30 Years of BGP

Design Expectations vs. Deployment Reality in Protocol Development

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In the Beginning...

• BGP was an evolution of the earlier EGP protocol (developed in 1982 by Eric Rosen and Dave Mills)

• **BGP-1** – RFC 1105, June 1989, Kirk Lougheed, Yakov Rekhter
  • TCP-based message exchange protocol, based on distance vector routing algorithm with explicit path attributes

• **BGP-3** – RFC1267, October 1991, Kirk Lougheed, Yakov Rekhter
  • Essentially a clarification and minor tweaks to the basic concepts used in BGP

• **BGP-4** – RFC 1654, July 1994, Yakov Rekhter, Tony Li
  • Added CIDR (explicit prefix lengths) and proxy aggregation
Containing the Routing "Explosion"

- IETF ROAD Efforts in 1992 (RFC1380)
  - Predicted exhaustion of IPv4 addresses and scaling explosion of inter-domain routing
- The chosen “solution” was to drop the concept of address classes from BGP
- It (sort of) worked
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IPv6 and BGP

• While the IETF adopted the IPv6 address architecture for the address exhaustion issue, it was unable to find an IPv6 routing architecture that had similar scaling properties
  • IETF efforts to impose a routing hierarchy (TLAs and sub-TLAs – RFC 2928) got nowhere!

• So we just used BGP for IPv6 in the same way as we used BGP for IPv4
  • Address allocation policies that allocated ‘independent’ address blocks of /35 or larger
  • ISP traffic engineering and hijack “defence” by advertising /48s
BGP isn't perfect

- Session insecurity
- Payload insecurity
- Protocol instability
- Sparseness of signalling
- No ability to distinguish between topology maintenance and policy negotiation
Scale generates inertia

- BGP-4 was introduced when the routing table contained ~20K entries – it is now ~800K entries.
- The network carries some 75K ASNs.
- Changing the internet to use a new common IDR protocol would be incredibly challenging – something would need to break to force change.
BGP Scaling

• BGP has scaled because the protocol only passes changes
• As long as the change rate is low the BGP load is low
• And the inter-AS topology of the Internet works in BGP’s favor
• And this has allowed BGP to grow well beyond the original design expectations
Expectations vs Deployment

• Session lifetime
  • Expectations of short session lifetimes – experience of longevity

• Session Security
  • Expectation of routing being a public function - experience of session attack

• Payload Integrity
  • Expectations of mutual trust – experience of malicious and negligent attack

• Protocol Performance
  • Expectations of slow performance – experience of more demanding environments

• Error Handling
  • Expectations of “clear session” as the universal solution – experience required better recovery without session teardown

• Use
  • Expectations of topology maintenance – experience of traffic engineering
Why does BGP still work?

• It’s a Hop-by-Hop protocol
  • This allows new behaviours to be deployed on an incremental basis, as long as there is a “tunnelling” capability to pass through legacy speakers
    • A classic example is the 2-byte to 4-byte AS number transition in BGP

• It’s layered above a generic reliable stream transport
  • Arbitrary message sizes are supportable
  • No need to refresh sent information