



Real-Time, Pseudo-Randomly Generated Features for Combat Experimentation in Urban Sprawl

Gregory B. Tackett, Distributed Simulation Manager
U S Army Aviation & Missile Command
Research, Development, and Engineering Center



Need for Urban Sprawl Representation

- Operations Other Than War
- Military Operations in Urban Terrain
- Peacekeeping
- Domestic Preparedness
- Homeland Defense
- Military/Civilian Partnerships



Live events in urban/suburban areas are rarely an option

Urban Sprawl Adds Realism

- Line-of-sight obstructions
- Mobility barriers / trafficability
- Serendipitous firing positions
- Civilian and commercial considerations
- Interior / exterior engagements
- Target acquisition clutter



Ubiquitous throughout an expansive battlespace

Urban Sprawl Problem Space

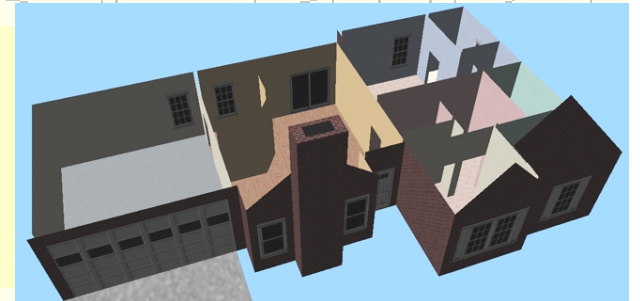
Unofficial definitions:

Urban: Billions and billions of objects

Sprawl: ...and they keep going, and going, and going

A Fact usually ignored in simulation:

All buildings have interiors



The problem complexity of these 3 dimensions of urban sprawl approaches a 3rd Order Infinity

Shortfalls of Traditional Approaches

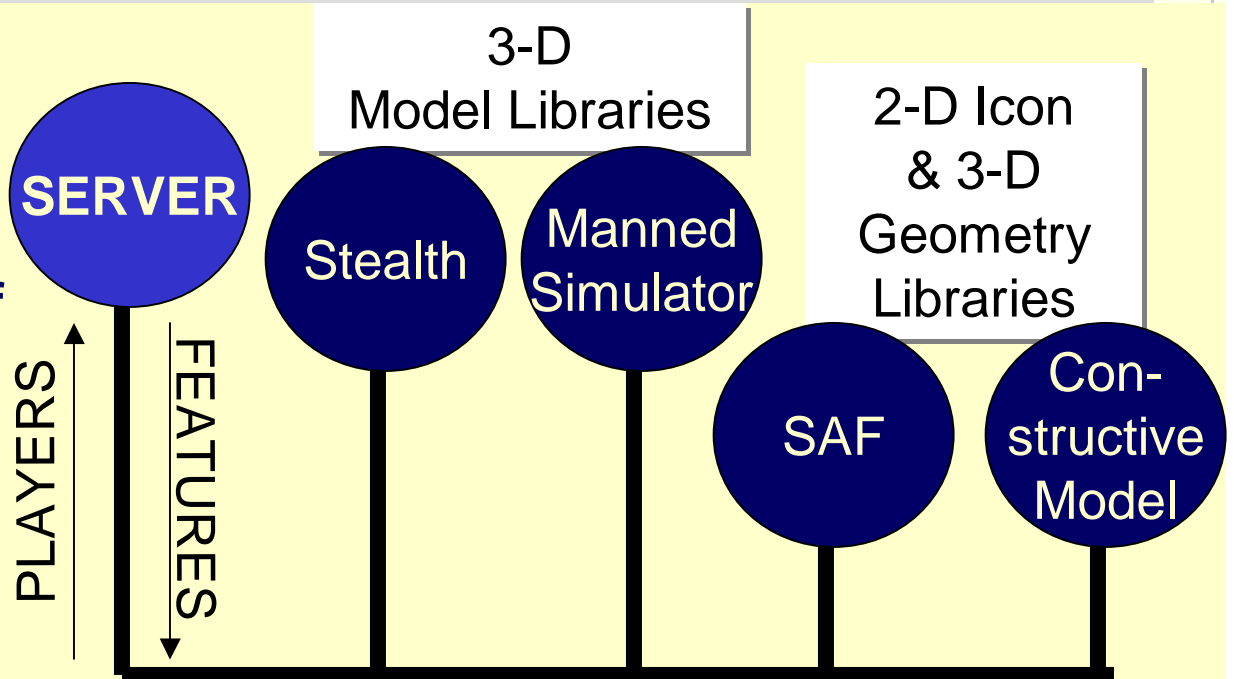
As terrain database complexity $\rightarrow \infty$,
development schedule $\rightarrow \infty$,
cost $\rightarrow \infty$,
simulation performance $\rightarrow \emptyset$,
ratio of detail used per event $\rightarrow \emptyset$.

