Kako je svet postao globalno selo?

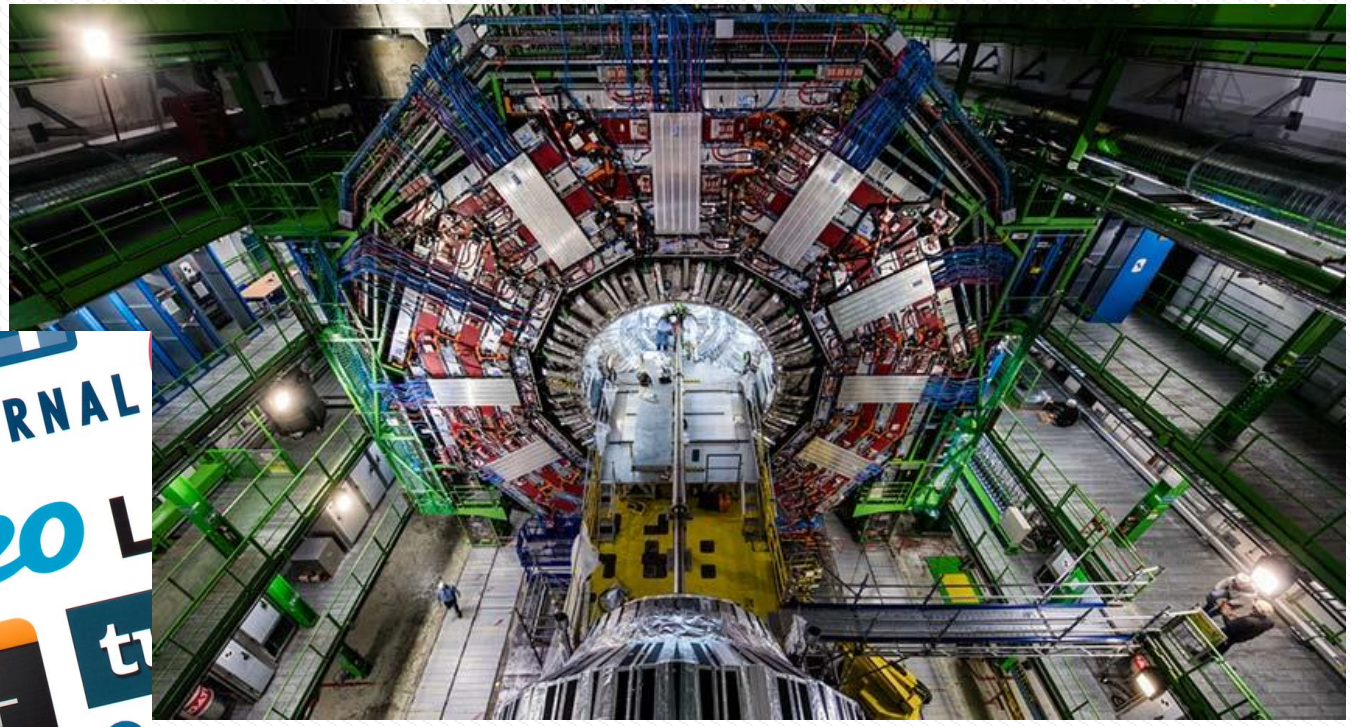
30 godina od nastanka World Wide Weba

dr Milan Milošević

Departman za fiziku, PMF u Nišu

EU info kutak Niš, 23. jul 2019.

WWW i CERN ???



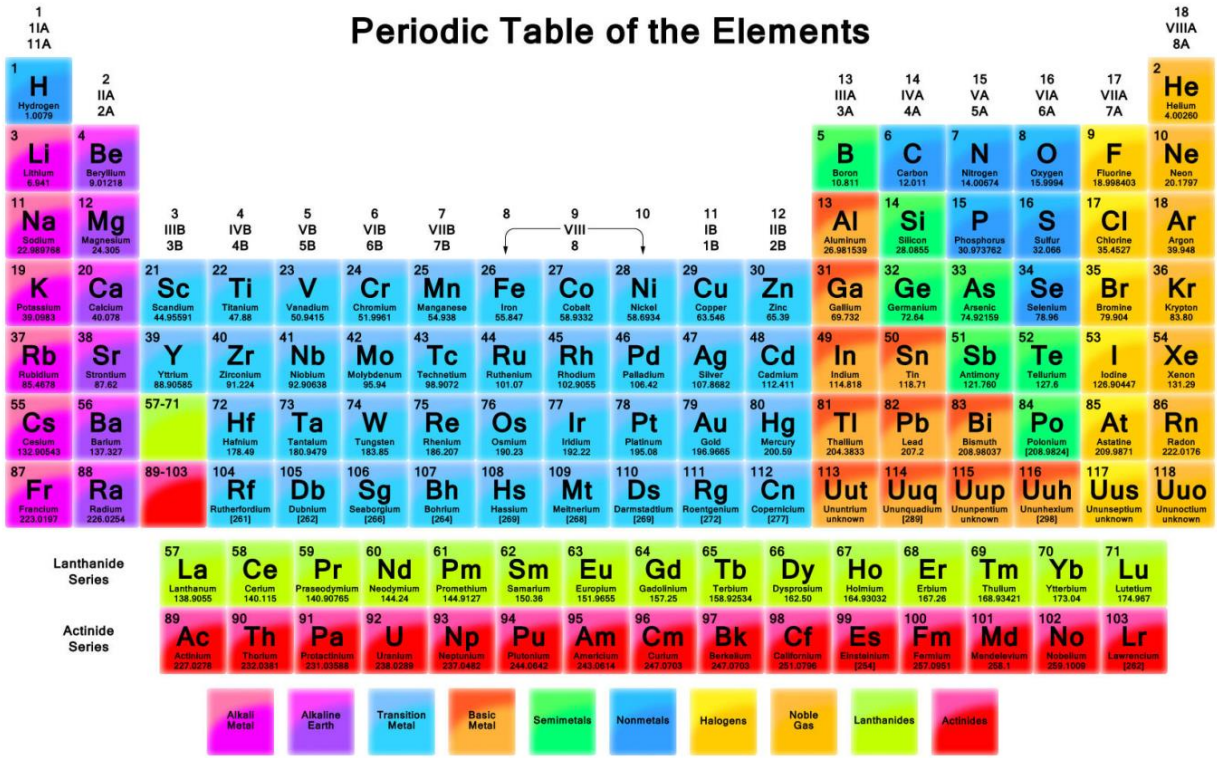
Credits: Max Brice/CERN

Malo fizike ☺ … ☹

CERN? …kolajderi

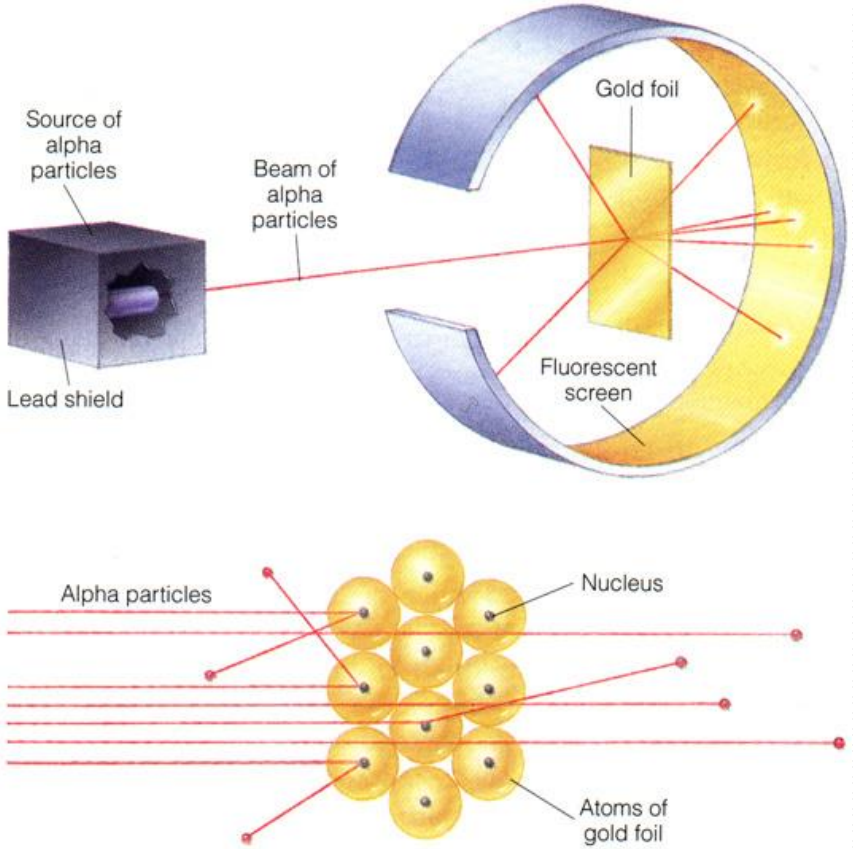
Malo hemije

- Dmitrij Ivanovič Mendeljejev (1834 - 1907)
- Periodni sistem – 1869. god.



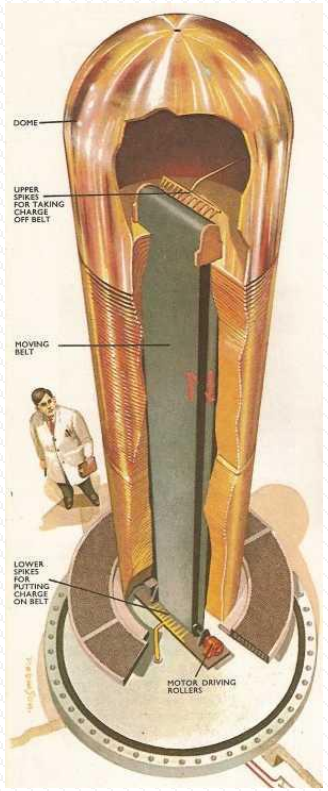
Atom i "atom"

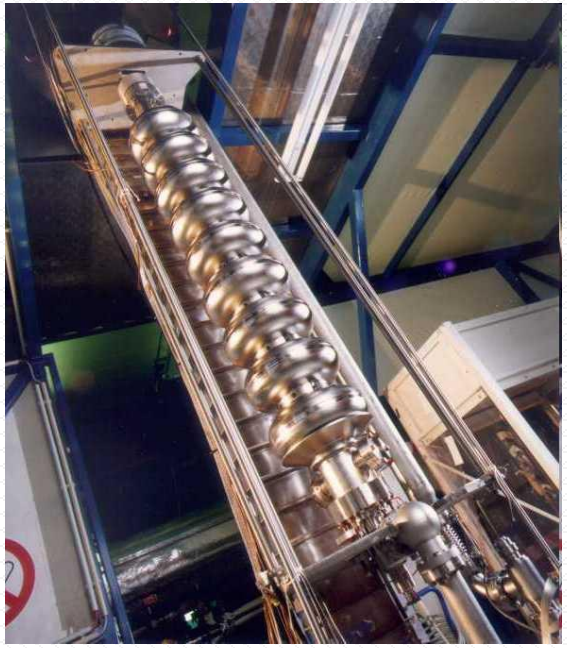
- Ernest Rutherford (1871-1937)

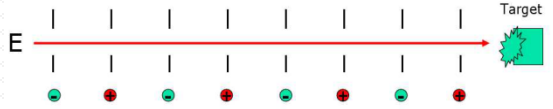


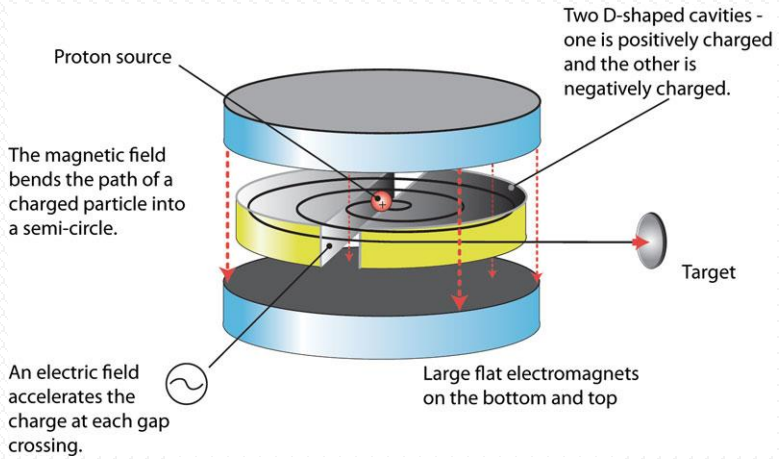
Akceleratori

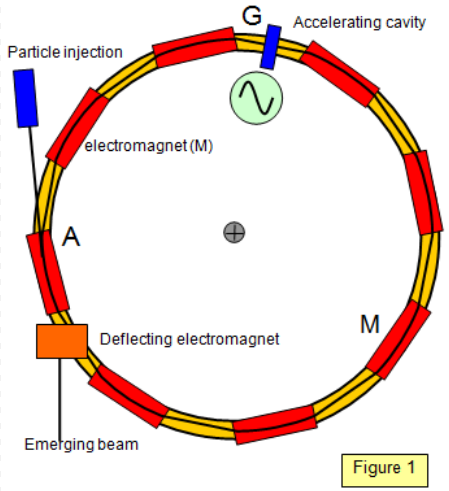
- Elektrostatički, linearni, ciklotroni, sinhrotroni...



