

Technology Trends: Present and Future Drivers

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- The **Good** (The Dream: Intelligent Internet of Everything)
- The **Bad** (The Nightmare: Computer & Network Security)
- The **Ugly?** (AI, Big Data, 5G, Blockchain, ...)



Prediction is very difficult, especially about the future.

[Niels Bohr]

In India, even the past is uncertain! [G. Sivakumar, 2014]



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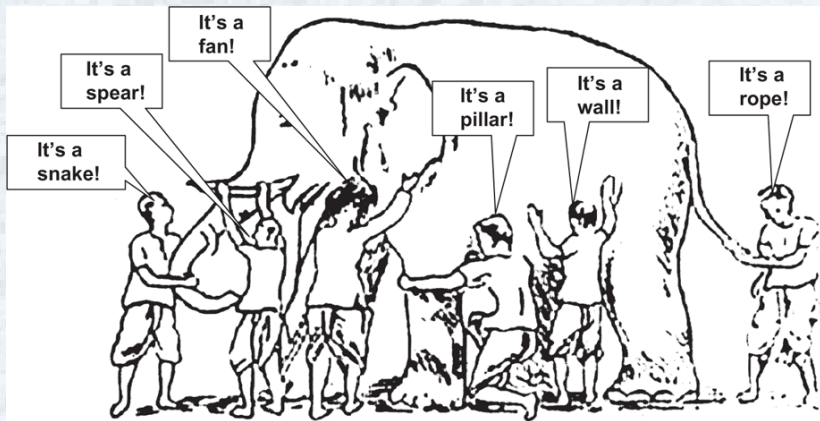
Prediction is very difficult, especially about the future.

[Niels Bohr]

In India, even the past is uncertain! [Y V Reddy, RBI]



One Single Truth? अन्ध-गज न्यायः



Note: The risks of analytical thinking and fragmentation of knowledge



What “PhD” Really Stands for...

Take your pick ... (from <http://www.thatwasfunny.com/>)

Patiently hoping for a Degree
 Professorship? hah! Dream on!
 Pretty heavily Depressed
 Philosophically Disturbed
 Probably heavily in Debt
 Patiently headed Downhill
 Potential heavy Drinker

Piled higher and Deeper
 Please hire. Desperate.
 Pour him (or her) a Drink
 Probably headed for Divorce
 Parents have Doubts
 Permanent head Damage
 Pizza hut Driver

Doctor of *Philosophy* (why philosophy?)

“not a routine degree, not even a degree, it is a state of mind”

“Carving statues out of stone”

Who is a Professor? (just another job?)



Stone Age to Information Age

Decision Making: *Might is right* to *Computer/AI is right!*

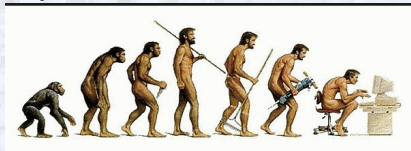
Technology (Wikipedia Definition)

Technology is the usage and knowledge of tools, techniques, crafts, systems or methods of organization in order to **solve a problem** or **serve some purpose**.

Zero, Wheel, Printing Press, Radio, Lasers, ... *Any sufficiently advanced technology is indistinguishable from magic.* [Arthur C. Clarke]

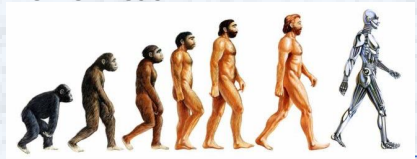
Two books by Yuval Noah Harari

Sapiens



Who **domesticated** whom?

Homo Deus



Brain implants, DNA sequencing



Web 1.0, Web 2.0, Web 3.0

Web 1.0 [1990-2005] (Right to Information)

- Internet: Info anytime, anywhere, any form
- Like *drinking water from a fire hose*
- Search Engines to the rescue

Web 2.0 [2005-2015] (Right to Assembly)

- Social Networking (Twitter, Facebook, Kolaveri, Flash crowds)
- Producers, not only consumers (Wikipedia, blogs, ...)
- *Proliferated unreliable, contradictory information?*
- *Facilitated malicious uses including loss of privacy, security.*

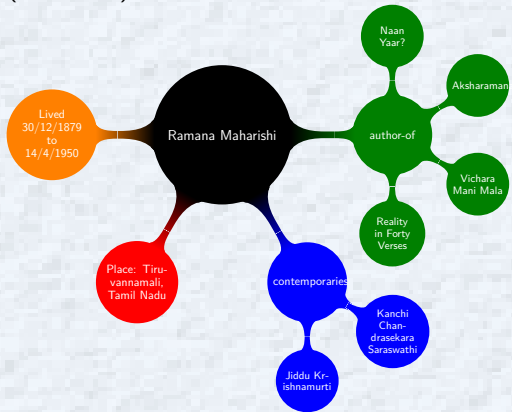
Web 3.0 [current] (AI & ML meet Semantic Web)

- Intelligent Agents that "understand"
- What do you want when you get up and put on computer?
- *I have a dream!*(MLK)



Semantic Web (Adding Intelligence 1.0)

The **application layer** tapping the *hardware* (Web 1.0) and *OS* (Web 2.0)?



