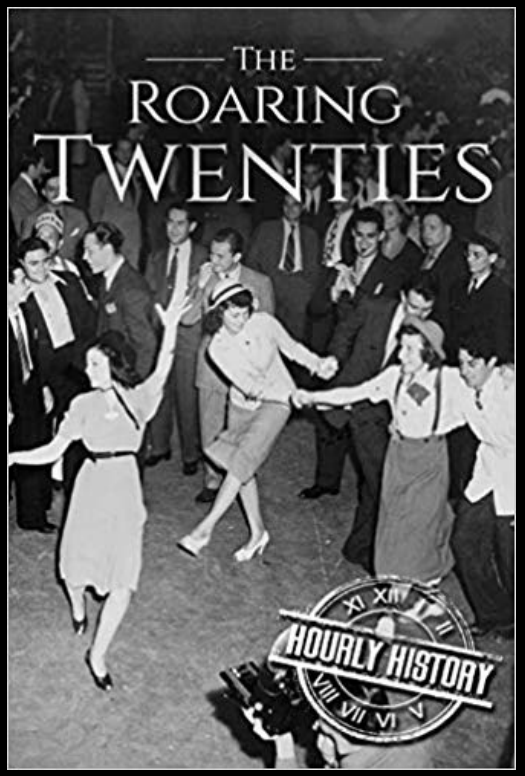
ICT to support the transformation of Science in the Roaring Twenties

Cees de Laat

Systems and Networking Laboratory
University of Amsterdam

ICT to support the transformation of Science in the Roaring Twenties



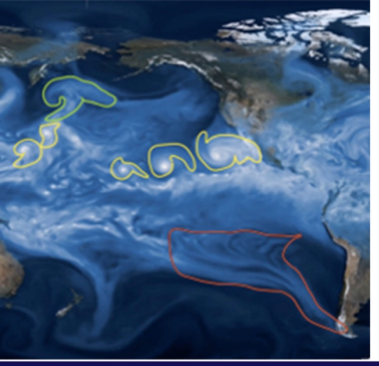
From Wikipedia: The Roaring Twenties refers to the decade of the 1920s in Western society and Western culture. It was a period of economic prosperity with a distinctive cultural edge in the United States and Western Europe, particularly in major cities such as Berlin, Chicago, London, Los Angeles, New York City, Paris, and Sydney. In France, the decade was known as the "années folles" ('crazy years'), emphasizing the era's social, artistic and cultural dynamism. Jazz blossomed, the flapper redefined the modern look for British and American women, and Art Deco peaked….

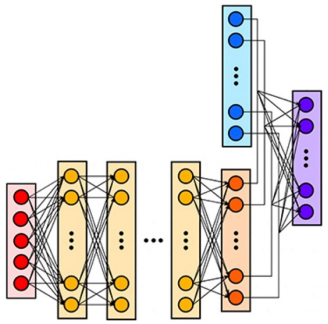
This period saw the large-scale development and use of automobiles, telephones, movies, radio, and electrical appliances being installed in the lives of thousands of Westerners. Aviation soon became a business. Nations saw rapid industrial and economic growth, accelerated consumer demand, and introduced significantly new changes in lifestyle and culture. The media focused on celebrities, especially sports heroes and movie stars, as cities rooted for their home teams and filled the new palatial cinemas and gigantic sports stadiums. In most major democratic states, women won the right to vote. The right to vote made a huge impact on society.

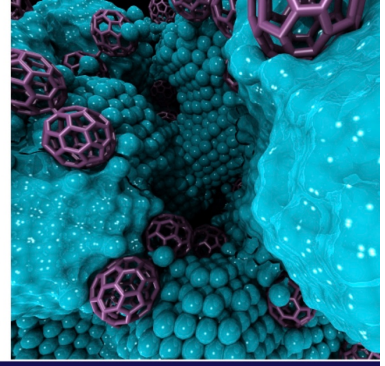
AIM

- Observe how the art of Science is transforming with AI & ML.
- Understand how the ICT world looks like in 2030.
- Understand what hinders Science, Industry, Society to progress.

- An anecdote or two
  - 200M
  - DoI



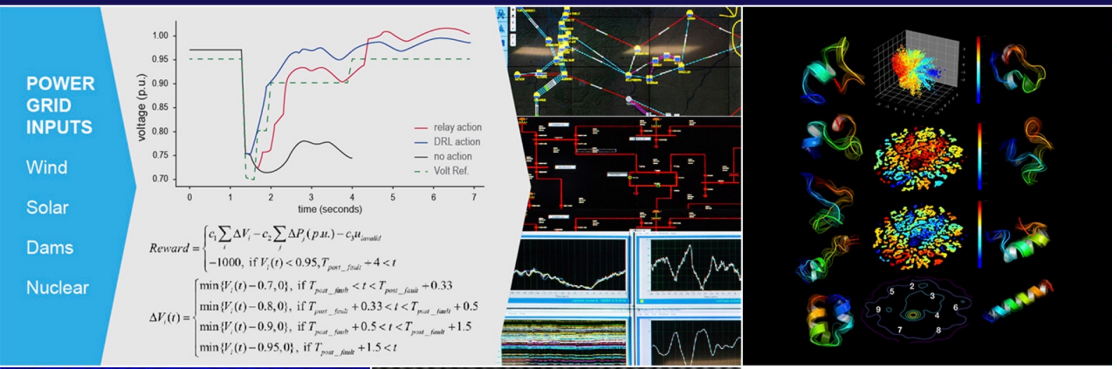


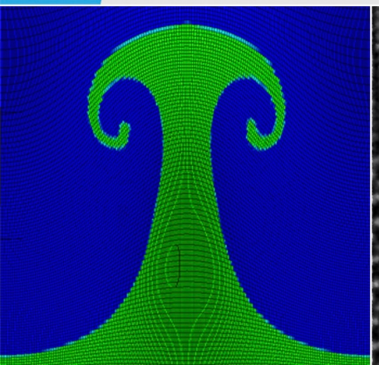


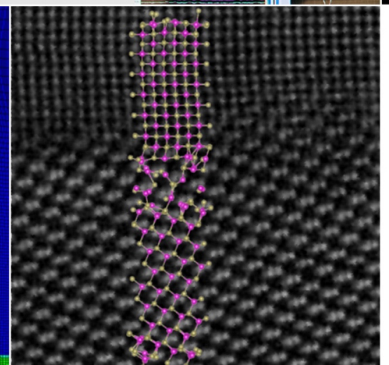
BASIC RESEARCH NEEDS FOR

Scientific Machine Learning

Core Technologies for Artificial Intelligence







Prepared for U.S. Department of Energy Advanced Scientific Computing Research

U.S. DEPARTMENT OF ENERGY

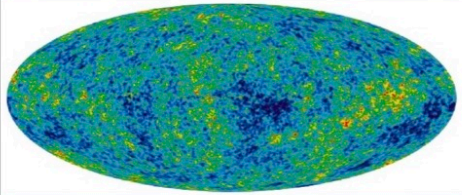
Scientific Machine Learning & Artificial Intelligence

Scientific progress will be driven by
- Massive data: sensors, simulations, networks
- Predictive models and adaptive algorithms
- Heterogeneous high-performance computing

Trend: Human-AI collaborations will transform the way science is done.

