

HyperVerse

Simulation and Testbed Reconciled

Jean Botev, Markus Esch, Hermann Schloss, Ingo Scholtes, Peter Sturm



Ingo Scholtes

Systemsoftware and Distributed Systems

University of Trier

Germany

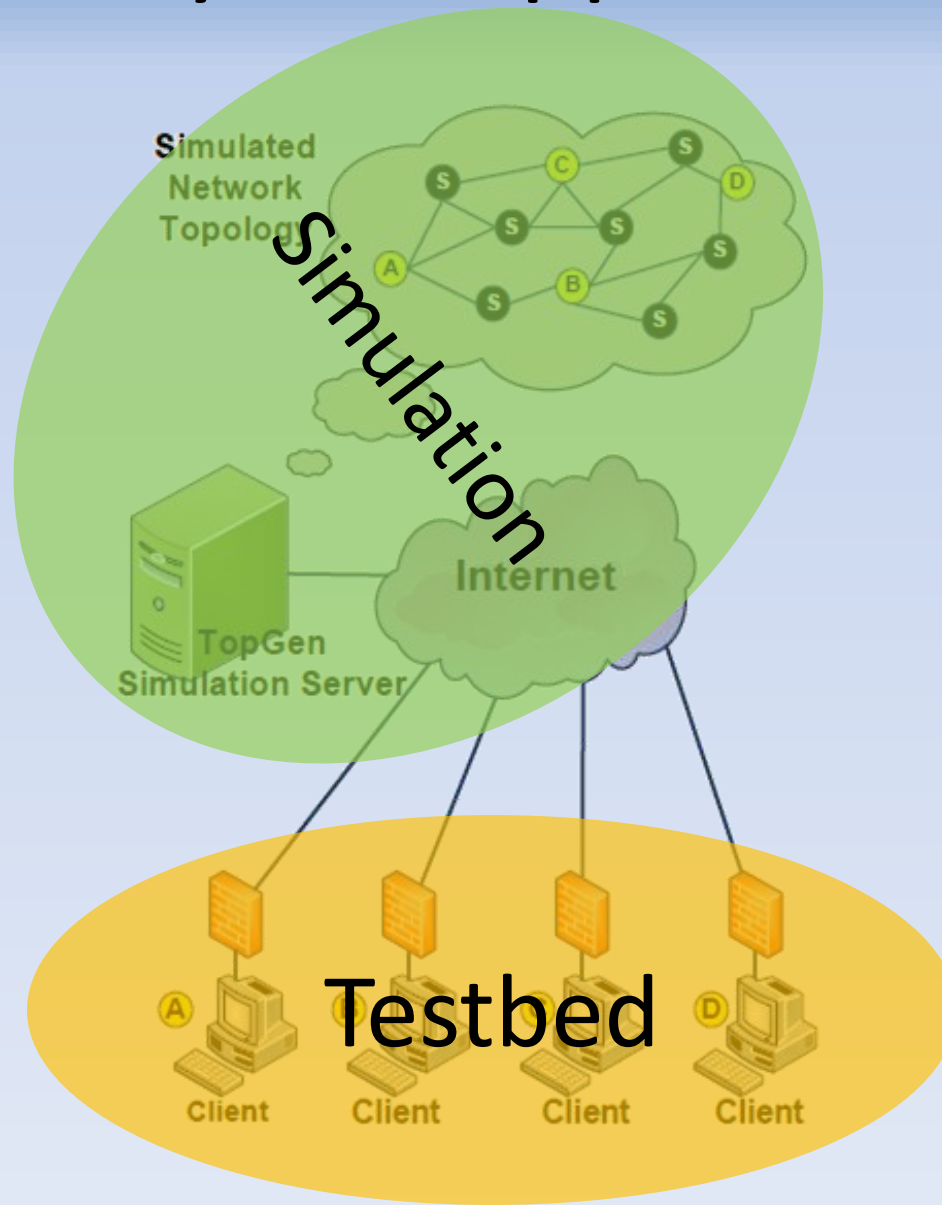
scholtes@syssoft.uni-trier.de

<http://syssoft.uni-trier.de/~scholtes>

Motivation

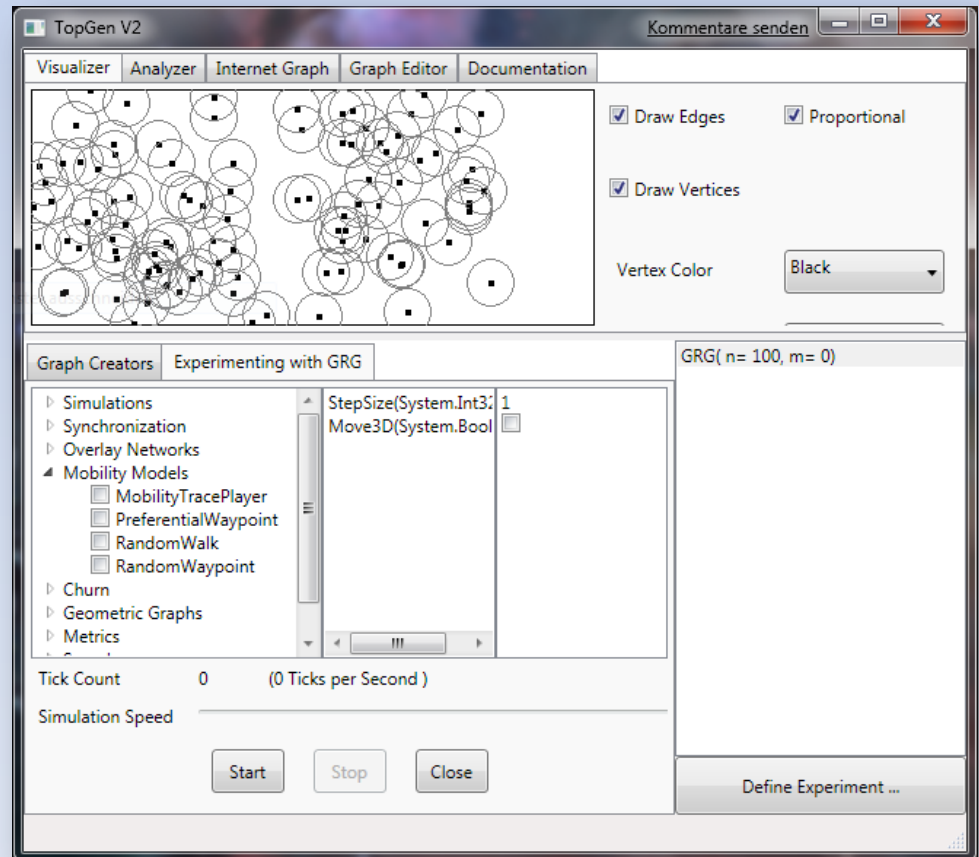
	Simulations	Test Deployment
Determinism	Yes	No
Scale	Large	Usually small
Development/Deployment	Simple	Complex
Flexibility	High	Low
Assessment	Synthetic	Realistic / Subjective
Usable	No	Yes
...		
HyperVerse	TopGen	HyperVerse Browser

A Hybrid Approach



TopGen

- Simulation Environment for **Complex Systems**
 - Network Topologies
 - Cellular Automata
 - Spatialized Entities
 - Autonomous Agents
 - Geometric Graphs
 - Router Networks
 - ...



Key Features (1/2)

- **Modular Design**

- Arbitrary Simulation
- Composable Simulation
- Modern Paradigm

- **Powerful Framework**

- Graphs, Networks, Autonomous Agents
- Thread-safe
- Full in-code
- Extensible

- **Real-time**

- Recordable

```
[TopGen.Experiments.Attributes.ExperimentTag("Mobility Models")]  
[TopGen.Experiments.Attributes.ExperimentType(ExperimentType.Event)]  
[TopGen.Experiments.Attributes.AcceptedGraphType(typeof(GeometricGraph))]  
public class RandomWalk : TopGen.Experiments.ExperimentalModule  
{  
  
    public override void Start(ref TopGen.Graph.Graph g, object settings, SimulationClock sc)  
    {  
        base.Start(ref g, settings, simulationClock);  
  
        simulationClock.OnTick += new SimulationContext.TickHandler(simulationContext => {  
            Settings = settings;  
        });  
    }  
}
```

The screenshot displays a software interface with a graph visualization and a class hierarchy menu. The graph shows black nodes connected by blue edges, with some nodes having blue arrows pointing to their neighbors. A menu is open, listing various methods and properties, with 'GetEdgeToSuccessor' highlighted. The background shows a code editor with C# code.

```
GeometricVertex w = y as GeometricVertex;  
if (!v.IsSuccessor(w) && v.GetDistance(w) < v.DiskRadius && v!=w)  
{  
    // ...  
    Edge Ve  
    Returns  
    either be  
    both ver
```

- Degree
- DiskRadius
- Draw
- Edges
- Equals
- GetDistance
- GetEdgeFromPredecessor
- GetEdgeToSuccessor**
- GetHashCode
- GetType

