Minimum Spanning Tree
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DPHPC

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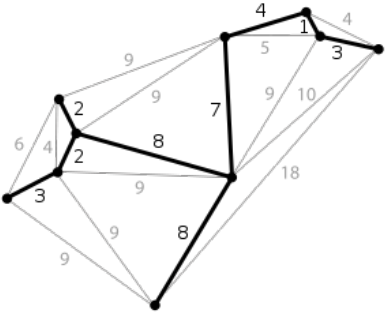
Problem definition - reminder

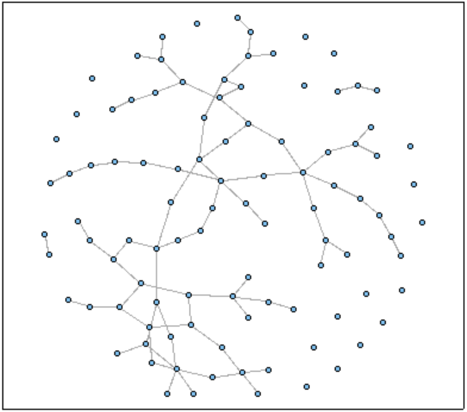
The MST problem

A minimum spanning tree (MST) or minimum weight spanning tree is a subset of the edges of a connected, edge-weighted (un)directed graph that connects all the vertices together, without any cycles and with the minimum possible total edge weight.



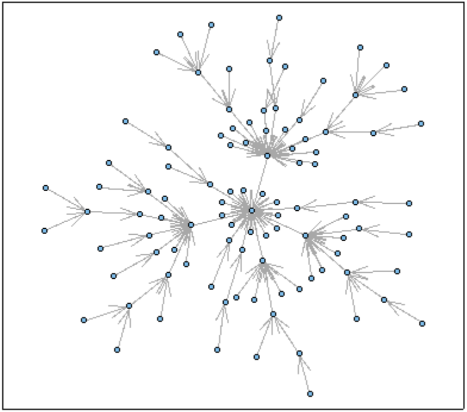
Input sets: $G(n,p)$

$G(100, 0.02)$



Input sets: $PA(n)$

$PA(100)$



Input sets: 9th DIMACS challenge dataset

USA Roads

Name	Description	# nodes	# arcs	L
USA	Full USA	23,947,347	58,333,344	-
CTR	Central USA	14,081,816	34,292,496	[
W	Western USA	6,262,104	15,248,146	[
E	Eastern USA	3,598,623	8,778,114	[
LKS	Great Lakes	2,758,119	6,885,658	[
CAL	California and Nevada	1,890,815	4,657,742	[
NE	Northeast USA	1,524,453	3,897,636	[
NW	Northwest USA	1,207,945	2,840,208	[
FLA	Florida	1,070,376	2,712,798	[
COL	Colorado	435,666	1,057,066	[
BAY	San Francisco Bay Area	321,270	800,172	[
NY	New York City	264,346	733,846	[

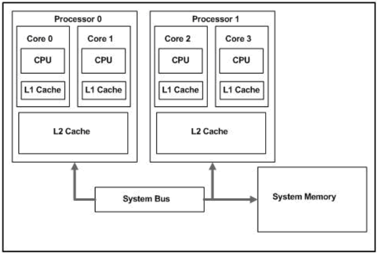
Setup

Software

- OMP
- Intel Threading Building Blocks (TBB)
- Parallel Streaming Transformation Loader Service (PSTL)

EULER

- 1 node limitation (OMP)
- 2 sockets filled with 18 cores - up to 3.7Ghz
- Inter-sockets bus speed: 10.4 GT/s



Algorithms and parallel implementations

Sollin

```
F = set(one-vertex trees)
while | F | > 1 do
    TODO
end while
```

Kruskal

$A = \emptyset$
for all $v \in G.V$ **do**
    MAKE-SET(v)
end for
Sort (asc.) $(weight(u,v))_{(u,v) \in G.E}$
for all (u,v) in $G.E$ ordered by weight **do**
    if FIND-SET(u) $\neq$ FIND-SET(v) **then**
        $A = A \cup (u,v)$
        UNION(u,v)
    end if
end for
return A

Boost implementations

- Boost-Kruskal used as a reference

Parallel sorting on Kruskal

Filter Kruskal

Filter Sollin

Results overview

EULER Cluster

Scalability

Speedups