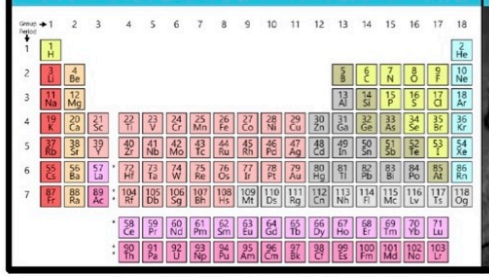
EXEMPLARS OF SCIENTIFIC ACHIEVEMENT

Cosmic Microwave Background

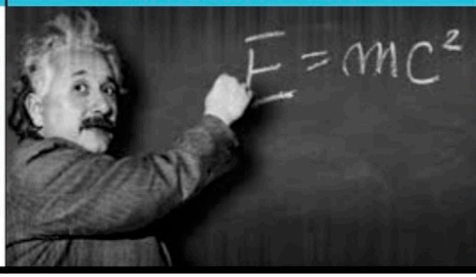


DNA Structure

Periodic Table of the Elements



Special Relativity



Human-AI insights enabled via scientific method, experimentation, & AI reinforcement learning.

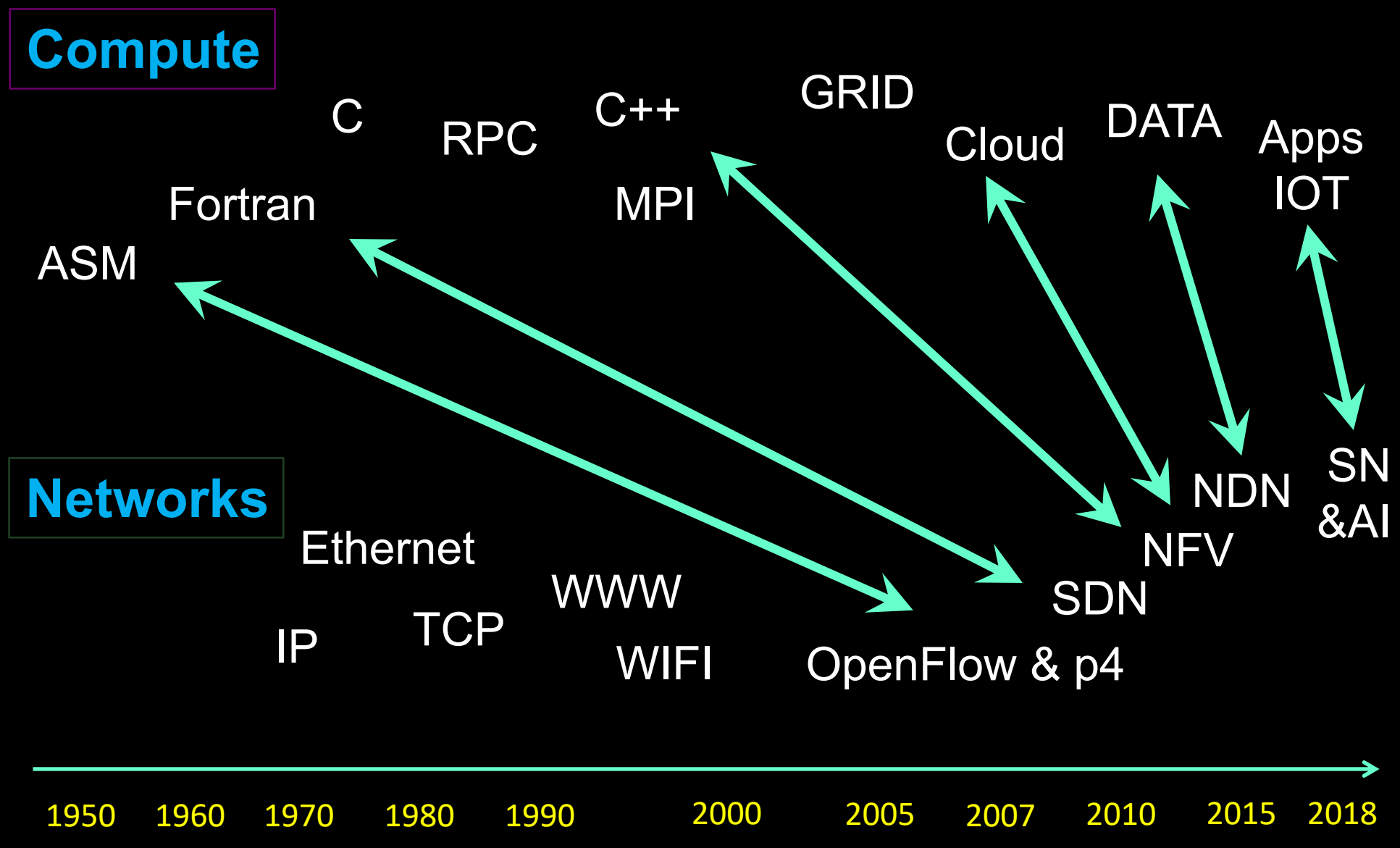
U.S. DEPARTMENT OF ENERGY | Office of Science

DOE Applied Mathematics Research Program
Scientific Machine Learning Workshop (January 2018)

