

未来信息网络体系研究

The Research of Future Information Network Architecture

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Next Generation Internet Research Center

Outline

- 研究背景
 - 主要工作
 - 研究成果
 - 发展趋势
- **Research Background**
 - **Main Task**
 - **Research Production**
 - **Development Direction**

Research Background

1. 现有信息网络的原始设计思想基本上是一种网络支撑一种主要服务的解耦模式。

The original designing idea of current information networks is basically *a specific network supports one major service*.

原始的设计思想存在局限性（如电信网、互联网），不能满足网络及服务的多元多样性需求，解决势在必行。

The limitation of the original designing idea can not support the *multiple requirements for networks and services* (such as Telecom network、Internet) . A solution is urgently required.

Research Background

2. 互联网的原始设计思想造成移动性差、可信性差
(安全性差、可靠性差、可控性差、可管性差)

The original design mode of Internet leads to its *shortage in mobility, security, controllable and administrable.*

急需突破性地构思和设计新一代互联网的网络体系，以解决现有互联网移动和可信方面的严重不足。

We urgently need redesign the framework of *new generation Internet* to overcome the serious shortage of current Internet.

Research Background

3. 基于一种网络为用户提供可信的普适服务已成为我国乃至世界各主要国家信息化战略的**核心研究内容**。

For China and other countries of the world, providing pervasive and trusted services based on a specific network has become *the key research directions* of national informatization.

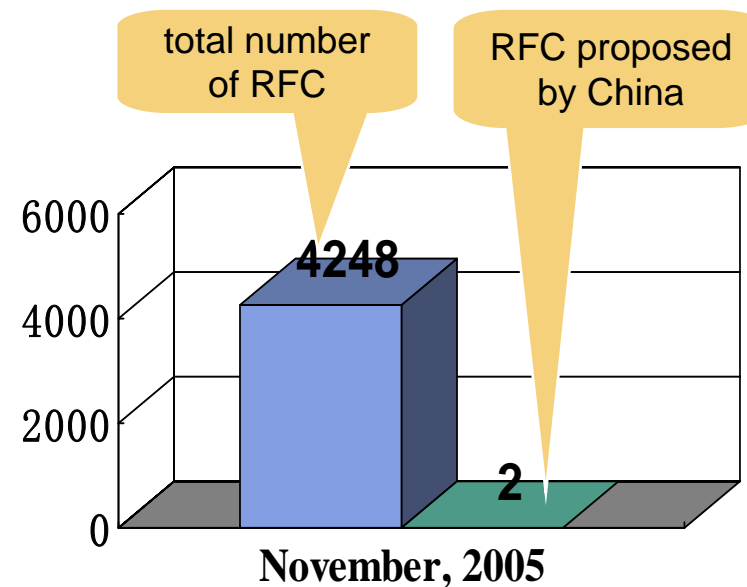
	YEAR	CORPORATION	INVESTMENT	PROJECTS
Other Countries	2002	NTT, Japan	5 billion dollars	RENA (Resonant Network Architecture)
	2003	NSF, US	7.5 million dollars	“100x100” Project
	2004	British Telcom	80 million pounds	21CN
	2005	NSF, US	300 million dollars	GENI(Global Environment for Networking Investigations)
	2006	NSF, US	20 million dollars	FIND (Future Internet Design)
China	2001	中国自然科学基金委		网络与信息安全
	2003	中国973项目		新一代互联网体系结构理论研究
	2005	中国863项目		一体化网络服务新技术及新一代网络面向业务的恢复与控制技术研究
	2006	中国973项目		“新的网络体系基础研究” 研究课题

Research Background

4. 我国在互联网**知识产权和基础研究**方面严重不足，迫切需要加大投入，进行这方面的研究

We have critical insufficiency in *intellectual property and fundamental research* of information network. We should enlarge investment on the fundamental research.

Rank	Country Name	N. of IPv4 address	Share
1	The United States	1,281,905,102	68.81%
2	Japan	119,730,688	6.42%
3	Canada	64,327,168	3.45%
4	The Great Britain	63,288,536	3.39%
5	China	55,659,008	2.99%



Research Background

5. IPv6及相关技术的出现为这些问题的解决奠定了良好的基础，其优点包括：

A perfect foundation was establish to solve these issues by IPv6 and correlative technologies. The advantages of IPv6 include:

- 巨大的地址空间 Large IP address space
- 安全性 Security supporting
- 移动性 Mobility supporting
- 服务质量 QoS supporting

Evolution History (International)

❖ 1996年IETF建立了全球范围的IPv6实验床6Bone。

IETF established IPv6 Backbone in 1996

❖ 1998年，面向实用的全球性IPv6研究和教育网6REN启动。

The project of global 6REN(IPv6 Research and Education Network) was started in 1998.

Evolution History (International)

- ❖ 2000年5月，3G标准化组织3GPP采纳IPv6为多媒体服务的必选协议。

The third Generation Partnership Project selected IPv6 as the necessary protocol to support multimedia services in May 2000.

- ❖ Cisco、Nortel、Microsoft、Lucent、Nokia、3Com等公司联合发起成立的IPv6论坛也极大地推动了IPv6的发展。

The IPv6 Forum accelerated the development of IPv6 in global areas.

Evolution History (Domestic)

- ❖ 1998年6月，中国国家教育科研网**CERNET**加入**6Bone**。

In June 1998, China Education and Research Network (CERNET) joined 6Bone.

- ❖ 1999年4月，**CERNET**启动**IPv6**实验床项目，极大推动了中国**IPv6**技术的研究。

In April 1999, the project of IPv6 Experimental Bed was started by CERNET, which advanced IPv6 research in China.