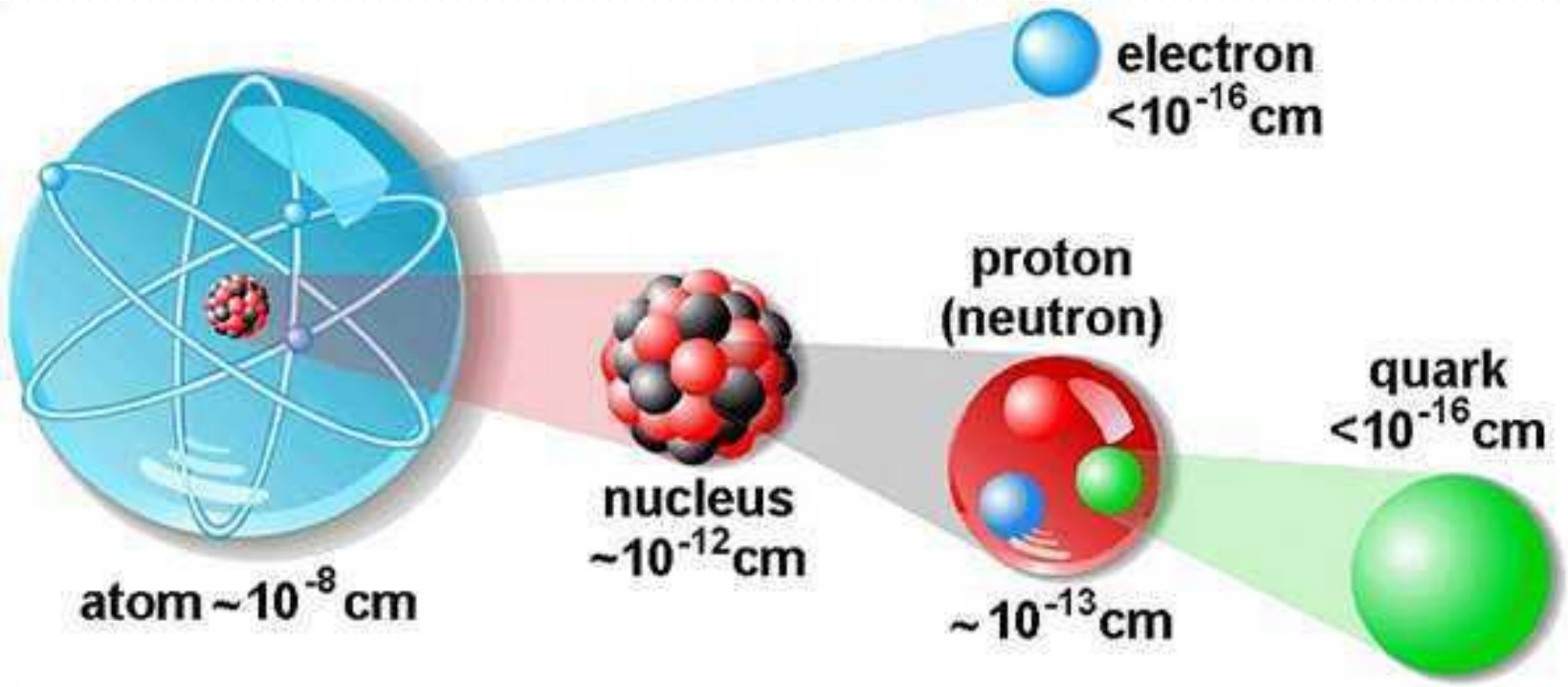




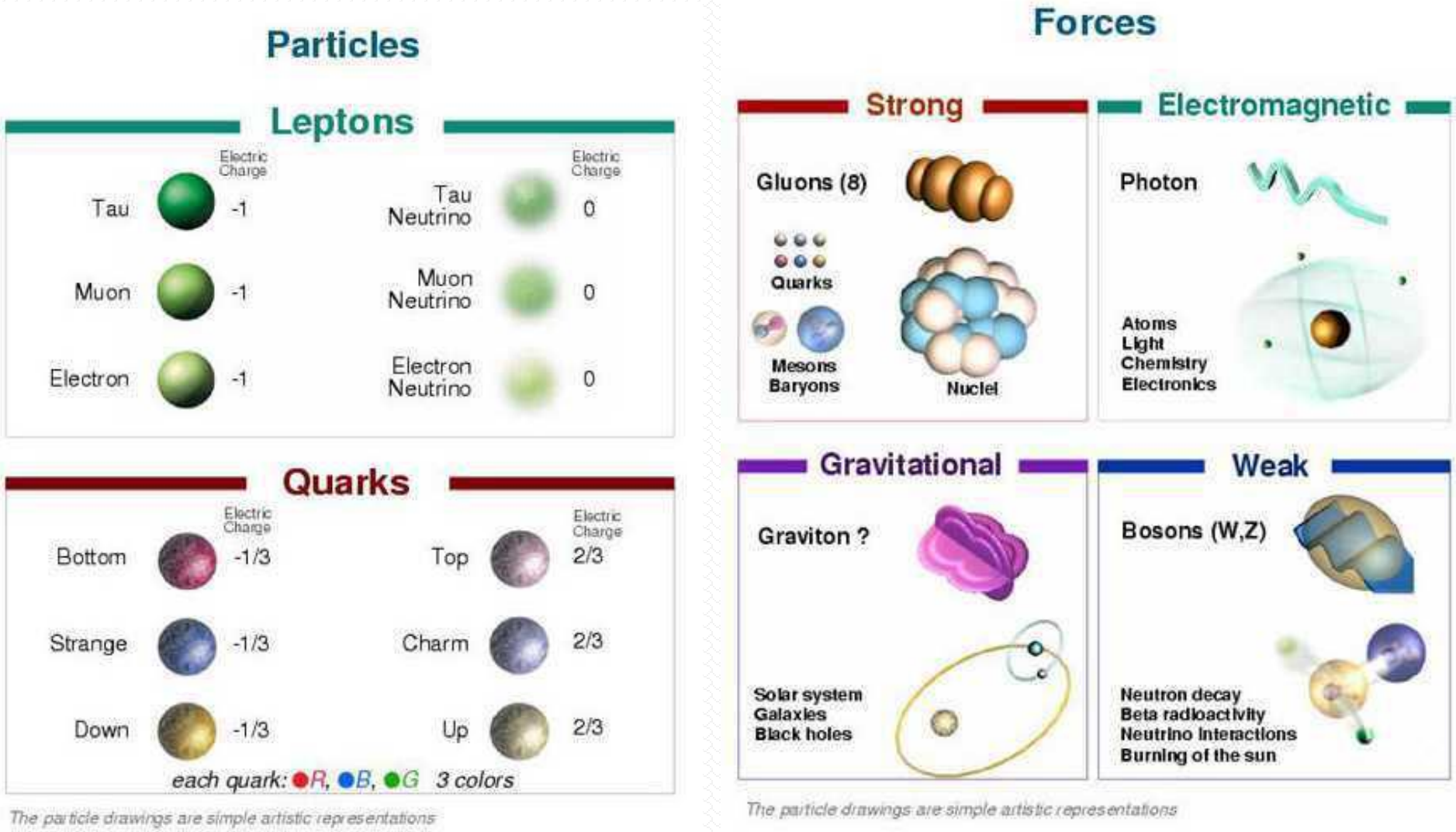


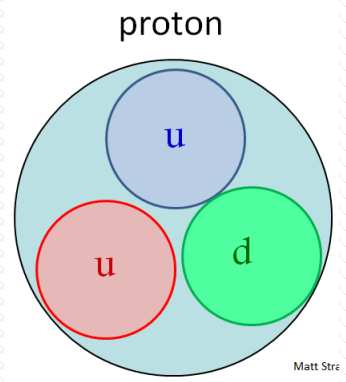


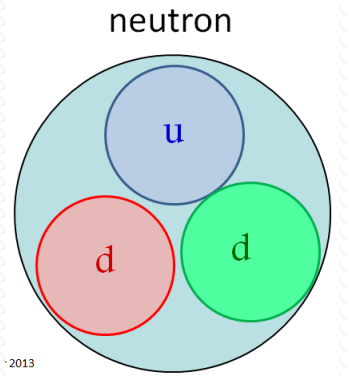
Struktura materije



Čestice i sile

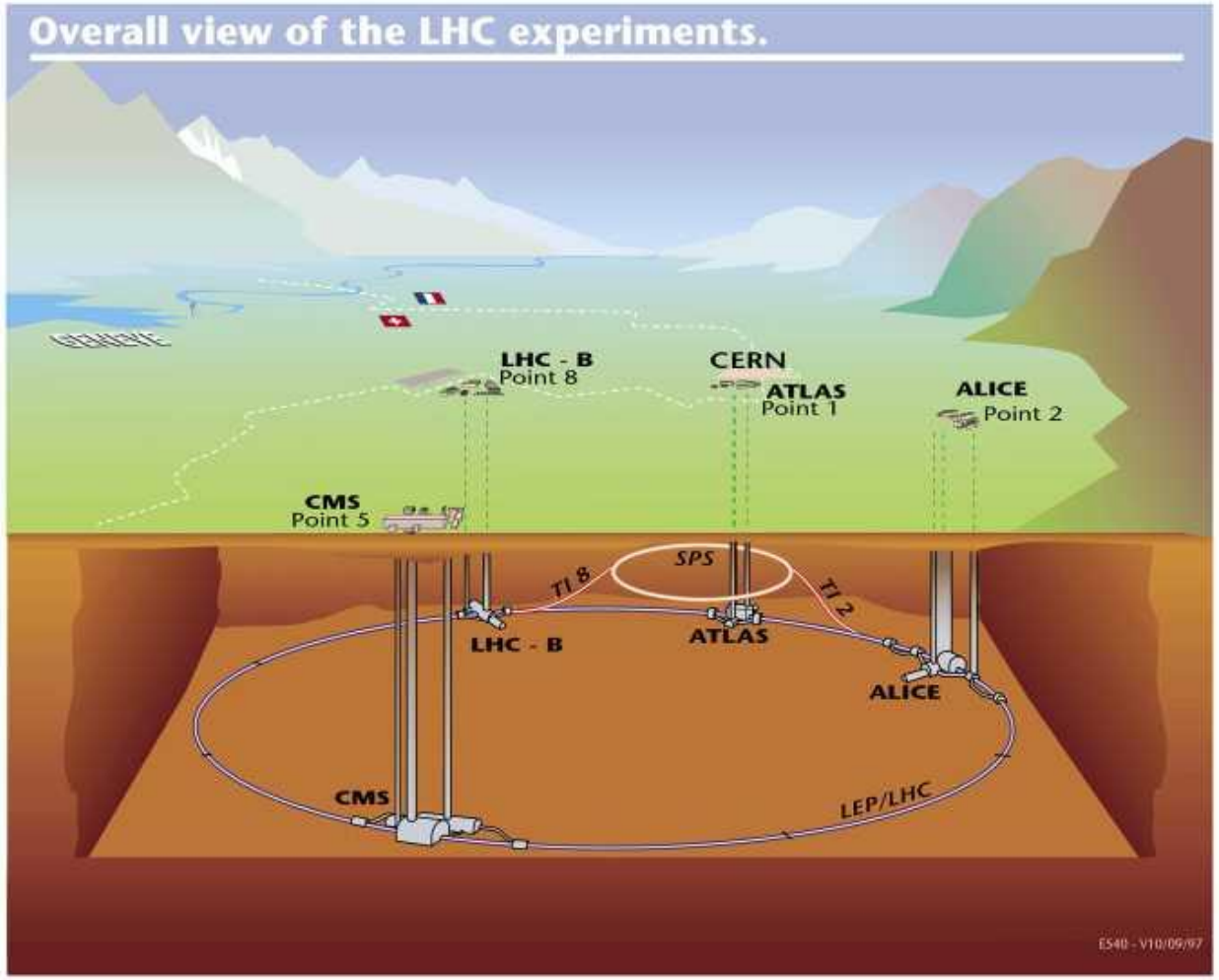






Ukratko o LHC

- Temperatura: 1.8K
- Dužina: 27 km
- 1300 magneta (~ 13 metara, ukupno 24 kilometara)
- Struja: 6500 – 9000 A
- Magnetno polje: 8.5 T
- Energija – max 14 TeV



Šta je TeV?

$1\ eV = 1.6 \times 10^{-19}\ J$

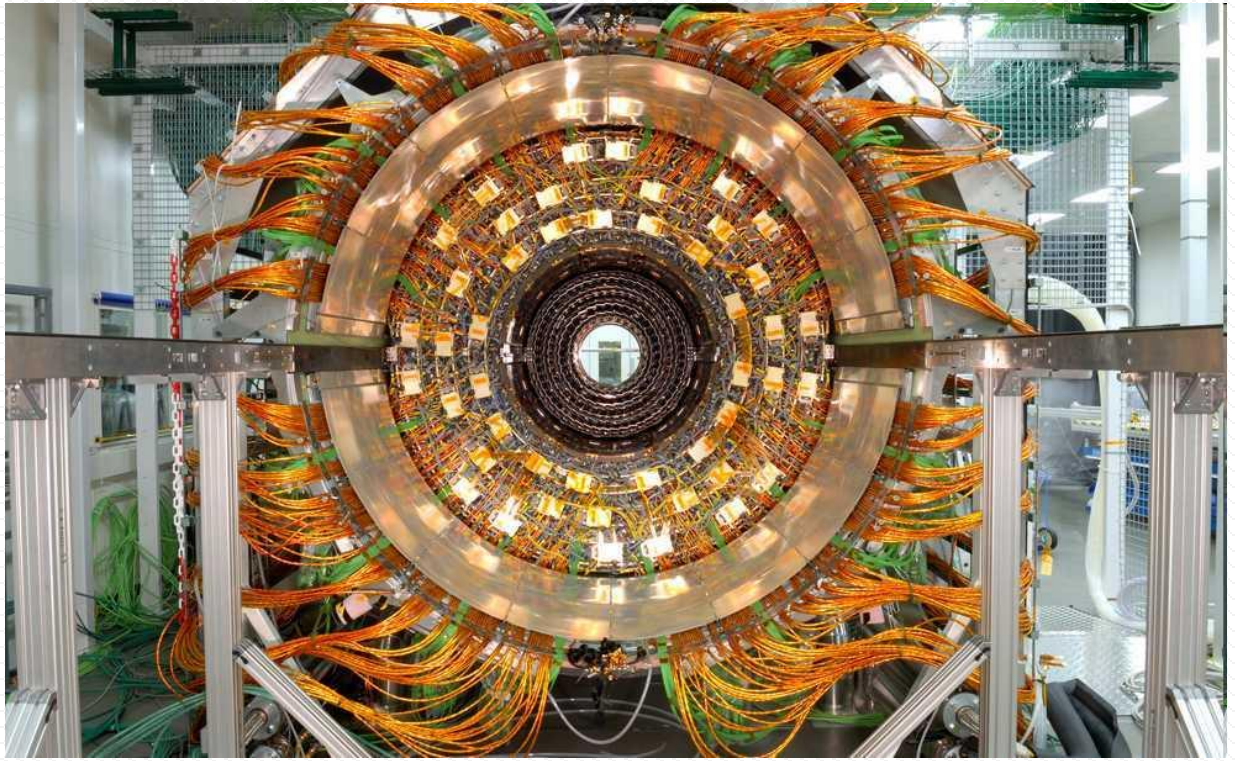
$1\ TeV = 1.6 \times 10^{-19} \times 10^{12}\ J$
$= 1.6 \times 10^{-7}\ J$

$1/2\ m\ v^2 = 1.6 \times 10^{-7}\ J,$

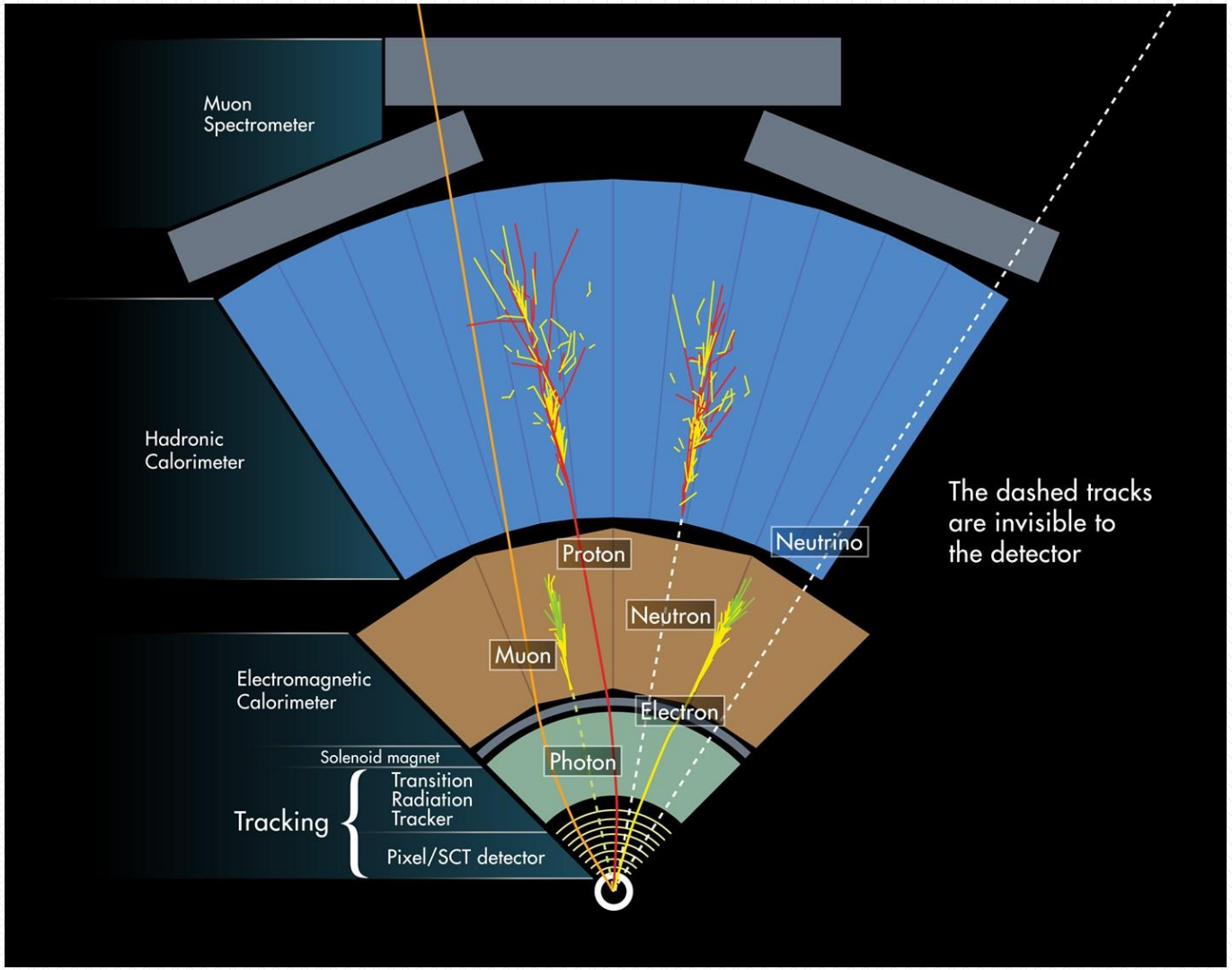
$m = 2 \times 10^{-6}\ kg$

$v = 0.4\ m/s = 1.4\ km/h$

Detektori – ATLAS i CMS

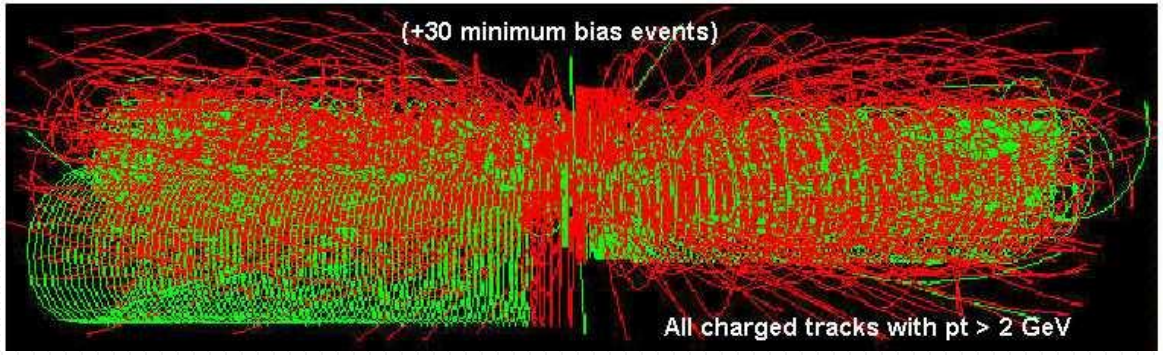


Detektovanje čestica

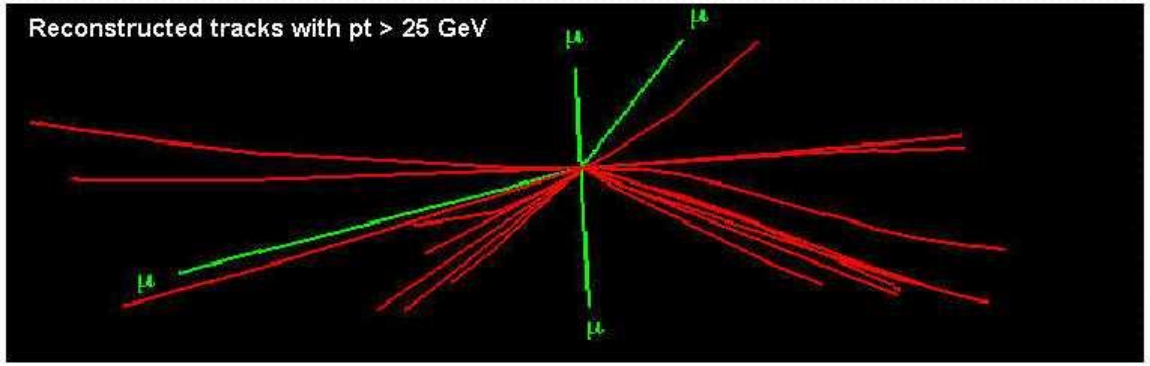


Mnogo podataka...

- U ovome:



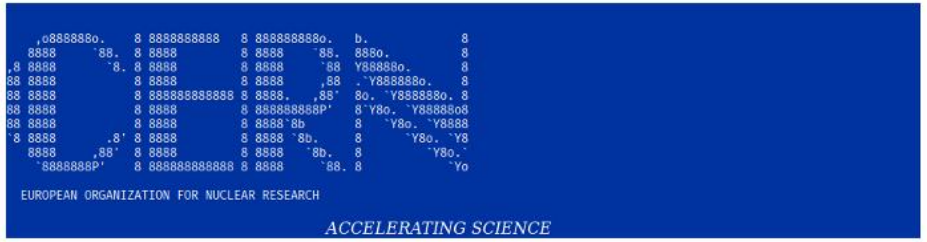
- Treba pronaći:



- Pretraga: 1 u 10^{13}
- Jedna osoba na 1000 „Zemlji“

CERN i internet

www.home.cern



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22 Mar '19 · A "muoscope" with CMS technology

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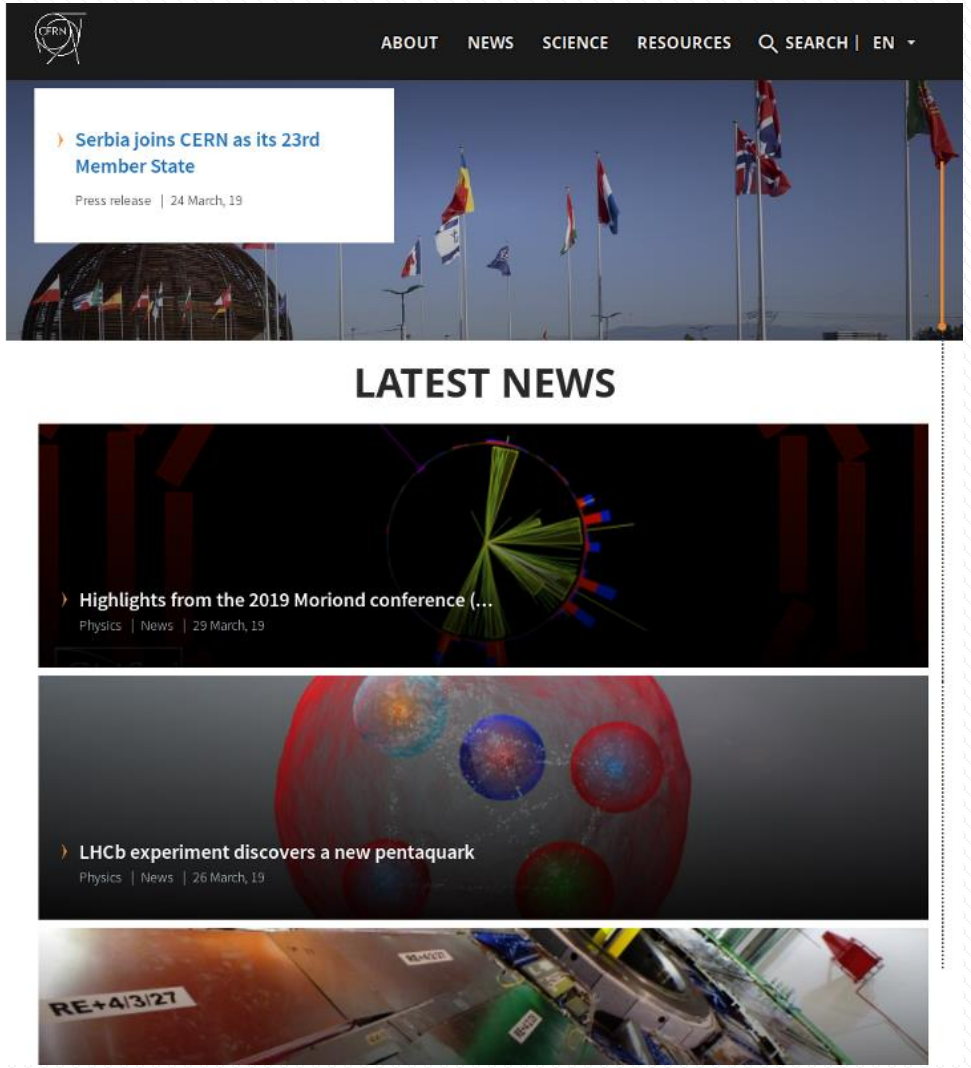
Knowledge from CERN to society

