Business Process Mining and Conformance

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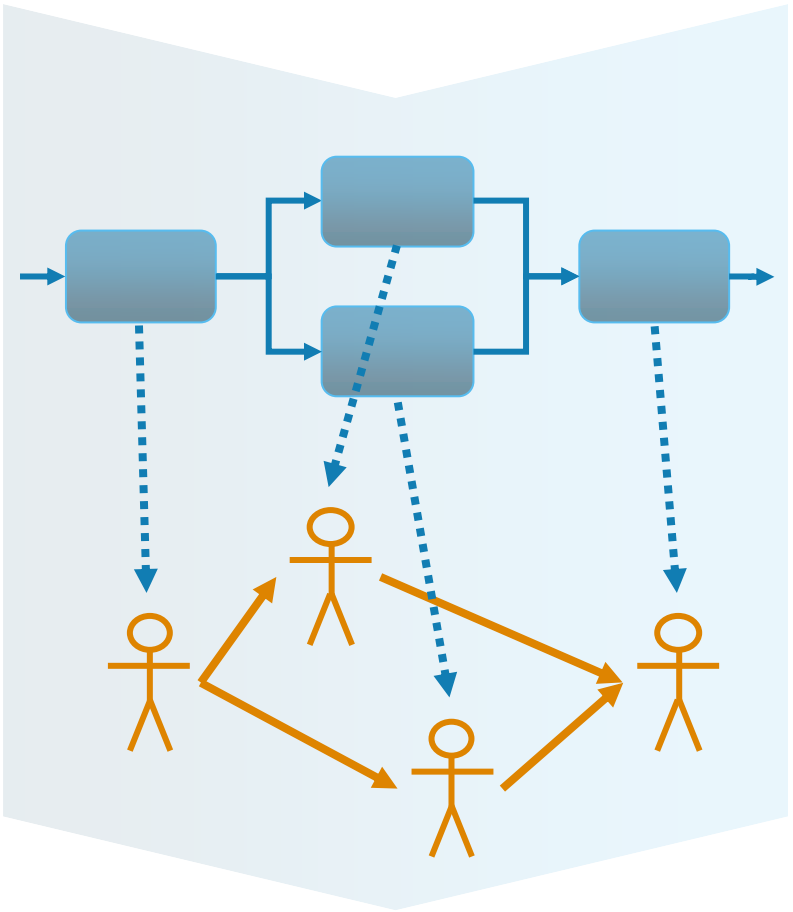
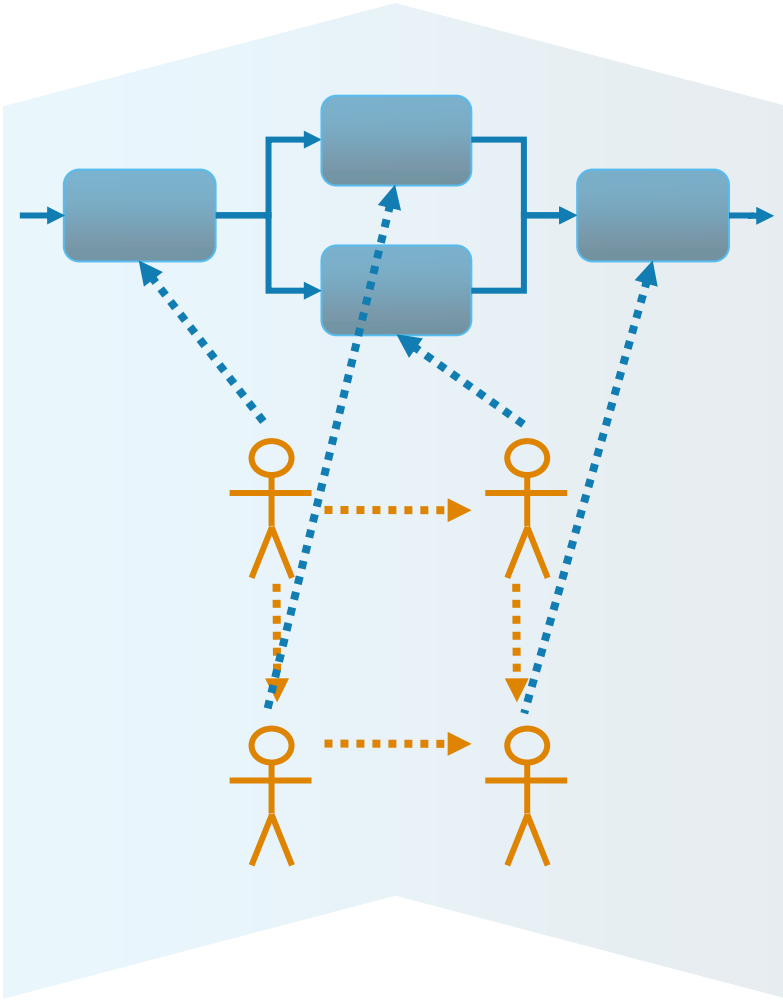
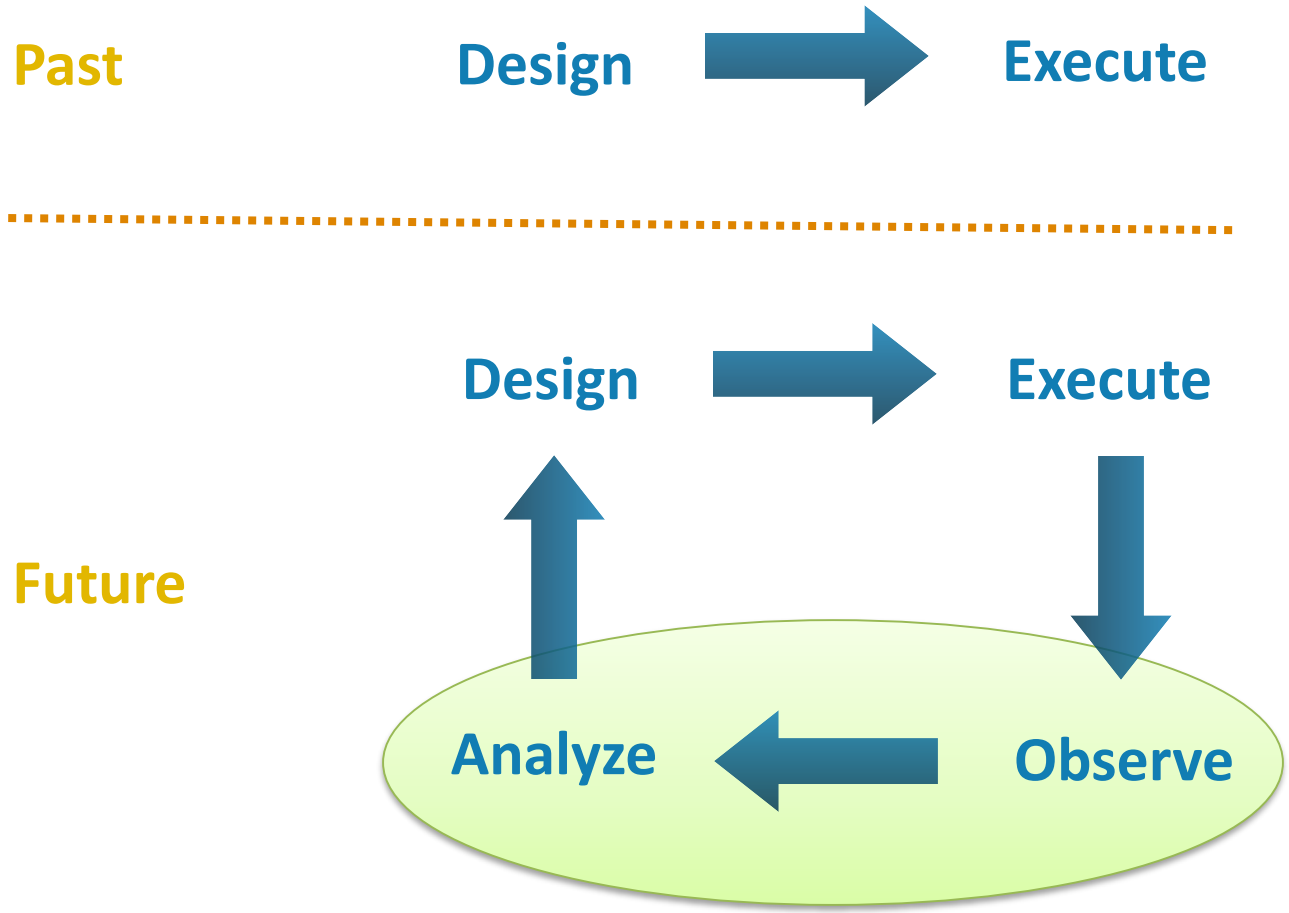
Top-down vs. bottom-up