Workshop report:
https://www.osti.gov/biblio/1478744

CI for AI & AI for CI

TimeLine


Compute
C
RPC
C++
GRID
Cloud
DATA
Apps
IOT
Fortran
MPI
ASM
Networks
Ethernet
WWW
IP
TCP
WIFI
SDN
NFV
NDN
SN
&AI
OpenFlow & p4
1950
1960
1970
1980
1990
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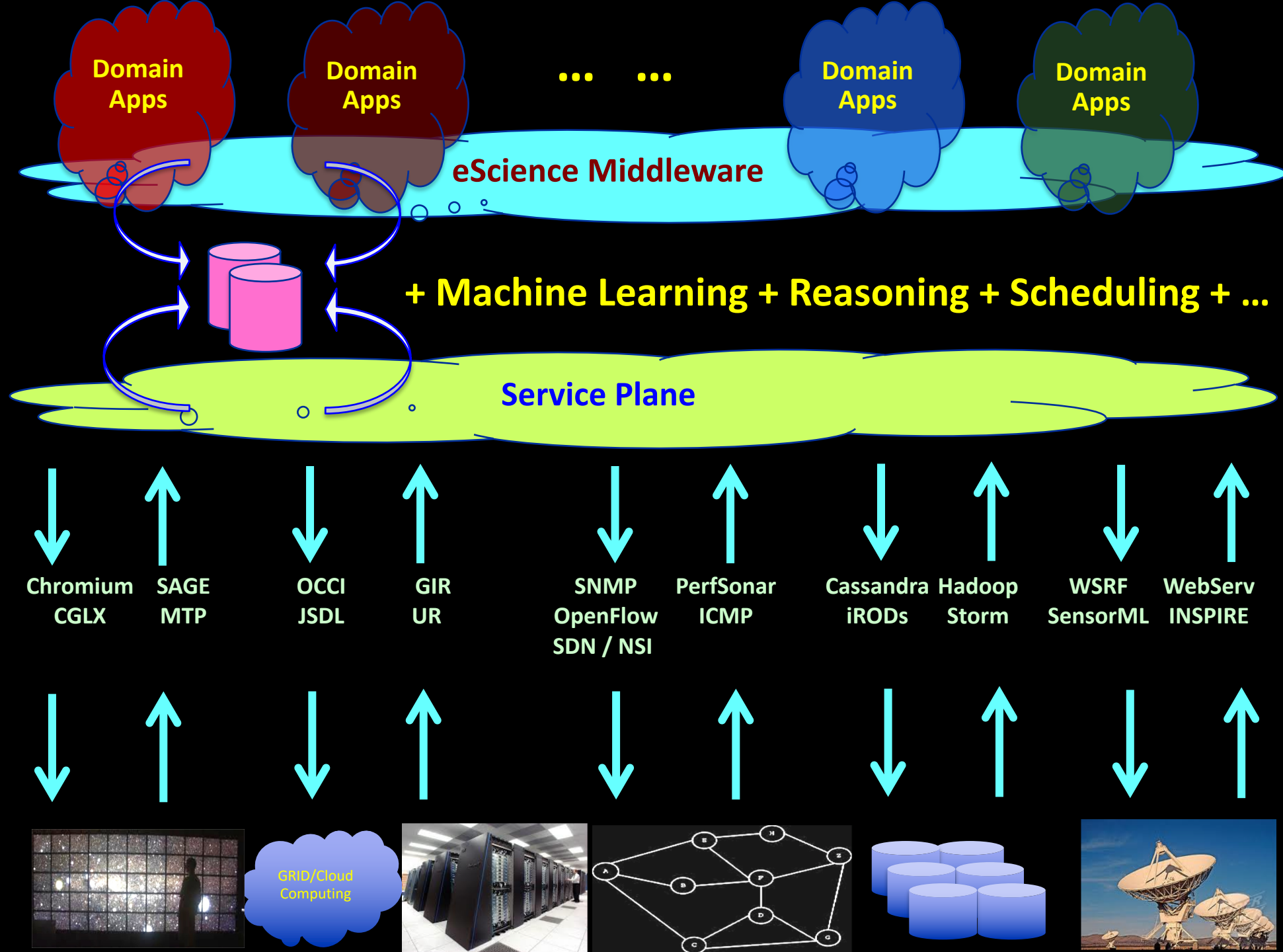
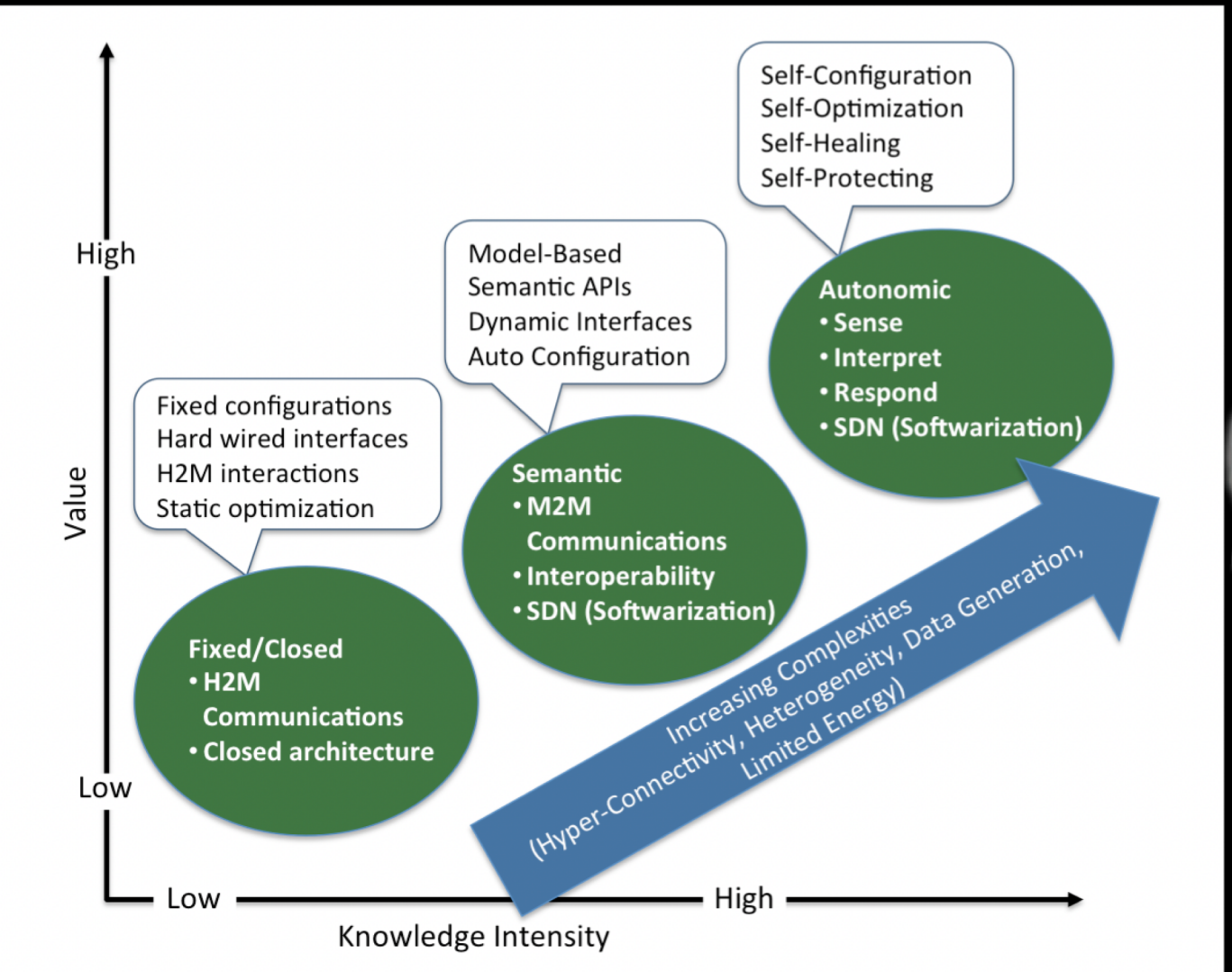
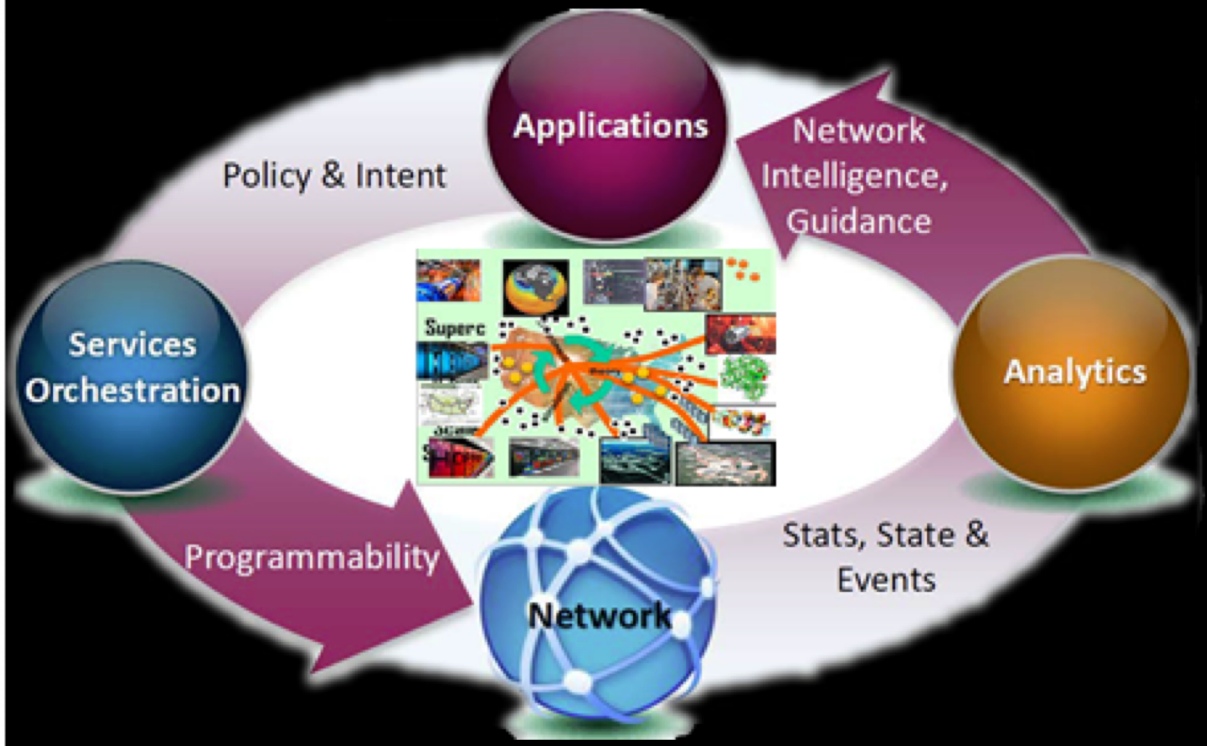
2018


