EXHIBIT D

REDACTED VERSION OF
DOCUMENT(S) SOUGHT TO BE SEALED

EXHIBIT 1

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14
                  UNITED STATES DISTRICT COURT
15
                  NORTHERN DISTRICT OF CALIFORNIA
16

17 MATTHEW CAMPBELL and MICHAEL   Case No. C 13-05996 PJH (MEJ)
   HURLEY, on behalf of themselves and all
18 others similarly situated,   **REBUTTAL REPORT OF DR. JENNIFER
                                           GOLBECK IN SUPPORT OF
19   Plaintiffs,   PLAINTIFFS' MOTION FOR CLASS
                                           CERTIFICATION**
20 v.
                                           HEARING
21 FACEBOOK, INC.,   Date: March 16, 2016
                                           Time: 9:00 a.m.
22   Defendant.   Place: Courtroom 3, 3rd Floor
                                                   The Honorable Phyllis J. Hamilton
23

24

25

26

27

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I.   SCOPE OF ENGAGEMENT

1.   I have been asked by the Plaintiffs through their counsel to respond to the conclusions expressed in the Expert Report of Dr. Benjamin Goldberg submitted with Defendant Facebook Inc.'s Opposition to Plaintiffs' Motion for Class Certification ("Goldberg Report"), statements made by Facebook Engineering Manager Alex Himel in his declaration submitted in support of Facebook's Opposition, and characterizations of my testimony made by Facebook in its Opposition to Plaintiffs' Motion for Class Certification.

II.   METHODOLOGY

2.   My rebuttal opinions, as well as the evidence I rely upon to support them, are set forth in detail in this rebuttal report. The contents of the various exhibits that I identify by name are meant to be incorporated, in their entirety, by such reference.

3.   As with my opening report submitted in connection with Plaintiffs' Motion for Class Certification ("Golbeck Opening Report"), in preparing this report, I have employed methods and analyses of a type reasonably relied upon by experts in my field in forming opinions or inferences on the subject. The opinions expressed are based upon a reasonable degree of computer science certainty.

4.   Between now and such time that I may be asked to testify before the Court, I expect to continue my review, evaluation, and analysis of information generated during discovery, as well as of relevant evidence presented before and/or at trial. I also expect to review any further reports submitted by Facebook's experts. I reserve the right to amend or supplement this rebuttal report, as necessary and as acceptable to the Court. I also reserve the right to develop materials and exhibits as appropriate for use in helping to demonstrate and explain my opinions in the event that I am asked to testify at trial.

5.   In forming my opinions, I have reviewed source code which I understand was provided by Facebook's counsel and which was represented as containing the relevant source code between some time in 2009 and December 2012.

6.   Additionally I have reviewed internal Facebook documents produced in this litigation, the Goldberg Report, the transcript of the deposition of Dr. Goldberg, the declarations

1   of various Facebook employees submitted in in support of Facebook's Opposition to Plaintiffs'

2   Motion for Class Certification, the deposition transcripts of those employees, as well as certain

3   public materials. The list of documents I have considered in forming my opinions in this rebuttal

4   report is attached to this report as Appendix A.

5   **III.   ASCERTAINABILITY**

6   **A.   Class Members are Ascertainable from Facebook's Records**

7   7.   Facebook has a database called ████████████████████

8   ██████ . I understand that Facebook produced the ██████████████████████

9   ██ Exhibit A to

10   Facebook's Second Supplemental Responses and Objections to Plaintiffs' Narrowed Second Set

11   of Interrogatories ██████████████████████ ████████ ██

12   ████████████████████████ .

13   ██

14   ██

15   ██████████ .

16   8.   The contents of the page include ████████████████████ , including:

17   ██   ████████

18   ██   ████████

19   ██   ████████████████████

20   ██   ██████████████████████████████

21   ████████████████████ .

22   9.   The ████████ can be used to access information about Class members. The

23   ██

24   ████████████████████████ could be written that would identify the senders and

25   recipients of Private Messages sent during the Class Period with URL attachments ████

26   ██████████████ by doing the following:

27

28   _____

[1] Facebook Appendix ("App.") at 1534-1555.
[2] Ex. 7 to the Declaration of David Slade ("Slade Decl.")

