The Internet of Things

seen and hidden

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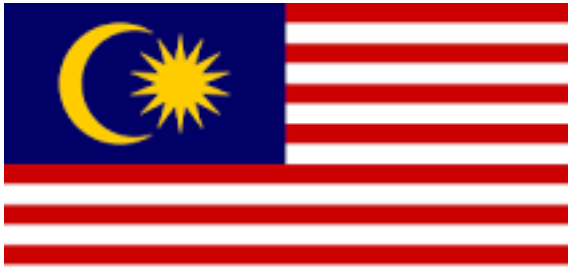
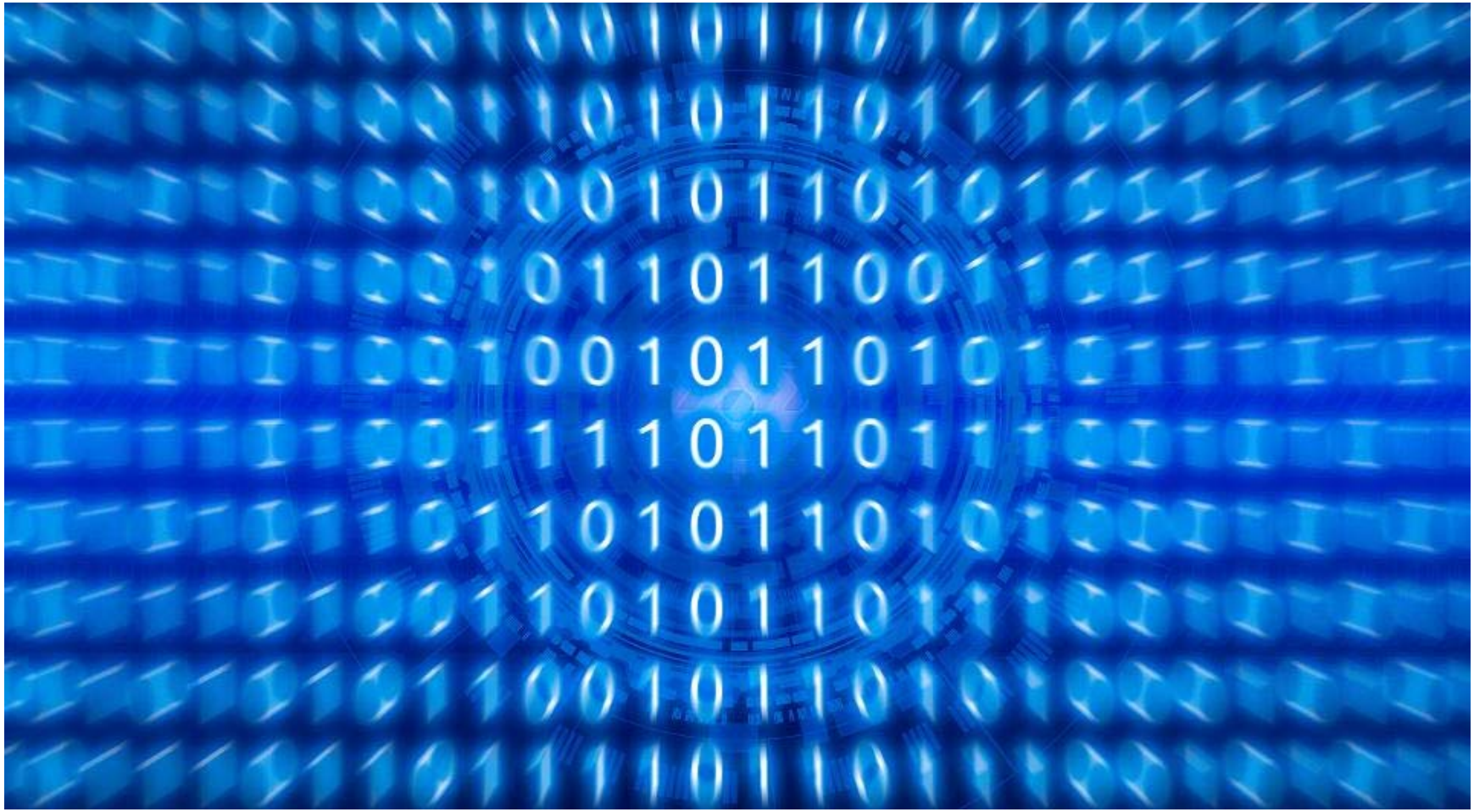
Wonderful Malaysia



This talk

- Human-to-Human communication
- A look back at our past
- Where we are today
- Some early communication technology and the modern community of people and devices we call The Internet of Things (IoT)

Increasingly we live in a world where everything is connected to everything



But this is relatively recent

Let’s start with how humans communicate…or have communicated up to the present time

Reflective…analytical…philosophical

From grunts & gestures to language and dialect variation

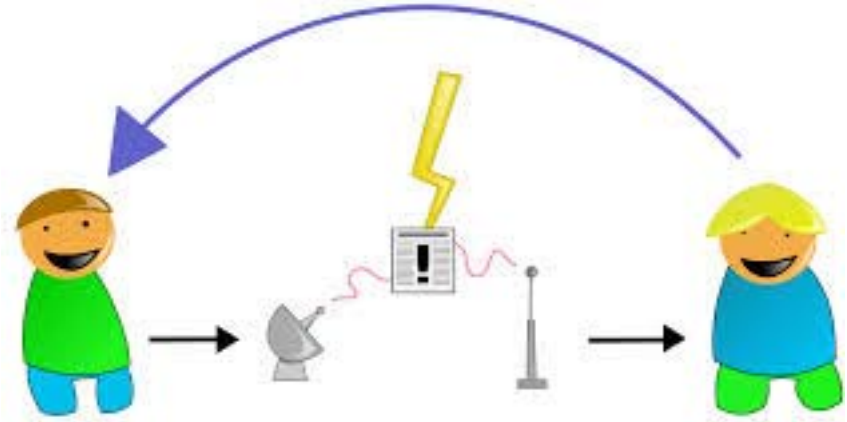
Enter technology

who remembers playing with tin cans?

Humans using technology to communicate
(using ***things/devices*** other than their unamplified voices)

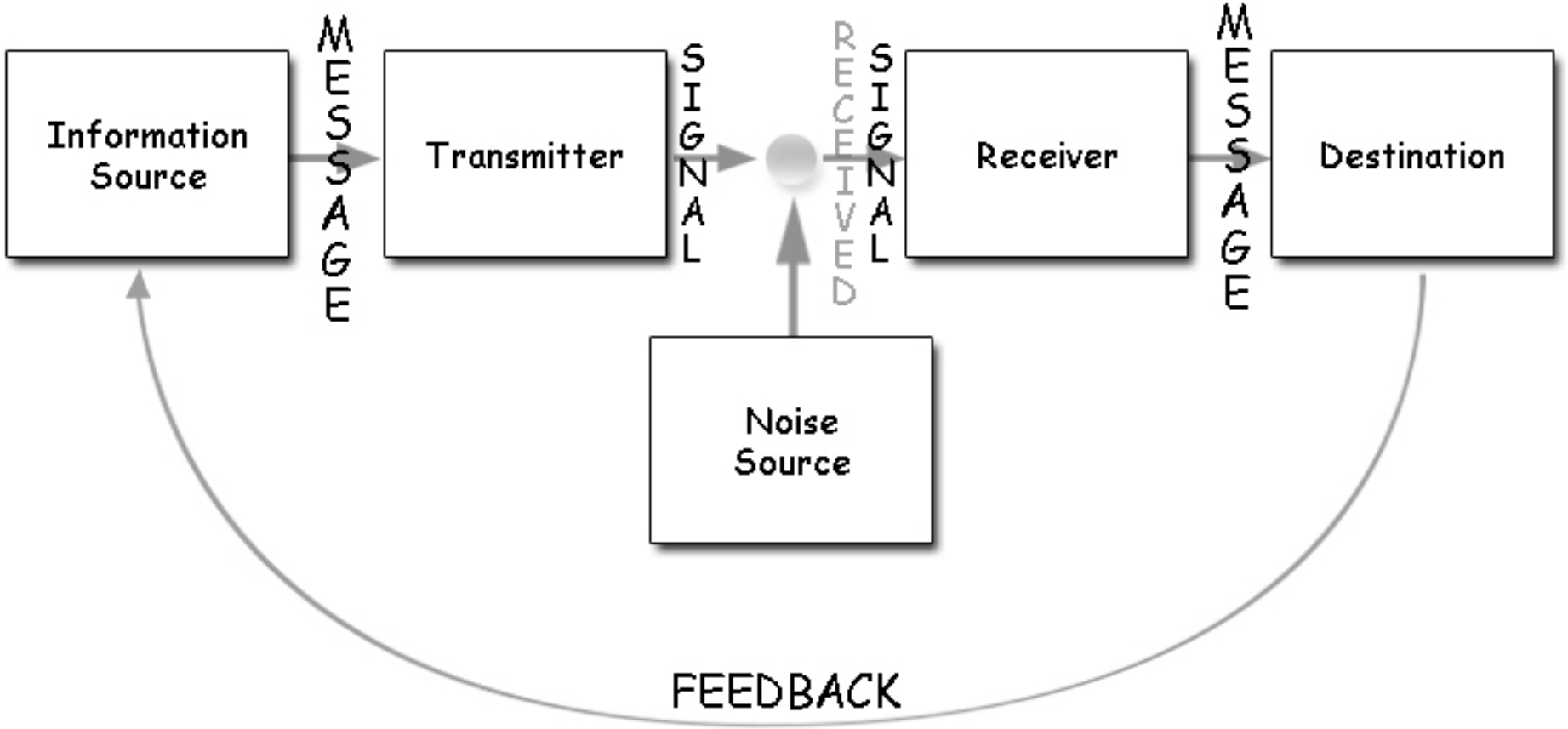
Communication technology evolved

Shannon and Weaver (1948) described a formal (mathematical) model of Communication