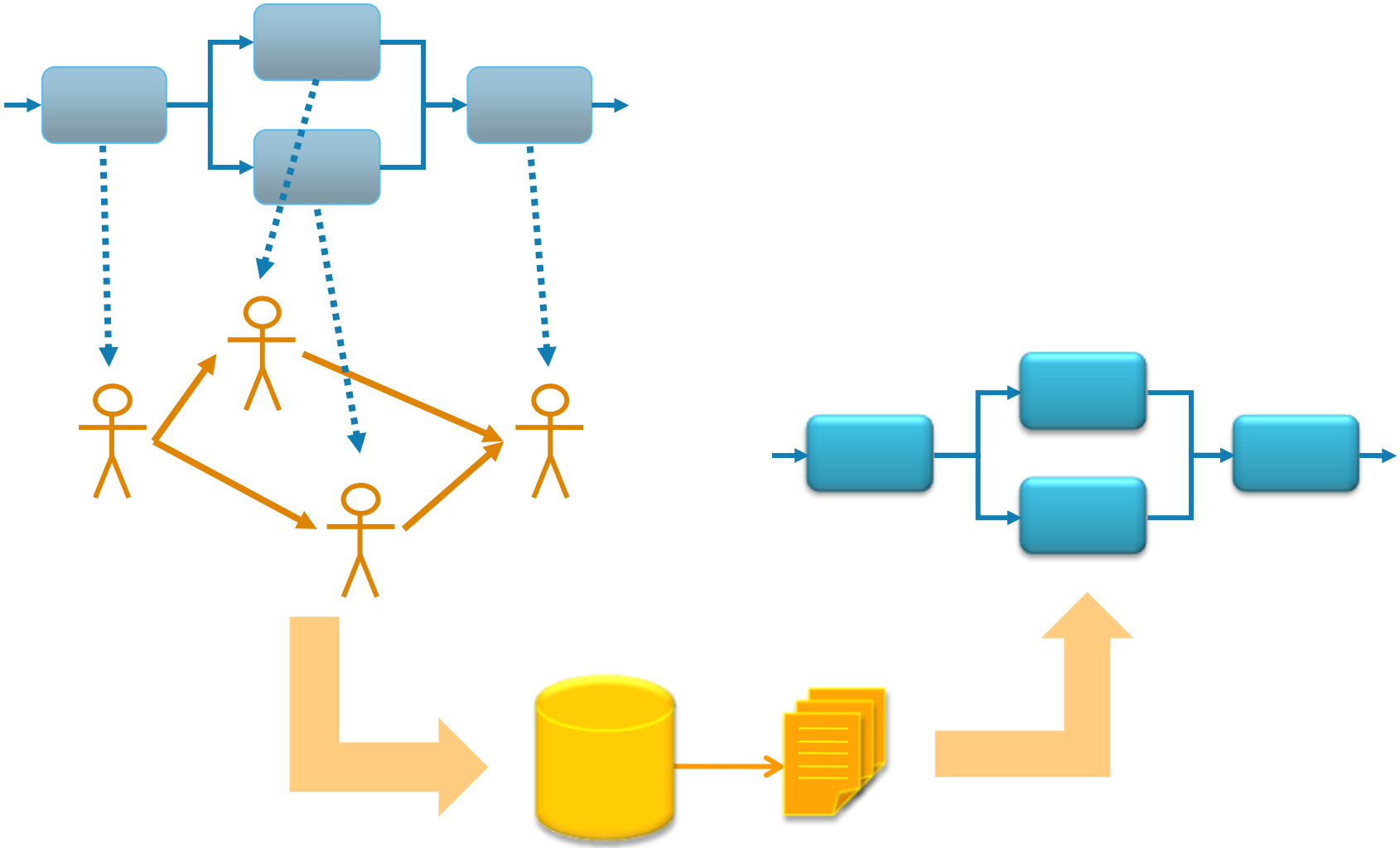




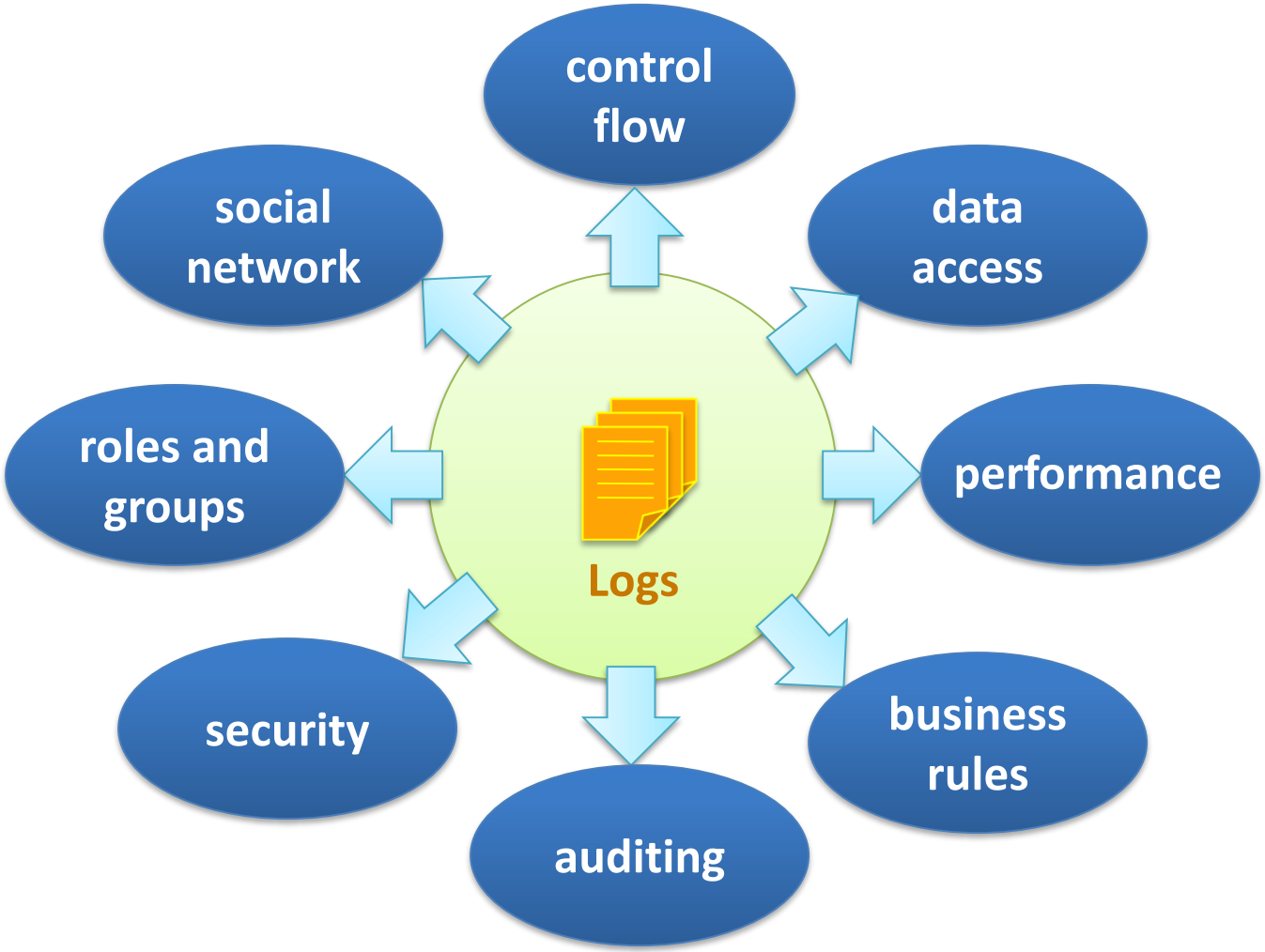
Life cycle


Past
Design
Execute
Future
Design
Execute
Analyze
Observe

Process mining



Mining potential



Need for conformance

- internal control (e.g. Sarbanes-Oxley)
- risk management (e.g. Basel II)
- best practices (e.g. ITIL)
- etc.

- *are processes being performed according to plan?*
- *do processes adhere to common best practices?*
- *…*

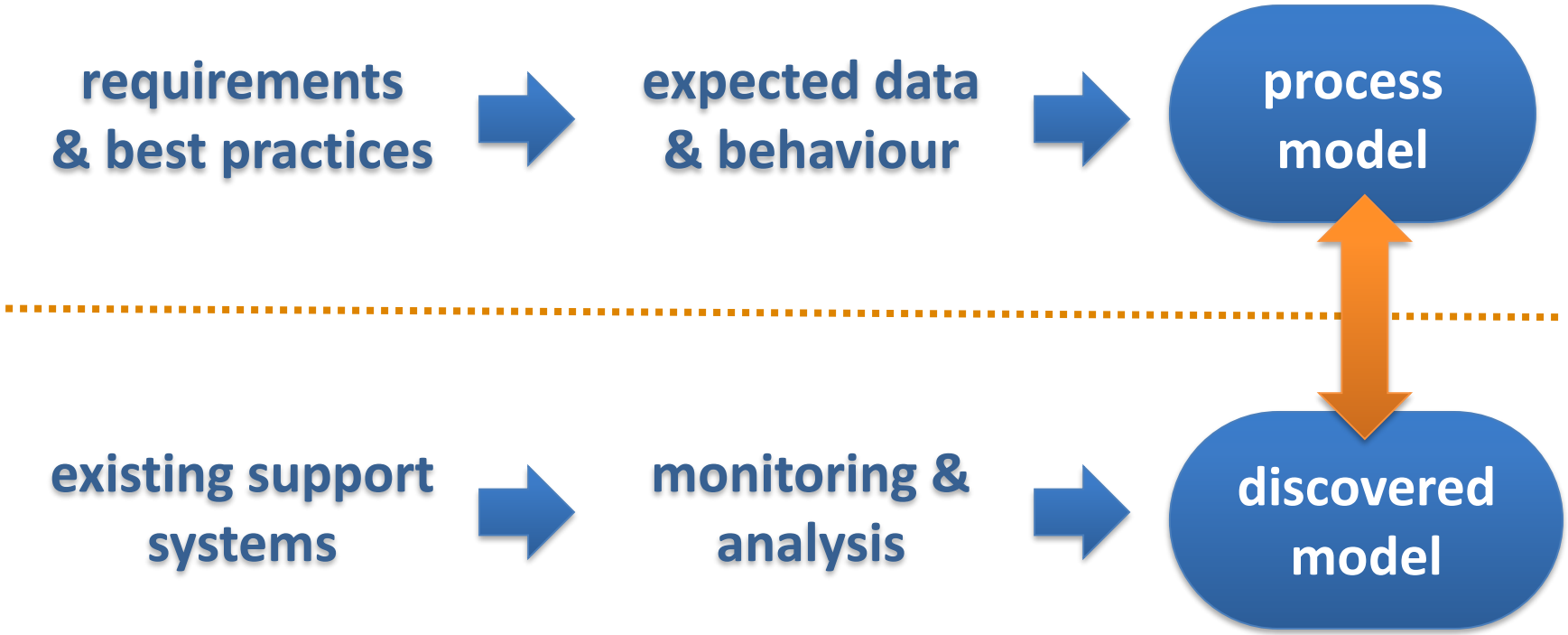
ITIL

- ITIL = Information Technology Infrastructure Library
  - comprehensive framework of best practices for ITSM
    - service level management
    - capacity management
    - incident management
    - configuration management
    - release management
    - change management
    - etc.
- customer-focus, quality, availability, reliability, cost,…

