Policy Development Framework for Government IPv6 Deployment
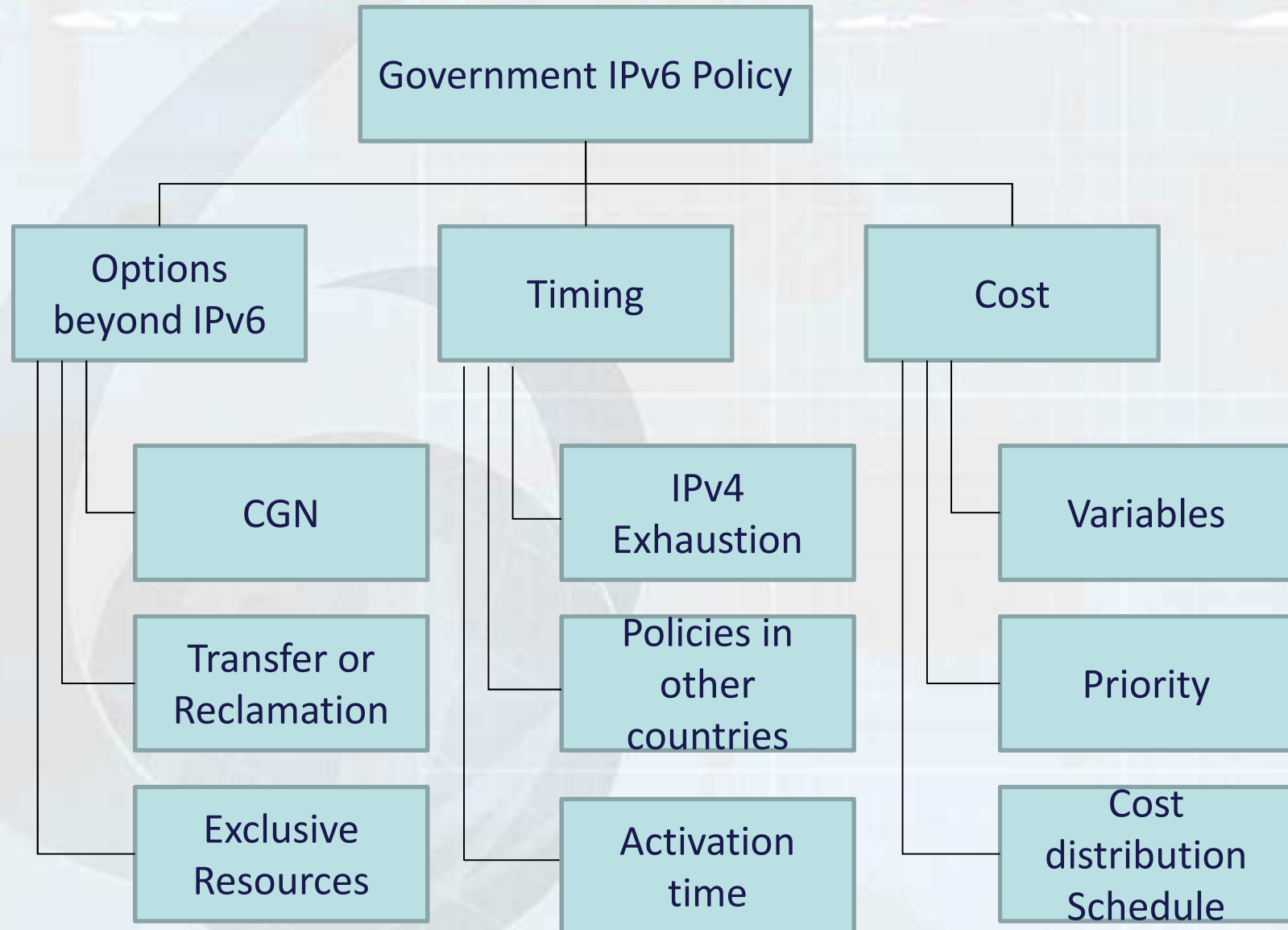
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huangk@mindext.com

