Swarm Programming
How to Program a MicroNet

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(Really) Brief History of Computer Science


Machines
Programming Methods
Reasoning Tools

Monolithic
First High-Level
Manual Proof of

Computers
Languages
Properties of

Fixed Networks of
Modular
Programs

PCs
Programming,
Interfaces, Objects
Trivial Programs

Swarms
Programming.
Group Behaviors
Tools for Reasoning
about Distributed
Programs
Tools for Reasoning
about Groups in
unpredictable
environments

Programming the Swarm:
Long-Range Goal

Cement
10 GFlop

Why this Might be Possible?

• Biology Does It
  – Ant routing
    • Find best route to food source using pheromone trails
  – Bee house-hunting
    • Reach consensus by dancing and split to new hive
  – Complex creatures self-organize from short DNA program and dumb chemicals
  • Genetic code for 2 humans differs in only 2M base pairs (.5 MB < 1% of Win2000)

Swarm Programming Model

Behavioral Description
Environment Model
Device Model

Behavior and primitives defined over groups, not individual units

Behavior and primitives defined over groups, not individual units

Swarm Program Generator

Primitives Library

Device Units

Research Issues

• How can we describe the properties of swarm behaviors, devices and environments?
• What are the right primitives and combination mechanisms?
• How can we synthesize swarm programs with known functional and non-functional properties?
• Security
  – Can we use swarm programming to build systems that are resilient to classes of attack?
  – Can we produce swarm programs with known behavioral constraints?
  – Can we provide privacy on a Micronet?