Military Solution:
Limited number of databases,
re-used exhaustively,
R&D towards faster/cheaper,
cannot catch up
with need

Gaming Solution:
Limits player choices,
movie set approach,
R&D towards prettier,
cannot meet military
requirement for freeplay

Service Interfaces

- Server subscribes to player entity locations
- Server publishes feature entity states in vicinities of player entities
- Clients use internal model libraries to instantiate features superimposed onto terrain



DIS: Rapid interoperability with legacy simulations
HLA: More control of feature data distribution

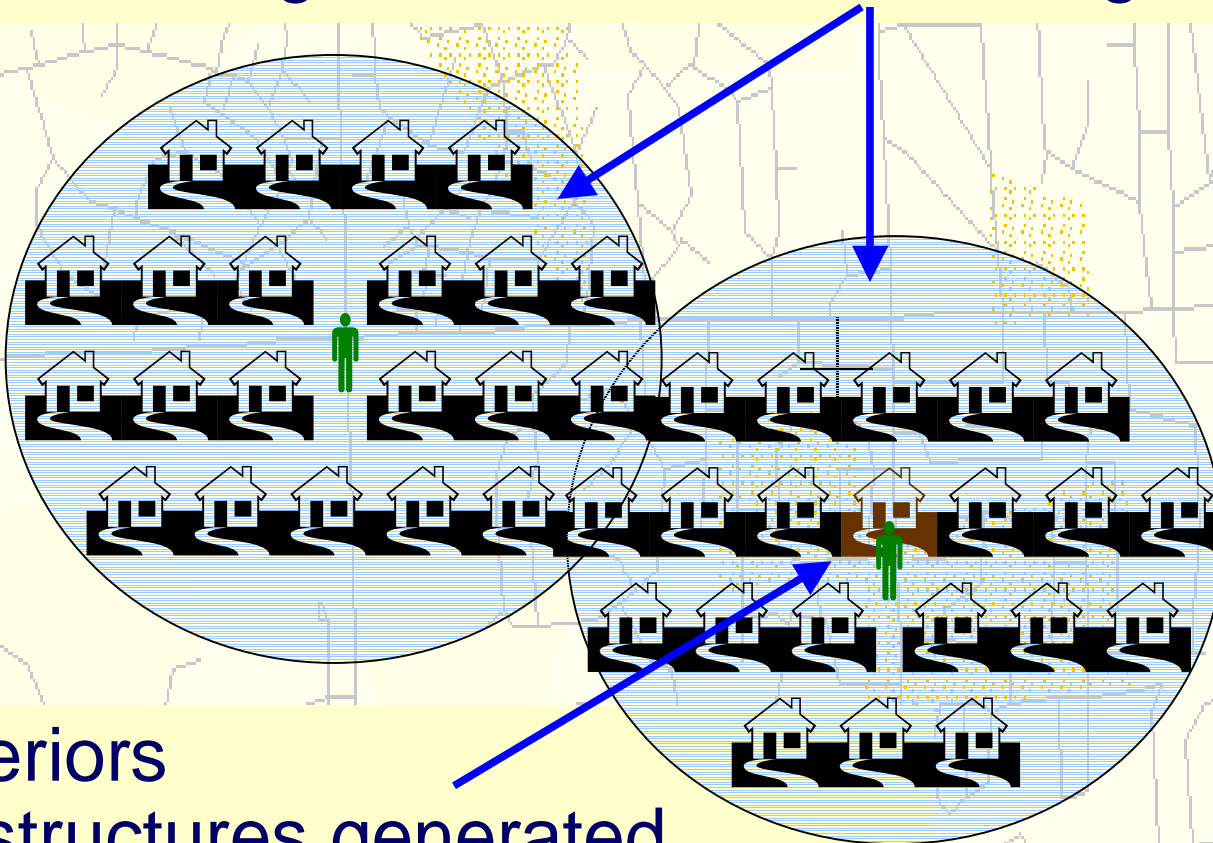
SERVER

Real-Time Generation

(decides *when* features are rendered)