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CERTIFICATION C 13-05996 PJH (MEJ)

1 ███ ██████████████████

2 ███ █████████████████████████

3 ███ ████████████████████████████████

4 ███████████████████████████████

5 ██ ███████████████████

6   10.   Specifically, the query would involve identifying the following information related

7   to the Class Definition:

8   a.   Private Messages within the Class Period based upon █████████████

9   ███████████████████████ (highlighted in yellow in Slade Decl. Ex. 7);

10   b.   Within that time period, Private Messages that ████████████████████

11   ██

12   ██

13   ████████████ (highlighted in red in Slade Decl. Ex. 7);

14   c.   Sender of each Class-qualifying message based upon ████████████

15   ██

16   (highlighted in blue in Slade Decl. Ex. 7); and

17   d.   Recipient(s) of each Class-qualifying message based upon ██████████

18   ████████████████████████████████████ (highlighted in green in Slade

19   Decl. Ex. 7).

20   11.   Focusing on the above-described fields also addresses an issue raised by Facebook

21   in its brief: the fact that ███

22   ██████████████████.[3] In discovery, I understand that Facebook was able to produce the

23   ██

24   ██, marked

25   as FB000005577, FB000005800, FB000005882, FB000006007, FB000006088, FB000012006,

26

27

28   ─────────────────────────
[3] Opp. at 12:11.

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1   and FB000012557.[4] Reviewing each of these █████████████████████████

2   ███

3   ████████████ :

4   a.   FB000005577[5] shows that ███████████████████████████████

5   ███

6   ████████████████████████████████ in the course of the transmission of this Private

7   Message, and the above-describe query I articulate would exclude such a message, accordingly.

8   b.   FB000005800[6] presents a similar case in that, ███████████████

9   ███

10 ███ this

11 message would be between Facebook users who were outside of the proposed Class.

12   c.   FB000005882,[7] like FB000005577, shows that ██

13 ███

14 ████████████████████████ .

15   d.   FB000006007,[8] like FB000005577, shows that ██

16 ███

17 ████████████████████████ .

18   e.   FB000006088,[9] like FB000005577, shows that ██

19 ███

20 ████████████████████████ .

21   f.   FB000012006,[10] like FB000005577, shows that ██

22 ███

23 ████████████████████████ .

24 --------------------------------

[4] This understanding is based upon the table represented in Exhibit A To Defendant Facebook,
Inc.'s Second Supplemental Responses And Objections To Plaintiffs' Narrowed Second Set Of
Interrogatories (App. 1534-1555).
[5] Slade Decl. Ex. 14.
[6] Slade Decl. Ex. 15.
[7] Slade Decl. Ex. 16.
[8] Slade Decl. Ex. 17.
[9] Slade Decl. Ex. 18.
[10] Slade Decl. Ex. 19.

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1   g.   FB000012557[11] displays a ████████████████████

2   ██

3   ████████████████████████, as this message would be between Facebook users who

4   were outside of the proposed Class.

5   12.   The above query identifies the relevant fields within ██████████████████

6   ████████████████. As I describe in paragraphs 98-105 of my Opening Report, ████████

7   ██

8   ██

9   ████████████████████████████████████, Class members can be readily identified.

10   The above query addresses what I understand to be the relevant inquiry for identifying Class

11   members: that is, whether or not █████████████████████ a Private Message sent with a

12   URL attachment. ██████████████████████████████████

13   ████████ will separate Class members from non-Class members .

14   13.   If the names of ████████████████████████████████████

15   ████████████████████ have subsequently changed, this query could be modified

16   accordingly to address any changes █████████████████████.

17   14.   It appears that Dr. Goldberg's and Facebook's criticism of my methods described

18   in my opening report and my deposition are based on an assumption that ████████████████

19   ████████████████████████████████

20   ████. Although I did not ████████████████████████████████████

21   ████████████████████ to make these identifications, even offering an example query

22   (though it may need some tweaking after I have the opportunity to test it in practice).

23   15.   As I state in my Opening Report, the queries I offered were not intended to

24   retrieve a final list of Class members. As a preface to the sample code, I stated, "[a] database

25   query could be used ████████████████████████████████

26   ████████████████████████ (¶ 103). I never suggested that everyone ████████████

27   ████████ was equivalent to the complete list of the Class members.

28

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[11] Slade Decl. Ex. 20.