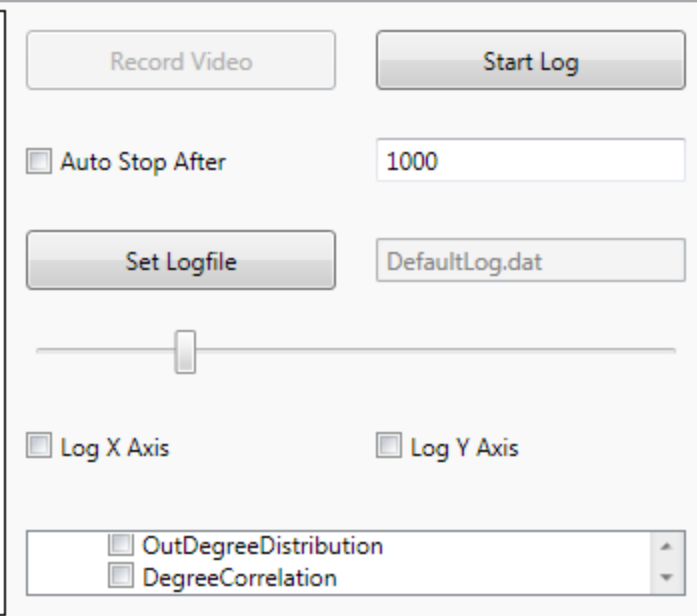
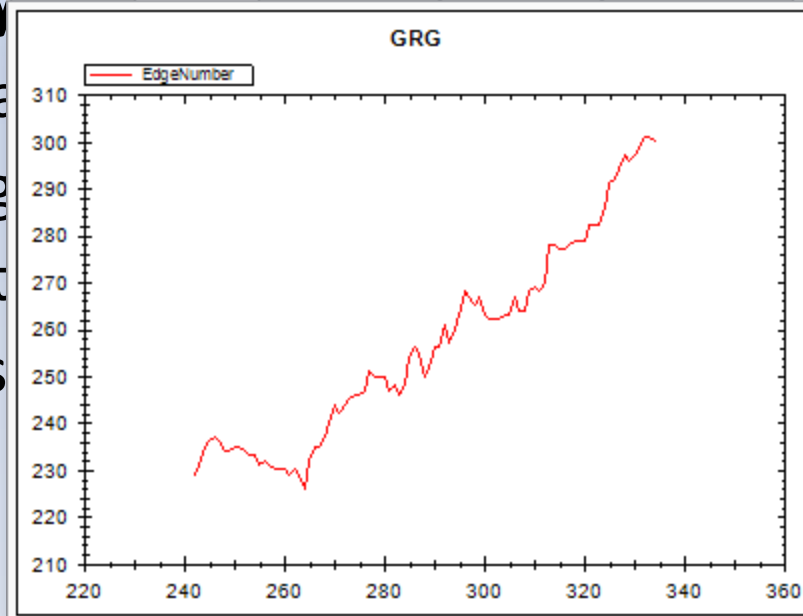
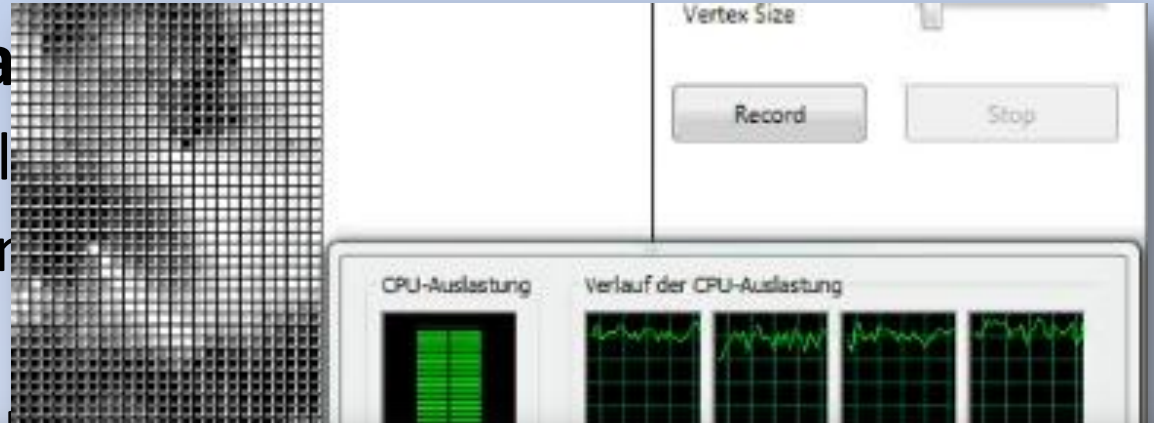
Key Features (2/2)

