Pantas and Ting
Sutardja Center
for Entrepreneurship & Technology
Berkeley Engineering

AutoSentinel
Auto security to prevent/detect thefts and break-ins
Engineering Leadership Professional Program

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Problem

"One morning, as I was feeding my dogs around 5:30 AM I heard a loud cutting noise as if someone was using a power tool in a shop. Since our house is in cul-de-sac on a normally quiet street, I looked out the front door and saw neighbors' Toyota Corolla lifted on one side with a man doing something under it. I did not pay much attention and thought there must be something wrong with the car and the neighbor is trying to fix it but moments later the man quickly got out and threw a heavy-looking metal object into a bed of a nearby-parked truck and released the jack used to lift the car. Seconds later the truck was racing away quickly. A minute later the neighbor appeared on his porch trying to realize what just happened. Later, he realized that his catalytic converter, which is a small but vital part of an exhaust system was stolen."

Figure. 1. Recent major network coverage of dramatic increase of auto burglaries and catalytic converter theft.

The above story happened to me around 2008 and at that time, the theft of catalytic converters has been quite rare. This has been changed dramatically in the last few years, partially driven by sky-rocketing prices of precious metals such as rhodium and palladium that are used in the production of catalytic converters. To put some numbers, there was almost five-fold increase in the number of catalytic converters stolen from 2019 to 2020, exponentially rose in 2021 and forecasted to continue its exponential rise in 2022. The theft usually involves jacking up a car by a few inches, a criminal getting under a car and cutting out the catalytic converter with a portable battery-operated saw. All in all, it takes on average 3 minutes and by the time, the homeowner realizes that something is going on, the criminals are gone. The criminals then can sell the catalytic converters to the scrap yards for $500-1000 apiece for certain vehicle models, with older Toyota Prius Hybrid catalytic converters being on the upper end of this range.

Figure 2. Desperate auto owners leaving their trunks open while parked to show that the car has no valuables inside.

For those unfortunate car owners who experienced a stolen catalytic converter, the problems involve a long wait for a replacement converter to become available (there is a national shortage of catalytic converters at this moment), hefty cost of replacement (as high as $2000), and the need to find an alternative transportation as the car is illegal to operate without a functional catalytic converter.

In addition to the catalytic converter theft, all types of auto burglaries have been on dramatic rise, as was captured in many news headlines of major networks. Just in San Francisco, there were more than 3,000 car break-ins in a single month. This affects not only the unfortunate car owners whose valuables are stolen during the break-in, but also the insurance companies who must pay out the cost of the lost goods and vehicle damage, and policy owners whose rates increase to account for rising auto burglaries. Some auto owners are getting so desperate that they keep their trunks open while parked to show to the criminals that the car is empty and has no valuables

inside. This does not prevent a determined criminal from stealing a navigation system or audio equipment.

Solution

The existing solutions to prevent converter thefts are quite inadequate and expensive. Due to nature of the materials used in constructing these traditional anit-theft devices, their cost can be several hundreds of dollars for just the device itself. While most of these devices provide a physical barrier between a potential perpetrator and the catalytic convertor, they must be professionally installed and are custom designed to fit the frame of specific vehicle models. Consequently, this limits their compatibility to all vehicle models and their portability of transferring the device from one vehicle to another should the consumer wish to remove and install the device on another vehicle.

What we are proposing instead is an AutoSentinel – a standalone security system, the size of a matchbox that can be plugged into the on-board diagnostics (OBD) port, which is present on all post-2000 automobile models. The OBD port is normally used for advanced diagnostics by mechanics or a handy auto-owner but can be used to add some features to a car (e.g., projecting output from an auto-market radar detector to car dashboard or heads-up-display (HUD)). The AutoSentinel installation is a Plug & Play – the car owner installs it into an OBD port (usually on the lower part of the dashboard) with optional installation of a phone app for additional features. The AutoSentinel includes a tilt sensor that is activated whenever a car is locked and is triggered if a car is tilted while being locked. That means that the catalytic converter theft will activate the alarm at the very beginning of the theft when the criminals start raising the car.
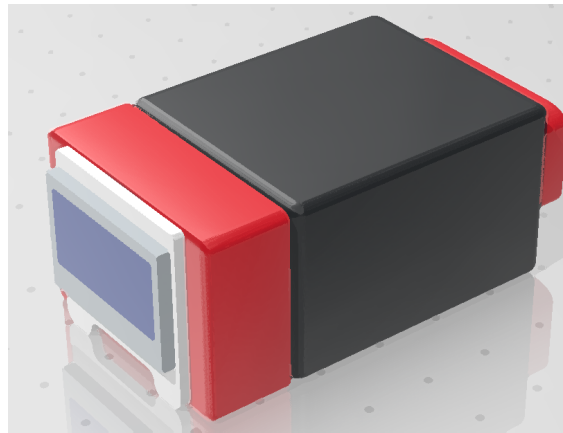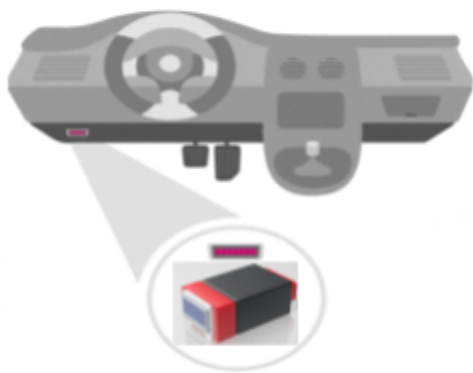

