

Integration Across Goals

Hani S. Mahmassani



NORTHWESTERN UNIVERSITY

NEXTRANS SUMMIT, PURDUE, MAY 5, 2008



NORTHWESTERN
UNIVERSITY



SAFETY



ENVIRONMENT



ENERGY



INTEGRATION

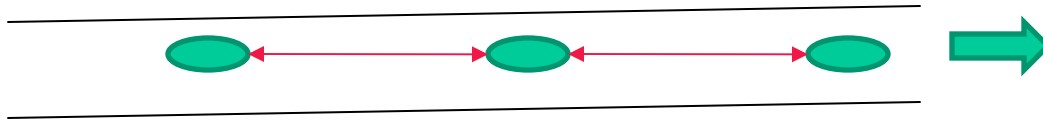


MOBILITY

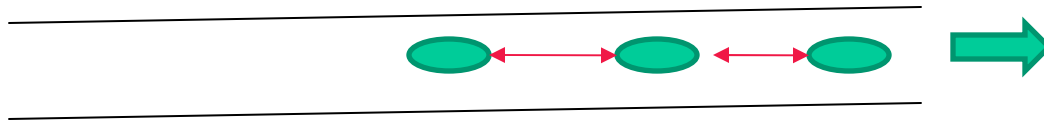


RENEWAL

THE TRADE-OFF: SAFETY vs. MOBILITY



Flow = speed x density



Closer together → slower

Spacing: governed by human factors—
time lags to react to sudden break

SOLUTION: TECHNOLOGY— sensors, control system

“intelligent cruise control”

THE CHALLENGE

- PLANNING
- OPERATION
- MONITORING
- MAINTENANCE/
RENEWAL

SEPARATION OF FUNCTIONS

INCONSISTENT DATA BASES

SEPARATE DATA COLLECTION ACTIVITIES

LACK OF COORDINATION

INEFFICIENCIES: COST, DELAY

OPPORTUNITIES

SHORT TO MEDIUM TERM

- INTEGRATED PLATFORMS: GEO-REFERENCED, LAND USE AND ACTIVITY SYSTEMS, NETWORK REPRESENTATION, INFRASTRUCTURE AND OPERATIONAL CONTROLS...
- CONSTANTLY UPDATED, “ALWAYS AWARE” NETWORK MODEL:
 - a. REFLECTS ONGOING AND PLANNED CONSTRUCTION, WORK ZONES ETC..
 - b. CONNECTED TO SENSOR INSTALLATION FOR UP TO DATE STATUS; CONDITION HEALTH MONITORING AS WELL AS OPERATIONAL STATUS
 - c. TIME TAGGED FOR DIFFERENT FUTURE YEARS TO REFLECT PLANNED AND PROGRAMMED PROJECTS AND PROJECTED DETERIORATION

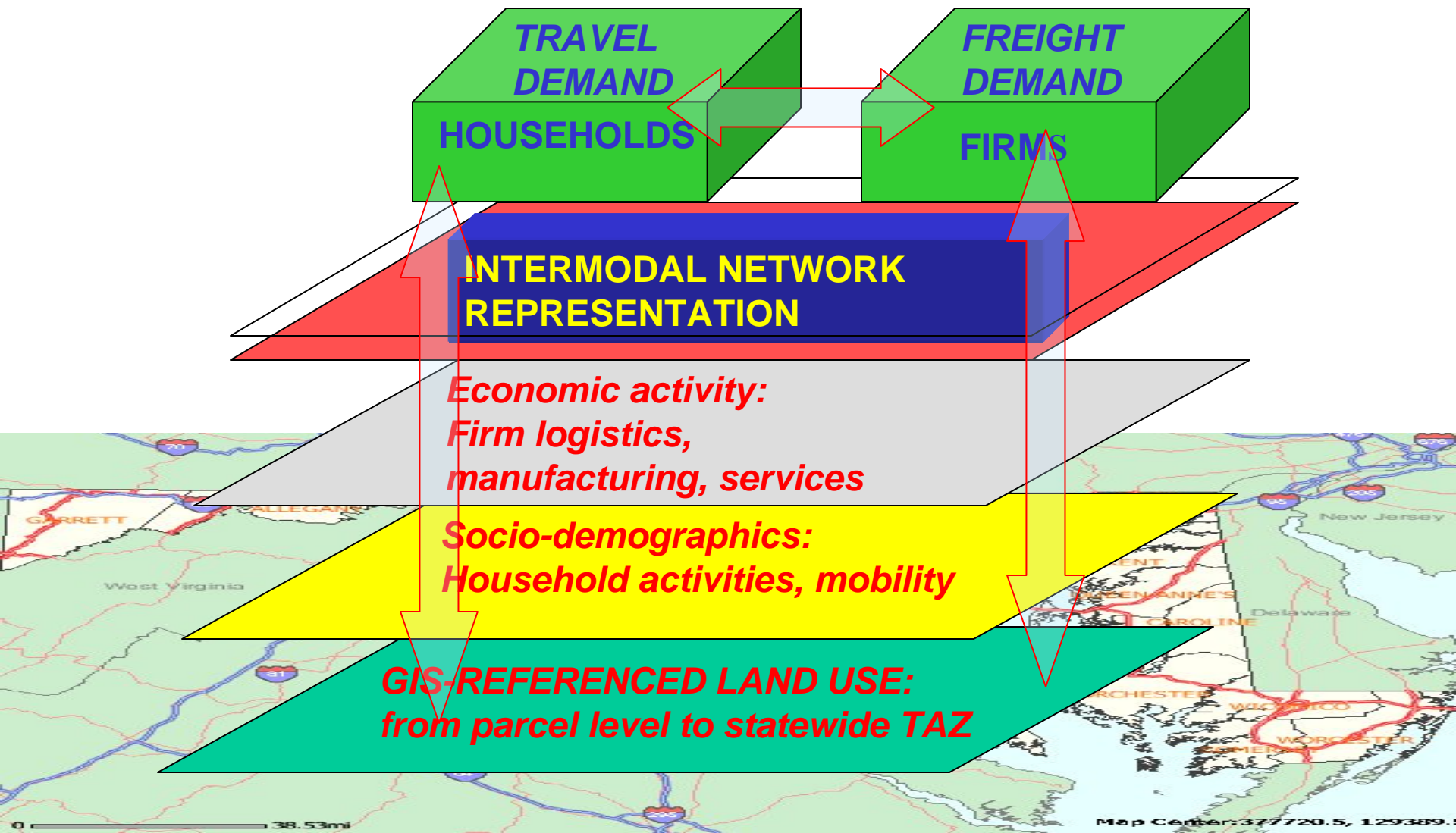
OPPORTUNITIES (ctd.)