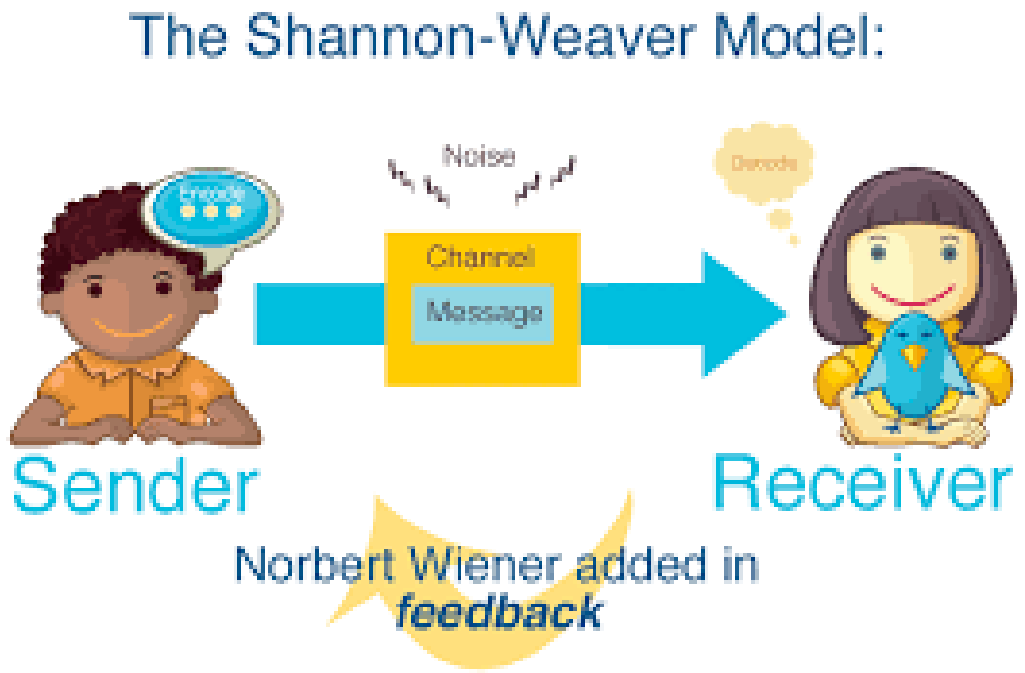


Shannon and Weaver (1948)

A mathematical model of communication



Signal Processing people enhanced and sophisticated the model



Soon after S&W's 1948 model, Norbert Wiener (inventor of Cybernetics) introduced the *Feedback Loop* to systems theory including the S&W Communication Model

Four years later and AI is born

a new kind of human-computer communication

- 1952 Marvin Minsky wrote a checkers playing program
- 1955 he wrote a 'learning' version of it - human playing against the computer
- 1958 Minsky and McCarthy with Shannon and IBM organised the 1st AIT conference at Dartmouth College
- 1963 MIT received a US$M2.2 grant for AI research and established DARPA for Advanced Research Projects

New terminology emerged
for use in relation to AI

Information

Knowledge

Learning

Understanding

Thinking

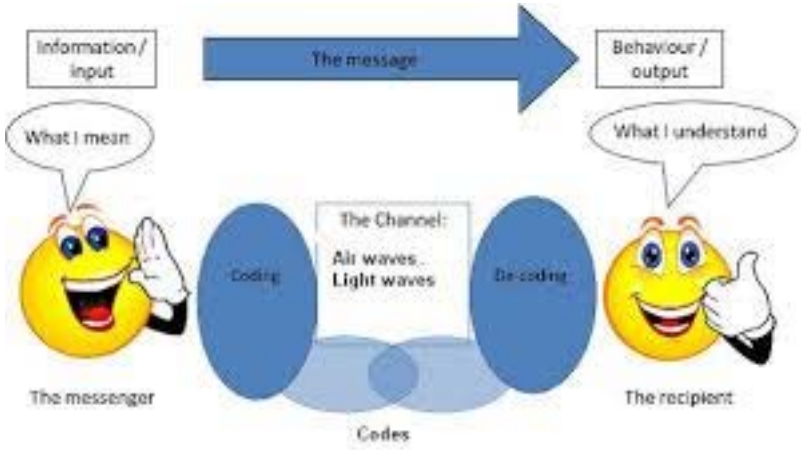
Reasoning

Question of the day

what do the terms mean (formal definitions)
for computers operating (communicating) in the likeness of humans?

Data → Information → Knowledge → Understanding

Learning
Reasoning
Thinking?



Each communication token has a very different character

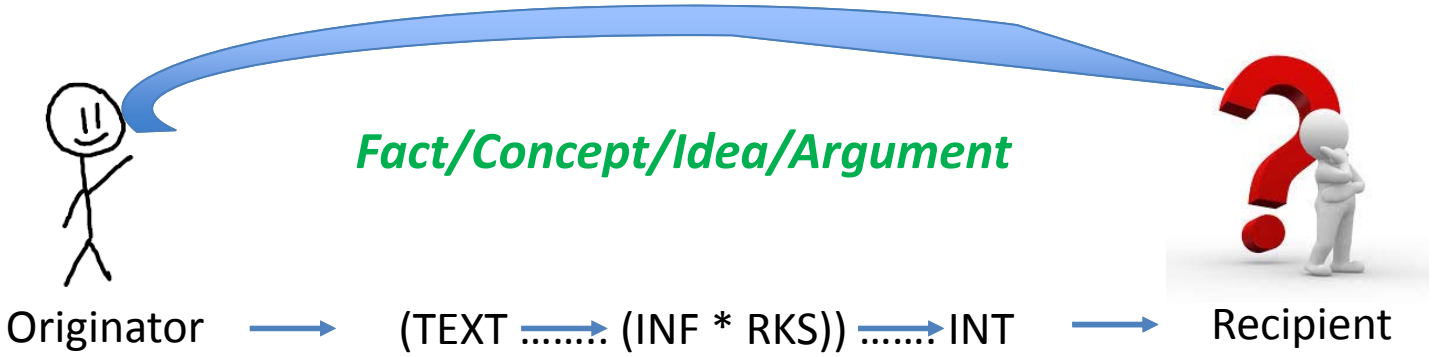
Spectrum of Communication Models

domains of Semiotics and Computational Linguistics

- Single text analysis – structural linguistics
- Corpus analysis – thematic and style
- Discourse analysis & Conversation modelling
- Story structure and meaning
- Poetry and Prose generation
- Authorship authentication
- Text context and plagiarism analysis

An example from written text as a communication medium

(A feed-forward communication model)



Text contains
surface data and meta-information (syntax and lexical semantics),
actual information (logical semantics)
and knowledge (deep meaning)

These all combine in a systematic process
for potential understanding and actual learning

Theory and Practice

1950's and 60's

Computers themselves were being connected

A few milestone examples:

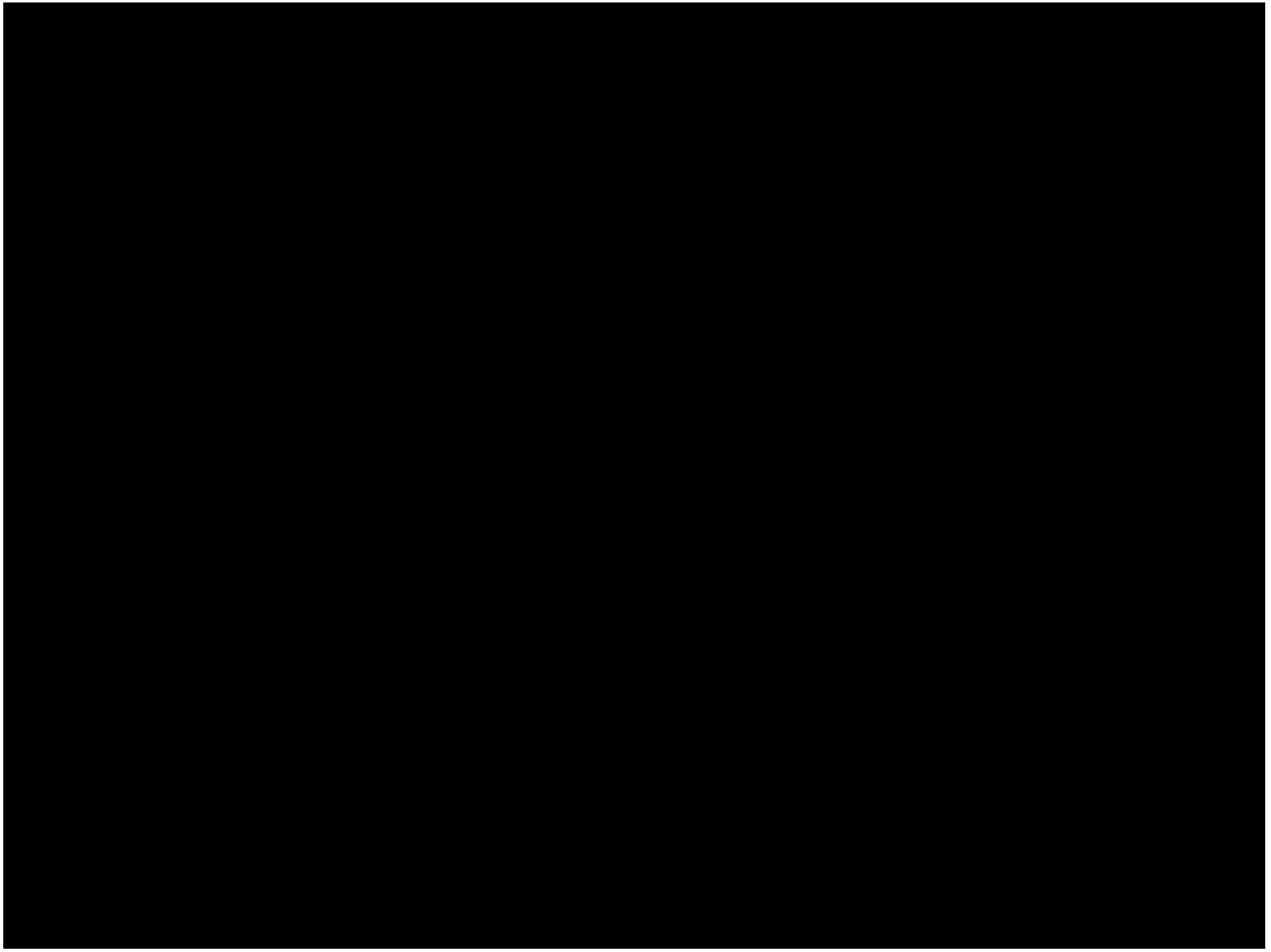
- **1957** - SAGE (Semi Automatic Ground Environment) a military radar communications computer network

- **1960** - SABRE (Commercial Airlines Reservation System) with two connected mainframes