Domain Apps
Domain Apps
... ...
Domain Apps
Domain Apps
eScience Middleware
+ Machine Learning + Reasoning + Scheduling + …
Service Plane
Chromium CGLX
SAGE MTP
OCCI JSDL
GIR UR
SNMP OpenFlow SDN / NSI
PerfSonar ICMP
Cassandra iRODs
Hadoop Storm
WSRF SensorML
WebServ INSPIRE
GRID/Cloud Computing

DoE workshop on Smart Networks

Bring AI in control plane to harness complexity
https://www.orau.gov/smarthp2016/

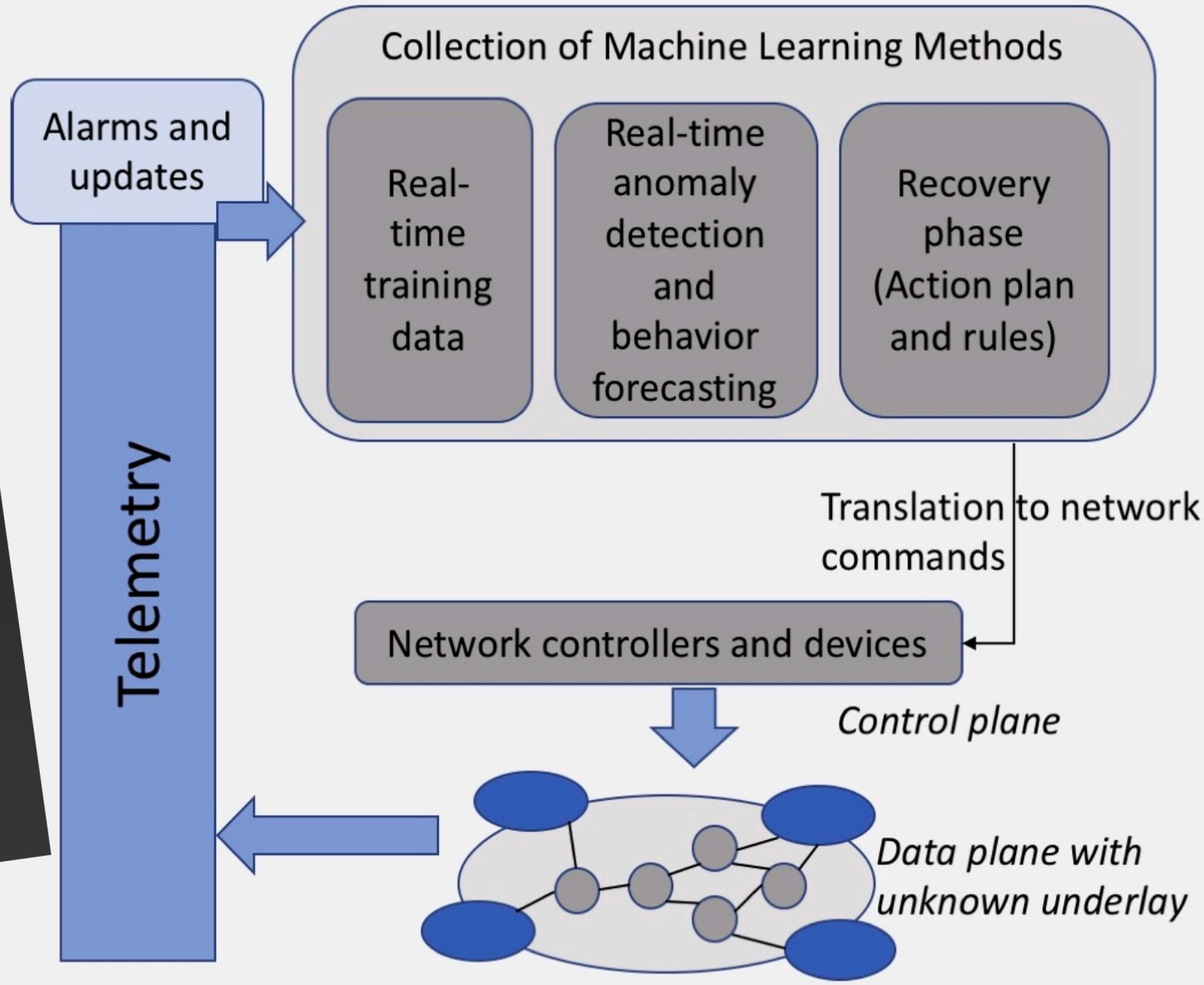




Example 1: Optimizing Network Traffic with Machine Learning

Exascale and increasingly complex science applications are exponentially raising demands for [illegible] DOE network [illegible] such as traffic management, operation scale, and reliability constraints. Network [illegible] backbone to complex science workflows, ensuring data are delivered [illegible] time for important computations to happen. To optimize these [illegible] ...rithms that can add autonomy and assist in decision making to sup-

Difficult to get learning data because of privacy rules Networks are distributed and multi-owned



Rethinking NSF's Computational Ecosystem for 21st Century Science and Engineering