- COMPATIBLE ACROSS DIFFERENT LEVELS OF AGGREGATION AND DISAGGREGATION: STATEWIDE PLANNING NETWORK MODEL ALLOWS EXTRACTION OF REGIONAL CORRIDORS FOR MESOSCOPIC TRAFFIC SIMULATION
- ENABLES CONSIDERATION OF OPERATIONAL CHARACTERISTICS IN PLANNING DECISIONS; ACHIEVES CONVERGENCE OF STRATEGIC AND OPERATIONAL PLANNING DECISIONS
- INCLUDES LAYERS FOR ALL APPLICABLE MODES, WITH SPECIAL FOCUS ON INTERMODAL CONNECTIONS AND TRANSFER HUBS FOR PEOPLE AND GOODS

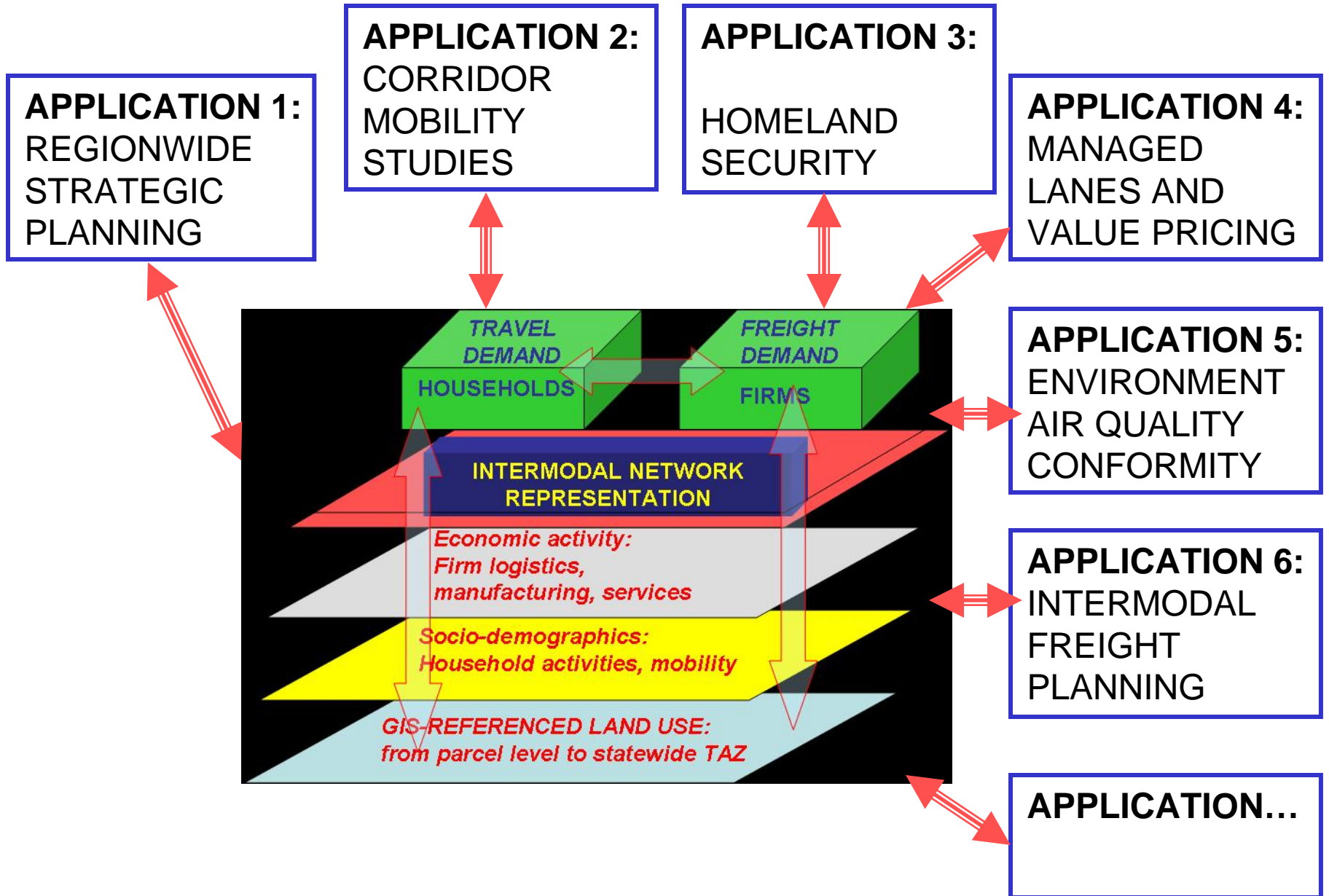
GREATER USE OF VEHICLE PROBES– PARTICLE-CENTRIC VIEW OF NETWORK; CONVEYS USER EXPERIENCE RE: INFRASTRUCTURE, OPERATIONAL STATUS, RELIABILITY.