Policy Theme

Government IPv6 Policy

Options beyond IPv6

- CGN
- Transfer or Reclamation
- Exclusive Resources

Timing

- IPv4 Exhaustion
- Policies in other countries
- Activation time

Cost

- Variables
- Priority
- Cost distribution Schedule

- s1 CGN (Carrier Grade NAT)
  - Increase CapEx, reduce network quality
- s2 Transfer/Reclamation IPv4
  - C1: Cost of IPv4 ownership/right to use
  - C2: Renumber
  - C3: H/W S/W cost
- r1: exclusive
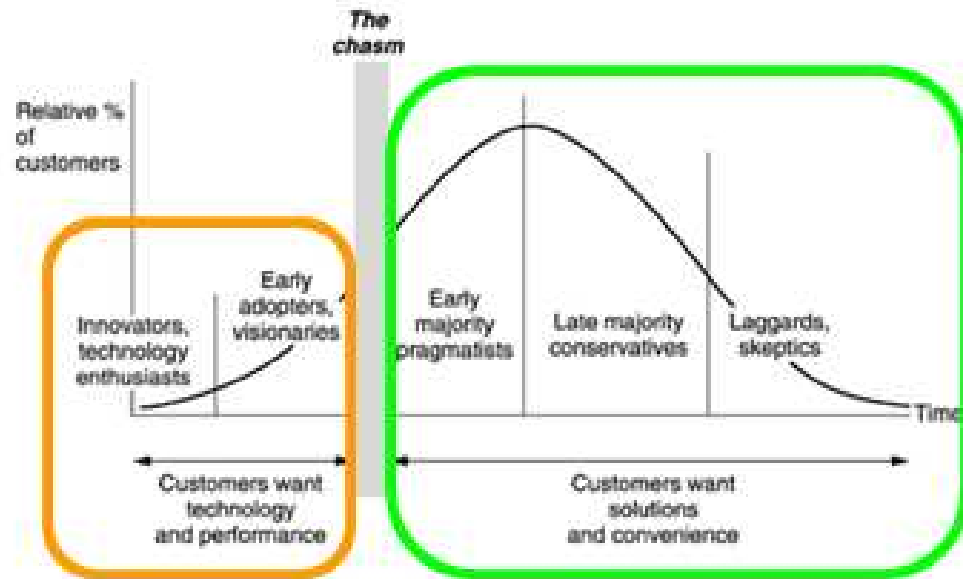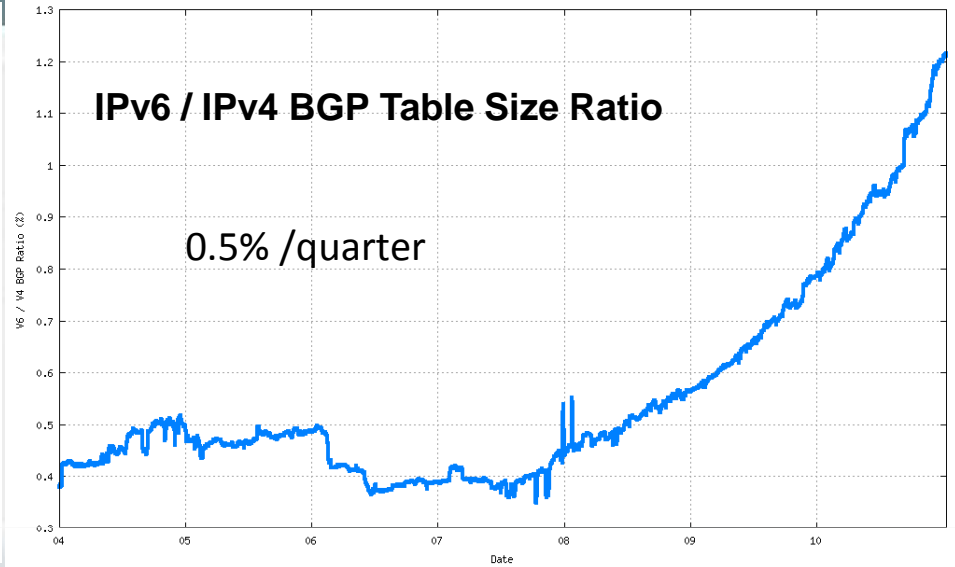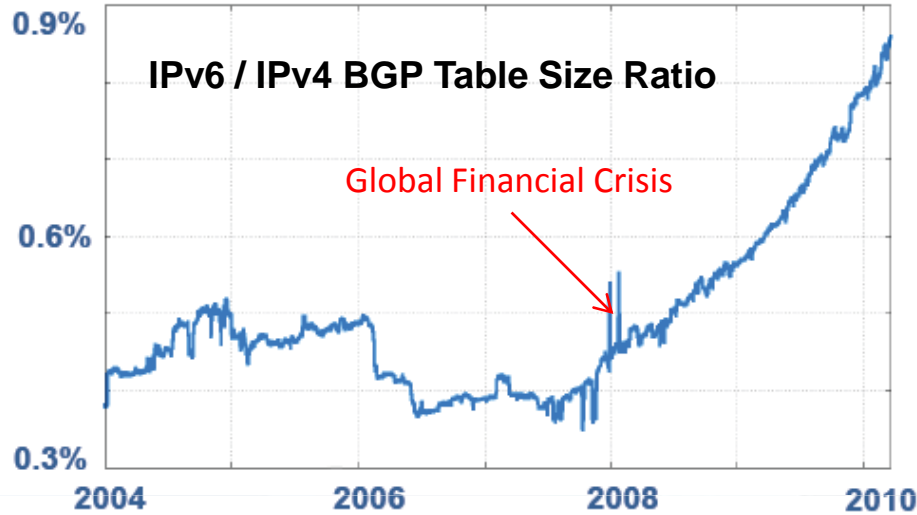 - IPv6 is the only practical and readily resource after IPv4 exhaustion

- ## Implication to private sector
  - s1/s2 are all feasible solutions to private sectors. Corporate chooses solution based on its existing requirements
- ## Implication to public sector
  - Beyond s1/s2, public sector has to provide a feasible mechanism for r1 (IPv6)
  - Public section should consider IPv6 deployment is necessary but not sufficient requirement
    - In addition to deploy IPv6 (must), public sector can also choose s1/s2 based on its own requirements
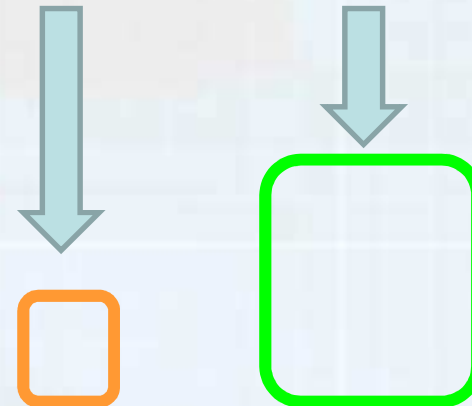
Timing

