A novel hierarchical and parallel model for wireless network simulations and its design using PtolemyII infrastructure

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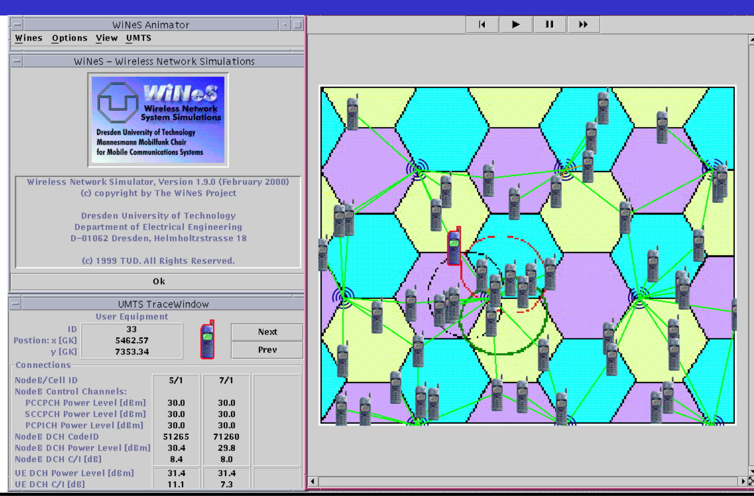
- Background and Problem Statement
- Approach
- Analysis
- Design
- Results and Conclusions

Background



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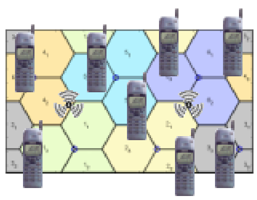
Modeling a Radio Access Network

Reality → Model



→ Static Analysis → Static Design (object oriented class library)

done

physical time, real world actions → Dynamic Analysis → Dynamic Design (Simulation Engine)

this talk

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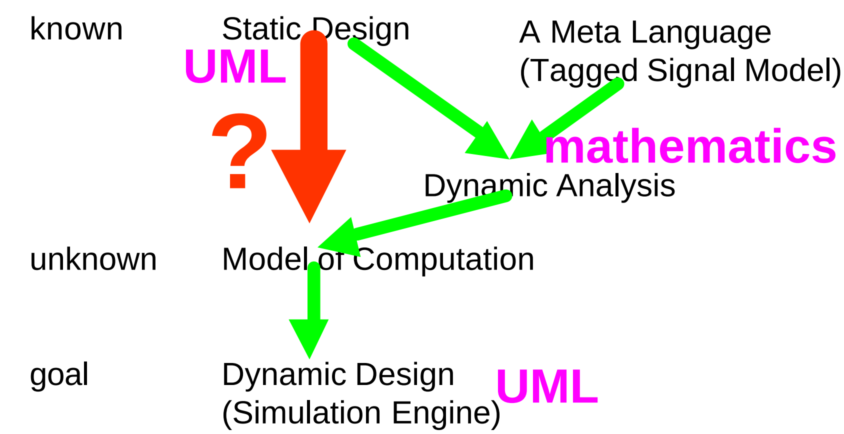
Simulation Engine : Problems

- stochastic, discrete, and dynamic simulations
- state of the art: discrete event simulations
  - sequential (slow, but simple scheduling)
  - parallel/distributed (PDES)
    - complicated synchronization algorithms
    - speed up in radio access network simulations depends on: partitioning vs. multiple access scheme
    - known partitioning strategies not usable with CDMA networks

