



Technology intervention in education - an agenda for constructive disruption

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Address to teachers at
HVPM College of Engineering and Technology
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Life, humans, language, script

Carbon based evolution

- RNA molecules ~4 B years
- Bacteria, Microbial mats ~3 B
- Multi-cellular ~ 1B
- Animals ~ 580M
- Humans ~3M
- **Language ~0.1M**
- **Writing/Script ~6000 years**



Carbon evolution ...

- Script permitted knowledge capture/share
- Gutenberg (and others) enabled spread
- Collaborative innovation gathered speed
- Led to Industrial revolution
 - Better life (convenient, comfortable)
- More innovation



The great carbon problem

- Amazing neural infrastructure
 - bound within a single entity
- Acquired knowledge cannot propagate
 - Each individual entity must learn
- Entities formed societies
 - Collaborating groups
- Humanity created the Institution of a ‘Teacher’
 - And provided support structures



Spread of Education

- Initially limited to a few elite
 - Mass education mostly in last few centuries
- Organizational divisions
 - School education, Higher Education, Skills
 - Faculties, Domains, Subjects, ...
- Large population needs many schools/colleges
 - More numbers to handle growing numbers

Indian Numbers (2015-16)



Age (Level)	Population (in Crore)	Number of students (In Crore)
6 to 13 (I-VIII)	20.4015	19.6717
14 to 15 (IX-X)	4.9363	3.9145
16 to 17 (XI-XII)	4.4386	2.4735
18 to 23 (HE)	14.1291	3.4585

Educational Institutes(2015-16)



Level	No of Institutes	Number of teachers
6 to 13 (I-VIII)	12,70,100	52,18,467
14 to 15 (IX-X)	1,39,500	14,31,591
16 to 17 (XI-XII)	1,12,600	20,41,864
18 to 23 (HE)	~40000	???
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Silicon appears on the scene

- Transistor invented (1948)



- Bardeen, Shockley, Brattain

Electronic circuits evolve rapidly



- Evolution
 - Discrete components on a PCB
 - First integrated circuits
 - SSI, MSI, LSI, VLSI, VVLSI, ...
- Digital Computers
 - ‘Intelligence’ due to software



Revenge of Silicon

(Term coined by Prof Balkrishnan IISc)

- Evolution of complex systems
 - General purpose computers
 - Embedded Systems
- Strides in software technology
 - Assemblers, Compilers, OS, Libraries, ...
- Programming matures
 - Algorithms, Languages, databases, AI/ML, ...

Cost and Size of digital storage



- Have reduced rapidly
- Hard Disks
 - 1974: Rs 50,000 for 10MB disk
 - Rs 50 lakhs for 1GB storage
 - 1994: Rs 2,0,000 for 1GB
 - 2018: Rs 3,000 for 1TB
- Pen drives
 - 2008: Rs 3,000 for 4GB
 - 2018: Rs 300 for 16GB