- IPv4 exhaustion
  - IANA IPv4 exhausted in 2011 Feb
  - APNIC IPv4 exhausted in 2011 Aug
  - IPv6 is the only practical and readily resource
- Government IPv6 deployment in other countries
  - Several countries already launched government IPv6 plan

Timing – Future Potential

IPv6 / IPv4 BGP Table Size Ratio

Global Financial Crisis

IPv6 / IPv4 BGP Table Size Ratio

0.5% /quarter

The chasm

Relative % of customers

Innovators, technology enthusiasts

Early adopters, visionaries

Early majority pragmatists

Late majority conservatives

Laggards, skeptics

Time

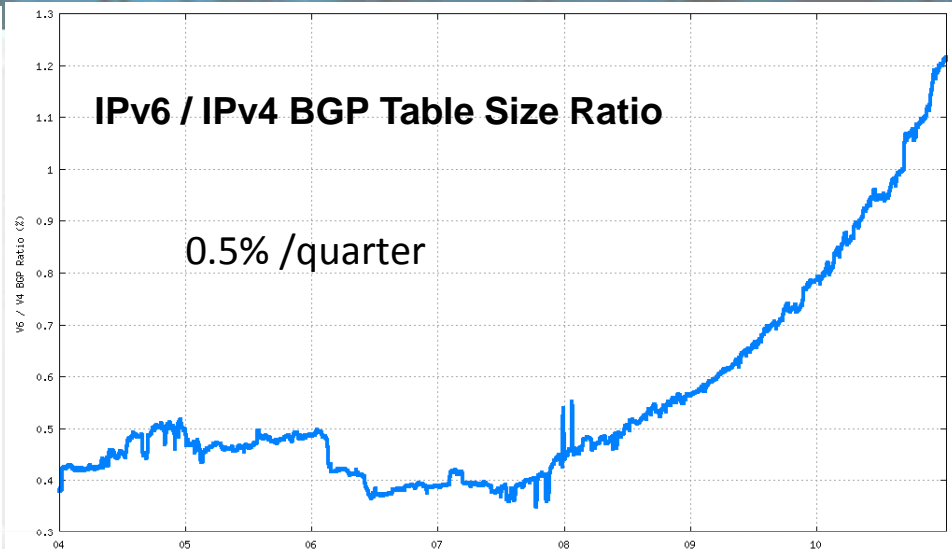Customers want technology and performance

Customers want solutions and convenience

Geoffrey Moore's Technology Adoption Curve (Crossing the Chasm)

IPv6 location in 3 years

Timing – IPv6 Population Estimation

IPv6 / IPv4 BGP Table Size Ratio

Global Financial Crisis

IPv6 / IPv4 BGP Table Size Ratio

0.5% /quarter
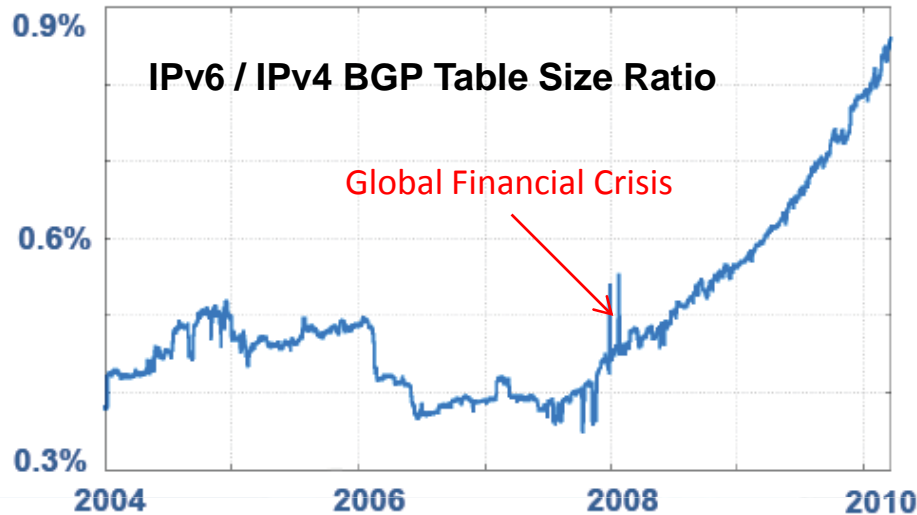
Assuming APNIC Exhaustion end of 2011, simulating IPv6 population in the end of 2012

Linear forecast

IPv6 deploy 5.3%, pure IPv6 3.3%

IPv6 population 160M

Pure IPv6 population 66M

TW pure IPv6 population 528K ➡ Can't access IPv4 Internet

- Activation Time
  - Pure IPv6 ISP, IPv6 users can't access IPv4 Government networks and websites
  - Act Now
    - Government should issue a position statement in support IPv6 deployment now

Cost

- Cost variables for IPv6 deployment
  - One time or phased deployment
  - Coverage ?
  - How long
  - Indirect cost (Training, Security, Service Quality)
- Economical solution
  - Dynamic provisioning
    - Server system : hosting, or enable dualstack in legacy systems
    - Network traffic: Rate limiting

Taiwan Trade vs. IPv6 Allocation

	Taiwan Trade with Partners, Jan 2010 – Oct 2010	Share of Total Exports	Share of Total Imports	Share of IPv6 /48s Allocated to Date	Share of IPv6 /48s Allocated Per Capita
1	CHINA	28.129%	14.105%	0.28%	0.063
2	JAPAN	6.64%	20.916%	7.46%	7.195
3	UNITED STATES	11.395%	9.962%	10.68%	4.234
4	HONG KONG	13.868%	0.653%	0.03%	0.657
5	KOREA	3.9%	6.387%	3.57%	8.643
6	SINGAPORE	4.45%	3.102%	0.03%	0.785
7	GERMANY	2.352%	3.258%	7.18%	10.546
8	MALAYSIA	2.164%	3.097%	0.03%	0.15
9	SAUDI ARABIA	0.367%	4.735%	0.01%	0.105
10	AUSTRALIA	1.156%	3.62%	5.57%	31.669
	Total	74.42%	69.84%	34.84%	64.047
	TAIWAN	n/a	n/a	1.59%	9.418