Workshop Website: https://uiowa.edu/nsfcyberinfrastructure

Workshop Report: https://www.uiowa.edu/nsfcyberinfrastructure/report.pdf

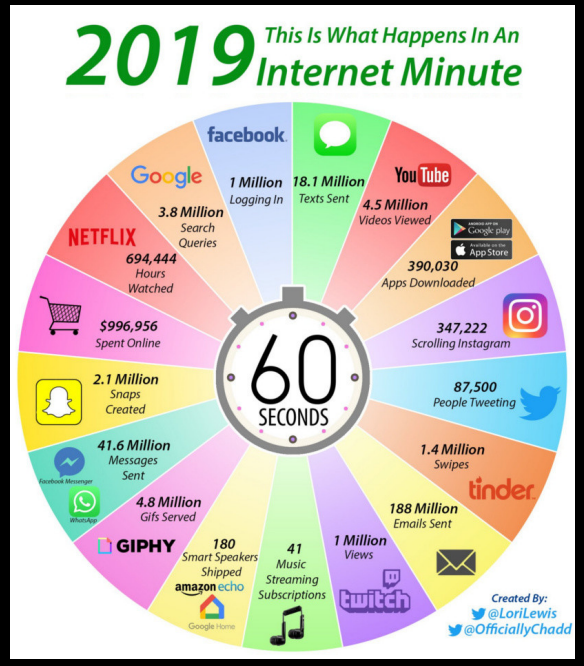
Initial debates about resource management and delivery options focused on expert personnel as a critical component of successful cyberinfrastructure delivery. Several examples such as Campus Champions (CC) or XSEDE's ECSS were described as critical to scientific advance but insufficient in numbers to meet demand. Regionally tasked staff might help to alleviate this shortfall. Benefits could include greater use of cloud or national resources if there was a local expert to help researchers with initial utilization. Along these lines, it was mentioned that the NSF CC* programs changed campus culture, spurring local networking expertise. A similar program to promote workforce development to incentivize local computational and data scientists could, for instance, result in the integration of otherwise isolated clusters on campuses with national resources. These key personnel, ranging from ECSS experts and developers to CCs, are often in careers that need professionalization.

People matter!

Change in computing

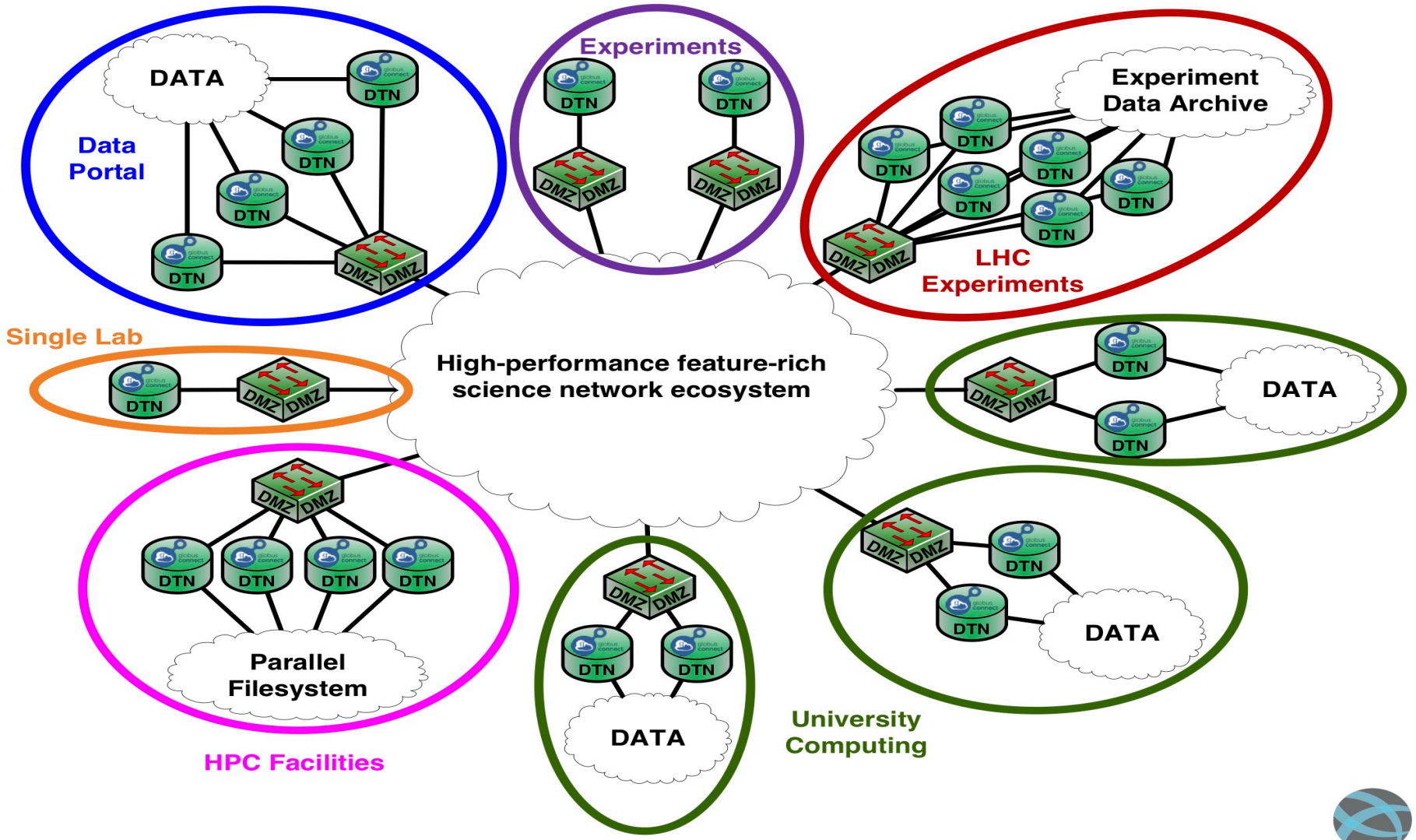
- Early days a few big Supercomputers
  - Mostly science domain
- Via grid to commercial cloud
  - AWS, Azure, Google Cloud, IBM, Salesforce
  - The big five: Apple, Alphabet, Microsoft, Facebook and Amazon
  - Computing has transformed into utility
- Data => Information is the key

