Il Software Libero nella ricerca universitaria: l'esperienza del gruppo di ricerca COMICS

Linux Day 2008

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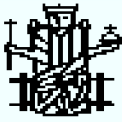
Università degli Studi di Napoli “Federico II”

Agenda

- Ringraziamenti
- Cosa significa fare ricerca
- Un settore a me caro: le reti
- La ricerca del gruppo COMICS
- Progetti OS di COMICS
- Conclusioni



La Ricerca ed il Metodo Scientifico (1/3)

- Il **metodo scientifico** è la modalità tipica con cui la scienza procede per raggiungere una conoscenza della realtà ***oggettiva***, ***affidabile***, ***verificabile*** e ***condivisibile***.
- Esso consiste, da una parte, nella raccolta di evidenza empirica e misurabile attraverso l'osservazione e l'esperimento; dall'altra, nella formulazione di ipotesi e teorie da sottoporre nuovamente al vaglio dell'esperimento.

Source: wikipedia

La Ricerca ed il Metodo Scientifico (2/3)

- Quale ricerca: di base, applicata, industriale.
- Condivisione della conoscenza e dei risultati.
- Il sistema di referaggio e validazione:
  - *Peer Review*
  - *Cross-Checking*

La Ricerca e Internet

Top Achievements

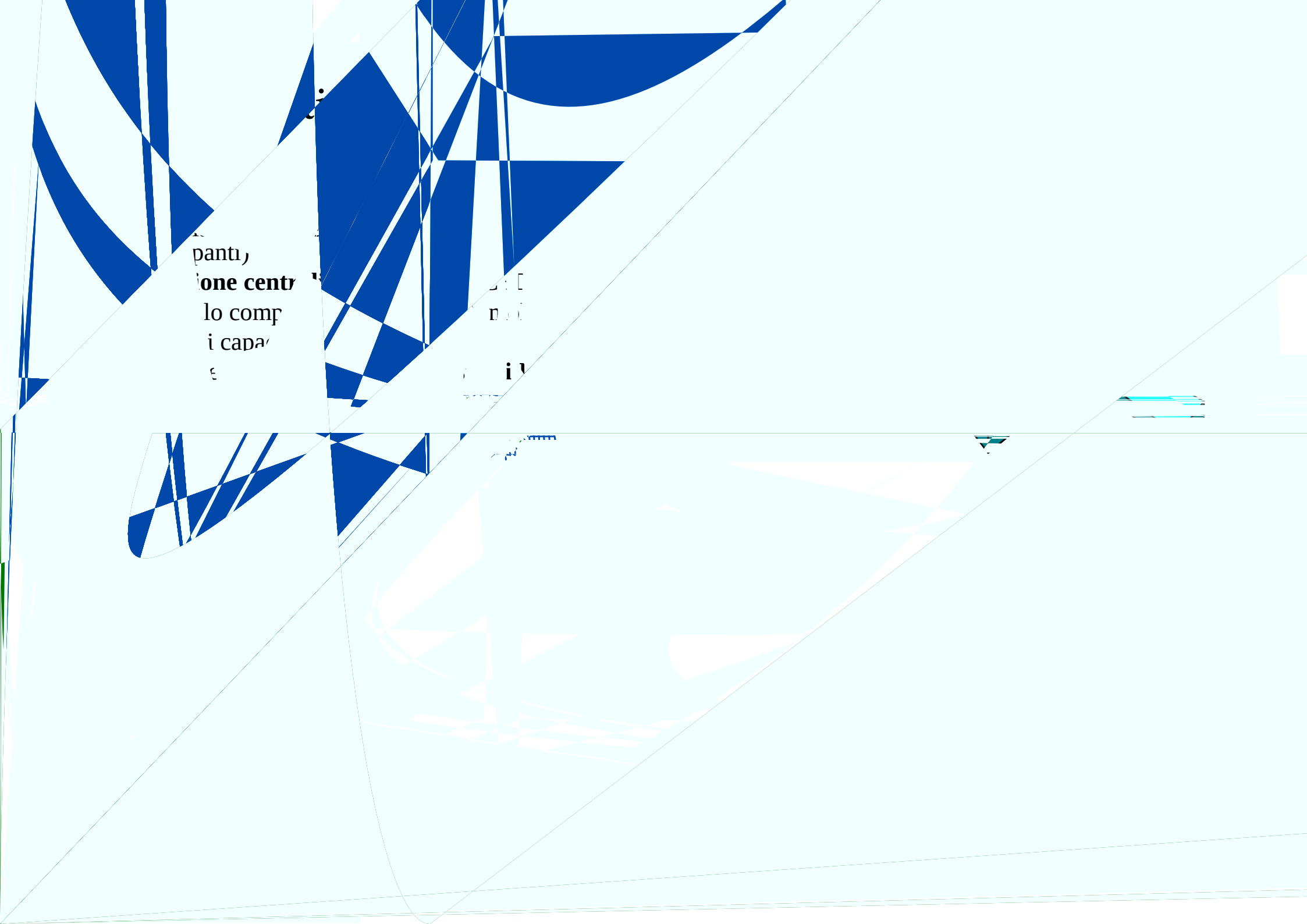
The National Academy of Engineering ranks the Internet No. 13 among the 20th century's top engineering achievements