- **Multi Core Scaling**

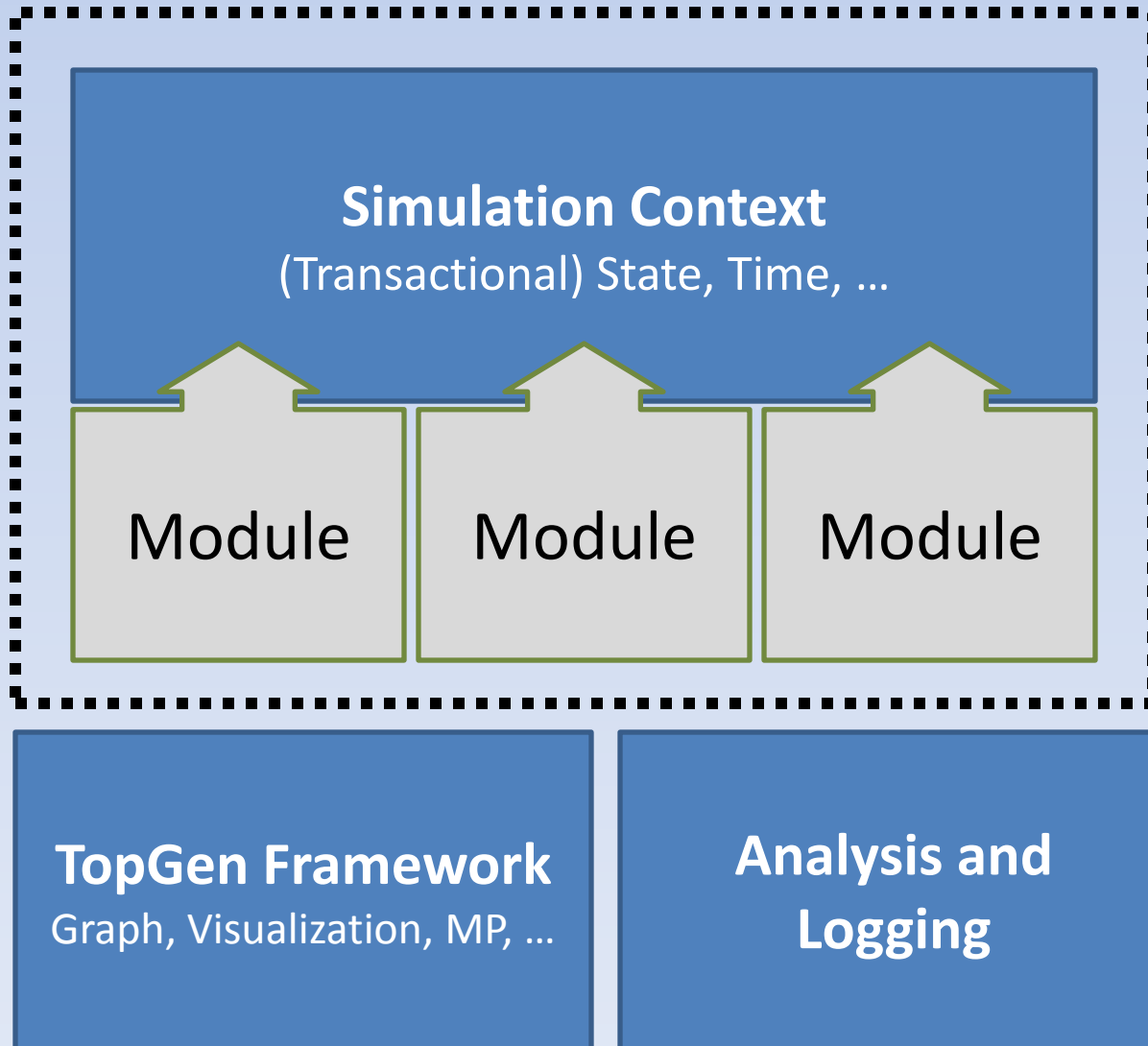
- Automatic parallelization
- Retaining deterministic results
- Low Memory

- **Analysis Components**

- Real-time monitoring
- Logging
- Fitting
- Fast
- ...