CLIENT

Dynamic regions for cultural feature generation



Simulation runtime not burdened with unobserved detail

Interiors of structures generated in immediate player vicinities

**SERVER
side**

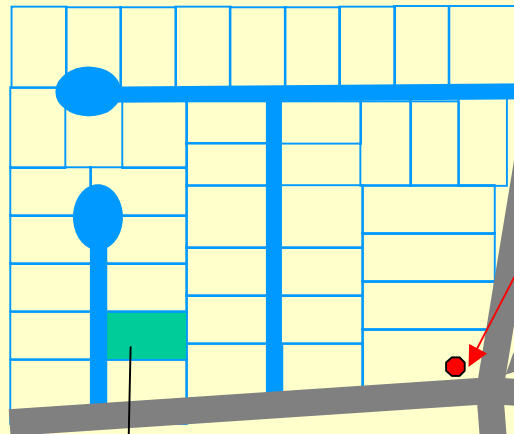
Pseudo-Random Rule Set

(decides *what* features are rendered *where*)

Suburban Example

- Rule set for virtual suburban zoning
- Random number seed for each grid zone repeatably determines feature mix
- Building interiors generated by template as players approach

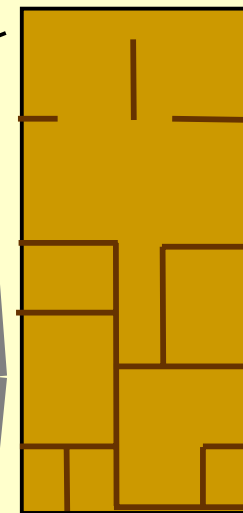
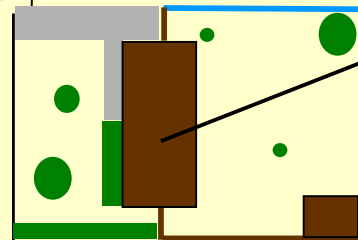
Rule 3: Quarter-block template for lot layout



Rule 2: Utility and sign entities at regular positions

Rule 1: Intersection offset to break up line-of-sight

Rule 4: Random draws for house, fence, plants, decks, driveway, outbuildings, etc.



