INSA

Technology for Usage Based Insurance

Privacy & Driving Quality Metrics

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Overview of INSA-UBI

INSA is an innovative smartphone and in-car hardware and software system as the basis for a non-discretionary Usage Based Insurance (UBI) solution. INSA uniquely provides insurers with detailed risk management data using dynamic driving characteristics collected while:

- Maintaining rigorous driver privacy that precludes tracking of their journeys.
- Providing comprehensive cyber-security, precluding hacking of the:
  - Vehicle computer
  - INSA Server and Processing Infrastructure
  - Dynamically collected driving characteristics to surreptitiously filter out high-risk driving events
- Maintaining low operational costs by removing the fees associated with GSM/SIM Card data-links between the INSA Application and the INSA Server
- Creating Remedial Feedback channels by the respective insured driver and detailing that feedback by locale: Urban, Rural, Highway and time slots like Rush Hour.

INSA consists of three closely coupled but distinct operating components (shown in Figure 1).

1. **Vehicle Synchronisation**

   INSA's non-discretionary operation is based on automatically detecting vehicle motion and then synchronising with the INSA Application operating in the driver's smartphone.
   Unique in this regard, INSA ensures much higher rates of detection/synchronisation than other solutions by using dual communication channels: Wi-Fi and Bluetooth/LE. The communication architecture barriers overcome by INSA to make possible Wi-Fi/Bluetooth synchronisation will be detailed in the related section to follow.

   INSA offers two low-cost, ($20 – $30 range) user installed, cyber-secure options for vehicle synchronisation:

   - a plug-in dongle into the OBD port
   - a long-life battery powered beacon, affixed inside the glove compartment

The choice of mode of vehicle synchronisation (i.e. dongle or beacon) depends on consumer preference and/or suitability of the vehicle to accommodate a plug-in dongle while being driven. To maximise the later, the INSA dongle's design point enables lowering the dongle protrusion above the OBD socket to 12 mm – a reduction of nearly 80% in the standard UBI Dongle protrusion height of nominally 55 mm.

2. INSA Smartphone Application

INSA provides UBI data to insurers for a service fee that is significantly lower than the current UBI market price point. A large part of this price advantage comes by leveraging components within the insured party's smartphone – namely: GPS, accelerometer, processor/memory and Wi-Fi/GSM communications[1].

From a customer perspective, the INSA application performs an engaging, personalised user interface with the following benefits:

- **Assessment of driving behaviour**, as measured by INSA Driver Quality Metrics. This includes summary and 'drill-down' capabilities to assess driving in specific environments.
- **Provision of remedial feedback,** necessary to improve driving behaviours and save more insurance premiums. Feedback can be configured as on-off 'nudge' to push recommendations to the driver, or as a prioritised improvement plan for which the driver is asked to 'opt-in' to the recommendations.
- **Access to other value added-services**, relevant to driving, which leverage on the communication via smartphone etc.

[1] In traditional non-discretionary UBI systems, all these components and facilities are duplicated and seated in the Dongle. This in-turn leads to a significantly higher Dongle unit price and causes the insurer to incur continuing charges for the dongle's GSM data uplink to its UBI server.

From a technical perspective, the INSA application in each insured party's smartphone performs the following operations:

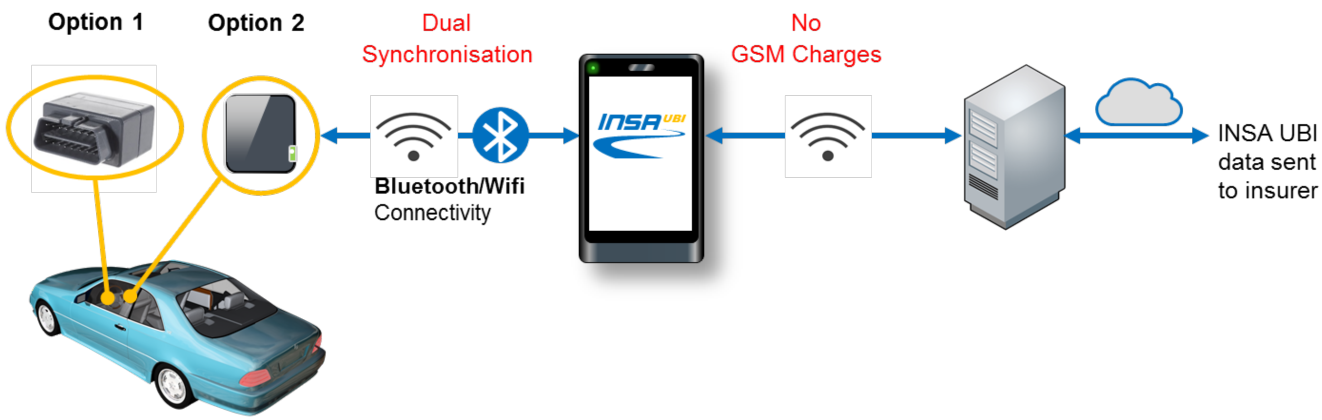
- **INSA transaction-centric hacking protection**: Protects its central processing role in collecting INSA driving characteristics from its GPS and accelerometer modules
- **INSA Trend Line computation:** The route privacy abstraction that makes tracking of the driver impossible
- **INSA Driving Quality Metrics raw data collection:** Collected and compiled per individual driver for their driving characteristics but in a manner providing no "Legally Actionable Data" usable for law enforcement.
- **Cooperative Applications:** Acts as the key part of the processing triad supporting an array of unique value-add applications that operate seamless to INSA as the Cooperative Application Processing Platform.

3. **INSA Server**

The INSA Server is the final nexus of the INSA UBI raw data uploaded from the individual INSA insured drivers' smartphones and the Geographic Information System (GIS) and real-time road speed (termed: Congestion Speed) databases.
The INSA Driver Quality Metric algorithms then take this data and, as will be detailed in the next section, performs the UBI scoring in terms of Driving Quality Metrics, specifically:

- Speed Metric
- Acceleration Metric
- Deceleration Metric
- Erratic Driving Metric
- Mobile Phone Utilisation Metric

The INSA Server also plays a role in the triad of processing that constitutes the INSA Application Platform.



1. Vehicle Synchronisation

- Non-discretionary use
- Widest coverage of car types with:
    1. Plugable OBD Dongle with Total Cyber Hacking Security
    2. Beacon in glove compartment with ultra long life battery & slim profile
- No professional installation required

2. INSA Application

- INSA Driving Quality Metrics without tracking
    1. Speed
    2. Acceleration
    3. Deceleration
    4. Erratic Driving
    5. Mobilephone Use

3. INSA Server

- Driving Quality Metrics Computation
- Co-operative Applications
- Remedial Feedback & Nudging by Driver
- GIS Data Base Access

Figure 1: INSA Operational Components: Vehicle Synchronisation, INSA Smartphone Application and INSA Server

INSA Driver Privacy Protection and Tracking Avoidance

INSA Route Reconstruction by Trend Lines

The INSA UBI process starts with reconstructing the route of a given transit in a manner that, while totally protecting driver privacy and precludes their tracking, still provides meaningful actuarial input. Furthermore the INSA Route Reconstruction allows us, while still maintaining driver privacy, to provide the Insurer with the INSA driver risk measurements: Speed Driving Quality Metric, Acceleration Driving Quality Metric, Deceleration Driving Quality Metric, Erratic Driving, Telephony Usage and Mileage – in a manner that provides actuarial inference by individual driver and locales: Urban, Rural, Highway as well as time slots – e.g., Rush Hour. Remedial feedback to the individual insured drivers is also enhanced by providing risk reduction guidance particularized by the above locales.

The key idea underlying INSA Route Reconstruction is to maintain more driver privacy than if driver would get by regular use of his/her mobile phone.
In brief, to be elaborated upon:

- We know less about where a driver is than when they are using their mobile phone
- We cannot at any time say that a driver is at any particular location. One might paraphrase this as: "Knowing generally where you have traveled from and gone to -- *BUT NOT HOW YOU GOT THERE"*

Personal privacy and avoidance of tracking are evolving issues of 21st century electronics and communications. Personal privacy UBI issues and potential abuses are a continuing headline story[2]. Most recently privacy and tracking have been highlighted as contributing factors in

[2] **Washington Post August 25, 2014** "Systems that can secretly track where cell phone users go around the globe" http://www.washingtonpost.com/business/technology/for-sale-systems-that-can-secretly-track-where-cellphone-users-go-around-the-globe/2014/08/24/f0700e8a-f003-11e3-bf76-447a5df6411f_story.html
The Telegraph November 11, 2014 "Insurers admit 'Black Box' data may be handed to police" http://www.telegraph.co.uk/finance/personalfinance/insurance/motorinsurance/11217690/Insurers-admit-black-box-

Progressive Insurance's decision to withdraw its original Snapshot UBI product and transition to a discretionary UBI smart phone application.[3]

Basically, as reported by the Wall Street Journal, customers respond negatively when the realize current-UBI entails being tracked. Although people might equivocate on the more nebulous term of "privacy"; there appears to be a more visceral reaction when it hits home that adoption of UBI means "*tracking*".[4]

This fact has not been lost on the French governmental standards group, CNIL, which already raised "red flags" several years ago that vehicle tracking could raise privacy issues.

Privacy advocates, as evidenced in the blogosphere, are also active because traditional (non-INSA) UBI data contains both GPS and GSM information that can be used to precisely track and pinpoint a vehicle 24/7.

Hence, INSA UBI has focused on achieving bullet-proof driver journey privacy. Customer privacy, in turn provides the Insurer with a unique sales point benefit when promoting INSA to its customer base as the industry leadership privacy sensitive, no tracking UBI insurance product:

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data-may-be-handed-to-police.html
The Economist Magazine September 6, 2014 "The Abuse of Mobile Phone Data"
The Economist Magazine July 26, 2014 "Unwarranted"

[3] **Wall Street Journal January 11, 2016** "Car Insurers Find Tracking Devices a Tough Sell"
http://www.wsj.com/articles/car-insurers-find-tracking-devices-are-a-tough-sell-1452476714

[4] This consumer response to UBI's vehicle tracking is analogous to the customer rejection of "iBeacons" tracking them during shopping. Even with the major smart phone suppliers supporting the technology standard, and major retail chains introducing iBeacons and monetary inducements; shoppers the responded negatively to the idea of being "tracked" just as the Wall Street Journal article outlines as being a frequent the driver response.

"We Respect Our Customers by Respecting Their Privacy."

Most recent customer feedback per Table 1 below and strong currents in the blogosphere further confirm that privacy/tracking is a real and growing customer awareness topic.

Towers Watson 10/21/13: "The Future is Now for Usage-Based Auto Insurance Consumers in the Towers Watson survey cited *several concerns related to privacy* including, • *fears that insurers will monitor and track driving destinations (42 percent)* • *apprehensions about insurers using data to invalidate claims (38 percent)* • insurers sharing consumer data (41 percent)" **InformationWeek 08/09/13: "Progressive Finds Telematics a Hard Sell:** • CEO Glenn Renwick says as much as 40% of its customer base is closed off to the idea of usage-based insurance. • Progressive CEO Glenn Renwick had some tepid comments regarding its Snapshot usage-based insurance program on the company's financial results call this week. According to Bloomberg, Renwick said that 40% of its Snapshot prospects say "no way in hell" would they adopt the program. Privacy concerns are the biggest cited concern, Renwick said."

Table 1: Privacy as a customer barrier

INSA Privacy based Route Reconstruction and Mileage Information

INSA Route Reconstruction starts by the INSA Application in the driver's smart phone taking at random intervals GPS coordinates as the INSA UBI insured vehicle transits a journey route (see Figure 2).

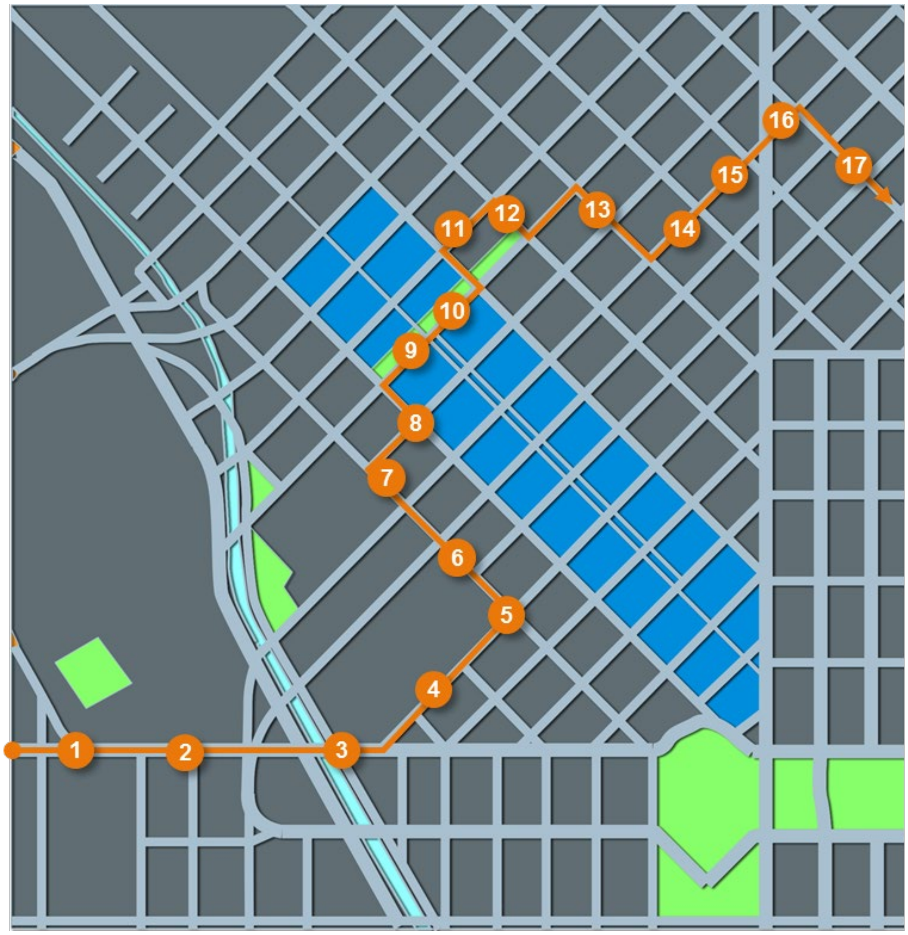

Figure 2: GPS positional data taken at random intervals

While still in the driver's smart phone, the INSA Application starts by camouflaging each received GPS set of positional coordinates by adding a random error, for example, varying up to 500m as shown in Figure 3. This means on average a given GPS data point no longer has a nominal Circular Error Probability (CEP) of less than 10 meters but rather a significantly greater distortion that we have purposely introduced while the data is still resident in the INSA UBI smart phone application. We call these camouflaged GPS data point INSA Fuzzy GPS

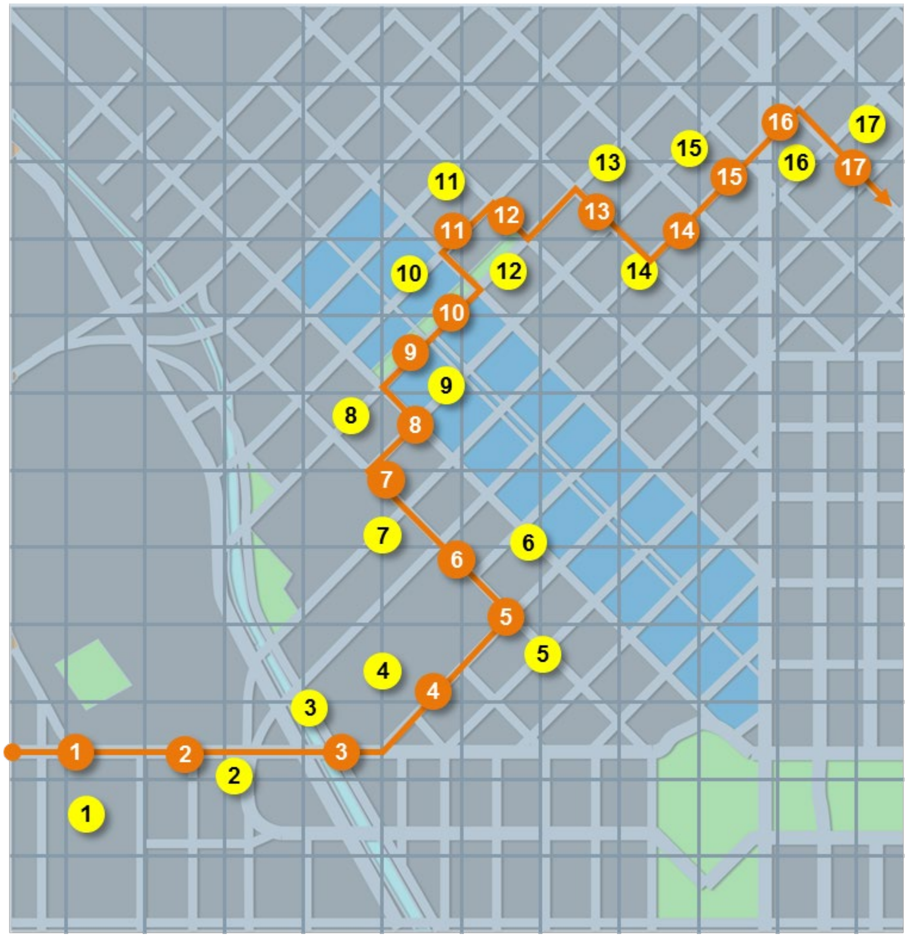

Figure 3: Random GPS displacement and camouflage via INSA Fuzzy GPS

Although this “Fuzzy GPS” data has already lost its CEP +/- 10m relevance, and hence gives the user greater anonymity than they would have when using a mobile phone, the Fuzzy GPS has not lost its value for Trend Line generation. Hence we can analytically smooth the Fuzzy GPS into Trend Lines via a series of Least Squares first order polynomials[5], (Y = a + bX).
In this manner we also use the pattern of a monotonic decrease in ”b”, as additional Fuzzy GPS

[5] Miller & Freund’s Probability and Statistic for Engineers by Richard A. Johnson, Chapter 11

points are added to the least squares calculation, as an indication that a directional change has taken place requiring the end of one trend line and the start of another as shown in .

A key cost of operation advantage of INSA UBI is that all the above GPS positional to Fuzzy GPS positional to Trend Line mapping has been done in the INSA smart phone application before it is uploaded to the INSA UBI Server. At no point in this process in the INSA smart phone application is a GPS Geographical Information System (GIS) data base used. Hence, the significant cost factor of individual GIS license fees per smart phone is avoided. Only a single GIS license is required for the INSA Server.

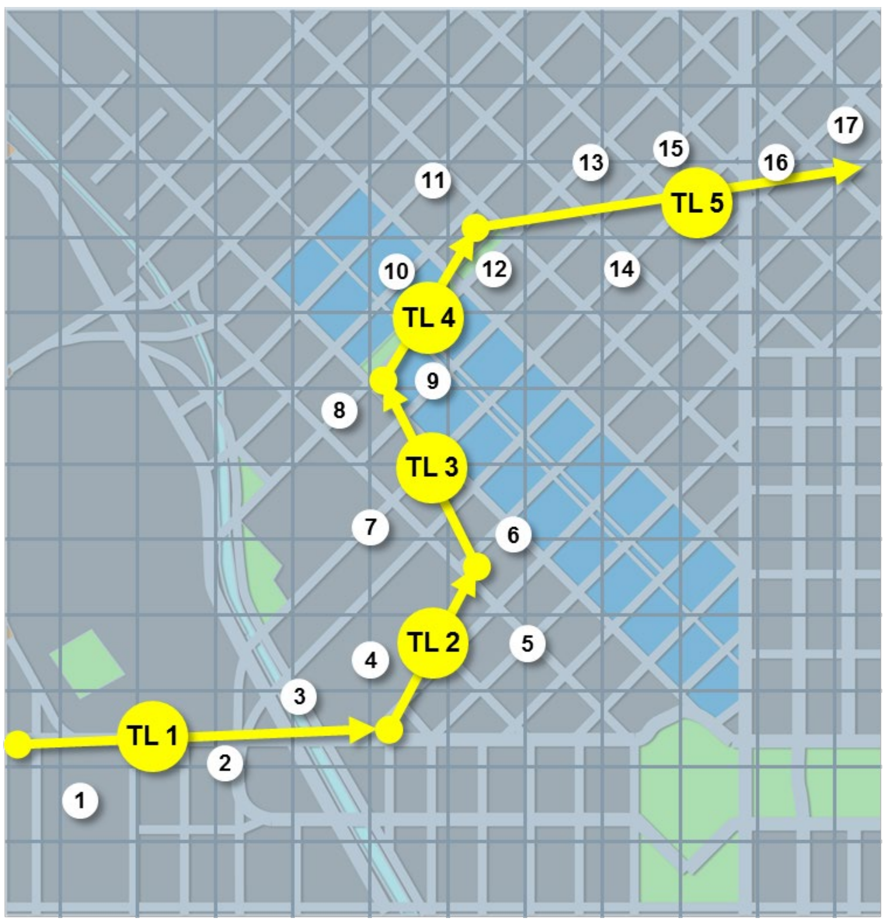

Figure 4: A transit's Fuzzy GPS points reconstituted as Trend Lines

When the respective Trend Lines are eventually uploaded to the INSA UBI Server we only need to transmit end points (i.e. data storage and transmission economical). In the UBI Server the Trend Lines are overlaid on the GIS digital road maps to provide an approximate but accurate road mileage for each Trend Line as shown in Figure 5.

