Collecting Pavement Condition Data Using Technologies Embedded in New Cars and Smart Phones

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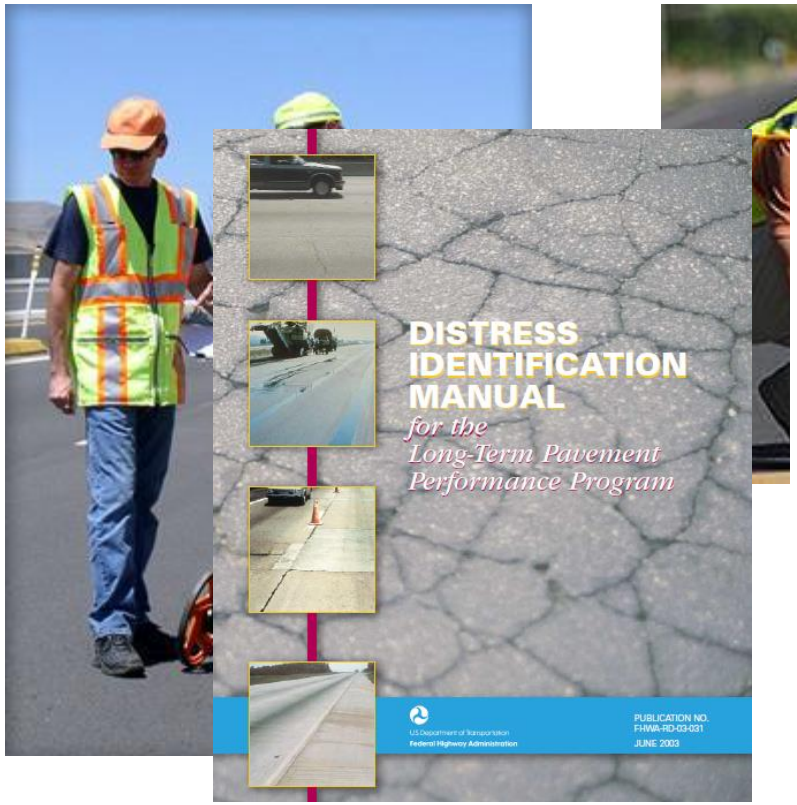
2.6 million

miles of
paved roads
in the United States

Walking Surveys



Designation: D6433 – 11

Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys[1]

This standard is issued under the fixed designation D6433; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the determination of roads and parking lots pavement condition through visual surveys using the Pavement Condition Index (PCI) method of quantifying pavement condition.

1.2 The PCI for roads and parking lots was developed by the U.S. Army Corps of Engineers (**1, 2**).[2] It is further verified and adopted by DOD and APWA.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* Specific precautionary statements are given in Section 6.

2. Terminology

2.1 *Definitions of Terms Specific to This Standard:*

2.1.1 *additional sample*—a sample unit inspected in addition to the random sample units to include nonrepresentative sample units in the determination of the pavement condition. This includes very poor or excellent samples that are not typical of the section and sample units, which contain an unusual distress such as a utility cut. If a sample unit containing an unusual distress is chosen at random it should be counted as an additional sample unit and another random sample unit should be chosen. If every sample unit is surveyed, then there are no additional sample units.

2.1.2 *asphalt concrete (AC) surface*—aggregate mixture with an asphalt cement binder. This term also refers to surfaces constructed of coal tars and natural tars for purposes of this practice.

2.1.3 *pavement branch*—a branch is an identifiable part of the pavement network that is a single entity and has a distinct function. For example, each roadway or parking area is a separate branch.

2.1.4 *pavement condition index (PCI)*—a numerical rating of the pavement condition that ranges from 0 to 100 with 0 being the worst possible condition and 100 being the best possible condition.

2.1.5 *pavement condition rating*—a verbal description of pavement condition as a function of the PCI value that varies from "failed" to "excellent" as shown in Fig. 1.

2.1.6 *pavement distress*—external indicators of pavement deterioration caused by loading, environmental factors, construction deficiencies, or a combination thereof. Typical distresses are cracks, rutting, and weathering of the pavement surface. Distress types and severity levels detailed in Appendix X1 for AC, and Appendix X2 for PCC pavements must be used to obtain an accurate PCI value.

2.1.7 *pavement sample unit*—a subdivision of a pavement section that has a standard size range: 20 contiguous slabs (±8 slabs if the total number of slabs in the section is not evenly divided by 20 or to accommodate specific field condition) for PCC pavement, and 2500 contiguous square feet, ± 1000 ft^2 (225 ± 90 m^2), if the pavement is not evenly divided by 2500 or to accommodate specific field condition, for AC pavement.

2.1.8 *pavement section*—a contiguous pavement area having uniform construction, maintenance, usage history, and condition. A section should have the same traffic volume and load intensity.

2.1.9 *portland cement concrete (PCC) pavement*—aggregate mixture with portland cement binder including nonreinforced and reinforced jointed pavement.

2.1.10 *random sample*—a sample unit of the pavement section selected for inspection by random sampling techniques, such as a random number table or systematic random procedure.

[1] This practice is under the jurisdiction of ASTM Committee E17 on Vehicle - Pavement Systems and is the direct responsibility of Subcommittee E17.42 on Pavement Management and Data Needs.

