

# How Can Architecture Help to Reduce Energy Consumption in Data Center Networking?

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# Large data centers with 10000+ servers

**amazon.com**<sup>®</sup>  
and you're done.<sup>™</sup>

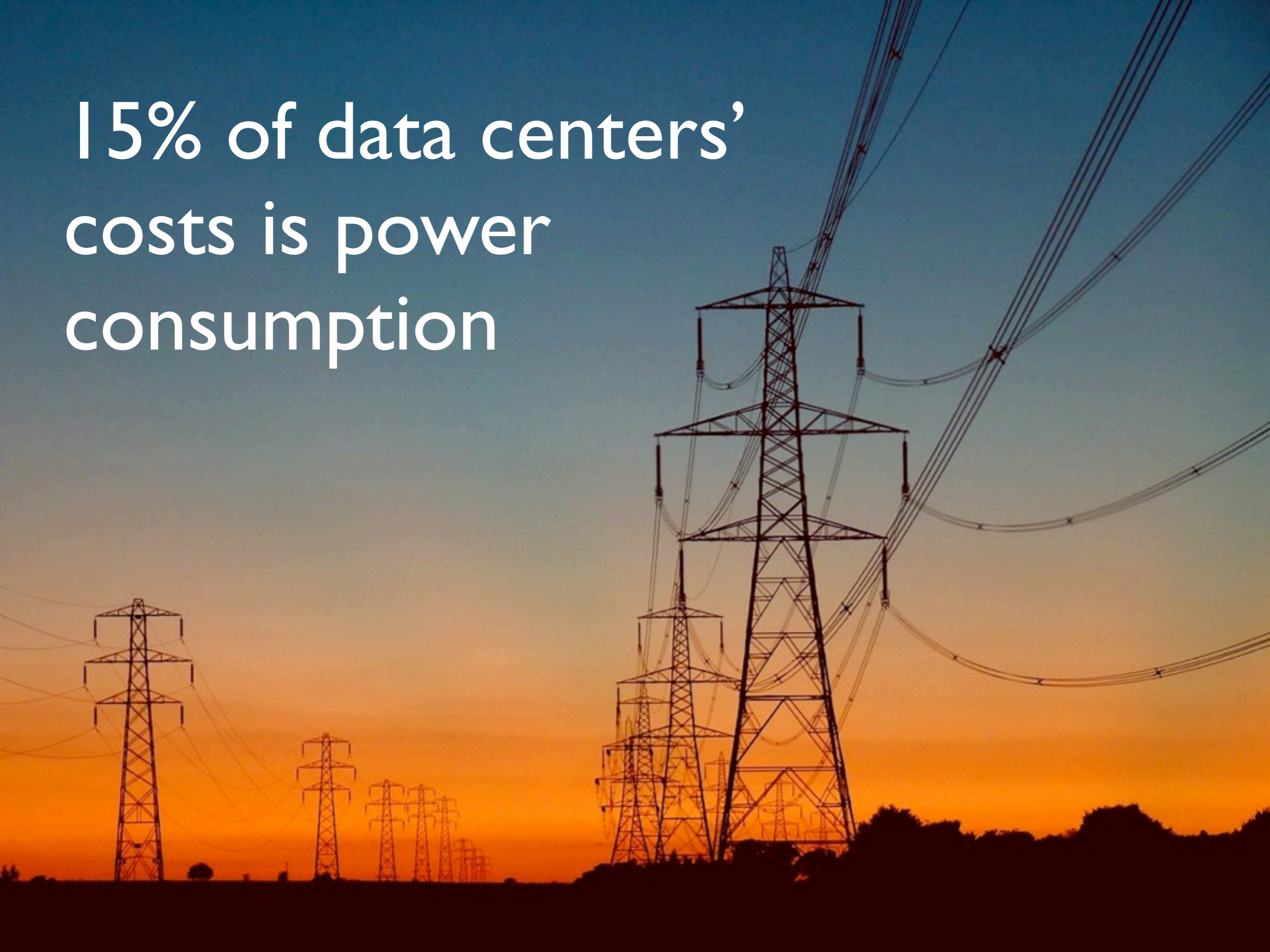
**facebook**<sup>®</sup>

**Microsoft**<sup>®</sup>

**Google**<sup>™</sup>

**YAHOO!**<sup>®</sup>

15% of data centers' costs is power consumption









Power  
Consumption



Power  
Consumption



**Structure**

**Power  
Consumption**

Structure

Power  
Consumption

Cooling



Structure

Power  
Consumption

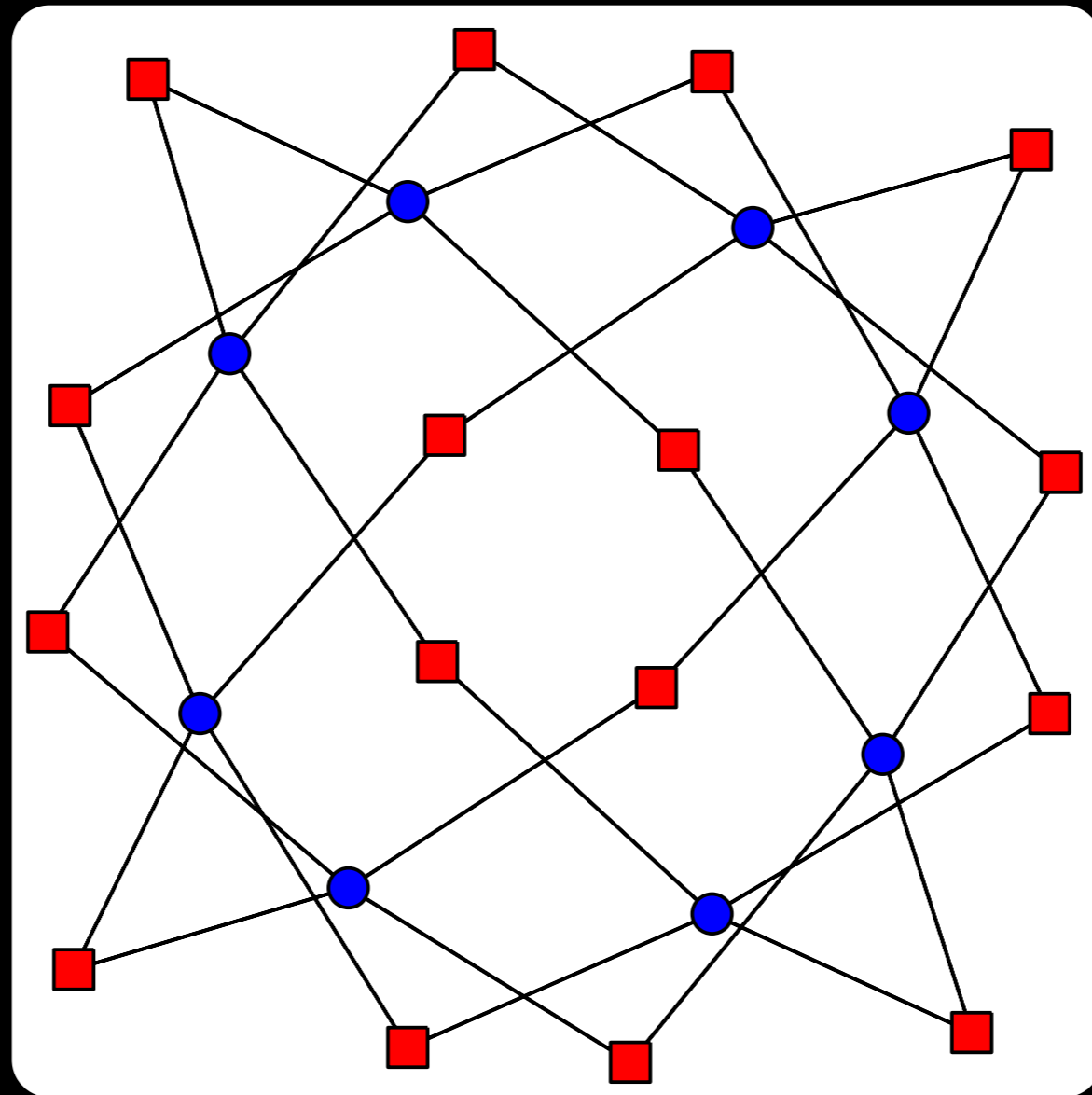
Cooling

Resilience

# Analyses of the power consumption of data center architectures

# State-of-the-art data center architectures

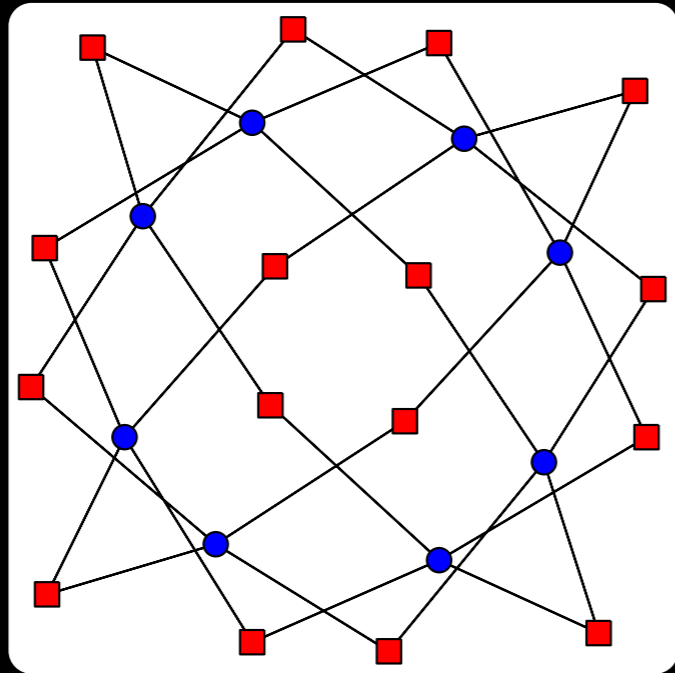
# State-of-the-art data center architectures



