WADS 2004

Improving Availability of Distributed Event-Based Systems via Run-Time Monitoring and Analysis

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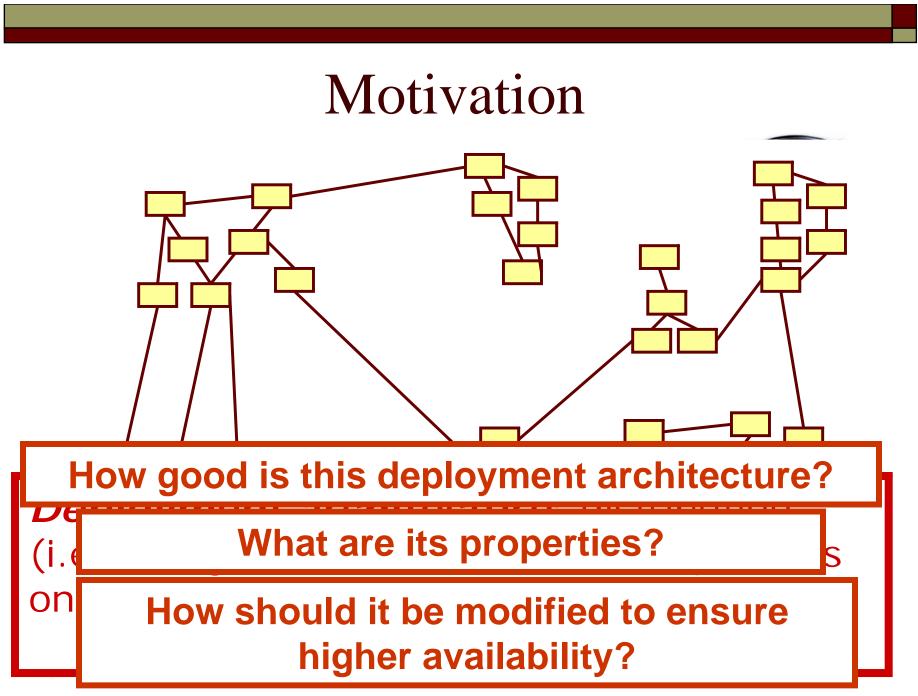
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Outline

> Motivation

- Problem description
- □ Prism-MW
- DeSi
- □ Algorithms
- □ Concluding remarks



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Problem description

Given system model parameters:

Software component properties

- Memory requirements
- Frequency of interaction
- □ Size of the exchanged data

Hardware host properties

- Memory capacity
- Network reliability
- Network bandwidth

Constraints

- Location
- Co-location

Problem description

Find a function $f: C \to H$ such that the system's overall availability A defined as $\sum_{i=1}^{n} \sum_{j=1}^{n} \left(freq(c_i, c_j) * rel(f(c_i), f(c_j)) \right)$ $A = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} freq(c_i, c_j)}{\sum_{i=1}^{n} \sum_{j=1}^{n} freq(c_i, c_j)}$

is maximized, and the deployment is valid.

Note that the possible number of different functions f is k^n

Problem breakdown

1) Lack of knowledge about runtime system model parameters

- System model parameters not known at the time of initial deployment
- System model parameters change at runtime
- Middleware with monitoring support

2) Exponentially complex problem

- n components and k hosts = k^n possible deployments
- Polynomial time approximating algorithms

3) Environment for assessing deployments

- Comparison of different solutions and algorithms
- performance vs. complexity, sensitivity analysis, etc
- Analysis and visualization utilities