Rule 5: Selection of interior wall template per house dimensions

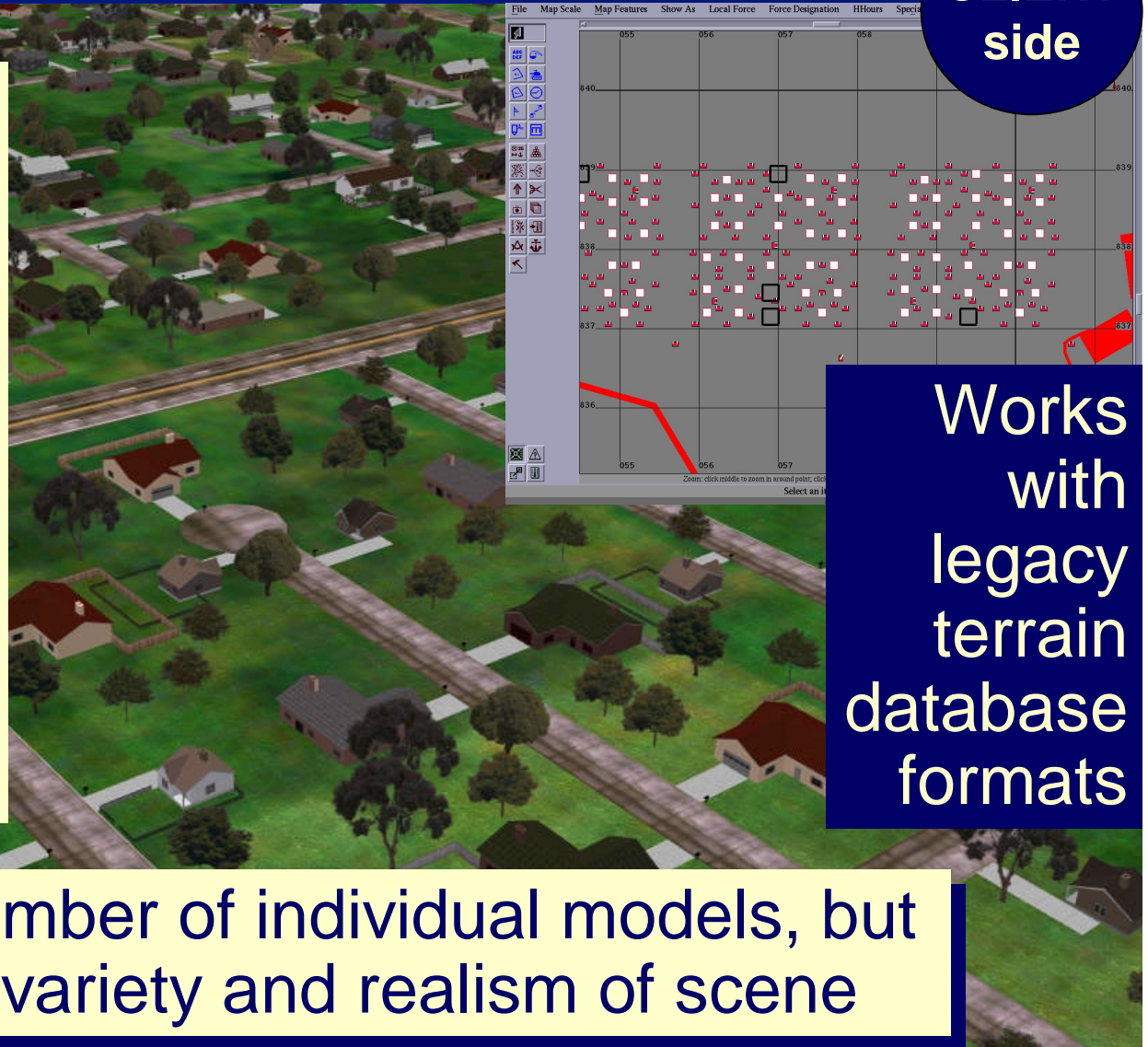
Cultural Feature Model Set

(decides *how* features are rendered)

CLIENT
side

Suburban Example

- Houses
- Streets
- Driveways
- Signs
- Fences
- Mailboxes
- Outbuildings
- Trees
- Shrubs
- Hedges
- Parked Cars
- etc...

