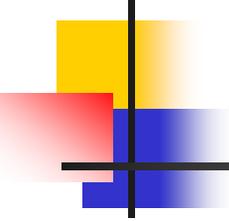


Infrastructure ENUM

Geoff Huston
Chief Scientist, APNIC
November 2006





Acknowledgements

- Thanks to
 - Patrik Fältström
 - Olaf Kolkman
 - Robert Schischka
 - Richard Stasny
 - Richard Schockey

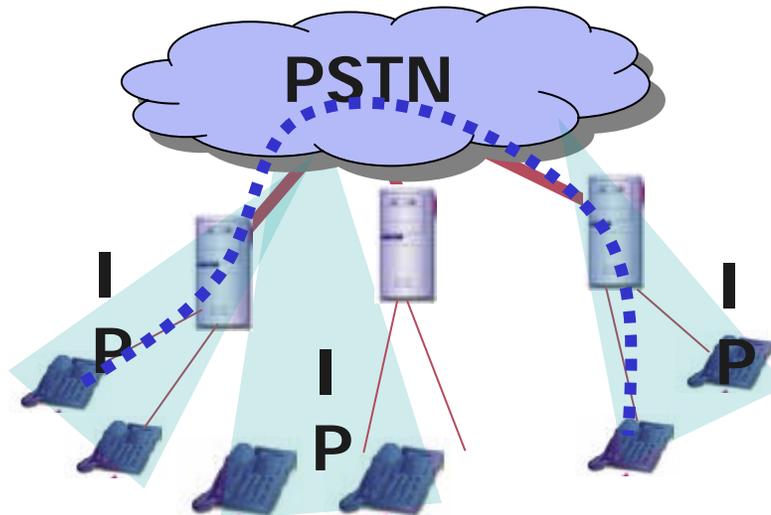
Whose ideas (and some slides) are contained in this presentation. I'd like to claim full credit for all the errors and mis-interpretations of their efforts!

Geoff

- And
 - Mark Williams, for the Chinese translation

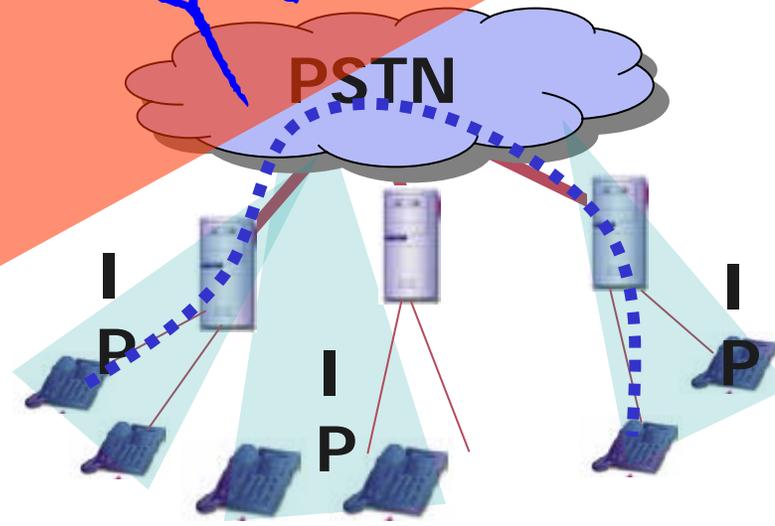
VOIP without ENUM

- Every VOIP is an Island (apologies to John Donne!)
 - Enterprise or carrier VOIP dial plans cannot be remotely accessed by other VOIP gateways
- The PSTN is used as the inter-VOIP “default” network
 - Obvious implications of revenue protection for PSTN operators
 - More subtle implications for extended private VOIP networks



VOIP without ENUM

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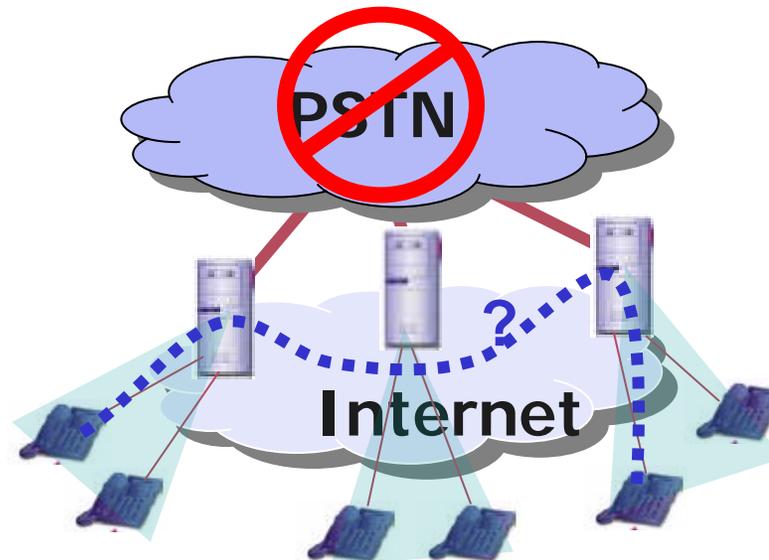


I've seen this before!

Yawn!