1. Electrification	11. Highways
2. Automobile	12. Spacecraft
3. Airplane	13. Internet
4. Water supply and distribution	14. Imaging
5. Electronics	15. Household appliances
6. Radio and television	16. Health technologies
7. Agricultural mechanization	17. Petroleum and petrochemical technologies
8. Computers	18. Laser and fiber optics
9. Telephone	19. Nuclear technologies
10. Air conditioning and refrigeration	20. High-performance materials

Sources: National Academy of Engineering, National Bureau of Economic Research

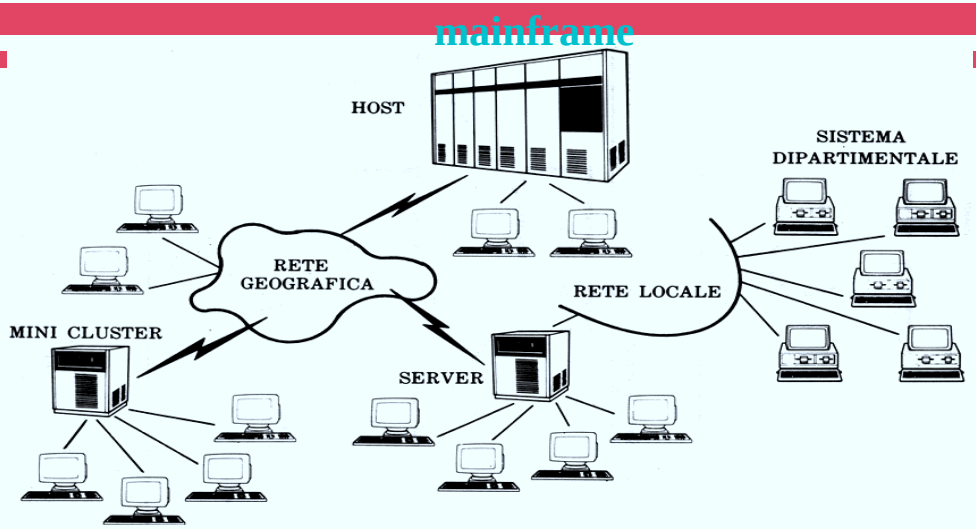
La ricerca nel campo delle reti: Internet

- Il mondo delle reti
- Il modello a livelli
- Gli standard: perché libero non significa senza regole
- La comunità Internet: RFC e IETF
  - le regole stesse di scrittura di una RFC sono una .... RFC



Sistemi Distribuiti: vantaggi e problematiche

- **Condivisione dell'Informazione**
- **Condivisione delle Risorse**
- **Accesso a Risorse Remote**
- **Alta Affidabilità**
- **Crescita Graduale**
- **Convenienza Economica**



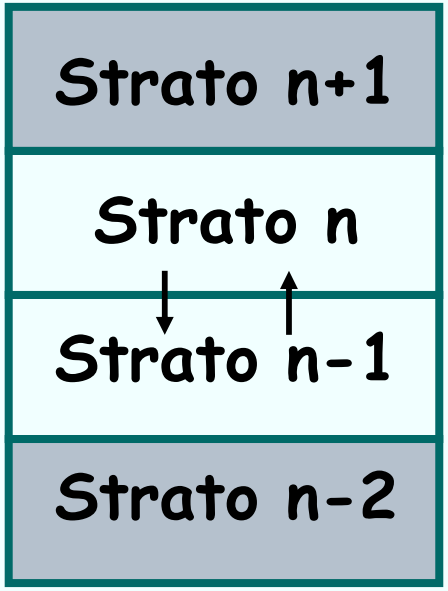
- **La comunicazione tra computer richiede soluzioni tecniche complesse riguardanti una serie di problemi:**
  - **Ricezione e Trasmissione fisica**
  - **Controllo degli errori**
  - **Controllo di flusso**
  - **Conversione dei dati**
  - **Crittografia e sicurezza**
  - **Sincronizzazione**

Un approccio logico è quello di analizzare tali problematiche singolarmente:

"Divide et Impera"

