Digital Protocols

Geotechnical Engineering Reconnaissance Working Group

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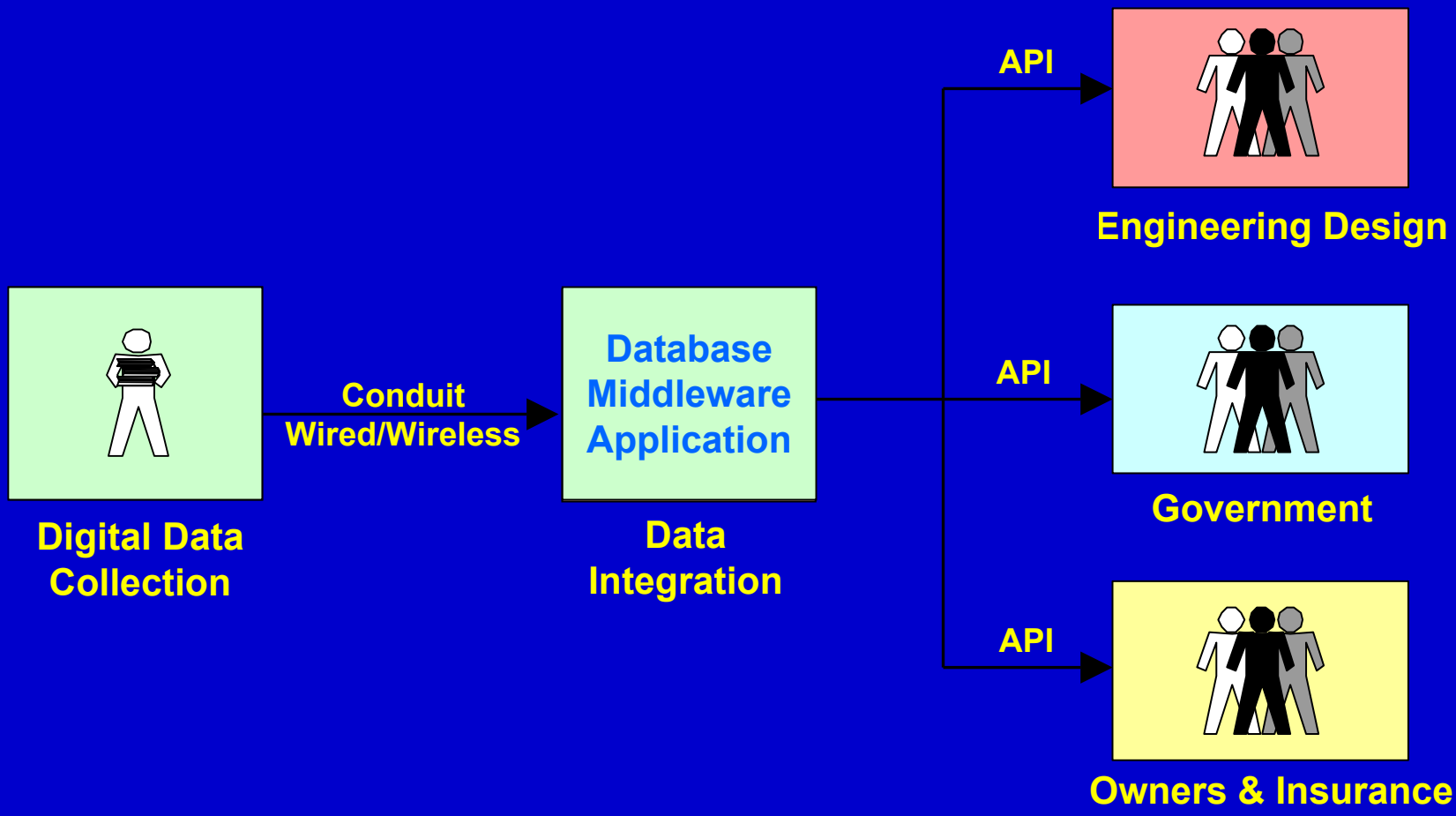
Three-Tier Technology Model

