


# Optimizing Splunk Knowledge Objects

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splunk>

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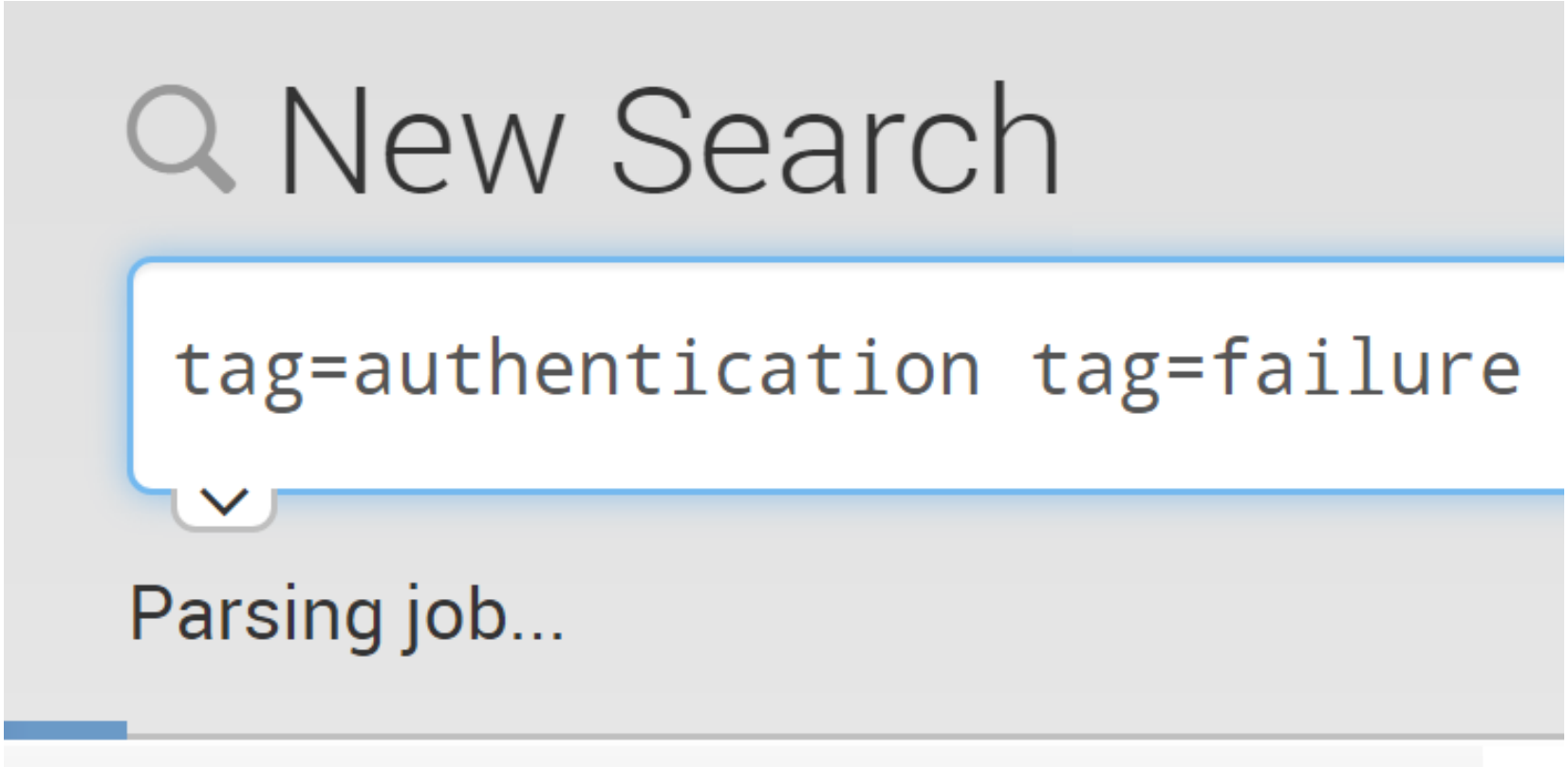
# Why are we here?



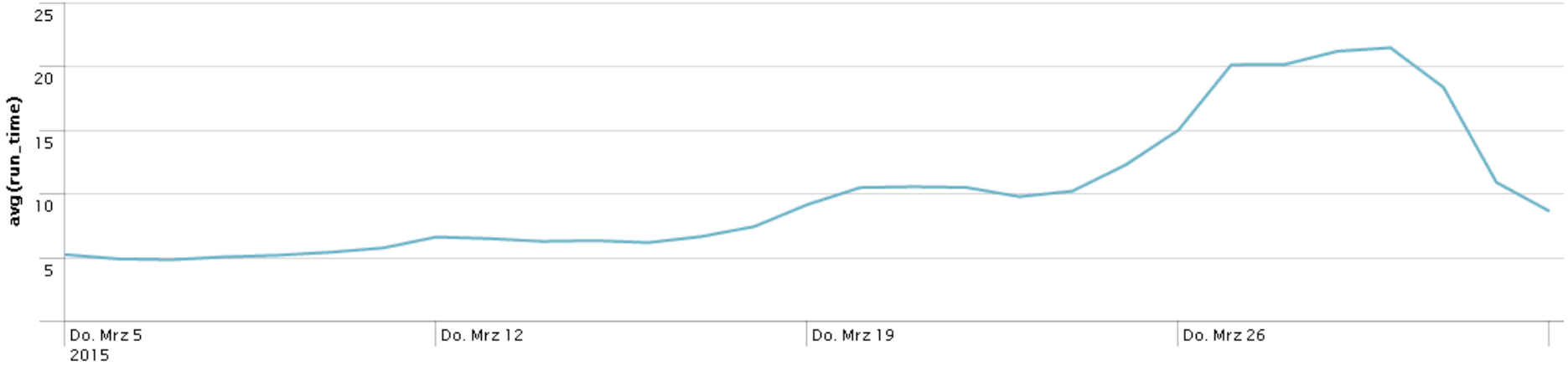
# Why are we here?

"Oversized litsearch is the largest performance problem we face in our environment."

