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Center for Networked Computing

Department of Computer and Information Sciences

That's My DNA: Digital Signatures to Ensure Authenticity and Integrity of Synthetic DNA Molecules

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Abstract: DNA synthesis has become increasingly common, and many synthetic DNA molecules are licensed as intellectual property (IP). DNA samples are shared between academic labs, ordered from DNA synthesis companies and manipulated for a variety of different purposes, mostly to study their properties and improve upon them. However, it is not uncommon for a sample to change hands many times with very little accompanying information and no proof of origin. This poses significant challenges to the original inventor of a DNA molecule, trying to protect her IP rights. More importantly, following the anthrax attacks of 2001, there is an increased urgency to employ microbial forensic technologies to trace and track agent inventories. However, attribution of physical samples is next to impossible with existing technologies. We try to bring in advances in the digital domain to solve this problem. In this talk, we discuss our efforts to physically embed digital signatures in DNA molecules synthesized in the laboratory. We encounter several challenges that we do not face in the digital world that makes this problem interesting. These challenges arise primarily from the fact that changes to a physical DNA molecule can affect its properties, random mutations can accumulate in DNA samples over time, DNA sequencers can sequence (read) DNA erroneously and DNA sequencing is still relatively expensive which means that laboratories would prefer not to read and re-read their DNA samples to get error-free sequences. Moreover, unlike in the digital world where an erroneously received message can be re-sent with little additional cost, it is expensive to re-send an erroneously received sample since the physical sample needs to be created once more. It makes more sense to determine if the erroneously received sequence can still be used.

Bio: Dr. Indrajit Ray is a Professor of Computer Science at Colorado State University. He joined CSU in 2001 moving from the University of Michigan-Dearborn where he worked as an Assistant Professor from August 1997 – July 2001. Dr. Ray obtained his Ph.D. in Information Technology from George Mason University in August 1997. Indrajit's primary research is in computer security and privacy. His major contributions have been in security risk modeling and security protocol design using applied cryptographic techniques. Other areas in which he has made valuable contributions are trust models for security and micro-data disclosure control. He has published more than 150 technical papers. His research has been well funded through various federal agencies. He has advised several Ph.D. students many of whom hold tenured positions in academia. He has also played leadership roles in the academic community by serving as program chairs in various conferences. In 2015 he served as General Chair of the 2015 ACM CCS conference which is the flagship conference of ACM SIGSAC, and in 2017 as the General Chair of the 2017 IEEE CNS conference. He was the founder of the IFIP TC 11, WG 11.9 on Digital Forensics and its first Chair. Recently, Indrajit has helped establish the CSU site of the NSF funded I/UCRC Center for Configuration Analytics and Automation, where he is Co-Director. This multi-university research center that includes fee-paying members from the industry and FFRDCs works with enterprises and government entities to improve service assurabsility, security and resiliency of enterprise IT systems, cloud/SDN data centers, and cyber-physical systems by applying innovative analytics and automation. Currently, he is serving as a Program Director at the National Science Foundation, where is responsible for the Secure and Trustworthy Cyberspace program.