ITIL Assessment

- compare:
  - the way the ITSM is currently performed
  - the ITIL guidelines
- possible gaps
  - process, people, technology, services supplied by third parties, etc.
    - a gap exists if not all incidents are recorded
    - a gap exists if incidents are not classified
    - etc.
- identify requirements for ITIL implementation

Process conformance



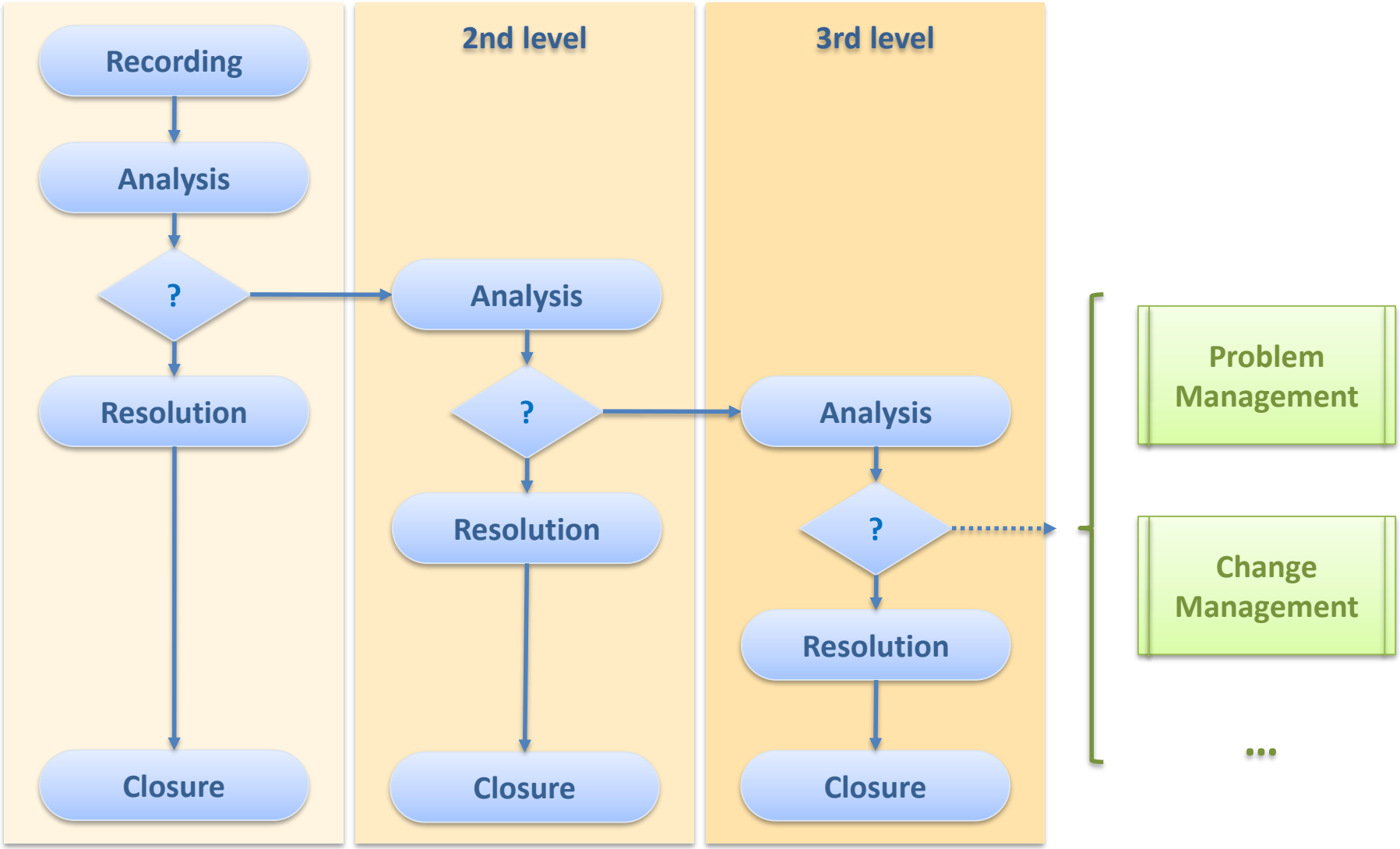
Case Study

Incident Management

ITIL Incident Management

- definition of incident
  - any event causing interruption or reduction in QoS
- purpose of incident management
  - restore normal service level as soon as possible
- comprises
  1. Recording
  2. Classification
  3. Matching
  4. Diagnosis
  5. Resolution
  6. Closure

