Fault Tolerant Solutions to the Firing Squad Synchronization Problem

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Plan

CA, LCA, FLCA

FSSP

Faulty CA

Freezed CA

Fault Tolerant FSSP:

H. Umeo, J.B. Yunès
CA : Cellular Automata:
- finite automata,
- inputs, outputs,
- synchronism,
- transition function,
- finite set of states, quiescent state,
- cells, configuration,
- space-time diagram.

LCA : Linear Cellular Automata: line of automata,

FLCA : Finite Linear Cellular Automata: finite line of automata,
starting configuration:
  - one general,
  - quiescent soldiers.

synchronizing configuration:
  - firing soldiers.

conditions on the computation:
  - no firing soldiers before synchronization.
Faulty CA

H. Umeo:
- self-diagnosis circuitry,
- faulty and non-faulty cell/regions,
- computation in faulty cells,
- detecting faulty and non-faulty regions,

Freezed CA

Freezing process: a mechanism which permits the computation to be stopped for a good while.

Thawing process: a mechanism which permits a freezed computation to be warmed up.
Fault Tolerant FSSP

H. Umeo:

1. FLCA synchronizing a $p$-faulty $n$-line in $2n - 2$ steps (minimal time): $p$ is known and $\forall i \in [1, p], n_i \geq m_i$.

2. FLCA synchronizing a $p$-faulty $n$-line in $2n - 2 + p$ steps (nearly minimal time): $p$ is unknown, $\forall i \in [1, p], n_i \geq m_i \land n_i + m_i \geq p - i$. 
Fault Tolerant FSSP

Reversing Umeo’s conditions

1. FLCA synchronizing a 1-faulty $n$-line in $2n - 2 + m_1 - n_1$ steps: $m_1 \geq n_1$,

2. FLCA synchronizing a 2-faulty $n$-line in $2n - 2 + m_1 - n_1 + m_2 - n_2$ steps: $m_1 \geq n_1$ and $m_2 \geq n_2$,

3. FLCA synchronizing a $p$-faulty $n$-line in $2n - 2 + \sum_{i=1}^{p} (m_i - n_i)$ steps: $p$ is known and $\forall i \in [1, p], m_i \geq n_i$,

Standardization

- $\forall i \in [1, p], n_i \geq m_i \lor n_i < m_i$