AC TRANSIT FLEX PILOT PROGRAM

JOHN URGO
TRANSPORTATION PLANNER
AC TRANSIT | OAKLAND, CA
• An on-demand transit service began operation in July 2016
• Replaced a fixed route in March 2017 for a pilot period of one year
**WHAT IS AC TRANSIT FLEX?**

1. **BOOK YOUR TRIP AS LITTLE AS 30 MINUTES IN ADVANCE**
   - Confirm your 10-minute pickup window

2. **WE’LL SEND YOU A PICKUP ETA WHEN YOUR BUS IS ON THE WAY**
   - The bus won’t leave before this time

3. **TRAVEL TO BUS STOP**

4. **TRACK YOUR BUS WHILE WAITING AT INTERSECTION**
   - Board bus and pay with cash, Clipper, or Pass

5. **SHARE YOUR RIDE AS OTHER PASSENGERS GET PICKED UP AND DROPPED OFF**

6. **ARRIVE AT DROP-OFF POINT AND WALK TO DESTINATION**
   - Transfer at BART for destinations in the East Bay and San Francisco

7. **ON YOUR RETURN, BOARD FLEX AT BART EVERY 30 MINUTES WITHOUT RESERVATION**
   - Reservations can also be made in advance, or on a subscription basis

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**flex.actransit.org**
**510-891-5470**
WHERE IS AC TRANSIT FLEX?

CASTRO VALLEY
- 1 bus
- Scheduled departure every 60 minutes
- Flex Bus Stop

NEWARK
- 2 buses
- Scheduled departure every 30 minutes
- Flex Bus Stop

Alameda-Contra Costa Transit
actransit.org
Why AC Transit Flex?

Goals of AC Transit Flex

1. Public Stewards
2. Transparency and Accountability
3. Mobility for those in need
4. Grow Ridership

Public Transit Agency Goals

City and Regional Goals

FLEX PILOT
1. Public Stewards
2. Transparency and Accountability
3. Mobility for those in need
4. Grow Ridership

1. Reduce Emissions
2. Reduce Congestion
3. Social Equity
WHY AC TRANSIT FLEX?

AC Transit Flex Goals

FLEX PILOT

1. Public Stewards
2. Transparency and Accountability
3. Mobility for those in need
4. Grow Ridership

Public Transit Agency Goals

City and Regional Goals

1. Reduce Emissions
2. Reduce Congestion
3. Social Equity
Why AC Transit Flex?

Improve service in low density and low demand areas

Respond to a changing marketplace

Ensure access and equity
COSTS AND FUNDING

- General operating funds
- AC Transit Buses
- AC Transit Operators
- Contract for technology services

Revenue and operating cost neutral

2 Buses

FLEX

Technology

SaaS
Maintenance and Operating **Cost Neutral**

**Line 275**
- **STANDARD BUS COST**

**Flex**
- **SMALL BUS COST**
- **TECHNOLOGY COST**

ANNUAL VEHICLE MAINTENANCE + TECHNOLOGY COST

- 30’ Diesel
- 26’ Cutaway
**Ridership to Date**

- **600+ Unique Riders**
- **70% Return Customers**
- **20,000 passenger trips**

Chart showing passenger trips from August to June, with peaks in March and April.
Customers are flexing on their own.

- Online Booking: 45%
- Call Agent Booking: 38%
- Walk On: 17%

Passengers mostly book trips on their own.
Passengers per revenue hour

5 to 7 boardings per hour

Ridership Target

Service Productivity

But productivity is lower than hoped.

Passengers per revenue hour

6:00 AM  7:00 AM  8:00 AM  9:00 AM  10:00 AM
6:00 PM  7:00 PM  8:00 PM  9:00 PM  10:00 PM

Castro Valley  Newark

Alameda-Contra Costa Transit
actransit.org
RESERVATION BARRIER

- 40% of passengers riding from BART are not taking the service to BART

Blue = Boarding, Red = Alighting
### Lessons Learned

- **Set realistic goals for low demand areas**
- **Upper limit 7 passengers/revenue hour**
- **Smallish 5-7 square mile service zones**
- **Reservationless + Scheduled Trips boost productivity but lower reliability**
- **Smaller buses reduce operating costs**
- **Technology leads to greater efficiency (as well as headaches)**
- **Operate!**
- **Replace is easier than repeal**
THE FUTURE OF FLEX: A NETWORK APPROACH

Existing **low frequency** network
Proposed high frequency network
**THE FUTURE OF FLEX: A NETWORK APPROACH**

Proposed **high frequency network + flex coverage zones = cost neutral**
THE FUTURE OF FLEX?

