Establishing a network for clock comparisons

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Since 1967, the realization of the SI unit second is based on microwave atomic clocks probing the narrow ground-state hyperfine transition (9.2 GHz) in cesium atoms. In the following time, the accuracy of cesium atomic clocks has improved by approximately one order of magnitude per decade, and the best clocks now have accuracies of a few parts in 10^{16}. Next generation clocks rely on narrow optical atomic transitions that are probed by laser light. These optical clocks take advantage of the fact that the achievable instability scales with the ratio of the clock transition frequency to its linewidth. While the linewidth-limiting processes are of similar order in both microwave and optical domains the frequency is larger by a factor of ~50000 for optical clocks. Together with an excellent control of the systematic effects in or even below the 10^{-17} range optical clocks may trigger a redefinition of the SI unit second in the future. But optical clocks are not only beneficial for timekeeping. They also act as extremely sensitive probes that allow tracking of minute variations, e.g. of earth's gravitational field through the relativistic redshift or of fundamental 'constants' by comparing different types of clocks.

To fully exploit the potential of these clocks it is necessary to compare them within a network, which is not straightforward since their operation frequencies may be separated by hundreds of terahertz. Here, since 1999 modelocked femtosecond lasers have revolutionized the field of frequency metrology as their regular comb-like optical spectra provide a simple and accurate link across the optical and microwave frequency domains. Nevertheless, with the rapid advances in the development of clocks the requirements to the spectral transfer capabilities of frequency combs are growing continually.

I will report on the establishment of a campus-wide fiber network including several frequency combs to connect numerous frequency standards in both optical and microwave domain. I will discuss possible uncertainty contributions that may be introduced by the network focusing on the frequency combs.