



# Smart Pavement for Smart Cities

Integrated Roadways, LLC - Proprietary and Confidential



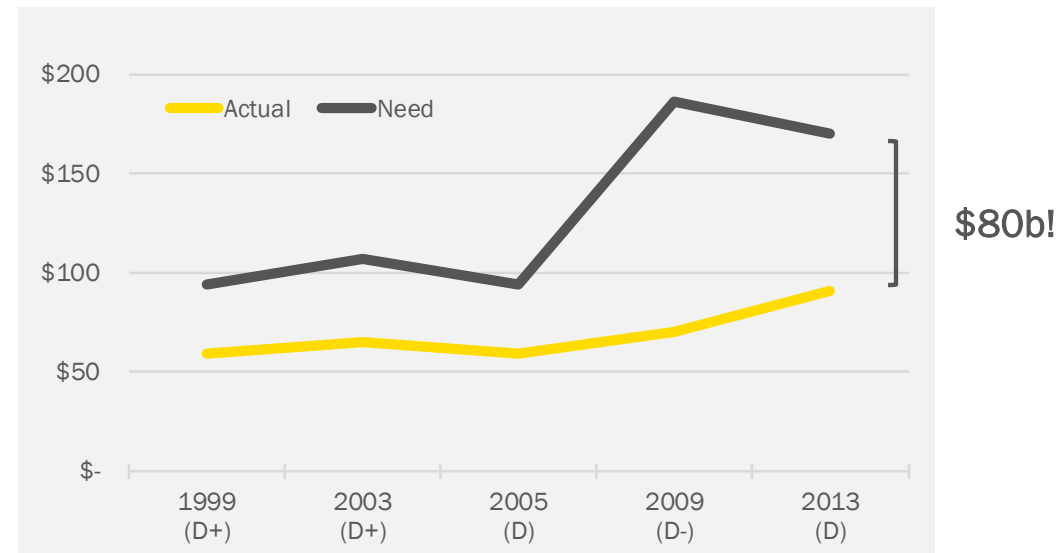
## HOW WILL WE PAY FOR SMART CITIES & C/E/AV'S?

The U.S. has underinvested in basic infrastructure for at least 25 years.

Existing infrastructure is inadequate for Smart Cities and Autonomous Vehicles.

Funding for upgrades is not available from cash-strapped public entities, tolls and increased taxes are not viable options.

U.S. Roadway Infrastructure Spending and Report Card, 1999 to 2013  
(\$ in billions)



Source: American Society of Civil Engineers, 2013 Report Card for America's Infrastructure

# ROADWAYS INTEGRATED

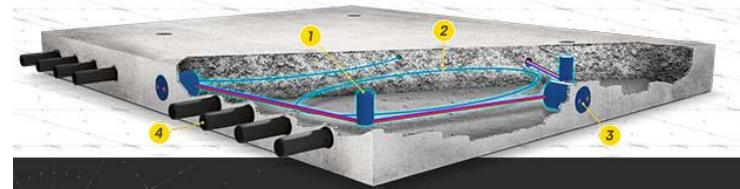
Our Smart Pavement™ system offers an all-encompassing solution.

Durable, precast concrete sections efficiently and economically replace current subpar infrastructure.

Embedded fiber optic and digital sensor technology turns the roadway into an intelligent, mobile Internet of Things-ready digital/physical hybrid transport network.

- Data capture for traffic analytics and road conditions
- Neutral host network services
- Connectivity for next-gen vehicles & devices
- Commercial fleet vehicle services
- Wireless charging for electric vehicles
- Telemetry for autonomous vehicles

## SMART PAVEMENT™ SYSTEM



- 1 PATENTED COMBINED ACCESS PORT (CAP)**  
Initially used to lift and position slab into place. Once positioned, void with interior connector accommodates a cylinder of sensors, processors, antennae and other technology to be installed, while remaining easily accessible for replacement or upgrade.
- 2 DIGITIZER LAYER/VEHICLE DETECTION LOOP**  
Fiber optic strain mesh laminated to the slab's reinforcement. Similar to a touch screen element and able to identify tire positions rather than finger positions.
- 3 ROUTER**  
Four routers connect to slab neighbors and send information to Linear Data Centers alongside highway.
- 4 DOWEL AND CONDUIT SYSTEM**  
Smart Pavement slabs are connected using a series of dowels extended into adjacent conduits, then filled with grout through grout ports for a solid connection.