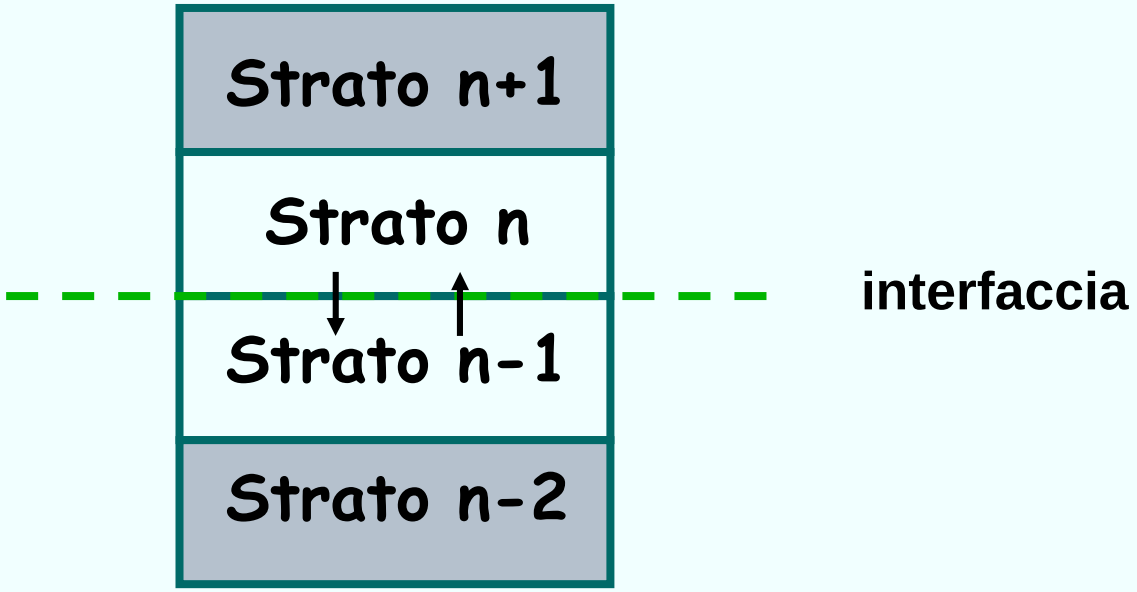
Modelli a strati (o a livelli)

- La suddivisione delle funzionalità secondo un modello a strati agevola la gestione della complessità
- Ciascuno **strato** (o **livello**):
  - è responsabile di un sottoinsieme definito e limitato di compiti
  - funziona in maniera lascamente accoppiata con gli altri
  - interagisce solo con gli strati immediatamente superiore ed inferiore
  - fa affidamento sui "servizi" forniti dallo strato immediatamente inferiore
  - fornisce "servizi" allo strato immediatamente superiore
- Alcuni strati sono realizzati in software altri in hardware
- Vantaggi:
  - l'indipendenza tra gli strati consente la sostituzione di uno strato con un altro di pari livello che offra i medesimi servizi allo strato superiore
  - limitare le funzionalità di uno strato ne semplifica la realizzazione
- Svantaggi:
  - L'eccessivo numero di strati può portare ad inefficienze



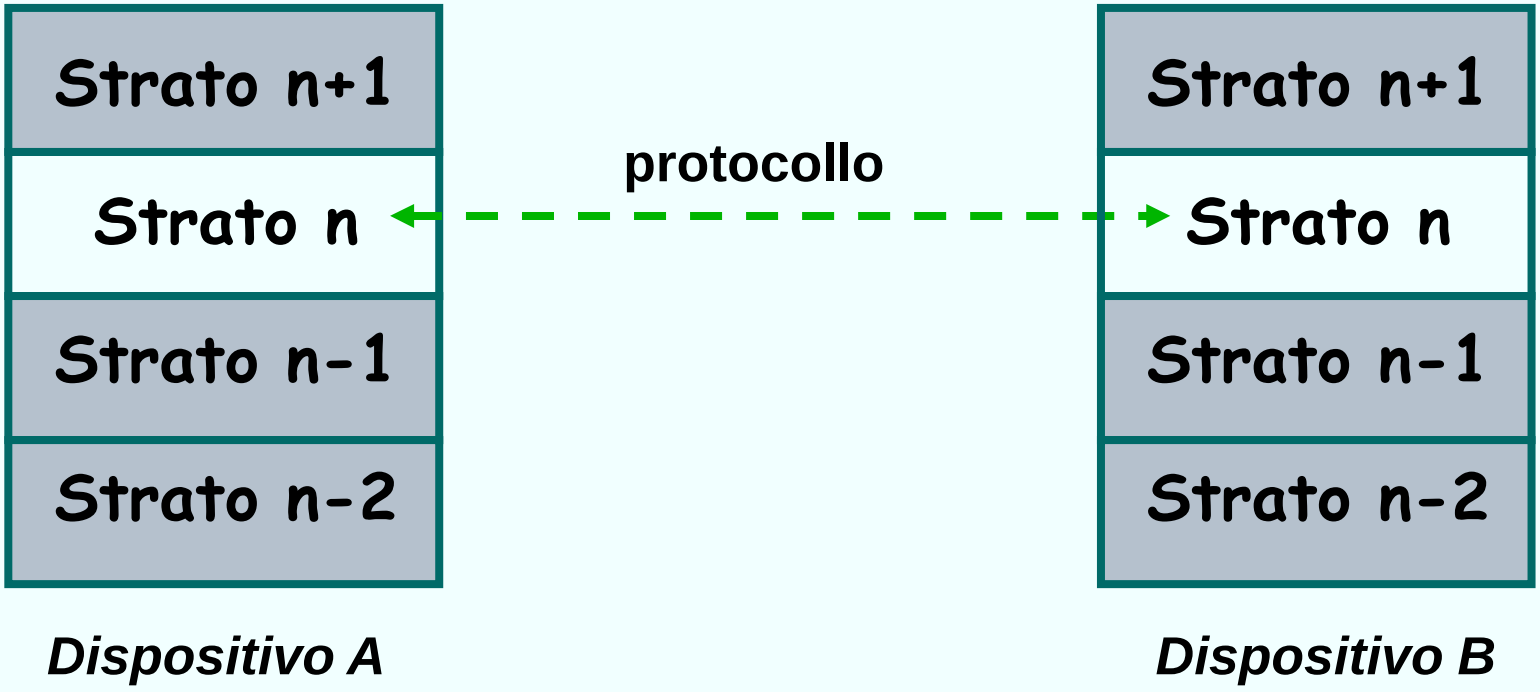
Modelli a strati: interfacce

- **All'interno di ciascun dispositivo di rete, lo scambio di informazioni tra due strati adiacenti avviene attraverso una interfaccia, che definisce i servizi offerti dallo strato inferiore allo strato superiore**