Figure 3. AutoSentinel – standalone security system that plus into an OBD port.

Features

Table 1 below details the prominent features included in the AutoSentinel product. These features will enable the product to provide the advertised security functions and scale in the future to include additional capabilities.

Autosentinel – main features		
Tilt Sensor	Detects tilt in the vehicle	
Acoustic Sensor	Detects specific sounds like shattering of glass	
Accelerometer	Detects change in acceleration	
Data services	Ability to send data over network	
Alarm	Trigger alarm on specific events	
LED Strobe Lights	Flash the lights on specific trigger	
USB Charging	Charge the battery in the product	

Table 1. Main features of the AutoSentinel product

Triaxial Accelerometer: The triaxial accelerometer is a device that measures acceleration of said device in three orthogonal directions. This device has three separate outputs for each direction that can be scaled to output the acceleration of the device as compared to the acceleration of gravity, or g, and the direction of that acceleration. Examples of applications of accelerometers are a smartphone app counting footsteps or providing angular level with respect to the ground reference. In the application of AutoSentinel, the accelerometer output is used to determine when the vehicle is in motion. The motion of the vehicle in horizontal direction, if not expected, will provide a warning that the vehicle is possibly stolen. In addition, a special case of this motion would be a vertical motion without horizontal motion, which would be interpreted as the vehicle being tilted or lifted and provide a warning that a catalytic converter theft is in progress.

Acoustic Glass Break Sensor: The acoustic glass break sensor uses a narrow band microphone that listens to sounds and provides a signal that can be used to interpret the frequencies in the sounds it hears. The sound produced by breaking window glass contains specific high pitch frequencies that are not common in other surrounding noises. In the application of AutoSentinel, the acoustic glass break sensor is used to determine when any window of a car has been shattered. When the signature frequencies of breaking glass are detected in a car, the AutoSentinel will provide a warning that someone is likely trying to enter your vehicle and steal its contents.

Data Communication: The AutoSentinel device will include the ability to warn you of an alarm in progress by sending alarms to your smartphone. Long term, the ability to warn others with AutoSentinel devices in the same local area will also be incorporated

Alarm: In addition to the ability to provide a wireless alarm warning to you, the AutoSentinel device will house a small but loud, high-pitch alarm to draw attention to the car being burglarized and drive thieves away before they can complete removing a catalytic converter or car contents

LED Strobe Light: The AutoSentinel device will also house a bright strobe light. This bright flashing light will accompany the loud alarm sound and help to also draw attention to the car being burglarized and drive thieves away before they can complete removing a catalytic converter or car contents