Upcoming Events

Open Days 2019 on 14–15 Sep '19



1. april 2019

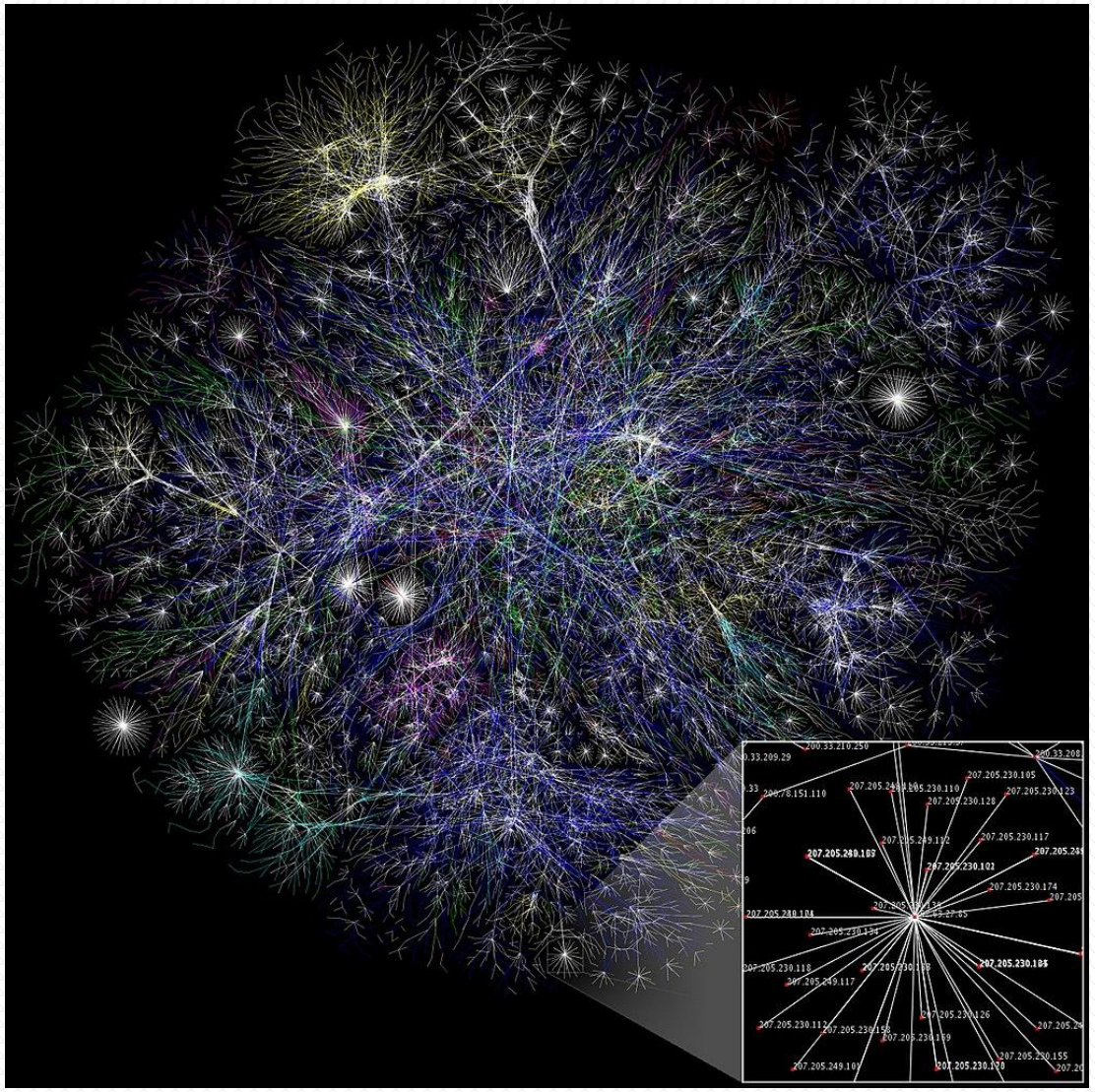
Svi ostali (normalni) dani ☺

Ipak, imaju veze ☺

12. mart 1989 – 12. mart 2019

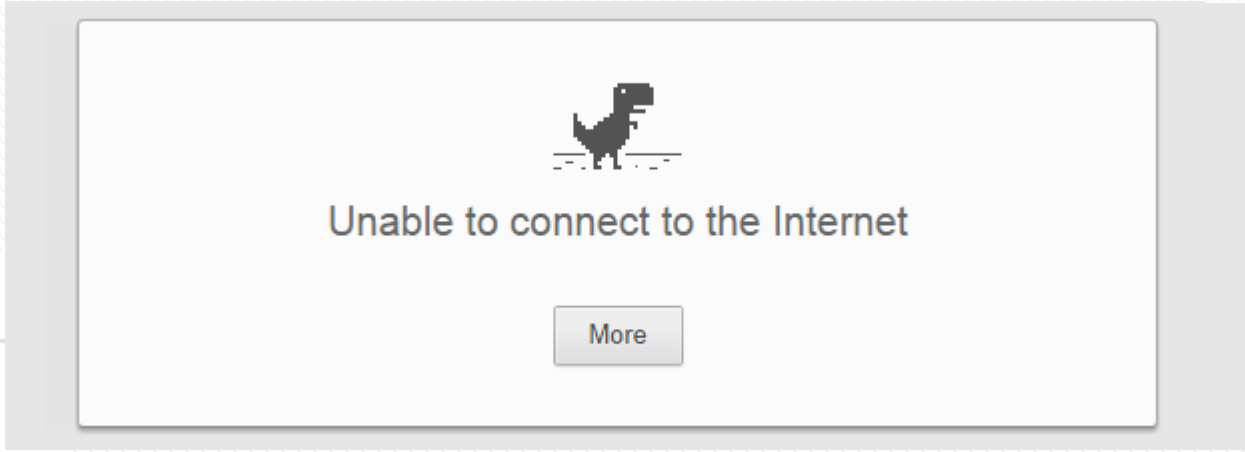
http://info.cern.ch/

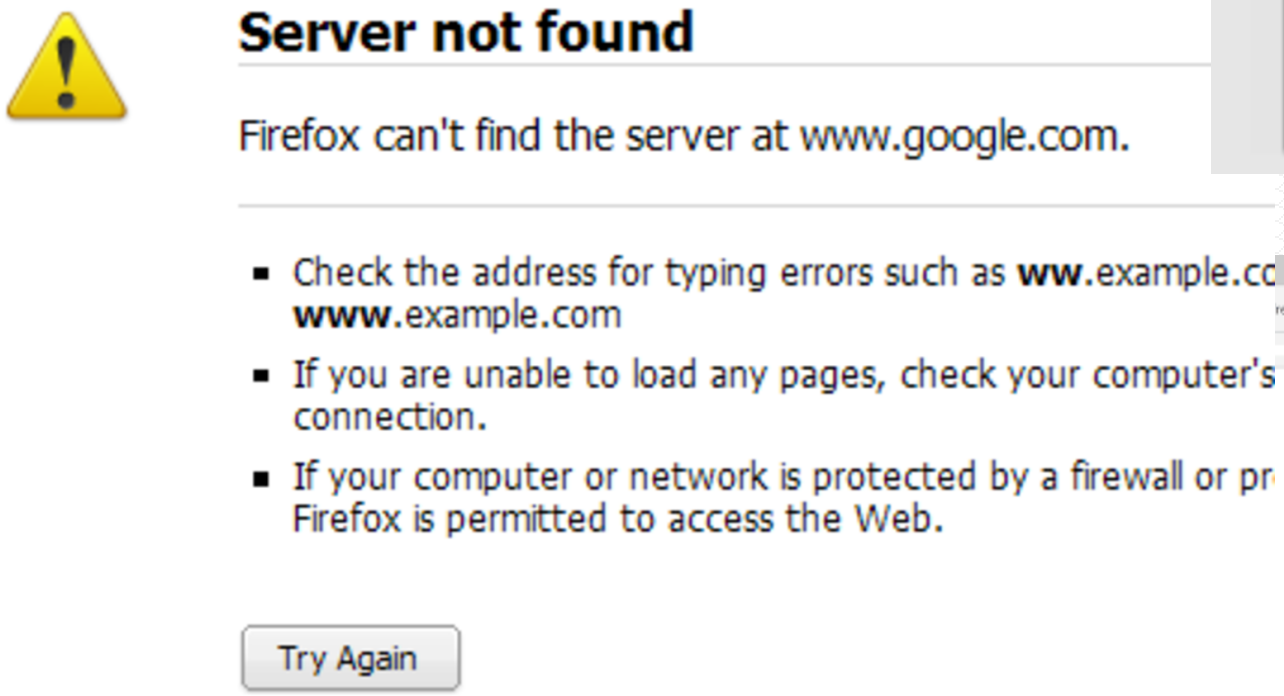
CERN, mesto gde je nastao „internet“?

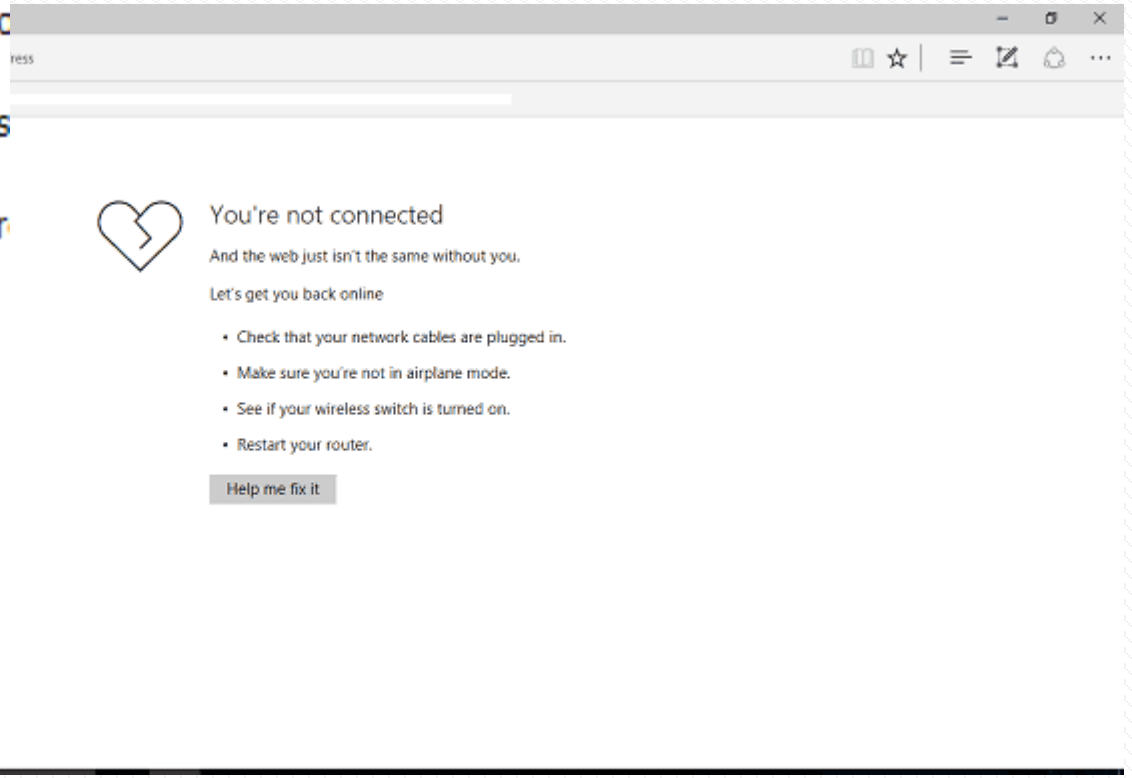


Deo „Puteva na internetu“
15. januar 2005, opte.org

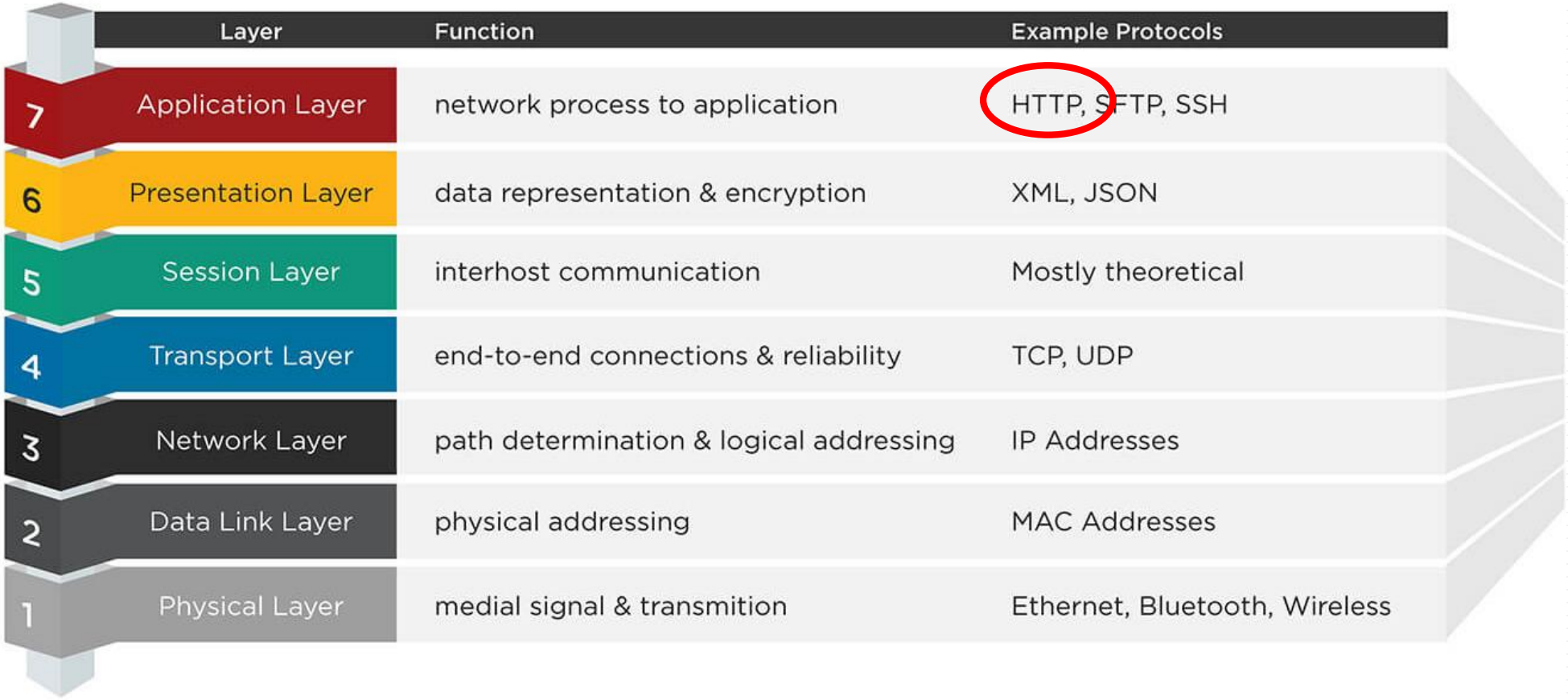
WWW nije internet!







OSI model



	Layer	Function	Example Protocols
7	Application Layer	network process to application	HTTP, SFTP, SSH
6	Presentation Layer	data representation & encryption	XML, JSON
5	Session Layer	interhost communication	Mostly theoretical
4	Transport Layer	end-to-end connections & reliability	TCP, UDP
3	Network Layer	path determination & logical addressing	IP Addresses
2	Data Link Layer	physical addressing	MAC Addresses
1	Physical Layer	medial signal & transmition	Ethernet, Bluetooth, Wireless

Wordfence™

wordfence.com/learn

Kako je nastao internet?

- Početak, 1950 – 1960. godina
- Veće institucije i univerziteti u SAD i Evropu imale svoje mreže
  - Često se javljala potreba za mrežama koje bi omogućile komunikaciju između različitih institucija
  - Svaka mreža funkcionisala je na specifičan način i komunikacija između dve mreže bila je teško izvodljiva ili potpuno nemoguća.
- **Robert Taylor**, direktor DARPA (*Defense Advanced Research Projects Agency*) bio je inicijator **prve mreže koja je povezala više institucija**

Kako je nastao internet?

- **Larry Roberts** (MIT) i **Robert Taylor** su uspostavili **prvi link** između Univerziteta Kalifornija (Los Anđeles) i Istraživačkog instituta Stanford
- Tako je nastao **ARPANET**, 29. oktobra 1969. godine
- Dupliranje čvorova, 5. decembar 1969. godine:
  - Univerzitet Juta
  - Univeritet Kalifornija (Santa Barbara)
- Brzina: 50 kbps
- Komunikacija između mreža bila je još uvek problem!
- **Vint Cerf** (Univerzitet Stanford) počeo je da radi (1973) na protokolu koji bi omogućio komunikaciju između različitih mreža

Kako je nastao **Internet**?

[Docs] [txt|pdf] [Tracker]

Obsoleted by: 7805 HISTORIC

Network Working Group — Vinton Cerf
Request for Comments: 675 — Yogen Dalal
NIC: 2 — Carl Sunshine
INWG: 72 — December 1974

SPECIFICATION OF INTERNET TRANSMISSION CONTROL PROGRAM

December 1974 Version

1. INTRODUCTION

This document describes the functions to be performed by the internetwork Transmission Control Program [TCP] and its interface to programs or users that require its services. Several basic assumptions are made about process to process communication and these are listed here without further justification. The interested reader is referred to [CEKA74, TOML74, BELS74, DALA74, SUNS74] for further discussion.

The authors would like to acknowledge the contributions of R. Tomlinson (three way handshake and Initial Sequence Number Selection), D. Belsnes, J. Burchfiel, M. Galland, R. Kahn, D. Lloyd, W. Plummer, and J. Postel all of whose good ideas and counsel have had a beneficial effect (we hope) on this protocol design. In the early phases of the design work, R. Metcalfe, A. McKenzie, H. Zimmerman, G. LeLann, and M. Elie were most helpful in explicating the various issues to be resolved. Of course, we remain responsible for the remaining errors and misstatements which no doubt lurk in the nooks and crannies of the text.

Processes are viewed as the active elements of all HOST computers in a network. Even terminals and files or other I/O media are viewed as communicating through the use of processes. Thus, all network communication is viewed as inter-process communication.

Since a process may need to distinguish among several communication streams between itself and another process [or processes], we imagine that each process may have a number of PORTs through which it communicates with the ports of other processes.

Since port names are selected independently by each operating system, TCP, or user, they may not be unique. To provide for unique names at each TCP, we concatenate a NETWORK identifier, and a TCP identifier with a port name to create a SOCKET name which will be unique throughout all networks connected together.

Cerf, Dalal & Sunshine [Page 1]

Reč **„Internet“, prvi put 1974**. godine, u specifikaciji TCP protokola (RFC675)

Kako je nastao internet?

- Razvoj protokola: krajem 1978 – konačna forma i naziv TCP/IP
- Do 1981. godine
  - Konačna forma TCP/IP protokola (RFC791, 792 i 793)
  - ARPANET - **213 čvorova** na mreži
  - Brzina nepromenjena, dodata komunikacija preko satelita i radio veza
- DARPA je počela da finansira i podstiče sve korisnike ARPANET-a da svoje sisteme prilagode TCP/IP protokolu.
- Od 1. januara 1983. godine **TCP/IP** u potpunosti je **potisnuo prethodni NCP protokol** i tako je postao jedini protokol čija je upotreba bila dozvoljena na ARPANET-u.

Kako je nastao internet?

