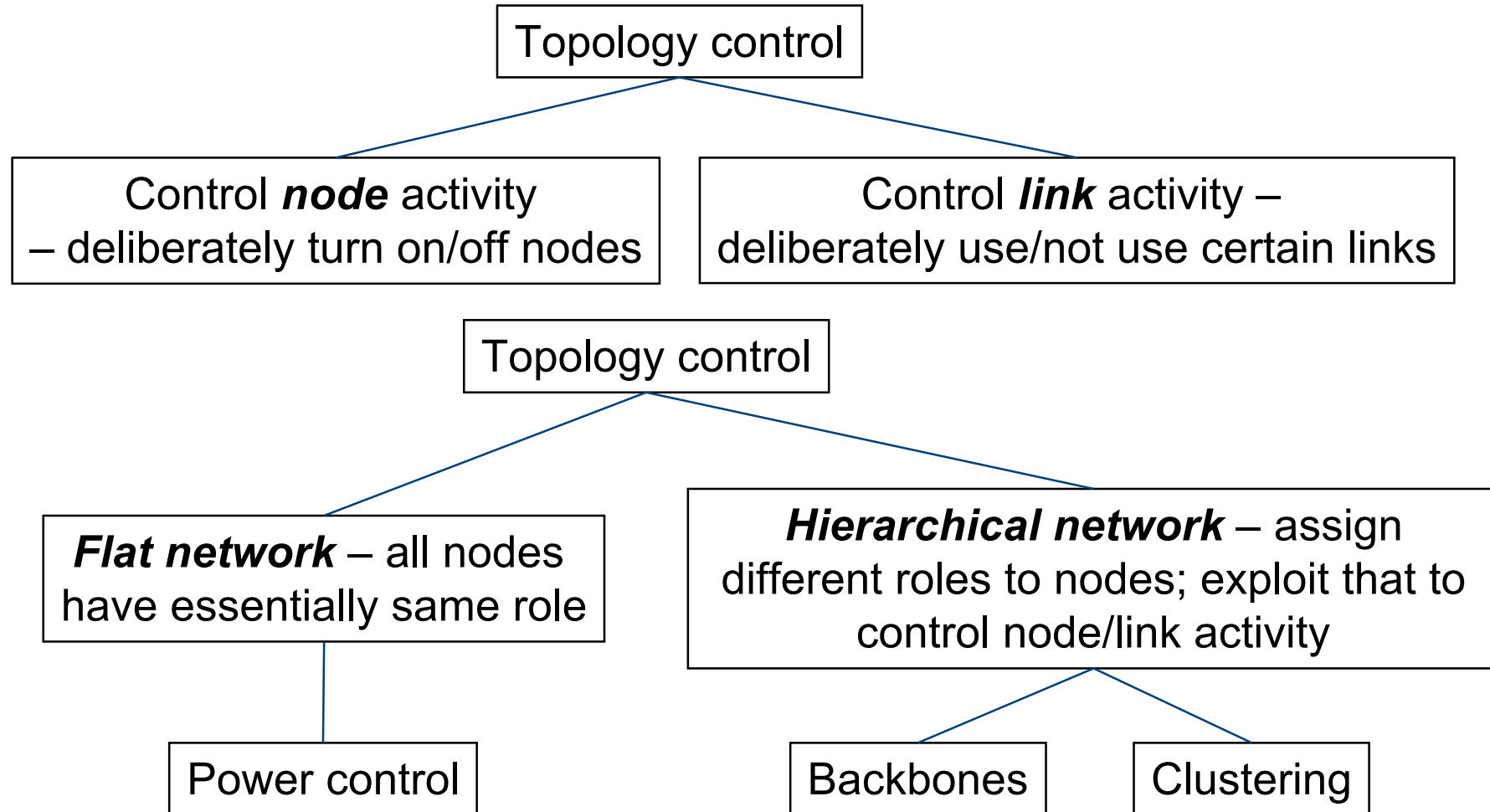
Geometric Spanner Graphs

➢ A Graph $G = (V, E)$ with $V \subseteq \mathbf{R}$ where for all $u, v \in V$ there exists a path $P = (u = u_1, u_2, \ldots, u_\ell = v)$ with
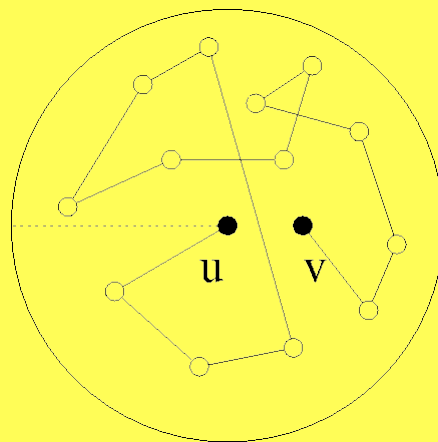
limited **length**:	-in a limited **radius**:	limited **energy costs**:
$\|P\| := \sum_{i=2}^{\ell} |u_i - u_{i-1}|$	$\max_{i=1,\ldots,\ell} |u - u_i| \le c \cdot |u - v|$	$\|P\|^\delta := \sum_{i=2}^{\ell} |u_i - u_{i-1}|^\delta$
$\le c \cdot |u - v|$		$\le c \cdot |u - v|^\delta$

c-Spanner Graph

weak c-Spanner Graph
