



Cisco Expo
2008

Cisco IPv6 Solutions Integration & Co-Existence



Jean-Charles Griviau

Technology Product Management, Cisco Systems

jgriviau@cisco.com

Agenda

- **Market Trends**
- **IPv6 standards & Technology overview**
- **IPv6 Deployment guidelines**
- **Cisco IPv6 solutions overview**

What is IPv6? Basic Perspectives

The Network Manager Perspective **Infrastructure evolution**

Stable specifications, commercial
implementations
Cost of deployment and operations



The End-User Perspective **Applications & Services evolution**

IP Agnostic



Key Aspects Reminder



- **IPv6 is NOT a feature.** It is about the fundamental IP network layer model developed for end-to-end services and network transparency

But it doesn't necessarily solve all Internet issues

- Deployments of production IPv6 infrastructures are under way, the time has come to move our focus to edge, access and usage

6Bone is phased out, 6NET is closed,...

- Today's IPv6 deployment drivers do not rely on uncovering the "future killer application" anymore, they focus instead on:

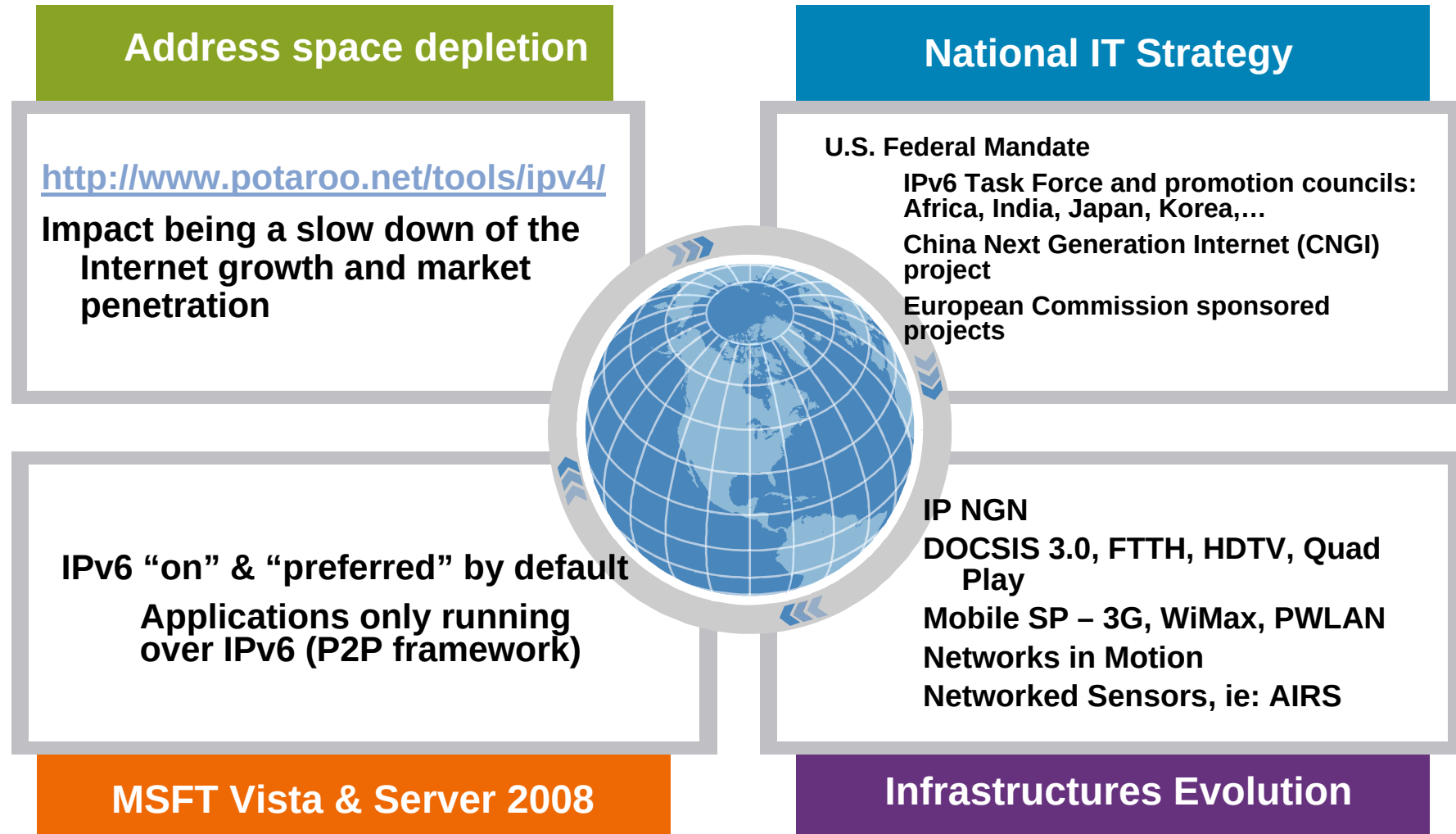
Performing the same as on IPv4 but on a larger scale

Operational cost savings or simpler network models when deploying applications

Leading the innovation



Monitoring Market Drivers



IPv4 Address Fractal Map Jan-2000

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084 RIPE	087 RIPE	088 RIPE	091 RIPE	100 Reserved	103 Reserved	104 Reserved	107 Reserved	148 Various	151 Various	152 Various	155 Various	164 Various	167 Various	168 Various	171 Various
085 RIPE	086 RIPE	089 RIPE	090 RIPE	101 Reserved	102 Reserved	105 Reserved	106 Reserved	149 Various	150 Various	153 Various	154 Various	165 Various	166 Various	169 Various	170 Various

Fractal map: Layout by Randall Munroe, Time Sequence by Tony Hain, Highlighted by Jeff Apcar

IPv4 Address Fractal Map Jan-2008

000 Reserved	001 Reserved	014 PDN	015 HP	016 DEC	019 Ford	020 CsC	021 US DoD	234 Multicast	235 Multicast	236 Multicast	239 Multicast	240 Class E	241 Class E	254 Class E	255 Class E
003 GE	002 Reserved	013 Xerox	012 AT&T	017 Apple	018 MIT	023 Reserved	022 US DoD	233 Multicast	232 Multicast	237 Multicast	238 Multicast	243 Class E	242 Class E	253 Class E	252 Class E
004 L3	007 Reserved	008 L3	011 US DoD	030 US DoD	029 US DoD	024 Cable	025 UK Defense	230 Multicast	231 Multicast	226 Multicast	225 Multicast	244 Class E	247 Class E	248 Class E	251 Class E
005 Reserved	006 US DoD	009 IBM	010 Private	031 Reserved	028 US DoD	027 Reserved	026 US DoD	229 Multicast	228 Multicast	227 Multicast	224 Multicast	245 Class E	246 Class E	249 Class E	250 Class E
058 APnic	057 SITA	054 Merck	053 Cap Debis	032 AT&T	035 MERIT	036 Reserved	037 Reserved	218 APnic	219 APnic	220 APnic	223 Reserved	202 APnic	201 LACnic	198 Various	197 Reserved
059 APnic	056 US Postal	055 US DoD	052 EI duPONT	033 US DoD	034 Haliburton	039 Reserved	038 PSI	217 RIPE	216 ARIN	221 APnic	222 APnic	203 APnic	200 LACnic	199 ARIN	196 AFRnic
060 APnic	061 APnic	050 Reserved	051 UK DSS	046 Reserved	045 Interop	040 Eli Lily	041 AFRNIC	214 US DoD	215 US DoD	210 APnic	209 ARIN	204 ARIN	205 ARIN	194 RIPE	195 RIPE
063 ARIN	062 RIPE	049 Reserved	048 Prudential	047 Bell North	044 Radio	043 Inet	042 Reserved	213 RIPE	212 RIPE	211 APnic	208 ARIN	207 ARIN	206 ARIN	192 RIPE	192 Various
064 ARIN	067 ARIN	068 ARIN	069 ARIN	122 APnic	123 APnic	124 APnic	127 Loopback	128 Various	131 Various	132 Various	133 Various	186 LACnic	187 LACnic	188 Various	191 Various
065 ARIN	066 ARIN	071 ARIN	070 ARIN	121 APnic	120 APnic	125 APnic	126 APnic	129 Various	130 Various	135 Various	134 Various	185 Reserved	184 Reserved	189 LACnic	190 LACnic
078 RIPE	077 RIPE	072 ARIN	073 ARIN	118 APnic	119 APnic	114 APnic	113 Reserved	142 Various	141 Various	136 Various	137 Various	182 Reserved	183 Reserved	178 Reserved	177 Reserved
079 RIPE	076 ARIN	075 ARIN	074 ARIN	117 APnic	116 APnic	115 APnic	112 Reserved	143 Various	140 Various	139 Various	138 Various	181 Reserved	180 Reserved	179 Reserved	176 Reserved
080 RIPE	081 RIPE	094 RIPE	095 RIPE	096 ARIN	097 ARIN	110 Reserved	111 Reserved	144 Various	145 Various	158 Various	159 Various	160 Various	161 Various	174 Reserved	175 Reserved
083 RIPE	082 RIPE	093 RIPE	092 RIPE	099 ARIN	098 ARIN	109 Reserved	108 Reserved	147 Various	146 Various	157 Various	156 Various	163 Various	162 Various	173 Reserved	172 Various
084 RIPE	087 RIPE	088 RIPE	091 RIPE	100 Reserved	103 Reserved	104 Reserved	107 Reserved	148 Various	151 Various	152 Various	155 Various	164 Various	167 Various	168 Various	171 Various
085 RIPE	086 RIPE	089 RIPE	090 RIPE	101 Reserved	102 Reserved	105 Reserved	106 Reserved	149 Various	150 Various	153 Various	154 Various	165 Various	166 Various	169 Various	170 Various

Fractal map: Layout by Randall Munroe, Time Sequence by Tony Hain, Highlighted by Jeff Apcar

IPv4 Address Fractal Map Today

000 Reserved	001 Reserved	014 PDN	015 HP	016 DEC	019 Ford	020 CsC	021 US DoD	234 Multicast	235 Multicast	236 Multicast	239 Multicast	240 Class E	241 Class E	254 Class E	255 Class E
003 GE	002 Reserved	013 Xerox	012 AT&T	017 Apple	018 MIT	023 Reserved	022 US DoD	233 Multicast	232 Multicast	237 Multicast	238 Multicast	243 Class E	242 Class E	253 Class E	252 Class E
004 L3	007 Reserved	008 L3	011 US DoD	030 US DoD	029 US DoD	024 Cable	025 UK Defense	230 Multicast	231 Multicast	226 Multicast	225 Multicast	244 Class E	247 Class E	248 Class E	251 Class E
005 Reserved	006 US DoD	009 IBM	010 Private	031 Reserved	028 US DoD	027 Reserved	026 US DoD	229 Multicast	228 Multicast	227 Multicast	224 Multicast	245 Class E	246 Class E	249 Class E	250 Class E
058 APnic	057 SITA	054 Merck	053 Cap Debis	032 AT&T	035 MERIT	036 Reserved	037 Reserved	218 APnic	219 APnic	220 APnic	223 Reserved	202 APnic	201 LACnic	198 Various	197 Reserved
059 APnic	056 US Postal	055 US DoD	052 EI duPONT	033 US DoD	034 Haliburton	039 Reserved	038 PSI	217 RIPE	216 ARIN	221 APnic	222 APnic	203 APnic	200 LACnic	199 ARIN	196 AFRnic
060 APnic	061 APnic	050 Reserved	051 UK DSS	046 Reserved	045 Interop	040 Eli Lily	041 AFRNIC	214 US DoD	215 US DoD	210 APnic	209 ARIN	204 ARIN	205 ARIN	194 RIPE	195 RIPE
063 ARIN	062 RIPE	049 Reserved	048 Prudential	047 Bell North	044 Radio	043 Inet	042 Reserved	213 RIPE	212 RIPE	211 APnic	208 ARIN	207 ARIN	206 ARIN	192 RIPE	192 Various
064 ARIN	067 ARIN	068 ARIN	069 ARIN	122 APnic	123 APnic	124 APnic	127 Loopback	128 Various	131 Various	132 Various	133 Various	186 LACnic	187 LACnic	188 Various	191 Various
065 ARIN	066 ARIN	071 ARIN	070 ARIN	121 APnic	120 APnic	125 APnic	126 APnic	129 Various	130 Various	135 Various	134 Various	185 Reserved	184 Reserved	189 LACnic	190 LACnic
078 RIPE	077 RIPE	072 ARIN	073 ARIN	118 APnic	119 APnic	114 APnic	113 Reserved	142 Various	141 Various	136 Various	137 Various	182 Reserved	183 Reserved	178 Reserved	177 Reserved
079 RIPE	076 ARIN	075 ARIN	074 ARIN	117 APnic	116 APnic	115 APnic	112 Reserved	143 Various	140 Various	139 Various	138 Various	181 Reserved	180 Reserved	179 Reserved	176 Reserved
080 RIPE	081 RIPE	094 RIPE	095 RIPE	096 ARIN	097 ARIN	110 Reserved	111 Reserved	144 Various	145 Various	158 Various	159 Various	160 Various	161 Various	174 Reserved	175 Reserved
083 RIPE	082 RIPE	093 RIPE	092 RIPE	099 ARIN	098 ARIN	109 Reserved	108 Reserved	147 Various	146 Various	157 Various	156 Various	163 Various	162 Various	173 Reserved	172 Various
084 RIPE	087 RIPE	088 RIPE	091 RIPE	100 Reserved	103 Reserved	104 Reserved	107 Reserved	148 Various	151 Various	152 Various	155 Various	164 Various	167 Various	168 Various	171 Various
085 RIPE	086 RIPE	089 RIPE	090 RIPE	101 Reserved	102 Reserved	105 Reserved	106 Reserved	149 Various	150 Various	153 Various	154 Various	165 Various	166 Various	169 Various	170 Various

Fractal map: Layout by Randall Munroe, Time Sequence by Tony Hain, Highlighted by Jeff Apcar

