SMART CITIES – A PARADIGM SHIFT FOR TRANSPORTATION ENGINEERS

ITE Presentation
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CHARACTERISTICS OF SMART CITIES

Infrastructure and services are interlinked using technology to improve the quality of life by enhancing their operation:

- Cloud-based services
- Internet of Things (IoT)
- Network of Sensors and RFIDs
- Smart Cars
- Autonomous/Connected Vehicles
CONNECTED VEHICLES IMPROVE OPERATIONAL EFFICIENCY
AUTONOMOUS INTERSECTION
CONNECTED VEHICLES INCREASE ROADWAY CAPACITY

• Reduced need to build roads and add lanes
  • 1800 vphpl → 7200 vphpl on Arterials
  • → 14400 vphpl on Freeways

Total Public Construction Spending in the U.S. as a Percentage of GDP

Source: Federal Reserve Bank of St. Louis, U.S. Global Investors
PARKING IN CBD WILL BE REDUCED

NOW= 40% of urban land for roads and parking, needs up to 4 parking spaces/vehicle
PARKING IN CBD WILL BE REDUCED

FUTURE = Reduced to 1-2 parking spaces/vehicle = 75 Billion SF of parking spaces available

• Parking spaces reduced from 10’ to 7’ wide
DESIGN OF FUTURE MALLS WILL CHANGE

- Reduction of parking needs at malls and retail centers
  - E.g. 1 Million SF retail center with 5.0 parking/1000SF = 5,000 spaces = 750,000SF
  - Halved = 2,500 spaces saved = 30 acres of land

- Larger drop-off area needed at malls, offices, etc.
CONNECTED VEHICLES IMPROVE ROADWAY SAFETY

- Reduction in pedestrian and auto accidents
  - 31 major pileups since 2011
- SOVs reduced
  - e.g. San Francisco 62% SOV dropped to 50% by 2015 40% by 2019
- VMT will go up
- Car ownership drops

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ROADSIDE INFRASTRUCTURE FOR CONNECTED VEHICLES

• Sensors
  • Presence detectors at intersections
  • Queue length detectors
  • Travel time measurement
  • Delay measurement

• Communications between Intersections

• DSRC Transceivers
  • Communicate with connected vehicles

• Artificial Intelligence algorithms to optimize control
  • Artificial Neural Networks
  • Evolutionary Computation, eg Genetic Algorithms
  • Computational Swarm Intelligence
  • Artificial Immune Systems
  • Fuzzy Logic Systems
WILL CONNECTED VEHICLES REPLACE ROADSIDE SENSORS?

• Connected vehicles will allow control devices to know its:
  • Location;
  • speed;
  • acceleration;
  • route or ‘intention’

• Under these conditions, roadside sensors is not necessary if:
  • 100% penetration of vehicle fleet
  • Stable, secure and tested technology before rollout
  • Reliability of electronic systems need to be tested to 99.99% with fallback safety measures
Connecting the “Unconnected Vehicles”

Before 100% Connected Vehicles Deployment:

- Need sensors to detect Unconnected Vehicles in real-time
  - Location
  - Speed

- Artificial Intelligence algorithms will incorporate ‘Unconnected Vehicles’ into the optimizing routines
TRAVEL WILL BECOME A SERVICE, NOT A COMMODITY

• Homebuilding in suburbs will increase
• Insurance
  • Now = owner/driver
  • Future = vehicle; user pay per trip cost
• InterCity Road Travel will go up
  • Short haul airfare about $0.5/mile
  • Cost of AV/CV less than $0.15/mile
  • Will go down in future
COST OF TRAVEL WILL GO DOWN

• Solar paneled roadway pavement providing cheaper free energy to cars
INTERCITY DRIVERLESS TRUCKS WILL REDUCE COST OF SHIPPING

Major shortage of long-haul truck drivers nationally

Average salary of truck drivers = $43,410 per year
Average salary of college graduates = $45,400
(Source: 2015 Census)

Most common job in each state in 2014
(Source: Planet Money)
IMPACT OF SHARED VEHICLES

• Reduction in fixed route transit usage
  • Increased shared use of vehicles
  • E.g. Las Vegas,
    • 2015 = 30% UBER utilization
    • 2016 = 60% to 70%
• Driverless buses and paratransit
• First and last mile connectivity for transit users
IMPACT OF SHARED VEHICLES

• Car utilization
  • Today = 5%
  • Future = 70%
• Cost of travel
  • $0.75-$1.5/mile → $0.15/mile
• People will be more mobile
  • Today = 2.5 trips/day per person
  • Future = 4 to 5 trips/day per person
• VMT will go up
• Improved mobility for children, old, visually impaired, etc.
• Reduced infant mortality
  • especially in challenged residential neighborhoods as a result of lack of access to consistent prenatal care – Columbus Smart City Challenge
IMPACT OF INTERNET OF THINGS

• People become more connected through cloud computing
  • Reduced travel to work
  • Workstation at home connected to cloud server
  • Video conferencing
  • Virtual meetings
WIRELESS BANDWIDTH WILL EXPAND

- 5G Telecom by 2020
  - Approved by FCC on 7/14/2016
  - 1GB/sec to 10GB/sec
  - Expand battery life x10
  - More secure connections
ENGINEERING DESIGN NEEDS TO ADAPT

- Smart Traffic Lights
- Smart Street Lights
- Smart Irrigation
SMART DISSEMINATION OF DATA

Palm Springs Earthquake Warning System

- 30 seconds advanced warning
- Allow garage door to open
- Elevators to suspend
- Emergency power to standby
- Gas valves to shut
THANK YOU!
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