Technology Insight Report

Hybrid Vehicles

Patent iNSIGHT Pro
Transform Patents to Intelligence

A hybrid vehicle is a vehicle that uses two or more distinct power sources to move the vehicle. The term most commonly refers to hybrid electric vehicles (HEVs), which combine an internal combustion engine and one or more electric motors.

The varieties of hybrid electric designs can be differentiated by the structure of the hybrid vehicle drivetrain, the fuel type, and the mode of operation.

This report takes a look into the patenting activity around hybrid vehicles uncovering the key companies, inventors, and different sub categories.

Introduction

A hybrid electric vehicle (HEV) is a type of hybrid vehicle and electric vehicle which combines a conventional internal combustion engine (ICE) propulsion system with an electric propulsion system. The presence of the electric powertrain is intended to achieve either better fuel economy than a conventional vehicle, or better performance. There are a variety of HEV types, and the degree to which they function as EVs varies as well. The most common form of HEV is the hybrid electric car, although hybrid electric trucks (pickups and tractors) and buses also exist

Several automobile manufacturers announced that future vehicles will use aspects of hybrid electric technology to reduce fuel consumption without the use of the hybrid drivetrain. Regenerative braking can be used to recapture energy and stored to power electrical accessories, such as air conditioning. Shutting down the engine at idle can also be used to reduce fuel consumption and reduce emissions without the addition of a hybrid drivetrain. In both cases, some of the advantages of hybrid electric technology are gained while additional cost and weight may be limited to the addition of larger batteries and starter motors. There is no standard terminology for such vehicles, although they may be termed mild hybrids.

Overview

With the help of Patent iNSIGHT Pro, we will analyze the patent data around hybrid vehicles to find answers to the following:

- What does the IP publication trend for hybrid vehicles look like and how have the filings evolved?
- Who are the top assignees or key players in hybrid vehicles and what are their technology wise trends?
- How is research in hybrid vehicles spread across different countries?
- How is the Assignee portfolio spread across different battery types?
- How is assignee portfolio spread across various power transmission modes?

Search Strategy

Using the commercial patent database PatBase as our data source we used the following search query to create our patent set.

FT- Full Text
IC – International Class
UC- US Class

FT=((hybrid* or electric* or "hybrid electric") w/3 (vehicle* or car or cars) or HEV or PHEV or drivetrain* or powertrain* or "power train" or "drive train" or transmission*)

AND

((IC= B60K or B60L or B60M or B60W or H02J or H02P or H01M or H01H or F02)

AND

(UC=903 or 180/65.1 or 123))

Class Descriptions of Classes used in Search Strategy

B60K: arrangement or mounting of propulsion units or of transmissions in vehicles; arrangement or mounting of plural diverse prime-movers; auxiliary drives; instrumentation or dashboards for vehicles; arrangements in connection with cooling, air intake, gas exhaust, or fuel supply, of propulsion units, in vehicles

B60L: propulsion of electrically-propelled vehicles

B60M: power supply lines, or devices along rails, for electrically-propelled vehicles

B60W: conjoint control of vehicle sub-units of different type or different function; control systems specially adapted for hybrid vehicles; road vehicle drive control systems for purposes not related to the control of a particular sub-unit

H02J: circuit arrangements or systems for supplying or distributing electric power; systems for storing electric energy

H02P: control or regulation of electric motors, generators, or dynamo-electric converters; controlling transformers, reactors or choke coils

H01M: processes or means, e.g. batteries, for the direct conversion of chemical energy into electrical energy

H01H: electric switches; relays; selectors; emergency protective devices

F02: combustion engines; hot-gas or combustion-product engine plants

UC 903: hybrid electric vehicles (HEVS)

180/65.1: electric

123: internal-combustion engines

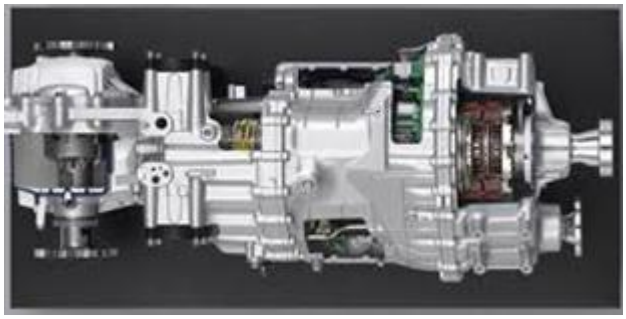
The query was directed to search through the full text and a patent set of 2956 records with one publication per family was generated.

The publications included in the report are updated as of 19th June, 2012.

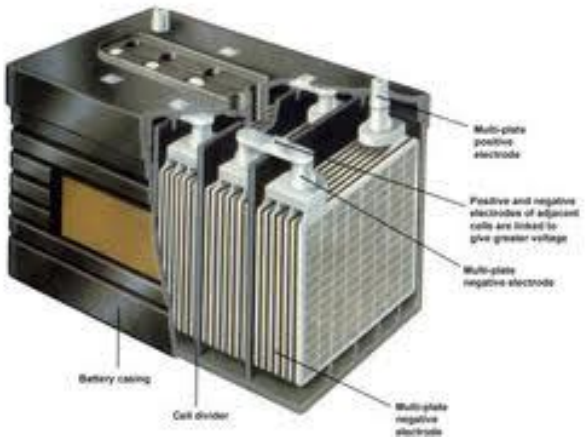
Patent Categorization

To get deeper insights the patent set has been classified as follows:

By Power Transmission Modes



- Degree of Hybridization
  a) Full Hybrid
  b) Mild Hybrid
  c) Plug-in Hybrid
- Dual-clutch Transmission
- Fuel Cells
- Parallel Hybrids
- Power-split Hybrids
- Series Hybrids



By Battery Types

- Lead Acid
- Lithium ion
- Lithium Ion Polymer
- Nickel- Metal Hybride
- Secondary Cells

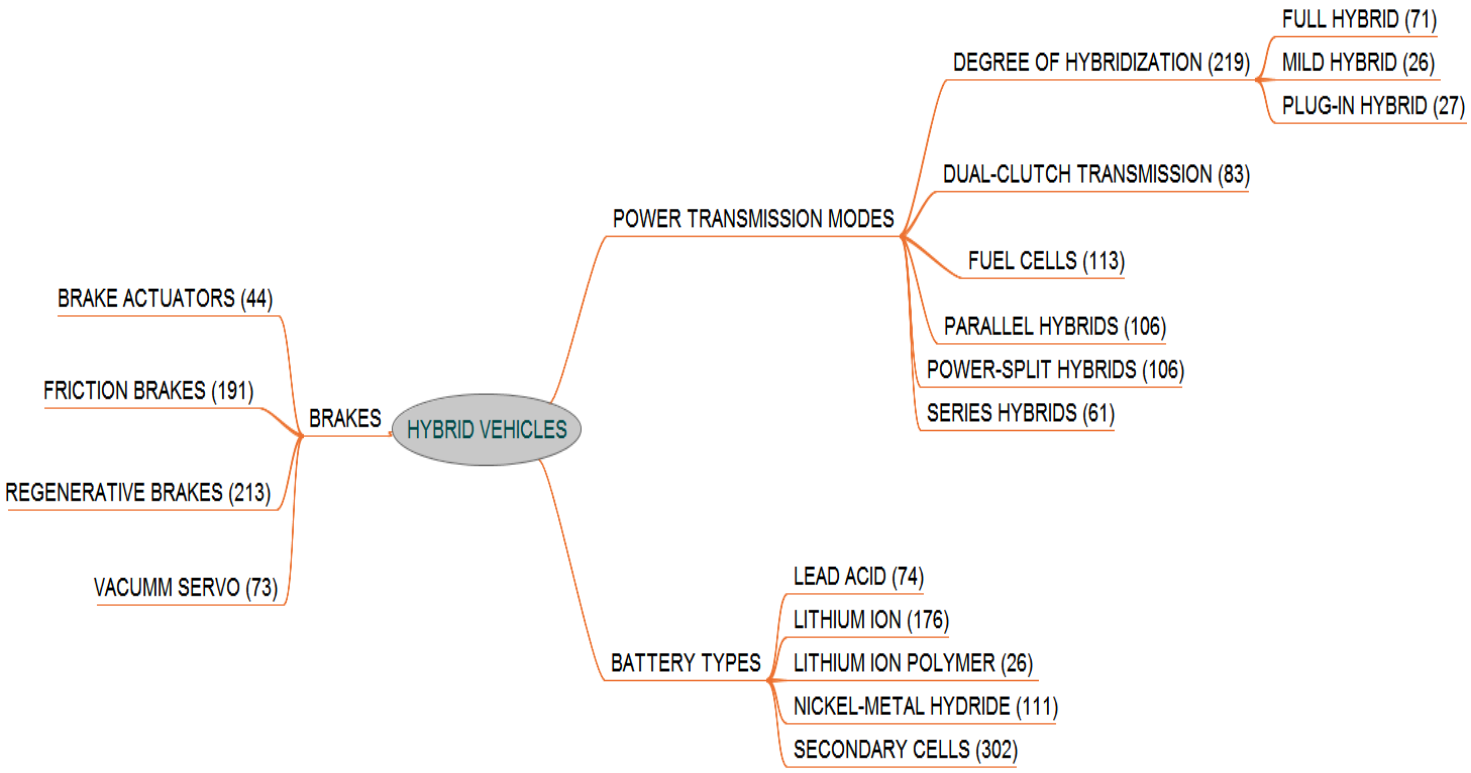
By Brakes

- Brake Actuators
- Friction Brakes
- Regenerative Brakes
- Vacuum Servo

Image source:
http://www.zerotohundred.com/2008/auto-news/revealed-cheap-double-clutch-gearbox/
http://howdohybridcarswork.info/hybrid-car-batteries-2.html/
http://es.123rf.com/photo_6382572_ilustracion-3d-de-automovil-hibrido-con-poder-enchufe-sobre-fondo-blanco.html

The illustration below shows the different categories prepared and the number of records in each. The categorization involved defining a search strategy for each topic and then conducting the search using the Advanced Searching capability in Patent iNSIGHT Pro. Details of search strings used for each category are given in Appendix B.