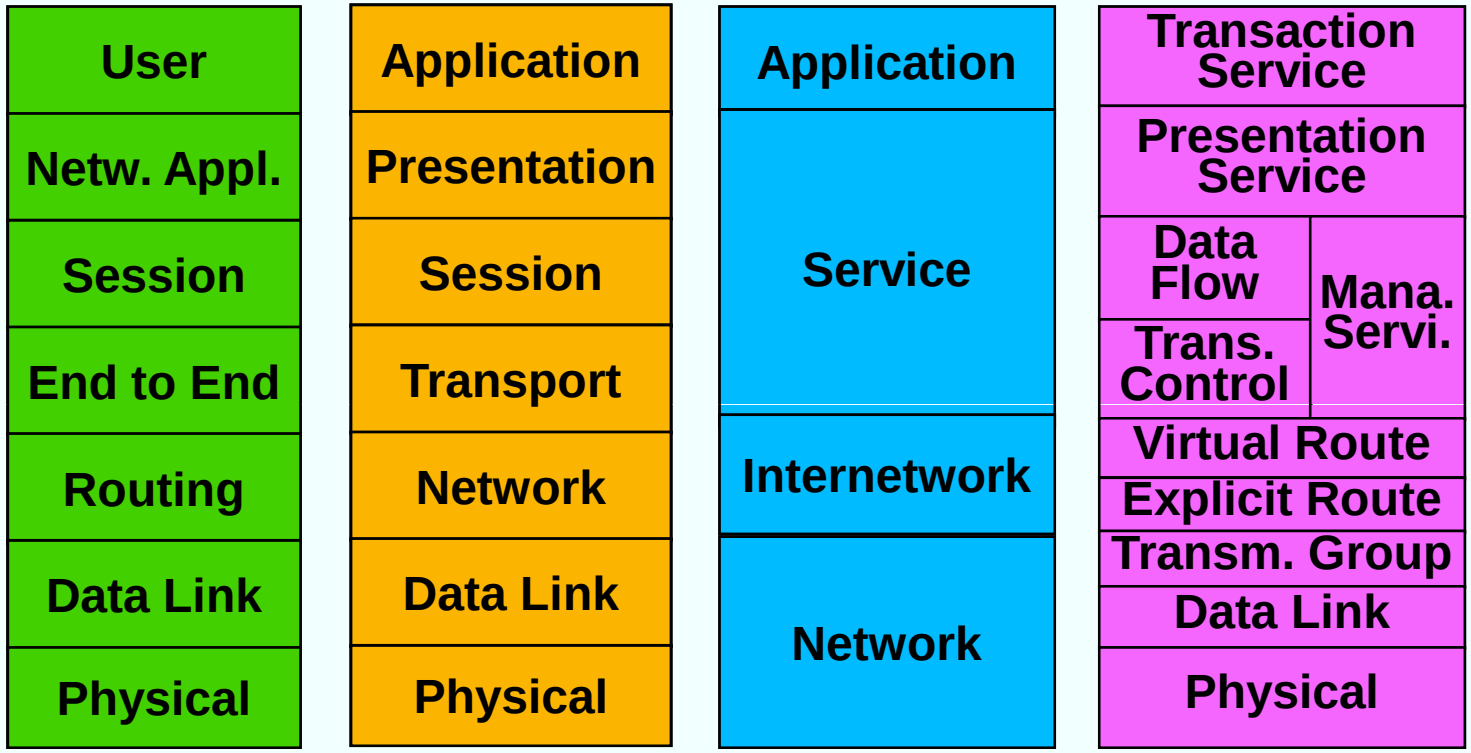


Modelli a strati: protocolli

- **Lo strato n-esimo di un dispositivo comunica con lo strato n-esimo di un'altra entità secondo un** protocollo **assegnato**

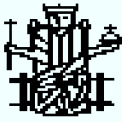


Modelli di rete a strati a confronto



Gli standard…

- Standard “de iure”
  - Ad es. ISO/OSI
- Standard “de facto”
  - Ad es. TCP/IP



Quando standardizzare?

