



Musings on Change: Driver for SDN

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Outline

- Change today
- Historical perspective
- Change & the Internet
- SDN challenges
- Conclusions

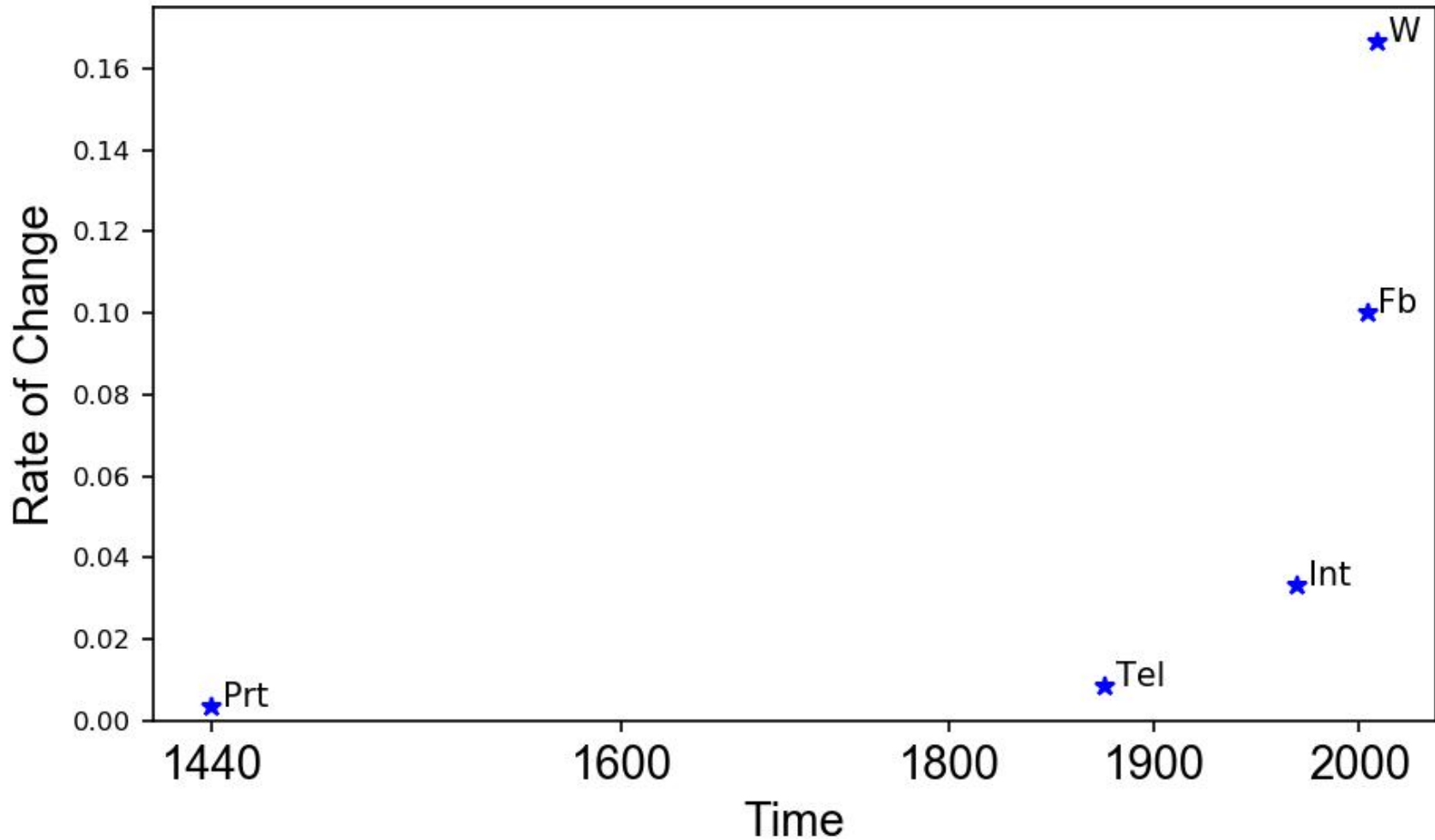


Disruptive Changes

<i>Technology</i>	Introduced	Global
Whatsapp	2009	6 years
Facebook	2004	10 years
Internet	1970	30 years
Telephone	1876	120 years
Printing	1440	~300 years
Agriculture	~11,000 BC	~6,000 years