Cost: Number Please

- Lack of Generalizability
  - IPv6 readiness varied among Gov agencies, thus transition cost are different
- Financial risk
  - Can't have precise financial measurement
  - Financial risk can be limited within an acceptable range through sizing/scoping IPv6 deployment
- Non-financial risk
  - Apply the existing IT practice /guideline to manage non-financial risk. Such as ITIL standards, Information Security ISO27000 series, or USG IT Enterprise Architecture

Initial Sizing

- DNS Capacity (IPv6 gov.tw)
  - v6 enable: activating dualstack in DNS and adding AAAA RR
  - expansion: no capacity expansion
  - connection : access IPv6 network or IPv6 colocation
- WWW Capacity
  - V6 enable: activating dualstack in the existing systems
  - expansion: existing WWW capacity x 3%-5%
  - connection : access IPv6 network or IPv6 colocation
- Network Capacity
  - V6 enable : activating dualstack in routers
  - expansion: existing bandwidth x3%-5%
  - Transit: purchase IPv6 Transit
  - Peering: deploy Layer2 switch for IPv6 public internet exchange (6PIX).
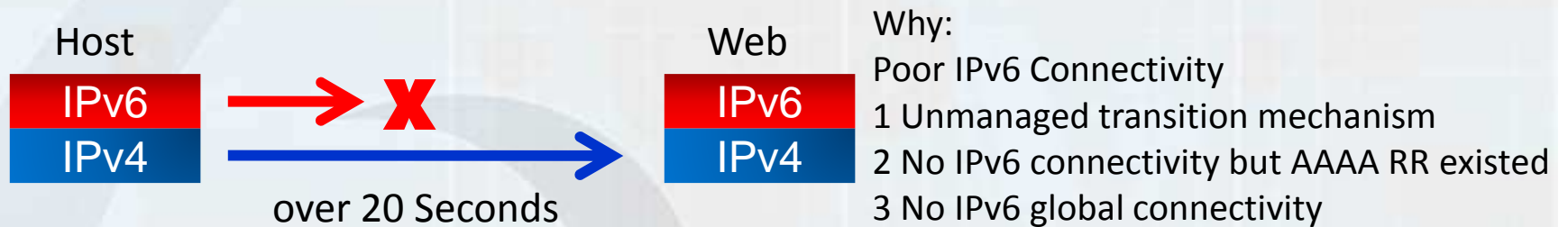
Priority Matrix

Perceived Value (vertical axis)

Cost Estimate (horizontal axis)

	L	M	H
H	**A** External Services — WWW, DNS, Email Transit/Peering Backbone , IX	Nodes < 1K? Tiered Deploy ? Tier Criteria	
M	Nodes <10K?	**B** Connectivity Expansion — Access Networks	
L		Nodes < 10M?	**C** Internal Use & All IPv6 — Internal Services, Database, Desktop H/W, S/W

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Non-financial Risk

Issue List

1 v6/v4 fallback

Host

| IPv6 | → **X** |
| IPv4 | → |

over 20 Seconds

Web

| IPv6 |
| IPv4 |

Why:
Poor IPv6 Connectivity
1 Unmanaged transition mechanism
2 No IPv6 connectivity but AAAA RR existed
3 No IPv6 global connectivity

2 DNS query increase

	FeeBSD	Linux	MacOS	Vista
A & AAAA query sequence order	A first	AAAA first	A first	A first
When does domain name completion occur	After A+AAAA	All AAAA completion	Alter A+AAAA	

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3 Operational practice/technology takes time

	Idea	Current
IP	1969	1981
TCP	1974	1981
Telnet	1969	1983
IDN	1998	2004
IPv6	1994	1998

4 Cost of management for long term overlapping period
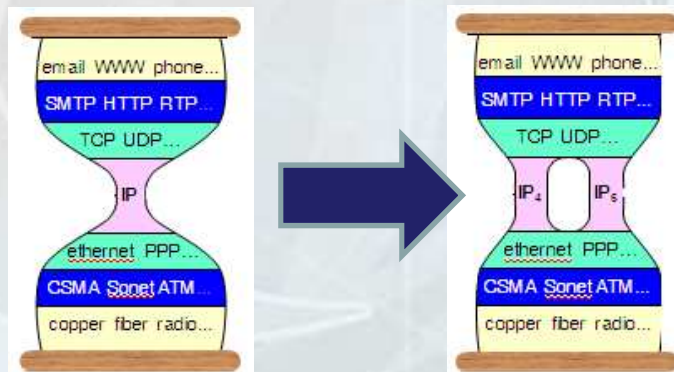
- doubles number of service interfaces
- requires changes above & below
- major interoperability issues

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Gain & Loss

| Perceived Gain	Perceived Loss
1. Meet pure IPv6 users/operators needs 2. Potential address needs: mobile-Internet, Internet of Things 3. Sustain ICT competitiveness	1. Financial risk: cost of deployment (ref: initial sizing) 2. Nonfinancial risk: service quality (ref. Issue List) 3. Future management cost (IPv4 Post-Transition)