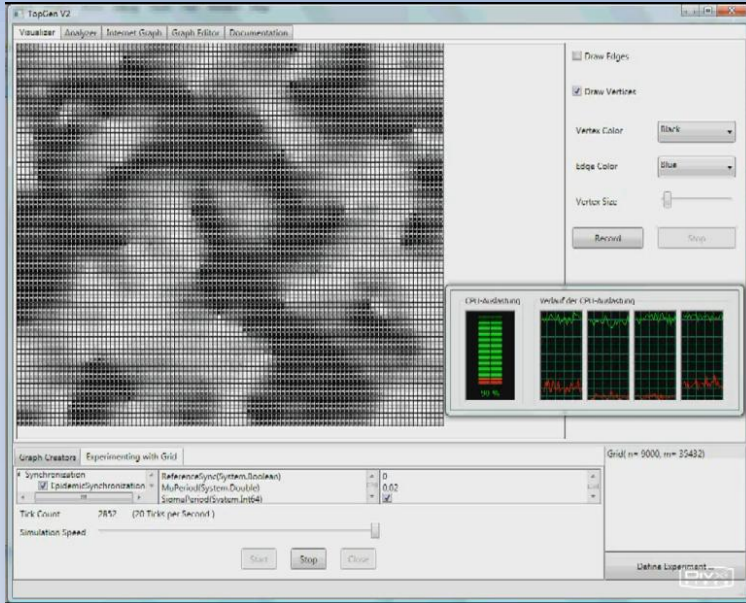
Programming Model



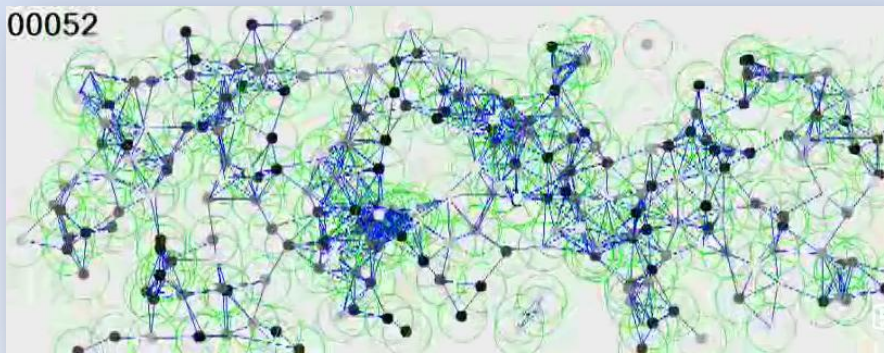
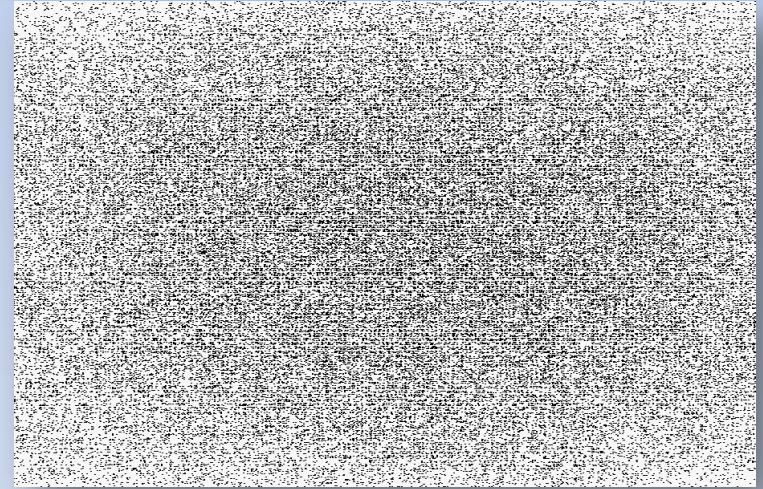
Technicalities

- Open source
- Implemented in C# 3.0 (.NET 3.5/MONO 2.0)
 - Compiles and runs on MONO (except WPF-GUI)
 - ECMA-standardized OpenSource CLR
- TopGen Framework
 - OS-independent
 - Architecture-independent
 - Language-independent
- Module-development
 - In any CLR-language (C#, J#, C++, Boo, F#, ...)

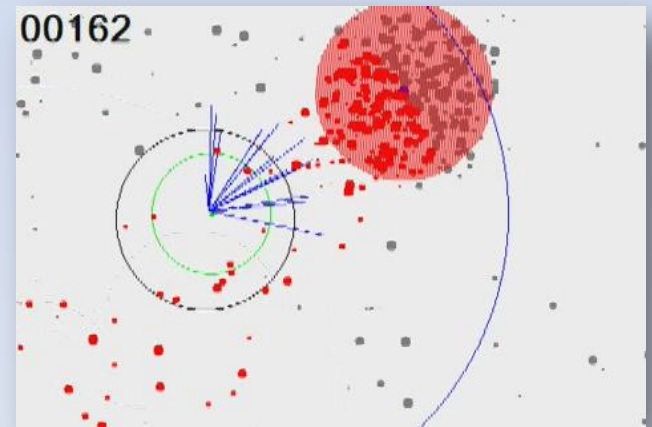
Showcases ...



(for details see *Complex'09*)

