Local-Knowledge Algorithms for Structured Message Diffusion in Unreliable Environments

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Motivation

- Reliable information dissemination in large-scale systems - how hard can it be?
  - No precise a priori information about the system characteristics
  - Systems’ dynamic nature
Model and Basic Definitions

- Wired large-scale networks
- Crash-recovery processes
- Adaptive algorithms
  - Better performance than traditional gossip
  - Take system’s configuration into account
  - Process crash probabilities
  - Link failure probabilities
Adaptive Algorithm

- Modular solution
- Graph-Discovery Algorithm (GDA)
  - Let us first learn about the system
  - What is the topology and system’s reliability aspects
- Global-/Local-Knowledge Algorithms (GKA/LKA)
  - Propagation scheme based on GDA
  - Lazy versus Eager LKA
Maximum Reliability Tree - MRT

- Spanning tree containing the most reliable paths connecting all processes in the network

- Global-Knowledge Algorithm
  - Broadcaster builds an MRT
  - Messages are assigned according to link reliabilities
  - Processes follow this scheme
Optimization problem

- Assigning messages to links in such a way to
  - achieve the maximum probability to reach all processes
  - having a constrained number of messages each process can send

\[
\text{maximize } \quad r(T_s, m_s) = \prod_{i=1}^{n_T-1} \left(1 - \chi_i^{m_s[i]}\right)
\]

\[\text{subject to } \quad \forall p_i \in T_s : \quad c_i(m_s) = \sum_{p_j \in Ch(i)} m_s[j] = \alpha \cdot |Ch(i)|\]
Local-Knowledge Algorithms

- Processes rely on limited knowledge
- Some processes recalculate MRT and message assignments
- Two Approaches
  - Lazy LKA
    - Processes at the border of the broadcaster’s knowledge recalculate
    - No right to change a parent’s decision
  - Eager LKA
    - Intermediate processes recalculate
- Tradeoff
  - Computation versus accuracy
Lazy LKA
Lazy LKA

Diagram with nodes labeled $p_1$ to $p_8$ and edges with weights such as 0.05, 0.30, 0.33, 0.25, 0.16, 0.04, 0.15, 0.10, 0.20, 0.22, and 0.13.
Local-Knowledge Algorithms

- Curious about the Eager Approach?
  - Come to the poster session
Thank you