

THE INTERNET OF THINGS (IOT)

CAL POLY MECHANICAL ENGINEERING GRADUATE SEMINAR

21 JANUARY 2015

ORGANIZATION

- WHAT IS THE INTERNET OF THINGS?
 - INGREDIENTS OF IoT
 - HOW SOME DEFINE AND DESCRIBE IoT
- SOME EXAMPLES
 - TRANSPORTATION
 - SMART CITIES
 - SMART MANUFACTURING
 - SMART CONDITION MONITORING
 - ET CETERA
- MY IoT DEVELOPMENT WORK IN ITALY

IOT AKA...

- INDUSTRY 4.0 (GERMANY)
- INDUSTRIAL INTERNET (G.E.)
- M2M, V2V, V2I
- SMART FACTORY
- CYBER-PHYSICAL SYSTEMS
- THE INTERNET OF EVERYTHING
- BIG-DATA ANALYTICS
- SMART FACTORY

2.2 IoT Strategic Research and Innovation Directions

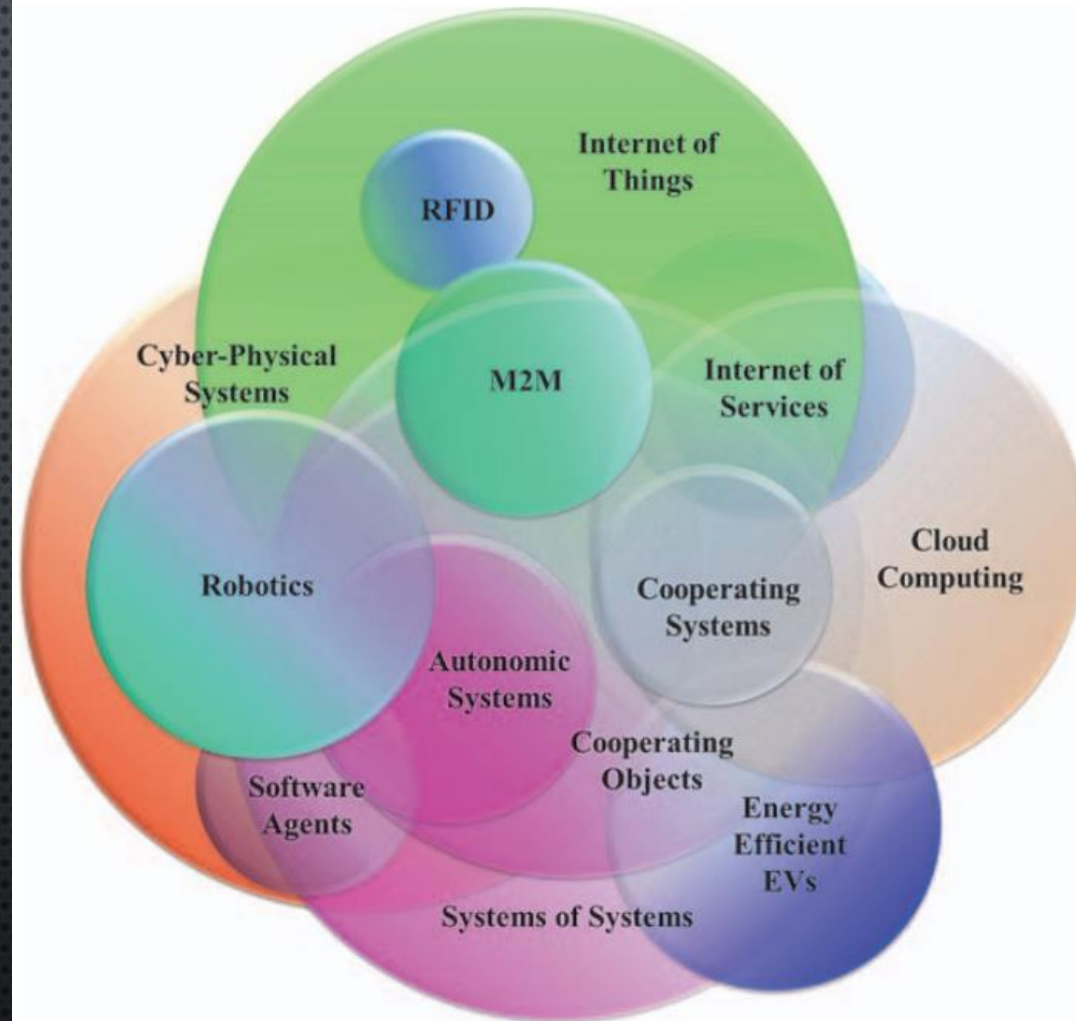


Fig. 2.8 Technology convergence.

