Smart content dustribution

Lukovszki Tamás

A projekt a Kutatási és Technológiai
Innovációs Alap támogatásával valósul meg.

Smart content distribution

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- Simplicity of creating, distributing content causing an enormous load on the networks.
- Challenge: development of more cost-effective communication.
- Multimedia real-time content distribution is a very complex task.
  - Caching, virtualization, distributed storage, streaming, content centric networking

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Smart content distribution

- Peer-to-peer (P2P) content distribution:
  - considered as one of the most efficient and most popular method for distributing content
  - P2P: connection between equal partners
- It allows to share multimedia content for millions of users at the same time.
  - Peers download and upload content from each other
  - Radically reduces the load of the server

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Smart content distribution

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- Our Focus:
  - Open source Java network coding library
    - EIT project (Smart Ubiquitous Content, 2013)
  - Overlay management, neighbor selection
  - Network coding based P2P streaming
  - Network coding based distributed storage
  - Early identification of P2P traffic

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Network coding

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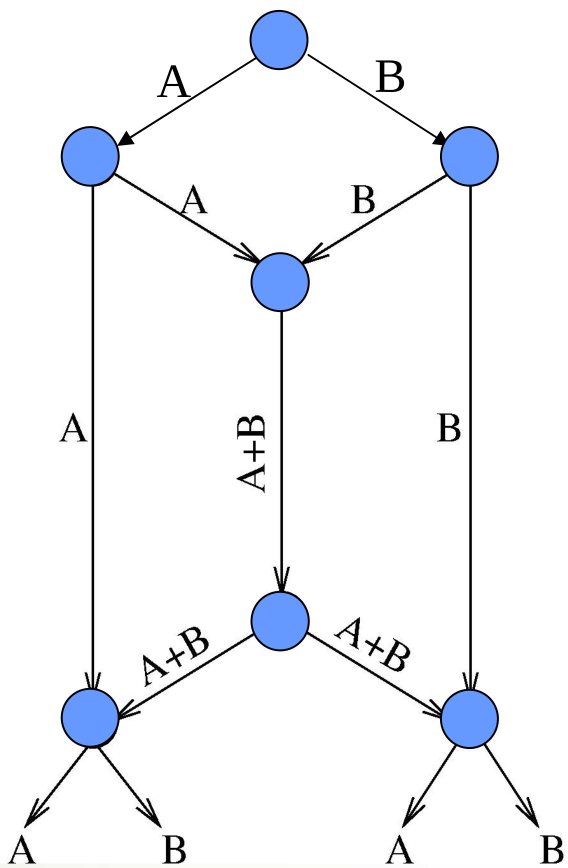
- Nodes are able to combine packets
- For all graphs, there is
  a network code, s.t.
  from a source node
  to a set of destination nodes
  the rate of the multicast can achieve
  the „cut bound”.
  [Ahlswede et al. 2000]
- Computable in polynomial time
  [Jaggi et al. 2005]
- Random Linear Coding is popular



Open Source Network Coding Library

- Developing an open source Java Network Coding library
  - Support for deterministic network coding method
  - Deterministic source coding has been developed and analyzed in our previous projekt in 2012
- Key: supporting peer-to-peer streaming
  - particularly in mobile environments
    - limited memory and computing resources (typical for mobile devices)
- EIT projekt: Smart Ubiquitous Content 2013
  - Partners: U. Trento, Telecom ParisTech, France Telecom Orange, KTH, T-Labs at TU-Berlin, BME, ELTE

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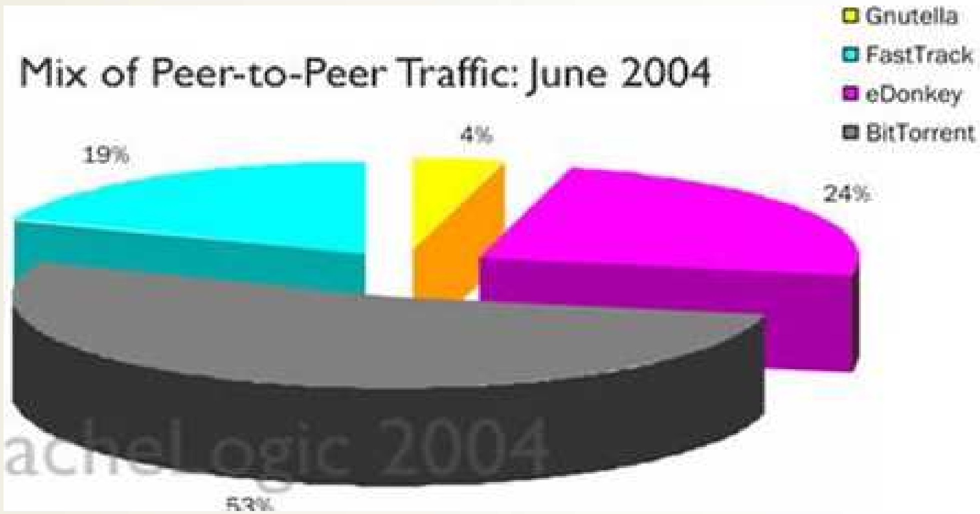
BitTorrent Networks

- **BitTorrent:**
  - Efficient and very popular file sharing system
  - Unstructured P2P network
  - 2001 – Bram Cohen – BitTorrent Inc.
  - And nowadays: More than 30% of the overall Internet traffic



