DEPENDABLE SYSTEMS AND SOFTWARE

Data Networks 2015 Dr. Arnd Hartmanns

# ML3: Randomised Multiple Access Protocols

The soft deadline for this modelling lab is August 09. The hard deadline is August 31.

> **Submission:** Your submission must be a `.zip` file that contains, at the top-level (i.e. not within any subfolders), the files specified in the task descriptions. Document any non-default settings you use for your experiments with modes (except for number of simulation runs), and explain why you need to use them and why you can do so without affecting your results in an undesired way. Your models must be free of any nondeterminism.

**Task 1**: CSMA, CD, BEB, Aloha

Your task is to model and evaluate CSMA-based multiple access protocols using MODEST. You shall consider all combinations of $\{$ *CSMA*, *CSMA/CD* $\}$ and $\{$ *Aloha Backoff*, *Binary Exponential Backoff* $\}$: CSMA and CSMA/CD are two different ways to determine 1) when to start sending and 2) when to stop sending as described in the lecture, whereas the two backoff schemes prescribe the way that retransmissions take place. *Aloha Backoff* is attempting a retransmission (if the medium is sensed idle) with probability $p$ in each slot of 1 packet transmission time following the end of the previous sending attempt (analogous to how the ALOHA protocol works); *Binary Exponential Backoff* (BEB) is as described in the lecture.

Use the template provided in dCMS to create a model including four nodes. The template already models a physical layer as well as upper layers that generate data packets to send. Carefully read the comments included in the template. The modelled physical layer represents a simplified broadcast medium with a maximum propagation delay of just less than 0.25 time units between any two nodes. Nodes start a transmission by synchronising with their physical layer process on action `send_start`, and finish the transmission by `send_stop`. The time between `send_start` and `send_stop` must be at least 0.5 time units to make sure that no collisions go undetected due to the propagation delay. The transmission time for any complete data packet shall be 1 time unit.

(a) Model each of the four protocol combinations. Include a property to determine the expected amount of time needed for the transmission of all `PACKETS` packets.

(Submit your models files named `csma-aloha.modest`, `csmacd-aloha.modest`, `csma-beb.modest` and `csmacd-beb.modest`. Also submit a text file named `description.txt` containing a very brief description of your models and the differences between the four files.)

*Hints:* The differences in MODEST code between your four models can be *very* small. You can look into the sample files included in the MODEST TOOLSET download for inspiration if you get stuck with the BEB implementation (but do not copy & past code). Sampling from the geometric distribution, which in MODEST has range $\{1, 2, \dots\}$, may simplify your *Aloha* implementation. Make sure that you manage the `packetsSent` and `packetsToSend` variables correctly.

(b) Use modes to perform simulation studies of at least 1000 runs each for the four models you have created in part (a) with parameters `PACKETS = 100` and, for the *Aloha* variants, $p \in \{0.35, 0.25, 0.15\}$. Report your results. Which of the protocols performs best? In case this is one of the *Aloha* variants, is there still a reason to prefer BEB in practice?

(Submit your results and answers in a text file named `results.txt`.)