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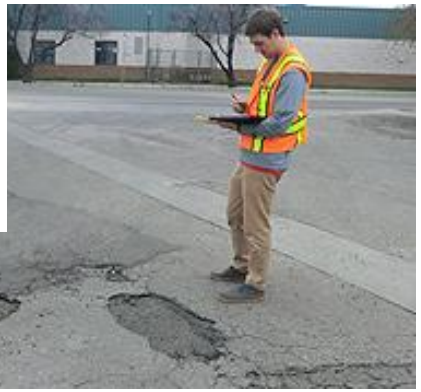
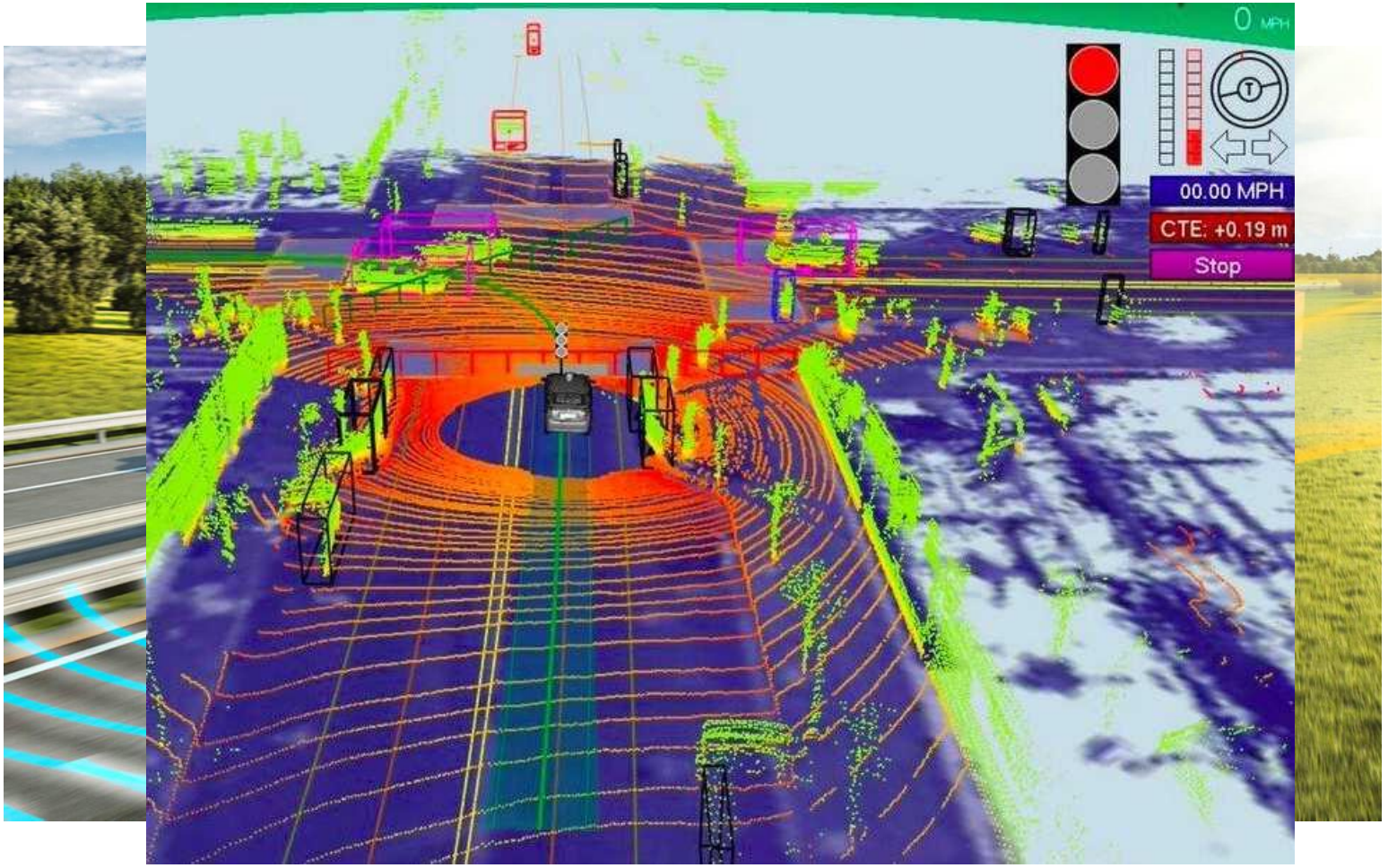
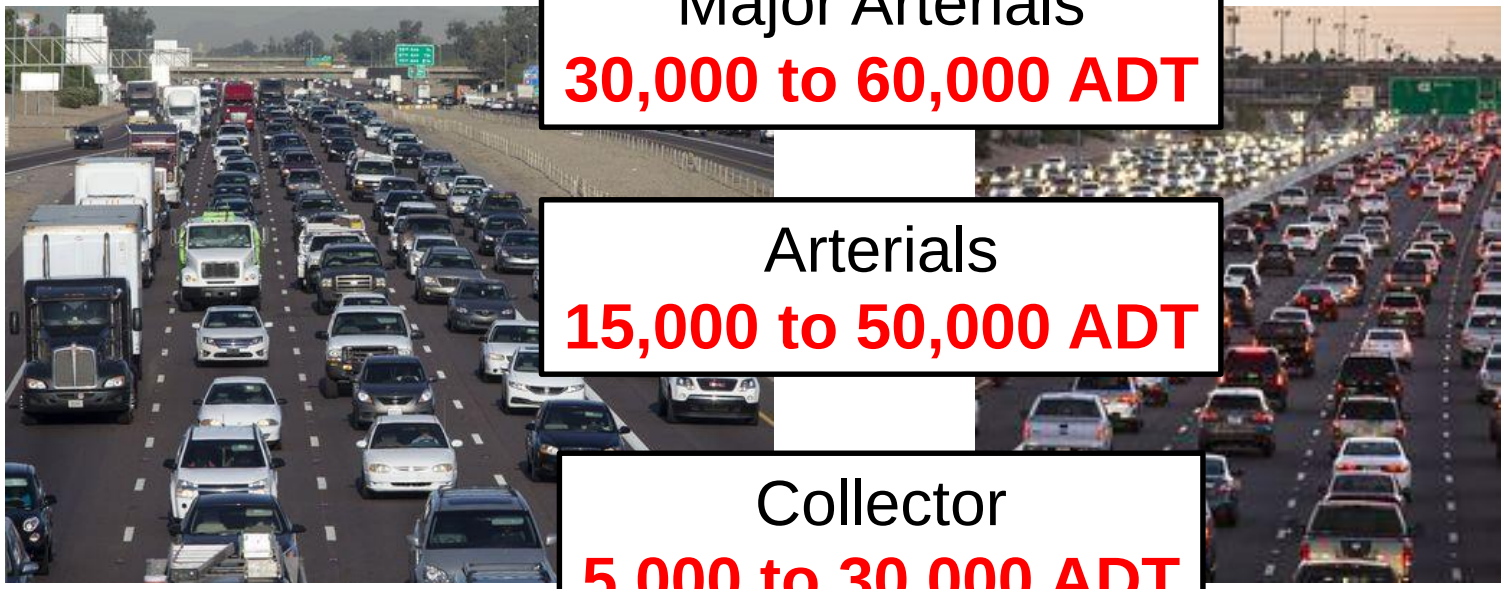
[2] The boldface numbers in parentheses refer to the list of references at the end of this standard.