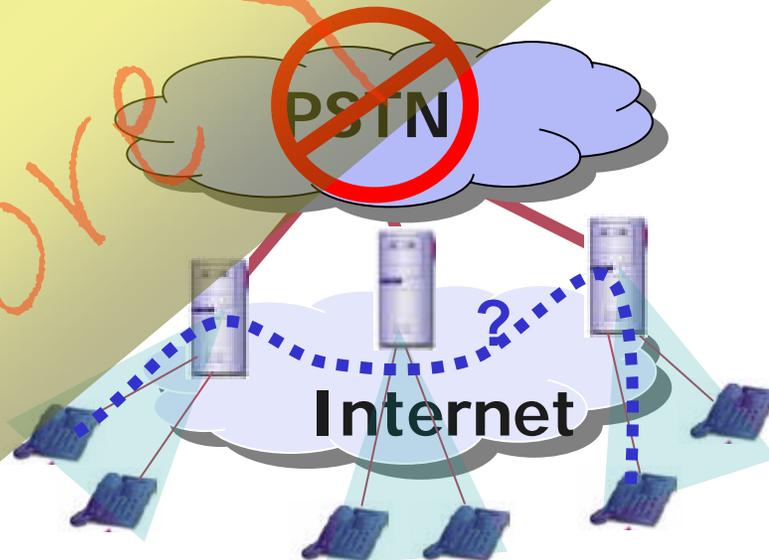
The Core ENUM Problem

- PSTN Carrier Bypass
- How can a VOIP gateway find out dynamically:
 - If a telephone number is reachable as an Internet device?
 - And if so, what's its Internet service address?



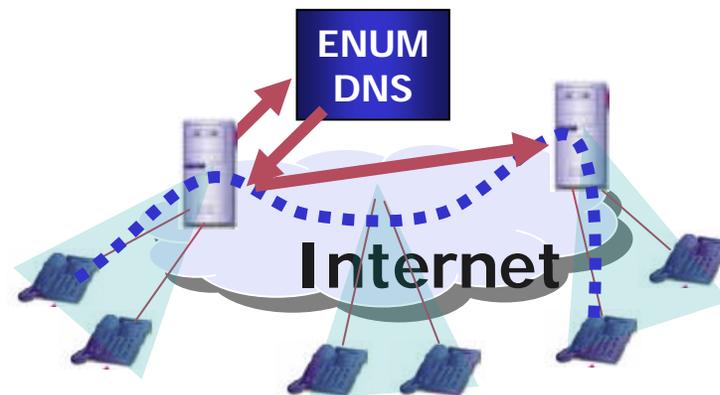
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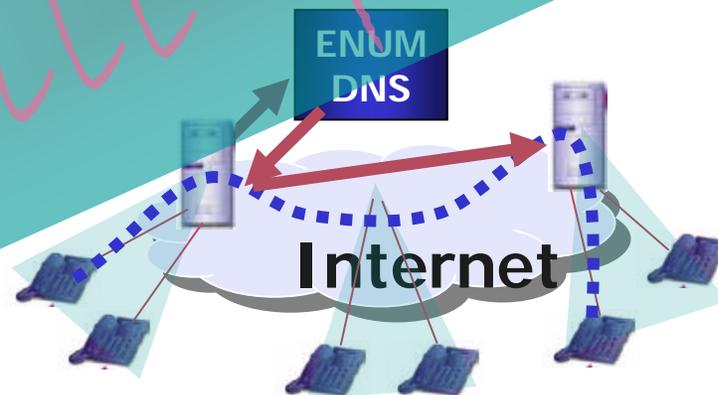
The ENUM Approach

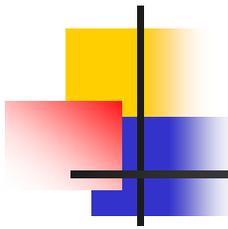
- Use the DNS Luke!
- It's a PSTN carrier default route bypass operation for VOIP-to-VOIP calls:
 - Identify the calling service
 - Lookup the ENUM DNS using the called number
 - Find a compatible terminating service URI
 - Connect directly to the URI over IP
- The DNS as a service rendezvous mechanism



The ENUM Approach

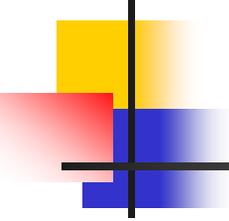
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(User) ENUM

- It's a User-centric approach
- Its all about the end user's service and call termination type preferences
 - Opt-in model into the DNS
 - Contains end-user preferences for rendezvous services
 - Potential for multiple service providers to be referenced in a single DNS zone file
- It was intended to be useable technology, solving a real problem

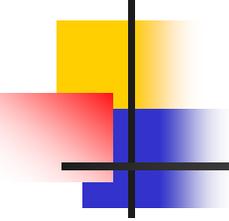


(User) ENUM isn't working

BUT: ENUM hasn't really "happened" yet

There have been significant imposed regulatory and economic constraints that have implied very limited ENUM uptake so far

- Effective use as a PSTN bypass has been limited by the lack of general admission of geo numbers into the ENUM framework
 - Making ENUM about as useful as VOIP walkie-talkies!
- The dreams of ENUM becoming the universal identity token were maybe another instance of just incredibly wishful thinking on the part of a rabidly insane DNS industry



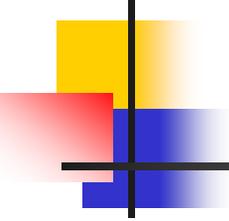
The Carrier's Perspective

- Its not really about the end user
 - Its about calls and internal VOIP infrastructure leverage
 - Its about call termination mechanisms that bypass the imposed inter-carrier SS7 paths and the PSTN
 - Its about re-defining call accounting settlements to bypass traditional paths
 - Its about number blocks, not individual numbers
 - Its all about inter-provider dynamics, not the end-user