IPv4 Address Fractal Map Jan-2009

000 Reserved	001 Reserved	014 PDN	015 HP	016 DEC	019 Ford	020 CsC	021 US DoD	234 Multicast	235 Multicast	236 Multicast	239 Multicast	240 Class E	241 Class E	254 Class E	255 Class E
003 GE	002 Reserved	013 Xerox	012 AT&T	017 Apple	018 MIT	023 Reserved	022 US DoD	233 Multicast	232 Multicast	237 Multicast	238 Multicast	243 Class E	242 Class E	253 Class E	252 Class E
004 L3	007 Reserved	008 L3	011 US DoD	030 US DoD	029 US DoD	024 Cable	025 UK Defense	230 Multicast	231 Multicast	226 Multicast	225 Multicast	244 Class E	247 Class E	248 Class E	251 Class E
005 Reserved	006 US DoD	009 IBM	010 Private	031 Reserved	028 US DoD	027 Reserved	026 US DoD	229 Multicast	228 Multicast	227 Multicast	224 Multicast	245 Class E	246 Class E	249 Class E	250 Class E
058 APnic	057 SITA	054 Merck	053 Cap Debis	032 AT&T	035 MERIT	036 Reserved	037 Reserved	218 APnic	219 APnic	220 APnic	223 Reserved	202 APnic	201 LACnic	198 Various	197 Reserved
059 APnic	056 US Postal	055 US DoD	052 EI duPONT	033 US DoD	034 Haliburton	039 Reserved	038 PSI	217 RIPE	216 ARIN	221 APnic	222 APnic	203 APnic	200 LACnic	199 ARIN	196 AFRnic
060 APnic	061 APnic	050 Reserved	051 UK DSS	046 Reserved	045 Interop	040 Eli Lily	041 AFRNIC	214 US DoD	215 US DoD	210 APnic	209 ARIN	204 ARIN	205 ARIN	194 RIPE	195 RIPE
063 ARIN	062 RIPE	049 Reserved	048 Prudential	047 Bell North	044 Radio	043 Inet	042 Reserved	213 RIPE	212 RIPE	211 APnic	208 ARIN	207 ARIN	206 ARIN	192 RIPE	192 Various
064 ARIN	067 ARIN	068 ARIN	069 ARIN	122 APnic	123 APnic	124 APnic	127 Loopback	128 Various	131 Various	132 Various	133 Various	186 LACnic	187 LACnic	188 Various	191 Various
065 ARIN	066 ARIN	071 ARIN	070 ARIN	121 APnic	120 APnic	125 APnic	126 APnic	129 Various	130 Various	135 Various	134 Various	185 Reserved	184 Reserved	189 LACnic	190 LACnic
078 RIPE	077 RIPE	072 ARIN	073 ARIN	118 APnic	119 APnic	114 APnic	113 Next	142 Various	141 Various	136 Various	137 Various	182 Reserved	183 Reserved	178 Next	177 Next
079 RIPE	076 ARIN	075 ARIN	074 ARIN	117 APnic	116 APnic	115 APnic	112 Next	143 Various	140 Various	139 Various	138 Various	181 Reserved	180 Reserved	179 Next	176 Next
080 RIPE	081 RIPE	094 RIPE	095 RIPE	096 ARIN	097 ARIN	110 Next	111 Next	144 Various	145 Various	158 Various	159 Various	160 Various	161 Various	174 Next	175 Next
083 RIPE	082 RIPE	093 RIPE	092 RIPE	099 ARIN	098 ARIN	109 Reserved	108 Reserved	147 Various	146 Various	157 Various	156 Various	163 Various	162 Various	173 Next	172 Various
084 RIPE	087 RIPE	088 RIPE	091 RIPE	100 Next	103 Reserved	104 Reserved	107 Reserved	148 Various	151 Various	152 Various	155 Various	164 Various	167 Various	168 Various	171 Various
085 RIPE	086 RIPE	089 RIPE	090 RIPE	101 Next	102 Reserved	105 Reserved	106 Reserved	149 Various	150 Various	153 Various	154 Various	165 Various	166 Various	169 Various	170 Various

Fractal map: Layout by Randall Munroe, Time Sequence by Tony Hain, Highlighted by Jeff Apcar

IPv4 Address Fractal Map Jan-2010

000 Reserved	001 Reserved	014 PDN	015 HP	016 DEC	019 Ford	020 CsC	021 US DoD	234 Multicast	235 Multicast	236 Multicast	239 Multicast	240 Class E	241 Class E	254 Class E	255 Class E
003 GE	002 Reserved	013 Xerox	012 AT&T	017 Apple	018 MIT	023 Reserved	022 US DoD	233 Multicast	232 Multicast	237 Multicast	238 Multicast	243 Class E	242 Class E	253 Class E	252 Class E
004 L3	007 Reserved	008 L3	011 US DoD	030 US DoD	029 US DoD	024 Cable	025 UK Defense	230 Multicast	231 Multicast	226 Multicast	225 Multicast	244 Class E	247 Class E	248 Class E	251 Class E
005 Reserved	006 US DoD	009 IBM	010 Private	031 Reserved	028 US DoD	027 Reserved	026 US DoD	229 Multicast	228 Multicast	227 Multicast	224 Multicast	245 Class E	246 Class E	249 Class E	250 Class E
058 APnic	057 SITA	054 Merck	053 Cap Debis	032 AT&T	035 MERIT	036 Reserved	037 Reserved	218 APnic	219 APnic	220 APnic	223 Reserved	202 APnic	201 LACnic	198 Various	197 Reserved
059 APnic	056 US Postal	055 US DoD	052 EI duPONT	033 US DoD	034 Haliburton	039 Reserved	038 PSI	217 RIPE	216 ARIN	221 APnic	222 APnic	203 APnic	200 LACnic	199 ARIN	196 AFRnic
060 APnic	061 APnic	050 Reserved	051 UK DSS	046 Reserved	045 Interop	040 Eli Lily	041 AFRNIC	214 US DoD	215 US DoD	210 APnic	209 ARIN	204 ARIN	205 ARIN	194 RIPE	195 RIPE
063 ARIN	062 RIPE	049 Reserved	048 Prudential	047 Bell North	044 Radio	043 Inet	042 Reserved	213 RIPE	212 RIPE	211 APnic	208 ARIN	207 ARIN	206 ARIN	192 RIPE	192 Various
064 ARIN	067 ARIN	068 ARIN	069 ARIN	122 APnic	123 APnic	124 APnic	127 Loopback	128 Various	131 Various	132 Various	133 Various	186 LACnic	187 LACnic	188 Various	191 Various
065 ARIN	066 ARIN	071 ARIN	070 ARIN	121 APnic	120 APnic	125 APnic	126 APnic	129 Various	130 Various	135 Various	134 Various	185 Next	184 Next	189 LACnic	190 LACnic
078 RIPE	077 RIPE	072 ARIN	073 ARIN	118 APnic	119 APnic	114 APnic	113 Next	142 Various	141 Various	136 Various	137 Various	182 Next	183 Next	178 Next	177 Next
079 RIPE	076 ARIN	075 ARIN	074 ARIN	117 APnic	116 APnic	115 APnic	112 Next	143 Various	140 Various	139 Various	138 Various	181 Next	180 Next	179 Next	176 Next
080 RIPE	081 RIPE	094 RIPE	095 RIPE	096 ARIN	097 ARIN	110 Next	111 Next	144 Various	145 Various	158 Various	159 Various	160 Various	161 Various	174 Next	175 Next
083 RIPE	082 RIPE	093 RIPE	092 RIPE	099 ARIN	098 ARIN	109 Next	108 Next	147 Various	146 Various	157 Various	156 Various	163 Various	162 Various	173 Next	172 Various
084 RIPE	087 RIPE	088 RIPE	091 RIPE	100 Next	103 Next	104 Next	107 Next	148 Various	151 Various	152 Various	155 Various	164 Various	167 Various	168 Various	171 Various
085 RIPE	086 RIPE	089 RIPE	090 RIPE	101 Next	102 Next	105 Next	106 Next	149 Various	150 Various	153 Various	154 Various	165 Various	166 Various	169 Various	170 Various

Fractal map: Layout by Randall Munroe, Time Sequence by Tony Hain, Highlighted by Jeff Apcar

IPv4 Address Fractal Map Jan-2011

000 Reserved	001 Reserved	014 PDN	015 HP	016 DEC	019 Ford	020 CsC	021 US DoD	234 Multicast	235 Multicast	236 Multicast	239 Multicast	240 Class E	241 Class E	254 Class E	255 Class E
003 GE	002 Next	013 Xerox	012 AT&T	017 Apple	018 MIT	023 Next	022 US DoD	233 Multicast	232 Multicast	237 Multicast	238 Multicast	243 Class E	242 Class E	253 Class E	252 Class E
004 L3	007 Next	008 L3	011 US DoD	030 US DoD	029 US DoD	024 Cable	025 UK Defense	230 Multicast	231 Multicast	226 Multicast	225 Multicast	244 Class E	247 Class E	248 Class E	251 Class E
005 Next	006 US DoD	009 IBM	010 Private	031 Next	028 US DoD	027 Next	026 US DoD	229 Multicast	228 Multicast	227 Multicast	224 Multicast	245 Class E	246 Class E	249 Class E	250 Class E
058 APnic	057 SITA	054 Merck	053 Cap Debis	032 AT&T	035 MERIT	036 Next	037 Next	218 APnic	219 APnic	220 APnic	223 Next	202 APnic	201 LACnic	198 Various	197 Next
059 APnic	056 US Postal	055 US DoD	052 EI duPONT	033 US DoD	034 Haliburton	039 Next	038 PSI	217 RIPE	216 ARIN	221 APnic	222 APnic	203 APnic	200 LACnic	199 ARIN	196 AFRnic
060 APnic	061 APnic	050 Next	051 UK DSS	046 Next	045 Interop	040 Eli Lily	041 AFRNIC	214 US DoD	215 US DoD	210 APnic	209 ARIN	204 ARIN	205 ARIN	194 RIPE	195 RIPE
063 ARIN	062 RIPE	049 Next	048 Prudential	047 Bell North	044 Radio	043 Inet	042 Next	213 RIPE	212 RIPE	211 APnic	208 ARIN	207 ARIN	206 ARIN	192 RIPE	192 Various
064 ARIN	067 ARIN	068 ARIN	069 ARIN	122 APnic	123 APnic	124 APnic	127 Loopback	128 Various	131 Various	132 Various	133 Various	186 LANnic	187 LANnic	188 Various	191 Various
065 ARIN	066 ARIN	071 ARIN	070 ARIN	121 APnic	120 APnic	125 APnic	126 APnic	129 Various	130 Various	135 Various	134 Various	185 Next	184 Next	189 LACnic	190 LACnic
078 RIPE	077 RIPE	072 ARIN	073 ARIN	118 APnic	119 APnic	114 APnic	113 Next	142 Various	141 Various	136 Various	137 Various	182 Next	183 Next	178 Next	177 Next
079 RIPE	076 ARIN	075 ARIN	074 ARIN	117 APnic	116 APnic	115 APnic	112 Next	143 Various	140 Various	139 Various	138 Various	181 Next	180 Next	179 Next	176 Next
080 RIPE	081 RIPE	094 RIPE	095 RIPE	096 ARIN	097 ARIN	110 Next	111 Next	144 Various	145 Various	158 Various	159 Various	160 Various	161 Various	174 Next	175 Next
083 RIPE	082 RIPE	093 RIPE	092 RIPE	099 ARIN	098 ARIN	109 Next	108 Next	147 Various	146 Various	157 Various	156 Various	163 Various	162 Various	173 Next	172 Various
084 RIPE	087 RIPE	088 RIPE	091 RIPE	100 Next	103 Next	104 Next	107 Next	148 Various	151 Various	152 Various	155 Various	164 Various	167 Various	168 Various	171 Various
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Internet around the world

<http://www.unicttaskforce.org/perl/documents.pl?id=1314>

North-America

Est. Pop: 334,659,631
Internet users: 237,168,545
Penetration rate: 70.9 %

Europe

Est. Pop: 801,821,187
Internet users: 343,787,434
Penetration rate: 42.9 %

Asia

Est. Pop: 3,733,783,474
Internet users: 461,703,143
Penetration rate: 12.4 %

Physical Map of the World, April 2006



World Total

Est. Pop (11/07):
6,606,970,166
Est. Pop (2050):
9.0B
Penetration rate
1,262,032,697
2007: 19.1 %
Target: 22%

Middle-East

Est. Pop: 192,755,045
Internet users: 33,510,500
Penetration rate: 17.4 %

Latin America/Caribbean

Est. Pop: 569,133,474
Internet users: 122,384,914
Penetration rate: 21.5 %

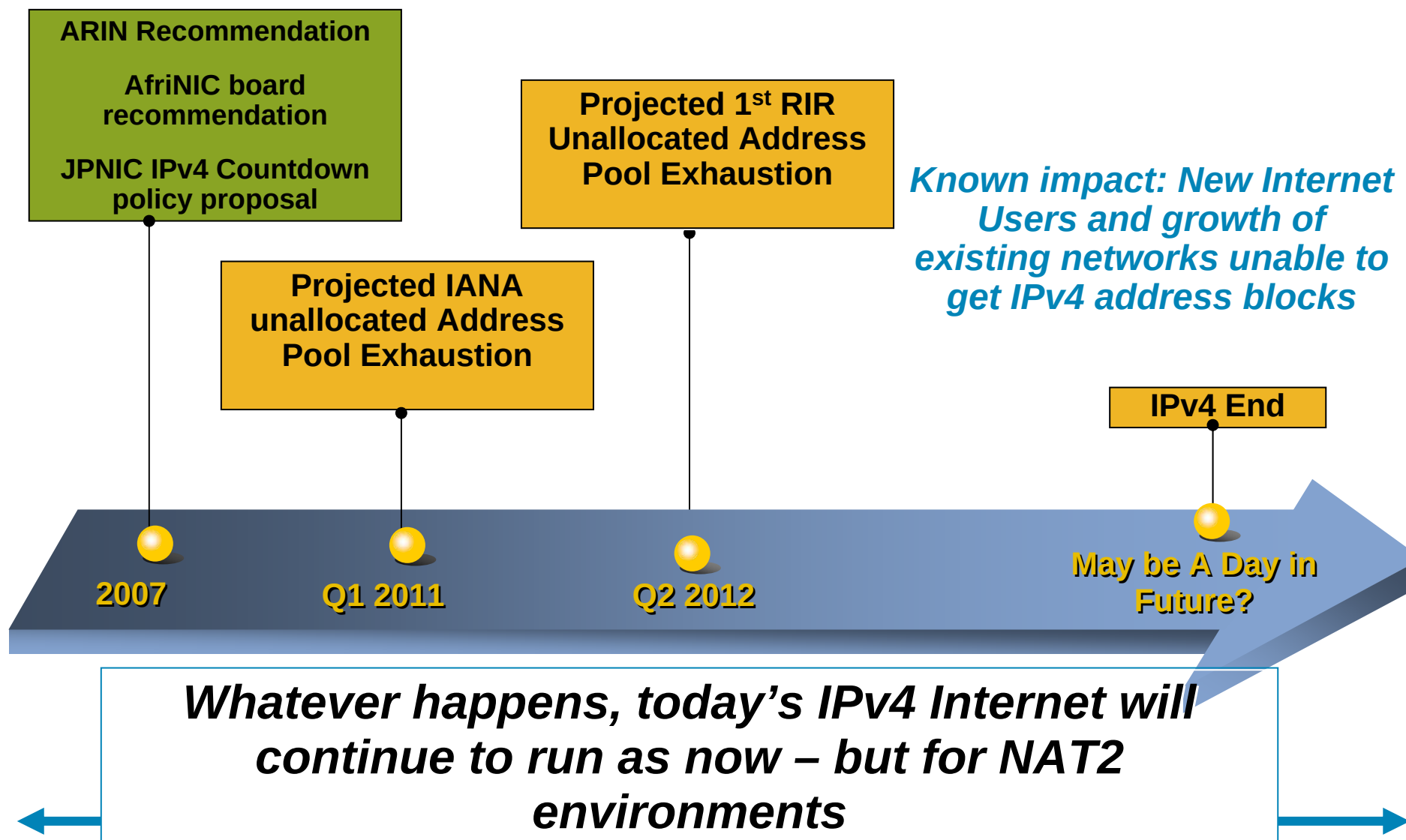
Africa

Est. Pop: 941,249,130
Internet users: 44,234,240
Penetration rate: 4.7 %

Australia/Oceania

Est. Pop: 33,568,225
Internet users: 19,243,921
Penetration rate: 57.3 %

Impacts of IPv4 Address Space Exhaustion



IPv6 Geo-Politics

Political Map of the World, April 2006

Legend:
• **INDEPENDENT STATE**
• **DEPENDENCY OR AREA OF SPECIAL SOVEREIGNTY**
• **INLAND / ISLAND GROUP**
• **CAPITAL**
Scale: 1:11,000,000
Projection: Robinson
Inset: 10°N 10°E

European Commission funded projects
6NET, 6DISS, Euro6IX, u-2010

China Next Generation
Internet (CNGI) project

- OMB mandate for Federal Agencies
- DoD mandate
- www.moonv6.org

Korea IT 839

E-Japan
IPv6 promotion council

National IPv6 Task Forces – www.ipv6tf.org

National IT Strategy paper

http://www.cisco.com/en/US/products/ps6553/products_white_paper0900aecd8032b2ad.shtml

Who is Deploying IPv6 Today?

