Computer Networks

Volume 54, Issue 8, 1 June 2010, Pages 1245-1265

Resilience and survivability in communication networks: Strategies, principles, and survey of disciplines

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https://doi.org/10.1016/j.comnet.2010.03.005

Abstract

The Internet has become essential to all aspects of modern life, and thus the consequences of network disruption have become increasingly severe. It is widely recognised that the Internet is not sufficiently resilient, survivable, and dependable, and that significant research, development, and engineering is necessary to improve the situation. This paper provides an architectural framework for resilience and survivability in communication networks and provides a survey of the disciplines that resilience encompasses, along with significant past failures of the network infrastructure. A resilience strategy is presented to defend against, detect, and remediate challenges, a set of principles for designing resilient networks is presented, and techniques are described to analyse network resilience.

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Keywords

Communication network; Future Internet resilience; Fault tolerance; Survivability; Disruption tolerance; Dependability; Reliability; Availability; Security; Performability; Critical infrastructure; Defence; Defense; Detection; Remediation; Recovery; Restoration; Diagnosis; Refinement; Metrics

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Dr. David Hutchison is Director of InfoLab21 and Professor of Computing at Lancaster University and has worked in the areas of computer communications and networking for more than 25 years. He has recently focused his research efforts towards network resilience. He has completed many UK, European and industry-funded research contracts and published many papers as well as writing and editing books on these and related areas. He has been an expert evaluator and member or chair of various advisory boards and committees in the UK (EPSRC, DTI, OFTEL, e-Science, UKLight, UKCRC, JISC, DC-KTN) and within the EU through several Framework Programmes. Also, he has served as member or chair of numerous TPCs (including the flagship ACM SIGCOMM and IEEE Infocom), and of journal editorial boards. He is an editor of the renowned Lecture Notes in Computer Science and of the Wiley CNDS book series.

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Dr. Marcus SchÃ¶ller is a research scientist at NEC Laboratories Europe, Germany. He received the diploma in computer science at University of Karlsruhe, Germany, in 2001 and his doctorate in engineering in 2006 on robustness and stability of programmable networks. Afterwards he held a postdoc position at Lancaster University, UK, focusing his research on autonomic networks and network resilience. Marcus is currently working on the EU FP7 projects ResumeNet, with a focus on future network architecture with resilience as a key property, and the EU FP7 BeFemto project, which investigates next generation LTE-A femtocell technologies and business opportunities. His interests also include network and system security, intrusion detection, self-organization of networks, future network architectures, mobile networks including mesh and opportunistic networks.

Dr. Paul Smith is a senior research associate at Lancaster Universityâ€™s Computing Department. He submitted his Ph.D. thesis in the area of programmable networking resource discovery in September 2003, and graduated in 1999 with an honours degree in Computer Science from Lancaster. Paul is interested in the various ways that networked (socio-technical) systems fail to provide a desired service when under duress from various challenges, such as attacks and mis-configurations. In particular, his work has focused on the rich set of challenges that face community-driven wireless mesh networks and how they can be tackled. He is currently working on an EU FP7 project called ResumeNet, which is investigating a framework and mechanisms for future Internet resilience.

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