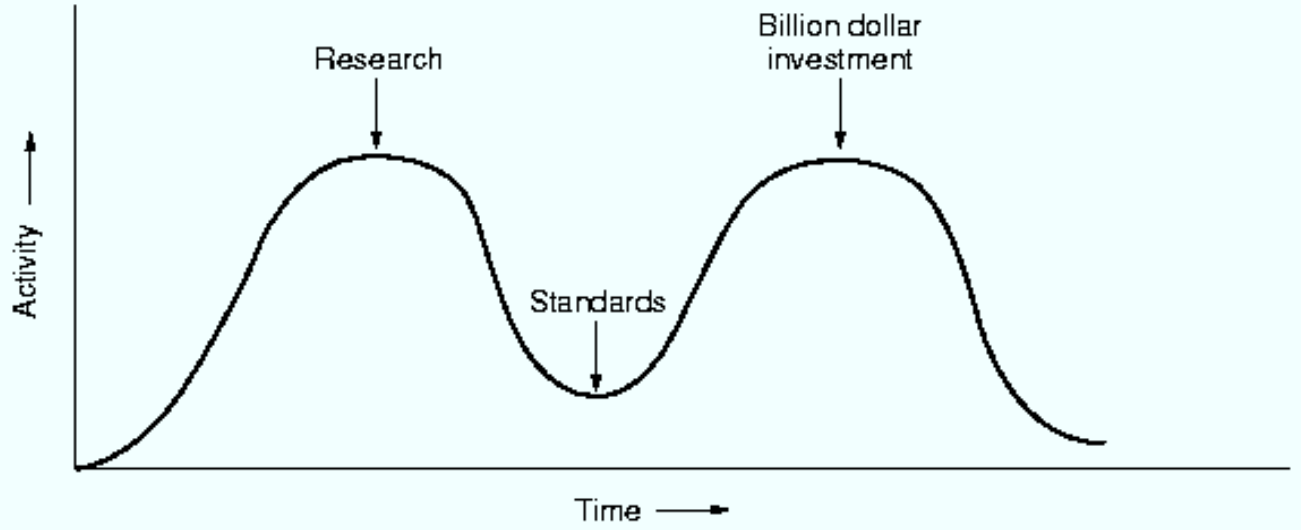
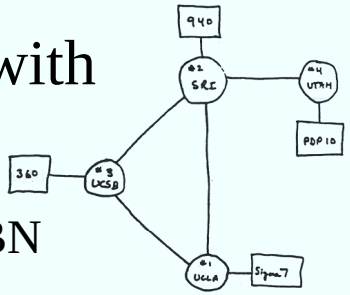


Fig. 1-20. The apocalypse of the two elephants.

(Very) Brief History of the Internet

- 1961: Kleinrock - queueing theory shows effectiveness of packet-switching
- 1964: Baran - packet-switching in military nets
- 1968 - DARPA (Defense Advanced Research Projects Agency) contracts with BBN (Bolt, Beranek & Newman) to create ARPAnet
- 1970 - First five nodes: UCLA, Stanford, UC Santa Barbara, U of Utah, BBN
- 1974 – TCP/IP specification by Vint Cerf (part of Berkeley UNIX)
- 1984 – On January 1, the Internet with its 1000 hosts converts masses to using TCP/IP for its messaging (deployment of TCP/IP)
- Early 1990's: ARPAnet decommissioned
- 1991: NSF lifts restrictions on commercial use of NSFnet (decommissioned, 1995)

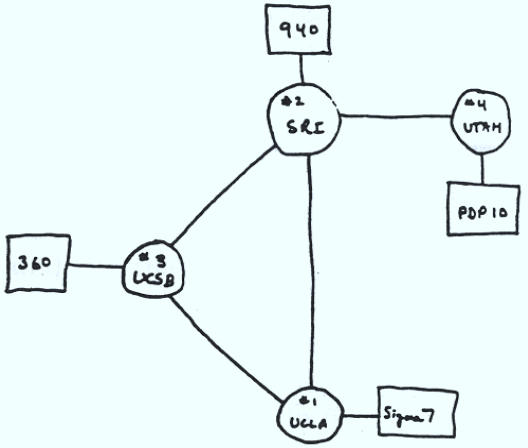


THE ARPA NETWORK

Internet History

1961-1972: Early packet-switching principles

- 1961: Kleinrock - queueing theory shows effectiveness of packet-switching
- 1964: Baran - packet-switching in military nets
- 1967: ARPAnet conceived by Advanced Research Projects Agency
- 1969: first ARPAnet node operational
- 1970: first five ARPAnet nodes operational:
  - UCLA
  - Stanford
  - UC Santa Barbara
  - U of Utah, and
  - BBN
- 1972:
  - ARPAnet public demonstration
  - NCP (Network Control Protocol) first host-host protocol
  - first e-mail program
  - ARPAnet has 15 nodes



THE ARPA NETWORK

Internet History

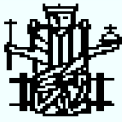
1972-1980: Internetworking, new and proprietary nets

- 1970: ALOHAnet satellite network in Hawaii
- 1974: Cerf and Kahn - architecture for interconnecting networks
- 1976: Ethernet at Xerox PARC
- ate70's: proprietary architectures: DECnet, SNA, XNA
- late 70's: switching fixed length packets (ATM precursor)
- 1979: ARPAnet has 200 nodes

Cerf and Kahn's internetworking principles:

- minimalism, autonomy - no internal changes required to interconnect networks
- best effort service model
- stateless routers
- decentralized control

define today's Internet architecture



Internet History

1980-1990: new protocols, a proliferation of networks

- 1983: deployment of TCP/IP
- 1982: smtp e-mail protocol defined
- 1983: DNS defined for name-to-IP-address translation
- 1985: ftp protocol defined
- 1988: TCP congestion control

- new national networks: Csnet, BITnet, NSFnet, Minitel
- 100,000 hosts connected to confederation of networks