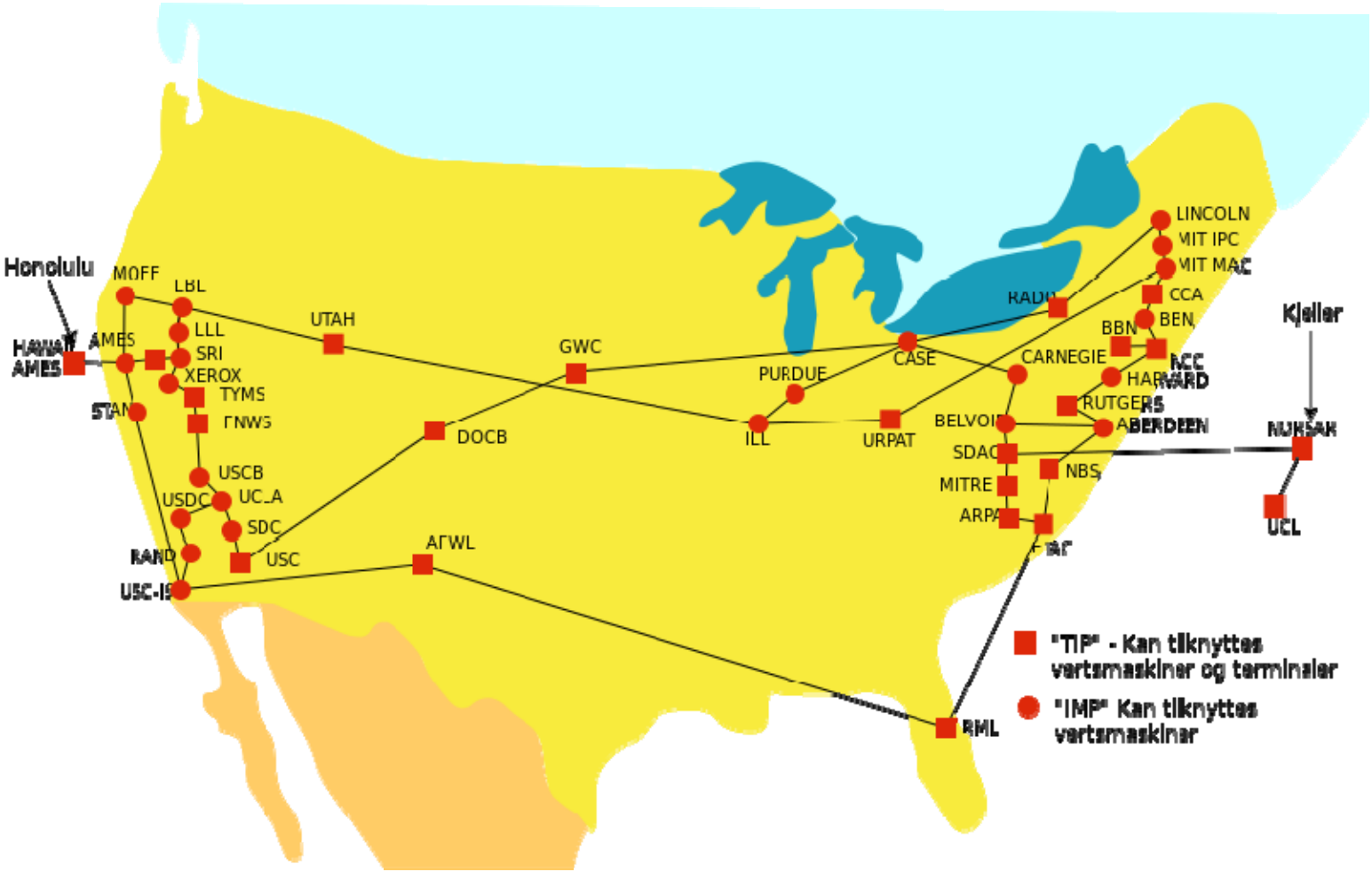
- **1964** – Dartmouth College *Time-Sharing System* with remotely connected terminals used by Bell labs and General Electric for a telephone routing and management system. HP then developed its TSB

- **1969** - the pre-Internet began with four computers connected from UCLA, UCSB, Stanford and Univ of Utah. This became ARPANET based on concept called ALOHANet and marked the dawn of the Internet, which didn't properly get underway until 1983

1969 - The First Internet Message



Early 1970's ARPANET was established and data was being passed between remotely located computers



The next decade saw huge advances in computer technology with terminal emulation, virtual memory, packet-switching, protocol definitions and a rapid reduction in hardware size, while an even more rapid increase in speed and computational functionality

1970s - Development was rapid

More milestone examples:

- 1972 – emergence of commercial services using X.25 and TCP/IP protocol for communications infrastructure

- 1972 – Robert Metcalf wrote a paper describing the Ethernet, expanding TCP/IP and packet switching. Terminal emulation, computer interconnectivity and virtual storage enabled a greater potential for electronic data sharing

- 1976 – ARCNET from Datapoint Corp commences with sophisticated token passing for high speed and secure computer connectivity

- 1977 - Index-sequential files evolved into new developments in database technology making data matching in a timely and sophisticated manner more possible

- 1979 – Declarative programming languages emerged from procedural languages enabling faster search and reporting functionality

1980s - Birth of the Internet

- 1983 (1st Jan) ARPANET adopted TCP/IP protocol and network-of-networks commenced the Internet concept

- Hypertext entered the computing world in 1980, followed in 1987 by an HTML tagged database called ENQUIRE, developed by computer scientist Tim Berners-Lee at CERN physics labs in Geneva.

- 1989 CERN released the World Wide Web with Berners-Lee's browser called NEXUS

- The world was ready to begin connecting devices-to-devices and by 1999, the IoT was with us…….

Daily newspaper reports and technical articles relating to the IoT

The Internet of Things

dictionary definition

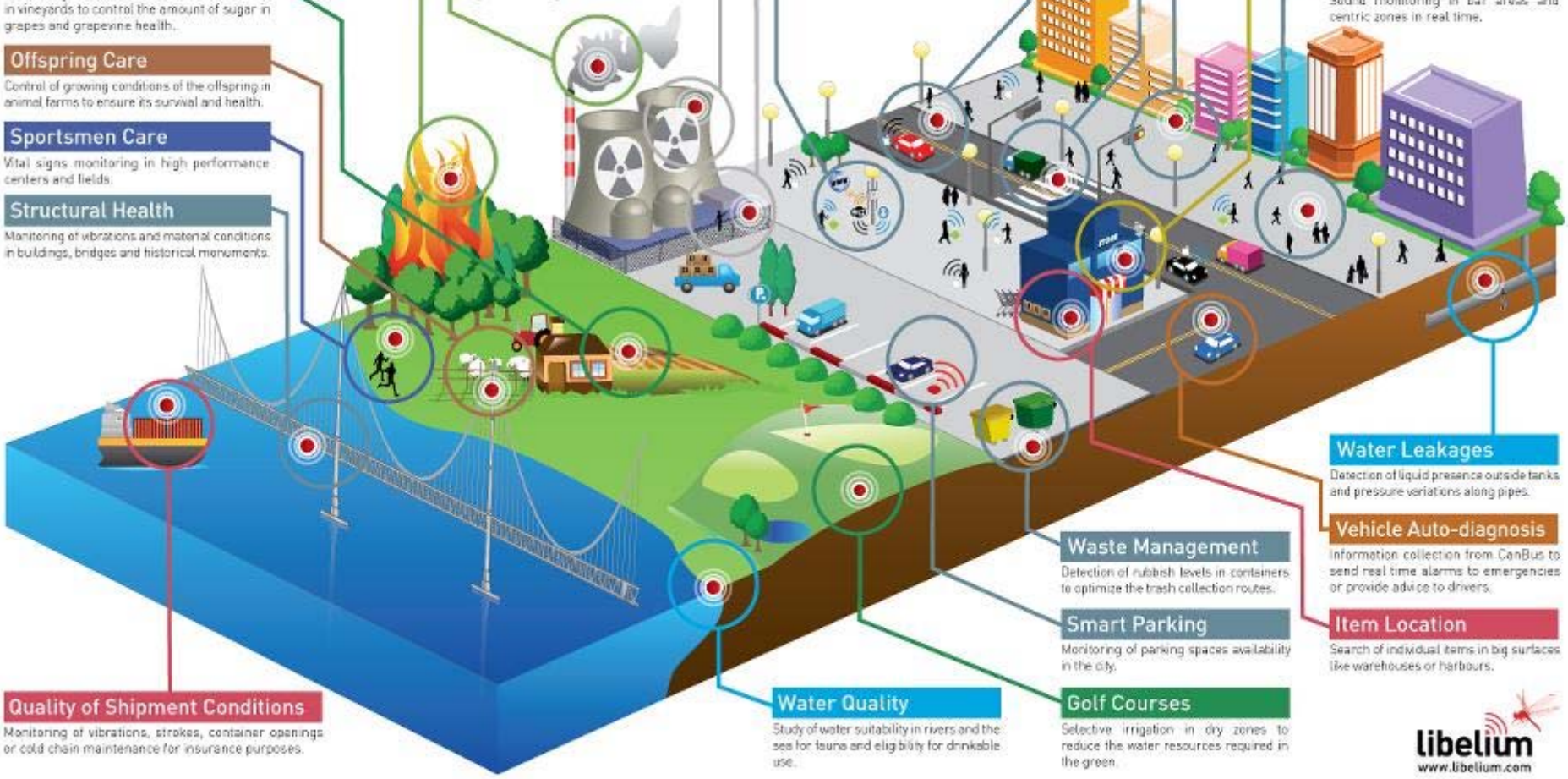
”the interconnection via the Internet of computing devices embedded in everyday objects, enabling them to send and receive data”

The IoT is a rapidly growing network of connected objects that are able to collect and exchange data using embedded sensors.

Mobile phones, computers and tablets, thermostats in various devices, cars, lighting controllers, security cameras, petrol pumps, refrigerators, pets, children(!) and many more appliances/devices/people can all be connected to one another in the ***Internet of Things.***

Some of the HUGE number of depictions of the IoT

Libelium Smart World



Air Pollution
Control of CO_2 emissions of factories, pollution emitted by cars and toxic gases generated in farms.

Forest Fire Detection
Monitoring of combustion gases and preemptive fire conditions to define alert zones.

Wine Quality Enhancing
Monitoring soil moisture and trunk diameter in vineyards to control the amount of sugar in grapes and grapevine health.

Offspring Care
Control of growing conditions of the offspring in animal farms to ensure its survival and health.

Sportsmen Care
Vital signs monitoring in high performance centers and fields.

Structural Health
Monitoring of vibrations and material conditions in buildings, bridges and historical monuments.

Quality of Shipment Conditions
Monitoring of vibrations, strokes, container openings or cold chain maintenance for insurance purposes.

Smartphones Detection
Detect iPhone and Android devices and in general any device which works with Wifi or Bluetooth interfaces.

Perimeter Access Control
Access control to restricted areas and detection of people in non-authorized areas.

Radiation Levels
Distributed measurement of radiation levels in nuclear power stations surroundings to generate leakage alerts.

Electromagnetic Levels
Measurement of the energy radiated by cell stations and and WiFi routers.

Traffic Congestion
Monitoring of vehicles and pedestrian affluence to optimize driving and walking routes.