Evolution History (Domestic)

- ❖ 2002年4月，中国科技部发布多项与IPv6相关的863课题，包括高性能IPv6路由器协议栈软件和IPv6协议测试技术等。

In April 2002, Ministry of S&T of China released a series of 863 (National High Technology R&D) programs on IPv6, including high performance IPv6 router software stack, IPv6 test technology, etc.

Evolution History (Domestic)

- ❖ **2003**年底，中国宣布实施名为“中国下一代互联网示范工程（**CNGI**）”的新一代互联网计划，在**2005**年底**前**投资**14**亿元构筑连接中国各主要城市的**IPv6**商用骨干网，**2006**年正式开始**IPv6**商用服务，形成全球最大规模的**IPv6**商用网。

In 2003, China government announced that “ China Next Generation Internet (CNGI)” program would be implemented.

Evolution History (Domestic)

- ❖ 2004年，我国第一个IPv6主干网CERNET2试验网正式开通服务，成为中国第一个全国性的下一代互联网主干网。

In 2004, CERNET2 began to supply IPv6 network service. It is the first countrywide IPv6 backbone.

- ❖ 此外，北京交通大学、清华大学、中科院计算所等研究院所在IPv6的理论与技术开发方面做了很多深入的探索。

Many research institutions such as Beijing Jiaotong University, Tsinghua University have done lots of work on IPv6 theory and technology.

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Main projects in recent five years

项目类别 Project categories	项目名称 Project name	起止时间 schedule
国家“973”重大项目 National “973” Program Key Project	一体化可信网络与普适服务体系基础研究 Fundamental Research on the Architecture of Universal Network and Pervasive Services	2007.5-2012.8
国家“863”重大项目 National “863” Program Key Project	高性能IPv6路由器协议栈软件 High Capability IPv6 Router Protocol Stack Software(1 st Phase)	2002.5-2004.5
国家“863”面向“十一五”创新引导项目 National “863” Program Innovation Project for “Eleventh Five-Year Plan”	一体化网络服务新技术研究 Research on new technology for integrative network service	2005.7-2006.6

Main projects in recent five years

国家“863”重大项目 National “863” Program Key Project	高性能IPv6路由器协议栈软件 (滚动课题) High Capability IPv6 Router Protocol Stack Software(2 nd Phase)	2005.7- 2005.12
国家“863”项目 National “863” Program	计算机信息系统安全体系结构研究 Research on the architecture of computer information system security	2002.1- 2003.12
国家“863”项目 National “863” Program	视频信息采集及网上多媒体实时传 输的研究 Research on collection of video information and real-time transmission for multimedia data	2001.10- 2003.12

Main projects in recent five years

国家自然科学基金 NSFC Program	动态变化网络路由协议理论及关键技术 Theory and key technology of routing protocols in dynamic mutative network	2005.1- 2007.12
国家自然科学基金 NSFC Program	变化网络动态组播理论及分层机制的研究 Dynamic multicast theory and layered scheme in mutative network	2005.1- 2007.12
国家自然科学基金 NSFC Program	基于IPv6的动态服务质量理论与应用研究 Research on theory and application of QoS in IPv6	2003.1- 2005.12
国家自然科学基金 NSFC Program	移动互联网理论和关键技术 Theory and key technologies for mobile Internet	2006.1- 2008.12
国家自然科学基金 NSFC Program	可信传感器网络路由交换理论与关键技术 Theory and key technologies for route and switch in believable sensor network	2006.1- 2008.12

Main projects in recent five years

国家自然科学基金 NSFC Program	宽带高速无线通信理论及关键技术 Theory and key technologies for high speed wireless communication	2002.1- 2004.12
国家自然科学基金 NSFC Program	业务内区分服务和个性化拥塞控制 Research on DiffServ and individuation congestion control	2002.5- 2005.12
国家自然科学基金 NSFC Program	网络探测的IP网络拓扑发现和性能分析的研究 Networking topology discovery and performance analysis in network detection	2003.1- 2005.12
国家973项目 National "973" Program	信息与网络安全体系结构研究 Research on architecture of information and network security	2002.1- 2005.12

Main projects in recent five years

<p>国家攻关项目 National Key Technologies R&D Program</p>	<p>IPv6网络攻防系统的研究 Research on IPv6 Network Attack and Defense System</p>	<p>2001.12- 2002.7</p>
<p>国家攻关项目 National Key Technologies R&D Program</p>	<p>IPv6网络防护系统的研究 Research on IPv6 Network Security Protecting System</p>	<p>2002.12- 2003.7</p>
<p>铁道部重点项目 National Railway Ministry Key Project</p>	<p>铁路移动用户IP管理技术研究与实现 Research and implementation of IP management technology for mobile users in railway</p>	<p>2004.4- 2005.12</p>

Main invention patents in three years

专利名称 Patent name	申请时间 Time	申请号 Application number
一种适用动态变化网络的IPv6无线/移动路由器及实现方法 IPv6 Wireless/Mobile router and its implement method which is adaptive to the dynamic mutative network	2004年9月 September 2004	200410009563.3
一种基于IPv6的移动互联网络接入技术 A new access technology for mobile network based on IPv6	2005年3月 March 2005	200510008690.6

Main invention patents in three years

一种实现主机移动性和多家乡功能的 密钥交换协议方法 An Internet Key Exchange method supporting host mobility and multi-homing	2004年8月 August 2004	200410057052.9
移动主机开展组播业务的系统及其方法 A system for mobile host to supply multicast service and its implement method	2005年1月 January 2005	200510002374.8
一种基于网络密钥交换协议的地址更新方法 A network address updating method based on IKE	2004年11月 November 2004	200410087132.9