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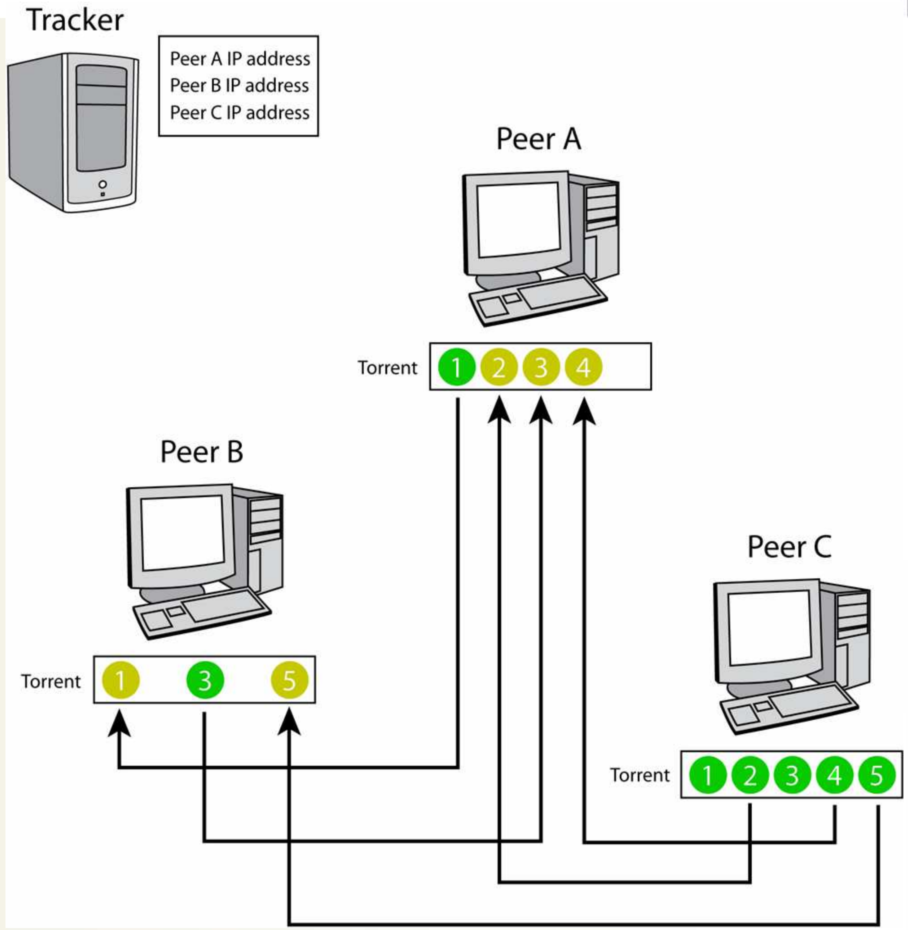
BitTorrent Networks

- Initialization
  - Peer connects to the tracker
  - obtains a list of neighboring peers downloading the same file
- File download
  - File is divided into pieces
  - Peers download pieces from their neighborhood
  - In the same time they upload to other peers



Overlay Management for BitTorrent-Like Networks

- The effectiveness of downloading largely depends on the neighbors of the peer.
- We have developed a new neighbor selection strategy.
- Distributing b blocks in a network of n peers in

O(b + log n) time steps, w.h.p.*

- Improves on previous best upper bound.
- Optimal up to a constant factor.
- Clients: no modification; Tracker: only slight modification

*An event E occurs with high ptobability (w.h.p.), if given $n > 1$, $Pr[E] > 1 - 1/n^c$, where $c \geq 1$ is a constant

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Simulations: Out-Degree

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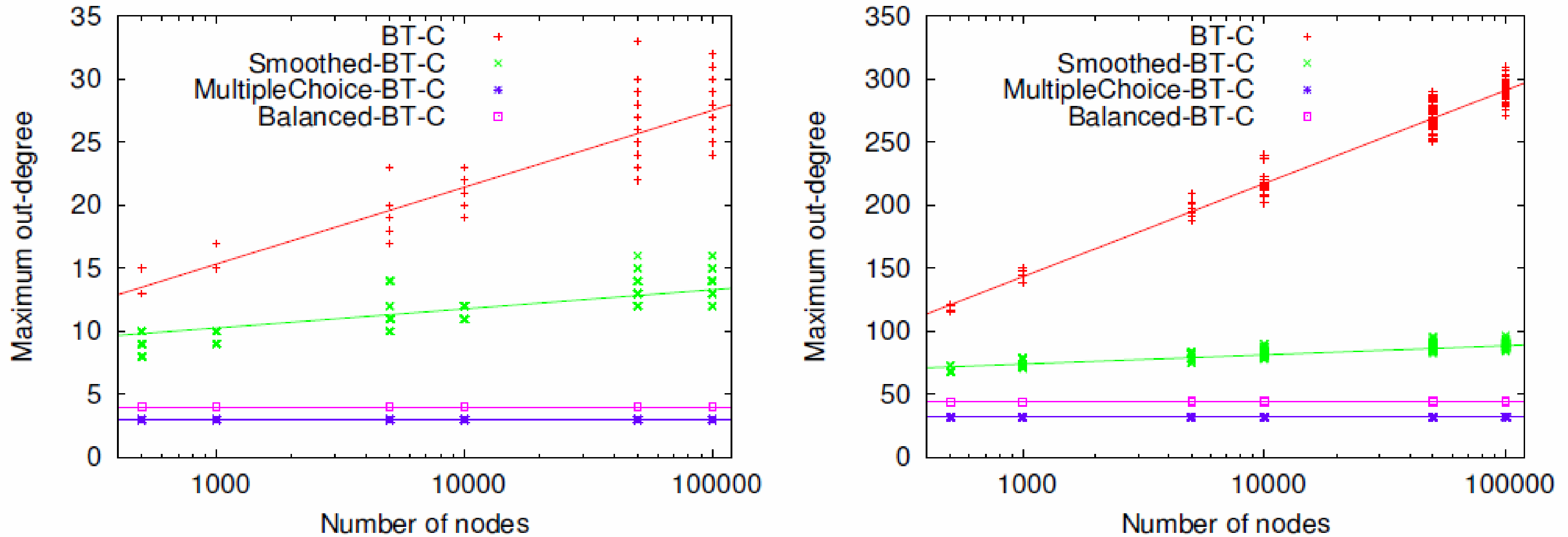
Parameters: n varies from 500 to 100000, C=2,30