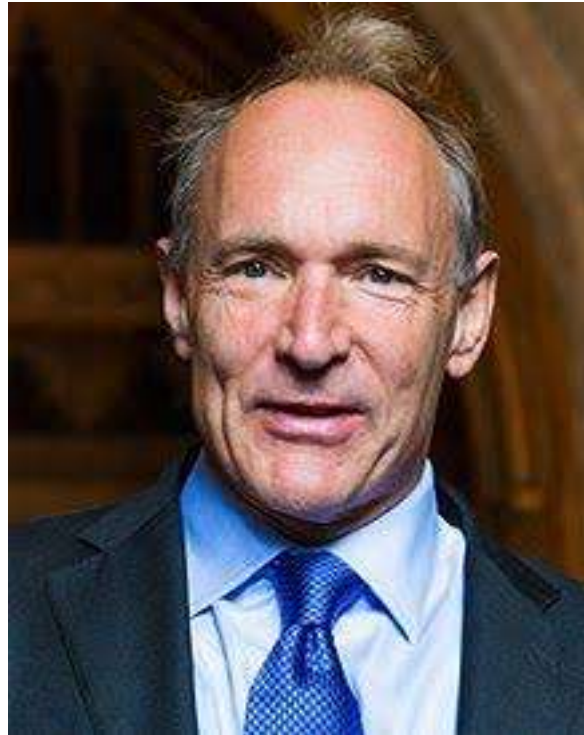


Spread of Silicon intelligence

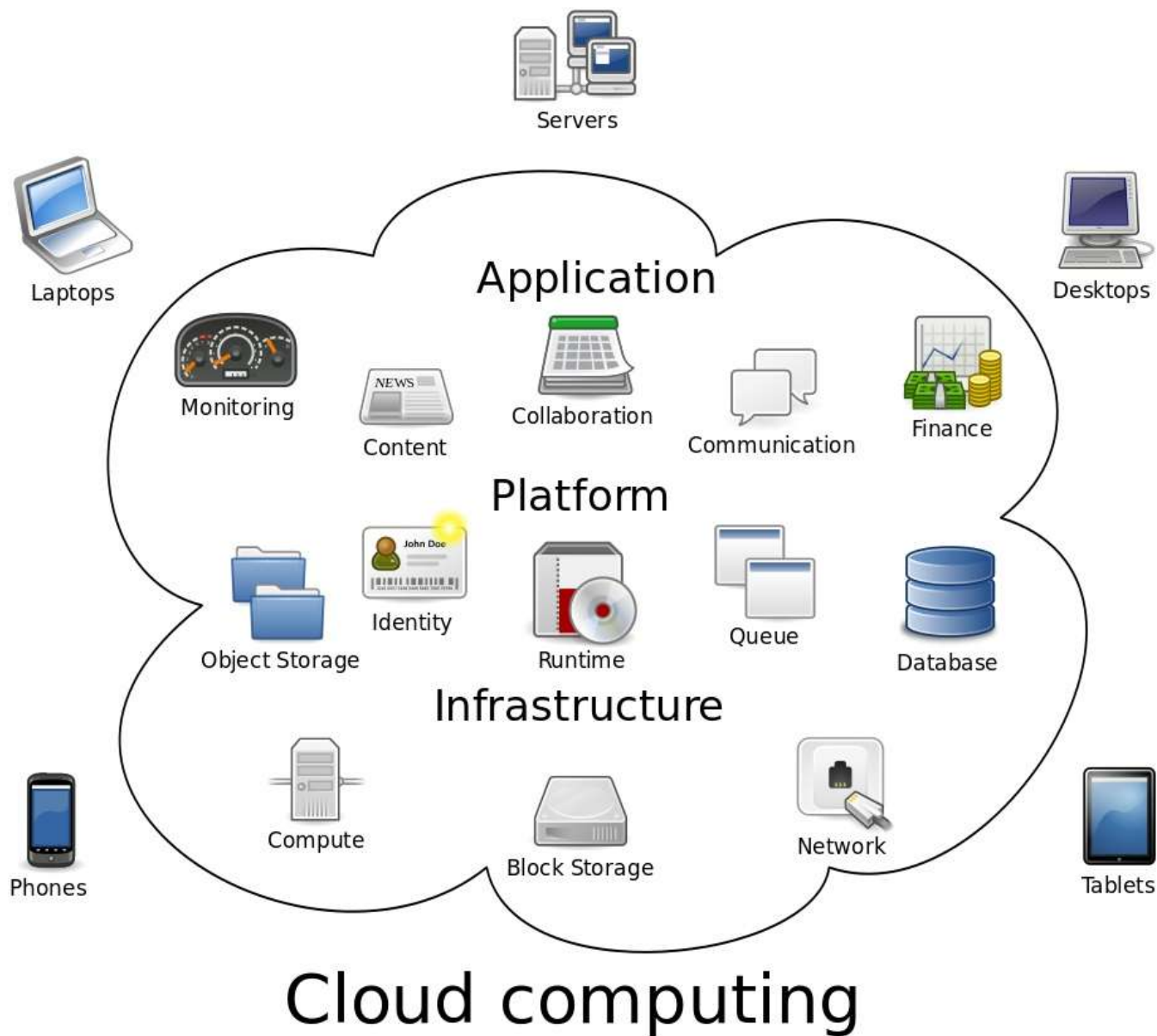
- Silicon starts communicating
 - Early networks (ARPANET)
 - Local Area Networks
 - Wide Area Networks
- Internet
- Superior bandwidths
- Kbps, Mbps, Gbps, ...