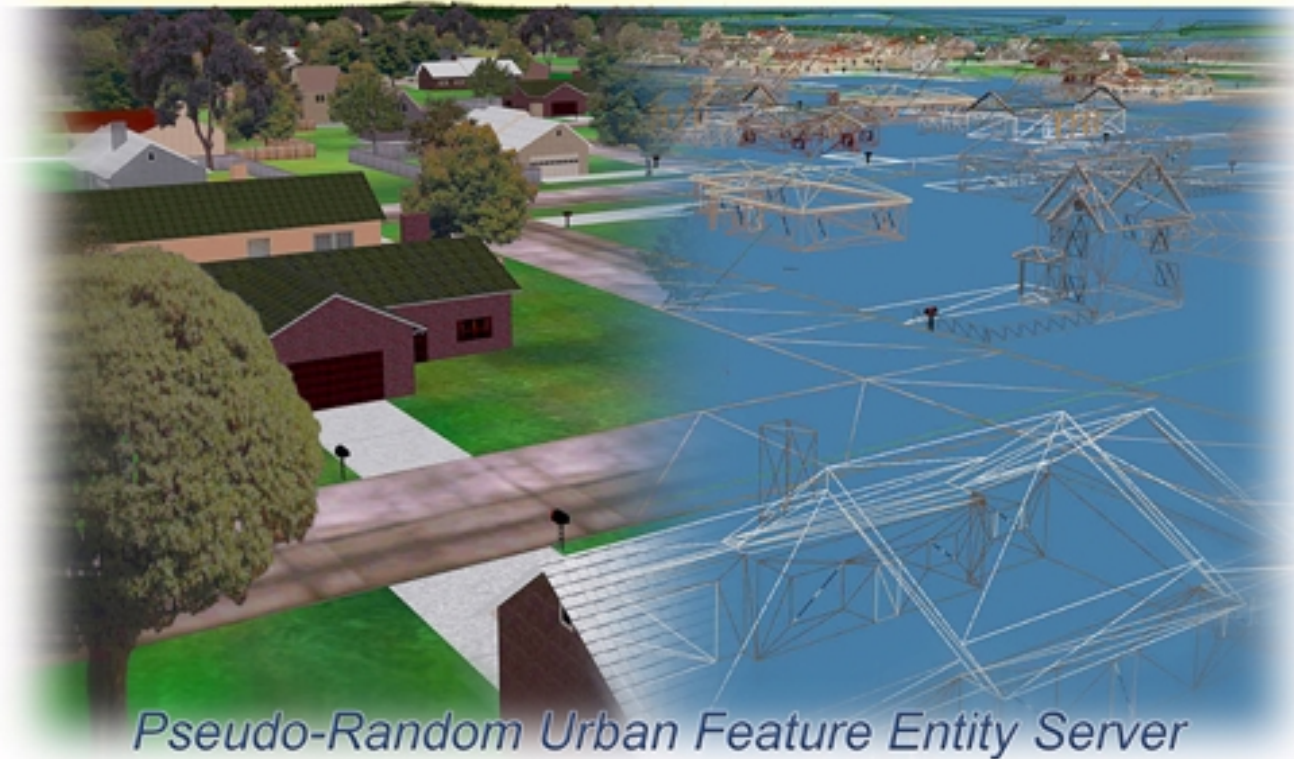


Works
with
legacy
terrain
database
formats

Minimize number of individual models, but
Maximize variety and realism of scene

PRUFES: A Prototype Application

PRUFES



Pseudo-Random Urban Feature Entity Server

PRUFES Design Goals

Develop a prototype cultural feature server that:

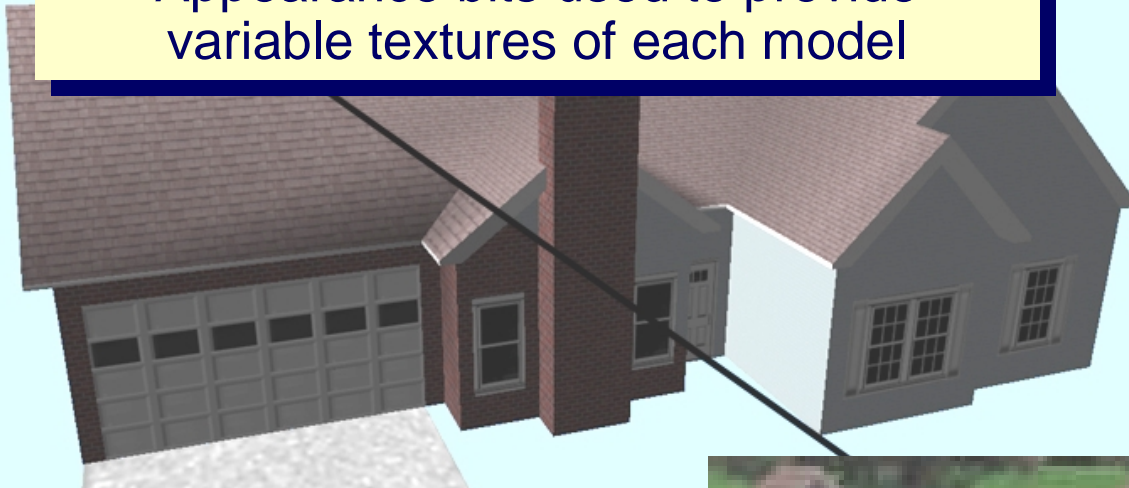
- represents a typical American suburb
- is plug-n-play with legacy distributed simulations
- is limited to flat or ground-clamped terrain regions
- supports any user-defined x,y dimensions
- includes “Open Flight” format 3-D model sets
- includes interior structures
- generates and publishes features real-time as needed



PRUFES Innovations

(Minimize Models/Maximize Variety)