*- Jacob Wilkins, General Electric*

# Why are we here?

- Observed search run time progression during development




- Massive growth in job startup time
- Knowledge Object optimization reduced that overhead by 80%

# Who‘s that guy?

- Professional Services Consultant, Certified Architect, Splunk-It-All
- Five years at EMEA Splunk Partner CONSIST Business Information Technology
- Heavy Splunker since 2012

- Get in touch with me: martin.mueller@consist.de
- Give karma at Splunk Answers: martin_mueller
- Hang in #splunk on Efnet: martin_m

# Session Objectives

- Understand how Splunk turns a search into results
- Learn how to recognize if you have a problem (Spoiler Alert: You do!)
- Use this to your advantage when specifying search-time knowledge

- Covered knowledge objects:
  - Fields
  - Reverse Lookups
  - Eventtypes
  - Tags


Let’s dive in…

splunk>

# …but first, to the Job Inspector!

- normalizedSearch: Ultra-verbose stage of search assembly

| normalizedSearch | litsearch index=_audit ( action=search OR ( sourcetype=audittrail ) ) \| litsearch index=_audit action=search \| fields keepcolorder=t "*" "_bkt" "_cd" "_si" "host" "index" "linecount" "source" "sourcetype" "splunk_server" |
|---|---|

- Performance stats, e.g. time spent assembling the normalizedSearch


- Links to search.log to look for more hidden performance hogs
- More at http://docs.splunk.com/Documentation/Splunk/latest/ Knowledge/ ViewsearchjobpropertieswiththeJobInspector


# Fields

# Calculated Fields (1)

- TA-splunk, props.conf: `[audittrail]`
  `EVAL-action=case(condN, valN, 1=1, action)`
- Splunk‘s assumption about looking for indexed tokens doesn‘t hold
- No way to translate the eval expression into tokens
- Plain Search: `index=_audit action=search`
  normalizedSearch: `index=_audit (action=search OR (sourcetype=audittrail))`
- Load all events for that stanza plus events with the token, filter later

# Calculated Fields (2)

- What if you're not searching for that sourcetype?
- ```
  index=_internal sourcetype=splunk*
    action=logout
  index=_internal sourcetype="splunk*"
   (action=logout OR (sourcetype=audittrail))
  ```
- Splunk expands each segment of your search on its own
- For each calculated field, add stanza to every search for that field
- This is only the beginning of normalizedSearch overhead!
  ```

# Field Aliases

- Sourcetype A has field `username`, sourcetype B has field `uid`, …
- Field aliases can normalize this to `user` over all sourcetypes
- `sourcetype=A user=martin` yields this normalizedSearch:

```
sourcetype=A (
  ((sourcetype=A) AND ((username=martin))) OR
  ((sourcetype=B) AND ((uid=martin))) OR
  ((sourcetype=audittrail) AND ((uid=martin)))
) OR (user=martin)
```

- All field aliases for all sourcetypes are used in all searches!

# A real-world example

- Splunk App for Enterprise Security 3.3.1
- The TAs shipped define 19 field aliases for `user`
- Your environment will have additional TAs
- Watch your normalizedSearch strings and search startup time grow

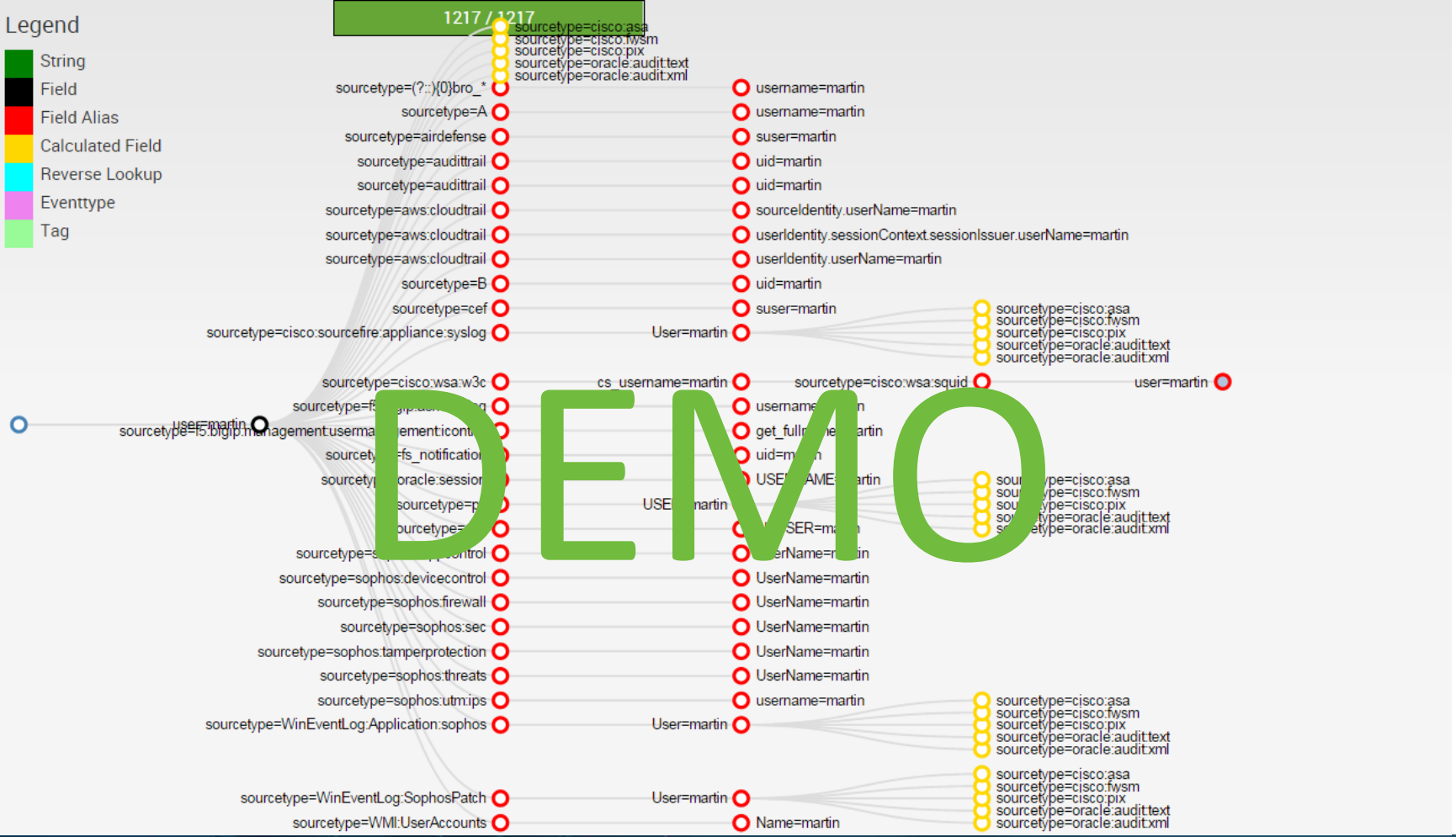
- Let‘s not forget the upside though: Without standardized field names, searching over different sourcetypes would be impossible
- Are you building a TA? Extract standardized field names directly!

# A real-world example

- Searching for `user=martin` yields 2kB of `normalizedSearch`:

```
((((sourcetype="*") AND ((username=martin))) OR ((sourcetype=A) AND ((username=martin))) OR
((sourcetype=B) AND ((uid=martin))) OR ((sourcetype="WMI:UserAccounts") AND ((Name=martin)))
OR ((sourcetype="WinEventLog:Application:sophos") AND ((User=martin))) OR
((sourcetype="WinEventLog:SophosPatch") AND ((User=martin))) OR ((sourcetype="WinEventLog:SophosDefense") AND
((suser=martin))) OR ((sourcetype=audittrail) AND ((uid=martin))) OR
((sourcetype="aws:cloudtrail") AND (("sourceIdentity.userName"=martin) OR
("userIdentity.sessionContext.sessionIssuer.userName"=martin) OR
("userIdentity.userName"=martin))) OR ((sourcetype=cef) AND ((suser=martin)) OR
((sourcetype="cisco:sourcefire:appliance:syslog") AND (User=martin))) OR
((sourcetype="cisco:wsa:w3c") AND ((cs_username=martin))) OR
((sourcetype="f5:bigip:asm:syslog") AND (username=martin))) OR
((sourcetype="f5:bigip:management:usermanagement:control") AND ((gt_fullname=martin))) OR
((sourcetype=fs_notification) AND ((uid=martin))) OR ((sourcetype="oracle:session") AND
((USERNAME=martin)) OR ((sourcetype=sav) AND ((USER=martin))) OR ((sourcetype=sav) AND
((LI_USER=martin))) OR ((sourcetype="sophos:appcontrol") AND ((UserName=martin))) OR
((sourcetype="sophos:devicecontrol") AND ((UserName=martin))) OR
((sourcetype="sophos:firewall") AND ((UserName=martin))) OR ((sourcetype="sophos:sec") AND
((UserName=martin))) OR ((sourcetype="sophos:tamperprotection") AND ((UserName=martin))) OR
((sourcetype="sophos:threat") AND ((UserName=martin))) OR ((sourcetype="sophos:utm:ips") AND
((username=martin))) OR (user=martin) OR (sourcetype="cisco:asa") OR
(sourcetype="cisco:fwsm") OR (sourcetype="cisco:pix") OR (sourcetype="oracle:audit:text") OR
(sourcetype="oracle:audit:xml"))
```

NOT PRETTY!


Legend
String
Field
Field Alias
Calculated Field
Reverse Lookup
Eventtype
Tag
1217 / 1217
sourcetype=cisco:asa
sourcetype=cisco:fwsm
sourcetype=cisco:pix
sourcetype=oracle:audit:text
sourcetype=oracle:audit:xml
sourcetype=(?::){0}bro_*
sourcetype=A
sourcetype=airdefense
sourcetype=audittrail
sourcetype=audittrail
sourcetype=aws:cloudtrail
sourcetype=aws:cloudtrail
sourcetype=aws:cloudtrail
sourcetype=B
sourcetype=cef
sourcetype=cisco:sourcefire:appliance:syslog
sourcetype=cisco:wsa:w3c
user=martin
sourcetype=f5:bigip:management:usermanagement:icont
sourcetype=fs_notification
sourcetype=oracle:session
sourcetype=sophos:devicecontrol
sourcetype=sophos:firewall
sourcetype=sophos:sec
sourcetype=sophos:tamperprotection
sourcetype=sophos:threats
sourcetype=sophos:utm:ips
sourcetype=WinEventLog:Application:sophos
sourcetype=WinEventLog:SophosPatch
sourcetype=WMI:UserAccounts
username=martin
username=martin
suser=martin
uid=martin
uid=martin
sourceIdentity.userName=martin
userIdentity.sessionContext.sessionIssuer.userName=martin
userIdentity.userName=martin
uid=martin
suser=martin
User=martin
cs_username=martin
username=martin
get_full
uid=m
USE
USE martin
UserName=martin
UserName=martin
UserName=martin
UserName=martin
UserName=martin
username=martin
User=martin
User=martin
Name=martin
sourcetype=cisco:asa
sourcetype=cisco:fwsm
sourcetype=cisco:pix
sourcetype=oracle:audit:text
sourcetype=oracle:audit:xml
sourcetype=cisco:wsa:squid
user=martin
DEMO

# Fields Recap

- Each search segment is expanded on its own without context
- props.conf for one sourcetype will radiate into normalizedSearch of other sourcetypes when field names match

- Avoid calculated fields and field aliases entirely where possible
  - Extract fields using standardized names in the first place!
  - Some calculated fields can be replaced with lookups
- Monitor their effects where unavoidable
- Both are fine for fields you only use as output


# Reverse Lookups

splunk>

# How reverse lookups work

- Automatic lookup in props.conf: `[splunk_web_access]`
  `LOOKUP-ul = user_location user OUTPUT location`
- Reverse lookup: Search for `location` rather than `user`:
  `index=_internal location="Las Vegas"`
- Splunk translates that into this normalizedSearch:

```
index=_internal
(((sourcetype=splunk_web_access) AND
  ((user=Martin) OR (user=Tom))
)) OR (location="Las Vegas")
```

# Actually, I lied…

```
index=_internal (((sourcetype=splunk_web_access) AND
((((((sourcetype=A) AND ((username=Martin))) OR
    ((sourcetype=B) AND ((uid=Martin))) OR
    ((sourcetype=audittrail) AND ((uid=Martin)))) OR
(user=Martin))) OR
 ((((((sourcetype=A) AND ((username=Tom))) OR
    ((sourcetype=B) AND ((uid=Tom))) OR
    ((sourcetype=audittrail) AND ((uid=Tom)))) OR
(user=Tom)))))) OR (location="Las Vegas")
```

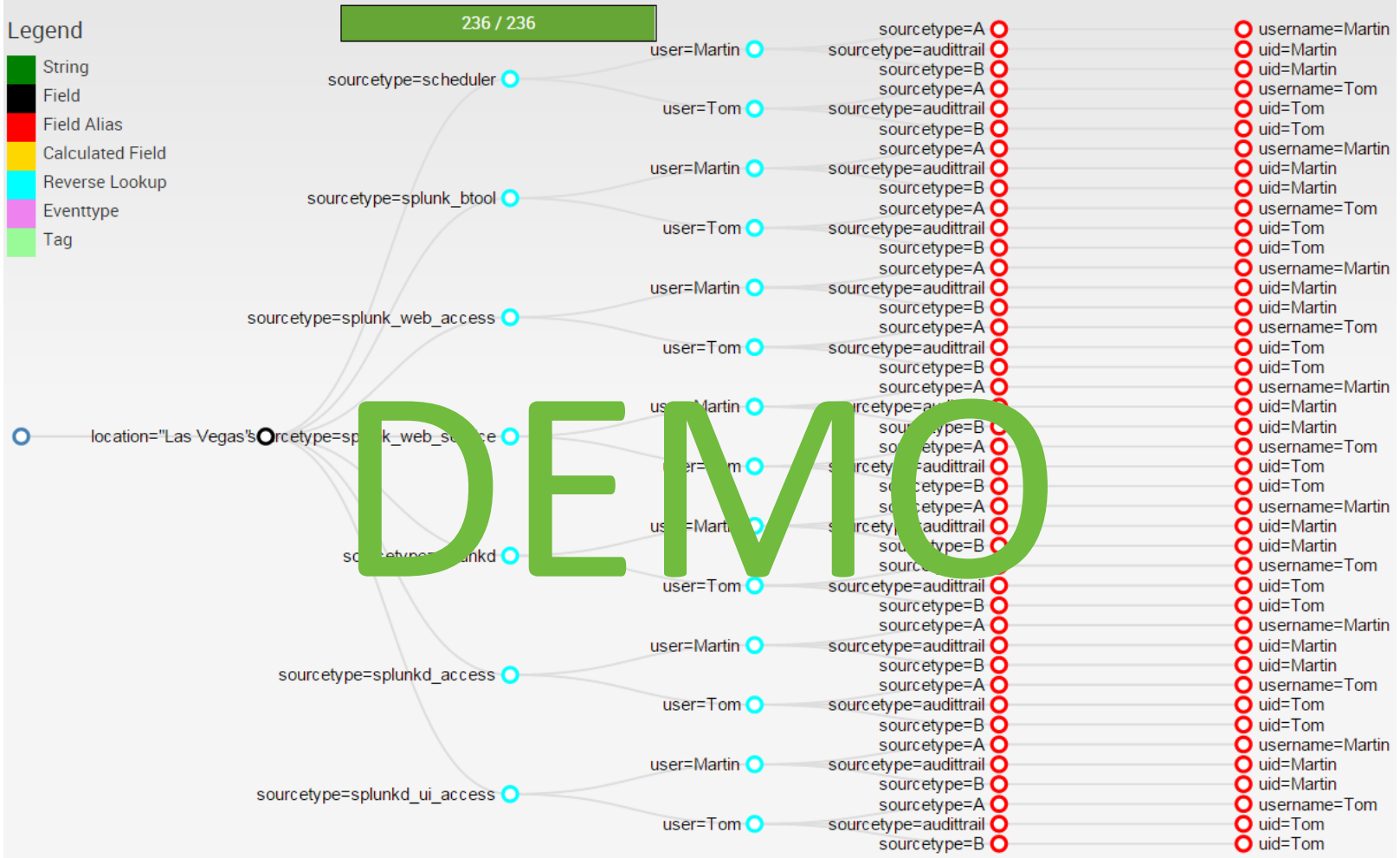
- Despite defining the lookup on `splunk_web_access`, other sourcetypes' props.conf settings radiate into this search

# Expanding to more sourcetypes

- Splunk's _internal index has seven sourcetypes with a `user` field

```
index=_internal (((sourcetype=scheduler) AND ((((((sourcetype=A) AND ((username=Martin))) OR ((sourcetype=B) AND
((uid=Martin))) OR ((sourcetype=audittrail) AND ((uid=Martin)))) OR (user=Martin))) OR (((((sourcetype=A) AND
((username=Tom))) OR ((sourcetype=B) AND ((uid=Tom))) OR ((sourcetype=audittrail) AND ((uid=Tom)))) OR (user=Tom)))))
OR ((sourcetype=splunk_btool) AND ((((((sourcetype=A) AND ((username=Martin))) OR ((sourcetype=B) AND ((uid=Martin))))
OR ((sourcetype=audittrail) AND ((uid=Martin)))) OR (user=Martin))) OR (((((sourcetype=A) AND ((username=Tom))) OR
((sourcetype=B) AND ((uid=Tom))) OR ((sourcetype=audittrail) AND ((uid=Tom)))) OR (user=Tom))))) OR
((sourcetype=splunk_web_access) AND ((((((sourcetype=A) AND ((username=Martin))) OR ((sourcetype=B) AND
((uid=Martin))) OR ((sourcetype=audittrail) AND ((uid=Martin)))) OR (user=Martin))) OR (((((sourcetype=A) AND
((username=Tom))) OR ((sourcetype=B) AND ((uid=Tom))) OR ((sourcetype=audittrail) AND ((uid=Tom)))) OR (user=Tom)))))
OR ((sourcetype=splunk_web_service) AND ((((((sourcetype=A) AND ((username=Martin))) OR ((sourcetype=B) AND
((uid=Martin))) OR ((sourcetype=audittrail) AND ((uid=Martin)))) OR (user=Martin))) OR (((((sourcetype=A) AND
((username=Tom))) OR ((sourcetype=B) AND ((uid=Tom))) OR ((sourcetype=audittrail) AND ((uid=Tom)))) OR (user=Tom)))))
OR ((sourcetype=splunkd) AND ((((((sourcetype=A) AND ((username=Martin))) OR ((sourcetype=B) AND ((uid=Martin))) OR
((sourcetype=audittrail) AND ((uid=Martin)))) OR (user=Martin))) OR (((((sourcetype=A) AND ((username=Tom))) OR
((sourcetype=B) AND ((uid=Tom))) OR ((sourcetype=audittrail) AND ((uid=Tom)))) OR (user=Tom))))) OR
((sourcetype=splunkd_access) AND ((((((sourcetype=A) AND ((username=Martin))) OR ((sourcetype=B) AND ((uid=Martin)))
OR ((sourcetype=audittrail) AND ((uid=Martin)))) OR (user=Martin))) OR (((((sourcetype=A) AND ((username=Tom))) OR
((sourcetype=B) AND ((uid=Tom))) OR ((sourcetype=audittrail) AND ((uid=Tom)))) OR (user=Tom))))) OR
((sourcetype=splunk_ui_access) AND ((((((sourcetype=A) AND ((username=Martin))) OR ((sourcetype=B) AND
((uid=Martin))) OR ((sourcetype=audittrail) AND ((uid=Martin)))) OR (user=Martin))) OR (((((sourcetype=A) AND
((username=Tom))) OR ((sourcetype=B) AND ((uid=Tom))) OR ((sourcetype=audittrail) AND ((uid=Tom)))) OR
(user=Tom)))))) OR (location="Las Vegas")
```

NOT PRETTY!


Legend
String
Field
Field Alias
Calculated Field
Reverse Lookup
Eventtype
Tag
236 / 236
location="Las Vegas"
sourcetype=scheduler
sourcetype=splunk_btool
sourcetype=splunk_web_access
sourcetype=splunkd_access
sourcetype=splunkd_ui_access
user=Martin
user=Tom
sourcetype=A
sourcetype=audittrail
sourcetype=B
username=Martin
username=Tom
uid=Martin
uid=Tom
DEMO

# A location with more than two users?

- 50 users produce a 72kB normalizedSearch that broke PowerPoint
- Noticeable overhead during `Parsing Job...` phase


- That‘s with three field aliases and no calculated fields – imagine 20+!

- Above 50 values per lookup Splunk will revert to „classic“behavior: Load all events, filter later

# Mitigation strategies (1)

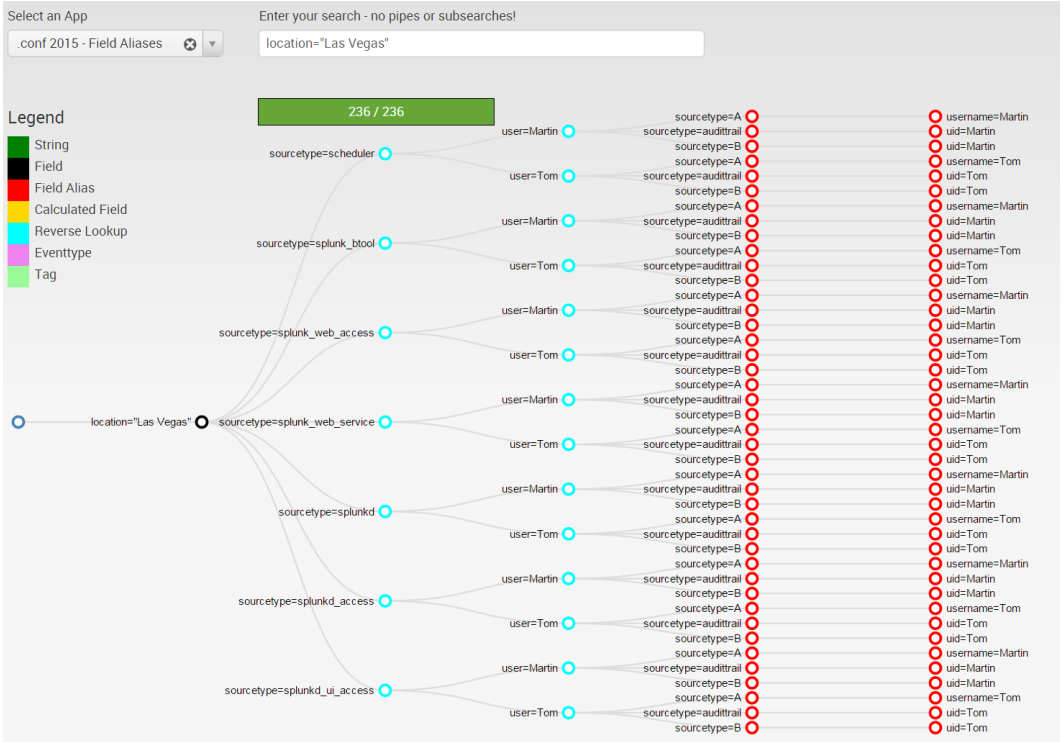
- Subsearch using inputlookup
  index=_internal [inputlookup user_location | search location="Las Vegas" | fields user]
- ✅ Removes the per-sourcetype duplication
- ✅ Lets you choose between reverse lookups and *classic* behavior
- ⚠ Ignores the configured knowledge per sourcetype
- ⚠ More effort required to write and maintain searches
- ⚠ Not eventtype-compatible
- ⚠ Subsearch overhead

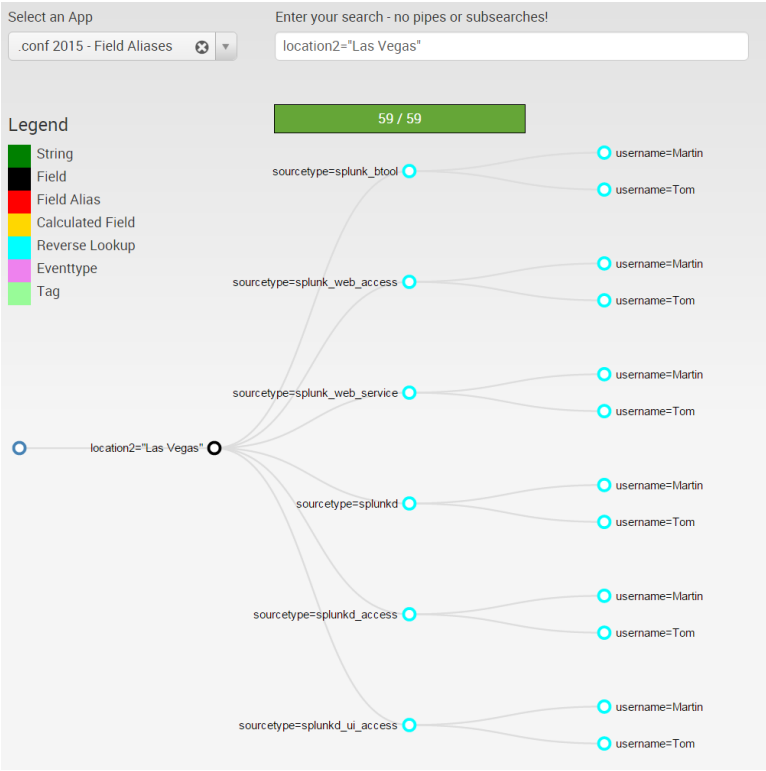
# Mitigation strategies (2)

- Define the per-sourcetype automatic lookup using sourcetype-specific **input** fields

```
LOOKUP-ul = user_location user AS username
OUTPUT location
```

- ✓ Removes the per-alias duplication
- ✓ Transparent to the search and user
- ⚠ More effort required to write and maintain knowledge objects
- ⚠ Retains the per-sourcetype duplication




Removed 80% of key-value pairs from the normalizedSearch!

# Mitigation strategies (3)

- Define the per-sourcetype automatic lookup using sourcetype-specific **output** fields

```
LOOKUP-ul = user_location user OUTPUT location
AS sourcetype_location
```

- ✓ Removes the per-sourcetype duplication
- ⚠ Not transparent at all
- ⚠ More effort required to write and maintain knowledge objects
- ⚠ Only really viable if hidden behind eventtypes and/or tags
- ⚠ Retains the per-alias duplication

# Mitigation strategies (4)

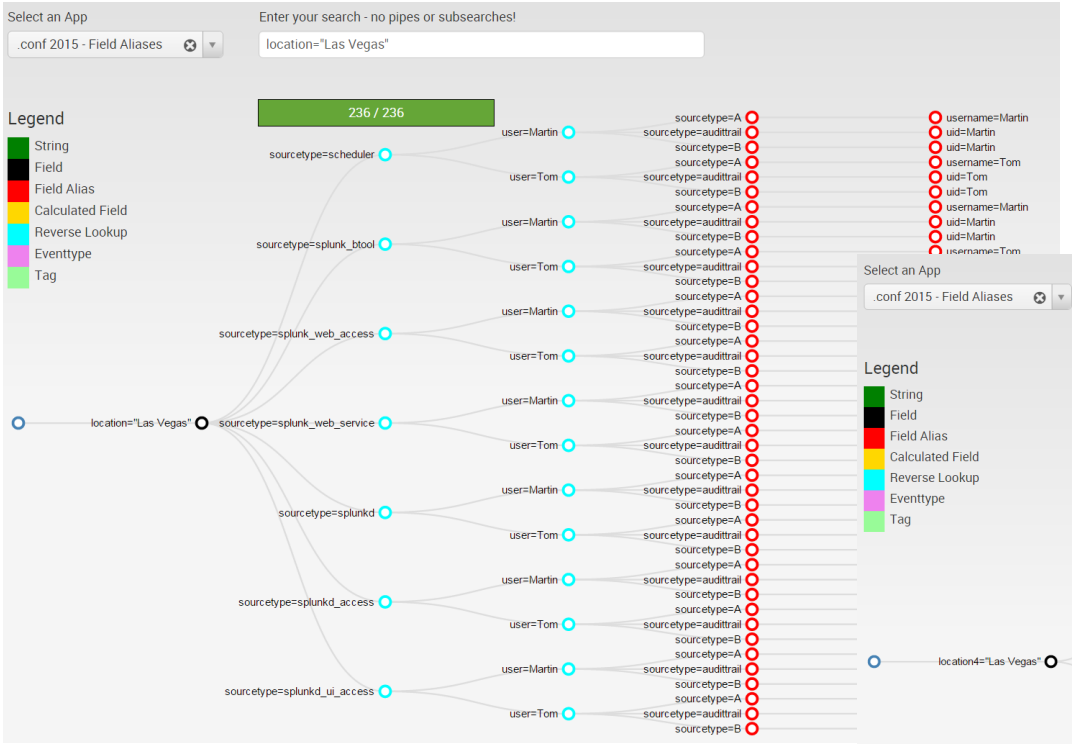
- Replace per-sourcetype lookups with broader props.conf stanzas
- Wildcards on source or host
  `[source::*access.log*]`
- Unofficial: Wildcards on sourcetype
  `[(?::){0}splunk*]`

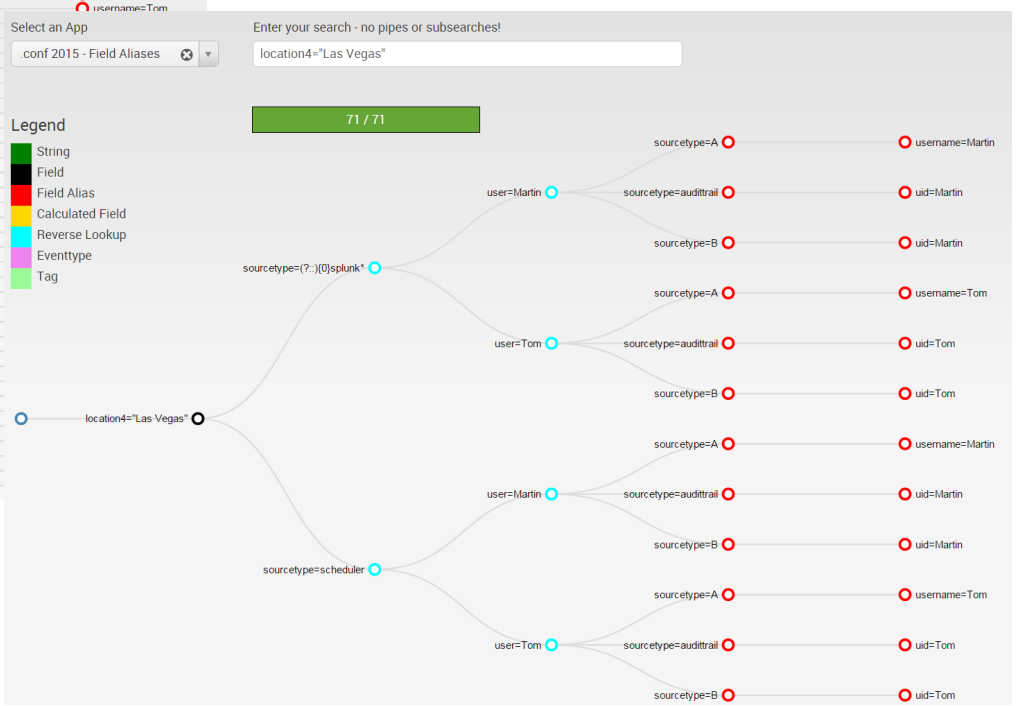
✓ Removes the per-sourcetype duplication

✓ Transparent to the search and user

⚠ Sourcetype wildcards are neither documented nor supported

⚠ Retains the per-alias duplication




70% key-value pair reduction!

# Indexed tokens footnote

- The normalizedSearch generated by reverse lookups can be efficient:

```
index=_internal location="Las Vegas"
index=_internal
(((sourcetype=splunk_web_access) AND
  ((user=Martin) OR (user=Tom))
)) OR (location="Las Vegas")
```

- But: Splunk is looking for a literal `location="Las Vegas"`!
- Watch out for `location=0` or similar values that aren‘t unique-ish
- This can blow up your scanCount and search duration
- More on dealing with indexed tokens after the end of the deck


# Eventtypes

# How eventtypes work

- Store a search filter or fragments thereof in a reusable box
- No pipes, no subsearches
- Run search and see `searchCanBeEventType` in Job Inspector
- `eventtype=foo` expands to the stored search fragment
- `eventtype=f*` expands to an `OR`'d list of matching eventtypes
- Events that match an eventtype have their `eventtype` field set, regardless of whether the eventtype was used in the search or not

# What are eventtypes good at?

- Two different systems likely don‘t log login attempts the same way
- Define eventtypes for each system, search on eventtypes
  - Tag your eventtypes and search on tags
- Configured knowledge simplifies searches
- Great way to hide complexity from the searcher
- Add systems to existing searches without touching searches
- Even when not searching on eventtypes, looking at the `eventtype` field helps quickly understand results

# Splunk login example

- TA-splunk, eventtypes.conf: `[splunk_access]`
  `search = index=_audit "action=login attempt" NOT "action=search"`
  normalizedSearch: `((index=_audit "action=login attempt" NOT "action=search"))`
- Note how Splunk chose not to use `action="login attempt"`!
- Avoids the wrath of calculated fields and aliases in the search
- Search relies on structure of raw events instead of field extractions
- The results contain the CIM-compatible `action` regardless


# Tags

# How tags work

- Give a set of `field=value` pairs a common name
- No wildcarded `field=v*`
  - can be worked around with tagged eventtypes
- `tag=foo` expands to the list of `field=value` pairs individually
- `tag=f*` expands to an `OR`'d list of matching tags
- Events that match a tag have their `tag` field set accordingly
- For each tagged `field`, additionally set `tag::field` field

# What are tags good at?

- Homogenize system-specific values to allow unified searches
- Great in combination with eventtypes:
  - Eventtypes define system-specific searches
  - Tags on those eventtypes provide a common interface
  - Searches on those tags don‘t need to know the systems particularly well
- Also great in combination with normalized field names and values
  - The unified searches find events over many systems
  - The returned results also provide homogenous data back to you
- That‘s the Splunk Common Information Model in a nutshell
- Further reading at http://docs.splunk.com/Documentation/CIM

# Splunk login example

- TA-splunk, tags.conf: `[eventtype=splunk_access]`
  `application = enabled`
  `authentication = enabled`
- The search `tag=application tag=authentication` yields
  `(((index=_audit "action=login attempt" NOT "action=search"))) (((index=_audit "action=login attempt" NOT "action=search")))`
- The eventtype is included twice!

# How tags really work

- Search for `tag=application tag=authentication`
- Splunk won‘t look for `field=value` pairs matching both tags
- Splunk will treat the search like this:
  `(tag=application) (tag=authentication)`
- Each tag is expanded individually
- `field=value` pairs will be included once per matching tag
- This can lead to even larger normalizedSearch strings!

# A real-world example

- Splunk_TA_Oracle defines a handful of tagged eventtypes
- Four match `tag=database tag=instance tag=stats`
- Expanding each tag on its own yields sixteen eventtypes!
- Every TA is influenced by every other TA: „Tag Expansion Explosion“

# Mitigation Strategies

- Avoid long lists of tags mapping to the same `field=value`
  - Especially with eventtypes and reverse lookups
- Use distributive properties to reduce tag-eventtype redundancy
  - Instead of tagging every Splunk eventtype with `application`, consider tagging `sourcetype`, `host`, etc. with `application`
  - Instead of tagging special eventtypes for admin users with `privileged`, consider tagging those users or a reverse lookup field identifying them
- Look for what actually defines the tag in the real world
- Charm Splunk into optimizing how tags are expanded ☺


# Wrapping up

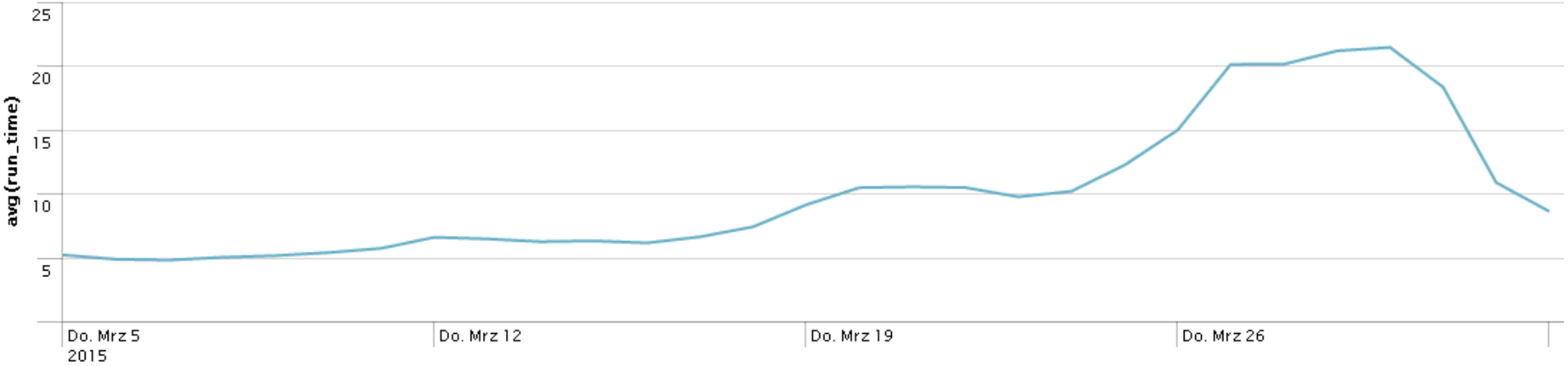
splunk>

# Dos and Don‘ts

- ⚠ Don‘t stop using field aliases, calculated fields, reverse lookups, etc.
- ⚠ Don‘t compromise maintainability for small gains

- ✔ Do take a good look at your environment
- ✔ Do identify and improve real performance hogs
- ✔ Do scope knowledge object sharing as narrowly as possible
- ✔ Do clean up unused knowledge objects and TAs
- ✔ Do keep monitoring as your knowledge object world grows

# Q&A


avg(run_time)
25
20
15
10
5
Do. Mrz 5
2015
Do. Mrz 12
Do. Mrz 19
Do. Mrz 26

# What Now?

Related breakout sessions and activities…

- You have access to your Splunk at .conf? Talk to me for a quick look!
- Grab the app: https://splunkbase.splunk.com/app/2871

- Duane & George: Beyond the Lookup Glass (Tuesday)
- Amrit & Jag: How splunkd Works (Tuesday)
- Duncan & Julian: Search Efficiency Optimization (Tuesday)
- Niklas: How to use CIM to Gain Security Awareness (Wednesday)
- Dritan: Notes on Optimizing Splunk Performance (later today!)


# THANK YOU

splunk>


# Fields: Optimizations Beyond Litsearch

splunk>

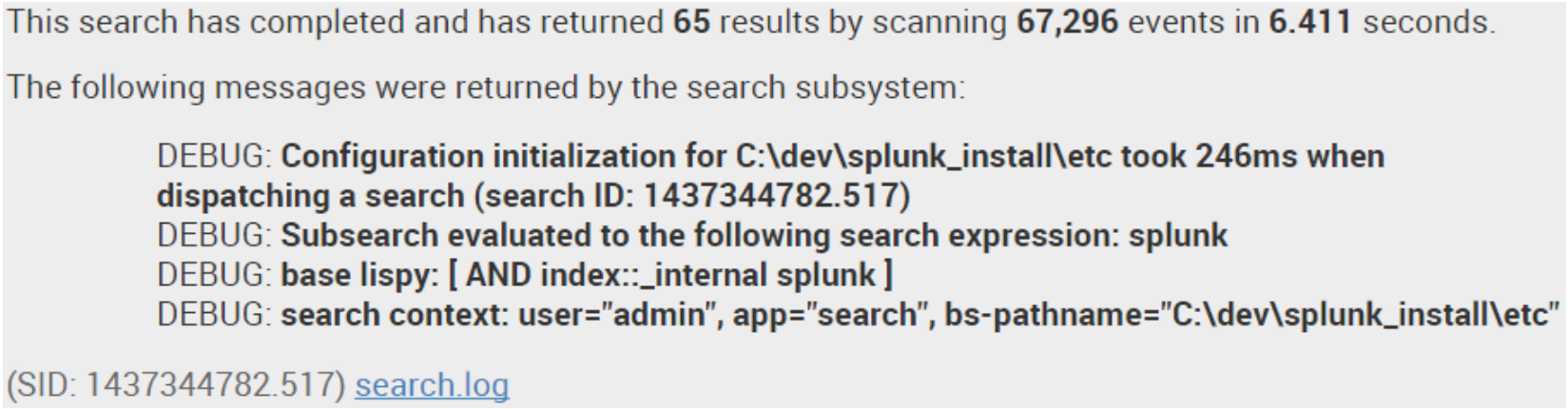
# Fields

"Let all values be indexed tokens, for indexed tokens power fast searches."

*- Splunk, late 2000s*

# Job Inspector continued

- base lispy: How did Splunk crawl its index for events?
- eventCount / scanCount: How efficient was the lispy-induced crawl?




- limits.conf: `[search_info] infocsv_log_level=DEBUG`

# How Splunk searches for field values (1)

```
index=_internal group=tpool
```

- Assume a field value is present as indexed tokens
- Load events containing those indexed tokens anywhere

```
[ AND index::_internal tpool ]
```

- Apply field extractions and filter again

```
07-21-2015 22:42:52.662 +0200 INFO Metrics -
group=tpool, name=indexertpool, qsize=0, ...
```

- Job Inspector: scanCount ≈ eventCount

# How Splunk searches for field values (2)

```
index=_internal qsize=0
[ AND index::_internal 0 ]
```

- Splunk returns the same event, but takes ages!

```
07-21-2015 22:42:52.662 +0200 INFO Metrics -
group=tpool, name=indexertpool, qsize=0, ...
```

| | |
|---|---|
| eventCount | 18225 |
| scanCount | 509781 |

- Default assumption works great iff field values are unique-ish

# Key-Value Tricks (1)

```
index=_internal qsize qsize=0
[ AND index::_internal qsize 0 ]
```

- Take advantage of default key-value field extractions

```
07-21-2015 22:42:52.662 +0200 INFO Metrics -
group=tpool, name=indexertpool, qsize=0, ...
```

| | |
|---|---|
| eventCount | 18225 |
| scanCount | 18691 |

- Flexible, zero-config speed-up that requires smart searchers!

# Key-Value Tricks (2)

- Move inline optimization to fields.conf

```
[qsize]
INDEXED_VALUE=[AND qsize <VALUE>]
```

- Adds the extra token `qsize`, whether the searcher likes it or not

```
index=_internal qsize=0
[ AND index::_internal qsize 0 ]
```

- fields.conf applies to **all** fields of that name, regardless of sourcetype
- This can break for multi-token values!

# Key-Value Tricks (3)

- Take it further and assemble longer tokens

```
[qsize]
INDEXED_VALUE=qsize=<VALUE>
```

- Rule out events with `qsize!=0` that contain a `0` elsewhere

```
index=_internal qsize=0
[ AND index::_internal qsize=0 ]
```

- This will even break for events with `qsize="0"` (major breaker)
- Be sure you know your data before fiddling with fields.conf!

# Wildcards (1)

- Splunk will only use indexed tokens for prefixes of wildcarded values
- `index=_internal component=`**`BucketMove*`**
  `[ AND index::_internal `**`bucketmove*`**` ]`
- `index=_internal component=*ucketMover`
  `[ AND index::_internal ]`
- Oops!

`07-21-2015 22:41:22.999 +0200 INFO `**`BucketMover`**` - idx=main Moving bucket=…`

# Wildcards (2)

- Force Splunk to use indexed tokens
- `index=_internal component=TERM(*ucketMover) [ AND index::_internal **\*ucketmover** ]`
- Much faster than loading all events, but there's a penalty for crawling the index without a prefix!


- fields.conf to remove the `TERM()` from all searches

```
[component]
INDEXED_VALUE=<VALUE>
```

# Fields Recap (Part 2)

- Indexed tokens are king
- scanCount performance hit when indexed tokens can‘t be used
- fields.conf optimizations can fix performance, but can break results