Content Connectivity Resiliency

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Outline

- Problem statement: review
- Logical topology design
- Optimization problem relaxation

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Problem Statement: Review

- Give a logical topology
- Map logical topology over physical topology with content connectivity after k link failures
- Define: Content connectivity = datacenter reachability in IP layer
- ANTS paper:
  - ✓Generic ILP for arbitrary k
  - ✓ Necessary conditions for feasible solution

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Operator: What Can be Flexible?

- Physical topology: fixed
- Logical topology:
  - ✓Logical nodes = Central Offices (CO) require content: fixed
  - ✓How logical nodes be connected: flexible
  - ✓Datacenter number and location: flexible (considering hardware available)
- Goal: Fulfill content connectivity against k link failures with minimal network resources

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Link Lower Bound of k-Connected Graph

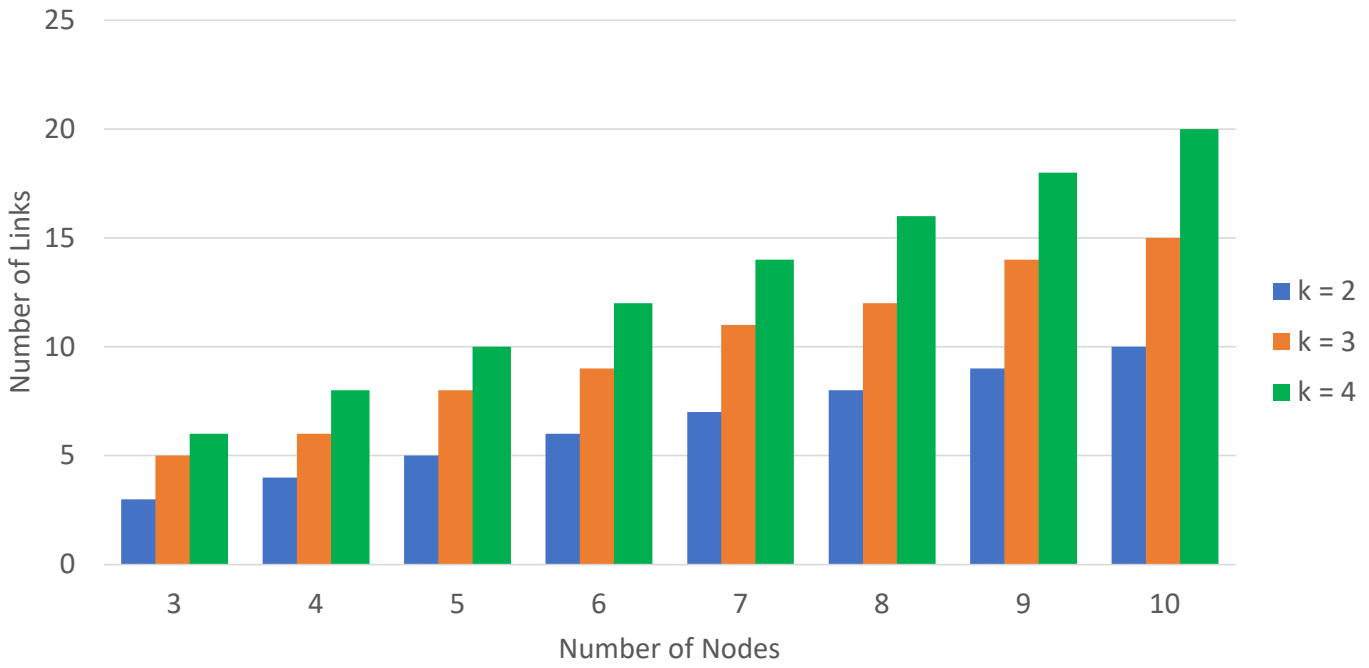
- Necessary condition for content connectivity against $k-1$ link failures: k-connected graph (k-link connected)