Automated Equipment

What Google Car "Sees"





Major Arterials
30,000 to 60,000 ADT

Arterials
15,000 to 50,000 ADT

Collector
5,000 to 30,000 ADT

Minor Collector
1,000 to 8,000 ADT

Data Collection Specs

- At least 528 ft straight and level road section, with in **0.05 percent** of true length.
- Elevation accuracy within **0.001 in**.
- Perform calibration in a **monthly basis**.

BIG
DATA
ALSO
TOOLS
DISK
TARGET
APPLIED
SENSOR
SHARED
DEFINITION
CURRENT
MAY
MOVING
WIRELESS
MANAGE
WITHIN
ARCHIVES
BIOGEOCHEMICAL
RECONSIDER
ZETTABYTES
PRACTITIONERS
CAPTURE
THOUGHT
BUSINESS
TECHNOLOGIES
USING
INTERNET
DESCRIBING
RADIO-FREQUENCY
DISTRIBUTED
SETS
GENOMICS
COMPLEXITY
NEEDED
REQUIRING
TIME
ONE
LARGE
MANAGEMENT
TERABYTES
CASE
ABILITY
SOFTWARE
PROCESS
PETABYTES
INCLUDE
FC
PERFORMANCE
STORE
ELAPSED
FORMS
SYSTEMS
TOLERABLE
SIZE
RESEARCH
PRESENTATIONS
COMBAT
STORAGE
MPP
LOGS
COST
SIGNIFICANT
DEFINING
RELATED
COMPUTING
SAN
QUALITIES
PARALLEL
SINCE
MASSIVELY
GROW
DIFFICULTY
SEARCH
RECORDS
NETWORKS
DATABASES
HUNDREDS
DESKTOP
CAPACITY
BURIED
WORLD'S
BIOLOGICAL
NOW
PROCESSING
USED
CREATED
UBIQUITOUS
SOLID
TYPES
CURRENTLY
GARTNER
WORKING
OPPORTUNITIES
AMOUNT
ANALYTICS
TENS
COMPLEX
CITATION
INDEXING
LARGER
CONTINUES
SOCIAL
USE
SET
CONNECTOMICS
ORGANIZATIONS
RELATIONAL
EVERY
EXAMPLES

CROWDSOURCING
CROWD
INDIVIDUALS
WORK
SOURCE
PEOPLE
INTERNET
PARTICIPATION
ONLINE
TASK
BASED
SOCIAL
USE
PARTICIPATE
ACTIVITY
CROWDS
RESULTS
ORGANIZATION
TASKS
MOTIVATION
USED
PUBLIC
GROUP
IDEAS
OWN
TRADITIONALLY
COMMUNITY
EXAMPLE
OPEN
SOLUTIONS
SUCCESSFUL
PROJECT
CROWDSOURCED
DESIGN
COLLABORATION
CALL
INTERVIEW
PROBLEM
PROBLEMS
OUTSOURCING
BETWEEN
BUSINESS
DISTRIBUTED
SOLVE
GLOBAL
ISSUES
QUESTIONS
WORKING
CUSTOMERS
AGREEMENTS
PRODUCTION
COST
EFFORTS
INCLUDE
ATTENTION
STATES
WEB