The World Wide Web



Tim Berners Lee





The Silicon advantage

- Identical replication
 - Quick system re-instantiation
- Individual entities directly communicate
 - One entity can generate data
 - Another can process
 - Yet another can digest and use



The unfolding century

- Heavily connected world
- Unparalleled data collection
 - Extensive (sensor) network
 - Internet of Things (IoT)
 - Smart Cities
- Overdose of Information
 - Easy and almost universal access



14 Grand challenges

- Advancing health informatics
- Securing cyber space
- Reverse engineering the brain
- Advancing personalized instructions

<https://www.nae.edu>



Loss of conventional jobs

- Predicted by Many
- PwC report: in 15 years
 - US 38%, Germany 35%, UK 30% ...
- New jobs will be less in numbers
- Existing jobs need new skills
- Andrew's observations

The MOOCs avalanche



- Started less than 10 years ago
- Great Promise
 - Learn at scale, anytime, anywhere
- Not accredited (the first elephant)
- Confusion (the second elephant)
 - Teachers NOT trained to run MOOCs
 - Students NOT trained to use MOOCs
- What, why, how? (the third elephant)

Three Elephants



Accreditation

Confusion

Strategy



Skilling MOOCs



- SKANI101X: Animation using Open Source tool: blender
- Each offering tracked
 - Innovations in learner engagement
- Significant benefits confirmed



3rd Offering

32.4

Got
Certificates

82.3%
participants got
certificates,
who
interacted

Participants were
offered internships
by Animation
Studios and
eLearning
companies

2nd Offering

20.0

Got
Certificates

46.6%
participants
got
certificates,
who
interacted

1st Offering

8.9

Got
Certificates



Punch Kanyas of Borawan





Clickable Map of India

Blender'ers of Rajkot



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Efforts at IIT Bombay

- T10KT trained over 1,75,000 teachers
- Aakash tablets for 1,00,000 students
- Blended MOOCs advocated in 2013
 - Flipped classroom routinely used
- IITBombayX launched in 2015
- Configurable version available
- Learner Centric MOOCs
 - Short Videos with reflection points
 - Force an action (quiz/activity)



Main challenge in education

- What, why, and how?
 - Education in 21st Century to be different
- Skills + Knowledge + Innovation
- Cannot predict what will be useful
 - Students must learn how to learn
- Learning by rote Vs
 - Understanding, critical thinking
 - Problem solving, collaboration



How should education change?

- Education:
 - Sensitization + Awareness + learning+ Training
- Technology is being adopted
 - But it has yet to percolate down the line
- Curriculum needs to be envisioned afresh
 - Smaller chunks, micro-modules
- Classroom transactions need to change
 - Teacher as a facilitator of learning
- What about attitude and values?

Constructive disruption – an agenda



- Skills + knowledge obligatory
 - Establish tinkerer Labs
- Regular labs need to be revamped
- Reorientation for ALL teachers
 - Use Senior students as TAs
- Reimagine curriculum
- Invest in blended MOOCs
 - Start with a flipped classroom for one topic
- Greater exposure to societal needs
 - Project work based on these

Concluding remarks



Please send your comments/suggestions to dbp@it.iitb.ac.in; dbphatak@gmail.com

Thank You