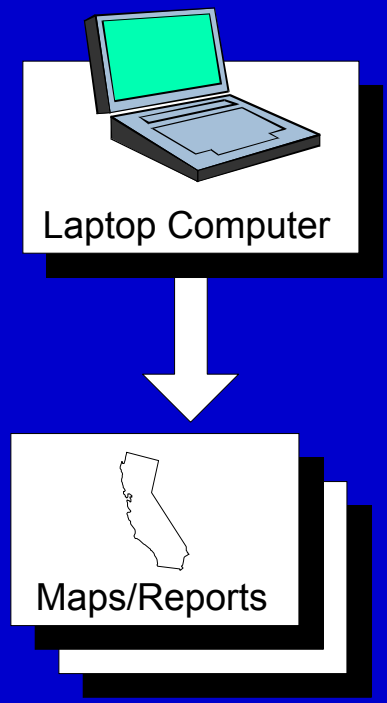


Technology for “Smart” Engineer

Field Reconnaissance Equipment

Conduit to Upload & Link Data

Analysis & Data Reduction Equipment

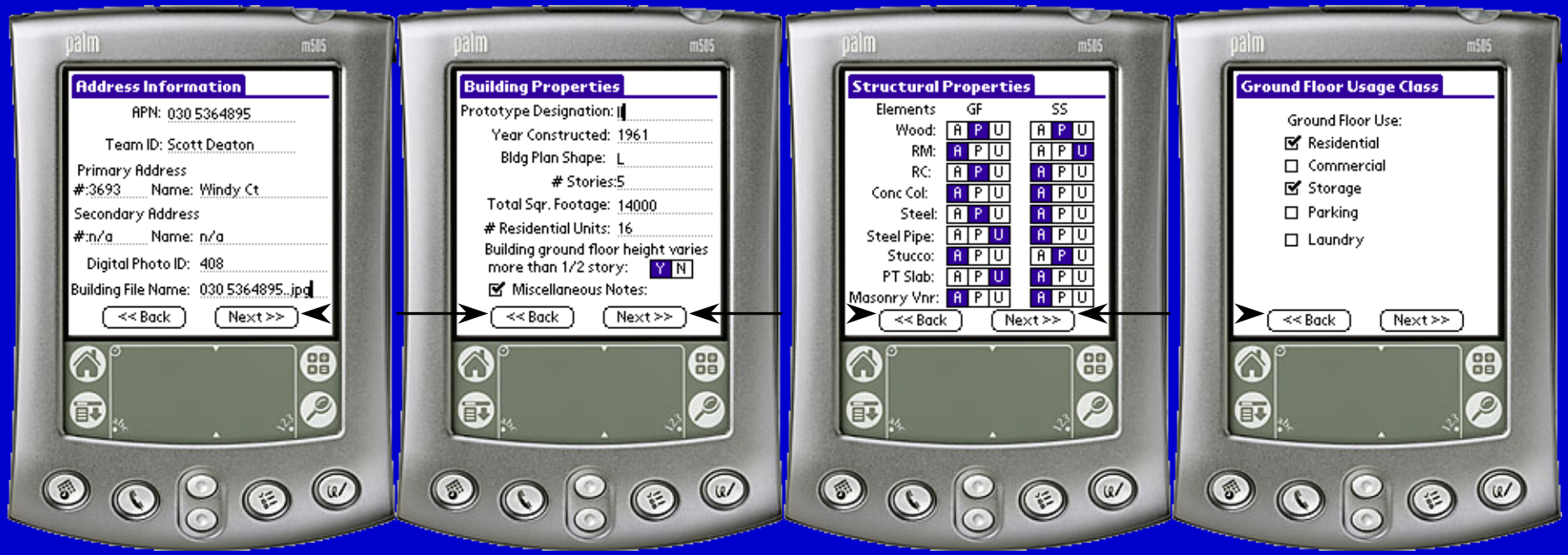


“Soft-Story” Inventory

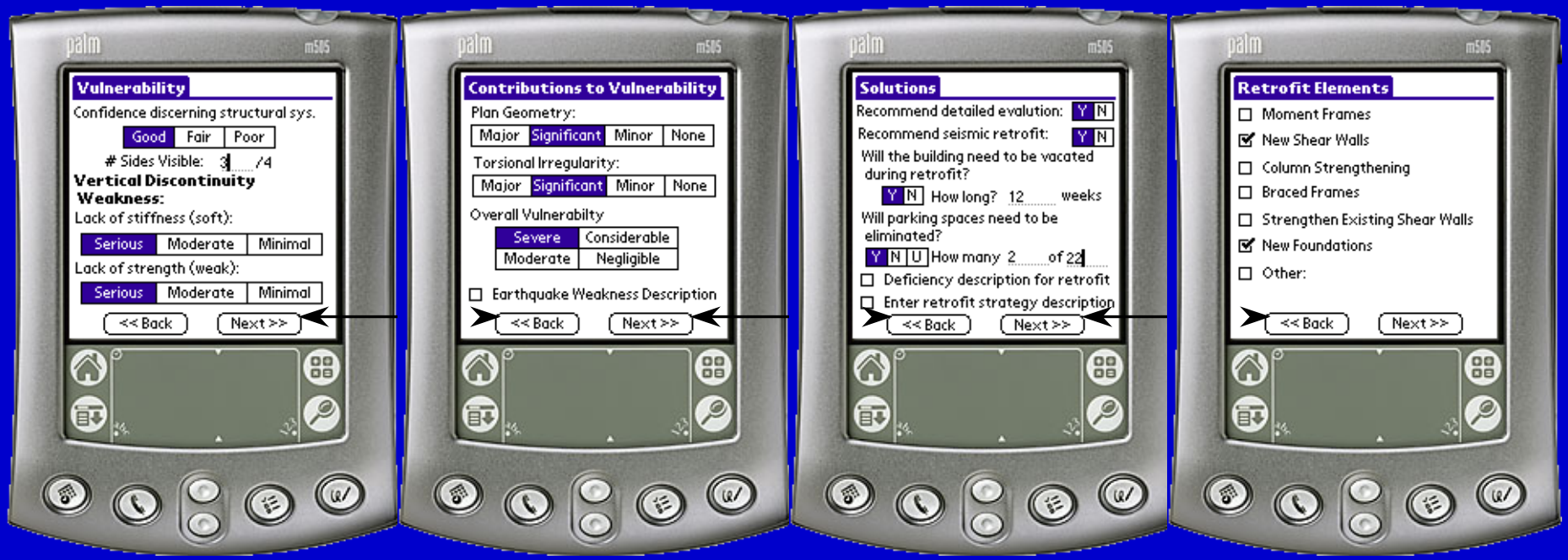
Pre-event Reconnaissance

- Utilized for rapid pre-event screening of buildings with a potential soft story for municipal program.
- Software based on a form that city engineers created
- Types of data recorded
  - Building/structure properties
  - Usage (know where to search for survivors)
  - Vulnerabilities
  - Possible solutions/retrofit
- Upload field data into Access database

Example


palm
m505
Address Information
APN: 030 5364895
Team ID: Scott Deaton
Primary Address
#:3693 Name: Windy Ct
Secondary Address
#:n/a Name: n/a
Digital Photo ID: 408
Building File Name: 030 5364895..jpg
<< Back
Next >>
Building Properties
Prototype Designation: I
Year Constructed: 1961
Bldg Plan Shape: L
Stories:5
Total Sqr. Footage: 14000
Residential Units: 16
Building ground floor height varies more than 1/2 story: Y N
Miscellaneous Notes:
<< Back
Next >>
Structural Properties
Elements GF SS
Wood: A P U A P U
RM: A P U A P U
RC: A P U A P U
Conc Col: A P U A P U
Steel: A P U A P U
Steel Pipe: A P U A P U
Stucco: A P U A P U
PT Slab: A P U A P U
Masonry Vnr: A P U A P U
<< Back
Next >>
Ground Floor Usage Class
Ground Floor Use:
Residential
Commercial
Storage
Parking
Laundry
<< Back
Next >>

Example (cont.)



Earthquake Damage Reconnaissance

Overview

- Integrated data acquisition and analysis software
- Record feature and/or area damage
- Links location, photographic and other digital data
- Keeps engineer “within data loop”
- Facilitates consistent/complete data
- Upload data into GIS extension