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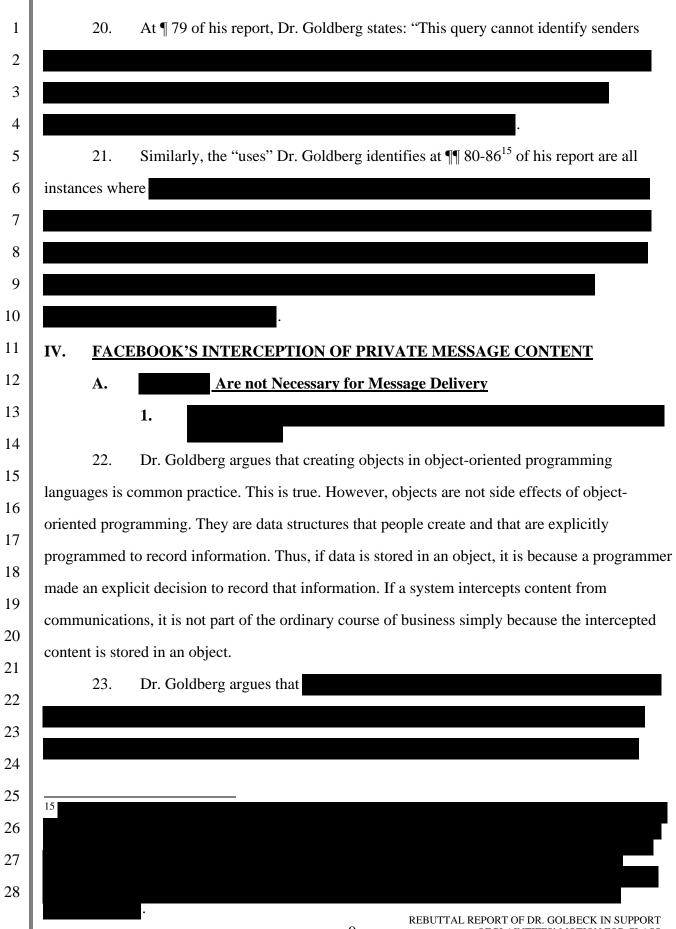1   16.   Dr. Goldberg and Mr. Himel both argue my example code will be both under- and

2   over- inclusive of Class members, without acknowledging that the parameters necessary to

3   identify the Class are readily available.

4   17.   At ¶¶ 66-77 of his report Dr. Goldberg argues that the method that I propose would

5   ███ (*id.* ¶

6   67). However, the examples that he provides are cases which either 1) take the user out of Class

7   definition or, 2) are due to system failures, the frequency of which is likely very low. I respond to

8   each of these cases below:

9   a.   ¶ 68: "*This query will be under-inclusive in that it will not reflect recipients*

10   *of messages* ███

11   ███████████████████████████████████.

12   b.   ¶ 69: "*This query will be under-inclusive in that it will not identify* ████

13   ██ I have not seen any

14   evidence or documentation supporting Dr. Goldberg's underlying assumption that if ████████

15   ██

16   ███

17   █████████████████████████

18   c.   ¶ 70: "*This query will be under-inclusive in that it will not identify senders*

19   *and recipients whose accounts were deleted.*" I have not seen any evidence or documentation

20   supporting Dr. Goldberg's underlying assumption that ███████████████████████████

21   ██

22   ██

23   ██████████████████████.

24   d.   ¶ 71: "*This query will be under-inclusive in that it will not identify* ████

25   ██

26   ██

27   ██

28   ██

1 ██

2 ██████████.

      e.   ¶ 72: "*This query will be under-inclusive in that it will not identify* ████

4 ██

5 ██

6 ███

7 ██.

      f.   ¶ 73: "*This query will be under-inclusive in that it will not identify* ████

9 ███

10 ██

11 ██

12 ██████████████████.

      g.   ¶ 74: "*This query will be over-inclusive in that it will include senders*

14 *whose messages did not contain URLs in their text*." This appears to be referencing a scenario

15 where ███████████████████████████████████████

16 ███

17 ██

18 ██

19 ████████████████████.

      h.   ¶ 75: "*This query will be over-inclusive in that it will include* ████

21 ██

22 ██

23 ██

24 ███

25 ████████████████████████.

      i.   ¶ 76: "*This query will be over-inclusive in that it will include senders and*

27 *recipients outside the United States*." Facebook knows if users are within the United States and

28 could check this for senders and recipients whose messages were intercepted. Facebook states on

1 its website that this data is collected for advertising purposes.[12] ██████████████████

2 ██

3 ██

4 ██

5 ██

6 ██████████████████████████.

7   j.   ¶ 77: "*This query will be over-inclusive in that it will include senders of*

8 *messages outside the Class Period.*" As explained above, ███████████████████████

9 ██.