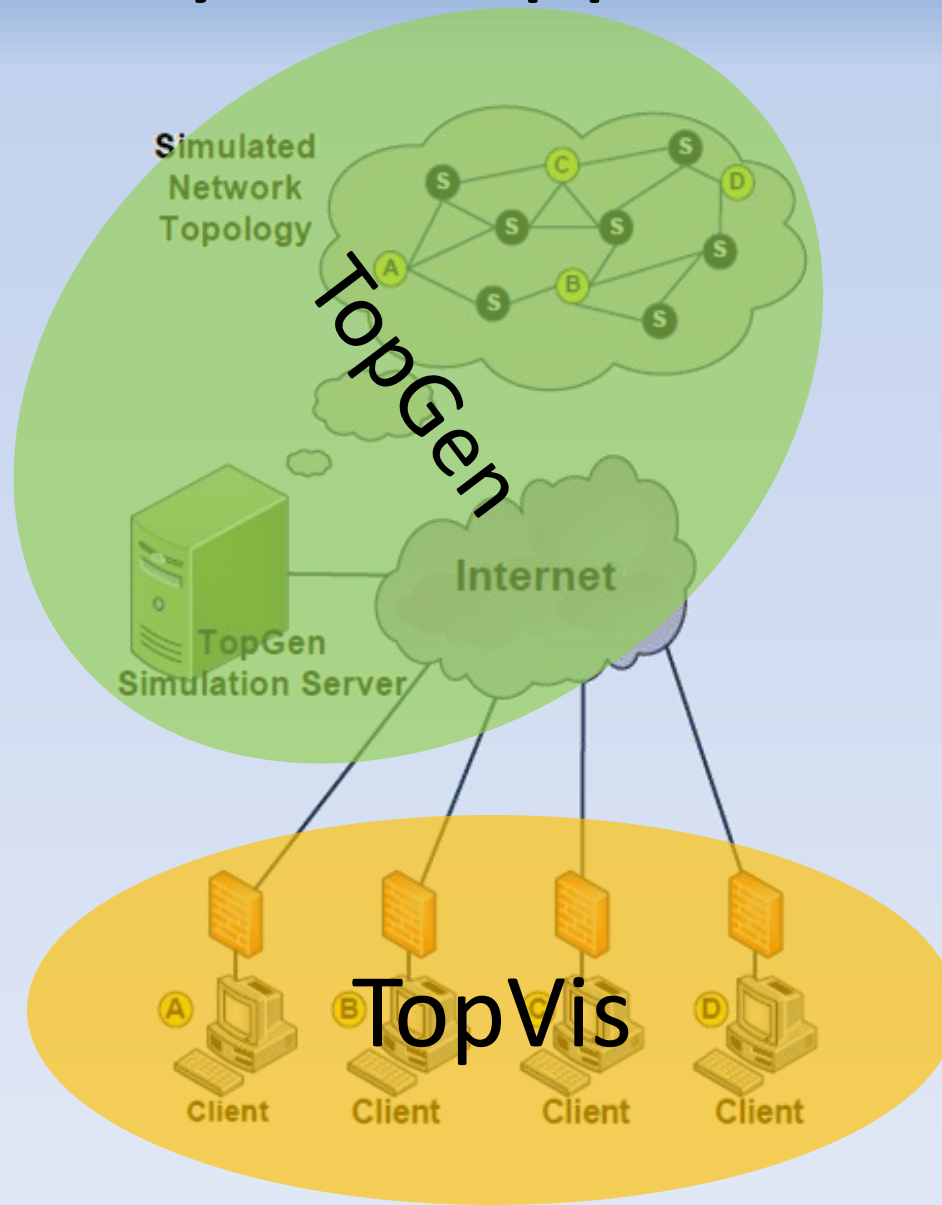


(for details see *Complex'09*)



(for details see *CollaborateCom 2008*)