- Lower bound of number of links of k-connected graph, $H(n,k)$:

$$\text{ceil}\left[\frac{nk}{2}\right]$$

where $H(n,k)$ is k-connected Harary graph of n nodes

Minimal Number of Links, k-Connected Graph



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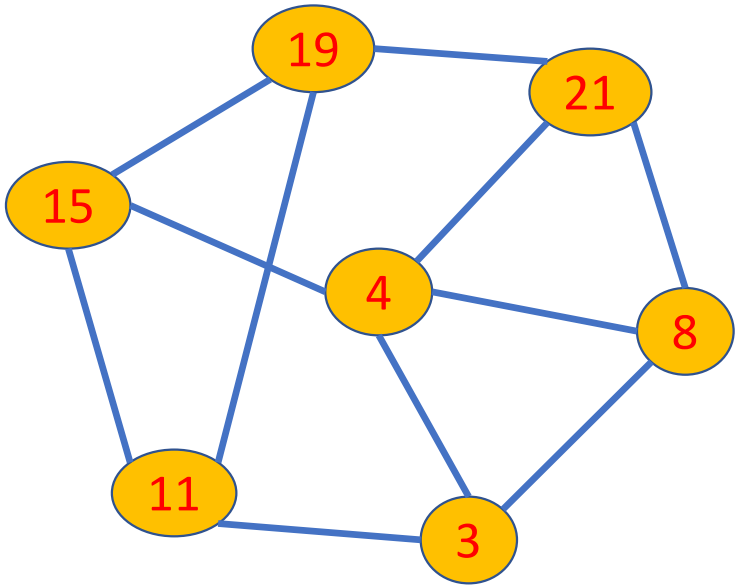
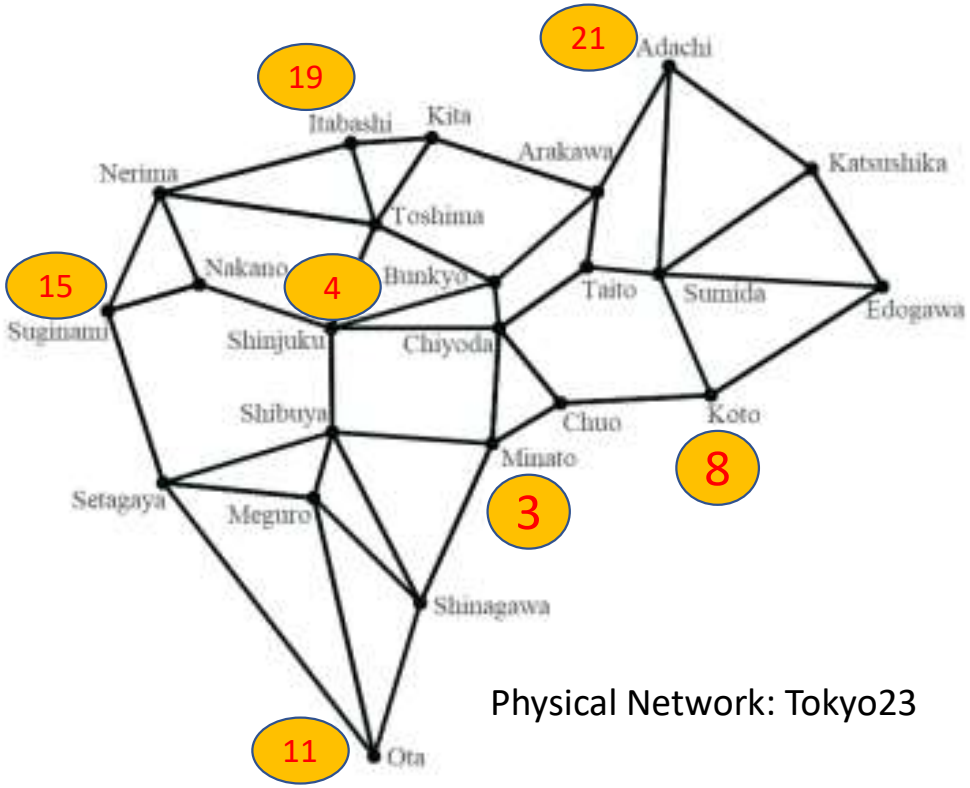
Numerical Simulation