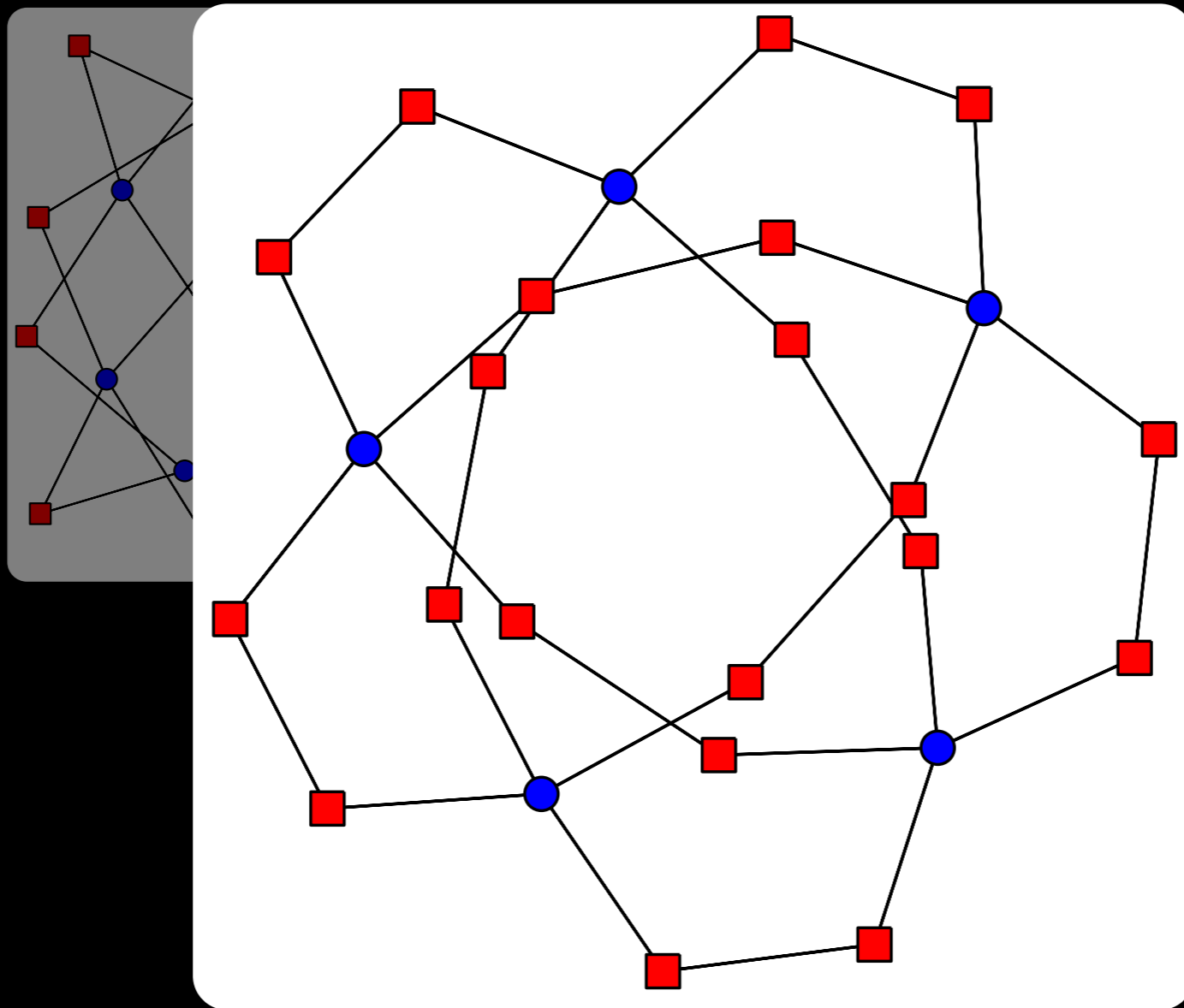
BCube



# State-of-the-art data center architectures

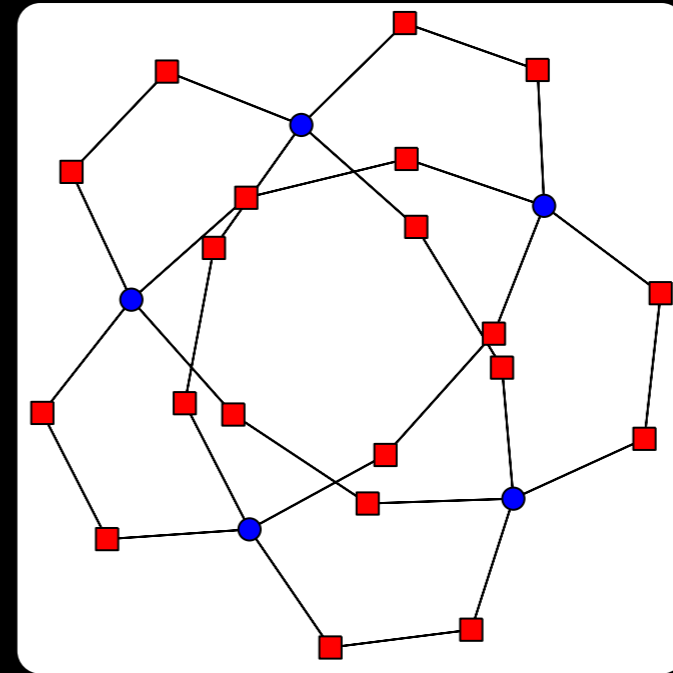
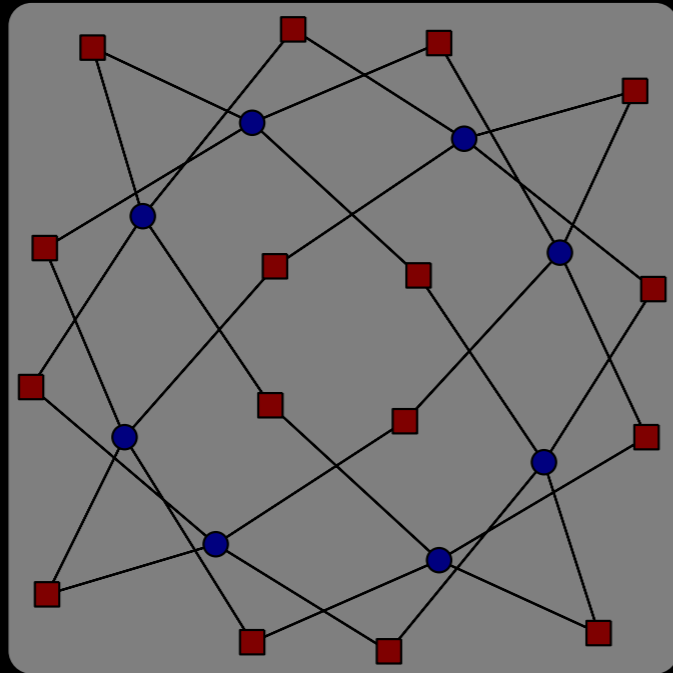