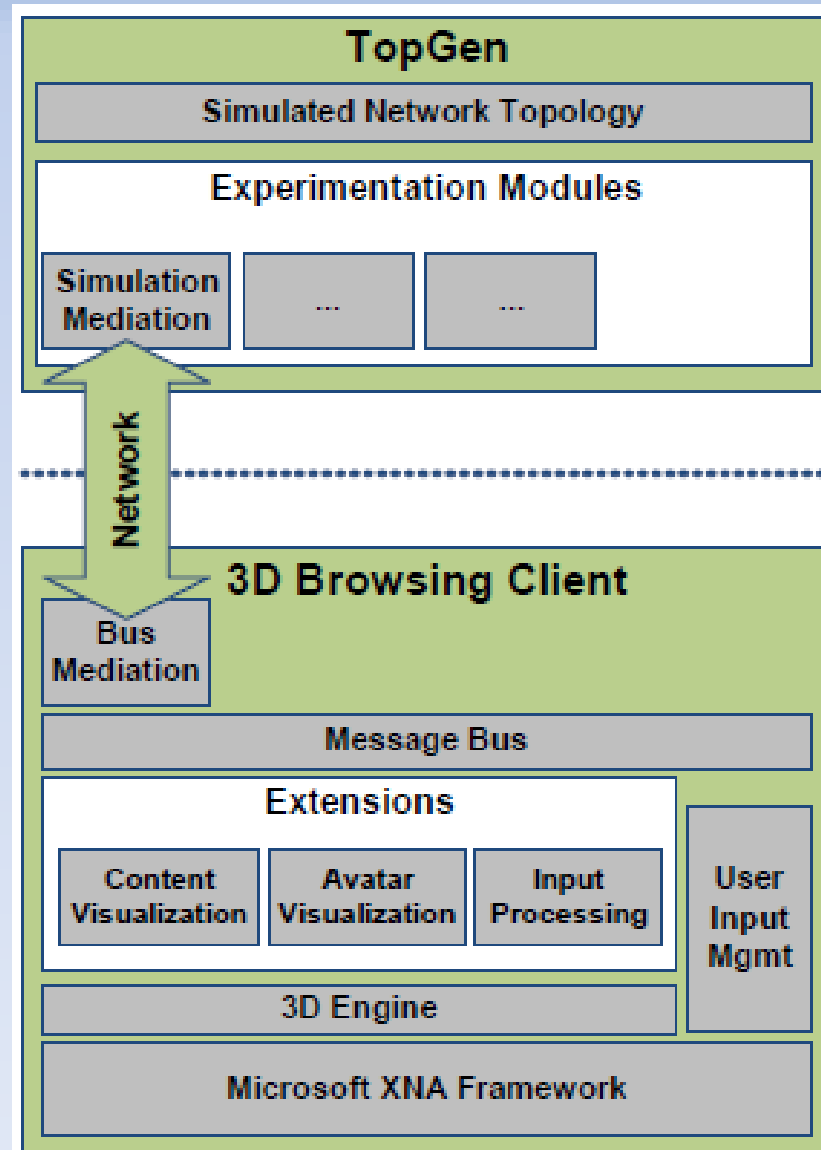
A Hybrid Approach



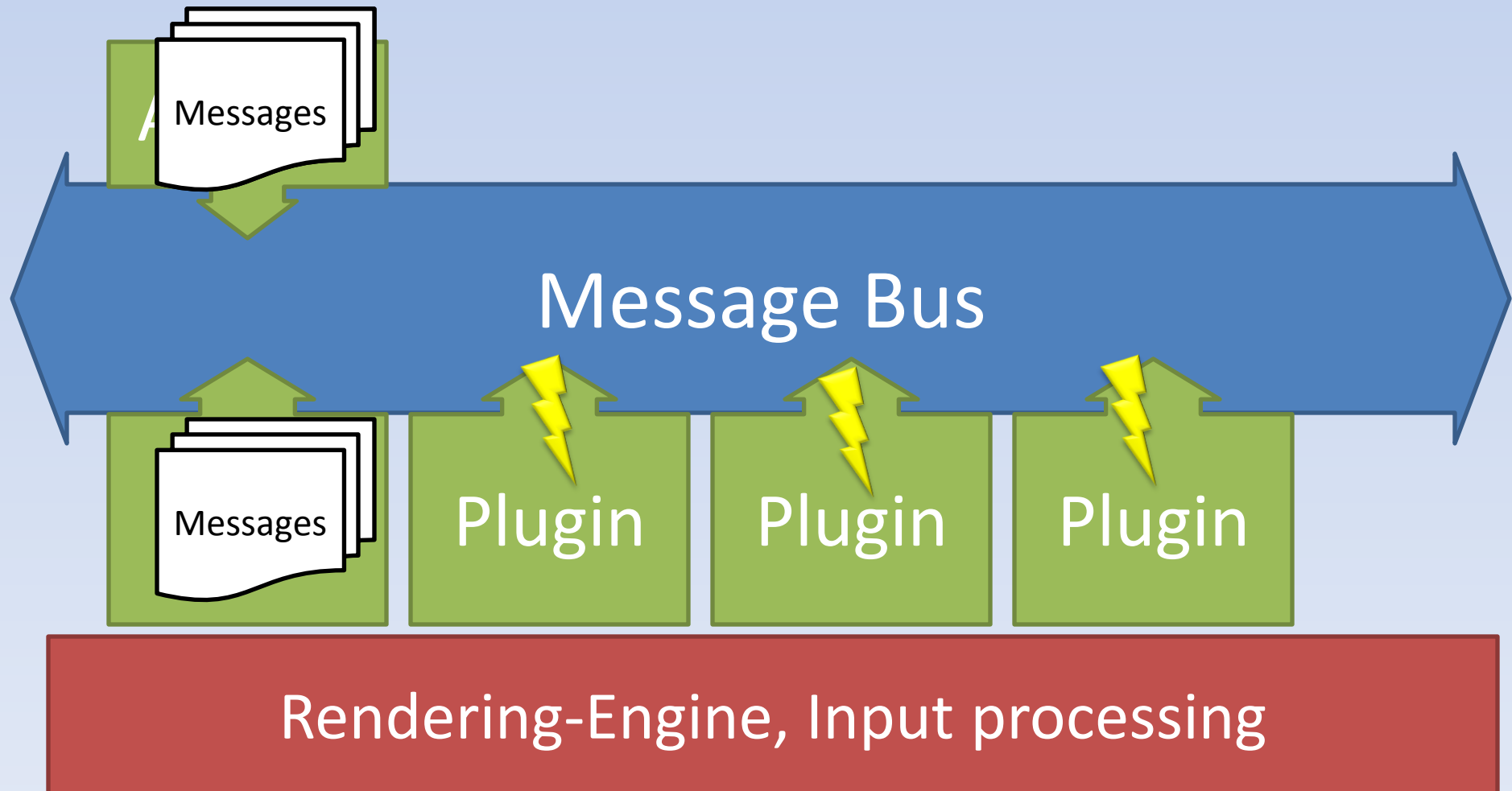
Client Considerations

- Generic and modular
 - Basic rendering facilities (any XNA-compatible content)
 - Client-logic customizable via dynamically-loadable plugins
- Ease-of-Implementation
 - High-level networking abstraction
 - Consistent communication model
 - „Message Bus“
- „Firewall-neutral“
 - No complex traversal required
 - All traffic via client-initiated TCP connection

