



互联网发展挑战与思考

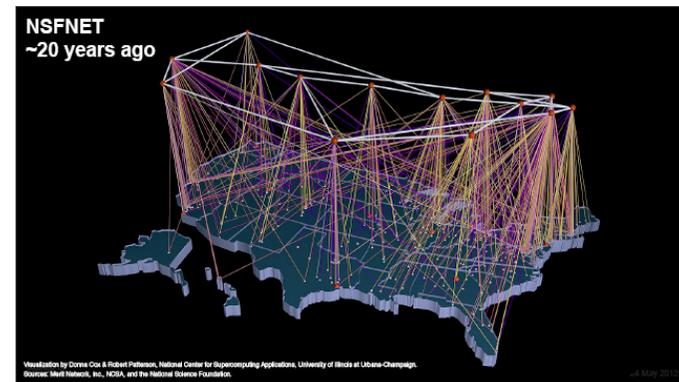
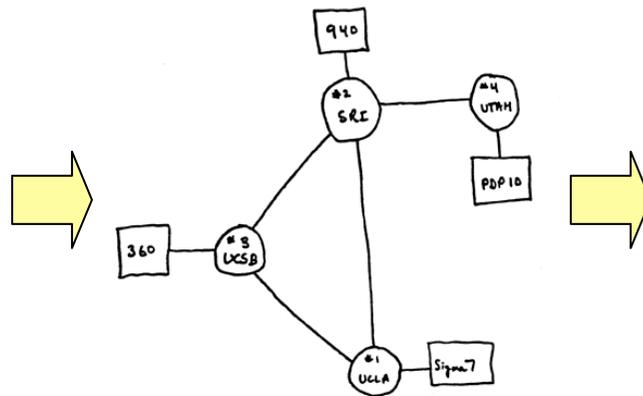
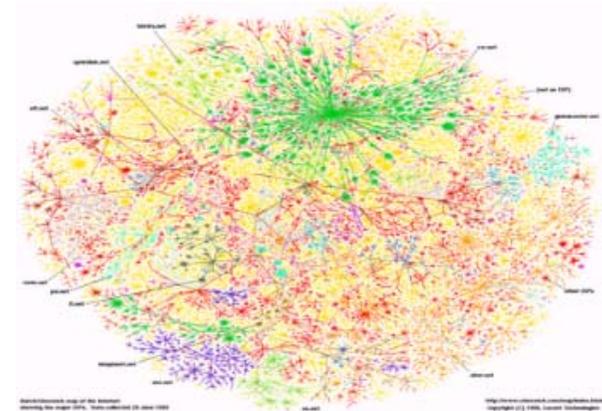
清华大学

李星

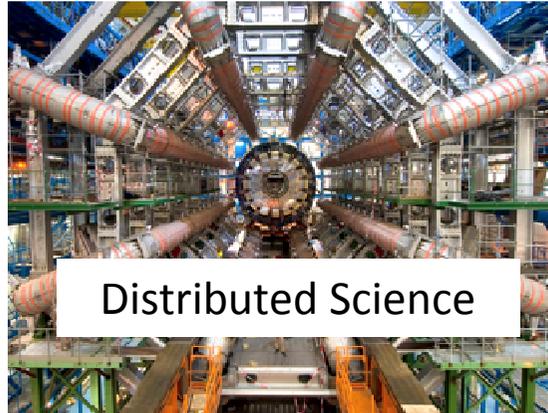
2013-10-12

历史

- 1969 ARPANET (44)
- 1986 NSFNET (27)
- 1995 互联网商业化 (18)
- 2011 IPv4地址耗尽 (2)
- 2013 斯诺登事件



教育面临的挑战



需求的演进

The majority of traffic is now packet

Traffic

Packet

Circuit

Time

Significant proliferation of mobile broadband

Workforce mobility & increased connectivity

Enterprise IT is shifting to the cloud

Servers

Applications

Storage

Video, video and more video

Real-time, low latency applications

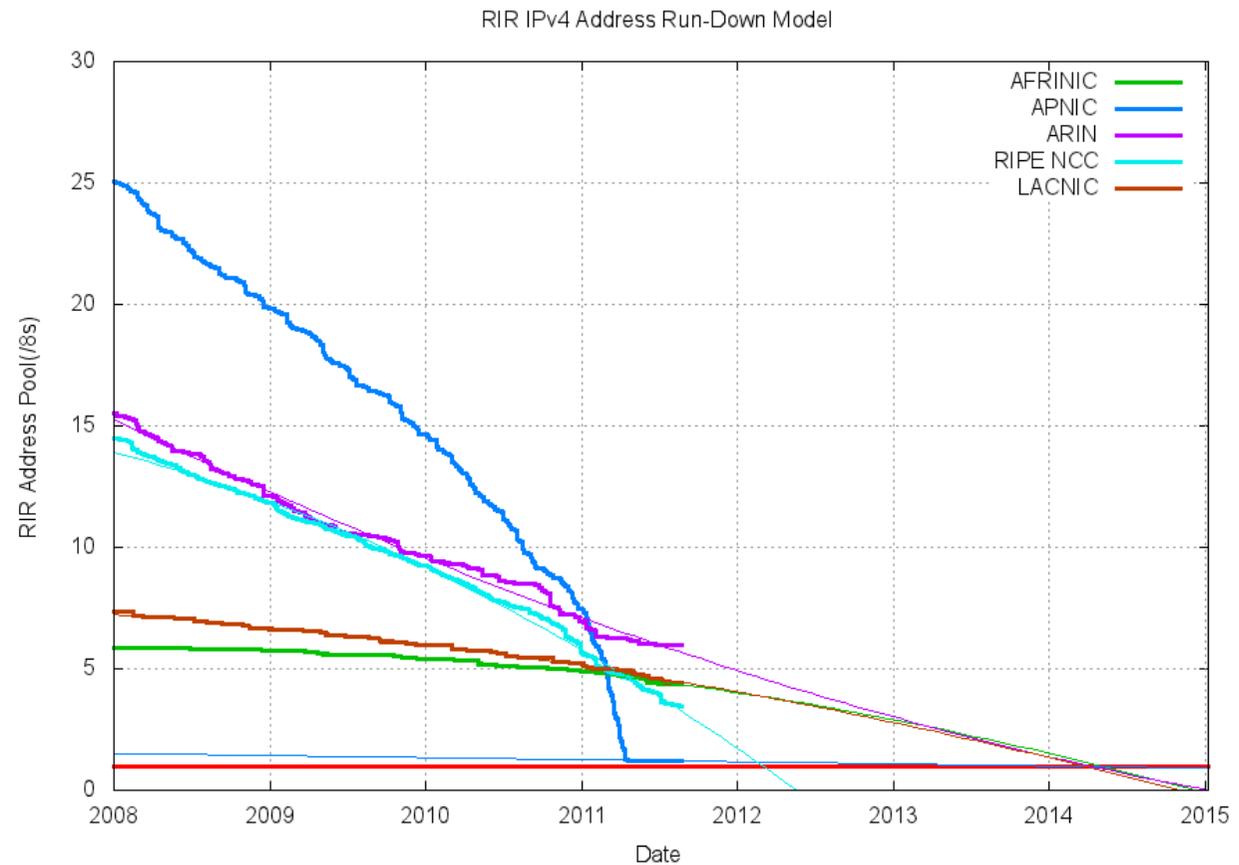
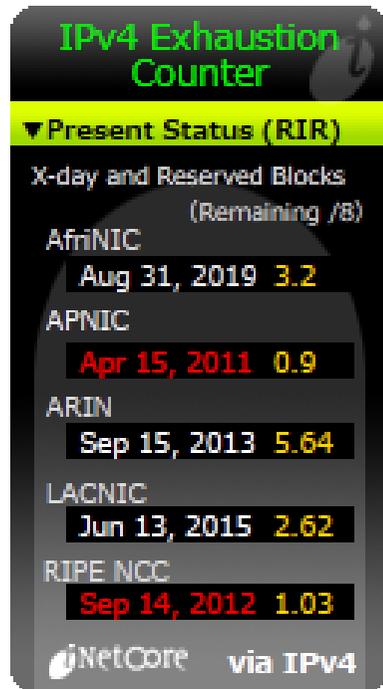
High-frequency trading & other financial apps

Medical imaging & other healthcare apps

Native video transport & other video apps

First we Connected Places, Then People, Then Things

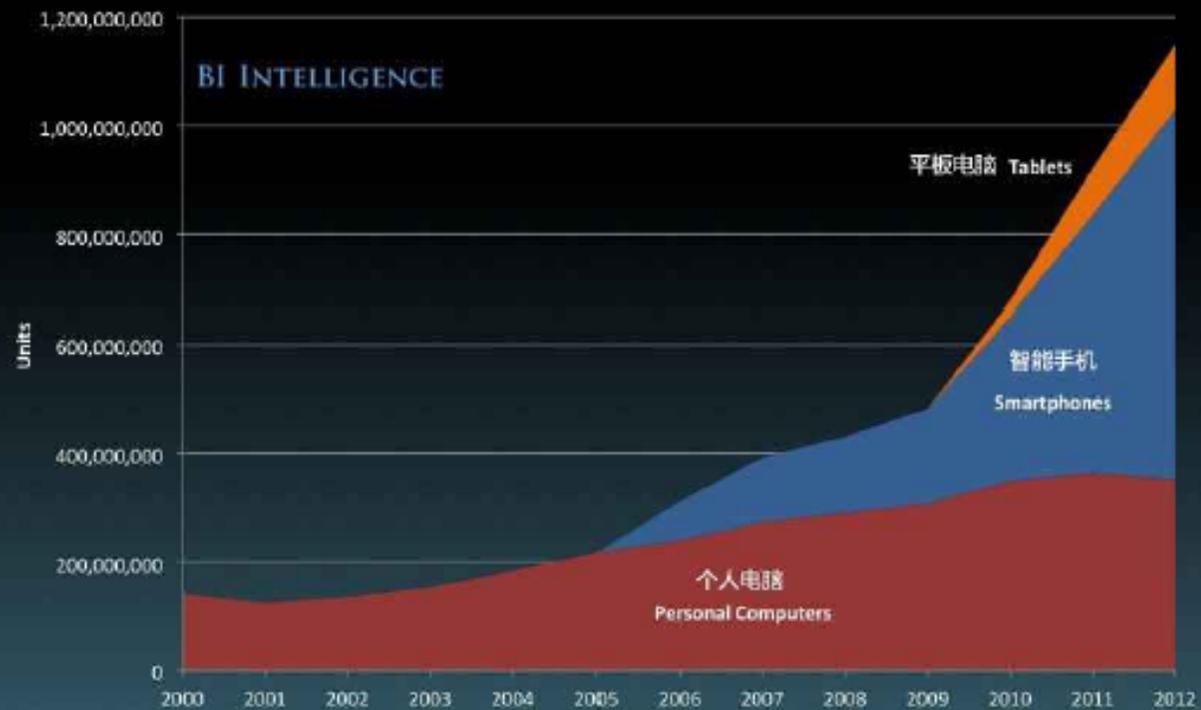
IPv4地址耗尽时间表



移动互联网

现在，移动设备的销量是PC的两倍

全球联网设备出货量



Source: Gartner, IDC, Strategy Analytics, company filings, BI Intelligence estimates

BUSINESS
INSIDER

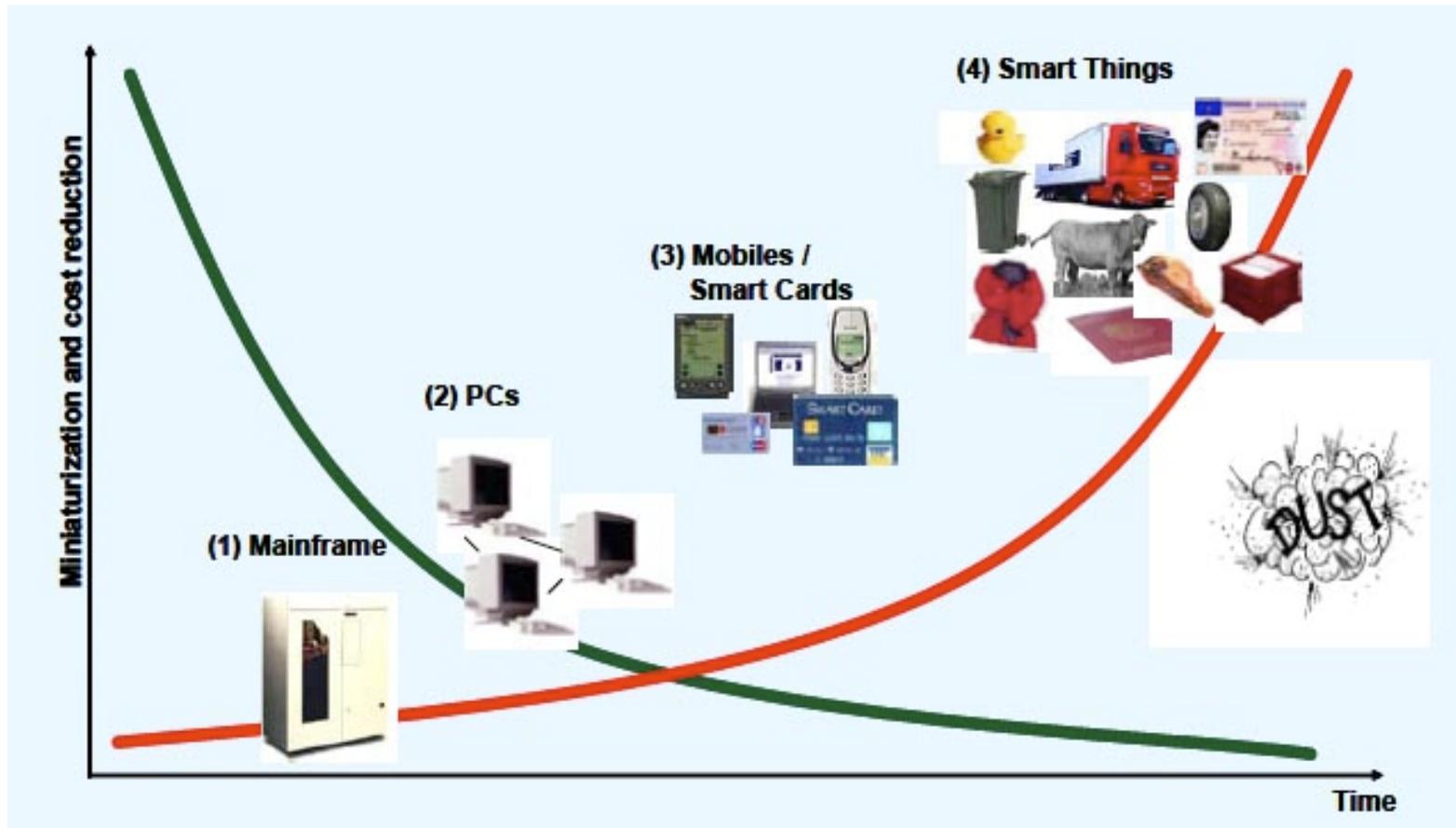
云计算



三网融合



物联网



网络空间战

Rapid and agile IT infrastructures with the capability to “discover” adjacent network systems and plug-n-play enable quicker, more dynamic responses..



Ubiquitous, robust and scalable end-to-end networks enable integrated operations.



Proliferation of IP-addressed sensors, munitions, logistics tracking, applications, ... will enhance situational assessments and information availability.

IPv6 Enabled Battlefield of the Future

Real time collaboration using integrated voice, video and data capabilities enabled by performance and QoS improvements.



Dynamic formation of COIs supported by improved multicasting.



Increased OPTEMPO supported by **rapid reorganizational capabilities, shared situational awareness and improved wireless and mobility support.** Support for communications on the move.



End-to-end security, authentication and non-repudiation will enable new IA strategies that support mission assurance.