Categorization Tree

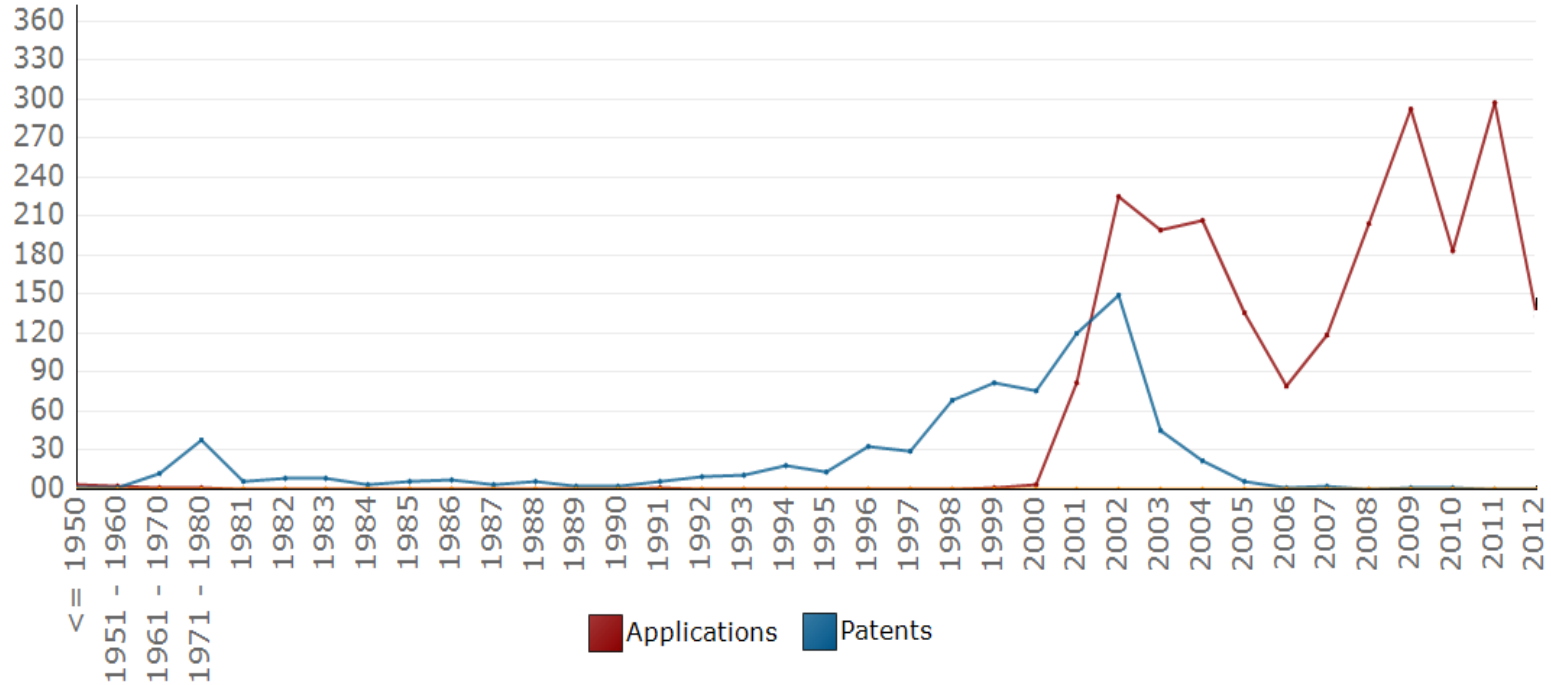


Publication Trend

What has been the IP publication trend for hybrid vehicles*?*

Patents related to hybrid vehicles can be traced back to 1951 and the real surge in the activity around this technology has happened in the last 5 years. Noticeably there was an increase in applications since last decade.

It's clear the current activity around these technologies is likely to continue seeing more innovation in the near future.

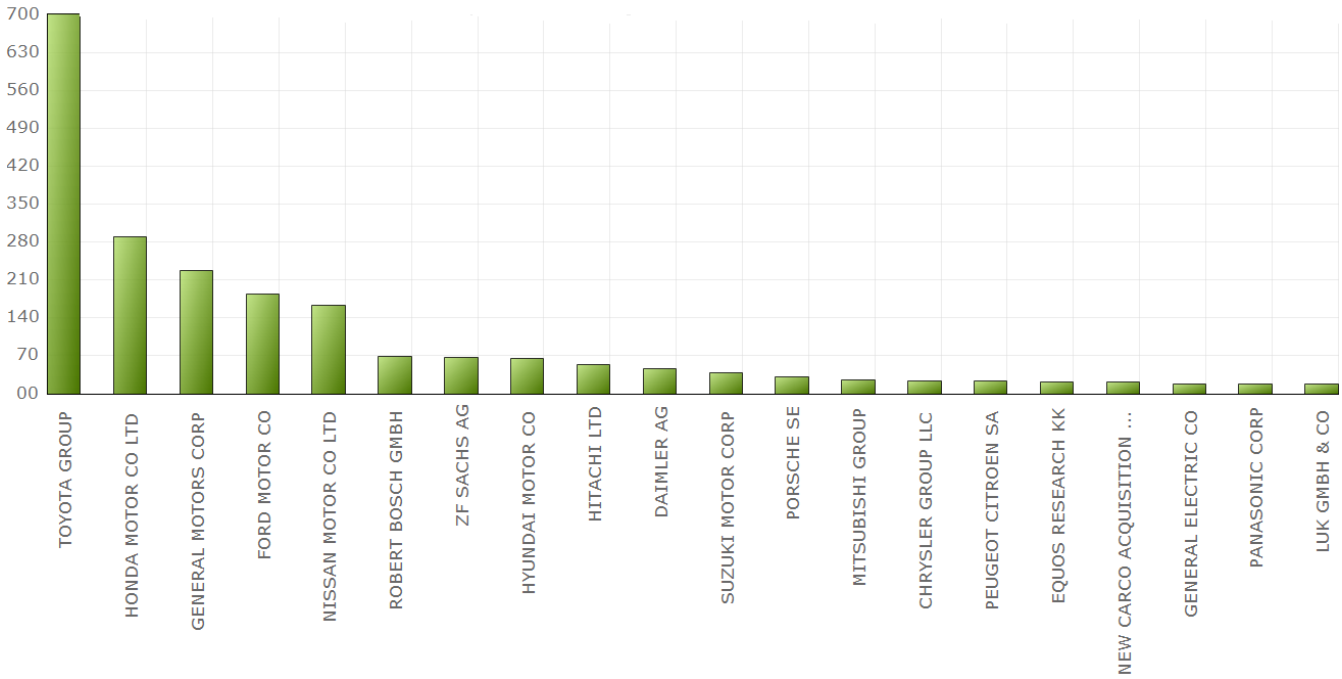


How we did it?

Once the patents were populated in Patent iNSIGHT Pro, the publication trend chart was generated on a single click using the dashboard tool.

Assignees Trend

Who have been the top assignees or the key players within this industry?



The top assignees are:

1. TOYOTA GROUP
2. HONDA MOTOR CO LTD
3. GENERAL MOTORS CORP
4. FORD MOTOR CO
5. NISSAN MOTOR CO LTD
6. ROBERT BOSCH GMBH
7. ZF SACHS AG
8. HYUNDAI MOTOR CO
9. HITACHI LTD
10. DAIMLER AG
11. SUZUKI MOTOR CORP
12. PORSCHE SE
13. MITSUBISHI GROUP
14. CHYSLER GROUP LLC
15. PEUGEOT CITROEN SA
16. EQUOS RESEARCH KK
17. NEW CARCO ACQUISITION LLC
18. GENERAL ELECTRIC CO
19. PANASONIC CORP
20. LUK GMBH & CO

How we did it?

Once the patents were populated in Patent iNSIGHT Pro, the assignee clean- up tools were used to normalize the names. Different cleanup tools were leveraged:

- To locate assignees for unassigned records
- To clean up records having multiple assignees
- To locate the correct assignee names for US records using the US assignments database
- To merge assignees that resulted from a merger or acquisition or name change.