4) Effecting the selected solution

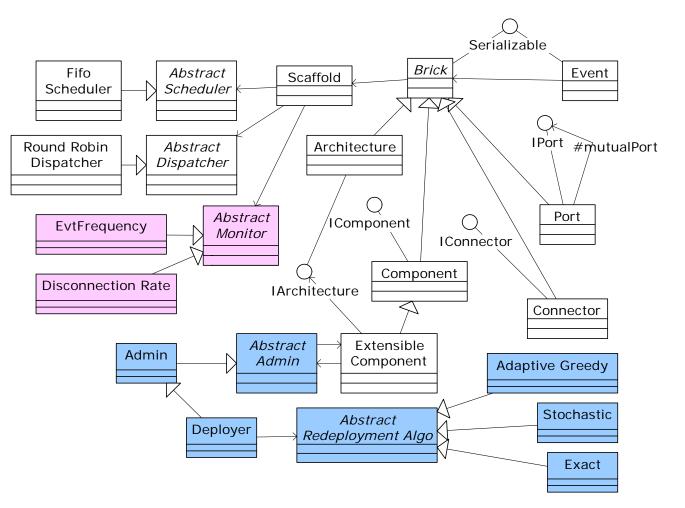
- Redeploying components
- Requires an automated solution
- Middleware with deployment support

Outline

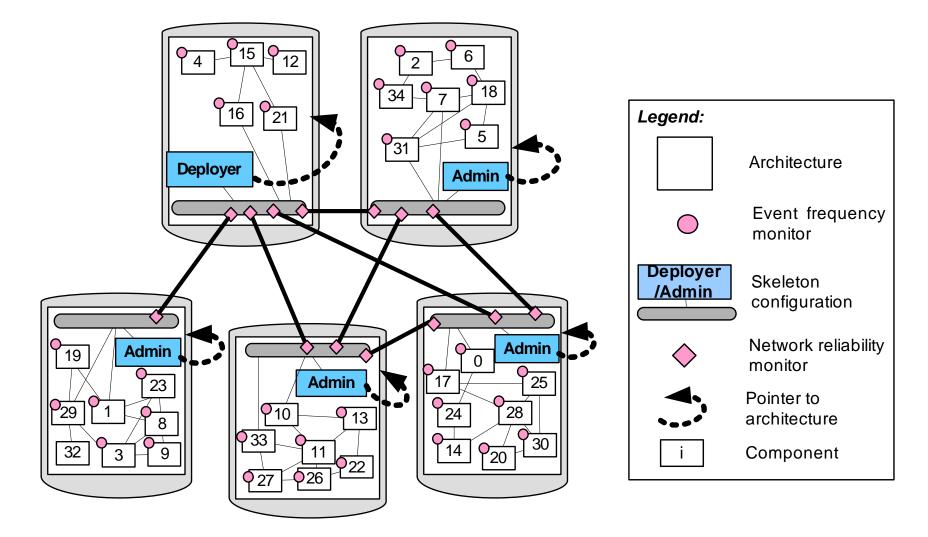
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Prism middleware

- An architectural middleware
- Support for monitoring and redeployment



Monitoring and redeploying



DeSi

Deployment simulation environment

- Specification and generation of deployment architectures
- Visualization and analysis of distributed system
- Estimation of the quality of deployment
- Facilitation of rapid development and comparison of algorithms