Simulations have been repeated 100 times

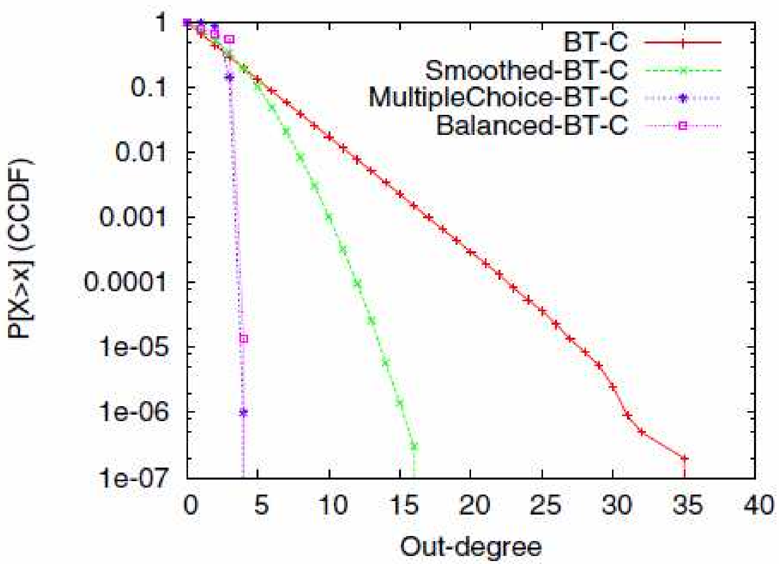


(a) C=2 (b) C=30

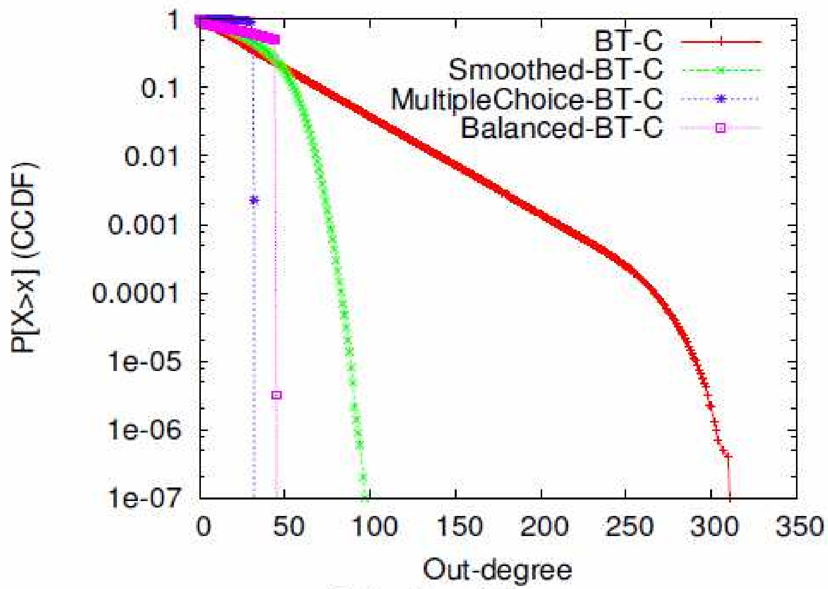
Simulations: Out-Degree

Parameters: n varies from 500 to 100000, C=2,30

Simulations have been repeated 100 times



(a) C=2

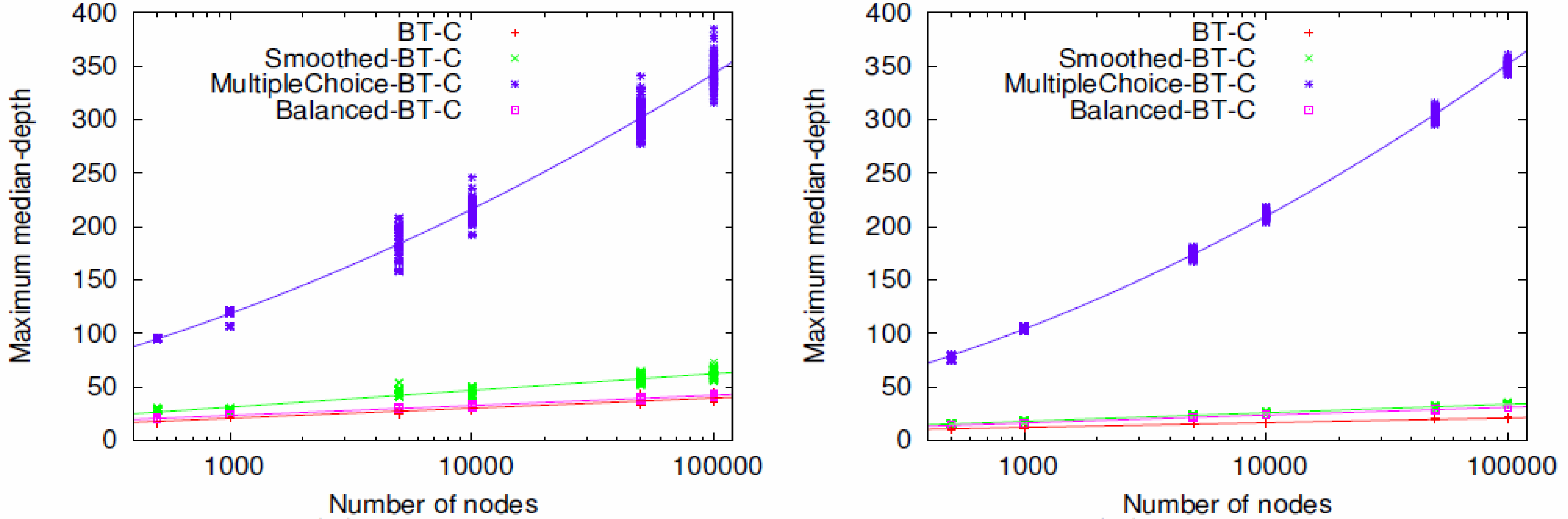


(b) C=30

Simulations: Median Depth

Parameters: n varies from 500 to 100000, C=2,30

Simulations have been repeated 100 times



(a) C=2 (b) C=30

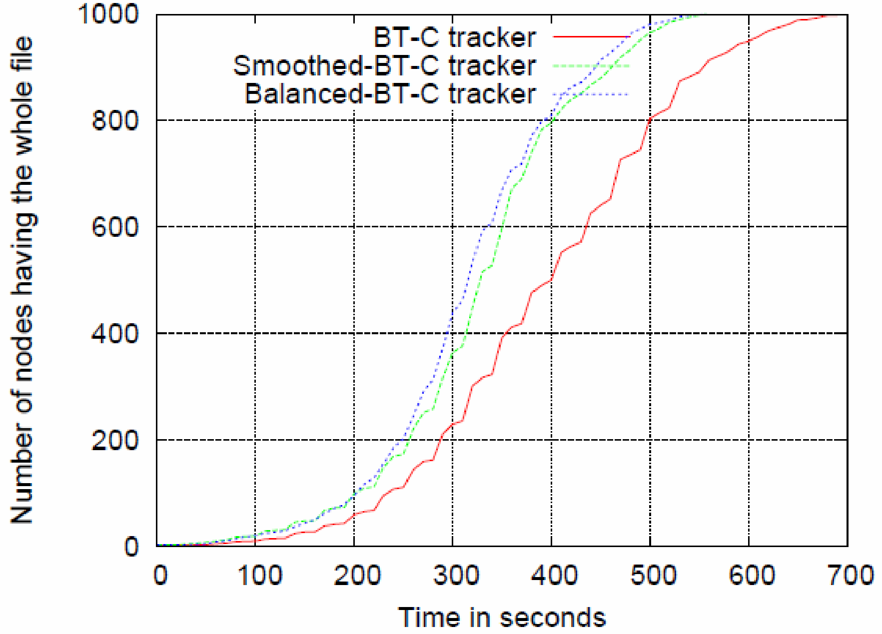
PeerSim Simulations: Download Time

Constant delay and link bandwidth

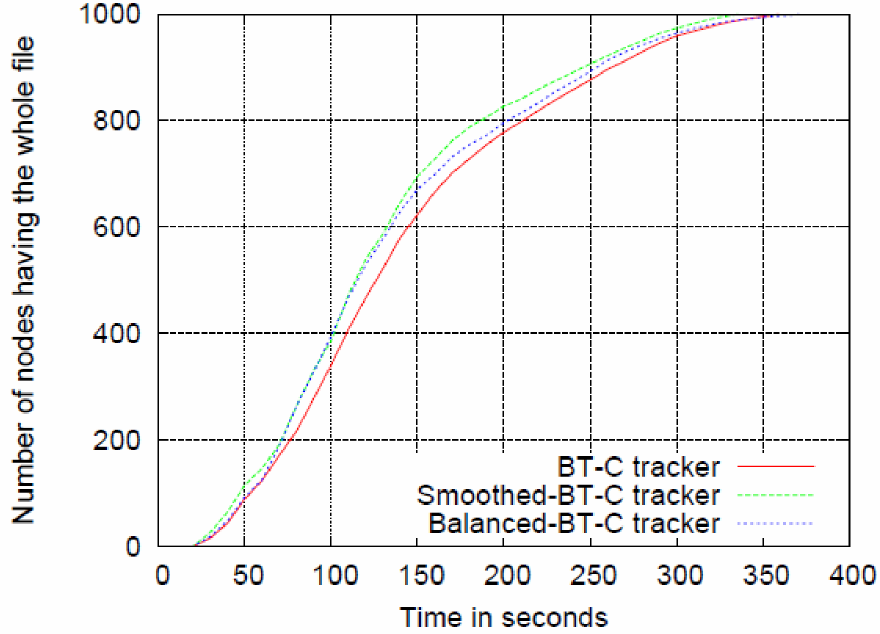
1000 peers joining one by one in a short time period (flash crowd)

File size 10MB

Simulations repeated 20 times



(a) C=4



(b) C=30

Extending BitTorrent with Network Coding

„Rescueing tit-for-tat with network coding" [Locher et al. 2007]

- Transmit random combination of blocks
- Decode the file after collecting enough linearly independent blocks
  - Increases the diversity of blocks
  - Avoids the problem of rear pieces

- Alternative solution: deterministic network coding [Agocs, Balaton, Lukovszki 2012]
  - Decodability is guaranteed
  - Checking independence of vectors: disjoint <==> independent
  - Lower communication overhead