国际化

Globalization: The higher ed world is getting smaller



NEW YORK UNIVERSITY



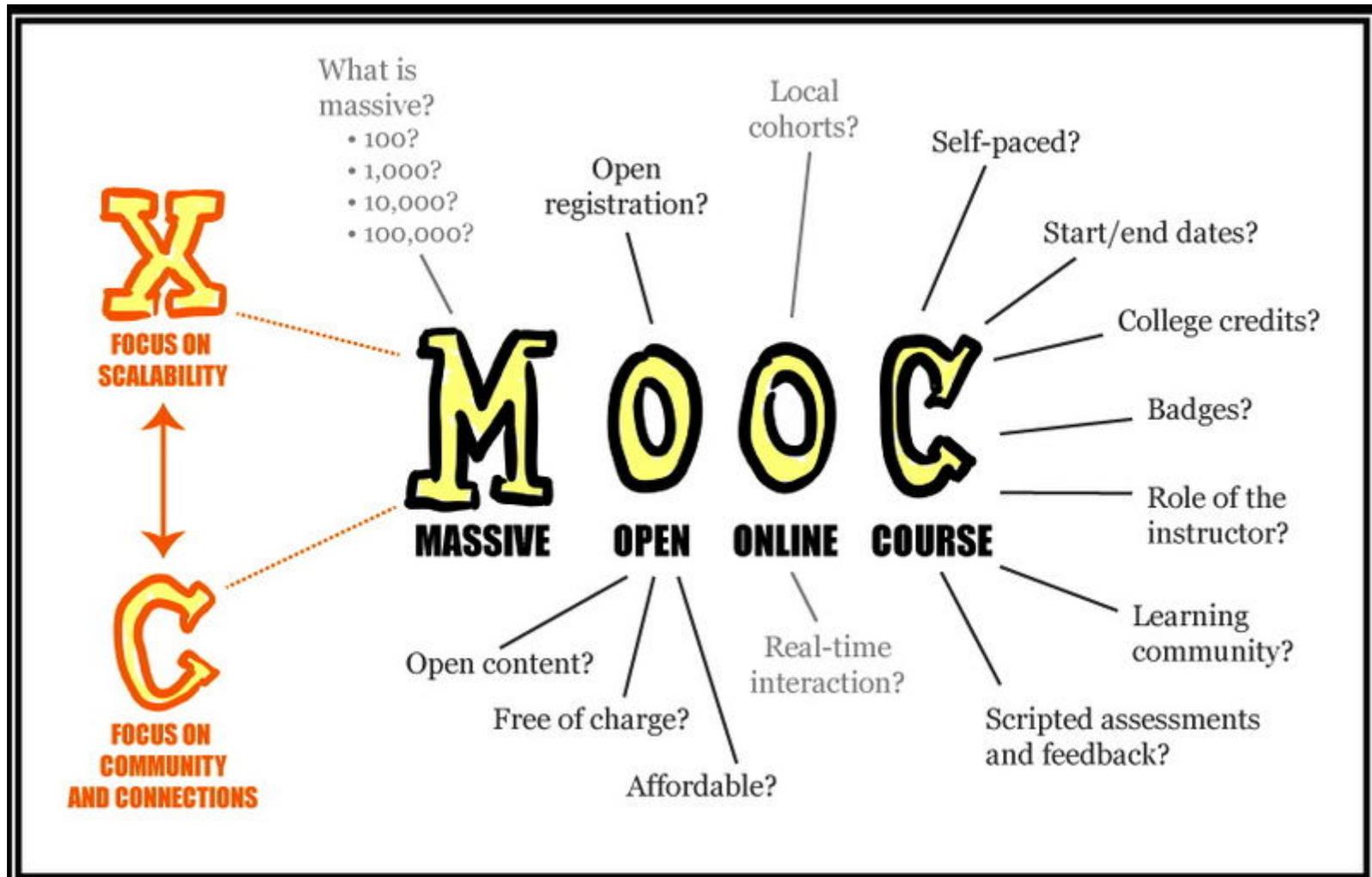
DUBAI
INTERNATIONAL
ACADEMIC CITY

28 - © 2012 Internet2



SPRING 2012 INTERNET2 MEMBER MEETING Arlington, Virginia, April 22-25, 2012

Massive open online course

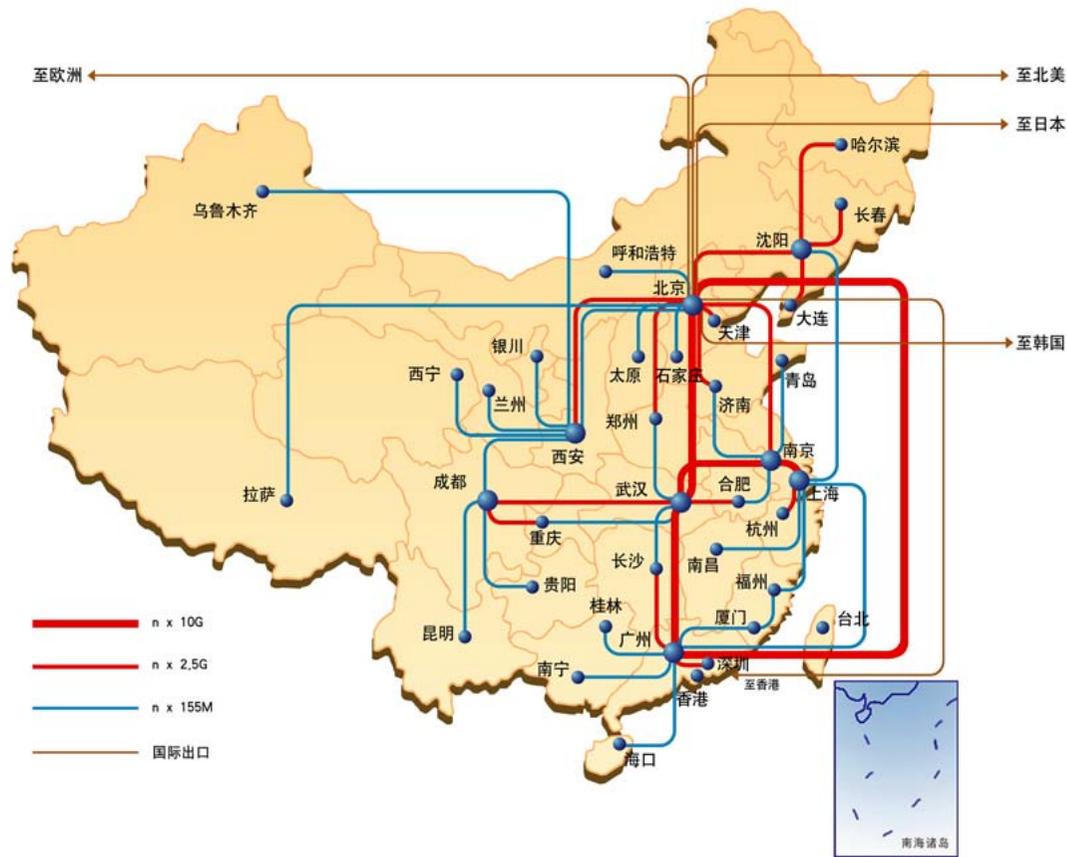


NET+

Internet2 NET+ Services: Four phases

| Research Incubator | Service Validation | Early Adopter | General Availability |
|---|--|---|--|
| Trial phase for development from concept to early service. Limited expectation of production pilot from "as is" state | Member CIOs as steering committee. Proof of concept, tuning of service, and development of business model. | Capped number of participating institutions. Business model finalized. Master contract developed. | Full availability to target community. Contracts signed and service level agreements in place. |

CERNET (IPv4)



- CERNET建于1994年
- CERNET 在全球IPv4 CIDR的报告排名26.
- 大约2000所高校联网

高校综合实力与网络使用率的排名

06 06

2006 中国大学研究生院前 100 名综合实力一览表

含各大学研究生部、研究生处、研究生学院、研究生培养办公室等

《中国大学评价》课题组 武书连、吕嘉、郭石林

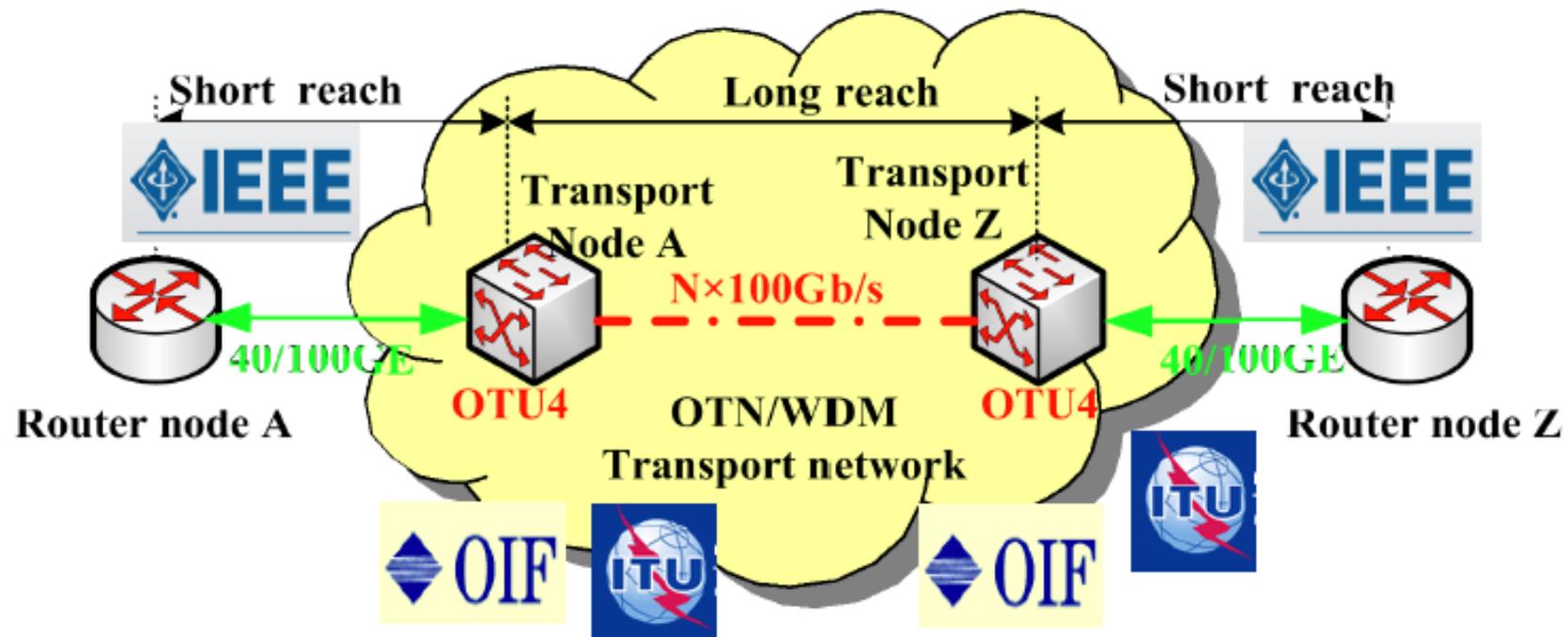
| 排名 | 校名 | 综合 | 学科门 | 分省 | 学校类型 | | | | | | | | | | | | | | |
|----|----------|----|-----|-----|------|-----|----|-----|-----|-----|-----|-----|-----|-----|-----|----|---|----------|----------|
| 1 | 清华大学 | | | | 理工 | | | | | | | | | | | | | | |
| 2 | 北京大学 | | | | 综合 | | | | | | | | | | | | | | |
| 3 | 浙江大学 | | | | 综合 | | | | | | | | | | | | | | |
| 4 | 上海交通大学 | | | | 综合 | | | | | | | | | | | | | | |
| 5 | 复旦大学 | | | | 综合 | | | | | | | | | | | | | | |
| 6 | 南京大学 | | | | 综合 | | | | | | | | | | | | | | |
| 7 | 华中科技大学 | | | | 理工 | | | | | | | | | | | | | | |
| 8 | 中山大学 | | | | 综合 | | | | | | | | | | | | | | |
| 9 | 武汉大学 | | | | 综合 | | | | | | | | | | | | | | |
| 10 | 中国科学技术大学 | | | | 综合 | | | | | | | | | | | | | | |
| 11 | 四川大学 | | | | 理工 | | | | | | | | | | | | | | |
| 12 | 吉林大学 | | | | 综合 | | | | | | | | | | | | | | |
| 13 | 西安交通大学 | | | | 综合 | | | | | | | | | | | | | | |
| 14 | 哈尔滨工业大学 | | | | 理工 | | | | | | | | | | | | | | |
| 15 | 山东大学 | | | | 综合 | | | | | | | | | | | | | | |
| 16 | 南开大学 | | | | 综合 | | | | | | | | | | | | | | |
| 17 | 天津大学 | A | A | B+ | C+ | A++ | E+ | E+ | D | C | E+ | C | D+ | - | A | 理 | 2 | 985 工程大学 | |
| 18 | 北京师范大学 | A | B+ | A++ | A | C+ | E+ | E | A | B+ | B+ | A++ | A++ | A++ | A | 京 | 3 | 985 工程大学 | |
| 19 | 中国协和医科大学 | A | A | E | B+ | D+ | - | A++ | E | - | - | - | - | - | - | 京 | 4 | 211 工程大学 | |
| 20 | 中南大学 | A | A | B | B | A | - | A | B | C | C+ | C+ | C+ | C+ | E | B+ | 湘 | 1 | 985 工程大学 |
| 21 | 中国人民大学 | A | E+ | A++ | E+ | E+ | - | - | A++ | A++ | A++ | - | A+ | A+ | A++ | 京 | 5 | 985 工程大学 | |

2007 中国大学排行榜十强名单 评论

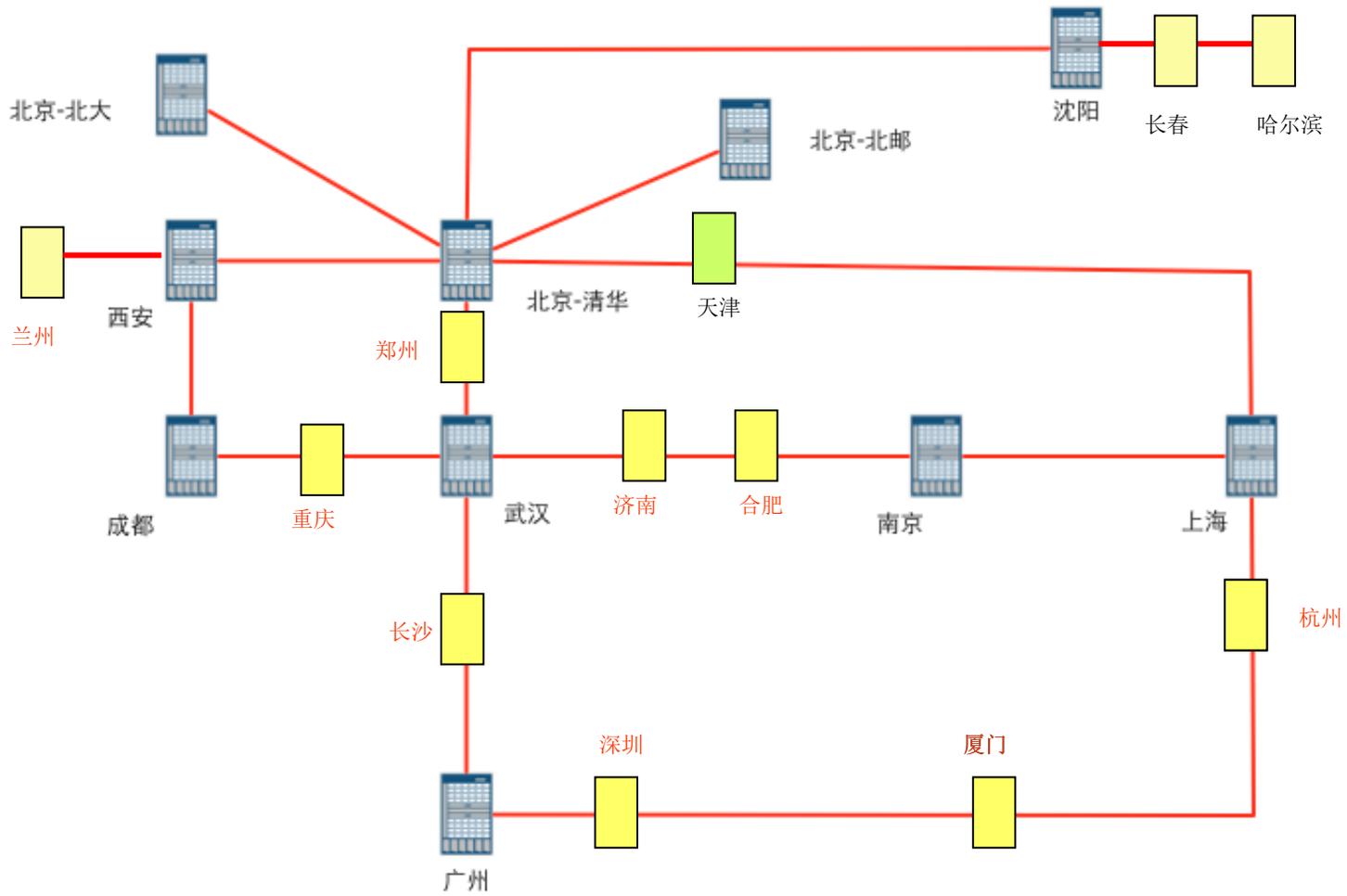
| 排名 | 校名 | 总得分 | 人才培养 | | | 科学研究 | | | 分省排名 | 学校类型 |
|----|------|--------|--------|-------|-------|--------|--------|--------|------|------|
| | | | 得分 | 研究生培养 | 本科生培养 | 得分 | 自然科学研究 | 社会科学研究 | | |
| 1 | 清华大学 | 296.77 | 128.92 | 93.83 | 35.09 | 167.85 | 148.47 | 19.38 | 京 1 | 理工 |
| 2 | 北京大学 | 222.02 | 102.11 | 66.08 | 36.03 | 119.91 | 86.78 | 33.13 | 京 2 | 综合 |
| 3 | 浙江大学 | 205.65 | 94.67 | 60.32 | 34.35 | 110.97 | 92.32 | 18.66 | 浙 1 | 综合 |
| 4 | 上海交大 | 150.98 | 67.08 | 47.13 | 19.95 | 83.89 | 77.49 | 6.41 | 沪 1 | 综合 |
| 5 | 南京大学 | 136.49 | 62.84 | 40.21 | 22.63 | 73.65 | 53.87 | 19.78 | 苏 1 | 综合 |
| 6 | 复旦大学 | 136.36 | 63.57 | 40.26 | 23.31 | 72.78 | 51.47 | 21.31 | 沪 2 | 综合 |
| 7 | 华中科大 | 110.08 | 54.76 | 30.26 | 24.50 | 55.32 | 47.45 | 7.87 | 鄂 1 | 理工 |
| 8 | 武汉大学 | 103.82 | 50.21 | 29.37 | 20.84 | 53.61 | 36.17 | 17.44 | 鄂 2 | 综合 |
| 9 | 吉林大学 | 96.44 | 48.61 | 25.74 | 22.87 | 47.83 | 38.13 | 9.70 | 吉 1 | 综合 |
| 10 | 西安交大 | 92.82 | 47.22 | 24.54 | 22.68 | 45.60 | 35.47 | 10.13 | 陕 1 | 综合 |