Service Providers



- Carrier – Transit services

<http://www.sixxs.net/faq/connectivity/?faq=ipv6transit>

- Internet eXchange Point (IX) – NRN & ISP

<http://www.bgp4.as/internet-exchanges>

- Broadband SP

Japan - <http://www.ipv6style.jp/en/statistics/services/index.shtml>

Europe - <http://www.sixxs.net/faq/connectivity/?faq=native>

- Mobile SP – R&D and Trials for 3G/4G services



Enterprises



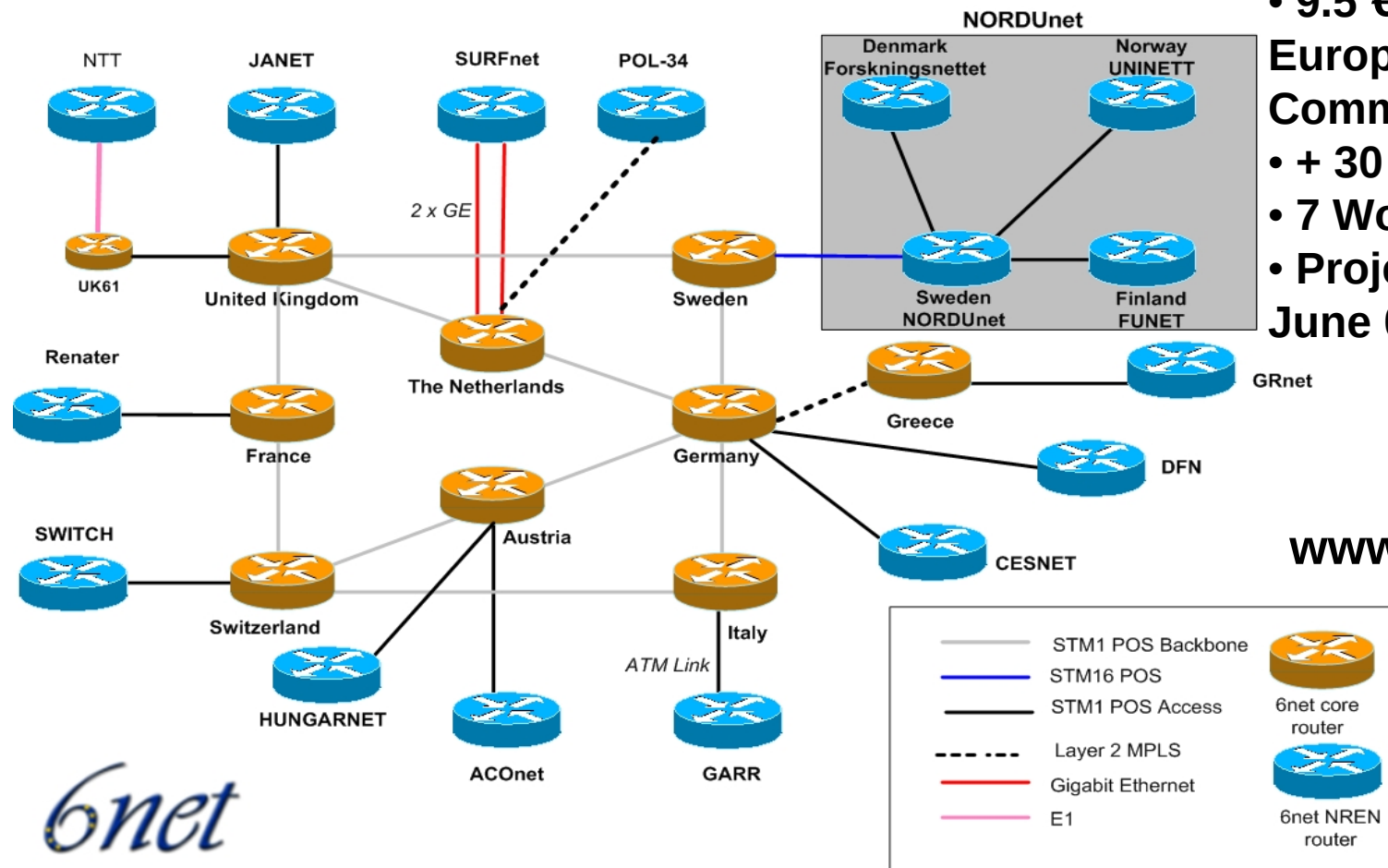
- NRN, Universities, Schools, Research Labs
- Government agencies, eg. US Federal mandate, Eurocontrol, Military,...
- IT Vendors and System Integrators, eg. Cisco, Bechtel, Microsoft, Command Information,...
- IT department deploying Vista and Server 2008

6NET Project Overview



www.6net.org

- 3 years project
- 9.5 € from European Commission
- + 30 partners
- 7 Work Packages
- Project **ended** in June 05

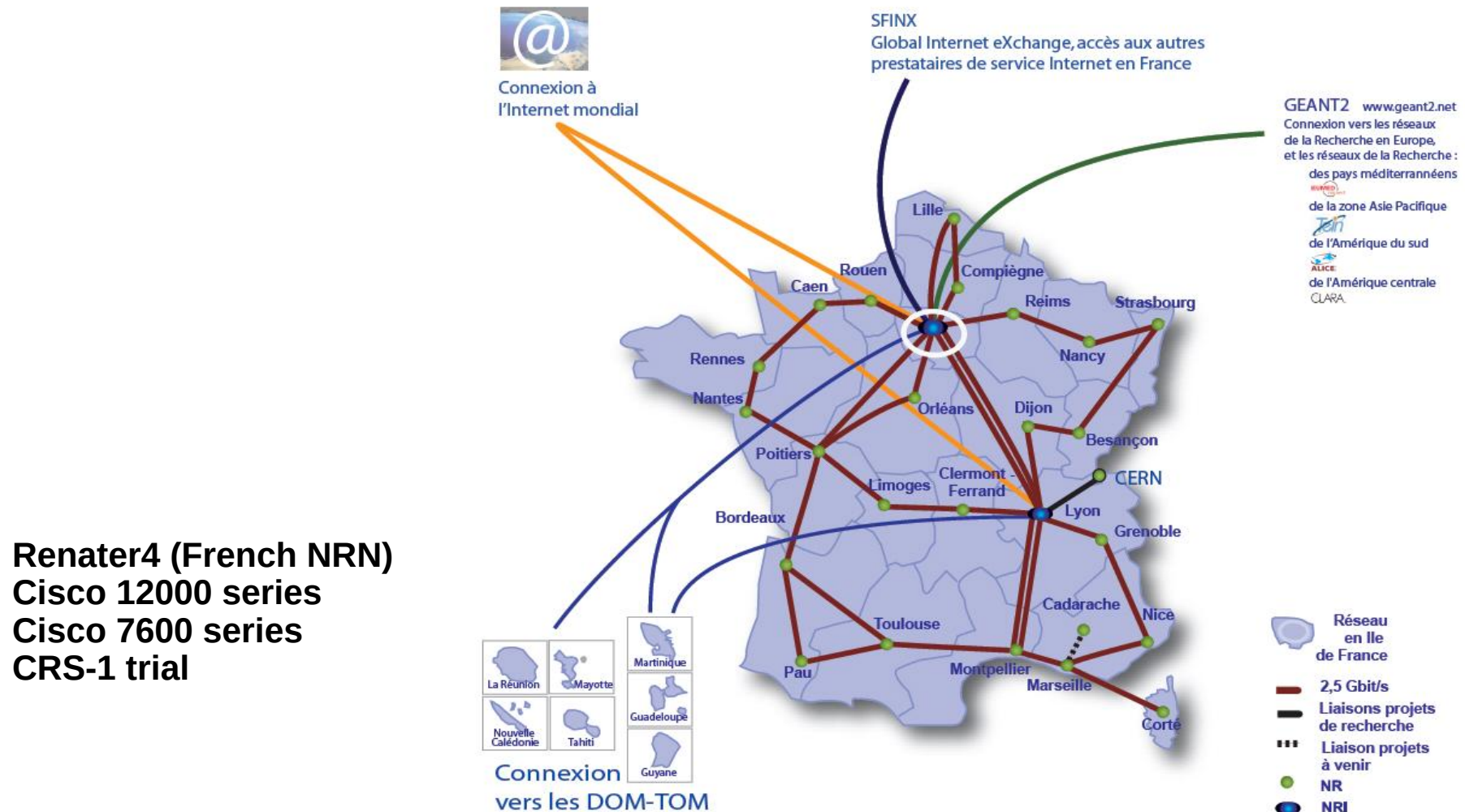


www.6diss.org



Cisco 12400 and 7200 series

Dual Stack IPv4-IPv6 in production



http://supervision-ipv6.renater.fr/Portail/IPv6WP/indexWP_renater.php

NTT East - 4th Media Video Service

- Short distance/regional provider
- Broadcast TV and VoD service
 - 8000 VoD titles
 - 42 Basic TV channels
 - 21 Specialty TV channels
- Based exclusively on IPv6 multicast
- 50K subscribers by Oct 2006
- TV/PC Tablet and Video Phone



IPv6 Integration – Per Application Model



- ***As soon as the infrastructure is IPv6 capable...IPv6 integration can follow a non-disruptive “per application” model***

6net Applications summary

Click on the column headers to change sorting order

name	category	class	summary	status	responsible	modified
6UMS	Streaming	C	IPv6-enabled unified messaging system	6UMS is being developed by UoS in Euro6K, but will be made available to 6NET. Existing tools will be re-used where appropriate.	UoS	2003-01-16
Agent Framework	E-business	C	Framework for agent research	Available, in Java. Unicast works. Multicast not tested yet.	UoS	2003-01-24
AMUSE	Streaming	C	Adaptive Multimedia Support Environment	Available. Usage limited to Sony and WP5. Work planned to support MobileIPv6.	Sony	2003-01-27
AWM	E-business	No	Application Workload Modeler	Released product with IPv6 support for zSeries. Needs special build for Linux/Intel.	IBM	2003-04-14
Bonephone	Streaming	B	Internet phone sending and receiving SIP messages	Demo version released.	FhG	2003-04-10
CDN	Edge Services	C	Content Distribution Networks	No specific work at the moment.	Cisco	2003-01-16
DVTS	Streaming	C	Application for sending and receiving Digital Video	The source and binaries for DVTS on various platforms are available from the DVTS URL.	UCL	2003-01-16
Edge Server	Edge Services	C	IBM Edge Server	Porting to IPv6 in progress.	IBM	2003-01-16
EGP	Gaming	No	Experimental Gaming Platform	Sony has stopped working on EGP. This activity has been dropped.	Sony	2003-03-27
FreeAMP	Streaming	A/B	Free unicast/multicast MP3 player	The code has been released on the web. Both a unicast and a multicast MP3 source will be activated in a network which will be available to all 6Net partners.	GARR	2003-01-24
FunnelWeb	E-business	C	Application level active services	Implemented as a Java application. Available on request within the project.	UCL	2003-01-16
Globus	E-business	C	GLOBUS toolkit (Grid)	Release 2.0 available. Globus 3.0 is expected early 2003. 6NET expectation is to get IPv6 support enabled as a patch for Globus 2.0, later as an integral part of Globus 3.0.	UCL	2003-01-16
GnomeMeeting	Streaming	C	Open source H323 Linux application	Deployment and support in progress for Greek Research Network community	GRNET	2003-02-05

- All software vendors officially support IPv6 in their latest O.S. releases
- Successful deployment is driven by Applications
- Applications examples on IPv6 Style - <http://www.ipv6style.jp/en/index.shtml>
- Applications should be developed as agnostic regarding IPv4 or IPv6.

Microsoft Windows Vista has IPv6 “On” by default,

P2P framework takes benefit of IPv6 (www.microsoft.com/p2p)

Bechtel Well Positioned to Serve Customers by Using Microsoft and Cisco IPv6 Solution



"Turning on IPv6 is just the start. The longer-term benefit will be looking at Software as a Service in conjunction with IPv6 and peer-to-peer discovery. Those capabilities will enable Bechtel to be more effective and efficient."

*Fred Wettling,
Bechtel Fellow and Technology Strategy Manager,
Bechtel*

Headquarters in San Francisco, California – 44,000 employees

2005 revenues of US\$18.1 billion

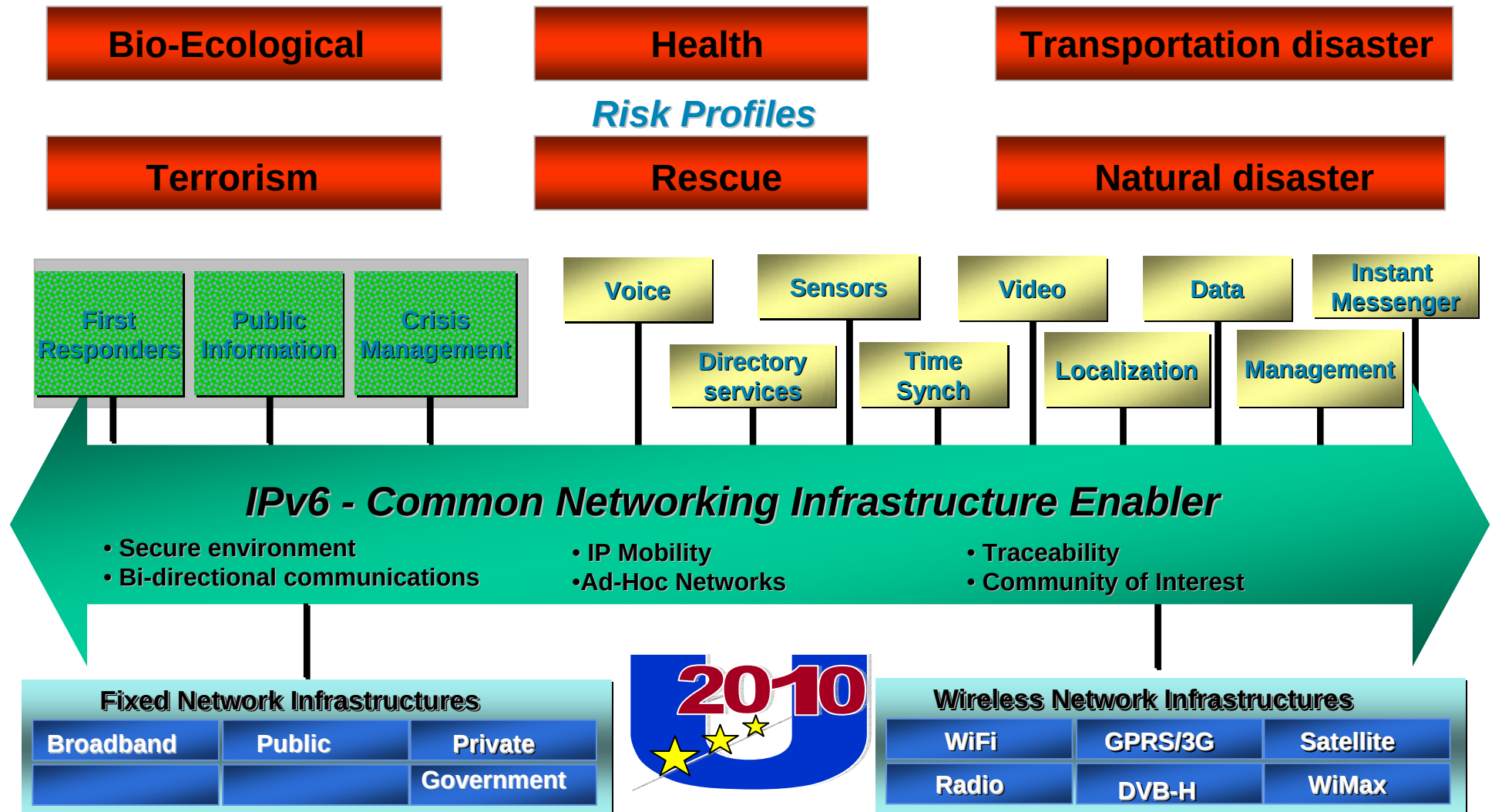
More than 22,000 projects in 140 countries