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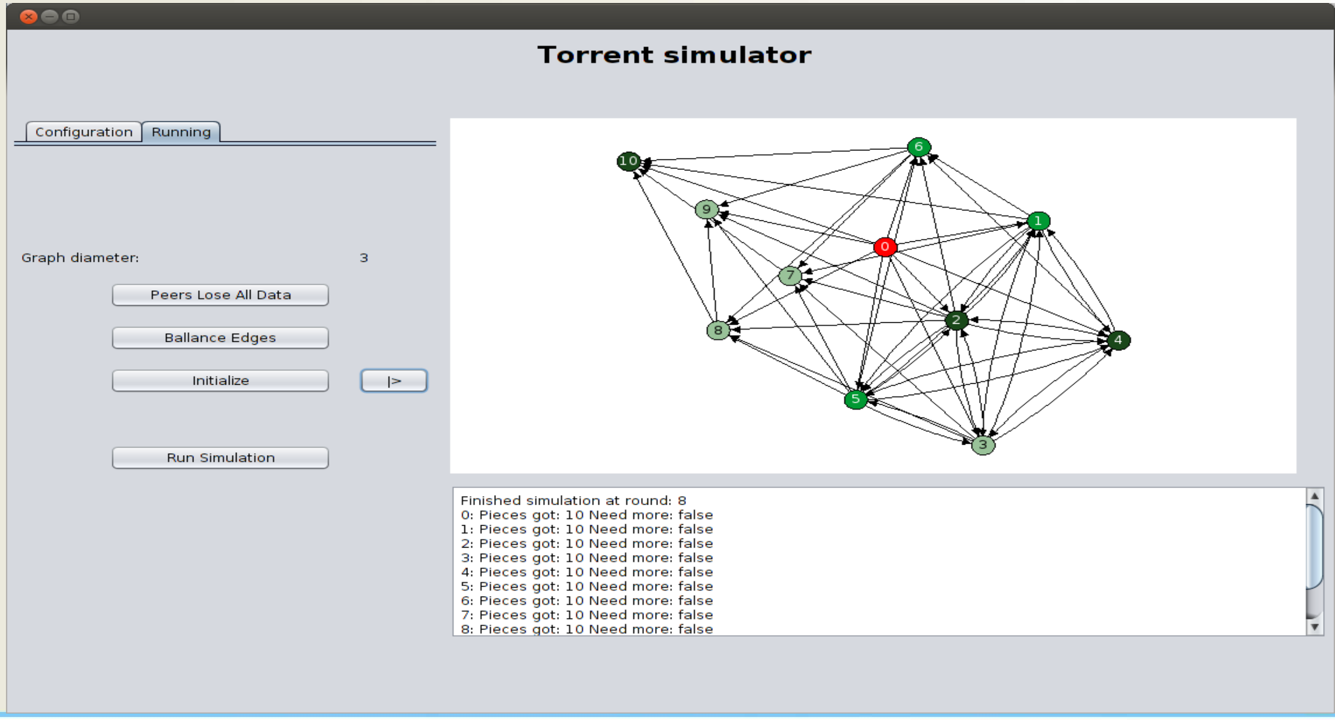
Network Coding Based BitTorrent Simulator

- Round based simulator
  - Overlay management: several neighbor selection strategies



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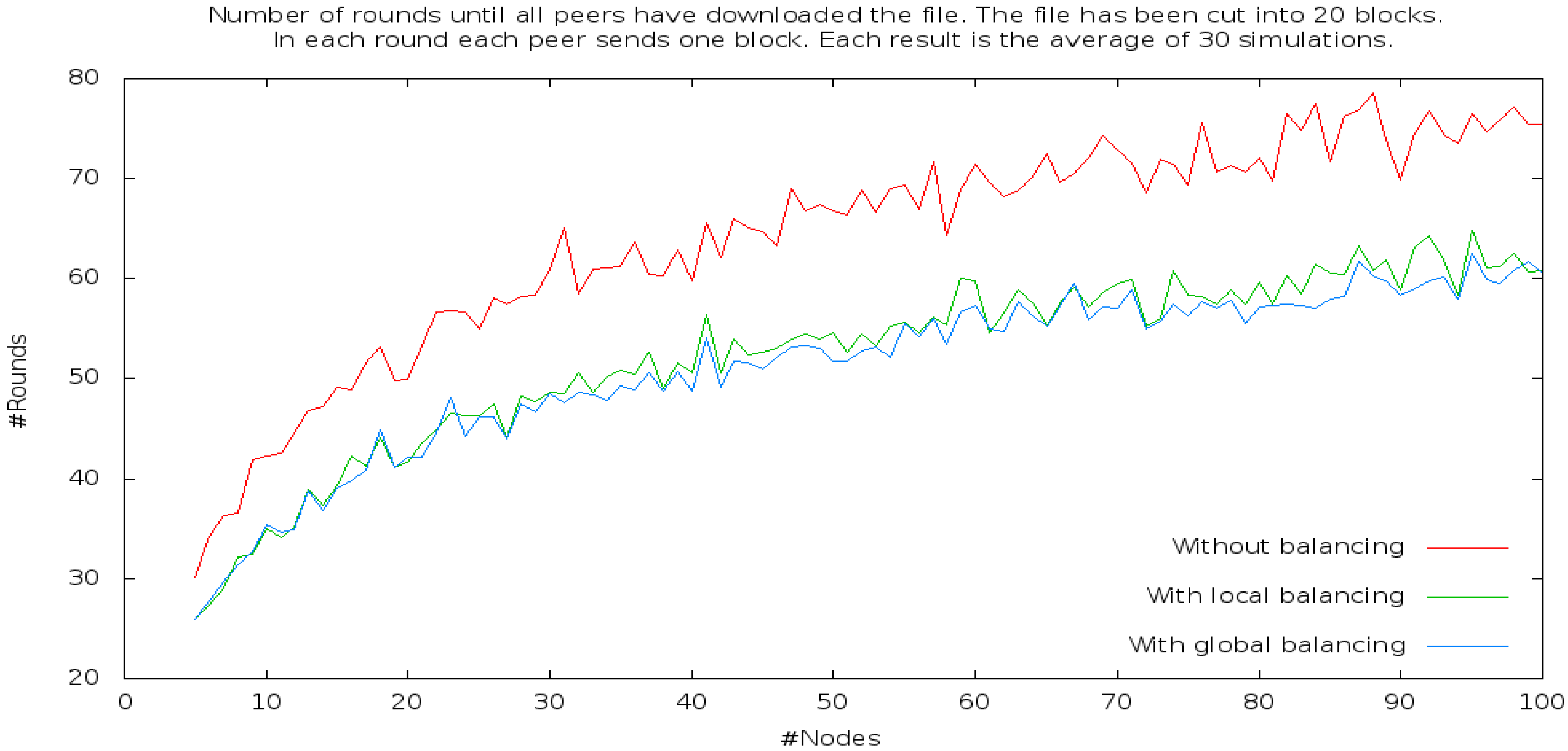
Network Coding Based BitTorrent Simulator

