Patents and Application of the New IEEE InnovationQ Plus Analysis and Discovery Tool

Joseph E. Jesson

- **- Chair, IEEE Princeton LIFE**
  - CEO RFSigint, jejesson4@gmail.com
- **- Adjunct Professor, The College of New Jersey**

Contact:
jejesson4@gmail.com
jessonj@tcnj.edu
M: 203-613-3344

Outline

- VEHICLE SENSORS TECHNOLOGY TAXONOMY
- BIRTH of VEHICLE SENSORS & Motivation
  - EEC I – EEC 3 EGR, Pressure, Temperature, Oxygen, etc.
  - ACCELEROMETER, ODOMETER, SENSOR PID CODES CAN BUS
- SENSORS which ENABLE SELF-DRIVING VEHICLES
  - LIDAR – LIGHT DETECTION AND RANGING
  - IMAGERS – MULTIMPLE 2D, 3D
  - RADAR – 24 GHz MICROWAVE
- INNOVATIONQ PLUS ANALYSIS AND DISCOVERY
  - CONVOLUTIONAL NEURAL NETWORK APPLICATIONS
  - LIDAR SENSOR APPLICATIONS
- SPECIFIC PATENT EXAMPLE

SAE and NHTSA Classification

<table>
<tr><th>SAE Name</th><th>SAE</th><th>NHTSA</th><th>NHTSA Name</th></tr>
<tr><td colspan="4">Human driver monitors the driving environment</td></tr>
<tr><td>No automation</td><td>0</td><td>0</td><td>No automation</td></tr>
<tr><td>Driver assistance</td><td>1</td><td>1</td><td>Function-specific automation</td></tr>
<tr><td>Partial automation</td><td>2</td><td>2</td><td>Combined function automation</td></tr>
<tr><td colspan="4">Automated driving system monitors the driving environment</td></tr>
<tr><td rowspan="2">Conditional automation</td><td rowspan="2">3</td><td rowspan="3">3</td><td rowspan="3">Limited self-driving automation</td></tr>
<tr></tr>
<tr><td rowspan="2">High automation</td><td rowspan="2">4</td></tr>
<tr><td rowspan="3">4</td><td rowspan="3">Full self-driving automation</td></tr>
<tr><td rowspan="2">Full automation</td><td rowspan="2">5</td></tr>
<tr></tr>
</table>

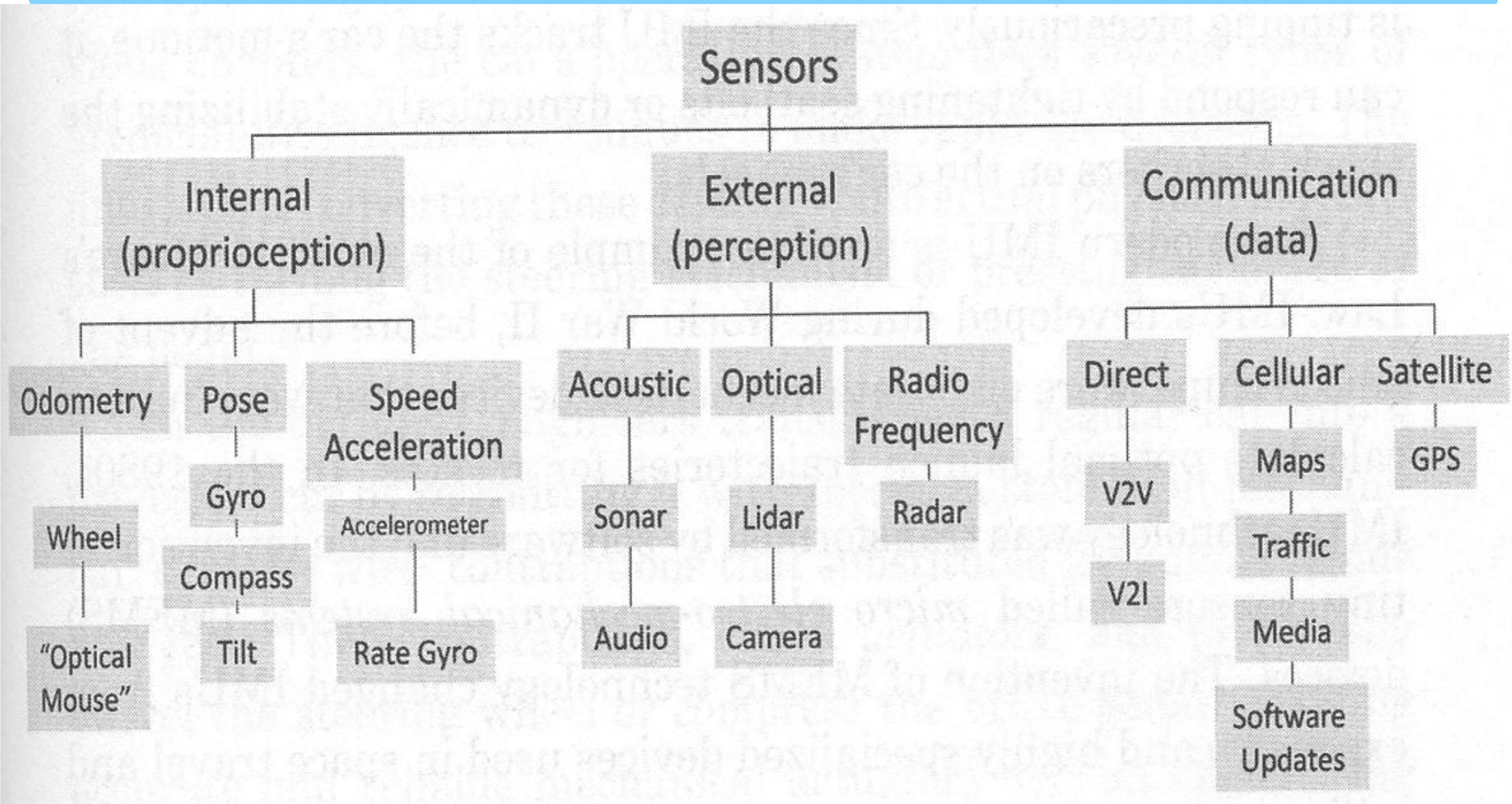
SAE J3016: http://www.sae.org/misc/pdfs/automated_driving.pdf

NHTSA: www.nhtsa.gov/staticfiles/rulemaking/pdf/Automated_Vehicles_Policy.pdf

Connected vs. Automated

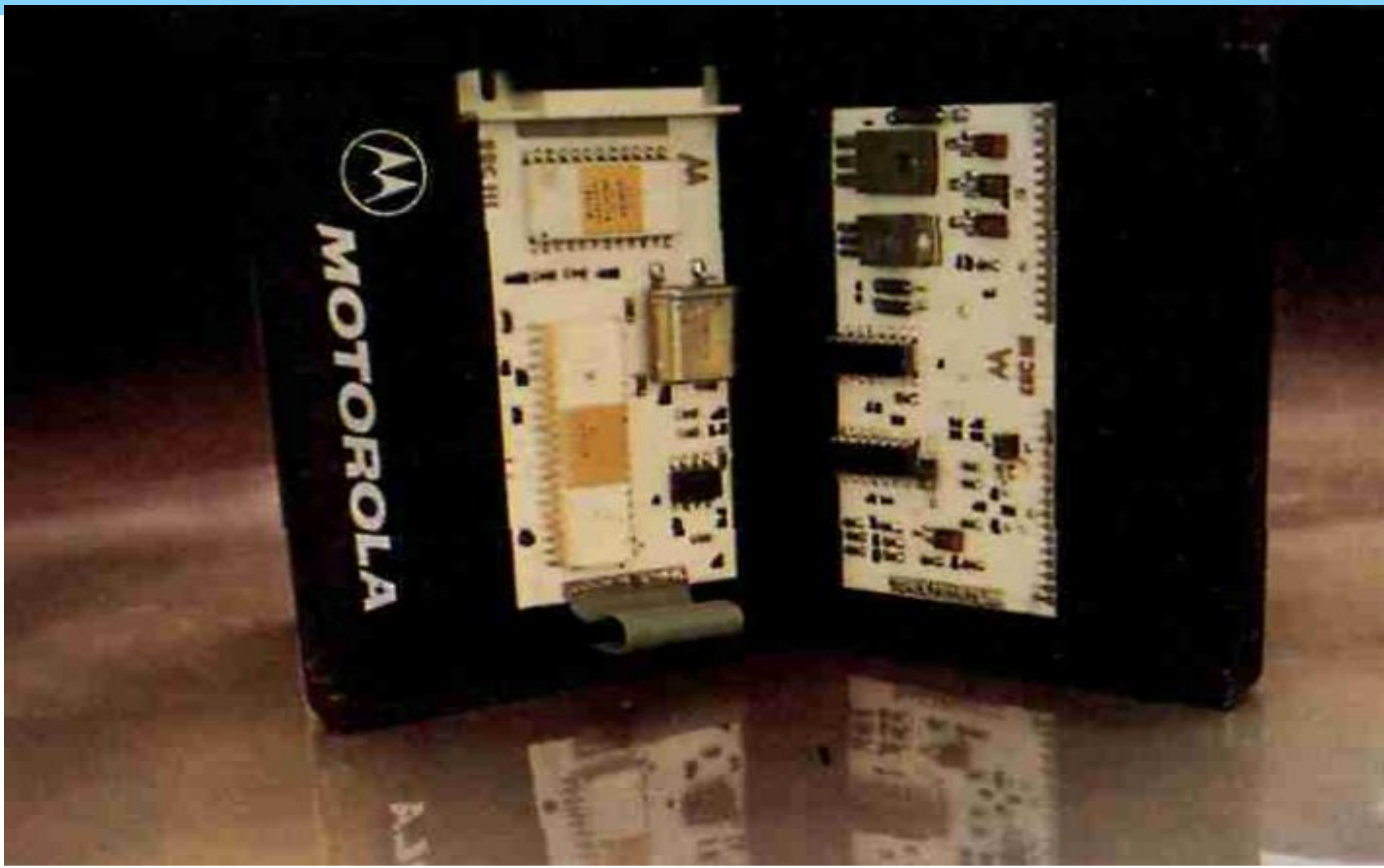
- **Automated**
  - At least some control of vehicle functions
  - Does not depend on CV technology
  - Examples: current applications (forward collision avoidance, traffic jam assist), Google car
- **Connected**
  - V2V, V2I, V2P communications
  - Advisories and warnings to the driver
  - Example: Safety Pilot
- **Automated and Connected**
  - Example: Cooperative Adaptive Cruise Control

Self-Driving Vehicle Sensor Taxonomy



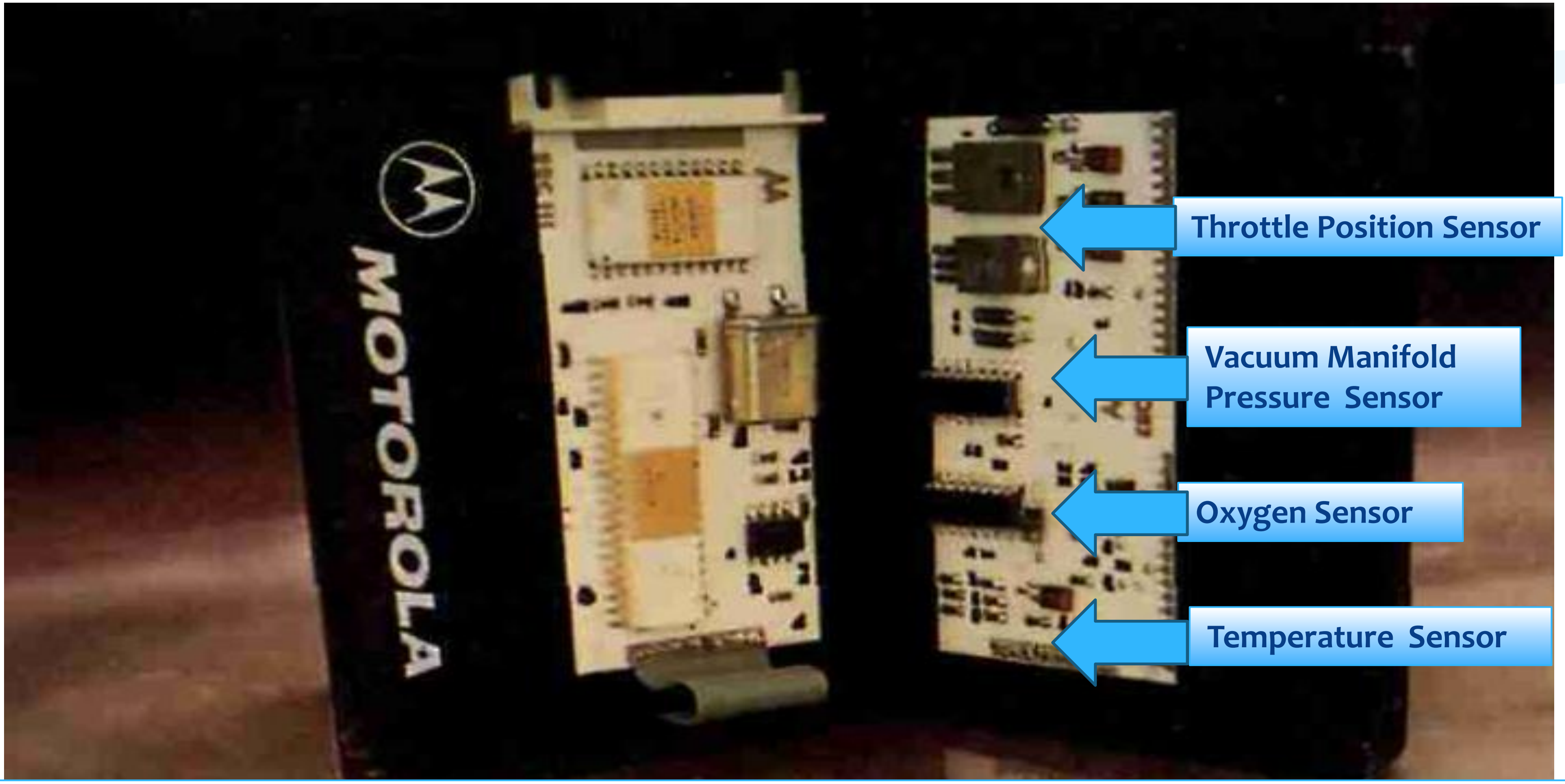
Ref: Driverless: Intelligent Cars and the Road Ahead, Hod Lipson and Melba Kurman, MIT Press, 2016, pg. 189