Combined, **categorized** information inferred from **various sites, languages**. www.dbpedia.org comes close today!



Open Enterprises of the Future

What the Future Holds?

Modify a Google Calendar to allow a colleague to add a Faaso's roll order to a meeting invite that can be picked up by Ola and delivered by a drone to a client's office five minutes before the scheduled meeting starts.

What this needs?

- Everything connected
- Ubiquitous sensing & actuation
- High data volume
- Context-aware Analytics
- Identity Management
- GDPR compliant Distributed Ledger
- Smart Contracts for Payments
- Multi-Party Services Orchestration
- Transparent Information Flow
- Transparent Event Flow
- Semantic Consistency
- Network and Protocol Adaptability
- End-to-End Security
- Business Management

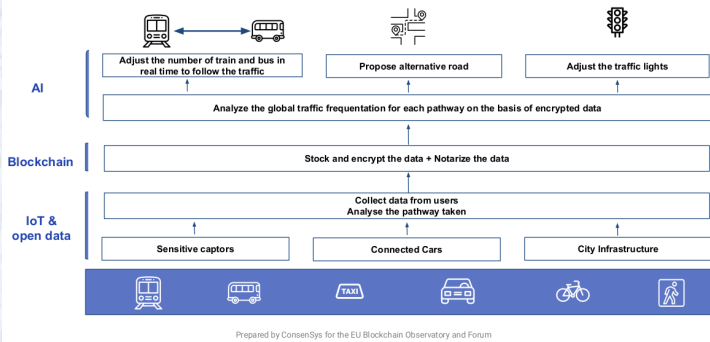
Web 3.0 meets AI, Big Data, 5g, IoT, Blockchain!



Traffic Management GoogleMaps++

From European Blockchain Observatory <https://www.eublockchainforum.eu/>

Full picture of blockchain AI and IOT convergence for mobility use case

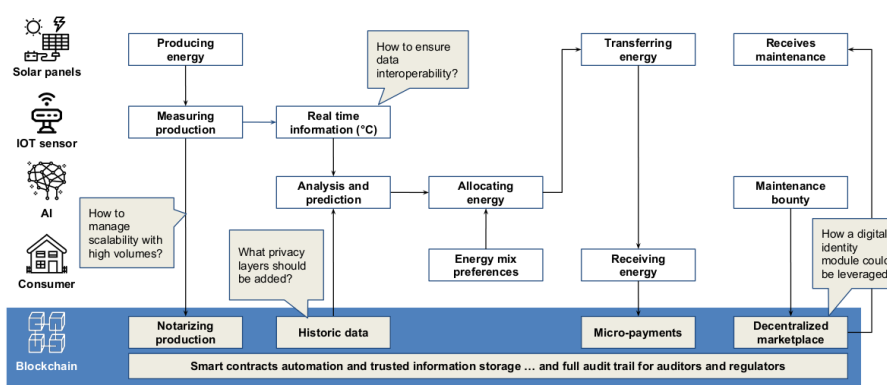


CMU developed AI traffic system in Pittsburgh has significantly reduced **travel time by 25%**, **braking by 30%** and **idling by more than 40%**



Smart Grid

From European Blockchain Observatory <https://www.eublockchainforum.eu/>

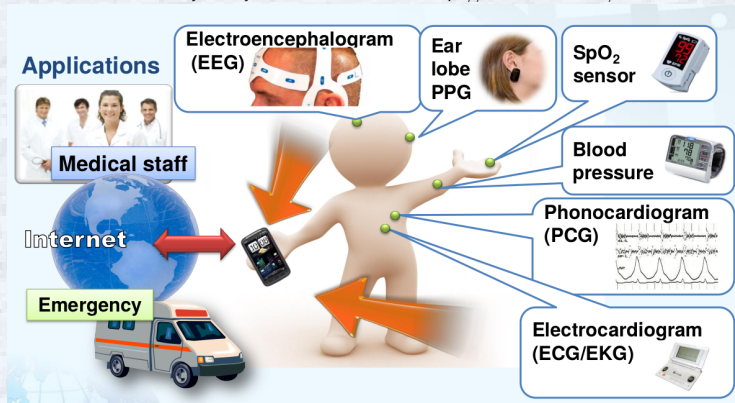


Prepared by ConsenSys for the EU Blockchain Observatory and Forum



Health Care

Slide from AnNet 2018 keynote by Prof. Wen-Tsuen Chen <https://annet2018.loria.fr/>



Eating for Doctor's stomach!

How to pay? (Smart Contracts on Blockchain/DLT)



Why Information Technology is different?

Transistor, VLSI, Microprocessor, ...

