

## Modeling and simulation applied to communications systems

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### TUTORIAL CONTENTS

#### DEFINITION OF THE PROBLEM

- Why simulation
- Application to analysis, design, test, evaluation, and training
- Simulation as a support tool

#### THE ANALYSIS/DESIGN/TEST AND EVALUATION PROCESSES

- The analysis process
  - Understanding objectives
  - Defining measures of merit
  - Classifying parameters
  - Classifying responses
  - Ordering of experiments
- Extension to the design process
- Design of experiments for test and evaluation

#### COMPUTER SIMULATION TO SUPPORT ANALYSIS, DESIGN, AND TEST

- Off-line simulation to support analysis, design, test planning, and live test augmentation.
- On-line simulation to drive tests and simulate units under test
- Scenario generation
- Data collection, reduction, and presentation for analysis
- Design for realistic stress cases (worst case design)
- Training support

#### OVERVIEW OF COMPUTER SIMULATION AND MODEL REQUIREMENTS

- Measures of performance, constraints, parameters, accuracies
- Replications, running times, presentation formats
- Specification of models
- Validation of models
- Scenario considerations
- Cost considerations

#### MODELING COMMUNICATIONS ENTITIES AND THEIR ENVIRONMENTS

- Electromagnetic propagation media
- Antennas
- Transmitters and receivers
- Signal processors
- Packet and message processors
- Routing and signaling processors
- Internetwork gateways
- Adaptive network management systems
- Human design processes (man in the loop)
- Voice subscribers
- Host data systems
- Sensor systems
- Moving platforms
- Control systems
- Dynamic interference generators

#### SELECTING MODELS TO USE IN A SIMULATION

- Measurement considerations - data collection constraints
- Accuracy considerations - validity constraints
- Speed considerations - run-time constraints
- Size considerations - storage constraints
- Fitting the level of resolution to the simulation requirements
- Incorporating instruments for collecting data
- Availability of existing validated models

#### BREAKING THE BARRIERS OF HIGH COST AND COMPLEXITY

- Reusing and expanding existing validated models
- Combining validated models into a bigger simulation
- Adding new models to a large simulation
- Sharing validated models across organizations

#### DESIRED ATTRIBUTES OF A MODELING AND SIMULATION ENVIRONMENT

- Provide for generic reductions in time, cost, plant and personnel resources needed to get results
- Provide for building models of large numbers of entities which
  - operate concurrently
  - share environments
  - interact differently as time passes
- Provide for many different simulations with these models using different:
  - input scenarios
  - output instruments
- Provide ease of understanding - require no knowledge of software languages or programming
- Allow ease of sharing of models between organizations
- Allow ease of handling of large amounts of data for input to and output from the simulation
- Provide simplified presentations for analysis and demonstration

#### CAPITALIZING ON THE COMPUTER AIDED DESIGN KNOWLEDGE BASE

- Eliminating software development from model and simulation development
- Modeling along physical lines
- Controlling complexity using hierarchical symbolic models
- Validating models in hierarchical steps
- Simplifying models via resolution changes at key points in the hierarchy
- Validating simplified representations of models

SPECIFIC TECHNIQUES FOR BUILDING MODELS,  
RUNNING SIMULATIONS, AND GETTING  
RESULTS QUICKLY

- Hierarchical symbolic modeling using graphics
  - Examples from network model design
- Hierarchical symbolic scenario development using graphics
  - Examples from mobile communications systems
  - Evaluation of network connectivity
- Run-time graphics presentation facilities
  - Examples of network routing evaluation
  - Evaluation of network capacity
- Post-simulation graphics presentation facilities
  - Examples of network capacity evaluation

SEMINAR SUMMARY AND WRAP-UP

- Downfall of the major barriers has come:
  - Memory sizes
  - Processor speeds
  - Data management systems
  - Presentation graphics
  - Multiprocessor compilers
- Taking full and immediate advantage of today's advances in computer technology
- Application to real time network management - in the field

AUTHOR'S BIOGRAPHY

WILLIAM C. CAVE, a nationally recognized expert in the field of modeling and simulation, has been president of Prediction Systems, Inc. (PSI) since 1974. During this period, PSI has developed several modeling and simulation tools that are well in advance of the state-of-the-art for computer and communications network modeling systems. In recent year, he has concentrated on applying modeling and simulation to design and test mobile and switched communications systems. Having 27 years experience in managing, planning, developing, and supporting computer automation, he has consulted for many major corporations and published numerous articles covering the fields of computer aided design, optimization, prediction and control. Mr. Cave holds BS and MS degrees in Electronic Engineering from Pennsylvania State University and New York University. He has done additional graduate work at the Polytechnic Institute of Brooklyn and Stevens Institute of Technology.