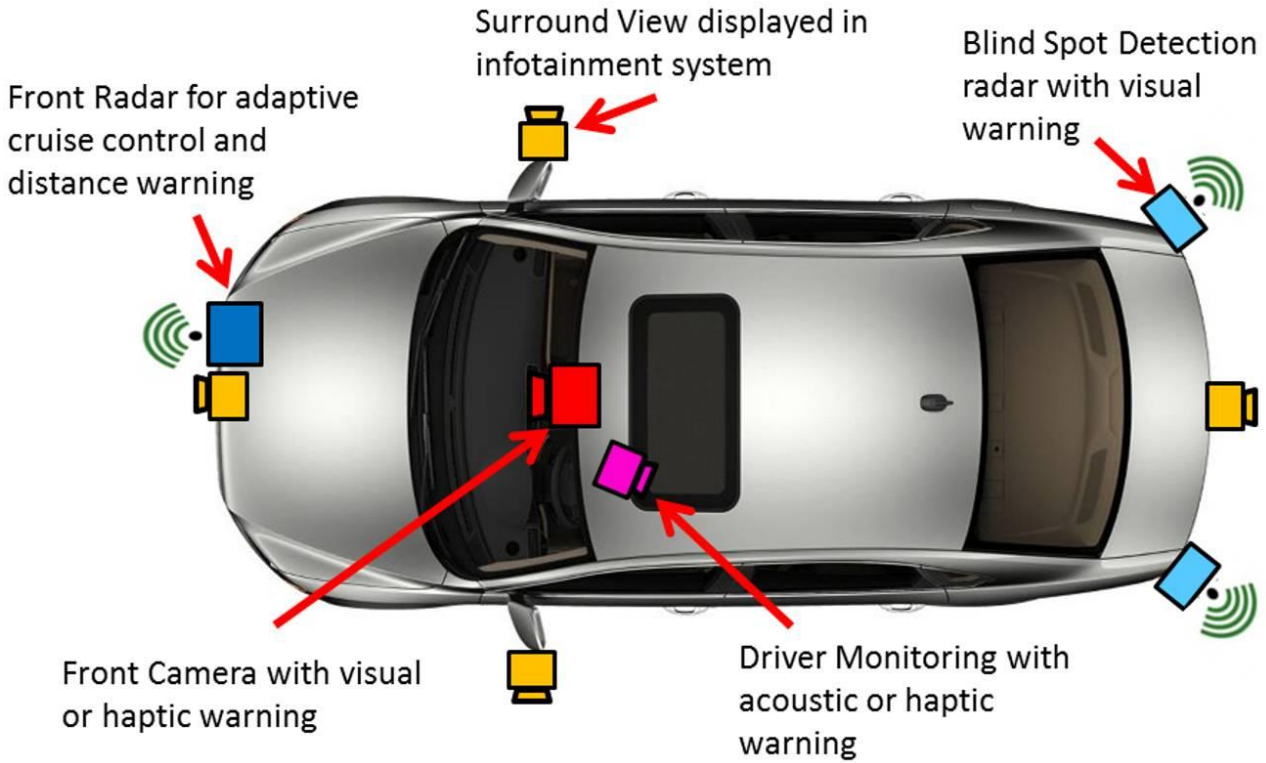
Crowdsourcing

Motivation

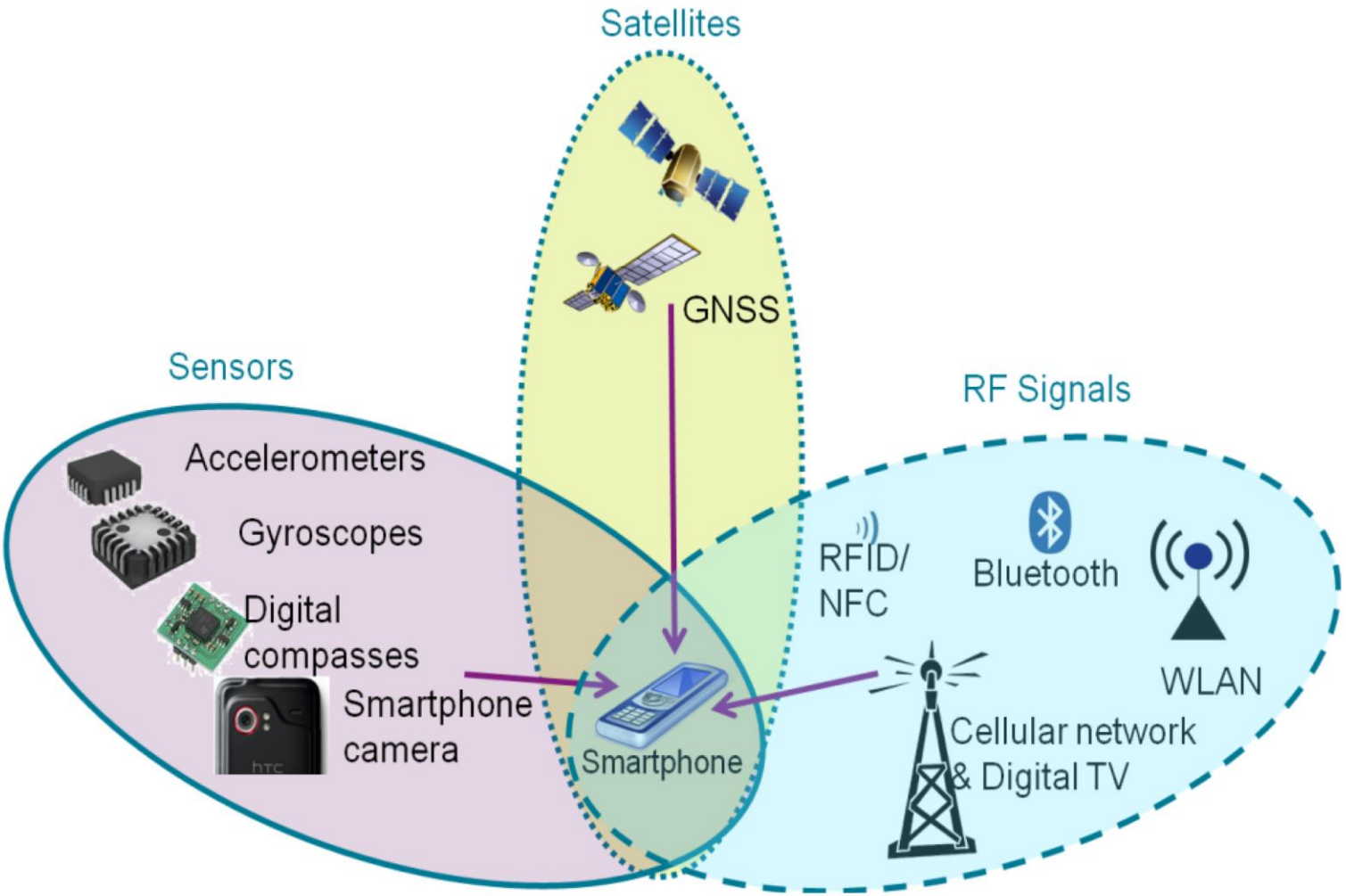
Data Collection

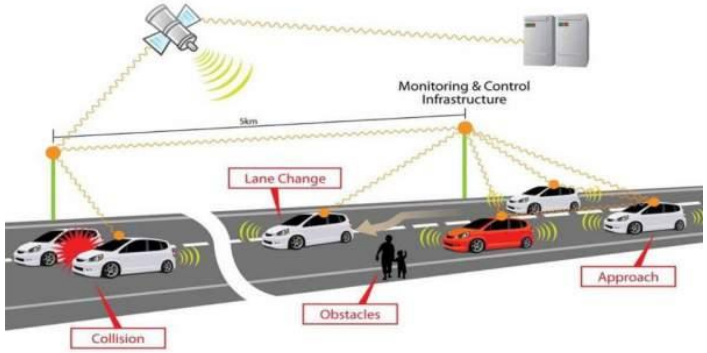
- Single lane condition survey.
- Most local agencies can not afford expensive equipment.
- Is time consuming and expensive.
- Can we use smartphones or portable devices to accurately assess pavement condition?
- How can we integrate this crowdsourced information into a pavement management system?

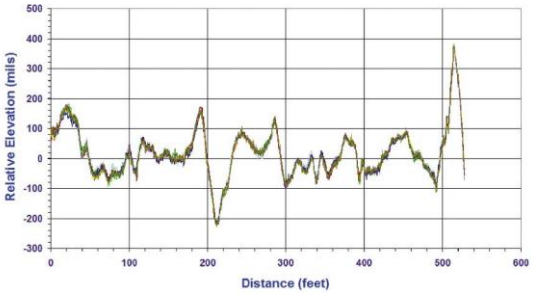
New Vehicles

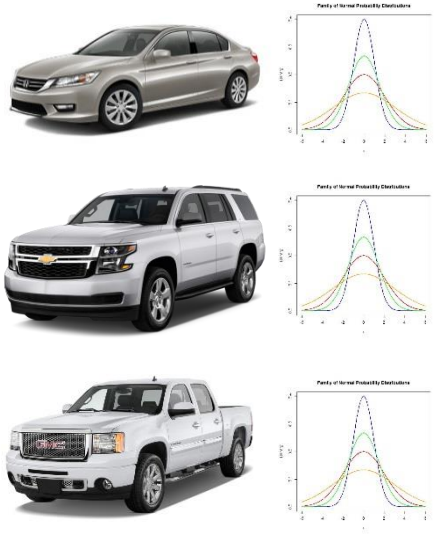