Danger: Computers are coming! Taking away our jobs!

Construction, Farming, Banking, Surgery, Composing music,

Teaching! Be very scared!

The Big Nine(Amy Webb) G-MAFIA + BAT

It's a **small group** of people working at a very few number of companies who are **making decisions** about what to optimize **using available data...**

Caveat

But **regulation doesn't make sense** because we shift from having a tiny group of people making decisions about optimization to a tiny group of people who are **lawmakers**, who are very well read and very smart people but **overwhelmingly lack degrees in the hard sciences and technical experience.**



Internet's Nightmare

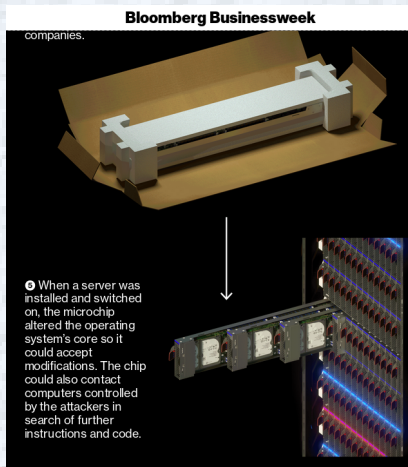
Match the following!

| Problems | Attackers |
|-----------------------------|---------------------------------------|
| Highly contagious viruses | Unintended blunders |
| Defacing web pages | Disgruntled employees or customers |
| Credit card number theft | Organized crime |
| On-line scams | Foreign espionage agents |
| Intellectual property theft | Hackers driven by technical challenge |
| Wiping out data | Petty criminals |
| Denial of service | Organized terror groups |
| Spam E-mails | Information warfare |
| Reading private files | ... |
| Surveillance | ... |

- Crackers vs. Hackers
- Note how much resources available to attackers.



Compromising the Supply Chain



Cisco *more trustworthy* than Huawei?



Can this happen to you?

KeyGrabber USB

Small, fast, and smart

This keystroke recorder has up to **8 gigabytes** memory capacity, organized into an advanced flash FAT file system. Super-fast data retrieve is achieved by switching into **Flash Drive mode** for download.

Completely transparent for computer operation, no software or drivers required. Supports **national keyboard layouts**.



Features

- **Huge memory capacity** (up to 8 gigabytes), organized as an advanced flash FAT file system
- Memory protected with strong **128-bit encryption**
- Works with **any USB keyboard**, including those with built-in hubs
- **Super fast** memory contents download (up to 125 kB/s)
- No software or drivers required, **Windows, Linux, and Mac** compatible
- **Transparent** to computer operation, **undetectable** for security scanners
- Quick and easy **national layout** support



blackMail received at IIT Bombay

Dear All,

There is a very **ingenious blackmailing email** circulating around asking for money in bitcoins. ... they all have a few similar features:

- They include a password that you probably have used
- Claim to have installed malware, and record video of you through your webcam.
- Threaten to reveal your adult website habits and send videos ...
- Demand bitcoins...

Subject: 15xxxxxxx@iitb.ac.in is hacked

From: 15xxxxxxx@iitb.ac.in

Date: Thu, October 18, 2018 4:35 pm

Hello!

My nickname in DARKNET is derrik82. I hacked this mailbox more than six months ago, through it I infected your operating system with a virus (trojan) created by me and have been monitoring you for a long time.

So, your password from 15xxxxxxx@iitb.ac.in is xxxxxxxxxx
Even if you changed the password after that - it does not matter, my virus

...

I was most struck by the intimate content sites that you occasionally visit. You have a very wild imagination, I tell you!


...

Send the above amount on my BTC wallet (bitcoin):
1EZS92K4xJbymDLwG4F7PNF5idPE62e9XY
Since reading this letter you have 48 hours!



3rd platform: IoT + SMAC

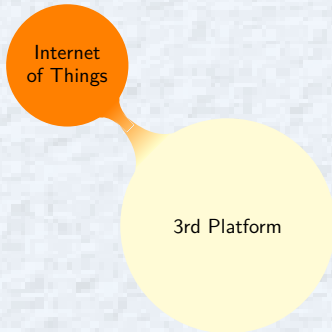
- Main Frame (1960s ...)
- Client Server (1990s ...)
- Today (Handheld, Pervasive Computing)



3rd Platform



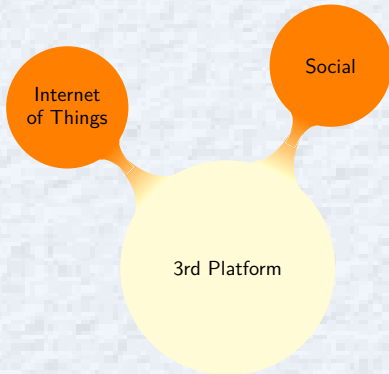
3rd platform: IoT + SMAC



- **Sensors** (Location, Temperature, Motion, Sound, Vibration, Pressure, Current,)
- **Device Eco System** (Smart Phones, Communicate with so many servers!)
- **Ambient Services** (Maps, Messaging, Traffic modelling and prediction, ...)
- **Business Use Cases** (Ola Cabs, Home Depot, Philips Healthcare, ...)
- Impact on wireless bandwidth, storage, analytics (**velocity** of BIG data, not size)