Hoover Dam, the Channel Tunnel, Hong Kong International Airport, the San Francisco Bay Area Rapid Transit system, reconstruction of Kuwait's oil fields after Gulf War

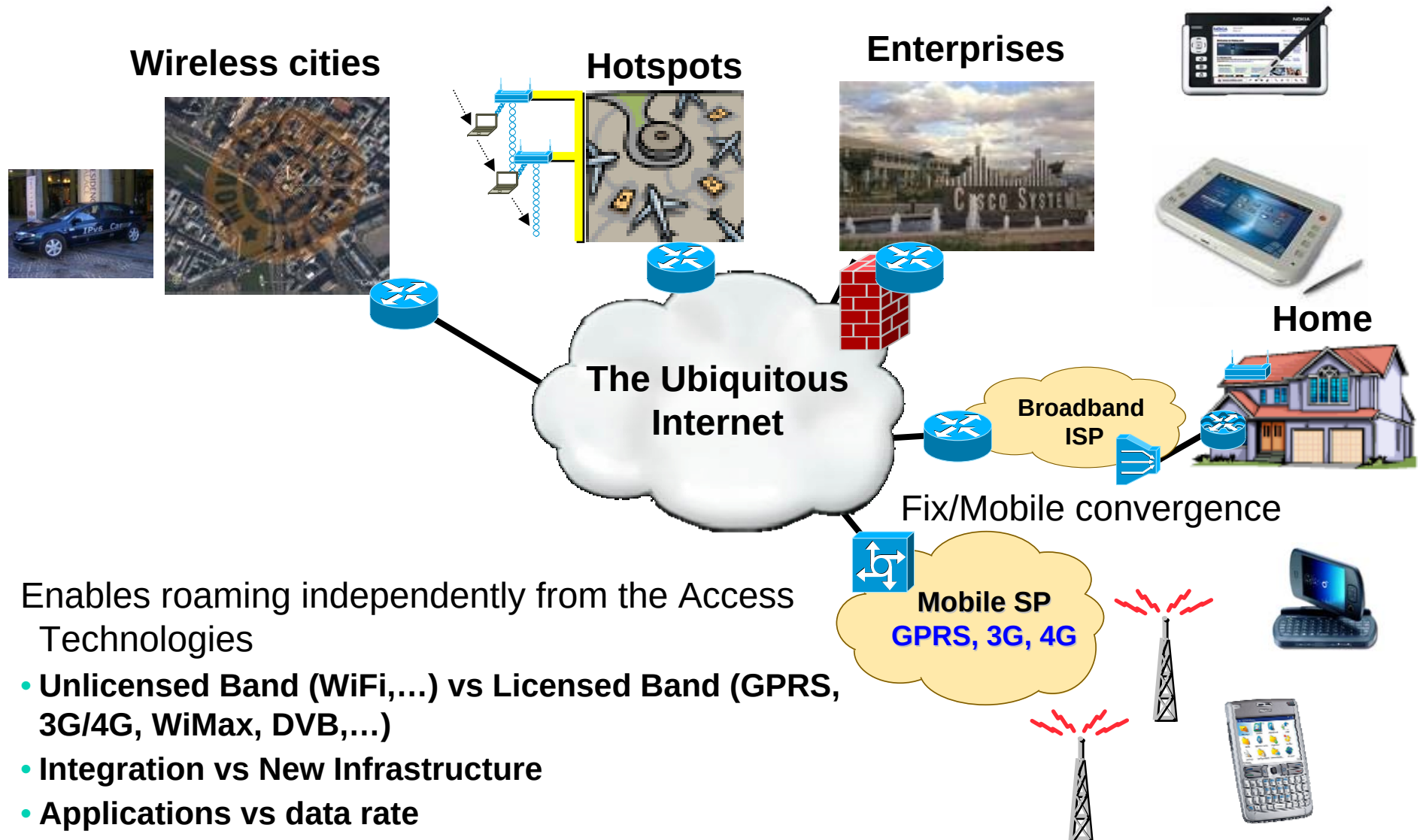
Bechtel National subsidiary: leading provider of services to the U.S. government

Software and Services	Hardware	Partners	
• Windows Vista • Microsoft Server Product Portfolio • Windows Server 2008 • Windows Server 2003 Enterprise Edition • Windows XP • Services • Microsoft Services • Cisco IOS Software	• Cisco Catalyst 6500 Series Switches, Cisco Catalyst 3500 XL Series Switches, Cisco Integrated Services Routers (ISRs), Cisco PIX firewalls, CiscoWorks LAN Management Solution (LMS) • Dell personal computers, portable computers, and server computers • HP personal computers, portable computers, and server computers • Lenovo portable computers	• Cisco	
		• Command Information	
		• Microsoft	

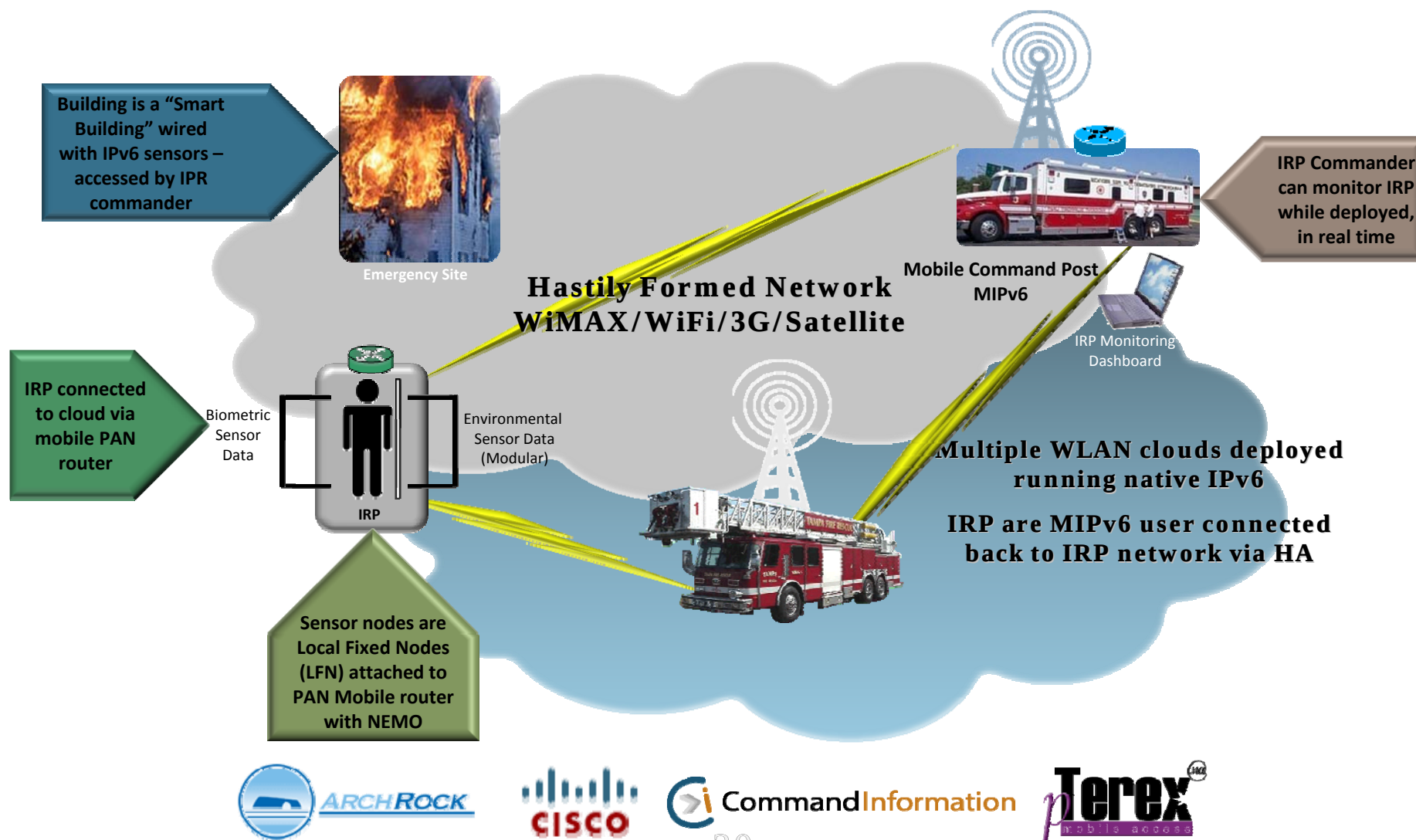
U-2010 – IPv6 Public Safety Framework



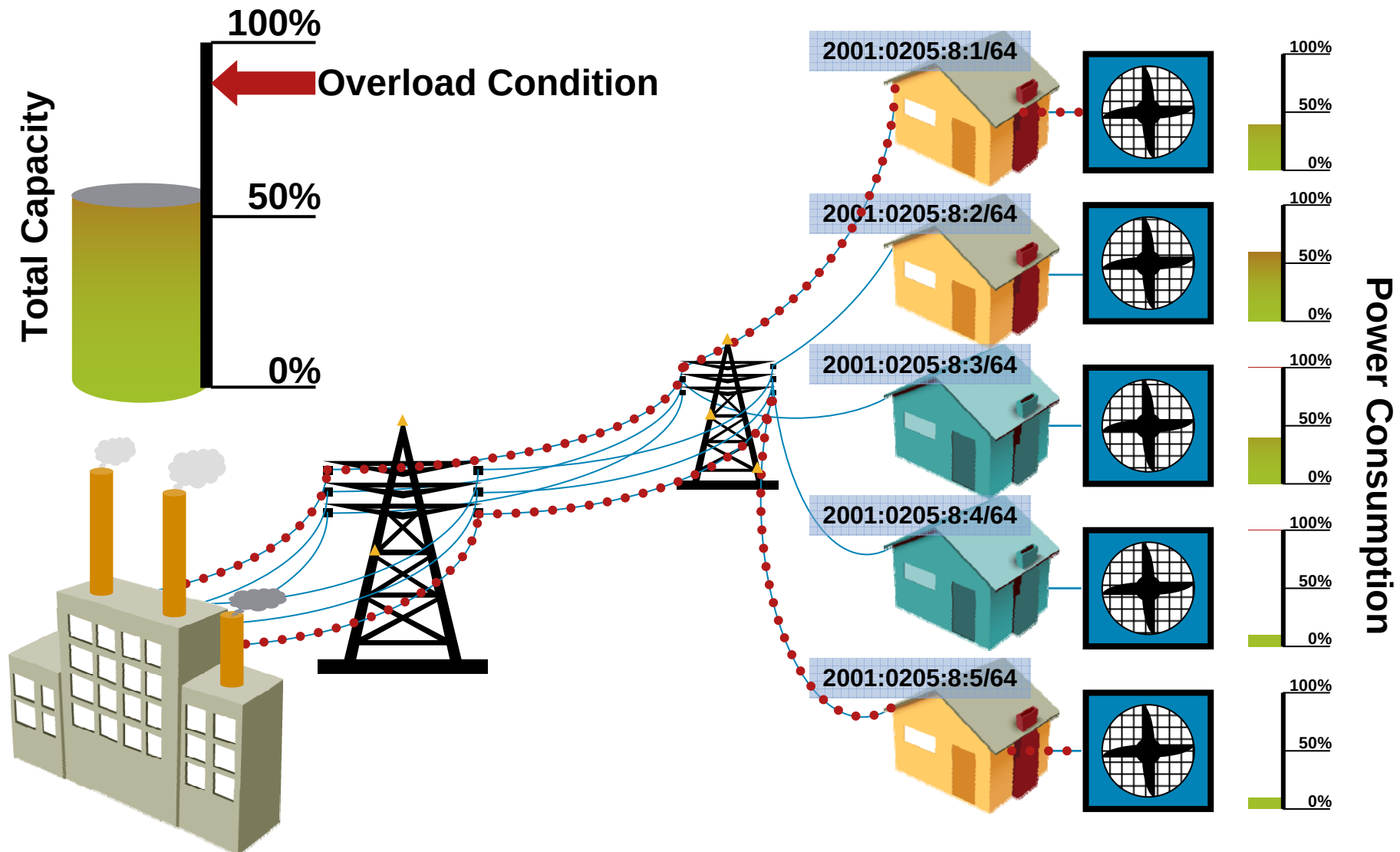
IPv6 Mobility Vision



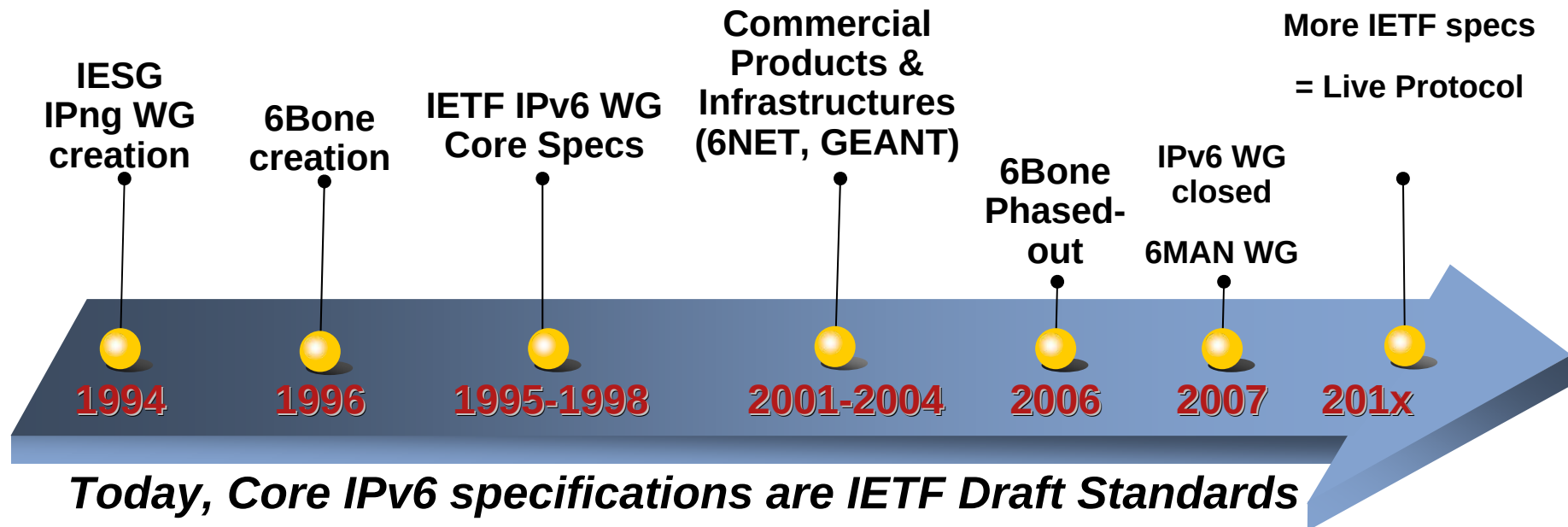
Advanced Incident Response System



Lastly, Imagine IPv6 Enabling This...



Building the “IPv6 House”



Today, Core IPv6 specifications are IETF Draft Standards well-tested & stable, enabling a move to “full production”

IETF IPv6 Standards



- **Core IPv6 specifications are stable and well tested IETF Draft Standards**

IPv6 Addressing Architecture, ICMPv6, Neighbor Discovery, Stateless Auto-configuration, IPv6 over “Data Link Layers”, DNS Record, Routing Protocols, Tunneling, MIB’s, Header Compression, MLD, etc.

