Dr. Klara Nahrstedt discusses digital transformations of cleanrooms in academic scientific environments. Her presentation focuses not on an industry lab, where they are working to improve scaling and reliability, but on an academic cleanroom lab, which focuses on diverse and riskier research on older equipment. One of the challenges is the multi-model facet of data which is looked at such as images from microscopes, graphs, optical images, spectrographs, and different types of metadata. Another challenge is the old equipment in these academic labs, some of which do not offer any means of capturing or storing data in a digitized manner. The implication is that the means of data capture from the instrument to the office computer is in the form of “sneakernet”, by walking a flash drive between two computers to transfer data. This method of data transfer has risks in security, has limited transport space, and can result in lost or forgotten flash drives. Furthermore, manual notetaking of any experiment can lead to inconsistencies and/or inadequate documentation.

The first proposed solution, or digital transformation, to meet some of the above challenges is a digital transformation via private cloud. For the labs Dr. Nahrstedt has been working with data is the research, while for computer scientists and computer researchers data is auxiliary and the algorithm is the result. The question then becomes how to design the cloud to deal with multi-model data. The direct web interface created into the private cloud had no thumb drives, had highly secured storage, and could transport large volumes of data all the while being easy to use. The data could be analyzed in real time which was a definite improvement over the old way of handling data with thumb drives.

The second digital transformation is around the aging technology in the campus labs. Simply upgrading to new personal computers in the lab is not as simple as it sounds. The microscopes used in these labs “are developed by a very different industry than the operating system and the computers”. (Dr. Nahrstedt) The operating system is developed by microsoft, the underlying hardware is either Intel or AMD, and the microscope is developed by Siemens or other scientific instrument manufacturers. These instrument manufacturers create the device drivers which drive the scientific instruments. Thus, the lab is stuck with the old computers until the instrument manufacturer creates a new driver for the new hardware and/or operating system. These device drivers could take years for the instrument manufacturer to create and they might never make one for the new technology if the specific hardware used in the lab is not being sold anymore. In addition, the instrument manufacturer could ask the lab to fund the device driver development. These older systems could have a performance mismatch with the network and there are also security concerns. The proposed solution is to put an edge device between older instruments and the private cloud. This solves the performance and security problems by giving older computers the ability to interface to modern technology.

The third digital transformation is around how to manage the impact of microclimate on the integrity of experiments. Imagine a clean room where the fume hoods from experiments cause excess humidity in said room which, in turn, creates a thin film of moisture over a microscope lens. The solution to this problem is to log environmental data, in real time via different sensors, so that those running experiments in the lab not only have access to the data of their experiments but also have access to what the environment was like when the experiment was being conducted. The system should be programmable so that thresholds can be set to notify cleanroom personnel that the lab is out-of-specification for conducting experiments.

The last data transformation of these clean rooms came about when the clean room researchers were asked, “What is currently your biggest issue with respect to these instruments?” The researchers stated that each of these devices are driven by pumps: oil pumps, chemical pumps, vacuum pumps, etc. When these devices go down then nothing happens and they have to be replaced. What was needed was a system that could detect when a pump was about to go down. Dr. Nahrstedt and her team created an IOT system that monitors pump performance and could provide an alert when the pump was about to fail.

The last slide presented stated that “digital transformations in scientific labs are challenging but necessary.” (slide presentation) Also, many challenges such as instrument maintenance, sustainability of cyber infrastructure, and compression of IOT sensory data still remain.