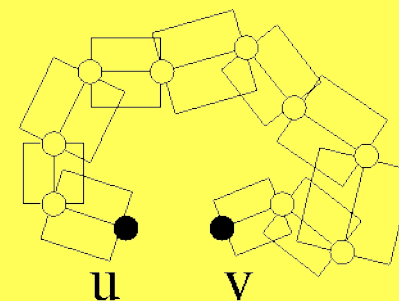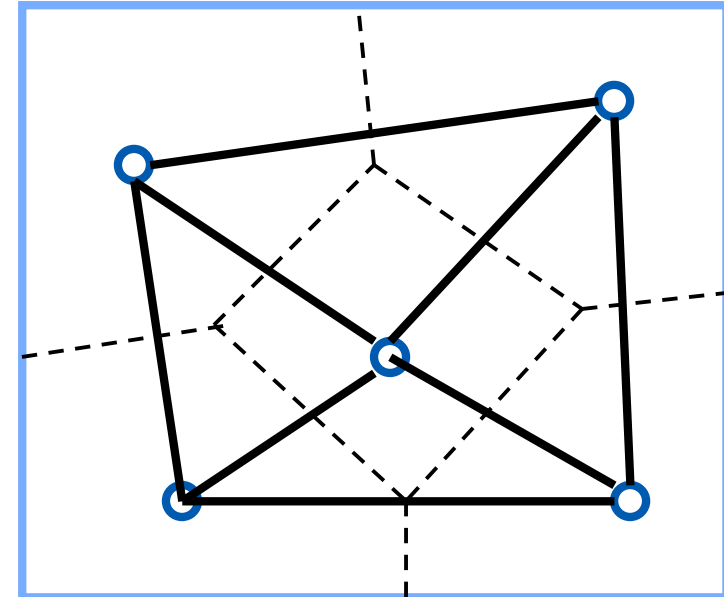
(c,δ)-Power-Spanner Graph

Delaunay Graph

> **Definition**

- – Triangularization of a point set p such that no point is inside the circumcircle of any triangle
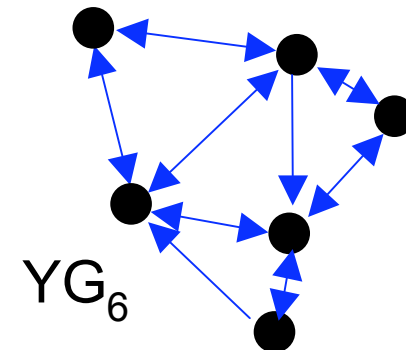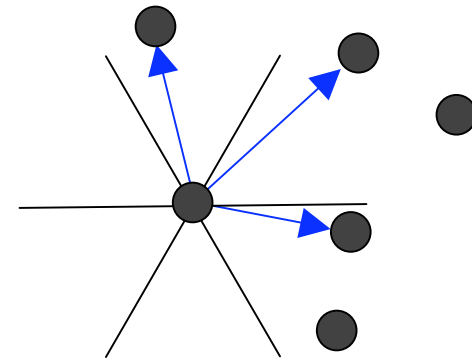
> **Facts**

- – Dual graph of the Voronoi-diagram
- – In 2-D
  - edge flipping leads to the Delaunay-graph
    - Flip edge if circumcircle condition is not fulfilled
  - planar graphs
  - 5.08-spanner graph
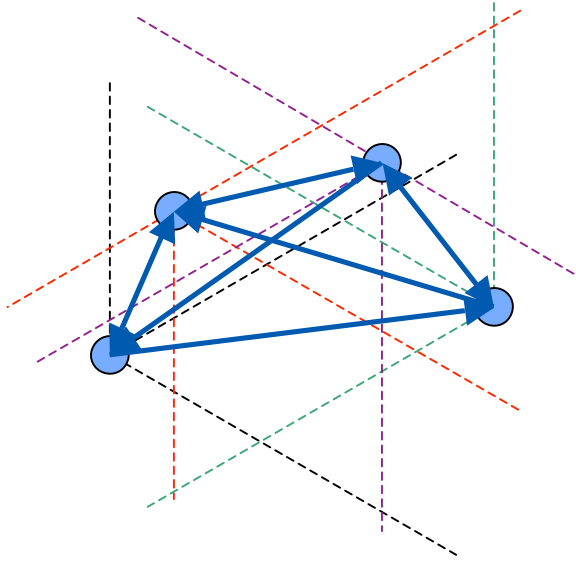- – Problem: Might produce very long links