SEE THESE INTRODUCTIONS:

- INTEL INTRO TO IOT: [HTTPS://WWW.YOUTUBE.COM/WATCH?V=Q3UR8WZZHBU](https://www.youtube.com/watch?v=Q3UR8WZZHBU)
- SAP INTRO TO IOT: [HTTPS://WWW.YOUTUBE.COM/WATCH?V=GCTQLHRNFTU](https://www.youtube.com/watch?v=GCTQLHRNFTU)

INDUSTRY 4.0

- FIRST INDUSTRIAL REVOLUTION WAS MECHANIZATION OF PRODUCTION USING WATER AND STEAM POWER
- SECOND INDUSTRIAL REVOLUTION WAS DEVELOPMENT OF MASS PRODUCTION USING ELECTRICAL POWER
- THIRD INDUSTRIAL REVOLUTION WAS THE DIGITAL REVOLUTION AND THE USE OF COMPUTERS AND ELECTRONICS TO AUTOMATE PRODUCTION
- FOURTH INDUSTRIAL REVOLUTION IS IoT

MARKET PREDICTION FOR IOT GROWTH

LAST BUT NOT LEAST, BRYZEK MENTIONS NEW FORECASTS REGARDING THE IOT OPPORTUNITY, WITH GE ESTIMATING THAT THE “INDUSTRIAL INTERNET” HAS THE POTENTIAL TO ADD \$10 TO \$15 TRILLION (WITH A “T”) TO GLOBAL GDP OVER THE NEXT 20 YEARS, AND CISCO INCREASING TO \$19 TRILLION ITS FORECAST FOR THE ECONOMIC VALUE CREATED BY THE “INTERNET OF EVERYTHING” IN THE YEAR 2020. “THIS IS THE LARGEST GROWTH IN THE HISTORY OF HUMANS,” SAYS BRYZEK.

JANUS BRYZEK IS “THE FATHER OF SENSORS” AND A VP AT FAIRCHILD SEMICONDUCTOR

INDUSTRIES IMPACTED MOST BY IOT

- TRANSPORTATION (AUTOS, DELIVERY VANS, TRUCKS, TRAINS, BOATS, AIRCRAFT)
- TRAFFIC INFRASTRUCTURE
- MANUFACTURING
- MACHINERY CONDITION MONITORING, DIAGNOSTICS, SELF-OPTIMIZATION
- ELECTRIC POWER GENERATION AND DISTRIBUTION (SMART GRID)
- SMART CITIES
- MEDICINE
- AGRICULTURE



*Vehicle, asset, person & pet
monitoring & controlling*



Agriculture automation



Energy consumption



*Security &
surveillance*



Building management



*Embedded
Mobile*



*M2M & wireless
sensor network*



Everyday things



Smart homes & cities



Telemedicine & helthcare

Internet of things

Everyday things
get connected  for smarter
tomorrow

WHY IS IT CALLED THE “INTERNET OF THINGS”?

- OVER THE PAST COUPLE OF DECADES MANY SMART DEVICES HAVE BEEN DEPLOYED INTO THE CONSUMER AND THE INDUSTRIAL WORLD
 - EVERY CAR IS EQUIPPED WITH AN ON-BOARD COMPUTER
 - DEVELOPMENT OF “SMART” DEVICES—VALVES, PUMPS, INDUSTRIAL FANS, TURBINES, MACHINE TOOLS
 - ALL ARE EQUIPPED WITH SENSORS AND MICRO-CONTROLLERS
 - ALL ARE NETWORKED TOGETHER
 - IN PROCESS INDUSTRY, FOR EXAMPLE, FIELDBUS
 - IN VEHICLES, CAN BUS
- THESE THINGS CAN COMMUNICATE WITH EACH OTHER AND MAKE DECISIONS WITHOUT INTERVENTION BY HUMANS
- WHAT’S MISSING IS SOFTWARE THAT ALLOWS THINGS TO COMMUNICATE, MAKE DECISIONS, AND CARRY THEM OUT WITHOUT HUMAN INTERVENTION

A DIFFERENT WAY TO LOOK AT DATA

“THE BASIC CONCEPT IS TO TAKE INDUSTRY OUT OF THE REALM OF AFTER-THE-FACT ANALYSIS. IOT TAKES A MOUNTAIN OF DATA AND PUTS IT TO WORK IN REAL TIME TO DRIVE BETTER DECISIONS.”