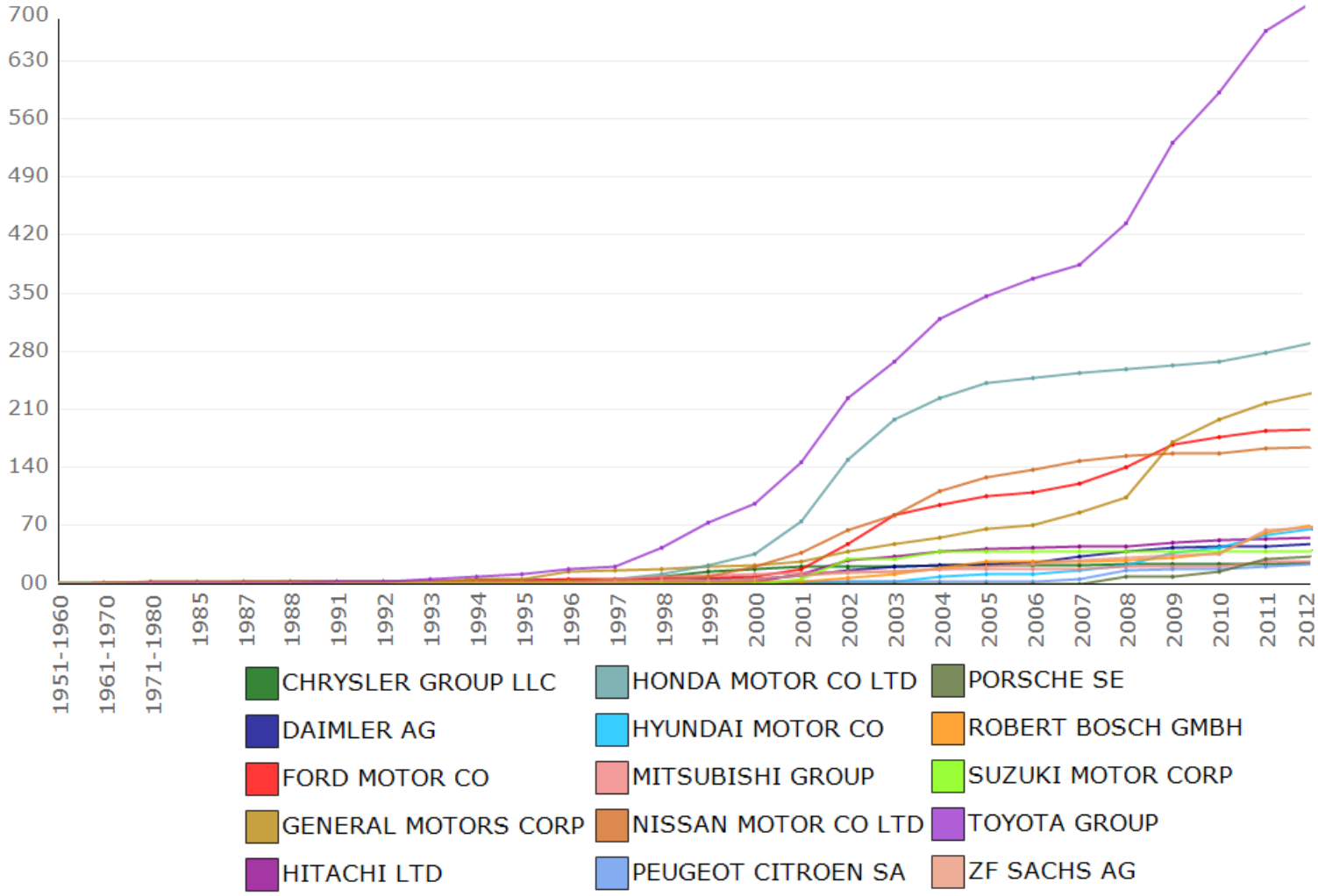
Please refer Appendix A for more details on Assignee merging.

Once the Assignee names were cleaned up, the dashboard tool within Patent iNSIGHT Pro was used to find the top 20 assignees within the given patent set. A visual graph was created based on the results of the top assignees with the number of patents alongside each one.

The complete Assignee table in available in the following Excel file:
http://www.patentinsightpro.com/techreports/0712/List%20of%20Assignees.xls

Assignee Trends

The below trend chart represents the assignee trend for patents assigned to the top assignees identified within the patent set for hybrid vehicles shown with respect to time. The violet trend line associated with Toyota Group shows an impressive spike from 2003 onwards. Hyundai Motor Co has publications from 2001 onwards.



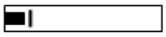
How we did it?

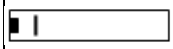
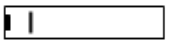
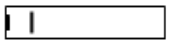
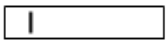
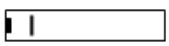
Using the Report Dashboard in Patent iNSIGHT Pro, the graph showing the cumulative filings of top 15 assignees with respect to time was created. The output was created in the form of a line graph to get a visual insight which could display comparisons across the assignees.

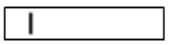
Top Countries

How is research in hybrid vehicles spread across different countries?

In terms of regional pockets where patent protection is being sought most frequently for these technologies, JP leads the count, followed by the US and DE. The table below ranks top priority countries and helps provide an indication of where innovation in this area is originating:

Priority Country	Total No. of Records	Average No. of Fwd Cites per Patents	Filing Trend (Absolute)	No. of Filings in last 5 yrs vs Average of Top 20 Priority Country	Filing Year Range	Top 5 Assignees	Top 5 Inventors
JP	1477 (50%)	5.75			1967-2011	TOYOTA GROUP(700) HONDA MOTOR CO LTD(289) NISSAN MOTOR CO LTD(165) HITACHI LTD(54) SUZUKI MOTOR CORP(39)	TABATA ATSUSHI(80) WAKASHIRO TERUO(52) TAGA YUTAKA(48) MATSUBARA ATSUSHI(45) KITAJIMA SHINICHI(39)
US	863 (29.2%)	8.08			1922-2012	GENERAL MOTORS CORP(225) FORD MOTOR CO(183) CHRYSLER GROUP LLC(25) NEW CARCO ACQUISITION LLC(22) GENERAL ELECTRIC CO(19)	HEAP ANTHONY H(41) HOLMES ALAN G(26) SCHMIDT MICHAEL R(26) SAH JY JEN F(20) KUANG MING LANG(17)
DE	324 (11%)	5.71			1962-2012	ZF SACHS AG(67) ROBERT BOSCH GMBH(67) PORSCHE SE(32) DAIMLER AG(30) LUK GMBH & CO(18)	KALTENBACH JOHANNES(20) WALLNER STEFAN(11) FALKENSTEIN JENS WERNER(11) LUTZ DIETER(10) BORNTRAEGER KAI(10)
KR	74 (2.5%)	2.57			1989-2011	HYUNDAI MOTOR CO(65) HALLA CLIMATE CONTROL CORP(2) JO KEUN WOO(1) PARKER INTANGIBLES LLC(1) CHOI YONG KAK(1)	PARK JONGSOOL(7) CHOI YONG KAK(6) KIM YEONHO(5) PARK JOON YOUNG(4) LEE CHANGWOOK(4)

FR	54 (1.8%)	4.89			1971-2011	PEUGEOT CITROEN SA(24) RENAULT SAS(8) VALEO SA(5) SMH MANAGEMENT SERVICES AG(3) CONCEPTION ET DEVELOPPEMENT MICHELIN S.A.(2)	ROCQ GAETAN(4) LE NEINDRE YVAN(3) POGNANT GROS PHILIPPE(3) LAEUFFER JACQUES(3) APTER ROBERT(3)
GB	34 (1.2%)	12.29			1918-2011	BMW(3) GENERAL MOTORS CORP(3) EVO ELECTRIC LTD(2) LUCAS INDUSTRIES LTD(2) JAGUAR CARS LTD(2)	LAMPERTH MICHAEL ULRICH(2) BOURNE CARL(2) HAMPSHIRE MICHAEL J(1) TURNER MICHAEL JAMES(1) WILLIAMSON JONATHAN H(1)
EP	24 (0.8%)	3.46			1997-2010	C R F SPA(5) SWATCH GROUP MANAGEMENT SERVICES AG THE(3) TNO(3) SAAB AUTOMOBILE AB(2) SIEMENS AG(2)	PIAZZA ANDREA(4) PREGNOLATO GIANLUIGI(4) GARABELLO MARCO(4) PASTORELLO VALTER(4) FOSTER DARREN LEIGH(3)
SE	20 (0.7%)	3.95			1977-2008	VOLVO CAR CORP(13) CARNELIAN CORDLESS LLC(2) STRIDSBERG POWERTRAIN AB(2) FORD MOTOR CO(1) SAAB AUTOMOBILE AB(1)	STERVIK HANS(4) CARLHAMMAR LARS(2) ALM IVAR(2) SADARANGANI CHANDUR(2) STRIDSBERG LENNART(2)
IT	17 (0.6%)	3.88			1992-2010	FIAT SPA(3) FERRARI S P A(3) C R F SPA(2) CIARLA ALBERTO(1) LENCI FABIO(1)	BORDINI GIORGIO(4) FAVARETTO FABRIZIO(3) CIMATTI FRANCO(2) ELLENA GIOVANNI(2) MESITI DOMENICO(2)
CN	14 (0.5%)	1.07			2001-2011	BYD CO LTD(7) CONG YANG(2) AI XIAOLAN(2) SHENZHEN MINGHUA ENVIRONMENTAL PROTECTION VEHICLE CO. LTD.(1) CHINA FIRST AUTOMOBILE GROUP CORP(1)	REN YI(3) LUO HONGBIN(2) YANG SHENGLIN(2) AI XIAOLIN(2) AI XIAOZHI(2)

IN	3 (0.1%)	0.67			2005-2010	INDIAN INSTITUTE OF TECHNOLOGY BOMBAY(1) EMPIRE TECHNOLOGY DEVELOPMENT LLC(1) KPIT CUMMINS INFOSYSTEMS LTD.(1)	CHACHRA DEEPAK(1) SETH BHARTENDU(1) AMUTHAM VELAYUTHAM KADAL(1) KSHATRIYA TEJAS KRISHNA(1)

How we did it?