# SMART PAVEMENT PILOT PROJECTS

## MoDOT Road to Tomorrow

- Revenue & data collection
- 1 mile
- I-70 lane addition
- Contract expected 8/17
- Build 2Q '18

## Kansas City

- CEVs & Smart Cities
- 1-2 miles
- Site undetermined
- Contract expected 3Q / 4Q '17
- Build 2Q / 3Q '18

## CDOT RoadX

- Safety & automated event alerts
- 1/2 mile
- Site has 10x accident / fatality rate
- Contract expected 7/17
- Build 2Q '18

## Undisclosed Owner

- Next-generation mobility
- >3 miles
- Undisclosed location
- Contract expected 3Q / 4Q '17
- Build late '18 – early '19



# PRECAST PAVEMENT – BETTER, FASTER, CHEAPER

15 yr FHWA “Highways for Life” focus area

- 80 year history in Europe and Asia
- >200 projects by CalTrans
- Trialed by most state DOTs
- Specified & PQ by half of state DOTs

Why?

- Faster construction rate
- Minimal equipment
- Minimal on-site labor
- Extended service life
- Better QA / QC
- Limited maintenance requirements
- Lower total cost of ownership



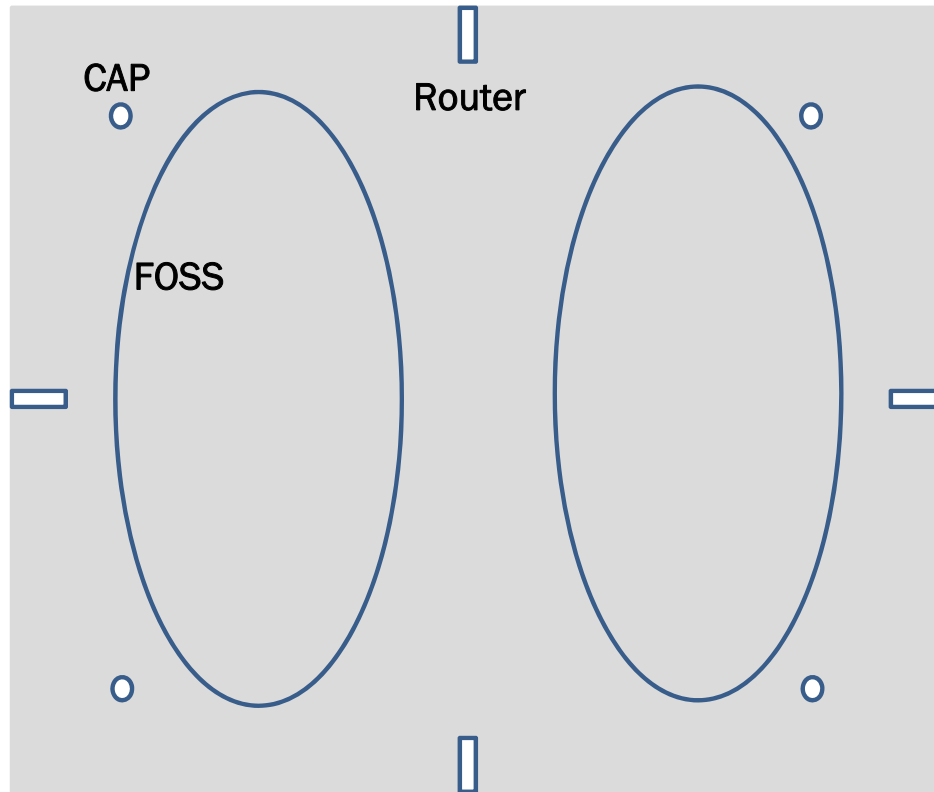


DEMO

00:00:02:28



# SMART PAVEMENT SYSTEM



## 4x Combined Access Ports (CAP)

- Lift, place, level, grout slab
- Internal connector for “smart” module
- 2” dia x 2” h to 2” dia x 8” h

## 4x Routers

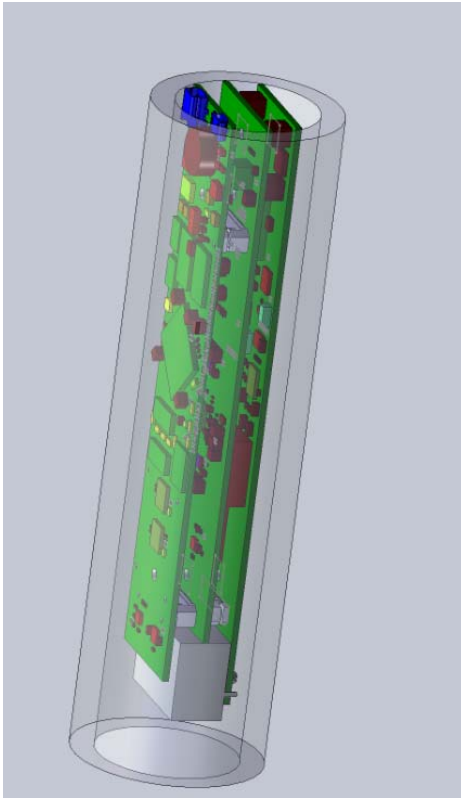
- Connects to slab neighbors
- Connects to Linear Data Center