• The future of public transit or an exit strategy?
• Will a high frequency + flex network sustain ridership?
• What role will ride-hailing and autonomous vehicles play in serving public transportation goals?
• Visit www.actransit.org/flex/ or call (510) 891-5470 for more information

(510) 891-5470 / Free language assistance / Asistencia gratuita en el idioma / 免費語言協助 / Libreng tulong para sa wika / Hỗ trợ giúp thông dịch miễn phí
 무료 언어 지원 / मुफ्त भाषा सहायता / 無料の言語支援 / مساعدة لغوية مجانية / Assistência linguagem livre / ประกาศบางภาษาติ้งอีสปันไน
Бесплатная помощь переводчиков / ภาษาอิอุยติจิ่วọจงงูสหกี้แย้ง่า / มุ่งล้อ ฮั่งจี๋ สกิ้งแย้ง่า / Assistance linguistique gratuite
**Passenger Trip Characteristics**

- **Average Wait for Desired Boarding Time:** 03:25
- **Average Lateness:** 03:15
- **Average Trip Time:** 14:54

**Trip Lengths**

- 0 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- 4 to 5
- 5 to 6
- 6 to 7
- 7 or more

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Alameda-Contra Costa Transit
actransit.org
ENSURING ACCESS AND EQUITY

Americans with Disabilities Act

Wheelchair Accessible vehicles

Title VI/Service Equity

Service Equity Analysis

Professionally Trained Operators

Policies for Unbanked/digital divide

Limited English Proficiency

Translation Services

Customer Booking Call Center
MARKETING AND OUTREACH

Billboards on bus shelters, exteriors, and BART stations

At-stop signage and inserts

Bi-lingual street teams

Direct mail; digital and social media

No online trip planning tools!
SERVICE PRODUCTIVITY

OPERATING EXPENSE PER PASSENGER TRIP

- Newark Flex: $71.52
- Castro Valley Flex: $63.57
- 275: $24.71
Cloud platform enabling autonomous mobility services

Automated Vehicles Symposium
July 11th 2017

Leemor Chandally, Director of Strategic Partnerships, NA
leemor.chandally@bestmile.com
MASSIVE PARADIGM SHIFT

4th industrial revolution - Shared electric autonomous mobility

Digitalization and automation of transportation of people and goods

From ownership economy to shared economy

Mobility industry greater revenue generator than automotive
Industry focus is currently **vehicle-centric** – getting to Level 4/5 autonomy.

Real economic driver of technology and transportation is in **fleets and mobility services** – usually an afterthought.

Mobility providers need to offer **on-demand and fixed-route services** in addressing transportation challenges.

- Manage **hybrid fleets**
  - Human-driven and autonomous vehicles

- Manage **mixed fleets**
  - Different brands of autonomous vehicles
VALUE PROPOSITION

Fleet mixing autonomous and human-driven vehicles + Agnostic, real-time coordination and optimization platform = EFFICIENT, FLEXIBLE MOBILITY SERVICES!

BestMile enables mobility providers to **deploy, operate and scale** innovative and efficient transportation services leveraging shared autonomous vehicles
BESTMILE CLOUD PLATFORM - CORE ENGINE

Sending the right missions to the right vehicles at the right time

- supply & demand matching
- automated dispatching
- energy management
- planning and scheduling
- real-time dynamic routing

Additional key features
- Health and asset management
- Machine learning
- Data integration
APPLICATIONS AND INTERFACES

PRO APPLICATIONS
for mobility providers

Operator Dashboard
Field Agent Application

PUBLIC APPLICATIONS
for travelers

Interactive Kiosk
Web Portal
Traveler Application
HOW IT WORKS

ON-DEMAND

1. Traveler books ride via the app and receives vehicle info

2. Platform receives data from vehicles (location, speed & battery level), performs optimization, and sends mission to the appropriate vehicle to go from point A to B

FIXED ROUTE

3. Platform receives data from vehicles (location, speed & battery level), performs optimization and sends mission to the vehicle to go from stop C to stop D
“Frost & Sullivan firmly believes that BestMile will be instrumental in building a new mobility paradigm” – Frost & Sullivan, March 2017
Track record