Global Market Realities

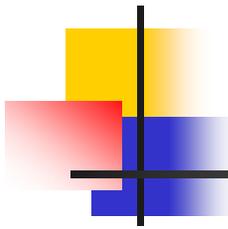
- Voice providers are losing control of pricing
- Flat Rate Pricing beginning to dominate
 - Variable costs unacceptable
- VOIP Carriers beginning to demand bill and keep vs inter carrier compensation
 - Current inter-carrier accounting costs outrageous
- Desire for advanced service integrity using IP end-to-end
- The Internet model of transit and peering is about to be applied to voice traffic as well





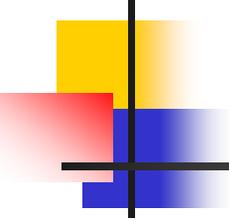
What's the motivation?

- Imagine you are a PSTN carrier that supports IP-based services internally:
 - That uses e164 numbers for called party identification for service completion
 - VOIP, MMS, ...
 - And you want to terminate a customer's call request
 - What database do you lookup?
 - Launch an SS7 request!
 - What if you don't like the answer?
 - What if you wish to use IP services to transit directly to the terminating carrier's call termination point rather than the default PSTN trunks?



What's "Infrastructure" ENUM?

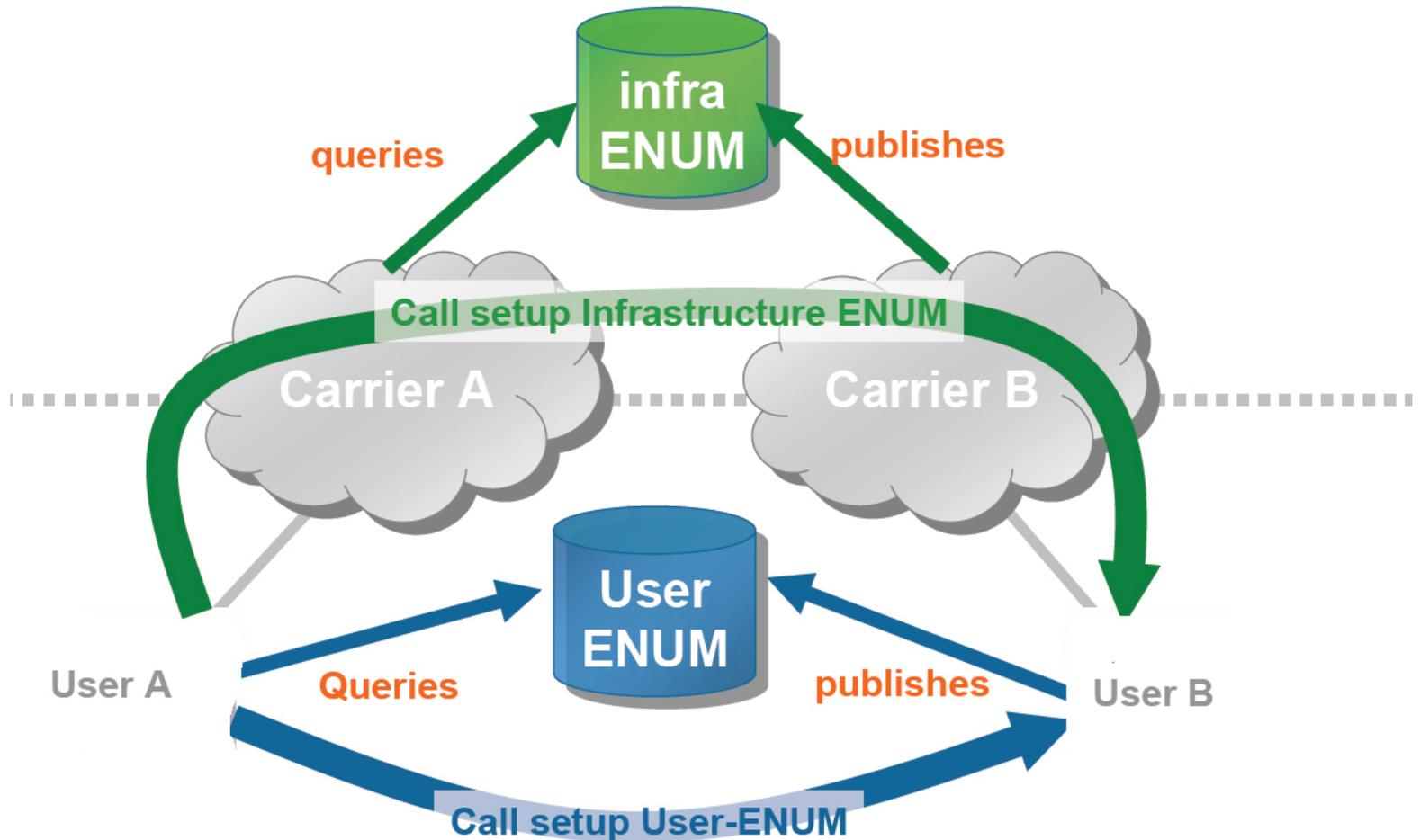
- Its for carriers to announce to other carriers a set of rendezvous points for terminating services
 - (International) PSTN Accounting Settlement Bypass
- Announce in some I-ENUM DNS the E.164 number set for which the announcer is the carrier-or-record
 - populate this I-ENUM DNS with the services that the carrier is willing to terminate for incoming IP-based service requests
 - Resolve carrier I-ENUM DNS queries to the IP rendezvous URIs that perform service termination in the terminating carrier's network

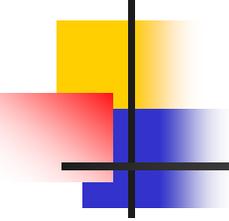


What's "Infrastructure" ENUM?

