

Space Allocation Optimization

NASA LaRC GIS TEAM

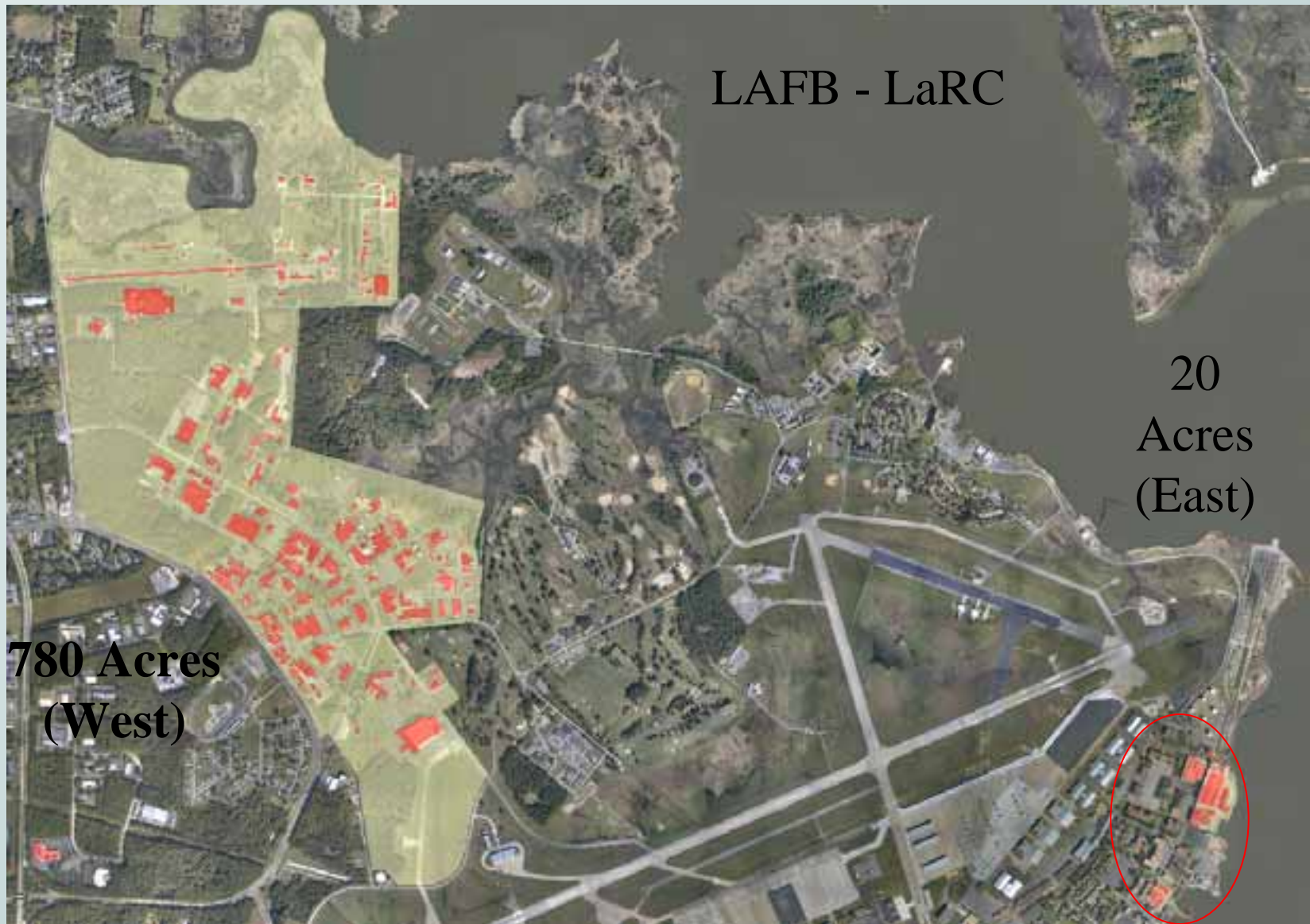
ESRI Fed User Conference Feb.09

- Background
- Past & Current Developments
- Planned Efforts
- Web Interface Movie