USB Charging: The AutoSentinel device will contain a battery to ensure long operation while your car is parked and unattended. The battery will be charged using the provided cord which will be plugged into the AutoSentinel and into your car's USB port or 12V outlet.
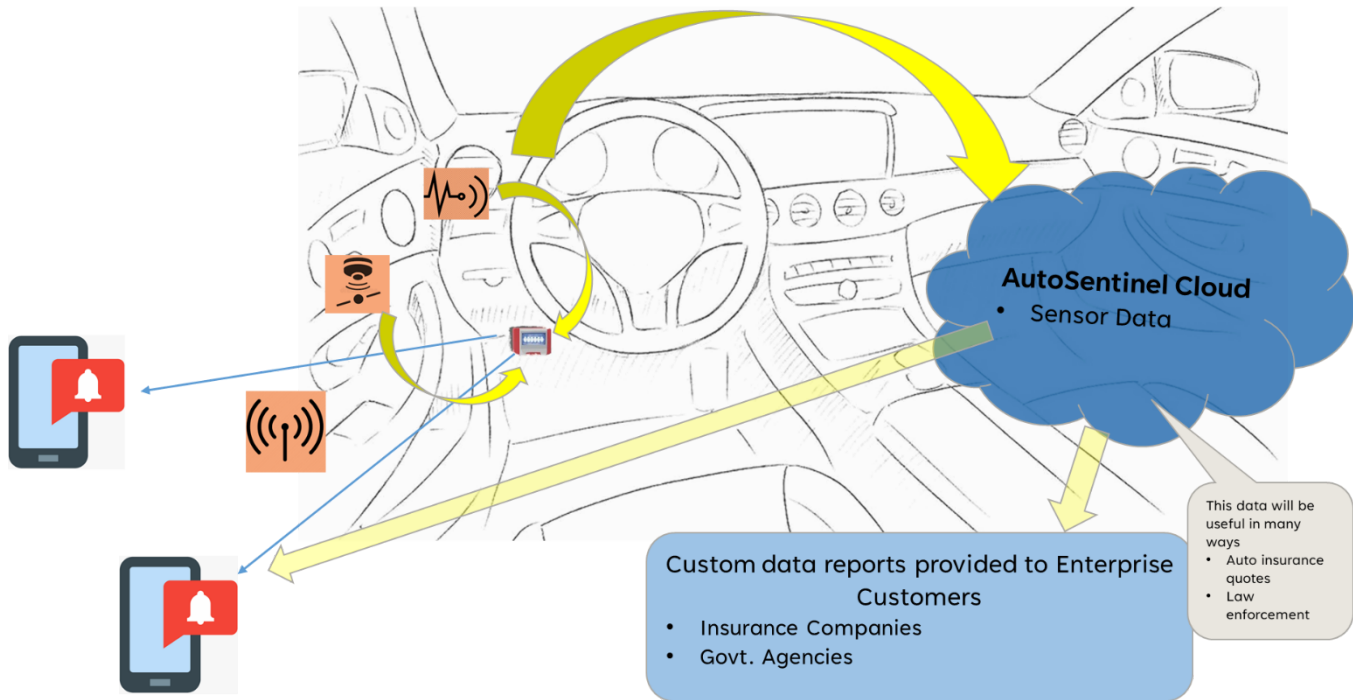
How the product works:
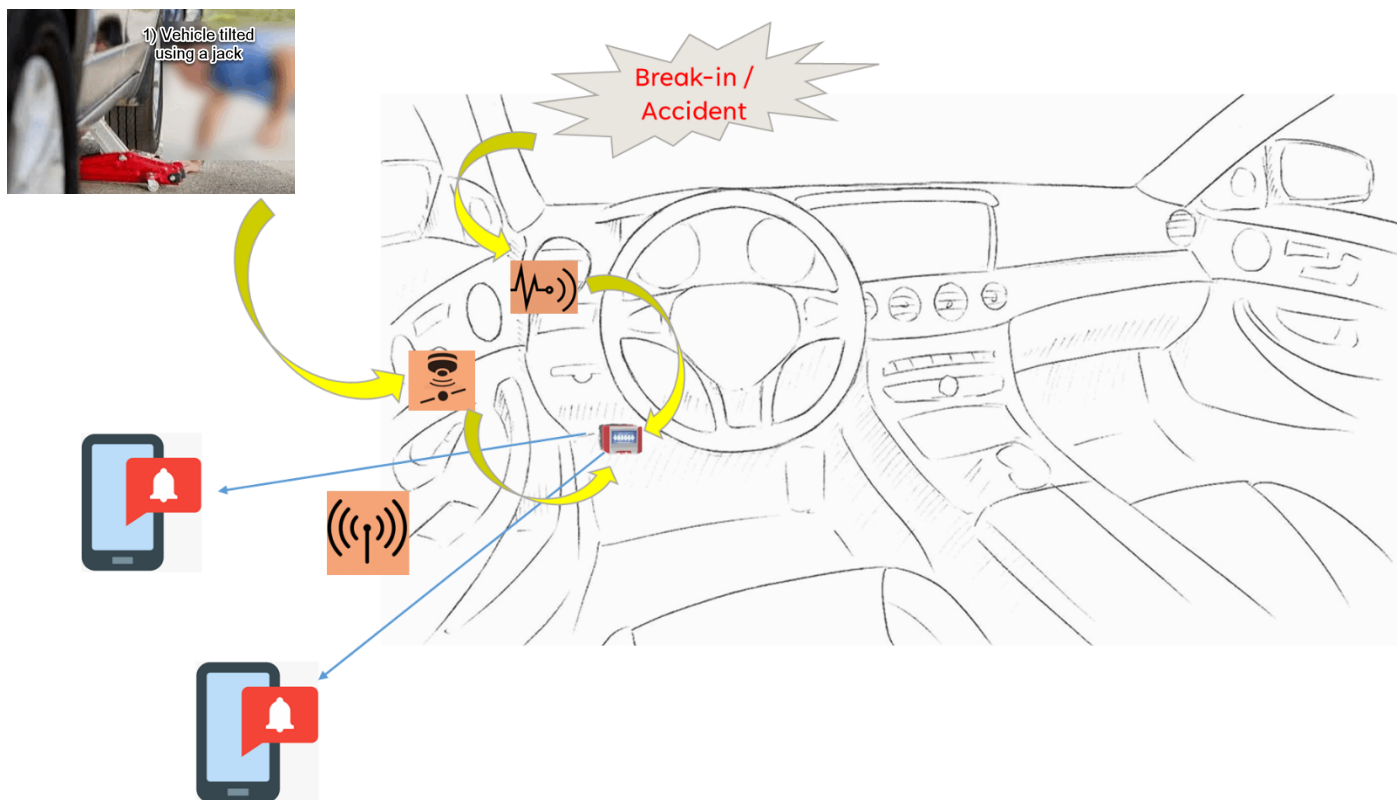
- Catalytic Convertor theft prevention: The catalytic convertor theft typically involves tilting of the car and then cutting off the Catalytic Convertor. The tilt sensor in the AutoSentinel immediately detects any tilt and triggers off the car alarm. The alarm will then deter the theft activity and thus prevent it from occurring

