Using Future Internet Technologies to Strengthen Criminal Justice

Appendix

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TECHNICAL APPENDIX

During the in-person workshop, panelists brainstormed needs in small breakout groups. Panelists also were asked to specify the criminal justice communities of practice (law enforcement, courts, and corrections) for which each need was relevant. The result was a total of more than 90 needs.

The electronic panel was developed and implemented as follows: First, following the in-person workshop, RAND researchers reviewed the original set of more than 90 needs generated during the workshop and compressed the set into 45 needs by identifying sets of needs that were highly similar (same technology area, same underlying operational need) and then drafting new needs that captured the content of the needs in each set. RAND researchers also copy edited the language of the needs. The revised list was then circulated to the panelists electronically, and the panel had the chance to review and comment on the consolidated and edited list of needs. RAND then revised the list of needs in response to the panelists' comments. All comments received were administrative; no panelist disagreed with the needs consolidations.

Second, the panelists filled out Excel worksheets to rate the needs. Panelists were asked to rate each need on a scale of 1 to 9 (1 low, 9 high) with respect to the following questions:

- *Questions 1–3*: How important could this need be in supporting each criminal justice community (law enforcement/courts/corrections)?
  - High ratings (7 to 9) mean that the need is critically important to that criminal justice community of practice. Here "critically important" means that—assuming there are no technical or operational barriers to using the solution to the need—the solution to the need would have a *high impact* on furthering criminal justice objectives where it is used, and would be used *pervasively* across the relevant criminal justice communities. We would assign a 9 to the notable "game-changing criminal justice technologies" in recent years, each of which is associated with a 15-percent to 30-percent improvement in performance in a key criminal justice objective where it is used. Examples include the practice of hot spot policing (associated with average crime-reduction effects of more than 15 percent in the meta analysis found in Braga, Papachristos, and Hureau, 2012) and the use of body armor (could reduce officer fatalities by up to 30 percent, per Bir et al., 2011).
  - Medium ratings (4 to 6) mean that the need is important to that criminal justice community.

  - Low ratings (1 to 3) mean that the need is not that important to that criminal justice community.
- *Question 4*: What is the likelihood that this need could be successfully met from a technical perspective?
  - High ratings (7 to 9) mean that a path to overcoming technical barriers is clear and seems achievable (70-percent to 90-percent chance of success)
  - Medium ratings (4 to 6) mean that technical barriers are difficult and success is uncertain (40-percent to 60-percent chance of success)
  - Low ratings (1 to 3) mean that technical barriers are formidable and success requires a breakthrough (10-percent to 30-percent chance of success)
- *Question 5*: What is the likelihood that this need could be successfully met from an operational perspective?
  - High ratings (7 to 9) mean that a path to overcoming operational and deployment barriers is clear and seems achievable (70-percent to 90-percent chance of success).
  - Medium ratings (4 to 6) mean that operational and deployment barriers are difficult and success is uncertain (40-percent to 60-percent chance of success).
  - Low ratings (1 to 3) mean that operational and deployment barriers are formidable and success requires a breakthrough (10-percent to 30-percent chance of success).

- Here, "operational and deployment barriers" might include problems related to human factors, affordability, maintainability, organizational acceptance, legal/policy (privacy, civil rights, etc.), and security (hacking risks, etc.).

Panelists also had an opportunity to write comments about why they rated needs as they did. In all, 12 of the 16 panelists completed worksheets.

The ratings were used to construct an *expected value* score from each panelist for each need. Estimating expected value is the baseline approach in decision analysis for assessing the worth of selecting an option under uncertainty (see, for example, de Neufville, 1990, pp. 312–313); it is also the approach used in prior RAND research on criminal justice technology needs, as well as a line of similar research.[1] This is the potential value of the need (as measured by the importance ratings) multiplied by the estimated probabilities that the need could be addressed both technically and operationally. Specifically, the formula for the expected value score, $E\left(V_i\right)$, is

$$E\left(V_i\right) = \frac{p_{it}\,p_{id}\left(V_{il} + V_{ic} + V_{ir}\right)}{3},$$

where P_{it} and P_{id} are the probabilities of success from technical and operational perspectives, respectively, and V_{il}, V_{ic}, and V_{ir} reflect the importance of the need to the law enforcement, courts, and corrections communities, respectively. The 3 in the denominator is used to take the average of the importance of the need across all three communities of practice.

Since it also is important to identify those needs of importance to individual communities of practice, we also calculate expected value scores with respect to individual communities. So, for example, the expected value score with respect to law enforcement is

$$E\left(V_{il}\right) = p_{it}\,p_{id}\,V_{il}.$$

To create an overall expected value score, we took the median of all the panelists' individual expected value scores for

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[1] It is the method used in prior RAND studies on identifying and prioritizing criminal justice needs (Hollywood et al., 2015; Jackson et al., 2015; and Silberglitt et al., 2015). Prior to these studies, expected values were used in a series of related RAND studies to assess portfolios of investment options (Silberglitt and Sherry, 2002; Chow, Silberglitt, and Hiromoto, 2009; Silberglitt et al., 2004; and Landree et al., 2009). In our case, the "investment options" are taking action to address a specific criminal justice technology need.

each need. The median is used as it is robust—it estimates the center of the distribution in a way that is resistant to outliers and atypical distributions. Medians also do not require making any assumptions about the underlying statistical distribution of the scores.

The ratings were done in two rounds. Following the first round, the panelists had an opportunity to see a summary of the results along with the comments on each need. In the second round (the Delphi round), panelists then had an opportunity to re-rate the needs given the summary of ratings and comments from Round 1. (Note that the panelists could choose not to re-rate their needs.)

In presenting the results, we list all needs along with the ratings *tiers* into which they fall. Tiers divide the needs into three categories based on their expected value scores—tier 1 corresponds to comparatively high priority needs, tier 2 corresponds to medium priority needs, and tier 3 corresponds to comparatively low priority needs. Here, we employ the *K*-means clustering algorithm to group the needs into three categories by expected value. *K*-means is a predominant clustering algorithm that iteratively partitions data into *k* subsets in which each element is assigned to the subset with the closest mean. Notably, *k*-means is the only clustering algorithm in the Institute of Electrical and Electronics Engineers (IEEE) International Conference on Data Mining's "top ten data mining algorithms" (Wu et al., 2007). *K*-means is a heuristic algorithm for solving the following problem: Subdividing data elements into *k* sets such that the total of the squared differences between each data point and its cluster center (i.e., each cluster's average) is minimized. Mathematically, we want to divide the data points into sets 1, 2, . . . *K* so that the following measure is minimized:

$$\min \sum_{i=1}^{K} \sum_{x_j \text{ in set } i} \left\| x_j - \mu_i \right\|^2.$$

Here, μ_i is the center, or average, of cluster *i*. This measure, also called the *within-cluster sum of squares* or *cluster cohesion*, is one of the most common measures for assessing how effectively the data have been portioned into clusters overall. The reason a heuristic algorithm like *K*-means is used is that minimizing cluster cohesion is known to be hard to solve exactly (mathematically, it is NP-hard). The version of *K*-means used is the StatScicCalc online tool (Ahmed, 2014).

In addition to overall expected value, we specify tiers for expected value with respect to supporting each community of practice (law enforcement, courts, and corrections). *K*-means was used to divide those needs that were relevant to that com-

munity into three tiers, as well. (Needs that are not relevant to a community of practice are assigned to a "not applicable" tier.)

Figure A.1 shows the expected values overall and for each community of interest, along with what tier needs with given expected values are in. Note that *K*-means did find substantially differing numbers of Tier 1 needs for each community of practice. In the case of overall expected value and law enforcement, a good number of needs with similar expected values were clustered at the top, with comparatively few needs with much lower expected values clustered at the bottom. For corrections, however, that pattern was reversed.

The distribution of expected values for courts was between that of law enforcement and corrections. However, there were comparatively few needs that were considered relevant to courts (only 23 of 45).

The body of the report notes that the need to provide video connections to correctional facilities was a "breakout" need. Mathematically, it was an outlier as measured by Grubbs' Test (National Institute of Standards and Technology, undated) for both overall value (p-value < 0.047) and for corrections (p-value = 0.006). The Contchart Software web tool was used to perform Grubbs' Test (Contchart Software, undated).