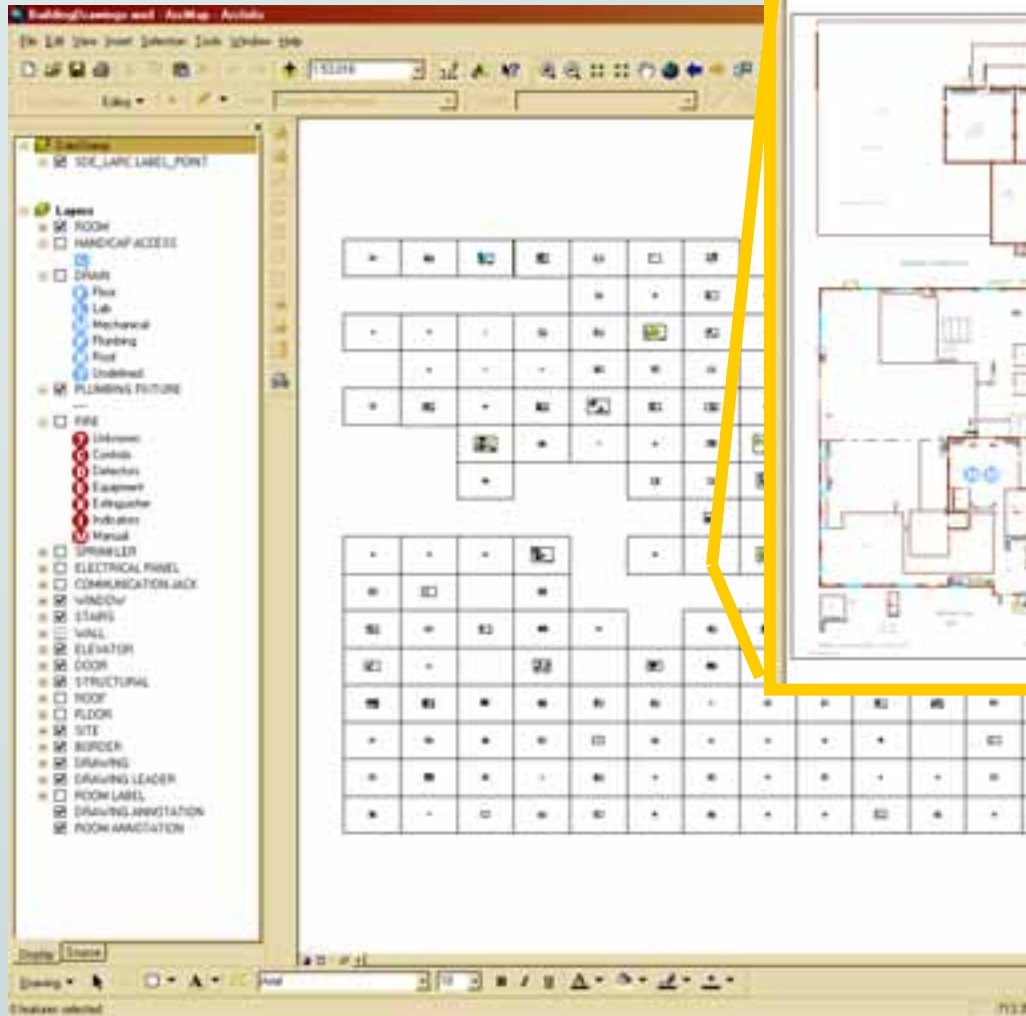
William (Brad) Ball



Background



Floor Plans in GIS

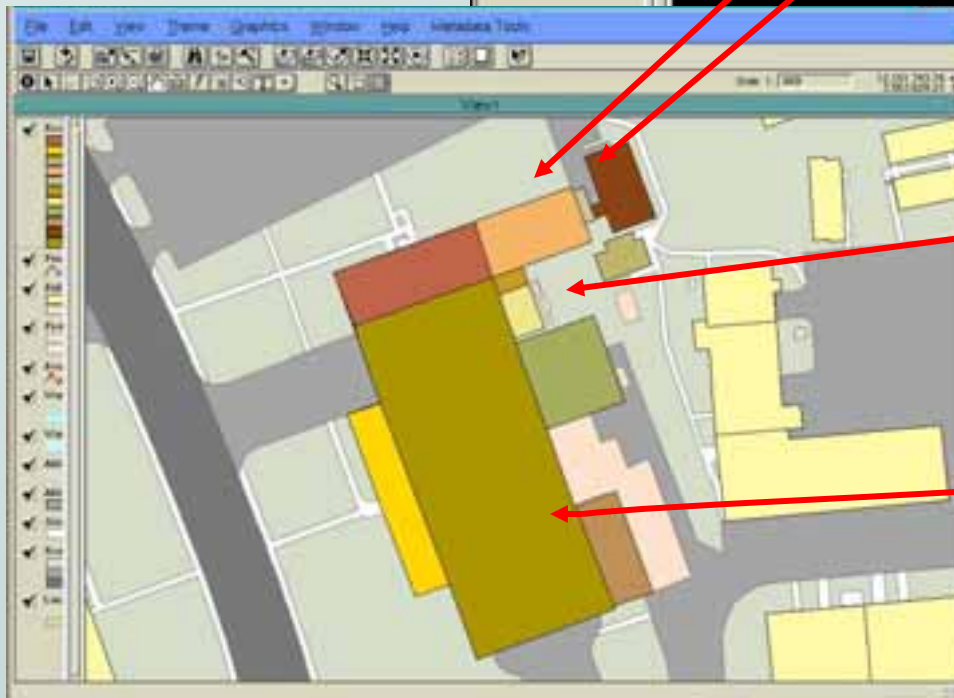
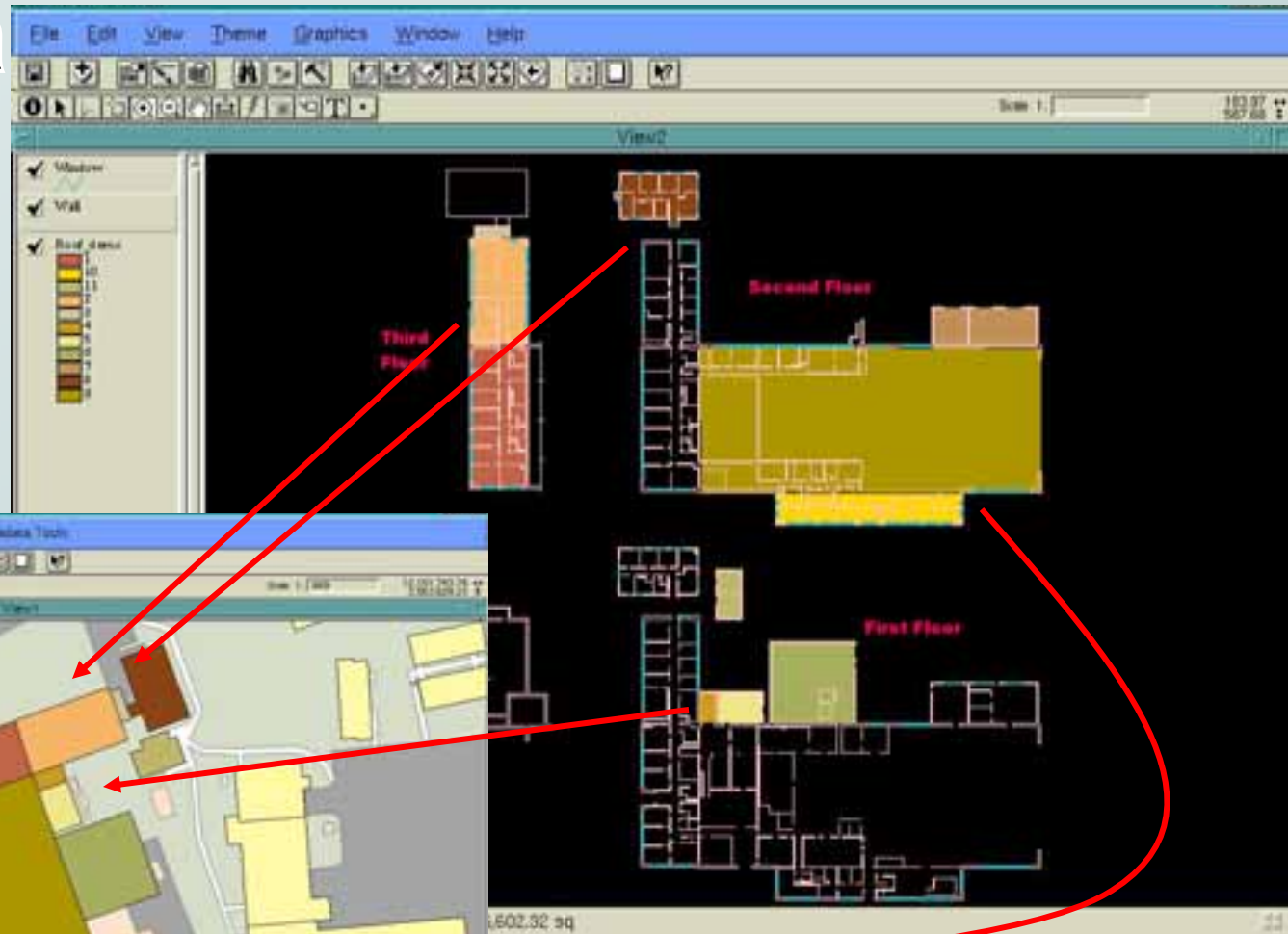