## Fiber Optic Sensing System (FOSS)

- Makes pavement “touch sensitive”



# MODULAR INTELLIGENCE



Dual-core ARM A7 processor

iNEMO 9D Inertial Module

- 3D Accelerometer
- 3D Gyroscope
- 3D Magnetometer

Fiber Optic Interrogator

- v1.0 sits outside pavement
- v2.0 integrated into intelligence module

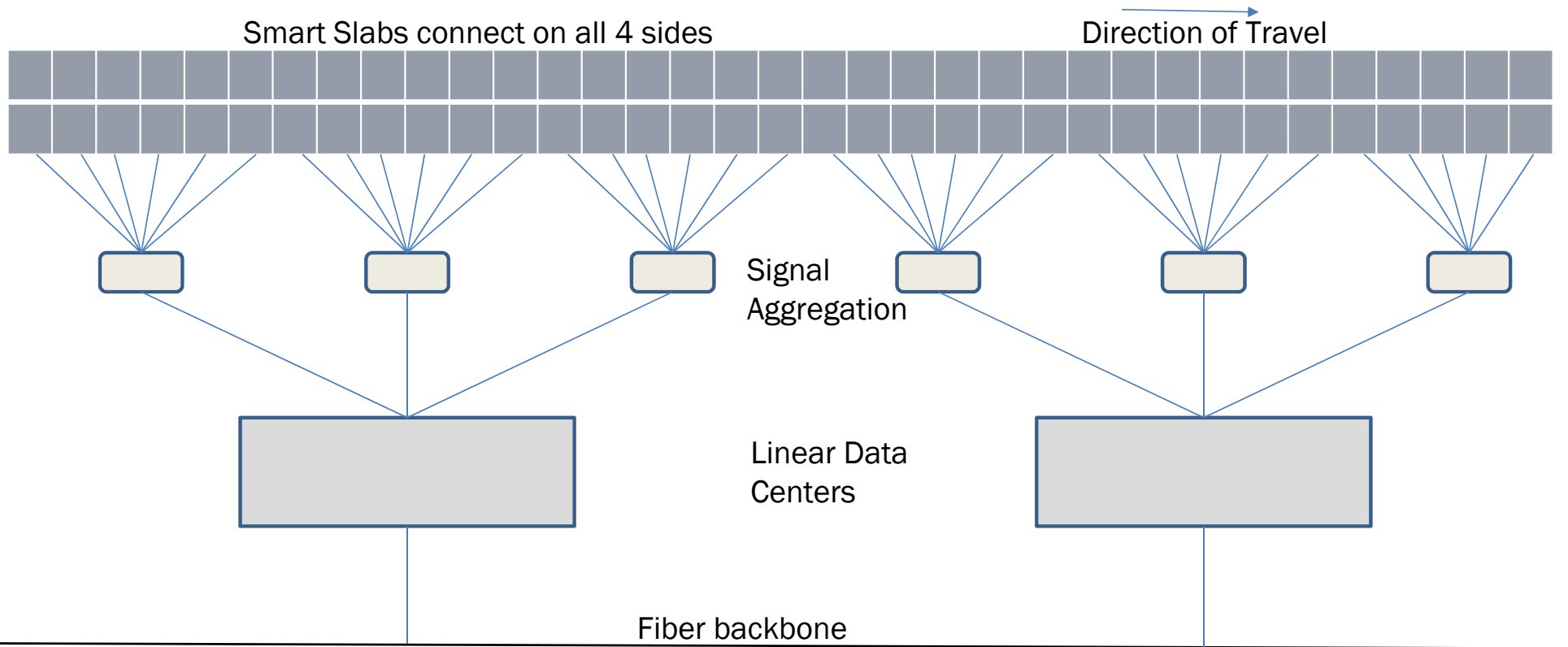
Dual 1 Gbps POE I/O

2" D x 6" L (v2.0 has 4" L)