Starting Point / Approach



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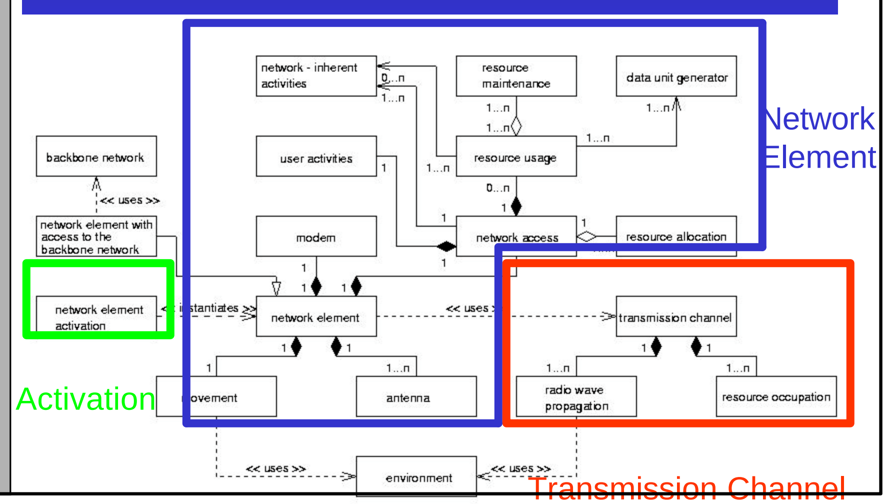
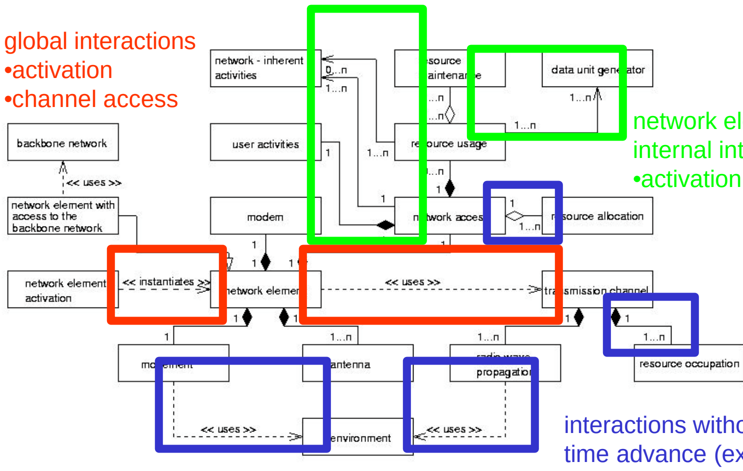
Static Design: 3 Key Elements



Dynamic Analysis

global interactions
•activation
•channel access



network element
internal interactions
•activation

interactions without
time advance (expl.)

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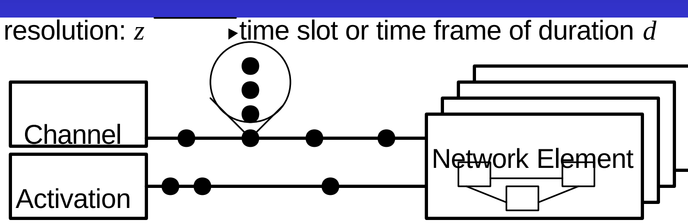
Example: Global Interactions

•time resolution: z ▸time slot or time frame of duration d



•channel: repeated interactions at: $h_{CAzj} = z \cdot d, N = \{z, 1 \le z < n, z \in / N\}$

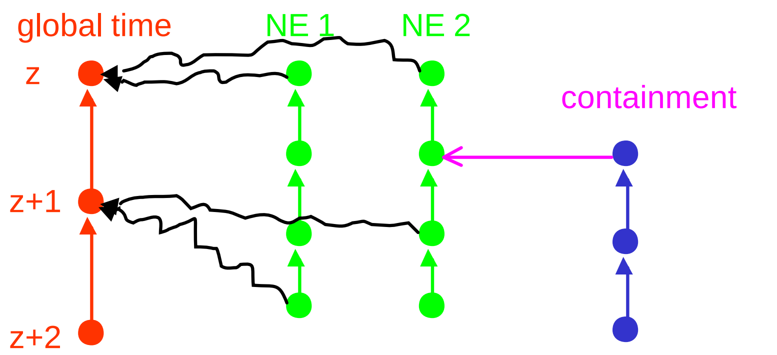
▸ $E_{CA} = (E_{CA1} \square\ E_{CA2} \square\ E_{CAz} \square\ E_{CAn}), \forall z \in N$

•activation: random interactions at: $h_{Aa} = l_a, M = \{a, 1 \le a < m, a \in / M\}$