1977 FIRST MICROCOMPUTER IN AN AUTOMOBILE – MOTOROLA EEC I-III



REF: https://www.motorolasolutions.com/content/dam/msi/docs/en-xw/static_files/1977_Motorola_Annual_Report.pdf

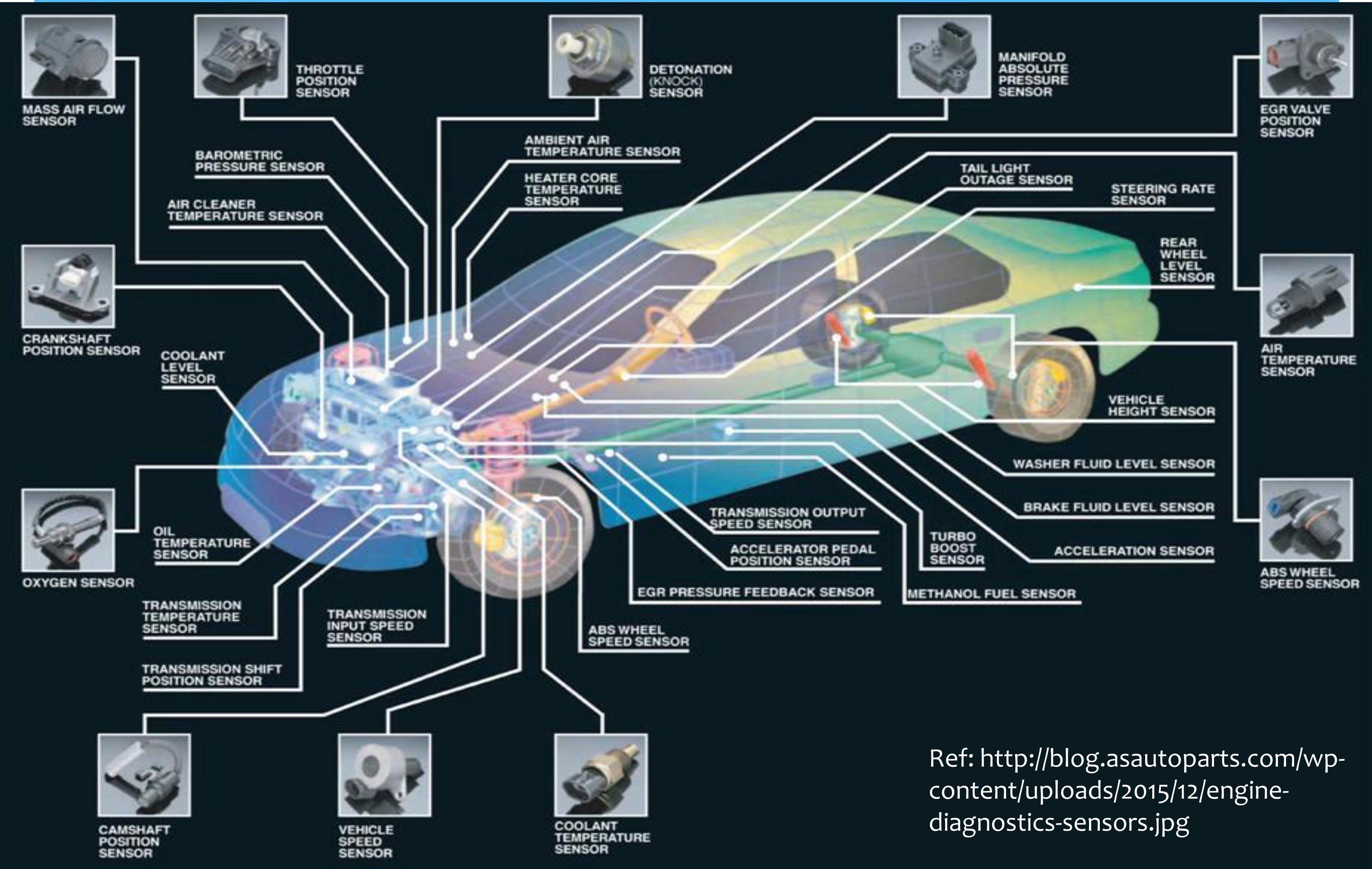
1977 FIRST MICROCOMPUTER IN AN AUTOMOBILE – MOTOROLA EEC I-III



"The company reinforced its strong position in the automotive engine electronics business when the Automotive Products Division, in cooperation with the Semiconductor Group, won a competitive design award from Ford for an electronic engine control (EEC). Under terms of the award. Motorola will supply to Ford at least 25 per cent of their EEC requirements for the 1980 model year."

REF: https://www.motorolasolutions.com/content/dam/msi/docs/en-xw/static_files/1977_Motorola_Annual_Report.pdf

2017 Internal Vehicle Sensors

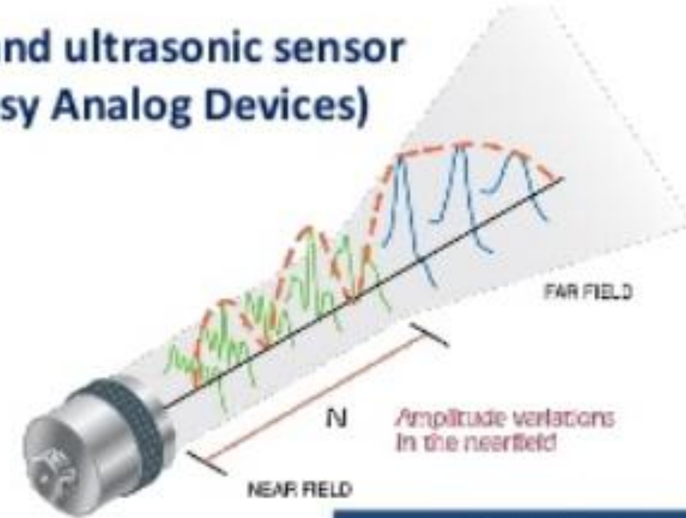


Ref: http://blog.asautoparts.com/wp-content/uploads/2015/12/engine-diagnostics-sensors.jpg

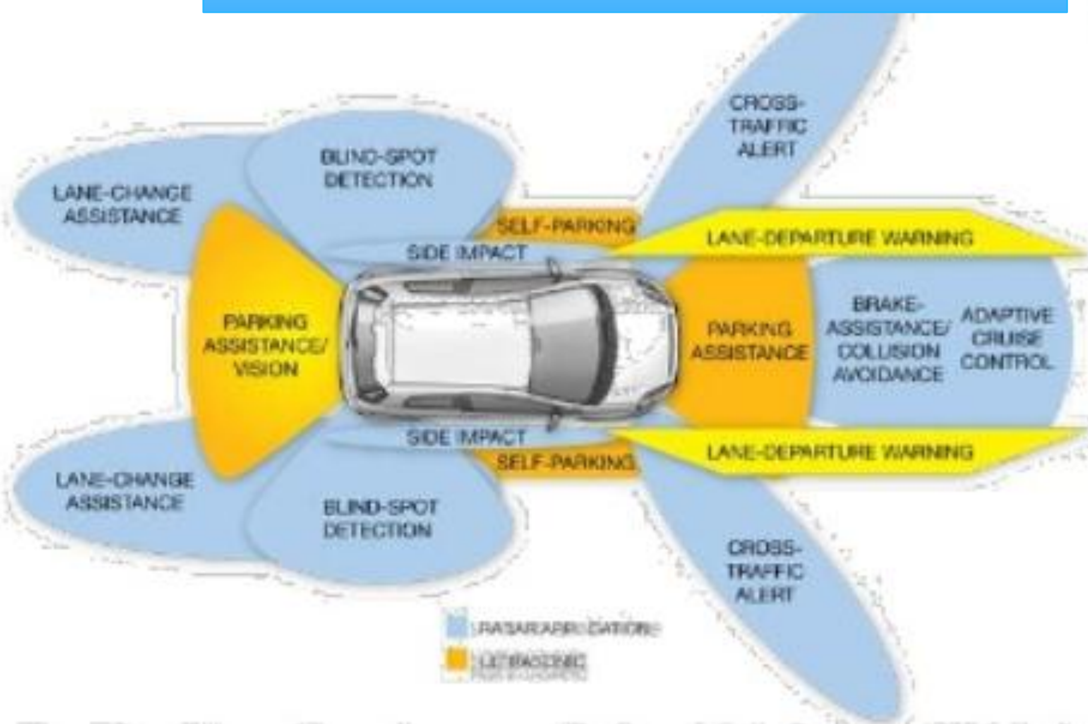
Ultrasonic and RF Radar Sensors

Ultrasonic sensors are used to assist the driver in autonomous vehicle.

Radar and ultrasonic sensor (Courtesy Analog Devices)



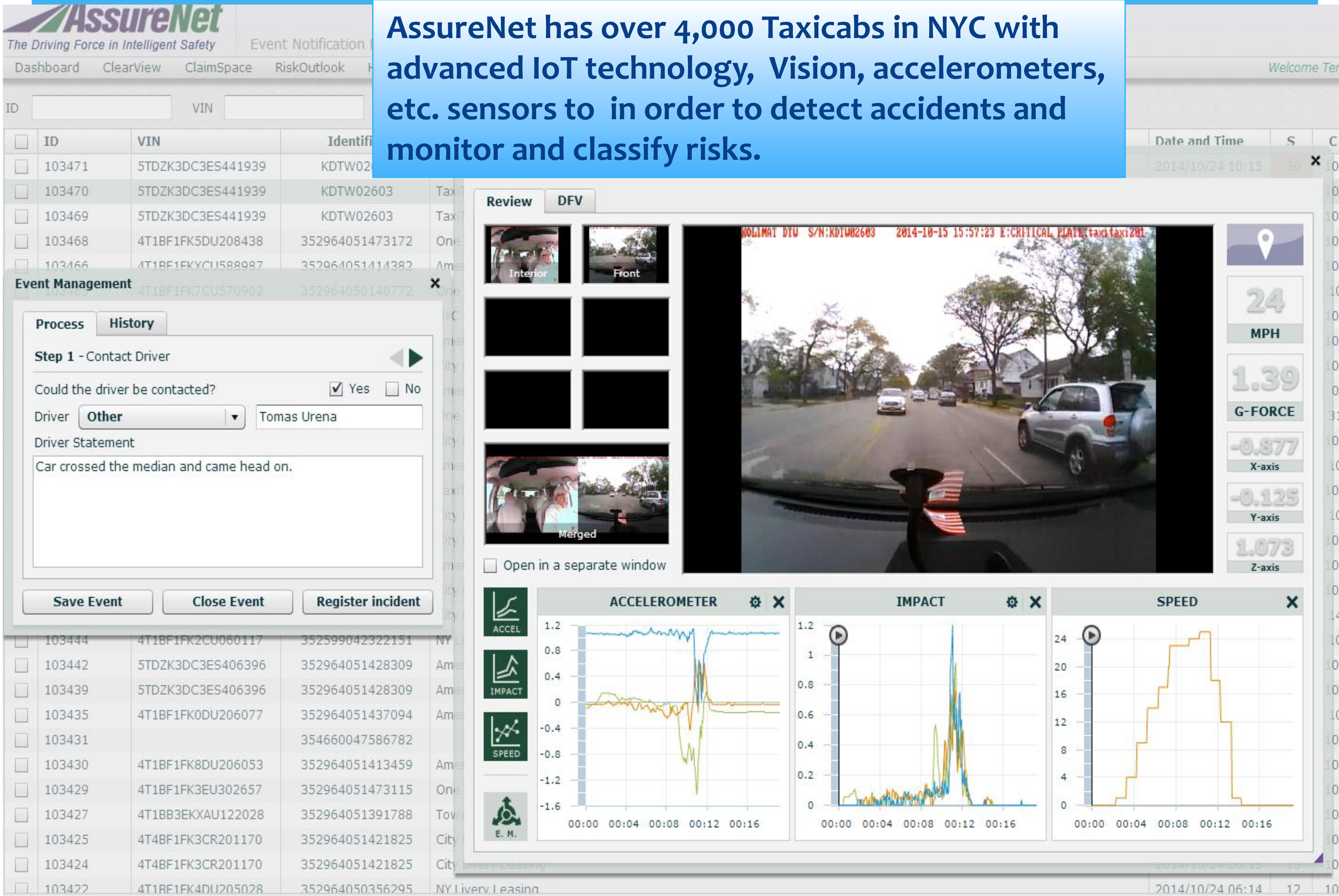
Ultrasonic and RF Radar sensors are limited in range but work through conditions of poor visibility and complements Vision and LIDAR sensors



Variable gain amplifier used in ultrasonic sensor (USD12 each) (Courtesy Analog Devices)

AssureNet's CLEARVIEW Platform

AssureNet has over 4,000 Taxicabs in NYC with advanced IoT technology, Vision, accelerometers, etc. sensors to in order to detect accidents and monitor and classify risks.



AssureNet's CLEARVIEW Platform

Trigger EVENTS e.g. may be an accelerometer G-force transition threshold or a manual EVENT where the driver manually initiates a threat switch. Other EVENTS are enabled and customized per risk.