- **2007: IPv6 WG now closed – replaced by 6MAN (Maintenance) WG**

<http://www.ietf.org/html.charters/ipv6-charter.html>

- **IPv6 Transition, then now Operations focused Working Groups**

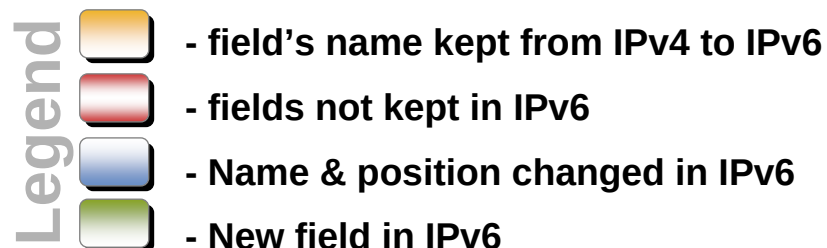
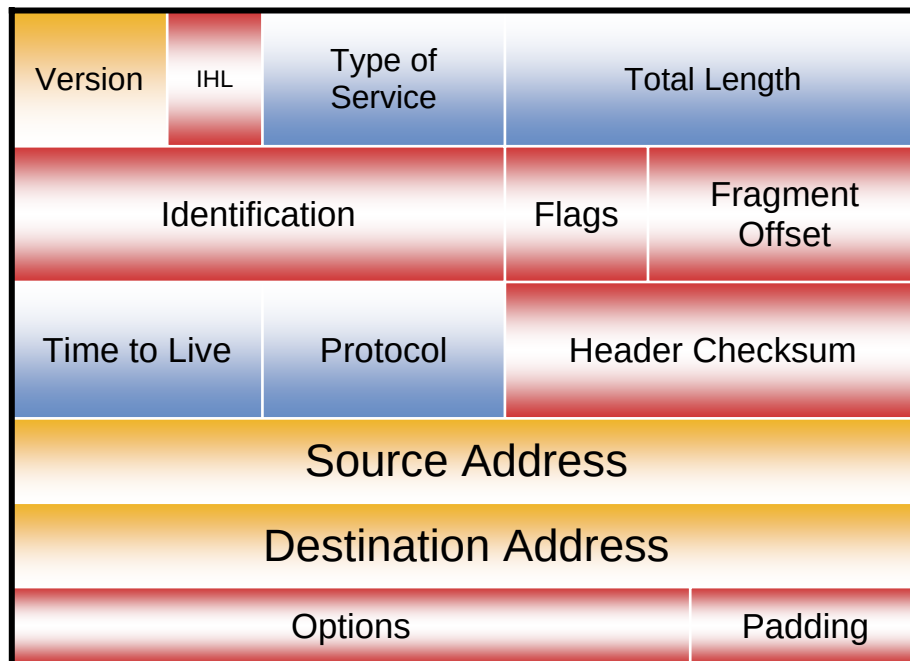
NGTrans WG (closed), v6ops (active)

- **Many other Working Groups working on IPv6 features**

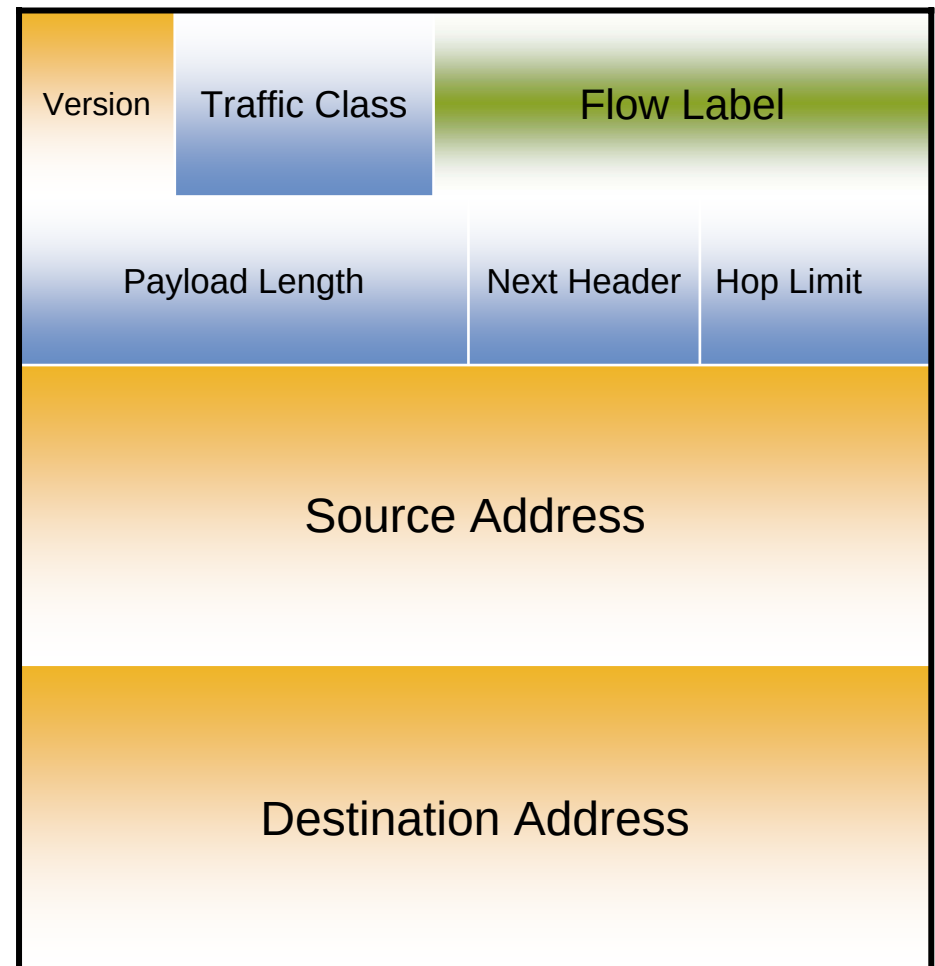
16ng, 6LoWPAN, DHC, DNSext, MIPv6, Monami6, NEMO, Routing, Shim6, Software,...

IPv4 & IPv6 Header Comparison

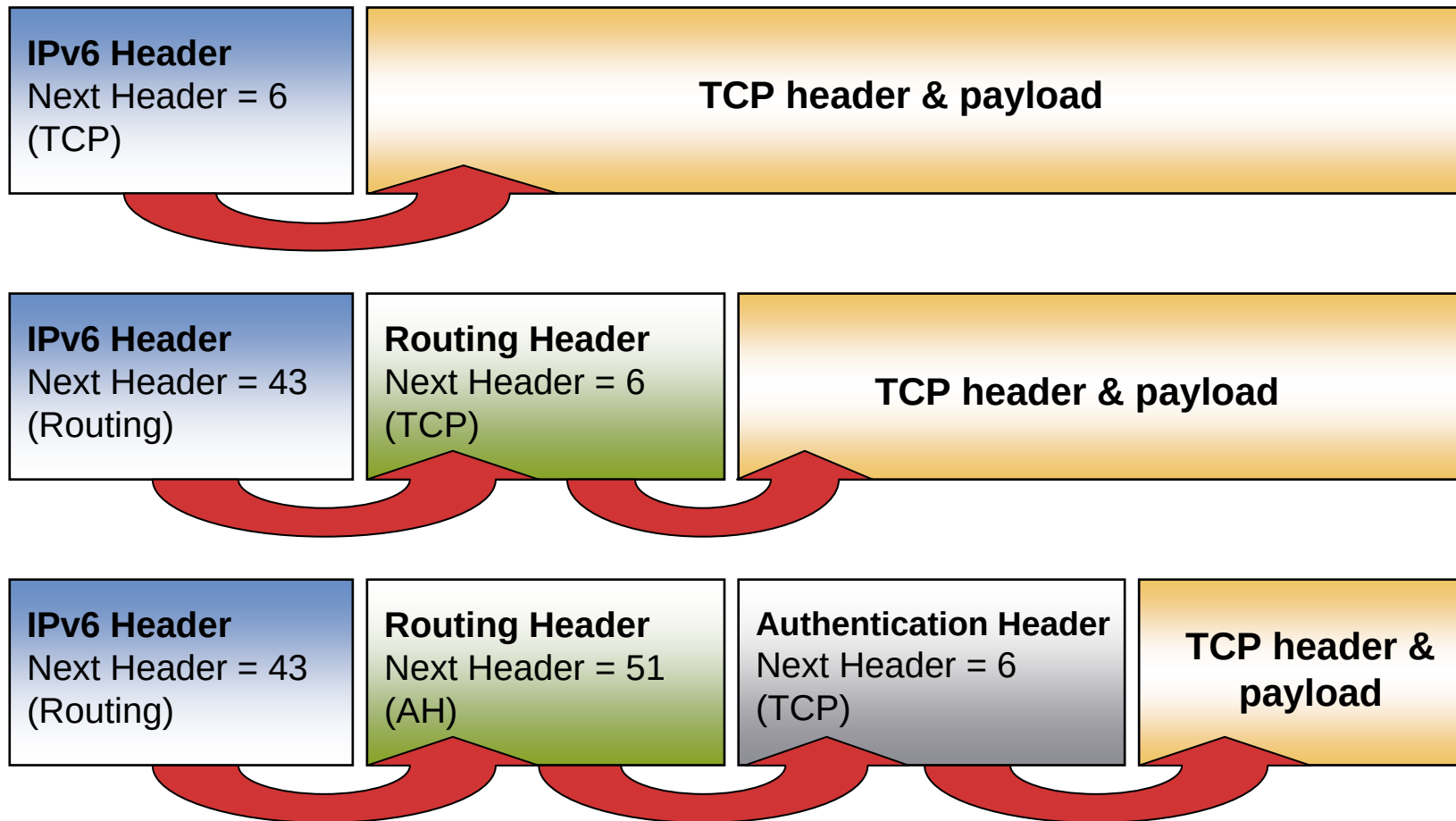
IPv4 Header



IPv6 Header

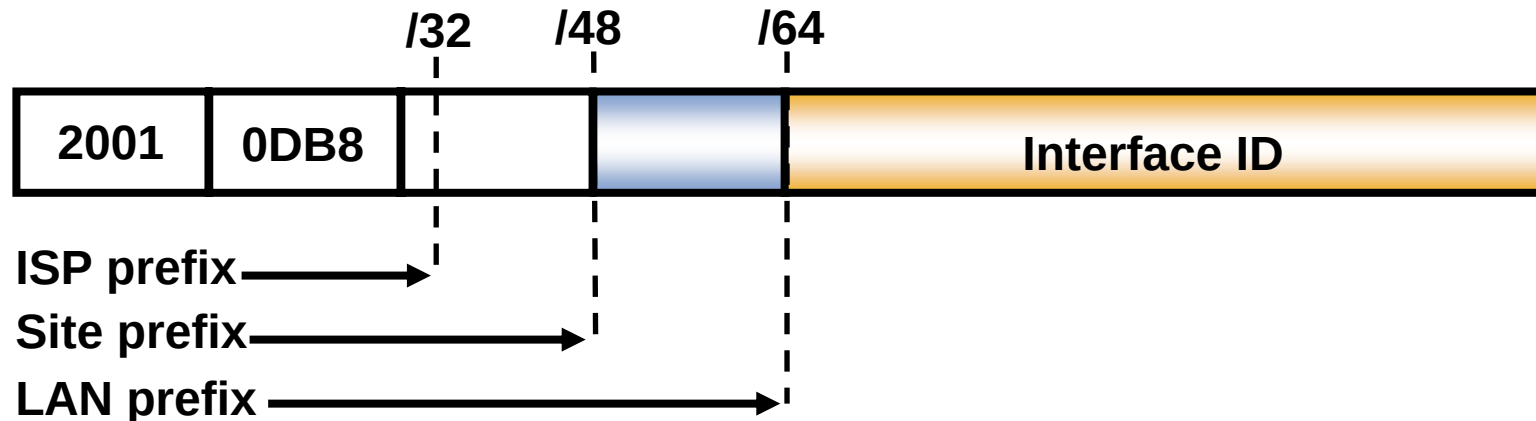


IPv6 Packet Structure – RFC 2460



- IPv6 hardware forwarding must be able to parse all fields to read about option headers and L4 details for packet filtering and monitoring
- Ref. http://www.cisco.com/en/US/products/ps6553/products_white_paper0900aecd8054d37d.shtml

Address Allocation



- The allocation process is defined by the 5 Registries:

IANA allocates 2000::/3 as Global Unicast [RFC 4291]

Registries get ::/12 prefix(es) from IANA [formerly /23] under new policy - <http://www.icann.org/announcements/announcement-12oct06.htm>

Registry allocates a /32 prefix [formerly /35] to IPv6 ISP and others

Then policies recommend that the ISP allocates a /48 prefix to each customer (or potentially /64)

<http://www.ripe.net/ripe/docs/ipv6policy.html>

<http://www.icann.org/announcements/ipv6-report-06sep05.htm>

New Policy to assign PI and IX prefixes as /48

IPv6 Address Assignment

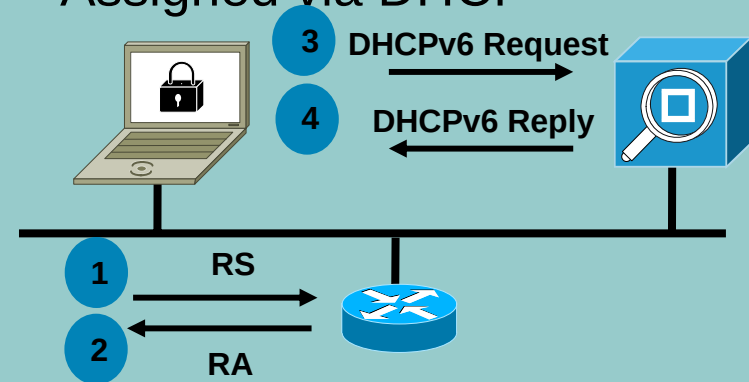
- Lowest-order 64-bit field of unicast addresses may be assigned in several different ways