Smart Roads
Warning messages and diversions according to climate conditions and unexpected events like accidents or traffic jams.

Smart Lighting
Intelligent and weather adaptive lighting in street lights.

Intelligent Shopping
Getting advices in the point of sale according to customer habits, preferences, presence of allergic components for them or expiring dates.

Noise Urban Maps
Sound monitoring in bar areas and centric zones in real time.

Water Leakages
Detection of liquid presence outside tanks and pressure variations along pipes.

Vehicle Auto-diagnosis
Information collection from CanBus to send real time alarms to emergencies or provide advice to drivers.

Item Location
Search of individual items in big surfaces like warehouses or harbours.

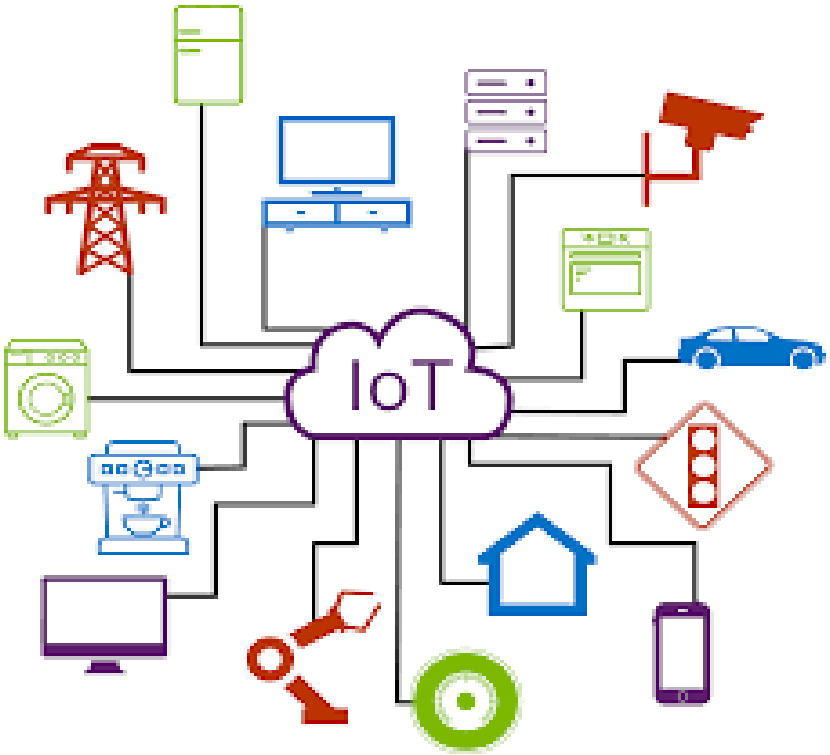
Waste Management
Detection of rubbish levels in containers to optimize the trash collection routes.

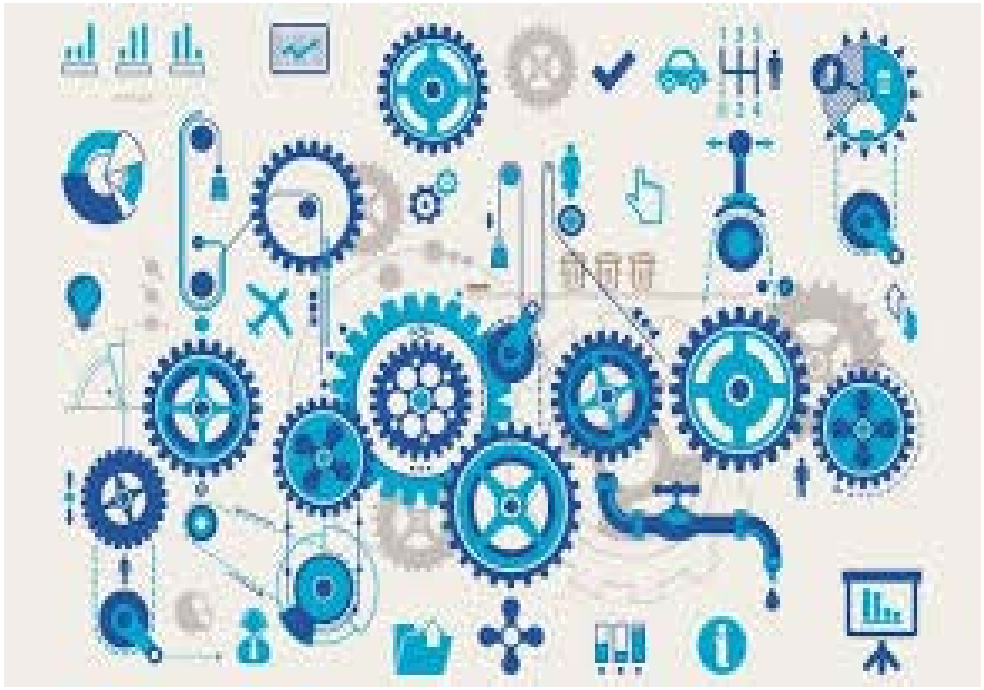
Smart Parking
Monitoring of parking spaces availability in the city.

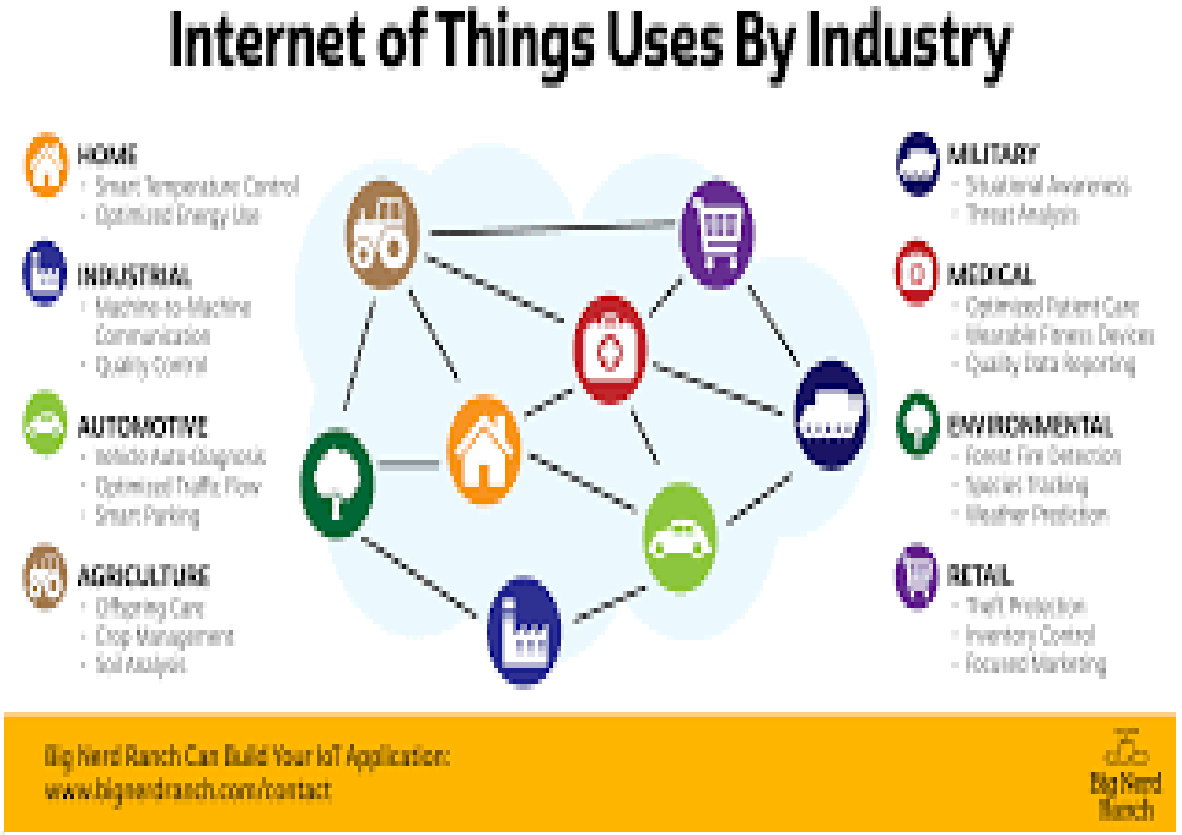
Water Quality
Study of water suitability in rivers and the sea for fauna and eligibility for drinkable use.

Golf Courses
Selective irrigation in dry zones to reduce the water resources required in the green.

libelium
www.libelium.com


IoT




Internet of Things Uses By Industry
HOME
Smart Temperature Control
Optimized Energy Use
INDUSTRIAL
Machine-to-Machine Communication
Quality Control
AUTOMOTIVE
Vehicle Auto-Diagnostics
Optimized Traffic Flow
Smart Parking
AGRICULTURE
Offspring Care
Crop Management
Soil Analysis
MILITARY
Situational Awareness
Threat Analysis
MEDICAL
Optimized Patient Care
Wearable Fitness Devices
Quality Data Reporting
ENVIRONMENTAL
Forest Fire Detection
Species Tracking
Weather Prediction
RETAIL
Theft Protection
Inventory Control
Focused Marketing
Big Nerd Ranch Can Build Your IoT Application:
www.bignerdranch.com/contact
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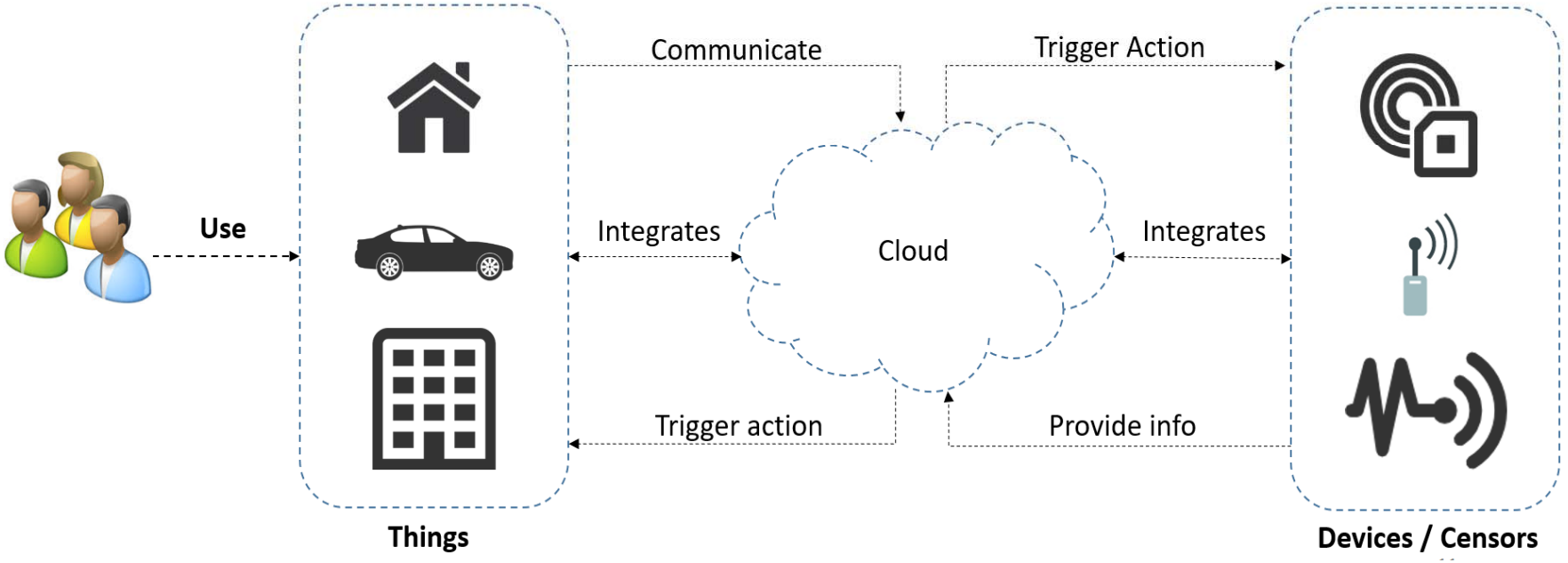
The Internet enables many devices
to be inter-connected…but what is being communicated?