清华大学
北京大学
上海交通大学
山东大学
吉林大学
暨南大学
电子科技大学
华南理工大学
华中科技大学
北京邮电大学
东北师范大学
厦门大学
北京航空航天大学
新疆大学
华南师范大学
中山大学
四川大学
郑州大学
上海大学
黄河科技大学
武汉大学
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北京大学医学部(北京)
西北工业大学
华中科技大学赛尔宽带
河北工业大学
北京理工大学
成都理工大学

Technology and standard



CERNET 100G主干网



Mozilla Firefox

文件(F) 编辑(E) 查看(V) 历史(S) 书签(B) 工具(T) 帮助(H)

http://202.38.97...ate2=2013100607 x plot x plot x plot

202.38.97.82:8036/cgi-bin/hour.pl?class=bj-wh-100g-sum.m.log&date1=2012010808&date2=2013100607

访问最多 CERNET Network M... 新手上路 最新头条

2012010808 - 2013100607

```

bj-wh-100g-sum.m.log in. act= 11.3008G (7810/8222) [max= 21.3408G med= 5.19674G min= 0 ] {ave= 5.26791G dev= 3.36449G skw= 0.410747 }
bj-wh-100g-sum.m.log out act= 18.8203G (7810/8222) [max= 35.5072G med= 7.67327G min= 0 ] {ave= 8.0817G dev= 5.77003G skw= 0.661109 }

bj-wh-100g-sum. 101922 5.37164e+09 6.83724e+09
bj-wh-100g-sum. 100606 3.62563e+09 3.826e+09

```

[data](#)

bj-wh-100g-sum.n.log

bj-wh-100g-sum.n.log

202.38.97.82:8036/cgi-bin/h-past.pl?lag=30&class=bj-wh-100g-sum.m.log

查找: q1r0p-12 下一个(N) 上一个(P) 全部高亮显示(A) 区分大小写(C) 到达页尾, 从页首继续

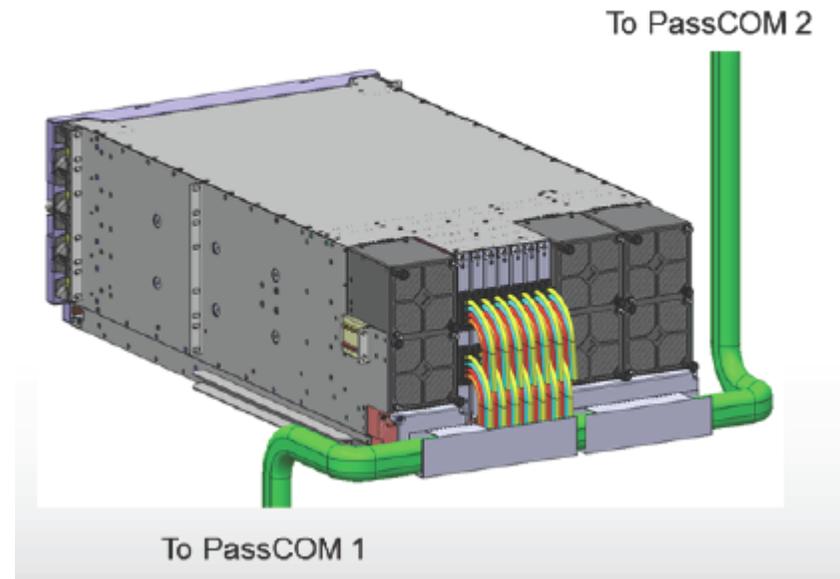
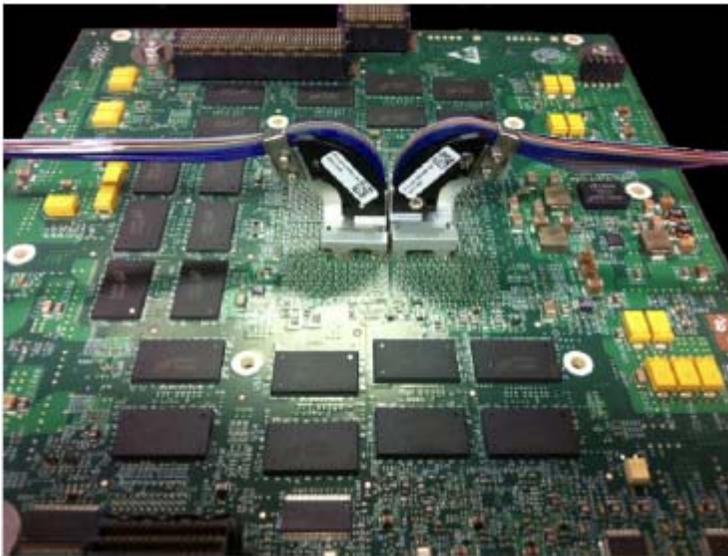
100% 7:50

Silicon photonics (1)

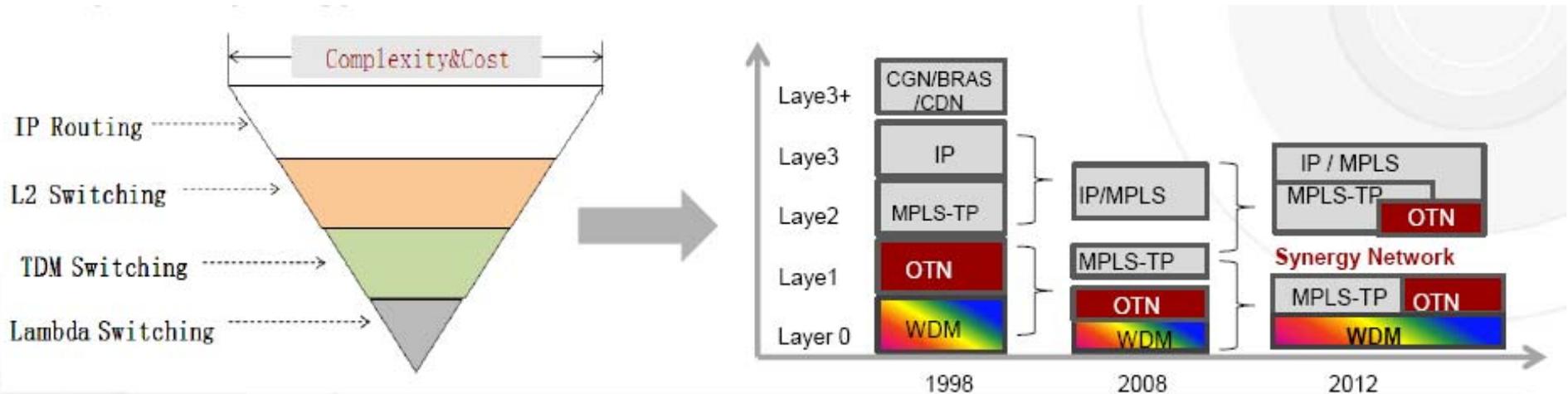


Compass EOS (The chip-to-chip direct silicon-to-photonics solution) for testing

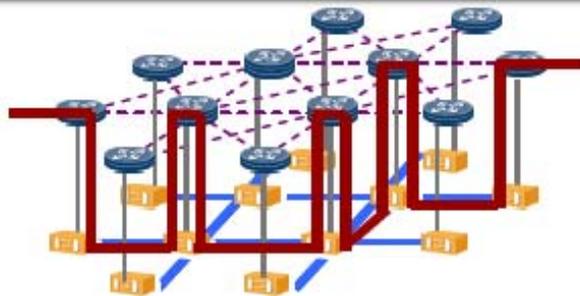
Silicon photonics (2)



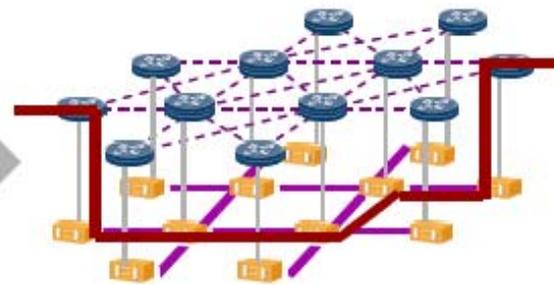
ROADM



Proposal: SingleBackbone with IP + Optical Synergy



Multi hops wasting router resources

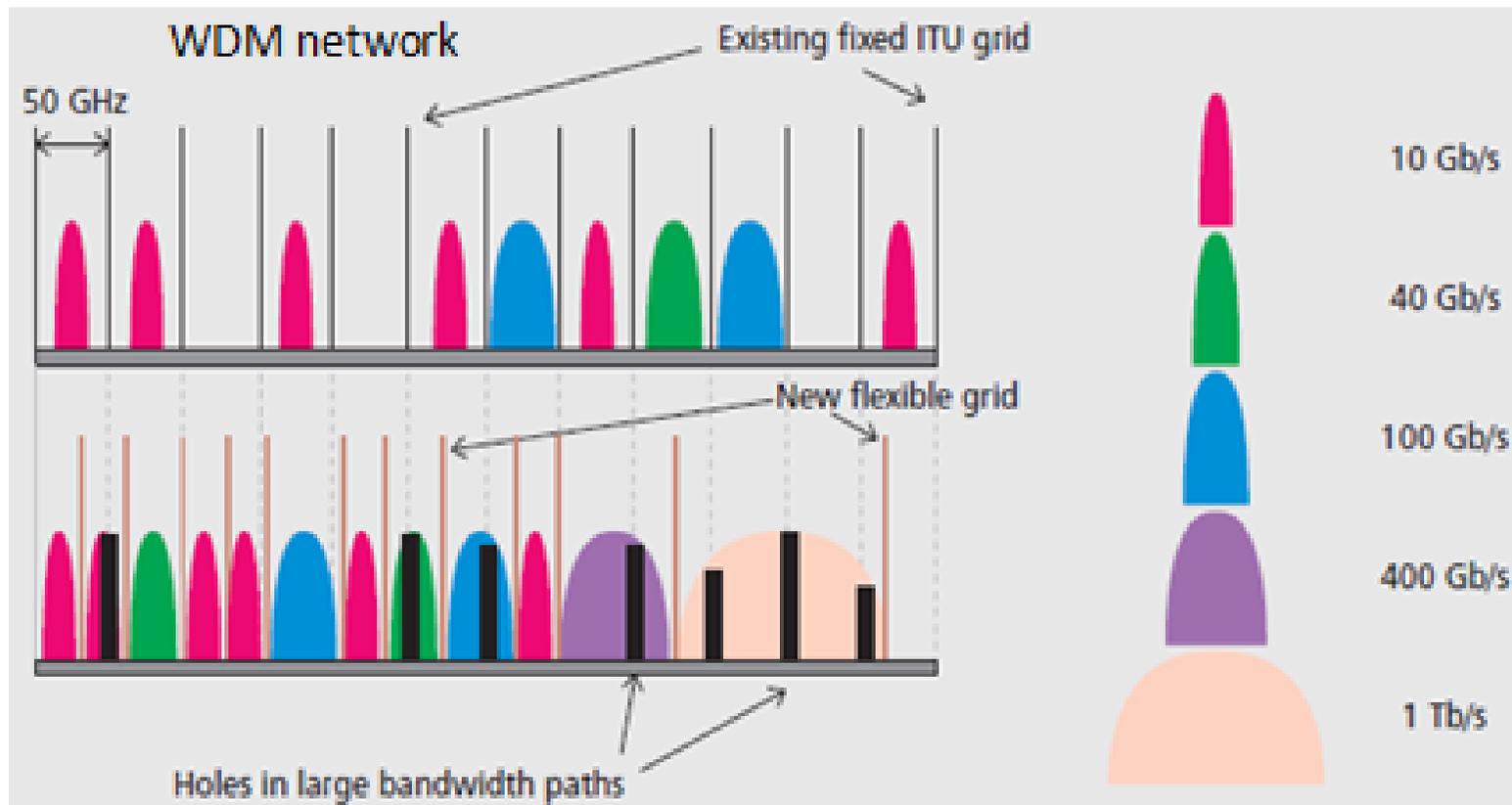


Fewer Router Hops

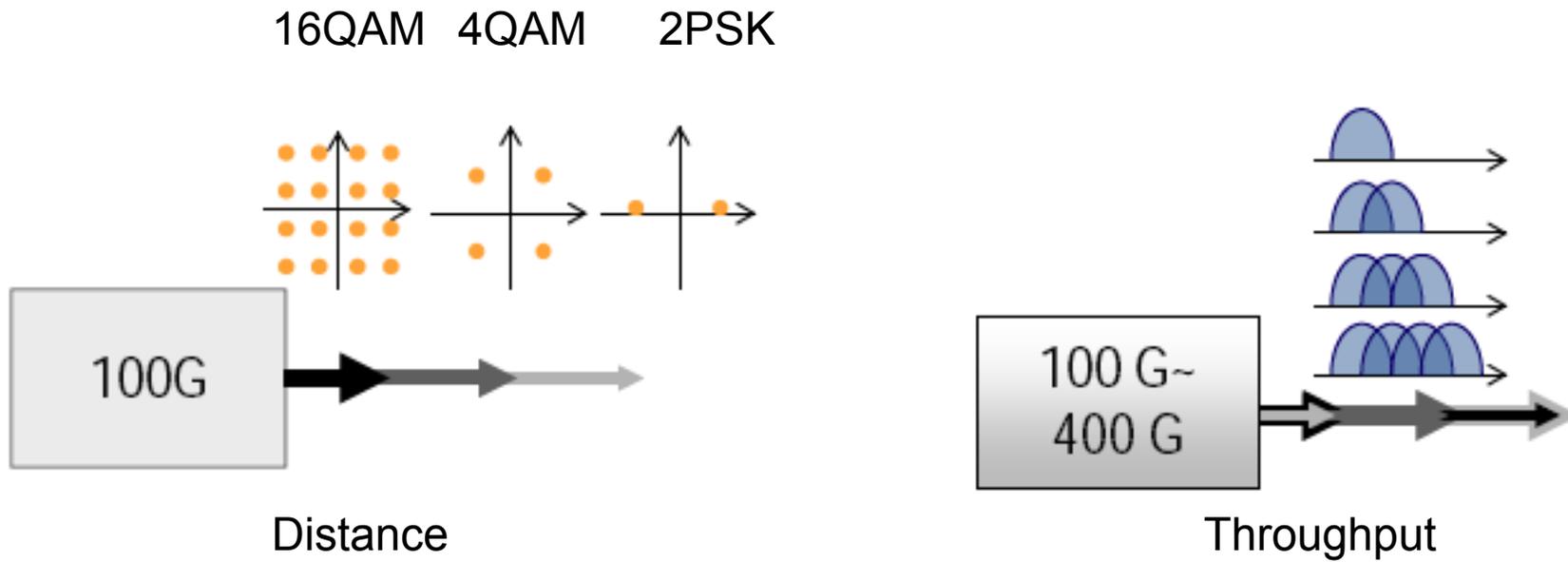
Investment in backbone for 3 years

50%

400G



Flexgrid



CNGI-CERNET2 (IPv6)