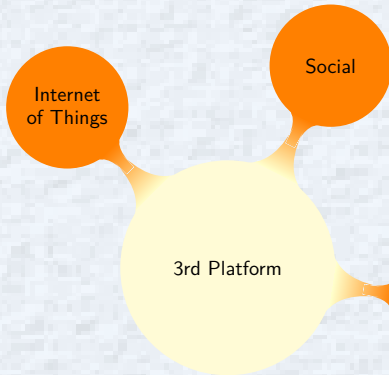
3rd platform: IoT + SMAC



- What's App (how many engineers?)
- Facebook, Twitter, GooglePlus ...
- Web 2.0 (Right to Assembly)
- Crowdsourcing (Wikipedia)
- Crowdfunding (no banks!)



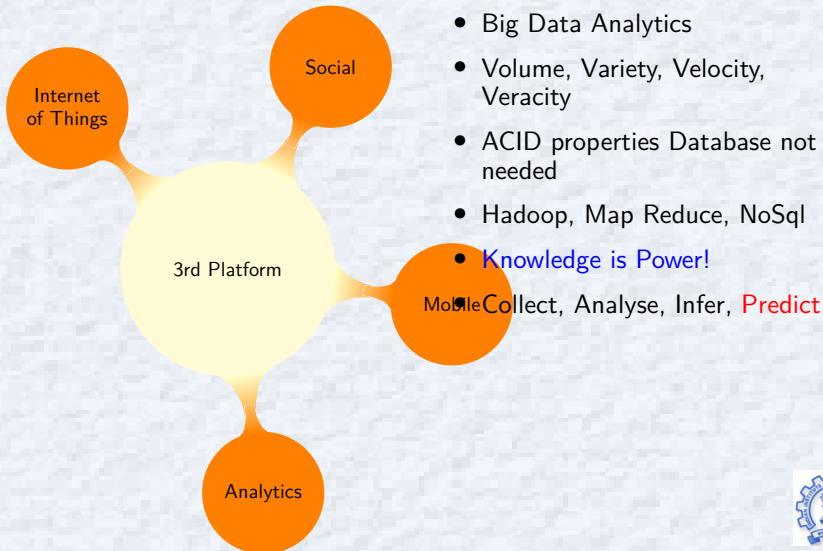
3rd platform: IoT + SMAC



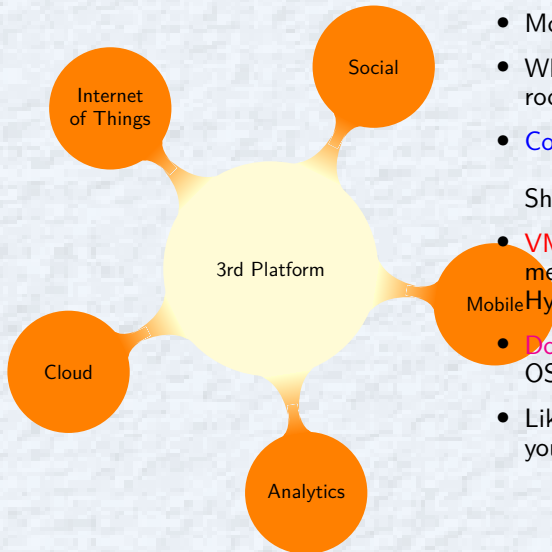
- Phone (Smart, Not-so-smart!)
- Wearables! (Google glass, Haptic)
- Internet of "Me" (highly personalized) Business (no *generic* products!)
- **BYOx**: Device security, App/content management
- **Data Loss Prevention** (Fortress Approach - Firewall, IDS/IPS - won't work!)




3rd platform: IoT + SMAC



3rd platform: IoT + SMAC

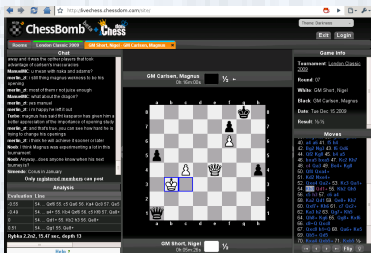


- Moore's law
- What could fit in a building .. room ... pocket ... blood cell!
- **Containers** Analogy from Shipping 
- **VMs** separate OS from bare metal (at great cost- Hypervisor, OS image)
- **Docker**- separates apps from OS/infra using containers.
- Like *IaaS*, *PaaS*, *SaaS* Have you heard of **CaaS**?