- Use the same ENUM technology, but now it's the carrier attempting to perform call completion with the terminating carrier:
 - Identify service
 - Lookup called number in the I-ENUM DNS domain
 - Find the terminating carrier's URI for a compatible terminating service for an enclosing number block entry
 - Pass the call to the other carrier's URI (via IP)

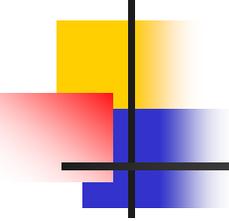
I-ENUM – the logical view





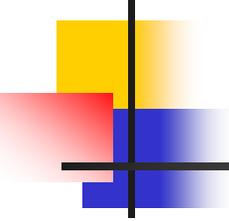
I-ENUM Requirements

- Carriers want to:
 - Map called numbers (E.164 numbers) to rendezvous points as specified by the terminating carrier
 - IP or PSTN termination capabilities
 - Under the full control of the terminating carrier
 - Carrier is in the call flow for call termination
 - Number blocks as well as individual numbers to be mapped into I-ENUM
 - Minimal provisioning overhead
 - Minimal opex
 - Terminating Carrier has full control of I-ENUM entries
 - Both Originating and Terminating Carriers have full control of interconnection policies
 - Neither the number blocks, nor the services, nor the rendezvous points are necessarily public



Status of I-ENUM

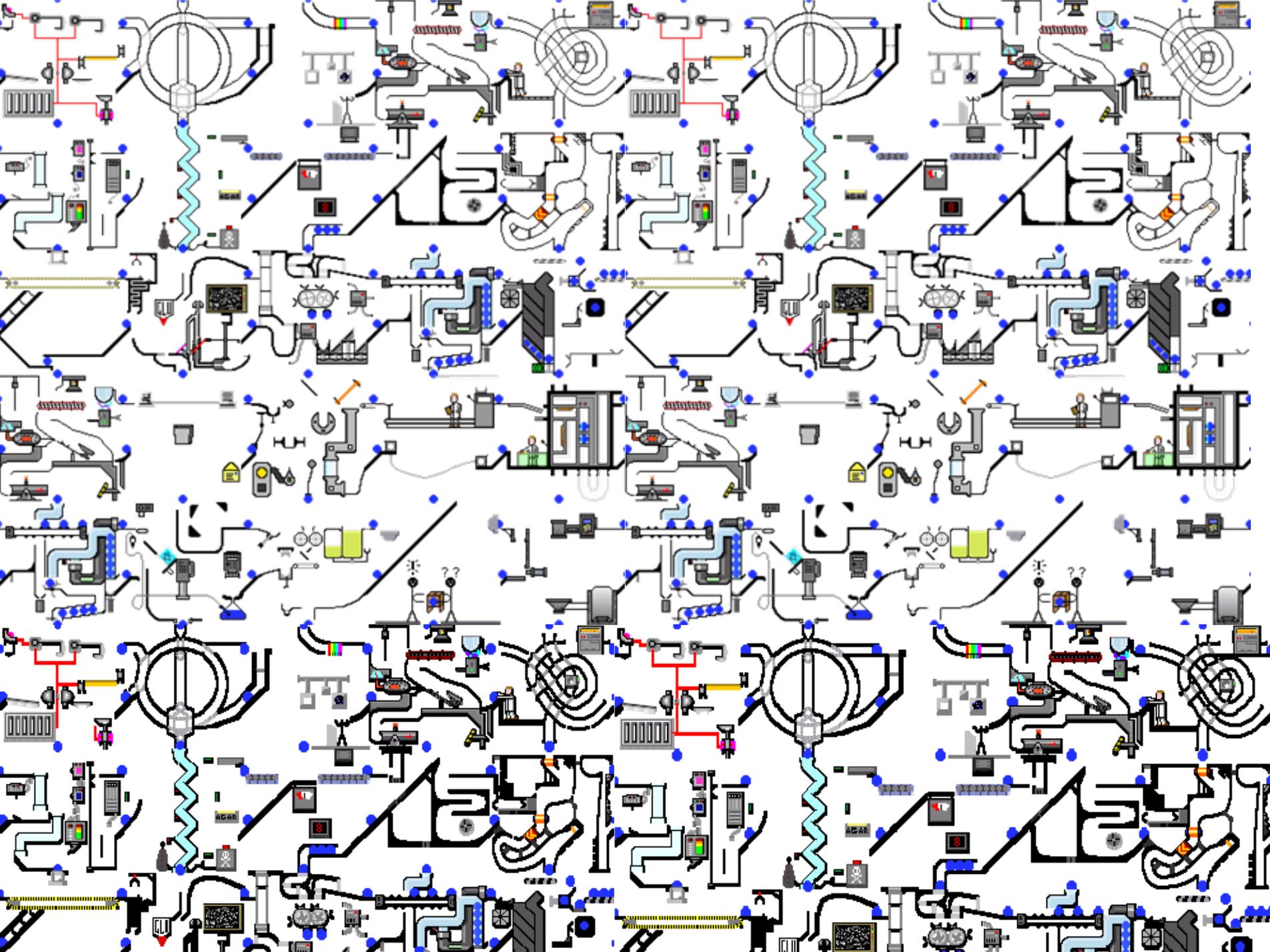
- Right now:
 - The industry thinks it knows what it wants
 - But we don't yet agree on how to achieve it!

