TinyGALS: A Programming Model for Event-Driven Embedded Systems

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Introduction

- Embedded software architecture today
  - Inherited from writing device drivers and optimizing assembly code.
  - Poor scalability.
  - Poor common infrastructure.
  - Poor resource management.

- Embedded software architecture tomorrow
  - Reusable, reconfigurable components.
  - Easy to use.
  - Fast prototyping.
  - Software synthesis
Motivation

- Application characteristics
  - Ad-hoc networked embedded systems
  - Low-power
  - Unstructured, unsynchronized events
  - Collaborative nodes
    - Local communication (peer-to-peer)
    - Global communication (ad-hoc routing)

Example: Sensor Networks
Software Synthesis

Target Tracking Example: Before and After…

OS View (TinyOS)  TinyGALS View

- PARAM_PUT()
- PARAM_GET()
- app_init()
- app_start()

Module A

- init
- start
- A_out1()

Module B

- B_init_put()
- BCOMP1_INPUT()

Scheduler

Event Queue

data structures

data structures

Target Tracking Example:
Before and After…
### Memory Usage

<table>
<thead>
<tr>
<th>Code Size</th>
<th>Scheduler</th>
<th>Target counting application</th>
</tr>
</thead>
<tbody>
<tr>
<td>TinyOS</td>
<td>86 bytes</td>
<td>19929 bytes</td>
</tr>
<tr>
<td>TinyGALS</td>
<td>112 bytes</td>
<td>24750 bytes</td>
</tr>
</tbody>
</table>

### Future Work

- Port to NesC language (TinyOS).
- Implement as Ptolemy domain?
  - Compare to CI domain.
- Blocking write: retry when queue is full.
- Priority scheduling algorithm with queue insertions.
- Run-time reconfigurability of modules.
- Heterarchy: distributed multi-tasking.
Conclusions

- TinyGALS provides a globally asynchronous, locally synchronous model of computation for event-driven embedded software.
- Allows reuse of software components.
- TinyGUYS provides protected, quick access to global data.
- Software synthesis tools created to generate communication and scheduling code.

http://ptolemy.eecs.berkeley.edu/papers/03/TinyGALS/