Artificial Intelligence & Machine Learning

- Can AI of computers match NS of humans?
- Old Joke: *Out of sight, out of mind*
- Consider chess, once the *holy grail* of AI.

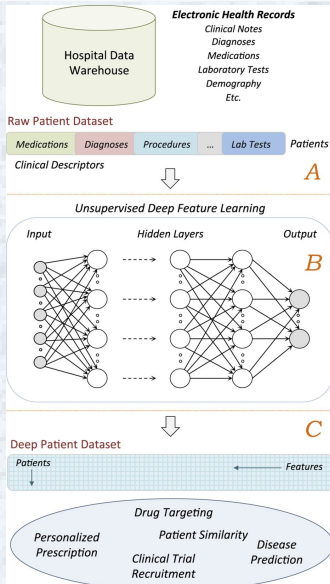


Does not play the human way at all! Mostly parallelized search in hardware (200 million positions/second!)

- December 2017: **AlphaGo Zero** used *reinforcement learning* to teach itself chess in 4 hours! Beat world's best program *Stockfish* comprehensively!
- **Not using any human data or expertise helped a lot!**



Deep Patient



Are doctors practicing **medical science?**

<https://www.nature.com/articles/srep>

The machine was given no information about how the human body works or how diseases affect us. It found correlations that let it predict the onset of some diseases more accurately than ever, and some diseases, such as schizophrenia, for the first time at all. It does this by creating a vast network of weighted connections that is just too complex for us to understand.



AI for the Earth

World Economic Forum (www3.weforum.org) report 2018 (must read!)



AI for ALL

Discussion paper (115 pages, June 2018) from Niti Ayog (niti.gov.in)
Identifies opportunities in Healthcare, Agriculture, Education, Smart
Cities, Smart Transportation...

- this paper focuses on how India can **leverage the transformative technologies** to ensure **social and inclusive growth** in line with the development philosophy of the government.
- aim at enhancing and empowering human capabilities to address the challenges of **access, affordability, shortage and inconsistency** of skilled expertise
- India's approach to implementation of AI has to be guided by **optimisation of social goods**, rather than maximisation of topline growth.
- From a technology perspective, the strategy is to **maximise the late-movers' advantage**.
- ...

Tata Memorial Hospital, one of the leading cancer hospitals in India, registered more than 67,000 new registrations for cancer treatment in 2015. While the hospital is located in Mumbai, less than 23% of the new patients were geographically based in Maharashtra, with a whopping 21.7% of patients traveling from the states of UP, Bihar, Jharkhand and West Bengal to TMH.



GDP Nowcast from NY Fed

2019:Q2 | **2019:Q1** | **2018:Q4** | **2018:Q3**

Last Release 11:15am EST May 31, 2019

ARCHIVE

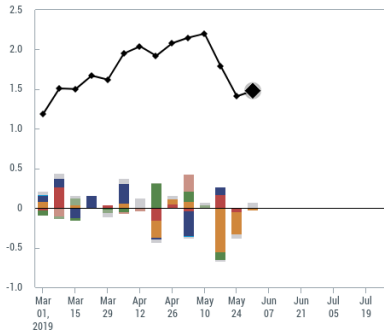


◆ The New York Fed Staff Nowcast ○ Advance GDP estimate □ Latest GDP estimate

■ Housing and construction ■ Manufacturing ■ Surveys ■ Retail and consumption ■ Income ■ Labor ■ International trade ■ Others

Percent (annual rate)

Expand



Data Flow (May 31, 2019)

| Model Update | Release Date | Data Series | Actual | Impact | Nowcast GDP Growth |
|--------------|---------------|---|--------|--------|--------------------|
| May 31 | | | | | 1.48 |
| | 8:30AM May 31 | Real personal consumption expenditures | -0.03 | -0.00 | |
| | 8:30AM May 31 | PCE: Chain price index | 0.31 | 0.02 | |
| | 8:30AM May 31 | PCE less food and energy: Chain price index | 0.25 | 0.03 | |
| | 8:30AM May 31 | Real disposable personal income | 0.12 | -0.00 | |
| | 8:30AM May 30 | Merchant wholesalers: Total inventories | 0.65 | -0.02 | |
| | 8:30AM May 30 | Real gross domestic income | 1.42 | 0.00 | |
| | | Data revisions | | 0.03 | |
| May 24 | | | | | 1.41 |

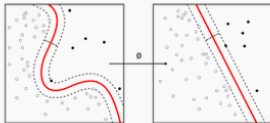


Data (based) Science

https://en.wikipedia.org/wiki/Data_science

- Turing award winner Jim Gray terms it the **4th paradigm** after Empirical, Theoretical and Computational
- How does Google translate documents?
- Combining data sources to produce new information not contained in any single one!
- How does Facebook tag pictures?
- Deep Learning! (Speech Recognition)