IoT Architecture



Actually, the IoT does provide a means for human communication…
with the messages being derived from a variety of sources

How many things are connected?

More than the 5 obvious things

An IoT equation

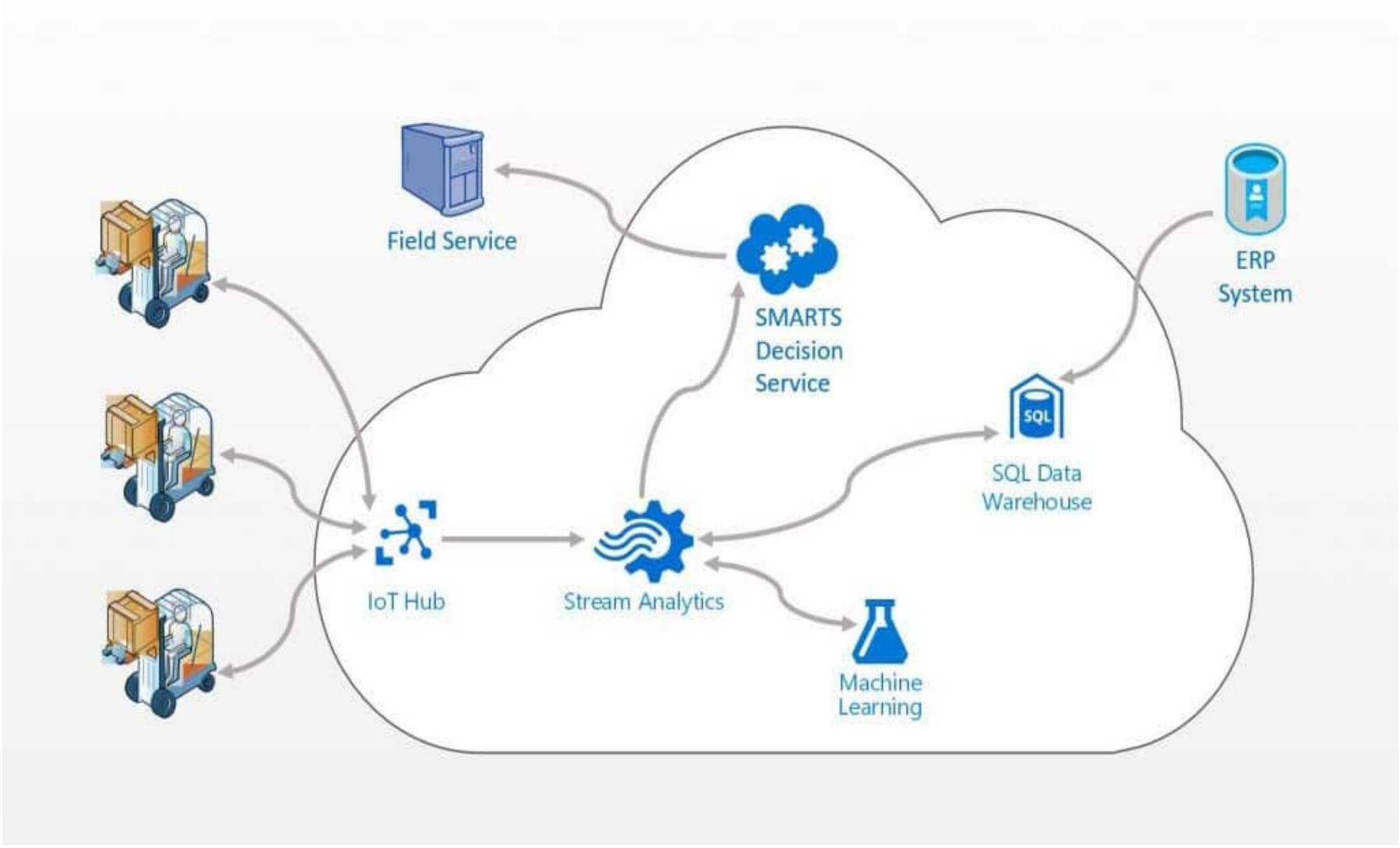
$$(d)^n = \sum_{k=0}^{n} f(n) + \mathrm{c(n)} + 2\mathrm{ph(n)} + \mathrm{v(n)} + 2\mathrm{p(n)}$$

Fridge + sensors + comms + software
Cloud + peripherals(data storage etc) + software
Phones + software
Veges+ sensors + comms + software
People……

15 or more things are connected via the Internet

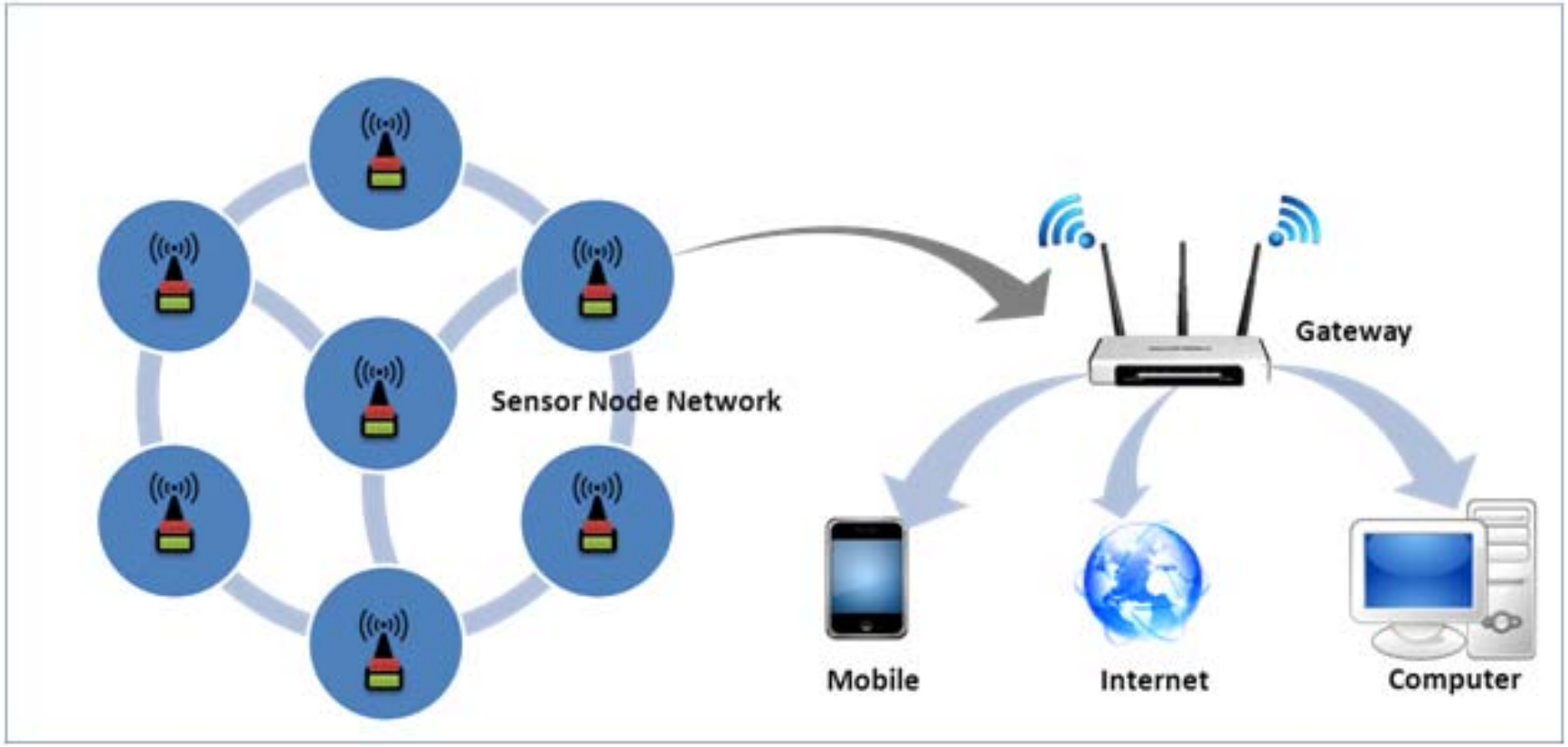
IoT applications abound

an ERP example

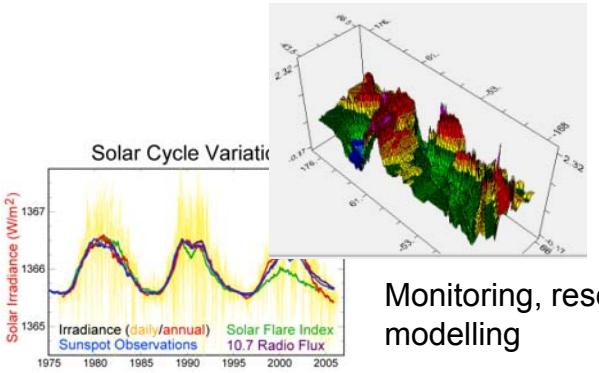


Wireless Sensor Networks

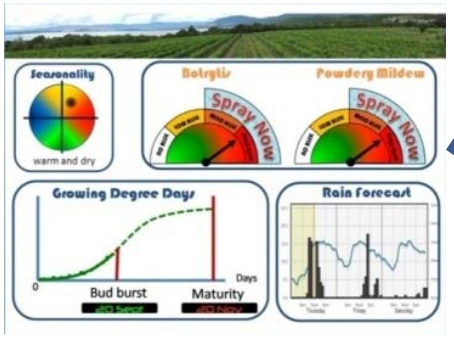
”The one I know best”