Main invention patents in three years

<p>一种虚拟路由器方式的虚拟 专用网络的组播方法</p> <p>A method for multicast in VPN based on virtual router mode</p>	<p>2004年12月</p> <p>December 2004</p>	<p>200410098718.5</p>
<p>一种IPv6传感器网络中支持压缩包 并行传输的实现方法</p> <p>A method to support compressed packets transmitted parallel in IPv6 sensor network</p>	<p>2005年5月</p> <p>May 2005</p>	<p>200510011747.8</p>
<p>一种IPv6网络中实现动态域名更新的方法</p> <p>A method to realize dynamic domain name updating in IPv6 network</p>	<p>2005年4月</p> <p>April 2005</p>	<p>200510011562.7</p>

Main invention patents in three years

<p>一种移动网络中基于熵模型的 移动路由器选择技术</p> <p>A mobile router selecting technology based on entropy mode in NEMO</p>	<p>2005年5月 May 2005</p>	<p>200510011929.5</p>
<p>服务器专用网络安全保护器</p> <p>Security system for privy server network</p>	<p>2004年1月 January 2004</p>	<p>ZL 2004 2 0000462.5</p>
<p>一种用于HMIPv6的MAP域内 快速切换的方法</p> <p>A method for fast handoff in MAP domain which is used in HMIPv6</p>	<p>2004年11月 November 2004</p>	<p>200410052516.7</p>
<p>路由表的组织与查找方法</p> <p>A method for organization and lookup of routing table</p>	<p>2002年12月 December 2002</p>	<p>02155157.x</p>

IETF Draft

- [1] **Zhang Hongke**, “Mobile IPv6 Multicast with Dynamic Multicast Agent”, IETF Draft, draft-zhang-mipshop-multicast-dma-03, 2007.1
- [2] **Zhang Hongke**, “Privacy Identifier in MIPv6”, IETF Draft, draft-zhang-mip6-pid-00, 2006.7
- [3] **Zhang Hongke**, “Firewall State Update Process for Mobile IPv6”, IETF Draft, draft-zhang-mip6-fsup-01, 2006.5

IETF Draft

- [4] **Zhang Hongke**, “Multicast in Virtual Router-based IP VPNs” , IETF Draft, draft-zhang-l3vpn-vr-mcast-01, 2005.7
- [5] Miao Fuyou, **Zhang Hongke**, “Firewall Traversal for Mobile IPv6”, IETF Draft, draft-miao-mip6-ft-02, 2006.5
- [6] Ren Yan, **Zhang Hongke**, “A proposal to replace HIP base exchange with IKE-H method” , IETF Draft, draft-yan-hip-ike-h-02, 2005.11

Collaboration

与Cisco、西门子、华为、TCL等国内外知名公司建立了良好的合作关系，同 Helicomm 等国内外公司成立了联合实验室，并接受了Intel、WindRiver 等多个国外企业的大学计划资助。

We have successively established cooperative relations with many famous internationally and famous Hi-tech corporations in America, etc, such as Cisco, Siemens, HUAWEI and TCL. And include the WindRiver and Intel ,many companies' University Plan also imburse us. Furthermore, we have founded many combine laboratories with Helicomm and other internationally famous Hi-tech corporations.

Collaboration



**Communicate with
Intel vice-president**



IETF-63th annual conference

北京交通大学下一代互联网研究中心

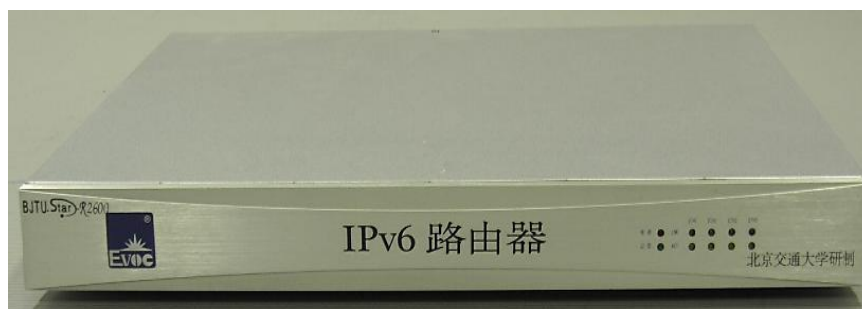
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 - **Development Direction**

Research Production

BJTU R2600 IPv6路由器

BJTU R2600 IPv6 Router



北京交通大学下一代互联网研究中心

Research Production

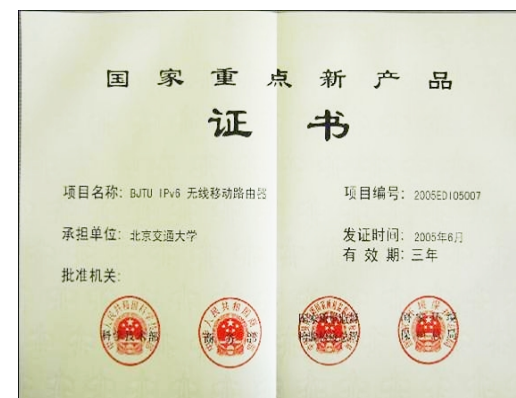
BJTU R2600 IPv6路由器由北京交通大学自主研制而成（原型系统于2000年研制成功，并在2002年1月通过科技成果鉴定）。该产品支持IPv6/v4等基本协议，RIPv1/v2/ng、OSPFv2/v3、BGP4/4+等动态路由协议，SNMPv2/v3网管协议等。该路由器通过了**IPv6 Ready**认证（ID 01-000335）

BJTU R2600 IPv6 Router is invented independently by Beijing Jiaotong University (The first generation IPv6 router was achieved in 2000, and passed Science and Technology Appraisal in January 2002). It supports basic IPv6/v4 protocols and dynamic routing protocols such as RIPv1/v2/ng, OSPFv2/v3, BGP4/4+, SNMPv2/v3, etc. The products passed the international **IPv6 Ready** authentication (ID 01-000335).