IPv4 & IPv6

Manually configured

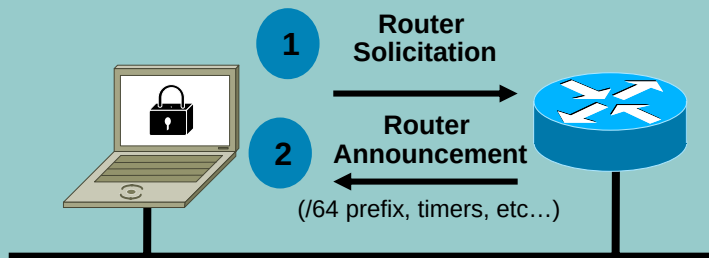


Assigned via DHCP



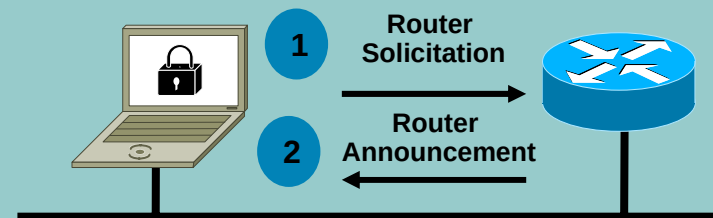
IPv6 Only

Stateless configuration



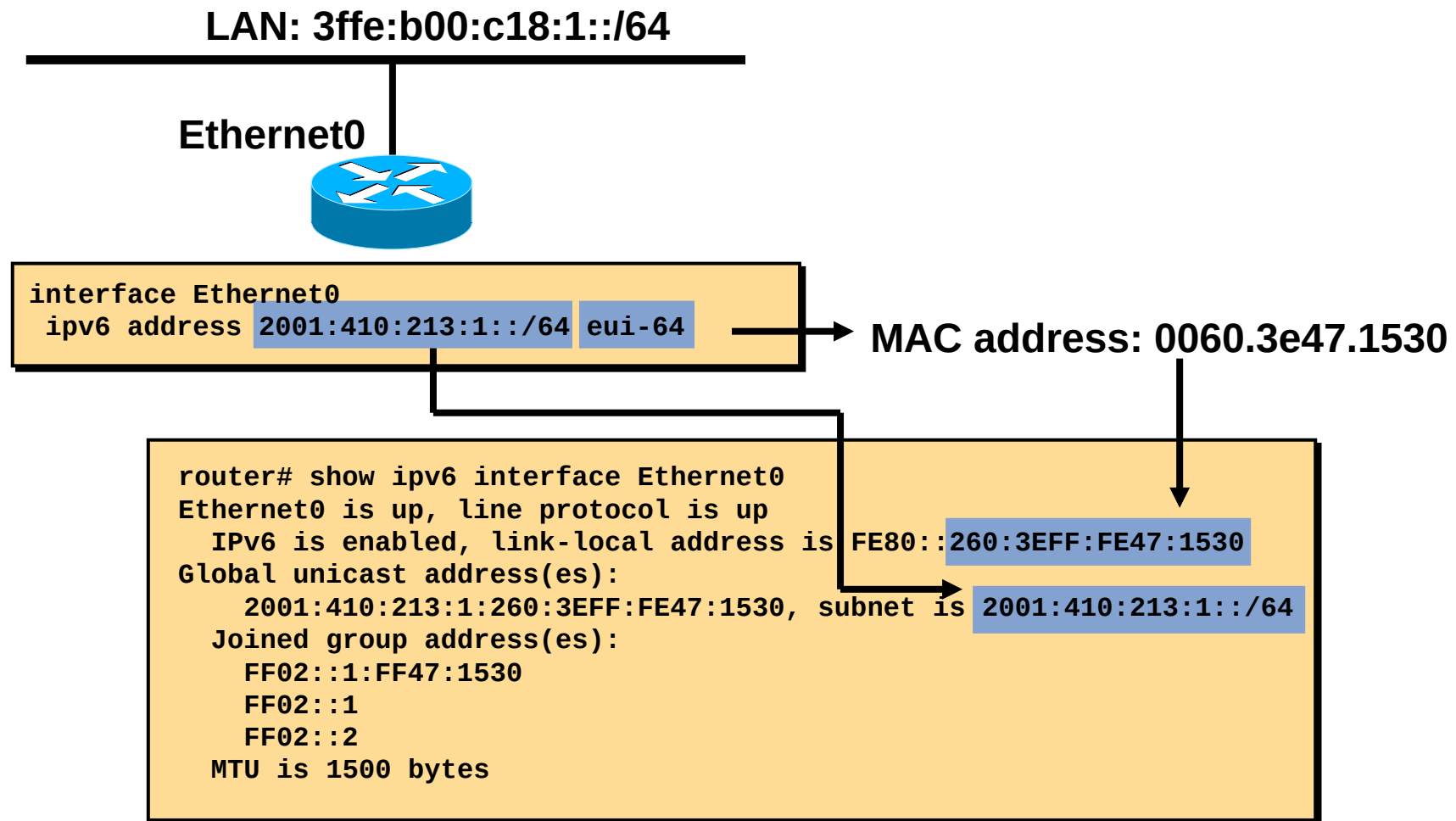
IPv6 Address = /64 prefix + EUI64 (e.g. MAC address)

Auto-generated pseudo-random number (rfc3041)



IPv6 Address = /64 prefix + Random 64 bits (rfc3041)

IPv6 Addressing Examples



Routing in IPv6

- IPv6 doesn't necessarily solve all Internet issues – Routing protocols are the same as on IPv4
- IGP and EGP, and still uses the longest-prefix match routing algorithm
 - RIPng, OSPFv3, Cisco EIGRP IPv6 address family
 - IS-IS IPv6 address family and Multi-Topology IS-IS
 - MP-BGP4 IPv6 address family (Unicast, Multicast, VPNv6)
- Globally routable prefixes are managed by RIR (~2200 allocated)
 - Private address space (ULA) is not really deployed and the implications of its use are still analyzed – Will IPv6 NAT emerge?
 - Provider Independent address space is still not available across all RIRs – ie: RIPE. Some organizations did however acquire PI space.
- A lot of education is still required to improve the Global IPv6 Internet routing table (<http://www.space.net/~gert/RIPE/ipv6-filters.html>)
 - Tunnels provide non-optimum paths
 - Small number of prefixes in intranets (aggregation) on Internet (most deployments not opened to the Internet)
 - Still a long way to the number of routes that can be handled by routers today

IPv6 Security

- The insertion of devices implementing dual-stack becomes a major concern:
 - Monitoring protocol port 41
 - Monitoring DNS AAAA records access
 - Setting-up rules which allow tighter control
- IPv6 is not identical to IPv4 so a review of the current architectures is necessary to understand the possible impact of integrating IPv6
 - Host ACL may not be appropriate – multiple addresses per interface, privacy
 - Secure Neighbor Discovery may enable new security designs at link level
- Lack of specific feature set implementation still represents a transitional security weakness

Network Management & IPv6

- In a dual-stack network, both IPv4 and IPv6 environments must be managed with the best optimization to decrease the cost of operations

- IPv6 impacts 3 areas of Network Management

Instrumentation (MIBs, Netflow record, IPv6 SLA,...)

Updated IP MIBs, RFC 4001 compliancy,...

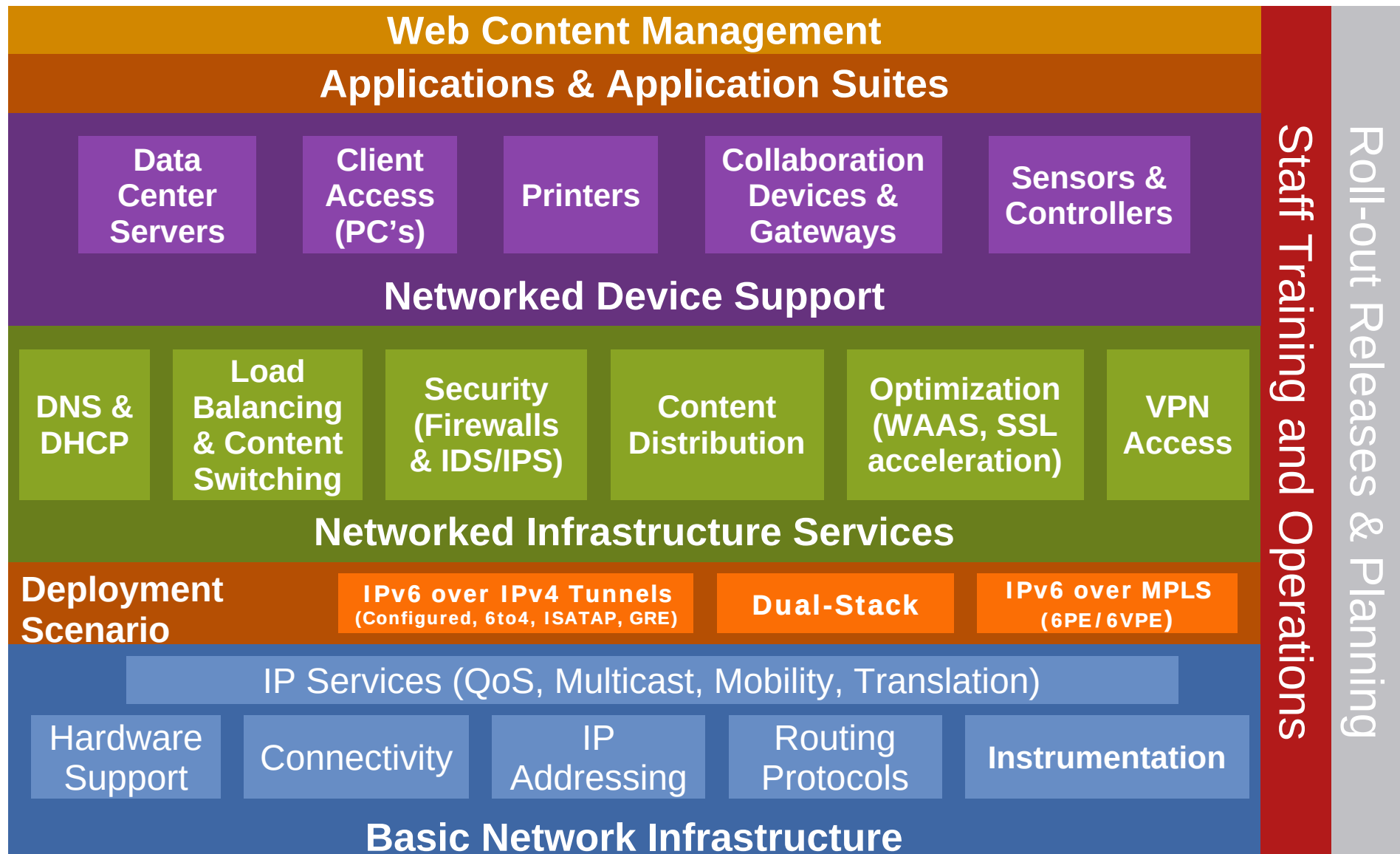
- Applications running over IPv6 (SNMP, TFTP, Syslog, Telnet, SSH, NTP, CNS Agents, Config logger, HTTP, Netconf, SOAP, TCL ...over IPv6)
- NMS & Tools for IPv6

DNS/DHCP server (CNR 6.2), Netflow Collector 5.x, Ciscoworks LMS 2.5 (Topology, User Tracking,...), NAM

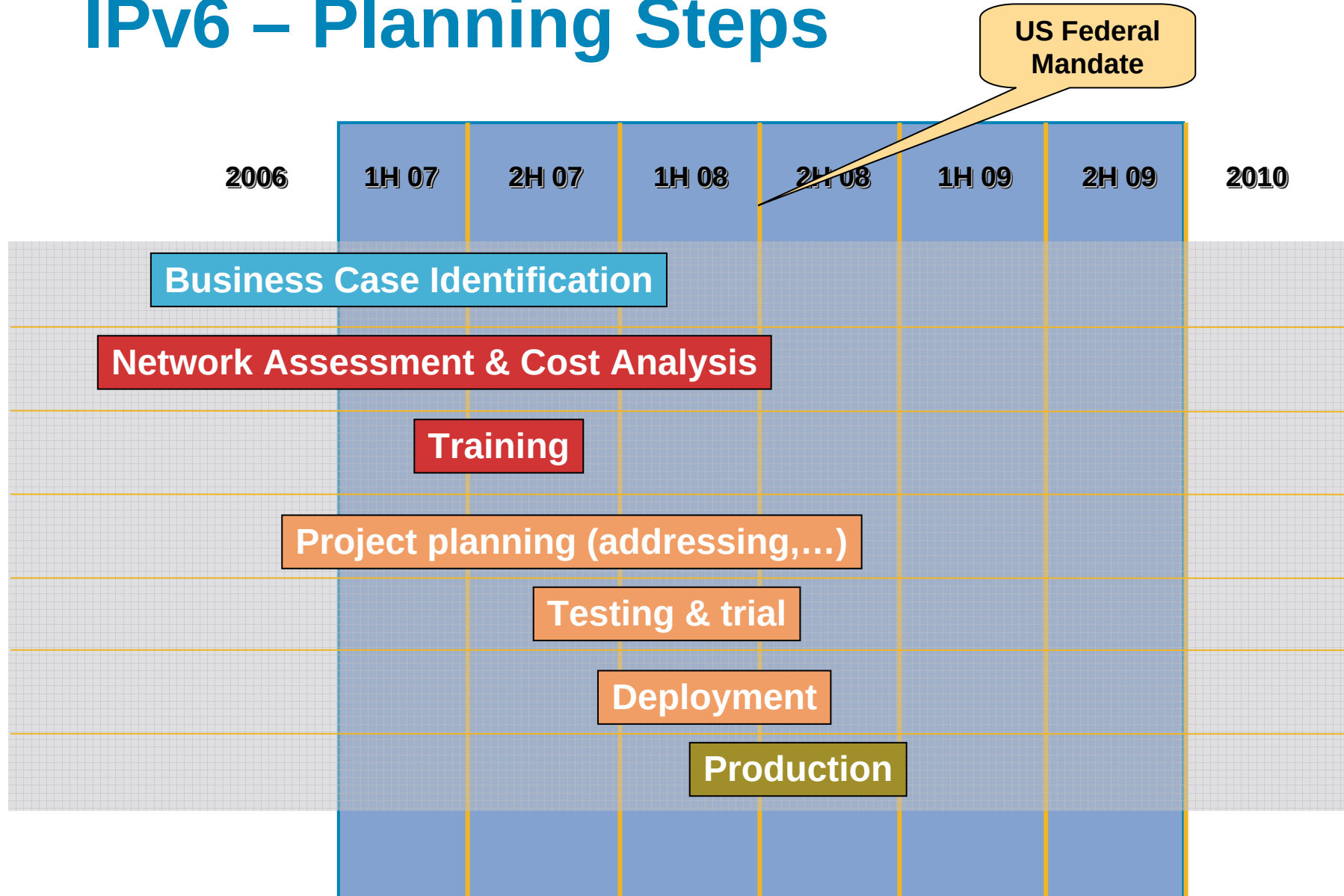
IPv6 Technology Scope

<i>IP Service</i>	<i>IPv4 Solution</i>	<i>IPv6 Solution</i>
Addressing Range	32-bit, Network Address Translation	128-bit, Multiple Scopes
Autoconfiguration	DHCP	Serverless, Reconfiguration, DHCP
Security	IPSec	IPSec Mandated, works End-to-End
Mobility	Mobile IP	Mobile IP with Direct Routing
Quality-of-Service	Differentiated Service, Integrated Service	Differentiated Service, Integrated Service
IP Multicast	IGMP/PIM/Multicast BGP	MLD/PIM/Multicast BGP, Scope Identifier

The Scope of IPv6 Deployment



IPv6 – Planning Steps



How long is needed for each phase of YOUR IPv6 deployment project?

Planning IPv6 Integration (1)

- **Evaluate IPv6 affect on business operation/model**

 - New applications, opportunities, threats/issues

 - To maximize ROI effect - must minimise disruption

 - Do you need to do it? (Most likely!)

- **Establish IPv6 project management team**

 - Help from partners (Cisco, Microsoft, SIs)

 - Project Management Office

 - Establish goals, critical path and timelines

- **Network Hardware & Software assessment**

 - Check Cisco + 3rd party hardware for correct memory/software

 - Use Cisco IPv6 Network Assessor Tool

 - Ensure any new hardware/software is IPv6 compliant/capable

 - Establish upgrade plan

Planning IPv6 Integration (2)

- Create IPv6 training strategy and plan

Operations staff need to know how to manage IPv6

Design architects must understand IPv6 capabilities

Security architects must understand IPv6 risks and mitigation

- Obtain an IPv6 prefix

Can be Provider Assigned/Aggregatable (PA)

Or Provider Independent (PI)

- Decide on IPv6 architectural solution

Native IPv6, Dual Stack, 4to6 tunnels, 6PE, 6VPE

Develop addressing plan

How will the addresses be distributed to customers?

