Supporting Heterogeneity in Data Driven Sensor Network Macroprogramming

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Introduction

Support for heterogeneity has been incorporated within a Macroprogramming framework. Policies for handling runtime and data routing for communication between nodes in a heterogeneous network were designed and implemented. Then, Macroprogramming support was added to compile Macroprograms and generate code for the heterogeneous network.
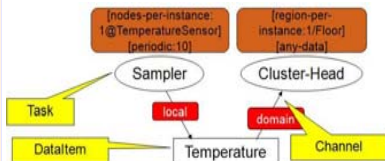
ATaG for building temperature management

Heterogeneous Network Description

Our heterogeneous network consists of:-

• **Sun SPOT** sensor nodes

• **PC**s (ex. Laptops and Desktops)

• **Base Station**s (PCs attached with Sun SPOTs configured as base-stations)

There were two types of network:-

• **IP** based (for communication from PC to PC or Base Station)

• **IEEE 802.15.14** based (from SPOT to SPOT or Base Station)

Target Heterogeneous Network

Challenges

• How to execute an integrated application on nodes with different lower level protocols for communication and task execution?
• How to write an efficient macroprogram compiler to generate appropriate code for nodes in the heterogeneous network, depending upon their type?

Routing Overview

The network is organized as a **two level hierarchy**
• at the **lower layer**, we have *Sun SPOT*s.
• at the **higher layer**, we have both *Base station*s and *PC*s

Target nodes for data delivery are specified through the *Logical Neighborhood* **(LN)** specification

For heterogeneous network routing, we divide **LN** into
• *RegionScope* – Part that specifies physical scope (Room no, Floor no etc)
• *LNScope* – the entire LN specification

• Routing at the l**ower layer** is done with matching for *LNScope* in the routing table

• Routing at the **higher layer** is done with matching for *RegionScope*. Upon such a matching, the routing is delegated to the lower layer in that corresponding region.
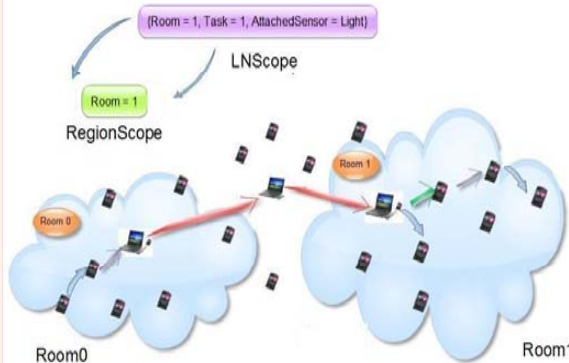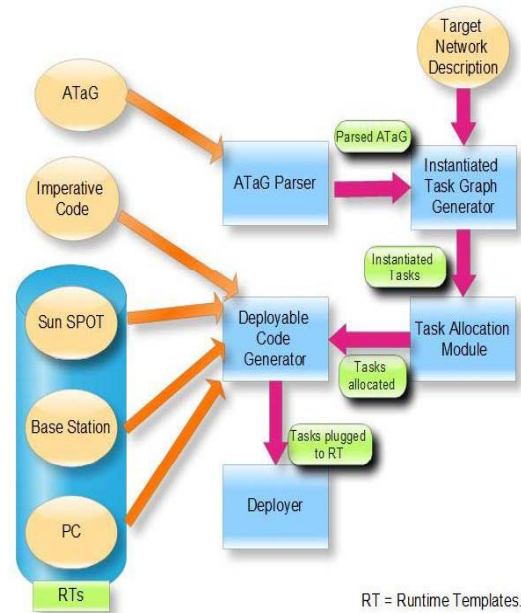

Illustration of Routing

Compilation Framework

RT = Runtime Templates.

Phases in Compilation

• **Inputs**: ATaG, Target Network Description, Imperative Code.
• **Outputs:** Deployable code for nodes in the network.

The various modules in the framework:

• **ATaGParser**: Parses the ATaG application specification.
• **Instantiated Task Graph Generator**: Instantiates copies of each unique task in ATaG specification, ready for assignment.
• **Task Allocator**: Assigns the instantiated tasks to nodes in the network.
• **Deployable Code Generator**: Assigned Tasks are plugged into appropriate runtime templates corresponding to nodes. This creates code ready for deployment.

Integration with our Macroprogramming toolkit (Srijan)

ATaG specification with Srijan

Srijan is a toolkit to,

• Specify macroprograms

• Compile them, and

• Deploy the generated code.

The work with supporting heterogeneity in data driven macroprogramming is successfully integrated with Srijan. We now have a Macroprogramming toolkit to specify, compile and deploy code on a heterogeneous network.

Experimental Results

With the toolkit, we were able to specify a WSN application, compile and deploy successfully on a network consisting of 2 Sun SPOTs, 2 Base stations(A laptop attached to a Sun SPOT configured as base station) and 1 PC (laptop) . Code was generated for larger networks too.

Conclusion

• LN routing algorithm was modified for rapid routing in higher layers of heterogeneous network.

• Macroprogram compilation was reworked to support heterogeneous networks as targets for code deployment.

• Currently ,work on energy optimizations in the routing protocol is under progress.