Smartphones

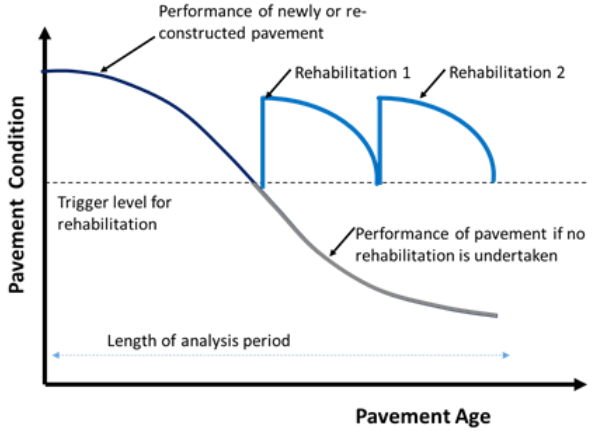


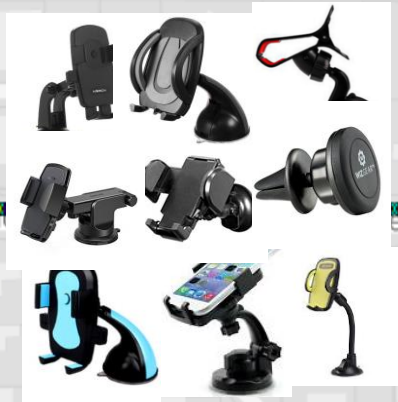

Monitoring & Control
Infrastructure
5km
Lane Change
Approach
Obstacles
Collision


Relative Elevation (mils)
Distance (feet)



Road Asset Management
and
Road Maintenance Management Systems
Time In Years


Performance of newly or re-constructed pavement
Rehabilitation 1
Rehabilitation 2
Trigger level for rehabilitation
Performance of pavement if no rehabilitation is undertaken
Length of analysis period
Pavement Condition
Pavement Age