> 8 x



- Streaming Data! ➔

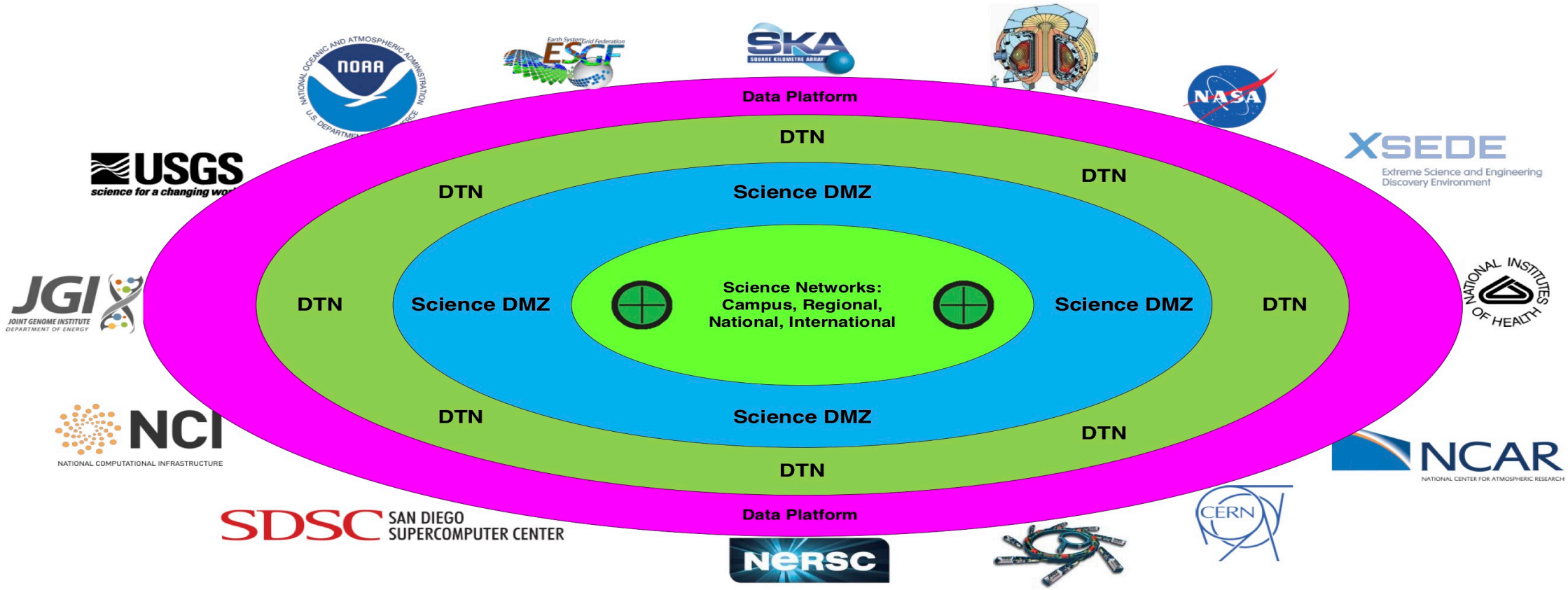
Science DMZs for Science Applications



ESnet

Courtesy Eli Dart, ESnet

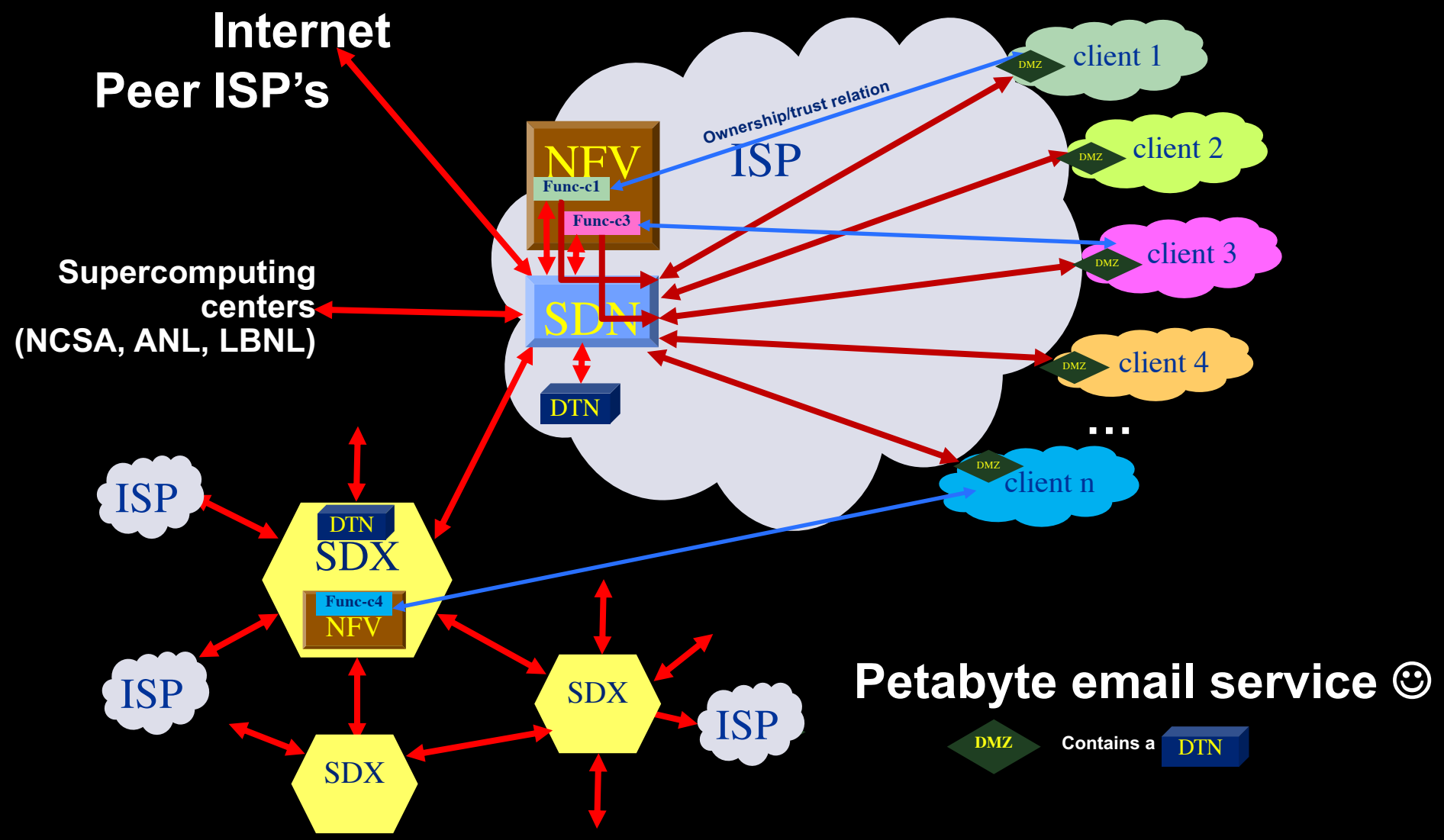
Data Ecosystem – Concentric View



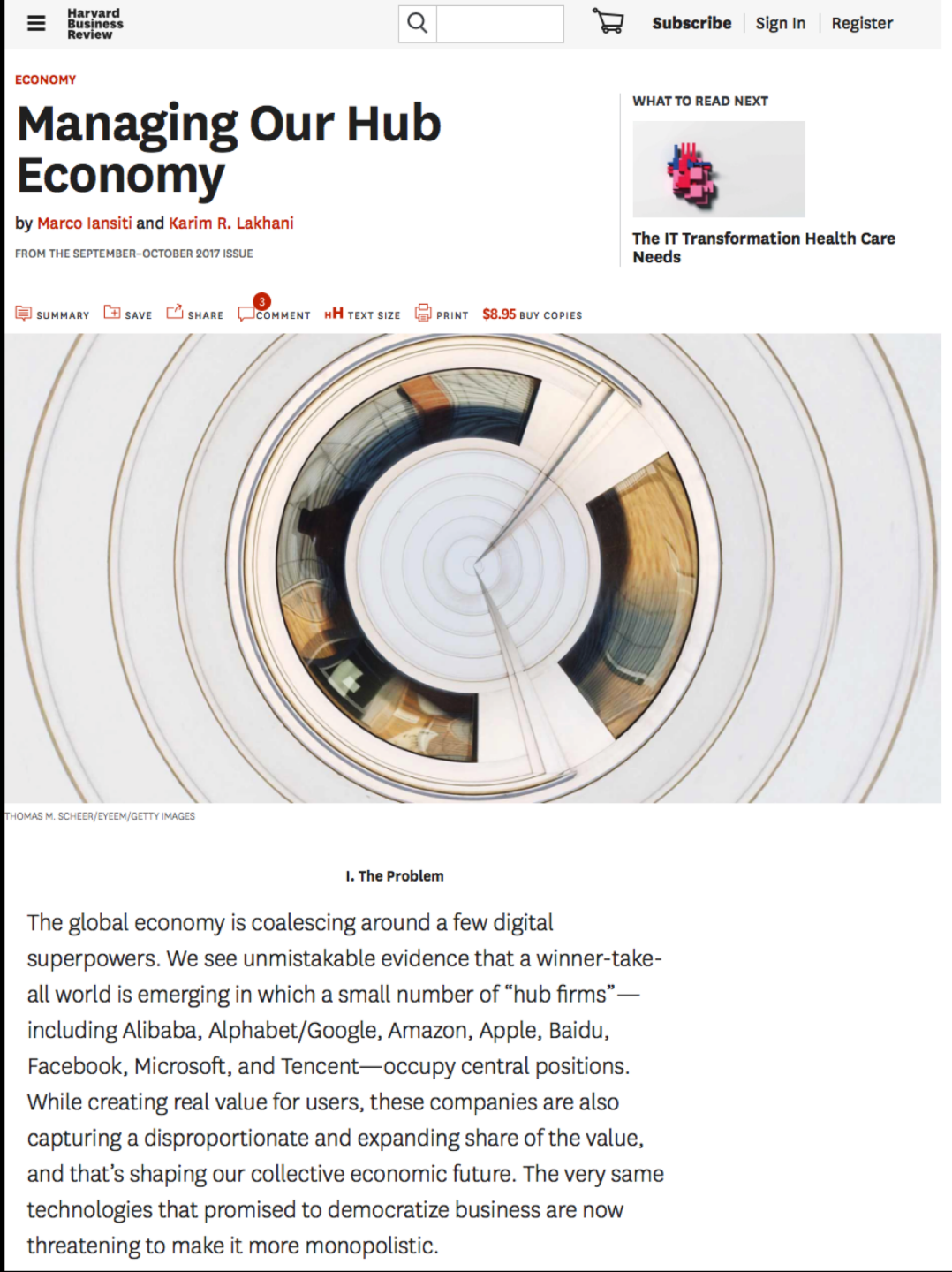
ESnet

Courtesy Eli Dart, ESnet

Networks of ScienceDMZ's & SDX's



Harvard Business Review



Harvard Business Review

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ECONOMY

Managing Our Hub Economy

by Marco Iansiti and Karim R. Lakhani

FROM THE SEPTEMBER–OCTOBER 2017 ISSUE

WHAT TO READ NEXT

The IT Transformation Health Care Needs

SUMMARY SAVE SHARE 3 COMMENT TEXT SIZE PRINT $8.95 BUY COPIES

THOMAS M. SCHEER/EYEEM/GETTY IMAGES

I. The Problem

The global economy is coalescing around a few digital superpowers. We see unmistakable evidence that a winner-take-all world is emerging in which a small number of "hub firms"—including