- FORBES, 6/23/14

FOR EXAMPLE

- SENSORS IN YOUR CAR KEEP TRACK OF CAR'S CONDITION
- IF A PROBLEM IS DETECTED, A PART GETTING READY TO FAIL, THIS IS NOTED
- CAR IS CONNECTED TO INTERNET; SOFTWARE DETERMINES WHEN PART WILL FAIL
- PART IS ORDERED AUTOMATICALLY AND SCHEDULED FOR DELIVERY TO A CONVENIENT REPAIR GARAGE
- APPOINTMENT IS SCHEDULED FOR YOU TO TAKE CAR TO GARAGE AFTER PART ARRIVES THERE, BEFORE PART FAILS AND LEAVES YOU STRANDED ON THE SIDE OF THE ROAD

FOR EXAMPLE

- ELEMENTARY SCHOOL KIDS' BACKPACKS EQUIPPED WITH IDENTIFYING RFID TAGS
- BUS STOP EQUIPPED WITH RFID READER AND INTERNET CONNECTION. PARENTS CAN MONITOR THEIR KID'S PRESENCE AT THE BUS STOP ON THEIR CELL PHONES.
- UPON BOARDING BUS, RFID TAGS READ. BUS ALSO CONNECTED TO INTERNET SO THAT KIDS' PROGRESS ON BUS ENROUTE TO SCHOOL CAN BE MONITORED.
- UPON DISEMBARKING AT SCHOOL, KID'S WHEREABOUTS CAN BE MONITORED AGAIN ON CELL PHONES.

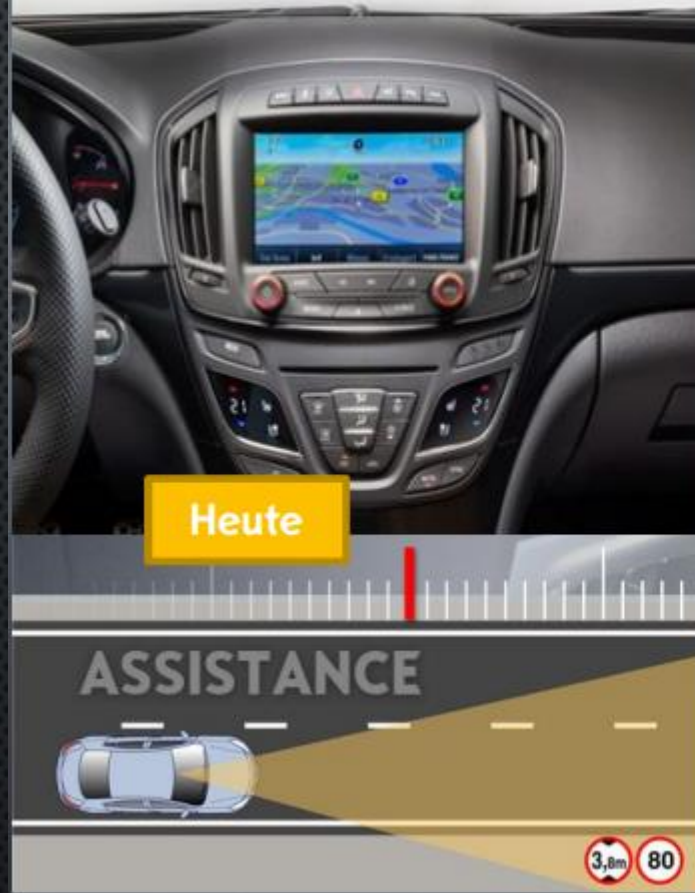
INGREDIENTS FOR IOT

- DEVICES EQUIPPED WITH SENSORS THAT ARE CONNECTABLE
- INTERNET CONNECTIVITY
 - NEW INTERNET PROTOCOL VERSION 6 (IPV6) CONNECTIVITY STANDARD
 - BLUETOOTH
 - WIFI
 - RFID
- SMART PHONES ARE NOW UBIQUITOUS
 - BESIDES THEIR CONNECTIVITY FEATURES, SMART PHONES ARE SMALL MOTION AND SPATIAL SENSOR PLATFORMS
- SOFTWARE TO MAKE DECISIONS