In order to compress all the information into a single report, we used the 360 ° series of reports available in the software. From the Priority Country 360° report options, we selected the priority countries and the different pieces of information we wanted to include in the singular display and then ran the report. The generated report was then exported to Excel using the option provided for the same.

Assignee - Key Statistics

Here we summarize key parameters of Top 15 Assignees such as filing trend, Avg. number of Forward citations per record, Top inventors in each Assignee, Top Co-Assignees and Coverage of underlying patent families

Assignee	Total No. of Records	Avg. No. of Fwd Cites per Patents	Filing Trend (Absolute)	Filing Year Range	Key Inventor (Top 5)	Co-Assignees	Coverage (Includes families)									
							US	EP	WO	JP	DE	FR	CN	GB	KR	IN
TOYOTA GROUP	702 (23.8%)	6.72		1973-2011	TABATA ATSUSHI(80) TAGA YUTAKA(48) IBARAKI RYUJI(34) MATSUBARA TOORU(28) WAKUTA SATORU(26)	BROTHER KOGYO KK(1) FUJITSU TEN LTD(1) TOSHIBA CORP(1)	697	284	254	671	388	27	291	1	97	8
HONDA MOTOR CO LTD	291 (9.9%)	7.56		1994-2011	WAKASHIRO TERUO(52) MATSUBARA ATSUSHI(45) KITAJIMA SHINICHI(39) KURODA SHIGETAKA(32) IZUMIURA ATSUSHI(28)	No Co-Assignee Present	291	135	39	280	168	2	79	2	32	15

GENERAL MOTORS CORP	229 (7.8%)	7.18		1969-2011	HEAP ANTHONY H(41) HOLMES ALAN G(26) SCHMIDT MICHAEL R(26) SAH JY JEN F(20) TAMAI GORO(14)	No Co-Assignee Present	229	59	5	16	148	0	151	5	4	83
FORD MOTOR CO	185 (6.3%)	8.09		1968-2011	KUANG MING LANG(17) SILVERI ANDREW J(16) SOLIMAN IHAB S(16) KOTRE STEPHEN JOHN(10) JANKOVIC MIROSLAVA(9)	No Co-Assignee Present	185	26	6	53	102	1	54	62	2	2
NISSAN MOTOR CO LTD	164 (5.6%)	9.84		1969-2011	KITADA SHINICHIRO(12) DEGUCHI YOSHITAKA(11) JOE SHINICHIRO(11) OSHIDARI TOSHIKAZU(9) KADOTA KEIJI(9)	No Co-Assignee Present	164	105	19	160	63	0	63	1	33	0

ROBERT BOSCH GMBH	70 (2.4%)	3.66		1974-2011	FALKENSTEIN JENS WERNER (11) LOEFFLER JUERGEN (7) TUMBACK STEFAN (6) HOETZER DIETER(5) SEEL ANDREAS(4)	No Co-Assignee Present	70	58	60	39	69	6	26	2	12	1
ZF SACHS AG	67 (2.3%)	4.96		1995-2011	KALTENBACH JOHANNES(17) BORNTRAEGER KAI(9) TENBROCK FRIEDRICH(8) WALLNER STEFAN(8) DREIBHOLZ RALF(8)	No Co-Assignee Present	67	32	34	40	67	9	20	2	1	0
HYUNDAI MOTOR CO	66 (2.2%)	1.48		2000-2011	PARK JONGSOOL(7) KIM YEONHO (5) CHOI YONG KAK(5) YI JAESHIN(4)	KIA MOTORS CORP(1)	65	0	0	33	23	0	37	0	66	0

					KIM WAN SOO(4)											
HITACHI LTD	55 (1.9%)	10.2		1992-2011	MASAKI RYOSO(9) MIYAZAKI TAIZO(9) HANYU TOMOYUKI(8) YAMAMOTO TATSUYUKI(7) MINOWA TOSHIMICHI(7)	No Co-Assignee Present	55	38	6	54	23	0	14	0	12	0
DAIMLER AG	48 (1.6%)	7.12		1983-2011	OGATA MAKOTO(9) BOLL WOLF(6) NOREIKAT KARL ERNST(5) YANASE TAKASHI(4) EBNER NORBERT(3)	No Co-Assignee Present	48	16	21	27	41	4	6	3	2	0
SUZUKI MOTOR CORP	39 (1.3%)	6.46		2000-2010	MORIMOTO KAZUHIKO(22) OMATA YOSHIAKI(21) MORI TATSUJI(8) NODA NORIHIRO(8) ITOH YOSHIKI(	No Co-Assignee Present	39	0	0	39	39	0	2	0	0	0

					7)											
PORSCHE SE	32 (1.1%)	0.44		2007-2011	SAUVLETNILS(9) KRAXNERDIETER(7) HENNINGS STEPHAN(6) FUECHTNER MARTIN(6) GOEHRING MARKUS(5)	No Co-Assignee Present	32	1	1	16	32	11	18	0	11	2
MITSUBISHI GROUP	27 (0.9%)	18.2		1991-2011	KAWAMURA NOBUYUKI(4) KOGA HISAMITSU(4) YOSHIDA MASATO(3) FURUKAWA NOBUYA(3) KATO MASAAKI(3)	No Co-Assignee Present	27	10	4	26	13	3	6	1	11	0
CHRYSLER GROUP LLC	25 (0.8%)	17.8		1946-2010	LAWRIE ROBERT E(6) BUGLIONE ARTHUR J(4) REED JR RICHARD G(4) COLELLO GARY M(4) MOORE THOMAS	NEW CARCO ACQUISITION LLC(22)	25	2	2	1	0	0	0	0	0	0

					S(3)											
PEUGEOT CITROEN AUTOMOBILES SA	24 (0.8%)	4.04		1978-2010	ROCQ GAETAN(4) LAEUFFER JACQUES(3) RIMAUX STEPHANE(3) LE NEINDRE YVAN(3) NOIRET CHRISTIAN(2)	No Co-Assignee Present	24	23	22	18	14	24	16	0	1	0

How we did it?

From the Assignee 360° report options, we selected Top 15 Assignees and the different pieces of information we wanted to include in the singular display and then ran the report. The generated report was then exported to Excel using the option provided for the same.

Inventor - Key Statistics

Here we summarize key parameters of Top 15 Inventors such as filing trend, average number of forward citations per record, key associated companies and top 5 co-inventors.

Inventor	Total No. of Records	Average No. of Fwd Cites per Patents	Filing Trend (Cumulative)	Filing Year Range	Key Assignees (Top 5)	Co-Inventors
TABATA ATSUSHI	80 (2.7%)	10.14		1996-2010	TOYOTA GROUP(80)	TAGA YUTAKA(34) MATSUBARA TOORU(24) IBARAKI RYUJI(22) KUMAZAKI KENTA(15) IWASE YUJI(13)
WAKASHIRO TERUO	52 (1.8%)	7.71		1998-2007	HONDA MOTOR CO LTD(52)	MATSUBARA ATSUSHI(29) KITAJIMA SHINICHI(25) SAWAMURA KAZUTOMO(18) TAKAHASHI HIDEYUKI(18) NAKAMOTO YASUO(17)
TAGA YUTAKA	48 (1.6%)	20.17		1995-2008	TOYOTA GROUP(48) BROTHER KOGYO KK(1)	TABATA ATSUSHI(34) IBARAKI RYUJI(23) HATA HIROSHI(13) MIKAMI TSUYOSHI(12) KUBO SEITOKU(6)
MATSUBARA ATSUSHI	45 (1.5%)	7.09		1999-2004	HONDA MOTOR CO LTD(45)	KITAJIMA SHINICHI(30) WAKASHIRO TERUO(29) KURODA SHIGETAKA(19) IZUMIURA ATSUSHI(18) NAKAMOTO YASUO(18)
HEAP ANTHONY H	41 (1.4%)	2.61		2004-2009	GENERAL MOTORS CORP(41)	SAH JY JEN F(10) HSIEH TUNG MING(8) KAMINSKY LAWRENCE A(7) KIM KEE YONG(6) BRUNSSEN WILFRIED(4)
KITAJIMA SHINICHI	39 (1.3%)	7.41		1999-2005	HONDA MOTOR CO LTD(39)	MATSUBARA ATSUSHI(30) WAKASHIRO TERUO(25) IZUMIURA ATSUSHI(19) KURODA SHIGETAKA(17) SAWAMURA KAZUTOMO(17)