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Estimated redeployment time N/A 20360 13149 16940 0	Availa Tables of parameters Hosts: reliability Hosts Host/Host 0 1 2 3 4 5 6 7	Ge bility neters y and memory 0 1.0 0.123 0.0 0.246 0.0 0.0 0.0 0.0 0.0 0.0 0.672	ry Comps: 1 0.123 1.0 0.0 0.0 0.0 0.0 0.0 0.0 0.883	frequency a 2 0.0 0.0 1.0 0.0 0.0 0.0 0.0 0.0	and memory 3 0.246 0.0 0.0 1.0 0.684 0.0 0.0 0.0 0.966	Componen Com	t-25 t-26 t-27 t-28 t-29 5 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.			Component 85 86 87 88 89 90 91 92 93 94 95 95 95 95 97 97 98 99 99		6 6 3 1 4 7 6 6 6 1 1 1 0 0 4 0 5	E	Unbias 7 4 0 6 6 3 1 0 6 4 3 0 6 5 2	Biased 6 7 7 7 2 7 0 7 7 0 7 7 6 0 7 7 6 0 4 1 1 6 4	Greedy 7 7 3 1 4 7 7 6 7 6 3 4 4 6 3 1	
	Availa Tables of parameters Hosts: reliability Hosts Host/Host 0 1 2 3 4 5 6 7	Ge bility neters y and memory 0 1.0 0.123 0.0 0.246 0.0 0.0 0.0 0.0 0.0 0.0 0.672	ry Comps: 1 0.123 1.0 0.0 0.0 0.0 0.0 0.0 0.0 0.883	frequency a 2 0.0 0.0 1.0 0.0 0.0 0.0 0.0 0.0	and memory 3 0.246 0.0 0.0 1.0 0.684 0.0 0.0 0.0 0.966	Componen Com	t-25 t-26 t-27 t-28 t-29 5 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.			Component 85 86 87 88 89 90 91 92 93 92 93 94 95 96 97 95 96 97 98 99 99 Availability		6 6 3 1 4 7 6 6 6 1 1 1 0 0 4 0 5 5 0.3091	E	Unbias 7 4 5 0 6 6 3 1 0 6 4 3 1 0 6 4 3 6 5 5 2 0.3937	Biased 6 7 7 7 2 7 0 7 7 0 7 7 6 0 7 7 6 0 4 1 6 6 4 1 1 6 6 4 1 1 6 4 1	Greedy 7 7 3 1 4 7 7 6 6 7 6 6 3 4 6 3 4 6 3 1 0.6334	