Logical Topology: H(7,3)



Physical Network: Tokyo23

Numerical Simulation

CC-1, 1 Datacenter	
DC Location	Cost
3	54
4	54
8	54
11	54
15	54
19	54
21	54

CC-1, 2 Datacenters	
DC Location	Cost
3, 4	54
11, 21	54
8, 15	54
3, 19	54

CC-1, 3 Datacenters	
DC Location	Cost
3, 4, 8	54
8, 15, 21	54

- ✓ Interestingly, there is no difference
- ✓ Reason: logical and physical topos are uniform distributed
- ✓ Consequently, logical links takes non-overlapping paths = shortest paths

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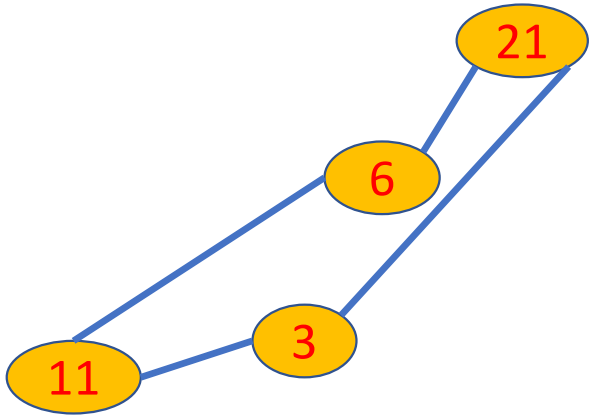
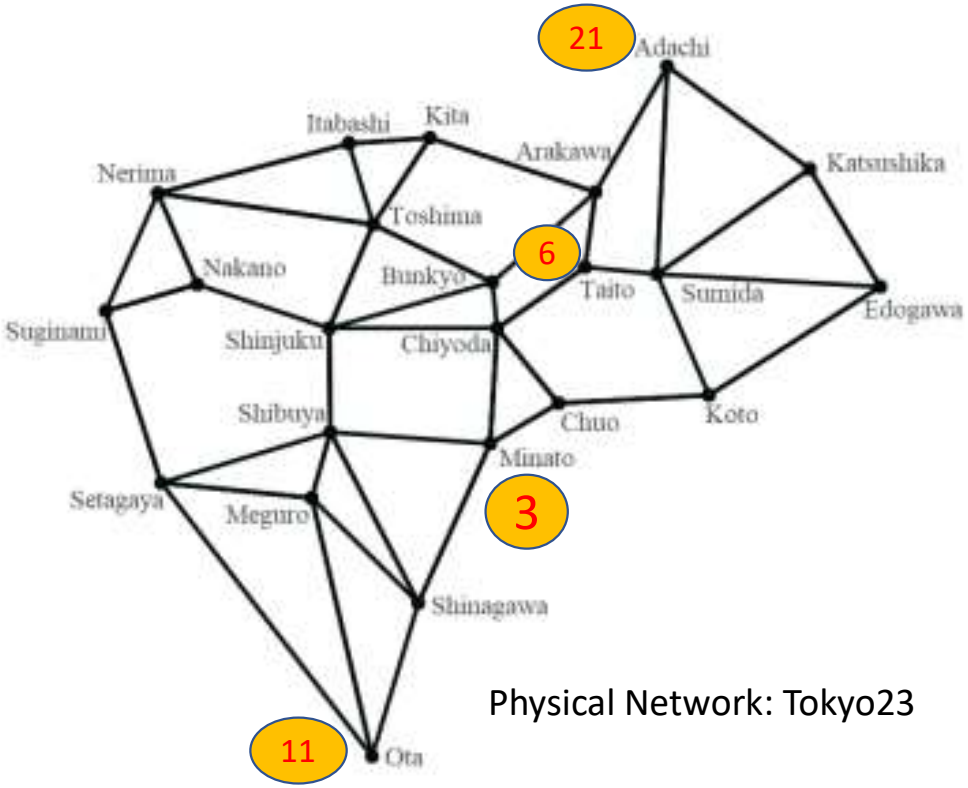
Numerical Simulation