Data Categories

Building
Residential Commercial Industrial Religious Government Educational

Lifeline Infrastructure
Water Sewer Gas Telecom Electrical

Transportation Facility
Road Rail Bus Ferry Port Airport

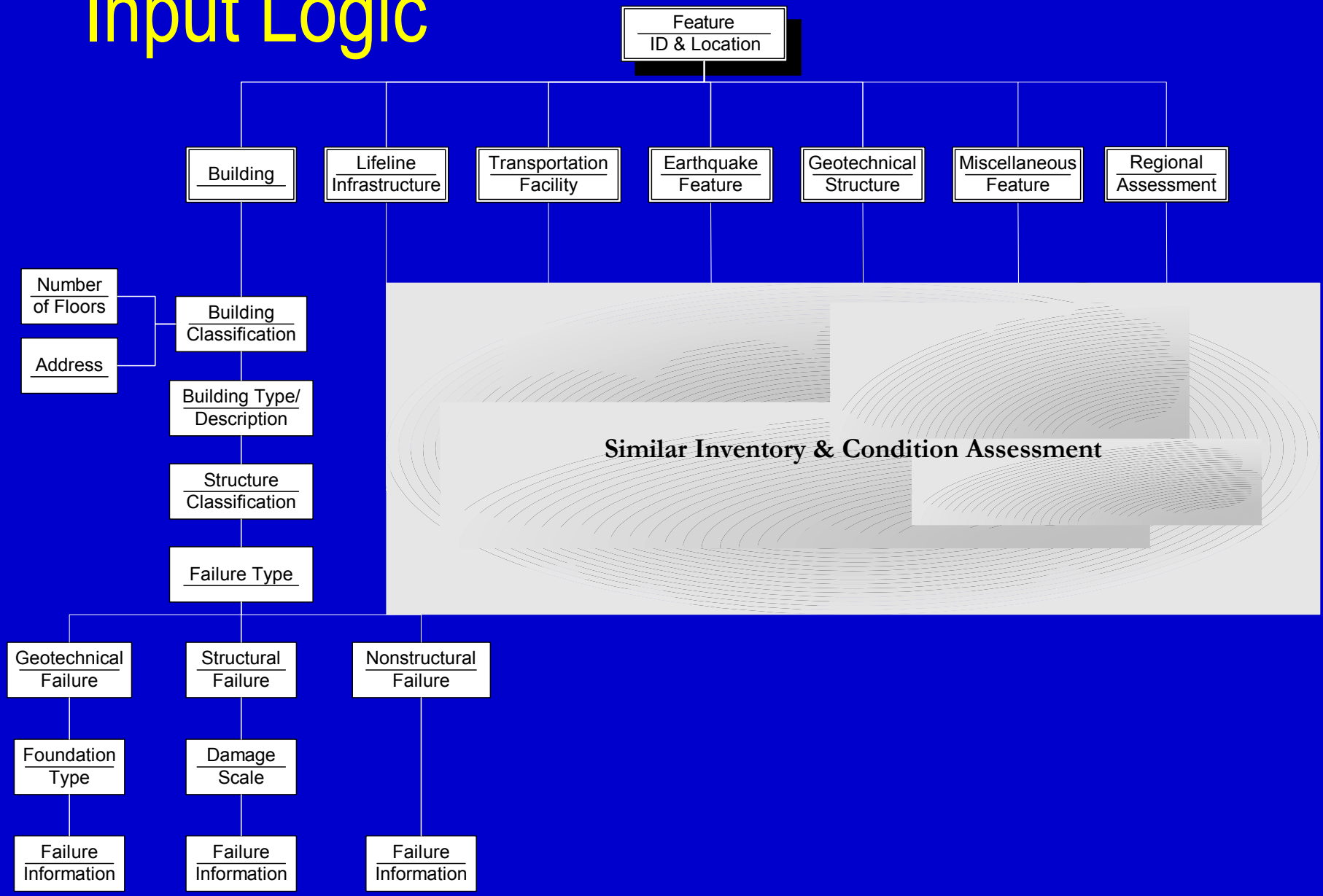
Geotechnical Structure
Dam/Levee Retaining Wall Landfill Embankment Cut Slope

Earthquake Feature
Landslide Fault Rupture Circular Sand Blow Linear Sand Blow Ground Cracking Lateral Spread