Planning IPv6 Integration (3)

- Test/identify application software and services

 - Establish a lab for testing applications and services

 - Check NMS and billing systems

 - Test interoperability

- Develop IPv6 security policy

 - IPv6 has same security threats as IPv4

 - Protect against threats that may arise during transition

- Develop IPv6 procurement plan

 - All future hardware, software and applications should be IPv6 compliant

- Develop IPv6 exception strategy

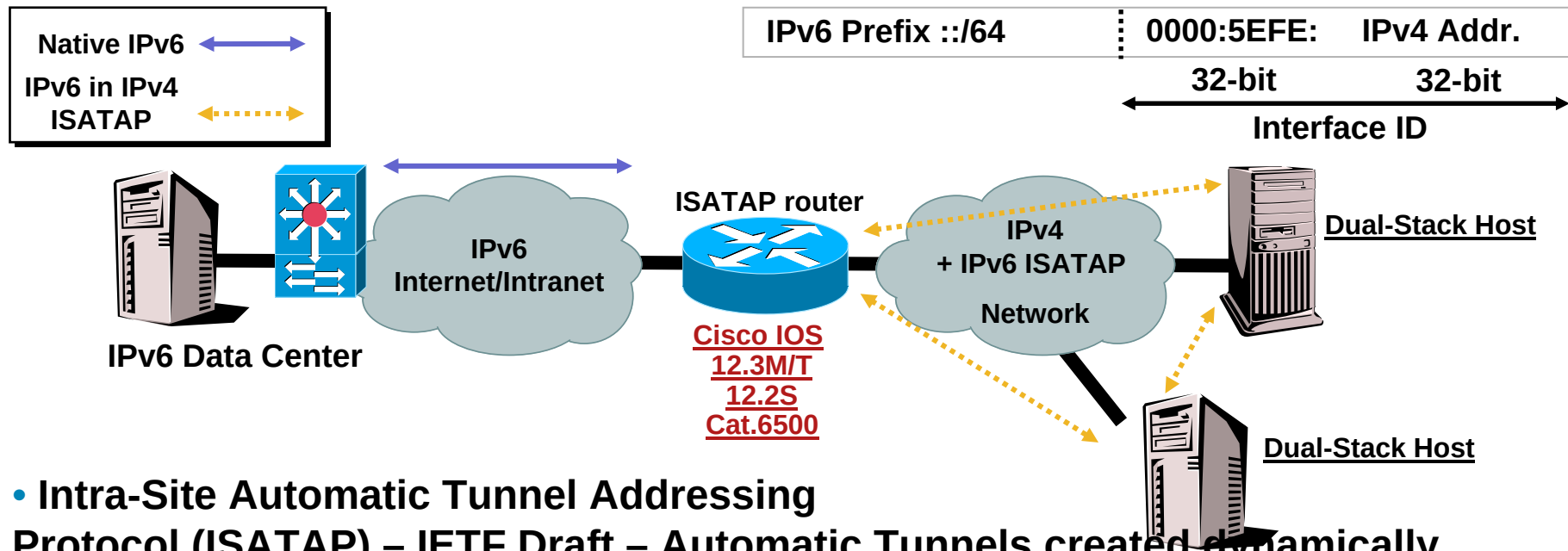
 - Identify components that will remain on IPv4

 - Could be for many reasons technical, business or cost

Common Deployment Scenarios

	Environment	Scenario	Cisco IOS support
Core	Native IP – Core is IPv6 aware	Dual Stack	Yes
	MPLS – Core is IPv6 unaware	6PE/6VPE	Yes
WAN	IPv6 services on L3 Managed Services	Dual Stack	Yes
	IPv6 over L2 services	Dual Stack	Yes
Campus	L3 infrastructure – IPv6 capable	Dual Stack	Yes
	L3 infrastructure – not IPv6 capable, or sparse IPv6 hosts population	ISATAP	Yes
Less optimum	IPv6 over IPv4 tunnels	Scalability & Management	Yes
	Translation (NAT-PT)	Scalability, adaptability,...	Yes

IPv6 on a Campus – ISATAP Tunnels

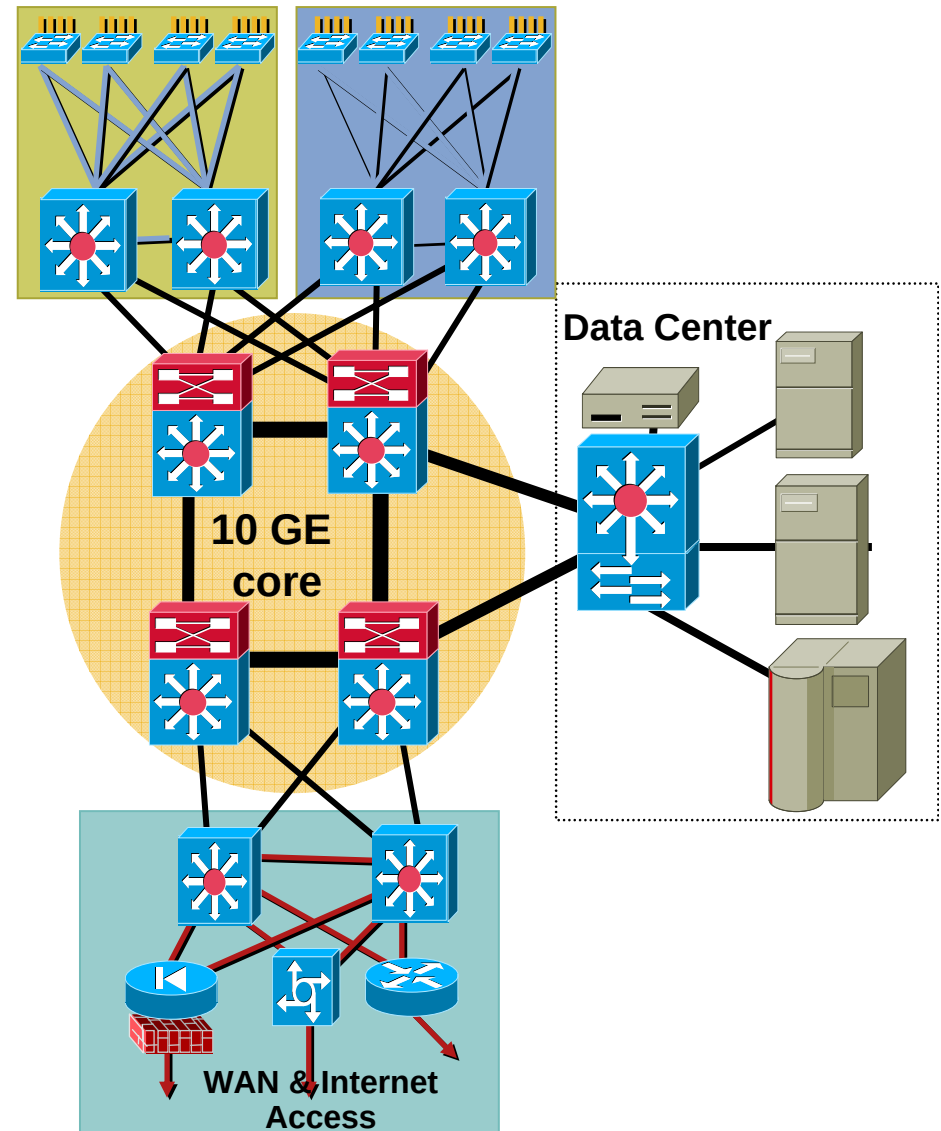


- Intra-Site Automatic Tunnel Addressing Protocol (ISATAP) – IETF Draft – Automatic Tunnels created dynamically based on embedded IPv4 addresses – IPv6 Unicast only
- Primarily intended for communication between [sparse] IPv6 hosts within a site with no native IPv6 infrastructure but an ISATAP router
- IPv6 hosts connect to virtual IPv6 link – that may spread several IPv4 subnets – to directly communicate between each others.
- IPv6 hosts reach the IPv6 Internet through an ISATAP router

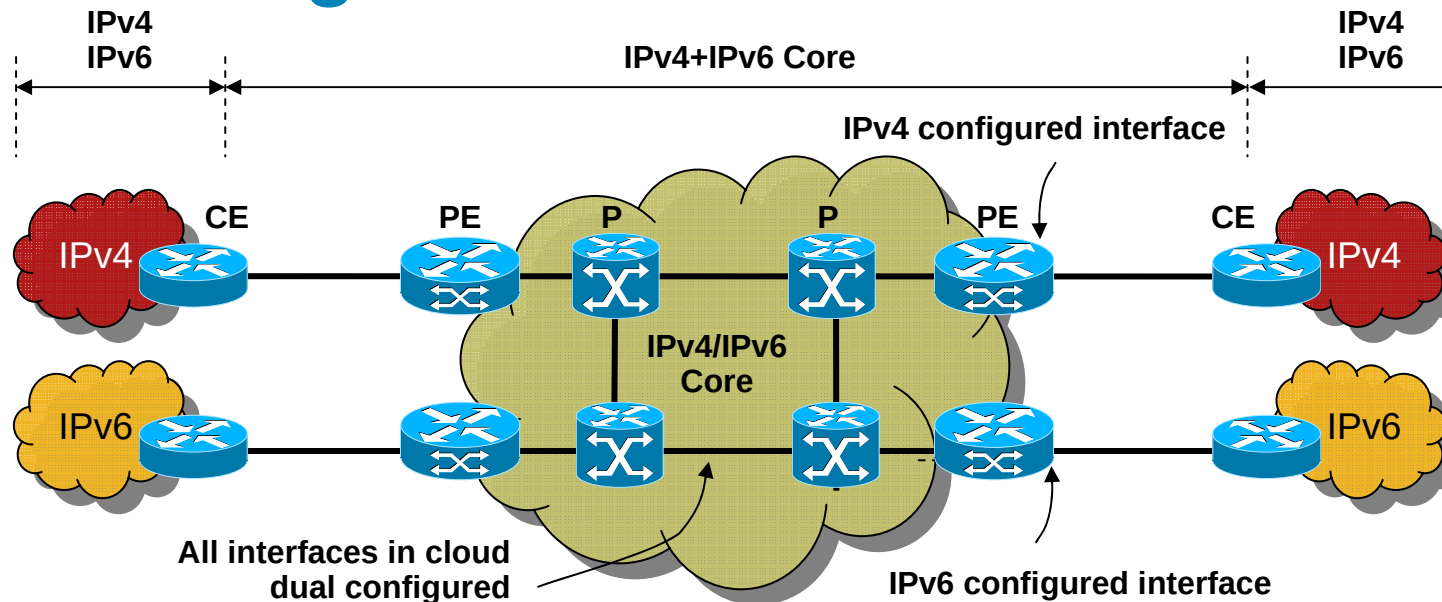


IPv6 on a Campus – Dual-Stack IPv4-IPv6

- Requires Switching / Routing Platforms to support hardware based forwarding for IPv4 & IPv6
 - IPv6 is transparent on L2 switches but for Multicast – MLD snooping
- Requires Robust Control Plane for both IPv4 & IPv6
 - Stateless Autoconfiguration
 - Routing protocols
- IPv6 Multicast and other Advanced Services such a QoS
- Security through IPv6 Access Control Capabilities
 - Including option headers
- IPv6 & IPv6 Control Planes & Data Planes must not impact each other

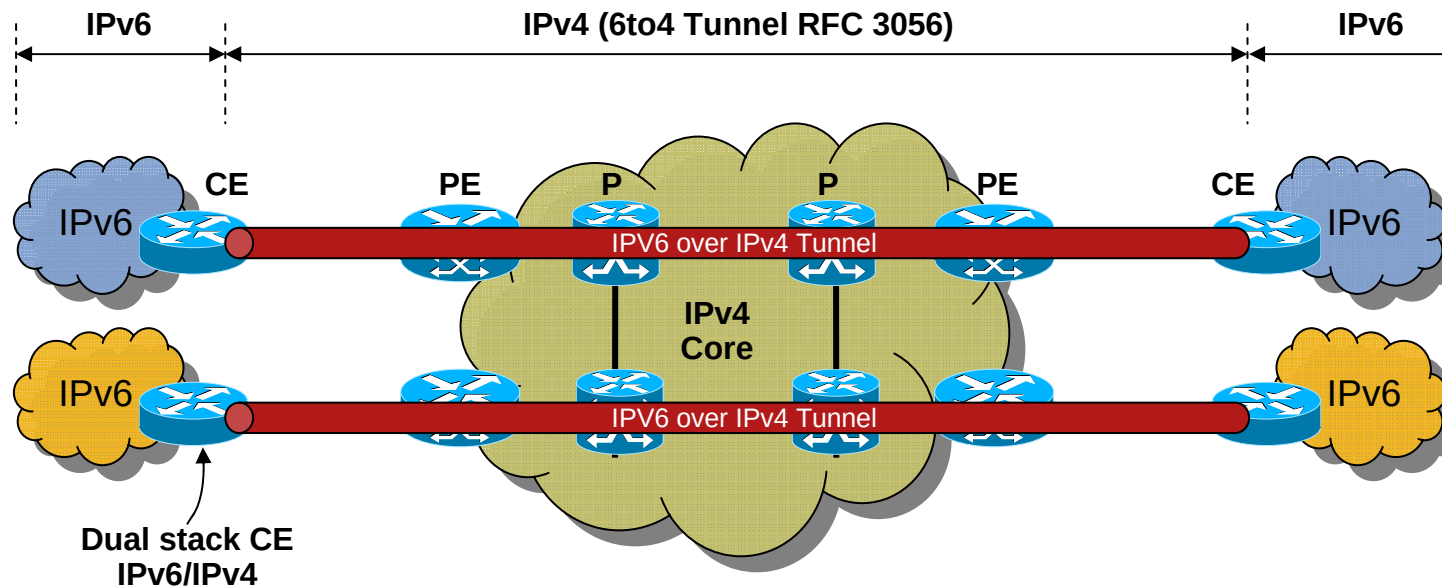


IPv6 using Dual Stack Backbone



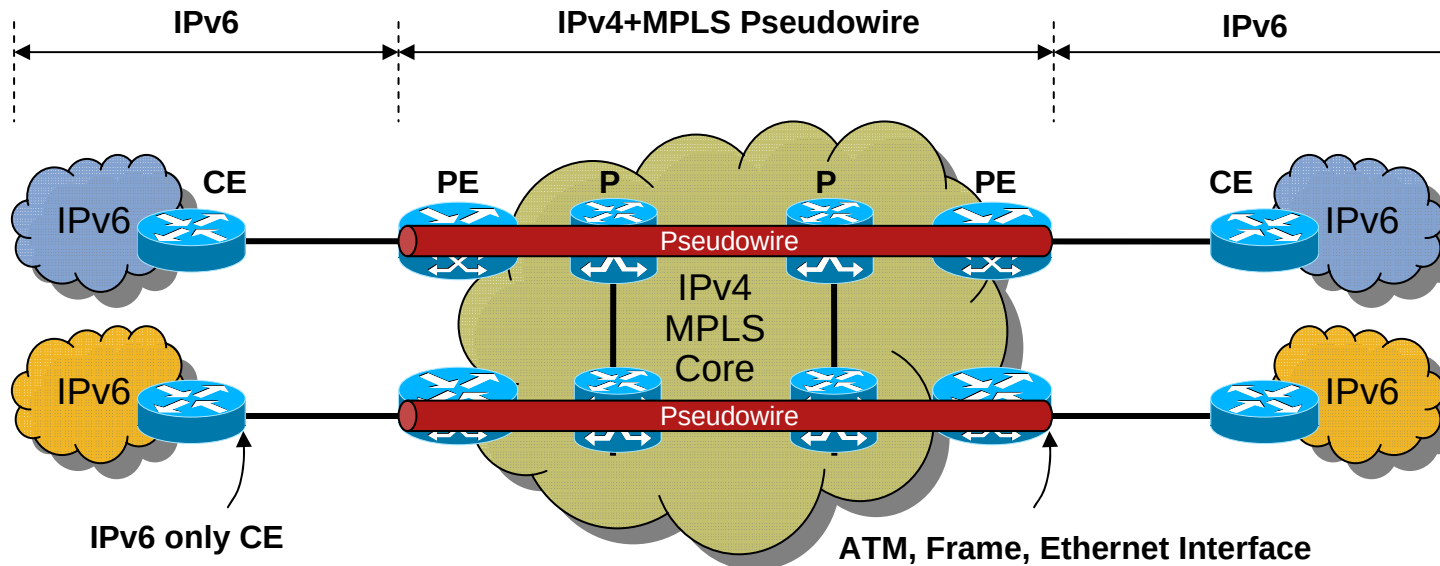
- All P + PE routers are capable of IPv4+IPv6 support
- Two IGPs supporting IPv4 and IPv6
- Memory considerations for larger routing tables
- Native IPv6 multicast support
- All IPv6 traffic routed in global space
- Good for content distribution and global services (Internet)

IPv6 over IPv4 CE – CE Tunnel (6to4)