Appearance bits used to provide variable textures of each model



Articulated signs provide unique street names and numbers with a single model



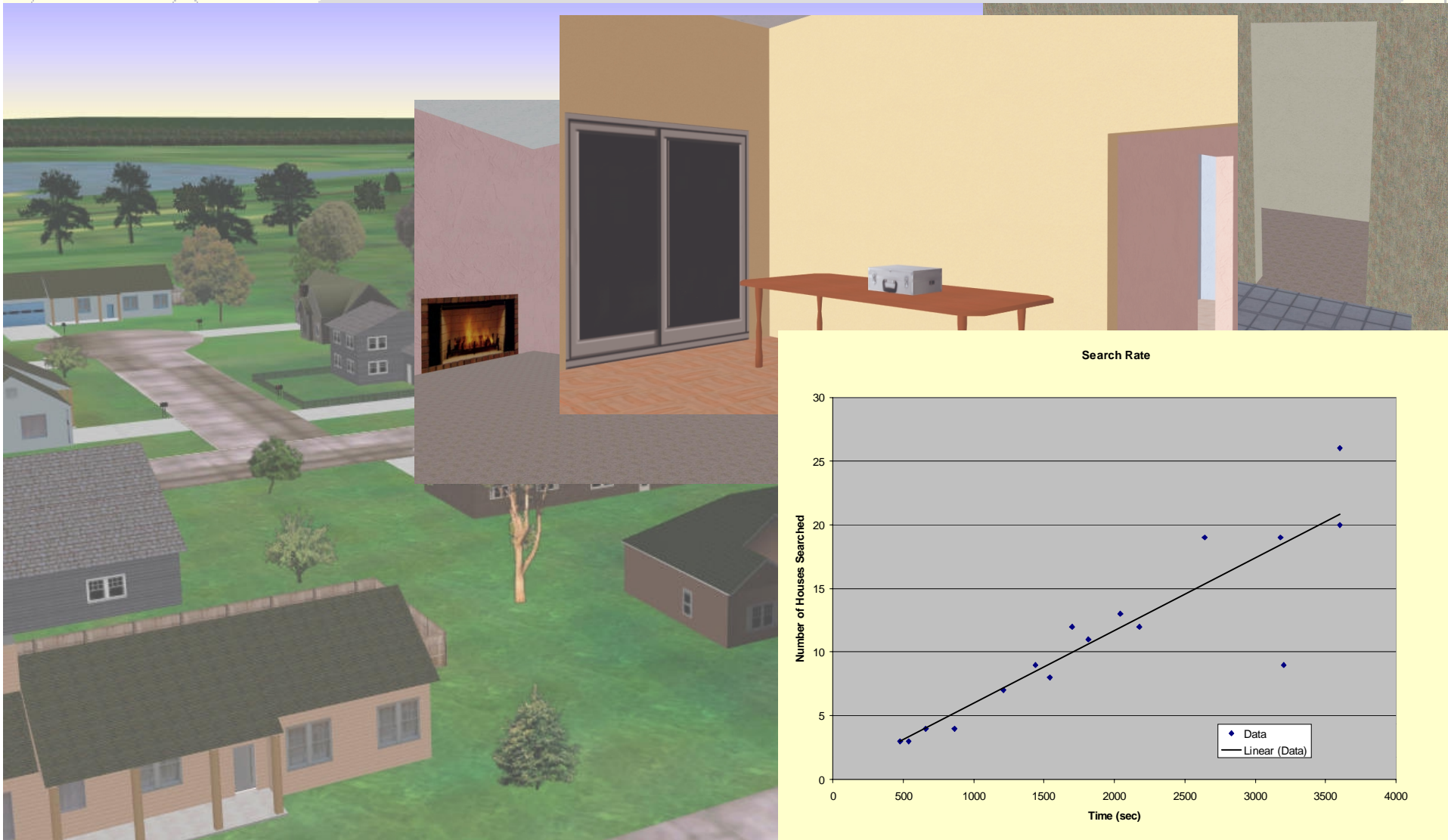
Textured interiors provide variety to internal building structure