Research Production

BJTU WR2600/2601 IPv6无线/移动路由器

BJTU WR2600/2601 IPv6 Wireless/Mobile Router



Research Production

BJTU WR2600/2601 IPv6无线 / 移动路由器由北京交通大学自主研制，该设备实现了移动**IPv6**技术、移动子网技术等，并于**2004年8月**通过了科技成果鉴定，专家认定该产品**填补了国内空白，达到国际先进水平**。该产品已经在国内多所科研教学机构组建的**IPv6**网络中应用并于 **2005年**获得国家重点新产品证书，并获北京市科学技术一等奖。

BJTU WR2600/2601 IPv6 Wireless/Mobile Router is invented independently by Beijing Jiaotong University. This router supports mobile IPv6, mobile sub-network, wireless interfaces, etc. It passed the Science and Technology Appraisal by Ministry of Education in August 2004, and is considered to be **the first invention in China and the advanced world standard.**

Research Production

BJTU S2600 IPv6网络安全防护系统

BJTU S2600 IPv6 Network Security Protecting System



Research Production

BJTU S2600 IPv6 网络安全防护系统依托国家攻关项目（2002年完成）研制，可以对IPv6、IPv4等协议的数据包进行捕获、分析、还原和阻断过滤，有效保护本地网络。该系统具有很强的数据包处理能力，并且具备在**异常情况下的自动旁路功能**，可用于中小企业内部网络流量监控和访问控制等。

BJTU S2600 IPv6 Network Security Protecting System is based on one of National Key Technologies R&D Programs (finished in 2002). It provides the functionality of IPv4/v6 data capture, protocol analysis, data filtering, and partial data reversion. Under abnormal scenario, it can be **bypassed in order to ensure the connectivity of network**. This system can be applied in those institutions which require high-level security. It can also be effectively used in corporations for the purpose of flow-monitor and access control.

Research Production

BJTU PA2600 IPv6网络性能分析系统

BJTU PA2600 IPv6 Network Performance Analysis System



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Research Production

BJTU PA2600 IPv6网络性能分析系统能同时支持IPv4、IPv6网络监测、事后调查和分析。该设备可以捕捉并记录链路上每一个数据包，并对这些数据进行实时的分析，从而可以侦测到正在进行的网络攻击，并及时发送告警，帮助安全管理人员迅速查明并修复安全漏洞。该设备不仅在性能和功能上超过了国外同类产品，而且增加了对**IPv6**的支持。

BJTU PA2600 IPv6 Network Performance Analysis System supports IPv4/v6 network monitoring, investigation and analysis. This system can capture and record data frame, analyze bulk of real-time data, and detect any anomaly. Therefore, this system can detect ongoing network attack and send warning signal and help managers detect and eliminate problems.

Research Production

BJTU R3600 IPv6路由器

BJTU R3600 IPv6 Router



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Research Production

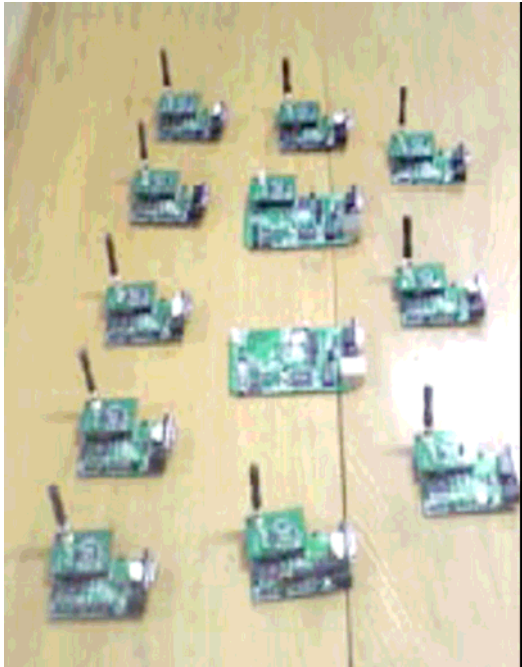
BJTU R3600 IPv6路由器基于IXP2400网络处理器和通用处理器构架，具有丰富的高速网络接口。网络处理器具有灵活的网络处理功能，是**新一代网络设备的核心**。该路由器的研发成功有望填补国内空白，达到国际先进水平。

BJTU R3600 IPv6 Router is based on IXP2400 network processor and general processor hardware architecture. Network processors have flexible network processing functionality and is considered to be **the key technology of next generation device**. Flexible and high-performance next generation IPv6 router based on network processor and general processor is considered to be a new research area in China. Other countries are still developing this technology. Therefore, this router is considered to be the first invention in China and to be the most advanced technology all over the world.