TWO-WAY COMMUNICATION: INFORMATION, GUIDANCE TO CONNECTED USERS;

PLATFORM LAYERS AND MODULAR DESIGN



MULTIPLE APPLICATION DEVELOPMENT



OPPORTUNITIES (ctd.)

- METHODOLOGY:
 - COMPATIBILITY ACROSS LEVELS OF AGGREGATION, TEMPORAL SCALES, MULTIPLE SPATIAL RESOLUTION
 - SCHEMES FOR DATA WAREHOUSING AND KNOWLEDGE EXTRACTION; DATA MINING; UP TO DATE CALIBRATION
 - PREDICTIVE METHODS FOR ONLINE MANAGEMENT
 - MULTIPLE OBJECTIVES AND TRADE-OFFS
 - CONSISTENT PLATFORMS SUPPORT COLLABORATIVE DECISION-MAKING ACROSS AGENCIES, PRIVATE ENTITIES (e.g. COLLABORATIVE LOGISTICS)
 - INDIVIDUAL-LEVEL CUSTOMIZATION COMPATIBLE WITH SYSTEM-LEVEL SCHEMES– EMERGENT PROPERTIES AND RAPID RESPONSE CAPABILITIES

Development trend # 1: Handset Capabilities, Wireless Internet

Precise Location Enables Wide Variety of LBS Apps



Development trend # 2: Inexpensive wireless sensor networks



Coming to markets near you
in next few months...



Relative low cost and high
performance of such systems would enable
deployment at larger scale than envisioned originally.

In the limit, nano-scale sensors with massively
parallel deployment.

Mobile units +
wireless internet:

Provides particle
(user-centric)
views of system

Inexpensive
wireless sensors

Provides view from
perspective of
infrastructure or
fixed assets

```
graph TD; A[Mobile units + wireless internet:] --> D[REAL-TIME INFORMATION]; B[Inexpensive wireless sensors] --> D;
```

REAL-TIME INFORMATION

Explosion of real-time information on system state

→ Calls for methods geared for shorter term engineering and business applications

→ Calls for methodologies for real-time decision making under real-time information

REAL-TIME DECISION-MAKING METHODOLOGIES,
e.g. DYNASMART-X for traffic estimation and prediction.