Machine learning and data mining



| | |
|---|--------|
| Problems | [show] |
| Supervised learning (classification • regression) | [show] |
| Clustering | [show] |
| Dimensionality reduction | [show] |
| Structured prediction | [show] |
| Anomaly detection | [show] |
| Neural nets | [show] |
| Reinforcement learning | [show] |



Analytics (भूतभव्य भवत्प्रभुः)

॥ हरिः ॐ ॥

विश्वं विष्णुर्वषट्कारो भूत भव्य भवत्प्रभुः।

- Past (What happened? Why? Reactive)
Designed Batch/Static Data
Reports, Standards, **Data Harmonization.**
Descriptive and **Diagnostic**
- Present (What is happening?)
Organic Unstructured Streaming/Real-time Data
Statistical Analysis, Anomalies, Alerts
- Future (What will happen? Pro-active)
Predictive Forecast, Optimize
- Make it happen!
Prescriptive (most difficult)

Analytics can convert *data to knowledge to wisdom.*



Two Cultures

Modern Data Sets

Ubiquity of sensing devices, the low cost of data storage, and the commodification of computing have led to high **volume**, **velocity** and **variety** of modern data sets.

Modern data sets are related in some way to *human behavior* raising concerns about *privacy* and not respecting traditional assumptions of identically distributed and independent observations.

Two cultures in the use of statistical modeling to reach conclusions from data.

One assumes that the data are **generated by a given stochastic data model**. (Statisticians, Economists)

The other uses **algorithmic models** and treats the data mechanism as unknown (black box). (Data Scientist)



Statisticians *versus* Data Scientists

Topic for Debate: **Statisticians will miss the data science boat!**

Yes They will willingly choose to maroon themselves on shore, forsaking *messy data science challenges* for the **purity of fundamental theoretical challenges in stylized circumstances** that have been **abstracted away from the reality of modern-day data sets.**

No Statistics is so integral to data science, the boat would sink without it!

Lack of consideration of (1) interpretability, (2) uncertainty quantification, (3) applications with limited training data, and (4) selection bias. Statistical methods can achieve (1)-(4)

Puzzle

At $t=0$ a boy and a girl are 1km apart, at $t=1$ apart by 0.5km, at $t=2$ apart by 0.25km ...

Will they be able to kiss each other?



50 years of Data Science

Excellent survey in 2015 by David Donoho available at

<https://courses.csail.mit.edu/18.337/2015/docs/50YearsDataScience.pdf>

Find 6 differences

Mathematics, Physics, Chemistry, Statistics

Economic Science, Political Science, Social Science, *Data Science!*

Attributes most of the success of Data Science to **Common Task Framework**.

Do whatever it takes to *solve the problem* efficiently!



Common Task Framework: Challenges

From <http://kaggle.com>

13 Active Competitions



TWO SIGMA

Two Sigma: Using News to Predict Stock Movements

Use news analytics to predict stock price performance

Featured · Kernels Competition · 20 days to go · news agencies, time series, finance, money

\$100,000

2,927 teams



Jigsaw Unintended Bias in Toxicity Classification

Detect toxicity across a diverse range of conversations

Featured · Kernels Competition · 16 hours to go · biases, nlp, text data

\$65,000

3,141 teams



SIIM-ACR Pneumothorax Segmentation

Identify Pneumothorax disease in chest x-rays

Featured · 2 months to go · image data, object segmentation

\$30,000

304 teams



Predicting Molecular Properties

Can you measure the magnetic interactions between a pair of atoms?

Featured · 2 months to go · chemistry, tabular data, regression

\$30,000

1,304 teams



Open Images 2019 - Object Detection

Detect objects in varied and complex images

Research · 3 months to go · image processing, image data

\$25,000

145 teams



Common Task Framework: Data Sets

From <http://kaggle.com>

Public



Zomato Bangalore Restaurants

Himanshu Poddar

3 months 88 MB 10.0 1 File (CSV)



Spanish High Speed Rail tickets pricing - Renfe

The Gurus

2 months 27 MB 10.0 1 File (CSV)



Australian Election 2019 Tweets

wayward_artisan

a month 29 MB 10.0 2 Files (CSV)



Berlin Airbnb Data

Britta Bettendorf

4 months 89 MB 8.2 6 Files (CSV)



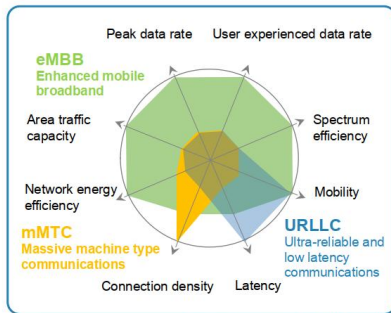
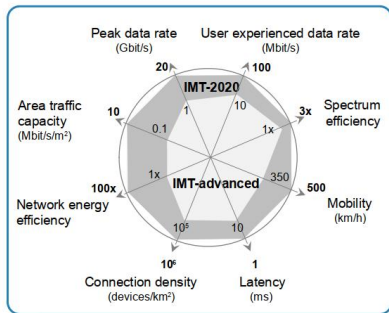
Missing Migrants Project

Stefano Nocco



What is 5G?