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Value Assessment

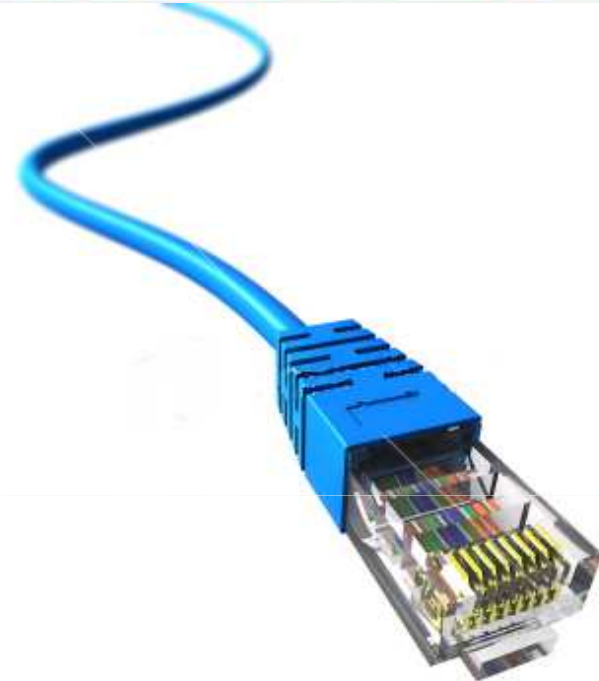| Item		Necessity	Perceived Value
A External Services	WWW, DNS, Email Transit/Peering Backbone, IX	MUST	Complied with Telecom Act. s20: universal access right to all citizen s21: fair connection service s22: undeniable interconnection
B Connectivity Expansion	Access Networks	MUST	Complied with Telecom Act. s20: universal access right to all citizen s21: fair connection service s22: undeniable interconnection
C Internal Use & All IPv6	Internal Services, Database, Desktop H/W, S/W	MAY	Only if IPv6 demonstrate its market momentum with positive externality at this stage

Proposed Schedule

	Position Statement	External Services	Connectivity Expansion	Internal Use & All IPv6
0	Government Official Support			
A		WWW, DNS, Email Transit/Peering Backbone, IX		
B			Access Networks	
C				Internal Services, Database, Desktop H/W, S/W

T_0 T_a T_b T_c
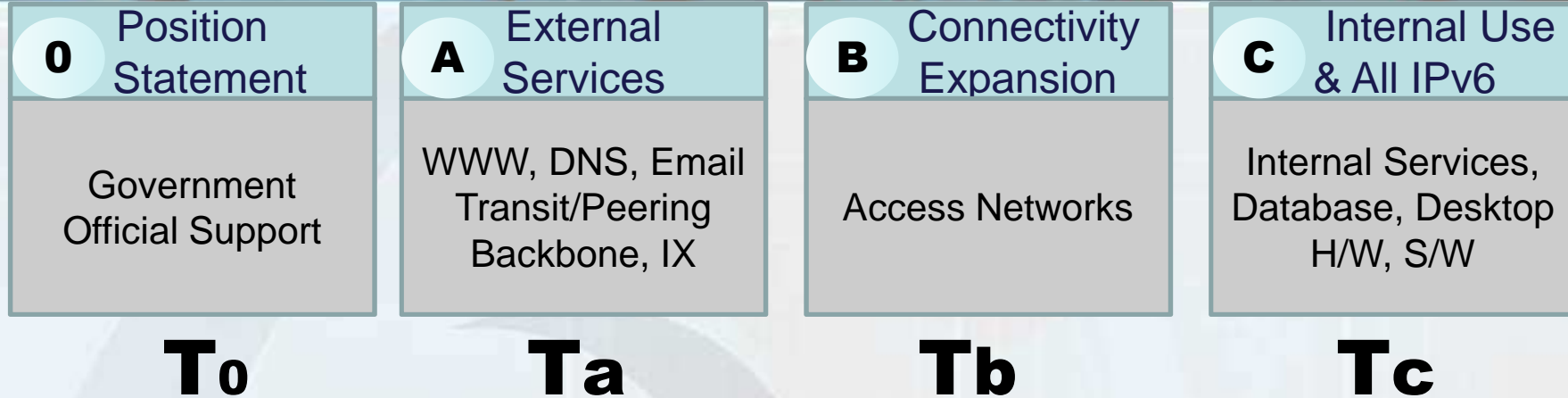
	Proposed schedule	Reason	Remark
T_0	Now	Ref : Activation Time	Must
T_a	T0+2 Y	12M after IPv4 exhaustion	Must
T_b	T0+4Y	Ref other country policy	Adjusted by budget
T_c	T0+4Y	Ref other country policy	Adjusted by budget

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Policy defined, It is just the beginning

IPv6 is not "plug and play"

Standards/mandatory ?
Infrastructure readiness ?
Transit/peering ?
Addressing ?
Dual-stack/tunnelling ?
v6 Routing protocols?
Security?
Cost?

Think Post-Transition Strategy First

Transition
Strategy

AS IS
Internet

→

TO BE
Internet
Mutation

> 20 Years ?

