The role of phase transitions in network control and design

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A common characteristic of many ad hoc networks being currently developed is their large scale. This is particularly true of proposals for the so called "smart dust" which aim to create networks by sprinkling an extremely large number of very simple nodes to create ad hoc networks for tasks such as surveillance, temperature monitoring, earthquake detection, etc. Large scale stochastic systems exhibit complicated macroscopic behaviour on an aggregate level, among the most interesting of which is the existence of multiple phases : identical local dynamic can give rise to widely different global dynamics. Some instances of this phenomenon in communication networks will be discussed.

Network design problems are considerably complicated and enriched by the phenomenon of multiple phases. For instance, certain phases may be more desirable than others, so one of the goals of design should be to ensure that the dynamics of the more favourable phase dominates the global behaviour of the network. What is more, control of the network can exploit the existence of multiple phases : the control effort can be expended cleverly so as to create the appropriate pattern of global dynamics in the network to achieve the desired goals with least effort. Examples of such design issues in the networking context that involve multiple phases will be discussed.

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