→ Calls for methods to extract knowledge from undifferentiated data

KNOWLEDGE EXTRACTION, e.g. through data mining

Development trend # 3:

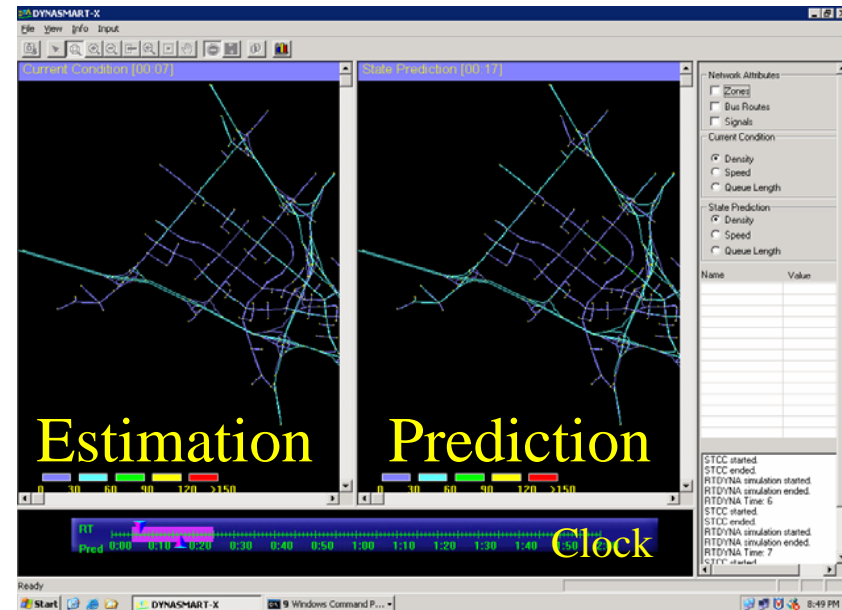
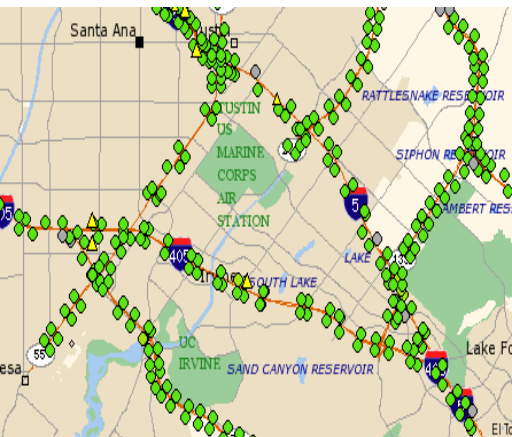
Network Simulation-Assignment Modeling for Advanced Traffic System Management

DYNASMART-X

REAL TIME DYNAMIC TRAFFIC ASSIGNMENT SYSTEM

- Irvine network overview:
 - 326 nodes and 626 links.
 - 70 actuated-controlled urban intersections.
 - 61 traffic demand zones

- Morning peak period (4:00 AM – 10:00 AM)
- 30-second observation intervals on 19 freeway links
- 5-minute observation interval on 28 arterial links





Development trend # 4: Dynamic Decision Support Tools for Vehicle Routing, Fleet Management and Collaborative Logistics

Subject to considerable academic development in the area of algorithm development and testing

Rapidly coming to market, in conjunction with asset tracking and management technologies

Prospect for tie-ins with predictive traffic management tools, e.g. DYNASMART-X

EIGHT BIG THEMES FOR RESEARCH

- **EXPLOSION OF REAL-TIME INFORMATION and REAL-TIME DECISION METHODOLOGIES for OPERATIONS: DYNAMIC NETWORK MANAGEMENT (incl. PRICING), INTERMODAL SYSTEMS, COLLABORATIVE LOGISTICS**
- **WIRELESS INTERNET, PERSONAL MOBILE DEVICES, RF TAGS, E_SEALS:**
 - *TELEMOBILITY* and *TELELOGISTICS* (CHANGES IN DEMAND), AND
 - PEOPLE/VEHICLES/SHIPMENTS AS PROBES (SOURCE OF REAL-TIME DATA FOR OPERATION, SURVEY DATA FOR PLANNING)
- **AUCTIONS and REAL-TIME INTERACTIVE MARKET-BASED MECHANISMS (INCL. PRICING) FOR PROCUREMENT AND CAPACITY ALLOCATION**
- **PEER-TO-PEER, AD-HOC NETWORKING AS SYSTEM MANAGEMENT APPROACHES: IMPLICATIONS FOR SYSTEM RESILIENCY**
- **UNDERSTANDING SYSTEM VULNERABILITY AND RESILIENCY; IMPLICATIONS OF OPERATIONAL CONSIDERATIONS FOR PLANNING AND DESIGN**

EIGHT BIG THEMES FOR RESEARCH (ctd.)

- USER BEHAVIOR AND RESPONSE: KEY BUILDING BLOCK FOR USE OF INFORMATION AS TOOL FOR POLICY AND CONTROL; BEHAVIOR CHANGE TOWARDS SUSTAINABLE PATTERNS
- NEW BUSINESS MODELS FOR INFRASTRUCTURE DEVELOPMENT, OWNERSHIP AND OPERATION; FOR SYSTEM AND SERVICE DEVELOPMENT AND MANAGEMENT.
- STRATEGIC MOBILITY, ENERGY AND SUSTAINABILITY