Research Production

BJTU IPv6 微型传感路由器

BJTU IPv6 Micro Sensor Router



Research Production

BJTU IPv6 微型传感路由器

BJTU IPv6 Micro Sensor Router



Equipment Demand&Supply Contact
Serial num: 20070100001

Products list and relevant prices:

SN	Product name and specification	num ber	unit	Unit price(¥)	Total price (¥)
1	Wireless sensor network micro Ethernet gateway	1	set	1100.00	1100.00
2	Micro sensor router(with serial port)	2	set	350.00	700.00
3	Micro sensor router(without serial port)	1	set	350.00	350.00
4	Micro node	1	set	350.00	350.00
5	Variable power	2	set	30.00	60.00
6	power	2	set	20.00	40.00
7	CD with technology documents, including 《IPv6micro sensor router user manual》 and 《micro sensing network management system configuration reference》	1	sheet	Cost-free	Cost-free

Total price: ¥2600

1. Paying: mailed within a month after the contact being signed
2. The contact takes effect after signature by both sides. The text version should be four copies, both sides withholding one Chinese version and English version. Fax is effective.
3. Issues involved with the contact without being stated here can be consulted by way of complemented protocols and other writing forms.
4. Signing date: the contact signed time is 1,4,2007

Supply: School of Electronic and information Engineering at Beijing Jiaotong University
Tel: 86-10-51685677
Client: 通信科
The badge:
Date: 2007-01-04

Demand: Engineering School at Sweden Jönköping University
Tel: 46-36-101601
Client: Youzh. Xu
Signature: [Signature]
Date: 2007-01-04

北京交通大学下一代互联网研究中心

Research Production

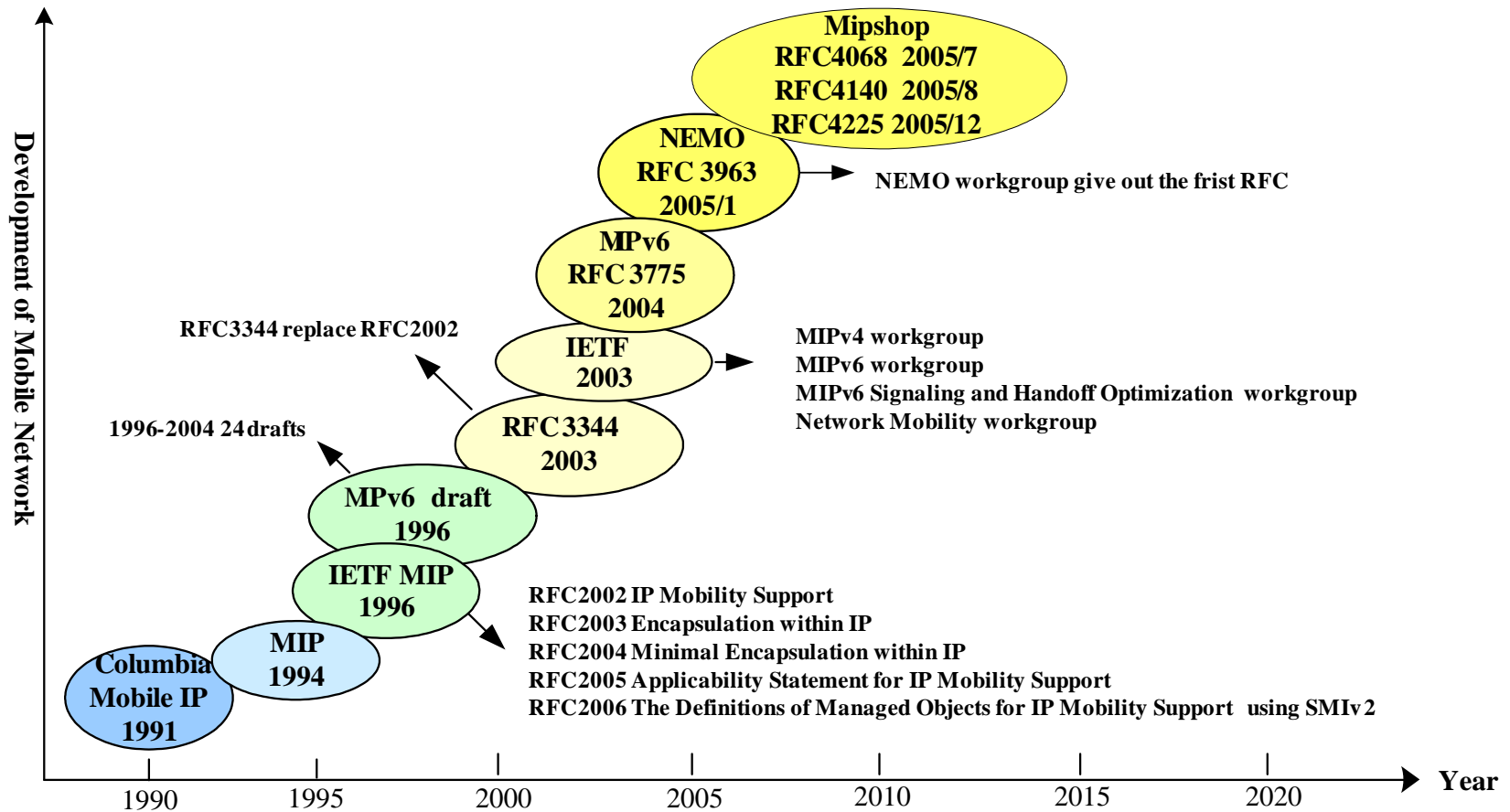
通过对传感器网络的体系和原理的深入研究，研制出 **IPv6 微型传感路由器**，2005年科技成果鉴定为“填补国内空白，整体达到国际先进水平，部分技术达到国际领先水平”。

After Researching on the theory of sensor network, we developed **IPv6 micro-sensor router**. It passed science and technology appraisal in 2005. It is considered to be the first invention in China and the advanced world standard.