- Grid of all floor plans
- Single layer for each feature



Mapping Floor Plan Data

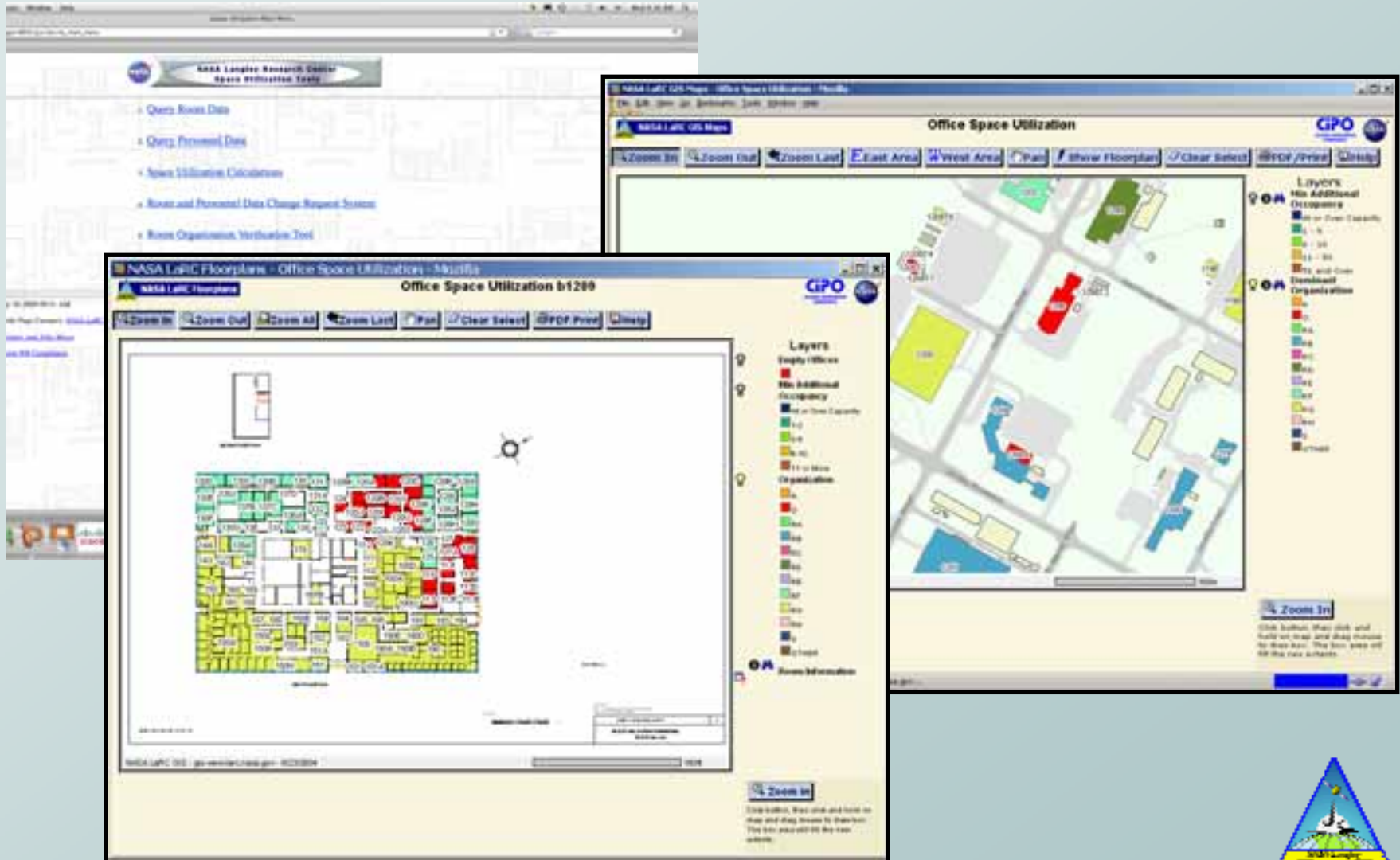
Integrates
Interior Bldg.
Details



Roof example



Analysis for Space Utilization



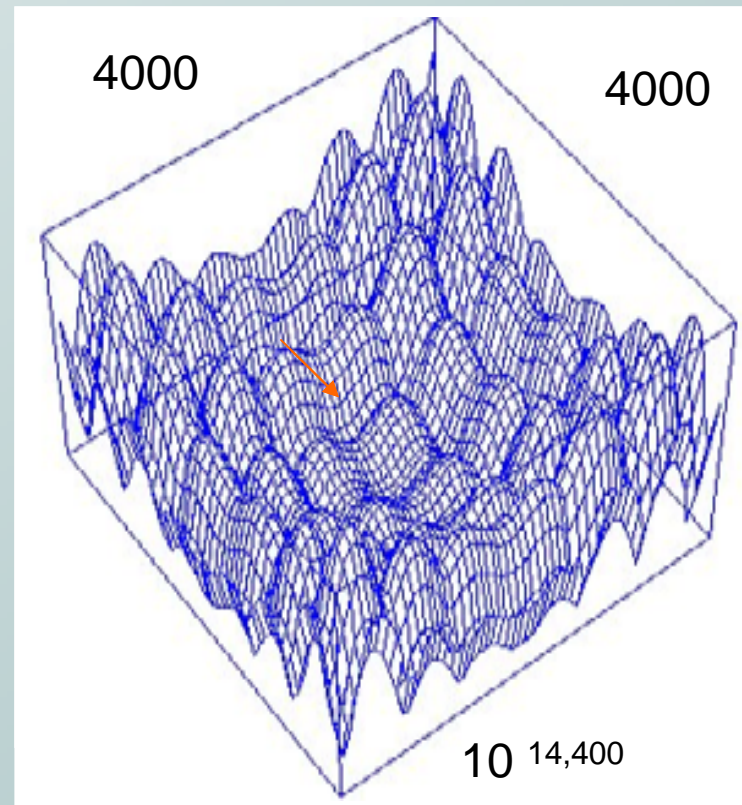
Goals, SU Optimization

- Integrated planning system
 - Schedule allocation of space based on org. and project requirements
 - Enhance synergy by co-locating within/between related organizations
 - Comply with space guidelines/requirements
 - Plan for changes due to new construction, demolition, rehab, lease
 - Minimize moves
 - Save money



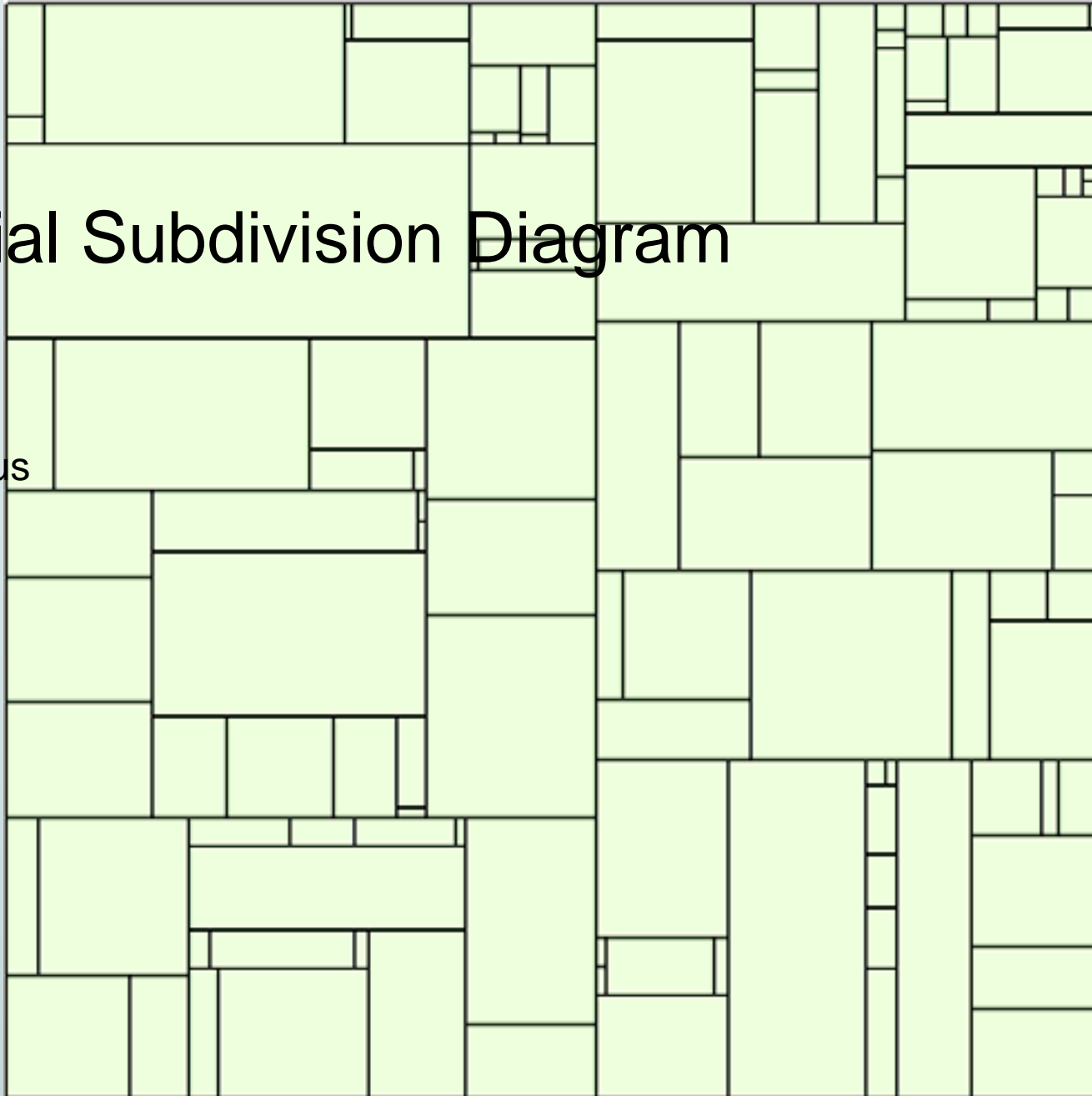
Optimization Techniques

- Large Search Space
 - Exhaustive Search not possible
 - Constraints and Metrics
 - Find the best local optima in a limited amount of time