Yao-Graph

➢ **Choose nearest neighbor in each sector**

➢ **c-spanner,**

- – with stretch factor

$$1/(1 - 2\sin(\theta / 2))$$

- – Simple distributed construction
- – High (in-) degree

YG_6

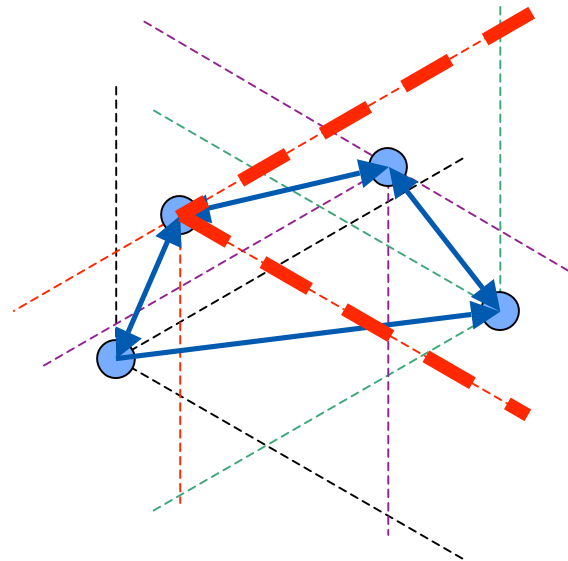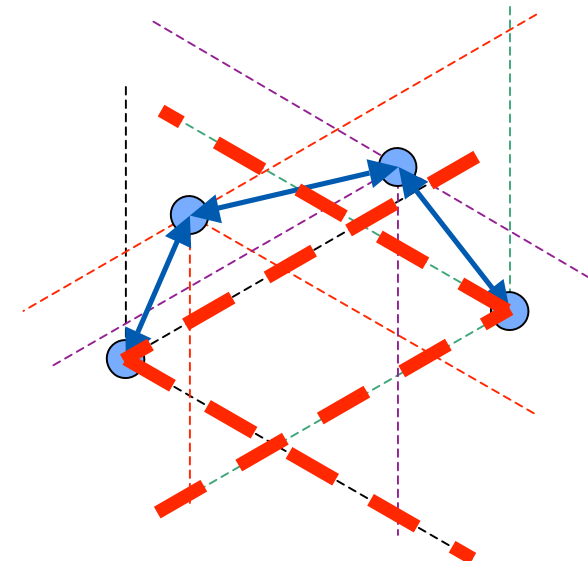# Yao-Family

Yao-Graph
Spanner

Disadvantage:
Unbounded in-degree

Interferences !

⊇ **SparsY**
Sparsified Yao-Graph

use only the shortest
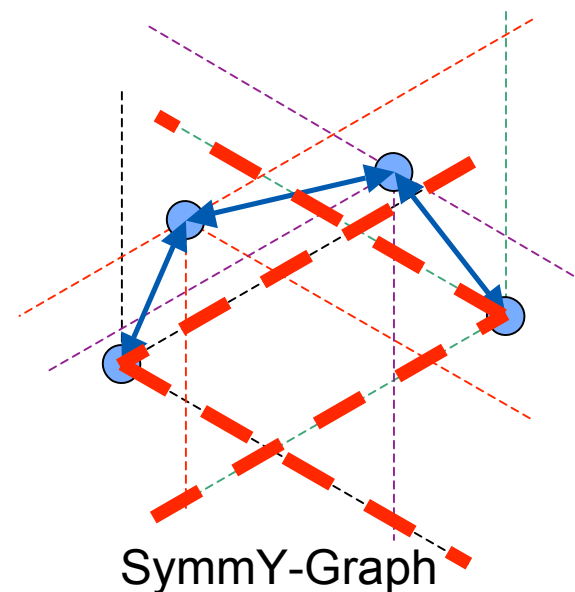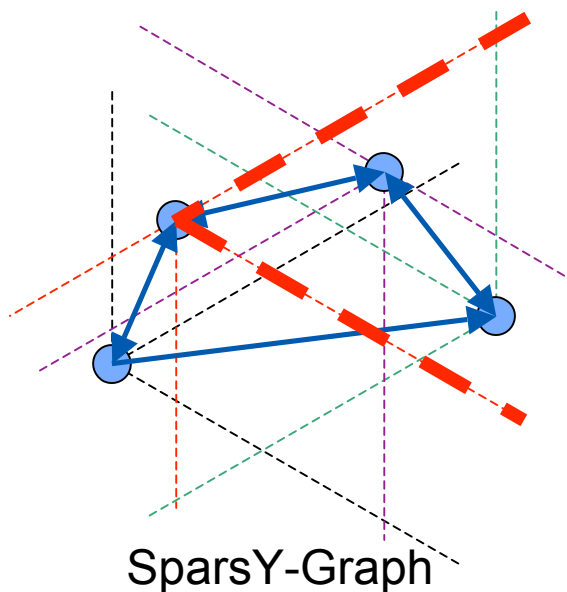ingoing edges
weak- & power-Spanner,
constant in-degree