- ✓ All nodes aligned on a line
- ✓ Expected:
  - ➢ Shorted paths: overlapping
  - ➢ CC constraints: avoid overlap
  - ➢ DC location: key role



Physical Network: Tokyo23

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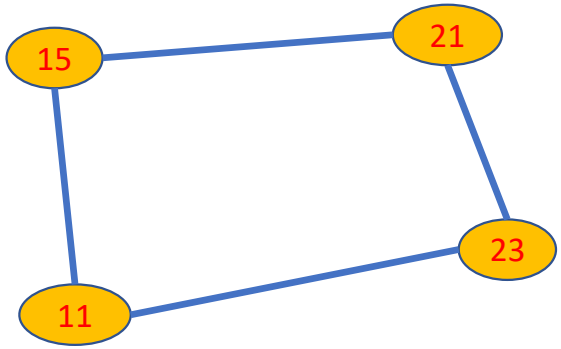
Numerical Simulation

Datacenter at 11 and 21	
Scenario	Cost
NC-1	24
CC-1	26

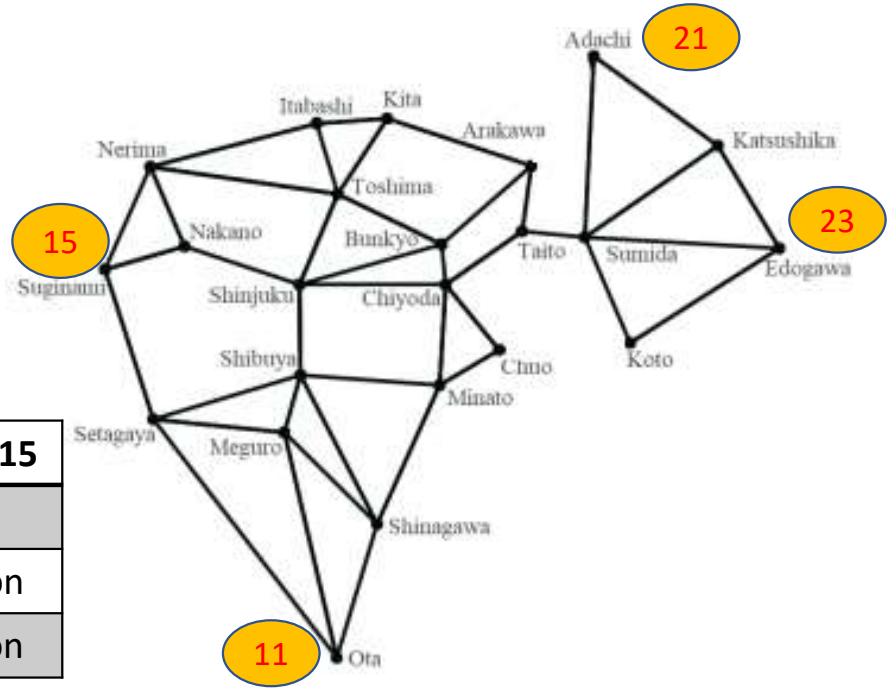
Datacenter at 3 and 6	
Scenario	Cost
NC-1	26
CC-1	26

Numerical Simulation



Datacenter at 15 and 23	
Scenario	Cost
NC-1	No solution
CC-1	32

Datacenter at 11 and 15	
Scenario	Cost
NC-1	No solution
CC-1	No solution



Physical Network: Modified Tokyo23

Ongoing work:

✓ DC placement with highest availability

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