- CNGI-CERNET2 建于2004年
- CNGI-CERNET2 是全球最大的IPv6 主干网之一
- 大约200所高校联网

未来网络研究

电路交换

ISDN

虚电路交换

X.25

FR

ATM

无连接分组交换

IPv4

80/443

IPv6

FI

IP

OSI

非IP

IPX

SNA

AppleTalk

DECNET

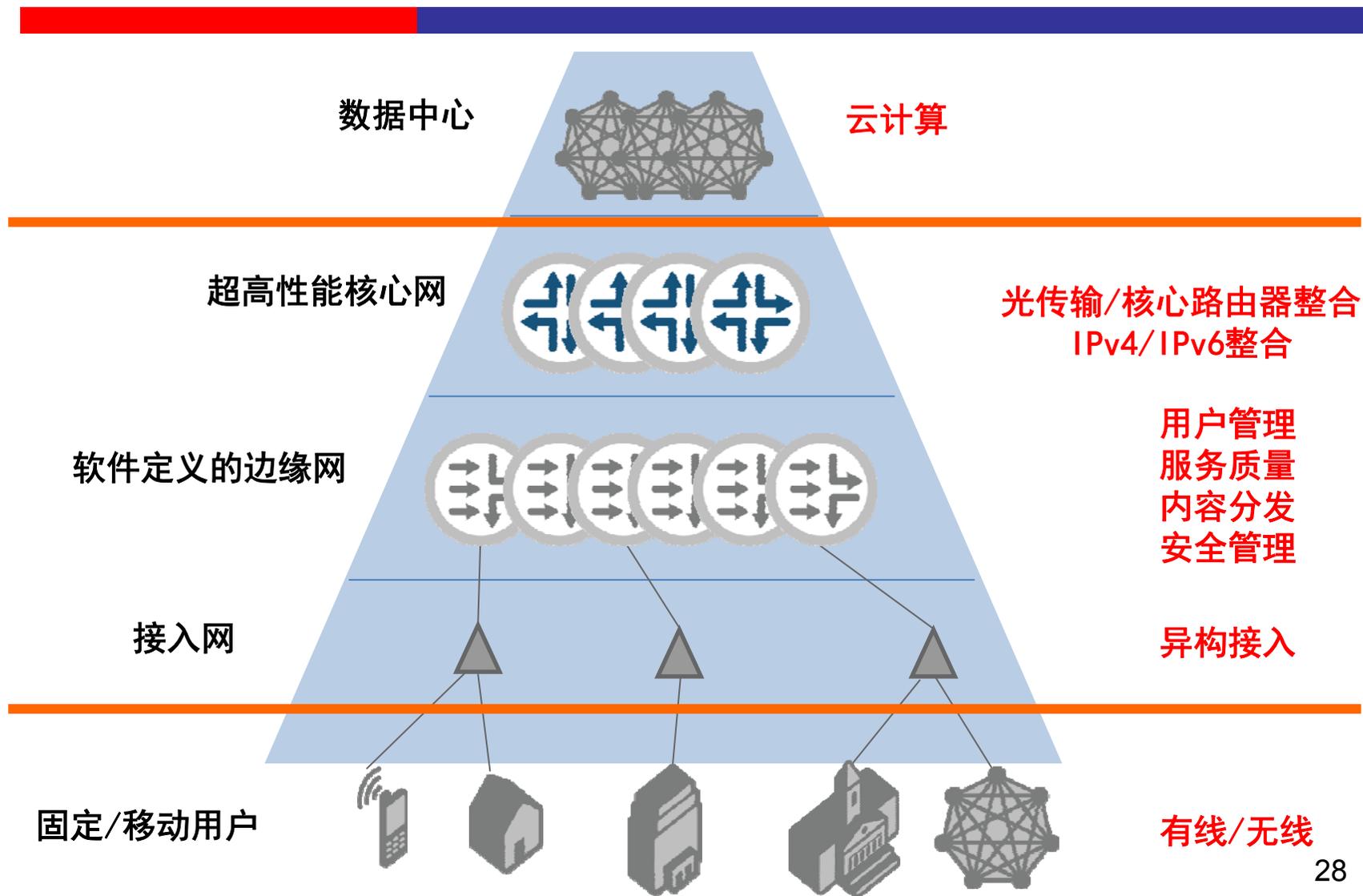
FN

网络基础设施需求

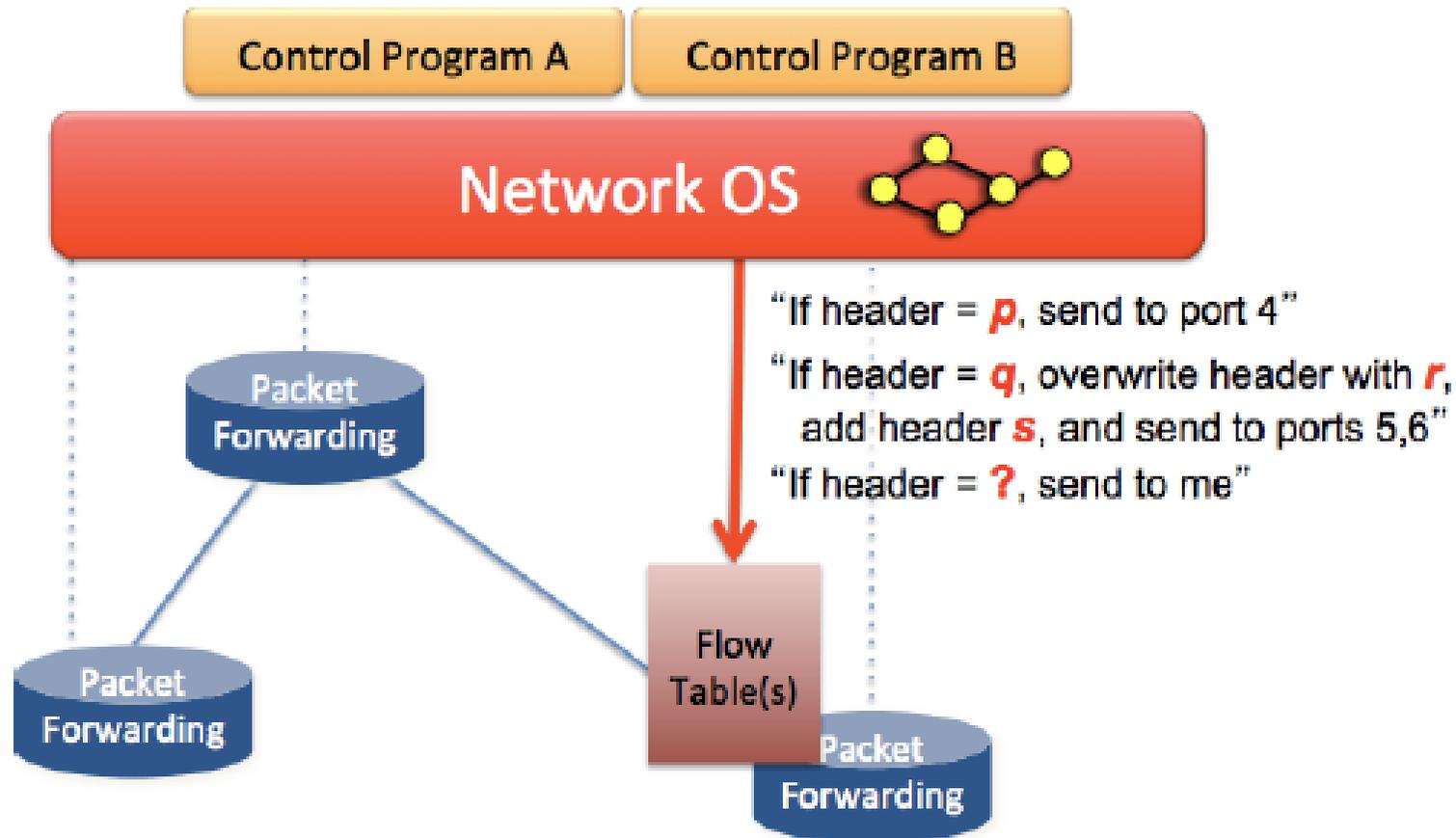
- 高速
 - 10G/40G/100G
- 安全
 - DMZ
 - VPN
 - IDC
 - user
- 移动
 - WLAN
- 泛在
 - IoT

SDN

网络结构



软件定义的网络



分析



- IPv6过渡技术
- 网络安全和开放源码
- 设计思想和人才培养

地址需求

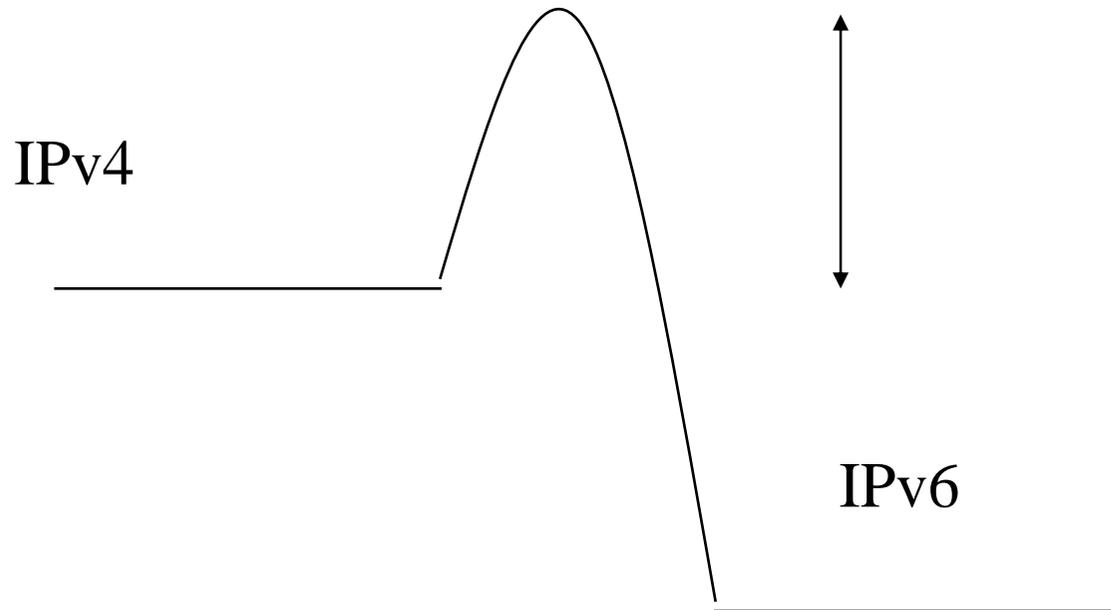
- 互联网普及率
 - CNNIC (2012.12) : 42.1% (5.64亿)
 - 发达国家: 70-80%
- 移动互联网
 - 3G/4G
 - WLAN
 - 微信 (信令爆炸)
- 云计算
 - 不能用私有地址
- 物联网
 - 100亿电灯泡

地址分配第三阶段：一次性1024个IPv4地址
地址交易：每个地址\$12

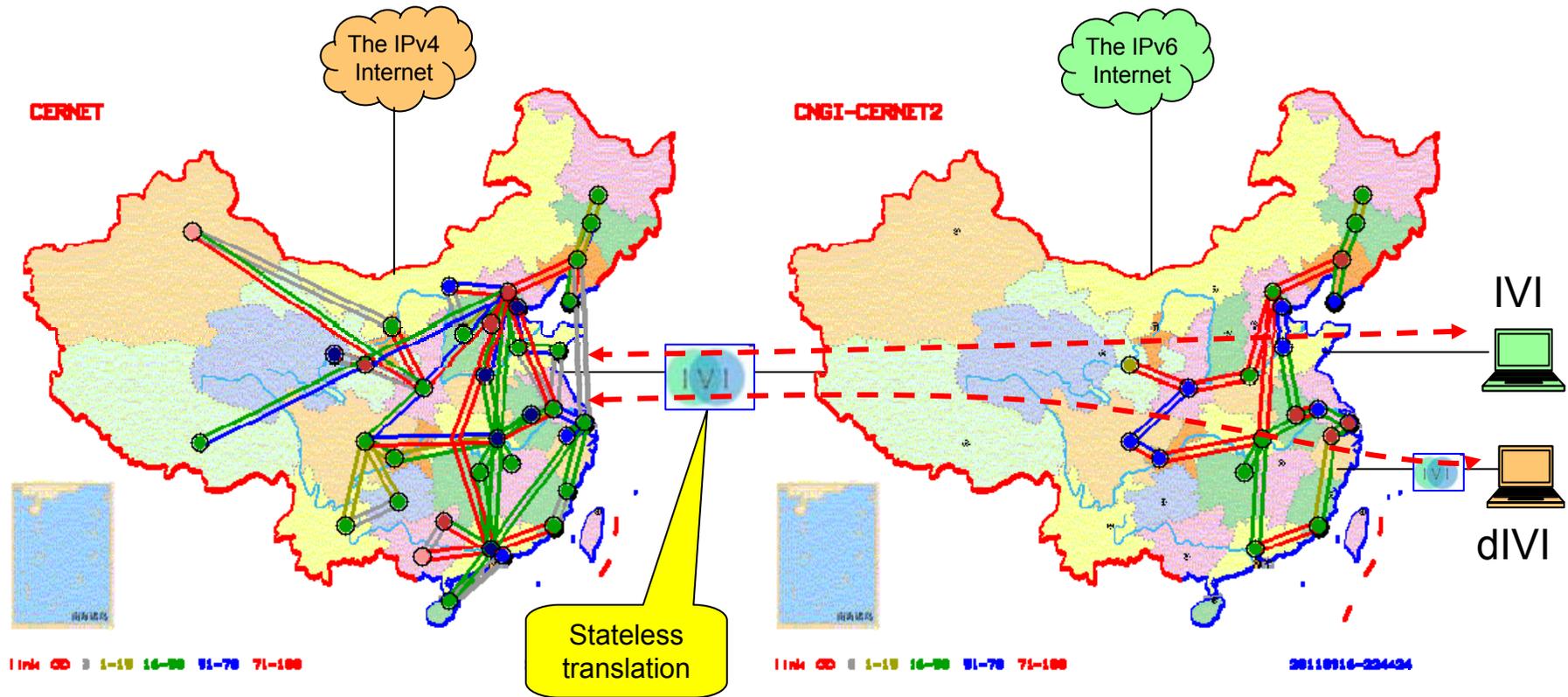
NAT44网络地址转换

- 优点：
 - 可以减少IP地址的消耗，并带来一定的安全性。
- 缺点：
 - 单向性，破坏了IP的端到端模式。
 - 降低了网络性能，增加了网络的时延，在网络很大的时候，会成为通信的瓶颈。
 - 一旦NAT网关遭受攻击，整个网络就会瘫痪，增加了安全风险。
 - 两个使用NAT的内部网络合并时需要重新编址。
 - 当一个网络中存在多个NAT设备时，这些设备的同步和协调变得非常困难。