NORSAR TIP

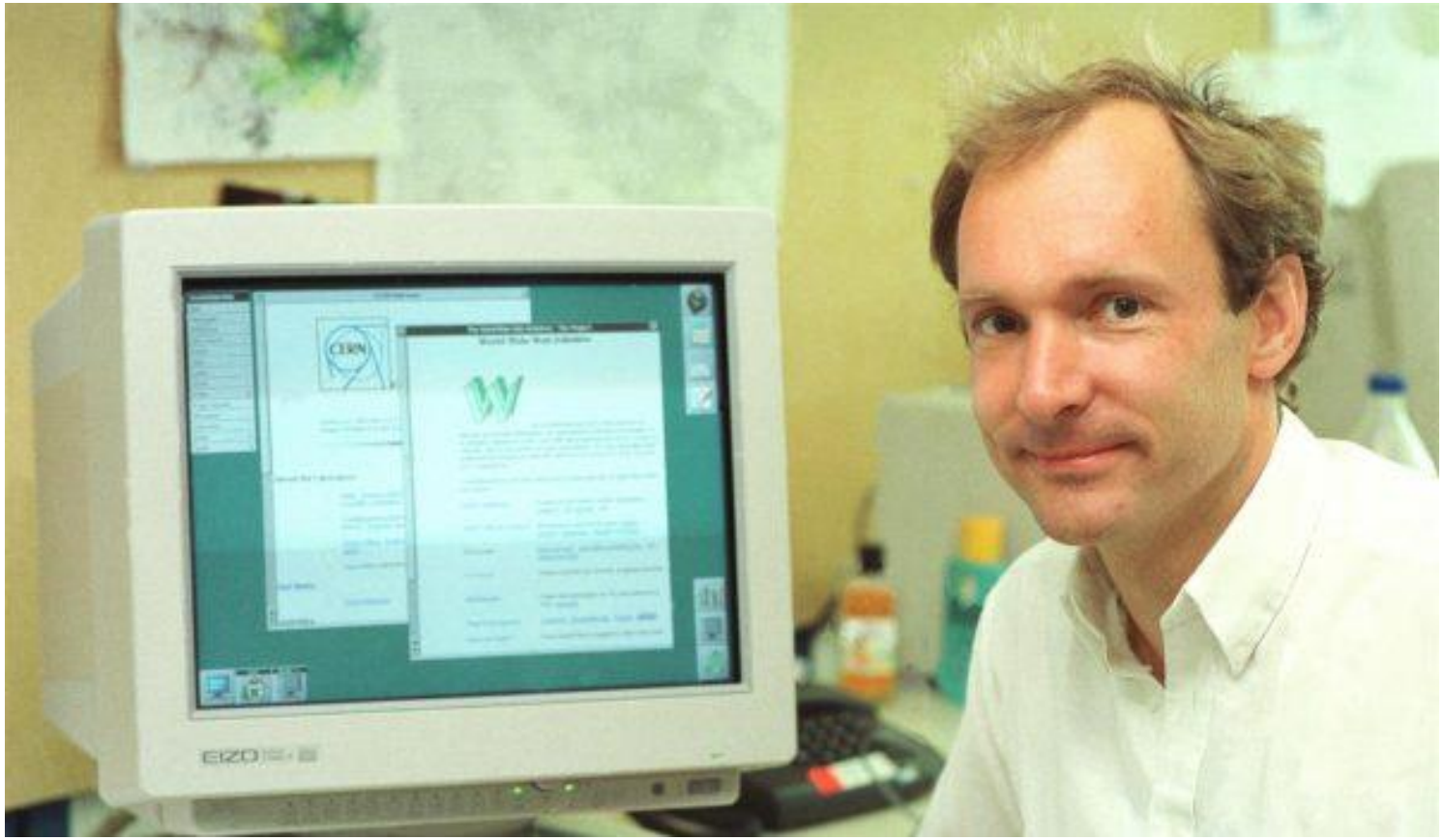
- Iste godine (1983) na **Univerzitetu Wisconsin** napravljen je **prvi DNS** (*Domain Name System*) što je omogućilo da se prilikom **komunikacije sa računarima koriste imena,** a ne IP adrese (brojevi).
- Za to vreme **u Evropi**
  - Paralelno sa razvojem ARPANET-a
  - Projekat je razvijala Norveška seizmička mreža (NORSAR).
  - **Juna 1973.** godine **NORSAR** postao je **prvi čvor ARPANET-a van SAD**.
  - U istom periodu Pošta Velike Britanije, Wester Union i Tymnet rade na svojoj mreži.
  - Za razliku od ARPANET-a Evropska mreža nije bila namenjena samo korisnicima sa univerziteta (vojska SAD koristila je sličnu mrežu MILNET) već i **za poslovnu upotrebu.**

TCP/IP u Evropi

- NORSAR - dva IBM računara povezana na ARPANET
- Prihvatanje TCP/IP protokola išlo sporije
- **CERN** - prihvatio i implementirao TCP/IP protokola unutar svoje mreže u periodu 1984 – 1989. godina
  - Mreža izolovana, tj. „nije bila na internetu“
- Kraj 1989. godine - **CERN otvorio “vrata” svoje mreže** ka Internetu krenulo je i masovno prihvatanje TCP/IP protokola širom Evrope, a nešto kasnije i sveta
- Ulaskom u poslednju deceniju XX veka sve mreže na planeti polako su postajale deo Interneta, “mreže svih mreža”.

Kako je tada izgledao internet?

- Otprilike **kao prethodnih nekoliko slajdova** ☺
  - Tekst, tekst, tekst…. i još teksta, u najboljem slučaju
- Korišćeni su servisi od kojih su mnogi nepoznati većini današnjih korisnika: **POP3/SMTP**, **FTP**, **gopher**, **telnet** itd.
- Nije bilo **ni traga** od slika, boja, grafike.
- Sve se dešavalo u komandnoj liniji
- Nije bilo ničega što bi bar malo ličilo na sadržaj današnjih sajtova, na poznate adrese koje počinju sa www….
- **Internet je nastao, a to WWW je tek trebalo da bude stvoreno.**



Kako je nastala „Mreža“? (Web)

- CERN, fizika čestica → neophodna razmena ogromne količine podataka
  - Brojke, slova, fotografije, grafikona, tekstovi, povezani podaci itd.
- Par godina pre definisanja TCP/IP protokola
  - Tim Berners-Lee - radio je na projektu koji bi omogućio **jednostavniju i bržu razmenu informacja** između naučnika angažovanih u oblasti fizike elementarnih čestica.
- Projekat ENQUIRE (1980)
  - Preteča World Wide Web-a
  - Nije bio namenjen javnoj upotrebi
  - Više je ličio na „Wiki“ nego na druge sajtove
  - Za skladištenje podataka koristio je **baze podataka** a tokom čitanja bilo je moguće i menjati sadržaj stranica
  - Preteča današnjih linkova
  - Napisan u programskom jeziku Pascal, a pokretala ga je Norsk Data mašina.

Računar?

- … na kome je napisan **ENQUIRE**
- Na slici - tipičan Norsk Data računar treće generacije ND-500 (1981)
- 32 bitni superminikompjuter, do 4 CPU sa deljenom memorijom
- Ali… ENQUIRE je napisan na NORD-10 računaru (1973)

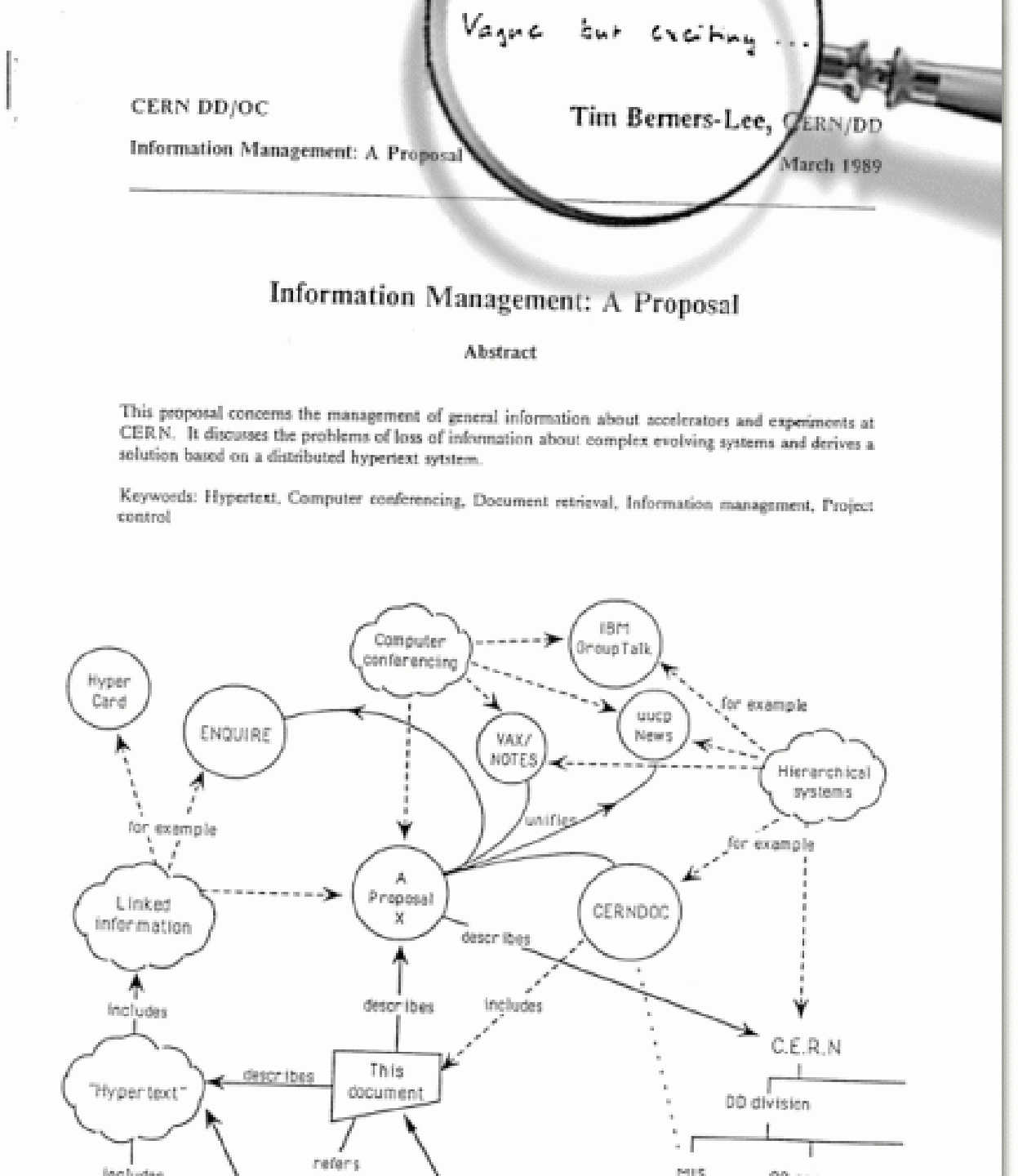
NORD-10

- 16 bitni računar, srednje veličine
- CPU – 24 štampane ploče ☺
- Memorija – moduli od po 8 K
  - 19“ ormari – maksimum 8 modula
  - Maksimum memorije 256 K
- Multitasking OS: SINTRAN III
- Software: FORTRAN IV, BASIC, Assembler, Pascal, itd

Web@30

- Ubrzo nakon pokretanja ENQUIRE projekta (1981) ugovor **Tim Berners-Lee** sa CERN-om ističe i on **napušta CERN**.
- Naredne tri godine radio je na drugom mestu, a onda se **1984.** godine **vraća u CERN** gde dobija stalan posao.

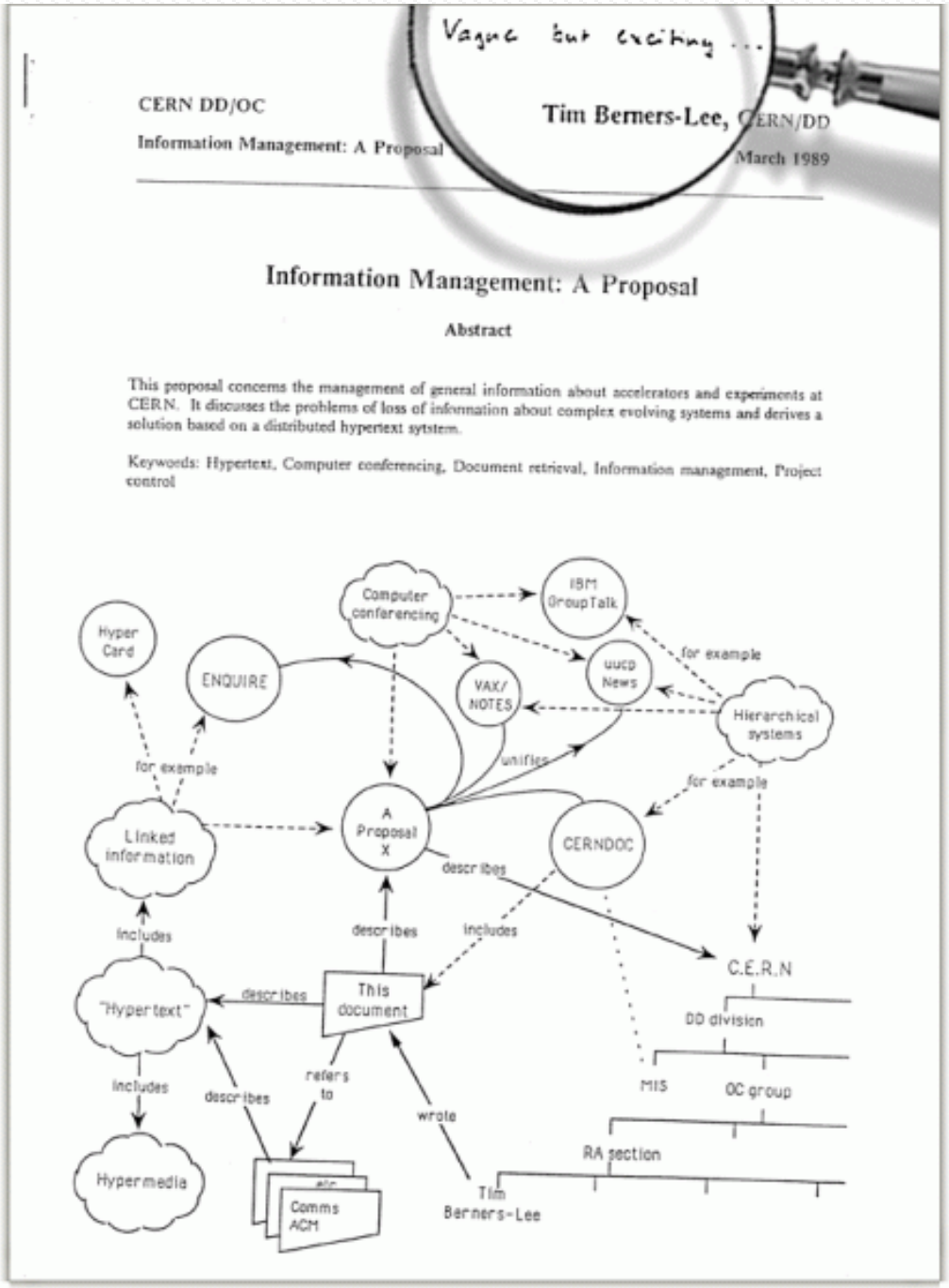
- **12. marta 1989**. godine, **Tim Berners-Lee** i **Robert Cailliau** (CERN), nezavisno jedan od drugog, upućuju **predlog projekta novog hypertext sistema** slične funkcionalnosti kao ENQUIRE.



„Vague, but exciting“

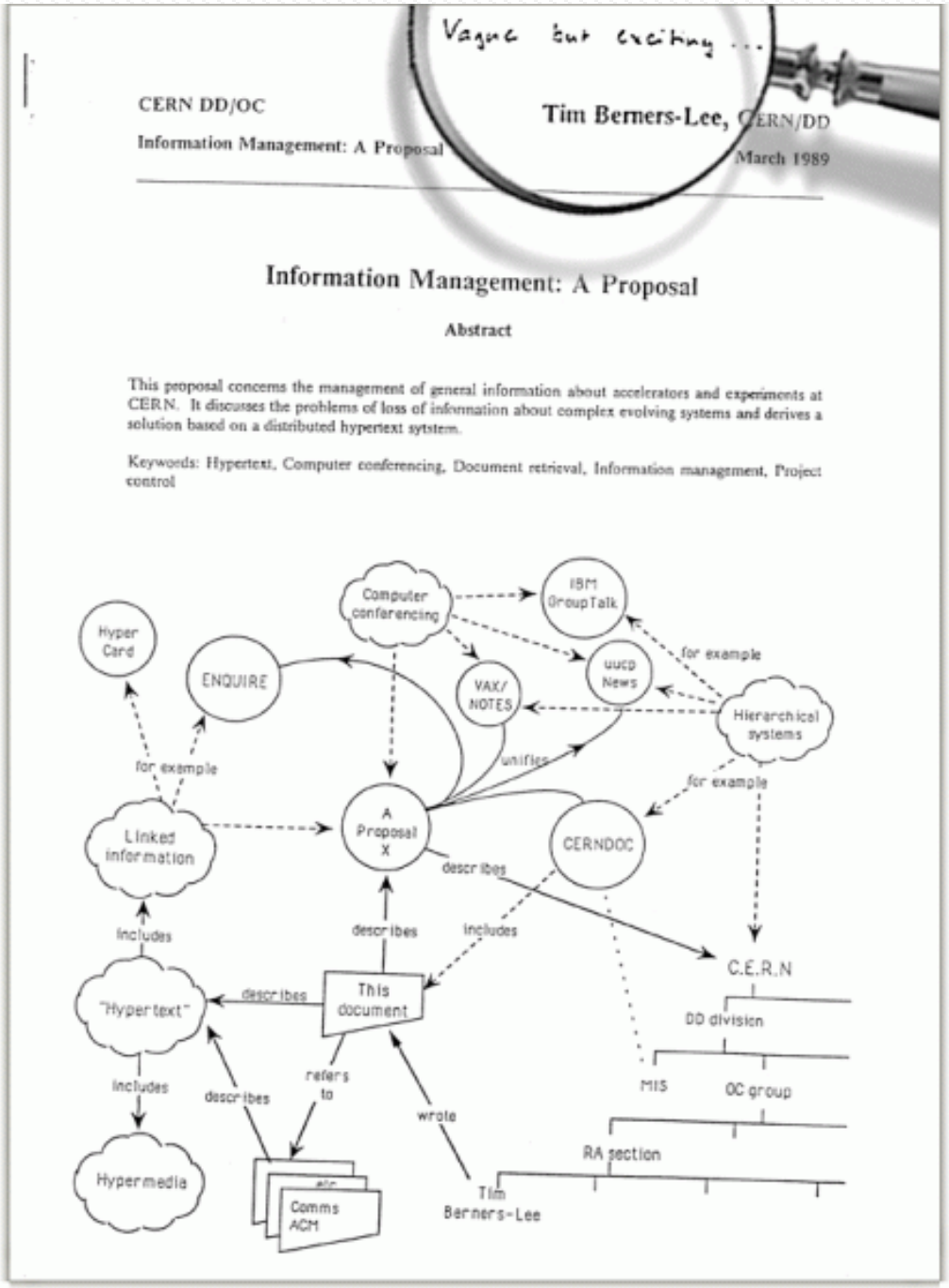
- „Nejasno, ali uzbudljivo“
- Prvi opis predloga, stigao kao odgovor 30. marta
- Originalni predlog
  - www.w3.org/History/1989/proposal.html