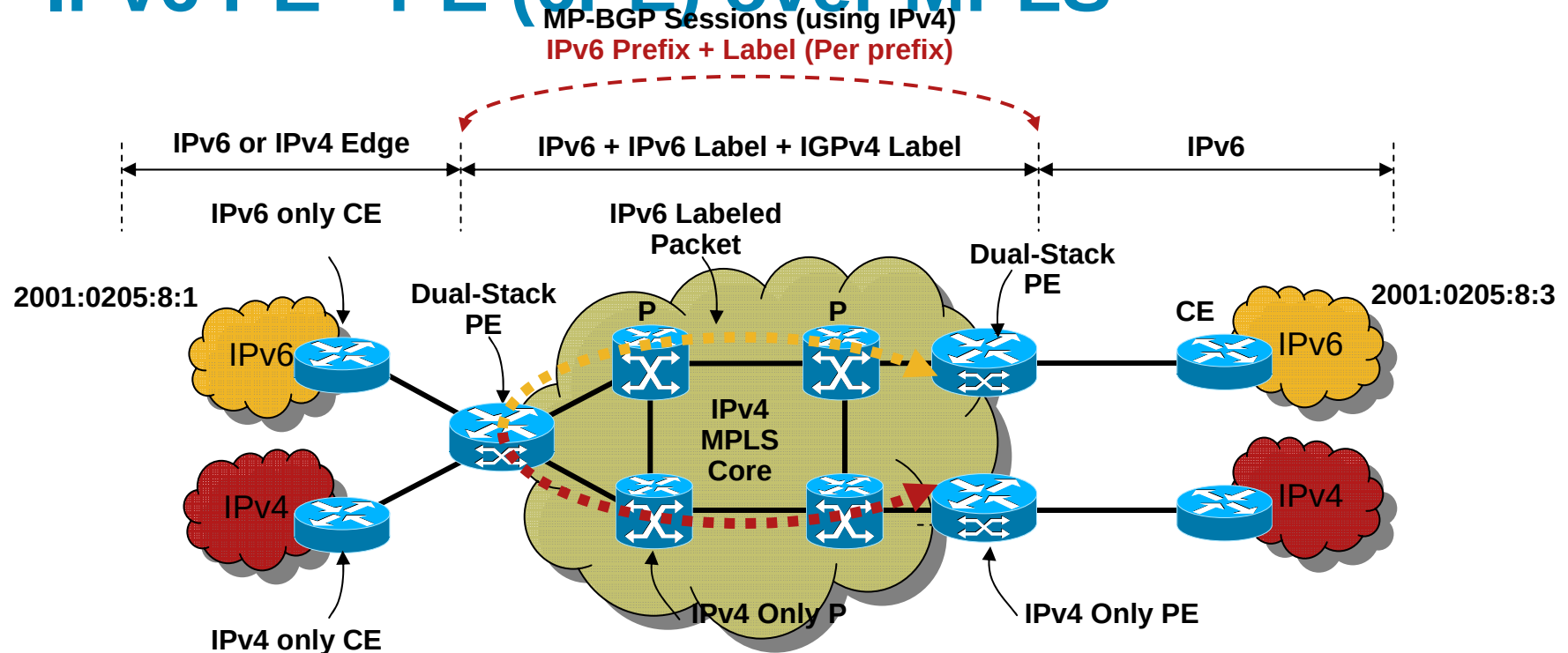
- No impact on existing IPv4 or MPLS Core (IPv6 unaware)
- CEs have to be IPv6 and IPv4 aware (Dual stack)
- Mesh of IPv6 to IPv4 Tunnels CE-to-CE for full connectivity
- Overhead: IPv4 header + MPLS header (if enabled)
- MPLS/VPN support IPv4-native and IPv6 tunnels
- No multicast support

IPv6 over MPLS Pseudowires



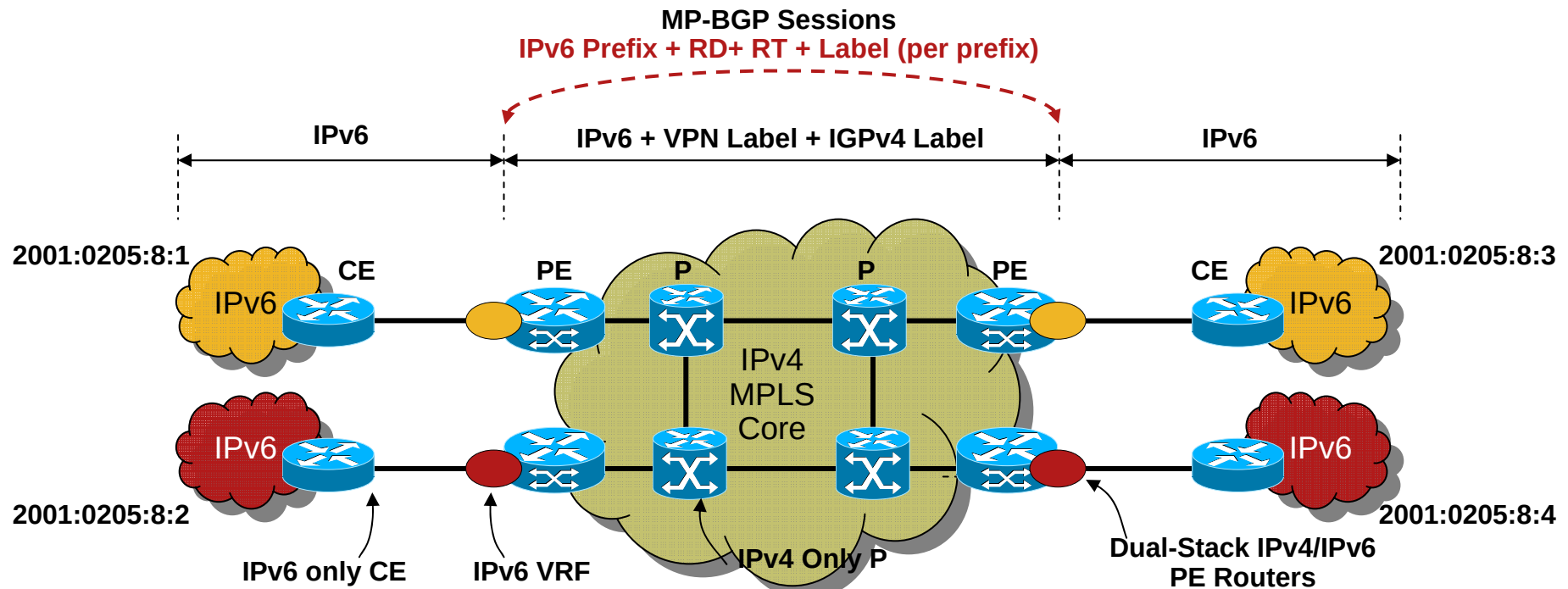
- No impact on existing MPLS Core (IPv6 unaware)
- CE routers can be single stack IPv6
- P2P PWs or P2MP PWs (VPLS) supported at PE
- Good for interconnecting discrete customer islands
- Sub-Optimal Multicast support
- Full Mesh required – scalability problems

IPv6 PE - PE (6PE) over MPLS



- PEs must support dual stack IPv4+IPv6 (MP-BGP used to exchange IPv6)
 - IPv6 packets transported from 6PE to 6PE inside IPv4 MPLS
 - All IPv6 addresses are in global table of PE routers only
 - Core uses IPv4 control plane (LDPv4, TEv4, IGPv4, MP-BGP)
 - Solution suitable for IPv6 support to internal SP infrastructure & services
- IPv6 is at the edge only

IPv6 MPLS-VPN (6VPE)

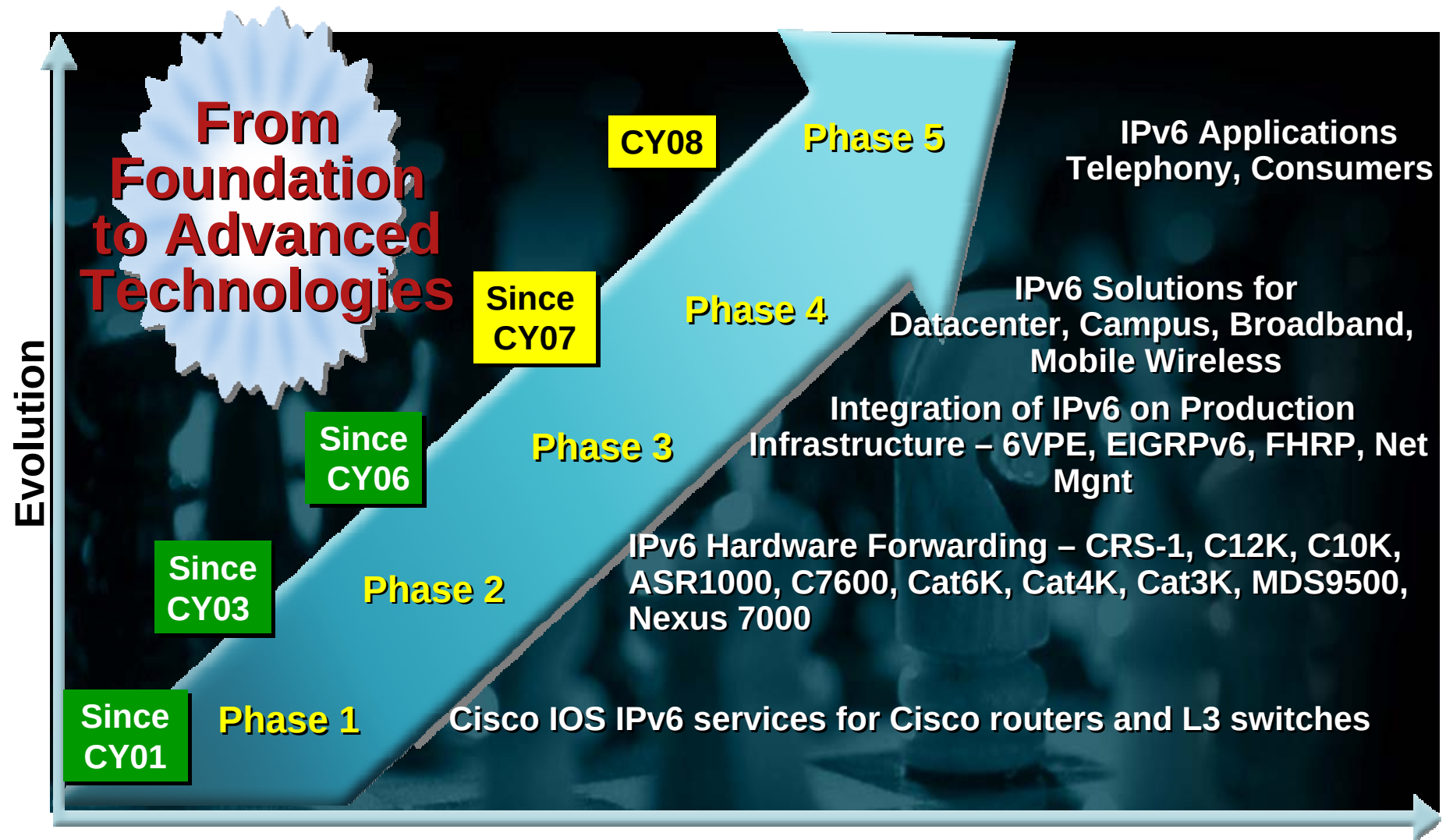


- 6VPE uses existing IPv4 MPLS infrastructure to provide IPv6 VPN
Core uses IPv4 control plane (LDPv4, TEv4, IGPv4)
- PEs must support dual stack IPv4+IPv6
- Offers same architectural features as MPLS-VPN for IPv4
RDs, RTs, VRFs, MP-BGP
- **Solution suitable for IPv6 support to enterprises and government with VPN**

IPv6 Delivery Model Comparisons

	IPv6 Existence	IPv6 Prefixes	Forwarding	CE Router Capability
Dual-Stack	PE + P	Global	IPv6	IPv6
6 to 4	None	None	IPv4	Dual-Stack
Pseudowires	None	None	MPLS	IPv6
6PE	PE	Global	MPLS	IPv6
6VPE	PE	VPN	MPLS	IPv6

CDO IPv6 – 5 Phases Plan



Industry's Broadest Platform Support



Cisco IOS 12.0S

Cisco 12000 Series Routers

Cisco 10720 Series

Cisco IOS 12.4/12.4T

Cisco 800 Series Routers

Cisco 1700 Series Routers

Cisco 1800 Series Routers

Cisco 2600 Series Routers

Cisco 2800 Series Routers

Cisco 3600 Series Routers

Cisco 3700 Series Routers

Cisco 3800 Series Routers

Cisco 7200 Series Routers

Cisco 7301 Series Routers

Cisco 7500 Series Routers (EoL)

Cisco IOS-XR

CRS-1, Cisco 12000

Cisco IOS 12.2S family

Cisco ASR1000 series

Cisco 72/7300 Series Routers

Cisco 75/7600 Series Routers

Cisco 10000 Series Routers

Catalyst 3750/3560/2960 Series

Catalyst 4500 Series

Catalyst 6500 Series



Cisco Product Portfolio

ASA Firewall (7.x), FWSM 3.1,

LMS 2.5, CNR 6.2, NFC 5.x, NAM 3.x,

MDS9500 series, Nexus 7000, GGSN 7.0

Cisco IPv6 compliance

- Conformance tests + Interoperability tests

IPv6 Ready Logo – www.ipv6ready.org

US DoD JITC conformance - <http://jitc.fhu.disa.mil/apl/ipv6.html>

Cable Labs DOCSIS 3.0 conformance

Microsoft Vista/Server 2008 interoperability – *Vista logo*

- Cisco IOS Release certification

Cisco IOS 12.4(11)T, C7600, C6500, C4500, IOS Firewall achieved JITC certification

Cisco IOS 12.3, 12.3T, 12.2SX, 12.0S and XR (3.2) are compliant with the IPv6 Ready Logo Phase I

Cisco IOS 12.4(9)T is compliant with IPv6 Ready Logo Phase II core specs



High Capacity Forwarding Cisco IPv6 Solutions

- **Cisco CRS-1**

OC-768, OC-48, 10GE and GE line cards

- **Cisco 12000 series**

Internet Service Engine 3 – up to 3.8Mpps per LC

Internet Service Engine 5 – Up to 16Mpps per LC

- **Cisco 10000 PRE2/PRE3**

- **Cisco ASR 1000 series**

- **Cisco 7600 and Catalyst 6500 series**

Sup. Engine 720, 720-3BXL, 32W, 32/PISA,
RSP720

Up to 200Mpps (EANTC report)

IPv6 tunneling—Configured, Automatic, 6to4 and
ISATAP tunnels in hardware

- **Catalyst 4500 series**

Supervisor Engine 6E

- **Catalyst 3750/3560 & 3750E/3560E series**



Summary

Markets Perspective

IPv6 enables innovation and will guarantee the Internet growth but its adoption is a multi-year, complex integration process

Software Developer Perspective

Applications must be “IP agnostic”

Network Manager Perspective Infrastructure must be deliver IPv6 up to the edge/access layer

The End-User Perspective

IP version needs to be transparent

Ensure an orderly and secured transition using Cisco IPv6 Solutions



Q and A



More Information

- CCO IPv6 - <http://www.cisco.com/ipv6>

- Cisco IPv6 Solutions

http://www.cisco.com/en/US/tech/tk872/technologies_white_paper09186a00802219bc.shtml

- Deployment guides

http://www.cisco.com/en/US/products/ps6553/products_data_sheets_list.html

- IPv6 Application Notes

http://www.cisco.com/warp/public/732/Tech/ipv6/ipv6_techdoc.shtml

- Cisco IOS IPv6 manuals

http://www.cisco.com/en/US/products/ps6441/products_configuration_guide_book09186a008049e1d7.html



Cisco Press Books