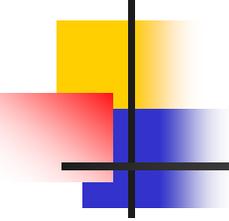


Approach A

- Leave it to the telco's to figure this out

Of course, don't forget that you are asking the Masters of Complexity to solve a simple problem – beware of what you ask for...



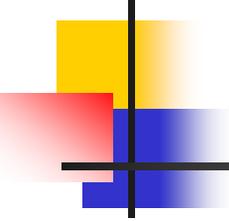


Approach B

- Leave it to the IETF to figure it out:
 - Generate Requirements documents
(wait)
 - Generate Framework documents
(wait)
 - Generate Solutions documents
(wait)
 - Publish RFCs

Of course, don't forget that you are of course asking for the Grand Masters of Glacially-Paced Perfection to solve this problem for you:

- Is there anyone alive who can remember what was the original problem again?

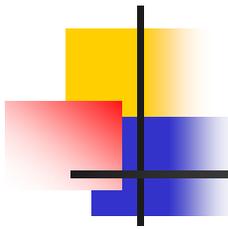


Approach C

- Have everyone just do something
 - Or anything!
 - Because sometimes, if you are lucky, you can get away with labeling any form of activity as “progress”

Of course, don't forget that too many Master Chefs do not like constructing a palatable solution

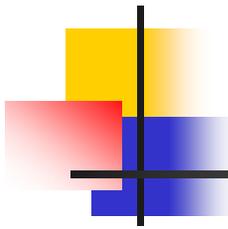
- it might be better to agree on a single approach at the outset!



百花齊放，百家爭鳴

*

- Split the DNS domains
or
- Play even more games in the DNS with Resource Records and query sequences
or
- Use private ENUM contexts



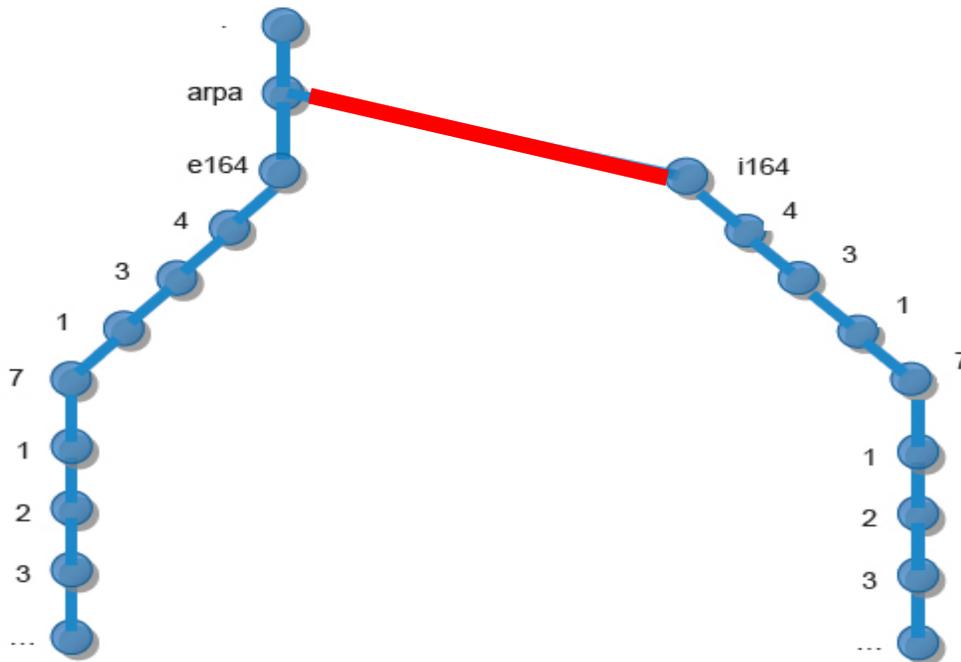
I-ENUM as a DNS hierarchy

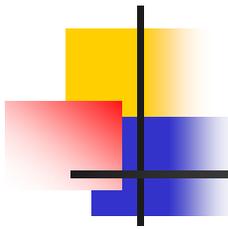
- Use the same NAPTR DNS RR entries
- Use the same lookup mechanism to resolve a called number to a URI set
- Use the regular expression substitution capabilities of NAPTRs to use a general NAPTR RR to generate called-number-specific rendezvous URIs

- No change to ENUM RR records
- No change to NAPTR capabilities

I-ENUM – a possible approach

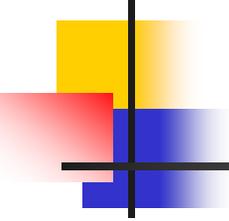
- Split I-ENUM into a new DNS tree
 - Use <number>.i164.arpa for i-enum





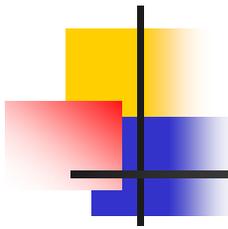
What's wrong with this picture?