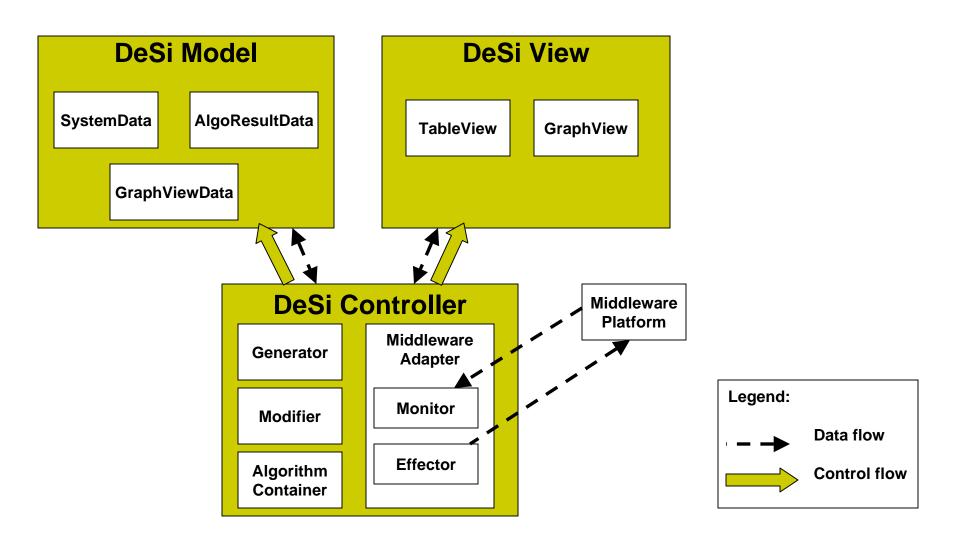
Constraints -

Deployment Control Window

-Input -

Algorithms

DeSi's architecture



Suite of algorithms

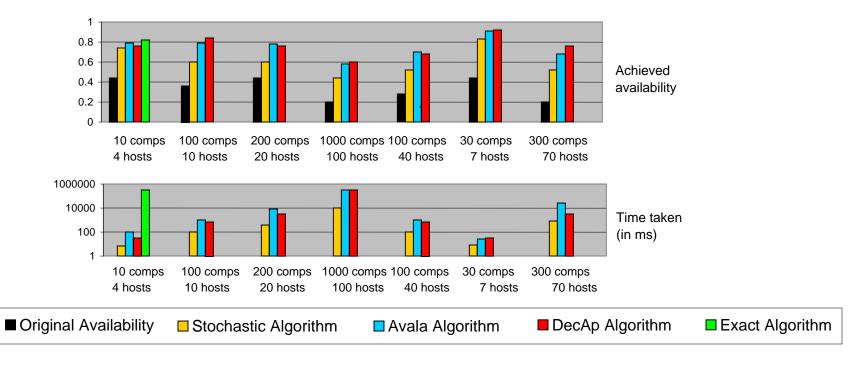
Exact – finds optimal solution $O(k^n)$

Biased/Unbiased stochastic – random selection $O(n^2)$

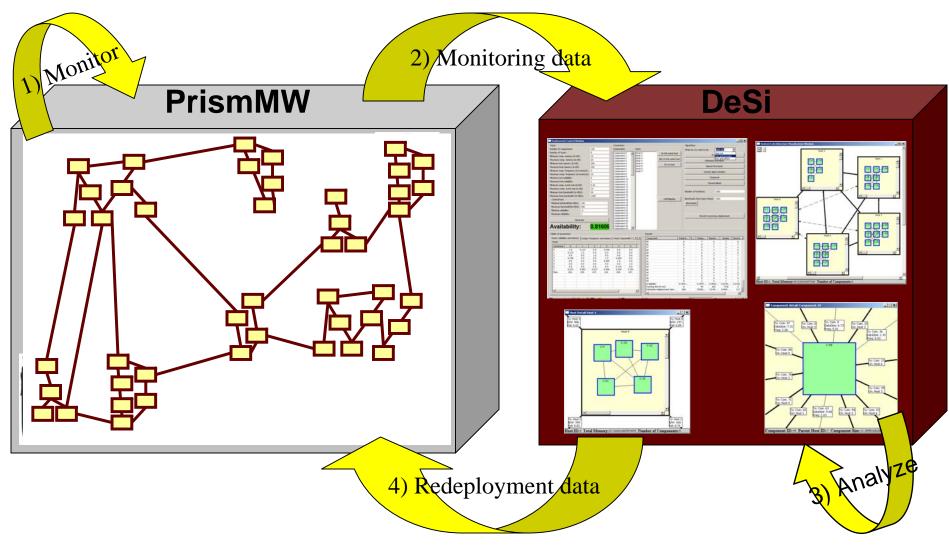
Avala – greedy approximation $O(n^3)$

DecAp – decentralized auction based $O(n^3)$

Clustering – decreases complexity



Integration



Conclusion and future work

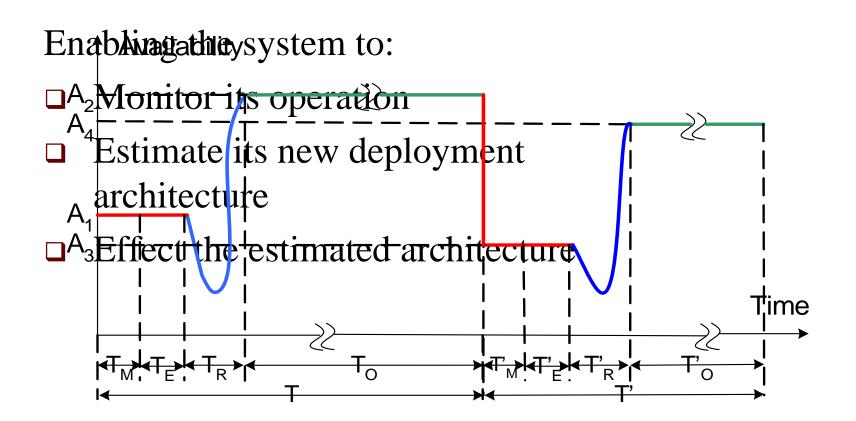
- Quality of deployment architectures
- □ Techniques/tools for improving availability