Miscellaneous Feature
Seismograph Wall

Regional Assessment
Block Street District Village Town City

Input Logic

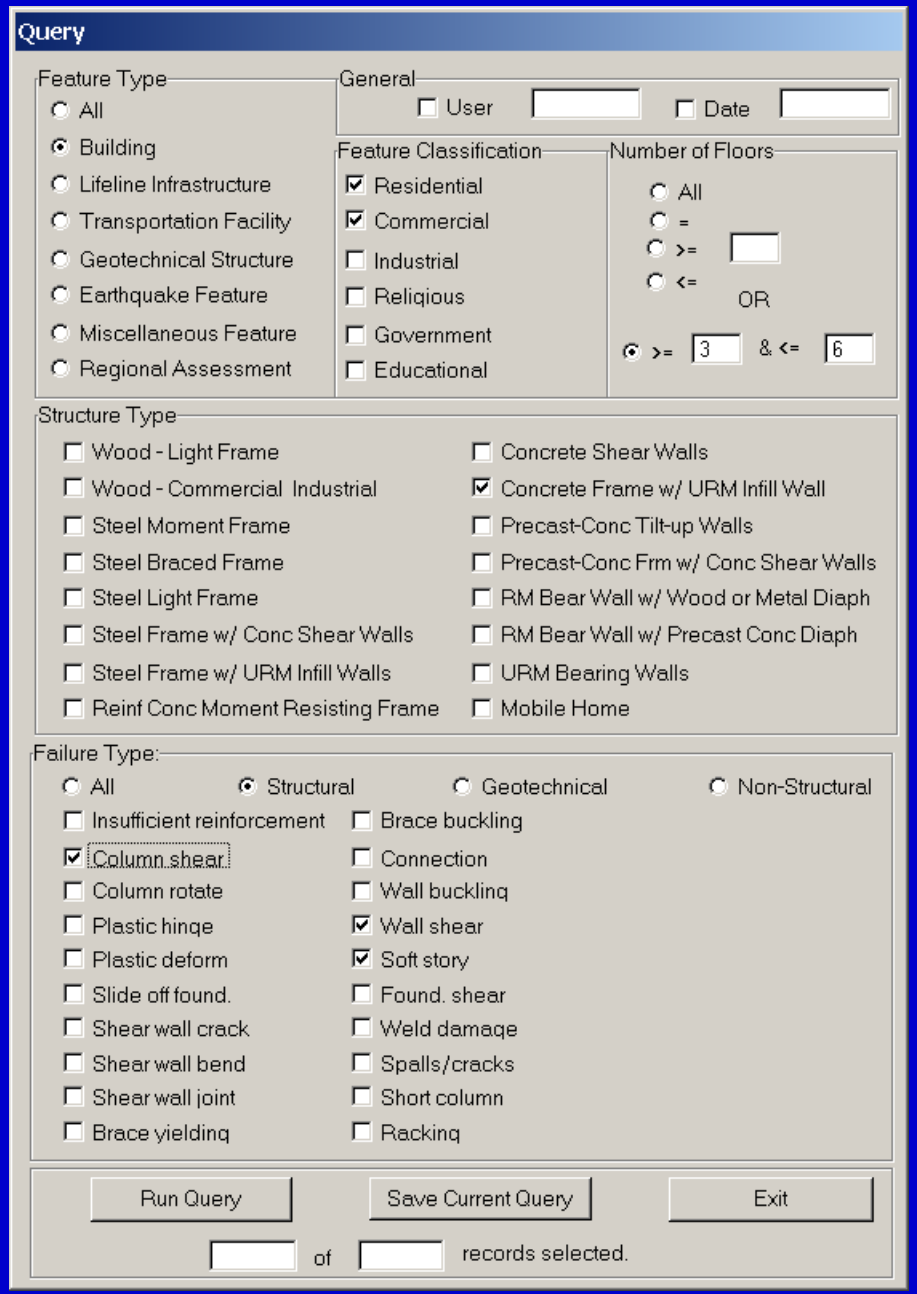

Feature
ID & Location
Building
Lifeline
Infrastructure
Transportation
Facility
Earthquake
Feature
Geotechnical
Structure
Miscellaneous
Feature
Regional
Assessment
Number
of Floors
Address
Building
Classification
Building Type/
Description
Structure
Classification
Failure Type
Similar Inventory & Condition Assessment
Geotechnical
Failure
Structural
Failure
Nonstructural
Failure
Foundation
Type
Damage
Scale
Failure
Information
Failure
Information
Failure
Information

Dam Failure Example

ArcGIS® Extension

- Rapidly assimilate data from multiple users
- Query data based on information type
  - e.g. Select all 5 story buildings that collapsed from soft story failure
  - e.g. Show location of all sand blow features
- Query individual features
- Create comprehensive maps of damage sites
- Real-time reconnaissance planning
- Integrated transfer of data to “home base”

