Modeling, Simulation and Performance Evaluation of Hybrid Networks

Objectives

- Develop and demonstrate a versatile set of modules for modeling and simulation of high data rate satellite constellations
- Develop and demonstrate hierarchical fast algorithms for modeling and performance evaluation of large hybrid networks.
- Develop trade-off analysis tools for evaluation of hybrid network architectures
- Develop efficient software architecture for modeling and simulation testbed operational through the Internet and World Wide Web

Accomplishments

- Developed a rich set of modules for modeling satellite network elements, modulation, access, routing schemes, orbits, etc.
- Developed fast algorithms for performance evaluation for satellite networks in terms of delay, blocking probabilities, and throughput.
- Developed multi-media traffic modeling tools
- Develop hierarchical algorithms and software architecture for modeling and performance evaluation of very large hybrid networks, with high data rate satellites.

Impact

- Network design tools for high data rate satellite constellations are critical needs for industry
- Economic future of many commercial and military networks depends on careful trade-off in architecture, components, cost and performance
- CSHCN tools and studies used and influencing major industry decisions and designs
• High data rate satellite constellations are being planned for the turn of the century. Several recent studies have identified the critical lack in software systems for modeling, simulation and performance evaluation of such networks. These tools are essential in analyzing the interoperability between satellite and terrestrial networks.

• Developed a set of software modules for modeling and performance evaluation of satellite networks including: multimedia traffic modeling tool, quality of service evaluation tool (via fast algorithms), validation and verification tool, protocol design and optimization tool, satellite orbit modeling tool, sensitivity analysis tool.

• Performed performance analysis of on-board switching schemes and compared to alternatives. Satellites with on-board processing capabilities are being planned and there is a need to quantify the benefits of on-board processing vs. costs and performance to the end user.
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• Developed hierarchical software architecture for implementation of hierarchical, progressive modeling and performance evaluation algorithms. It is a client/server based architecture where the simulation kernel is hosted at the server while the client has a browser-based GUI. Java and CORBA are used in the software. All Java objects are specified in CORBA’s Interface Definition Language. The basic objects are nodes and channels. Nodes form their own hierarchy, where server node objects are decorated versions of server objects with additional GUI function. Client channel objects capture spatial, topological and qualitative characteristics. Server channel objects contain the mathematical description of the model. Software architecture uses “composition” pattern, so as to permit easy construction of hierarchical evaluation algorithms using aggregation etc. GUI is accessible via World Wide Web browser and contains flexible tools for visualization and performance evaluation.

• Developed progressive algorithms for performance evaluation of large hybrid networks with large star topologies architectures. The algorithms accept OPNET input at the lower level and produce fast estimates of performance metrics such as blocking probabilities. Initial results indicate good estimates can be obtained at times 100 to 1000 faster than discrete event simulations. Demonstrated use of progressive algorithms in performance evaluation of small networks embedded in large networks.