# State-of-the-art data center architectures

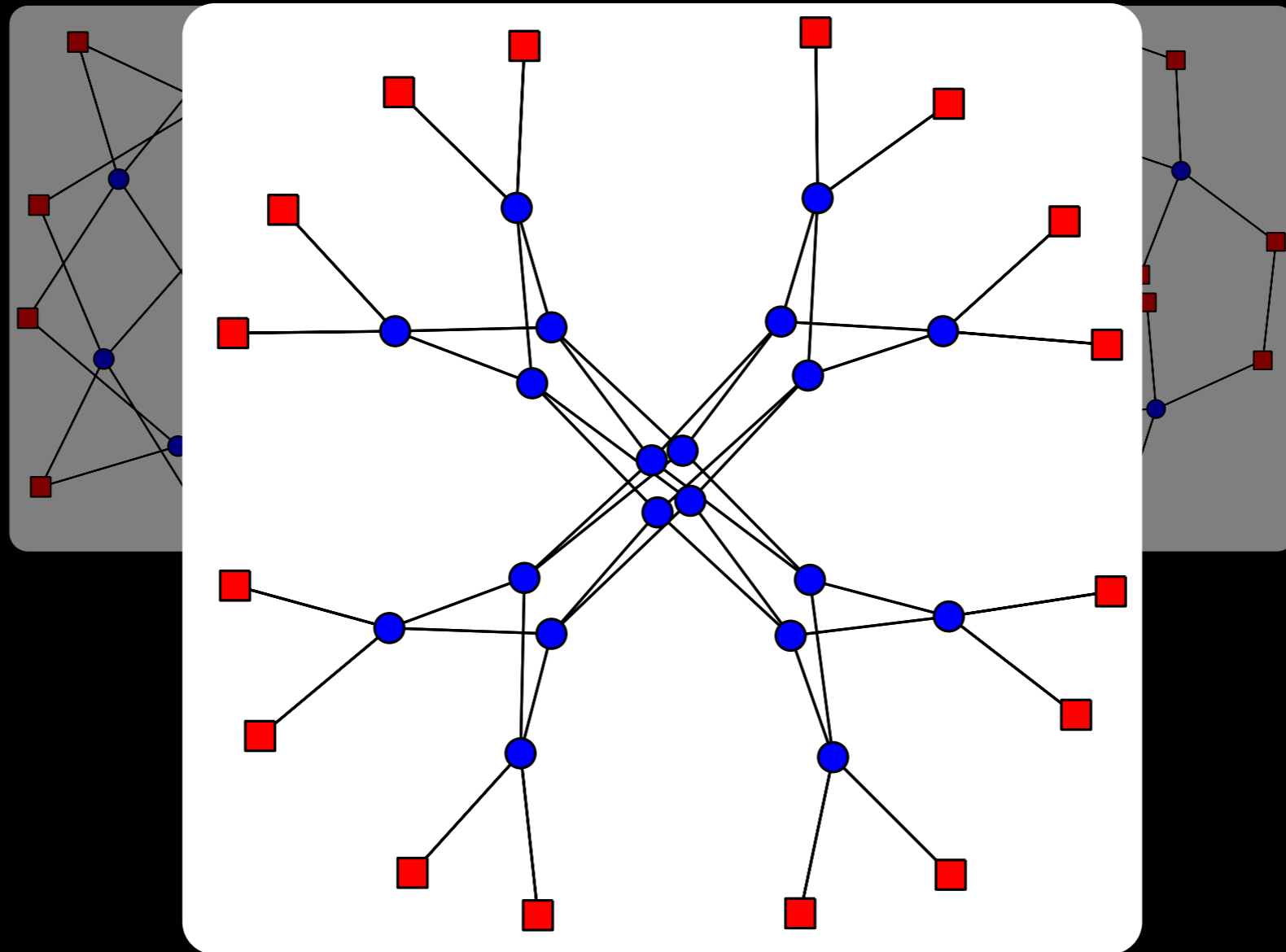


DCell

# State-of-the-art data center architectures



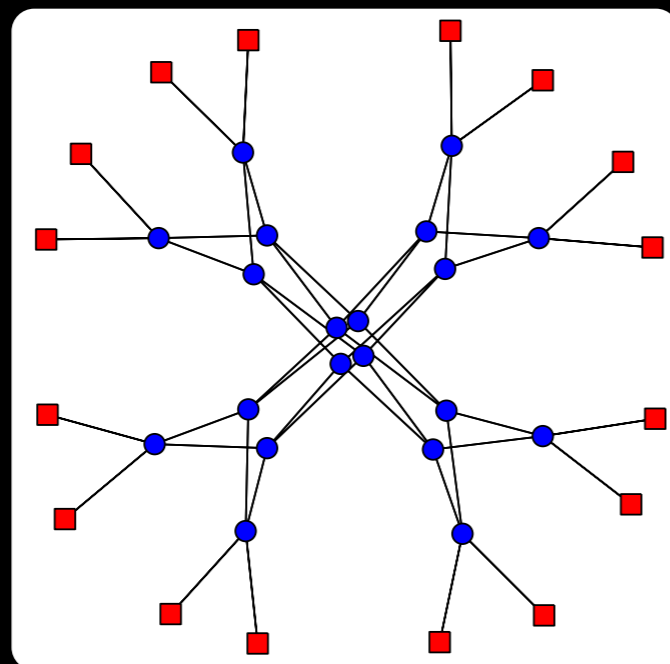
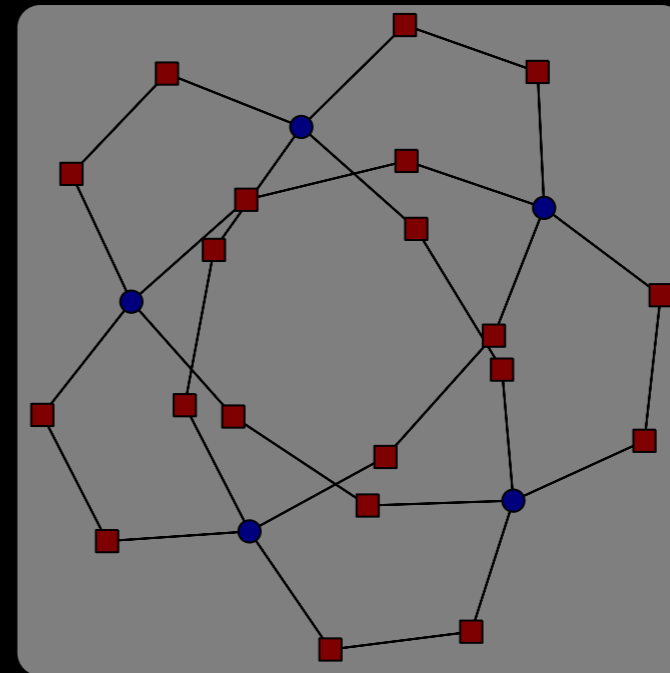
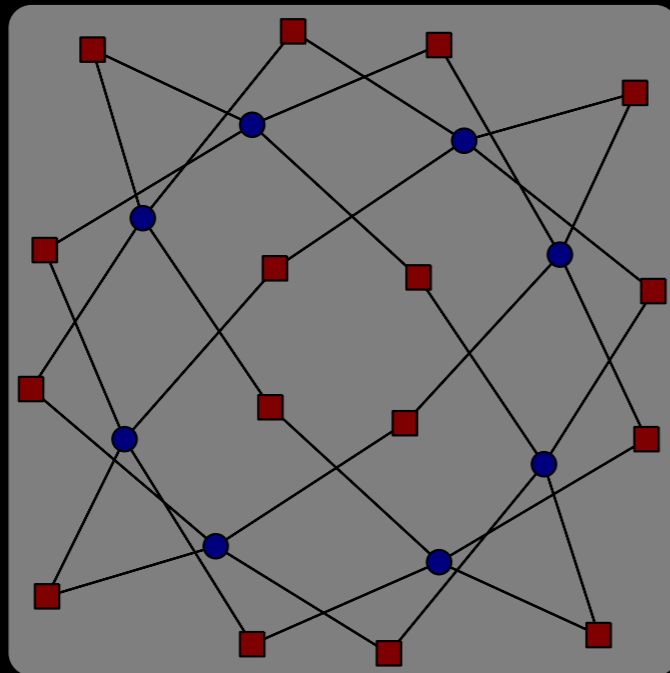
# State-of-the-art data center architectures