过渡的代价



CERNET/CNGI-CERNET2



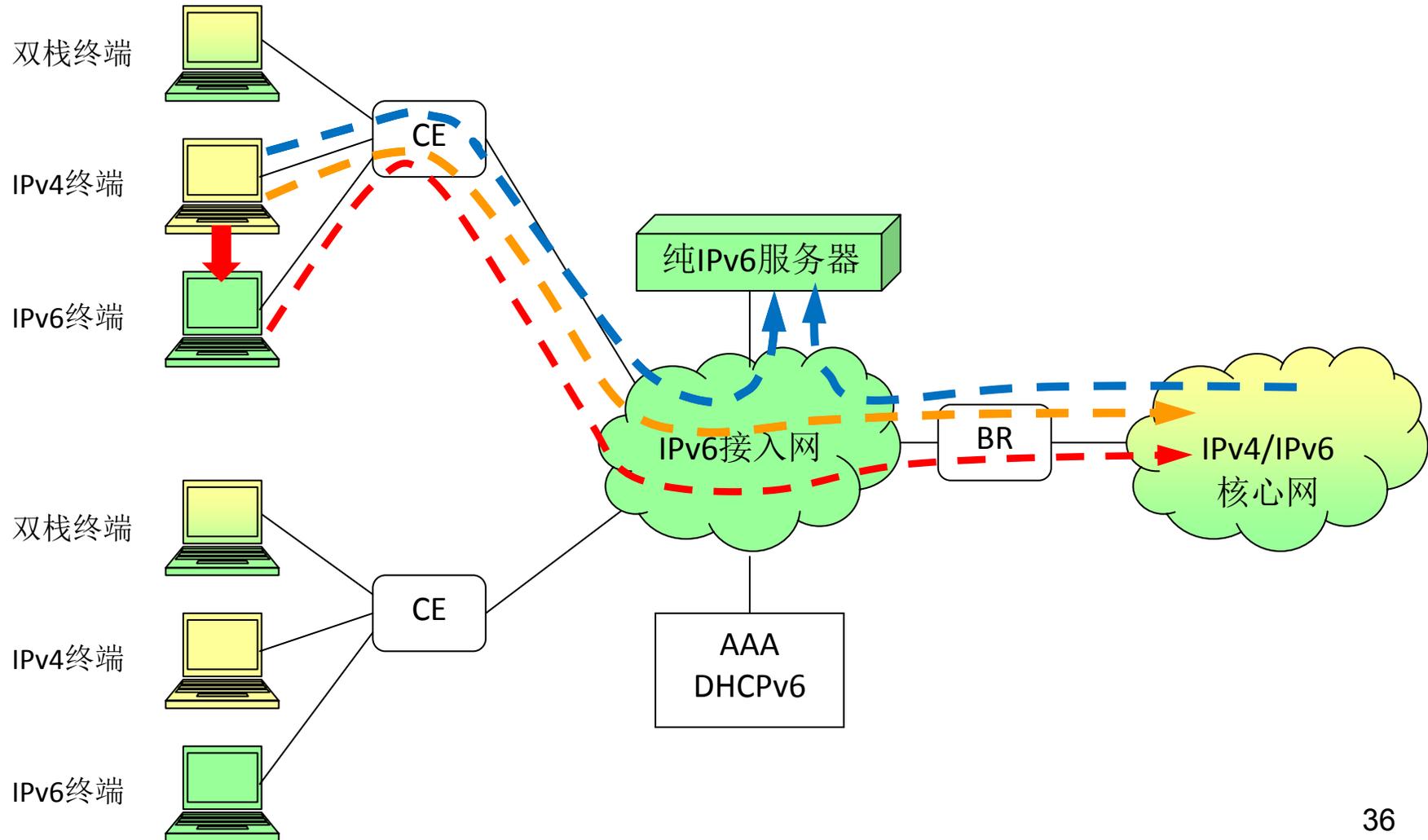
IPv4

IPv6

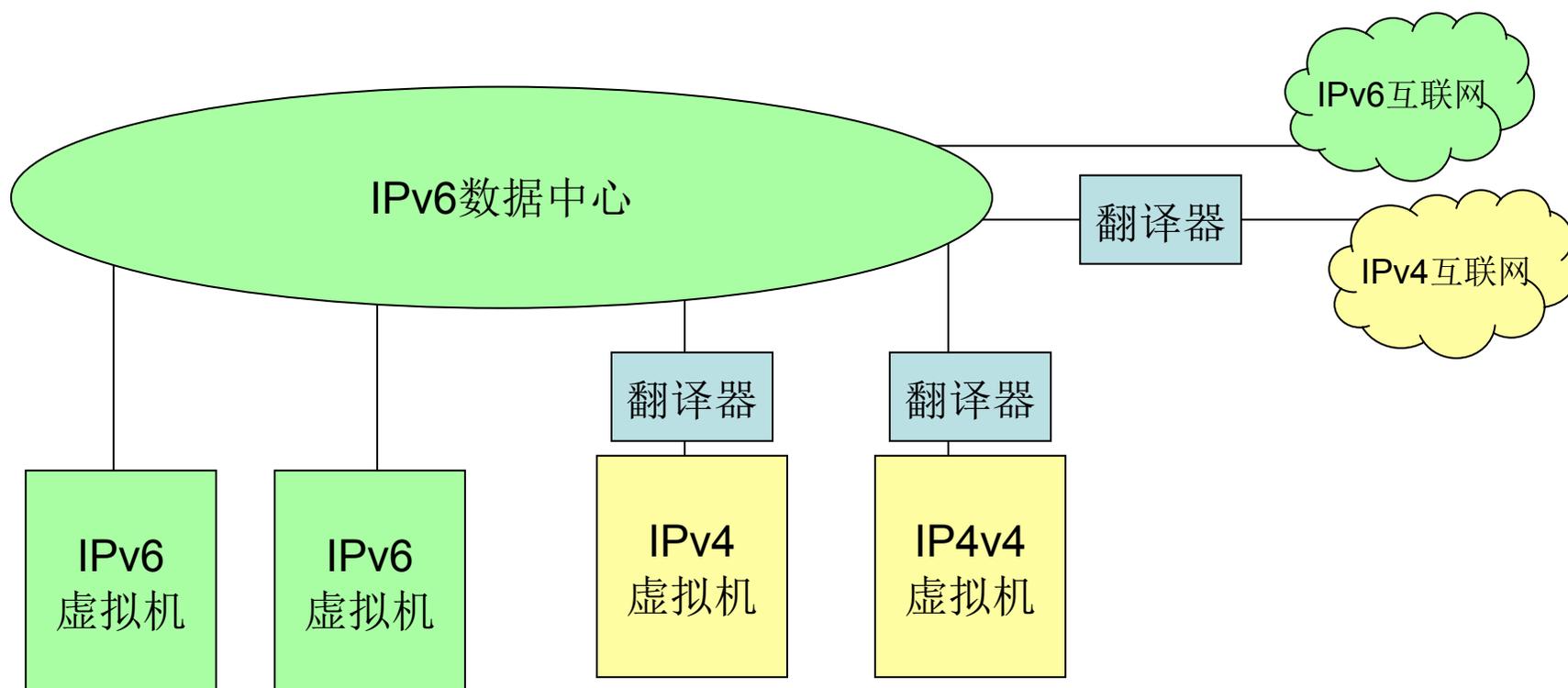
我国发展下一代互联网的 路线图和时间表

- **2003-2010：准备阶段（技术试验与试商用）**
 - 启动中国下一代互联网示范工程**CNGI**
 - 政府引引导，进行技术、人才、产业准备
 - 首先在高校开展试商用，为大规模商用做准备
- **2011-2015：过渡阶段（开展大规模商用）**
 - 政府引导全社会向**IPv6**过渡，**IPv4**与**IPv6**共存
 - 新建网络必须为**IPv6**，并实现与**IPv4**的互通
- **2016-2020：完成过渡阶段**
 - 政府引导全面普及**IPv6**
 - 抓住发展机遇，是中国成为互联网技术强国

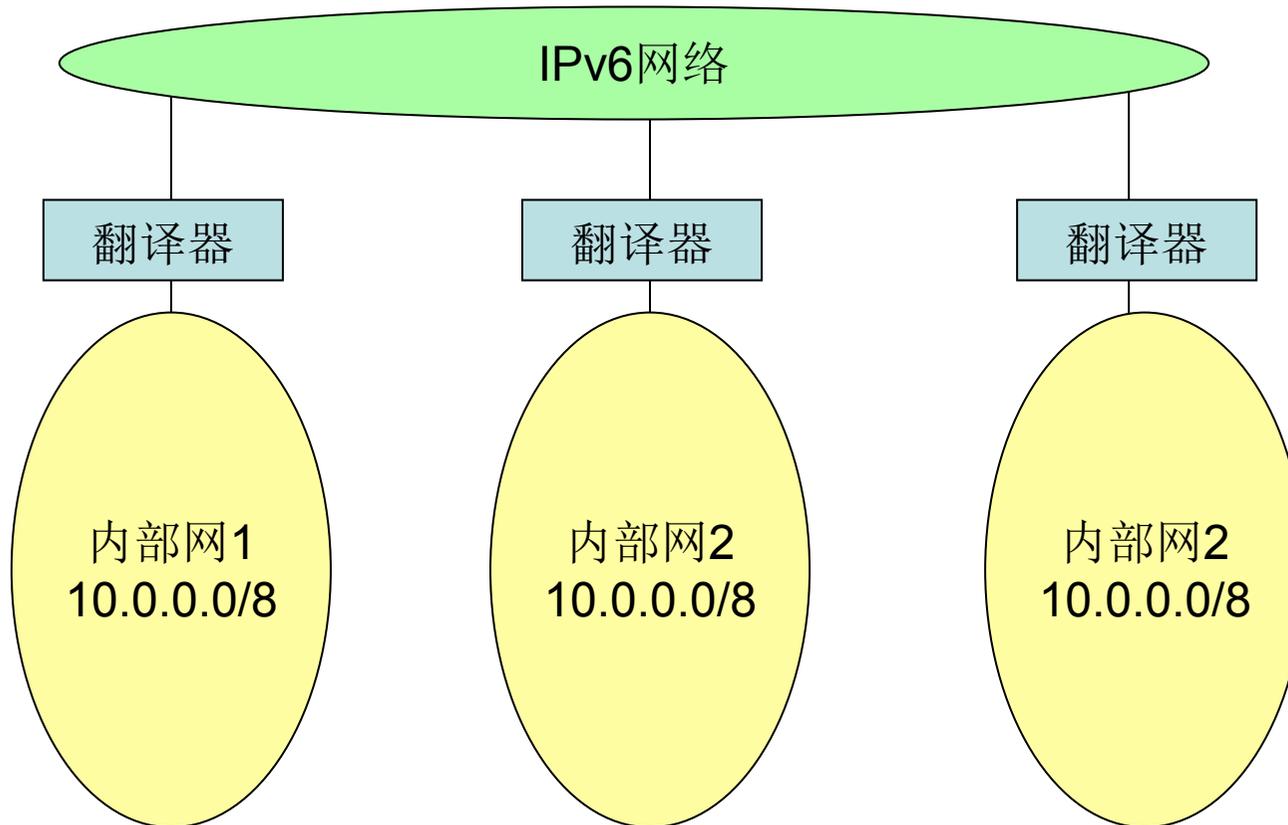
发展用户平滑过渡



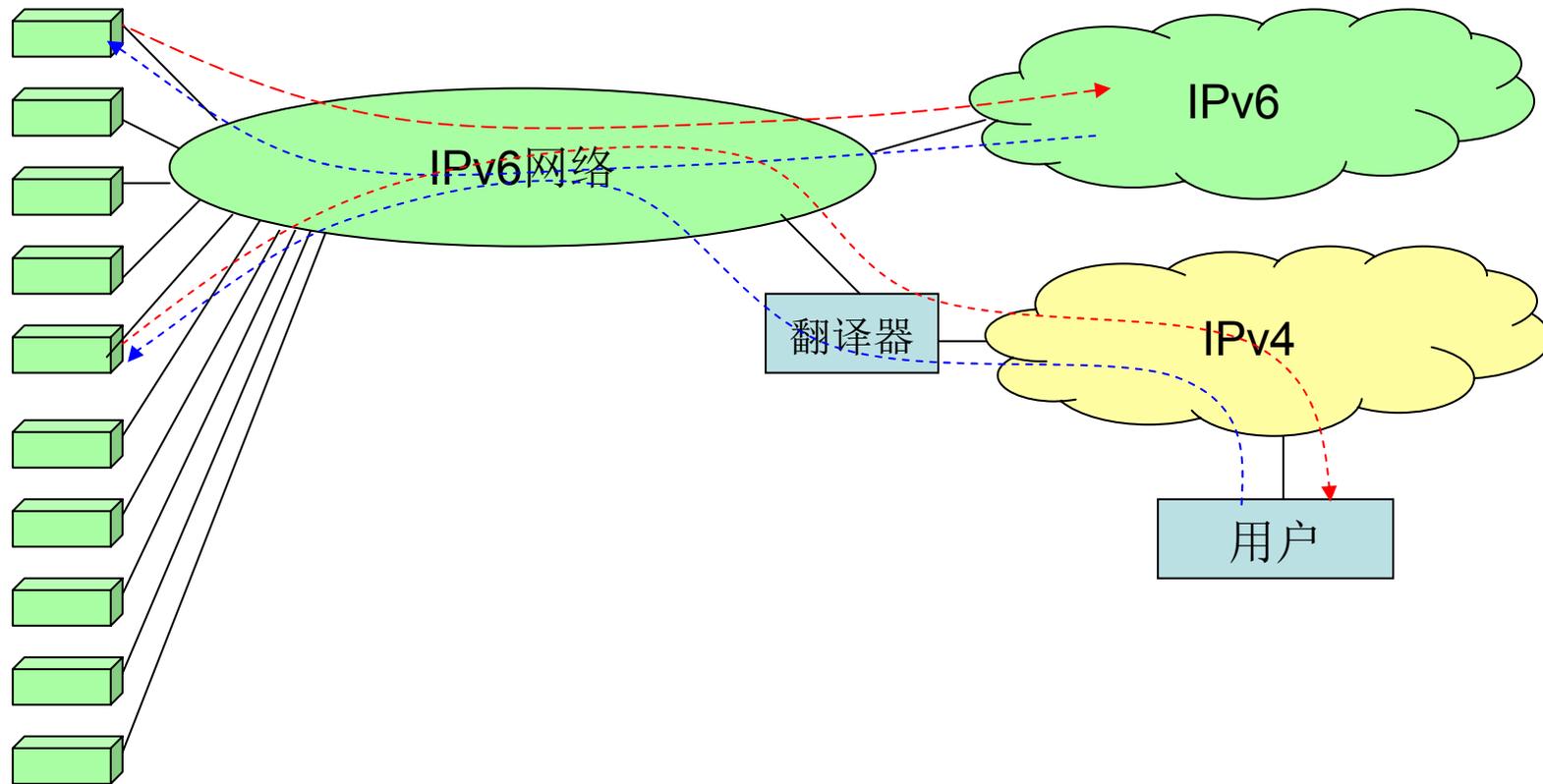
IPv6数据中心和云计算



私网地址整合互通



全互联互通的物联网



斯诺登事件

The screenshot shows a Mozilla Firefox browser window displaying a news article from the South China Morning Post. The article title is "EXCLUSIVE: NSA targeted China's Tsinghua University in extensive hacking attacks, says Snowden". The author is Lana Lam, and the date is Sunday, 23 June, 2013, 8:02am. The article text states that Tsinghua University was the target of extensive hacking by US spies in 2013. A sidebar on the right features a graphic with a man in a suit and hat, with the text "See and be seen". Below the graphic is a "Most Popular" section listing three related articles. The browser's address bar shows the URL: www.scmp.com/news/china/article/1266892/exclusive-nsa-targeted-chinas-tsinghua-university-extensive-hacking. The Windows taskbar at the bottom shows the system tray with the time 10:35 and 100% battery.

EXCLUSIVE: NSA targeted China's Tsinghua University in extensive hacking attacks, says Snowden | South China Morning Post - Mozilla Firefox

文件(F) 编辑(E) 查看(V) 历史(S) 书签(B) 工具(T) 帮助(H)

http://202.38.97....gettxt.php?id=41 x EXCLUSIVE: NSA targeted China's ... x +

www.scmp.com/news/china/article/1266892/exclusive-nsa-targeted-chinas-tsinghua-university-extensive-hacking

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Edward Snowden

29-year-old American Edward Snowden, a contract employee at the National Security Agency, is the whistleblower behind significant revelations that surfaced in June 2013 about the US government's top secret, extensive domestic surveillance programmes. Snowden flew to Hong Kong from Hawaii in May 2013, and supplied confidential US government documents to media outlets including the *Guardian*.

NEWS • CHINA

EXCLUSIVE: NSA targeted China's Tsinghua University in extensive hacking attacks, says Snowden

Tsinghua University, widely regarded as the mainland's top education and research institute, was the target of extensive hacking by US spies this year

Lana Lam
lana.lam@scmp.com

Sunday, 23 June, 2013, 8:02am



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22 8

Comments

Email Print

RELATED TOPICS

Edward Snowden

See and be seen

Most Popular

VIEWED SHARED COMMENTED

- 1 EXCLUSIVE: US spies on Chinese mobile phone companies, steals SMS data: Edward Snowden
- 2 EXCLUSIVE: Snowden safe in Hong Kong, more US cyberspying details revealed
- 3 EXCLUSIVE: US hacked Pacnet, Asia Pacific fibre-optic network operator, in 2009

10:35 100%

端系统

Apple iPhones, Android and even BlackBerry smartphones all compromised by NSA

By Graeme Burton

09 Sep 2013

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The US National Security Agency (NSA) has acquired the power to tap 3G and 4G smartphones - not only Apple iPhones and Android devices, but also supposedly secure BlackBerries.

The revelation is the latest in a series of leaks orchestrated by whistleblower Edward Snowden and journalist Glenn Greenwald.

The news that even BlackBerry devices are vulnerable to security service tapping will be particularly damaging to the company as security is one of BlackBerry's key selling points.

The latest NSA leaks were published in German newspaper *Der Spiegel* as *The Guardian* newspaper in the UK is rumoured to have been gagged by "D-Notices" issued by the government.