ÚJ SZÉCHENYI TERV



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Network Coding Based Streaming Simulator

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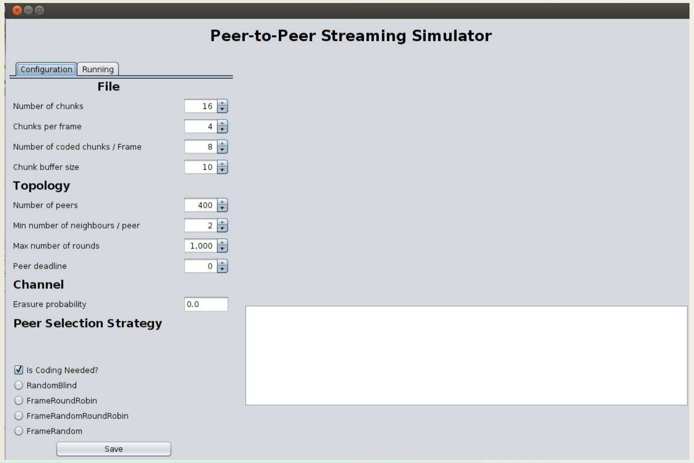
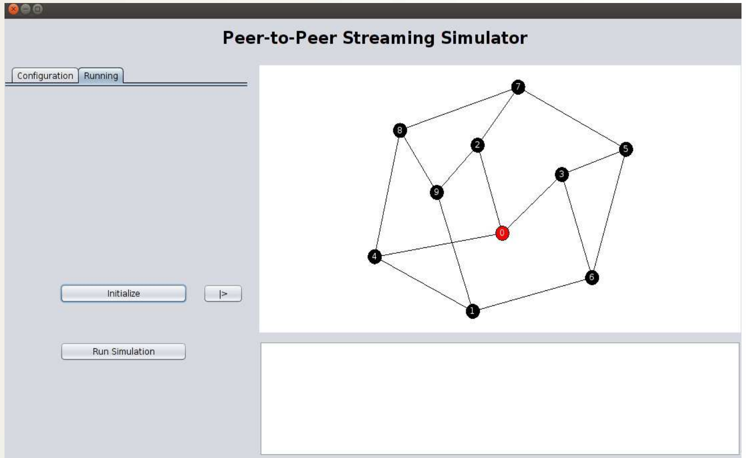
- Round based simulator
- Overlay management:
  - random neighbor selection
  - balanced neighbor selection
  - random d-regular graphs
- Chunk selection strategies
- Peer selection strategies
- Buffer management
- Erasure channels





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Network Coding Based Streaming Simulator

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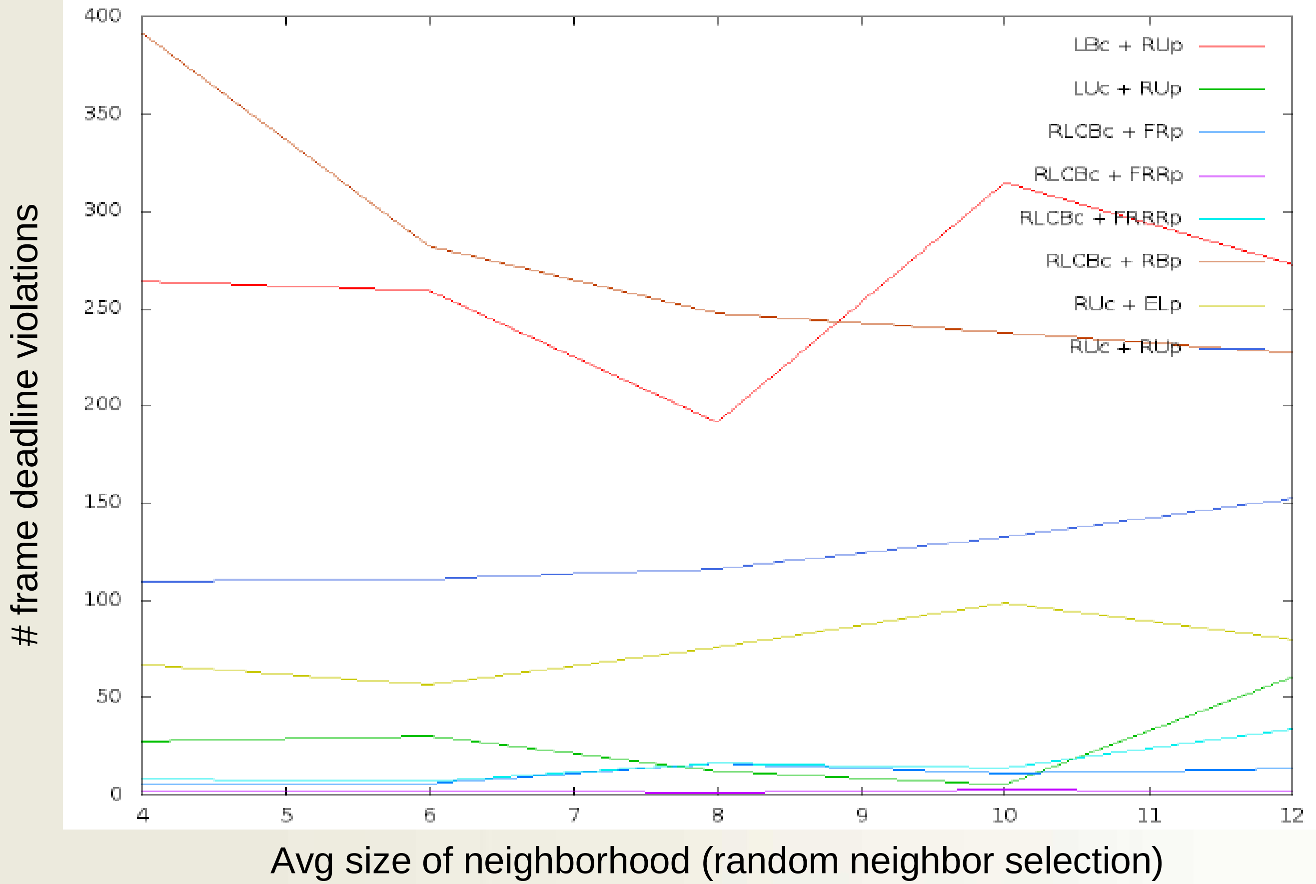