Overlapping Period
Post Transition Management

TO BE
Internet
Mutation

IT Maturity Model

|	Understanding and Awareness	Training and Communication	Process and Practice	Techniques and Automation	Compliance	Expertise
1	Recognition	Sporadic communication on issues	Ad hoc approach to process and practice			
2	Awareness	Communication on the overall issue and needs	Similar but intuitive process emerges	Common tools are appearing	Inconsistent monitoring on isolated issues	
3	Understanding of need to act	Informal training supports individual initiatives	Practices are defined, standardized and documented; sharing of better practices begins	Tool set is standardized; currently available practices are used and enforced	Inconsistent monitoring; measurement emerges; balanced score card adopted; root cause analysis is intuitive	Involvement of IT specialists in business processes
4	Understand full requirements	Formal training supports a managed program	Process ownership and responsibilities are set; process is sound and complete; internal best practices are applied	Mature techniques are used; standard tools are enforced; limited tactical use of technology	Balanced scorecard are used in some areas; root cause analysis is standardized	Involvement of all internal domain experts
5	Advanced. Forward-looking understanding	Training and communications support external best practices and use leading edge concepts	Best external practices are applied	Sophisticated techniques are deployed; extensive optimized use of technology	Balanced scorecard is globally applied; root cause analysis is always applied	Use of external experts and industry leaders for guidance
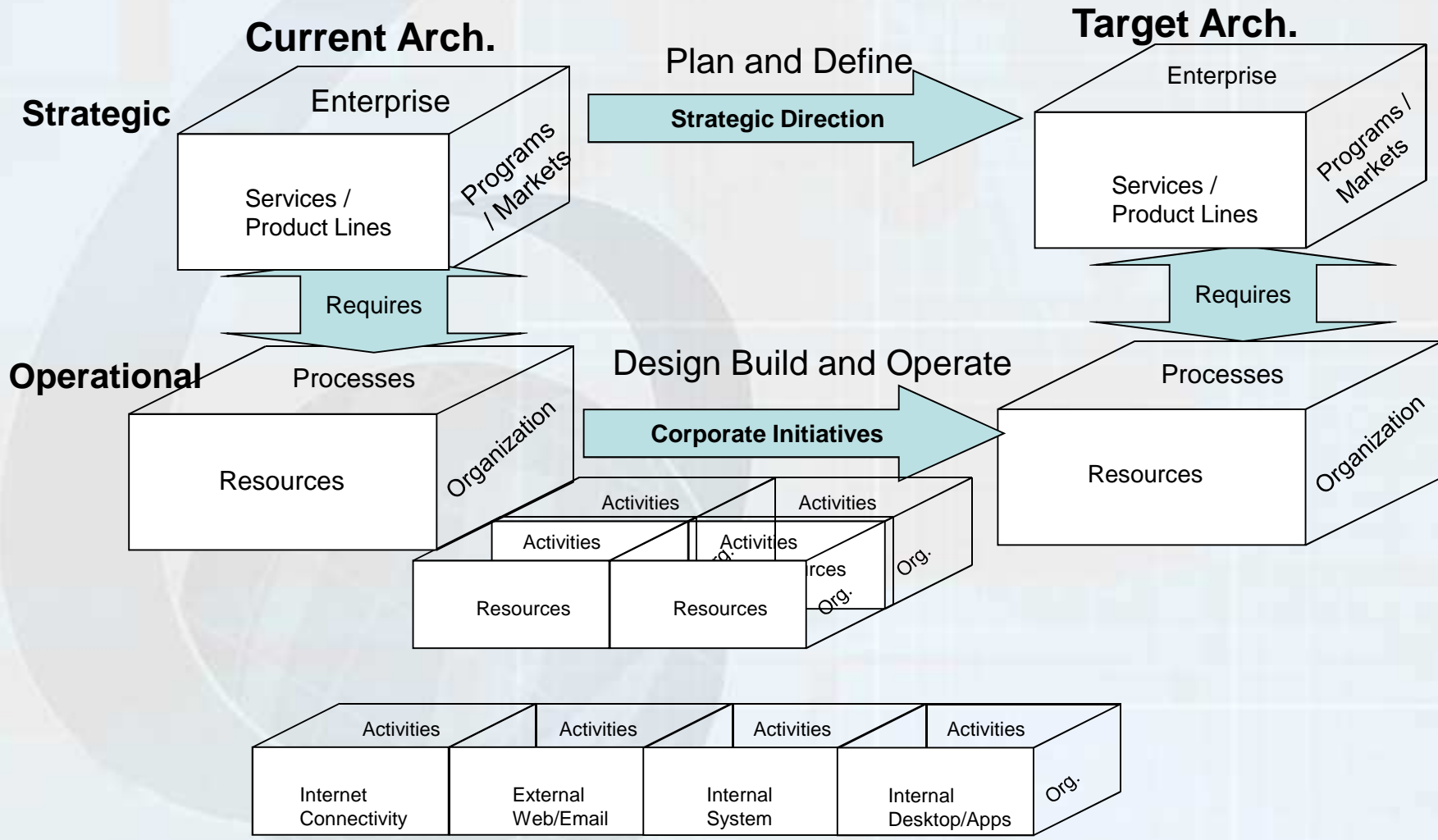
IPv6 Transition Model
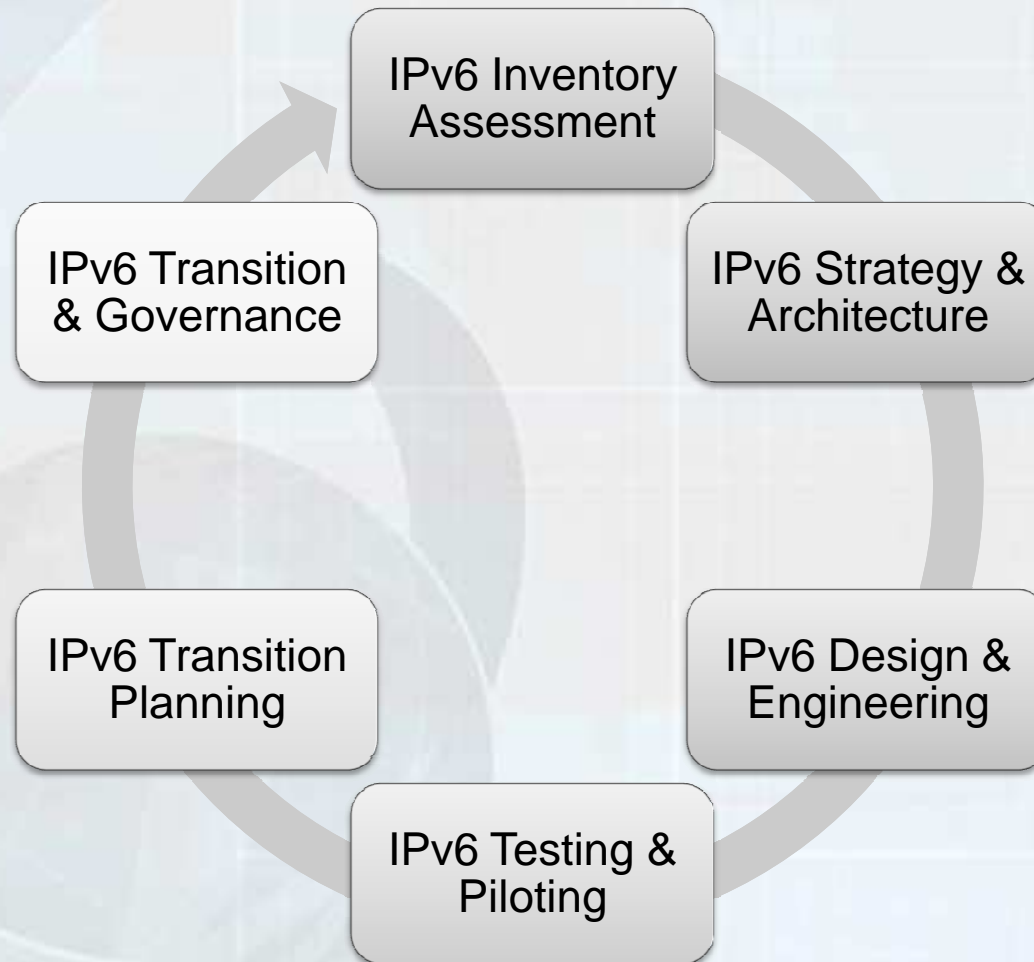
IPv6 Inventory Assessment