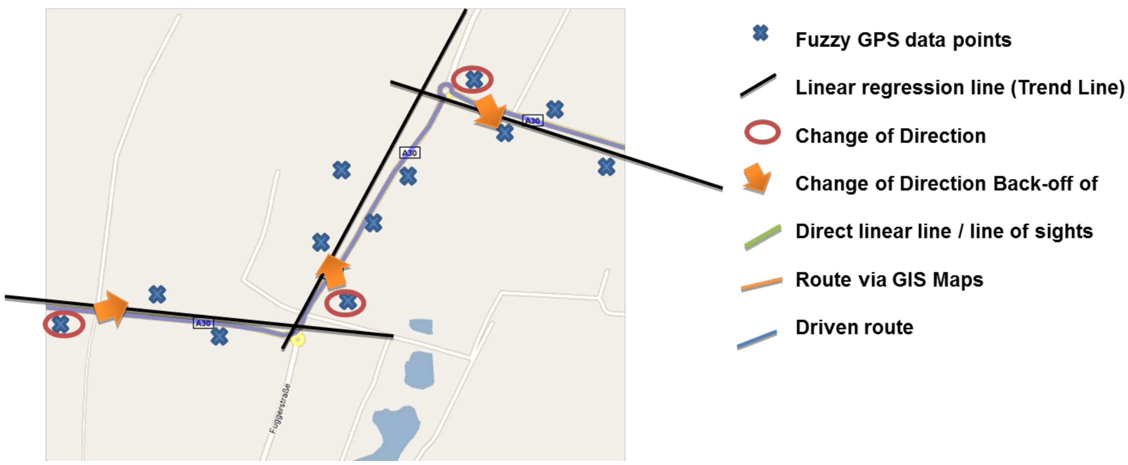

Figure 5: Trend line to road and street fitting

Mapping respective Trend Line end points to “possible” roads/streets is like a second encoding of the actual transited route and further obscures any details of the vehicle’s actual route. Although we can never be sure exactly which streets/roads were transited, we can assess whether respective route segments were most likely in Urban, Rural or Highway and from the general time of day that they were compiled we can associate relevant actual traffic speed that we term: Congestion speed data, weather, lighting and road conditions. As will be discussed later, we can also detect and correct for the event that, let’s say, a highway bypass was taken through an Urban area.

In the INSA Server representative trip mileage can be compiled by summing the GPS GIS computed mileage for each Trend Line’s head and tail coordinates as shown in Figures 6 – 8.

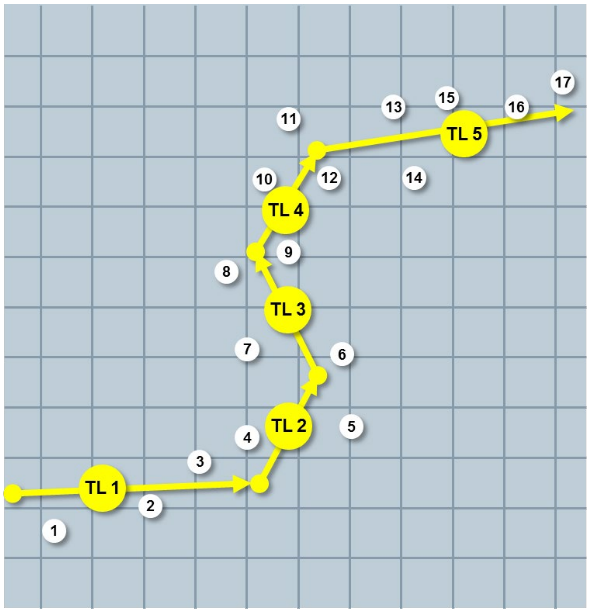

Figure 6: Trend Lines Defined by Head and Tail coordinates

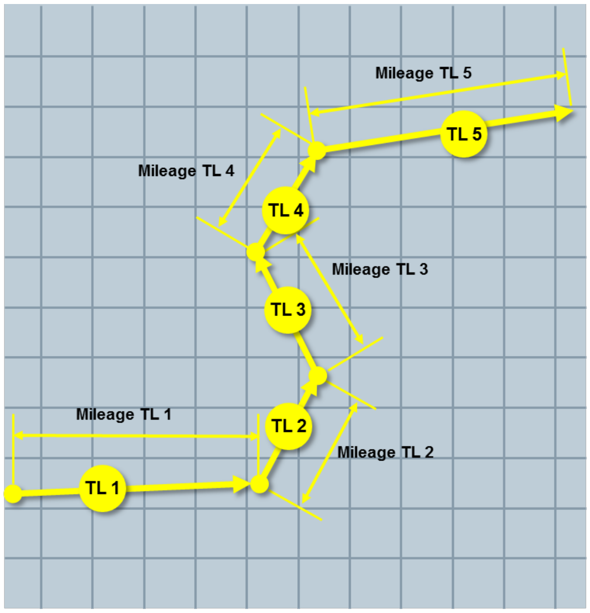

Figure 7: Computing Mileage using Trend Lines

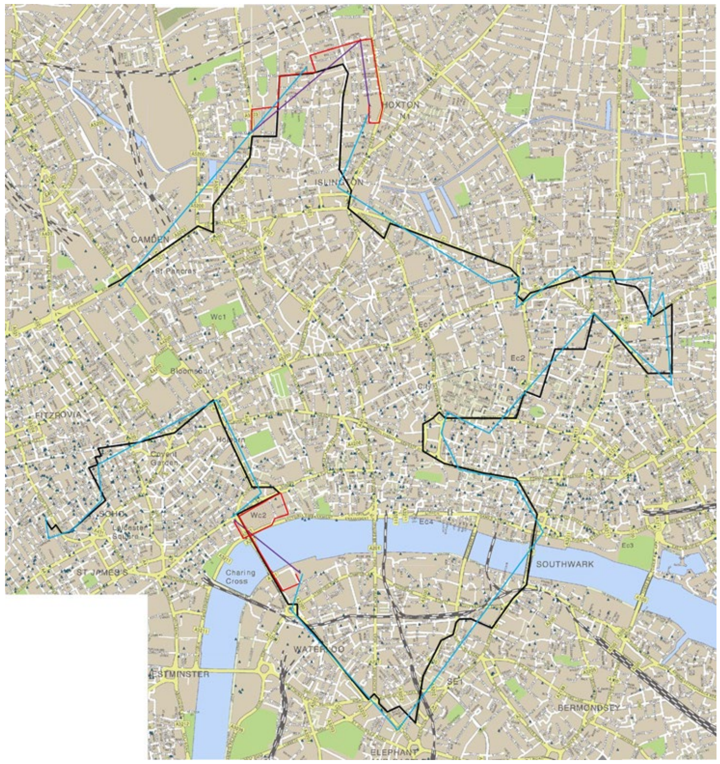

Figure 8: Trend Lines used for mileage measurement in London.
Actual route: 13.30 km
INSA Trend Line Reconstructed Route: 12.31 km

The Trend Line properties of being Least Square Error line fits introduces random deviations that erase any trackable driving route pattern while causing random error in mileage computation that cancel out as shown in Table 2 giving quite accurate totals while maintaining individual journey ambiguity.

		Actual route [km]	INSA route reconstruction [km]
Route 1	Alcester	7,3	7,1
	Birmingham	5	6,2
	Andover	12	9,33
	Wallingford	8	11,39
	London	13,3	12,31
	Total route	**47**	**47,91**
Route 2	Pattingham	9,6	9,76
	Wantage	8,0	8,08
	Exeter	13,6	12,32
	Birmingham	3,0	2,47
	Tewkesbury	10,56	11,12
	Manchester	16,1	15,89
	Total route	**153,96**	**153,88**

Table 2: Trend Line mileage summary and totaling of multiple journeys

Note: Random errors in individual Trend Lines sum to Zero

Also in the INSA Server, further using the GPS GIS database, we can delineate and cluster Trend Line segments into whether they represent Urban, Rural and Highway etc. driving environments. (Figure 9)

In summary, when discussing INSA for UBI risk management in the following sections, the Fuzzy GPS and reconstitution as Trend Lines enable us to cluster and report all INSA UBI driving information by **Zones of Actuarial Interest** – like: Urban, Rural, Highway (by time of day) while maintaining the total Privacy of the insured driver:
INSA determines where the driver has gone, **but not how she/he got there!**

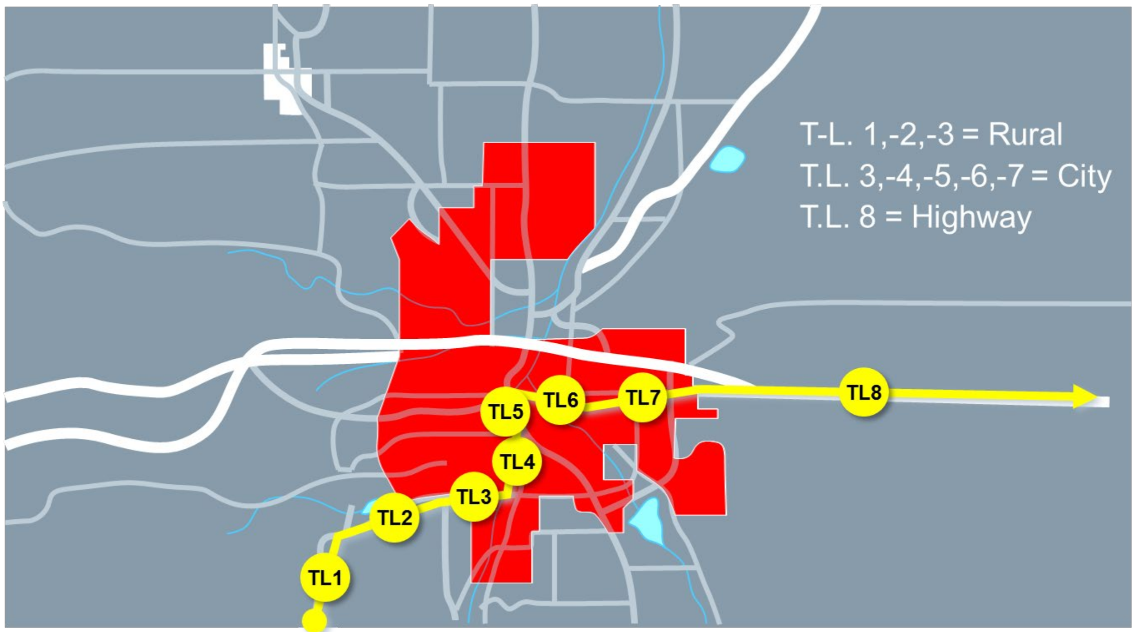

Figure 9: Using the GPS GIS to Label/Cluster Trend Lines as Urban, Rural Highway, etc.

Speed Driving Quality Metrics

Functional Principles

At this point in our INSA solution discussion, we have stored in the INSA Server camouflaged route information with some degree of time stamp information -- but at no point are we able to say anything definitive about when and where the vehicle was at any point in the transit.

The next step to be detailed in this section is how we obtain, relevant speed information useable for actuarial risk management. Also discussed is how, while maintaining privacy, we can provide effective remedial feedback to the insured driver to improve their driving behavior and reduce risk.

In proceeding to monitor driving attributes, once again we acknowledge the need to avoid US and EU Privacy guidelines as typified by Article 9 of the French Data Protection Act[6] where actionable data pertaining to violations of the law cannot be compiled by non-governmental organizations.

Hence in quantifying speed and acceleration for assessing UBI actuarial risk and for feedback to the insured, we need to ensure that INSA UBI **never keeps a speeding event or unusual acceleration in context with the exact time of its occurrence and the location where it occurred.**

Computation and use of the Speed Quality Metric follows by once again monitoring the INSA UBI vehicle and at random times measuring instantaneous speed via GPS. (Note: We discard Zero or very low “creeping” speeds as would be the case if our random sample instant occurred at a stop light or a traffic jam as not indicative of transit speed while moving)

As shown in Figures 10 and 11, the INSA application splits and detaches the instantaneous GPS measured speed from the positional coordinates where it was measured.

We store the GPS coordinates in the INSA application **in random order** in a file that is separate and distinct from the file in which we store the recorded instantaneous speed.
(Figures 10 and 11)

At a given point in time, when sufficient random data points have been collected, we upload to the UBI Server from the smart phone INSA application:

- The average instantaneous speed recorded

[6] Privacy Friendly Pay As You Drive Insurance – page 6
IEEE TRANSACTIONS ON DEPENDABLE AND SECURE COMPUTING, VOL. 8, NO. X, 2011

- The randomized list of GPS positional coordinates where the respective instantaneous speeds were recorded (but we have maintained no record or correspondence of what was the actual speed measure at any given point)

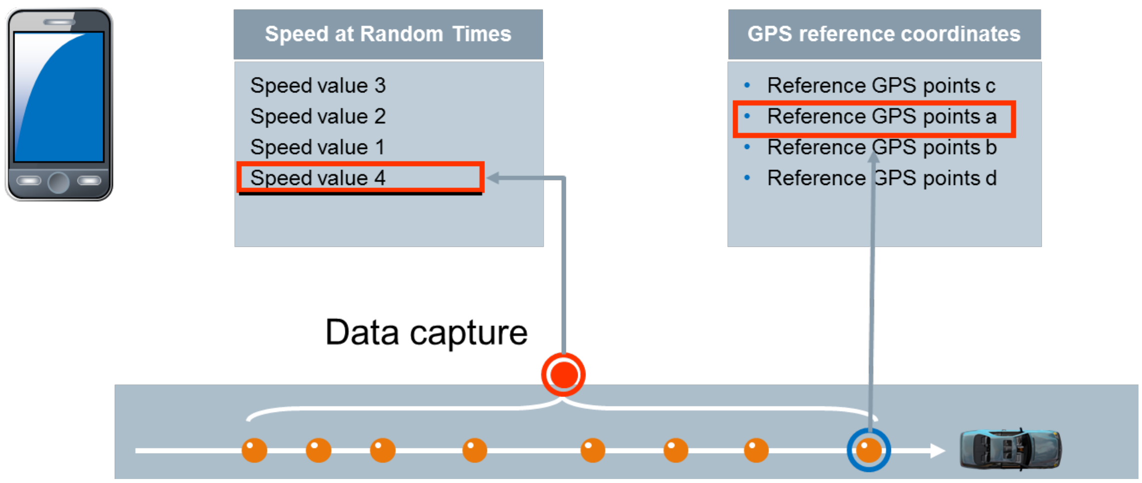

Figure 10: Random recording of instantaneous speed

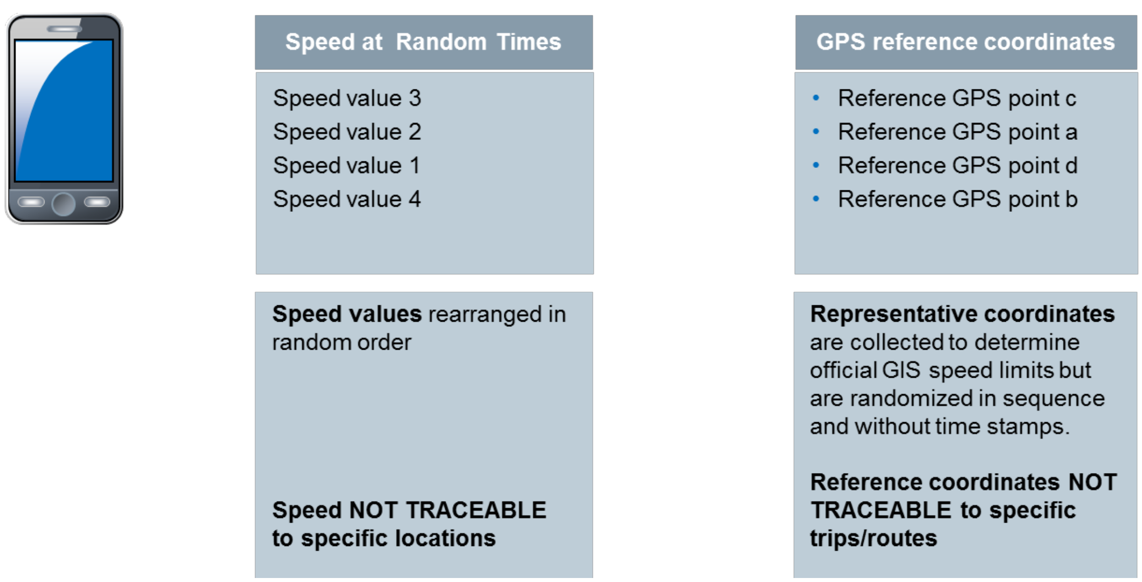

Figure 11: Independent non-associated storage of speed and GPS coordinates

The Speed Quality Metric follows by proceeding to take every set of GPS coordinates[7] where at random time intervals instantaneous speed was recorded and looking it up in the INSA Server GPS GIS[8] database to determine the statutory (i.e. legal) speed limit at that road location. (Figure 12)

After the INSA Server has determined the statutory/legal speed limit for each road position where a GPS instantaneous vehicle speed was measured, we compute the average statutory speed/legal limits and compare that with the average instantaneous vehicle speed. (Figures 13 and 14)

It is the delta difference between average GPS measured speed and GIS derived average statuary speed limit that represents the INSA UBI Speed Quality Metric. Essentially, a high-risk driver will tend to be frequently and consistently significantly in excess of the statutory speed limits to the degree that when averaged over many events these high risk driving patterns will be captured by a succession of high Driving Speed Quality Metric scores.

Introducing Actual Road Speed Due to Congestion into the Quality Metric Computation

From this point on in our discussion, we can readily introduce a roads **Congestion Speed** as a "real-world" traffic flow speed, and substitute it into the Speed Driving Quality Metric calculation in place of the statuary or legal speed limit.

Specifically for our purposes, Congestion Speed is more representative of the road speed for Quality Metric purposes than statutory speed during Rush Hours periods. These prevailing

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[7] We collect and store nominally two or three GPS positional coordinates (with no precise time interval) to ensure that while we can associate the event with a specific road or highway that was being travelled -- even where we have a dense road network; we do not have enough spacial points or precise timing to accurately compute speed.

[8] Note that in implementing INSA we have the operational economy that the GIS license fee is for the UBI Server instead of each smart phone.

traffic flow speed – Congestion Speed – can be derived statistical for high traffic density roads/times or can be obtained as live measurements via WAZE or open source municipality traffic reporting networks.