[...tate that it is possible for the NSA to tap most sensitive](#)

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E-skills and Cyber Security Challenge bid to make cyber security appealing to students

- > IETF to consider 'Prism-proof' security architectures for the web
- > How can you attract talent to the cyber security profession?
- > NSA has 'circumvented or cracked' internet encryption exposing banking systems, medical records and more

也谈棱镜门无自主知识产权何谈信息安全

棱镜门事件以来，很多国人可能都抱着幸灾乐祸看美国政府笑话的心态。美国一直指责他国网络监控，而自己却一直干着肆意窃取他国和本国国民隐私的勾当，是个实足的“全球偷窥者”，这令美国政府在国内外颜面尽失，非常尴尬。

没错，美国这次糗大了！可是，别高兴的太早，仔细琢磨琢磨，真正尴尬和危险的恰恰是我们自己。

让我们先简单看看什么是棱镜计划？棱镜计划（PRISM）是一项由美国国家安全局（NSA）自2007年起，开始实施的绝密电子监听计划，正式名号为“US-984XN”。美国可通过直接接触位于美国的互联网和科技巨头的用户数据，侦查用户行为。这些巨头主要包括谷歌、雅虎、微软、苹果、Facebook、美国在线、PalTalk、Skype、YouTube、思科等，他们则向美国两大情报机构开放服务器，使美国政府能够轻而易举地监控全球。

当然，我并不是鼓吹排外，而只是希望我们应该有一种觉醒和紧迫感，在涉及到核心安全的技术方面能够早日拥有完全自主知识产权，在重要的部门尽快实现完全国产化。在核心部门采用国产产品在欧美国家也是惯例。

棱镜门事件后，还有一些人在大谈政府的网络监管，我觉得在此时发出这种论调非常不合时宜，当下之急应是呼吁社会对于自主知识产权的重视，防范和抵抗他国的信息入侵。皮之不存毛将焉附？当一个国家的隐私尚且无法保全，谈个人隐私又有何意义呢？（本文作者沈志勇系资深公共关系顾问、新桥公关CEO，作者微信公号：沈志勇@公关）

数字时代人权保护何时开启

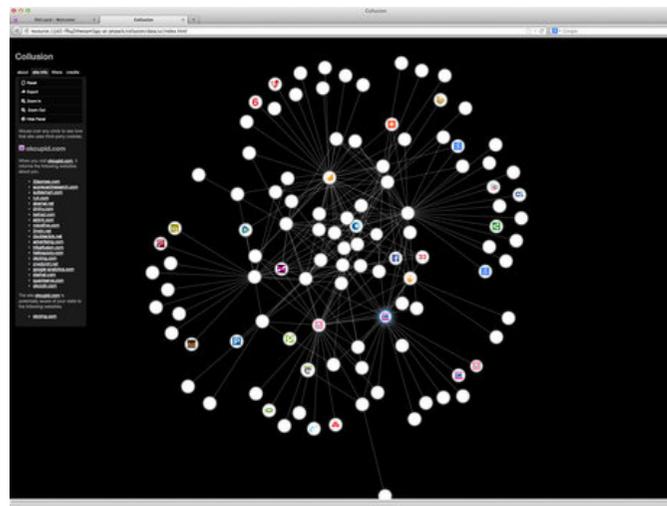
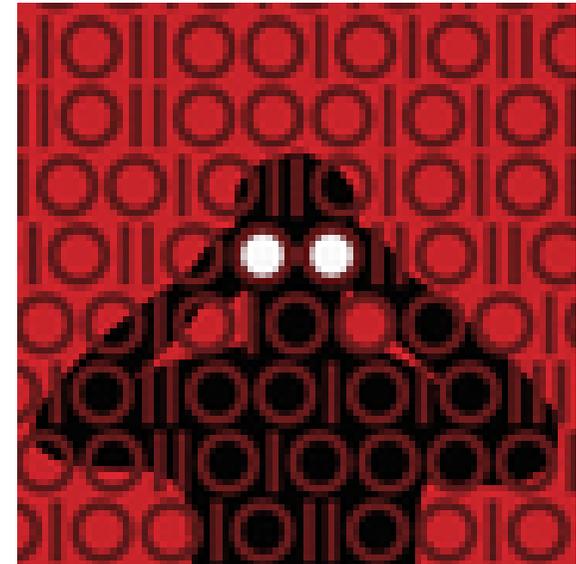
“棱镜”与斯诺登事件引发了一场对美国政府的信任危机，人们甚至开始怀疑美国政府的根本准则和价值观。一直以来，在中国“改革派”眼中，美国政府是维护人权和言论自由的典范。在中国的博客圈内，存在着两派网民：“强硬派”与“改革派”，两派人之间经常激烈争论：“美国政府的根本准则和价值观是否适用于中国？”而现在，“强硬派”在争论中占据上风。他们向对手提出追问：看看美国政府到底是怎么保护人权的吧！你还能相信虚伪的美国政府吗？美国的所谓“民主”、“法制”，根本就是个大失败！他们甚至对谷歌、微软和苹果产品提出质疑：“小心你心爱的美国互联网服务吧，说不定中情局正在下载你的个人隐私呢！”

对此次“棱镜”事件，美国政府表示出一副“事不关己”的态度，但是，他们始终没能说清楚，“棱镜”计划到底是什么，是针对恐怖分子的专项计划？还是一项孤立的事件，或是一次系统的崩溃？面对“强硬派”网民的冷嘲热讽，“改革派”们只能保持沉默。

大多数网民都同情斯诺登，人们觉得，他是个敢于揭露阴谋的正直之人。许多人称赞他是“英雄”，因为为了揭露真相，他不仅放弃20万美元的高薪，还远离美貌的女友。甚至他曾经的模特生涯和英俊的外表都成了网民的议论话题。相对的，几乎无人在乎，斯诺登此举是对美国法律和政府的背弃。81%的网民认为，中国政府应给斯诺登提供庇护，只有3%的人认为，应将他引渡回美国。

也有少数网民开始思考，“棱镜”计划对于全球和中国而言，究竟会产生哪些影响？在这个数字和网络时代，是否所有政府都能肆无忌惮地运用侵犯个人隐私和言论自由？“国家安全”、“公民安全”是否就是政府侵犯个人隐私的理由？连美国这样重视自由、平衡的国家都在实施类似“棱镜”的计划，那么其他国家的政府岂非更加肆无忌惮？至少西方媒体值得表扬，因为他们冒着受罚的威胁，持续监督政府的作为。有人在微博上提出上述问题，但很快，就被淹没在网民们激烈的口水仗之中了。

新的挑战



It's an attack



- The actions of NSA and their partners (nation-state and corporate) are a multi-faceted form of attack, or are indistinguishable from that.
 - We don't think they are unique, others are likely to be doing the same or will
- The scale arguably makes this an example of a new pervasive monitoring threat model that is neither purely passive nor a classic Man-in-the-Middle and that we have not normally considered
- A purely technical response will not counter this attack

There are things we can do



- There are technical things we can do that might significantly affect the cost of pervasive monitoring and that might improve security and privacy
- Some of those are short-term “point” changes, others less so and may take time to be agreed, mature and get deployed
- if we're serious about tackling the problem, some may affect long-held positions, deployments or business models
 - confidentiality vs packet inspection
 - nymity vs authentication/law enforcement/advertising

So let's do them



- There is a time element to some of this – it could be that we can get some changes made or started more easily while the news is fresh
- Equally, being seen not to act in this situation could inflict more damage
- We should do and be seen to be doing as much as we can to counter this attack, and now is the time – publicity counts and NSA haven't just crossed a line, they've moved it

开放 (Open)

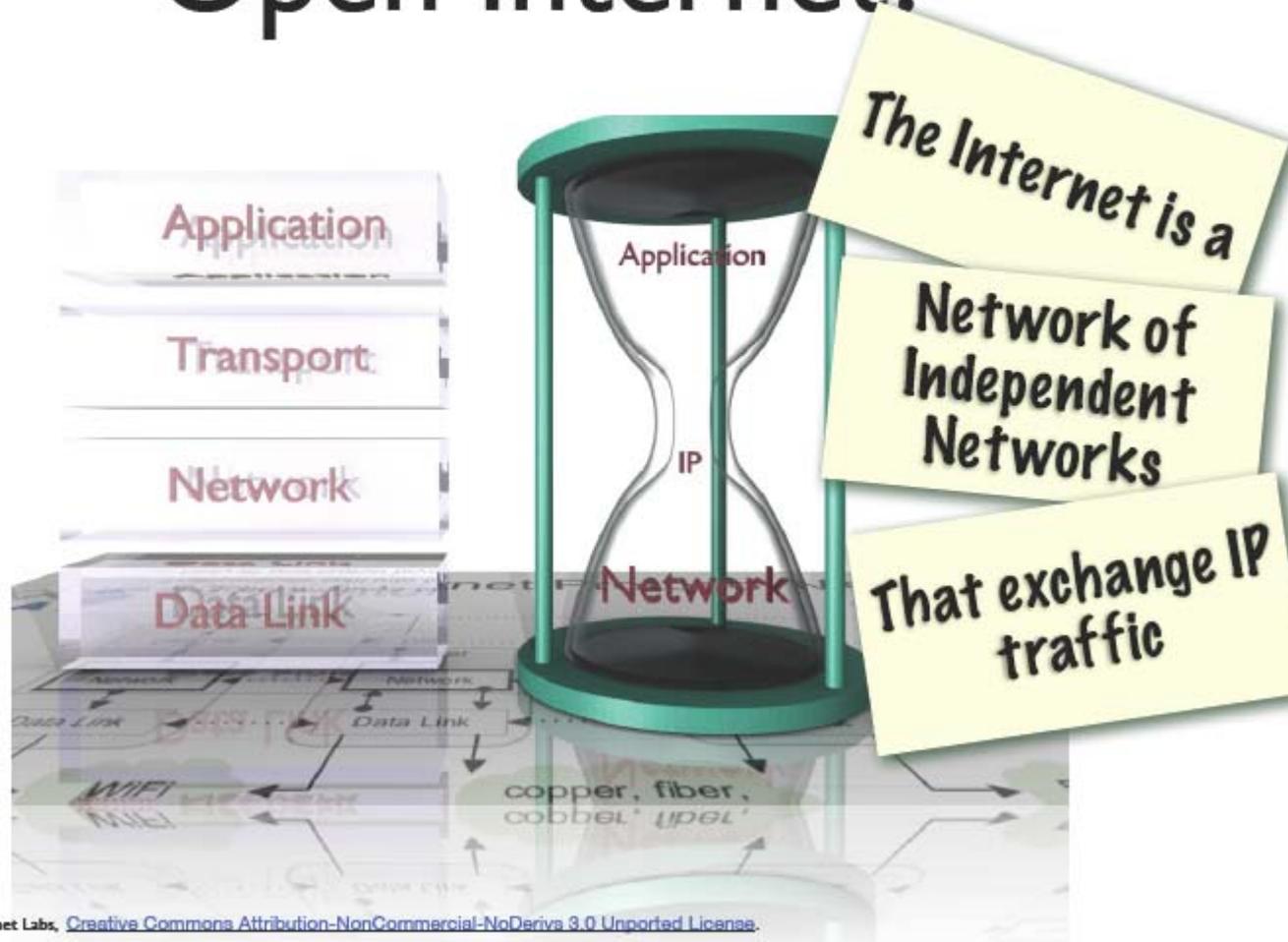


Open Process

- 开放的协议 (Open protocol)
- 开放的实现 (Open implementation)
- 开放的系统 (Open system)

人

Open Internet?



Picture by: O. Kolkman/NLnet Labs, [Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License](https://creativecommons.org/licenses/by-nc-nd/3.0/).

Open Internet Keywords



How Do Open Standards Play a Role

| Browsing The Web | | | |
|------------------|--------------------|--------|----------------|
| 802.11 | IEEE | TCP/IP | IETF |
| URI | IETF | BGP | IETF |
| NAT | No Standard | HTTP | IETF |
| CSS | W3C | PNG | IETF |
| HTML | W3C/ISO | MPEG | ISO/IEC |
| XML | W3C | ADSL | ITU-T |

Interoperability

Standardization
the Internet way

Cooperation
Collective Empowerment
Voluntary Adoption
Adherence to Principles
Availability

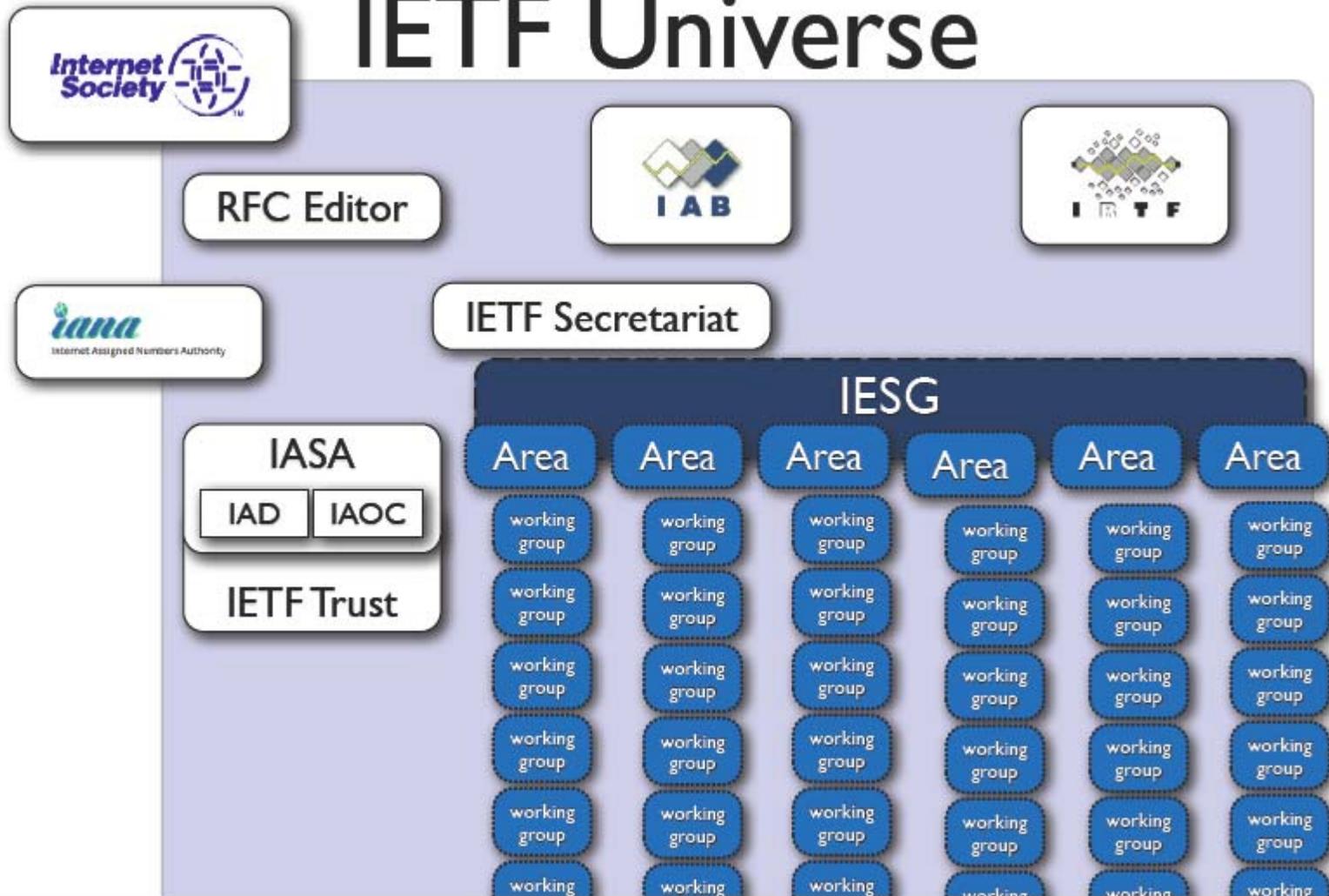


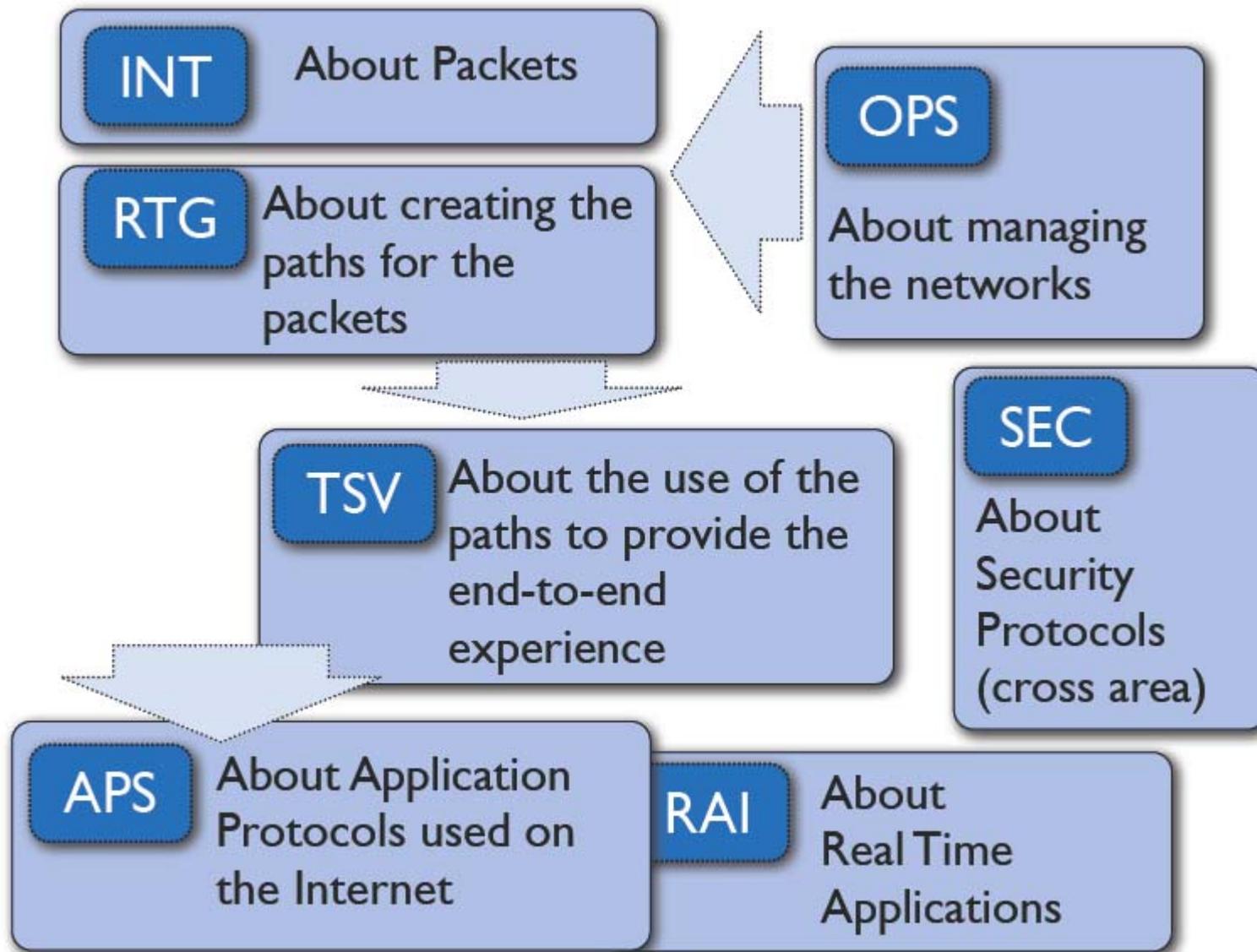
driver for innovation
Borderless commerce