- e164.arpa was hard
 - The split control between the ITU-T and the IETF was tough to set up and contentious to operate
 - The e164 number space is a political nightmare
 - Oddly enough, “countries” are a pain to deal with:
 - China, Taiwan and +886
 - North American Number Plan
 - The line data base is often in the hands of the ex-monopoly telco
 - These telcos see ENUM as a diabolical invention of a evil revenue-stripping deity that must be resisted
- So why would i164.arpa be any easier to pull off?
 - Why would any service provider ASK for more government intervention and regulation in the critical signaling infrastructure?
 - Choice of i164.arpa requires Govt approval and delegation
 - Isn't the telecom industry moving to deregulation?



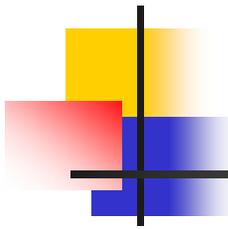
But what's the real issue here?

- Each service provider wants to maintain the record entry for the services where they offer call termination to other service providers
 - We need to be careful about biasing I-ENUM for a single vertically integrated service provider world
 - How do you publish routing information in the DNS?
 - How do you offer different routing views to different parties?
 - How do you solve the problem for multiple service providers to maintain their service record within the same delegation zone in the DNS?
 - With I-ENUM how do you know that 2 DNS ENUM trees are enough? Is 4 a better number? or 42?
- If 1 ENUM tree is not enough, how many is 'enough'?



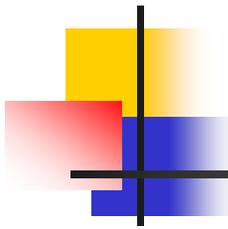
We've been here before...

- This is not a new concept:
 - **tpc.int** (1993) used A records in a DNS tree to create a fax service that bypassed the truck PSTN
 - A messaging pager service was added, using A records in a new subtree: **pager.tpc.int**
 - More services added to tpc.int implied the need to create more **<service>.tpc.int** DNS trees and new service deployment networks
 - Ergo, ENUM
 - Combine **all** services associated with a number endpoint into a single zone, and “neutralize” the DNS tree



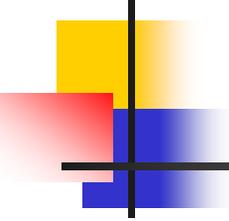
Back to the Future

- So I-ENUM via a new DNS hierarchy wants to do this again, using <service>164.arpa trees
 - But this was precisely the “problem” with tpc.int that ENUM was intended to solve!
 - So can we do the same ENUM approach at the leaves of the DNS tree rather than reverting to service-specific tree replication?
 - i.e. is the service embedded in the DNS name, or is the service a RR entry at the leaf of the DNS?



Games with DNS NAPTR RRs

- The user has the ability to delegate service records for individual services
- Add NAPTR records with the 'd' flag
 - The replacement DNS string is used as a lookup the URI record for this string
 - Take the replacement field, not the regular expression, prefix the replacement field with the service field content, which is prefixed with an underscore (just like SRV records)
- This is another level of DNS indirection
 - Allow delegations per service
 - Or allow for other service delegations
- Provide the distinction in the DNS between the queries:
 - What services exist for this domain?
 - What URI should I use for this service?



Example

```
$ORIGIN 3.8.0.0.6.9.2.3.6.1.4.4.e164.arpa.
```

```
NAPTR 10 100 "u" "E2U+sip" "!^.*$!sip:info@example.com!" .
```

```
NAPTR 10 102 "u" "E2U+msg" "!^.*$!mailto:info@example.com!" .
```

```
NAPTR 10 100 "d" "E2U+sip" "" 3.8.0.0.6.9.2.3.6.1.4.4.e164.arpa.
```

```
NAPTR 10 102 "d" "E2U+msg" "" 3.8.0.0.6.9.2.3.6.1.4.4.e164.arpa.
```

```
$ORIGIN _e2u.3.8.0.0.6.9.2.3.6.1.4.4.e164.arpa.
```

```
_sip NS sipservice.example.com
```

```
_msg NS mailservice.example.com
```

```
$ORIGIN _sip._e2u.3.8.0.0.6.9.2.3.6.1.4.4.e164.arpa.
```