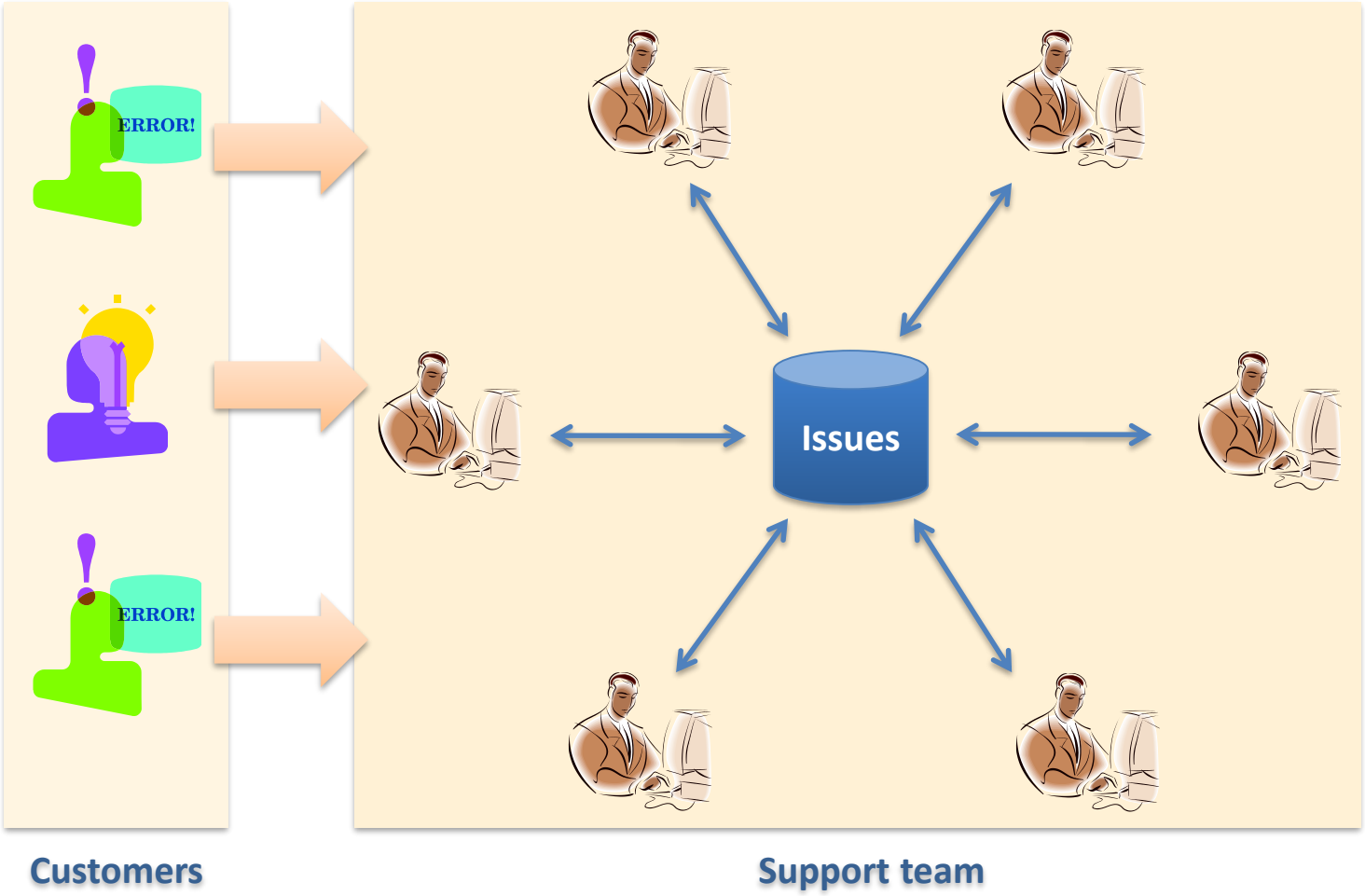
ITIL Incident Management – *Escalation*



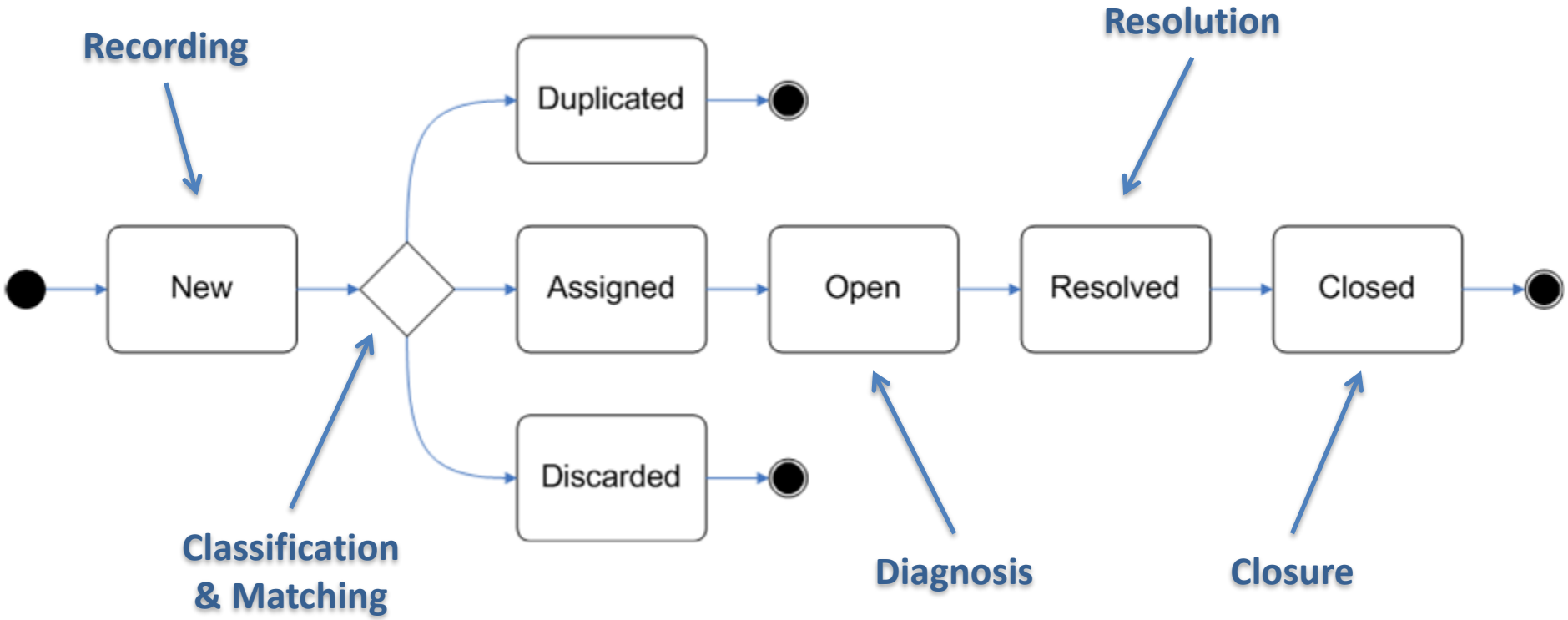
Case study scenario

- IT company
  - complex software platform for custom business solutions
  - continuously improved by successive release versions
  - extensive in-house testing
    - both manual and automated
  - users play active role
    - desired improvements
    - problems to be solved
  - issue handling process & supporting system

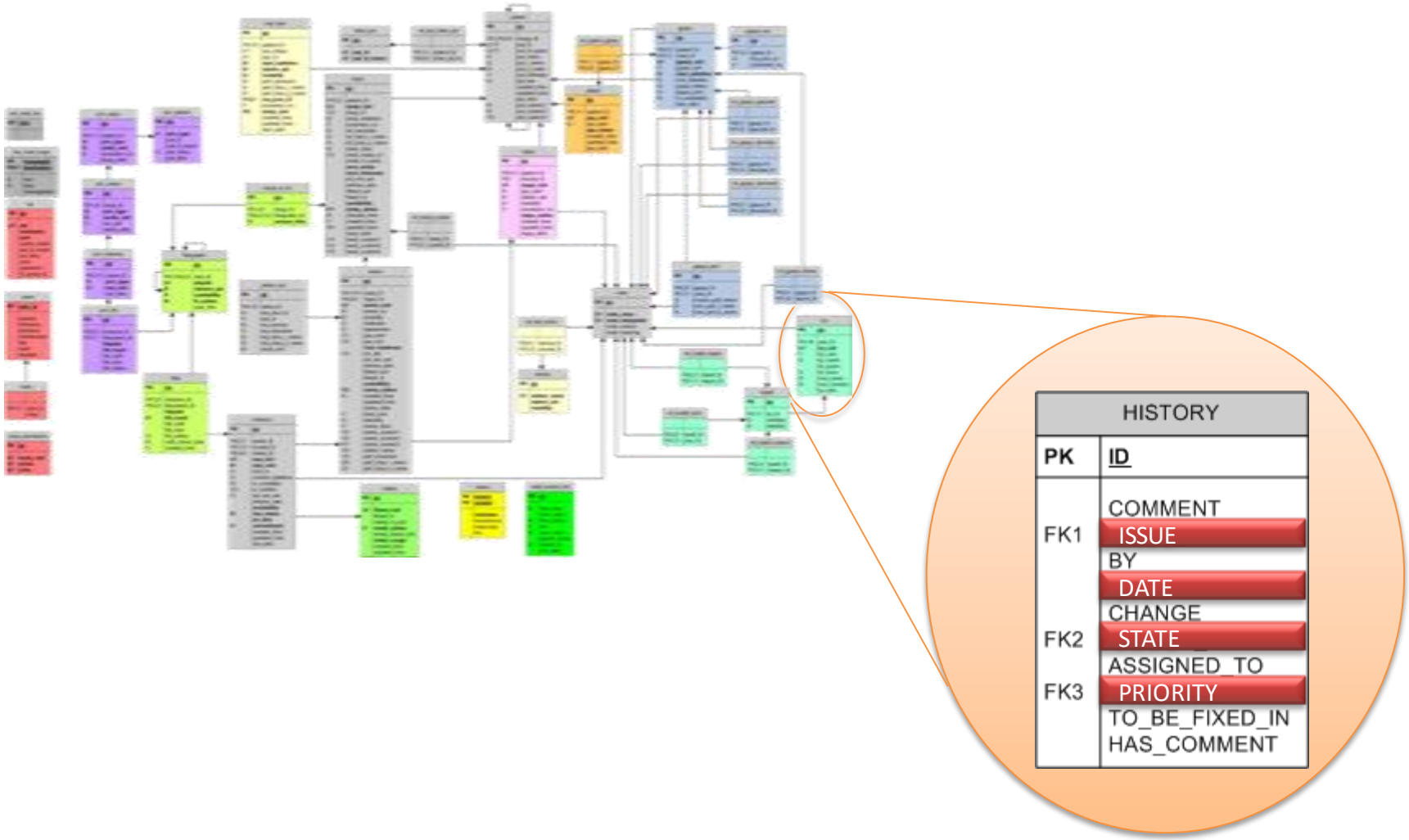
Case study scenario



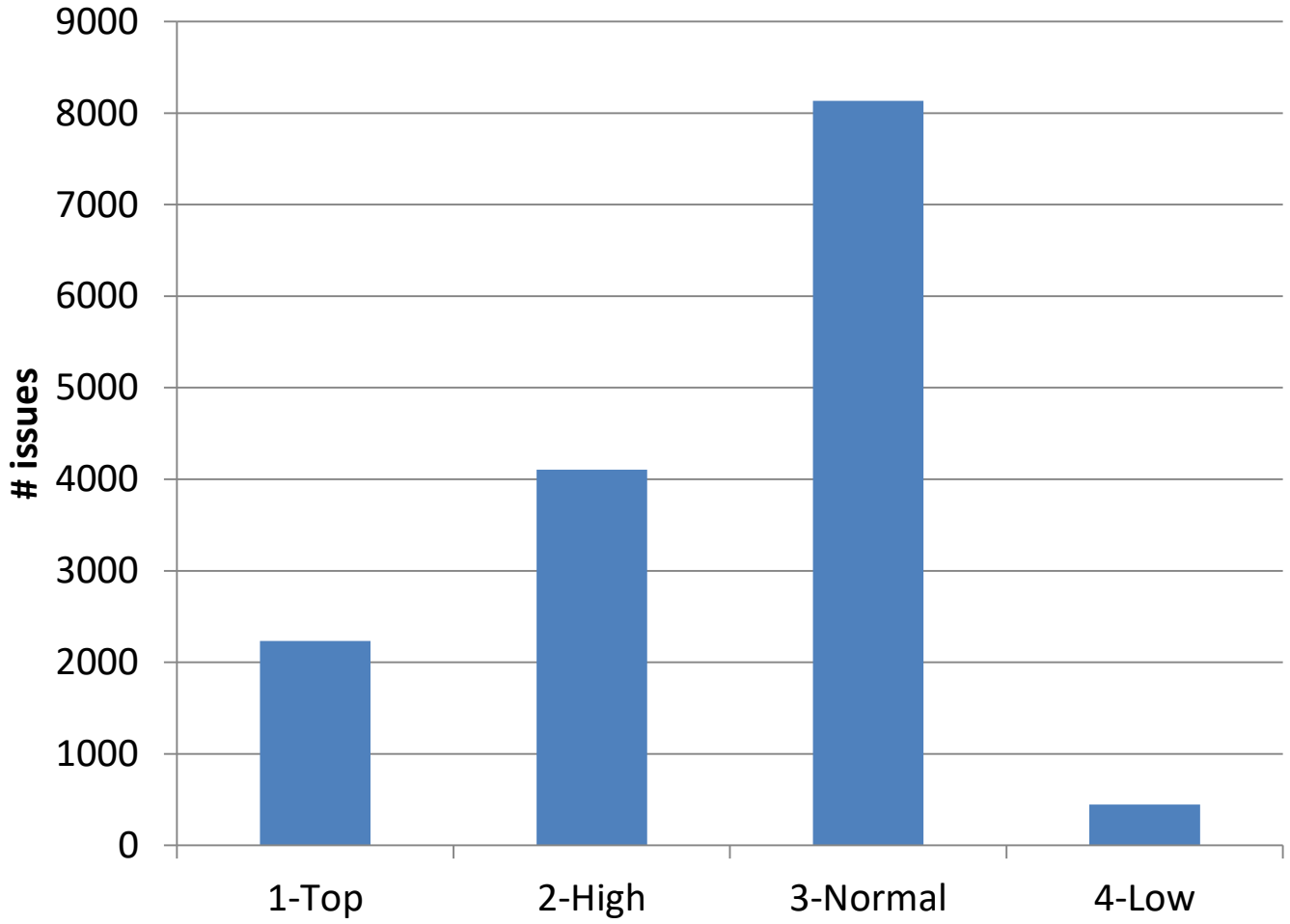
Case study scenario



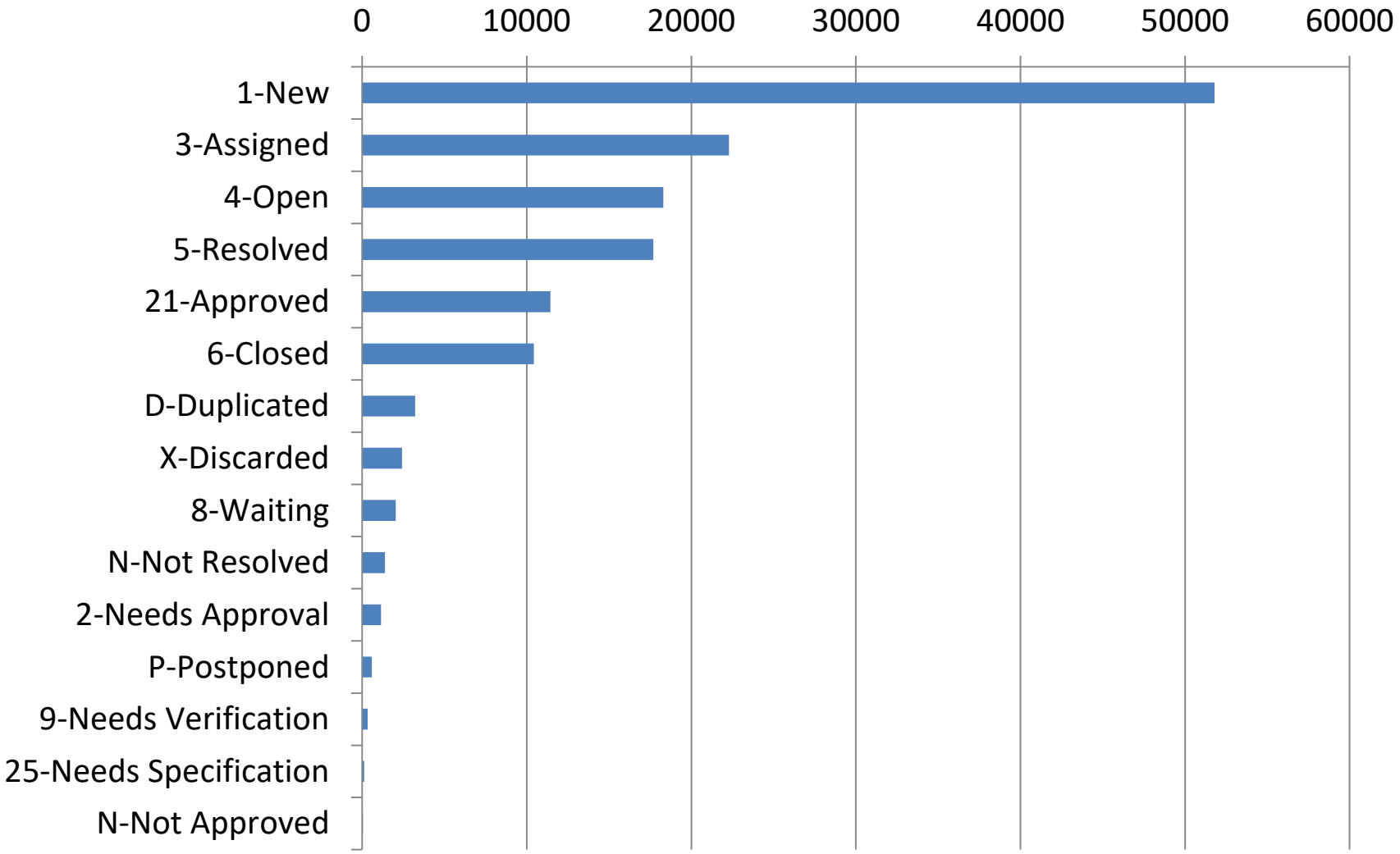
System database



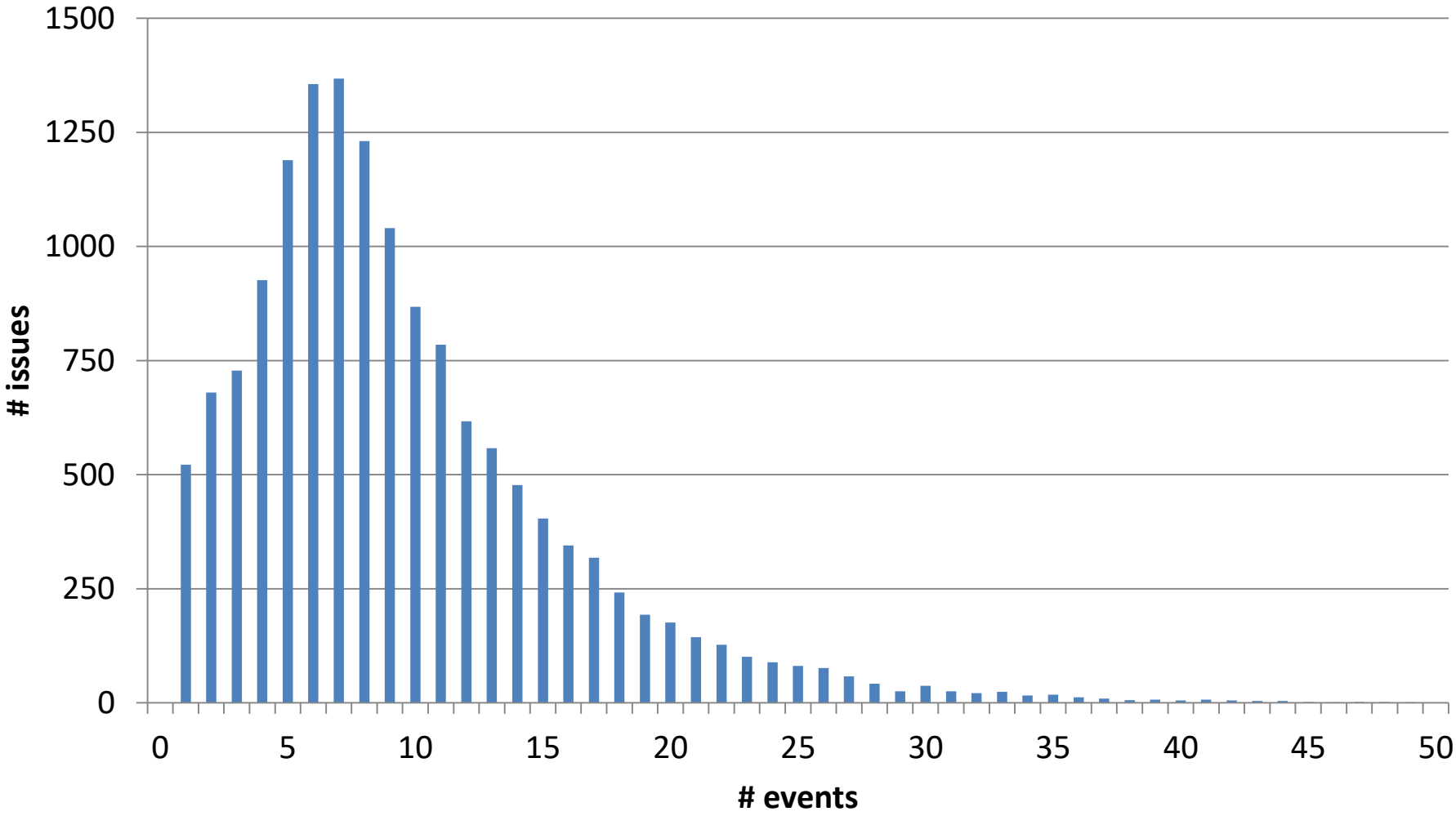
Priority


9000
8000
7000
6000
5000
4000
3000
2000
1000
0
issues
1-Top
2-High
3-Normal
4-Low

State


0
10000
20000
30000
40000
50000
60000
1-New
3-Assigned
4-Open
5-Resolved
21-Approved
6-Closed
D-Duplicated
X-Discarded
8-Waiting
N-Not Resolved
2-Needs Approval
P-Postponed
9-Needs Verification
25-Needs Specification
N-Not Approved

Sequence length



Sequence length

- Shortest sequence:

  New **(1 event)**

- Longest sequence:

  New => New => New => New => Assigned => Assigned => Assigned => Assigned => Approved => Approved => Approved => Approved => Approved => Approved => Waiting => Assigned => Assigned => Assigned => Open => Waiting => NotResolved => NotResolved => New => New => New => New => Assigned => Open => Open => Waiting => Open => Open => Waiting => Waiting => Resolved => Resolved => Resolved => Resolved => Resolved => Resolved => Closed **(75 events)**

- Average length: 143 220 / 14 982 ≈ 10 events

Input data

- 14 982 sequences in total
- 7164 different sequences!
  - on average, each sequence repeats only once (2x)
- 5909 unique sequences!
  - 40% of all behavior never repeats itself!

Strong component of ad-hoc behavior!

1. Drop consecutive repeated events

New => Assigned => Assigned => Open => Resolved => Resolved => Closed

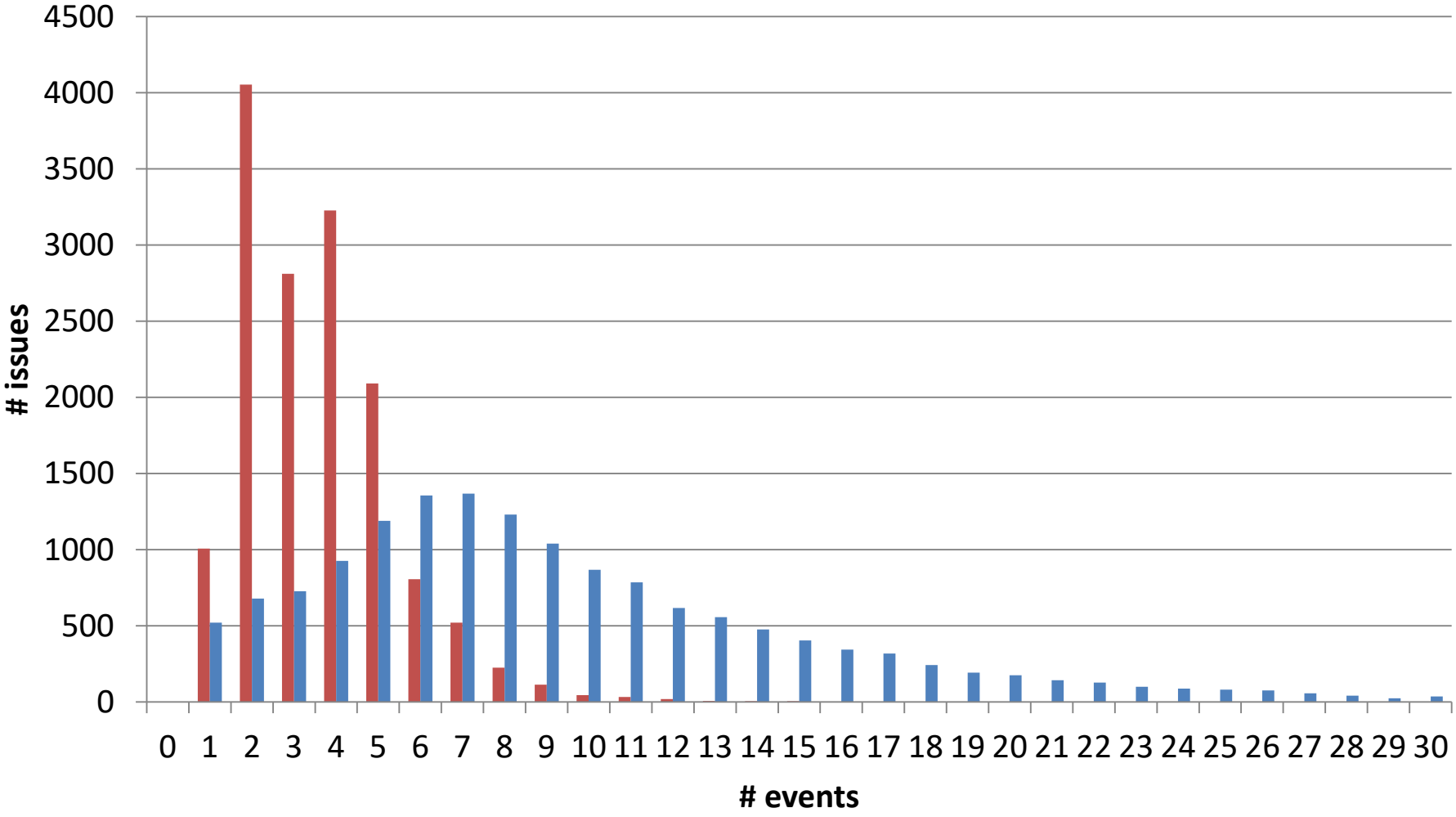
New => Assigned => Open => Resolved => Closed

New => New => New => New => Duplicated

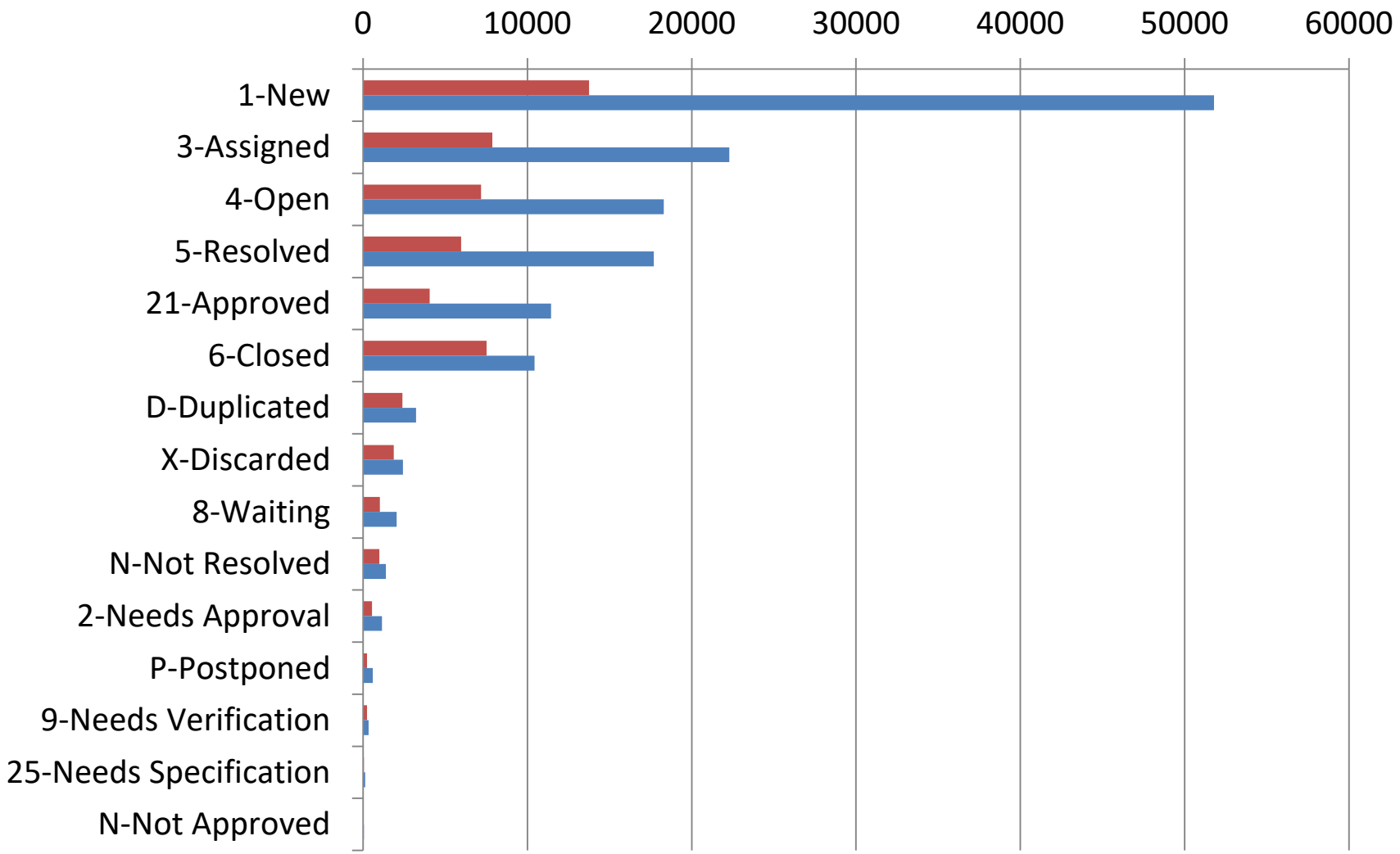
New => Duplicated

Eliminated 89 577 of 143 220 events (62.5%)

Sequence length



State


0
10000
20000
30000
40000
50000
60000
1-New
3-Assigned
4-Open
5-Resolved
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D-Duplicated
X-Discarded
8-Waiting
N-Not Resolved
2-Needs Approval
P-Postponed
9-Needs Verification
25-Needs Specification
N-Not Approved

2. Drop single-event sequences

- sequences with a single step

New	(419)
Closed	(358)
Discarded	(128)
Duplicated	(83)
Approved	(9)
Assigned	(4)
NotResolved	(4)
Resolved	(2)

Eliminated 1007 of 14 982 sequences (6.7%)

3. Drop sequences with repeated events

New => Assigned => Open => Resolved => Assigned => Resolved => Closed

New => Assigned => Approved => Open => Approved => NotResolved

New => Duplicated => New => Duplicated => New => Duplicated

Closed => Assigned => NeedsApproval => Approved => Resolved => Closed

New => Assigned => Open => Discarded => New => Approved => Discarded

New => Open => NotResolved => Open => NotResolved => Resolved => Closed

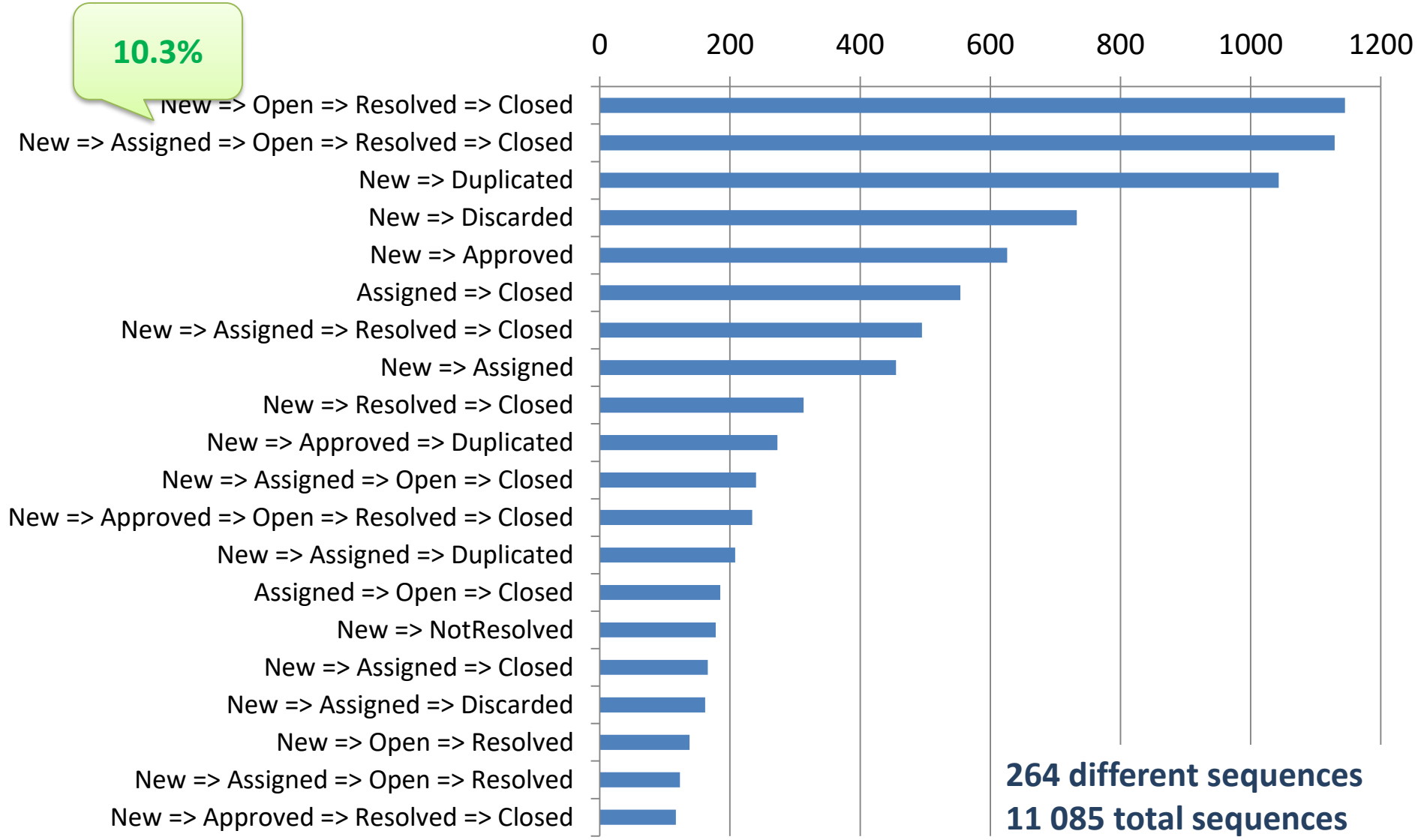
Eliminated 2584 of 13 975 sequences (18.5%)

4. Drop unique sequences

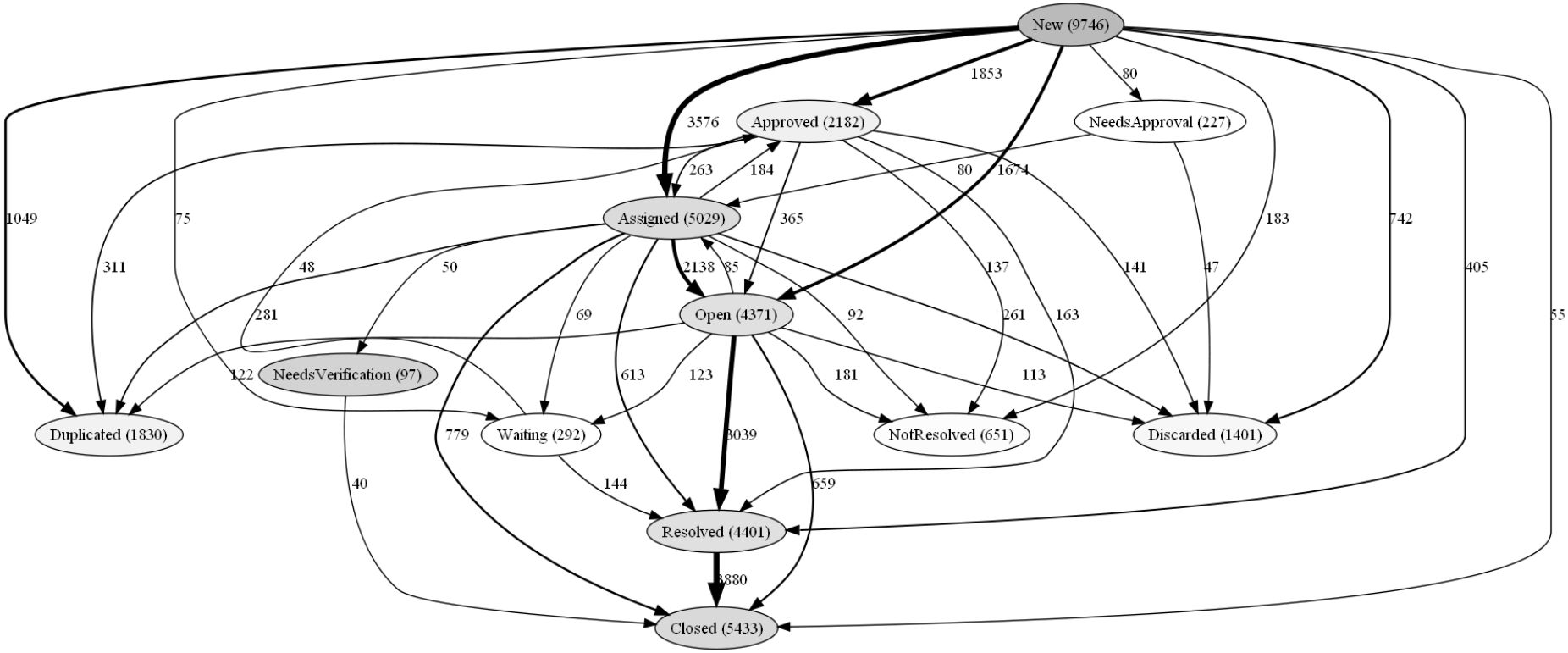
- from very short ones:
  - Closed => Discarded
  - Waiting => Approved
  - Postponed => New
- to longer ones:
  - New => NeedsApproval => NeedsSpecification => Approved => Assigned => Resolved => Closed
  - New => Discarded => Approved => Waiting => Assigned => Resolved => Closed => Duplicated

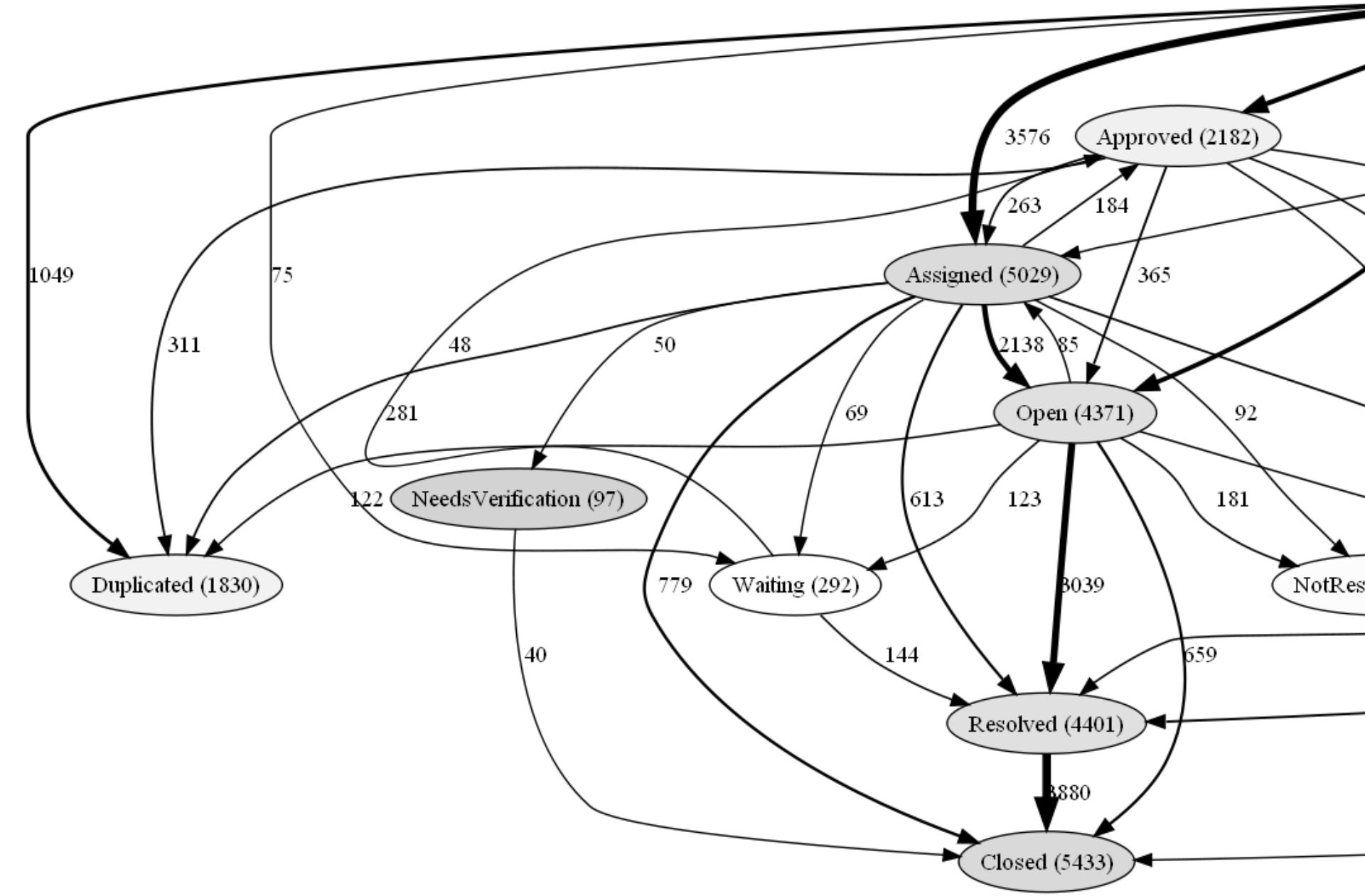
Eliminated 306 of 11 391 sequences (2.7%)

Most frequent sequences (top 20)



Global behavioral model




Approved (2182)
Assigned (5029)
Open (4371)
NeedsVerification (97)
Duplicated (1830)
Waiting (292)
Resolved (4401)
Closed (5433)
NotRes
3576
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75
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123
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779
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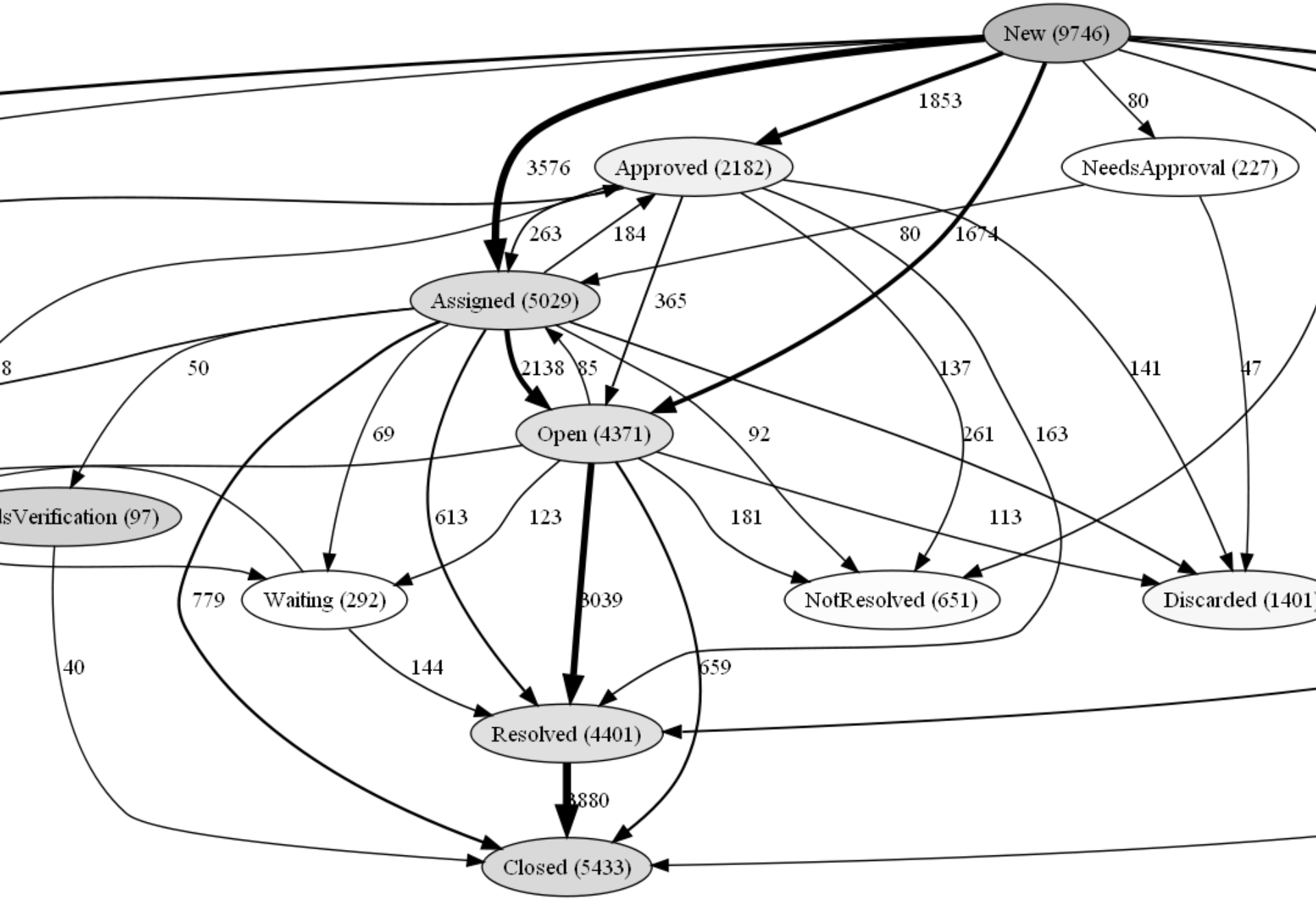
40
144
659
880


New (9746)
1853
80
3576
Approved (2182)
NeedsApproval (227)
263
184
80
1674
Assigned (5029)
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Open (4371)
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sVerification (97)
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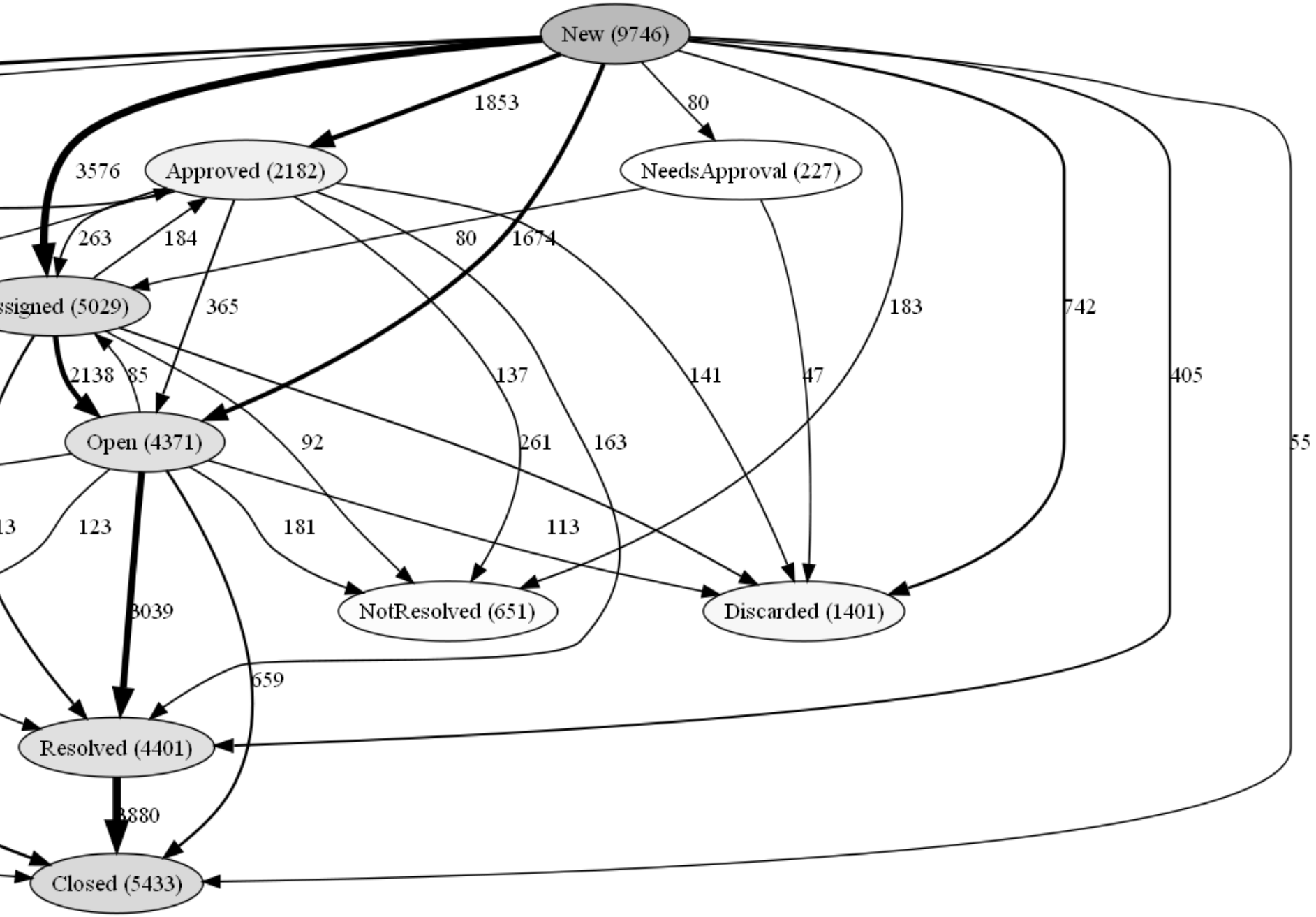
779
Waiting (292)
3039
NotResolved (651)
Discarded (1401)
40
144
659
Resolved (4401)
880
Closed (5433)


New (9746)
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Approved (2182)
NeedsApproval (227)
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ssigned (5029)
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85
137
141
47
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Open (4371)
92
261
163
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13
123
181
113
3039
NotResolved (651)
Discarded (1401)
659
Resolved (4401)
3880
Closed (5433)

Explaining the results

- New => Approved (?)
  - issue approval is no longer being used
  - approval is implicit in New => Assigned
- New => Open (?)
  - support team skips steps when solution obvious
- Open => Assigned (?)
  - arbitrary loops / wrong assignment / escalation
- Assigned / Open => Duplicated / Discarded (?)
  - decision comes later when more data is available

Conclusion

- case study
  - overall behaviour is close to Incident Management
  - unusual behavior can now be further investigated

- in general
  - process mining facilitates extraction and analysis
  - valuable tool for process conformance
  - relies on available systems and data
  - focus on behavioral perspective

Additional info & resources

- Process Mining Group: *http://www.processmining.org/*
- ProM Framework: *http://prom.sourceforge.net/*
- Process Mining TV: *http://ga1717.tm.tue.nl/user/christian/pmtv/*
- W.M.P. van der Aalst and A.J.M.M. Weijters, *Process Mining: A Research Agenda*, Computers in Industry, vol.53, no.3, pp.231-244, 2004
- A. Rozinat, W. van der Aalst, *Conformance checking of processes based on monitoring real behavior,* Information Systems, vol.33, no.1, 2008
- D. Ferreira, M. Zacarias, M. Malheiros, P. Ferreira, *Approaching Process Mining with Sequence Clustering: Experiments and Findings,* 5th International Conference on Business Process Management (BPM 2007), LNCS 4714, Springer, 2007
- ITIL: *http://www.itil-officialsite.com/*