- 42,000 miles driven
- 120,000 passengers transported
- 13 fleets managed
- 6 fleets live: USA, Europe, Japan
‘SMARTSHUTTLE’ - SION, SWITZERLAND

- Operating since June 2016
- 2 shuttles in a busy city downtown
- 2 km loop among cars and pedestrians
- Daily operation from 1 to 6pm
- Moved 21,500 pax; Traveled 4,500 kms
- Public acceptance
PROJECT MILESTONES

Public Announcement

Project Launch

Testing

Official Permit
Federal Roads Office

Go Live

Full Operation Hours

Network Extension

Nov 2015  Dec 2015  Jun 2016  2017
GOMENTUM STATION - CALIFORNIA

- Partnership since Dec 2016
- Pilot with 2 EasyMile shuttles
- FM/LM project goal to deploy large scale of AV's on public road
- Developing requirements with input from local stakeholders
- How to implement FM/LM project?
LESSONS

**Partnerships** are critical to successful deployments

**Pilot projects** important as first step in iterative process. We’re doing something new and innovative – break into phases and iterate.

**Tolerance** for trialing and testing – we’re all in R&D; spirit of exploration.

**Understanding of local context**; navigating cultural and corporate differences
ADDRESSING TRANSPORT CHALLENGES

Mobility-as-a-Service – citizens want more automated, connected, affordable, comfortable, sustainable and on-demand transportation services.

Short-Distance Connectivity (FM/LM) – to enable seamless mobility and complement existing transportation systems.

"By 2030, over 60% of people will live in cities. Transportation is seen as the biggest infrastructure challenge and is a key factor in city competitiveness and development."

Megacity Challenges - Siemens

Mobility On Demand
leemor.chandally@bestmile.com
bestmile.com

535 Mission St
14th Floor
San Francisco, CA 94105 USA

EPFL Innovation Park
Building D
1015 Lausanne, Switzerland

14, Bedford Square
London, WC1B 3JA, UK
Costs & Benefits of Automating U.S. Bus Fleets

Neil Quarles
Dr. Kara Kockelman

June 14, 2017
Background

Full Automation Technology

• Should be available in the next few years.
• Ongoing public testing of self-driving buses.
• Different expectations for public transit impacts.

Powertrain

• Self-driving electric buses
Austin’s Transit Agency: CapMetro

- 82 Bus Routes + 438 Buses (+ 1 commuter rail line)
- 30.5 M/yr passenger boardings (FY2016)
- $264 M operating budget (FY2017)
  - 45% Driver costs ($119 M/yr)
  - 6.4% Fuel costs ($17 M/yr)
- $158M capital budget (FY2017)
Fleet Conversion

Evaluated effects of converting Capital Metro’s bus fleet:

- Fully Automated Buses
- Electric Buses
- Both Technologies Together

Criteria used:

- Qualitative impacts
- Financial impacts
- Possible implementation schedules
Qualitative Effects

- **Traveler comfort** at bus stops
- **Public perceptions**
- **Energy & Emissions Impacts**
  - Depend on electricity source
  - Austin generates power using 20%+ renewables (vs. Texas: 10%)
  - Seeks 55% renewables by 2025.
Full Automation’s Costs & Benefits

• **Bus drivers cost** Capital Metro $119M/year
  - $271K per bus-year, or **$3.3M over each bus’s 12-year (avg.) life**

• Assuming **$80K per bus, full automation premium**...
  - $3.2M life-cycle savings per bus = **97% operating cost reduction!**

• **Crash cost & insurance savings** from safer driving
  - Possibly ~40%

• Smoother driving → **Fuel savings, emissions reductions, & greater rider comfort**

• **Public perceptions** (good & bad?)

• But **fewer jobs** for drivers.
Investment Scheduling

- Recognizing bus fleet turnover & driver contracts.

- Starting in 2017, autonomous-only adoption delivers immediate savings & year-zero payback.

- Electrification should break even in 2024 to 2029 if battery costs fall at 14% per year (or 2027 to 2035 if fall at 8%/yr).

- Co-implementation of these 2 technologies will breakeven after 6 to 9 years (assuming 14% to 8%/yr reductions in battery costs).
Conclusions

• **Full automation** can *drastically lower* transit agency costs → Funding for more service, better service, etc.

• **Electric buses** are not yet cost-competitive with diesel, but *offer other benefits*.