•set of all interactions: $E_{global} = E_{CA} \square\ E_A$

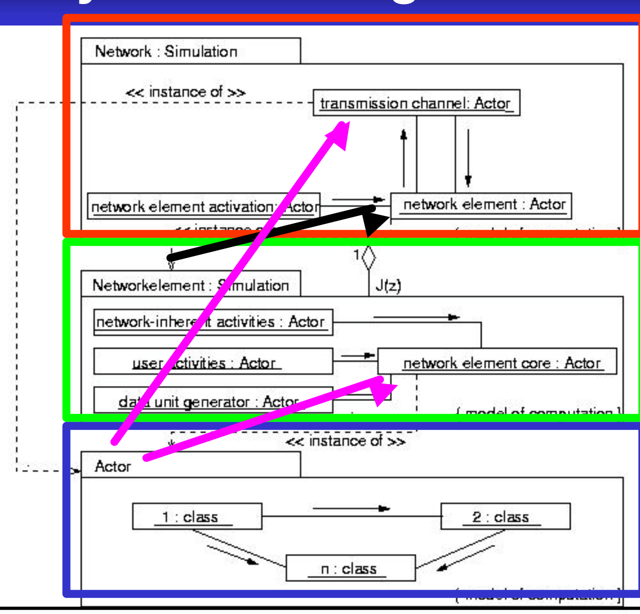
•set of all time stamps: $H_{global} = H_{CA} \square\ (H_A \setminus H_{CA})$

Dynamic Analysis : Results

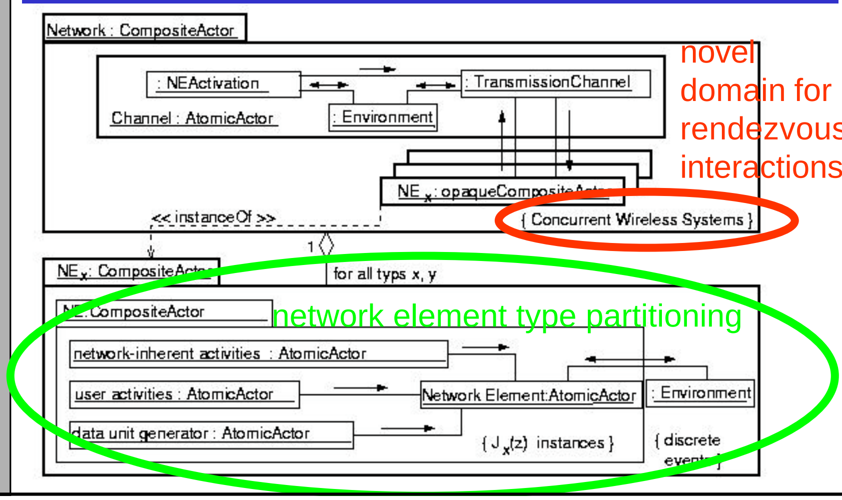


synchronization = rendezvous

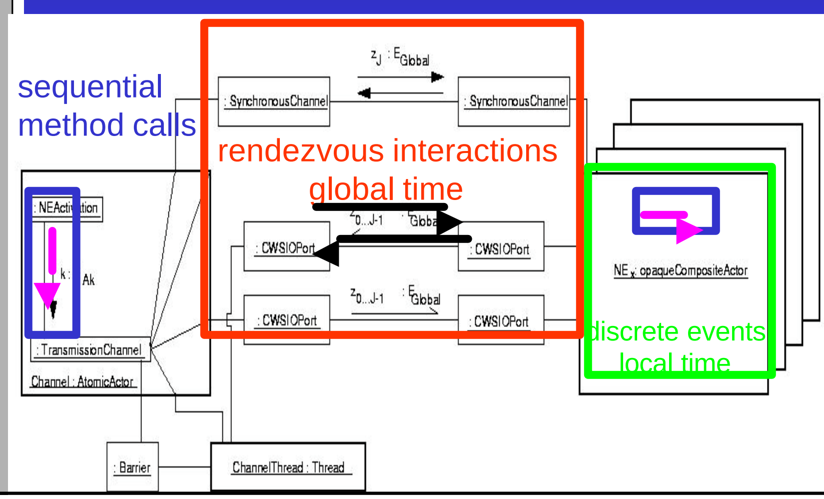
Dynamic Design : Theory



Dynamic Design on PtolemyII



Interactions in PtolemyII



Conclusions: PDES of CDMA Radio Access Networks

- **Synchronization algorithms**
  - mathematical analysis of interactions proves unordered interactions: parallelism possible
  - a-priori knowledge about interactions' course allows novel, tailored, and very simple „pessimistic" synchronization using rendezvous interactions
- **Partitioning, especially for CDMA networks**
  - hierarchical design
  - partitioning strategy: types of network elements
- **Speed up vs. sequential**
  - on multi processor workstation about 1.2 ... 1.6