Objectives

• Develop and demonstrate an algorithmic and software framework for modeling and performance evaluation of large hybrid networks, including wireless, multihop, multirate networks

• Develop trade-off analysis tools for evaluation of alternative hybrid network architectures

• A hierarchical modeling architecture

• Fast and accurate analytical end-to-end performance evaluation
Approach

- Real Hierarchy → Abstract Hierarchy
- Hierarchical algorithms based on network hierarchies
- Fast algorithms for progressive performance evaluation
- Performance metrics: Delay, Throughput, Cell or Packet loss
Reduced Load Approximations

- Network equilibrium, conservative performance estimate
- Hierarchical extensions of the algorithms
- Orders of magnitude faster than OPNET-based simulation
- Fixed point achieved through mappings and iterations

\[ a_{ij}(s) \quad v_{ij}(s) \quad p_{ij}(n) \quad q^{(m)}(k, l, s) \]
 mappings

\[ \nu_{i,j}^{(m)}(k,l,s) = \lambda_{k,l}(s)q^{(m)}(k,l,s)I[(i,j) \in \mathcal{R}^{(m)}_{k,l}] \prod_{(u,v) \in \mathcal{R}^{(m)}_{k,l},(u,v) \neq (i,j)} a_{u,v}(s) \]

\[ \nu_{i,j}(s) = \sum_{k,l} \sum_{m} \nu_{i,j}^{(m)}(k,l,s) \]

\[ np_{i,j}(n) = \sum_{s} b_{s} \frac{\nu_{i,j}(s)}{\mu_{s}} p_{i,j}(n-b_{s}), \quad n = 1, \ldots, C_{i,j} \]

\[ a_{i,j}(s) = 1 - \sum_{n=C_{i,j}-b_{a}}^{C_{i,j}} p_{i,j}(n) = \sum_{n=0}^{C_{i,j}-b_{a}} p_{i,j}(n) \]

\[ T_{i,j}(n) = \sum_{t=0}^{n} p_{i,j}(C_{i,j} - t) \]

\[ q^{(m)}(k,l,s) = \sum_{n=0}^{C_{k,l}^{(m)}} p_{L_{k,l}^{(m)}}(C_{L_{k,l}^{(m)}} - n) \prod_{t=1}^{m-1} T_{L_{k,l}^{(t)}}(n-1) \prod_{t=m+1}^{M} T_{L_{k,l}^{(t)}}(n) \]

end-to-end blocking probabilities

\[ B(k,l,s) = 1 - \sum_{m} q^{(m)}(k,l,s) \prod_{(u,v) \in \mathcal{R}^{(m)}_{k,l}} a_{u,v}(s) \]
• \( \nu_{i,j}(s) \): arrival rates of calls of class \( s \) from any node pair that includes link \((i,j)\) on some route, given that link \((i,j)\) is in a state that admits calls of class \( s \)

• \( a_{i,j}(s) \): probabilities that link \((i,j)\) is in a state that admits calls of class \( s \)

• \( q^{(m)}(k,l,s) \): the probability that a call of class-\( s \) with source-destination pair of \((k,l)\) is attempted on its \( m^{th} \) route

• \( p_{i,j}(n) \): the link occupancy distribution of link \((i,j)\)
Software Architecture Developed

- Client/Server based architecture
- Java, CORBA
- Object structure: nodes and channels