⊇ **SymmY**
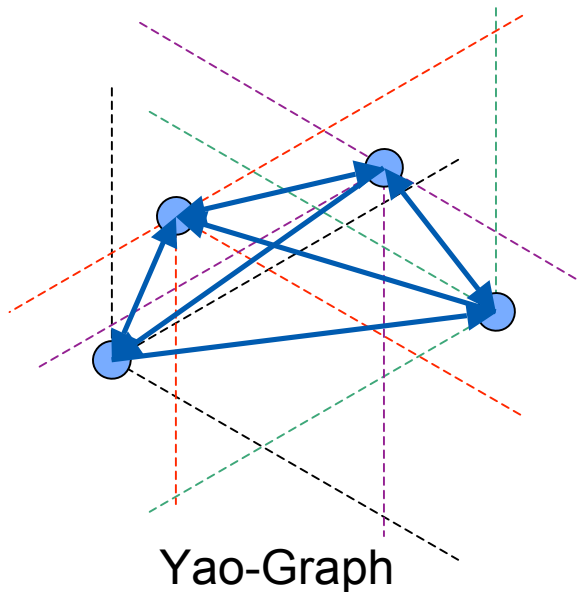Symmetric Yao-Graph

only symmetric edges
not a spanner,
nor weak spanner,
yet power-spanner

Directed Topologies

Yao-Graph   SparsY-Graph   SymmY-Graph

Topology	Directed Interference	Spanner	Energy-Approx.	Congestion-Approx.
Yao	n-1	$\dfrac{1}{1 - 2\sin(\frac{\theta}{2})}$	O(1)	O(n log n)
SparsY	1	weak and power	O(1)	O(log n)
SymmY	1 (bi-directional!)	No	–	–

Proximity Graphs

> **Relative Neighborhood Graph (RNG):**
> – There is an edge between u and v only if there is no vertex w such that d(u,w) and d(v,w) are both less than d(u,v)
> – No spanners
> – Small degree
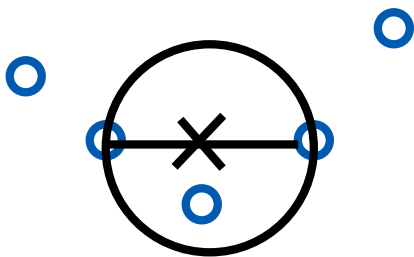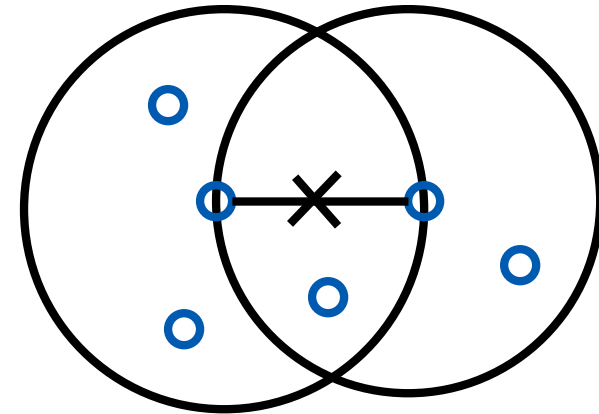
> **Gabriel Graph (GG):**
> – There is an edge between u and v if there is no vertex w in the circle with diameter chord (u,v)
> – Perfect (1,2)-power spanners
> – No strong spanners
> – Possibly high degree

Thank you

and thanks to Holger Karl and Rajmohan Rajamaran for some slides

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