PANEL Services, Adaptation and Future Computing

Awareness and Adaptation in Service Computation and Delivery

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Panelists

- Kendall Nygard, North Dakota State University, USA
- Fatma Mili, Oakland University - Michigan, USA
- Li Li, Avaya Labs Research/Avaya Inc., USA
- Steffen Fries, Siemens, Germany
- Ali Beklen, IBM, Turkey
Designing Adaptive Systems
A necessity rather than choice

Fatma Mili, Oakland University
Embodied cognition

- Situatedness: Systems viewed in situ. Behavior cannot be dissociated from the situation.
- Embodiment: bodies through which they receive input, produce actions.
- Emergence: Granularity—very small scale interactions give rise to high level behavior.
Adaptive design paradigm

- **Top down design**
  - Requirements (set of pairs context-behavior) →
    - designer selects a process
    - Designer implements a process

- **Bottom up adaptive behavior**
  - Requirements (desired high level behavior) →
    - Designer selects rewards
    - Autonomous units explore, select
Comparison

<table>
<thead>
<tr>
<th>Traditional (top down)</th>
<th>Adaptive (autonomous interacting components)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• necessity to fully capture all possible interactions</td>
<td>• Desired behavior not instantaneous</td>
</tr>
<tr>
<td>• Problems often computationally hard</td>
<td>• Evolution ➔</td>
</tr>
<tr>
<td>• Complexity of the problem and solution</td>
<td>• Time delay</td>
</tr>
<tr>
<td>• Potential for many unexpected interactions</td>
<td>• Possibility of dead ends and trial and error</td>
</tr>
<tr>
<td></td>
<td>• Interactions between the different components weaved into the behavior</td>
</tr>
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<td></td>
<td>• Randomized algorithms</td>
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Towards Intelligent Communication – Convergence with the Web

Li Li
Current Affair: Standard Highlights

- **Web Service**: proprietary API → SOAP → REST → Web?
  - SOAP: CSTA from ECMA, Parlay X 3.0 from ETSI
  - REST: OneAPI 1.0 from GSMA, Constrained RESTful Environments from IETF, Facebook API, twitter API

- **Presence**: phone tag → simple presence → rich presence and location → context and prediction?
  - SIP and XMPP from IETF, Parlay X, CSTA (location)

- **User Interface**: array of windows → web browser → rich interaction and collaboration in one client?
  - HTML 5 from W3C
  - Server-Sent Events from W3C, WebSocket from IETF
Problems and opportunities

Web is fragmenting…

- Started as an interconnected information space
- Becoming a platform of isolated applications – fragmented user contexts
- approach: use semantic web to integrate user contexts

Web is asynchronous…

- Information is not reachable until linked
- Unbounded delay between information publication and consumption – delayed user awareness
- approach: use real-time web and event-driven web to reduce delays
Security in Industrial Automation Environments

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Panel Discussion @ Service Computation 2010, Lisbon, Portugal
Increasing Intelligence and Open Communication in Industry Automation Environments

Process Automation

Factory Automation

Building Automation

Energy Automation
IT-Security Becomes a Pre-requisite for Future Control Systems Driven by Convergence of Safety & Security

Status
- Predominantly isolated communication networks
- Often proprietary networks and applications
- Physically secured access to networks
- Long lifetime of control equipment
- Systems are mainly designed for performance, reliability and safety, not security
- Often availability is the most important security objective

Trends
- Increasing usage of standard OSs and applications
- Widespread usage of Ethernet and TCP/IP (including Internet)
- Increasing usage of wireless networks
- Interconnection of formerly isolated networks
- Increasing intelligence in peripheral components (e.g. Intelligent Access Devices)
- IT-security becomes a pre-requisite for safety applications
## Embedded Security Mechanisms Provide Essential Functionality for Ensuring System Integrity

Security is required to ensure Safety-relevant system properties in environments exposed to attacks.

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plant Integrity Check</strong></td>
<td>Verify integrity of overall plant installation (deployed components, cabling, software).</td>
</tr>
<tr>
<td><strong>Original spare parts</strong> (Anti-Counterfeiting)</td>
<td>Ensure that original spare parts are installed, and not counterfeited replacements with poor quality.</td>
</tr>
<tr>
<td><strong>Software Integrity Check</strong></td>
<td>Ensure that firmware and configuration has not been altered. Device operating only with valid configuration.</td>
</tr>
<tr>
<td><strong>Secure Software Update</strong></td>
<td>Ensure that only approved software updates are installed in compliance with defined update procedures.</td>
</tr>
<tr>
<td><strong>Secured Machine Communication</strong></td>
<td>Prevents manipulation and interception of communicated control and service data (device control, remote service).</td>
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</table>
Trends and potential Research Topics in Industrial Automation Security

Security Trends

- Machine-2-Machine connectivity down to field level devices is a major driver for Future Internet.
- Device authentication as prerequisite to protected communication of devices and device-oriented services.
- The non-human security environment requires new device-oriented security and identity infrastructures.