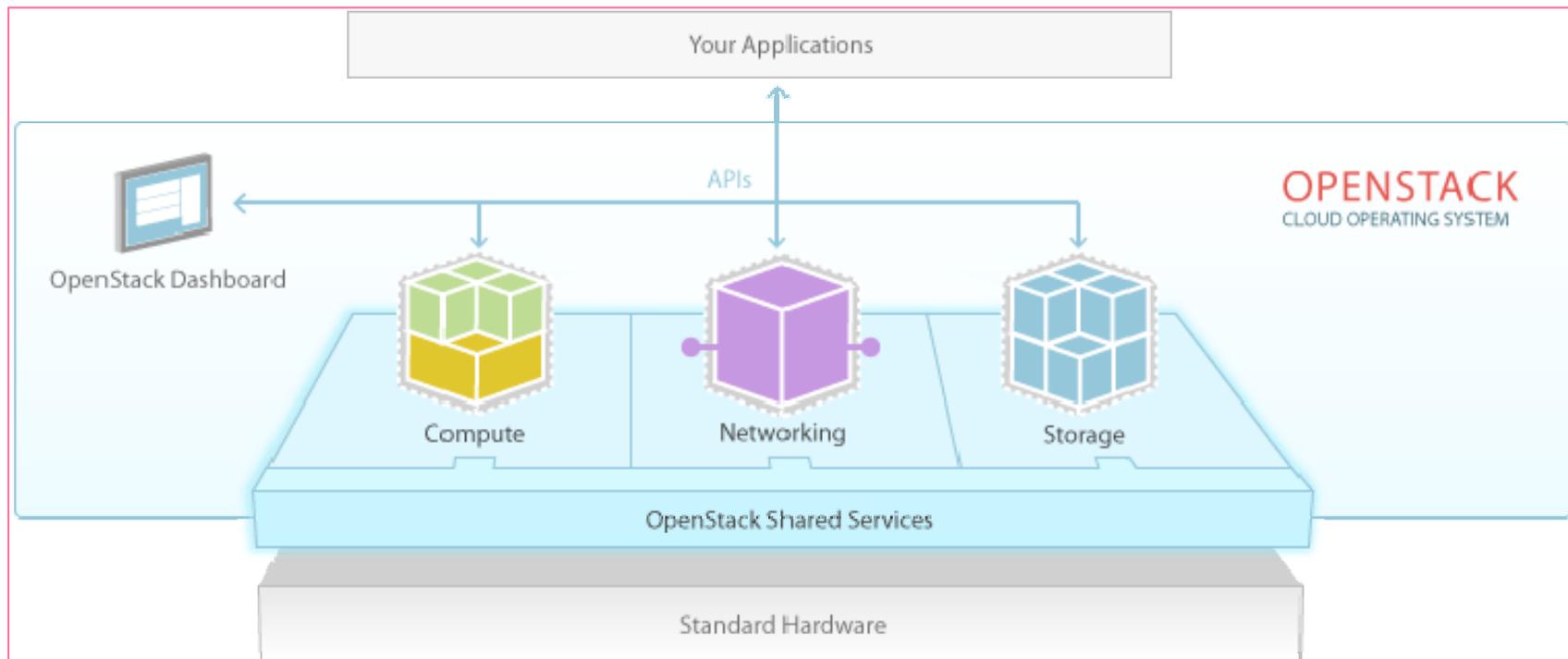
Details on:
<http://open-stand.org>

IETF Universe

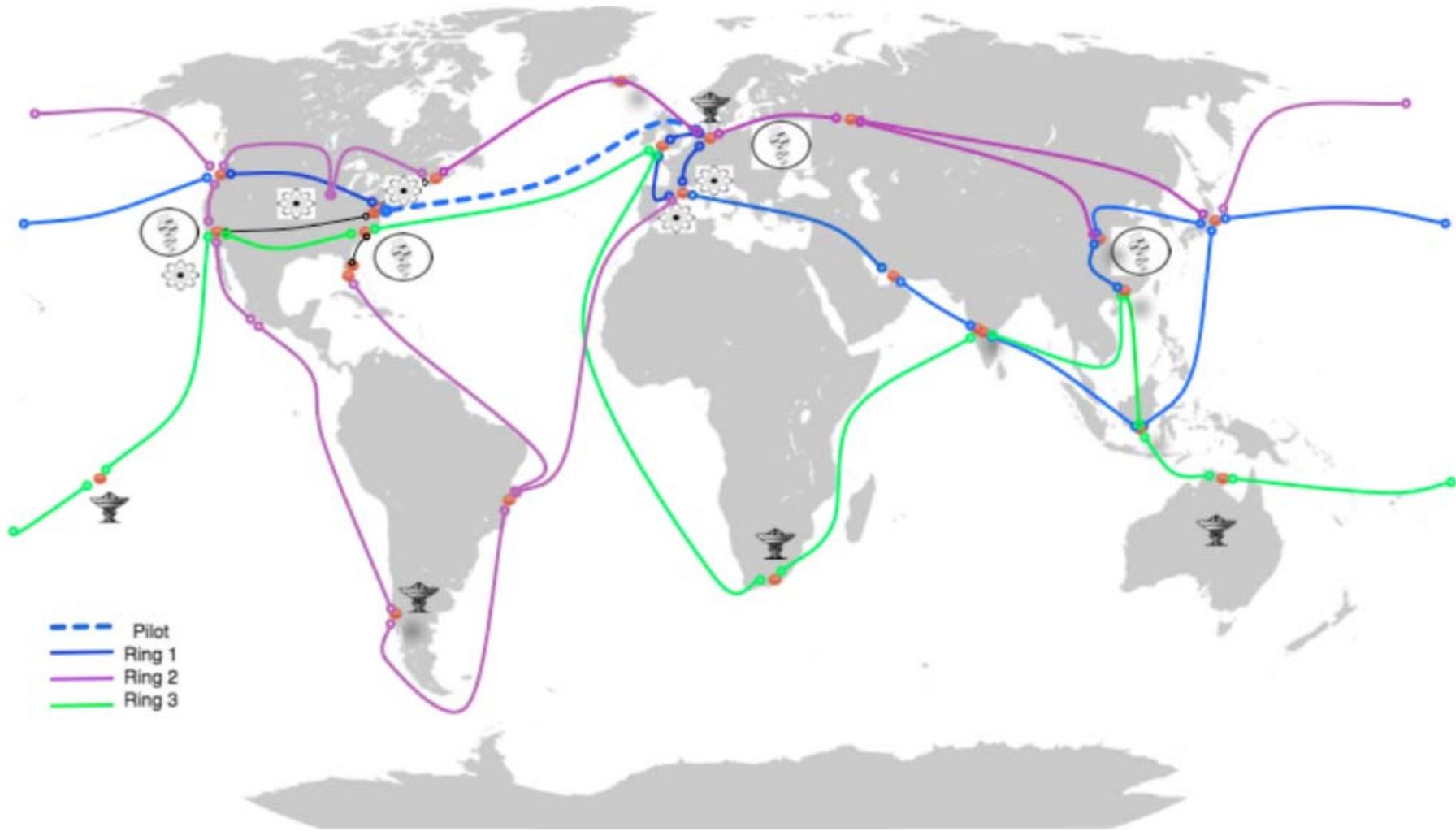




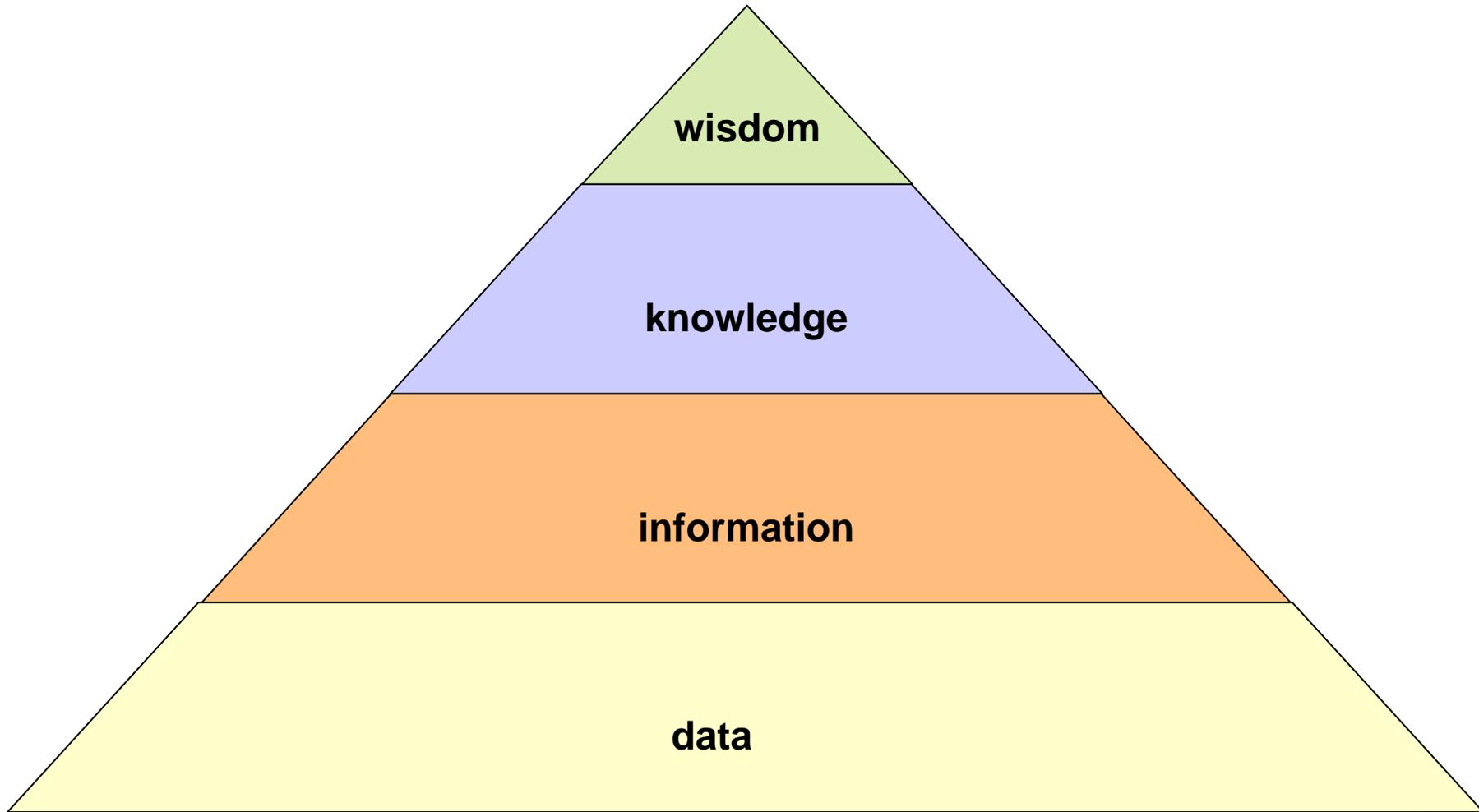
OpenStack



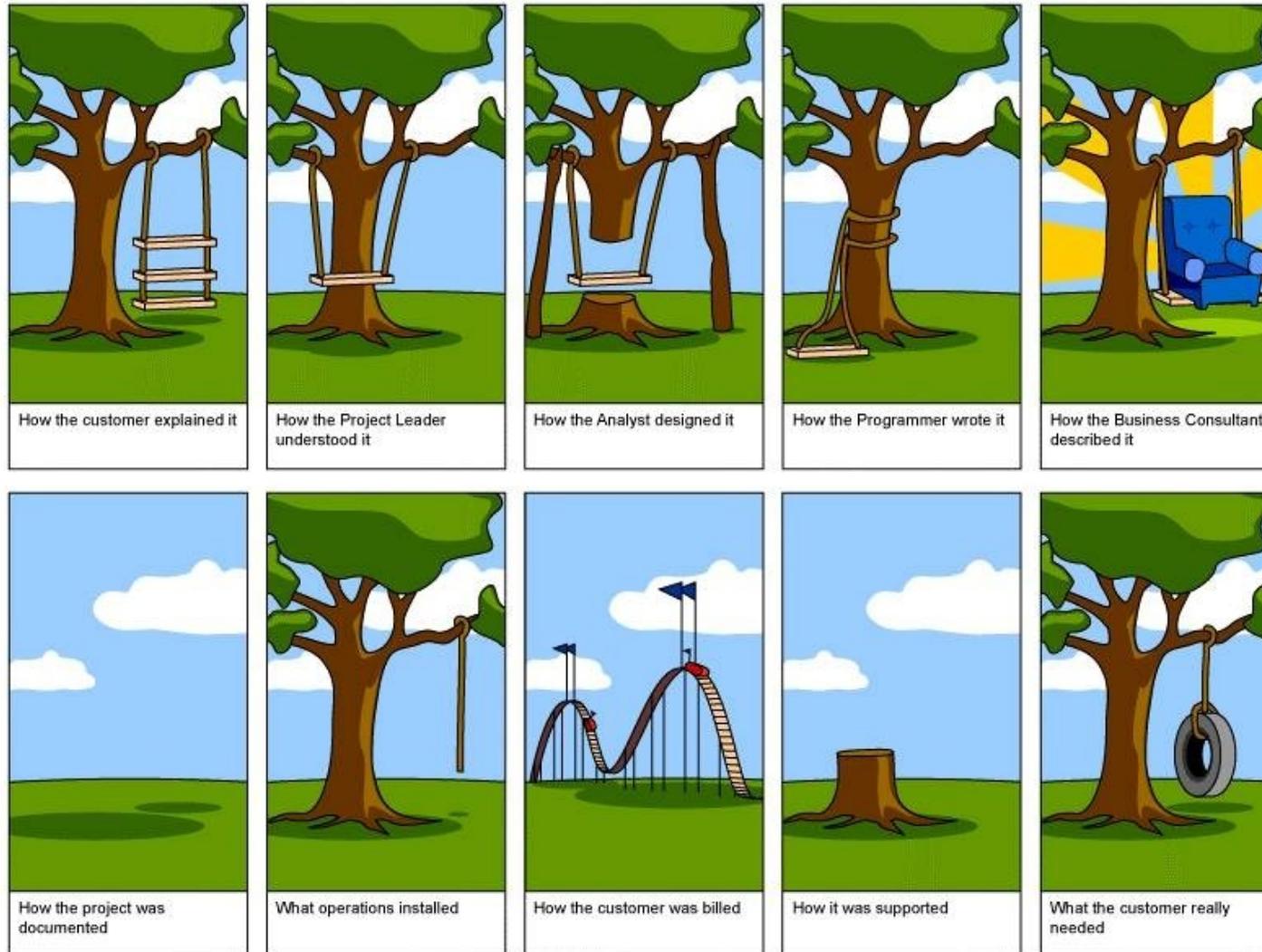
GNA – artist's impression



教育的金字塔



知难行易

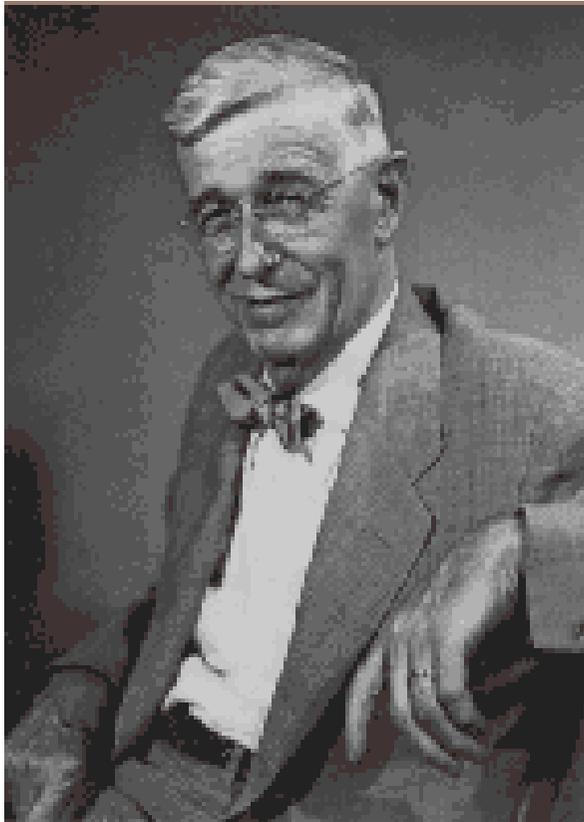


设计的原则

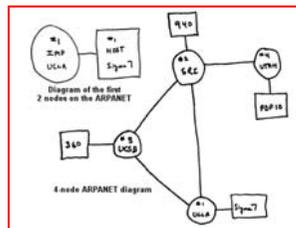
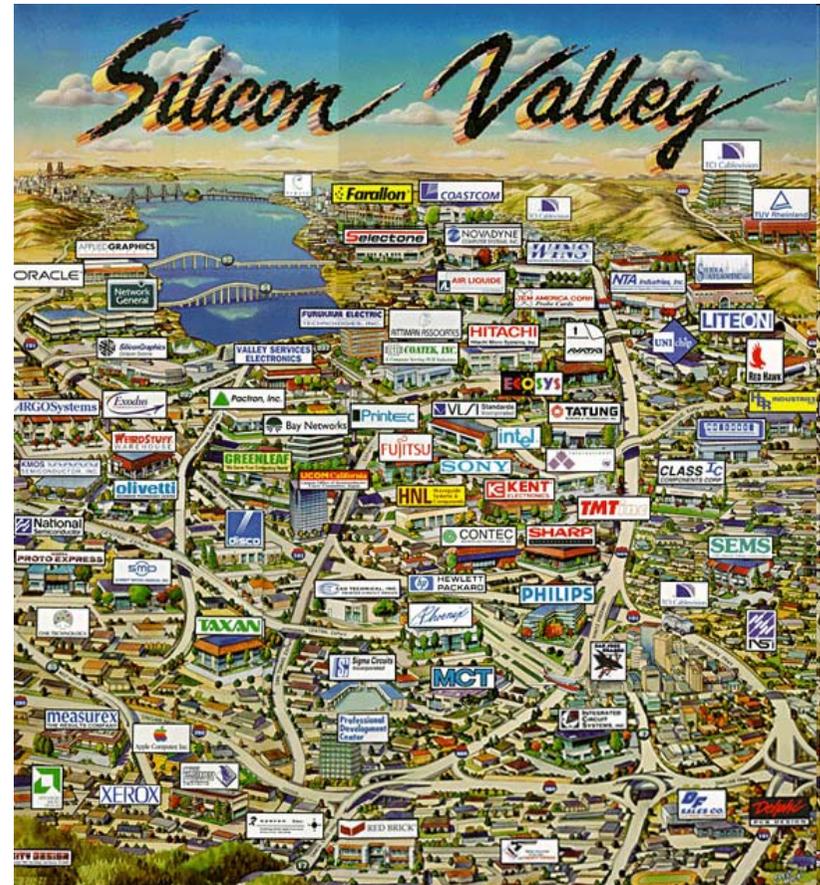


- *Principles such as **simplicity** and **modularity** are the stuff of software engineering*
- ***Decentralisation** and **tolerance** are the life and breath of Internet*

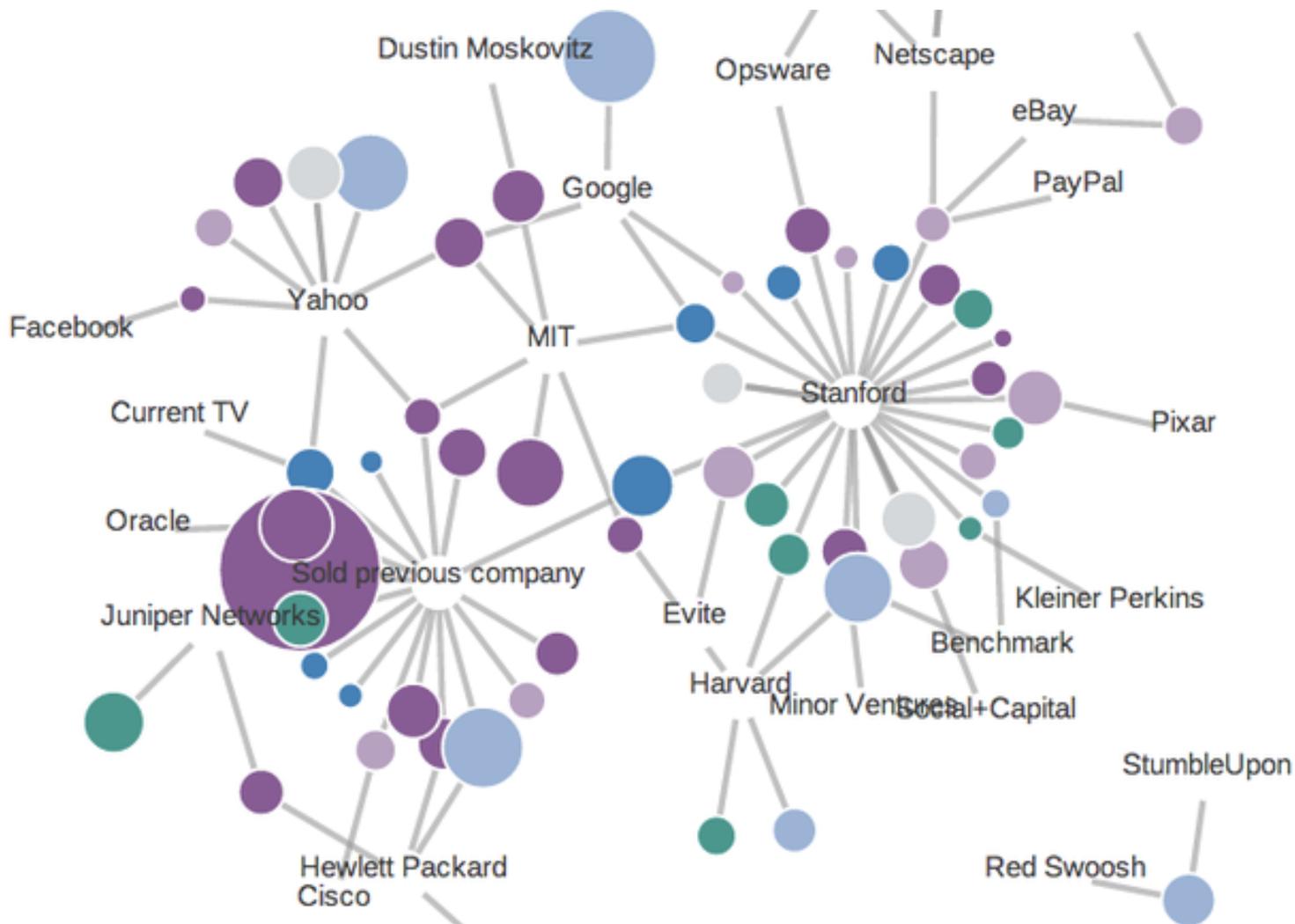
- Tim Berners-Lee



1945年，布什在7月号《大西洋月刊》（Atlantic Monthly）发表了一篇名为《我们可能这样思想》（As We May Think）的文章，赢得了意想不到的声誉，从此被尊称为“计算机先知”。



英雄也问出处



Stay hungry, Stay foolish



领导力



VIEWS OF THE FUTURE

**A Cloudy Crystal Ball
--
Visions of the Future**

David D. Clark
M.I.T. Laboratory for Computer Science
IETF, July 1992