IBARAKI RYUJI	34 (1.2%)	25.32		1995-2009	TOYOTA GROUP(34)	TAGA YUTAKA(23) TABATA ATSUSHI(22) HATA HIROSHI(16) MIKAMI TSUYOSHI(12) KUBO SEITOKU(5)
KURODA SHIGETAKA	33 (1.1%)	10.94		1999-2004	HONDA MOTOR CO LTD(32) BNP PARIBAS AS(1)	MATSUBARA ATSUSHI(19) KITAJIMA SHINICHI(17) WAKASHIRO TERUO(16) IZUMIURA ATSUSHI(14) SAWAMURA KAZUTOMO(13)
YAMAGUCHI KOZO	30 (1%)	25.9		1993-2004	EQUOS RESEARCH KK(17) TOYOTA GROUP(12) LUMEND INC.(1)	MIYAISHI YOSHINORI(7) MOROTO SHUZO(5) HISADA HIDEKI(4) TAKENAKA MASAYUKI(4) TUZUKI SHIGEO(4)
IZUMIURA ATSUSHI	28 (0.9%)	10.43		1999-2002	HONDA MOTOR CO LTD(28)	KITAJIMA SHINICHI(19) MATSUBARA ATSUSHI(18) KURODA SHIGETAKA(14) WAKASHIRO TERUO(13) OKI HIDEYUKI(11)
MATSUBARA TOORU	28 (0.9%)	1.75		2001-2010	TOYOTA GROUP(28)	TABATA ATSUSHI(24) KUMAZAKI KENTA(15) SHIBATA HIROYUKI(12) IWASE YUJI(7) KAIFUKU MASAKAZU(5)
HOLMES ALAN G	26 (0.9%)	8.08		2001-2010	GENERAL MOTORS CORP(26)	SCHMIDT MICHAEL R(8) KLEMEN DONALD(6) CONLON BRENDAN M(4) NITZ LARRY T(4) HEAP ANTHONY H(3)
SCHMIDT MICHAEL R	26 (0.9%)	26.88		1995-2007	GENERAL MOTORS CORP(26)	KLEMEN DONALD(12) HOLMES ALAN G(8) HEAP ANTHONY H(3) NITZ LARRY T(3) HUBBARD GREGORY A(2)
WAKUTA SATORU	26 (0.9%)	8.42		1999-2008	TOYOTA GROUP(26)	OMOTE KENJI(10) ADACHI MASATOSHI(8) SUZUKI TAKEHIKO(8) INUZUKA TAKESHI(6) MIURA KIYOTOMO(6)

SAWAMURA KAZUTOMO	25 (0.8%)	11.92		1998-2002	HONDA MOTOR CO LTD(25)	WAKASHIRO TERUO(18) KITAJIMA SHINICHI(17) MATSUBARA ATSUSHI(16) KURODA SHIGETAKA(13) IZUMIURA ATSUSHI(11)

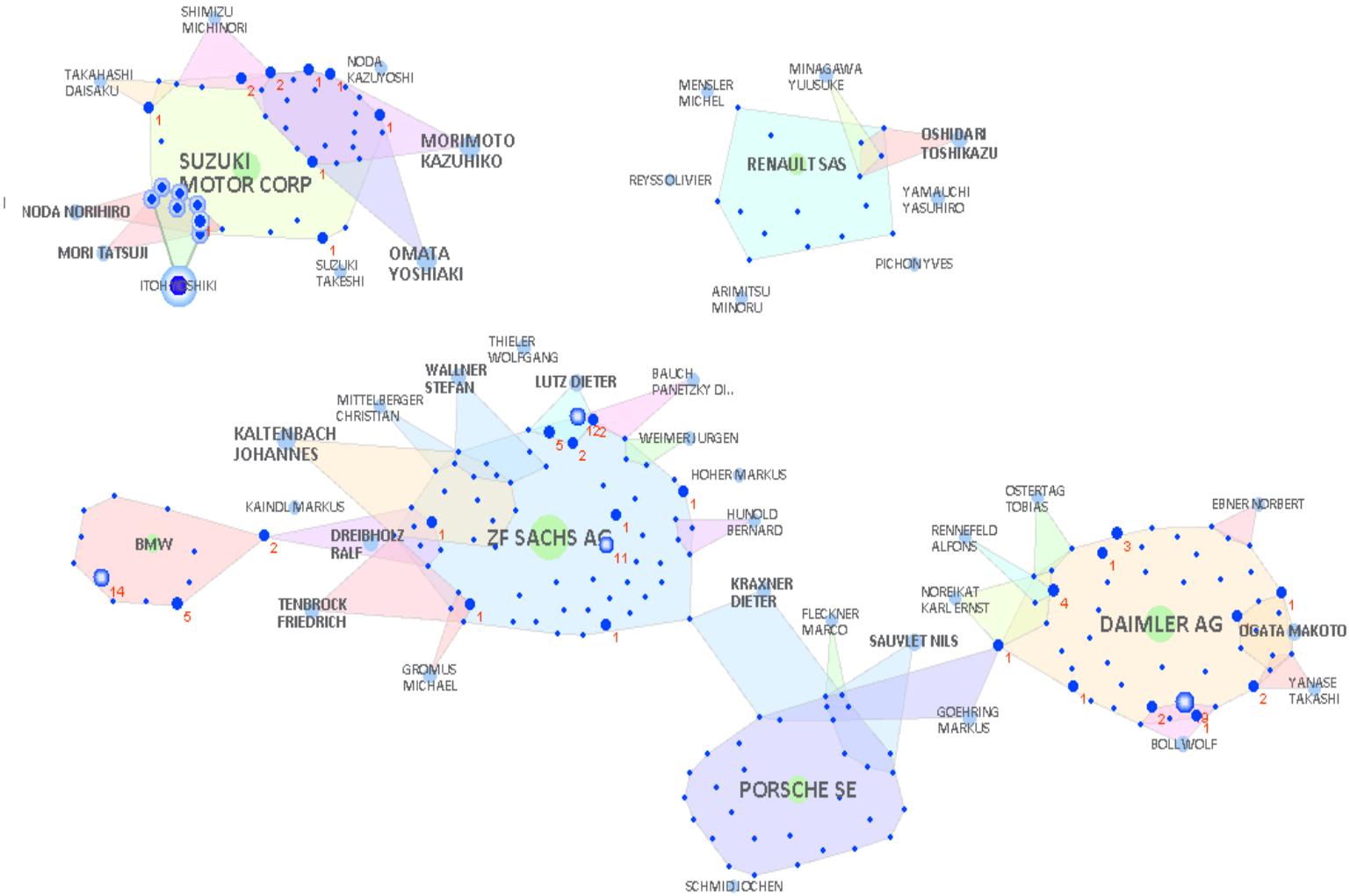
How we did it?

From the Inventor 360° report options, we selected the different pieces of information we wanted to include in the singular display and then ran the report. The generated report was then exported to Excel using the option provided for the same.

Analysis of key inventor groups of key assignees

The generated map below highlights the key inventor groups of key assignees. The records (blue dots) are positioned on the map based on their relationship to the Assignee and to the inventors listed on the graph. The numbers besides the nodes represent citation count for respective inventors.

Key inventors present in the map, for instance, Lutz Dieter for ZF Sachs AG has total 12 citations. Also groups of inventors who file together appear clustered together.