Key Capabilities of IMT-2020 Defined by ITU



Source: Recommendation ITU-R M.2083

5G is characterized by increased data rate, enhanced spectrum efficiency and reduced latency.

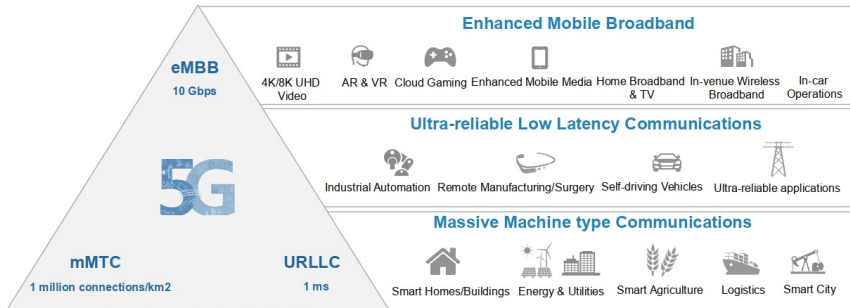
1000 times higher mobile data volume per geographical area., 10 to 100 times more connected devices.
 10 times to 100 times higher typical user data rate., 10 times lower energy consumption.
 End-to-End latency of < 1ms.. Ubiquitous 5G access including in low density areas.

4



Use Cases for 5G

Key Usage Scenarios Drive for 5G



Source: Recommendation ITU-R M.2083

5G connections will go beyond human beings' communications, and will enable intelligent internet of things in the future. Next generation of telecommunication technologies will be adopted by a wider range of industries and sectors.

5



Use Cases for 5G from Qualcomm Brochure



Making India 5G Ready

5G High Level Forum report <http://dot.gov.in/>

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Key Recommendations

We now discuss the key recommendations of the Committee to enable early, efficient and pervasive rollout of 5G in India.

These recommendations recognise the following underlying factors:

- 5G will serve a much broader range of consumers including many economic verticals unfamiliar with wireless technology.
- The 5G technology is currently aimed at applications in the developed countries, India will have to adapt 5G for the country's needs.
- India has begun to participate in the 5G eco-system and needs to catch up quickly.
- 5G must reach economically weaker and the rural segments of our society and be an inclusive technology.
- 5G needs new spectrum bands to operate effectively.
- 5G is a much denser network requiring regulatory support for rapid deployment.

The Committee's recommendations are a summary of those proposed in the following Task Force Reports.

- Spectrum Policy
- Regulatory Policy
- Education and Awareness Promotion Program
- Application & Use Case Labs
- Development of Application Layer Standards
- Major Trials and Technology Demonstration
- Participation in International Standards



5G Vision for India

5G technology has the potential for ushering a major societal transformation in India by enabling a rapid expansion of the role of information technology across **manufacturing, educational, healthcare, agricultural, financial and social sectors**. India must embrace this opportunity by **deploying 5G networks early**, efficiently, and pervasively, as well as emerge as a significant **innovator and technology supplier** at the global level. Emphasis should be placed on 5G touching the lives of rural and weaker economic segments so as to make it a truly **inclusive** technology.

5G Enabling Technologies

For 5G to deliver on its promise, it will also need enabling technologies for deploying networks efficiently and flexibly. Some of them are IoT devices, Millimetric Band, Network Function Virtualization (NFV), Network Slicing (NS), MIMO, Software Defined Networks (SDN), Distributed or Edge Cloud Computing and Artificial Intelligence / Advanced Analytics.

Budgetary Recommendations The 5G programs will require funding by the Govt. At present there are only notional figures available. The actual funding requirements can only be finalized once well-defined project proposals with budgetary justifications are submitted to DoT. The committee recommends a broad planning estimate of INR 3000 million in Year 1, INR 4000 million in Year 2, INR 5000 million in Year 3 and INR 4000 million in year 4



DLT

Wikipedia Definition

Distributed Ledger Technology or DLT

is a consensus of replicated, shared, and synchronized digital data geographically spread across multiple sites, countries, or institutions. There is no central administrator or centralized data storage.

A peer-to-peer network is required as well as **consensus** algorithms to ensure replication across nodes is undertaken.

One form of distributed ledger design is the **blockchain** system, which can be either public or private.

Some implementations- Bitcoin, Ethereum, Hyperledger, R3 Corda ...

Smart Contracts

Code running on top of a blockchain containing a set of rules under which the parties agree.. When the pre-defined rules are met, the agreement is automatically enforced. The smart contract code facilitates, verifies, and enforces the negotiation or performance of an agreement or transaction.