Alibaba, Alphabet/Google, Amazon, Apple, Baidu, Facebook, Microsoft, and Tencent—occupy central positions. While creating real value for users, these companies are also capturing a disproportionate and expanding share of the value, and that's shaping our collective economic future. The very same technologies that promised to democratize business are now threatening to make it more monopolistic.

HARVARD BUSINESS PUBLISHING

Data value creation monopolies

→

Create an equal playing field

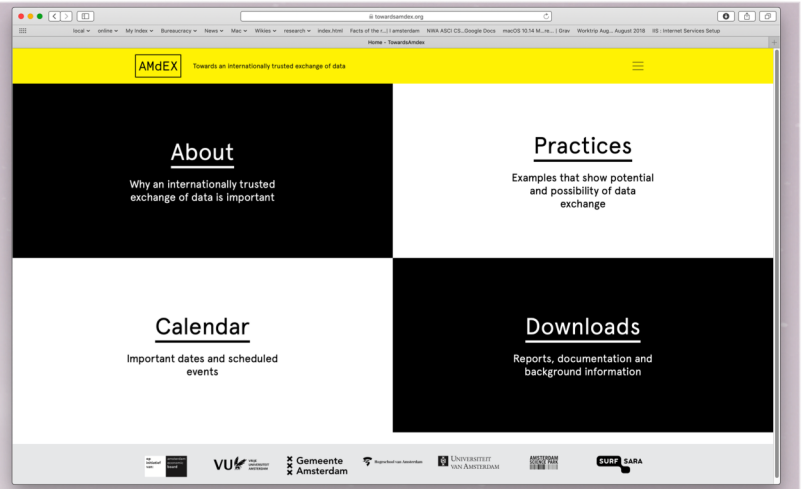
→

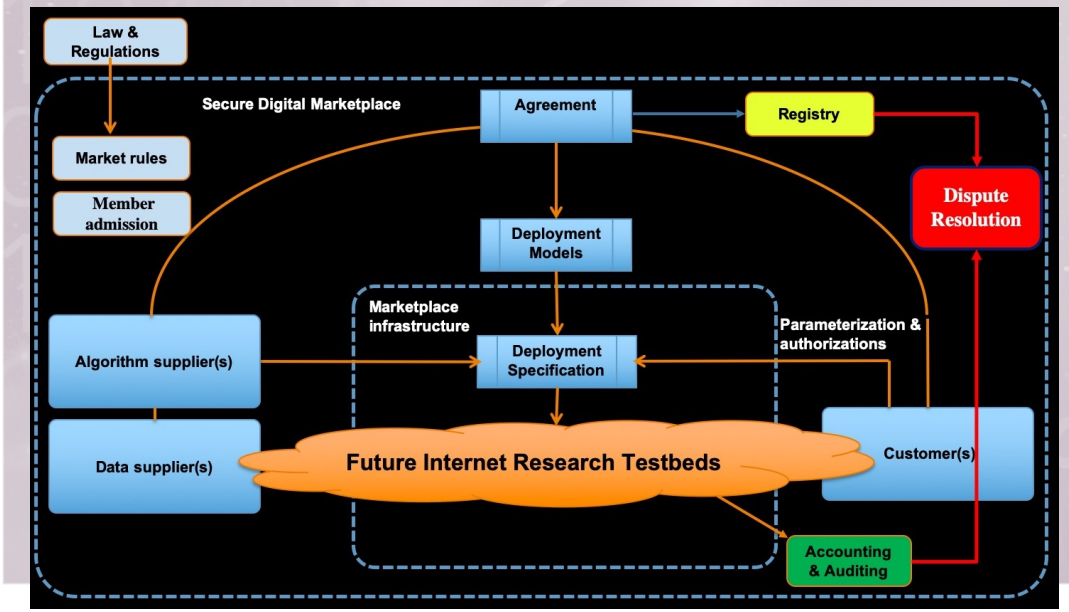
Sound Market principles

https://hbr.org/2017/09/managing-our-hub-economy

AMdEX.eu

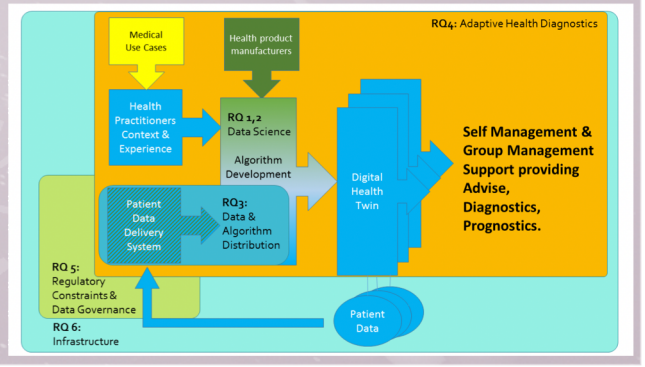
- Competing organisations, share data for common benefit
- Trust, Risk, data ownership & control
  - Industry: AF-KLM, Health, etc
  - Science: European Open Science Cloud
  - Society: Amsterdam Economic Board

