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# Supporting Heterogeneity in Data Driven Sensor Network Macroprogramming

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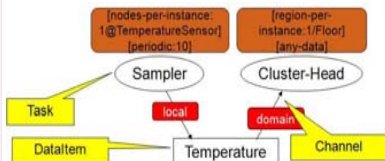
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## Introduction

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
- PCs (ex. Laptops and Desktops)
- Base Stations (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 SPOTs**.
- at the **higher layer**, we have both **Base stations** and **PCs**

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 **lower 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.

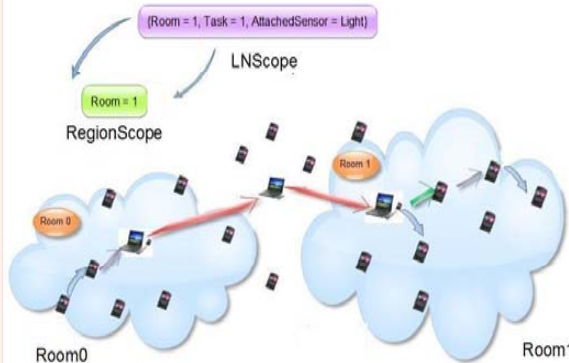
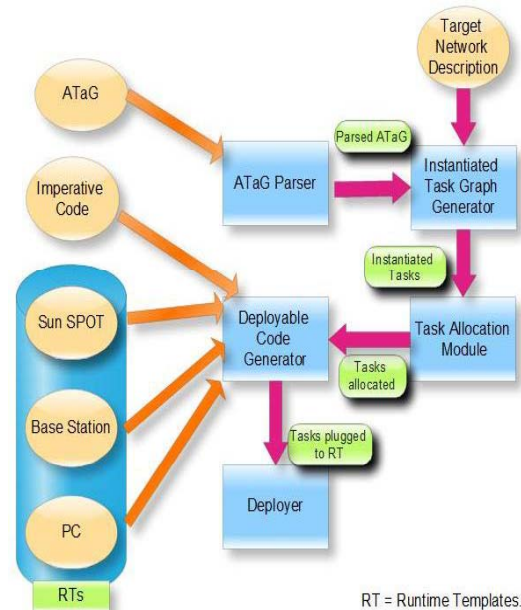


Illustration of Routing

## Compilation Framework



RT = Runtime Templates.

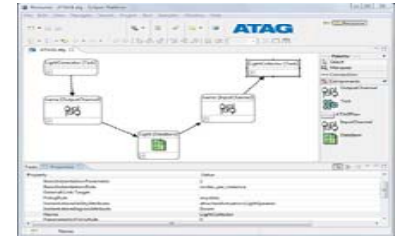
## Phases in Compilation

- **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.