- Od „gomile izgubljenih podataka“ do današnjeg „Interneta“…



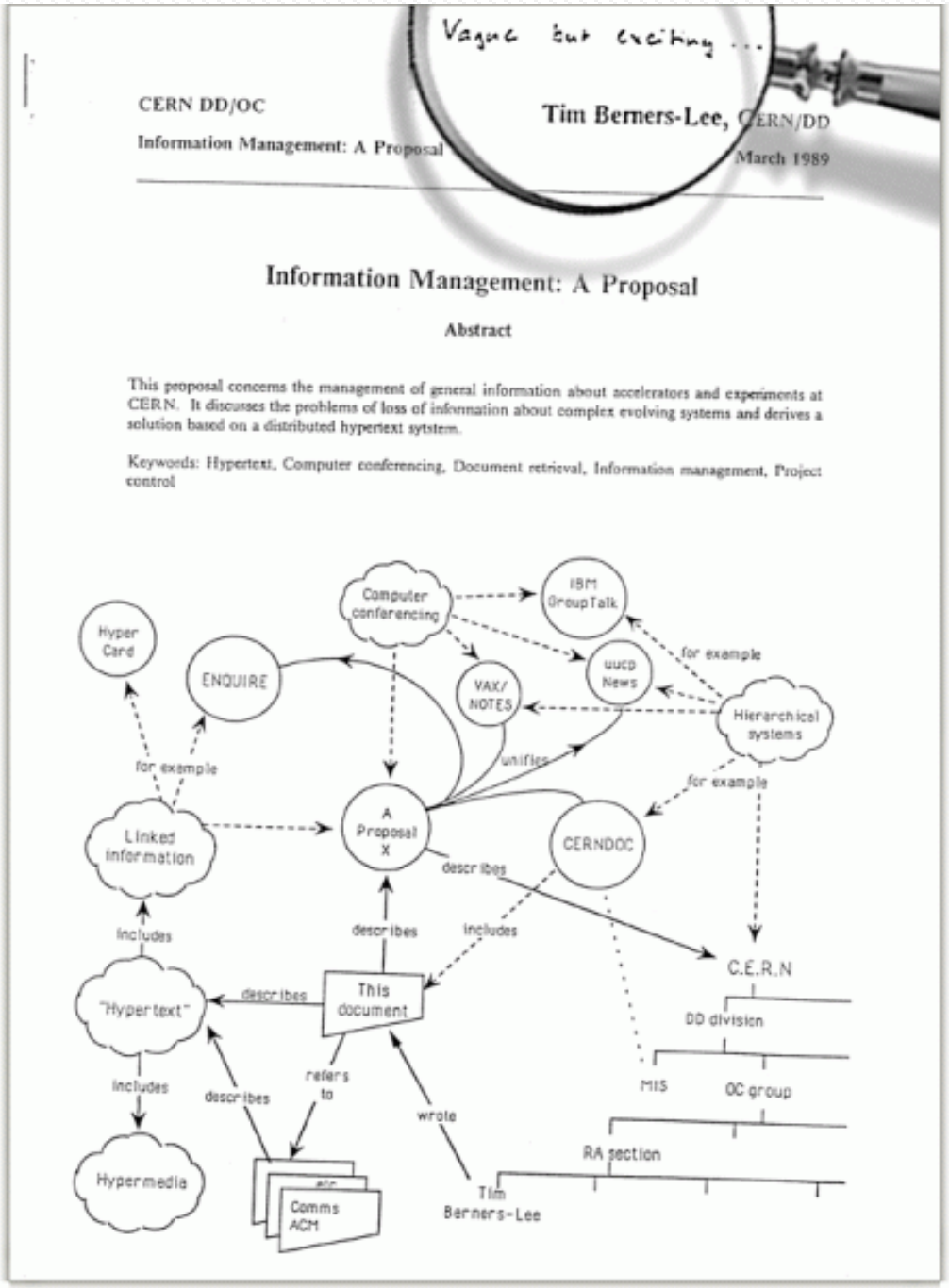
„Nejasno, ali uzbudljivo

- CERN bio i ostao **ogromna institucija**.
- Broj onih koji u CERN-u stalno rade nije tako veliki, ali **ogroman je broj ljudi koji stalno posećuju CERN**, tamo provedu neko vreme i onda putuju nazad u svoje matične institute ili fakultete.
- Veliki broj ljudi koji rade zajedno rade neki posao sa sobom nosi i **određene probleme**
  - kako organizovati podatke o gostima
  - kako organizovati dokumentaciju
  - kako beležiti ko je šta i kada radio
  - saznati koje laboratorije rade na kojim projektima
  - koji sistemi zavise od nekog uređaja
  - gde se šta nalazi, gde šta ide, kome šta pripada…
- Mnogo pitanja i mnogo informacija koje je trebalo čuvati, organizovati i… od kojih su se neke **stalno gubile i nestajale.**



„Nejasno, ali ubudljivo“

- Upravo tu, u mnoštvu naizgled nepovezanih informacija i podataka Tim Berners-Lee našao je logiku i vezu.
- Predlog je uveo mnoge simbole:
  - **Dijagrami** su označavali hijerarhiju podataka
  - **Čvorovi:** ljude, softver, module, zadatke
  - **Strelice:** relacije – “roditelje”, pravce kretanja, zavisnost, obaveze, izveštaje.
- Povezao različite vrste i baze podataka.
  - Povezao je ljude, projekte, softver, grupe ljudi, ideje, dokumente, tipove hardvera, specifične objekte…
- Sve to je povezao “vezama” – **hiperlinkovima**, koji su se nalazili u različitim dokumentima.
- Dokumenti, osim teksta i hiperlinkova, mogli su da sadrže i slike – **multimediju**.



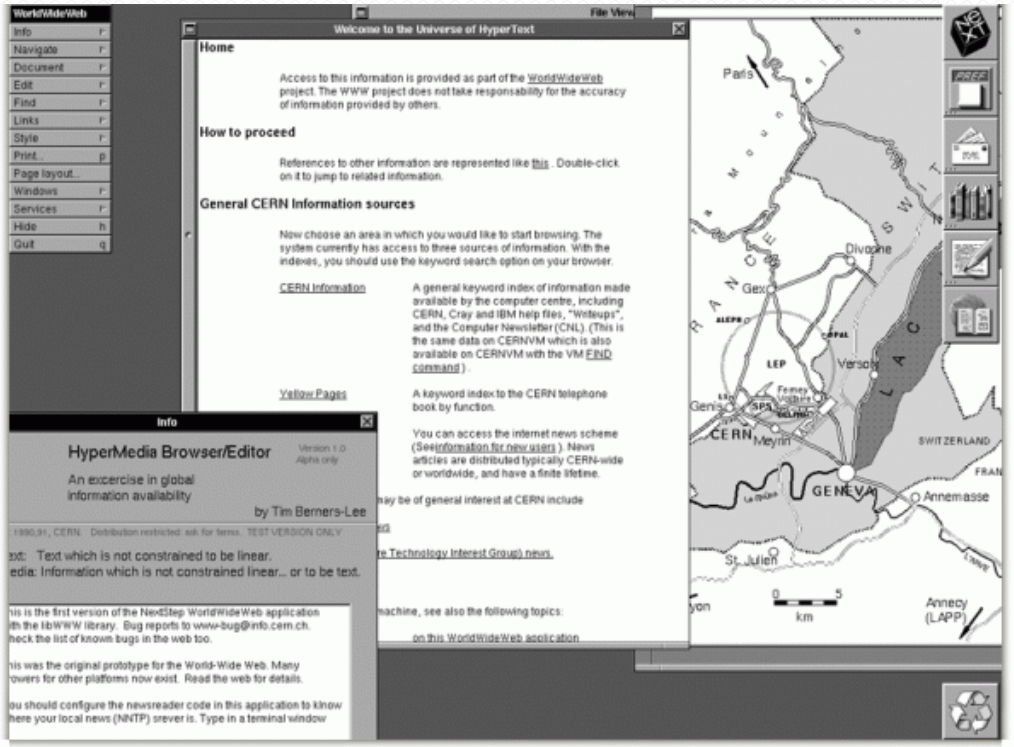
„Where the Web was Born“

- CERN - mesto gde je rođen World Wide Web
- Prvi Internet sajt nalazio se na adresi http://info.cern.ch/
  - Prvi IP: 128.141.201.74
- Prva verzija sajta nije sačuvana, ali kopija istog sajta iz 1992. godine nalazi se na istoj adresi!

Browser

- Prvi browser 1990, Tim Berners-Lee
- Radio na „superračunarima“

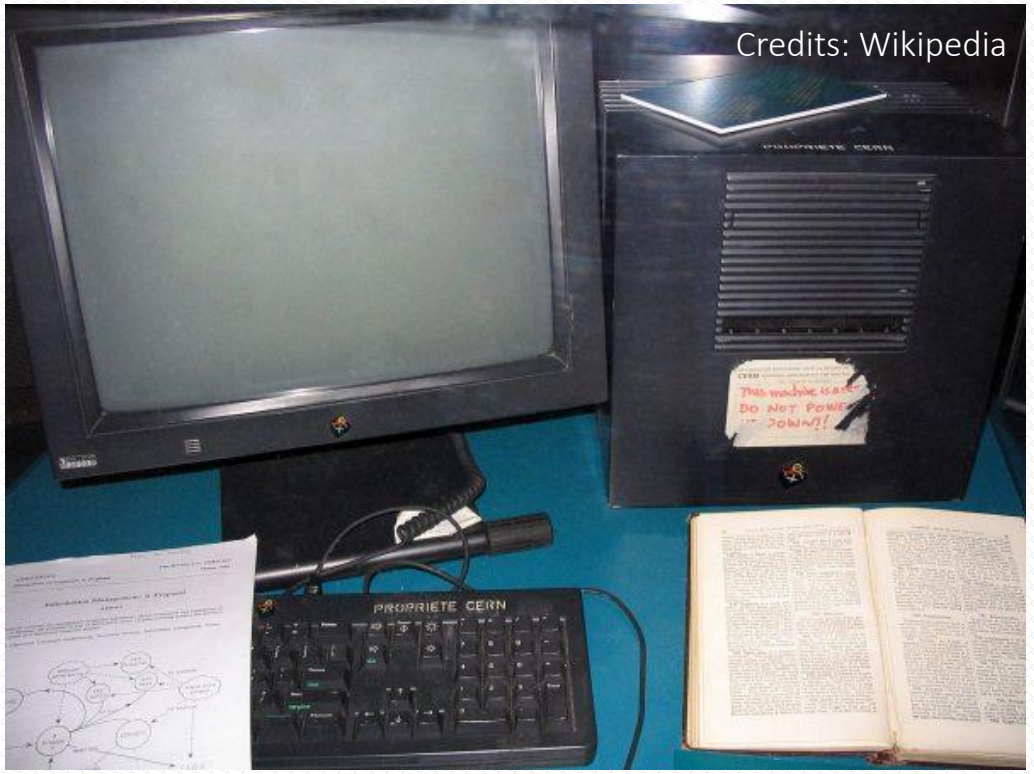
- „Linijski“ browser 1991. godina
- Radio na „običnim“ računarima tog vremena
- Demo verzija
  - http://line-mode.cern.ch/www/hypertext/WWW/TheProject.html



http://line-mode.cern.ch/

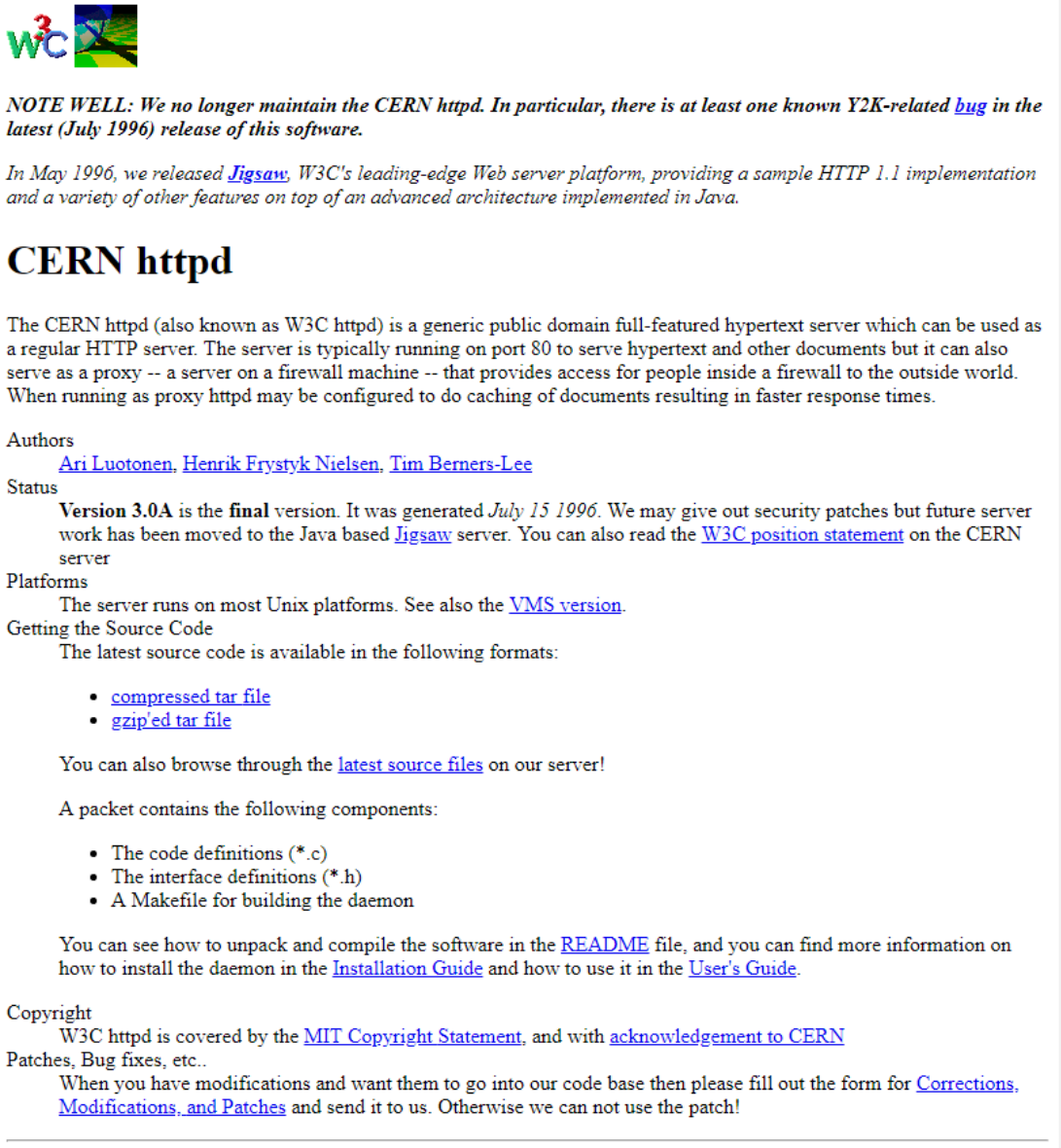
Server

- NeXTcube – prva dva web servera
- Karakteristike:
  - Ekran: 1120×832, 17“ grayscale
  - OS: NeXTstep 2.2 ili noviji
  - CPU: 25 MHz, 68040 with integrated floating-point unit
  - RAM: 16 MB, proširivo do 64 MB
  - HDD: 400 MB, 1.4GB ili 2.8GB SCSI



CERN httpd

- Prvi web server **CERN httpd**
  - u CERN biblioteci od 1991
  - U upotrebi do 1996. godine
  - Web browser, Alati za dalji razvoj
- 1992 - počeo je da radi prvi web server u SAD. Korisnici su opet bili naučnici, fizičari elementranih čestica, a server je bio smešten u Linearnom akceleratoru Stanford (SLAC), Kalifornija.
- CERN je **1993.** godine **softver** za korišćenje World Wide Web-a ustupio u **javno vlasništvo**.
- Nakon toga World Wide Web i Internet nastavili su da se **šire ogromnom brzinom** i dolaze prvo na računare a zatim na telefone i ostale uređaje.
- Godine **1994**. na Internetu se nalazilo oko **10000 web servera** i bilo je **10 miliona korisnika**.
- Tako je sve počelo a stiglo je do... to već znate i vidite sami. **Malo je onih koji danas mogu da zamisle jedan dan bez World Wide Web-a.**



NOTE WELL: We no longer maintain the CERN httpd. In particular, there is at least one known Y2K-related bug in the latest (July 1996) release of this software.

In May 1996, we released Jigsaw, W3C's leading-edge Web server platform, providing a sample HTTP 1.1 implementation and a variety of other features on top of an advanced architecture implemented in Java.

CERN httpd

The CERN httpd (also known as W3C httpd) is a generic public domain full-featured hypertext server which can be used as a regular HTTP server. The server is typically running on port 80 to serve hypertext and other documents but it can also serve as a proxy -- a server on a firewall machine -- that provides access for people inside a firewall to the outside world. When running as proxy httpd may be configured to do caching of documents resulting in faster response times.

Authors
Ari Luotonen, Henrik Frystyk Nielsen, Tim Berners-Lee

Status
Version 3.0A is the **final** version. It was generated *July 15 1996*. We may give out security patches but future server work has been moved to the Java based Jigsaw server. You can also read the W3C position statement on the CERN server

Platforms
The server runs on most Unix platforms. See also the VMS version.

Getting the Source Code
The latest source code is available in the following formats:

- compressed tar file
- gzip'ed tar file

You can also browse through the latest source files on our server!

A packet contains the following components:

- The code definitions (*.c)
- The interface definitions (*.h)
- A Makefile for building the daemon

You can see how to unpack and compile the software in the README file, and you can find more information on how to install the daemon in the Installation Guide and how to use it in the User's Guide.

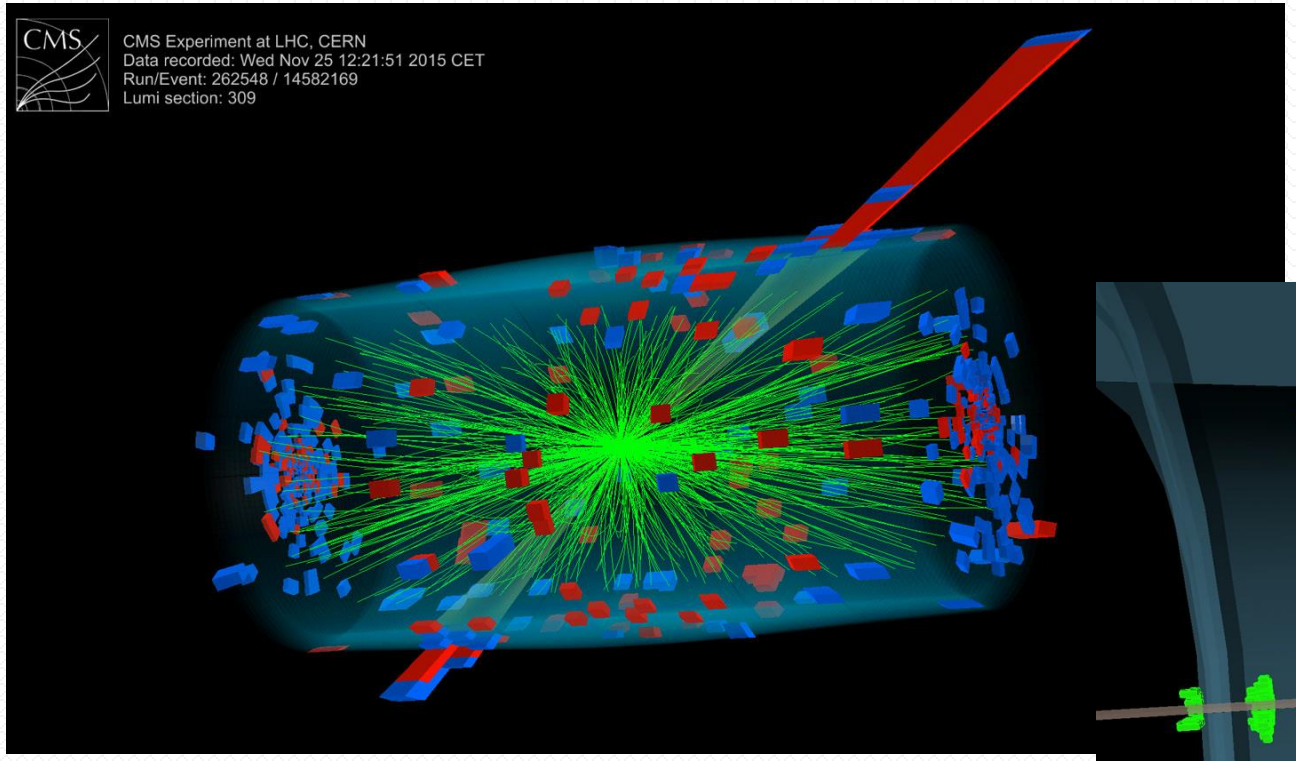
Copyright
W3C httpd is covered by the MIT Copyright Statement, and with acknowledgement to CERN

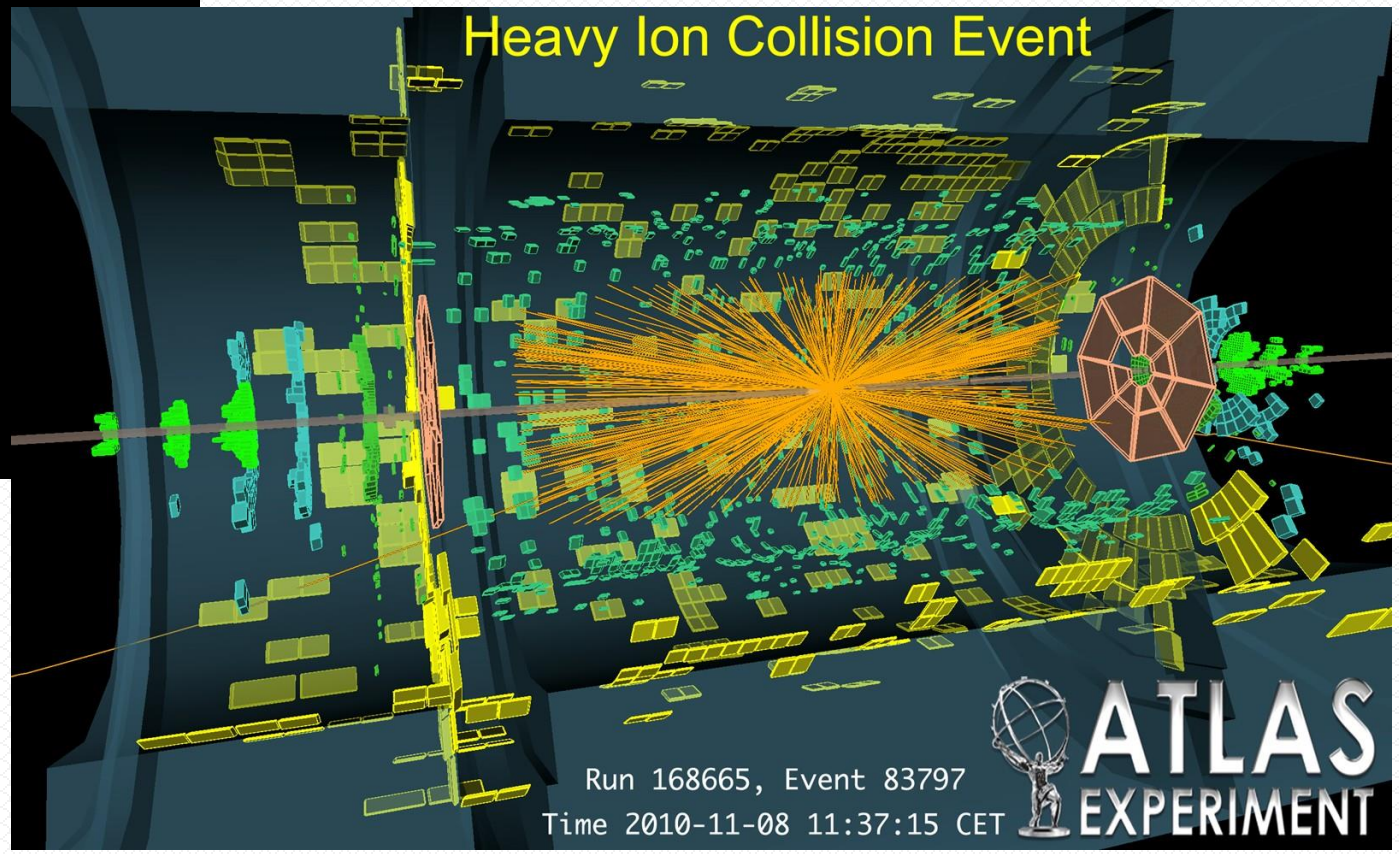
Patches, Bug fixes, etc..
When you have modifications and want them to go into our code base then please fill out the form for Corrections, Modifications, and Patches and send it to us. Otherwise we can not use the patch!

https://www.w3.org/Daemon/Overview.html

Internet u CERN-u, danas...