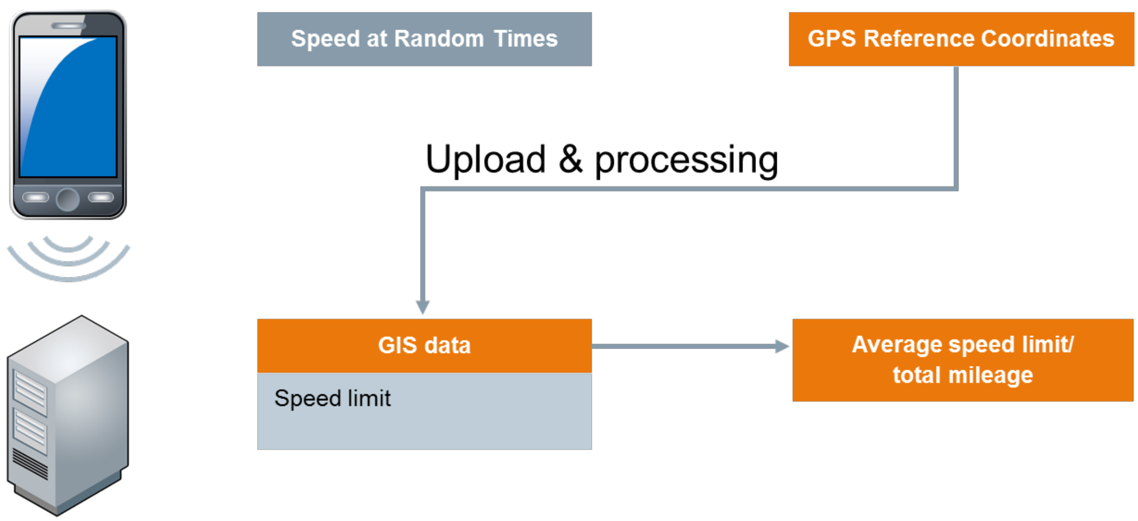

Figure 12: GPS Points mapped to Statuary Speed Limits

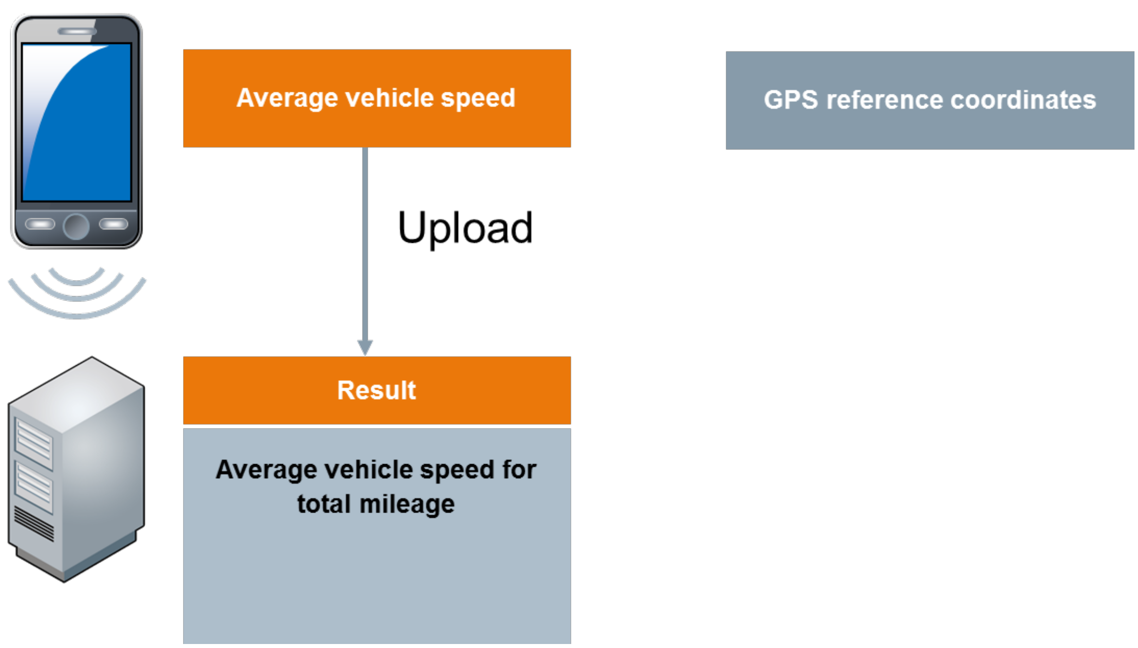

Figure 13: The Average of Randomly taken Instantaneous Speed Measurements

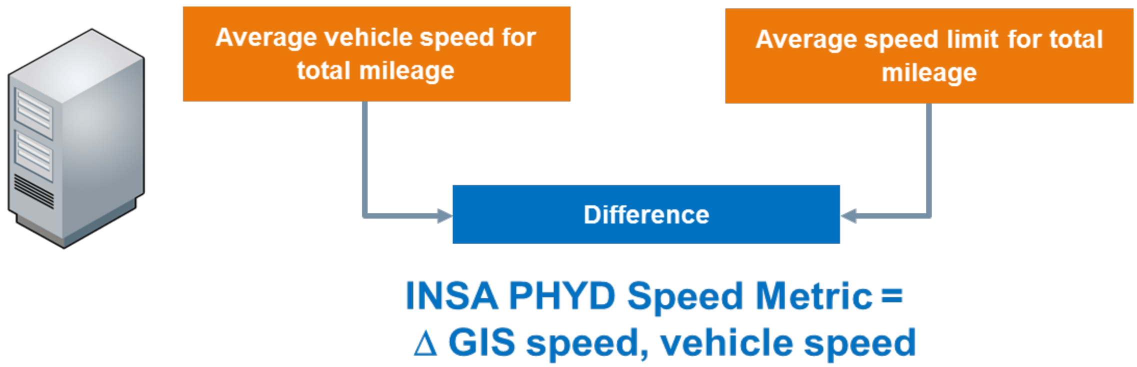

Figure 14: Speed Driving Quality Metric

Speed Quality Metrics: Moving from a Macro to a Micro Level

As it may have occurred to the reader as we went through the steps to compute the Speed Quality Metric, our random sampling for instantaneous speed may be on too broad or macro a level. Hence it might in actuarial practice be desirable to compute these metrics, for example, separately for rush hours or to delineate rural from urban and highways.

This ability to focus and report the Speed and other Driving Quality Metrics by time of day like Rush Hour and zones of actuarial interest like Urban, Rural and Highway is accomplished by once again taking into account the Trend Lines that we computed as part of the Fuzzy Route Reconstruction.

We now proceed with the same process used above to calculate the Speed Quality Metric; but this time, at each step taking into account the Trend Line being computed as a separate parallel operation in the background as depicted in Figures 15 and 16.

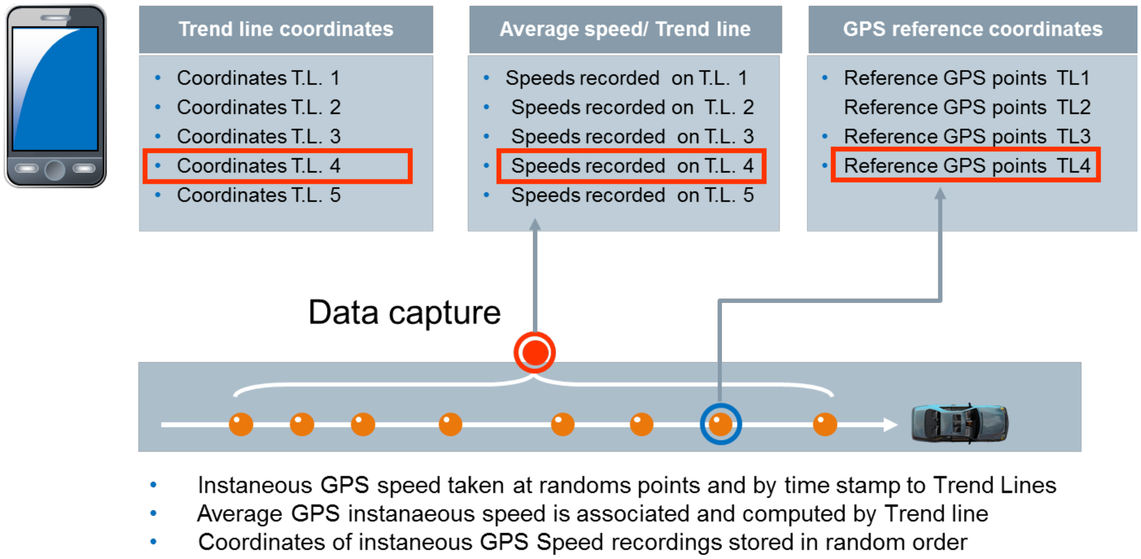

Figure 15: Mapping Speed Metric to Zones of Actuarial Interest

Trend line coordinates	Average speed/ Trend line	GPS reference coordinates
• Coordinates T.L. 1 • Coordinates T.L. 2 • Coordinates T.L. 3 • Coordinates T.L. 4 • Coordinates T.L. 5	• Speeds recorded on T.L. 1 • Speeds recorded on T.L. 2 • Speeds recorded on T.L. 3 • Speeds recorded on T.L. 4 • Speeds recorded on T.L. 5	• Reference GPS points TL1 Reference GPS points TL2 • Reference GPS points TL3 • Reference GPS points TL4
Routes are loosely represented by **Trend Lines.** **Trend Lines NOT TRACEABLE to specific locations**	**Speed** is associated as an average to Trend Lines not to actual route segments **Speed NOT TRACEABLE to specific locations**	**Sample coordinates** are collected to determine official speed limits but are randomized in sequence and without time stamps. **Reference coordinates NOT TRACEABLE to specific Trend Lines**

Figure 16: Mapping Speed Metric to Zones of Actuarial Interest

We now proceed to upload from the smart phone INSA UBI application to the INSA UBI Server the three data sets shown above.

We have reduced the instantaneous GPS speed measurements to average values that we can associate with the respective Trend Line that was being compiled when their random instantaneous speeds were recorded.
(The tie between each instantaneously measured GPS speed value and a given Trend Line is via a time stamp with a resolution granularity of several minutes. Note: No geographic or road data is used to maintain the INSA strict anonymity of driving.)

As depicted in Figure 17, we also examine the Trend Lines in light of the GPS GIS database to tag individual Trend Line segments according to driving regions of actuarial significance like classification by Urban, Rural and Highway. As will be explained later in this section we can also detect if the INSA transit through an Urban or Rural area has taken place on a “bypass highway” and if so correctly attribute that driving to the Highway related Driving Quality Metrics.

The remaining steps for computing Speed Quality Metrics by city, country, highway, etc. follow by combining the respective GPS Instantaneous Speeds with their time stamp related Trend Lines that themselves have been classified and clustered into Urban, Rural, and Highway etc. categories. By this iterative classification of Trend Lines, the actuarial unit of Driving Quality Metric inference can be even further focused, such as by further sub-clustering the respective Trend Lines by the time of day they were compiled – (e.g., rush hour, after dark …) or even by weather conditions or construction presence.

Hence although Trend Lines, just like the Driving Quality Metrics are abstractions of driving reality that maintain absolute privacy, they can still be configured to convey a unique wealth of actuarial inference.

The sequence of remaining steps for providing Driving Speed Quality Metrics with as a more micro level of inference is depicted in Figures 18 - 20.

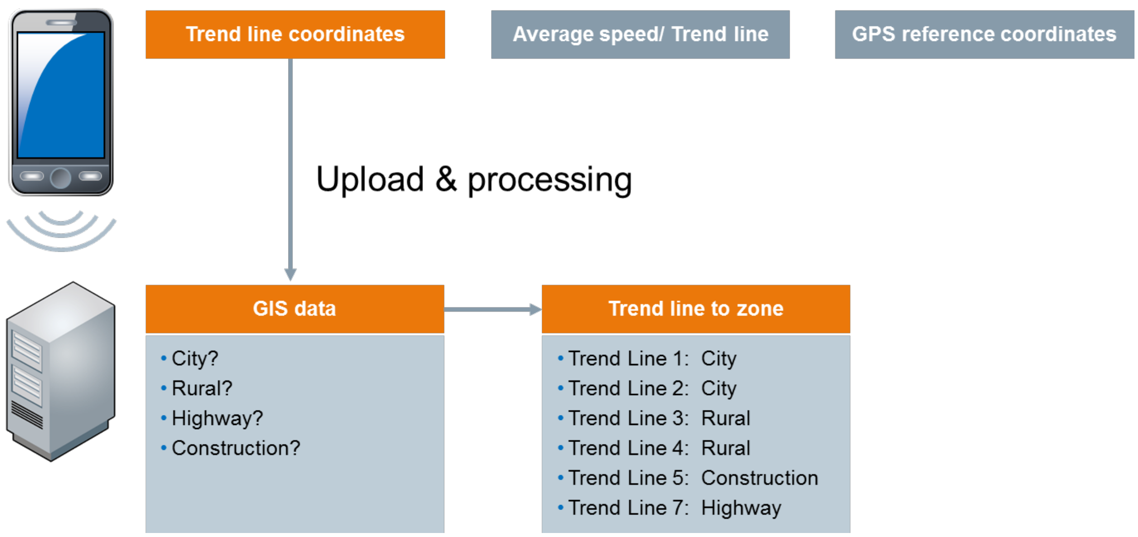

Figure 17: Step 1 - Mapping Speed Metrics to Zones of Actuarial Interest

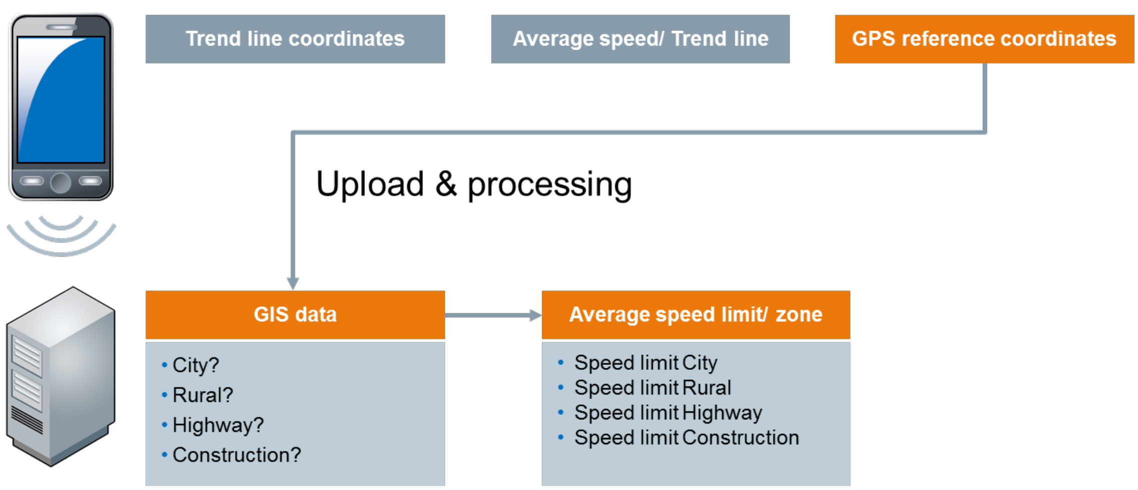

Figure 18: Step 2 - Mapping Speed Metrics to Zones of Actuarial Interest

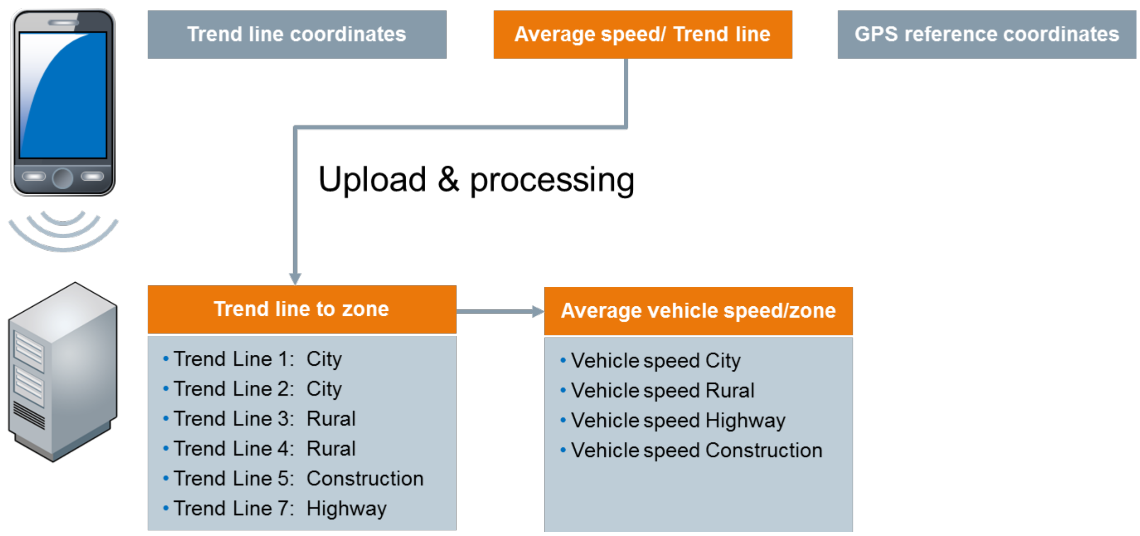

Figure 19: Step 3 - Mapping Speed Metrics to Zones of Actuarial Interest

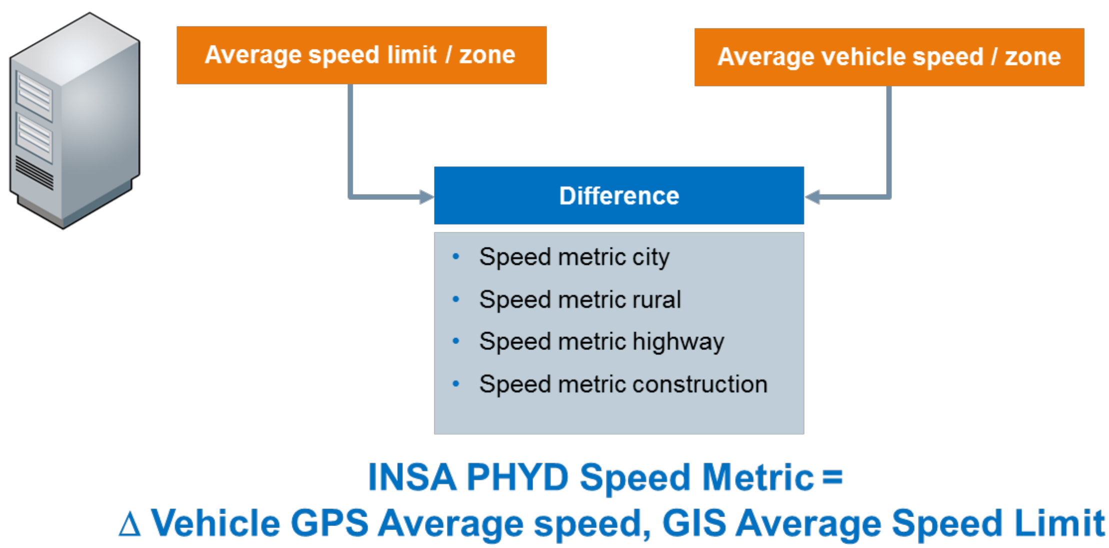

Figure 20: Step 4 - Mapping Speed Metrics to Zones of Actuarial Interest

Having now subdivided the Driving Speed Quality Metric into Zones of Actuarial Interest such as Urban, Rural, Highway we can hone our actuarial inference on Risk to Rates while also targeting our remedial feedback to the insured in a more mentored, nuanced manner.

Speed Driving Quality Metric: Congestion Adjusted

Now that we have been able to pose the Driving Speed Quality Metric at a more “micro – level”; where respective Driving Speed Metrics can be computed by time of day and then by locales such as Urban, Rural and Highway – we can take one more step.
We now proceed to uniquely leverage INSA on the increasingly available Traffic Congestion data when computing the Driving Speed Quality Metrics.

By Congestion Data we mean the kind of live or statistical data that is increasingly being provided by GPS-GIS sources such as WAZ or by highway authorities using real-time highway monitoring or from their statistical traffic flow data over time. This Congestion Data gives us expected actual traffic speed – such as during rush hour -- that is less than the posted legal speed limit. For Speed Quality Metrics computed for rush hour in high density traffic areas, use of Congestion Data provides an additional powerful driving risk qualifier and inference.

Although there are several layers of data association required to coordinate Congestion Data within the Speed Quality Metric algorithm computation, it suffices to start our discussion with the linkage between the previous Speed Quality Metric at the micro-level and the Congestion Adjusted: Speed Quality Metric. The linkage to introduce Congestion Data into the Speed Quality Metric computation starts with the series of GPS coordinates taken in parallel with each Instantaneous Speed measurement. For later Congestion attribution we add an association with the Trend Line that was being compiled during that time in a manner similar to that detailed above for the Instantaneous Speed measurements.

When these data sets, i.e. Randomized Instantaneous Speed Measurements and the separate Randomized Sets of GPS Coordinates, are uploaded to the INSA Server, we group them by Time Slot (e., Rush Hour), then by Trend Line and then map the respective sets of GPS Coordinates to the Congestion Adjusted Speed values instead of the posted legal limits. The rest of the Speed Quality Metric computation remains unchanged.

Correcting Driving Quality Metrics for Bypass Highways in Urban and Rural Areas

Per Figure 21, below, we see the case where, upon entering the GIS data base to resolve a set of GPS Reference Points to the posted speed value, it becomes immediately apparent that although the related Trend Line (T6) has been label Urban, in reality it is at least in part a Highway transit such as a Bypass road.