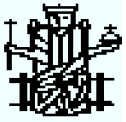
Internet History

1990, 2000's: commercialization, the Web, new apps

- Early 1990's: ARPAnet decommissioned
- 1991: NSF lifts restrictions on commercial use of NSFnet (decommissioned, 1995)
- early 1990s: Web
  - hypertext [Bush 1945, Nelson 1960's]
  - HTML, HTTP: Berners-Lee
  - 1994: Mosaic, later Netscape
  - late 1990's: commercialization of the Web

Late 1990's – 2000's:

- more killer apps: instant messaging, P2P file sharing
- network security to forefront
- est. 50 million host, 100 million+ users
- backbone links running at Gbps

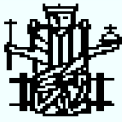


Statistics from the IITF Report, The Emerging Digital Economy *

- To get a market of 50 Million People Participating:
  - Radio took 38 years
  - TV took 13 years
  - Once it was open to the General Public, The Internet made to the 50 million person audience mark in just 4 years!!!

- http://www.ecommerce.gov/emerging.htm
  - Released on April 15, 1998

* Delivered to the President and the U.S. Public on April 15, 1998 by Bill Daley, Secretary of Commerce and Chairman of the Information Infrastructure Task Force



Internet

- Da infrastruttura militare ad infrastruttura di ricerca, ed infine ad infrastruttura commerciale (ma non solo…)
- Basata su TCP/IP
  - Standard “de facto”
  - Aperto
- Libera e Senza regole?

IETF, What is it?

- IETF, Internet Engineering Task Force
- An International Open, Non-Membership Organization
- It is Constituted under the ISOC (Internet Society) Legal Umbrella
- An IETF member is anybody who subscribe to one of the IETF mailing lists and take part in the discussion
- No subscription/acceptance procedures
- Many IETF members never went to an IETF meeting, nevertheless they make very useful contributions to the IETF work

IETF, What is its Scope?

- International Body to define **Internet Standards**, Informational and Procedural Documents
- IETF collaborates with the other International Standard Bodies (ITU, W3C, IEEE, ISO, ETSI...) to avoid overlaps and duplications
- IETF does NOT prepare Policy Regulations !
  - “a domain name is what is defined in RFC 1035”
- IETF requires products interworking, but does not make nor endorse ANY product

IETF, The "IETF Motto"

"We reject kings, presidents and voting. We believe in rough consensus and running code"

IETF, Working Groups

- Working groups, each with a specific charter and a specific scope and limited life:
  - produce technical specification on a specific topic
  - revise the technical specifications
  - control the actual implementations status and interworking
  - progress (or abandon) specifications to “Standard”
  - dissolve when work is finished

IETF, The RFCs

- RFC, Request for Comments
- NOT all RFCs are STANDARDS !
- Informational RFCs (for example BCPs)
- Experimental Status Specifications
- The Standard Track:
  - Proposed Standard
  - Draft Standard
  - Standard (Internet Standard no. xxx)
- Where to get them?
  - ftp://ftp.ietf.org/rfc/
  - ftp://ftp.nic.it/rfc/

IETF, The Internet Drafts (I-Ds)

- They are the “work in progress” documents of the IETF
  - prepared by WGs (with authors - editors)
  - prepared by individuals
  - they may change quite dramatically between versions
  - never “believe” in one of them too seriously!

People@COMICS

- Today around 30 people in the group
- Work spans 2 laboratories:
  - UoN/DIS
    - @ University of Napoli
  - CINI/ITEM
    - a research lab of the Italian University Consortium in Computer Science & Engineering
- Funding mainly from EU, Industry, with some money from national and local government.

COMICS Lab: COMputers for Interaction and CommunicationS

- Research areas:
  - Traffic Measurement and Analysis
  - Network Monitoring
  - QoS in heterogeneous networks
  - Traffic Engineering
  - Wireless Mesh Networks
  - Management and control of network infrastructures
    - SLA, SLS, Policy based management
  - Security, Reliability and Resiliency
  - Multimedia services engineering
  - …

Progetti OS @ DIS/Comics

- Modello cooperativo tra docenti, dottorandi, studenti, collaboratori, aziende
- Creare competenze sulle tecnologie
- Creare valore aggiunto grazie alle competenze acquisite (non vendendo software !!! ☺)
- Piattaforme sviluppate sono su sourceforge oppure liberamente scaricabili dai nostri siti.