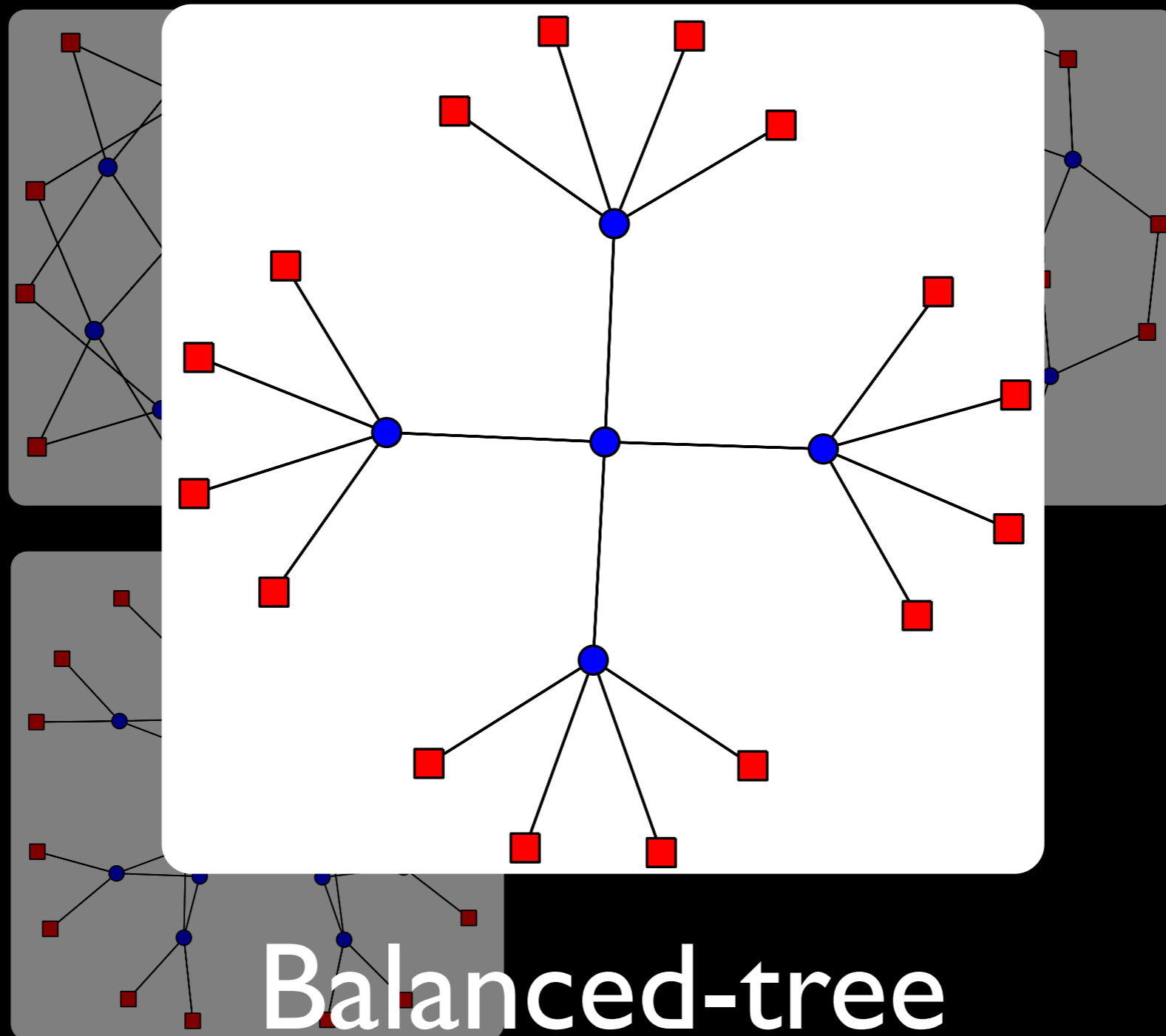
Fat-tree



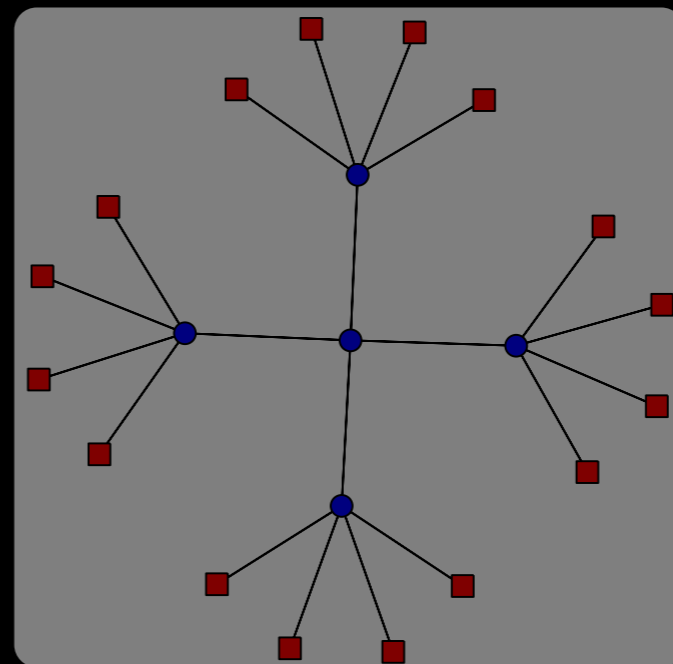
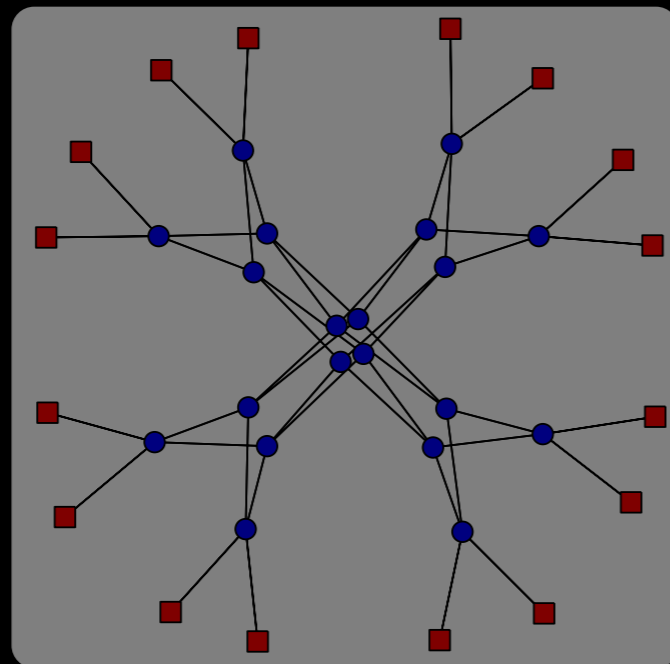
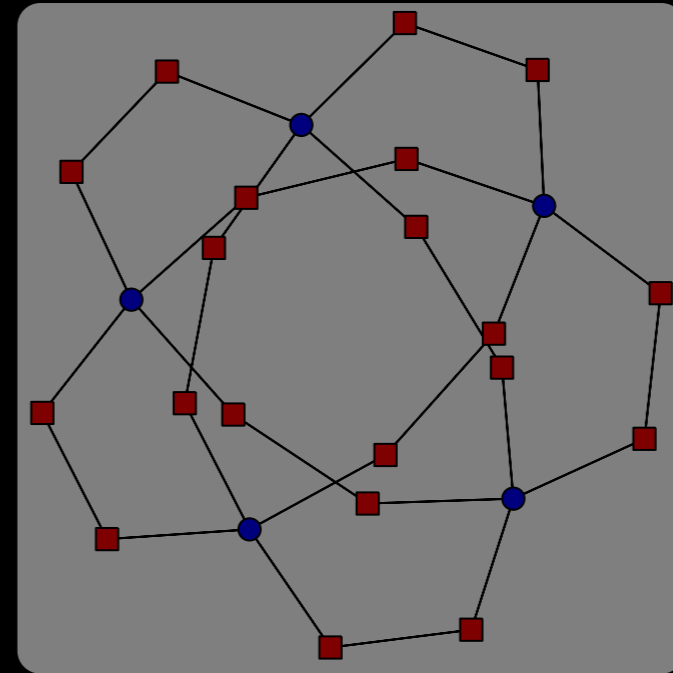
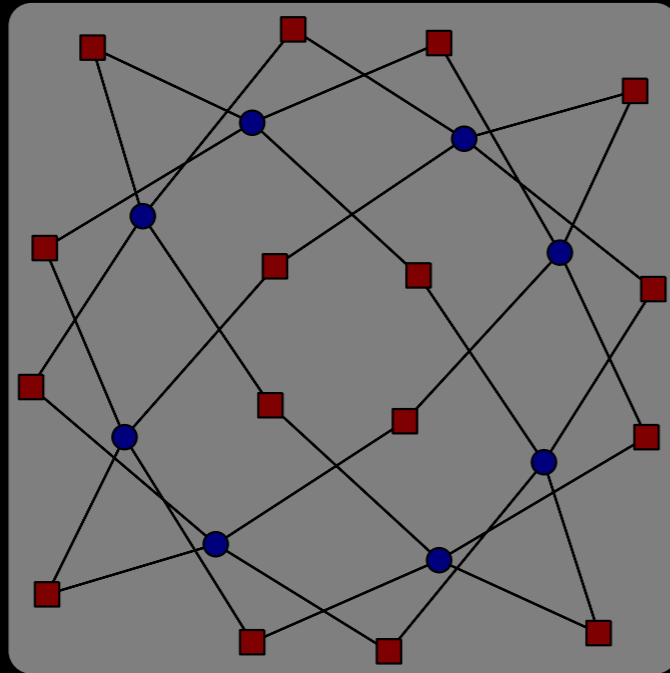
# State-of-the-art data center architectures



