Newton-Multigrid or Nonlinear Multigrid?

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Nonlinear multigrid methods such as the Full Approximation Scheme (FAS) and Newton-multigrid (Newton-MG) are well established as fast solvers for nonlinear PDEs of elliptic and parabolic type. In this presentation Newton-MG and FAS iterations are considered in a general setting and a theoretical approximation of the execution time of the algorithms is derived, which is shown to be sharp, that clearly demonstrates that Newton-MG is a faster iteration for finite element discretisations. Results are provided for elliptic and parabolic problems, demonstrating a faster execution time as well as greater stability of the Newton-MG iteration. Results are tied in with current theory for the convergence of multigrid methods, giving a qualitative insight into how the nonlinear multigrid methods can be expected to perform in practice.