Integration Across Goals

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SAFETY
MOBILITY
ENVIRONMENT
ENERGY
INTEGRATION
RENEWAL
Flow = speed \times\ density

Closer together $\implies$ slower

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

SOLUTION: TECHNOLOGY—sensors, control system

“intelligent cruise control”
THE CHALLENGE

• PLANNING
• MONITORING

• OPERATION
• MAINTENANCE/RENEWAL

SEPARATION OF FUNCTIONS
INCONSISTENT DATA BASES
SEPARATE DATA COLLECTION ACTIVITIES
LACK OF COORDINATION
INEFFICIENCIES: COST, DELAY
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

Economic activity: Firm logistics, manufacturing, services

Socio-demographics: Household activities, mobility

GIS-REFERENCED LAND USE: from parcel level to statewide TAZ

INTERMODAL NETWORK REPRESENTATION

TRAVEL DEMAND

FREIGHT DEMAND

HOUSEHOLDS

FIRMS
APPLICATION 1: REGIONWIDE STRATEGIC PLANNING

APPLICATION 2: CORRIDOR MOBILITY STUDIES

APPLICATION 3: HOMELAND SECURITY

APPLICATION 4: MANAGED LANES AND VALUE PRICING

APPLICATION 5: ENVIRONMENT AIR QUALITY CONFORMITY

APPLICATION 6: INTERMODAL FREIGHT PLANNING

MULTIPLE APPLICATION DEVELOPMENT

TRAVEL DEMAND

FREIGHT DEMAND

HOUSEHOLDS

FIRMS

INTERMODAL NETWORK REPRESENTATION

Economic activity:
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Household activities, mobility

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from parcel level to statewide TAZ
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
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

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

**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

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