Spatial Subdivision Diagram

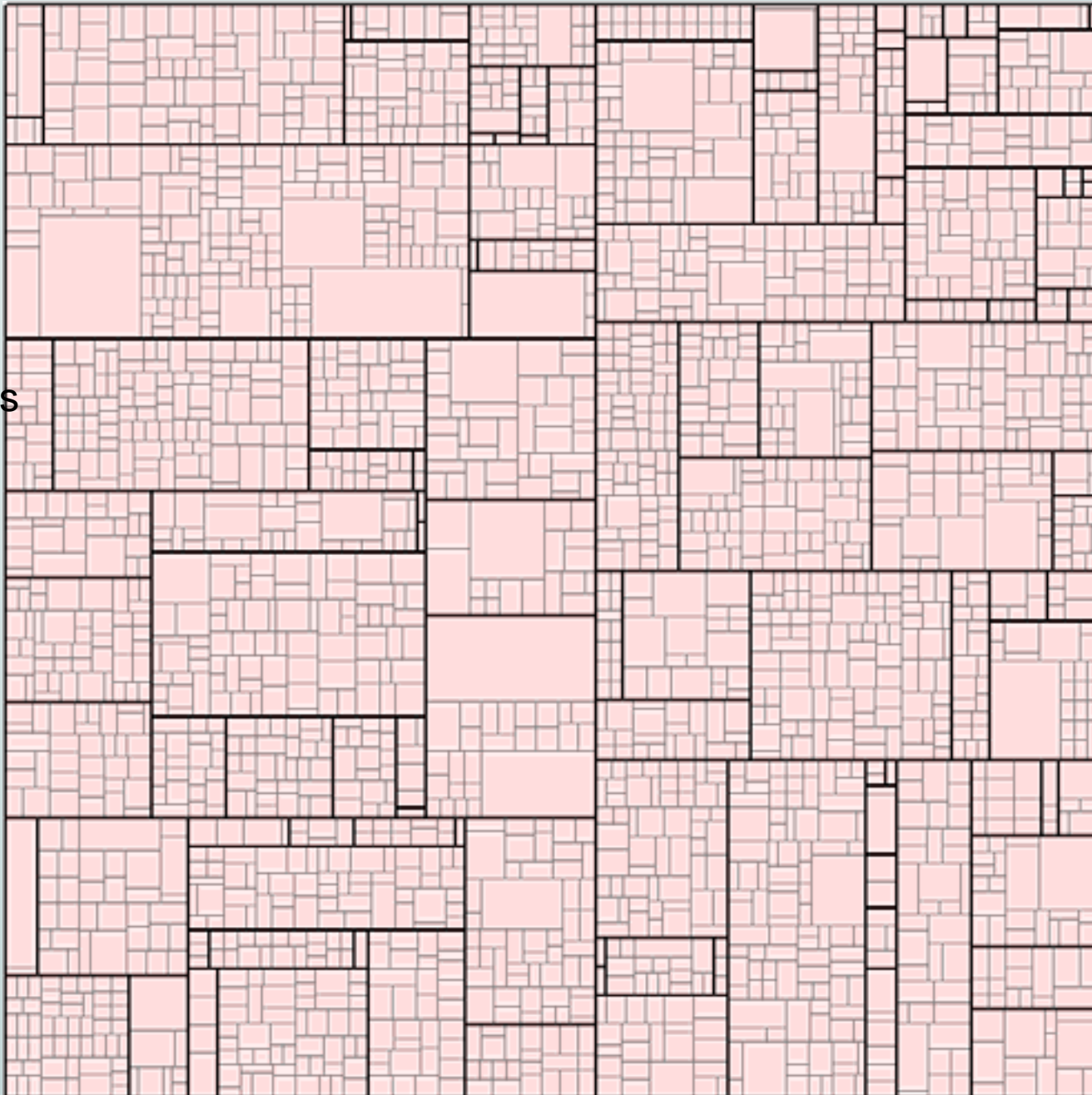
Abstract
For various
quantities