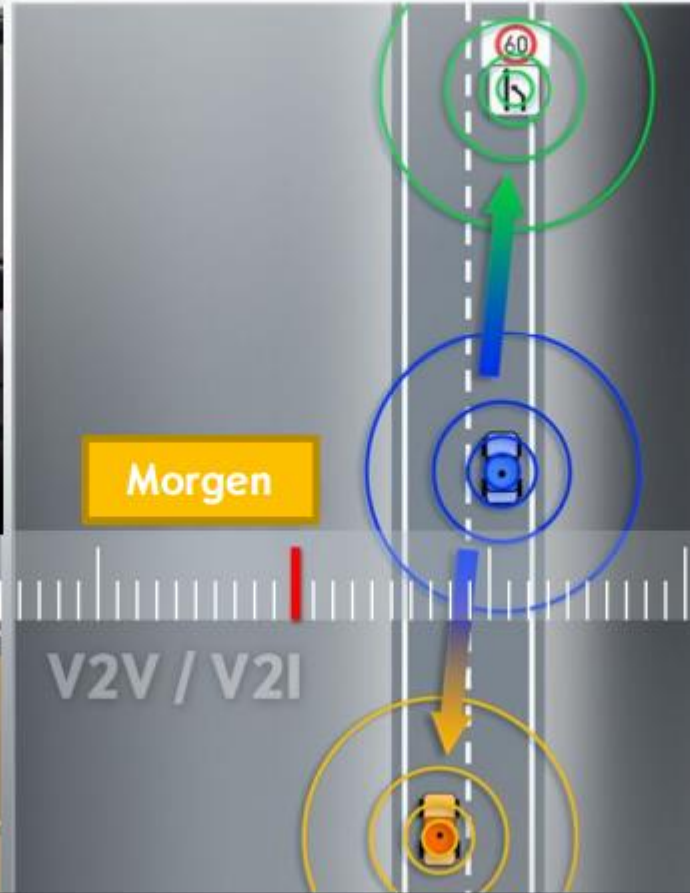
TRANSPORTATION

- SMART PHONE ENABLES CAR SHARING
- NAVIGATION SYSTEMS — MUCH BETTER TODAY THAN JUST A FEW YEARS BACK, AWARENESS OF CURRENT TRAFFIC SITUATIONS AND ABILITY TO RE-ROUTE TRAFFIC TO AVOID TRAFFIC JAMS
- V2V — VEHICLE-TO-VEHICLE COMMUNICATION — EACH VEHICLE KNOWS WHERE OTHER VEHICLES ARE IN ITS PROXIMITY
- V2I — VEHICLE-TO-INFRASTRUCTURE — THERE IS COMMUNICATION BETWEEN VEHICLES AND THE TRAFFIC CONTROL DEVICES IN ITS PROXIMITY
- NETWORKED VEHICLES AND TRAINS CAN USE ON-BOARD ACCELEROMETER DATA TO SENSE LOCATIONS WHERE THERE ARE POTHOLE OR TRACKS THAT NEED REPAIR AND REPORT TO STREET OR RAIL REPAIR FACILITY

Fahrerassistenz-Systeme



Vehicle-to-Vehicle/Infrastructure Kommunikation



Vom semi- zum voll- automatisierten Fahren



TRANSPORTATION – AVIATION

- [FLIGHTRADAR24](#) – SHOW DEMONSTRATION
- AIRCRAFT ENGINE HEALTH MONITORING TO REDUCE FUEL AND MAINTENANCE COSTS:

“BY REVIEWING REAL-TIME DATA, THERE IS NO NEED TO BREAK DOWN AN ENGINE EVERY 2,000 HOURS,” PAUL MARITZ (CEO OF PIVOTAL) SAYS. “THIS WILL ENABLE [ORIGINAL EQUIPMENT MANUFACTURERS] TO PROFITABLY CHANGE THEIR BUSINESS MODEL TO CONTRACTING FOR HOURS OF OPERATION, NOT SALES OF MACHINES.”

CONSEQUENTLY, AIRCRAFT MANUFACTURERS ARE GEARING UP FOR WHAT PROMISES TO BE A REVOLUTION IN FLIGHT PROFITABILITY AND EFFICIENCY. FOR INSTANCE, GE’S FLIGHT EFFICIENCY SERVICES ARE HELPING AIRLINES FIND EFFICIENCIES THAT CAN REDUCE UP TO 2 PERCENT OF THEIR ANNUAL FUEL BILLS. GE HAS BEEN COLLABORATING WITH ITALIAN AIRLINE ALITALIA SINCE 2011 IN USING BIG DATA TO IDENTIFY AND REALIZE FUEL EFFICIENCIES. BY PROVIDING PROJECT IMPLEMENTATION SUPPORT, AUTOMATED REPORTING AND ANALYSIS OF DAILY FUEL USAGE, ALITALIA IDENTIFIED A 1.5 PERCENT SAVINGS IN FUEL COSTS WITHIN THE FIRST YEAR—SAVING \$15 MILLION (\$46 MILLION TO DATE).

