MISSION and Safety Critical Support Environment

Executive Overview

by:

Dr. Charles McKay
Dr. Colin Atkinson

Motivation and Goals

MISSION is concerned with MASC (Mission And Safety Critical) Systems which are:

• Large  • Complex  • Non-stop  • Distributed  • Real-time

For this kind of MASC system, there is a need to:

• improve definition, evolution and sustenance techniques,
• lower development and maintenance costs,
• support safe, timely and affordable system modifications,
• support fault tolerance and survivability.

The goal of the MISSION project is to:

"lay the foundation for a new generation of integrated systems software providing a unified infrastructure for MASC applications and systems"

This will involve the definition of:

• a common, modular target architecture.
• a supporting infrastructure.
Background

SIZE
21 man years

DURATION
1990 .. 1996

SPONSOR
NASA Headquarters, Code R (through RICIS)

ADVISORS
Industrial Advisory Group (IAG)

Co PI's
Dr. C.W. McKay & Dr. C. Atkinson

PAST CONTRIBUTORS
- University of Bradford (Dr. Alan Burns)
- Softech
- GHG Corporation
- Honeywell (Minneapolis)
- Softlab (Munich)

MISSION Interaction Diagram
Integrated Life-Cycle Support Environment for MASC Applications and Systems

Advanced Host Environments
(Contractor Development Sites)

Monitoring, Integration and Control Environment
(elements of JSC Mission Control Center and SAIL)

Distributed Target Environment
(e.g., Lunar Outpost, Human Mission to Mars)

Requirements versus Features Matrix

<table>
<thead>
<tr>
<th>Fault-tolerant</th>
<th>Maintainable</th>
<th>Distributed</th>
<th>Survivable</th>
<th>Non-stop</th>
<th>Reliable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>2</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>5</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>6</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>7</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>8</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

System Goals

On-board software models for monitoring and control
Dedicated software for system level fault tolerance and survivability
Separation of policies and mechanisms
Adaptable run-time policies during non-stop operation
Use of a full, concurrent object-oriented, paradigm
Firewalling of application and system objects
Multiple and adjustable levels of security and integrity
Synchronous and asynchronous communication mechanisms
Distributed nested transactions
Unique identification of all network messages
Redundancy management
Stable storage support for recovery
Generic System Architecture (GSA) for the Distributed Target Environment (DTE)

Feature 2 Features 1 & 4

Features
3, 5 & 6

DAS Distributed Application System MASC Mission And Safety Critical
DIS Distributed Information System LAN Local Area Network
DCS Distributed Communications System WAN Wide Area Network
DMS Distributed Monitoring System DPS Distributed Policy System

GSA Requirements on Supporting Infrastructure

Monitoring, Integration and Control Environment (MICE)

- Maintenance of precise models which describe the DTE:
  - software,
  - hardware,
  - communications links,
  - human-machine interfaces,
  - interactions with the environment.
- Distributed Command Interpreter
- Symbolic Diagnostic System

Advanced Host Environment (AHE)

- Construction of precise models of the DTE components
- Rigorous life-cycle approach to evolution and sustenance
- Precise software process models
- Support for special tools and modeling representations.
MISSION's Contribution

Distributed Target Environment

- GSA Requirements,
- GSA Interface Specifications,
- Guidelines for Applying, Tailoring, Modifying and Extending GSA,
- Proof-of-Concept Prototypes of Key and Unique Features.

Monitoring, Integration and Control Environment

- Form of semantic models,
- Guidelines for utilizing semantic models in MICE and DTE,
- Distributed Command Interpreter (DCI) interface.

Advanced Host Environment

- Process Model,
- Model-based life-cycle activities (CLAR/CLAD/CLAIM),
- Prototype semantic model repositories (LMS/OMS).

Anticipated Benefits

Improvements in:

Safety

- fault tolerance
- survivability (availability)
- risk management / certification

Adaptability

- upgrade interoperability
- dynamic reconfiguration

Cost Effectiveness

- reuse
- maintainability
- extensibility
Anticipated Application

NASA Future Programs

- Lunar Outpost
- Manned Mission to Mars

Upgrade to Current NASA Programs

- Space Shuttle
- Space Station

Other MASC Application Areas

- Avionics Systems
- Integrated Weapons Control Systems
- Industrial Process Control
- Transportation Systems
- Hospital Monitoring Systems

Schedule Overview

Significant accomplishments:

- Established MISSION test bed
- Defined semantic modeling representations in Ada-IRDS
- Prototyped Object and Library Management Systems
- Produced distributed nested transactions simulation
- Participated in relevant international standards groups

Future Milestones:

FY93

Begin second iteration of key components of the GSA
Specify interface sets for first iteration of GSA study (with simplifying assumptions)

FY94

Specify interface sets for second iteration of GSA study (without simplifying assumptions)
Begin second iteration of study of key infrastructure components

FY95/96

Complete proof-of-concept prototypes of key and unique features of the GSA Complete specifications of the key infrastructure components