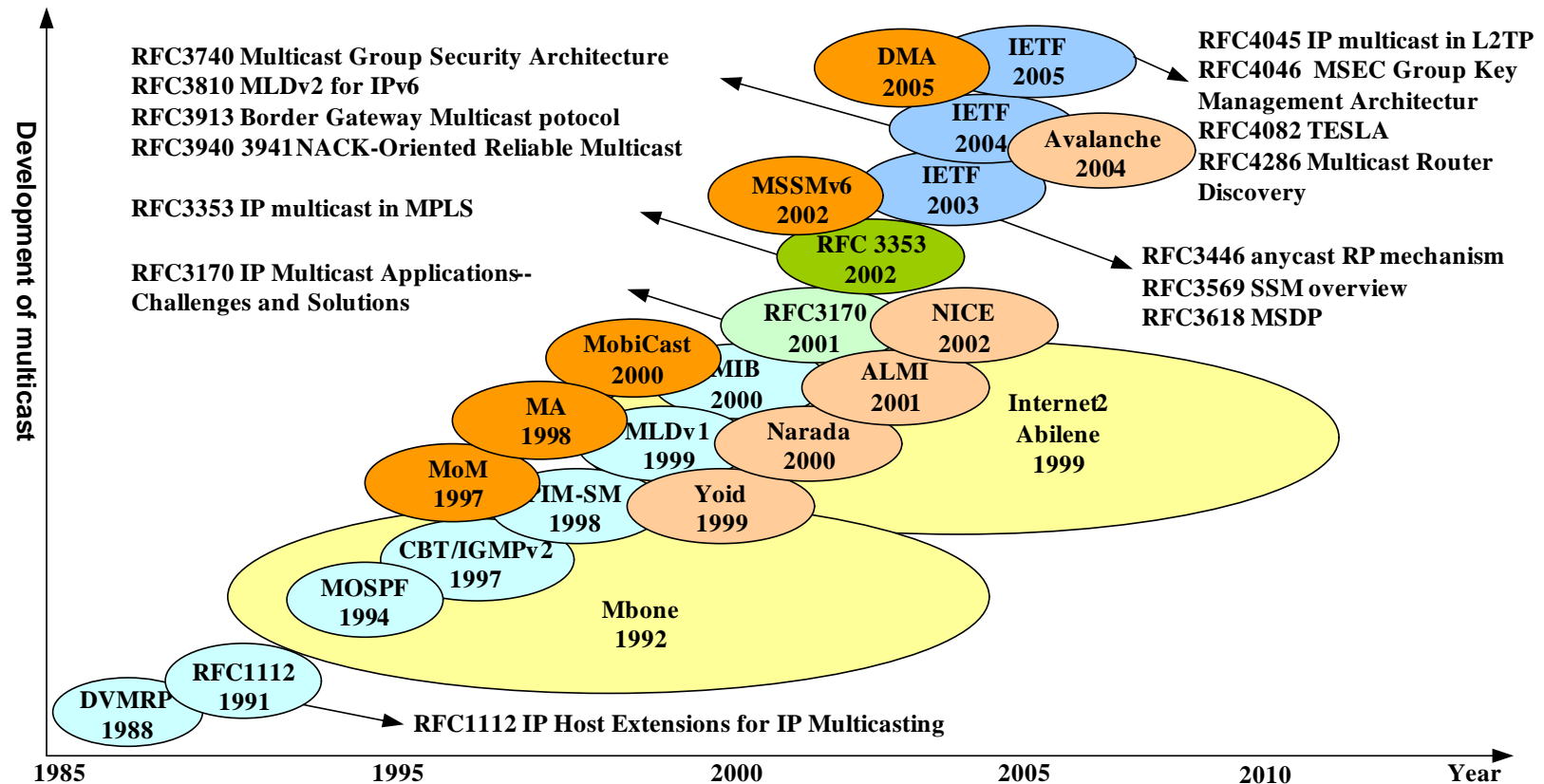
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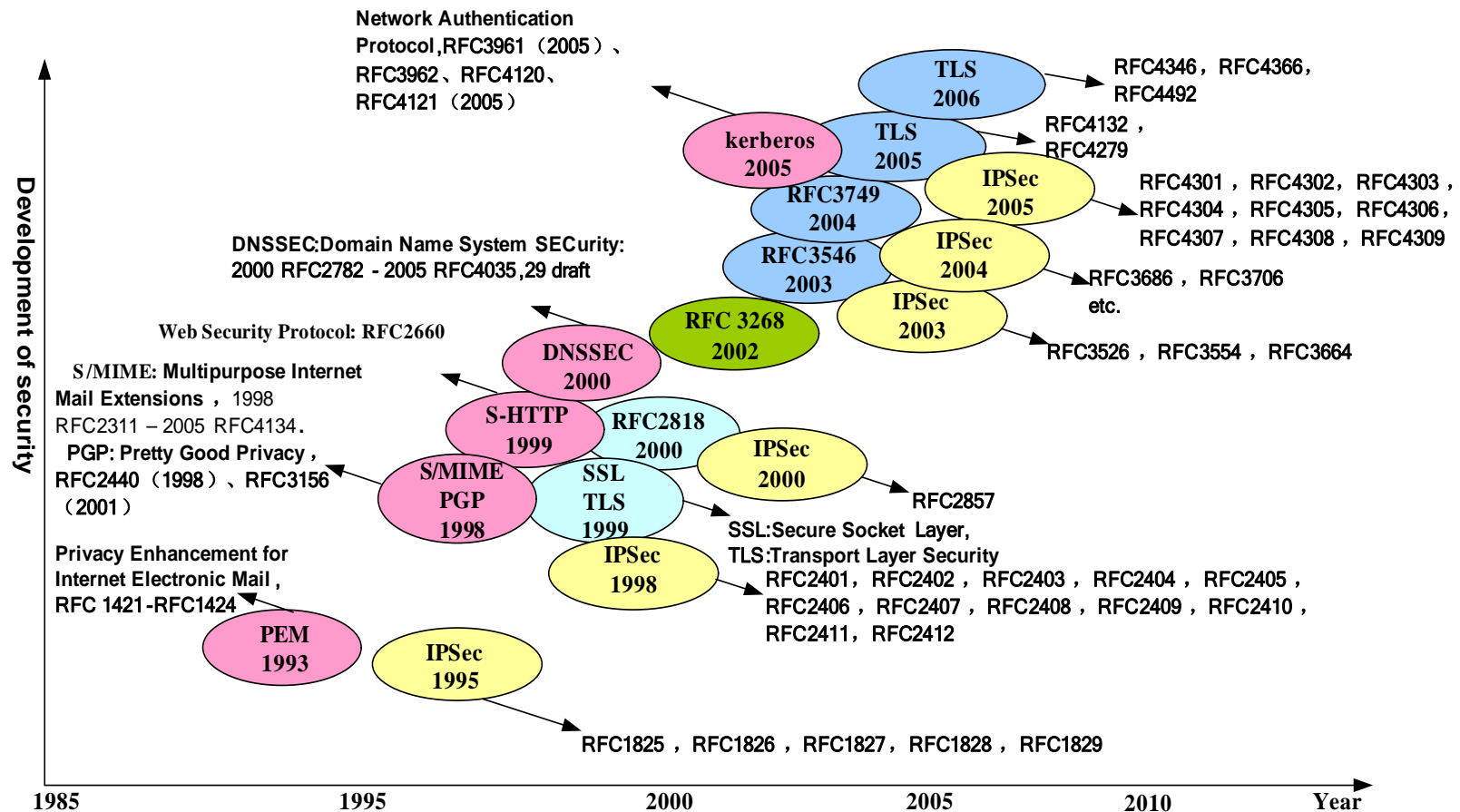
Development Direction — — Mobility