AssureNet

miniEgress™

AssureNet's Universal IoT Mobile Sensor Platform

Powerful Industrial IoT Platform
Based on Qualcomm® Snapdragon™ 410 processor (APQ8016)

ClearView 'Big Data' Platform
Unstructured Data & Streaming Analytics

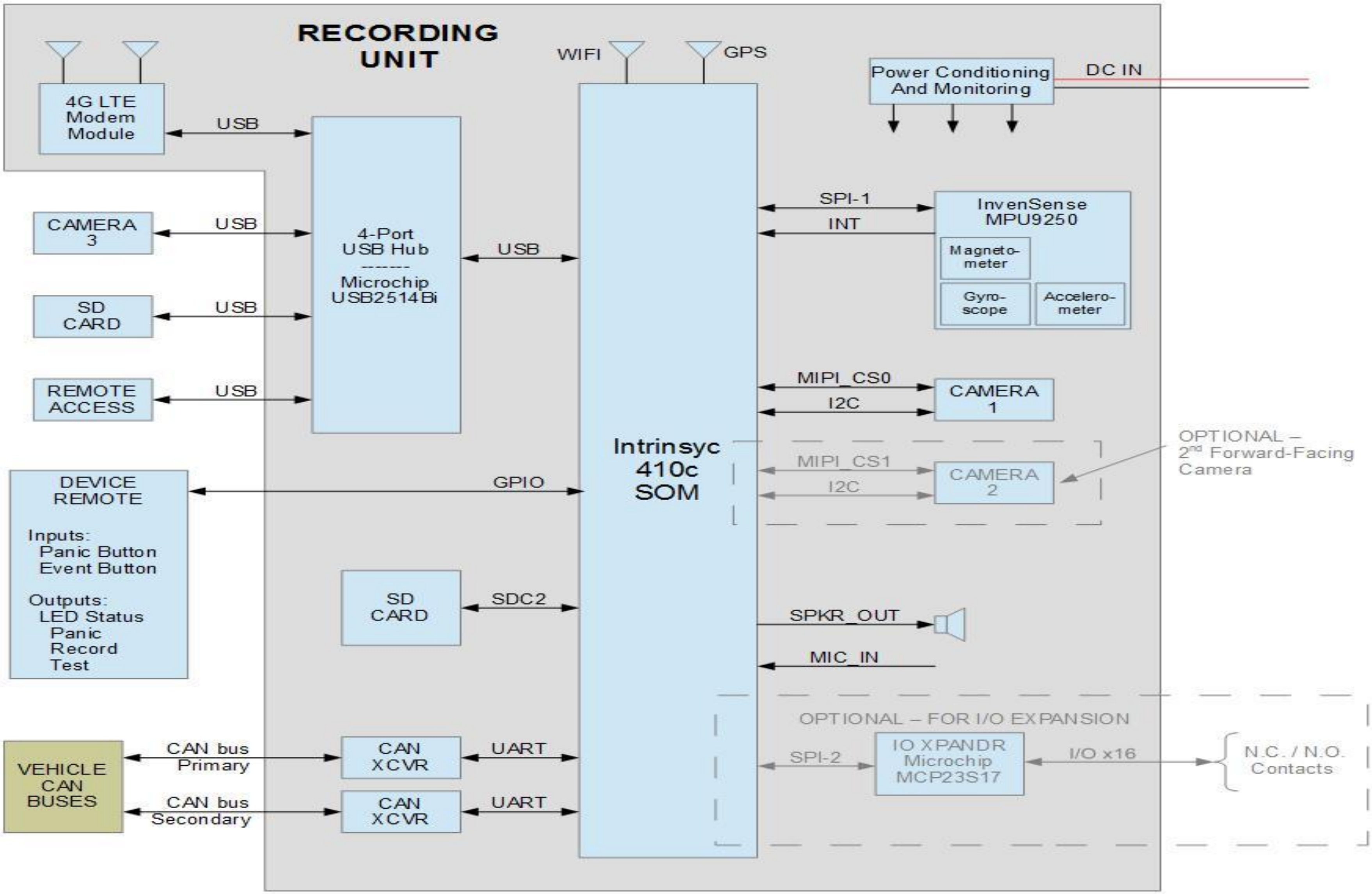
Android or Linux OS Applications
VEDR+ ADAS + Open/FastCV

WiFi 802.11b/g/n & Bluetooth 4.1
3G/4G, mesh & Orbcomm satellite options

Ruggedized
IP-69 enclosure for Industrial IoT Application

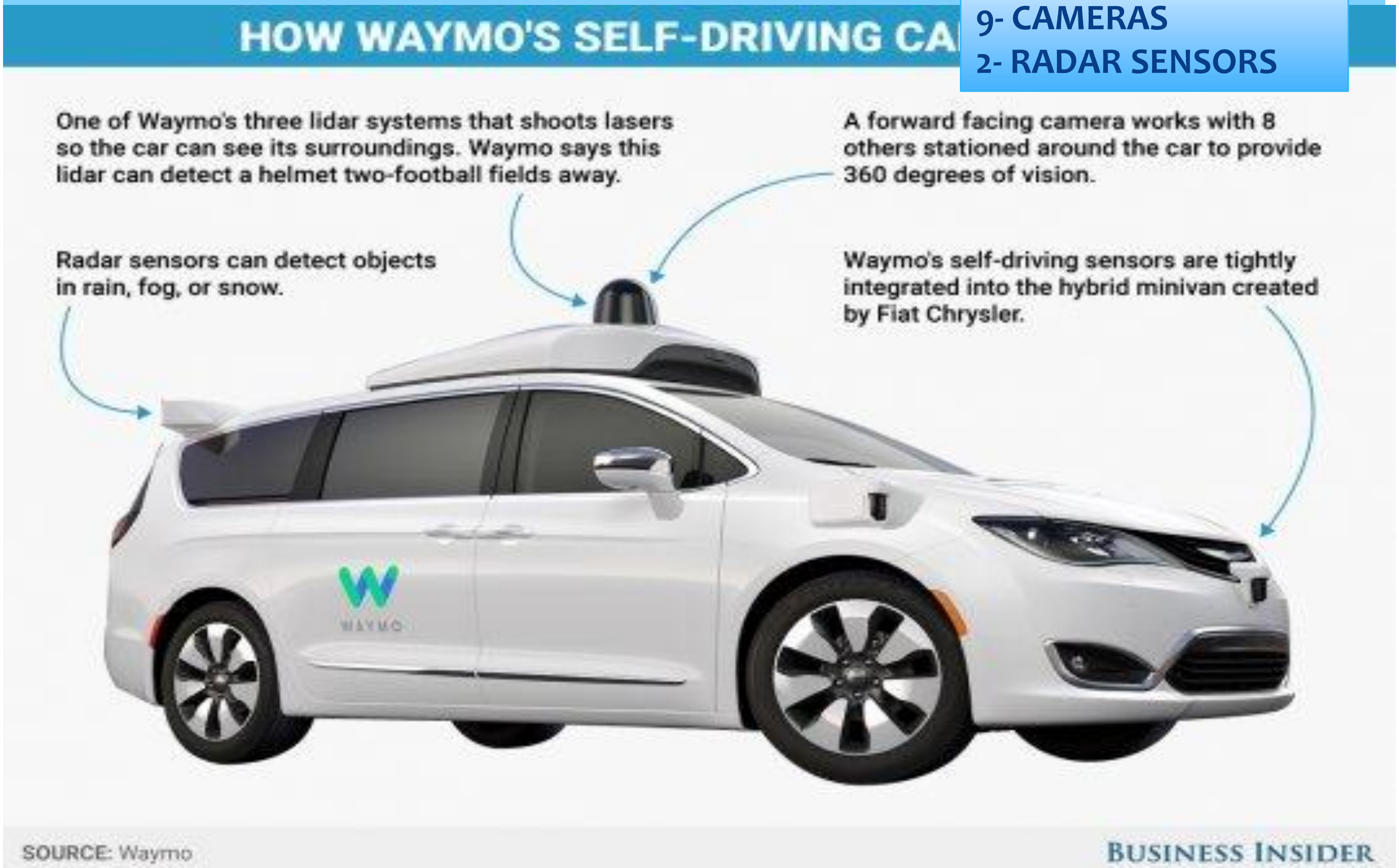
[1] Qualcomm Snapdragon processors are a product of Qualcomm Technologies, Inc

AssureNet's miniE Architecture



WAYMO (GOOGLE) SELF-DRIVING CAR

3- LIDAR SYSTEMS
9- CAMERAS
2- RADAR SENSORS



UBER SELF-DRIVING CAR

"Short-Term, as cars gain Level 2 or 3 automation (note SAE J3016 levels of automation) and legislation still requires human drivers to take the wheel as a backup – drivers will build confidence over time and ready for full automation."

http://electronicdesign.com/embedded/11-myths-about-autonomous-vehicles

TESLA SELF-DRIVING CAR

Tesla Model S cars and the newer Model X have had an Autopilot feature

http://electronicdesign.com/embedded/11-myths-about-autonomous-vehicles

TESLA SELF-DRIVING CAR

Tesla Model S cars and the newer Model X have had an Autopilot feature

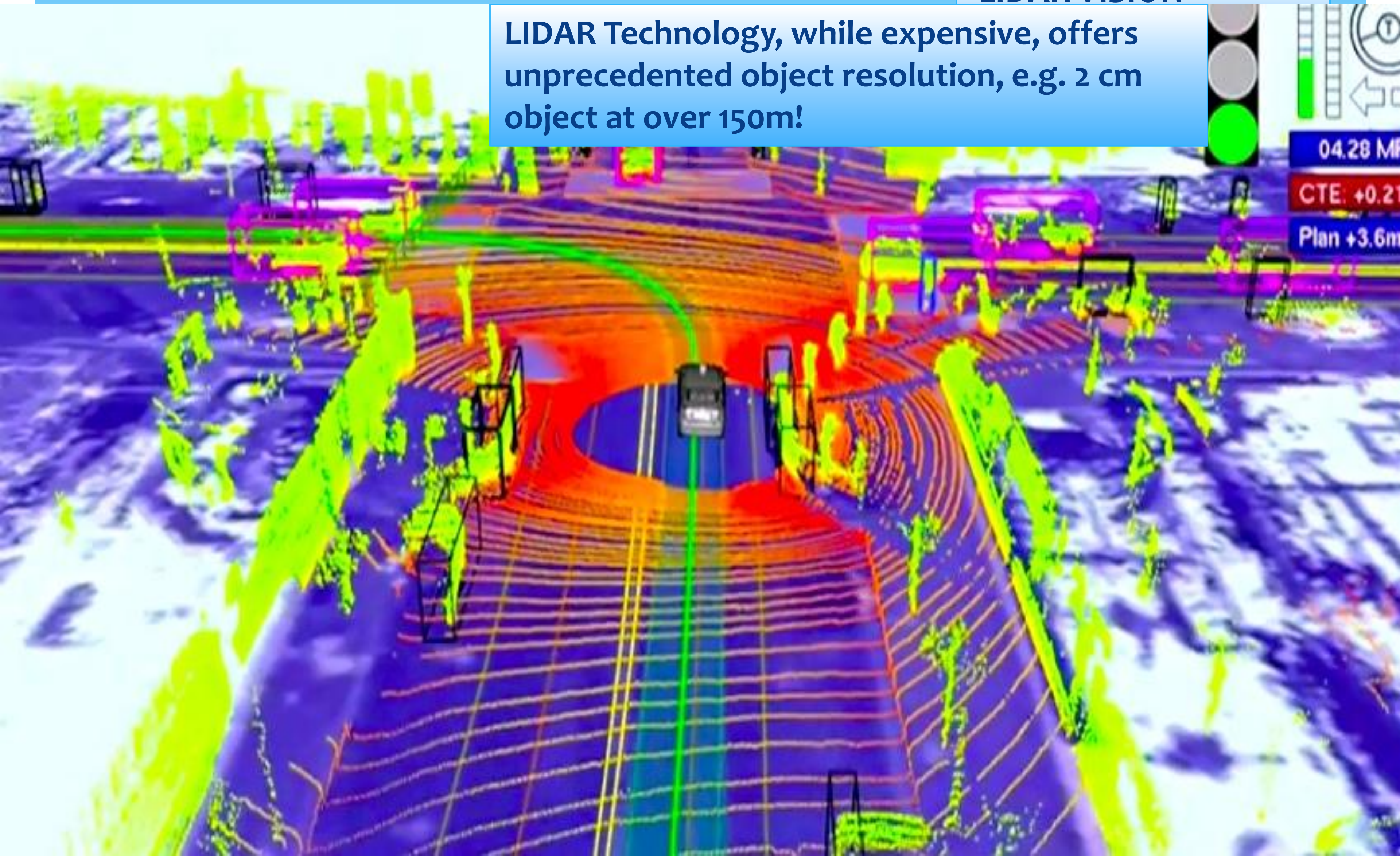
In May of 2016, a driver using Tesla's Autopilot **collided fatally with a tractor trailer**. Analysis indicates the autopilot software did not detect the white tractor trailer against a background of a bright sky – **additional fused radar & LIDAR sensors would have prevented this optical camera dynamic range limitation** as integrated in the WAYMO vehicle

http://electronicdesign.com/embedded/11-myths-about-autonomous-vehicles

WAYMO (GOOGLE) SELF-DRIVING CAR

LIDAR VISION

LIDAR Technology, while expensive, offers unprecedented object resolution, e.g. 2 cm object at over 150m!



GEN I LIDAR SPECS

Velodyne LiDAR™

HOME PRODUCTS INDUSTRY FAQ DOWNLOADS RESELLERS MEDIA ABOUT CAREERS CONTACT US

$8,000 each in 2015 !

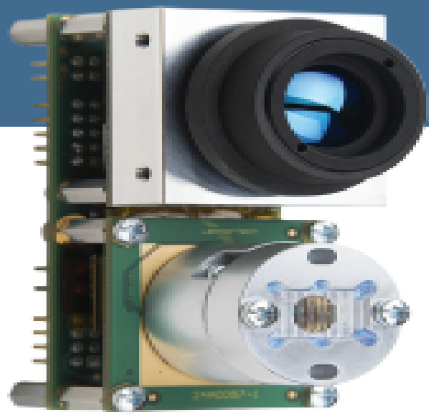
- 64 Channels
- 120m range
- 2.2 Million Points per Second
- 360° Horizontal FOV
- 26.9° Vertical FOV
- 0.08° angular resolution (azimuth)
- <2cm accuracy
- ~0.4° Vertical Resolution
- User selectable frame rate

GEN 2 LIDAR SPECS

Ref: https://www.youtube.com/watch?v=P3G_inKfj9A

COMPACT FIXED-BEAM LIDAR SENSOR MODULE

Multi-object, wide-beam optical detection and ranging over 8 segments



GEN II, <$250 in 2017

LeddarVu is a new solid-state LiDAR platform that combines the benefits of a compact architecture with superior performance, robustness and cost-efficiency.

LeddarVu Benefits

- Compact form factor (190 cm³)
- Fixed beam, no moving parts
- Proven reliability, even in harsh conditions
- Immune to ambient light
- Modular platform for flexible integration and customization
- Best cost/performance ratio

Vu8 Module Features

- Detection range up to 215 meters (~700 ft.)
- Compact and lightweight (~107 g)
- Multiple independent segments with simultaneous acquisition and lateral discrimination capabilities
- 20°, 48° and 100° beam width options, for optimized field of view
- Rapid refresh rate up to 100 Hz

LeddarVu - The new platform for next-gen Leddar sensors

LeddarVu brings a whole new dimension to sensing applications with an optimized modular design that offers a better range, a smaller form-factor and greater flexibility of integration than any other sensor module. Leveraging LeddarTech's unique expertise in LiDAR detection and ranging, every optical sensor built on the LeddarVu platform inherits the unique added value of Leddar, which is better sensitivity, immunity to ambient light and robust performance in inclement weather, and powerful signal processing.

Conceived to follow the evolution of the next generations of LeddarCore ICs, the LeddarVu platform fosters the development of highly differentiated and affordable solutions powered by optimized Leddar configurations.