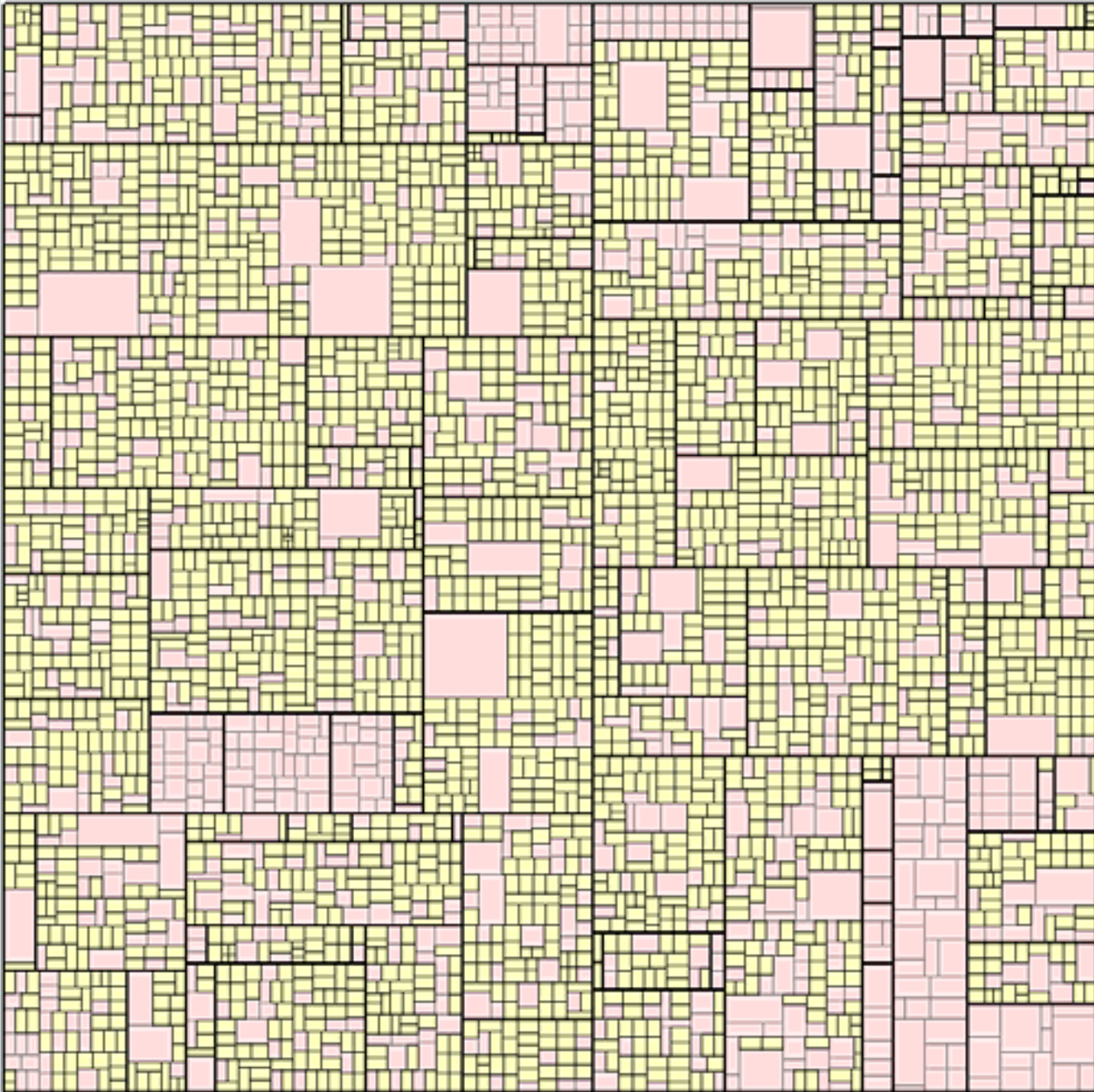
Bldg.
Area



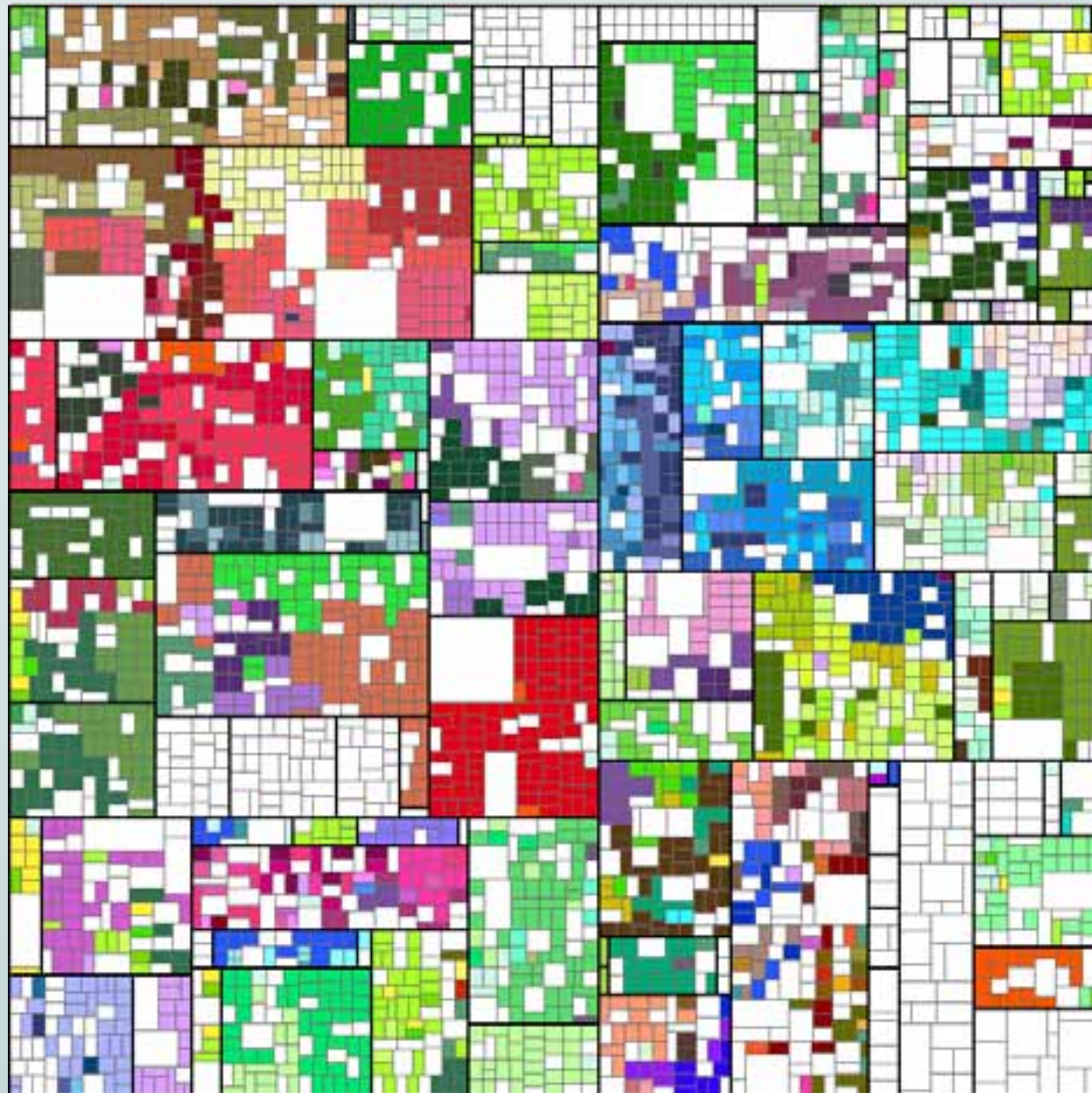
All Rooms



Offices



By
Org.