10   18.   At ¶¶ 78-86 of his report, Dr. Goldberg argues that my proposed methods are

11 "overbroad in that [they] will identify senders that were not subject to the challenged 'uses.'"

12 However, the Facebook code is written such that ████████████████████████████████

13 ██

14 ██

15 ██

16 ██████████████████████████████.

17   19.   At ¶ 78 of his report, Dr. Goldberg states: "Dr. Golbeck's query is overbroad in

18 that it will identify senders that were not subject to the challenged 'uses.' In her deposition, Dr.

19 Golbeck conceded each of these flaws in her proposed query and said that identifying those that

20 were subject to the challenged 'uses' would be 'case-specific.'" This is a misstatement of my

21 deposition testimony. I was asked specifically if ████████████████████████████████

22 ██ not if it was possible to

23 identify senders subject to uses.[14]

24

25

---

26 [12] *See* https://www.facebook.com/business/help/133609753380850 ("**How does Facebook know when people are in the locations I'm targeting?** Facebook uses information from multiple

27 sources such as current city from profile, IP address, data from mobile devices if location services are enabled, and aggregated information about the location of friends.").

28 [13] FB000027191.
    [14] App. 1337 (Golbeck Depo. 344:7-19).

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20.   At ¶ 79 of his report, Dr. Goldberg states: "This query cannot identify senders

███

███

███.

21.   Similarly, the "uses" Dr. Goldberg identifies at ¶¶ 80-86[15] of his report are all

instances where ██

███

███

███

███████████████████████.

IV.   FACEBOOK'S INTERCEPTION OF PRIVATE MESSAGE CONTENT

A.   ██████████ Are not Necessary for Message Delivery

1.   ██
████████████████

22.   Dr. Goldberg argues that creating objects in object-oriented programming

languages is common practice. This is true. However, objects are not side effects of object-

oriented programming. They are data structures that people create and that are explicitly

programmed to record information. Thus, if data is stored in an object, it is because a programmer

made an explicit decision to record that information. If a system intercepts content from

communications, it is not part of the ordinary course of business simply because the intercepted

content is stored in an object.

23.   Dr. Goldberg argues that ████████████████████████████

███

███

15 ██
██
██
██
████.

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1 ██ ██ Information stored in a

2 database is not part of the code. While the stored data may map to what is implemented in objects

3 in the code, it is not an object-oriented programming object itself.

4   **2.**   **Alternative methods** ██████████████

5   24.   There are alternative methods for ███████████████████████████

6 ██.

7   a.   For example, rather than ████████████████████████████

8 ██

9 ██

10 ████████████████████████████.

11   b.   Additionally, ████████████████████████████████

12 ██████████████████████.

13   c.   The fact that these alternative methods of ██████████████████

14 ██

15 ██

16 ██

17 ██

18 ██

19 ██

20 ██

21 ██.[17]

22   **3.**   **Code-Based Devices**

23   25.   Dr. Goldberg argues that he has never heard the term "code-based device" before

24 (¶ 8). However, code-based or software devices are quite common, and just because Dr. Goldberg

25 has not heard the term does not mean they cannot exist.

26

---

27 [16] *See, e.g.* section "Dissection of an Object" in Hasin Hayder, *Object-Oriented Programming with PHP5* (Packt Publishing Ltd, 2007) .

28 [17] *See* App. 1522-23 (Himel Decl. ¶ 44); App. 1697-98, 1699-1700, 1702 (Fechete Decl. ¶¶ 13-14, 18, 26).