... Disruptive Changes

Rate of Change = $1/\text{Time to go global}$





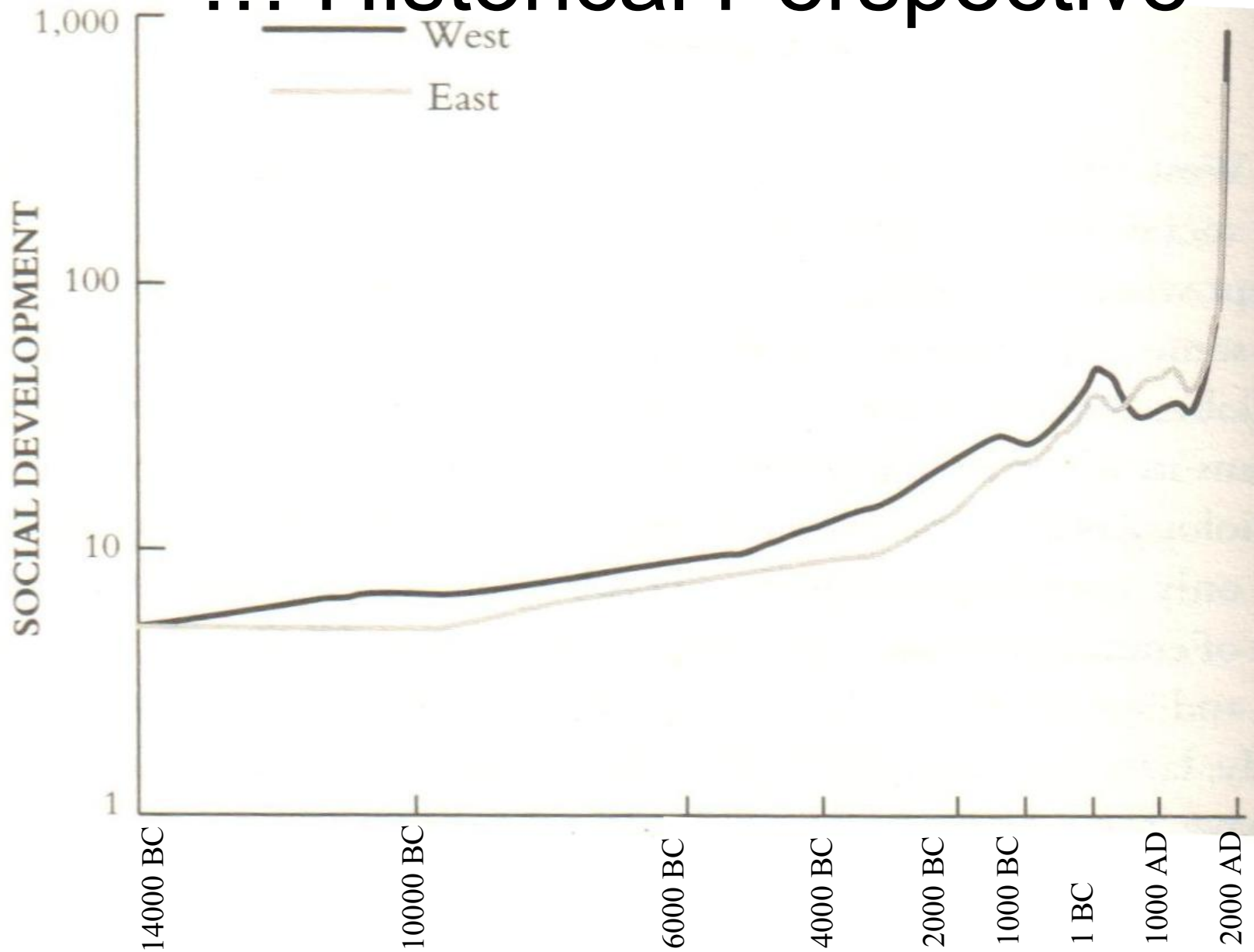
Historical Perspective

- Ian Morris: Professor of History, Classics, Archaeology at Stanford University
- Measure of society's development based on:
 1. Energy capture
 2. Social organisation
 3. Information technology
 4. War-making capacity