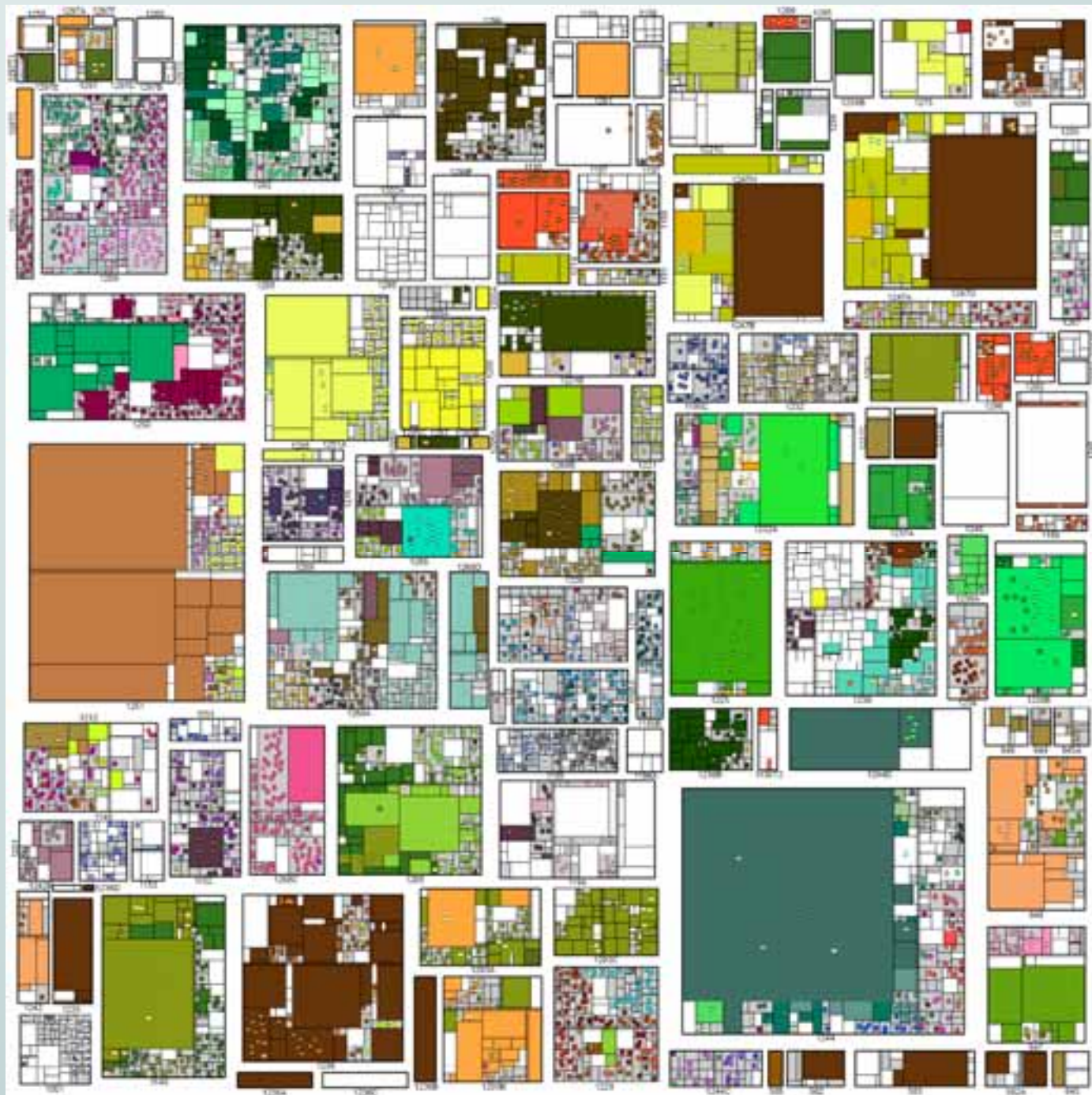


Legend

A	C103	D301	E101
A1	C104	D302	E102
A2	C105	D303	E105
A4	C2	D304	E106
AH	C201	D305	E107
B1	C202	D306	E109
B101	C3	D307	E111
B102	C4	D308	E112
B103	D1	D309	E113
B2	D101	D310	E116
B3	D102	D311	E117
B4	D103	D312	E1A
B401	D104	D313	E3
B402	D105	D314	E301
B403	D106	D315	E302
B5	D107	D316	E303
B501	D108	D317	E4
B501B	D2	D318	E401
B502	D201	D319	E402
B6	D202	D320	E403
B601	D203	D321	E404
B601A	D204	D322	E405
B601B	D205	D323	E4A
B602	D206	D4	E5
B603	D207	D401	E501
B603A	D208	D401A	E502
B603B	D209	D401B	E503
B7	D210	D402	E504
B701	D211	D402A	E505
B702	D212	D402B	E506
B703	D214	D403	E507
B704	D215	D406	H1
C1	D216	D407	
C101	D217	D4A	
C102	D3	E1	



All
Personnel



TECHNICAL SPACE UTILIZATION

OWNERSHIP

Organizational control
(current)



FAMILIARITY – Status
Quo
Resist change

LEGACY – AREAS ARE
IDENTIFIED AS BEING A
CERTAIN TYPE BASED ON:



USAGE

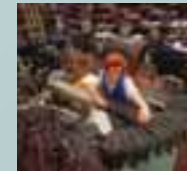
Functionality (current)

Electronics Lab

Laboratories: Chemical Lab,
Laser Lab, Biological Lab, ...

Tech Areas: Control Room,
Computer Operations, ...

Shops: Maintenance,
Grounds, Automotive,
Fabrication, ...



EQUIPPED (currently) –
over time equipment added
solidifies the perception of
singular use



TECHNICAL SPACE OPTIMIZATION

BUT IN TODAY'S LEAN ECONOMIC TIMES – BETTER CATEGORIZED ACCORDING TO THE UNIQUE FEATURES THE SPACE PROVIDES.



- Drop Ceiling w/lights
- HVAC
- Fume Hood Ventilation
- Network Access
- 120V AC (floor Access)

Chemical Lab # 1, # 2, # 3, ...
..., # 99, # 100

**FILTERED FOR
PREDOMINANT
FEATURES**



**BECOMES A SET OF
DESCRIPTORS FOR A
PARTICULAR TYPE OF
TECHNICAL SPACE.**

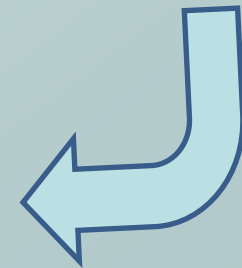


**CHEMICAL LABS
SHALL CONSIST
OF:**

- Fume Hood
- Sink
- Shower/Eye Wash
- Low Pressure Air

Wall Fan (RS Means # 15830-100)
 -8300 (4800 CFM) @ \$550.00 ea.
 -8310 (7000 CFM) @ \$600.00 ea.
 -8320 (10000 CFM) @ \$670.00 ea.
 -8330 (16000 CFM) @ \$835.00 ea.
average = \$664.00 ea.

**COST AVERAGED TO
ACCOMMODATE VARYING
OPERATIONAL CONDITIONS
(WITHIN NORMAL RANGE OF
FACILITY USE).**



TECHNICAL SPACE OPTIMIZATION

EXPRESSED IN EQUATION
FORM WHERE ROOM
SPECIFICS ARE
VARIABLES.

EXAMPLES:

Max horizontal distance in a room = $0.5LF$

Approx. room length = $LF + (\text{SQRT}((LF(LF) - 16SF)/4))$

Approx. room width = $LF - (\text{SQRT}((LF(LF) - 16SF)/4))$

RECTANGULAR & NEAR RECTANGULAR SHAPED ROOMS

Exhaust $CFM_{\min.} = SF/5$

EXCLUDING HEAT LOAD CALCULATIONS

SUMMARY

STEP 1

Identify unique features of technical spaces

(an integral part of that space)



Generates a complete listing of technical features

(for particular federal facility?)

STEP 2

Determine unique features that are true descriptors.

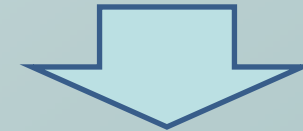


Provides unbiased room identification

(greater insight into resource capabilities)

STEP 3

Determine installation and removal costs for each unique feature.