On-going/future work:

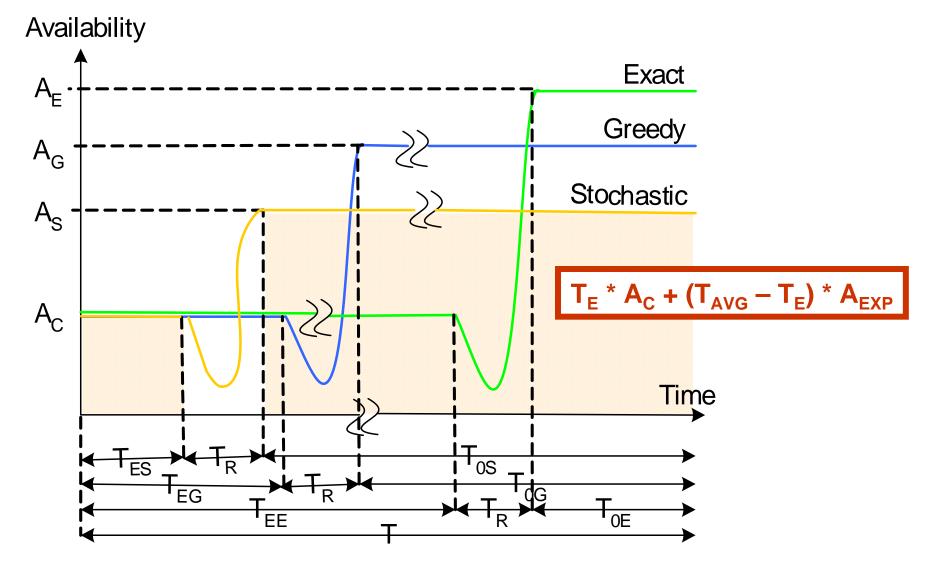
- Modeling other system properties
- □ Integrating DeSi with other platforms
- Decentralization and trust



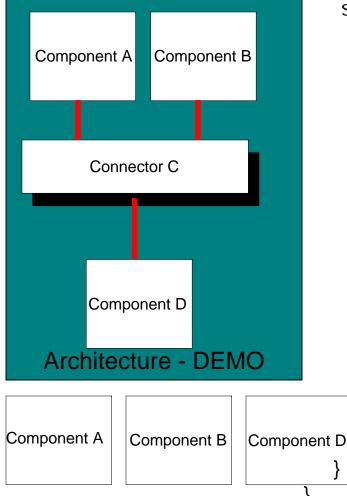
Approach - overview



Automatic algorithm selection

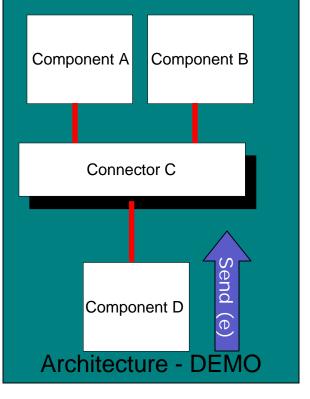


Using Prism-MW



static public void main(String argv[]) { Architecture arch = new Architecture ("DEMO "); // create components ComponentA a = new ComponentA ("A"); ComponentB b = new ComponentB ("B"); ComponentD d = new ComponentD ("D"); // create connectors Connector conn = new Connector("Conn"); // add components and connectors arch.addComponent(a); arch.addComponent(b); arch.addComponent(d); arch.addConnector(conn); // establish the interconnections arch.weld(a, conn); arch.weld(b, conn); Connector C arch.weld(conn, d)

Using Prism-MW



Event e = new Event ("Event_D"); e.addParameter("param_1", p1); send (e);

Component B handles the event and sends a response

public void handle(Event e)

```
if (e.equals("Event_D")) {
```

```
Event e1= new Event("Response_to_D");
e1.addParameter("response", resp);
send(e1);
}...
```

}