- Estimated development of East and West from 14,000 BC to 2,100 AD

Ian Morris, *Why the West Rules for Now*, 2011

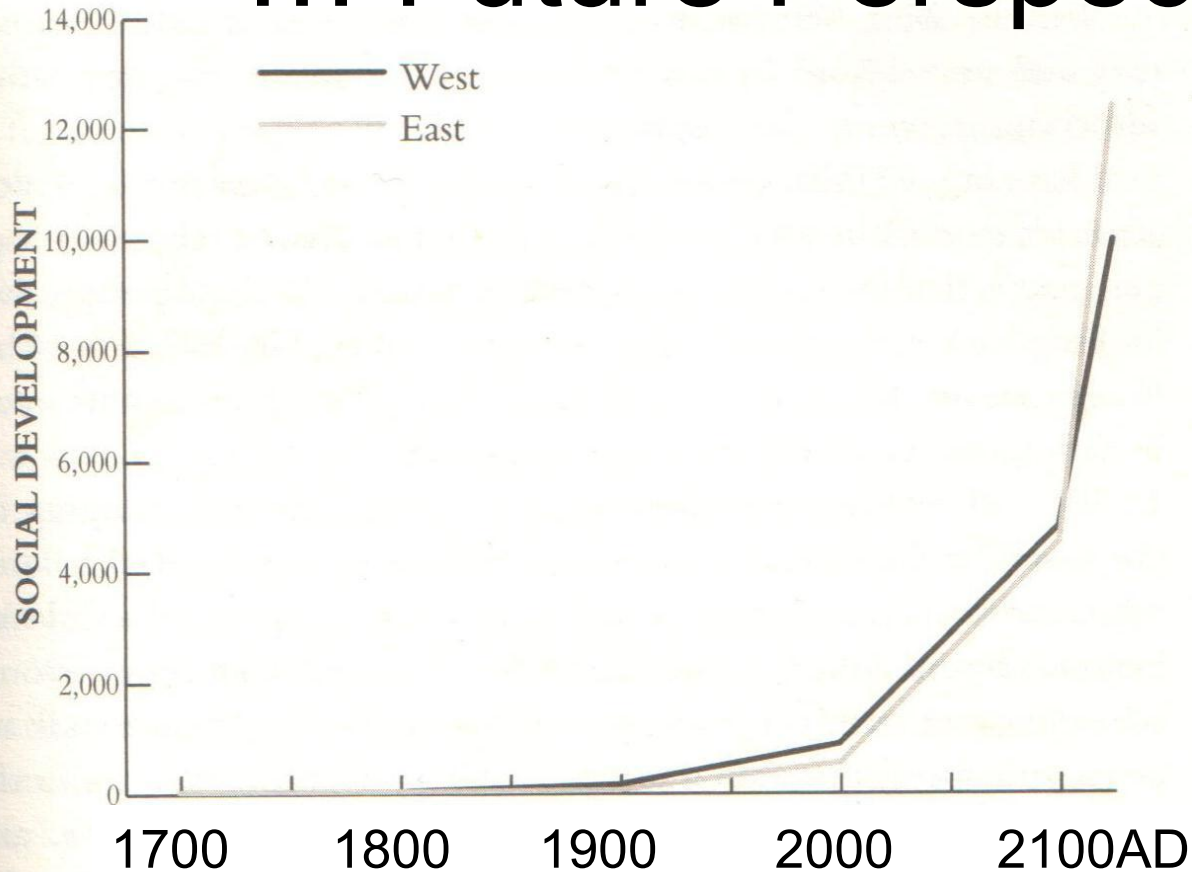


... Historical Perspective





... Future Perspective



- Development next 100 years = 10x development past 16,000 years
- Unimaginable rate of change in next 100 years
- Unpredictable changes