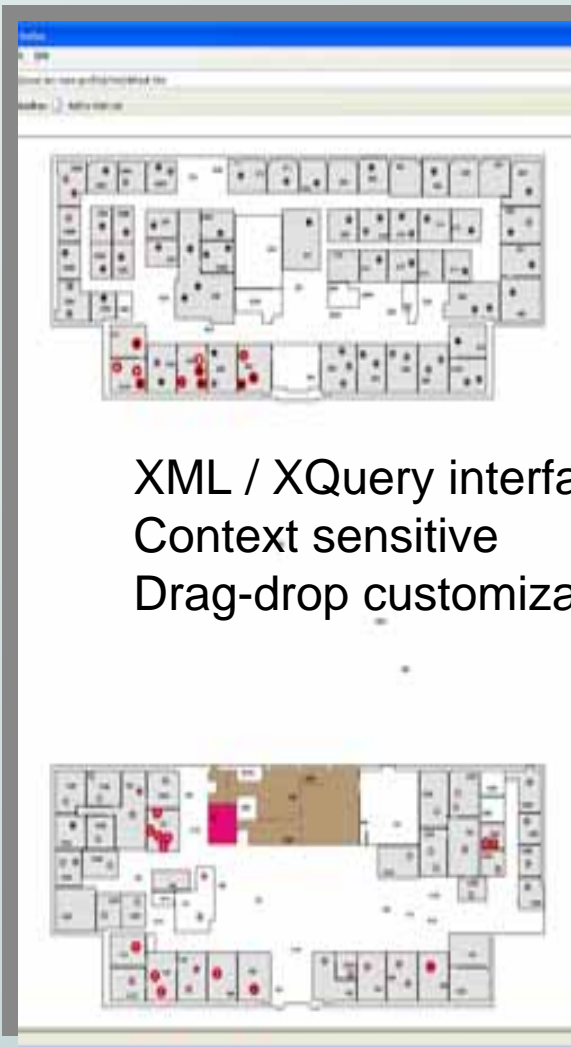


Provides rough estimate of costs

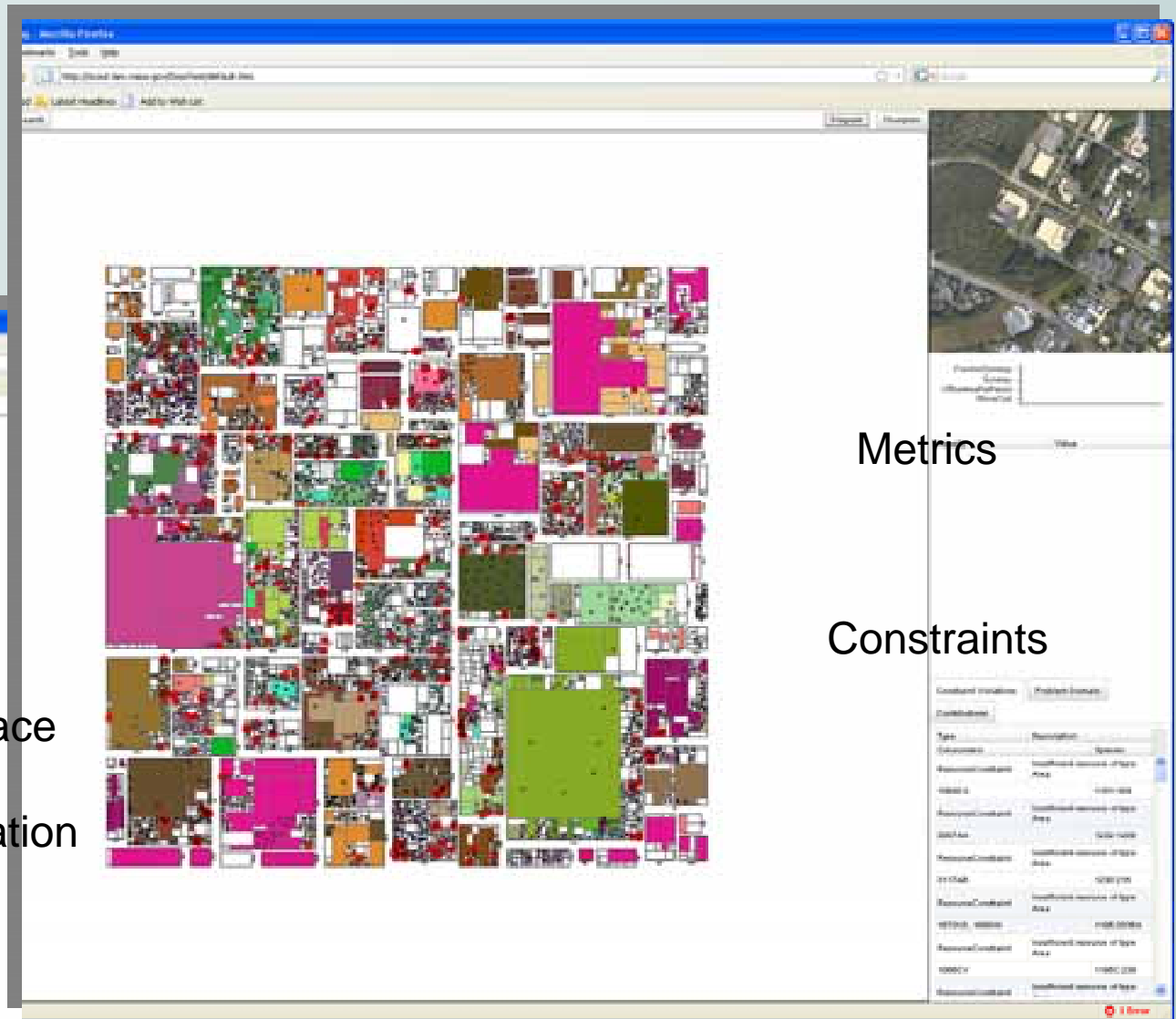
(new construction verses resource modification)



Web Dashboard



XML / XQuery interface
Context sensitive
Drag-drop customization



Metrics

Constraints

Rest, Ajax, Dojo
Spin-offs...



Core Optimization – Modeling – Search	Visualization – Spatial Diagram – Point, Color, Labeling
Data Processing – XQuery – XML I/O	User Interface – Javascript / Dojo – Ajax
	Services – Optimization – Visualization & Map

Key

We are here

Integrated Scheduling

Comprehensive Technical (Model, Opt)

Building Closure (Model, Optimization)

Goal-driven Planning

Advanced Web Opt
(Strategies, Mixed Auto/Man)

Web Optimization
(Basic Strategies)

Web Planning (Drag and Drop, Offline Setup)

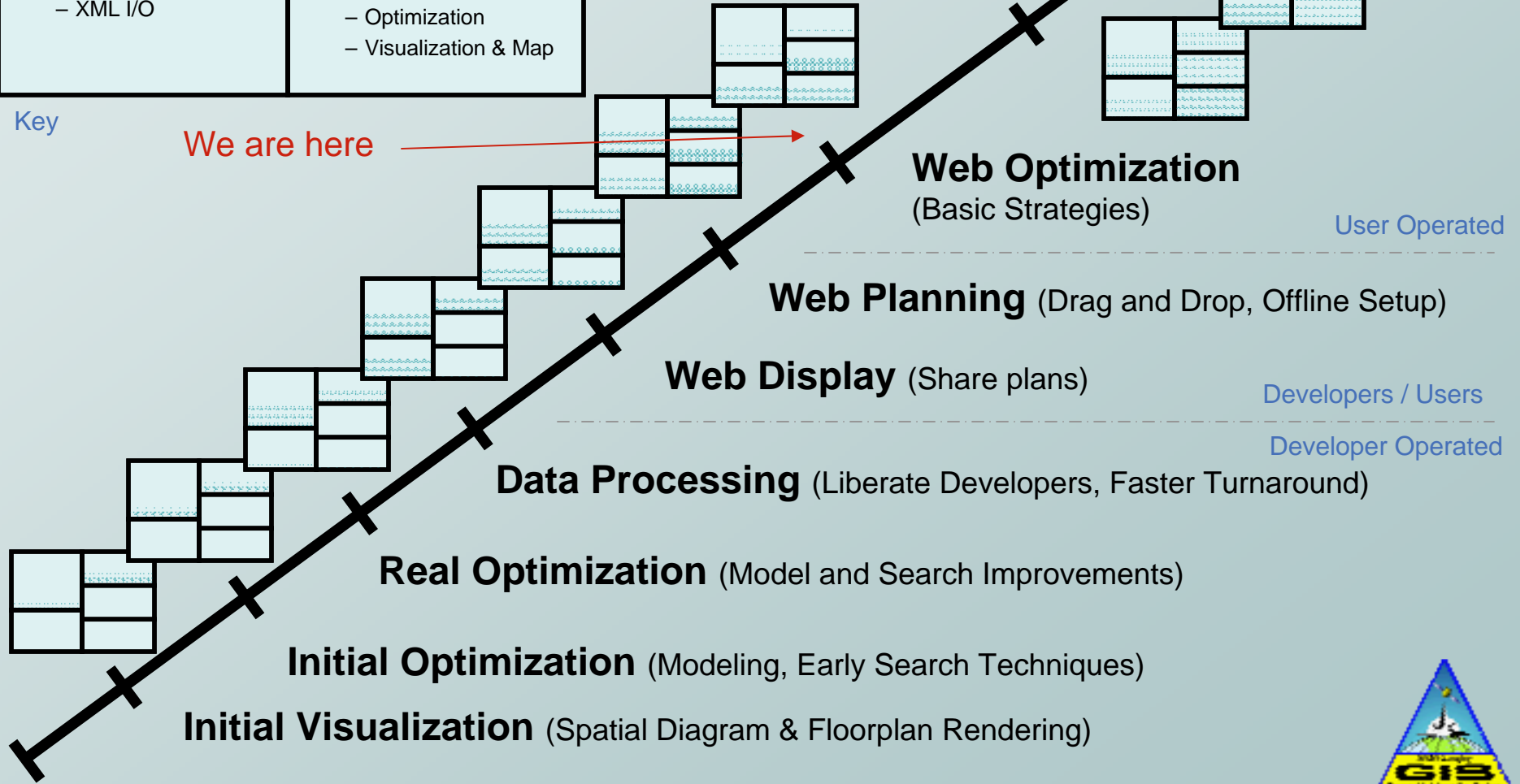
Web Display (Share plans)

Data Processing (Liberate Developers, Faster Turnaround)

Real Optimization (Model and Search Improvements)

Initial Optimization (Modeling, Early Search Techniques)

Initial Visualization (Spatial Diagram & Floorplan Rendering)



User Operated

Developers / Users

Developer Operated



For additional info.