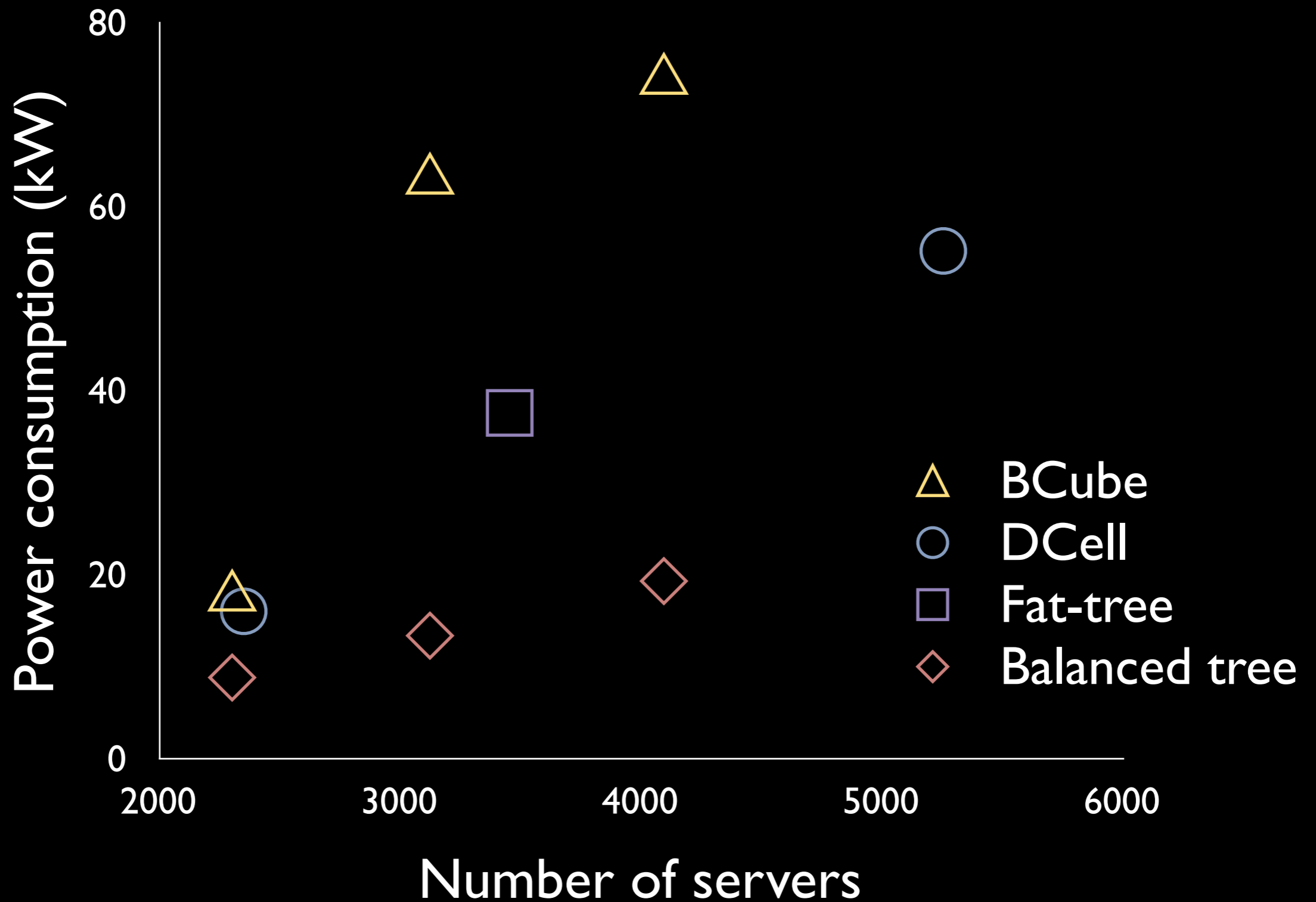
# State-of-the-art data center architectures



# State-of-the-art data center architectures

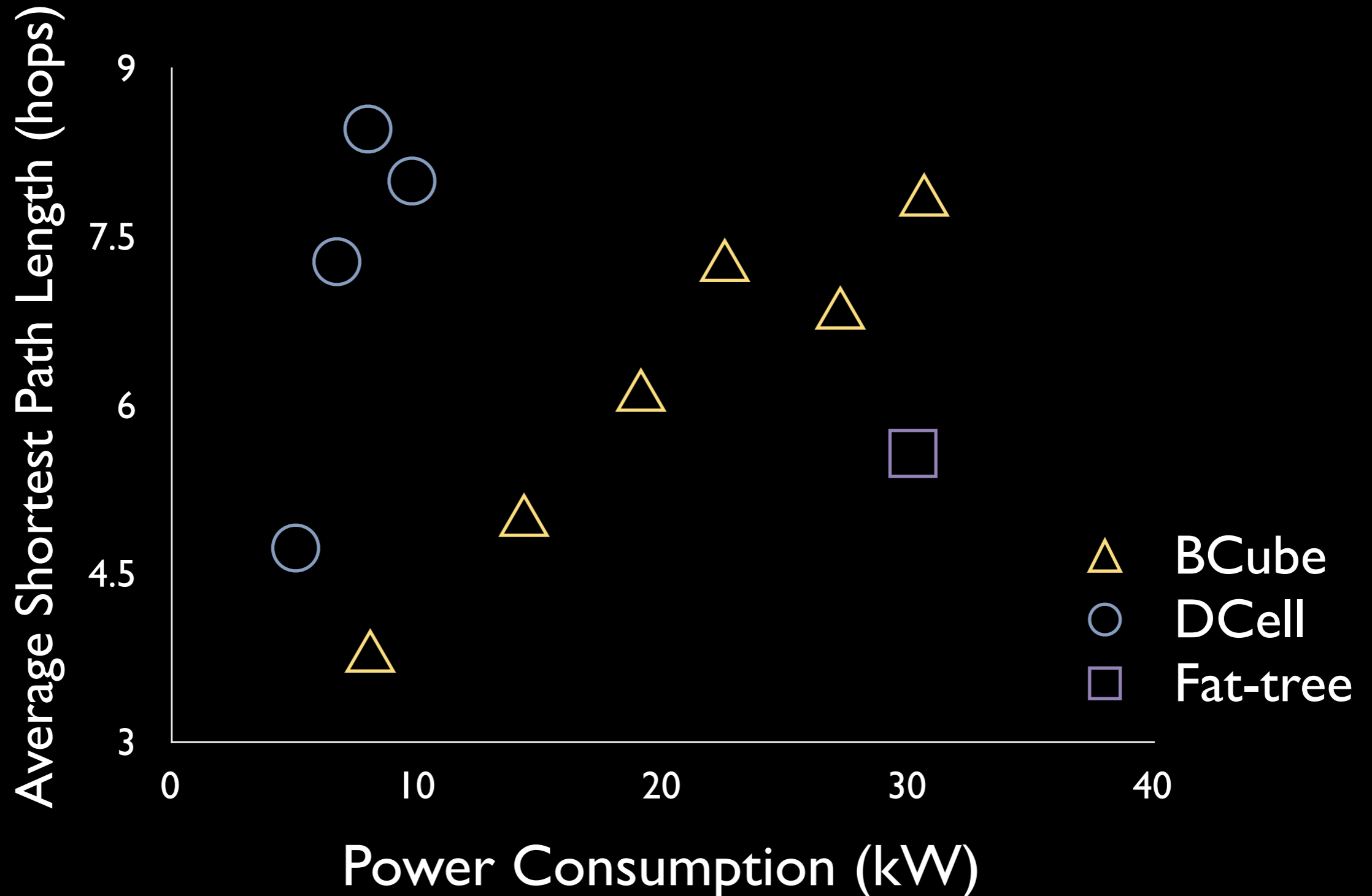


# Diverse power consumption





# Trade-off between power consumption and path length



The source code of our simulator is  
available at

[http://netecon\\_group.tmit.bme.hu](http://netecon_group.tmit.bme.hu)