Nature of Networks

- End devices – PCs, laptops, phones, tablets
 - Capabilities growing exponentially with Moore's Law
 - Replace in 1-5 years
 - Easy firmware/software upgrade
- End devices – IoT sensors
 - Limited capabilities
 - Billions of very diverse devices
- **Network devices**
 - Replace in 5-20 years
 - Firmware/software upgrades – vendor-lockin

Requirements

- Today: instant, seamless global connectivity
- Tomorrow: connectivity to the Moon (2024-2030)
- **Fundamental Limit – speed of light**

Area	RTT
India	20 ms
World	200 ms
Earth-Moon	6,000 ms

Need radically
different policies
and protocols in
IP and TCP
layers

Seamless Net



"On the Internet, nobody knows you're a dog."

*"On the Internet,
nobody knows
you're a dog"
The New Yorker
5 July 1993*



Seamless Net

- All hosts equal
 - Any-to-any connectivity
- ==> Highly flexible, completely decentralised
- IPv4 – 32-bit ==> ~1 billion nodes
 - **Solution:** IPv6 – 128-bit ==> address for every grain of sand!
 - **Reality:** NAT, Proxies, server-centric applications
- ==> fragmented, balkanised Internet



Seamless Net: Latency

- 200 ms global latency ==> off-shore sites too slow
 - **Solution:** Content distribution networks
 - Mirrors at many edge locations
- ==> Big, global sites have an advantage
- Small, local sites a dying breed

The Net becoming increasingly centralised, controlled by very few mega-corporations

SDN as the Solution

- **Hardware-defined networks** of the past have led to the serious problems with the Internet architecture
- Galloping, unpredictable changes in society and technology
==> **Software-defined networks are a solution**



SDN Challenges

- Scalability
- Security
- IoT
- Wireless mobility
 - OpenConfig
- Information-Centric Networks
- Standards
- Rollout roadmap