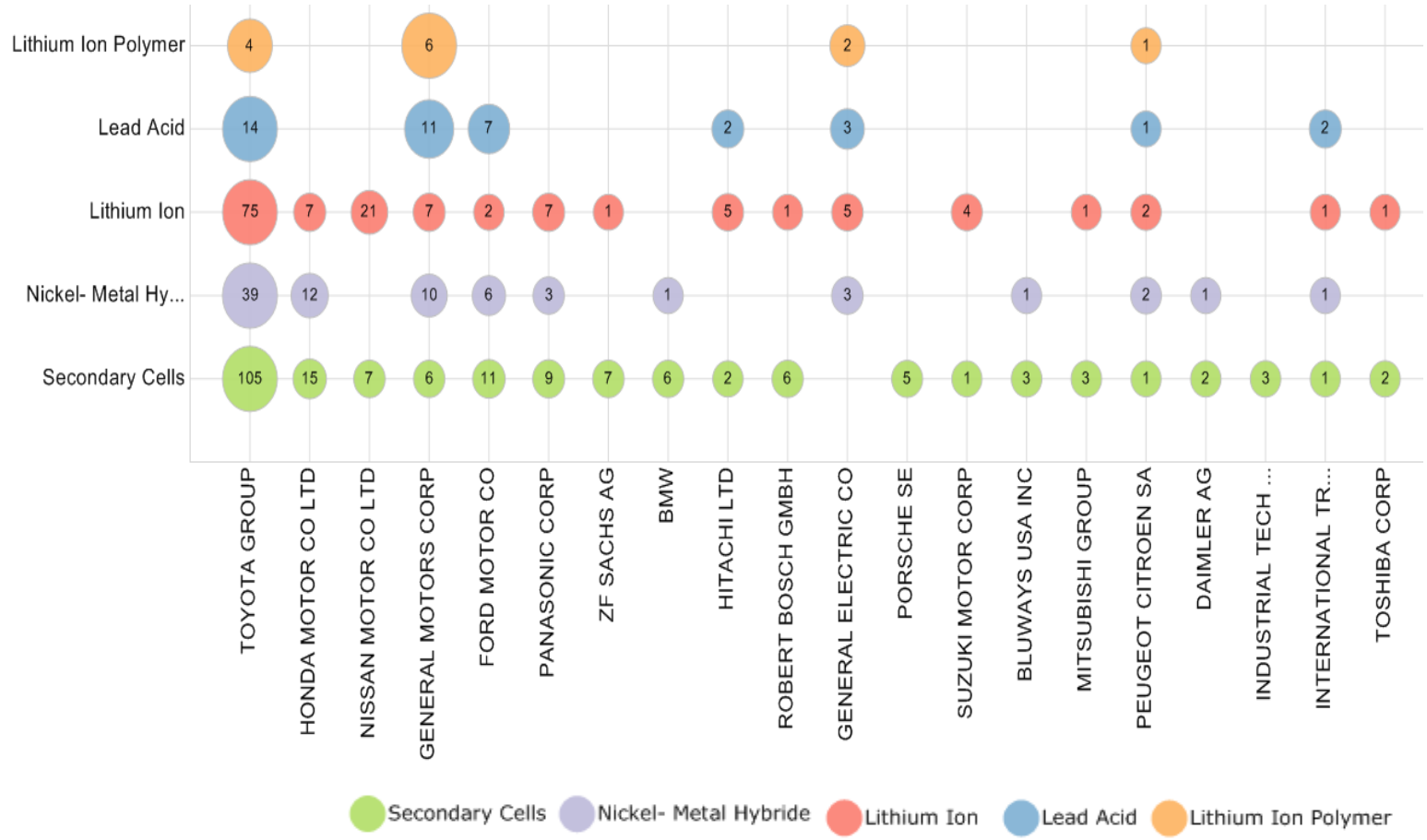
How we did it?

Using the VizMAP tool, patents of key assignees were loaded. These were then expanded by their respective inventor names. The VizShade option was used to shade the inventors with potential overlapping patents between them and citation count from the current data set is displayed.

Battery Types vs Assignees

How is the Assignee portfolio spread across different battery types?

General Motors Corp is active across Lithium Ion Polymer batteries. Toyota Group leads with 14 records followed by General Motors Corp and Ford Motor Co in Lead Acid batteries



How we did it?

First the various battery types used in hybrid vehicles were identified by manual research. Then by using a combination of semantic analysis tools such as clustering tools and searching tools available in Patent iNSIGHT Pro, patents were categorized under different battery types. A co-occurrence matrix was generated and the resulting matrix was converted into a bubble chart.

Key Companies vs Power Transmission Mode

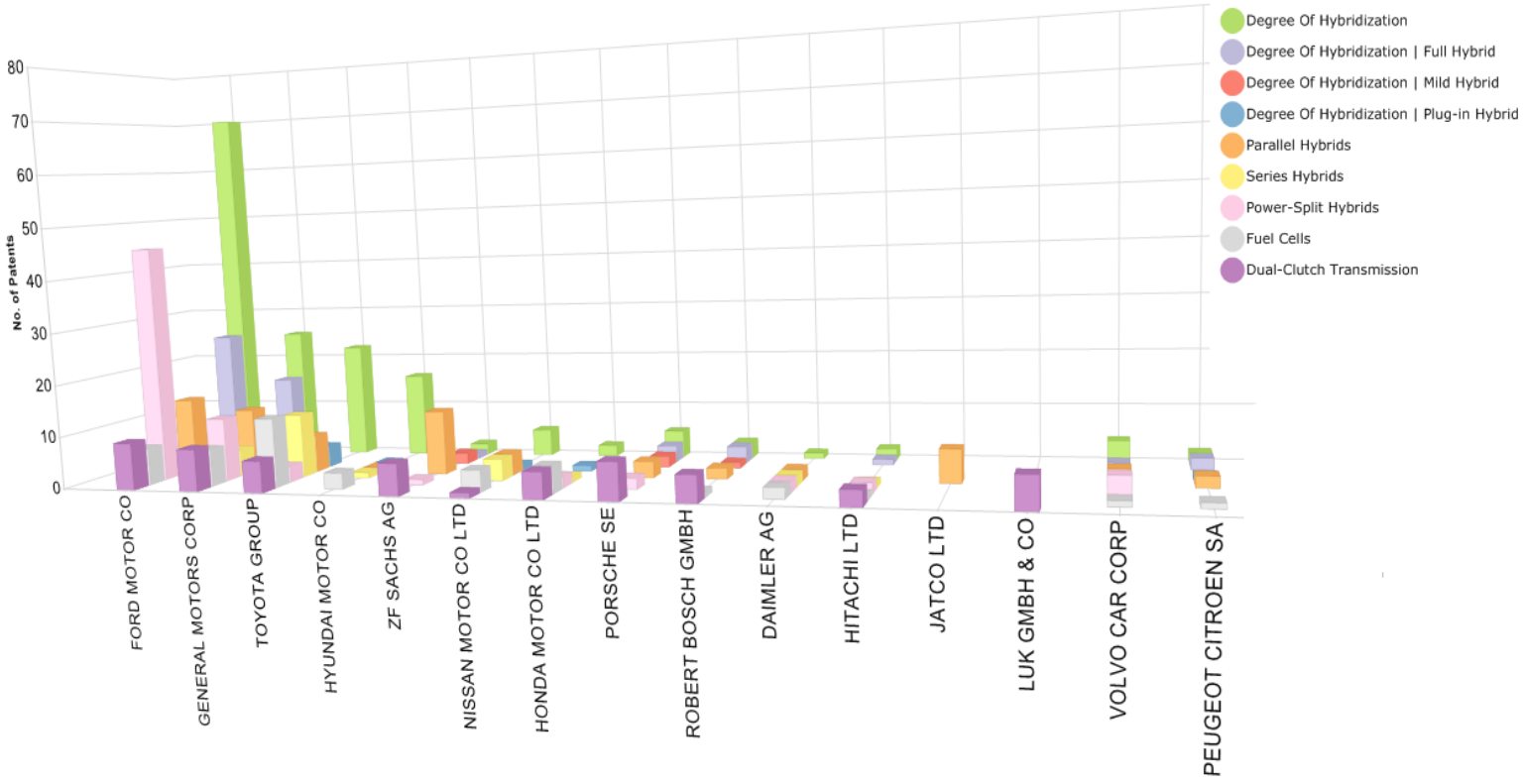
How is assignee portfolio spread across various power transmission modes?

Ford Motor Co has presence across the 'power transmission modes' portfolio leading with 45 records on power-split hybrids. Porsche SE is involved in Dual-Clutch Transmission.

Power Transmission Modes (Rows) / Key Assignees (Columns)	Total	Degree Of Hybridization				Parallel Hybrids	Series Hybrids	Power-Split Hybrids	Fuel Cells	Dual-Clutch Transmission
		Degree Of Hybridization	Full Hybrid	Mild Hybrid	Plug-in Hybrid					
Total	353	159	52	15	11	68	27	73	45	56
FORD MOTOR CO	105	70	25	5	3	14	1	45	7	9
GENERAL MOTORS CORP	60	25	16	5		12	5	12	7	8
TOYOTA GROUP	55	22			4	7	12	3	13	6
HYUNDAI MOTOR CO	21	16			1	1	1		3	
ZF SACHS AG	19	2	1	2		12		1		6
NISSAN MOTOR CO LTD	17	5			1	4	4		4	1
PORSCHE SE	13	5	3	2		3		2		7
HONDA MOTOR CO LTD	13	2			1		1	2	5	5
ROBERT BOSCH GMBH	11	3	3	1		2			1	5
HITACHI LTD	8	2	1				1	2	1	3
DAIMLER AG	8	1				2	2	2	2	
VOLVO CAR CORP	6	4	1			3		4	1	
LUK GMBH & CO	6									6
JATCO LTD	6					6				