Agrometeorological Example

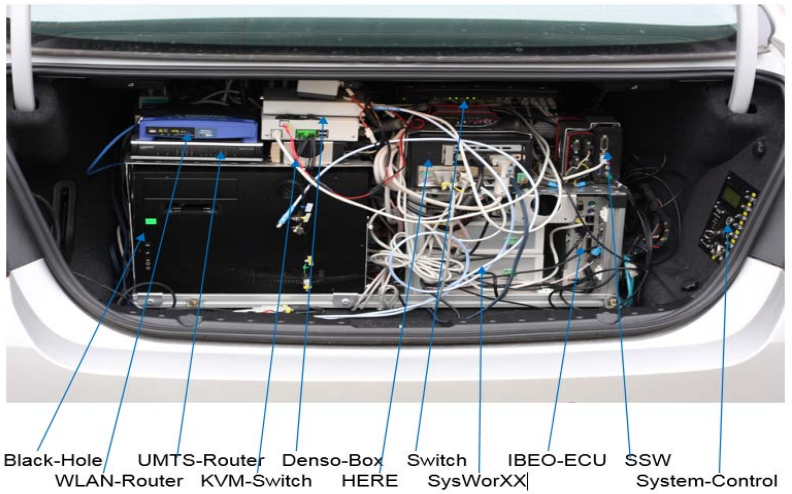


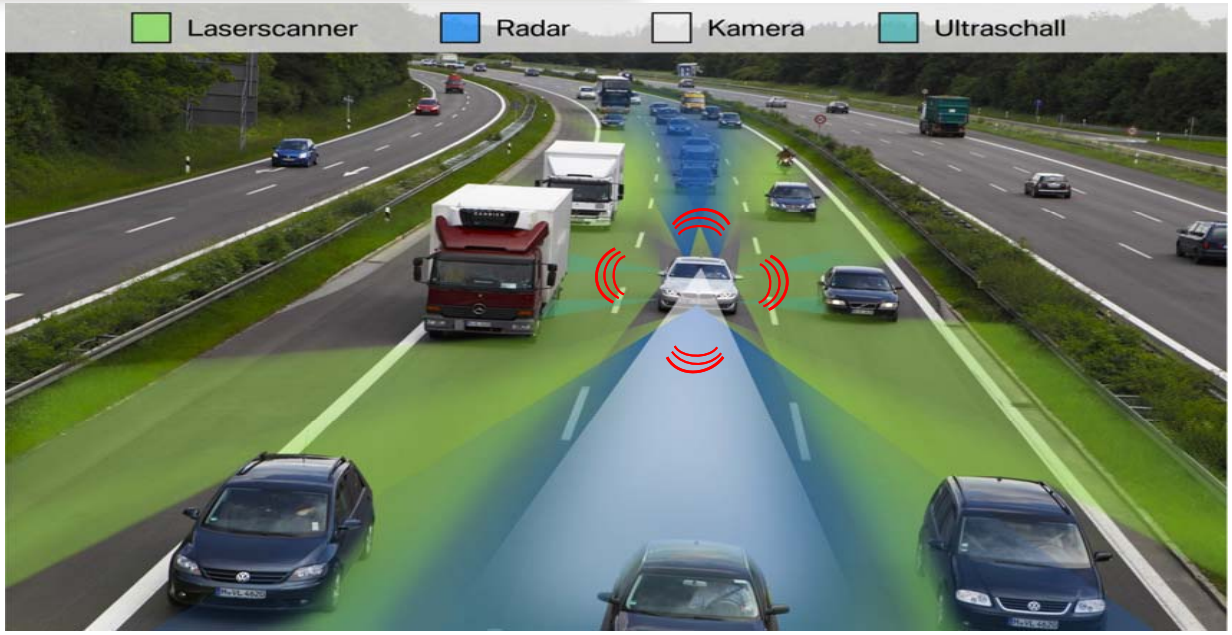
Monitoring, research and modelling



End-user management and planning information

The BMW *Connected Car* Project





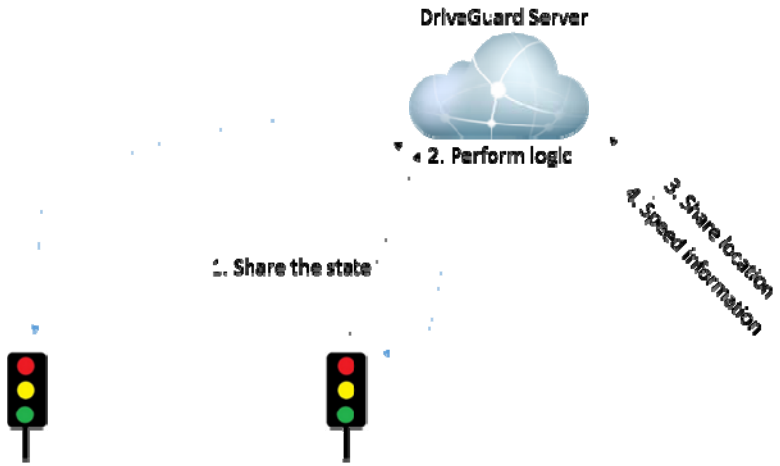
SPEED ADJUSTMENT FOR WEATHER CONDITIONS

Real time experiment BMW 530

– Automated speed adaption

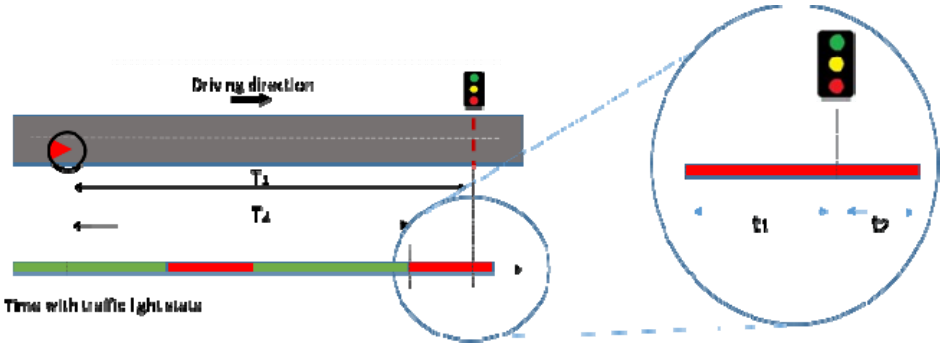
– Navigational influence

SMART TRAFFIC LIGHTS WITH CONNECTED CAR INFORMATION

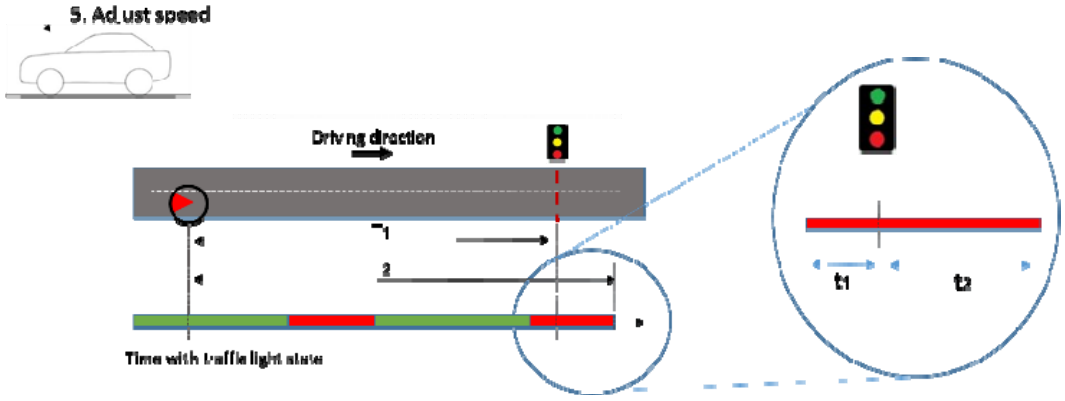


$$\beta(\tau_i, \tau_j) = \begin{cases} \frac{1}{\sigma}\log\left(\frac{\sigma}{\tau_i - \tau_j}\right)\nu_i & 0 < \tau_i - \tau_j < \sigma \\ \frac{-1}{\sigma}\log\left(\frac{-\sigma}{\tau_i - \tau_j}\right)\nu_i & -\sigma < \tau_i - \tau_j < 0 \\ 0 & |\tau_i - \tau_j| > 0 \end{cases}$$

$$dV_1 = \int_0^{T_2+\sigma} -\frac{1}{2}\lambda_1(v_1 - v_{d1}) - \lambda_2\frac{1}{\sigma}\log\left(\frac{\sigma}{\tau_2 - \tau_1}\right)dt$$



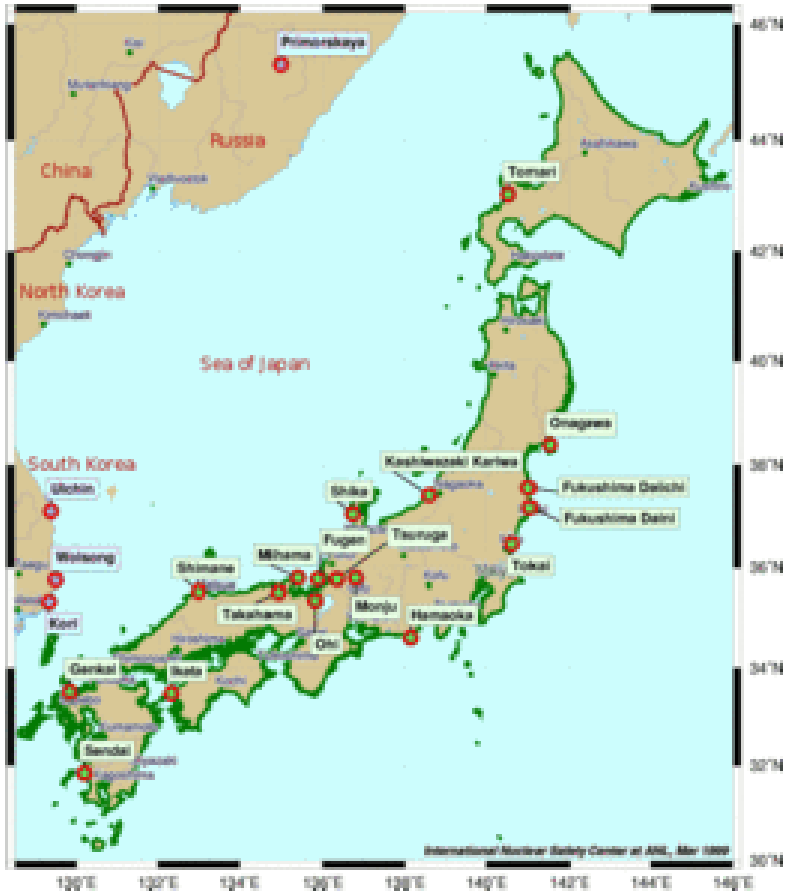
Deceleration due to insufficient timing (case $t_1 > t_2$)



