Theoretical prediction and project report

Every project will be accompanied by a detailed report, which must at least contain the following elements (the order is not important, although some make more sense than others…):

Theoretical prediction report

1. Provide a brief description of the application. Include a discussion of its computational complexity (O(n), O($n$log$n$), …). Provide an upper bound to the achievable speedup using Amdahl's law. Consider the order of complexity of the ratio between processing time and communication time, when increasing the size n of the problem.
2. Define different parallelization strategies, and describe the pros and cons of each one of them. Compute their respective communication complexities, as well the computation to communication ratio.
    a. If you use DPS, draw the DPS flow graph that implements your solution: flow graphs, data object contents, thread collections.
    b. If you use MPI, draw a message-passing graph that describes your implementation, and specify the content of the transferred messages.
    c. If you use OpenMP or CUDA, describe the flow of your program as a sequence of serial and parallel sections (kernels), possibly with the type of chunk decomposition and scheduling used.
3. Provide a detailed theoretical analysis of one or more of your strategies using a timing diagram taking into account measured computation times, estimated communication times, the pipelining of operations, etc. From the critical path, derive a theoretical model enabling predicting the speedup of the application on an arbitrary number of machines. Some applications may have data dependent behaviors preventing a general theoretical model from being derived. In such cases, choose one or two inputs and derive a model for these particular cases. Compare the results with your initial guess using Amdahl's law.
4. If applicable, discuss possible optimizations of the parallel implementation and of the algorithm.
5. Depending on the complexity of the application, implement one or several of the described strategies, and describe the related issues.
6. Evaluate the performance of the application on at least 1, 2, 4 and 8 nodes (on CUDA at least 32 cores). Draw a speedup graph combining the practical and theoretical speedup, as well as Amdahl's law. Mention the reference execution time used to compute the speedups. Discuss any difference between your original prediction and the actual results and provide a corrected model if needed. If applicable, compare practical results for different types of sizes of inputs, the impact of the different optimizations, etc.

The theoretical prediction report must contain parts 1 to 3. The final report is an extension of the theoretical prediction report that includes parts 4 to 6 and may include corrections to the original prediction model.

The report should be fairly brief and include figures and graphs. A printed version of the report is to be delivered. In addition, the pdf of the report, the source code and the data of the application, with a user manual about how to launch the application are to be delivered on a CD-ROM or DVD.