• Both technologies can *improve transit provision & lower environmental impacts*.

Any questions &/or suggestions?
Autonomous Vehicle Safety Standards
SAFETY AND TRUST ARE BIG HURDLES LIMITING ACCEPTANCE WITH REGULATORS, INSURERS, CONSUMERS

“When you’re talking about potentially life-threatening technologies, you need real standards that can be enforced.”

“The software vulnerabilities found in vehicles’ network connections pose a significant risk to the security of driverless cars.”

“Consumer Reports also published a column calling on Tesla to deactivate the Autopilot system because of safety concerns after the accidents.”

“It is time to stop your administration’s undue haste to get autonomous vehicle technology on the road.”
Dec 2014
Zendrive hits 10K daily miles

Dec 2015
Zendrive hits 100M daily tracked

Dec 2016
Zendrive 1st Billion miles

Oct 2016
Google hits 2M all time miles

Oct 2015-2016
Tesla hits 150M miles

Dec 2016
Tesla hits 1.3B miles

Progressive took 18 years to analyze 15B miles
What did we learn?

#1 Zendrive’s massive dataset delivers robust coverage across the country

#2 In different parts of the country, people drive differently

(#3 We all use our phones a lot behind the wheel: In 88% of trips we analyzed, a driver was on their smartphone for an average of 3.5-minutes per hour)
What did we learn?

#1 Zendrive accurately measures driver behavior

#2 Driver behavior is a predictor of collisions

NYU: 71% Correlation Between Zendrive Risky Driving Events & NYPD Crash Data

Risky Driver Events - Zendrive
July to December 2015:
33,450 Zendrive risky driver events
Now, Zendrive collects 70M+ events/month

Crashes - NYPD
July 2012 and March 2017:
127,423 NYPD collisions reports
JOIN US IN BUILDING THE INDUSTRY’S AUTONOMOUS VEHICLE SAFETY STANDARD
What’s Next?

Three ways we could start working together...

---

**Data Partnership**

Adding Zendrive data to your autonomous vehicle will bring human driver behavior to bear for the first time.

**Evaluation Partnership**

Zendrive provides an independent system to measure autonomous vehicle safety and compare it to human driver safety.

**PR Partnership**

Zendrive’s unique behavior data tells a compelling story for a broad array of audiences.
Thank you.

Jonathan Matus
Co-Founder, CEO
jonathan@zendrive.com
Appendix
TRAFFIC COLLISIONS CAUSE 1.3 MILLION PREVENTABLE DEATHS WORLDWIDE
AUTOMATED VEHICLES HAVE THE POTENTIAL TO PREVENT CASUALTIES
Zendrive has analyzed billions of driving events

4.5B
Monthly miles analyzed by Zendrive

5M+
Active drivers using Zendrive

Billions
Driving events detected by Zendrive
WITHOUT A STANDARD ASSESSING SAFETY OF AUTONOMOUS VEHICLES: TOUGH, COMPLEX, TIME & DATA INTENSIVE
In 88% of trips we analyzed, a driver was on their smartphone.

Of these trips, the average phone use was **3.5-minutes per hour of driving**.

Taking your eyes off the road for **2-seconds** increases your chances of collision by over 20x.

At 55mph, **2-seconds** is enough time to travel the length of two basketball courts.
NYU 75% Correlation Between Zendrive Phone Use & NYPD Phone-related Crashes

Driver Phone Use - Zendrive

Cell Phone Crashes - NYPD
ASSESSING SAFETY OF AUTONOMOUS VEHICLES: TOO COMPLEX FOR ANY SINGLE REGULATOR, INSURER OR AV VENDOR

Rapid Acceleration  Turn Speeds  Hard Braking  Speeding Behavior  Phone Use  Time of Day  Traffic Patterns  Road Sign Compliance  Road Rage

Human Behavior Risks

Autonomous Vehicle Risks

Total Miles Experience  Software Quality  Cyber Threats  Network Support  Type 1 / 2 Human-Machine Transition  Sensor Mix & Quality  Context Adaptability  Physical Vehicle Safety

Environmental Risks

Weather  Road Conditions  Infrastructure Wear & Tear  Traffic Mix  Mapping Quality  Animals