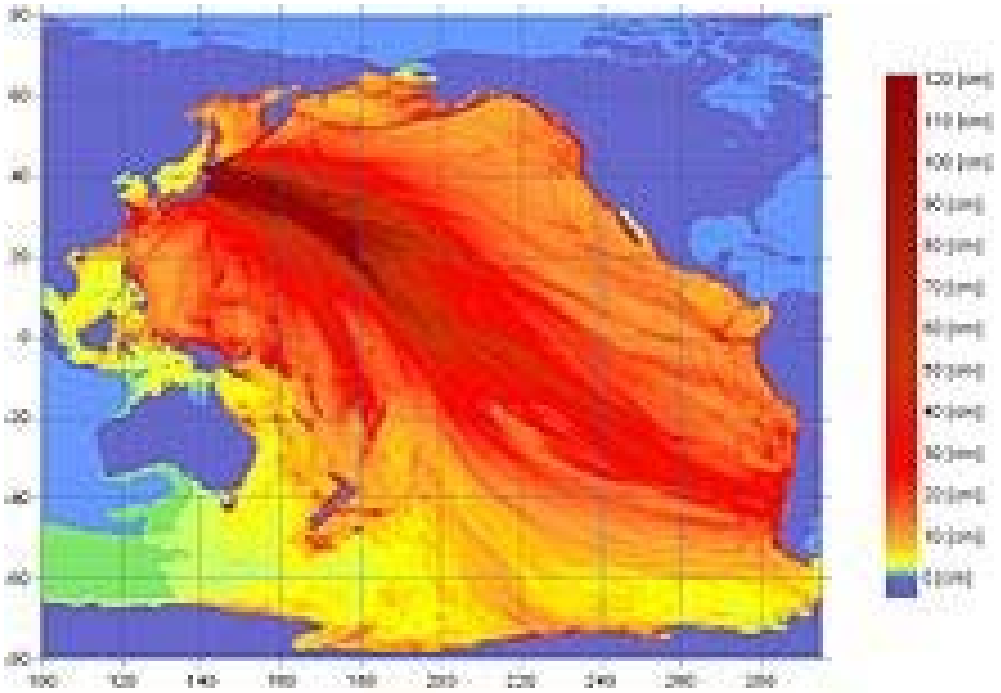
Acceleration due to sufficient timing (case $t_1 < t_2$)

IoT connecting radiation (uranium) sensors

safecast



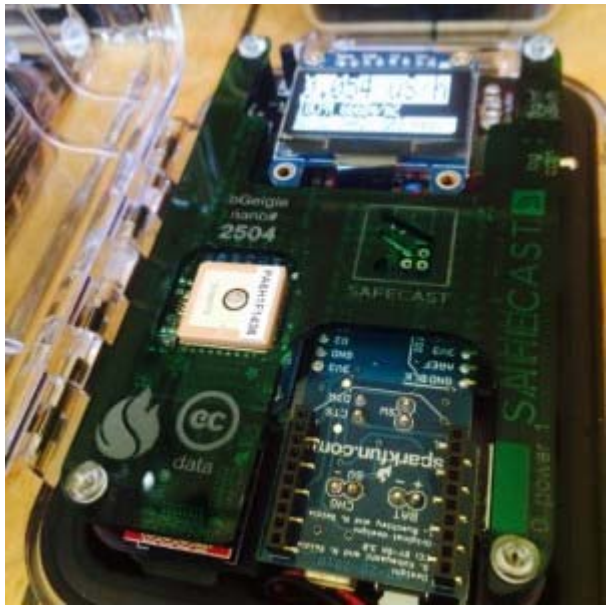
Japan earthquake led to Fukushima nuclear disaster on 7th April 2011



An enormous energy thrust across the planet. The loss of life, injuries and destruction was devastating

Not only nuclear plant meltdowns but also oil refinery failures and fires

Mobile Sensors

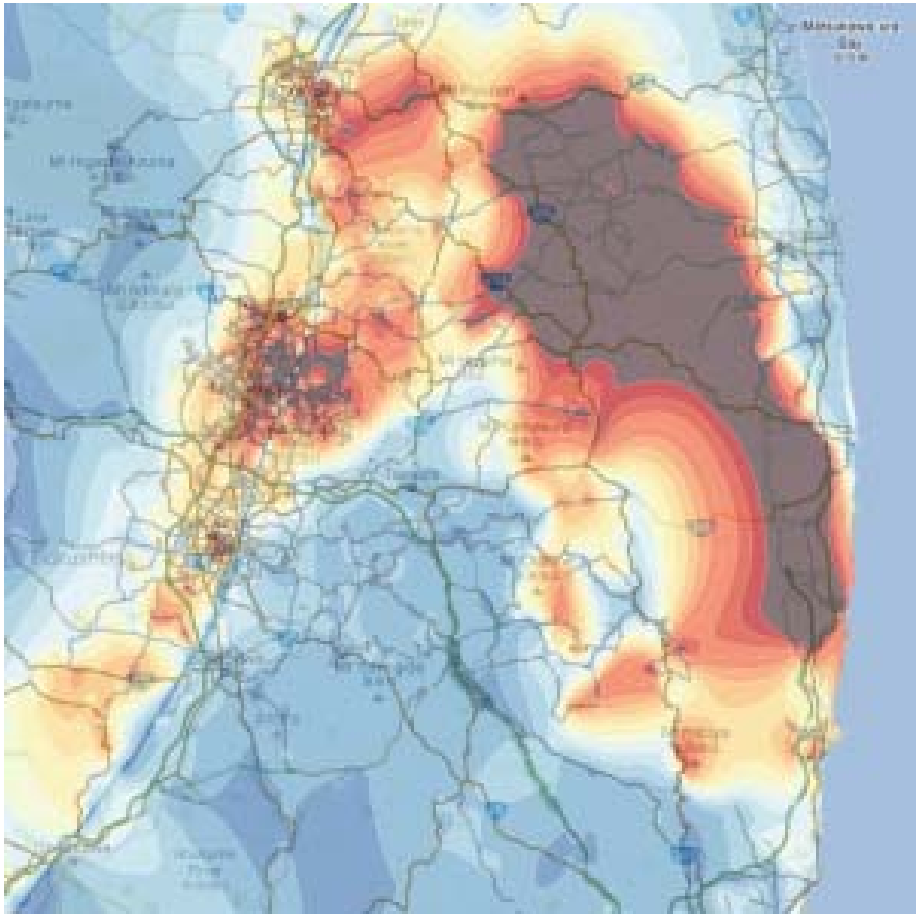


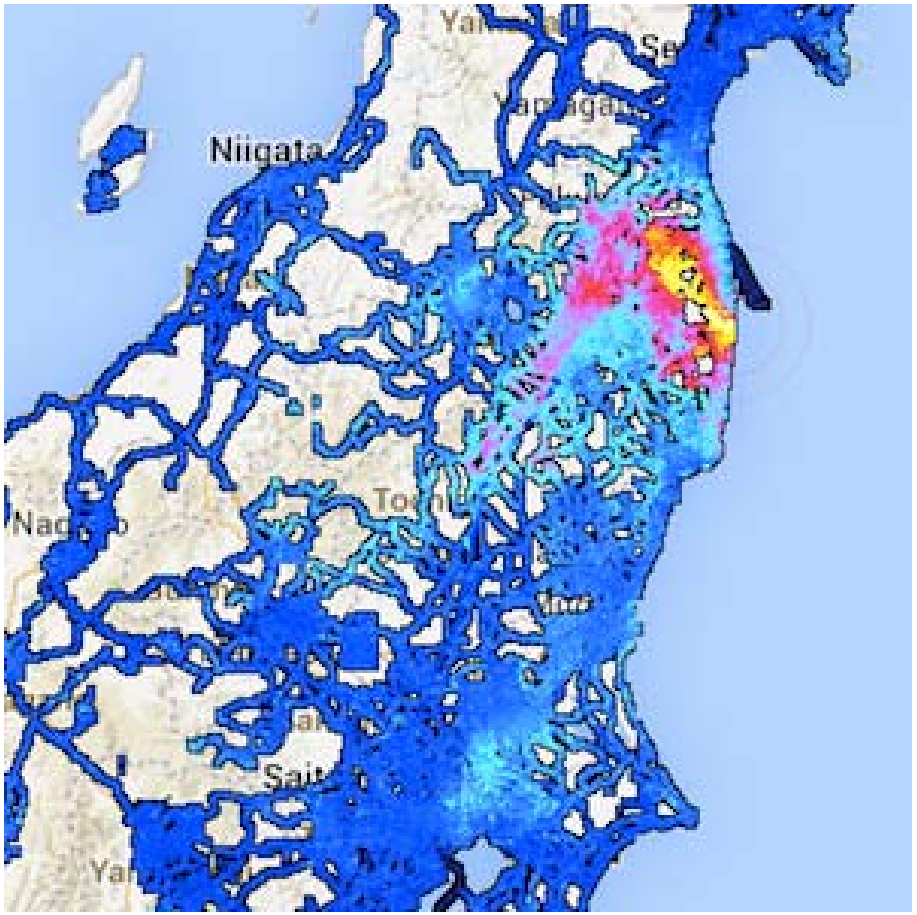
15,000 built in the first 10 days…total of 50,000 built

Safecast is now a global sensor network for collecting and sharing radiation measurements to empower people with data about their environments

Monitoring uranium dispersal

Data from 18,000,000 readings
interpolated over 1 month following the disaster





The good and not-so-good aspects of IoT

Personal privacy and security are the BIG issues

How easy is it to interrogate a device connected on the Internet?

What access is there to data on individual devices and from one device to another?

Does permission to retrieve data from one source, enable viewers to get to other or all data on a person, place or entity?