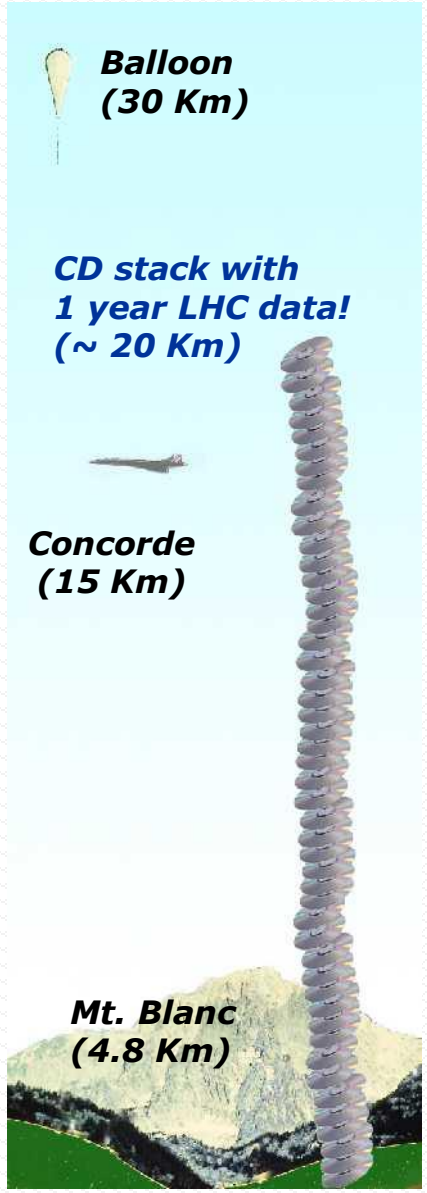
Mnogo podataka...





Koliko podataka?

- LHC
  - 600 miliona sudara u sekundi, svaki sudar oko 1 Mb
  - Značajno događaji - 1 u milion!
  - 1. faza: filtriranje na 100.000 događaja/sekundi (idu na digitalnu rekonstrukciju)
  - 2. faza: sofisticirani algoritmi → 100-200 događaja/sekundi
  - Ovi sirovi podaci snimaju se u data centru (približno 1,5 CD-a / sekundi)
- Protok podataka, oko 25 GB/s
  - ALICE: 4 GB/s (Pb-Pb running)
  - ATLAS: 800 MB/s – 1 GB/s
  - CMS: 600 MB/s
  - LHCb: 750 MB/s



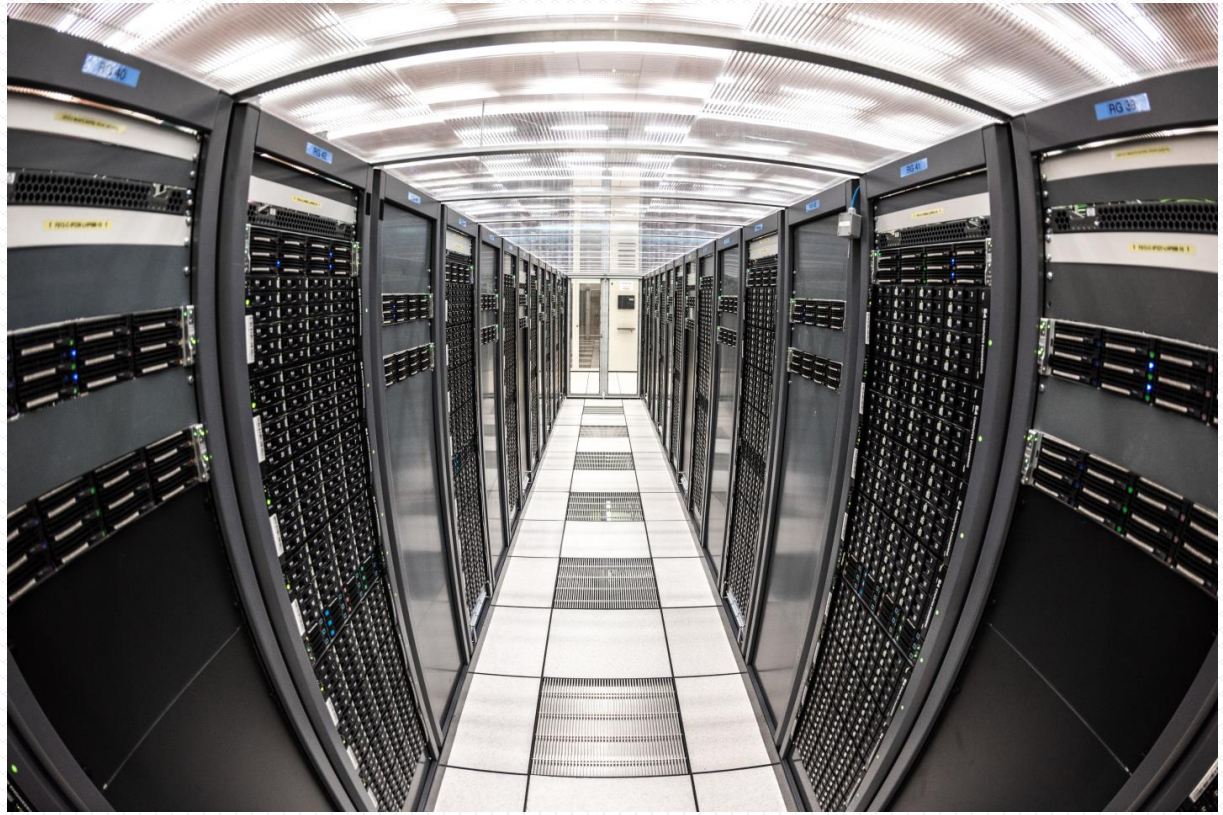
Obrada i čuvanje podataka

- Do kraja 2017. godine **trajno sačuvano 230 PB podataka**
  - U **2017** – 40 PB LHC podataka, ukupno **72 PB** (max: 12,3 PB u julu)
- Najviše podataka sačuvano na **magnetnim trakama** (32.200 kaseta, 400 PB kapacitet)
- Ukupno **90.000 diskova** u CERN-u, kapacitet 280 PB, 10-15% SSD (prostor mnogo manji od 10%)
  - 230 PB na trakama (kapacitet 400 PB)
  - 173 PB na diskovima (u proseku 30 diska otkazuje nedeljno!)
  - Sve se kopira dva puta na disk!

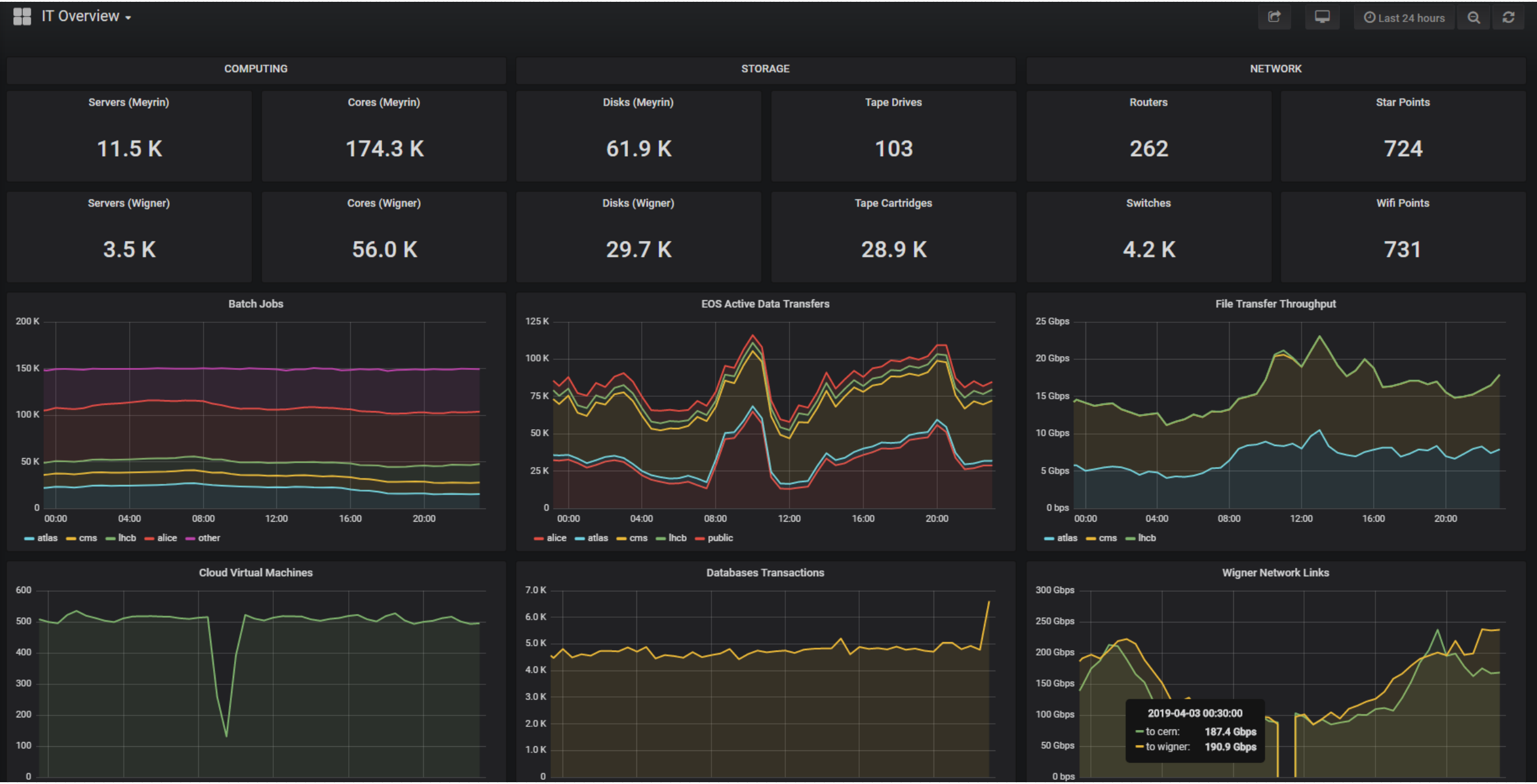
Credits: Bennett, Sophia Elizabeth / CERN

Obrada i čuvanje podataka

- Dva data centra
  - Meyrin Data Centre
  - Wigner Extension
    - 1200 km dalje (Budimpešta)
- 11.500 + 3.500 servera
- 174.300 + 56.000 CPU
- 61.900 + 29.700 diskova



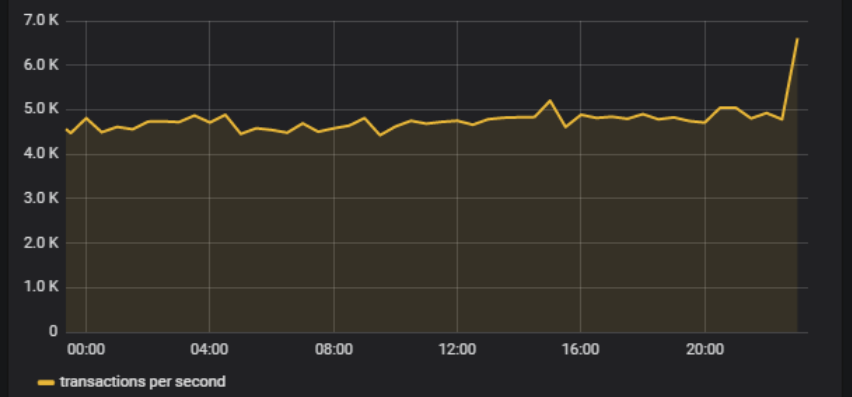
Credits: Bennett, Sophia Elizabeth / CERN

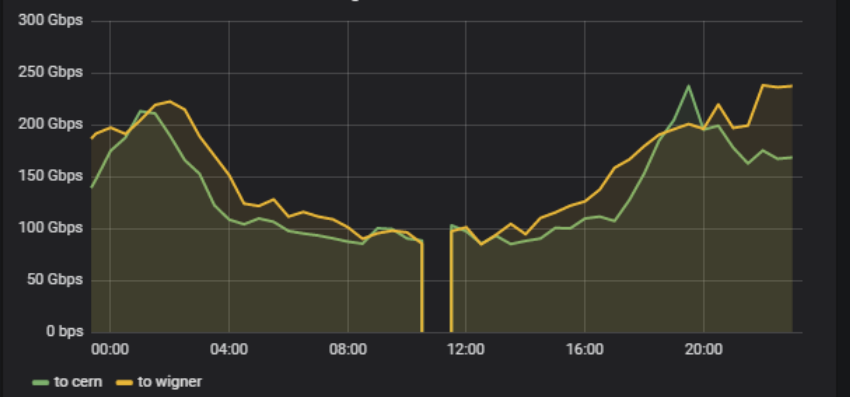


http://monit-grafana-open.cern.ch

IT Overview

Last 24 hours





Details

Meyrin

Metric	Avg
Servers	11 K
Processors	22 K
Cores	174 K
Disks	62 K
Memory Modules	86 K
1GB NICs	17 K
10GB NICs	16 K

Wigner

Metric	Avg
Servers	4 K
Processors	6 K
Cores	56 K
Disks	30 K
Memory Modules	28 K
1GB NICs	7 K
10GB NICs	3 K

Network

Metric	Avg
Routers	262
Start Points	724
Switches	4 K
Wifi Points	731
UTP Outlets	82 K
Devices	326 K

Meyrin

Metric	Avg
Disk Space (TB)	150135
Total Memory (TB)	1038

Wigner

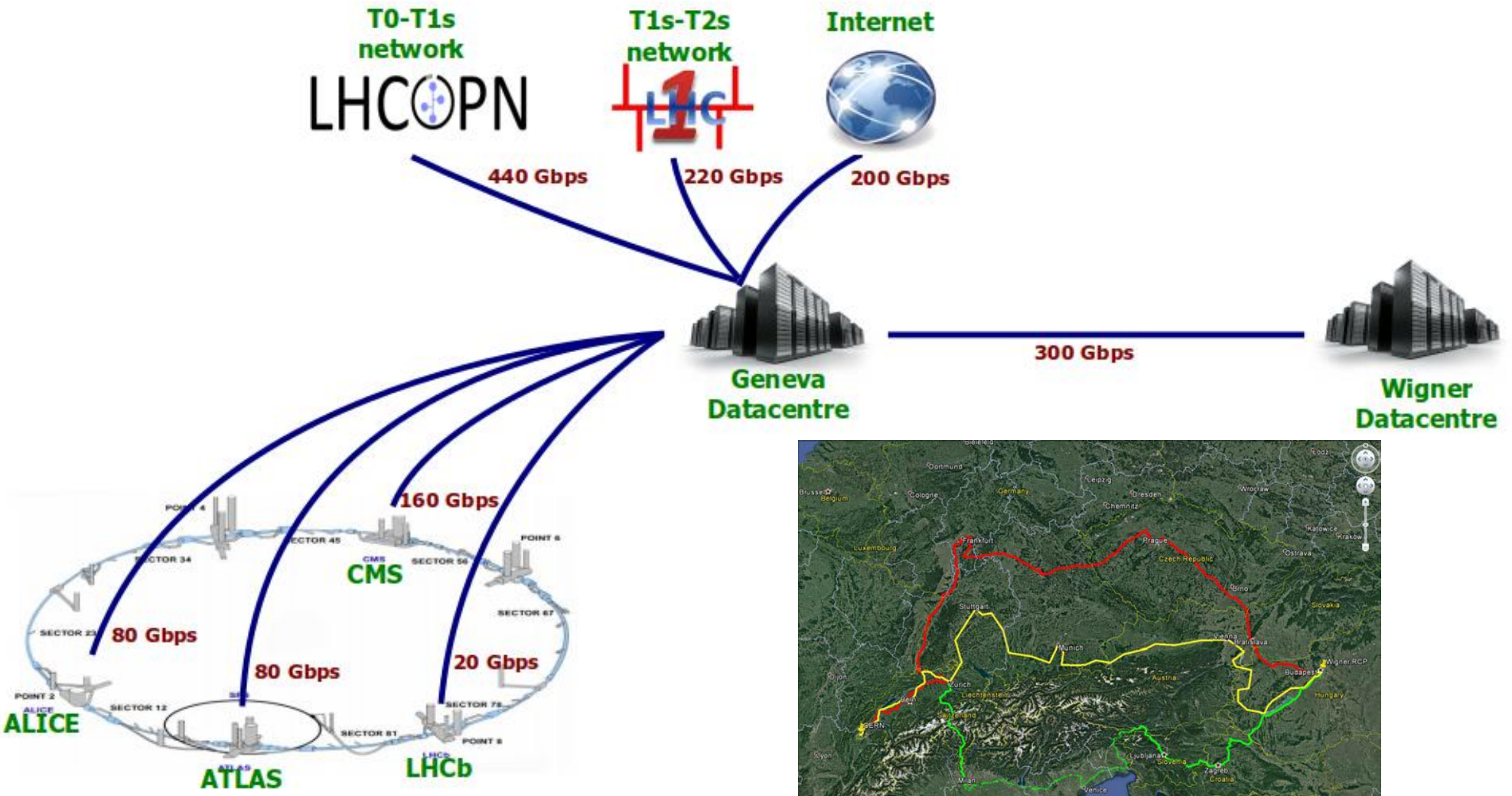
Metric	Avg
Disk Space (TB)	97252
Total Memory (TB)	221

