Assignment Topics

What follows is a list of suggested topics for your assignment. Get inspired by it! If you don't find a topic that you like here or if you have some nice idea not listed here... contributions to the list are welcome, but require instructor approval :)

Epidemic Dissemination

Performance of different epidemic protocols

This is the ideal "KIND1 - theory validation" assignment, suitable for MESA.

Check the report template document where, essentially, this sugessted assignment is described in more detail. In short, implement different anti-entropy or rumor-mongering mechanisms and then study and compare their convergence speed. It is also interesting to keep count of the number of messages genereated during the whole dissemination process before reaching convergence... which mechanism ensures the greatest efficiency (smaller number of messages)?

If your simulation results provide insigth about the properties of different epidemic protocols then a high mark is almost granted! ;)

Consensus Protocols

Implement an easy consensus protocol of your choice

What about the Mostéfaoui and Raynal consensus protocol with rotating coordinators?

- Define a workload of proposals (sent by nodes according to some given scheduling policy),
- Setup a network of processes with an initial leader
- Let nodes run the consensus protocol that you should implement according to pseudocode shown on slides 25-26 of the "Beyond Impossibility Results" theory slides
- Simulate, from time to time, the failure of nodes
- Implement the Failure Detector as global object that knows everything about the simulation and can, according to your parametrization, inform all simulated processes in a perfect or "less perfect" way.

What happens if you simulate more than f/2 failures? Can you stress your implementation so as to verify the termination properties described on slide 27?

Complex Networks

Another convergence study, parametrized by... network type!

What is the best way to organize our overlay network, supporting our nice P2P content-delivery application, so as to achieve the fastest possible delivery of our files in the whole network?

Go back the epidemic protocols and simulate them over different random graphs https://networkx.org/documentation/stable/reference/generators.html

Measure performance metrics, e.g., termination time and number of generated messages, and try to understand what are the main network properties driving performance. A good report should be able to clarify if and why an Erdos-Renyi graph for some reason better supports epidemic protocols compared to Watts-Strogatz or a Barabasi-Albert network.

P2P

Comparative study of neighbour (or chunck) selection strategies

Chunks: "Rarest-first" or "strict priority"? For which kind of networks one policy leads to faster download termination time?

Actions list:

- define a parametrized network model. Parameters must be (at least):
  - number of nodes
  - avg node degree
  - bandwidth distribution per channel
  - source-file dimension and its initial replication level over seed-nodes ... some other if you like to be clever! :)
- implement a P2P diffusion protocol similar to Gnutella or Bittorrent and implement both policies
- measure the download time for varying assignments of the model parameter and... comment on these results!

Peers: best latency or larger-bandwidth? Other criteria? Implement different peer selection mechanisms and then measure the emergent feature of the resulting overlay-network. Do some nodes become overly selected, thus overloaded? In a "latency-first" network download-times are higher or smaller than in a bandwidth-first overlay?

- define a parametrized network model. Ofc bandwidth and latency distribution over channels are critical!
- implement different peer-selection algorithms and, for each step of your simulation, measure some network level parameter like "overall bandwidth summing up all overlay channels" "overall latency ..."
- Comment on results! :)

http://disi.unitn.it/~montreso/ds/papers/P2PSurvey.pdf

Beyond Epidemic

Compare Newscast and Cyclon

in MESA or with DES!!! The experiments to be done are somehow already described on slide 10 of the related theory slides.

Simulation parameters (you may choose some others as you prefer) N = 100000 nodes C = 20 neighbors ...

You can measure many different indexes:

- Clustering coefficient
- Average path length
- Degree distribution
- Robustness to catastrophic failures
- Self-cleaning

Comment on the emergent features of the resulting overlay network. For which P2P application you would choose Newscast rather than Cyclon? Provide these kind of conclusions and... high marks will come :)