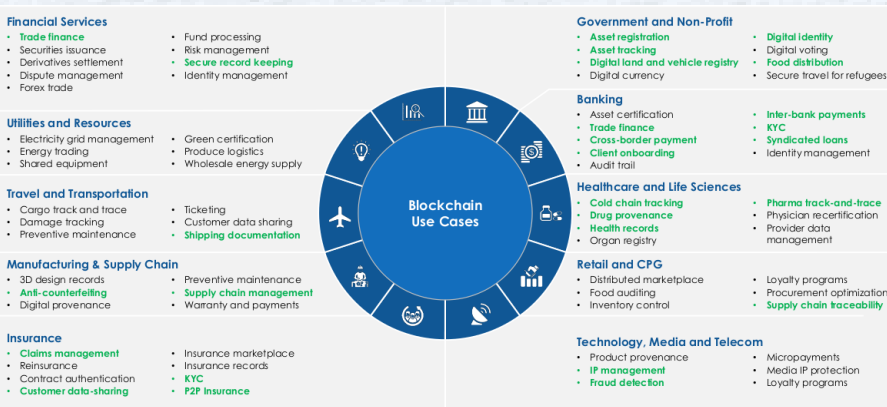
... assets automatically get redistributed among those parties according to a formula based on certain data, which may not be known at the time of contract initiation.

Zero-Knowledge Proofs

Only know that the valid transaction has taken place, but not know about the sender, recipient, and quantity. Allows blockchains to have the key elements like security and privacy without abandoning redundancy and immutability, which comes from synchronizing the full transaction information throughout the network.



NASSCOM Avasant India Blockchain Report 2019



Note: Green coloured use cases indicate higher adoption in India
Source: Avasant Blockchain Services RadarView 2018

NASSCOM

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What next?

चिन्तनीया हि विपदां आदावेव प्रतिक्रिया
न कूपखननं युक्तं प्रदीप्ते वह्निना गृहे

The effect of disasters should be thought of beforehand. It is not appropriate to **start digging a well when the house is ablaze with fire.**

आचार्यात् पादमादत्ते पादं शिष्यः स्वमेधया ।
सब्रह्मचारिभ्यः पादं पादं कालक्रमेण च ॥

one fourth from the **teacher**,
one fourth from **own intelligence**,
one fourth from **classmates**,
and one fourth **only with time**.



www.phdcomics.com (Can be Life Saver!)

to a friend! >>originally published 5/22/2006

WRITING YOUR THESIS OUTLINE

NOTHING SAYS "I'M ALMOST DONE" TO YOUR ADVISOR/ SPOUSE/PARENTS LIKE PRETENDING YOU HAVE A PLAN

STEP 1 Aim for a respectable number of chapters:

1.
2.
3.
4.
5.
6.
7.
8.

5 = "That's IT??"
6-7 = "Not bad!"
8+ = "Are you crazy??"

STEP 2 Fill in the "freebies":

1. INTRODUCTION
2. LIT REVIEW
3. METHODOLOGY
4.
5.
6.
7. CONCLUSIONS

You're half way done!

STEP 3 Make up titles for the "meat" chapters:

6. LIT REVIEW
3. METHODOLOGY
4. (THAT STUFF YOU DID YOUR FIRST YEAR)
5. (STUFF YOU'RE SUPPOSED TO BE DOING NOW)
6. (MAKE STUFF UP)
7. CONCLUSIONS

(It'll be years before you actually have to work on that later chapter, and by then your thesis topic will have changed anyway)

STEP 4 Voila! You just bought yourself another two years

JUDGE CHANI © 2006

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email this comic to a friend! >>originally published 1/18/2004

DECIPHERING ACADEMESE

YES, ACADEMIC LANGUAGE CAN BE OBTUSE, ABSTRUSE AND DOWNRIGHT DAEDAL. FOR YOUR CONVENIENCE, WE PRESENT A SHORT THESAURUS OF COMMON ACADEMIC PHRASES

| | | | | | |
|--|---|---|---------------------------------|---|---|
| "To the best of the author's knowledge..." | = | "WE WERE TOO LAZY TO DO A REAL LITERATURE SEARCH" | "It should be noted that..." | = | "OK, SO MY EXPERIMENTS WEREN'T PERFECT. ARE YOU HAPPY NOW??" |
| "Results were found through direct experimentation." | = | "WE PLAYED AROUND WITH IT UNTIL IT WORKED." | "These results suggest that..." | = | "IF WE TAKE A HUGE LEAP IN REASONING, WE CAN GET MORE MILEAGE OUT OF OUR DATA..." |
| "The data agreed quite well with the predicted model." | = | "IF YOU TURN THE PAGE UPSIDE DOWN AND SQUINT, IT DOESN'T LOOK TOO DIFFERENT." | "Future work will focus on..." | = | "YES, WE KNOW THERE IS A BIG FLAW, BUT WE PROMISE WE'LL GET TO IT SOMEDAY." |
| | | | "...remains an open question." | = | "WE HAVE NO CLUE EITHER." |

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