Tape Storage

Metric	Avg
Drives	103
Cartridges	28934
Used Space (TB)	337258

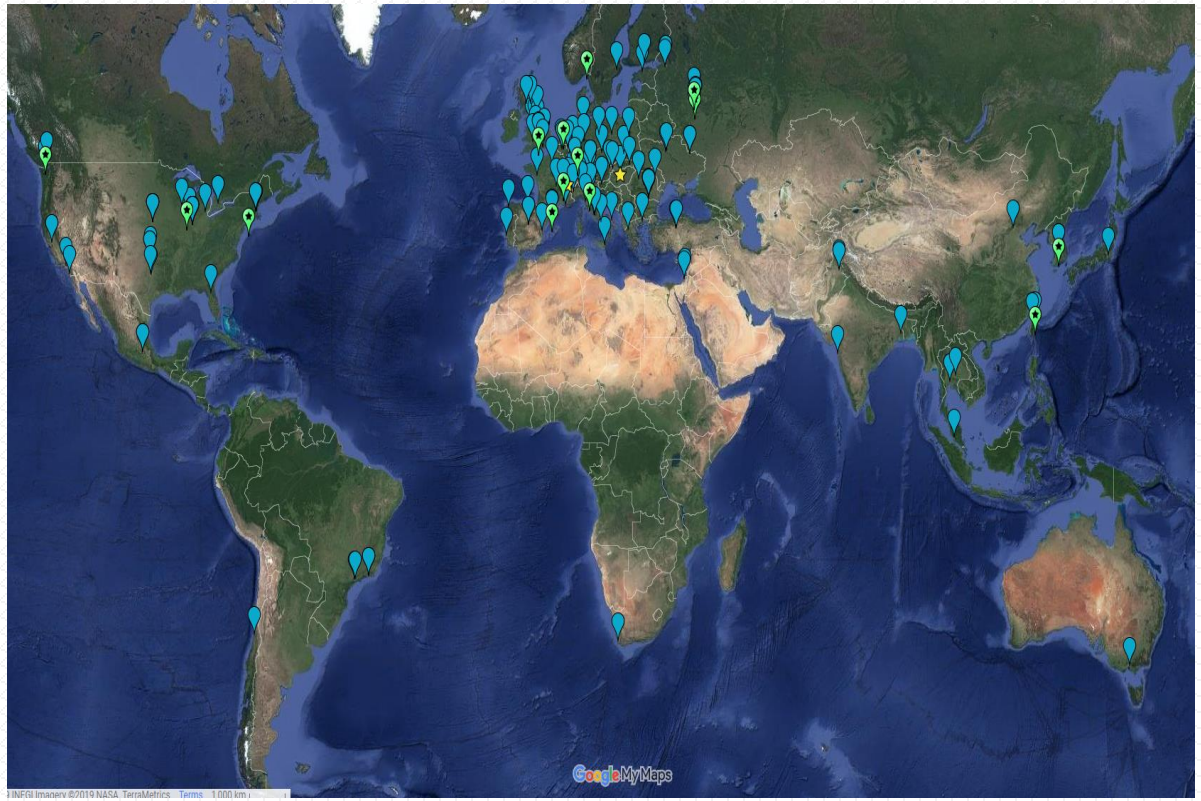
http://monit-grafana-open.cern.ch

Mreža – 35.000 km optičkih kablova ☺

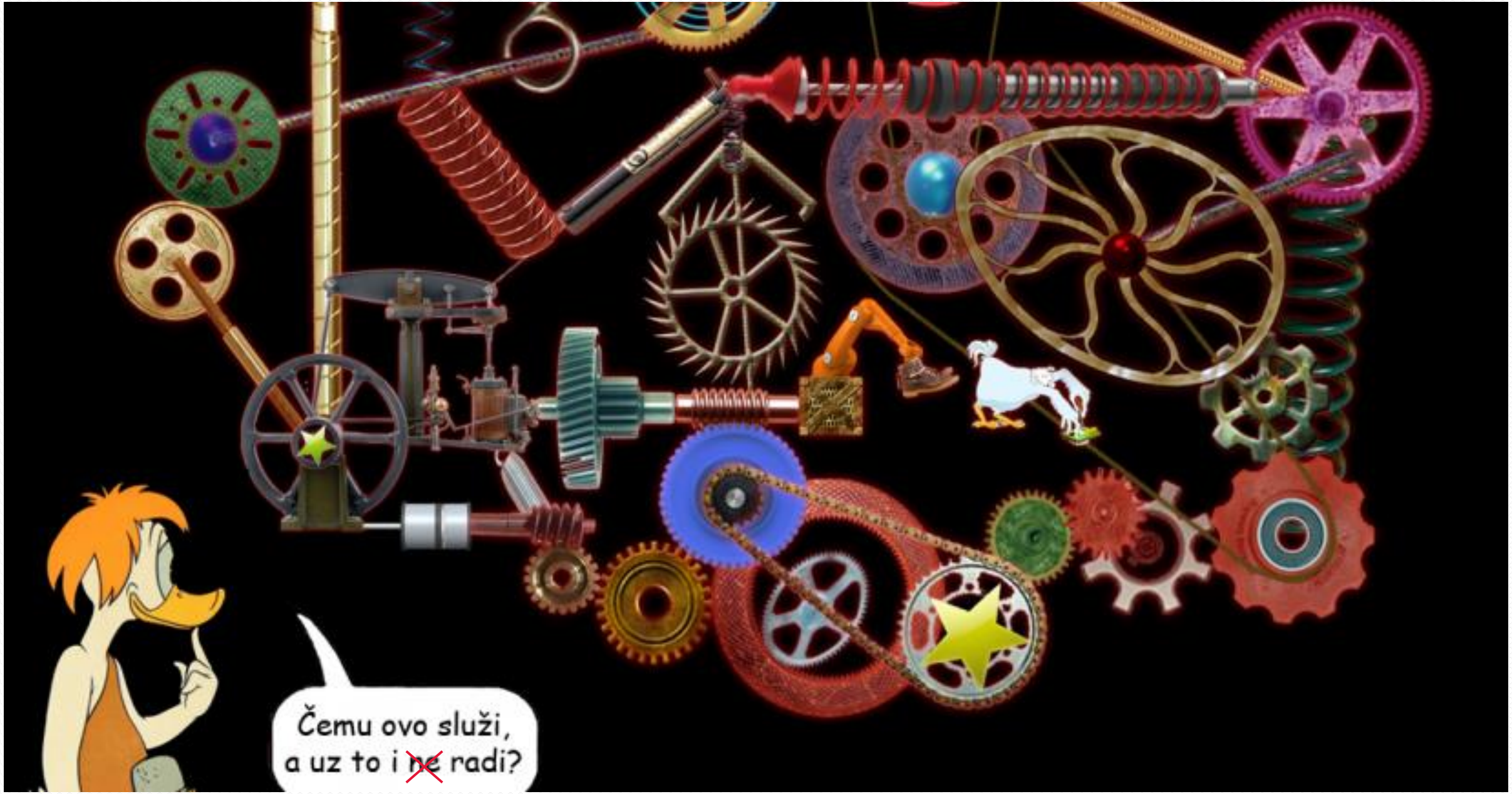


Ali… ni ovo nije dovoljno

- WLCG – Worldwide LHC Computing Grid
  - http://wlcg-public.web.cern.ch/
- 170+ data centara, 42 države, 800.000 CPU
- CERN „samo“ 20% resursa
- Više od 10.000 fizičara ima pristup podacima
- 250.000 „jobs“ stalo radi na gridu
- Skladištenje: 400 PB diskovi + 400 PB trake (globalno) ~ 1 EB (exabyte)
- 2016. godine – transfer podataka 35+ GB/s (stalno)



Čemu sve ovo služi?


Čemu ovo služi,
a uz to i ne radi?

Higsovo polje

*Work supported in part by the U. S. Atomic Energy Commission and in part by the Graduate School from funds supplied by the Wisconsin Alumni Research Foundation.

[1]R. Feynman and M. Gell-Mann, Phys. Rev. 109, 13 (1958).

[2]T. D. Lee and C. N. Yang, Phys. Rev. 119, 1410 (1960); S. B. Treiman, Nuovo Cimento 15, 916 (1960).

[3]S. Okubo and R. E. Marshak, Nuovo Cimento 28, 56 (1963); Y. Ne'eman, Nuovo Cimento 27, 922 (1963).

[4]Estimates of the rate for $K^+ \to \pi^+ + e^+ + e^-$ due to induced neutral currents have been calculated by several authors. For a list of previous references see Mirza A. Baqi Bég, Phys. Rev. 132, 426 (1963).

[5]M. Baker and S. Glashow, Nuovo Cimento 25, 857 (1962). They predict a branching ratio for decay mode (1) of $\sim 10^{-6}$.

[6]N. P. Samios, Phys. Rev. 121, 275 (1961).

[7]The best previously reported estimate comes from the limit on $K_2^0 \to \mu^+ + \mu^-$. The 90% confidence level is $|g_{\mu\bar{\mu}}|^2 < 10^{-3}|g_{\mu\bar{\nu}}|^2$: M. Barton, K. Lande, L. M. Lederman, and William Chinowsky, Ann. Phys. (N.Y.) 5, 156 (1958). The absence of the decay mode $\mu^+ \to e^+ + e^+ + e^-$ is not a good test for the existence of neutral currents since this decay mode may be absolutely forbidden by conservation of muon number: G. Feinberg and L. M. Lederman, Ann. Rev. Nucl. Sci. 13, 465 (1963).

[8]S. N. Biswas and S. K. Bose, Phys. Rev. Letters 12, 176 (1964).

BROKEN SYMMETRY AND THE MASS OF GAUGE VECTOR MESONS*

F. Englert and R. Brout
Faculté des Sciences, Université Libre de Bruxelles, Bruxelles, Belgium
(Received 26 June 1964)

It is of interest to inquire whether gauge vector mesons acquire mass through interaction[1]: by a gauge vector meson we mean a

those vector mesons which are coupled to currents that "rotate" the original vacuum are the ones which acquire mass [see Eq. (6)]

BROKEN SYMMETRIES AND THE MASSES OF GAUGE BOSONS

Peter W. Higgs
Tait Institute of Mathematical Physics, University of Edinburgh, Edinburgh, Scotland
(Received 31 August 1964)

In a recent note[1] it was shown that the Goldstone theorem,[2] that Lorentz-covariant field theories in which spontaneous breakdown of symmetry under an internal Lie group occurs contain zero-mass particles, fails if and only if the conserved currents associated with the internal group are coupled to gauge fields. The purpose of the present note is to report that, as a consequence of this coupling, the spin-one quanta of some of the gauge fields acquire mass; the longitudinal degrees of freedom of these particles (which would be absent if their mass were zero) go over into the Goldstone bosons when the coupling tends to zero. This phenomenon is just the relativistic analog of the plasmon phenomenon to which Anderson[3] has drawn attention: that the scalar zero-mass excitations of a superconducting neutral Fermi gas become longitudi-

about the "vacuum" solution $\varphi_1(x) = 0$, $\varphi_2(x) = \varphi_0$:

$$\partial^\mu\{\partial_\mu(\Delta\varphi_1) - e\varphi_0 A_\mu\} = 0, \tag{2a}$$

$$\{\partial^2 - 4\varphi_0^2 V''(\varphi_0^2)\}(\Delta\varphi_2) = 0, \tag{2b}$$

$$\partial_\nu F^{\mu\nu} = e\varphi_0\{\partial^\mu(\Delta\varphi_1) - e\varphi_0 A_\mu\}. \tag{2c}$$

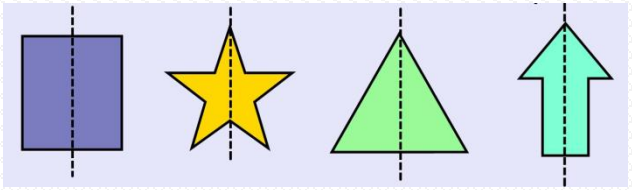
Equation (2b) describes waves whose quanta have (bare) mass $2\varphi_0\{V''(\varphi_0^2)\}^{1/2}$; Eqs. (2a) and (2c) may be transformed, by the introduction of new variables

$$B_\mu = A_\mu - (e\varphi_0)^{-1}\partial_\mu(\Delta\varphi_1),$$

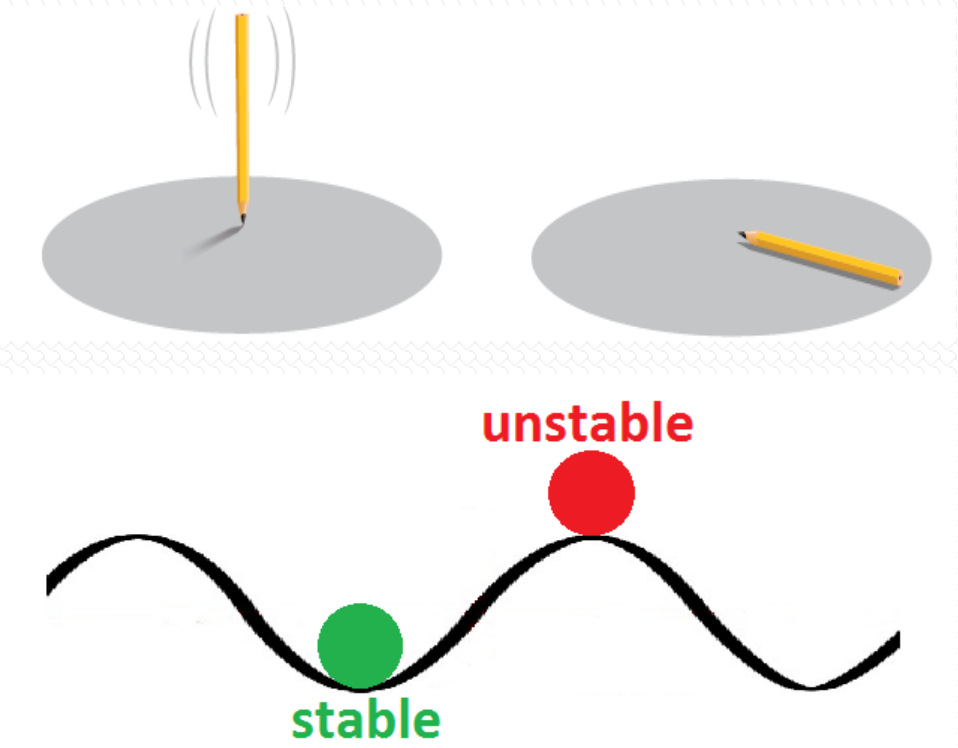
$$G_{\mu\nu} = \partial_\mu B_\nu - \partial_\nu B_\mu = F_{\mu\nu}, \tag{3}$$