Vu8 – 8 segments LiDAR sensor module

Vu8, the first Leddar sensor module built on the LeddarVu platform, leverages powerful class-1 laser illumination and 8 independent active detection elements into a single sensor, resulting in rapid, continuous and accurate detection and ranging of objects — including lateral discrimination — in the entire wide beam, without any moving parts. Detecting targets up to 215 m and weighting only 107 grams, the Vu8 uses a fixed laser light source, which significantly increases the sensor's robustness and cost-efficiency compared to any scanning LiDAR solution.

Vu8's source assembly combines the IR Laser emitter with a dominant wavelength of 905 nm and diffractive optics, providing a wide illumination beam which is available in three horizontal and two vertical field of view options. The receiver assembly includes 8 independent detection elements with simultaneous multi-object measurement capabilities and hosts the powerful Leddar signal processing algorithms. Vu8's carrier board hosts the electrical and communication interface of the module. Two interface configurations are available: SPI or USB-CAN-Serial (UART/RS-485).

Software Development Kit (SDK)

The Leddar Enabler SDK provides a user-friendly application programming interface (API) with .Net and C libraries and code examples. Sample code for both Windows and Linux, as well as MATLAB integration examples, are also provided.

GEN 2 LIDAR SPECS

<$250 in 2017

Characteristics

Number of segments 8

Beams 20°, 48°, 100°

Vertical FoV options 0.3°, 3°

Wavelength 905 nm

Power supply 12 VDC

Interface options SPI, USB, CAN, Serial (UART/RS-485)

Ocular safety Fulfills the requirements of IEC 60825-1:2014 (Third Edition); Class I laser product (certification pending)

System performance

Accuracy 5 cm

Data refresh rate up to 100 Hz[1]

Operating temperature range -40°C to +85°C

Distance precision 6 mm

Distance resolution 10 mm

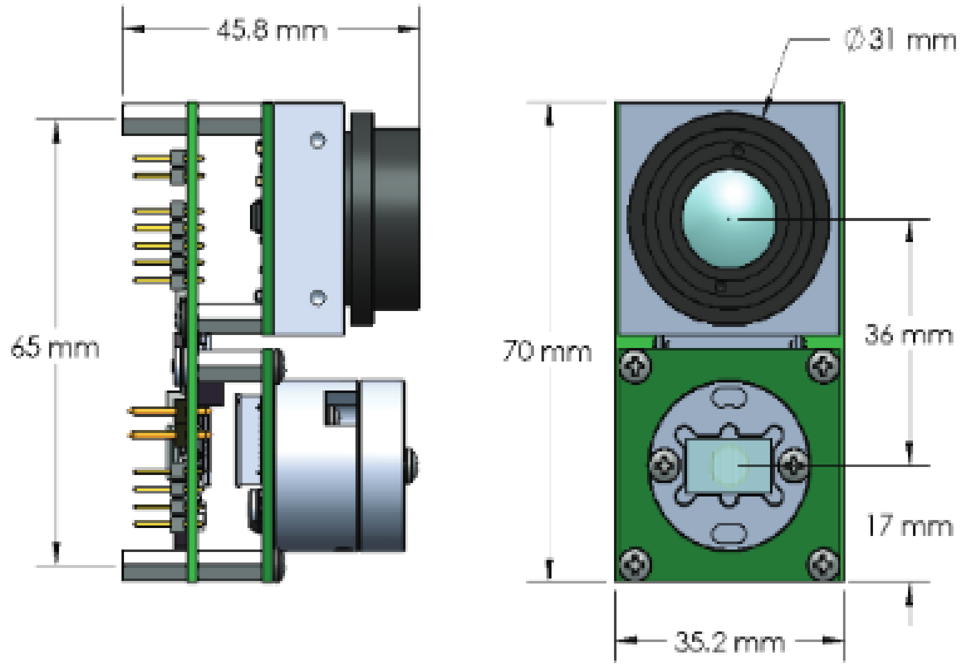
Power consumption 2 W

1 Depends on configuration

Ordering Information

VU8 - XXX - YYY - ZZ

Dimensions

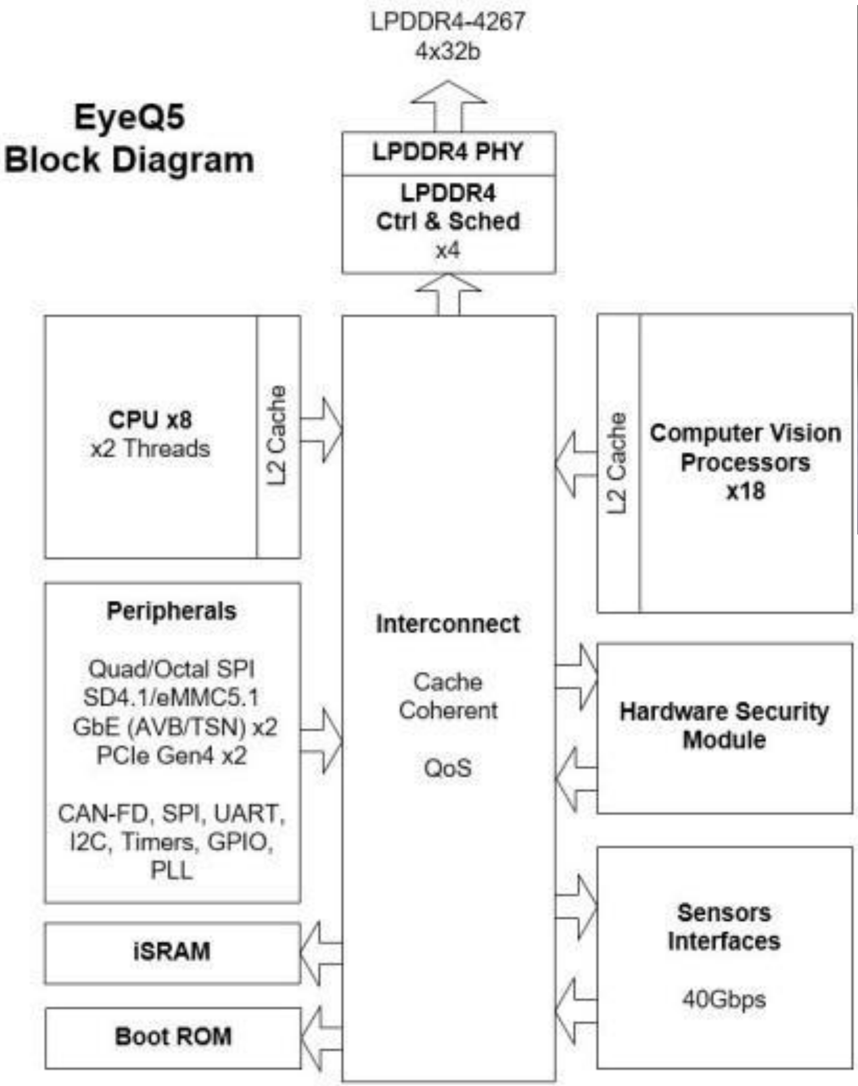


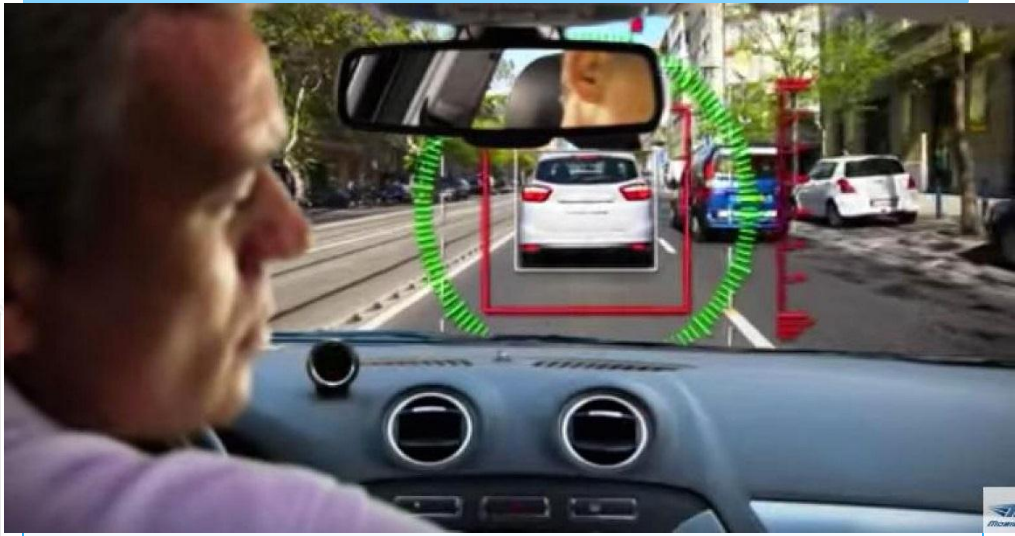
Dimensions for 48° configuration

Modular architecture

Sensors built on the LeddarVu platform offer

VISION and RADAR AUTOMOBILE CHIP SETS for MOBILEYE





The EyeQ5 will contain eight multithreaded CPU cores coupled with eighteen cores of Mobileye's next-generation, well-proven vision processors, explained Marco Monti, ST's executive vice president, Automotive and Discrete Group. In contrast, EyeQ4, a previous generation vision SoC, had 4 CPU cores and six Vector Microcode Processors

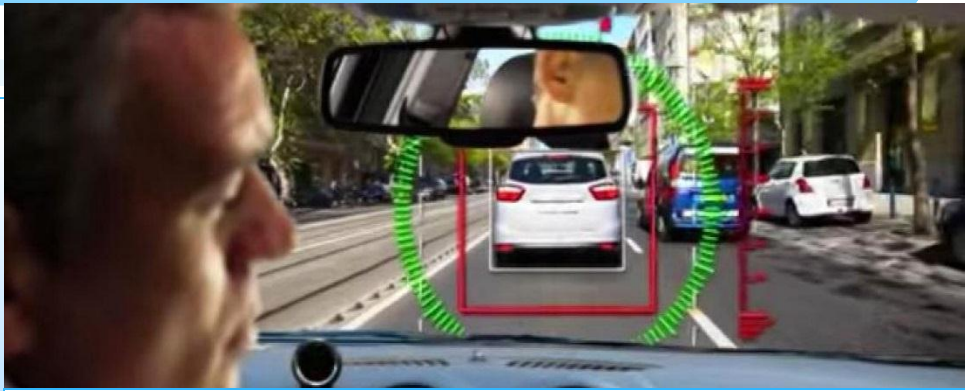
http://www.eetimes.com/document.asp?doc_id=1329704

VISION & MOBILEYE

Mobileye has been THE leader in the vehicle image and image recognition space and has recently been acquired by Intel (March 13, 2017) for $15.3B despite Tesla's claim that Mobileye's vision system is flawed.

"He (Intel's CEO) believes the future of autonomous driving hinges on 3D sensor fusion and machine learning. Chowry sees Mobileye's camera-focused technology as expendable and when it comes to advancing autonomous driving."

Ref: https://www.benzinga.com/analyst-ratings/analyst-color/17/03/9170134/intel-may-have-just-burned-15-billion-on-mobileye



System and method for vehicle detection and tracking US 7764808 B2 Priority Date March 20, 2003

A system and method for detecting and tracking an object is disclosed. A camera captures a video sequence comprised of a plurality of image frames. A processor receives the video sequence and analyzes each image frame to determine if an object is detected. The processor applies one or more classifiers to an object in each image frame and computes a confidence score based on the application of the one or more classifiers to the object. A database stores the one or more classifiers and vehicle training samples. A display displays the video sequence

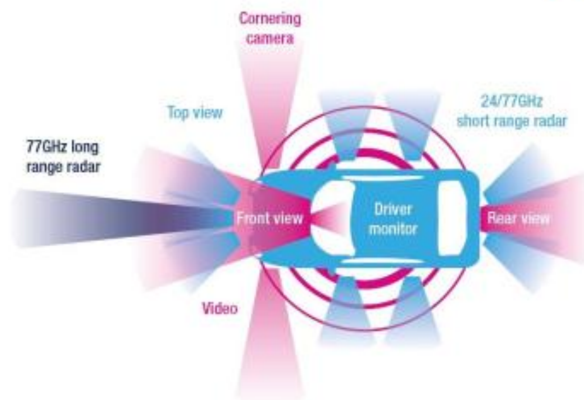
VISION and RADAR AUTOMOBILE CHIP SETS for MOBILEYE

ST Leadership

Vision Processors & RADAR sensors

The ADAS functionality

- #1 with 30% market share in ADAS safety
- #1 Machine Vision in 2016
- #1 in RF RADAR Transceivers Market in 2016



ST Sales in ADAS (M$)

2005
- Mobileye 1st Gen

2010
- Mobileye 2nd Gen
- 1st 24Ghz Gen

2015
- Mobileye 3rd Gen
- 2nd 24Ghz Gen
- 1st 77Ghz Gen

2017
- Mobileye 4th Gen
- 2nd 77Ghz Gen
- Auto Parking MPU
- Surround view Video Processor

2020
- Mobileye 5th Gen
- High data rate Radar MCU
- 360º Vision video processor

Highest Growth in RADAR Transceivers (> 30Munits expected to be shipped)

Powering de facto market standard for vision based ADAS (EyeQ)

Progressively expanding vision-based ADAS solutions

life.augmented

CONVOLUTIONAL NEURAL NETWORKS

The equivalent of the X-Prize applied to Vision recognition is to win the ImageNet Large-Scale Visual Recognition Challenge

"This contest has run every year since 2010 to evaluate image recognition algorithms.

Contestants in this competition have two simple tasks. Presented with an image of some kind, the first task is to decide whether it contains a particular type of object or not.

There are 1,000 different categories of objects ranging from abacus to zucchini, and contestants have to scour a database of over 1 million images to find every instance of each object.

