Demo: Distributed Task Execution in Mobile Ad Hoc Networks

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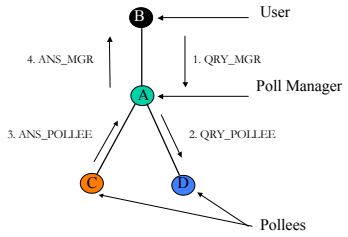
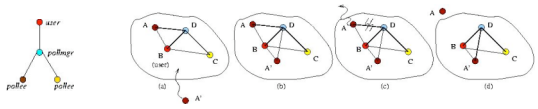
Demo #1 : TG Instantiation

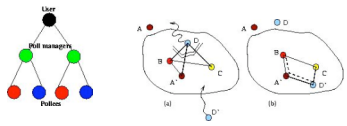


All messages shown are encapsulated as TASK_DATA packets processed by TaskApp layer only.

Demo #2: TG Re-instantiation



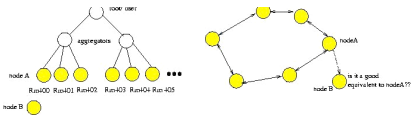
Demo #3: TG-Patching



Task Graph Extensions to Sensor Networks

- Limited battery power → Hello messages are an overkill!
- Accommodation of Sleep Wake cycle scheduling
- Links are very intermittent in very harsh environments
- → more *intelligent* and *proactive* instantiation which relies less on hello messages and more on collected state information along with multiple alternative mappings

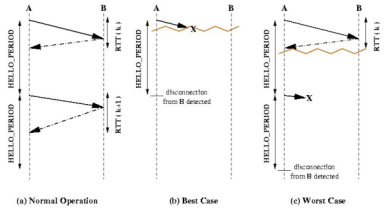
Instantiating Alternative Sensors



•*Query1(aggregation tree): find temperatures in rooms on the 4th floor:* If node A becomes unavailable, node B can be a replacement if it resides in Rm. 400
•*Query2 (in-network processing): estimate (in situ) a parameter of observation* (e.g. level of contamination in soil): requires collaboration (communication) among neighboring nodes. How do we determine a suitable replacement to a node that becomes unavailable?

Sensor Network Aware Instantiation

•Sleep wake (SW) schedules are communicated to a root/ coordinator to reduce patching due to SW scheduling
•Alternative mappings are calculated based on expected SW schedules. Cycle between alternative mappings without having to re-compute or interrupt a task
•Low mobility, but possible bad links → hello messages are sent during wake cycles only and at low frequencies
•Before sleep cycle kicks in, a node transfers its state to its replacement if possible



Detection of Disconnections

•Disconnections between instantiated nodes causes tasks to get disrupted

•These disconnections can be *detected* by periodic soft state HELLO messaging

Recovery from Disconnections (in taskd)

•Source of disconnections
  –Network partitions due to failure or mobility
  –Route failures for extremely long routes
•Next steps after detection:
  –**Re-instantiation** (replacement of a lost child)
  –**TG-patching** (salvaging the tree below the lost child)

Summary of Key Research Contributions

•A novel distributed framework for task based resource discovery and deployment

•**Algorithms**
  –Theoretical foundations: computational complexity issues in embedding TGs onto irregular networks (MANETs)
  –New algorithms and protocols for discovery/selection of devices in the network while obeying the TG structure/attributes
  –Approximation bounds for the heuristic algorithms
  –Techniques for efficient adaptation of distributed application / task to device mobility in the MANET

•**Performance Evaluation**
  –Metrics for analyzing performance of the above protocols
  –Performance evaluation by extensive simulation in *ns-2*
  –Development of a proof-of-concept prototype in a laboratory environment on off-the-shelf hardware

•**Scalability Issues**
  –Service composition using hierarchical task graphs
  –Focus: reuse of service instances that have been composed before by other users

•Future Work: Extending TG concepts to other application scenarios

Selected Publications

•P. Basu, W. Ke, and T.D.C. Little, "Dynamic Task Based Anycasting on Mobile ad hoc Networks," *ACM/Kluwer Journal on Mobile Networks and Applications (MONET), Vol. 8, No. 5*, October 2003 (*to appear*)

•P. Basu, W. Ke, and T.D.C. Little, "Scalable Service Composition in Mobile Ad Hoc Networks using Hierarchical Task Graphs," *Proc. First Annual Mediterranean Ad Hoc Networking Workshop, (Med-Hoc-Net 2002, sponsored by IFIP),* Sardegna, Italy, September 2002.

•P. Basu, W. Ke, and T.D.C. Little, "A Novel Approach for Execution of Distributed Tasks on Mobile Ad Hoc Networks," *Proc. IEEE WCNC 2002*, Orlando, FL, March 2002.

•W. Ke, P. Basu, and T.D.C. Little, "A Task Graph Based Application Framework for Mobile Ad Hoc Networks," *Proc. IEEE ICC 2002*, New York, NY, April-May 2002.

•P. Basu, W. Ke, and T.D.C. Little, "Metrics for Performance Evaluation of Distributed Application Execution in Ubiquitous Computing Environments," *Position paper at the ACM UbiComp 2001 Workshop on Evaluation Methodologies for Ubiquitous Computing*, Atlanta, GA, September 2001.