National Aeronautics and Space Administration

partnership opportunity

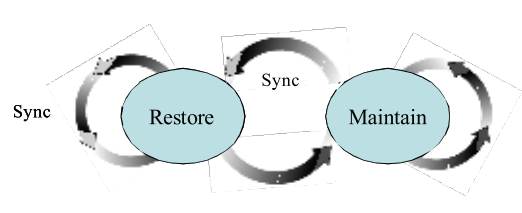
NASA Langley's Byzantine-Fault-Tolerant Clock

A self-stabilizing synchronization protocol

NASA Langley Research Center has developed a protocol for clock synchronization in the presence of Byzantine faults after a transient event has dissipated. In the presence of arbitrary faulty node(s), the method is proven to self-stabilize the clock. The protocol has been shown to tolerate bursts of transient failures and deterministically unite with respect to synchronization period. The innovative protocol's timing measures of variables are based on the node's local clock, and thus, no central clock or externally generated pulse is needed. The protocol produces strong results because it does not rely on any assumptions regarding the initial state or internal status of the system. The minimum assumption enables the protocol to be employed for many practical as well as theoretical applications. NASA is seeking development partners and potential licensees for the patented protocol.

Benefits

- Byzantine fault resilient
- Distributed autonomous synchronization
- Rapid convergence time
- Fast error detection and recovery
- Low communication overhead – single bit synchronization message
- No need to rely on assumptions about the initial state of the clocks
- No central clock or externally generated pulse system



Synchronization flowchart

Applications

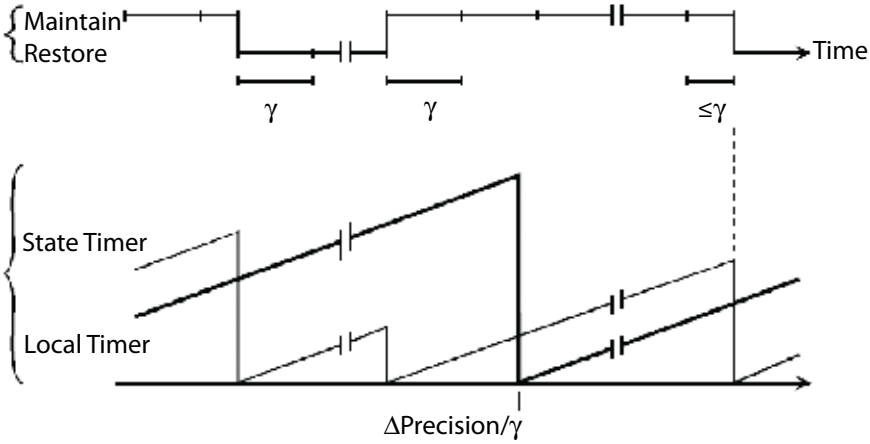
The technology offers wide-ranging market applications, including:

- Computer hardware, computer software, networking, and telecommunication
- Aerospace and aeronautics
  - Aviation control systems (including long duration flight and mission control)
  - Space exploration control systems (including space vehicles and the space shuttle)
- Transportation
  - Automotive applications
  - Public transportation
- Process control
  - Embedded systems
  - Internet and enterprise networking
  - Internet-based applications
- Voter and election applications
- Security applications
- Safety applications

The Technology

Clock synchronization algorithms are essential for managing the use of resources and controlling communication in a distributed system. A fundamental criterion in the design of a robust distributed system is to provide the capability of tolerating and potentially recovering from failures that are not predictable in advance. Overcoming such failures is most suitably addressed by incorporating tolerances to Byzantine faults.

NASA's novel synchronization protocol was developed because communication between independently clocked nodes is inherently imprecise. The imprecision is due to the drift of the clocks with respect to real time and Byzantine faults. Unless the system is designed to be Byzantine fault tolerant, it may not only behave erroneously but will also fail to work consistently when interacting with multiple other components. The NASA protocol communicates a self-stabilization message labeled 'sync' derived from the state timer, at which time all good nodes transition to a 'restore' state and then synchronously to a 'maintain' state. The process is complete when all good nodes are returned to a 'maintain' state, thereby recovering from drift and Byzantine faults. The patented protocol will ensure that the same group decisions are reached regardless of faulty components.



Activities of a good node during steady state

For More Information

If your company is interested in licensing or joint development opportunities associated with this technology, or if you would like additional information on partnering with NASA, please contact:

The Technology Gateway

National Aeronautics and Space Administration

Langley Research Center
Mail Stop 218
Hampton, VA 23681
757.864.1178
LARC-DL-technologygateway@nasa.gov
technologygateway.nasa.gov

www.nasa.gov

LAR 17609-1

TOA 92
NP-2009-09-206-LaRC