Privacy and Security

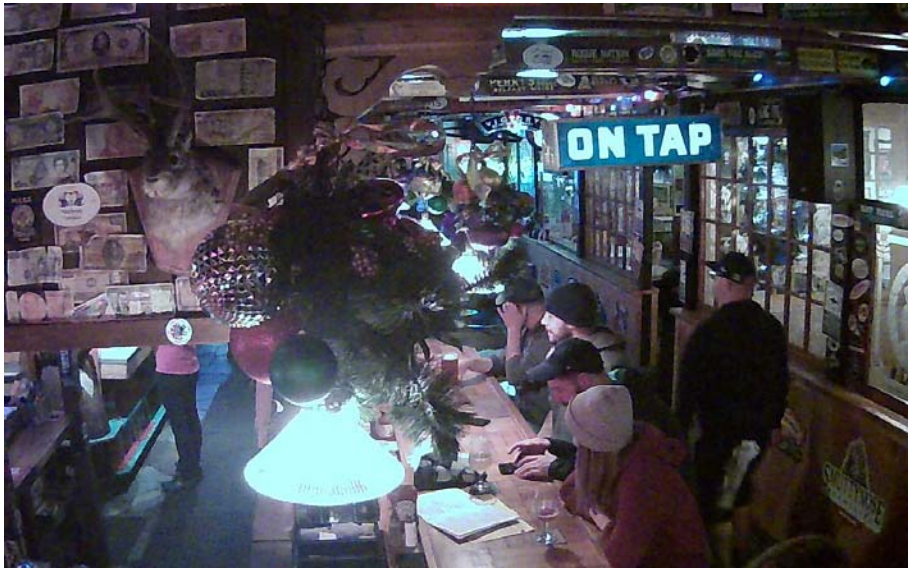
- Who can hack into individual devices and from there to all the other devices connected to it?
- Some examples:
  - *Insecam* – access to more than 100,000 (or more?) webcams around the world
  - *Shodan* (a search engine for the IoT) – looking at video feeds from private webcams
  - Smart Watches for eavesdropping
  - Dolls used for surveillance

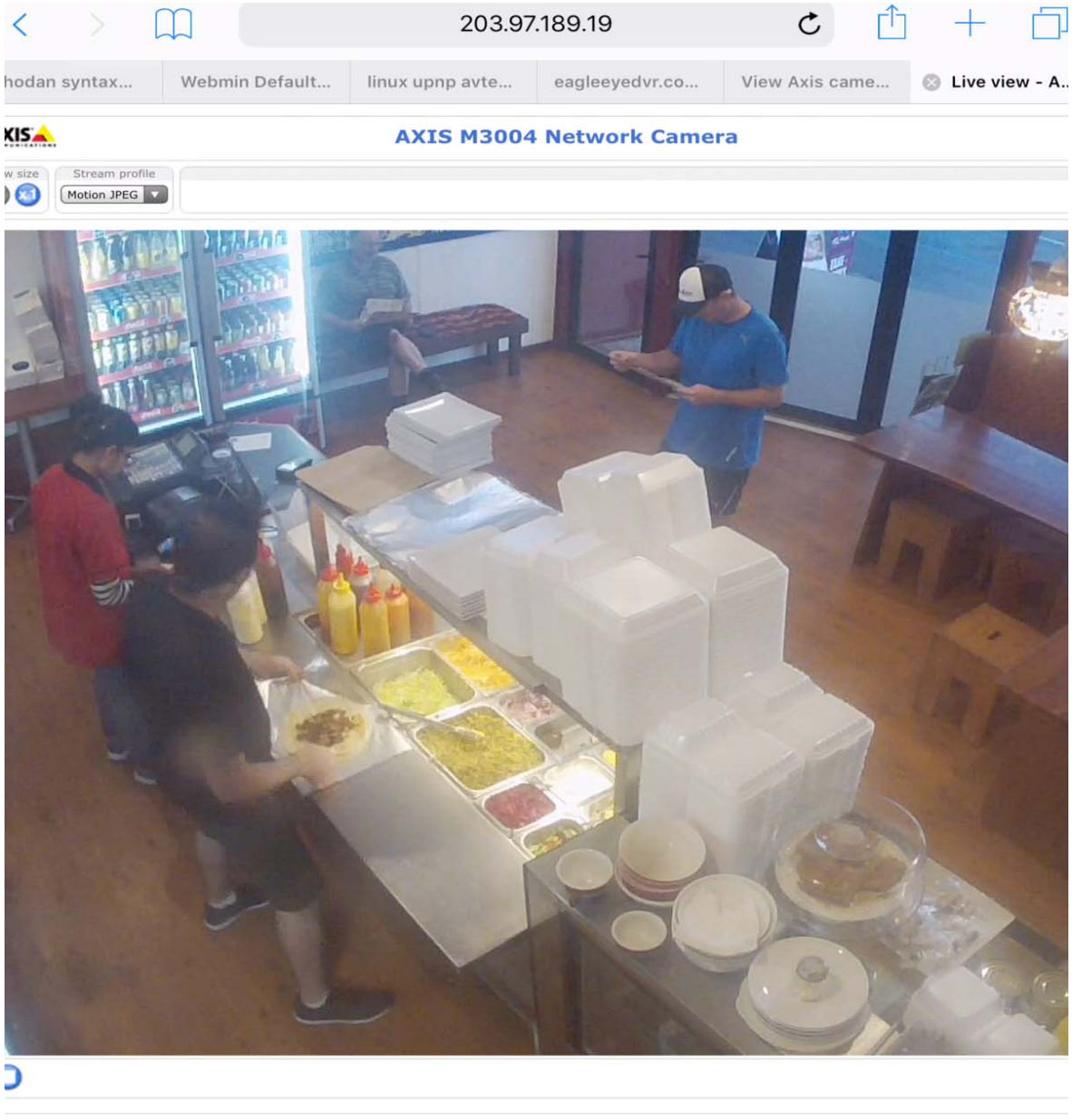
Insecam

purports to display more than 100,000 unsecured webcams from around the world, most of them CCTV and simple IP cameras.


17/11/28 11:24:24


2017/11/28 11:32:52


ON TAP



Shodan

Using **Shodan** to locate and copy live video from an unsuspecting security camera feed.

The webcam is unsecured and therefore, in the public domain.

A recent newspaper report

”Germany bans kids’ smartwatches that can be used for eavesdropping”

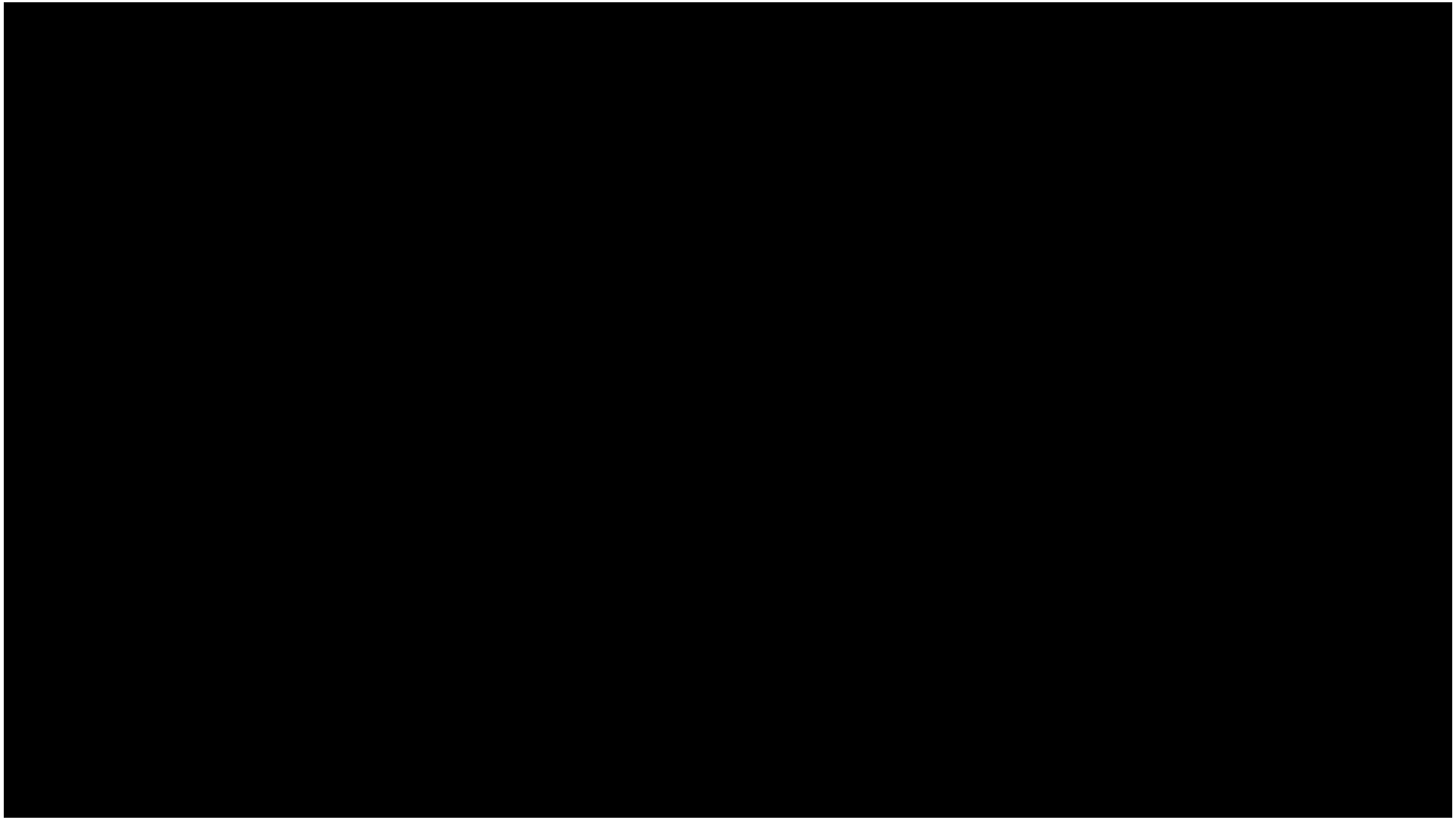
”*My Friend Cayla* doll banned in Germany over surveillance concerns”

As with the Internet itself, any kind of data we share on social media, genealogical sites or via commercial transactions, IoT can be used for good or for bad purposes

…but it's not all bad news…

I'll leave you with this more optimistic video clip and thank you for listening

But it’s not all bad news



In Summary

- In terms of message transmission, Humankind has come a long way since the Stone Age
- Technically, message transmission is a form of Communication
- Technical Communication is high quality and now facilitated by the IoT
- The quality of Communication is not always high in terms of its intent and outcomes…and that's a human thing in this *IoT milieu*

The Take Home Message

We can only see what we see and know what we know of the zillions of messages being transmitted via the Internet. How well we use those messages…how well we 'communicate' with one another…is the real worthiness metric for the IoT.

In the world of the IoT, the single most vulnerable point-of-failure in this everything-to-everything connected technology, is its inventors!

Thank you!