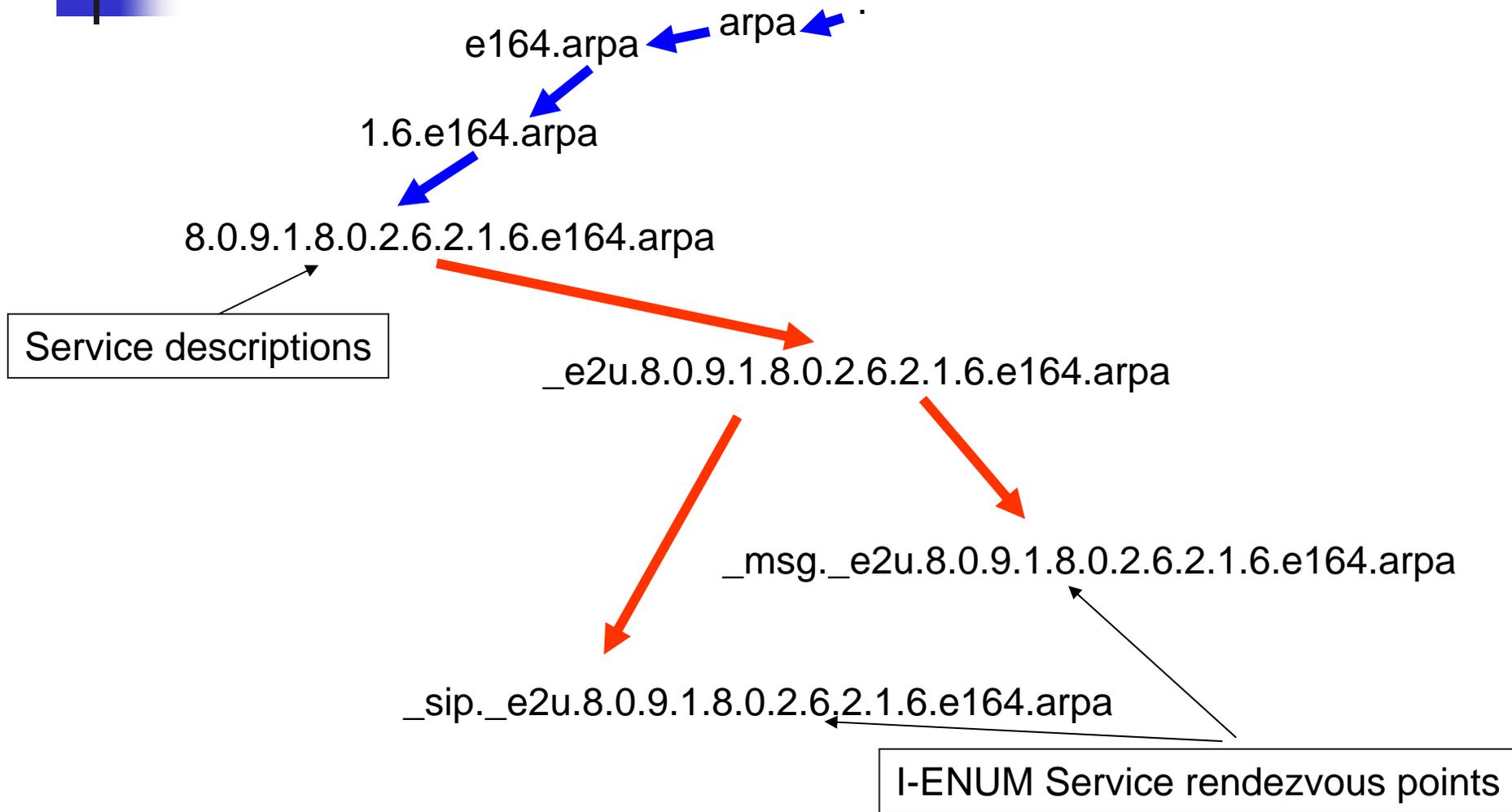
```
. URI 10 10 "sip:info@example.com"
```

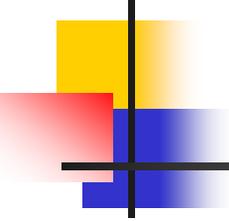
```
. URI 10 10 "sip:info@example2.net"
```

```
$ORIGIN _msg._e2u.3.8.0.0.6.9.2.3.6.1.4.4.e164.arpa.
```

```
. URI 10 10 mailto:info@example.com
```

Delegation Structure





The Good, the Bad, and the Ugly

Good

- Does not need endlessly replicating ENUM trees for each service type, sub-service type, meta-service type,...
- Does not require multiple service entities attempting to maintain records in a shared DNS zone

Not so Good

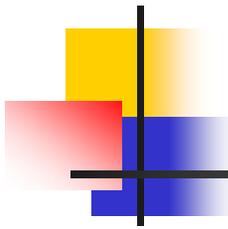
- Another Resource Record in the DNS
- Another layer of indirection in the DNS

Bad

- Exposes inter-carrier service termination points to public view
- Exposes inter-carrier signalling into the public IP network

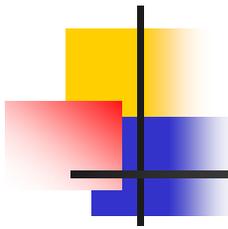
Ugly!

- Requires carrier delegations at the end-point of the single ENUM delegation tree
 - What happened to number blocks?



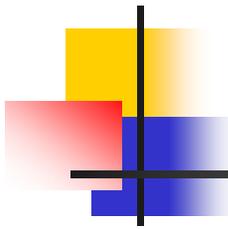
What does the Carrier really want out of ENUM?

- The terminating carrier's service capabilities
- The terminating carrier's preference for service rendezvous URIs
- And **not** to disclose this signalling and the signalled information to every hacker/evil party on the planet
 - Can you say "DOS?"
 - And how many ways can you say "DOS"?
- And to disclose different information to different carriers
 - Can you say "bilateral"?
- To execute an SS7 financial bypass
 - Can you say "money"?



Private I-ENUM

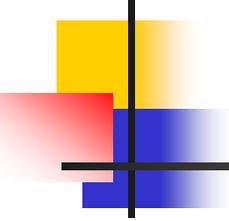
- Each carrier achieves its numbers, services, and termination points in a private world of contracts and bi-lats:
 - Use private DNS roots
 - Use DNS filters
 - Use DNS selective responses to each carrier
 - Use shielded rendezvous points
- DNS technology is about the cheapest and most efficient distributed database we've managed to figure out
- Use DNS technology, but alter the publication model, to suit the actual business need for fine-grained bilateral control of service and policy interaction
- So what is gained, and who gains, by making this carrier interconnection information public through publication in the public DNS?