- Car break-in detector: The acoustic sensor detects any time a glass is shattered as it is tuned to identify this range of acoustic signal. The sensor will then trigger the car alarm. This can possibly prevent any theft taking place after the glass is shattered and scare away the intruder
- Both the tilt and acoustic sensors will not only trigger the alarm, but also notify the registered owners of the product on their cell phones

Monetizing the data generated by the sensors:

AutoSentinel Cloud
- Sensor Data

Custom data reports provided to Enterprise Customers
- Insurance Companies
- Govt. Agencies

This data will be useful in many ways
- Auto insurance quotes
- Law enforcement

- The data generated by the sensors across all the products installed on the vehicles, will be collected in the AutoSentinel cloud
- The data will provide valuable insights into area wise auto security incidents
- This data will be used to generate custom reports and metrics which can be of high value to enterprise customers like Auto Insurance Companies and Government Agencies
    - The Auto Insurance companies can use the data to plan their quotes and claims strategy, and more
    - Law enforcement agencies can use the date in coming up with optimal planning for the law-and-order management of a particular area
- The reports based on this data will be sold to these enterprise customers using a subscription model

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Value Proposition:

The below figure provides a quantitative cost comparison between the AutoSentinel product and other Catalytic Convertor theft prevention devices present in the market.
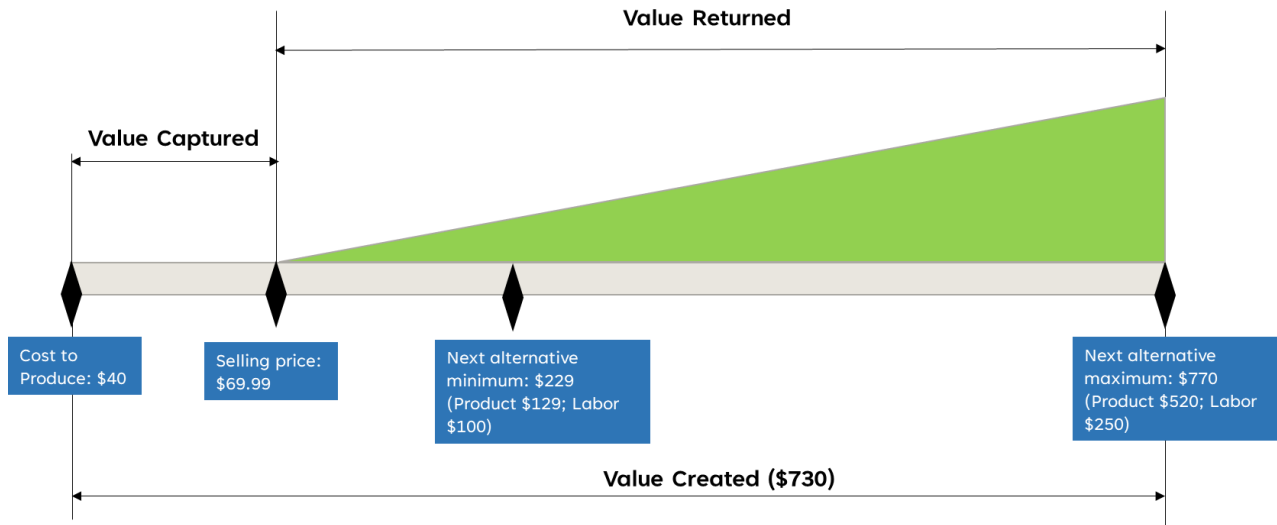
- The cost to produce and the selling price of AutoSentinel are listed on the left side of the figure. The difference between these two numbers (production and selling price) depicts the value that is captured by selling the AutoSentinel product
- On the right side, the range of costs for procuring and installing alternate theft prevention devices are listed
- As demonstrated in this figure, the AutoSentinel product is priced much lower and generates significant value when compared with the other products. Also, a major portion of this value is returned to the user of the product
- Apart from the cost savings demonstrated above, the AutoSentinel product is:
  - Easy to mount – no labor needed
  - Portable across vehicles
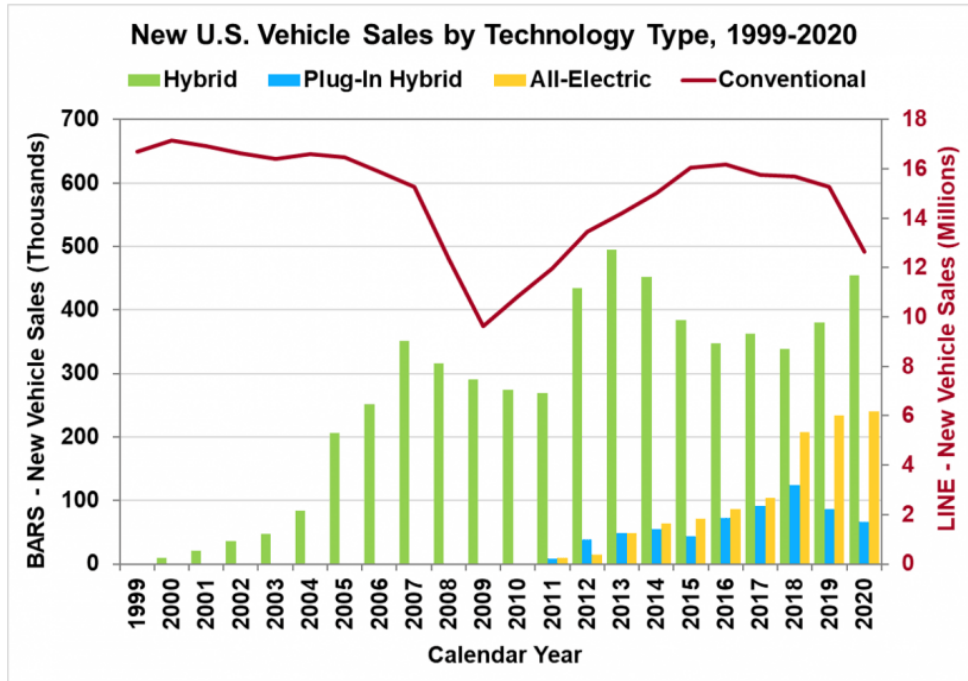 - Loaded with multiple features