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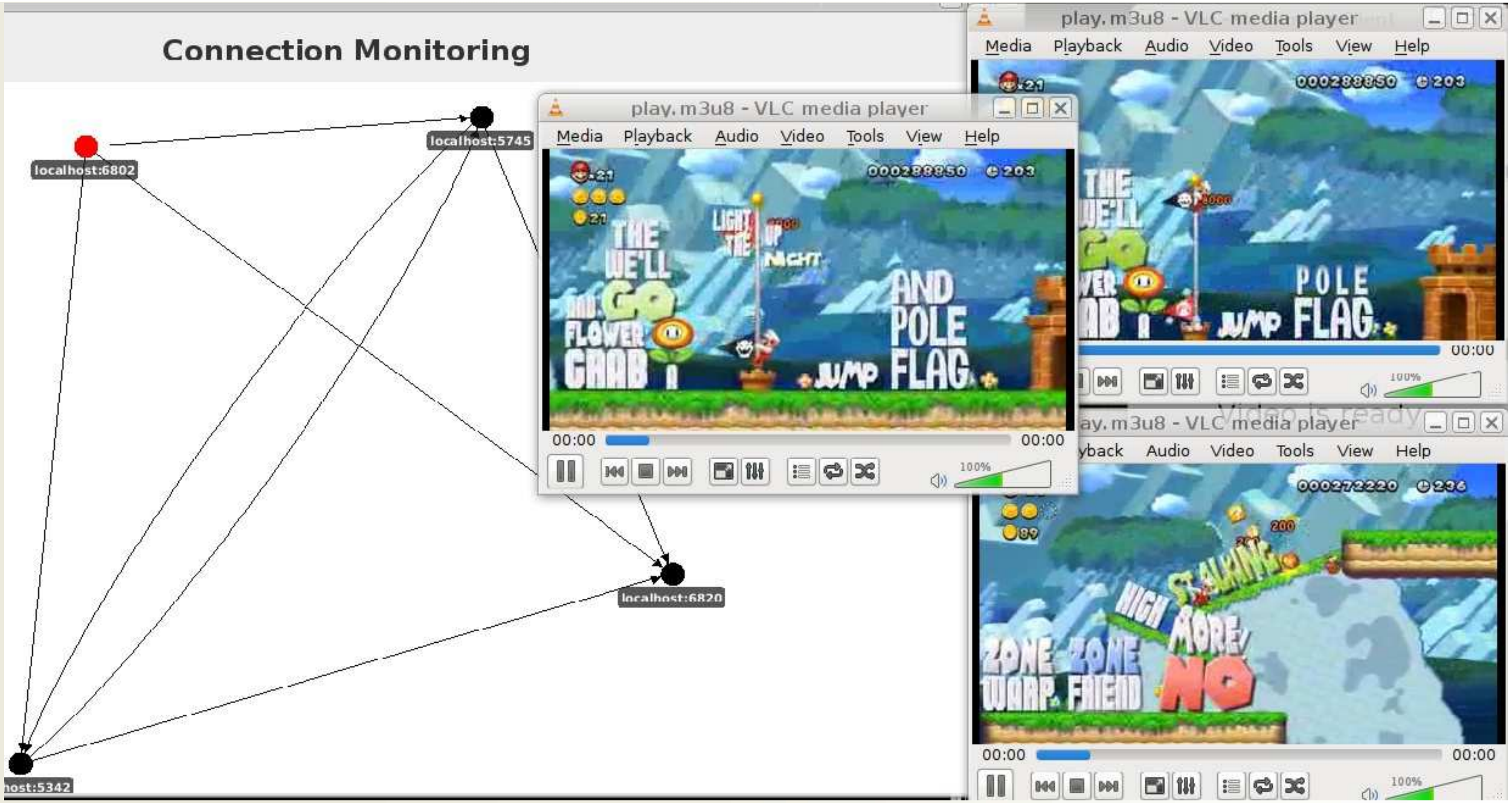
Network Coding Based Streaming



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Network Coding Based Distributed Storage Simulator