PEUGEOT CITROEN SA	5	2	2		1	2			1

The below chart represents the graphical interpretation of the above matrix

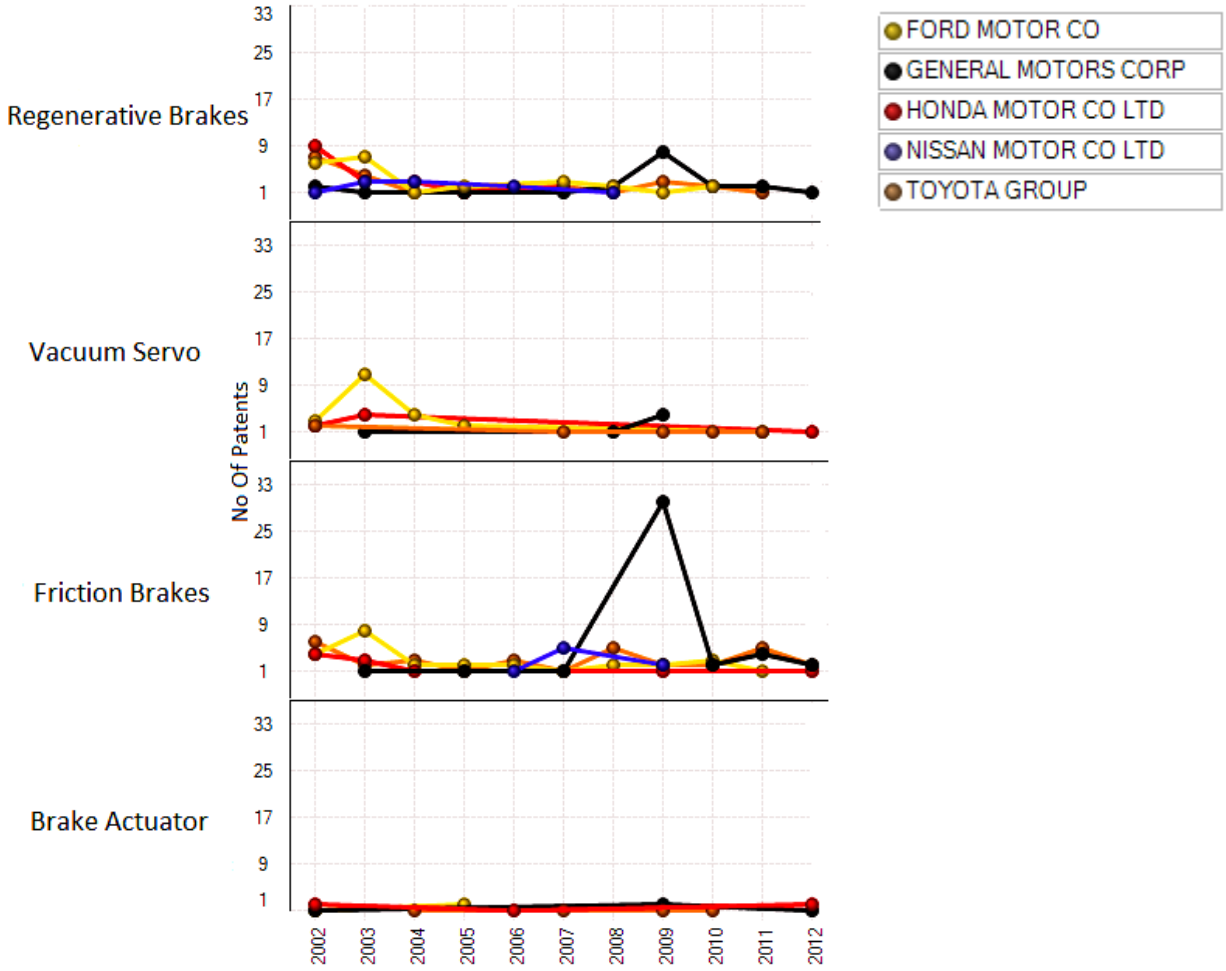


How we did it?

The clusters that were created for the analysis were correlated using the co-occurrence analyzer and then the resulting matrix was exported to Excel and a 3-D bar chart was generated.

Brakes vs Assignees

How is the Assignee portfolio spread across different Brake types?



As compared to other assignees General Motors had more no of published records in friction brakes from 2007-2009.

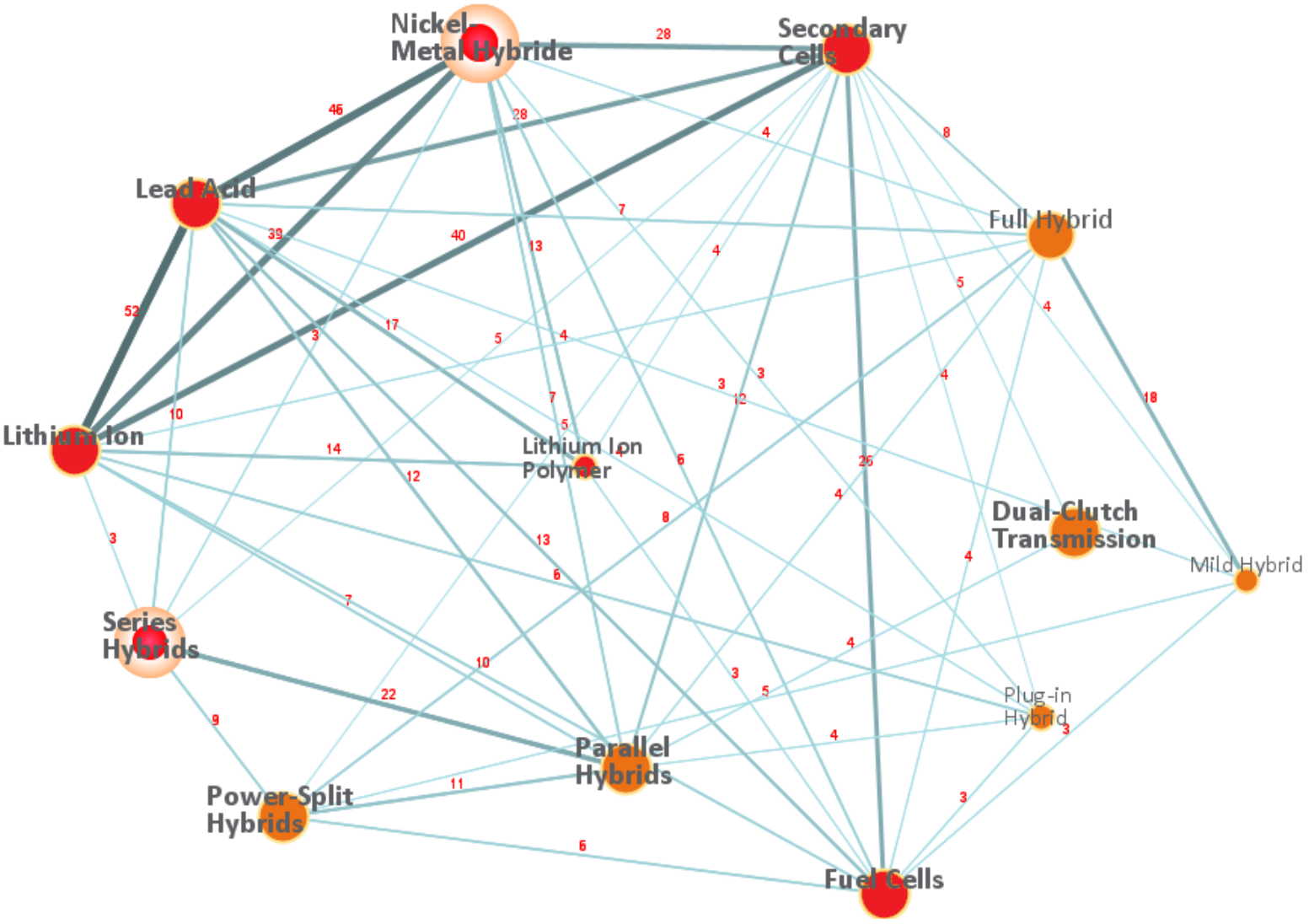
How we did it?

The clusters that were created for the previous analysis were correlated using the co-occurrence analyzer and the resulting matrix was converted into a 4-D Matrix containing assignees, types of brakes, publication year and results were restricted to last decade.

Inter-category Relationship between battery types and power transmission modes

How are records correlated across different types of batteries and power transmission modes?

In the map, each battery type is connected through links whose thickness and color intensity is directly proportional to the number of records relating them. The number (in red) next to each line represents the number of records present in a particular battery type and power transmission mode.
It can be seen that secondary cells are more used in fuel cells. Also, Series Hybrids use Lead acid type of batteries.