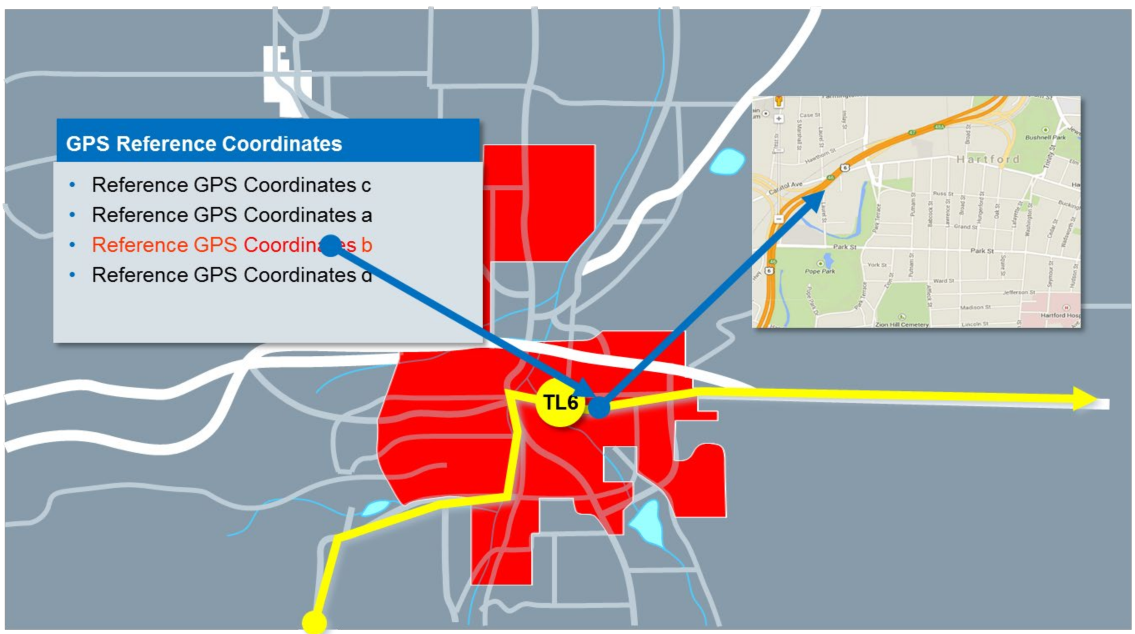

Figure 21: Detecting that a GPS Reference Coordinate on a Trend Line labeled Urban is actually Highway

The rectification of the related Quality Metric data now follows as schematically shown in Figure 22. We now re-classify the subject GPS Reference Points as “Highway” and associate them with that Driving Quality Metric computation. For the related Instantaneous Speed Value and in keeping with the anonymity of the Quality Metric computation, we examine the list of Instantaneous Speeds associated with the Trend Line (e.g. T6). Accordingly, we proceed by take the highest speed value in that list of Instantaneous Speed Values and associate it with the continuously randomized file listing being compiled for the Highway Driving Quality Metrics.

The same process follows for any further GPS Reference Coordinates related to an Urban or Rural designated Trend Line that are resolved and re-attributed to be "Highway". The Instantaneous Speed Value associated with these successive re-attributed GPS Reference Coordinates are the next highest speed value in that Trend Line's Instantaneous Speed Value file.

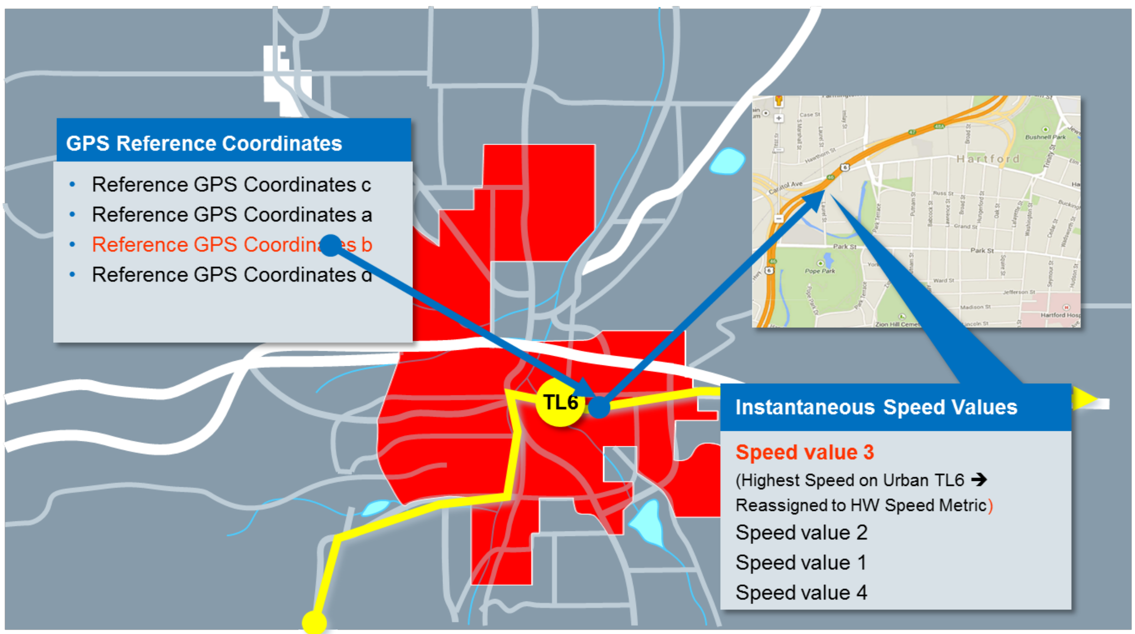

Figure 22: Selecting an Instantaneous Speed Value when a GPS Reference Coordinate has been reattributed as Highway

Driving Acceleration and Deceleration Quality Metrics

The Acceleration Driving Quality Metric: Logic & Implementation

Acceleration and deceleration, intuitively and from crash studies, are important parameters in quantifying driving risk. However by their nature, “acceleration” and “deceleration” are hard to quantify in a manner that strongly correlates them to safe driving or risk. Table 3 shows that they have fundamentally different driving accident dynamics.

Two fundamentally different driving events:

1. Acceleration

- Frequently part of safe driving: Highway entry merge
- Critical indicator of reckless driving: Erratic lane changing

Gauge: Excess of acceleration speed to legal speed limit

2. Deceleration

- Rarely associated with safe driving: response to cut-off
- Critical indicator of lapse of attention: Short stops

Gauge: Magnitude of deceleration speed to legal speed limit

Table 3: Acceleration and Deceleration have very different Accident Dynamics

Elaborating on Table 3, some of the most immediate complexities that affect relating acceleration and deceleration to accident occurrence are:

1. Rapid acceleration and deceleration are also integral to safe driving as when entering a “limited access” highway and when taking a highway exit. A safe driver in these circumstances needs to accelerate or decelerate rapidly.
   Hence, acceleration/deceleration monitored and reported in a vacuum represents noisy data that cannot be strictly correlated with driver risk. A very safe driver doing a lot of highway driving will accrue many “acceleration events” and “deceleration events” in the course of safe driving onto and off modern highways!

2. Acceleration and deceleration are hard to quantify as a risk factor in absolute terms. Rather it needs to be assessed relative to the likely prevailing speed and traffic conditions in given areas and times of actuarial interest. The risk factor significance of a given acceleration or deceleration is not an absolute but rather relates to where and when it takes place.
3. Acceleration is simply a rate of change and only has relative meaning -- i.e., there are no legal or absolute limits on acceleration

The **Acceleration and Deceleration Quality Metrics** will now be detailed to show how we can address and filter necessary and safe acceleration and deceleration events from acceleration/deceleration incidents that are risk- flags. The resulting Acceleration and Deceleration Driving Quality Metrics proceed separately to quantify acceleration and deceleration respectively in a manner that they can be mapped to UBI parameters that systematically quantify acceleration and deceleration for actuarial risk management.

The Acceleration and Deceleration Quality Metric use the Route Reconstruction by Trend Lines methodology discussed above and also shadows the process flow of the Speed Quality Metric.

Acceleration Quality Metric Process Flow

Much of the Acceleration Quality Metric process flow is analogous to the Speed Quality Metric and its details unfold quickly once we defined a new parameter called: **Maximum Acceleration Speed**.

The Maximum Acceleration Speed is simply the maximum speed a vehicle attains within, let's say, 15 seconds after an "acceleration event" has been detected. The term "acceleration event" relates to accelerometer in the driver's smart phone having registered a directional acceleration of greater than 0.25g and then the GPS determining what was the maximum speed attained during that acceleration episode that directly followed. Figure 23 schematically depicts the connection between the "acceleration event" and Maximum Acceleration Speed that we now use for computing the Acceleration Metric.

We need to introduce the Maximum Acceleration Speed, because measuring acceleration itself is essentially meaningless. As stated above, acceleration is simply a rate of change and only has relative meaning based on where, when and how you are driving (i.e., there are no legal or absolute limits on acceleration and as we discussed acceleration is very much part of normal highway driving). Hence, the Maximum Acceleration Speed, when associated as the Acceleration Quality Metric, gives us an objective and absolute measure of what a given acceleration event means based on the circumstances in which it took place and with respect to specific driving risk at that point in time.

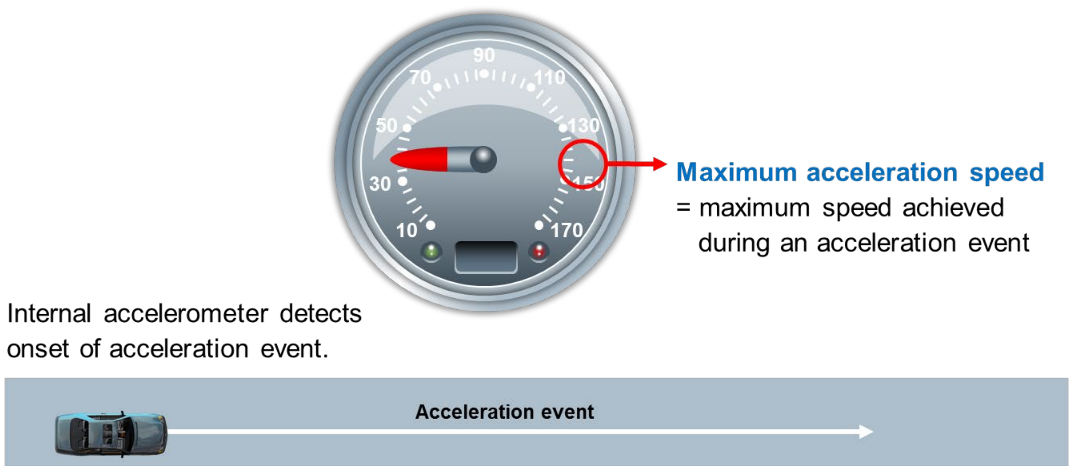

Figure 23: Schematic description of Maximum Acceleration Speed

We now continue to document the Acceleration Quality Metric analogously to the Speed Quality even though both Driving Metrics respectively describe driving scenarios that have very different risk profiles.

Figure 24 shows how we capture Maximum Acceleration Speed and their related GPS Locational data (that is; as sequence of several GPS Reference Coordinates) and keep them in separate files that removes any correspondence between Maximum Acceleration Speed and Location of that event by separately randomizing the entries in each file.

Continuing to follow along the same steps as the Speed Quality Metric, the Acceleration Quality Metric process next converts the respective GPS Reference coordinates sequences into legal speed limits using a GPS GIS data base to identify the related road or highway and then record its legal speed limit.

Figure 25 completes the sequence of steps for the Acceleration Quality Metric computation by examining how closely the **Average Maximum Acceleration Speed** compares with the **Average Legal Speed Limit** at the location where the "Acceleration Events" took place.

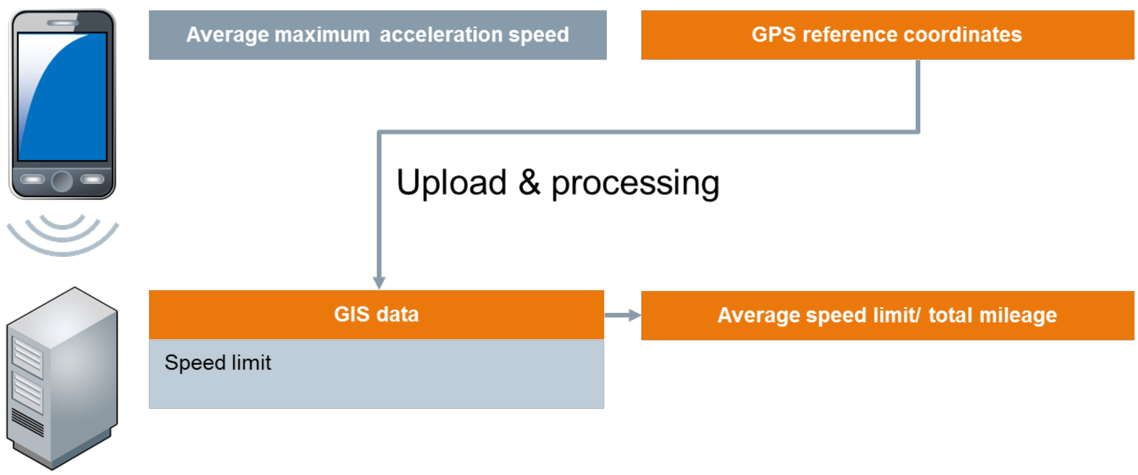

Figure 24: Storing Maximum Acceleration Speed and GPS Reference Coordinates

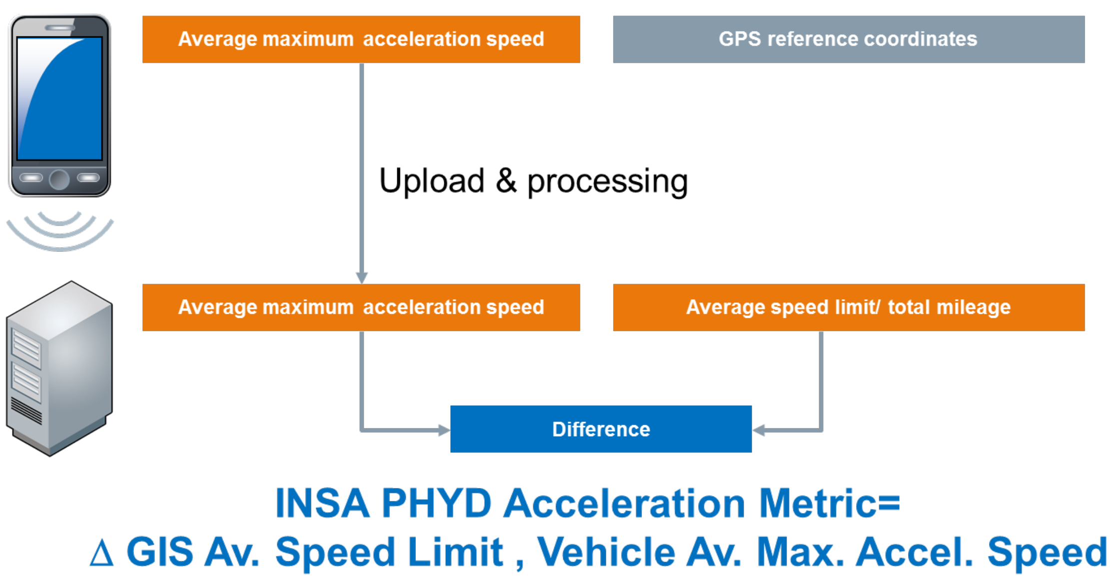

Figure 25: Mapping GPS Reference Coordinate Sequences to Speed Limits

Although our next steps are going to take the Macro Level analysis to a more Micro Level – Actuarial times and locales of interest; it is useful to pause for a moment to see how the Acceleration Quality Metric addresses some of the noisy data conundrums mentioned above.

1. **Acceleration onto a highway:**
   Measuring just magnitude and frequency of acceleration would distort and bias UBI against those safe drivers who frequently use highways where they have to accelerate into the traffic flow. With the above Acceleration Quality Metric formulation, during a safe entry to highway traffic flow, the Maximum Acceleration Speed matches the legal speed limit that will be mapped to that set of GPS locational coordinates. Hence, having these corresponding data in each randomized file effectively cancels each other out in the final Acceleration Quality Metric comparison of averages of the Maximum Acceleration Speed and the Legal speed Limit.

2. **Acceleration is a relative factor tied to the event's specific driving environment:**
   Although kept in separate randomized files, each physical acceleration event has associated with a road/highway speed limit. Hence, we can infer if in general, that is; on-average, if a driver's acceleration patterns dangerously exceed the legal limit. Additionally, as detailed in the last sections of the Speed Quality Metric discussion, we can adjust or scale the road/highway speed limits by using readily available information on Congestion. The full details are not repeated here for brevity but this facility of the Driving Quality Metrics to reflect Congestion has particular relevance for the Acceleration Quality Metric computation and its actuarial risk management value. To make the Acceleration Quality Metric more actuarially relevant and able to adjust for Congestion; we need to take the macro-level discussion of the Acceleration Quality Metric to a more micro level where we cluster by time slot (e.g., Rush Hour; Locales of Actuarial Interest: Urban, Rural, Highway and etc.) The method for associating the Acceleration Quality Metric to these time range and locational categories is the same as detailed for the Speed Driving Quality Metric and hence we only give the highlights in the following brief discussion.

Per Figure 26 we once again use the Trend Lines to represent a transit. Upon uploading the Trend Lines to the INSA Server and using GPS-GIS data in the INSA Server we roughly map the privacy protected route into general locale categories of actuarial interest: e.g., Urban, Rural, Highway etc.

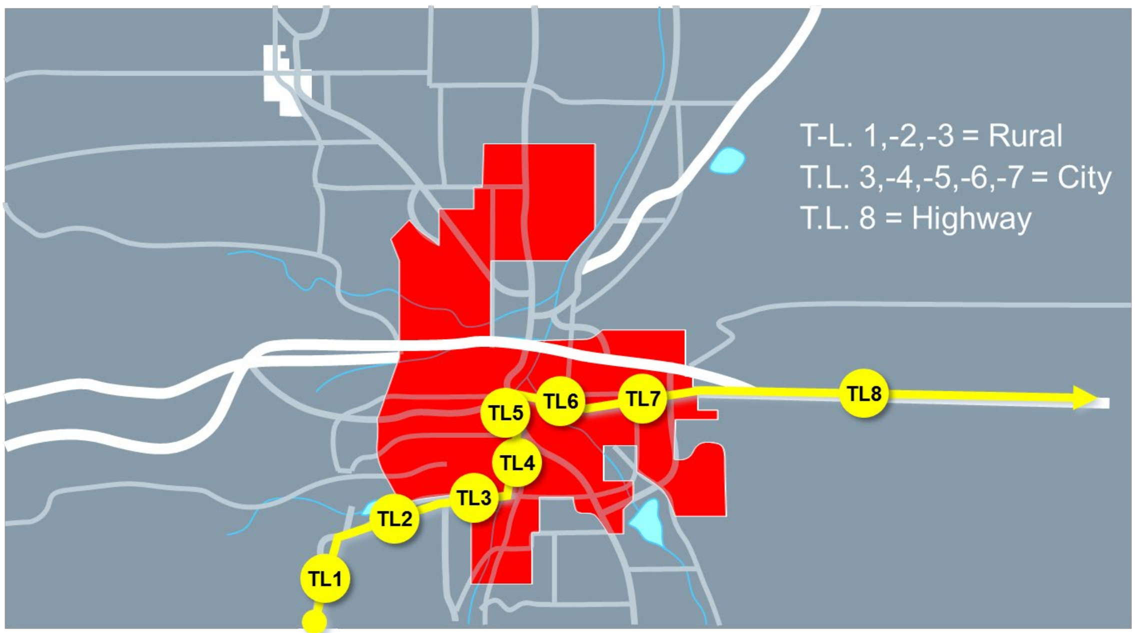

Figure 26: INSA Trend Line being mapped and clustered by Actuarial Zones of Interest

We then, as shown schematically in Figure 27; relate specific Maximum Acceleration Speed events to respective Trend Lines and proceed to compute weighted averages by Trend Line.