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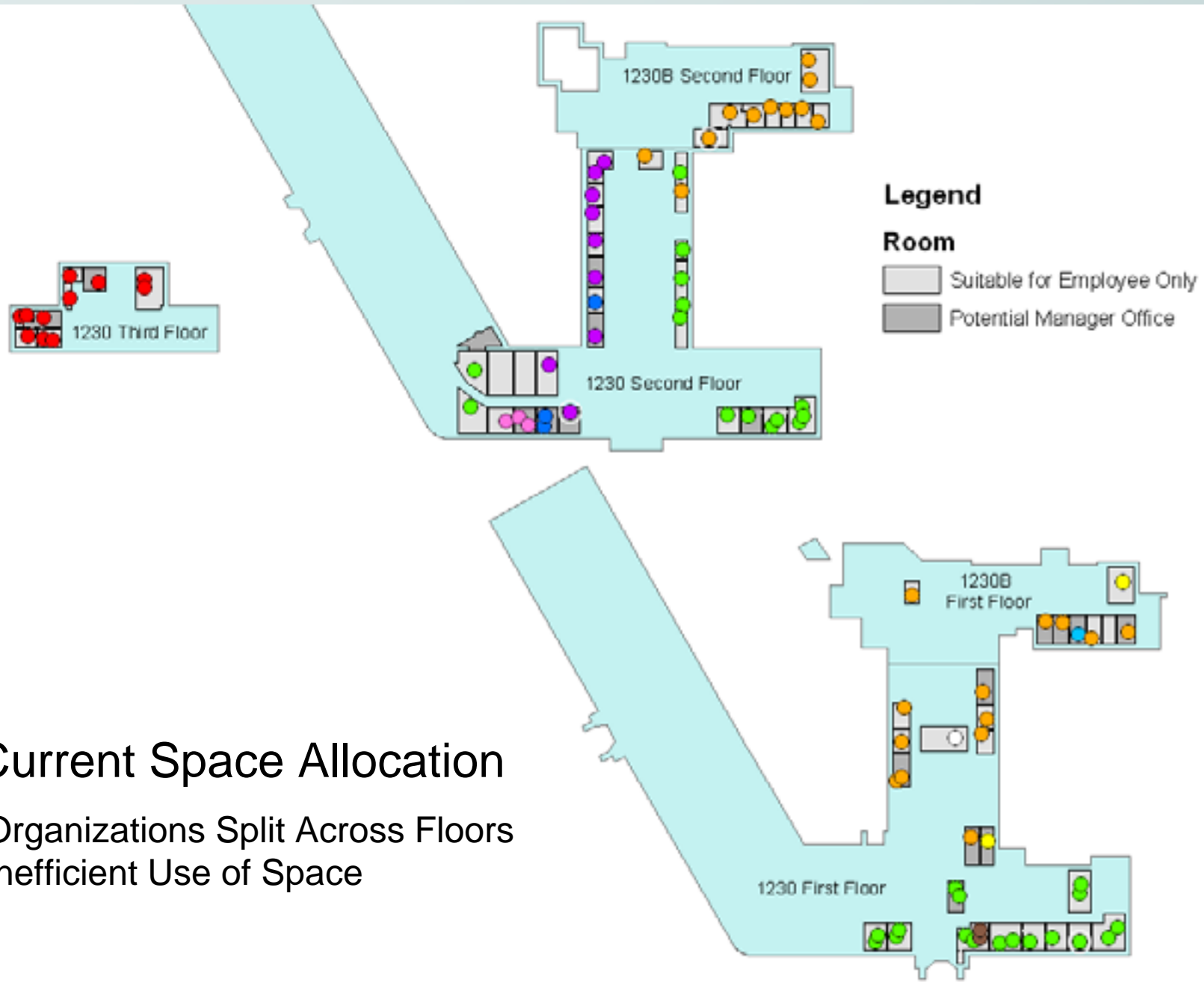
Outside website:

<http://gis.larc.nasa.gov/>



Backup Bldg Details

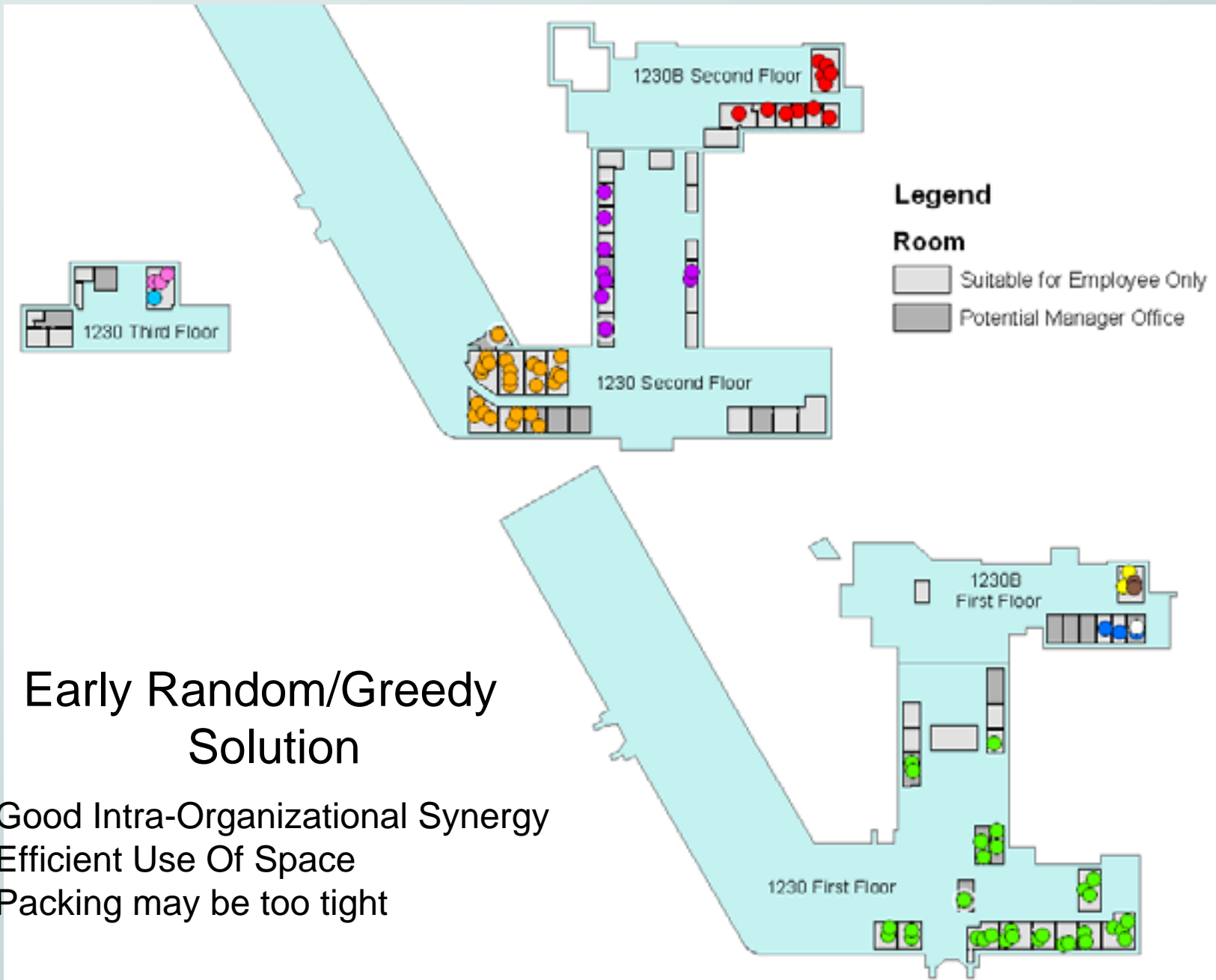




Current Space Allocation

- Organizations Split Across Floors
- Inefficient Use of Space





Early Random/Greedy Solution

- Good Intra-Organizational Synergy
- Efficient Use Of Space
- Packing may be too tight