Event Query


Query
Feature Type
All
Building
Lifeline Infrastructure
Transportation Facility
Geotechnical Structure
Earthquake Feature
Miscellaneous Feature
Regional Assessment
General
User
Date
Feature Classification
Residential
Commercial
Industrial
Religious
Government
Educational
Number of Floors
All
=
>=
<=
OR
>= 3 & <= 6
Structure Type
Wood - Light Frame
Wood - Commercial Industrial
Steel Moment Frame
Steel Braced Frame
Steel Light Frame
Steel Frame w/ Conc Shear Walls
Steel Frame w/ URM Infill Walls
Reinf Conc Moment Resisting Frame
Concrete Shear Walls
Concrete Frame w/ URM Infill Wall
Precast-Conc Tilt-up Walls
Precast-Conc Frm w/ Conc Shear Walls
RM Bear Wall w/ Wood or Metal Diaph
RM Bear Wall w/ Precast Conc Diaph
URM Bearing Walls
Mobile Home
Failure Type:
All
Structural
Geotechnical
Non-Structural
Insufficient reinforcement
Column shear
Column rotate
Plastic hinge
Plastic deform
Slide off found.
Shear wall crack
Shear wall bend
Shear wall joint
Brace yielding
Brace buckling
Connection
Wall buckling
Wall shear
Soft story
Found. shear
Weld damage
Spalls/cracks
Short column
Racking
Run Query
Save Current Query
Exit
of
records selected.

ArcView GIS 3.2

File Edit Table Field Window Help

1 of 65 selected

India

Attributes of Location.dbf

Shape	Photo_id	Eq_name	Latitude	Longitude	Date	Time
Point	DSCN0262	Gujarat	23.199175	70.720567	2/17/01	12:33:52
Point	DSCN0259	Gujarat	23.300564	70.423067	2/17/01	11:58:15
Point	DSCN0251	Gujarat	23.248358	70.301414	2/17/01	11:14:27
Point	DSCN0247	Gujarat	23.104725	70.159733	2/17/01	10:36:57
Point	DSCN0242	Gujarat	23.112797	70.029731	2/16/01	20:25:02
Point	DSCN0233	Gujarat	23.399725	70.227514	2/16/01	17:53:06
Point	DSCN0230	Gujarat	23.314458	70.355278	2/16/01	16:32:44

Pppoly

structfail.dbf

Photo_id	Failure_ty
DSCN0251	Column shear
DSCN0242	95% buildings destroyed - anjar
DSCN0242	Wall shear
DSCN0230	wall tilting - roof collapse
DSCN0230	Wall shear
DSCN0221	Wall shear
DSCN0221	warehouse collapsed too

photo.dbf

Photo_id	User_initi	Linkphoto
DSCN0251	SLD	DSCN0255
DSCN0251	SLD	DSCN0254
DSCN0251	SLD	DSCN0253
DSCN0251	SLD	DSCN0252
DSCN0247	SLD	DSCN0249
DSCN0247	SLD	DSCN0248
DSCN0242	SLD	DSCN0246

Other Photos

Ahmedabad

India

bldgdamage.dbf

Photo_id	Operationa	Damage	Configurat
DSCN0251	Non-operational	D4	Asymmetric
DSCN0242	Non-operational	D5	Symmetric
DSCN0230	Non-operational	D5	Symmetric
DSCN0221	Non-operational	D5	Symmetric
DSCN0209	Non-operational	D4	Symmetric
DSCN0205	Non-operational	D4	Symmetric
DSCN0182	Non-operational	D5	Symmetric
DSCN0170	Non-operational	D5	Symmetric