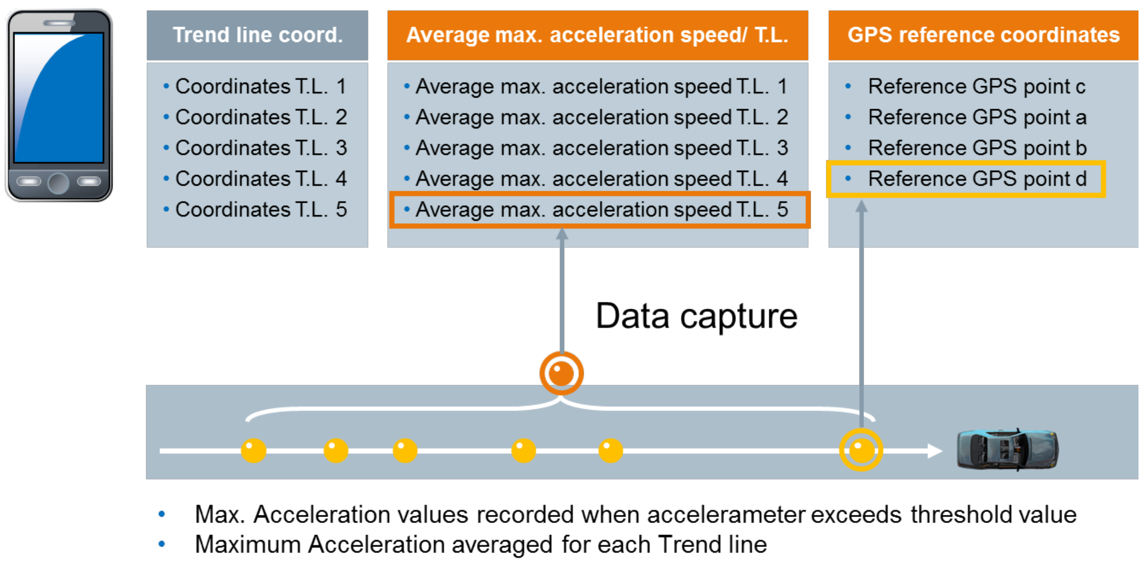

Figure 27: Associating Maximum Acceleration Speeds with their respective Trend Lines

The last step as shown in Figure 28, takes the Maximum Acceleration Speed data associated with Trend Lines and clusters them by Zones of Actuarial Interest and respectively computes separate Acceleration Quality Metrics. The procedure can of course also be further subdivided into time ranges like Rush Hour.

Deceleration Quality Metric Process Flow

The role and relevance that deceleration plays as a gauge of safe or unsafe driving is surprisingly quite different from acceleration. Hence, the following discussion of the INSA Deceleration Driving Quality Metric will focus on these differences in driving context and how INSA maps them into a Quality Metric formulation germane to accident risk management.

Treatment of deceleration as a risk factor diverges from acceleration by being highly tied to the speed at which the rapid speed reduction starts and ends. In current non-INSA UBI, deceleration events are logged based on a G-force event that exceeds a threshold – nominally 0.3G. However the risk-reality of deceleration as a risk management parameter is tied to a more complex interplay of events than just a G-force event. Interestingly the omission of such associated relevant factors is one of the most frequent blogosphere critiques[9] of the efficacy of traditional current UBI methodologies.

Essentially the safe driving relevance of deceleration events is integrally tied to the speed at which the event starts and the degree of total speed reduction. Implicitly this means the same amount of speed reduction and rate of speed reduction (G-force) has a totally difference safety connotation at highway speed (120 km/h) than urban speed (45 km/h).

- A sharp breaking that amounts to a minor speed delta – like avoiding being “cut off” on a highway may characterize an alert, defensive driver

- This is very different from a “short stop” from a relatively lo/w speed to zero (dead-stop) that if repeated is likely a sign of lack of attention, tiredness or slowed reflexes due to medication or age.

All these events may start with the same magnitude G-force event but their respective risk realities are very different.

It is the goal of the INSA Deceleration Driving Quality Metric to delineate these deceleration risk-reality differences as they happen and quantify the respective scenarios in a manner that is actuarially relevant to risk management.

Deceleration Driving Quality Metric Assessment and Computation

The INSA Deceleration Driving Quality Metric starts from a similar event measurement as the Acceleration Driving Quality Metric. (Figure 28)

[9] A good example is: https://blog.joemanna.com/progressive-snapshot-review/

However the quantum captured per Figure 28 differs in the critical regard of capturing the delta magnitude of the deceleration event and tying to the instantaneous speed.

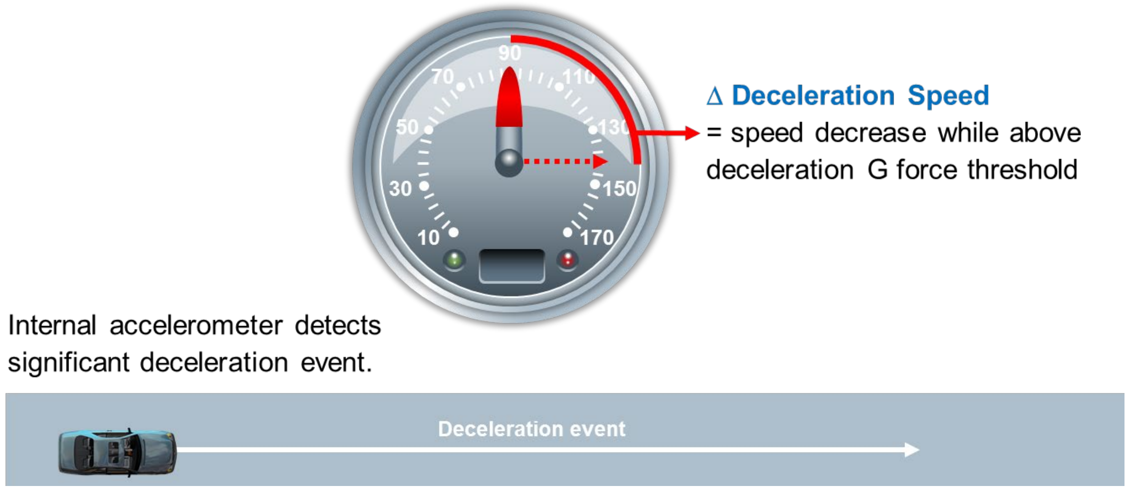

Figure 28: Capturing the Delta Speed decrease relative to initial road speed

Key at this juncture is that we have to capture a very different measure of driving at the outset of the Deceleration Driving Quality Metric than with respect to acceleration.

Per Figure 29 we see how the delta speed measurement and relevant road speed are recorded in the normal Driving Quality Metric manner protecting privacy. As in the other Driving Quality Metric scenarios the GPS reference coordinates are mapped to either the statuary speed limits or the relevant congestion speed.

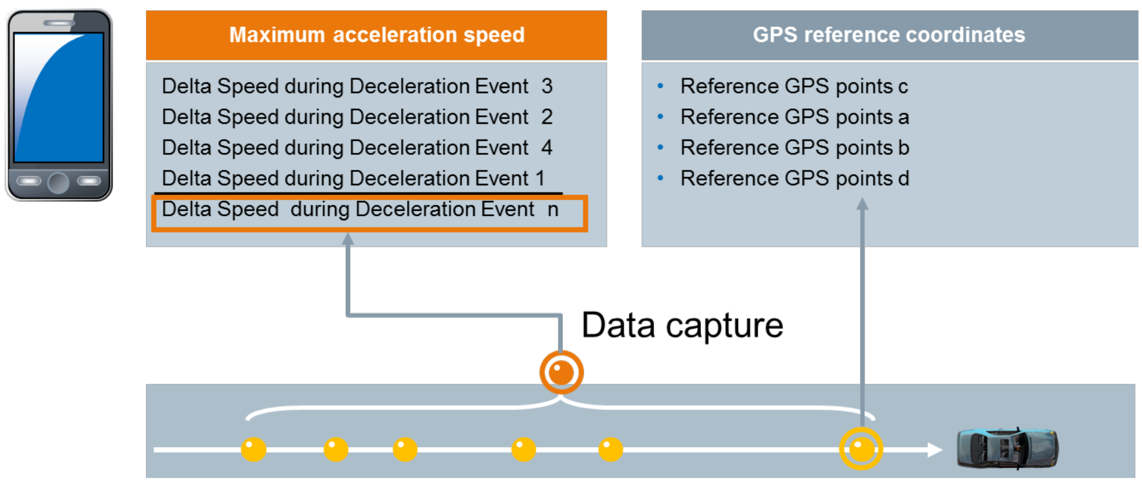

Figure 29: Deceleration Driving Quality Metric Data Elements

The key departure of the Deceleration Driving Quality Metric from previous Driving Quality Metrics follows from Figure 30.
We note that the relevance of the delta deceleration to road speed is computed as the quotient: *Average Delta Speed Deceleration Event divided by GIS average statutory speed or congestion speed*, to maintain the sensitivity to the diverse risk profiles of deceleration events depending on the immediate driving speed environment.

As with the previously detailed Speed and Acceleration Driving Quality Metrics, the Deceleration Driving Quality Metric can be subtended by categories like Urban, Rural, Highway, time of day etc. The process steps to go from the macro-level of the example above to the more micro-levels of Urban, Rural, etc. utilizing Trend Lines are the same as previously detailed and hence are not repeated here.

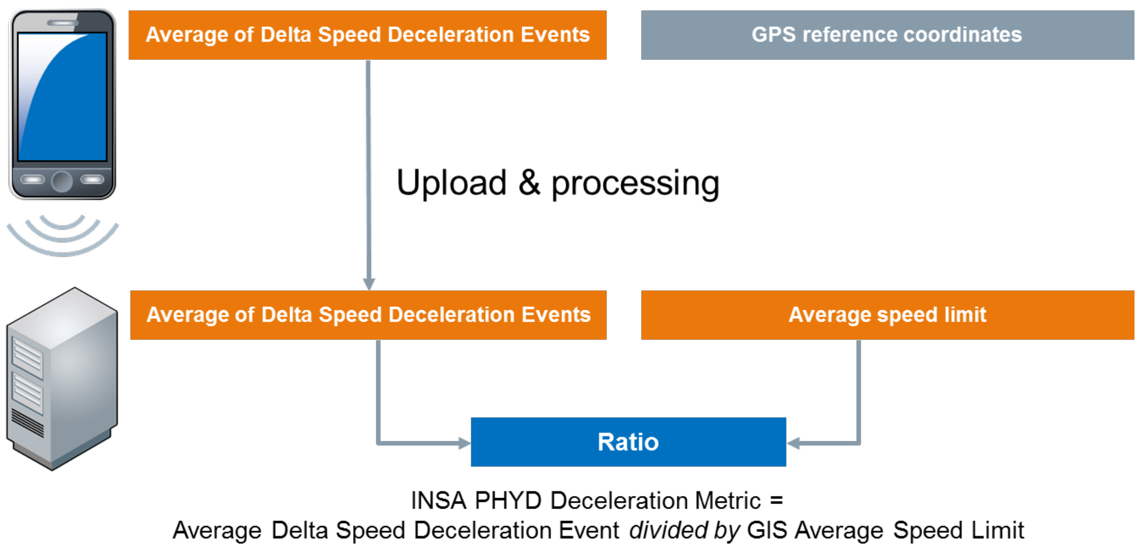

Figure 30: Deceleration Driving Quality Metric

Capture and Assessment of Erratic Driving

A UBI Meaningful and Quality Metric Quantifiable Model for Erratic Driving

Erratic Driving is a distinct driving characteristic from any of the previous Quality Metrics: speed, acceleration and deceleration. Mainly the former can on occasion be part of acceptably safe transit whereas it is hard to envisage Erratic Driving ever in context of safe driving. Even defining Erratic Driving is a challenge. It is akin to challenge U.S. Supreme Court Justice Potter Stewart responded when asked to define pornography
– Quote: *"I can't provide an intelligible definition – but I know it when I see it."* This in large measure sums up the UBI conundrum surrounding Erratic Driving and it has had a particular practical impact when trying to incorporate this important driving trait as a UBI factor.

To date competitive UBI formulations have suffered from lack of a meaningful model that catches both the dynamics behind the dangerous and aggressive aspects of Erratic Driving while also being readily quantifiable. Hence, a major INSA UBI breakthrough with respect to

Erratic Driving has been finding a general model[10] that captures the essence of erratic and aggressive driving.

In contrast to competitive UBI solutions that somehow try to quantify aggression while driving via cornering (that is measuring the radians per second of turning) or ignore it totally; INSA Erratic Driving is based on a simple but meaningful sequence of event: *significant acceleration followed by a relatively significant deceleration.*

Figure 31 depicts the INSA Erratic Driving UBI metric being used for detecting and quantifying aggressive, erratic driving, such as weaving between lanes. Fundamental to the INSA Erratic Driving UBI quantum is the time delta between tandem driving events: *sharp acceleration (> 0.3g) followed by a deceleration -- even moderate (> 0.15g).*
According to this model of aggression in driving -- the longer between the acceleration and deceleration events, the less severity is attributed to the event from an INSA UBI standpoint.

Table 4 summarizes the INSA Erratic Driving model and the Metric. It is worth noting that the same process steps outlined in Table 4 would also capture urban bad driving like running a red light or rural high risk driving like passing cars on a 2-lane highway against crowded oncoming traffic.

The INSA Erratic Driving Metric adds an important facet to INSA, unique in the practice of UBI, which provides a pivotal new inference for actuarial risk management and for remedial feedback to the driver.

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[10] IP protected

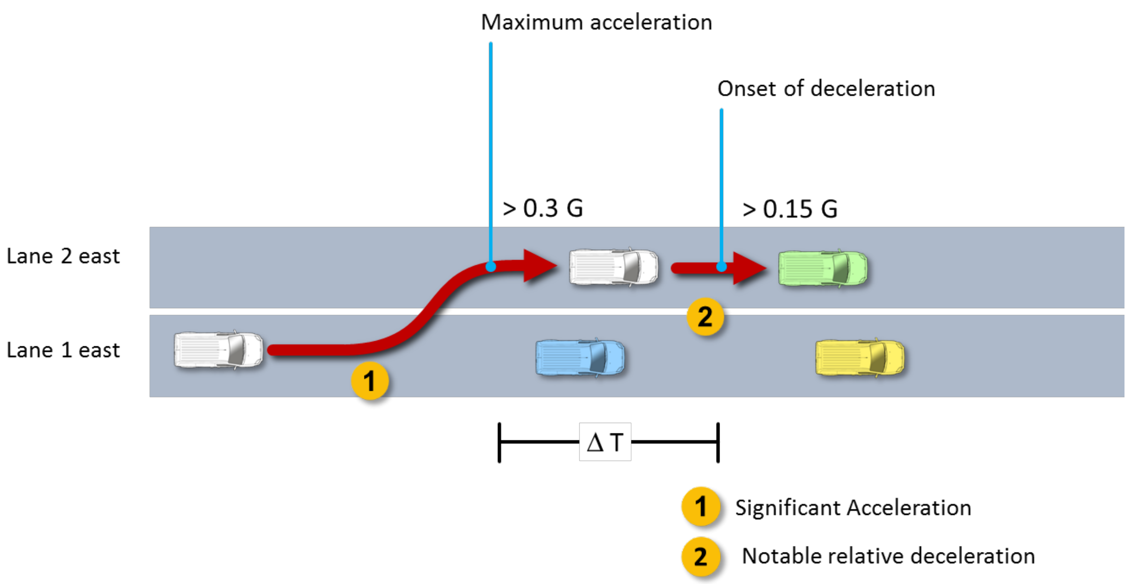

Figure 31: A depiction of the sequence of events INSA captures to quantify Erratic Driving

Erratic Driving Metric

- Catches rapid acceleration/deceleration as an indicator of Erratic Driving
  - Example: Rapid lane change ➔ weaving in and out of traffic
    - Metric Event: Rapid acceleration followed by marked deceleration.
    - Metric Quantum: Delta Time between Max. Acceleration and Deceleration event onset
- Erratic Driving Metric detects Acceleration Events (> 0.3G) looks for notable Deceleration Events (> 0.15G)
  - Measures Delta T between Acceleration Events and Deceleration Events
  - Delta T associated with Trend Line under compilation
    - Average Delta T computed by locales: Urban, Rural and Highway. ➔ Lower Average Delta T value infers higher Erratic metric value

Table 4: Summary of the Driving Events quantified as the INSA Erratic Driving Metric

Telephony Driving Quality Metric

INSA PHYD Detection of Smartphone Telephony: Voice and Messaging

A unique aspect of INSA PHYD is detection of potentially dangerous driver use of their smart phone for telephony: phone conversations or messaging. Recent studies have shown that telephony related auto accidents are rising faster[11] than any other category of driving incidents. The Times of February 7, 2015 (page 37) summed up telephony while driving as: "*one of the biggest causes of accidents on British roads*".

Although both hand-held telephony and keypad messaging while driving are illegal in most jurisdictions the following INSA PHYD sensing and categorizing of such driver smart phone usage is not intended for legal enforcement. Rather, INSA PHYD telephony detection is meant to provide the Insurer with an important new factor for PHYD risk assessment. Also, because of Driver telephony's high correlation with auto accidents, via the INSA app, the Insurer has a powerful tool to dis-incentivize the Driver from continuing to use their smart phone while driving. One such alarming study is synopsized in Table 5.

INSA UBI Assessment of Smartphone Usage: Voice and Messaging

Because INSA UBI has an active application in the driver's smart phone, INSA can immediately detect the occurrence of voice or messaging activity. The INSA application then proceeds to capture UBI relevant information about each telephony events. This Telephony Information refers to characteristics rather than content information and hence does not infringe privacy. Relevant UBI telephony information for voice and messaging telephony that are used the INSA Telephony Quality Metric are shown in Table 6.

[11] "Fatal Distraction" The Economist -- November 30, 2013

“We found that using a cellular telephone was associated with a risk of having a motor vehicle collision that was about four times as high as that among the same drivers when they were not using their cellular telephones.

This relative risk is similar to the hazard associated with driving with a blood alcohol level at the legal limit.”

Donald A. Redelmeier, M.D., Robert J. Tibshirani, Ph.D.
Association between cellular-telephone calls and motor vehicle collisions
The New England Journal Of Medicine
Volume 336 February 13, 1997 Number 7

Table 5: Dramatic effect of telephony on driving safety

Phone use risk categorized by INSA

- **Voice**
  - Hand-held
  - Hands-free – loud-speaker
- **Messaging**
- **Related data**
  - Locale
  - Duration
  - Speed

Table 6: Telephony activity registered by the INSA Telephony Quality Metric

The INSA Telephony Quality Metric allows the Insurer to reconstitute a driver’s smart phone telephony usage data as actuarially meaningful risk factors, by introducing the driving and “situational” information the INSA UBI continuously collects on each transit.

Location such as: Urban, Rural or Highway and speed can magnify or reduce the basic telephony accident risk. That is; INSA UBI seeks to broaden the risk assessment of a telephony event by adding dimensions of speed and congestion to the fact that voice or messaging took place. Not all instances of telephony are equal in driving risk.

Basically, as detailed in the previous sections on the Speed and Acceleration Metrics, without compromising driver travel route privacy, we can determine via Trend Lines whether the telephony session is happening in an Urban*, Rural or Highway* setting. Obviously, for example, a rush hour, urban setting magnifies the risk versus late night highway driving.

In brief summary of the Telephony Driving Quality Metric, we once again parallel the way we used Trend Lines internal to the Speed and Acceleration Quality Metrics to map concurrently collected Telephony information to Locales of Actuarial Interest: e.g., Urban, Rural, Highway, without compromising privacy.

Accordingly, without going into repetitive detail, Figures 32 – 33 show how INSA smart phone usage for voice and messaging can be quantified for actuarial purposes. Key is that the INSA Telephony Quality Metric scope of concurrent data enables the Insurer to put telephony events into context of traffic and general location in assessing actual risk.