Ref: https://www.technologyreview.com/s/530561/the-revolutionary-technique-that-quietly-changed-machine-vision-forever/

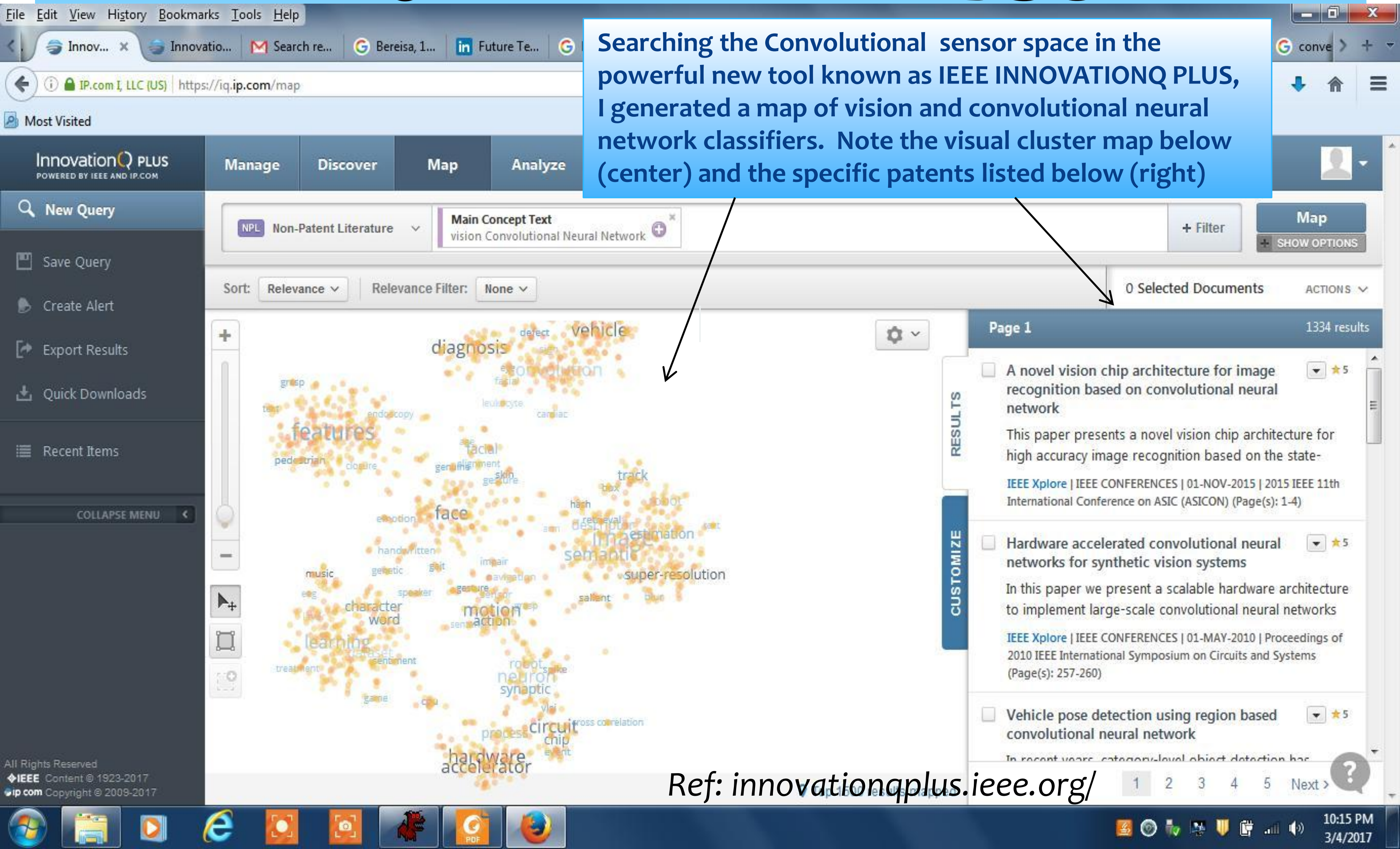
A team from the University of Toronto in Canada, in 2012, entered an algorithm called **SuperVision**, which swept the floor with the opposition.

"This was the first time that a **deep convolutional neural network had won the competition, and it was a clear victory.** In 2010, the winning entry had an error rate of 28.2 percent, in 2011 the error rate had dropped to 25.8 percent. But SuperVision won with an error rate of only 16.4 percent in 2012 (the second best entry had an error rate of 26.2 percent).

That clear victory ensured that this approach has been widely copied since then."

CONVOLUTIONAL NEURAL NETWORK PATENT LANDSCAPE

Searching the Convolutional sensor space in the powerful new tool known as IEEE INNOVATIONQ PLUS, I generated a map of vision and convolutional neural network classifiers. Note the visual cluster map below (center) and the specific patents listed below (right)

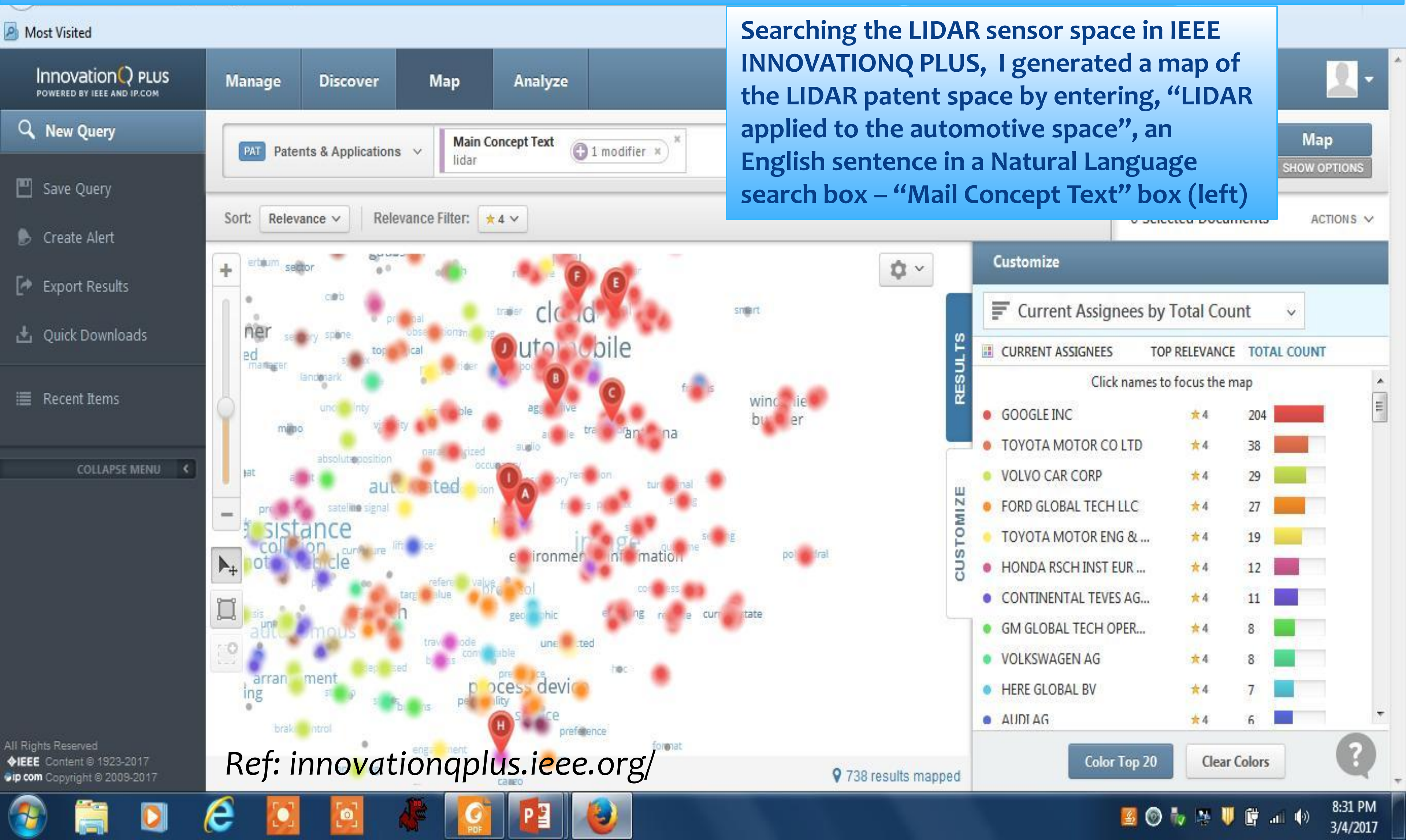


Ref: innovationqplus.ieee.org/

LIDAR SENSOR PATENT LANDSCAPE

LIDAR - Light Detection and Ranging, is a remote sensing method that uses light in the form of a pulsed laser to measure ranges. Two variations, a spinning / MEMs or Solid State LIDAR.

Searching the LIDAR sensor space in IEEE INNOVATIONQ PLUS, I generated a map of the LIDAR patent space by entering, "LIDAR applied to the automotive space", an English sentence in a Natural Language search box – "Mail Concept Text" box (left)



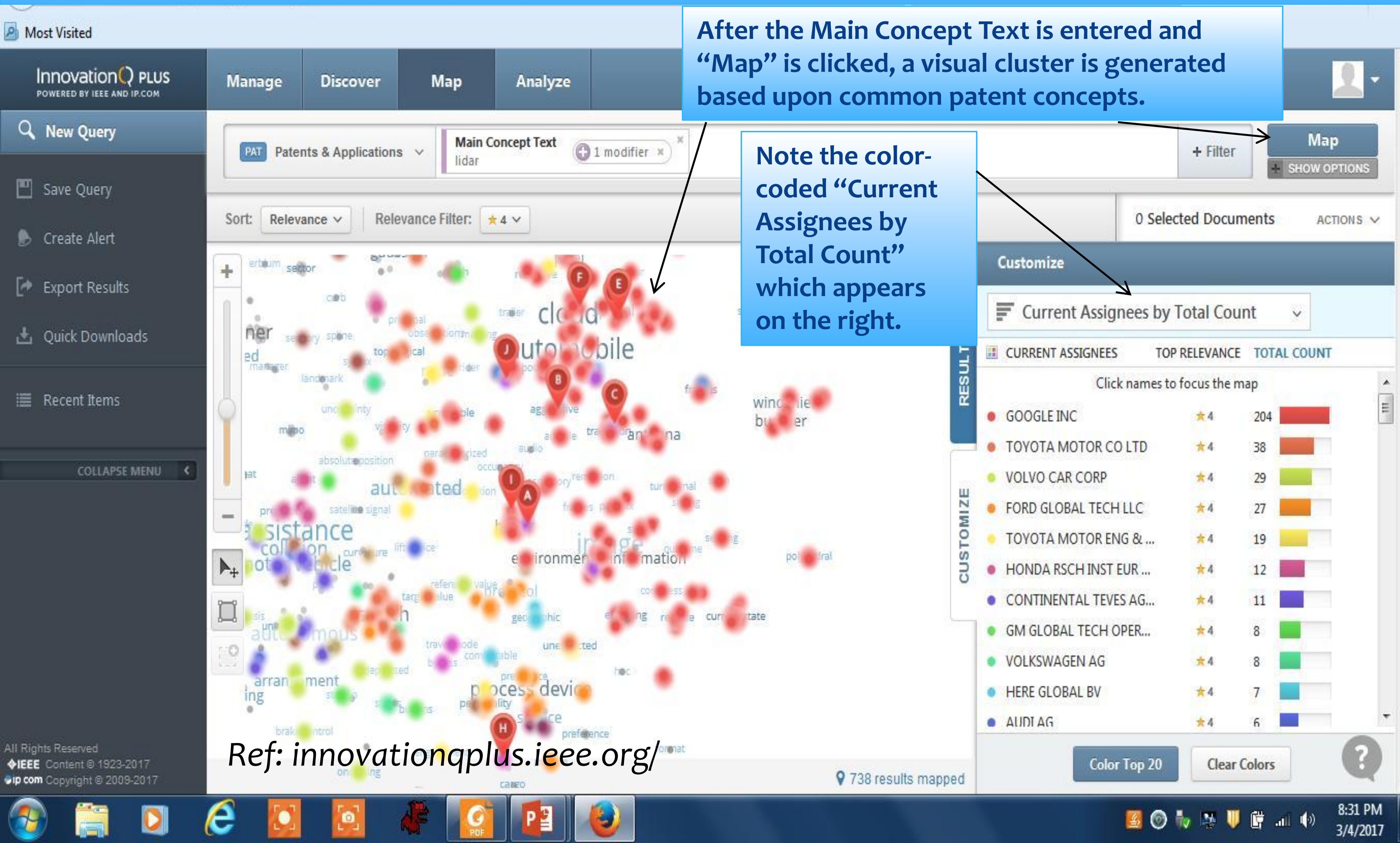
Ref: innovationqplus.ieee.org/

LIDAR SENSOR PATENT LANDSCAPE

LIDAR - Light Detection and Ranging, is a remote sensing method that uses light in the form of a pulsed laser to measure ranges. Two variations, a spinning / MEMs or Solid State LIDAR.

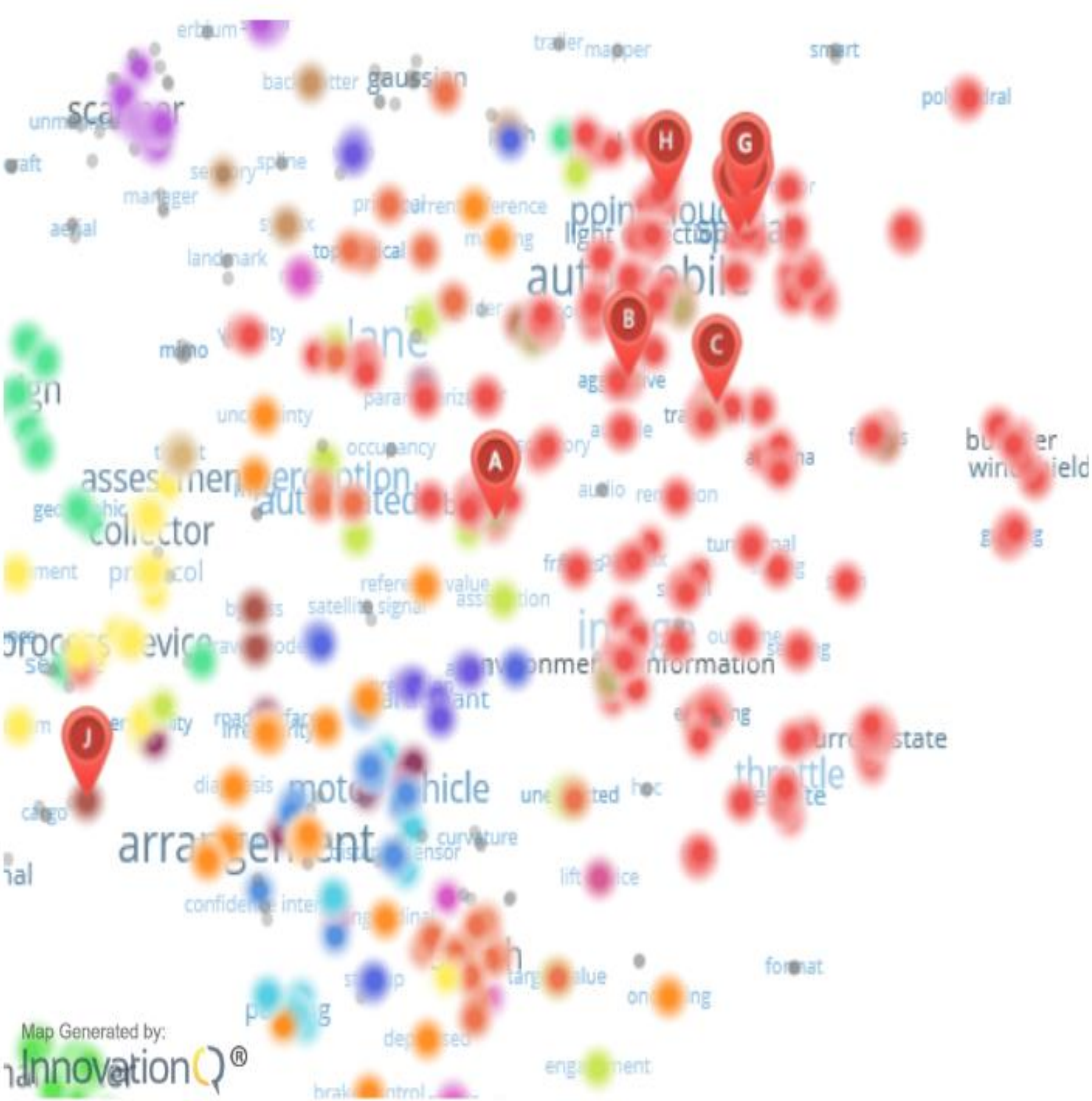
After the Main Concept Text is entered and "Map" is clicked, a visual cluster is generated based upon common patent concepts.

