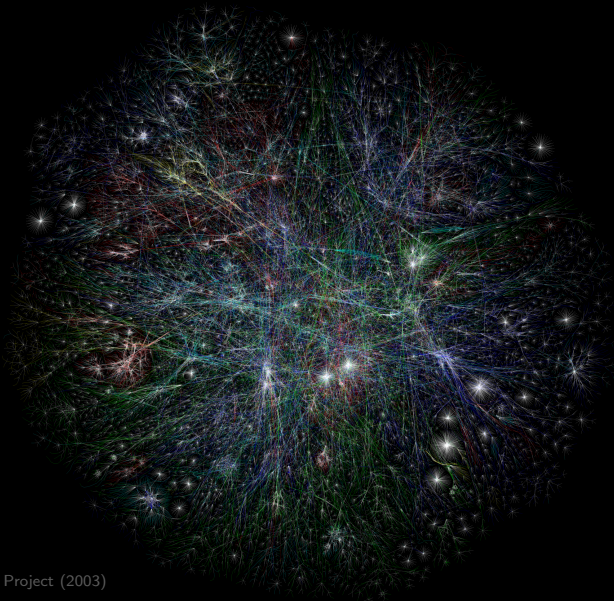


# The Internet (in 2003)

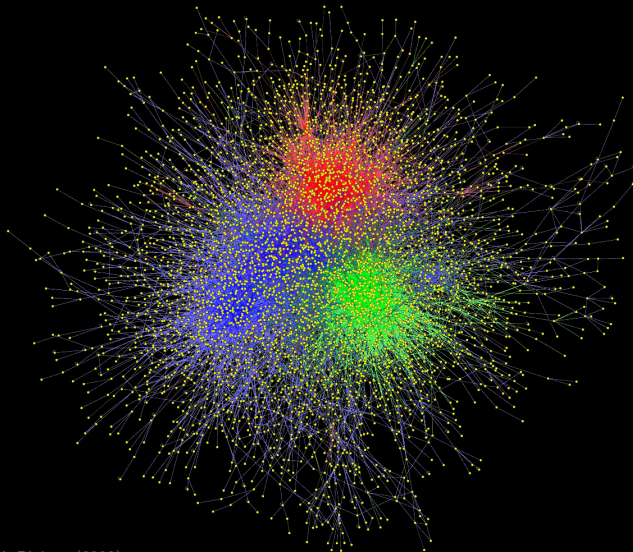


Source: The Opte Project (2003)

# Facebook (in 2010)



# Protein Interactions in Human Cells



Source: Ferrell, J. Biology (2009)

Graphs are increasingly massive:

- Web graphs: over 100 billion ( $10^{11}$ ) edges.
- Social graphs: over 1 trillion ( $10^{12}$ ) edges.
- Data sizes: 100s of GBs, if not TBs.

Graph processing systems must be **distributed**.

Must consider **time**, **memory**, and **network**.



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*Pregel-like* graph processing systems are increasingly popular.

## Giraph:

The Facebook logo, consisting of the word 'facebook' in white lowercase letters on a blue rectangular background.


## GraphLab:



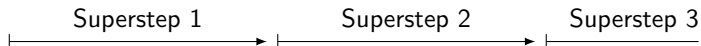
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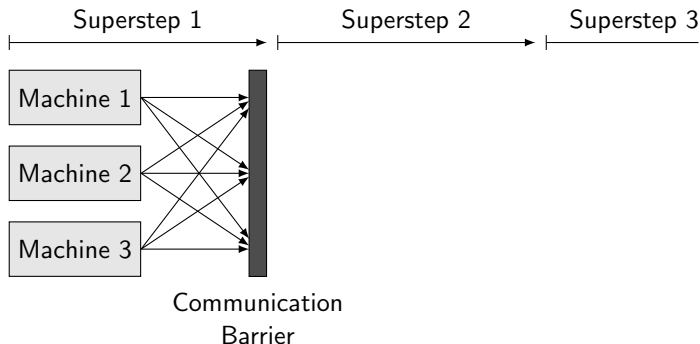
Computation



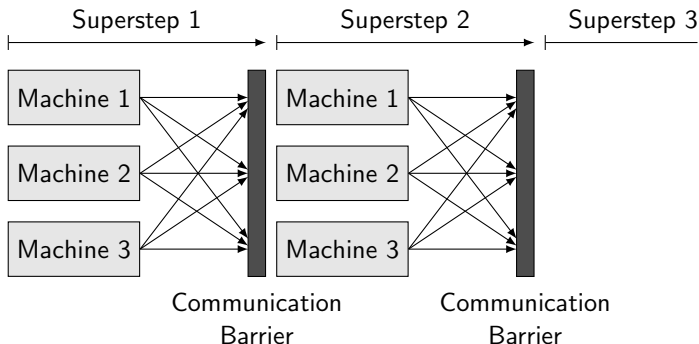
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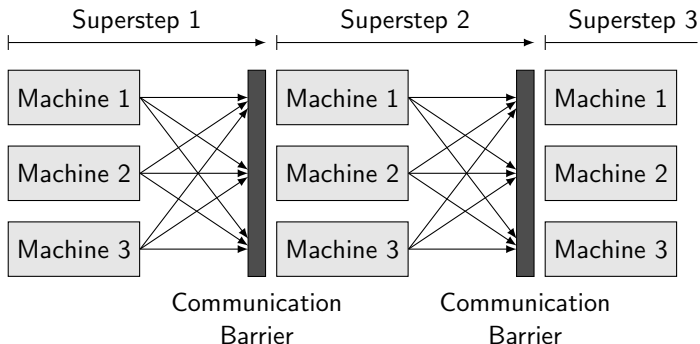
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Pregel-like systems are **BSP**, **vertex-centric** programs.

- “Think like a vertex”:

