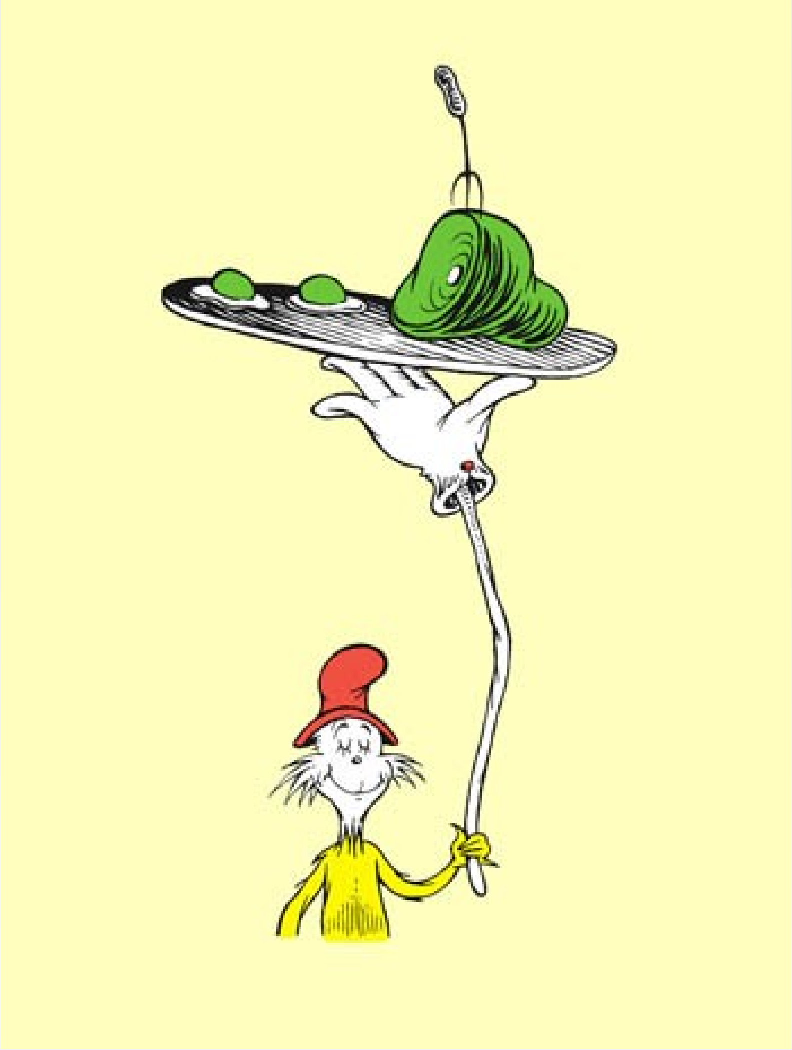
The guy



Like magic...


lots of hard work


mostly other peoples'
VFS layer
Kerberos & delegated
credential support
Samba generally

SambaXP Party

Samba4 WAFS Discourse

- The problem
- The solution
- Implementation
- All the other bits

The problem

- CIFS performs poorly over the internet
- Measureable in terms of:
  - # seconds to save a file
  - % idle bandwidth wasted
  - Low ROI on bandwidth investment
  - Users waste of even more time while waiting
  - Cost of WAFS solutions

The Causes

- Low bandwidth
- High latency
- Chattiness

Nigella Lawson chatting instead of book signing.

I'll bet there's a long queue moving slowly.

Bandwidth as a cause

Special antique low-bandwidth pen

- LAN link speeds: 10 - 1000 Mb/s
  - File transfer speeds 80 – 400Mb/s
- WAN link speeds: 300Kb/s – 10Mb/s
  - Up to 30 times slower

Bandwidth as a cause

- robot pen from coolest-gadgets.com
  - Will it help speed things up?

Latency as a cause

- LAN latency 2ms
  - Theoretical 500 requests per second
- WAN latency 50 – 100ms
  - Theoretical 10 – 20 requests per second
  - A process needing 500 requests takes 50 seconds
- WAN at least 25 – 50 times slower than LAN
- Taking message size into account

  means even slower due to lower bandwidth

Chattiness – the worst of both

- Most applications are synchronous
  - CIFS client waits for file to open before reading
  - Waits for read to finish before reading more
  - Repeated requests for the same meta-data
  - The problem can't be solved with a bigger pipe
- Chattiness / Poor CIFS pipelining
  - latency adds up
  - Under-utilisation of available bandwidth

Chattiness – the maths

- Request time
  - $SIZE_{request} / BW_{upstream} + LATENCY_{upstream}$
- Response time
  - $SIZE_{response} / BW_{downstream} + LATENCY_{downstream}$
- Total = $TIME_{request} + TIME_{response} + LATENCY_{server}$

Chattiness - examples

Request / Response		Size / bytes			
Count:	1000	Request:	64	Response:	4100

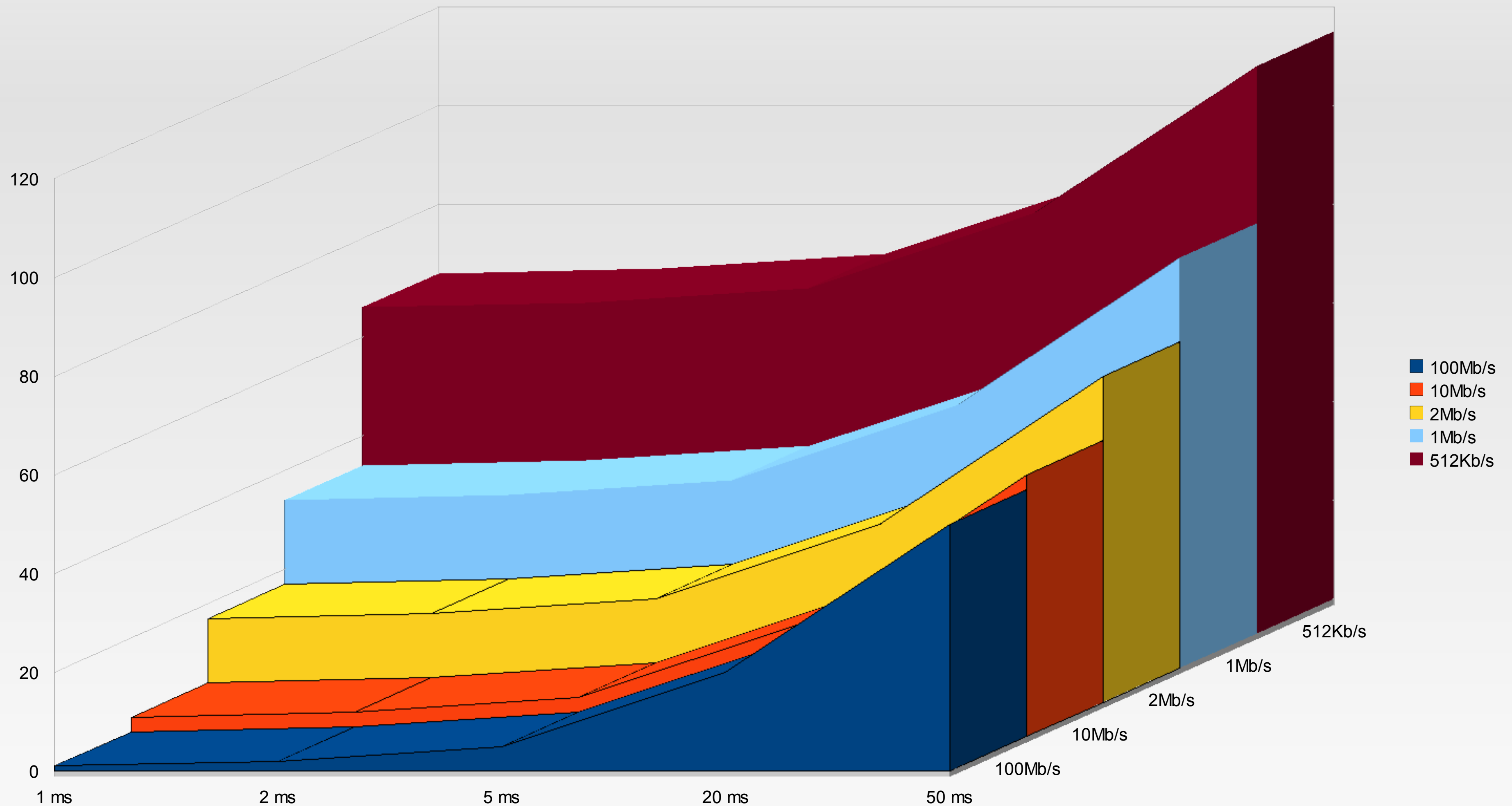
Combined total request response time in seconds

	Symmetric Link Bandwidth Kbit/s				
RTT/mS	***102400***	***10240***	***2048***	***1024***	***512***
1	1	4	17	34	66
2	2	5	18	35	67
5	5	8	21	38	70
20	20	23	36	53	85
50	50	53	66	83	115

At 50ms latency a bandwidth increase of 2,000% decreases load time to about 50%

More bandwidth doesn't help much!

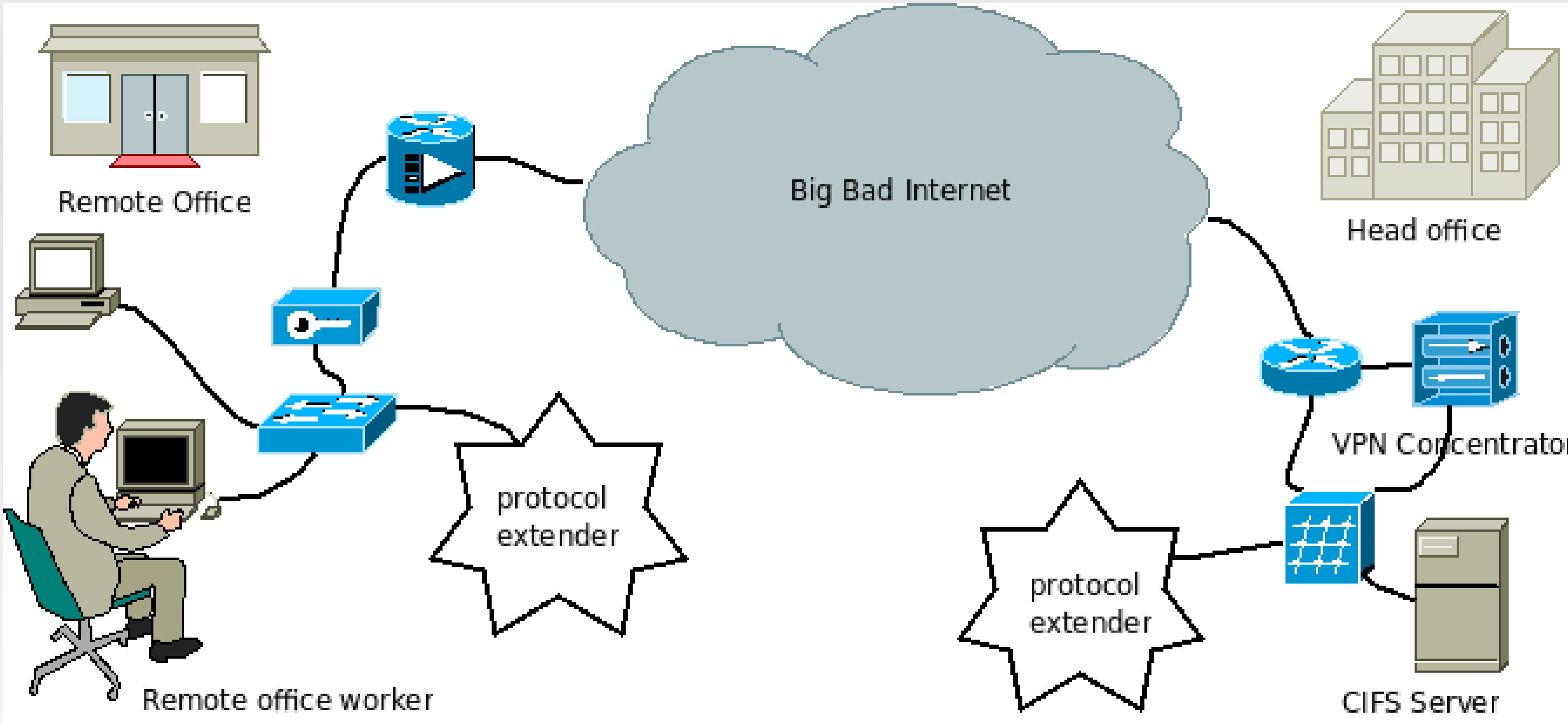
Chattiness – the graphs



The Solution

- Remove harms of chattiness
  - Of course!
- Reduce latency with read-ahead
- Reduce bandwidth demands with compression
  - Also reducing link contention

An opportunity



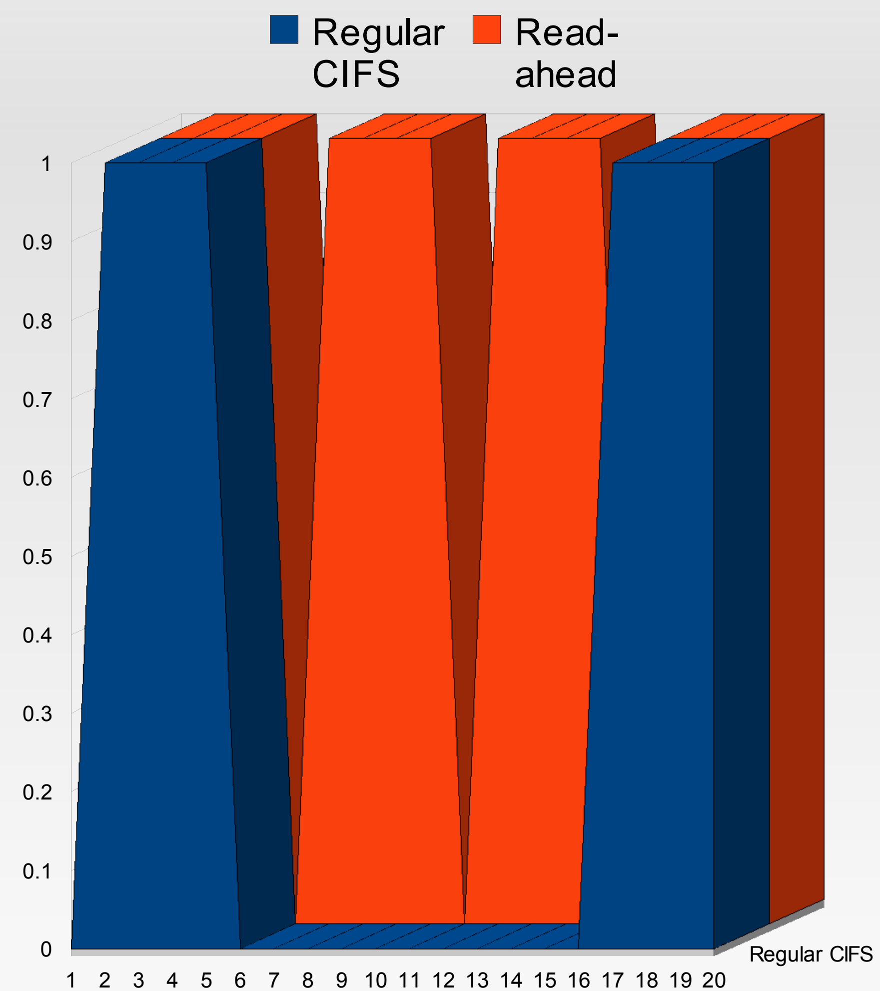
A device at each site to extend CIFS protocol

Read-ahead

- Done already, Jeeves?
- I trust that sir is satisfied?

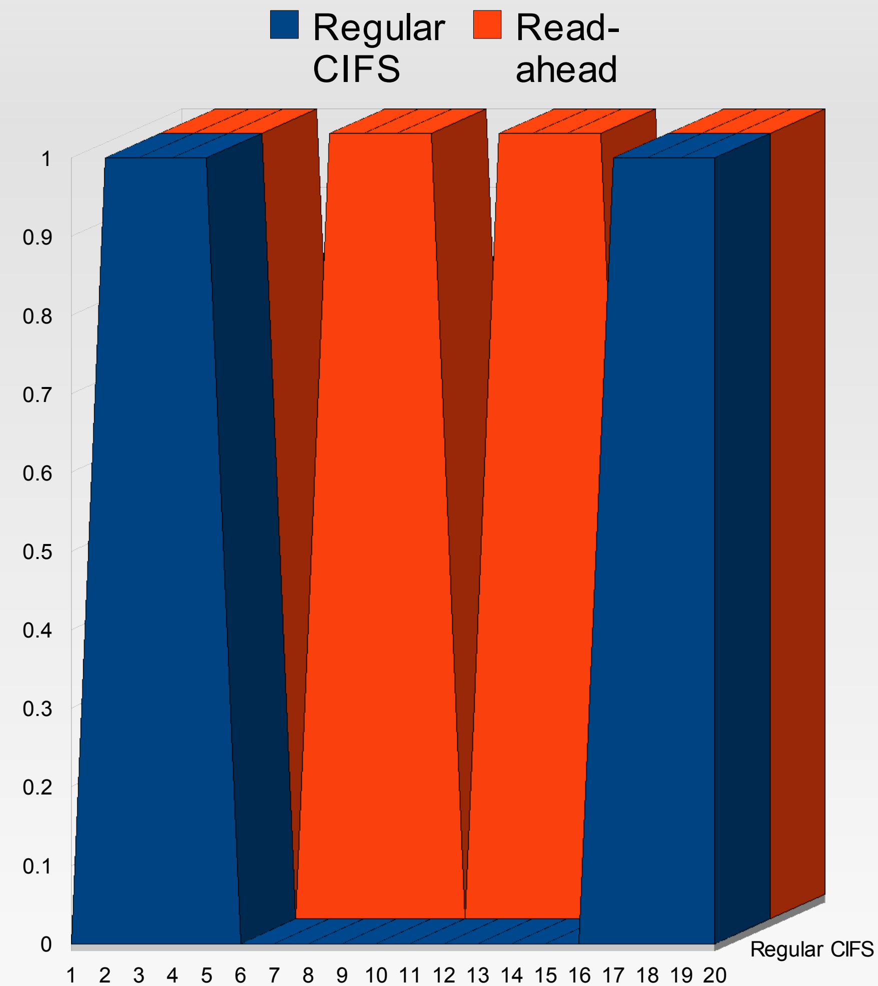
Read-ahead

- Abolish RTT latency
- Response processed before related request
- Read ahead by **RTT * bandwidth** to get link speed



Read-ahead

- File-read using full available bandwidth
- Latency still problem for folder browsing
- In early tests, read-ahead on a 600Kb/s ~50ms link reduced the time to read a file by 25%



Read-ahead latency improvement

- With read-ahead the new apparent LAN-side latency is effectively:
  - $SIZE_{request} / BW_{upstream} – LATENCY_{lan}$
- 500Kb/s =~ 500bits per millisecond
  - 4Kbyte response takes 65ms
  - With LAN latency of 2ms effective LAN latency is 63ms at LAN bandwidth

Read-ahead vs Latency

Request / Response		Size / bytes			
Count:	1000	Request:	64	Response:	4100

Combined total request response time in seconds

	Symmetric Link Bandwidth Kbit/s				
RTT/mS	***102400***	***10240***	***2048***	***1024***	***512***
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Reducing latency to LAN levels makes a BIG difference even at moderate bandwidth

Compression

- Increase effective bandwidth
- Zlib often gives 50% compression rates
- Custom dictionarys can give better compression

Read-ahead and Compression

Request / Response		Size / bytes			
Count:	1000	Request:	64	Response:	4100

Combined total request response time in seconds

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Compression and read-ahead make great savings of

67% off

LAN Speeds over the WAN

1. If the file is previously cached
2. If the cache can be cheaply validated on open

- Then READ operations are at
  - LAN speeds
  - LAN latency
- Validation-on-open strategy not simple
  - Avoid processing unwanted cache
  - Avoid extra latency on open

Caching

- Solves latency and bandwidth issues *entirely*
- Non-validated cache can help compression
  - MD5 to validate cache
  - Use cache contents as a dictionary
  - Unroll rsync / rdiff
  - Dynamic dictionary management

Caching-Compression

Request / Response		Size / bytes			
Count:	1000	Request:	64	Response:	4100

Combined total request response time in seconds

	Symmetric Link Bandwidth Kbit/s				
RTT/mS	***102400***	***10240***	***2048***	***1024***	***512***
[illegible]	1	[illegible]	[illegible]	34	66
2	2	5	18	35	67
5	5	8	21	38	70
20	20	23	36	53	85
50	50	53	66	83	115

Read from cache

Compress from cache

Zlib compress

Read-ahead

Caching and compression and read-ahead make great savings

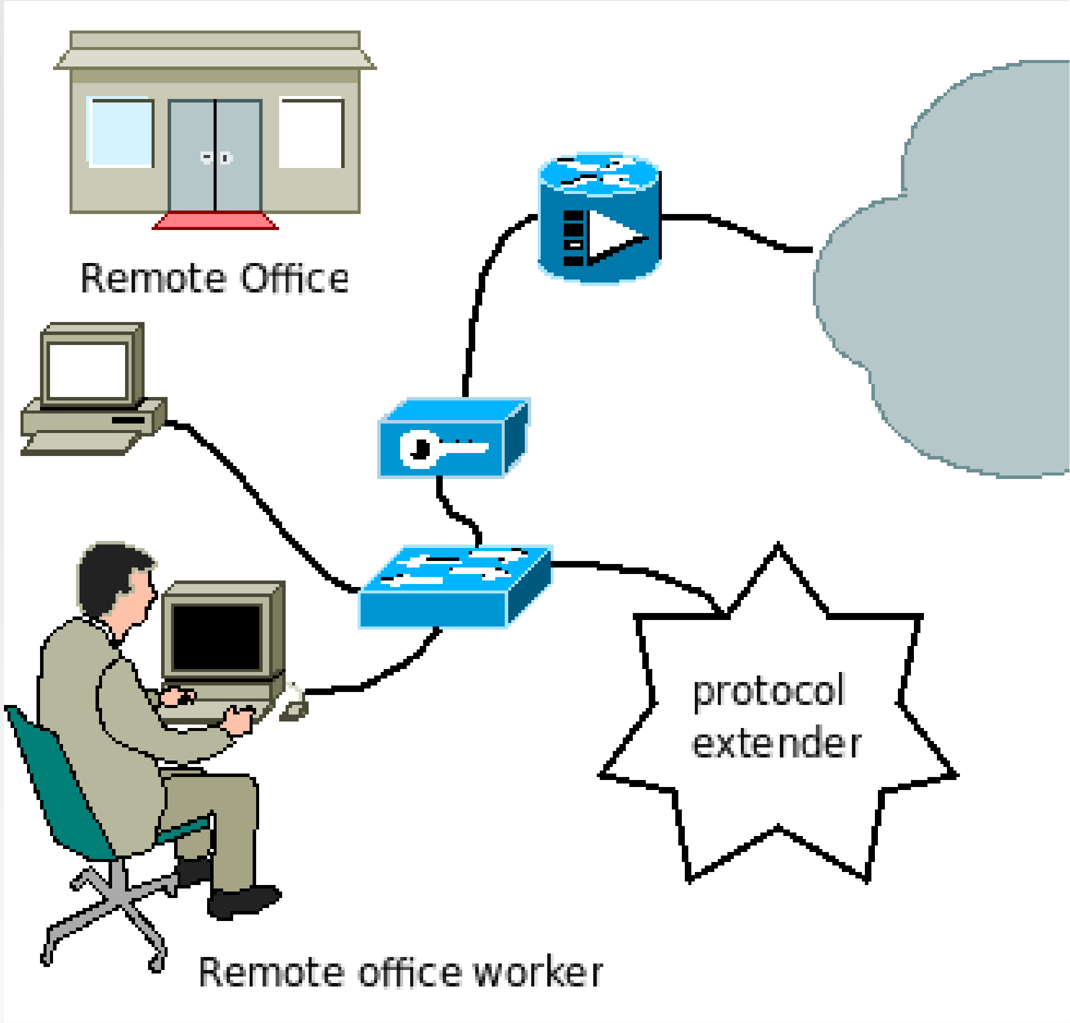
95% off

Cache Coherency

- A nasty headache, see Coda, Intermezzo, AFS
- Nobody wants to resolve conflicts anyway
- Oplocks and notifications to the rescue
- Cache validated while an oplock is held stays valid – well worth reading ahead in this case!
- Metadata can be cached when folder change notifications are registered – no more repeats
- All other requests to the server – but optimized

Other requirements

- Maintain user identity
  - ACL's
  - Permissions
  - Ownerships
  - Quotas
- Maintain locking
- Cache coherency



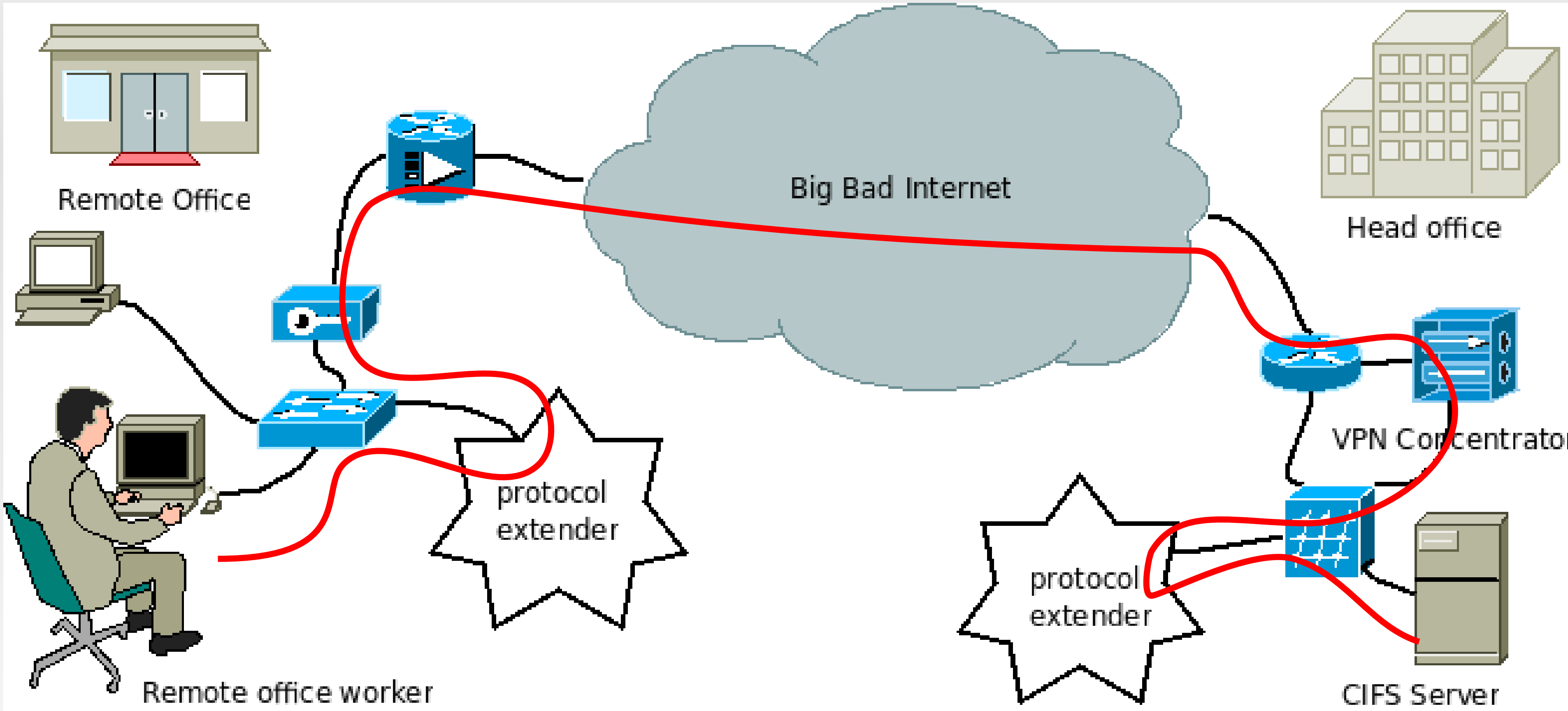
Samba4 platform benefits

- Samba4 maintains CIFS semantics
- Samba4 already has a CIFS proxy
- Samba4 integrates with AD trust system
- Kerberos supports delegated credentials
- Trust of proxies can be managed standard AD management tools or set when provisioning
- Proxies can read-ahead using users credentials
- There's a load of brains working on it already

Implementing the solution

- Based on Samba4 proxy module
- Keep caching engine seperate
- All reads requests consult a cache and validate from server where required
- All read responses stored in a cache
- Do writes hit the cache after completion?
  - What if a read comes in the meantime?
- Meta data can be cached too
- oplock breaks and notifications invalidate cache

Deployment and Provisioning



- Directly access shares from the proxy
  - Maybe DFS referrals could pick nearest proxy?

Implementing the solution

It all works together so well
in theory

Samba4 infrastructre

- Proof of concept very simple
- It's all there, it looked so easy right away
- Read-ahead and zlib easy to add to cifs_proxy
- Code was well structured so I didn't have to get to grips with all of it.
  - At first
- My first bug: oplock handling in cifs_proxy
  - Took 3 months to get patched - exciting

Multiple proxies

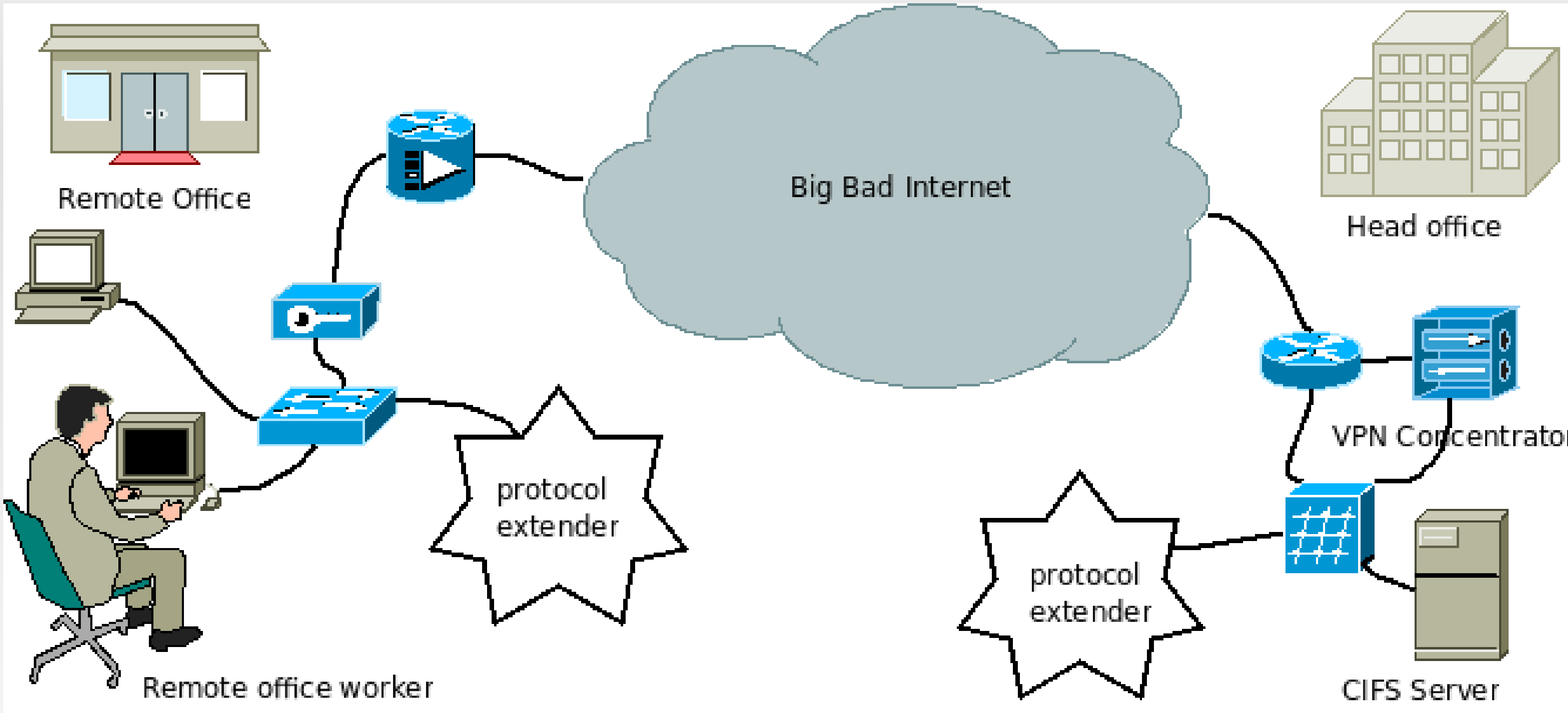
- Extend share definition to match called name

```
[\\proxy-alias\share]
```

- Use additional SPN's for each proxied server

```
[\\local-accounts\secret]
server=accounts.realm.net
share=top_secret$
[\\local-games]
server=games.realm.net
[*]
server=main.realm.net
```

Implementing the solution



0xACE

Proxy – Proxy Communication

- New opcode? New nttrans?
- New ntioctl – 0xACE
- Ioctl gives the option of implementing natively in windows server, so I'm told
- Use the dcerpc NDR code to marshall RPC
  - transport over ntioctl
    - which transports over nttrans
      - Which transports over SMB
        - Which transports over...

Lots of copying anyway!

How reads work

- Look for a pending read and attach to the callback handler as a read-fragment
- Read from cache and issue optimized reads
- Repeat until all *mincount* is satisfied
- Callback handlers re-assemble read buffer
- Make sure attached read-fragment isn't free'd by original caller before we've finished with it.
- Now I've got to stop excess simultanous reads!

Problems

- Client negotiates large write with proxy
  Server negotiates small writes with proxy
  Likewise for reads
  - Simple request proxying won't work
- Requires fragmenting reads and writes and collating results.
- What happens if a middle request fails?
- What happens if the server thinks we queued too many simultaneous fragments?

Attaching to existing requests

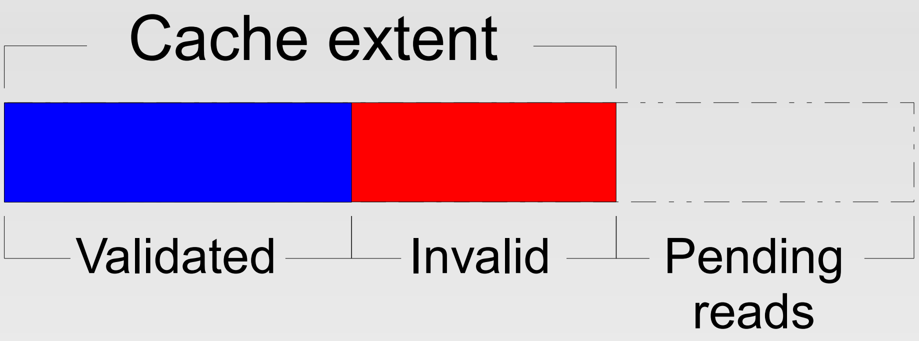
- talloc_referencing multiple handlers sticking onto each-others memory
- Changed whole async callback mechanism
- Callback chains to reverse map incoming responses – ntioctl, nttrans etc
- New meta-infrastructure that selects between proxy-proxy comms or proxy-server
- Will change again to avoid need for references

New callback mechanism

- Related calls typically use same smb_* struct
  Not any more!
- Related calls now have different encapsulations
  - smb_read as standard
  - proxy_read uses NDR / NTIOCL / NTTRANS
  - The encapsulator queue's a de-encapsulator
  - So the caller gets an unpacked struct
  - The first callback calls smb_receive()
- Sync or async have same handlers!

Simple cache

- Simple file-based linear extents
  - Length
  - Validated length
  - Pending length
- No holes in cache
- Cache key is user + server + share + path
- Delete random cache content when full



Better Cache management

- Ideally fragments should be selected based on reimen polynomials
  - rolling_checksum % frag_size_key == 0
- This could also be the fragment key
  - to avoid the birthday problem, we probably want to negotiate a unique key between all caches
- Per-user file cache becomes index of fragments
- Duplicate data is stored only once
- Delete low value content when full

The pain of the blessed Samba

- nttrans and ioctl had various bugs
  - multi-packet requests/responses
  - >64K requests responses
  - Is >64K ntioctl allowed? Dunno
- I wasn't wanting to have to fix these!
  - Forced acquaintance with code base and tools
- But at least I got 0xACE is my ntioctl
- Hope no-one else picks such a cool function id
  They might, it's so cool; agghhh

Pain of rejection

- No-one likes DLIST_FIND

```
#define DLIST_FIND(list, result, test) \
do { \
  for ((result) = (list); \
        (result) && !(test); \
        (result) = (result)->next); \
} while (0)
DLIST_FIND(thingy->list; item; item->id==id);
```

The joy of acceptance

- Poor-mans debug_ctx()
  Uses a DEBUG() scoped variable instead of a static variable.
  - Compatible with samba3 debug_ctx()
  - Wastes a lot of memory
  - Works without DEBUG being thread-safe

The joy of acceptance

- Fix large request fixups in receive.c
  - Were taking wrong affect on non AND_X requests
  - Allows >64K nttrans to be handled
- Fix OP_LOCK breaks on vfs_proxy
- smb_abort macro for talloc_get_type_abort
  - allows per-caller abort mechanism
- talloc_memdup_type also clones struct name

It works!

- Testers like it – saves time
  - I'm not lying
  - No longer feel let down or hurt by performance
  - Or give up and play around while waiting
  - Goodbye!