Energy efficiency issues  
due to poor scaling

# Poor scaling

# Poor scaling



# Poor scaling

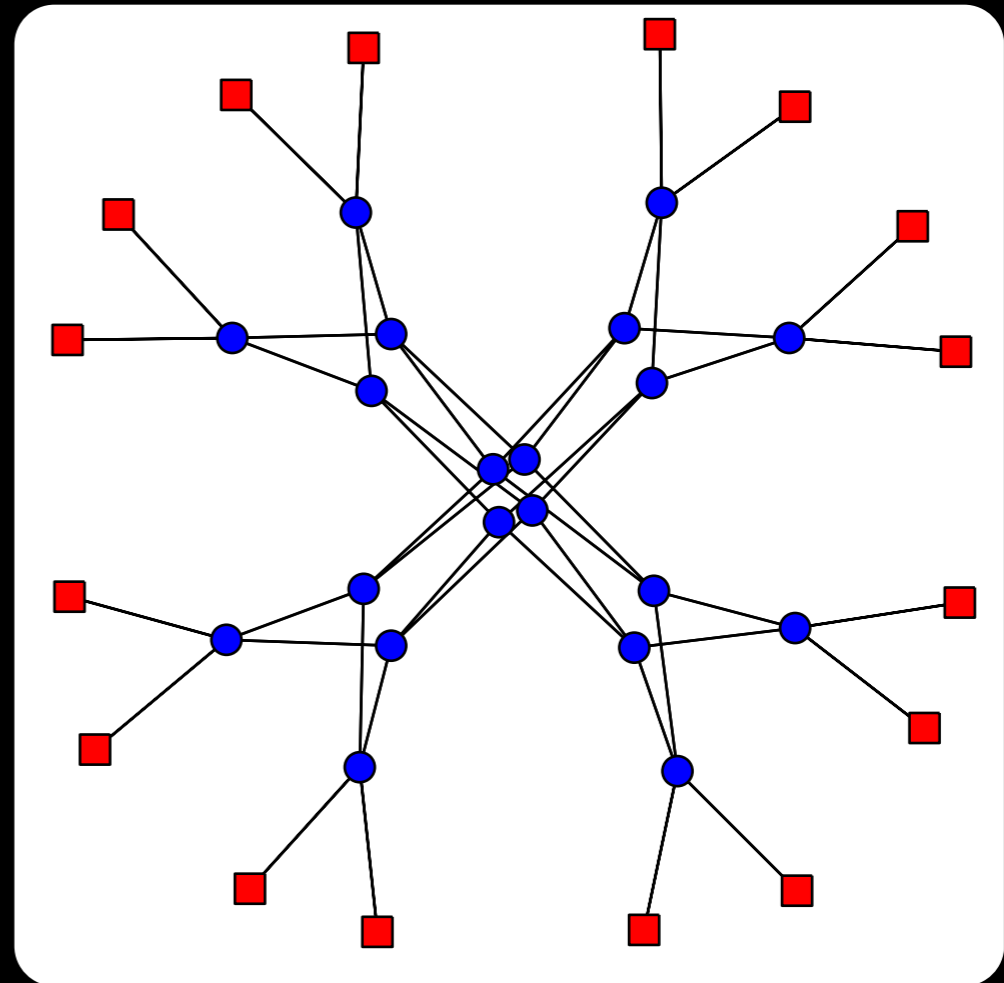


Homogeneous  
equipments

# Poor scaling



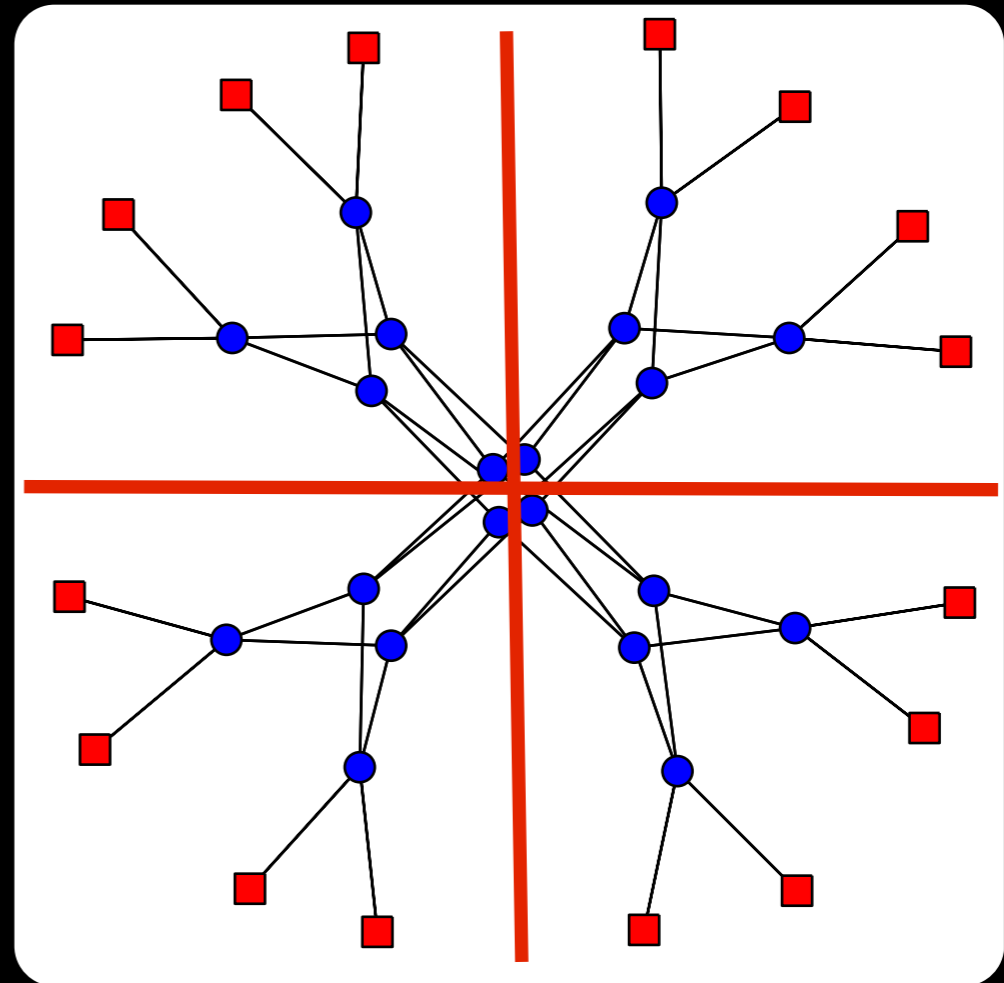
Homogeneous equipments



# Poor scaling



Homogeneous equipments

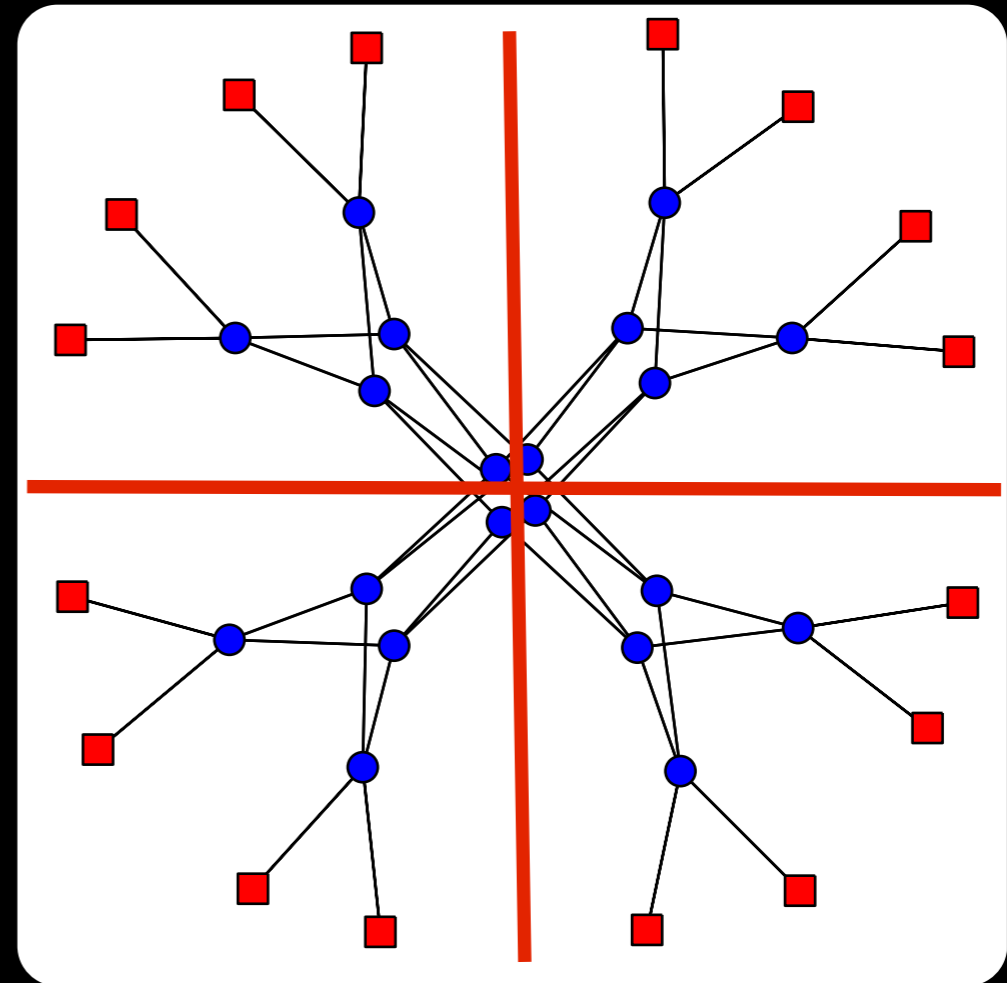




# Poor scaling



Homogeneous equipments

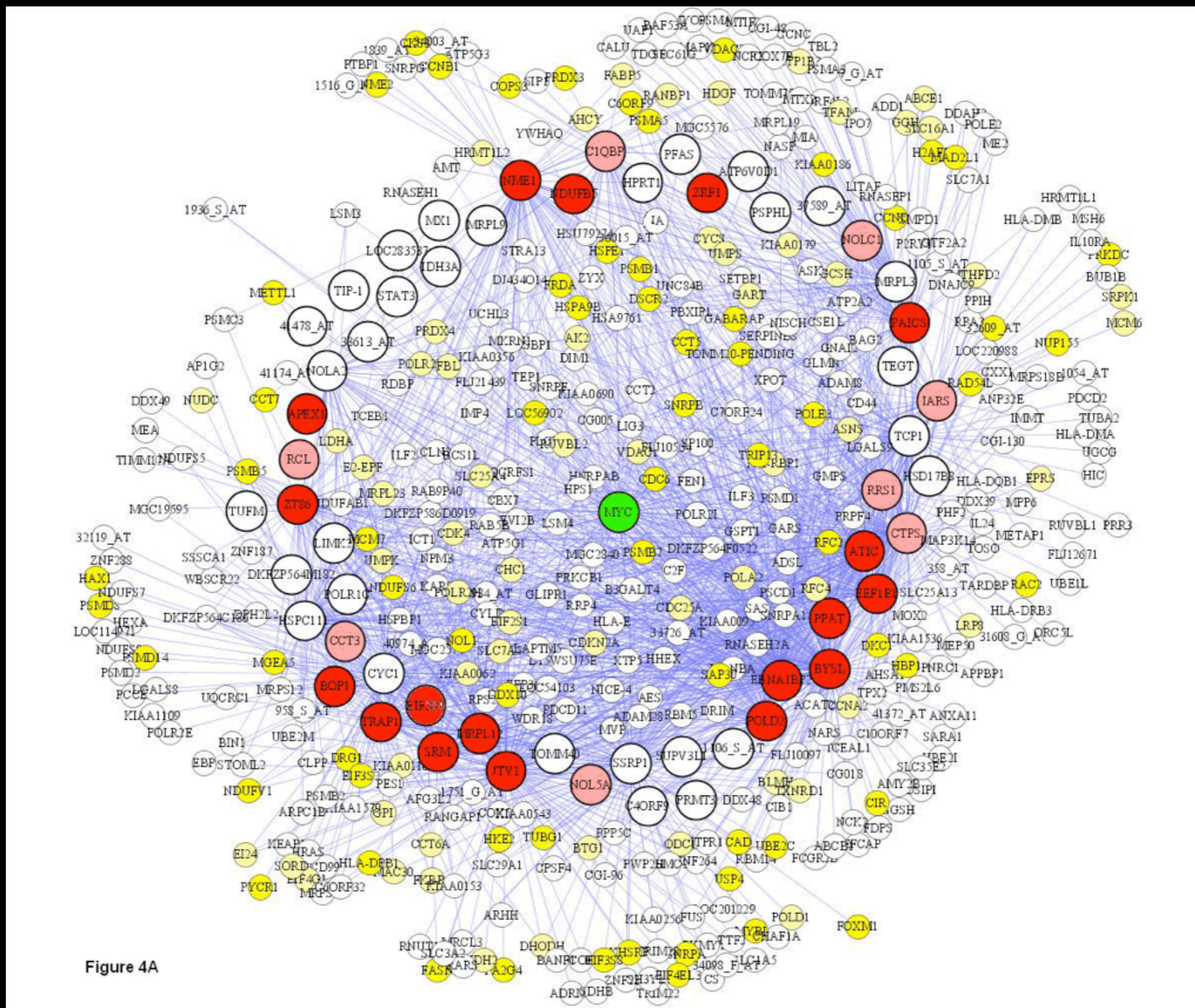


Symmetric structure

Our vision

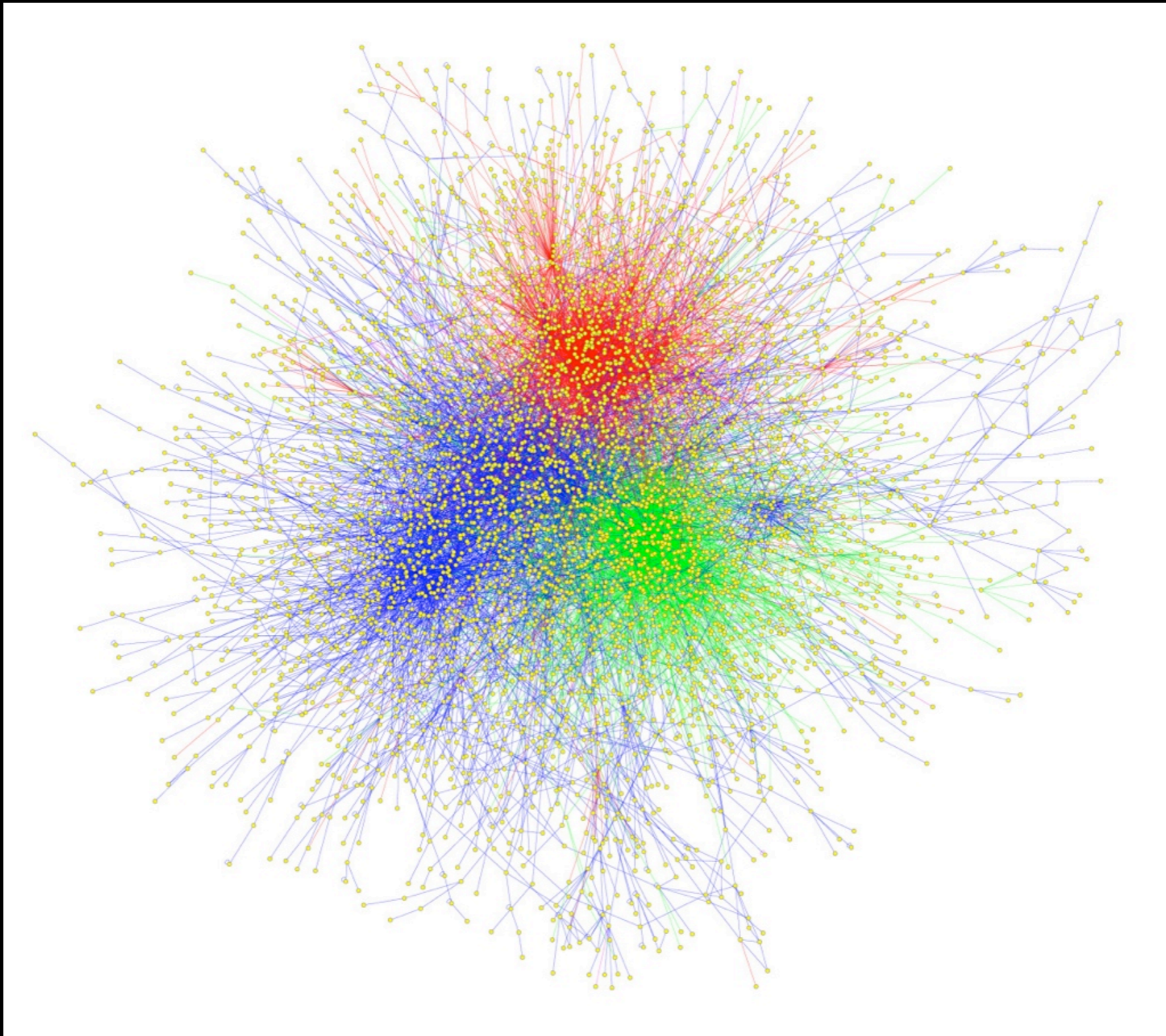


# Metabolic network of E.coli bacteria





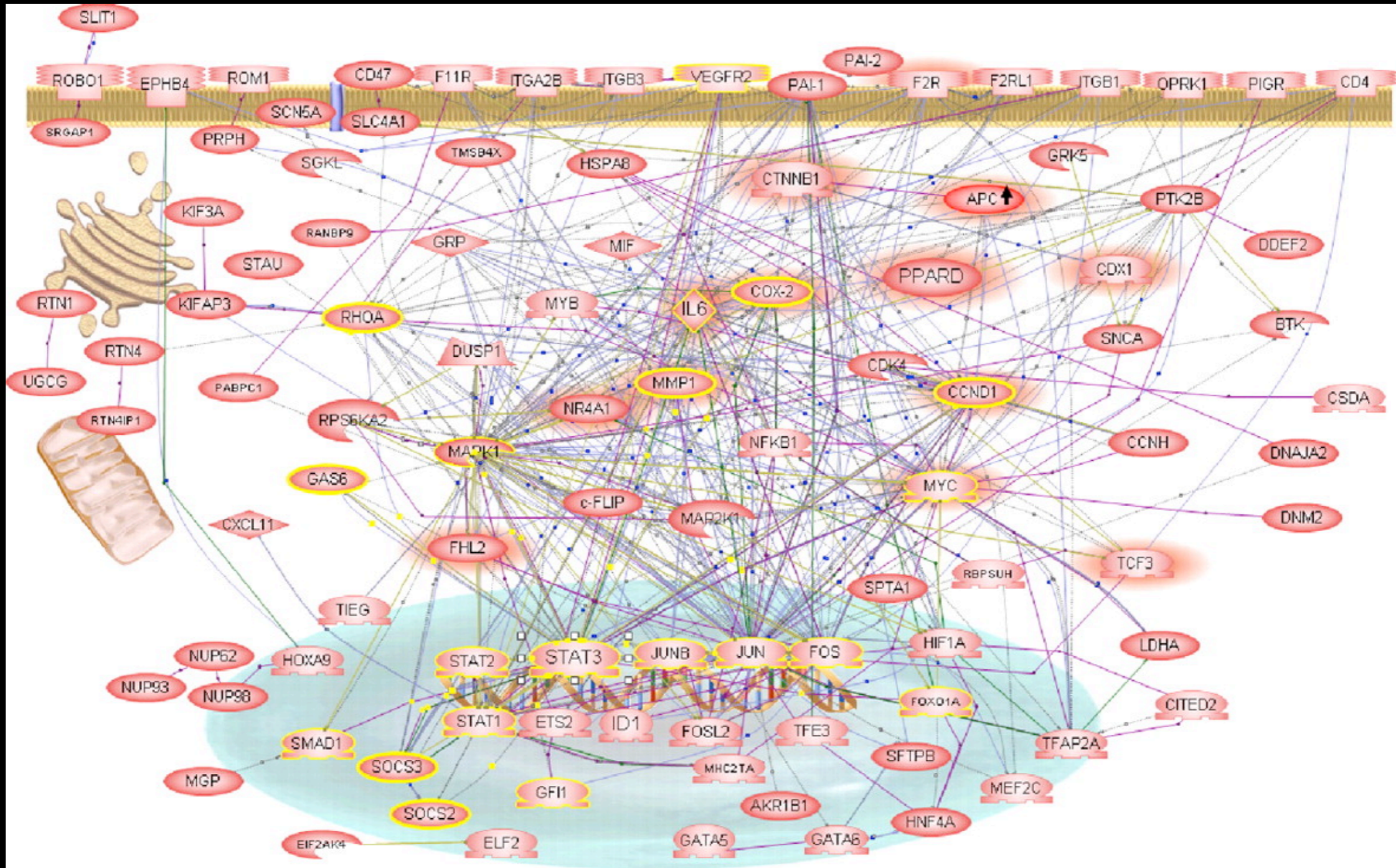
# Human protein-protein interaction network



Source: Ferrell, Journal of Biology 2009, 8:2



# Human signalling network



Source: Abdollahi et al., PNAS, 2007 vol. 104 no. 31  
12890-12895

Energy efficient structures as they survived the selection of evolution

# Our Vision

Our Vision

Biology-inspired data center  
architecture



Currently ongoing  
work

# Currently ongoing work

- Network generation method based on biological proposals

# Currently ongoing work

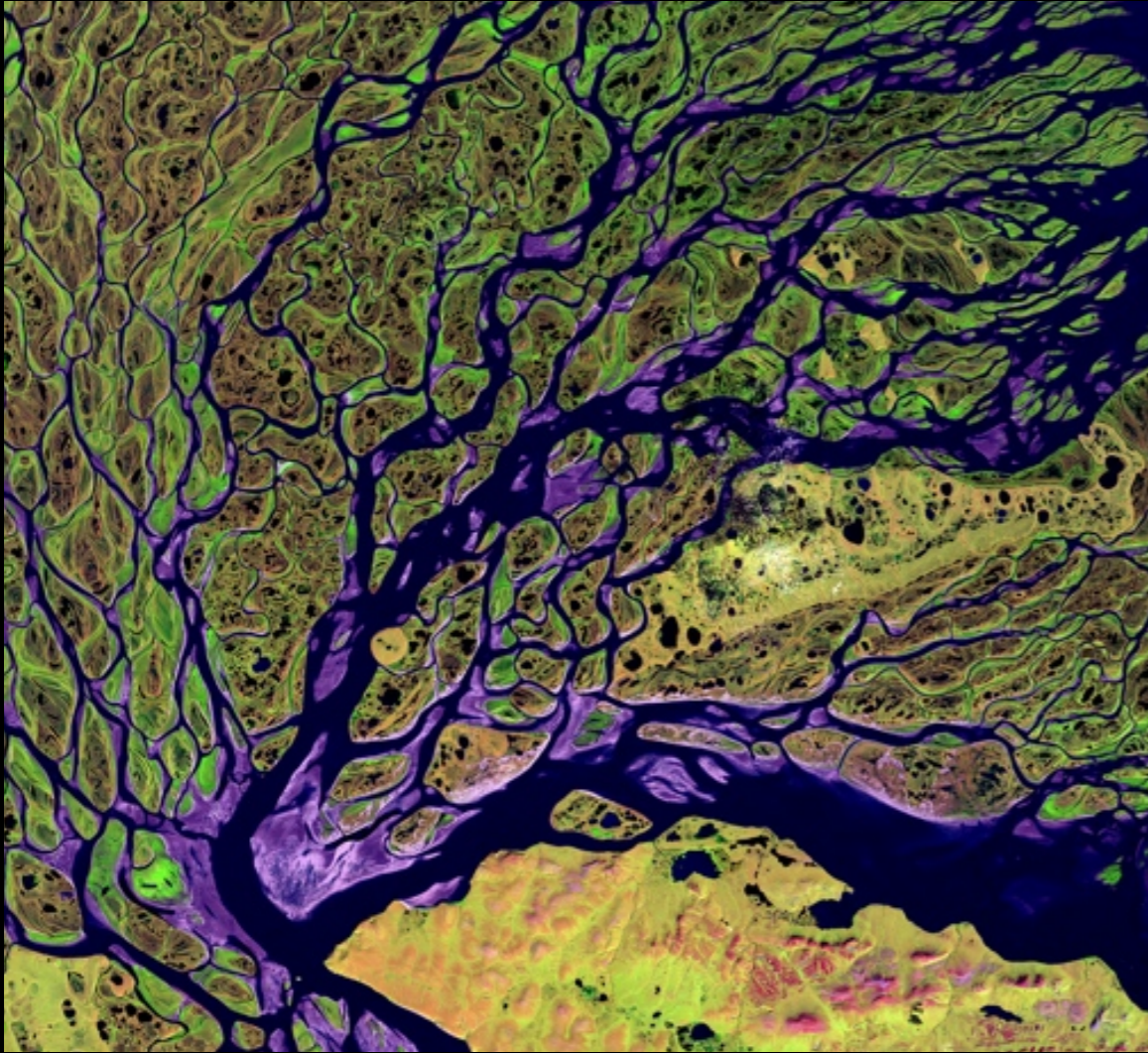
- Network generation method based on biological proposals
- Challenge: constrained capabilities of network equipments

# Currently ongoing work

- Network generation method based on biological proposals
- Challenge: constrained capabilities of network equipments
- Adapting existing methods to meet this constraint

# Challenge

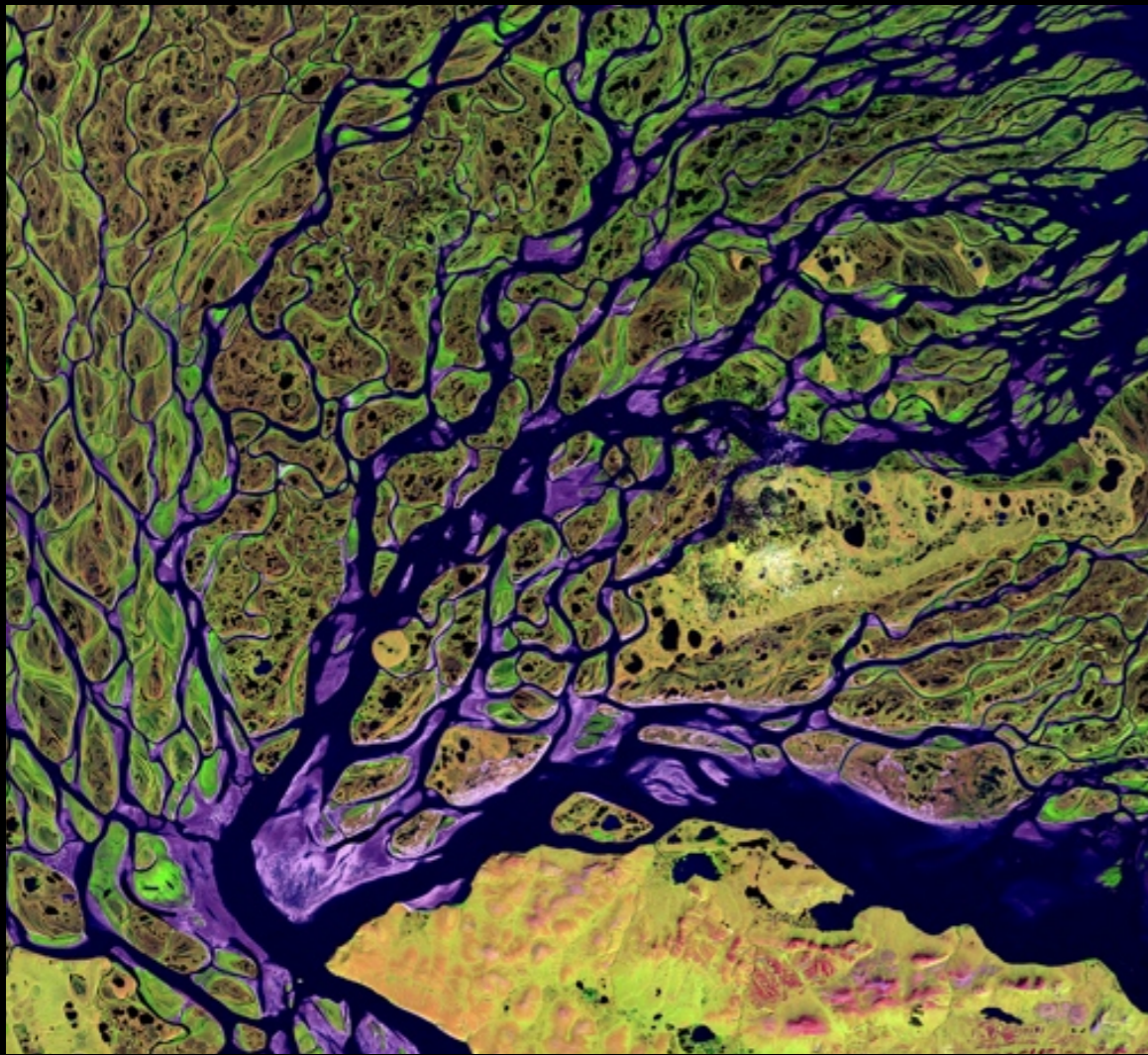
# Challenge



Biological  
networks



# Challenge



Biological  
networks



Communication  
networks

# Challenge



# Challenge

- Commodity switches due to economic reasons

# Challenge

- Commodity switches due to economic reasons
- Fixed number of switch ports

# Challenge

- Commodity switches due to economic reasons
- Fixed number of switch ports
- Some available commodity switches:

Name	DLink DGS-2205	Cisco 2960-8TC-L	Cisco 2960-24TC-L	Cisco 2960-48TC-L
Ports	5	8	24	48

Thank you for your attention!

[http://netecon\\_group.tmit.bme.hu](http://netecon_group.tmit.bme.hu)