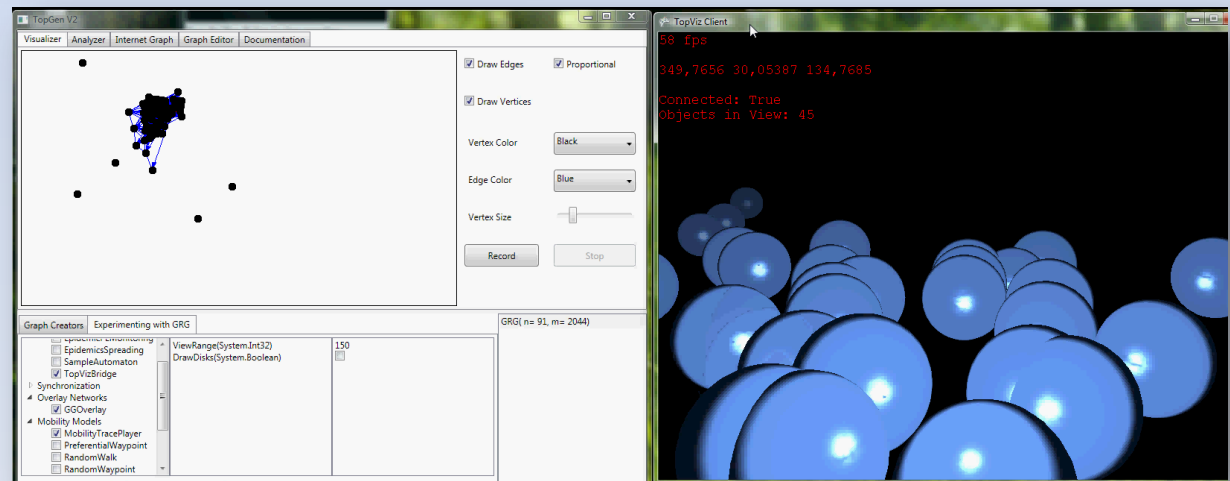
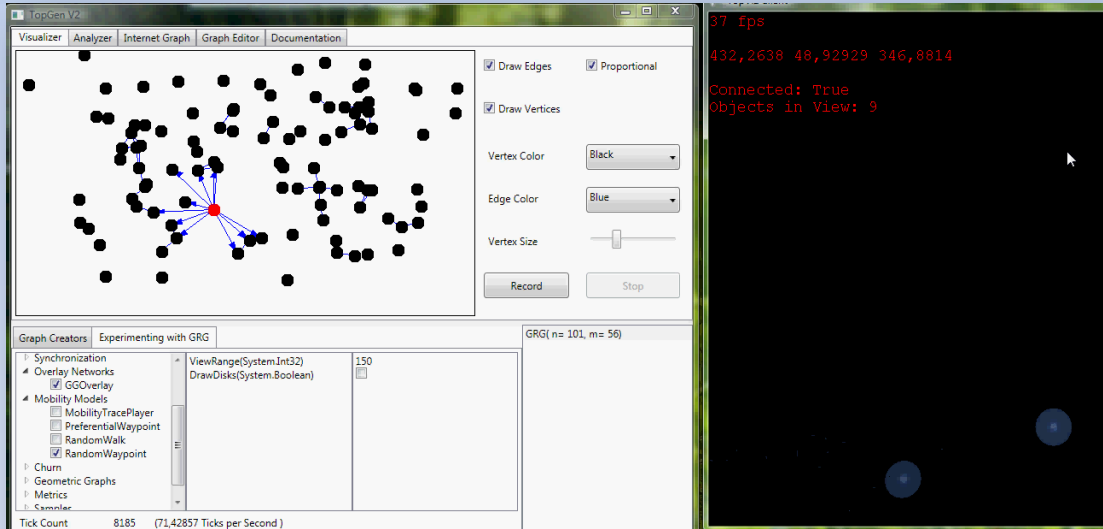
TopVis Architecture



TopVis Programming Model



Showcases ...



Usage Scenarios

- Pure Simulation Scenario
 - TopGen as simulation environment
 - No active TopVis clients
 - TopVis usable for Realtime 3D Visualization
- Pure Testbed Scenario
 - TopGen as (centralized) DVE Server
 - Simulated overlay with controllable delays
 - No simulated entities
 - TopVis as DVE clients
- Hybrid Scenario
 - TopGen as simulation environment + DVE server
 - Active/Passive TopVis clients

Benefits and Open Issues

- Benefits

- Overlay topologies can be tested with actual clients
- Topologies can be changed in real-time
- Simplified Development/Deployment
- Controllable network delays based on router network
- Flexible usage

- Open Issues

- Number of supportable TopVis clients
- Ready-to-use MONO version

TopGen(-powered) References

- [SimuTools08]** Scholtes et al.: „*TopGen - Internet Router-Level Topology Generation based on Technology Constraints*“, In Proceedings of SimuTools, March 2008, Marseille, France
- [IJAMC08]** Botev et al.: „*The HyperVerse: Concepts for a federated and Torrent-based 3D Web*“, In IJAMC, Vol.2, No. 4, June 2008
- [SaSo08]** Scholtes et al.: „*Awareness-driven Phase Transitions in Very Large Scale Distributed Systems*“, In Proceedings of IEEE SaSo, Oct. 2008, Venice, Italy
- [CollaborateCom08]** Scholtes et al.: „*Minimizing Load Delays in Distributed Virtual Environments using Epidemic Hoarding*“, In Proceedings of CollaborateCom, Nov. 2008, Orlando, FL, USA
- [Complex09]** Scholtes et al.: „*Epidemic Self-Synchronization in Complex Networks*“, In Proceedings of Complex'09, Feb. 2009, Shanghai, China

Thank you ...

- Questions? Comments?
- Check it out!



<http://syssoft.uni-trier.de/~scholtes>

<http://hyperversesyssoft.uni-trier.de>

scholtes@syssoft.uni-trier.de