Development Direction — — Multicast



Development Direction — — Security



Development Direction

(1) 未来信息网络的体系结构

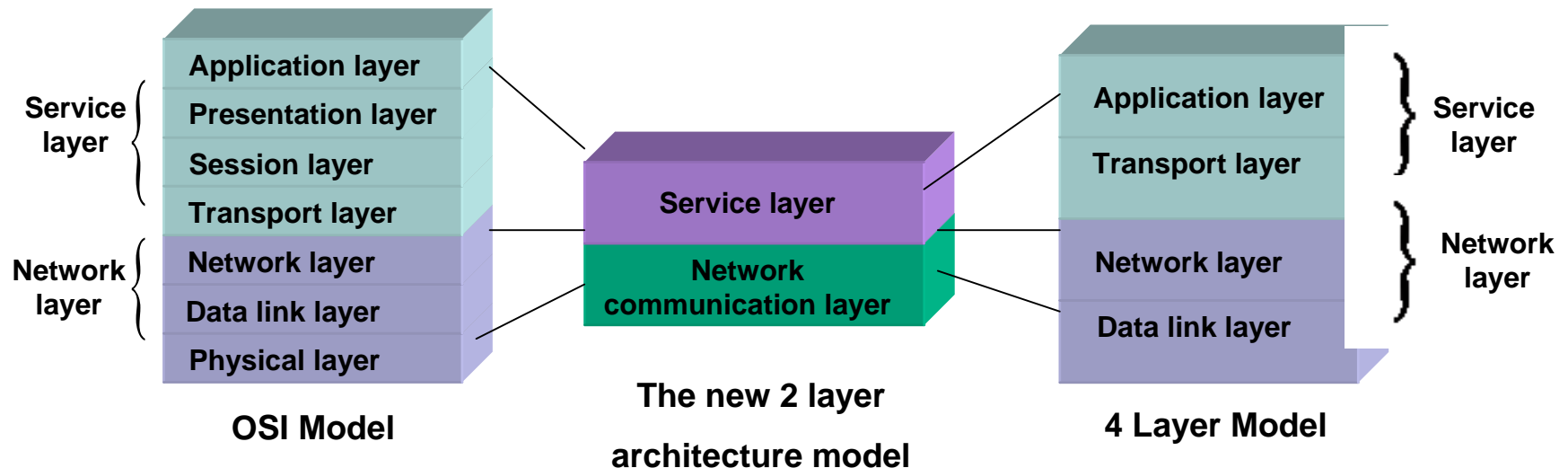
通过对现有各种信息网络分层理论的大量研究，发现各种网络体系结构，都可以划分为两个基本层面：一个是服务层面，一个是网络层面。

According to research on theories of layer division to current various information network, we finds the structure of each network architecture can be divided into two basic layers, one is service layer and the other is network layer.

Development Direction

由此我们给出一个全新的两层体系结构模型，即“**服务层**”和“**网通层**”

Therefore we get a new two-layer architecture model, that is “*service layer*” and “*network communication layer*” .