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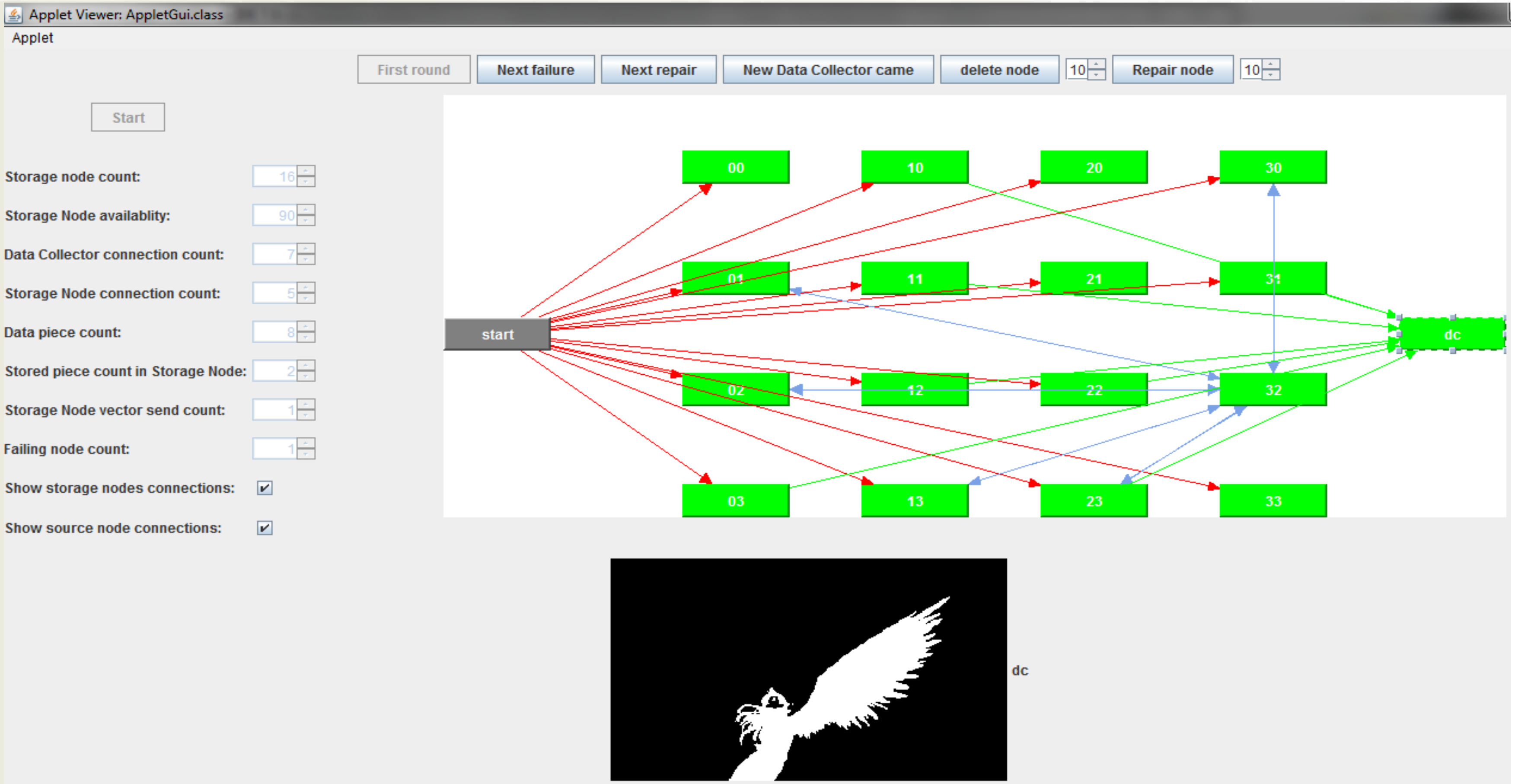
- Distributed storage systems use redundancy to provide reliable access to data spread over individually unreliable nodes.
- In case of a node failure a new node must substitute the failing one.
- We are examining, how network coding can be used to reduce the repair traffic in distributed storage systems
- Developing a network coding based distributed storage simulator
- Considering also erasure channels

Network Coding Based Distributed Storage Simulator



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Participants

Researcher:

- Dr. Tamás Lukovszki (team leder)
- Sándor Laki

Students:

- Dániel Csubák
- Marcell Kressz
- Péter Varga
- Péter Vörös

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Publications

1. Sándor Laki, Tamás Lukovszki: On a Balanced Neighbor Selection Strategy for Tracker-Based Peer-to-Peer Networks. In: *13th IEEE International Conference on Peer-to-Peer Computing (P2P'13)*, 2013.

2. Sándor Laki, Tamás Lukovszki: Balanced Neighbor Selection for BitTorrent-Like Networks. In: *21st European Symposium on Algorithms (ESA 2013)*, Springer, LNCS, Vol. 8125, pp 659-670, 2013.

3. László Blázovics, Tamás Lukovszki: Fast Localized Sensor Self-Deployment for Focused Coverage. In: *9th International Symposium on Algorithms and Experiments for Sensor Systems, Wireless Networks and Distributed Robotics (ALGOSENSORS 2013)*, Revised selected papers: Springer, LNCS Vol. 8243, pp 83-94, 2014.

4. László Blázovics, Tamás Lukovszki, B. Forster: Surrounding robots -- A discrete localized solution for the intruder problem. In: *Journal of Advanced Computational Intelligence and Intelligent Informatics*, Vol. 18(3), 315-319, 2014.

5. Béla Hullár, Sándor Laki, András György: Efficient methods for early protocol identification. Accepted: *IEEE Jornal on Selected Areas in Communications (JSAC), Special Issue on Deep Packet Inspection: Algorithms, Hardware, and Applications, 2014.*

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Thank you!

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