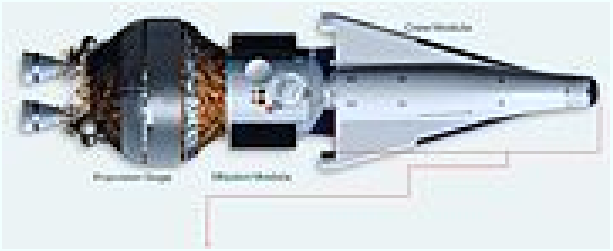
D-ITG, Distributed Internet Traffic Generator

- Traffic Generation and Measurement
  - measure main QoS parameters (*delay*, *jitter*, *packet-loss*, *throughtput*, …) in the presence of "realistic" traffic
  - emulate network applications behavior
  - test real implementations of novel protocols (*IPv6, SCTP, DCCP*,…)
  - easily emulate very complex scenarios …
- Distributed platform with multiple senders/receivers and remote logging
- Capable to emulate traffic statistics of real-world applications
  - VoIP, DNS, Telnet, Network Games, …
- Running on different architectures
  - X86, ARM, XSCALE (Intel IXP)
  - Windows, Linux, Montavista Linux, ..
- Currently used by several research projects all over the world
  - VirginiaTech, Rutgers-Columbia-Princeton, Lucent Bell Labs, IBM Research, …

- D-ITG, http://www.grid.unina.it/software/ITG

D-ITG: some success stories

- A large number of Google Hits !!!
- Slax-tlc
- OSiAN Solution
  (an open source based network solution for African National Research a nd Education Networks .
- Orbit
- The Network Toolkit of CACETechnologies
- Traffic Generator of CISCO certifications learning systems
- D-ITG as a traffic generator for the NASA Crew Exploration Vehicle (CEV) Space communication Link sizing.



Hynetd: Hybrid Network Topology Discovery

- Topology Discovery:
  - Fields of applicability:
    - Fault isolation, performance analysis, network planning, node and service positioning, “topology aware” algorithms, network communications optimization, simulation studies

ø IP level

» Routers, links, subnets

ø Hybrid approach (both active and passive)

ø High accuracy, short discovery time, low intrusiveness

ø Ongoing Work:

» Porting onto embedded platforms (e.g., Intel IXP)

» Distributed Discovery

♦ Planetlab

ø Hynetd, http://www.grid.unina.it/software/TD

Plab

- Measurement and Analysis of Network Traffic
  - Extracting traffic properties at several levels
    - By hosts, conversations, connections, flows, ..
    - At *packet-level*: inter-packet times and payload size
    - Header inspection
    - Payload inspection
  - Traffic characterization and modeling, user/application profiling, anomaly detection, ..
- A flexible architecture:
  - running on Linux, FreeBSD, MacOS-X
  - capable to rapidly analyze traces of hundreds of millions packets
  - enriched with several filtering capabilities (*tcpdump*-style, by payload, by time, …)

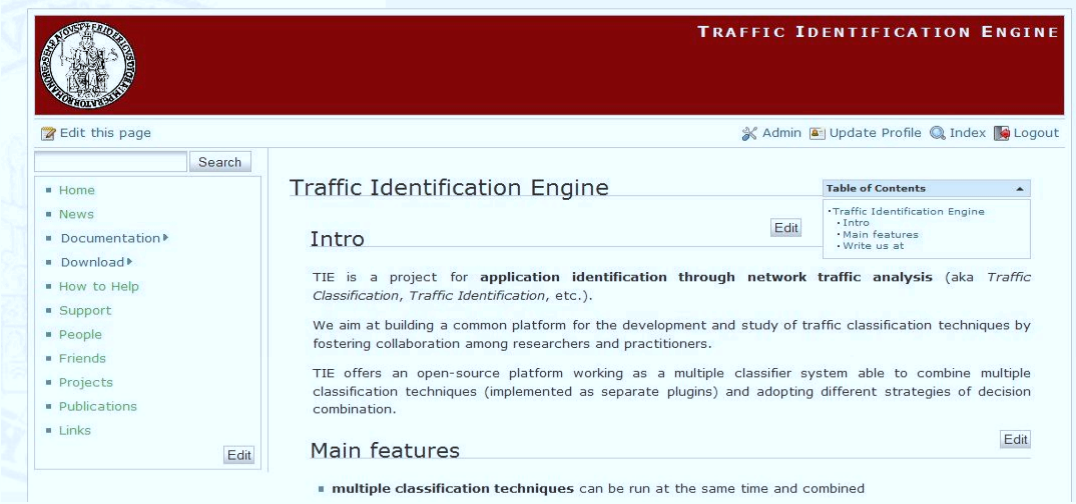
ø Plab, http://www.grid.unina.it/software/Plab

TIE: Traffic Identification Engine

- A platform working as a multiple classifier system
- Purpose: to allow the community to work with *shared tools and data* to investigate several aspects of traffic classification
  - Offline, Online, historical web reports
  - Easy to add: classification techniques, classification features, combination strategies
  - Programming API and documentation. Users mailing list.
  - Anonymized Traces with GT data
  - Code to the data

TIE: Traffic Identification Engine

- TIE is a *community-oriented* project for traffic classification



- Project started in 2007. Collaborations too!

caida

http://tie.comics.unina.it

IMS based services: CONFIANCE & DCON

- CONFIANCE: CONFerencing IMS-enabled Architecture for Next-generation Communication Experience
  - Open source implementation of the IETF XCON Framework, compliant with the IMS specification
    - Extends RFC 4353
      - Protocol-agnostic (not only SIP)
      - Data Sharing (not only audio/video)
    - Suite of Protocols: Conference Control (CCMP), Floor Control (BFCP), Call Signaling (SIP/H.323/IAX/etc.), Notification (Event Package)
  - http://sourceforge.net/projects/confiance
- DCON: Distributed Conferencing
  - An extension of CONFIANCE aimed at providing scalability through distribution of components/functionality
  - Based on XMPP-based spreading of information
  - Draft proposal from UoN at the IETF (waiting for time to become ripe…)
  - http://sourceforge.net/projects/dcon