Human Behavior Risks

Autonomous Vehicle Risks

Environmental Risks
ZENDRIVE UNDERSTANDS HUMAN BEHAVIOR & ENVIRONMENTAL RISKS AT MASSIVE SCALE, GLOBALLY

- Rapid Acceleration
- Turn Speeds
- Hard Braking
- Speeding Behavior
- Phone Use
- Time of Day
- Traffic Patterns
- Road Sign Compliance
- Road Rage

- Weather
- Road Infrastructure
- Traffic Mix
- Mapping
- Animals
REQUIRED: AUTONOMOUS VEHICLE SAFETY STANDARD (AVSS)

HOW DO PEOPLE DRIVE IN DIFFERENT PLACES?
HOW SAFE ARE AV VENDORS IN RELATION TO AGREED BENCHMARK?
HOW SHOULD RISK BE PRICED FOR INSURERS?
WHICH AV IS SAFE ENOUGH FOR MY NEEDS / MY CITY?

Quantitative, algorithmic approach to understanding and quantifying AV safety:

- Gives regulators **consistency**
- Provides **benchmarks** across industry & improve safety overall
- Gives consumers **confidence**
- **Reduces time-to-market** for AV vendors
- **Decreases insurance costs** across industry
QUESTIONS?

Jonathan Matus
@matusjon

CEO/founder

@zendrive
THANK YOU
Laws, regulations, and the future of AV transit

Kimley Horn
Expect More. Experience Better.
REP. RON PACKARD  
(R) California
The entire year I use the bus,
I don't have any other way to move
<table>
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<th>Activity</th>
<th>Budget</th>
<th>Schedule (months)</th>
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Minnesota User Based Fee Demonstration: Pre-Implementation Plan

Frank Douma, U of MN
Ken Buckeye, MnDOT
Chris Berrens, MnDOT
Summary

• Propose an efficient, scalable, acceptable user based fee that anticipates where personal mobility will be
• Develop a partnership Shared Mobility providers
• Understand the “value proposition”
  – Transparent
  – Robust
  – Clear goals
  – Reliable
  – Public acceptance
  – Ease of collections
• Societal, technological and economic trends are driving change to the transportation model - Shared Mobility is the change agent
Basis for Project

- AV and EV Technologies are rapidly maturing
- Shared Mobility models are maturing, and fit well with AV’s and EV’s
- Long term transition shared AV’s fits with need for long term transition away from motor fuel tax
Goals and Objectives

• Partner with shared mobility provider to propose a distance-based fee demonstration that is efficient:
  – Easily paid
  – Easily collected
  – Easily understood (transparent)
Goals and Objectives

• Partner with shared mobility provider to propose a distance-based fee demonstration that is sustainable:
  – Long term revenue source (compared to current tools)
  – Evolves with advances in technology
  – Scalable
Goals and Objectives

• Partner with shared mobility provider to propose a distance-based fee demonstration that is acceptable:
  – Safeguards data (privacy)
  – Accounts for Equity
    • Payment (electric vs. gasoline)
    • Ability to pay
    • Demographics
AUTOMATED TO AUTONOMOUS, LESSONS LEARNED
Wessel van der Pol
2getthere has realized automated vehicle applications in various demanding environments since 1984

- Industrial applications
- Cargo handling
- Entertainment
- People movers
MASDAR CITY PRT
ABU DHABI, UNITED ARAB EMIRATES
DIFFERENT AUTOMATED APPLICATIONS
IN RELATION TO THE ENVIRONMENT AND THE CAPACITY TO BE ACHIEVED

Automated People Movers (APM)
Automated Transit Networks (ATN)
Shared Autonomous Vehicles (SAV)
THE COMPLEXITY OF AUTOMATION
TO CONTROL THE APPLICATION ENVIRONMENT, OR NOT? THAT'S THE QUESTION
BLUEWATERS: AUTOMATED PEOPLE MOVER
HIGH CAPACITY: UP TO 5,000 PPHPD
RIVIUM 3.0: SHARED AUTONOMOUS VEHICLES
TRULY AUTONOMOUS: NO STEWARD OR SAFETY DRIVER!
VEHICLE DESIGN
NEW GRT
VEHICLE DESIGN: INTERIOR
LUXURIOUS AND SPACIOUS
VEHICLE DESIGN
Test Beds: Lessons Learned

- Have a vision, mission, strategic, business and marketing plan
- Commitment of Key Partners
- Keep it simple to attract private sector
- Understand the needs of private sector
- Do not underestimate permitting requirements
- Funding Coalition is Key