Market Size

The market size for this product is based on the potential number of vehicles that can use this product. To arrive at the potential number of vehicles we collect the data from two perspectives:
1. Number of vehicles registered in the last 10 years
2. Number of vehicles per household and the number of those households that do not have a facility to park the vehicle inside a garage
   The thought process is that vehicles that are not garaged are the primary targets of theft. The number of these vehicles will provide a dependable market size. Additional point to note is that the vehicles that are parked in a garage overnight can also be targets of theft when they are in use and parked in public spaces outside. Hence the market size could potentially be higher than the one we initially calculate

Below two figures show the number of new vehicle sales over the last decade

New U.S. Vehicle Sales by Technology Type, 1999-2020

[New Light-Duty Vehicle Sales | Department of Energy](#)
Source:
https://www.energy.gov/eere/vehicles/articles/fotw-1200-august-23-2021-sales-new-electric-vehicles-us-were-2020-while

Vehicle Type	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Hybrid electric (Thousands)	274.648	268.749	434.648	495.535	452.172	384.4	346.949	362.868	338.083	380.794	454.89
Plug–in hybrid–electric (Thousands)	0.326	7.671	38.584	49.008	55.357	42.959	72.885	91.188	123.883	85.791	66.157
Conventional (Millions)	9	11	13	13.5	14.5	15.5	16	16	15.5	14	11.5

[Hybrid-Electric, Plug-in Hybrid-Electric and Electric Vehicle Sales | Bureau of Transportation Statistics (bts.gov)](#)
Source: https://www.bts.gov/content/gasoline-hybrid-and-electric-vehicle-sales

Based on the above two data charts:

  ☐ Number of light duty vehicles (Conventional + Hybrid + Hybrid Electric) in operation assuming
     10-year lifetime is approximately **154 to 200 million**
Households' data

- Total number of households in US ~ **128 million** (source: CENSUS.GOV)

- Average number of vehicles per household ~ **1.88**

- Number of households not having a garage/carport ~ **40%** (source: ENERGY.GOV)

Potential number of vehicles that could use the product in year 1:
Considering the above factors based on households and vehicle population in general, the potential number of vehicles that can use this product are:
<mark>128 x 40% x 1.88 = 96 million vehicles</mark>

This becomes our Total Addressable Market: 96M vehicles.