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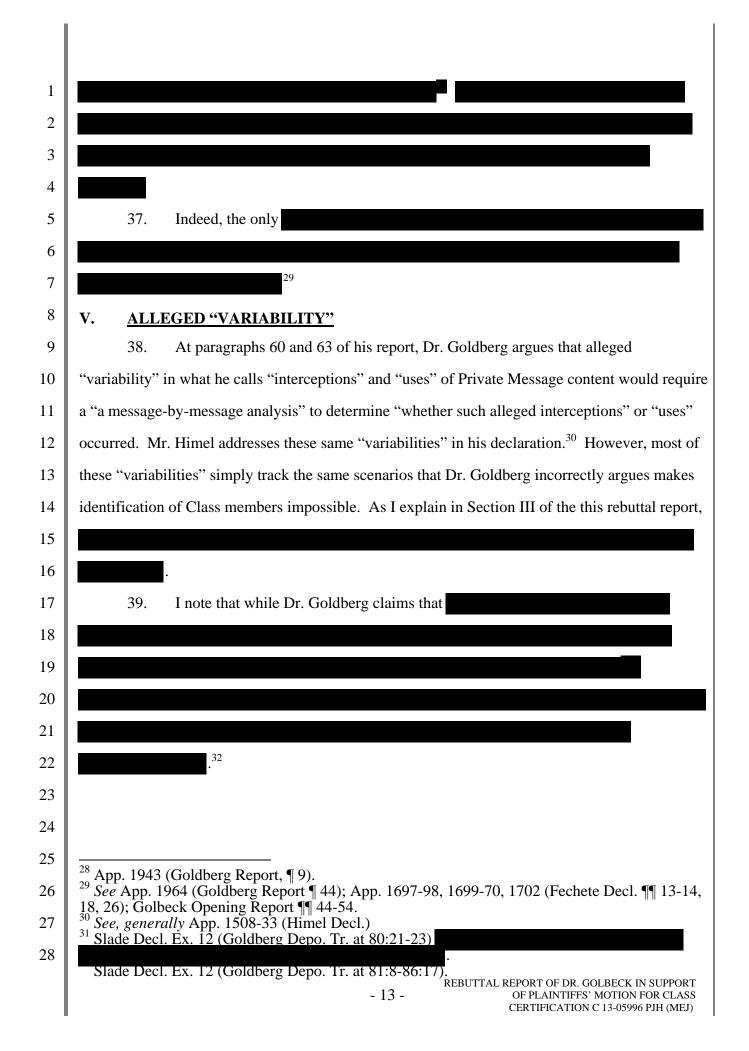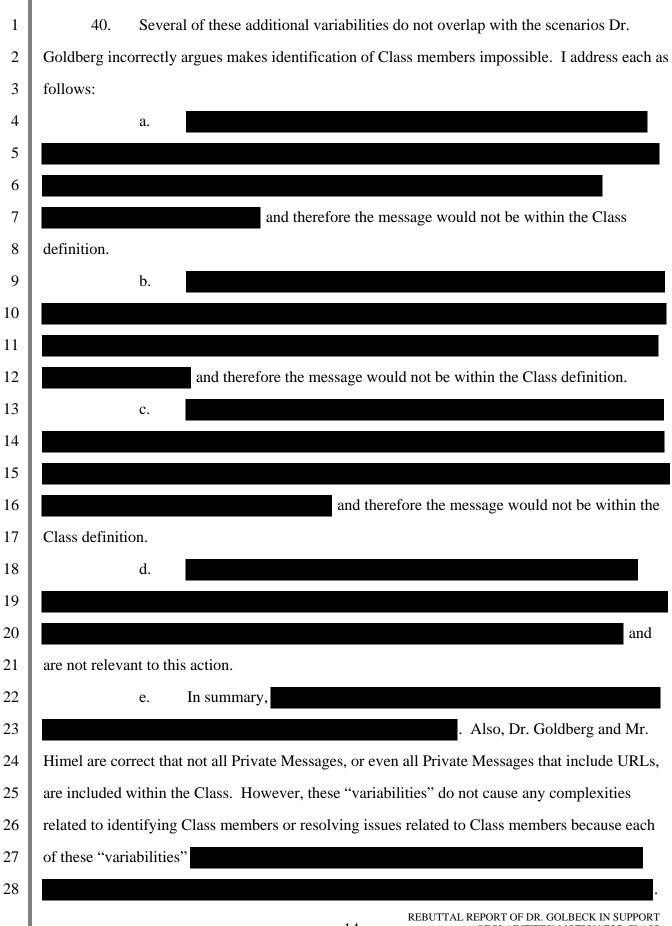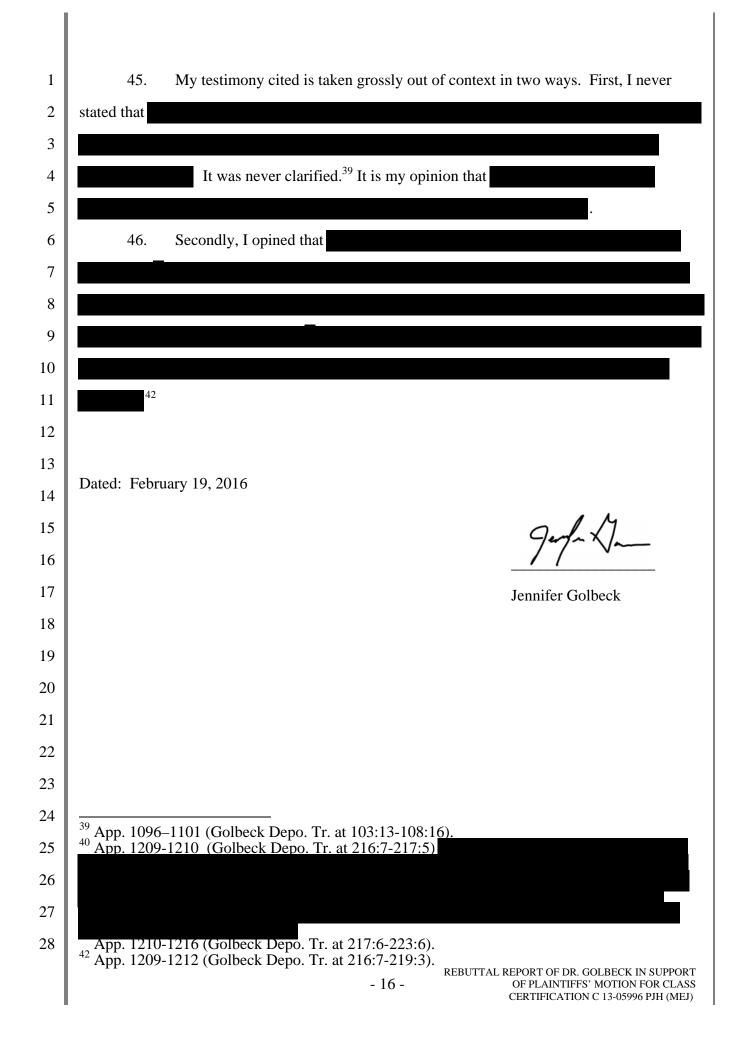OF PLAINTIFFS' MOTION FOR CLASS
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26.   For example, one domain where the public is hearing a lot about code-based devices now is in the Volkswagen emissions controversy.[18] Indeed, a Google News search for "Volkswagen 'software device'" returned about 37,400 results.[19] I understand that the Environmental Protection Agency has stated that software can constitute a "device" as that term is used in government regulations. [20]

27.   The term "software device" has also appeared in US patents[21] and publications from NASA.[22]

B.   ████████████████

28.   I understand that Mr. Himel claims that ██████████████████████████ ████ ██
██
██
████████████████

29.   I analyzed ██
██████████████████████████████████.

30.   Based upon ████████████████████████████████████
██████████████████.

31.   In ████████████████████████████████████
██
██
██:

[18] *See* Slade Decl. Ex 12 (Goldberg Depo. Tr. at 171:10-177:22.)
[19] Slade Decl. Ex 13.
[20] *See id.*; *see also* "EPA, California Notify Volkswagen of Clean Air Act Violations / Carmaker allegedly used software that circumvents emissions testing for certain air pollutants," available at http://yosemite.epa.gov/opa/admpress.nsf/a883dc3da7094f97852572a00065d7d8/dfc8e33b5ab16 2b985257ec40057813b!OpenDocument ("As described in the [Notice of Violation], a sophisticated software algorithm on certain Volkswagen vehicles detects when the car is undergoing official emissions testing, and turns full emissions controls on only during the test . . . The software produced by Volkswagen is a "defeat device," as defined by the Clean Air Act.")
[21] *See, e.g.* , U.S Patent No. 6,032,223.
[22] *See, e.g.,* V. Kreinovich, A. Bernat, E. Villa, Y. Mariscal, "Parallel computers estimate errors caused by imprecise data," Interval Computations, 1991, No. 2, pp. 31–46. (available at http://ntrs.nasa.gov/search.jsp?R=19930068753).
[23] *See* App. 1522-23 (Himel Decl. ¶ 44).
[24] *See, e.g.,* FB000014213; FB000027011; FB000027015; FB000027018.

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1 ███████████████████████████████

2 ████████████████████████████████████

3 ██████████████████████████

4 32. ███████████████████████████████████████

5 ██████████████████████████████████████

6 ██

7 █████████████████████████

8 ████████████████

9 ███████████████████

10 █████████████████████████████████

11 ████████████████████

12 33. These show ████████████████████████████████████ .

13 34. Even if this information is not ████████████████████

14 ██

15 ███

16 ██████████████████████████████████████

17 ██████████████████████████████████████

18 ████████████████

19 35. Dr. Goldberg stated in his deposition that he ████████████

20 ███████████████████████████████████ ███████████████

21 ███████████████████████████████

22 █████████████████████████████████

23 ████████[27]

24 36. I note that, in the context of Facebook's ████████████

25 ██

26 ████████████████████████████████████

27 _____
[25] ██ .
[26] Slade Decl. Ex. 12 (Goldberg Depo. Tr. at 139:10-143:6).
[27] FB000027190.