IPv6 Inventory Assessment
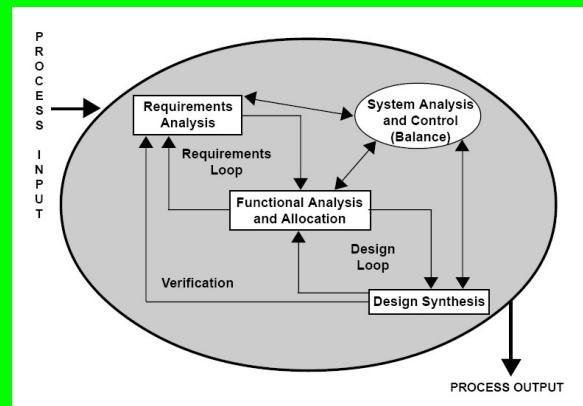
Discover and document infrastructure readiness

Cost impacts of transition to IPv6

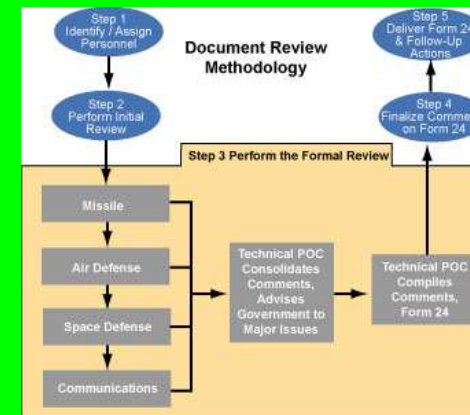Inventory IP elements to understand the ability to support IPv6

Align element mapping to refresh cycles

Understand vendor and carrier dual stack roadmap

Item

Methodology

Requirement Analysis Framework

Document Review Technique

Functions & Gov Agency

GSN Management
REDC

ISP IPv6 Innovation Act
MOT

Administration
IPv6 Transition Office

Policy
STAG

Deployment
All Agencies

Procurement
PCC

Technology Support
TWNIC

Strategic Policy for IPv6 Deployment

1. Political Return

P1 policy making	• Position statement for IPv6 deployment
P2 Greater participation	• RIR policy development
P3. Risk management	• IPv4 exhaustion
P4. Economic impact	• Reduce risk of ISP/ICP

2. Constituent Service

C1 increase value	• Training and awareness • IPv6 product certification • technology
C2 reduce cost	• Industrial innovative Act: Tax Credit
C3 single POC	• IPv6 transition office
C4 service availability	• Government network dualstack

3 Operation Efficiency

O1 service transform	• Government IPv6 deployment
O2 Policy Goal	• Business / service continuity
O3 Government responsibility	• complied with Telecom Act