Main Photo

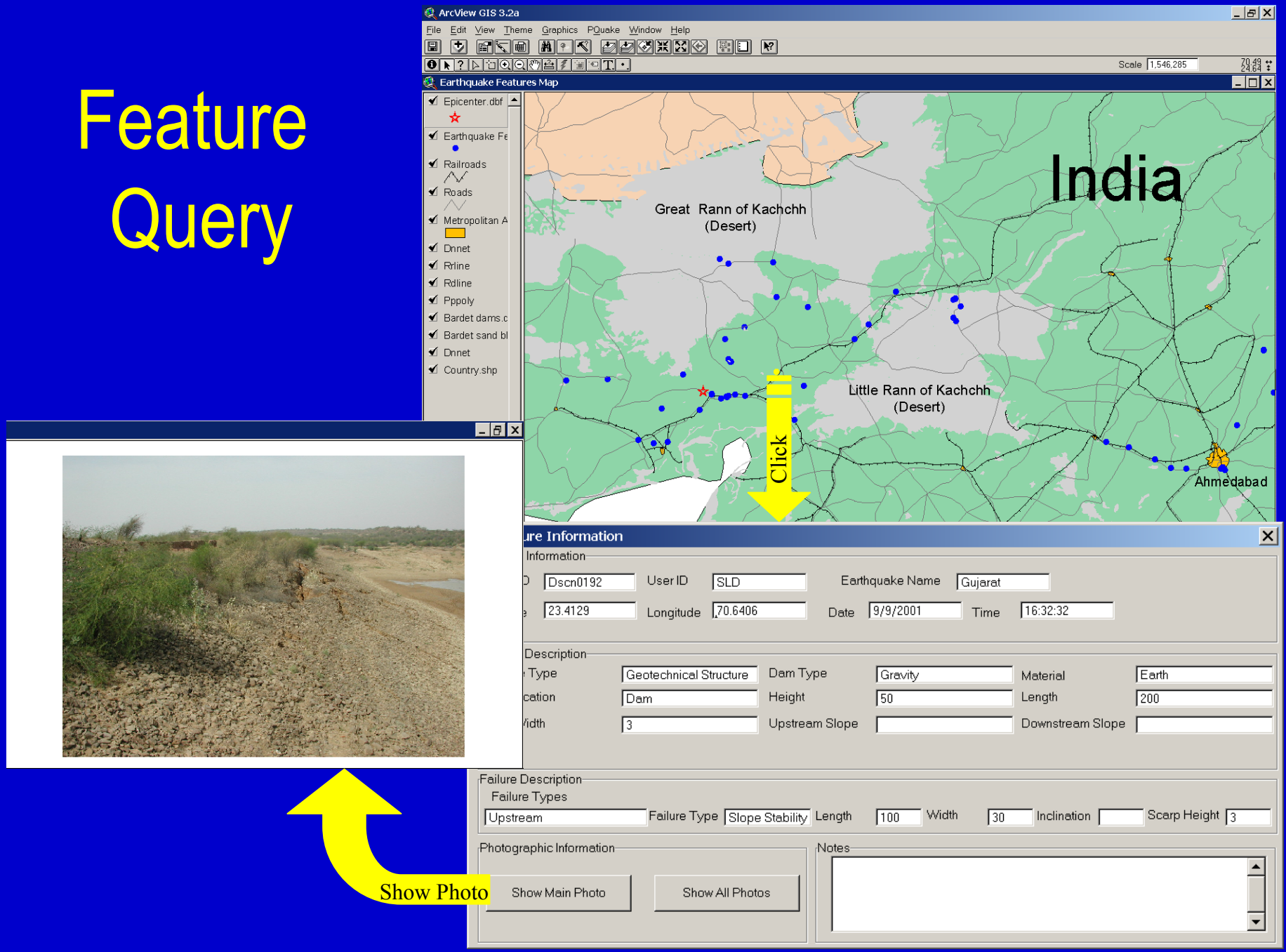
Dscn0287.jpg
Dscn0286.jpg
Dscn0285.jpg
Dscn0284.jpg
Dscn0283.jpg
Dscn0282.jpg
Dscn0281.jpg
Dscn0280.jpg
Dscn0279.jpg
Dscn0278.jpg
Dscn0277.jpg
Dscn0276.jpg

building.dbf

Photo_id	Num_floors	Building_c	Address	Building_t	Structure_
DSCN0251	6	Industrial		Food/Drugs/Chemicals	Concrete Frame w/ URM Infill Wall
DSCN0242	4	Residential		Apartment/Condo	Concrete Frame w/ URM Infill Wall
DSCN0230	1	Industrial		Warehouse	Concrete Frame w/ URM Infill Wall
DSCN0221	3	Industrial		Food/Drugs/Chemicals	Concrete Frame w/ URM Infill Wall
DSCN0220	1	Commercial		Service Station/Shop	Concrete Frame w/ URM Infill Wall
DSCN0209	1	Commercial		Service Station/Shop	Steel Light Frame
DSCN0205	4	Residential		House	Concrete Frame w/ URM Infill Wall
DSCN0182	5	Residential		Hotel/Motel	Concrete Frame w/ URM Infill Wall
DSCN0170	1	Residential		House	URM Bearing Walls