28

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[REDACTED]

5   37.   Indeed, the only [REDACTED]

[REDACTED]

[REDACTED][29]

V.   ALLEGED "VARIABILITY"

38.   At paragraphs 60 and 63 of his report, Dr. Goldberg argues that alleged "variability" in what he calls "interceptions" and "uses" of Private Message content would require a "a message-by-message analysis" to determine "whether such alleged interceptions" or "uses" occurred. Mr. Himel addresses these same "variabilities" in his declaration.[30] However, most of these "variabilities" simply track the same scenarios that Dr. Goldberg incorrectly argues makes identification of Class members impossible. As I explain in Section III of the this rebuttal report, [REDACTED]

[REDACTED].

39.   I note that while Dr. Goldberg claims that [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED].[32]

---

[28] App. 1943 (Goldberg Report, ¶ 9).

[29] *See* App. 1964 (Goldberg Report ¶ 44); App. 1697-98, 1699-70, 1702 (Fechete Decl. ¶¶ 13-14, 18, 26); Golbeck Opening Report ¶¶ 44-54.

[30] *See, generally* App. 1508-33 (Himel Decl.)

[31] Slade Decl. Ex. 12 (Goldberg Depo. Tr. at 80:21-23) [REDACTED].

Slade Decl. Ex. 12 (Goldberg Depo. Tr. at 81:8-86:17).

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1   40.   Several of these additional variabilities do not overlap with the scenarios Dr.

2 Goldberg incorrectly argues makes identification of Class members impossible. I address each as

3 follows:

4   a.   ██

5 ██

6 ██

7 ███████████████████████ and therefore the message would not be within the Class

8 definition.

9   b.   ██

10 ██

11 ██

12 ████████████████ and therefore the message would not be within the Class definition.

13   c.   ██

14 ██

15 ██

16 █████████████████████████████████ and therefore the message would not be within the

17 Class definition.

18   d.   ██████████████████████████████████████

19 ██

20 ██ and

21 are not relevant to this action.

22   e.   In summary, ██████████████████████████████

23 ██. Also, Dr. Goldberg and Mr.

24 Himel are correct that not all Private Messages, or even all Private Messages that include URLs,

25 are included within the Class. However, these "variabilities" do not cause any complexities

26 related to identifying Class members or resolving issues related to Class members because each

27 of these "variabilities" ██████████████████████████████████

28 ██.

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VI. WHETHER PRIVATE MESSAGE CONTENT WAS INTERCEPTED IN TRANSIT OR IN STORAGE

41.   Messages are in transit when they are intercepted. They are delivered ███████ ██.[33] Dr. Goldberg argues that messages that are in memory are in "storage" and that he has never heard of the two being distinguished in any context. However, the distinction is commonly made.

42.   As a few examples, Microsoft distinguishes the two on their Windows website[34] as does PC Magazine[35] and numerous other websites.[36] Page 370 of the textbook, "Discovering Computers," by Misty E. Vermaat, *et al*. distinguishes them.[37] While Dr. Goldberg may be unaware that these are treated differently, such a distinction does in fact exist.

43.   Indeed, if Dr. Goldberg's position were correct, it would be impossible for a computer-based violation of wiretap law, since computers must have data in memory in order to operate on it.

VII. FACEBOOK'S USE OF PRIVATE MESSAGE CONTENT IN THE SOCIAL GRAPH AND TARGETED ADVERTISING

44.   I note that Facebook states the following concerning my deposition testimony:

█ ███

███

██████.,"[38]

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[33] *See* Golbeck Opening Report ¶¶ 30-31.
[34] *See* "Memory and storage," available at http://windows.microsoft.com/en-us/windows7/memory-and-storage.
[35] *See* "Definition of: storage vs. memory," http://www.pcmag.com/encyclopedia/term/63352/storage-vs-memory ("The difference between storage and memory is that non-volatile storage is used to hold programs and data until purposely changed or removed by the user, while volatile memory is a temporary workspace for retrieving programs and processing data. Storage consists of drives (hard, optical, USB, solid state). Memory consists of RAM chips that lose their content when power is removed.")
[36] *See, e.g.,* "THE DIFFERENCE BETWEEN MEMORY AND STORAGE" available at http://www.technick.net/public/code/cp_dpage.php?aiocp_dp=guide_umg_01_003 ("People often confuse the terms memory and storage, especially when describing the amount they have of each. The term memory refers to the amount of RAM installed in the computer, whereas the term storage refers to the capacity of the computer's hard disk."); "What's the Difference Between Memory and Storage?," available at http://www.tucows.com/article/593.
[37] Vermaat, M., Sebok, S., Freund, S., Campbell, J. and Frydenberg, M., "Discovering Computers" Cengage Learning (2016).
[38] Opp. at 25:2-4.

REBUTTAL REPORT OF DR. GOLBECK IN SUPPORT OF PLAINTIFFS' MOTION FOR CLASS CERTIFICATION C 13-05996 PJH (MEJ)

1   45.   My testimony cited is taken grossly out of context in two ways. First, I never

2 stated that ███

3 ██

4 ████████████ It was never clarified.[39] It is my opinion that ██████████████

5 ██████████████████████████████████████.

6   46.   Secondly, I opined that ████████████████████████████

7 ██

8 ██

9 ██

10 ██

11 ████████[42]

13 Dated: February 19, 2016

16   _____

17   Jennifer Golbeck

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[39] App. 1096–1101 (Golbeck Depo. Tr. at 103:13-108:16).
[40] App. 1209-1210 (Golbeck Depo. Tr. at 216:7-217:5) ████████████████████

██

██

[41] App. 1210-1216 (Golbeck Depo. Tr. at 217:6-223:6).
[42] App. 1209-1212 (Golbeck Depo. Tr. at 216:7-219:3).

REBUTTAL REPORT OF DR. GOLBECK IN SUPPORT
OF PLAINTIFFS' MOTION FOR CLASS
CERTIFICATION C 13-05996 PJH (MEJ)

Appendix A: List of Materials Relied On

I relied on the following documents and materials in forming my opinions:

Documents from *Campbell et al. v. Facebook, Inc.:*

Facebook's Second Supplemental Responses and Objections to Plaintiffs' Narrowed Second Set of Interrogatories, and Exhibit A thereto

Expert Report of Dr. Benjamin Goldberg submitted with Defendant Facebook Inc.'s Opposition to Plaintiff's Motion for Class Certification

Declaration of Alex Himel in Support of Defendant Facebook, Inc.'s Opposition to Plaintiffs' Motion for Class Certification

Declaration of Dan Fechete in Support of Defendant Facebook, Inc.'s Opposition to Plaintiffs' Motion for Class Certification

Defendant Facebook, Inc.'s Opposition to Plaintiffs' Motion for Class Certification

Deposition of Dr. Jennifer Golbeck (Dec. 16, 2015)

Deposition of Dr. Benjamin Goldberg (Feb. 2, 2016)

Report of Dr. Jennifer Golbeck in Support of Plaintiffs' Motion for Class Certification

Plaintiffs' Motion for Class Certification

FB000005575
FB000005577
FB000005800
FB000005882
FB000006007
FB000006088
FB000012006
FB000012557
FB000014213
FB000027011
FB000027015
FB000027018
FB000027190
FB000027191
Source Code Produced by Facebook

Other Materials:

https://www.facebook.com/business/help/133609753380850

Hasin Hayder, *Object-Oriented Programming with PHP5* (Packt Publishing Ltd, 2007)

www.google.com (search for "Volkswagen 'software device'")

"EPA, California Notify Volkswagen of Clean Air Act Violations / Carmaker allegedly used software that circumvents emissions testing for certain air pollutants," available at http://yosemite.epa.gov/opa/admpress.nsf/a883dc3da7094f97852572a00065d7d8/dfc8e33b5ab16 2b985257ec40057813b!OpenDocument

U.S Patent No. 6,032,223

V. Kreinovich, A. Bernat, E. Villa, Y. Mariscal, *"Parallel computers estimate errors caused by imprecise data,"* Interval Computations, 1991, No. 2, pp. 31–46. (available at http://ntrs.nasa.gov/search.jsp?R=19930068753)

http://windows.microsoft.com/en-us/windows7/memory-and-storage

http://www.pcmag.com/encyclopedia/term/63352/storage-vs-memory

http://www.technick.net/public/code/cp_dpage.php?aiocp_dp=guide_umg_01_003

http://www.tucows.com/article/593

Vermaat, M., Sebok, S., Freund, S., Campbell, J. and Frydenberg, M., "Discovering Computers" Cengage Learning (2016).