一花独放，一家主鸣

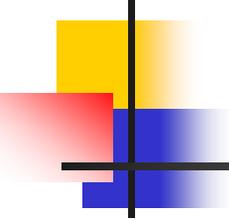
*

- I suspect that there is no clear agreement about the merits of I-ENUM beyond Private ENUM bilats
 - Private bilats have a long and respected history in this industry
 - Private contracts, private interconnects, private rendezvous points
 - And no carrier is really willing to disclose their number blocks and service rendezvous points to the great unwashed masses
 - And private ENUM is now replete with vendors, products, customers and carrier users



But Wait – There's More!

- You can't let those precious VOIP packets be passed around just anywhere
- Obviously, you need to hand-craft special policy-based routes here, don't you!

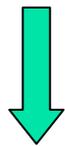


Which leads to...

- VOIPEER and SPEERMINT
 - Technology frameworks that attempt to paste QoS and policy-based forwarding elements into the IP forwarding plane

Scope: ENUM and SPEERMINT

Number

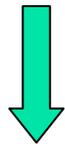


ENUM Lookup

Infrastructure
ENUM

I-ENUM

SIP URI

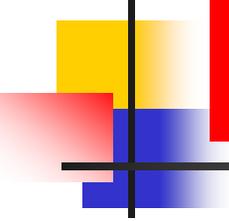


Policy Lookup

Policy
Database

SPEERMINT

Routing Parameter

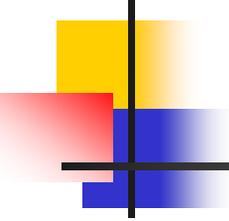


CAUTION: You've just entered the
NGN twilight zone!

There are so many curious (or bizarre!) aspects to this form of policy-based traffic and service management overlays that this is best left for someone else, as another topic !

Thanks

Questions?



一花独放，一家主鸣

I consulted my friend Mark Williams on this. When Mark is not travelling he lives in Beijing working for Juniper and he is a keen student of the Chinese language. I wanted the opposite of Mao Zedong's original saying, in Chinese characters. I thought I was asking for a simple translation, but as it turned out I really did not understand the task of the language translator at all well! Chinese is an old language, and including all or part of traditional sayings into one's writings or speech is an integral part of Chinese language use. In English-speaking cultures we often refer to such a device as an aphorism which has slightly disparaging overtones – not so in Chinese. Mao cleverly constructed his phrase by putting parts of two sayings together, leaving the couplet of four character constructs in place, but adding through the juxtaposition of two different thoughts, his own touch.

To undertake the translation in a faithful manner Mark came up with a similar construct. The first four characters, “Let one flower bloom (only one flower is allowed to bloom)” comes from a common Chinese saying, in the same style of Mao's saying. The second part Mark had to construct in the style of a saying. “One house (school of thought) alone be heard” is formed again using four characters.

My education here is that translation is not just words, but it's the style and context of the words that really create the sense of a “natural” text rather than a clumsy translation. While translating between various Latin-derived languages can often be accomplished on a word for word basis, with transforms largely dictated by changes in grammar, once you move away from a common linguistic root the translator's task is far more challenging. In this case I had asked for a translation of a linguistic artifice based on a “poetic proverb”. A phrase that not just had meaning but a cadence and a tone. The translation, to make sense, also needed to reproduce the same style.

Mark also kindly provided me with the saying in “simplified” Chinese (above), and in traditional Chinese (“一花獨放，一家主鳴”). My choice of simplified Chinese in the pack is again a reference to Mao, and the efforts in that period to simplify the Chinese script. At the time there were some moves in China towards a Roman character derived alphabet that used the same style of phonetic foundation as European languages, which represented a major shift away from the Chinese pictogram foundation. However this did not eventuate, and the outcome of this particular Chinese reform was the “simplification” of a number of Chinese characters. These simplified characters are used predominately in China itself, while the Chinese diaspora, which in itself represents a considerable language population, predominately continue to use traditional Chinese script.

Mark also provided me with alternatives in his search for the “one flower” translation. I reproduce them here to show the extent of the challenge I had unwittingly set out:

- 一枝独秀，一家主鸣 One branch shines out, only one voice is heard.
- 一枝独秀，一家成鸣 One branch shines out, one house (school of thought) rises above the others.
- 一枝独秀，独占鳌头 One branch shines out, stands alone at the top.
- 一枝独秀，脱头而出
- 一枝独秀，一家长鸣

He assures me that in making the recommendation he consulted his copy of “*A Dictionary of Chinese Idioms and Phrases, Proverbs and Allusions, Eulogistic and Derogatory Terms, Enigmas and Euphemisms, Famous and Popular Sayings, Sparkling Sentences and Well-Known Lines in Ancient Poems, Lyrics and and Literary Compositions with English Translation*” (Shanghai Jiaotong University Press). Obviously I feel more confident now – if only because if someone is prepared to run with a title like that they are not trying to write next week's #1 bestseller! The author or authors must be true believers in linguistic integrity!

I have a new respect for those who embark on the course of learning Chinese. This exercise has, for me, been for me a fascinating education in the deeper aspects of symbols and their use in cultures that thread through millenia.

And, of course, I now owe Mark multiple beers!

Thanks Mark!