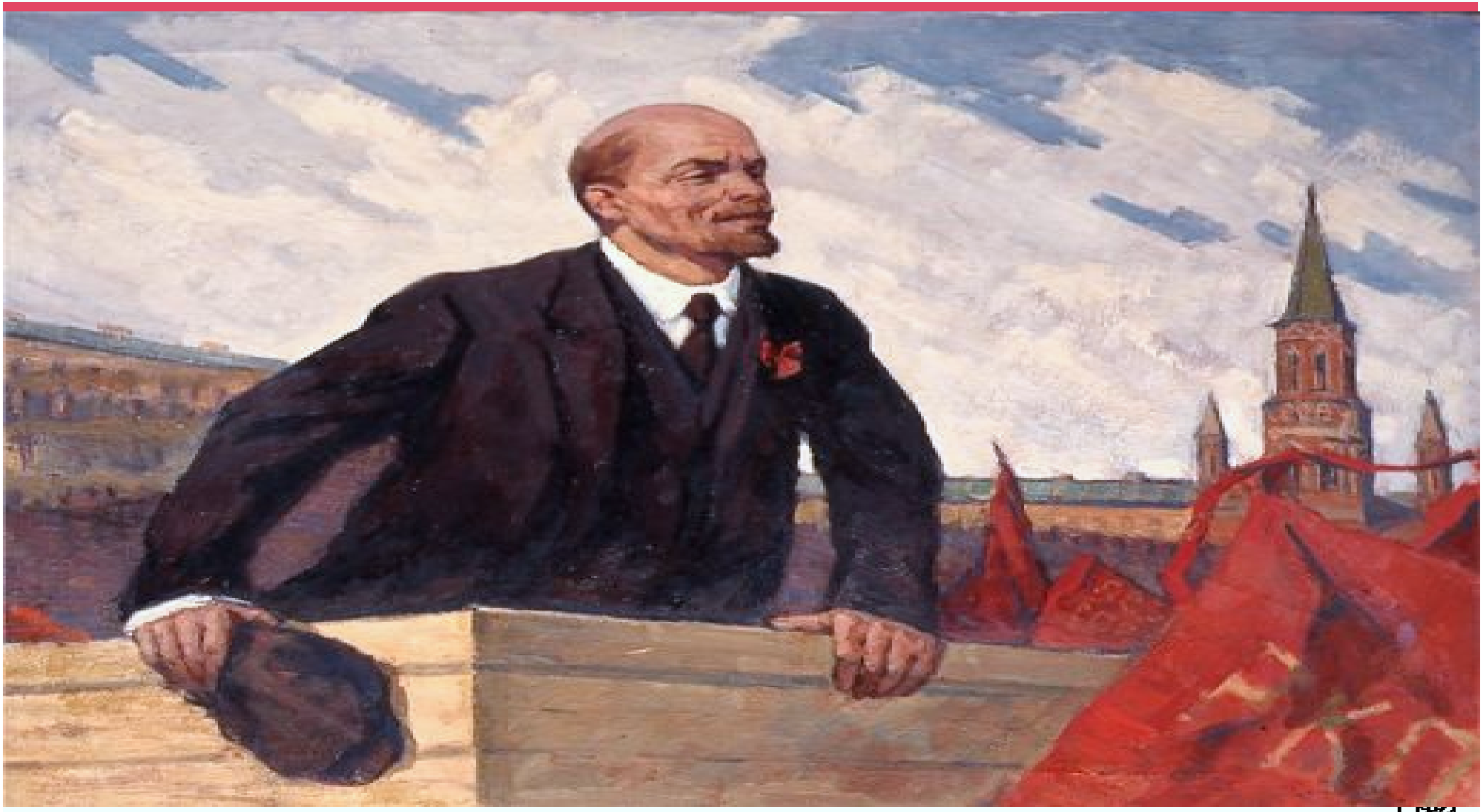
Media Control (IETF mediactrl WG)

- A framework for controlling a Media Server from an Application server
  - Similar to MRFC (Media Resource Function Controller) & MRFP (Media Resource Function Processor) approach in the IMS
  - Exploiting SIP (with so-called COMEDIA negotiation) to establish an ad-hoc mediactrl Control Channel
  - Making use of so-called “control packages” designed for specific applications (conferencing, IVR, etc.)
  - Currently under definition in the IETF:
    - UoN among the most active contributors:
      - Provided an advanced open source prototype of the overall framework
      - See demo slides at the latest IETF meeting in Vancouver:
        - http://www3.ietf.org/proceedings/07dec/slides/mediactrl-3/sld1.htm
      - Sourceforge web site:
        - http://sourceforge.net/projects/mediactrl

Conclusioni

- La ricerca è “aperta” per definizione.
- Noi proponiamo non solo la condivisione di tool (aperti) ma anche quella dei dati.
- I paradossi.

Looking at the future: Hackers, Unite !!!



Reference e Fonti (ufficiali)

- Internet History and Growth, William F. Slater, III Chicago Chapter of the Internet Society September 2002
- IETF In Italy History and Future View, Claudio Allocchio GARR

Domande?