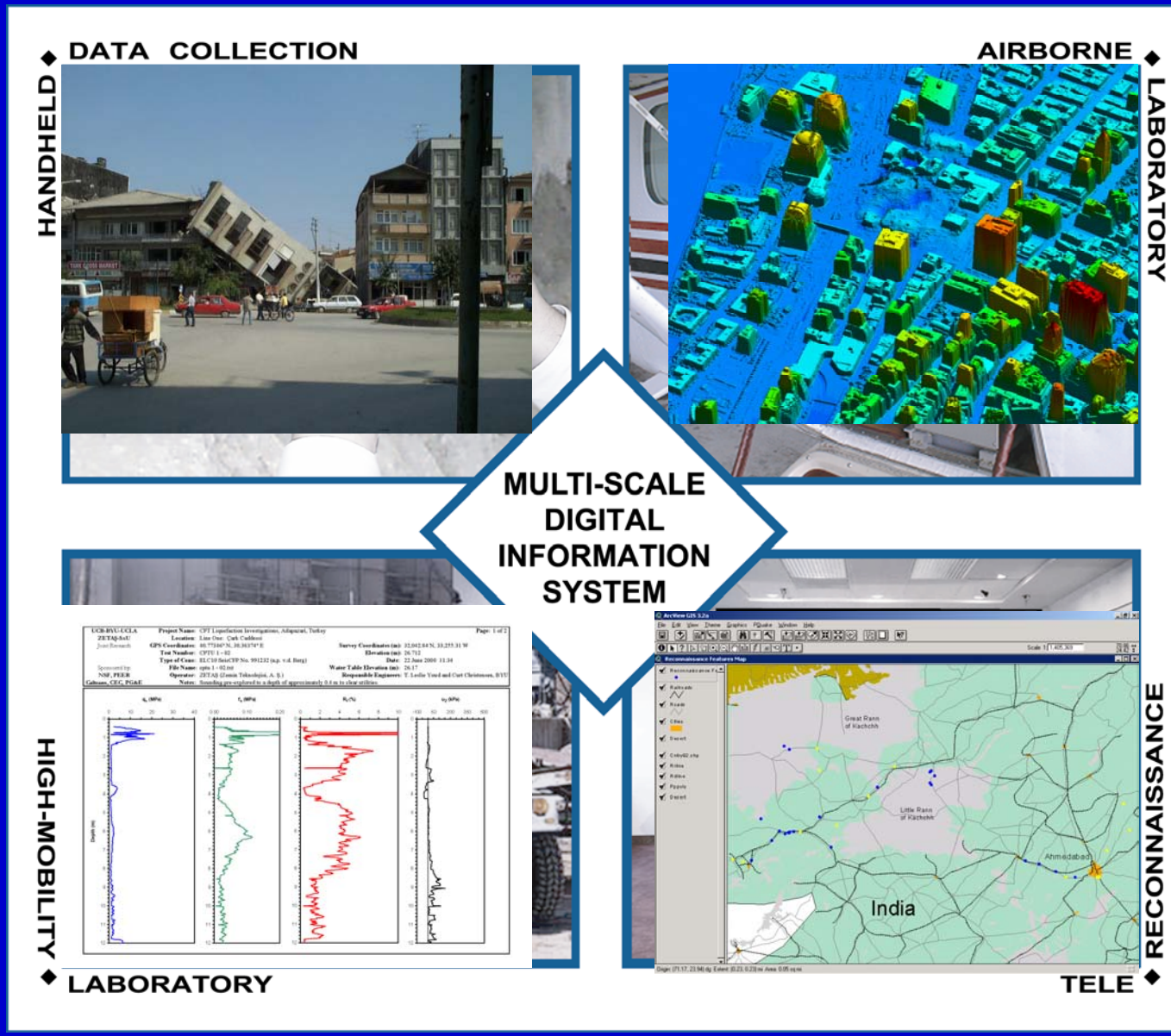
Origin: (71.14, 22.22) dg Extent: (81.30, 42.34) mi Area: 3,442.17 sq mi

Feature Query



Beyond Handheld Systems

Next Generation...



Importance of Digital Protocols

- Proposed approach opens up new opportunities for integration of forensic studies in education and research
- Ability to involve larger “Response Team” than those operating in immediate earthquake zone
- Ability to “take” students to site and show them consequences of poor engineering and/or unanticipated loading conditions

Research Issues

- Data collection protocols and standards
- Platform software development
- Multi-scale system integration
- Tele-reconnaissance
- Information compression and transmission
- Simulation analysis and feedback

Thank you.