Development Direction

(2) 异质异构网络的一体化问题

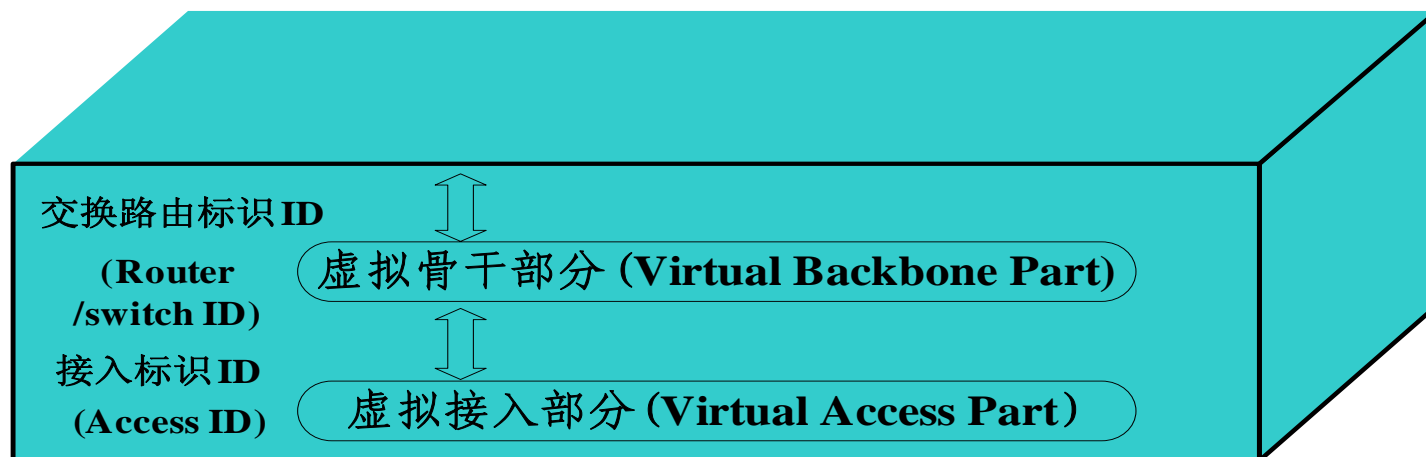
通过对现有多种信息网络长期深入研究和归纳总结，发现各种网络交换路由的**工作机理和原理**非常类似，都是完成**各种数据的交换与转发**，区别只是各种数据的格式和所支持的服务不同。

After long research on current information network, we find the principle of various network routing is similar. The principle is that fulfill data exchanging and forwarding, only few differences in data formats and supported services.

Development Direction

基于上述共性机理，我们提出了**广义交换路由理论、标识分离映射机制**，并以此为核心创建了一体化网络模型与理论，以解决多种网络一体化问题。

Based on the above mechanism, we bring out *broad sense routing theory, identity detached mapping theory*, and creates *model and theory of universal network*, providing solution for multiple network.



Architecture of Network communication layer

Development Direction

(3) 未来信息网络的普适服务

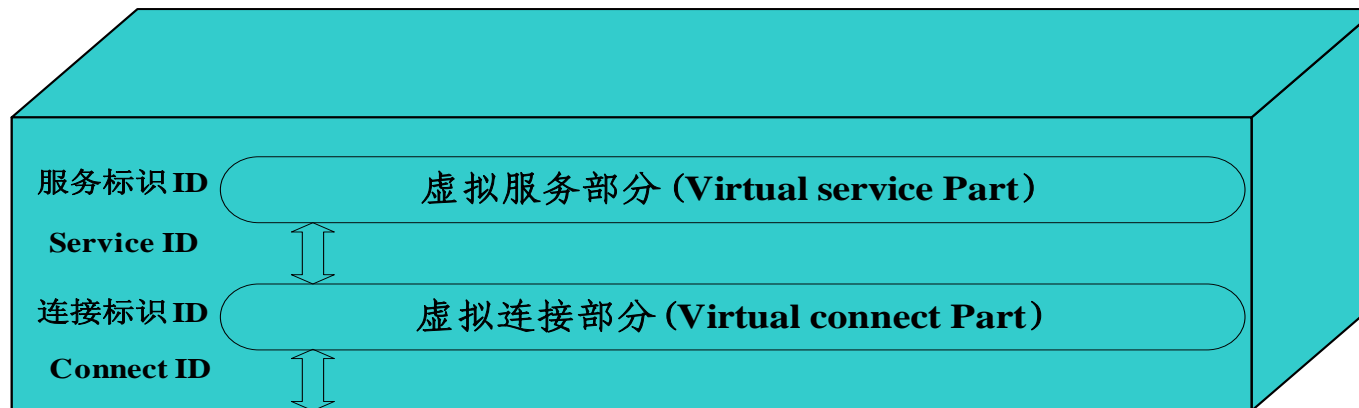
通过对现有网络服务的深入分析和研究，发现各种网络完成服务（业务）的机理和原理非常类似：**所有服务（业务）首先建立连接，然后这个连接再基于交换路由进行选路，实现数据传输。**

After long research on current information network, we find that the principle that various networks fulfill service (business) is similar: All service (business) sets up link first, then the link routs based on the routing principles, realizing data transportation.

Development Direction

在这种共性机理的基础上，我们提出了能够支持普适服务问题的**服务标识与连接标识解析映射理论**，并以此为核心创建了**普适服务模型与理论**。

Based on the common principle, we bring out service identity and connect identity paring and mapping theory that supports persuasive service, and create model and theory of persuasive service.



Architecture of Service layer

Development Direction

(4) 未来信息网络中的可信与移动

在对互联网机理深入研究的基础上，发现安全和移动性差的主要原因是IP地址的定义既包含位置信息也包含身份信息，易被冒充且不利于移动。为此，提出了位置信息和身份信息分离解析映射理论，解决新体系下的可信和移动问题。

According to research on Internet principles, we find that the major flaw of trust and mobility is that the IP address contains both position information and identity information, both of which are easy to be pretended and are weak in mobile. To solve the problem of trust and mobility, we bring out *detached paring and mapping theory of position information and identity information.*



Thanks!

2007年4月8日