In addition to computing expected value scores, the panelists frequently flagged particular needs as raising civil rights, privacy rights, or cyber security issues. We tracked which needs were flagged as raising one or more of these issues, as well. Privacy, civil rights, and security risks of the emerging technologies were major topics of discussion at the workshop and in the comments about the needs during the ratings rounds. While panelists did not specifically rate needs by their privacy, civil rights, and security implications, panelists explicitly considered these factors in their operational feasibility ratings.

Figure A.1. Expected Value Scores by Tier
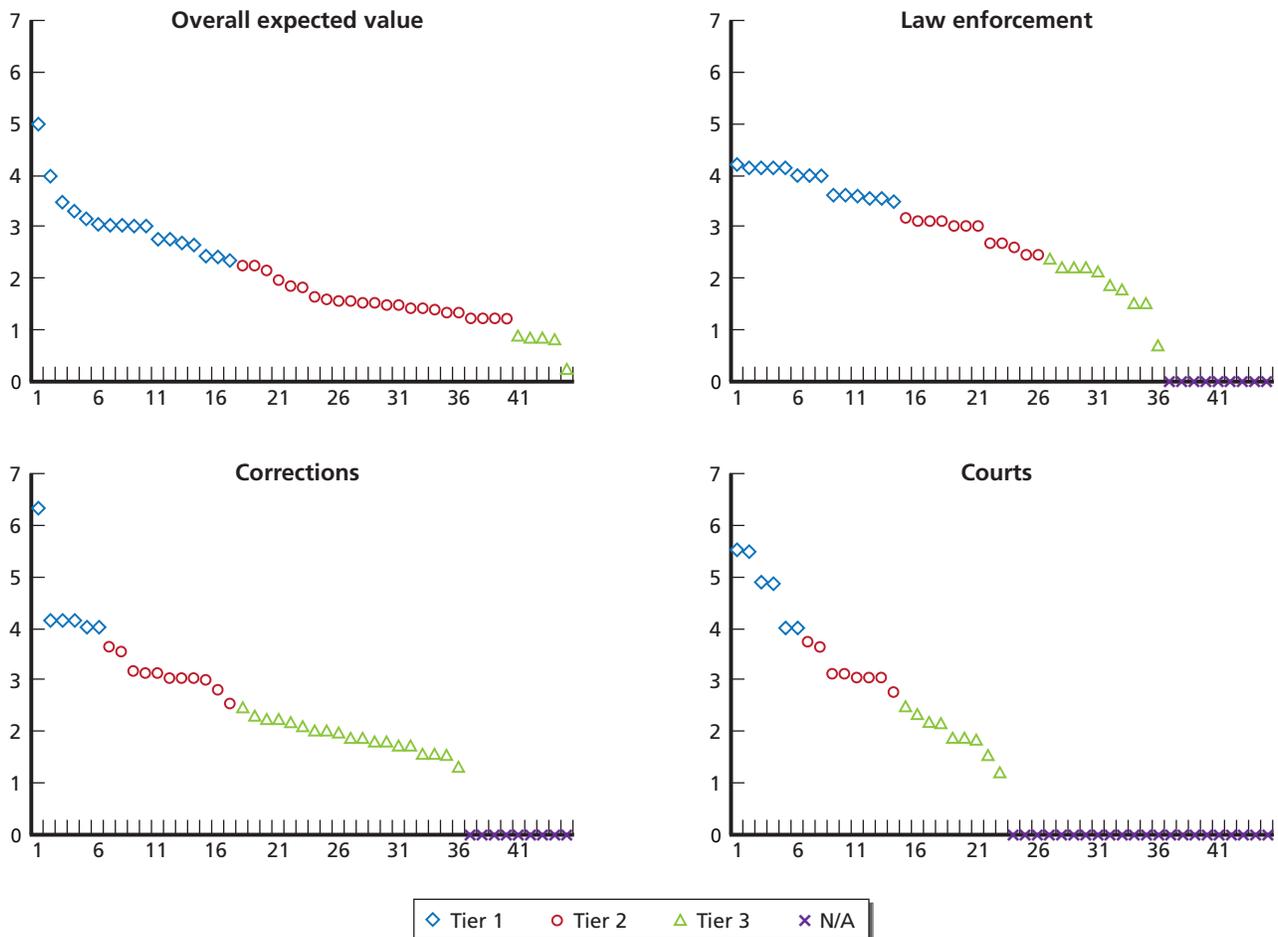
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