Feasibility

Technology

Operation

Economy

Legal
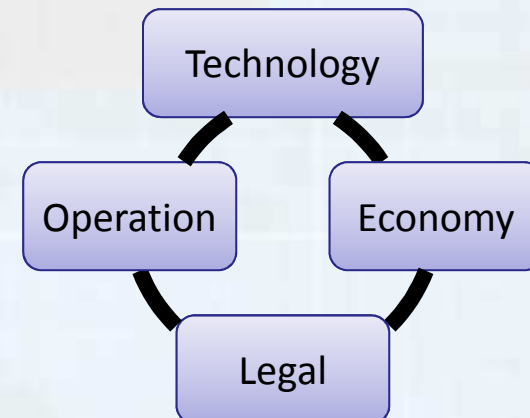
Policy Value Assessment

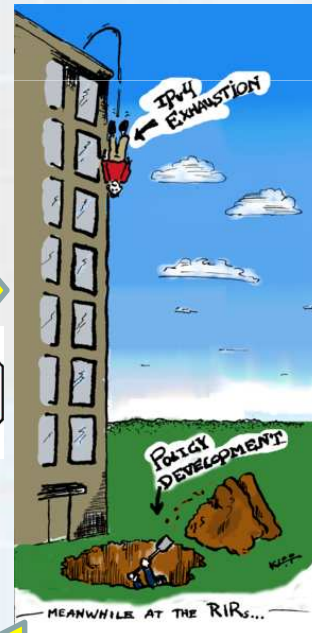|	Current State	Intended State	Project Component
Political Return			
Policy making		Clear IPv6 Strategy	Position Statement
Greater participation	RIR participation	RIR participation	
Crisis management	IPv4 exhaustion	Minimal impact	IPv6 Transition
Constituent Service			
Constituent value		Certification/tech transfer	IPv6 Tech Support Center
Lower constituent cost		Lower cost for ISPs	Industrial innovation act
Single point of contact		Single POC	IPv6 Transition Office
Greater service availability	IPv4 only	IPv4/IP6 availability	GSN dualstack deployment
Operational Efficiency			
Service Transformation	Ad hoc	Best practice	Phased IPv6 transition plan
Policy objectives	Service availability	Sustained service availability	Secure IPv6 migration
Gov responsibility		Complied with Telecom Act	IPv6 transition plan

IPv6 Policy Deliveries

	Current State	Intended State	Project Component
Political Return			
Policy making		Clear IPv6 Strategy	Position Statement
Greater participation	RIR participation	RIR participation	
Crisis management	IPv4 exhaustion	Minimal impact	IPv6 Transition
Constituent Service			
Constituent value		Certification/tech transfer	IPv6 Tech Support Center
Lower constituent cost		Lower cost for ISPs	
Single point of contact		Single POC	IPv6 Transition Office
Greater service availability	IPv4 on	IPv4/IP6 availability	GSN dualstack deployment
Operational Efficiency			
Service Transformation	Ad hoc	Best practice	Phased IPv6 transition plan
Policy objectives	Service availability	Sustained service availability	Secure IPv6 migration
Gov responsibility		Complied with Telecom Act	IPv6 transition plan

+6 Million v6 Users

6PIX

Procurement Drive Innovation

STOP

STIMULUS PLAN
TAX CREDIT
UP TO
$450000000 **
PLUS our current offer!

CapEx OpEx

IPV4 EXHAUSTION

POLICY DEVELOPMENT

— MEANWHILE AT THE RIRs...

THANK YOU

Reference

1. Geoff Huston. 2010. IPv4 Address Report. Retrieved 5 May 2010, from http://www.potaroo.net/tools/IPv4/
2. Geoff Huston. 2010. Measuring more IPv6. The ISP Column. April 2010
3. Geoff Huston, Kenny Huang. 2010. Economic Considerations for IPv6 Transition. IPv6 Economics and Implementation Workshop, Kuala Lumpur. 2 March 2010
4. JPNIC. 2008. Report on Study Group on Internet Smooth Transition to IPv6.
5. JPNIC. 2009. Action Plan and Milestone – Toward IPv4 Address Exhaustion. October 5 2009.
6. Kahn, Herman, and Anthony J. Wiener. 1967. The Next Thirty-Three Years: A Framework for Speculation. Daedalus963 (1967):705-32
7. NIST (National Institute of Standards and Technology). 2010. Guidelines for Secure Deployment of IPv6. Special publication 800-119. Feb 2010
8. NRO.2010. Less than 10% of IPv4 Addresses Remain Unallocated. Number Resource Organization. Retrieved 05 May 2010, from http://www.nro.net/media/less-than-10-percent-IPv4-addresses-remain-unallocated.html
9. RFC2185 (Routing Aspects of IPv6 Transition)
10. RFC3142(An IPv6-to-IPv4 Transport Relay Translator)
11. RFC3053 (IPv6 Tunnel Broker)
12. RFC3056(Connection of IPv6 Domains via IPv4 Clouds)
13. RFC4213(Basic Transition Mechanisms for IPv6 Hosts and Routers)
14. RFC4214(Intra-Site Automatic Tunnel Addressing Protocol ISATAP)
15. RFC4380(Teredo:Tunneling IPv6 over UDP through Network Address Translations NATs)
16. RFC4966(Reasons to Move the Network Address Translator-Protocol Translator NAT-PT to Historic Status)
17. RFC5211(An Internet Transition Plan)
18. RFC5569(IPv6 Rapid Deployment on IPv4 Infrastructures (6rd))
19. RFC5572(IPv6 Tunnel Broker with the Tunnel Setup Protocol (TSP))
20. US Government. 2002. "eGovernment Strategy", Feb 27 2002.
21. 曾憲雄(2010).政府網路及e政府網站導入IPv6參考要點, 新一代網際網路協定互通認證計畫