MACHINE CONDITION MONITORING AND DIAGNOSTICS

- MOTIONICS: [HTTP://MOTIONICS.COM/PRODUCTS.HTML](http://motionics.com/products.html)
- SAP PREDICTIVE MAINTENANCE AND SERVICE:
[HTTPS://WWW.YOUTUBE.COM/WATCH?V=YBOQMD3OKf0](https://www.youtube.com/watch?v=YBOQMD3OKf0)

IOT IN MANUFACTURING – M2M

- FOCUS IS TO
 - REDUCE MACHINE ENERGY USE
 - IMPROVE MACHINE MANUFACTURING EFFICIENCY
 - MAKE MACHINES FLEXIBLE SO THAT ASSEMBLY LINE CAN MANUFACTURE OR ASSEMBLE MULTIPLE VARIANTS OF A PRODUCT (BMW ASSEMBLY LINE IN MUNICH)
 - MAKE MACHINES SELF-DIAGNOSE THEIR CONDITION AND SELF-OPTIMIZE THEIR OPERATION
 - SEE [CONTROL ENGINEERING](#) ARTICLE OF 7/23/13
- NEXT BIG STEP IN AIRCRAFT MANUFACTURE IS AUTOMATED MANUFACTURING

SMART CITIES

- BARCELONA AND IOE: [HTTPS://WWW.YOUTUBE.COM/WATCH?V=TCBVXB5T5_8](https://www.youtube.com/watch?v=TCBVXB5T5_8)
 - CITY-WIDE HIGH-SPEED INTERNET

POWER GENERATION – WIND TURBINES

- SAP SYSTEM FOR WIND TURBINE MONITORING:
[HTTPS://WWW.YOUTUBE.COM/WATCH?V=Y8DHGI8ZRZs](https://www.youtube.com/watch?v=Y8DHGI8ZRZs)

IOT IN AGRICULTURE



- MONSANTO HAS DEVELOPED SYSTEM COMBINING HIGH-RESOLUTION WEATHER PREDICTION WITH SOIL CONDITIONS
 - SPREADING THIS SYSTEM TO DEVELOPING WORLD USING CELL PHONE NETWORK
 - SEEDS DEVELOPED SPECIFICALLY FOR LOCAL CONDITIONS – DROUGHT AND INSECT RESISTANCE
- ROBOTS IN THE FIELDS
 - NETWORKED, AUTONOMOUS, AND GPS-EQUIPPED
- WIRELESS FARMING (VERIZON): [HTTPS://WWW.YOUTUBE.COM/WATCH?V=WDA-4lFJQL8](https://www.youtube.com/watch?v=wDA-4lFJQL8)
- SMART VINEYARD (CISCO): [HTTPS://WWW.YOUTUBE.COM/WATCH?V=UPQIDQ405Bo](https://www.youtube.com/watch?v=UPQIDQ405Bo)

IOT IN MEDICINE

- REMOTE DIAGNOSTICS OF MEDICAL PROBLEMS
 - IPHONE APP TO DIAGNOSE REMOTELY KIDS' EAR PROBLEMS
- ABILITY TO MONITOR CONDITION OF ELDERLY PATIENTS, ALLOWING THEM TO LIVE LONGER AT HOME

MY IOT-APP WORK IN ITALY

- ANDROID APP, "TOUCHPLANT", TO ALLOW REMOTE DIAGNOSTICS OF USE OF LIFTRONIC ASSEMBLY MACHINE BY INDEVA
- LIFTING MOTOR IN MACHINE REMOVES WEIGHT OF OBJECT BEING INSTALLED/ASSEMBLED
- MACHINE HAS CAN BUS THAT RECORDS OPERATING PARAMETERS OF MACHINE AS IT IS USED IN A FACTORY
- PROBLEM WAS DIAGNOSING PROBLEMS WITH MACHINE REMOTELY
- WITH TOUCHPLANT INDEVA PERSONNEL IN NORTHERN ITALY CAN DIAGNOSE PROBLEMS WITH MACHINE IN MALAYSIA, FOR EXAMPLE
- AUTOMATION LAB AT UNIVERSITY OF BERGAMO IN DALMINE, ITALY



QUESTIONS?