“Baby Gate” articulated fences provide variable length with a single model



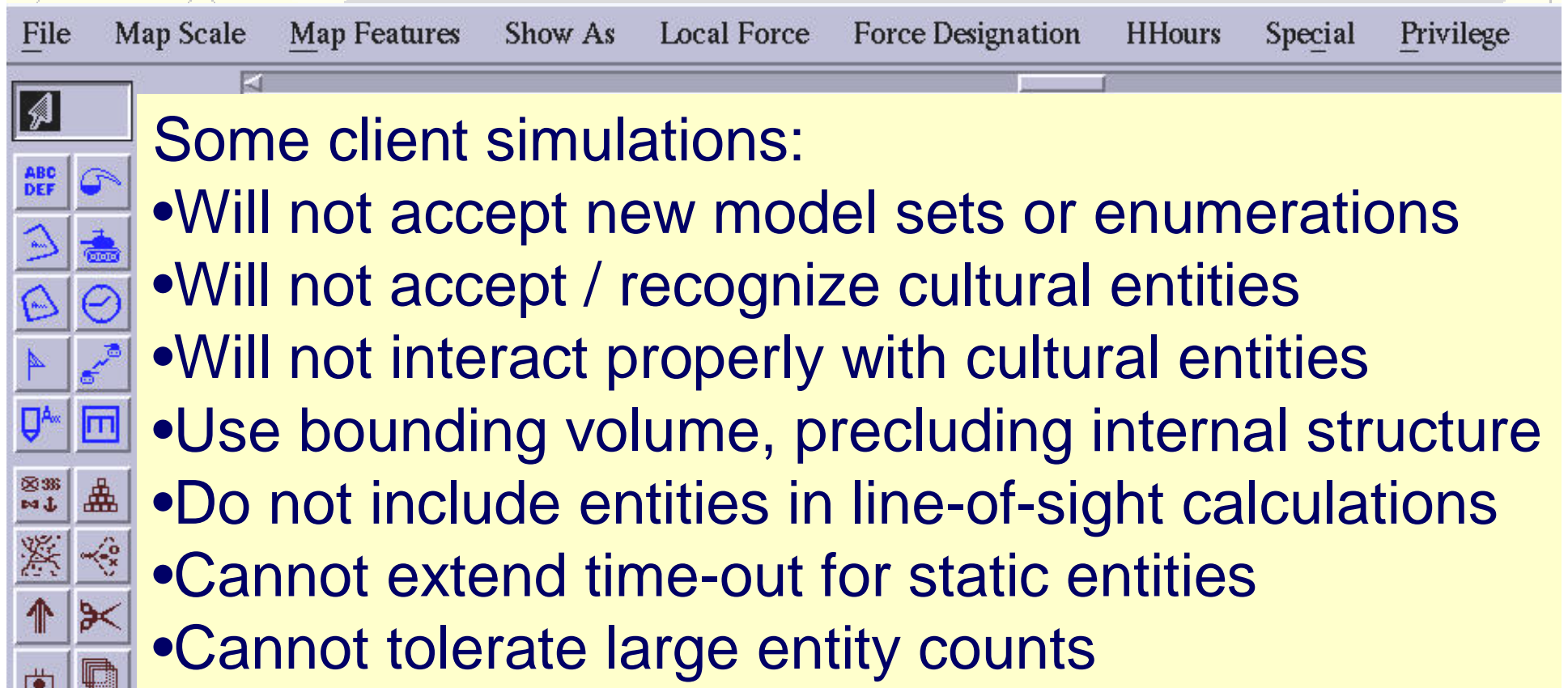
HomeLand Security Experiment



25 Oct, 2001

ACAS2001 - PRUFES

Feature Server Integration Issues



The screenshot shows a software interface with a menu bar at the top containing the following items: File, Map Scale, Map Features, Show As, Local Force, Force Designation, HHours, Special, and Privilege. Below the menu bar is a toolbar with various icons, including a cursor, a globe, a map, a clock, a flag, a document, a stack of papers, a compass, a pair of scissors, and a magnifying glass.

Some client simulations:

- Will not accept new model sets or enumerations
- Will not accept / recognize cultural entities
- Will not interact properly with cultural entities
- Use bounding volume, precluding internal structure
- Do not include entities in line-of-sight calculations
- Cannot extend time-out for static entities
- Cannot tolerate large entity counts

These issues are not universal nor insurmountable,
Many legacy manned simulators are plug-n-play

Potential Future Development

- More rule / model sets = more sprawl types
- More scene complexities
- User-defined tuning of rules during runtime
- Elevation / orientation algorithms for sloped terrain
- Interspersing built-in and real-time features
- Native HLA interfaces
- Non-static cultural entities
- Geo-specific data sets
- Real-time feature damage / alteration
- Complex, multi-story internal structure
- Nested fidelity for furniture, contents



For More Information

Greg Tackett

U S Army Aviation & Missile Command Research,
Development, & Engineering Center (AMRDEC)

AMSAM-RD-SS-AA

Redstone Arsenal, AL 35898

256-842-9501

greg.tackett@rdec.redstone.army.mil