Experiment

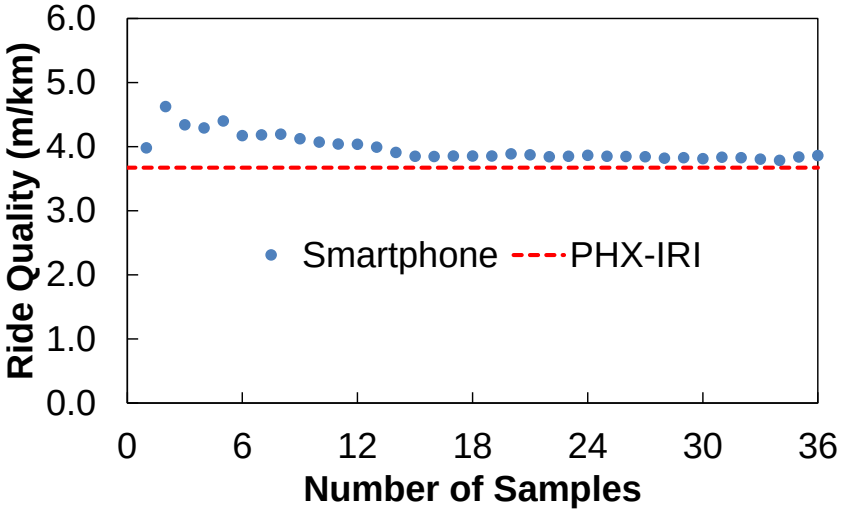
Experiment 1

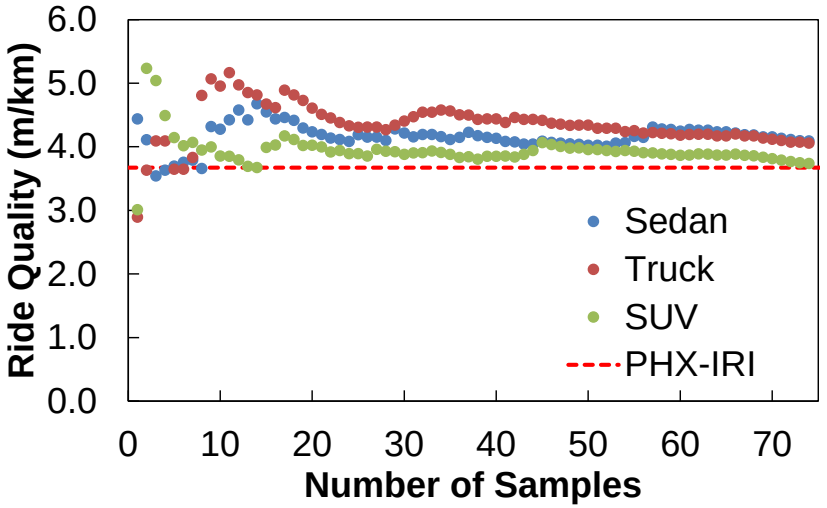
- 1 Vehicle
- 2 Cellphones
- 3 Mounts
- 2 Speeds

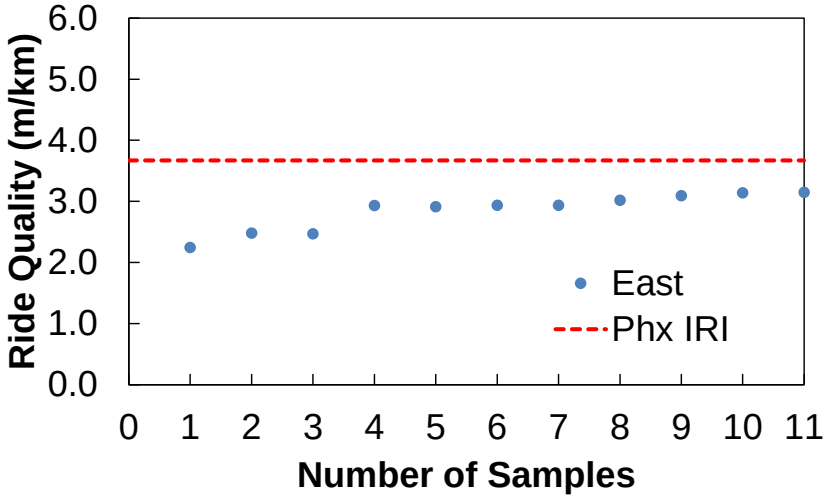
Experiment 2

- 45 Vehicles
  - 15 Sedans
  - 15 Trucks
  - 15 SUV-Minivans
- 5 Mounts
- More than 15 Phones
- 2 Speeds

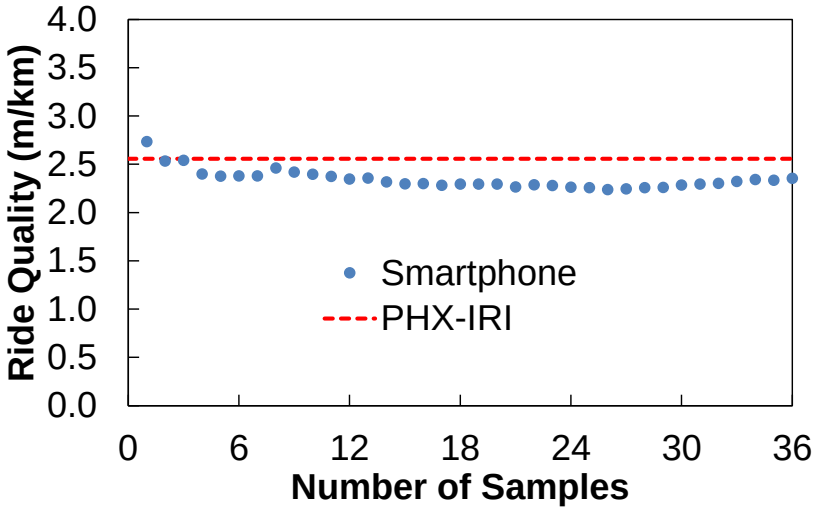
Van Buren St.