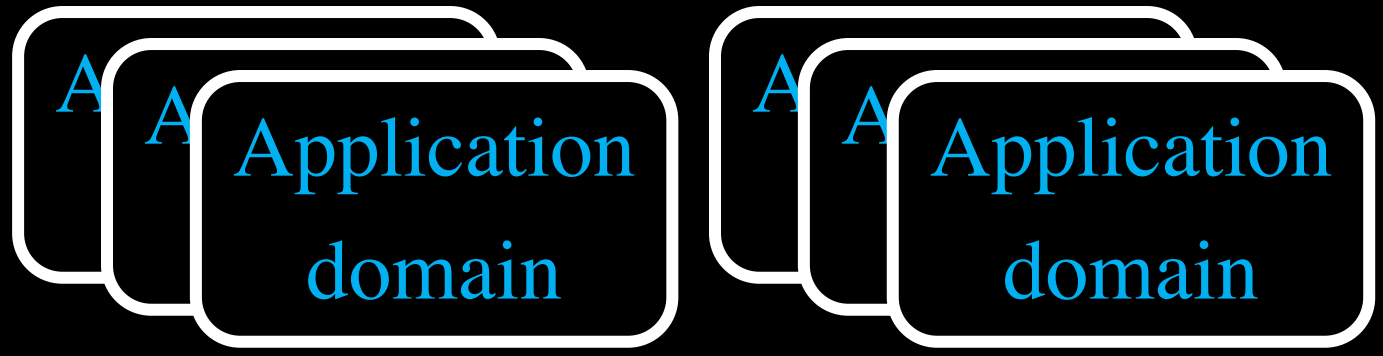




Aircraft Maintenance AF-KLM

Health: Enabling Personal Interventions





AmDex

Data objects & methods
Data & Algorithms service

FAIR / USE

AmsIX

Routers - Internet – ISP's - Cloud
IP packet service

IP / BGP

Layer 2 exchange service
Ethernet frames

ETH / ST

The Big Data Challenge

Doing Science

ICT to enable Science

Wis dom

Knowledge to act

Information

Data

a.o. from ESFRI's

AI

Analytics Decision Support

Web/OWL

Docker, VM, XML, RDF, rSpec, SNMP

The Big Data Challenge

Doing Science

ICT to enable Science

Scientists live here!

Wis dom

AI

Interdisciplinary Science App Store

Analytics library / Github / etc

Knowledge to act

Analytics Decision Support

MAGIC DATA CARPET

curation - description - trust - security - policy – integrity

Information

Web/OWL

Data

a.o. from ESFRI's

Docker, VM,
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Web/OWL

Data

a.o. from ESFRI's

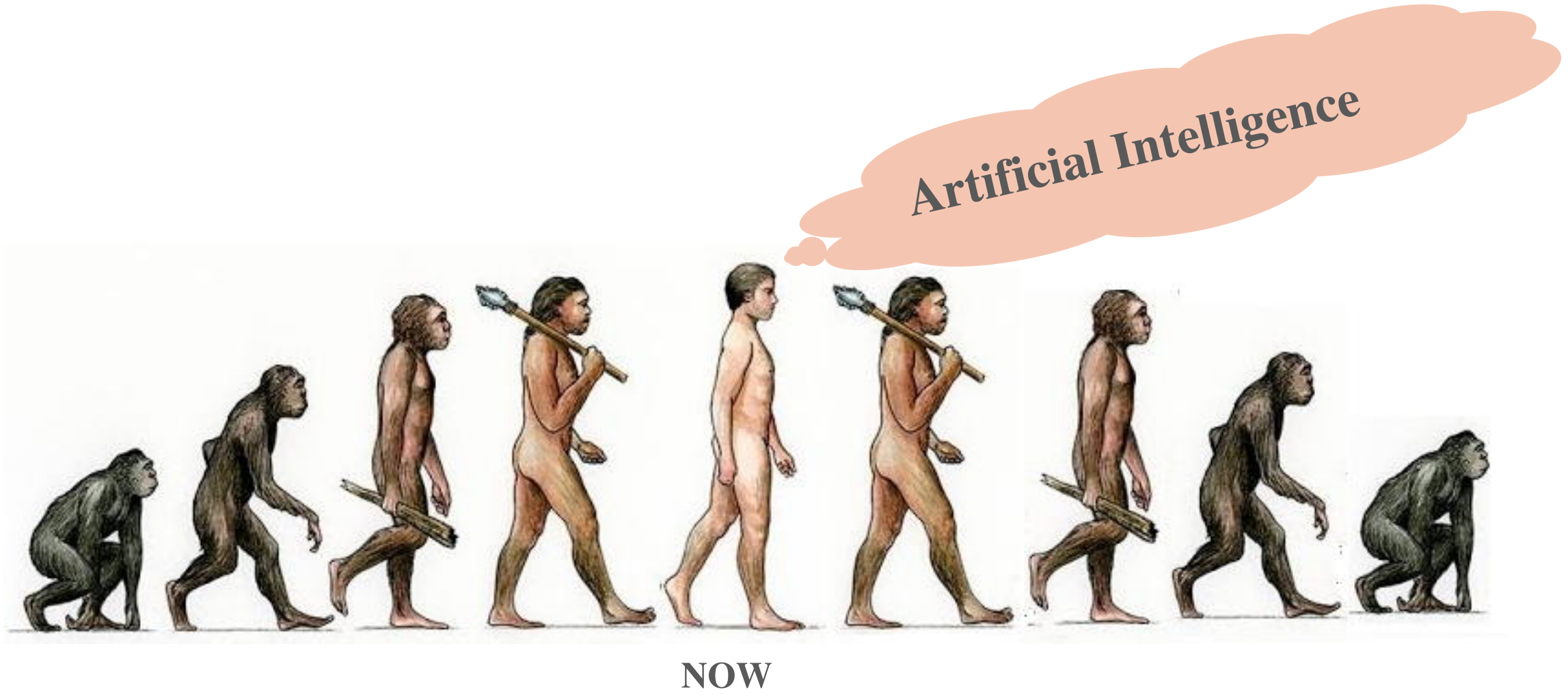
Docker, VM,
XML, RDF, rSpec, SNMP

DSC eScience

RDM/ DANS

ICT/ SURF

AI forking off



Conclusion, Q&A

Need for Network to Data level experimental Infrastructure.

Europe's own DTN infra, CC program, CI Ambitions

Data at scale.

P.S. I did not mention Quantum Compute & Networking; See:

- https://www.orau.gov/quantumnetworks2018/default.htm
- https://science.energy.gov/%7E/media/ascr/pdf/programdocuments/docs/2019/QNOS_Workshop_Final_Report.pdf
- https://delaat.net/qn
- https://delaat.net/
  - https://delaat.net/sarnet
  - https://delaat.net/dl4ld
  - https://delaat.net/epi

This trip is supported by SARNET, DL4LD and EPI projects.