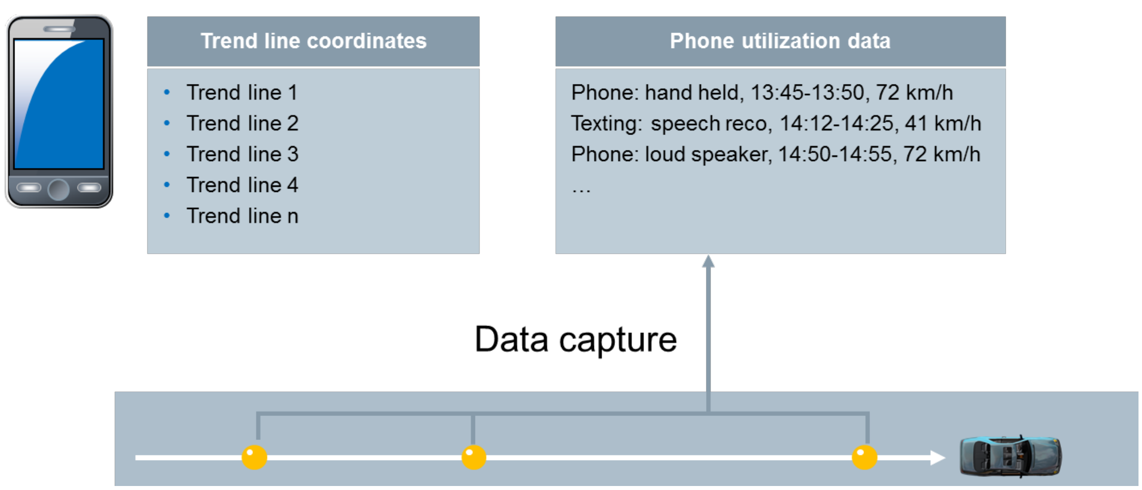

Figure 32: Telephony event data captured from the INSA Smart Phone and mapped to respective Trend Lines

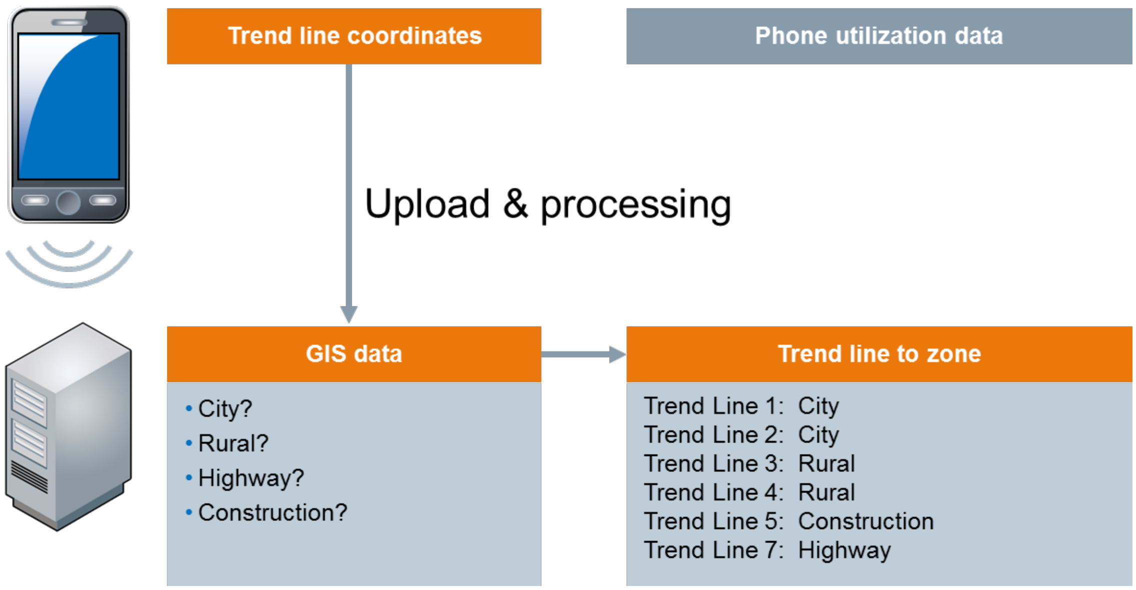

Figure 33: INSA Telephony Quality Metric as clustered by Actuarial Zones of Interest

Remedial Feedback and User Interface

Structuring User Feedback as a Critical UBI Risk Management Asset

In this section we step back from the INSA details given in the previous sections on UBI data capture and the respective Driving Quality Metric models and formulations. Our focus now shifts to the insured driver remedial feedback aspects of INSA. Specifically we will see how we use the INSA methodology to craft uniquely effective remedial feedback reports and target it by the respective insured driver. This completes the UBI risk management loop that starts with infusing dynamic UBI driving information into the insurer's actuarial model and now complements that internal process with targeted feedback to each insured driver. The remedial objective is to either reinforce safe driving or, coached in a positive behavioral science format, convey those areas of insured party's driving that require attention.

INSA's regiment of remedial feedback is built around the well-established behavioral science principles of Nudging[12]. All aspects of INSA feedback are posed to the driver as meaningful coaching that is easily internalized. In INSA feedback we avoid "scores" that convey only relative and subjective information. Instead, the INSA Remedial Feedback Interface is built around showing the driver objective information they can use to improve the safety of their driving. We also seek to achieve a cognitive balance that avoids "data overload" leading to the driver becoming inured to the whole feedback process.

Lastly INSA Remedial Feedback leverages on INSA's low operational cost that makes long-term UBI monitoring and feedback to the insured party an economically viable risk management proposition.

Note: The need to couple remedial feedback to a long term UBI strategy has been particularly highlighted by an OECD conference paper by Jan W. Bolderdijk (2011) of the University of

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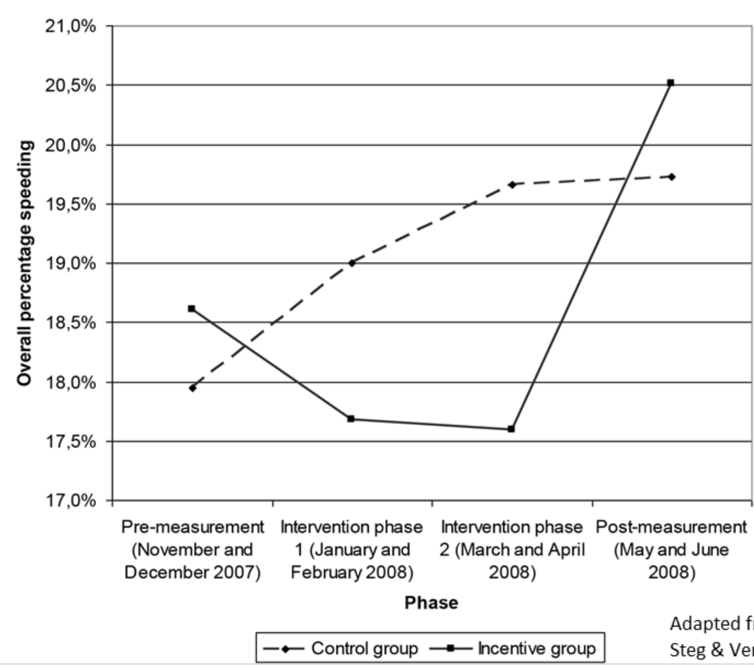
[12] https://en.wikipedia.org/wiki/Nudge_theory

Groningen in the Netherlands. In Figure 34 taken from Bolderdijk's paper we see that pre-UBI rates of speed return quickly after UBI monitoring ceases.



Adapted from Bolderdijk, Knockaert, Steg & Verhoef (2011)

Figure 34: Negative Behavioral Effects of "Limited Duration" UBI Monitoring
When UBI monitoring/feedback ceases ➔ Higher risk driving returns

Similarly the Insurance Information Institute (Figure 34) published similar guidelines in 2014 for effective UBI.

INSURANCE INFORMATION INSTITUTE

> "If vehicle operators are more aware of such behavioral factors, they may actually become better drivers. Studies indicate crash rates fell between 20 percent and one third in cars monitored via telematics."
> November 2014

Figure 35: Insurance Information Institute UBI Guidelines

INSA Remedial Feedback Interface

In operation, the following schema of INSA Remedial Feedback is proposed. (Figure 36)

Figure 36: Summary Screen introducing INSA Remedial feedback to the driver. Focus on High-Level Performance against each of INSA Quality Metrics

The above introductory INSA Remedial Feedback screen provides a snapshot at a glance to orient drivers as to how they stand versus the key safe driving measurements.
Central to this layout is the immediate focus on the UBI tie-in of Safe Driving ➔ Reward.

The core remedial message starts from the next screens (Figure 37 - 38) where we begin to drill down in a clear “cause & effect” manner into what each Driving Quality Metric conveys about the respective driver’s safe driving.

Figure 37: Speed Remedial Feedback as required kph reduction based on INSA Driving Quality Metric. Driver is focused on exact speed reduction required by locale to achieve UBI reward status

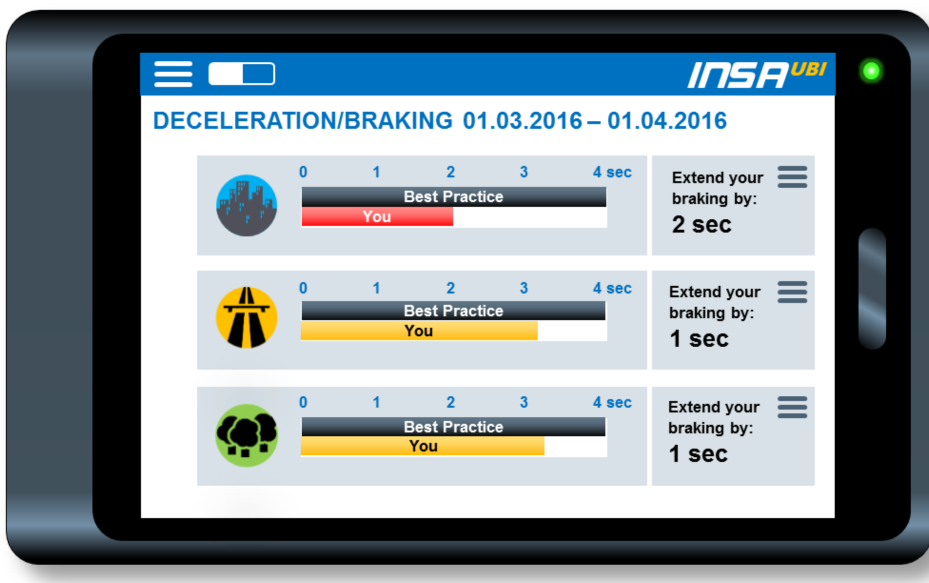


Figure 38: Deceleration Remedial Feedback in Braking Time based on INSA Driving Quality Metric. Driver is focused on "Defensive Driving" to increase safe braking time by locale

Per the above Remedial Feedback screens we convey the unique dialogue that we attempt to build with INSA insured drivers. Our aim is to reach drivers who want to improve their driving safety and give them concise, direct information how to go about doing just that. Note, we avoid nebulous feedback like you are "Braking Too Hard!" but rather convey an idea of how by improving awareness and focus on Defensive Driving like extending braking lead time.

The Remedial Defensive Driving Value for the Deceleration Metric, as stated, is intended to increase braking lead time consistent with safe driving. This value, ΔT_{DD} is derived from the equations used to measure deceleration and the methodology is detailed in Appendix 1.

Lastly, the full array of INSA Remedial Feedback also lends itself to Knowledge Base like coaching as shown in Figures 39 - 40. The driver can decline a remedial suggestion and then be posed with another alternative.

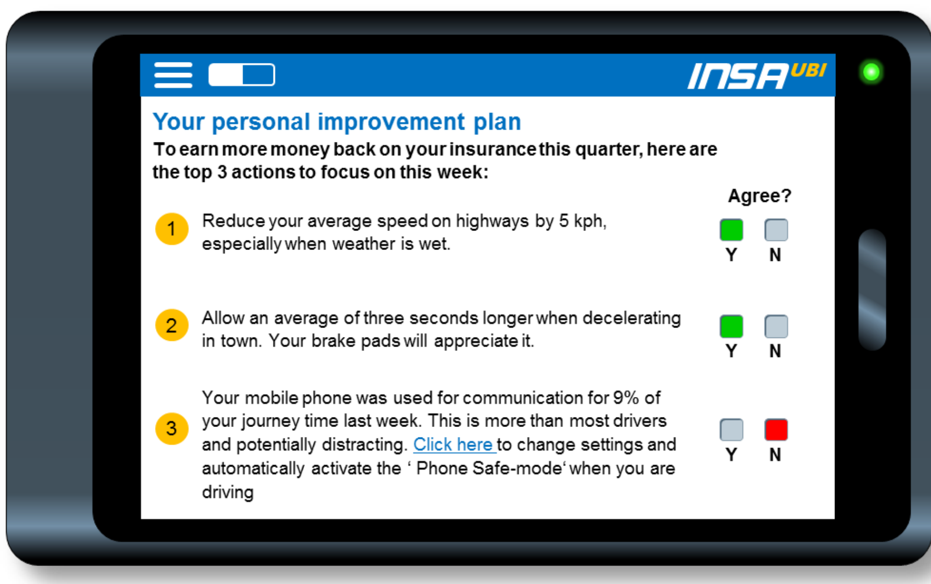


Figure 39: INSA Remedial Feedback using a Knowledge Base Coaching Approach

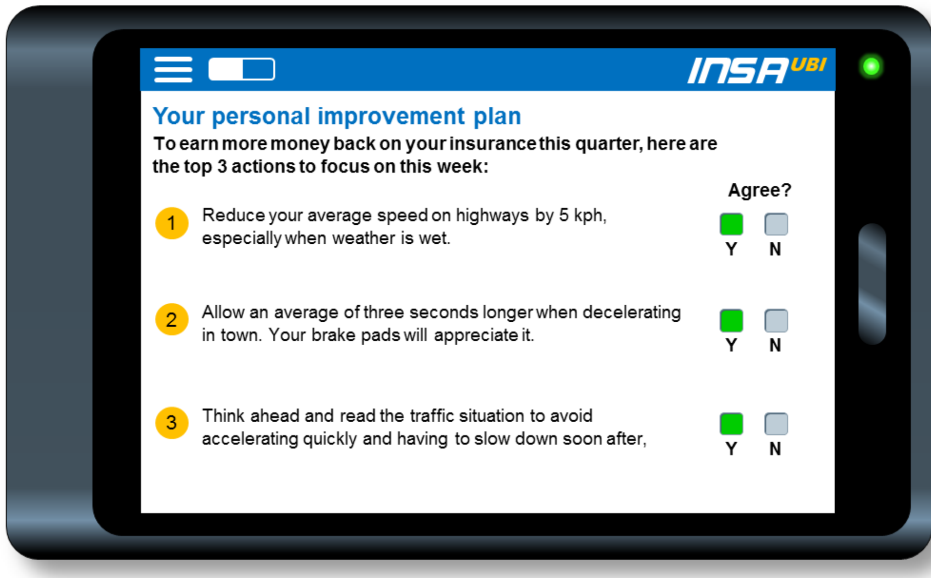


Figure 40: Remedial Feedback is updated based on dialog with the INSA insured driver Recommendation 3 was decline (Figure 37) and a new recommendation is proposed to the INSA Insured party

Providing INSA Remedial Feedback by Individual Driver

A further unique aspect of INSA Remedial feedback is that we can attribute each journey to an individual INSA INSA driver – not only a vehicle. This means if we have multiple INSA insured drivers in one insured vehicle and their respective smart phones register with the INSA Dongle, we can determine which party was the driver.

The full and comprehensive discussion of how we do this will follow in a separate document where we detail the INSA Dongle and INSA Beacon systems and interaction with INSA.

Interim Remedial Feedback

Lastly the array of formal INSA Remedial Feedback can be augmented by a methodology of Interim Remedial Feedback. The details are given in Appendix 3.

Appendix 1

Mapping the Deceleration Metric (DeM) into a Defensive Driving Time Window

Process Steps

The INSA Deceleration remedial feedback concept of coaching the driver to extend braking time and hence focusing them on “Defensive Driving” is unique to INSA and is predicated on its Deceleration Quality Metric formulation previous discussed in the body of this document.

The following is a brief outline of how we affect translating the INSA Deceleration Metric into a Defensive Driving “time window”.

1. For each Driver we separately clustered the sets Deceleration Metric (DeM) events by Urban, Rural and Highway.

2. Following the logic in the attached Appendix 2 document *Mapping INSA Quality Metrics to Rebates* – Figure 4; we plot the respective INSA insured drivers’ DeM values to create a distribution curve. If, for example, the related accident rate by locale: Urban and age group 30 is 10%, we focus on those specific Drivers(j) whose DeM_j value falls in the upper 10% tail that implies they are the most likely to incur an accident.

3. We now proceed to solve for a Defensive Driving ΔT (ΔT_{DD}) value that will have relevance for Remedial Feedback as the additional Defensive Driving braking time that the INSA insured driver should consciously added when braking. This, as mentioned in the body of this document, is a fundamentally different way of giving Deceleration remedial feedback from that of competitor UBI solutions to date.

   We start by re-examining for Driver(j) each of the individual braking events(i) that went into the computation of DeM_j that was flagged as high-risk.

a. The compilation of a DeM_i event is triggers by a deceleration above 0.3g. Deceleration below 0.3g is assumed safe driving (although we may vary these g thresholds based on road conditions.)

b. The value g is a measure related to gravity caused by a change in an object/vehicle's velocity over time– in the case of DeM_i – that is a negative velocity change – "Deceleration".

c. For INSA remedial feedback purposes this is the deceleration computed for the change in vehicle velocity/speed during deceleration that exceeded 0.3g.

   In analysing this event our focus is on the $Velocity_1$ at the start of the Deceleration that exceeds a g value of 0.3g and $Velocity_2$ when the vehicle is no longer decelerating at above 0.3g

   The g values are measured via an Accelerometer in the smart phone that INSA constantly monitors concurrently with the GPS that that gives us velocity/speed.

   Hence for each braking event Dem_i above 0.3g we record:

   $Velocity_1 = V_1$ = **speed at beginning of problematic deceleration related to DeM_i**
   $Velocity_2 = V_2$ = **speed at end of problematic deceleration related to DeM_i**

   associate with the Accelerometer measuring a g force of > 0.3.

   We also record the time duration of the ΔT_i of the problematic part of this deceleration event.

d. Now proceeding with the general equations defining Deceleration and g we get:

i. Deceleration = D = $\Delta V/\Delta T$

ii. "g" results from dividing D by the factor 9.8 (in metric calculations).

Hence: $g = (\Delta V/\Delta T)/9.8$

4. We now want to solve for the time delta – we refer to Defensive Driving Brake Time ΔT_{DD} that that when added to the time duration of the high g braking would have reduced the above problematic deceleration into a "safe deceleration/braking" below 0.3g.

a. Using the relationship given in 3.c - d above:

$g = (\Delta V/\Delta T)/9.8$ becomes:

$$\mathbf{0.3 = \big((V_1 - V_2)/\Delta T\big)/9.8}$$

which allows us to solve for what let's call the Safe Braking Time -- $\mathbf{\Delta T_S}$ value that is the time required to decelerate from $\mathbf{V_1 - V_2}$ <u>not exceeding</u> $\mathbf{g = 0.3}$

$$\mathbf{\Delta T_S = (V_1 - V_2)/(9.8 \times 0.3)}$$

b. We now solve for the increment in braking time that we call Defensive Driving Braking Time $\Delta \mathbf{T}_{\mathbf{DD}}$ for the DeM_j braking event (i) as:

$$\Delta \mathbf{T}_{\mathbf{DD(i)}} = \Delta \mathbf{T}_{\mathbf{s}} - \Delta \mathbf{T}_{\mathbf{i}}$$

5. Lastly for all braking events(i) in DeM_j the value of their respective $\Delta \mathbf{T}_{\mathbf{DD(i)}}$ is computed and averaged. It is the Average $\Delta \mathbf{T}_{\mathbf{DD(i)}}$ (or some confidence interval value thereof) **that** is used for the DeM Remedial Feedback parameter of Defensive Driving additional braking time.

Appendix 2

Monetization INSA Quality Metrics to Premium Rebates by Age Groups

Overview

In the following discussion we will outline how the INSA Quality Metrics can be managed in a deterministic manner and thereby be structured as a systematic process that, while reflecting the insurer's premium rebate strategy, is amenable to outsourcing.

Before going into detail of the methodology proposed to make the INSA processes deterministically mapped to premium rebates, it is useful to summarize some of INSA's succinct properties that are the foundation of our proposed mapping of Quality Metrics to Premium Rebates.

From the associated INSA PHYD Overview documentation and INSA PHYD Solution Description PowerPoint presentation we have shown how INSA maps individual insured driver characteristics into Quality Metrics, respectively what we call the Speed, Acceleration and Deceleration Quality Metrics. A key attribute of the Speed, Acceleration, Deceleration and Quality Metrics is that they yield, for both actuarial purposes and remedial feedback, values that are "ordinal numbers". That is, per the example depicted in Figure 1, the Quality Metric reconstitutes a given period of driving into an ordinal value, miles per hour, that is highly correlated with accident occurrence (sometimes euphemistically summed up as: "Speed Kills!") and also has direct relative value versus other INSA insured drivers for eventual mapping to respective driver rebates .