Note the color-coded "Current Assignees by Total Count" which appears on the right.



Ref: innovationqplus.ieee.org/

LIDAR SENSOR PATENT LANDSCAPE

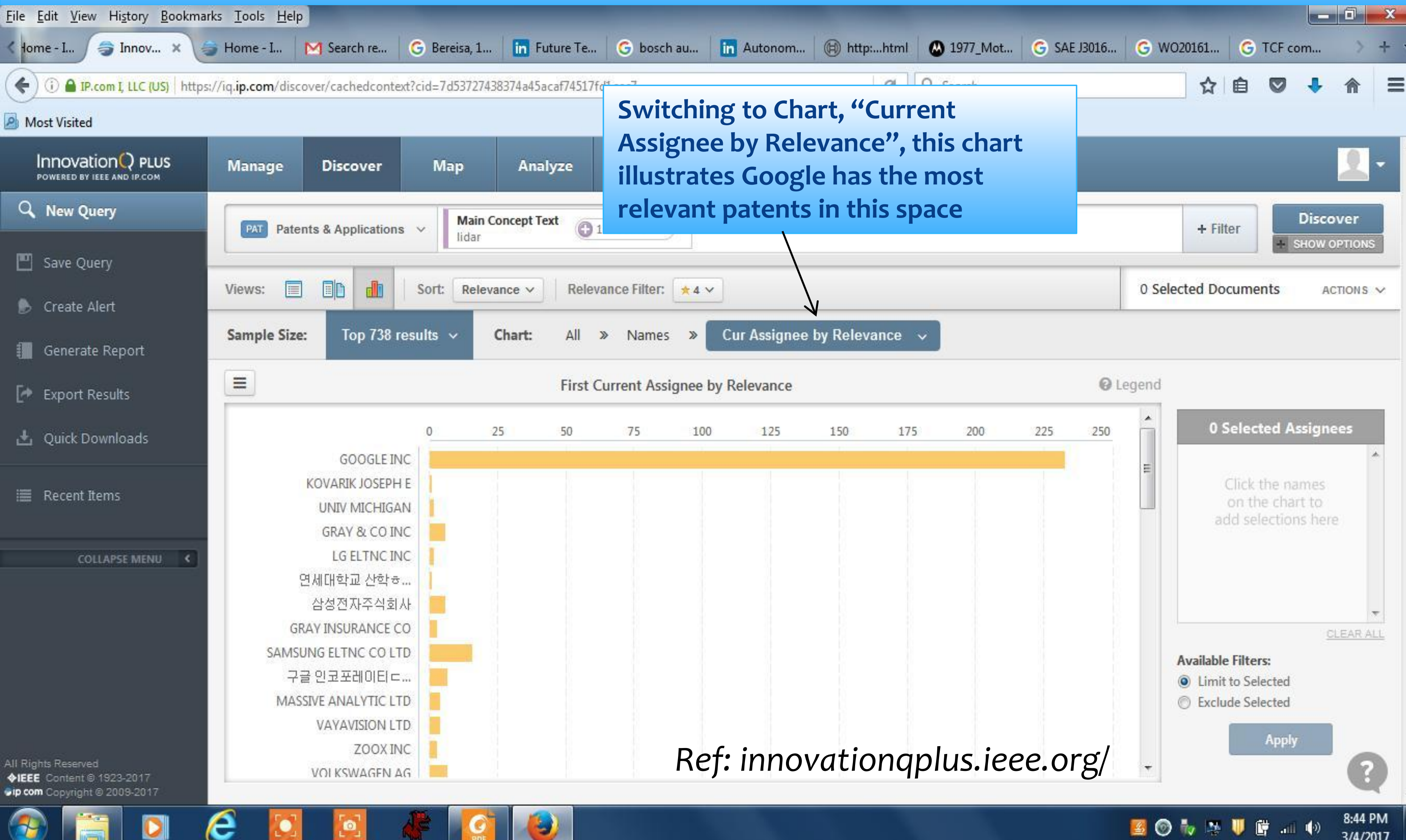


Selected Current Assignees

- GOOGLE INC (220)
- TOYOTA MOTOR CO LTD (38)
- VOLVO CAR CORP (38)
- FORD GLOBAL TECH LLC (23)
- TOYOTA MOTOR ENG & MFG NORTH AMERICA INC (20)
- ROBERT BOSCH GMBH (14)
- CONTINENTAL TEVES AG & CO OHG (13)
- GM GLOBAL TECH OPERATIONS INC (12)
- HONDA RSCH INST EUR GMBH (12)
- HERE GLOBAL BV (10)
- DEERE & CO (9)
- SAMSUNG ELTNC CO LTD (9)
- AUDI AG (7)
- DAIMLER AG (6)
- 삼성전자주식회사 (6)
- グーグル インコーポレイテッド (6)
- CARNEGIE MELLON UNIV (5)
- VOLKSWAGEN AG (5)
- 구글 인코포레이티드 (5)
- MASSACHUSETTS INST TECH (4)

LIDAR SENSOR PATENT LANDSCAPE

LIDAR - Light Detection and Ranging, is a remote sensing method that uses light in the form of a pulsed laser to measure ranges. Two variations, a spinning / MEMs or Solid State LIDAR.

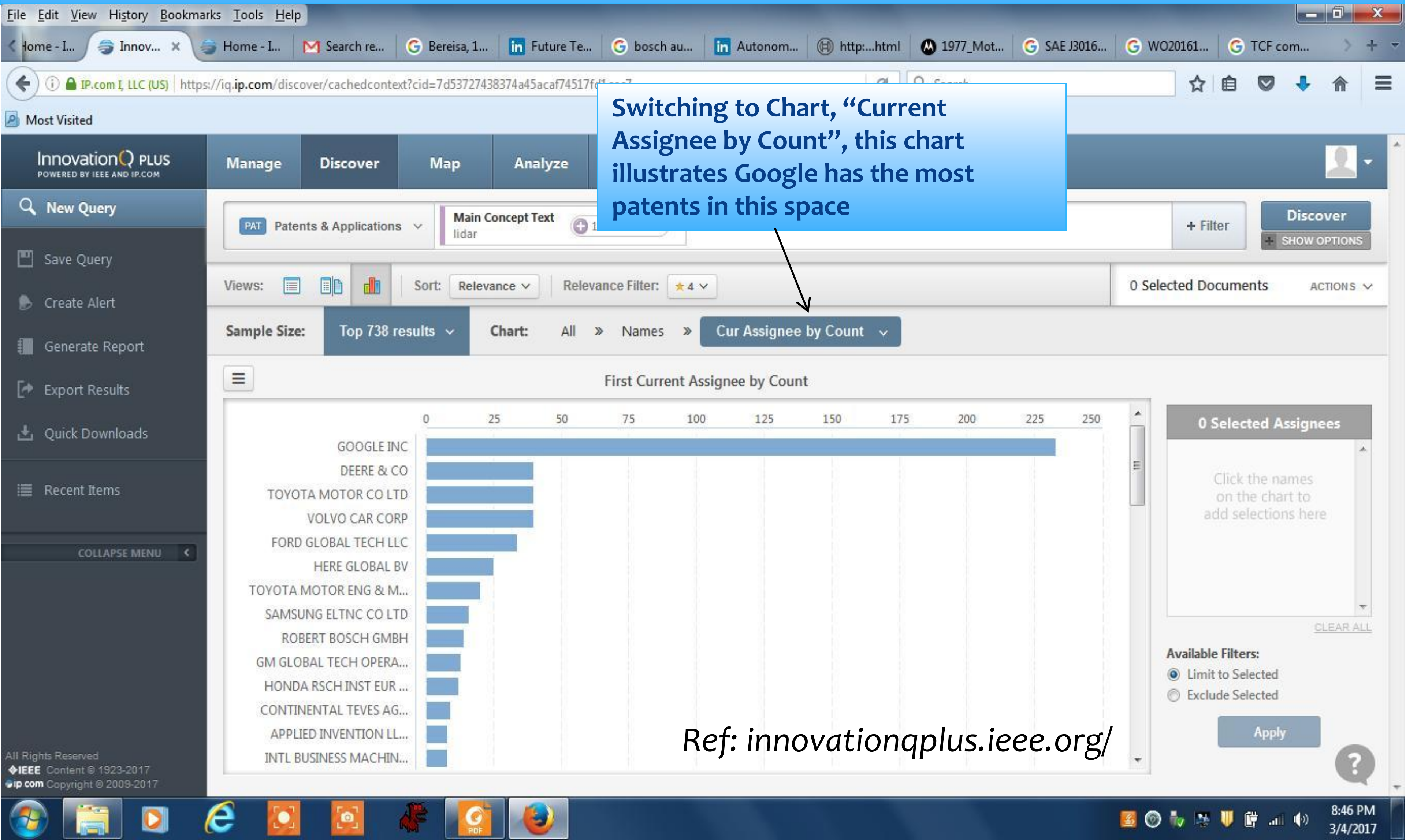


Switching to Chart, "Current Assignee by Relevance", this chart illustrates Google has the most relevant patents in this space

Ref: innovationqplus.ieee.org/

LIDAR SENSOR PATENT LANDSCAPE

LIDAR - Light Detection and Ranging, is a remote sensing method that uses light in the form of a pulsed laser to measure ranges. Two variations, a spinning / MEMs or Solid State LIDAR.

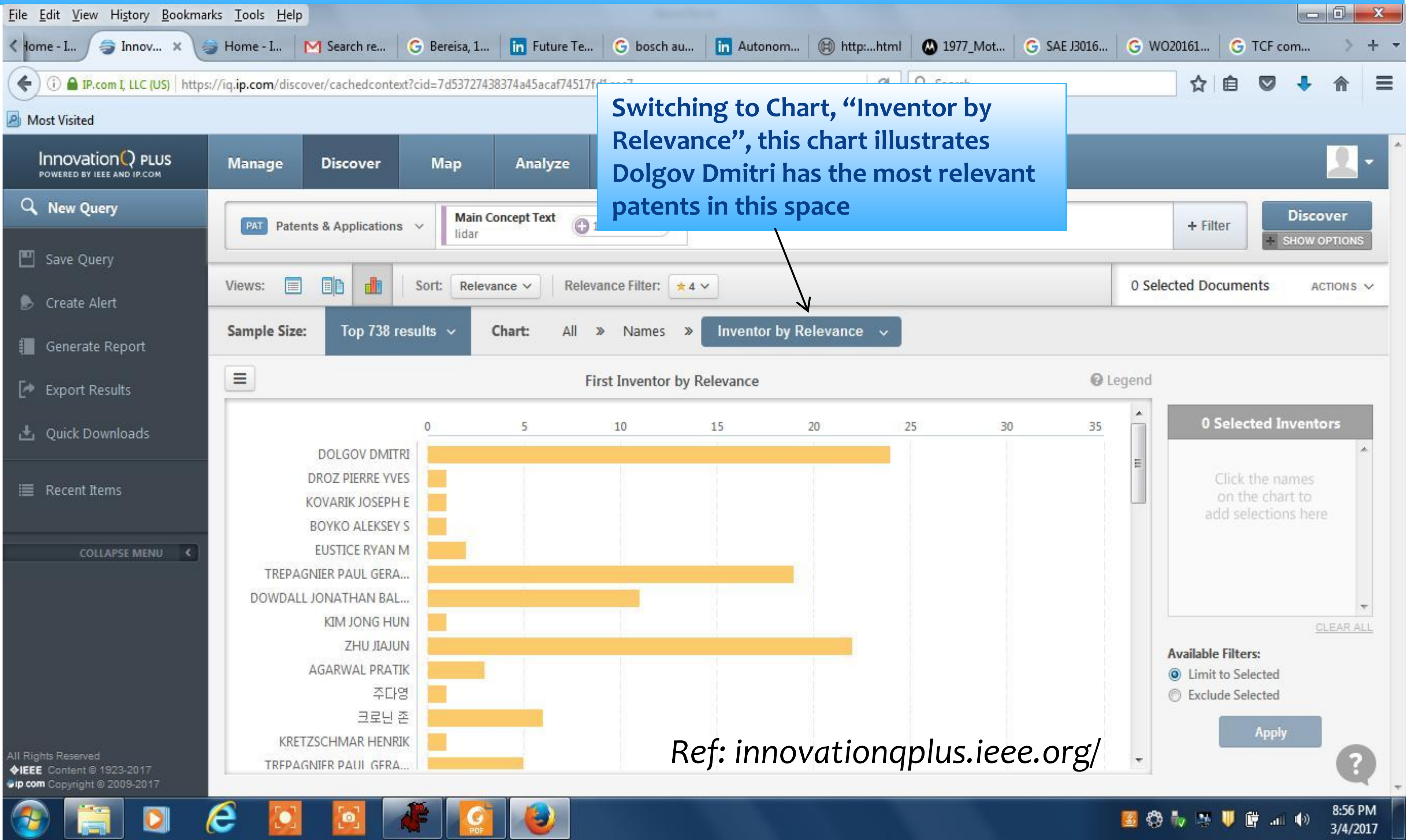


Switching to Chart, "Current Assignee by Count", this chart illustrates Google has the most patents in this space

Ref: innovationqplus.ieee.org/

LIDAR SENSOR PATENT LANDSCAPE

LIDAR - Light Detection and Ranging, is a remote sensing method that uses light in the form of a pulsed laser to measure ranges. Two variations, a spinning / MEMs or Solid State LIDAR.