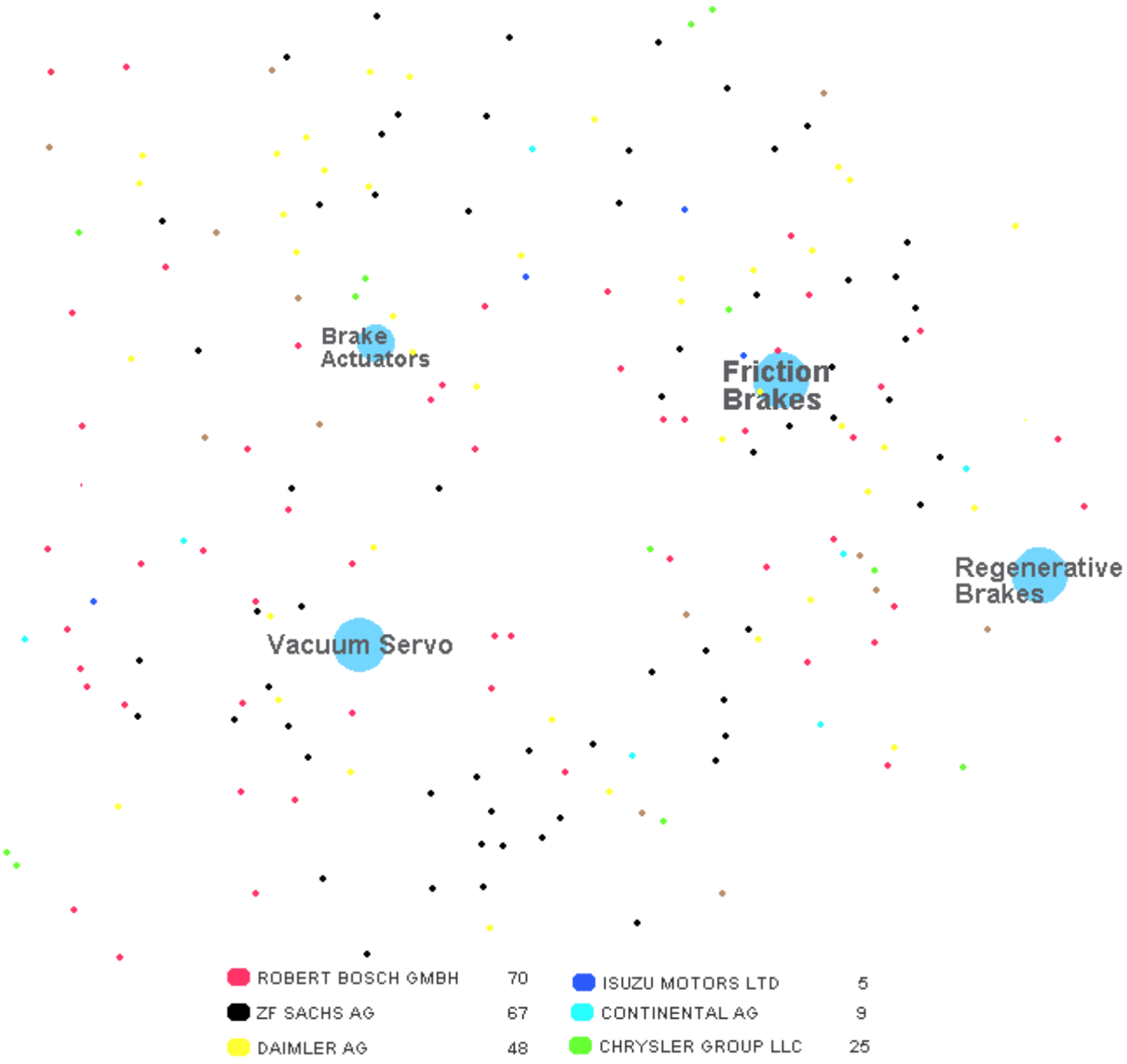
Note: The darker nodes represent the battery types, whereas remaining nodes refer to the power transmission nodes.

How we did it?

The clusters that were created for the previous analysis were correlated using the co-occurrence analyzer and then the resulting matrix was represented as Correlation Map.

Sample Portfolio Comparison of key assignees

How does the portfolio landscape of key assignees compare with other? What are the overlaps in the portfolios?



The map shows patents of key assignees clustered together based on the basis of brake technology. The map also shows the overlapping areas and patents in respective categories.

How we did it?

The VizMAP tool in Patent iNSIGHT Pro was used for this analysis. First the patents of key assignees were loaded on the map. The map was then analyzed in the context mode wherein each patent record is placed across to the contextual similarity with other records. The contextual similarity was calculated over Title, Abstract and Claims.

Appendix A: Key Assignee Normalization Table

Note: The tables below include normalization from US Assignments database and so some assignees may appear under multiple normalized names.

TOYOTA GROUP

AISIN SEIKI CO LTD
DENSO CORP
TOYODA CHUO KENKYUSHO KK
TOYOTA MOTOR CO LTD
AISIN AL CO LTD
MASUDA ATSUSHI OBATA ATSUOMI YAMAGUCHI KOICHI
NISHIUCHI SHIGETO NONAKA YOUICHI

HONDA MOTOR CO LTD

MATSUOKA TOSHIYUKI YAMAMOTO KOICHI ASAKA SATORU HASEGAWA OSAMU IKEO MITSURU MATSUMOTO KENJI
HONDA GIKEN KOYGO KABUSHIKI KA
MATSUOKA TOSHIYUKI YAMAMOTO KOICHI ASAKA SATORU HASEGAWA OSAMU IKEO MITSURU MATSUMOTO KENJI

FORD MOTOR CO

FORD GLOBAL TECH INC
KUANG MING LANG MCCARTHY JAMES PAUL PATIL PRABHAKAR B

GENERAL MOTORS CORP

GM GLOBAL TECH OPERATIONS INC
GM GLOBAL TECHNOLOGY OPERATIONS LLC
SATURN CORP
HEAP ANTHONY H HOLMES ALAN G NITZ LARRY T SCHMIDT MICHAEL R
ALDRICH WILLIAM LEONARD HOANG TONY T RISSE PATRICK L TAMAI GORO

Appendix B: Search Strings Used for Categorization

Categorization: Power Transmission Modes

1. Degree of Hybridization

a. Full Hybrid

Full Hybrid	
(FT) contains (((full or strong) w/3 hybrid*) or "negative split*" or "power boost*")	71 results

b. Mild Hybrid

Mild Hybrid	
(FT) contains ("mild hybrid*" or "static start*")	26 results

c. Plug-in Hybrid

Plug-in Hybrid	
(TAC) contains ("Plug* hybrid*" or PHEV or "gas-option*" or gas option* or "grid* hybrid*")	27 results

2. Dual- clutch Transmission

Dual- clutch Transmission	
(FT) contains ("dual-clutch" or "dual clutch" or DCT or ((twin* or double*) w/2 clutch*))	83 results

3. Fuel Cells

Fuel Cells	
(TAC) contains (fuel* cell* or electric* hybrid*)	113 results

4. Parallel Hybrids

Parallel Hybrids	
(TAC) contains ((parallel* w/2 hybrid*) or PHV or PH or "parallel mild*")	106 results

5. Power-split Hybrids

Power-split Hybrids	
(FT) contains ((("power*split" or "series*parallel") w/4 hybrid*) or SPHVS or powersplit* or "power-split")	106 results

6. Series Hybrids

Series Hybrids	
(TAC) contains (((series* or serial*) w/2 hybrid*) or SHV or SH)	61 results

Categorization: Battery Types

1. Lead Acid

Lead Acid	
(FT) contains ((lead* acid*) or (lead-acid*))	74 results

2. Lithium Ion

Lithium Ion	
(FT) contains ((("lithium-ion" or "lithium ion" or "Li-ion") w/2 (batter* or cell*)) or LIB)	176 results

3. Lithium ion Polymer

Lithium ion Polymer	
(FT) contains (lithium* polymer* or Li-poly or Li-Pol or LiPo or LIP or PLI or LiP)	26 results

4. Nickel- Metal Hybride

Nickel- Metal Hybride	
(FT) contains (((nick* metal*) w/2 (hydride* or hybrid*)) or Ni-MH or NiMH)	111 results

5. Secondary Cells

Secondary Cells	
(TAC) contains (((rechargeable or secondary or storage) w/2 (battery or batteries or cell or cells)) or accumulator)	302 results

Categorization: Brakes

1. Brake Actuators

Brake Actuators	
(TAC) contains (brak* w/3 actuat*)	44 results

2. Friction Brakes

Friction Brakes	
(FT) contains (friction w/3 brak*)	191 results

3. Regenerative Brakes

Regenerative Brakes	
(TAC) contains ((regenerat*or dynamic or renew*) w/2 brak*)	213 results

4. Vacuum Servo

Vacuum Servo	
(FT) contains (((vacuum* or vaccum*) w/3 servo*) or (brak* w/2 boost*) or ((electro-mechanical* or electromechanical*) w/2 (boost* or brak*)))	73 results

Summary

Current HEVs reduce petroleum consumption under certain conditions, compared to otherwise similar conventional vehicles by using three mechanisms:

1. Reducing wasted energy during idle/low output by turning the ICE off.
2. Regenerative braking which is recapturing waste energy.
3. Reducing the size and power of the ICE.

Any combination of these three primary hybrid advantages may be used in different vehicles to realize different fuel usage, power, emissions, and weight and cost profiles. The ICE in an HEV can be smaller, lighter, and more efficient than the one in a conventional vehicle, because the combustion engine can be sized for slightly above average power demand rather than peak power demand. The drive system in a vehicle is required to operate over a range of speed and power, but an ICE's highest efficiency is in a narrow range of operation, making conventional vehicles inefficient. On the contrary, in most HEV designs, the ICE operates closer to its range of highest efficiency more frequently. The greater fuel economy of HEVs has implication for reduced petroleum consumption and vehicle air pollution emissions worldwide.

This report talks about the existing & emerging trends in the different technological advancements in hybrid vehicle domain.

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Sources & References

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2. *http://en.wikipedia.org/wiki/Hybrid_electric_vehiclez*
3. *http://en.wikipedia.org/wiki/Hybrid_vehicle_drivetrain#Types_by_degree_of_hybridization*