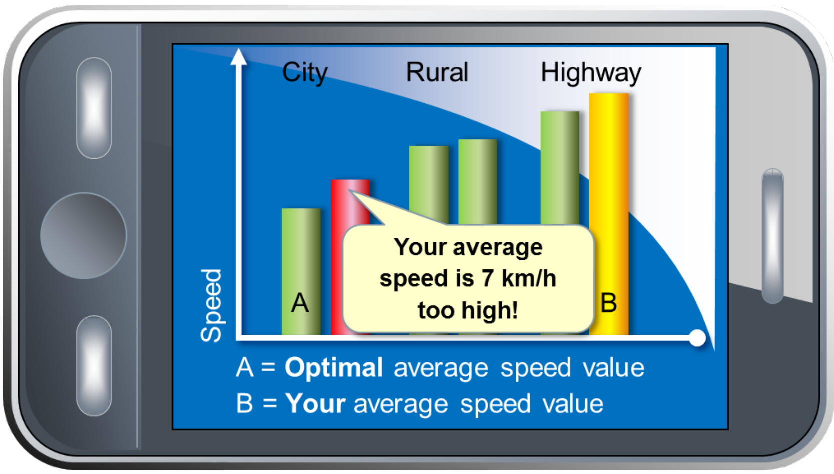


Figure 41: INSA Quality Metric data provides "Ordinal" data with Relative Safe Driving Inference

In the text that follows we will show how we can leverage on this ordinal characteristic of Quality Metrics to create a reward rebate strategy for premium reduction from the outset of INSA implementation. Also, significantly, beside its outsourcing properties, INSA can avoid the necessity of a "burn-in" period where we would otherwise need to independently collect volumes of driver/vehicle UBI data over time and correlate them against liability before we could meaningfully and responsibly equate it to various level of rebates. INSA needs no such "burn-in" preparation phase.

Establishing an Accident Occurrence Rate Expected Value

The first step is to establish a likelihood per year of accident occurrence. Auto insurers from their claims data base can be assumed to have such a data by driver age group.
For our general purpose example, we reference the open literature like Figure 2a from Quebec which indicates an expected yearly accident rate of 10% for young drivers: ages 16 – 20 years.

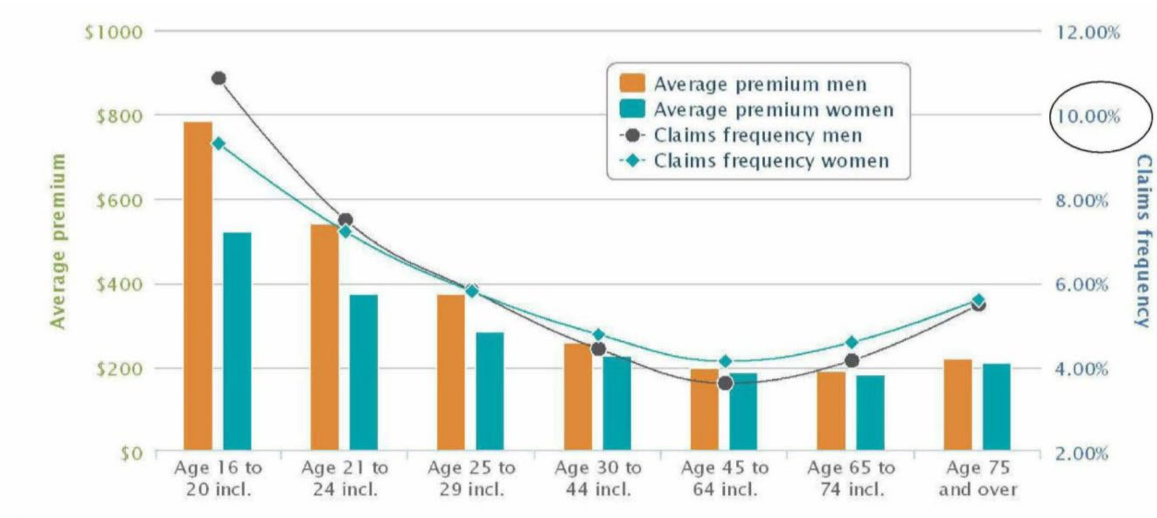


Figure 42a: Sample Accident Rate and Premium Rates by Age Group – French Canada, Data Source: *Groupement des assureurs automobile*

More recently we have found Association of British Insurer (ABI) data (Figure 2b) of accident frequency and premium data that differs somewhat from the above graphed *Groupement des assureurs automobile* (GAA) data. The ABI shows significantly higher accident frequency across the board. This may reflect the difference between UK and Canada of the latter's lower density traffic and the prevalence of a super-highway network. However, for purposes of this discussion and the associated analytics we continue with the above accident statistics compiled by GAA.

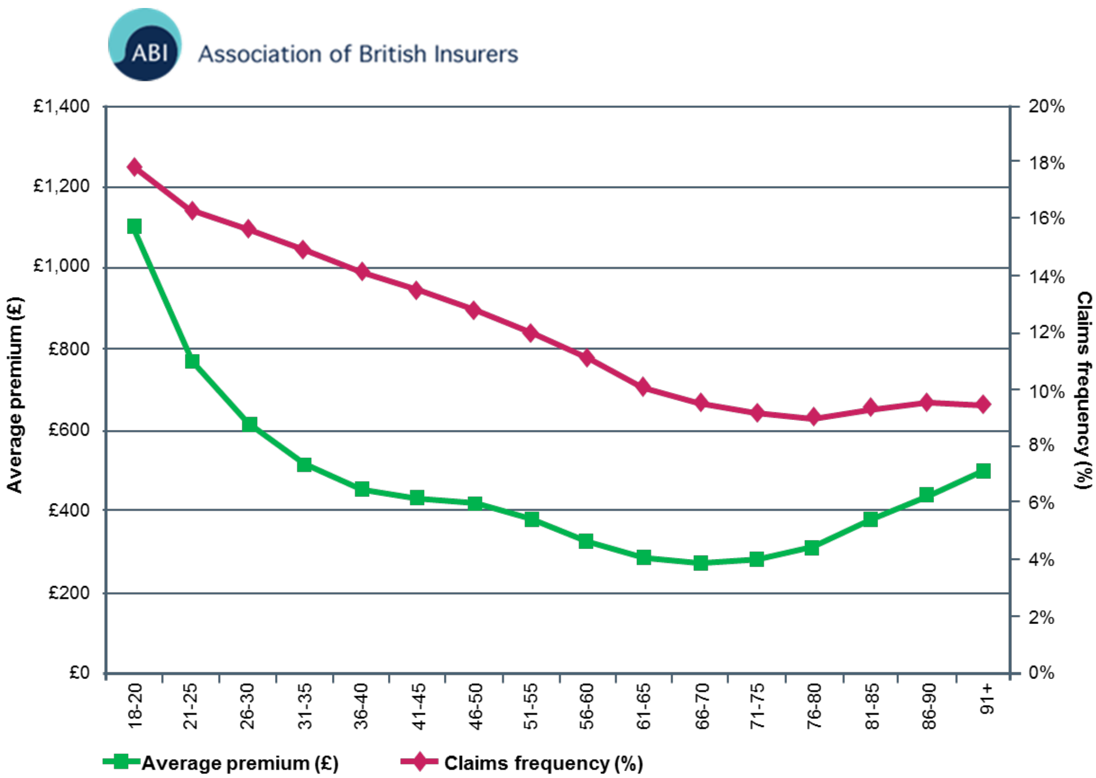


Figure 2b: UK Accident Frequency and Average Premium by Age Groups

Relating Speed Quality Metric Values to Accident Likelihood

For brevity, the following analysis will focus on the INSA Speed Quality Metric and how we relate those values to determining the appropriate amount of premium rebate by insured party or vehicle. The actual computation will also include additional Quality Metrics: Acceleration and Deceleration. They follow in a step by step analogous manner and are not detailed in this paper.

Hence we now proceed, per Figure 3, by plotting the values of the Speed Quality Metric recorded for the population of INSA insured drivers. (Note: Figure 3 can be computed from the outset of INSA operational deployment and will successively be enhanced as additional drivers are added.) The graph's horizontal is the Speed Quality Metric in terms of delta speed of respective insured parties[13] and the vertical is the number of insured parties scoring a given Speed Quality Metric value. For purposes of the example depicted in Figure 3, the Speed Quality Metrics range from 1 through 11 mph with a mean of 6 mph. The actual range of Quality Speed Metrics and the symmetric shape of the curve will differ somewhat with live INSA data, but in the analysis that follows these are not critical factors.

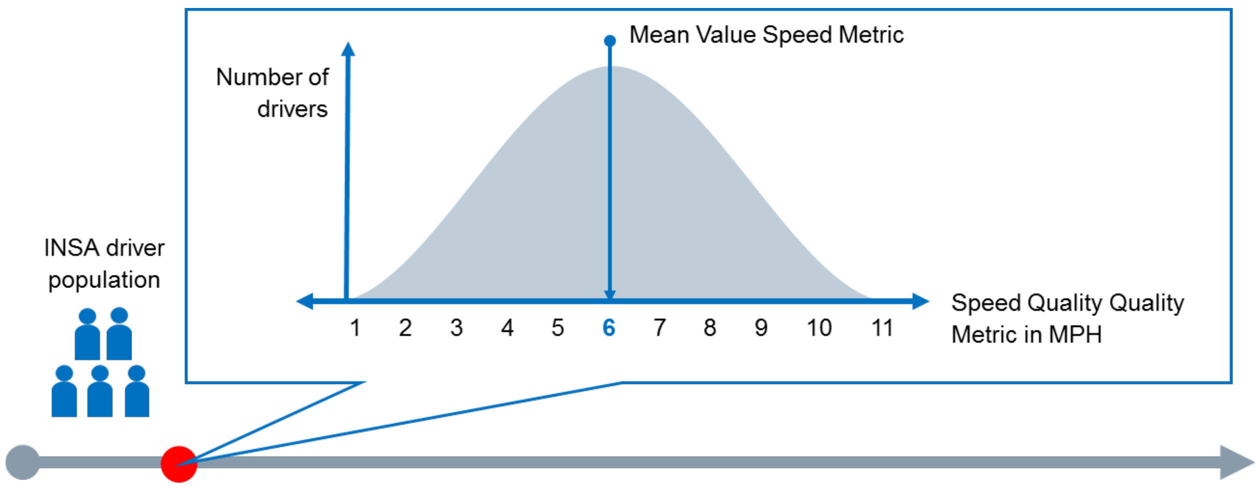


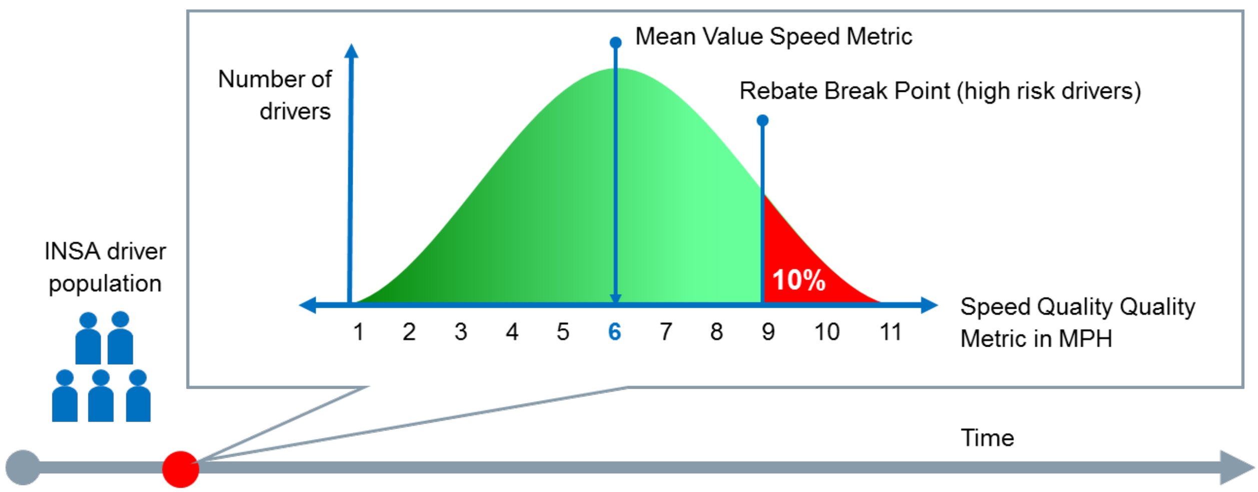
Figure 43: Distribution of Speed Quality Metric Values for all INSA Insured Parties

Using now the information on likelihood of accident for the subject group/population of INSA insured drivers/vehicles (i.e., Figure 1: 10%) we particularize the distribution of Speed Quality Metric vales in Figure 3 per Figure 4.

Figure 4 now allows us to delimit where Speed Quality Metric value would indicate a cut off in rebate. We then can proceed to superimpose, per Figure 5, a Bonus-Malus line paralleling the range of acceptable Speed Quality Metric values. The Bonus-Malus scale gives us a deterministic measure on how to relate the rebate values to the magnitude of respective driver's

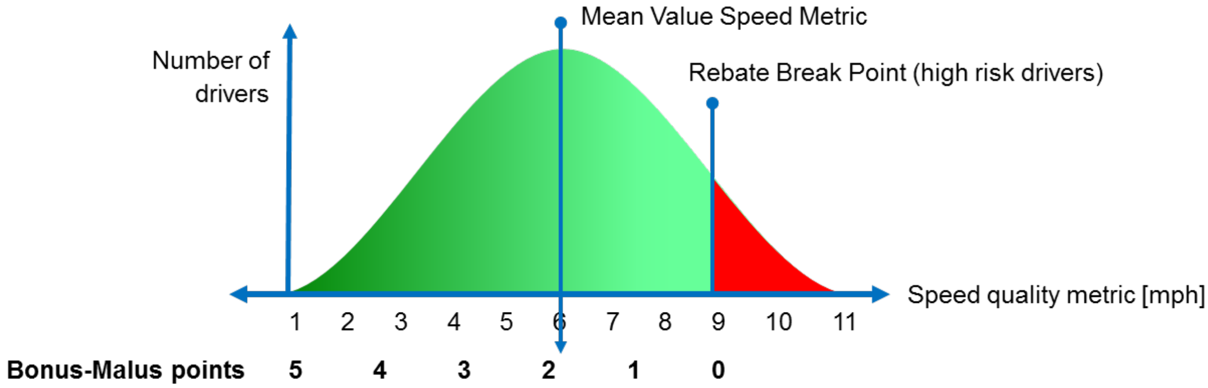
[13] *INSA PHYD Overview* pages: 11 -14

Speed Quality Metric scores (and similarly and independently the other Quality Metrics: Acceleration and Deceleration scoring).



- High Risk Driver Accident Rate Statistic: 10%: **Delimit Rebates**
- Drivers with Speed Quality Metrics in Red Tail of Distribution **get no rebate**.

Figure 44: Using information on Accident Likelihood to Delimit Premium Rebates



Introduce a Bonus-Malus scale related to Speed Metric deviation in MPH.

Figure 45: Using the Likelihood of Accident (10%) to Initially Delimit Non-Rebate Eligible Drivers

Up to this point we have proceeded at a "macro-level", taking advantage of the ordinal character of the Speed Quality Metric values in all driving environments to lump together Urban, Rural and Highway driving. However, INSA's solution is intended to provide, while maintaining driver privacy, Speed Quality Metric measurements at a more "micro-level", that is, subtended by Urban, Rural and Highway driving[14].

We accomplish this micro-level Quality Metric refocus by decomposing the gross level accident occurrence frequency (i.e. 10% in our example) into these respective driving domains (Urban, Rural and Highway)[15] and using the INSA Speed Metric data reported for each driving domain to duplicate the previous analysis through to computing the Bonus-Malus premium rebate score. (Figures 6 and 7). As shown schematically in Figure 7, we now can sum a **composite Bonus-Malus of 5.5** reflecting different driver conduct in each respective driving domains: Urban, Rural and Highway.

The analogous set of steps can be performed mapping the Acceleration and Deceleration Quality Metrics to a Bonus-Malus.

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[14] *INSA PHYD Overview* pages: 17 - 21

[15] We assume that the insurer's accident data files allow them to compute accident rate statistics by driven domain: Urban, Rural and Highway; and the total accident occurrence rate summed over these domains equals the value at the macro level of the likelihood of an accident occurrence – that is in our example 10% for a given Age Group.

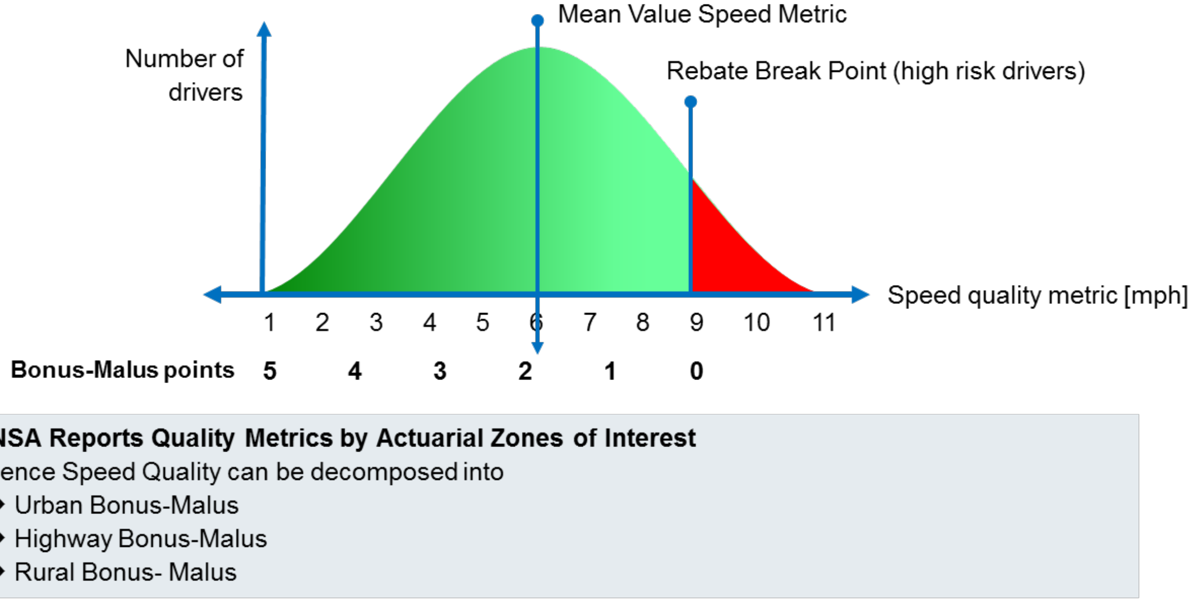

Figure 46: Mapping Speed Quality Metric to Driving Domain

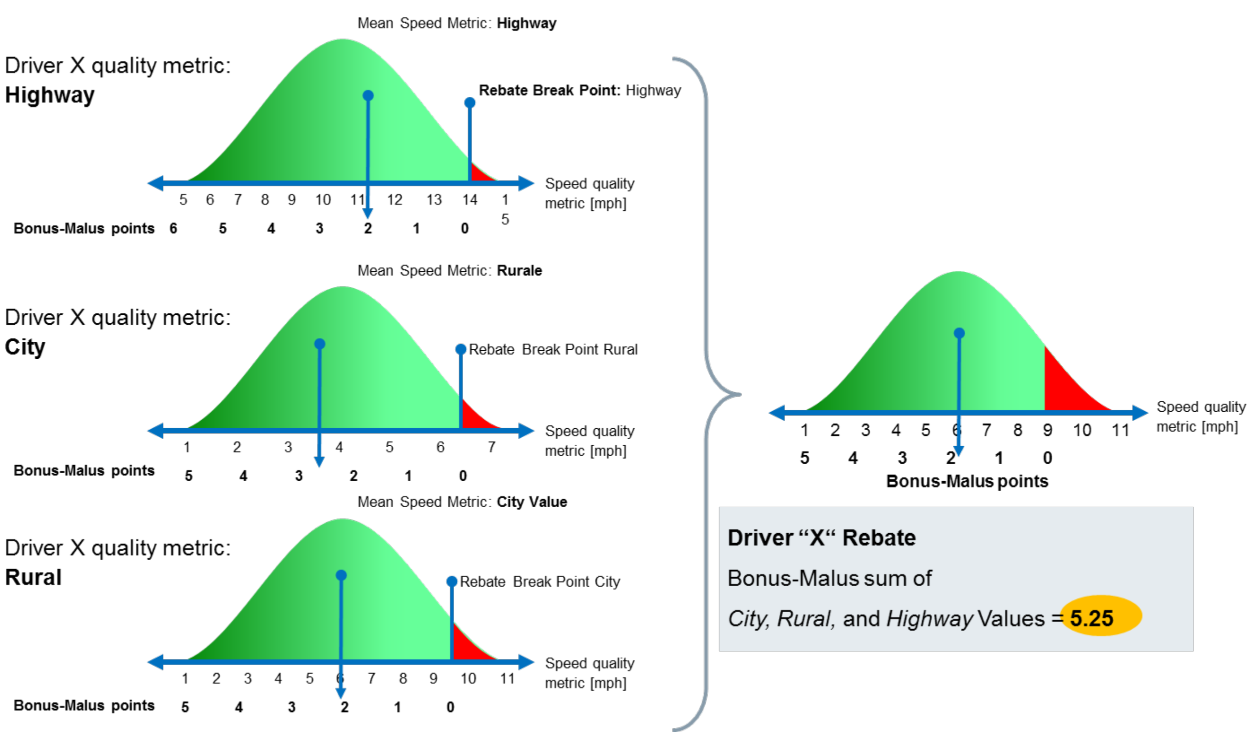

Figure 47: Micro Level Speed Metric Decomposition and Bonus-Malus Summation for Rebate Purposes

Monetizing Bonus-Malus Points as INSA Premium Rebates

The final step in our mapping of Quality Metric data to premium rebate value to the INSA insured party follows per Figure 7.

