Contribution ID: **578**   Type: **Plenary talk**

Data Storage Redundancy: the Two Matrix Toolkits for Failed Device Reconstruction

Friday 11 July 2025 13:30 (15 minutes)

The network storage systems are treated, organized into several groups of devices with data redundancy capability.
We consider two schemes for managing data reconstruction process, namely the declustered Redundant Array of Independent Disks (RAID) technique and, more generally, the Reed-Solomon (RS) error correction coding within the framework of the Welch-Berlekamp algorithm. These approaches essentially exploit the properties of circulant or Hankel matrices.

The reconstruction of all the units in the failed device causes a certain read/write load onto the survived devices. One of the major requirements to the storage device array is to manage the chunk group distribution across devices to produce a balanced read/write load on survived devices regardless of the location of the failed device. Construction of the data layout with the aid of an appropriate circulant matrix provides one with such an opportunity. This surprisingly relates to the classical Graph Coloring problem.

For the problem of the error locator polynomial construction in the RS-coding, we propose an effective algorithm for recursive computation of the potential candidates in the form of Hankel polynomials.

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Session Classification: Application software in HTC and HPC