Dependability Challenges in the Age of Omnipresent Computing

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1. Overview

As this decade (2011-2020) will be dominated by embedded and cloud computing, the omnipresence of universal use of such systems will only further raise expectations of the users, whose daily lives are increasingly dependent on such systems. This trend will force system manufacturers and operators to deliver higher levels of dependability. Meeting user expectations will not be easy as dependability is and will remain a key and permanent challenge due to: ever-increasing systems complexity, growing connectivity and interoperability, dynamicity (frequent configurations, reconfigurations, updates, upgrades and patches) and the expected global, 7x24 access and utilization (any place , any time).

Some major roadblocks on the way to universal use of cloud computing, internet of things and phones as main I/O devices are dependability and security which in addition to low power challenge will dominate this decade.

2. Key Dependability Challenges

From my perspective the following key challenges will need further research and novel solutions:

- Proactive Fault Management
- QQ-challenge
- Securability
- Configurability Test and Control
- Translucency
- Dependability Economics

Proactive Fault Management or **One Step Ahead** challenge requires that we develop algorithms and methods of failure prediction in order to avoid a failure (e.g., by failover) or minimize its impact. In 2009, Felix Salfner, Kishor Trivedi and I have started a DSN Workshop on Proactive Fault Avoidance, Recovery and Maintenance (PFARM) as the area is maturing and begins to enter an industrial practice. The potential of such approach is immense as it may improve a system availability by an order of magnitude or more.

QQ-challenge focuses on online quantitative assessment and qualitative measurements (QQ) considering Software and Hardware, Infrastructure/interoperability and Personnel (SHIP). Together with a company AvailabilityPlus GmbH we are able to model and analyze systems using the SHIP-IT approach focusing on evaluation of IT-enterprise availability. With rising proliferation of services it is also imperative to assess service and business process availability based on supporting IT-infrastructure and management.

Securability as with performability in the past as the challenge was a tradeoff between performance and dependability, there is a need to pose a security/dependability challenge. There is no security without dependability and vice versa. But merging these two worlds is by no means trivial and requires expertise in both fields which is relatively rare. Unreliable systems are usually vulnerable to security breaches and low security systems are vulnerable to hostile attacks resulting in crashes or data loss.

Configurability Test and Control challenge should result in development of better configurability test, diagnosis, control methods and configurability architectures. According to Google's study by Robert Stroud (2009) almost 30% of service disruptions are due to configuration problems.

Translucency requires ability to assess effectiveness and cost of dependability techniques at every level, be it hardware, software, operating system, service or business process. Such capability is highly desirable as systems providers and refined users would be able to easily assess where they can get "the biggest bang for the buck."

Dependability Economics concerns the risk and cost/benefit analysis of IT infrastructure investments in an enterprise caused by planned or unplanned downtime as a result of scheduled maintenance, upgrades, updates, failures, disasters and malicious attacks. Research community shied away from this question with only a few notable exceptions (e.g., D. Patterson, UC-Berkeley), yet from industrial perspective the problem is fundamental. Providers and users want to know what will be the Return-On-Investment (ROI) when they invest in dependability improvement.

3. What should be done?

Since keeping the systems running in the age of omnipresent computing is becoming essential for all critical infrastructures and impacts our daily lives, the challenges have to be faced to ensure our economic and social well being for the decades to come.

Miroslaw Malek is professor and holder of Chair in Computer Architecture and Communication at the Department of Computer Science at Humboldt University in Berlin. His research interests focus on dependable architectures and services in parallel, cloud, distributed and embedded computing environments including failure prediction, dependable architectures and service availability.. He has participated in two pioneering parallel computer projects, contributed to the theory and practice of parallel network design, developed the comparison-based method for system diagnosis, codeveloped comprehensive WSI and networks testing techniques, proposed the consensus-based framework for responsive (fault-tolerant, real-time) computer systems design and has made numerous other contributions, reflected in over 200 publications and six books.

He has supervised almost 30 Ph.D. dissertations (ten of his students are professors) and founded, organized and co-organized numerous workshops and conferences. He served and serves on editorial boards of several journals and is consultant to government and companies on technical and strategic issues in information technology. Malek received his PhD in Computer Science from the Technical University of Wroclaw in Poland, spent 17 years as professor at the University of Texas at Austin and was also, among others, visiting professor at Stanford, Universita di Roma “La Sapienza”, Politecnico di Milano, Keio University, Technical University in Vienna, New York University, Chinese University of Hong Kong, and guest researcher at Bell Laboratories and IBM T.J. Watson Research Center.