Challenges

- Security is a process → adaptation
  - technical (system design and development)
  - organizational (system management and operation)
- Device-oriented security and identity infrastructure and services
- Plug-and-play security to ease additional administrative effort

Security parameter are the base to ensure an appropriate protection of communication between different system entities as well as services like licensing or anti counterfeiting. Setting up and maintaining security parameter securely is crucial!
Context Awareness and Adaptation: Intelligence, Control, and Decision-making Issues

Kendall E. Nygard
North Dakota State University
Cooperative Distributed Autonomous Systems

• Examples
  – Sensor networks
  – Networked weapons systems
  – Ambient systems
  – Pervasive systems
  – Ubiquitous systems
  – The Smart Grid

• Characteristics
  – Many heterogeneous platforms
  – Widely distributed
  – Distributed Intelligent processing
  – Highly interconnected
  – Must work together in purposeful ways
Reactiveness and Directedness

Reactiveness is achieved by a set of behaviors

Directedness is achieved by an intelligent capability that identifies and exploits structure, maintains a knowledge base, and accesses system knowledge to advantage
Distributed Decision Making

The Case for Centralization
- Rich sources of very complete data and information promotes “best practice” decisions
- Resources can be managed efficiently and effectively
- Embedded devices, processors and systems are viewed as parts of larger and complex infrastructure

The Case for Decentralization
- Individual entities can be context-aware and combine dynamically to drive emergent and adaptive behaviors
- Embedded devices, processors and systems can (sometimes) perform well for certain autonomous functions
- It is essentially impossible to control a large and diverse system with a ‘top-down’ logic – this would require a way to instruct each element as to what to do at each step
- Robustness, redundancy, and timeliness of decision-making is improved through distributing responsibilities.
A Key Unmet Need in Cooperative Control

Develop protocols and algorithms that....

- Work from the bottom-up
- Allow agents to reach consensus on shared information
- Work with limited and unreliable information
- Work with dynamically changing interaction topologies
- Are reliable, secure, and resilient
Cross Cutting Concerns

• Inherently distributed, resulting in systems with duplication of code across many components.
  – Makes functional components less self-contained
  – Often decreases software quality
  – Makes functional components less self-contained
  – Makes reasoning at the architectural level difficult

• Security, context awareness and cultural and language issues are cross-cutting
Some Research Questions

• How to....
  – Balance the need for local autonomy with the need for global consistency and control?
  – Monitor systems that are configured in ad hoc networks?
  – Exploit large-scale concurrency?
  – Maintain appropriate levels of security and privacy?
  – Design distributed software in situations with massive non-functional requirements?
Event Driven 
Service Oriented Architecture

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Computation World 2010
Agenda

- Events
- Event driven SOA
Events

A call to the help desk

Data center temperature is changed

A PIN is changed

A sale is made

Multiple Product Inquiries

A New Location is Detected

Event Sources

External Event Sources

Internal Event Sources

Sensors

Other

Business Systems

BAM

Applications

Business Processes
Events and SOA

**Event Sources**

1. Password Change
2. New Account Opening
3. Large Withdrawal
4. Account Mgr Visit
5. Change Mailing Address
6. New Loan Application
7. Frequent Option Trading

**Turbulent, Disparate, Non-Deterministic, Un-sequenced Events**

**Capture**

- Event based process triggering

**Automated Action**

- “Initiate a business process” based on Async events
Events and SOA

**Turbulent, Disparate, Non-Deterministic, Un-sequenced Events**

**Event Sources**
- External Event Sources
  - Sensors
  - Other
- Internal Event Sources
  - Systems
  - Business
  - BAM
  - Applications

**Event based process triggering**

**Capture**
- Radio signal
- HTTP Req.
- DB trx
- EJB call
- TCPIP socket call
- More...

**Automated Action**

“Initiate a business process”
Will next generation SOA or SOA 2.0 be based on events

What are the potential research areas for implementation
- Event handling frameworks or adapters
- A new web service specification for sensor events
- Supporting all types of sensors in a box
- more