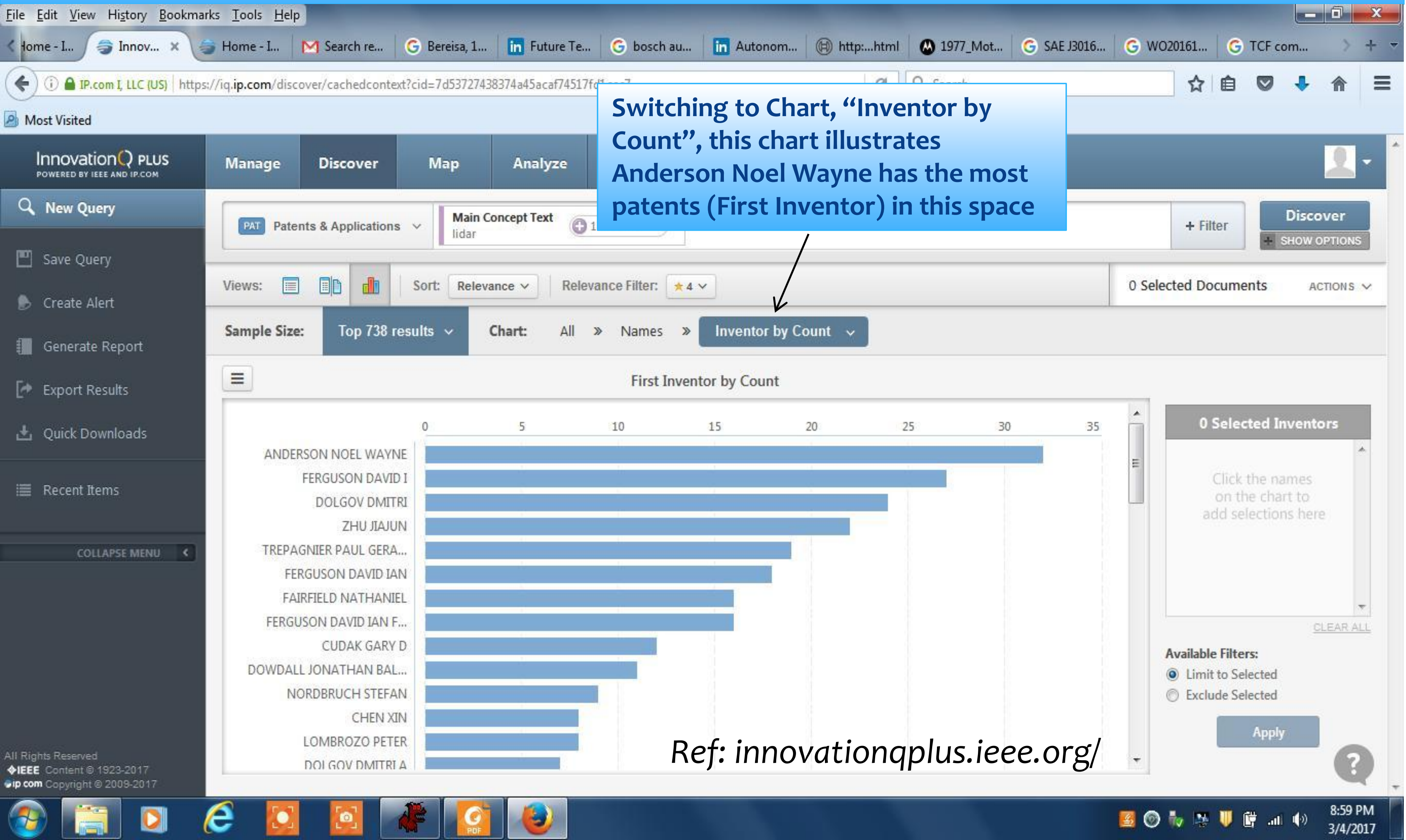


Switching to Chart, "Inventor by Relevance", this chart illustrates Dolgov Dmitri has the most relevant patents in this space

Ref: innovationqplus.ieee.org/

LIDAR SENSOR PATENT LANDSCAPE

LIDAR - Light Detection and Ranging, is a remote sensing method that uses light in the form of a pulsed laser to measure ranges. Two variations, a spinning / MEMs or Solid State LIDAR.

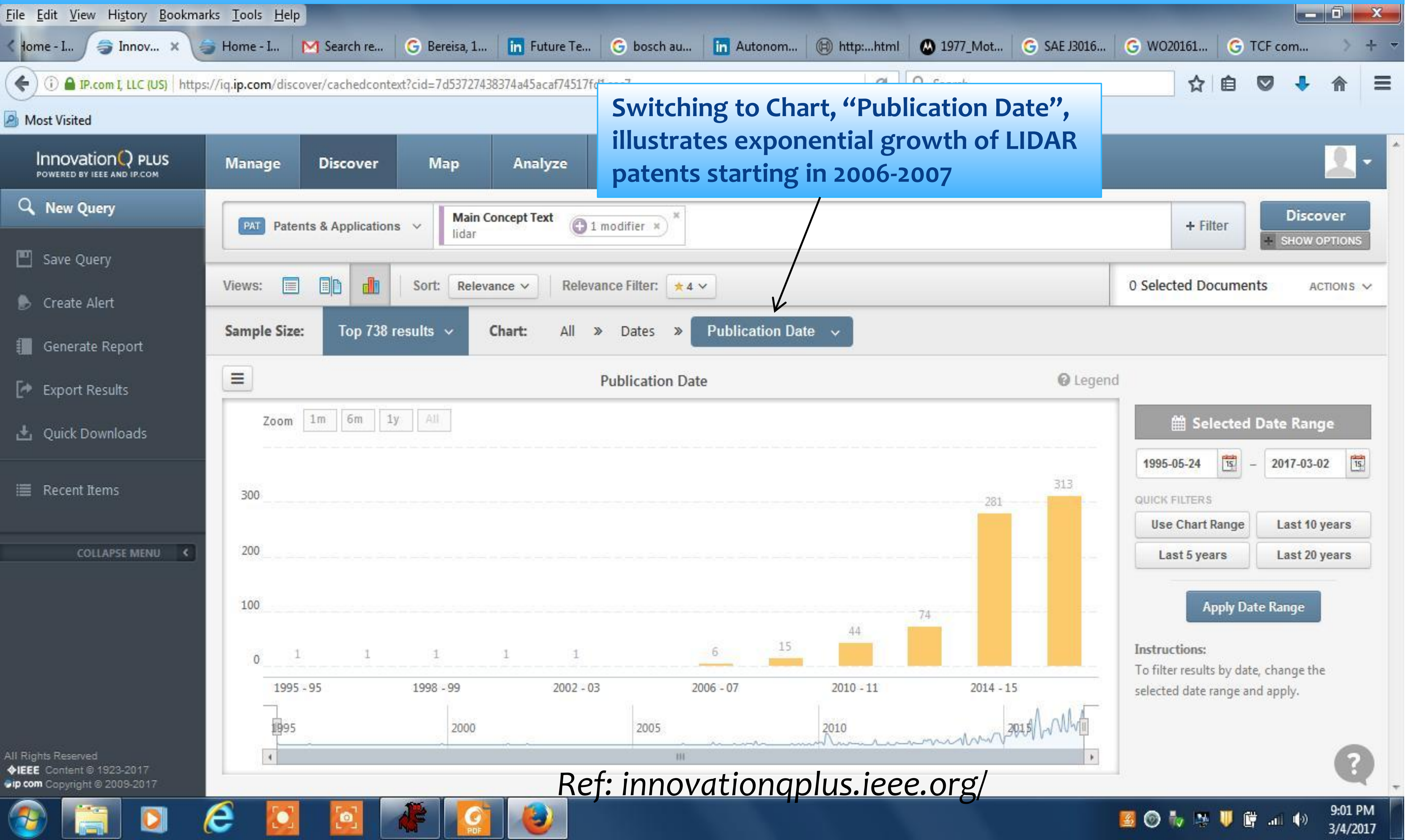


Switching to Chart, "Inventor by Count", this chart illustrates Anderson Noel Wayne has the most patents (First Inventor) in this space

Ref: innovationqplus.ieee.org/

LIDAR SENSOR PATENT LANDSCAPE

LIDAR - Light Detection and Ranging, is a remote sensing method that uses light in the form of a pulsed laser to measure ranges. Two variations, a spinning / MEMs or Solid State LIDAR.

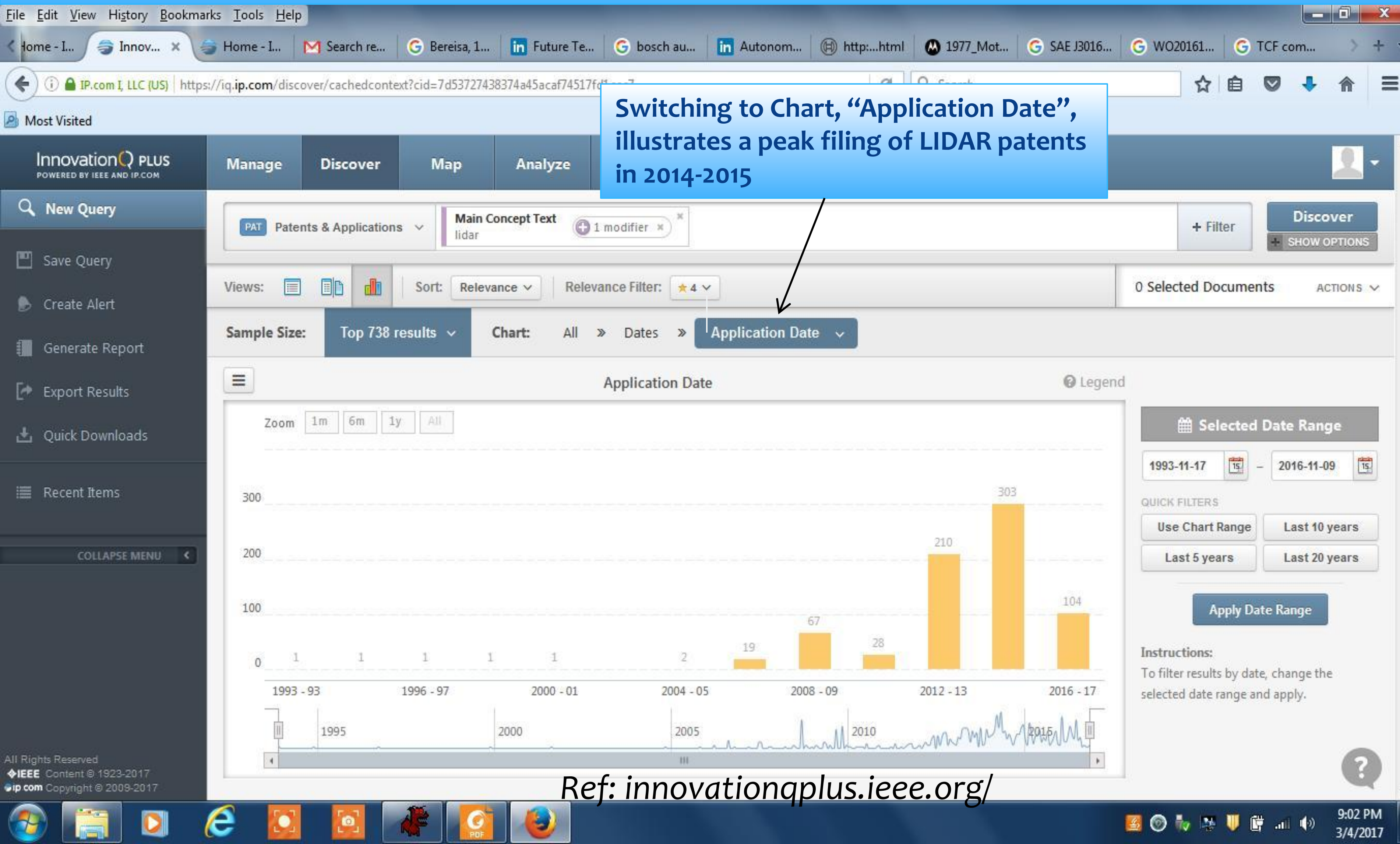


Switching to Chart, "Publication Date", illustrates exponential growth of LIDAR patents starting in 2006-2007

Ref: innovationqplus.ieee.org/

LIDAR SENSOR PATENT LANDSCAPE

LIDAR - Light Detection and Ranging, is a remote sensing method that uses light in the form of a pulsed laser to measure ranges. Two variations, a spinning / MEMs or Solid State LIDAR.

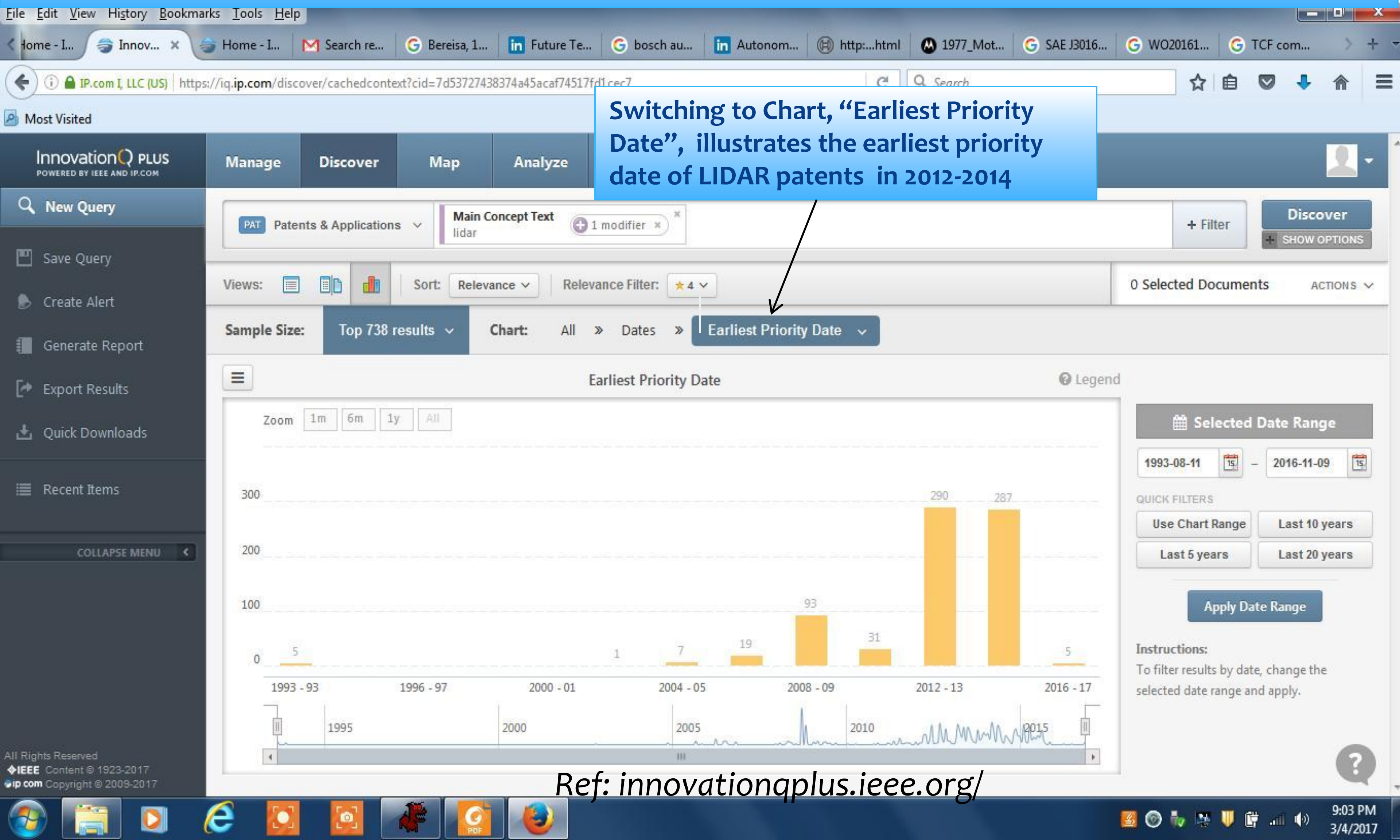


Switching to Chart, "Application Date", illustrates a peak filing of LIDAR patents in 2014-2015

Ref: innovationqplus.ieee.org/

LIDAR SENSOR PATENT LANDSCAPE

LIDAR - Light Detection and Ranging, is a remote sensing method that uses light in the form of a pulsed laser to measure ranges. Two variations, a spinning / MEMs or Solid State LIDAR.