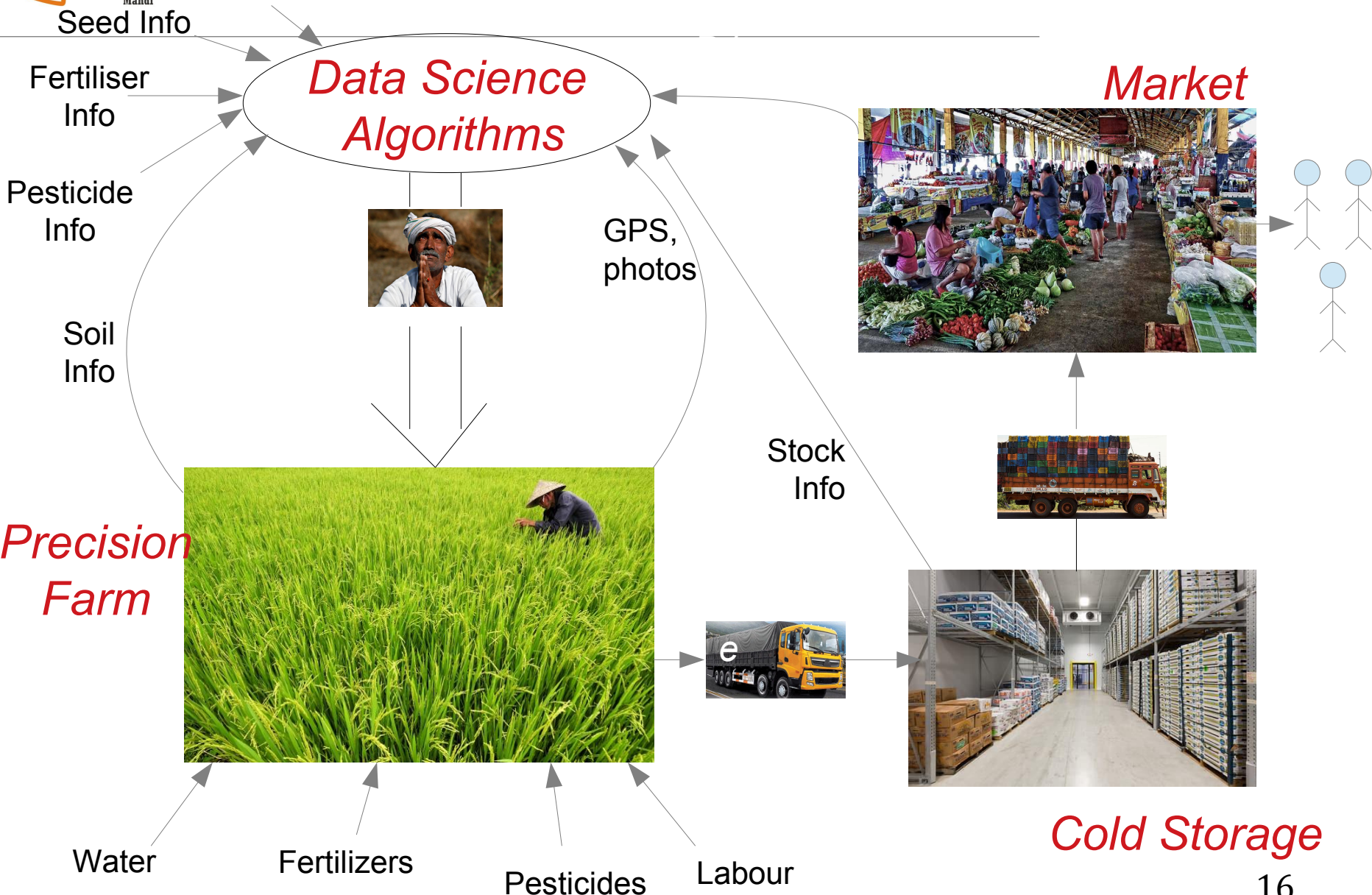


Traditional knowledge
globalisation, climate change

Agriculture



Precision Agriculture: IoT





Precision Agriculture

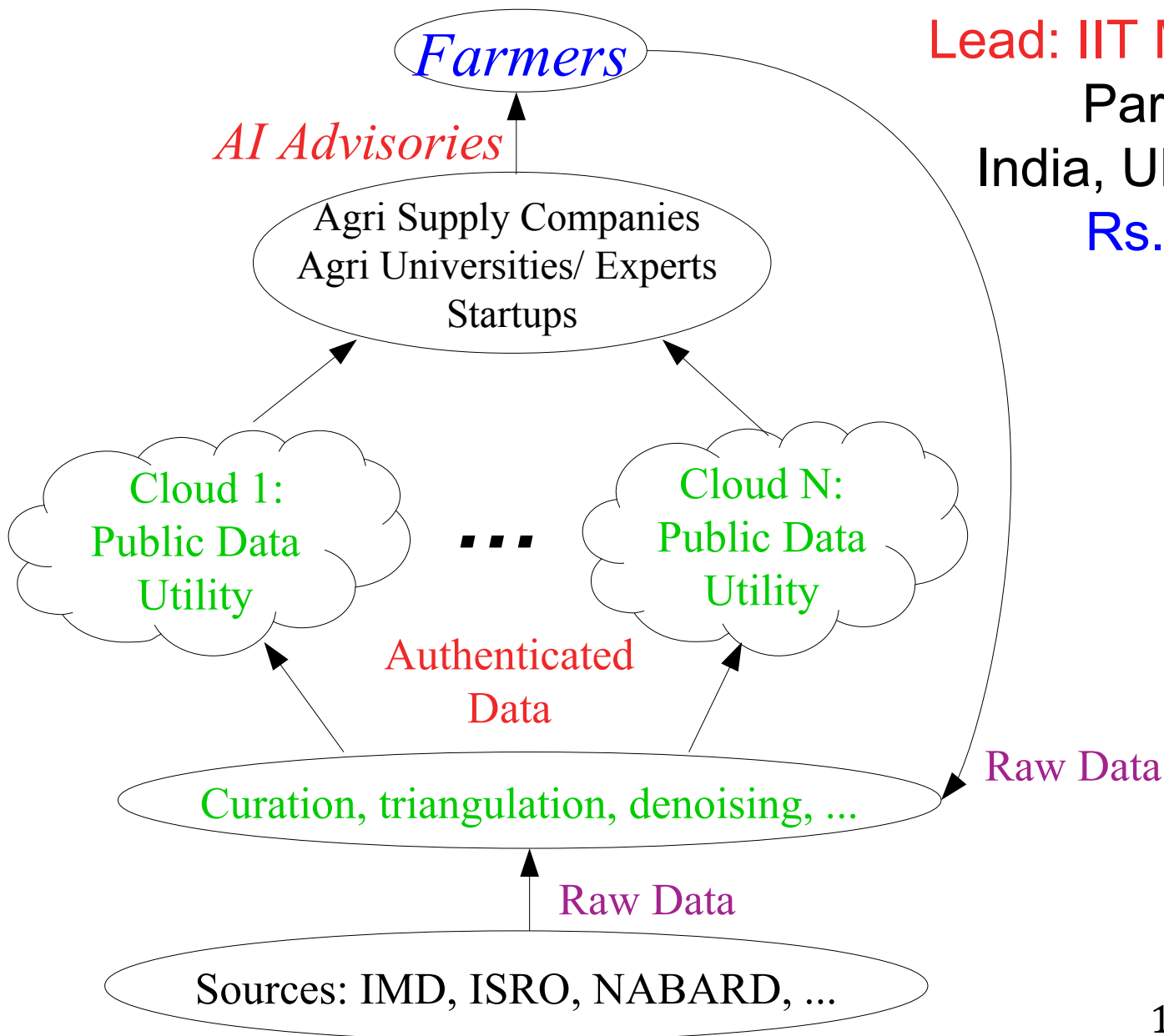
- Very large number of sensors in every farm:
 - Soil condition, weather parameters, images of plants, etc
- Data on inputs, outputs, market prices, transport, cold storage, etc
- **Use Machine Learning to identify patterns and advise farmers**
- **India: >100 million farmers, >20 major crops**

FarmerZone: A DBT Initiative



Industry
Ecosystem

Govt
funded



Lead: IIT Mandi

Partners:

India, UK, US

Rs. 10 cr



Scalability & Security

- Centralised SDN control plane
 - Not scalable, single-point for attack
- Distributed SDN control plane
 - More scalable, more secure
 - But: **cascading failures**
- Control applications developed by many 3rd party vendors
 - **Authentication of such applications is a security vulnerability**
- **Network as critical infra → major outage unacceptable**



SDN Challenges

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- Security
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- Wireless mobility
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Conclusions

- Change in next 50 years = 5x change in last 16,000 years
- Disruptive technologies spread globally at exponentially increasing speeds
 - approaching the speed of light in near future
- Hardware-Defined Networks resulted in Internet losing some essential characteristics
- **SDN is the need of the future!**
 - Security, scalability and rollout are critical



Links

- Ian Morris, *Why the West Rules for Now*, 2011
- A. Banafac, “Three Major Challenges Facing IoT”, IEEE Internet of Things Newsletter, Mar ‘17
- Ahmad *et al.*, “Security in SDN: A Survey”, *IEEE Commun. Surveys & Tutorials*, v17, n4, 2015
- Gacianin & Ligata, “WiFi Self-Organising Networks: Challenges & Use Cases”, *IEEE Commun. Mag.*, Jul ‘17
- Special issue on Moon base, *IEEE Spectrum*, July 2019



Scaling the heights

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