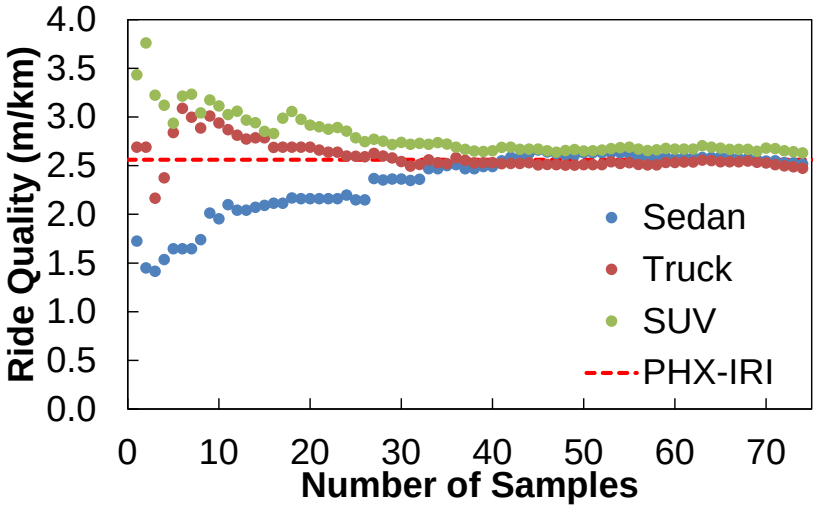

Ride Quality (m/km)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
6
12
18
24
30
36
Number of Samples
Smartphone
PHX-IRI


Ride Quality (m/km)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
10
20
30
40
50
60
70
Number of Samples
Sedan
Truck
SUV
PHX-IRI

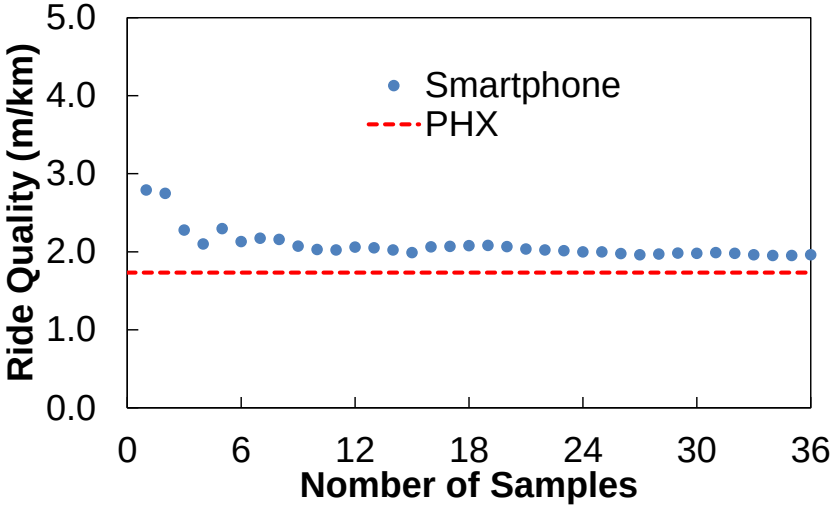

Ride Quality (m/km)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
1
2
3
4
5
6
7
8
9
10
11
Number of Samples
East
Phx IRI

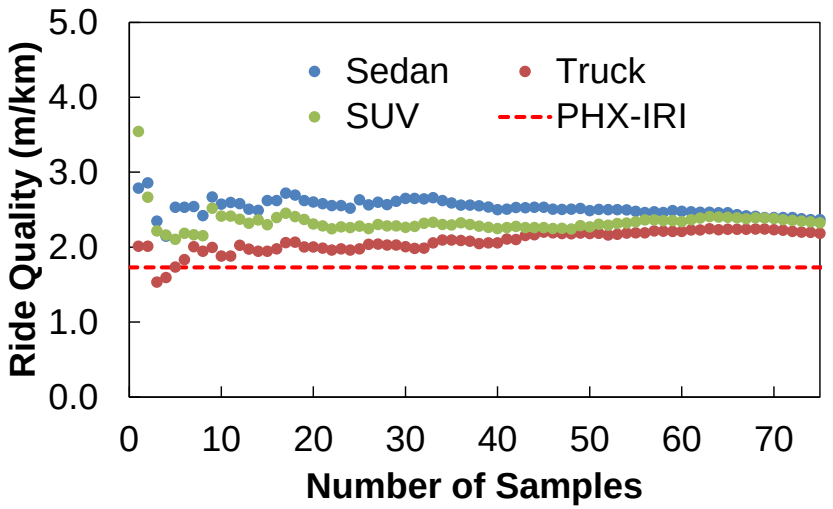
Glendale Ave.