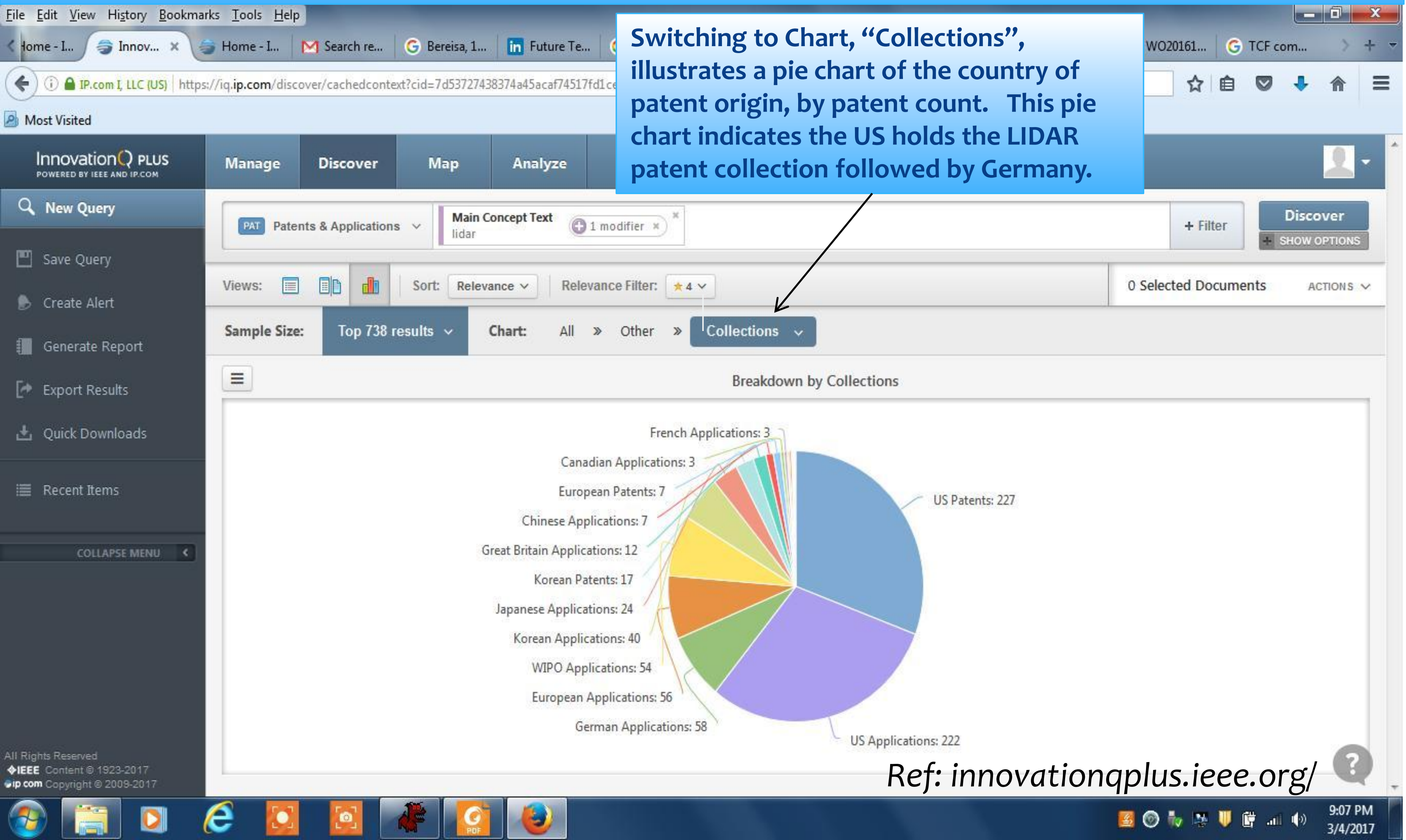
Switching to Chart, "Earliest Priority Date", illustrates the earliest priority date of LIDAR patents in 2012-2014

Ref: innovationqplus.ieee.org/

LIDAR SENSOR PATENT LANDSCAPE

LIDAR - Light Detection and Ranging, is a remote sensing method that uses light in the form of a pulsed laser to measure ranges. Two variations, a spinning / MEMs or Solid State LIDAR.

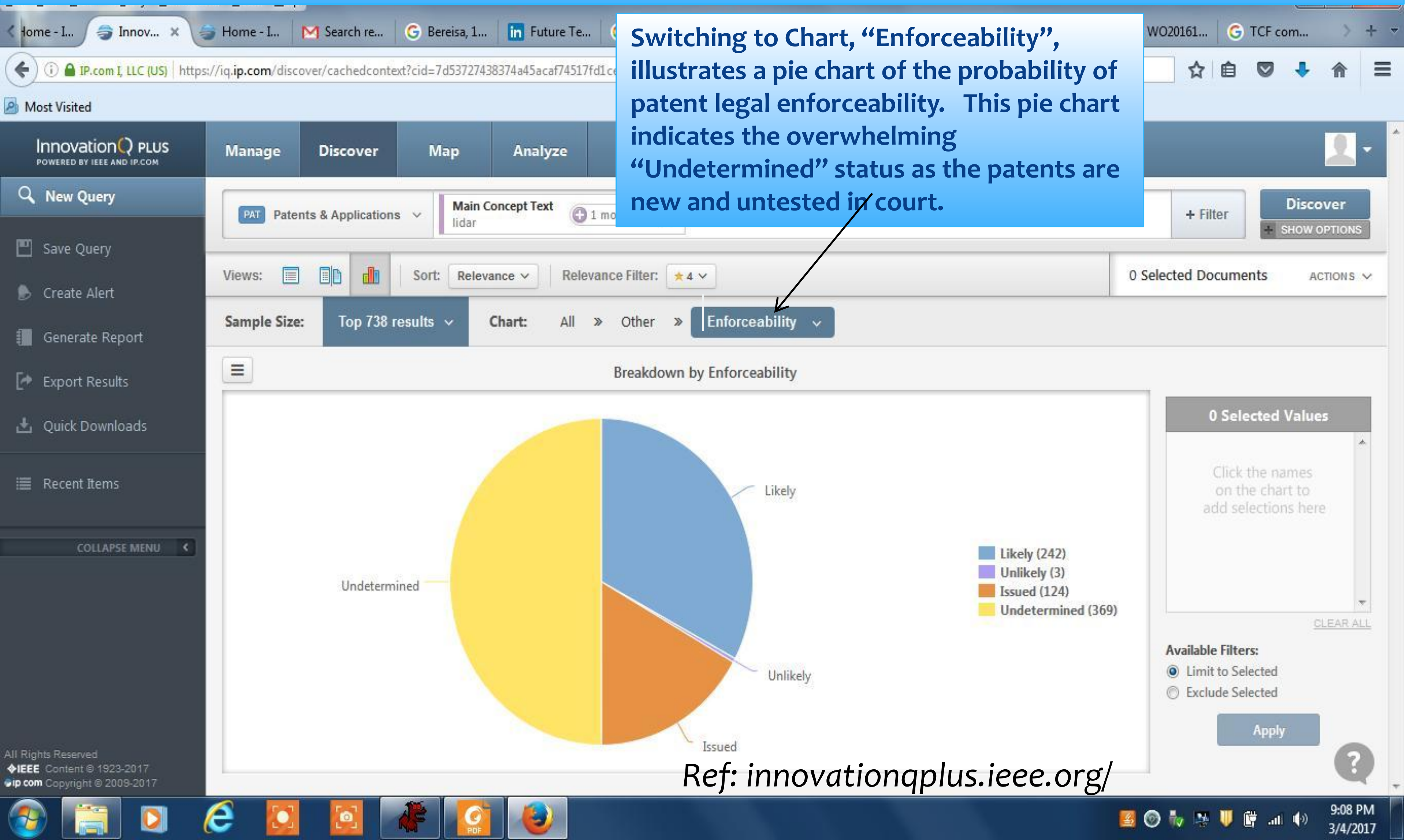
Switching to Chart, "Collections", illustrates a pie chart of the country of patent origin, by patent count. This pie chart indicates the US holds the LIDAR patent collection followed by Germany.



Ref: innovationqplus.ieee.org/

LIDAR SENSOR PATENT LANDSCAPE

LIDAR - Light Detection and Ranging, is a remote sensing method that uses light in the form of a pulsed laser to measure ranges. Two variations, a spinning / MEMs or Solid State LIDAR.



Switching to Chart, "Enforceability", illustrates a pie chart of the probability of patent legal enforceability. This pie chart indicates the overwhelming "Undetermined" status as the patents are new and untested in court.

Ref: innovationqplus.ieee.org/

SPECIFIC PATENT INFORMATION

INTRODUCTORY Information – Inventor, Assignee, Date Filed.

United States Patent [19] [11] **4,420,744**

Jesson [45] **Dec. 13, 1983**

[54] **KEYBOARD CROSSPOINT ENCODER HAVING N-KEY ROLLOVER**

[75] Inventor: **Joseph E. Jesson**, Lake Villa, Ill.

[73] Assignee: **Oak Industries Inc.**, Rancho Bernardo, Calif.

[21] Appl. No.: **233,903**

[22] Filed: **Feb. 12, 1981**

[51] **Int. Cl.**³ **G08C 25/00**

[52] **U.S. Cl.** .... **340/365 E**; 340/365 S; 340/365 R

[58] **Field of Search** .... 340/365 E, 365 S, 365 R; 179/90 K; 178/17 C; 400/477, 479, 479.1, 479.2

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,920,926	11/1975	Lenaerts et al.	340/365 E
4,106,011	8/1978	Melanson et al.	340/365 E
4,231,016	10/1980	Ueda	340/365 E

FOREIGN PATENT DOCUMENTS

971883	7/1975	Canada	340/365 E
54-121026	9/1979	Japan	340/365 E

Primary Examiner—Donnie Lee Crosland
Attorney, Agent, or Firm—Kinzer, Plyer, Dorn & McEachran

[57] **ABSTRACT**

A keyboard crosspoint encoder and a method of operating it which provide N-key rollover. The encoder has an information storage device. The matrix of crosspoint switches is scanned to determine the status of each switch and this information is stored in an array in the storage device. This array is checked to determine if a phantom switch condition exists. The encoder then provides an output of all newly-closed switches which are not involved in a phantom switch condition.

6 Claims, 4 Drawing Figures

SPECIFIC PATENT EXAMPLE

INTRODUCTORY Information – CLAIMS Section, Claim 1. is crtical to filings

involved in the phantom switch condition. In terms of the actual hardware involved, the phantom condition is four data locations at the corners of a rectangle in the array which have a voltage low condition. The status of these points is changed to a voltage high condition. The net effect of the step **44** is to "ignore" the four switches involved in the phantom switch condition. After the phantom condition has been removed, or if no phantom condition was found in the array, the operation proceeds to the comparison step labeled **46**. The current array is compared with the history array. Any crosspoint switch whose condition has changed from open to closed is provided as output, as indicated at **48**. It can be seen that comparison of the current array with the history array prevents repeated output of a key until it has been released and then pressed again. The history array is updated with the information of newly actuated and/or released keys, as indicated at **50**. The operation continues by reading in a new set of data from the encoder.

It can be seen from the foregoing that the present invention provides a keyboard crosspoint encoder having N-key rollover and which will not provide erroneous output due to phantom switch conditions. The keyboard is readily adapted for membrane type encoders with no isolation of the crosspoints required. It will be understood that changes may be made in the details of the embodiments shown and described without departing from the spirit and scope of the invention.

I claim:

1. In a crosspoint encoder of the type having an information storage device and rows and columns of conductors which define a matrix of crosspoint switches, a

spondent in the history array does not indicate a closed switch; and

g. updating the history array by reading all the data from the array into it.

3. The method of claim **1** or **2** wherein the step of determining the existence of a phantom switch condition comprises the steps of selecting a pair of rows in the array, comparing the information in each column position of the rows to determine if there are two columns where each row indicates a closed crosspoint switch, and repeating the above selecting and comparing steps until all combinations of row pairs have been selected.

4. A method of operating a crosspoint encoder including the steps of detecting which crosspoints are closed, determining whether a phantom switch condition exists and providing an output of those crosspoints which are not involved in a phantom switch condition.

5. A crosspoint encoder of the type having rows and columns of conductors which define a matrix of crosspoint switches, comprising, means for detecting which crosspoints are closed, means for determining whether a phantom switch condition exists and means for providing an output of those crosspoints which are not involved in a phantom switch condition.

6. A crosspoint encoder of the type having rows and columns of conductors which define a matrix of crosspoint switches, comprising an information storage device, means for detecting and storing in an array in said storage device the status of each crosspoint switch, means for locating a phantom switch condition in said array and for removing only switches involved in a phantom switch condition from the array, and means for providing an output of the array.

* * * * *