Alternate title: Apocalypse Now

DDO 7/16/92 19:39 COPYRIGHT © David Clark 1992

VIEWS OF THE FUTURE

The last force on us -- us

The standards elephant of yesterday -- OSI.

The standards elephant of today -- it's right here.

As the Internet and its community grows, how do we manage the process of change and growth?

- Open process -- let all voices be heard.
- Closed process -- make progress.
- Quick process -- keep up with reality.
- Slow process -- leave time to think.
- Market driven process -- the future is commercial.
- Scaling driven process -- the future is the Internet.

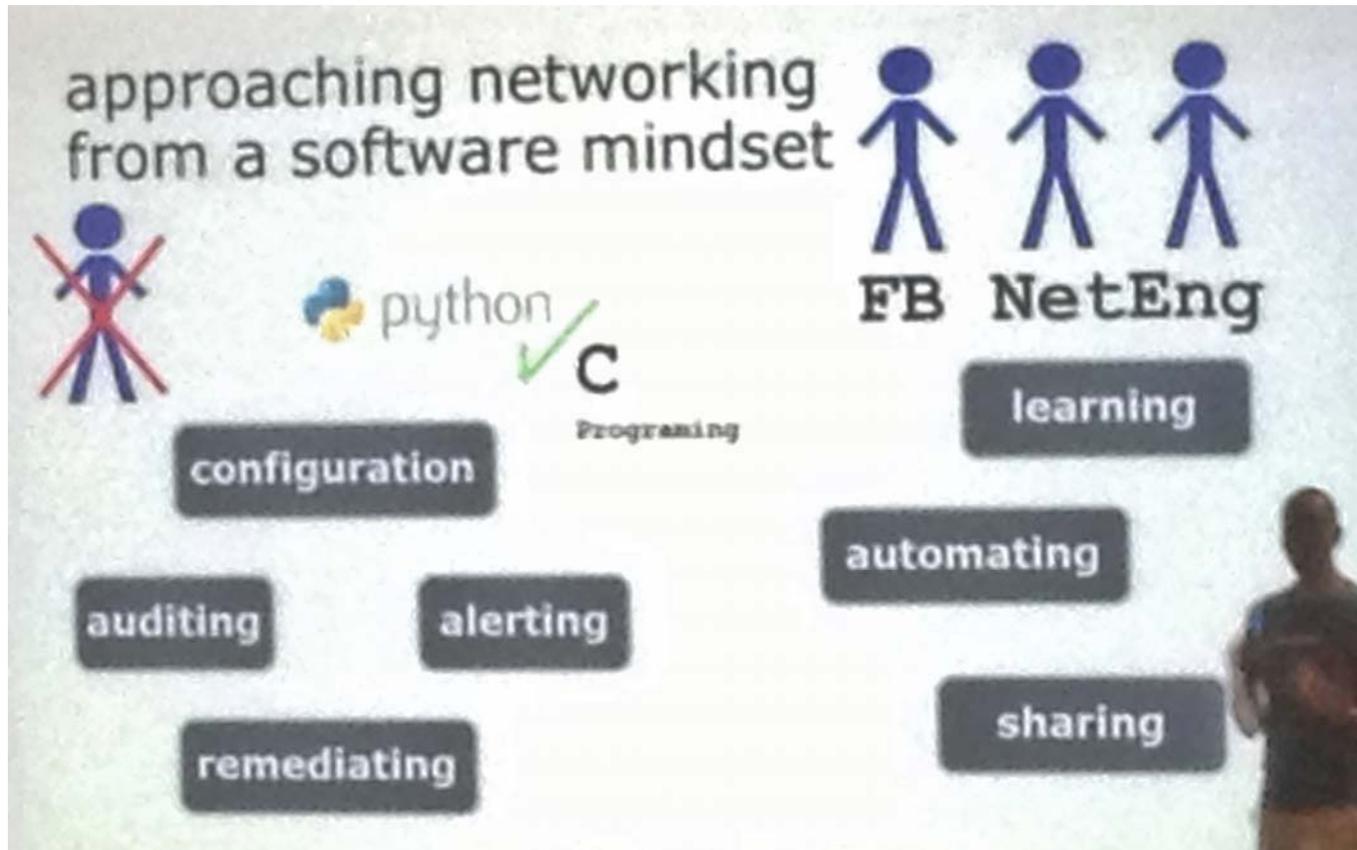
We reject: kings, presidents and voting.

We believe in: rough consensus and running code.

DDO 7/16/92 19:39 COPYRIGHT © David Clark 1992

SLIDE 19

三代网络工程师



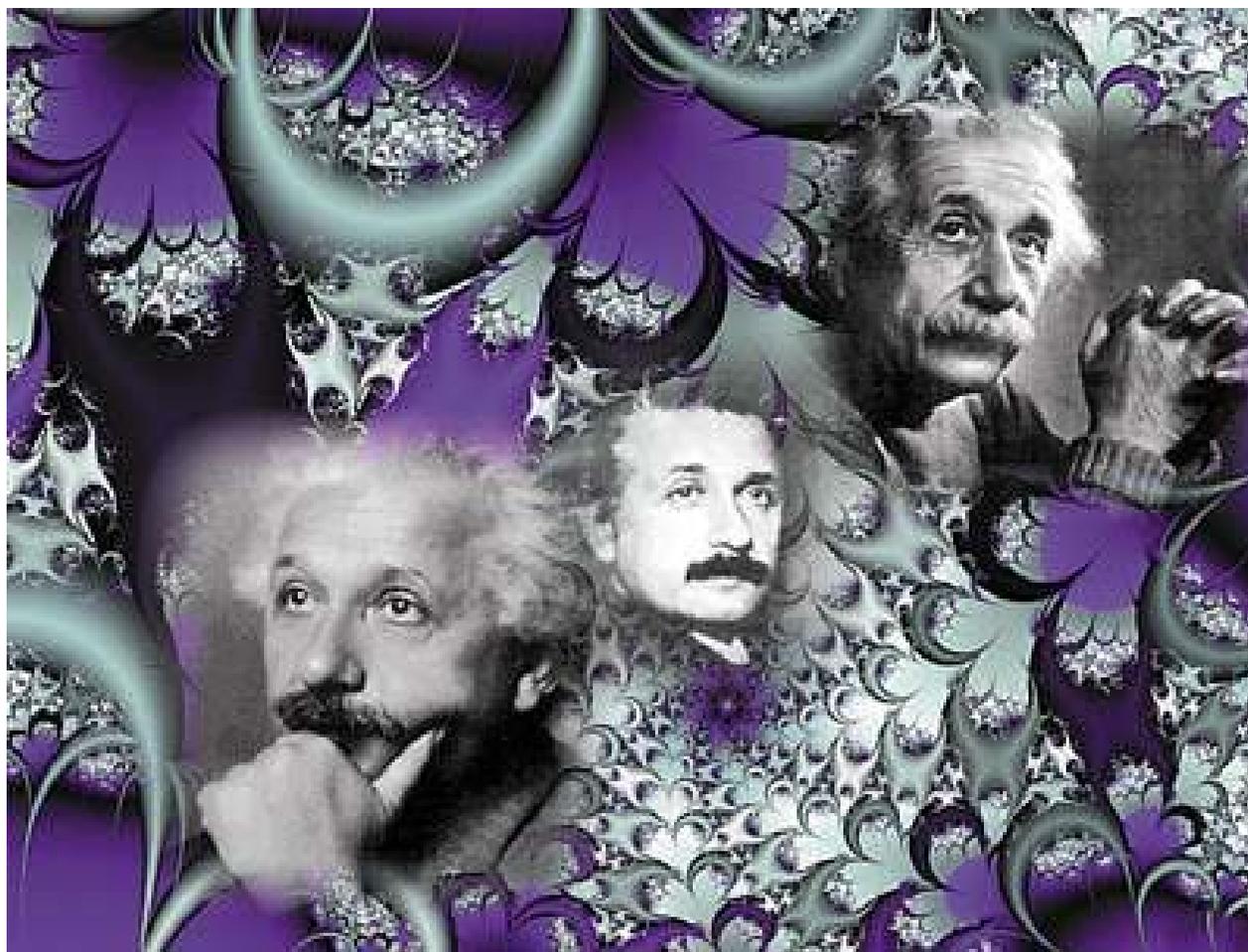
电话/传输系统 → 路由器 → 程序员

历史之间



标准
开放

想象力比知识更重要



小结



- 挑战
 - 中国的发展
 - 斯诺登事件
- 机遇
 - 满足需求
 - 规则制定
- 核心
 - 网络
 - 人才
 - 跨学科