# SUPPORT NETWORK AND ROAD SIDE EQUIPMENT

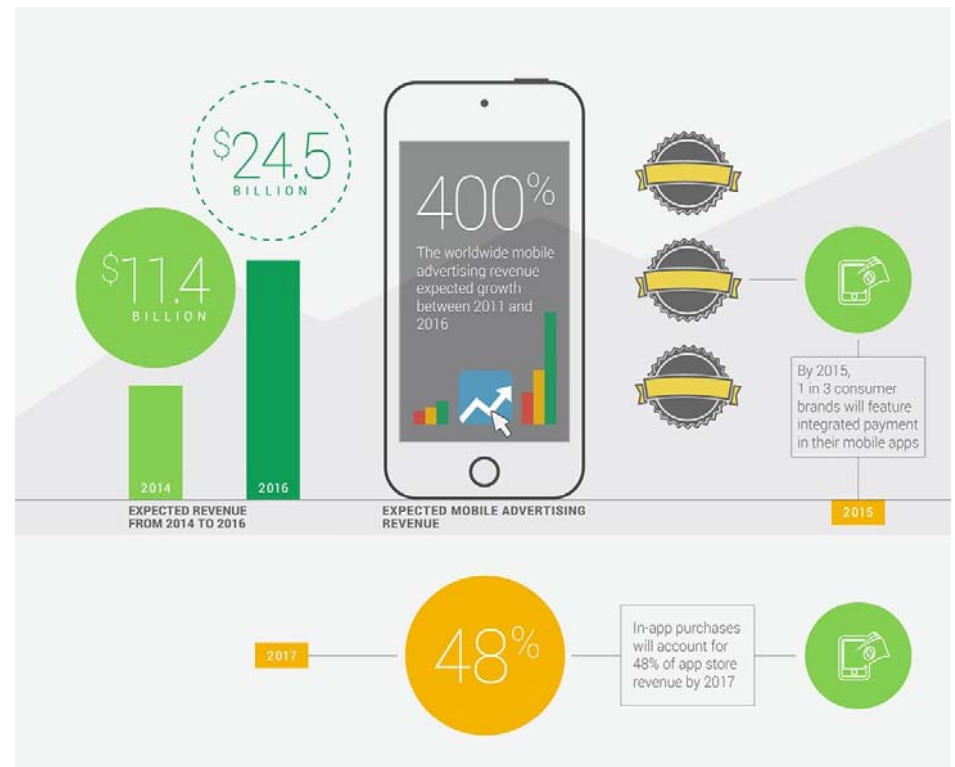


# APPS & SERVICES FOR MOBILITY

[In] 2017, the App Market Will Be a \$77 Billion Industry – Forbes

[A connected vehicle] platform will allow for growth, expandability, and incorporation of newly evolving technologies. – US DOT

Internet of Things Market to Reach \$1.7 Trillion by 2020: IDC





# MAKING THE ROAD PAY FOR ITSELF

## Infancy – Data for:

- Smart Cities
- Real Estate development
- Advertising & insurance
- Safety improvements

## Mid-Term:

- Neutral host network for advanced comms
- Navigation & telemetry
- Wireless vehicle charging
- Commercial Fleet services

## Maturity:

- Ecosystem of autonomous-related services
- High-speed ubiquitous connectivity
- 3rd party applications & services

## Revenue at infancy:

- >\$0.02 avg per VMT
- \$250k ann. per lane-mile

## At mid-term:

- >\$0.07 avg per VMT
- \$750k aplm

## At maturity:

- >\$0.12 avg per VMT
- \$1.5m aplm



## ***BIDDING, LETTING, & FINANCING***

Create a P3 w/ owner

- Vest owner assets in the P3
- Owner contributes 10% of cost

Finance 90% with private capital

- DBFOM
- P3 bears full responsibility for debt, ops, maintenance

Private finance does NOT mean private ownership!

Project can still be let for bidding through normal processes

Respondents must use our tech

Bidders must be PQ & certified

PQ training & cert is inexpensive





## **ENGINEERING & CONSTRUCTION MEANS & METHOD**

Engineering is very similar to traditional methods

- Modular / unitized material
- Much more ITS / IT inclusion
- Network deployed along road
- Handholes for switches @ 200'
- Linear Data Center 2x per mile

Construction is straightforward

- Replaces material
- Reduces labor & equipment
- Some additional specialty trade
- Base & grade set using the same m&m as CIPC / PCCP
- Similar revenues + lower expenses = higher margins



## **MAINTENANCE & REPAIR**

Same physical maintenance schedule as precast pavement

- Mill post-install
- Inspect & clean joints @ 5 yrs
- Respond to alerts & notices
- Mill @ half-life
- Patch as necessary

FOSS monitors stress / strain to predict & report maintenance & repair needs





## UPGRADES & OPERATIONS

Electronics replaced every 3-15 yrs

- No active systems in paving slab
- Only copper wire & glass fiber

RSE HW & SW improvements will not disrupt system operation

In-pavement intelligence module designed to be easily replaced

- Can be performed autonomously in low-traffic periods
- Estimated 15 mins replacement

We only use a fraction of the system capacity

- 4 CAP per 10 feet
  - 1 intelligence module per slab
  - 1 wireless module ever 100'
- Over-provision switches at edge
- Over-provision LDC

Unused CAP, switch, & LDC capacity is available to lease



## **SAY HELLO TO THE INFORMATION SUPERHIGHWAY**

Integrated Roadways is a technology developer, vendor, and network operator that delivers innovative self-funding smart infrastructure.



Smart Pavement™ connects Smart Cars and Smart Cities