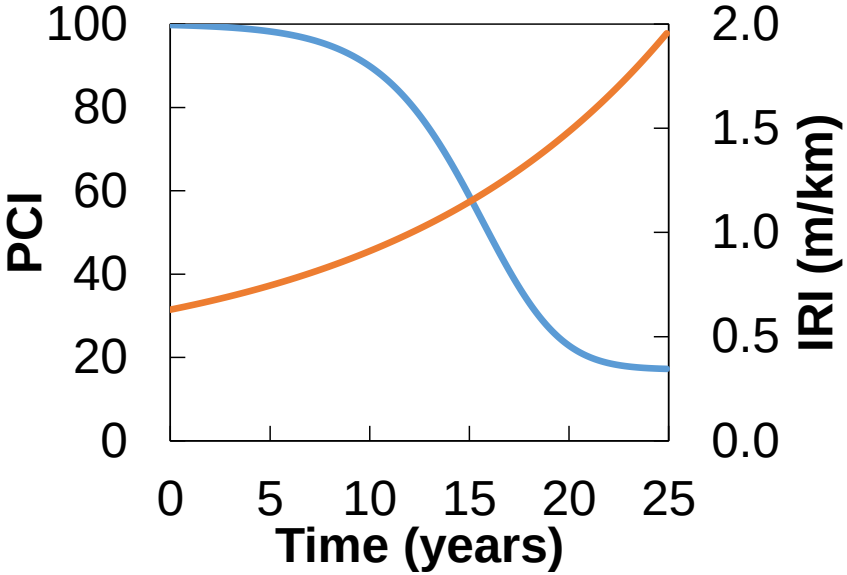
44th St.


Ride Quality (m/km)
5.0
4.0
3.0
2.0
1.0
0.0
Smartphone
PHX
0
6
12
18
24
30
36
Nomber of Samples


Ride Quality (m/km)
5.0
4.0
3.0
2.0
1.0
0.0
Sedan
Truck
SUV
PHX-IRI
0
10
20
30
40
50
60
70
Number of Samples

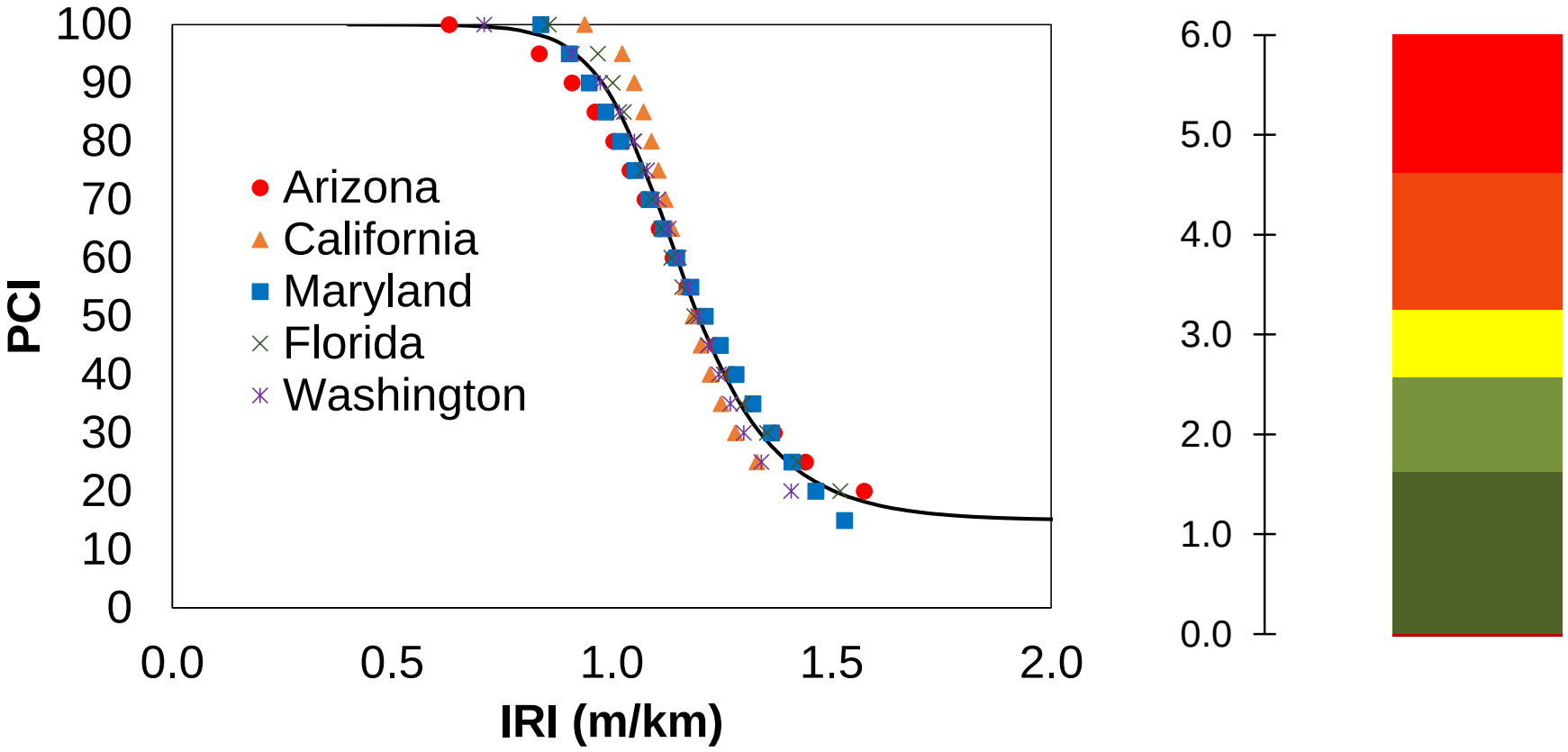
What is next?

Determine Sample Size



Link Ride Quality to PCI

What is next?


100
90
80
70
60
50
40
30
20
10
0
PCI
Arizona
California
Maryland
Florida
Washington
0.0
0.5
1.0
1.5
2.0
IRI (m/km)
6.0
5.0
4.0
3.0
2.0
1.0
0.0

Acknowledgments

- Ryan Stevens, Todd Nunn and James William
- All Volunteers
- ASU Pavement Materials Group
- PMS Class

Thank You!
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