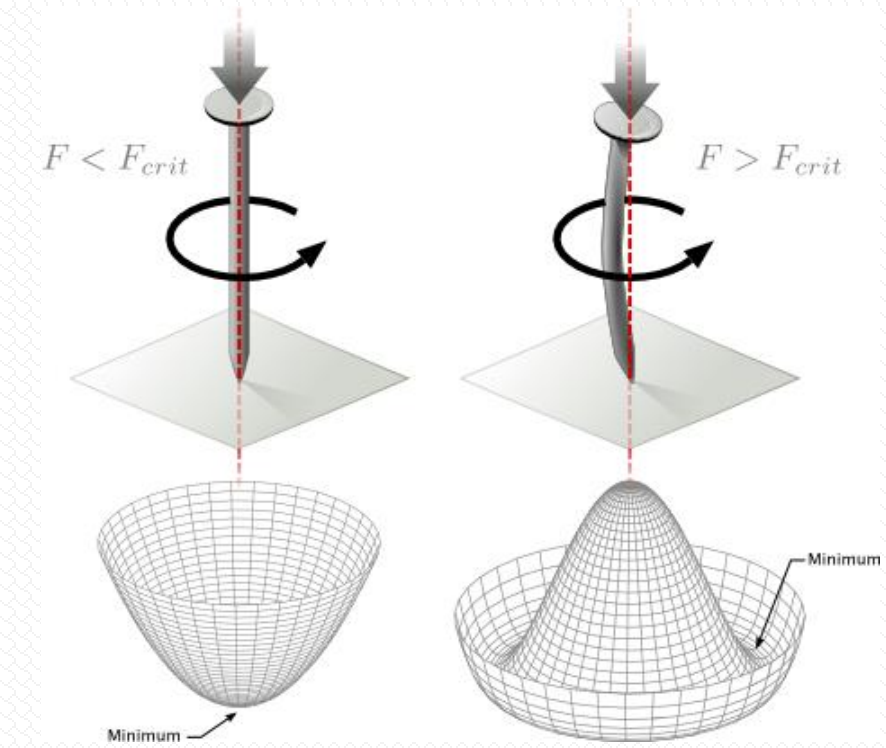
into the form

Simetrije

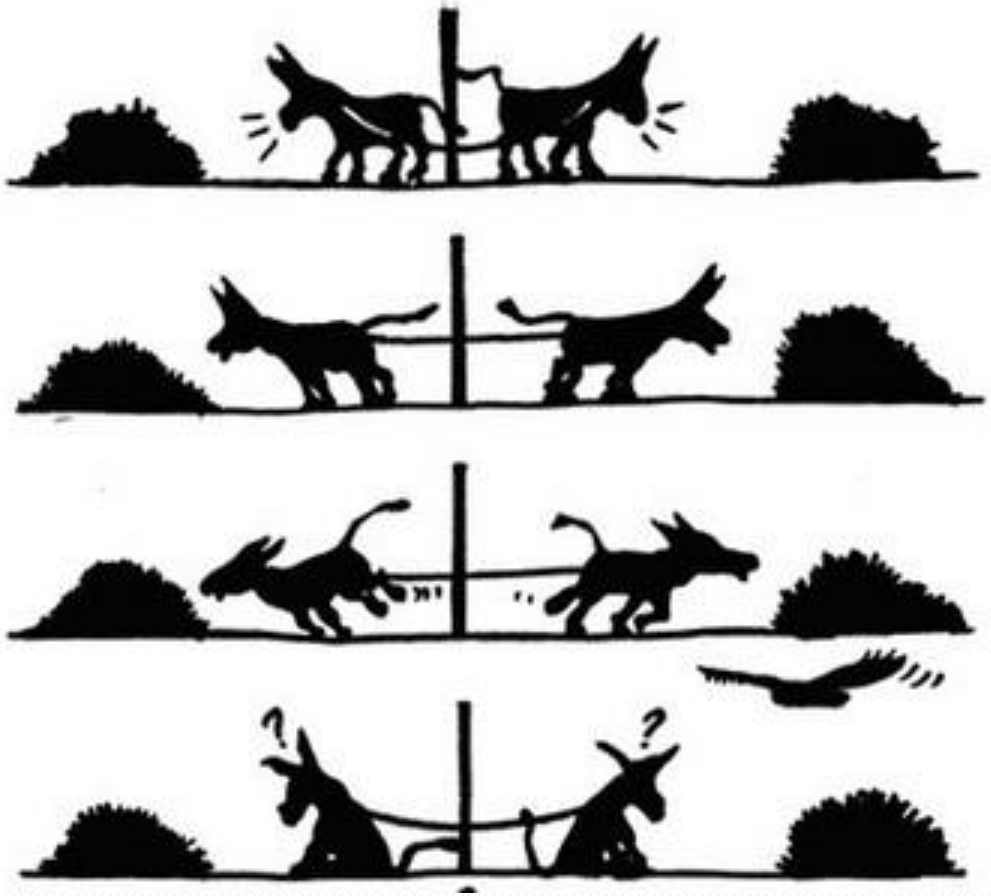


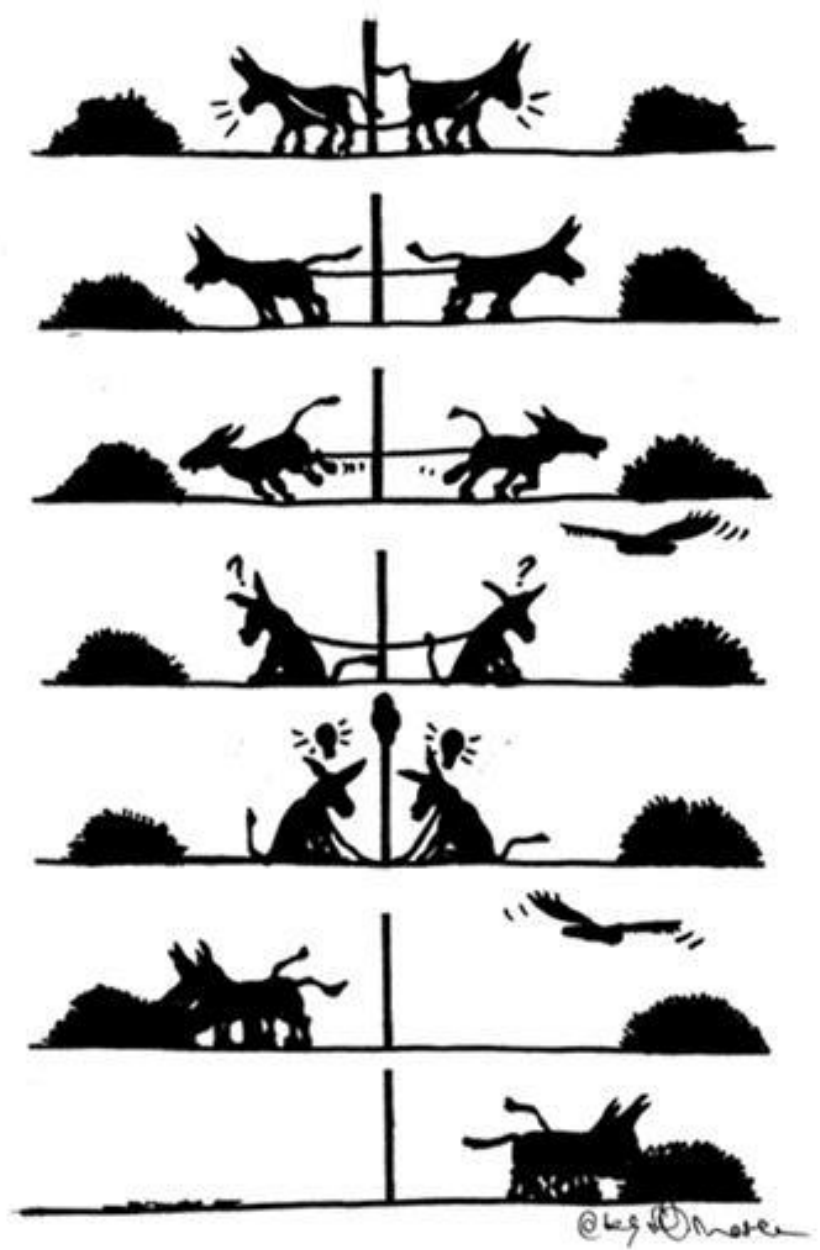
Narušenje simetrije





Narušenje simetrije

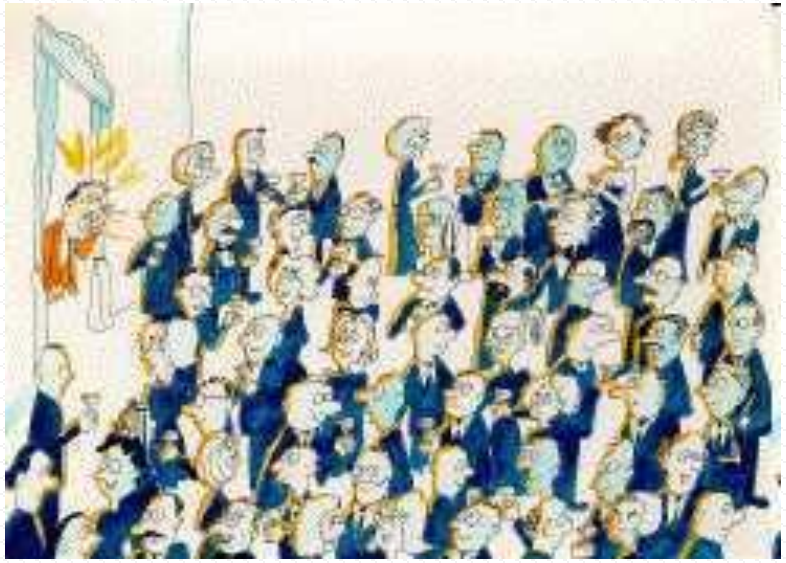




Higsov mehanizam za neupućene

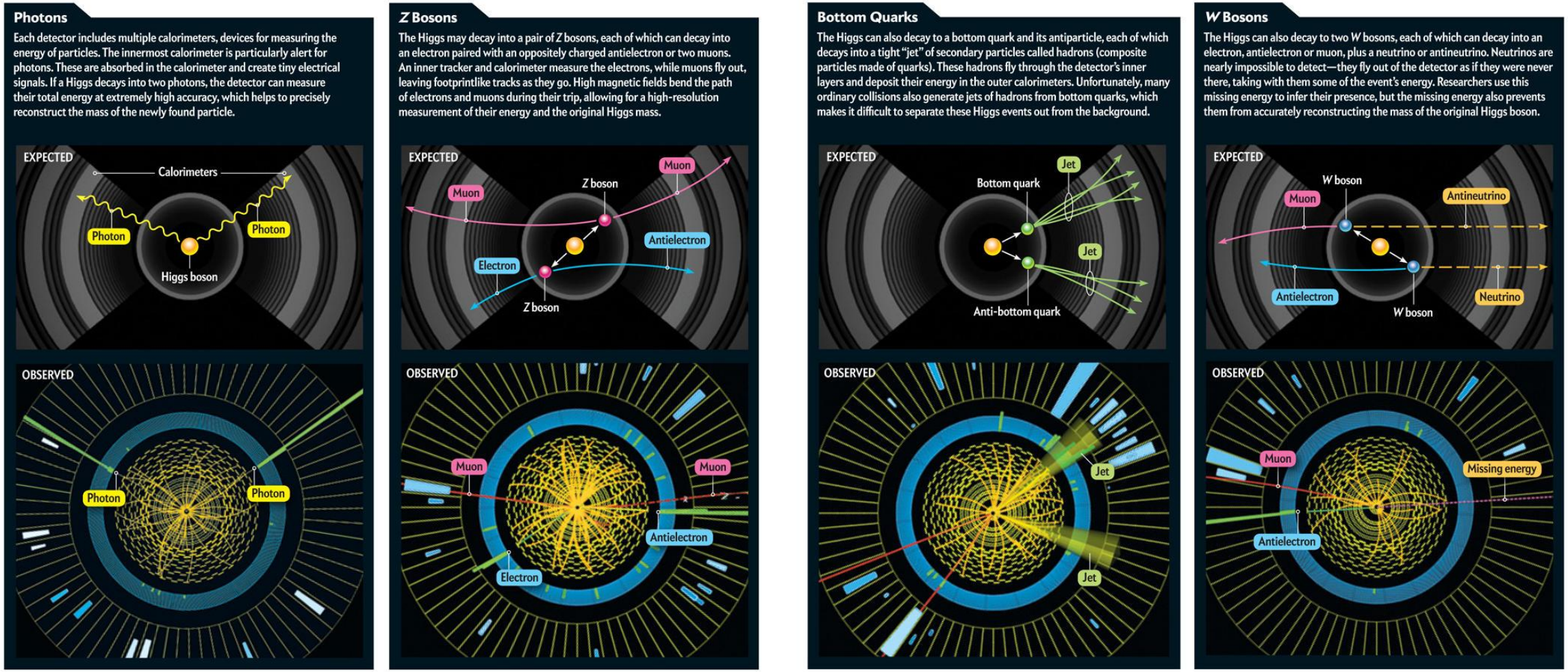
Izvor: David Miller (University College London)

Higsov mehanizam za neupućene

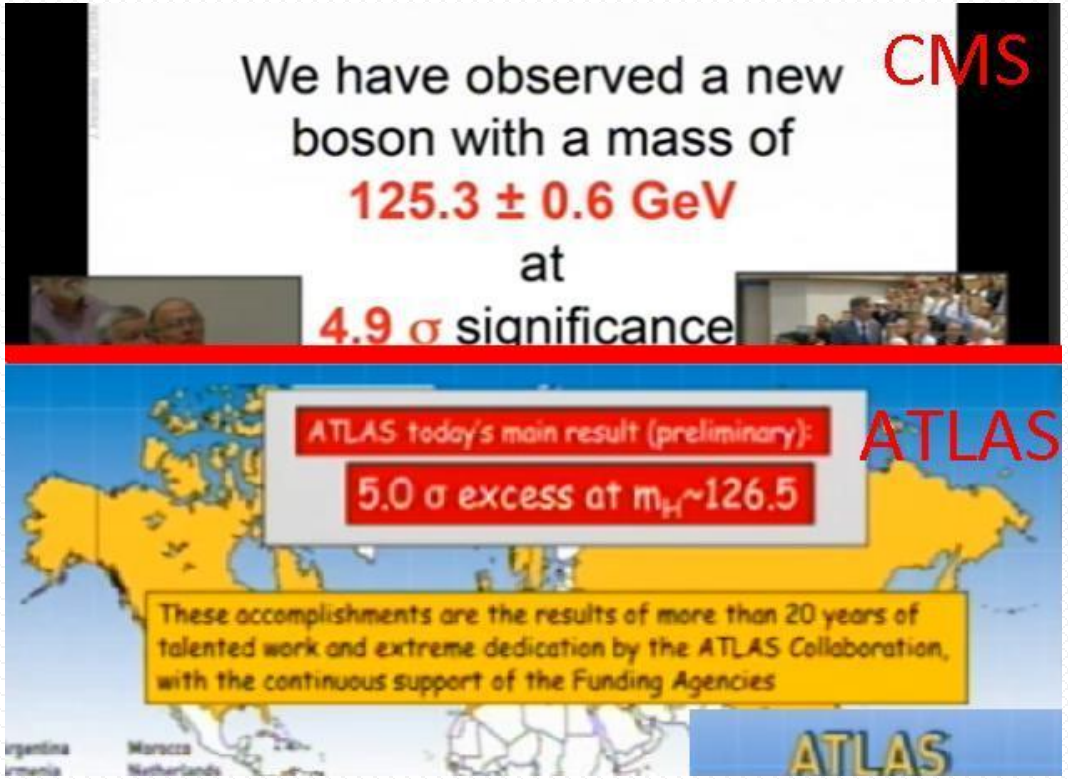


Izvor: David Miller (University College London)

Detekcija Higsove čestice?



CERN: 4. jul 2012. godine



Nobelova nagrada za fiziku

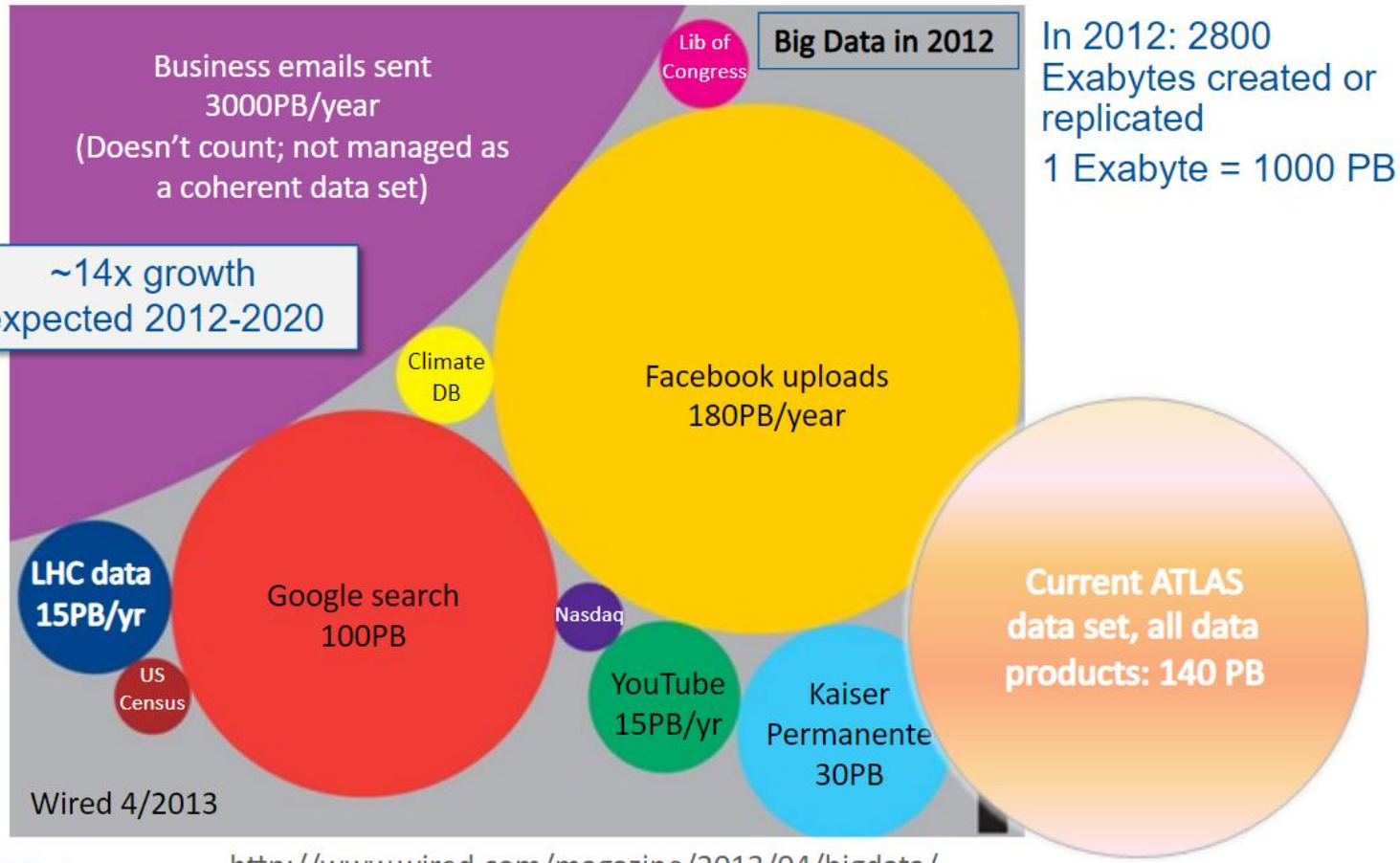
- 2013. godina
- *“za teorijsko otkriće mehanizma koji daje značajan doprinos razumevanju porekla mase subatomskih čestica”*

- Franso Angler
  University of Edinburgh, UK

- Piter Higs
  Université Libre de Bruxelles, Brussels, Belgium

Internet, danas…

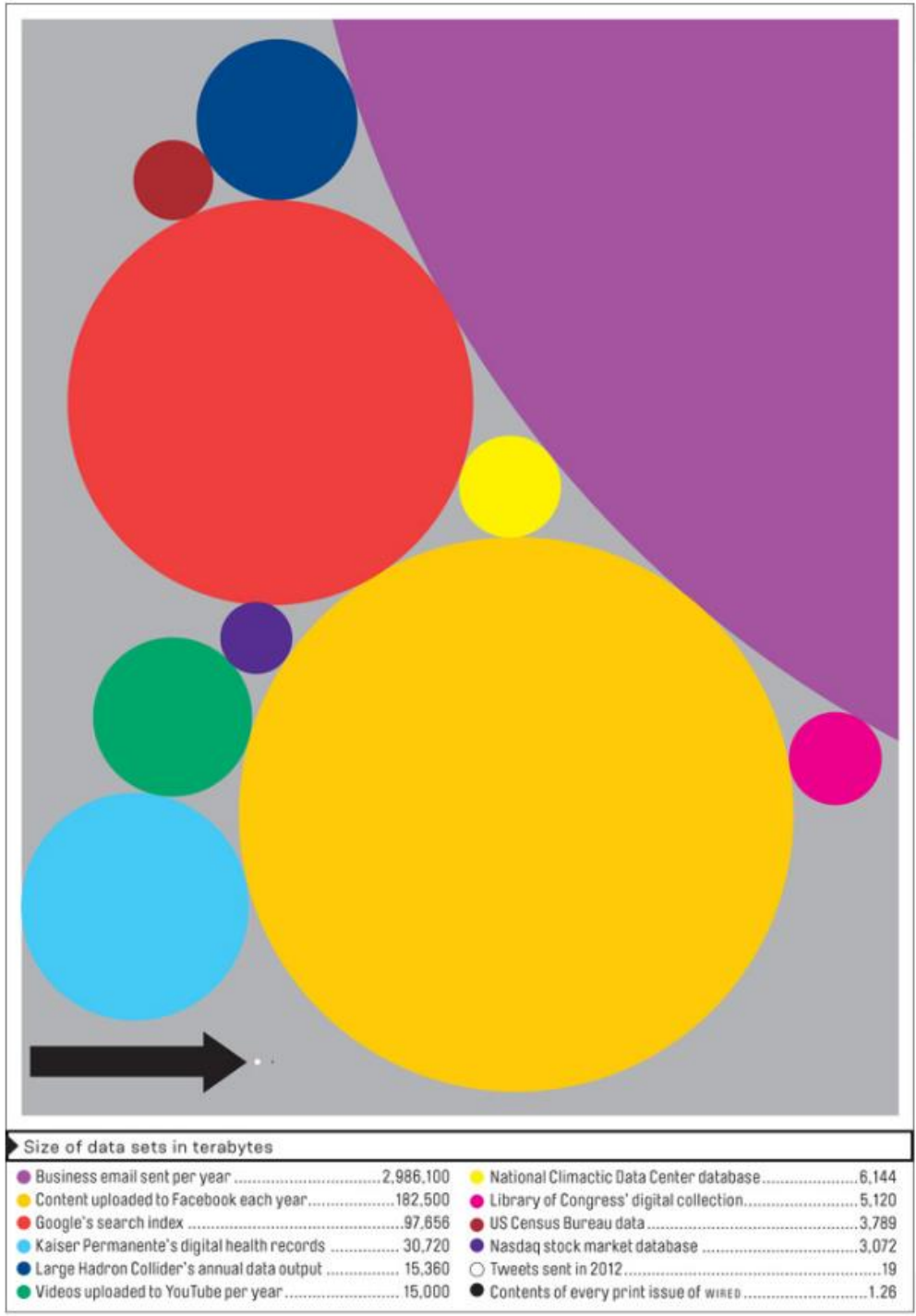
Where is LHC in Big Data Terms?



In 2012: 2800 Exabytes created or replicated

1 Exabyte = 1000 PB

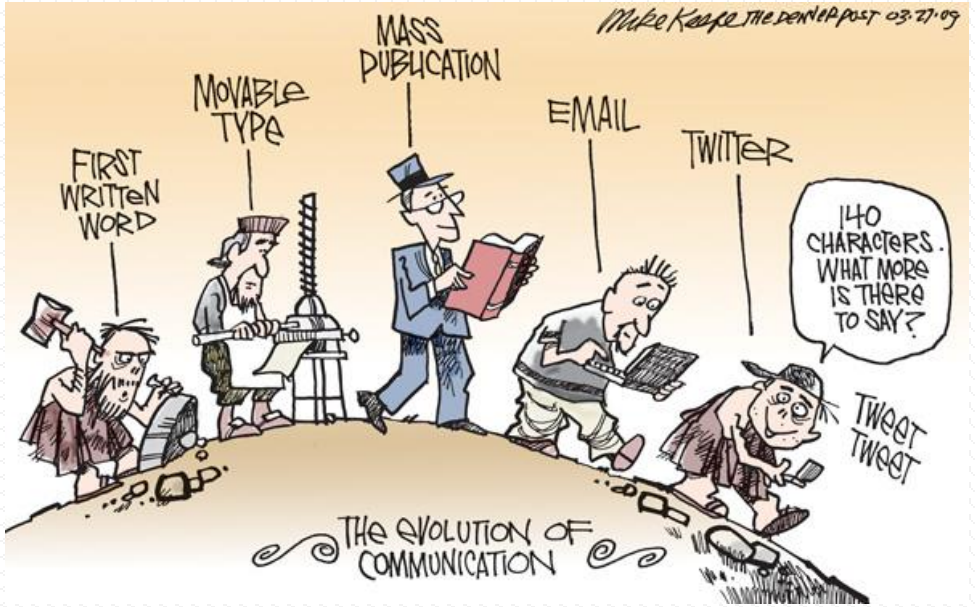
http://www.wired.com/magazine/2013/04/bigdata/



Size of data sets in terabytes

Business email sent per year	2,986,100	National Climactic Data Center database	6,144
Content uploaded to Facebook each year	182,500	Library of Congress' digital collection	5,120
Google's search index	97,656	US Census Bureau data	3,789
Kaiser Permanente's digital health records	30,720	Nasdaq stock market database	3,072
Large Hadron Collider's annual data output	15,360	Tweets sent in 2012	19
Videos uploaded to YouTube per year	15,000	Contents of every print issue of WIRED	1.26

https://www.wired.com/2013/04/bigdata/



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