Assuming 10% of these 96M vehicles might considering buying this product, our **Target Addressable Market will be**: <mark>96 x 10% = 9.6M vehicles</mark>

The company believes there will be enough resources to serve a market size of 1.5M vehicles. So, the **Served Addressable Market** will be: <mark>1.5M vehicles</mark>

Business Model:

This AutoSentinel company proposes below business model:

- The product hardware will be priced at **$69.99**

- The subscription charges for consumers will be **$4.99**. This subscription will allow registration of two mobile phone numbers for alerts and notifications

- At a later phase after the launch and sufficient product sales, the company will target to sell data to enterprise customers. These customers will be charged between **$5000** and **$10000** for subscriptions per month
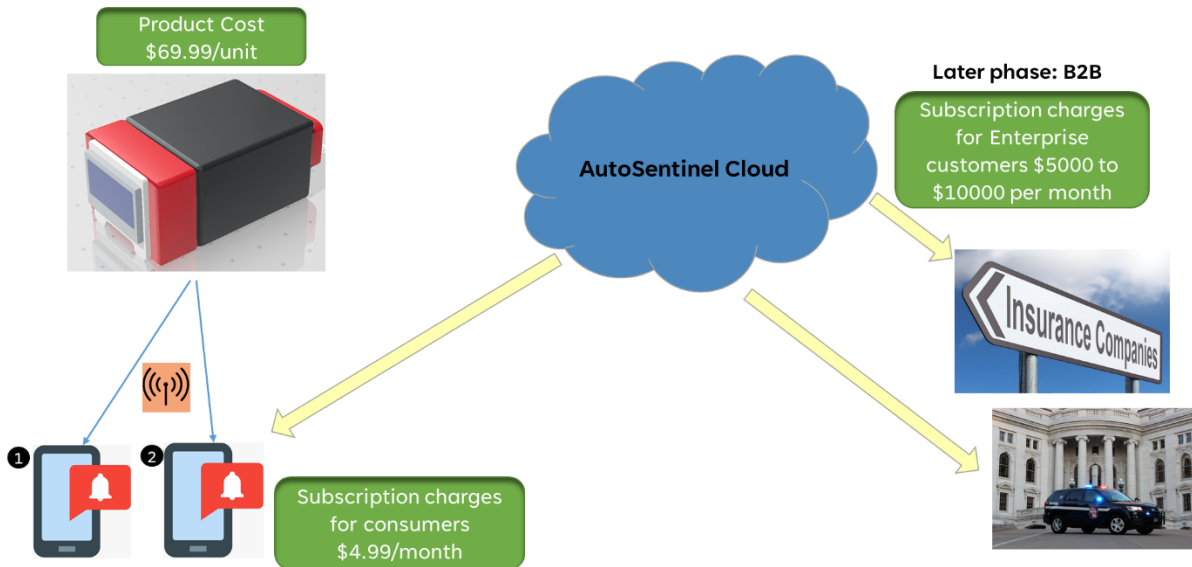
Go to Market Strategy

The primary go to market strategy will be to tie up with an insurance company, to get the product into the hands of the consumers. The thought process is that since the value proposition of this product is to secure the car, it will be beneficial for the insurance companies to have this product installed on their customers' cars.

- An effective partnership with an insurance company will help come up policy structure that includes discounts to accommodate the subscription cost

- This mode of go to market will instill more trust in the product from the consumer's viewpoint

Target Market

Plug-in hybrid electric

Hybrid electric

Conventional low-duty (*e.g.*, sudans)

Go To Market Strategy

o **Partner with auto insurance companies to get product to consumers**

- Policy discounts
- Periodicals/mailers/magazines
- E-commerce fulfillment

o **Revenue through consumer subscriptions**

- Notifications/reports

o **Revenue through sale of AUTOSENTINEL data to enterprise entities**

KNOWLEDGE

Launch Market Team

Seek out networked talent with strong ties & influence with top-tier auto insurance companies

State Farm   GEICO

PROGRESSIVE   Allstate.
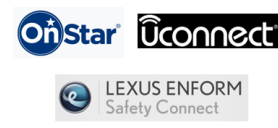
Competitive landscape:

Comparative analysis with other Catalytic Convertor theft prevention devices

The table below offers comparison of the AutoSentinel with other traditional Catalytic Convertor theft prevention devices currently available on the market. Sensor-based devices, like the AutoSentinel, that exist in the market are based on motion and/or heat signatures. However, they often tend to either falsely trigger an alarm due to their oversensitivity or fail to trigger altogether. Thus, they are simply just too unreliable. For example, consumer reviews have documented cases where their catalytic convertor anti-theft sensor devices have triggered an alarm simply by approaching the vehicle to unlock their vehicle's doors. Other reviews have reported false alarm triggering due to animal movements underneath their vehicles. In one case, a consumer fortunately avoided a potential fire incident due to a design flaw in one sensor product (lack of fuses despite being powered by the vehicle battery). Unlike these devices, the AutoSentinel is portable and compatible to any vehicle type manufactured after the year 2000 through use of the OBD port. Furthermore, the device can be installed without professional help, reducing the cost to the consumer.

	AUTOSENTINEL	CATEVE	cat security™ MILLERCAT	CatClamp	CATSTRAP
COST	69.99	180 – 200	190 – 460	200 – 900	130 – 200
INSTALL LABOR (IF PROFESSIONAL)	0 (not required)	~150	~150	~50 - 100	~100
PORTABILITY	🟩	🟩	🟨	🟨	🟥
COMPATIBILITY	🟩	🟩	🟥	🟨	🟨
RISKS	o Versatility to high rise vehicles o Manufacturing date >2000	o Fire risk o Long-term reliability o False triggering	Limited market (7 vehicle types)	o Vehicle compatibility o Parasitic rattling noises	o Custom sizing required by consumer o Voided part warranty

Competitive landscape – other features

Automobile sensor data generation is not a new concept and exists in many forms in the market, as shown in the table below. In fact, many of these sensors simply plug into the OBD port, like the AutoSentinel. However, all of these plug-in devices fail to feature catalytic convertor and vehicle break-in deterrence measures. A majority of these plug-ins simply provide global positioning system (GPS) and/or vehicle health monitoring. Furthermore, in addition to a monthly fee, some of these plug-ins are network-carrier-exclusive (e.g., Verizon, AT&T, T-Mobile) and require additional data plans and activation fees to use them. The AutoSentinel's built-in features allow for vehicle break-in and catalytic convertor deterrence while offering a low-cost monthly subscription fee and mobile network flexibility for the consumer.

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	NON-EXCLUSIVE PLUG-INS		CARRIER-EXCLUSIVE PLUG-INS	CONNECTED VEHICLE PLATFORMS	
	AUTOSENTINEL	Bouncie vyncs FIXD LandAirSea	hum SyncUP DRIVE HARMAN spark	OnStar Uconnect LEXUS ENFORM Safety Connect	
PRICE TO CONSUMER	$69.99 + $4.99/mo.	$59–$77 + $6–8/mo.	~$100 + ~$35–40 activation fee + hot-spot data plan	$8–$50/mo.	
NETWORK CONNECTIVITY	Consumer dependent	Consumer dependent	Data plan dependent	Satellite coverage	
CC THEFT DETERRENCE	Tilt sensing	No deterrence features	No deterrence features	No deterrence features (except Telsa)	
BREAK-IN DETERRENCE	Acoustic & vibration sensing	Vibration sensing in some models	No deterrence features	No deterrence features (except Telsa)	
SELLABLE DATA GENERATION	Sensor output, vehicle health	Sensor output, GPS, vehicle health	GPS, vehicle health	GPS, vehicle health	
VEHICLE SPECIFICITY	No specification	No specification	No specification	Plug-in versions available	

Future roadmap to expand the capabilities of the product

AutoSentinel product provides a sound base to expand on its capabilities in the future phases. Some of the proposed enhancements are listed below:

1. **Capturing engine performance data via the OBD port**: This data will provide additional value that could be tapped by more enterprise customers like Fleet owners and vehicle OEMs
2. **Inter devices connectivity:** The AutoSentinel products will be enhanced to communicate with each other when they are installed on different vehicles and the vehicles are in a close vicinity of 500 ft radius. This connectivity will help alert other vehicle owners in the vicinity if one of them senses a security incident. This feature will be a great value proposition for the product
3. **GPS connectivity:** The product will be able to communicate with the GPS satellite. This communication can further enable a host of features including tracking of auto thefts
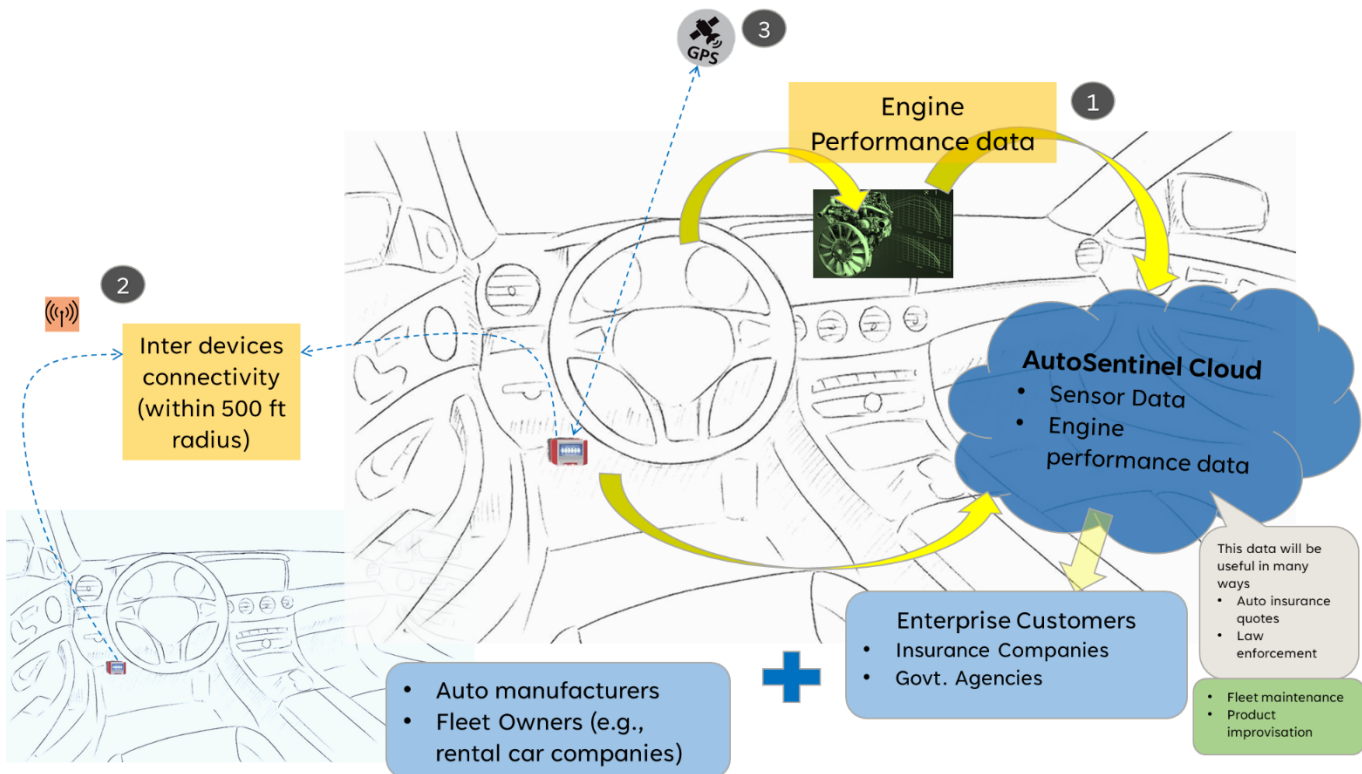
Revenues, Costs, profit

- Below table summarizes the projected revenues, costs and profits based on the estimates of product and subscription sales in the first five years.
- The calculation considers cost of the resources that will be required to get the product to the market and sustain the operations
- The spreadsheet embedded below the table provides the details behind the numbers summarized in the below table

Based on this projection the breakeven can be expected between the years two and three.

	Year One	Year Two	Year Three	Year Four	Year Five
Number of units sold	1200	30000	84000	126000	168000
Revenue from HW sale	$83,988	$2,099,700	$5,879,160	$8,818,740	$11,758,320
Revenue from Subscription	$114,950	$1,825,086	$6,072,796	$13,334,986	$23,542,136
Total Revenue (A)	$198,938	$3,924,786	$11,951,956	$22,153,726	$35,300,456
Cost of Goods Sold (B)	$54,250	$1,439,250	$4,510,500	$7,791,750	$11,703,000
Fixed Costs (C)	$2,650,000	$2,280,000	$2,910,000	$2,910,000	$3,010,000
Net Profit [A-(B+C)]	-$2,505,312	-$794,464	$3,031,456	$9,451,976	$18,087,456

AutoSentinel - Revenue, Costs and P

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Timeline:

Below figure provides the proposed timeline of the company with certain key milestones. To get the product built and start its fulfillment in the span of first year, the company will need a funding of 3 million. Of these 3 million, one million will be needed that time of launch and the remaining towards the end of first year. Apart from finance there are other specific asks for the VCs. These are primarily access to contract manufacturers/suppliers and entry into the retail giants as sales channels.

TIMELINE