As we have seen in the example detailed above, our hypothetical insured party, ended up in Figure 7 with **5.25 Speed Quality Metric Bonus-Malus points**. An analogous set of steps applied to Acceleration Quality Metric and then the Deceleration Quality Metric would yield additional increments (or decrements) in Bonus-Malus points. Doing the same process for all the INSA insured drivers/vehicles we now proceed to do the final monetary conversion of Quality Metric Points into individualized INSA Premium rebates.

Referencing Figure 8 we introduce a *Total Premium Rebate Budget* which is the amount of money the insurer has allocated for a given period, e.g. monthly, for INSA safe driving premium rebates. This Rebate amount may change month by month particularly as the insurer begins to accrue savings via decreased liability pay-out costs.

Per the first equation in Figure 8, we see that, as one would expect, this kitty of money, *Rebate Budget*, needs to equal the

Total Number of Bonus – Malus points *accrued by all the INSA insured drivers/vehicles* *multiplied by the Rebate Value per Bonus- Malus point.*

The second equation in Figure 8 hence solves the *Rebate Value per Bonus-Malus point* as the

Total Premium Rebate Budget divided by Total Number of Bonus-Malus Points *accrued by all the INSA insured drivers/vehicles)*

Accordingly the INSA Premium Rebate per individual driver/vehicle follows via the third equation in Figure 8 as

Premium Rebate per individual driver/vehicle = Total Number of Bonus- Malus Points *accrued by an individual*

$$\textbf{Total Rebate Budget} = \sum_{i=\text{ individual driver}}^{N} (\text{Speed Metric B-M})_i \times (\text{Rebate Value per B-M point})$$

$$\textbf{Rebate Value per B-M point} = \frac{\text{Total Rebate Budget}}{\sum_{i=\text{ individual driver}}^{N} (\text{Speed Metric B-M})_i}$$

$$\textbf{Driver}_i\ \textbf{premium rebate} = (\textbf{Rebate Value per B-M point}) \times (\textstyle\sum \textbf{of B-M points driver}_i)^*$$

*B_M points actually credited to the driver

Figure 48: Crediting Driver $_i$ with a Premium Rebate based on Speed Quality Metric
→ Basic Formula not adjusted for *Insured Premium vs Premium-Range by Age Grouping*
Conversion of Bonus- Malus (B-M) units into a Cash-Value

Adjusting the Bonus-Malus Monetization for Age Group Differences in Premiums

Figure 9 takes the computation of Rebate Value of Bonus-Malus Points one step further by scaling the value of Bonus-Malus points accrued by a driver based on where their “Current Premium” ranks relative to the range of premiums in their Age Group.

To overlay on each INSA policy this level of Premium Rebate “tuning” we need to define and insert, as shown in Figure 9, what we call a **Scaling Factor**. (Note: Potentially each insurer will have their own particularized Scaling Factor – reflecting how they envisage focusing their PHYD Rebate strategy to affect and reward safer driving over time.)
For purposes of this discussion we have assumed a Rebate Strategy whereby the insurer wants

to focus on rewarding higher risk drivers who start and continue to show safer driving characteristics, while still recognizing, in more of a taken CRM vein, their existing cadre of “safe drivers” who already enjoy lower premiums. Hence, this strategy nets out as:

- **Higher-risk/higher-premium drivers** who show safe driving improvement will get proportionately larger premium rebates.
- **Established safe drivers**, already enjoying the lower/lowest premiums for their Age Group, will see much more modest premium rebates – that do however show individualized CRM recognition.

Hence, an example of a Scaling Factor reflecting such a Rebate Strategy is shown in Figures 9 and 10. We start by defining a scaling factor that is

Scaling Factor for $\textit{Driver}_i$*- Age* $\textit{Group}_j$ *= (Current Premium* $\textit{Driver}_i$ *– Lowest-Premium Age* $\textit{Group}_j$*) divided by (Premium Range of Age* $\textit{Group}_j$*)*

$$\textbf{Total Rebate Budget} = \sum_{\substack{i=\text{ individual driver}\\ j=\text{driver age groups}}}^{N} (\text{Speed Metric B-M})_i\,(\text{Rebate Value per B-M point})$$

$$\textbf{Rebate Value per B-M point} = \frac{\text{Total Rebate Budget}}{\displaystyle\sum_{\substack{i=\text{ individual driver}\\ j=\text{driver age groups}}}^{N} (\text{Speed Metric B-M})_i}$$

$$\textbf{Scaling factor for driver}_{ij} = \frac{(\text{current premium driver}_i\,) - \text{ lowest premium in age group}_j}{\text{premium range of age group}_j}$$

$$\textbf{Driver}_i\textbf{ premium rebate}_{\,Pass\ 1} = (\textbf{Rebate Value per B-M point}) \times (\textstyle\sum \textbf{ of B-M points driver}_i\,) \times \textbf{Scaling factor for driver}_{ij}$$

Figure 49: Conversion of Bonus- Malus (B-M) units into a Cash-Value
□ scaling by “Insured driver$_i$ Premium vs Premium-Range by Age Grouping (Pass 1)

In Figure 9 we see the role of the previously defined Scaling Factor in making each driver’s Bonus-Malus Points have an Age Group adjusted Premium Rebate Value. The Scaling Factor essentially takes into account where that driver’s current premium stands in the range premiums within each their Age Group.

However, given that now the value of each Bonus-Malus Point differs by driver, in the first pass of applying the Scaling Factor, as shown in Figure 9, we will not allocate all of the cash value in the original “Total Rebate Budget” (Figure 8). Hence we proceed per Figure 10 to compute

Residual Rebate Budget = “Total Rebate Budget” minus “Allocated Rebates” $_{\text{Pass 1 –Figure 9}}$

and proceed to reallocate this Residual Rebate Budget using the same steps as laid out in Figure 9. This process can continue interactively until the Residual Rebate Budget that remains is not significant.

$$\textbf{Allocated rebates} = \sum_{\substack{i = \text{individual driver} \\ j = \text{driver age groups}}}^{N} driver_{ij}\ premium\ rebate$$

$$\textbf{Residual Rebate Budget} = Total\ Rebate\ Budget - Allocated\ Rebates$$

$$\textbf{Residual Rebate Value per B-M point} = \frac{Residual\ Rebate\ Budget}{\sum_{\substack{i = \text{individual driver} \\ j = \text{driver age groups}}}^{N} (Speed\ Metric\ B\text{-}M)_{ij}}$$

$$\textbf{Scaling factor for driver}_{ij} = \frac{(current\ premium\ driver_i) - lowest\ premium\ in\ age\ group_j}{premium\ range\ of\ age\ group_j}$$

$$\textbf{Driver}_i\ \textbf{premium rebate}_{\ Pass\ 2} = (\textbf{Residual Rebate Value per B-M point}) \times (\textstyle\sum \textbf{of B-M points driver}_i) \times \textbf{Scaling factor for driver}_{ij}$$

$$\textbf{Driver}_i\ \textbf{premium rebate}_{\ Total} = \textbf{Driver}_i\ \textbf{premium rebate}_{\ Pass\ 1} + \textbf{Driver}_i\ \textbf{premium rebate}_{\ Pass\ 2} + \ldots\ \textbf{Driver}_i\ \textbf{premium rebate}_{\ Pass\ n}$$

Figure 10: Distribution of Residual Rebate (remaining from initial Total Rebate Budget) (Pass 2)

Appendix 3

INSA Interim Feedback: Bridging Between Quality Metric Premium Milestones
A Remedial Strategy for Providing Maximum "Ongoing" Coaching using Nudging

Background INSA Remedial Feedback

One of the strengths of INSA is its remedial feedback specific to each insured driver. In this document we assume that the INSA insured driver will be advised of their Premium Rebate status on a monthly basis reflecting their INSA Driving Quality Metric scoring as outlined in the previous documentation entitled: *Mapping Quality Metrics to Premium Rebates.*

INSA is able to assess and report driving behavior in a manner that each driver can understand in simple kilometers per hour what they need to do to be compliant with driving standards for Premium Rebate. We call this part of the monthly remedial feedback to the insured driver the **INSA Milestone:** *Driving Quality Metric Remedial Feedback.*

For purposes of the following discussion, we also assume the **INSA Milestone:** *Driving Quality Metric Remedial Feedback* will be communicated as coaching to each insured party in a simple, but definitive graphical manner such as Figure 1. The resulting Premium Rebate status can then be stated to the insured party in light of their Driving Quality Metric scoring in a CRM sensitive manner consistent with the insurers practice.

Figure 1: Periodic INSA Remedial Feedback to the Insured Driver ➔ *Simple, Definitive Coaching*

The Challenges of Providing Coherent Interim Remedial Feedback

The INSA Remedial Feedback question that we now address is, how do we; consistent with the "monthly" INSA Milestones: Driving Quality Metrics Remedial Feedback report,

…. give the INSA insured party meaningful interim status updates on how their driving is progressing toward Premium rebate status, when the interim update period may be as short as daily?

How we manage and report these INSA Interim Updates, consistent with the monthly INSA Milestones reports has both practical and statistical ramifications.

From a practical standpoint, the insurer does not want to send the insured driver conflicting information – that is; updates that erode the coherent rebate message that is the focal point of the "monthly" INSA Milestone: Driving Quality Metrics. However, we do want to be able to establish an effective channel to continuously convey, between INSA Milestones reports, useful coaching to the insured party consistent with any "statistical meaningful" driving trends we may detect.

The statistical standpoint, when mixing the INSA Milestone: Driving Quality Metrics; with the INSA Interim Updates, we need to exercise caution to not fall into the trap of mixing and conflicting statistical "apples and oranges". The Driving Quality Metrics tend to be combinations of mean values that by virtue of the Central Limit Theorem will be statistically conformant with the Normal Distribution and statistical hypotheses and confidence intervals built on Normal statistics.

However, in contrast, we cannot necessarily be sure that the limited, raw driving data collected in short daily snapshots for the INSA Interim Updates, in and of themselves, are necessarily Normally Distributed.

Hence we need to be cautious how we draw inference from and how we report back relatively short snapshots of interim driving data, that may differ radically day to day, and may have a tenuous statistical basis relative to the monthly INSA Milestones: Driving Quality Metrics.

Lastly, the Customer Relationship Management (CRM) value of INSA Interim Updates; requires that they be coupled and leveraged upon the most recently computed and reported INSA Milestone: Driving Quality Metrics.

Relative to the last INSA Milestone, each INSA Interim Feedback needs to be a succinct message, that should provide the insured party with immediate cognition of what we gauge as an emerging driving trend that will affect the next, INSA Milestone – now being compiled.

In this vein the INSA Interim Feedback strategy provides a channel to the insured for succinct messages either unsolicited or initiated by the insured driver's specific request to know: "How am I doing"?

INSA Interim Feedback becomes effectively a "Coaching Tweet" between Insured and Insurer like:

- **We see an improving trend. Keep up the progress**
- **Sorry no progress so far but we can work together on this.**
- **We see some Red Flags. Please focus on ……**

How we develop the inference behind each Tweet and some additional ideas of INSA Tweet etiquette are discussed in the next section.

Obtaining the Data and Deriving Inference for INSA Interim Update

Let us assume our INSA Interim Update reporting cycle has as its objective providing feedback on a daily basis given that a meaningful amount of driving is done and that our analysis shows a statistically significant trend or status quo relative to the previously reported **INSA Milestone:** *Driving Quality Metrics Remedial Feedback.*

For brevity in the process steps that follow let's assume we are focusing on the aspect of INSA Interim Update pivoting on the INSA Milestone: Speed Quality Metric. The other INSA Interim Updates are analogous.

1. The INSA Interim Update process starts by capturing via the Virtual Cradle/OBD speed data at random points in the day's journey. The INSA Interim Update data sample is relatively limited size compared with the data points being compiled in the background for the next INSA Milestone: Driving Quality Metrics Remedial Feedback Report[16].

   We plot these randomly sampled values: (Instantaneous Speed minus Legal Limit[17]) around the value previously reported INSA Milestone: Speed Quality Metric as shown in Figure 2.

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[16] Details of how the Driving Quality Metrics are computed and their actuarial significance are detailed in the associated documentation: **INSA PHYD Overview**

[17] Could also be the road's Congestion Speed as discussed in the INSA Solution documentation

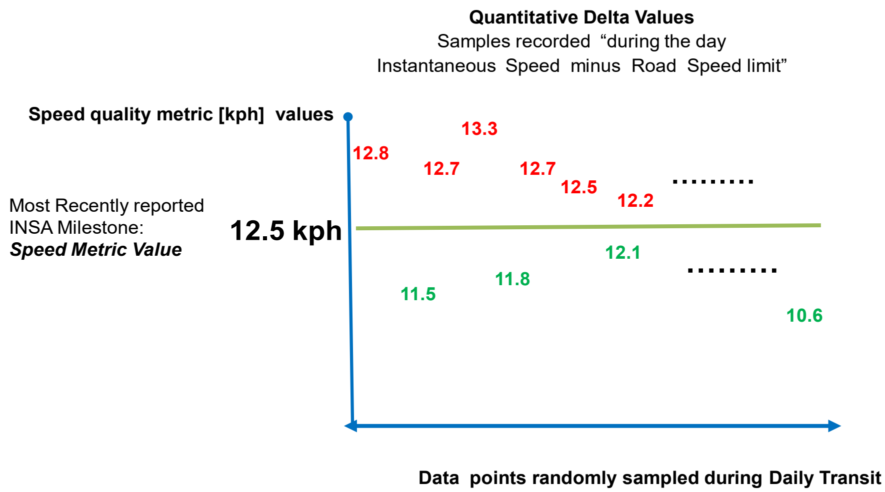


Figure 2: Random sampled INSA Interim Update data points plotted relative to the last reported INSA Milestone: Speed Driving Quality Metric (in this example: Speed Metric value is given as 12.5kph)

2. Given that we cannot a priori assume that these randomly sampled INSA Interim Update data points as displayed in Figure 2 are Normally Distributed random variants, it is prudent to proceed using Significance testing based on Non-Parametric statistical methods.

For our purposes, where we would want to determine if, for example the data points show, a statistically significant trend of reduced (or increased) Speed Driving Quality Metric values implying a positive (or negative)movement with respect to Premium Rebate status, an appropriate non-parametric statistical inference test is the so called "Sign Test".

Per Figure 3 we see the non-parametric fundamentals follow by remapping the numeric values of the data points displayed in Figure 2, into + or – values based on how they deviated from the INSA Milestone: Speed Driving Quality Metric Value.

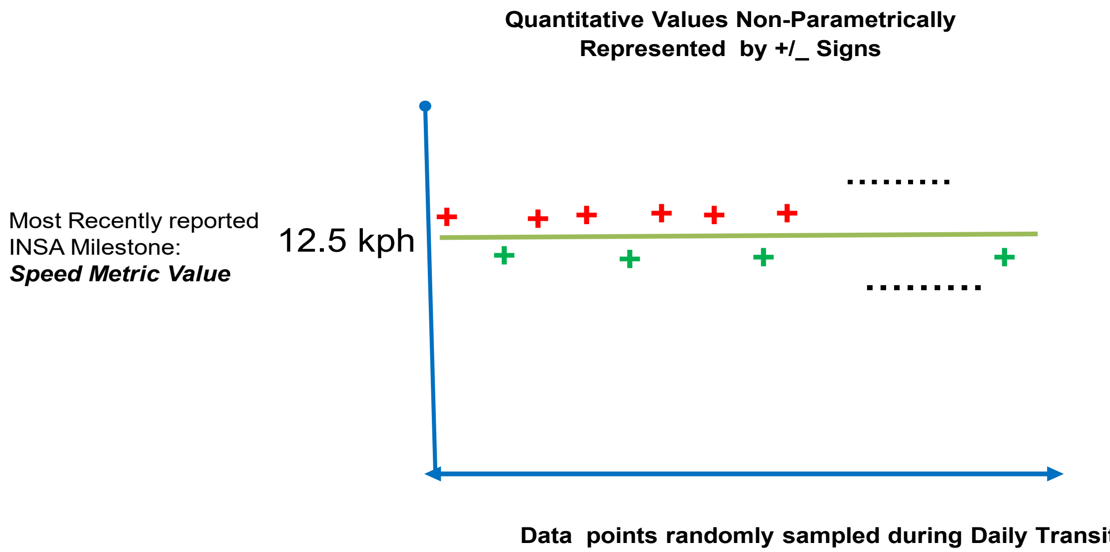


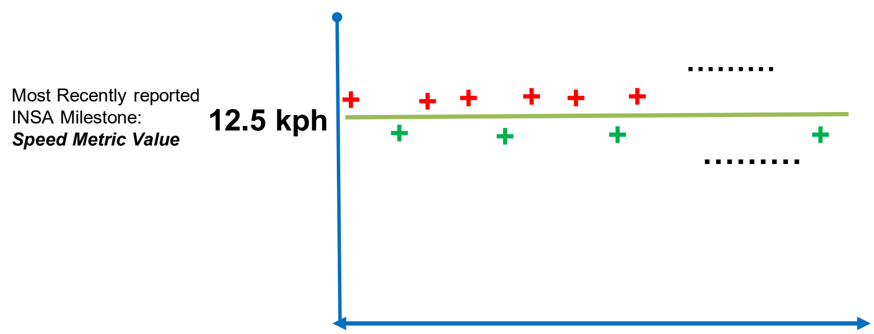
Figure 3: Randomly sampled data points quantitatively displayed in Figure 2, now mapped to non-parametric +/- values

3. In the particular example now displayed in Figure 3, the Sign Test gives a fairly high significance toward there being a Trend toward “increased speed” -- that moves the insured party further away from Premium Rebate.

In this circumstance, or if a “decreased speed” Trend had been evidenced, we perform an additional non-parametric test for Randomness. The non-parametric test for Randomness reflects the number of “runs” that is; clusters of multiple successive variations with the same sign. Intuitively, the more clustered speed data points are higher or lower than the reported INSA Milestone: Speed Quality Metric value, the more likely the statistically inferred Trend reflects a conscious driving pattern by the insured. (Figure 4)

Quality Trend Inference from Daily Driving Snapshot

Reporting "Quality Metric Trend" to the Insured Non-Parametric



Null Hypothesis: *REJECTED* ➔ positive speed inference

Randomness Hypothesis: *REJECTED* ➔ conscious driving pattern

Figure 4: Non-Parametric dual inference that an observed Driving Trend reflects conscious increased speed of driving.

4. Now we move on to how do we convey information that is "statistically inferred" Trend to the insured driver in succinct manner that alerts them to a Trend that we detect, but of course being statistical, can never be posed as a 100% fact.

What I proposed is to treat the whole INSA Interim Update as a good-natured Tweet. In this vein one might even consider a brief synopsis Tweet like Figure 5.

Quality Trend Inference from Daily Driving Snapshot

Informally Tweeted Coaching Reported to Driver

Sorry, but the daily Update Report you requested shows that you still need to concentrate more on reducing your Urban Speed rate.
Please keep in mind your goal of Reducing City Driving Speed by 7 kph.

Lets Keep trying Together

Figure 5: An idea of a low key, but succinct Tweet used to convey a INSA Interim Update

Summary

The preceding outlines a coherent strategy for assessing and communicating how the insured party is doing between the formal INSA notifications of their Premium Rebate status.

The process is sensitive to CRM, and is innovative in establishing coaching channels, while being statistically based on well established principles.

The final schema can of course be tailored to how the Insurer wants to dialog with their clients and in each of its fours steps above is open to Insurer customization.